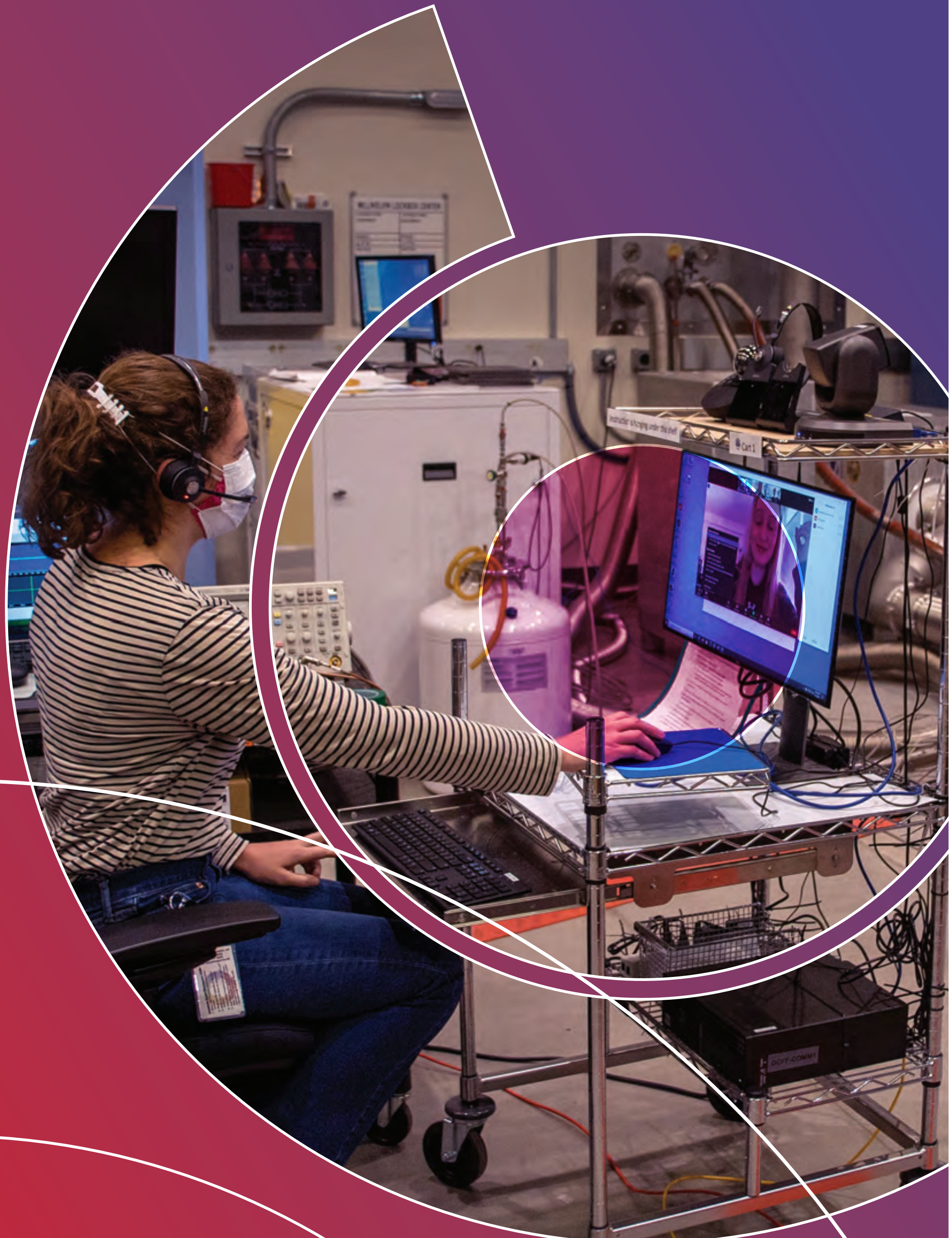

NATIONAL HIGH
MAGNETIC
FIELD LABORATORY

NationalMagLab.org

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Tallahassee, Fl 32310

2021 ANNUAL REPORT

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DIRECTOR'S EXECUTIVE SUMMARY

While 2021 was impacted by the continuing effects of the COVID-19 pandemic, it was also a year of cutting edge science, magnet milestones, and efforts to expand the STEM pipeline at the National High Magnetic Field Laboratory.

THE NSF-FUNDED MAGLAB USER PROGRAM

The MagLab continued to serve scientists from across the globe in 2021, advancing society's understanding of new materials, energy solutions, and the science that underlies life. More than 1,600 researchers, students and technicians conducted experiments across the lab in 2021 – many remotely due to continued impacts of COVID-19 on travel.

To meet user needs despite COVID, the lab created new opportunities for researchers to access our fleet of world-record magnets. Some users worked seamlessly with on-site user support scientists through collaboration carts, specially-created mobile carts with remotely-controlled cameras and communications to allow geographically-distant researchers the feeling of being on-site. Other users were able to remotely control their experiment, operating their magnet via the internet. And still others were able to access MagLab data sets to conduct their own independent research on previously-collected data. These new modes allowed the lab to operate at between 75 and 100 percent capacity thanks especially to the hard work and dedication of our in-house user support scientists who performed experiments on behalf of remote users.

Remarkably, the National MagLab's user community continued to expand with new researchers using the facility to investigate interdisciplinary scientific questions that span the spectrum – from physics to biology, chemistry to engineering. Of the 427 principal investigators in 2021, 23 percent were new to the MagLab user facility that they accessed to conduct their research. More than 45% of the lab's 2021 user community were students and postdocs, nearly 34% of whom identified as females and more than 9 percent who identified as a minority.

National MagLab users remained exceptionally positive about their experience in 2021. A user survey conducted in June continues to show overwhelming satisfaction:

- 95% external users are satisfied with the performance of the facilities and equipment
- 98% external users are satisfied with the assistance provided by technical staff
- 97% external users are satisfied with the proposal process

Across the National MagLab's seven user facilities, enhancements and upgrades were made in 2021 that improved the user experience and experimental environment. These enhancements included:

- A 600MHz wide bore system at AMRIS was upgraded to the latest generation Bruker NEO console, allowing multichannel transmit and receive experiments, while maintaining its full range of ^{19}F experiments and significantly expanding our MAS capabilities.
- The AMRIS 800MHz with dedicated 5mm Cryoprobe has been upgraded with an automated sample changer.
- All AMRIS NMR systems were modified to be run remotely by users.
- A 3.0T Philips Ingenia Elition X, 70cm bore MRI scanner at AMRIS is fully operational for users. It includes the latest acquisition techniques for human MRI research such as multinuclear capabilities, functional MRI, advanced diffusion imaging, magnetic resonance elastography, spectroscopy, and whole-body scanning.
- Progress continued in DC Field Facility to upgrade to the active filters on the four, 14MW power supplies. Stable operation of a single bank of MOSFET modules at an output current of 337.5A was achieved meeting the design goals for current and ripple. Thermal testing provided engineers with critical information and MagLab engineers are working to further optimize the heat transfer between the MOSFETs and the heat sink.
- Significant progress was made in the ongoing effort to increase the signal-to-noise ratio for FIR measurements in DC Field's 35T magnet system. A new low-noise preamplifier that can be mounted directly to the top of the probe was designed and built resulting in an 87% decrease in the observed electrical noise. The bolometer circuitry and resistor were also redesigned yielding a factor of 8 reduction in the measured dark signal noise at 35T.
- A torque magnetometer was developed for high magnetic moment, anisotropic samples which is able to measure the absolute value of torque generated, thereby providing the absolute value of the magnetic moment of the sample being measured.
- Development of a rudimentary 950GHz / 36T EPR setup for use in the Series Connected Hybrid (SCH) resonance magnet within the DC-field facility was completed.
- A major upgrade of the EMR user interface on the HiPER spectrometer was undertaken, including software advances that enable generation of arbitrary shaped high-power waveforms.
- The ICR facility reported significant improvements in sequence coverage and detection sensitivity of higher molecular weight proteoforms with PTR and PIP performed at 21T compared to conventional methods. A dramatic S/N enhancement and spectral simplification brought about by PTR improved sequence coverage from 12% to 39%.

- The 600 DNP instrument has been improved via modification of the commercial hardware, the purchase of a better cold gas transfer line, and the continued in-house development of MAS-DNP NMR probes.
- A benchtop EPR spectrometer and tabletop MAS spinner for sample screening were installed to the DNP system to improve the instrument's runtime and improve sample preparation. The benchtop EPR is also key for assessing the distribution of the biradicals, their interactions with the substrate, and if they undergo decay.
- Probe advances in 2021 include a 3.2mm HXY MAS low-E probe for unreceptive low-γ nuclei research on the 36T-SCH; a 3.2mm middle-γ MAS probe that has been rebuilt with new RF coils designed to deliver stronger decoupling for biological experiments and to improve S/N for nuclei in the 377-481MHz range; a 1.3mm HXY MAS low-E probe or 800#1, 800#2 and a 1.3mm HXY MAS low-E probe for the 36T-SCH; and new DNP probes.
- The 900-UWB console is in the process of being upgraded with a NEO console and new state-of-the-art gradient and shim systems (450V/300A), with shimming capabilities for *in vivo* MRI/S.
- Upgrades were made to the Pulsed Field Facility's 4MJ bank including on the cabling and ground hooks, software and new bus arrangements that will enable the 8 modules of the bank to be fired in an additional configuration.
- Efforts to return the 1.4GW LANL motor generator to service saw several key milestones reached, the largest of which included bringing subcontractors onsite for a major 8-week maintenance effort featuring the removal, cleaning, and re-installation of the coolers, re-assembly of the oil system closure, and a large battery of electrical tests on the entire system, many of which are still ongoing.
- The PFF performed a series of inspections and tests on the motor generator's remaining major component, the stator, including thorough visual examination, mechanical inspections of wedges and other internal fasteners, borescope inspections of the cooling passages, and epoxy inspections, all of which identified no issues.
- Efforts on the generator axillaries also continued this year, with the new Drive and Exciter in place.

USER RESEARCH

More than 400 articles appeared in peer-reviewed scientific and engineering journals in many in significant journals like *Science, Nature, Physical Review Letters, Energy & Fuels, Analytical Chemistry,* and the *Proceedings of the National Academy of Sciences*. A complete database of user publications can be found at https://nationalmaglab.org/research/publications-all/peer-reviewed-publications. Important discoveries include:

- Using both 65T and 75T magnets at the Pulsed Field Facility to study the Hall effect of the unconventional superconductor $CeCoIn_5$, a material closely related to high-temperature-superconducting cuprates. A change in the carrier concentration was observed as the doping of the material changed, resulting in a quantum phase transition without any evidence of a broken symmetry. These findings are important because they provide vital clues on the path to understanding high temperature superconductivity and the effect of being in close proximity to a quantum phase transition may play.
- The NMR/MRI Facility is collaborating with the ICR Facility on a new series of environmentally related projects, with the first publication describing the characterization of Kentucky bluegrass biochar constituents using DNP NMR and FT-ICR MS
- DC Field users from Cornell University explored the possibility of using the epitaxially grown materials NbN and GaN in combination as a potential host for topological superconductivity.
- The outstanding sensitivity of the ^{13}C HTS probe at the AMRIS Facility allowed acquisition from a single pupa, enabling a study on metabolism cycles during insect dormancy using multiple tracers in a time efficient manner.
- The search for a better understanding of the mechanism behind exchange bias in magnetic materials was undertaken by MagLab users in the DC Field Facility from the University of California, Berkeley with the study of Fe_xNbS_2 via NMR and magnetization at high fields. The investigation yielded surprising results that showed the magnitude of the exchange bias observed in Fe_xNbS_2 is a factor of 100 larger than what has been observed previously in engineered thin film materials.
- ICR PTR-MS1-PIP technology was used to analyze proteins recovered from *H. sapiens* MCF7 (breast cancer) cell lysate by LC-MS at 21T. The total number of proteoforms detected following automated peak deconvolution and chromatographic clustering improved by greater than 75%.
- Stabilization of the elusive benzene radical dianion with a magnetic ground state in which the two unpaired electrons align their magnetic moments, giving rise to triplet ground state. High-field EPR studies were employed in order to confirm the magnetic state of this unusual molecule. This study demonstrates how coordination chemistry may be leveraged to stabilize a desired electronic state in an organic molecule.
- EMR users focused on one of the first metal-metal bonded single molecule magnets, an Fe_6 cluster that may be thought of as a tiny fragment of elemental iron. Very strong exchange coupling between the 19 associated unpaired electrons gives rise to a robust total spin moment which is maintained all the way to room temperature. Detailed EPR measurements were performed at unprecedented high frequencies to gain unique microscopic insights into the strongly coupled nature of the electron spins in the core of the Fe_6 molecule. The results suggest strategies for developing polynuclear SMMs with polarizable metal-metal bonds for future magnetoelectric applications.

- In the triangular-lattice antiferromagnet $NdTa_7O_{19}$, EMR users determined that its magnetic ground state gives rise to spin excitations persisting down to the lowest accessible temperature of 40 mK, demonstrating the key role of strong spin–orbit coupling in stabilizing spin liquids that result from magnetic anisotropy and highlights the large family of rare-earth (RE) heptatantalates $RETa_7O_{19}$ as a framework for realization of these states, which represent a promising platform for quantum applications.
- To understand restoration of breathing after drug overdose and spinal cord injuries, MRI was used to monitor neurological and physiological behavior in healthy and spinal cord injury rat models using the 4.7T scanner at the AMRIS Facility. The MRI scanner was used to determine placement of intramuscular electrodes relative to spinal segments in order to determine which electrode locations, waveforms, and configurations could sufficiently activate the diaphragm while reducing off target effects, such as forelimb muscle activation.
- ICR users characterized the initial formulations and resulting dissolved photoproducts of four single-use consumer polyethylene bags from major retailers and one pure PE film and found that sunlight exposure consistently increased production of dissolved organic carbon (DOC), findings that suggest that plastic formulation, especially TiO_2, plays a determining role in the amount and composition of DOC generated by sunlight.
- High B/T demonstrated successful operation of scalable thermometers based on quartz tuning fork resonators immersed in liquid 3He operation at the combined extreme conditions available at our user facility and are exploring the feasibility of fast and compact thermal probes.
- The 21T FT-ICR MS expanded its biological research in 2021 to include proteomic analyses of rare proteoforms involved in cancer, construction of proteoform families by accurate intact mass, and rapid and accurate diagnosis of hemoglobinopathies from 1 µL of blood. Hemoglobinopathies are one of the most prevalent genetic disorders, affecting millions throughout the world. Caused by pathogenic variants in genes that control the production of hemoglobin (Hb) subunits, it has become more challenging to obtain unambiguous results from routine chromatographic assays employed in the clinical laboratory. Top-down proteomic analysis of Hb by FT-ICR MS is a definitive method to directly characterize the sequences of intact subunits.
- Ultra-High Resolution Mass Spectrometry combined with *in vivo* metabolic labeling of follicle lipids with deuterated water can provide unequivocal identification of de novo lipid species during ovarian development. Using liquid chromatography in tandem with the 14.5T Fourier Transform Ion Cyclotron Resonance Mass Spectrometer, researchers found that ovarian lipids are consumed or recycled during the PVG stage, with variable time dynamics, results that provide further evidence of the complexity of the molecular mechanism of follicular lipid dynamics during oogenesis in mosquitoes.
- Scientists at the PFF studied the magnetically frustrated mineral atacamite ($Cu_2Cl(OH)_3$), whose magnetic structure finds the magnet moment-carrying copper ions arranged in a chain of triangles resembling a saw blade. The experiment showed a surprising result that deviated from theoretical predictions; a large plateau-like region above 35T that was much wider than expected and in an unexpected magnetic field range, implying that the existing theoretical model is insufficient to describe the interactions of the system.
- ^{27}Al (*I* = 5/2) MAS NMR spectra of dehydrated H-ZSM-5 catalysts were used to study framework and coordinated-framework Al sites; the high resolution only obtainable on the 36T-SCH provided, for the first time, detailed structural characterization of the latter, which are crucial for determining optimal catalytic reaction condition.
- Two NMR studies completed in 2021 will produce exciting publications in 2022, including a landmark study on the NMR crystallography of a tryptophan synthase α-aminoacrylate intermediate and the first high-resolution ^{17}O MQMAS NMR spectra of fully ^{17}O-enriched α-D-glucose.
- In NMR, the first application of Neurite Orientation Dispersion and Density Imaging (NODDI) was performed at 21.1T to evaluate the efficacy of stem cell therapy.
- A multinuclear (^{1}H/^{13}C/^{15}N) NMR investigation of the dynamics and interactions of the SARS-CoV-2 N protein N-terminal region with other regions of the protein as well as interacting partners including RNA and CypA host cells
- DNP NMR on ^{17}O was used to study the mechanochemical ^{17}O enrichment of silica surfaces.
- DNP NMR studies (largely focusing on ^{13}C and ^{15}N) were conducted on materials in plant cell walls like lignocellulose and polysaccharides (including experiments at natural abundance biomaterials, in bones and cartilage-like collagen and to aid in the aforementioned NMR crystallographic determination of tryptophan synthase α-aminoacrylate intermediate.

MAGNET-MAKING MILESTONES

In September 2021, a $15.8M grant from NSF's Mid-Scale Research Infrastructure 1 program was awarded to the MagLab to fund the Preliminary and Final Designs of a new all superconducting 40T magnet system (Award number: NSF/DMR 2131790). The 40T magnet will be a 12T Low Temperature Superconducting (LTS) magnet of 320mm cold bore and a 28T HTS insert. The LTS magnet will be acquired commercially. The 28T HTS insert will use REBCO tape conductor wound into double-pancakes and will be developed in-house. Several test coils were designed, built and used this year to further investigate winding technology, quench protection and axial compression. After completion of the mid-scale test coils, the insulation technology for the 40T magnet will be selected, completing the first major milestone of the project.

A Pulsed "Magnet Surge" has accelerated the recent development of capacitor-driven magnets. After the successful 75T duplex magnet for user operations, the pulsed surge focused on the design and production of a mid-pulse magnet to reach fields around 60T at a slower rate than current short-pulse magnets. The first magnet was tested to 56T in June 2021 and has been serving users since then with fields up to 55T with total pulse length of about 300ms. Engineers are now pursuing an 80T+ pulsed magnet that is expected to be operational in 2022. In 2021, more than 5,500 pulses over 60T were provided to users.

Additionally, in-house research includes improvements to our Yatestar device for quality assurance as well as a novel characterization approach based on torque magnetometry that allows for quick measurement of critical current in REBCO tape in 2 to 4 hours instead of weeks and with far less LHe than other processes. It also enables measurements to be performed at a range of fields (up to 35T to date) and temperatures (4K and 55K). A new Over Pressure Heat Treatment furnace is now in commissioning and will provide an increase in processing volume by a factor of 10 and accommodate larger accelerator model coils and solenoids with larger outer diameters. The furnace will operate solely at a pressure of 50 bar.

Beyond these in-house magnet projects, other magnet development work includes collaborations with the Spallation Neutron Source (SNS) at Oak Ridge National Lab, Cryomagnetics, and others:

- An STTR Phase I grant funded by the Department of Energy Office of High Energy Physics (DOE-HEP) is underway with Cryomagnetics Inc. The goals of this Phase I project include developing a viable design of a 30T class commercial all-superconducting magnet based on REBCO superconducting tape.
- The development of compact 25T, all superconducting, general science magnets, a project that we are currently working on in collaboration with Cryomagnetics Inc. and with additional financial support through the Department of Energy (DOE). The final magnet system will consist of a 17T low temperature superconducting (LTS) outsert with an 8T Bi-2212 coil nested inside.
- In anticipation of a grant through the National Institute of Health (NIH) for a 28T UHF magnet system, we started working on a scoping design for a magnet system in collaboration with Oxford Instruments Nano Science (OINS).
- In collaboration with Princeton Plasma Physics Laboratory (PPPL) and Advanced Superconductor Technology (ACT), an experiment is currently under preparation to characterize the fatigue behavior of a CORC™ cable wound solenoid made by ACT
- Continued efforts on the application of Rutherford type cabled Bi-2212 round wire for low inductance and high current magnets including both high field solenoids and accelerator magnets for the HEP community. In 2021, the MagLab built a first Bi-2212 Rutherford-cable-based solenoid. The 10m long cable, in a nine-strand configuration, was supplied by collaborators at LBNL and generated 1.6T in an 8T background field. Next steps will focus on a dedicated cable insulation coating route to produce a TiO_2 coating in cables.
- We are utilizing model developments by collaborators at the Conseil Européen pour la Recherche Nucléaire (CERN) to expedite model building and scale-up to quickly discriminate between protection schemes with models that can be further refined to implement circuit interactions including LTS coupling and nonlinear elements like varistors.

BROADENING PARTICIPATION & EXPANDING THE STEM PIPELINE

Work to broaden participation in and appreciation of STEM continued in 2021 at the MagLab. For the first time in MagLab history, Open House was offered virtually and expanded to feature a collection of live virtual events, video demonstrations, behind-the-scenes/all-access video tours and web-based games for all ages. In total, more than 11,000 people attended, watched, played or participated during the two week event, including participants from across the US and 13 international countries.

At the K-12 level, virtual classroom outreach was provided to 1,820 students from seven states during the 2020-2021 school year. Summer Camps were all held virtually in 2021 reaching 75 middle-school aged students. A partnership developed with Florida Agricultural and Mechanical University Developmental Research School to host a session of SciGirls Coding Camp. The high school externship program paired 11 Tallahassee high schoolers with a mentor at the MagLab to work on a STEM project. More than 85% of the participants said the externship program increased their interest in studying science in college, and 71% said they will pursue a career in a STEM field. A virtual Research Experiences for Teachers program worked to help 21 educators incorporate culturally-responsive teaching strategies into their STEM lessons. All participants taught in Title I schools or worked with low-income youth in five diverse states, and nearly 95% of participants said the program made them a more effective STEM teacher

The 2021 Research Experiences for Undergraduates program reached 20 local students with their own housing or non-local students who participated virtually. Participants were relatively divided across undergraduate stages and represented a variety of majors: 20.0% physical science, 45.0% engineering, 20.0% life sciences, 15.0% math and social/behavior. In addition, more than 45 PhDs and 10 masters degrees were supported at the lab in 2021. Within the Diversity Committee's partnership with CIRL, an expansion of the FSUIntern program has funded several students from neighboring minority serving institutions, including Tallahassee Community College and Florida Agricultural and Mechanical University.

In 2021, MagLab staff gave 191 lectures, talks and presentations to organizations around the country and the world. Due to the ongoing effects of COVID-19, many national and international meetings were hosted virtually or were offered as hybrid experiences. As such, nearly 80% of the 2021 MagLab presentations were conducted virtually. In addition, five virtual workshops and conferences were hosted by the lab in 2021 reaching close to 400 people, including the User Summer School in which 32 attendees received presentations on experimental techniques given by MagLab scientific staff and industry scientists.

SECURING A HEALTHY, SAFE & INCLUSIVE LAB ENVIRONMENT

With the continuation of the COVID-19 pandemic, the MagLab worked in partnership with its host institutions to protect users, employees, visitors and the community. COVID-specific training was updated as CDC recommendations evolved and staff and users were required to complete before entry was permitted.

In 2021, the MagLab strategically invested around $190,000 for safety-related equipment, supplies, security, training, and processes. Some of the key investments included personal protective equipment, equipment used to lockout/tagout and verify hazardous energy sources, surveillance cameras, monitoring devices, and COVID-19 related supplies. In addition, an alarm system to check for the presence of R-1233ZD was installed to warn workers if a small leak or unplanned event occurred. Engineering controls were also designed and installed to mitigate an oxygen deficient hazard by both actively and passively dispersing refrigerant safely in the event of an emergency. An annual maintenance shutdown safely allowed for the repair of magnet power disconnects, regeneration of the water treatment resin, breaker and transformer testing, and upgrades to the power supply, helium liquefier, capacitor yard, chiller, and pump.

User safety also remains a key goal. Before coming to the lab, users are assigned online training specific to the experiment they are conducting and the hazards associated with each facility. When they arrive on-site, they receive additional hands-on training as needed and work with on-site user support staff to complete their experiments safely. In 2021, 95% of external users were satisfied or very satisfied with the lab's user training and safety procedures and 100% were satisfied or very satisfied with overall safety at the MagLab.

MagLab staff attended several train-the-trainer style workshops in 2021 to help create a more inclusive lab: One such workshop was hosted by the Center for the Improvement of Mentored Experiences in Research (CIMER) and trained five MagLab facilitators to provide mentorship skills training. Another workshop was led by the Center for Women and Work (CWW) at the University of Massachusetts Lowell and provided invaluable experience in acknowledging and confronting microaggressions in the workplace. In 2021, three faculty searches were completed successfully, two of which selected candidates that increased the diversity of our staff.

LOOKING AHEAD

As the lab looks ahead, more exciting technology, magnets, programs and partnerships will continue to advance high magnetic field research.

Eight new secondary chilled water pumps will be installed in our DC Magnet Facility during 2022 to circulate water produced by the chillers through the magnet cooling water heat exchangers. The pumps will have soft-start capabilities that allow the pump speed to be ramped up slowly, extending the life of the pump and improving the temperature stability of the DC Magnet cooling water loops as the pumps turn on and off depending on the heat load.

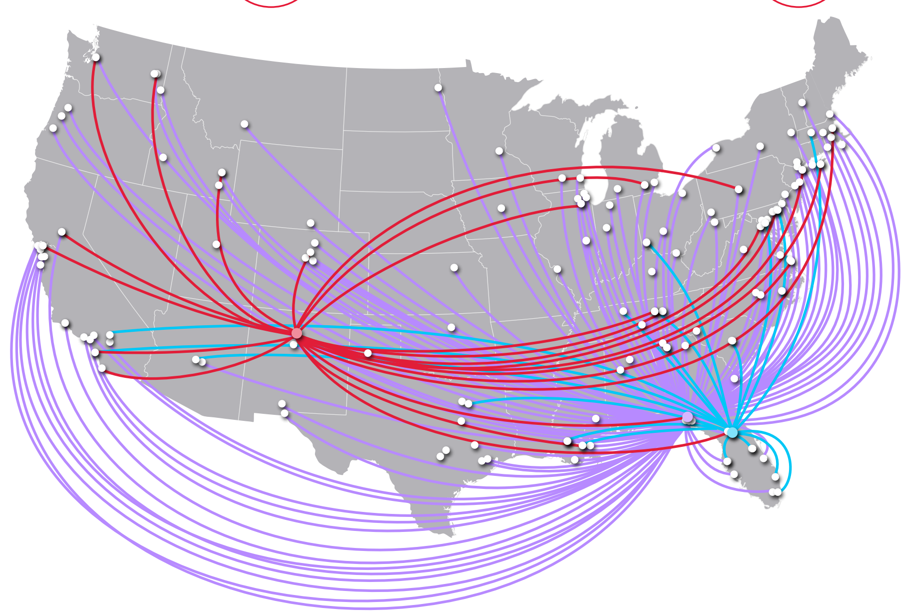
Pulsed Field Facility plans to commission a new 30kV 1.2MJ capacitor bank in 2022. This capacitor bank, funded via NSF for the Magnet Surge, is designed to be integrated with the 4MJ capacitor bank to provide power for the next generation of duplex magnets in excess of 80T. A design for an 85T magnet to be energized by existing 4MJ and 2MJ capacitor banks is nearly finalized and the building and commissioning of this 85T magnet is anticipated to be completed in 2022. Development of such a magnet will allow us to perform crucial preliminary R&D steps both to prove the magnet technology, but also demonstrate feasibility of data acquisition in such a fast-rise pulse prior to the design phase of a future pulsed magnet exceeding 101T.

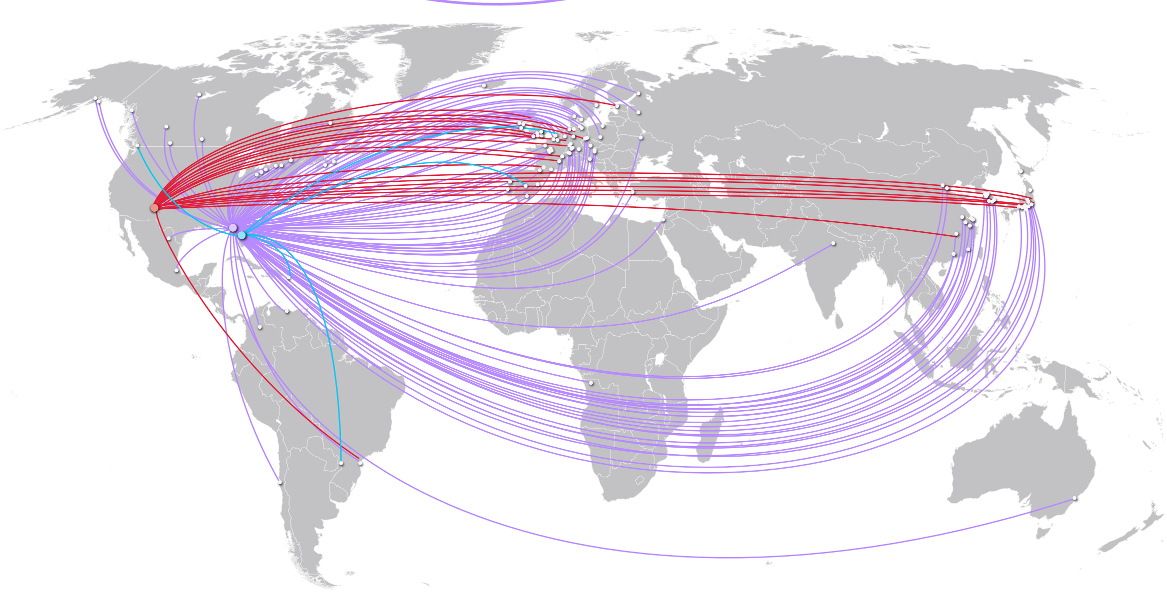
A single-channel X Magic Angle Spinning NMR prototype probe for the 32T-SCM was constructed and tested in the NMR Facility, paving the way for the design in 2022-23 of a low-temperature HX static NMR probe for this unique magnet platform located in the MagLab's DC Magnet Facility. AMRIS and NMR will also continue planning for a national network of Ultra-High-Field NMR instruments (28.2T/1.2GHz) with colleagues from five other universities across the U.S.

SCIENCE KNOWS NO BOUNDARIES

Seeking the most powerful magnetic fields on Earth, scientists and engineers from around the world conduct their experiments at the National MagLab. In 2021, our **1,615** users represented **279** universities, government labs and private companies worldwide.

76% UNIVERSITIES **16%** GOVERNMENT LABS **8%** INDUSTRY





2021 LAB STATS

USERS:
1,615

PERCENTAGE OF USERS WHO WERE NEW:
21%

ARTICLES PUBLISHED IN PEER-REVIEWED JOURNALS:
404

TALKS, LECTURES AND PRESENTATIONS GIVEN TO ORGANIZATIONS AROUND THE COUNTRY & WORLD:
191

MAGLAB WORLD RECORDS:
17

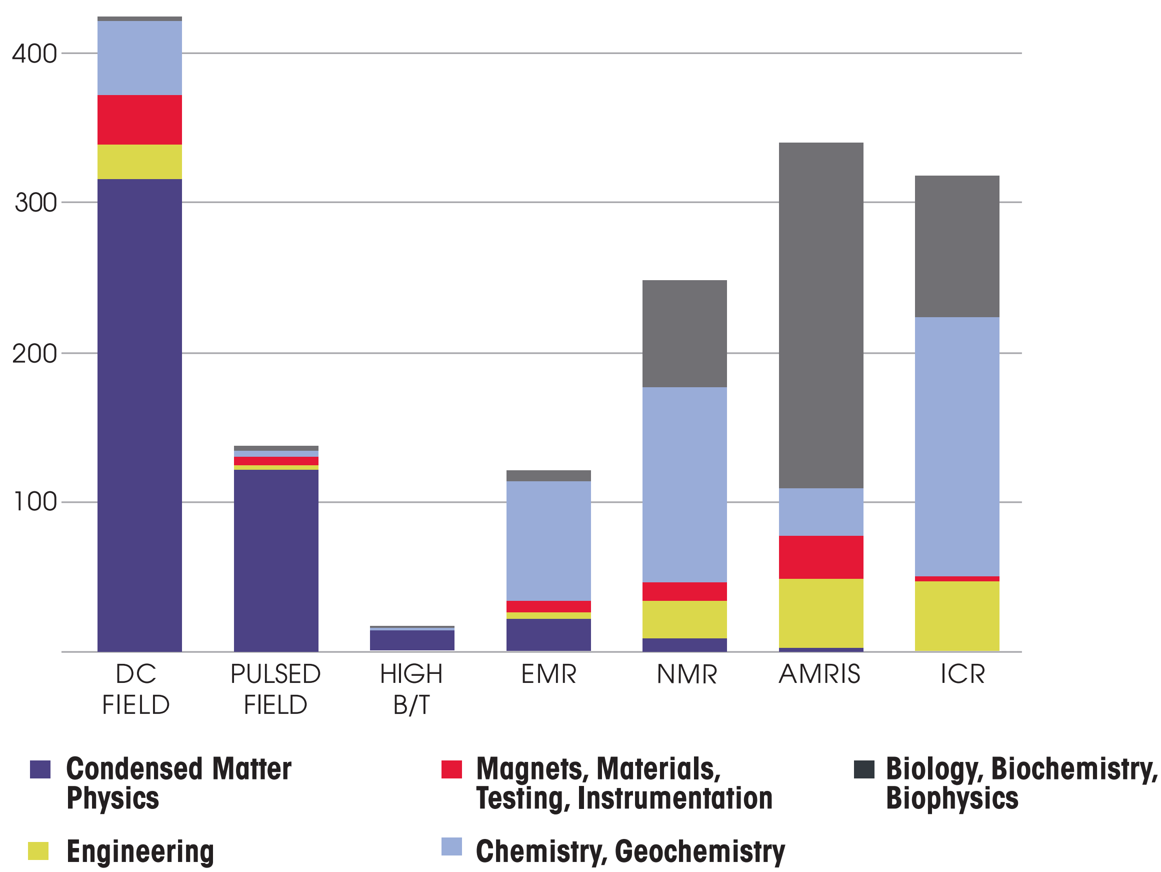
PERCENTAGE OF TALKS GIVEN VIRTUALLY:
79%

WHO OUR USERS ARE

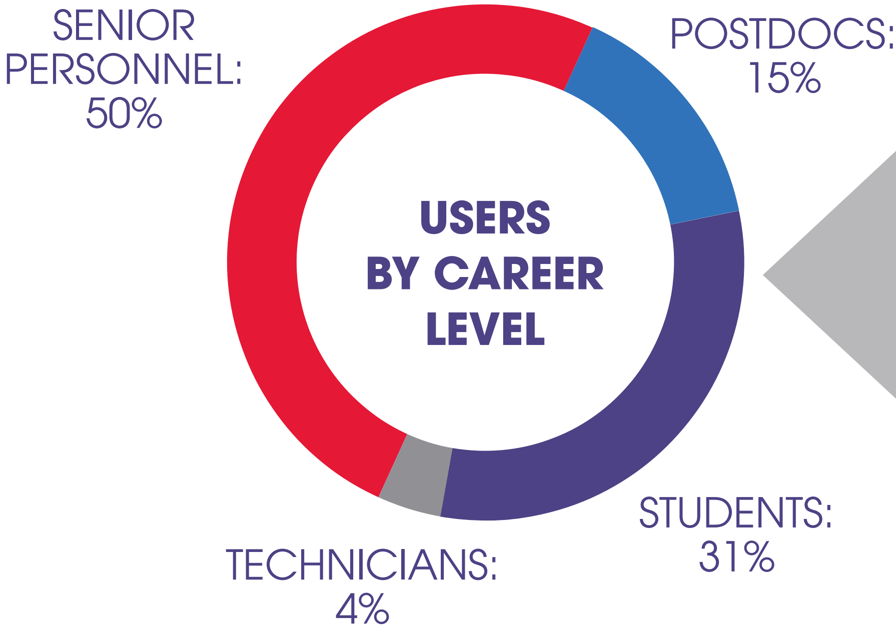
High magnetic fields are a powerful research tool across many disciplines leading to groundbreaking discoveries that impact your life. The lab comprises 7 distinct user facilities that offer our researchers a wide range of research capabilities:

- **DC Field**
  Steady, continuous magnetic fields up to 45 T
- **Pulsed Field**
  Short, ultra-powerful magnetic fields up to 100 T
- **High B/T**
  Magnetic fields up to 15 T combined with ultra-cold temperatures of 0.4 mK
- **Electron Magnetic Resonance (EMR)**
  Magnetic resonance techniques associated with the electron
- **Nuclear Magnetic Resonance (NMR)**
  Solid & solution state NMR & animal imaging
- **Advanced Magnetic Resonance Imaging & Spectroscopy (AMRIS)**
  High-resolution solution and solid-state, NMR, animal imaging & human imaging
- **Ion Cyclotron Resonance (ICR)**
  Ultra-high resolution and high mass accuracy Fourier transform ion cyclotron resonance (FT-ICR) mass spectrometry

2021 USERS BY DISCIPLINE



34% OF STUDENT USERS ARE FEMALE. & **33%** OF POSTDOC USERS ARE FEMALE.



USERS BY FACILITY

- DC FIELD - **434**
- PULSED FIELD - **137**
- HIGH B/T - **17**
- EMR - **121**
- NMR - **248**
- AMRIS - **340**
- ICR - **318**

WHAT OUR USERS SAY

95% of users were satisfied with performance of the facilities and equipment.

98% of users were satisfied with the assistance provided by MagLab technical staff.

96% of users were satisfied with the proposal process.

Data reflects external users only.

MAGLAB STAFF

The MagLab employs a diverse workforce that includes scientists, machinists, engineers, administrators, writers and even artists.

Total MagLab Staff: **751**

- Senior Personnel: **239**
- Other Professional: **85**
- Support Staff - Technical: **117**
- Support Staff - Secretarial: **29**
- Postdoctoral: **50**
- Graduate Student: **170**
- Undergraduate Student: **61**

41% of MagLab students are female.

SPARKING CURIOSITY

Whether in a traditional classroom setting or on our website, within the walls of our lab or in universities around the globe, the National MagLab is committed to sharing our passion for science. We are growing the next generation of scientists and inspiring all individuals about the magic of discovery in high magnetic fields.

1,950+

K-12 students participated in Classroom Outreach. **60%** of the classrooms reached are from Title I schools.

54

scientists & staff reported conducting outreach to the community. Together, these scientists reached **2,825+** people.

1.64 MILLION+

website **pageviews**

105+

Students in long-term mentorship or camp programs.

55 THOUSAND+

hours of MagLab video content watched on YouTube.

1. LABORATORY MANAGEMENT

1.1 ORGANIZATION

The Florida State University (FSU), the University of Florida (UF) and Los Alamos National Laboratory (LANL) jointly operate the National High Magnetic Field Laboratory (NHMFL or MagLab) for the National Science Foundation (NSF) under a cooperative agreement that establishes the MagLab's goals and objectives. As the signatory of the agreement, FSU is responsible for establishing and maintaining administrative and financial oversight of the MagLab and ensuring that the operations are in line with the objectives outlined in the cooperative agreement.

The structure of the MagLab is shown in the three figures below. **Figure 1.1.1** illustrates the external oversight and advisory committees, as well as the three internal committees that provide guidance to MagLab leadership.

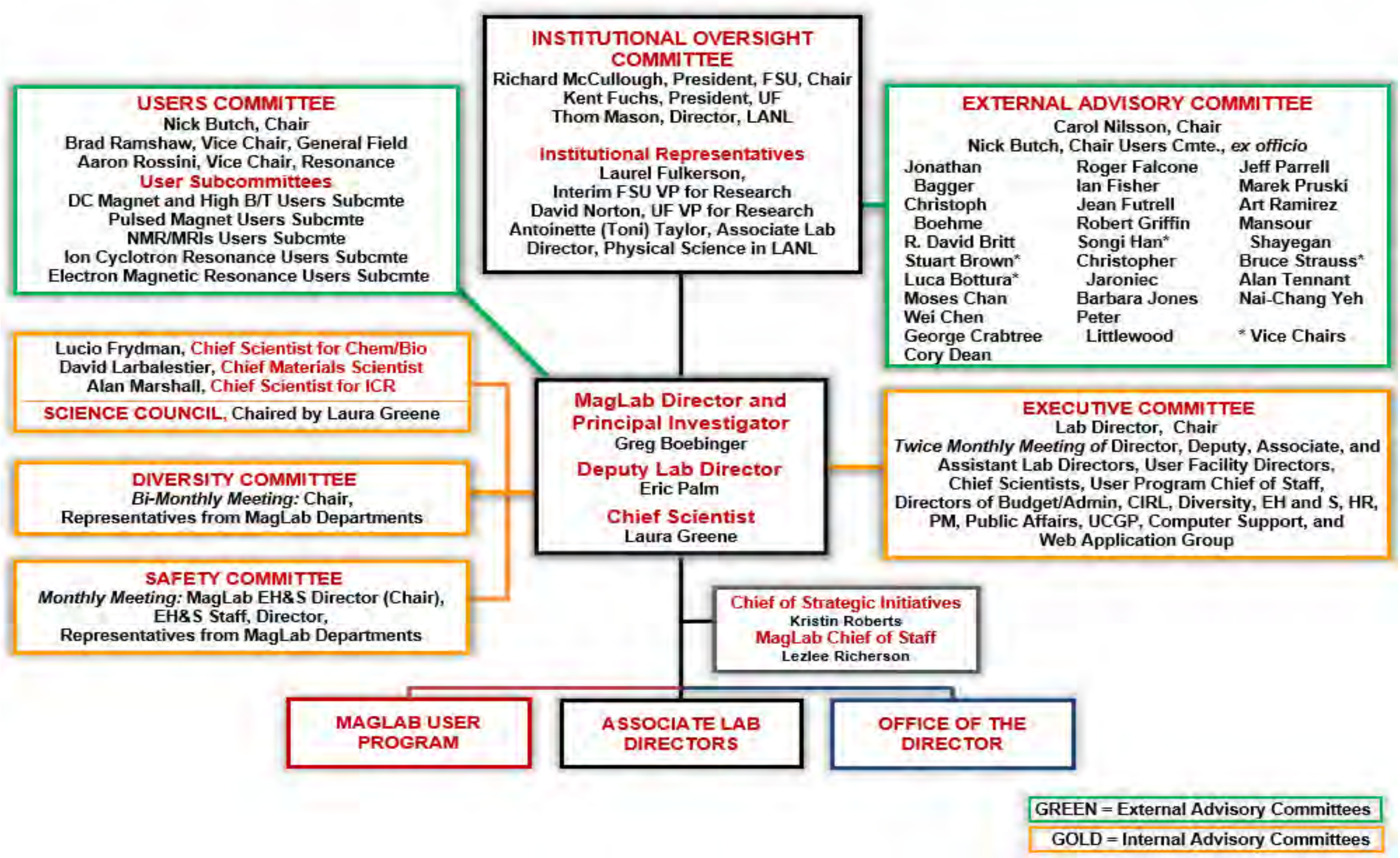


Figure 1.1.1: *Advisory Committees of the MagLab, showing internal and external advisory committees (as of December 2021).*

Greg Boebinger is the Director of the MagLab and PI of the cooperative agreement. Together, the Director, Deputy Laboratory Director, **Eric Palm,** and Chief Scientist, **Laura Greene**, function as a team to provide management oversight. **Lab Leadership —** consists of the MagLab Director, Deputy Lab Director, Chief Scientists, Associate Lab Directors and MagLab Facility Directors.

The **Executive Committee** meets monthly to discuss Lab-wide as well as program-specific issues. The Lab's scientific direction is overseen by the **Science Council**, a multidisciplinary "think tank" group of distinguished faculties from all three sites. Two external committees meet regularly to provide critical advice on important issues. The **External Advisory Committee**, made up of representatives from academia, government, and industry, offers advice on matters critical to the successful management of the Lab. The **User Committee**, which reflects the broad range of scientists who conduct research at the Lab, provides guidance on the development and use of facilities and services in support of the work of those scientists. These committees are further described below.

Figure 1.1.2 shows the structure of the user program with its seven user facilities – DC Field Facility, Pulsed Field Facility, High B/T Facility, Electron Magnetic Resonance Facility, Nuclear Magnetic Resonance and Magnetic Resonance Imaging at both FSU and UF, and Ion Cyclotron Resonance.

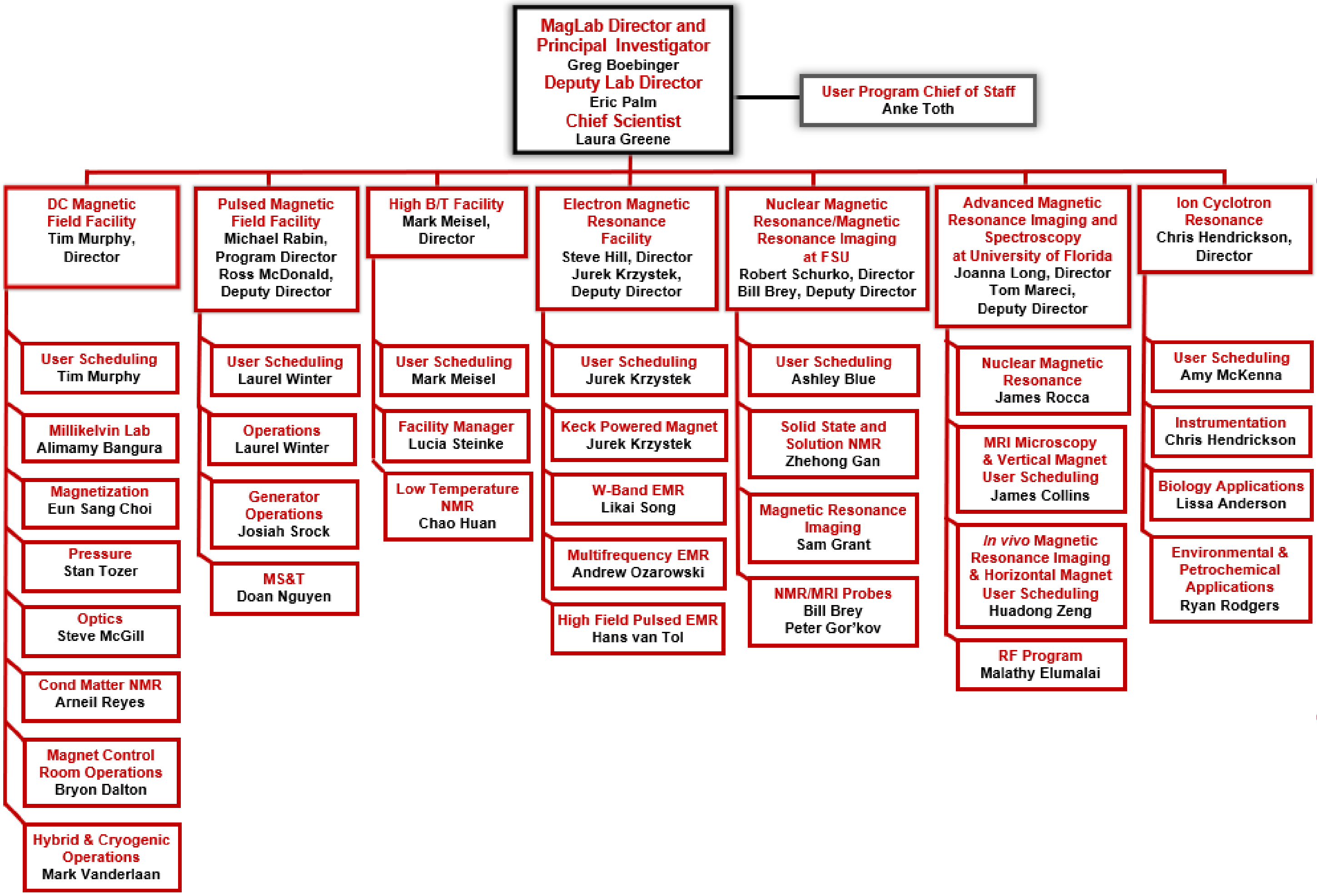


Figure 1.1.2: *MagLab User Program (as of December 2021)*

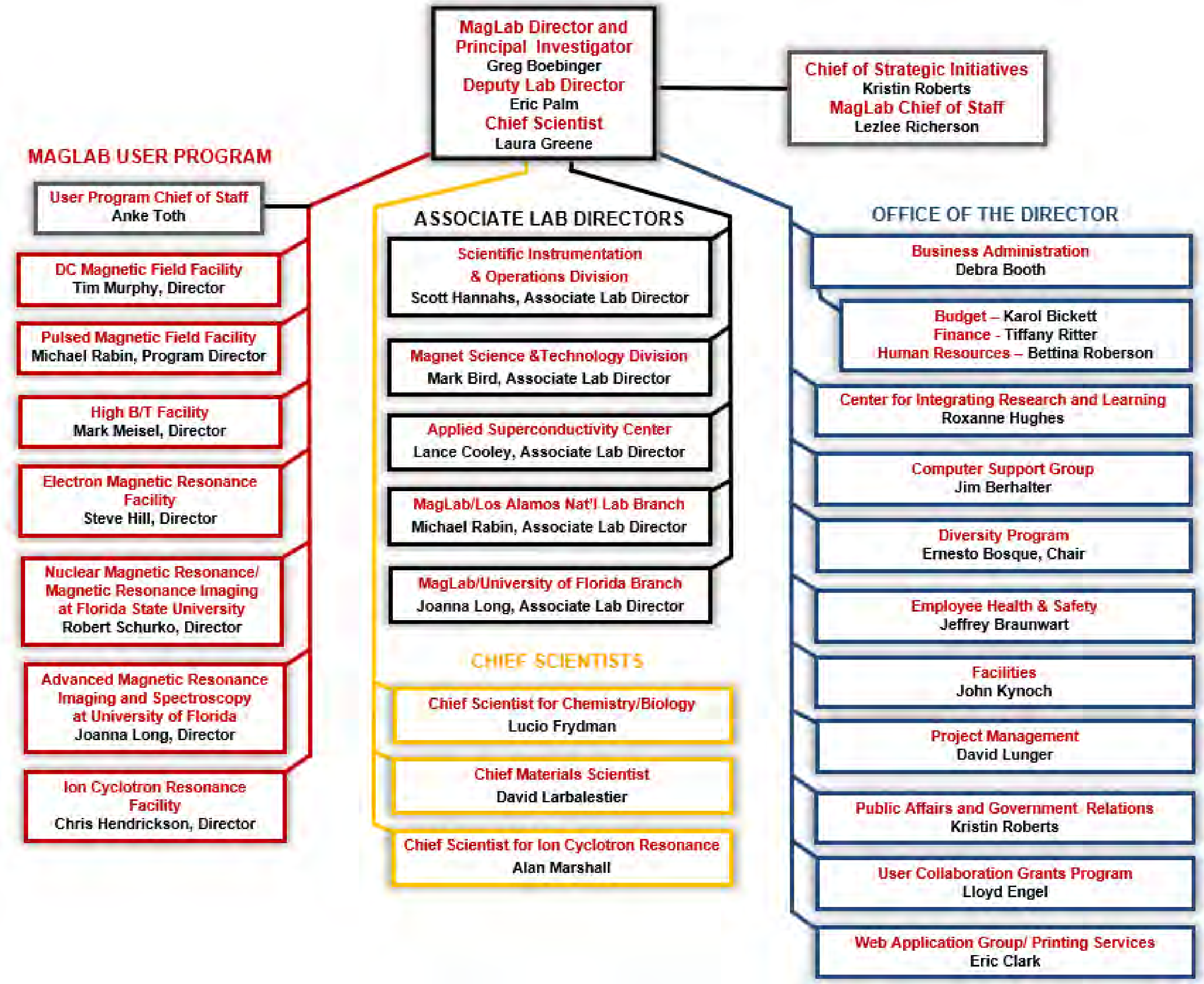


Figure 1.1.3: *MagLab Organizational Chart (as of December 2021)*

Figure 1.1.3 displays the internal operational organization of the MagLab including the seven user facilities, all Associate Lab Directors, and the Office of the Director structure.

1.2 EXTERNAL ADVISORY COMMITTEE

The External Advisory Committee is made up of representatives from academia, government and industry. This committee offers advice on matters critical to the successful management of the lab.

External Advisory Committee Chair
- Carol Nilsson—Swedish National Infrastructure for Biological Mass Spectrometry

User Committee Chair (ex officio member of EAC)
- Philip Moll —Ecole Polytechnique Federale de Lausanne

Biology and Chemistry Subcommittee
- R. David Britt—UC-Davis
- Wei Chen—University of Minnesota
- Jean Futrell—Battelle
- Robert Griffin—MIT
- Songi Han—UC-Santa Barbara (Vice Chair)
- Christopher Jaroniec—Ohio State University

- Marek Pruski—Ames Lab

Condensed Matter Subcommittee

- Christoph Boehme—University of Utah
- Stuart Brown—UC-Los Angeles (Vice Chair)
- Moses Chan—Penn State University
- Cory Dean—City College of New York
- Ian Fisher—Stanford University
- Barbara A. Jones—IBM Almaden Research Center
- Art Ramirez—UC-Santa Cruz
- Mansour Shayegan—Princeton University
- Nai-Chang Yeh—California Institute of Technology

Magnet Technology and Materials Subcommittee

- Luca Bottura—Magnets, Superconductors and Cryostats (Vice Chair)
- Jeff Parrell—Oxford Superconducting Technology

Science Management

- Jonathan Bagger—TRIUMF
- George Crabtree—Argonne National Laboratory
- Roger Falcone—University of California, Berkeley
- Peter Littlewood—University of Chicago
- Bruce P. Strauss—U.S. Department of Energy
- Alan Tennant—Oak Ridge National Laboratory

1.3 USER COMMITTEE

The MagLab's User Committee represents the MagLab's broad, multidisciplinary user community and advises the Lab's leadership on all issues affecting users of our facilities. The User Committee is elected from the user base of the MagLab, and each facility has a subcommittee elected by its users to represent their interests. DC Field and High B/T facilities have a single, combined subcommittee representing the two user facilities. Likewise, the NMR facilities at UF and FSU have a single, combined subcommittee. Pulsed Field, ICR and EMR facilities have their individual subcommittees. Each subcommittee then elects members to represent it on the User Executive Committee. This User Executive Committee elects a chair and two vice chairs. The DC Field/High B/T Advisory Committee, the Pulsed Field Advisory Subcommittee, the EMR Advisory Subcommittee, the NMR/MRI Advisory Committee and the representative from the ICR Advisory Committee met via zoom October 12-14, 2021, to discuss the state of the MagLab and provide feedback to the NSF and MagLab management. The 2021 User Advisory Committee Report has been made available on our website.

Besides the fall annual meeting, the User Committee also met on January 11, 2021, to discuss the FAIR Data Management Plan. On May 17, 2021, the MagLab invited the User Committee to a meeting to address updates regarding the DC Field and Pulsed Field facilities.

DC Field/High B/T Advisory Subcommittee

- Philip Moll, Chair—Max Planck Institute (Chair)*
- Joseph G. Checkelsky—Massachusetts Institute of Technology
- Nat Fortune—Smith College
- Ben Hunt—Carnegie Mellon
- Jane Musfeldt—University of Tennessee
- Raivo Stern—National Institute of Chemical Physics & Biophysics
- Jairo Velasco—University of California, Santa Cruz*
- Matt Yankowitz—University of Washington*
- Andrea Young—UC-Santa Barbara

EMR Advisory Sub-committee

- Rodolphe Clerac—Centre de Recherche Paul Pascal
- Carole Duboc—Université Grenoble Alpes
- Sandrine Heutz—Imperial College London
- Troy Stich—Wake Forest University*
- Joshua Telser—Roosevelt University
- Joseph Zadrozny—Colorado State University

ICR Advisory Sub-committee
- Nathalie Agar—Harvard University
- Jack Beauchamp—California Institute of Technology
- Rene Boiteau—Oregon State University
- Franklin Leach—University of Georgia*
- Patricia Medeiros—University of Georgia
- Paul Thomas—Northwestern University

NMR/MRI Advisory Subcommittee
- Christian Bonhomme—Laboratoire de Chimie de la Matière Condensée de Paris
- Galia Debelouchina—University of California San Diego
- Brian Hansen—Aarhus University
- Shella Keilholz—Emory University/Georgia Tech*
- Vladimir Michaelis—University of Alberta
- Dylan Murray—UC-Davis
- Thoralf Niendorf—Max Delbruck Center for Molecular Medicine
- Anant Paravastu—Georgia Tech
- Aaron Rossini—Iowa State University (Vice Chair) *

Pulsed Field Advisory Subcommittee
- Adam Aczel—Oak Ridge National Laboratory
- Nicholas P. Butch—University of Maryland*
- Krzysztof Gofryk—Idaho National Laboratory
- Paul Goddard—University of Warwick
- Lu Li—University of Michigan
- Brad Ramshaw—Cornell University (Vice Chair) *
- Priscila Rosa—Los Alamos National Laboratory

*Note: * Are members of the User Executive Committee*

1.4 PERSONNEL

As of January 3, 2022, the MagLab employs 751 individuals across its three sites. These personnel are funded by the NSF core grant, State of Florida funding, and individual investigator awards, as well as a variety of home institutions and other sources. A list of MagLab personnel by department is presented in **Appendix I**.

Principal Investigators
- Gregory Boebinger (PI)—Director/Professor
- Joanna Long (Co-PI)—Program Director, AMRIS, UF
- Alan Marshall (Co-PI)—Chief Scientist for Ion Cyclotron Resonance
- Eric Palm (Co-PI)—Deputy Lab Director
- Michael Rabin (Co-PI)—Program Director, LANL

User Facility Directors
- Advanced Magnetic Resonance Imaging and Spectroscopy Facility (UF) —Joanna Long
- DC Field Facility (FSU)—Tim Murphy
- Electron Magnetic Resonance Facility (FSU)— Stephen Hill
- High B/T Facility (UF)—Mark Meisel
- Ion Cyclotron Resonance Facility (FSU)—Chris Hendrickson
- Nuclear Magnetic Resonance (FSU)—Robert Schurko
- Pulsed Field Facility (LANL)—Michael Rabin

Of our 751 employees, senior personnel represent the largest group at 32%, followed by graduate students at 23%, technical support staff at 15%, other professionals at 11%, undergraduate students at 8%, post docs at 7% and secretarial support staff at 4%. The total distribution appears in **Figure 1.4.1.**

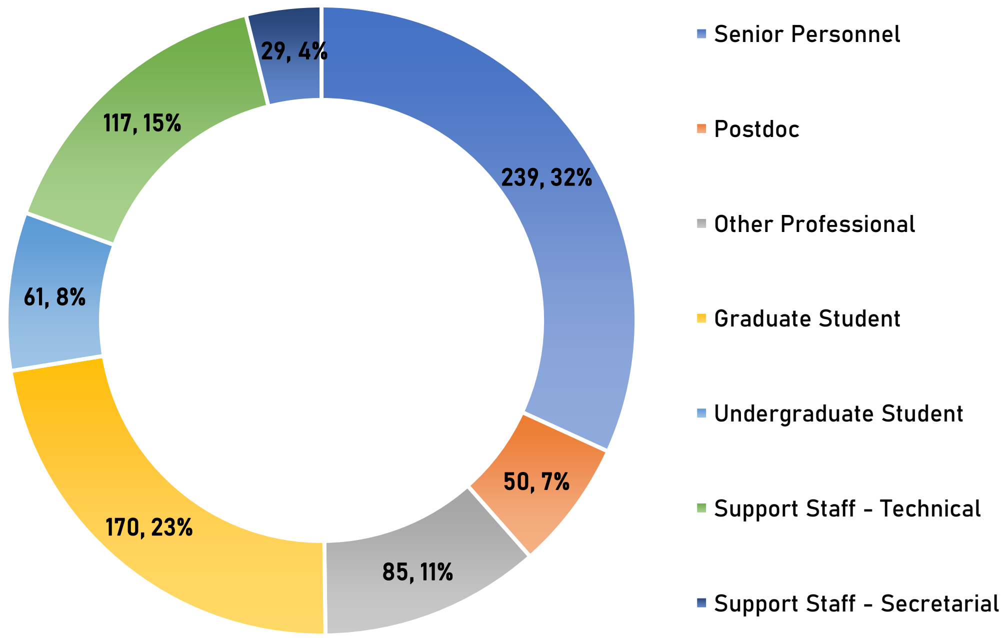


Figure 1.4.1: *MagLab Position Distribution (as of January 3, 2022)*

Overall distribution of diversity for all three sites of the MagLab includes: 47.1% white males, 21% Asian males and females, 18% white females, 5.5% black or African American, and 0.7% American Indian or Alaska Native. The distribution by diversity appears in **Figures 1.4.2 and 1.4.3** on the following page.

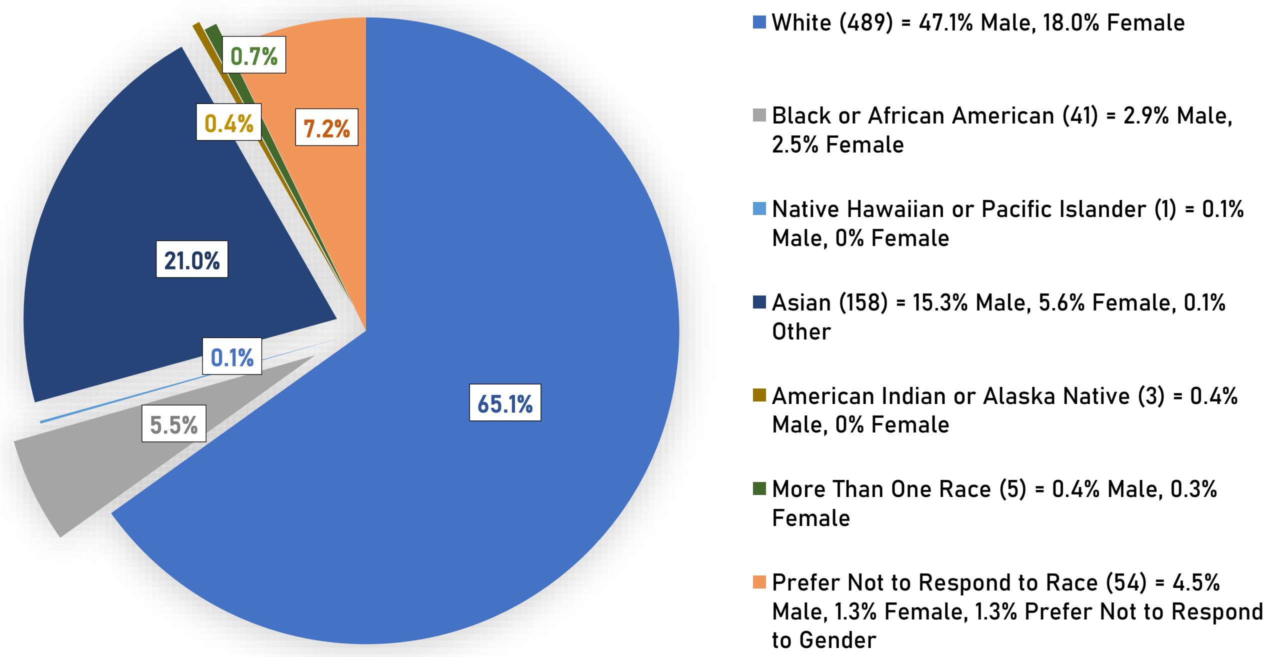


Figure 1.4.2*: MagLab Distribution by Race (as of January 3, 2022).*

Figure 1.4.3: *MagLab Distribution by Ethnicity (as of January 3, 2022).*

1.5 DIVERSITY ACTION PLAN

The MagLab continues its commitment to diversity and inclusion in the STEM workforce within the lab as well as throughout the nation. Our efforts center on: outreach to underrepresented and underserved populations in STEM from K-early career scientists; utilizing best practices in our hiring strategies to improve the representation of underrepresented minority groups (including women) at the lab and in the STEM workforce; and creating a climate where all personnel feel that they have equal opportunities for career development.

Three subcommittees form the solid base for the Diversity Committee. **Broadening Participation** actively looks for opportunities to support and extend our mission. **Compliance** engages with faculty search committees and human resources to maintain best practices. **Retention** focuses on workshops and internal support for our scientists and staff to encourage our workforce to remain at the lab/within the STEM. As part of this strategic plan, the diversity committee structures its budget and subcommittees to align with these efforts. The MagLab Diversity Committee meets periodically to discuss issues facing the lab. The members of the MagLab Diversity Committee in 2021 can be found in **Table 1.5** (*new member, **acknowledge our three subcommittee chairs).

Table 1.5: *2021 MagLab Diversity Committee members*

Greg Boebinger – Director of MagLab **Ernesto Bosque – Diversity Committee Chair**			
FSU Site		**UF Site**	**LANL Site**
Erick Arroyo	Emma Martin (Graduate Student)	Mark Meisel	John Singleton
Ryan Baumbach	Amy McKenna		Amanda Valdez
Alfie Brown	Jennifer Neu (Graduate Student)		Laurel Winter
Whitney Brown	Martha L. Chacon Patino		
Huan Chen	Zeljka Popovic (Graduate Student)		
Shalinee Chikara	Bettina Roberson		
Malathy Elumalai	Kari Roberts **		
Kevin Gamble	Kristin Roberts **		
Dave Graf	Komalavalli Thirunavukkuarasu		
Elizabeth Green	Anke Toth		
Laura Greene	Hans van Tol		
Roxanne Hughes	Carlos Villa		
Kawana Johnson*	Kaya Wei		
Jason Kitchen **	Yan Xin		
Walt Lee			

1.5.1 DIVERSITY INITIATIVES

The Compliance Subcommittee, chaired by Jason Kitchen, is responsible for helping coordinate the efforts of faculty hiring committees in the search for diverse candidates, particularly from underrepresented-in-STEM groups, and maintaining metrics to assess progress toward our mission. This subcommittee meets with the chair of each hiring committee at the outset of a position search, screens the position advertisement for gender bias verbiage, ensures that all members of a hiring committee have been trained for best practices in successfully staging diversity-promoting candidate searches, and that advertisements are sent to networks that reach underrepresented groups. Before hiring committees make a final offer to a candidate, the Compliance Subcommittee is expected to review a summary of the candidate interviewing and selection process.

In 2021, **four** faculty searches were completed successfully, three of which selected candidates that increased the diversity of our staff. Within CIRL, Kawana Johnson has been brought on board into a Research Faculty II position. This search was started in October of 2020. In September, NMR successfully hired Malathy Elumalai as an Associate in Research, completing a search begun in August of 2019. Shermane Benjamin has joined the DC Fields group, and finally, MS&T completed a search that resulted in hiring of Kwangmin Kim. At the close of 2021, five searches remain open: one for EMR, two for ICR (both of which started in early 2019), and two for NMR.

Through the Retention Subcommittee and Broadening Participation Subcommittee (chaired by Kari Roberts and Kristin Roberts, respectively) a number of evocative activities were led and/or supported by the Diversity Committee.

- Support was given to register a handful of our workforce to attend a 'training the trainer' workshop put on by the Center for Women and Work (CWW) at the University of Massachusetts Lowell under their NSF ADVANCE award. Focused on "Activating Bystanders to Address Workplace Microaggressions," the workshop was interactive and provided invaluable experience in acknowledging and confronting microaggressions in the workplace.
- In 2020, the Diversity Committee started a series of Town Hall Style Open Conversations, wherein everyone in our force is invited to join discussions on climate and work condition related topics. As a continuation of these discussions, a "Conflict Resolution in the Workplace" Open Conversation was hosted in July.
- Based on the feedback from the Open Conversations held in 2020, Dr. Roxanne Hugues assembled a lunchtime summer book club for a guided reading of *Black, Brown, and Bruised* by Ebony McGee. Dr. Sophia Rahming from the FSU Center for Advancement of Teaching was invited to facilitate our better understanding of how racism detrimentally affects STEM innovation and the STEM workforce.
- Professional Development Travel Grants are also made available for our workforce, and in 2021 we awarded three of these grants.
- The smaller focused workgroup formed to participate in the APS IDEA (Inclusion, Diversity, and Equity Alliance) continues to engage with dozens of scientific institutions to improve our organization and impact with innovative tool building.
- Within the Diversity Committee partnership with CIRL, an expansion of the FSUIntern program has funded several students from neighboring minority serving institutions, including Tallahassee Community College and Florida Agricultural and Mechanical University. This year, we were able to extend the benefit to a minority REU student as well.

Externally, the Diversity Committee is proud to support engaging meetings, workshops, and conference that further our diversity mission. Though such meetings were significantly impacted by the COVID-19 pandemic, we were pleased to continue our annual support for the 2021 IGEN (Inclusive Graduate Education Network) National Meeting, held in June. In addition, we also found opportunity to provide 'Apollo' level support for the Conference of Undergraduate Women in Physics (CUWiP), held virtually in January of 2022.

1.6 SAFETY

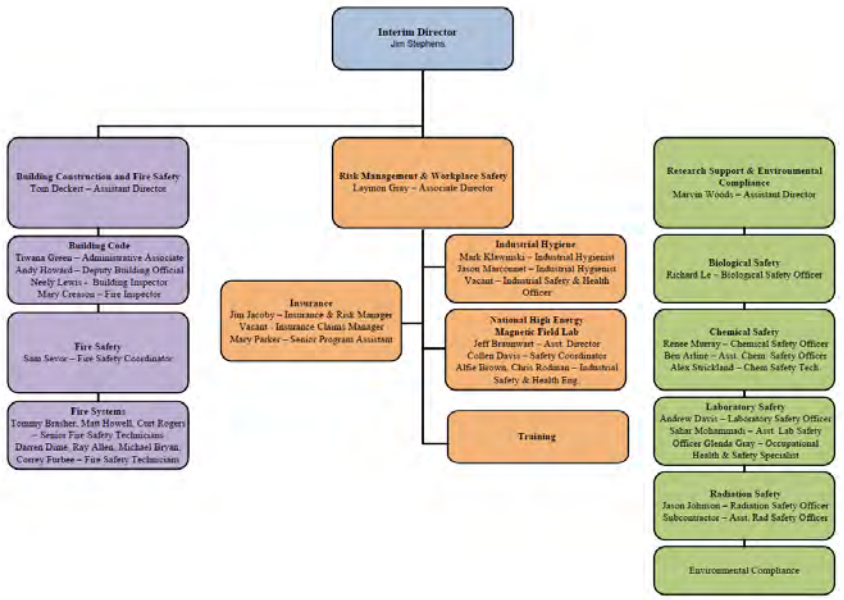


Figure 1.6.1: *Environmental Health & Safety (EHS) Organization Chart*

A central focus of all activities conducted at the MagLab is to ensure employees, users, visitors, and contractors are provided with a safe and educational environment. The MagLab's Environmental, Health and Safety team works collaboratively with management, researchers, staff, and users, as well as with other public and private entities, to proactively mitigate hazards in our industrial, laboratory, and office settings. The MagLab Safety Department is integrated with FSU's Central Environmental Health and Safety Department. This integration provides substantial support to existing safety programs at the MagLab. Areas of integration and support include Chemical Safety, Laboratory Safety, Biological Safety, Radiation Safety, Industrial Hygiene, Fire Safety, Environmental Compliance and Building Code Compliance (**Figure 1.6.1**). The MagLab uses Integrated Safety Management (ISM) to integrate safety, health requirements and controls into daily work activities to ensure the protection of the MagLab Community. The MagLab continues to foster a sustainable and strong Safety Culture. Examples of the activities that contribute to our commitment to a strong Safety Culture at the MagLab are listed below:

1. Safety is a **core value** and is viewed as an investment, not a cost.
2. Management drives and is actively involved in promoting our Safety Culture.
3. Quarterly Safety Meetings are conducted by the Director of the MagLab to address lab-wide safety issues and initiatives.
4. The Director of the MagLab and Director of Safety routinely walk-through lab areas to engage researchers, staff, and users, and to observe ongoing work. New Employee Orientation and New Employee safety training is provided to all incoming employees with their supervisor with specific emphasis on our ISM System. New employees are taught that safety is a value at the MagLab, to have a questioning attitude about their safety, our Stop Work Policy, and no-fault self-reporting near miss and accident policy.

1.6.1 INVESTMENTS IN SAFETY

Our investments in safety equipment and materials along with management support and employee involvement demonstrates our strong commitment to sensibly utilize resources in a manner that protect all MagLab personnel, property, and the environment. In 2021, the MagLab strategically invested just under $190,000 for safety-related equipment, supplies, security, training, and processes. Some of the key investments included personal protective equipment, equipment used to lockout/tagout and verify hazardous energy sources, surveillance cameras, monitoring devices, and COVID-19 related supplies.

1.6.2 SAFETY SUPPORT AND COORDINATION WITH FSU MAIN CAMPUS SAFETY TEAM

Safety at the MagLab is supported by a dedicated on-site team as well the FSU Environmental, Health and Safety Department team. The two teams work together to provide comprehensive integrated safety support to all activities at the MagLab. Machine Shop, Biosafety, Laboratory, Laser, and Radiation inspections were completed with team members from both groups. The two teams also work together to provide safety training.

1.6.3 COMMITTEES

Safety committees are an integral part of the MagLab's ISM. Committees meet to discuss and address safety concerns and provide program reviews. The following is a list of committees.

- Safety Committee (meets monthly and includes representative from UF and LANL Facilities)
- Safety Concerns Committee
- Lock/Tag Verification Committee
- Cryogen Safety Committee

- Laser Safety Committee

Meetings in 2021 continued to take place via Zoom because of the COVID-19 pandemic. These were very successful, and participation levels remained the same or increased. Members of these committees also form subcommittees as needed based on the need to address specific safety issues.

1.6.4 SAFETY HIGHLIGHTS

COVID-19 Training and Building Access

With the COVID-19 pandemic continuing, the MagLab continued to take extra precautions to protect its employees. Mandated requirements by states, counties, and local municipalities all affected the MagLab. Users and visitors were not allowed access during certain mandates. However, essential personnel still needed to access the MagLab for specific and critical duties. The safety department, with the help of Public Affairs, created and updated a MagLab-specific COVID-19 training that all employees and staff were required to take before entry was permitted. The MagLab's COVID-19 team reviewed projects and personnel and granted authorization to those who were given permission to come to the lab to perform research and their duties. Safety was an integral part of this team as the facility was on restricted access and the safety department acted as the "gate keeper" for training, entry, and COVID-19 related questions. These COVID-19 safety protocols have evolved with time, and some of these safety protocols are still in place and could change in the future.

Annual Maintenance Shutdown

During December, the MagLab performed its annual maintenance shutdown. Extensive annual maintenance occurred including repair of magnet power disconnects, regeneration of the water treatment resin, breaker testing and exercising, transformer testing, power supply, helium liquefier, capacitor yard, chiller, and pump maintenance. Project work included making welded connections on the 24" chilled water piping for the upcoming replacement of cooling pumps, the replacement of several exhaust fans and a reconfiguration of the capacitor banks. A daily meeting was held to review the work plans, lockout reverification status, and task hazard analysis. Meetings were conducted in person in a large open space to improve engagement of workers using a microphone and speaker to ensure everyone in the group could hear clearly. This year's shutdown was greatly impacted by global shipping delays but was not impacted by employees or contractors having to isolate or quarantine due to COVID-19.

Chiller Oxygen Deficient Hazard Upgrade

An alarm system to check for the presence of R-1233ZD was installed to warn workers if a small leak or unplanned event was to occur. In addition, engineering controls utilizing the alarm system were designed and installed to mitigate an oxygen deficient hazard by both actively and passively dispersing the refrigerant safely in the event of a release.

Arsenic Glove Bag Re-use

Safety and researchers successfully collaborated to decommission and reuse a glove box for a new Principal Investigator, resulting in a cost savings of over $20,000. The glove box was dedicated for the use of arsenic, which is highly toxic, can be harmful to the eyes, skin, liver, kidneys, lungs, and lymphatic system. Exposure to arsenic can also cause cancer. In order for the work to be completed safely, researchers utilized the Integrated Safety Management System (ISM). MagLab subject matter experts were consulted, an approved Safety Standard Operating Procedure was written, two qualified workers were always present during the process, the ventilation was continuously monitored, and FSU chemical safety office was used for hazardous waste disposal.

Statistics

In 2021, there were 111 safety concerns entered into the SafeMag system. These entries included near misses, safety concerns, good catches/practices, and suggestions. Four incidents occurred in 2021 and none resulted in lost time/days away from work or restricted work. Two incidents resulted in first aid and two were for reporting purposes only.

1.6.5 USER FACILITY SAFETY

The MagLab's User facilities (DC Field, Pulsed Field, High B/T, NMR, AMRIS, EMR and ICR) provide support to internal and external users. To facilitate their visit, users are assigned online training modules that are specific to the experiment they are conducting, and the hazards associated with each facility they will be working in. These are generally coordinated several weeks prior to their arrival if they are an external user. Internal users complete the required training prior to receiving authorization to start work. When users arrive at the facility, they receive hands-on training that is specific to each location and discuss any potential safety concerns with user support. While at each facility, users are assigned an in-house scientist and support technician to ensure both technical and safety needs are met. Non-routine and any particularly hazardous activities are completed by trained and experienced facility technicians to minimize risks to users. While the COVID-19 pandemic has affected our user programs, these safety requirements are still in place and will continue to be in place along with COVID-19 safety requirements and training.

1.7 BUDGET

The National High Magnetic Field Laboratory with its seven user programs is primarily funded by the National Science Foundation. Other operating funds are provided through the participating institutions: The Florida State University, the University of Florida, and the Los Alamos National Laboratory. Additionally, faculty and staff have been very successful in securing individual research funding for specific areas of research from a wide variety of sources, including federal, State, and private sectors.

The National Science Foundation Division/Directorate approved the National High Magnetic Field Laboratory's facilities award for 2018-2022 on March 23, 2018.

For the Calendar Year 2021, NSF provided an operating budget of $38,133,942. This includes an additional $303,942 for FAIR Data Supplement.

Table 1.7.1 represents the budget allocation and percentage of the total budget to each division of the National High Magnetic Field Laboratory and **Table 1.7.2** summarizes the MagLab's budget position as of December 31, 2021. The report includes our annual funding per our Cooperative Agreement.

***Table 1.7.1:** NSF Budget by NHMFL Division*

Division/Program	CY 2021 Total Funding ($)	Budget (%)
Operations/Safety	2,071,536	5.43%
DC Field Facility	7,875,303	20.65%
Magnet Science & Technology	5,698,039	14.94%
NMR	1,579,005	4.14%
ICR	1,730,000	4.54%
EMR	947,628	2.48%
CIRL and REU	553,661	1.45%
ASC	2,305,044	6.04%
Electricity & Gases	4,056,325	10.64%
LANL	8,602,985	22.56%
UF High B/T	454,241	1.19%
UF - AMRIS	930,273	2.44%
Diversity	79,999	0.21%
User Collaboration Grants Program	930,962	2.44%
FAIR Data	318,941	0.84%
Total Operations	**38,133,942**	100.0%

***Table 1.7.2:** NSF Budget & Expenses - Calendar Year 2021*

Expense Classification	Budget	Disbursed and Encumbered	Balance as of 12/31/2021
Salaries and Fringe	11,648,016	12,802,707	(1,154,691)
Equipment	1,663,564	3,239,806	(1,576,242)
Subawards	10,454,370	12,454,321	(1,999,951)
Other Direct Costs	5,609,068	5,798,464	(189,396)
Subtotal	**29,375,018**	**34,295,298**	**(4,920,280)**
Indirect Cost	8,758,924	7,738,549	1,020,375
Total Direct and Indirect Cost	**38,133,942**	**42,033,847**	**(3,899,905)**

Notes:
Per the Cooperative Agreement, DMR 11644799, the CY 2021 budget is $37,830,000.
The FAIR Data Supplement was awarded in February 2021 in the total amount of $303,942
Negative values are attributed to the following:

- Salaries for 01/01/2022-03/31/2022 were encumbered in December 2021.
- Equipment encumbrances include purchases that have a lengthy lead time from the time the order is placed until receipt of the goods.
- Subaward contracts for 01/01/2022-03/31/2022 were encumbered or paid in December 2021.
- Other Direct Costs had unspent funds from previous years.

1.8 MAGLAB COST RECOVERY REPORT

Seldom does the MagLab incur costs due to resources used for companies doing proprietary research. On those occasions that companies will need access to the unique equipment at the MagLab, they will contract for the use of that equipment. The MagLab has established procedures to accumulate and report costs continuously and consistently for all such contracts based on an agreed upon schedule of fees and costs to cover the use of such equipment that involves proprietary research. During 2021, the MagLab did not receive any income for the use of NSF-funded equipment/software during the period of performance of our federal award.

1.9 COVID-19 RESPONSE

In 2021, we have had our workers who could productively work from home do so and those who could not have come in to work while wearing masks and appropriately social distancing. Supervisors have utilized flexible schedules to allow workers to maintain social distancing and also to accommodate other issues such as childcare, eldercare and school support needs. In August 2021, University employees returned to in-person work. The availability of staff, however, is expected to continue to have an appreciable impact on operations due to COVID-19 restraints and work force needs and staff burnout. We will work and continue to attract and retain a talented and diverse workforce.

The economic factors of inflation due to COVID-19 and the unprecedented supply chain disruption caused by COVID-19 may continue to have operational and financial consequences. We will continue to leverage data to help manage delays, look for ways to increase our efficiencies across the entire organization, manage inventory and to define and prioritize demand. It is anticipated that these challenges will continue into 2022.

1.10 INDUSTRIA PARTNERSHIPS AND COLLABORATIONS

The MagLab collaborated with dozens of companies, national/international labs, universities and community groups in 2021. In addition, several spinoff companies continued to operate in 2021.

1.10.1 INDUSTRY

Advanced Conductor Technologies, Boulder, CO: The Applied Superconductivity Center and the Magnet Science and Technology Division of the MagLab are collaborating with Advanced Conductor Technologies on the development and testing of Conductor on Round Core (CORC®) cables, using multi-layer spiraling tapes around a core, for magnet applications. Danko van der Laan, Director of the company and associated with NIST/University of Colorado Boulder, is developing compact cables based on REBCO coated conductors, a high temperature superconductor. The ongoing collaboration on measurements of HTS cables at low temperature and high magnetic fields (4K and 20T in Cell 4) continues to set new benchmarks for peak current, current density, bend radius and ramp rates. *(MagLab contact: Ulf Trociewitz, ASC)*

ATI Specialty Metals and Products, Albany, OR: The Applied Superconductivity Center is collaborating with ATI metals in the development of new Nb alloys for Nb_3Sn superconducting wire fabrication. The new alloys exhibit improved properties at high fields and could be used for accelerator magnets in facilities like the Future Circular Collider (FCC) under consideration by CERN. *(MagLab contacts: David C. Larbalestier, Chiara Tarantini, Shreyas Balachandran, ASC*

Bridge12 Technologies Inc., Framingham, MA: Bridge12 is a small business specialized in the design and manufacturing of active and passive high frequency microwave components. The EMR division is collaborating with Bridge12 on novel designs of high field in-situ EPR spectrometers, as well as working together on future development of high frequency gyrotrons for DNP. *(MagLab contact: Stephen Hill and Thierry Dubroca, EMR)*

Bruker Biospin Corp., Billerica, MA: The EMR and NMR groups have entered into a collaborative effort with Bruker Biospin regarding the Dynamic Nuclear Polarization (DNP) program. In particular, the effort aims at improving Bruker's recently acquired products (395GHz gyrotron, 600MHz/14.1T DNP probe) beyond their normal commercial uses by making technical modifications. The modifications allow the DNP instruments to be more user program friendly without voiding the warranty. *(MagLab contact: Stephen Hill, EMR)*

Bruker Biospin Corp., Billerica, MA: Investigators from MagLab facilities at UF and FSU collaborate with technical staff at Agilent on two NIH-funded projects to develop improved superconductive cryogenic probes for solution NMR. *(MagLab contacts: William Brey, NMR and Matthew Merritt, AMRIS*)

Bruker OST, Carteret, NJ: Bruker OST is manufacturing accelerator quality Nb_3Sn strands based on the restacked-rod process that provide the production conductor for the High-Luminosity Upgrade of the Large Hadron Collider at CERN. The Applied Superconductivity Center oversees conductor production on behalf of the upgrade project, and

ASC and the Magnet Science and Technology divisions perform quality verification utilizing the electromagnetic testing facilities at the MagLab. *(MagLab contacts: Lance Cooley, ASC; Jun Lu, MS&T)*

Bruker-OST, Carteret, NJ: Extensive collaborations exist between ASC and BOST on both Nb_3Sn and Bi-2212 conductor development, aided by direct support of R&D on these materials from DOE-High Energy Physics to ASC PIs and to BOST through the Conductor Development Program (now called Conductor Procurement and R&D Program) managed by ASC in partnership with Lawrence Berkeley National Laboratory. Through these collaborations, BOST has been able to develop the most advanced Nb_3Sn and Bi-2212 conductors produced. *(MagLab contacts: Lance Cooley, David C. Larbalestier, Eric Hellstrom, Peter J. Lee, Chiara Tarantini, Jianyi Jiang, ASC)*

Criotec Impianti & ENEA, Italy: The MagLab is collaborating with Criotec Impianti, an Italian cryogenic system manufacturing company, and ENEA, an Italian Fusion Energy Research Organization, to jacket the cable-in-conduit superconductor for the outsert coils of the series-connected hybrid magnets. This work includes the welding and inspection of the stainless-steel conduit, insertion of the cabled superconductor strands into the conduit, and compaction of the assembled conductor to a rectangular cross-section. *(MagLab contact: Iain R. Dixon, MS&T)*

Cryomagnetics Inc.: Extensive collaborations exist with Cryomagnetics in the area of superconducting high field hybrid magnets that make use of HTS coils made with Bi-2212 nested in the high field area of the magnet. Cryomagnetics is collaborating with the MagLab under a phase-IIa Small Business Innovative Research award from the Department of Energy. Cryomagnetics has also obtained a license to use magnet technology based on $Bi_2Sr_2CaCu_2O_{8-x}$ superconductors developed at the MagLab. Magnets will use unique high-pressure high-temperature reaction furnaces and other techniques developed in the ASC to reach 25 T in magnet systems. ASC's involvement focuses on the design, construction, and heat treatment of Bi-2212 coils to be supplied to Cryomagnetics and embedded into their LTS magnet systems. *(Maglab contact: Ulf Trociewitz, ASC)*

Danfoss Turbocor, Tallahassee, FL: Danfoss Turbocor Inc. is a company specializing in compressors, notably those that are totally oil-free. These compressors are specifically designed for the heating, ventilation, air conditioning and refrigeration (HVACR) industry and need high performance soft and hard magnet materials. The company and the laboratory have a joint research project on selection, characterization and development of permanent magnet materials and structural materials for high performance and environmentally friendly compressors. *(MagLab contact: Ke Han, MS&T)*

DMS South Bailey Tool and Manufacturing (BTM), Lancaster, TX: BTM is a specialty tool and die company that produces complicated metal components by seamless forming and additive manufacturing techniques. The MagLab is collaborating with BTM to investigate complex cavity resonator shapes using bronze and other materials that facilitate the formation of Nb_3Sn superconductor under a grant from the US Department of Energy. The components delivered from BTM are coated with niobium and converted to Nb_3Sn using thin-film coating facilities in the Applied Superconductivity Center. *(MagLab contact: Lance Cooley, ASC)*

Energy to Power Solutions, Tallahassee, FL: The MS&T division has partnered with Energy to Power Solutions and secured a Small Business Incentive for Research grant from the US Department of Energy to develop technology suitable for HTS split magnets suitable for fields higher than 20T. *(MagLab contact: Iain R. Dixon)*

Engi-Mat Co., Lexington, KY: Engi-Mat is a small business specializing in manufacturing advanced nanomaterials. MagLab collaborates with Engi-Mat Co on a small business innovation research grant funded by US Department of Energy. The goal of this research is to improve the quality of $Bi_2Sr_2CaCu_2O_{8-x}$ powder for superconducting wires. *(MagLab contact: Jianyi Jiang, ASC)*

HC Starck, Newton, MA: The Applied Superconductivity Center is collaborating with HC Starck in the development of new Nb alloys for the Nb_3Sn superconducting wire fabrication to be used for accelerator magnets like the Future Circular Collider (FCC) to be built at CERN. *(MagLab contacts: David C. Larbalestier, Chiara Tarantini, Shreyas Balachandran, ASC)*

Hyper Tech Research Inc., Columbus, OH: Hyper Tech Research Inc. develops and manufactures MgB_2 superconducting wires for MRI applications. In this collaboration, the Magnet Science and Technology division measures critical current of MgB_2 wires developed by Hyper Tech Research. The critical current measurements are performed at 4.2K and in 0 – 10T magnetic fields. *(MagLab contact: Jun Lu, MS&T)*

Hyper Tech Research Inc., Columbus, OH: The Applied Superconductivity Center is collaborating with HTRI on the development of a new generation of Nb_3Sn wires with high critical current density for the next generation of higher magnetic field accelerator magnets as part of the US-Magnet Development Program. *(MagLab contacts: David C. Larbalestier, Chiara Tarantini, Shreyas Balachandran and Peter J. Lee, ASC*)

Mevion Medical Systems, Littleton, MA: Mevion is a pioneer in the development of proton radiation therapy systems for the non-invasive treatment of cancer. The center of the systems is the proton accelerator that utilizes low temperature superconductors. The MagLab provides engineering support to Mevion by assisting in qualification testing of full-scale high current superconductors in background fields at low temperatures. The tests require the MagLab's unique test facility designed for tests of large conductors in a 12T split solenoid superconducting magnet system and the unique variable temperature – variable strain apparatus in ASC. *(MagLab contact: Bob Walsh, MS&T, ASC contact: Najib Cheggour)*

Nikon, Melville, NY: The MagLab maintains close ties with Nikon on the development of an educational and technical support microscopy website, including the latest innovations in digital-imaging technology. As part of the collaboration, the MagLab is field-testing new Nikon equipment and developing new methods of fluorescence microscopy. *(MagLab contact: Eric Clark, Optical Microscopy)*

Olympus Corp., Tokyo, Japan: Investigators at the MagLab have been involved in collaboration with engineers at Olympus to develop and test new optical microscopy systems for education and research. In addition to pacing the microscope prototypes through basic protocols, the Optical Microscopy group is developing technical support and educational websites as part of the partnership. *(MagLab contact: Eric Clark, Optical Microscopy)*

Oxford Instruments NanoScience (OINS), UK: The ASC has a collaboration with OINS on the development of high field insert magnets made with Bi-2212 wire for use in 30+T NMR as well as 25 T class compact research magnet systems. Particularly for NMR magnets, Bi-2212 conductor promises several significant advantages that will be exploited here. *(Maglab contact: David Larbalestier, ASC)*. OINS is also negotiating a license to use magnet technology based on $Bi_2Sr_2CaCu_2O_{8-x}$ superconductors developed at the MagLab. Magnets will use unique high-pressure high-temperature reaction furnaces and other techniques developed in the ASC. OINS aims to produce advanced magnets for laboratory research and NMR systems. *(MagLab contact: David Larbalestier, Ulf Trociewitz, and Lance Cooley, ASC)*

Oxford Instruments, Abingdon, UK: Oxford Instruments delivered a 15T large-bore low temperature superconductor magnet to the MagLab that was combined with 17T YBCO-coated conductor coil developed to create the first 32T all-superconductor magnet. In case of a quench, the LTS and HTS coils interact in a complex manner. The quench protection systems for the individual coil sets are inter-dependent. This could not be handled by routine specifications in a standard vendor relationship. Therefore, Oxford Instruments and the MagLab worked closely together to develop quench protection for the combined system to ensure compatibility of the coil sets and developed a numerical code to model quench in combined YBCO-LTS magnets. Additionally, Oxford Instruments Nanoscience worked with MagLab personnel to specify, design and construct a custom top-loading dilution refrigerator for the 32T magnet system. Coupling the ultra-low temperatures of a dilution refrigerator with the 32T superconducting magnet creates a unique system for scientists to explore material properties. *(MagLab contact: Tim Murphy, DC Field)*

Oxford Instruments Superconducting Technology, Carteret, NJ: Oxford Instruments Superconducting Technology (OST) is one of the major manufacturers of superconducting wires. In this collaboration, the Magnet Science and Technology division measures hysteresis loss of Nb_3Sn wires developed by OST. The hysteresis loss measurements are performed at 4.2K and in 0 – 5TK magnetic fields by a vibrating sample magnetometer. *(MagLab contact: Jun Lu, MS&T)*

Phoenix NMR, LLC, Loveland, CO: Phoenix NMR used the NMR Dynamic Nuclear Resonance facility to test a commercial DNP probe. *(MagLab Contact: Fred Mentink, NMR)*

Revolution NMR LLC, Fort Collins, CO: Revolution NMR has licensed from FSU the Low-E probe technology developed at the MagLab in order to fabricate static NMR probes for biological (protein) samples. Additionally, the MagLab's NMR instrumentation program and Revolution NMR collaborate on the development of stators for magic angle spinning NMR. *(MagLab contact: Peter Gor'kov, NMR)*

SuperPower Inc., Schenectady, NY: The Applied Superconductivity Center and the Magnet Science and Technology division of the MagLab are collaborating with SuperPower Inc. on the characterization of YBCO coated conductors.

This material has the potential to transform the field of high-field superconducting magnet technology and is in an early stage of commercialization. The MagLab will work to improve our understanding of this product and provide guidance to SuperPower on enhancing the quality of their product. The MagLab has also taken the lead in encouraging a Coated Conductor Round Table of users of coated conductors at which much information about the long length performance of coated conductors has been shared. *(MagLab contacts: David Larbalestier, Dmytro Abraimov and Jan Jaroszynski, ASC)*

Thomas Keating LtD, UK: The EMR group has entered into a partnership with Thomas Keating (TK) LtD in the UK as part of its program aimed at developing a new characterization tool, Dynamic Nuclear Polarization Nuclear Magnetic Resonance (DNP - NMR) at high fields (14.1T / 600MHz). TK draws on tool-making skills to design and develop quasi-optical Terahertz systems and subsystems. *(MagLab contact: Stephen Hill, EMR)*

ThermoFisher Scientific, Waltham, MA: The ICR Facility is collaborating with ThermoFisher Scientific and the University of Virginia (Charlottesville, VA) to use advanced control of proton transfer reactions to manipulate ion charge states for improved sensitivity (e.g., for proteomics and other biological applications). Further, this collaboration seeks to couple the latest Thermofisher Scientific mass spectrometry platforms with the Maglab's high field Fourier Transform ion cyclotron resonance (FT-ICR) instruments. (*MagLab contact: Chris Hendrickson, ICR)*

Urban Mining Company, San Marcos, TX: Scientists and engineers from Urban Mining Company came to the MagLab to study the complete magnetization loop of the rare-earth permanent magnet alloys which they are developing. Urban mining specializes in recovering rare-earth magnetic material from recycled electronics and processing that material into new magnets for use in industry. *(MagLab contact: Tim Murphy, DC Field)*

Virginia Diodes Inc., Charlottesville, VA: VDI is a technology company specialized in high frequency microwave sources and detectors. The EMR division collaborates with VDI on the development of microwave sources for high-sensitivity high-field EPR spectroscopy. These new sources allow the MagLab to stay at the forefront of high field EPR instrumentation. The development of high-power solid-state sources for DNP at very high magnetic fields (>30T) is also being planned. *(MagLab contact: Stephen Hill and Thierry Dubroca, EMR)*

Waters Corporation, Miford, MA: The ICR and Future Fuels Institute are a Waters Corporation, Center of Innovation and collaborate on advances in instrumentation for biological and petroleum applications. Instrument and ion source advances are provided to both facilities before their commercial release and allow for applications development well before mainstream introduction. *(MagLab Contact: Ryan Rodgers, ICR)*

1.10.2 NATIONAL OR INTERNATIONAL LABORATORIES AND INSTITUTES

Advanced Photon Source, Argonne National Laboratory, Lemont, IL: The Applied Superconductivity Center is collaborating with APS to perform Extended X-ray absorption fine structure (EXAFS) characterization on Nb_3Sn superconducting wires in order to locate the substitution sites of the dopants and to correlate them with the superconducting performance. *(MagLab contacts: Chiara Tarantini, ASC)*

CERN, Geneva, Switzerland: The Large Hadron Collider (LHC) at CERN uses a 27km ring of superconducting magnets based on Nb-Ti to accelerate particles in the world's largest and most powerful collider but plans to increase the energy capability of LHC will require higher magnetic fields. Moreover, the planned Future Circular Collider (FCC) at CERN will be realized in a 100km ring of Nb_3Sn and HTS magnets. The Applied Superconductivity Center is collaborating with CERN to fabricate, characterize and optimize a new generation of accelerator quality Nb_3Sn strands that have the potential to provide the performance necessary for the LHC upgrades and the FCC realization. *(MagLab contacts: David C. Larbalestier, Chiara Tarantini and Peter J. Lee, ASC)*

Dana-Farber Cancer Institute, Boston, MA: Current collaboration between Dana-Farber Cancer Institute and the Magnetic Lab is aimed at determining the molecular details of HIV envelope protein gp41 using electron paramagnetic resonance methods. Other goals include characterization of antibody-induced structural changes of gp41 and developing optimized vaccine immunogens by structural approaches. *(MagLab contact: Likai Song, EMR)*

EUCARD2 (European Collaboration for Accelerator R&D), Geneva, Switzerland: EUCARD2 is a European Framework collaboration of about 10 European labs aimed at developing kiloamp high temperature superconductor cables for future application to a high energy LHC. The European emphasis is on Roebel cables of REBCO coated conductors, but an equally attractive cable for accelerator purposes is a round wire cable made in the Rutherford style out of Bi-2212 ($Bi_2Sr_2CaCu_2O_{8-x}$). This conductor has been developed at the MagLab under DOE-HEP support in the context of the Bismuth Strand and Cable Collaboration (BSCCo) that unites the MagLab, BNL, FNAL, LBNL and OST in a team developing this material for accelerator use. The MagLab is now the US point of contact for collaborations between EUCARD2 and the US program. *(MagLab contacts: David C. Larbalestier, ASC)*

Fermilab, Batavia, IL: The Applied Superconductivity Center is collaborating with Fermilab on the development of a new generation of Nb_3Sn wires with high critical current density for the next generation of higher magnetic field accelerator magnets as part of the US-Magnet Development Program. (*MagLab contacts: David Larbalestier, Chiara Tarantini, Shreyas Balachandran and Peter J. Lee, ASC)*

Fermi National Accelerator Laboratory (FNAL), Batavia, IL: Applied Physics and Superconducting Technology Division, Magnet Systems Department of FNAL manages Nb_3Sn wire procurement for the LHC high luminosity upgrade. MS&T physical property measurement lab is contracted by FNAL to measure critical current and residual-resistance-ratio of Nb_3Sn wires as a part of the quality verification program. This collaboration started in 2015 and will continue through the end of 2021. *(MagLab contact: Jun Lu, MS&T)*

Facility for Rare Isotope Beams (FRIB), East Lansing, MI: FRIB at Michigan State University collaborated with MS&T physical property measurement lab on high critical current measurement of NbTi wires up to 3000A. *(MagLab contact: Jun Lu, MS&T)*

Fusion and Fission Energy and Science Division, Oak Ridge National Laboratory (ORNL), Oak Ridge, TN: The MS&T's Electro-Mechanical Properties Lab is one of the United States' primary materials research and qualification laboratories that specializes in low temperature superconductor and structural materials testing in support of high-field superconducting magnets. The MagLab has a long-term relationship with ORNL and its US-ITER program to provide engineering support that will continue in the post-ITER fusion program era. The funding for this research is provided by US-DOE and ORNL. *(MagLab contact: Bob Walsh, MS&T)*

Helmholtz Zentrum Berlin, Berlin, Germany: The MagLab has partnered with the Helmholtz Zentrum Berlin (HZB) to develop the highest field magnet worldwide for neutron scattering at HZB. In March 2007, HZB (formerly the Hahn-Meitner Institute) signed an agreement with Florida State University Magnet Research and Development Inc. The magnet is intended to provide 25T on-axis using 4.4MW of DC power and have upstream and downstream scattering angles of 30 degrees. The magnet reached 26T on October 16, 2014. Since then, it has been moved from the test site into the neutron guide hall and served the first users in July 2015. We are now discussing an agreement for assistance with ongoing operations and maintenance. *(MagLab contact: Mark D. Bird, MS&T)*

HL-LHC Accelerator Upgrade Project (AUP), Geneva, Switzerland: The AUP is the US contribution to the High-Luminosity Upgrade of the Large Hadron Collider. All the magnets are Nb_3Sn; there is no HTS. AUP will deliver new quadrupole magnets, 20 magnets x 4 coils = 80 coils measuring 4.2m long at 11.4T field and 1.9K, that intensify the focus of the CERN proton beams at the ATLAS and CMS intersection regions, and new crab cavities that rotate the beam slightly and ensure that collisions are head-on, even when the focusing magnets are highly converging. These new elements will make physics happen 10 times faster than before (new physics being proportional to luminosity). The Hi-Lumi project in European accounting is around CHF 2.2 billion, AUP cost is $225 million, and MagLab oversees a $25 million component to procure 10 tons of the highest-performing Nb_3Sn conductor ever made and verify its quality by testing critical current and other properties. The AUP is supported by the DOE Office of Science. The AUP team consists of six US laboratories and two universities: Fermilab, Brookhaven National Laboratory, Lawrence Berkeley National Laboratory, SLAC National Accelerator Laboratory, Thomas Jefferson National Accelerator Facility (all DOE national laboratories), the National High Magnetic Field Laboratory, Old Dominion University and the University of Florida. *(MagLab contacts: Lance Cooley and David C. Larbalestier, ASC)*

International Thermonuclear Experimental Reactor (ITER), US-ITER Project Office, Oak Ridge National Laboratory (ORNL), Oak Ridge, TN: The United States is part of an exciting international collaboration to demonstrate the feasibility of an experimental fusion reactor that is under construction in France. The MS&T's Mechanical Properties Lab is the US-ITER primary materials research and qualification laboratory supporting the US effort. The Tokamak machine consists of three types of very large, complex superconducting magnets that all utilize Cable-in-Conduit Conductors (CICC) as the main structural components. Another important component for stress management of the Central Solenoid is a massive CS pre-compression structure (Tie Plates). The conduit and tie plate alloys, and their welds, are being studied and characterized here to ensure their performance and reliability. The funding for this research is provided by US-DOE, US-ITER Project Office at ORNL. In addition, MS&T's physical property measurement lab has been preparing Nb_3Sn wire samples as witness for heat treatment ITER central solenoid modules. The MagLab subsequently measures critical current of these heat treatment witness samples. *(MagLab contacts: Bob Walsh & Jun Lu MS&T)*

Japan Proton Accelerator Research Complex (J-PARC), Japan: ASC is collaborating with the Japan Proton Accelerator Research Complex (J-PARC) to perform neutron-diffraction experiments on RRP® Nb_3Sn wires to find the origin of the strain irreversibility cliff in these conductors and to identify the different phases present in the conductor after heat-treatments. This collaboration also includes Kozo Osamura from the Research Institute for Applied Sciences RIAS (Kyoto, Japan) and Shutaro Machiya from Daido University (Nagoya, Japan). Work from this collaboration will expand to also include other conductors currently being developed such as Nb_3Sn containing additional pinning centers. *(MagLab contact: Najib Cheggour and Peter J. Lee, ASC)*

Jefferson Lab, Newport News, VA: Recently, Nitrogen and Titanium doping have emerged as highly effective methods of improving the quality factor on Nb SRF cavities; the Applied Superconductivity Center is working with scientists at Jefferson Lab to evaluate the interaction between prior cold-work and doping treatment of Nb samples and their influence on the superconducting properties. Doping is carried out at Jefferson Lab and superconducting property measurements, including magneto optical imaging area carried out at the MagLab. *(MagLab contact: Peter J. Lee and Lance Cooley, ASC)*

Key Laboratory of Electromagnetic Processing of Materials, Northeastern University, Shenyang, China: The collaboration between the Northeastern University and the MagLab is related to the magnetic field impact on fabrication of high strength conductors and magnetic materials. Two graduate students visited the MagLab between 2019 and 2020. They published three joint papers between 2019 and 2021. *(MagLab contact: Ke Han, MS&T)*

Korea Advanced Institute of Science and Technology (KAIST), Daejeon, South Korea: Professor Hyoungsoon Choi's group at the Korea Institute of Science and Technology (KAIST) has developed a co-operative agreement with Professor Yoonseok Lee and the National High Magnetic Field Laboratory's High B/T Facility for the study and development of the design of coolant materials used in nuclear demagnetization refrigerators. The collaboration focuses on the techniques and expertise required to produce high residual resistant ratios for the metallic materials used for the coolants and the associated components. KAIST is a leading center for ultra-low temperature research in Korea. *(MagLab contacts: Yoonseok Lee, High B/T)*

Lawrence Berkeley Laboratory, Accelerator, Berkeley, CA: ASC is collaborating with the Lawrence Berkeley National Laboratory (LBNL) to test strain properties of high-performance RRP® Nb_3Sn wires to be used in the LBNL Test Facility Dipole Project (TFD). This collaboration will explore the strain sensitivity of a specific Nb_3Sn conductor to help LBNL researchers decide early in the project whether this conductor is suitable for TFD. *(MagLab contact: Najib Cheggour, ASC)*

Lawrence Berkeley National Laboratory (LBNL), Berkeley, CA: Division of Accelerator Technology and Applied Physics collaborated with MS&T physical property measurement lab in thermal properties measurements of a polymer composite material that is used in development of the accelerator magnets. *(MagLab contact: Jun Lu, MS&T)*

Lawrence Berkeley Laboratory, Accelerator Technology & Applied Physics Division, Berkeley, CA: MS&T's Electro-Mechanical Properties group specializes in low temperature structural materials testing in support of DOE High-Luminosity LHC Accelerator Upgrade Project (AUP). The MagLab performs low temperature mechanical tests and microstructural evaluation of structural aluminum alloys and composites that are critical to the safe/reliable operation of large accelerator magnets being constructed for the project. *(MagLab contact: Bob Walsh, MS&T)*

Lawrence Livermore National Laboratory, Livermore, CA: ASC and the Magnet Science and MS&T are collaborating with researchers at Lawrence Livermore National Laboratory to develop cavity resonators and magnets for the Advanced Dark Matter Experiment. Fabrication and microstructural characterization facilities in the ASC are used to investigate Nb_3Sn and other superconducting coatings for use in cavities. MS&T consultation related to very large and high field detector magnets is ongoing. *(MagLab contacts: Lance Cooley, ASC)*

Los Alamos National Laboratory Community Programs Office, Los Alamos, NM: CIRL works closely with our counterpart, the Los Alamos National Laboratory Community Programs Office. Over the last year, the MagLab has developed a partnership to share information and resources on our educational activities. The community programs office has a large staff that oversees more than 15 different educational/ community outreach programs including the Bradbury Museum. *(MagLab contact: Carlos R. Villa, Educational Programs)*

Los Angeles County Museum of Natural History, Los Angeles, CA: The collaboration between the IVPP and the MagLab is related to the investigation of Late Cenozoic Vertebrate Paleontology and Paleoenvironments of the Tibetan Plateau (China). Stable isotopic compositions of the samples collected in this project are analyzed in the Geochemistry Laboratories in the MagLab. *(MagLab contact: Yang Wang, Geochemistry Program)*

National Aeronautics and Space Administration, Washington DC: The MagLab is collaborating with a multi-university NASA University Leadership Institute to research zero-emission aviation. Collaboration members include Florida State University, Georgia Tech, University at Buffalo, University of Kentucky and industrial partners Boeing, Raytheon, and Advanced Magnet Lab. *(MagLab contacts: Wei Guo, MS&T and Lance Cooley, ASC)*

Princeton Plasma Physics Laboratory (PPPL): ASC and PPPL are collaborating on the R&D of high-field superconducting cable coil for use in nuclear fusion systems. In this context, a particular interest exists for CORC™-type cables made with ReBCO conductor as well as Rutherford-type cables made with Bi-2212 wire. *(Maglab contact: Daniel Davis, ASC)*

School of Mechanical Engineering and Automation, Fuzhou University, Fuzhou, China: The collaboration between the Fuzhou University and the MagLab is related to the characterization of high strength conductors. *(MagLab contact: Ke Han, MS&T)*

South Florida Water Management District (SFWMD), West Palm Beach, FL: The collaboration between the SFWMD and the MagLab is related to the investigation of land-use and change on food web structure and mercury cycling in the Everglades. Isotopic compositions of the samples collected in this project were analyzed in the Geochemistry Laboratories in the MagLab. *(MagLab contact: Yang Wang, Geochemistry Program)*

Thomas Jefferson National Accelerator Facility, Newport News, VA: Large-grain Nb has become a viable alternative to fine-grain Nb for the fabrication of superconducting radio-frequency cavities. The MagLab collaborated with engineers at Jefferson Lab to evaluate the effect of thermal processing and grain size on the mechanical properties of Nb. The mechanical properties evaluation was carried out at MS&T's Mechanical Properties Lab. (*MagLab contact: Bob Walsh, MS&T*) Nitrogen surface treatments has emerged as a highly effective method of improving the quality factor on Nb SRF cavities; the Applied Superconductivity Center is working with scientists at Jefferson Lab to evaluate the interaction between prior cold-work and doping treatment of Nb samples and their influence on the superconducting properties. Doping, heat treatment and cavity testing are carried out at Jefferson Lab, and superconducting property measurements, including magneto optical imaging, as well as microstructural and microchemical analyses are carried out at the MagLab. *(MagLab contact: Peter J. Lee, ASC)*

Ultramet, Pacoima, CA: Nb_3Sn coatings are seen as an important next step in the development of Superconducting Radio Frequency (SRF) cavities beyond Nb. The MagLab has assisted the development of CVD-based Nb_3Sn cavities at Ultramet by supplying precursor material as well as microscopy and critical temperature measurements. (MagLab contacts: Peter J. Lee and Shreyas Balachandran, ASC)

US Magnet Development Program (*MDP*), Berkeley, CA: The US Magnet Development Program aggressively pursues the development of superconducting accelerator magnets that operate as closely as possible to the fundamental limits of superconducting materials and at the same time minimize or eliminate the need to break in a magnet in a series of steps to achieve its design field strength. MDP looks forward 15-30 years at accelerators that might be built. CERN is already thinking about a Future Circular Collider at 10x the energy than the present LHC, i.e. > 100TeV, in the 2050 timeframe. An important thing about the FCC is that it is constrained by mountains, and to get to 100TeV, the envisioned Nb_3Sn technology, which as a limit at ~16T, must be replaced by or combined with HTS to get to 20T. However, while MDP partners closely with CERN, the technology being developed is generic, and it is important to note that the physics reach of an accelerator scale with the ring diameter and the field strength. MagLab's major developments to date include pioneering Bi-2212 magnet technology and its high-pressure, high-temperature reaction and demonstrating several Bi-2212 coils, demonstrating REBCO cables, and leading the national conductor development effort. LBNL serves as the host institution for the MDP organization. *(MagLab contacts: Lance Cooley and David C. Larbalestier, ASC)*

Woods Hole Oceanographic Institution (WHOI), Falmouth, MA: The collaboration between WHOI and the MagLab is related to ocean crust formation. WHOI is providing samples and analyses of abyssal peridotites, which are analyzed for Hf, Nd and Osisotopic composition. The MagLab also participates in seagoing expeditions. One has been to the mid-Atlantic Ridge; another is planned to the Marion Rise on the southwest Indian Ridge. Samples collected from these expeditions will be analyzed at both the MagLab and WHOI. *(MagLab contact: Vincent Salters, Geochemistry Program)*

Woods Hole Oceanographic Institution (WHOI), Falmouth, MA: The MagLab collaborates with Christopher Reddy and Robert Nelson at WHOI in characterization of petroleum oil spills at the molecular level, by gas chromatography x gas chromatography and FT-ICR mass spectrometry. Although characterization of the 2010 Macondo wellhead oil has been completed, ongoing research focuses on subsequent physical, chemical, and biological changes as the spill ages in the environment, and analysis of future spills. *(MagLab contact: Ryan Rodgers, ICR)*
(MagLab contact: Ryan Rodgers, ICR)

1.10.3 UNIVERSITIES

Florida State University, College of Education, Tallahassee, FL: CIRL works closely with faculty from the FSU College of Education to network and strengthen programs on campus and at the lab. The MagLab utilizes the expertise of FSU faculty for research projects and recruits graduate students from FSU departments to conduct research on CIRL programs. *(MagLab contact: Roxanne Hughes, Educational Programs)*

Michigan State University, Lansing, MI: ASC is collaborating with Michigan State University on a DOE funded project to study the impact of grain boundaries and associated microstructural defects on the performance of superconducting cavities using the advance microstructural, microchemical, and electromagnetic characterization techniques and expertise available in the MagLab. *(MagLab contact: Peter J. Lee, ASC)*

Nagoya University, Nagoya, Japan & Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany: ASC is collaborating with Nagoya University and the Karlsruhe Institute of Technology in the investigation of iron-based superconducting thin films in order to establish their intrinsic properties and determine their potential for applications using electromagnetic characterization techniques also in high field and expertise available in the MagLab. *(MagLab contact: Chiara Tarantini, ASC)*

Osaka City University, Japan: The EMR group received joint funding with the University of Modena in Italy and Osaka City University in Japan through an International Program sponsored by the Air Force's Asian Office of Aerospace Research and Development (AOARD). This joint program focuses on quantum properties of molecular magnets. A cooperative agreement between Osaka City University and Florida State University has been established in order to formalize this collaboration. *(MagLab contact: Stephen Hill, EMR)*

Radboud University, Nijmegen, The Netherlands: The MagLab has partnered with the High Magnetic Field Lab in The Netherlands to develop a 45T hybrid magnet using only 24MW of power. The project was funded by the Dutch government in 2006, and in 2012 an agreement was signed for the MagLab to play a leading role in the development of the Nb_3Sn cable-in-conduit superconducting coil for this magnet system. This will be the fourth hybrid outsert to be developed at the MagLab (MagLab 45T, HZB, FSU SCH, Nijmegen), and the Dutch lab will benefit from our extensive experience. When complete, it is expected to be one of three 45T systems worldwide. The CICC coil has been delivered to Nijmegen. The Nijmegen lab is building the cryostat and resistive coils. *(MagLab contact: Mark D. Bird, MS&T)*

Shanghai University, Shanghai, China: The collaboration between the Shanghai University and the MagLab is related to the solidification of metallic materials. Two scientists from Shanghai University visited the MagLab in 2019 as visiting scholars for one year to do research on microstructure of high strength materials. *(MagLab contact: Ke Han, MS&T)*

St. Andrews University, UK: The EMR group has an ongoing partnership with St. Andrews University in the UK, involving the development of a high-power (1kW) high-frequency (94GHz) pulsed EPR spectrometer (HiPER) for its user program. *(MagLab contact: Stephen Hill, EMR)*

Tokyo University of Agriculture and Technology, Japan: ASC is collaborating with TUAT in the investigation of iron-based superconducting bulks in order to establish their intrinsic properties and determine their potential for applications using electromagnetic characterization techniques also in high field and expertise available in the MagLab. *(MagLab contact: Chiara Tarantini, ASC)*

University of Cambridge, UK: The MS&T division is collaborating with the University of Cambridge to develop high-current coils based on high temperature superconductors driven by a flux pump. This collaboration involves

Cambridge developing flux pumps that are able to provide more energy to the load than traditional systems and the MagLab developing high-current HTS coils. *(MagLab contact: Thomas Painter)*

University of Colorado Boulder, Boulder, CO: The NIST-Boulder electromechanical testing facilities were the primary location for the determination of the strain sensitivity of a wide range of superconducting wires, and these important instruments have been transferred to ASC so that this critical work can be continued. *(MagLab contact: Najib Cheggour, ASC)*

University of Edinburgh, UK: The EMR group received funding through a joint program between the National Science Foundation and the Engineering and Physical Sciences Research Council in the UK, enabling an International Collaboration with the Chemistry Department at the University of Edinburgh, Scotland. This joint program involved the development of high-pressure/High-field EPR techniques. *(MagLab contact: Stephen Hill, EMR*)

University of Modena, Italy: The EMR group received joint funding with the University of Modena in Italy and Osaka City University in Japan through an International Program sponsored by the Air Force's Asian Office of Aerospace Research and Development (AOARD). This joint program focuses on quantum properties of molecular magnets. *(MagLab contact: Stephen Hill, EMR)*

University of Oxford, UK: ASC is collaborating with University of Oxford in the investigation of doped Nb_3Sn superconducting wires in order to determine by atom probe tomography the elemental distribution of dopants and their effect on the superconducting properties. *(MagLab contact: Chiara Tarantini, ASC)*

University of Texas, Arlington, TX: ASC Center is working with Choong-Un Kim and his research group to understand electrochemical methods to apply refractory metals to copper and copper alloys. Kim's team have unique expertise in preparing non-aqueous methods that ensure very little oxygen is incorporated into the refractory metals, using expertise developed for semiconductor inter-connections. The MagLab's microstructural and electromagnetic characterization facilities are used to evaluate the quality of coatings and their properties, including potential use as a superconducting material in a cavity resonator. *(MagLab contact: Lance Cooley, ASC)*

1.10.4 COMMUNITY GROUPS AND EDUCTIONAL GROUPS

American Physical Society – Committee on the Status of Women in Physics, College Park, MD: This committee works to improve the representation and experiences of women in physics. The MagLab has engaged with this group for external reviews and advice. In addition, Dr. Hughes has served as a member of the committee and continues to help with Site Visits. *(MagLab contact: Roxanne Hughes, Educational Programs)*

American Physical Society - Forum on Outreach and Engaging the Public, College Park, MD: The Forum's goal is to increase the public's awareness of physics. CIRL works with this group to utilize best practices and engage in international discussions around physics outreach. *(MagLab contact: Roxanne Hughes, Educational Programs)*

Applied Superconductivity Educational Foundation (ASEF), Potomac, MD: The mission of the Applied Superconductivity Educational Foundation (ASEF) is to promote exploration, learning and the exchange of scientific and technical ideas, breakthroughs and accomplishments, and to provide an array of educational and interactive experiences and events. The Applied Superconductivity Educational Foundation (ASEF) engages this vision on a variety of fronts, including the Applied Superconductivity Conference (ASC), the flagship, international conference on applied superconductivity, and ELEVATE, our integrated thrust to promote educational opportunities, professional & leadership development, and outreach between our scientific community and society. Prof. Cooley and Prof. Hellstrom are Board Officers *(MagLab contact: Lance Cooley, Eric Hellstrom, ASC)*

Big Bend/Leon Association of Science Teachers (BLAST), Tallahassee, FL: The Big Bend/Leon Association of Science Teachers (BLAST) is a group that brings together formal and informal science educators to establish lines of communication among all persons involved in science education in the North Florida community and foster life-long interest in the sciences. They do this by coordinating services most conducive to outstanding science educators, including hosting workshops and presentations that aim to increase the knowledge and skills of science teachers. Additionally, they recognize outstanding achievements in science instruction and provide monetary support for science teacher and student projects. *(MagLab contact: Carlos R. Villa, Educational Programs)*

CAISE - Center for the Advancement of Informal Science Education (CAISE), Washington, DC: CAISE works in collaboration with the NSF Advancing Informal STEM Learning (AISL) Program to strengthen and advance the field of professional informal science education and its infrastructure by providing resources for practitioners, researchers, evaluators and STEM-based professionals. CAISE also facilitates conversation, connection and collaboration across the ISE field — including in media (TV, radio and film), science centers and museums, zoos and aquariums, botanical gardens and nature centers, cyberlearning and gaming, and youth, community, and out of school time programs. CIRL has worked with CAISE to provide advice for reaching Principal Investigators and improving the evaluation of broader impacts. *(MagLab contact: Roxanne Hughes, Educational Programs)*

Community Classroom Consortium, Tallahassee, FL: The Community Classroom Consortium (CCC) is a coalition of more than thirty cultural, scientific, natural history and civic organizations in North Florida and South Georgia that provide educational experiences and resources to the public, especially K-12 teachers and students. Representatives from CIRL and Public Affairs represent the Lab on the board of this organization and as general members. *(MagLab contact: Kari Roberts, Director's Office)*

Florida Afterschool Network, Tallahassee, FL: The Florida Afterschool Network (FAN) is an organization that is working toward creating and sustaining a statewide infrastructure to establish collaborative public and private partnerships that connect local, state, and national resources supporting afterschool programs that are school-based or school-linked; develop quality afterschool standards that are endorsed and promoted by statewide stakeholders and through Florida Afterschool Network; and promote public awareness and advocate for policy that expands funding, quality improvement initiatives and accessibility of afterschool programs. CIRL is a member of the advisory council for this organization. *(MagLab contact: Carlos R. Villa, Educational Programs)*

Florida A&M University Developmental Research School (FAMU DRS), Tallahassee, FL: FAMU DRS is the lab school of FAMU, a historically black college and university. The mission of FAMU DRS is to conduct research, demonstrations, and evaluations of the management of teaching and learning. FAMU DRS places emphasis on mathematics, science, technology, and foreign languages. The MagLab partnered with FAMU DRS to provide a SciGirls Coding Summer Camp to their students to increase the representation of African American women in computer science. *(MagLab contact: Carlos R. Villa, Educational Programs)*

Florida Association of Science Teachers (FAST), Tallahassee, FL: FAST is a diverse group of teachers, scientists, science educators, science supervisors, curriculum designers, administrators and educational business partners who have a common goal of improving education for students in the state of Florida. FAST provides a way for all members to keep up with what is happening in education in Florida and across the United States. *(MagLab contact: Carlos R. Villa, Educational Programs)*

Future Physicists of Florida, Tallahassee, FL: Future Physicists of Florida is an organization dedicated to recognizing talented middle school math and science students and providing educational guidance to these students to prepare them for careers in physics and engineering. CIRL is a partner in the organization. *(MagLab contact: Carlos R. Villa, Educational Programs)*

Inclusive Graduate Education Network (IGEN), College Park, MD: The MagLab has worked with IGEN to beta test a mentor training for mentors at National Labs. MagLab staff will be able to participate in the final curriculum to strengthen the quality of mentorship at the MagLab. *(MagLab contact: Kawana Johnson, Educational Programs)*

Institute of Electrical and Electronic Engineers (IEEE), Piscataway, NJ: The MagLab works with the IEEE Council on Superconductivity to award student fellowships for research and travel. The awards are solicited and reviewed through the council for students nearing the PhD degree. *(MagLab contacts: Eric Hellstrom and Lance Cooley, ASC)*

International Mentoring Association (IMA), Newberry, FL: This organization is a leading source for best practice solutions and support of mentoring and coaching professionals and their programs. The IMA advances individual and organizational development by promoting the use of mentoring best practices in every organizational setting. CIRL staff benefit from the professional development that this organization provides. *(MagLab contact: Kawana Johnson, Educational Programs)*

Leon County Schools, Tallahassee, FL: CIRL works closely with Leon County Schools (LCS) through our K-12 outreach and our middle school mentorship program. In 2014, CIRL staff worked with Title I elementary school teachers from LCS to develop and facilitate a year-long teacher professional development that culminated in a STEM challenge for students. *(MagLab contact: Roxanne Hughes or Carlos R. Villa, Educational Programs)*

National Girls Collaborative Project, Seattle, WA: This is a national nonprofit organization that works to improve girls' interest in and access to STEM programs and careers. CIRL has utilized their publications and webinars for best practices in STEM education. CIRL's research has also informed their work. *(MagLab contact: Roxanne Hughes or Kari Roberts, Educational Programs)*

National Postdoc Association, Washington, DC: The National Postdoc Association (NPA) advocates for postdoctoral scholars at a national level and coordinates an annual meeting of postdoctoral scholars, their mentors and postdoctoral affairs staff. FSU is an affiliate member, so all postdocs at the FSU branch receive complementary membership to the NPA. Additionally, representatives from the lab attend the annual meeting regularly to stay up to date on the latest issues and initiatives related to postdoctoral affairs. The NPA provides direct support to postdocs through professional development and a virtual career center. (*MagLab contact: Kawana Johnson, Educational Programs*)

SciGirls National, Saint Paul, MN: This program is run by Twin Cities Public Television and provides both programming and resources for educators and girls to increase their interest and sense of belonging in STEM. CIRL utilizes these resources to train our summer camp educators and local teachers. In addition, CIRL's research has informed the SciGirls program and curriculum. *(MagLab contact: Roxanne Hughes, Educational Programs)*

Supporting Teachers to Encourage the Pursuit of Undergraduate Physics (STEP UP), Miami, FL: STEP UP is a national community of physics teachers, researchers and professional societies. They have designed high school physics lessons to empower teachers, create cultural change, and inspire young women to pursue physics in college. It is supported by NSF, APS Physics, AAPT and FIU. *(MagLab contact: Carlos R. Villa, Educational Programs)*

WFSU-TV, Tallahassee, FL: CIRL partners with WFSU-TV, the area's public television station, to administer SciGirls. The program includes two summer camps for middle school girls with an interest in science. The collaboration between the MagLab and WFSU-TV has resulted in a successful partnership that has lasted over a decade. *(MagLab contact: Roxanne Hughes, Educational Programs)*

1.10.5 SPIN OFFS OF RESEARCH LABORATORIES AND CORPORATIONS

Center for Advanced Power Systems (CAPS), Tallahassee, FL: The Center for Advanced Power Systems (CAPS) is a multidisciplinary research center organized to perform basic and applied research to advance the field of power systems technology. CAPS' emphasis is on application to electric utility, defense, and transportation, as well as developing an education program to train the next generation of power systems engineers. The research focuses on electric power systems modeling and simulation, power electronics and machines, control systems, thermal management, cyber-security for power systems, high temperature superconductor characterization and electrical insulation research*. (MagLab contact: Greg Boebinger)*

Future Fuels Institute, Tallahassee, FL: The Future Fuels Institute (FFI) was established to enhance the existing Ion Cyclotron Resonance (ICR) Program at the MagLab to deal specifically with bio- and fossil fuels, particularly for heavy oils and synthetic crudes. Supported by sponsoring companies and collaborative entities (instrument companies, universities, and research institutes), the FFI works to develop and advance novel techniques for research applications and industrial problem solving. Recent research has focused on biofuels and recycling efforts for petroleum-based materials (plastics). The institute also serves as a training center for fuel-related science and technology. It is currently part of an international joint laboratory (iC2MC), funded by TotalEnergies. (*MagLab contact/ Director: Ryan Rodgers*)

High-Performance Materials Institute (HPMI), Tallahassee, FL: The High-Performance Materials Institute (HPMI) is a multidisciplinary research institute for research and education in the field of advanced materials. Currently, HPMI is involved in four primary technology areas: High-Performance Composite and Nanomaterials, Structural Health Monitoring, Multifunctional Nanomaterials Advanced Manufacturing and Process Modeling. Over the last several years, HPMI has proven a number of technology concepts that have the potential to narrow the gap between research and practical applications of nanotube-based materials. These technologies include magnetic alignment of nanotubes, fabrication of nanotube membranes or buckypapers, production of nanotube composites, modeling of nanotube-epoxy interaction at the molecular level, and characterization of SWNT nanocomposites for mechanical properties, electrical conductivity, thermal management, radiation shielding and EMI attenuation. *(MagLab contact: Greg Boebinger)*

MagCorp, Tallahassee, FL: MagCorp is a new Tallahassee company that facilitates access to the world's leading magnetic experts to solve real world industrial problems. MagCorp was created to meet industry needs for feasibility studies, prototyping, and product development while eliminating the confusion that can come from partnering with academic institutions and research foundries. MagCorp is the world's one-stop shop for magnet science solutions and is the essential conduit between the private & government sectors and the MagLab. Leveraging completely new client & partner facing business models, MagCorp has already begun to attract industry to Tallahassee and put it on the map as the emerging magnetic capital of the world. (*MagLab contact: Greg Boebinger*)

MAXIKAT, Inc., Tallahassee, FL: Maxikat is a spinoff company that performs data analysis for petroleum industry. It was formed in 2015. *(MagLab contact: Vladislav Lobodin)*

Omics LLC, Tallahassee, FL: Omics LLC is a spinoff company that serves the data analysis and interpretation needs of the high-resolution mass spectrometry market. It was formed more than fifteen years ago and has grown over the years to address a wider analytical community. *(MagLab contact: Ryan Rodgers)*

2. USER FACILITIES

2.1 USER PROGRAM

2.1.1 PROPOSAL REVIEW PROCESS

Across all seven facilities, proposals for magnet time are submitted online via https://users.magnet.fsu.edu and reviewed in accordance with the MagLab User Proposal Policy. In brief, each user facility has a User Proposal Review Committee (UPRC) comprised of at least seven members, with more external members than internal. UPRC memberships are treated confidentially by the laboratory but are available for review by NSF and MagLab advisory committees. Proposal reviews are conducted in strict confidence and are based on two criteria: (1) the scientific and/or technological merit of the proposed research and (2) the "broader impacts" of the proposed work. They are graded online according to a scale, ranging from "A" (Proposal is high quality and magnet time must be given a high priority) to "C" (Proposal is acceptable and magnet time should be granted at MagLab discretion) to "F" (Proposal has little/no merit and magnet time should not be granted). The Facility Directors merge the UPRC recommendations with the availability and scheduling of specific magnets, experimental instrumentation, and user support scientists and make recommendations for magnet time assignments to the MagLab Director. The MagLab Director is responsible for final decisions on scheduling of magnet time based on these recommendations. All 2021 User Proposals can be found in **Appendix V.**

2.1.2 USER FUNDING OPPORTUNITIES

2.1.2.1 Dependent Care Travel Grant

The MagLab recognizes the extra demands outside of a research career placed on caregivers of children and other dependents. For caregivers, travel to the MagLab in order conduct experiments or to conferences to disseminate research findings often incurs extra costs for dependent care. In place since 2011, the MagLab's Dependent Care Travel Grant (DCTG) program offers up to $800 per year for travel expenses for MagLab scientists traveling to conferences or MagLab users traveling to any of the three MagLab facilities. Although no travel requests were made in 2021, largely due to the lack of in-person conferences and workshops, this funding source remains a highly valued avenue to promote equity among our workforces.

2.1.2.2 First Time User Support

The MagLab is charged by the National Science Foundation with developing and maintaining facilities for magnet-related research that are open to all qualified scientists and engineers through a peer-reviewed proposal process. Facilities are generally available to users without cost. In an effort to encourage new research activities, first-time users are provided financial support for travel expenses. International users are provided $ 1,000 of support and domestic users are provided $500 of support for their travel costs. This funding is provided by the State of Florida and is available for Tallahassee user facilities only.

2.1.2.3 Visiting Scientist Program

To apply for support from the Visiting Scientist Program, interested researchers are required to submit an application and a proposal that will be reviewed by appropriate facility directors and scientist at the MagLab. All requests for support must be submitted online at https://vsp.magnet.fsu.edu/. Because of COVID, no Visiting Scientist Program requests have been received in 2021.

2.1.2.4 User Collaboration Grants Program (UCGP)

The National Science Foundation charged the National High Magnetic Field Laboratory with developing an internal grants program that utilizes the NHMFL facilities to carry out high quality research at the forefront of science and engineering and advances the facilities and their scientific and technical capabilities. User Collaboration Grants Program (UCGP), established in 1996, stimulates magnet and facility development and provides intellectual leadership for research in magnetic materials and phenomena.

The Program strongly encourages collaboration between NHMFL scientists and external users of NHMFL facilities. Projects are also encouraged to drive new or unique research, i.e., serve as seed money to develop initial data leading to external funding of a larger program. In accord with NSF policies, the NHMFL cannot fund clinical studies.

Twenty-two (24) UCGP solicitations have now been completed with a total of 603 pre-proposals being submitted for review. Of the 603 proposals, 320 were selected to advance to the second phase of review, and 145 were funded (24.05% of the total number of submissions).

2021 Solicitation Skipped

There was no UCGP solicitation in 2021, so that awards would not be split between existing and renewed NHMFL core grants. The last solicitation was held in 2020, and awards from it were made in early 2021. Results from that solicitation are summarized in the 2020 Annual Report. The 2022 Solicitation announcements should be released around April 2022. Awards from the 2022 solicitation will be announced by the end of the year and made in early 2023.

Results Reporting

To assess the success of the UCGP, reports were requested in January 2022, on grants issued from the five solicitations which had start dates from 2016 through 2021. At the time of the reporting, some of these grants were in progress, and some had been completed. For this “retrospective” reporting, PIs were asked to include external grants, NHMFL facilities enhancements, and publications that were generated by the UCGP. Since UCGP grants are intended to seed new research through high-risk initial study or facility enhancements, principal investigators (PIs) were allowed and encouraged to report results that their UCGP grant had made possible, even if these were obtained after the term of the UCGP grant was complete.

The PIs reported:

- Lab enhancements, which are listed in **Table 2.1.2.4.1** below.
- At least partial support for 8 undergraduate researchers, 23 graduate students and 14 postdocs.
- 18 funded external grants, which were seeded by results from UCGP awards. The total dollar value of the external grants was $33.2M, of which $10.5M was an Energy Frontier Research Center, and $15.6M was a MRSEC.
- 146 publications, many in high profile journals, including 6 in *JACS*, 2 in *Nature*, 10 in *Nature Communications*, 3 in *Nature Physics,* 1 in *Nature Quantum Materials,* 4 in *Physical Review Letters*, 4 in *PNAS* and 2 in *Science.*

Table 2.1.2.4.1: *Facility Enhancements Reported from last five UCGP Solicitations*

Enhancement and Available Date	**Users ***
Software to model proteins of bacteria from isotopically depleted media (1/20)	1
PEPPI-MS for eluting proteins from polyacrylamide gels	2
GUPPI software for proteonomic analysis	1
3GPa proximity detector (7/19)	1
Tunnel diode oscillator to 7 GPa (12/19)	1
Heat capacity in 32T superconducting magnet (1/22)	5
35T heat capacity with angle dependence and 5fJ/T resolution (8/21)	2
System for continuous flow 97% para enrichment at 30K (12/19)	4
Time-domain THz spectroscopy using TOPTICA Teraflash system (11/17)	3
Coil winder for AC susceptibility (10/16)	5
Hybrid piston cylinder cell (10/16)	2
High-temperature, high-resolution NMR (11/16)	9
Two-channel homodyne pulsed NMR spectrometer (9/17)	1
Customized Razorbill piezo for uniaxial strain, for 31 T (6/19)	3
Piezoelectric strain device for pulse fields (1/21)	1
Torque magnetometer for critical current measurements (10/20)	2
FPGAs for faster resistive critical current measurement (10/21)	1
Strong rotator probe to simulate flux jumps in REBCO magnets (4/21)	1
Superconducting transformer for 45kA test of superconducting cable (9/20)	1
Thermo Ultimate 3000 sample prep for 21T ICR	2
Instrumentation and software for measurements of high resistance tunnel junctions (2/21)	2
mK faraday Force magnetometer (6/15)	1
Pulsed EPR at 395GHz (5/18)	3
Quasioptical beam transport in MAS DNP 600MHz NMR (11/17)	12

* Number of external users (PI’s or private companies only) reported to have used the enhancement.

2.1.3 ANNUAL USER SURVEY

The MagLab conducted its eleventh annual user survey between June 2, 2021, and June 30, 2021. This annual survey assists all seven facilities in responding to user needs, improving facilities and services, and guides the MagLab in setting priorities and planning for the future. This request was sent to all MagLab User Principal Investigators (PI) and to their collaborators who received magnet time between March 1, 2020, and May 31, 2021, including PIs who sent samples where the experiment was performed by laboratory staff scientists. Due to COVID-19 impacts, the MagLab extended the surveyed users starting March 1 instead of the usual May 1st. From 648 eligible users, we received feedback from 106 (16.3%) users. 11% of all external users responded to the survey. All user responses were treated as confidential. **Figures 2.1.3.1-2.1.3.7** exclude internal responses.

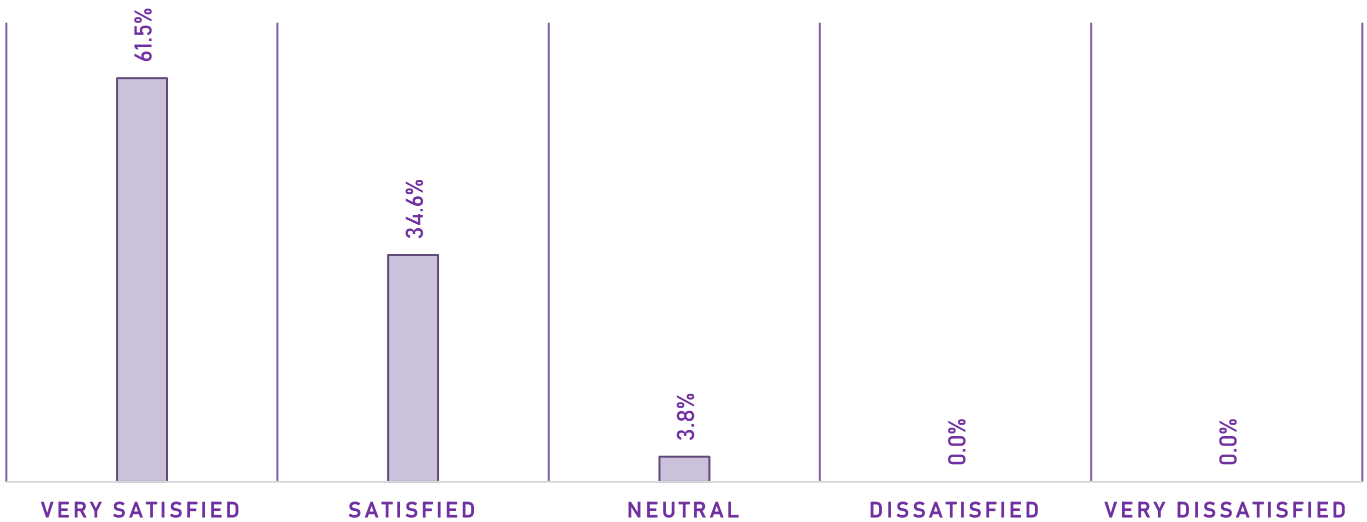


Figure 2.1.3.1: *96.2% of external users were satisfied or very satisfied with the proposal process (e.g., submission, review).*

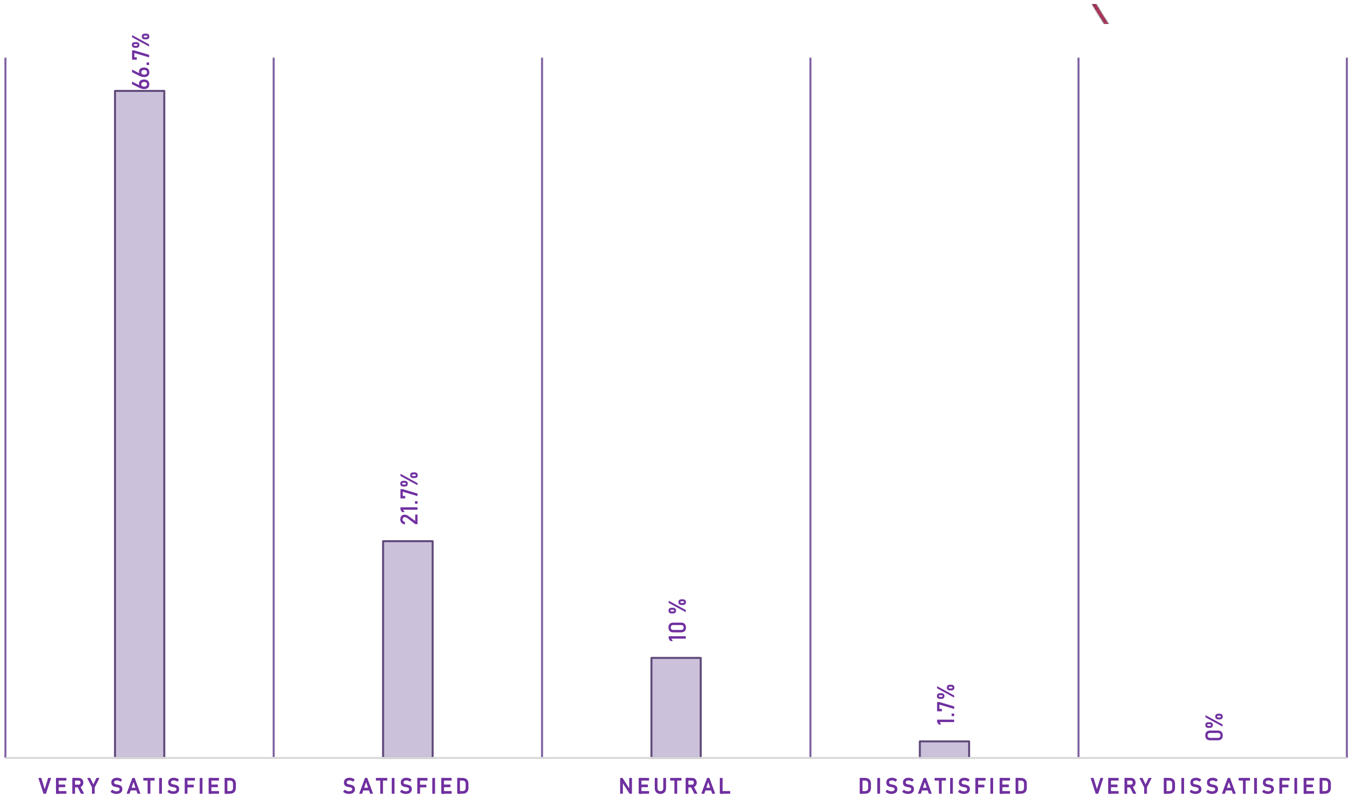


Figure 2.1.3.2: *88.3% of external users were satisfied or very satisfied with the availability of the facilities and equipment.*

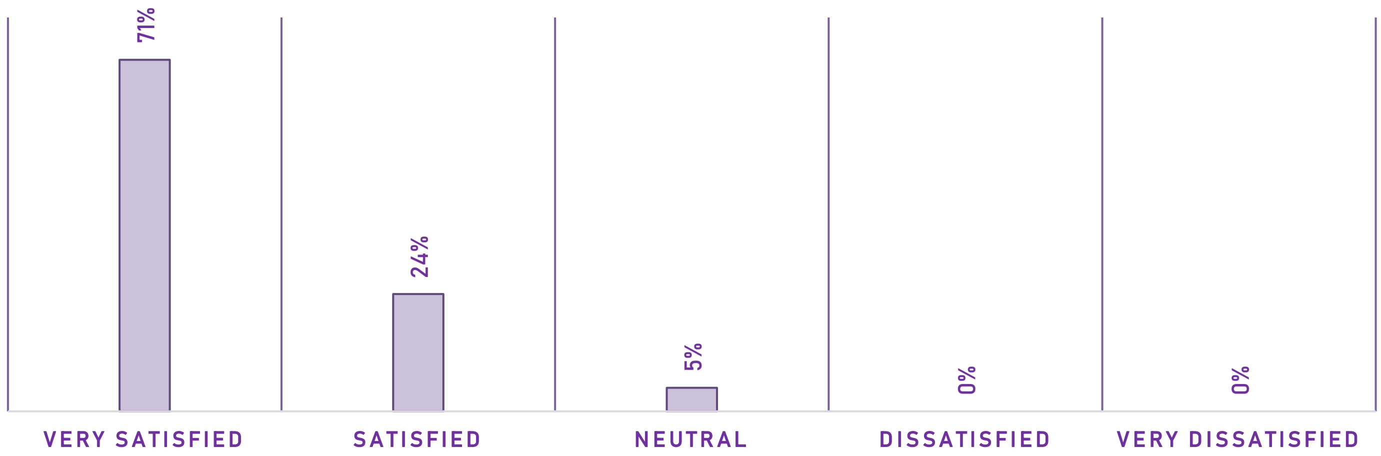


Figure 2.1.3.3: *95% of external users were satisfied or very satisfied with user friendliness of training and safety procedures.*

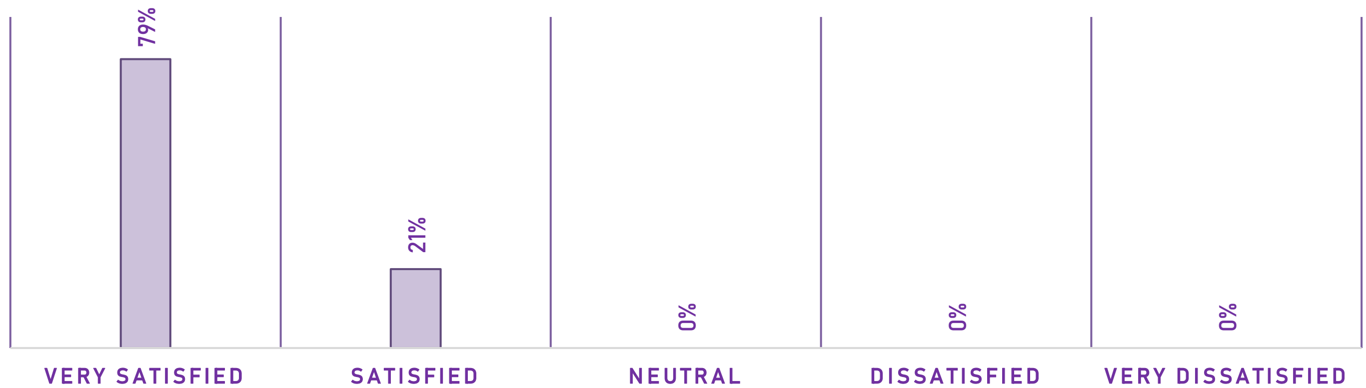


Figure 2.1.3.4: *100% of external users were satisfied or very satisfied with the overall safety at the MagLab.*

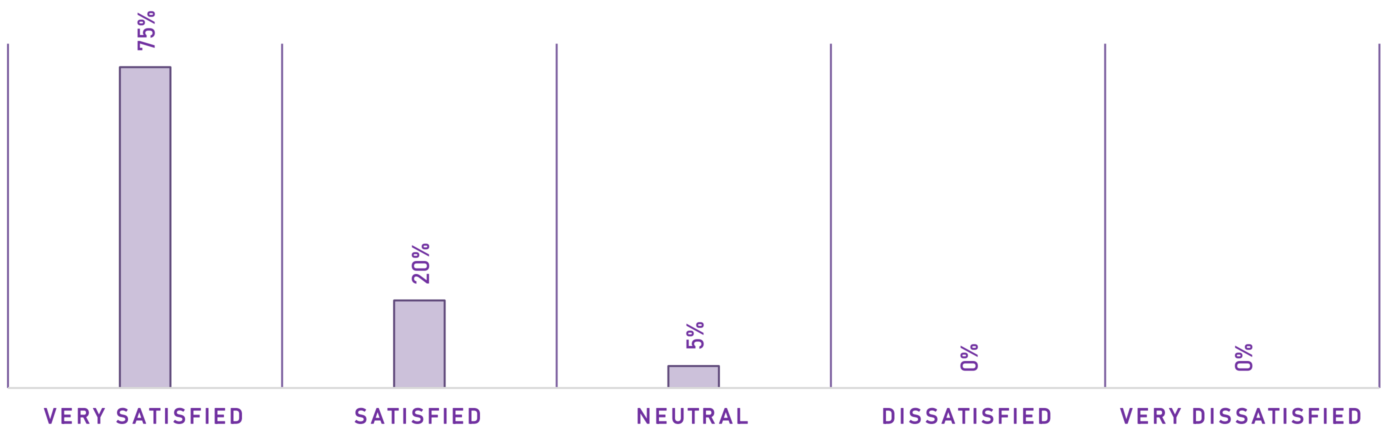


Figure 2.1.3.5: *95% of external users were satisfied or very satisfied with the performance of facilities and equipment (e.g., were they maintained to specifications for intended use, ready when scheduled, etc.).*

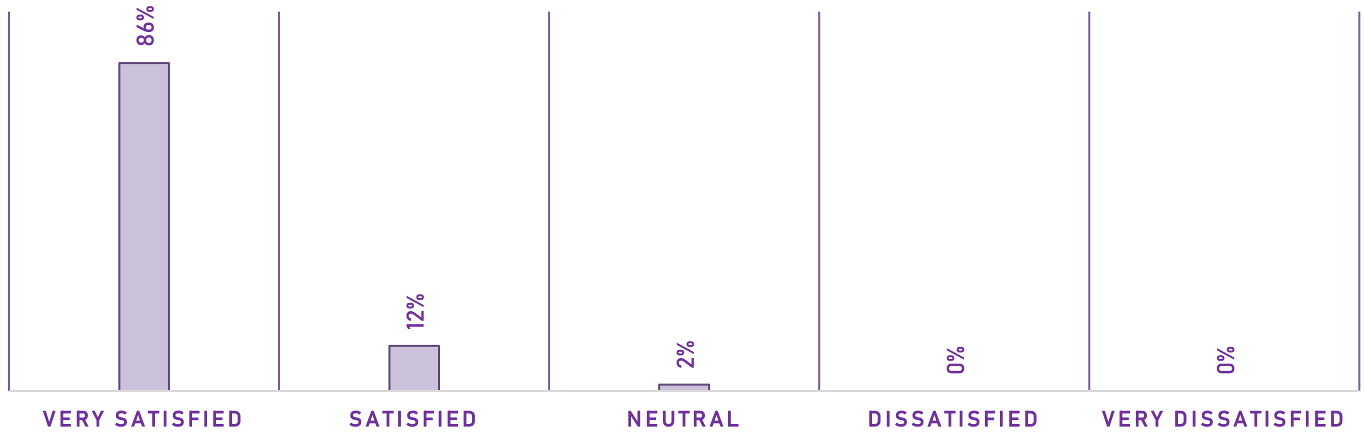


Figure 2.1.3.6: *98% of external users were satisfied or very satisfied with the assistance provided by MagLab facilities technical staff.*

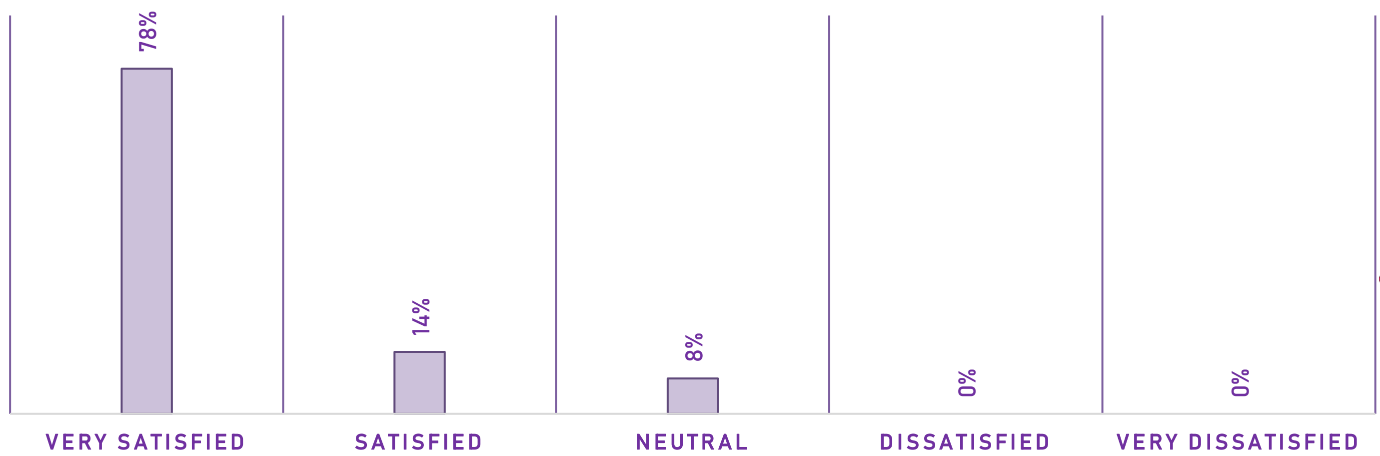


Figure 2.1.3.7: *92% of external users were satisfied or very satisfied with the assistance provided by MagLab facilities administrative staff.*

2.1 SEVEN USER FACILITIES

The geographical distribution of our users' organizations can be found on our website.

2.2.1 AMRIS FACILITY

The AMRIS Facility at University of Florida supports nuclear magnetic resonance spectroscopy (NMR) and magnetic resonance imaging (MRI) studies of chemical compounds, biomolecular systems, tissues, small animals, large animals and humans. We offer fourteen systems with different magnetic fields and configurations to users for magnetic resonance experiments. AMRIS has fifteen professional staff members to assist users, maintain instrumentation, build new coils and probes, and help with administration.

2.2.1.1 Unique Aspects of Instrumentation Capabilities

AMRIS Magnetic Resonance instruments **(Table 2.2.1.1),** offer users unique capabilities: the 750MHz wide bore provides outstanding high-field imaging for excised tissues and small animals, as well as diffusion measurements with gradient strengths up to 30T/m; the 11.1T horizontal MRI has a large 400mm bore size and gradient strengths up to 1.5T/m; the 600MHz 1.5mm HTS cryoprobe is the most mass-sensitive NMR probe in the world for ^{13}C detection and is ideal for natural products research; the 5T DNP polarizer enables both fundamental studies of DNP mechanisms down to 1.2K as well as *in vivo* metabolism measurements when coupled to either the 4.7T or 11.1T systems. The 3.35T DNP polarizer enables perfused organ studies to be conducted in two of the 600MHz NMR spectrometers. Two spectrometers are now equipped with state-of-the-art Bruker NEO hardware, which support multichannel transmit and receive experiments. These systems support a broad range of science, including natural product identification, membrane protein structure determination, cardiac studies in animals and humans and correlation of neural structures with brain function and chemistry.

Table 2.2.1.1: *NMR & MRI Systems in the AMRIS Facility at UF in Gainesville*

^{1}H Frequency	Field (T), Bore (mm)	Homogeneity	Measurements
800MHz	18.8, 63	1ppb	Solution/solid-state NMR and HR-MAS
800MHz	18.8, 54	1ppb	Solution NMR (Cryoprobe)
750MHz	17.6, 89	1ppb	Solution/solid-state NMR and MRI/S
600MHz	14.1, 51	1ppb	NMR, microimaging, hyperpolarization
600MHz	14.1, 89	1ppb	NMR and hyperpolarization
600MHz	14.1, 54	1ppb	Solution NMR (Cryoprobe)
600MHz	14.1, 54	1ppb	Solution NMR (HTS Cold Probe)
500MHz	11.7, 54	1ppb	Solution/solid-state NMR
470MHz	11.1, 400	0.1ppm	DNP, MRI and NMR of animals
212MHz	5.0, 89	1ppm	DNP polarization
200MHz	4.7, 330	0.1ppm	DNP, MRI and NMR of animals
143MHz	3.35, 52	1ppm	DNP polarization
128MHz	3.0, 900 (600 for subjects)	0.1ppm	MRI/S of humans, large animals
128MHz	3.0, 900 (700 for subjects)	0.1ppm	MRI/S of humans

2.2.1.2 Facility Developments and Enhancements

The 600MHz wide bore (89mm) system was upgraded to the latest generation Bruker NEO console, allowing multichannel transmit and receive experiments, while maintaining its full range of ^{19}F experiments. This upgrade includes, once delivered, a four channel $^{1}H/^{19}F/X/Y$ 1.9mm MAS probe, which will significantly expand our MAS capabilities. The 800MHz standard bore system with dedicated 5mm Cryoprobe has been upgraded with an automated sample changer. All of our NMR systems can be run remotely by users and three systems now have sample changers to enhance user throughput. A 3.0T Philips Ingenia Elition X, 70cm bore MRI scanner was installed in May 2020 and is fully operational for users. It features a 70cm bore and includes the latest acquisition techniques for human MRI research such as multinuclear capabilities, functional MRI (fMRI), advanced diffusion imaging (dMRI), magnetic resonance elastography (MRE), spectroscopy (MRI/S), and whole-body scanning. One of the 600MHz systems suffered a spontaneous quench, which has prevented operations in the latter half of 2021. Plans are in place to bring this system back to full operations by repairing or replacing the magnet. All other high field systems (≥11T) have been kept fully operational despite the ongoing pandemic conditions, with users offered remote access where appropriate.

2.2.1.3 Major Research Activities and Discoveries/ Research Science Highlights

Despite the challenges posed by the ongoing COVID-19 pandemic, our users have continued to collect data through the tireless efforts of our staff to provide on-site support while users mail samples to us and collect data by controlling the spectrometers remotely. Local graduate students and postdoctoral fellows were able to continue developing DNP hyperpolarization and *in vivo* spectroscopy techniques for metabolic studies. Many users pursued quantitative studies for metabolomics and structural biology. AMRIS facility users reported 71 peer-reviewed publications and eight theses and dissertations during 2021, despite access and personnel restrictions in place since March 2020. Two notable examples from the publications and graduate research projects are listed below.

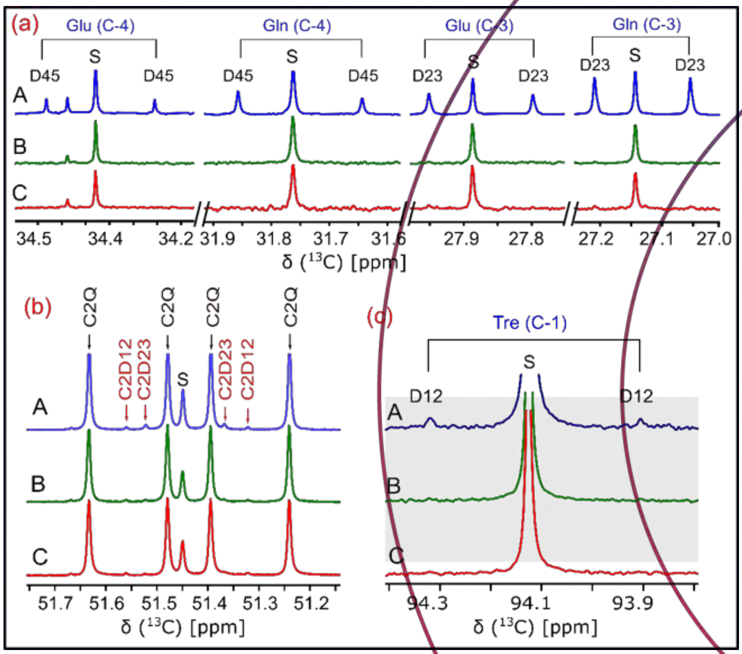


Figure 2.2.1.3.1: Representative stacked spectra from metabolic stages of pupae during the dormancy period: A) interbout of metabolic arousal (IBA), B) early metabolic depression, and C) late metabolic depression. ***(a)*** *^{13}C NMR spectra of glutamate-C3, glutamine-C3, glutamate-C4, and glutamine-C4 in flesh fly pupae injected with [U-^{13}C]alanine;* ***(b)*** *alanine recycled through pyruvate kinase (PK) flux: C2D12 and C2D23 represent [1,2-^{13}C]alanine and [2,3-^{13}C]alanine, whereas C2Q signals represent [U-13C]alanine;* ***(c)*** *^{13}C NMR spectra of labeled trehalose C-1. S, singlet; D12, D23 and D45, doublet; Q, quartet.*

HTS NMR Probe Tracks Metabolism Cycles during Insect Dormancy

Rohit Mahar and Matthew E. Merritt, Department of Biochemistry and Molecular Biology; Chao Chen and Daniel A. Hahn, Department of Entomology and Nematology, University of Florida, Gainesville, FL; and David L. Denlinger, Department of Entomology, Ohio State University, Columbus, OH, USA

Funding: NHMFL (NSF DMR-1644779, G. Boebinger); Merritt (NIH P41-122698); Hahn (NSF IOS 1257298 and DEB 163900); United Nations FAO/IAEA Coordinated Research in Insect Dormancy Management

Citation: Chen, C.; Mahar, R.; Merritt, M.E.; Denlinger, D.L.; Hahn, D.A., ROS and hypoxia signaling regulate periodic metabolic arousal during insect dormancy to coordinate glucose, amino acid, and lipid metabolism, Proceedings of the National Academy of Sciences of the USA (PNAS), 118 (1), 603118 (2021)
https://doi.org/10.1073/pnas.2017603118

Surviving long periods without eating is a challenge which insects confront during pupation. The flesh fly, *Sarcophaga crassipalpis*, is a model known to cycle metabolic products effectively during this dormant stage. It can survive the diverse changes in its environment through hormonal regulation and metabolic homeostasis. Intermediary metabolism and respiration is naturally diminished within a hypoxic state of burning glucose via glycolysis during this period, but its metabolism also periodically cycles to enable aerobic respiration in order to engage mitochondria to replenish the pupal nutrient stores and clear anaerobic byproducts. The nutrient and waste cycles which occur during insect diapause are quite similar to mammalian torpor-arousal cycles, offering clues to the critical control mechanisms related to suppression of metabolic functions during organ transplantation.

^{13}C-nuclear magnetic resonance (NMR) spectroscopy is chemically selective, allowing direct assessment of how ^{13}C is incorporated into downstream metabolites. Positional ^{13}C, spin-spin multiplets, and [U-^{13}C]alanine tracers measure changes occurring through multiple pathways including anaplerotic and pyruvate oxidative fluxes, pyruvate cycling, and trehalose synthesis during the metabolic arousal stage (**Figure 2.2.1.3.1**). The outstanding sensitivity of the ^{13}C HTS probe at the AMRIS Facility allows acquisition from a single pupa, enabling this study using multiple tracers in a time efficient manner.

Restoration of breathing after drug overdose and spinal cord injuries

Michael D. Sunshine, Thomas H. Mareci, Kevin J. Otto, David D. Fuller, University of Florida, Gainesville, FL, USA; Antonino Cassara and Esra Neufeld, Foundation for Research on Information Technologies in Society (IT'IS), Zurich, Switzerland; Nir Grossman, Imperial College London, London, SW7 2BU, United Kingdom; Edward S. Boyden, Howard Hughes Medical Institute, Cambridge, MA, USA

Funding: NHMFL (NSF DMR-1644779, G. Boebinger); Sunshine (NIH F31HL145931); Fuller (NIH R21NS109571)

Citation: Sunshine, M.; Cassara, A.; Neufeld, E.; Grossman, N.; Mareci, T.H.; Otto, K.; Boyden, E.; Fuller, D., Restoration of breathing after opioid overdose and spinal cord injury using temporal interference stimulation, Communications Biology, 4 (1), 1-15 (2021) https://doi.org/10.1038/s42003-020-01604-x

Respiratory insufficiency is a leading cause of death from opioid overdose. Electrical stimulation under a temporal interference (TI) protocol could be used to restore breathing while first responders apply other life-saving treatments. Electrodes placed onto the neck can activate the diaphragm to rhythmically stimulate a respiratory rate of 12-16 breaths per minute. The evoked response to this electrical activation may sufficiently restore ventilation and arterial blood oxygenation during the overdose period. Additionally, this method may be introduced through epidural insertion directly to the cervical spine, to prevent fatality from cessation of breathing in patients with chronic spinal cord injuries, thus providing an attractive alternative to manual ventilation techniques.

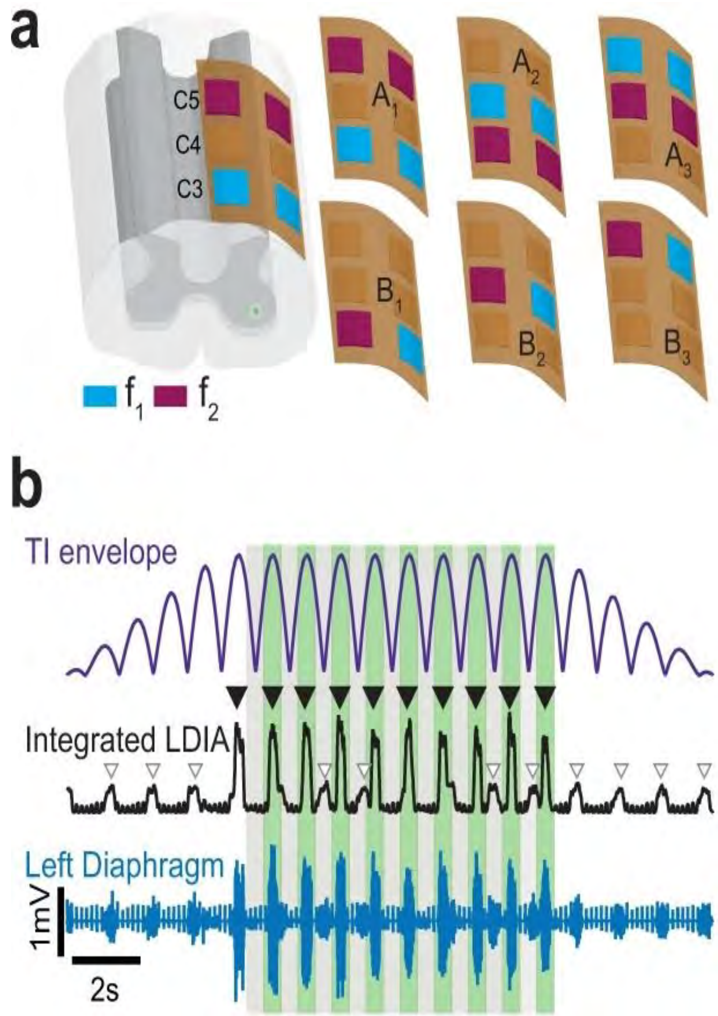


Figure 2.2.1.3.1.2: (a) Epidural electrode grid C3-C5 with three bipolar (A1, A2, and A3) and three monopolar configurations (B1, B2, and B3); actual wire width is 25 µm. (b) Temporal interference (TI) stimulation of respiratory activity during TI peak (green boxes) and trough (gray boxes) over the period of stimulation.

MRI was used to monitor neurological and physiological behavior in healthy and spinal cord injury rat models using the 4.7T scanner at the AMRIS Facility. Important to this study, shown **Figure 2.2.1.3.2**, the MRI scanner was used to determine placement of intramuscular electrodes relative to spinal segments, in order to determine which electrode locations, waveforms, and configurations could sufficiently activate the diaphragm while reducing off target effects, such as forelimb muscle activation.

2.2.1.4 Facility Plans and Directions

In spite of the COVID-19 pandemic and continued challenging budgetary climate, our users have consistently and successfully pursued federal funding to support their research programs in addition to assisting the AMRIS facility in writing proposals to upgrade instrumentation. The successful partnership of the MagLab user program with individual investigator research grants provides constant scientific motivation for our technology development. In 2021 we were awarded a $2 million NIH grant to purchase a state-of-the-art preclinical 7T MRI and spectroscopy scanner. The system will be installed in summer 2022, enhancing our imaging capabilities, and replacing the 4.7T MRI which has reached end-of-life (purchased 1988 and last upgraded 2010). It includes the capability for imaging cryoprobes that will greatly increase sensitivity. The new scanner will be used to non-invasively examine anatomy and physiology, such as measuring brain structure and function, monitoring muscle fitness and examining metabolism *in vivo*. Construction of a Low-E MAS probe at 800MHz was begun and will greatly enhance our high field MAS capabilities; it is expected to be in operation by early summer 2022. A commercial 1.3mm 800MHz MAS probe is on order, with delivery scheduled for spring 2022. Through our NIH P41 technology development grant, construction of a new 3mm HTS cryoprobe for use with the state-of-the-art Bruker NEO console will soon begin. The 600MHz system supporting the HTS cryoprobe, our last Agilent system, will be upgraded with a Bruker console in April 2022, aligning all systems in AMRIS to Bruker hardware and software, improving knowledge transfer and interoperability between them. The 750MHz console (last upgraded in 2013) is aging, and plans are in place to upgrade to the latest Bruker NEO generation, which will include improved frequency-compensated gradients, making it cross compatible with other AMRIS MRI/S systems and the NHMFL 900MHz system in Tallahassee. This will provide users with state-of-the-art MRI/S instrumentation at four different field strengths—7, 11.1, 17.6, and 21.1T, allowing users facile field-dependent studies.

2.2.1.5 Outreach to Generate New Proposals-Progress on STEM and Building User Community

Historic AMRIS outreach venues remained inaccessible throughout 2021 due to the COVID-19 pandemic. We experienced challenges of local closures, frequent event calendar changes that led to cancellations, withdrawal of students from public classrooms into virtual or homeschooling options, and strict restrictions on visitor access to school campuses and to the University of Florida. Despite this, our Research and Outreach Coordinator, Amy Howe, was able to maintain classroom outreach to local schools using virtual methods, reaching 130 Title-1 elementary (K-5) students with a combination of interactive video sessions and magnet loaner-kits, allowing hands-on activities to occur inside the school's own socially distanced settings. The number of students reflects a 68% decrease from previous years; however, student contact time per session increased from the previous average of 40-45min per session to 60-75min (up to 90min) because the students' schedules were not as rigid as they were not moving between classrooms or teachers during the day. In addition, the loaner kits were designed for prolonged individual use of the materials, and to be easily sanitized between students, allowing activities and lessons to continue for at least two additional class days beyond the virtual outreach session.

All of our traditional secondary (6-12) and collegiate outreach activities were cancelled or shifted to virtual formats for the 2021 calendar year, and outside visitors were strictly prohibited at the facilities, except in outdoor or well-distanced settings that excluded many of our laboratory spaces. To address this challenge, we shifted our focus to local groups, whose access to campus fell under different restrictions, so half of our total annual contacts (126 college students and instructors) were UF-affiliated students and staff that were reached through virtual course lectures, online seminars, and small group tours. The remainder came from leadership participation in the MagLab Research Experiences for Undergrads (REU) and Teachers (RET) programs. We expect some of our previous historical activities to remain in a virtual format in the future, or at least to maintain some virtual component to increase the reach from any small in-person event. Likewise, our in-person activities remain limited as of December 2021.

2.2.1.6 Facility Operations Schedule

The AMRIS facility operates year-round, except during the last week of December when the University of Florida is shut down. Vertical instruments for *ex vivo* samples are scheduled 24/7, including holidays and weekends. Horizontal instruments operate primarily 8-10 hours/day, 5 days/week due to the difficulty in running animal or human studies overnight, with the except of 11.1T scanner which operates at 7 days a week due to oversubscription. By January 2021, mandatory COVID-19 testing and masking requirements were in place to allow UF faculty, students, and staff to return to work on campus as desired. A slow ramp up of on-campus operations continued until the full return of on-campus operations for the fall semester in August 2021. With AMRIS staff as essential personnel to facilitate users to operate instruments remotely, NMR operations continued at normal levels throughout the year. However, experiments involving animal or human subjects experienced impacts from the limited schedule imposed to allow greater physical distancing. Overall operations were sustained at 50-60% of our normal levels, then increased to ~80% after August. Most external users were not allowed to visit campus until after October, and many remained under travel restrictions imposed by their home institution or travel base throughout the calendar year. Even with these restrictions in place, we were able to provide external users with access to NMR spectrometers though staff support (loading of samples) and remote access of consoles.

2.2.2 DC FIELD FACILITY

The DC Field Facility in Tallahassee serves a large and diverse user community by providing continuously variable magnetic fields in a range and quality unmatched anywhere in the world. The DC Field user community is made up of undergraduate students, graduate students, post docs and senior investigators from around the country and the world. State-of-the-art instrumentation is developed and coupled to these magnets through the efforts of our expert scientific and technical staff. The users of the DC Field Facility are supported throughout their visit by the scientific, technical and administrative staff to ensure that their visit is as productive as possible. The interaction between the NHMFL scientific and technical staff with the students, post docs and senior investigators who come to the DC Field Facility to perform their research results in a continuous mix of scientific ideas and advanced techniques that are passed both to and from users.

2.2.2.1 Unique Aspects of Instrumentation Capabilities

Table 2.2.2.1: *DC Field Magnets*

FLORIDA-BITTER and HYBRID MAGNETS		
Field, Bore, (Homogeneity)	**Power (MW)**	**Supported Research**
45T, 32mm, (25ppm/mm)	30.4	Magneto-optics – ultra-violet through far infrared; Magnetization; Specific heat; Transport – DC to microwaves; Magnetostriction; High Pressure; Temperatures from 30mK to 1500K; Dependence of optical and transport properties on field, orientation, etc.; Materials processing; Wire, cable, and coil testing. NMR, EMR, and sub/millimeter wave spectroscopy.
41.5T, 32mm, (25ppm/mm)	32	
36T, 40mm, (1ppm/mm)[2]	14	
35T, 32mm (x2)	19.2	
31T, 32mm to 50mm[1] (x2)	18.4	
25T, 32mm bore (with optical access ports)[3]	27	
SUPERCONDUCTING MAGNETS		
Field (T), Bore (mm)	**Sample Temperature**	**Supported Research**
32T, 34mm	14mK – 300K	Magneto-optics – ultra-violet through far infrared, Magnetization, Specific heat, Transport – DC to microwaves, Magnetostriction; High pressure, Temperatures from 20mK to 300K, Dependence of optical and transport properties on field, orientation, etc. Low to medium resolution NMR, EMR, and sub/millimeter wave spectroscopy.
18/20T, 52mm	20mK – 1K	
18/20T, 52mm	0.3K – 300K	
17.5T, 47mm	4K – 300K	
10T, 34mm[3]	0.3K – 300K	
9T, 25mm[4]	2.0K – 325K	
7T, 7mm[4]	2.0K – 325K	

[1] A coil for modulating the magnetic field and a coil for superimposing a gradient on the center portion of the main field are wound on 32mm bore tubes.
[2] Higher homogeneity magnet for magnetic resonance measurements.
[3] Optical ports at field center with 4 ports each 11.4° vertical x 45° horizontal taken off of a 5mm sample space.
[4] Quantum Design PPMS and MPMS user "on-ramp" magnet systems.

Table 2.2.2.1 lists the magnets in the DC Field Facility. The MagLab leads the world in available continuous magnetic field strength, number of high field DC magnets available to users and accessibility for scientific research. The 45T hybrid magnet is the highest field DC magnet in the world, which is reflected in the number of proposals from international PIs. The 41.5T resistive magnet is the highest field resistive magnet in the world. The 36T Series Connected hybrid magnet features two configurations: a 40mm bore, with 1ppm homogeneity for chem/bio-NMR experiments and a 48mm bore with 20ppm homogeneity for condensed matter physics experiments in a top-loading cryogenic system. The 35T, 32mm bore and 31T, 50mm bore resistive magnets are coupled to top loading cryogenic systems that have impressive performance, flexibility and ease of use. The 25T Split-Helix magnet is the highest field direct optical access / scattering magnet in the world. With four optical ports located at field center each having a 11.4° vertical x 45° horizontal taken off of a 5mm opening, the ability to perform ultrafast, time resolved and x-ray scattering experiments are now a reality at high magnetic fields. The 32T, 34mm bore all-superconducting magnet saw its first use by an external user in 2020 for condensed matter NMR experiments on a quantum spin-nematic compound.

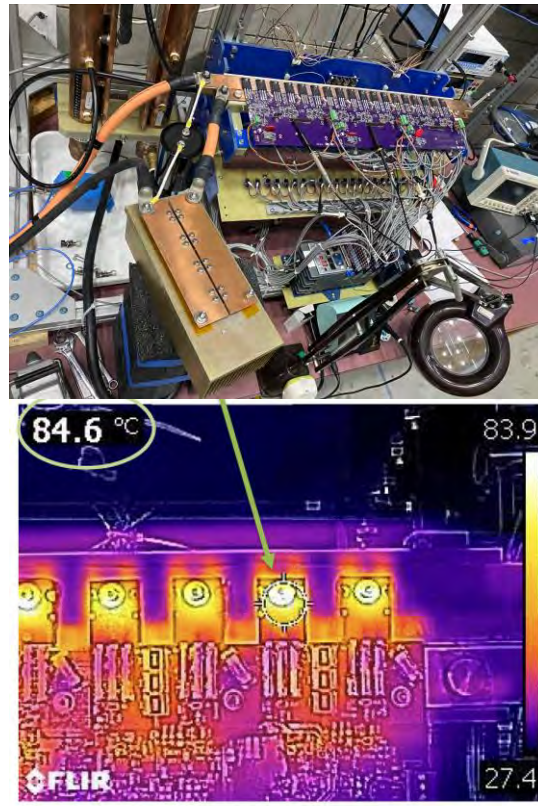


Figure 2.2.2.2.1 *top: MOSFET bank testing setup. bottom: thermal image of bank in operation.*

2.2.2.2 Facility Developments and Enhancements

Progress on Power Supply Upgrade Project

Work on the project to upgrade to the active filters on the four, 14MW power supplies proceeded as planned in 2021. Stable operation of a single bank of MOSFET modules **(Figure 2.2.2.2.1 top)** at an output current of 337.5A was achieved meeting the design goals for current and ripple. Thermal testing of the module **(Figure 2.2.2.2.1 bottom)** provided engineers with critical information as to the ability of the design to transfer heat from the individual MOSFETs to the water-cooled heat sink they are mounted to. Based on the data from these tests MagLab engineers are working to further optimize the heat transfer between the MOSFETs and the heat sink to provide a greater operating margin.

Noise Reduction in High-Field FIR Measurements

Significant progress was made in the ongoing effort to increase the signal-to-noise ratio (S/N) for FIR measurements in Cell 8 (35T). DC Field Facility Research Faculty member Mike Ozerov designed and built a new low-noise preamplifier that replaces the mainstay PAR113 preamplifier used previously. One of the several benefits of designing and building a bespoke preamplifier is that it can be mounted directly to the top of the probe, greatly reducing the unamplified cable length that the bolometer signal has to travel before it is brought into the spectrometer, thus eliminating the microphonic noise that had been present previously in the cable linking the probe to the preamplifier. The improvement between the two amplifiers is shown in **Figure 2.2.2.2.2** with an ***87% decrease in the observed electrical noise*** including RF pickup from ambient sources. Ozerov next turned his attention to redesigning the bolometer circuitry itself to replace the single 10M ohm resistor used to couple the bolometer to the preamplifier with an array of smaller surface mount resistors. **Figure 2.2.2.2.3** dramatically shows how much lower magnetic background of the new resistors resulted in a ***factor of 8 reduction in the measured dark signal noise at 35T***.

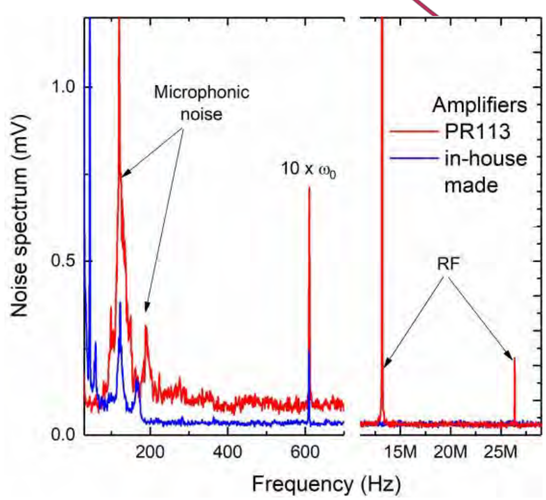


Figure 2.2.2.2.2: *Plot showing noise reduction from new FIR preamplifier.*

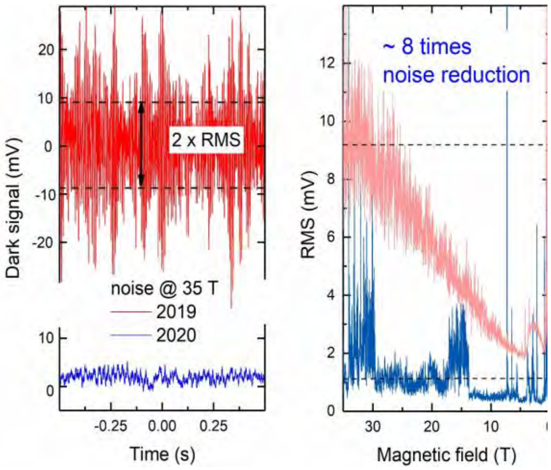


Figure 2.2.2.2.3: *Plot showing dark noise reduction from redesigned bolometer circuitry.*

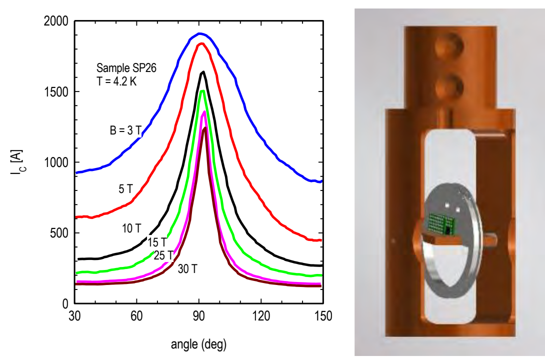


Figure 2.2.2.2.4: *Plot showing critical current as a function of angle and field at 4.2 K for a REBCO conductor and a mechanical model of the sample holder.*

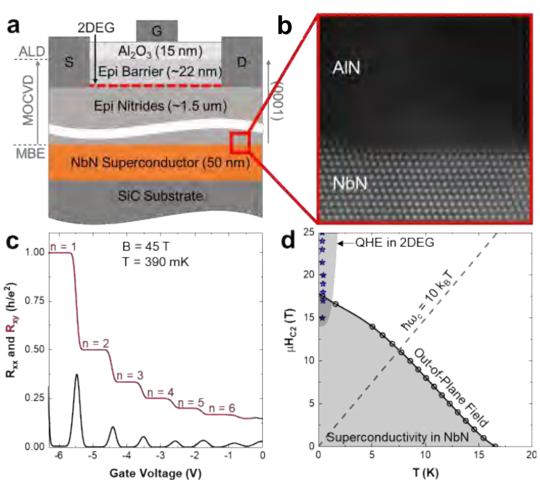


Figure 2.2.2.3.1: a) *Layer structure of the epitaxial nitride heterostructure.* ***b)*** *High-resolution transmission electron microscopy image of the semiconductor /superconductor interface.* ***c)*** *The quantum Hall effect in the GaN semiconductor.* ***d)*** *The temperature and magnetic field region where superconductivity in NbN and the quantum Hall effect in GaN coexist.*

Development of Torque Magnetometry for Anisotropic, Large Magnetic Moment Materials.

Torque magnetometry measurements are commonly performed at the DC Field Facility on samples that are typically small (less than 0.5mm on a side) that have small magnetic moments ($M<10^{-6}\mu_B$). These constraints are due to the mechanical properties of the cantilevers used to measure the torque. Larger, higher magnetic moment samples are measured in a vibrating sample magnetometer (VSM), but the VSM is not able to perform angular studies of anisotropic materials. A team of researchers led by Jan Jaroszynski has developed a torque magnetometer **(Figure 2.2.2.2.4)** for high magnetic moment, anisotropic samples which is able to measure the absolute value of torque generated, thereby providing the absolute value of the magnetic moment of the sample being measured. For Jaroszynski and his team, the motivating material was REBCO thin film superconducting tape where an accurate measurement of the magnetization versus angle at high field would also yield the critical current (J_c) of the tape versus angle at high field. Using this method, critical current data can be taken much more quickly (hours vs. days) than the traditional high current measurement approach. The torque method has the added benefit of ensuring that the sample is in thermal equilibrium with its surroundings as it is not necessary to push hundreds of amps through a sample to determine J_c.

2.2.2.3 Major Research Activities and Discoveries/ Research Science Highlights

Users from Cornell University explored the possibility of using the epitaxially grown materials NbN and GaN in combination as a ***potential host for topological superconductivity.*** This is done by creating the conditions via a heterostructure, gate voltage and magnetic field where the integer quantum Hall effect (IQHE) state and superconductivity (SC) would exist at the same time. The advantage of this approach is that the growth parameters and properties of these widely used, technologically important materials are well understood so that if such a state can be realized, then the route to potential device fabrication would be much shorter. The research showed that in the tested heterostructures the IQHE and SC states coexisted for temperatures below 1K and magnetic fields below 18T. High magnetic field measurements were necessary to determine where in the H-T phase diagram the two states would exist and potentially co-exist. The region above the gray dashed line in **Figure 2.2.2.3.1** (d) shows the region expected by theory where robust IQHE states would form at lower electron densities in the 2-dimensional electron gas pointing to a region of future exploration. This work was published in ***Science Advances.***

The search for a better understanding of the mechanism behind ***exchange bias in magnetic materials*** was undertaken by MagLab users from the University of California, Berkeley with the study of Fe_xNbS_2 via NMR and magnetization at high fields. Fe_xNbS_2 is a unique material in that it is able to support an ordered anti-ferromagnetic state and a disordered spin-glass state simultaneously. The investigation yielded surprising results (**Figure 2.2.2.3.2)** that showed the magnitude of the exchange bias observed in Fe_xNbS_2 is a factor of 100 larger than what has been observed previously in engineered thin film materials. These results provide an insight into the role disorder plays in the

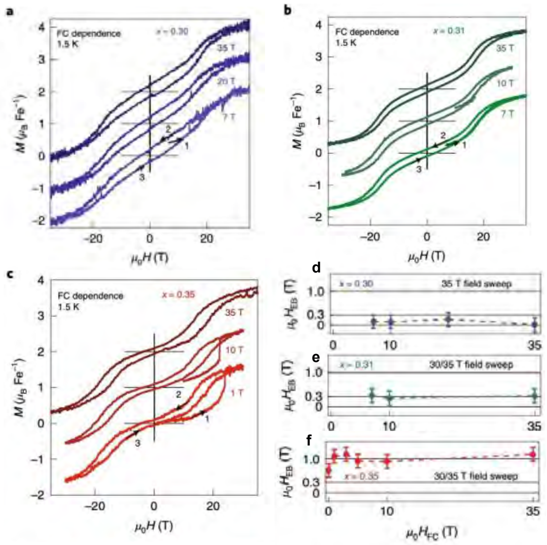


Figure 2.2.2.3.2: High-field exchange bias characterization. ***a-c),*** *Out of plane magnetization curves for three different field-cooling conditions for each intercalation.* ***d-f),*** *Exchange bias magnitude for each intercalation as a function of the magnitude of field cooling.* ***f),*** *Exchange bias value of ~ 1T at all values of field cooling.*

physics of exchange bias and also present possible technological implications as exchange bias plays a critical role in the manufacture of spin-valves which are utilized in high-density magnetic storage. The results of this work were published in ***Nature Physics.***

2.2.2.4 Facility Plans and Directions

The installation of new secondary chilled water pumps originally scheduled to occur during our 2021 annual maintenance shutdown had to be postponed to June 2022 due to shifting delivery schedules from suppliers for pumps and associated equipment and contractor personnel availability. These pumps circulate the 40F water produced by the chillers through the magnet cooling water heat exchangers. The existing pumps have neared the end of their service lifetimes and we will need to be able to supply additional water flow through the magnet cooling water heat exchangers once a second 34MW water-cooled magnet is added. Eight new pumps will be installed and will feature soft-start capability which brings the pump speed up slowly which extends the life of the pump and improves the temperature stability of the magnet cooling water loops as the pumps turn on and off depending on the heat load.

Helium recovery and liquefaction improvements. As part of the MagLab's ongoing efforts to maximize the amount of helium gas recovered from cryostats and superconducting magnet systems the plumbing and fittings between the magnet cells and the central medium vacuum system (house vacuum) was upgraded. This involved removing the original industrial-grade PVC pipe system with many glue joints and installing a system of welded stainless steel pipe using ISO and KF vacuum connections and components. The house vacuum system is used to reduce the pressure on liquid helium baths to lower their temperature to 1.5K. Historically, this helium was not recovered due to the high level of air present in the process gas due to the leaks in the PVC plumbing that would recur shortly after being found and fixed. After construction, the new system was extensively tested and was recently put into regular operation. The helium recovery volume and contamination levels are being logged and the data fed into our helium recovery database. An added benefit of the new system for users is the amount of audio noise in the magnet cells has been reduced as the 1K pot vacuum pumps for the top-loading cryostats are no longer needed in the magnet cells.

2.2.2.5 Outreach to Generate New Proposals-Progress on STEM and Building User Community

Both the DC Field Facility and its users continued to be impacted by the COVID-19 pandemic in 2021 although the effects on operations were less severe than in 2020. This affected both our current user base and our ability to reach out to potential new users as conference travel was still not recommended during 2021. In a normal year the MagLab hosts a booth at the annual APS March Meeting trade show but due to the continued persistence of the COVID-19 pandemic this was not possible in 2021.

Appendix 2, Table 10, shows the DC Field Facility attracted ***20 new PIs*** in 2021 with 18 of those new to the MagLab as a whole. This is in addition to the 20 new PIs reported last year (2020) and 41 reported in 2019.

Figure 2.2.2.5.1: Screen shot from the 2021 MagLab virtual user Summer School.

The Annual DC Field Facility NHMFL User Summer School was held on July 13-16 and presented in a virtual format **(Figure 2.2.2.5.1).** The virtual format allowed us to increase the number of attendees to 32 with 11 presentations on experimental techniques given by MagLab scientific staff and industry scientists. The very popular hands-on practical exercises were not able to be done as a result of the virtual format, but we are hopeful they will return in 2022 along with a return to in-person events.

2.2.2.6 Facility Operations Schedule

At the heart of the DC Field Facility are the four 14MW, low noise, DC power supplies. Each 20MW or 28MW resistive magnet requires two power supplies to run, the 45T hybrid and the 41.5T resistive magnets each require three power supplies and the 36T Series Connected Hybrid requires one power supply. Thus, the DC Field Facility operates in the following manner: in a given week there can be four resistive magnets and six superconducting magnets operating or the 45T hybrid/41.5T resistive, series connected hybrid, two resistive magnets and five superconducting magnets. The water-cooled DC resistive and hybrid magnets operated for 41 weeks in 2021 with eight weeks of downtime resulting from issues with the MagLab's 12.5kV electrical feeder, a two-week shutdown for infrastructure maintenance from December 13 to December 23 and a one-week shutdown period for the university mandated holiday break from December 24, 2021, to January 3, 2022. The six superconducting magnets operated for 48 weeks out of the year with staggered maintenance periods as required. The daily operation schedule for the resistive and hybrid magnets is as follows: 7 hours/day on Monday and 21 hours/day Tuesday-Friday. The superconducting magnets operate 24 hours/day 7 days/week.

2.2.3 EMR FACILITY

Electron Magnetic Resonance (EMR) covers a variety of magnetic resonance techniques associated with the electron. The most widely employed is Electron Paramagnetic/Spin Resonance (EPR/ESR), which can be performed on anything that contains unpaired electron spins. EPR/ESR has thus proven to be an indispensable tool in a large range of applications in physics, materials science, chemistry, and biology, including studies of impurity states, molecular clusters, molecular magnets; antiferromagnetic/ferromagnetic compounds in bulk, as well as thin films and nanoparticles; natural or induced radicals, optically excited paramagnetic states, electron spin-based quantum information devices; transition-metal based catalysts; and for structural and dynamical studies of metalloproteins, spin-labeled proteins, and other complex bio-molecules and their synthetic models.

2.2.3.1 Unique Aspects of Instrumentation Capabilities

The EMR facility at the NHMFL offers users several home-built, high-field, and multi-high-frequency instruments covering the continuous frequency range from 9GHz to ~1THz. Several transmission probes are available for continuous-wave (CW) measurements, which are compatible with a range of magnets at the Lab, including the highest field 45T hybrid. Some of the probes can be configured with resonant cavities, providing enhanced sensitivity as well as options for *in-situ* rotation of single-crystal samples in the magnetic field, and the simultaneous application of pressure (up to ~3GPa). Quasi-optical (QO) reflection spectrometers are also available in combination with high-resolution 12 and 17T superconducting magnet systems; a simple QO spectrometer has also been developed for use in the resistive and hybrid magnets (up to 45T). EMR staff members can assist users in the DC field facility using broadband tunable homodyne and heterodyne spectrometers as well. Moreover, frequency coverage up to ~180THz (6,000cm^{-1}) is now possible through collaboration with staff in the DC field facility using broadband Fourier transform infrared spectrometers to acquire EPR spectra in the frequency domain – so-called far-infrared magneto-spectroscopy (FIRMS).

In addition to CW capabilities, the NHMFL EMR group boasts the highest frequency pulsed EPR spectrometer in the world, operating at 120, 240, 336GHz, and now 316 and 395GHz with < 100ns time resolution. A high-power (1kW) quasi-optical 94GHz spectrometer (HiPER) with 1ns time resolution (1GHz instantaneous bandwidth) is also available. Meanwhile, a commercial Bruker Elexsys 680 operating at 9/94GHz (X-/W-band) is available upon request. This unique combination of CW and pulsed instruments may be used for a large range of applications in addition to EPR, including the study of optical conductivity, electron cyclotron resonance and Dynamic Nuclear Polarization.

Finally, the EMR group collaborates with the NMR program in developing instrumentation for high-field DNP-enhanced NMR studies of solids and solution samples at fields up to 14.1T. The centerpiece of this installation is a quasioptical EPR spectrometer based on a 395GHz high-power CW gyrotron source.

2.2.3.2 Facility Developments and Enhancements

As in 2020, the COVID-19 pandemic impacted efforts directed towards facility enhancements during 2021. In spite of this, development of a rudimentary 950GHz / 36T EPR setup for use in the Series Connected Hybrid (SCH) resonance magnet within the DC-field facility was completed. At the time of writing of this report, the first measurements using this new capability are taking place, and spectra of good quality have been obtained on model spin systems at a frequency of 934GHz (corresponding to a magnetic field of ~33.4T). We hope to be able to highlight new scientific results obtained in the SCH in next year's report.

As first mentioned in the 2020 Annual Report, a major upgrade of the user interface on the HiPER spectrometer was undertaken during 2021. Software development has been carried out in collaboration with Femi Instruments, LLC, a company specializing in the development of standardized user interfaces for EPR spectrometers. On the MagLab side, the work was overseen by two postdocs, Jonathan (Jon) Marbey and Krishnendu (Krish) Kundu. The new user interface replaces the original pulse generating front-end of the spectrometer with a completely separate and independent multiplier chain fed by a Keysight 12 bit, 12GSa/s arbitrary waveform generator. This capability enables generation of arbitrary shaped high-power waveforms, including chirped pulses spanning a 1GHz (94.0±0.5GHz) bandwidth, allowing for wideband excitation and implementation of state-of-the-art pulse schemes, e.g., chirp echo Fourier transform EPR, akin to what is possible in NMR. The new capability is available to external users and several exciting results have been obtained during 2021. Again, we hope to be able to highlight publications resulting from this development in next year's annual report.

The past year has also seen important developments in terms of EMR staffing. Two new postdocs joined the team: Elvin Salerno, who completed his PhD in 2021 at the University of Michigan; and Xiaoling (Cocoa) Wang, who is rejoining the group from UC Santa Barbara after a previous stint in 2018. Elvin brings experience in magneto-optics and plans to develop new EMR capabilities involving optical excitation. Meanwhile, an international search for an EMR DNP Research Faculty was conducted during 2021. Interviews recently concluded and we hope to provide an update on the outcome of this search in next year's annual report.

2.2.3.3 Major Research Activities and Discoveries/ Research Science Highlights

Our users reported 26 peer-reviewed journal articles during the past year. This is down from the previous year's number of 43, yet only marginally below the 29 publications reported in 2019. The ~40% reduction compared to 2020 can be attributed to the reduction in user activities in both 2020 and 2021 resulting from the COVID-19 pandemic, as well as an increase in publication output in 2020 attributed to lab shutdowns, i.e., more time devoted to writing. Again, the quality of publications in 2021 was exceptionally high, including articles in the following journals: Nature publishing group (3); J. Am. Chem. Soc. (1); Angew. Chem. (1); Chem. Sci. (1); Chem. Comm. (1); Inorg. Chem. (4); Dalton Trans. (3); and Inorganic Chemistry Frontiers (1). Projects in the facility spanned a range of disciplines, from fundamental physics studies of spin liquids, to applied materials research on batteries, to chemical investigations of catalysts.

The EMR Program has also continued to support efforts associated with several major center-type research initiatives and international collaborations involving multiple universities. These include: the DOE funded Energy Frontier Research Center for Molecular Magnetic Quantum Materials (M^2QM) based at the University of Florida (PI and Director – Hai-Ping Cheng; Associate Director – Stephen Hill), with co-PIs at the University of Central Florida, Florida State University, UTEP, Caltech and Los Alamos National Laboratory; an AFOSR funded Multidisciplinary University Research Initiative focusing on Terahertz Electronics Based on Antiferromagnets, headquartered at the University of Central Florida (PI – Enrique del Barco), with co-PIs at New York University, Oakland University, The Ohio State University, UC Riverside and UC Santa Cruz; an AFOSR funded international network focusing on Molecular Quantum Technologies involving Florida State University, the University of Modena and Reggio Emilia in Italy, and Osaka City University in Japan; and a trilateral international collaboration entitled "Molecular Magnetoelectric Materials" involving FSU (Stephen Hill, funded by the US NSF), University College Dublin in Ireland (Professor Grace Morgan, an EMR user, funded by the Science Foundation Ireland), and Queens University Belfast in Northern Ireland (Professor Steven Bell, funded by the Department of the Economy in Northern Ireland). In particular, M^2QM supports an EMR postdoc, Daphne Lubert-Perquel, and two graduate students working in the group.

The EMR Director also teamed up with researchers at Lawrence Berkeley National Lab (LBNL) and UC Berkeley to secure a collaborative DOE award totaling $3.4M, focusing on "Molecular f-Element Qubits with Controllable Quantum Coherence and Entanglement". This project will support a new EMR postdoc, Jakub Hruby, who obtained his PhD in the group of Petr Neugebauer (an EMR user) at Brno University of Technology in the Czech Republic. Jakub will join the group in March 2022.

We report three scientific highlights from 2021 in the next section of this report. The highlighted work, published in Nature Chemistry, Inorganic Chemistry and Nature Materials, involved a truly international mix of users from UC Berkeley, UC Davis, LBNL, KU Leuven (Belgium), Harvard University, University of Washington, the Helmholtz-Zentrum Berlin (Germany), Max Planck Institute for Chemical Energy Conversion (Germany), University of Hamburg (Germany), NICPB Tallin (Estonia), MTA-BME Budapest (Hungary), ISSP (Vienna), RIKEN and AIST (Japan), IoP Augsburg (Germany), HMFL-EMFL Nijmegen (The Netherlands), Florida A&M University, ORNL and Augusta University, Georgia.

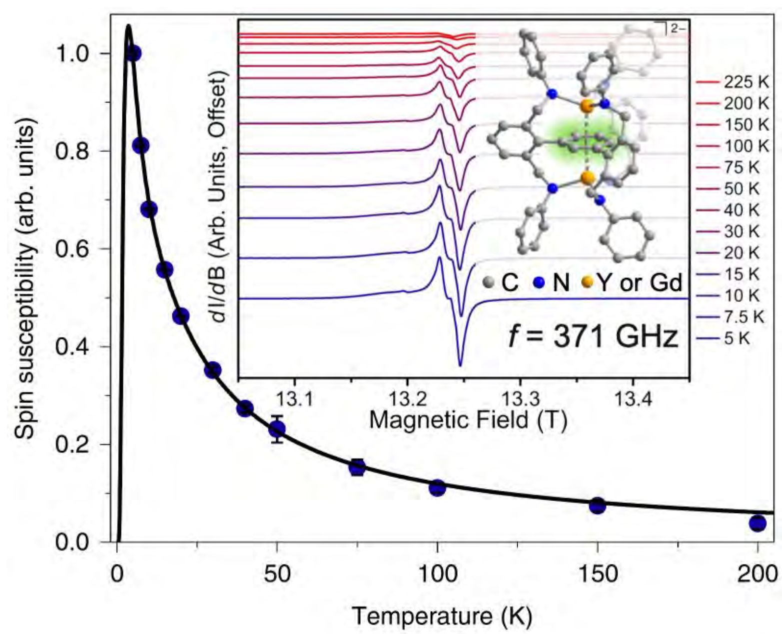


Figure 2.2.3.3.1. *(main) Temperature dependence of spin susceptibility deduced from the high-field EPR spectra shown in the main inset, for the compound: [K(18-crown-6) (THF)$_2$]$_2$[M$_2$(BzN$_6$-Mes)] (M = Y, Gd; BzN$_6$-Mes = 1,3,5-tris[2',6'-(N-mesityl)dimethanamino-4'-tert-butylphenyl]benzene), shown in the upper right inset. The EPR spectra were recorded in derivative mode, dI/dB, where I is the microwave intensity transmitted through the sample and B the applied magnetic field. The spin susceptibility is obtained via double-integration of the dI/dB signal.*

Isolation of a Triplet Benzene Dianion

This study reports stabilization of the elusive benzene radical dianion **(Figure**

2.2.3.3.1.) with a magnetic ground state, that is, a doubly reduced form of the benzene molecule in which the two unpaired electrons align their magnetic moments, giving rise to a total spin $S = ½ + ½ = 1$ (triplet) ground state. High-field EPR studies were employed in order to confirm the magnetic state of this unusual molecule **(Figure 2.2.3.3.1.)**.

This study demonstrates how coordination chemistry may be leveraged to stabilize a desired electronic state in an organic molecule. Specifically, this approach enables isolation of a negatively charged (2-) benzene dianion in which the magnetic $S = 1$ (triplet) state—typically a high-energy excited state in such ring-like organic molecules—instead exists as the well-isolated molecular ground state. In turn, this enabled verification of a decades-old theoretical model predicting a delocalized nature of the unpaired electrons on the benzene ring.

EPR measurements at multiple high magnetic fields and frequencies (substantially above those of commercial spectrometers) were essential in order to deconvolute several contributions to the HFEPR spectra. In particular, separating the effects of intra- and inter-molecular interactions is impossible at low magnetic fields. In this way, analysis of spectra recorded at 13T and 371GHz informs the isolation of the S = 1 state, without dependence on other unknown interactions.

This work research was led by researchers at UC Berkeley, in collaboration with scientists at UC Davis and the Catholic University of Leuven in Belgium.

Citation: Colin A. Gould, Jonathan Marbey, Veacheslav Vieru, David A. Marchiori, R. David Britt, Liviu F. Chibotaru, Stephen Hill and Jeffrey R. Long, *Isolation of a Triplet Benzene Dianion*, Nature Chemistry **13**, 1001 – 1005; https://doi.org/10.1038/s41557-021-00737-8

Spectroscopic investigation of a metal-metal bonded Fe_6 single-molecule magnet with an $S = {}^{19}/_2$ spin ground state

Single-molecule magnets (SMMs) that retain their magnetization state ('up' or 'down') below a characteristic blocking temperature, offer a bottom-up chemical synthesis approach for development of classical nanoscale magnetic memory units. Early work focused on polynuclear oxo-bridged transition metal clusters such as the famous Mn_{12} molecule. However, weak super exchange interactions between spins on the constituent ions give rise to a total molecular magnetic moment that is susceptible to thermal and quantum fluctuations, limiting operation to very low temperatures.

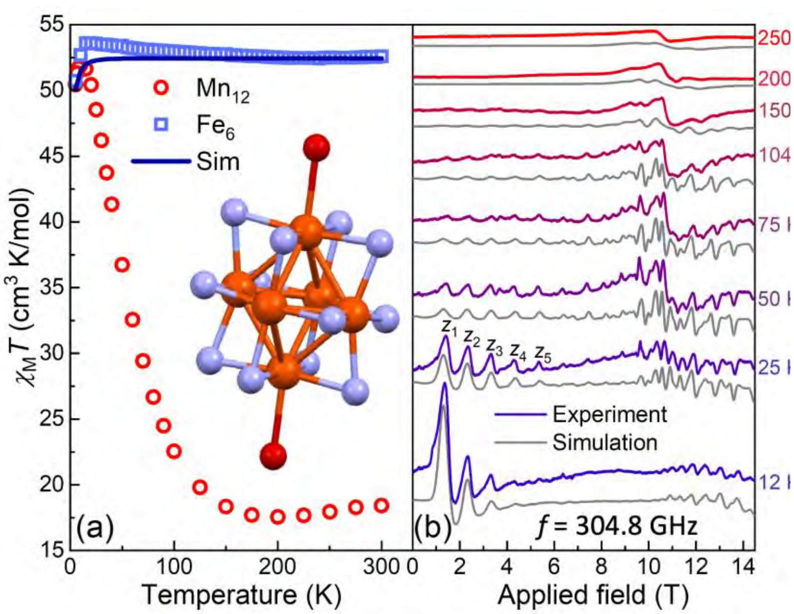


Figure 2.2.3.3.2: *Temperature dependence of **(a)** susceptibility-temperature product ($\chi_M T$) for Mn_{12} & Fe_6, and **(b)** Fe_6 EPR spectra, with simulations superimposed for the latter; inset to (a) depicts Fe_6 molecular core (Fe – orange, N – purple, O – red).*

This investigation focused on one of the first metal-metal bonded SMMs, an Fe_6 cluster that may be thought of as a tiny fragment of elemental iron. Very strong exchange coupling between the 19 associated unpaired electrons gives rise to a robust total spin moment, $S_T = {}^{19}/_2$, which is maintained all the way to room temperature; see **Figure *2.2.3.3.2 (a)*** for comparison between Mn_{12} ($S_T = 10$ at 4 K) and Fe_6 susceptibility-temperature products ($\chi_M T \propto S_T$).

Detailed EPR measurements **(Figure *2.2.3.3.2* b)** were performed at unprecedented high frequencies to gain unique microscopic insights into the strongly coupled nature of the electron spins in the core of the Fe_6 molecule. The results suggest strategies for developing polynuclear SMMs with polarizable metal-metal bonds for future magnetoelectric applications.

This work was initiated through a collaboration involving Harvard University, the University of Washington and the MagLab, with additional contributions from the Helmholtz-Zentrum Berlin, the Max Planck Institute for Chemical Energy Conversion and the University of Hamburg (Germany).

Citation: J. Nehrkorn, S. M. Greer, B. Malbrecht, K. Anderton, A. Aliabadi, J. Krzystek, A. Schnegg, K. Holldack, C. Herrmann, T. A. Betley, S. Stoll and S. Hill, *Spectroscopic Investigation of a Metal-Metal Bonded Fe_6 Single-Molecule Magnet with an Isolated $S = {}^{19}/_2$ Giant-Spin Ground State,* Inorg. Chem. **60**, 4610 – 4622 (2021). https://doi.org/10.1021/acs.inorgchem.0c03595

The Ising triangular-lattice antiferromagnet neodymium heptatantalate as a quantum spin liquid candidate

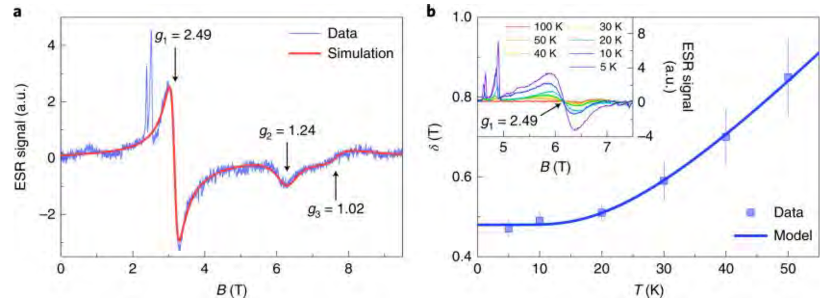


Figure 2.2.3.3.3: (a) The ESR spectrum recorded at 109GHz and 10K shows broad features at g factors g_1 = 2.49, g_2 = 1.24 and g_3 = 1.02 and is well accounted for by a powder-spectrum simulation. This corresponds well to the g factors g_z = 2.78 and g_{xy} = 1.22 obtained from crystal field modelling assuming uniaxial symmetry. A couple of additional, narrow impurity signals are detected, which, however, have orders-of-magnitude smaller intensities than the main broad lines. (b) The temperature dependence of the peak-to-peak ESR line-width (main panel) of the g_1 component recorded at 211.9GHz (inset) is explained by the Orbach model, while the large low-temperature saturation value of the line-width is accounted for by a large exchange anisotropy.

Disordered magnetic states known as spin liquids are of paramount importance in both fundamental and applied science. A classical state of this kind was predicted for the Ising antiferromagnetic triangular model, while additional non-commuting exchange terms were proposed to induce its quantum version—a quantum spin liquid. However, these predictions have not yet been confirmed experimentally. In this study, evidence is reported for such a state in the triangular-lattice antiferromagnet $NdTa_7O_{19}$. It is determined that its magnetic ground state, which is characterized by effective spin-½ degrees of freedom with Ising-like nearest-neighbor correlations, gives rise to spin excitations persisting down to the lowest accessible temperature of 40 mK. This study demonstrates the key role of strong spin-orbit coupling in stabilizing spin liquids that result from magnetic anisotropy and highlights the large family of rare-earth (RE) heptatantalates $RETa_7O_{19}$ as a framework for realization of these states, which represent a promising platform for quantum applications.

This work was led by researchers at Jozef Stefan Institute and the University of Ljubljana in Slovenia, in collaboration with scientists at the Indian Institute of Technology in Madras, India, the ISIS Facility at the Rutherford Appleton Laboratory in the UK, and the Institut Laue-Langevin in Grenoble, France.

Citation: T. Arh, B. Sana, M. Pregelj, P. Khuntia, Z. Jagličić, M. D. Le, P. K. Biswas, P. Manuel, L. Mangin-Thro, A. Ozarowski & A. Zorko, *The Ising triangular-lattice antiferromagnet neodymium heptatantalate as a quantum spin liquid candidate*, Nature Materials (2021); https://doi.org/10.1038/s41563-021-01169-y

2.2.3.4 Facility Plans and Directions

In terms of hiring, we will fill the new EMR DNP Research Faculty position during the coming year. This person will support ongoing collaborative efforts between the EMR and NMR groups in support of a high-field Dynamic Nuclear Polarization user program. In addition, we anticipate arrival of a new postdoctoral research associate, Jakub Hruby, in March 2022. Jakub completed his PhD at Brno University of Technology in the Czech Republic in December 2021. Jakub will work on the DOE collaborative project together with users from Lawrence Berkeley National Lab and UC Berkeley on the project entitled "Molecular f-Element Qubits with Controllable Quantum Coherence and Entanglement".

The recent commissioning of an EPR capability in the 36T high-resolution SCH magnet, spearheaded by EMR Engineer, Bianca Trociewitz, together with Research Faculty Jurek Krzystek and Thierry Dubroca, opens up a completely new capability for EMR users. The ultra-high resolution achievable in the SCH is ideally suited to systems with very weak spin-orbit anisotropy. Targets include carbon-centered organic radicals of interest in biological processes and organic electronics, as well as d^5 and f^7 metal complexes with very weak 2nd order spin-orbit anisotropic contributions to their *g*-tensors. The latter are of interest for spin-labeling EPR applications as well as DNP.

2.2.3.5 Outreach to Generate New Proposals-Progress on STEM and Building User Community

Despite the COVID-19 pandemic, operations continued at about 80% normal capacity during 2021, with users primarily sending samples so that measurements could be performed by EMR Staff Scientists. However, two US users did visit Tallahassee to perform experiments in person towards the end of the year. Therefore, the facility is now returning to some degree of normalcy. Although recruiting efforts were hampered due to limitations on travel, significant efforts were made to let users know that the MagLab EMR program remained open for business. In particular, EMR staff made many presentations at virtual conferences, where updates on the status of the facility were given. As can be seen from the Facility Operations Schedule below, spectrometer usage remained strong, and it was possible to recruit several new users during the year.

The total number of proposals that received magnet time during 2021 was 48, up from 45 in 2020, but still down from pre-pandemic levels (~60). The number of PIs who received magnet time was 43, of which 8 PIs were first time users, meaning that >20% of our users were new to the program. Meanwhile, the EMR program assisted 121 individual researchers in 2021, which is exactly the same number as 2020, of which 21 were first time users. In terms of diversity, 18% of EMR user PIs were female and 5% minority.

Members of the EMR group continue to make aggressive efforts to advertise the facility at regional, national, and international workshops and conferences, as well as via seminars at universities around the globe. Most of these activities during 2021 were held virtually. Nevertheless, tremendous effort was made to advertise opportunities at the MagLab at these events (the EMR Director gave six virtual and three in-person presentations in 2021 highlighting the MagLab), with particular emphasis on the fact that users could send samples.

Members of the EMR group also served on the organizing committees for the following events: the 2021 International Conference on Molecule-based Magnets (ICMM), organized by the University of Manchester, UK, which was held virtually in June; the 2021 Pacifichem conference in Honolulu, Hawaii, which was also held virtually; the 2022 Rocky Mountain Conferences on Magnetic Resonance, which is expected to take place in-person in July; and the 2nd Magnetism in North America (MAGNA) conference that will go ahead in-person in Orlando in May 2022.

Finally, the EMR Director has been very active in assisting current and potential future users in the development of research proposals to US and overseas funding agencies, for continued support of activities requiring use of the MagLab EMR facilities. These efforts have been particularly intensive during the past year due to the strong emphasis on quantum sciences, an area of intense activity for many EMR users. As noted elsewhere in this report, one of these applications was successful and will support a postdoc at the lab. Two others were funded and, although they will not result in direct support to the lab, they are expected to result in new user activities. Of particular note, one of these projects will support a new EPR center in Copenhagen, Denmark, to be led by current user and former EMR user sub-committee member, Stergios Piligkos. This facility will stage many low-field EPR projects and the MagLab will recruit users from that facility in cases where high-field measurements are needed.

2.2.3.6 Facility Operations Schedule

Operations in the EMR program were obviously impacted due to the COVID-19 pandemic during 2021. However, overall activity was maintained at essentially the same level as 2020, or about 80% compared to pre-pandemic levels, through users sending their samples for measurement by MagLab EMR staff and students. The workhorse 17T homodyne spectrometer operated for a total of 231 days during 2021, which is a substantial increase compared to 2019 (135 days) due to the construction that took place in the EMR in that year. However, it is down from ~300 days in a normal year, i.e., ~80% of normal operation. Meanwhile, the 12.5T heterodyne spectrometer logged 131 days of usage, down from an average of ~180 days in recent years, i.e., usage was about 75% of normal operations.

A total of 212 days were logged on the high-power pulsed 94GHz EPR spectrometer, HiPER, just a small decrease (10%) from the 236 days reported in 2019. It should be noted that 96 days were devoted to testing, maintenance and methods development. However, this is quite typical of a normal year due to the significant methods development associated with this unique, cutting-edge spectrometer. Moreover, we performed a complete renovation of the user interface during 2021. Significant in-house methods development was included in the plan when integrating HiPER into user operations, as much of the cost of the instrument was covered by funding separate from the MagLab core. Therefore, HiPER operated at close to normal (100%) capacity during 2021.

The commercial Bruker E680 spectrometer logged 196 days during 2020, down from 234 days in 2019, i.e., 84% of normal usage. Much of this reduction was due to a component failure that affects pulsed operation of the instrument and has yet to be resolved. Indeed, as of March 2022, the pulse programmer has been shipped back to the manufacturer, and the spectrometer is completely out of commission. Therefore, we anticipate a further reduction in usage of this ageing instrument in 2022.

As a whole, the four instruments offered by the EMR User Program were oversubscribed by ~24% in 2021, i.e., 958 days were requested and only 770 total days allocated.

2.2.4 HIGH B/T FACILITY

2.2.4.1 Unique Aspects of Instrumentation Capabilities

The High B/T Facility, located on the University of Florida campus, offers users a safe, diverse, and inclusive atmosphere for performing research in high magnetic fields (up to 16.5T) and at ultralow temperatures (down to 0.5mK) with an ultraquiet electromagnetic interference (EMI) environment. The Microkelvin Laboratory, the core of the High B/T Facility, is a separate, specially designed and built building with Tempest-quality shielded rooms to specifically afford access to the extremes of ultralow temperatures and high magnetic fields. Two demagnetization cryostats, one employing a PrN_5 + Cu refrigeration stage while the other uses a pure Cu stage, provide the main access to the unique environments by using high magnetic fields of 8T to adiabatically cool the experimental region. In other words, the high magnetic fields provide the means refrigeration for cooling quantum materials in a steady high magnetic field applied to the sample region. A third bay, scheduled to open in 2022, is being modernized to provide access to these extremes of parameter space to provide users with a nimble environment required for the study of modern quantum materials and devices.

2.2.4.2 Facility Developments and Enhancements

In March 2020, a Fast-Turnaround Facility, which was located in Williamson Hall adjacent to the Microkelvin Laboratory, was operating down to 50mK and providing magnetic fields up to 10T. This instrument was available for sample and signal verification tests to confirm the appropriate dynamic range required for the experiment. Due to the COVID-19 pandemic and scheduling constraints, this instrument was closed and is being relocated to the main Physics Building and is now being revitalized to provide temperatures to below 20mK while in magnetic fields of 10 or 16T, depending on the insert being used and configured.

A new Assistant Scientist line was provided by the University of Florida as part of the initiative to open the third bay in the Microkelvin Laboratory. The search for this non-tenure accruing faculty position was authorized in Fall 2019, and the recommendations of the search committee were presented to the faculty in early January 2020. In early February 2020, Rasul Gazizulin, then a member of the CNRS low temperature and high magnetic field team in Grenoble, France, accepted the position. Although his original start date was anticipated in early November 2020, a combination of conditions arising from the pandemic and the evolving Visa polices has delayed his arrival to July 2021. In October 2021, a "dry" dilution refrigerator cryostat system was ordered and is expected to be delivered in August 2022.

2.2.4.3 Major Research Activities and Discoveries/ Research Science Highlights

Developing compact tuning fork thermometers for sub-mK temperatures and high magnetic fields (Lucia Steinke, Andrew J. Woods, Alexander M. Richard Donald, MagLab HBT and UF Physics). To meet the growing user demand for calorimetric and thermal transport measurements, particularly on milligram-sized solid samples, we are developing scalable thermometers based on quartz tuning fork resonators immersed in liquid 3He. We are demonstrating successful thermometer operation at the combined extreme conditions available at our user facility and are exploring the feasibility of fast and compact thermal probes. The overall approach is sketched in **Figure 2.2.4.3**. More specifically, we have shown that quartz tuning forks immersed in liquid 3He provide robust thermometry at the combined extremes of ultra-low temperatures down to 1mK and high magnetic fields up to 14.5T, presenting a viable alternative to the much slower and more difficult to implement 3He melting curve or NMR thermometry that is presently being used.

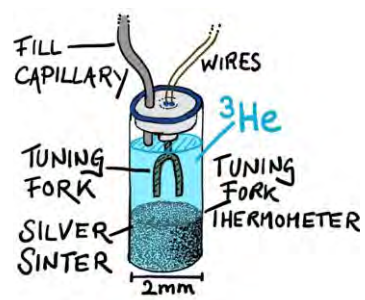


Figure 2.2.4.3: *A schematic of the compact tuning fork thermometer being studied for low millikelvin temperatures and high magnetic fields. Drawing by L. Steinke.*

2.2.4.4 Facility Plans and Directions

Table 2.2.4.4 summarizes the present and future capabilities, which are described in this section. Proposals for magnet time may be submitted at any time, and contact/discussions with staff is recommended prior to submission. Users work with the staff scientists to mount and tune the experiments on site, and when the experiments begin, most users have the staff perform the instant-to-instant steps while the users are consulting from off-site locations. This arrangement is particularly effective when the experiments span long periods of time due to their nature at the extremes of parameter space.

Table 2.2.4.4: The instrumentation available in the MagLab High B/T Facility tabulated, and their unique combination of temperature, magnetic field, and techniques are highlighted. Specialty shielding and filtering of the equipment provides the ultraquiet electromagnetic interference environment.

Equipment	Features	Supported Research
Bay 3: 16.5T superconducting magnet, 20mm dia. sample space	Temperatures ≤ 1mK, by 8T demag of $PrNi_5$ + Cu stage.	Magnetization, quantum transport, torsional oscillator, viscosity, specific heat, dielectric, MEMS
Bay 2: 8T superconducting magnet, 32mm dia. sample space	Temperatures ≤ 0.5mK, by 8T demag of copper stage.	NMR, quantum transport, ultrasound, capacity, pressure cell, thermal transport
Bay 1: 8T superconducting magnet, 32mm dia. sample space	Added 2020, Update/Revisions in progress, specs TBA for "nimble" instrument, to open 2022.	Planned: quantum transport with rotation, novel magnetometry, scanning probes
Annex: 10T superconducting magnet, 25mm dia. sample space	Retired March 2020 – Renovated and revitalized version to NPB 135, for 2022 operation. Temperatures ≤ 20mK in 10T / 16T for efficient and fast sample/cell transfer to Bays 1-3. To reopen in 2022.	Exploratory, novel technique development, sample/cell verification prior to use on Bays 1-3

2.2.4.5 Outreach to Generate New Proposals-Progress on STEM and Building User Community

In 2021, we experienced pandemic-related challenges of local closures, event calendar changes, withdrawal of students into virtual or homeschooling options, and strict restrictions on visitor access to school campuses and to the High B/T (HBT) Facility at the University of Florida in Gainesville, FL. Despite this, our Research and Outreach Coordinator, Amy Howe, was able to maintain some classroom outreach to local schools using virtual methods, reaching 130 Title-1 elementary (K-5) students with a combination of interactive video sessions and magnet loaner-kits, allowing hands-on activities to occur inside the school's own socially distanced settings. The number of students we were able to contact therefore reflects a 68% decrease in student numbers from previous years, however, the student contact time per session was increased from the previous average of 40-45min per session to 60-75min (up to 90 min) because the students' schedules were not as rigid once they were no longer moving between classrooms or teachers during the day. In addition, the loaner kits were designed to allow prolonged individual use of the materials, which could easily be sanitized between students, so activities and lessons could continue for at least two additional class days beyond the virtual outreach session. These loaner kits for the Magnet Exploration and Build an Electromagnet activities were requested in equal numbers.

All of our traditional secondary (6-12) and collegiate outreach activities were cancelled or shifted to virtual formats for the 2021 calendar year, and outside visitors were strictly prohibited at the facilities, except in outdoor or well-distanced settings that excluded many of our laboratory spaces. To address this challenge, we shifted our focus to local groups under different restrictions, so half of our total annual contacts (126 college students and instructors) were UF-affiliated students and staff reached through lectures, seminars, and virtual tours provided by our facilities. The remainder came from internet participation by Directors Joanna Long (AMRIS) and Mark Meisel (HBT) in the Tallahassee and Gainesville offerings of the MagLab Research Experiences for Undergrads (REU) and Teachers (RET) programs. We expect some of our previous historical activities to remain in a virtual format for the future, or at least to maintain some virtual component to increase the reach from any small in-person event, however our in-person activities remain limited as of December 2021.

2.2.4.6 Facility Operations Schedule

We previously reported that the Fast-Turnaround instrument was closed coincident with the initial COVID-19 pandemic shut down in 2020, but the timeline for its relocation was subsequently delayed by the restrictions on physical access allowable within the small lab spaces where it was housed in Williamson Hall. By December 2021, this instrument was finally relocated to the main Physics Building, where it is being revitalized to provide temperatures below 20mK while in magnetic fields of 10 or 16T, depending on the insert being used and configured. Bays 2 and 3 in the Microkelvin Facility remain operational, and purchasing orders are underway to bring Bay 1 online with a 14T system. Over the course of 2021, we also completed installation of the 400MHz (9.4T), 89mm bore system, referred to as BxT (high magnetic field times temperature) versus other systems at high B/T (magnetic field divided by temperature to get big ratio), to emphasize the unique capabilities of this system at the facility. Studies on the 9T BxT system are expected to begin in 2022, following the installation of a heat treatment oven for sample preparation.

The High B/T Facility is operational year-round, including during University of Florida holidays and campus closure during the final week of December. Experiments are able to continue overnight and through closures, as long as direct supervision of the experiment is not required. Through compliance with mandatory COVID-19 testing and masking policies, UF faculty, students, and staff were fully approved to return to work on campus by January 2021; however, the Microkelvin Bays continued to have restricted access necessary to maintain distancing requirements through June, preventing visitors from accessing the facility but allowing staff to work within the building. These campus-wide visitor access policies began to lift over the summer, until a full reopening to allow in-state travelers on campus by the time the semester started in August, followed by travel permissions extending to the non-student visitors after October. Although external users were restricted for most of the calendar year, we were able to provide full staff support and communications methods to allow external users' research to continue throughout the year. Visiting scientists from outside of Florida were able to return on-site for limited activities by December.

2.2.5 ICR FACILITY

During 2021, the Fourier Transform Ion Cyclotron Resonance (ICR) Mass Spectrometry program continued instrument and technique development as well as pursuing novel applications of FT-ICR mass spectrometry. These methods are made available to external users through the NSF National High-Field FT-ICR Mass Spectrometry Facility. The facility features nine staff scientists who support instrumentation, software, biological, petrochemical, and environmental applications, as well as a machinist, technician, and several rotating postdocs who are available to collaborate and/or assist with projects.

2.2.5.1 Unique Aspects of Instrumentation Capabilities

The Ion Cyclotron Resonance facility provides sample analysis that requires the ultrahigh resolution ($m/\Delta m_{50\%}$ > 1,000,000 at *m/z* 500, where $\Delta m_{50\%}$ is the full mass spectral peak width at half-maximum peak height) and sub-ppm mass accuracy only achievable by FT-ICR MS coupled to high magnetic field. The facility's four FT-ICR mass spectrometers feature high magnetic fields (as high as 21T) and are compatible with multiple ionization and fragmentation techniques.

Table 2.2.5.1. ICR systems at the MagLab in Tallahassee

Field (T), Bore (mm)	Homogeneity	Ionization Techniques
21, 123	< 1ppm	ESI, APPI, MALDI
14.5, 104	1ppm	ESI, APPI, APCI, MALDI
9.4, 220	1ppm	ESI, APPI

2.2.5.2 Facility Developments and Enhancements

In 2015, the ICR facility revealed the design and initial performance of the **first 21T Fourier transform ion cyclotron resonance mass spectrometer**. The 21T magnet is the highest field superconducting magnet ever used for FT-ICR and features high spatial homogeneity, high temporal stability, and negligible liquid helium consumption (**Figure 2.2.5.2.1**) (*J. Am. Soc. Mass Spectrum.*, **26**, 1626-1632 (2015)).

Mass resolving power of 150,000 (m/Δm50%) is achieved for bovine serum albumin (66 kDa) for a 0.38 second detection period (see **Figure 2.2.5.2.2**), and greater than 2,000,000 resolving power is achieved for a 12 second detection period. Externally calibrated broadband mass measurement accuracy is typically less than 150ppb rms, with resolving power greater than 300,000 at m/z 400 for a 0.76 second detection period. Combined analysis of electron transfer and collisional dissociation spectra results in 68% sequence coverage for carbonic anhydrase. The instrument is part of the NSF High-Field FT-ICR User Facility and is available free of charge to qualified users, with optimized experimental conditions, including top-down proteomics (*Clin. Chem. Lab. Med.*, 59, 653-661 (2021)), ultrahigh resolution ion isolation via SWIFT Fourier Transform mass spectrometry (*Anal. Chem.*, **92**, 3213-3219 (2020)), MALDI imaging (*Anal. Chem.* **92**, 3133-3142 (2020)), and complex mixture analysis (*Glob. Biogeochem. Cycles.*, **35**, e2020GB006871 (2021)).

The instrument includes a commercial dual linear quadrupole trap front end that features high sensitivity, precise control of trapped ion number, and collisional and electron transfer dissociation. A third linear quadrupole trap offers high ion capacity and ejection efficiency, and rf quadrupole ion injection optics deliver ions to a novel dynamically harmonized ICR cell.

An **actively-shielded 14.5T**, 104mm bore system offers the highest mass measurement accuracy (<300 parts-per-billion rms error) and highest combination of scan rate and mass resolving power available in the world. The spectrometer

Figure 2.2.5.2.1: *Picture of the 21T FT-ICR mass spectrometer.*

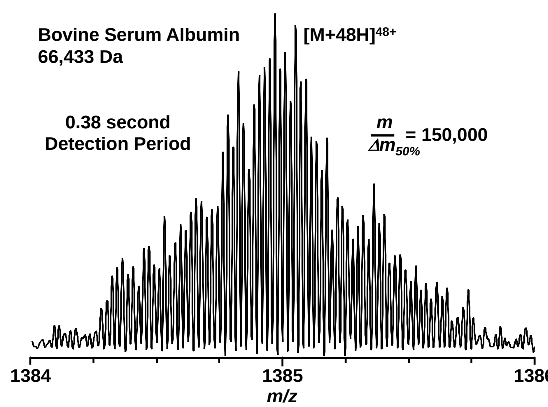


Figure 2.2.5.2.2: *Single-scan electrospray FT-ICR mass spectrum of the isolated 48+ charge state of bovine serum albumin following a 12s detection period. Mass resolving power is approximately 2,000,000, and the signal-to-noise ratio of the most abundant peak is greater than 500:1. The ion accumulation period was 250ms and the ion target was 5,000,000.*

features electrospray, atmospheric pressure photoionization (APPI), atmospheric pressure chemical ionization sources (APCI); linear quadrupole trap for external ion storage, mass selection, and collisional dissociation (CAD); and automatic gain control (AGC) for accurate and precise control of charge delivered to the ICR cell. The combination of AGC and high magnetic field make sub-ppm mass accuracy routine without the need for an internal calibrant. Mass resolving power > 200,000 at m/z 400 is achieved at one scan per second. An additional pumping stage has been added to improve resolution of small molecules.

The **9.4T, passively-shielded**, 220mm bore system offers a unique combination of mass resolving power ($m/\Delta m$ = 8,000,000 at mass 9,000 Da) and dynamic range (>10,000:1), as well as high mass range, mass accuracy, dual-electrospray source for accurate internal mass calibration, efficient tandem mass spectrometry (as high as MS^8), and long ion storage period (*J. Am. Soc. Mass Spectrom.,* **31**, 1783-1802 (2020); *Anal. Chem.,* **92**, 12193-12200 (2020)). A redesign to the custom-built mass spectrometer coupled to the 9.4T, 200mm bore superconducting magnet designed around custom vacuum chambers has improved ion optical alignment, minimized distance from the external ion trap to magnetic field center and facilitates high conductance for effective differential pumping (*J. Am. Soc. Mass Spectrom*. **22**, 1343-1351, (2011)). The length of the transfer optics is 30% shorter than the prior system, for reduced time-of-flight mass discrimination and increased ion transmission and trapping efficiency at the ICR cell (*J. Am. Soc. Mass Spectrom.* **25**, 943-949 (2014)). The ICR cell, electrical vacuum feed through, and cabling have been improved to reduce the detection circuit capacitance (and improve detection sensitivity) 2-fold (*Rev. Sci. Instrum.,* **85**, 066107 (2014)). When applied to compositionally complex organic mixtures such as dissolved organic matter (*Sci. Tot. Environ.,* **754**, 142411 (2021); *Org. Geochem.,* **151**, 104164 (2021); *Limnol. Oceanogr.* **66**, 1730-1742 (2021); *Glob. Biogeochem. Cycles,* **35**, e2020GB006709 (2021); *J. Geophys. Res. Biogeosci.,* **126**, e2020JG005977 (2021), soil organic matter (*Front. Plant Sci.,* **12**, 660224 (2021); *Environ. Sci. Technol.,* **55**, 9637-9656 (2021); biofuels (*Algal Res*., **57**, 102282 (2021); *Sust. Energy Fuels*, **5**, 941-955 (2021); *J. Environ. Chem. Eng*., **9**, 106255 (2021); *Energy Fuels*, **35**, 12165-12174 (2021); emerging contaminants (*Energy Fuels,* **35**, 16713-16723 (2021); *Energy Fuels.,* **25**, 18153-18162 (2021), and petroleum fractions (*Fuel*, **292**, 120259 (2021); (*Anal. Chem*., **93**, 4611-4618 (2021); *Energy Fuels* **35**, 3808-3824 (2021); mass spectrometer performance improves significantly, because those mixtures are replete with mass "splits" that are readily separated and identified by FT-ICR MS *(Energy Fuels*, **35**, 16335-16376 (2021)). The magnet is passively shielded to allow proper function of all equipment and safety for users. The system features external mass selection prior to ion injection for further increase in dynamic range and rapid (~100 ms time scale) MS/MS (*Anal. Chem*., **75**, 3256-3262 (2003)), with ultrahigh resolution ion isolation via stored waveform inverse Fourier transform (SWIFT) followed by infrared multiphoton (IRMPD) dissociation (*Energy Fuels*, **34**, 3013-3030 (2020); *Energy Fuels*, **35**, 16335-16376 (2021)).

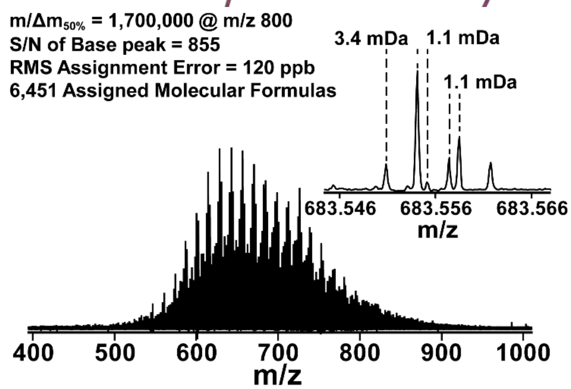


Figure 2.2.5.3.1: *Scan from the 2-ring elution window of online LCMS of an Athabasca bitumen heavy distillate. High magnetic field strength enables the analysis of large ion populations for a high dynamic range, high mass accuracy, and high mass resolving power. The common 3.4 and 1.1mDa mass differences observed in APPI of complex mixtures are baseline resolved across the m/z range of interest.*

2.2.5.3 Major Research Activities and Discoveries/ Research Science Highlights

Complex mixture analysis benefits from the 21T FT-ICR system through high mass-resolving power, mass accuracy, and dynamic range, and fast scan speed that enables resolution and confident elemental formula assignment for tens of thousands of unique species in complex organic mixtures (e.g., petroleum, natural organic matter). Here we report the coupling of online liquid chromatography of complex mixtures with a 21T FT-ICR mass spectrometer. The high magnetic field enables large ion populations to be analyzed for each spectrum for a high dynamic range, with 3.2 million mass resolving power at m/z 400 (6.2 s transient duration) or 1.6 million (3.1s transient duration) while maintaining high mass accuracy for molecular formula assignment (root-mean-square assignment error < 0.150ppm). Thousands of unique elemental compositions are assigned per mass spectrum, which can be grouped by the heteroatom class, double bond equivalents (the number of rings and double bonds to carbon), and carbon number. **Figure 2.2.5.3.1** illustrates the performance metrics that the 21T provides for online analysis of complex mixtures, namely, high dynamic range (and signal-to-noise, S/N) for large ion populations, while retaining high mass accuracy for elemental formula assignment and high mass resolving power.

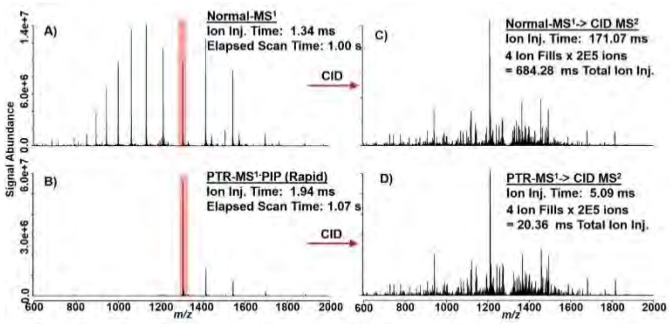


Figure 2.2.5.3.2: *21 T FT-ICR mass spectra of myoglobin under (A) normal MS^1 and (B) PTR-MS^1-PIP with rapid ion parking. The highlighted charge state was isolated and subjected to tandem MS by CID. (C) CID spectrum generated under normal MS^1 conditions and (D) PTR-MS^1-PIP. CID tandem MS spectra are nearly indistinguishable and were generated from the same number of precursors, but ion accumulation times were far lower for the PTR-MS^1-PIP condition.*

Proton-transfer reactions (PTRs) have emerged as a powerful tool for the study of multiply charged precursors. The reactions are used to reduce the charge of analytes inside the mass spectrometer, increasing their mass-to-charge ratio (m/z). When coupled with *m/z*-selective kinetic excitation, such as parallel ion parking (PIP), one can exert exquisite control over rates of reaction with a high degree of specificity. This allows one to "concentrate", in the gas phase, nearly all the signals from an analyte's charge state envelope into a single charge state, improving the signal-to-noise ratio (S/N) by 10× or more.

Advanced strategies for performing PTR with PIP were developed including subjecting all analyte ions entering the mass spectrometer to PTR and PIP. This experiment, which we call "PTR-MS^1-PIP", generates a pseudo-MS^1 spectrum derived from ions that are exposed to the PTR reagent and PIP waveforms but have not undergone any prior true mass filtering or ion isolation (**Figure 2.2.5.3.2**), saving valuable analysis time. The significant improvement in the spectral S/N and reduction in spectral complexity permits the observation of many more analytes and reduces ion injection periods for subsequent tandem mass spectrometry characterization (*Anal. Chem.*, **93**, 9119-9128 (2021)).

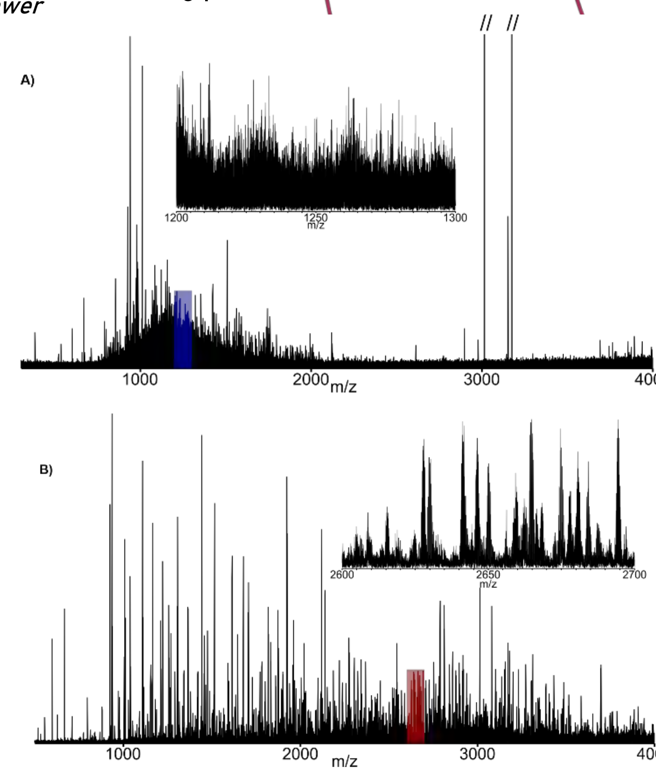


Figure 2.2.5.3.3: *Tandem MS spectra from of protein AG [M+50H]50+ (m/z 1010.2) utilizing both ETD alone **(A)** and ETD followed by a PTR **(B)**. These data illustrate the importance of relieving "spectral congestion", even with ultra-high-resolution FT-ICR MS.*

Biological applications of FT-ICR MS include "top-down" proteomics (*Proteomics*, **19**, 1800361 (2019)), which provides proteoform-specific structural information that is otherwise unobtainable. However, collection of high-quality data from intact proteins requires ultrahigh mass resolving power, mass accuracy, sensitivity, and spectral acquisition rate. Further, these requirements scale with protein molecular weight. The 21T FT-ICR MS provides all these capabilities, and implementation of PTR and PIP raises the MW-ceiling for protein detection and structural characterization even further. In 2021, the ICR facility reported significant improvements in sequence coverage and detection sensitivity of higher molecular weight proteoforms with PTR and PIP performed at 21T compared to conventional methods (*Anal. Chem.*, **93**, 9119-9128 (2021)). **Figure 2.2.5.3.3** shows tandem MS spectra of protein A/G (50.4kDa) with and without an additional PTR activation stage. The insets illustrate the qualitative difference in spectral complexity over a 100m/z domain. The dramatic S/N enhancement and spectral simplification brought about by PTR improved sequence coverage from 12% to 39%.

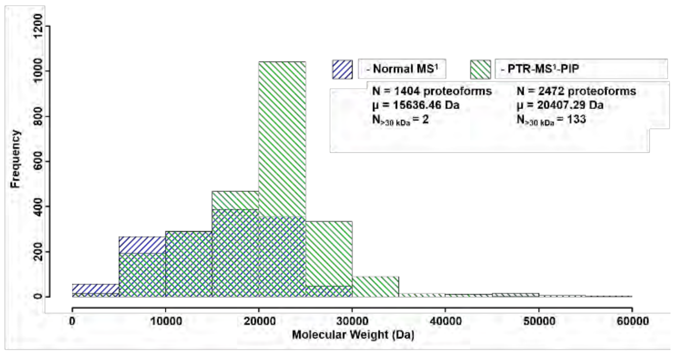


Figure 2.2.5.3.4: *Histogram of MW for all detected proteoforms from the LC-MS analysis of whole cell lysate proteins derived from H. sapiens MCF7 cells. PTR-MS1-PIP improved the total number of detected proteoforms, especially those of larger MW.*

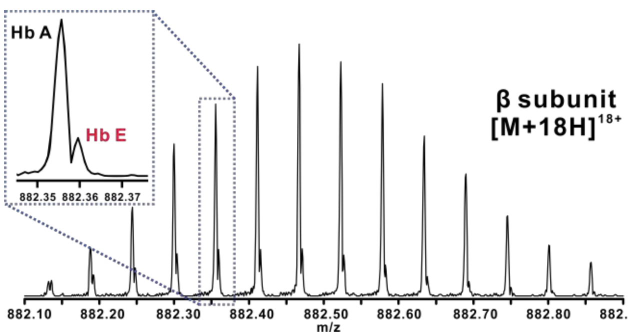


Figure 2.2.5.3.5: *Isotopic distributions for the 18+ charge state of Hb AE β subunits were distinguished with a mass resolving power (m/Δm50%) of 270k and peaks assigned with RMS errors of 0.29ppm (Hb A β) and 1.07ppm (Hb E β).*

In addition, PTR-MS1-PIP technology was used to analyze proteins recovered from *H. sapiens* MCF7 (breast cancer) cell lysate by LC-MS at 21T. The total number of proteoforms detected following automated peak deconvolution and chromatographic clustering improved by >%75 (**Figure 2.2.5.3.4**) with PTR-MS1-PIP (1404 vs. 2472 proteoforms; normal MS1 vs. PTR-MS1-PIP). Other important aspects of the analysis that improved through the use of PTR-MS1-PIP include the average molecular weight of the proteoforms detected (15.6kDa vs. 20.4kDa; normal MS1 vs. PTR-MS1-PIP) and the number of proteoforms >30kDa detected (2 vs. 133; normal MS1 vs. PTR-MS1-PIP). The S/N improvement imparted by these technologies, including the ability to isotopically resolve high molecular weight proteins (>50kDa) in single transients, provides tremendous analytical advantages for LC-MS analysis of intact proteins.

Other biological applications of 21T FT-ICR MS include **proteomic analyses of rare proteoforms** involved in cancer (*Clin. Chem. Lab. Med.,* **59**, 653-661 (2021)), sequence determination of monoclonal antibodies (*J. Am. Soc. Mass Spectrom.,* **31**, 1783-1802 (2020)), construction of proteoform families by accurate intact mass (*J. Proteome Res.,* **20**, 317-325 (2021)), and rapid and accurate diagnosis of hemoglobinopathies from 1 μL of blood (*J. Am. Soc. Mass Spectrom.,* **5**, 123-130 (2021)). Hemoglobinopathies are one of the most prevalent genetic disorders, affecting millions throughout the world. They are caused by pathogenic variants in genes that control the production of hemoglobin (Hb) subunits. As the number of known Hb variants has increased, it has become more challenging to obtain unambiguous results from routine chromatographic assays employed in the clinical laboratory. Top-down proteomic analysis of Hb by FT-ICR MS is a definitive method to directly characterize the sequences of intact subunits. In 2021, we applied "chimeric ion loading" (Anal. Chem., 92, 12193-12200 (2020)) and developed R programming tools to diagnose patient samples containing β chain variants (*J. Am. Soc. Mass Spectrom.,* **5**, 123-130 (2021)). Ultrahigh mass measurement accuracy and resolving power afforded by 21T FT-ICR enable unequivocal characterization of even heterozygous samples such as Hb AE (**Figure 2.2.5.3.5**), in which the monoisotopic mass of the β subunits differ by less than one Da.

Hexapolar Detection at 14.5T. Understanding the molecular and biochemical basis of egg development is a central topic in mosquito reproductive biology. Lipids are a major source of energy and building blocks for the developing ovarian follicles. Ultra-High Resolution Mass Spectrometry (UHRMS) combined

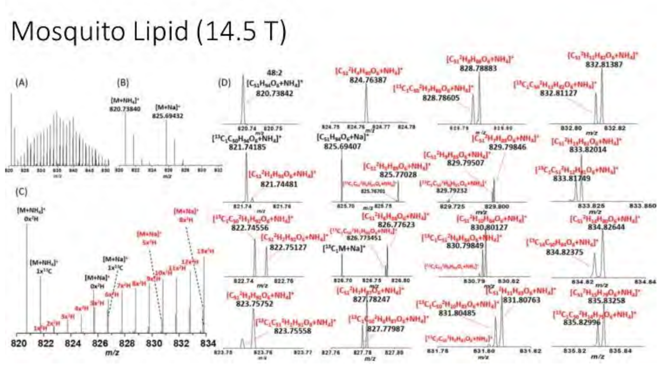


Figure 2.2.5.3.6: *(A, B) Typical MS projections for the signal corresponding to 48:2 TG from ovarian samples. Deuterium labeled diet **(A)** and normal diets **(B)**. Note the increase complexity of the MS signals with increases of the number of deuteriums incorporated and ion forms. **(C, D)** Amplified MS projections denoting the sources for isobaric interferences in the 820-834m/z range, and the corresponding nominal masses. The TG species containing deuterium are highlighted in red.*

with *in vivo* metabolic labeling of follicle lipids with deuterated water (2H2O) can provide unequivocal identification of de novo lipid species during ovarian development. The incorporation of stable isotopes from the diet was evaluated using liquid chromatography (LC) in tandem with the high accuracy (< 0.3ppm) and high mass resolution (over 1M) of a 14.5T Fourier Transform Ion Cyclotron Resonance Mass Spectrometer (14.5T FT-ICR MS) equipped with hexapolar detection. LC-UHRMS provides effective lipid class separation and chemical formula identification based on the isotopic fine structure. The monitoring of stable isotope incorporation into *de novo* incorporated TGs suggests that ovarian lipids are consumed or recycled during the PVG stage, with variable time dynamics. These results provide further evidence of the complexity of the molecular mechanism of follicular lipid dynamics during oogenesis in mosquitoes (**Figure 2.2.5.3.6**, *Nature Sci. Reports.*, **11**, 9636 (2021)).

The 9.4T and 21T instruments are primed for immediate impact in **environmental and petrochemical analysis**, where previously intractably complex mixtures are common. The field of "petroleomics" has been developed largely due to the unique ability of high-field FT-ICR mass spectrometry to resolve and identify all of the components in complex environmental, petrochemical and biofuels samples (*Sustain. Food Syst.*, **5**, 160 (2021), *Environ. Sci. Technol.*, **54**, 9968-9979 (2020); *Energy Fuels*, **35**, 16713-16723 (2021), *Environ. Sci. Technol.*, **54**, 2500-2509 (2020); *J. Environ. Chem. Eng*, 9, 106255 (2021), *Global Biogeochem. Cycles*, **34**, e2020GB006719 (2021).

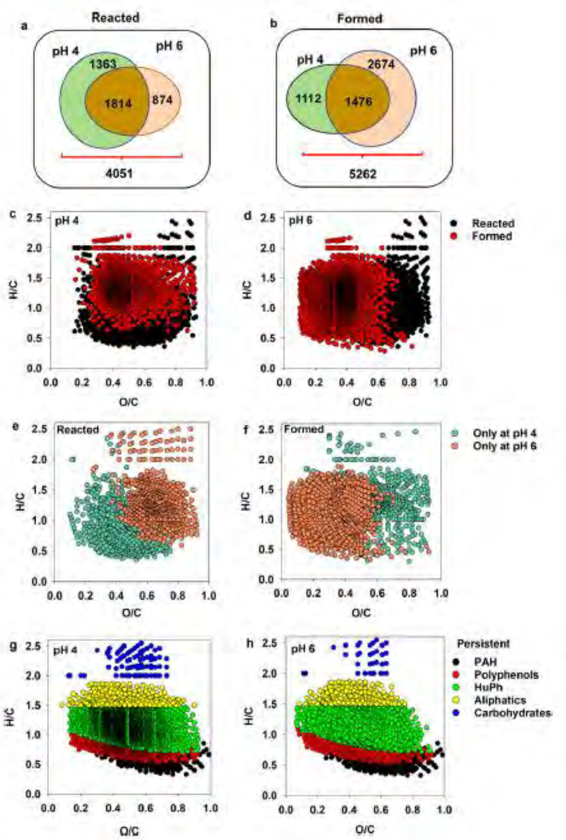


Figure 2.2.5.3.7: Numbers of the selectively oxidized (reacted) and newly formed compounds (formed) at pH 4 or 6 (a, b). The number in the overlapped region is for compounds shared at both pH levels. van Krevelen diagrams for the parent and produced compounds at pH 4 or 6 (c, d), reacted and formed compounds at pH 4 only (e) or pH 6 only (f), and persistent compounds at pH 4 (g) or 6 (h). PAH, polycyclic aromatic hydrocarbons; Polyph, polyphenols; HuPh, highly unsaturated C and phenolic compounds; Aliph, aliphatic compounds; and Carbo, carbohydrates.

Natural Organic Matter (dissolved organic matter) consists of soluble organic materials derived from the partial decomposition of organic materials (*Front. Plant Sci.*, **12**, 660224 (2021); *Biogeochemistry.*, **19**, (2021); *Limnol. Oceanogr.*, **66**, 1730-1742 (2021); J. *Geophys. Res.-Biogeosci.*, **126**, e2020JG005977 (2021); *Life*, **11**, 234 (2021); *Sci. Tot. Environ.*, **754**, 142411 (2021); *Glob. Biogeochem. Cyc.*, **35**, e2020GB006871 (2021); *ACS Earth Space Chem.*, 5, 870-879 (2021); *Limnol. Oceanog.*, **66**, 3040–3054 (2021); *J. Geophys. Res.-Biogeosci.*, **126**, e2020JG005988 (2021). DOM actively participates in carbon cycling through promoting the formation of stabilized, mineral-associated organic matter, and can be degraded through abiotic oxidation by environmental oxidants (e.g., radicals, H_2O_2, manganese (III,IV) oxides and Mn(III)-ligand complexes. One study, there aimed at quantifying the degree of oxidation, determining the compound selectivity for oxidation, and characterizing the oxidative alterations by Mn oxides for DOM as a single pool or for each compound class at the macromolecular level using electrospray ionization (ESI) FT-ICR MS (**Figure 2.2.5.3.7**, *Environ. Sci. Technol.*, **55**, 7741-7751 (2021). A common layered Mn oxide (δ-MnO_2) and an analogue to naturally occurring Mn oxides, and Suwannee River fulvic acid (SRFA) were used as model reactants to provide a proof of concept, while both Mn oxides and DOM are highly heterogeneous in the environment. To address those questions, we compared the macromolecular signature before and after the reaction of SFRA with δ-MnO_2 to identify the compounds that were reacted, formed (i.e., newly produced), and persistent. (*Environ. Sci. Technol.*, **55**, 7741-7751 (2021)).

Emerging contaminants of anthropogenic origin. In 2021, several studies investigated the quantity of species that are produced when oil and organic matter were subjected to sunlight over time. There is a general paucity of laboratory studies surrounding the characterization, transformation, and toxicity of DOMHC produced from the photo-dissolution of petroleum. Identifying the optical and molecular composition of DOMHC and how it changes over time can lead to important inferences about how it influences bioavailability, dissolution, and toxicity in the environment. (*J. Haz. Mat.*, **402**, 123998 (2021); *Energy Fuels*, **35**, 18153-18162 (2021). Comparison of liquid/liquid extraction with solid-phase extraction enabled by 21T FT-ICR MS provide insight into preferential isolation of water-soluble species produced through photo- or biodegradation (*Anal. Chem.*, **93**, 4611-4618 (2021).

Photodegradation Controls the Fate of Plastics. Sunlight exposure is a control of long-term plastic fate in the environment that converts plastic into oxygenated products spanning the polymer, dissolved, and gas phases. However, our understanding of how plastic formulation influences the amount and composition of these photoproducts remains incomplete.

Here, we characterized the initial formulations and resulting dissolved photoproducts of four single-use consumer polyethylene (PE) bags from major retailers and one pure PE film. Consumer PE bags contained 15–36% inorganic additives, primarily calcium carbonate (13–34%) and titanium dioxide (TiO_2; 1–2%). Sunlight exposure consistently increased production of dissolved organic carbon (DOC) relative to leaching in the dark (3- to 80-fold). All consumer PE bags produced more DOC during sunlight exposure than the pure PE (1.2- to 2.0-fold). The DOC leached after sunlight exposure increasingly reflected the ^{13}C and ^{14}C isotopic composition of the plastic. Ultrahigh resolution Fourier transform ion cyclotron resonance mass spectrometry at 21T revealed that sunlight exposure substantially increased the number of DOC formulas detected (1.1- to 50-fold). TiO2-containing bags photochemically degraded into the most compositionally similar DOC, with 68– 94% of photoproduced formulas in common with at least one other TiO_2-containing bag. Conversely, only 28% of photoproduced formulas from the pure PE were detected in photoproduced DOC from the consumer PE. Overall, these findings suggest that plastic formulation, especially TiO_2, plays a determining role in the amount and composition of DOC generated by sunlight. Consequently, studies on pure, un-weathered polymers may not accurately represent the fates and impacts of the plastics entering the ocean (**Figure 2.2.5.3.8,** *Environ. Sci. Technol.*, **55,** 12383-12392 (2021).

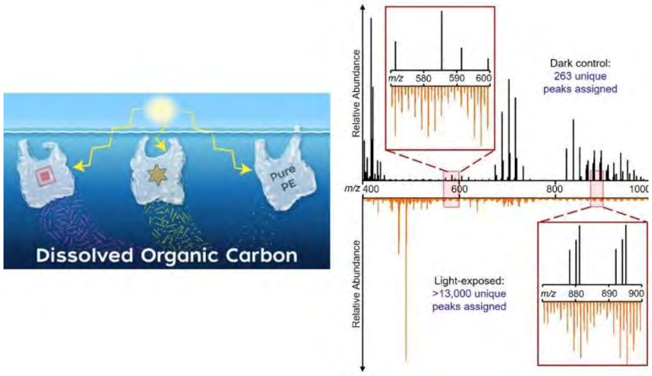


Figure 2.2.5.3.8: *Negative ion ESI 21 T FT-ICR mass spectra of peaks unique to dark control (black) and photoproduced DOC (orange) for the conventional CVS bag. This bag is generally representative of the trends observed for all samples (Environ. Sci. Technol.,* ***55,*** *12383-12392 (2021).*

2.2.5.4 Facility Plans and Directions

The ICR facility will continue to expand its user facility to include user access to the world's first 21 tesla FT-ICR mass spectrometer, including expansion of the MALDI imaging sampling and acquisition capabilities, LC FT-ICR MS for complex organic mixtures, and upgrade of the front-end of the 21T.

2.2.5.5 Outreach to Generate New Proposals-Progress on STEM and Building User Community

The ICR program had **22** new principal investigators in 2021. The ICR program also enhanced its undergraduate research and outreach program for several undergraduate scientists through the REU program, in addition to co-supervising nine graduate students from FAMU-FSU (Huan Chen, 4), Colorado State University (Amy McKenna, 4), and University of Santander, Colombia (Martha L. Chaćon-Patiño, 1). The ICR program in 2021 supported the attendance of research faculty; postdoctoral associates; and graduate, and undergraduate students at numerous virtual national conferences.

2.2.5.6 Facility Operations Schedule

The ICR facility operates year-round, with weekend instrument scheduled. Due to COVID-19 restrictions, the ICR facility shifted from on-site users to users sending samples for data acquisition by internal ICR support staff and was able to maintain an active user program with minimal downtime. In addition, the lab-wide power outage December 22, 2021, required all ICR instruments to be shut down with no instrument usage during that time.

2.2.6 NMR FACILITY

*The NMR/MRI User Program at the MagLab in Tallahassee (FSU) is partnered with the AMRIS User Program in Gainesville (UF). Major research areas in Tallahassee include solid-state NMR (**SSNMR**) research in areas of materials science, biology, biochemistry and chemistry; in vivo magnetic resonance imaging (**MRI**) of small animals and tissues; and solution NMR of biomolecules. There are **fourteen** NMR platforms on site, including several flagship instruments supported by the NSF core grant, including **(i)** the 36T Series Connected Hybrid (**36T-SCH**) platform, which operates at 35.2T/1.5GHz for ^{1}H NMR, making it the highest-field magnet for NMR in the world; **(ii)** the 14.1T/600MHz/395GHz dynamic nuclear polarization (**600-DNP**) NMR platform, a unique DNP NMR platform in the world capable running 24 hours per day for up to 21 consecutive days; **(iii)** the 21.1T/900MHz (**900-UWB**) platform, which is currently the highest-field MRI/S instrument in existence; and **(iv)** one 19.6T/830MHz (**830**) and two 18.8T/800MHz platforms (**800#1, 800#2**), which are configured for biosolids and materials ssNMR, as well as methods development and staging of UHF NMR experiments for the 36T-SCH. These instruments are unique, in part, due to their coupling with staff expertise and some of the world's best NMR probes, which are designed and constructed by our **NMR Technology Group**. In addition, there are a series of moderate-field instruments (**600#1, 600#2, 500**), which are essential for triaging experiments for the high-field instruments, running unique high-temperature and/or ^{1}H/^{19}F/X experiments, and supporting the research of numerous users from around the U.S. and the world, including those from HBCUs, HSIs, WCUs, and PUIs.*

*Annually, the NMR/MRI user program, which is run by our **Staff Scientists**, serves ca. 225-300 users from around the world, including PIs, students, postdocs, and technicians. In 2021, we continued to have a limited number of users onsite due to the COVID-19 pandemic; but remote support flourished, and the magnet times for most instruments were at full capacity, far above 2020 numbers in almost every case (see **Appendix 2, NMR table 7**). However, the overall number of users in 2021 is still low (**248**) compared to pre-pandemic (2019: **287**). We believe this trend will turn around in 2022, as users are starting to come back on site, we are currently hosting long-term visiting scientists, and as of mid-February 2022, we have already had 112 unique users. Finally, the number of peer-reviewed publications from the NMR/MRI UP for 2021 was **71**, the second highest count in 20 years (second only to 2020, which had **75**).*

2.2.6.1 Unique Aspects of Instrumentation Capabilities

2.2.6.1.1 Ultra-High Field (UHF) NMR: **36T-SCH**. The 36T-SCH was in its third year of user service in 2021; unfortunately, instrument time continued to be limited by staffing issues related to the COVID-19 pandemic (operations on the SCH requires a full team of engineers for field ramping and monitoring) and failures of the helium-liquefier turbine and a local substation transformer, the latter of which only came back online in mid-2021. Nonetheless, this platform has resulted in over **30** peer-reviewed publications since commissioning in November 2018 (including **13** in 2020 and **9** in 2021), and is seeing much use in 2022, with large time allocations upcoming in March, April, and May of this year. The 36T-SCH continues to prove its unmatched value for the SSNMR of half-integer quadrupolar nuclei (*i.e.*, nuclear spins of 3/2, 5/2, 7/2, and 9/2, which constitute 73% of NMR-active nuclides in the Periodic Table) in a wide range of materials. We continue to have success studying challenging, unreceptive nuclei like ^{67}Zn (I = 5/2) and ^{43}Ca (I = 7/2); however, in 2021, our focus has shifted away from conventional high-resolution SSNMR of spin-1/2 nuclei to its combination with ^{17}O SSNMR for the study of biosolids, chemicals, and materials, in part due to new ^{17}O-enrichment protocols being developed with our collaborators (*vide infra*). As in 2020, we took advantage of limited SCH operations to work on improving both the hardware and software used to reduce short- and long-term field fluctuations (at the end of 2021, we have achieved a field homogeneity of ~0.3ppm and hope to hit ~0.1ppm by the end of 2022). A new probe (of a total of six for the 36T-SCH) came online: a 3.2mm HX MAS probe for unreceptive low-γ nuclei (available January 2021 for users). A 3.2mm middle-γ MAS probe has been rebuilt with new RF coils designed to deliver stronger decoupling for biological experiments and to improve S/N for nuclei in the ^{13}C…^{11}B range (377-481MHz). Finally, a sixth HXY probe, with a fast MAS 1.3 spinner for indirect ^{1}H-detection, is currently under construction (commissioning expected in early 2022). The improvements in this new class of probes will open up many new possibilities for UHF SSNMR of unreceptive nuclei, and support our new focus on high-resolution ^{1}H, ^{13}C, ^{15}N, and ^{17}O SSNMR of biosolids and materials.

2.2.6.1.2 Ultra-High Field (UHF) NMR at very low temperatures: 32T-SCM. Our achievements with half-integer quadrupolar nuclei on the 36T-SCH platform encouraged us to explore the potential of conducting ultra-wideline (UW) NMR experiments on a 32T magnet housed in the *DC Facility*. The 32T all-HTS (high-temperature superconductor) magnet (34mm bore, 2.5ppm homogeneity – unshimmed), which was commissioned for operation in 2020, is the first in a brand new class of all-SC magnets featuring a 16T LTS outsert and a 16T HTS insert, the combination of which leads to a high-stability and high-homogeneity magnet at low operational costs (*e.g.*, the 36T-SCH is a 14MW system, whereas the 32T-SCM uses more than three orders of magnitude less power at ~5kW – this directly translates to more user time as the magnet is operational 24/7). Preliminary tests on the 32T-SCM involving ^{35}Cl UW SSNMR have convinced us that this magnet will be perfect to expand the scope of our studies of unreceptive nuclei. Uniquely, this system has a variable-temperature insert (**VTI**) that allows temperatures from 1.4K - 290K; low-T experiments (*i.e.*, < 35K), in combination with a static HX NMR probe (to be developed in 2022) and our recently developed broadband cross-polarization pulse sequences, offer much promise for exciting new applications to biological, chemical, and materials research. This effort represents new collaborations involving Schurko, Z. Gan, P. Gor'kov, and I. Hung (*NMR/MRI*) and A. Reyes, E. Greene (*DC Facility*, *Condensed Matter Physics*), along with numerous users.

2.2.6.1.3 DNP MAS NMR: **600-DNP**. The 600-DNP platform, a joint effort between NMR, AMRIS, and EMR that opened for users in late 2018, has yielded **31** publications so far, with more forthcoming in 2022 (4 published so far). This still one of, if not the most efficient 600MHz/395GHz instrument in the world, due to the improved microwaive delivery and lower sample temperatures. Much of the developmental research takes advantage of the expertise across divisions at the MagLab, enabling bridges between NMR/MRI and both EPR and ICR Facilities. Due to the expertise and diligence of Drs. Fred Mentink-Vigier and Thierry Dubroca, the 600-DNP had almost 250 magnet days available in 2022, and several new PIs/research groups were recruited. The instrumentation has been improved via modification of the commercial hardware, the purchase of a better cold gas transfer line, and the continued in-house development of MAS-DNP NMR probes. New DNP probes were developed by Dr. Faith Scott under the supervision of Mr. Peter Gor'kov, Dr. Mentink-Vigier, and Dr. Long and will be ready for use in early 2022 (*vide infra*). The unique DNP platform is comprised of DNP MAS NMR and Overhauser DNP instruments (two separate 600MHz magnets), which receive microwave irradiation via a quasi-optical table (built in-house) that splits the gyrotron microwave beam. The DNP can be operated continuously (24/7) for up to three weeks at a time, unlike any other DNP platform in the world, and at no cost for users. This enables the execution of extremely challenging DNP NMR experiments for our users, and the support of PIs across the career spectrum, including numerous young professors who are just starting out. Finally, a benchtop EPR spectrometer and tabletop MAS spinner for screening of samples were also installed to improve the instrument's runtime: this improves sample preparation while avoiding probe damage due to unbalanced rotors. In particular, the benchtop EPR is key for assessing the distribution of the biradicals, their interactions with the substrate, and if they undergo decay.

2.2.6.2 Facility Developments and Enhancements

2.2.6.2.1 Probes. The probes designed by the ***NMR Technology Group*** are a major factor in setting the MagLab apart from other facilities around the world and keeping our user program on the cutting edge. This team, led by Dr. Bill Brey and Mr. Peter Gor'kov, designs, manufactures, and implements probes of very high quality. They provide versatile tuning configurations for multinuclear ssNMR, low-*E* coils for lossy biosolids samples, and some of the best rf circuits and coils for detection of weak NMR signals. Additionally, Dr. Brey is working on the incorporation of HTS coils in solution NMR probes for optimized efficiency and increased sensitivity, which are being used at AMRIS, and also at U. Georgia in the near future. In 2021, three probes were developed/commissioned, including: (i) a 3.2mm HXY MAS low-E probe (low-γ) (biosolids, materials) for the 36T-SCH; (ii) a 1.3mm HXY MAS low-E probe (NHFML stator) (biosolids, materials) for 800#1, 800#2 (**N.B.**: this probe operates at 0°C, unlike Bruker probes (+30°C), has 2× signal-to-noise over analogous commercial probes, and has been tuned and configured so far for 75% of periodic table in 2-resonance mode, as low as ^{103}Rh!); and (iii) a 1.3mm HXY MAS low-E probe (mid-γ) (biosolids, materials) for the 36T-SCH. In addition, the 0.75mm HXY MAS low-E probe (JEOL stator) (biosolids, materials) for 800#1 and 800#2 was completed in 2020 and regularly used throughout 2020-2021: this probe is one-of-a-kind, with indirect ^{1}H detection (spinning up to 100kHz) with twice the sensitivity of analogous commercial probes. In terms of DNP MAS NMR probes, a new 3.2mm HXY MAS probe is currently under testing, and 1.3 and 1.9mm HXY DNP probes are in the construction and design phases, respectively. A single-channel X MAS NMR prototype probe for the 32T-SCM was constructed and tested, paving the way for the design of a low-T HX static NMR probe for this platform in 2022-23. Our static HX Low-E probe for the 900-UWB was configured for low-γ operation (again, down to ^{103}Rh!) and special 5 mm containers for air-sensitive samples were designed and are now being used.

2.2.6.2.2 Platform upgrades. The 900-UWB console is still in the process of being upgraded with a NEO console and new state-of-the-art gradient and shim systems (450V/300A), with shimming capabilities for *in vivo* MRI/S. With multiple channels and transceiver capabilities, this will offer enhanced capabilities in a new super-wide configuration to augment the existing microimaging and SSNMR applications. Spectroscopy on the 36T-SCH continues to benefit from the work of Prof. Jeff Schiano (Penn State). Careful measurements and analysis of the gain and phase responses of the cascade field regulation (CFR) system and new algorithms to better compensate for fluctuations in cooling water temperature have given us a very stable field with a homogeneity of ~0.3ppm. In addition, Drs. Bill Brey and Ilya Litvak continued working on the reductions in long-term field drift by improving the stability of the low-noise electronics in the CFR system.

2.2.6.3 Major Research Activities and Discoveries/ Research Science Highlights

The **36T-SCH** continued to prove its value for SSNMR studies of half-integer quadrupolar nuclei, due to the scaling of signal proportional to B_0^2, and the narrowing of central transition (+½ ↔ −½) pattern breadths scale as B_0^{-1}, which provides unparalleled enhancement of both signal and resolution. Over the past year, investigations of metal centres and oxygen sites in biosolids and materials are proving invaluable structural characterization that is simply not possible on lower field platforms. ***Metal NMR.*** ^{27}Al (I = 5/2) MAS NMR spectra of dehydrated H-ZSM-5 catalysts were used to study framework and coordinated-framework Al sites; the high resolution only obtainable on the 36T-SCH provided, for the first time, detailed structural characterization of the latter, which are crucial for determining optimal catalytic reaction conditions [*J. Am. Chem. Soc*. **2021**, *143*, 6669; DOI]. ^{95}Mo (I=5/2), an extremely unreceptive nucleus, was the focus of two SSNMR studies: one for detecting active Mo sites on Mo/ZSM-5 zeolite catalysts (promising for natural gas transformations) [*Angew. Chem. Int. Ed.* **2021**, *60*, 10709; DOI] and the other for studying pseudo-amorphous MoS_2 nanomaterials (**Figure 2.2.6.3.1**) and MoS_2 layered on an Al_2O_3 hydrodesulfurization catalyst [*J. Phys. Chem. C* **2021**, *125*, 7824; DOI]. ***^{17}O NMR.*** We continued to pursue opportunities for the investigation of both biosolids and materials with ^{17}O NMR, as evidenced by four papers accepted for publication in late 2021: the report of a general method for ^{17}O labeling of recombinant proteins (*i.e.*, yeast ubiquitin) in *E. coli* and their investigation by ^{17}O solution QCT NMR and SSNMR [*ChemBioChem* **2021**, *22*, 761; DOI]; a landmark study on the NMR crystallography of a tryptophan synthase α-aminoacrylate intermediate [*PNAS* **2022**, *119*, e2109235119; DOI]; the first high-resolution ^{17}O MQMAS NMR spectra of fully ^{17}O-enriched α-D-glucose [*Chem. Sci.* **2022**, *in press*; DOI]; and a paper reporting new methods for efficient mechanochemical ^{17}O enrichment of silicas, studied with UHF ^{17}O SSNMR on the 36T-SCH and ^{1}H-^{17}O CP/MAS DNP NMR on the 600-DNP [*Chem. Eur. J.* **2021**, *27*, 12574; DOI].

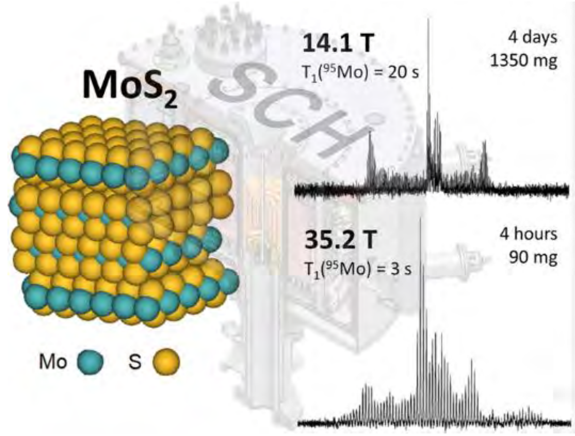


Figure 2.2.6.3.1: *^{95}Mo SSNMR spectra of MoS_2 acquired at 14.1T (4 days) and 35.2T (4 hours), demonstrating the power of UHF NMR for quadrupolar nuclei.*

The **600-DNP** platform continued to provide ground-breaking science in both DNP NMR developments and applications to a wide array of biosolids and materials. Major user projects in the areas of chemistry and materials science included the use of ^{17}O DNP NMR to study mechanochemical ^{17}O enrichment of silica surfaces [*Chem. Eur. J.* **2021**, *27*, 12574; DOI] and the use of ^{13}C DNP NMR to determine that cyclic polyacetylene is indeed cyclic, via observation of the increased *trans*-conformation content associated with its cyclic nature [*Nat. Chem.*, **2021**, *13*, 792; DOI]. In the realm of biological solids and biomaterials, DNP NMR studies (largely focusing on ^{13}C and ^{15}N) were conducted on materials in plant cell walls like lignocellulose and polysaccharides (including experiments at natural abundance, **Figure 2.2.6.3.2**) [*Nat. Commun.*, **2022**, *13*, 538; DOI; *Biotechnol. Biofuels*, **2021**, *14*, 14; DOI]; biomaterials in bones and cartilage-like collagen [*J. Phys. Chem. B*, **2021**, *125*, 4757; DOI; *J. Magn. Reson.*, **2022**, *335*, 107144; DOI]; and most recently, to aid in the aforementioned NMR crystallographic determination of tryptophan synthase α-aminoacrylate intermediate [*PNAS* **2022**, *119*, e2109235119; DOI]. The NMR/MRI Facility is also collaborating with the ICR Facility on a new series of environmentally related projects, with the first publication describing the characterization of Kentucky bluegrass biochar constituents using DNP NMR and FT-ICR MS [*Analyt. Chem*. **2021**, *93*, 46; DOI]. In terms of developmental DNP NMR methods, our users explored the use of gated µwave pulses to study the direction of nuclear polarization flow near paramagnetic centers, which may overcome the "spin diffusion barrier" that currently limits many types of DNP experiments on different phases and temperature ranges [*Sci. Adv.*, **2021**, *7*, eabf5735], and a study of the distances between *g*-tensors in the bT-urea family of polarizing agents and their impact on DNP efficiency [*J. Magn. Reson.* **2021**, *329*, 107026; DOI].

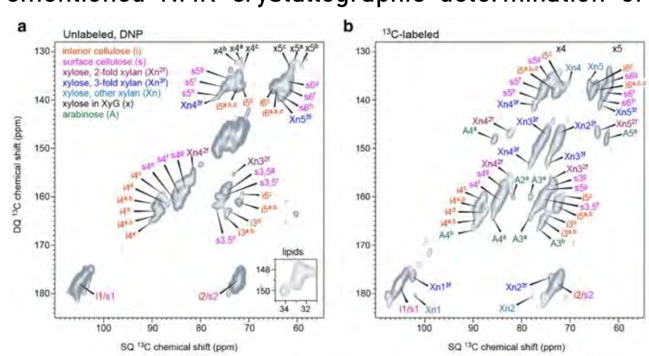


Figure 2.2.6.3.2: *DNP enables 2D correlations using unlabeled and native cell walls:* ***(a)*** *2D ^{13}C–^{13}C INADEQUATE spectrum of unlabeled WT rice collected on a 600MHz/395GHz DNP system. (b) The same experiment on a fully labelled sample at 400MHz.*

On our 900, 830, 800(2), 600(2) and 500MHz platforms, numerous solution NMR, SSNMR, and MRI studies of biosolids and materials, along with methods development papers, were published. These include SSNMR for the characterization of Li^+- and Na^+-ion batteries and energy materials [*Nature* **2021**, *598*, 590; DOI; *Nat. Commun.* **2021**, *12*, 4903; DOI]; MRI and SSNMR for *in situ* studies of Li/Na batteries [*Adv. Mater.* **2021**, *33*, 2005878; DOI]; ^{35}Cl and ^{14}N SSNMR studies of nutraceuticals in their bulk and dosage forms [*Mol. Pharm* **2022**, *19*, 440; DOI]; ^{13}C-^{13}C correlation SSNMR of an intrinsically disordered protein with acidic membranes [*JACS Au* **2021**, *1*, 66; DOI]; NMR diffusometry of worm-like micelles in solution [*Langmuir* **2021**, *37*, 3585; DOI]; the first application of Neurite Orientation Dispersion and Density Imaging (NODDI) at 21.1T to evaluate the efficacy of stem cell therapy [*Magn. Reson. Med.* **2021**, *86*, 3211; DOI]; a multinuclear (^{1}H/^{13}C/^{15}N) NMR investigation of the dynamics and interactions of the SARS-CoV-2 N protein N-terminal region with other regions of the protein as well as interacting partners including RNA and CypA host cells [*J. Mol. Bio.* **2021**, *433*, 167108; DOI]; and many others.

2.2.6.4 Facility Plans and Directions

In 2021, we hired a new RF engineer (Malathy Elumalai) and new machinist (Joe Collins) for the *NMR Technology Group*. We also hired a postdoc (Yijue Collette Xu) to assist users with experiments on the 36T-SCH. We also continued interviews for the 36T-SCH and MRI Research Faculty positions; the search for the former is concluding in February 2022, but the latter was canceled due to upcoming cuts in the NMR/MRI program (in the 2023-2028 NSF Renewal).

A number of new initiatives were launched in 2021 and continue into 2022, with support from the NSF Core Grant, as well as from external funding sources, which augment support of the NMR/MRI User Program. These include **(i)** the development of a 400MHz DNP NMR platform that utilizes a 5W klystron as a µwave source (NSF-MRI, with EMR, *N.B.*: the original proposal for this instrumentation was rejected in 2020 due to a clerical error, and was resubmitted in late 2021); **(ii)** the submission of an NIH RM1 (Collaborative Program Grant for Multidisciplinary Teams) to support biomedical NMR applications (essentially a renewal of our previous NIH P41), including the construction of a ^{1}H/^{13}C/^{15}N/^{17}O quadruple-resonance MAS probe; **(iii)** the planning for a national network of UHF NMR instruments (28.2T/1.2GHz) with colleagues from five other universities across the U.S.; and **(iv)** continued work with the *DC Facility* and *C.M. Physics* on development of ultra-wideline NMR techniques on the 32T-SCM. Under NSF core funding from 2023-2028, we had hoped to pursue **(v)** a proposal for ultra-low temperature closed He loop DNP operations at 600MHz (core funding, with EMR, in progress); **(vi)** conversion of an 800MHz solutions NMR spectrometer to a dedicated SSNMR spectrometer for ^{1}H-indirect detection experiments on biosolids and repositioning of solution NMR operations at 750MHz in the Department of Chemistry and Biochemistry at FSU; and **(vii)** development of DNP NMR methods at 30+ T; however, due to the aforementioned budget cuts, we plan to look elsewhere for financial support of these projects.

2.2.6.5 Outreach to Generate New Proposals-Progress on STEM and Building User Community

In pre-pandemic years, user recruitment was carried out via in-person solicitations at conferences and meetings; we continued these activities virtually in both 2020 and 2021, via lectures and posters at national and international online conferences, as well as the usual email solicitations and a limited number of sponsorships. This will drastically change in 2022, as many NMR and MRI related meetings are returning to in-person formats. In 2021, we completed inventories of the spectrometers, probes, and related hardware; developed useful databases; and translated this information to our updated web site. As a result of this work, we now have up-to-date descriptions of all of the spectrometers and probes available to our users, along with active projects, and interesting items about ongoing research at the MagLab. In further efforts to recruit users, we continued with online group meetings and continued to invite high profile speakers (and potential collaborators); these activities continue in 2022. In 2022, we plan on resuming in-person workshops on topics like RF circuits, DNP, and NMR on the 36T-SCH (we had hoped to do this in 2021, but it was not possible due to the ongoing COVID-19 pandemic).

STEM outreach continued to be challenging due to the COVID-19 pandemic – nonetheless, we continued to offer a number of virtual activities for school-age children, undergraduatess, and members of the general public. Many of our team members participated in the first Virtual MagLab Open House in Feb. 2021, either with video presentations or online videos. For instance, Dr. Ilya Litvak organized a virtual "*Neighborhood Camp Fair*", which had 20 individual attendees and two online connections from classrooms (Bond Elementary and Pineview Elementary, both serving predominantly URM areas), and Dr. Sam Grant gave an online presentation entitled: "*Try it at Home: Fruit DNA*" to discuss the principles of DNA and harvest from fruit, which included getting the students to do live demos at home. Other activities oriented at primary and middle school children included a virtual science night (6-12 y.o.) at the Tallahassee Library run by Dr. Faith Scott, presentations at the Tesla Summer Camp hosted through the CIRL by Dr. Scott, and participation in local and regional science fairs as judges and organizers by several of our team members. Faith Scott and Rob Schurko provided virtual tours of the MagLab facilities and introductions to NMR for groups of undergraduates, such as those in the Women in Math, Science & Engineering

(WIMSE) Program at FSU. Our team also had several REU, one InternFSU, and one UROP, and four Honors URP/HITM undergraduate research students who participated in research activities at the MagLab. Drs. Sam Grant and Fred Mentink-Vigier also presented in-person and online lectures to undergraduates at Thomas University and Louisiana State University, respectively.

2.2.6.6 Facility Operations Schedule

Almost all of our instruments saw an increase of magnet days in comparison to 2020 (in the height of the COVID-19 pandemic, numbers dropped due to the decrease in users). Our fleet of high- and moderate-field NMR spectrometers, including 800#1, 800#2, 830, 600#1, and 600#2, are back to numbers approaching **365** days per year, with very limited downtimes for maintenance and testing – this is likely because remote instrument use and virtual communication have become more routine, and therefore streamlined. Drs. Zhehong Gan, Ivan Hung, Riqiang Fu, and Sungsool Wi are largely responsible for the great success on these instruments, in terms of both exceptional science as well as keeping the instruments and probes in top condition. The 900-UWB has not been operating at full capacity for MRI purposes since July 2021, due to some issues with the new console installation; nonetheless, Dr. Grant has been conducting MRI experiments when time is available, Dr. Schepkin established a remote connection to 900 for our European users allowing them to start experiments with triple-quantum ^{23}Na MRI, and we have filled other available times with increased usage of the 900-UWB for SSNMR of unreceptive nuclei like ^{103}Rh (I = 1/2) and ^{99}Ru (I = 5/2) – still achieving a remarkable **335** magnet days (vs. only **259** in 2020). NMR experimentation on the 36T-SCH remained low at **42** days (same as in 2020 and **90** in 2019) due to aforementioned failures of the helium-liquefier turbine and a local substation transformer; again, we note that in 2022, UHF NMR experiments are proceeding apace on this instrument, with large time allocations over the next four months. The 600-DNP platform continued its outstanding performance, providing **243** magnet days in 2021 (there was a slight decrease below our four-year average of **250** days, as downtimes for maintenance were taken to activate a closed-loop He system, provide maintenance on the cooling cabinets, and other general improvements to hardware).

2.2.7 PULSED FIELD FACILITY

The Pulsed Field Facility (PFF) is located in Los Alamos, New Mexico, at Los Alamos National Laboratory (LANL), where the utilization of LANL and U.S. Department of Energy (DOE) assets enable us to provide world record pulsed magnetic fields to our international community of users – from undergraduate students through to senior investigators. To make the most of these world record magnets we provide users with both robust scientific instrumentations engineered to operate in the transient pulsed magnetic field environment, along with the support of scientists who are active researchers with expertise in high magnetic field-driven science. Our users additionally benefit from the strong complementary expertise and experimental capabilities of the DC Facility; often both facilities contribute to a given user's research. The interconnectedness of the two NHMFL facilities is further supported by the use of a common application process for the DC and PFF, by which experiments can be requested at either location under a single overarching scientific proposal, as with all facilities.

2.2.7.1 Unique Aspects of Instrumentation Capabilities

Table 2.2.7.1: *Pulsed field magnets available to users at the NHMFL-PFF.*

Capacitor Driven Pulsed Magnets					
Magnet System	**Field**	**Bore**	**Maximum Rise Time**	**Pulse Duration**	**Supported Research***
Cell 1 Cell 2 Cell 3 Cell 4	65T	15mm	8ms	60ms	Magneto-optics (IR through UV) Magnetization (susceptibility, extraction, torque) Magneto transport (DC – MHz, GHz Conductivity) Pulse Echo Ultrasound Spectroscopy Fiber Bragg Grating Dilatometry Polarization, Magnetocaloric Temperature environments from 350mK to 300K For compatible techniques: Pressures up to 9GPa and in-situ sample rotation
Duplex	75T	15mm	1.8ms (30T – 75T)	80ms	
Mid-pulse	55T	15mm	32ms	300ms	
Generator Driven Magnets**					
Magnet System	**Field**	**Bore**	**Maximum Rise Time**	**Pulse Duration**	**Supported Research***
100T Multi-shot	101T	10mm	4.5ms (40T – 100T)	3s	All techniques listed above
60T Controlled Waveform	60T	32mm	100ms (plateau)	3s	All techniques listed above Magnetothermal studies (Heat capacity and magnetocaloric) FIR and THz optics Larger Sample Volumes

**We will dedicate resources to work with users to develop and field new/novel techniques as needed in our magnet systems.*
***Offline while LANL's 1.4GW AC generator is being repaired.*

The pulsed magnets available to users at the PFF are listed in **Table 2.2.7.1**. At the heart of the PFF's magnet operations is a fully multiplexed (8 output) computer controlled 4MJ (32mF @ 16kV) capacitor bank. This capacitor bank is responsible for providing power to all of our currently operational pulsed magnet systems, which includes our workhorse 65T short-pulse magnets and our newest 55T mid-pulse and 75T duplex magnets. Beyond these capacitor bank driven magnets, we provide users with access to the highest nondestructive magnetic fields in the world. The 100T multi-shot magnet is the first and only magnet in the world to successfully perform a magnetic field pulse to 100T in a nondestructive manner. The energy necessary – hundreds of megajoules – to run this highest field magnet is provided by LANL's 1.4GW AC generator, a unique pulsed power supply. The AC rectification of the generator output enables the control of the pulsed power waveform, allowing for the optimization of the associated magnet systems – the 100T multi-shot magnet and 60T controlled waveform ("Long Pulse") magnet – and sample diagnostics. Currently these two magnets are unavailable to users while the AC generator is under repair.

2.2.7.2 Facility Developments and Enhancements

2.2.7.2.1 New mid-pulse magnet

After the successful fielding of the 75T duplex magnet for user operations, magnet development efforts turned to the design and production of a mid-pulse magnet to reach fields of up to 60T at slower rate than our current short-pulse magnets. This mid-pulse magnet is driven by 6 modules of the 4MJ capacitor bank, requiring about 2.1MJ to reach peak field. The magnet itself is made of hard-copper wire and wound using a continuous-winding technique. The first magnet was tested to 56T in June 2021 – downgraded due to minor winding defects – and has been serving users with fields up to 55T since then. The lessons learned from the first winding of the new mid-pulse was implemented during the winding of a second mid-pulse which is anticipated to be commissioned to 59T for user operations once the existing magnet reaches the end of its life cycle. The field profile of the 55T mid-pulse, as shown in **Figure 2.2.7.2.1**, highlights the much longer rise time and pulse duration, ~3ms and ~300ms respectively, of this new magnet.

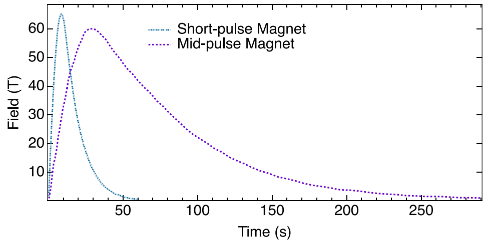


Figure 2.2.7.2.1: *Magnetic field versus time for both 65T short-pulse and 60T mid-pulse magnets, highlighting the longer duration and slower rise time of the newly designed mid-pulse magnet.*

2.2.7.2.2 Upgrades to the 4MJ capacitor bank.

In preparation for future magnet designs that will require the tandem operation of both the 4MJ capacitor bank and the 2MJ capacitor bank that powers the insert of the 100T, upgrades to the 4MJ bank were undertaken in the latter half of 2021. These upgrades focused on new bus arrangements and switches that will enable the 8 modules of the bank to be fired in an additional configuration, differing from that which is currently required for the operation of the existing suite of pulsed magnets. Other upgrades such as additional cabling and ground hooks, as well as modification of the software needed to operate the bank, were also completed at this time.

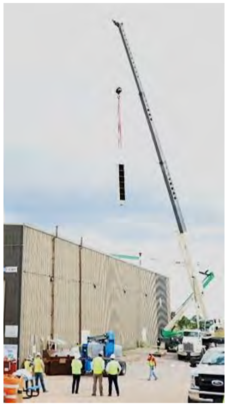


Figure 2.2.7.2.2: *The cleaning of the 4 motor generator coolers required removing each 16-foot tall and 7,500lbs. cooling towers via a small hatch in the roof above each corner of the motor generator. The teams responsible for this high consequence operation included LANL, PFF, and external contactor personnel.*

2.2.7.2.3 Work on generator continues while rotor replacement underway

During 2021 the effort to return the 1.4GW LANL motor generator to service saw several key milestones reached, the largest of which included bringing subcontractors onsite for a major 8-week maintenance effort in the late summer. The main efforts included the removal, cleaning, and re-installation of the coolers, which required precise coordination of many teams to bring the cooling towers out and in through the roof as shown in **Figure 2.2.7.2.2**. The re-assembly of the oil system closure was also performed around this time to allow for continued oil flow operations which are necessary to preserve components until the new rotor is delivered. In addition, a large battery of electrical tests on the entire system, many of which are still ongoing, were begun by subcontractors during this time.

While the motor generator is still under repair, the PFF's power delivery team took advantage of the downtime to perform a series of inspections and tests on the remaining major component, the stator. This included a thorough visual examination (**Figure 2.2.7.2.3**), mechanical inspections of wedges and other internal fasteners, borescope inspections of the cooling passages, and epoxy inspections, all of which identified no issues. Efforts on the generator axillaries also continued this year, with the new Drive and Exciter in place. Once the installation of cable trays is completed the rewiring of these two axillary systems can commence.

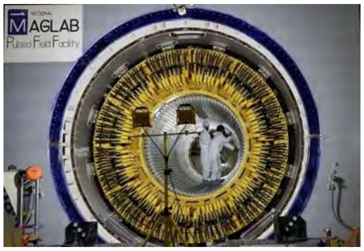


Figure 2.2.7.2.3: *A visual inspection of the stator required personnel to climb inside.*

2.2.7.3 Major Research Activities and Discoveries/ Research Science Highlights

The first full year of 75T duplex magnet operations for users continued on the success of the prior year with another high-profile paper, this time from the group of long time PFF user James Analytis and his team at UC Berkley, published in *Science*. In this collaborative work which included PFF staff, the team used both 65T and 75T magnets to study the Hall effect of the unconventional superconductor $CeCoIn_5$, a material closely related to high-temperature-superconducting cuprates. In the high-field limit the gradient of the Hall resistivity (**Figure 2.2.7.2.4**) is field-independent over a wide range of magnetic fields, which allowed researchers to more accurately determine the carrier (hole or electron) densities in $CeCoIn_5$ at high fields. As a result, a change in the carrier concentration was observed as the doping of the material changed, resulting in a quantum phase transition without any evidence of a broken symmetry. These findings are important because they provide vital clues on the path to understanding high temperature superconductivity and the effect of being in close proximity to a quantum phase transition may play. For more details see: N. Maksimovic, *et al.* "Evidence of delocalization quantum phase transition without symmetry breaking in $CeCoIn_5$," Science (2021) (DOI: 10.1126/science/aaz4566).

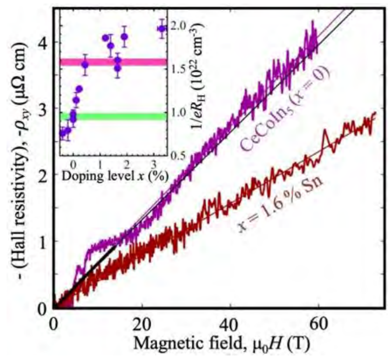


Figure 2.2.7.2.4. *On one side of the quantum phase transition (purple curve, x = 0) the Hall resistivity grows steeply with field once the linear regime is accessed in high magnetic fields; on the other side of the transition (red curve, x = 1.6% Sn) the increase is more gradual. Insert: the quantum phase transition is evidenced by the steep jump with increasing electron concentration in data from a dozen samples with different doping concentrations.*

Frustrated magnets are materials in which the interactions between magnetic moments are such that the competing interactions cannot all be satisfied at the same time and ordering is prevented. These frustrated systems can give rise to a multitude of complex and novel magnetic states and are a prime candidate for hosting a quantum spin liquid (QSL) state; a theoretically predicted state that may have applications in data storage and memory. Recently scientists at the PFF and their colleagues studied the magnetically frustrated mineral atacamite ($Cu_2Cl(OH)_3$), whose magnetic structure finds the magnet moment-carrying copper ions arranged in a chain of triangles resembling a saw blade. The theoretical model for such a "sawtooth chain" predicted a magnetization plateau for certain configurations of the magnetic moments, which provided strong motivation for measuring the magnetization of this material in fields up to 65T. The experiment showed a surprising result that deviated from theoretical predictions; a large plateau-like region above 35T that was much wider than expected and in an unexpected magnetic field range, as shown in **Figure 2.2.7.2.5**. As these results are inconsistent with the theory, the implication is that the existing model is insufficient to describe the interactions of the system. This work and follow-up studies will aid in improving the theoretical models which could help engineer future QSL materials. For more details see: L. Heinze, *et al.* "Magnetization Process of Atacamite: A Case of Weakly Coupled S = ½ Sawtooth Chains," PRL (2021) (DOI:10.1103/PhysRevLett.126.207201).

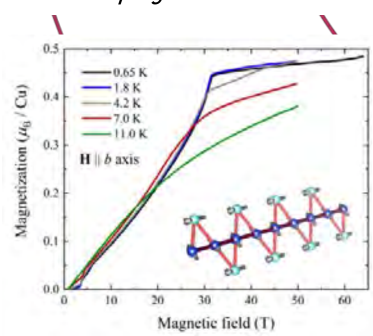


Figure 2.2.7.2.5. *The inset shows the "sawtooth chain" magnetic structure of atacamite in zero magnetic field. This magnetically frustrated system showed a wide plateau-like feature above 35T, which was not in agreement with the magnetization plateau theorized from existing models.*

2.2.7.4 Facility Plans and Directions

2.2.7.4.1 New 30kV bank and future duplex magnets.

Originally planned to be onsite in late 2021 but delayed due to ongoing COVID-19 related supply chain issues, we look forward to the commissioning of the new 30kV 1.2MJ capacitor bank in mid-2022. This capacitor bank, funded via NSF for the Magnet Surge, is designed to be integrated with the 4MJ capacitor bank to provide power for the next generation of duplex magnets in excess of 80T. A design for an 85T magnet to be used with these two banks is nearly finalized. Whilst we await the 30kV bank, designs for a second 85T duplex magnet – this one driven by both the 4MJ and the 2MJ capacitor bank – was finalized late last year and was the impetus for the upgrades to the 4MJ bank listed above. The building and commissioning of this 85T magnet is anticipated to be completed by the end of 2022.

Purchased late in 2021, we are planning for the arrival of a new liquid helium production assembly in late 2022. The brand-new system – consisting of a helium liquefier, a helium gas purifier, and a new 3000L liquid helium storage tank – will replace our existing system which is comprised of an over 30-year-old helium liquefier. While we do not anticipate bringing this new equipment online for helium production until mid-2023, efforts will begin this year in anticipation of its arrival.

2.2.7.5 Outreach to Generate New Proposals-Progress on STEM and Building User Community

In-person outreach activities continued to be limited this year, but many of our staff gave virtual talks at universities and conferences throughout the year. In addition to these outreach efforts, three PFF staff members took part in the 5th annual Los Alamos National Laboratory (virtually) hosted Summer Physics Camp for Young Women, a free camp that focuses on inspiring interest in STEM through inquiry-based labs lead almost entirely by women currently working in STEM. The PFF staff members were instrumental in the development and teaching of a hands-on magnet related lab, as well as giving a virtual tour of the pulsed field facility. The virtual forum of the annual MagLab User Summer School provided an opportunity for the PFF user program director to give an overview of the facility as well as a lecture on measuring magnetization in both pulsed and DC fields.

2.2.7.6 Facility Operations Schedule

Jointly with the DC Facility, the PFF solicits proposals through a common call three times a year to streamline the application process and ensure availability of resources (both of personnel and magnets). Hours of operation for the capacitor bank driven pulsed magnets are Monday through Friday 8:00am to 7:00pm. Maintenance is scheduled each Monday from 8:00am to 10:00am, or on an as needed basis. Generally, no more than three pulsed magnets are scheduled for use in a given week (including the duplex or the mid-pulse) to enable turnaround and continuation of an experiment following a magnet failure and to ensure adequate liquid helium availability. As the COVID-19 pandemic continued, many of our users continued in a virtual manner throughout the year, with a small number of domestic users returning to onsite visits in the latter half of 2021. In 2022, we will continue to adapt and be flexible with onsite and virtual users as needed and we look forward to welcoming back internationally located users in early 2022.

3. EDUCATION AND OUTREACH

3.1 OVERVIEW

The Center for Integrating Research and Learning (CIRL) oversees the K-12 educational and broader mentoring efforts of the MagLab's education and outreach mission. Our programs are designed to include research-based best practices in science and engineering education for K-12 students as well as research-based practices in mentoring for students, teachers, postdocs and faculty in STEM. Our staff are committed to ongoing professional development in their field so that we can effectively help the MagLab build a more diverse STEM workforce.

In addition to the programs outlined in this chapter, CIRL also works with MagLab students, staff, and faculty to conduct additional education and outreach activities outside of our programs (e.g., science nights at schools, undergraduate and graduate student tours). In 2021, 54 scientists and staff reached 2,825 people through their individual efforts. The break down for this number was 44% K-12 students, 37% undergraduate or graduate students, 17% general public, and 2% K-12 teachers. Of the 54 scientists who conducted outreach in 2021, 28 conducted long-term (i.e., longer than a tour or one-time event) outreach working with K-12 or undergraduate students. These scientists mentored a total of 49 individuals this year.

The K-12 education and outreach, along with mentoring across all educational and career levels, would not be possible without the CIRL team. Below are some examples of the leadership and relative professional development initiatives that CIRL staff engaged in in 2021:

- CIRL's K-12 Education Director Carlos R. Villa was awarded the 2021 Tallahassee Scientific Society Gold Medal by the Tallahassee scientific community to recognize outstanding career contributions to science, public service, and science education. He also served as a reviewer for the NSF Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST), and finished his term as a STEP UP (Supporting Teachers to Encourage the Pursuit of Undergraduate Physics) ambassador in August, a program that is supported by the NSF.
- CIRL's Mentoring Director Dr. Kawana Johnson published *Business and Management Internships: Improving Employability Through Experiential Learning,* a book on internships and experiential learning. She also attended the 2021 ECMC CTE Leadership Collaborative Convening in New Orleans as an alum of the North Carolina State Postsecondary Research Fellow's program. The ECMC Foundation is a national foundation working to improve postsecondary outcomes for students from underserved backgrounds.
- CIRL's Evaluator Kari Roberts currently serves as a board member at large for the Community Classroom Consortium and serves as a committee member for FSU's ORCID Taskforce, and the MagLab's FAIR Data Working Group. She is currently working with other members of the FAIR Data working group and faculty members at FSU to develop a workshop connecting FAIR data initiatives to broader impacts.
- CIRL's Director Dr. Roxanne Hughes began serving a 4-year term as Chair of the American Physical Society's Forum on Outreach and Engaging the Public, where she will use CIRL's research to inform national efforts for physics educational outreach. She completed her service as a member of FSU's *ad hoc* Anti-Racism, Equity and Inclusion Task Force which developed recommendations that are currently being reviewed by the university leadership.

Diversity and Inclusion in Education and Outreach

Diversity and inclusion are focal points of all MagLab activities, and especially our education and outreach efforts. The following table summarizes participant demographics for CIRL's long-term programs (i.e., one week or longer).

Table 3.1: *2021 Education Program Participant Demographics*

Program	Total Participants	% Women	% African American	% Hispanic	% American Indian/Native Hawaiian
Research Experiences for Undergraduates (REU) summer	20 undergraduates	60%	15%	10%	N/A
Research Experiences for Teachers (RET) summer	21 K-12 teachers and informal STEM educators	86%	19%	24%	5%
High School Externship (2020-2021 Academic Year)	11 (high school)	64%	18%	9%	9%
Virtual Camp TESLA (Three 1-week camps)	37 (middle school students)	14%	27%	11%	3%

Program	Total Participants	% Women	% African American	% Hispanic	% American Indian/Native Hawaiian
SciGirls Virtual Coding Camp (Two 1-week camp)	17 (middle school students)	100%	47%	6%	6%
SciGirls Virtual Summer camp (Two 1-week camps)	21 (middle school students)	100%	29%	5%	N/A

3.1.1 K-12 PROGRAM FOR STUDENTS

CIRL provides three educational outreach programs to K-12 classrooms, developed and facilitated by Mr. Villa:

- Classroom outreach: visits to local classrooms near FSU and UF that engage students in MagLab related hands-on activities,
- Loaner kits: educational kits that teachers can borrow and use to supplement their teaching (available to any teacher/classroom in the area), and
- Fieldtrips: visits to the Tallahassee location of the MagLab for K-12 school groups.

These programs were all affected by the COVID-19 pandemic, especially the latter two which were not offered at all during the 2020-2021 school year.

The MagLab's educational outreach efforts are advertised directly to local school administrators, surrounding school boards, and the MagLab Educators Club (a mailing list with over 500 subscribers that includes educators and parents), as well as through local and national educational organizations such as the Big Bend/Leon Association for Science Teaching, the Florida Association of Science Teachers, and the National Science Teaching Association.

3.1.1.1 Classroom Outreach

Classroom outreach aims to engage students in hands-on science activities while teaching them about the research being done at the MagLab and exciting them about STEM topics. Each activity includes an introduction to the MagLab through an open-ended hands-on educational activity. Mr. Villa then facilitates the activity with the students. Each visit concludes with a review of the phenomena demonstrated during the activity and a question-and-answer session.

Tallahassee. Classroom educational outreach is reported based on the school year as opposed to the calendar year. To accommodate the various classroom formats in place during the COVID-19 pandemic (all virtual, hybrid class, all in-person class), virtual classroom outreach was offered using the Zoom webinar platform **(Figure 3.1.1.1).** This allowed for student participation in the classroom as well as allowing students to join in from home. CIRL tries to focus on teachers and students at Title I schools (schools in which children from low-income families make up at least 40 percent of enrollment) who typically have less access to free, high-quality STEM education programming.

Figure 3.1.1.1: Students learn about the MagLab's 21T NMR Magnet during a virtual tour to a school as part of the MagLab's virtual outreach program.

During the 2020-2021 school year, Mr. Villa provided outreach to 1,820 students, 59.8% of which were with Title I schools. During this year, *Magnet Exploration* was the most requested outreach activity, followed by *Electricity*, then *Build an Electromagnet*. (For more information on the activities listed and all of CIRL's outreach activities please visit our outreach website). A majority of participating classrooms came from elementary schools (66.0%), with middle schools making up 17.0% of outreach and high school classes making up 6.4%. The remaining 10.6% was made up of mixed grade classes. Requests for virtual outreach in 2020-2021 came from seven states: Florida, New York, Texas, New Mexico, Georgia, California, and Maryland.

Metrics for Success: After virtual classroom outreach, teachers were sent a survey asking them about their outreach experience. Overall, teachers were very satisfied with their experience. 100% of teachers rated their virtual outreach experience as very good or excellent. 100% of survey respondents said that the website provided them with enough information to appropriately select an activity and incorporate it into their class. **Table 3.1.1.1** presents average satisfaction scores for the quality of the instruction that Mr. Villa provides. The data shows that the outreach experiences were well received by the educators requesting them. Individual comments from educators in the survey led to revisions to the materials listed in the pre- and post- packets to include easily accessible household items that could be used.

Table 3.1.1.1: Teacher Ratings of Classroom Outreach

(n=29)	Mean Response	Standard Deviation
The outreach educator employed instructional strategies that made the content/concept(s) understandable to my students	4.9	.30
The outreach educator used strategies to appeal to different types of students	4.8	.38
There were connections made between the content/concepts presented and the real world	4.9	.25
Students were encouraged to ask scientific questions to shape their understandings	4.9	.30
The content was relevant to my instructional needs	4.8	.48
The content was developmentally appropriate for my students	4.9	.30
The outreach activity aligned with relevant state/national standards	4.9	.34

Gainesville. During the 2020-2021 school year, Amy Howe conducted and facilitated outreach efforts with staff at the AMRIS and High B/T MagLab facilities located in Gainesville, FL. Despite the challenges of local school closures and other COVID restrictions, staff provided virtual classroom outreach to local Title I schools, reaching 130 elementary (K-5) students with a combination of interactive video sessions and magnet loaner kits.

Los Alamos. The ongoing COVID-19 pandemic prevented guests from coming onto the campus at Los Alamos National Laboratory (LANL), and restricted the group's access to classrooms in their local area. However, staff at LANL participated in virtual science programs reaching viewers from across the country, and also participated in the Summer Physics Camp for Young Women. This virtual activity included science demonstrations and a virtual tour of the Pulsed Field Facility (PFF).

National and International. To offer MagLab educational outreach to as many people as possible and accommodate multiple requests and time zones, asynchronous materials were created online beginning in 2021. These programs covered the same materials as the synchronous offerings listed above but were offered on YouTube in a shortened video format (under 20 minutes as opposed to the 45-60-minute time requirement for synchronous visit). Two videos were created to cover the most popular outreach activities requested over the past five years, *Build an Electromagnet* and *Magnet Exploration*. These links were viewed a combined 449 times as of February 2022. These videos are available to anyone with an internet connection so they may be viewed by students, teachers, or members of the general public.

3.1.1.2 MagLab Summer Camps

MagLab Summer Camps were all held virtually in 2021. The goal of these camps is to provide a space for participants to engage in the doing of science and to introduce participants to careers and role models in STEM. This year's virtual camps were able to achieve both goals by creating a program that included interviews and activities with relevant STEM professionals as well as including activities where materials were mailed to campers' homes so that they could work on projects and participate virtually with their camp cohort. Material boxes are shown in **Figure 3.1.1.2.1.** CIRL offered three unique one-week camps with seven opportunities for campers to attend: three sessions of Camp TESLA, two sessions of SciGirls, and two sessions SciGirls Coding. Each camp consisted of an online interactive portion, a break that allowed the students to work at their own pace, virtual office hours with MagLab instructors, and a wrap up session to end the day. Each camp week finished with a virtual reception where the students were able to share projects that they had worked on as well as a slideshow highlighting the campers' experiences.

Figure 3.1.1.2.1: *Boxes of materials for the MagLab Summer Camps were mailed out to each participant so that activities were interactive.*

Camp TESLA (Technology, Engineering, and Science in a Laboratory Atmosphere)

During 2021's Camp TESLA, 37 students participated in hands-on activities led by MagLab scientists and engineers including magnet engineers, electrical engineers, chemists, geologists, and biologists. The three highest rated activities were the construction of a solar powered car, creating cell phone holograms, and building a speaker. The virtual reception included a slideshow that showed screenshots of activities as well as a short vignette where each camper talked about the moment of their week where they felt most empowered.

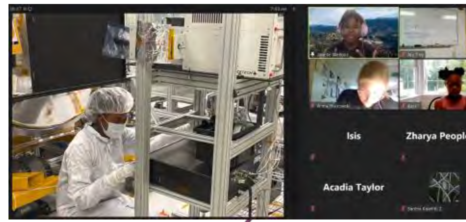


Figure 3.1.1.2.2: *Janelle Wellons from NASA's Jet Propulsion Laboratory joined SciGirls as a STEM Role Model and engaged campers in a discussion of her work on the Cassini Saturn Mission.*

SciGirls Summer Camp

SciGirls Summer Camp was offered in two separate weeks. SciGirls is a PBS Kids show that encourages girls in STEM and as such the camp is offered in partnership with the MagLab's local PBS affiliate, WFSU. Several female role models were brought in from around the United States, highlighting many different fields of science. These guests connected their presentations to hands-on activities **(Figure 3.1.1.2.2)**, the highest rated of which were the archeological site virtual tour and the microbial growth activity. The virtual reception included representatives from the MagLab and WFSU and included a question-and-answer session with two former SciGirls campers who are now pursuing degrees in STEM majors, one majoring in computational biology at FSU, and the other earning her Ph. D in mathematics from Harvard University.

Figure 3.1.1.2.3: *FAMU DRS SciGirls Code campers during an interview with Dr. Karmella Haynes on how computer coding can be incorporated with medical science.*

SciGirls Coding Camp

This year, SciGirls Coding Camp was offered twice, once through the MagLab and a second time through a partnership between the MagLab and the Florida Agricultural and Mechanical University Developmental Research School (FAMU DRS). A total of 17 campers took part in the camps. Of these campers, all 17 identified as female, 13 attended Title I schools (76.5%), eight were African American, one was Hispanic/Latina, and one was American Indian/Alaskan Native. The camp used the Code: SciGirls curriculum developed by the SciGirls national program at Twin Cities Public Television and brought in female role models in tech and computer sciences. **Figure 3.1.1.2.3** shows a session that connected computer coding to medical research. The camp offered activities in coding, augmented reality, and game design. At the end of the week each camper shared their primary design for a video game that included story, art, and of course, code for the game's mechanics. All campers were able to keep their Micro:bit and accessories for future coding enrichment.

Metrics for Success: To assess how successful all of the summer camps were at achieving the goals, we gave each participant a pre- and post-program survey measuring their STEM Self-Efficacy, STEM Identity, STEM Sense of Belonging, and their attitudes towards making mistakes before and after camp. **Tables 3.1.1.2.1, 3.1.1.2.2,** and **3.1.1.2.3** show that the Summer Camps achieved their goals by giving campers a space to do science and introduced them to role models that were working in STEM. The tables highlight that 90.9% said that they felt comfortable making mistakes during camp and 98.4% of the campers said they were able to learn from any mistakes they made during camp. Furthermore, 100% of the campers said that they felt they were a part of the camp and 100% of all campers said they felt accepted by their peers at camp.

Table 3.1.1.2.1: Participant self-reported learning about careers.

During Camp…	TESLA Percent (n=33)	SciGirls Percent (n=20)	SciGirls Code Percent (n=10)
Did you learn about new STEM disciplines and fields?	96.9%	95.0%	100%
Did you learn about STEM careers you had not heard of before?	87.9%	90.0%	90.0%
Did you learn more about how to achieve a career in STEM?	93.9%	95.0%	80.0%

Table 3.1.1.2.2: Participant connections to STEM role models.

During Camp…	TESLA Percent (n=33)	SciGirls Percent (n=20)	SciGirls Code Percent (n=10)
Did you meet any STEM role models?	76.3%	100%	100%
Did you meet someone who taught you more about what it is like to work in science?	81.6%	100%	100%

Table 3.1.1.2.3: Sense of Belonging in Camp

During Camp…	TESLA Percent Agree	SciGirls Percent Agree	SciGirls Code Percent Agree
I was a part of the camp	100%	100%	100%
I was accepted by my peers at camp.	100%	100%	100%

3.1.1.3 High School Externship

CIRL's High School Externship program works with local Tallahassee high schools to recruit students interested in a career in STEM. Once accepted these students are paired with a mentor at the MagLab to work on a STEM project for an entire school year. The goal of the externship program is to give students real-world experience in the student's interested STEM career path. During the 2020-2021 school year, the externship program was run virtually. A virtual poster session was held at the end of the school year to provide students with a chance to showcase the work they accomplished during the externship program. A full list of students, their mentors, and their research topics are presented in **Table 3.1.1.3.1.**

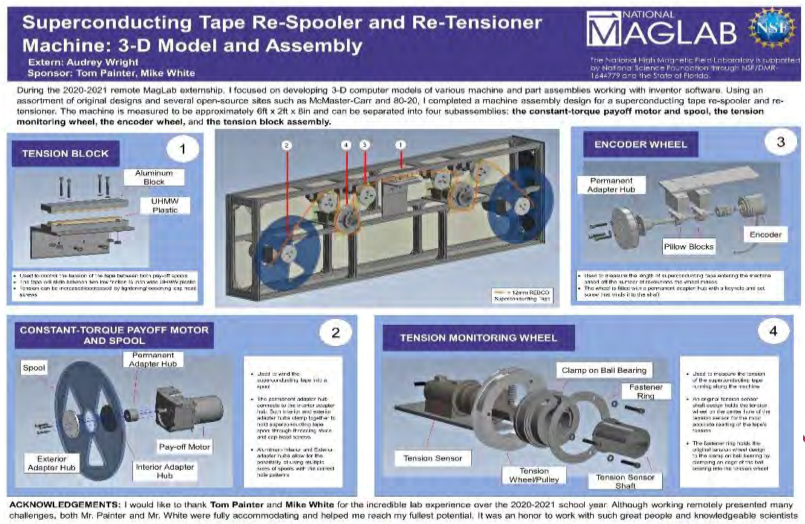


Figure 3.1.1.3: A poster created by a high school extern during their virtual experience describing their work in materials science and technology.

Table 3.1.1.3.1: High School Externship 2021-2022

Student *URM in italics*	Mentors	Research Subject
Nicholas Bosque	Dmitry Semenov	Using Technology (Autodesk Inventor, C++, Arduino, and C#) in Engineering Design
Spencer Gibbs	Kaya Wei	Commercial Thermoelectric Generator Cogeneration as a Method to Combat Power Plant Energy Inefficiency
Antariksh Krishnan	Subramanian Ramakrishnan	Impellers in Electrical and Petroleum Engineering
Alexus Manners	Martha Chacon Patino	Emulsions, Leavening Agents, and Gluten Development as Building Blocks of Molecular Gastronomy
Katie Matthews	Jamel Ali	Impact of Iron Supplementation on Salmonella Typhimurium Mobility
McKenna Parker	Martha Chacon Patino	Emulsions, Leavening Agents, and Gluten Development as Building Blocks of Molecular Gastronomy
Vamsi Posinasetty	Kari Roberts	With Age Comes Wisdom? An Analysis of Attitudes Towards Determinants of Health and Age
Timi Sobanjo	Jamel Ali	Impact of Iron Supplementation on Salmonella Typhimurium Mobility
Azaria Varnado	Bianca Trociewitz	3D Print Filament Environmental Exposure Study
Audrey Wright	Tom Painter	Superconducting Tape Re-spooling and Re-tensioning Machine: 3-D Model and Assembly **(Figure 3.1.1.3)**

Metrics for Success: Data collection for the evaluation of High School Externship was done through a post-program survey of participants. After their experience, 85.7% of the participants said the program increased their interest in studying science in college, and 71.4% said they think they will pursue a career in a STEM field. **Table**

3.1.1.3.2 shows more measurements describing how the students' experiences increased their interest in STEM careers, demonstrating that the program reached its goal of giving students real-world experience in STEM careers.

Table 3.1.1.3.2: *Externship students indicated the following benefits of participating in the externship program:*

My participation in externship…	Mean N=7	SD	Percent Agree
Helped me understand science better.	3.14	.99	85.7%
Led me to a better understanding of my own career goals.	3.57	.53	85.7%
Increased my interest in studying science in college.	3.29	.49	85.7%
Made me think more about what I will do after graduating.	3.29	.49	85.7%
Made me more confident in my ability to succeed in science.	3.29	.49	85.7%
Increased my confidence in my ability to participate in science projects or activities.	3.00	.57	71.4%

3.1.1.4 K-12 Teachers and Informal STEM Educators

Besides the educational outreach and Magnet Academy resources, CIRL also facilitates professional development for educators (i.e., formal K-12 classroom teachers and informal STEM educators). These include both educator workshops and our Research Experiences for Teachers program. Educator workshops are designed to introduce educators to MagLab-specific STEM topics that can be incorporated into the science lessons and conform to state and national education standards. These hands-on workshops provide participating educators with strategies for engaging students in MagLab-related, inquiry-based, hands-on science activities. **Table 3.1.1.4.1** highlights the workshops offered in 2021.

Table 3.1.1.4.1: *Teacher Workshops offered by CIRL*

Date	Presentation Title	Conference/Organization (Location if in-person)	Attendance
2/19	Open House Field Trip	MagLab Virtual Open House	178
2/22	The Story of Attraction (A History of Magnetism)	MagLab Virtual Open House	13
2/25	Strategies for STEM Inclusiveness	MagLab Virtual Open House	12
4/7	The Role of Communications, Education and Public Outreach During and After COVID-19	Large Facilities Virtual Workshop	156
8/13	Culturally Responsive Teaching	Chattahoochee Elementary School Virtual Faculty Workshop	32
10/6	MagLab Educational Opportunities	Leon County School Administrators Virtual Meeting	42
10/20	Expanding Code SciGirls Camp to Engage African American Girls	2021 National Science Foundation (NSF) Advancing Informal STEM Learning (AISL) Awardee Virtual Meeting	87
10/26	Nature of Science & Science Fair	Pineview Elementary School Virtual Faculty Workshop	34
11/20	Educational Outreach & The MagLab's Unique Middle School Mentorship Program	The Southeastern Section of the American Physical Society (Tallahassee, FL)	30

Research Experiences for Teachers (RET) Program

Due to the COVID-19 pandemic, the summer 2021 RET program was held virtually. The goal of this year's program was to help educators incorporate culturally responsive teaching strategies into their STEM lessons. We partnered with a faculty member from the FSU College of Education, Dr. Stacey Hardin, who has expertise in culturally responsive teaching to help us develop and facilitate the RET curriculum. Dr. Hughes facilitated the program, which was held over eight weeks during which the teachers met twice a week via Zoom; **Table 3.1.1.4.2** has an outline of the schedule and MagLab presenters. Teachers developed a culturally responsive STEM lesson plan (available on the RET website) and completed a reflection on the development and teaching process.

Table 3.2.2.4.2: *RET Schedule*

	Tuesday Topic	Thursday Presenter
Week 1 (6/15/21)	Introduction and Orientation	Amy McKenna
Week 2 (6/22/21)	Self-Identity and Awareness	Mark Meisel
Week 3 (6/29/21)	Your Agency as an Educator	Laurel Winter
Week 4 (7/6/21)	Power and Privilege	Ernesto Bosque

	Tuesday Topic	Thursday Presenter
Week 5 (7/13/21)	The -Isms	Huan Chen
Week 6 (7/20/21)	What's STEM Got to do with it	Ryan Baumbach
Week 7 (7/27/21)	My students and myself	Educators presented lesson plan ideas
Week 8 (8/3/21)	Educators presented lesson plan ideas.	Final reflection and discussion

We had over 400 applicants for limited spots in our RET program. We accepted 21 educators, all of whom taught in Title I schools or worked with low-income youth, representing five states (Florida, Colorado, California, New Jersey, and Illinois). 23.8% of RET participants worked with elementary students, 28.6% worked with middle school students, 47.6% worked with high school students, 19.0% worked with students ranging K-12 grades, and 14.3% worked with another age group.

Metrics for Success. Our pre-/post-survey to all participants, helped us to assess the success of the program. In terms of recruitment, the most successful form of communication about the program came from emails from principals and district supervisors. In addition, participants credited their participation in the 2021 program to:

- Increasing their commitment to learning and seeking new ideas related to their STEM teaching (100% of respondents).
- Motivating them to seek out other culturally responsive and anti-racist professional development opportunities (94.5%)
- Making them a more effective STEM teacher (94.5%)

Besides this self-reported evidence of success, we were also able to quantitatively measure actual changes in beliefs from pre- to post-, not just reflections. To measure the success of the program on teachers' ability to incorporate culturally responsive teaching into their lessons, we used multiple metrics. The first was a modified pre-/post-survey series of questions that measure educators' teaching efficacy beliefs (Riggs & Knochs, 1990[1]). This metric allowed us to see whether educators belief in their own abilities to effectively teach science to their students improved. **Table 3.2.2.4.3** shows the statistically significant improvements made from pre- to post- which we relate to their participation in the program.

*Table **3.2.2.4.3**: Changes in RET participants' Beliefs about Teaching*

	(Pre) N=21	SD pre	Post N=19	SD post	*d*
When a student does better than usual in STEM, it is often because the educator exerted a little extra effort.	4.1	0.91	4.7	0.95	0.65**
I am continually finding better ways to teach STEM.	5.0	0.8	5.5	0.61	0.70**
I know the steps necessary to teach STEM concepts effectively.	4.1	0.73	5.0	0.77	1.20***
I am not very effective in monitoring science experiments.	3.0	1.3	2.1	0.73	-0.85**
I will generally teach STEM ineffectively.	2.3	1.01	1.5	0.71	-0.92*
I understand STEM concepts well enough to be effective in teaching STEM.	4.5	1.03	5.2	0.73	0.78**
Increased efforts in STEM teaching produces little change in some youths' STEM achievement.	2.9	1.31	1.9	0.94	-0.88*
I find it difficult to explain to youth why science experiments work.	2.5	1.17	1.8	0.79	-0.70*
I wonder if I have the necessary skills to teach STEM.	3.0	1.14	2.3	1.08	-0.63*

(5 pt. Likert scale 5=Strongly Agree, 1=Strongly Disagree) *=p<.05, **=p<.01, ***=p<.001

Lessons Learned. Based on the open-ended survey feedback and data collected during focus groups, we plan to make two major changes for the RET program in 2022, which will continue to be held virtually: (1) We plan to pair educators with a MagLab mentor who can answer scientific related questions they might have to improve their lesson plan; and (2) We plan to have educators bring a lesson plan that can incorporate MagLab related science along with culturally responsive teaching. These two additions will make the web-posted lesson plans more

[1] Riggs, I., & Knochs, L. (1990). Towards the development of an elementary teacher's science teaching efficacy belief instrument. Science Education, 74, 625-637.

MagLab specific, which will ensure that these lesson plans will help other educators incorporate the MagLab along with culturally responsive strategies into their lessons.

3.1.2 UNDERGRADUATE STUDENTS

3.1.2.1 Research Experiences for Undergraduates (REU)

The goals of the 10-week REU program are to provide undergraduate students with opportunities to learn research skills and explore research career options. The REU program also gives MagLab scientists and engineers an opportunity to develop their mentor skills. Due to the COVID-19 pandemic, we limited the 2021 REU program to local students with their own housing and non-local students participating virtually. Additionally, Dr. Hughes ran the program because of a hiring freeze limiting our ability to hire a Mentoring Director. As part of our diversity, equity and inclusion efforts, Dr. Hughes wrote to physics, chemistry, and engineering department chairs at Historically Black Colleges and Universities throughout the United States to tell them about the program. The MagLab REU program had 145 applicants. Mentors selected students from applications based on their research project and the students' interest in that type of discipline. Close to half of our selected students heard about the program from a MagLab employee with the remaining half hearing about the program from faculty at their home institutions or by visiting the website. Twenty REUs participated in the 2021 program and were relatively divided across all undergraduate stages: 30.0% freshmen, 25.0% sophomores, 35.0% juniors, and 10.0% seniors. The participants represented a variety of majors: 20.0% physical science, 45.0% engineering, 20.0% life sciences, 15.0% math and social/behavior. Besides the demographic statistics provided in **Table 3.1**, 25% of our REUs came from Minority Serving Institutions and community colleges.

Dr. Hughes planned professional development sessions that were held twice a week. These sessions included panels by MagLab research faculty, tenure-track faculty, graduate students, and industry/entrepreneur/national lab alumni so that students could gain an understanding of what careers in STEM looked like. In addition, Dr. Hughes held sessions on researcher identity, graduate school applications, and communication of science. The students also led each other on virtual tours of their labs and projects. The program culminated in a short pitch presentation wherein the students described their project in three minutes or less. A list of the REU participants, their respective university/college, research topic and mentor can be found in **Table 3.1.2.1.1.**

Table 3.1.2.1.1: *2021 REU Participants*

Participant	School	Research Area	Mentor	Department
Caleb Betts	FSU	Building a SPM Lab	Guangxin Ni, Cui Songbin	CMS
Huan-Hsing Chiang	University of Texas - Austin	MnO2 Nanoparticles on sisal fibers for environmental applications	Martha Chacon	ICR
Rachel Field	Morgan State University	Image Processing: Measurements at an atomic scale	Yan Xin	MST
Alexander Fryer	FSU	Microwave absorption of TEMPO in Hexane at 400 GHz	Thierry Dubroca	EMR
Spencer Gibbs	University of Pennsylvania	Thermoelectric cogeneration to increase efficiency in power plants	David Graf, Kaya Wei	CMS/DC Field
Lauren Hearn	FSU	Characterization of biogeochemical processes in the Southern Ocean	Peter Morton	Geochemistry
Eliana Karr	FSU	Thermoelectric crystalline materials	Kaya Wei, Ryan Baumbach, Benny Schundelmier	CMS/DC Field
Elzbieta Krekora	FSU	Effect of heat treatment on delta phase of Nb3Sn	Peter Lee, Najob Cheggour	ASC
Benjamin Labiner	FSU	Designing a miniature drive system for STM	Lin Jiao	CMS/DC Field
Lauren McNealy	Florida Agricultural and Mechanical University	High entropy alloys as biomaterials	Ryan Baumbach, Kaya Wei, William Lucas Nelson	CMS/DC Field
Paige Nielsen	FSU	Analysis of passive and active microrheological methods for probing biomimetic fluids	David Quashie Jr., Jamel Ali	CMS
Vamsi Posinasetty	FSU	Data management - the unknown summarized	Kari Roberts	CIRL
Jenna Radovich	FSU	rs-fMRI-based network analysis to longitudinally assess functional recovery post-ischemia at 21.1 T	Sam Grant, David Hike	NMR

Participant	School	Research Area	Mentor	Department
Fernando Ramos-Diaz	Virginia Tech	Rabi oscillations & precession	Irinel Chiorescu, Giovanni Franco	CMS
Megan Reid	FSU	Study of cool down effects on optical displacement sensors	Adam Voran	MST
Yazmin Rodriguez-Millan	Universidad Interamericana de Puerto Rico	MnO2 Nanoparticles on sisal fibers for environmental applications	Martha Chacon	ICR
Iain Siegrist	FSU	Corrective Ferroshim MATLAB Script	Ilya Litvak	NMR
Audrey Wright	Tallahassee Community College	Superconducting REBCO tape lap joints: Optimization testing	Tom Painter, Robert Stanton, Mike White	MST
LaDonna Wyatt	Morgan State University	Biofuel of the future: Molecular characterization of polar lipid from nanoparticle-treated cyanobacteria by FT-ICR MS	Huan Chen	ICR
Russell Zimmerman	Washington and Lee University	Molecular dynamics simulation of Al-Cu-O system	Ke Han	MST

Metrics for Success. On our pre-/post-survey, all of the participants indicated that the experience increased their positive perception of STEM careers or reaffirmed their already positive perception of STEM careers. Specifically for STEM research, five participants indicated that their perceptions of research had improved, and two participants indicated that their interest in research was reaffirmed as a result of their participation in the program. Two participants indicated that they were more interested in new types of STEM careers (entrepreneurship and teaching). All of the REU students rated their mentor as above average or outstanding.

In terms of research skill development, we used a modified version of the undergraduate research student's self-assessment (URSSA) survey instrument (Weston & Laursen, 2015[2]). Although this survey has historically been administered post program by other REU programs, because CIRL has an internal evaluator, we were able to incorporate a pre-survey to measure actual changes in skills rather than retrospective self-reported changes. The full evaluation report is available upon request. **Table 3.1.2.1.2** highlights the significant gains that REUs showed from pre- to post-program, demonstrating the mentors' success in helping students develop STEM competence.

Table 3.1.2.1.2: *Skill Development for REU Participants*

	Pre			Post			
How would you rate your ability to…	**Mean N=20**	**Standard Deviation**	**Percent No Experience**	**Mean N=16**	**Standard Deviation**	**Percent No Experience**	***d***
Analyze data for patterns	3.5	.60	0.0%	4.2	.58	0.0%	1.19**
Figure out the next step in a research project	3.4	.67	0.0%	4.2	.66	0.0%	1.20**
Understand the relevance of research to my coursework.	3.6	.75	0.0%	4.4	.62	0.0%	1.16*
Contribute to science	3.4	.94	0.0%	4.4	.62	0.0%	1.26***
Understand what everyday research work is like	3.4	.96	5.0%	4.6	.51	0.0%	1.56***
Defend an argument when asked questions	3.3	.66	0.0%	4.1	.77	0.0%	1.12***
Explain my projects to people outside my field	3.5	.76	0.0%	4.3	.70	0.0%	1.09**
Prepare a scientific poster	3.2	.81	10.0%	4.2	.54	0.0%	1.45***
Conduct observations in the lab or field	3.6	.60	0.0%	4.3	.60	0.0%	1.17**
Calibrate instruments needed for measurement	2.8	.83	20.0%	4.0	.73	0.0%	1.54***
Engage in real-world science research	3.5	.70	5.0%	4.2	.68	0.0%	1.01***

(5 point Likert scale 5= Very High 1=Very Low) *=$p<.05$, **=$p<.01$, ***=$p<.001$

To measure mentoring quality, we reviewed the categories of quality mentoring developed by the Center for the Improvement of Mentored Experiences in Research (CIMER) to determine which were most relevant to

[2] Weston, T. J., & Laursen, S. L. (2015). The undergraduate research student self-assessment (URSSA): Validation for use in program evaluation. *CBE—Life Sciences Education*, *14*(3), ar33.

undergraduate mentees in the 10-week program. We focused on the following categories that were assessed through open-ended questions on the post survey to REU participants and to REU mentors: aligning expectations, assessing understanding, and maintaining effective communication. We asked REUs to rate their mentors and to tell us the effective strategies that their mentor used throughout the program. We also asked mentors to tell us what strategies they used to ensure the REU understood their expectations and completed their projects. All participants said they worked well together with their mentor, with 100% rating their primary supervisor as outstanding. By asking both mentees and mentors to describe quality mentoring strategies we were able to determine (1) what strategies were rated most impactful by REUs and (2) whether mentors were using these best practices. The full list of strategies can be found in **Table 3.1.2.1.3**. We plan to present this information to mentors in future programs so that they can see what types of strategies are most admired by undergraduates. The most impactful mentoring strategies were regular meetings and check-ins to ensure that participants could receive ongoing coaching on their work and project, as well as encouraging students to ask questions.

Table 3.1.2.1.3: *Quality Mentoring Themes Triangulated by REU Students and Mentors*

REU students (N=16)	REU Mentors (N=16)
Students were asked what strategies their mentor(s) used to **check for understanding.** The strategies identified were: - Establishing regular communication between mentor and mentee (n=8) - Having the REU's present a summary of background readings to the mentor, and the mentor providing feedback (n=2) - Encouraging REU's to ask questions (n=2) - Providing regular instruction on background information (n=1)	REU mentors were asked how they **checked for understanding** when communicating expectations to REU students. They indicated that they used the following strategies: - Regular meetings (n=5) - Informal check-ins on project progress (n=3) - Having students share verbally or in writing what they learned/heard (n=4) - Repeating expectations (n=1) - Asking Questions (n=1)
REU participants were also asked about the overall **mentoring strategies** that mentors used that they found **particularly impactful**. The strategies identified were: - Providing ongoing coaching/feedback on work/projects (n=5) - Presenting material in an understandable way (n=2) - Encouraging REU's to ask questions (n=1) - Connecting work to coursework and careers (n=1) - Providing exposure to new fields and software (n=1) - Having patience and enthusiasm (n=1) - Allowing REU's to see different roles on a project (n=1) - Providing an understanding of a research environment (n=1) - Providing videos of what was happening at the MagLab (n=1)	Mentors were asked what **mentoring strategies** they used that they thought were **impactful**. They provided the following strategies: - Regular meetings (n=4) - Having students take a leading role (n=3) - Staying flexible in research/project plan (n=2) - Having a mentoring team (n=2) - Being positive (n=1) - Set expectations early (n=1)

Although the program was altered because of the COVID-19 pandemic, our virtual participants indicated that the experience improved their understanding of STEM careers and research. Virtual participants were asked additional questions about this experience. All agreed that the major advantage of participating virtually was the ability to have flexible schedules and said they would participate in another virtual experience, despite acknowledging challenges associated with virtual participation.

3.1.3 GRADUATE STUDENTS AND POSTDOCS

During 2021, members of CIRL continued to work with the Inclusive Graduate Education Network (IGEN) grant – updating the current CIMER curriculum to include case studies and lessons that incorporate national laboratory scenarios. Dr. Hughes and Ms. Roberts presented with other members of the IGEN team at the annual IGEN[3]

[3] M. McDaniels, R. Dineros, C. Henne, R. Hughes, M. Rising, K. Roberts (2021, July 15). Promoting Inclusive Research Mentoring in your Organizations, Labs, or Bridge Programs. 2021 Inclusive Graduate Education Network National Meeting. Virtual.

conference and the annual National Postdoctoral Association[4] conference in 2021. Five additional MagLab employees (Huan Chen, Kawana Johnson, Kristin Roberts, Laurel Winter, Kaya Wei) completed the CIMER training and presented an abbreviated training session to MagLab leadership in December 2021. The goal of this session was to develop a core group of mentoring advocates and to expand knowledge of the context and relevance of mentor training. Ultimately, we hope to offer a formal mentoring training series for students, postdocs, faculty and staff at the MagLab.

To address postdoc mentoring specifically, Dr. Johnson developed a postdoc survey to gain feedback about their overall experience in the MagLab. Twenty-three postdocs responded to the survey in December 2021 and based on this feedback Dr. Johnson is developing programs for postdocs in 2022 *(e.g., mentoring and professional development training sessions).*

3.1.4 EVALUATION AND RESEARCH

3.1.4.1 Evaluation

Evaluation for MagLab educational programs is conducted by Ms. Roberts, who uses up to date best practices from evaluation and social sciences experts, and the National Science Foundation. All CIRL education programs are evaluated, and results are shared with program managers every year to allow for data-driven decision-making in planning programs for future years. Primary metrics for each program are determined based on the program's goals and mission and measured using appropriate methodology. Evaluation methodology for each program conducted in 2021 is described briefly below in **Table 3.1.4.1**.

Table 3.1.4.1: *Evaluation Description for 2021 MagLab Education and Outreach Programs*

Program	Form of Evaluation
Classroom outreach	Post-survey to teachers after outreach conducted
Summer Camps	Pre-/Post-survey to students, post-camp interviews with teachers, observation of camp activities
REU	Pre-/Post-survey to all REU participants, mid-program and post-program focus groups with REU participants, post-program survey to mentors
RET	Pre-/Post-surveys to RET participants, mid-program and post-program focus groups with participants
High School Externship	Post-program survey to externship participants

3.1.4.2 Research

A cornerstone of our programs is that they are developed based on research conducted by CIRL staff. Our research not only informs our MagLab programs but adds to scholarship for K-16 informal STEM education and mentoring programs nationally. Dr. Hughes continues to lead CIRL's research efforts, which are supported by a STEM identity lens (one's sense of belonging and future success in STEM). In 2021, CIRL staff had multiple publications that added to the STEM identity dialogue.

- Roberts, K., Villa, C.R., & Hughes, R. (2021). Unknown Territory: K-12 STEM Summer Exploration through Zoom. Journal of STEM Outreach, 4(4). https://doi.org/10.15695/jstem/v4i4.03
- Hughes, R., Schellinger, J., & Roberts, K. (2021). The Role of Recognition in Disciplinary Identity for Girls. Journal of Research on Science Teaching, 58(3), 420-455. https://doi.org/10.1002/tea.21665
- Schellinger, J., Enderle, P. J., Roberts, K., Skrob-Martin, S., Rhemer, D., & Southerland, S. A. (2021). Describing the Development of the Assessment of Biological Reasoning (ABR). Education Sciences, 11(11), 669.

In 2021, Dr. Hughes' research led to her involvement as a co-PI on an NSF Quantum Convergence grant led by PIs at Morgan State University. During the project, Hughes along with Tim Murphy and Amy McKenna developed the key terms necessary for quantum literacy. They developed a framework for a quantum literacy curriculum for K-12, undergraduates, and vocational students to broaden participation of underrepresented racial minorities in the quantum workforce.

3.2 PUBLIC OUTREACH

Public outreach is run by the MagLab's Public Affairs team who use a comprehensive communications strategy to reach broad and diverse audiences with content designed for varying levels of scientific understanding. In 2021, the MagLab posted 19 news stories and was included in more than **270 media articles** reaching nearly **600 million readers** in Salon, Yahoo News, and NPR, along with many other local and national news outlets.

3.2.1 WEBSITE AND SOCIAL MEDIA

In 2021, the MagLab website received 1.64 million total pageviews, a 9% increase from 2020. The website also saw a 6.5% growth in sessions. Certain sections of the website experienced substantial growth: the "User Facility"

[4] M. McDaniels, R. Dineros, C. Henne, R. Hughes, M. Rising, K. Roberts (2021, April 15). Customizing Mentorship Training Curricula to Meet Unique Needs of Researchers in National Laboratories. National Postdoctoral Association Annual Conference. Virtual.

pages increased more than 16%, "User Resources" increased 12%, "About" increased more than 13%, and "Careers" increased nearly 3%.

Additionally, our Education pages saw a 3.5% overall increase from 2020, but a nearly 50% increase from 2019. As the COVID-19 pandemic continued, the lab's online interactive content continued to find an audience including the newly created games and puzzles, which earned nearly 6,000 pageviews in 2021. Content on certain sections of Magnet Academy continued to see exceptional growth:

- *Explore History* - pageviews increased 24%
- *Learn the Basics* - pageviews increased 12%
- *Plan a Lesson* - pageviews increased 14%
- *Watch & Play* - pageviews increased about 1%

Try This at Home was the only section to decrease in views from 2020; however, the pageviews for 2021 are still more than 51% higher than they were in 2019.

The MagLab's social media accounts continued to grow and reach new and diverse audiences. Our Facebook and Instagram accounts grew with posts reaching different ages, genders and geographic locations including India, Brazil, Mexico and Egypt. The lab's audience gender distribution on Facebook is predominantly female and Facebook is better at reaching 45-65+ audiences. Instagram provided more growth in the 18-24 age group (**Figure 3.2.1.1**), while the MagLab's Twitter account reached more than 425,000 people in 2021. Top tweets of 2021 included celebrations and recognitions of awards/accomplishments, research findings and a #Magic or #Magnets Halloween campaign (**Figure 3.2.1.2**).

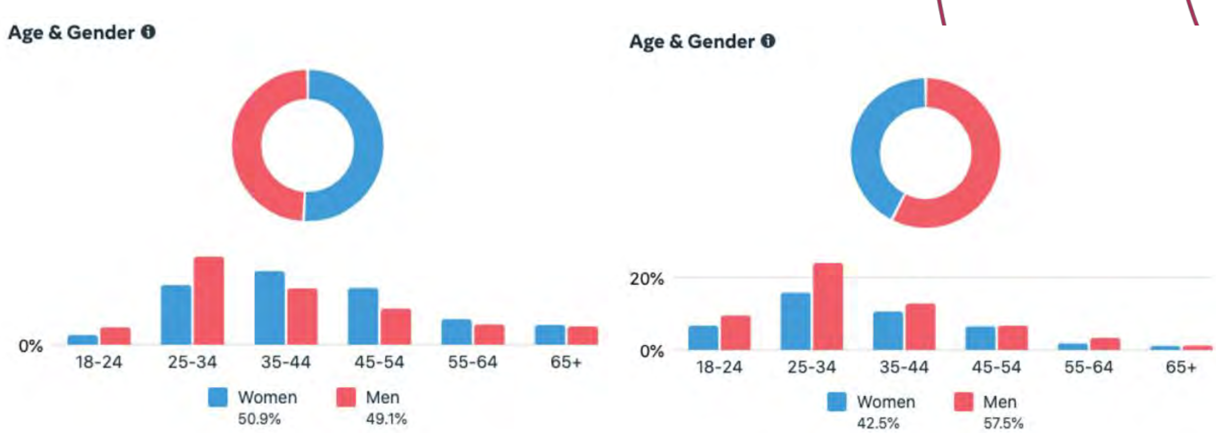


Figure 3.2.1.1: *Breakdown of audience by gender and age reached through Facebook (left) and Instagram (right) in 2021.*

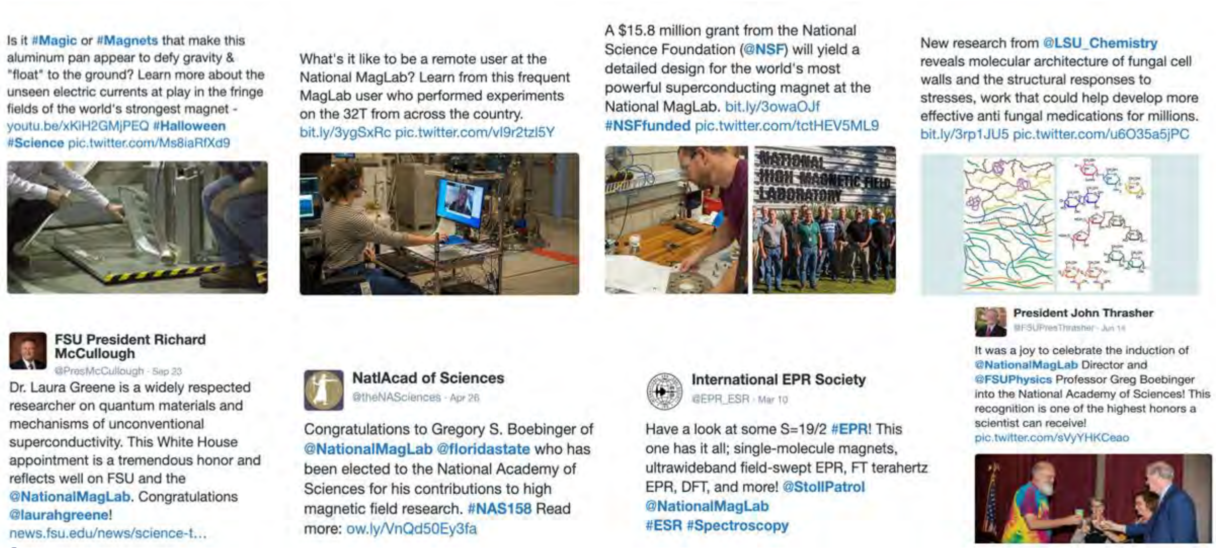


Figure 3.2.1.2: *Featured tweets from 2021 (top row, tweets from the National MagLab Twitter account. Bottom row, tweets from other accounts mentioning the National MagLab).*

The lab's LinkedIn account saw some of the largest percentage growth in 2021, gaining more than 475 followers and reaching nearly 135,000 people across diverse career levels and categories **(Figure 3.2.1.3).**

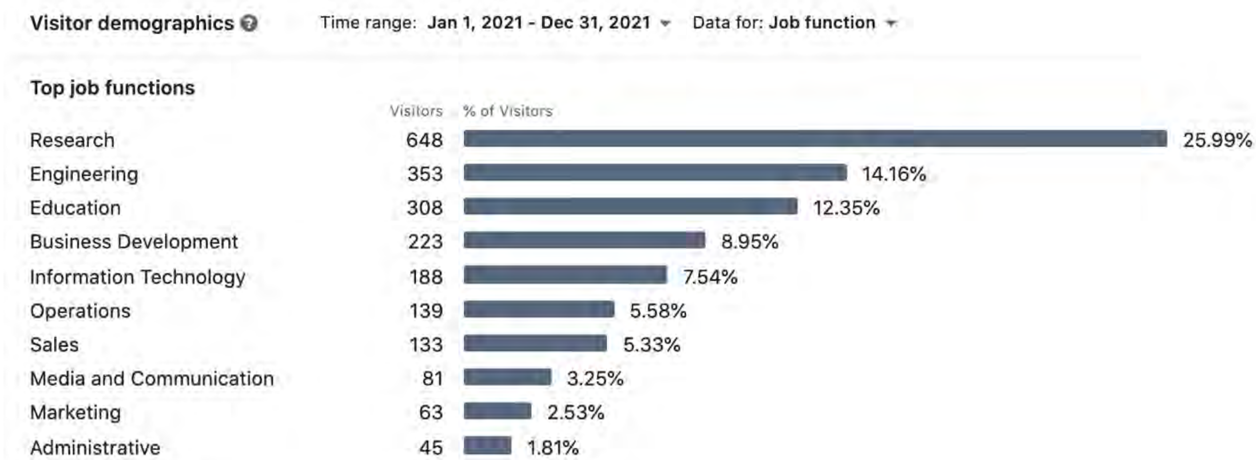


Figure 3.2.1.3: *LinkedIn followers by career category 2021*

MagLab videos received more than 23 million impressions on YouTube in 2021 and were viewed 1.7 million times. The lab's YouTube channel added 17,600 subscribers and more than 55,000 hours of MagLab videos were watched in 2021. Peaks in views coincide with social media promotion, the release of new video content and virtual Open House in late Feb/early March **(Figure 3.2.1.4).**

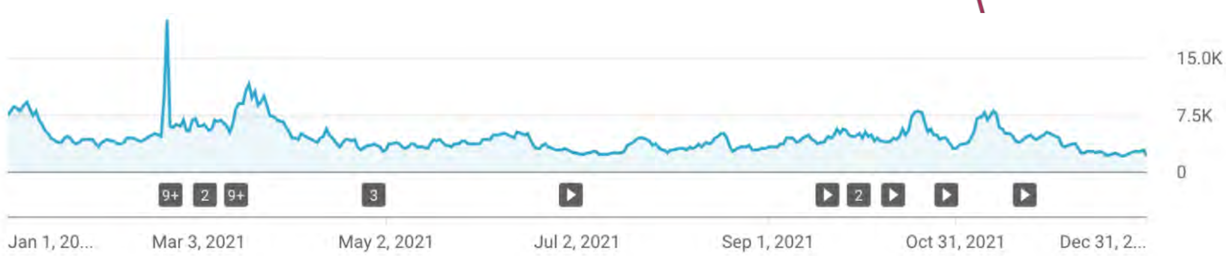


Figure 3.2.1.4: *YouTube views 2021.*

MagLab YouTube viewers come from all ages with more than 57% of viewers between 18 and 34 **(Figure 3.2.1.5).** Nearly 16% of the MagLab's YouTube watchers are female and audiences come from all ages and around the world. Outside of the United States, the MagLab's YouTube audience is from India, Pakistan, The Philippines, Indonesia, Bangladesh, United Kingdom, Canada, Sri Lanka, Malaysia, Turkey, Australia, South Africa, Brazil, Egypt, Vietnam, Thailand, and Kenya.

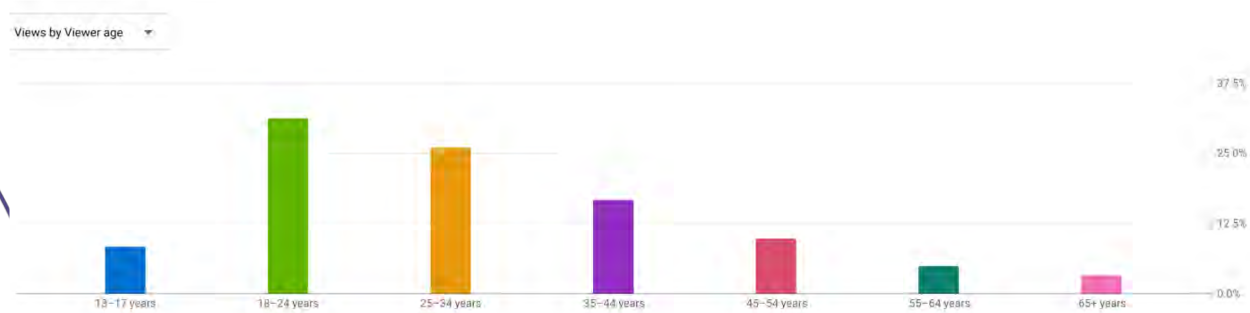


Figure 3.2.1.5: *YouTube viewers by age, 2021.*

The most popular videos on the MagLab's YouTube channel continue to be the See-Thru Science video series which shows viewers what electricity and magnetism might look like if they weren't invisible. In 2021, the lab released 55 new videos including video versions of live virtual events (Open House live sessions, Science Nights, etc.), a Meet the User feature and a feature story about early STEM mentorship shaping a STEP career path.

Figure 3.2.2.1: *Open House 2021 select events*

3.2.2 EVENTS

The MagLab continued to host virtual-only events in 2021. For the first time in MagLab history, Open House went to the virtual world and expanded from a five-hour event to feature a collection of live virtual events, video demonstrations, behind the scenes/all access video tours and web-based games for all ages.

About 500 people attended one of the 20+ live virtual events held from February 19 – March 6, 2021, to do hands-on science, learn about MagLab research or meet and interact with MagLab scientists.

These live sessions included special try-this-at home activities, including a kitchen chemistry session, DIY chromatography butterflies, and fruit DNA extractions. There were also sessions on STEM entrepreneurship and inclusiveness. **(Figure 3.2.2.1)** More than 10,000 views during the Open House period (February 19-March 12) of specially created Open House content including video demonstrations and behind the scenes 360-degree tours. More than 600 people played a MagLab web-based game or puzzle including a virtual scavenger hunt, and veggie MRI game.

The lab also held its first-ever Escape Room where more than 50 participants solved a series of puzzles to "escape" by saving a discovery. 2021 Open House participants came from around the country and world including participants from 13 countries (Canada, Netherlands, Germany, Thailand, Colombia, United Arab Emirates, United Kingdom, Russia, Mexico, Norway, Italy, China & Brazil).

Figure 3.2.2.2: *Other MagLab events 2021.*

In addition to Open House, we also hosted several stand-alone virtual events in 2021 **(Figure 3.2.2.2)**, including a fieldwork event in January ("Stroke of Genius") with Sam Grant, and an Scientist Speed Session with Director Greg Boebinger in May and Chief Scientist Laura Greene in October. We also partnered with *Ask A Scientist Gaming* in December to feature Dr. Ryan Baumbach, who talked about magnets, intermetallics, exotic materials, and more while answering questions and playing Castlvania on Twitch.

The Science Nights series run by MagLab scientist Julia Smith also continued to be offered virtually in partnership with the Leon County Public Library in 2021. Seven live sessions were held featuring topics from electricity to DNA. Videos of those monthly sessions have more than 2,000 views on YouTube, expanding the audience far beyond the traditional local community.

3.3 CONFERENCES AND WORKSHHOPS

Each year, the MagLab hosts or sponsors a variety of workshops and conferences related to high magnetic field research **(Table 3.2)**. All 2021 meetings were offered virtually.

Table 3.2: *List of 2021 sponsored workshops and conferences.*

Event	Date	Location/ Type	Description	Attendees
Theory Winter School	January 11-15	Virtual	This year's School focused on "Modern aspects of quantum condensed matter," a subject inspired by recent developments in condensed matter physics. These developments shed new light on open questions of quantum criticality, unconventional super-conductivity, and new types of topological phases of matter. The tentative topics of the school include novel phases in twisted bilayer graphene and other moire systems, recent developments in unconventional superconductivity, topology of electronic states, and quantum magnetism.	140
User Summer School	July 13-16	Virtual	A weeklong workshop with talks from experts in the field of condensed matter physics on: - Noise types and theory; noise suppression techniques - Transport techniques - Magneto-optics - Infrared and terahertz spectroscopy - NMR techniques for condensed matter - Cryogenic techniques - Heat capacity - Measuring fermi surfaces - The nuts and bolts of data acquisition	28
External Advisory Committee Meeting	September 27, 28, and 30	Virtual	The EAC is charged with reporting on the State of the MagLab to the leadership of its three partner institutions: Florida State University, the University of Florida, and Los Alamos National Laboratory.	50
FAIR Data Workshop	October 12	Virtual	This virtual 2021 User Workshop on October 12 featured talks from FAIR Data experts across scientific fields. Speakers shared their best practices for ensuring scientific data is findable, accessible, interoperable, and reusable to advance far-reaching goals and build a more equitable STEM ecosystem.	85
User Committee Meeting	October 13-14	Virtual	An annual meeting of users who represent the laboratory's broad multidisciplinary user community and advises lab leadership on all issues affecting users of our facilities.	90

3.4 BROADENING OUTREACH

In addition to the Diversity and Education sections of this report which speak to the MagLab's work to broaden participation through education and outreach, MagLab staff regularly take advantage of conferences and workshops to share information about the lab's user program with diverse researchers from around the globe. Each talk, presentation, poster or abstract opportunity provides the chance for scientists to learn more about the lab's research capabilities and broaden our user program to new scientists from across disciplines and career level – from graduate students and postdocs to tenure track faculty.

In 2021, MagLab staff gave **191** lectures, talks and presentations to organizations around the country and the world **(Figure 3.4.1)**. Due to the ongoing effects of COVID-19, many national and international meetings were hosted virtually or were offered as hybrid experiences. As such, nearly 80% of the 2021 MagLab presentations were conducted virtually **(Figure 3.4.2)**.

During the year, the MagLab continued the important work to broaden participation through outreach and presentations at prominent meetings and conferences including the American Physical Society (APS) March Meeting, ASC 2021, 2021 American Institute of Chemical Engineers (AIChE) Annual Meeting, 2021 International Society of Magnetic Resonance in Medicine Meeting, 27th International Conference on Magnet Technology, 34th International Symposium on Superconductivity, 62nd Experimental Nuclear Magnetic Resonance Conference, 69th Amer. Soc. for Mass Spectrometry Conference on Mass Spectrometry, Cryogenic Engineering Conference [CEC], International Conference on Strongly Correlated Electron Systems, and National Postdoctoral Association Annual Conference.

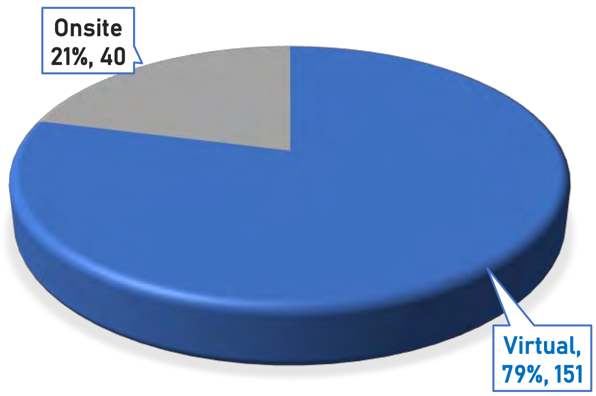


Figure 3.4.1: *Breakdown of 2021 Presentations given virtually.*

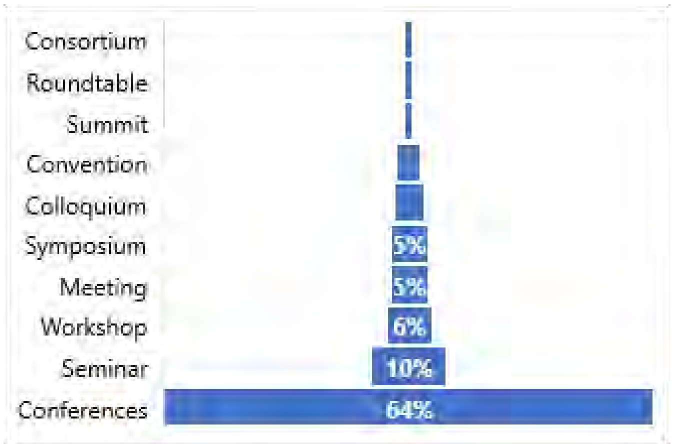


Figure 3.4.2: *2021 Presentation types.*

4. INHOUSE RESEARCH

4.1 CRYOGENICS

The Cryogenics Laboratory located at the MagLab is a fully developed facility for conducting low temperature experimental research and development. A number of specialized experimental equipment are available in the lab, including the Cryogenic Helium Experimental Facility (CHEF) for horizontal single- and two-phase heat transfer and flow research, the Liquid Helium Flow Visualization Facility (LHFVF) for high Reynolds number superfluid helium (He II) pipe flow visualization research, the Laser Induced Fluorescence Imaging Facility (LIFIF) for high precision molecular tagging velocimetry measurement in both gaseous and liquid helium, and the Cryogenic Magnetic Levitation Facility (CMLF) for studying cryogenic fluid hydrodynamics in controlled gravity environment. The laboratory supports in-house development projects as well as contracted scientific work directed by Prof. Guo of the Mechanical Engineering department at FSU. Currently, the major research areas of the cryogenics lab include: 1) fundamental turbulence and heat transfer research in cryogenic helium; 2) quench spot detection for accelerator cavities; and 3) catastrophic loss of vacuum in liquid helium cooled pipes. These research activities are supported by external funding agencies including the National Science Foundation, the Department of Energy, the Army Research Office, and our industrial partners.

4.1.1 TURBULENCE RESEARCH WITH HE II

Many flows in nature have extremely high Reynolds (Re) or Rayleigh (Ra) numbers, such as those generated by flying aircraft and atmospheric convection. Better understanding of these flows can have profound positive impacts on everyday life, like improving the design in energy efficient applications or increasing our understanding of the effects of climate change. To achieve large Re values in the laboratory, a common route is to increase the characteristic length of the flow, which normally requires the construction of expensive and energy consuming large-scale flow facilities and wind tunnels. An alternative method is to use a fluid material with very small kinematic viscosity. At the cryogenics lab, we adopt helium-4 as the working fluid.

Helium-4 has extremely small kinematic viscosity (three orders of magnitude smaller than that for air) which enables the generation of highly turbulent flows in compact table-top equipment. Furthermore, when helium-4 is cooled below about 2.17K, it undergoes a phase transition into a superfluid phase (He II) which consists of two miscible fluid components: a viscous normal component and an inviscid superfluid fluid component. Turbulence in He II is a cutting-edge research area that is important both in fundamental science and in practical applications of He II as a coolant. In order to make quantitative flow field measurements, we have developed two powerful flow visualization techniques. One is the so-called molecular-line tagging velocimetry technique which is developed based on tracking thin lines of He_2 excimer tracers created via femtosecond-laser field ionization of helium atoms. Besides this technique, a particle tracking velocimetry (PTV) method in He II using seeded micron-sized frozen hydrogen particles has also been developed and implemented. The application of these techniques to the study of heat-induced counterflow in He II has revealed a novel form of turbulence, the characterization of which is critical for the development of a theoretical model that could describe the complex two-fluid dynamics in various quantum fluids systems. We have also designed and fabricated sophisticated towed-grid system for studying turbulence in He II generated via mechanical forcing. This system has allowed us to examine both the vortex dynamics and the motion of the thermal component in He II, which has led to two publications:

- Y. Tang, S. Bao, and W. Guo, "Superdiffusion of quantized vortices uncovering scaling laws in quantum turbulence", **Proc. Natl. Acad. Sci.**, 118, e2021957118 (2021).
- Y. Tang, W. Guo, V. S. L'vov, and Anna Pomyalov†, "Eulerian and Lagrangian second-order statistics of superfluid 4He grid turbulence", **Phys. Rev. B** 103, 144506 (2021).

4.1.2 QUENCH SPOT DETECTION FOR ACCELERATOR CAVITIES

Many modern particle accelerators utilize superconducting ratio-frequency (SRF) cavities, cooled by He II, to accelerate charged particles. There is a strong demand to reach ever higher accelerating fields in these cavities so that the particles can gain higher energies over shorter distances. The prospect of shorter accelerator beamlines is very significant due to the high costs of typical accelerators. The maximum accelerating field of SRF cavities is limited by cavity quenching caused by Joule heating from tiny resistive defects near the cavity surface (i.e., quench spots). By locating and subsequently removing the defects, the maximum accelerating field can be significantly improved. Therefore, a long-standing research effort in the accelerator field is to develop reliable methods to detect those sub-millimeter defects. Our lab is active in developing novel technologies for surface quench spot detection based on our molecular tagging flow visualization in He II. We have conducted a proof-of-concept experiment using a miniature heater to simulate a quench spot and have demonstrated hot-spot detection with an unprecedented resolution.

Recently, an imaging scheme for hot spot detection in 3D space is developed. Our work has the potential to advance the state of the art of accelerator cavity diagnostics. Recent papers are listed below:

- S. Bao, T. Kanai, Y. Zhang, L. N. Cattafesta III, W. Guo, "Stereoscopic detection of hot spots in superfluid helium-4 for accelerator-cavity diagnosis", **Int. J. Heat Mass Tran., 161**, 120259 (2020).
- S. Bao and W. Guo†, "Transient heat transfer of superfluid 4He in non-homogeneous geometries: Second sound, rarefaction, and thermal layer", **Phys. Rev. B** 103, 134510 (2021).

4.1.3 LOSS-OF-VACUUM HEAT AND MASS TRANSFER

SRF cavities in linear accelerators are operated with high vacuum on their inside, while being immersed in a bath of LHe (typically He II around 2K). A string of SRF cavities housed in a cryomodule essentially forms a long LHe cooled vacuum tube (i.e., the beamline tube). An accelerator can experience a catastrophic breakdown if the cavities accidently lose their vacuum to the surrounding atmosphere. To understand this vacuum break process and to aid the development of accelerator cryogenics safety protocols, our lab has launched a project to study nitrogen gas propagation in a purposely designed helium-cooled tube system and has developed a theoretical model to interpret the gas dynamics and the heat transfer process. Recent representative publications include:

- N. Garceaua, S. Bao, and W. Guo, "Heat and mass transfer during a sudden loss of vacuum in a liquid helium cooled tube - Part I: Interpretation of experimental observations", **Int. J. Heat Mass Tran.**, 129, 1144-1150 (2019).
- S. Bao, N. Garceau, and W. Guo, "Heat and mass transfer during a sudden loss of vacuum in a liquid helium cooled tube - Part II: Theoretical modeling", **Int. J. Heat Mass Tran.**, 146, 118883 (2020).
- N. Garceau, S. Bao, and W. Guo, "Heat and mass transfer during a sudden loss of vacuum in a liquid helium cooled tube - Part III: Heat deposition in He II", **Int. J. Heat Mass Tran.**, 181, 121885 (2021).

4.1.4 NUMERICAL STUDIES

4.1.4.1 Vortex order in superfluid

In the reporting period, we have also conducted numerical study of vortex order in 2D superfluid turbulence. In a 2D turbulent fluid containing pointlike vortices, Nobel Laureate Lars Onsager predicted that adding energy to the fluid can lead to the formation of persistent clusters of like-signed vortices, i.e., Onsager vortex (OV) clusters. In the evolution of 2D superfluid turbulence in a uniform disk-shaped Bose-Einstein condensate (BEC), it was discovered that a pair of OV clusters with opposite signs can form without any energy input. This striking spontaneous order was explained as being due to a vortex evaporative-heating mechanism, i.e., annihilations of vortex-antivortex pairs which remove the lowest-energy vortices and thereby boost the mean energy per vortex. However, in our search for exotic OV states in a boundaryless 2D spherical BEC, we found that OV clusters never form despite the annihilations of vortex pairs. Our analysis reveals that contrary to the general belief, vortex-pair annihilation emits intense sound waves, which damp the motion of all vortices and hence suppress the formation of OV clusters. We finally figure out that the true mechanism underlying the observed spontaneous OV state is the vortices exiting the BEC boundaries. This work has been published in Phys. Rev. Letts.

- T. Kanai and W. Guo, "True Mechanism of Spontaneous Order from Turbulence in Two-Dimensional Superfluid Manifolds", **Phys. Rev. Lett.**, 127, 095301 (2021).

4.1.4.2 Magnetic levitation based low-gravity simulator modeling

Low-gravity environments can have a profound impact on the behaviors of biological systems, the dynamics of fluids, and the growth of materials. Systematic research on the effects of gravity is crucial for advancing our knowledge and for the success of space missions. Due to the high cost and limitations in the payload size and mass in typical spaceflight missions, ground-based low-gravity simulators have become invaluable for preparing spaceflight experiments and for serving as stand-alone research platforms. Among various simulator systems, the magnetic levitation-based simulator (MLS) has received long-lasting interest due to its easily adjustable gravity and practically unlimited operation time. However, a recognized issue with MLSs is their highly non-uniform force field. For a solenoid MLS, the functional volume $V_{1\%}$, where the net force results in an acceleration less than 1% of the Earth's gravity g, is typically a few microliters (μL) or less. In this work, we reported an innovative MLS design that integrates a superconducting magnet with a gradient-field Maxwell coil. Through an optimization analysis, we showed that an unprecedented $V_{1\%}$ of over 4000 μL can be achieved in a compact coil with a diameter of 8 cm. We also discussed how such an MLS can be made using existing high-T_c-superconducting materials. When the current in this MLS is reduced to emulate the gravity on Mars (g_M = 0.38g), the functional volume can exceed 20,000μL. Our design may break new ground for future low-gravity research.

- H. Sanavandi and W. Guo, "A magnetic levitation based low-gravity simulator with an unprecedented large functional volume", **npj Microgravity**, **7**, 40 (2021).

On the education side, our research has allowed us to educate both graduate and undergraduate students, as well as postdoc researchers. Over the past a few years, we have engaged more than 10 undergraduate students (including four females) and six graduate students in our quantum fluids research. These graduate students include Jian Gao, Brian Mastracci, Andrew Wray, Toshiaki Kanai, and visiting students Alex Marakov (from University of Florida) and Emil Varga (from Charles University in Prague). The training that these students have received makes them well prepared for their career. Jian, Brian, and Andrew are research scientists at the Thomas Jefferson National Laboratory Facility for Rare Isotope Beams, and the Lawrence Livermore National Laboratory, respectively. Alex joined the quantum computing team at Northrop Grumman, and Emil is now a postdoc at the University of Alberta. Toshiaki will continue to be supported in the proposed research. Among the undergraduate students, O. Ebere has been recruited as a graduate student at Florida A&M University, a historically black university.

4.2 GEOCHEMISTRY

4.2.1 OVERVIEW

The MagLab's geochemistry facility primarily investigates natural processes, both recent and ancient, through the analysis of element content and isotopic compositions.

4.2.2 INTRODUCTION

The Geochemistry Program's main funding is through grants from the Geoscience directorate at NSF and NASA. On average the program has about fifteen active grants with average budget per grant of $100,000/year.

The facility has seven mass spectrometers, which are available to outside users. Three instruments are single collector inductively coupled plasma mass spectrometers for elemental analysis, in which one is dedicated to *in situ* trace element analyses on solid materials using laser ablation. The other two are dedicated to elemental analyses of solutions. The facility has four mass spectrometers dedicated to determination of isotopic compositions. One is a multi-collector inductively coupled plasma mass spectrometer (NEPTUNE) used for determination of isotopic abundances of metals. A second is a thermal ionization multi collector mass spectrometer, which is mainly used for Sr-isotopic compositions. The third mass spectrometer is designed for the measurement of the light stable isotope compositions (C, N O). A fourth mass spectrometer is dedicated to sulfur isotope analyses.

4.2.3 PUBLICATIONS AND OUTREACH

The program members have published 16 papers and given a large number of presentations at meetings and invited presentations at other institutions. Almost all of the presentations were done virtually. The research of the geochemistry group covered a large area of topics. An area of concentrated interest are environmental events such as volcanism and asteroid impacts that can result in mass extinctions. The exact sequence of events associated with these extinctions can be investigated by trace element and isotopic compositions that are sensitive to environmental conditions. Other areas of interest include the composition of meteorites as they record the early conditions of our solar system; the cycling of nutrients and trace nutrients through the hydrosphere; origin and distribution of magmas in the subsurface in the vicinity of Mount St. Helens and Mt. Adams, Cascades. The program normally involves a large number of undergraduate students in their research as well as through the REU summer interns. However, this year this activity was very limited.

4.2.4 SCIENCE HIGHLIGHTS

The end-Permian mass extinction (EPME) represents the largest biocrisis in Earth's history, a result of environmental perturbations following volatiles released during Siberian Traps magmatism. A leading hypothesis links the marine mass extinction to the expansion of oceanic anoxia, although uncertainties exist as to the timing and extent. Our findings suggest a brief oxygenation episode before a return to more anoxic conditions, implying a more complex redox scenario, with rapid changes in oceanic (de)oxygenation leading to spatially and temporally variable biotic stresses. This oxygenation event may have been related to a transient cooling episode, based on published oxygen isotope records. These findings show that the Earth system experienced a highly fluctuating response to forcings linked to volcanogenic volatiles during the EPME. This work was published in Nature Geoscience.

A second highlight concerns the geochemistry staff contribution to the first finding and characterization of the mineral davemaoite. Davemoite has the mineral structure of calcium perovskite and occurs at high pressure (>20GPa) in the Earth's mantle and, although produced in the laboratory, is not observed at the Earth surface. Bridgemanite, the magnesium version of perovskite, found naturally occurring in a shocked meteorite less than ten years ago, is the most abundant mineral on Earth. Davemoite, its Ca-rich cousin, was found as an inclusion in diamond from the Orapa kimberlite in Botswana. The trace element analyses that were conducted at the MagLab shows that davemoite is harboring the heat producing elements K, U and Th. The location of the heat-producing elements and the capacity for the lower mantle to harbor these elements has been unknown. This work was published in *Science Advances*.

A third highlight is our research related to mid-ocean ridge volcanism at the Marion Rise in the southern part of the Indian Ocean. Samples taken from a prominent near-ridge seamount have trace element and isotopic characteristics that are compatible with their source containing a component of lower continental crust. Crustal contributions to oceanic magmatism have been contributed to crustal recycling to the deep mantle and subsequent return in a hot mantle plume. This work shows a different pathway of continental material into the upper mantle. This work was presented at the AGU Fall meeting.

A fourth highlight on Dissolved Organic Matter (DOM) from Artic rivers exemplifies the use of the FT-ICR program by Geochemistry affiliates. Climate change is causing the Arctic to warm, leading to the thaw of permafrost (permanently frozen ground) and shifting the distribution of plants, which in turn impact the quantity and quality of DOM in rivers. The fate of the carbon found in river DOM depends on its source as this determines its composition – a smorgasbord of organic substrates with some destined to be rapidly turned into greenhouse gases through respiration, while others may be exported to and sequestered in the ocean for millennia. Understanding the sources and composition of DOM presently in Arctic rivers will help predict future changes in the global carbon cycle. This work suggests that DOM in large Arctic rivers contains a universal core Arctic riverine fingerprint (which may contribute to long-term ocean carbon sequestration), and that there are predictable, pan-Arctic seasonal increases in labile heteratom-containing DOM that can stimulate primary productivity. Future warming may shift DOM sources in Arctic rivers, particularly due to increasing groundwater inputs to rivers caused by thawing permafrost in the region. This increased groundwater input is preferentially contributing stable DOM compounds which enhances long-term carbon sequestration. This study demonstrates that the shifts in temperature due to climate change has significant effects on the carbon cycle. This work was published in the journal *Global Geochemical Cycles*.

4.2.5 PROGRESS ON STEM AND BUILDING THE USER COMMUNITY

The facility is open to users of all disciplines, and we have a long-time collaboration with the USGS and the South Florida Water Management District. Due to COVID-19 pandemic safety restrictions, the number of outside users, undergraduate students, and Grade 9-12 students we mentored was limited in 2021. Graduate student users are 65% female. Within the area of Geosciences, our faculty have collaborations with researchers throughout the US, Europe as well as Asia. Locally, the geochemistry program' collaborations range from magnet science to pharmacy and anthropology.

4.3 CONDENSED MATTER SCIENCES
CMP EXPERIMENT, HBT, PFF AND CMP THEORY

Here we have taken a few exciting research discoveries that are driven not by our Users, but by the MagLab's own Research faculty members. Although the MagLab is primarily a User Facility, our faculty are also internationally known for their front-line science. This international acclaim brings new users and stresses the eminence of our MagLab. The examples presented in this section were selected by our Chief Scientist for their impact, however there are many more examples of exciting in-house research than we are able to show here.

We start with the growth and measurement of multifunctional and soft materials – in understanding their responses to various thermodynamic parameters, including temperature, and applied magnetic field; many of which have long-term practical applications for magneto-strictive devices and solar panels. We then move on to hard condensed (correlated electron systems) experiments, including a fascinating new material, the heavy fermion superconductor UTe_2. Measurements at the DC and the pulsed field facilities revealed that at certain angles of the applied field the superconductivity is destroyed above about 10T. Then, as the field increases to above about 35T, superconductivity re-appears and exists at least up to 60T. These measurements opened a new area of research. Recently, MagLab scientists have learned to grow single crystals large enough for neutron scattering to help elucidate the microscopic mechanism of the Cooper pairing. Moving to other materials with possible qubit applications, NMR studies of multiferroics in metal-organic frameworks (MOF) have characterized the origin of an order-disorder phase transition due to electric ordering: These single-molecule magnets define a growing field due to their magneto-caloric effects and promise for qubit applications. High-frequency electron parametric resonance (HFEPR) and far-infrared magnetospectroscopy (FIRMS) measurements in single-molecule magnets revealed spin-phonon coupling, which is a key to our understanding of how this coupling can be related to magnetic relaxation, and how it may be controlled. Moving on to topology, a novel topological electron transport was found in a layered van der Waals ferromagnetic (Fe-Ge-Te) that may be due to chiral spin structures – noted by the absence of the interaction between the transport currents and applied magnetic field. Magnetostriction measurements of in-house grown crystals of $AlFe_2B_2$ showed a large lattice changing effect and showcased our ability to make precise x-ray diffraction measurements in high fields. In the heavy fermion superconductor $CeCoIn_5$, a new Cooper pairing mechanism that invokes Kondo scattering was found. In the highly studied and controversial Kondo insulator, SmB_6, it was found that a tiny change in Sm vacancy number had a profound change on the electronic structure, which explains at least some of the controversy. Also, in the field of correlated electron materials, it was found that in stripe-ordered cuprates (doped La-Sr-Cu-O), the Hall coefficient vanishes at high fields, which is fundamentally different from cuprates that are not stripe ordered. Finally, a new technique for sensitive spin detection using dual feedback magnetometry was developed and could be essential for coherent spin qubit control.

At ultra-low temperatures (10mK), Coulomb drag of a spin-polarized Luttinger liquid was observed – showing the exquisite capability of the High-B/T (HBT) facility to resolve these 1-D transport signals in laterally coupled quantum wires. Also at HBT, NMR was used to measure spin relaxation times of ^3He in narrow (< 2nm) tubes that were consistent with 1D behavior predicted by Tomonaga-Luttinger liquid theory. To aid our Users at HBT: a) thermometers based on tuning forks were developed for calorimetry at high field; b) a new bay was opened to accommodate our expanding user access; and c) a new furnace that can grow materials at high-temperature (1200°C) and high magnetic field (9.4T) in a wide-bore (89mm) superconducting magnet was developed for advanced materials synthesis and processing– unique in the world.

At our pulsed field facility (PFF), $RuCl_3$ was found to have scale-invariant anisotropy – no intrinsic energy scale characteristic of the spin itself – so this material remains a candidate for being a quantum spin liquid. A study of the magnetic phase diagram of a quasi-2D square lattice Heisenberg antiferromagnetic exhibited a very strong uniaxial magnetic anisotropy – up to 65T – revealing possible multiferroic phases and promising optical properties to be studied. Using THz spectroscopy at high fields, the first direct measurement of cyclotron resonance in a cuprate superconductor and the fist measurement of the cyclotron mass in the high-temperature superconductor LSCO was accomplished. In the ultra-high temperature superhydride (LaH_{10}) superconductors, a remarkable correlation between superconductivity and a structural instability was discovered. Also, at the PFF, magnetostatic standing waves were induced in UO_2 by microsecond magnetic field pulses, making this material an interesting candidate for fast magnetoelastic transducers. Other work at PFF revealed the possible existence of a pseudogap plutonium.

Our theory group has also been extremely productive. In collaboration with several experimental groups, the transition between the Mott insulating and the metallic regime (with a coexistence regime connecting) was modeled – furthering our understanding of highly correlated electron states; particularly the high-temperature superconducting cuprates. Our theorists also have been working on understanding the key experiments performed at the MagLab on magic angle twisted bilayer graphene. A strong-coupling description of the itinerant carriers, including screening effects, are helping to build a framework at which superconductivity (at lower temperatures and certain fillings) in this fascinating 2D material can be understood.

4.3.1 FSU CMS

4.3.1.1 Magneto-elastic coupling in multiferroic metal-organic framework $[(CH_3)_2NH_2]Co(HCOO)_3$

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Introduction

Metal-organic framework is a class of compounds where organic groups are used in combination with transition metal ions to obtain multifunctional materials. Recently, it has been demonstrated that the family of compounds $[(CH_3)_2NH_2]M(HCOO)_3$ (with M=Ni, Mn, Co and Fe) exhibit multiferroic properties [1]. Several efforts have been made to understand the exchange interactions in these materials including magnetization at high magnetic fields up to 60T and infrared spectroscopy at magnetic fields up to 35T [2,3]. In the infrared studies under applied magnetic fields, it was concluded that Co complex adopts a different mechanism involving format stretching distortions unlike other complexes in the family that use the format bending mode [3]. Concurrently, we performed Raman spectroscopy on $[(CH_3)_2NH_2]Co(HCOO)_3$ at magnetic fields up to 31T to probe the magneto-elastic coupling.

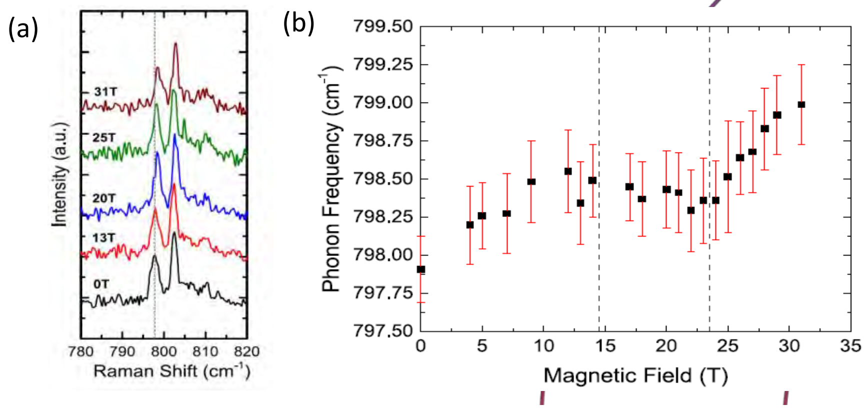

*Figure 4.3.1.1: Magnetic field dependent changes in phonon of $[(CH_3)_2NH_2]Co(HCOO)_3$. **(a)** Selected Raman spectra in a narrow frequency range around 800 cm-1 at magnetic fields from 0T to 31T plotted with vertical offset. **(b)** The phonon frequency change vs magnetic field. The dashed lines represent the magnetic fields at which phase transitions have been observed [5].*

Experimental

Magneto-Raman measurements on $[(CH_3)_2NH_2]Co(HCOO)_3$ were performed using Trivista Raman spectrometer with 532nm laser excitation. These measurements were done at 2.3K and in magnetic fields of up to 31T using resistive magnet. The sample will be placed on X-Y-Z actuator to obtain the best alignment as well as for position selectivity.

Results and Discussion

We find that a weak Raman active vibrational mode at about 798cm^{-1} corresponding to symmetric bending of the format ion does exhibit magnetic-field-induced frequency shifts up to highest measured field of 31T while other phonons remain largely unaffected. This indicates that the bending mode is indeed involved in the magnetoelastic coupling in this family of MOFs (shown in **Figure 4.3.1.1.a)**. The total change in the energy of the vibrational mode is about 134meV corresponding to a temperature change of 1.56K. Although the change is very small it is consistent with magnetic field induced response in infrared spectroscopic investigation [3] and observed to be extremely reproducible with magnetic field increase. The phonon shifts were not observed at even slightly higher temperature of 5K indicating that highly stable lower temperatures and magnetic fields are required to observe these small changes. The slope of the field induced changes was observed to change at two magnetic fields around 14.5T and 23.5T corresponding to transitions from weak ferromagnetic phase to spin-flop phase and spin-flop phase to paramagnetic phase, respectively, when magnetic field was applied along the [010] crystallographic direction [4]. The shift of the phonon modes is nearly linear at magnetic field above 23.5T **(Figure 4.3.1.1.b).**

Conclusions

We performed successful magneto-Raman investigation on $[(CH_3)_2NH_2]Co(HCOO)_3$ at magnetic fields up to 31T. Only one of the phonons (at 798cm^{-1}) corresponding to format bending mode exhibits magnetic field induced shifts. This clearly indicates that this phonon is involved in the magneto-elastic coupling mechanism in this multiferroic material. Raman experiments presented here indicate that the nature of the mageto-elastic coupling is not different from those of the other analogs even though the energy scale is altered due to the octahedral distortions.

Acknowledgements

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4.3.1.2 Propulsion Kinematics of Achiral Swimmers in Viscous Fluids

Benhal, P. (FAMU-FSU, Chem. Eng.); Quashie, D. (FAMU-FSU, Chem. Eng.); Cheang, UK. (SUSTech, Mech. Eng.); Ali, J. (FAMU-FSU, Chem. Eng.)

Introduction

In a low Reynold's environment, chirality and flexibility have been the main geometrical requirement to achieve propulsion. However, it was recently shown that achiral swimmers [1] – objects that have an axis of symmetry; could achieve propulsion as a result of the transformative ability of their magnetic dipole [2]. Achiral swimmers' structural simplicity and manufacturing scalability make them attractive for *in-vitro* and *in-vivo* applications. Hence, swimmer's kinematics have been studied, and three distinct regimes were identified: Near-symmetrical swimming (negligible propulsion (1)), nonsymmetrical swimming (translational propulsion (2)), and wiggling motion (no swimming (3)) as shown in **Figure 4.3.1.2.a**. However, the effect of viscosity on swimming dynamics such as velocity, precession angle, and turning duration have not been considered. Therefore, we fabricate synthetic fluids that match the physiological fluid viscosities found in the human body [3] to study the kinematics of achiral swimmers.

Experimental

Achiral swimmers were fabricated by binding functionalized ~ 4-micron superparamagnetic particles, with either biotin (TM-40-10, Spherotech Inc.) or streptavidin ((VM-40-10, Spherotech Inc.) to form 3 and 4 bead assemblies. The synthetic fluids were made by filtering and diluting a 1% w/v methylcellulose (MC) solution into 0.2, 0.4 and 0.6% w/v. The particles were then suspended in the synthetic fluids and placed in a sealed chamber. Finally, an 8-coil magnetic field was used to induce a magnetic torque on the achiral swimmers.

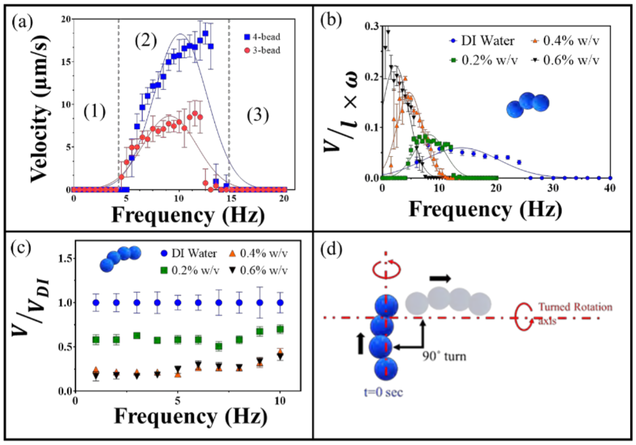

*Figure 4.3.1.2 **(a)** Achiral swimmers in 0.2% MC. **(b)** normalized velocity of 3 bead swimmers using characteristic length (l) and frequency (ω) in MC. **(c)** normalized velocity w.r.t. DI water when the achiral frequency/field ratio is constant. **(d)** Schematic of turn rate characterization.*

Results and Discussion

We first varied the frequency of the magnetic field at a constant field strength to observe the effect on the nonsymmetrical swimming region. Overall, 4 bead achiral swimmers maintain a higher velocity due to increased magnetic material and rotational anisotropy. The frequency range that results in nonsymmetrical swimming is reduced as the viscosity increases (**Figure 4.3.1.2.b**). Linear control of the swimmers was achieved by changing the frequency while the frequency/field strength ratio was held constant. However, the presence of polymers introduced nonlinearities at frequencies greater than 5 in the 0.4 and 0.6% w/v MC solutions (**Figure 4.3.1.2.c**). Finally, the timed response of the achiral swimmers to changes in the magnetic field's orientation was characterized (**Figure 4.1.1.2.d**). In 0.6% MC, we found that 3 and 4 beads have a 6-8% increase in the duration of their turn when compared to DI water.

Conclusions

Achiral swimmers have been demonstrated as deployment mechanisms to deliver and release doxorubicin to cancer cells [4]. Therefore, our findings on the effect of viscosity on swimmer kinematics provide insight into the controllability of these achiral swimmers for future applications.

Acknowledgements

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4.3.1.3 Growth and Characterization of Off-Stoichiometric $LaVO_3$ Thin Films

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Introduction

$LaVO_3$ (LVO) has been proposed as a promising material for photovoltaics because the strong correlations between the d-electrons can facilitate the creation of multiple electron-hole pairs per incoming photon. This makes LVO a great candidate to be used as an absorber material in high-efficiency photovoltaics. We intentionally grow off-stoichiometric LVO thin films on $SrTiO_3$ (STO) substrates, to study how deviating La:V stoichiometries affect the electronic properties of LVO thin films.

Experimental

Thin films were grown via pulsed laser deposition (PLD), in which a KrF excimer laser (λ = 248 nm) is focused on a ceramic target $LaV_{1.2}O_4$. All films were grown on STO substrates that were treated to obtain atomically flat and TiO_2 terminated surfaces. The laser fluence ranged from ~0.6J/cm^2 to ~2.0J/cm^2, while the repetition rate of the laser was kept at 1 Hz. La-rich films were grown at low fluence (La:V = 55:45), while V-rich films resulted from the high fluence growths (La:V = 45:55). All films are deposited at ~ 10^{-7} mTorr to stabilize the perovskite phase of $LaVO_3$. The temperature of the substrate was kept in the range of 600-650°C during growth. Structural characterization was done using a Scintag DMC105 x-ray diffractometer, a Rigaku SmartLab SE x-ray diffractometer (both with Cu Kα1, λ = 0.154nm), and the Advanced Photon Source at Argonne National Laboratory (photon energy = 12.398keV, λ = 1Å) at beamline 33-BM-C. Detailed information on the microstructure and the chemical composition of the films was obtained using the probe-aberration-corrected cold field emission JEM-ARM200cF at 200kV. Electrical resistivity measurements were carried out from 300K to 2K using a Quantum Design physical property measurement system (PPMS). Absorption measurements we used an Ocean Optics USB2000 Spectrometer with a quartz-tungsten-halogen lamp as the source.

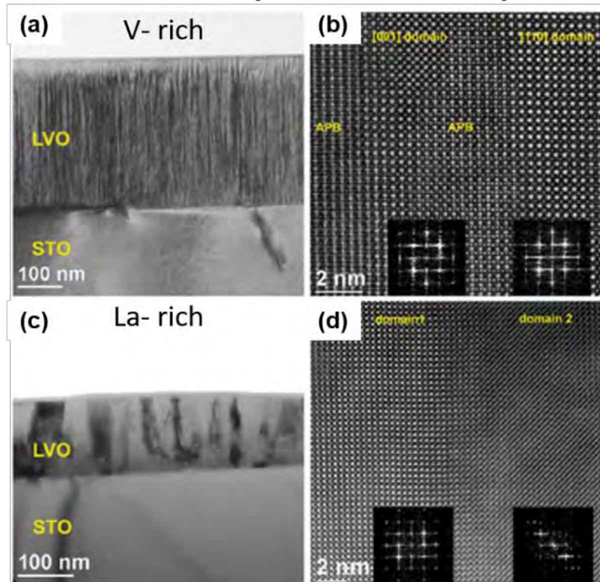

Fig. 4.3.1.3: Top row: Film with La:V = 45:55. a) Low magnification bright field TEM image of the cross-section view. The streaky lines inside the film are contrast from the anti-phase domains (b) Atomic resolution scanning TEM image. Insets: (left) Fast Fourier Transform (FFT) from [001] domain; (right) FFT from [110] domain. Bottom row: Film with La:V = 55:45 (c) Low magnification bright field TEM image of the cross-section view. (d) Atomic resolution scanning TEM image. Inset: FFTs from domain 1 (left) and domain 2 (right). Figure adapted from Ref. [1].

Results and Discussion

Structural characterization shows that La-rich (V-rich) films have a larger (smaller) out-of-plane lattice parameter compared to what one would expect from epitaxial strain effects alone. Transmission electron microcopy (TEM) shows that twinning causes oriented nanodomains in the V-rich films and that larger low-angle domains form causing reduced structural coherence in the La-rich films **(see Figure 4.3.1.3**). Both types of films show deviation from the behavior of bulk LVO in optical measurement, i.e., they do not show signatures of the expected long range orbital order at low temperature, which can be a result of the presence of structural domains and strain-induced structural distortions. In transport measurements, La-rich films display clear signatures of electronic phase separation accompanying a temperature induced metal-insulator transition, while V-rich films behave more like bulk, i.e., as Mott insulators.

Conclusions

Results on off-stoichiometric $LaVO_3$ thin films show that the variation of the La:V ratio in the films leads to changed out-of-plane lattice parameters, which plays a crucial role in determining the physical properties of the films. The structural changes control whether the films behave as Mott-insulators or if they show disorder-induced electronic phase separation at low temperature. For more details, see Ref. [1].

Acknowledgements
The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida. C.B. acknowledges support from the National Research Foundation, under grant NSF DMR-1847887. Use of the Advanced Photon Source was supported by the U.S. Department of Energy (DOE), Office of Science User Facility, operated for the DOE Office of Science by Argonne National Laboratory under Contract No. DE-AC02-06CH11357. Extraordinary facility operations were supported in part by the DOE Office of Science through the National Virtual Biotechnology Laboratory, a consortium of DOE national laboratories focused on the response to COVID-19, with funding provided by the Coronavirus CARES Act. S.M. acknowledges support under grant NSF DMR-1229217.

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4.3.1.4 Single Crystals of UTe_2 for Inelastic Neutron Scattering Measurements

Duan, C. (Rice U.), Baumbach, R. E. (NHMFL, FSU Physics), Podlesnyak, A. (ORNL), Deng, Y. (UC San Diego), Moir, C (UC San Diego), Breindel, A. J. (UC San Diego), Maple, M. B. (UC San Diego), Nica, E. M. (Arizona State U.), Si, Q. (Rice U.), Dai, P. (Rice U.)

Introduction
UTe_2, which has a superconducting transition temperature $T_c \approx 1.6$ - 2K, has recently been identified as a candidate for a chiral spin-triplet topological superconductor near an FM instability [1]. It also exhibits an unprecedented magnetic field driven electronic phase diagram with an enormous upper critical field, as well as a field induced superconducting state ("Lazarus superconductivity") [2]. As a result, there has been substantial demand for high quality specimens from collaborators both internal and external to the MagLab. This motivated us to (i) investigate growth procedures to optimize sample quality and size, (ii) provide specimens to collaborators, and (iii) investigate chemical modification of UTe_2.

Experimental
Single crystal specimens of UTe_2 were produced using an iodine vapor transport method. Their bulk electronic properties were assessed using electrical transport and heat capacity measurements at temperatures 0.4K < T < 300K in a Quantum Design Physical Properties Measurement System. These activities occurred in the Baumbach laboratory, after which more than 2 grams of single crystal specimens were provided to the group of M. B. Maple for alignment by Laue diffraction. Subsequent inelastic neutron scattering measurements were carried out by P Dai *et al.* using the Cold Neutron Chopper Spectrometer (CNCS) at Oak Ridge National Laboratory. The theoretical analysis was performed by Q. Si *et al.*

Results and Discussion
As shown in **Figure 4.3.1.4,** our specimens exhibit a second-order phase transition near $T_c \approx 1.6$K, which marks the onset of superconductivity. All samples resulting from these growth experiments show this feature, but as previously reported, some show a single transition whereas others exhibit a double transition. Subsequent improvements of the growth procedure have increased the superconducting transition to $T_c \approx 2$K and only a single transition is observed (not shown). These crystals were provided to our collaborator P. Dai for inelastic neutron scattering measurements, which show that superconductivity is coupled to a sharp magnetic excitation at the Brillouin zone boundary near antiferromagnetic order [3]. This type of resonance has only been found in spin-singlet unconventional superconductors near anti-ferromagnetic instabilities, suggesting that anti-ferromagnetic spin fluctuations may also induce spin-triplet pairing or that electron pairing in UTe_2 has a spin-singlet component.

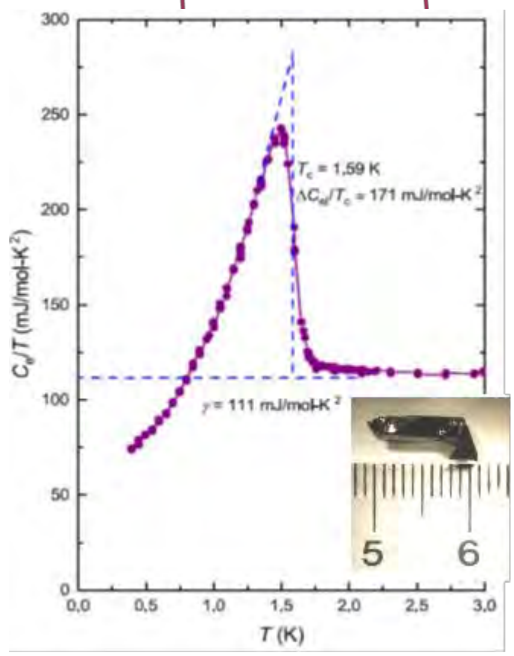

Figure 4.3.1.4: Tthe electronic component of the heat capacity c_e/t for ute_2, showing the superconducting phase transition at t_c. (inset) a typical piece of ute_2 single crystal of 10mm by 3mm by 3mm in size. the direction of the longest edge is the intersection of [1, 1, 0] plane and [0, 0, 1] plane.

Conclusions
The observation of an anti-ferromagnetic resonance in UTe_2 provides new insights into the superconducting state in this compound. Future work includes studies of its evolution under applied pressure, as well as the impact of magnetic impurities on the phase diagram of UTe_2.

Acknowledgements
Work performed by R.E.B. at the National High Magnetic Field Laboratory was supported by National Science Foundation Cooperative Agreement No. DMR-1644779 and the State of Florida. Synthesis of crystalline materials and measurements by R.E.B. were supported by the Center for Actinide Science and Technology (CAST), an Energy Frontier Research Center (EFRC) funded by the US DOE, BES, under grant no. DE-SC0016568. The INS work at Rice is supported by the US DOE, BES under grant no. DE-SC0012311 (P.D.). Part of the material characterization efforts at Rice is supported by the Robert A. Welch Foundation grant nos C-1839 (P.D.). Research at UC San Diego was supported by the US DOE, BES under grant no. DEFG02-04-ER46105 (single-crystal growth) and NSF under grant no. DMR-1810310 (characterization of physical properties). The theory work at Rice has primarily been supported by the US DOE, BES under award no. DE-SC0018197, with travel support provided by the Robert A. Welch Foundation grant no. C-1411. Q.S. acknowledges the hospitality of the Aspen Center for Physics, which is supported by NSF grant no. PHY-1607611. E.M.N. was supported by an ASU startup grant. A portion of this research used resources at the Spallation NeutronSource, a DOE Office of Science User Facility operated by ORNL.

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4.3.1.5 NMR Studies of Magnetic and Electric phase transitions in MOF Multiferroics

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Introduction

Multiferroic materials exhibiting simultaneous electric and magnetic ordering are of intense research interest due to its potential applications in memory devices, sensors, etc. [1] One such effective method of achieving multiferroicity is through Metal-Organic Framework materials (MOF).[2] We report the result of NMR studies of their structure and the mechanism responsible for the magnetic and electric ordering by using Dimethylammonium magnesium format $[(CH)_3NH_2]Mg(HCOO)_3$, (Mg-MOF).

Experimental

^{15}N, ^{25}Mg and ^{13}C solid-state NMR were carried out to study the spectra, T_1 relaxation, and chemical shift in Mg-MOF using the 17T and 12T magnets at the condensed matter NMR lab and the 600MHz, 830MHz Bruker NMR instruments at the high-resolution NMR lab. We analyzed the chemical shifts of the nuclei near the phase transition and measured the correlation time (τ_c) of the ^{13}C and ^{15}N nuclei in the MOF cavity using the T_1 relaxation time and BPP theory.

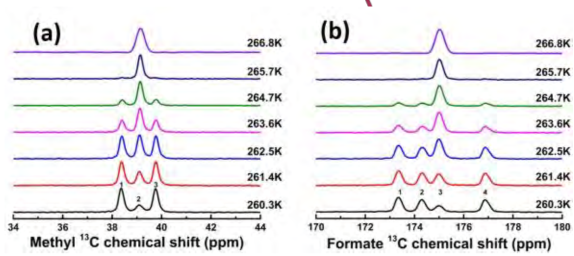

Figure 4.3.1.5.1. *a) ^{13}C spectra of the dimethylammonium cation. b)^{13}C spectra of the format framework.*

Results and Discussion

Mg-MOF exhibits a dielectric phase transition at 270K. [3] The methyl spectra near the dielectric phase transition show a change from one peak at $T > T_c$ to two peaks below T_c while the format ^{13}C spectra change from one peak to three peaks upon cooling **(Figure 4.3.1.5.1)**. As seen in other compounds of the same class, we also observed the coexistence of high-temperature and low-temperature phases at certain temperatures in both methyl and format ^{13}C, implying that some lattice in the compound is still in high temperature phase while some lattices have already transitioned. The average chemical shift (not shown) of the low temperature peaks does not coincide with the high temperature peak which is a signature of displacive type electric ordering. The ^{15}N spectra and T_1 data **(Figure 4.3.1.5.2)** show the change in chemical shift and the narrowing of the line width indicating that the nitrogen atom is hopping in the cavity. By fitting the T_1 relaxation of ^{15}N to BPP model we calculated the correlation time corresponding to the dimethylammonium cation in the cavity. In the case of ^{25}Mg NMR, (not shown), the line width changed near the phase transition around 270K, but no chemical shift was observed implying that the electric ordering in this compound has little

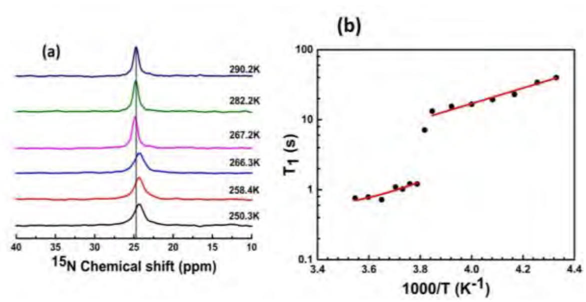

Figure 4.3.1.5.2*. a) Temperature dependence of ^{15}N spectra in Mg-MOF b) ^{15}N T_1 relaxation. Red line shows fit to BPP model.*

to do with the metal cations and the framework of the compound.

Conclusions

The mechanism of dielectric phase transition in Mg-MOF was probed using ^{13}C, ^{15}N, ^{25}Mg NMR. The changes in the spectra of ^{13}C, ^{15}N indicate that the phase transition is prominently governed by the dynamics of the DMA^{+} cations. The changes in the average chemical shift of ^{13}C and the step-like behavior in ^{15}N chemical shift near phase transition indicate that the phase transition is characterized by a mixed behavior of order–disorder and displacive features. From the fitting of T_1 experimental data to BPP relaxation model the correlation time (τ_c) of ^{15}N is found to be in the range of 10^{-9} s and corresponding activation energy of 28.62kJ/mol which is in reasonable agreement with the values in literature. Results of this study are detailed in Ref. 4.

Acknowledgements

This work is supported by the NSF Cooperative Agreement DMR-1644779 and the State of Florida.

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4.3.1.6 Applying Unconventional Spectroscopies to the Single-Molecule Magnets, Co(PPh3)2X2 (X=Cl, Br, I): Unveiling Magnetic Transitions and Spin-Phonon Coupling

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Introduction

Large separation of magnetic levels and slow relaxation in metal complexes are desirable properties of single-molecule magnets. Magnetic transitions among zero-field split (ZFS) levels of the S=3/2 electronic ground state were probed by high-frequency and -field EPR (HFEPR) and far-infrared magnetospectroscopy (FIRMS), giving magnetic excitation spectra and determining ZFS parameters (*D, E*) and *g* values.

Experimental

The FIRMS and HFEPR measurements were performed at the MagLab using SCM#3 at DC and a 15/17T magnet at EMR facilities, respectively.

Results and Discussion

These techniques allowed the direct observation of the magnetic transitions between the two zero-field splitting sublevels (e. g., m_S=-3/2->1/2 and m_S= +3/2->+1/2) in the tetra-coordinated Co(II) series, Co(PPh3)2X2 (Co-X; X=Cl, Br, I). The frequency-field dependence of the magnetic resonance energies is shown in the **Figure 4.3.1.6** The spin-phonon coupling manifest itself in the anti-crossing behavior of the magnetic levels (vertical blue lines, **Figure 4.3.1.6, right**). Ligand-field theory was used to analyze earlier electronic absorption spectra and give calculated ZFS parameters matching those from the experiments.

Conclusions

We have found that FIRMS spectra of Co(PPh3)2X2 (Co-X; X=Cl, Br, I) reveal rarely observed spin-phonon coupling as avoided crossings between magnetic and *u*-symmetry phonon transitions. The current work reveals dynamics of magnetic and phonon excitations in SMMs. Studies of such couplings in the future would help to understand how spin-phonon coupling may lead to magnetic relaxation and develop guidance to control such coupling.

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida. US National Science Foundation (NSF, CHE-1900296 to Z.-L.X. and DMR-2004732 to S.H.) and a Shull Wollan Center Graduate Research Fellowship also supported this research. Neutron scattering experiments were supported by the Scientific User Facilities Division, Office of Basic Energy Sciences (BES), U.S. Department of Energy (DOE), under Contract No. DEAC05000R22725 with UT Battelle, LLC. We acknowledge the support of the National Institute of Standards and Technology, U.S. Department of Commerce. The computing resources were funded by the Laboratory Directed Research and Development program and the Compute and Data Environment for Science (CADES) facility at ORNL.

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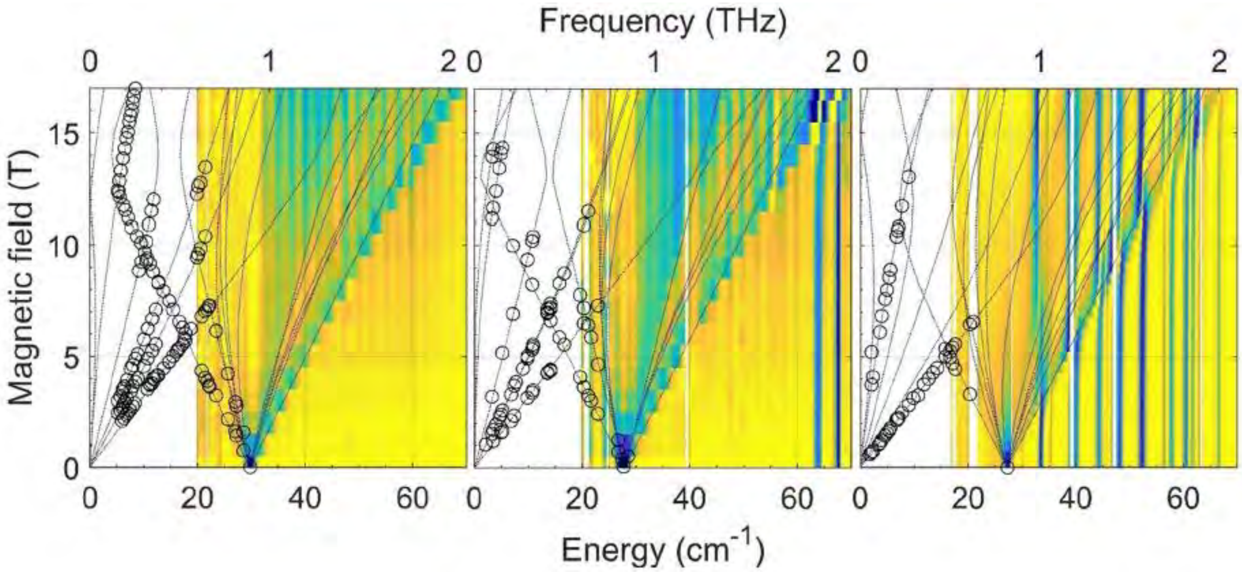

Figure 4.3.1.6: *FIRMS maps (normalized transmission vs. field and energy/frequency): (Left) Co-Cl, (Middle) Co-Br, (Right) Co-I with HFEPR results superimposed. The color trend from blue to yellow corresponds to a decrease of the magnetic absorption. The lines are simulations of turning points in the powder spectra that assume the (best-fitted) spin-Hamiltonian parameters. The circles correspond to the observed HFEPR resonances, except for the zero-field resonance obtained from FIRMS spectra. The equidistant vertical stripes are due to instrumental artifacts, while the white regions correspond to spectral ranges without reliable data.*

4.3.1.7 Magnetic field-induced non-trivial electronic topology in $Fe_{3-x}GeTe_2$

Macy, J., Ratkovski, D., Chiu, Y.-C., Flessa Savvidou, A.; Moon, A., Zheng, W., Choi, E. S., Balicas, L. (FSU and NHMFL); Balakrishnan, P. P., Grutter, A. J., Borchers, J. A., Ratcliff, W. D. (NIST); Weiland, A. McCandless, G. T., Chan, J. Y. (UT Dallas, Chemistry); Kumar, G. S., Shatruk, M. (FSU Chemistry); Strungaru, M., Santos, E. J. G. (U. Edinburgh)

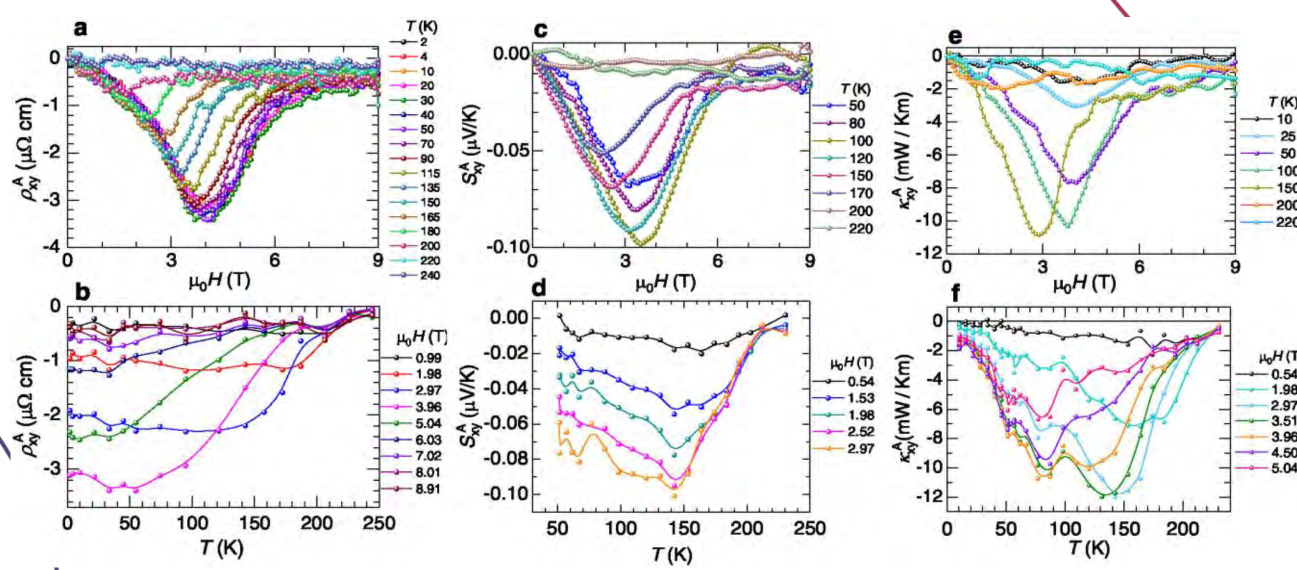

Figure 4.3.1.7: *Field-induced maxima in the anomalous transport variables for currents and thermal gradients aligned along m_0H // to the a-axis. (a) Anomalous Hall resistivity r^A_{xy} for a $Fe_{2.84}GeTe_2$ crystal as a function of m_0H applied along the a-axis and for several Ts. r^A_{xy} displays a minimum as a function of m_0H whose position is T-dependent. (b) r^A_{xy} as a function of T for several values of m_0H applied along a planar direction. (c) Anomalous Nernst effect S^A_{xy} as a function of m_0H along a planar direction for several T_s. (d) S^A_{xy} as a function T collected under several values of the field applied along a planar direction. (e) Anomalous thermal Hall conductivity k^A_{xy} as a function of m_0H applied along a planar direction and for several values of T. (f) k^A_{xy} as a function of T and for several values of m_0H applied along a planar direction. The anomalous transport variables follow a similar dependence on magnetic field, which contrasts with the one followed by the magnetization.*

Introduction

$Fe_{3-x}GeTe_2$ is a layered, van der Waals-like ferromagnet displaying a simple collinear spin arrangement with the magnetic moments oriented along the out-of-the plane direction. However, this simple magnetic order is claimed to trigger complex phenomena, such as (i) the development of a Kondo lattice below a coherence temperature of ~150K, (ii) electric field tuning of its Curie temperature T_c = (220±10)K up to room temperature, (iii) skyrmions, (iv) and very large anomalous Hall and Nernst coefficients claimed to result from its non-trivial electronic topology.

Experimental

We observe a pronounced topological transport[1] (i.e., anomalous Hall, anomalous Nernst, and anomalous thermal Hall) for $m_0H//a$-axis or when the field is aligned along the gradient of the chemical potential generated by thermal gradients or electrical currents, a configuration that should not lead to their observation. These anomalous planar quantities are found to not scale with the component of the planar magnetization ($M_{||}$), showing instead a sharp decrease beyond $m_0H_{||}$ ~ 4T or the field required to align the magnetic moments along $m_0H_{||}$.

Results and Discussion

We measured anomalous and topological Hall, Nernst and thermal Hall for fields along both the c-axis and the ab-plane. (**Figure 4.3.1.7**)

Conclusions

We argue that chiral spin structures like skyrmions and Bloch domain walls, lead to a field-dependent spin chirality that produces a novel type of topological transport in the absence of interaction between the magnetic field and electrical or thermal currents.

Acknowledgements

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4.3.1.8 Magnetostriction of $AlFe_2B_2$ in High Magnetic Fields

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Introduction

The experimental study of induced magnetostriction in $AlFe_2B_2$ above and below the ferromagnetic ordering temperature (Curie temperature, *Tc*) in DC magnetic fields up to ±25T is presented here. Our results provide direct insights into the structural changes of $AlFe_2B_2$ across *Tc* and highlight the experimental capabilities of the novel high magnetic field XRD setup used for the present work. The observed magnetoelastic coupling is analyzed using Landau theory and spin polarized DFT calculations.

Experimental

The sample of $AlFe_2B_2$ was synthesized using arc melting. To investigate the magneto-elastic effect in $AlFe_2B_2$, we used a custom diffraction setup equipped with Mo Ka radiation integrated with the Florida Split Coil Magnet in Cell 5 at the MagLab and capable of diffraction in the presence of high *DC* magnetic field of up to ±25T. A Pilatus 300K-W X™ hybrid pixel detector was used to detect the X-rays.

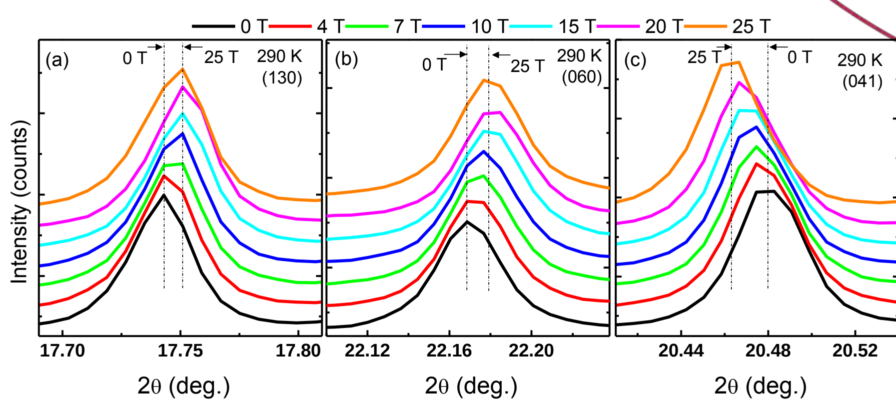

Figure 4.3.1.8: *XRD peak profiles of (a) (130), (b) (060), and (c) (041) reflections recorded at 290K under 0, 25, and -25T applied field.*

Results and Discussion

The magnetostriction was measured in the vicinity of T_C namely, at 250, 290, and 300K. **Figure 4.3.1.8** shows the field dependent XRD plots measured at 290K. $AlFe_2B_2$ exhibits an anisotropic change in lattice parameters as a function of magnetic field near T_C, and a monotonic variation as a function of applied field has been observed, i.e., the *c*-axis increases significantly while the *a*- and *b*-axes decrease with the increasing field, irrespective of the measurement temperature. The volume magnetostriction decreases with decreasing temperature and changes its sign across T_C, consistent with DFT results. The relationships for magnetostriction are estimated based on a simplified Landau model that agrees well with the experimental results.

Conclusions

$AlFe_2B_2$ exhibits anisotropic magnetostriction in an applied *DC* magnetic field up to 25T. Close to T_C, i.e., at 300K and 290K, the magnitude of the magnetostriction is larger than at 250K. The unit cell parameter *c* increases while the *a*- and *b*- decrease with increasing magnetic field, with the largest effect for the elongation of the *c*-parameter in the vicinity of T_C, consistent with DFT calculations.

Acknowledgements

This work is supported by the National Science Foundation under award DMR – 1625780. Part of the work was carried out at the National High Magnetic Field Laboratory, which is supported by the National Science Foundation under Cooperative Agreement No. DMR-1644779 and the State of Florida.

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4.3.1.9 Spectroscopic evidence for the direct involvement of local moments in the pairing process of the heavy-fermion superconductor $CeCoIn_5$

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Introduction

The superconductivity in the heavy-fermion compound $CeCoIn_5$ has been well studied including the order parameter symmetry of d_{x2-y2}-type [1,2]. However, the exact pairing mechanism is not yet established since: (i) the observed neutron spin resonance, widely considered as one of the key experimental signatures for the spin-fluctuation-mediated pairing, remains controversial [3,4]; and (ii) the corresponding signature in tunneling conductance, namely a hump-dip structure outside the gap, is missing. The results from our recent tunneling spectroscopy [5] provide strong evidence that: (i) the pairs form well above the T_c (2.3K); and (ii) the pairing process directly involves localized moments.

Experiments and Data Analysis

Planar tunnel junctions were prepared on the polished crystal surface oriented along three major crystallographic axes [5], namely, [001], [100], and [110]. The differential tunneling conductance was taken using the four-probe lock-in technique over wide ranges of temperature down to 20mK and magnetic field up to 18T. The reproducible conductance spectra of high quality were analyzed by fitting to the Blonder-Tinkham-Klapwijk (BTK) model [6] and the Anderson-Appelbaum (AA) model [7]. Contrary to the common expectation, the pairing gap turns into a field-induced gaplike feature (FIG) with increasing field. The field evolution of the FIG was compared to the conductance computed with the AA model.

Results and Discussion

As shown in **Figure 4.3.1.9.1,** the pairing gap opens below $T_p \approx$ 5K, well above the T_c. This observation is in good agreement with several other experiments reported in the literature [8,9]. What is surprising is that the pairing gap turns into a FIG at high field instead of closing out at the upper critical field **(Figure 4.3.1.9.2)**. The peak position of the FIG increases linearly with field, reminiscent of the

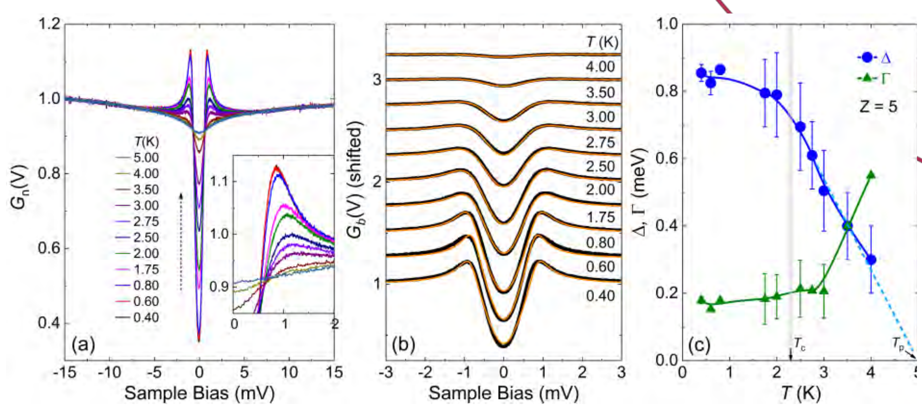

Figure 4.3.1.9.1: (a) Temperature-dependent normalized conductance, $G_n(V)$, for a (001) junction on $CeCoIn_5$ in which the pairing gap emerges out of a zero-bias conductance dip below T_p (~ 5K). Inset: Magnified view of the gap edge. (b) Background-normalized conductance, $G_b(V)$, curves (black symbols) and their best fits (solid orange lines) to the d-wave BTK model [6]. $G_b(V)$ is obtained by dividing out each $G_n(V)$ with $G_n(V)$ at 5 K. (c) Best-fit values for the energy gap (D) and the broadening parameter (Γ). The effective barrier strength (Z) is kept to a constant, 5. At 0.4 K, (D, Γ, Z) = (0.855meV, 0.179meV, 5.0). D remains finite above T_c and extrapolates to zero at T_p, as indicated by the dashed line.

Zeeman splitting. The deduced g-factor value is as follows: 1.81 ± 0.43, 2.14 ± 0.22, and 1.96 ± 0.25, for the [001], [100], and [110] directions, respectively, in agreement with the value extracted from the field-split neutron spin resonance peak [10]. Considering these observations, we infer that the pairing process directly involves the localized moments, supporting the composite pairing model proposed by Coleman and coworkers [11]. However, the high-field conductance curves can't be reproduced by the AA model, even qualitatively, indicating that a more sophisticated model is needed, e.g., by considering the exact ground state for the Ce 4*f* electron in $CeCoIn_5$ [12].

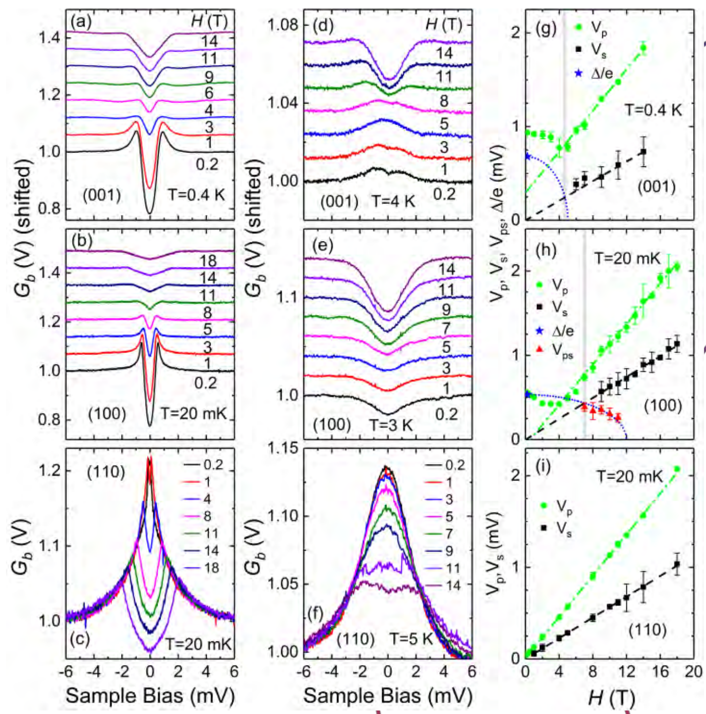

Figure 4.3.1.9.2: Magnetic field evolution of the background-normalized conductance in $CeCoIn_5$. (a)–(c) Waterfall plots of the conductance for varying magnetic field applied along the junction normal at temperatures well below T_c for (001), (100), and (110) junctions, respectively. (d)–(f) The same at temperatures well above T_c. Curves are shifted vertically in (a), (b), (d), and (e) for clarity. (g)–(i) Peak position, V_p (filled green circles), and steepest slope point, V_s (filled black squares), of the FIG at low temperature. In (g) and (h), D is also plotted for H = 0.2T with (D, G, Z) = (0.69meV, 0.405meV, 1.81) for (g) and (0.535meV, 0.198meV, 1.21) for (h). The crossing field (H_c) is indicated by gray lines. In (h), slope-changing points due to the pairing gap, V_{ps}, above H_c are also shown by filled triangles. Dashed-dotted and dashed lines are linear fits to V_p and V_s, respectively. The blue dotted lines crossing the point D (0.2T) in (g) and (h) show field dependence of the pairing gap according to the Ginzburg-Landau theory.

Conclusions

Our tunneling spectroscopic studies show that the superconductivity in $CeCoIn_5$ occurs in two steps: pair formation well above the T_c and pair condensation below T_c. What is new is that the pairing process directly involves the localized moments via a cooperative two channel Kondo effect. It is remarkable that the local physics manifested via Kondo resonance plays a key role in the superconductivity, which may also apply to some other heavy-fermion superconductors.

Acknowledgements

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4.3.1.10 Topological nature of the Kondo insulator SmB_6 and its sensitiveness to Sm vacancy

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Chemistry); Koohpayeh, S.M. (Johns Hopkins Univ, Physics and Astronomy); Phelan, W.A. (Johns Hopkins Univ, Physics and Astronomy); McQueen, T.M. (Johns Hopkins Univ, Physics and Astronomy, Chemistry, & Materials Science and Engineering)

Introduction

The well-known Kondo insulator SmB_6 has been intensively studied over the last decade owing to the proposed possibility as the first correlated topological phase, coined as topological Kondo insulator [1]. Although there is a large body of the literature supporting this proposal [2], the true topological nature remains to be unveiled. Building upon our previous tunneling spectroscopic studies indicating that the topological surface states in SmB_6 interact with the spin excitons [3,4], we carried out similar measurements on SmB_6 crystals with Sm deficiency up to 1% to investigate how such disorder affects the topological properties [5]. While the bulk hybridization gap is found to be insensitive to the Sm vacancy, the surface states exhibit quite different temperature evolutions.

Experiments and Data Analysis

The tunneling conductance spectra taken from two Sm-deficient crystals grown by the floating-zone (FZ) technique [6], labeled as FZ-Pure and FZ-Def, are compared with those from stoichiometric flux-grown (FG) ones [3]. Planar tunnel junctions were prepared on polished surfaces oriented along the [001] direction by forming a tunnel barrier via plasma oxidation followed by the deposition of Pb as the counter-electrode. The differential conductance was taken using the four-probe lock-in technique over wide temperature ranges as a function of bias voltage and at fixed bias voltages as well. The detailed features in the conductance spectra were analyzed based on a model that considers an inelastic tunneling channel involving the emission and absorption of the spin excitons in addition to the usual elastic tunneling [3].

Results and Discussion

A hybridization gap of similar size is commonly observed in all three crystals as seen in **Figure 4.3.1.10.1.**, indicating that it is insensitive to the disorder (Sm vacancy) in the Kondo lattice. However, the surface states undergo quite distinct evolution as a function of temperature, as shown in **Figure 4.3.1.10.2**. The conductance at a bias voltage of 4mV, where a kink is observed in the conductance curve after the linear dependence characteristic of the surface states, exhibits a noticeable jump followed by a plateau

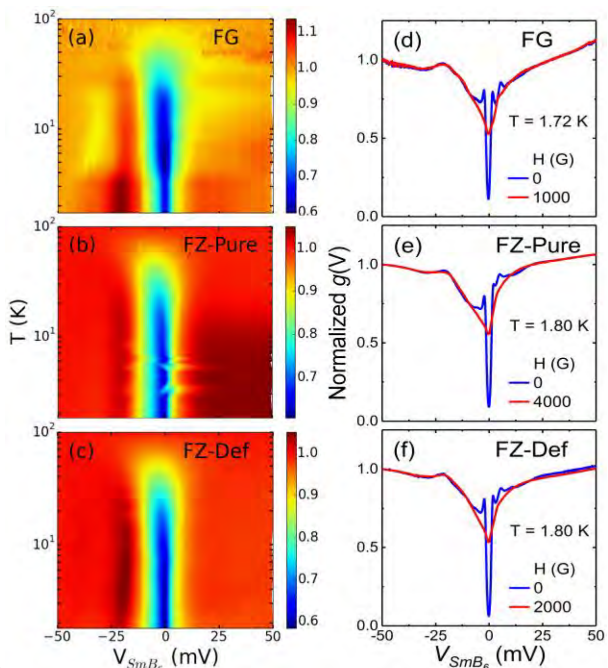

Figure 4.3.1.10.1: Bulk hybridization gap and the topological surface states in SmB_6. (a)-(c) Color-contour maps of the normalized tunneling conductance, g(V). Below the T_c (7.2K) of Pb (the counter-electrode), the conductance was measured with the Pb driven normal by magnetic fields indicated in (d)-(f). Overall, all three crystals exhibit similar features due to the opening of a bulk hybridization gap. (d)-(f) Normalized conductance at the lowest temperature with the Pb superconducting (blue solid lines) and driven normal (red solid lines). An additional peak is seen only in the positive-bias branch (5-6mV), a signature for inelastic tunneling involving the spin excitons [3].

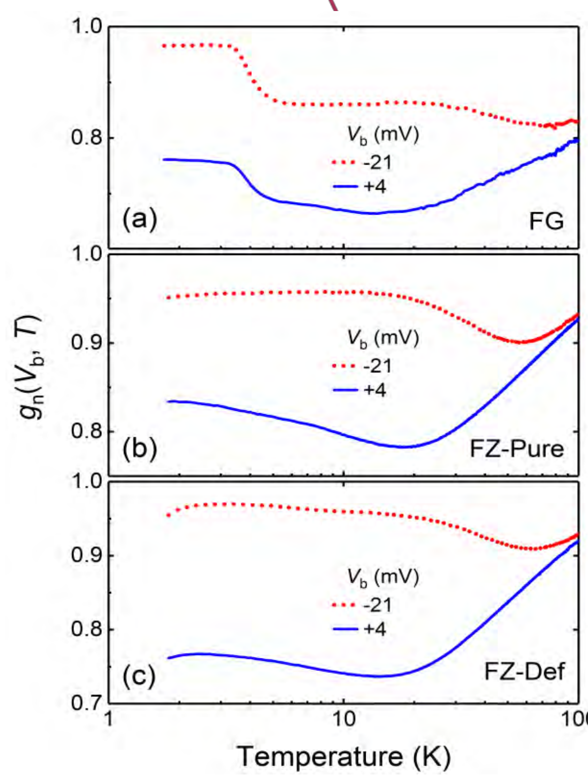

Figure 4.3.1.10.2: Temperature evolution of the topological surface states. (a)-(c) Temperature dependence of the conductance at two fixed bias voltages (V_b = -21 and +4 mV) normalized against -50 mV. At low temperature, while the FG exhibits a rapid increase followed by plateauing, the FZs exhibit gradual changes.

below ~4K for the FG crystal. In contrast, the FZ crystals show only gradual changes. Based on the previous findings that the topological surface states in SmB_6 interact with the spin excitons [3,7], we interpret this as due to whether they become coherent (in the FG) at low temperature or remain incoherent (in the FZs) depending on the condensation of the spin excitons [8,9].

Conclusions

Our comparative tunneling studies on SmB_6 crystals of varying Sm deficiency show that the topological surface states persistently exist but showing distinctly different temperature evolution. This is attributed to the difference in their interaction with the spin excitons that may or may not condense at low temperature. This sensitiveness of the topological nature to a disorder is seemingly contradictory to the celebrated topological protection, but it can be understood as due to the interplay between strong correlations and topological effects. This aspect should be carefully considered when addressing the outstanding questions.

Acknowledgements

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4.3.1.11 Magnetic Field Reveals Vanishing Hall Response in the Normal State of Stripe-Ordered Cuprates

Shi, Z., Baity, P.G., Terzic, J. and Pokharel, B.K. (FSU, NHMFL); Sasagawa, T. (Tokyo Institute of Technology, Japan); Popović, D. (FSU, NHMFL)

Introduction

The central issue for understanding the high-temperature superconductivity in cuprates is the nature of the ground state that would have appeared had superconductivity not intervened. Therefore, magnetic fields (*H*) have been commonly used to suppress superconductivity and expose the properties of the normal state, but the nature of the high-*H* normal state may be further complicated by the interplay of charge and spin orders with superconductivity. Indeed, here we show that the field-revealed normal state of $La_{2-x-y}Sr_x(Nd,Eu)_yCuO_4$ cuprates with static spin and charge stripes, characterized by the peculiar weak insulating behavior of the resistivity, i.e. $\rho_{xx} \propto \ln(1/T)$ [1], also exhibits a zero, i.e. immeasurably small, Hall coefficient.

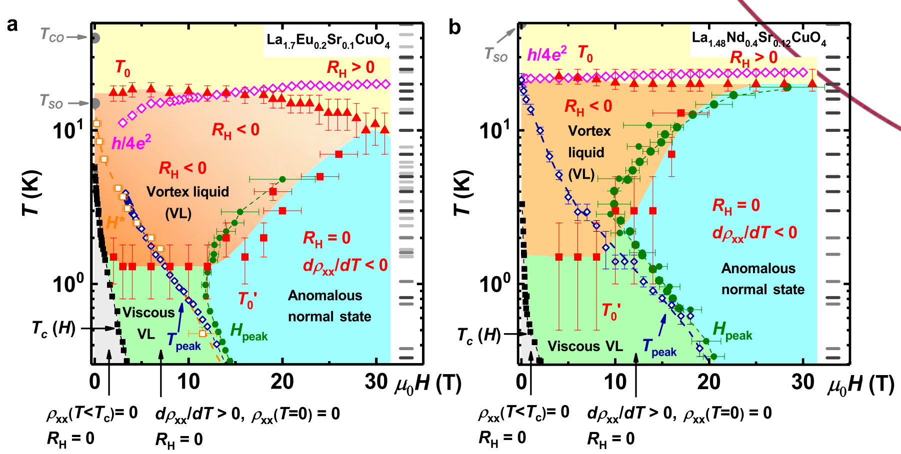

Figure 4.3.1.11: In-plane Hall coefficient R_H across the T-H phase diagram of stripe-ordered cuprates. (a) $La_{1.7}Eu_{0.2}Sr_{0.1}CuO_4$; (b) $La_{1.48}Nd_{0.4}Sr_{0.12}CuO_4$. T_{SO} and T_{CO} are the zero-field onset temperatures of spin and charge orders, respectively. The upper critical field H_{c2} ~ $H_{peak}(T)$ (green dots).

Experimental

In-plane resistivity ρ_{xx} and the Hall effect were measured on stripe-ordered $La_{1.7}Eu_{0.2}Sr_{0.1}CuO_4$ and $La_{1.48}Nd_{0.4}Sr_{0.12}CuO_4$ over the entire, previously established [1] in-plane *T-H* vortex phase diagram (*T* is temperature). Highest-field measurements were performed in the DC Field Facility using SCM1, SCM2, and Cell 9 systems.

Results and Discussion

Figure 4.3.1.11 shows regions in (T, H) phase space with different signs of the Hall coefficient R_H [2]. We have clarified and further confirmed that the origin of R_H = 0 reported in earlier studies of stripe-ordered cuprates is associated with the presence of superconducting (SC) fluctuations. In contrast, our central result is that R_H = 0 at much higher fields, above the upper critical field H_{c2} and corresponding to the anomalous normal state region in **Figure 4.3.1.11**. The vanishing of the Hall coefficient in this field-revealed normal state is observed for all $T <$ (2- 6) T^0_c, where T^0_c is the zero-field SC transition temperature.

Conclusions

Our measurements demonstrate [2] that the vanishing of the Hall coefficient is a robust fundamental property of the normal state of cuprates with intertwined orders, exhibited in the previously unexplored regime of T and H. The behavior of the high-field Hall coefficient in stripe-ordered cuprates is fundamentally different from that in other cuprates such as $YBa_2Cu_3O_{6+x}$ and $YBa_2Cu_4O_8$, and may imply an approximate particle-hole symmetry that is unique to stripe-ordered cuprates. Our results highlight the important role of the competing orders in determining the normal state of cuprates.

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through DMR-1644779 and the State of Florida. This work was also supported by NSF DMR-1707785.

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4.3.1.12 Dual feedback squid magnetometry for sensitive spin detection

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Introduction

Detection of spin resonance is essential for achieving coherent spin qubit control. Recent experiments have involved superconducting chips operating at low temperatures and are usually designed as dedicated spin systems. However, a broadband device is needed for complex materials that need large magnetic fields. A novel differential squid detection method for spin systems on a microwave waveguide is being developed at the MagLab and is presented here [1].

Experimental

Sensitive magnetometers that can operate in high magnetic fields are essential for detecting magnetic resonance signals originating from small ensembles of quantum spins. Such devices have potential applications in quantum technologies, in particular quantum computing. We present a novel experimental setup implementing a differential

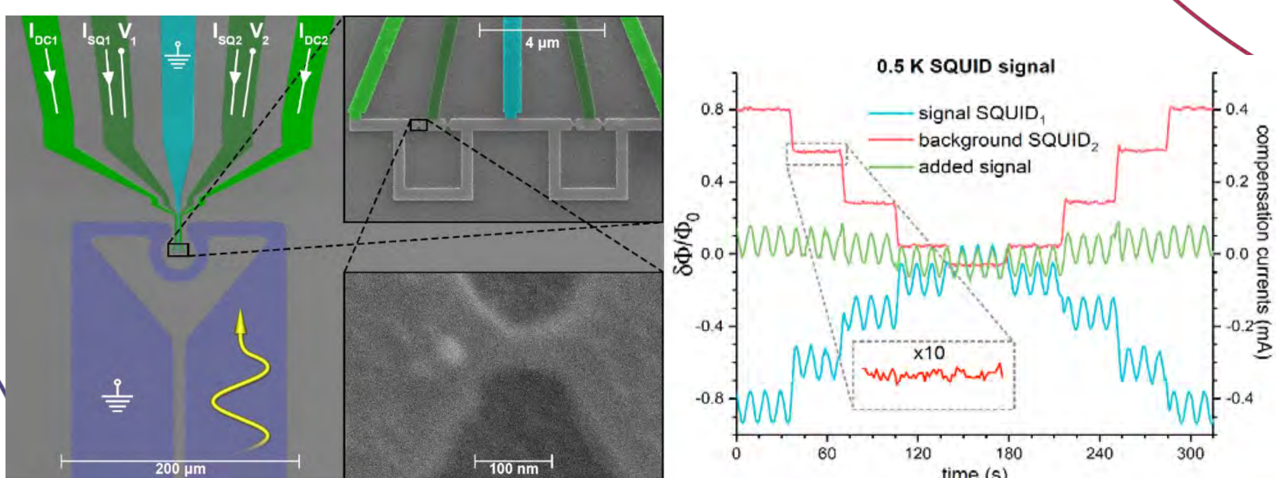

Figure 4.3.1.12: Figure1 (left) *Scanning Electron Micrograph (SEM) images of the Nb microwave-SQUID device at different magnifications; the scales are indicated in white, the purple shows the Nb waveguide terminated in an Ω-loop, the light green are flux bias lines for each SQUID, the dark green indicate the current bias and voltage pickups and the middle line is the ground. The two SQUIDs (top inset) have nanobridge junctions (bottom inset) on the upper branch with the bias current lines located in-between the junctions. One of the SQUIDs will pick up the sample magnetic signal. Another one, placed further away (not shown) will pick up the background magnetic signal.* ***(right)*** *Experimental results at 0.5K. The blue and red curves show the SQUIDs bias currents in mA (right axis) and Φ_0 units (left axis), respectively. The green curve is their calibrated difference which is a measure of the simulated sample flux (from [1]).*

flux measurement using two DC-SQUID magnetometers. The differential measurement allows for cancellation of background flux signals while enhancing sample signal.

Results and Discussion

The main idea consists of placing a SQUID inside a microwave loop where the sample is to be placed. At the same time, a second SQUID is placed far away (mm scale) ensuring only a background flux detection. The device is discussed in **Figure 4.3.1.12 (left)** that shows SEM images at different scales, down to an individual Josephson junction. The automated feedback measurement protocol is discussed in [1]: a bias current keeps the SQUID at a specified operating point (usually 50% switching probability) thus tracking changes in the loop flux. **Figure 4.3.12 (right)** shows in blue the SQUID bias in the presence of an oscillating flux (that is, the "sample"). At the same time, background flux changes are detected by a second SQUID, in red; their addition (in green) indicates the final measurement.

Conclusions

We have introduced a differential measurement that allows the cancellation of background flux signals while enhancing sample signal. The developed protocol uses a pulsed readout which minimizes on-chip heating since sub-Kelvin temperatures are needed to preserve quantum spin coherence.

Acknowledgements

J.C., G.F.-R. and I.C. thank the support from the National Science Foundation Cooperative Agreement No. DMR-1644779 and the State of Florida. L.C. and Z.W. acknowledge the support from the Frontier Science Key program and the Strategic Priority Research program of the CAS (Grant No. QYZDY-SSW-JSC033, XDA18000000) and the National Science Foundation of China (Grant No. 11827805, 62071458).

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4.3.2 UF – HIGH B/T CMS

4.3.2.1 Coulomb drag of spin-polarized Luttinger liquids at ultra-low temperatures

Kassar, H. (UF, Physics); Cravey, C. (UF, Physics); Gervais, G. (McGill U, Physics) and Laroche, D. (UF, Physics)

Introduction

This study aims to probe 1D Coulomb drag under extreme conditions of both ultra-low temperature and strong magnetic field. Longstanding theoretical predictions concerning 1D drag [1] expect an exponential increase of the drag resistance below a critical temperature T*, owing to the formation of an interlocked charge density wave across the quantum wire pair. This critical temperature is predicted to be strongly enhanced in the spin polarized regime [1]. Prior temperature dependence of 1D Coulomb drag [2] successfully observed an upturn and subsequent increase in the Coulomb drag temperature dependence. However, the minimal electron temperature of ~100 mK was insufficient to establish the functional form of 1D Coulomb drag in the zero-temperature limit. The extreme temperature and magnetic field conditions available at the NHMFL High B/T facilities are expected to enable the experimental confirmation of these longstanding predictions of the Luttinger liquid model.

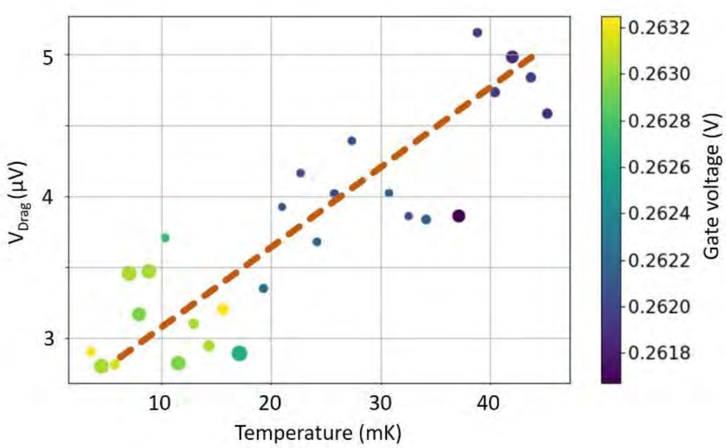

***Figure 4.3.2.1:** Coulomb-induced drag voltage as a function of temperature. Electron temperatures down to ~10mK have been observed. Slow drift in the position of the Coulomb drag features as a function of gate voltage has been monitored over the duration of the measurements (~ days) and can be assessed from the color scale of the data.*

Experimental details

The Coulomb drag experiment is being carried out in the NHMFL High-B/T Facility located at the University of Florida. To reduce electrical noise and improve electron cooling, low-pass filters consisting of 5th order RC filters combined with finite elements filters encased in an RF absorbent were added to the measurement lines and anchored to the mixing chamber of the cryostat. Such filters were previously shown to help achieving sub milli-Kelvin electron temperatures in nanodevices [3]. The initial 1D Coulomb drag measurements will initially be performed in laterally-coupled quantum wires separated by ~150nm. Future studies will also probe vertically-coupled quantum wired where the interwire separation is reduced down to ~15nm. All quantum wires are nanofabricated from high quality GaAs/AlGaAs heterostructures.

Results and Discussion

The preliminary results of this study, realized in the NHMFL High-B/T Facility and shown in **Figure 4.3.2.1.**, showcase our ability to:

i) Resolve 1D Coulomb drag signals in laterally coupled quantum wires.

ii) Cool electrons down to a temperature of ~10mK, nearly one order of magnitude colder than previous studies [2].

On-going efforts focus on reproducing this result in higher quality devices, and extending the temperature range of the measurement up to ~ 1K. Future work will focus on the magnetic field dependence of 1D Coulomb drag, with particular attention devoted to magnetic fields above 8T, where spin polarization is expected to occur in GaAs quantum wires

Acknowledgements

This work was supported by a National High Magnetic Field Laboratory User Collaboration Grant. The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1644779 and the State of Florida.

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4.3.2.2 NMR Study on the One-Dimensional properties of ^{3}He

Adams, J. (UF, Physics); Huan, C. (UF, Physics); Masuhara, N. (UF, Physics); Candela D. (UMass Amherst, Physics); Sullivan, N. S. (UF, Physics)

Introduction

It has long been proposed that one-dimensional (1D) systems should exhibit collective excitations described by the Tomonaga-Luttinger liquid (TLL) theory instead of quasiparticle behavior. Extensive studies on the 1D electronic systems have been conducted, however only limited studies have been carried out for neutral systems. In this study, we used nuclear magnetic resonance (NMR) methods to probe the dynamics of ^{3}He atoms adsorbed in MCM-41. Due to the narrow (<2nm) cross-section of the hexagonal tubes of MCM-41, it was found that the adsorbed ^{3}He atoms show behavior consistent with a 1D system [1]. By studying the adsorbed ^{3}He atoms with NMR, we can compare the dynamics of a 1D neutral system with the prediction of TLL theory [2].

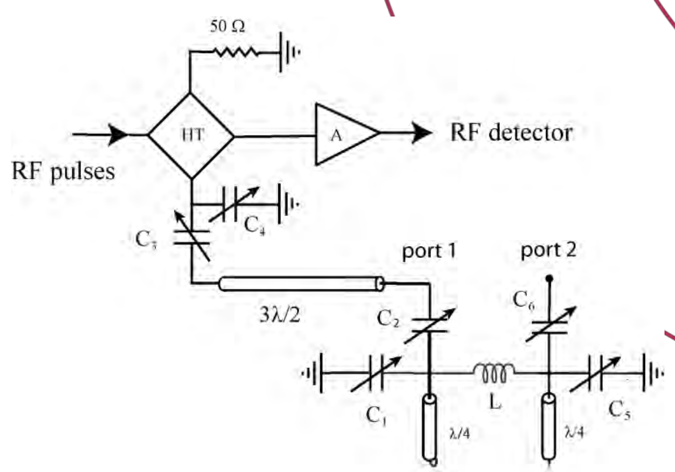

Figure 4.3.2.2: *Schematic view of the RF circuit used in the pulsed NMR experiments. A stripline hybrid tee was used as a RF bridge. Two quarter wavelengths (one shorted, one open) are used to create a two-frequency probe. Only one of the 3/2 lines connecting the low temperature probe to room temperature is shown.* C_1 *and* C_2 *are matching capacitors to tune the resonance frequency and impedance to 160 MHz and match to 50Ω.* C_5 *and* C_6 *provide matching to 49 MHz at port 2.* C_3 *and* C_4 *compensate any changes in impedance during the cool down from room temperature to low temperature.*

Experimental

The experiment was carried out in the Bay 2 of the High B/T facilities of the NHMFL. A polycarbonate cell containing MCM-41 is mounted and thermalized at the bottom of a nuclear demagnetization refrigerator. A homemade NMR spectrometer including a double-tuned probe was employed to make the measurements down to ultra-low temperatures. The measurement circuit is shown in **Figure 4.3.2.2.** In order to better thermalize the adsorbed ^{3}He, fine silver powder was mixed with MCM-41. The MCM-41 was carefully characterized with *in situ* measurements of helium adsorption isotherms and then plated with a monolayer coating of ^{4}He atoms prior to inserting ^{3}He.

Results and Discussion

We measured the temperature dependence of the spin lattice relaxation times (T1) of the ^{3}He in the 1D channels of MCM-41 in a range between 500mK and 3mK. A peak predicted by very general TLL theory was observed at close to twice the Fermi-temperature of the 1D system. The results (currently under review at Physical Review Letters) are in good agreement with TTL predictions provided one also accounts for transverse excitations in the 1D channels.

Conclusions

By measuring the temperature dependence of T_1, we studied the dynamics of a 1D neutral system. The experimental results can be reasonably fitted to a TLL model.

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida. In addition, the project was supported in part by the Collaborative Users Grant Program of the NHMFL.

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4.3.2.3 Thermometers for calorimetry at ultra-low temperatures and high fields

Steinke, L. (NHMFL, High B/T and UF, Physics), Donald, A. M. (NHMFL, High B/T and UF, Physics), Woods, A. J. (NHMFL, High B/T and LANL), Gazizulin, R. (NHMFL, High B/T and UF, Physics)

Introduction

Calorimetric measurements of material properties like specific heat and thermal conductivity can distinguish ground states by measuring entropy or show characteristic fingerprints of exotic quantum materials, e. g. anomalous thermal transport in topological systems. To make these techniques available for user experiments studying quantum materials - typically in the form of mg-sized single crystals – we are developing highly sensitive miniature thermometers that are compatible with the combined extremes of ultra-low temperatures and high magnetic fields at the High B/T facility.

Experimental The thermometers are based on quartz tuning fork (TF) resonators immersed in liquid ^{3}He [1], where the temperature-dependent viscosity of the liquid [2] leads to broadening of Lorentzian resonance curves, and the temperature *T* can be inferred from the measured linewidth. Experiments were conducted using the Bay 3 instrument of the NHMFL High B/T facility at the University of Florida.

Results and Discussion

Figure 4.3.2.3.1 (a) shows resonance curves of the TF response current at various *T*. Panel (b) shows the field-independent calibration constant *a* derived from the current response, indicating that the resonance characteristics are not influenced by an applied magnetic field *B*. Panel (c) shows the linewidth obtained from fits to the resonance curves, for two types of TF used at UF, compared to data from international collaborators. The *T*-dependence above 10 mK is calculated from first principles using a hydrodynamic model derived by Brumley *et al.* [3] (solid lines). In the high viscosity regime below 10 mK, where the viscous mean free path becomes comparable to the tuning fork dimensions, a slip correction based on [4] is adapted to different TF geometries (dashed lines), providing an excellent fit to the data.

Conclusions

We demonstrated reliable tuning fork operation up to 14.5 *T* [5] and developed a semiempirical model to predict resonance characteristics over a wide *T*-range from 1mK to > 100mK

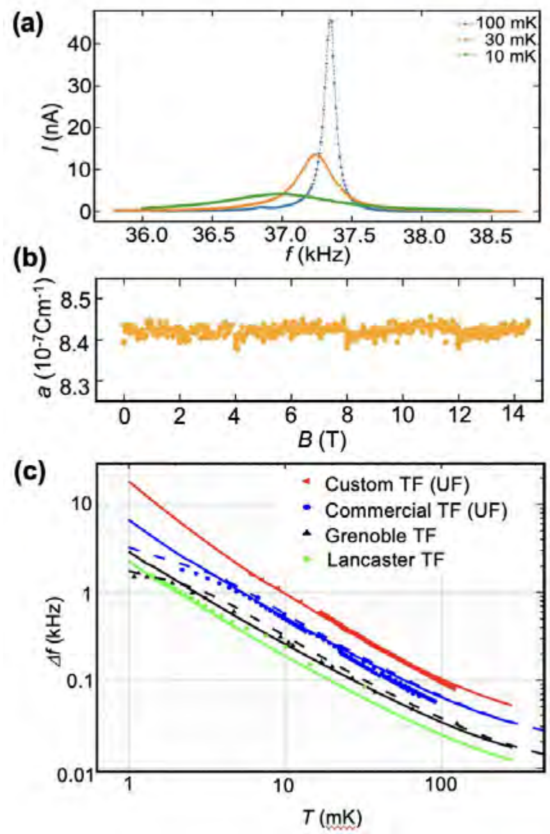

Figure 4.3.2.3.1 *(a) TF resonance curves at various T. (b) B-independent TF constant a. (c) T-dependent resonance width for various TF.*

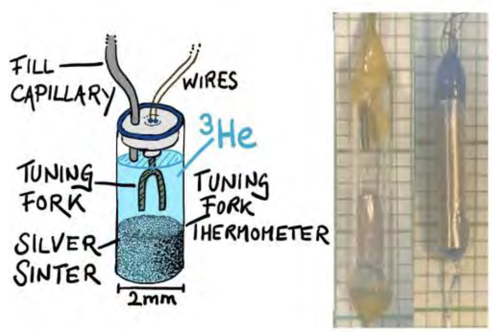

Figure 4.3.2.3.2: *Concept sketch of a miniature TF thermometer with encapsulated 3He volume and photographs of prototypes with a clear quartz body or a silver body.*

(which may remove the need for individual thermometer calibration in the future). We also developed prototype miniature thermo-meters (pictured in **Figure 4.3.2.3.2)** with a small encapsulated ^{3}He volume and low thermal masses suitable as thermal probes for small crystals and are currently testing a first functional prototype.

Acknowledgements

The NHMFL is supported by the National Science Foundation Cooperative Agreement DMR-1644779 and the State of Florida. LS and AD acknowledge support from the NHMFL UCGP program (2021-2022).

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4.3.2.4 Expanded User Access to the High B/T Facility: Opening Additional Bay

Gazizulin, R. (NHMFL, High B/T and UF, Physics); Steinke, L. (NHMFL, High B/T and UF, Physics); Meisel, M.W. (NHMFL, High B/T and UF, Physics)

Introduction

To meet the increasing User demand for efficient characterization of quantum materials and devices relevant to the rapidly emerging field of quantum information science, the High B/T Facility of the MagLab has ordered a nimble, modern cryostat from BlueFors, Inc. The cryostat system is scheduled to be delivered in August 2022 and will be operated in the Microkelvin Laboratory building located on the main UF campus. The presence of this instrument on the UF campus as part of the MagLab High B/T Facility will keep the UF Physics and MagLab communities at the forefront of quantum information and computing research.

Mission

The mission of the High B/T Facility at UF is to provide Users with a safe, diverse, and inclusive atmosphere for performing research in high magnetic fields and at ultralow temperatures with an ultra-quiet electromagnetic interference environment. The name of the facility comes from the ratio B (magnetic field) to T (temperature) which many experiments want to maximize to reach the quantum regime.

History

Starting in 1986, the Microkelvin Laboratory was created by an NSF grant [1] that provided the instrumentation for two Cu demagnetization cryostats which were sited in a new, specialized building provided by funding from UF [2]. This lab building provides the infrastructure for vibration isolation and shielding of electromagnetic interference necessary to attain world-class ultra-low temperature environments where fundamental quantum interactions can be studied. The high magnetic fields are used for demagnetization refrigeration and for high magnetic fields that experiments require.

Since the building was designed with three bays and two were used for the initial instruments, the third bay was funded in 1990 [3] and became operational in 1994 [4]. In 2006, one of the original instruments became part of the MagLab funded operations, and in 2019, the MagLab and UF Office of Research dedicated funding for the expanded operations described in this report.

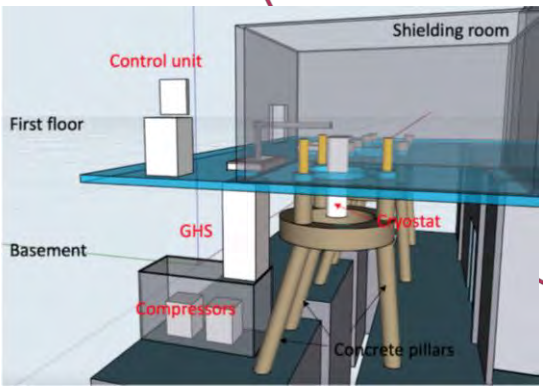

Figure 4.3.2.4: *Redesigned lab space and new instrument. The cryostat will be housed in a shielding room on a table supported by three concrete pillars. The control unit will be located on the first floor of the building outside the shielding room. The Gas Handling System (GHS) will be installed on top of the compressor house in the basement.*

Experimental Designs and Capabilities

By removing one of the initial cryostats built in the late 1980s, the BlueFors system will be sited in an existing shielding room, **Figure 4.3.2.4.** The modern system belongs to a new generation of dilution cryostats which do not require a liquid helium bath because cooling from room temperature to 3K is provided by a pulse-tube cooler.

This cryogen-free ("dry") technology affords independence from liquid helium supply and faster turn-around time to change experiments. Specifically, automated cool-down operation of about 8 hours will significantly enhance the capabilities of the High B/T Facility, especially with respect to quantum materials and computing experiments requiring ultra-low temperatures, high magnetic fields, and rapid characterization of multiple devices.

The large sample space will allow for quantum materials to be integrated into complex measurement configurations and quantum computer layouts. The design and fabrication of these unique experimental setups is made possible by access to the expertise and resources available in the UF Physics instrument, electronics, and cryogenics shops, which are partners in both the education and research missions.

Acknowledgements

The MagLab is supported by the National Science Foundation Cooperative Agreement DMR-1644779 and the State of Florida. Specifically, this expansion is made possible by shared investments by the MagLab and the UF Office of Research. RG: orcid.org/0000-0002-4874-4610, LS: orcid.org/0000-0002-4041-2902, MWM: orcid.org/0000-0003-4980-5427.

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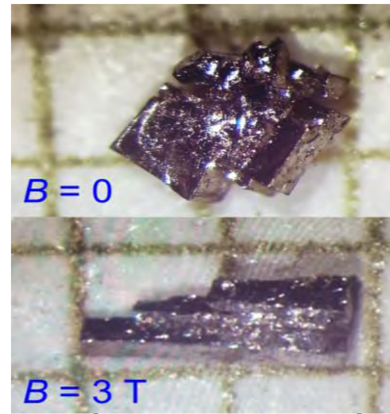

Figure 4.3.2.5.2: *Single crystals of Co metal grown from a Co-S flux. Those grown without an applied field (top) have cubic and block-like morphologies. Those grown in 3T (bottom) are elongated and appear as square rods. Grid squares are 1mm x 1mm.*

4.3.2.5 A Simultaneous High Temperature and High Magnetic Field Furnace for Advanced Materials Synthesis and Processing

Steven Flynn (UF, Physics), Michael E. Bates (UF, Physics), Jared Lee (UF, Physics), Michael R. Tonks (UF, MSE), Michael S. Kesler (ORNL, MST), Michele V. Manuel (UF, MSE), Victoria M. Miller (UF, MSE), Mark W. Meisel (NHMFL, High B/T and UF, Physics), James J. Hamlin (UF, Physics)

Motivation

The application of magnetic fields during materials synthesis and processing has recently produced promising effects on the product properties. Heat treatments in high magnetic fields have been reported to result in enhanced kinetics [1], improved mechanical properties [1], shifting phase equilibria [1,2], or even highly altered quantum states [3]. The underlying physical processes responsible for these effects, as well as the opportunities for materials design and discovery they offer, remain largely underexplored. A critical obstacle to developing this understanding is the lack of instrumentation which can perform a controlled experiment over a wide range of both field and temperature. To address this need, we have developed a maximum 1200°C furnace insert for a 400MHz NMR (9.4T), 89mm bore superconducting magnet from the High B/T NHMFL facility located at the University of Florida.

Design Description and Status

Design and construction of the furnace is complete. The system can heat to 1200 °C for short periods of time or 1050°C for indefinite dwells and can apply magnetic fields from -9T to 9T. The cryogen-immersed magnet is protected from stray heat from the furnace by our custom designed and manufactured cooling jacket insert **(Figure 4.3.2.5.1),** which holds the furnace plus additional ceramic insulation. Cooling water is supplied to the insert via a custom cooling water manifold that splits the flow into 8 to ensure uniform cooling within the jacket. Samples are held in the furnace by a baffle that is inserted from the bottom and locked in place with the mounting ring **(Figure 4.3.2.5.1)**. The furnace height within the magnet is fixed using a custom-made adjustable clamp **(Figure 4.3.2.5.1),** allowing samples to be heated under both maximum applied field and maximum field gradient conditions.

A programmable temperature controller and built-in safety monitoring allow for long-term unsupervised operation. The safety measures include pressure, flow, and temperature

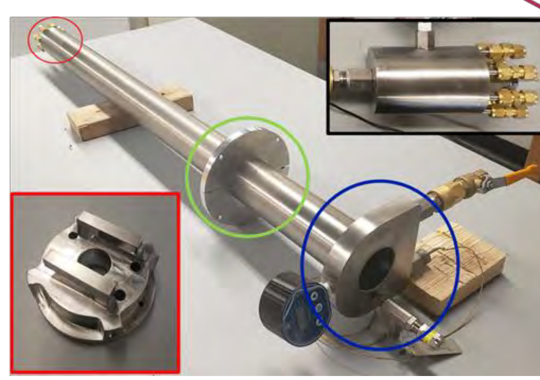

Figure 4.3.2.5.1: *Fully assembled insert of the 1200°C resistively-heated 9T system. Blue, red, and green circles respectively indicate the top flange, mounting ring, and adjustable clamp. (Insert, bottom left) Close-up of the mounting ring when removed from the cooling jacket. (Insert, top right) Cooling water manifold with ¼" union fittings attached.*

probes in the cooling water, as well as overpressure protection. Our custom program logs data and will abort an experiment in the case of an abnormal condition.

Initial magnetothermal experiments with this system are underway. The high Curie temperature of Co (1115°C [6]) means that single crystals may be grown out of a molten flux directly in the ferromagnetic state, where the effect of an applied field will be maximized. Crystals grown in this manner at both B = 0 and 3T show a clear morphological dependence on the presence of an applied field, as depicted in **Figure 4.3.2.5.2**. Ongoing work aims to determine the effect of these differences on properties.

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida. Furnace development and assembly is supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under the Advanced Manufacturing Office award number DE-EE000913.

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4.3.3 LANL-PFF CMS

4.3.3.1 Scale-invariant magnetic anisotropy in RuCl3 at high magnetic fields [1]

K. A. Modic; Ross D. McDonald; J. P. C. Ruff; Maja D. Bachmann; You Lai; Johanna C. Palmstrom; David Graf; Mun K. Chan; F. F. Balakirev; J. B. Betts; G. S. Boebinger; Marcus Schmidt; Michael J. Lawler; D. A. Sokolov; Philip J. W. Moll; B. J. Ramshaw; Arkady Shekhter

Introduction

RuCl3 is a spin-1/2 antiferromagnetic insulator where Ru-ion spins form a layered honeycomb lattice, similar to that of carbon in graphite. This system has come into research focus after it has been pointed out [2] that the Ru-Ru exchange tensor might be highly anisotropic --- due to interference between equivalent exchange paths in the edge-sharing ligand environment --- thus possessing some of the key aspects of the well understood Kitaev Hamiltonian, such as chargeless Majorana excitations [3]. RuCl3 does exhibit a range of anomalous behavior, such as unusual spectrum of spin excitations as reveled by neutron scattering [4]. Whether the physics of RuCl3 (and related materials such as NaIr03 or a family of 3D-honecombs LiIr03) overlaps---in detail, or in quality—with that of the Kitaev model is an interesting possibility. Regardless, exploring the effect of strong spin-anisotropic exchange on magnetic behavior of this spin system deserves careful experimental attention.

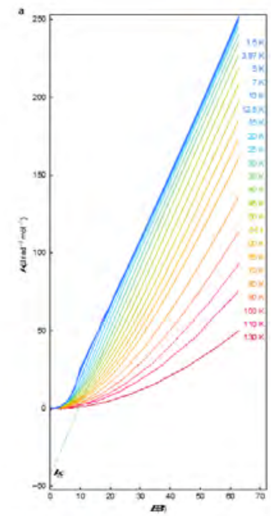

Figure 4.3.3.1: Magnetic field dependence of the magnetotropic susceptibility in a broad range of temperatures. The scale-invariant form of the dependence of the magnetotropic susceptibility on magnetic field and temperature indicates vanishing intrinsic energy scale.

Experiment, Results and Discussion

To explore the physics of RuCl3 we have studied magnetotropic susceptibility [1,5,6] (the thermodynamic coefficient associated with the rotation of the sample in external magnetic field) of a sub-microgram mass sample in a broad range of magnetic fields and temperatures. The conclusions reported in the paper are drawn from a set of measurements in both DC and pulsed magnet systems. Our magnetic field dependence measurements in the pulsed magnet system up to 65T **(Figure 4.3.3.1])** reveal a strikingly simple field-temperature dependence of the magnetic part of the free energy, reminiscent of the free (non-interacting) spins in an anisotropic g-factor environment. Such behavior

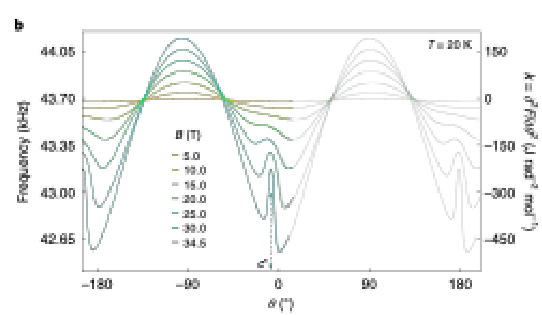

Figure 4.3.3.2 Angular dependence of magnetotropic coefficient showing high-field singularity along c axis. The singularity indicates a large exchange interaction energy in RuCl3*

is not expected in a conventional spin system with strong exchange interaction – or for that matter in a Kitaev's model at strong magnetic fields. Our extensive angular dependence measurements of magnetotropic coefficient in the DC magnet system up to 35T **(Figure 4.3.3.2)** reveal the behavior that is inconsistent with the non-interacting-spins picture. Instead, it reveals large spin-anisotropic exchange interaction. This tension between naïve interpretation of the field- and angular dependence of the magnetotropic susceptibility (and the magnetic part of the free energy) is our main experimental result.

A distinct characteristic of the free energy of an isolated spin in external magnetic field is its scale-invariance: there is no intrinsic energy scale characteristic of the spin itself, other than those introduced by temperature and external magnetic field. One peculiar aspect of the Kitaev model is that exchange interaction tensor has only one non-vanishing exchange component. This introduces degeneracy of a macroscopic fraction of many-body spin states, which within the Kitaev's model is resolved into a peculiar ground state with fractionalized excitations. This degeneracy can be thought of as vanishing of a certain intrinsic energy scale which otherwise would be responsible for lifting the degeneracy. Our measurement shows that in broad range of magnetic fields the magnetic free energy of RuCl3 is characterized by a vanishing intrinsic energy scale. Whether the degeneracy associated with this behavior is rooted in the Kitaev-like physics or is a more generic result of strong correlations remains an open question.

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida.

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[4] Ref. 8 in [1]

[5] Ref 30 in [1]

[6] K. Modic et. al., unpublished

4.3.3.2 Magnetic phase diagram of Ba2FeSi2O7: a quasi-two-dimensional square lattice Heisenberg antiferromagnet with a strong uniaxial magnetic anisotropy

Lee, Minseong (LANL, MPAMAG); Schoenemann, Rico (LANL, MPAMAG); Zhang, Hao (U. of Tennessee, Physics); Jang, Tae-Hwan (Postech, Physics, Korea); Cheong, Sang-Wook (Rutgers U., Physics); Park, Jae-Hoon (Postech, Physics, Korea); Brosha, Eric (LANL, MPAMAG); Jamie, Marcelo (LANL, MPAMAG); Batista, Cristian D. (U. of Tennessee, Physics); and Zapf, Vivien S. (LANL, MPAMAG)

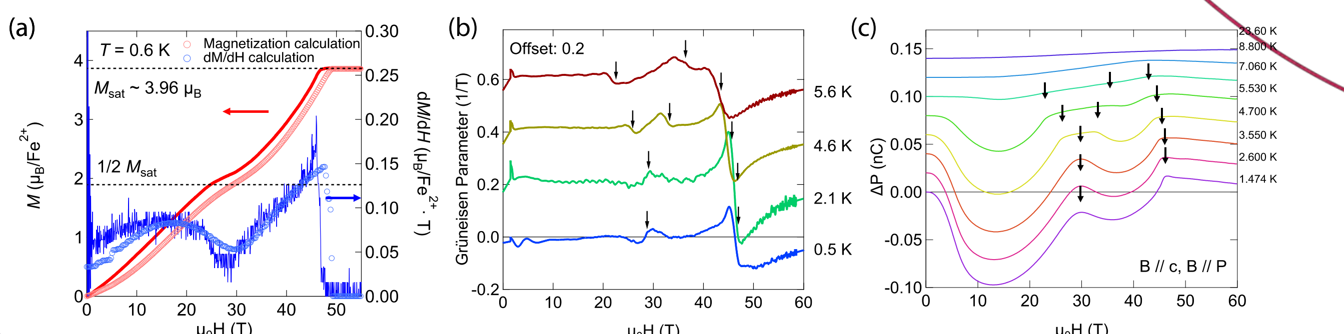

Figure 4.3.3.3.1: *(a) High field magnetization and theoretical calculation. (b) Grüneisen parameter extracted from the magnetocaloric effect under high magnetic field. (c) Polarization a long c-axis as a function of magnetic field.*

Introduction

The quantum model of Heisenberg square lattice antiferromagnets is an important paradigm of low dimensional magnetism because the quantum fluctuations characterize the magnetic ground states. Quantum magnets with a strong magnetic anisotropy provide great testbeds to investigate exotic phase transitions and magnetic versions of atomic physics phenomena such as quantum critical points of magnetic Bose-Einstein condensates and magnetic supersolid phase [1]. Here, we study the magnetic and electrical properties of $Ba_2FeSi_2O_7$ (S = 2) with strong easy-plane anisotropy [2] using a magnetic field along the uniaxial direction, which is perpendicular to the plane. We map out the low-temperature magnetic phase diagram of $Ba_2FeSi_2O_7$ that contains two dome multiferroic phases.

Experimental

We measured high-field magnetization, magnetocaloric effect measurements, and electric polarization using a 65T pulsed field magnet at LANL.

Results and Discussion

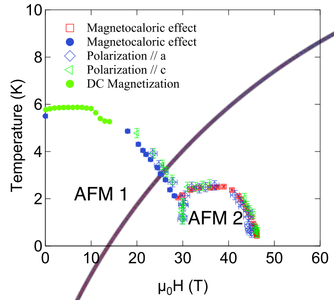

Figure 4.3.3.4.2: Magnetic field vs. temperature phase diagram of the title.

We present experimental data of magnetization along with theoretical calculation results at 0.6K in **Figure 4.3.3.5.1 a)**. It shows sharp saturation around 48T with $3.96\mu_B/Fe^{2+}$ and a notable plateau around 30T whose magnetization is close to ½ saturation value. Our theoretical calculations [3] describe the magnetization process very well. **Figure 4.3.3.6.1 b)** shows the Grüneisen parameter calculated from the sample temperature change due to the magnetocaloric effect at various temperatures. We found the single magnetic phase transition at very low temperatures around 30T, which splits into two transitions with increasing temperature. This transition is consistent with the magnetic plateau observed in magnetization. At saturation, we observe the strong sign change in the Grüneisen parameter which indicates the existence of a quantum critical point. Lastly, we measured the polarization along the c-axis under the magnetic field. The clear polarization changes accompanying the magnetic phase transitions as shown in **Figure 4.3.3.7.1 c)** demonstrate the magnetoelectric and multiferroic properties of this compound. A magnetic field versus low-temperature phase diagram was constructed by combining the data as shown in **Figure 4.3.3.8.2**. We observed two magnetic phases in addition to the paramagnetic phase: AFM1 and AFM2. The AFM 1 state is the result of the strong mixture of S_z=|±1> and S_z= |0> state and Sz= |0> is placed at the lower energy state since the system has the strong easy-plane anisotropy. As the field increases, the spin states at higher energy lower their energy due to the Zeeman energy. Around the plateau, S_z=|1> state becomes dominant— thus the spin state becomes paramagnetic, showing the half-plateau feature in magnetization curves. Qualitatively, AFM1 and AFM2 phases are similar as the AFM2 state is formed by the S_z = |2> and S_z = |1> state.

Conclusions

In this study, we observe the two magnetic phases that have antiferromagnetic long-range ordering with spin canted along the c-axis. Both magnetic phases accompany the electric polarization, which strongly indicate possible multiferroic phases. Spectroscopic measurements that directly probe the spin level crossings are desired. More intriguing optical phenomena such as directional dichroism and magnetochiral effect will be also very interesting studies on this material.

Acknowledgments

This work was performed at The National High Magnetic Field Laboratory supported by the National Science Foundation through NSF/DMR 1157490/1644779 and the State of Florida. This work is also supported by the U.S. Department of Energy, Office of Science, National Quantum Information Science Research Centers.

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4.3.3.3 Direct Observation of Carrier Cyclotron Resonance in a Superconducting Cuprate via THz Spectroscopy in Pulsed Magnetic Fields

Post, K. W., Rickel, D. G., Singleton, J., McDonald, R. D., Crooker, S. A. (NHMFL-LANL); He, X., Xu, X., Shi, X., Bozovic, I. (Brookhaven National Lab)); Legros, A., Armitage, N. P. (Johns Hopkins)

Introduction

The renormalization of effective electronic masses in materials is a consequence of electron-electron (*e-e*) and electron-lattice interactions. However, precisely how this renormalization manifests depends on the particular measurement. Angle-resolved photoemission, quantum oscillation studies in high magnetic, and heat capacity all measure masses that reflect the renormalized quasiparticle dispersion. In contrast, susceptibility or compressibility measurements are sensitive to *e-e* correlations but not electron-phonon renormalizations. In this regard, cyclotron resonance (CR) experiments merit special consideration. Famously, Kohn showed that in Galilean invariant systems, CR reveals a cyclotron mass $mc = eB/\omega c$ (where ωc is the cyclotron frequency) that is *un*affected by *e-e* interactions. The key point is that *e-e* correlations can influence effective masses measured by CR very differently in comparison to other experimental methods.

In the high-temperature superconducting cuprate (HTSC) materials, many transport, spectroscopic, and thermodynamic studies have pointed to heavy carrier masses (~ 1–10m_0, where m_0 is the bare electron mass), that tend to increase near optimal doping, likely due to *e-e* interactions. As such, CR studies can complement existing methods and help to disentangle the role of electronic correlations in HTSCs. However, direct detection of CR in HTSCs has proven challenging because heavy masses mean that cyclotron shifts will be small (<30GHz/T). Additionally, scattering times even in high-quality samples are short, typically <1ps, so that the low-frequency Drude conductivity peak has a broad linewidth >1THz. Based on these considerations, it is clear that high magnetic fields (tens of teslas) are needed to make ω_c sufficiently large that a cyclotron shift of the broad Drude peak can be resolved.

Experiment, Results and Discussion

To this end, we combined THz time-domain spectroscopy (THz-TDS) with a purpose-built 20kJ capacitor bank and small table-top 31 T pulsed magnet **(Figure 4.3.3.3 a)** to reveal CR of carriers in the normal state of an optimally-doped $La_{1.84}Sr_{0.16}CuO_4$ thin film [1]. Both real and imaginary components of the complex optical conductivity are measured, using photoconductive antennas and ultrafast optical methods based on electronically-controlled optical sampling (ECOPS). The field dependence of the circularly polarized complex optical conductivity reveals a shift of the Drude conductivity peak that is consistent with CR, which directly reveals a hole mass m_c = 4.9 ± 0.8 m_0. These studies represent the first direct measurement of CR in a cuprate superconductor, and the first measurement of cyclotron mass in LSCO.

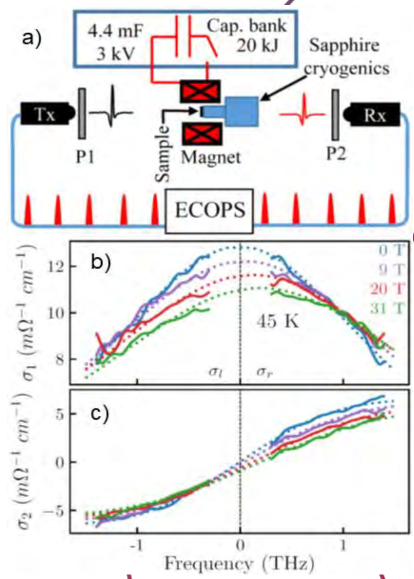

Figure 4.3.3.3: a) Broadband THz spectroscopy in a tabletop 31T magnet. b,c) Cyclotron shift of the real and imaginary optical conductivity reveals a CR shift and therefore the mass of holes in optimally-doped LSCO.

Acknowledgements

The NHMFL is supported by the National Science Foundation through NSF/DMR-1644779 and the State of Florida.

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4.3.3.4 Effects of Structural Instability on Superconductivity in Superhydride

Sun, D., Mozaffari, S., Balicas, L., Balakirev, F.F (NHMFL, USA), Minkov, V. S., Eremets, M. E (MPI for Chemistry, Germany), Chariton, S., Prakapenka, V. B. (U. of Chicago, USA), Sun, Y., Ma, Y. (Jilin U., China)

Introduction

The discovery of high temperature superconductivity in hydrogen-rich materials revolutionized the search for room-temperature superconductors with conventional phonon-mediated mechanism [1,2]. The role of crystal lattice is one of the key questions in understanding their high-temperature superconductive properties. The structural instabilities that lead to the phonon softening and the enhancement of electron-phonon coupling are particularly important.

Experimental

We synthesized the superconducting sample of LaH_{10} in a miniature diamond anvil cell (DAC) **(Figure 4.3.3.4 a, inset)** [3]. The DAC fit the bore of high field DC and pulsed magnets and allows for electrical transport, X-ray diffraction and spectroscopic measurements. The sample was contacted via gold leads for four-probe electrical transport measurements. The sample crystal structure was characterized by X-ray diffraction at the Advanced Photon Source (APS). Magnetotransport measurements under high magnetic fields were conducted in the 45T hybrid magnet and in the 65T pulsed magnet at the NHMFL.

Results and Discussion

We observed a sharp change in the pressure dependence of the superconducting transition temperature (T_c) **(Figure 4.3.3.4 a)**. The change was linked to the pressure-induced *Fm-3m – C2/m* structural transition in the sample. We established key superconducting quantities of superhydrides under high magnetic fields **(Figure 4.3.3.4 b-c)**, including upper critical fields and coherence lengths and find a remarkable correlation between superconductivity and a structural instability indicating that lattice vibrations, responsible for the monoclinic structural distortions in LaH_{10}, strongly affect the superconducting coupling. A likely mechanism for the structural instability is phonon softening associated with a gradual distortion of the lattice, which boosts electron-phonon coupling constant and re-normalizes the Fermi velocity, leading to increase in T_c.

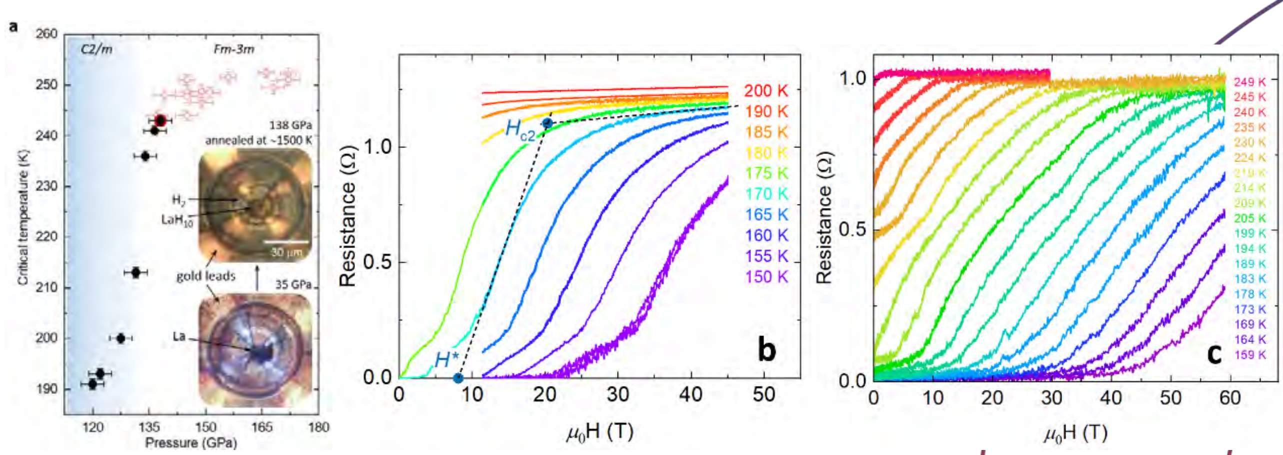

*Figure 4.3.3.4: **a,** Pressure dependence of T_c in LaH_{10}. Inset: La precursor before synthesis (35GPa) and synthesized LaH_{10} sample (135GPa). **b,** Magnetoresistance measurements detect the upper critical field (Hc2) and the irreversibility field (H*) in LaH_{10}. DC field measurements in the C2/m phase of LaH_{10} at 120GPa. **c,** Pulsed field measurements in the Fm-3m phase at 136GPa. Both DC and pulsed field traces were recorded under isothermal conditions with no observation of eddy-current generated Joule heating due to the sweeping of the field.*

Acknowledgements

The NHMFL is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida. APS is a U.S. Department of Energy (DOE) Office of Science User Facility operated for the DOE Office of Science by Argonne National Laboratory under Contract No. DE-AC02-06CH11357. This research is supported by the National Science Foundation-Earth Sciences (EAR-1634415) and Department of Energy-GeoSciences (DE-FG02-94ER14466). L. B. is supported by the Department of Energy, Basic Energy Sciences through award DE-SC0002613. M.I.E acknowledges great support from the Max Planck Society.

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4.3.3.5 Magnetoelastic Standing Waves Induced in UO_2 by Microsecond Magnetic Field Pulses

Schönemann, R., Rickel D., Balakirev, F., McDonald, R.D., Evans, J.A., Maiorov, B., Salamon, M.B., Stier A.V., and Jaime, M. (MPA-MAGLAB, LANL); Rodriguez, G. (LANL); Paillard, C. (CNRS, Universite Paris-Saclay); Bellaiche, L. (University of Arkansas); Gofryk, K. (Idaho National Lab.)

Introduction

UO_2 is a material of interest due to its use as a nuclear fuel in 90% of power reactors, its unusually poor thermal conductivity, and its uniquely strong magnetoelastic properties characterized by a linear coupling between strain and magnetization. This research reveals for the first time mechanical standing waves and elastic resonances in a single crystal, induced by microsecond field pulses to 150T [1]. The phase and amplitude of the resonances are modulated by the piezomagnetic switching behavior, offering a sensitive probe for hard-to-detect magnetic dynamics in UO_2.

Experimental

This work features axial magnetostriction data obtained with an optical interferometry technique based on fiber Bragg gratings inscribed in the core of single-mode optical fibers and a 100MHz coherent pulse interrogation method. The ultrahigh magnetic

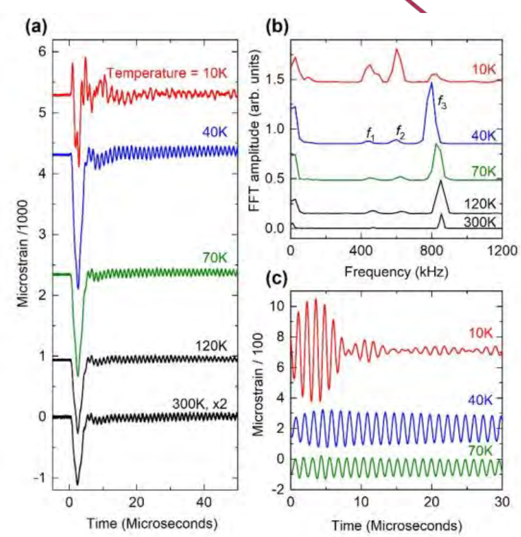

*Figure 4.3.3.5: **(a)**. Axial magnetostriction of UO_2 along the [111] crystallographic direction vs time. The minimum at approx. 2s corresponds to peak field of 150T. **(b)** Fast Fourier transform (FFT) of the magnetostriction data. **(c)** Experimental data after band-pass filter used.*

field pulses were produced by a capacitor-bank driven single-turn-solenoid resistive magnet at the NHMFL Pulsed Field Facility at Los Alamos National Laboratory.

Results and Discussion

We show that in microsecond timescales, pulsed-magnetic fields excite mechanical resonances in the range of 400kHz to 900kHz at temperatures ranging from 10 to 300K, in the paramagnetic as well as within the robust antiferromagnetic state of the material **(see Figure 4.3.3.5)**. These resonances, barely attenuated within the 100-µs observation window, are attributed to the strong magnetoelastic coupling in UO_2 combined with the high crystalline quality of the samples. The phase and amplitude of the mechanical resonances are modulated by the piezomagnetic switching behavior, offering a sensitive probe for otherwise hard-to-detect magnetic dynamics in UO_2. We highlight the importance of magnetic domains in the attenuation of the mechanical resonances and the robustness of the antiferromagnetic state against externally applied magnetic fields to 150T.

Conclusions

We show that UO_2 is an interesting candidate for fast magnetoelastic transducers. We demonstrate in our theory modeling that the reversal of the AFM order, $L_0 \rightarrow -L_0$, due to the piezomagnetic switching leads to a π phase shift in the standing waves and report a distinct mode dependent attenuation of the mechanical resonances. Our findings present a way to study magnetic dynamics in high magnetic fields and will most likely have an impact on the interpretation of past and future data collected in experiments involving semi destructive pulsed magnetic fields.

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida. R.S. acknowledges support by the G. T. Seaborg Institute under Project 20210527CR and the NHMFL User Collaboration Grants Program. C.P. and L.B. acknowledge the ARO Grant No. W911NF-21-1-0113 and the Vannevar Bush Faculty Fellowship (VBFF) Grant No. N00014-20-1-2834 from the US DoD. K.G. acknowledges support from the US DOE Early Career Research Program and US DOE BES Energy Frontier Research Center "Thermal Energy Transport under Irradiation". M.J. acknowledges support from the US DOE BES center "*Science at 100T*". M.J. and G.R. acknowledge support from the LANL Institute for Materials Science.

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4.3.3.6 Pulsed-field Magnetometry of Plutonium

John Singleton, Mark Wartenbe, Laurel Winter, Paul Tobash and Neil Harrison
National High Magnetic Field Laboratory Pulsed-Field Facility, MPA-MAGLAB, Los Alamos, NM 87545, USA

Introduction

Plutonium (Pu) is positioned at a large volume discontinuity between lighter and heavier elements in the actinide series of the Periodic Table; it is also unique amongst the elements in exhibiting six different crystallographic phases at ambient pressure. Coulomb interactions are known to be important for stabilizing the largest volume δ phase of Pu. Such interactions are expected to produce localized 5*f* electrons and consequent magnetism, yet at low temperatures there is little or no evidence for magnetic moments. In an effort to shed light on these apparent contradictions, magnetization measurements in fields of up to 55T and temperatures from 1.5 to 300K have been carried out on the α and δ phases of Pu, the latter being stabilized to low temperatures by small quantities of Ga.

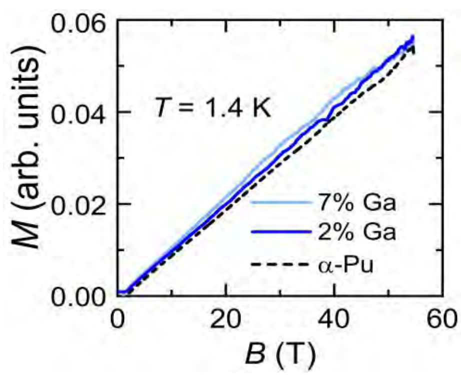

Figure 4.3.3.6: Example of raw magnetization data for two Ga-stabilized δ-Pu samples and a pure α-Pu sample in pulsed magnetic fields at T = 1.4K. For ease of comparison, all samples were cut to have almost identical volumes. The similarity of the signals provides evidence for a dominant Van Vleck contribution [1].

Experimental

Pu is a high consequence material; hence, precautions must be taken to prevent its escape into the experimental system or surrounding environment. A LANL pulsed-field extraction magnetometer was adapted for the experiments by replacing the standard Delrin sample ampoules (1.3mm outer diameter, 1mm inner diameter) with ones made from titanium (Ti) grade 5. The Ti ampoules are sealed using a metal frit, allowing exchange gas or liquid to cool the Pu sample inside but preventing the escape of contamination.

Initial tests of the Ti ampoules were carried out using crystals of an organic multiferroic compound that exhibits sharp metamagnetic transitions with very strong temperature dependences. It was found that heating of these crystals due to eddy currents induced in the Ti by the rapidly changing pulsed field was negligible. Spurious features due to Ti's superconducting state at temperatures < 1.5K were easily removed by subtracting data taken from an identical empty Ti ampoule.

The experiments were carried out using a standard LANL 65T pulsed magnet. The highest field allowed was 55T, representing around 72% of the maximum design stress (NB, in over 15 years of service, this type of magnet has never failed at 55T). Additional protection of the Pu samples is provided by the metal tails of the helium cryostat and sheath around the probe.

Results and Conclusion

At all measurement temperatures, the magnetization shows no significant departures from linearity in fields of up to 55T **(Figure 4.3.3.6)**. This, and the small size of the observed sample moment, are evidence that a Van Vleck contribution dominates. Taken in conjunction with high-precision heat-capacity data, these results suggest that a robust pseudogap state is present in Pu [1].

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida. Funding was also provided by Los Alamos National Laboratory LDRD Project No. XWPF. High magnetic field measurement techniques are underwritten by DOE Basic Energy Science project "Science of 100 tesla."

Reference

[1] *Pseudogap in elemental plutonium*, Mark Wartenbe, Paul H. Tobash, John Singleton, Laurel E. Winter, Scott Richmond, and Neil Harrison, PHYS. REV. B 105, L041107 (2022).

4.3.4 FSU THEORY

4.3.4.1 Approaching the Mott transition: theory vs. experiment

Vladimir Dobrosavljevic (FSU/Physics- MagLab). These studies were done in collaboration with several experimental groups, also involving FSU graduate student Yuting Tan, who carried out most theory calculations, together with the PI.

Introduction

The Mott metal-insulator transition (MIT) stands out among the key unresolved phenomena in interacting electron systems. At low temperatures magnetic instabilities typically mask the Mott MIT; the antiferromagnetic ground state dominates the low-energy excitations. To circumvent this problem, we study Mott insulators that are currently under scrutiny for their quantum spin liquid ground state (QSL) as a result of large geometrical frustration. The absence of anti-ferromagnetism enables us to investigate the genuine Mott state down to T $\rightarrow$ 0, and in doing so to test various theoretical ideas and scenarios. This program was carried out in several systems that display Mott-like physics in absence of magnetic order, where we show that most experimental features can be described, in surprising detail, within appropriate applications of Dynamical Mean-Field Theory (DMFT).

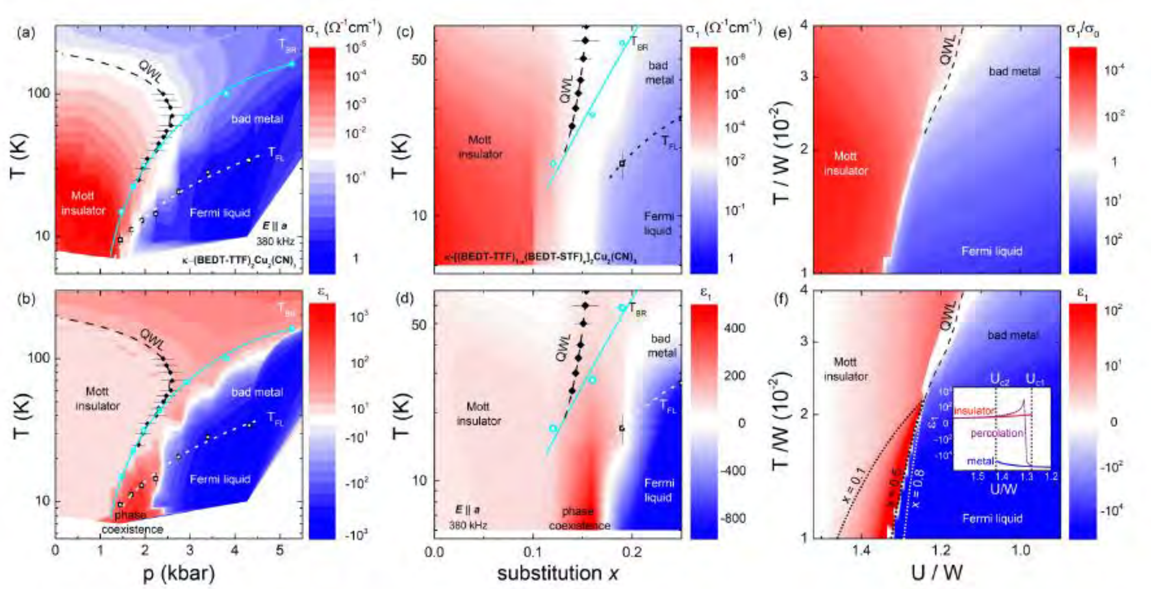

Figure 4.3.4.1.1: Phase diagram of kappa-(BEDT-TTF)$_2$Cu$_2$(CN)$_3$ when tuned through the Mott MIT [1] by physical pressure (a,b) or chemical substitution (c,d), compared with hybrid DMFT calculations as a function of correlation strength U=W (e,f

Inhomogeneous Electronic states in spin-liquid Mott organics materials

Coulomb repulsion among conduction electrons in solids hinders their motion and leads to a rise in resistivity. A regime of electronic phase separation is expected at the first-order phase transition between a correlated metal and a paramagnetic Mott insulator but remains unexplored experimentally as well as theoretically nearby $T = 0$. We approach this issue [1,2] by assessing the complex permittivity via dielectric spectroscopy, which provides vivid mapping **(Figure 4.3.4.1.1)** of the Mott transition and deep insight into its microscopic nature. Our experiments utilizing both physical pressure and chemical substitution consistently reveal a strong enhancement of the quasi-static dielectric constant ε_1 when correlations are tuned through the critical value. All experimental trends are captured by dynamical mean-field theory of the single-band Hubbard model supplemented by percolation theory **(Figure 4.3.4.1.2).** Our findings suggest a similar 'dielectric catastrophe' in many other correlated materials and explain previous observations that were assigned to multiferroicity or ferroelectricity. Results further confirming this physical picture were obtained from complementary experimental and theoretical studies of the optical conductivity on the metallic side, as reported in Ref. [3].

Acknowledgements

Work in Florida (V. Dobrosavljevic and Yuting Tan) was supported by the NSF Grant No. 1822258, and the National High Magnetic Field Laboratory through the NSF Cooperative Agreement No. 1644779 and the State of Florida.

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4.3.4.2 Cascades between light and heavy fermions in the normal state of magic angle twisted bilayer graphene

Jian Kang (NHMFL→ Soochow U.), B. Andrei Bernevig (Princeton U.) and Oskar Vafek (NHMFL)

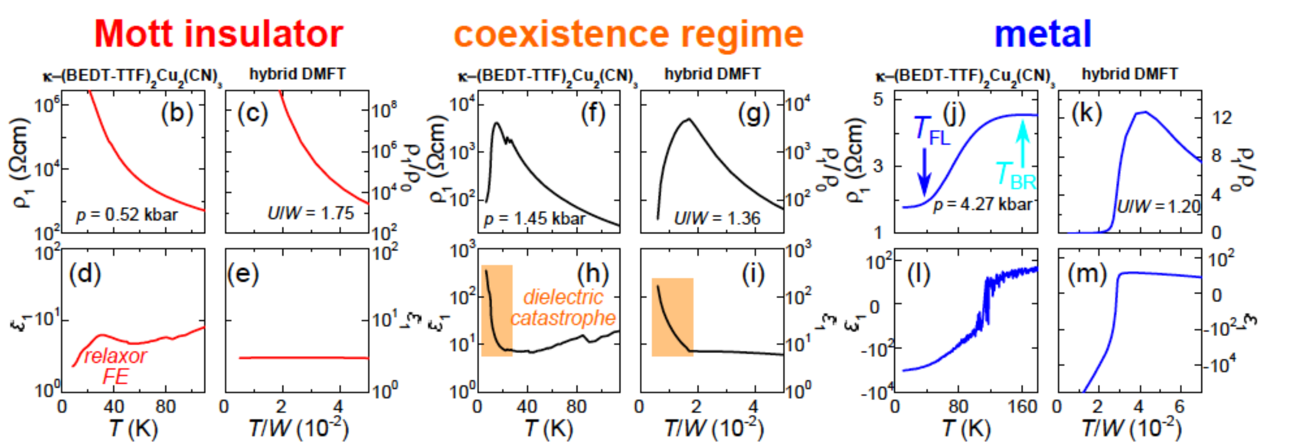

Figure 4.3.4.1.2: The Mott-insulating state (b-e) yields thermally activated resistivity and small, positive values of the dielectric permittivity. While the permittivity indicates a reduction with cooling when metallic clusters percolate is strongly increased upon entering the metal-insulator phase coexistence region (f-i). In contrast, the correlated metallic state (j-m) in the heavy quasiparticle regime exhibits Fermi-liquid properties with a quadratic temperature dependence of the resistivity at low temperatures, accompanied by large negative values of the dielectric permittivity [2].

Introduction

The discovery of the correlated insulating phases and superconductivity in the magic-angle twisted bilayer graphene has generated a flurry of experimental and theoretical research activity. This remarkable system exhibits correlated insulating phases at integer fillings of narrow bands, a hallmark of strong coupling physics. Away from certain integer fillings, the same system becomes superconducting below a sufficiently low temperature, descending from a normal state exhibiting Fermi liquid-like quantum oscillations, both hallmarks of charge itineracy.

Recent observations of the cascade transitions in the compressibility and scanning tunneling microscopy studies at temperatures above the full onset of insulation or superconductivity have further sharpened this dichotomy. On the one hand, clear features associated with an integer filling of the moiré unit cell were observed as expected in strong coupling. On the other hand, the electron system appears highly compressible when integer filling is approached from the charge neutrality point side—even with negative compressibility—and much less compressible when approached from the remote bands side, producing sawtooth features in the inverse compressibility vs filling plots.

Here, we developed theoretical framework for understanding the cascade transitions and the Landau level degeneracies of twisted bilayer graphene. We show that the nontrivial narrow band topology and geometry combined with Coulomb interaction can drive the itineracy of the single particle charge excitations near the integer filling even in strong coupling, when the non-interacting kinetic energy of the narrow bands is entirely neglected.

Methods of Theoretical Studies and Results

We find that the band dispersion of a single particle or a single hole added to the strong coupling phases at a non-zero integer n is highly asymmetric **(see Figure 4.3.4.2)**. If the excitation moves n closer to (away from) the charge neutrality point, it is heavy with a narrow bandwidth (light with a large bandwidth). The light mass excitations have a minimum at the center of the Brillouin zone and a smaller degeneracy than the heavy ones, whose minima are away from a high symmetry **k**-point.

At a finite density away from an integer n, the single particle excitations repel each other. By estimating the ratio of the residual interaction to the kinetic energy obtained by filling the new (non-rigid) bands, the system on the small mass side is a Fermi liquid. The mass compares favorably with experiments. On the heavy mass side, we found several nearly degenerate states that are related by many particle-hole excitations, suggesting that there, the residual interactions lead to additional instabilities of a heavy Fermi liquid. This explains the observed Landau fans pointing away from the charge neutrality point and their degeneracies. The chemical potential m is also similar to experiments, including negative compressibilities and the overall magnitude of its difference between fully occupied and empty eight narrow bands, regardless of whether the strong coupling states at odd integer n are gapped or gapless.

Conclusions

The framework presented here provides a strong coupling description of the itinerant carriers, whose residual interactions and dispersion both depend on the Coulomb interaction. The description of the charge itineracy presented here builds a framework within which superconductivity, emerging at lower temperatures at some fillings, should be understood.

Acknowledgements

This work was supported by NSF Cooperative Agreement No. 1644779.

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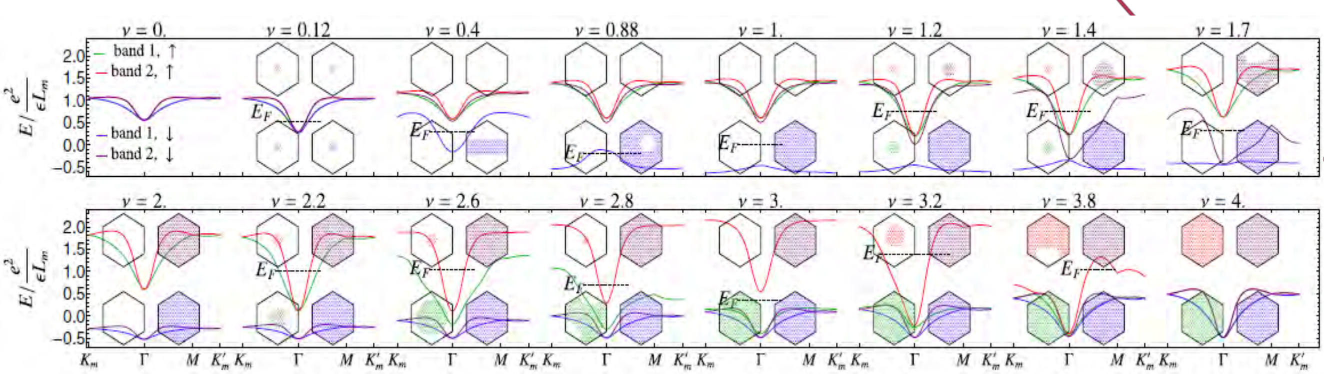

Figure 4.3.4.2: *Quasiparticle bands at different fillings n for product trial state at interlayer AA to AB ratio w_0/w_1=0.7 when the C2T symmetry is allowed to be broken. The hexagonal insets show occupied k points.*

4.3.4.3 Tuning electron correlation in magic-angle twisted bilayer graphene using Coulomb screening

Liu , X. (Brown U.), Wang , Z. (Brown U.), Watanabe, K (Nat. Inst. For Mat. Sci., Tsukuba), Taniguchi, T.(Nat. Inst. For Mat. Sci., Tsukuba)), Vafek, O. (NHMFL), Li, J.I.A. (Brown U.)

Introduction

Controlling the strength of interactions is essential for studying quantum phenomena emerging in systems of correlated fermions. We introduce a device geometry whereby magic-angle twisted bilayer graphene is placed in close proximity to a Bernal bilayer graphene, separated by a 3-nanometer-thick barrier. By using charge screening from the Bernal bilayer, the strength of electron-electron Coulomb interaction within the twisted bilayer can be continuously tuned. Transport measurements show that tuning Coulomb screening has opposite effects on the insulating and superconducting states: As Coulomb interaction is weakened by screening, the insulating states become less robust, whereas the stability of superconductivity at the optimal doping is enhanced. The results provide important constraints on theoretical models for understanding the mechanism of superconductivity in magic-angle twisted bilayer graphene.

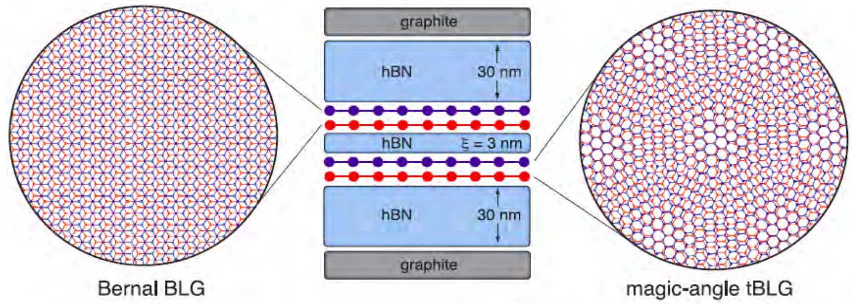

Figure 4.3.4.3.1: *Schematic of the hybrid double-layer structure consisting of a Bernal BLG and a magic-angle tBLG, separated by a thin insulating barrier with thickness of x=3nm. The structure is encapsulated with dual hexagonal boron nitride (hBN) dielectric and graphite gate electrodes.*

Methods and Results

It has long been recognized that elucidating the role of Coulomb interaction is essential to determining the nature of superconductivity. For a conventional superconductor, electron-phonon coupling competes against Coulomb repulsion in stabilizing superconductivity at low temperature. As such, a weaker Coulomb repulsion will lead to a more robust superconducting order parameter. By contrast, an unconventional superconducting phase arises from an all-electron mechanism, whereby the order parameter strengthens with increasing Coulomb interaction. For conventional solid-state materials, it remains an experimental challenge to directly control Coulomb interaction within a superconductor without introducing additional changes to the material. The flexibility of the van der Waals materials offers a valuable opportunity to control Coulomb interaction in magic-angle twisted bilayer graphene structures using proximity screening.

Here, we address this obstacle by tuning the strength of the Coulomb interaction in a single device using screening, while studying the response in both the correlated insulators and the superconducting phase using transport measurement. We use a hybrid double-layer structure, in which a Bernal bilayer graphene (BLG) and a magic-angle twisted bilayer graphene (tBLG) are separated by a thin insulating barrier with a 3 nm thickness **(Figure 4.3.4.3.1).** The close proximity allows charge carriers from BLG to screen the Coulomb interaction in the tBLG, offering direct control of electron correlations in the moiré flat band.

We find that the superconducting phase is more robust when BLG is metallic as compared to fully insulating **(Figure 4.3.4.3.2).** Resistance measured at B=0.1T, where superconductivity is fully suppressed, reflects the transport behavior of tBLG in the normal state (black curve). We note that increased BLG screening shifts the blue resistance R-T curve to the the red curve, enhancing superconductivity. The temperature dependence of resistance leads to additional observations: (i) The normal state T $\gtrsim$ 3K resistance in tBLG is insensitive to changes in BLG, demonstrating that modifications in impurity scattering resulting from a nearby metallic layer do not play a dominating role; (ii) the onset of Cooper pairing is observed at T ~ 3K (vertical black arrows), evidenced by the bifurcation between measured at B=0 and 0.1T. The shift in the R-T curves occurs over the entire range associated with Cooper pair formation, not only in the vortex-antivortex fluctuation regime.

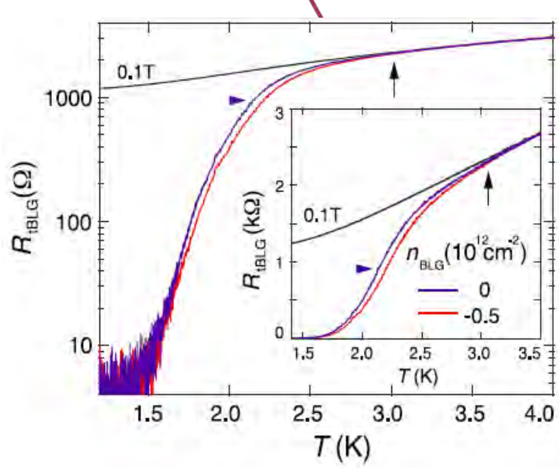

Figure 4.3.4.3.2: *Resistance of twisted bilayer R_{tBLG} as a function of temperature measured at optimal doping $n_{tBLG}=-1.48\times10^{12}cm^{-2}$ and perpendicular displacement field D_{BLG} =-350mV/nm for different density in Bernal bilayer n_{BLG}. The blue and red traces are measured at B=0, whereas the black trace is measured at the perpendicular magnetic field B=0.1T where superconductivity is fully suppressed. Inset: Temperature dependence of R_{tBLG} on a linear scale. T_c is operationally defined by 50% of normal state resistance and marked by the blue horizontal arrowhead. The separation of B=0 and B=0.1T curves marks the onset of pairing (black vertical arrow).*

Conclusions

Our result suggests that the dominant effect of BLG induced screening is changing the strength of Coulomb interactions in the magic-angle tBLG. That Cooper pair formation and superconductivity at the optimal doping become more robust with increasing screening appears consistent with electron-phonon coupling competing against Coulomb interaction to stabilize the superconducting phase. Alternatively, Coulomb screening could affect superconductivity by modifying properties of the moiré flat band, such as the size of the Fermi surface. The ability to control Coulomb interaction promises to provide important constraints on theoretical models aiming to accurately describe superconductivity in magic-angle tBLG.

Acknowledgements
This work was supported by NSF Cooperative Agreement No. 1644779.

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4.3.4.4 Quantum Hall Edges and Interfaces

Kun Yang, Ken W. W. Ma and Ruojun Wang (NHMFL)

Introduction

Quantum Hall states are the very first topological states of matter. Edges and interfaces are windows that allow us to peek into their bulk topological properties. In the past year we studied the edge of Moore-Read Pfaffian state and demonstrated that it can realize the (1,0) supersymmetry (SUSY), which is the simplest possible type of SUSY. We have also studied dynamical properties of various types of quantum Hall interfaces, including the interface between the Pfaffian and anti-Pfaffian quantum Hall states that are relevant to the 5/2 fractional quantum Hall state, which is the leading candidate of a non-Abelian quantum Hall state that is of very strong current interest.

Methods of Theoretical Studies and Results

In Ref. [1], we suggest the simplest type of SUSY, namely the N = (1,0) SUSY, and its spontaneous breaking can be realized on the edge of non-Abelian Moore-Read quantum Hall liquid. We show that the unreconstructed edge has a SUSY-preserving ground state. Meanwhile, the SUSY becomes spontaneously broken by an edge reconstruction. The existence of a gapless fermionic Goldstino mode in the SUSY-broken phase can be identified from the temperature dependence of the low-temperature specific heat.

A quantum Hall (QH) interface is different from an ordinary QH edge, as the latter has its location determined by the confining potential, while the former can be unpinned and behave like a free string. In Ref. [2] we demonstrate this difference by studying three different interfaces formed by (i) the Laughlin state and the vacuum, (ii) the Pfaffian state and the vacuum, and (iii) the Pfaffian and the anti-Pfaffian states. We find that string-like interfaces propagating freely in the QH system have very different dynamical properties from edges. This qualitative difference gives rise to fascinating physics and suggests a different direction for future research on QH physics.

Conclusions

We have performed comprehensive theoretical and numerical studies on quantum Hall edges and interfaces. Our results shed considerable light on their topological as well as dynamical properties.

Acknowledgements
This work was supported by NSF Cooperative Agreement No. 1644779 and DOE.

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4.4 AMRIS CHEMISTRY AND BIOLOGY

UF Faculty affiliated with the AMRIS Facility are at the forefront of developing and exploiting magnetic resonance techniques to provide unique insights into complex chemical and biological problems. Particular areas of interest include enhancing sensitivity through hyperpolarization, developing multinuclear magnetic resonance approaches that take advantages of high magnetic fields, and pairing high magnetic fields with ultrastrong gradients to provide insights into structure, function, and diffusion on the nanometer to micrometer length scales. The unique RF engineering capabilities of the MagLab enable researchers to develop MRI and NMR coils which are tailored for specific nuclei and samples. Science and technology highlights this year include characterization of mixed-matrix membranes composed of metal-organic frameworks (MOFs) developed for liquid-liquid separations [1]; development of a parahydrogen-based hyperpolarizer and heterogeneous catalysts to maximize ^{1}H and ^{13}C polarization [2]; demonstration that ^{2}H-enriched water provides a robust method for tracking glycolytic flux [3]; combining MRI and in vivo NMR spectroscopy to measure lipid infiltration into damaged muscle [4]; using microimaging to understand how changes in glial cells lead to MRI contrast signals observed in stroke [5]; and using diffusion tensor imaging combined with fMRI to characterize the effects of traumatic brain injury on brain connectivity networks [6].

4.4.1 CHEMISTRY

4.4.1.1 Quantification of molecular diffusion in different local environments of hybrid membranes designed for liquid separations

Baniani, A. (UF, Chemical Engineering); Rivera, M.P. (Georgia Tech, Chemical Engineering); Lively, R.P. (Georgia Tech, Chemical Engineering); Vasenkov, S. (UF, Chemical Engineering)

Introduction

This study focuses on quantifying microscopic transport of organic liquids in mixed-matrix membranes (MMMs) composed of metal–organic framework (MOF) particles, which are dispersed in polymers. MOFs are high porosity materials consisting of metal ions or clusters interconnected by organic molecules. Recent studies reported in the literature demonstrate that MOF-based MMMs are very promising candidates for removal of dilute organic components from aqueous mixtures as well as for organic-organic mixture separations much needed in industry.[1] Until now, the design of MOF-based MMMs has been based on assumptions instead of actual knowledge of the transport properties of MOF crystals dispersed in MMMs. Hence, there is a clear need for a quantification and understanding of intra-MOF transport in MMMs. This need is emphasized by the possibility that the MOF confinement in polymers can reduce structural flexibility of MOF crystals, and thus change their transport properties.

Experimental details

^{13}C PFG NMR at 14T was utilized at the AMRIS facility of the MagLab to measure self-diffusivities of methanol, ethanol, p-xylene and o-xylene inside MOF crystals of the type ZIF-71 that were either confined in Torlon polymer and served as a filler in ZIF-71/Torlon MMMs or were loosely packed to form crystal beds without any confinement. Selected ^{13}C PFG NMR measurements were also performed at a larger field of 17.6T. The observed coincidence of the data measured with the same samples at different magnetic field strengths and otherwise the same conditions (**Figure 4.4.1.1**) was used to rule out any possible measurement artifacts.

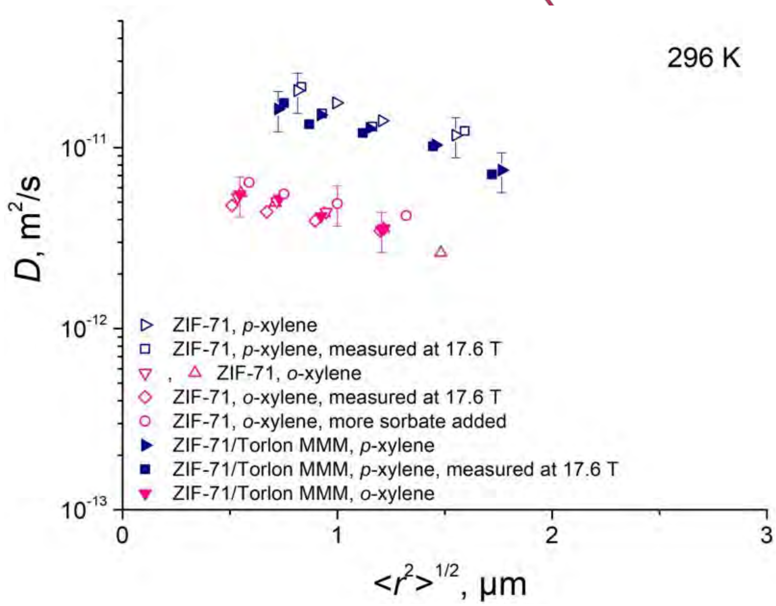

***Fig.4.4.1.1:** Self-diffusivities of p-xylene and o-xylene plotted as a function of root MSD for ZIF-71 crystal beds (hollow symbols) and ZIF-71/Torlon MMMs (filled symbols). The data were measured at 14T, unless indicated otherwise in the figure.* [2]

Results and Discussion

The intra-MOF self-diffusivities in the MMM and MOF bed were found to decrease with increasing diffusion time and the corresponding root mean square displacement, viz. root MSD (**Figure 4.4.1.1**).[2] The observed diffusivity dependencies were attributed to an influence of the external crystal surface on trajectories of the diffusing molecules, which reach this surface. The quantitative analysis of the dependencies of the self-diffusivities on the diffusion time and root MSD resulted in the intra-MOF self-diffusivities that were not perturbed by the influence of the external crystal surface.[2] To our knowledge, this work represents the first study demonstrating direct measurement of self-diffusion and self-diffusion selectivity of liquid sorbates inside MOF crystals located in MMMs. Direct access to diffusion data for liquids inside MOF crystals in MMMs is required for knowledge-based design of such MMMs for liquid separations, which can be influenced by diffusion changes due to crystal boundary effects and/or reduction in the framework flexibility of MOF crystals.

Acknowledgements

This research was financially supported by National Science Foundation (NSF CBET 1836735 and 1836738), with a portion performed in the McKnight Brain Institute at the National High Magnetic Field Laboratory's AMRIS Facility, which is supported through NSF/DMR-1644779 and the State of Florida. This work was also supported in part by an NIH award, S10 RR031637, for magnetic resonance instrumentation.

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4.4.1.2 New Reactor Systems and Infrastructure for Parahydrogen Based Hyperpolarization

Bowers, C.R. (UF, Chemistry), Hagelin-Weaver, H.E. (UF, Chemical Engineering), Huang, W. (Iowa State University, Chemistry; Ames National Laboratory)

Parahydrogen-based hyperpolarization provides an efficient and robust method for sensitivity-enhanced NMR spectroscopy and imaging.[1] Chemical hydrogenation mediates conversion of the symmetry-protected singlet order of parahydrogen (pH_2) into NMR-observable hyperpolarization that can yield carbon-13 NMR signal enhancements of up to 140,000 at 7T and 300K. This report describes new state-of-the-art infrastructure for parahydrogen enhanced NMR spectroscopy and imaging research, including systems for producing pH_2 and several types of novel reactor systems. This work is currently supported by the NHMFL UCGP.

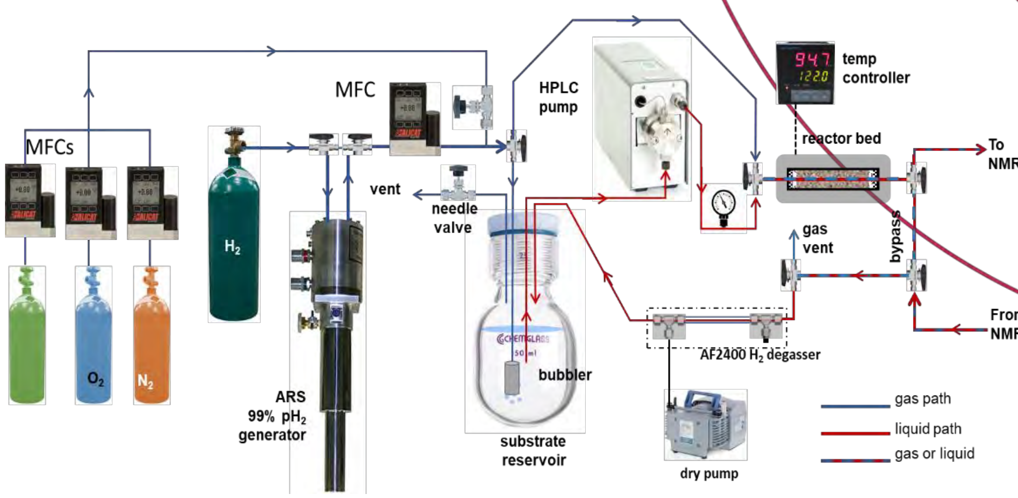

***Figure 4.4.1.2:** Closed-loop continuous-flow hyperpolarization of liquids or gases from pH_2.*

Cryo-Cooler Based Continuous Parahydrogen Enrichment

To provide routine pH_2 enrichments of 99% at flow rates up to 1000sccm, an Advanced Research Systems helium cryocooler based parahydrogen converter was purchased and installed in summer 2021. As a backup system, a liquid helium immersion cryostat converter for enrichments up to 97% and 500sccm was constructed and demonstrated.

Hyperpolarization from Heterogeneous Catalysis with Parahydrogen

A novel continuous-flow, packed-bed catalytic reactor system for liquids and gases, designed for high pressure and high temperature reaction conditions, has been constructed and demonstrated (**Figure 4.4.1.2**). Hyperpolarization from pH_2 and heterogeneous catalysis can produce streams of pure hyperpolarized metabolites with spontaneous separation from the solid catalyst material, making this ideal for *in vivo* use.

Ultrasonic Spray Injection Reactor

Production of continuous streams of ^{13}C highly hyperpolarized pyruvate and other metabolites would be ideal for biomedical imaging. Toward this end, an ultrasonic spray injection reactor system for use with dissolved or suspended catalysts has been constructed. Use of the ultrasonic nozzle for spray injection of precursor solutions into a reaction chamber pressurized with 99% pH_2 provides the most efficient possible method for rapid chemical conversion to hyper-polarized metabolites. This reactor is coupled to a dual syringe pump for precise administration into a flow NMR probe. Density matrix simulations show that rapid adiabatic transport under certain spin Hamiltonians in selectively deuterated precursors, when followed by a selective INEPT pulse sequence, can produce ^{13}C pyruvate esters with up to 82% polarization, a factor of two better than any previously established method.

Heterogeneous Catalyst Development

Hyperpolarization by heterogeneous catalysis would be ideal for *in vivo* use, but only if a high pairwise selectivity of hydrogenation is achieved. Through extensive investigations of surface properties and reaction mechanisms, it was found that atomically dispersed Pt/CeO_2[2] and PtSn intermetallic nanoparticles[3] can deliver spin polarizations up to 20%. Catalyst development activities are ongoing with support from two independent NSF grants, which benefit from a close synergy with the UCGP award.

Acknowledgements

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4.4.2 BIOLOGY

4.4.2.1 Detecting HDO production as a biomarker of glycolytic flux

Mahar, R., Chang, M.C., Giacalone, A., Ragavan, M., Mareci, T.H., Merritt, M. (UF, Biochemistry and Molecular Biology); Zeng, H. (National Magnet Lab - AMRIS Facility)

Deuterium magnetic resonance imaging, DMI, has the demonstrated ability to identify changes in brain metabolism associated with cancer. However, the downstream products of glucose metabolism, glutamate/glutamine (glx)

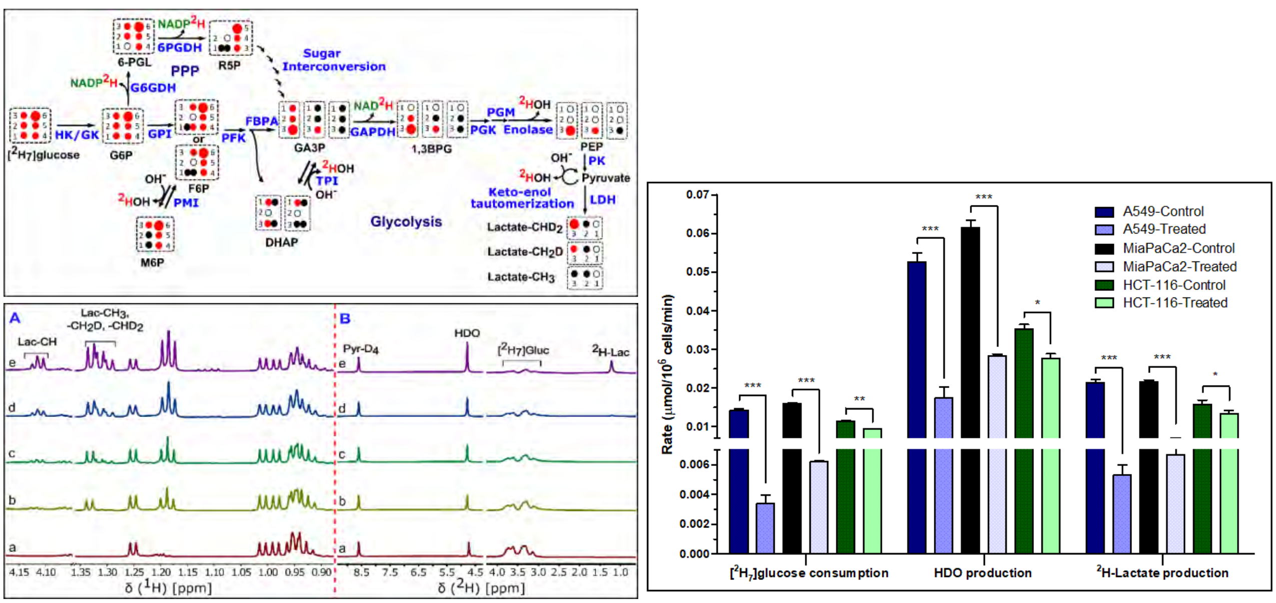

Figure 4.4.2.1: (Top left) Glucose can be enriched for deuterium (red circles), which can be subsequently eliminated by enzymatic action, yielding HDO at various points in glycolysis and in the TCA cycle. (Bottom left) ^1H NMR spectra showing the production of deuterated lactate as detected in the ^1H spectrum. (right) ^2H NMR spectrum showing glucose consumption as well as ^2H-lactate and HDO production. (Bottom) Relative rates of HDO production in NQO1$^+$ versus NQO1$^-$ cells after β-lap treatment.

and lactate, have intrinsically low signal to noise ratios that make detection challenging. This work posited that imaging of HDO following metabolism of D_7-glucose will produce a more sensitive means of detecting glycolysis and glucose oxidation in the Krebs cycle. The Merritt lab has been developing this approach to DMI over the past several years, demonstrating results in cell culture an *in vivo* in the rat brain.

Perdeuterated glucose eliminates HDO at multiple reactions in glycolysis, and can produce lactate that is natural abundance, singly labeled, or doubly labeled with deuterium. As illustrated in **Figure 4.4.2.1,** the number of mols of HDO produced from glucose should be at least twice the number of mols of lactate. Natural abundance water has an HDO enrichment of ~17.5mM, observable *in vivo* and in cell culture (panel B) and acts as an internal control for HDO. Partial enrichment at the CH_3 position of lactate causes an isotope shift in the ^1H spectrum (panel A), enabling a straightforward readout of the relative isotopomer concentrations. The broad signals associated with D_7-glucose decrease over a 6-hour sampling period as the deuterated lactate and HDO signals increase in intensity. Our work has produced several seminal insights into the analysis of D_7-glucose metabolism. 1) While lactate production *must* track glucose consumption in detail, the low signal to noise associated with initial time points hinders the use of lactate as a marker of glucose consumption. 2) In contrast, as the natural abundance HDO provides a detectable baseline, excess enrichment is easily detected, and is relatable to glucose consumption. This central observation forms the basis of a patent awarded to Dr. Matthew Merritt this year (T17984US001).

HDO detection has since been extended to monitoring of interruption of glycolysis by chemotherapeutic agents. Serine/ threonine kinase (STK11) mutation is common in non-small cell lung cancer and promotes a particular treatment resistant phenotype. STK11 mutation is often accompanied by activation of an associated protein which controls expression of the phase II detoxifying enzyme, which is metabolized in a futile cycle consuming NADPH, producing high levels of superoxide and peroxide, and triggering hyperactivation of the repair enzyme poly ADP ribose polymerase, ultimately resulting in massive NAD^+ and ATP loss and cell death. NAD^+ is a cofactor in multiple steps of glycolysis and the Krebs cycle, and its loss thereby inhibits flux through the associated enzyme complex. Inhibition of these enzymes causes a consequent loss of HDO production, which we have shown is recapitulated across multiple cancer cell types. This result is central to a submitted R21 which seeks to develop decremented HDO production as a marker of β-lap efficacy *in vivo*, where we hope to demonstrate that more effective dosing schedules are possible.

Acknowledgements

This research was funded by the National Institute of Health grants: NIH P41-122698, 5U2C-DK119889, and NIH R01-DK105346. The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida.

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Mahar, R., *et al.*, *Cancers 13*(16), 4165 (2021)

4.4.2.2 Quantification of skeletal muscle lipid infiltration in a Western diet-fed mouse model of Duchenne Muscular Dystrophy using MRI and MRS

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Introduction

Rodent models of Duchenne muscular dystrophy (DMD) are notorious for failing to recapitulate the severity of lipid infiltration observed in humans. Preclinical models that reliably reproduce physio pathological processes associated with human condition are important not only for determining the underlying pathologic mechanisms but also for the development of effective interventions. For this purpose, we introduce a mouse model of chronic muscle damage which can facilitate the examination of human muscle pathophysiology. In this study, we examined the role and utility of both noninvasive and invasive Magnetic Resonance Imaging and Spectroscopy (MRI and MRS) to determine lipid deposition and saturation in the lower hindlimb skeletal muscles of two novel preclinical models of DMD (*mdx* and *mdx*-apolipoprotein E (mdx-ApoE) knocked out mice) fed on high cholesterol- and triglyceride rich Western diet (*mdx*^{W} and *mdx*-ApoE^W) and we compared to their counterparts on regular chow diet (*mdx*-ApoE^R and *mdx*^{R}). We hypothesize that the *mdx*-ApoE^W mouse model on Western diet regimes mimics the disease process in humans, and therefore, this model can play a crucial role to understand disease pathology, underlying pathways, and finding therapeutic interventions for DMD in the future.

Experimental details

Experiments were performed at the MagLab's AMRIS Facility, with all animal-based experiments performed according to the rules and guidelines provided by Institutional Care and Use Committee, University of Florida, Gainesville, and the UBC Committee for Animal Care. Time domain Nuclear Magnetic Resonance (TDNMR) was acquired with LF90 Minispec TD-NMR analyzer (Bruker, Spring, TX, USA) to measure whole body fat and lean body mass of all mice under study. The 4.7T (Agilent, Santa Clara, CA) magnet system was used to image (proton-weighted T_2 spin echo and muscle water T_2 images) left hindlimb of anesthetized mice using custom-built 200-MHz ^{1}H solenoid coil with 1.5 cm internal diameter. The 11.1T MR with horizontal bore magnet, (Bruker Biospect Inc., Massachusetts) with single voxel ^{1}H-MRS (STEAM) was utilized to acquire *in vivo* MRS of the posterior compartment of the hindlimb. In addition, three-dimensional radial UTE sequence (UTE3D) was performed using a non-slice-selective RF block-pulse (α = 5°, bandwidth = 100kHz) with various TEs in fixed scale of receiver gain. Furthermore, high-resolution ^{1}H magic angle spinning (HRMAS) experiments were acquired using Bruker 800MHz spectrometer for intact gastrocnemius, quadriceps, liver, EDL, and soleus tissues. Solution state NMR experiments (1D & 2D) were performed on Bruker 800MHz spectrometer (with TCI cryoprobe) for the whole and FOLCH(1) extracted serum samples.

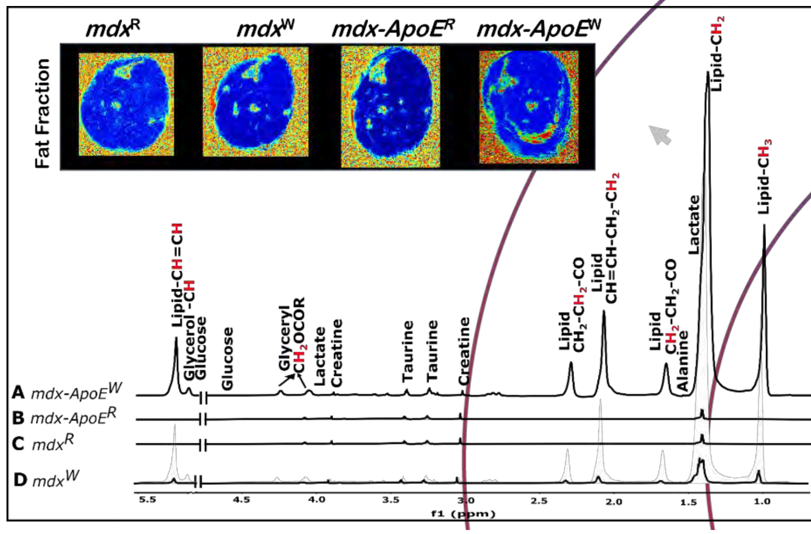

Figure 4.4.2.2: Top panel shows Dixon maps for the fat fraction from mdx and mdx ApoE knockout mice on a western diet. Lower spectra showed a portion of 1D 1H HR-MAS representative spectra for gastrocnemius muscles with few lipids and metabolites peaks. Western high-fat diet samples showed clear elevation in lipid level.

Results and Discussion

Both non-invasive and invasive magnetic resonance (MRs) methods demonstrated human-like fat infiltration and disease severity in hyperlipidemic *mdx*-ApoE model of chronic muscle damage utilized in this study (**Figure 4.4.2.2**). In serum and most of the extracted tissues studied, lipid saturation was significantly altered in different diet regime groups, clearly indicating towards complicated meta-bolism.

Acknowledgements

This work was supported by a National High Magnetic Field Laboratory User Collaboration Grant. The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1644779 and the State of Florida.

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[1] Folch, J., *et al.*, *J Biol Chem*, 226(1), 497-509 (1957).

4.4.2.3 On the Origin of MRI Signal in Stroke

Blackband, S.J. (UF, Neuroscience, NHMFL); Flint, J.J. (UF, Neuroscience); Hansen, B. (Aarhus University, Denmark); Shepherd, T.M. (NYU); Lee, C.H. (NYU); Streit, W.J. (UF, Neuroscience); Forder, J.R. (UF, Radiology)

Introduction

Nearly 30 years ago it was demonstrated that a diffusion weighted MR image shows a signal hyperintensity in the region of ischemia almost immediately after an infarct; however, the origin of this signal change has been a matter of debate. Several mechanisms have been suggested that may individually or in some combination be responsible for this signal change. Our own studies developing MR microscopy at the cellular level aim to shed light on this process. For decades we believed that the signal change was a result of neuronal cell swelling, in that the diffusion in the cells is slower than that of the extracellular space, and since diffusion stays constant with cell swelling, the cell volume increases at the expense of the extracellular space, resulting in the average diffusion in the tissue decreasing.

Our recent studies using MR microscopy at the cellular level on isolated and perfused rat, pig, and human brain tissue slices contradict this point of view. In those data the neurons are observed to have a faster diffusion coefficient compared to the extracellular space. That being the case, one would expect that if the neuronal cell swelling was the origin of the signal changes, then the exact opposite would happen, and the signal would be hypointense. To address this quandary, our recent perspectives piece[1] suggests an alternative origin for these signal changes and evidences it with data from previous studies.

Experimental

All data collected over the last three decades was collected at 360MHz at Johns Hopkins University, and at 600 and 750MHz in magnet systems at the MagLab in Tallahassee or in the AMRIS facility at UF. The magnet systems used a mix of custom or commercial RF microcoils of solenoidal or planar design which in combination with strong, fast switching gradient coils and high magnetic fields facilitated spatial resolutions of up to 7 microns. Live tissues were supported with custom built perfusion systems that featured a home-built oxygenator that could fit inside the magnet bore close to the sample to maintain tissues stable for up to 15 hours.

Results and Discussion

We propose that the observed signal changes are not due to neuronal cell swelling, but glial cell swelling. Of many functions, a primary function of glial cells is osmoregulation. Further, although smaller than neurons, glial cells are ubiquitous in the brain and account for 30-40% of the brain volume.

Mammalian glial cells are too small to resolve with present MR microscopy spatial resolutions. However, as shown in **Figure 4.4.2.3,** large excised Aplysia neurons surrounded by satellite cells, mainly glia, show the region of the satellite cells to be hyperintense compared to the neuron cell body. Thus, if the glial cells swell with ischemia, maintaining neuronal cell volume for optimal functioning, then this increased satellite cell hyperintense signal will account for the hyperintensity in ischemia.

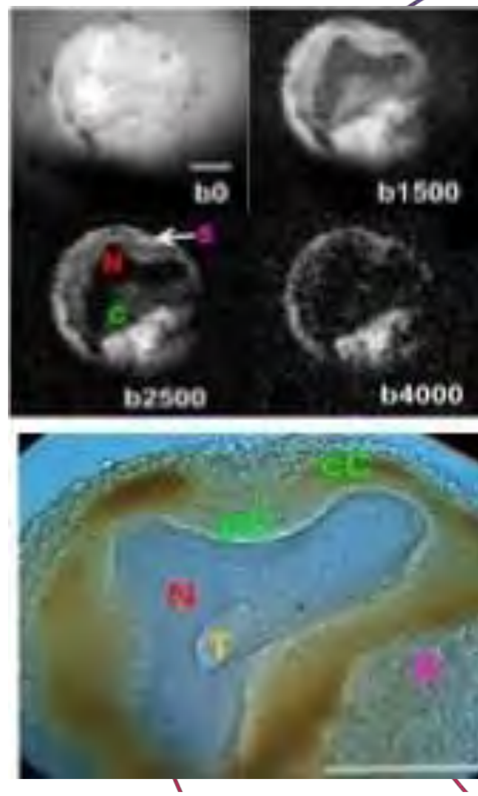

Figure 4.4.2.3: *Diffusion MR microscopy of a sea slug neuron (**top**) shows the hyperintensity (brightness) as water diffusion occurs in glial satellite cells. The cellular structures can also be identified using traditional light microscopy at 40X (**bottom**).*
N = nucleus
C = cytoplasm (perinuclear and cortical)T = trophospongium (sea slug invagination)
S = satellite cells. Scale bar is 100 μm.

Conclusions

Glial cell swelling offers a mechanism for the observed signal changes in stroke. Future studies will aim to validate this hypothesis. Working mathematical models can be developed to understand the changes in MRI signals that can be observed in disease and distinguish reversible and irreversible stroke events that require different treatments. We expect that these models will also improve the sensitivity and specificity of clinical MRI diagnostics for other brain disorders where glial cells may play a role, for example, mood disorders, movement disorders such as Parkinson's, memory disorders such as Alzheimer's, and sleep disorders.

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida. This project is additionally funded by the National Institutes of Health (Blackband, NIH R01 EB012874).

References

[1] Blackband, S.J. et al, Frontiers in Neurology, 11, 549 (2020)

4.4.2.4 Compensatory Functional Connectome Changes in a Rat Model of Traumatic Brain Injury

Yang, Z., Zhu, T., Fu, Y., Arjona, K., Arja, R.D., Grudny, M.M., Wang, K.K. (UF, Emergency Medicine); Zhu, J. (UF, Anesthesiology); Pompilus, M., Febo, M. (UF, Psychiatry)

Introduction: Understanding how traumatic brain injury (TBI) reorganizes local and brain wide nodal functional interactions may provide valuable quantitative parameters for monitoring pathological progression and functional recovery for penetrating cortical impact injuries which alter neuronal communication beyond the injury epicenter, across regions involved in affective, sensorimotor, and cognitive processing.

Experimental: We investigated spontaneous fluctuations in the functional magnetic resonance imaging (fMRI) signal obtained at 11.1T in rats sustaining controlled cortical impact (CCI) and imaged at 2- and 30-days post-injury. Graph theory-based calculations were applied to weighted undirected matrices constructed from 12,879 pairwise correlations between fMRI signals from 162 regions.

Results and Discussion: The CCI epicenter sustained significant localized cortical damage across subjects on day 2, which appeared to expand below the cortex to underlying white matter and ventrally towards ipsilateral dorsal hippocampal and thalamic areas, similar to previously reported in histological assess-ments (**Figure 4.4.2.4.1**). The structural differences between the control and CCI groups were partly, but not completely, corrected by the symmetric normalization warping. Areas outside the CCI epicenter, including contralateral structures, appeared well aligned to the template and its accompanying parcellation. Our data indicate that on days 2 and 30 post-CCI there is a significant increase in connectivity strength in nodes located in contralesional cortical, thalamic, and basal forebrain areas (**Figure 4.4.2.4.2**). Rats imaged on day 2 post-injury had significantly greater network modularity than controls, with influential nodes (with high eigenvector centrality) contained within the contralesional module and participating less in cross-modular interactions. By day 30, modularity and cross-modular interactions recover, although a cluster of nodes with low strength and low eigenvector centrality remain in the ipsilateral cortex.

Conclusions: Our results suggest that changes in node strength, modularity, eigenvector centrality, and participation coefficient track early and late TBI effects on brain functional connectivity. We propose that the observed compensatory functional connectivity reorganization in response to CCI may be unfavorable to brain wide communication in the early post-injury period.

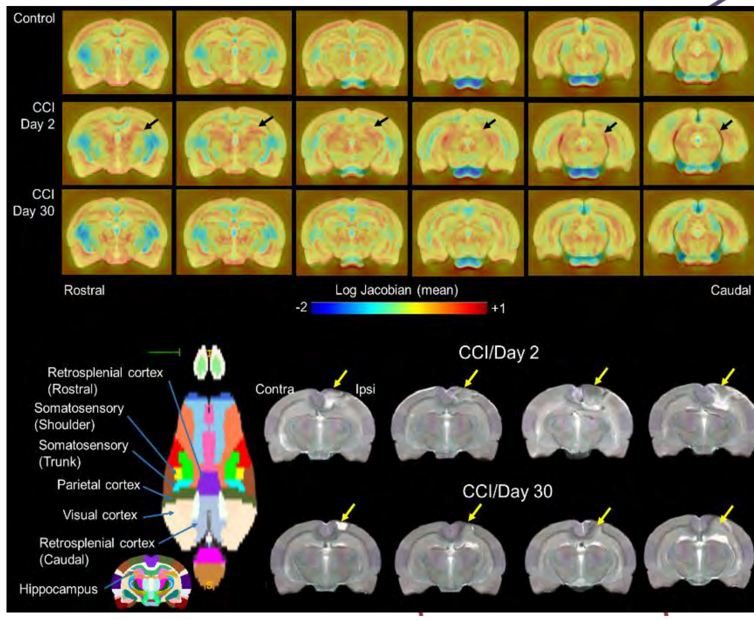

Figure 4.4.2.4.1: Nonlinear registration to a reference T2-weighted scan revealed cortical and subcortical thalamic structural differences in controlled cortical impact (CCI) rats relative to controls.

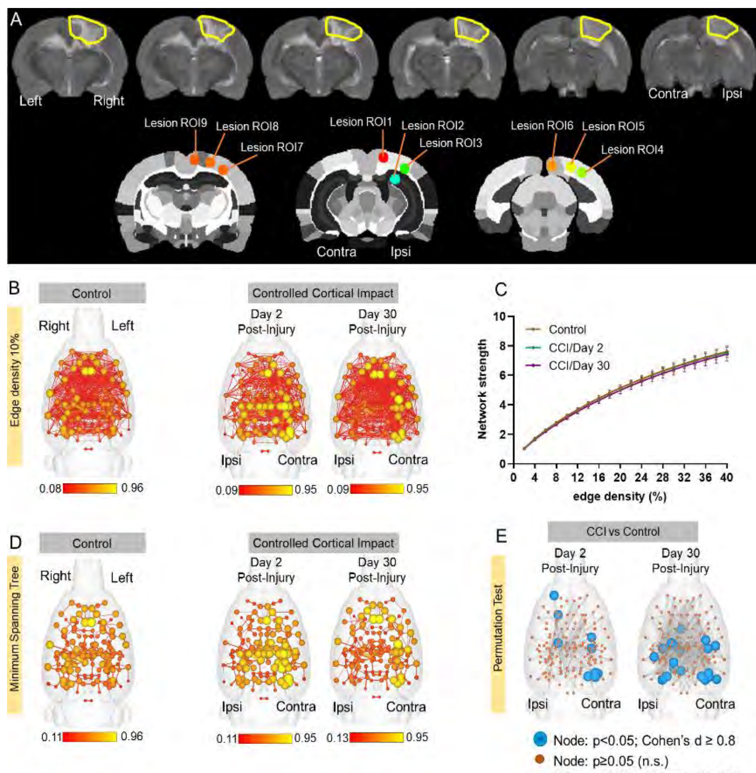

Figure 4.4.2.4.2: Nodes in cortical regions contralateral to the controlled cortical impact (CCI) site show a significant increase in connectivity strength at day 2 and 30 post-injury.

Acknowledgements: The National High Mag-netic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida. This work was also supported by National Institute on Neurological Disorders and Stroke grant (UG3 NS106938).

References: [1] Yang, Z., *et al.*, Brain Comm, **3**(4), 1-17, (2021)

4.5 FSU BIOLOGY/ FSU CHEMISTRY

In addition to building and making available high-field magnets, NHMFL in-house research staff continuously upgrade the instrumentation and techniques associated with those magnets. For example, in mass spectrometry, neutral analytes must be ionized to enable mass analysis. Thus, for compositionally complex mixtures, the mass spectrum will be dominated by the most easily ionized components. NHMFL has pioneered the development of "extragraphy" (i.e., extraction with multiple solvents) to separate different fractions of a mixture to enable detection of the less efficiently ionized components. In 2021, the NHMFL ICR staff applied those methods to the products of simulated solar irradiation of petroleum, thereby revealing the pathways and mechanisms of photoionization [1]. They went on to identify the water-soluble (and thus environmentally distributed) photoproducts from an oil spill and their biological toxicity [2]. The EMR group characterized the alignment of cell membrane lipids in "bicelles" (i.e., model lipid/protein membrane bilayers) produced by high magnetic field. Such alignment is critical to understanding the function of proteins in cell membranes [3]. The NMR staff applied high magnetic field gradients to reveal the structure of commercially important surfactant "micelles" (i.e., assemblies of self-aggregating molecules in water) [4]. The NMR group showed how to exploit the relatively high NMR sensitivity of protons to detect and chemically characterize other important but low-sensitivity nuclei (e.g., nitrogen, sulfur, mercury, lead) in solids [5]. The NMR group applied high-speed sample spinning to identify the chemical partners involved in transport of lithium in solid-state batteries, thereby revealing what happens as the battery is discharged and charged many times [6]. Finally, the EMR and NMR groups combined to use microwave irradiation to enhance otherwise weak NMR signals, thereby achieving orders of magnitude reduction in the time required for NMR analysis [7].

4.5.1 ICR

4.5.1.1 Structural Dependence of Photogenerated Transformation Products for Aromatic Hydrocarbons Isolated from Petroleum

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Introduction

After the Deepwater Horizon (DWH) oil spill, which released ~3 million barrels of crude oil into the Gulf of Mexico, the weathering of oil in the environment has been greatly studied. Photooxidation has been previously implicated as a dominant process for the formation of oxygenated transformation products; however, additional studies are necessary to determine the chemical processes as well as the structural dependence of photooxidation reactions in petroleum. Photochemical reactions can cause oil molecules to become water-soluble upon the addition of oxygen atoms (as demonstrated in **Figure 4.5.1.1.1**), enabling potentially toxic hydrocarbons to enter waterways and ecosystems, with unknown effects on wildlife and human health. Thus, understanding these processes and how they change molecular composition and subsequent solubility behavior is of paramount importance.

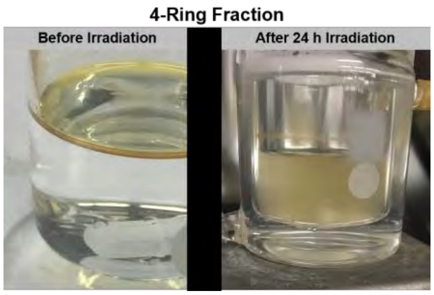

Figure 4.5.1.1.1: *Photos of the 4-ring fraction before irradiation (left), 24 hours after irradiation (right).*

Previous work has suggested a potential structural dependence for the formation of oil and water-soluble photoproducts from the simulated solar irradiation of petroleum. Aromatic species in petroleum are thought to play a role in the type and amount of transformation products due to their ability to act as chromophores and promote photochemical reactions. To investigate the effect of the aromatic ring number on the formation of photoproducts from petroleum, we subject an Arabian heavy crude oil to a previously developed HPLC-3 method, which fractionates oil based on the number of aromatic rings (**Figure 4.5.1.1.2**). All five aromatic ring fractions (1 ring to 5+ rings) produce abundant oil and water-soluble photoproducts with high oxygen content and similar chemical composition upon photoirradiation in the laboratory, despite large differences in aromaticity in the starting material. The 3- and 4-ring fractions produce the highest amount of dissolved organic carbon, which is quantified by non-purgeable organic carbon analysis. We investigate photoinduced fragmentation, oxidation, and potential polymerization as key processes in the formation of water-solubles from starting material containing different numbers of aromatic rings. As a result of the high amount of sulfur in Arabian heavy crude oil, sulfur-containing photoproducts (O_xS_1) are also investigated.

Acknowledgements

This research was made possible in part by a grant from the Gulf of Mexico Research Initiative and in part by the National Science Foundation Division of Chemistry through Cooperative Agreement DMR-1644779, the Florida

State University Future Fuels Institute, and the State of Florida. Data are publicly available through the Gulf of Mexico Research Initiative Information & Data Cooperative (GRIIDC) at https://data.gulfresearchinitiative.org (DOI: 10.7266/FY9QWH5F).

References

[1] Niles, S.F., *et al.*, Energy and Fuels, 35, 18153-18162 (2021).

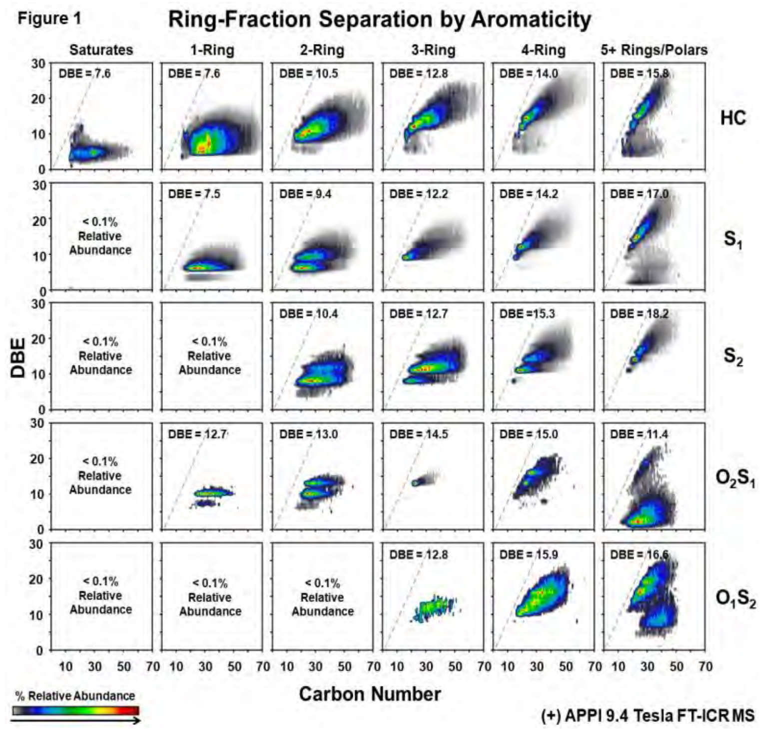

Figure 4.5.1.1.2: Isoabundance-contoured plots of double bond equivalents (DBE = number of rings plus double bonds to carbon) versus carbon number from (+) APPI FT-ICR MS of ring fractions (saturates, 1 ring, 2 ring, 3 ring, 4 ring, and 5+ ring/polar) isolated from Arabian heavy crude oil. The abundance-weighted DBE values increase with an increasing number of rings.

4.5.1.2 Time-dependent Molecular Progression and Acute Toxicity of Oil-soluble, Interfacially-active, and Water-soluble Species Reveals their Rapid Formation in the Photodegradation of Macondo Well Oil

Chen, H. (NHMFL); McKenna, A. M. (NHMFL); Niles, S. F. (NHMFL); Frye, J. W. (NHMFL); Glattke, T. J. (NHMFL); Rodgers, R. P. (NHMFL)

Introduction

Photodegradation is a significant weathering process that transforms spilled oil, yet the fate, degradation rate, and molecular transformations that occur through photoinduced pathways remain relatively unknown. Here, we catalogue the molecular progression of photochemical transformation products of Macondo Well Oil by negative-ion electrospray ionization (ESI) Fourier transform ion cyclotron resonance mass spectrometry (FT-ICR MS).

Results and Discussion

We track the molecular compositions of oil-soluble, interfacially-active, and water-soluble oil species formed at varying time intervals in photomicrocosm experiments. **Figure 4.5.1.2.1** displays the molecular oxygen content

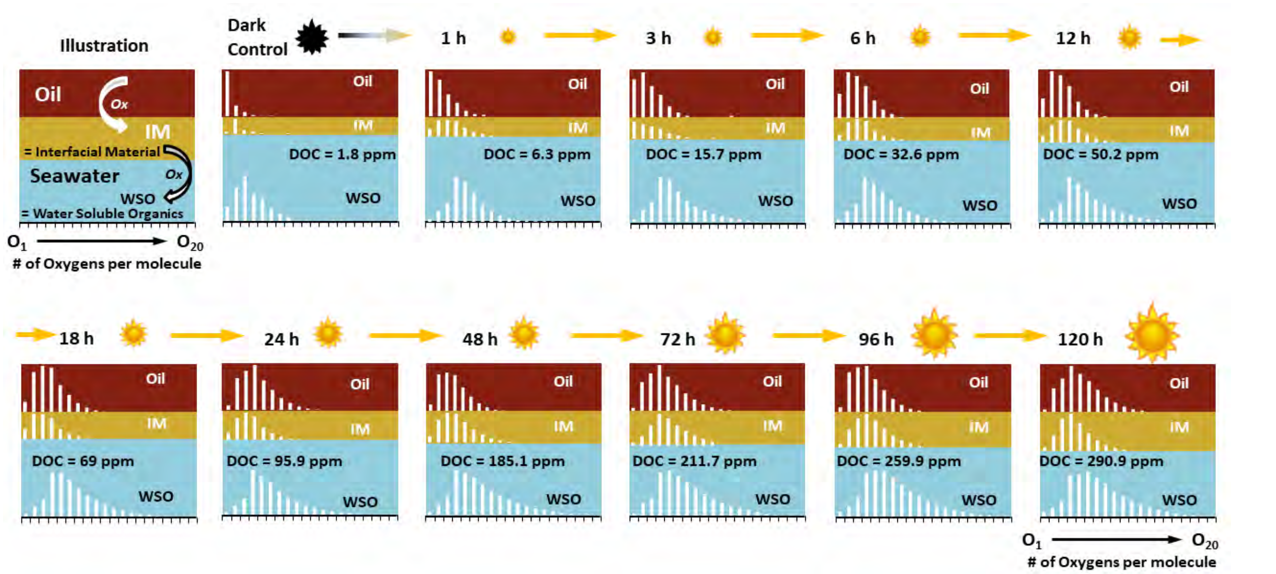

Figure 4.5.1.2.1: Schematic summary of solar simulation microcosms depicting the temporal progression of Ox revealed by FT-ICR MS. X-axis exhibits the molecular oxygen content (O_1-O_{20}), and the y-axis shows the relative abundance of these oxygenated species. The dark control serves as a t=0 marker for the subsequent monitoring of photo transformation products.

relative abundances of oxygenated species and thus depicts compositional changes as the MWO photochemically degrades over time and reveals the temporal progression of Ox compositional changes in oil-soluble, IM, and WSO fractions. It shows how progressive oxidation could affect the chemical/physical behavior through the generation of IM, which partitions to the oil/water interface. FT-ICR MS analysis of acidic species of each fraction identifies tens of thousands of oil-soluble, interfacially-active, and water-soluble phototransformation products, including O_x, NO_x, and SO_x species. Results highlight the temporal, molecular progression of photo products as they partition from oil-soluble to oil-soluble interfacially-active, and finally to water-soluble species.

Acknowledgements

This research was made possible in part by a grant from the Gulf of Mexico Research Initiative and in part by the National Science Foundation Division of Chemistry through Cooperative Agreement DMR-1644779, the Florida State University Future Fuels Institute, and the State of Florida. Data are publicly available through the Gulf of Mexico Research Initiative Information & Data Cooperative (GRIIDC) (DOI: 10.7266/FY9QWH5F).

References

[1] Chen, H., *et al.*, Science of The Total Environment, 151884 (2021).

4.5.2 EMR

4.5.2.1 EPR Study of Protein-Lipid Interactions Using Magnetically Aligned Bicelles

Nhat Nguyen Bui (FSU, NHMFL) and Likai Song (FSU, NHMFL)

Introduction

Bicelles mimic biological cell membranes and are known to self-align in a magnetic field under critical conditions such as temperature and field strength. The extensive use of bicelles in magnetic resonance, especially in nuclear magnetic resonance (NMR), has enabled the collection of crucial information in structural and functional studies of membrane proteins. By having a large magnetic moment of an electron spin, EPR is amenable to much smaller sample quantities and more physiological lipid/protein (L/P) ratios than NMR. Our aim was to develop an EPR method using aligned bicelles to study protein structure, functions, and dynamics.

In this study, bicelle alignment in various conditions was examined. Bicelle alignment improvement at high fields was also inspected using a recently developed quasi-optical 94 GHz EPR spectrometer (HiPER). Using aligned bicelles, protein-lipid interactions of the N-terminal helix (helix 0) of endophilin (H0-Endo) and amphiphysin (H0-Amph), both of which belong to the N-BAR domain-containing family of membrane proteins, were investigated. In addition, the orientation of the membrane proximal ectodomain region (MPER) and transmembrane domain (TM) of the HIV envelope protein gp41 relative to the lipid bilayer was determined using site-specifically spin-labeled MPERTM.

Experimental

Bicelles were prepared by mixing and drying lipids. The dried lipids were resuspended in buffer, followed by sonication and freeze/thaw cycles. The resulting bicelle solution was transparent and viscous. The proteins were mixed with bicelles at the amounts required to achieve the desired L/P ratios. EPR experiments were conducted at the NHMFL using a Bruker E680 spectrometer (X-band, 9.5GHz) and a W-band 94GHz continuous wave and pulsed EPR spectrometer (HiPER).

Results and Discussion

Bicelle alignment was first optimized using different lipid compositions relevant to mammalian membranes, including phospholipids, cholesterol (Chol), and sphingomyelin (SM), at various temperatures and lipid ratios. We found that more than 99% of 1,2-dimyristoyl-sn-glycero-3-phosphocholine (DMPC) bicelles could align at

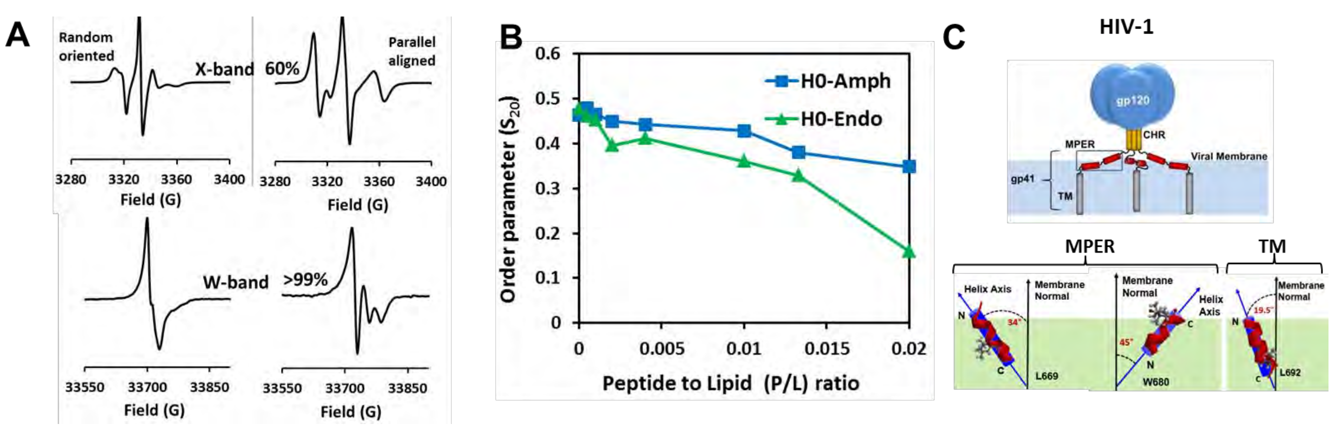

Figure 4.5.2.1: *(A) EPR spectra of DMPC/SM/Chol bicelles aligned at X-band and W-band. (B) Reduction of order parameter S_{20} when adding H0-Endo and H0-Amph proteins. (C) MPERTM orientation in lipid bilayers.*

temperatures above 308K at X-band, while the percentage of aligned bicelles was reduced to 82% for DMPC/Chol and 60% for DMPC/SM/Chol. Higher fields remarkably improved bicelle alignment, from 60% alignment at X-band to more than 99% at W-band **(Fig. 4.5.2.1. A).** Using aligned bicelles, we studied the protein-lipid interactions of different proteins and found that H0-Endo had a significant effect on lipid orientational order while H0-Amph had a reduced impact on lipid chain order. The order parameter S_{20}, simulated from the EPR spectra, which estimates the orientational order of lipid acyl chains ranging from 1 to 0 for complete order to disorder, was drastically decreased when H0-Endo was present **(Fig. 4.5.2.1 B**, green trace), while the change was much less dramatic for H0-Amph (blue trace). This suggested that by interacting with lipid bilayers, H0-Endo could cause dramatic membrane disturbance and lipid chain order alteration, while H0-Amph could only moderately perturb the lipid bilayers. This technique was also utilized to determine MPERTM orientation in lipid membranes using site-specific spin-labeled proteins. We found that each helix of MPERTM is oriented at different angles in lipid membranes **(Fig. 4.5.2.1 C)**. While the two helixes of the MPER appear to reside in wide open angles, the TM helix is at a narrow angle with respect to the membrane normal.

Conclusion

This study illustrates that bicelles can be a valuable EPR tool to study protein dynamics and topology on lipid membranes. Bicelles of DMPC can align in EPR at 308K. Addition of cholesterol and sphingomyelin reduces bicelle alignment, while using high fields significantly enhances the alignment of bicelles. EPR using aligned bicelles was successfully applied to study the effects of H0-Endo and H0-Amph on lipid order and the orientation of MPERTM in lipid bilayers.

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida. L.S. acknowledges the support of National Institutes of Health grant AI126901.

4.5.3 NMR

4.5.3.1 Diffusion Discriminates Between Micellar Networks

Holder, S.W.; Grant, S.C.; Mohammadigoushki, H., Chemical & Biomedical Engineering, FAMU-FSU College of Engineering, Florida State University; National High Magnetic Field Laboratory

Introduction

When mixed in aqueous solutions, surfactants self-assemble into a variety of highly dynamic micelle nanostructures of spherical, cylindrical, or wormlike shapes. The final structure of wormlike micelles (linear or branched) directly controls the properties and processing of commercial products. The goal of this work is to assess the sensitivity of NMR diffusometry to different types of micellar microstructures and identify the mechanism(s) of surfactant self-diffusion in micellar solutions. We used NMR based diffusion measurements to differentiate micellar structures (linear and branched) from each other. Diffusion studies using Nuclear Magnetic Resonance (NMR) spectroscopy were conducted at 11.75T and 21.1T on two model systems: cetyltrimethylammonium bromide (CTAB) and cetylpyridinium chloride (CPCl) with sodium salicylate in deuterium oxide (NaSal/D2O). By increasing salt-to-surfactant ratios (R), these solutions display a transition from linear to branched micellar networks.

Experimental

The high gradient fields at a magnetic field of 11.75T and 21.1T are used to investigate surfactant self-diffusion, provided the high sensitivity necessary to probe the evolving network of micelles across different diffusional regimes. NMR facility and FAMU-FSU College of Engineering, 500MHz magnet and also 900MHz magnet located in the NHMFL were used to perform this research.

Results and Discussion

Figure 4.5.3.1 shows that at low salt-to-surfactant concentration ratios, for which wormlike micelles are linear, the surfactant self-diffusion is best described by a mean squared displacement, Z^2, that varies as $Z^2 \propto T_{diff}^{0.5}$, where T_{diff} is the diffusion time. As the salt concentration increases to establish branched micelles, $Z^2 \propto T_{diff}$, indicating a Brownian-like self-diffusion of surfactant molecules in branched micelles. This result indicates that NMR diffusometry is capable of differentiating various types of micellar microstructures. In addition, the self-

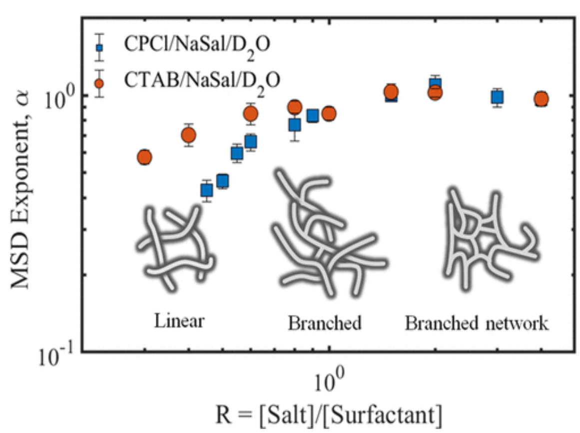

***Figure 4.5.3.1:** The mean squared displacement (MSD, Z^2) exponent (α) as a function of salt-to-surfactant concentration ratio, R, for two wormlike micellar solutions.*

diffusion coefficient of the surfactant molecules in linear and branched micelles are determined, for the first time, by comparing the existing restricted diffusion models and are shown to be much slower than the diffusion of proton molecules in the bulk. Moreover, in linear and moderately branched wormlike micelles, the dominant mechanism of surfactant self-diffusion is through the curvilinear diffusion of the surfactant molecules along the contour length of the micelles, whereas in the branched micelles, before the second viscosity maxima, the surfactant self-diffusion could arise from a combination of micellar breakage, exchange between micelles and/or the bulk.

Conclusions

Diffusion NMR discriminates between different structure networks. For linear micelles, the dominant mechanism of surfactant diffusion is curvilinear. As micellar branches form, self-diffusion arises from surfactant exchange with the bulk solution and other micelles. At high branching densities, curvilinear diffusion along the micellar contour-length is evident.

Acknowledgements

This work was performed at the US National High Magnetic Field Laboratory (NHMFL), which is supported by the State of Florida and the National Science Foundation Cooperative Agreement NSF/DMR-1157490/1644779. In addition, H.M. gratefully acknowledges support by the National Science Foundation through award CAREER CBET 1942150. S.C.G. and S.W.H. are supported by the US National Institutes of Health through award R01-NS072497.

References

[1] S.W. Holder *et al.*, *Langmuir* 37, 3585-3596 (2021).

4.5.3.2 New Methods for Solid-State NMR Across The Periodic Table

Altenhof, A.R., Schurko, R.W. (FSU, Chemistry; NHMFL); Jaroszewicz, M.J., Frydman, L. (Weizmann Institute of Science, Chemical & Biological Physics; NHMFL); Harris, K.J. (Louisiana Tech University, Chemistry); Wi, S. (NHMFL)

Introduction

Over 75% of the elements in the Periodic Table have NMR-active isotopes that are regarded as ***unreceptive*** to the NMR experiment, due to low natural abundance, low gyromagnetic ratios, and/or inconvenient relaxation characteristics. Solid-state NMR (SSNMR) investigations of many of these isotopes are further complicated by anisotropic interactions, which give rise to extremely broad patterns that range in breadth from 250kHz to several MHz, so-called ultra-wideline NMR (UW NMR) spectra. From the perspective of chemists, biochemists, and materials scientists, it is vital that many of these elements be available to routine investigation by SSNMR. Over the past year, our group has broken new ground in developing new techniques to acquire UW NMR spectra of numerous elements, such as ^{2}H, ^{14}N, ^{33}S, ^{35}Cl, ^{119}Sn, ^{195}Pt, ^{199}Hg, and ^{207}Pb. Our new methods include the use of broadband adiabatic inversion cross polarization (BRAIN-CP) to acquire spectra of integer spin nuclei like ^{2}H [1], a robust method for measuring T_1 and T_1 anisotropy in UW NMR spectra of spin-1/2 and quadrupolar nuclei [2], and an exciting new method known as PROSPR (Progressive Saturation of the Proton Reservoir) for indirect detection of unreceptive nuclei via abundant and highly receptive ^{1}H's [3].

Experimental

SSNMR experiments were conducted at the NHMFL on 14.1T (600MHz) and 18.8T (800MHz) NMR spectrometers outfitted with Bruker NEO consoles and state-of-the-art NMR probes designed and constructed at the NHMFL.

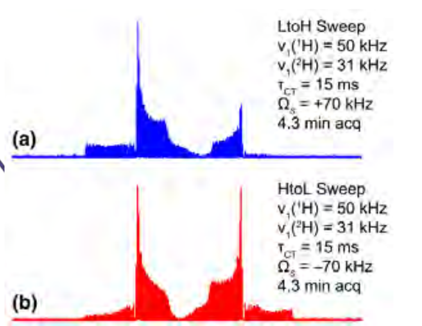

Figure 4.5.3.2.1: *^{1}H-^{2}H BRAIN-CP NMR spectra of MIL-53 acquired with WURST pulses sweeping in opposite directions (experimental times of 4.3 minutes).*

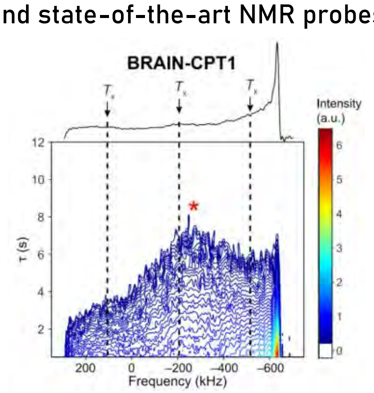

Figure 4.5.3.2.2: *^{1}H-^{2}H BRAIN-CPT1 NMR data for $Pt(NH_3)_4Cl_2{\cdot}H_2O$, from which the $T_1(^{195}Pt)$ and T_1 anisotropy (i.e., orientation dependence) are measured.*

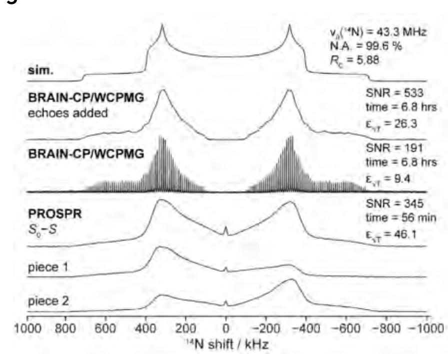

Figure 4.5.13.2.3: *^{14}N UW NMR spectra of $Pt(NH_3)_2Cl_2$ acquired with BRAIN-CP/WCPMG (6.8 hrs.) and PROPSR (56 min.) techniques.*

Results and Discussion

Based on a combination of numerical simulations and experimental investigations, we investigated the mechanisms behind ^1H-^2H BRAIN-CP, and obtained signal enhancements and reductions in experimental times far outpacing any method to date (**Fig. 4.5.3.2.1**) [1]. We then went on to devise a rapid means of measuring longitudinal relaxation time constants (T_1) from UW NMR spectra, and established a reliable method of determining T_1 anisotropies (*e.g.*, as in the case of ^{195}Pt, **Fig. 4.5.3.2.2**) [2]. Perhaps most excitingly, we introduced the PROSPR method, which is a SSNMR analog to the famous chemical-exchange saturation transfer (CEST) solution NMR experiment [3]. Here, dipolar order and spin diffusion are exploited to detect ^{14}N UW NMR patterns via dipolar-coupled ^1H (**Fig. 4.5.3.2.3**).

Conclusions

Our new methodologies, which are available for users at MagLab and around the world, hold much promise for expansion of SSNMR to NMR-active isotopes of spin-1/2 and quadrupolar nuclei from elements across the Periodic Table, opening possibilities of characterization of molecular-level structure, dynamics, and reactivity for many new materials.

Acknowledgements

The NHMFL is supported by the NSF through NSF/DMR-1157490/1644779 and the State of Florida. RWS acknowledges the support of the NSF Chemical Measurement and Imaging Program, with partial co-funding from the Solid State and Materials Chemistry Program (NSF-2003854), additional research funding from FSU, NHMFL, and the State of Florida, and early support on some of these projects from the Natural Sciences and Engineering Research Council of Canada (NSERC, Grant No. RGPIN-2016_06642 Discovery Grant). LF is supported by the Israel Science Foundation (Grant 965/18), the EU Horizon 2020 program (Marie Skłodowska-Curie Grant 642773), and by the Perlman Family Foundation.

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4.5.3.3 Understanding Ion Transport in Disordered Functional Materials

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Introduction

Ion transport occurs in both biological and technological systems. Fundamental understanding of ion transport mechanisms is critical to tackling biological malfunctions and enhancing performance of functional materials. However, ion migration can be challenging to track, especially for small and light ions in disordered materials. We developed a new method, electrochemically driven tracer-exchange NMR, which combines high-resolution NMR with tracer exchange to determine ion transport pathways in complex systems [1]. This method has been applied to decipher ion transport paths in inorganic and organic-inorganic composite solid electrolytes for rechargeable lithium-ion batteries. Recently, we have applied this method to unveil the origin of the high ionic conductivity of cellulose-derived fast ion conductors [2].

Experimental

To investigate the Li^+-transport pathways in the copper-coordinated cellulose Li^+-ion conductors, denoted as Li-Cu-CNF hereafter, we performed $^6Li \rightarrow {}^7Li$ tracer-exchange NMR. The tracer exchange ($^6Li \rightarrow {}^7Li$) was driven by electrochemical cycling using ^6Li-enriched metal (95 atom%; Sigma Aldrich) as electrode foils. The Li-Cu-CNF (or Li-CNF as a control) electrolyte was assembled between two ^6Li foils to form a symmetric cell (^6Li// Li-Cu-CNF//^6Li). The cell was galvanically polarized for 50 cycles with a current density of 32μA cm^{-2}, and the current switched directions every 30 min. After cycling, the electrolyte was removed from the cell for ^6Li NMR measurements. ^6Li magic-angle-spinning (MAS) NMR experiments were performed on a Bruker Avance III-500 spectrometer at the NHMFL. Samples were packed in 2.5-mm rotors and spun at a speed of 25kHz. The NMR resonances were assigned to different chemical environments of Li^+-ions in cellulose and the normalized areal integrals of these resonances are used to determine Li^+-ion transport pathways.

Results and Discussion

After ^7Li in Li-Cu- CNF was exchanged with ^6Li tracer by electrochemical cycling, the number of $^6Li^+$-ions coordinated with COO−, RO−, ROH/H_2O and PF^{6-} in Li-Cu-CNF increased by 15, 20, 25 and 4.5 times, respectively, compared with Li-Cu-CNF before cycling **(Fig. 4.5.3.3).** Thus, the hopping sites of Li^+ are mainly the counter-anions in the cellulose.

The Li–Cu– CNF exhibits an ionic conductivity of 1.5mS/cm, which is nearly two orders of magnitude higher than traditional polymer ion conductors. Based on the NMR investigations, this unusual fast ion conduction in Li–Cu–CNF can be partially attributed to the diverse anion functional groups, which weakens Li^+-anion pair interactions with flattened energy landscape for ion transport and affords high Li^+-ion mobility.

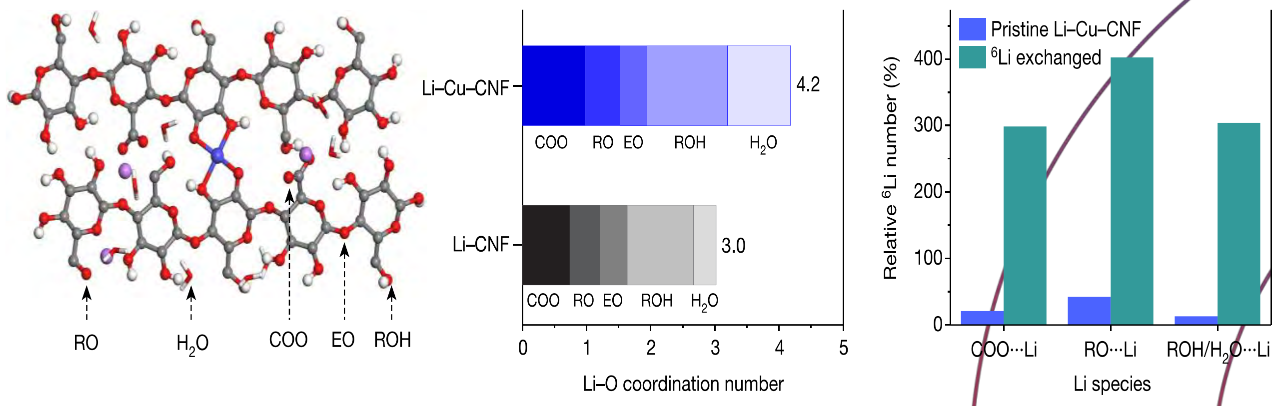

Figure 4.5.3.3: *Left: local structures of Li-Cu-CNF with anion groups indicated. Middle: Li-anion coordination numbers. Right: results from tracer-exchange NMR, suggesting that COO-, RO, and ROH/H_2O are the functional groups that constitute Li^+-ion transport pathways.*

Conclusions

Electrochemically driven tracer-exchange NMR reveals the origin of fast ion transport in a high-performance cellulose ion conductor, Li–Cu– CNF. Balanced interactions of the charge carrier cations with a variety of anions minimizes cation local trapping and thus facilitates fast ion conduction. This work provides new insights in the future design of novel materials with exceptional ionic conductivities.

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida. Y.-Y. Hu acknowledges support from the National Science Foundation under the grant DMR-1847038.

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4.5.3.4 Solution-State High Field DNP On Large Volume Samples: Sensitivity-Enhanced NMR For The Organic Chemist

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Introduction

The NMR and EMR groups at the MagLab are working to implement sensitivity-enhanced liquid-state NMR spectroscopy at high fields, while utilizing the platform of a conventional liquid-state NMR spectrometer of the type used in organic chemistry analysis, targeting large sample volumes (50~200µL) by means of novel DNP mechanisms. By developing new forms of DNP-enhanced NMR in organic solutions, we envision that signal enhancements of ~10-100-fold can be achieved, without sacrificing the highly optimized conditions involved in the contemporary high-field solution-state NMR.

Experimental

In order to achieve this, we have built a state-of-the-art DNP NMR facility that includes a high-powered gyrotron, a quasi-optical bench, a field sweep device, and a customized double-resonance mode ^{1}H-X NMR probe capable of delivering high-power microwaves – all of this operating at 14.1T and interfaced to a 600MHz NMR spectrometer (**Fig. 4.5.3.4**) [1].

Results and Discussion

Using this system, we have successfully obtained large volume DNP-enhanced ^{31}P, ^{13}C, and ^{1}H-^{13}C INEPT NMR spectra at ambient temperature at high fields, via scalar-driven Overhauser mechanisms [2,3]. We have also identified two independent, complementary approaches that could enable extending these successes to enhancing the NMR signals of arbitrary molecules [4]. One of these approaches relies on the use of low-viscosity supercritical solvents enabling electron→nuclear Overhauser-based DNP (ODNP); the other relies on our breakthrough discovery of new mechanisms that, by relying on hitherto unknown relaxation processes arising in biradicals, enable transfers from two *J*-coupled electrons to one nucleus over a wide variety of fields and correlation times.

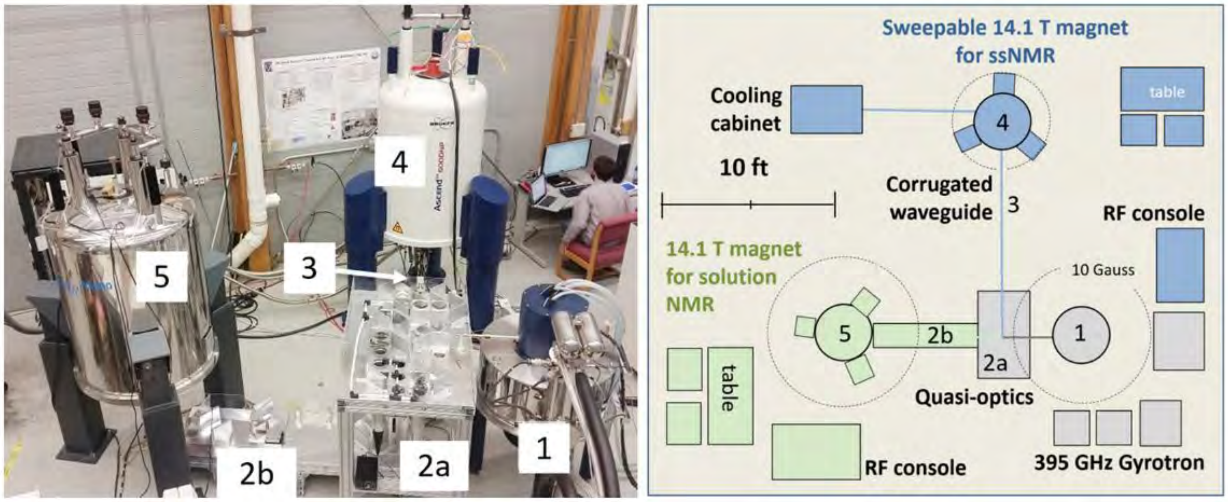

Figure 4.5.3.4: *Photograph (left) and schematic (right) of the dual 14.1 T DNP-NMR systems. Components: 395 GHz gyrotron (1), upper quasi-optical table (2a), lower quasi-optical table (2b), corrugated waveguide (3), 14.1 T MAS-DNP magnet (4), and 14.1 T Overhauser DNP magnet (5).*

Conclusions

Being compatible with conventional signal averaging, either of these DNP NMR breakthroughs could enable faster acquisitions of 1D and 2D NMR experiments, probe via polarization transfer experiments involving isotopes such as ^{13}C or ^{15}N at natural abundance, and facilitate collaborations with scientists from academia and industry to study small organic molecules in scarce amounts found in applications including metabolomics, food and pharmaceutical sciences, natural products, polymer additives, and the petroleum/energy industry.

Acknowledgements

The National High Magnetic Field Laboratory is supported by the National Science Foundation through NSF/DMR-1157490/1644779 and the State of Florida. LF is supported by the Israel Science Foundation (Grant 965/18), the Weizmann/UK program, and the Perlman Family Foundation. SH and LF also acknowledge the support of the NSF (CHE-1229170, CHE-1808660).

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4.6 MAGNETS AND MAGNET MATERIALS

4.6.1 INTRODUCTION

A central part of the MagLab's Mission is to develop, operate, and maintain the new magnet systems that enable a world-leading high-magnetic-field user program. One of the MagLab's science drivers is to develop the materials and other technologies required to enable these and other state-of-the art magnets.

For twenty-six years the MagLab's user facilities were based on copper alloys and low-temperature superconducting (LTS) materials. In 2020 the MagLab commissioned its first magnet using High Temperature Superconducting (HTS) materials, a 32T magnet, presently the highest field superconducting (SC) magnet worldwide! This magnet is the product of a development effort that started at a low level in 2007 when the first coil using a new generation of commercial REBCO (rare earth barium copper oxide, $REBa_2Cu_3O_7$) conductor became available. The total cost, greater than $16M to develop the technology and deliver the working system, is an indication of the tremendous amount of development that went into characterizing the conductor, developing an insulation system, joints, terminals, winding technology, quench-protection technology and controls system.

The presently operational user magnet provides field approaching that of our workhorse resistive magnets (35T in 32mm room-temperature bore) while having lower field ripple and electronic noise, and consuming approximately 20MW less power. While eight resistive magnets share two pairs of power supplies, the 32T SC magnet is expected to eventually be running 24/7, like the other (20T) SC magnets in the milliKelvin facility, thereby providing a 60% field increase for this class of magnet.

While this magnet produced a remarkable 7T more field than any other SC magnet worldwide when it was first tested in 2017, this is not the end of the story, rather just the beginning. The MagLab has initiated development of a 40T SC magnet using similar REBCO technology. In 2021 a Conceptual Design Report was completed and a $15.8M grant from NSF's Mid-Scale Research Infrastructure 1 program was awarded to fund the Preliminary and Final Designs of the 40T magnet system. We intend to submit a proposal for construction of the magnet in early 2025.

Meanwhile, a development of ultra-high field (UHF) magnets (above 24T) has picked up pace worldwide, in labs and in industry. Like the user magnets above, many efforts use the REBCO conductor, where notably fusion endeavors have invested hundreds of millions of dollars. The MagLab has grown interactions with fusion and has extended its capabilities to characterize conductors and cables. Uniquely, the MagLab has been leading the development of improved Bi-2212 ($Bi_2Sr_2CaCu_2O_{10}$) conductor and coils, which show great potential for future UHF SC magnets, particularly due to its multi-filamentary structure and consequent low screening currents and resulting field distortion. Recent test coils have demonstrated very high current densities, and great progress is being made to support the Lorenz forces inherent in UHF magnets.

In 2018 the generator that powers the 100T multi-shot (100TMS) and 60T long-pulse (60TLP) magnets was damaged and was taken out of service for repair. To continue to provide state-of-the-art facilities to users of the pulsed field facility, a "Magnet Surge" project was introduced to accelerate the development of capacitor-driven magnets at the 75T level in short-pulses (now operational) and the 60T level with longer pulses (operational since mid-2021). Another component of the Surge is an 80T magnet that should start to serve users in 3Q2022.

Materials development for magnet applications continues to advance with important developments in Bi-2212, Fe-based, and Nb_3Sn superconductors, qualification of REBCO from multiple suppliers, as well as reinforcing materials for pulsed and SC magnets.

Collaborations with leading industry, academic and government groups are synergistic with the materials and magnets science driver, and our report describes work in this broader context as well. Collaboration with the high-energy physics community continues, particularly regarding development of higher current-density superconductors, both LTS and HTS. The MagLab is one of the four central players in the US Magnet Development Program (MDP) funded by the Department of Energy (DOE) Office of High Energy Physics (HEP) to drive ultra-high field accelerator dipole magnet technology.

4.6.2 SUPERCONDUCTING MAGNETS AND MATERIALS

4.6.2.1 40 T All-Superconducting Magnet

The MagLab is developing a 40T all superconducting user magnet with a cold bore size of 34mm. When complete, the 40T SC magnet will be installed in the DC Field facility of the MagLab, near the existing 32T SC magnet. The 40T SC magnet will provide a very low noise environment for experiments lasting days at a time, surpassing the time available from present-day powered (resistive and hybrid) magnets that provide similar field. Upon its commissioning, the 40T SC magnet will become a flagship in the MagLab's suite of high-field magnets that exist to serve the User Community.

The 40T superconducting magnet project progressed from the conceptual design phase to the preliminary design phase in 2021. The conceptual design project started in December 2019 (Award number: NSF/DMR #1938789), and the conceptual design report was completed and submitted to the NSF in April 2021. A Mid-Scale Research Infrastructure - 1 grant for the preliminary and final design was awarded to the MagLab in September 2021 (Award number: NSF/DMR 2131790) and will be complete in 5 years. The paragraphs below highlight the achievements in 2021.

(1) Conceptual design of the 40T magnet

We completed the 40T magnet conceptual design, which consists of a 12T Low Temperature Superconducting (LTS) magnet of 320mm cold bore and a 28T HTS insert. The LTS magnet will be acquired commercially. The 28T HTS insert will use REBCO tape conductor wound into double-pancakes and will be developed in-house. There are two options for the HTS coils: MTI (Multi-Tape, Insulated) and RI (Resistive Insulation). The major difference between the two options is the insulation technology between turns and their corresponding quench protection technique. LTS magnets have insulated conductor, and the REBCO magnets installed by both the MagLab and Bruker also use insulated conductor. The MTI version of the insert design continues this tradition of insulated conductor but uses two REBCO tapes in parallel to reduce the sensitivity to point defects in a single strand. The RI approach does not use insulated conductor, but a controlled inter-turn resistance, which allows current to bypass any point defects in the conductor. Both options require stainless steel tape to be co-wound with the REBCO tape to provide additional structural support and both require a controlled surface treatment of the stainless-steel strip (insulating for MTI, controlled resistance for RI). **Table 4.6.2.1.2** shows the HTS coil design parameters. **Figure 4.6.2.1.1** shows the field distribution.

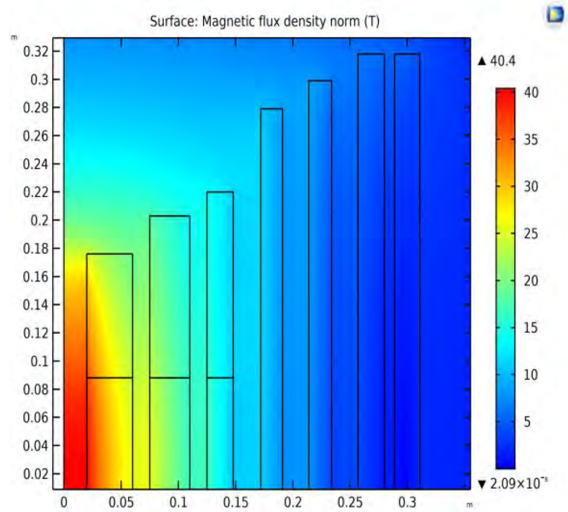

Figure 4.6.2.1.1: *Field distribution of 40T conceptual design, which consists of three nested HTS coils providing 28T at field center and a 12T LTS magnet.*

Table 4.6.2.1.2: *HTS Coils Design Parameters*

Parameter	Units	Inner Coil	Middle Coil	Outer Coil
Inner Diameter	mm	40	140	240
Outer Diameter	mm	120	220	306
Length	mm	352	404	440
Field Generated	T	13.0	8.8	6.3
Central Field	T	40.1	27.1	18.3
Max Radial Field	T	4.7	5.8	5.9
Max Field Angle	°	13	21	27
Max. ratio of operating to critical current I_{op}/I_c	%	70	70	70
Minimum I_{op}/I_c	%	30	50	55
Average current density	A/mm²	275	205	198
Copper current density – MTI-REBCO	A/mm²	695	695	695
Copper current density – RI-REBCO	A/mm²	1008	1008	1008
Amount of REBCO tape	km	3.5	5.0	6.5

(2) MTI Test Coil 1 (MTI-TC1)

MTI-TC1 is a sub-scale test coil to develop MTI-REBCO magnet technology. It was built to investigate the two-in-hand winding technology with I_c graded REBCO tapes. The goals of TC1 are to demonstrate the two-in-hand coil with REBCO tape of standard thickness and co-wound copper, and to demonstrate quench protection of a two-in-hand winding coil with I_c graded conductors, among other features. TC1 consists of 8 modules with inner and outer radii of 23 and 70mm, respectively, and uses various conductors to maintain a ratio of operating current to critical current (I_{op}/I_c ratio) up to ~60% (twice that of the 32T magnet). **Figure 4.6.2.1.3** shows the fabricated coil.

Figure 4.6.2.1.3: *MTI-TC1 with instrumentation wiring.*

TC1 was cycled to a peak strain of ~0.6% 718 times. Despite the high operating strain, the coil did not show any obvious damage during fatigue operation. TC1 was also tested with deliberate quench initiation by resistive heaters. The heaters use an improved design compared with those of the 32T. A new energy source for the quench protection system consisting of a Pulse Forming Network (PFN) was fabricated for TC1 quench testing, and the test results showed very good agreement with the design **(Figure 4.6.2.1.4).**

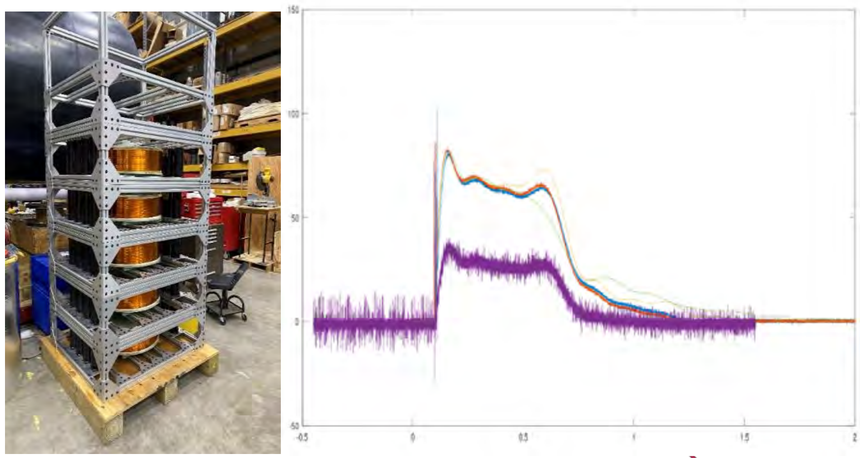

Figure 4.6.2.1.4: *The PFN fabricated in-house and the output waveform during TC1 testing.*

(3) Resistive Insulation Test Coils (PTC4, PTC5, PTC6)

For the RI-REBCO technology development, we focused on the quench protection of RI coils. Three subscale coils, PTC4, PTC5 and PTC6, were fabricated and tested in the past year to investigate the quench protection of RI coils progressively. **Figure 4.6.2.1.5** shows the pictures of the three test coils. PTC4 has 5 modules with REBCO tapes of standard I_c. PTC5 has the same size as PTC4 but using I_c graded tapes. PTC6 has 6 modules, smaller inner diameter but thicker radial build (20mm). PTC6 also incorporated contact resistance control with I_c graded tapes.

PTC6 was quenched 22 times, and the quench initiations in the Resistive Insulation coil with both inductive coils and resistive heaters were demonstrated. We measured the large axial force during quench of these coils, which is expected but not desirable.

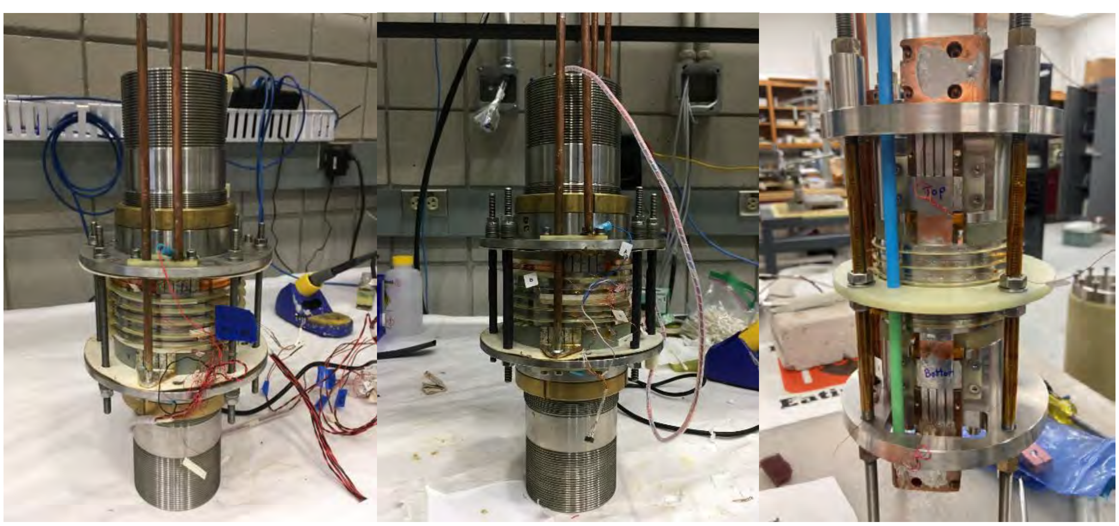

Figure 4.6.2.1.5: *Petten Test Coil 4, 5, and 6.*

(4) Axial pressure test coils

We performed fatigue tests on axial pressure test coils with the objective of determining the limits of axial compression in REBCO double-pancake coils both under static and cyclic loads.

The test coils were wound with 95µm thick SuperPower tape and co-wound with stainless steel and loaded in their axial direction with the 500kN MTS test machine in liquid nitrogen. Two RI coils were tested, one with stainless co-wind wider and one narrower than the REBCO. A third coil, the MTI coil wound with a copper tape co-wind, was also tested. **Figure 4.6.2.1.6** shows the test results. The sample with wider co-wind reached 151 MPa and survived 50 kcycles at 100MPa and 50 kcycles at 150MPa. In contrast, the specimen with more narrow co-wind reached 5% degradation at 95MPa prior to cycling. It did not however appear to further degrade at the 100 MPa, 50 kcycle cycling. For the MTI-wound, wax impregnated axial pressure coil, the narrower than REBCO co-wind reinforcement did not limit performance up to the testing requirements of 125MPa applied axial load.

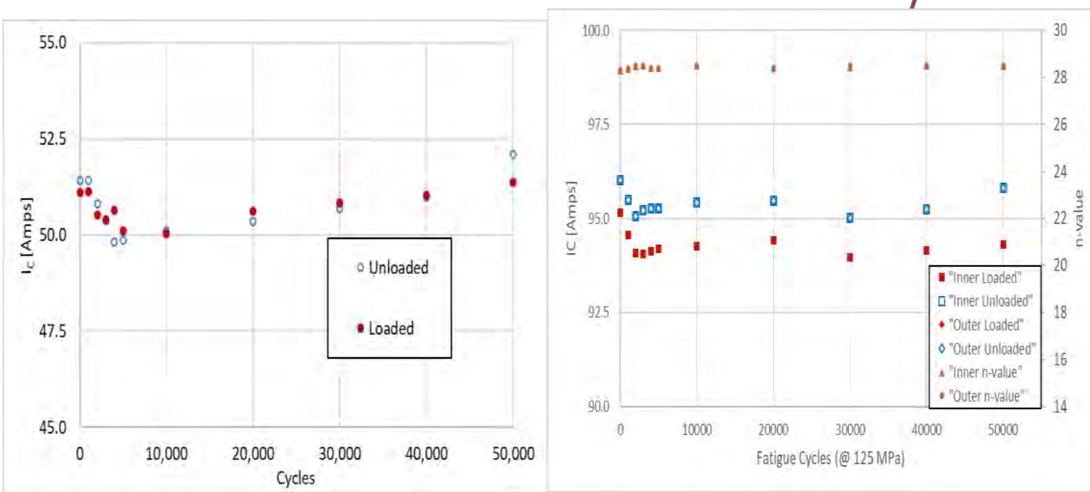

Figure 4.6.2.1.6: *Test results of axial pressure test coils: critical current I_c is plotted versus the number of cycles of axial pressure. Left: 100MPa applied to RI test coil with wide SS co-wind. Right: 125MPa pressure applied to the MTI coil with narrow co-wind.*

(5) Preliminary and Final Design Project of the 40T SC magnet

In 2021, the preliminary and final design proposal of the 40T SC magnet was awarded, and the project started in October. The project will proceed with mid-scale test coils (MTI-TC2 and RI-NC) and complete their tests in the first year. After completion of the mid-scale test coils, the insulation technology for the 40T magnet will be selected, and this will complete the first major milestone of the project.

4.6.2.2 Other REBCO Coil Development

Beyond the 40T all superconducting magnet project, other work includes collaborations with the Spallation Neutron Source (SNS) at Oak Ridge National Lab, Cryomagnetics, and others. Additionally, in-house research includes improvements to our Yatestar device for quality assurance as well as a novel characterization approach based on torque magnetometry.

The work with SNS was a pre-conceptual design study to determine what central field might be feasible from an all-superconducting magnet using REBCO double-pancake technology and LTS coils in a magnet with a 12mm split at the mid-plane and 8 ports for neutron scattering. The design approach is based on the 40T MTI concept developed for the 40T magnet project described above. The effort focused on three aspects: (1) analyzing the forces and stress in the spacer separating the two halves of the magnet and providing the scattering space, (2) the hoop strain in the REBCO coils, and (3) optimizing the coil lengths to maximize central field and control the axial clamping and resulting stress in the mid-plane spacer. Two different port shapes were considered: elliptical and rectangular conical ports. We see that the stress concentrations near the corners of the rectangular ports require this version of the mid-plane spacer to be thicker than the one with conical ports. This increases the separation between the two halves of the magnet and reduces the central field by ~2T. The stress distribution of the mid-plane spacer for the conical configuration is shown in **Figure 4.6.2.2.1.**

An STTR Phase I grant funded by the Department of Energy Office of High Energy Physics (DOE-HEP) is underway with Cryomagnetics Inc. The goals of this Phase I project include developing a viable design of a 30T

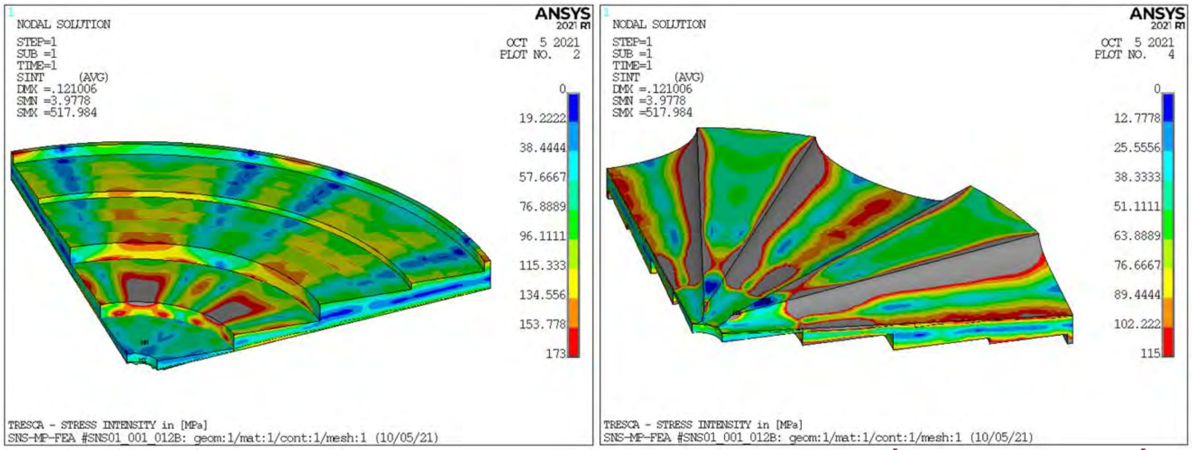

Figure 4.6.2.2.1: *Stress distribution in mid-plane spacer of the split magnet pre-conceptual design for SNS with elliptical holes.*

class commercial all-superconducting magnet based on REBCO superconducting tape. This magnet design is significantly different from that of our 32T magnet presently in operation at the MagLab because it incorporates information developed over the past nine years since the design of the 32T magnet was finalized. At this point we believe RECO double-pancake coils can operate at much higher current density than those of the 32T magnet. Consequently, this 30T design is much more compact than that of the MagLab's 32T magnet. In addition, this STTR project is focused on developing REBCO double-pancake technology with turns bonded together, which should simplify the design process as well as reduce the peak strains.

In collaboration with Princeton Plasma Physics Laboratory (PPPL) and Advanced Superconductor Technology (ACT), an experiment is currently under preparation to characterize the fatigue behavior of a CORC™ cable wound solenoid made by ACT. This coil will be tested inside our 14T, 161mm cold bore superconducting magnet system. The 2-layer thick coil is about 60mm high, has a total of 12 turns with an ID of 119mm and an OD of 152mm.

A novel technique to characterize REBCO samples efficiently and fully has shown tremendous success. Torque magnetometry allows for quick measurement of J_c for a piece of REBCO tape over the full range of applied field angles. The traditional approach to measure this uses transport current and is difficult to employ successfully when the applied field is parallel to the surface of the tape (*ab* plane) because the high currents needed introduce significant heating to the experiment. The new approach can be completed in 2 to 4 hours instead of weeks and consumes far less LHe. It enables measurements to be performed at a range of fields (up to 35T to date) and temperatures (4K and 55K to date). Some results are shown in **Figure 4.6.2.2.2.** Being able to measure critical current with field parallel to the tape is critical for high-performance magnets because most of the conductor in a magnet has the field close to this orientation. Knowing the behavior at a variety of temperatures is important for predicting the way quench will evolve in the magnet and prevent damage due to it.

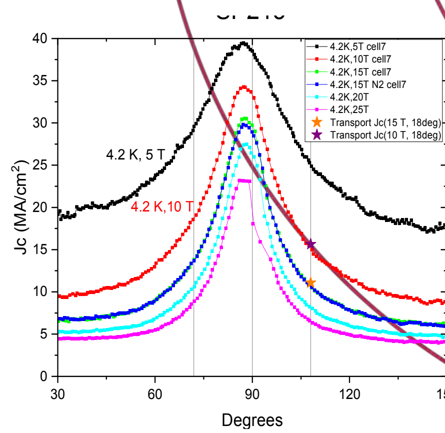

Figure 4.6.2.2.2: *Measurements of critical current density of REBCO tapes at 4.2K with different applied field magnitude and direction using force magnetometry. The angle is measured from the c-axis (perpendicular to the tape).*

4.6.2.3 Bi-2212 Coils

25T general science magnet with Bi-2212

One of the goals the ASC pursues is the development of compact 25T, all superconducting, general science magnets, a project that we are currently working on in collaboration with Cryomagnetics Inc. and with additional financial support through the Department of Energy (DOE). The final magnet system will consist of a 17T low temperature superconducting (LTS) outsert with an 8T Bi-2212 coil nested inside. The cold bore will be ~40mm

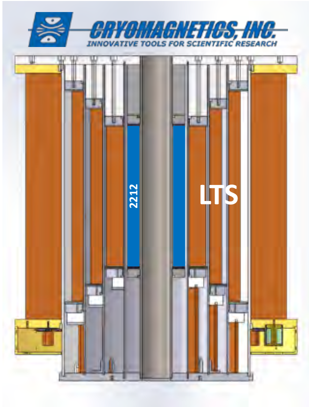

Figure 4.6.2.3.1: *Sketch of the the 25T general science magnet system to be built in collaboration with Cryomagnetics Inc. It shows the 8T Bi-2212 HTS insert inside a 17T LTS outsert magnet to be built at Cryomagnetics. The ID of the HTS section and cold bore of the magnet will be ~40mm. At an OD of the HTS section of ~100mm it will be using ~700m of Bi-2212 conductor.*

Bi-2212 and Bi-2223 Insert Coil Design for 28.2 T / 40 mm Bore UHF NMR Magnet System		
Bi-2212 Coil #1	a1; a2; z1; z2 [mm]	22.2; 40.5; -178.6; 178.6
	Turns	3920
	Field [T]	5.17
	wire length [km]	0.77
Bi-2212 Coil #2	a1; a2; z1; z2 [mm]	44.45; 55.3; -178.6; 178.6
	Turns	2240
	Field [T]	2.89
	wire length [km]	0.71
Bi-2223 Coil	a1; a2; z1; z2 [mm]	58.5; 81.4; -212.5; 212.5
	Turns	5767
	Field [T]	6.16
	wire length [km]	2.6
HTS Section Current [A]		380.5
Store Energy [MJ]		< 3 (~0.5 MJ in HTS)

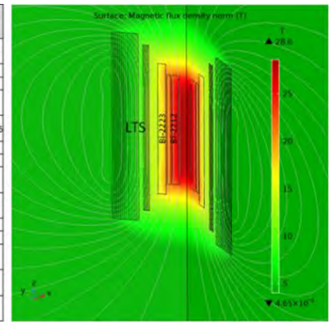

Figure 4.6.2.3.2: *Overview of the 28T UHF magnet to be built in collaboration with OINS. The magnet consists of three HTS sections, two Bi-2212 coils and one Bi-2223 coil nested inside the 12T IMPDAHMA LTS magnet. The cold bore of the system will be ~40mm. Field compensators and shim-coil sets are not shown in this picture.*

with the Bi-2212 section using about 1km of conductor, which is well within the typical commercially available conductor piece lengths of about 1.3km, so that internal joints may not be required, **Figure 4.6.2.3.1.**

28T ultra-high field (UHF) magnet with high homogeneity

In anticipation of a grant through the National Institute of Health (NIH) for a 28T UHF magnet system, we started working on a scoping design for a magnet system in collaboration with Oxford Instruments Nano Science (OINS). As an efficient way to reduce total costs, we intend to use our 12T LTS magnet ("IMPDAHMA") made by OINS as outsert. In preparation for this work and with support from OINS, the IMPDAHMA magnet was modified to its current layout as a 12T, 212mm cold bore magnet. The HTS insert consists of two inner coils made with Bi-2212 conductor nested inside a layer-wound coil made with Bi-2223 (i.e., $Bi_2Sr_2Ca_2Cu_3O_{14}$), which promises a cost effective HTS insert, while at the same time providing a solution to overcome minimum bending radii limitations due to bending stresses of the Bi-2223 section. The Bi-2212 coils will each use about 800m of conductor, while the Bi-2223 section will be using about 2.6km of conductor already in MagLab inventory. Due to different current requirements, it is planned to power the HTS coil set in series and separately from the LTS coil. Field models have shown that within this scenario a total field of ~28T appears possible. Including a particular arrangement of field compensation coils and shims - as per collaboration agreement with OINS further details cannot be shown in the picture - models predict a field homogeneity within the target range of 1ppm over 1cm, **Figure 4.6.2.3.2**. Achieving this homogeneity would be a significant step toward a nuclear magnetic resonance (NMR) magnet at 1.1GHz and above.

Low inductance high-field coils with 2212 Rutherford cable

Within the framework of the DOE Magnet Development Program (MDP), where we collaborate with other leading national laboratories and with a synergistic view towards 50+T magnet systems at the NHMFL, we continued efforts on the application of Rutherford type cabled Bi-2212 round wire for low inductance and high current magnets including both high field solenoids and accelerator magnets for the HEP community. Within the collaboration, we heat treated several racetrack and canted cosine theta (CCT) type coils made with Bi-2212 Rutherford cable at Lawrence Berkeley National Lab (LBNL) that were tested successfully, including a 4.7T (5.7kA) dipole. This year we added a first Bi-2212 Rutherford cable solenoid to the mix to start exploring its suitability as a high field insert inside an all-superconducting cable-based magnet system, **Figure 4.6.2.3.3a.** As is the case with Bi-2212 strand, Rutherford cable provides a very versatile form factor. It is fully transposed and can be wound to very tight radii without performance loss regarding

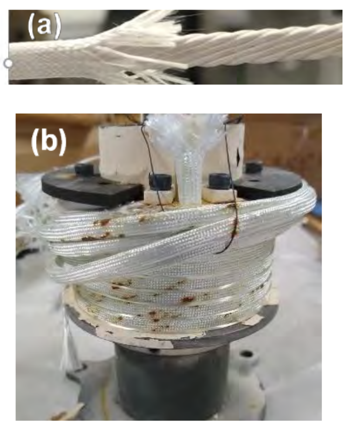

Figure 4.6.2.3.3: *a) Picture of a 9-strand TiO_2 coated Bi-2212 Rutherford cable inside an alumino-silicate fiber braid. b) The Rutherford cable coil after OPHT. There is leakage visible in several locations where the cable is in close contact with the ceramic braid. The terminal area, where the braid had been removed beforehand, no leakage was observed. The loosely wound turns at the top of the coil are excess wire past the terminals that are being removed before the coil test.*

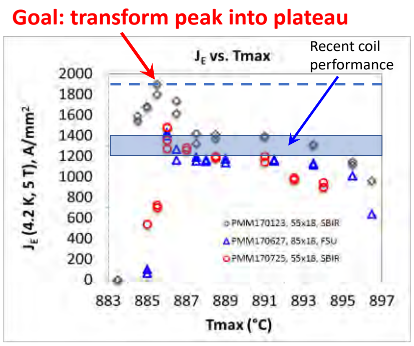

Figure 4.6.2.3.4: This graph compares of the typical performance of current Bi-2212 conductor with the performance of most recent conductor revealing even higher performance than currently available. This performance, however, is currently only achievable in a very narrow OPHT processing window that is not compatible with coil processing. It is the goal of our ongoing conductor R&D effort to transform this peak into a plateau to also make these extremely high performing conductors available for coils. The blue-gray area marks the typical performance range of samples extracted from coils that perform on par with short conductor samples.

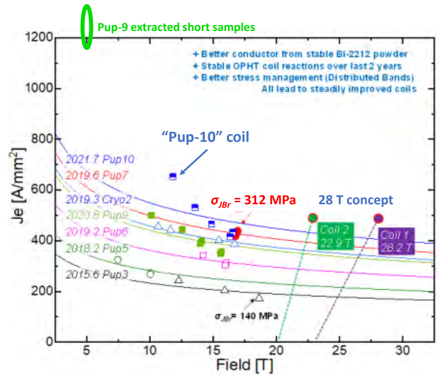

Figure 4.6.2.3.5: A history of test coils compounding OPHT process improvements as well as changes in coil reinforcement and terminals. While a steady improvement of coil performance can be seen in the plot, there is still work ahead to close the gap between coil and short sample performance.

bending strain, which is absent in these wind-and-react conductors. Thus, one obvious application is as the innermost and highest field nested coil inside mid- and low- field outsert coils.

Strand based Bi-2212 test coils: Current Bi-2212 conductors have excellent transport properties and with critical current densities (current divided by superconductor area) J_c of 6500A/mm² (16T, 4.2K), by far exceeding the Future Circular Collider (FCC) specification of 1500A/mm². In most recent conductors, in fact, we showed that even higher transport properties appear to be possible, **Figure 4.6.2.3.4.** At this point however, these extremely high transport properties are accessible only within a small set of thermal processing variables that can be used for the heat treatment of conductor samples but are currently not compatible with the thermal masses of larger coils. Finding ways to bridge this application gap is one of the goals of the ongoing, DOE-funded conductor R&D effort at the ASC.

A critical step towards high magnetic fields is to make mechanically resilient coils that withstand the enormous forces exerted on the coil windings under operating conditions. Several model coils have been made to explore the limits of our strengthening techniques towards defining safe application at larger diameter and higher field magnets. The coil series generated progressively higher stress levels, as shown in **Figure 4.6.2.3.5.** Our test vehicles are medium size, 200m class coils with substantial winding thicknesses to provide a meaningful test environment. One of these coils is shown in **Figure 4.6.2.3.6** and its specification in **Table 4.6.2.3.7.** We have learned valuable lessons from post-mortem deconstruction of one of our recent test coils, which had extensive but non-uniformly distributed reinforcement through its winding pack. A primary lesson was that a uniform distribution of reinforcing layers reduces radial stress discontinuities that can cause failure of the winding-epoxy-reinforcement interfaces and amplify conductor stresses in layers outward of those interfaces. Follow-up FEA modelling confirmed that this interface failure resulted in unacceptably high strains that degrade transport properties in 2-3 layers next to

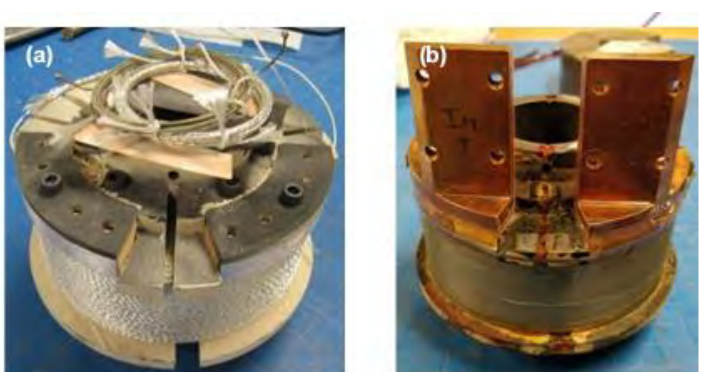

Figure 4.6.2.3.6: "Pup"-type coils are our test vehicle to tackle mechanical integrity issues, terminals, and other developmental aspects of Bi-2212 strand-based coils. They are short but relatively thick and to stay cost efficient use a moderate amount (~200m) of conductor. The pictures show a coil right after OPHT (a) and fully instrumented after epoxy impregnation and ready for testing (b).

Table 4.6.2.3.7: Coil specification

Pup 9		
Wire	Product No.	PMM180410-1
	Powder	nGimat 116 (85 x 18)
	Insulation	In-house coating+mullite braid
	Diameter [mm]	Φ 1.0 (bare) / Φ 1.2 (ins.)
ID ; OD ; Height [mm]		44.5 ; 113.9 ; 40.7
Turn ; Layer (Total)		30 ; 26 (772)
Magnet constant [mT/A]		11.303
Center field @ 100 A [T]		1.13
Inductance [mH]		31.5
Conductor length [m]		~ 200
Status		Tested

that interface. Overall, however, we observed consistently high J_e (critical current divided by entire strand area) within a representative sub-set of hundreds of short samples extracted from the mechanically undamaged portions of the coil. Those transport properties were at the level of the reproducible short sample limit shown in **Figure 4.6.2.3.8a**, and clearly indicate that we can reliably heat treat larger coils with excellent conductor transport properties throughout the winding pack. This observation alleviates many of our concerns about potential variations in critical current I_c in the kilometer length Bi-2212 wires presently being manufactured. This leaves mechanical reinforcement of coils as the most critical effort towards high coil performance. Our internal reinforcement strategies have allowed us to double the effective safe peak stress to over 310MPa in recent coils. However, while we have the J_e required to build a 28+T magnet system, we have to push the effective safe peak stresses in coils further up. Besides adding, redistributing, or changing reinforcement in coils, we will have to improve our understanding and the control of interfaces.

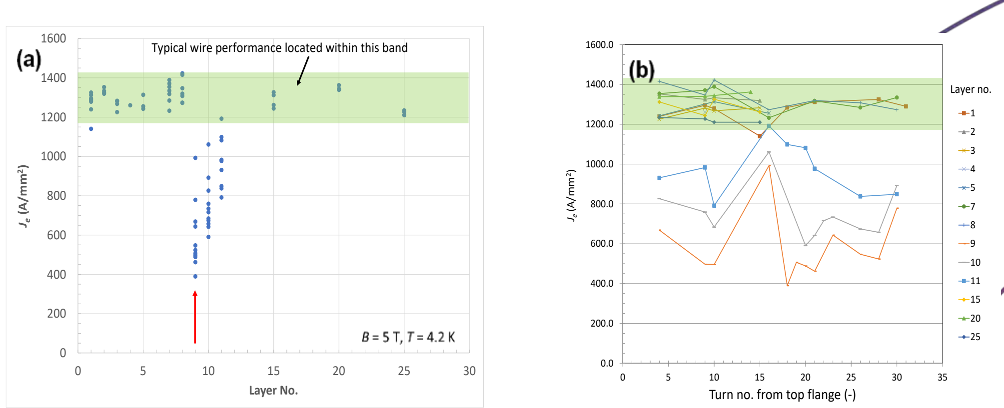

Figure 4.6.2.3.8: *(a) Short sample performance of samples extracted from one of the "Pup" coils after in-field testing of the coil. A failure of the interface between winding and reinforcement caused damage in layer 9, which then propagated into 2-3 consecutive layers. (b) The same data set highlighting the performance variations of the damaged layers from flange to flange. Transport properties are clearly degrading towards the flanges and recover towards the midplane of the coil.*

As can be seen in **Figure 4.6.2.3.8b,** the transport properties in the damaged layers of the coil shown degrade towards the flanges and appear to recover towards the coil's midplane. This indicates another contributing factor besides hoop stresses that affect the mechanical integrity of coils. A FEA model, shown in **Figure 4.6.2.3.9,** which focused on thermal contraction between room temperature and the coil operating temperature of 4.2K, revealed potential stress concentrations at the reinforcement material starting from the flanges.

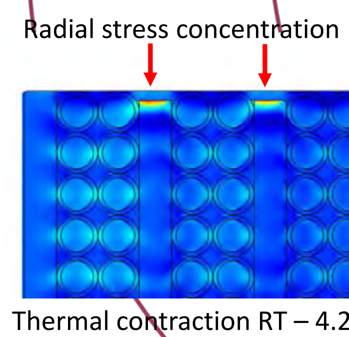

Figure 4.6.2.3.9: *Detail of a FEM coil model. The vertical bars (left to right) mark the bore tube and two reinforcement layers. The model indicates the occurrence of radial stress concentrations near the interfaces of the flanges.*

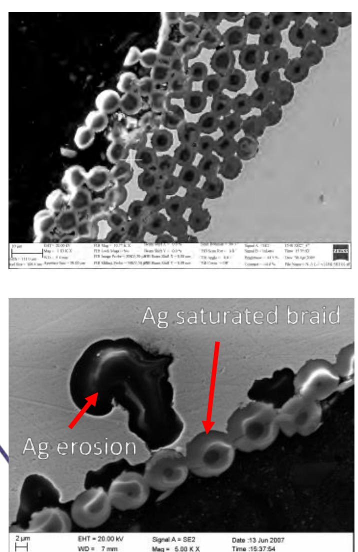

Figure 4.6.2.3.10: *These SEM images of an alumino-silicate braided Bi-2212 conductor show (top) the interface, braid against silver matrix, with the braid saturated with silver after heat treatment and (bottom) the significant amount of erosion of the silver sheath.*

Rutherford cable-based Bi-2212 test coils:

One of the big advantages of Bi-2212 conductor is its high versatility and literal flexibility, which is a strong benefit of wind-and-react type round wire conductors that easily adapt to different form factors. In 2021 we built a first Bi-2212 Rutherford-cable-based solenoid. The 10m long cable, in a nine-strand configuration, shown in **Figure 4.6.2.3.10,** was supplied to us by our collaborators at LBNL. Driven by the knowledge of a chemical incompatibility between the silver of the conductor matrix and small amounts of silica in the ceramic fiber electrical insulation around the conductor, we have previously set up a coating route that applies a TiO_2 layer on round-wire strands to serve as a buffer. The interaction between the silver and the ceramic fiber, which causes silver erosion during that process, is shown in **Figure 4.6.2.3.10 bottom.** The erosion results in leakage, and thus loss of Bi-2212 core material, as well as a pressure equilibrium between the high-pressure furnace environment and the inside of the conductor. This local loss of over-pressure prevents the conductor core from being fully compressed during over-pressure heat treatment (OPHT), necessary to reach the high material densities required for large J_e. Unfortunately, the existing coating route cannot be used in its current setup to coat Rutherford cable, so we coated the cable by hand, which yielded a less abrasion resistant coating layer. In the processes that followed, applying the fiber insulation and winding the coil, a quantity of the TiO_2 wore off causing conductor leakage during the OPHT of the coil. The coil is shown in **Figure 4.6.2.3.3** with leaks clearly visible. We decided to test the coil in field anyway expecting loss of I_c. The conductor leakage caused a performance reduction to ~40% of short sample value. Nevertheless, we were able to feed a current of up to 1650A at ramp rates of up to 440A/s. With this the coil generated 1.6T in an 8T background field. In conclusion, the Rutherford cable coil program will move forward, but we will have to spend resources and time to set up a dedicated cable insulation coating route to produce a TiO_2 coating in cables with as reliable results as we achieve with strand conductors.

Quench protection

While Bi-2212 magnets can be considered comparatively easier to protect than ReBCO coils due to Bi-2212's more moderate temperature margin and high silver stabilizer fraction, quench management is still critical when moving towards larger volume magnets with higher stored energies. With our unique test facility (14T magnet, Ø 160mm cold bore, 7.2kA power supply), we are advancing HTS magnet technology by extending to higher magnet stresses while implementing novel quench management, detection and protection, of both single-strand and cable HTS magnets. Among these were the installation of capacitance sensor arrays for rapid heat/quench detection, combining the quench management and power supply control with a LabView controlled (field programmable gate array) FPGA which can resolve down to 20μs time steps, implementing varistor energy extraction to validate predicted improvements to quench protection, as well as demonstrating the benefits of Rutherford cable solenoids for rapid detection and protection (lower inductance and voltage tap section length).

Faster quench protection was achieved, limited by the 50ms switching time of the mechanical contractors, which remove the power supply from the circuit. Designs to upgrade these with insulated-gate bipolar transistors (IGBT) are currently underway. Calculations for the current decay were validated and then extrapolated to the full improvement expected with faster solid state switching less than 10ms for the dump resistor extraction of the 0.064mH Rutherford cable solenoid and less than 5ms for the varistor protection of our 32mH single strand test coil "Pup-10", as can be seen in **Figure 4.6.2.3.11** that shows calculations *vs.* experimental results. We are also continuing to advance the quench modelling toward full-scale systems. We are utilizing model developments by collaborators at the Conseil Européen pour la Recherche Nucléaire (CERN) to expedite model building and scale-up to quickly discriminate between protection schemes with models that can be further refined to implement circuit interactions including LTS coupling and nonlinear elements like varistors.

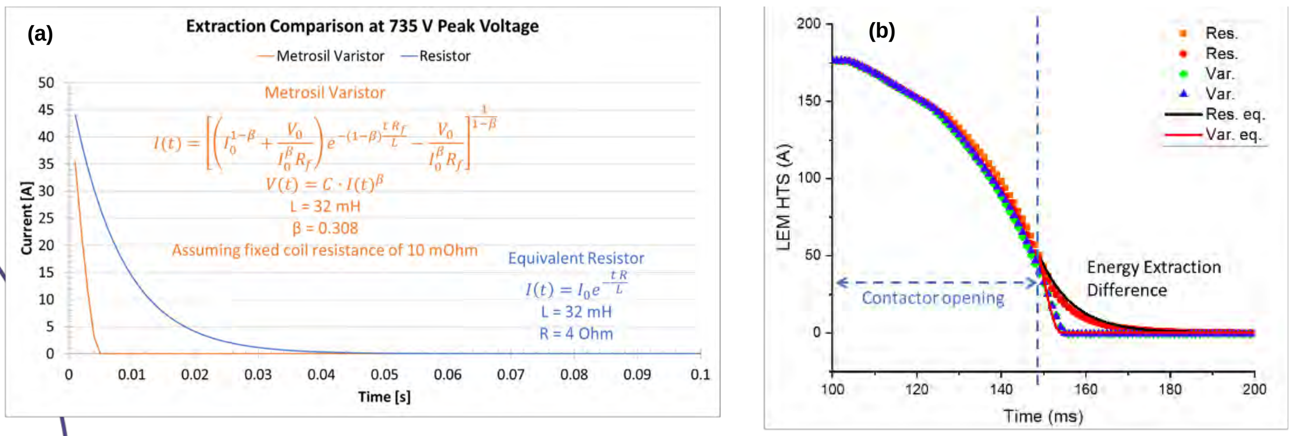

Figure 4.6.2.3.11: (a) Calculated energy extraction improvement of test coil Pup-10 using a varistor over a linear resistor at a fixed peak voltage. (b) measured energy extraction of that coil under the same experimental conditions.

Over-pressure heat treatment (OPHT) process and furnace development and implementation

With some delay due to the ongoing Covid-19 pandemic, the new OPHT furnace, shown in **Figure 4.6.2.3.12,** is now under commissioning trials, which will enhance our OPHT capabilities for ourselves and our collaborators. This furnace will provide an increase in processing volume by a factor of 10 over the previous furnace and accommodate larger accelerator model coils from our collaborators as well as accommodate solenoids with larger outer diameters like the one proposed for the 28+T UHF magnet. As shown in the **Table 4.6.2.3.2,** the new furnace will be operating solely at a pressure of 50 bar, which has shown to be sufficient for all types of heat treatments providing high densification of the Bi-2212 core of about 95%. A long-identified weakness in the controls of the furnace systems has finally been addressed and the previously IDEC control software has now been migrated to a significantly more flexible and reliable Labview-based software to control both furnaces. After many heat-treated coils, OPHT can now be considered reliable and reproducible. After some processing and significant design changes that were implemented in both furnaces around mid-2019, coil and conductor samples are consistently producing transport properties J_e in the 900 – 1000A/mm^2 range.

Table 4.6.2.3.2: Specification

	Deltech	Renegade
Commissioned	c. 2014	now
Zones	6	6
Heat Treatment Pressure	100 bar (de facto 50 bar)	50 bar
Peak Temperature	890°C	890°C
Pressure	2% - O_2 in Argon (1 bar pO_2)	2% - O_2 in Argon (1 bar pO_2)
Homogeneous Zone Diameter	130 mm	**250 mm**
Homogeneous Zone Height	450 mm	**1000 mm**

Figure 4.6.2.3.12: *Our new OPHT furnace and specifications of the two OPHT furnaces that are now installed at the ASC.*

Acknowledgements for OPHT process & furnace development

This work has been supported by grants from the DOE under DE-SC0018683 and DE-SC0010421, by the National Science Foundation under DMR-1644779 and the State of Florida. It is amplified by the MDP.

4.6.2.4 Iron-based Conductors

What determines the intergrain connectivity of $BaFe_2As_2$ (Ba122) Fe-based conductors (FBS) is still elusive, but there is a major concern that the extrinsic current blocker that is caused by the segregation of oxide and 2nd phase impurities. We established the clean synthesis in which the oxygen and water level is maintained below 0.005ppm and 0.06ppm, respectively. Our effort to eliminate oxide impurities started with establishing controllable oxygen and moisture-free environment by using high performance glovebox, energy controllable planetary ball-mill, and high purity elements that are commercially available.

The optimum heat treatment temperature was revisited to set the optimum synthesis condition in our very clean environment. Starting from 600°C, 4 different temperatures were studied for the 1st and 2nd heat treatment temperature: 600°C, 675°C, 750°C, and 825°C. However, no correlation was found between the magnetization T_c onset ($T_{c,mag}$ evaluated by SQUID measurements) and J_c in the clean samples described above. We systematically investigated the effects of heat treatment (by varying either the 1st or 2nd HT temperature from 600up to 825°C) on bulk superconducting properties of 122 using specific heat characterization. Interestingly, the specific heat measurements indicated that, even in our best specimen, a significant portion (~50%) of the bulk volume doesn't contribute to the intergrain J_c. We conducted extensive transmission electron microscopy (TEM) and nanostructural chemical analysis **(Figure 4.6.2.4.1).** We found that, although the oxygen trace at the grain boundaries (GBs) was almost eliminated by our clean synthesis, there are

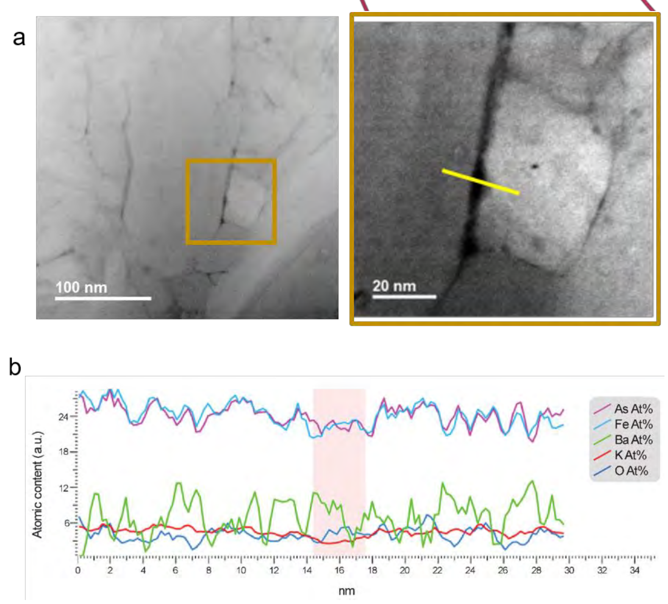

Figure 4.6.2.4.1: *(a) GBs in samples made with our clean synthesis protocol (at two magnifications) do not show chemical degradation, but the dark trace of GBs indicates a lower material density at the GB due to GB nanocracks. (b) Energy Dispersive X-ray (EDS) along the line in (a) showed there is almost no chemical variation across the GB.*

nanocracks at many of the GBs, degrading the physical connectivity. These results suggest a possible change in the synthesis route to improve J_c. Since the best bulk properties, connectivity, and J_c are found in the sample heat treated at the lowest tested 2nd HT temperature, lowering the 2nd HT temperature even further may improve the phase properties. In addition, decreasing the cooling rate in the Hot Isostatic Press may eliminate possible nanocracks caused by thermal stress.

Polycrystalline 122 has made progress in J_c. A Chinese Japanese collaboration led by Dr. Ma reported J_c (15 T) of 900-1000A/mm^2 in a polycrystalline flat tape. Tamegai *et al.* recently reported J_c (5T) of 600A/mm^2 in round wires, which is preferred by magnet designers and builders. However, it is important to point out that those advances were mostly made by Edisonian trial-and-error during their wire fabrication processing without full fundamental understanding of the GB connectivity. Dr. Ma sent us a sample of their best tape for STEM/TEM analysis. We observed significant amounts of secondary phases segregated at GBs even in their best J_c tape **(Figure 4.6.2.4.2)**, strongly suggesting that their J_c optimization process does not include efforts to clean the GBs nor understand what causes the dirty GBs, and that the supercurrent paths and effective cross section for current flow in their tapes are unknown. Nevertheless, J_c (15T) of 900-1000A/mm^2 in their samples with many contaminated GBs shows 122 FBS's potential as a conductor technology if the GBs are fully connected by eliminating all extrinsic blockers.

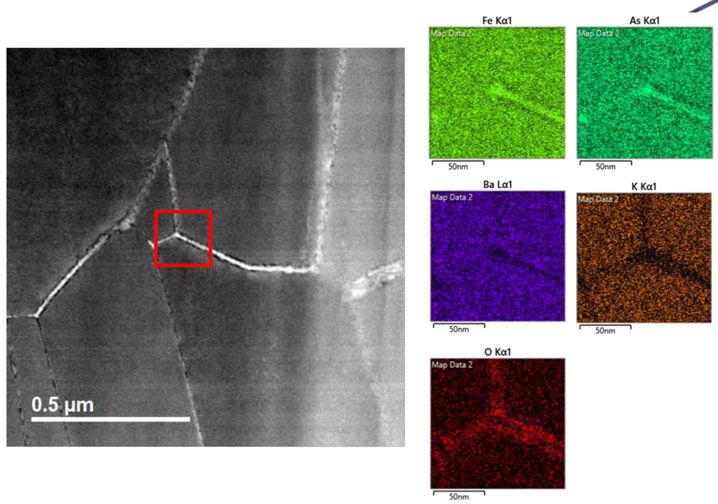

Figure 4.6.2.4.2: *Chemically degraded GBs found in a tape made by Dr. Ma's group with a J_c(4.2K, 10T) = 10^{3}A/mm^2. The red box in the left figure is a GB triple point that is analyzed in the right figures. These results show that many GBs are still compromised by FeAs and Ba-O.*

Acknowledgements

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4.6.2.5 Low temperature superconducting materials

Improving the superconducting performance in high field of Nb_3Sn wires is essential for the realization of the next generation of accelerator magnets, such as the Future Circular Collider (FCC) at CERN. After our discovery of the beneficial effect of hafnium addition [1,2] to the more commonly used Ta-doped Nb_3Sn, we focused our research in the evaluation of the properties of new commercially produced Nb4Ta1Hf alloy and on its use for the realization of TaHf-Nb_3Sn wires.

For the realization of Nb_3Sn wires made with special alloys, it is necessary to verify the material draw-ability. In **Figure 4.6.2.5.1** we evaluated the Vickers hardness as a function of true strain of the new commercial Nb4Ta1Hf alloy, comparing it with commercial Nb4Ta (both produced by ATI Specialty Materials) and similar alloys casted at the Applied Superconductivity Center (ASC). We found that, although the Nb4Ta1Hf hardness is always higher

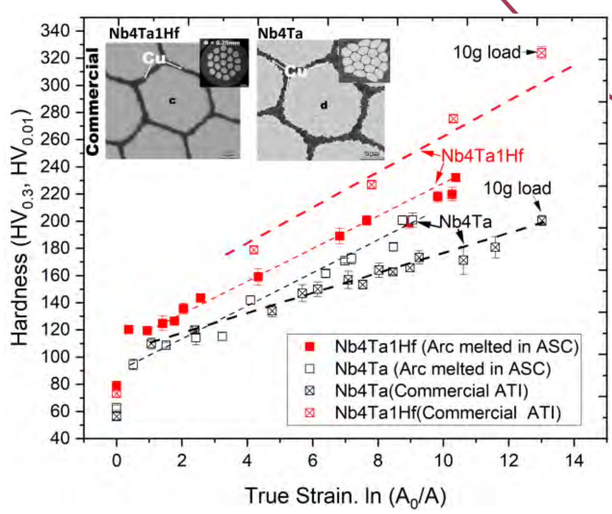

Figure 4.6.2.5.1. *Hardness versus true strain of commercial Nb4Ta1Hf and Nb4Ta alloys restacked in a Cu matrix compared with similar alloys cast at the Applied Superconductivity Center (ASC). The Nb4Ta1Hf alloy is consistently harder than the Nb4Ta alloy but no wire breakage has occurred so far in the commercial alloys. In the inset, BSE cross-section magnifications of the Nb4Ta1Hf and Nb4Ta multi-filaments in Cu-matrix at a strain of ~15 showing the uniform deformation.*

than in Nb4Ta, the rate of increase of ATI-Nb4Ta1Hf is similar to ATI-Nb4Ta. Moreover, no breakage occurred by using ATI-Nb4Ta1Hf, tested so far up to a true strain of 15, and its hardness is similar to the Nb-47Ti alloy used in Nb-Ti magnets. These results indicate that Nb4Ta1Hf has no ductility issue and can potentially be used for the fabrication of commercial Nb_3Sn conductors.

These ATI commercial alloys (both Nb4Ta1Hf and Nb4Ta, as a reference) have then been employed for the realization in ASC of 19-filament Rod-In-Tube (RIT) Nb_3Sn wires. The microstructural characterization identifies desirable properties in the Nb4Ta1Hf wire. Fractographs in **Figure 4.6.2.5.2** reveal that the grain morphology of Nb_3Sn in the TaHf-doped case is more refined (minor axis of 72 ± 13nm for TaHf-wire, against 102 ± 24nm in Ta-case) and more equiaxed (aspect ratio = 1.55 in TaHf-wire versus 2.0 in Ta-case) than in the Ta-doped one. The smaller Nb_3Sn grain size is important because in this material the main pinning mechanism is by grain boundaries (GBs), so the higher GB density enhances the superconducting performance and so the high-field critical current density. The reduction of the grain aspect ratio can be significant as well. In fact, high aspect ratio is usually associated with poor Sn-content in the A15 phase that can lead to suppressed upper critical field. The reduced grain size and limited aspect ratio caused by the addition of Hf may facilitate the Sn diffusion leading a better A15 quality [2].

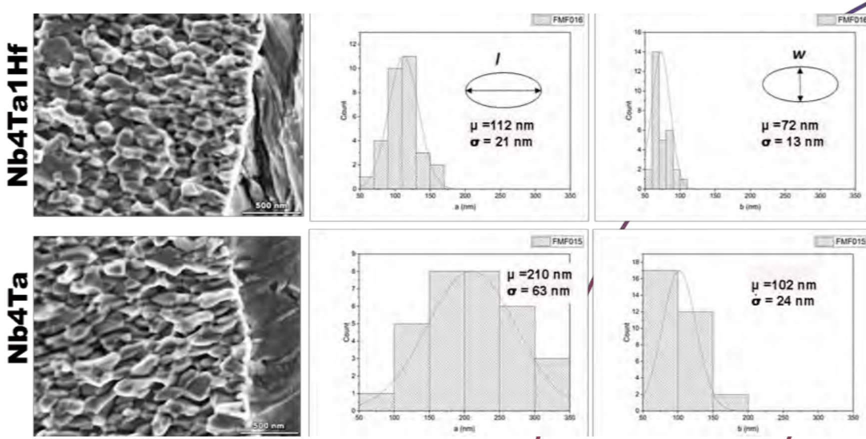

Figure 4.6.2.5.2: *Microstructure of Nb_3Sn in 19-filaments RIT conductors, made with Nb4Ta1Hf (top) and Nb4Ta (bottom) after 550°C/100h + 670°C/100h reaction heat treatment. Left images are fractographs. Panels in the central and on the right are grain size histograms measured as major and minor diameters of an ellipse, respectively.*

References for Low temperature superconducting materials

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Acknowledgements for LTS Materials

This work is funded by the US Department of Energy, Office of Science, and Office of High Energy Physics under Award Number DE-SC0012083 and by CERN, and it was performed under the purview of the US-Magnet Development Program. This work was performed at the National High Magnetic Field Laboratory, which is supported by National Science Foundation Cooperative Agreements NSF DMR-1644779 and by the State of Florida.

4.6.3 STRUCTURAL MATERIALS FOR MAGNETS

The construction of magnets with ever higher magnetic fields requires everer strong and tougher reinforcement materials. Nitronic stainless steels (Fe-Cr-Ni alloys with internal N hardening) have roughly twice the yield strength of more traditional 316L and are sometimes used. Avoiding the sensitization temperature of these steels during fabrication is of critical importance because excessive exposure to this temperature may make them sensitive to corrosion. Even though these steels have high mechanical strength and satisfactory toughness for use at room temperatures, low cryogenic temperatures may reduce their toughness to the degree that they are rendered unsatisfactory as reinforcement materials [1]. This low toughness at cryogenic temperature in Nitronic steels often stems from the microstructure established during fabrication, even when the heat treatment profile follows the required protocol. Even materials that have not previously been exposed to sensitization temperatures during fabrication may

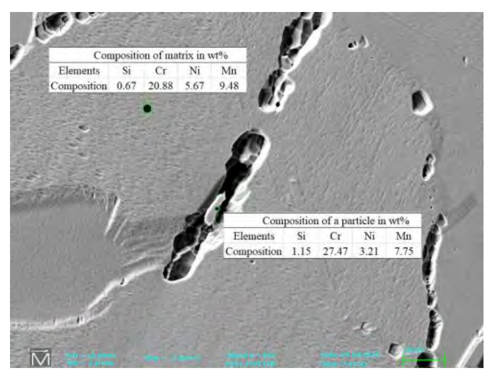

Figure 4.6.3: *Scanning electron microscopy image and Energy Dispersion Spectroscopy (EDS) data showing grain boundary precipitates in a Nitronic-40 sample that shows low Charpy V-notch data. EDS was used to detect the chemistry in the matrix (indicated by a large circle) and in the precipitate (indicated by a small circle).*

later be exposed during the construction of magnets. Consequently, quality control of reinforcement materials must include both toughness assessments and microstructure analyses [2]. Recently, four shells were fabricated by Scot Forge for use in pulsed magnets. When received, Charpy V-nothc specimens were cut from the ends of the shells and subjected to impact testing at 77J as well as tensile testing and scaning electron microscopy. We saw that one shell had grain boundary particles as well as low impact fracture energy (60J vs 100J) compared with the other three shells. The mechanical strength of the four shells was quite similar. In addition, the sample with low impact energy also showed pitting due to the etchant used to prepare the sample for microscopy as well as distinct grain boundaries. These features were not evident in the other three samples. We believe this shell became overheated and sensitized durign fabrication. The grain boundary precipitates in it were rich in Cr and poor in Ni, suggesting they may have been Cr-containing intermetallics **(Figure 4.6.3)**. This shell was remade. The replacement shell had tensile mechanical properties similar to those of the other shells. The CVN energy at 77K for this new shell was above 100J, and close examination of the shell revealed no large grain boundary precipitates [3].

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4.6.4 RESISTIVE MAGNETS AND MATERIALS

4.6.4.1 Pulsed Magnets

For many years the Pulsed Field Facility (PFF) at LANL has operated four 65T short-pulse magnets (some parameters are in the right column of **Table 4.6.4.1.1)** as well as the 100TMS (Multi-Shot) and 60TCW (Continuous Waveform) magnets. In 2019, the generator that powers the 60TCW and 100TMS developed a flaw and has been offline. To maintain some level of user operations at >65T, the PFF commissioned a novel 75T "duplex" magnet late in 2019. This duplex magnet is the first at the PFF to combine two capacitor banks in a single magnet system **(Table 4.6.4.1.1)**. During 2021, magnet development effort at the PFF focused on development of new capacitor-driven magnets capable of both higher field than the 75T magnet and longer pulses than the standard 65T pulsed magnets, thereby allowing these sorts of experiments to continue while repairs are made to the generator **(Table 4.6.4.1.1)**.

Table 4.6.4.1.1: *Comparison of capacitor-driven magnet systems at the PFF*

	>80T	**65TMP**	**75T**	**65T**
Inner Coil Bank	2.5MJ, 15.6kV	None	1MJ,13.5kV	None
Outer Coil Bank	4MJ, 14kV	3MJ, 13.5kV	3MJ, 13.5kV	3MJ, 9kV
Inner Coil Construction	8 layers CuNb	N/A	8 layers CuNb	N/A
Outer Coil Construction	6 layers AL15	Cu	8 layers AL15	AL60
Maximum Magnetic Energy	5MJ	2.1MJ	2.9MJ	1MJ
Maximum field for users	84T	55T	75T	65T
Pulse Length	80ms	300ms	90ms	60ms
Bore	10.5mm	15.5mm	15.5mm	15.5mm
1st Operation	2022	2021	2019	2008

New 60T Mid-Pulsed Magnets

A new magnet was designed to produce magnetic fields up to 60T with total pulse length of about 300ms, about five times longer than that of the 65T short-pulsed magnet. **Figure 4.6.4.1.2** (left) plots the profiles of the magnetic field and current of the magnet. The magnet is driven by 6 modules of our 4MJ capacitor bank, and it requires about 2.1MJ to reach its peak magnetic field of 60T. The magnet uses hard-copper wire and is fabricated by newly developed continuous-winding technique, which reduces the magnet fabrication time by half compared to the traditional multi-helix winding.

The first magnet with some minor winding defects was tested to 56T in June 2021, and it has been used to generate magnetic fields up to 55T for users. Lessons learned from winding the first magnet with the continuous winding technique enabled us to improve the tooling and G10 supporting parts. Those improvements have been implemented to wind the second mid-pulsed magnet with much better quality during the winding process. The second magnet will be tested to the designed magnetic field of 60T and will provide a magnetic field up to 59T to users.

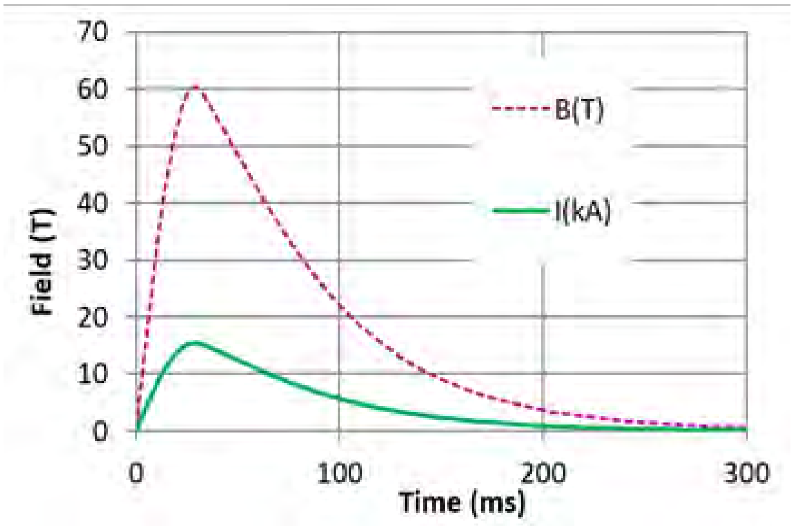
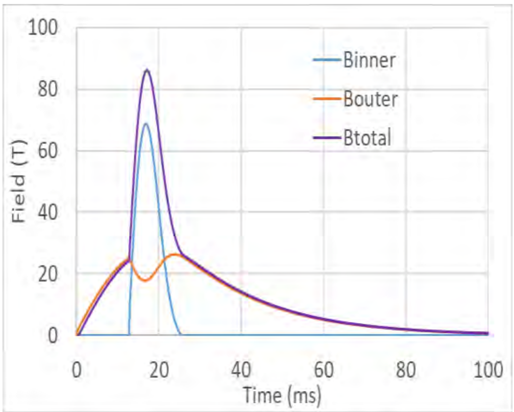


Figure 4.6.4.1.2: *(Left) The profiles of magnetic field and current of the mid-pulsed magnet and (right) the picture of the mid-pulsed magnet user cell with a user running his experiment*

Development of a new 84T User Duplex Magnet

To quickly deliver magnetic fields higher than 80T to users, we are investigating using the two existing capacitor banks (4MJ -16kV user capacitor bank and 2.5MJ – 18kV 100T insert capacitor bank) to power a duplex magnet. Design of the magnet was thoroughly optimized, and we expect to generate magnetic field of 86T with this alternative power configuration. **Table 4.6.4.1.1** summarizes the specifications of that magnet. We see that the energy stored in the magnetic field of this magnet is five times that of the 65T workhorse magnets. This magnet will use the existing 4MJ capacitor bank to power the outer coil, and the existing 2.5MJ – 18kV capacitor bank to power the inner coil. **Figure 4.6.4.1.3** (left) plots the profiles of magnetic fields generated by the individual coils



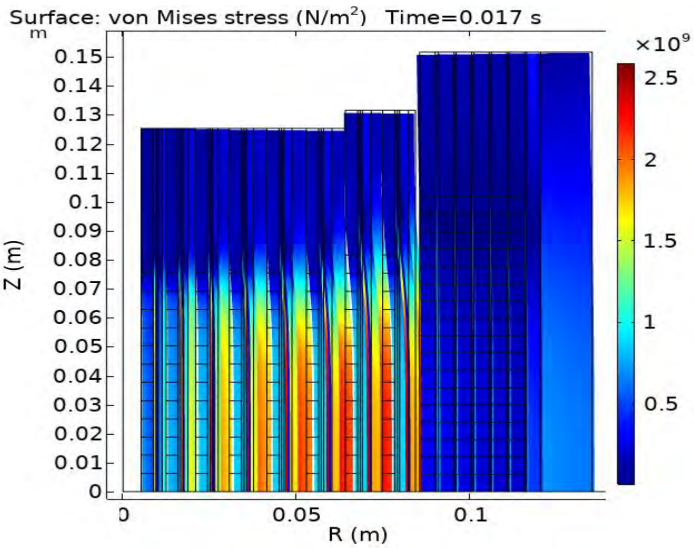


Figure 4.6.4.1.3: *(left) the magnetic field profiles reaching 86T generated by duplex magnet with option-2 design and (right) von Mises stress distribution and deformation in the winding of that magnet when it generates 86T field.*

and the total magnetic field inside the bore of the duplex magnet. **Figure 4.6.4.1.3** (right) depicts von Mises stress distribution and deformation in the winding of that magnet when it generates 86T. The maximum stress in Zylon reinforcement reaches 2600MPa, and the maximum stress in conductor winding reaches 1050MPa, indicating that the magnet has nearly similar mechanical performance as our proven 75T duplex magnet.

Potential failure modes of this new magnet system have been identified and analyzed via extensive circuit simulations and multi-physics modelling of the magnets. The simulations were also used to assess the risks develop risk-mitigation strategies to ensure the safe operation of the magnet. Magnet fabrication and modification/reconfiguration of the power infrastructure will be carried out in Q1 of 2022. The magnet is expected to be tested in Q2 of 2022 and potentially commissioned for users at or above 80T in Q3 of 2022, extending the range of available magnetic fields until the 100TMS magnet comes back online.

Procurement of 30kV – 1.2MJ capacitor bank

One of the long-term goals of the Pulsed Field Facility is to develop magnet technology to safely deliver 120T to users. The driving energy for the insert coils of such a magnet must be limited to a level of about 5 to 6MJ so that the insert failure can be well contained, preventing it from transferring to the outsert coils and damaging those very expensive components. This is about 3 to 4MJ more than is used for the insert of the 100T magnet. Thus, a higher voltage capacitor bank is desired to drive the magnet faster (higher dB/dt) thereby suppressing the heating in the magnet windings and generating higher magnetic fields with lower required energy. A new 1.2MJ - 30kV capacitor bank was purchased for testing faster rise time capacitor bank driven magnet coils at such voltages. Although scheduled to be delivered and commissioned in Q3 of 2021, the impact of the pandemic on global supply chain issues has delayed this until Q2 of 2022. To test this new 30kV bank in a multiplex mode of operation, we plan to combine it with our existing 4MJ capacitor bank to power a new duplex test coil to generate magnetic fields in excess of 80T later this year. Development of such a magnet will allow us to perform crucial preliminary R&D steps both to prove the magnet technology but also demonstrate feasibility of data acquisition, in such a fast-rise pulse prior to the design phase of a future 120T magnet.

65T short-pulsed and 75T Duplex magnets.

Both of these magnet systems have been well maintained and, despite evolving COVID restrictions on the user program, have been employed for both remote and on-site users extensively throughout the year. As always, all user cells contain operational magnets regardless of their scheduled use. At the end of the year, we had four spare 65T magnets and one spare 75T duplex magnet on the shelf. Four 65T magnets failed in 2021 delivering >1700 pulses of 60-65T. The 75T duplex magnet ran smoothly throughout the year without any replacements, delivering 316 pulses of 70-75T. In total, both of these magnet systems delivered 5500 pulses to users. This compares to an average of over 7000 shots a year at the Pulsed Field Facility since 2014, culminating in a record of 8200 shots with 2600 over 60T in 2019, before the impact of COVID.

4.6.4.2 High Strength High Conductivity Materials

High-field magnets require the development and fabrication of conductors with both high mechanical strength and high electrical conductivity on an appropriate scale. High-strength conductors can be manufactured from a variety of *in situ* composites strengthened by deformable particles. Such conductors can also be made from composites strengthened by ceramic particles, which are not deformable.

In our laboratory, one of the precursors for making ceramic-strengthened conductor material is Glidcop® AL-60, an alumina strengthened copper-matrix composite. In the as-consolidated condition without cold work, this precursor has higher strength than can be achieved under these conditions in most comparable Cu matrix conductors [HSHC1]. In order to improve the yield in fabrication of these conductors, we have undertaken a new comprehensive study of Glidcop® AL-60 with respect to microstructure and resulting mechanical properties. Scanning electron microscopy (SEM) images of the longitudinal cross-section indicated that the particles did not have a uniform size and were not randomly distributed. Large particles had irregular shapes and seemed to form bands parallel to the drawing direction. Near the large particles, the density of fine particles was very low. Similar sized particles formed bands along the extrusion direction, and the average particle size varied across the transverse direction of the image.

High-angle-annular-dark-field (HAADF) scanning transmission electron microscopy imaging is a better way to reveal alumina particles in Cu matrix than scanning electron microscopy, which has a lower resolution. HAADF is also better than bright field transmission electron microscope imaging, in which weak particle contrast is usually obscured by diffraction contour bands. Since HAADF image intensity is proportional to the square of atomic number, Al and O with lower atomic number in alumina particles showed dark contrast compared to Cu in the matrix **(Figure 4.6.4.2.1).** The regions free of visible particles were evident in the HAADF image. This might be the result of incomplete internal oxidation, which could stem from non-uniform mixing of the oxidant and the Cu-Al powders in the AL-60 fabrication process. We believe that difficulties involved in fabrication of AL-60 into magnet conductors are caused by the presence of both larger particles and large regions free of particles in the same precursor. Collaborating with Hypertech, Inc. and using the knowledge that we gained from our microscopy study, we were able to draw AL-60 conductors with continuous length greater than 400 meters, enough for numerous short-pulsed magnets. Our mechanical testing indicated that the AL-60 conductor met the requirements for the 65T short-pulsed magnets. We observed breakage during fabrication. Naturally, we subject AL-60 conductor to non-destructive inspection developed at the MagLab before using them in any user magnets [HSHC2].

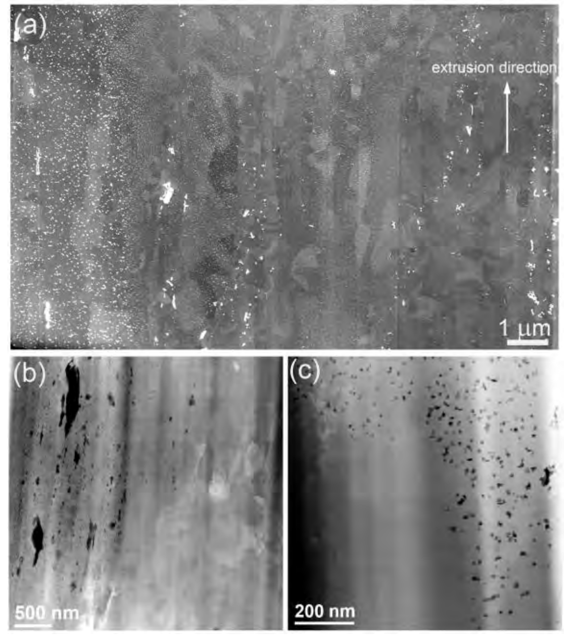


Figure 4.6.4.2.1: *(a) SEM image of longitudinal cross-section view of the hot extruded Al-60 sample, which was prepared by focused ion beam. The white speckles and dots are alumina particles. Medium sized particles can be seen on the left of the figure, smaller sized particles with high density in the rest of the image; (b) HAADF image of one region from a cold drawn wire showing large particles (dark contrast) of irregular shapes and a second region without any alumina particles; (c) A third region from the same cold drawn wire showing small particles adjacent to an area of Cu that contains no particles at all.*

We also investigated *in situ* composites that have not previously been used in our pulsed magnets. These composites were strengthened by malleable particles that can be co-deformed with the Cu matrix. Cu-Ag composites, for example, have sufficient ductility for deformation and a higher work-hardening rate than Cu-alumina, and therefore are capable of achieving higher strength after heavy deformation. To do so, Cu-Ag ingots need significantly more cold work than Cu-alumina because of the coarse spacing between Ag precipitates in some areas of the as-cast samples. In collaboration with Northeastern University in China, we studied the influence of Nb doping on the kinetics of Ag precipitation. We found that Nb doping had a disproportionate synergistic effect on the ratio of fine-spaced to coarse-spaced precipitates, thus producing higher hardness and higher strength in cast ingots. After aging for 1h, hardness values for Nb-doped samples were 16% higher; after aging for 16h, they were 63% higher [HSHC3].

We also studied Cu-Cr-Zr composites, which were developed by alloying with traces of Cr and Zr. These composites were composed of a high volume-fraction of Cr-rich secondary phase particles embedded in Cu matrix. During cold drawing, these Cr-rich particles demonstrated appreciable co-deformation capability with the Cu matrix. This co-deformation benefited wire fabrication by decreasing the chance of de-cohesion and by avoiding the formation of cracks. A large number of Cr precipitates formed after aging, which significantly decreased the Cr content dissolved in the Cu matrix, thereby contributing to the high conductivity and high strength of Cu-Cr-Zr composites. Our first trial, which was undertaken in collaboration with Hypertech, Inc., demonstrated that these composites were much more easily drawn to long lengths than Cu-alumina. Our preliminary characterization indicated that the composites were suitable for use in certain pulsed magnets.

References for high-strength, high-conductivity materials:

[HSHC1] K. Han, J. Lu, V. Toplosky, R. Niu, R. Goddard, Y. Xin, R. Walsh, I. Dixon, V. Pantsyrny, Properties of Selected High-Strength Composite Conductors with Different Strengthening Components, IEEE Transactions on Applied Superconductivity 30(4) (2020) 1-5.

[HSHC2] J. Lu, T. Adkins, I. Dixon, D. Nguyen, K. Han, IEEE Transactions on Applied Superconductivity 30 (2020) 1-5.

[HSHC3] C. Zhao, R. Niu, Y. Xin, D. Brown, D. McGuire, E. Wang, K. Han, Improvement of properties in Cu-Ag composites by doping induced microstructural refinement, Materials Science and Engineering: A 799 (2021) 140091.

4.6.4.3 Resistive Magnets

2021 has been a very successful fifth year of operation of the MagLab's 36T, 1ppm Series-Connected Hybrid magnet, the world's highest field 1ppm magnet. The resistive insert for this magnet provides 23T while operating in the background 13T provided by the superconducting outsert. The insert has now accumulated more than 3,400 hours of operation over a five-year period without any coil replacement. Most of the MagLab's resistive magnets running at similar stress levels require replacement after two or three years. The reduced maintenance requirements for this magnet are believed to be due to the fact that it is primarily used for NMR, which results in much fewer high field sweeps and fewer fatigue cycles per day of operation than is experienced by other high field magnets. To assure continued reliable operation of this magnet, in February 2021 the insert housing was opened up for the first time since it was assembled in 2016, and all coils were carefully inspected preforming low current (50A) turn-to-turn voltage evaluations and compared with the data collected during commissioning of the magnet. All data checks and surface inspections turned out positive and allowed re-installation of all original coils without replacement, and only the bore tube and voltage tabs were replaced with new ones.

Procurement of sheet metal required for resistive magnet winding parts was cumbersome and difficult in 2021 due to supply chain problems in the commercial market. Also, in 2021 the DC resistive magnet operations were greatly reduced compared to typical prior years due to the COVID-19 pandemic. Consequently, less on-site work in the magnet shop building and installing spare coils was required.

5. PUBLICATION

The Laboratory continued its strong record of publishing, with **404** articles appearing in peer-reviewed scientific and engineering journals in 2021. Among these, **353** acknowledge NSF support for the operation of the NHMFL and **198 (49** percent) appeared in significant journals.

Table 5.1 provides an overview about NSF-acknowledged peer-reviewed and significant peer reviewed publications by division then non-NSF funded units.

***Table 5.1**: Submitted peer-reviewed publications from OPMS live database. The point-in-time snapshot was on March 11, 2022. A total number of publications per year should NOT be drawn from this report because a submitter may, as appropriate, link a publication to two or more facilities. We note that the State of Florida contributes significantly to NHMFL and hired faculty at UF and FSU to enhance NHMFL programs. Publications from these professors are included as they significantly enhance the NHMFL research effort and are listed here in the UF physics and CMT/E categories.*

Facility	2021 Peer Reviewed	2021 Significant Peer Reviewed	Acknowledges Core Grant
AMRIS Facility at UF	25	7	22
DC Field Facility at FSU	92	63	91
EMR Facility at FSU	26	11	26
High B/T Facility at UF	-	-	-
ICR Facility at FSU	37	15	36
NMR Facility at FSU	71	31	68
Pulsed Field Facility at LANL	31	20	31
ASC	14	10	14
MS & T	24	13	24
Education at FSU	2	-	2
CMT/E	65	48	NA[1]
Geochemistry Facility	16	3	NA[1]
MBI at UF	47	4	NA[1]
UF Physics	3	2	NA[1]

[1]Research not funded by NSF.

Table 5.2 summarizes the publications generated by external users and in-house research activities. A detailed list of these publications can be found below **Table 5.2.**

***Table 5.2:** Overview of publications generated by external users and in-house research activities. A total number of publications per year should NOT be drawn from this report because a submitter may, as appropriate, link a publication to two or more facilities.*

Facility	All Internal Authors		Internal Corresponding Author(s) with External Co Authors		External Corresponding Author(s) with Internal Co Authors		All External Authors		Totals		Total
	NSF Core Grant Cited	NSF Core Grant Not Cited	NSF Core Grant Cited	NSF Core Grant Not Cited	NSF Core Grant Cited	NSF Core Grant Not Cited	NSF Core Grant Cited	NSF Core Grant Not Cited	NSF Core Grant Cited	NSF Core Grant Not Cited	Pubs for (selected period)
AMRIS Facility at UF	-	-	7	1	13	2	2	-	22	3	25
DC Field Facility at FSU	7	-	9	-	64	1	11	-	91	1	92
EMR Facility at FSU	1	-	7	-	17	-	1	-	26	-	26
High B/T Facility at UF	-	-	-	-	-	-	-	-	-	-	-
ICR Facility at FSU	3	-	10	-	22	1	1	-	36	1	37
NMR Facility at FSU	6	-	16	-	41	2	5	1	68	3	71
Pulsed Field Facility at LANL	2	-	10	-	19	-	-	-	31	-	31
ASC	4	-	7	-	3	-	-	-	14	-	14
MS & T	9	-	6	-	8	-	1	-	24	-	24
Education at FSU	1	-	-	-	1	-	-	-	2	-	2
CMT/E[1]	11	-	23	1	29	1	-	-	63	2	65
Geochemistry Facility[1]	-	-	5	-	10	1	-	-	15	1	16
MBI at UF[1]	-	-	2	2	3	10	3	27	8	39	47
UF Physics[1]	-	-	1	1	1	-	-	-	2	1	3

[1]Research not funded by NSF.

Besides 404 peer reviewed publications, the following other products have also been published at the MagLab in 2021:

- Books: **5**
- Disseminations: **8**
- Awards: **10**
- M.S. Theses: **10**
    - Local: 10
    - External: 0
- Ph.D. Theses: **48**
    - Local: 15
    - External: 32

5.1 PUBLICATIONS GENERATED BY AMRIS AT UF (25)

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Askey, B.; Liu, D.; Rubin, G.; Kunik, A.; Song, Y.; Ding, Y.; Kim, J.	*Metabolite profiling reveals organ-specific flavone accumulation in Scutellaria and identifies a scutellarin isomer isoscutellarein 8-O-β glucuronopyranoside*	Plant Direct	5	12	e372	10.1002/pld3.372	Yes
Baniani, A.; Rivera, M.; Lively, R.; Vasenkov, S.	*Quantifying diffusion of organic liquids in a MOF component of MOF/Polymer mixed-matrix membranes by high field NMR*	Journal of Membrane Science	640		119786	10.1016/j.memsci.2021.119786	Yes
Berens, S.; Hillman, F.; Hamid, M.; Jeong, H.; Vasenkov, S.	*Influence of 2-ethylimidazole linker-doping in ZIF-8 crystals on intracrystalline self-diffusion of gas molecules by high field diffusion NMR*	Microporous and Mesoporous Materials	315		110897	10.1016/j.micromeso.2021.110897	Yes
Caffall, Z.F.; Wilkes, B.J.; Hernandez-Martinez, R.; Rittiner, J.E.; Fox, J.T.; Wan, K.K.; Shipman, M.K.; Titus, S.A.; Zhang, Y.; Patnaik, S.; Hall, M.D.; Boxer, M.B.; Shen, M.; Li, Z.; Vaillancourt, D.; Calakos, N.	*The HIV protease inhibitor, ritonavir, corrects diverse brain phenotypes across development in mouse model of DYT-TOR1A dystonia*	Science	13	607	13	10.1126/scitranslmed.abd3904	No
Chen, C.; Mahar, R.; Merritt, M.E.; Denlinger, D.L.; Hahn, D.A.	*ROS and hypoxia signaling regulate periodic metabolic arousal during insect dormancy to coordinate glucose, amino acid, and lipid metabolism*	Proceedings of the National Academy of Sciences of the USA (PNAS)	118	1	603118	10.1073/pnas.2017603118	Yes
Gatto, R.; Weissmann, C.; Amin, M.; Angeles-Lopez, Q.; Garcia-Lara, L.; Castellanos, L.; Deyoung, D.; Segovia, J.; Mareci, T.H.; Uchitel, O.; Magin, R.	*Evaluation of early microstructural changes in the R6/1 mouse model of Huntington's disease by ultra-high field diffusion MR imaging*	Neurobio-logy of Aging	102		32-49	10.1016/j.neurobiolaging.2021.02.006	Yes
Hale, W.G.; Zhao, T.Y.; Choi, D.; Ferrer, M.J.; Song, B.C.; Zhao, H.Q.; Hagelin-Weaver, H.E.; Bowers, C.R.	*Toward Continuous-Flow Hyperpolarisation of Metabolites via Heterogenous Catalysis, Side-Arm-Hydrogenation, and Membrane Dissolution of Parahydrogen*	ChemPhys Chem	22	9	822-827	10.1002/cphc.202100119	Yes
Henry, J.; Khattri, R.; Guingab-Cagmat, J.; Merritt, M.E.; Garrett, T.; Patterson, J.; Lohr, K.	*Intraspecific variation in polar and nonpolar metabolite profiles of a threatened Caribbean coral*	Meta-bolomics	17	7	1-12	10.1007/s11306-021-01808-0	Yes
Mahar, R.; Chang, M.C.; Merritt, M.E.	*Measuring NQO1 Bioactivation Using [2H7] Glucose*	Cancers	13	16	4165	10.3390/cancers13164165	Yes
Mahar, R.; Zeng, H.; Giacalone, A.; Ragavan, M.; Mareci, T.H.; Merritt, M.E.	*Deuterated water imaging of the rat brain following metabolism of [2H7] glucose*	Magnetic Resonance in Medicine	85	6	3049-3059	10.1002/mrm.28700	Yes
Matthew, S.; Chen, Q.; Ratnayake, R.; Fermaintt, C.; Lucena-Agell, D.; Bonato, F.; Prota, A.; Lim, S.; Wang, X.;	*Gatorbulin-1, a distinct cyclodepsipeptide chemotype, targets a*	Proceedings of the National Academy of	118	9	e2021847118	10.1073/pnas.2021847118	No

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Diaz, J.; Risinger, A.; Paul, V.; Oliva, M.; Luesch, H.	*seventh tubulin pharmacological site*	Sciences of the USA (PNAS)					
Milugo, T.; Tchouassi, D.; Kavishe, R.; Dinglasan, R.; Torto, B.	*Root exudate chemical cues of an invasive plant modulate oviposition behavior and survivorship of a malaria mosquito vector*	Nature Scientific Reports	11		14785	10.1038/s41598-021-94043-5	Yes
Mulry, E.; Ray, A.; Eddy, M.T.	*Production of a Human Histamine Receptor for NMR Spectroscopy in Aqueous Solutions*	Bio-molecules	11	5	632	10.3390/biom11050632	Yes
Normand, A.E.; Turner, B.L.; Lamit, L.J.; Smith, A.N.; Baiser, B.; Clark, M.W.; Hazlett, C.; Kane, E.S.; Lilleskov, E.; Long, J.R.; Grover, S.P.; Reddy, K.R.	*Organic matter chemistry drives carbon dioxide production of peatlands*	Geophysical Research Letters	48	18	e2021GL093392	10.1029/2021GL093392	Yes
Norwood IV, V.; Murillo-Solano, C.; Goertzen, M.; Brummel, B.; Perry, D.; Rocca, J.R.; Chakrabarti, D.; Huigens III, R.	*Ring Distortion of Vincamine Leads to the Identification of Re-Engineered Antiplasmodial Agents*	American Chemical Society Omega	6	31	20455-20470	10.1021/acsomega.1c02480	Yes
Qi, Y.F.; Dasa, O.; Maden, M.; Vohra, R.; Batra, A.; Walter, G.A.; Yarrow, J.F.; Aranda, J.M.; Raizada, M.K.; Pepine, C.J.	*Functional heart recovery in an adult mammal, the spiny mouse*	International Journal of Cardiology	338		196-203	10.1016/j.ijcard.2021.06.015	Yes
Ragavan, M.; Li, M.; Giacalone, A.; Wood, C.; Keller-Wood, M.; Merritt, M.E.	*Application of Carbon-13 Isotopomer Analysis to Assess Perinatal Myocardial Glucose Metabolism in Sheep*	Metabolites	11	1	33	10.3390/metabo11010033	Yes
Ragavan, M.; McLeod, M.; Giacalone, A.; Merritt, M.E.	*Hyperpolarized Dihydroxyacetone Is a Sensitive Probe of Hepatic Gluconeogenic State*	Metabolites	11	7	441	10.3390/metabo11070441	Yes
Rodriguez, A.F.; Gerber, S.; Inglett, P.W.; Tran, N.; Long, J.R.; Daroub, S.H.	*Soil carbon characterization in a subtropical drained peatland*	Geoderma	382		114758	10.1016/j.geoderma.2020.114758	Yes
Sanati, O.; Edison, A.S.; Hornak, L.A.; Litvak, I.; Ramaswamy, V.; Freytag, N.; Brey, W.W.	*C-13-Optimized HTS NMR RF Coil Design at 21.1 T*	IEEE Transactions on Applied Super-conductivity	3	5	4300305	10.1109/TASC.2021.3069678	Yes
Sunshine, M.; Cassar, A.; Neufeld, E.; Grossman, N.; Mareci, T.H.; Otto, K.; Boyden, E.; Fuller, D.	*Restoration of breathing after opioid overdose and spinal cord injury using temporal interference stimulation*	Communi-cations Biology	4	1	1-15	10.1038/s42003-020-01604-x	Yes
Thomas, J.; Ramaswamy, V.; Litvak, I.; Johnston, T.; Edison, A.S.; Brey, W.W.	*Progress Towards a Higher Sensitivity C-13-Optimized 1.5 mm HTS NMR Probe*	IEEE Transactions on Applied Super-conductivity	31	5	1500504	10.1109/TASC.2021.3061042	Yes
Wilkes, B.J.; DeSimone, J.C.; Liu, Y.; Chu, W.T.; Coombes, S.A.; Li, Y.; Vaillancourt, D.	*Cell-specific effects of Dyt1 knock-out on sensory processing, network-level connectivity, and motor deficits*	Experi-mental Neurology	343		9	10.1016/j.expneurol.2021.113783	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Xu, B.; Li, Z.; Alsup, T.; Ehrenberger, M.; Rudolf, J.	*Bacterial Diterpene Synthases Prenylate Small Molecules*	American Chemical Society Catalysis	11	10	5906--5915	10.1021/acscatal.1c01113	Yes
Yang, C.; Lavayen, B.; Liu, L.; Sanz, B.; DeMars, K.; Larochelle, J.; Pompilus, M.; Febo, M.; Sun, Y.; Kuo, Y.; Mohamadzadeh, M.; Farr, S.; Kuan, C.; Butler, A.; Candelario-Jalil, E.	*Neurovascular protection by adropin in experimental ischemic stroke through an endothelial nitric oxide synthase-dependent mechanism*	Redox biology	48		102197	10.1016/j.redox.2021.102197	No

5.2 PUBLICATIONS GENERATED BY DC FIELD AT FSU (91)

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Allenspach, S.; Puphal, P.; Link, J.; Heinmaa, I.; Pomjakushina, E.; Krellner, C.; Lass, J.; Tucker, G.S.; Niedermayer, C.; Imajo, S.; Kohama, Y.; Kindo, K.; Krämer, S.; Horvatic, M.; Jaime, M.; Madsen, A.; Mira, A.; Laflorencie, N.; Mila, F.; Normand, B.; Rüegg, CH.; Stern, R.; Weickert, D.F.	*Revealing three-dimensional quantum criticality by Sr substitution in Han purple*	Physical Review Research	3		23177	PhysRevResearch.3.023177	Yes
Almoalem, A.; Silber, I.; Sandik, S.; Lotem, M.; Ribak, A.; Nitzav, Y.; Kuntsevich, A.; Sobolevskiy, O.A.; Selivanov, G.; Prudkoglyad, V.A.; Shi, M.; Petaccia, L.; Goldstein, M.; Dagan, Y.; Kanigel, A.	*Link between superconductivity and a Lifshitz transition in intercalated Bi_2Se_3*	Physical Review B	103		174518	10.1103/PhysRevB.103.174518	Yes
Blockmon, A.; Ullah, A.; Hughey, K.; Duan, Y.; O'Neal, K.; Ozerov, M.; Baldovi, J.; Arago, J.; Gaita-Arino, A.; Coronado, E.; Musfeldt, J.	*Spectroscopic Analysis of Vibronic Relaxation Pathways in Molecular Spin Qubit [Ho(W5O18)2]9−: Sparse Spectra Are Key*	Inorganic Chemistry	60	18	14096 – 14104	10.1021/acs.inorgchem.1c01474	Yes
Bone, A.N.; Widener, C.N.; Moseley, D.H.; Liu, Z.; Lu, Z.; Cheng, Y.; Daemen, L.L.; Ozerov, M.; Telser, J.; Thirunavukkuarasu, K.; Smirnov, D.; Greer, S.; Hill, S.; Krzystek, J.; Holldack, K.; Aliabadi, A.; Schnegg, A.; Dunbar, K.R.; Zue, X.L.	*Applying Unconventional Spectroscopies to the Single-Molecule Magnets, Co(PPh3)2X2 (X = Cl, Br, I): Unveiling Magnetic Transitions and Spin-Phonon Coupling*	Chemistry a European Journal	27		11110-11125	10.1002/chem.202100705	Yes
Campbell, D.J.; Collini, J.; Slawińska, J.; Autieri, C.; Wang, L.; Wang, K.; Wilfong, B.; Eo, Y.S.; Neves, P.; Graf, D.E.; Rodriquez, E.E.; Butch, N.P.; Buongiorno Nardelli, M.; Paglione, J.	*Topologically driven linear magnetoresistance in helimagnetic FeP*	Nature Partner Journals Quantum Materials (npj)	6	1	38	10.1038/s41535-021-00337-2	Yes
Chapai, R.; Browne, D.A.; Graf, D.E.; DiTusa, J.F.; Jin, R.	*Quantum Oscillations with Angular Dependence in PdTe2 Single Crystals*	Journal of Physics	33		35601	10.1088/1361-648X/abb548	Yes
Chatterjee, S.; de Lima, F.; Logan, J.A.; Fang, Y.; Inbar, H.; Goswami, A.; Dempsey, C.; Dong, J.; Khalid, S.; Brown-Heft, T.; Chang, Y.; Guo, T.; Pennachio, D.J.; Wilson, N.; Chikara, S.; Suslov, A.; Fedorov, A.V.; Read, D.; Cano, J.; Janotti, A.; Palmstrøm, C.J.	*Identifying the fingerprints of topological states by tuning magnetoresistance in a semimetal: The case of topological half-Heusler Pt1−xAuxLuSb*	Physical Review Materials	5		124207	10.1103/PhysRevMaterials.5.124207	Yes
Chen, C.; Mentink-Vigier, F.; Trebosc, J.; Goldberga, I.; Gaveau, P.; Thomassot, E.; Iuga, D.; Smith, M.; Chen, K.; Gan, Z.; Fabregue, N.; Metro, T.; Alonso, B.; Laurencin, D.	*Labeling and Probing the Silica Surface Using Mechanochemistry and 17O NMR Spectroscopy*	Chemistry a European Journal	-	-	chem.202101421	10.1002/chem.202101421	Yes
Curley, S.P.; Huddart, B.M.; Kamenskyi, D.; Coak, M.J.;	*Anomalous magnetic exchange in a dimerized*	Physical Review B	104		214435	10.1103/PhysRevB.104.214435	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Williams, R.C.; Ghannadzadeh, S.; Schneider, A.; Okubo, S.; Sakurai, T.; Ohta, H.; Tidey, J.P.; Graf, D.E.; Clark, S.J.; Blundell, S.J.; Pratt, F.L.; Telling, M.T.; Lancaster, T.; Manson, J.L.; Goddard, P.A.	*quantum magnet composed of unlike spin species*						
Dang, P.; Khalsa, G.; Chang, C.S.; Scott Katzer, D.; Nepal, N.; Downey, B.P.; Wheeler, V.D.; Suslov, A.; Xie, A.; Beam, E.; Cao, Y.U.; Lee, C.; Muller, D.A.; Grace Xing, H.; Meyer, D.J.; Jena, D.	*An all-epitaxial nitride heterostructure with concurrent quantum Hall effect and superconductivity*	Science Advances	7	8	eabf1388	10.1126/sciadv.abf1388	Yes
Devarakonda, A.; Suzuki, T.; Fang, S.; Zhu, J.; Graf, D.E.; Kriener, M.; Fu, L.; Kaxiras, E.; Checkelsky, J.G.	*Signatures of bosonic Landau levels in a finite-momentum superconductor*	Nature	599	7883	51-56	10.1038/s41586-021-03915-3	Yes
Devlin, K.P.; Zhang, J.; Fettinger, J.C.; Choi, E.; Hauble, A.K.; Taufour, V.; Hermann, R.P.; Kauzlarich, S.M.	*Deconvoluting the Magnetic Structure of the Commensurately Modulated Quinary Zintl Phase Eu11 xSrxZn4Sn2As12*	Inorganic Chemistry	60	8	5711-5723	10.1021/acs.inorgchem.0c03769	Yes
Ding, X.; Xing, J.; Li, G.; Balicas, L.; Gofryk, K.; Wen, H. H.	*Crossover from Kondo to Fermi-liquid behavior induced by high magnetic field in 1T−VTe_2 single crystals*	Physical Review B	103		125115	10.1103/PhysRevB.103.125115	Yes
Drichko, I.L.; Smirnov, I.Y.; Suslov, A.; Baldwin, K.W.; Pfeiffer, L.N.; West, K.W.	*Dresselhaus spin-orbit interaction in the p-AlGaAs/GaAs/AlGaAs structure with a square quantum well: Surface acoustic wave study*	Physical Review B	104		155302	10.1103/PhysRevB.104.155302	Yes
Dun, Z.; Daum, M.; Baral, R.; Fischer, H.E.; Cao, H.; Liu, Y.; Stone, M.B.; Rodriguez-Rivera, J.A.; Choi, E.; Huang, Q.; Zhou, H.; Mourigal, M.; Frandsen, B.A.	*Neutron scattering investigation of proposed Kosterlitz-Thouless transitions in the triangular-lattice Ising antiferromagnet TmMgGaO4*	Physical Review B	103	6	64424	10.1103/PhysRevB.103.064424	No
Fang, Y.; Nair, H.P.; Miao, L.; Goodge, B.; Schreiber, N.J.; Ruf, J.P.; Kourkoutis, L.F.; Shen, K.M.; Schlom, D.G.; Ramshaw, B.J.	*Quantum oscillations and quasiparticle properties of thin film Sr2RuO4*	Physical Review B	104		45152	10.1103/PhysRevB.104.045152	Yes
Fortune, N.A.; Huang, Q.; Hong, T.; Ma, J.; Choi, E.S.; Hannahs, S.T.; Zhao, Z.Y.; Sun, X.F.; Takano, Y.; Zhou, H.D.	*Evolution of magnetic field induced ordering in the layered quantum Heisenberg triangular-lattice antiferromagnet Ba3CoSb2O9*	Physical Review B	103	18	184425	10.1103/PhysRevB.103.184425	Yes
Fu, H.; Huang, K.; Watanabe, K.; Taniguchi, T.; Zhu, J.	*Gapless Spin Wave Transport through a Quantum Canted Antiferromagnet*	Physical Review X	11	2	21012	10.1103/PhysRevX.11.021012	Yes
Fu, X.; Shi, Q.; Zudov, M.A.; Gardner, G.C.; Watson, J.D.; Manfra, M.J.; Baldwin, K.W.; Pfeiffer, L.N.; West, K.W.	*Anomalous nematic state to stripe phase transition driven by in-plane magnetic fields*	Physical Review B	104		L081301	10.1103/PhysRevB.104.L081301	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Galley, S.S.; Pattenaude, S.A.; Ray, D.; Gaggioli, C.; Whitefoot, M.A.; Qiao, Y.; Higgins, R.F.; Nelson, W.L.; Baumbach, R.; Sperling, J.M.; Zeller, M.; Collins, T.S.; Schelter, E.J.; Gagliardi, L.; Albrecht-Schönzart, T.E.; Bart, S.C.	*Using Redox-Active Ligands to Generate Actinide Ligand Radical Species*	Inorganic Chemistry	60	20	15242 - 15252	10.1021/acs.inorgchem.1c01766	Yes
Gaudet, J.; Yang, H.; Baidya, S.; Lu, B.; Xu, G.; Zhao, Y.; Rodriguez-Rivera, J.A.; Hoffmann, C.M.; Graf, D.E.; Torchinsky, D.H.; Nikolic, P.; Vanderbilt, D.; Tafti, F.; Broholm, C.L.	*Weyl-mediated helical magnetism in NdAlSi*	Nature Materials	20	12	1650-1656	10.1038/s41563-021-01062-8	Yes
Ghosh, T.; Marbey, J.; Wernsdorfer, W.; Hill, S.; Abboud, K.A.; Christou, G.	*Exchange-biased Quantum Tunnelling of Magnetization in a $[Mn_3]_2$ Dimer of Single-Molecule Magnets with Rare Ferromagnetic Inter-Mn_3 Coupling*	Physical Chemistry Chemical Physics	23		8854-8867	10.1039/d0cp06611g	Yes
Gilmutdinov, I.F.; Schoenemann, R.U.; Vignolles, D.; Proust, C.; Mukhamedshin, I.R.; Balicas, L.; Alloul, H.	*Interplay between strong correlations and electronic topology in the underlying kagome lattice of Na2/3CoO2*	Physical Review B: Rapid Comm/ Letters	104		L201103	10.1103/PhysRevB.104.L201103	Yes
Gourgout, A.; Ataei, A.; Boulanger, M.E.; Badoux, S.; Thériault, S.; Graf, D.E.; Zhou, J.S.; Pyon, S.; Takayama, T.; Takagi, H.; Doiron-Leyraud, N.; Taillefer, L.	*Effect of pressure on the pseudogap and charge density wave phases of the cuprate Nd-LSCO probed by thermopower measurements*	Physical Review Research	3		23066	10.1103/PhysRevResearch.3.023066	Yes
Grissonnanche, G.; Fang, Y.; Legros, A.; Verret, S.; Laliberte, F.; Collignon, C.; Zhou, J.; Graf, D.E.; Goddard, P.; Taillefer, L.; Ramshaw, B.	*Linear-in temperature resistivity from an isotropic Planckian scattering rate*	Nature	595		667-672	10.1038/s41586-021-03697-8	Yes
Hamill, A.; Heischmidt, B.; Sohn, E.; Shaffer, D.; Tsai, K.; Zhang, X.; Xi, X.; Suslov, A.; Berger, H.; Forro, L.; Burnell, F.J.; Shan, J.; Mak, K.F.; Fernandes, R.M.; Wang, K.; Pribiag, V.S.	*Two-fold symmetric superconductivity in few-layer $NbSe_2$*	Nature Physics	17		949-954	10.1038/s41567-021-01219-x	Yes
Han, M.; Inoue, H.; Fang, S.; John, C.; Ye, L.; Chan, M.; Graf, D.E.; Suzuki, T.; Ghimire, M.; Cho, W.; Kaxiras, E.; Checkelsky, J.G.	*Evidence of two-dimensional flat band at the surface of antiferromagnetic kagome metal FeSn*	Nature Communi-cations	12	1	5345	10.1038/s41467-021-25705-1	Yes
Harrison, N.; Kushwaha, S.K.; Chan, M.K.; Jaime, M.	*Proximity to a critical point driven by electronic entropy in URu_2Si_2*	Nature Partner Journals Quantum Materials (npj)	6		24	10.1038/s41535-021-00317-6	Yes
Hassan, N.M.; Thirunavukkuarasu, K.; Lu, Z.; Smirnov, D.; Zhilyaeva, E.I.; Torunova, S.; Lyubovskaya, R.N.; Drichko, N.	*Probing the effect of magnetic field on charge order in the quasi-two-dimensional Mott insulator κ-(ET)2Hg(SCN)2Cl*	Physical Review B	104		245120	10.1103/PhysRevB.104.245120	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Hsu, Y.T.; Berben, M.; Culo, M.; Adachi, S.; Kondo, T.; Takeuchi, T.; Wang, Y.; Wiedmann, S.; Hayden, S.M.; Hussey, N.E.	*Anomalous vortex liquid in charge-ordered cuprate superconductors*	Proceedings of the National Academy of Sciences of the USA (PNAS)	118	7	e2016275118	10.1073/pnas.2016275118	Yes
Inosov, D.S.; Avdoshenko, S.; Portnichenko, P.Y.; Choi, E.; Schneidewind, A.; Mignot, J.M.; Nikolo, M.	*Local origin of the strong field-space anisotropy in the magnetic phase diagrams of Ce1-xLaxB6 measured in a rotating magnetic field*	Physical Review B	103	21	214415	10.1103/PhysRevB.103.214415	Yes
Jayasinghe, A.S.; Lai, Y.; Potter, W.M.; Windorff, C.J.; Baumbach, R.; Albrecht-Schönzart, T.E.; Latturner, S.E.	*$An_{1.33}T_4Al_8Si_2$ (An = Ce, Th, U, Np; T = Ni, Co): Actinide Intermetallics with Disordered $Gd_{1+x}Fe_4Si_{10-y5}$ Structure Type Grown from Metal Flux*	Inorganic Chemistry	60	17	13062 – 13070	10.1021/acs.inorgchem.1c01480	Yes
Jiang, Q.; Wang, C.; Malinowski, P.; Liu, Z.; Shi, Y.; Lin, Z.; Fei, Z.; Song, T.; Graf, D.E.; Chikara, S.; Xu, X.; Yan, J.; Xiao, D.; Chu, J.	*Quantum oscillations in the field-induced ferromagnetic state of $MnBi_{2-x}Sb_xTe_4$*	Physical Review B	103		205111	10.1103/PhysRevB.103.205111	Yes
Joe, A.Y.; Jaurergui, L.A.; Pistunova, K.; Mier Valdivia, A.M.; Lu, Z.; Wild, D.S.; Scuri, G.; De Grev, K.; Gelly, R.J.; Zhou, Y.; Sung, J.; Sushko, A.; Taniguchi, T.; Watanabe, K.; Smirnov, D.; Lukin, M.D.; Park, H.; Kim, P.	*Electrically controlled emission from singlet and triplet exciton species in atomically thin light-emitting diodes*	Physical Review B	103	16	L161411	10.1103/PhysRevB.103.L161411	Yes
Jones, S.C.; Miura, M.; Yoshida, R.; Kato, T.; Civale, L.; Willa, R.; Eley, S.	*Designing high-performance superconductors with nanoparticle inclusions: Comparisons to strong pinning theory*	APL Materials	9	9	91105	10.1063/5.0057479	Yes
Kong, P.; Minkov, V.S.; Kuzovnikov, M.A.; Drozdov, A.P.; Besedin, S.P.; Mozaffari, S.; Balicas, L.; Balakirev, F.; Prakapenka, V.B.; Chariton, S.; Knyazev, D.A.; Greenberg, E.; Eremets, M.I.	*Superconductivity up to 243 K in the yttrium-hydrogen system under high pressure*	Nature Communi-cations	12		5075	10.1038/s41467-021-25372-2	Yes
Krstovska, D.; Choi, E.S.; Steven, E.	*Seebeck effect studies in the charge density wave state of organic conductor alpha-(BEDT-TTF)2KHg(SCN)4*	Physica Scripta	96	12	125734	10.1088/1402-4896/ac45a9	Yes
Krstovska, D.; Choi, E.S.; Steven, E.	*The Magnetothermopower of Organic Superconductor κ-(ET)2Cu(NCS)2: Possible Charge Density Wave Scenario*	Romanian Journal of Physics	66		612	na	Yes
Lee, S.; Dong, S.; Lee, W.E.; Choi, Y.; van Tol, J.; Reyes, A.P.; Gorbunov, D.; Chen, W.; Choi, K.	*Dichotomy in temporal and thermal spin correlations observed in the breathing pyrochlore LiGa1−xInxCr4O8*	Nature Partner Journals Quantum Materials (npj)	6		47	10.1038/s41535-021-00347-0	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Lee, S.; Lee, W.; Guohua, W.; Macy, J.J.; Zhou, H.; Lee, M.; Choi, E.S.; Choi, K.Y.	*Experimental evidence for a valence-bond glass in the 5d1 double perovskite Ba2YWO6*	Physical Review B	103	22	224430	10.1103/PhysRevB.103.224430	Yes
Lee, S.H.; Graf, D.E.; Min, L.; Zhu, Y.; Yi, H.; Ciocys, S.; Wang, Y.; Choi, E.S.; Basnet, R.; Fereidouni, A.; Wegner, A.; Zhao, Y.; Verlinde, K.; He, J.; Redwing, R.; Gopalan, V.; Churchill, H.O.H.; Lanzara, A.; Samarth, N.; Chang, C.; Hu, J.; Mao, Z.Q.	*Evidence for a Magnetic-Field-Induced Ideal Type-II Weyl State in Antiferromagnetic Topological Insulator* $Mn(Bi_{1-x}Sb_x)_2Te_4$	Physical Review X	11	3	31032	10.1103/PhysRevX.11.031032	Yes
Li, N.; Huang, Q.; Brassington, A.; Yue, X.; Chu, W.; Guang, S.; Zhou, X.; Gao, P.; Feng, E.; Cao, H.; Choi, E.S.; Sun, Y.; Li, Q.; Zhao, X.; Zhou, H.; Sun, X.	*Quantum spin state transitions in the spin-1 equilateral triangular lattice antiferromagnet Na2BaNi(PO4)2*	Physical Review B	104		104403	10.1103/PhysRevB.104.104403	Yes
Liu, E.; Barré, E.; van Baren, J.; Wilson, M.; Taniguchi, T.; Watanabe, K.; Cui, Y.; Gabor, N.M.; Heinz, T.F.; Chang, Y.; Lui, C.	*Signatures of moiré trions in WSe2/MoSe2 heterobilayers*	Nature	594		46-50	10.1038/s41586-021-03541-z	Yes
Liu, E.; van Baren, J.; Lu, Z.; Taniguchi, T.; Watanabe, K.; Smirnov, D.; Chang, Y.; Lui, C.	*Exciton-polaron Rydberg states in monolayer MoSe2 and WSe2*	Nature Communi-cations	12	1	6131	10.1038/s41467-021-26304-w	Yes
Liu, X.; Fang, S.; Fu, Y.; Ge, W.; Kareev, M.; Kim, J.; Choi, Y.; Karapetrova, E.; Zhang, Q.; Gu, L.; Choi, E.S.; Wen, F.; Wilson, J.H.; Fabbris, G.; Ryan, P.J.; Freeland, J.W.; Haskel, D.; Wu, W.; Pixley, J.H.; Chakhalian, J.	*Magnetic Weyl Semimetallic Phase in Thin Films of Eu2Ir2O7*	Physical Review Letters	127	27	277204	10.1103/PhysRevLett.127.277204	Yes
Liu, X.; Yue, C.; Erohin, S.V.; Zhu, Y.; Joshy, A.; Liu, J.; Sanchez, A.; Graf, D.E.; Sorokin, P.B.; Mao, Z.; Hu, J.; Wei, J.	*Quantum Transport of the 2D Surface State in a Nonsymmorphic Semimetal*	American Chemical Society Nano Letters	21	11	4887-4893	10.1021/acs.nanolett.0c04946	Yes
Lu, Z.; Hollister, P.; Ozerov, M.; Moon, S.; Bauer, E.; Ronning, F.; Ju, L.; Ramshaw, B.	*Weyl Fermion Magneto-Electrodynamics and Ultra-low Field Quantum Limit in TaAs*	Science Advances	0		0	arxiv	Yes
Macy, J.J.; Ratkovski, D.R.; Balakrishnan, P.P.; Strungaru, M.; Chiu, Y.C.; Flessa Savvidou, A.K.; Moon, A.; Zheng, W.; McCandless, G.T.; Chan, J.Y.; Kumar, G.S.; Shatruk, M.; Grutter, A.J.; Borchers, J.A.; Ratcliff, W.D.; Choi, E.S.; Santos, E.J.G.; Balicas, L.	*Magnetic field-induced non-trivial electronic topology in Fe3-xGeTe2*	Applied Physics Reviews	8		41401	10.1063/5.0052952	Yes
Maksimovic, N.; Eilbott, D.H.; Cookmeyer, T.; Wan, F.; Rusz, J.; Nagarajan, V.; Haley, S.C.; Maniv, E.; Gong, A.; Faubel, S.; Hayes, I.M.; Bangura, A.; Singleton, J.; Palmstrom, J.C.; Winter, L.; McDonald, R.; Jang, S.; Ai, P.; Lin, Y.I.;	*Evidence for a delocalization quantum phase transition without symmetry breaking in* $CeCoIn_5$	Science	375	6576	76-81	10.1126/science.aaz4566	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Ciocys, S.; Gobbo, J.; Werman, Y.; Oppeneer, P.M.; Altman, E.; Lanzara, A.; Analytis, J.G.							
Maniv, E.; Murphy, R.A.; Haley, S.C.; Doyle, S.; John, C.; Maniv, A.; Ramakrishna, S.K.; Tang, Y.; Ercius, P.; Ramesh, R.; Reyes, A.P.; Long, J.R.; Analytis, J.G.	*Exchange bias due to coupling between coexisting antiferromagnetic and spin-glass orders*	Nature Physics	17		1-7	10.1038/s41567-020-01123-w	Yes
Maniv, E.; Nair, N.L.; Haley, S.C.; Doyle, S.; John, C.; Cabrini, S.; Maniv, A.; Ramakrishna, S.K.; Tang, Y.L.; Ercius, P.; Ramesh, R.; Tserkovnyak, Y.; Reyes, A.P.; Analytis, J.G.	*Antiferromagnetic switching driven by the collective dynamics of a coexisting spin glass*	Science Advances	7	2	eabd8452	10.1126/sciadv.abd8452	Yes
Mauws, C.; Hiebert, N.; Rutherford, M.L.; Zhou, H.D.; Huang, Q.; Stone, M.B.; Butch, N.P.; Su, Y.; Choi, E.S.; Yamani, Z.; Wiebe, C.R.	*Magnetic ordering in the Ising antiferromagnetic pyrochlore Nd2ScNbO7*	Journal of Physics-Condensed Matter	33	24	245802	10.1088/1361-648X/abf594	Yes
Molodyk, A.; Samoilenkov, S.; Markelov, A.; Degtyarenko, P.; Lee, S.; Petrykin, V.; Gaifullin, M.; Mankevich, A.; Vavilov, A.; Sorbom, B.; Cheng, J.; Garberg, S.; Kesler, L.; Hartwig, Z.; Gavrilkin, S.; Tsvetkov, A.; Okada, T.; Awaji, S.; Abraimov, D.V.; Francis, A.; Bradford, G.; Larbalestier, D.; Senatore, C.; Bonura, M.; Pantoja, A.; Wimbush, S.; Strickland, N.; Vasiliev, A.	*Development and large volume production of extremely high current density $YBa_2Cu_3O_7$ superconducting wires for fusion*	Scientific Reports	11	1	1-11	10.1038/s41598-021-81559-z	Yes
Munir, R.; Siddiquee, K.A.M.H.; Dissanayake, C.; Hu, X.; Takano, Y.; Choi, E.; Nakajima, Y.	*Unusual upper critical fields of the topological nodal-line semimetal candidate SnxNbSe2−δ*	Journal of Physics-Condensed Matter	33	23	23LT01	10.1088/1361-648X/abf386	Yes
Niu, C.; Qiu, G.; Wang, Y.; Si, M.; Wu, W.; Ye, P.	*Bilayer Quantum Hall States in an n-Type Wide Tellurium Quantum Well*	American Chemical Society Nano Letters	21	18	7527-7533	10.1021/acs.nanolett.1c01705	Yes
Ok, J.M.; Zhang, J.; Mohanta, N.; Yoon, S.; Okamoto, S.; Choi, E.; Zhou, H.; Lupini, A.R.; Pai, Y.Y.; Skoropata, E.; Sohn, C.; Choi, W. S.; Briggeman, M.; Irvin, P.; Levy, J.; Lee, H.N.	*Correlated Dirac semimetal in the extreme quantum limit*	Science Advances	7		eabf9631	10.1126/sciadv.abf9631	Yes
Park, W.K.; Sittler, J.A.; Greene, L.H.; Fuhrman, W.T.; Chamorro, J.R.; Koohpayeh, S.M.; Phelan, W.A.; McQueen, T.M.	*Topological nature of the Kondo insulator SmB6 and its sensitiveness to Sm vacancy*	Physical Review B	103		155125	10.1103/PhysRevB.103.155125	Yes
Rahn, M.C.; Gallagher, A.; Orlandi, F.; Khalyavin, D.D.; Hoffmann, C.; Manuel, P.; Baumbach, R.; Janoschek, M.	*Collinear antiferromagnetic order in $URu_2Si_{2-x}P_x$ revealed by neutron diffraction*	Physical Review B	103		214403	10.1103/PhysRevB.103.214403	Yes
Ran, S.; Saha, S.R.; Liu, I.L.; Graf, D.E.; Paglione, J.; Butch, N.P.	*Expansion of the high field-boosted superconductivity in UTe2 under pressure*	Nature Partner Journals	6	1	75	10.1038/s41535-021-00376-9	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
		Quantum Materials (npj)					
Rao, X.; Hussain, G.; Huang, Q.; Chu, W.; Li, N.; Zhao, X.; Dun, Z.; Choi, E.S.; Asaba, T.; Chen, L.; Li, L.; Yue, X.; Wang, N.; Cheng, J.G.; Gao, Y.; Shen, Y.; Zhao, J.; Chen, G.; Zhou, H.; Sun, X.	*Survival of itinerant excitations and quantum spin state transitions in YbMgGaO4 with chemical disorder*	Nature Communi-cations	12		4949	10.1038/s41467-021-25247-6	Yes
Reiss, P.; Graf, D.E.; Haghighirad, A.A.; Vojta, T.; Coldea, A.I.	*Signatures of a Quantum Griffiths Phase Close to an Electronic Nematic Quantum Phase Transition*	Physical Review Letters	127		246402	10.1103/PhysRevLett.127.246402	Yes
Rhodes, D.A.; Jindal, A.; Yuan, N.F.Q.; Jung, Y.; Antony, A.; Wang, H.; Kim, B.; Chiu, Y.C.; Taniguchi, T.; Watanabe, K.; Barmak, K.; Balicas, L.; Dean, C.R.; Qian, X.; Fu, L.; Pasupathy, A.N.; Hone, J.	*Enhanced Superconductivity in Monolayer T_d-$MoTe_2$*	American Chemical Society Nano Letters	21		2505	10.1021/acs.nanolett.0c04935	Yes
Sarkis, C.L.; Saeubert, S.; Williams, V.; Choi, E.; Reeder, T.R.; Nair, H.S.; Ross, K.A.	*Low-temperature domain-wall freezing and nonequilibrium dynamics in the transverse-field Ising model material CoNb2O6*	Physical Review B	104		214424	10.1103/PhysRevB.104.214424	Yes
Sarte, P.M.; Cruz-Kan, K.; Ortiz, B.R.; Hong, K.H.; Bordelon, M.M.; Reig-i-Plessis, D.; Lee, M.; Choi, E.S.; Stone, M.B.; Calder, S.; Pajerowski, D.M.; Mangin-Thro, L.; Qiu, Y.; Attfield, J.P.; Wilson, S.D.; Stock, C.; Zhou, H.D.; Hallas, A.M.; Paddison, J.A.M.; Aczel, A.A.; Wiebe, C.R.	*Dynamical ground state in the XY pyrochlore Yb2GaSbO7*	Nature Partner Journals Quantum Materials (npj)	6	1	42	10.1038/s41535-021-00343-4	Yes
Seo, J.; De, C.; Ha, H.; Lee, J.E.; Park, S.; Park, J.; Skourski, Y.; Choi, E.S.; Kim, B.; Cho, G.Y.; Yeom, H.W.; Cheong, S.W.; Kim, J.H.; Yang, B.J.; Kim, K.; Kim, J.S.	*Colossal angular magnetoresistance in ferrimagnetic nodal-line semiconductors*	Nature	599		576	10.1038/s41586-021-04028-7	Yes
Sharma, S.; Kovalev, A.; Rebar, D.; Mann, D.; Yannello, V.; Shatruk, M.; Suslov, A.; Smith, J.H.; Siegrist, T.M.	*Magnetostriction of AlFe2B2 in high magnetic fields*	Physical Review Materials	5		64409	10.1103/PhysRevMaterials.5.064409	Yes
Shcherbakov, D.; Stepanov, P.; Memaran, S.; Wang, Y.; Xin, Y.; Yang, J.; Wei, K.; Baumbach, R.; Zheng, W.; Watanabe, K.; Tanigushi, T.; Bockrath, M.; Smirnov, D.; Siegrist, T.M.; Windl, W.; Balicas, L.; Lau, C.N.	*Layer- and gate-tunable spin-orbit coupling in a high-mobility few-layer semiconductor*	Science Advances	7		eabe2892	10.1126/sciadv.abe2892	Yes
Shi, Y.; Parker, D.S.; Choi, E.; Devlin, K.P.; Yin, L.; Zhao, J.; Klavins, P.; Kauzlarich, S.M.; Taufour, V.	*Robust antiferromagnetism in Y_2Co_3*	Physical Review B	104		184407	10.1103/PhysRevB.104.184407	Yes
Shi, Z.; Baity, P.G.; Terzic, J.; Pokharel, B.K.; Sasagawa, T.; Popovic, D.	*Magnetic field reveals vanishing Hall response in*	Nature Communi-cations	12		3724	10.1038/s41467-021-24000-3	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
	the normal state of stripe-ordered cuprates						
Siddiquee, K.A.M.H.; Munir, R.; Dissanayake, C.; Hu, X.; Yadav, S.; Takano, Y.; Choi, E.; Le, D.; Rahman, T.; Nakajima, Y.	*Fermi surfaces of the topological semimetal CaSn3 probed through de Haas van Alphen oscillations*	Journal of Physics-Condensed Matter	33		17LT01	10.1088/1361-648X/abe0e2	Yes
Sittler, J.A.; Park, W.K.	*Self-oxidation-formed boron oxide as a tunnel barrier in SmB6 junctions*	Journal of Alloys and Compounds	874		159841	10.1016/j.jallcom.2021.159841	Yes
Steinhardt, W.; Maksimov, P.A.; Dissanayake, S.; Shi, Z.; Butch, N.P.; Graf, D.E.; Podlesnyak, A.A.; Liu, Y.; Zhao, Y.; Xu, G.; Lynn, J.W.; Marjerrison, C.A.; Chernyshev, A.L.; Haravifard, S.	*Phase diagram of YbZnGaO4 in applied magnetic field.*	Nature Partner Journals Quantum Materials (npj)	6		78	10.1038/s41535-021-00380-z	Yes
Steinhardt, W.; Shi, Z.; Samarakoon, A.; Dissanayake, S.; Graf, D.E.; Liu, Y.; Zhu, W.; Marjerrison, C.; Batista, C.D.; Haravifard, S.	*Constraining the parameter space of a quantum spin liquid candidate in applied field with iterative optimization*	Physical Review Research	3		33050	10.1103/PhysRevResearch.3.033050	Yes
Sun, D.; Mikov, V.S.; Mozaffari, S.; Sun, Y.; Ma, Y.; Chariton, S.; Prakapenka, V.B.; Eremets, M.I.; Balicas, L.; Balakirev, F.	*High-temperature superconductivity on the verge of a structural instability in lanthanum superhydride*	Nature Communi-cations	12		6863	10.1038/s41467-021-26706-w	Yes
Switlicka, A.; Machura, B.; Bienko, A.; Koziel, S.; Bienko, D. C.; Rajnak, C.; Boca, R.; Ozarowski, A.; Ozerov, M.	*Non-traditional thermal behavior of Co(II) coordination networks showing slow magnetic relaxation*	Inorganic Chemistry Frontiers	8		4356-4366	10.1039/d1qi00667c	Yes
Thirunavukkuarasu, K.; Richardson, R.; Lu, Z.; Smirnov, D.; Huang, N.; Combs, N.; Pokharel, G.; Mandrus, D.	*Magneto-elastic coupling in multiferroic metal-organic framework [(CH3)2NH2]Co(HCOO)3.*	AIP Advances	11		15040	10.1063/9.0000147	Yes
Ungor, O.; Choi, E.; Shatruk, M.	*Solvent-Dependent Spin-Crossover Behavior in Semiconducting Co-Crystals of [Fe(1-bpp)2]2+ Cations and [TCNQ]d- Anions (0<d<1).*	European Journal of Inorganic Chemistry	2021	46	4812-4820	10.1002/ejic.202100707	Yes
Ungor, O.; Choi, E.S.; Shatruk, M.	*Optimization of crystal packing in semiconducting spin-crossover materials with fractionally charged TCNQδ− anions (0 < δ < 1)*	Chemical Science	12		10765-10779	10.1039/D1SC02843J	Yes
Vanderlaan, M.; Brumm, T.	*Oxygen sensor errors in helium-air mixtures*	Cryogenics	116		103297	10.1016/j.cryogenics.2021.103297	Yes
Wang, A.; Du, F.; Zhang, Y.; Graf, D.E.; Shen, B.; Chen, Y.E.; Liu, Y.; Smidman, M.; Cao, C.; Steglich, F.; Yuan, H.	*Localized 4f-electrons in the quantum critical heavy fermion ferromagnet CeRh6Ge4*	Science Bulletin	66	14	1389-1394	10.1016/j.scib.2021.03.006	Yes
Wang, D.; Telford, E.J.; Benyamini, A.; Jesudasan, J.; Raychaudhuri, P.; Watanabe, K.; Taniguchi, T.; Hone, J.; Dean, C.R.; Pasupathy, A.N.	*Andreev Reflections in NbN/Graphene Junctions under Large Magnetic Fields*	American Chemical Society Nano Letters	21	19	8229-8235	10.1021/acs.nanolett.1c02020	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Wang, J.; Jiang, Y.; Zhao, T.; Dun, Z.; Miettinen, A.L.; Wu, X.; Mourigal, M.; Zhou, H.; Pan, W.; Smirnov, D.; Jiang, Z.	*Magneto-transport evidence for strong topological insulator phase in ZrTe5*	Nature Communi-cations	12	1	6758	10.1038/s41467-021-27119-5	Yes
Wang, K.; Mori, R.; Wang, Z.; Wang, L.; Ma, J.; Latzke, D.W.; Graf, D.E.; Denlinger, J.D.; Campbell, D.; Bernevig, B.A.; Lanzara, A.; Paglione, J.	*Crystalline symmetry-protected non-trivial topology in prototype compound* $BaAl_4$	Nature Partner Journals Quantum Materials (npj)	6	1	28	10.1038/s41535-021-00325-6	Yes
Wang, P.; Yu, G.; Jia, Y.; Onyszczak, M.; Cevallos, F.A.; Lei, S.; Klemenz, S.; Watanabe, K.; Taniguchi, T.; Cava, R.J.; Schoop, L.M.; Wu, S.	*Landau quantization and highly mobile fermions in an insulator*	Nature	-	-	1-18	10.1038/s41586-020-03084-9	Yes
Wang, X.; Cao, J.; Lu, Z.; Cohen, A.; Kitadai, H.; Li, T.; Tan, Q.; Wilson, M.; Lui, C.; Smirnov, D.; Sharifzadeh, S.; Ling, X.	*Spin-induced linear polarization of photoluminescence in antiferromagnetic van der Waals crystals*	Nature Materials	20	7	964-970	10.1038/s41563-021-00968-7	Yes
Wang, Z.; Chen, K.; Jiang, Y.; Trebosc, J.; Yang, W.; Amoureux, J.; Hung, I.; Gan, Z.; Baiker, A.; Lafon, O.; Huang, J.	*Revealing Brønsted Acidic Bridging SiOHAl Groups on Amorphous Silica Alumina by Ultrahigh Field Solid-State NMR*	Journal of Physical Chemistry Letters	12	47	11563--11572	10.1021/acs.jpclett.1c02975	Yes
Weiland, A.; Wei, K.; McCandless, G.T.; Baumbach, R.E.; Chan, J.Y.	*Fantastic n = 4:* $Ce_5Co_{4+x}Ge_{13-y}Sn_y$ *of the* $A_{n+1}M_nX_{3n+1}$ *homologous series*	Journal of Chemical Physics	154		114707	10.1063/5.0045015	Yes
Yang, H.; Singh, B.; Gaudet, J.; Lu, B.; Huang, C.; Chiu, W.; Huang, S.; Wang, B.; Bahrami, F.; Xu, B.; Franklin, J.; Sochnikov, I.; Graf, D.E.; Xu, G.; Zhao, Y.; Hoffman, C.M.; Lin, H.; Torchinsky, D.H.; Broholm, C.L.; Bansil, A.; Tafti, F.	*Noncollinear ferromagnetic Weyl semimetal with anisotropic anomalous Hall effect*	Physical Review B	103		115143	10.1103/PhysRevB.103.115143	Yes
Yang, H.Y.; Yao, X.; Plisson, V.; Mozaffari, S.; Scheifers, J.P.; Flessa Savvidou, A.K.; Choi, E.S.; McCandless, G.T.; Padlewski, M.F.; Putzke, C.; Moll, P.J.W.; Chan, J.Y.; Balicas, L.; Burch, K.S.; Tafti, F.	*Evidence of a coupled electron-phonon liquid in NbGe2*	Nature Communi-cations	12		5292	10.1038/s41467-021-25547-x	Yes
Yang, Y.; Sumption, M.D.; Rindfleisch, M.; Tomsic, M.; Collings, E.W.	*Enhanced higher temperature irreversibility field and critical current density in MgB2 wires with Dy2O3 additions*	Super-conductor Science and Technology	34	2	25010	10.1088/1361-6668/abc73c	Yes
Zhang, L.; Jiang, Y.; Smirnov, D.; Jiang, Z.	*Landau quantization in tilted Weyl semimetals with broken symmetry*	Journal of Applied Physics	129	10	105107	10.1063/5.0042307	Yes
Zhu, Y.; Hu, J.; Graf, D.E.; Gui, X.; Xie, W.; Mao, Z.	*Quasi-two-dimensional relativistic fermions probed by de Haas--van Alphen quantum oscillations in* $LuSn_2$	Physical Review B	103		125109	10.1103/PhysRevB.103.125109	Yes

5.3 PUBLICATIONS GENERATED BY EMR AT FSU (26)

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Ajibola, A.A.; Obaleye, J.A.; Sieron, L.; Maniukiewicz, W.; Wojciechowska, A.; Ozarowski, A.	*Structural, spectroscopic insights, and antimicrobial properties of mononuclear and dinuclear metal(II) carboxylate derivatives with metronidazole*	Polyhedron	194	114931	1-12	10.1016/j.poly.2020.114931	Yes
Arth, T.; Pregelj, M.; Khuntia, P.; Jagličić, Z.; Le, M.D.; Biswas, P.K.; Manuel, P.; Mangin-Thro, L.; Ozarowski, A.; Zorko, A.	*The Ising triangular-lattice antiferromagnet neodymium heptatantalate as a quantum spin liquid candidate*	Nature Materials	2021		1-10	10.1038/s41563-021-01169-y	Yes
Boča, R.; Titi□, J.; Rajnák, C.; Krzystek, J.	*Positive zero-field splitting and unexpected slow magnetic relaxation in the magneto-chemical calibrant HgCo(NCS)4*	Dalton Transactions	50		3468-3472	10.1039/d1dt00407g	Yes
Bone, A.N.; Widener, C.N.; Moseley, D.H.; Liu, Z.; Lu, Z.; Cheng, Y.; Daemen, L.L.; Ozerov, M.; Telser, J.; Thirunavukkuarasu, K.; Smirnov, D.; Greer, S.; Hill, S.; Krzystek, J.; Holldack, K.; Aliabadi, A.; Schnegg, A.; Dunbar, K.R.; Zue, X.L.	*Applying Unconventional Spectroscopies to the Single-Molecule Magnets, Co(PPh3)2X2 (X = Cl, Br, I): Unveiling Magnetic Transitions and Spin-Phonon Coupling*	Chemistry a European Journal	27		11110-11125	10.1002/chem.202100705	Yes
Ghosh, T.; Marbey, J.; Wernsdorfer, W.; Hill, S.; Abboud, K.A.; Christou, G.	*Exchange-biased Quantum Tunnelling of Magnetization in a $[Mn_3]_2$ Dimer of Single-Molecule Magnets with Rare Ferromagnetic Inter-Mn_3 Coupling*	Physical Chemistry Chemical Physics	23		8854-8867	10.1039/d0cp06611g	Yes
Gompa, T.P.; Greer, S.M.; Rice, N.T.; Jiang, N.; Telser, J.; Ozarowski, A.; Stein, B.W.; La Pierre, H.S.	*High-Frequency and -Field Electron Paramagnetic Resonance Spectroscopic Analysis of Metal Ligand Covalency in a 4f7 Valence Series (Eu2+, Gd3+, and Tb4+)*	Inorganic Chemistry	60	12	9064-9073	10.1021/acs.inorgchem.1c01062	Yes
Gould, C.A.; Marbey, J.; Vieru, V.; Marchiori, D.A.; Britt, R.D.; Chibotaru, L.; Hill, S.; Long, J.R.	*Isolation of a Triplet Benzene Dianion*	Nature Chemistry	13		1001-1005	10.1038/s41557-021-00737-8	Yes
Janas, Z.; Jezierska, J.; Ozarowski, A.; Bienko, A.; Lis, T.; Jezierski, A.; Krawczyk, M.	*Investigation of vanadium(III) and vanadium(IV) compounds supported by the linear diaminebis(phenolate) ligands: correlation between structures and magnetic properties*	Dalton Transactions	50		5184-5196	10.1039/d0dt04302h	Yes
Lee, S.; Dong, S.; Lee, W.E.; Choi, Y.; van Tol, J.; Reyes, A.P.; Gorbunov, D.; Chen, W.; Choi, K.	*Dichotomy in temporal and thermal spin correlations observed in the breathing pyrochlore LiGa1−xInxCr4O8*	Nature Partner Journals Quantum Materials (npj)	6		47	10.1038/s41535-021-00347-0	Yes
Maier, R. A.; Garrity, K. F.; Ozarowski, A.; Donohue, M. P.; Cibin, G.; Levin, I.	*Effects of octahedral tilting on the site of substitution of manganese in CaTiO3*	Acta Materialia	207		116688	10.1016/j.actamat.2021.116688	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Manson, J.; Curley, S.; Williams, R.; Walker, D.; Goddard, P.; Ozarowski, A.; Johnson, R.; Vibharkar, A.; Villa, D.; Rhodehouse, M.; Birnbaum, S.M.; Singleton, J.	*Controlling Magnetic Anisotropy in a Zero-Dimensional S=1 Magnet Using Isotropic Cation Substitution*	Journal of the American Chemical Society	143		4633-4638	10.1021/jacs.0c12516	Yes
Marbey, J.; Kragskow, J.G.C.; Buch, C.D.; Nehrkorn, J.; Ozerov, M.; Piligkos, S.; Hill, S.; Chilton, N.F.	*Vibronic Coupling in a Molecular 4f Qubit*	ChemRxiv	1372 5904		1-3	10.26434/chemrxiv. 13725904.v1	Yes
Mentink-Vigier, F.; Dubroca, T.; van Tol, J.; Sigurdsson, S.	*The distance between g-tensors of nitroxide biradicals governs MAS-DNP performance: the case of the bTurea family*	Journal of Magnetic Resonance, Series A	nc		10702 6	10.1016/j.jmr.2021.10 7026	Yes
Nehrkorn, J.; Greer, S.M.; Malbrecht, B.J.; Anderton, K.J.; Aliabadi, A.; Krzystek, J.; Schnegg, A.; Holldack, K.; Herrmann, C.; Betley, T.A.; Stoll, S.; Hill, S.	*Spectroscopic Investigation of a Metal-Metal-Bonded Fe6 Single-Molecule Magnet with an Isolated S = 19/2 Giant-Spin Ground State*	Inorganic Chemistry	60		4610-4622	10.1021/acs.inorgch em.0c03595	Yes
Nesterova, O.V.; Kuznetsov, M.L.; Pombeiro, A.J.L.; Shul'pin, G.B.; Nesterov, D.S.	*Homogeneous oxidation of CH bonds with m-CPBA catalysed by a Co/Fe system: mechanisticinsights from the point of view of the oxidant*	Catalysis Science & Technology	2021		1-18	10.1039/d1cy01991k	Yes
Orio, M.; Bindra, J.K.; van Tol, J.; Giorgi, M.; Dalal, N.S.; Bertaina, S.U.	*Quantum dynamics of Mn^{2+} in dimethylammonium magnesium format*	Journal of Chemical Physics	154	15	15420 1	10.1063/5.0046984	Yes
Saiz, C.L.; Delgado, J.A.; van Tol, J.; Tartaglia, T.; Tafti, F.; Singamaneni, S.R.	*2D correlations in the van der Waals ferromagnet CrBr3 using high frequency electron spin resonance spectroscopy*	Journal of Applied Physics	129		23390 2	10.1063/5.0051651	Yes
Shylin, S. I.; Pogrebetsky, J. L.; Husak, A. O.; Bykov, D.; Mokhir, A.; Hampel, F.; Shova, S.; Ozarowski, A.; Gumienna-Kontecka, E.; Fritsky, I. O.	*Expanding manganese(IV) aqueous chemistry: unusually stable water-soluble hexa-hydrazideclathrochelate complexes*	Chemical Communicat ions	57		11060-11063	10.1039/D1CC04870 H	Yes
Stoian, S.; Moshari, M.; Ferentinos, E.; Grigoropoulos, A.; Krzystek, J.; Telser, J.; Kyritsis, P.	*Electronic Structure of Tetrahedral, S = 2, [Fe{(EPiPr2)2N}2], E = S, Se, Complexes: Investigation by High-Frequency and -Field Electron Paramagnetic Resonance, 57Fe Mössbauer Spectroscopy, and Quantum Chemical Studies*	Inorganic Chemistry	60		10990 -11005	10.1021/acs.inorgch em.1c00670	Yes
Switlicka, A.; Machura, B.; Bienko, A.; Koziel, S.; Bienko, D. C.; Rajnak, C.; Boca, R.; Ozarowski, A.; Ozerov, M.	*Non-traditional thermal behavior of Co(II) coordination networks showing slow magnetic relaxation*	Inorganic Chemistry Frontiers	8		4356-4366	10.1039/d1qi00667c	Yes
Tang, M.; Bui, N.N.; Jin, Z.; Song, L.; Hu, Y.	*Real-time monitoring of the lithiation process in organic electrode 7,7,8,8-tetracyanoquinodimethane by in situ EPR*	Journal of Energy Chemistry	60		9-15	10.1016/j.jechem.202 0.12.009	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Ungor, O.; Choi, E.S.; Shatruk, M.	*Optimization of crystal packing in semiconducting spin-crossover materials with fractionally charged TCNQδ− anions (0 < δ < 1)*	Chemical Science	12		10765 - 10779	10.1039/D1SC02843J	Yes
Van Trieste, G.P.; Reid, K.A.; Hicks, M.H.; Das, A.; Figgins, M.T.; Bhuvanesh, N.; Ozarowski, A.; Telser, J.; Powers, D.C.	*Nitrene Photochemistry of Manganese N-Haloamides*	Angewandte Chemie	60	51	26647 - 26655	10.1002/anie.202108304	Yes
Vassilyeva, O.Y.; Buvaylo, E.A.; Kokozay, V.N.; Skelton, B.W.; Sobolev, A.N.; Bienko, A.; Ozarowski, A.	*Ferro- vs. antiferromagnetic exchange between two Ni(ii) ions in a series of Schiff base heterometallic complexes: what makes the difference?*	Dalton Transactions	50		2841-2853	10.1039/D0DT03957H	Yes
Witwicki, M.; Lewinska, A.; Ozarowski, A.	*o-Semiquinone radical anion isolated as an amorphous porous solid*	Physical Chemistry Chemical Physics	23		17408 -17419	10.1039/D1CP01596F	Yes
Zolnhofer, E.M.; Opalade, A.A.; Jackson, T.A.; Heinemann, F.W.; Meyer, K.; Krzystek, J.; Ozarowski, A.; Telser, J.	*Electronic structure and magnetic properties of a low-spin Cr(II) complex: trans-[CrCl2(dmpe)2], dmpe = 1,2-dimethylphosphinoethane*	Inorganic Chemistry	60		17865 - 17877	10.1021/acs.inorgchem.1c02471	Yes

5.4 PUBLICATIONS GENERATED BY ICR AT FSU (37)

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Audu, M.; Wang, H.; Arellano, D.; Cheng, F.; Dehghanizadeh, M.; Jarvis, J.M.; Yan, J.; Brewer, C.E.; Jena, U.	*Ash-pretreatment and Hydrothermal Liquefaction of Filamentous Algae Grown on Dairy Wastewater*	Algal Research	57		102282	10.1016/j.algal.2021.102282	Yes
Bahureksa, W.; Tfaily, M.M.; Boiteau, R.M.; Young, R.B.; Logan, M.N.; McKenna, A.M.; Borch, T.	*Soil Organic Matter Characterization by Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (FTICR MS): A Critical Review of Sample Preparation, Analysis, and Data Interpretation*	Environmental Science and Technology	55	14	9637-9656	10.1021/acs.est.1c01135	Yes
Bayat, H.; Dehghanizade, M.; Jarvis, J.M.; Brewer, C.E.; Jena, U.	*Hydrothermal Liquefaction of Food Waste: Effect of Process Parameters on Product Yields and Chemistry*	Frontiers in Sustainable Food Systems	5		160	10.3389/fsufs.2021.658592	Yes
Behnke, M.I.; McClelland, J.W.; Tank, S.E.; Kellerman, A.M.; Holmes, R.M.; Haghipour, N.; Eglinton, T.I.; Raymond, P.A.; Suslova, A.; Zhulidov, A.V.; Gurtovaya, T.; Zimov, N.; Zimov, S.; Mutter, E.A.; Spencer, R.G.M.	*Pan-Arctic Riverine Dissolved Organic Matter: Synchronous Molecular Stability, Shifting Sources and Subsidies*	Global Biogeochemical Cycles	35		e2020GB006871	10.1029/2020GB006871	Yes
Bojan, O.K.; Irianni-Renno, M.; Hanson, A.J.; Chen, H.; Young, R.B.; De Long, S.K.; Borch, T.; Sale, T.C.; McKenna, A.M.; Blotevogel, J.	*Discovery of Oxygenated Hydrocarbon Biodegradation Products at a Late-Stage Petroleum Release Site*	Energy and Fuels	35	20	1671316723	10.1021/acs.energyfuels.1c02642	Yes
Chacon Patino, M.L.; Gray, M.R.; Ruger, C.; Smith, D.F.; Glattke, T.; Niles, S.; Neumann, A.; Weisbrod, C.; Yen, A.; McKenna, A.M.; Giusti, P.; Bouyssiere, B.; Barrere-Mangote, C.; Yarranton, H.; Hendrickson, C.L.; Marshall, A.G.; Rodgers, R.P.	*Lessons Learned from a Decade-Long Assessment of Asphaltenes by Ultrahigh-Resolution Mass Spectrometry and Implications for Complex Mixture Analysis*	Energy and Fuels	35	20	1633516376	10.1021/acs.energyfuels.1c02107	Yes
Chacon Patino, M.L.; Nelson, J.; Rogel, E.; Hench, K.; Poirier, L.; Lopez-Linares, F.; Ovalles, C.	*Vanadium and Nickel Distributions in Pentane, In-between C5-C7 Asphaltenes, and Heptane Asphaltenes of Heavy Crude Oil*	Fuel	292		120259	10.1016/j.fuel.2021.120259	Yes
Chen, M.; Li, C.; Spencer, R.G.M.; Maie, N.; Hur, J.; McKenna, A.M.; Yan, F.	*Climatic, Land Cover, and Anthropogenic Controls on Dissolved Organic Matter Quantity and Quality from Major Alpine Rivers Across the Himalayan-Tibetan Plateau*	Science of the Total Environment	754		142411	10.1016/j.scitotenv.2020.142411	Yes
Cheng, F.; Tompsett, G.A.; Alvarez, D.V.F.; Romo, C.I.; McKenna, A.M.; Niles, S.F.; Nelson, R.K.; Reddy, C.M.; Granados-Focil, S.; Paulsen, A.D.; Zhang, R.; Timko, M.T.	*Metal oxide supported Ni-impregnated bifunctional catalysts for controlling char formation and maximizing energy recovery during catalytic*	Sustainable Energy and Fuels	5	4	941-955	10.1039/d0se01662d	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
	hydrothermal liquefaction of food waste.						
Cui, F.; Cheng, F.; Jarvis, J.M.; Jena, U.; Brewer, C.E.	*Integrated Extraction and Catalytic Upgrading of Biocrude Oil from Co-hydrothermal Liquefaction of Crude Glycerol and Algae*	Energy and Fuels	35	15	121651 2174	10.1021/acs.energyfuels.1c01336	Yes
Feng, L.; An, Y.; Xu, J.; Kellerman, A.M.; Chacon Patino, M.L.; Spencer, R.G.M.	*Molecular Insights into Glacial Cryoconite Dissolved Organic Matter Evolution under Dark Conditions during the Ablation Season on the Tibetan Plateau*	American Chemical Society Earth and Space Chemistry	5	4	870-879	10.1021/acsearthspacechem.0c00361	Yes
Gray, M.R.; Yarranton, H.W.; Chacon Patino, M.L.; Rodgers, R.P.; Bouyssiere, B.; Giusti, P.	*Distributed Properties of Asphaltene Nanoaggregates in Crude Oils: A Review*	Energy and Fuels	35	22	18078 18103	10.1021/acs.energyfuels.1c01837	Yes
Guttenberg, N.; Chen, H.; Mochizuki, T.; Cleaves II, H.J.	*Classification of the Biogenicity of Complex Organic Mixtures for the Detection of Extraterrestrial Life*	Life	11	3	234	10.3390/life11030234	Yes
Harfmann, J.L.; Avery Jr., G.B.; Rainey, H.D.; Mead, R.N.; Skrabal, S.A.; Kieber, R.J.; Felix, D.; Helms, J.R.; Podgorski, D.C.	*Composition and Lability of Photochemically Released Dissolved Organic Matter from Resuspended Estuarine Sediments*	Organic Geo-chemistry	151		104164	10.1016/j.orggeochem.2020.104164	Yes
Holt, A.; Kellerman, A.M.; Li, W.; Stubbins, A.; Wagner, S.; McKenna, A.M.; Fellman, J.; Hood, E.; Spencer, R.G.M.	*Assessing the Role of Photochemistry in Driving the Composition of Dissolved Organic Matter in Glacier Runoff*	Journal of Geophysical Research Biogeo-sciences	126	12	e2021 JG006 516	10.1029/2021JG006516	Yes
Ian Deighan, W.; Winton, V.J.; Melani, R.D.; Anderson, L.C.; McGee, J.P.; Schachner, L.F.; Barnidge, D.; Murray, D.; Denis Alexander, H.; Gibson, D.S.; Deery, M.J.; McNicholl, F.P.; McLaughlin, J.; Kelleher, N.L.; Thomas, P.M.	*Development of Novel Methods for Non-canonical Myeloma Protein Analysis with an Innovative Adaptation of Immunofixation Electrophoresis, Native Top-down Mass Spectrometry, and Middle-down de Novo Sequencing*	Clinical Chemistry and Laboratory Medicine	59	4	653-661	10.1515/cclm-2020-1072	Yes
Kellerman, A.M.; Vonk, J.; McColaugh, S.G.; Podgorski, D.C.; van Winden, E.; Hawkings, J.; Johnston, S.E.; Humayun, M.; Spencer, R.G.M.	*Molecular Signatures of Glacial Dissolved Organic Matter from Svalbard and Greenland*	Global Biogeo-chemical Cycles	35	3	e2020 GB00 6709	10.1029/2020GB006709	Yes
Letourneau, M.L.; Schaefer, S.C.; Chen, H.; McKenna, A.M.; Alber, M.; Medeiros, P.M.	*Spatio-temporal Changes in Dissolved Organic Matter Composition Along the Salinity Gradient of a Marsh-influenced Estuarine Complex*	Limnology and Oceano-graphy	9999		1-15	10.1002/lno.11857	Yes
Manning, T.J.; Phillips, J.; Sharpe, B.; Soria, K.	*Pharmaceutical Aquaculture in a Marine Environment: A Green Technology Approach to Synthesis and Discovery*	Journal of Ocean Technology	16	4	23-30	n/a	Yes
McKenna, A.M.; Chacon Patino, M.L.; Chen, H.; Blakney, G.T.; Mentink-Vigier, F.; Young, R.B.; Ippolito, J.A.; Borch, T.	*Expanding the Analytical Window for Biochar Speciation: Molecular Comparison of Solvent Extraction and Water-*	Analytical Chemistry	93	46	15365 15372	10.1021/acs.analchem.1c03058	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
	Soluble Fractions of Biochar by FT-ICR Mass Spectrometry						
McKenna, A.M.; Chacon Patino, M.L.; Salvato Vallverdu, G.; Bouyssiere, B.; Giusti, P.; Afonso, C.; Shi, Q.; Combariza, M.Y.	*Advances and Challenges in the Molecular Characterization of Petroporphyrins*	Energy and Fuels	35	22	18056 - 18077	10.1021/acs.energyfuels.1c02002	Yes
McKenna, A.M.; Chen, H.; Weisbrod, C.; Blakney, G.T.	*Molecular Comparison of Solid-Phase Extraction and Liquid/Liquid Extraction of Water-Soluble Petroleum Compounds Produced through Photodegradation and Biodegradation by FT-ICR Mass Spectrometry*	Analytical Chemistry	93	10	4611-4618	10.1021/acs.analchem.0c05230	Yes
Monda, H.; McKenna, A.M.; Fountain, R.; Lamar, R.T.	*Bioactivity of Humic Acids Extracted from Shale Ore: Molecular Characterization and Structure-activity Relationship with Tomato Plant Yield under Nutritional Stress*	Frontiers in Plant Science	12		958	10.3389/fpls.2021.660224	Yes
Neumann, A.; Chacon Patino, M.L.; Rodgers, R.P.; Rüger, C.P.; Zimmermann, R.	*Investigation of Island/ Single Core and Archipelago/ Multicore Enriched Asphaltenes and their Solubility Fractions by Thermal Analysis Coupled to High Resolution Fourier Transform Ion Cyclotron Resonance Mass Spectrometry*	Energy and Fuels	35	5	3808-3824	10.1021/acs.energyfuels.0c03751	Yes
Niles, S.; Chacon Patino, M.L.; Chen, H.; Marshall, A.G.; Rodgers, R.P.	*Structural Dependence of Photogenerated Transformation Products for Aromatic Hydrocarbons Isolated from Petroleum*	Energy and Fuels	25	22	18153 18162	10.1021/acs.energyfuels.1c02373	Yes
Podgorski, D.C.; Zito, P.; Kellerman, A.M.; Cozzarelli, I.M.; Smith, D.F.; Cao, X.; Schmidt-Rohr, K.; Wagner, S.; Stubbins, A.; Spencer, R.G.M.	*Hydrocarbons to Carboxyl-Rich Alicyclic Molecules: A Continuum Model to Describe Biodegradation of Petroleum-Derived Dissolved Organic Matter in Contaminated Groundwater Plumes*	Journal of Hazardous Materials	402		123998	10.1016/j.jhazmat.2020.123998	Yes
Rogers, J.; Galy, V.; Kellerman, A.M.; Chanton, J.; Zimov, N.; Spencer, R.G.M.	*Limited Presence of Permafrost Dissolved Organic Matter in the Kolyma River, Siberia Revealed by Ramped Oxidation*	Journal of Geophysical Research Biogeo-sciences	126	7	e2020JG005977	10.1029/2020JG005977	Yes
Rowland, S.M.; Smith, D.F.; Blakney, G.T.; Corilo, Y.E.D.; Hendrickson, C.L.; Rodgers, R.P.	*Online Coupling of Liquid Chromatography with Fourier Transform Ion Cyclotron Resonance Mass Spectrometry at 21 T Provides Fast and Unique Insight into Crude Oil Composition*	Analytical Chemistry	93	41	13749 - 13754	10.1021/acs.analchem.1c01169	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Struhs, E.; Mirkouei, A.; Ramirez-Corredores, M.M.; McDonald, A.G.; Chacon Patino, M.L.	*Overview and Technology Opportunities for Thermochemically-produced Bio-blendstocks*	J. Environ. Chem. Eng.	9	5	106255	10.1016/j.jece.2021.106255	Yes
Tose, L.V.; Weisbrod, C.; Michalkova, V.; Nouzova, M.; Noriega, F.G.; Fernandez-Lima, F.	*Following de Novo Triglyceride Dynamics in Ovaries of Aedes aegypti during the Previtellogenic Stage*	Scientific Reports	11		9636	10.1038/s41598-021-89025-6	Yes
Vaughn, D.R.; Kellerman, A.M.; Wickland, K.P.; Striegl, R.G.; Podgorski, D.C.; Hawkings, J.R.; Nienhuis, J.H.; Dornblaser, M.M.; Sets, E.G.; Spencer, R.G.M.	*Anthropogenic Landcover Impacts Fluvial Dissolved Organic Matter Composition in the Upper Mississippi River Basin*	Biogeo-chemistry	X	X	X	10.1007/s10533-021-00852-1	Yes
Walsh, A.N.; Reddy, C.M.; Niles, S.; McKenna, A.M.; Hansel, C.M.; Ward, C.P.	*Plastic Formulation is an Emerging Control of its Photochemical Fate in the Ocean*	Environmental Science and Technology	55	18	12383-12392	10.1021/acs.est.1c02272	Yes
Weisbrod, C.R.; Anderson, L.C.; Hendrickson, C.L.; Schaffer, L.V.; Shortreed, M.R.; Smith, L.M.; Shabanowitz, J.; Hunt, D.F.	*Advanced Strategies for Proton-Transfer Reactions Coupled with Parallel Ion Parking on a 21 T FT-ICR MS for Intact Protein Analysis*	Analytical Chemistry	93	26	9119-9128	10.1021/acs.analchem.1c00847	Yes
Wologo, E.; Shakil, S.; Zolkos, S.; Textor, S.R.; Ewing, S.; Klassen, J.; Spencer, R.G.M.; Podgorski, D.C.; Tank, S.E.; Baker, M.A.; O'Donnell, J.A.; Wickland, K.P.; Foks, S.S.W.; Zarnetske, J.P.; Lee-Cullin, J.; Liu, F.; Yang, Y.; Kortelainen, P.; Kolehmainen, J.; Dean, J.F.; Vonk, J.E.; Holmes, R.M.; Pinay, G.; Powell, M.M.; Howe, J.; Frei, R.; Bratsman, S.P.; Abbott, B.W.	*Stream Dissolved Organic Matter in Permafrost Regions Shows Surprising Compositional Similarities but Negative Priming and Nutrient Effects*	Global Biogeochemical Cycles	34		e2020GB006719	10.1029/2020GB006719	Yes
Zhang, J.; McKenna, A.M.; Zhu, M.	*Macromolecular Characterization of Compound Selectivity for Oxidation and Oxidative Alterations of Dissolved Organic Matter by Manganese Oxide*	Environmental Science and Technology	55	11	7741-7751	10.1021/acs.est.1c01283	Yes
Zheng, F.; Moulian, R.; Chacon Patino, M.L.; Rodgers, R.P.; Barrere-Mangote, C.; Gray, M.R.; Giusti, P.; Shi, Q.; Bouyssiere, B.	*Tracking Changes in Asphaltene Nanoaggregate Size Distributions as a Function of Silver Complexation via Gel Permeation Chromatography Inductively Coupled Plasma Mass Spectrometry*	Energy and Fuels	35	22	18125-18134	10.1021/acs.energyfuels.1c02173	No
Zhou, Y.; Yao, X.; Zhou, L.; Zhao, Z.; Wang, X.; Jang, K.S.; Tian, W.; Zhang, Y.; Podgorski, D.C.; Spencer, R.G.M.; Kothawala, D.N.; Jeppesen, E.; Wu, F.	*How Hydrology and Anthropogenic Activity Influence the Molecular Composition and Export of Dissolved Organic Matter: Observations Along a Large River Continuum*	Limnology and Oceano-graphy	66	5	1730-1742	10.1002/lno.11716	Yes

5.5 PUBLICATIONS GENERATED BY NMR AT FSU (71)

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Altenhof, A.; Wi, S.; Schurko, R.W.	*Broadband adiabatic inversion cross-polarization to integer-spin nuclei with application to deuterium NMR*	Magnetic Resonance in Chemistry	59		1009-1023	10.1002/mrc.5145	Yes
Altenhof, A.R.; Jaroszewicz, M.J.; Harris, K.J.; Schurko, R.W.	*Broadband adiabatic inversion experiments for the measurement of longitudinal relaxation time constants*	Journal of Chemical Physics	154	3	34202	10.1063/5.0039017	Yes
Bagdasarian, F.; Yuan, X.; Athey, J.D.; Bunnell, B.A.; Grant, S.C.	*NODDI highlights recovery mechanisms in white and gray matter in ischemic stroke following human stem cell treatment*	Magnetic Resonance in Medicine	86	6	3211-3223	10.1002/mrm.28929	Yes
Baggi, G.; Wilson, B.H.; Dhara, A.; O'Keefe, C.A.; Schurko, R.W.; Loeb, S.J.	*Dynamics of a [2]rotaxane wheel in a crystalline molecular solid*	Chemical Communi-cations Cambridge	57		8210-8213	10.1039/d1cc03009d	Yes
Chakraborty, A.; Fernando, L.D.; Fang, W.; Dickwella Widanage, M.C.; Wei, P.; Jin, C.; Fontaine, T.; Latge, J.P.; Wang, T.	*A molecular vision of fungal cell wall organization by functional genomics and solid-state NMR*	Nature Communi-cations	12		6346	10.1038/s41467-021-26749-z	Yes
Chaudhary, B.; Zoetewey, D.; McCullagh, M.; Mohanty, S.	*NMR and MD Simulations Reveal the Impact of the V23D Mutation on the Function of Yeast Oligosaccharyltransferase Subunit Ost4*	Glycobiology	-	-	-	10.1093/glycob/cwab002	Yes
Chen, C.; Mentink-Vigier, F.; Trebosc, J.; Goldberga, I.; Gaveau, P.; Thomassot, E.; Iuga, D.; Smith, M.; Chen, K.; Gan, Z.; Fabregue, N.; Metro, T.; Alonso, B.; Laurencin, D.	*Labeling and Probing the Silica Surface Using Mechanochemistry and 17O NMR Spectroscopy*	Chemistry a European Journal	-	-	chem.202101421	10.1002/chem.202101421	Yes
Chen, C.; Sesti, E.L.; Lee, J.J.; Mentink-Vigier, F.; Sievers, C.; Jones, C.W.; Hayes, S.E.	*NMR Reveals Two Bicarbonate Environments in SBA15-Solid-Amine CO 2 Sorbents*	Journal of Physical Chemistry C	125	30	16759--16765	10.1021/acs.jpcc.1c04145	Yes
Chen, K.; Gan, Z.; Horstmeier, S.; White, J.L.	*Distribution of Aluminum Species in Zeolite Catalysts: 27Al NMR of Framework, Partially-Coordinated Framework, and Non-Framework Moieties*	Journal of the American Chemical Society	143	17	6669--6680	10.1021/jacs.1c02361	Yes
Cone, A.S.; Yuan, X.; Sun, L.; Duke, L.C.; Vreones, M.P.; Carrier, A.N.; Kenyon, S.M.; Carver, S.C.; Benthem, S.D.; Stimmell, A.C.; Moseley, S.C.; Hike, D.C.; Grant, S.C.; Wilbur, A.A.; Olcese, J.M.; Meckes, D.G.	*Mesenchymal stem cell-derived extracellular vesicles ameliorate Alzheimer's disease-like phenotypes in a preclinical mouse model*	Theranostics	11	17	8129-8142	10.7150/thno.62069	No
Duong, N.; Lee, D.; Mentink-Vigier, F.; Lafon, O.; De Paepe, G.	*On the use of radio-frequency offsets for improving double-quantum homonuclear dipolar*	Magnetic Resonance in Chemistry	59	9-10	991--1008	10.1002/mrc.5142	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
	recoupling of half-integer-spin quadrupolar nuclei						
Fernando, L.D.; Dickwella Widanage, M.C.; Penfield, J.; Lipton, A.S.; Washton, N.; Latge, J.P.; Wang, P.; Zhang, L.; Wang, T.	*Structural Polymorphism of Chitin and Chitosan in Fungal Cell Walls From Solid-State NMR and Principal Component Analysis*	Frontiers in Molecular Biosciences	8		727053	10.3389/fmolb.2021.727053	Yes
Fu, R.; Rooney, M.T.; Zhang, R.; Cotten, M.L.	*Coordination of Redox Ions within a Membrane-Binding Peptide: A Tale of Aromatic Rings*	Journal of Physical Chemistry Letters	12		4392-4399	10.1021/acs.jpclett.1c00636	Yes
Gao, W.; Qi, G.; Wang, Q.; Wang, W.; Li, S.; Hung, I.; Gan, Z.; Xu, J.; Deng, F.	*Dual Active Sites on Molybdenum/ZSM-5 Catalyst for Methane Dehydroaromatization: Insights from Solid-State NMR Spectroscopy*	Angewandte Chemie International Edition	60	19	10709--10715	10.1002/anie.202017074	Yes
Ghassemi, N.; Poulhazan, A.; Deligey, F.; Mentink-Vigier, F.; Marcotte, I.; Wang, T.	*Solid-State NMR Investigations of Extracellular Matrixes and Cell Walls of Algae, Bacteria, Fungi, and Plants*	Chemical Reviews	-		acs.chemrev.1c00669	10.1021/acs.chemrev.1c00669	Yes
Gonzalez-Nelson, A.; Mula, S.; Simenas, M.; Balciunas, S.; Altenhof, A.; Vojvodin, C.S.; Canossa, S.; Banys, J.; Schurko, R.W.; Coudert, F.; van der Veen, M.A.	*Emergence of Coupled Rotor Dynamics in Metal–Organic Frameworks via Tuned Steric Interactions*	Journal of the American Chemical Society	143	31	12053--12062	10.1021/jacs.1c03630	Yes
Harada, J.K.; Chien, P.; Liu, H.; Patel, S.; Chen, C.A.; Charles, N.; Hu, Y.; Poeppelmeier, K.R.; Rondinelli, J.M.	*Phase transitions and potential ferroelectricity in noncentrosymmetric KNaNbOF5*	Physical Review Materials	5	12	124401	10.1103/PhysRevMaterials.5.124401	Yes
Hicks, A.; Escobar Bravo, C.A.; Cross, T.A.; Zhou, H.	*Fuzzy Association of an Intrinsically Disordered Protein with Acidic Membranes*	Journal of the American Chemical Society AU	1	1	66--78	10.1021/jacsau.0c00039	Yes
Holder, S.W.; Grant, S.C.; Mohammadigoushki, H.	*Nuclear Magnetic Resonance Diffusometry of Linear and Branched Wormlike Micelles*	Langmuir	37	12	3585-3596	10.1021/acs.langmuir.0c03486	Yes
Holmes, S.; Hook, J.M.; Schurko, R.W.	*Nutraceuticals in Bulk and Dosage Forms: Analysis by 35Cl and 14N Solid-State NMR and DFT Calculations*	Molecular Pharmaceutics				10.1021/acs.molpharmaceut.1c00708	Yes
Hung, I.; Altenhof, A.R.; Schurko, R.W.; Bryce, D.L.; Hee Han, O.C.; Gan, Z.	*Field-stepped ultra-wideline NMR at up to 36 T: On the inequivalence between field and frequency stepping*	Magnetic Resonance in Chemistry	59		951-960	10.1002/mrc.5128	Yes
Hung, I.; Gan, Z.	*Isotropic solid-state MQMAS NMR spectra for large quadrupolar interactions using satellite-transition selective inversion pulses and low rf fields*	Journal of Magnetic Resonance	324		106913	10.1016/j.jmr.2021.106913	Yes
Hung, I.; Gan, Z.	*On the use of single-frequency versus double-frequency satellite-*	Journal of Magnetic Resonance	328		106994	10.1016/j.jmr.2021.106994	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
	transition pulses for MQMAS						
Hung, I.; Gan, Z.; Wu, G.	*Two- and Three-Dimensional 13C-17O Heteronuclear Correlation NMR Spectroscopy for Studying Organic and Biological Solids*	Journal of Physical Chemistry Letters	12	36	8897--8902	10.1021/acs.jpclett.1c02465	Yes
Hung, I.; Ionescu, E.; Sen, J.; Gan, Z.; Sen, S.	*Structure and Connectivity in an Amorphous Silicon Oxycarbide Polymer-Derived Ceramic: Results from 2D 29Si NMR Spectroscopy*	Journal of Physical Chemistry C	125	8	4777--4784	10.1021/acs.jpcc.0c09860	Yes
Jakobsen, H.J.; Bildsoe, H.; Bondesgaard, M.; Iversen, B.B.; Brorson, M.; Larsen, F.H.; Gan, Z.; Hung, I.	*Exciting Opportunities for Solid-State 95Mo NMR Studies of MoS2 Nanostructures in Materials Research from a Low to an Ultrahigh Magnetic Field (35.2 T)*	Journal of Physical Chemistry C	125	14	7824--7838	10.1021/acs.jpcc.0c10522	Yes
Jaroszewicz, M.J.; Altenhof, A.; Schurko, R.W.; Frydman, L.	*Sensitivity Enhancement by Progressive Saturation of the Proton Reservoir: A Solid-State NMR Analogue of Chemical Exchange Saturation Transfer*	Journal of the American Chemical Society				10.1021/jacs.1c08277	Yes
Kaseman, D.C.; Sen, S.	*A review of the application of 2D isotropic-anisotropic correlation NMR spectroscopy in structural studies of chalcogenide glasses*	Journal of Non-Crystalline Solids	561		120500	10.1016/j.jnoncrysol.2020.120500	Yes
Lin, B.; Hung, I.; Gan, Z.; Chien, P.; Spencer, H.L.; Smith, S.P.; Wu, G.	*^{17}O NMR Studies of Yeast Ubiquitin in Aqueous Solution and in the Solid State*	ChemBio-Chem				10.1002/cbic.202100061	Yes
Lin, M.; Liu, X.S.; Xiang, Y.X.; Wang, F.; Liu, Y.P.; Fu, R.; Cheng, J.; Yang, Y.	*Unravelling the Fast Alkali-ion Dynamics in Paramagnetic Battery Materials Combined with NMR and Deep-Potential Molecular Dynamics Simulation*	Angewandte Chemie	60		12547-12553	10.1002/anie.202102740	Yes
Liu, X.S.; Liang, Z.T.; Xiang, Y.X.; Lin, M.; Li, Q.; Liu, Z.G.; Zhong, G.; Fu, R.; Yang, Y.	*Solid-State NMR and MRI Spectroscopy for Li/Na Batteries: Materials, Interface, and In Situ Characterization*	Advanced Materials	2005878		1-21	10.1002/adma.202005878	Yes
Martins, V.; Xu, J.; Hung, I.; Gan, Z.; Gervais, C.; Bonhomme, C.; Huang, Y.	*17O solid-state NMR at ultrahigh magnetic field of 35.2 T: Resolution of inequivalent oxygen sites in different phases of MOF MIL-53(Al)*	Magnetic Resonance in Chemistry	59	9-10	940--950	10.1002/mrc.5122	Yes
Marzano, M.; Bou-Dargham, M.J.; Cone, A.S.; York, S.; Helsper, S.; Grant, S.C.; Meckes, D.G.; Sang, Q.A.; Li, Y.	*Biogenesis of Extracellular Vesicles Produced from Human-Stem-Cell-Derived Cortical Spheroids Exposed to Iron Oxides*	American Chemical Society Biomaterials Science and Engineering	7	3	1111-1122	10.1021/acsbiomaterials.0c01286	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
McKenna, A.M.; Chacon Patino, M.L.; Chen, H.; Blakney, G.T.; Mentink-Vigier, F.; Young, R.B.; Ippolito, J.A.; Borch, T.	*Expanding the Analytical Window for Biochar Speciation: Molecular Comparison of Solvent Extraction and Water-Soluble Fractions of Biochar by FT-ICR Mass Spectrometry*	Analytical Chemistry	93	46	15365 - 15372	10.1021/acs.analchem.1c03058	Yes
Meiyazhagan, A.; Serles, P.; Salpekar, D.; Oliveira, E.F.; Alemany, L.B.; Fu, R.; Gao, G.; Arif, T.; Vajtai, R.; Swaminathan, V.; Galvao, D.S.; Khabashesku, V.N.; Filleter, T.; Ajayan, P.M.	*Gas-Phase Fluorination of Hexagonal Boron Nitride*	Advanced Materials	2106084		1-11	10.1002/adma.202106084	Yes
Mentink-Vigier, F.	*Numerical recipes for faster MAS-DNP simulations*	Journal of Magnetic Resonance	333		107106	10.1016/j.jmr.2021.107106	Yes
Mentink-Vigier, F.; Dubroca, T.; van Tol, J.; Sigurdsson, S.	*The distance between g-tensors of nitroxide biradicals governs MAS-DNP performance: the case of the bTurea family*	Journal of Magnetic Resonance, Series A	nc		107026	10.1016/j.jmr.2021.107026	Yes
Miao, Z.; Gonsales, S.A.; Ehm, C.; Mentink-Vigier, F.; Bowers, C.R.; Sumerlin, B.S.; Veige, A.S.	*Cyclic polyacetylene*	Nature Chemistry	-		In revision	10.1038/s41557-021-00713-2	Yes
Mosiman, D.S.; Sutrisno, A.; Fu, R.; Marinas, B.J.	*Internalization of Fluoride in Hydroxyapatite Nanoparticles*	Environmental Science and Technology	55		2639-2651	10.1021/acs.est.0c07398	Yes
Ndung'u, M.; Ngatia, L.W.; Onwonga, R.N.; Mucheru-Muna, M.W.; Fu, R.; Moriasi, D.N.; Ngetich, K.F.	*The influence of organic and inorganic nutrient inputs on soil organic carbon functional groups content and maize yields*	Heliyon	7		e07881	10.1016/j.heliyon.2021.e07881	Yes
Ngatia, L.; De Oliveira, L.; Be-tiku, O.; Fu, R.; Moriasi, D.; Steiner, J.; Verse, A.; Taylor, R.	*Relationship of arsenic and chromium availability with carbon functional groups, aluminum and iron in Little Washita River Experimental Watershed Reservoirs, Oklahoma, USA*	Ecotoxicol-ogy and En-vironmental Safety	207		111468	10.1016/j.ecoenv.2020.111468	Yes
Patel, S.V.; Banerjee, S.; Liu, H.; Wang, P.; Chien, P.; Feng, X.; Liu, J.; Ong, S.; Hu, Y.	*Tunable Lithium-Ion Transport in Mixed-Halide Argyrodites Li6-xPS5-xClBrx: An Unusual Compositional Space*	Chemistry of Materials	33	4	1435--1443	10.1021/acs.chemmater.0c04650	Yes
Poulhazan, A.; Dickwella Widanage, M.C.; Myszynski, A.; Arnold, A.A.; Warschawski, D.E.; Azadi, P.; Marcotte, I.; Wang, T.	*Identification and Quantification of Glycans in Whole Cells: Architecture of Microalgal Polysaccharides Described by Solid-State NMR*	Journal of the American Chemical Society	143	46	19374 - 19388	10.1021/jacs.1c07429	Yes
Rahman, M.; McGuigan, S.; Li, S.; Gao, L.; Hou, D.; Yang, Z.; Xu, Z.; Lee, S.; Sun, C.; Liu, J.; Huang, X.; Xiao, X.; Chu, Y.; Sainio, S.; Nordlund, D.; Kong, X.; Liu, Y.; Lin, F.	*Chemical Modulation of Local Transition Metal Environment Enables Reversible Oxygen Redox in Mn-Based Layered Cathodes*	American Chemical Society Energy Letters	6	8	2882 2890	10.1021/acsenergylett.1c01071	No

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Ramakrishna, S.K.; Kundu, K.; Bindra, J.K.; Locicero, S.A.; Talham, D.R.; Reyes, A.P.; Fu, R.; Dalal, N.S.	*Probing the Dielectric Transition and Molecular Dynamics in the Metal Organic Framework [(CH3)2NH2]Mg(HCOO)3 Using High Resolution NMR*	Journal of Physical Chemistry C	125	6	3441-3450	10.1021/acs.jpcc.0c11149	Yes
Redzic, J.S.; Lee, E.; Born, A.; Issaian, A.; Henen, M.A.; Nichols, P.J.; Blue, A.K.; Hansen, K.C.; D'Alessandro, A.; Vogeli, B.; Eisenmesser, E.Z.	*The Inherent Dynamics and Interaction Sites of the SARS-CoV-2 Nucleocapsid N-Terminal Region*	Journal of Molecular Biology	433	15	167108	10.1016/j.jmb.2021.167108	Yes
Sanati, O.; Edison, A.S.; Hornak, L.A.; Litvak, I.; Ramaswamy, V.; Freytag, N.; Brey, W.W.	*C-13-Optimized HTS NMR RF Coil Design at 21.1 T*	IEEE Transactions on Applied Super-conductivity	3	5	4300305	10.1109/TASC.2021.3069678	Yes
Schwartz, A.B.; Kapur, A.; Huang, Z.; Anangi, R.; Spear, J.M.; Stagg, S.; Fardone, E.; Dekan, Z.; Rosenberg, J.T.; Grant, S.C.; King, G.F.; Mattoussi, H.; Fadool, D.A.	*Olfactory bulb targeted QD bioconjugate and Kv1.3 blocking peptide improve metabolic health in obese male mice*	Journal of Neuro-chemistry	157		1876-1896	10.1111/jnc.15200	Yes
Stern, Q.; Cousin, S.; Mentink-Vigier, F.; Pinon, A.; Elliott, S.; Cala, O.; Jannin, S.	*Direct observation of hyperpolarization breaking through the spin diffusion barrier*	Science Advances	7	18	eabf5735	10.1126/sciadv.abf5735	Yes
Stirk, A.J.; Wilson, B.H.; O'Keefe, C.A.; Amarne, H.; Zhu, K.; Schurko, R.W.; Loeb, S.J.	*Applying reticular synthesis to the design of Cu-based MOFs with mechanically interlocked linkers*	Nano Research	14	2	417--422	10.1007/s12274-020-3123-z	Yes
Sun, F.; Xiang, Y.X.; Sun, Q.; Zhong, G.; Banis, M.N.; Li, W.H.; Liu, Y.L.; Luo, J.; Li, R.Y.; Fu, R.; Sham, T.K.; Yang, Y.; Sun, X.H.; Sun, X.L.	*Insight into Ion Diffusion Dynamics/Mechanisms and Electronic Structure of Highly Conductive Sodium-Rich Na3+xLaxZr2−xSi2PO12 (0 ≤ x ≤ 0.5) Solid-State Electrolytes*	American Chemical Society Applied Materials and Interfaces	13		13132-13138	10.1021/acsami.0c21882	Yes
Sun, F.; Xiang, Y.X.; Sun, Q.; Zhong, G.; Banis, M.N.; Liu, Y.L.; Li, R.Y.; Fu, R.; Zheng, M.; Sham, T.K.; Yang, Y.; Sun, X.H.; Sun, X.L.	*Origin of High Ionic Conductivity of Sc-Doped Sodium-Rich NASICON Solid-State Electrolytes*	Advanced Functional Materials	2102129		1-8	10.1002/adfm.202102129	Yes
Tang, M.; Bui, N.N.; Jin, Z.; Song, L.; Hu, Y.	*Real-time monitoring of the lithiation process in organic electrode 7,7,8,8-tetracyanoquinodimethane by in situ EPR*	Journal of Energy Chemistry	60		9-15	10.1016/j.jechem.2020.12.009	Yes
Thames, T.; Bryer, A.J.; Qiao, X.; Jeon, J.; Weed, R.; Janicki, K.; Hu, B.; Gor'kov, P.L.; Hung, I.; Gan, Z.; Perilla, J.R.; Chen, B.O.	*Curvature of the Retroviral Capsid Assembly Is Modulated by a Molecular Switch*	Journal of Physical Chemistry Letters	12	32	7768--7776	10.1021/acs.jpclett.1c01769	Yes
Thomas, J.; Ramaswamy, V.; Litvak, I.; Johnston, T.; Edison, A.S.; Brey, W.W.	*Progress Towards a Higher Sensitivity C-13-Optimized 1.5 mm HTS NMR Probe*	IEEE Transactions on Applied Super-conductivity	31	5	1500504	10.1109/TASC.2021.3061042	Yes
Tiwari, N.; Wi, S.; Mentink-Vigier, F.; Sinha, N.	*Mechanistic Insights into the Structural Stability of Collagen-Containing*	Journal of Physical Chemistry B	135		acs.jpcb.1c01431	10.1021/acs.jpcb.1c01431	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
	Biomaterials Such as Bones and Cartilage						
Tuan Duong, N.; Gan, Z.; Nishiyama, Y.	*Selective 1H-14N Distance Measurements by 14N Overtone Solid-State NMR Spectroscopy at Fast MAS*	Frontiers in Molecular Biosciences	8		-	10.3389/fmolb.2021.645347	Yes
Vugmeyster, L.; Ostrovsky, D.; Greenwood, A.; Fu, R.	*Deuteron Chemical Exchange Saturation Transfer for the Detection of Slow Motions in Rotating Solids*	Frontiers in Molecular Biosciences	8		705572	10.3389/fmolb.2021.705572	Yes
Wang, F.; Ramakrishna, S.K.; Sun, P.C.; Fu, R.	*Triple-pulse excitation: An efficient way for suppressing background signals and eliminating radio-frequency acoustic ringing in direct polarization NMR experiments*	Journal of Magnetic Resonance	332		107067	10.1016/j.jmr.2021.107067	Yes
Wang, Z.; Chen, K.; Jiang, Y.; Trebosc, J.; Yang, W.; Amoureux, J.; Hung, I.; Gan, Z.; Baiker, A.; Lafon, O.; Huang, J.	*Revealing Brønsted Acidic Bridging SiOHAl Groups on Amorphous Silica Alumina by Ultrahigh Field Solid-State NMR*	Journal of Physical Chemistry Letters	12	47	11563--11572	10.1021/acs.jpclett.1c02975	Yes
Wilson, B.H.; Abdulla, L.M.; Schurko, R.W.; Loeb, S.J.	*Translational dynamics of a non-degenerate molecular shuttle imbedded in a zirconium metal-organic framework*	Chemical Science	12	11	3944--3951	10.1039/d0sc06837c	Yes
Wilson, B.H.; Gholami, G.; Zhu, K.; O'Keefe, C.A.; Schurko, R.W.; Loeb, S.J.	*Exploring the Dynamics of Zr-Based Metal-organic Frameworks Containing Mechanically Interlocked Molecular Shuttles*	Faraday Discussions	225		358-370	10.1039/D0FD00004C	No
Wilson, B.H.; Vojvodin, C.; Gholami, G.; Abdulla, L.M.; O'Keefe, C.A.; Schurko, R.W.; Loeb, S.J.	*Precise Spatial Arrangement and Interaction between Two Different Mobile Components in a Metal-Organic Framework*	Chem	7		202-211	10.1016/j.chempr.2020.11.009	Yes
Xiang, Y.X.; Tao, M.; Zhong, G.; Liang, Z.T.; Zheng, G.R.; Huang, X.; Liu, X.S.; Jin, Y.T.; Xu, N.B.; Armand, M.; Zhang, J.G.; Xu, K.; Fu, R.; Yang, Y.	*Quantitatively analyzing the failure processes of rechargeable Li metal batteries*	Science Advances	7		eabj3423	10.1126/sciadv.abj3423	Yes
Xiao, B.; Wang, Y.; Tan, S.; Song, M.; Li, X.; Zhang, Y.; Lin, F.; Han, K.; Omenya, F.; Amine, K.; Yang, X.; Reed, D.; Hu, Y.; Xu, G.; Hu, E.; Li, X.; Li, X.	*Vacancy-Enabled O3 Phase Stabilization for Manganese-Rich Layered Sodium Cathodes*	Angewandte Chemie	60	15	8258-8267	10.1002/anie.202016334	Yes
Xu, C.; Kandel, N.; Qiao, X.; Khan, M.D.; Pratakshya, P.; Tolouei, N.E.; Chen, B.; Gorodetsky, A.A.	*Long-Range Proton Transport in Films from a Reflectin-DerivedPolypeptide*	American Chemical Society Applied Materials and Interfaces	13		20936	10.1021/acsami.0c18929	Yes
Yang, C.; Wu, Q.; Xie, W.; Zhang, X.; Brozena, A.; Zheng, J.; Garaga, M.N.; Ko, B.; Mao, Y.; He, S.; Gao, Y.; Wang, P.;	*Copper-coordinated cellulose ion conductors for solid-state batteries*	Nature	598	7882	590--596	10.1038/s41586-021-03885-6	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Tyagi, M.; Jiao, F.; Briber, R.; Albertus, P.; Wang, C.; Greenbaum, S.; Hu, Y.; Isogai, A.; Winter, M.; Xu, K.; Qi, Y.; Hu, L.							
Yuan, B.; Aitken, B.; Hung, I.; Gan, Z.; Sen, S.	*Compositional Evolution of the Structure and Connectivity in Binary P Se Glasses: Results from 2D Multinuclear NMR and Raman Spectroscopy*	Journal of Physical Chemistry B	125	47	13057 -- 13067	10.1021/acs.jpcb.1c07601	Yes
Zhang, R.; Cross, T.A.; Fu, R.	*Detecting water-protein chemical exchange in membrane-bound proteins/peptides by solid-state NMR spectroscopy*	Magnetic Resonance Letters	1		99-111	10.1016/j.mrl.2021.09.002	Yes
Zhao, W.; Kirui, A.; Deligey, F.; Mentink-Vigier, F.; Zhou, Y.; Zhang, B.; Wang, T.	*Solid-state NMR of unlabeled plant cell walls: high-resolution structural analysis without isotopic enrichment*	Bio-technology for Biofuels	14	1	14	10.1186/s13068-020-01858-x	Yes
Zuo, W.H.; Liu, X.S.; Qiu, J.M.; Zhang, D.X.; Xiao, Z.M.; Xie, J.S.; Ren, F.C.; Wang, J.M.; Li, Y.X.; Ortiz, G.F.; Wen, W.; Wu, S.Q.; Wang, M.S.; Fu, R.; Yang, Y.	*Engineering Na+-layer spacings to stabilize Mn-based layered cathodes for sodium-ion batteries*	Nature Communi-cations	12		4903	10.1038/s41467-021-25074-9	Yes

5.6 PUBLICATIONS GENERATED BY PFF AT LANL (31)

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Allenspach, S.; Puphal, P.; Link, J.; Heinmaa, I.; Pomjakushina, E.; Krellner, C.; Lass, J.; Tucker, G.S.; Niedermayer, C.; Imajo, S.; Kohama, Y.; Kindo, K.; Krämer, S.; Horvatic, M.; Jaime, M.; Madsen, A.; Mira, A.; Laflorencie, N.; Mila, F.; Normand, B.; Rüegg, CH.; Stern, R.; Weickert, D.F.	*Revealing three-dimensional quantum criticality by Sr substitution in Han purple*	Physical Review Research	3		23177	PhysRevResearch.3.023177	Yes
Antonio, J.D.; Weiss, J.T.; Shanks, K.S.; Ruff, J.P.C.; Jaime, M.; Saul, A.; Swinburne, T.; Salamon, M.; Shrestha, K.; Lavina, B.; Koury, D.; Gruner, S.M.; Andersson, D.A.; Stanek, C.R.; Durakiewicz, T.; Smith, J.L.; Islam, Z.; Gofryk, K.	*Piezomagnetic switching and complex phase equilibria in uranium dioxide*	Nature Communi-cations Materials	2		17	10.1038/s43246-021-00121-6	Yes
Bian, M.; Kamenskii, A.; Han, M.; Li, W.; Lin, J.; Crooker, S.; Hou, Y.; Zeng, H.	*Covalent 2D Cr2Te3 ferromagnet*	Materials Research Letters	9		205	10.1080/21663831.2020.1865469	Yes
Carr, A.; Bowlan, J.; Mazzoli, C.; Walker, C.; Ding, X.N.; Barbour, A.; Hu, W.; Wilkins, S.; Kim, J.; Lee, N.; Choi, Y.; Lin, S.; Sandberg, R.L.; Zapf, V.	*Dynamics of a fractal set of first-order magnetic phase transitions in frustrated Lu_2 $CoMnO_6$*	Physical Review B: Rapid Comm/-Letters	103		L060401	10.1103/PhysRevB.103.L060401	Yes
Carulli, F.; Pinchetti, V.; Zaffalon, M.; CAmellini, A.; Loria, S.; Moro, F.; Fanciulli, M.; Zavelani-Rossi, M.; Meinardi, F.; Crooker, S.; Brovelli, S.	*Optical and Magneto-Optical Properties of Donor-Bound Excitons in Vacancy-Engineered Colloidal Nanocrystals*	American Chemical Society Nano Letters	21		6211	10.1021/acs.nanolett.1c01818	Yes
Chai, Y.; Cong, J.; He, J.; Suarez, D.B.; Ding, X.; Singleton, J.; Zapf, V.; Sun, Y.	*Giant magnetostriction and nonsaturating electric polarization up to 60 T in the polar magnet CaBaCo4O7*	Physical Review B	103		174433	10.1103/PhysRevB.103.174433	Yes
Curley, S.M.; Scatena, R.; Williams, R.C.; Goddard, P.A.; Macchi, P.; Hicken, T.J.; Lancaster, T.; Xiao, F.; Blundell, S.J.; Zapf, V.; Eckert, J.C.; Krenkel, E.H.; Villa, J.A.; Rhodehouse, M.L.; Manson, J.L.	*Magnetic ground state of the one-dimensional ferromagnetic chain compounds M(NCS)2thiourea2 (M=Ni,Co)*	Physical Review Materials	5		34401	10.1103/PhysRevMaterials.5.034401	Yes
Ding, L.; Xu, X.; Jeschke, H.O.; Bai, X.; Feng, E.; Alemayehu, A.S.; Kim, J.W.; Huang, F.; Zhang, Q.; Ding, X.; Harrison, N.; Zapf, V.S.; Khomskii, D.; Mazin, I.I.; Cheong, S.W.; Cao, H.	*Field-tunable toroidal moment in a chiral-latticemagnet*	Nature Communi-cations	1		1	10.1038/s41467-021-25657-6	Yes
Dobbelaar, E.; Jakobsen, V.B.; Trzop, E.; Lee, M.; Chikara, S.; Ding, X.N.; Müller-Bunz, H.; Esien, K.; Felton, S.;	*Thermal and Magnetic Field Switching in a Two-Step Hysteretic Mn(III) Spin Crossover Compound*	Angewandte Chemie International Edition	60		2	10.1002/anie.202114021	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Carpenter, M.A.; Collet, E.; Morgan, G.G.; Zapf, V.	*Coupled to Symmetry Breakings*						
Fedin, I.; Goryca, M.; Liu, D.; Tretiak, S.; Klimov, V.I.; Crooker, S.	*Enhanced Emission from Bright Excitons in Asymmetrically Strained Colloidal CdSe/CdxZn1 xSe Quantum Dots*	American Chemical Society Nano	15		14444	10.1021/acsnano.1c03864	Yes
Goryca, M.M.; Zhang, X.; Li, J.; Balk, A.N.; Watts, J. D.; Leighton, C.; Nisoli, C.; Schiffer, P.; Crooker, S.	*Field-Induced Magnetic Monopole Plasma in Artificial Spin Ice*	Physical Review X	11		11042	10.1103/PhysRevX.11.011042	Yes
Han, M.; Inoue, H.; Fang, S.; John, C.; Ye, L.; Chan, M.; Graf, D.E.; Suzuki, T.; Ghimire, M.; Cho, W.; Kaxiras, E.; Checkelsky, J.G.	*Evidence of two-dimensional flat band at the surface of antiferromagnetic kagome metal FeSn*	Nature Communi-cations	12	1	5345	10.1038/s41467-021-25705-1	Yes
Harrison, N.; Kushwaha, S.K.; Chan, M.K.; Jaime, M.	*Proximity to a critical point driven by electronic entropy in* URu_2Si_2	Nature Partner Journals Quantum Materials (npj)	6		24	10.1038/s41535-021-00317-6	Yes
Heinze, L.; Jeschke, H.O.; Mazin, I.I.; Metavitsiadis, A.; Reehuis, M.; Feyerherm, R.; Hoffmann, J.U.; Bartkowiak, M.; Prokhnenko, O.; Wolter, A.U.B.; Ding, X.N.; Zapf, V.; Corvalan Moya, C.; Weickert, D.F.; Jaime, M.; Rule, K.C.; Menzel, D.; Valenti, R.; Brenig, W.; Sullow, S.	*Magnetization Process of Atacamite: A Case of Weakly Coupled S = 1=2 Sawtooth Chains*	Physical Review Letters	126	20	207201	10.1103/PhysRevLett.126.207201	Yes
Jakobsen, V.; Trzop, E.; Dobbelaar, E.; Gavin, L.C.; Chikara, S.; Ding, X.N.; Lee, M.; Esien, K.; Müller-Bunz, H.; Felton, S.; Collet, E.; Carpenter, M.A.; Zapf, V.; Morgan, G.G.	*Domain Wall Dynamics in a Ferroelastic Spin Crossover Complex with Giant Magnetoelectric Coupling*	Journal of the American Chemical Society	0	0	0	10.1021/jacs.1c08214	Yes
Jang, T.; Do, S.; Lee, M.; Wu, H.; Brown, C.M.; Christianson, A.D.; Cheong, S.; Park, J.	*Physical properties of the quasi-two-dimensional square lattice antiferromagnet Ba2FeSi2O7*	Physical Review B	104		214434	10.1103/PhysRevB.104.214434	Yes
Kish, L.L.; Thaler, A.; Lee, M.; Zakrzewski, A.V.; Reig-i-Plessis, D.; Wolin, B.A.; Wang, X.; Littrell, K.C.; Budakian, R.; Zhou, H.D.; Gai, Z.; Frontzek, M.D.; Zapf, V.; Aczel, A.A.; DeBeer-Schmitt, L.; MacDougall, G.J.	*Domain Wall Patterning and Giant Response Functions in Ferrimagnetic Spinels*	Advanced Science	n/a	n/a	2101402	10.1002/advs.202101402	Yes
Kong, P.; Minkov, V.S.; Kuzovnikov, M.A.; Drozdov, A.P.; Besedin, S.P.; Mozaffari, S.; Balicas, L.; Balakirev, F.; Prakapenka, V.B.; Chariton, S.; Knyazev, D.A.; Greenberg, E.; Eremets, M.I.	*Superconductivity up to 243 K in the yttrium-hydrogen system under high pressure*	Nature Communications	12		5075	10.1038/s41467-021-25372-2	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Li, J.; Goryca, M.; Yumigeta, K.; Li, H.; Tongay, S.; Crooker, S.	*Valley relaxation of resident electrons and holes in a monolayer semiconductor: Dependence on carrier density and the role of substrate-induced disorder*	Physical Review Materials	5		44001	10.1103/PhysRevMaterials.5.044001	Yes
Liu, J.Y.; Yu, J.; Ning, J.L.; Yi, H.M.; Miao, L.; Min, L.J.; Zhao, Y.F.; Ning, W.; Lopez, K.A.; Zhu, Y.L.; Pillsbury, T.; Zhang, Y.B.; Wang, Y.; Hu, J.; Cao, H.B.; Chakoumakos, B.C.; Balakirev, F.; Weickert, D.F.; Jaime, M.; Lai, Y.; Kang, K.; Sun, J.W.; Alem, N.; Gopalan, V.; Chang, C.Z.; Samarth, N.; Liu, C.X.; McDonald, R.; Mao, Z.Q.	*Spin-valley locking and bulk quantum Hall effect in a noncentrosymmetric Dirac semimetal BaMnSb2*	Nature Communi-cations	12		4062	10.1038/s41467-021-24369-1	Yes
Maksimovic, N.; Eilbott, D.H.; Cookmeyer, T.; Wan, F.; Rusz, J.; Nagarajan, V.; Haley, S.C.; Maniv, E.; Gong, A.; Faubel, S.; Hayes, I.M.; Bangura, A.; Singleton, J.; Palmstrom, J.C.; Winter, L.; McDonald, R.; Jang, S.; Ai, P.; Lin, Y.I.; Ciocys, S.; Gobbo, J.; Werman, Y.; Oppeneer, P.M.; Altman, E.; Lanzara, A.; Analytis, J.G.	*Evidence for a delocalization quantum phase transition without symmetry breaking in* $CeCoIn_5$	Science	375	6576	76-81	10.1126/science.aaz4566	Yes
Manson, J.; Curley, S.; Williams, R.; Walker, D.; Goddard, P.; Ozarowski, A.; Johnson, R.; Vibharkar, A.; Villa, D.; Rhodehouse, M.; Birnbaum, S.M.; Singleton, J.	*Controlling Magnetic Anisotropy in a Zero-Dimensional S=1 Magnet Using Isotropic Cation Substitution*	Journal of the American Chemical Society	143		4633-4638	10.1021/jacs.0c12516	Yes
Post, K.W.; Legros, A.; Rickel, D.G.; Singleton, J.; McDonald, R.; He, X.; Bozovic, I.; Xu, X.; Shi, X.; Armitage, N. P.; Crooker, S.	*Observation of cyclotron resonance and measurement of the hole mass in optimally doped La2−xSrxCuO4*	Physical Review B	103		134515	10.1103/PhysRevB.103.134515	Yes
Sarkar, T.; Poniatowski, N.R.; Higgins, J.S.; Mandal, P.R.; Chan, M.K.; Greene, R.L.	*Hidden strange metallic state in underdoped electron-doped cuprates*	Physical Review B	103		224501	10.1103/PhysRevB.103.224501	Yes
Schoenemann, R.U.; Rodriguez, G.; Rickel, D.G.; Balakirev, F.; McDonald, R.; Evans, J.A.; Maiorov, B.A.; Paillard, C.; Bellaiche, L.; Stier, A.; Salamon, M.B.; Gofryk, K.; Jaime, M.	*Magnetoelastic standing waves induced in UO2 by microsecond magnetic field pulses*	Proceedings of the National Academy of Sciences of the USA (PNAS)	118		e2110555118	10.1073/pnas.2110555118	Yes
Singleton, J.; Schmidt, A.C.	*Launching information from faster-than-light polarization currents*	Research Features	138		38	10.26904/RF-138-1814560505	Yes
Sun, D.; Mikov, V.S.; Mozaffari, S.; Sun, Y.; Ma, Y.; Chariton, S.; Prakapenka, V.B.; Eremets, M.I.; Balicas, L.; Balakirev, F.	*High-temperature superconductivity on the verge of a structural instability in lanthanum superhydride*	Nature Communications	12		6863	10.1038/s41467-021-26706-w	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Sun, D.; Naud, M.; Nguyen, D.N.; Betts, J.; Singleton, J.; Balakirev, F.	*Composite pressure cell for pulsed magnets*	Review of Scientific Instruments	92		23903	10.1063/5.0025557	Yes
Willwater, J.; Steinki, N.; Menzel, D.; Reuter, R.; Amitsuka, H.; Sechovský, V.; Vali�ka, N.; Jaime, M.; Weickert, F.; Sullow, S.	*Magnetic and electronic phases of U2Rh3Si5*	Physical Review B	103		54408	10.1103/PhysRevB.103.054408	Yes
Xiang, Z.; Chen, L.; Chen, K.; Tinsman, C.; Sato, Y.; Asaba, T.; Lu, H.; Kasahara, Y.; Jaime, M.; Balakirev, F.; Iga, F.; Matsuda, Y.; Singleton, J.; Li, L.	*Unusual high-field metal in a Kondo insulator*	Nature Physics	-	-	1-6	10.1038/s41567-021-01216-0	Yes
Zaffalon, M.L.; Pinchetti, V.; Camellini, A.; Vikulov, S.; Capitani, C.; Bai, B.; Xu., M.; Meinardi, F.; Zhang, J.; Manna, L.; Zavelani-Rossi, M.; Crooker, S.; Brovelli, S.	*Intrinsic and Extrinsic Exciton Recombination Pathways in AgInS2 Colloidal Nanocrystals*	Energy Materials Advances	2021		1959321	10.34133/2021/1959321	Yes

5.7 PUBLICATIONS GENERATED BY ASC (14)

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Balachandran, S.; Cooper, J.; Van Oss, O.; Lee, P.J.; Bottura, L.; Devred, A.; Savary, F.; Scheuerlein, C.; Wolf, F.	*Metallographic analysis of 11 T dipole coils for High Luminosity-Large Hadron Collider (HL-LHC)*	Super-conductor Science and Technology	34	2	25001	10.1088/1361-6668/abc56a	Yes
Balachandran, S.; Polyanskii, A.A.; Chetri, S.; Dhakal, P.; Su, Y.; Sung, Z.; Lee, P.J.	*Direct evidence of microstructure dependence of magnetic flux trapping in niobium*	Scientific Reports	11	1	5364	10.1038/s41598-021-84498-x	Yes
Barua, S.; Davis, D.S.; Oz, Y.; Jiang, J.; Hellstrom, E.; Trociewitz, U.P.; Larbalestier, D.C.	*Critical Current Distributions of Recent Bi-2212 Round Wires*	IEEE Transactions on Applied Super-conductivity	31	5	6400406	10.1109/TASC.2021.3055479	Yes
Davis, D.S.; Shen, T.; Marchevsky, M.; Ravaioli, E.	*Stray-Capacitance As a Simple Tool for Monitoring and Locating Heat Generation Demonstrated in Three Superconducting Magnets*	IEEE Transactions on Applied Super-conductivity	31	6	1--11	10.1109/TASC.2021.3094769	Yes
Iida, K.; Qin, D.; Tarantini, C.; Hatano, T.; Wang, C.; Guo, Z.; Gao, H.; Saito, H.; Hata, S.; Naito, M.; Yamamoto, A.	*Approaching the ultimate superconducting properties of (Ba,K)Fe2As2 by naturally formed low-angle grain boundary networks*	Nature Publishing Group (NPG) Asia Materials	13	1	68	10.1038/s41427-021-00337-5	Yes
Jiang, J.; Hossain, S. I.; Oloye, A.; Oz, Y.; Barua, S.; Cooper, J.; Miller, E.; Huang, Y.; Parrell, J. A.; Kametani, F.; Trociewitz, U. P.; Hellstrom, E.; Larbalestier, D. C.	*Effects of Wire Diameter and Filament Size on the Processing Window of Bi-2212 Round Wire*	IEEE Transactions on Applied Super-conductivity	31	5	6400206	10.1109/TASC.2021.3055475	Yes
Kim, S.; Larbalestier, D.C.	*Influence of strain-driven segregation in low-angle grain boundaries on critical current density of* $Y_{0.9}Nd_{0.1}Ba_2Cu_3O_{7-d}$	Super-conductor Science and Technology	34	2	25008	10.1088/1361-6668/abc8d1	Yes
Molodyk, A.; Samoilenkov, S.; Markelov, A.; Degtyarenko, P.; Lee, S.; Petrykin, V.; Gaifullin, M.; Mankevich, A.; Vavilov, A.; Sorbom, B.; Cheng, J.; Garberg, S.; Kesler, L.; Hartwig, Z.; Gavrilkin, S.; Tsvetkov, A.; Okada, T.; Awaji, S.; Abraimov, D.V.; Francis, A.; Bradford, G.; Larbalestier, D.; Senatore, C.; Bonura, M.; Pantoja, A.; Wimbush, S.; Strickland, N.; Vasiliev, A.	*Development and large volume production of extremely high current density* $YBa_2Cu_3O_7$ *superconducting wires for fusion*	Scientific Reports	11	1	1--11	10.1038/s41598-021-81559-z	Yes
Oloye, A.; Matras, M.; Jiang, J.; Hossain, S.I.; Su, Y.; Trociewitz, U.P.; Hellstrom, E.E.; Larbalestier, D.C.; Kametani, F.	*Correlation of critical current density to quasi-biaxial texture and grain boundary cleanliness in fully dense Bi-2212 wires*	Super-conductor Science and Technology	34	3	35018	10.1088/1361-6668/abd575	Yes
Oz, Y.; Jiang, J.; Matras, M.; Oloye, A.; Kametani, F.; Hellstrom, E.; Larbalestier, D.C.	*Conundrum of strongly coupled supercurrent flow in both under- and overdoped Bi-2212 round wires*	Physical Review Materials	5		74803	10.1103/PhysRevMaterials.5.074803	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Sundahl, C.; Welander, P.B.; Su, Y.F.; Kametani, F.; Xie, L.; Zhang, H.; Li, L.; Gurevich, A.; Eom, C.B.	*Development and characterization of Nb3Sn/Al2O3 superconducting multilayers for particle accelerators*	Nature Scientific Reports	11		7770	10.1038/s41598-021-87119-9	Yes
Tarantini, C.; Kametani, F.; Balachandran, S.; Heald, S.M.; Wheatley, L.; Grovenor, C.R.M.; Moody, M.P.; Su, Y.; Lee, P.J.; Larbalestier, D.C.	*Origin of the enhanced Nb3Sn performance by combined Hf and Ta doping*	Nature Scientific Reports	11		17845	10.1038/s41598-021-97353-w	Yes
Tarantini, C.; Pak, C.; Su, Y.; Hellstrom, E.; Larbalestier, D.C.; Kametani, F.	*Effect of heat treatments on superconducting properties and connectivity in K-doped $BaFe_2As_2$*	Nature Scientific Reports	11		3143	10.1038/s41598-021-82325-x	Yes
Withanage, W.K.; Juliao, A.; Cooley, L.D.	*Rapid Nb3Sn film growth by sputtering Nb on hot bronze*	Superconductor Science and Technology	34	6	06LT01	10.1088/1361-6668/abf66f	Yes

5.8 PUBLICATIONS GENERATED BY MS & T (24)

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Akhmeteli, A.; Gavrilin, A.V.	*Vacuum Balloon - A 350-Year-Old Dream*	MDPI, Eng	2	4	480-491	10.3390/eng2040030	Yes
Bao, S.; Guo, W.	*Transient heat transfer of superfluid 4He in nonhomogeneous geometries: Second sound, rarefaction, and thermal layer*	Physical Review B	103		134510	10.1103/PhysRevB.103.134510	Yes
Du, L.; Nosratabad, N.A.; Jin, Z.C.; Zhang, C.Q.; Wang, S.S.; Chen, B.H.; Mattoussi, H.	*Luminescent Quantum Dots Stabilized by N-Heterocyclic CarbenePolymer Ligands*	Journal of the American Chemical Society	143		1873-1884	10.1021/jacs.0c10592	Yes
Garceau, N.; Bao, S.; Guo, W.	*Heat and mass transfer during a sudden loss of vacuum in a liquid helium cooled tube - Part III: Heat deposition in He II*	International Journal Heat and Mass Transfer	181		121885	10.1016/j.ijheatmasstransfer.2021.121885	Yes
Gavrilin, A.V.; Kolb-Bond, D.J.; Kim, K.L.; Kim, K.; Marshall, W.S.; Dixon, I.R.	*Quench and Stability Modelling of a Metal-Insulation Multi-Double-Pancake High-Temperature-Superconducting Coil*	IEEE Transactions on Applied Super-conductivity	31	5	1-7	10.1109/TASC.2021.3066548	Yes
Han, K.; Xin, Y.; Niu, R.; Goddard, R.E.; Toplosky, V.J.	*Characterization of Nitronic-40 Stainless Steel Shells*	IEEE Transactions on Applied Super-conductivity	31	5	7800105	10.1109/TASC.2021.3070819	Yes
He, L.; Li, H.G.; Liang, M.H.; Zhang, W.; Han, K.; Zhai, Q.J.	*Characterization of structure evolution of Ti O clusters in molten iron*	Modelling and Simulation in Materials Science and Engineering	29	7	75006	10.1088/1361-651X/ac1f86	Yes
Hu, C.; Zhang, J .; Zhang, Y.; Han, K.; Song, C.J.; Zhai, Q.J.	*Improvement on Mechanical Properties of a bcc Matrix Al8 (FeCuCrMn) 92 High-Entropy Alloy by Phase Modulation of Interstitial Carbon Element*	Metals and Materials International	28		523-533	10.1007/s12540-021-01063-x	Yes
Ijagbemi, K.; Davis, D.S.; Yuan, X.; Stiers, E.; Yuan, L.; Pamidi, S.V.	*Electrical Model of Frequency Loss Induced Quench Protection System for High Temperature Superconducting Magnets*	IEEE Transactions on Applied Super-conductivity	31	5	1-4	10.1109/TASC.2021.3066116	Yes
Kanai, T.; Guo, W.	*True Mechanism of Spontaneous Order from Turbulence in Two-Dimensional Superfluid Manifolds*	Physical Review Letters	127		95301	10.1103/PhysRevLett.127.095301	Yes
Kolb-Bond, D.; Bird, M.D.; Dixon, I.R.; Painter, T.A.; Lu, J.; Kim, K.L.; Kim, K.; Walsh, R.P.; Grilli, F.	*Screening current rotation effects: SCIF & strain I REBCO magnets*	Super-conductor Science and Technology	34		95004	10.1088/1361-6668/ac1525	Yes
Li, J.F.; Kolekar, S.; Xin, Y.; Coelho, P.M.; Lasek, K.; Nugera, F.A.; Gutiérrez, H.R.; Batzill, M.	*Thermal Phase Control of Two-Dimensional Pt-Chalcogenide (Se and Te)*	Chemistry of Materials				10.1021/acs.chemmater.1c02163	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
	Ultrathin Epitaxial Films and Nanocrystals						
Lu, J.; Xin, Y.; Jarvis, B.; Bai, H.	*Oxygen out-diffusion in REBCO coated conductor due to heating*	Super-conductor Science and Technology	34	7	75004	10.1088/1361-6668/abfd0c	Yes
Luciano-Velázquez, J.; Xin, Y.; Su, Y.; Quiles-Vélez, C.I.; Cruz-Romer, S.A.; Torres-Mejías Department of Chemistry and Physics, Univer, G.E.; Rivera-De Jesús University of Puerto Rico at Mayagüez,, J.; Bailón-Ruiz Department of Chemistry and Physic, S.J.	*Synthesis, characterization, and photocatalytic activity of ZnS and Mn-doped ZnS nanostructures*	MRS Advances	6		252 258	10.1557/s43580-021-00035-y	Yes
Sanavandi, H.; Guo, W.	*A magnetic levitation based low-gravity simulator with an unprecedented large functional volume*	Nature Partner Journals Microgravity	7		40	10.1038/s41526-021-00174-4	Yes
Skaggs, C.M.; Siegfried, P.E.; Kang, C.J.; Brown, C.M.; Chen, F.; Ma, L.; Ehrlich, S.N.; Xin, Y.; Croft, M.; Xu, W.; Lapidus, S.H.; Ghimire, N.J.; Tan, X.Y.	*Iridate Li8Ir06: An Antiferromagnetic Insulator*	Inorganic Chemistry	60		17201 17211	10.1021/acs.inorgchem.1c02535	Yes
Tang, Y.; Bao, S.; Guo, W.	*Superdiffusion of quantized vortices uncovering scaling laws in quantum turbulence*	Proceedings of the National Academy of Sciences of the USA (PNAS)	118		e2021957118	10.1073/pnas.2021957118	Yes
Tang, Y.; Guo, W.; L'vov, V.S.; Pomyalov, A.	*Eulerian and Lagrangian second-order statistics of superfluid 4He grid turbulence*	Physical Review B	103		144506	10.1103/PhysRevB.103.144506	Yes
Tian, Q.L.; Deng, K.; Xu, Z.H.; Han, K.; Zheng, H.X.	*Microstructural Characterization and Mechanical Property of Al-Li Plate Produced by Centrifugal Casting Method*	Metals	11		966	10.3390/met11060966	Yes
Xiang, Z.; Zhang, L.; Xin, Y.; An, B.; Niu, R.; Mardani, M.; Siegrist, T.M.; Lu, J.; wang, E.G.; Goddard, R.E.; Man, T.; Han, K.	*Ultrafine microstructure and hardness in Fe-Cr-Co alloy induced by spinodal decomposition under magnetic field*	Materials and Design	199		109383	10.1016/j.matdes.2020.109383	Yes
Xiang, Z.L.; Zhang, L.; Xin, Y.; An, B.L.; Niu, R.M.; Lu, J.; Mardani, M.; Han, K.; Wang, E.G.	*Effect of Cr Content on Microstructure of Spinodal Decomposition and Properties in FeCrCoSi Permanent Magnet Alloy*	Acta Metallurgica Sinica	58	1	103-113	10.11900/0412.1961.2021.00094	Yes
Yu, H.; Levitan, J.W.; Lu, J.	*Calibration of a superconducting transformer by measuring critical current of a NbTi Rutherford cable*	Super-conductor Science and Technology	34	8	85019	10.1088/1361-6668/abf623	Yes
Zhang, B.; Xin, Y.; Karapetrova, E.; Holleman, J.; McGill, S.A.; Beekman, C.	*Growth and characterization of off-stoichiometric LaVO3 thin films*	Physical Review Materials	5		85006	10.1103/PhysRevMaterials.5.085006	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Zhao, C.; Niu, R.; Xin, Y.; Brown, D.; McGuire, D.; wang, E.G.; Han, K.	*Improvement of properties in Cu Ag composites by doping induced microstructural refinement*	Materials Science and Engineering A	799		140091	10.1016/j.msea.2020.140091	Yes

5.9 PUBLICATIONS GENERATED BY EDUCATION AT FSU (2)

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Roberts, K.L.; Villa, C.R.; Hughes, R.	*Unknown Territory: K-12 STEM Summer Exploration Through Zoom*	Journal of STEM Outreach	4	4	12	10.15695/jstem/v4i4.03	Yes
Schellinger, J.; Enderle, P.J.; Roberts, K.L.; Skrob-Martin, S.; Rhemer, D.; Southerland, S.A.	*Describing the Development of the Assessment of Biological Reasoning (ABR)*	Education Sciences	11	11	669	10.3390/educsci11110669	Yes

5.10 PUBLICATIONS GENERATED BY CMT/E (65)

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Alahmed, L.; Nepal, B.; Macy, J.J.; Zheng, W.; Casas, B.W.; Sapkota, A.; Jones, N.; Mazza, A.R.; Brahlek, M.; Jin, J.; Mahjouri-Samani, M.; Zhang, S.S.L.; Mewes, C.; Balicas, L.; Mewes, T.; Li, P.	*Magnetism and Spin Dynamics in Room-Temperature van der Waals Magnet Fe_5GeTe_2*	2D Materials	8		45030	10.1088/2053-1583/ac2028	Yes
Bao, S.; Guo, W.	*Transient heat transfer of superfluid 4He in nonhomogeneous geometries: Second sound, rarefaction, and thermal layer*	Physical Review B	103		134510	10.1103/PhysRevB.103.134510	Yes
Benhal, P.G.; Quashie Jr, D.; Cheang, U.K.; Ali, J.N.	*Propulsion Kinematics of Achiral Microswimmers in Viscous Fluids*	Applied Physics Letters	118		204103	10.1063/5.0048277	Yes
Bernevig, B.A.; Vafek, O.; Kang, J.	*Cascades between Light and Heavy Fermions in the Normal State of Magic-Angle Twisted Bilayer Graphene*	Physical Review Letters	127		266402	10.1103/PhysRevLett.127.266402	Yes
Chen, B.B.; Liao, Y.D.; Chen, Z.; Vafek, O.; Kang, J.; Li, W.; Meng, Z.Y.	*Realization of topological Mott insulator in a twisted bilayer graphene lattice model*	Nature Communi-cations	12		5480	10.1038/s41467-021-25438-1	Yes
Cochran, J.R.; Franco-Rivera, G.; Zhang, D.; Chen, L.; Wang, Z.; Chiorescu, I.	*Dual On-Chip SQUID Measurement Protocol for Flux Detection in Large Magnetic Fields*	IEEE Transactions on Applied Super-conductivity	31	6	1-5	10.1109/TASC.2021.3090758	Yes
Dai, J.; Frantzeskakis, E.; Aryal, N.; Chen, K.; Fortuna, F.; Rault, J.E.; Le Fèvre, P.; Balicas, L.; Miyamoto, K.; Okuda, T.; Manousakis, E.; Baumbach, R.; Santander-Syro, A.F.	*Experimental Observation and Spin Texture of Dirac Node Arcs in Tetradymite Topological Metals*	Physical Review Letters	126		196407	10.1103/PhysRevLett.126.196407	Yes
Ding, X.; Xing, J.; Li, G.; Balicas, L.; Gofryk, K.; Wen, H. H.	*Crossover from Kondo to Fermi-liquid behavior induced by high magnetic field in 1T−VTe_2 single crystals*	Physical Review B	103		125115	10.1103/PhysRevB.103.125115	Yes
Flessa Savvidou, A.K.; Clark, J.K.; Wang, H.; Wei, K.; Choi, E.S.; Mozaffari, S.; Qian, X.; Shatruk, M.; Balicas, L.	*Complex Dirac-like Electronic Structure in Atomic Site-Ordered $Rh_3In_{3.4}Ge_{3.6}$*	Chemistry of Materials	33		1218 1227	10.1021/acs.chemmater.0c03943	Yes
Frank, M.S.; Lee, T.; Bhattacharyya, G.; Tsang, P.H.; Quito, V.L.; Dobrosavljevic, V.; Christiansen, O.; Lanata, N.	*Quantum embedding description of the Anderson lattice model with the ghost Gutzwiller approximation*	Physical Review B: Rapid Comm/ Letters	104		L081103	10.1103/PhysRevB.104.L081103	Yes
Galley, S.S.; Pattenaude, S.A.; Ray, D.; Gaggioli, C.; Whitefoot, M.A.; Qiao, Y.; Higgins, R.F.; Nelson, W.L.; Baumbach, R.; Sperling, J.M.; Zeller, M.; Collins, T.S.; Schelter, E.J.; Gagliardi, L.;	*Using Redox-Active Ligands to Generate Actinide Ligand Radical Species*	Inorganic Chemistry	60	20	15242 - 15252	10.1021/acs.inorgchem.1c01766	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Albrecht-Schönzart, T.E.; Bart, S.C.							
Garceau, N.; Bao, S.; Guo, W.	*Heat and mass transfer during a sudden loss of vacuum in a liquid helium cooled tube - Part III: Heat deposition in He II*	International Journal Heat and Mass Transfer	181		121885	10.1016/j.ijheatmasstransfer.2021.121885	Yes
Gilmutdinov, I.F.; Schoenemann, R.U.; Vignolles, D.; Proust, C.; Mukhamedshin, I.R.; Balicas, L.; Alloul, H.	*Interplay between strong correlations and electronic topology in the underlying kagome lattice of Na2/3CoO2*	Physical Review B: Rapid Comm/ Letters	104		L201103	10.1103/PhysRevB.104.L201103	Yes
Haldane, F.D.M.; Rezayi, E.H.; Yang, K.	*Graviton chirality and topological order in the half-filled Landau level*	Physical Review B: Rapid Comm/ Letters	104		L121106	10.1103/PhysRevB.104.L121106	Yes
Hertz, M.B.; Baumbach, R.; Wang, X.; Latturner, S.E.	*Unexpected Hydride: Ce4B2C2H2.42, a Stuffed Variant of the Nd2BC Structure Type*	Crystal Growth and Design	21	9	5164-5171	10.1021/acs.cgd.1c00521	Yes
Jayasinghe, A.S.; Lai, Y.; Potter, W.M.; Windorff, C.J.; Baumbach, R.; Albrecht-Schönzart, T.E.; Latturner, S.E.	*$An_{1.33}T_4Al_8Si_2$ (An = Ce, Th, U, Np; T = Ni, Co): Actinide Intermetallics with Disordered $Gd_{1+x}Fe_4Si_{10-y5}$ Structure Type Grown from Metal Flux*	Inorganic Chemistry	60	17	13062 - 13070	10.1021/acs.inorgchem.1c01480	Yes
Kanai, T.; Guo, W.	*True Mechanism of Spontaneous Order from Turbulence in Two-Dimensional Superfluid Manifolds*	Physical Review Letters	127		95301	10.1103/PhysRevLett.127.095301	Yes
Kong, P.; Minkov, V.S.; Kuzovnikov, M.A.; Drozdov, A.P.; Besedin, S.P.; Mozaffari, S.; Balicas, L.; Balakirev, F.; Prakapenka, V.B.; Chariton, S.; Knyazev, D.A.; Greenberg, E.; Eremets, M.I.	*Superconductivity up to 243 K in the yttrium-hydrogen system under high pressure*	Nature Communi-cations	12		5075	10.1038/s41467-021-25372-2	Yes
Krstovska, D.; Choi, E.S.; Steven, E.	*The Magnetothermopower of Organic Superconductor κ-(ET)2Cu(NCS)2: Possible Charge Density Wave Scenario*	Romanian Journal of Physics	66		612		Yes
Lee, K.; Pal, A.; Changlani, H.J.	*Frustration-induced emergent Hilbert space fragmentation*	Physical Review B	103		235133	10.1103/PhysRevB.103.235133	Yes
Li, Q.; Ma, K.; Wang, R.; Hu, Z.; Wang, H.; Yang, K.	*Dynamics of quantum Hall interfaces*	Physical Review B	104		125303	10.1103/PhysRevB.104.125303	Yes
Liu, X.; Wang, Z.; Watanabe, K.; Taniguchi, T.; Vafek, O.; Li, J.	*Tuning electron correlation in magic-angle twisted bilayer graphene using Coulomb screening*	Science	371	6535	1261-1265	10.1126/science.abb8754	Yes
Long, S.; Cai, S.; Schoenemann, R.U.; Rosa, P.F.S.; Balicas, L.; Huang, C.; Guo, J.; Zhou, Y.; Han, J.; Zhou, L.; Li, Y.; Li, X.; Wu, Q.; Weng, H.; Xiang, T.; Sun, L.	*Observation of nearly identical superconducting transition temperaturesin the pressurized Weyl semimetals $MIrTe_4$(M = Nb and Ta)*	Physical Review B	104		144503	10.1103/PhysRevB.104.144503	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Ma, K.; Wang, R.; Yang, K.	*Realization of Supersymmetry and Its Spontaneous Breaking in Quantum Hall Edges*	Physical Review Letters	126		206801	10.1103/PhysRevLett.126.206801	Yes
Macy, J.J.; Ratkovski, D.R.; Balakrishnan, P.P.; Strungaru, M.; Chiu, Y.C.; Flessa Savvidou, A.K.; Moon, A.; Zheng, W.; McCandless, G.T.; Chan, J.Y.; Kumar, G.S.; Shatruk, M.; Grutter, A.J.; Borchers, J.A.; Ratcliff, W.D.; Choi, E.S.; Santos, E.J.G.; Balicas, L.	*Magnetic field-induced non-trivial electronic topology in Fe3-xGeTe2*	Applied Physics Reviews	8		41401	10.1063/5.0052952	Yes
Maniv, E.; Murphy, R.A.; Haley, S.C.; Doyle, S.; John, C.; Maniv, A.; Ramakrishna, S.K.; Tang, Y.; Ercius, P.; Ramesh, R.; Reyes, A.P.; Long, J.R.; Analytis, J.G.	*Exchange bias due to coupling between coexisting antiferromagnetic and spin-glass orders*	Nature Physics	17		1-7	10.1038/s41567-020-01123-w	Yes
Pal, S.; Sharma, P.; Changlani, H.J.; Pujari, S.	*Colorful points in the XY regime of XXZ quantum magnets*	Physical Review B	103		144414	10.1103/PhysRevB.103.144414	Yes
Park, W.K.; Sittler, J.A.; Greene, L.H.; Fuhrman, W.T.; Chamorro, J.R.; Koohpayeh, S.M.; Phelan, W.A.; McQueen, T.M.	*Topological nature of the Kondo insulator SmB6 and its sensitiveness to Sm vacancy*	Physical Review B	103		155125	10.1103/PhysRevB.103.155125	Yes
Patil, P.D.; Wasala, M.; Alkhaldi, R.; Weber, L.; Kovi, K.K.; Chakrabarti, B.; Nash, J.A.; Rhodes, D.A.; Rosenmann, D.; Divan, R.; Sumant, A.V.; Balicas, L.; Pradhan, N.R.; Talapatra, S.	*Photogating-driven enhanced responsivity in few-layered ReSe2 phototransistor*	Journal of Materials Chemistry C	9		12168	10.1039/D1TC01973B	No
Paul, A.; Chung, C.; Birol, T.; Changlani, H.J.	*Paul et al. Reply:*	Physical Review Letters	127		49702	10.1103/PhysRevLett.127.049702	Yes
Pokharel, B.K.; Wang, Y.; Jaroszynski, J.J.; Sasagawa, T.; Popovic, D.	*Charge-order dynamics in underdoped $La_{1.6-x}Nd_{0.4}Sr_xCuO_4$ revealed by electric pulses*	Applied Physics Letters	118		244104	10.1063/5.0055413	Yes
Pustogow, A.; Rosslhuber, R.; Tan, Y.; Uykur, E.; Bohme, A.; Wenzel, M.; Saito, Y.; Lohle, A.; Hubner, R.; Kawamoto, A.; Schlueter, J.A.; Dobrosavljevic, V.; Dressel, M.	*Low-temperature dielectric anomaly arising from electronic phase separation at the Mott insulator-metal transition*	Nature Partner Journals Quantum Materials (npj)	6	1	9	10.1038/s41535-020-00307-0	Yes
Pustogow, A.; Saito, Y.; ohle, A.; Alonso, M.; Kawamoto, A.; Dobrosavljevic, V.; Dressel, M.; Fratini, S.	*Rise and fall of Landau's quasiparticles while approaching the Mott transition*	Nature Communi-cations	12	1	1571	10.1038/s41467-021-21741-z	Yes
Rahn, M.C.; Gallagher, A.; Orlandi, F.; Khalyavin, D.D.; Hoffmann, C.; Manuel, P.; Baumbach, R.; Janoschek, M.	*Collinear antiferromagnetic order in $URu_2Si_{2-x}P_x$ revealed by neutron diffraction*	Physical Review B	103		214403	10.1103/PhysRevB.103.214403	Yes
Resende, G.; Ribeiro, G.; Silveira, O.; Lemos, J.; Brant, J.C.; Rhodes, D.; Balicas, L.; Terrones, M.; Mazzoni, M.S.C.;	*Origin of the complex Raman tensor elements in single-layer triclinic $ReSe_2$*	2D Materials	8		25002	10.1088/2053-1583/abce07	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Fantini, C.; Carvalho, B.R.; Pimenta, M. A.							
Resende, G.C.; Ribeiro, G.A.S.; Silveira, O.J.; Lemos, J.S.; Rhodes, D.A.; Balicas, L.; Terrones, M.; Mazzoni, M.S.C.; Fantini, C.; Carvalho, B.R.; Pimenta, M.A.	*Effects of dimensionality and excitation energy on the Raman tensors of triclinic ReSe2*	Journal of Raman Spectro-scopy	52		22	10.1002/jrs.6212	Yes
Rhodes, D.A.; Jindal, A.; Yuan, N.F.Q.; Jung, Y.; Antony, A.; Wang, H.; Kim, B.; Chiu, Y.C.; Taniguchi, T.; Watanabe, K.; Barmak, K.; Balicas, L.; Dean, C.R.; Qian, X.; Fu, L.; Pasupathy, A.N.; Hone, J.	*Enhanced Superconductivity in Monolayer T_d-$MoTe_2$*	American Chemical Society Nano Letters	21		2505	10.1021/acs.nanolett.0c04935	Yes
Rogers, J.; Lee, T.; Pakdel, S.; Xu, W.; Dobrosavljevic, V.; Yao, Y.; Christiansen, O.; Lanata, N.	*Bypassing the computational bottleneck of quantum-embedding theories for strong electron correlations with machine learning*	Physical Review Research	3		13101	10.1103/PhysRevResearch.3.013101	Yes
Rogowski, L. W.; Ali, J.N.; Zhang, X.; Wilking, J.N.; Fu, H.C.; Kim, M.J.	*Symmetry Breaking Propulsion of Magnetic Microspheres in Nonlinearly Viscoelastic Fluids*	Nature Communi-cations	12		1116	10.1038/s41467-021-21322-0	Yes
Romanini, M.; Wang, Y.; Gürpinar, K.; Ornelas, G.; Lloveras, P.; Zhang, Y.; Zheng, W.; Barrio, M.; Aznar, A.; Gràcia-Condal, A.; Emre, B.; Atakol, O.; Popescu, C.; Zhang, H.; Long, Y.; Balicas, L.; Lluís Tamarit, J.; Planes, A.; Shatruk, M.; Mañosa, L.	*Giant and Reversible Barocaloric Effect in Trinuclear Spin-Crossover Complex $Fe_3(bntrz)_6(tcnset)_6$*	Advanced Materials	33		2008076	10.1002/adma.202008076	Yes
Rosslhuber, R.; Pustogow, A.; Uykur, E.; Bohme, A.; Lohle, A.; Hubner, R.; Schlueter, J.A.; Tan, Y.; Dobrosavljevic, V.; Dressel, M.	*Phase coexistence at the first-order Mott transition revealed by pressure-dependent dielectric spectroscopy of κ-BEDT-TTF_2-Cu_2CN_3*	Physical Review B	103		125111	10.1103/PhysRevB.103.125111	Yes
Sanavandi, H.; Guo, W.	*A magnetic levitation based low-gravity simulator with an unprecedented large functional volume*	Nature Partner Journals Microgravity	7		40	10.1038/s41526-021-00174-4	Yes
Shcherbakov, D.; Stepanov, P.; Memaran, S.; Wang, Y.; Xin, Y.; Yang, J.; Wei, K.; Baumbach, R.; Zheng, W.; Watanabe, K.; Tanigushi, T.; Bockrath, M.; Smirnov, D.; Siegrist, T.M.; Windl, W.; Balicas, L.; Lau, C.N.	*Layer- and gate-tunable spin-orbit coupling in a high-mobility few-layer semiconductor*	Science Advances	7		eabe2892	10.1126/sciadv.abe2892	Yes
Shrestha, K.; Zhang, S.; Greene, L.H.; Lai, Y.; Baumbach, R.; Sasmal, K.; Maple, M.B.; Park, W.K.	*Spectroscopic evidence for the direct involvement of local moments in the pairing process of the heavy-fermion superconductor CeCoIn5*	Physical Review B	103		224515	10.1103/PhysRevB.103.224515	Yes
Sittler, J.A.; Park, W.K.	*Self-oxidation-formed boron oxide as a tunnel barrier in SmB6 junctions*	Journal of Alloys and Compounds	874		159841	10.1016/j.jallcom.2021.159841	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Stanley, L.J.; Chuang, H.J.; Zhou, Z.; Koehler, M.R.; Yan, J.; Mandrus, D.G.; Popovic, D.	*Low-temperature 2D/2D Ohmic contacts in WSe_2 field-effect transistors as a platform for the 2D metal-insulator transition*	American Chemical Society Applied Materials and Interfaces	13		10594	10.1021/acsami.0c21440	Yes
Suarez-Villagran, M.Y.; Mitsakos, N.; Lee, T.; Miller, J.H.; Miranda, E.; Dobrosavljevic, V.	*Unusually thick metal-insulator domain walls around the Mott point*	Physical Review B	104		155114	10.1103/PhysRevB.104.155114	Yes
Sun, D.; Mikov, V.S.; Mozaffari, S.; Sun, Y.; Ma, Y.; Chariton, S.; Prakapenka, V.B.; Eremets, M.I.; Balicas, L.; Balakirev, F.	*High-temperature superconductivity on the verge of a structural instability in lanthanum superhydride*	Nature Communi-cations	12		6863	10.1038/s41467-021-26706-w	Yes
Tang, Y.; Bao, S.; Guo, W.	*Superdiffusion of quantized vortices uncovering scaling laws in quantum turbulence*	Proceedings of the National Academy of Sciences of the USA (PNAS)	118		e2021957118	10.1073/pnas.2021957118	Yes
Tang, Y.; Guo, W.; L'vov, V.S.; Pomyalov, A.	*Eulerian and Lagrangian second-order statistics of superfluid 4He grid turbulence*	Physical Review B	103		144506	10.1103/PhysRevB.103.144506	Yes
Tian, C.; Yang, K.	*Breakdown of quantum-classical correspondence and dynamical generation of entanglement*	Physical Review B	104		174302	10.1103/PhysRevB.104.174302	Yes
Ungor, O.; Burrows, M.; Liu, T.; Bodensteiner, M.; Adhikari, Y.; Hua, Z.; Casas, B.W.; Balicas, L.; Xiong, P.; Shatruk, M.	*Paramagnetic Molecular Semiconductors Combining Anisotropic Magnetic Ions with TCNQ Radical Anions*	Inorganic Chemistry	60		10502 10512	10.1021/acs.inorgchem.1c01140	No
Ungor, O.; Choi, E.S.; Shatruk, M.	*Optimization of crystal packing in semiconducting spin-crossover materials with fractionally charged TCNQδ− anions (0 < δ < 1)*	Chemical Science	12		10765 - 10779	10.1039/D1SC02843J	Yes
Ünzelmann, M.; Bentmann, H.; Rohlf, S.; Buck, J.; Hoesch, M.; Sangiovanni, G.; Sante, D.; Figgemeier, T.; Eck, P.; Neu, J.N.; Geldiyev, B.; Diekmann, F.; Kallåne, M.; Rossnagel, K.; Thomale, R.; Siegrist, T.M.; Reinert, F.	*Momentum-space signatures of Berry flux monopoles in the Weyl semimetal TaAs*	Nature Communi-cations	12	1	1--7	10.1038/s41467-021-23727-3	Yes
Vafek, O.; Kang, J.	*Lattice model for the Coulomb interacting chiral limit of magic-angle twisted bilayer graphene: Symmetries, obstructions, and excitations*	Physical Review B	104		75143	10.1103/PhysRevB.104.075143	Yes
Wang, J.; Jiang, Y.; Zhao, T.; Dun, Z.; Miettinen, A.L.; Wu, X.; Mourigal, M.; Zhou, H.; Pan, W.; Smirnov, D.; Jiang, Z.	*Magneto-transport evidence for strong topological insulator phase in ZrTe5*	Nature Communi-cations	12	1	6758	10.1038/s41467-021-27119-5	Yes
Wang, X.; Cao, J.; Lu, Z.; Cohen, A.; Kitadai, H.; Li, T.;	*Spin-induced linear polarization of*	Nature Materials	20	7	964-970	10.1038/s41563-021-00968-7	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Tan, Q.; Wilson, M.; Lui, C.; Smirnov, D.; Sharifzadeh, S.; Ling, X.	*photoluminescence in antiferromagnetic van der Waals crystals*						
Wang, X.; Christensen, M.H.; Berg, E.; Fernandes, R.M.	*Strong-coupling expansion of multi-band interacting models: Mapping onto the transverse-field J1-J2 Ising model*	Annals of Physics	435		168522	10.1016/j.aop.2021.168522	Yes
Wolowiec, C.; Kanchanavatee, N.; Huang, K.; Ran, S.; Briendel, A.; Pouse, N.; Sasmal, K.; Baumbach, R.; Chappell, G.L.; Riseborough, P.; Maple, M.B.	*Isoelectronic perturbations to f-d-electron hybridization and the enhancement of hidden order in URu2Si2*	Proceedings of the National Academy of Sciences of the USA (PNAS)	118	20	e2026591118	10.1073/pnas.2026591118	Yes
Yang, H.Y.; Yao, X.; Plisson, V.; Mozaffari, S.; Scheifers, J.P.; Flessa Savvidou, A.K.; Choi, E.S.; McCandless, G.T.; Padlewski, M.F.; Putzke, C.; Moll, P.J.W.; Chan, J.Y.; Balicas, L.; Burch, K.S.; Tafti, F.	*Evidence of a coupled electron-phonon liquid in NbGe2*	Nature Communications	12		5292	10.1038/s41467-021-25547-x	Yes
Yang, K.	*Exactly solvable model of Fermi arcs and pseudogap*	Physical Review B	103		24529	10.1103/PhysRevB.103.024529	Yes
Yue, L.; Yang, L.; Li, J.; Qi, Y.; Wang, X.; Cao, J.	*On the absence of phonon bottleneck in lead selenide quantum dot*	Ultrafast Phenomena XXII	22		Tu4A.40	10.1364/UP.2020.Tu4A.40	Yes
Zhang, B.; Xin, Y.; Karapetrova, E.; Holleman, J.; McGill, S.A.; Beekman, C.	*Growth and characterization of off-stoichiometric LaVO3 thin films*	Physical Review Materials	5		85006	10.1103/PhysRevMaterials.5.085006	Yes
Zhang, L.; Jiang, Y.; Smirnov, D.; Jiang, Z.	*Landau quantization in tilted Weyl semimetals with broken symmetry*	Journal of Applied Physics	129	10	105107	10.1063/5.0042307	Yes
Zheng, C.; Yang, K.; Wan, X.	*Effect of surface disorder on the chiral surface states of a three-dimensional quantum Hall system*	Physical Review B	103		75401	10.1103/PhysRevB.103.075401	Yes

5.11 PUBLICATIONS GENERATED BY GEOCHEMISTRY (16)

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Ahmed, N.; Ye, M.; Wang, Y.; Greenhalgh, T.; Fowler, K.	*Using δ18O and δ2H to Detect Hydraulic Connection Between a Sinkhole Lake and a First-Magnitude Karst Spring.*	Ground-water	59	6	856 865	10.1111/gwat.13105	Yes
Bowman, C.N.; Them, T.; Knight, M.; Kaljo, D.; Eriksson, M.; Hints, O.; Martma, T.; Owens, J.D.; Young, S.A.	*A multi-proxy approach to constrain reducing conditions in the Baltic Basin during the late Silurian Lau carbon isotope excursion*	Palaeogeo-graphy, Palaeo-climatology, Palaeo-ecology	581		11062 4	10.1016/j.palaeo.2021 .110624	Yes
Gaschnig, R.; Rader, S.; Reinhard, C.; Owens, J.D.; Planavsky, N.; Wang, X.; Asael, D.; Greaney, A.; Helz, R.	*Behavior of the Mo, Tl, and U isotope systems during differentiation in the Kilauea Iki lava lake*	Chemical Geology	574		12023 9	10.1016/j.chemgeo.2 021.120239	Yes
Goderis, S.; Sato, H.; Ferriere, L.; Schmitz, B.; Burney, D.; Kaskes, P.; Vellekoop, J.; Wittman, A.; Schulz, T.; Chernonozhkin, S.M.; Claeys, P.; De Graaff, S.J.; Dehais, T.; De Winter, N.J.; Elfman, M.; Feignon, J.G.; Ishikawa, A.; Koeberl, C.; Kristiansson, P.; Neal, C.R.; Owens, J.D.; Schmieder, M.; Sinnesael, M.; Vanhaecke, F.; Van Malderen, S.J.M.; Bralower, T.J.; Gulick, S.P.S.; Kring, D.A.; Lowery, C.M.; Morgan, J.V.; Smit, J.; Whalen, M.T.	*Globally distributed iridium layer preserved within the Chicxulub impact structure*	Science Advances	7	9	eabe3 647	10.1126/sciadv.abe3 647	Yes
Jahan, S.; Wang, Y.; Burnett, W.; Means, G.H.; Sun, F.	*Evaluating organic geochemical proxies for application to coastal lake sediments along the Gulf Coast of Florida for paleotempestology*	Quaternary Science Reviews	266		10707 7	10.1016/j.quascirev.2 021.107077	Yes
Kendall, B.; Andersen, M.; Owens, J.D.	*Assessing the Effect of Large Igneous Provinces on Global Oceanic Redox Conditions Using Non-traditional Metal Isotopes (Molybdenum, Uranium, Thallium)*	Large Igneous Provinces: A Driver of Global Environment al and Biotic Changes			305--323	10.1002/97811195074 44.ch13	Yes
Li, Z.; Cole, D.; Newby, S.; Owens, J.D.; Kendall, B.; Reinhard, C.	*New constraints on mid-Proterozoic ocean redox from stable thallium isotope systematics of black shales*	Geo-chimica et Cosmo-chimica Acta	315		185-206	10.1016/j.gca.2021.09 .006	Yes
Newby, S.; Owens, J.D.; Schoepfer, S.; Algeo, T.	*Transient ocean oxygenation at end-Permian mass extinction onset shown by thallium isotopes*	Nature Geoscience	14	9	678--683	10.1038/s41561-021-00802-4	Yes
Qian, S.; Gazel, S.; Nichols, A.; Cheng, H.; Zhang, L.; Salters, V.J.; Li, J.; Xia, X.; Zhou, H.	*The Origin of Late Cenozoic Magmatism in the South China Sea and Southeast Asia*	Geochemis-try, Geo-physics, Ge-osystems	22		0	10.1029/2021GC0096 86	No*

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Rader, S.; Gaschnig, R.; Newby, S.; Bebout, G.; Mirakian, M.; Owens, J.D.	*Thallium behavior during high-pressure metamorphism in the Western Alps, Europe*	Chemical Geology			120349	10.1016/j.chemgeo.2021.120349	Yes
Sanfilippo, A.; Salters, V.J.; Sokolov, S.; Peyve, A.; Stracke, A.	*Ancient refractory asthenosphere revealed by mantle re-melting at the Arctic Mid Atlantic Ridge*	Earth and Planetary Science Letters	566		116981	10.1016/j.epsl.2021.116981	Yes
Sun, F.; Wang, Y.; Jablonski, N.; Hou, S.; Ji, X.; Wolff, B.H.; Tripati, A.; Cao, J.; Yang, X.	*Paleoenvironment of the Late Miocene Shuitangba hominoids from Yunnan, Southwest China: Insights from stable isotopes.*	Chemical Geology	569		120123	10.1016/j.chemgeo.2021.120123	Yes
Tschauner, O.; Huang, S.; Yang, S.; Humayun, M.; Liu, W.; Corder, S.N.G.; Bechtel, H.A.; Tischler, J.; Rossman, G.R.	*Discovery of davemaoite, $CaSiO_3$-perovskite, as a mineral from the lower mantle.*	Science	374	6569	891-894	10.1126/science.abl8568	Yes
Turner, S.; McGee, L.; Humayun, M.; Creech, J.; Zanda, B.	*Carbonaceous chondrite meteorites experienced fluid flow within the past million years.*	Science	371		164-167	10.1126/science.abc8116	Yes
van Ginneken, M.; Goderis, S.; Artemieva, N.; Debaille, V.; Decrée, S.; Harvey, R.P.; Huwig, K. A.; Hecht, L.; Yang, S.; Kaufmann, F.E.D.; Soens, B.; Humayun, M.; van Maldeghem, F.; Genge, M.; Claeys, P.	*A large meteoritic event over Antarctica ca. 430 ka ago inferred from chondritic spherules from the Sør Rondane Mountains.*	Science Advances	7		eabc1008	10.1126/sciadv.abc1008	Yes
Wang, Y.; Passey, B.; Roy, R.; Deng, T.; Jiang, S.; Hannold, C.D.; Wang, X.; Lochner, E.; Tripati, A.	*Clumped isotope thermometry of modern and fossil snail shells from the Himalayan-Tibetan Plateau: Implications for paleoclimate and paleoelevation reconstructions.*	Geological Society of America Bulletin	133	7-8	1370 1380	10.1130/B35784.1	Yes

Note: *This is an editorial that does not cite the NSF due to its type of publication.

5.12 PUBLICATIONS GENERATED BY MBI AT UF (47)

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Bo, K.; Yin, S.; Liu, Y.; Hu, Z.; Meyyappan, S.; Kim, S.; Keil, A.; Ding, M.	*Decoding Neural Representations of Affective Scenes in Retinotopic Visual Cortex*	Cerebral Cortex	31	6	3047--3063	10.1093/cercor/bhaa411	No
Bottari, S.; Lamb, D.; Murphy, A.; Porges, E.; Rieke, J.; Harciarek, M.; Datta, S.; Williamson, J.	*Hyperarousal symptoms and decreased right hemispheric frontolimbic white matter integrity predict poorer sleep quality in combat-exposed veterans*	Brain Injury	35	8	922-933	10.1080/02699052.2021.1927186	No
Boutzoukas, E.; O'Shea, A.; Albizu, A.; Evangelista, N.; Hausman, H.; Kraft, J.; Van Etten, E.; Bharadwaj, P.; Smith, S.; Song, H.; Porges, E.; Hishaw, A.; DeKosky, S.; Wu, S.; Marsiske, M.; Alexander, G.; Cohen, R.; Woods, A.J.	*Frontal White Matter Hyperintensities and Executive Functioning Performance in Older Adults*	Frontiers in Aging Neuro-science	13		672535	10.3389/fnagi.2021.672535	No
Chaarani, B.; Hahn, S.; Allgaier, N.; Adise, S.; Owens, M.; Juliano, A.; Yuan, D.; Loso, H.; Ivanciu, A.; Albaugh, M.; Dumas, J.; Mackey, S.; Laurent, J.; Ivanova, M.; Hagler, D.; Cornejo, M.; Hatton, S.; Cottler, L.; Nixon, S.; Striley, C.; Wiens, B.; Potter, A.; Garavan, H.	*Baseline brain function in the preadolescents of the ABCD Study*	Nature Neuro-science	24	8	621263	10.1038/s41593-021-00867-9	No
Chamberlain, J.; Gagnon, H.; Lalwani, P.; Cassady, K.; Simmonite, M.; Seidler, R.; Taylor, S.; Weissman, D.; Park, D.; Polk, T.	*GABA levels in ventral visual cortex decline with age and are associated with neural distinctiveness*	Neuro-biology of Aging	102		170--177	10.1016/j.neurobiolaging.2021.02.013	No
Chu, W.; Mitchell, T.; Foote, K.; Coombes, S.; Vaillancourt, D.	*Functional imaging of the brainstem during visually-guided motor control reveals visuomotor regions in the pons and midbrain*	NeuroImage: Clinical	226		117627	10.1016/j.neuroimage.2020.117627	No
Comi, G.; Niks, E.; Cinnante, C.; Kan, H.; Vandenborne, K.H.; Willcocks, R.; Velardo, D.; Ripolone, M.; van Benthem, J.; van de Velde, N.	*Characterization of patients with Becker muscular dystrophy by histology, magnetic resonance imaging, function, and strength assessments*	Muscle and Nerve	65	3	326-333	10.1002/mus.27475	No
Conner, L.; Horta, M.; Ebner, N.; Lighthall, N.	*Value network engagement and effects of memory-related processing during encoding and retrieval of value*	Brain and Cognition	152		105754	10.1016/j.bandc.2021.105754	No
Coppens, S.; Barnard, A.; Puusepp, S.; Pajusalu, S.; Ounap, K.; Vargas-Franco, D.; Bruels, C.; Donkervoort, S.; Pais, L.; Chao, K.; Pacak, C.; Walter, G.A.; Kang, P.	*A form of muscular dystrophy associated with pathogenic variants in JAG2*	The American Journal of Human Genetics	108	5	840--856	10.1016/j.ajhg.2021.03.020	No
Crowley, S.; Banan, G.; Amin, M.; Tanner, J.; Hizel, L.; Nguyen, P.; Brumback, B.;	*Statistically defined Parkinson's Disease executive and memory*	Journal of Parkinson's Disease	11	1	283-297	10.3233/JPD-202166	No

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Rodriguez, K.; McFarland, N.; Bowers, D.; Ding, M.; Mareci, T.H.; Price, C.	*cognitive phenotypes: demographic, behavioral, and structural neuroimaging comparisons*						
Cruz-Almeida, Y.; Coombes, S.; Febo, M.	*Pain differences in neurite orientation dispersion and density imaging measures among community-dwelling older adults*	Experimen-tal Gerontology	154		111520	10.1016/j.exger.2021.111520	No
Cruz-Almeida, Y.; Porges, E.	*Additional considerations for studying brain metabolite levels across pain conditions using proton magnetic resonance spectroscopy*	NeuroImage	224		117392	10.1016/j.neuroimage.2020.117392	No
Dayton, K.; Bril, F.; Barb, D.; Lai, J.; Kalavalapalli, S.; Cusi, K.	*Severity of non-alcoholic steatohepatitis is not linked to testosterone concentration in patients with type 2 diabetes*	PLoS ONE	16	6	e0251449	10.1371/journal.pone.0251449	No
Dion, C.; Tanner, J.; Crowley, S.; Wiggins, M.; Mareci, T.H.; Ding, M.; Price, C.; Manini, T.	*Functional connectivity of key resting state networks and objectively measured physical activity in older adults with joint pain: A pilot study*	Experimen-tal Gerontology	153		111470	10.1016/j.exger.2021.111470	No
Evangelista, N.; O'Shea, A.; Kraft, J.; Hausman, H.; Boutzoukas, E.; Nissim, N.; Albizu, A.; Hardcastle, C.; Van Etten, E.; Bharadwaj, P.; Smith, S.; Song, H.; G, H.; DeKosky, S.; Wu, S.; Porges, E.; Alexander, G.; Marsiske, M.; Cohen, R.; Woods, A.	*Independent Contributions of Dorsolateral Prefrontal Structure and Function to Working Memory in Healthy Older Adults*	Cerebral Cortex	31	3	1732--1743	10.1093/cercor/bhaa322	No
Finkel, R.; Finanger, E.; Vandenborne, K.H.; Sweeney, H.L.; Tennekoon, G.; Shieh, P.; Willcocks, R.; Walter, G.A.; Rooney, W.; Forbes, S.C.; Triplett, W.; Yum, S.W.; Mancini, M.; MacDougall, J.; Fretzen, A.; Bista, P.; Nichols, A.; Donovan, J.	*Disease-modifying effects of edasalonexent, an NF-κB inhibitor, in young boys with Duchenne muscular dystrophy: Results of the MoveDMD phase 2 and open label extension trial*	Neuro-muscular Disorders	31	5	385--396	10.1016/j.nmd.2021.02.001	No
Frazier, I.; Lin, T.; Liu, P.; Skarsten, S.; Feifel, D.; Ebner, N.	*Age and intranasal oxytocin effects on trust-related decisions after breach of trust: Behavioral and brain evidence.*	Psychology and Aging	36	1	10-21	10.1037/pag0000545	Yes
Gastaldelli, A.; Sabatini, S.; Carli, F.; Gaggini, M.; Bril, F.; Belfort-DeAguiar, R.; Positano, V.; Barb, D.; Kadiyala, S.; Harrison, S.; Cusi, K.	*PPAR-γ-induced changes in visceral fat and adiponectin levels are associated with improvement of steatohepatitis in patients with NASH*	Liver International	41	11	2659-2670	10.1111/liv.15005	No
Gawrieh, S.; Noureddin, M.; Loo, N.; Mohseni, R.; Awasty, V.; Cusi, K.; Kowdley, K.; Lai, M.; Schiff, E.; Parmar, D.; Patel, P.; Chalasani, N.	*Saroglitazar, a PPAR-α/γ Agonist, for Treatment of NAFLD: A Randomized Controlled Double-Blind Phase 2 Trial*	Hepatology	74	4	1809-1824	10.1002/hep.31843	No

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Gullett, J.; Albizu, A.; Fang, R.; Loewenstein, D.; Duara, R.; Rosselli, M.; Armstrong, M.; Rundek, T.; Hausman, H.; Dekosky, S.; Woods, A.; Cohen, R.	*Baseline Neuroimaging Predicts Decline to Dementia From Amnestic Mild Cognitive Impairment*	Frontiers in Aging Neuroscience	13		828	10.3389/fnagi.2021.758298	No
Hardcastle, C.; Hausman, H.; Kraft, J.; Albizu, A.; Evangelista, N.; Boutzoukas, E.; O'Shea, A.; Langer, K.; Van Van Etten, E.; Bharadwaj, P.; Song, H.; Smith, S.; Porges, E.; DeKosky, S.; Hishaw, G.; Wu, S.; Marsiske, M.; Cohen, R.; Alexander, G.; Woods, A.	*Higher-order resting state network association with the useful field of view task in older adults*	GeroScience			113783	10.1007/s11357-021-00441-y	No
Hui, S.; Mikkelsen, M.; Zollner, H.; Porges, E.C.; Rosenberg, J.T.; Woods, A.J.; Edden, R.A.E.; Nakajima, S.L.; Honda, S.	*Frequency Drift in MR Spectroscopy at 3T*	NeuroImage	241		118430	10.1016/j.neuroimage.2021.118430	No
Hupfeld, K.; Hyatt, H.; Jerez, P.; Mikkelsen, M.; Hass, C.; Edden, R.; Seidler, R.; Porges, E.	*In Vivo Brain Glutathione is Higher in Older Age and Correlates with Mobility*	Cerebral Cortex	31	10	4576-4594	10.1093/cercor/bhab107	Yes
Indahlastari, A.; Albizu, A.; Kraft, J.; O'Shea, A.; Nissim, N.; Dunn, A.; Carballo, D.; Gordon, M.; Taank, S.; Kahn, A.; Hernandez, C.; Zucker, W.; Woods, A.	*Individualized tDCS modeling predicts functional connectivity changes within the working memory network in older adults*	Brain Stimulation	14	5	1205--1215	10.1016/j.brs.2021.08.003	No
Johnson, A.; Wilson, A.; Laffitte Nodarse, C.; Montesino-Goicolea, S.; Valdes-Hernandez, P.; Somerville, J.; Peraza, J.; Fillingim, R.; Bialosky, J.; Cruz-Almeida, Y.	*Age Differences in Multimodal Quantitative Sensory Testing and Associations With Brain Volume*	Innovation in Aging	5	3	igab033	10.1093/geroni/igab033	Yes
Lopez, C.; Taivassalo, T.; Berru, M.G.; Saavedra, A.; Rasmussen, H.C.; Batra, A.; Arora, H.; Roetzheim, A.M.; Walter, G.A.; Vandenborne, K.; Forbes, S.C.	*Post-contractile blood oxygenation level-dependent (BOLD) response in Duchenne muscular dystrophy*	Journal of Applied Physiology	131	1	83-94	10.1152/japplphysiol.00634.2020	Yes
McGregor, H.; Lee, J.; Mulder, E.; De Dios, Y.; Beltran, N.; Kofman, I.; Bloomberg, J.; Mulavara, A.; Smith, S.; Zwart, S.; Seidler, R.	*Ophthalmic changes in a spaceflight analog are associated with brain functional reorganization*	Human Brain Mapping	42	13	4281-4297	10.1002/hbm.25546	No
Meyyappan, S.; Rajan, A.; Mangun, G.; Ding, M.	*Role of Inferior Frontal Junction (IFJ) in the Control of Feature versus Spatial Attention*	Journal of Neuro-science	41	38	8065--8074	10.1523/JNEUROSCI.2883-20.2021	No
Mitchell, T.; Lehericy, S.; Chiu, S.; Strafella, A.; Stoessl, A.; Vaillancourt, D.	*Emerging Neuroimaging Biomarkers Across Disease Stage in Parkinson Disease: A Review*	JAMA Neurology			154822	10.1001/jamaneurol.2021.1312	No
Nir, T.; Fouche, J.; Ananworanich, J.; Ances, B.; Boban, J.; Brew, B.; Chaganti, J.; Chang, L.; Ching, C.; Cysique, L.; Ernst, T.;	*Association of Immunosuppression and Viral Load With Subcortical Brain Volume in an*	JAMA Network Open	4	1	e2031190--e2031190	10.1001/jamanetworkopen.2020.31190	No

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Faskowitz, J.; Gupta, V.; Harezlak, J.; Heaps-Woodruff, J.; Hinkin, C.; Hoare, J.; Joska, J.; Kallianpur, K.; Kuhn, T.; Lam, H.; Law, M.; Lebrun-Frenay, C.; Levine, A.; Mondot, L.; Nakamoto, B.; Navia, B.; Pennec, X.; Porges, E.; Salminen, L.; Shikuma, C.; Surento, W.; Thames, A.; Valcour, V.; Vassallo, M.; Woods, A.; Thompson, P.; Cohen, R.; Paul, R.; Stein, D.; Jahanshad, N.	*International Sample of People Living With HIV*						
Nunez-Peralta, C.; Montesinos, P.; Alonso-Jimenez, A.; Alonso-Perez, J.; Reyes-Leiva, D.; Sanchez-Gonzalez, J.; Llauger-Rosello, J.; Segovia, S.; Belmonte, I.; Pedrosa, I.; Martinez-Noguera, A.; Matellini-Mosca, B.; Walter, G.A.; Diaz-Manera, J.	*Magnetization Transfer Ratio in Lower Limbs of Late Onset Pompe Patients Correlates With Intramuscular Fat Fraction and Muscle Function Tests*	Frontiers in Neurology	12		634766	10.3389/fneur.2021.634766	No
Oschwald, J.; Merillat, S.; Jancke, L.; Seidler, R.	*Fractional Anisotropy in Selected, Motor-Related White Matter Tracts and Its Cross-Sectional and Longitudinal Associations With Motor Function in Healthy Older Adults*	Frontiers in Human Neuro-science	15		621263	10.3389/fnhum.2021.621263	No
Porges, E.; Jensen, G.; Foster, B.; Edden, R.; Puts, N.	*The trajectory of cortical GABA across the lifespan, an individual participant data meta-analysis of edited MRS studies*	eLife	10		e62575	10.7554/eLife.62575	No
Quattrone, AN.; Antonini, A.; Vaillancourt, D.; Seppi, K.; Ceravolo, R.; Strafella, A.; Quattrone, AL.	*Reply to:Experience with a New Index to Differentiate Parkinson's Disease and Progressive Supranuclear Palsy*	Movement Disorders	36	9	2208--2209	10.1002/mds.28725	No
Rajan, A.; Meyyappan, S.; Liu, Y.; Samuel, I.; Nandi, B.; Mangun, G.; Ding, M.	*The Microstructure of Attentional Control in the Dorsal Attention Network*	Journal of Cognitive Neuro-science	33	6	965--983	10.1162/jocn_a_01710	No
Rieke, J.; Lamb, D.; Lewis, G.; Davila, M.; Schmalfuss, I.; Murphy, A.; Tran, A.; Bottari, S.; Williamson, J.	*Posttraumatic stress disorder subsequent to apparent mild traumatic brain injury*	Cognitive and behavioral neurology	34	1	26--37	10.1097/WNN.0000000000000264	No
Salazar, A.; Hupfeld, K.; Lee, J.; Banker, L.; Tays, G.; Beltran, N.; Kofman, I.; De Dios, Y.; Mulder, E.; Bloomberg, J.; Mulavara, A.; Seidler, R.	*Visuomotor Adaptation Brain Changes During a Spaceflight Analog With Elevated Carbon Dioxide (CO2): A Pilot Study*	Frontiers in Neural Circuits	15		51	10.3389/fncir.2021.659557	No
Schwartz, A.B.; Kapur, A.; Huang, Z.; Anangi, R.; Spear, J.M.; Stagg, S.; Fardone, E.; Dekan, Z.; Rosenberg, J.T.;	*Olfactory bulb targeted QD bioconjugate and Kv1.3 blocking peptide improve metabolic health in obese male mice*	Journal of Neuro-chemistry	157		1876-1896	10.1111/jnc.15200	Yes

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Grant, S.C.; King, G.F.; Mattoussi, H.; Fadool, D.A.							
Seider, T.R.; Porges, E.C.; Woods, A.J.; Cohen, R.A.	*Dedifferentiation of Functional Brain Activation Associated With Greater Visual Discrimination Accuracy in Middle-Aged and Older Adults*	Frontiers in Aging Neuro-science	13	651284	408	10.3389/fnagi.2021.651284	No
Staud, R.; Boissoneault, J.; Lai, S.; Mejia, M.S.; Ramanlal, R.; Godfrey, M.M.; Stroman, P.W.	*Spinal cord neural activity of patients with fibromyalgia and healthy controls during temporal summation of pain: an fMRI study*	Journal of Neuro-physiology	126	3	946--956	10.1152/jn.00276.2021	No
Tanner, J.; Johnson, A.; Terry, E.; Cardoso, J.; Garvan, C.; Staud, R.; Deutsch, G.; Deshpande, H.; Lai, S.; Addison, A.; Redden, D.; Goodin, B.; Price, C.; Fillingim, R.; Sibille, K.	*Resilience, pain, and the brain: Relationships differ by sociodemographics*	Journal of Neuro-science Research	99	5	1207--1235	10.1002/jnr.24790	Yes
Torres, V.; Rosselli, M.; Loewenstein, D.; Lang, M.; Velez-Uribe, I.; Arruda, F.; Conniff, J.; Curiel, R.; Greig, M.; Barker, W.; Vaillancourt, D.	*The Contribution of Bilingualism to Cognitive Functioning and Regional Brain Volume in Normal and Abnormal Aging*	Bilingualism: Language and Cognition	First View		1--20	10.1017/S1366728921000705	No
White, T.; Gonsalves, M.; Cohen, R.; Harris, A.; Monnig, M.; Walsh, E.; Nitenson, A.; Porges, E.; Lamb, D.; Woods, A.; Borja, C.	*The neurobiology of wellness: 1H-MRS correlates of agency, flexibility and neuroaffective reserves in healthy young adults*	NeuroImage	225		117509	10.1016/j.neuroimage.2020.117509	No
Wilkes, B.J.; DeSimone, J.C.; Liu, Y.; Chu, W.T.; Coombes, S.A.; Li, Y.; Vaillancourt, D.	*Cell-specific effects of Dyt1 knock-out on sensory processing, network-level connectivity, and motor deficits*	Experimen-tal Neurology	343		9	10.1016/j.expneurol.2021.113783	Yes
Willcocks, R.; Forbes, S.C.; Walter, G.A.; Sweeney, H.L.; Rodino-Klapac, L.; Mendell, J.; Vandenborne, K.H.	*Assessment of rAAVrh.74.MHCK7.micro-dystrophin Gene Therapy Using Magnetic Resonance Imaging in Children With Duchenne Muscular Dystrophy*	JAMA Network Open	4	1	e2031851--e2031851	10.1001/jamanetworkopen.2020.31851	Yes
Williamson, J.B.; Lamb, D.G.; Porges, E.C.; Bottari, S.; Woods, A.J.; Datta, S.; Langer, K.; Cohen, R.	*Cerebral metabolite concentrations are associated with cortical and subcortical volumes and cognition in older adults*	Frontiers in Aging Neuro-science	12		479	10.3389/fnagi.2020.587104	No
Ziaei, M.; Oestreich, L.; Reutens, D.; Ebner, N.	*Age-related differences in negative cognitive empathy but similarities in positive affective empathy*	Brain Structure and Function	226	6	1--18	10.1007/s00429-021-02291-y	No

5.13 PUBLICATIONS GENERATED BY UF PHYSICS (3)

Authors	Title	Journal Name	Vol	Issue	Pages	DOI	Cites NSF Core Grant
Chen, D.; Cai, S.; Hsu, N.; Huang, S.; Chuang, Y.; Nielsen, E.; Li, J.; Liu, C.; Lu, T.; Laroche, D.	*Density dependence of the excitation gaps in an undoped Si/SiGe double-quantum-well heterostructure*	Applied Physics Letters	119	22	223103	10.1063/5.0068538	Yes
Fortune, N.A.; Huang, Q.; Hong, T.; Ma, J.; Choi, E.S.; Hannahs, S.T.; Zhao, Z.Y.; Sun, X.F.; Takano, Y.; Zhou, H.D.	*Evolution of magnetic field induced ordering in the layered quantum Heisenberg triangular-lattice antiferromagnet Ba3CoSb2O9*	Physical Review B	103	18	184425	10.1103/PhysRevB.103.184425	Yes
Kumar, P.; Khare, A.; Saxena, A. B.	*A minimal non-linearity logarithmic potential:Kinks with super-exponential profiles*	International Journal of Modern Physics B	35	8	215	10.1142/S0217979221501149	No

5.14 BOOKS, CHAPTERS, REVIEWES AND OTHER ONE-TIME PUBLICATIONS (5)

Authors	Title	Facility
Johnson, K. W.	*Business and Management Internships: Improving Employability through Experiential Learning*	Education (NHMFL only)
Ngatia, L.; Moriasi, D.; Grace III, J.; Fu, R.; Gardner, C. and Taylor, R.	*Land use change affects soil organic carbon: An indicator of soil health.*	NMR Facility
Ngatia, L.W.; Moriasi, D.; Grance III, J.M. Fu, R.; Gardner, C.S.; and Taylor, R.W.	*Land Use Change Affects Soil Organic Carbon: An Indicator of Soil Health*	NMR Facility
Paglione, J.; Butch, N. P.; and Rodriguez, E. E., Editors	*Chapter 5: Induction Furnace Heating for Growth of Intermetallic Quantum Materials*	CMT/E
Yang, Y.; Fu, R.; Huo, H.	*NMR and MRI of Electrochemical Energy Storage Materials and Devices*	NMR Facility

5.15 INTERNET DISSIMINATIONS (8)

Authors	Title	Facility
Chai, Y.; Cong, J.; He, J.; Su, D.; Ding, X.; Singleton, J.; Zapf, V.; Sun, Y.	*Giant magnetostriction and nonsaturating electric polarization up to 60 T in the polar magnet CaBaCo4O7*	Pulsed Field Facility at LANL
Drichko, I.L.; Smirnov, I.Y.; Suslov, A.; Baldwin, K.W.; Pfeiffer, L.N. and West, K.W.	*Dresselhaus spin-orbit interaction in the p-AlGaAs/GaAs/AlGaAs structure with a square quantum well: Surface Acoustic Waves Study*	DC Field Facility
Götze, K.; Pearce, M. J.; Coak, M.; Goddard, P. A.; Grockowiak, A. D.; Coniglio, W. A.; Tozer, S. W.; Graf, D. E.; Maple, M. B.; Ho, P. C.; Brown, M. C.; Singleton, J	*Pressure-induced shift of effective Ce valence, Fermi energy and phase boundaries in CeOs4Sb12*	Pulsed Field Facility at LANL
Saiz, C.L.	*High Frequency Electron Spin Resonance Investigations On Quasi-Two-Dimensional Chromium Halide Magnets*	EMR Facility
Sato, Y.; Xiang, Z.; Kasahara, Y.; Kasahara, S.; Chen, L.; Tinsman, C.; Iga, F.; Singleton, J.; Nair, N. L.; Maksimovic, N.; Analytis, J.G.; Li, L.; Matsuda, Y.	*Topological surface conduction in Kondo insulator YbB12*	Pulsed Field Facility at LANL
Schepkin, V.D.	*Reveal Veggie MRI*	NMR Facility
Xiang, Z.; Chen, K.; Chen, L.; Asaba, T.; Sato, Y.; Zhang, N.; Zhang, D.; Kasahara, Y.; Iga, F.; Coniglio, W. A.; Matsuda, Y.; Singleton, J.; Li, L.	*Hall anomaly, quantum oscillations and possible Lifshitz transitions in Kondo insulator YbB12: evidence for unconventional charge transport*	Pulsed Field Facility at LANL
Ziji Xiang, Lu Chen, Kuan-Wen Chen, Colin Tinsman, Yuki Sato, Tomoya Asaba, Helen Lu, Yuichi Kasahara, Marcelo Jaime, Fedor Balakirev, Fumitoshi Iga, Yuji Matsuda, John Singleton, Lu Li	*Unusual high-field metal in a Kondo insulator*	Pulsed Field Facility at LANL

5.16 AWARDS (10)

Authors	Title	Facilities
Balicas, L.	*Referee/Panelist- National Science Foundation - Division of Materials Research*	CMT/E
Boebinger, G.	*Member of the National Academy of Sciences*	DC Field Facility, Pulsed Field Facility at LANL, CMT/E
Greene, L.	*Appointed to President's Council of Advisors on Science and Technology*	DC Field Facility, CMT/E
McKenna, A.M	*Florida State University Faculty Senator, NHMFL*	ICR Facility
Popovic, D.	*American Physical Society, Member-at-Large on the Executive Committee of the Division of Condensed Matter Physics*	DC Field Facility, CMT/E
Reed, K.	*ACS Undergraduate Student Award in Environmental Chemistry*	ICR Facility
Smith, K.	*Summer 2021 Travel Award*	ICR Facility
Villa, Carlos R.	*National Selection Committee (NSC) review panel for the 2021 Presidential Awards for Excellence in Mathematics and Science Teaching (PAEMST)*	Education (NHMFL only)

Villa, Carlos R.	*The Tallahassee Scientific Society Gold Medal Honoree*	Education (NHMFL only)
Zeng, Huadong	*University of Florida Superior Accomplishment Award - Division 5 (Health Colleges)*	AMRIS Facility at UF

5.17 M.S. DEGREES* (LOCAL) (10)

Authors	Title	Facility	University	Department
Bhagu, Jamini	*Probing the in-situ Conformation of Monoclonal Antibodies at Hydrophobic Interfaces Using NMR Spectroscopy*	NMR Facility	FAMU	Chemical & Biomedical Engineering
Britton, Mark	*HIV Serostatus and Alcohol Reduction Predict Reduction in Task-Related Visual Working Memory Network Activation*	AMRIS Facility at UF	UF	Psychology
Bush, Nicholas James	*Task-Dependent Functional Connectivity of Pain Related Brain Regions Is Related to the Magnitude of Placebo Analgesia*	AMRIS Facility at UF	UF	Psychology
Cooper, Jonathan	*Failure Analysis of High- Temperature Superconducting Magnets*	Applied Superconductivity Center	FSU	Applied Superconductivity Center
Farukanmi, Iyanu	*Pinewood decomposition: carbon, nitrogen and phosphorus dynamics after hurricane Michael at Chipola experimental forest*	NMR Facility	FAMU	College of Agriculture and Food Sciences
Karl, Adam	*Assessing water column and sedimentary redox conditions in the geographically isolated wetlands of the Munson Sand Hills*	Geochemistry Facility	FSU	Earth, Ocean and Atmospheric Science
Langer, Kailey	*Factors Predicting Chronological vs Brain Age Discrepancies in Healthy Older Adults*	AMRIS Facility at UF	UF	Psychology
Polk, Rebecca	*The Effect of Oxytocin on Mentalizing in Aging: A Brain-Behavior Analysis*	AMRIS Facility at UF	UF	Psychology
Sheikh, Daniel	*Trace Element Constraints on Processes and Precursors of Chondrule Formation in Unequilibrated Ordinary Chondrites.*	Geochemistry Facility	FSU	Earth, Ocean & Atmospheric Science
Small, Michael	*Study of the quality of laser and mechanically slit edges of REBCO superconducting tapes*	Applied Superconductivity Center	FSU	Mechanical Engineering

*No external M.S. Degree

5.18 PH.D. DEGREES (LOCAL) (15)

Authors	Title	Facility	University	Department
Bagdasarian, Frederick	*Stem Cell Treatments for Ischemic Stroke: Evaluating Cellular Dynamics with Diffusion MRI*	NMR Facility	FSU	Chemical & Biomedical Engineering
Baniani, Amineh	*Fundamental transport studies in novel porous media for industrial applications by NMR diffusometry*	AMRIS Facility at UF	UF	Chemical Engineering
Chappell, Greta	*Exploring the Hidden Order Magnetic Phase Space in URu2Si2 using Electronic Tuning via Chemical Substitution and Applied Pressure*	DC Field Facility, CMT/E	FSU	Physics
Chu, Winston	*Advances in Neuroimaging of an Alpha-Synuclein Mouse Model and Human Brainstem*	AMRIS Facility at UF	UF	Applied Physiology and Kinesiology
Curry-Pochy, Lisa	*Restricted, Repetitive Behavior in C58 Mice and the Role of the Subthalamic Nucleus*	AMRIS Facility at UF	UF	Psychology
Hike, David	*MRI-based Network Analysis of Rodent Brains in the Monitoring of Disease Progression and Treatment Efficacy*	NMR Facility	FSU	Chemical & Biomedical Engineering
Jahan, Shakura	*Reconstruction of Paleo-Storm History Using Geochemical Proxies in Coastal Lake*	Geochemistry Facility	FSU	Earth, Ocean and Atmospheric Science

Authors	Title	Facility	University	Department
	Sediments from the North and Northeastern Gulf Coastal Plain of Florida			
Miao, Zhihui	*Synthesis, Characterization, and Functionalization of Cyclic Polymers: from Cyclic Polyolefins to Semi-Conducting Cyclic Polyacetylene*	AMRIS Facility at UF	UF	Chemistry
Moon, Seongphill	*Magneto-optical studies of Dirac and Weyl semimetals*	DC Field Facility, CMT/E	FSU	Physics
Nelson, William	*Investigations of the f-electron state in novel crystalline environments*	DC Field Facility, CMT/E	FSU	Physics
Neu, Jennifer	*Nb2PdxSe5: Tuning Superconductivity, Electronic Properties and Structure with Pd Intercalation*	CMT/E	FSU	Physics
Ramakrishna, Sanath Kumar	*Probing Phase Transitions in Metal-Organic Framework Multiferroics Using Solid-State NMR*	NMR Facility	FSU	Chemistry and Biochemistry
Stanley, Lily	*Charge dynamics near phase transitions in two-dimensional systems*	CMT/E	FSU	Physics
Sun, Fajun	*Geochemical proxies preserved in fossils and lake sediments: New insights into ancient diets and environments in South China and storm activity in South Florida*	Geochemistry Facility	FSU	Earth, Ocean, and Atmospheric Science
Zhang, Shengzhi	*Observation of gap-like features in superconductors and heavy fermions via quasiparticle scattering and tunneling spectroscopies*	DC Field Facility, CMT/E	FSU	Physics

5.19 PH.D. DEGREES (EXTERNAL) (32)

Authors	Title	Facility	University	Department
Breindel, Alexander	*High Magnetic Field Investigations of Correlated Electron Quantum Materials.*	Pulsed Field Facility at LANL	University of California - San Diego	Physics
Carbonell Vilar, Jose Miguel	*Estudio de propiedades magnéticas en compuestos de coordinación multifuncionales*	EMR Facility	University of Valencia, Spain	Institute of Molecular Science
Chapai, Ramakanta	*Topological Properties in Selected Transition-Metal Pnictides and Chalcogenides*	DC Field Facility	Louisiana State University	Physics
Clune, Amanda	*Using applied field, pressure, and light to control magnetic states of materials*	DC Field Facility, Pulsed Field Facility at LANL	University of Tennessee	Chemistry
Dowdy, Kelsey	*Reframing Plant Invasion: Altered Watershed Biogeochemistry as a Cause and Consequence of Giant Reed Arundo Donax*	ICR Facility	University of California, Santa Barbara	Ecology, Evolution, and Marine Biology
Fu, Xiaojun	*Magnetotransport in two-dimensional electron systems at high Landau levels*	DC Field Facility	University of Minnesota	School of Physics and Astronomy
Hameed, Sajna	*Investigation of emergent phenomena in quantum materials induced via chemical substitution, plastic deformation and ionic-liquid gating*	DC Field Facility	University of Minnesota	School of Physics and Astronomy
Hartstein, Mate	*Fermi Surfaces and Where to Find Them: Quantum Oscillations in Kondo Insulators and High-Temperature Superconductors*	DC Field Facility, Pulsed Field Facility at LANL	University of Cambridge	Cavendish Laboratory
Hermes, Anna	*Revealing Modern Sulfur Cycle Change: The Biogeochemical Fingerprint of Agricultural Sulfur from Field-to-watershed Scales*	ICR Facility	University of Colorado, Boulder	Environmental Studies Program
Huang, Danny	*The mechanical properties of Y-Ba-Cu-O and Gd-Ba-Cu-O/Ag bulk superconductor magnets*	DC Field Facility	University of Cambridge	Engineering

Authors	Title	Facility	University	Department
Kirui, Alex	*Functional Structure of Biomacromolecules in Plant Biomass Using Solid-State NMR and Dynamic Nuclear Polarization,*	NMR Facility	Louisiana State University	Chemistry
Kleimaier, Dennis	*Exploring Protein Interactions with23Na Triple-quantum MRS and1H Chemical Exchange Saturation Transfer MRI*	NMR Facility	the Ruperto-Carola University of Heidelberg, Germany	Combined Faculties for the Natural Sciences and for Mathematics
LaBarre, Patrick	*Experimental Manifestations of Topology and the Development of a Non-Local Conductivity Apparatus*	DC Field Facility	University of California, Santa Cruz	Physics
Meng, Xinxing	*Improving the Performance of Magnetic Resonance Systems using Feedback Control*	DC Field Facility, NMR Facility	The Pennsylvania State University	Electrical Engineering
Mosiman, Daniel Mosiman	*Probing Structure-Property Relationships of Hydroxyapatite Defluoridation to Enhance Performance*	NMR Facility	University of Illinois at Urbana-Champaign	Civil and Environmental Engineering
Mottaghi, Navid	*Magnetic Properties of LSMO/STO Thin Films: Magnetocaloric, Spin Dynamics and Magnetic Viscosity Investigations*	DC Field Facility	West Virginia University	Physics
Munir, Riffat	*Unusual superconductivity in topological nodal line semimetals*	DC Field Facility	University of Central Florida	Physics
Patzner, Monique Sézanne	*Microbial Iron Cycling in Permafrost Peatlands Affected by Global Warming - Impact on Carbon Mobilization and Greenhouse Gas Emissions*	ICR Facility	University Tuebingen	Department of Geosciences
Precker, Christian Eike	*Superconducting Effects in the Electrical Transport Properties of Graphite*	DC Field Facility, Pulsed Field Facility at LANL	Leipzig University	Division of Superconductivity and Magnetism
Rosen, Ilan	*Transport in Gapped Topological Surface States*	DC Field Facility	Stanford University	Applied Physics
SantaLucia, Daniel	*Investigations of the Electronic Structures of Multimetallic Iron-Chalcogenide Clusters and Five-Coordinate Cobalt Complexes*	DC Field Facility, EMR Facility	University of Wisconsin, Madison	Chemistry
Seckler, Henrique	*Apolipoprotein Proteoforms and Their Association with Cardiometabolism*	ICR Facility	Northwestern University	Chemistry
Siddiquee, KAM Hasan	*Superconductivity and topological properties in a topological semimetal*	DC Field Facility	University of Central Florida	Physics
Steinhardt, William	*Investigating the Magnetic Properties of Triangular Lattice Systems*	DC Field Facility, Pulsed Field Facility at LANL	Duke University	Physics
Stiller, Markus	*Defect induced magnetism in TiO2*	DC Field Facility, Pulsed Field Facility at LANL	University Leipzig	Physics
Sulekha, Anamika	*Disulphide Locking: Contrasting Effects on Disparate Proteins*	NMR Facility	Dalhousie University	Biochemistry & Molecular Biology
Tan, Chunhua	*NMR J Coupling Measurement Methods and Their Applications in Biological Tissues and Solid Samples*	NMR Facility	Xiamen University	Department of Electronic Science
Xin,Yizhou	*Nuclear Magnetic Resonance Study of Magnetism in NaFe1−xCuxAs Single Crystals*	DC Field Facility	Northwestern University	Physics
Yang, Chunjie	*Novel Electromagnetic Responses in Topological Semimetals*	DC Field Facility	Boston College	Physics
You, Jung Sang	*Thermoelectric Transport Properties of Correlated van der Waals Materials*	DC Field Facility	POSTECH	Physics

Authors	Title	Facility	University	Department
Zeng, Yihang	*Study of Two-dimensional Correlated Quantum Fluid in Multi-layer Graphene System*	DC Field Facility	Columbia University	Physics
Ziegler, Eric	*The aqueous stability of N-acyl-L-homoserine lactones, their affinity for cyclodextrin inclusion, and the investigation of a catalyst for their hydrolysis*	AMRIS Facility at UF	Florida Institute of Technology	Chemistry

APPENDIX 1 – PERSONNEL

Data as of January 3, 2022

APPLIED SUPERCONDUCTIVITY CENTER - ASC

First Name	Last Name	Title
Dmytro	Abraimov	Research Faculty III
Natalie	Arnett	Associate Professor
Shreyas	Balachandran	Visiting Research Faculty I
Audra	Barnes	Research Assistant
Shaon	Barua	Graduate Research Assistant
Ernesto	Bosque	Research Faculty II
Griffin	Bradford	Graduate Research Assistant
Tauben	Brenner	Laboratory Assistant / Technician
Alexander	Cairns	Laboratory Assistant / Technician
Najib	Cheggour	Research Faculty II
Santosh	Chetri	Graduate Research Assistant
Lance	Cooley	ASC Director/Professor
Robert	Craig	Affiliate
Kadisha	Culpepper	Graduate Research Assistant
Daniel	Davis	Postdoctoral Associate
Charles	English	Research Engineer
Ashleigh	Francis	Graduate Research Assistant
James	Gillman	Research Engineer
Van	Griffin	Sr. Research Associate
Seungyong	Hahn	Professor
Kayla	Hancock	Office Assistant
Eric	Hellstrom	Professor
Andres	Hernandez Chapa	Laboratory Assistant / Technician
S Imam	Hossain	Graduate Research Assistant
Jianyi	Jiang	Research Faculty III
Andre	Juliao	Graduate Research Assistant
Fumitake	Kametani	Associate Professor
Youngjae	Kim	Research Faculty II
Elzbieta	Krekora	Laboratory Assistant / Technician
Jozef	Kvitkovic	Sr. Research Associate
David	Larbalestier	Chief Materials Scientist
Jonathan	Lee	Graduate Research Assistant
Peter	Lee	Research Faculty III
Shah Alam	Limon	Graduate Research Assistant
Connie	Linville	Sr. Administrative Specialist
Emma	Martin	Laboratory Assistant / Technician
D'Andra	Moxey	Graduate Research Assistant
Ryker	Mullinix	Graduate Research Assistant
Abiola	Oloye	Graduate Research Assistant
Yavuz	Oz	Postdoctoral Associate
Sastry	Pamidi	Associate Professor, Electrical & Computing Engineering; Associate Director, Center for Advanced Power Systems
Nawaraj	Paudel	Graduate Research Assistant
Virginia	Phifer	Graduate Research Assistant
Anatolii	Polyanskii	Magneto Optical Research Specialist
Felicia	Rogers	Administrative Support Specialist
Michael	Small	Graduate Research Assistant
William	Starch	Sr. Research Associate
Chiara	Tarantini	Research Faculty III
John	Tietsworth	Laboratory Assistant / Technician
Ulf	Trociewitz	Research Faculty III
Brian	Vail	Laboratory Assistant- Level 1

First Name	Last Name	Title
Benjamin	Walker	Research Associate II
Wenura	Withanage	Postdoctoral Associate
Aixia	Xu	Visiting Scientist/Researcher

CIMAR

First Name	Last Name	Title
Adam	Altenhof	Graduate Research Assistant
Lissa	Anderson	Research Faculty I
Benhur	Asefaw	Graduate Research Assistant
Heather	Barnes	Program Assistant
Jamini	Bhagu	Graduate Research Assistant
Gregory	Blakney	Research Faculty II
Ashley	Blue	Technical/Research Designer
Shefik	Bowen	Graduate Research Assistant
William	Brey	Research Faculty III
Eric	Breynaert	Visiting Scientist/Researcher
David	Butcher	Research Faculty I
Martha	Chacon Patino	Research Faculty I
Huan	Chen	Research Faculty I
Yudan	Chen	Postdoctoral Associate
Joseph	Collins	Scientific Research Specialist
Timothy	Cross	Professor
Cameron	Davis	Undergraduate Research Assistant
Michael	Deck	Graduate Research Assistant
Mary	Desilets	Administrative Support Assistant
Zachary	Dowdell	Graduate Research Assistant
Malathy	Elumalai	Associate In Research
Grisel	Fierros Romero	Graduate Research Assistant
Carl	Fleischer III	Graduate Student
Lucio	Frydman	Chief Scientist for Chemistry & Biology
Joseph	Frye	Graduate Research Assistant
Riqiang	Fu	Research Faculty III
Zhehong	Gan	Research Faculty III
Taylor	Glattke	Graduate Research Assistant
Blaine	Gordon	Graduate Research Assistant
Peter	Gor'kov	Sr. Research Associate
Samuel	Grant	Professor
Daniel	Hallinan	Associate Professor
Julia	Hartzog	Undergraduate Student
Shannon	Helsper	Graduate Research Assistant
Christopher	Hendrickson	Research Faculty III/Director of ICR Program
Samuel	Holder	Graduate Research Assistant
Sean	Holmes	Postdoctoral Associate
Taylor	Howard	Graduate Research Assistant
Wenhao	Hu	Graduate Research Assistant
Yan-Yan	Hu	Assistant Professor
Ivan	Hung	Associate in Research
Krista	Jemmott	Program Associate
Richard	Jeske	Research Assistant
Yongkang	Jin	Graduate Research Assistant
Taylor	Johnston	Graduate Research Assistant
James	Kimball	Graduate Research Assistant
Jason	Kitchen	NMR Engineer
Yuan	Lin	Graduate Research Assistant
Brittany	Lindsay	Graduate Research Assistant
Ilya	Litvak	Associate in Research
Haoyu	Liu	Graduate Research Assistant
Jie	Lu	Assistant in Research
Wenping	Mao	Visiting Assistant In Research
Alan	Marshall	Professor, Chief Scientist for Ion Cyclotron Resonance (ICR) and Robert O. Lawton Distinguished Professor of Chemistry
Amy	McKenna	Research Faculty III
Frederic	Mentink-Vigier	Research Faculty II

First Name	Last Name	Title
Hadi	Mohammadigoushki	Assistant Professor
Lisa	Monluc	Graduate Research Assistant
Kimberly	Mozolic	Sr Administrative Specialist
Sydney	Niles	Graduate Research Assistant
Mojtaba	Nouri Goukeh	Graduate Research Assistant
Melaine	Oliveira Couch	Postdoctoral Associate
Sawankumar	Patel	Graduate Research Assistant
Austin	Peach	Graduate Research Assistant
Zeljka	Popovic	Graduate Research Assistant
Tej	Poudel	Graduate Research Assistant
Jonathan	Putman	Graduate Research Assistant
Huajun	Qin	Associate in Research
David	Quezada Estrada	Graduate Research Assistant
John	Quinn	Research Engineer
Jenna	Radovich	Undergraduate Student
Steven	Ranner	Research Engineer
Ralm	Ricarte	Assistant Professor
Dayna	Richter	Graduate Research Assistant
Ryan	Rodgers	Research Faculty III
Jazmine	Sanchez	Graduate Research Assistant
Victor	Schepkin	Research Faculty II
Jasmin	Schoenzart	Graduate Research Assistant
Robert	Schurko	NMR Program Director, Professor of Chemistry
Faith	Scott	Postdoctoral Associate
Robert	Silvers	Assistant Professor
Karl	Smith	Postdoctoral Associate
Robert	Smith	Graduate Student
Ermias	Tesfamariam	Graduate Research Assistant
Jeremy	Thomas	Graduate Research Assistant
Erica	Truong	Graduate Research Assistant
Cameron	Vojvodin	Postdoctoral Associate
Pengbo	Wang	Graduate Research Assistant
Chad	Weisbrod	Research Faculty I
Sungsool	Wi	Research Faculty II
Yijue	Xu	Postdoctoral Associate
Rongfu	Zhang	Postdoctoral Associate

CONDENSED MATTER SCIENCE – CMS

First Name	Last Name	Title
Moein	Adnani	Postdoctoral Associate
Thomas	Albrecht-Schmitt	Professor
Jamel	Ali	Assistant Professor
Petru	Andrei	Associate Professor
Nafiza	Anjum	Graduate Research Assistant
Luis	Balicas	Research Faculty III
Alimamy	Bangura	Research Faculty II, User Technical Support Chief
Kevin	Barry	Graduate Research Assistant
Abhisek	Basu	Postdoctoral Associate
Rogelio	Baucells	Research Assistant
Ryan	Baumbach	Research Faculty I
Christianne	Beekman	Associate Professor
Shermane	Benjamin	Research Faculty I
Anish	Bhardwaj	Graduate Research Assistant
Alexander	Bieber	Graduate Research Assistant
Nicholas	Bonesteel	Professor of Physics
Nicole	Burnett	Graduate Research Assistant
Ian	Campbell	Graduate Research Assistant
Jianming	Cao	Professor of Physics
Brian	Casas	Postdoctoral Associate
Abigail	Centers	Research Assistant
Shantanu	Chakraborty	Postdoctoral Associate
Hitesh	Changlani	Assistant Professor
Benjamin	Chen	Technician
Shalinee	Chikara	Research Faculty I
Irinel	Chiorescu	Professor
Eun Sang	Choi	Research Faculty III
Wei-Hao	Chou	Graduate Research Assistant
Josiah	Cochran	Graduate Research Assistant
William	Coniglio	Research Faculty I
Jakob	Consoliver-Zack	Graduate Research Assistant
Songbin	Cui	Postdoctoral Associate
Naresh	Dalal	Professor of Chemistry
Melissa	Davis	Graduate Research Assistant
Haoyun	Deng	Graduate Research Assistant
Sanjay Kumar	Devendhar Singh	Postdoctoral Associate
Marissa	Dickerson	Research Assistant
Vladimir	Dobrosavljevic	Professor of Physics
Thierry	Dubroca	Visiting Research Faculty
Lloyd	Engel	Research Faculty III
Paul	Eugenio	Research Assistant
Vincent Obiozo	Eze	Postdoctoral Associate
Catherine	Fabiano	Graduate Research Assistant
Piotr	Fajer	Professor
Nathaniel	Falb	Research Assistant
Aubrey	Farrell	Graduate Research Assistant
Keke	Feng	Graduate Research Assistant
Aikaterini Katafygi	Flessa Savvidou	Graduate Research Assistant
Giovanni	Franco-Rivera	Graduate Research Assistant
Daniel	Fredin	Microscopist
Delaney	Freeman	Research Assistant
Matthew	Freeman	Graduate Research Assistant
Alexander	Fryer	REU 21 Participant
Miguel	Gakiya	Graduate Research Assistant
Jorge	Galeano Cabral	Graduate Research Assistant
Kersten	Galeta	Research Assistant
Hanwei	Gao	Assistant Professor

First Name	Last Name	Title
Nathaniel	Garceau	Graduate Research Assistant
Gary	Germanton	Research Assistant
Madilyn	Getz	Research Assistant
Anna	Gilliard	Research Assistant
David	Gordon	Research Assistant
David	Graf	Research Faculty II
Saliya	Grandison	Research Assistant
Bertram	Green	Research Faculty I
Elizabeth	Green	Research Faculty I
Tyler	Gregory	Graduate Research Assistant
Brittany	Grimm	Graduate Research Assistant
Wei	Guo	Professor
Aakash	Gupta	Graduate Research Assistant
Arijit	Gupta	Graduate Research Assistant
Clemente	Guzman	Graduate Research Assistant
Manoj Vinayaka	Hanabe Subramanya	Graduate Research Assistant
Bobby	Haney	Research Assistant
Kiram	Harrison	Research Assistant
Stephen	Hennigar	Assistant Professor
Chiraz	Hicheri	Research Assistant
Stephen	Hill	Professor/EMR Director
Wai-Ga	Ho	Graduate Research Assistant
Jade	Holleman	Graduate Research Assistant
Md. Alamgir	Hossain	Graduate Research Assistant
Chen	Huang	Assistant Professor
Robert	Huber	Research Assistant
Mikai	Hulse	Graduate Research Assistant
Sean	Jackson	Research Assistant
Jan	Jaroszynski	Research Faculty II
Arshad	Javed	Grants Compliance Analyst
Sophie	Jermyn	Research Assistant
Lin	Jiao	Research Faculty I
Claire	Jolowsky	Graduate Research Assistant
Brendon	Jones	Graduate Research Assistant
Toshiaki	Kanai	Graduate Research Assistant
Mehmet	Kaplan	Graduate Research Assistant
Shannon	Kelley	Research Assistant
Sangsoo	Kim	Graduate Research Assistant
Jason	King	Research Assistant
Alexey	Kovalev	Associate in Research
Balaji	Krishna Kumar	Postdoctoral Associate
Jurek	Krzystek	Research Faculty III
Krishnendu	Kundu	Postdoctoral Associate
Matthew	Kurilich	Graduate Research Assistant
Jason	Kuszynski	Research Assistant
Ashlyn	Langford	Research Assistant
Denis	Le	Research Assistant
Kyungmin	Lee	Postdoctoral Associate
Haoran	Li	Graduate Research Assistant
Victoria	Li	Graduate Research Assistant
Mengtian	Liu	Graduate Research Assistant
Eric	Lochner	Research Faculty II
Renee	Luallen	Program Coordinator
Daphne	Lubert-Perquel	Postdoctoral Associate
Biwu	Ma	Associate Professor
Kwok Wai	Ma	Postdoctoral Associate
Efstratios	Manousakis	Professor
Pengsu	Mao	Graduate Research Assistant

First Name	Last Name	Title
Yating	Mao	Graduate Research Assistant
Masoud	Mardani	Graduate Research Assistant
Bianca	Marius	Technician
Gabrielle`	Mayans	Research Assistant
Stephen	McGill	Research Faculty II
Peter	McGoron	Research Assistant
Lauren	McNealy	REU 21 Participant
Lingrui	Mei	Graduate Research Assistant
Ronald	Melendrez	Graduate Research Assistant
Sophie	Merchant	Research Assistant
Katelyn	Miller	Graduate Research Assistant
Mainak	Mookherjee	Assistant Professor
Alex	Moon	Graduate Research Assistant
Shirin	Mozaffari	Postdoctoral Associate
Timothy	Murphy	Director, DC Field Facility
Samantha	Myers	Research Assistant
William	Nelson	Graduate Research Assistant
Jennifer	Neu	Graduate Research Assistant
Guangxin	Ni	Assistant Professor
Paige	Nielsen	Research Assistant
Lea	Nienhaus	Assistant Professor
Natalija	Nikolic	Research Assistant
William	Oates	Assistant Professor
Olatunde	Oladehin	Graduate Research Assistant
Andrzej	Ozarowski	Research Faculty II
Mykhaylo	Ozerov	Research Faculty I
Jeongmin	Park	Postdoctoral Associate
Jin Gyu	Park	Associate in Research, Ph. D
Wan Kyu	Park	Research Faculty II
Keely	Paul	UROP program
Bal	Pokharel	Graduate Research Assistant
Dragana	Popovic	Research Faculty III
Nihar	Pradhan	Visiting Research Faculty I
Sean	Psulkowski	Research Assistant
David	Quashie Jr	Graduate Research Assistant
Aisha	Qureshi	Administrative Assistant
Sanath Kumar	Ramakrishna	Graduate Research Assistant
Subramanian	Ramakrishnan	Associate Professor
Fernando	Ramos-Diaz	REU 21 Participant
Milan	Rede	Graduate Research Assistant
Shane	Reed	Research Assistant
Arneil	Reyes	Research Faculty III
MariaPia	Ricossa	Research Assistant
Angel	Rosado-Trinidad	Graduate Research Assistant
Alexander	Roubos	Graduate Research Assistant
Elvin	Salerno	Postdoctoral Associate
Hamid	Sanavandi	Graduate Research Assistant
Govind	Sasi Kumar	Graduate Research Assistant
Mary Jean	Savitsky	Research Assistant
Madison	Sayles	Research Assistant
Pedro	Schlottmann	Professor
John	Schlueter	Visiting Scientist/Researcher
Benny	Schundelmier	Graduate Research Assistant
Annie	Scutte	Research Assistant
Shivani	Sharma	Postdoctoral Associate
Prakash	Sharma	Graduate Research Assistant
Mykhailo	Shatruk	Assistant Professor
Theo	Siegrist	Professor

First Name	Last Name	Title
Ayomide	Sijuade	Graduate Research Assistant
Dmitry	Smirnov	Research Faculty III
Julia	Smith	Research Faculty I
Likai	Song	Research Faculty II
Lily	Stanley	Graduate Research Assistant
Robert	Stewart	Graduate Research Assistant
Sebastian	Stoian	Assistant Professor
Alexey	Suslov	Research Faculty III
Yuting	Tan	Graduate Research Assistant
Yuan	Tang	Postdoctoral Associate
Jasminka	Terzic	Postdoctoral Associate
Komalavalli	Thirunavukkuarasu	Assistant Professor at FAMU
Bikash	Timalsina	Graduate Research Assistant
Sergio	Torino	Research Assistant
Stanley	Tozer	Research Faculty III
Bianca	Trociewitz	Research Engineer
Pak Ki	Tsang	Graduate Research Assistant
Oguz	Turker	Postdoctoral Associate
Okten	Ungor	Graduate Research Assistant
Oskar	Vafek	Professor of Physics, Director, CMS-Theory
Johan	van Tol	Research Faculty III
Taylor	Vanderlinden	Research Assistant
Matthew	Wadsworth	Graduate Research Assistant
Jiabao	Wang	Graduate Research Assistant
Qi	Wang	Research Assistant
Youcheng	Wang	Postdoctoral Associate
Yuxin	Wang	Graduate Research Assistant
Ruojun	Wang	Graduate Research Assistant
Xiaoyu	Wang	Postdoctoral Associate
Kaya	Wei	Research Faculty I
Ty	Wilson	Research Assistant
Li	Xiang	Postdoctoral Associate
Kaitai	Xiao	Graduate Research Assistant
Peng	Xiong	Professor
Kun	Yang	Professor of Physics
Sandugash	Yergeshbayeva	Graduate Research Assistant
Tsegai	Yhdego	Graduate Research Assistant
Zhibin	Yu	Assistant Professor
Changchun	Zeng	Assistant Professor
Biwen	Zhang	Graduate Research Assistant
Mei	Zhang	Associate Professor
Wenkai	Zheng	Graduate Research Assistant
Haidong	Zhou	Visiting Research Faculty I

DC INSTRUMENTATION – DC INST

First Name	Last Name	Title
Heinrich	Boenig	Engineer
William	Brehm	Technician/Research Designer
Troy	Brumm	User Technical Support
Robert	Carrier	Technical/Research Designer
Bryon	Dalton	Head of Magnet Operations
Daniel	Freeman	Technical/Research Designer
Larry	Gordon	Control Room Operator
Scott	Hannahs	Director for Scientific Instrumentation and Operations
Michael	Hicks	Technical/Research Designer
Glover	Jones	Scientific Research Specialist
Scott	Maier	Scientific Research Specialist
Daniel	McIntosh	Scientific Research Specialist
Jonathan	Melendez	Technical/Research Designer
Robert	Nowell	Scientific Research Specialist
Joel	Piotrowski	Control Room Operator
James	Powell	Electronics Engineer
Bobby	Pullum	Scientific & Research Technician
Harsha	Ravindra	Associate in Research
Edward	Rubes	Scientific Research Specialist
Dmitry	Semenov	Scientific Research Specialist
David	Sloan	Technician/Research Designer
Eric	Stiers	Research Engineer
Christopher	Thomas	Control Room Operator
Jesus	Torres Camacho	Technical/Research Designer
Sujana Sri Venkat	Uppalapati	Scientific Research Specialist
Mark	Vanderlaan	Research Engineer, Cryogenic Operations
Vaughan	Williams	Research Engineer

DIRECTOR'S OFFICE – DIR OFFICE

First Name	Last Name	Title
Raymond	Allen	FSU Fire Tech
Norman	Anderson	VP Research
Benjamin	Arline	Asst Chem Safety Officer
Sara	Bell	Asst. Lab Animal Technician
Stephen	Bilenky	Videographer
Gregory	Boebinger	Director, Professor of Physics
Thomas	Brasher	Fire Systems Technician
Jeffrey	Braunwart	Assistant Director, Science & Research (Safety Director)
Rodney	Brimm	Asst. Lab Animal Technician
Alfie	Brown	Industrial Safety & Health Engineer
Crystal	Brown	Assistant Lab Animal tech
Michael	Bryan	Fire Safety Tech
Terry	Clark	Asst Lab Animal Technician
Charles	Coshatt	Assistant Animal Lab Tech
Mary	Creason	Fire Code Inspector
Andrew	Davis	Asst Chemical Safety Officer
Tom	Deckert	Building Code, Assistant Director Environmental Health & Safety Campus
Darren	Dime	FSU Fire Tech
Stephen	Dyal	Critical Systems Technician
Janet	Fryman	Training Coordinator Environmental Health & Safety
Corey	Furbee	Fire Tech
Murray	Gibson	Visiting Scientist/Researcher
Laymon	Gray	Assistant Director Safety & Security
Alvin	Haire	Receptionist
Debin	Hammons	Receptionist
Glenda	Herrera-Gray	Occ Health & Safety Specialist
William	Hill	Director of LAR
Kurt	Hodges	Coordinator, Animal Welfare Compliance
Andy	Howard	Deputy Building Official
Matt	Howell	Fire Systems Technician
Roxanne	Hughes	Director, Center for Integrating Research and Learning
Kawana	Johnson	Research Faculty II
Jason	Johnson	Radiation Safety Officer
Mark	Klawinski	Industrial Hygienist
Richard	Le	Biological Safety Officer
Neely	Lewis	Building Code Inspector
Joshua	Maleszewski	Biological Safety Assistant
Matthew	Maleszewski	Safety Assistant
Jason	Marconnet	Industrial Hygienist
Megan	Maxton	Research Assistant
Caroline	McNiel	Graphic Designer
Albert	Migliori	Staff Member and LANL Fellow
Seyedehsahar	Mohammadi	Industrial Safety Hygienist
Renee	Murray	Chemical Safety Officer
Jason	Nipper	lab animal technologist
Colleen	Ochat	Safety Coordinator
Eric	Palm	Deputy Lab Director
Johnathan	Parker	Critical Systems
Lezlee	Richerson	Administrative Specialist
Bettina	Roberson	Assistant Director, Administrative Services
Kari	Roberts	Program Coordinator
Kristin	Roberts	Director of Public Affairs
Christopher	Rodman	Industrial Safety & Health Eng.
Curt	Rogers	EHS Fire Tech
Ekaterina	Semenova	Receptionist
Sam	Sevor	Fire Safety Coordinator

First Name	Last Name	Title
Christian	Strickland	Chemical Safety Technician
Nilubon	Tabtimtong	Media Specialist
Michael	Tentnowski	Licensing Manager, FSU
Anke	Toth	User Program, Chief of Staff
Carlos	Villa	K-12 Education Outreach Coordinator
Mali	Weingarten	Research Assistant
Laurie	Whetstone	Quality Control Program Coord
Jaime	White-James	Assistant Director, Laboratory Animal Resources
Thomas	Williams	Critical Systems Technician
Marvin	Woods	Assistant Director of Research Support
Sheryl	Zavion	Sr. Research Associate (MS&T Operations Manager)

MAGNET SCIENCE & TECHNOLOGY – MS&T

First Name	Last Name	Title
Todd	Adkins	Research Engineer
Salem Fa	Aldawsari	Research Assistant
Erick	Arroyo	Technician
Andrew	Atallah	Research Assistant
Hongyu	Bai	Research Faculty II
Mark	Bird	Director, Magnet Science & Technology
Scott	Bole	Engineer
Kurtis	Cantrell	Engineer
Liang	Chen	Research Assistant
Xingchi	Chen	Graduate Research Assistant
Ana	De Leon	Research Assistant
Justin	Deterding	Research Engineer
Iain	Dixon	Research Faculty III
Greg	Erickson	Biology Professor
Cecil	Evers	Research Assistant
Andrey	Gavrilin	Research Faculty III
Robert	Goddard	Scientific Research Specialist
Tomas	Grejtak	Graduate Research Assistant
Scott	Gundlach	Engineer
Ke	Han	Research Faculty III
Sarajeen Saima	Hoque	Graduate Research Assistant
Tyler	Hunt	Graduate Research Assistant
Brent	Jarvis	Technician
Kwangmin	Kim	Visiting Research Faculty I
Dylan	Kolb-Bond	Research Engineer
Jeremy	Levitan	Research Engineer
He	Liu	Laboratory Assistant / Technician
Jun	Lu	Research Faculty III
Joseph	Lucia	Welder/Technician
William	Markiewicz	Research Faculty III
Emsley	Marks	Research Engineer
William	Marshall	Sr. Research Associate
Atousa	Mehrani	Graphic Artist
George	Miller	Engineer
Rongmei	Niu	Associate In Research
James	O'Reilly	Technician
Thomas	Painter	Sr. Research Associate
Christopher	Ray	Technician
Megan	Reid	Research Assistant
Nicholas	Samuda	Laboratory Assistant / Technician
Robert	Stanton	Research Engineer
Rebekah	Sweat	Assistant in Industrial and Manufacturing Engineering
Omar	Taleb	Microscopist
Mehul	Tank	Graduate Research Assistant
Vince	Toplosky	Scientific Research Specialist
Jack	Toth	Research Faculty III, Resistive Magnet Program Leader
Steven	Van Sciver	Emeritus Professor
Adam	Voran	Research Engineer
Robert	Walsh	Sr. Research Associate
Sisi	Wang	Graduate Research Assistant
James	White	Research Engineer
Yan	Xin	Research Faculty III
Peng	Xu	Postdoctoral Associate
Al	Zeller	Visiting Scientist/Researcher
Yang	Zhang	Visiting Research Faculty III

MANAGEMENT AND ADMINISTRATION – MANAG & ADMIN

First Name	Last Name	Title
Rob	Allen	ITS Technician
Cristina	Alonso	Web Designer/Programmer
William	Barker	Campus Service Assistant
David	Barnes	Electrician
James	Berhalter	Systems Administrator
Karol	Bickett	Assistant Director, Business Systems
Debra	Booth	Business Systems Director
Kenneth	Braverman	Mechanical Engineer Tech.
Whitney	Brown	Administrative Specialist
Marcela	Castano	Maintenance Engineer
Sarah	Childers	Program Coordinator
John	Childs	Graphic Artist
Eric	Clark	Assistant Director, Technology Services
Raymond	Cone	Maintenance Mechanic
Russ	Cooper	Senior Electrician FSU Campus
Robert	Coshatt	Maintenance Technician
Sean	Coyne	Facilities Engineer
Douglas	Davey	Electrician
Travis	Durham	Maintenance Technician
Larry	English	Pipe Fitter/Welder
Tonya	Eovacious	Accounting Specialist
Brian	Fienemann	Plumber
Sarita	Finn	Web Designer/Programmer
Kevin	Gamble	Facilities Superintendent
Laura	Greene	Chief Scientist
Lindsay	Grooms	UBA Associate Director
Miranda	Hacker	Office Administrator
David	Hahn	Web Designer/Programmer
Carolyn	Hall	Program Assistant
Kyle	Hawkins	Systems Administrator
Scott	Hermance	Campus Service Assistant
Philip	Hill	Clerk
Jonathon	Howell	Controls/HVAC Technician
Tra	Hunter	Plant Engineer
Micheal	Ivester	Maintenance Technician
Kevin	John	Graphic Artist
Steve	Johnson	Maintenance Mechanic
Sylvonta	Johnson	Maintenance Technician
Karen	Joiner	Clerk
Marsha	Jones	Accounting Assistant
James	Kalnin	Maintenance Supervisor
Matthew	Kirschner	Programmer
Jacqueline	Kornegay	Senior Financial Specialist
John	Kynoch	Department Head & Mechanical Engineer
Walter	Lee	Budget Analyst
Ermal	Liko	Welder
Richard	Ludlow	Graphic Artist
David	Lunger	Project Manager
James	Maddox	Technical/Research Designer
William	Morgan	Maintenance Technician
Christopher	Oxendine	Engineering Technician / Designer
Don	Pagel	Maintenance Mechanic
Eric	Perkins	Critical Systems Shop Supervisor
Billy	Phinazee	Maintenance Mechanic
Ryan	Porter	Maintenance Supervisor
Daniel	Preston	Maintenance Mechanic
Becky	Price	Network Architect

First Name	Last Name	Title
Daniel	Price	AC Technician
Duncan	Proctor	Web Designer/Programmer
Biff	Quarles	FSU Facilities PM
Clyde	Rea	Assistant Director of ABA Program
Andrew	Rettig	Technical Support Analyst
Tiffany	Ritter	Assistant Director, Fiscal Office
Andrew	Sapronetti	Administrative Support Specialist
Verbon	Scott	Plumber
Rodney	Shreve	Industrial Engineer
Stacy	Slavichak	Water Resources Manager
Kyle	Spears	Maintenance Technician
Holly	Stafford	Administrative Support Assistant
Dustin	Stevens	Mechanical Trades Technician
Jeffery	Sutton	Maintenance Technician
Dustin	Szelong	Systems Programmer
Angelena	Turvaville	Program Assistant
Monroe	Walker	Network Specialist
Ronald	Wallace	Plumber
Shauna	Walsh	Budget Assistant
Carl	Windham	Research Assistant
Cary	Winkler	Controls / Alarm Systems Technician
Marshall	Wood	Facilities Electrical Supervisor
Aaron	Young	Engineer Technician

LOS ALAMOS NATIONAL LABORATORY - LANL

First Name	Last Name	Title
Oscar	Ayala Valenzuela	Technologist 2
Fedor	Balakirev	Staff Member
Scott	Betts	Technician
Ashish	Bhardwaj	R&D Engineer
Mun Keat	Chan	Staff Member
Junho	Choi	Postdoctoral Associate
Scott	Crooker	Staff Member
Julie	Gallegos	Professional Staff Assistant/Program Administrator
Neil	Harrison	Staff Member
Richard	Herrera	R&D Technologist
Mark	Hinrichs	Electrical Engineer
Marcelo	Jaime	Staff Member
Thomas	Kline	MOST Technologist
Rubi	Km	Postdoc
Satya	Kushwaha	Postdoctoral Associate
Minseong	Lee	Postdoc
Jason	Lucero	Research Technician
Boris	Maiorov	Staff Member
Jeff	Martin	Controls Specialist
Ross	McDonald	Deputy Director, Pulsed Field Facility
James	Michel	Research Technologist
Christopher	Mizzi	Postdoc
Doan	Nguyen	Director of Pulsed Field Facility Magnet Science and Technology
Johanna	Palmstrom	Postdoctoral Associate
Michael	Rabin	Program Director
Dwight	Rickel	Emeritus Staff Member
Dave	Sattler	Designer
Krista	Sawchuk	Postdoc
Rico	Schoenemann	Postdoctoral Associate
John	Singleton	Staff Member and LANL Fellow
Josiah	Srock	Operations Technician
Hazuki	Teshima	Research Technician 5
Amanda	Valdez	Administrative Assistant
James	Wampler	Postdoctoral Researcher
Laurel	Winter	User Program Director, Pulsed Field Facility
Vivien	Zapf	Staff Member
Shengzhi	Zhang	Postdoctoral Associate

UNIVERSITY OF FLORIDA – UF

First Name	Last Name	Title
Alexander	Angerhofer	Professor
Stephen	Blackband	Professor, Neuroscience
Clifford	Bowers	Professor
Perihan	Brown	Research Administrator II
Rebecca	Butcher	Associate Professor
Shane	Chatfield	3 T Tech
Hai Ping	Cheng	Professor of Physics
George	Christou	Drago Chair and Distinguished Professor
James	Collins	Core Research Facility Manager
Yousong	Ding	Assistant Professor
Alexander	Donald	Graduate Research Assistant
Matthew	Eddy	Assistant Professor
Gail	Fanucci	Professor
Marcelo	Febo	Assistant Professor
Jeffrey	Fitzsimmons	Professor, Radiology
Sean	Forbes	Research Assistant Professor
John	Forder	Associate Professor of Radiology
Rasul	Gazizulin	Assistant In Research
Stephen	Hagen	Professor & Associate Chair of Physics
James	Hamlin	Associate Professor
Arthur	Hebard	Distinguished Professor of Physics
Selman	Hershfield	Professor of Physics
Peter	Hirschfeld	Distinguished Professor
Amy	Howe	Research Coordinator II
Chao	Huan	Research Faculty I
Gary	Ihas	Emeritus Professor
Kevin	Ingersent	Chair of UF Physics Department & Professor
Kelly	Jenkins	RF Coil Engineer
Chalermchai	Khemtong	Associate Professor
Pradeep	Kumar	Emeritus Professor
Song	Lai	Professor of Radiation Oncology and Neurology, Director, CTSI Human Imaging Core McKnight Brain Institute
Dominique	Laroche	Assistant Professor
Yoonseok	Lee	Professor
Joanna	Long	Professor, NHMFL Director of AMRIS
Hendrik	Luesch	Professor and Chair, Department of Medicinal Chemistry, Professor
Thomas	Mareci	Professor, Biochemistry & Molecular Biology
Dmitrii	Maslov	Professor of Physics
Anil	Mehta	Core Research Facility Manager
Mark	Meisel	Director of High B/T Facility, Professor of Physics
Matthew	Merritt	Associate Professor
Denise	Mesa	NHMFL Administrative Assistant
Leslie	Murray	Assistant Professor
Khandker	Muttalib	Professor of Physics
Tammy	Nicholson	Certified Radiology Technology Mgr. (3T Imaging Applications)
Reese	Peppler	Engineer II
Andrew	Rinzler	Professor of Physics
James	Rocca	Senior Chemist
Jens	Rosenberg	Core Research Facility Manager / AMRIS facilities manager of Clinical MRI instrumentation
Cynthia	Sager	Office Manager
Joshua	Slade	Engineering Technician
Christopher	Stanton	Professor of Physics
Judith	Steadman	MRI Technologist
Lucia	Steinke	Research Faculty II
Gregory	Stewart	Professor of Physics

First Name	Last Name	Title
Neil	Sullivan	Professor of Physics
Christi	Swiers	MRI Technologist
Yasumasa	Takano	Professor of Physics
Daniel	Talham	Professor
David	Tanner	Distinguished Professor of Physics
David	Vaillancourt	Professor
Krista	Vandenborne	Professor and Chair, Physical Therapy
Sergey	Vasenkov	Professor
Glenn	Walter	Professor, UF Physiology & Functional Genomics
Huadong	Zeng	Specialist, Animal MRI/S Applications

GEOCHEMISTRY - GEOCHEM

First Name	Last Name	Title
Alyssa	Atwood	Assistant Professor
Megan	Behnke	Graduate Research Assistant
Samantha	Bosman	Graduate Research Assistant
Chelsie	Bowman	Graduate Research Assistant
Jeff	Chanton	Professor
Xinming	Chen	Postdoctoral Associate
Kyle	Compare	Graduate Research Assistant
Kristie	Dick	Undergraduate Intern
Gary	Fowler	Graduate Research Assistant
Philip	Froelich	Research Faculty III
Christian	Gfatter	Graduate Research Assistant
William	Gladwin	Undergraduate Research Assistant
John	Goodin	Graduate Research Assistant
Jade	Greene	Graduate Research Assistant
Malia	Hallaway	Undergraduate Research Assistant
Chance	Hannold	Graduate Research Assistant
Lauren	Hearn	Undergraduate Research Assistant
Amy	Holt	Graduate Research Assistant
Munir	Humayun	Professor
Johanna	Imhoff	Graduate Research Assistant
Anne	Kellerman	Postdoctoral Associate
Thomas	Kelly	Postdoctoral Associate
John	Kerigan	Undergraduate Research Assistant
Cloe	Knutson	Undergraduate Research Assistant
Nevin	Kozik	Graduate Research Assistant
Martin	Kurek	Graduate Research Assistant
William	Landing	Professor
Grace	Larson	Undergraduate Research Assistant
Siqi	Li	Graduate Research Assistant
Stephanie	McColaugh	Graduate Research Assistant
Jacob	Mitchem	Undergraduate Research Assistant
Peter	Morton	Visiting Assistant In Research
Alexandra	Music	Undergraduate Research Assistant
Sean	Newby	Graduate Research Assistant
Leroy	Odom	Professor of Geology
Jeremy	Owens	Assistant Professor
Elizabeth	Perison	Graduate Research Assistant
Luis	Rodriguez	Graduate Research Assistant
Afi	Sachi-Kocher	Scientific Research Specialist
Vincent	Salters	Professor and Director, Geochemistry Program
Merid	Schwartz	Graduate Research Assistant
Srishti	Sharma	Graduate Research Assistant
Steffanie	Sillitoe-Kukas	Graduate Research Assistant
Robert	Spencer	Assistant Professor
Emily	Steward	Assistant Professor
Michael	Stukel	Assistant Professor
Yahyia	Talebi	Graduate Research Assistant
Justin	Vaughan	undergraduate research assistant
Derrick	Vaughn	Postdoctoral Associate
Jane	Wadhams	Undergraduate Research Assistant
Madison	Walker	Undergraduate Research Assistant
Yang	Wang	Professor
Gary	White	Scientific Research Specialist
Dominic	Woelki	Postdoctoral Associate
Burt	Wolff	Assistant in Research
Shuying	Yang	Postdoctoral Associate
Seth	Young	Assistant Professor

First Name	Last Name	Title
Theodore	Zateslo	Senior Engineer
Yin	Zhang	Graduate Research Assistant

APPENDIX 2
USER FACILITY STATISTICS

Seven user facilities — AMRIS (NMR-MRI@UF), DC Field, EMR, High B/T, ICR, NMR-MRI @FSU, and Pulsed Field — each with exceptional instrumentation and highly qualified staff scientists and staff, comprise the magnet lab's user program. In this appendix, each facility presents detailed information about its user demographics, operations statistics and requests for magnet time. A user is an individual or a member of a research group that is allocated magnet time. The user does not have to be "on site" for the experiment. A researcher who sends samples for analysis; a scientist who uses new lab technologies to conduct experiments remotely; or a PI who sends students to the magnet lab, are all considered users. All user numbers reflect distinct individuals, i.e., if a user has multiple proposals (different scientific thrusts) or is allocated magnet time more than once during the year, he/she is counted only once.

AMRIS Facility

Table 1a. Users by Demographic – NSF-Funded

	Users[1]	Minority[2]	Non-Minority[2]	No Response to Race[3]	Male	Female	Other	No Response to Gender[3]
Senior Personnel, U.S.	42	6	28	8	33	2	0	7
Senior Personnel, non-U.S.	4	2	2	0	4	0	0	0
Postdocs, U.S.	9	2	7	0	7	2	0	0
Postdocs, non-U.S.	0	0	0	0	0	0	0	0
Students, U.S.	17	1	10	6	11	4	0	2
Students, non-U.S.	0	0	0	0	0	0	0	0
Technician, U.S.	3	0	3	0	1	2	0	0
Technician, non-U.S.	0	0	0	0	0	0	0	0
TOTAL	75	11	50	14	56	10	0	9

[1] Users using multiple facilities are counted in each facility listed.
[2] NSF Minority status includes the following races: American Indian, Alaska Native, Black or African American, Hispanic, Native Hawaiian or other Pacific Islander. The definition also includes Hispanic Ethnicity as a minority group. Minority status excludes Asian and White-Not of Hispanic Origin.
[3] Includes pending user account activations.

Table 1b. Users by Demographic – Non-NHMFL-Funded

	Users	Minority	Non-Minority	No Response to Race	Male	Female	Other	No Response to Gender
Senior Personnel, U.S.	102	7	67	28	48	31	0	23
Senior Personnel, non-U.S.	0	0	0	0	0	0	0	0
Postdocs, U.S.	38	4	24	10	17	12	0	9
Postdocs, non-U.S.	0	0	0	0	0	0	0	0
Students, U.S.	87	14	45	28	27	37	0	23
Students, non-U.S.	0	0	0	0	0	0	0	0
Technician, U.S.	38	6	13	19	10	10	0	18
Technician, non-U.S.	0	0	0	0	0	0	0	0
TOTAL	265	31	149	85	102	90	0	73

Table 1c. Users by Demographic – Summary

	Users	Minority	Non-Minority	No Response to Race	Male	Female	Other	No Response to Gender
NSF-FUNDED	75	11	50	14	56	10	0	9
NON-NHMFL-FUNDED	265	31	149	85	102	90	0	73
TOTAL	340	42	199	99	158	100	0	82

Table 2a. Users by Participation – NSF-Funded

	Users[1]	Users Present	Users Operating Remotely[2]	Users Sending Sample[3]	Off-Site Collaborators[4]
Senior Personnel, U.S.	42	19	2	0	21
Senior Personnel, non-U.S.	4	0	0	2	2
Postdocs, U.S.	9	8	0	0	1
Postdocs, non-U.S.	0	0	0	0	0
Students, U.S.	17	14	2	0	1

	Users[1]	Users Present	Users Operating Remotely[2]	Users Sending Sample[3]	Off-Site Collaborators[4]
Students, non-U.S.	0	0	0	0	0
Technician, U.S.	3	3	0	0	0
Technician, non-U.S.	0	0	0	0	0
TOTAL	75	44	4	2	25

[1] Users using multiple facilities are counted in each facility listed.
[2] "Users Operating Remotely" refers to users who operate the magnet system from a remote location. Remote operations are not currently available in all facilities.
[3] "Users Sending Sample" refers to users who send the sample to the facility and/or research group and the experiment is conducted by other collaborators on the experiment. Users at UF, FSU, and LANL cannot be "sample senders" for facilities located on their campuses.
[4] "Off-Site Users" are scientific or technical participants on the experiment; who will not be present, sending sample, or operating the magnet system remotely; and who are not located on the campus of that facility (i.e., they are off-site).

Table 2b. Users by Participation – Non-NHMFL-Funded

	Users	Users Present	Users Operating Remotely	Users Sending Sample	Off-Site Collaborators
Senior Personnel, U.S.	102	70	0	0	32
Senior Personnel, non-U.S.	0	0	0	0	0
Postdocs, U.S.	38	31	1	0	6
Postdocs, non-U.S.	0	0	0	0	0
Students, U.S.	87	85	0	0	2
Students, non-U.S.	0	0	0	0	0
Technician, U.S.	38	38	0	0	0
Technician, non-U.S.	0	0	0	0	0
TOTAL	265	224	1	0	40

Table 2c. Users by Participation - Summary

	Users	Users Present	Users Operating Remotely	Users Sending Sample	Off-Site Collaborators
NSF-FUNDED	75	44	4	2	25
NON-NHMFL-FUNDED	265	224	1	0	40
TOTAL	340	268	5	2	65

Table 3a. Users by Organization – NSF-Funded

	Users[1]	External Users	Local Users[2]	NHMFL-Affiliated Users[2,3,4]	Laboratory[3,5]	University[4,5]	Industry[5]
Senior Personnel, U.S.	42	24	6	12	2	40	0
Senior Personnel, non-U.S.	4	4	0	0	1	2	1
Postdocs, U.S.	9	4	4	1	0	9	0
Postdocs, non-U.S.	0	0	0	0	0	0	0
Students, U.S.	17	6	11	0	0	17	0
Students, non-U.S.	0	0	0	0	0	0	0
Technician, U.S.	3	0	1	2	0	3	0
Technician, non-U.S.	0	0	0	0	0	0	0
TOTAL	75	38	22	15	3	71	1

[1] Users using multiple facilities are counted in each facility listed.
[2] NHMFL-Affiliated users are defined as anyone in the lab's personnel system (i.e., on our web site/directory), even if they travel to another site. Local users are defined as any non-NHMFL-Affiliated researchers originating at any of the institutions in proximity to the MagLab sites (i.e., researchers at FSU, UF, FAMU, or LANL), even if they travel to another site.
[3] Users with primary affiliations at NHMFL/LANL are reported in NHMFL-Affiliated Users and National Laboratory.
[4] Users with primary affiliations at FSU, UF, or FAMU are reported in NHMFL-Affiliated Users and National University.
[5] The TOTAL of university, industry, and national lab users will equal the TOTAL number of users.

Table 3b. Users by Organization – Non-NHMFL-Funded

	Users	External Users	Local Users	NHMFL-Affiliated Users	Laboratory	University	Industry
Senior Personnel, U.S.	102	40	45	17	1	99	2
Senior Personnel, non-U.S.	0	0	0	0	0	0	0
Postdocs, U.S.	38	14	22	2	0	38	0
Postdocs, non-U.S.	0	0	0	0	0	0	0
Students, U.S.	87	16	71	0	0	87	0
Students, non-U.S.	0	0	0	0	0	0	0
Technician, U.S.	38	13	22	3	1	37	0
Technician, non-U.S.	0	0	0	0	0	0	0
TOTAL	265	83	160	22	2	261	2

Table 3c. Users by Organization - Summary

	Users	External Users	Local Users	NHMFL-Affiliated Users	Laboratory	University	Industry
NSF-FUNDED	75	38	22	15	3	71	1
NON-NHMFL-FUNDED	265	83	160	22	2	261	2
TOTAL	340	121	182	37	5	332	3

Table 4a. Users by Discipline – NSF-Funded

	Users[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Senior Personnel, U.S.	42	1	13	9	0	19
Senior Personnel, non-U.S.	4	0	0	0	0	4
Postdocs, U.S.	9	0	1	0	1	7
Postdocs, non-U.S.	0	0	0	0	0	0
Students, U.S.	17	0	6	4	1	6
Students, non-U.S.	0	0	0	0	0	0
Technician, U.S.	3	0	0	3	0	0
Technician, non-U.S.	0	0	0	0	0	0
TOTAL	75	1	20	16	2	36

[1] Users using multiple facilities are counted in each facility listed.

Table 4b. Users by Discipline – Non-NHMFL-Funded

	Users	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Senior Personnel, U.S.	102	0	8	15	7	72
Senior Personnel, non-U.S.	0	0	0	0	0	0
Postdocs, U.S.	38	0	0	3	3	32
Postdocs, non-U.S.	0	0	0	0	0	0
Students, U.S.	87	1	3	12	9	62
Students, non-U.S.	0	0	0	0	0	0
Technician, U.S.	38	0	0	0	9	29
Technician, non-U.S.	0	0	0	0	0	0
TOTAL	265	1	11	30	28	195

Table 4c. Users by Discipline - Summary

	Users	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
NSF-FUNDED	75	1	20	16	2	36
NON-NHMFL-FUNDED	265	1	11	30	28	195
TOTAL	340	2	31	46	30	231

Table 5 Subscription Rate – Summary

	Experiments Submitted (Current Year)	Experiments Submitted (Deferred from prev. year)	Experiments With Usage	Experiments with Usage Percentage	Experiments Declined	Experiments Declined Percentage	Experiments Reviewed	Experiments Subscription Percentage
NSF-FUNDED	12	20	31	96.9 %	1	3.1 %	32	103.2 %
NON-NHMFL-FUNDED	46	75	118	97.5 %	3	2.5 %	121	102.5%
TOTAL	58	95	149		4		153	

Table 6a. Research Proposals[1] Profile (Demographics) with Magnet Time – Summary

	Total Proposals[1]	Minority[2]	Non-Minority	No Race Response	Female[3]	Male	Other	No Gender Response
NSF-FUNDED	31	4	23	4	7	21	0	3
NON-NHMFL-FUNDED	97	7	64	26	34	43	0	20
TOTAL	128	11	87	30	41	64	0	23

[1] A "proposal" may have associated with it a single experiment or a group of closely related experiments. A PI may have more than one proposal.
[2] The number of proposals satisfying the following condition: The PI is a minority.
[3] The number of proposals satisfying the following condition: The PI is a female.

Note: The table refers to proposal disciplines.

Table 6b. Research Proposals Profile (Discipline) with Magnet Time – Summary

	Total Proposals	CMP	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
NSF-FUNDED	31	0	4	4	4	19
NON-NHMFL-FUNDED	97	0	0	0	2	95
TOTAL	128	0	4	4	6	114

Find the list of user proposals in **Appendix V** and on our [website]

Table 7a. *Operations by Magnet System Group – NSF-Funded*

	Total Days Used	Percentage of Total Days Used	500MHz NMR Spec-trometer	600MHz NMR Spec-trometer with Cry-oprobe	600MHz NMR Spec-trometer - Perfusion Applications	600MHz NMR Spec-trometer	600MHz Wide Bore Spectrome-ter	750MHz Wide Bore Spectrome-ter	800MHz, 63mm bore NMR Spec-trometer	800MHz NMR Spec-trometer with Cry-oprobe	4.7T/33 MRI Sys-tem	11T/40 MRI System
NHMFL-Affiliated	40.8	3.2 %	0	0	0	0	3.3	0	24.5	13	0	0
Local	80.5	6.2 %	0	0	0	3.8	24.8	0	1.3	50.5	0	0
University, U.S.	401.8	31.1 %	0	0	145.1	32.8	83.8	86.2	0	11	25.8	17
University, non-U.S.	33.5	2.6 %	0	0	0	0	0	0	4	25	1.5	3
Government Lab, U.S.	30	2.3 %	0	0	0	0	0	30	0	0	0	0
Government Lab, non-U.S.	0	0 %	0	0	0	0	0	0	0	0	0	0
Industry, U.S.	0	0 %	0	0	0	0	0	0	0	0	0	0
Industry, non-U.S.	0	0 %	0	0	0	0	0	0	0	0	0	0
Test/Calibration/ Maintenance	293	22.7 %	12.5	37.8	25.4	25.5	17.2	30.8	36.8	22	43.3	41.7
Method Development	119.8	9.3 %	1	18	3.5	33	10.8	9.5	12.5	13.5	3.5	14.5
Analytical Chemistry	0	0 %	0	0	0	0	0	0	0	0	0	0
Upgrade Cell Design/Hardware	101	7.8 %	0.5	10	8	26.2	15.5	11.5	16.0	0	1.5	11.8
Setup	191.6	14.8 %	14	36.3	12	12.7	17.5	12	30.8	18	13.3	25
Repair	0	0 %	0	0	0	0	0	0	0	0	0	0
TOTAL	1,292		28	102	194	134	173	180	126	153	89	113

Table 7b. *Operations by Magnet System Group – Non-NHMFL-Funded*

	Total Days Used	Percentage of Total Days Used	500MHz NMR Spec-trome-ter	600MHz NMR Spec-trome-ter with Cry-oprobe	600MHz NMR Spec-trometer - Perfu-sion Ap-plica-tions	600MHz NMR Spec-trometer	600MHz Wide Bore Spec-trometer	750MHz Wide Bore Spec-trometer	800MHz, 63mm bore NMR Spec-trometer	800MHz NMR Spec-trometer with Cry-oprobe	3T Sie-mens Whole Body Sys-tem	3T Philips Whole Body Sys-tem	4.7T/33 MRI Sys-tem	11T/40 MRI Sys-tem
NHMFL-Affiliated	472.7	28.9 %	118	1	0	0	112	41.5	42.5	65.8	10	38.9	3	40
Local	327.8	20.1 %	0	23	15.5	9	0	13	19.5	32	56.5	30.3	34	95.1
University, U.S.	788.1	48.2 %	6	31	85.5	80	4	35.5	51	111.2	190.9	122.1	26	44.9
University, non-U.S.	0	0 %	0	0	0	0	0	0	0	0	0	0	0	0
Government Lab, U.S.	0	0 %	0	0	0	0	0	0	0	0	0	0	0	0
Government Lab, non-U.S.	0	0 %	0	0	0	0	0	0	0	0	0	0	0	0
Industry, U.S.	5	0.3 %	0	0	0	0	0	0	0	0	0	0	0	5
Industry, non-U.S.	0	0 %	0	0	0	0	0	0	0	0	0	0	0	0
Test/ Calibration/ Maintenance	0	0 %	0	0	0	0	0	0	0	0	0	0	0	0
Method Development	35.8	2.2 %	0	0	0	0	0	0	0	0	8.6	24.2	0	3
Analytical Chemistry	0	0 %	0	0	0	0	0	0	0	0	0	0	0	0
Upgrade Cell Design/Hardware	0	0 %	0	0	0	0	0	0	0	0	0	0	0	0
Setup	4.5	0.3 %	0	0	0	0	0	0	0	0	0	3.5	0	1
Repair	0	0 %	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	1,634		124	55	101	89	116	90	113	209	266	219	63	189

Table 7c. Operations by Magnet Systems - Summary

	Total Days Used	500 MHz NMR Spectrometer	600 MHz NMR Spectrometer with Cryoprobe	600 MHz NMR Spectrometer - Perfusion Applications	600 MHz NMR Spectrometer	600 MHz Wide Bore Spectrometer	750 MHz Wide Bore Spectrometer	800 MHz, 63 mm bore NMR Spectrometer	800 MHz NMR Spectrometer with Cryoprobe	3 T Siemens Whole Body System	3 T Philips Whole Body System	4.7 T/33 MRI System	11 T/40 MRI System
NSF-FUNDED	1,292	28	102	194	134	173	180	126	153	0	0	89	113
NON-NHMFL-FUNDED	1,634	124	55	101	89	116	90	113	209	266	219	63	189
TOTAL	2,926	152	157	295	223	289	270	239	362	266	219	152	302

Table 8a. Operations by Discipline – NSF-Funded

	Total Days Used	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
NHMFL-Affiliated	40.8	0	0	0	0	40.8
Local	80.5	0	26.2	0	0	54.3
University, U.S.	401.8	0	100.8	174.8	0	126.2
University, non-U.S.	33.5	0	0	0	0	33.5
Government Lab, U.S.	30	0	0	0	0	30
Government Lab, non-U.S.	0	0	0	0	0	0
Industry, U.S.	0	0	0	0	0	0
Industry, non-U.S.	0	0	0	0	0	0
Test/ Calibration/ Maintenance	293	0	0	0	0	293
Method Development	119.8	0	0	0	0	119.8
Analytical Chemistry	0	0	0	0	0	0
Upgrade Cell Design/Hardware	101	0	0	0	0	101
Setup	191.6	0	0	0	0	191.6
Repair	0	0	0	0	0	0
TOTAL	1,292	0	127	174.8	0	990.3

Table 8b. Operations by Discipline – Non-NHMFL-Funded

	Total Days Used	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
NHMFL-Affiliated	472.7	0	0	0	2.5	470.2
Local	327.8	0	0	0	0	327.8
University, U.S.	788.1	0	32.5	6.5	0	749.1
University, non-U.S.	0	0	0	0	0	0
Government Lab, U.S.	0	0	0	0	0	0
Government Lab, non-U.S.	0	0	0	0	0	0
Industry, U.S.	5	0	0	0	0	5
Industry, non-U.S.	0	0	0	0	0	0
Test/ Calibration/ Maintenance	0	0	0	0	0	0
Method Development	35.8	0	0	0	3	32.8
Analytical Chemistry	0	0	0	0	0	0
Upgrade Cell Design/Hardware	0	0	0	0	0	0
Setup	4.5	0	0	0	1	3.5
Repair	0	0	0	0	0	0
TOTAL	1,634	0	32.5	6.5	6.5	1,588.5

Table 8c. Operations by Discipline - Summary

	Total Days Used	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
NSF-FUNDED	1,292	0	127	174.8	0	990.3
NON-NHMFL-FUNDED	1,634	0	32.5	6.5	6.5	1,588.5
TOTAL	2,926	0	159.5	181.3	6.5	2,578.8

Table 9a. New PIs[1] and New Users – NSF-Funded

	PIs	New PIs at the MagLab	New PIs at Facility	Returning PIs at Facility	All Users	New Users at the MagLab	New Users at Facility	Returning Users at Facility
Senior Personnel, U.S.	29	6	6	23	42	4	4	38
Senior Personnel, non-U.S.	2	0	0	2	4	2	2	2
Postdocs, U.S.	1	1	1	0	9	1	1	8
Postdocs, non-U.S.	0	0	0	0	0	0	0	0
Students, U.S.	0	0	0	0	17	0	2	15
Students, non-U.S.	0	0	0	0	0	0	0	0
Technician, U.S.	0	0	0	0	3	0	0	3
Technician, non-U.S.	0	0	0	0	0	0	0	0
TOTAL	32	7	7	25	75	7	9	66

[1] PIs who received magnet time for the first time.

Table 9b. New PIs and New Users – Non-NHMFL-Funded

	PIs	New PIs at the MagLab	New PIs at Facility	Returning PIs at Facility	All Users	New Users at the MagLab	New Users at Facility	Returning Users at Facility
Senior Personnel, U.S.	74	13	13	61	102	2	4	98
Senior Personnel, non-U.S.	0	0	0	0	0	0	0	0
Postdocs, U.S.	9	1	1	8	38	4	4	34
Postdocs, non-U.S.	0	0	0	0	0	0	0	0
Students, U.S.	0	0	0	0	87	9	9	78
Students, non-U.S.	0	0	0	0	0	0	0	0
Technician, U.S.	0	0	0	0	38	3	3	35
Technician, non-U.S.	0	0	0	0	0	0	0	0
TOTAL	83	14	14	69	265	18	20	245

Table 9c. New PIs and New Users - Summary

	PIs	New PIs at the MagLab	New PIs at Facility	Returning PIs at Facility	All Users	New Users at the MagLab	New Users at Facility	Returning Users at Facility
NSF-FUNDED	32	7	7	25	75	7	9	66
NON-NHMFL-FUNDED	83	14	14	69	265	18	20	245
TOTAL	115	21	21	94	340	25	29	311

Table 10a. New[1] User PIs – NSF-Funded

Name	Organization	Proposal	Year of Magnet Time	Is New to MagLab
Bill Baker	University of South Florida	P19767	Received 2021	Yes
Jimmy Lawrence	Louisiana State University	P19782	Received 2021	Yes
Jonathan Nickels	University of Cincinnati	P19438	Received 2021	Yes
Lorena Bianchine Areal	Florida Atlantic University	P19487	Received 2021	Yes
Luke Arbogast	National Institute of Standards and Technology MD	P19588	Received 2021	Yes
Sandra Loesgen	University of Florida	P19658	Received 2021	Yes
Stanislaw Deja	University of Texas, Southwestern	P19414	Received 2021	Yes

[1] PIs who received magnet time for the first time.

Table 10b. New User PIs – Non-NHMFL-Funded

Name	Organization	Proposal	Year of Magnet Time	Is New to MagLab
Andre Obenaus	University of California, Irvine	P19645	Received 2021	Yes
Andrew Judge	University of Florida	P19655	Received 2021	Yes
Carla Zingariello	University of Florida	P19883	Received 2021	Yes
Carol Mathews	University of Florida	P19871	Received 2021	Yes
Chalermchai Khemtong	University of Florida	P19735	Received 2021	Yes
Christopher Vulpe	University of Florida	P19762	Received 2021	Yes
Liya Pi	Tulane University	P19593	Received 2021	Yes
Martha Campbell-Thompson	University of Florida	P19592	Received 2021	Yes
Matthew Burns	University of Florida	P19760	Received 2021	Yes
Melissa Armstrong	University of Florida	P19799	Received 2021	Yes
Paramita Chakrabarty	University of Florida	P19739	Received 2021	Yes
Sandra Loesgen	University of Florida	P19674	Received 2021	Yes
Steven Weisberg	University of Florida	P19763	Received 2021	Yes

Name	Organization	Proposal	Year of Magnet Time	Is New to MagLab
Tanja Taivassalo	University of Florida	P19654	Received 2021	Yes

DC Field Facility

Table 1. Users by Demographic

	Users[1]	Minority[2]	Non-Minority[2]	No Response to Race[3]	Male	Female	Other	No Response to Gender[3]
Senior Personnel, U.S.	161	5	136	20	125	22	0	14
Senior Personnel, non-U.S.	38	1	24	13	24	7	0	7
Postdocs, U.S.	60	2	52	6	46	12	0	2
Postdocs, non-U.S.	7	0	5	2	3	2	0	2
Students, U.S.	146	6	98	42	98	18	0	30
Students, non-U.S.	17	1	11	5	12	1	0	4
Technician, U.S.	5	0	5	0	3	2	0	0
Technician, non-U.S.	0	0	0	0	0	0	0	0
TOTAL	434	15	331	88	311	64	0	59

[1] Users using multiple facilities are counted in each facility listed.
[2] NSF Minority status includes the following races: American Indian, Alaska Native, Black or African American, Hispanic, Native Hawaiian or other Pacific Islander. The definition also includes Hispanic Ethnicity as a minority group. Minority status excludes Asian and White-Not of Hispanic Origin.
[3] Includes pending user account activations.

Table 2. Users by Participation

	Users[1]	Users Present	Users Operating Remotely[2]	Users Sending Sample[3]	Off-Site Collaborators[4]
Senior Personnel, U.S.	161	73	0	23	65
Senior Personnel, non-U.S.	38	1	0	9	28
Postdocs, U.S.	60	32	0	5	23
Postdocs, non-U.S.	7	0	0	1	6
Students, U.S.	146	89	0	6	51
Students, non-U.S.	17	0	0	3	14
Technician, U.S.	5	5	0	0	0
Technician, non-U.S.	0	0	0	0	0
TOTAL	434	200	0	47	187

[1] Users using multiple facilities are counted in each facility listed.
[2] "Users Operating Remotely" refers to users who operate the magnet system from a remote location. Remote operations are not currently available in all facilities.
[3] "Users Sending Sample" refers to users who send the sample to the facility and/or research group and the experiment is conducted by other collaborators on the experiment. Users at UF, FSU, and LANL cannot be "sample senders" for facilities located on their campuses.
[4] "Off-Site Users" are scientific or technical participants on the experiment; who will not be present, sending sample, or operating the magnet system remotely; and who are not located on the campus of that facility (i.e., they are off-site).

Table 3. Users by Organization

	Users[1]	External Users	Local Users[2]	NHMFL-Affiliated Users[2,3,4]	Laboratory[3,5]	University[4,5]	Industry[5]
Senior Personnel, U.S.	161	105	5	51	19	141	1
Senior Personnel, non-U.S.	38	38	0	0	6	31	1
Postdocs, U.S.	60	46	6	8	11	49	0
Postdocs, non-U.S.	7	7	0	0	3	4	0
Students, U.S.	146	119	16	11	11	135	0
Students, non-U.S.	17	17	0	0	0	17	0
Technician, U.S.	5	0	0	5	0	5	0
Technician, non-U.S.	0	0	0	0	0	0	0
TOTAL	434	332	27	75	50	382	2

[1] Users using multiple facilities are counted in each facility listed.
[2] NHMFL-Affiliated users are defined as anyone in the lab's personnel system (i.e., on our web site/directory), even if they travel to another site. Local users are defined as any non-NHMFL-Affiliated researchers originating at any of the institutions in proximity to the MagLab sites (i.e., researchers at FSU, UF, FAMU, or LANL), even if they travel to another site.
[3] Users with primary affiliations at NHMFL/LANL are reported in NHMFL-Affiliated Users and National Laboratory.
[4] Users with primary affiliations at FSU, UF, or FAMU are reported in NHMFL-Affiliated Users and National University.
[5] The TOTAL of university, industry, and national lab users will equal the TOTAL number of users.

Table 4. Users by Discipline

	Users[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Senior Personnel, U.S.	161	114	19	10	10	8
Senior Personnel, non-U.S.	38	29	6	0	2	1
Postdocs, U.S.	60	50	2	1	4	3
Postdocs, non-U.S.	7	5	2	0	0	0
Students, U.S.	146	105	17	11	13	0
Students, non-U.S.	17	13	3	1	0	0

	Users[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Technician, U.S.	**5**	0	0	0	4	1
Technician, non-U.S.	**0**	0	0	0	0	0
TOTAL	**434**	**316**	**49**	**23**	**33**	**13**

[1] Users using multiple facilities are counted in each facility listed.

Table 5a. *Subscription Rate (Experiments)*

Experiments Submitted (Current Year)	Experiments Submitted (Deferred from prev. year)	Experiments With Usage	Experiments with Usage Percentage	Experiments Declined	Experiments Declined Percentage	Experiments Reviewed	Experiment Subscription Rate	Experiments Subscription Percentage
237	57	198	67.3 %	96	32.7 %	294	1.5	148.5 %

Table 5b. *Subscription Rate (Magnet Days)*

Days Submitted	Days Used by External User	Days Used by Local User	Days Used by NHMFL-Affiliated User	Days Used for Inst., Dev., Test and Maintenance[1]	Total Days Used	Days Subscription Rate	Days Subscription Percentage
1,862	1,012.6	29	239.2	48	1,328.8	1.5	140.1 %

[1] Test/Calibration/ Maintenance, Method Development, Analytical Chemistry, Upgrade Cell Design/Hardware Setup, Repair

Table 6a. *Research Proposals [1] Profile (Demographics) with Magnet Time*

TOTAL Proposals[1]	Minority[2]	Non-Minority	No Race Response	Female[3]	Male	Other	No Gender Response
131	2	116	13	20	104	0	7

[1] A "proposal" may have associated with it a single experiment or a group of closely related experiments. A PI may have more than one proposal.
[2] The number of proposals satisfying the following condition: The PI is a minority.
[3] The number of proposals satisfying the following condition: The PI is a female.
Note: The table refers to proposal disciplines.

Table 6b. *Research Proposals Profile (Discipline) with Magnet Time*

TOTAL Proposals	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
131	103	11	2	11	4

Find the list of user proposals in **Appendix V** and on our [website]

Table 7. *Operations by Magnet System Group*

	Total Days Used[1]	% of Total Days Used	45T	Resistive	SCH	Super-conducting
NHMFL-Affiliated	**239.2**	18 %	3	56.2	18	162
Local	**29**	2.2 %	0	0	0	29
University, U.S.	**776.8**	58.5 %	16	147.8	33	580
University, non-U.S.	**133.5**	10 %	0	25.5	11	97
Government Lab, U.S.	**73.4**	5.5 %	0	28.4	0	45
Government Lab, non-U.S.	**29**	2.2 %	0	0	0	29
Industry, U.S.	**0**	0 %	0	0	0	0
Industry, non-U.S.	**0**	0 %	0	0	0	0
Test/Calibration/Maintenance	**0**	0 %	0	0	0	0
Method Development	**48**	3.6 %	0	0	0	48
Analytical Chemistry	**0**	0 %	0	0	0	0
Upgrade Cell Design/Hardware	**0**	0 %	0	0	0	0
Setup	**0**	0 %	0	0	0	0
Repair	**0**	0 %	0	0	0	0
TOTAL	**1,328.8**		**19**	**257.8**	**62**	**990**

[1] Each 20MW resistive magnet requires two power supplies to run, the 45T hybrid magnet requires three power supplies, and the 36T Series Connected Hybrid requires one power supply. Thus, there can be four resistive magnets + three superconducting magnets operating or the 45T hybrid, series connected hybrid, two resistive magnets and three superconducting magnets. User Units are defined as magnet days. Users of water-cooled resistive or hybrid magnets can typically expect to receive enough energy for 7 hours a day of magnet usage, so a magnet day is defined as 7 hours. Superconducting magnets are scheduled typically 24 hours a day.

Table 8. *Operations by Discipline*

	Total Days Used	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
NHMFL-Affiliated	**239.2**	172.7	0	0	61.5	5
Local	**29**	16	0	0	13	0
University, U.S.	**776.8**	642.1	84.9	6	43.7	0
University, non-U.S.	**133.5**	101.5	20	0	7	5
Government Lab, U.S.	**73.4**	73.4	0	0	0	0

	Total Days Used	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Government Lab, non-U.S.	**29**	29	0	0	0	0
Industry, U.S.	**0**	0	0	0	0	0
Industry, non-U.S.	**0**	0	0	0	0	0
Test/ Calibration/ Maintenance	**0**	0	0	0	0	0
Method Development	**48**	48	0	0	0	0
Analytical Chemistry	**0**	0	0	0	0	0
Upgrade Cell Design/Hardware	**0**	0	0	0	0	0
Setup	**0**	0	0	0	0	0
Repair	**0**	0	0	0	0	0
TOTAL	**1,328.8**	**1,082.7**	**104.9**	**6**	**125.2**	**10**

Table 9. *New PIs[1] and New Users*

	PIs	New PIs at the MagLab	New PIs at Facility	Returning PIs at Facility	All Users	New Users at the MagLab	New Users at Facility	Returning Users at Facility
Senior Personnel, U.S.	**91**	10	11	80	161	12	13	148
Senior Personnel, non-U.S.	**17**	6	7	10	38	5	7	31
Postdocs, U.S.	**1**	1	1	0	60	17	18	42
Postdocs, non-U.S.	**1**	1	1	0	7	1	3	4
Students, U.S.	**0**	0	0	0	146	58	62	84
Students, non-U.S.	**0**	0	0	0	17	4	6	11
Technician, U.S.	**0**	0	0	0	5	1	1	4
Technician, non-U.S.	**0**	0	0	0	0	0	0	0
TOTAL	**110**	**18**	**20**	**90**	**434**	**98**	**110**	**324**

[1] PIs who received magnet time for the first time.

Table 10. *New[1] User PIs*

Name	Organization	Proposal	Year of Magnet Time	Is New to MagLab
Al-Amin Dhirani	University of Toronto (Toronto)	P19678	Received 2021	Yes
Badih Assaf	University of Notre Dame	P17982	Received 2021	Yes
Cui-Zu Chang	Pennsylvania State University	P19615	Received 2021	Yes
George Nolas	University of South Florida	P19700	Received 2021	Yes
Grace Morgan	University College Dublin	P16285	Received 2021	No
Guangxin Ni	Florida State University	P19501	Received 2021	Yes
Jaewook Kim	Korea Atomic Energy Research Institute	P19610	Received 2021	Yes
Jun Yang	Institute of Physics, Chinese Academy of Sciences	P19677	Received 2021	Yes
Nirmal Ghimire	George Mason University	P19163	Received 2021	No
Robert Butera	Laboratory for Physical Sciences, College Park	P19708	Received 2021	Yes
Sheng Ran	Washington University in St. Louis	P19470	Received 2021	Yes
Soon-Gil Jung	Sungkyunkwan University	P19352	Received 2021	Yes
Sunil Karna	Norfolk State University	P19711	Received 2021	Yes
Tomasz Klimczuk	Gdansk University of Technology	P19447	Received 2021	Yes
Valentin Taufour	University of California, Davis	P19616	Received 2021	Yes
Xavier Roy	Columbia University	P19632	Received 2021	Yes
Xiang Yuan	East China Normal University	P19239	Received 2021	Yes
Xiao-Xiao Zhang	University of Florida	P19224	Received 2021	Yes
Yangmu Li	Brookhaven National Laboratory	P19556	Received 2021	Yes
Zhenzhong Shi	Soochow University	P19630	Received 2021	Yes

[1] PIs who received magnet time for the first time.

EMR Facility

Table 1. Users by Demographic

	Users[1]	Minority[2]	Non-Minority[2]	No Response to Race[3]	Male	Female	Other	No Response to Gender[3]
Senior Personnel, U.S.	54	0	45	9	39	8	0	7
Senior Personnel, non-U.S.	13	4	8	1	7	6	0	0
Postdocs, U.S.	9	1	5	3	6	1	0	2
Postdocs, non-U.S.	6	1	4	1	3	3	0	0
Students, U.S.	35	1	22	12	22	6	0	7
Students, non-U.S.	4	0	1	3	1	1	0	2
Technician, U.S.	0	0	0	0	0	0	0	0
Technician, non-U.S.	0	0	0	0	0	0	0	0
TOTAL	121	7	85	29	78	25	0	18

[1] Users using multiple facilities are counted in each facility listed.
[2] NSF Minority status includes the following races: American Indian, Alaska Native, Black or African American, Hispanic, Native Hawaiian or other Pacific Islander. The definition also includes Hispanic Ethnicity as a minority group. Minority status excludes Asian and White-Not of Hispanic Origin.
[3] Includes pending user account activations.

Table 2. Users by Participation

	Users[1]	Users Present	Users Operating Remotely[2]	Users Sending Sample[3]	Off-Site Collaborators[4]
Senior Personnel, U.S.	54	25	0	10	19
Senior Personnel, non-U.S.	13	0	0	5	8
Postdocs, U.S.	9	6	0	2	1
Postdocs, non-U.S.	6	1	0	4	1
Students, U.S.	35	16	0	9	10
Students, non-U.S.	4	0	0	1	3
Technician, U.S.	0	0	0	0	0
Technician, non-U.S.	0	0	0	0	0
TOTAL	121	48	0	31	42

[1] Users using multiple facilities are counted in each facility listed.
[2] "Users Operating Remotely" refers to users who operate the magnet system from a remote location. Remote operations are not currently available in all facilities.
[3] "Users Sending Sample" refers to users who send the sample to the facility and/or research group and the experiment is conducted by other collaborators on the experiment. Users at UF, FSU, and LANL cannot be "sample senders" for facilities located on their campuses.
[4] "Off-Site Users" are scientific or technical participants on the experiment; who will not be present, sending sample, or operating the magnet system remotely; and who are not located on the campus of that facility (i.e., they are off-site).

Table 3. Users by Organization

	Users[1]	External Users	Local Users[2]	NHMFL-Affiliated Users[2,3,4]	Laboratory[3,5]	University[4,5]	Industry[5]
Senior Personnel, U.S.	54	33	5	16	6	48	0
Senior Personnel, non-U.S.	13	13	0	0	2	11	0
Postdocs, U.S.	9	5	2	2	2	7	0
Postdocs, non-U.S.	6	5	0	1	2	4	0
Students, U.S.	35	24	7	4	0	35	0
Students, non-U.S.	4	4	0	0	0	4	0
Technician, U.S.	0	0	0	0	0	0	0
Technician, non-U.S.	0	0	0	0	0	0	0
TOTAL	121	84	14	23	12	109	0

[1] Users using multiple facilities are counted in each facility listed.
[2] NHMFL-Affiliated users are defined as anyone in the lab's personnel system (i.e., on our web site/directory), even if they travel to another site. Local users are defined as any non-NHMFL-Affiliated researchers originating at any of the institutions in proximity to the MagLab sites (i.e., researchers at FSU, UF, FAMU, or LANL), even if they travel to another site.
[3] Users with primary affiliations at NHMFL/LANL are reported in NHMFL-Affiliated Users and National Laboratory.
[4] Users with primary affiliations at FSU, UF, or FAMU are reported in NHMFL-Affiliated Users and National University.
[5] The TOTAL of university, industry, and national lab users will equal the TOTAL number of users.

Table 4. Users by Discipline

	Users[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Senior Personnel, U.S.	54	12	33	2	0	7
Senior Personnel, non-U.S.	13	1	10	0	2	0
Postdocs, U.S.	9	3	4	1	1	0
Postdocs, non-U.S.	6	0	5	0	1	0
Students, U.S.	35	6	25	1	3	0
Students, non-U.S.	4	0	3	0	1	0

	Users[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Technician, U.S.	0	0	0	0	0	0
Technician, non-U.S.	0	0	0	0	0	0
TOTAL	121	22	80	4	8	7

[1] Users using multiple facilities are counted in each facility listed.

Table 5a. Subscription Rate (Experiments)

Experiments Submitted (Current Year)	Experiments Submitted (Deferred from prev. year)	Experiments With Usage	Experiments with Usage Percentage	Experiments Declined	Experiments Declined Percentage	Experiments Reviewed	Experiment Subscription Rate	Experiments Subscription Percentage
99	22	113	93.4 %	8	6.6 %	121	1.1	107.1 %

Table 5b. Subscription Rate (Magnet Days)

Days Submitted	Days Used by External User	Days Used by Local User	Days Used by NHMFL-Affiliated User	Days Used for Inst., Dev., Test and Maintenance[1]	Total Days Used	Days Subscription Rate	Days Subscription Percentage
958	415.5	40.0	92.5	222.0	770.0	1.2	124.4 %

[1] Test/Calibration/ Maintenance, Method Development, Analytical Chemistry, Upgrade Cell Design/Hardware Setup, Repair

Table 6a. Research Proposals[1] Profile (Demographics) with Magnet Time

TOTAL Proposals[1]	Minority[2]	Non-Minority	No Race Response	Female[3]	Male	Other	No Gender Response
48	2	42	4	8	38	0	2

[1] A "proposal" may have associated with it a single experiment or a group of closely related experiments. A PI may have more than one proposal.
[2] The number of proposals satisfying the following condition: The PI is a minority.
[3] The number of proposals satisfying the following condition: The PI is a female.
Note: The table refers to proposal disciplines.

Table 6b. Research Proposals Profile (Discipline) with Magnet Time

TOTAL Proposals	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
48	6	32	0	5	5

Find the list of user proposals in **Appendix V** and on our **website**

Table 7. Operations by Magnet System Group

	Total Days Used[1]	Percentage of Total Days Used	12.5T Superconducting Magnet, Pulsed EPR	17T Superconducting Magnet	Bruker	HiPER
NHMFL-Affiliated	92.5	12 %	26.5	28	0	38
Local	40	5.2 %	0	11	14	15
University, U.S.	347.5	45.1 %	95	98.5	91	63
University, non-U.S.	56	7.3 %	2	54	0	0
Government Lab, U.S.	0	0 %	0	0	0	0
Government Lab, non-U.S.	12	1.6 %	6	6	0	0
Industry, U.S.	0	0 %	0	0	0	0
Industry, non-U.S.	0	0 %	0	0	0	0
Test/Calibration/Maintenance	71.5	9.3 %	1.5	33.5	13.5	23
Method Development	150.5	19.5 %	0	0	77.5	73
Analytical Chemistry	0	0 %	0	0	0	0
Upgrade Cell Design/Hardware	0	0 %	0	0	0	0
Setup	0	0 %	0	0	0	0
Repair	0	0 %	0	0	0	0
TOTAL	770		131	231	196	212

[1] User Units are defined as magnet days. One magnet day is defined as 24 hours in superconducting magnets.

Table 8. Operations by Discipline

	Total Days Used	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
NHMFL-Affiliated	92.5	7	21	0	52.5	12
Local	40	0	40	0	0	0
University, U.S.	347.5	30.2	227.3	0	0	90
University, non-U.S.	56	0	53.5	0	2.5	0
Government Lab, U.S.	0	0	0	0	0	0
Government Lab, non-U.S.	12	6	6	0	0	0
Industry, U.S.	0	0	0	0	0	0

	Total Days Used	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Industry, non-U.S.	**0**	0	0	0	0	0
Test/ Calibration/ Maintenance	**71.5**	0	0	0	71.5	0
Method Development	**150.5**	0	0	0	34	116.5
Analytical Chemistry	**0**	0	0	0	0	0
Upgrade Cell Design/Hardware	**0**	0	0	0	0	0
Setup	**0**	0	0	0	0	0
Repair	**0**	0	0	0	0	0
TOTAL	**770**	**43.2**	**347.8**	**0**	**160.5**	**218.5**

Table 9. *New PIs[1] and New Users*

	PIs	New PIs at the MagLab	New PIs at Facility	Returning PIs at Facility	All Users	New Users at the MagLab	New Users at Facility	Returning Users at Facility
Senior Personnel, U.S.	**32**	7	7	25	54	4	6	48
Senior Personnel, non-U.S.	**10**	1	1	9	13	0	0	13
Postdocs, U.S.	**0**	0	0	0	9	3	3	6
Postdocs, non-U.S.	**1**	0	0	1	6	1	1	5
Students, U.S.	**0**	0	0	0	35	12	12	23
Students, non-U.S.	**0**	0	0	0	4	1	1	3
Technician, U.S.	**0**	0	0	0	0	0	0	0
Technician, non-U.S.	**0**	0	0	0	0	0	0	0
TOTAL	**43**	**8**	**8**	**35**	**121**	**21**	**23**	**98**

[1] PIs who received magnet time for the first time.

Table 10. *New[1] User PIs*

Name	Organization	Proposal	Year of Magnet Time	Is New to MagLab
David Herbert	University of Manitoba	P19661	Received 2021	Yes
David Powers	Texas A&M University	P19590	Received 2021	Yes
Eric Gale	Massachusetts General Hospital	P19823	Received 2021	Yes
Kevin Kittilstved	University of Massachusetts Amherst	P17861	Received 2021	Yes
Lavrent Khachatryan	Louisiana State University	P19570	Received 2021	Yes
Martin Bakker	University of Alabama, Tuscaloosa	P19771	Received 2021	Yes
Polly Arnold	University of California, Berkeley	P19738	Received 2021	Yes
Sebastian Stoian	University of Idaho	P19784	Received 2021	Yes

[1] PIs who received magnet time for the first time.

High B/T Facility

Table 1. Users by Demographic

	Users[1]	Minority[2]	Non-Minority[2]	No Response to Race[3]	Male	Female	Other	No Response to Gender[3]
Senior Personnel, U.S.	**9**	0	8	1	8	0	0	1
Senior Personnel, non-U.S.	**2**	0	2	0	1	1	0	0
Postdocs, U.S.	**3**	0	1	2	1	1	0	1
Postdocs, non-U.S.	**0**	0	0	0	0	0	0	0
Students, U.S.	**3**	0	3	0	2	0	0	1
Students, non-U.S.	**0**	0	0	0	0	0	0	0
Technician, U.S.	**0**	0	0	0	0	0	0	0
Technician, non-U.S.	**0**	0	0	0	0	0	0	0
TOTAL	**17**	**0**	**14**	**3**	**12**	**2**	**0**	**3**

[1] Users using multiple facilities are counted in each facility listed.
[2] NSF Minority status includes the following races: American Indian, Alaska Native, Black or African American, Hispanic, Native Hawaiian or other Pacific Islander. The definition also includes Hispanic Ethnicity as a minority group. Minority status excludes Asian and White-Not of Hispanic Origin.
[3] Includes pending user account activations.

Table 2. Users by Participation

	Users[1]	Users Present	Users Operating Remotely[2]	Users Sending Sample[3]	Off-Site Collaborators[4]
Senior Personnel, U.S.	**9**	5	0	0	4
Senior Personnel, non-U.S.	**2**	0	0	0	2
Postdocs, U.S.	**3**	3	0	0	0
Postdocs, non-U.S.	**0**	0	0	0	0
Students, U.S.	**3**	2	0	0	1
Students, non-U.S.	**0**	0	0	0	0
Technician, U.S.	**0**	0	0	0	0
Technician, non-U.S.	**0**	0	0	0	0
TOTAL	**17**	**10**	**0**	**0**	**7**

[1] Users using multiple facilities are counted in each facility listed.
[2] "Users Operating Remotely" refers to users who operate the magnet system from a remote location. Remote operations are not currently available in all facilities.
[3] "Users Sending Sample" refers to users who send the sample to the facility and/or research group and the experiment is conducted by other collaborators on the experiment. Users at UF, FSU, and LANL cannot be "sample senders" for facilities located on their campuses.
[4] "Off-Site Users" are scientific or technical participants on the experiment; who will not be present, sending sample, or operating the magnet system remotely; and who are not located on the campus of that facility (i.e., they are off-site).

Table 3. Users by Organization

	Users[1]	External Users	Local Users[2]	NHMFL-Affiliated Users[2,3,4]	Laboratory[3,5]	University[4,5]	Industry[5]
Senior Personnel, U.S.	**9**	4	1	4	2	7	0
Senior Personnel, non-U.S.	**2**	2	0	0	0	2	0
Postdocs, U.S.	**3**	1	1	1	0	3	0
Postdocs, non-U.S.	**0**	0	0	0	0	0	0
Students, U.S.	**3**	1	2	0	0	3	0
Students, non-U.S.	**0**	0	0	0	0	0	0
Technician, U.S.	**0**	0	0	0	0	0	0
Technician, non-U.S.	**0**	0	0	0	0	0	0
TOTAL	**17**	**8**	**4**	**5**	**2**	**15**	**0**

[1] Users using multiple facilities are counted in each facility listed.
[2] NHMFL-Affiliated users are defined as anyone in the lab's personnel system (i.e., on our web site/directory), even if they travel to another site. Local users are defined as any non-NHMFL-Affiliated researchers originating at any of the institutions in proximity to the MagLab sites (i.e., researchers at FSU, UF, FAMU, or LANL), even if they travel to another site.
[3] Users with primary affiliations at NHMFL/LANL are reported in NHMFL-Affiliated Users and National Laboratory.
[4] Users with primary affiliations at FSU, UF, or FAMU are reported in NHMFL-Affiliated Users and National University.
[5] The TOTAL of university, industry, and national lab users will equal the TOTAL number of users.

Table 4. Users by Discipline

	Users[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Senior Personnel, U.S.	**9**	7	1	0	0	1
Senior Personnel, non-U.S.	**2**	2	0	0	0	0
Postdocs, U.S.	**3**	3	0	0	0	0
Postdocs, non-U.S.	**0**	0	0	0	0	0
Students, U.S.	**3**	3	0	0	0	0
Students, non-U.S.	**0**	0	0	0	0	0

	Users[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Technician, U.S.	**0**	0	0	0	0	0
Technician, non-U.S.	**0**	0	0	0	0	0
TOTAL	**17**	**15**	**1**	**0**	**0**	**1**

[1] Users using multiple facilities are counted in each facility listed.

Table 5a. Subscription Rate (Experiments)

Experiments Submitted (Current Year)	Experiments Submitted (Deferred from prev. year)	Experiments With Usage	Experiments with Usage Percentage	Experiments Declined	Experiments Declined Percentage	Experiments Reviewed	Experiment Subscription Rate	Experiments Subscription Percentage
6	4	7	70 %	3	30 %	10	1.4	142.9 %

Table 5b. Subscription Rate (Magnet Days)

Days Submitted	Days Used by External User	Days Used by Local User	Days Used by NHMFL-Affiliated User	Days Used for Inst., Dev., Test and Maintenance[1]	Total Days Used	Days Subscription Rate	Days Subscription Percentage
645	179	66.5	48	282.5	645	0.5	100 %

[1] Test/Calibration/ Maintenance, Method Development, Analytical Chemistry, Upgrade Cell Design/Hardware Setup, Repair

Table 6a. Research Proposals[1] Profile (Demographics) with Magnet Time

TOTAL Proposals[1]	Minority[2]	Non-Minority	No Race Response	Female[3]	Male	Other	No Gender Response
5	0	4	1	1	4	0	0

[1] A "proposal" may have associated with it a single experiment or a group of closely related experiments. A PI may have more than one proposal.
[2] The number of proposals satisfying the following condition: The PI is a minority.
[3] The number of proposals satisfying the following condition: The PI is a female.
Note: The table refers to proposal disciplines.

Table 6b. Research Proposals Profile (Discipline) with Magnet Time

TOTAL Proposals	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
5	4	0	0	1	0

Find the list of user proposals in **Appendix V** and on our **website**

Table 7. Operations by Magnet System Group

	Total Days Used[1]	Percentage of Total Days Used	Bay 2 (UF Microkelvin Lab) 0.02mK, 8T	Bay 3 (UF Microkelvin Lab) 0.3mK, 16T
NHMFL-Affiliated	**48**	7.4 %	48	0
Local	**66.5**	10.3 %	0	66.5
University, U.S.	**179**	27.8 %	88	91
University, non-U.S.	**0**	0 %	0	0
Government Lab, U.S.	**0**	0 %	0	0
Government Lab, non-U.S.	**0**	0 %	0	0
Industry, U.S.	**0**	0 %	0	0
Industry, non-U.S.	**0**	0 %	0	0
Test/Calibration/Maintenance	**120**	18.6 %	71	49
Method Development	**131.5**	20.4 %	71	60.5
Analytical Chemistry	**0**	0 %	0	0
Upgrade Cell Design/ Hardware	**69**	10.7 %	39	30
Setup	**31**	4.8 %	28	3
Repair	**0**	0 %	0	0
TOTAL	**645**		345	300

[1] User Units are defined as magnet days. One magnet day is defined as 24 hours in superconducting magnets.

Table 8. Operations by Discipline

	Total Days Used	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
NHMFL-Affiliated	**48**	0	0	0	48	0
Local	**66.5**	66.5	0	0	0	0
University, U.S.	**179**	179	0	0	0	0
University, non-U.S.	**0**	0	0	0	0	0
Government Lab, U.S.	**0**	0	0	0	0	0
Government Lab, non-U.S.	**0**	0	0	0	0	0
Industry, U.S.	**0**	0	0	0	0	0

	Total Days Used	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Industry, non-U.S.	**0**	0	0	0	0	0
Test/ Calibration/ Maintenance	**120**	49	0	0	71	0
Method Development	**131.5**	60.5	0	0	71	0
Analytical Chemistry	**0**	0	0	0	0	0
Upgrade Cell Design/Hardware	**69**	41	0	0	28	0
Setup	**31**	27	0	0	4	0
Repair	**0**	0	0	0	0	0
TOTAL	**645**	**423**	**0**	**0**	**222**	**0**

Table 9. *New PIs[1] and New Users*

	PIs	New PIs at the MagLab	New PIs at Facility	Returning PIs at Facility	All Users	New Users at the MagLab	New Users at Facility	Returning Users at Facility
Senior Personnel, U.S.	**3**	1	3	0	9	0	1	8
Senior Personnel, non-U.S.	**0**	0	0	0	2	0	2	0
Postdocs, U.S.	**2**	1	1	1	3	0	0	3
Postdocs, non-U.S.	**0**	0	0	0	0	0	0	0
Students, U.S.	**0**	0	0	0	3	1	1	2
Students, non-U.S.	**0**	0	0	0	0	0	0	0
Technician, U.S.	**0**	0	0	0	0	0	0	0
Technician, non-U.S.	**0**	0	0	0	0	0	0	0
TOTAL	**5**	**2**	**4**	**1**	**17**	**1**	**4**	**13**

[1] PIs who received magnet time for the first time.

Table 10. *New[1] User PIs*

Name	Organization	Proposal	Year of Magnet Time	Is New to MagLab
Collin Broholm	Johns Hopkins University	P19504	Received 2021	No
Dominique Laroche	University of Florida	P19332	Received 2021	Yes
Lucia Steinke	University of Florida (UF)	P19653	Received 2021	Yes
Michael Shatruk	National High Magnetic Field Laboratory	P19416	Received 2021	No

[1] PIs who received magnet time for the first time.

ICR Facility

Table 1. Users by Demographic

	Users[1]	Minority[2]	Non-Minority[2]	No Response to Race[3]	Male	Female	Other	No Response to Gender[3]
Senior Personnel, U.S.	135	9	85	41	72	30	0	33
Senior Personnel, non-U.S.	61	3	26	32	24	11	0	26
Postdocs, U.S.	21	1	13	7	8	8	0	5
Postdocs, non-U.S.	10	0	7	3	4	4	0	2
Students, U.S.	69	5	47	17	24	32	0	13
Students, non-U.S.	15	2	7	6	4	9	0	2
Technician, U.S.	4	1	2	1	1	2	0	1
Technician, non-U.S.	3	0	1	2	1	1	0	1
TOTAL	318	21	188	109	138	97	0	83

[1] Users using multiple facilities are counted in each facility listed.
[2] NSF Minority status includes the following races: American Indian, Alaska Native, Black or African American, Hispanic, Native Hawaiian or other Pacific Islander. The definition also includes Hispanic Ethnicity as a minority group. Minority status excludes Asian and White-Not of Hispanic Origin.
[3] Includes pending user account activations.

Table 2. Users by Participation

	Users[1]	Users Present	Users Operating Remotely[2]	Users Sending Sample[3]	Off-Site Collaborators[4]
Senior Personnel, U.S.	135	25	3	16	91
Senior Personnel, non-U.S.	61	1	0	6	54
Postdocs, U.S.	21	5	0	1	15
Postdocs, non-U.S.	10	0	0	1	9
Students, U.S.	69	27	0	8	34
Students, non-U.S.	15	0	0	0	15
Technician, U.S.	4	0	0	2	2
Technician, non-U.S.	3	0	0	0	3
TOTAL	318	58	3	34	223

[1] Users using multiple facilities are counted in each facility listed.
[2] "Users Operating Remotely" refers to users who operate the magnet system from a remote location. Remote operations are not currently available in all facilities.
[3] "Users Sending Sample" refers to users who send the sample to the facility and/or research group and the experiment is conducted by other collaborators on the experiment. Users at UF, FSU, and LANL cannot be "sample senders" for facilities located on their campuses.
[4] "Off-Site Users" are scientific or technical participants on the experiment; who will not be present, sending sample, or operating the magnet system remotely; and who are not located on the campus of that facility (i.e., they are off-site).

Table 3. Users by Organization

	Users[1]	External Users	Local Users[2]	NHMFL-Affiliated Users[2,3,4]	Laboratory[3,5]	University[4,5]	Industry[5]
Senior Personnel, U.S.	135	109	11	15	23	98	14
Senior Personnel, non-U.S.	61	61	0	0	18	35	8
Postdocs, U.S.	21	17	1	3	3	18	0
Postdocs, non-U.S.	10	10	0	0	2	7	1
Students, U.S.	69	43	16	10	1	68	0
Students, non-U.S.	15	15	0	0	2	13	0
Technician, U.S.	4	4	0	0	0	3	1
Technician, non-U.S.	3	3	0	0	0	3	0
TOTAL	318	262	28	28	49	245	24

[1] Users using multiple facilities are counted in each facility listed.
[2] NHMFL-Affiliated users are defined as anyone in the lab's personnel system (i.e., on our web site/directory), even if they travel to another site. Local users are defined as any non-NHMFL-Affiliated researchers originating at any of the institutions in proximity to the MagLab sites (i.e., researchers at FSU, UF, FAMU, or LANL), even if they travel to another site.
[3] Users with primary affiliations at NHMFL/LANL are reported in NHMFL-Affiliated Users and National Laboratory.
[4] Users with primary affiliations at FSU, UF, or FAMU are reported in NHMFL-Affiliated Users and National University.
[5] The TOTAL of university, industry, and national lab users will equal the TOTAL number of users.

Table 4. Users by Discipline

	Users[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Senior Personnel, U.S.	135	0	82	25	2	26
Senior Personnel, non-U.S.	61	0	30	1	0	30
Postdocs, U.S.	21	0	15	1	0	5
Postdocs, non-U.S.	10	0	6	0	0	4
Students, U.S.	69	0	34	20	0	15
Students, non-U.S.	15	0	5	0	0	10

	Users[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Technician, U.S.	4	0	3	0	0	1
Technician, non-U.S.	3	0	0	0	0	3
TOTAL	**318**	**0**	**175**	**47**	**2**	**94**

[1] Users using multiple facilities are counted in each facility listed.

Table 5a. Subscription Rate (Experiments)

Experiments Submitted (Current Year)	Experiments Submitted (Deferred from prev. year)	Experiments With Usage	Experiments with Usage Percentage	Experiments Declined	Experiments Declined Percentage	Experiments Reviewed	Experiment Subscription Rate	Experiments Subscription Percentage
98	14	91	81.3 %	21	18.8 %	112	1.2	123.1 %

Table 5b. Subscription Rate (Magnet Days)

Days Submitted	Days Used by External User	Days Used by Local User	Days Used by NHMFL-Affiliated User	Days Used for Inst., Dev., Test and Maintenance[1]	Total Days Used	Days Subscription Rate	Days Subscription Percentage
2,947	295.6	24.9	28.1	255.5	794	3.7	371.2 %

[1] Test/Calibration/ Maintenance, Method Development, Analytical Chemistry, Upgrade Cell Design/Hardware Setup, Repair

Table 6a. Research Proposals[1] Profile (Demographics) with Magnet Time

TOTAL Proposals[1]	Minority[2]	Non-Minority	No Race Response	Female[3]	Male	Other	No Gender Response
75	4	58	13	19	49	0	7

[1] A "proposal" may have associated with it a single experiment or a group of closely related experiments. A PI may have more than one proposal.
[2] The number of proposals satisfying the following condition: The PI is a minority.
[3] The number of proposals satisfying the following condition: The PI is a female.
Note: The table refers to proposal disciplines.

Table 6b. Research Proposals Profile (Discipline) with Magnet Time

TOTAL Proposals	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
75	0	53	5	0	17

Find the list of user proposals in **Appendix V** and on our **website**

Table 7. Operations by Magnet System Group

	Total Days Used[1]	Percentage of Total Days Used	9.4T, 155mm bore FT-ICR MS	9.4T, 220mm bore FT-ICR MS	14.5T Hybrid LTQ/ FT-ICR MS	21T Hybrid LTQ/FT-ICR MS
NHMFL-Affiliated	28.1	3.5 %	0	10	3	15.1
Local	24.9	3.1 %	0	0	11	13.9
University, U.S.	78.7	9.9 %	0	5.5	21.5	51.7
University, non-U.S.	200.3	25.2 %	0	0.5	0	199.8
Government Lab, U.S.	5.4	0.7 %	0	1	0	4.4
Government Lab, non-U.S.	3.7	0.5 %	0	0	0	3.7
Industry, U.S.	6.5	0.8 %	0	6	0	0.5
Industry, non-U.S.	1	0.1 %	0	1	0	0
Test/Calibration/Maintenance	4	0.5 %	0	0	0	4
Method Development	0	0 %	0	0	0	0
Analytical Chemistry	251.5	31.7 %	0	0	179.5	72
Upgrade Cell Design/ Hardware	190	23.9 %	0	190	0	0
Setup	0	0 %	0	0	0	0
Repair	0	0 %	0	0	0	0
TOTAL	**794**		**0**	**214**	**215**	**365**

[1] User Units are defined as magnet days. One magnet day is defined as 24 hours in superconducting magnets.

Table 8. Operations by Discipline

	Total Days Used[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
NHMFL-Affiliated	28.1	0	25.1	0	0	3.0
Local	24.9	0	13.5	10.5	0	0.8
University, U.S.	78.7	0	57.2	5.3	0	16.2
University, non-U.S.	200.3	0	195.8	0	0	4.6
Government Lab, U.S.	5.4	0	4.1	1	0	0.3
Government Lab, non-U.S.	3.7	0	3.7	0	0	0

	Total Days Used[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Industry, U.S.	**6.5**	0	6.5	0	0	0
Industry, non-U.S.	**1**	0	1	0	0	0
Test/ Calibration/ Maintenance	**4**	0	4	0	0	0
Method Development	**0**	0	0	0	0	0
Analytical Chemistry	**251.5**	0	235	3	0	13.5
Upgrade Cell Design/ Hardware	**190**	0	190	0	0	0
Setup	**0**	0	0	0	0	0
Repair	**0**	0	0	0	0	0
TOTAL	**794**	**0**	**735.8**	**19.8**	**0**	**38.5**

[1] User Units are defined as magnet days. One magnet day is defined as 24 hours in superconducting magnets.

Table 9. *New PIs[1] and New Users*

	PIs	New PIs at the MagLab	New PIs at Facility	Returning PIs at Facility	All Users	New Users at the MagLab	New Users at Facility	Returning Users at Facility
Senior Personnel, U.S.	**49**	13	14	35	135	34	37	98
Senior Personnel, non-U.S.	**12**	8	8	4	61	14	14	47
Postdocs, U.S.	**1**	0	0	1	21	6	6	15
Postdocs, non-U.S.	**2**	0	0	2	10	2	2	8
Students, U.S.	**0**	0	0	0	69	37	37	32
Students, non-U.S.	**0**	0	0	0	15	11	11	4
Technician, U.S.	**0**	0	0	0	4	1	1	3
Technician, non-U.S.	**0**	0	0	0	3	3	3	0
TOTAL	**64**	**21**	**22**	**42**	**318**	**108**	**111**	**207**

[1] PIs who received magnet time for the first time.

Table 10. *New [1] User PIs*

Name	Organization	Proposal	Year of Magnet Time	Is New to MagLab
Alexandre Anesio	Aarhus University	P19510	Received 2021	Yes
Amie Lund	University of North Texas	P19719	Received 2021	Yes
Benjamin Gilbert	Lawrence Berkeley National Laboratory	P19512	Received 2021	Yes
Changchun Huang	Nanjing University	P19601	Received 2021	Yes
Diego Cobice	Ulster University	P19498	Received 2021	Yes
Ercan Cakmak	Oak Ridge National Laboratory	P19586	Received 2021	Yes
Francesca Kerton	Memorial University of Newfoundland	P19754	Received 2021	Yes
Hadi Mohammadigoushki	Florida State University	P19663	Received 2021	No
Hui Pu	University of North Dakota	P19603	Received 2021	Yes
Jack Ferrell	National Renewable Energy Laboratory	P19503	Received 2021	Yes
Jeffrey Stryker	University of Alberta	P19669	Received 2021	Yes
Jonathan Sweedler	University of Illinois at Urbana-Champaign	P19357	Received 2021	Yes
Katrina Counihan	Alaska SeaLife Center	P19625	Received 2021	Yes
Livia Schiavinato Eberlin	University of Texas, Austin	P19585	Received 2021	Yes
Michael Stukel	Florida State University	P19226	Received 2021	Yes
Murray Gray	Alberta Innovates	P19753	Received 2021	Yes
Qing-Xiang "Amy" Sang	Florida State University	P19666	Received 2021	Yes
Robyn Conmy	Environmental Protection Agency	P19519	Received 2021	Yes
Roderich Süssmuth	Technical University of Berlin	P19769	Received 2021	Yes
Sebastian Doetterl	ETH Zurich	P19672	Received 2021	Yes
Tullis Onstott	Princeton University	P19668	Received 2021	Yes
Yang Lin	University of Florida	P19511	Received 2021	Yes

[1] PIs who received magnet time for the first time.

NMR Facility

Table 1. Users by Demographic

	Users[1]	Minority[2]	Non-Minority[2]	No Response to Race[3]	Male	Female	Other	No Response to Gender[3]
Senior Personnel, U.S.	93	4	64	25	60	11	0	22
Senior Personnel, non-U.S.	37	4	12	21	16	6	0	15
Postdocs, U.S.	24	2	13	9	11	8	0	5
Postdocs, non-U.S.	9	0	4	5	1	3	0	5
Students, U.S.	67	3	48	16	37	17	0	13
Students, non-U.S.	13	2	7	4	6	4	0	3
Technician, U.S.	3	0	3	0	2	1	0	0
Technician, non-U.S.	2	0	1	1	1	0	0	1
TOTAL	248	15	152	81	134	50	0	64

[1] Users using multiple facilities are counted in each facility listed.
[2] NSF Minority status includes the following races: American Indian, Alaska Native, Black or African American, Hispanic, Native Hawaiian or other Pacific Islander. The definition also includes Hispanic Ethnicity as a minority group. Minority status excludes Asian and White-Not of Hispanic Origin.
[3] Includes pending user account activations.

Table 2. Users by Participation

	Users[1]	Users Present	Users Operating Remotely[2]	Users Sending Sample[3]	Off-Site Collaborators[4]
Senior Personnel, U.S.	93	33	6	17	37
Senior Personnel, non-U.S.	37	1	1	11	24
Postdocs, U.S.	24	15	0	3	6
Postdocs, non-U.S.	9	0	1	3	5
Students, U.S.	67	39	6	17	5
Students, non-U.S.	13	0	2	7	4
Technician, U.S.	3	3	0	0	0
Technician, non-U.S.	2	0	0	0	2
TOTAL	248	91	16	58	83

[1] Users using multiple facilities are counted in each facility listed.
[2] "Users Operating Remotely" refers to users who operate the magnet system from a remote location. Remote operations are not currently available in all facilities.
[3] "Users Sending Sample" refers to users who send the sample to the facility and/or research group and the experiment is conducted by other collaborators on the experiment. Users at UF, FSU, and LANL cannot be "sample senders" for facilities located on their campuses.
[4] "Off-Site Users" are scientific or technical participants on the experiment; who will not be present, sending sample, or operating the magnet system remotely; and who are not located on the campus of that facility (i.e., they are off-site).

Table 3. Users by Organization

	Users[1]	External Users	Local Users[2]	NHMFL-Affiliated Users[2,3,4]	Laboratory[3,5]	University[4,5]	Industry[5]
Senior Personnel, U.S.	93	60	8	25	7	84	2
Senior Personnel, non-U.S.	37	36	0	1	4	33	0
Postdocs, U.S.	24	11	6	7	2	22	0
Postdocs, non-U.S.	9	9	0	0	3	6	0
Students, U.S.	67	30	22	15	0	67	0
Students, non-U.S.	13	13	0	0	3	10	0
Technician, U.S.	3	0	0	3	0	3	0
Technician, non-U.S.	2	2	0	0	2	0	0
TOTAL	248	161	36	51	21	225	2

[1] Users using multiple facilities are counted in each facility listed.
[2] NHMFL-Affiliated users are defined as anyone in the lab's personnel system (i.e., on our web site/directory), even if they travel to another site. Local users are defined as any non-NHMFL-Affiliated researchers originating at any of the institutions in proximity to the MagLab sites (i.e., researchers at FSU, UF, FAMU, or LANL), even if they travel to another site.
[3] Users with primary affiliations at NHMFL/LANL are reported in NHMFL-Affiliated Users and National Laboratory.
[4] Users with primary affiliations at FSU, UF, or FAMU are reported in NHMFL-Affiliated Users and National University.
[5] The TOTAL of university, industry, and national lab users will equal the TOTAL number of users.

Table 4. Users by Discipline

	Users[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Senior Personnel, U.S.	93	3	46	11	3	30
Senior Personnel, non-U.S.	37	0	23	1	2	11
Postdocs, U.S.	24	2	7	0	5	10
Postdocs, non-U.S.	9	0	8	0	0	1
Students, U.S.	67	4	37	13	1	12
Students, non-U.S.	13	0	8	0	0	5

	Users[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Technician, U.S.	**3**	0	0	0	1	2
Technician, non-U.S.	**2**	0	2	0	0	0
TOTAL	**248**	**9**	**131**	**25**	**12**	**71**

[1] Users using multiple facilities are counted in each facility listed.

Table 5a. Subscription Rate (Experiments)

Experiments Submitted (Current Year)	Experiments Submitted (Deferred from prev. year)	Experiments With Usage	Experiments with Usage Percentage	Experiments Declined	Experiments Declined Percentage	Experiments Reviewed	Experiment Subscription Rate	Experiments Subscription Percentage
516	10	490	93.2 %	36	6.8 %	526	1.1	107.3 %

Table 5b. Subscription Rate (Magnet Days)

Days Submitted	Days Used by External User	Days Used by Local User	Days Used by NHMFL-Affiliated User	Days Used for Inst., Dev., Test and Maintenance[1]	Total Days Used	Days Subscription Rate	Days Subscription Percentage
3,222	1,285	314	1,153.5	338.5	3,091	1.0	104.2 %

[1] Test/Calibration/ Maintenance, Method Development, Analytical Chemistry, Upgrade Cell Design/Hardware Setup, Repair

Table 6a. Research Proposals[1] Profile (Demographics) with Magnet Time

TOTAL Proposals[1]	Minority[2]	Non-Minority	No Race Response	Female[3]	Male	Other	No Gender Response
66	4	51	11	13	49	0	4

[1] A "proposal" may have associated with it a single experiment or a group of closely related experiments. A PI may have more than one proposal.
[2] The number of proposals satisfying the following condition: The PI is a minority.
[3] The number of proposals satisfying the following condition: The PI is a female.
Note: The table refers to proposal disciplines.

Table 6b. Research Proposals Profile (Discipline) with Magnet Time

TOTAL Proposals	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
66	1	22	3	6	34

Find the list of user proposals in **Appendix V** and on our **website**

Table 7. Operations by Magnet System Group

Usage Type	Total Days Used	Percentage of Total Days Used	900MHz, 105mm bore, 21.1T	830MHz, 31 m bore, 19.6T	800MHz, 63mm bore, (MB) 18.8T #1	800MHz, 63mm bore, (MB) 18.8T #2	800MHz, 54mm bore (NB), 18.8T	600MHz, 89mm bore, 14T #1	600MHz, 89mm bore, 14T #2	600MHz, 89mm bore MAS DNP	500MHz, 89mm bore, 11.7T	Cell 14 36T 40mm SCH
NHMFL-Affiliated	**1,153.5**	37.3 %	102.5	81	128	298	34	304	163	15	11	17
Local	**314**	10.2 %	58	0	4	0	1	0	0	0	251	0
University, U.S.	**774**	25 %	0	157	111	7	250	36	138	61	0	14
University, non-U.S.	**352**	11.4 %	4	101	92	22	0	14	0	98	10	11
Government Lab, U.S.	**84**	2.7 %	0	0	0	0	0	0	55	0	29	0
Government Lab, non-U.S.	**14**	0.5 %	0	14	0	0	0	0	0	0	0	0
Industry, U.S.	**61**	2 %	61	0	0	0	0	0	0	0	0	0
Industry, non-U.S.	**0**	0 %	0	0	0	0	0	0	0	0	0	0
Test/Calibration/ Maintenance	**279.5**	9 %	109.5	0	2	35	80	2	4	44	3	0
Method Development	**59**	1.9 %	0	11	18	0	0	5	0	25	0	0
Analytical Chemistry	**0**	0 %	0	0	0	0	0	0	0	0	0	0
Upgrade Cell Design/ Hardware	**0**	0 %	0	0	0	0	0	0	0	0	0	0
Setup	**0**	0 %	0	0	0	0	0	0	0	0	0	0
Repair	**0**	0 %	0	0	0	0	0	0	0	0	0	0
TOTAL	**3,091**		**335**	**364**	**355**	**362**	**365**	**361**	**360**	**243**	**304**	**42**

[1] User Units are defined as magnet days. One magnet day is defined as 24 hours in superconducting magnets.

Table 8. Operations by Discipline

	Total Days Used[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
NHMFL-Affiliated	**1,153.5**	0	398	0	124	631.5
Local	**314**	0	267.5	41.5	0	5

	Total Days Used[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
University, U.S.	**774**	0	170	6	54	544
University, non-U.S.	**352**	0	190	0	17	145
Government Lab, U.S.	**84**	0	84	0	0	0
Government Lab, non-U.S.	**14**	0	14	0	0	0
Industry, U.S.	**61**	0	0	0	0	61
Industry, non-U.S.	**0**	0	0	0	0	0
Test/ Calibration/ Maintenance	**279.5**	0	0	0	279.5	0
Method Development	**59**	0	26	10	23	0
Analytical Chemistry	**0**	0	0	0	0	0
Upgrade Cell Design/ Hardware	**0**	0	0	0	0	0
Setup	**0**	0	0	0	0	0
Repair	**0**	0	0	0	0	0
TOTAL	**3,091**	**0**	**1,149.5**	**57.5**	**497.5**	**1,386.5**

[1] User Units are defined as magnet days. One magnet day is defined as 24 hours in superconducting magnets.

Table 9. *New PIs[1] and New Users*

	PIs	New PIs at the MagLab	New PIs at Facility	Returning PIs at Facility	All Users	New Users at the MagLab	New Users at Facility	Returning Users at Facility
Senior Personnel, U.S.	**40**	6	8	32	93	20	25	68
Senior Personnel, non-U.S.	**12**	2	2	10	37	9	9	28
Postdocs, U.S.	**1**	1	1	0	24	8	8	16
Postdocs, non-U.S.	**0**	0	0	0	9	4	4	5
Students, U.S.	**0**	0	0	0	67	20	26	41
Students, non-U.S.	**0**	0	0	0	13	5	5	8
Technician, U.S.	**1**	0	0	1	3	0	0	3
Technician, non-U.S.	**0**	0	0	0	2	0	0	2
TOTAL	**54**	**9**	**11**	**43**	**248**	**66**	**77**	**171**

[1] PIs who received magnet time for the first time.

Table 10. *New[1] User PIs*

Name	Organization	Proposal	Year of Magnet Time	Is New to MagLab
Biyi Xu	University of Texas, Austin	P19686	Received 2021	Yes
Cesario Borlongan	University of South Florida	P19565	Received 2021	Yes
Ercan Cakmak	Oak Ridge National Laboratory	P19640	Received 2021	Yes
Eric Breynaert	University of Leuven	P19796	Received 2021	Yes
Jeffrey Reimer	University of California, Berkeley	P19732	Received 2021	No
Jun Yang	Institute of Physics, Chinese Academy of Sciences	P19677	Received 2021	Yes
Katherine Henzler-Wildman	University of Wisconsin, Madison	P19681	Received 2021	Yes
Michael Famiano	Western Michigan University	P19582	Received 2021	Yes
Robbie Iuliucci	Washington and Jefferson College	P19772	Received 2021	Yes
Thomas Borch	Colorado State University	P19338	Received 2021	No
Xiaodan Gu	University of Southern Mississippi	P19855	Received 2021	Yes

[1] PIs who received magnet time for the first time.

PFF Facility

Table 1. Users by Demographic

	Users[1]	Minority[2]	Non-Minority[2]	No Response to Race[3]	Male	Female	Other	No Response to Gender[3]
Senior Personnel, U.S.	50	2	40	8	34	10	0	6
Senior Personnel, non-U.S.	12	0	7	5	8	0	0	4
Postdocs, U.S.	33	0	30	3	25	7	0	1
Postdocs, non-U.S.	6	1	3	2	3	2	0	1
Students, U.S.	32	1	25	6	19	9	0	4
Students, non-U.S.	3	1	1	1	2	1	0	0
Technician, U.S.	1	0	1	0	1	0	0	0
Technician, non-U.S.	0	0	0	0	0	0	0	0
TOTAL	137	5	107	25	92	29	0	16

[1] Users using multiple facilities are counted in each facility listed.
[2] NSF Minority status includes the following races: American Indian, Alaska Native, Black or African American, Hispanic, Native Hawaiian or other Pacific Islander. The definition also includes Hispanic Ethnicity as a minority group. Minority status excludes Asian and White-Not of Hispanic Origin.
[3] Includes pending user account activations.

Table 2. Users by Participation

	Users[1]	Users Present	Users Operating Remotely[2]	Users Sending Sample[3]	Off-Site Collaborators[4]
Senior Personnel, U.S.	50	24	0	2	24
Senior Personnel, non-U.S.	12	1	0	1	10
Postdocs, U.S.	33	19	0	2	12
Postdocs, non-U.S.	6	0	0	0	6
Students, U.S.	32	11	0	7	14
Students, non-U.S.	3	2	0	0	1
Technician, U.S.	1	1	0	0	0
Technician, non-U.S.	0	0	0	0	0
TOTAL	137	58	0	12	67

[1] Users using multiple facilities are counted in each facility listed.
[2] “Users Operating Remotely” refers to users who operate the magnet system from a remote location. Remote operations are not currently available in all facilities.
[3] “Users Sending Sample” refers to users who send the sample to the facility and/or research group and the experiment is conducted by other collaborators on the experiment. Users at UF, FSU, and LANL cannot be “sample senders” for facilities located on their campuses.
[4] “Off-Site Users” are scientific or technical participants on the experiment; who will not be present, sending sample, or operating the magnet system remotely; and who are not located on the campus of that facility (i.e., they are off-site).

Table 3. Users by Organization

	Users[1]	External Users	Local Users[2]	NHMFL-Affiliated Users[2,3,4]	Laboratory[3,5]	University[4,5]	Industry[5]
Senior Personnel, U.S.	50	28	5	17	21	29	0
Senior Personnel, non-U.S.	12	12	0	0	1	11	0
Postdocs, U.S.	33	16	10	7	20	13	0
Postdocs, non-U.S.	6	6	0	0	1	5	0
Students, U.S.	32	31	1	0	5	27	0
Students, non-U.S.	3	3	0	0	0	3	0
Technician, U.S.	1	0	1	0	1	0	0
Technician, non-U.S.	0	0	0	0	0	0	0
TOTAL	137	96	17	24	49	88	0

[1] Users using multiple facilities are counted in each facility listed.
[2] NHMFL-Affiliated users are defined as anyone in the lab’s personnel system (i.e., on our web site/directory), even if they travel to another site. Local users are defined as any non-NHMFL-Affiliated researchers originating at any of the institutions in proximity to the MagLab sites (i.e., researchers at FSU, UF, FAMU, or LANL), even if they travel to another site.
[3] Users with primary affiliations at NHMFL/LANL are reported in NHMFL-Affiliated Users and National Laboratory.
[4] Users with primary affiliations at FSU, UF, or FAMU are reported in NHMFL-Affiliated Users and National University.
[5] The TOTAL of university, industry, and national lab users will equal the TOTAL number of users.

Table 4. Users by Discipline

	Users[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Senior Personnel, U.S.	50	45	2	0	0	3
Senior Personnel, non-U.S.	12	12	0	0	0	0
Postdocs, U.S.	33	30	1	0	2	0
Postdocs, non-U.S.	6	3	0	0	3	0
Students, U.S.	32	28	1	3	0	0
Students, non-U.S.	3	3	0	0	0	0

	Users[1]	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Technician, U.S.	**1**	1	0	0	0	0
Technician, non-U.S.	**0**	0	0	0	0	0
TOTAL	**137**	**122**	**4**	**3**	**5**	**3**

[1] Users using multiple facilities are counted in each facility listed.

Table 5a. *Subscription Rate (Experiments)*

Experiments Submitted (Current Year)	Experiments Submitted (Deferred from prev. year)	Experiments With Usage	Experiments with Usage Percentage	Experiments Declined	Experiments Declined Percentage	Experiments Reviewed	Experiment Subscription Rate	Experiments Subscription Percentage
81	18	69	69.7 %	30	30.3 %	99	1.4	143.5 %

Table 5b. *Subscription Rate (Magnet Days)*

Days Submitted	Days Used by External User	Days Used by Local User	Days Used by NHMFL-Affiliated User	Days Used for Inst., Dev., Test and Maintenance[1]	Total Days Used	Days Subscription Rate	Days Subscription Percentage
639	287	72	98	0	457	1.4	139.8 %

[1] Test/Calibration/ Maintenance, Method Development, Analytical Chemistry, Upgrade Cell Design/Hardware Setup, Repair

Table 6a. *Research Proposals[1] Profile (Demographics) with Magnet Time*

TOTAL Proposals[1]	Minority[2]	Non-Minority	No Race Response	Female[3]	Male	Other	No Gender Response
43	0	36	7	14	24	0	5

[1] A "proposal" may have associated with it a single experiment or a group of closely related experiments. A PI may have more than one proposal.
[2] The number of proposals satisfying the following condition: The PI is a minority.
[3] The number of proposals satisfying the following condition: The PI is a female.
Note: The table refers to proposal disciplines.

Table 6b. *Research Proposals Profile (Discipline) with Magnet Time*

TOTAL Proposals	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
43	39	1	0	2	1

Find the list of user proposals in **Appendix V** and on our **website**

Table 7. *Operations by Magnet System Group*

	Total Days Used	Percentage of Total Days Used	Duplex	Short Pulse
NHMFL-Affiliated	**98**	21.4 %	6	92
Local	**72**	15.8 %	9	63
University, U.S.	**182**	39.8 %	30	152
University, non-U.S.	**53**	11.6 %	0	53
Government Lab, U.S.	**52**	11.4 %	22	30
Government Lab, non-U.S.	**0**	0 %	0	0
Industry, U.S.	**0**	0 %	0	0
Industry, non-U.S.	**0**	0 %	0	0
Test/Calibration/ Maintenance	**0**	0 %	0	0
Method Development	**0**	0 %	0	0
Analytical Chemistry	**0**	0 %	0	0
Upgrade Cell Design/ Hardware	**0**	0 %	0	0
Setup	**0**	0 %	0	0
Repair	**0**	0 %	0	0
TOTAL	**457**		**67**	**390**

Table 8. *Operations by Discipline*

	Total Days Used	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
NHMFL-Affiliated	**98**	83	0	0	15	0
Local	**72**	72	0	0	0	0
University, U.S.	**182**	176	6	0	0	0
University, non-U.S.	**53**	43	0	0	10	0
Government Lab, U.S.	**52**	52	0	0	0	0
Government Lab, non-U.S.	**0**	0	0	0	0	0
Industry, U.S.	**0**	0	0	0	0	0
Industry, non-U.S.	**0**	0	0	0	0	0

	Total Days Used	Condensed Matter Physics	Chemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Test/ Calibration/ Maintenance	**0**	0	0	0	0	0
Method Development	**0**	0	0	0	0	0
Analytical Chemistry	**0**	0	0	0	0	0
Upgrade Cell Design/ Hardware	**0**	0	0	0	0	0
Setup	**0**	0	0	0	0	0
Repair	**0**	0	0	0	0	0
TOTAL	**457**	**426**	**6**	**0**	**25**	**0**

Table 9. *New PIs[1] and New Users*

	PIs	New PIs at the MagLab	New PIs at Facility	Returning PIs at Facility	All Users	New Users at the MagLab	New Users at Facility	Returning Users at Facility
Senior Personnel, U.S.	**25**	4	7	18	50	3	8	42
Senior Personnel, non-U.S.	**4**	0	1	3	12	2	2	10
Postdocs, U.S.	**5**	2	2	3	33	7	13	20
Postdocs, non-U.S.	**2**	2	2	0	6	1	1	5
Students, U.S.	**0**	0	0	0	32	9	17	15
Students, non-U.S.	**0**	0	0	0	3	2	3	0
Technician, U.S.	**0**	0	0	0	1	0	0	1
Technician, non-U.S.	**0**	0	0	0	0	0	0	0
TOTAL	**36**	**8**	**12**	**24**	**137**	**24**	**44**	**93**

[1] PIs who received magnet time for the first time.

Table 10. *New[1] User PIs*

Name	Organization	Proposal	Year of Magnet Time	Is New to MagLab
Chris Palmstrom	University of California, Santa Barbara	P18013	Received 2021	No
Cui-Zu Chang	Pennsylvania State University	P19621	Received 2021	Yes
Eugenio Coronado	University of Valencia	P19393	Received 2021	No
Huibo Cao	Oak Ridge National Laboratory	P19536	Received 2021	Yes
James Wampler	Los Alamos National Laboratory	P19634	Received 2021	Yes
Jiun-Haw Chu	University of Washington	P17782	Received 2021	No
Kathrin Goetze	Deutsches Elektronen-Synchrotron DESY	P19537	Received 2021	Yes
Magdalena Owczarek	Los Alamos National Laboratory	P19535	Received 2021	Yes
Matthew Coak	University of Warwick	P19533	Received 2021	Yes
Nitin Samarth	Pennsylvania State University	P19651	Received 2021	Yes
Rongying Jin	University of South Carolina	P19126	Received 2021	No
Valentin Taufour	University of California, Davis	P19616	Received 2021	Yes

[1] PIs who received magnet time for the first time.

APPENDIX 3
USER FACILITIES OVERVIEW

Table 1a. Users by Demographic of All Facilities

	Users[1]	Minority[2]	Non-Minority[2]	No Response to Race[3]	Male	Female	Other	No Response to Gender[3]
Senior Personnel, U.S.	646	33	473	140	419	114	0	113
Senior Personnel, non-U.S.	167	14	81	72	84	31	0	52
Postdocs, U.S.	197	12	145	40	121	51	0	25
Postdocs, non-U.S.	38	2	23	13	14	14	0	10
Students, U.S.	456	31	298	127	240	123	0	93
Students, non-U.S.	52	6	27	19	25	16	0	11
Technician, U.S.	54	7	27	20	18	17	0	19
Technician, non-U.S.	5	0	2	3	2	1	0	2
TOTAL	1,615	105	1,076	434	923	367	0	325

[1] Users using multiple facilities are counted in each facility listed.
[2] NSF Minority status includes the following races: American Indian, Alaska Native, Black or African American, Hispanic, Native Hawaiian or other Pacific Islander. The definition also includes Hispanic Ethnicity as a minority group. Minority status excludes Asian and White-Not of Hispanic Origin.
[3] Includes pending user account activations.

Table 1b. Users by Demographic by Facilities

	Users	Minority	Non-Minority	No Response to Race	Male	Female	Other	No Response to Gender
AMRIS – NSF-Funded	75	11	50	14	56	10	0	9
AMRIS – Non-NHMFL-Funded	265	31	149	85	102	90	0	73
DC Field	434	15	331	88	311	64	0	59
EMR	121	7	85	29	78	25	0	18
High B/T	17	0	14	3	12	2	0	3
ICR	318	21	188	109	138	97	0	83
NMR	248	15	152	81	134	50	0	64
Pulsed Field	137	5	107	25	92	29	0	16
TOTAL	1,615	105	1,076	434	923	367	0	325

Table 2a. Users by Participation of All Facilities

	Users[1]	Users Present	Users Operating Remotely[2]	Users Sending Sample[3]	Off-Site Collaborators[4]
Senior Personnel, U.S.	646	274	11	68	293
Senior Personnel, non-U.S.	167	4	1	34	128
Postdocs, U.S.	197	119	1	13	64
Postdocs, non-U.S.	38	1	1	9	27
Students, U.S.	456	283	8	47	118
Students, non-U.S.	52	2	2	11	37
Technician, U.S.	54	50	0	2	2
Technician, non-U.S.	5	0	0	0	5
TOTAL	1,615	733	24	184	674

[1] Users using multiple facilities are counted in each facility listed.
[2] "Users Operating Remotely" refers to users who operate the magnet system from a remote location. Remote operations are not currently available in all facilities.
[3] "Users Sending Sample" refers to users who send the sample to the facility and/or research group and the experiment is conducted by other collaborators on the experiment. Users at UF, FSU, and LANL cannot be "sample senders" for facilities located on their campuses.
[4] "Off-Site Users" are scientific or technical participants on the experiment; who will not be present, sending sample, or operating the magnet system remotely; and who are not located on the campus of that facility (i.e., they are off-site).

Table 2b. Users by Participation by Facilities

	Users	Users Present	Users Operating Remotely	Users Sending Sample	Off-Site Collaborators
AMRIS – NSF-Funded	75	44	4	2	25
AMRIS – Non-NHMFL-Funded	265	224	1	0	40
DC Field	434	200	0	47	187
EMR	121	48	0	31	42
High B/T	17	10	0	0	7
ICR	318	58	3	34	223

	Users	Users Present	Users Operating Remotely	Users Sending Sample	Off-Site Collaborators
NMR	248	91	16	58	83
Pulsed Field	137	58	0	12	67
TOTAL	1,615	733	24	184	674

Table 3a. Users by Organization of All Facilities

	Users[1]	External Users	Local Users[2]	NHMFL-Affiliated Users[2,3,4]	Laboratory[3,5]	University[4,5]	Industry[5]
Senior Personnel, U.S.	646	403	86	157	81	546	19
Senior Personnel, non-U.S.	167	166	0	1	32	125	10
Postdocs, U.S.	197	114	52	31	38	159	0
Postdocs, non-U.S.	38	37	0	1	11	26	1
Students, U.S.	456	270	146	40	17	439	0
Students, non-U.S.	52	52	0	0	5	47	0
Technician, U.S.	54	17	24	13	2	51	1
Technician, non-U.S.	5	5	0	0	2	3	0
TOTAL	1,615	1,064	308	243	188	1,396	31

[1] Users using multiple facilities are counted in each facility listed.
[2] NHMFL-Affiliated users are defined as anyone in the lab's personnel system (i.e., on our web site/directory), even if they travel to another site. Local users are defined as any non-NHMFL-Affiliated researchers originating at any of the institutions in proximity to the MagLab sites (i.e., researchers at FSU, UF, FAMU, or LANL), even if they travel to another site.
[3] Users with primary affiliations at NHMFL/LANL are reported in NHMFL-Affiliated Users and National Laboratory.
[4] Users with primary affiliations at FSU, UF, or FAMU are reported in NHMFL-Affiliated Users and National University.
[5] The total of university, industry, and national lab users will equal the total number of users.

Table 3b. Users by Organization by Facilities

	Users	External Users	Local Users	NHMFL-Affiliated Users	Laboratory	University	Industry
AMRIS – NSF-Funded	75	38	22	15	3	71	1
AMRIS – Non-NHMFL-Funded	265	83	160	22	2	261	2
DC Field	434	332	27	75	50	382	2
EMR	121	84	14	23	12	109	0
High B/T	17	8	4	5	2	15	0
ICR	318	262	28	28	49	245	24
NMR	248	161	36	51	21	225	2
Pulsed Field	137	96	17	24	49	88	0
TOTAL	1,615	1,064	308	243	188	1,396	31

Table 4a. Users by Discipline of All Facilities

	Users[1]	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
Senior Personnel, U.S.	646	182	204	72	22	166
Senior Personnel, non-U.S.	167	44	69	2	6	46
Postdocs, U.S.	197	88	30	6	16	57
Postdocs, non-U.S.	38	8	21	0	4	5
Students, U.S.	456	147	123	64	27	95
Students, non-U.S.	52	16	19	1	1	15
Technician, U.S.	54	1	3	3	14	33
Technician, non-U.S.	5	0	2	0	0	3
TOTAL	1,615	486	471	148	90	420

[1] Users using multiple facilities are counted in each facility listed.

Table 4b. Users by Discipline by Facilities

	Users	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
AMRIS – NSF-Funded	75	1	20	16	2	36
AMRIS – Non-NHMFL-Funded	265	1	11	30	28	195
DC Field	434	316	49	23	33	13
EMR	121	22	80	4	8	7
High B/T	17	15	1	0	0	1
ICR	318	0	175	47	2	94
NMR	248	9	131	25	12	71
Pulsed Field	137	122	4	3	5	3
TOTAL	1,615	486	471	148	90	420

Table 5a. Subscription Rate (Experiments) by Facilities

	Experiments Submitted (Current Year)	Experiments Submitted (Deferred from prev. year)	Experiments With Usage	Experiments With Usage Percentage	Experiments Declined	Experiments Declined Percentage	Experiments Reviewed	Experiment Subscription Rate	Experiments Subscription Percentage
AMRIS – NSF-Funded	**12**	20	31	96.9 %	1	3.1 %	32	1.0	103.2 %
AMRIS – Non-NHMFL-Funded	**46**	75	118	97.5 %	3	2.5 %	121	1.0	102.5 %
DC Field	**237**	57	198	67.3 %	96	32.7 %	294	1.5	148.5 %
EMR	**99**	22	113	93.4 %	8	6.6 %	121	1.1	107.1 %
High B/T	**6**	4	7	70 %	3	30 %	10	1.4	142.9 %
ICR	**98**	14	91	81.3 %	21	18.8 %	112	1.2	123.1 %
NMR	**516**	10	490	93.2 %	36	6.8 %	526	1.1	107.3 %
Pulsed Field	**81**	18	69	69.7 %	30	30.3 %	99	1.4	143.5 %
TOTAL	**1,095**	**220**	**1,117**		**198**		**1,315**		

Table 5b. Subscription Rate (Magnet Days) by Facilities

	Days Submitted	Days Used by External User	Days Used by Local User	Days Used by NHMFL-Affiliated User	Days Used for Inst., Dev., Test and Maintenance	Total Days Used	Days Subscription Rate	Days Subscription Percentage
AMRIS – NSF-Funded	**1,292**	465.3	80.5	40.8	604.4	1,292	1.0	100 %
AMRIS – Non-NHMFL-Funded	**1,634**	793.1	327.8	472.7	40.3	1,634	1.0	100 %
DC Field	**1,862**	1,012.6	29	239.2	48	1,328.8	1.4	140.1 %
EMR	**958**	415.5	40	92.5	222	770	1.2	124.4 %
High B/T	**645**	179	66.5	48	282.5	645	1.0	100 %
ICR	**2,947**	295.6	24.9	28.1	255.5	794	3.7	371.2 %
NMR	**3,222**	1,285	314	1,153.5	338.5	3,091	1.0	104.2 %
Pulsed Field	**639**	287	72	98	0	457	1.4	139.8 %
TOTAL	**13,204**	**4,733**	**954.7**	**2,172.8**	**1,791.2**	**10,011.8**		

Table 6. Research Proposals[1] Profile with Magnet Time by Facilities

	Total Proposals[1]	Minority[2]	Non-Minority	No Race Response	Female[3]	Male	Other	No Gender Response	CMP	Chemistry, Geochemistry	Engineering	Magnets, Materials	Biology, Biochem, Biophys.
AMRIS – NSF-Funded	**31**	4	23	4	7	21	0	3	0	4	4	4	19
AMRIS – Non-NHMFL-Funded	**97**	7	64	26	34	43	0	20	0	0	0	2	95
DC Field	**131**	2	116	13	20	104	0	7	103	11	2	11	4
EMR	**48**	2	42	4	8	38	0	2	6	32	0	5	5
High B/T	**5**	0	4	1	1	4	0	0	4	0	0	1	0
ICR	**75**	4	58	13	19	49	0	7	0	53	5	0	17
NMR	**66**	4	51	11	13	49	0	4	1	22	3	6	34
Pulsed Field	**43**	0	36	7	14	24	0	5	39	1	0	2	1
TOTAL	**496**	**23**	**394**	**79**	**116**	**332**	**0**	**48**	**153**	**123**	**14**	**31**	**175**

[1] A "proposal" may have associated with it a single experiment or a group of closely related experiments. A PI may have more than one proposal.
[2] The number of proposals satisfying the following condition: The PI is a minority.
[3] The number of proposals satisfying the following condition: The PI is a female.
Note: The table refers to proposal disciplines.

Find the list of user proposals in **Appendix V** and on our website

Table 7. Operations by User Type by Facilities

	Total Days Used	Days Used by External User[8]	Days Used by Local User[9]	Days Used by NHMFL-Affiliated User[10]	Days of Instrumentation Development and Maintenance[11]
AMRIS – NSF-Funded[1]	**1,292**	465.3	80.5	40.8	604.4
AMRIS – Non-NHMFL-Funded[1]	**1,634**	793.1	327.8	472.7	40.3
DC Field[2]	**1,328.8**	1,012.6	29	239.2	48
EMR[3]	**770**	415.5	40	92.5	222
High B/T[4]	**645**	179	66.5	48	282.5
ICR[5]	**794**	295.6	24.9	28.1	255.5
NMR[6]	**3,091**	1,285	314	1,153.5	338.5
Pulsed Field[7]	**457**	287	72	98	0
TOTAL	**10,011.8**	**4,733.0**	**954.7**	**2,172.8**	**1,791.2**

[1] User Units are defined as magnet days; time utilized is recorded to the nearest 15 minutes. Magnet day definitions for AMRIS instruments: Verticals (500, 600s, & 750MHz), 1 magnet day = 24 hours. Horizontals (4.7 and 11.1T), 1 magnet day = 8 hours. This accounts for the difficulty in running animal or human studies overnight. Magnet days were

calculated by adding the total number of real used for each instrument and dividing by 24 (vertical) or 8 (horizontal). Note: Due to the nature of the 4.7T and 11T studies, almost all studies with external users were collaborative with UF investigators.

[2] Each 20MW resistive magnet requires two power supplies to run, the 45T hybrid magnet requires three power supplies, and the 36T Series Connected Hybrid requires one power supply. Thus, there can be four resistive magnets + three superconducting magnets operating or the 45T hybrid, series connected hybrid, two resistive magnets and three superconducting magnets. User Units are defined as magnet days. Users of water-cooled resistive or hybrid magnets can typically expect to receive enough energy for 7 hours a day of magnet usage, so a magnet day is defined as 7 hours. Superconducting magnets are scheduled typically 24 hours a day.

[3, 4, 5, 6] User Units are defined as magnet days. One magnet day is defined as 24 hours in superconducting magnets.

[7] User Units are defined as magnet days. Magnets are scheduled typically 12 hours a day.

[8] Days to external users at facility => all U.S. University, U.S. Govt. Lab., U.S. Industry, Non-U.S. excluding NHMFL Affiliated, Local, Test, Calibration, Set-up, Maintenance, Inst. Dev.

[9] Days to local => local only

[10] Days to NHMFL-Affiliated (in-house) research => NHMFL-Affiliated only

[11] Days to instrument development and maintenance (combined) => Test/Calibration/ Maintenance, Method Development, Analytical Chemistry, Upgrade Cell Design/Hardware Setup, Repair

Table 8. *Operations by Discipline of All Facilities*

	Total Days Used	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
NHMFL-Affiliated	**2,172.8**	262.7	444.1	0	303.5	1,162.5
Local	**954.7**	154.5	347.2	52	13	388
University, U.S.	**3,527.8**	1,027.3	678.8	198.5	97.7	1,525.5
University, non-U.S.	**828.3**	144.5	459.3	0	36.5	188.1
Government Lab, U.S.	**244.8**	125.4	88.1	1	0	30.3
Government Lab, non-U.S.	**58.7**	35	23.7	0	0	0
Industry, U.S.	**72.5**	0	6.5	0	0	66
Industry, non-U.S.	**1**	0	1	0	0	0
Test/Calibration/ Maintenance	**768**	49	4	0	422	293
Method Development	**544.7**	108.5	26	10	131	269.2
Analytical Chemistry	**251.5**	0	235	3	0	13.5
Upgrade Cell Design/Hardware	**360**	41	190	0	28	101
Setup	**227.1**	27	0	0	5	195.1
Repair	**0**	0	0	0	0	0
TOTAL	**10,011.8**	**1,974.8**	**2,503.5**	**264.5**	**1,036.7**	**4,232.2**

Table 8b. *Operations by Discipline of All Facilities*

	Total Days Used	Condensed Matter Physics	Chemistry, Geochemistry	Engineering	Magnets, Materials	Biology, Biochemistry, Biophysics
AMRIS – NSF-Funded	**1,292**	0	127	174.8	0	990.3
AMRIS – Non-NHMFL-Funded	**1,634**	0	32.5	6.5	6.5	1,588.5
DC Field	**1,328.8**	1,082.7	104.9	6	125.2	10
EMR	**770**	43.2	347.8	0	160.5	218.5
High B/T	**645**	423	0	0	222.0	0
ICR	**794**	0	735.8	19.8	0	38.5
NMR	**3,091**	0	1,149.5	57.5	497.5	1,386.5
Pulsed Field	**457**	426	6	0	25	0
TOTAL	**10,011.8**	**1,974.8**	**2,503.5**	**264.5**	**1,036.7**	**4,232.2**

Table 9a. *New PIs[1] and New Users of All Facilities*

	PIs	New PIs at the MagLab	New PIs at Facility	Returning PIs at Facility	All Users	New Users at the MagLab	New Users at Facility	Returning Users at Facility
Senior Personnel, U.S.	**343**	60	69	274	646	79	98	548
Senior Personnel, non-U.S.	**57**	17	19	38	167	32	36	131
Postdocs, U.S.	**20**	7	7	13	197	46	53	144
Postdocs, non-U.S.	**6**	3	3	3	38	9	11	27
Students, U.S.	**0**	0	0	0	456	146	166	290
Students, non-U.S.	**0**	0	0	0	52	23	26	26
Technician, U.S.	**1**	0	0	1	54	5	5	49
Technician, non-U.S.	**0**	0	0	0	5	3	3	2
TOTAL	**427**	**87**	**98**	**329**	**1,615**	**343**	**398**	**1,217**

[1] PIs who received magnet time for the first time.

Table 9b. *New PIs and New Users by Facilities*

	PIs	New PIs at the MagLab	New PIs at Facility	Returning PIs at Facility	All Users	New Users at the MagLab	New Users at Facility	Returning Users at Facility
AMRIS – NSF-Funded	**32**	7	7	25	434	98	110	324
AMRIS – Non-NHMFL-Funded	**83**	14	14	69	248	66	77	171

	PIs	New PIs at the MagLab	New PIs at Facility	Returning PIs at Facility	All Users	New Users at the MagLab	New Users at Facility	Returning Users at Facility
DC Field	110	18	20	90	318	108	111	207
EMR	43	8	8	35	121	21	23	98
High B/T	5	2	4	1	137	24	44	93
ICR	64	21	22	42	17	1	4	13
NMR	54	9	11	43	75	7	9	66
Pulsed Field	36	8	12	24	265	18	20	245
TOTAL	427	87	98	329	1,615	343	398	1,217

Table 10a. *Funding Source of Users' Research-Day Allotted (Counts) by Facilities*

	Total Days Used	NSF[1]	NIH	DOE	DOD[2]	FFI	UF MBI	EPA	International	National	Industry[3]
AMRIS – NSF-Funded	1,292	1,266.4	4.3	0	3	0	0	0	0	18.3	0
AMRIS – Non-NHMFL-Funded	1,634	52.6	1,107.2	0	14.4	0	17.6	0	0	384.3	14.4
DC Field	1,328.8	627.8	20	375.8	15.3	0	0	0	122.3	167.6	0
EMR	770	581.2	5.5	72.3	4.0	0	0	0	44.5	62.5	0
High B/T	645	497	0	148	0	0	0	0	0	0	0
ICR	794	116.7	412.9	5.7	126.3	1	0	0.5	21.5	86.6	21.7
NMR	3,091	1,221	883.5	108.7	0	0	0	0	375.5	251.3	251
Pulsed Field	457	117.5	0	264.5	0	0	0	0	33	42	0
TOTAL	10,011.8	4,480.2	2,433.4	975	163	1	17.6	0.5	596.7	1,012.7	287

[1] Includes NSF, UCGP, and 'No other support'.
[2] Includes NASA, US Army, US Navy, and US Air force.
[3] Includes US Industry and Non-US Industry.

Table 10b. *Funding Source of Users' Research-Day Allotted (Percentage) by Facilities*

	NSF	NIH	DOE	DOD	FFI	UF MBI	EPA	International	National	Industry
AMRIS – NSF-Funded	98 %	0.3 %	0 %	0 %	0 %	0 %	0 %	0 %	1.4 %	0 %
AMRIS – Non-NHMFL-Funded	3.2 %	67.8 %	0 %	0.4 %	0 %	1.1 %	0 %	0 %	23.5 %	0.9 %
DC Field	47.3 %	1.5 %	28.3 %	1.2 %	0 %	0 %	0 %	9.2 %	12.6 %	0 %
EMR	75.5 %	0.7 %	9.4 %	0.5 %	0 %	0 %	0 %	5.8 %	8.1 %	0 %
High B/T	77.1 %	0 %	22.9 %	0 %	0 %	0 %	0 %	0 %	0 %	0 %
ICR	14.7 %	52 %	0.7 %	0 %	0.1 %	0 %	0.1 %	2.7 %	10.9 %	2.7 %
NMR	39.5 %	28.6 %	3.5 %	0 %	0 %	0 %	0 %	12.1 %	8.1 %	8.1 %
Pulsed Field	25.7 %	0 %	57.9 %	0 %	0 %	0 %	0 %	7.2 %	9.2 %	0 %

APPENDIX 4
GEOGRPHIC DISTRIBUTION

AMRIS – NSF FUNDED – NATIONAL USERS

First Name	Last Name	Organization	State	Country
Fernando	Alferez	University of Florida	FL	USA
Anastasios	Angelopoulos	University of Cincinnati	OH	USA
Luke	Arbogast	National Institute of Standards and Technology MD	MD	USA
Bill	Baker	University of South Florida	FL	USA
Amineh	Baniani	University of Florida	FL	USA
Elisabeth	Barton	University of Florida	FL	USA
Abhinandan	Batra	University of Florida	FL	USA
Juan	Beltran-Huarac	East Carolina University	NC	USA
Lorena	Bianchine Areal	Florida Atlantic University	FL	USA
Randy	Blakely	Florida Atlantic University	FL	USA
Clifford	Bowers	University of Florida	FL	USA
Joe	Bracegirdle	University of South Florida	FL	USA
A. Caroline	Buchanan	University of Florida	FL	USA
Eduardo	Candelario-Jalil	University of Florida	FL	USA
James H.P.	Collins	University of Florida	FL	USA
Luis	Colon-Perez	University of California, Irvine	CA	USA
John	Cooper	East Carolina University	NC	USA
Kunjan	Dave	University of Miami	FL	USA
Stanislaw	Deja	University of Texas, Southwestern	TX	USA
Matthew	Eddy	University of Florida	FL	USA
Malathy	Elumalai	University of Florida	FL	USA
Alec	Esper	University of Florida	FL	USA
Marcelo	Febo	University of Florida	FL	USA
Guillaume	Ferre	University of Florida	FL	USA
Johnny	Figueroa	Loma Linda University	CA	USA
Leo	Fontenot	Louisiana State University	LA	USA
Niloofar	Gopal Pour	University of Florida	FL	USA
Hala	Hachem	University of Florida	FL	USA
Michael	Harris	University of Florida	FL	USA
Chongyang	Huang	university of Florida	FL	USA
Kelly	Jenkins	University of Florida	FL	USA
Jonathan	Judy	University of Florida	FL	USA
Ram	Khattri	University of Florida	FL	USA
Peder	Larson	University of California, San Francisco	CA	USA
Jimmy	Lawrence	Louisiana State University	LA	USA
Ryan	Lively	Georgia Institute of Technology	GA	USA
Sandra	Loesgen	University of Florida	FL	USA
Joanna	Long	University of Florida	FL	USA
Rohit	Mahar	University of Florida	FL	USA
Thomas	Mareci	University of Florida	FL	USA
John	Marino	National Institute of Standards and Technology MD	MD	USA
Marc	McLeod	University of Florida College of Medicine	FL	USA
Andrew	Medford	Georgia Institute of Technology	GA	USA
Matthew	Merritt	University of Florida	FL	USA
Zhihui	Miao	University of Florida	FL	USA
Gerardo	Morell	University of Puerto Rico	PR	USA
Emma	Mulry	University of Florida	FL	USA
Sean	Najmi	Georgia Institute of Technology	GA	USA
Jonathan	Nickels	University of Cincinnati	OH	USA
Marjory	Pompilus	University of Florida	UF	USA
Mukundan	Ragavan	University of Florida	FL	USA
Arka Prabha	Ray	University of Florida	FL	USA
Julian	Rey	University of Florida	FL	USA

First Name	Last Name	Organization	State	Country
Mario	Rivera	Louisiana State University	LA	USA
James	Rocca	University of Florida	FL	USA
Jens	Rosenberg	National High Magnetic Field Laboratory	FL	USA
Pratik	Roy	University of Florida	FL	USA
Jeffrey	Rudolf	University of Florida	FL	USA
Malisa	Sarntinoranont	University of Florida	FL	USA
Carsten	Sievers	Georgia Institute of Technology	GA	USA
Joshua	Slade	University of Florida	FL	USA
Brent	Sumerlin	University of Florida	FL	USA
Daniel R.	Talham	University of Florida	FL	USA
Blake	Trusty	University of Florida	FL	USA
Sergey	Vasenkov	University of Florida	FL	USA
Adam	Veige	University of Florida	FL	USA
Glenn	Walter	University of Florida	FL	USA
Thomas	Weldeghiorghis	Louisiana State University	LA	USA
Benjamin	Wylie	Texas Tech University	TX	USA
Baofu	Xu	University of Florida	FL	USA
Huadong	Zeng	University of Florida	FL	USA

AMRIS – NSF FUNDED – INTERNATIONAL USERS

First Name	Last Name	Organization	Country
Pascal	Bernatchez	University of British Columbia	Canada
Jaime	Cuber	Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria	Spain
John	Jones	Center for Neurosciences and Cell Biology	Portugal
Rui	Leite	Instituto Agronômico do Paraná	Brazil

AMRIS – NON-NHMFL-FUNDED USERS

First Name	Last Name	Organization	State	Country
Matthew	Burns	University of Florida	FL	USA
Jose	Abisambra	University of Florida	FL	USA
Qutell	Adderley	Fisk University	TN	USA
Rahul	Ainpudi	University of Florida	FL	USA
Meryl	Alappattu	University of Florida	FL	USA
Seif	Aldalil	University of Florida	FL	USA
Manish	Amin	University of Florida	FL	USA
Kara	Anazia	University of Florida	FL	USA
Melissa	Armstrong	University of Florida	FL	USA
Tetsuo	Ashizawa	University of Florida	FL	USA
Pratiksha	Awale	University of Florida	FL	USA
Guita	Banan	University of Florida	FL	USA
Fatemeh	Baniasad	University of Florida	FL	USA
Alison	Barnard	University of Florida	FL	USA
Adam	Barnas	University of Florida	FL	USA
Ana	Barran-Berdon	University of Florida	FL	USA
Elisabeth	Barton	University of Florida	FL	USA
Abhinandan	Batra	University of Florida	FL	USA
Samuel	Berens	University of Florida	FL	USA
Avni	Bhatt	University of Florida	FL	USA
Mieniecia (Nieci)	Black	Laboratory for Rehabilitation Neuroscience	FL	USA
Jeff	Boissoneault	University of Florida	FL	USA
Mackenzie	Bolen	University of Florida	FL	USA
Zachary	Boogaart	University of Florida	FL	USA
Dawn	Bowers	University of Florida	FL	USA
Jeannine	Brady	University of Florida	FL	USA
Isadora	Braga	University of Florida	FL	USA
William	Brey	National High Magnetic Field Laboratory	FL	USA
Fernando	Bril	University of Florida	FL	USA
Albert	Brotgandel	University of Florida	FL	USA
Madison	Bryan	University of Florida	FL	USA

First Name	Last Name	Organization	State	Country
Michael	Bubb	University of Florida	FL	USA
Roxana	Burciu	University of Florida	FL	USA
Sara	Burke	University of Florida	FL	USA
Rebecca	Butcher	University of Florida	FL	USA
Barry	Byrne	University of Florida	FL	USA
Martha	Campbell-Thompson	University of Florida	FL	USA
Josue	Cardoso	University of Florida	FL	USA
Paramita	Chakrabarty	University of Florida	FL	USA
Mario	Chang Reyes	University of Florida	FL	USA
Shane	Chatfield	University of Florida	FL	USA
Munish	Chauhan	Arizona State University	AZ	USA
Qiyin	Chen	University of Florida	FL	USA
Miriam	Cintron	University of Florida	FL	USA
David	Clark	Malcom Randall VA Medical Center	FL	USA
Virginia	Clark	University of Florida	FL	USA
Christina	Clarke	University of Florida	FL	USA
Asia	Cobb	University of Florida	FL	USA
Ron	Cohen	University of Florida	FL	USA
James H.P.	Collins	University of Florida	FL	USA
Luis	Colon-Perez	University of California, Irvine	CA	USA
Diego	Compte	University of Florida	FL	USA
Stephen	Coombes	University of Florida	FL	USA
Manuela	Corti	University of Florida	FL	USA
Tina	Cousins	University of Florida	FL	USA
Yenisel	Cruz-Almeida	University of Florida	FL	USA
Lisa	Curry-Pochy	University of Florida	FL	USA
Kenneth	Cusi	University of Florida	FL	USA
Kristin	Dayton	University of Florida	FL	USA
Mingzhou	Ding	University of Florida	FL	USA
Yousong	Ding	University of Florida	FL	USA
Catherine	Dion	University of Florida	FL	USA
Natalie	Ebner	University of Florida	FL	USA
Matthew	Eddy	University of Florida	FL	USA
Nicole	Evangelista	University of Florida	FL	USA
Darin	Falk	Lacerta Therapeutics	FL	USA
Anna	Farmer (Liner)	University of Florida	FL	USA
Allie	Farone	University of Florida	FL	USA
Marcelo	Febo	University of Florida	FL	USA
Guillaume	Ferre	University of Florida	FL	USA
Daniel	Ferris	University of Florida	FL	USA
Tyler	Fettrow	University of Florida	FL	USA
Matthew	Fillingim	University of Florida	FL	USA
Roger	Fillingim	University of Florida	FL	USA
Sara	Fleehart	U.S. Department of Veterans Affairs	FL	USA
Briana	Foerman	University of Florida	FL	USA
Megan	Forbes	University of Florida	FL	USA
Sean	Forbes	University of Florida	FL	USA
Vanessa	Garcia	University of Florida	FL	USA
Anthony	Giacalone	University of Florida	Fl	USA
Drew	Gillett	University of Florida	FL	USA
Todd	Golde	University of Florida	FL	USA
Benjamin	Griffith	University of Florida	FL	USA
Anthony	Gruber	University of Florida	FL	USA
Matteo	Grudny	University of Florida	FL	USA
Danielle	Guess	University of Florida	FL	USA
Kimberly	Guice	University of Florida	FL	USA
Joseph	Gullett	University of Florida	FL	USA
Michael	Haller	University of Florida	FL	USA
Matthew	Hamm	University of Florida	FL	USA
Moriah	Hanson	University of Florida	FL	USA
Cheshire	Hardcastle	University of Florida	FL	USA
Hanna	Hausman	University of Florida	FL	USA

First Name	Last Name	Organization	State	Country
Matthew	Hey	University of Florida	FL	USA
Brian	Hoh	University of Florida	FL	USA
Josh	Holbrook	University of Florida	FL	USA
Haiqing	Huang	University of Florida	FL	USA
Kathleen	Hupfeld	University of Florida	FL	USA
Bryant	Hutchins	University of Florida	FL	USA
Aprinda	Indahlastari	University of Florida	FL	USA
Noelle	Jacobsen	University of Florida	FL	USA
Victoria	Jensen	Lacerta Therapeutics	FL	USA
Keyanni	Johnson	University of Florida	FL	USA
Andrew	Judge	University of Florida	FL	USA
Aditya	Kasinadhuni	University of Florida	FL	USA
Mary	Kasper	University of Florida	FL	USA
Sushain	Kaul	University of Florida	FL	USA
Ellen	Keeley	University of Florida	FL	USA
Wiliam R.	Kem	University of Florida	FL	USA
Saher	Khalaf	University of Florida	FL	USA
Ram	Khattri	University of Florida	FL	USA
Chalermchai	Khemtong	University of Florida	FL	USA
Gee	Kim	University of Florida	FL	USA
Jessica	Kraft	University of Florida	FL	USA
Eric	Krause	University of Florida	FL	USA
Lee	Kugelmann	University of Florida	FL	USA
Magdoom Mohamed	Kulam Najmudeen	University of Florida	FL	USA
Chavier	Laffitte	University of Florida	FL	USA
Damon	Lamb	University of Florida	FL	USA
Mark	Lewis	University of Florida	FL	USA
Hong	Li	Florida State University	FL	USA
Yuqing	Li	University of Florida	FL	USA
Nichole	Lighthall	University of Central Florida	FL	USA
Suzanne	Lightsey	University of Florida	FL	USA
Tian	Lin	University of Florida	FL	USA
Dake	Liu	University of Florida	FL	USA
Peiwei	Liu	University of Florida	FL	USA
Sandra	Loesgen	University of Florida	FL	USA
Joanna	Long	University of Florida	FL	USA
Christopher	Lopez	University of Florida	FL	USA
Donovan	Lott	University of Florida	FL	USA
Hendrik	Luesch	University of Florida	FL	USA
Rohit	Mahar	University of Florida	FL	USA
Wendi	Malphurs	University of Florida	FL	USA
Paul	Mangal	University of Florida	FL	USA
Eleana	Manousiouthakis	University of Florida	FL	USA
Nesmine	Maptue	University of Florida	FL	USA
Thomas	Mareci	University of Florida	FL	USA
Kelsey	Marr	University of Florida	FL	USA
Carol	Mathews	University of Florida	FL	USA
Johanna	McCracken	University of Florida	FL	USA
Nikolaus	McFarland	University of Florida	FL	USA
Marc	McLeod	University of Florida College of Medicine	FL	USA
Borna	Mehrad	University of Florida	FL	USA
David	Mendez	University of Florida	FL	USA
Matthew	Merritt	University of Florida	FL	USA
Amber	Miller	University of Florida	FL	USA
Ann	Mislovic	University of Florida	FL	USA
Andrea	Mitchell	University of Florida	FL	USA
Soamy	Montesino Goicolea	University of Florida	FL	USA
Giuseppe	Morelli	University of Florida	FL	USA
Lauren	Morelli	University of Florida	FL	USA
Rebecca	Morgan	University of Florida	FL	USA
John	Neubert	University of Florida	FL	USA
Daria	Neyroud	University of Florida	FL	USA

First Name	Last Name	Organization	State	Country
Binh	Nguyen	University of Florida	FL	USA
Tammy	Nicholson	University of Florida	FL	USA
Sara	Nixon	University of Florida	FL	USA
Samantha	Norman	University of Florida	FL	USA
Andre	Obenaus	University of California, Irvine	CA	USA
Rebecca	O'Connell	University of Florida	FL	USA
Brian	Odegaard	University of Florida	FL	USA
Walter	O'Dell	University of Florida	FL	USA
Edward	Ofori	University of Florida	FL	USA
Marite	Ojeda	University of Florida	FL	USA
Michael	Okun	University of Florida	FL	USA
Naphlim	Olwe	University of Florida	FL	USA
Andrew	O'Shea	University of Florida	FL	USA
Chris	Pampo	University of Florida	FL	USA
Qingqing (Emily)	Peng	University of Florida	FL	USA
Wenbo	Peng	University of Florida	FL	USA
Leronne	Perera	University of Florida	FL	USA
Eliany	Perez	University of Florida	FL	USA
Liya	Pi	Tulane University	LA	USA
Aeja	Pinto	University of Florida	FL	USA
Rebecca	Polk	University of Florida	FL	USA
Marjory	Pompilus	University of Florida	FL	USA
Eric	Porges	University of Florida	FL	USA
Danielle	Poulton	University of Florida	FL	USA
Cathy	Powers	University of Florida	FL	USA
Catherine	Price	University of Florida	FL	USA
Joseph	Pruitt	University of Florida	FL	USA
Mukundan	Ragavan	University of Florida	FL	USA
Maryam	Rahman	University of Florida	FL	USA
Rayn	Ramclam	University of Florida	FL	USA
Sakthivel	Ravi	University of Florida	FL	USA
Alyssa	Ray	University of Florida	FL	USA
Matthew	Reyna	University of Florida	FL	USA
Leah	Reznikov	University of Florida	FL	USA
Lori	Rice	University of Florida	FL	USA
Sutton	Richmond	University of Florida	FL	USA
Derek	Ridgeway	University of Florida	FL	USA
Samuel	Riehl	University of Florida	FL	USA
Gwladys	Riviere	University of Florida	FL	USA
Michael	Robinson	University of Florida	FL	USA
James	Rocca	University of Florida	FL	USA
Alex	Rodriguez	University of Florida	FL	USA
Jens	Rosenberg	National High Magnetic Field Laboratory	FL	USA
Anna	Rushin	University of Florida	FL	USA
Terence	Ryan	University of Florida	FL	USA
Rosalind	Sadleir	Arizona State University	AZ	USA
Stephanie	Salabarria	University of Florida	FL	USA
Addison	Sans	University of Florida	FL	USA
Malisa	Sarntinoranont	University of Florida	FL	USA
Michael	Schär	Johns Hopkins University	MD	USA
Christine	Schmidt	University of Florida	FL	USA
Rachael	Seidler	University of Florida	FL	USA
Medina	Serdarevic	University of Florida	FL	USA
Valay	Shah	University of Florida	FL	USA
Blanka	Sharma	University of Florida	FL	USA
Bryanna	Sharot	University of Florida	FL	USA
Kimberly	Sibille	University of Florida	FL	USA
Dietmar	Siemann	University of Florida	FL	USA
Amanda	Slater	University of Florida	FL	USA
Jasmine	Smith	University of Florida	FL	USA
Jessie	Somerville	University of Florida	FL	USA
Benjamin	Spoto	University of Florida	FL	USA

First Name	Last Name	Organization	State	Country
Judith	Steadman	University of Florida	FL	USA
Bethany	Stennett	University of Florida	FL	USA
Amanda	Studnicki	University of Florida	FL	USA
Sub	Subramony	University of Florida	FL	USA
Chunbao	Sun	University of Florida	FL	USA
Clayton	Swanson	University of Florida	FL	USA
Maurice	Swanson	University of Florida	FL	USA
Lee	Sweeney	University of Florida	FL	USA
Tanja	Taivassalo	University of Florida	FL	USA
Mai	Tanaka	University of Florida	FL	USA
Madison	Temples	University of Florida	FL	USA
Ellen	Terry	University of Florida	FL	USA
Naveen	Thakur	University of Florida	FL	USA
Grace	Thompson	University of Florida	FL	USA
Zhaohui	Tong	University of Florida	FL	USA
Natasha	Tracy	University of Florida	FL	USA
Yvette	Trahan	University of Florida	FL	USA
Nhi	Tran	University of Florida	FL	USA
Tram-Ahn	Tran	University of Florida	FL	USA
Blake	Trusty	University of Florida	FL	USA
Monica	Tschosik	University of Florida	FL	USA
Shahabeddin	Vahdat	University of Florida	FL	USA
David	Vaillancourt	University of Florida	FL	USA
K.	Vandenborne	University of Florida	FL	USA
Sergey	Vasenkov	University of Florida	FL	USA
Christopher	Vulpe	University of Florida	FL	USA
Aparna	Wagle Shukla	University of Florida	FL	USA
Zachary	Wakefield	University of Florida	FL	USA
Ariel	Walker	University of Florida	FL	USA
Glenn	Walter	University of Florida	FL	USA
Kevin	Wang	University of Florida	FL	USA
Zheng	Wang	University of Florida	FL	USA
Eric	Weber	University of Florida	FL	USA
Steven	Weisberg	University of Florida	FL	USA
Bradley	Wilkes	University of Florida	FL	USA
Rebecca	Willcocks	University of Florida	FL	USA
Lakiesha	Williams	University of Florida	FL	USA
John	Williamson	University of Florida	FL	USA
Adam	Woods	University of Florida	FL	USA
Zhihui	Yang	University of Florida	FL	USA
QIANG	YANG	University of Florida	FL	USA
ChiSu	Yoon	University of Florida	FL	USA
Zareen	Zaidi	University of Florida	FL	USA
Huadong	Zeng	University of Florida	FL	USA
Jie	Zhou	University of Florida	FL	USA
Tian	Zhu	University of Florida	FL	USA
Carla	Zingariello	University of Florida	FL	USA
Abigail	Zulich	University of Florida	FL	USA

DC FIELD – NATIONAL USERS

First Name	Last Name	Organization	State	Country
Dmytro	Abraimov	National High Magnetic Field Laboratory	FL	USA
Charles	Agosta	Clark University	MA	USA
Luis	Aguirre Quintana	Georgia Institute of Technology	GA	USA
Muhtar	Ahart	University of Illinois at Chicago	IL	USA
Kevin	Allen	Norfolk State University	VA	USA
Mashael	Altaiary	University of California, Riverside	CA	USA
James	Analytis	University of California, Berkeley	CA	USA
Badih	Assaf	University of Notre Dame	IN	USA
Hongwoo	Baek	National High Magnetic Field Laboratory	MA	USA
Sungha	Baek	University of Maryland, College Park	MA	USA
Rabindranath	Bag	Duke University	NC	USA
Terence	Baker	Norfolk State University	VA	USA
Luis	Balicas	National High Magnetic Field Laboratory	FL	USA
Alimamy	Bangura	National High Magnetic Field Laboratory	FL	USA
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Christianne	Beekman	National High Magnetic Field Laboratory	FL	USA
John	Berry	University of Wisconsin, Madison	WI	USA
Hari	Bhandari	George Mason University	VA	USA
Avery	Blockmon	University of Tennessee, Knoxville	TN	USA
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Alexandria	Bone	University of Tennessee, Knoxville	TN	USA
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Alexander	Brassington	University of Tennessee, Knoxville	TN	USA
William	Brey	National High Magnetic Field Laboratory	FL	USA
Stuart	Brown	University of California, Los Angeles	CA	USA
Troy	Brumm	National High Magnetic Field Laboratory	FL	USA
Nicholas	Butch	National Institute of Standards and Technology MD	MD	USA
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Jiaqi	Cai	University of Washington	WA	USA
Fernando	Camino	Brookhaven National Laboratory	NY	USA
Ian	Campbell	Florida State University	FL	USA
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Brian	Casas	National High Magnetic Field Laboratory	FL	USA
Mun	Chan	National High Magnetic Field Laboratory	NM	USA
Aaron	Chan	University of Michigan	MI	USA
Cui-Zu	Chang	Pennsylvania State University	PA	USA
Ramakanta	Chapai	Argonne National Laboratory	IL	USA
Joseph	Checkelsky	Massachusetts Institute of Technology	MA	USA
Kuizhi	Chen	National High Magnetic Field Laboratory	FL	USA
Kuan-Wen	Chen	University of Michigan	MI	USA
Lu	Chen	University of Michigan	MI	USA
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Shalinee	Chikara	National High Magnetic Field Laboratory	FL	USA
Eun Sang	Choi	National High Magnetic Field Laboratory	FL	USA
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Jiun-Haw	Chu	University of Washington	WA	USA
Judith	Clark	Florida State University	FL	USA
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Xin	Cong	University of Florida	FL	USA
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Pengcheng	Dai	University of Tennessee, Knoxville	TN	USA
Cory	Dean	City College of New York	NY	USA
Maximilien	Debbas	Massachusetts Institute of Technology	MA	USA
Peng	Deng	University of California, Los Angeles	CA	USA
Liangzi	Deng	University of Houston	TX	USA
Vikram	Deshpande	University of Utah	UT	USA
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Lloyd	Engel	National High Magnetic Field Laboratory	FL	USA
Matthew	Ennis	Duke University	NC	USA
Yun Suk	Eo	University of Michigan	MI	USA
Zaiyao	Fei	University of Washington	WA	USA
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Adam	Fiedler	Marquette University	WI	USA
Joseph	Finney	Stanford University	CA	USA
Zachary	Fisk	University of California, Irvine	CA	USA
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Matthew	Freeman	National High Magnetic Field Laboratory	FL	USA
Riqiang	Fu	National High Magnetic Field Laboratory	FL	USA
Hailong	Fu	Pennsylvania State University	PA	USA
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Raju	Ghimire	Clark University	MA	USA
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Spencer	Gibbs	University of Pennsylvania	PA	USA
Krzysztof	Gofryk	Idaho National Laboratory	ID	USA
David	Goldhaber-Gordon	Stanford University	CA	USA
Thaige	Gompa	Georgia Institute of Technology	GA	USA
Colin	Gould	University of California, Berkeley	CA	USA
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Samuel	Greer	Los Alamos National Laboratory	NM	USA
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Brittany	Grimm	Florida State University	FL	USA
Audrey	Grockowiak	National High Magnetic Field Laboratory	FL	USA
Onder	Gul	Harvard University	MA	USA
Yanbo	Guo	University of Florida	FL	USA
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Seungyong	Hahn	National High Magnetic Field Laboratory	FL	USA
William	Halperin	Northwestern University	IL	USA
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Adam	Hand	University of Tennessee, Knoxville	TN	USA
Scott	Hannahs	National High Magnetic Field Laboratory	FL	USA
Zeyu	Hao	Harvard University	MA	USA
Sara	Haravifard	Duke University	NC	USA
Liam	Harrigan	Norfolk State University	VA	USA
Zahid	Hasan	Princeton University	NJ	USA
Autumn	Heltman	Pennsylvania State University	PA	USA
Russell	Hemley	University of Illinois at Chicago	IL	USA
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David	Hilton	University of Alabama, Birmingham	AL	USA
Jade	Holleman	Florida State University	FL	USA
James	Hone	Columbia University	NY	USA
Md Shafayat	Hossain	Princeton University	NJ	USA
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Xinbo	Hu	National High Magnetic Field Laboratory	FL	USA
Xinzhe	Hu	University of Florida	FL	USA
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Apoorv	Jindal	Columbia University	NY	USA
Caolan	John	Massachusetts Institute of Technology	MA	USA
Janakiram	Kadiyala	Ampeers LLC	TX	USA
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Mehdi	Kochat	University of Houston	TX	USA
Barry	Koehne	Texas State University	TX	USA
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Jia	Li	Brown University	RI	USA
Qi	Li	Pennsylvania State University	PA	USA
Lu	Li	University of Michigan	MI	USA
Zizhong	Li	University of Wisconsin, Madison	WI	USA
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Paul	Neves	Massachusetts Institute of Technology	MA	USA
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Chang	Niu	Purdue University	IN	USA
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First Name	Last Name	Organization	State	Country
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Yuval	Ronen	Harvard University	MA	USA
Xavier	Roy	Columbia University	NY	USA
Shanta	Saha	University of Maryland, College Park	MD	USA
Leroy	Salary	Norfolk State University	VA	USA
Prathum	Saraf	University of Maryland, College Park	MA	USA
Govind	Sasi Kumar	Florida State University	FL	USA
Jeffrey	Schiano	Pennsylvania State University	PA	USA
John	Schlueter	Argonne National Laboratory	IL	USA
Scott	Schmucker	Sandia National Laboratories	NM	USA
Leslie	Schoop	Princeton University	NJ	USA
Robert	Schurko	Florida State University	FL	USA
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Qianhui	Shi	University of California, Los Angeles	CA	USA
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Jiabao	Wang	Florida State University	FL	USA
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Ziqiao	Wang	Pennsylvania State University	PA	USA
Pengjie	Wang	Princeton University	NJ	USA
Tianmeng	Wang	Rensselaer Polytechnic Institute	NY	USA
Kang	Wang	University of California, Los Angeles	CA	USA
Jiashu	Wang	University of Notre Dame	IN	USA
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Matthew	Wilson	University of California, Riverside	CA	USA
Sanfeng	Wu	Princeton University	NJ	USA
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Ziji	Xiang	University of Michigan	MI	USA
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Yizhou	Xin	Northwestern University	IL	USA
Jie	Xing	University of South Carolina	SC	USA
Chengkun	Xing	University of Tennessee, Knoxville	TN	USA
Xingchen	Xu	Fermi National Accelerator Laboratory	IL	USA
Yijue	Xu	National High Magnetic Field Laboratory	FL	USA
Xiaodong	Xu	University of Washington	WA	USA
Ziling	Xue	University of Tennessee, Knoxville	TN	USA
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Hung-Yu	Yang	Boston College	MA	USA
Qi	Yang	Stanford University	CA	USA
Linda	Ye	Massachusetts Institute of Technology	MA	USA
Peide	Ye	Purdue University	IN	USA
Sandugash	Yergeshbayeva	Florida State University	FL	USA
Hemian	Yi	Pennsylvania State University	PA	USA
Le	Yi	Pennsylvania State University	PA	USA
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Naiyuan	Zhang	Brown University	RI	USA
Shengzhi	Zhang	Los Alamos National Laboratory	NM	USA
Rongfu	Zhang	National High Magnetic Field Laboratory	FL	USA
Zheneng	Zhang	Ohio State University	OH	USA
RuoXi	Zhang	Pennsylvania State University	PA	USA
Qi	Zhang	Princeton University	NJ	USA
Zhuocheng	Zhang	Purdue University	IN	USA
Peng	Zhang	University of California, Los Angeles	CA	USA
Xiao-Xiao	Zhang	University of Florida	FL	USA
Dechen	Zhang	University of Michigan	MI	USA
Han	Zhang	University of Tennessee, Knoxville	TN	USA
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DC FIELD – INTERNATIONAL USERS

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Kwang Yong	Choi	Sungkyunkwan University	South Korea
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Matthew	Coak	University of Warwick	UK
Sam	Curley	University of Warwick	UK
Al-Amin	Dhirani	University of Toronto (Toronto)	Canada
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Masaki	Fujita	Tohoku University IMR	Japan
Christel	Gervais	Sorbonne University	France
Paul	Goddard	University of Warwick	UK
Ieva	Goldberga	French National Center for Scientific Research	France
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Alex	Hickey	University of Cambridge	UK
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Shintaro	Ishiwata	Osaka University	Japan
Vibe	Jakobsen	University College Dublin	Ireland
Ho Seong	Jeon	Pohang University of Science and Technology	South Korea
YounJung	Jo	Kyungpook National University	South Korea
Soon-Gil	Jung	Sungkyunkwan University	South Korea
Woun	Kang	Ewha Womans University	South Korea
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Conor	Kelly	University College Dublin	Ireland
Hoil	Kim	Pohang University of Science and Technology	South Korea
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Jun Sung	Kim	Pohang University of Science and Technology	South Korea
Tomasz	Klimczuk	Gdansk University of Technology	Poland
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Danielle	Laurencin	University of Montpellier	France
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Yuji	Matsuda	Kyoto University	Japan
Kimberly	Modic	Institute of Science and Technology Austria	Austria
Grace	Morgan	University College Dublin	Ireland
So	Noguchi	Hokkaido University	Japan
Shimpei	Ono	Central Research Institute of Electric Power Industry	Japan
Armando	Paduan-Filho	University of Sao Paulo	Brazil
Tuson	Park	Sungkyunkwan University	South Korea
Helene	Raffy	University of Paris-Sud	France
Andreas	Rydh	Stockholm University	Sweden
Junho	Seo	Pohang University of Science and Technology	South Korea
Zeping	Shi	East China Normal University	China
Zhenzhong	Shi	Soochow University	China
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Ziming	Wu	Soochow University	China
Jun	Yang	Institute of Physics, Chinese Academy of Sciences	China
Xiang	Yuan	East China Normal University	China
Cheng	Zhang	Fudan University	China
Qi	Zhang	Nanjing University	China
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EMR – NATIONAL USERS

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Mohamad	Barekati-Goudarzi	Louisiana State University	LA	USA
John	Berry	University of Wisconsin, Madison	WI	USA
Alexandria	Bone	University of Tennessee, Knoxville	TN	USA
Clifford	Bowers	University of Florida	FL	USA
ChristiAnna	Brantley	University of Florida	FL	USA
Shalinee	Chikara	National High Magnetic Field Laboratory	FL	USA
George	Christou	University of Florida	FL	USA
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Daphné	Lubert-Perquel	Imperial College London	FL	USA
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Roxanna	Martinez	Colorado State University	CO	USA
Frederic	Mentink	National High Magnetic Field Laboratory	FL	USA
Zhihui	Miao	University of Florida	FL	USA
Clay	Mings	University of Tennessee, Knoxville	TN	USA
Ian	Moseley	Colorado State University	CO	USA
Duncan	Moseley	University of Tennessee, Knoxville	TN	USA
Michael	Nippe	Texas A&M University	TX	USA
Andrew	Ozarowski	National High Magnetic Field Laboratory	FL	USA
Mykhaylo	Ozerov	National High Magnetic Field Laboratory	FL	USA
Jianjun	Pan	University of South Florida	FL	USA
Nathan	Peek	Florida State University	FL	USA
Cedomir	Petrovic	Brookhaven National Laboratory	NY	USA
David	Powers	Texas A&M University	TX	USA
Bradley	Price	University of California, Santa Barbara	CA	USA
Chandrasekhar	Ramanathan	Dartmouth College	NH	USA

First Name	Last Name	Organization	State	Country
Arun	Ramanathan	Georgia Institute of Technology	GA	USA
Ellis	Reinherz	Dana-Farber Cancer Institute	MA	USA
Christian	Saiz	University of Texas, El Paso	TX	USA
Elvin	Salerno	National High Magnetic Field Laboratory	FL	USA
Susannah	Scott	University of California, Santa Barbara	CA	USA
Kyle	Seabourn	University of Idaho	ID	USA
Hannah	Shafaat	Ohio State University	OH	USA
Fedor	Sharov	Pennsylvania State University	PA	USA
Michael	Shatruk	National High Magnetic Field Laboratory	FL	USA
Mark	Sherwin	University of California, Santa Barbara	CA	USA
Srinivasa Rao	Singamaneni	University of Texas, El Paso	TX	USA
John	Singleton	National High Magnetic Field Laboratory	NM	USA
Dmitry	Smirnov	National High Magnetic Field Laboratory	FL	USA
Likai	Song	National High Magnetic Field Laboratory	FL	USA
Benjamin	Stein	Los Alamos National Laboratory	NM	USA
Robert	Stewart	Florida State University	FL	USA
Albert	Stiegman	Florida State University	FL	USA
Sebastian	Stoian	University of Idaho	ID	USA
Brent	Sumerlin	University of Florida	FL	USA
Siyoung	Sung	Colorado State University	CO	USA
Fazel	Tafti	Boston College	MA	USA
Joshua	Telser	Roosevelt University	IL	USA
Pagnareach	Tin	University of Tennessee, Knoxville	TN	USA
Aaron	Tondreau	Los Alamos National Laboratory	NM	USA
Adam	Valaydon-Pillay	University of Idaho	ID	USA
Johan	van Tol	National High Magnetic Field Laboratory	FL	USA
Gerard	Van Trieste	Texas A&M University	TX	USA
Adam	Veige	University of Florida	FL	USA
Xiaoling	Wang	University of California, Santa Barbara (UC Santa Barbara, UCSB)	CA	USA
Sungsool	Wi	National High Magnetic Field Laboratory	FL	USA
Chelsea	Widener	University of Tennessee, Knoxville	TN	USA
Ethan	Williams	Dartmouth College	NH	USA
Michael	Wojnar	Northwestern University	IL	USA
Ziling	Xue	University of Tennessee, Knoxville	TN	USA
Joseph	Zadrozny	Colorado State University	CO	USA
Vivien	Zapf	National High Magnetic Field Laboratory	NM	USA
Jianyuan	Zhang	Rutgers University	NJ	USA
Tommy	Zhao	University of Florida	FL	USA

EMR – INTERNATIONAL USERS

First Name	Last Name	Organization	Country
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Joan	Cano	University of Valencia	Spain
Enrique	Colacio	University of Granada	Spain
Igor	Fritsky	Taras Shevchenko National University of Kyiv	Ukraine
David	Herbert	University of Manitoba	Canada
Sandrine	Heutz	Imperial College London	UK
Vibe	Jakobsen	University College Dublin	Ireland
Daniel	Jardón Álvarez	Weizmann Institute of Science	Israel
Miguel	Julve	University of Valencia	Spain
Kinga	Kaniewska	Gdansk University of Technology	Poland
Irina	Kuehne	University College Dublin	Ireland
Michal	Leskes	Weizmann Institute of Science	Israel
Francesc	Lloret	University of Valencia	Spain
Grace	Morgan	University College Dublin	Ireland
Dmytro	Nesterov	Technical University of Lisbon	Portugal
Svitlana	Petrusenko	Taras Shevchenko National University of Kyiv	Ukraine
Renato	Rabelo De Souza Filho	University of Valencia	Spain
Oleg	Stetsiuk	Taras Shevchenko National University of Kyiv	Ukraine
Brijith	Thomas	Weizmann Institute of Science	Israel

First Name	Last Name	Organization	Country
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Marta	**Viciano-Chumillas**	University of Valencia	Spain
Andrej	**Zorko**	Jozef Stefan Institute	Slovenia

HIGH B/T – NATIONAL USERS

First Name	Last Name	Organization	State	Country
Johnny	Adams	University of Florida	FL	USA
Collin	Broholm	Johns Hopkins University	MD	USA
Donald	Candela	University of Massachusetts	MA	USA
Ovidiu	Garlea	Oak Ridge National Laboratory	TN	USA
Alireza	Ghasemi	Johns Hopkins University	MD	USA
Chao	Huan	University of Florida	FL	USA
Dominique	Laroche	University of Florida	FL	USA
Marc	Lewkowitz	University of Florida	FL	USA
Naoto	Masuhara	University of Florida	FL	USA
Mark	Meisel	University of Florida	FL	USA
John	Reno	Sandia National Laboratories	NM	USA
Michael	Shatruk	National High Magnetic Field Laboratory	FL	USA
Lucia	Steinke	University of Florida (UF)	FL	USA
Neil	Sullivan	University of Florida	FL	USA
Andrew	Woods	University of Florida	FL	USA

HIGH B/T – INTERNATIONAL USERS

First Name	Last Name	Organization	Country
Guillaume	Gervais	McGill University	Canada
Suchitra	Sebastian	University of Cambridge	UK

ICR – NATIONAL USERS

First Name	Last Name	Organization	State	Country
Marianna	Acker	Woods Hole Oceanographic Institution	MA	USA
Archana	Agarwal	University of Utah	UT	USA
Lissa	Anderson	National High Magnetic Field Laboratory	FL	USA
Lydia	Babcock-Adams	University of Georgia	GA	USA
Allan	Bacon	University of Florida	FL	USA
William	Bahureksa	Colorado State University	CO	USA
Mace	Barron	Environmental Protection Agency	OH	USA
Megan	Behnke	Florida State University	FL	USA
Sara	Bell	University of Illinois at Urbana-Champaign	IL	USA
Jamini	Bhagu	Florida Agricultural and Mechanical University	FL	USA
Greg	Blakney	National High Magnetic Field Laboratory	FL	USA
Rene	Boiteau	Oregon State University	OR	USA
Thomas	Borch	Colorado State University	CO	USA
William	Braaton	Willamette University	OR	USA
Nathan	Bramall	Leiden Technology LLC	CA	USA
Catherine	Brewer	New Mexico State University, Main Campus	NM	USA
Emily	Bristol	University of Texas, Austin	TX	USA
Kristen	Buck	University of South Florida	FL	USA
Radha Krishna Murthy	Bulusu Raja	Florida State University	FL	USA
David	Butcher	National High Magnetic Field Laboratory	FL	USA
Kathryn	Bywaters	Honeybee Robotics	CA	USA
Ercan	Cakmak	Oak Ridge National Laboratory	TN	USA
Humberto	Carvajal-Ortiz	Core Laboratories	TX	USA
Daniel	Castro	University of Illinois at Urbana-Champaign	IL	USA
Peter	Chace	Oregon State University	OR	USA
Martha	Chacon	National High Magnetic Field Laboratory	FL	USA
Romy	Chakraborty	Lawrence Berkeley National Laboratory	CA	USA
Ni-Bin	Chang	University of Central Florida	FL	USA
Jeffrey	Chanton	Florida State University	FL	USA
Dreux	Chappell	Old Dominion University	VA	USA
Huan	Chen	National High Magnetic Field Laboratory	FL	USA
Feng	Cheng	Worcester Polytechnic Institute	MA	USA
Brent	Christner	University of Florida	FL	USA
Daniel	Colopietro	University of Florida	FL	USA
Robyn	Conmy	Environmental Protection Agency	OH	USA
Katrina	Counihan	Alaska SeaLife Center	AK	USA
Than	Dam	University of Wyoming	WY	USA
Juliana	D'Andrilli	Louisiana Universities Marine Consortium	LA	USA
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Rachel	DeHoog	University of Texas, Austin	TX	USA
Peter	Doran	Louisiana State University	LA	USA
Ashley	Dubnick	Montana State University	MT	USA
David	Eaton	University of Kentucky	KY	USA
Alina	Ebling	University of Delaware	DE	USA
Karam	Eeso	Florida State University	FL	USA
Hollie	Emery	Harvard University	MA	USA
Thomas	Ennis	City of Austin, Texas	TX	USA
Jason	Fellman	University of Alaska Southeast	AK	USA
Francisco	Fernandez-Lima	Florida International University	FL	USA
Jack	Ferrell	National Renewable Energy Laboratory	CO	USA
Sarah	Fischer	University of Colorado, Boulder	CO	USA
Ryan	Fountain	Bio Huma Netics, Inc.	AZ	USA
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Karen	Frey	Clark University	MA	USA
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Rachel	Gallan	Florida State University	FL	USA
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Rana	Ghannam	University of New Orleans	LA	USA
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First Name	Last Name	Organization	State	Country
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Samuel	Grant	National High Magnetic Field Laboratory	FL	USA
Benjamin	Granzow	Woods Hole Oceanographic Institution	MA	USA
David	Griffith	Willamette University	OR	USA
Sara	Gushgari-Doyle	Lawrence Berkeley National Laboratory	CA	USA
Colleen	Hansel	Woods Hole Oceanographic Institution	MA	USA
Jon	Hawkings	Florida State University	FL	USA
Cynthia	Heil	Mote Marine Laboratory	FL	USA
Chris	Hendrickson	National High Magnetic Field Laboratory	FL	USA
Anna	Hermes	University of Colorado, Boulder	CO	USA
Eve-Lyn	Hinckley	University of Colorado, Boulder	CO	USA
William	Hockaday	Baylor University	TX	USA
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Patricia	Holland	Mote Marine Laboratory	FL	USA
Amy	Holt	Florida State University	FL	USA
Eran	Hood	University of Alaska Southeast	AK	USA
Sarajeen Saima	Hoque	Florida State University	FL	USA
Aixin	Hou	Louisiana State University	LA	USA
Zhen	Hu	University of Wyoming	WY	USA
Donald	Hunt	University of Virginia	VA	USA
Carolyn	Hutchinson	Iowa State University	IA	USA
Kristiina	Iisa	National Renewable Energy Laboratory	CO	USA
Jim	Ippolito	Colorado State University	CO	USA
Stephan	Irle	Oak Ridge National Laboratory	TN	USA
Jackie	Jarvis	New Mexico State University, Main Campus	NM	USA
Miguel	Jimenez Jacome	University of North Dakota	ND	USA
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Gang Seob	Jung	Oak Ridge National Laboratory	TN	USA
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Anne	Kellerman	Florida State University	FL	USA
Eugene	Kelly	Colorado State University	CO	USA
Thomas	Kelly	Florida State University	FL	USA
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Ishwar	Kohale	Massachusetts Institute of Technology	MA	USA
Martin	Kurek	Florida State University	FL	USA
Richard	Lamar	Bio Huma Netics, Inc.	AZ	USA
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Edgar	Lara-Curzio	Oak Ridge National Laboratory	TN	USA
Boris	Lau	University of Massachusetts	MA	USA
Franklin	Leach	University of Georgia	GA	USA
Kiara	Lech	Environmental Protection Agency	OH	USA
Heather	LeClerc	Worcester Polytechnic Institute	MA	USA
Wenbo	Li	Florida State University	FL	USA
Jingxuan	Li	Woods Hole Oceanographic Institution	MA	USA
Yuan	Lin	Florida State University	FL	USA
Qianxin	Lin	Louisiana State University	LA	USA
Yang	Lin	University of Florida	FL	USA
Clarissa	Lincoln	Willamette University	OR	USA
Omics	LLC	Omics, LLC	FL	USA
Bruce	Locke	Florida State University	FL	USA
Merritt	Logan	Colorado State University	CO	USA
Francisco	Lopez Linares	Chevron, Richmond	CA	USA
Amie	Lund	University of North Texas	TX	USA
Mary	Lusk	University of Florida	FL	USA
Hairuo	Mao	University of Wyoming	WY	USA
Alan	Marshall	National High Magnetic Field Laboratory	FL	USA
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Alexander	Mazzorana	Florida State University	FL	USA
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First Name	Last Name	Organization	State	Country
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Amy	McKenna	National High Magnetic Field Laboratory	FL	USA
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Frederic	Mentink	National High Magnetic Field Laboratory	FL	USA
Carlos	Miranda	Florida State University	FL	USA
Amin	Mirkouei	University of Idaho	ID	USA
Hadi	Mohammadigoushki	Florida State University	FL	USA
Hiarhi	Monda	Bio Huma Netics, Inc.	AZ	USA
Megan	Moore	Florida State University	FL	USA
Willard	Moore	University of South Carolina	SC	USA
Remi	Moulian	National High Magnetic Field Laboratory	FL	USA
Calvin	Mukarakate	National Renewable Energy Laboratory	CO	USA
Amanda	Muni-Morgan	University of Florida	FL	USA
Jay	Nadeau	Portland State University	OR	USA
Jenny	Nelson	Agilent Technologies	CA	USA
Amelia	Nelson	Colorado State University	CO	USA
Robert	Nelson	Woods Hole Oceanographic Institution	MA	USA
Sydney	Niles	National High Magnetic Field Laboratory	FL	USA
Devan	Nisson	Princeton University	NJ	USA
Fernando	Noriega	Florida International University	FL	USA
Mojtaba	Nouri Goukeh	Florida State University	FL	USA
Tullis	Onstott	Princeton University	NJ	USA
Diana	Ordonez	University of Central Florida	FL	USA
Cesar	Ovalles	Chevron Energy Tech. Comp.	CA	USA
Jeremy	Owens	National High Magnetic Field Laboratory	FL	USA
Alex	Paulsen	Mainstream Engineering Corp	FL	USA
James	Pinckney	University of South Carolina	SC	USA
Dante	Placido	U.S. Department of Agriculture	CA	USA
David	Podgorski	University of New Orleans	LA	USA
Zeljka	Popovic	Florida State University	FL	USA
Brett	Poulin	University of California, Davis	CA	USA
Hui	Pu	University of North Dakota	ND	USA
Maria Magdalena	Ramirez Corredores	Idaho National Laboratory	ID	USA
Chris	Reddy	Woods Hole Oceanographic Institution	MA	USA
Zachary	Redman	University of Alaska, Anchorage	AK	USA
Carley	Reid	Florida State University	FL	USA
Clare	Reimers	Oregon State University	OR	USA
Daniel	Repeta	Woods Hole Oceanographic Institution	MA	USA
Charles	Rhoades	U.S. Department of Agriculture	CO	USA
Ryan	Rodgers	National High Magnetic Field Laboratory	FL	USA
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Holly	Roth	Colorado State University	CO	USA
Steven	Rowland	National Renewable Energy Laboratory	CO	USA
Matthew	Ryder	Oak Ridge National Laboratory	TN	USA
Qing-Xiang "Amy"	Sang	Florida State University	FL	USA
Mst	Sayadujjhara	Morgan State University	MD	USA
Leah	Schaffer	University of Wisconsin, Madison	WI	USA
Livia	Schiavinato Eberlin	University of Texas, Austin	TX	USA
Leah	Schneider	University of North Texas	TX	USA
Jeffrey	Shabanowitz	University of Virginia	VA	USA
Sunita	Shah Walter	University of Delaware	DE	USA
Sergei	Shalygin	New Mexico State University, Main Campus	NM	USA
Kavita	Sharma	Idaho State University	ID	USA
Michael	Shortreed	University of Wisconsin, Madison	WI	USA
Ronish	Shrestha	Worcester Polytechnic Institute	MA	USA
Viji	Sitther	Morgan State University	MD	USA
Mark	Skidmore	Montana State University	MT	USA
Donald	Smith	National High Magnetic Field Laboratory	FL	USA
Karl	Smith	National High Magnetic Field Laboratory	FL	USA
Lloyd	Smith	University of Wisconsin, Madison	WI	USA

First Name	Last Name	Organization	State	Country
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Robert	Spencer	Florida State University	FL	USA
Sommer	Starr	Florida State University	FL	USA
Ethan	Struhs	University of Idaho	ID	USA
Aron	Stubbins	Northeastern University	MA	USA
Michael	Stukel	Florida State University	FL	USA
Devi	Sundaravadivelu	Pegasus Technical Services Inc	OH	USA
Jonathan	Sweedler	University of Illinois at Urbana-Champaign	IL	USA
Youneng	Tang	Florida State University	FL	USA
Andrew	Teixeira	Worcester Polytechnic Institute	MA	USA
Rachel	Thomas	Florida State University	FL	USA
Carson	Thompson	University of Wyoming	WY	USA
Kevin	Thorn	U.S. Geological Survey	CO	USA
Michael	Timko	Worcester Polytechnic Institute	MA	USA
Patrick	Tomco	University of Alaska Anchorage	AK	USA
Geoffrey	Tompsett	Worcester Polytechnic Institute	MA	USA
Lilian	Tose	Florida International University	FL	USA
Richard	Vachet	University of Massachusetts Amherst	MA	USA
Andrea	Valencia	University of Central Florida	FL	USA
Frederic	Vautard	Oak Ridge National Laboratory	TN	USA
Elena	Vialykh	University of Colorado, Boulder	CO	USA
Sasha	Wagner	University of Georgia	GA	USA
Anna	Walsh	Woods Hole Oceanographic Institution	MA	USA
Clifford	Walters	University of Texas, Austin	TX	USA
Robert	Wandell	Florida State University	FL	USA
Martin	Wanielista	University of Central Florida	FL	USA
Collin	Ward	Woods Hole Oceanographic Institution	MA	USA
Chad	Weisbrod	National High Magnetic Field Laboratory	FL	USA
Dan	Wen	University of Central Florida	FL	USA
Elizabeth	Whisenhant	University of Alaska, Anchorage	AK	USA
Forest	White	Massachusetts Institute of Technology	MA	USA
Mike	Wilkins	Colorado State University	CO	USA
Rachel	Wilson	Florida State University	FL	USA
Alicia	Wilson	University of South Carolina	SC	USA
Leland	Wood	University of Delaware	DE	USA
Andrew	Wozniak	University of Delaware	DE	USA
Xiaoqin	Wu	Lawrence Berkeley National Laboratory	CA	USA
LaDonna	Wyatt	Morgan State University	MA	USA
Richard	Xie	University of Illinois at Urbana-Champaign	IL	USA
Yavuz	Yalcin	Morgan State University	MA	USA
Pilsun	Yoo	Oak Ridge National Laboratory	TN	USA
Robert	Young	New Mexico State University, Main Campus	NM	USA
Jianchao	Zhang	University of Wyoming	WY	USA
Ruihan	Zhang	Worcester Polytechnic Institute	MA	USA
Mengqiang	Zhu	University of Wyoming	WY	USA
Phoebe	Zito	University of New Orleans	LA	USA

ICR – INTERNATIONAL USERS

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Carlos	Afonso	Normandy University	France
Alexandre	Anesio	Aarhus University	Denmark
Tom	Battin	Ecole Polytechnique Federale de Lausanne	Switzerland
Samuel	Bode	Ghent University	Belgium
Pascal	Boeckx	Ghent University	Belgium
Matthew	Bogard	University of Lethbridge	Canada
Paolo	Bomben	Alberta Innovates	Canada
Michael	Böttcher	Leibniz Institute for Baltic Sea Research Warnemünde	Germany
Brice	Bouyssiere	University of Pau and Pays de l'Adour	France
Simon	Brockbank	Randox Laboratories Ltd	UK

First Name	Last Name	Organization	Country
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Herve	Carrier	University of Pau and Pays de l'Adour	France
Jimmy	Castillo	Central University of Venezuela	Venezuela
Meilian	Chen	Guangdong Technion	China
Diego	Cobice	Ulster University	UK
Paul	Covert	Fisheries and Oceans Canada	Canada
Maik	Damm	Technical University of Berlin	Germany
Jean-Luc	Daridon	University of Pau and Pays de l'Adour	France
Vincent	De Staerke	Ecole Polytechnique Federale de Lausanne	Switzerland
Bienvenu	Dinga	Institut de Recherche en Sciences et Exactes et Naturelles	Congo - Brazzaville
Sebastian	Doetterl	ETH Zurich	Switzerland
Eva	Doting	Aarhus University	Denmark
Travis	Drake	Swiss Federal Institute of Technology in Zurich	Switzerland
Kerri	Finlay	University of Regina	Canada
Pierre	Giusti	Total	France
Pierre	Giusti	Total	France
Murray	Gray	Alberta Innovates	Canada
Carla	Harkin	Ulster University	UK
Benjamin-Florian	Hempel	Humboldt University of Berlin	Germany
Carmen	Höschen	Technical University of Munich	Germany
Changchun	Huang	Nanjing University	China
Jin	Hur	Sejong University	South Korea
Anna-Kathrina	Jenner	Leibniz Institute for Baltic Sea Research Warnemünde	Germany
Sophia	Johannessen	Fisheries and Oceans Canada	Canada
Sarah	Johnston	University of Lethbridge	Canada
Hanna	Joss	Eberhard Karls University of Tübingen	Germany
Andreas	Kappler	Eberhard Karls University of Tübingen	Germany
Francesca	Kerton	Memorial University of Newfoundland	Canada
Anna	Khreptugova	Lomonosov Moscow State University	Russia
Sara	Kleindienst	Eberhard Karls University of Tübingen	Germany
Steven	Kokelj	Northwest Territories Geological Survey	Canada
Chaoliu	Li	Fujian Institute of Research on the Structure of Matter, Chinese Academy of Sciences	China
Shuaidong	Li	Nanjing University	China
Stephanie	MacQuarrie	Cape Breton University	Canada
Nagamitsu	Maie	Kitasato University	Japan
Caroline	Mangote	Total	France
Matthew	Marshall	University of Bristol	UK
Aurora	Mejia	University of Pau and Pays de l'Adour	France
Veronika	Michalkova	Biology Centre CAS	Czech Republic
Tara	Moore	Ulster University	UK
Sandra	Mounicou	University of Pau and Pays de l'Adour	France
Carsten	Mueller	University of Copenhagen	Denmark
Ayse	Nalbantsoy	Ege University	Turkey
Marcela	Nouzova	Biology Centre CAS	Czech Republic
Landry	Ntaboba	Université Catholique de Bukavu	Democratic Republic of Congo
Benjamin	Nyilitya	Ghent University	Belgium
Allison	Oliver	Skeena Fisheries Commission	Canada
Jorge	Orrego-Ruiz	Ecopetrol	Colombia
Monique Sézanne	Patzner	University Tuebingen	Germany
Irina	Perminova	Lomonosov Moscow State University	Russia
Hannes	Peter	Ecole Polytechnique Federale de Lausanne	Switzerland
Vincent	Piscitelli	Central University of Venezuela	Peru
Sadia	Radji	University of Pau and Pays de l'Adour	France
Fernando	Rojas Ruiz	Ecopetrol	Colombia
Christopher	Rüger	University of Rostock	Germany
Thomas	Scholten	Eberhard Karls University of Tübingen	Germany
Martina	Schön	Ecole Polytechnique Federale de Lausanne	Switzerland
David	Scott	University of Alberta	Canada
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First Name	Last Name	Organization	Country
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Jeffrey	Stryker	University of Alberta	Canada
Michael	Styllas	Ecole Polytechnique Federale de Lausanne	Switzerland
Roderich	Süssmuth	Technical University of Berlin	Germany
Suzanne	Tank	University of Alberta	Canada
Marina	Taskovic	University of Alberta	Canada
Matteo	Tolosano	Ecole Polytechnique Federale de Lausanne	Switzerland
Kristof	Van Oost	University of Leuven	Belgium
Juliana	Vidal	Memorial University of Newfoundland	Canada
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Jemma	Wadham	University of Bristol	UK
Daniel	Wasner	Swiss Federal Institute of Technology in Zurich	Switzerland
Fanping	Yan	Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences	China
Erick	Zagal	University of Concepcion	Chile
Mary	Zeller	Leibniz Institute for Baltic Sea Research Warnemünde	Germany
Fang	Zheng	University of Pau and Pays de l'Adour	France
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NMR – NATIONAL USERS

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Shiva	Agarwal	Western Michigan University	MI	USA
Adewale	Akinfaderin	Florida State University	FL	USA
Hannah	Alderson	Florida State University	FL	USA
Adam	Altenhof	Florida State University	FL	USA
Jacob	Athey	Florida State University	FL	USA
Jochen	Autschbach	University of Buffalo	NY	USA
Frederick	Bagdasarian	Florida State University	FL	USA
Jamini	Bhagu	Florida Agricultural and Mechanical University	FL	USA
Ashley	Blue	National High Magnetic Field Laboratory	FL	USA
Thomas	Borch	Colorado State University	CO	USA
Cesario	Borlongan	University of South Florida	FL	USA
Clifford	Bowers	University of Florida	FL	USA
Michael	Brady	University of Southern California	CA	USA
William	Brey	National High Magnetic Field Laboratory	FL	USA
Nhat Nguyen	Bui	National High Magnetic Field Laboratory	FL	USA
Bruce	Bunnell	Tulane University	LA	USA
Ercan	Cakmak	Oak Ridge National Laboratory	TN	USA
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Kuizhi	Chen	National High Magnetic Field Laboratory	FL	USA
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Po-Hsiu	Chien	Florida State University	FL	USA
Carl	Conti	Florida State University	FL	USA
Whitney	Costello	University of Texas, Southwestern	TX	USA
Myriam	Cotten	College of William and Mary	VA	USA
Tim	Cross	National High Magnetic Field Laboratory	FL	USA
Naresh	Dalal	National High Magnetic Field Laboratory	FL	USA
Anvesh Kumar Reddy	Dasari	East Carolina University	NC	USA
Matthew	DeJong	Florida State University	FL	USA
Fabien	Deligey	Louisiana State University	LA	USA
Rick	Dorn	Iowa State University	IA	USA
Zach	Dowdell	Florida State University	FL	USA
Thierry	Dubroca	National High Magnetic Field Laboratory	FL	USA
Elan	Eisenmesser	University of Colorado, Denver	CO	USA
Alec	Esper	University of Florida	FL	USA
Michael	Famiano	Western Michigan University	MI	USA
David	Fenning	University of California, San Diego	CA	USA
Liyanage	Fernando	Louisiana State University	LA	USA
Carl	Fleischer	Florida State University	FL	USA
Kendra	Frederick	University of Texas, Southwestern	TX	USA
Lucio	Frydman	National High Magnetic Field Laboratory	FL	USA
Riqiang	Fu	National High Magnetic Field Laboratory	FL	USA
Eric	Gabriel	Boise State University	ID	USA
Zhehong	Gan	National High Magnetic Field Laboratory	FL	USA
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Carlos	Garcia	Clemson University	SC	USA
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John	Goodenough	University of Texas, Austin	TX	USA
Blaine	Gordon	Florida State University	FL	USA
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Samuel	Grant	National High Magnetic Field Laboratory	FL	USA
Robert	Griffin	Massachusetts Institute of Technology	MA	USA
Alexander	Greenwood	University of Cincinnati	OH	USA
Xiaodan	Gu	University of Southern Mississippi	MS	USA
Terry	Gullion	West Virginia University	WV	USA
Sossina	Haile	Northwestern University	IL	USA
Manoj Vinayaka	Hanabe Subramanya	Florida State University	FL	USA

First Name	Last Name	Organization	State	Country
Jaye	Harada	Northwestern University	IL	USA
Michael	Harrington	Huntington Medical Research Institutes	CA	USA
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Katherine	Henzler-Wildman	University of Wisconsin, Madison	WI	USA
David	Hike	Florida State University	FL	USA
Stephen	Hill	National High Magnetic Field Laboratory	FL	USA
Anthony	Hoffman	Florida State University	FL	USA
Samuel	Holder	Florida State University	FL	USA
Sean	Holmes	Florida State University	FL	USA
Sarah	Horstmeier	Oklahoma State University	OK	USA
Yan-Yan	Hu	Florida State University	FL	USA
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Sonjong	Hwang	California Institute of Technology	CA	USA
Jim	Ippolito	Colorado State University	CO	USA
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Robbie	Iuliucci	Washington and Jefferson College	PA	USA
Gang Seob	Jung	Oak Ridge National Laboratory	TN	USA
Mercouri	Kanatzidis	Northwestern University	IL	USA
Eugene	Kelly	Colorado State University	CO	USA
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James	Kimball	Florida State University	FL	USA
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Edgar	Lara-Curzio	Oak Ridge National Laboratory	TN	USA
Cathy	Levenson	Florida State University	FL	USA
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Kwang Hun	Lim	East Carolina University	NC	USA
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Haoyu	Liu	Florida State University	FL	USA
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Teng	Ma	Florida State University	FL	USA
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Amelia	Nelson	Colorado State University	CO	USA
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Jens	Rosenberg	National High Magnetic Field Laboratory	FL	USA
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NMR – INTERNATIONAL USERS

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David	Bryce	University of Ottawa	Canada
Chia-Hsin	Chen	French National Center for Scientific Research	France
Elisabete	Coelho	University of Aveiro	Portugal
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Rivera	de la Rosa	Autonomous University of Nuevo León	Mexico
Gael	De Paepe	The French Alternative Energies and Atomic Energy Commission	France
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Tomislav	Friscic	McGill University	Canada
Christel	Gervais	Sorbonne University	France
Ieva	Goldberga	French National Center for Scientific Research	France
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Matthew	Harrington	McGill University	Canada
Sabine	Hediger	The French Alternative Energies and Atomic Energy Commission	France
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Yining	Huang	University of Western Ontario	Canada
Igor	Huskic	McGill University	Canada
Michael	Jaroszewicz	University of Windsor	Canada
Dennis	Kleimaier	Heidelberg University	Germany
Xueqian	Kong	Zhejiang University	China
Adam	Lange	Leibniz-Forschungsinstitut für Molekulare Pharmakologie, Berlin	Germany
Danielle	Laurencin	University of Montpellier	France
Daniel	Lee	University of Grenoble Alpes	France
César	Leroy	French National Center for Scientific Research	France
Józef	Lewandowski	University of Warwick	UK
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Isabelle	Marcotte	University of Quebec at Montreal	Canada
Ildefonso	Marin-Montesinos	University of Aveiro	Portugal
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Thomas-Xavier	Métro	Institut des Biomolécules Max Mousseron	France
Francisco José	Morales-Leal	Autonomous University of Nuevo León	Mexico
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Jan	Rainey	Dalhousie University	Canada
Jeremy	Rawson	University of Windsor	Canada
Simon	Reichert	Heidelberg University	Germany
Mariana	Sardo	University of Aveiro	Portugal
Lothar	Schad	Heidelberg University	Germany
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George	Christou	University of Florida	FL	USA
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Maxime	Leroux	French National Center for Scientific Research	France
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Sven	Meyer	Karlsruhe Institute of Technology	Germany
Masashi	Miura	Seikei University	Japan
Philip	Moll	Ecole Polytechnique Federale de Lausanne	Switzerland
Joonbum	Park	Helmholtz-Zentrum Dresden-Rossendorf	Germany
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APPENDIX 5 – USER PROPOSALS

1. AMRIS FACILITY

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)		Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Joanna Long (S)	PI	University of Florida	Biochemistry & Molecular Biology	University of Florida matching support	US College and University	P17621	The Effect of Glassing Matrix Deuteration on 13C and 1H DNP at 5T	Biology, Biochemistry, Biophysics	1	18.33
James H.P. Collins (P)	C	University of Florida	Biochemistry & Molecular Biology							
Chongyang Huang (P)	C	university of Florida	Biochem/Molecular Biology							
Juan Beltran-Huarac (S)	PI	East Carolina University (ECU)	Physics	NASA		P17820	Enhanced MRI Relaxivity in Surface-Complexed Morphology-Tunable Iron Oxide Based Building Blocks: Towards High Performance Targeted Cancer Imaging	Biology, Biochemistry, Biophysics	1	3
John Cooper (G)	C	East Carolina University	Physics							
Gerardo Morell (S)	C	University of Puerto Rico, Rio Piedras	Dept. of Physics							
John Jones (S)	PI	Center for Neurosciences and Cell Biology	Metabolic Control Lab	No other support		P17827	High-sensitivity 13C NMR isotopomer analysis of triglyceride fatty acid enrichment from [U-13C]fructose	Biology, Biochemistry, Biophysics	1	12.5
Ram Khattri (P)	C	University of Florida	Biochemistry and molecular biology/medicine							
Rohit Mahar (P)	C	University of Florida	Biochemistry and molecular biology							
Marc McLeod (G)	C	University of Florida College of Medicine	Biochemistry and Molecular Biology							
Matthew Merritt (S)	C	University of Florida	Biochemistry and Molecular Biology							
Mukundan Ragavan (P)	C	University of Florida	Department of Biochemistry and Molecular Biology							
Peder Larson (S)	PI	University of California - San Francisco	Radiology and Biomedical Imaging	No other support		P17846	ML-LARSON-001: Hyperpolarized 13C Metabolism Studies for Preclinical Detection of Hypertrophic Cardiomyopathy	Biology, Biochemistry, Biophysics	1	41.83
Matthew Merritt (S)	C	University of Florida	Biochemistry and Molecular Biology							
Mukundan Ragavan (P)	C	University of Florida	Department of Biochemistry and Molecular Biology							
Daniel R. Talham (S)	PI	University of Florida	Chemistry	No other support		P17951	Polymer coated lanthanide nanoparticles as PARACEST MRI contrast agents	Chemistry	1	52
Pratik Roy (G)	C	University of Florida	Chemistry							
Luis Colon-Perez (S)	PI	University of California, Irvine	Neurobiology and Behavior	No other support		P18050	Characterization of brain structure at multiple scales in a rodent model early life stress	Biology, Biochemistry, Biophysics	1	2
Pascal Bernatchez (S)	PI	University of British Columbia	Anesthesiology, Pharmacology, & Therapeutics	No other support		P18061	Imaging tissue heterogeneity in a new model of chronic muscle damage with fibrofatty infiltration and wasting.	Biology, Biochemistry, Biophysics	1	10
Elisabeth Barton (S)	C	University of Florida	Applied Physiology and Kinesiology							
Abhinandan Batra (G)	C	University of Florida	Physical therapy							
Ram Khattri (P)	C	University of Florida	Biochemistry and molecular biology/medicine							
Glenn Walter (S)	C	University of Florida	Physiology and Functional Genomics							
Huadong Zeng (S)	C	University of Florida	AMRIS Affiliated Faculty & Staff							
Kunjan Dave (S)	PI	University of Miami	Neurology	No other support		P18093	Accelerated brain aging in diabetes: The impact of recurrent hypoglycemia.	Biology, Biochemistry, Biophysics	1	5.5
Eduardo Candelario-Jalil (S)	C	University of Florida	Neuroscience							
Marcelo Febo (S)	C	University of Florida	Psychiatry							
Marjory Pompilus (G)	C	University of Florida	Psychiatry							

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Benjamin Wylie (S) Anil Mehta (O)	PI C		Texas Tech University Department of Chemistry and Biochemistry University of Florida	Chemistry and Biochemistry AMRIS	No other support		DMR1644779	P19164	Determining the dynamic structure of lipid-membrane protein complexes via solid-state NMR	Biology, Biochemistry, Biophysics	1	16
Adam Veige (S) Clifford Bowers (S) Alec Esper (G) Zhihui Miao (G) Brent Sumerlin (S)	PI C C C C		University of Florida University of Florida University of Florida University of Florida University of Florida	Chemistry Chemistry Chemistry Department of Chemistry Chemistry	NSF	CHE - Chemistry	CHE1808234	P19170	Quantification of End Groups in Cyclic vs. Linear Polyacetylenes by Carbon-13 Magic Angle Spinning Nuclear Magnetic Resonance Spectroscopy	Biology, Biochemistry, Biophysics	1	27.83
Johnny Figueroa (S) Marcelo Febo (S) Marjory Pompilus (G)	PI C C		Loma Linda University University of Florida University of Florida	Center for Health Disparities and Molecular Medicine Psychiatry Psychiatry	No other support			P19197	MICROSTRUCTURAL CORRELATES OF ADOLESCENT ADVERSITY	Biology, Biochemistry, Biophysics	1	4
Stanislaw Deja (S) Matthew Merritt (S) Mukundan Ragavan (P)	PI C C	*	University of Texas, Southwestern University of Florida University of Florida	Center for Human Nutrition Biochemistry and Molecular Biology Department of Biochemistry and Molecular Biology	No other support			P19414	13C NMR measurements of liver samples for development of unified model of hepatic metabolism	Biology, Biochemistry, Biophysics	1	8
Matthew Eddy (S) James H.P. Collins (P) Guillaume Ferre (P) Niloofar Gopal Pour (G) Hala Hachem (G) Emma Mulry (G) Arka Prabha Ray (G)	PI C C C C C C		University of Florida University of Florida University of Florida University of Florida University of Florida University of Florida University of Florida	Chemistry Biochemistry & Molecular Biology Chemistry Chemistry Chemistry Chemistry Chemistry	No other support			P19419	ML-EDDY-002: Small molecule fragment screening with GPCRs in natural membranes by HRMAS NMR	Biology, Biochemistry, Biophysics	1	22.5
Mario Rivera (S) Leo Fontenot (G) Anil Mehta (O) Thomas Weldeghiorghis (S)	PI C C C		Louisiana State University Louisiana State University University of Florida Louisiana State University	Chemistry Chemistry AMRIS Chemistry	NSF NIH	MCB - Molecular and Cellular Biosciences NIAID - National Institute of Allergy and Infectious Diseases	MCB1837877 AI125529	P19426	Probing the impact of iron limitation on the metabolome of P. aeruginosa	Biology, Biochemistry, Biophysics	1	8.5
Carsten Sievers (S) James H.P. Collins (P) Andrew Medford (S) Sean Najmi (G)	PI C C C		Georgia Institute of Technology University of Florida Georgia Institute of Technology Georgia Institute of Technology	School of Chemical & Biomolecular Engineering Biochemistry & Molecular Biology Chemical Engineering Chemical Engineering	No other support			P19432	Diffusion of a model sugar through Lewis acidic metal oxides in various solvents	Engineering	1	29.83
Ryan Lively (S) Amineh Baniani (G) Sergey Vasenkov (S)	PI C C		Georgia Institute of Technology University of Florida University of Florida	School of Chemical & Biomolecular Engineering, Chemical Engineering Chemical Engineering	NSF NSF	CBET - Chemical, Bioengineering, Environmental, and Transport Systems CBET - Chemical, Bioengineering, Environmental, and Transport Systems	CBET1836735 CBET1836738	P19434	Quantification of liquid diffusion in MOF-based hybrid membranes by high field diffusion NMR	Engineering	1	84.42
Jeffrey Rudolf (S)	PI		University of Florida	Chemistry	No other support			P19437	Bacterial terpenoids and their biosynthesis		1	3.67

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Baofu Xu (P)	C		University of Florida	chemistry						Biology, Biochemistry, Biophysics		
Jonathan Nickels (S)	PI	*	University of Cincinnati	Department of Chemical and Environmental Engineering	NSF	CBET - Chemical, Bioengineering, Environmental, and Transport Systems	CBET1836551	P19438	Relationship between structural properties and self-diffusion of molecular mixtures in Nafion by high field diffusion NMR	Engineering	1	62.5
Anastasios Angelopoulos (S)	C		University of Cincinnati	Department of Chemical and Environmental Engineering	NSF	CBET - Chemical, Bioengineering, Environmental, and Transport Systems	CBET1836556					
Blake Trusty (G)	C		University of Florida	Chemical Engineering								
Sergey Vasenkov (S)	C		University of Florida	Chemical Engineering								
Jonathan Judy (S)	PI		University of Florida	Soil and Water Sciences	No other support			P19466	Evaluating the Nature of Phosphorus Entering, Within and Leaving Everglades Stormwater Treatment Areas (STAs)	Chemistry	1	22.5
A. Caroline Buchanan (G)	C		University of Florida	Ag - Soil and Water Science								
Michael Harris (S)	PI		University of Florida	Chemistry	No other support			P19469	ML-HARRIS-001: Analysis of RNA induced protein folding during ribonucleoprotein assembly	Biology, Biochemistry, Biophysics	1	46.5
Matthew Eddy (S)	C		University of Florida	Chemistry								
Lorena Bianchine Areal (P)	PI	*	Florida Atlantic University	Biomedical Science	No other support			P19487	Investigation of serotonergic functional connectivity in a mouse model expressing the ADHD and Autism-Associated DAT Val559 Mutation.	Biology, Biochemistry, Biophysics	1	5.5
Randy Blakely (S)	C		Florida Atlantic University	Biomedical Science and Brain Institute								
Marcelo Febo (S)	C		University of Florida	Psychiatry								
Malisa Sarntinoranont (S)	PI		University of Florida	unknown	No other support			P19525	Changes in Root Flow with Huanglongbing (Citrus Greening)	Engineering	1	27.83
Fernando Alferez (S)	C		University of Florida	Horticultural Sciences Department								
Jaime Cuber (S)	C		Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria	Department of Plant Protection								
Rui Leite (S)	C		Instituto Agronômico do Paraná	Department of Plant Protection								
Thomas Mareci (S)	C		University of Florida	Biochemistry and Molecular Biology								
Julian Rey (G)	C		University of Florida	Mechanical Engineering								
Joanna Long (S)	PI		University of Florida	Biochemistry & Molecular Biology	No other support			P19543	MAINTENANCE: Routine maintenance of existing equipment (formerly P09510 and P17541)	Magnets, Materials	1	314
James H.P. Collins (P)	C		University of Florida	Biochemistry & Molecular Biology								
Thomas Mareci (S)	C		University of Florida	Biochemistry and Molecular Biology								
Anil Mehta (O)	C		University of Florida	AMRIS								
James Rocca (S)	C		University of Florida	AMRIS Affiliated Faculty & Staff								
Jens Rosenberg (S)	C		National High Magnetic Field Laboratory	AMRIS								
Huadong Zeng (S)	C		University of Florida	AMRIS Affiliated Faculty & Staff								
Joanna Long (S)	PI		University of Florida	Biochemistry & Molecular Biology	No other support			P19551	New equipment/upgrades/troubleshooting on horizontals (formerly P09509 and P17540	Magnets, Materials	1	48.67
Malathy Elumalai (T)	C		University of Florida	AMRIS, McKnight Brain Institute								
Kelly Jenkins (T)	C		University of Florida	AMRIS Affiliated Faculty & Staff								
Joshua Slade (T)	C		University of Florida	AMRIS								
Huadong Zeng (S)	C		University of Florida	AMRIS Affiliated Faculty & Staff								
Joanna Long (S)	PI		University of Florida	Biochemistry & Molecular Biology	No other support			P19552	New equipment/upgrades/troubleshooting	Magnets, Materials	1	226.92

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)	Proposal #	Proposal Title	Discipline	Exp. #	Days Used
James H.P. Collins (P)	C		University of Florida	Biochemistry & Molecular Biology			on verticals (formerly P09507 and P17539)			
Malathy Elumalai (T)	C		University of Florida	AMRIS, McKnight Brain Institute						
Anil Mehta (O)	C		University of Florida	AMRIS						
James Rocca (S)	C		University of Florida	AMRIS Affiliated Faculty & Staff						
Joshua Slade (T)	C		University of Florida	AMRIS						
Joanna Long (S)	PI		University of Florida	Biochemistry & Molecular Biology	No other support	P19554	New user training (formerly P09511 and P17542)	Magnets, Materials	1	115.83
James H.P. Collins (P)	C		University of Florida	Biochemistry & Molecular Biology						
Malathy Elumalai (T)	C		University of Florida	AMRIS, McKnight Brain Institute						
Thomas Mareci (S)	C		University of Florida	Biochemistry and Molecular Biology						
Anil Mehta (O)	C		University of Florida	AMRIS						
James Rocca (S)	C		University of Florida	AMRIS Affiliated Faculty & Staff						
Huadong Zeng (S)	C		University of Florida	AMRIS Affiliated Faculty & Staff						
Luke Arbogast (S)	PI	*	National Institute of Standards and Technology MD	Institute for Bioscience and Biotechnology Research	No other support	P19588	Investigation of solid-state NMR for characterization of stability in spray-dried protein therapeutic formulations	Biology, Biochemistry, Biophysics	1	30
John Marino (S)	C		National Institute of Standards and Technology MD	Institute for Bioscience and Biotechnology Research						
Anil Mehta (O)	C		University of Florida	AMRIS						
Sandra Loesgen (S)	PI	*	University of Florida	Chemistry	No other support	P19658	Structural characterization of novel microbial metabolites and their biological activity	Chemistry	1	7.83
Bill Baker (S)	PI	*	University of South Florida	Chemistry	No other support	P19767	Natural Product Drug Discovery for Infectious Diseases and the need for High-Sensitivity NMR Equipment	Biology, Biochemistry, Biophysics	1	4
Joe Bracegirdle (P)	C		University of South Florida	Chemistry						
Jimmy Lawrence (S)	PI	*	Louisiana State University	Chemical Engineering	No other support	P19782	Advanced NMR Spectroscopy as a Versatile Platform for Elucidating the Structure-Property Relationship of Bottlebrush Polymers	Chemistry	1	19
James H.P. Collins (P)	C		University of Florida	Biochemistry & Molecular Biology						
John Jones (S)	PI		Center for Neurosciences and Cell Biology	Metabolic Control Lab	No other support	P19803	Developing H2180 as a tracer of carbohydrate metabolism: Positional analysis of liver glycerol and glycogen 18O-enrichment by isotope-shifted 13C and 31P NMR	Biology, Biochemistry, Biophysics	1	11
Matthew Merritt (S)	C		University of Florida	Biochemistry and Molecular Biology						
							Total Proposals:		Experiments:	Days:
							31		31	1,292.00

2. DC FIELD FACILITY

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Dmytro Abraimov (S)	PI		National High Magnetic Field Laboratory	The Applied Superconductivity Center	No other support			P13640	Angular dependence of Jc for modern ReBCO Coated Conductors at high magnetic fields	Magnets, Materials	1	7.62
Griffin Bradford (O)	C		National High Magnetic Field Laboratory	Applied Superconductivity Center								
Ashleigh Francis (T)	C		National High Magnetic Field Laboratory	ASC								
Jan Jaroszynski (S)	C		National High Magnetic Field Laboratory	CMS								
David Larbalestier (S)	C		National High Magnetic Field Laboratory	ASC								
Yasu Takano (S)	PI		University of Florida	Physics	UCGP			P14886	Magnetic and thermal properties of novel quantum magnets	Condensed Matter Physics	1	4.42
Eun Sang Choi (S)	C		National High Magnetic Field Laboratory	Physics Department								
Yanbo Guo (G)	C		University of Florida	Physics								
Xinzhe Hu (G)	C		University of Florida	Physics								
David Mandrus (S)	C		University of Tennessee, Knoxville	Materials Science and Engineering								
Stephen Nagler (S)	C		Oak Ridge National Laboratory									
Joseph Checkelsky (S)	PI		Massachusetts Institute of Technology	Physics	DOD	ARO - Army Research Office		P16258	High Field Studies of Magnetic Weyl Semimetals	Condensed Matter Physics	2	11.36
Alimamy Bangura (S)	C		National High Magnetic Field Laboratory	CMS	MIT	US College and University						
Aravind Devarakonda (P)	C		Columbia University	Physics								
David Graf (S)	C		National High Magnetic Field Laboratory	DC Field CMS								
Minyong Han (G)	C		Massachusetts Institute of Technology	Physics								
Hisashi Inoue (P)	C		Massachusetts Institute of Technology	Physics								
Caolan John (G)	C		Massachusetts Institute of Technology	Physics								
Takashi Kurumaji (P)	C		Massachusetts Institute of Technology	Physics								
Paul Neves (G)	C		Massachusetts Institute of Technology	Physics								
Takehito Suzuki (P)	C		Massachusetts Institute of Technology	Department of Physics								
Joshua Wakefield (G)	C		Massachusetts Institute of Technology	Physics								
Linda Ye (G)	C		Massachusetts Institute of Technology	Physics								
Junbo Zhu (G)	C		Massachusetts Institute of Technology	Physics								
Grace Morgan (S)	PI	*	University College Dublin	School of Chemistry and Chemical Biology	NSF	DMR - Division of Materials Research	DMR1625780	P16285	Multiferroic behavior at spin-state transitions – beyond Mn(taa)	Condensed Matter Physics	1	0.2
Shalinee Chikara (S)	C		National High Magnetic Field Laboratory	CMS, DC Field Facility								
Xiaxin Ding (P)	C		Idaho National Laboratory	NST								
Vibe Jakobsen (G)	C		University College Dublin	School of Chemistry								
Conor Kelly (G)	C		University College Dublin	Department of Chemistry								
Alexey Kovalev (S)	C		National High Magnetic Field Laboratory	CMS								
Irina Kuehne (P)	C		University College Dublin	School of Chemistry								
Masoud Mardani (G)	C		Florida State University	CMS								
Andrew Ozarowski (S)	C		National High Magnetic Field Laboratory	EMR								
Theo Siegrist (S)	C		National High Magnetic Field Laboratory	Chemical and Biomedical Engineering								
John Singleton (S)	C		National High Magnetic Field Laboratory	Physics								
Alexey Suslov (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science								
Johan van Tol (S)	C		National High Magnetic Field Laboratory	EMR								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Vivien Zapf (S)	C	National High Magnetic Field Laboratory	Physics								
Sara Haravifard (S)	PI	Duke University	Department of Physics	Duke University	US College and University		P16289	Role of Site Mixing on the Ground State of a spin-1/2 Triangular Antiferromagnetic System	Condensed Matter Physics	1	7
Rabindranath Bag (P)	C	Duke University	Physics								
Matthew Ennis (G)	C	Duke University	Physics								
David Graf (S)	C	National High Magnetic Field Laboratory	DC Field CMS								
Zhenzhong Shi (S)	C	Soochow University	School of Physical Science and Technology & Institute for Advanced Study								
Sergei Zvyagin (S)	PI	Helmholtz-Zentrum Dresden-Rossendorf	EPR	Deutsche Forschungsgemeinschaft (DFG)	Other	ZV 6/2-2	P17345	Spin dynamics and magnetic properties of spin systems with competing magnetic interactions	Condensed Matter Physics	1	8
David Graf (S)	C	National High Magnetic Field Laboratory	DC Field CMS								
Armando Paduan-Filho (S)	C	University of Sao Paulo	Physics								
Hidekazu Tanaka (S)	C	Tokyo Institute of Technology	Physics								
William Halperin (S)	PI	Northwestern University	Physics	DOE	Office of Science - BES – Basic Energy Sciences	DE-FG02-05ER46248	P17355	Superconductivity and Magnetism	Condensed Matter Physics	1	14
Mun Chan (S)	C	National High Magnetic Field Laboratory	Pulsed field Facility								
Elizabeth Green (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science								
Arneil Reyes (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science								
Ingrid Stolt (G)	C	Northwestern University	Physics								
Yizhou Xin (G)	C	Northwestern University	Physics								
Peide Ye (S)	PI	Purdue University	School of Electrical and Computer Engineering	NSF	EFMA - Emerging Frontiers and Multidisciplinary Activities	EFMA1433459	P17462	Magneto-transport in one-dimensional van der Waals chiral material tellurene	Condensed Matter Physics	1	5.31
Lin Jiao (S)	C	National High Magnetic Field Laboratory	CMS								
Chang Niu (G)	C	Purdue University	Electrical and Computer Engineering								
Gang Qiu (P)	C	University of California, Los Angeles (UCLA)	Electrical and Computer Engineering								
Zhuocheng Zhang (G)	C	Purdue University	Electrical and Computer Engineering								
Lu Li (S)	PI	University of Michigan	Physics	NSF	DMR - Division of Materials Research	DMR1707620	P17469	Spin-orbit-coupled Correlated Metals	Condensed Matter Physics	1	2
Kuan-Wen Chen (P)	C	University of Michigan	Physics	DOE	Office of Science - BES – Basic Energy Sciences	DE-SC0020184					
Lu Chen (G)	C	University of Michigan	Physics								
William Coniglio (S)	C	National High Magnetic Field Laboratory	A1								
Bernhard Keimer (S)	C	Max Planck Institute for Solid State Research, Stuttgart	Solid State Spectroscopy								
Dmitri Mihaliov (G)	C	University of Michigan	Applied Physics								
John Singleton (S)	C	National High Magnetic Field Laboratory	Physics								
Ziji Xiang (P)	C	University of Michigan	Physics								
Dechen Zhang (G)	C	University of Michigan	Department of Physics								
Guoxin Zheng (G)	C	University of Michigan	Department of Physics								
Jun Zhu (S)	PI	Pennsylvania State University	Physics	NSF	DMR - Division of Materials Research	DMR1904986	P17473	Probing quasi-particle charge and statistics in the quantum Hall and fractional quantum Hall regimes of bilayer graphene	Condensed Matter Physics	1	7
Alimamy Bangura (S)	C	National High Magnetic Field Laboratory	CMS								
Hailong Fu (P)	C	Pennsylvania State University	Physics								
Elizabeth Green (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science								
Ke Huang (G)	C	Pennsylvania State University	Physics								
Jun Sung Kim (S)	PI	Pohang University of Science and Technology	Physics	National Research Foundation in Korea	Other		P17521	Exotic topological transport induced by	Condensed Matter Physics	1	3.15

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Eun Sang Choi (S)	C	National High Magnetic Field Laboratory	Physics Department					spin/pseudospin texture at high magnetic fields			
Joonyoung Choi (G)	C	Kyungpook National University	Physics								
Min Hyuk Choi (G)	C	Pohang University of Science and Technology	Physics								
Ho Seong Jeon (G)	C	Pohang University of Science and Technology	Physics								
YounJung Jo (S)	C	Kyungpook National University	Physics								
Woun Kang (S)	C	Ewha Womans University	Department of Physics								
Hoil Kim (G)	C	Pohang University of Science and Technology	Physics								
Changll Kwon (G)	C	Pohang University of Science and Technology	Physics								
Jong Mok Ok (G)	C	Oak Ridge National Laboratory	Physics								
Junho Seo (G)	C	Pohang University of Science and Technology	Physics								
Nikoleta Theodoropoulou (S)	PI	Texas State University	Physics	Texas State University	US College and University		P17528	Electronic Properties of epitaxial SrTiO3 films on Si	Condensed Matter Physics	1	7
Barry Koehne (G)	C	Texas State University	Physics								
John Miracle (G)	C	Texas State University	Physics								
Zhehong Gan (S)	PI	National High Magnetic Field Laboratory	NHMFL	No other support			P17597	Development of 1.5 GHz NMR using 36T Series-Connected-Hybrid (SCH) Magnet	Magnets, Materials	1	8
William Brey (S)	C	National High Magnetic Field Laboratory	NMR								
Kuizhi Chen (P)	C	National High Magnetic Field Laboratory	NMR								
Po-Hsiu Chien (G)	C	Florida State University	Chemistry and Biochemistry								
Tim Cross (S)	C	National High Magnetic Field Laboratory	NHMFL/Chemistry & Biochemistry								
Ivan Hung (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Ilya Litvak (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Joana Paulino (P)	C	National High Magnetic Field Laboratory	CIMAR								
Jeffrey Schiano (S)	C	Pennsylvania State University	Electrical Engineering								
Geetha Balakrishnan (S)	PI	University of Warwick	Physics	European Research Council	Non US Council		P17678	Quantum oscillations in Kondo insulators	Condensed Matter Physics	1	5.68
Monica Ciomaga Hatnean (S)	C	Paul Scherrer Institute	Research with Neutrons and Muons, Laboratory for Multiscale materials eXperiments								
Alex Eaton (G)	C	University of Cambridge	Physics								
David Graf (S)	C	National High Magnetic Field Laboratory	DC Field CMS								
Alex Hickey (G)	C	University of Cambridge	Department of Physics								
James Analytis (S)	PI	University of California, Berkeley	Physics	DOE	Office of Science - BES – Basic Energy Sciences	DE-AC02-05CH11231	P17755	Superconductor to Insulator Transition in a Non-Centrosymmetric Rare-Earth Compound	Condensed Matter Physics	1	7
Alimamy Bangura (S)	C	National High Magnetic Field Laboratory	CMS								
Nikola Maksimovic (G)	C	University of California, Berkeley	Physics								
Eran Maniv (P)	C	University of California, Berkeley	Physics								
Vikram Nagarajan (G)	C	University of California, Berkeley	Physics								
Ziling Xue (S)	PI	University of Tennessee, Knoxville	Chemistry	NSF	CHE - Chemistry	CHE1900296	P17767	Investigating Molecular Magnetism by Magneto-Far-IR Spectroscopy	Chemistry	1	7
Alexandria Bone (G)	C	University of Tennessee, Knoxville	Chemistry								
Adam Hand (G)	C	University of Tennessee, Knoxville	Chemistry								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Michael Jenkins (G)	C	University of Tennessee, Knoxville	Chemistry								
Mykhaylo Ozerov (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS								
Dmitry Smirnov (S)	C	National High Magnetic Field Laboratory	Instrumentation & Operations								
Pagnareach Tin (G)	C	University of Tennessee, Knoxville	Chemistry								
Minhyea Lee (S)	PI	University of Colorado, Boulder	Physics	NSF	DMR - Division of Materials Research	DMR2001376	P17772	Probing novel magnetism in spin-orbit coupled systems	Condensed Matter Physics	1	7
Gang Cao (S)	C	University of Colorado, Boulder	Department of Physics.	University of Colorado Boulder	US College and University						
Eun Sang Choi (S)	C	National High Magnetic Field Laboratory	Physics Department								
Kwang Yong Choi (S)	C	Sungkyunkwan University	Department of Physics								
Ian Leahy (G)	C	University of Colorado, Boulder	Physics								
Tyrel McQueen (S)	C	Johns Hopkins University	Chemistry and Physics and Astronomy								
Christopher Pocs (G)	C	University of Colorado, Boulder	Physics								
Peter Siegfried (P)	C	George Mason University	Physics and Astronomy								
Arthur Ramirez (S)	PI	University of California, Santa Cruz	Physics	DOE	Office of Science - BES - Basic Energy Sciences	DE-SC0017862	P17775	Probing the Putative Neutral Fermi Surface of SmB6 Using Specific Heat	Condensed Matter Physics	1	14
Alimamy Bangura (S)	C	National High Magnetic Field Laboratory	CMS								
Priscila Ferrari Silveira Rosa (P)	C	Los Alamos National Laboratory	MPA-CMMS								
Zachary Fisk (S)	C	University of California, Irvine	Physics and Astronomy								
Nathanael Fortune (S)	C	Smith College	Department of Physics								
Scott Hannahs (S)	C	National High Magnetic Field Laboratory	Instrumentation								
Patrick LaBarre (G)	C	University of California, Santa Cruz	Physics								
Tyrel McQueen (S)	C	Johns Hopkins University	Chemistry and Physics and Astronomy								
Joyce Palmer-Fortune (S)	C	Smith College	Physics								
Andreas Rydh (S)	C	Stockholm University	Department of Physics								
Eun Sang Choi (S)	PI	National High Magnetic Field Laboratory	Physics Department	No other support			P17780	Magnetothermal conductivity studies on breathing pyrochlore magnets	Condensed Matter Physics	1	7
Hongwoo Baek (S)	C	National High Magnetic Field Laboratory	DC field								
Rabindranath Bag (P)	C	Duke University	Physics								
Alimamy Bangura (S)	C	National High Magnetic Field Laboratory	CMS								
Sachith Dissanayake (P)	C	Duke University	Physics								
Matthew Ennis (G)	C	Duke University	Physics								
Sara Haravifard (S)	C	Duke University	Department of Physics								
Hongcheng Lu (P)	C	Duke University	Physics								
Zhenzhong Shi (S)	C	Soochow University	School of Physical Science and Technology & Institute for Advanced Study								
William Steinhardt (G)	C	Duke University	Physics								
Lalit Yadav (G)	C	Duke University	Physics								
Sabyasachi Sen (S)	PI	University of California, Davis	Chemical Engineering and Materials Science	NSF	DMR - Division of Materials Research	DMR1855176	P17811	Investigation of the atomistic basis of structural relaxation and viscous flow in supercooled chalcogenide liquids by high field dynamical NMR spectroscopy	Condensed Matter Physics	1	4
Zhehong Gan (S)	C	National High Magnetic Field Laboratory	NHMFL								
Ivan Hung (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Yiqing Xia (G)	C	University of California, Davis	Materials Science								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Name	Role	Org.	Dept.	Funding Agency	Division	Award #					
Weidi Zhu (G)	C	University of California, Davis	Materials Science & Engineering								
Jeffrey Schiano (S)	PI	Pennsylvania State University	Electrical Engineering	NIH	NIGMS - National Institute of General Medical Sciences	GM122698	P17819	Flux Regulation for Powered Magnets	Engineering	1	3
William Brey (S)	C	National High Magnetic Field Laboratory	NMR								
Ilya Litvak (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Xinxing Meng (G)	C	Pennsylvania State University	Electrical Engineering								
Waroch Tangbampensountorn (G)	C	Pennsylvania State University	Electrical Engineering								
Qi Li (S)	PI	Pennsylvania State University	Physics	DOE	Office of Science - BES – Basic Energy Sciences	DE-FG02-08ER46531	P17849	Shubnikov de Haas oscillation of two dimensional electron gases with strong spin-orbit coupling at transition metal oxide interfaces	Condensed Matter Physics	1	3.65
Autumn Heltman (U)	C	Pennsylvania State University	Physics								
Lin Jiao (S)	C	National High Magnetic Field Laboratory	CMS								
Shalini Kumari (P)	C	Pennsylvania State University	Physics								
Ziqiao Wang (G)	C	Pennsylvania State University	Physics								
Xiaodong Xu (S)	PI	University of Washington	Physics	DOD	US Air Force	FA9550-21-1-0177	P17854	pressure tuning magnetic properties of van der Waals magnets	Condensed Matter Physics	1	6.32
Jiaqi Cai (G)	C	University of Washington	Physics								
Zaiyao Fei (P)	C	University of Washington	Physics								
David Graf (S)	C	National High Magnetic Field Laboratory	DC Field CMS								
Dmitry Ovchinnikov (P)	C	University of Washington	Physics								
Alexey Suslov (S)	PI	National High Magnetic Field Laboratory	Condensed Matter Science	No other support			P17866	Improvement of the ultrasonic techniques at the DC field facility 2018	Magnets, Materials	1	7
Sanfeng Wu (S)	PI	Princeton University	Department of Physics	NSF	DMR - Division of Materials Research	DMR1942942	P17871	Exploring Topological Quantum Phases and Devices Based on 2D Materials	Condensed Matter Physics	2	18.56
Yanyu Jia (G)	C	Princeton University	Physics								
Michael Onyszczak (G)	C	Princeton University	Physics								
Leslie Schoop (S)	C	Princeton University	Chemistry								
Pengjie Wang (P)	C	Princeton University	Department of Physics								
Guo Yu (G)	C	Princeton University	Physics								
Christianne Beekman (S)	PI	National High Magnetic Field Laboratory	Physics	NSF	CAREER - Faculty Early Career Development Program	1847887	P17889	The effect of strain and confinement on spin ice physics in pyrochlore titanate thin films.	Condensed Matter Physics	2	13
David Graf (S)	C	National High Magnetic Field Laboratory	DC Field CMS								
Sangsoo Kim (G)	C	Florida State University	Physics								
Ryan Baumbach (S)	PI	National High Magnetic Field Laboratory	CMS	DOE	Other	DE-AC02-07CH11358	P17894	Investigation of dual nature f-electron intermetallics using high magnetic fields	Condensed Matter Physics	2	11.5
Luis Balicas (S)	C	National High Magnetic Field Laboratory	Condensed Matter Experiment	DOE	Office of Science - BES – Basic Energy Sciences	DE-SC0016568					
Eun Sang Choi (S)	C	National High Magnetic Field Laboratory	Physics Department								
Aikaterini Flessa Savvidou (G)	C	National High Magnetic Field Laboratory	Condensed Matter								
Mykhaylo Ozerov (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS								
Andriy Palasyuk (S)	C	Iowa State University	CMI								
Seungyong Hahn (S)	PI	National High Magnetic Field Laboratory	Applied Superconductivity Center, Mechanical Engineering	NSF	DMR - Division of Materials Research	DMR1644779	P17900	No-Insulation Type High Temperature Superconductor Winding Techniques for All-Superconducting >30-T DC User Magnets	Magnets, Materials	1	4.1
Dmytro Abraimov (S)	C	National High Magnetic Field Laboratory	The Applied Superconductivity Center								
Jeseok Bang (G)	C	Seoul National University	Department of Electrical and Computer Engineering								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Griffin Bradford (O)	C	National High Magnetic Field Laboratory	Applied Superconductivity Center								
Ashleigh Francis (T)	C	National High Magnetic Field Laboratory	ASC								
Xinbo Hu (G)	C	National High Magnetic Field Laboratory	ASC								
Jan Jaroszynski (S)	C	National High Magnetic Field Laboratory	CMS								
Kwanglok Kim (O)	C	National High Magnetic Field Laboratory	Applied Superconductivity Center								
Kwangmin Kim (O)	C	National High Magnetic Field Laboratory	Applied Superconductivity Center								
David Larbalestier (S)	C	National High Magnetic Field Laboratory	ASC								
So Noguchi (S)	C	Hokkaido University	Graduate School of Information Science and Technology								
Michael Small (U)	C	Florida State University	Applied Superconductivity Center								
Xi Ling (S)	PI	Boston University	Department of Chemistry	NSF	CHE - Chemistry	CHE1945364	P17901	Magneto-optics of 2D Antiferromagnetic Semiconductors	Condensed Matter Physics	1	2.4
Jade Holleman (G)	C	Florida State University	Physics								
Stephen McGill (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science								
Qishuo Tan (G)	C	Boston University	Department of Chemistry								
Minhyea Lee (S)	PI	University of Colorado, Boulder	Physics	DOE	Office of Science - BES - Basic Energy Sciences	DE-SC0021377	P17906	Investigation on unusual magnetic responses in quantum magnets	Condensed Matter Physics	2	14
Alimamy Bangura (S)	C	National High Magnetic Field Laboratory	CMS	University of Colorado Boulder	US College and University						
Gang Cao (S)	C	University of Colorado, Boulder	Department of Physics.								
Ian Leahy (G)	C	University of Colorado, Boulder	Physics								
Ross McDonald (S)	C	National High Magnetic Field Laboratory	Physics								
Christopher Pocs (G)	C	University of Colorado, Boulder	Physics								
Arkady Shehter (S)	C	Los Alamos National Laboratory	LANL MPA-MAGLAB								
Peter Siegfried (P)	C	George Mason University	Physics and Astronomy								
Venkat Selvamanickam (S)	PI	University of Houston	Mechanical Engineering	DOE	Office of Science - HEP - High Energy Physics	DE-SC0016220	P17917	Critical current characterization of Symmetric Tape Round (STAR) REBa2Cu3Ox wires at 4 K and very high magnetic fields	Magnets, Materials	1	3.13
Eduard Galstyan (S)	C	University of Houston	Texas Center for Superconductivity	DOE	Office of Science - SBIR - Small Business Innovation Research	DE-SC0015983					
Jan Jaroszynski (S)	C	National High Magnetic Field Laboratory	CMS								
Janakiram Kadiyala (S)	C	Ampeers LLC	UH Technology Bridge								
Soumen Kar (S)	C	University of Houston	Mechanical Engineering								
Mehdi Kochat (G)	C	University of Houston	Mechanical engineering								
Lloyd Engel (S)	PI	National High Magnetic Field Laboratory	CMS	DOE	Office of Science - BES - Basic Energy Sciences	DE-FG02-05-ER46212	P17920	Microwave spectroscopy of electron solids in anisotropic semiconductor systems	Condensed Matter Physics	1	7
Matthew Freeman (G)	C	National High Magnetic Field Laboratory	Condensed Matter Science								
Loren Pfeiffer (S)	C	Princeton University	Electrical Engineering								
Mansour Shayegan (S)	C	Princeton University	Department of Electrical Engineering								
Nicholas Butch (S)	PI	National Institute of Standards and Technology MD	NIST Center for Neutron Research	NIST	US Government Lab		P17928	Physical properties of spin triplet superconductor UTe2 in high magnetic field	Condensed Matter Physics	1	3.23
David Graf (S)	C	National High Magnetic Field Laboratory	DC Field CMS								
Sheng Ran (S)	C	Washington University in St. Louis	Physics								
Sufei Shi (S)	PI	Rensselaer Polytechnic Institute	Chemical and Biological Engineering	DOD	US Air Force		P17976	Probing Excitonic Fine Structures in Van der Waals Heterostructures	Condensed Matter Physics	1	4.02
Zhengguang Lu (G)	C	National High Magnetic Field Laboratory	Physics								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Lei Ma (G)	C		Rensselaer Polytechnic Institute	Chemical and Biological Engineering								
Shengnan Miao (G)	C		Rensselaer Polytechnic Institute	Chemical Engineering								
Dmitry Smirnov (S)	C		National High Magnetic Field Laboratory	Instrumentation & Operations								
Tianmeng Wang (G)	C		Rensselaer Polytechnic Institute	Chemical and Biological Engineering								
Badih Assaf (S)	PI	*	University of Notre Dame	Physics	NSF	DMR - Division of Materials Research	DMR1905277	P17982	Symmetry breaking in Landau quantized topological crystalline insulators	Condensed Matter Physics	2	14
David Graf (S)	C		National High Magnetic Field Laboratory	DC Field CMS								
Xinyu Liu (S)	C		University of Notre Dame	.								
Mykhaylo Ozerov (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS								
Dmitry Smirnov (S)	C		National High Magnetic Field Laboratory	Instrumentation & Operations								
Jiashu Wang (G)	C		University of Notre Dame	Physics								
Fazel Tafti (S)	PI		Boston College	Physics	NSF	DMR - Division of Materials Research	DMR1708929	P17991	Revealing the Weyl-Kondo physics in a new semimetal	Condensed Matter Physics	1	7
David Graf (S)	C		National High Magnetic Field Laboratory	DC Field CMS								
Paul Goddard (S)	PI		University of Warwick	Department of Physics	European Research Council Consolidator Grant	Non US Council	681260	P17992	Molecule-based quantum magnets in applied pressures	Condensed Matter Physics	1	14
Matthew Coak (P)	C		University of Warwick	Department of Physics								
Sam Curley (G)	C		University of Warwick	Physics and Astronomy								
David Graf (S)	C		National High Magnetic Field Laboratory	DC Field CMS								
Jamie Manson (S)	C		Eastern Washington University	Chemistry and Biochemistry								
Robert Williams (P)	C		University of Warwick	Dept of Physics								
Jia Li (S)	PI		Brown University	Department of Physics	Brown University	US College and University		P18016	Studying correlated electron states in two-dimensional material in high magnetic field with microwave techniques	Condensed Matter Physics	1	8
Jiangxiazi Lin (G)	C		Hong Kong University of Science and Technology	Center for Quantum materials								
Xiaoxue Liu (P)	C		Brown University	Physics department								
Naiyuan Zhang (G)	C		Brown University	Department of Physics								
Seng Huat Lee (S)	PI		Pennsylvania State University	Physics	NSF	MIP - Materials Innovation Platform	DMR1539916	P18018	Seeking for Weyl State in Intrinsic Antiferromagnetic Topological Insulator MnBi2Te4 under High Magnetic Fields	Condensed Matter Physics	1	5.4
David Graf (S)	C		National High Magnetic Field Laboratory	DC Field CMS								
Zhiqiang Mao (S)	C		Pennsylvania State University	Department of Physics								
Lujin Min (G)	C		Pennsylvania State University	Department of Physics								
Wei Ning (P)	C		Pennsylvania State University	Department of Physics								
Jian Liu (S)	PI		University of Tennessee, Knoxville	Physics	DOE	Office of Science - BES - Basic Energy Sciences	DE-SC0020254	P18024	Low-temperature high-field magnetotransport study of geometrically frustrated spin ice heterostructures	Condensed Matter Physics	4	28
Alimamy Bangura (S)	C		National High Magnetic Field Laboratory	CMS								
Qing Huang (G)	C		University of Tennessee, Knoxville	Physics								
Kyle Noordhoek (U)	C		University of Tennessee, Knoxville	Physics and Astronomy								
Chengkun Xing (G)	C		University of Tennessee, Knoxville	Physics								
Han Zhang (P)	C		University of Tennessee, Knoxville	Physics								
Adam Fiedler (S)	PI		Marquette University	Chemistry	NSF	CHE - Chemistry	CHE1900562	P18030	Probing the Magnetic Anisotropy of Co(II) Complexes Featuring Radical Ligands	Chemistry	1	7
John Berry (S)	C		University of Wisconsin, Madison	Department of Chemistry								
Jurek Krzystek (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science								
Mykhaylo Ozerov (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS								
Joshua Telser (S)	C		Roosevelt University	Biological, Physical and Health Sciences								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Luis Balicas (S)	PI		National High Magnetic Field Laboratory	Condensed Matter Experiment	DOE	Office of Science - BES – Basic Energy Sciences	DE-SC0002613	P19122	Understanding the anomalous Hall-effect in the magnetic topological semi-metallic candidates Fe3GeTe2 and Fe5GeTe2	Condensed Matter Physics	2	21
Brian Casas (P)	C		National High Magnetic Field Laboratory	Condensed Matter Sciences								
Juan Macy (G)	C		National High Magnetic Field Lab	Condensed Matter Sciences								
Shirin Mozaffari (P)	C		University of Tennessee, Knoxville	Materials Science and Engineering								
Haidong Zhou (S)	PI		University of Tennessee, Knoxville	Physics and Astronomy	DOE	Office of Science - BES – Basic Energy Sciences	DE-SC0020254	P19130	Manipulating the strong quantum spin fluctuations in new triangular lattice antiferromagnets with spin-1/2	Condensed Matter Physics	4	27
Alexander Brassington (G)	C		University of Tennessee, Knoxville	Physics								
Eun Sang Choi (S)	C		National High Magnetic Field Laboratory	Physics Department								
Qing Huang (G)	C		University of Tennessee, Knoxville	Physics								
Kyle Noordhoek (U)	C		University of Tennessee, Knoxville	Physics and Astronomy								
Chengkun Xing (G)	C		University of Tennessee, Knoxville	Physics								
Han Zhang (P)	C		University of Tennessee, Knoxville	Physics								
Krzysztof Gofryk (S)	PI		Idaho National Laboratory	Fuel Performance & Design	DOE	Office of Science - BES – Basic Energy Sciences	KG's Early career award	P19145	Transport and magnetic properties of selected d- and f-electron topological materials in high magnetic fields	Condensed Matter Physics	1	4.16
Xiaxin Ding (P)	C		Idaho National Laboratory	NST								
David Graf (S)	C		National High Magnetic Field Laboratory	DC Field CMS								
Narayan Poudel (P)	C		Idaho National Laboratory	Nuclear Materials								
Nirmal Ghimire (S)	PI	*	George Mason University	Physics and Astronomy	George Mason University	US College and University		P19163	High field magnetization and quantum oscillations of metallic Kagome net magnets	Condensed Matter Physics	1	4.43
Hari Bhandari (G)	C		George Mason University	Physics								
Peter Siegfried (P)	C		George Mason University	Physics and Astronomy								
John Singleton (S)	C		National High Magnetic Field Laboratory	Physics								
Nishchal Thapa Magar (G)	C		George Mason University	Physics and Astronomy								
Eun Sang Choi (S)	PI		National High Magnetic Field Laboratory	Physics Department	No other support			P19217	Magnetometry instrumentation: calibration and background measurements	Condensed Matter Physics	1	7
Xiao-Xiao Zhang (S)	PI	*	University of Florida	Physics	UCGP		Subaward R000002800	P19224	Magneto-optical investigation of Van der Waals magnetic-semiconductor heterostructure	Condensed Matter Physics	1	7
Xin Cong (P)	C		University of Florida	Physics	University of Florida	US College and University						
Stephen McGill (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science								
Dmitry Smirnov (S)	C		National High Magnetic Field Laboratory	Instrumentation & Operations								
Mingyang Zheng (G)	C		University of Florida	Physics Department								
Henry La Pierre (S)	PI		Georgia Institute of Technology	School of Chemistry and Biochemistry	Beckman Young Investigator Award	Other		P19236	Magnetic Properties Characterization of Kagome Lattice Compounds, (CH3NH3)2MM'3F12 (M = Na+, K+ and NH4+, M' = V3+ and Ti3+)	Chemistry	2	28
Ryan Baumbach (S)	C		National High Magnetic Field Laboratory	CMS								
Arun Ramanathan (G)	C		Georgia Institute of Technology	Chemsitry								
Luis Balicas (S)	PI		National High Magnetic Field Laboratory	Condensed Matter Experiment	DOE	Office of Science - BES – Basic Energy Sciences	DE-SC0002613	P19238	Unconventional Topological Fermions in Rh silicides and germanides	Condensed Matter Physics	1	4.68
Brian Casas (P)	C		National High Magnetic Field Laboratory	Condensed Matter Sciences								
Aikaterini Flessa Savvidou (G)	C		National High Magnetic Field Laboratory	Condensed Matter								
Shirin Mozaffari (P)	C		University of Tennessee, Knoxville	Materials Science and Engineering								
WenKai Zheng (G)	C		National High Magnetic Field Laboratory	Condensed Matter Sciences								
Xiang Yuan (S)	PI	*	East China Normal University	state key laboratory of precision spectroscopy	East China Normal University	Non US College and University		P19239	Probing electronic structure of topological	Condensed Matter Physics	2	14

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Mykhaylo Ozerov (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS					semimetal under magnetic field by infrared spectroscopy			
Zeping Shi (G)	C	East China Normal University	State Key Laboratory of Precision Spectroscopy								
Wenbin Wu (G)	C	East China Normal University	State Key Laboratory of Precision Spectroscopy								
Cheng Zhang (S)	C	Fudan University	Institute for Nanoelectronic Devices and Quantum Computing								
Stuart Brown (S)	PI	University of California, Los Angeles	Department of Physics and Astronomy	NSF	DMR - Division of Materials Research	DMR1709304	P19266	High field magnetic properties of Nd2-xCexCuO4	Condensed Matter Physics	1	14
Elizabeth Green (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science								
Arneil Reyes (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science								
Arkady Shehter (S)	PI	Los Alamos National Laboratory	LANL MPA-MAGLAB	No other support			P19272	Heat capacity study of high-temperature superconductors across the phase diagram in high magnetic fields	Condensed Matter Physics	3	33.72
Alimamy Bangura (S)	C	National High Magnetic Field Laboratory	CMS	NSF	DMR - Division of Materials Research	DMR1157490					
Greg Boebinger (S)	C	National High Magnetic Field Laboratory	Directors Office	NSF	DMR - Division of Materials Research	DMR1644779					
Ross McDonald (S)	C	National High Magnetic Field Laboratory	Physics								
Kimberly Modic (S)	C	Institute of Science and Technology Austria	Physics								
Shimpei Ono (S)	C	Central Research Institute of Electric Power Industry	Materials Science Research Laboratory								
Brad Ramshaw (S)	C	Cornell University	Laboratory of Atomic and Solid State Physics								
Andreas Rydh (S)	C	Stockholm University	Department of Physics								
Alimamy Bangura (S)	PI	National High Magnetic Field Laboratory	CMS	No other support			P19273	Development of high field calorimetry probe	Condensed Matter Physics	1	4
Greg Boebinger (S)	C	National High Magnetic Field Laboratory	Directors Office								
Ross McDonald (S)	C	National High Magnetic Field Laboratory	Physics								
Kimberly Modic (S)	C	Institute of Science and Technology Austria	Physics								
Brad Ramshaw (S)	C	Cornell University	Laboratory of Atomic and Solid State Physics								
Andreas Rydh (S)	C	Stockholm University	Department of Physics								
Arkady Shehter (S)	C	Los Alamos National Laboratory	LANL MPA-MAGLAB								
Henry La Pierre (S)	PI	Georgia Institute of Technology	School of Chemistry and Biochemistry	DOE	Office of Science - BES – Basic Energy Sciences	DE-SC0019385	P19275	Study of Zero Field Splitting in Molecular Tb4+ Complexes by High Field EPR	Biology, Biochemistry, Biophysics	3	28
Luis Aguirre Quintana (G)	C	Georgia Institute of Technology	Chemistry and Biochemistry								
Ryan Baumbach (S)	C	National High Magnetic Field Laboratory	CMS								
Thaige Gompa (G)	C	Georgia Institute of Technology	School of Chemistry and Biochemistry								
Samuel Greer (P)	C	Los Alamos National Laboratory	C-PCS: PHYSICAL CHEM & APPLIED SPECTROSCOPY								
Arun Ramanathan (G)	C	Georgia Institute of Technology	Chemsitry								
Natalie Rice (G)	C	Georgia Institute of Technology	School of Chemistry and Biochemistry								
Joshua Telser (S)	C	Roosevelt University	Biological, Physical and Health Sciences								
Janice Musfeldt (S)	PI	University of Tennessee, Knoxville	Department of Chemistry	DOE	Office of Science - BES – Basic Energy Sciences	DE-FG02-01ER45885	P19343	High field spectroscopy of materials with broken symmetry and strong spin-orbit coupling	Chemistry	3	9.78
Avery Blockmon (G)	C	University of Tennessee, Knoxville	Chemistry								
Stephen McGill (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science								
Kiman Park (G)	C	University of Tennessee, Knoxville	Chemistry								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Kang Wang (S)	PI		University of California, Los Angeles	Electrical Engineering	DOE	MSE - Materials Science and Engineering	DE-SC0012670	P19344	Transport of the quantum anomalous Hall insulators with mesoscopic dephasing length	Condensed Matter Physics	2	14
Su Kong Chong (P)	C		University of California, Los Angeles	Department of Electric and Computer Engineering								
Peng Deng (P)	C		University of California, Los Angeles	Electrical engineering								
Chris Eckberg (G)	C		University of Maryland, College Park	Physics								
David Graf (S)	C		National High Magnetic Field Laboratory	DC Field CMS								
Gang Qiu (P)	C		University of California, Los Angeles (UCLA)	Electrical and Computer Engineering								
Lixuan Tai (G)	C		University of California, Los Angeles	Electrical and Computer Engineering								
Peng Zhang (G)	C		University of California, Los Angeles	Electric engineering								
Qi Zhang (S)	PI		Nanjing University	Physics and Astromony	Nanjing University	Non US College and University	New Faculty Startup Funds	P19349	Terahertz magnons, phonons and magnetic phase transitions in 2D honeycomb antiferromagnets	Condensed Matter Physics	1	3.89
Jiun-Haw Chu (S)	C		University of Washington	Physics								
Mykhaylo Ozerov (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS								
Xiaodong Xu (S)	C		University of Washington	Physics								
Soon-Gil Jung (S)	PI	*	Sungkyunkwan University	Physics	National Research Foundation of Korea	Other		P19352	Quantum Griffiths singularity in disordered FeSeTe thin films	Condensed Matter Physics	1	5.05
Eun Sang Choi (S)	C		National High Magnetic Field Laboratory	Physics Department								
Lin Jiao (S)	C		National High Magnetic Field Laboratory	CMS								
YounJung Jo (S)	C		Kyungpook National University	Physics								
Tuson Park (S)	C		Sungkyunkwan University	Physics								
Stan Tozer (S)	PI		National High Magnetic Field Laboratory	Physics	NSF	DMR - Division of Materials Research	DMR1157490	P19362	Search for and an Understanding of Room Temperature Superconductivity	Condensed Matter Physics	1	3.79
Muhtar Ahart (S)	C		University of Illinois at Chicago	Physics								
William Coniglio (S)	C		National High Magnetic Field Laboratory	A1								
Audrey Grockowiak (S)	C		National High Magnetic Field Laboratory	DC Field/CMS								
Toni Helm (P)	C		Max Planck Institute for Chemical Physics of Solids, Dresden	Physics of Quantummaterials								
Russell Hemley (S)	C		University of Illinois at Chicago	Physics								
Maddury Somayazulu (S)	C		Argonne National Laboratory	Advanced Photon Source HPCAT sector 16								
David Graf (S)	PI		National High Magnetic Field Laboratory	DC Field CMS	No other support			P19363	Two-axis rotation for DC magnetic fields	Condensed Matter Physics	2	11.45
Martin Greven (S)	PI		University of Minnesota, Twin Cities	Physics and Astronomy	DOE	Office of Science - BES – Basic Energy Sciences	DE-SC0006858	P19371	Critical fields for enhanced superconductivity in plastically deformed SrTiO3	Condensed Matter Physics	2	12.53
Shalinee Chikara (S)	C		National High Magnetic Field Laboratory	CMS, DC Field Facility								
Lin Jiao (S)	C		National High Magnetic Field Laboratory	CMS								
Damjan Pelc (P)	C		University of Minnesota	School of Physics and Astronomy								
Philip Kim (S)	PI		Harvard University	Department of Physics	DOE	Office of Science - BES – Basic Energy Sciences	DOE DE-SC0012260	P19376	Emergent phenomena in graphene heterostructures at the extreme quantum limit	Condensed Matter Physics	1	7
Onder Gul (P)	C		Harvard University	Department of Physics								
Zeyu Hao (G)	C		Harvard University	Physics								
Antti Laitinen (P)	C		Harvard University	Department of Physics								
Yuval Ronen (P)	C		Harvard University	Physics								
Thomas Werkmeister (G)	C		Harvard University	Applied Physics								
Jonathan Zauberman (G)	C		Harvard University	Physics								
Andrew Zimmerman (P)	C		Harvard University	Physics								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Matthew Grayson (S)	PI	Northwestern University	Electrical Engineering & Computer Science	Air Force Office of Scientific Research	Other	FA9550-15-1-0377	P19379	SdH oscillation for Fermi-surface mapping in novel transverse thermoelectric material CsBi4Te6	Magnets, Materials	1	7
Shalinee Chikara (S)	C	National High Magnetic Field Laboratory	CMS, DC Field Facility								
Mercouri Kanatzidis (S)	C	Northwestern University	Chemistry								
Qing Shao (G)	C	Northwestern University	Electrical Engineering and Computer Science								
Abhay Pasupathy (S)	PI	Columbia University	Physics	NSF	MRSEC - Materials Research Science and Engineering Centers	1420634	P19383	Topologically protected quasiparticle excitations in 2D superconductors	Condensed Matter Physics	4	25.44
Eun Sang Choi (S)	C	National High Magnetic Field Laboratory	Physics Department								
Lin Jiao (S)	C	National High Magnetic Field Laboratory	CMS								
Apoorv Jindal (G)	C	Columbia University	Physics								
Zizhong Li (G)	C	University of Wisconsin, Madison	Department of Materials Science and Engineering								
Daniel Rhodes (S)	C	University of Wisconsin, Madison (UW)	Materials Science and Engineering								
Fazel Tafti (S)	PI	Boston College	Physics	DOE	Office of Science - BES - Basic Energy Sciences	DE-SC0002613	P19384	Hydrodynamic Electron Flow in NbGe2	Condensed Matter Physics	2	13.97
Luis Balicas (S)	C	National High Magnetic Field Laboratory	Condensed Matter Experiment								
Shirin Mozaffari (P)	C	University of Tennessee, Knoxville	Materials Science and Engineering								
Alexey Suslov (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science								
Hung-Yu Yang (G)	C	Boston College	Physics								
Cedomir Petrovic (S)	PI	Brookhaven National Laboratory	Condensed Matter Physics	DOE	Office of Science - BES - Basic Energy Sciences	DE-SC0012704	P19385	Size effects and Electronic transport anisotropy in correlated electron Dirac and Weyl semimetals	Biology, Biochemistry, Biophysics	3	21.61
Fernando Camino (S)	C	Brookhaven National Laboratory	Center for Functional Nanomaterials								
Qianheng Du (G)	C	Brookhaven National Laboratory	Condensed Matter Physics and Materials Science								
Spencer Gibbs (U)	C	University of Pennsylvania	Chemistry								
David Graf (S)	C	National High Magnetic Field Laboratory	DC Field CMS								
Zhixiang Hu (G)	C	Brookhaven National Laboratory	Condensed Matter Physics								
Cedomir Petrovic (S)	C	Brookhaven National Laboratory	Condensed Matter Physics								
Mike Sumption (S)	PI	Ohio State University	CSMM, MSE	DOE	Office of Science - HEP - High Energy Physics	DE-SC0013849	P19391	High Field Transport in Ternary and Quaternary APC type Nb3Sn Conductors with Increased Engineering Je and Stability	Magnets, Materials	1	5.57
Jan Jaroszynski (S)	C	National High Magnetic Field Laboratory	CMS								
Jacob Rochester (G)	C	Ohio State University	Materials Science								
Xingchen Xu (S)	C	Fermi National Accelerator Laboratory	Magnet System								
Chun Ning (Jeanie) Lau (S)	PI	Ohio State University	Department of Physics and Astronomy	NSF	DMR - Division of Materials Research	DMR1922076	P19392	Symmetry-broken phases and topological phenomena in layered quantum materials	Condensed Matter Physics	5	31.4
Xueshi Gao (G)	C	Ohio State University	Physics	NSF	DMR - Division of Materials Research	DMR1807928					
Yulu Liu (G)	C	Ohio State University	Physics	DOE	Office of Science - BES - Basic Energy Sciences	DE-SC0020187					
Dmitry Shcherbakov (G)	C	Ohio State University	Physics								
Dmitry Smirnov (S)	C	National High Magnetic Field Laboratory	Instrumentation & Operations								
Haidong Tian (G)	C	Ohio State University	Physics								
Greyson Voigt (G)	C	Ohio State University	Dept of Physics								
Zheneng Zhang (G)	C	Ohio State University	Physics								
Wan Kyu Park (S)	PI	National High Magnetic Field Laboratory	Condensed Matter Science	UCGP		TBD	P19398	Electron Tunneling Spectroscopy under High Magnetic Fields	Condensed Matter Physics	1	2.88
Arijit Gupta (G)	C	Florida State University	Physics								
Robert Huber (U)	C	National High Magnetic Field Laboratory	CMS								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Philip Kim (S)	C	Harvard University	Department of Physics								
Seongshik Oh (S)	C	Rutgers University, New Brunswick	Physics and Astronomy								
Joon Young Park (P)	C	Harvard University	Physics								
Shengzhi Zhang (P)	C	Los Alamos National Laboratory	MPA-MAGLAB: MPA-MAG LAB NHMFL GROUP								
Amir Yacoby (S)	PI	Harvard University	Physics and Applied Physics	DOE Gordon and Betty Moore Foundation	Office of Science - BES – Basic Energy Sciences US Foundation	DE-SC001819	P19399	Engineering Novel Topological Phases in Graphene Heterostructures	Condensed Matter Physics	1	5
Onder Gul (P)	C	Harvard University	Department of Physics								
Zeyu Hao (G)	C	Harvard University	Physics								
Philip Kim (S)	C	Harvard University	Department of Physics								
Antti Laitinen (P)	C	Harvard University	Department of Physics								
Seung Hwan Lee (G)	C	Harvard University	Physics								
Yuval Ronen (P)	C	Harvard University	Physics								
Thomas Werkmeister (G)	C	Harvard University	Applied Physics								
Qi Yang (G)	C	Stanford University	Physics								
Andrew Zimmerman (P)	C	Harvard University	Physics								
Johnpierre Paglione (S)	PI	University of Maryland, College Park	Center for Nanophysics and Advanced Materials, Department of Physics	NSF	DMR - Division of Materials Research	DMR1905891	P19400	Study of Multiple Superconducting phases and Fermi Surface in Spin-Triplet Superconductor UTe2	Condensed Matter Physics	3	15.97
Nicholas Butch (S)	C	National Institute of Standards and Technology MD	NIST Center for Neutron Research								
Yun Suk Eo (G)	C	University of Michigan	Physics Department								
David Graf (S)	C	National High Magnetic Field Laboratory	DC Field CMS								
Wen-Chen Lin (G)	C	University of Maryland, College Park	physics								
I-LIn Liu (G)	C	University of Maryland, College Park	Chemical Physics								
Sheng Ran (S)	C	Washington University in St. Louis	Physics								
Shanta Saha (P)	C	University of Maryland, College Park	Physics								
Prathum Saraf (G)	C	University of Maryland, College Park	Physics								
Danila Sokratov (G)	C	University of Maryland, College Park	Physics								
Zhigang Jiang (S)	PI	Georgia Institute of Technology	School of Physics	DOE	Office of Science - BES – Basic Energy Sciences	DE-FG02-07ER46451	P19401	Magneto-infrared Spectroscopy Study of Emerging Topological Materials with Layered Structures	Condensed Matter Physics	1	7
Seongphill Moon (G)	C	National High Magnetic Field Laboratory	Physics								
Mykhaylo Ozerov (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS								
Dmitry Smirnov (S)	C	National High Magnetic Field Laboratory	Instrumentation & Operations								
Tianhao Zhao (G)	C	Georgia Institute of Technology	School of Physics								
YounJung Jo (S)	PI	Kyungpook National University	Physics	National Research Foundation of Korea	Non US Foundation		P19408	Topological transport of Half-metallic Weyl semimetal candidates	Condensed Matter Physics	1	5.73
Eun Sang Choi (S)	C	National High Magnetic Field Laboratory	Physics Department								
Joonyoung Choi (G)	C	Kyungpook National University	Physics								
James Hone (S)	PI	Columbia University	Mechanical Engineering	DOE	Office of Science - BES – Basic Energy Sciences	DE-SC0016703	P19411	Correlated states in 2D semiconducting transition metal dichalcogenide heterostructures under high magnetic fields	Condensed Matter Physics	3	15.36
Luis Balicas (S)	C	National High Magnetic Field Laboratory	Condensed Matter Experiment								
Cory Dean (S)	C	City College of New York	Physics								
Qianhui Shi (S)	C	University of California, Los Angeles	Physics								
En-Min Shih (G)	C	Columbia University	Physics								
Yihang Zeng (G)	C	Columbia University	Physics								
Dmitry Smirnov (S)	PI	National High Magnetic Field Laboratory	Instrumentation & Operations	DOE	Office of Science - BES – Basic Energy Sciences	DE-FG02-07ER46451	P19412	Electrical and magnetic field control of optical	Condensed Matter Physics	2	8.9

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Zhigang Jiang (S)	C		Georgia Institute of Technology	School of Physics	DOE	Office of Science - BES - Basic Energy Sciences	DE- FG02-07ER46451		processes in atomicallythin layers and van der Waals heterostructures			
Chun Ning (Jeanie) Lau (S)	C		Ohio State University	Department of Physics and Astronomy								
Zhengguang Lu (G)	C		National High Magnetic Field Laboratory	Physics								
Seongphill Moon (G)	C		National High Magnetic Field Laboratory	Physics								
Mykhaylo Ozerov (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS								
Sufei Shi (S)	C		Rensselaer Polytechnic Institute	Chemical and Biological Engineering								
Irina Drichko (S)	PI		Ioffe Physical-Technical Institute of the Russian Academy of Sciences	Physics of Semiconductors and Dielectrics	No other support			P19427	Magnetotransport Properties of High-Mobility p-AlGaAs/GaAs/AlGaAs Structures: Acoustic Studies.	Condensed Matter Physics	1	14
Loren Pfeiffer (S)	C		Princeton University	Electrical Engineering								
Ivan Smirnov (S)	C		Ioffe Physical-Technical Institute of the Russian Academy of Sciences	Physics of Semiconductors and Dielectrics								
Alexey Suslov (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science								
Ken West (S)	C		Princeton University	Princeton Institute for the Science and Technology of Materials								
Sara Haravifard (S)	PI		Duke University	Department of Physics	NSF	DMR - Division of Materials Research	DMR1828348	P19445	High Pressure Studies of Frustrated Magnets	Condensed Matter Physics	2	14
Rabindranath Bag (P)	C		Duke University	Physics	Duke University	US College and University						
Sachith Dissanayake (P)	C		Duke University	Physics								
Matthew Ennis (G)	C		Duke University	Physics								
David Graf (S)	C		National High Magnetic Field Laboratory	DC Field CMS								
Lalit Yadav (G)	C		Duke University	Physics								
Jan Jaroszynski (S)	PI		National High Magnetic Field Laboratory	CMS	UCGP		5206	P19446	Torque acting on REBCO coated conductors in external magnetic field	Magnets, Materials	4	14.65
Ernesto Bosque (S)	C		National High Magnetic Field Laboratory	ASC/MST								
Griffin Bradford (O)	C		National High Magnetic Field Laboratory	Applied Superconductivity Center								
Ashleigh Francis (T)	C		National High Magnetic Field Laboratory	ASC								
Jonathan Lee (G)	C		National High Magnetic Field Laboratory	Applied Superconductivity Center								
Aixia Xu (O)	C		Florida State University	ASC								
Tomasz Klimczuk (S)	PI	*	Gdansk University of Technology	Department of Applied Physics	National Science Agency	Non US College and University		P19447	Magnetotransport in Pt_5P2	Condensed Matter Physics	1	1.75
Shintaro Ishiwata (S)	C		Osaka University	Department of Materials Engineering Science								
Jan Jaroszynski (S)	C		National High Magnetic Field Laboratory	CMS								
Keshav Shrestha (S)	PI		Texas A&M University	Chemistry and Physics	Killgore Faculty Grant	Other	NA	P19467	Search of Topological Phases of Materials	Condensed Matter Physics	1	3.01
Ramakanta Chapai (P)	C		Argonne National Laboratory	Materials Science Division								
David Graf (S)	C		National High Magnetic Field Laboratory	DC Field CMS								
Bal Pokharel (G)	C		National High Magnetic Field Laboratory	Physics								
Dragana Popovic (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science / Experimental								
Sheng Ran (S)	PI	*	Washington University in St. Louis	Physics	Washington University in St. Louis	US College and University		P19470	Study of high magnetic field induced superconductivity and Fermi surface of UTe2	Condensed Matter Physics	1	5.59
David Graf (S)	C		National High Magnetic Field Laboratory	DC Field CMS								
Lin Jiao (S)	PI		National High Magnetic Field Laboratory	CMS	No other support			P19480	High Magnetic Field Probe Design and Technique Development	Condensed Matter Physics	1	2
Ryan Baumbach (S)	C		National High Magnetic Field Laboratory	CMS								
Talal Mallah (S)	PI		University of Paris-Sud	ICMMO	No other support			P19496		Magnets, Materials	2	21

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Brittany Grimm (G)	C		Florida State University	Physics					Electronic structure of magnetic Ni(II) complexes as potential quantum bits			
Stephen Hill (S)	C		National High Magnetic Field Laboratory	EMR								
Mykhaylo Ozerov (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS								
Guangxin Ni (S)	PI	*	Florida State University	Physics	No other support			P19501	Optical investigation of spin-triplet superconductor candidate UTe2 in high magnetic fields	Condensed Matter Physics	1	7
Sirak Mekonen (G)	C		Johns Hopkins University	Department of Physics and Astronomy								
Youcheng Wang (P)	C		National High Magnetic Field Laboratory	NHMFL								
Sergey Suchalkin (S)	PI		State University of New York at Stony Brook	Electrical and Computer Engineering	NSF	DMR - Division of Materials Research	DMR1809708	P19506	Band structure of semiconductor alloys with engineered nanoscale ordering	Condensed Matter Physics	1	7
Mykhaylo Ozerov (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS								
Yining Huang (S)	PI		University of Western Ontario	Chemistry	NSERC of Canada	Other		P19515	17O and 91Zr solid-state NMR of metal-organic frameworks at 35.2 T	Chemistry	1	4
Zhehong Gan (S)	C		National High Magnetic Field Laboratory	NHMFL								
Ivan Hung (S)	C		National High Magnetic Field Laboratory	CIMAR/NMR								
Vinicius Martins (G)	C		University of Western Ontario	Chemistry								
Tim Cross (S)	PI		National High Magnetic Field Laboratory	NHMFL/Chemistry & Biochemistry	NIH	NIGMS - National Institute of General Medical Sciences	GM122698	P19516	Structural Characterization of SARS-CoV-2 E protein in lipid bilayer with Solid-State NMR	Biology, Biochemistry, Biophysics	1	5
Riqiang Fu (S)	C		National High Magnetic Field Laboratory	NMR								
Huajun Qin (T)	C		Florida State University	Chemistry & Biochemistry								
Rongfu Zhang (P)	C		National High Magnetic Field Laboratory	NHMFL								
Jeffrey Long (S)	PI		University of California, Berkeley	Chemistry	NSF	CHE - Chemistry	CHE1800252	P19520	Hard Permanent Magnetism from Mixed-Valence Dilanthanide Complexes with Metal-Metal Bonding	Chemistry	1	4.17
Eun Sang Choi (S)	C		National High Magnetic Field Laboratory	Physics Department								
Colin Gould (G)	C		University of California, Berkeley	Chemistry								
Danielle Laurencin (S)	PI		University of Montpellier	Institut Charles Gerhardt de Montpellier	European Research Council	Other		P19531	Identification of interfacial bonding environments in functional nanomaterials and biomaterials using high resolution solid state NMR at (ultra)-high fields	Chemistry	1	2
Christian Bonhomme (S)	C		Pierre and Marie Curie University	Laboratoire de Chimie de la Matière Condensée								
Zhehong Gan (S)	C		National High Magnetic Field Laboratory	NHMFL								
Christel Gervais (S)	C		Sorbonne University	Laboratoire de Chimie de la Matière Condensée								
Ieva Goldberga (P)	C		French National Center for Scientific Research	Institut Charles Gerhardt de Montpellier								
Ivan Hung (S)	C		National High Magnetic Field Laboratory	CIMAR/NMR								
Joseph Checkelsky (S)	PI		Massachusetts Institute of Technology	Physics	NSF	DMR - Division of Materials Research	DMR1231319	P19540	High Field Studies of Novel Layered Materials	Condensed Matter Physics	3	21.8
Maximilien Debbas (G)	C		Massachusetts Institute of Technology	Physics								
Aravind Devarakonda (P)	C		Columbia University	Physics								
David Graf (S)	C		National High Magnetic Field Laboratory	DC Field CMS								
Minyong Han (G)	C		Massachusetts Institute of Technology	Physics								
Caolan John (G)	C		Massachusetts Institute of Technology	Physics								
Paul Neves (G)	C		Massachusetts Institute of Technology	Physics								
Mallika Randeria (P)	C		Massachusetts Institute of Technology	Physics								
Junbo Zhu (G)	C		Massachusetts Institute of Technology	Physics								
Yangmu Li (P)	PI	*	Brookhaven National Laboratory	CMPMS	DOE	MSE - Materials Science and Engineering	DE-SC0012704	P19556		Condensed Matter Physics	2	14

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
David Graf (S)	C		National High Magnetic Field Laboratory	DC Field CMS					Axion Transport in Topological Kagome Superconductors			
Bal Pokharel (G)	C		National High Magnetic Field Laboratory	Physics								
Dragana Popovic (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science / Experimental								
John Tranquada (S)	C		Brookhaven National Laboratory	Condensed Matter Physics and Materials Science								
Youcheng Wang (P)	C		National High Magnetic Field Laboratory	NHMFL								
Yuxin Wang (G)	C		Florida State University	CMS								
Sara Haravifard (S)	PI		Duke University	Department of Physics	NSF	DMR - Division of Materials Research	DMR1828348	P19562	Thermal Properties of Frustrated Magnets	Condensed Matter Physics	1	21
Eun Sang Choi (S)	C		National High Magnetic Field Laboratory	Physics Department								
Sachith Dissanayake (P)	C		Duke University	Physics								
Zhenzhong Shi (S)	C		Soochow University	School of Physical Science and Technology & Institute for Advanced Study								
Zahid Hasan (S)	PI		Princeton University	Physics	DOE	Office of Science - BES - Basic Energy Sciences	DE-FG-02-05ER46200	P19566	Magnetotransport studies of topological magnets under hydrostatic pressure	Condensed Matter Physics	3	16.45
Luis Balicas (S)	C		National High Magnetic Field Laboratory	Condensed Matter Experiment	Gordon and Betty Moore Foundation	US Foundation	GBMF4547					
Md Shafayat Hossain (P)	C		Princeton University	Physics								
Qi Zhang (P)	C		Princeton University	Physics								
David Mandrus (S)	PI		University of Tennessee, Knoxville	Materials Science and Engineering	Gordon and Berry Moore	Other	GBMF9069	P19572	Topological Hall Effect in Kagome Lattice Materials	Condensed Matter Physics	1	5.84
Luis Balicas (S)	C		National High Magnetic Field Laboratory	Condensed Matter Experiment								
Shirin Mozaffari (P)	C		University of Tennessee, Knoxville	Materials Science and Engineering								
Michael Shatruk (S)	PI		National High Magnetic Field Laboratory	Department of Chemistry and Biochemistry	NSF	CHE - Chemistry	CHE1955754	P19599	Investigation of Low-Dimensional Magnetism in Inorganic and Organic Materials	Magnets, Materials	2	14
Luis Balicas (S)	C		National High Magnetic Field Laboratory	Condensed Matter Experiment								
Ryan Baumbach (S)	C		National High Magnetic Field Laboratory	CMS								
Sandugash Yergeshbayeva (G)	C		Florida State University	Chemistry and Biochemistry								
Jaewook Kim (P)	PI	*	Korea Atomic Energy Research Institute	Advanced Materials Group	Korea Atomic Energy Research Institute	Non US Government Lab		P19610	Study of high spin quantum magnetism in triangular lattice antiferromagnets	Condensed Matter Physics	1	7
Eun Sang Choi (S)	C		National High Magnetic Field Laboratory	Physics Department								
Seongsu Lee (P)	C		Rutgers University, New Brunswick	Physics Department								
Tim Murphy (S)	PI		National High Magnetic Field Laboratory	Operations	No other support			P19611	Testing of DCFF magnets, power supplies and associated equipment	Condensed Matter Physics	3	19.89
Alimamy Bangura (S)	C		National High Magnetic Field Laboratory	CMS								
Troy Brumm (T)	C		National High Magnetic Field Laboratory	DC Field								
Robert Nowell (T)	C		National High Magnetic Field Laboratory	DC User Support								
Andy Powell (S)	C		National High Magnetic Field Laboratory	Operations								
Julia Smith (S)	C		National High Magnetic Field Laboratory	DC Field								
Eric Stiers (O)	C		National High Magnetic Field Laboratory	DC Field								
Sujana Sri Venkat Uppalapati (O)	C		National High Magnetic Field Laboratory	DC Field Facility								
Vikram Deshpande (S)	PI		University of Utah	Physics & Astronomy	NSF	DMR - Division of Materials Research	DMR1936383	P19613	Quantum Transport in Intrinsic Magnetic Topological Insulators	Condensed Matter Physics	1	7
Su Kong Chong (P)	C		University of California, Los Angeles	Department of Electric and Computer Engineering								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Jan Jaroszynski (S)	C		National High Magnetic Field Laboratory	CMS								
Seng Huat Lee (S)	C		Pennsylvania State University	Physics								
Zhiqiang Mao (S)	C		Pennsylvania State University	Department of Physics								
Amit Vashist (P)	C		University of Utah	Department of Physics & Astronomy								
Kang Wang (S)	C		University of California, Los Angeles	Electrical Engineering								
Pengcheng Dai (S)	PI		University of Tennessee, Knoxville	Physics	DOE	Other	DOE-SC0012311	P19614	Magnetoresistance in detwinned BaFe2As2	Condensed Matter Physics	1	2.54
Luis Balicas (S)	C		National High Magnetic Field Laboratory	Condensed Matter Experiment								
Kelly Neubauer (G)	C		Rice University	Physics & Astronomy								
Cui-Zu Chang (S)	PI	*	Pennsylvania State University	Physics	DOE	Office of Science - BES - Basic Energy Sciences	DE-SC0019064	P19615	Quantum Anomalous Hall Sandwiches Under High Magnetic Fields	Condensed Matter Physics	1	5
Hemian Yi (P)	C		Pennsylvania State University	Department of physics								
RuoXi Zhang (G)	C		Pennsylvania State University	Physics								
Yi-Fan Zhao (G)	C		Pennsylvania State University	Physics								
Valentin Taufour (S)	PI	*	University of California, Davis	Physics Department	University of California, Davis	US College and University		P19616	High Magnetic Field Studies of Co-based Materials	Condensed Matter Physics	1	7
Eun Sang Choi (S)	C		National High Magnetic Field Laboratory	Physics Department								
Audrey Grockowiak (S)	C		National High Magnetic Field Laboratory	DC Field/CMS								
Peide Ye (S)	PI		Purdue University	School of Electrical and Computer Engineering	NSF	EFMA - Emerging Frontiers and Multidisciplinary Activities	EFMA1433459	P19617	Quantum transport in n-type chiral semiconductor Tellurene	Condensed Matter Physics	2	11.36
Chang Niu (G)	C		Purdue University	Electrical and Computer Engineering								
Zhuocheng Zhang (G)	C		Purdue University	Electrical and Computer Engineering								
Jun Zhu (S)	PI		Pennsylvania State University	Physics	NSF	DMR - Division of Materials Research	DMR1904986	P19619	Valley Isospin-Driven Correlated Phenomena in Bilayer Graphene	Condensed Matter Physics	3	28
Hailong Fu (P)	C		Pennsylvania State University	Physics								
Ke Huang (G)	C		Pennsylvania State University	Physics								
Le Yi (G)	C		Pennsylvania State University	Physics								
Lu Li (S)	PI		University of Michigan	Physics	DOE	Office of Science - BES - Basic Energy Sciences	DE-SC0020184	P19627	Search for novel electronic, magnetic, and thermal properties in intense magnetic fields	Condensed Matter Physics	6	35.44
Aaron Chan (G)	C		University of Michigan	Department of Physics	NSF	DMR - Division of Materials Research	DMR2004288					
Kuan-Wen Chen (P)	C		University of Michigan	Physics								
David Mandrus (S)	C		University of Tennessee, Knoxville	Materials Science and Engineering								
Yuji Matsuda (S)	C		Kyoto University	Physics								
Dmitri Mihaliov (G)	C		University of Michigan	Applied Physics								
Emilia Morosan (S)	C		Rice University	Physics and Astronomy								
Dechen Zhang (G)	C		University of Michigan	Department of Physics								
Guoxin Zheng (G)	C		University of Michigan	Department of Physics								
Dragana Popovic (S)	PI		National High Magnetic Field Laboratory	Condensed Matter Science / Experimental	NSF	DMR - Division of Materials Research	DMR1707785	P19628	Electrical Transport Studies of Quasi-Two-Dimensional Strongly Correlated Materials	Condensed Matter Physics	2	16
Bernd Buechner (S)	C		Technical University of Dresden	Institute for Solid State Research								
Masaki Fujita (S)	C		Tohoku University IMR	Materials Property Division								
Jun Sik Lee (S)	C		SLAC National Accelerator Laboratory	XXX								
Shimpei Ono (S)	C		Central Research Institute of Electric Power Industry	Materials Science Research Laboratory								
Bal Pokharel (G)	C		National High Magnetic Field Laboratory	Physics								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Helene Raffy (S)	C		University of Paris-Sud	Laboratoire de Physique des Solides								
Takanori Taniguchi (S)	C		Tohoku University IMR	Materials Property Division								
Jasminka Terzic (P)	C		National High Magnetic Field Laboratory	CMS								
Olesia Voloshyna (P)	C		Technical University of Dresden	Institute for Solid State Research								
Youcheng Wang (P)	C		National High Magnetic Field Laboratory	NHMFL								
Yuxin Wang (G)	C		Florida State University	CMS								
Zhenzhong Shi (S)	PI	*	Soochow University	School of Physical Science and Technology & Institute for Advanced Study	Soochow University	Non US College and University		P19630	Studies of Thermal Transport Properties of cuprates in High Magnetic Field	Condensed Matter Physics	3	28
Eun Sang Choi (S)	C		National High Magnetic Field Laboratory	Physics Department								
Bal Pokharel (G)	C		National High Magnetic Field Laboratory	Physics								
Dragana Popovic (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science / Experimental								
Youcheng Wang (P)	C		National High Magnetic Field Laboratory	NHMFL								
Yuxin Wang (G)	C		Florida State University	CMS								
Ziming Wu (G)	C		Soochow University	School of Physical Science and Technology & Institute for Advanced Study								
Xavier Roy (S)	PI	*	Columbia University	Chemistry	DOE	Office of Science - BES - Basic Energy Sciences	DE-sc0019443	P19632	Magnetic Order and Correlated Electronic Phenomena in Novel 2D van der Waals Materials	Chemistry	1	14
David Graf (S)	C		National High Magnetic Field Laboratory	DC Field CMS								
Elena Meirzadeh (P)	C		Columbia University	Chemistry								
Victoria Posey (G)	C		Columbia University	Chemistry								
Evan Telford (G)	C		Columbia University	Physics								
Michael Ziebel (P)	C		Columbia University	Chemistry and Physics								
Yasu Takano (S)	PI		University of Florida	Physics	UCGP			P19638	Calorimetric and magnetic studies of quantum spin liquid candidates	Condensed Matter Physics	2	13.33
Eun Sang Choi (S)	C		National High Magnetic Field Laboratory	Physics Department								
Yanbo Guo (G)	C		University of Florida	Physics								
Xinzhe Hu (G)	C		University of Florida	Physics								
Jun Yang (S)	PI	*	Institute of Physics, Chinese Academy of Sciences	Wuhan Institute of Physics and Mathematics	NIH	NIGMS - National Institute of General Medical Sciences	GM122698	P19677	Structural characterization of AqpZ protein at 35.2T magnet	Biology, Biochemistry, Biophysics	1	5
Riqiang Fu (S)	C		National High Magnetic Field Laboratory	NMR								
Rongfu Zhang (P)	C		National High Magnetic Field Laboratory	NHMFL								
Al-Amin Dhirani (S)	PI	*	University of Toronto (Toronto)	Chemistry	Natural Science and Engineering Research Council of Canada	Non US Council		P19678	The Kondo Effect at High Impurity Densities in Nanostructured Materials	Condensed Matter Physics	2	20
Ryan Baumbach (S)	C		National High Magnetic Field Laboratory	CMS	Natural SCience and Engineering Research Council for Canada	Other Non US Federal Agency						
David Mandrus (S)	PI		University of Tennessee, Knoxville	Materials Science and Engineering	Gordon and Betty Moore Foundation	Other	GBMF9069	P19679	Thermal transport properties of TbNi3Ga9	Condensed Matter Physics	1	24
Luis Balicas (S)	C		National High Magnetic Field Laboratory	Condensed Matter Experiment								
Eun Sang Choi (S)	C		National High Magnetic Field Laboratory	Physics Department								
Guangxin Ni (S)	PI	*	Florida State University	Physics	No other support			P19684	Exploring the nature of 2D twistronics under photon excitations	Condensed Matter Physics	1	7
Stephen Hill (S)	C		National High Magnetic Field Laboratory	EMR								
James Hone (S)	C		Columbia University	Mechanical Engineering								
Philip Kim (S)	C		Harvard University	Department of Physics								
Dmitry Smirnov (S)	C		National High Magnetic Field Laboratory	Instrumentation & Operations								
Jiabao Wang (G)	C		Florida State University	Physics								
Youcheng Wang (P)	C		National High Magnetic Field Laboratory	NHMFL								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Kaitai Xiao (G)	C		Florida State University	physics								
Theo Siegrist (S)	PI		National High Magnetic Field Laboratory	Chemical and Biomedical Engineering	No other support			P19690	Investigating the magnetic properties across the valence state transition in EuPd2-xAxSi2-yBy	Condensed Matter Physics	1	7
Masoud Mardani (G)	C		Florida State University	CMS								
Shivani Sharma (P)	C		National High Magnetic Field Laboratory	CMS								
Kaya Wei (P)	C		National High Magnetic Field Laboratory	CMS								
Ziling Xue (S)	PI		University of Tennessee, Knoxville	Chemistry	NSF	CHE - Chemistry	CHE2055499	P19694	Probing Molecular Magnetism by Far-IR and Raman Magneto-Spectroscopies	Chemistry	1	7
Alexandria Bone (G)	C		University of Tennessee, Knoxville	Chemistry								
Adam Hand (G)	C		University of Tennessee, Knoxville	Chemistry								
Michael Jenkins (G)	C		University of Tennessee, Knoxville	Chemistry								
Mykhaylo Ozerov (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS								
Pagnareach Tin (G)	C		University of Tennessee, Knoxville	Chemistry								
Mykhaylo Ozerov (S)	PI		National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS	No other support			P19696	Far-Infrared magneto-spectroscopy at DC-facility, NHMFL: New developments, tests and optimization of experimental protocols	Condensed Matter Physics	1	7
George Nolas (S)	PI	*	University of South Florida	Department of Physics	NSF	DMR - Division of Materials Research	DMR1748188	P19700	Investigation of transport and potential topological complexity in GdTe1.8 using high magnetic field	Condensed Matter Physics	1	7
Kaya Wei (P)	C		National High Magnetic Field Laboratory	CMS								
Robert Butera (S)	PI	*	Laboratory for Physical Sciences, College Park	Physics	University of Maryland - College Park	US College and University	H9823017C0194	P19708	Weak localization and large field magnetoresistance effects in ultra-doped Si and Ge	Condensed Matter Physics	1	4.2
Sungha Baek (G)	C		University of Maryland, College Park	Physics								
Kevin Dwyer (P)	C		University of Maryland, College Park	Physics								
Tzu-Ming Lu (S)	C		Sandia National Laboratories	1117								
Scott Schmucker (S)	C		Sandia National Laboratories	Multiscale Fab Sci & Tech Dev								
Sunil Karna (S)	PI	*	Norfolk State University	Physics Department	NSF	DMR - Division of Materials Research	DMR1832031	P19711	Investigating the suppression of dHvA oscillations with the emergence of strong diamagnetism of chiral compound PdGa	Condensed Matter Physics	1	4
Kevin Allen (U)	C		Norfolk State University	Physics Department								
Terence Baker (G)	C		Norfolk State University	Physics Department								
Orrin Clarke Delgado (G)	C		Norfolk State University	Physics Department								
John DiTusa (S)	C		Louisiana State University	Department of Physics and Astronomy								
Liam Harrigan (U)	C		Norfolk State University	Physics Department								
Ronald Pagano (G)	C		Louisiana State University	Physics and Astronomy								
Leroy Salary (S)	C		Norfolk State University	Physics Department								
Doyle Temple (S)	C		Norfolk State University	Physics Department								
Denis Karaiskaj (S)	PI		University of South Florida	Physics	NSF	ECCS - Electrical, Communications, and Cyber Systems	ECCS1952957	P19712	Electronic and spin dynamics of materials at very high magnetic fields explored with coherent multidimensional spectroscopy	Condensed Matter Physics	1	7
David Hilton (S)	C		University of Alabama, Birmingham	Physics								
Hengzhou Liu (G)	C		University of South Florida	Physics								
Varun Mapara (G)	C		University of South Florida	Physics								
Minhyea Lee (S)	PI		University of Colorado, Boulder	Physics	DOE	Office of Science - BES - Basic Energy Sciences	DE-SC0021377	P19717	Investigating thermal transport properties in strong spin-orbit coupled systems	Condensed Matter Physics	1	9
Gang Cao (S)	C		University of Colorado, Boulder	Department of Physics.								
Ian Leahy (G)	C		University of Colorado, Boulder	Physics								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Christopher Pocs (G)	C	University of Colorado, Boulder	Physics								
Jie Xing (P)	C	University of South Carolina	Department of physics and astronomy								
Chun Hung Lui (S)	PI	University of California, Riverside	Physics	NSF	DMR - Division of Materials Research	DMR1945660	P19723	Exploring novel correlated states in 2D materials and moiré superlattices	Condensed Matter Physics	1	7
Mashael Altaiary (G)	C	University of California, Riverside	Physics and Astronomy								
Erfu Liu (P)	C	University of California, Riverside	Astronomy & Physics								
Tianyi Ouyang (G)	C	University of California, Riverside	Physics and Astronomy								
Ao Shi (G)	C	University of California, Riverside	Physics and Astronomy								
Matthew Wilson (G)	C	University of California, Riverside	Physics and Astronomy								
Dmitry Smirnov (S)	PI	National High Magnetic Field Laboratory	Instrumentation & Operations	DOE	Office of Science - BES - Basic Energy Sciences	DE-FG02-07ER46451	P19727	Testing new probes and techniques for high-field optical magnetospectroscopy	Condensed Matter Physics	1	7
Mykhaylo Ozerov (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS								
Dmitry Semenov (T)	C	National High Magnetic Field Laboratory	DC Field								
Komalavalli Thirunavukkuarasu (S)	C	Florida Agricultural and Mechanical University	Physics								
Li Xiang (P)	C	National High Magnetic Field Laboratory	DC field								
Guangxin Ni (S)	PI *	Florida State University	Physics	No other support			P19728	Study of higher-order topological quantum materials	Condensed Matter Physics	1	7
Jiabao Wang (G)	C	Florida State University	Physics								
Youcheng Wang (P)	C	National High Magnetic Field Laboratory	NHMFL								
Kaitai Xiao (G)	C	Florida State University	physics								
Charles Agosta (S)	PI	Clark University	Department of Physics	NSF	DMR - Division of Materials Research	DMR1905950	P19729	Search for Inhomogeneous Superconductivity using field and angular sweeps.	Condensed Matter Physics	1	7
Raju Ghimire (G)	C	Clark University	Physics								
Brett Laramee (G)	C	Clark University	Physics								
John Schlueter (S)	C	Argonne National Laboratory	Materials Science								
C. W. (Paul) Chu (S)	PI	University of Houston	Physics	DOD	US Air Force	FA9550-20-1-0068	P19731	Fermi surface studies of topological phases of materials	Condensed Matter Physics	1	2.4
Liangzi Deng (S)	C	University of Houston	Department of Physics and Texas Center for Superconductivity	T. L. L. Temple Foundation	Other						
David Graf (S)	C	National High Magnetic Field Laboratory	DC Field CMS	John J. and Rebecca Moores Endowment	Other						
Duncan Mierstchin (U)	C	West Texas A&M University	Chemistry and Physics	State of Texas through the Texas Center for Superconductivity at the University of Houston	Other						
Thinh Nguyen (G)	C	West Texas A&M University	Chemistry and Physics								
Keshav Shrestha (S)	C	Texas A&M University	Chemistry and Physics								
Michael Shatruk (S)	PI	National High Magnetic Field Laboratory	Department of Chemistry and Biochemistry	NSF	DMR - Division of Materials Research	DMR1905499	P19737	Investigation of Magnetic Properties of Liquid-Exfoliated 2D Materials	Magnets, Materials	2	13
Ian Campbell (G)	C	Florida State University	Chemistry and Biochemistry								
Judith Clark (G)	C	Florida State University	Chemistry and Biochemistry								
Govind Sasi Kumar (G)	C	Florida State University	Chemistry and Biochemistry								
David Goldhaber-Gordon (S)	PI	Stanford University	Physics	Gordon and Betty Moore Foundation	US Foundation	GBMF9460	P19746	High flux per moire cell in van der Waals stacks	Condensed Matter Physics	1	8
Joseph Finney (G)	C	Stanford University	Physics								
Linsey Rodenbach (G)	C	Stanford University	Physics								
Ayyalusamy Ramamoorthy (S)	PI	University of Michigan	Chemistry & Biophysics	NIH	NIGMS - National Institute of General Medical Sciences	GM351395	P19766	Measurement of 17O Residual Quadrupolar Couplings in Small	Chemistry	1	4

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Riqiang Fu (S)	C	National High Magnetic Field Laboratory	NMR					Molecules Using Lipid Nanodiscs			
Rongfu Zhang (P)	C	National High Magnetic Field Laboratory	NHMFL								
Chetan Dhital (S)	PI	Kennesaw State University	Physics	No other support			P19797	Investigation of magnetic and electrical transport properties of non-centrosymmetric rare earth magnets.	Condensed Matter Physics	2	14
Zhehong Gan (S)	PI	National High Magnetic Field Laboratory	NHMFL	No other support			P19856	Development and implementation of solid-state NMR methods at high magnetic fields	Chemistry	1	4
William Brey (S)	C	National High Magnetic Field Laboratory	NMR								
Ivan Hung (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Ilya Litvak (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Wenping Mao (P)	C	National High Magnetic Field Laboratory	NMR								
Robert Schurko (S)	C	Florida State University	Chemistry								
Yijue Xu (P)	C	National High Magnetic Field Laboratory	solid-state NMR								
Jeffrey Schiano (S)	PI	Pennsylvania State University	Electrical Engineering	NIH	NIGMS - National Institute of General Medical Sciences	GM122698	P19858	Flux Regulation for Powered Magnets	Engineering	1	3
William Brey (S)	C	National High Magnetic Field Laboratory	NMR								
Ilya Litvak (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Waroch Tangbampensountorn (G)	C	Pennsylvania State University	Electrical Engineering								
								Total Proposals:		Experiments:	Days:
								131		198	1,328.77

EMR Facility

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Likai Song (S)	PI	National High Magnetic Field Laboratory	EMR	No other support			P17449	Developing Multifrequencey EPR Methods for Biological Applications	Biology, Biochemistry, Biophysics	7	128.5
Manoj Vinayaka Hanabe Subramanya (G)	C	Florida State University	Physics								
Krishnendu Kundu (P)	C	National High Magnetic Field Laboratory	EMR								
Jonathan Marbey (G)	C	National High Magnetic Field Laboratory	EMR								
Alina Bienko (S)	PI	University of Wroclaw	Faculty of Chemistry	Wroclaw University	Non US College and University		P17642	Search for New Single-Molecule Magnets: High-Field EPR Studies on High-Spin Complexes of d-Electron Metals – Co(II), Ni(II), Re(IV)	Chemistry	1	2
Andrew Ozarowski (S)	C	National High Magnetic Field Laboratory	EMR								
Ziling Xue (S)	PI	University of Tennessee, Knoxville	Chemistry	No other support			P17697	Investigating Molecular Magnetism by Magneto-Raman Spectroscopy	Chemistry	1	1
Alexandria Bone (G)	C	University of Tennessee, Knoxville	Chemistry								
Adam Hand (G)	C	University of Tennessee, Knoxville	Chemistry								
Brian Kettell (G)	C	University of Tennessee Space Institute	Chemistry								
Jurek Krzystek (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science								
Clay Mings (G)	C	University of Tennessee, Knoxville	Chemistry								
Duncan Moseley (G)	C	University of Tennessee, Knoxville	Chemistry								
Pagnareach Tin (G)	C	University of Tennessee, Knoxville	Chemistry								
Chelsea Widener (G)	C	University of Tennessee, Knoxville	Chemistry								
Srinivasa Rao Singamaneni (S)	PI	University of Texas, El Paso	Physics	The University of Texas at El Paso	US College and University		P17698	Controlling Spin States in Honeycomb Two-Dimensional Layered Solids using Coherent Light	Condensed Matter Physics	1	11
Christian Saiz (G)	C	University of Texas, El Paso	Physics								
Johan van Tol (S)	C	National High Magnetic Field Laboratory	EMR								
Joseph Zadrozny (S)	PI	Colorado State University	Chemistry	NSF	CHE - Chemistry	CHE1836537	P17730	Molecular Control of Spin Relaxation and EPR Linewidth in Transition Metal Complexes	Chemistry	6	23
Cassidy Jackson (G)	C	Colorado State University	Chemistry	NIH	NIBIB - National Institute for Biomedical Imaging and Bioengineering	EB027293					
Roxanna Martinez (G)	C	Colorado State University	Chemistry	Colorado State University	US College and University						
Ian Moseley (G)	C	Colorado State University	Chemistry	Colorado State University	US College and University	Start up funding					
Andrew Ozarowski (S)	C	National High Magnetic Field Laboratory	EMR								
Siyoung Sung (P)	C	Colorado State University	Chemistry								
Johan van Tol (S)	C	National High Magnetic Field Laboratory	EMR								
Ziling Xue (S)	PI	University of Tennessee, Knoxville	Chemistry	NSF	CHE - Chemistry	CHE1900296	P17767	Investigating Molecular Magnetism by Magneto-Far-IR Spectroscopy	Chemistry	1	2
Alexandria Bone (G)	C	University of Tennessee, Knoxville	Chemistry								
Adam Hand (G)	C	University of Tennessee, Knoxville	Chemistry								
Michael Jenkins (G)	C	University of Tennessee, Knoxville	Chemistry								
Jurek Krzystek (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science								
Mykhaylo Ozerov (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS								
Dmitry Smirnov (S)	C	National High Magnetic Field Laboratory	Instrumentation & Operations								
Pagnareach Tin (G)	C	University of Tennessee, Knoxville	Chemistry								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Michael Nippe (S)	PI		Texas A&M University	Chemistry	NSF	CHE - Chemistry	CHE1753014	P17842	Exploring Magnetic Coupling and Spin Relaxation in Ln-[1]metallocenophane Compounds using High-Field and Pulsed EPR spectroscopy	Chemistry	1	7
Stephen Hill (S)	C		National High Magnetic Field Laboratory	EMR								
Trevor Latendresse (G)	C		Texas A&M University	Chemistry								
Jonathan Marbey (G)	C		National High Magnetic Field Laboratory	EMR								
Kevin Kittilstved (S)	PI	*	University of Massachusetts Amherst	Chemistry	NSF	DMR - Division of Materials Research	DMR1747593	P17861	High-field EPR investigation of ferrous ions in ZnO nanocrystals	Chemistry	1	4
Andrej Zorko (S)	PI		Jozef Stefan Institute	Solid State Physics Department	Slovenian Research Agency	Other Non US Federal Agency		P17949	ESR Investigation of Novel Spin-Liquid Candidates on Frustrated Lattices	Condensed Matter Physics	1	6
Benjamin Stein (S)	PI		Los Alamos National Laboratory	C-PCS: PHYSICAL CHEM & APPLIED SPECTROSCOPY	No other support			P17990	Applications of Advanced Electron Paramagnetic Resonance Techniques to Actinide-Based Molecular Systems	Chemistry	5	31
Thomas Albrecht-Schmitt (S)	C		Florida State University	Chemistry and Biochemistry	DOE	LDRD - Laboratory Directed R&D						
Samuel Greer (P)	C		Los Alamos National Laboratory	C-PCS: PHYSICAL CHEM & APPLIED SPECTROSCOPY	DOE	LDRD - Laboratory Directed R&D						
Manoj Vinayaka Hanabe Subramanya (G)	C		Florida State University	Physics								
Stephen Hill (S)	C		National High Magnetic Field Laboratory	EMR								
Stosh Kozimor (S)	C		Los Alamos National Laboratory	C-IIAC: INORGANIC ISOTOPE & ACTINIDE CHEM								
Krishnendu Kundu (P)	C		National High Magnetic Field Laboratory	EMR								
Aaron Tondreau (S)	C		Los Alamos National Laboratory	C-IIAC: INORGANIC ISOTOPE & ACTINIDE CHEM								
Adam Fiedler (S)	PI		Marquette University	Chemistry	No other support			P18030	Probing the Magnetic Anisotropy of Co(II) Complexes Featuring Radical Ligands	Chemistry	3	10
John Berry (S)	C		University of Wisconsin, Madison	Department of Chemistry								
Kinga Kaniewska (G)	C		Gdansk University of Technology	Department of Inorganic Chemistry								
Jurek Krzystek (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science								
Andrew Ozarowski (S)	C		National High Magnetic Field Laboratory	EMR								
Mykhaylo Ozerov (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS								
Joshua Telser (S)	C		Roosevelt University	Biological, Physical and Health Sciences								
Sandrine Heutz (S)	PI		Imperial College London	London Centre for Nanotechnology	No other support			P18041	Molecular magnetic superstructures	Chemistry	1	2
Stephen Hill (S)	C		National High Magnetic Field Laboratory	EMR								
Daphné Lubert-Perquel (P)	C		Imperial College London	Physics								
Johan van Tol (S)	C		National High Magnetic Field Laboratory	EMR								
Jianyuan Zhang (S)	PI		Rutgers University	Chemistry and Chemical Biology	No other support			P18049	A Route to Molecular Quantum Technologies Using Endohedral Metallofullerenes	Chemistry	4	51
Manoj Vinayaka Hanabe Subramanya (G)	C		Florida State University	Physics								
Stephen Hill (S)	C		National High Magnetic Field Laboratory	EMR								
Krishnendu Kundu (P)	C		National High Magnetic Field Laboratory	EMR								
Jonathan Marbey (G)	C		National High Magnetic Field Laboratory	EMR								
Elvin Salerno (P)	C		National High Magnetic Field Laboratory	EMR								
Sungsool Wi (S)	PI		National High Magnetic Field Laboratory	NMR	NSF	CHE - Chemistry	CHE1808660	P18056	Solution State Overhauser DNP at 14 T	Chemistry	2	14
Thierry Dubroca (S)	C		National High Magnetic Field Laboratory	EMR								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Jonathan Marbey (G)	C	National High Magnetic Field Laboratory	EMR								
Adam Veige (S)	PI	University of Florida	Chemistry	NSF	CHE - Chemistry	CHE1808234	P19170	Quantification of End Groups in Cyclic vs. Linear Polyacetylenes by Carbon-13 Magic Angle Spinning Nuclear Magnetic Resonance Spectroscopy	Biology, Biochemistry, Biophysics	1	2
Clifford Bowers (S)	C	University of Florida	Chemistry								
Alec Esper (G)	C	University of Florida	Chemistry								
Frederic Mentink (S)	C	National High Magnetic Field Laboratory	NMR Division								
Zhihui Miao (G)	C	University of Florida	Department of Chemistry								
Brent Sumerlin (S)	C	University of Florida	Chemistry								
Johan van Tol (S)	C	National High Magnetic Field Laboratory	EMR								
Tommy Zhao (G)	C	University of Florida	Chemistry								
Danna Freedman (S)	PI	Northwestern University	Chemistry	No other support			P19174	Optically Addressable Molecular Qubits	Chemistry	1	6
Moses Amdur (G)	C	Northwestern University	Chemistry								
Michael Wojnar (P)	C	Northwestern University	Chemistry								
Dmytro Nesterov (P)	PI	Technical University of Lisbon	Chemistry Department	FCT - Fundação para a Ciência e Tecnologia (Portugal)	Non US Foundation		P19177	Magnetic Properties and EPR spectroscopy of Tetranuclear Copper Complexes	Chemistry	2	11
Andrew Ozarowski (S)	C	National High Magnetic Field Laboratory	EMR								
George Christou (S)	PI	University of Florida	Chemistry	No other support			P19185	High-Field EPR Studies of Exchange Coupling Within Single-Molecule Magnet Oligomers	Chemistry	7	39.33
ChristiAnna Brantley (G)	C	University of Florida	Chemistry	DOE	Office of Science - EFRC - Energy Frontier Research Centers	DE-SC0019330					
Alexander Diodati (G)	C	University of Florida	Chemistry								
Tuhin Ghosh (P)	C	University of Florida	Department of Chemistry								
Stephen Hill (S)	C	National High Magnetic Field Laboratory	EMR								
Daphné Lubert-Perquel (P)	C	Imperial College London	Physics								
Johan van Tol (S)	C	National High Magnetic Field Laboratory	EMR								
Johan van Tol (S)	PI	National High Magnetic Field Laboratory	EMR	No other support			P19207	Testing and Maintenance	Condensed Matter Physics	3	8.5
Elvin Salerno (P)	C	National High Magnetic Field Laboratory	EMR								
Frederic Mentink (S)	PI	National High Magnetic Field Laboratory	NMR Division	No other support			P19241	Improving biradicals for MAS-DNP at high field: a combined approach of Spin-Dynamics theory, DFT and high-field EPR	Chemistry	1	5
Manoj Vinayaka Hanabe Subramanya (G)	C	Florida State University	Physics								
Krishnendu Kundu (P)	C	National High Magnetic Field Laboratory	EMR								
Elvin Salerno (P)	C	National High Magnetic Field Laboratory	EMR								
Henry La Pierre (S)	PI	Georgia Institute of Technology	School of Chemistry and Biochemistry	Arnold and Mabel Beckman Foundation	US Foundation		P19275	Study of Zero Field Splitting in Molecular Tb4+ Complexes by High Field EPR	Biology, Biochemistry, Biophysics	3	14
Manoj Vinayaka Hanabe Subramanya (G)	C	Florida State University	Physics								
Arun Ramanathan (G)	C	Georgia Institute of Technology	Chemsistry								
Robert Stewart (G)	C	Florida State University	Physics								
Likai Song (S)	PI	National High Magnetic Field Laboratory	EMR	No other support			P19282	Instrument Development and Maintenance	Magnets, Materials	6	82.5
Manoj Vinayaka Hanabe Subramanya (G)	C	Florida State University	Physics								
Krishnendu Kundu (P)	C	National High Magnetic Field Laboratory	EMR								
Jonathan Marbey (G)	C	National High Magnetic Field Laboratory	EMR								
Elvin Salerno (P)	C	National High Magnetic Field Laboratory	EMR								
Linda Doerrer (S)	PI	Boston University	Chemistry Department	NSF	CHE - Chemistry	CHE1800313	P19306	A Unique {Mn6} Cluster with Axial Symmetry as a Single-Molecule Magnet Candidate	Chemistry	3	11
Andrew Ozarowski (S)	C	National High Magnetic Field Laboratory	EMR								
Kirill Kovnir (S)	PI	Iowa State University	Chemistry	Iowa State University	US College and University		P19330	EPR investigation of Cr2Se2 dimer	Chemistry	1	3
Eranga Gamage (G)	C	Iowa State University	Chemistry								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Andrew Ozarowski (S)	C	National High Magnetic Field Laboratory	EMR								
Jianjun Pan (S)	PI	University of South Florida	Physics	NIH	NIGMS - National Institute of General Medical Sciences	GM117531	P19341	Interactions of the Helix 0 of Endophilin with Lipid Membranes Defined by Multi-Frequency EPR	Biology, Biochemistry, Biophysics	1	1
Likai Song (S)	C	National High Magnetic Field Laboratory	EMR								
Albert Stiegman (S)	PI	Florida State University	Chemistry	DOE	Office of Science - BES - Basic Energy Sciences	DE-FG-02-03ER15467	P19345	Characterization of the active sites in the Phillip's ethylene polymerization catalyst with EPR spectroscopy	Chemistry	3	9
Jurek Krzystek (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science								
Nathan Peek (G)	C	Florida State University (FSU)	Chemistry and Biochemistry								
Susannah Scott (S)	C	University of California, Santa Barbara	Chemical Engineering								
Ellis Reinherz (S)	PI	Dana-Farber Cancer Institute	Medicine	No other support			P19358	EPR analysis of HIV-1 MPER segment for optimized vaccine design	Biology, Biochemistry, Biophysics	6	87
Likai Song (S)	C	National High Magnetic Field Laboratory	EMR								
Jurek Krzystek (S)	PI	National High Magnetic Field Laboratory	Condensed Matter Science	No other support			P19369	Development of high-resolution THz EPR spectrometer based on the series-connected hybrid	Magnets, Materials	3	13.5
Thierry Dubroca (S)	C	National High Magnetic Field Laboratory	EMR								
Songi Han (S)	C	University of California, Santa Barbara	Department of Chemistry and Biochemistry								
Stephen Hill (S)	C	National High Magnetic Field Laboratory	EMR								
Bradley Price (G)	C	University of California, Santa Barbara	Physics								
Mark Sherwin (S)	C	University of California, Santa Barbara	Physics								
Xiaoling Wang (P)	C	University of California, Santa Barbara (UC Santa Barbara, UCSB)	Physics								
Grace Morgan (S)	PI	University College Dublin	School of Chemistry and Chemical Biology	No other support			P19428	Multiferroic behavior at spin-state transitions – beyond Mn(taa)	Chemistry	2	17
Shalinee Chikara (S)	C	National High Magnetic Field Laboratory	CMS, DC Field Facility								
Brittany Grimm (G)	C	Florida State University	Physics								
Stephen Hill (S)	C	National High Magnetic Field Laboratory	EMR								
Vibe Jakobsen (G)	C	University College Dublin	School of Chemistry								
Irina Kuehne (P)	C	University College Dublin	School of Chemistry								
Andrew Ozarowski (S)	C	National High Magnetic Field Laboratory	EMR								
John Singleton (S)	C	National High Magnetic Field Laboratory	Physics								
Vivien Zapf (S)	C	National High Magnetic Field Laboratory	Physics								
Michael Shatruk (S)	PI	National High Magnetic Field Laboratory	Department of Chemistry and Biochemistry	No other support			P19472	EPR Investigation of Lantanide Complexes as Potential Hosts for Clock Transitions and Molecular Qubits	Magnets, Materials	4	40.5
Miguel Gakiya (G)	C	Florida State University	Chemistry and Biochemistry								
Manoj Vinayaka Hanabe Subramanya (G)	C	Florida State University	Physics								
Stephen Hill (S)	C	National High Magnetic Field Laboratory	EMR								
Krishnendu Kundu (P)	C	National High Magnetic Field Laboratory	EMR								
Daphné Lubert-Perquel (P)	C	Imperial College London	Physics								
Elvin Salerno (P)	C	National High Magnetic Field Laboratory	EMR								
Robert Stewart (G)	C	Florida State University	Physics								
Michal Leskes (S)	PI	Weizmann Institute of Science	Materials and Interfaces	European Research Council	Non US Council	803024	P19484	Determining spin relaxation properties of metal phosphates with	Chemistry	3	6
Daniel Jardón Álvarez (P)	C	Weizmann Institute of Science	Materials and Interfaces								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Brijith Thomas (P)	C		Weizmann Institute of Science	Materials and Interfaces					varying Mn(II) content at high field			
Enrique Colacio (S)	PI		University of Granada	Inorganic Chemistry	No other support			P19485	High-frequency and -field EPR and FIRMS of prismatic trigonal Co(II) and pentagonal bipyramidal Dy(III) SIMs complexes	Chemistry	1	2
Jurek Krzystek (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science								
Mykhaylo Ozerov (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS								
Andrew Ozarowski (S)	PI		National High Magnetic Field Laboratory	EMR	No other support			P19505	CALIBRATION AND MAINTENANCE OF THE 15/17 T EPR INSTRUMENT	Magnets, Materials	1	22
Igor Fritsky (S)	PI		Taras Shevchenko National University of Kyiv	Chemistry	Taras Shevchenko University, Kiev, Ukraine	Non US College and University		P19517	HF-EPR study of stable water-soluble manganese(IV) hexahydrazide clathrochelate complexes with unusual electronic structure	Chemistry	2	4
Andrew Ozarowski (S)	C		National High Magnetic Field Laboratory	EMR								
Lavrent Khachatryan (S)	PI	*	Louisiana State University	Chemistry	Louisiana State University	US College and University	NSF CBET-1805677	P19570	Homogeneous and Heterogeneous pathways for formation of Environmentally Persistent Free Radicals (EPFRs)	Chemistry	1	4.5
Mohamad Barekati-Goudarzi (P)	C		Louisiana State University	Chemistry								
Stephania Cormier (S)	C		Louisiana State University	Biological Sciences								
Slawo Lomnicki (S)	C		Louisiana State University	Energy Coast & Environment Bldg								
Andrew Ozarowski (S)	C		National High Magnetic Field Laboratory	EMR								
David Powers (S)	PI	*	Texas A&M University	Chemistry	DOE	Office of Science - BES - Basic Energy Sciences	DE-SC0018977	P19590	HFEPR Characterization Porphyrin-Supported Metallonitrenoids	Chemistry	2	9
Madeline Hicks (G)	C		California Institute of Technology	Chemistry								
Andrew Ozarowski (S)	C		National High Magnetic Field Laboratory	EMR								
Joshua Telser (S)	C		Roosevelt University	Biological, Physical and Health Sciences								
Gerard Van Trieste (G)	C		Texas A&M University	Chemistry								
Joseph Zadrozny (S)	PI		Colorado State University	Chemistry	DOE	Office of Science - BES - Basic Energy Sciences	DE-SC0021259	P19618	High-Field/Frequency Spin Relaxation Phenomena in Metal Complexes	Chemistry	3	14.5
Cassidy Jackson (G)	C		Colorado State University	Chemistry	NIH	NIBIB - National Institute for Biomedical Imaging and Bioengineering	EB210272					
Roxanna Martinez (G)	C		Colorado State University	Chemistry	Research Corporation for Scientific Advancement	US Foundation	27663					
Andrew Ozarowski (S)	C		National High Magnetic Field Laboratory	EMR	ACS Petroleum Research Foundation	US Foundation	60033-DNI3					
Johan van Tol (S)	C		National High Magnetic Field Laboratory	EMR								
David Herbert (S)	PI	*	University of Manitoba	Department of Chemistry	Natural Sciences and Engineering Research Council of Canada	Other Non US Federal Agency	RGPIN-2014-03733	P19661	High-Frequency and High-Field EPR Spectroscopy of Pseudo-Octahedral Ni(II) Complexes of Strongly Absorbing Benzannulated Pincer-Type Amido Ligands with Non-Aufbau Electronic Behavior	Chemistry	1	2
Jurek Krzystek (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science								
Joshua Telser (S)	C		Roosevelt University	Biological, Physical and Health Sciences								
Ziling Xue (S)	PI		University of Tennessee, Knoxville	Chemistry	NSF	CHE - Chemistry	CHE2055499	P19694	Probing Molecular Magnetism by Far-IR and Raman Magneto-Spectroscopies	Chemistry	3	8
Alexandria Bone (G)	C		University of Tennessee, Knoxville	Chemistry								
Adam Hand (G)	C		University of Tennessee, Knoxville	Chemistry								
Michael Jenkins (G)	C		University of Tennessee, Knoxville	Chemistry								
Jurek Krzystek (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science								
Mykhaylo Ozerov (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS								
Pagnareach Tin (G)	C		University of Tennessee, Knoxville	Chemistry								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Chandrasekhar Ramanathan (S)	PI		Dartmouth College	Physics and Astronomy	NSF	OIA - Office of Integrative Activities	1921199	P19697	Spectral diffusion of electron spins in semiconductors at high magnetic field	Condensed Matter Physics	1	12
Johan van Tol (S)	C		National High Magnetic Field Laboratory	EMR	NSF	DMR - Division of Materials Research	DMR1747426					
Ethan Williams (G)	C		Dartmouth College	Department of Physics and Astronomy								
Polly Arnold (S)	PI	*	University of California, Berkeley	Chemistry	DOE	Office of Science - BES - Basic Energy Sciences	DE-AC02-05CH11231	P19738	Electronic structure of new f-block molecular qubits	Chemistry	3	6
Manoj Vinayaka Hanabe Subramanya (G)	C		Florida State University	Physics								
Amy Kynman (G)	C		University of California, Berkeley	Chemistry								
Elvin Salerno (P)	C		National High Magnetic Field Laboratory	EMR								
Joan Cano (S)	PI		University of Valencia	Instituto de Ciencia Molecular	NSF	DMR - Division of Materials Research	DMR1644779	P19756	Building quantum gates and quantum computer through assembling mononuclear single-molecule magnets based on Co(II) and other 3d transition metal ions. In pursuit of new physics in spintronics	Magnets, Materials	1	2.5
Miguel Julve (S)	C		University of Valencia	Inorganic Chemistry								
Jurek Krzystek (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science								
Francesc Lloret (S)	C		University of Valencia	Institut de Ciència Molecular (ICMOL).								
Mykhaylo Ozerov (S)	C		National High Magnetic Field Laboratory	Condensed Matter Science, DC Field CMS								
Renato Rabelo De Souza Filho (G)	C		University of Valencia	Instituto de Ciencia Molecular (ICMol)								
Marta Viciano-Chumillas (P)	C		University of Valencia	Instituto de Ciencia Molecular								
Martin Bakker (S)	PI	*	University of Alabama, Tuscaloosa	Chemistry and Biochemistry	NSF	CBET - Chemical, Bioengineering, Environmental, and Transport Systems	CBET2050507	P19771	High Field EPR of Transition Metal Phthalocyanines for Oxidation Reactions	Chemistry	1	3
Sebastian Stoian (S)	PI	*	University of Idaho	Chemistry	University of Idaho	US College and University		P19784	Elucidating the Electronic Structure and Magnetic Ordering of Extended Chains Incorporating Co(II) and Fe(II) Ions	Chemistry	2	9
Andrew Ozarowski (S)	C		National High Magnetic Field Laboratory	EMR								
Kyle Seabourn (G)	C		University of Idaho	Chemistry								
Adam Valaydon-Pillay (G)	C		University of Idaho	Chemistry								
Olga Vassilyeva (S)	PI		Taras Shevchenko National University of Kyiv	Chemistry	Taras Shevchenko National University of Kyiv	Non US College and University		P19785	Various types of transition metal Schiff base complexes: from theoretical studies to applications	Chemistry	3	13.5
Andrew Ozarowski (S)	C		National High Magnetic Field Laboratory	EMR								
Svitlana Petrusenko (S)	C		Taras Shevchenko National University of Kyiv	Chemistry								
Oleg Stetsiuk (U)	C		Taras Shevchenko National University of Kyiv	Inorganic Chemistry								
Srinivasa Rao Singamaneni (S)	PI		University of Texas, El Paso	Physics	NSF	DMR - Division of Materials Research	DMR2105109	P19791	Magnetic Correlations and Anisotropy in Layered quasi-2D van der Waals Magnets: A Very High Frequency Electron Paramagnetic Resonance Study	Condensed Matter Physics	1	3.17
Cedomir Petrovic (S)	C		Brookhaven National Laboratory	Condensed Matter Physics								
Fazel Tafti (S)	C		Boston College	Physics								
Patrick Lenahan (S)	PI		Pennsylvania State University	Engineering Science and Mechanics, Inter-College Graduate Program in Materials Science and Engineering	DOD	DTRA - Defense Threat Reduction Agency		P19805	Electrically Detected Magnetic Resonance Measurements on 4H SiC MOSFETs at NHMFL	Condensed Matter Physics	1	4
James Ashton (P)	C		National Institute of Standards and Technology MD	Magnetic Resonance, Nanoscale Device Characterization								
Fedor Sharov (G)	C		Pennsylvania State University	Engineering Science and Mechanics								
Johan van Tol (S)	C		National High Magnetic Field Laboratory	EMR								
Eric Gale (S)	PI	*	Massachusetts General Hospital	Radiology	NIH	NIDDK - National Institute of Diabetes and Digestive and Kidney Diseases	DK120663	P19823	Mechanisms of High-Spin Fe(III) Nuclear Magnetic Relaxation	Chemistry	1	2

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)	Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Jurek Krzystek (S)	C	National High Magnetic Field Laboratory	Condensed Matter Science						
Hannah Shafaat (S)	C	Ohio State University	Chemistry and Biochemistry						
						Total Proposals:	Experiments:		Days:
						48	113		770

3. HIGH B/T FACILITY

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Chao Huan (P)	PI		University of Florida	Physics	UCGP			P17606	Studies of Novel Phases of 3He in Extreme Conditions	Condensed Matter Physics	1	36
Johnny Adams (G)	C		University of Florida	Physics								
Donald Candela (S)	C		University of Massachusetts	Physics								
Marc Lewkowitz (G)	C		University of Florida	Physics								
Neil Sullivan (S)	C		University of Florida	Physics								
Dominique Laroche (S)	PI	*	University of Florida	Physics	UCGP		TBD	P19332	Coulomb drag of spin-polarized Luttinger liquids at ultra-low temperatures - UCGP	Condensed Matter Physics	1	111.5
Rasul Gazizulin (O)	C		University of Florida	Physics								
Guillaume Gervais (S)	C		McGill University	Physics Department								
John Reno (S)	C		Sandia National Laboratories	-								
Lucia Steinke (P)	C		University of Florida (UF)	High B/T Facility								
Michael Shatruk (S)	PI	*	National High Magnetic Field Laboratory	Department of Chemistry and Biochemistry	NSF	DMR - Division of Materials Research	DMR1905499	P19416	Investigation of Spin Frustration in Na2Mn2Se3	Magnets, Materials	2	222
Ovidiu Garlea (S)	C		Oak Ridge National Laboratory	Neutron Scattering sciences								
Naoto Masuhara (S)	C		University of Florida	Microkelvin Laboratory, Physics								
Mark Meisel (S)	C		University of Florida	Department of Physics								
Neil Sullivan (S)	C		University of Florida	Physics								
Collin Broholm (S)	PI	*	Johns Hopkins University	Physics and Astronomy	DOE	Office of Science - BES – Basic Energy Sciences	DE-SC0019331	P19504	NaBaYb(BO3)2, spin liquid candidate with triangular lattice	Condensed Matter Physics	2	148
Johnny Adams (G)	C		University of Florida	Physics								
Rasul Gazizulin (O)	C		University of Florida	Physics								
Alireza Ghasemi (G)	C		Johns Hopkins University	Physics and Astronomy								
Chao Huan (P)	C		University of Florida	Physics								
Lucia Steinke (P)	PI	*	University of Florida (UF)	High B/T Facility	NSF	Other	R000002799	P19653	Probing exotic quasiparticles in calorimetric and thermal transport experiments at ultra-low temperatures	Condensed Matter Physics	1	127.5
Rasul Gazizulin (O)	C		University of Florida	Physics								
Suchitra Sebastian (S)	C		University of Cambridge	Physics								
Andrew Woods (P)	C		University of Florida	Physics								
									Total Proposals: 5		Experiments: 7	Days: 645

4. ICR FACILITY

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Ni-Bin Chang (S)	PI	University of Central Florida	Department of Civil Engineering	NSF	Other	1830036	P17749	Carbon and copper Impacts on biological removal of dissolved organicnitrogen (DON) via biosorption activated media (BAM)	Engineering	1	1.48
Huan Chen (S)	C	National High Magnetic Field Laboratory	Ion Cyclotron Resonance	Florida Dept of Transportation	US Government Lab	Grant No. BDV24 TWO 977-14)					
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Diana Ordonez (U)	C	University of Central Florida	CECE								
Andrea Valencia (G)	C	University of Central Florida	Civil, Environmental and Construction Engineering								
Martin Wanielista (S)	C	University of Central Florida	Department of Civil, Environmental, and Construction Engineering Department								
Dan Wen (G)	C	University of Central Florida	Civil Environmental & Construction Engineering								
Aixin Hou (S)	PI	Louisiana State University	Department of Environmental Sciences	Gulf of Mexico Research Initiative	Other US Federal Agency		P17789	A Decade-long Study on Impact, Recovery, and Resilience in Louisiana Salt Marshes: The evolution of oil transformation compounds and plant-soil-microbialresponses to the Deepwater Horizon oil spill	Chemistry	1	0.33
Huan Chen (S)	C	National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
Qianxin Lin (S)	C	Louisiana State University	Department of Oceanography and Coastal Science								
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Robert Spencer (S)	PI	Florida State University	Earth, Ocean & Atmospheric Science	Florida State University Research Foundation	US College and University	Winchester Fund	P17791	Land use change in the Congo Basin: how does seasonality and land-use control the composition of DOM?	Chemistry	1	0.58
Pascal Boeckx (S)	C	Ghent University	Applied analytical and physical chemistry								
Jeffrey Chanton (S)	C	Florida State University	Department of Earth, Ocean and Atmospheric Science								
Bienvenu Dinga (S)	C	Institut de Recherche en Sciences et Exactes et Naturelles	Plant Science								
Travis Drake (P)	C	Swiss Federal Institute of Technology in Zurich	Environmental Systems Science								
Martin Kurek (G)	C	Florida State University	Earth, Ocean, and Atmospheric Science								
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Landry Ntaboba (S)	C	Université Catholique de Bukavu	Faculty of Agronomy								
Benjamin Nyilitya (G)	C	Ghent University	Green Chemistry								
Johan Six (S)	C	Swiss Federal Institute of Technology in Zurich	Earth Sciences								
Kristof Van Oost (S)	C	University of Leuven	Earth Sciences								
Omics LLC (S)	PI	Omics, LLC	Omics	FFI			P17792	Omics LLC	Chemistry	1	1
Martha Chacon (S)	C	National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
Ryan Rodgers (S)	C	National High Magnetic Field Laboratory	ICR								
Jeremy Owens (S)	PI	National High Magnetic Field Laboratory	Earth, Ocean and Atmospheric Sciences	NASA		NNA15BB03A)	P17838	Molecular characterization of vanadyl compounds from the Demerara Rise	Chemistry	1	0.33
Martha Chacon (S)	C	National High Magnetic Field Laboratory	Ion Cyclotron Resonance	NSF	EAR - Earth Sciences	EAR1338299					
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR	NSF	OCE - Ocean Sciences	OCE1624895					
Angela Knapp (S)	PI	Florida State University	Earth, Ocean and Atmospheric Sciences	NSF	OCE - Ocean Sciences	OCE1736557	P17850	Characterizing the chemical composition of	Chemistry	1	0.14

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Rene Boiteau (S)	C	Oregon State University	College of Earth, Ocean, Atmospheric Sciences	NSF	OCE - Ocean Sciences	OCE1829761		dissolved organic matter in submarine groundwater discharge collected on the South Carolina and West Florida Shelves			
Kristen Buck (S)	C	University of South Florida	College of Marine Science								
Dreux Chappell (S)	C	Old Dominion University	Ocean, Earth and Atmospheric Science								
Huan Chen (S)	C	National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
Susan Lang (S)	C	University of South Carolina	School of the Earth, Ocean, and Environment								
Carlos Miranda (U)	C	Florida State University	Oceanography								
Willard Moore (S)	C	University of South Carolina	School of the Earth, Ocean, and Environment								
James Pinckney (S)	C	University of South Carolina	School of the Earth, Ocean, and Environment								
Rachel Thomas (G)	C	Florida State University	Earth, Ocean, and Atmospheric Science								
Alicia Wilson (S)	C	University of South Carolina	School of the Earth, Ocean, and Environment								
Martha Chacon (S)	PI	National High Magnetic Field Laboratory	Ion Cyclotron Resonance	EU FT-ICR MS Centers		731077	P17944	Comprehensive characterization of asphaltenes by FT-ICR MS and chromatography separations	Chemistry	2	6.17
Nelson Acevedo (S)	C	University of Pau and Pays de l'Adour	IPREM	German Research Foundation		INST 264/56					
Brice Bouyssiere (S)	C	University of Pau and Pays de l'Adour	IPREM								
Herve Carrier (S)	C	University of Pau and Pays de l'Adour	UPPA								
Jimmy Castillo (S)	C	Central University of Venezuela	Escuela de Quimica								
Jean-Luc Daridon (S)	C	University of Pau and Pays de l'Adour	IPREM								
Pierre Giusti (S)	C	Total	Refining and Chemicals								
Taylor Glattke (G)	C	Florida State University	ICR								
Caroline Mangote (S)	C	Total	Research & Technology								
Aurora Mejia (S)	C	University of Pau and Pays de l'Adour	UPPA								
Remi Moulian (G)	C	National High Magnetic Field Laboratory	ICR								
Vincent Piscitelli (S)	C	Central University of Venezuela	Escuela de Quim´ica								
Sadia Radji (S)	C	University of Pau and Pays de l'Adour	UPPA								
Ryan Rodgers (S)	C	National High Magnetic Field Laboratory	ICR								
Franklin Leach (S)	PI	University of Georgia	Environmental Health Science	UCGP			P17979	High-Speed Molecular Imaging by FT-ICR MS with Multiple Frequency Detection	Chemistry	1	2.5
Chris Hendrickson (S)	C	National High Magnetic Field Laboratory	Ion Cyclotron Resonance Program	University of Georgia	US College and University	startup funds					
Karl Smith (P)	C	National High Magnetic Field Laboratory	ICR								
Chad Weisbrod (S)	C	National High Magnetic Field Laboratory	ICR								
Mengqiang Zhu (S)	PI	University of Wyoming	Ecosystem Science and Management	NSF	CAREER - Faculty Early Career Development Program	EAR-1752903	P18048	Oxidation of Dissolved Organic Matter by Manganese Oxides	Chemistry	1	0.5
Huan Chen (S)	C	National High Magnetic Field Laboratory	Ion Cyclotron Resonance	NSF	DEB - Division of Environmental Biology	DEB2027284					
Than Dam (G)	C	Univesity of Wyoming	Department of Ecosystem Science and Management								
Zhen Hu (G)	C	University of Wyoming	COLLEGE OF AGRICULTURE AND NATURAL RESOURCES								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Hairuo Mao (P)	C	University of Wyoming	Ecosystem science and management								
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Jianchao Zhang (P)	C	University of Wyoming	Ecosystem Science and Management								
Thomas Borch (S)	PI	Colorado State University	Soil and Crop Science	NSF	CBET - Chemical, Bioengineering, Environmental, and Transport Systems	CBET1512670	P18055	Investigation into Dissolved Organic Matter in Arctic Soil	Chemistry	1	0.67
William Bahureksa (G)	C	Colorado State University	Chemistry	NSF	CBET - Chemical, Bioengineering, Environmental, and Transport Systems	CBET2114868					
Casey Bryce (P)	C	University of Tuebingen	Center for Applied Geoscience	University Tuebingen	Non US College and University						
Carmen Höschen (P)	C	Technical University of Munich	Soil Science	German Academic Scholarship Foundation	Other Non US Federal Agency	390838134					
Hanna Joss (G)	C	Eberhard Karls University of Tübingen	Geosciences, Geomicrobiology	Institutional Strategy of the University of Tuebingen	Other Non US Federal Agency	DFG, ZUK63					
Andreas Kappler (S)	C	Eberhard Karls University of Tübingen	Center for Applied Geosciences								
Sara Kleindienst (S)	C	Eberhard Karls University of Tübingen	Geosciences								
Merritt Logan (G)	C	Colorado State University	Chemistry								
Carsten Mueller (S)	C	University of Copenhagen	Department of Geoscience and Natural Resource Management								
Monique Sézanne Patzner (G)	C	University Tuebingen	Geoscience								
Fernando Rosario-Ortiz (S)	C	University of Colorado, Boulder	Environmental Engineering								
Thomas Scholten (S)	C	Eberhard Karls University of Tübingen	Geosciences								
Daniel Straub (P)	C	Eberhard Karls University of Tübingen	Quantitative Biology Center (QBiC)								
Kevin Thorn (S)	C	U.S. Geological Survey	Water Resources								
Robert Young (S)	C	New Mexico State University, Main Campus	Chemical Analysis & Instrumentation Laboratory								
Zhe Zhou (P)	C	Alfred Wegener Institute for Marine and Arctic Research	Marine Geochemistry								
Daniel Repeta (S)	PI	Woods Hole Oceanographic Institution	Marine Chemistry	UCGP		227000-520-38653	P18079	Molecular speciation of organic nutrients in marine dissolved organic matter	Chemistry	3	7.17
Marianna Acker (G)	C	Woods Hole Oceanographic Institution	Watson Laboratory	NSF	OCE - Ocean Sciences	OCE1634080					
Lydia Babcock-Adams (G)	C	University of Georgia	Marine Sciences	NSF	OCE - Ocean Sciences	OCE1736280					
Benjamin Granzow (G)	C	Woods Hole Oceanographic Institution	Watson Laboratory	Simmons Foundation	Other	SCOPE POP 49476					
Jingxuan Li (S)	C	Woods Hole Oceanographic Institution	Watson Laboratory								
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Zeljka Popovic (G)	C	Florida State University	Ion Cyclotron Resonance								
Meilian Chen (S)	PI	Guangdong Technion	Environmental program	Guangdong Province, China & STEP		2019QZKK0605	P18102	Dynamics of dissolved organic matter from Alpine watersheds in the Himalayan-Tibetan Plateau	Chemistry	1	0.5
Jin Hur (S)	C	Sejong University	Department of Environment & Energy	Guangdong Technion	Non US College and University						
Anne Kellerman (P)	C	Florida State University	Earth, Ocean and Atmospheric Science								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Chaoliu Li (S)	C	Fujian Institute of Research on the Structure of Matter, Chinese Academy of Sciences	Institute of Tibetan Plateau Research								
Nagamitsu Maie (S)	C	Kitasato University	Department of Environmental Bioscience								
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Sydney Niles (G)	C	National High Magnetic Field Laboratory	Chemistry								
Robert Spencer (S)	C	Florida State University	Earth, Ocean & Atmospheric Science								
Fanping Yan (S)	C	Northwest Institute of Eco-Environment and Resources, Chinese Academy of Sciences	State Key Laboratory of Cryospheric Sciences								
Francisco Fernandez-Lima (S)	PI	Florida International Unversity	Chemistry and Biochemistry	NIH	NIAID - National Institute of Allergy and Infectious Diseases	AI135469	P19108	Lipids dynamics during the mosquito reproductive cycle	Biology, Biochemistry, Biophysics	1	0.5
Veronika Michalkova (S)	C	Biology Centre CAS	Institute of Parasitology	NSF	CHE - Chemistry	CHE1654274					
Fernando Noriega (S)	C	Florida International University	Department of Biology	NIH	NIAID - National Institute of Allergy and Infectious Diseases	AI04554_					
Marcela Nouzova (S)	C	Biology Centre CAS	Institute of Parasitology								
Lilian Tose (P)	C	Florida International University	Chemistry and Biochemistry								
Chad Weisbrod (S)	C	National High Magnetic Field Laboratory	ICR								
Collin Ward (S)	PI	Woods Hole Oceanographic Institution	Department of Marine Chemistry and Geochemistry,	No other support			P19124	Chemical characterization of marine plastic partial photochemical oxidation	Chemistry	1	0.33
Colleen Hansel (P)	C	Woods Hole Oceanographic Institution	Marine Chemistry and Geochemistry								
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Sydney Niles (G)	C	National High Magnetic Field Laboratory	Chemistry								
Ryan Rodgers (S)	C	National High Magnetic Field Laboratory	ICR								
Anna Walsh (G)	C	Woods Hole Oceanographic Institution	Marine Chemistry and Geochemistry								
Chad Weisbrod (S)	C	National High Magnetic Field Laboratory	ICR								
Andrew Wozniak (S)	PI	University of Delaware	School of Marine Science and Policy	University of Delaware	US College and University	Start Up	P19159	Environmental controls on the chemical composition of Delaware Bay's surface microlayer	Chemistry	1	0.33
Alina Ebling (T)	C	University of Delaware	Earth, Ocean & Environment	Univ of Delaware	US College and University						
Hollie Emery (P)	C	Harvard University	Department of Organismic and Evolutionary Biology								
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Sunita Shah Walter (S)	C	University of Delaware	School of Marine Science & Policy								
Leland Wood (G)	C	University of Delaware	School of Marine Science and Policy								
Michael Timko (S)	PI	Worcester Polytechnic Institute	Chemical Engineering	MassCEC			P19162	Comprehensive Mass Spectrometer Analysis of Algae and Food Waste Hydrothermal Liquefaction Products	Chemistry	1	1
Feng Cheng (T)	C	Worcester Polytechnic Institute	Chemical Engineering	NSF	CAREER - Faculty Early Career Development Program	155428					
Daniela Fraga Alvarez (G)	C	Worcester Polytechnic Institute	Department of Chemical Engineering	DOE	Other	DE-SC0015784					

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Sergio Granados-Focil (S)	C	Clark University	Department of Chemistry	DOE	Other	DE-EE0008513					
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Robert Nelson (S)	C	Woods Hole Oceanographic Institution	Dept Marine Chemistry and Geochemistry								
Sydney Niles (G)	C	National High Magnetic Field Laboratory	Chemistry								
Alex Paulsen (S)	C	Mainstream Engineering Corp	Defense and Space								
Chris Reddy (S)	C	Woods Hole Oceanographic Institution	Geochemistry								
Carla Romo (G)	C	Worcester Polytechnic Institute	Chemical Engineering								
Geoffrey Tompsett (S)	C	Worcester Polytechnic Institute	Chemical Engineering								
Ruihan Zhang (S)	C	Worcester Polytechnic Institute	Dept. Mechanical Engineering								
Allison Oliver (S)	PI	Skeena Fisheries Commission	Fisheries	Fisheries and Oceans Canada	Non US Government Lab		P19184	From ice to rainforest: Delineation of complex DOM sources in coastal Canadian waters	Chemistry	1	0.67
Megan Behnke (P)	C	University of Alaska Southeast	Natural Science	Prince Rupert Port Authority	Non US Government Lab						
Paul Covert (S)	C	Fisheries and Oceans Canada	Institute of Ocean Sciences	Skeena River Salmon Enhancement Program	Non US Government Lab						
Sophia Johannessen (S)	C	Fisheries and Oceans Canada	Institute of Ocean Sciences								
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Robert Spencer (S)	C	Florida State University	Earth, Ocean & Atmospheric Science								
Sarah Johnston (P)	PI	University of Lethbridge	Biological Sciences	NASA		ABoVE Project 14-TE14-0012	P19190	The Chemical Composition of Freshwater Zooplankton Dissolved Organic Matter Cycling	Chemistry	1	189.26
Matthew Bogard (S)	C	University of Lethbridge	Biological Sciences	NASA		ABoVE NNX15AU07A					
Kerri Finlay (S)	C	University of Regina	Department of Biology	Delta Stewardship Council Delta Science Program	Other	5298					
Robert Spencer (S)	C	Florida State University	Earth, Ocean & Atmospheric Science								
Boris Lau (S)	PI	University of Massachusetts	Civil and Environmental Engineering	NSF	CBET - Chemical, Bioengineering, Environmental, and Transport Systems	CBET1454443	P19198	Probing the Effects of Sulfidation on the Reactivity of Natural Organic Matter with Polymer-Capped Silver Nanoparticles by Fourier-Transform Ion Cyclotron Resonance Mass Spectrometry	Biology, Biochemistry, Biophysics	3	2
Martha Chacon (S)	C	National High Magnetic Field Laboratory	Ion Cyclotron Resonance	University of Massachusetts - Internal Research Grant	Other						
Salimar Cordero (O)	C	University of Massachusetts	Civil and Environmental Engineering								
William Hockaday (S)	C	Baylor University	Geosciences								
Richard Vachet (S)	C	University of Massachusetts Amherst	Chemistry								
Alan Marshall (S)	PI	National High Magnetic Field Laboratory	ICR	NSF	DMR - Division of Materials Research	DMR1644779	P19213	Derivatization of carboxylic acid and alcohol functional groups from photo-oxidized petroleum samples	Chemistry	1	3
Lissa Anderson (S)	C	National High Magnetic Field Laboratory	ICR								
Joseph Frye (G)	C	National High Magnetic Field Laboratory	CIMAR								
Ryan Rodgers (S)	C	National High Magnetic Field Laboratory	ICR								
David Griffith (S)	PI	Willamette University	Chemistry	No other support			P19215	Identification and resolution of isobaric interferences of estrogens in wastewater	Chemistry	1	2.5
William Braaton (U)	C	Willamette University	Chemistry								
Carolyn Hutchinson (G)	C	Iowa State University	Chemistry								
Clarissa Lincoln (U)	C	Willamette University	Chemistry								
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Zeljka Popovic (G)	C	Florida State University	Ion Cyclotron Resonance								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Chad Weisbrod (S)	C		National High Magnetic Field Laboratory	ICR								
Hiarhi Monda (S)	PI		Bio Huma Netics, Inc.	Humic Lab Research	No other support			P19216	Molecular characterization of natural organic matter (NOM) and its fractions (humic and fulvic acids) from ores, peat, and compost and correlation with their plant biostimulant activity	Chemistry	1	1
Ryan Fountain (T)	C		Bio Huma Netics, Inc.	Humic Lab Research								
James Junker (S)	C		Louisiana Universities Marine Consortium	Aquatic Ecology								
Richard Lamar (S)	C		Bio Huma Netics, Inc.	R&D								
Elena Vialykh (P)	C		University of Colorado, Boulder	Civil, Environmental & Architectural Engineering								
Cynthia Heil (S)	PI		Mote Marine Laboratory	Red Tide Institute	NOAA/NOS/NCCOS/Competitive Research Award	Other	NA19NOS4780183	P19223	Molecular composition and bioavailability of dissolved organic nutrients in urban stormwater and municipal wastewater discharges to the Florida red tide dinoflagellate Karenia brevis	Biology, Biochemistry, Biophysics	1	1
Huan Chen (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
Patricia Holland (S)	C		Mote Marine Laboratory	HAB Ecology and Mitigation								
Mary Lusk (G)	C		University of Florida	Soil and Water Science Dept.								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Amanda Muni-Morgan (G)	C		University of Florida	Soil and Water Sciences								
Michael Stukel (S)	PI	*	Florida State University	Earth, Ocean, and Atmospheric Science	NSF	OCE - Ocean Sciences	OCE1637632	P19226	Characterizing alterations in sinking organic matter in the pelagic ocean	Chemistry	1	7.67
Huan Chen (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance	NSF	OCE - Ocean Sciences	OCE1756610					
Thomas Kelly (G)	C		Florida State University	Earth, Ocean & Atmospheric Sciences	NSF	OCE - Ocean Sciences	OCE1851347					
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR	NOAA	Other US Federal Agency	NOAA-NOS-NCCOS-2017-2004875					
Zeljka Popovic (G)	C		Florida State University	Ion Cyclotron Resonance								
Jeffrey Chanton (S)	PI		Florida State University	Department of Earth, Ocean and Atmospheric Science	DOE	Other	DE-SC0007144	P19276	Characterizing the relationship between peatland temperature stability and DOM composition	Chemistry	1	0.67
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR	DOE	Other	DE-SC0012088					
Rachel Wilson (S)	C		Florida State University	EOAS	DOE	Other	Award No. Pending					
					Oak Ridge National Laboratory	US Government Lab	DE-AC05-00OR22725					
Robert Spencer (S)	PI		Florida State University	Earth, Ocean & Atmospheric Science	Alaska EPSCoR		OIA-1757348	P19289	Global perspective on the sources, cycling and composition of dissolved organic matter exported from mountain glaciers	Chemistry	1	0.45
Tom Battin (S)	C		Ecole Polytechnique Federale de Lausanne	ENAC IEE SBER	NSF	DEB - Division of Environmental Biology	DEB1145932					
Vincent De Staerke (T)	C		Ecole Polytechnique Federale de Lausanne	Stream Biofilm and Ecosystem Research Laboratory	NSF	OCE - Ocean Sciences	OCE1333157					
Jason Fellman (S)	C		University of Alaska Southeast	Environmental Science								
Amy Holt (G)	C		Florida State University	EAOS								
Eran Hood (S)	C		University of Alaska Southeast	Environmental Science								
Anne Kellerman (P)	C		Florida State University	Earth, Ocean and Atmospheric Science								
Wenbo Li (G)	C		Florida State University	Earth, Ocean& Atmospheric Science								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Hannes Peter (S)	C		Ecole Polytechnique Federale de Lausanne	Stream Biofilm and Ecosystem Research Lab								
Martina Schön (T)	C		Ecole Polytechnique Federale de Lausanne	Stream Biofilm and Ecosystem Research Laboratory								
Aron Stubbins (S)	C		Northeastern University	Marine and Environmental Science								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Michael Styllas (P)	C	Ecole Polytechnique Federale de Lausanne	Stream Biofilm and Ecosystem Research Laboratory								
Matteo Tolosano (T)	C	Ecole Polytechnique Federale de Lausanne	Stream Biofilm and Ecosystem Research Laboratory								
Sasha Wagner (P)	C	University of Georgia	Marine Sciences and Oceanography								
Pierre Giusti (S)	PI	Total	Research & Technology	Conseil Régional d'Aquitaine		20071303002PFM	P19298	Analysis of Petroleum Products by Gel Permeation Chromatography (GPC) Online with Inductively Coupled Plasma Mass Spectrometry (ICP MS) and with Fourier Transform Ion Cyclotron Resonance Mass Spectrometry (FT-ICR MS)	Biology, Biochemistry, Biophysics	1	1
Nelson Acevedo (S)	C	University of Pau and Pays de l'Adour	IPREM	FEDER		31486/08011464					
Carlos Afonso (S)	C	Normandy University	Chemistry	EU		636829					
Brice Bouyssiere (S)	C	University of Pau and Pays de l'Adour	IPREM	Total and the university of pau et des pays de l'adour	Other						
Herve Carrier (S)	C	University of Pau and Pays de l'Adour	UPPA								
Jimmy Castillo (S)	C	Central University of Venezuela	Escuela de Quimica								
Martha Chacon (S)	C	National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
Jean-Luc Daridon (S)	C	University of Pau and Pays de l'Adour	IPREM								
Pierre Giusti (S)	C	Total	Refining and Chemicals								
Caroline Mangote (S)	C	Total	Research & Technology								
Aurora Mejia (S)	C	University of Pau and Pays de l'Adour	UPPA								
Remi Moulian (G)	C	National High Magnetic Field Laboratory	ICR								
Sandra Mounicou (S)	C	University of Pau and Pays de l'Adour	Chimie Analytique								
Vincent Piscitelli (S)	C	Central University of Venezuela	Escuela de Quim´ica								
Sadia Radji (S)	C	University of Pau and Pays de l'Adour	UPPA								
Ryan Rodgers (S)	C	National High Magnetic Field Laboratory	ICR								
Fang Zheng (S)	C	University of Pau and Pays de l'Adour	Centre National de la Recherche Scientifique								
Juliana D'Andrilli (S)	PI	Louisiana Universities Marine Consortium (LUMCON)	Environmental Chemistry	NSF	CBET - Chemical, Bioengineering, Environmental, and Transport Systems	CBET1804736	P19300	Disentangling the Underlying Chemistry of Absorbance and Fluorescence Spectroscopy: Coupling Multi-detector Size-Exclusion Based Fractionation of Dissolved Organic Matter to Molecular-Level FT-ICR MS Composition Analysis	Chemistry	1	0.25
Martha Chacon (S)	C	National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
Sarah Fischer (P)	C	University of Colorado, Boulder	Civil, Environmental and Architectural Engineering								
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Fernando Rosario-Ortiz (S)	C	University of Colorado, Boulder	Environmental Engineering								
Amin Mirkouei (S)	PI	University of Idaho	Mechanical and Biological Engineering	University of Idaho (EIS Grant)	Other		P19334	Multi-level chemical fractionation scheme to enable in-depth characterization of bio-oil	Chemistry	1	1.5
Martha Chacon (S)	C	National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
Armando McDonald (S)	C	University of Idaho	Department of Forest, Rangeland and Fire Sciences								
Maria Magdalena Ramirez Corredores (S)	C	Idaho National Laboratory	Chemistry and radiation measurements								
Kavita Sharma (P)	C	Idaho State University	Department of Chemistry								
Ethan Struhs (G)	C	University of Idaho	Engineering								
Thomas Borch (S)	PI	Colorado State University	Soil and Crop Science	NSF	CBET - Chemical, Bioengineering, Environmental, and Transport Systems	CBET1512670	P19338	Forest fire-impacted soil organic matter chemistry	Chemistry	3	3.2

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Martha Chacon (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance	USDA - Department of Agriculture		AFRI 2021-67019034608					
Jim Ippolito (S)	C		Colorado State University	Soil and Crop Sciences	USDA - Department of Agriculture		COL00292D/1020695					
Eugene Kelly (S)	C		Colorado State University	College of Agricultural Sciences	DOE	Other	SC0021349					
Merritt Logan (G)	C		Colorado State University	Chemistry	DOE	Other	SC0021349					
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR	DOE	Other	SC00020205					
Frederic Mentink (S)	C		National High Magnetic Field Laboratory	NMR Division	DOE	Other	DE-SC0020205					
Amelia Nelson (G)	C		Colorado State University	Soil and Crop Sciences	United States-Israel Binational Science Foundation	Other	2018130					
Sydney Niles (G)	C		National High Magnetic Field Laboratory	Chemistry								
Charles Rhoades (S)	C		U.S. Department of Agriculture	Rocky Mountain Research Station								
Holly Roth (G)	C		Colorado State University	Chemistry								
Mike Wilkins (S)	C		Colorado State University	College of Agricultural Sciences								
Robert Young (S)	C		New Mexico State University, Main Campus	Chemical Analysis & Instrumentation Laboratory								
Jonathan Sweedler (S)	PI	*	University of Illinois at Urbana-Champaign	Department of Chemistry	NIH	NHGRI - National Human Genome Research Institute	HG010023	P19357	High Resolution MALDI Mass Spectrometry for Single-cell and Subcellular Measurements	Biology, Biochemistry, Biophysics	1	8.83
Sara Bell (G)	C		University of Illinois at Urbana-Champaign	Department of Chemistry	NIH	NIDA - National Institute on Drug Abuse	DA018310					
Daniel Castro (G)	C		University of Illinois at Urbana-Champaign	Molecular and Integrative Physiology								
Donald Smith (S)	C		National High Magnetic Field Laboratory	ICR								
Karl Smith (P)	C		National High Magnetic Field Laboratory	ICR								
Richard Xie (G)	C		University of Illinois at Urbana-Champaign	Department of Bioengineering								
Estrella Rogel (S)	PI		Chevron ETC	Products and Analytical	Chevron Research	Other		P19359	Entangling Petroleum Properties with Molecular Composition: Analysis of Asphaltene Fractions by High-Temperature GC Coupled to ICP MS.	Chemistry	1	5
Martha Chacon (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
Francisco Lopez Linares (S)	C		Chevron, Richmond	Downstream and Service-Petroleum and Material Characterization								
Jenny Nelson (S)	C		Agilent Technologies	Atomic Spectroscopy								
Cesar Ovalles (S)	C		Chevron Energy Tech. Comp.	Downstream and Services								
Ryan Rodgers (S)	C		National High Magnetic Field Laboratory	ICR								
Colleen McMahan (S)	PI		U.S. Department of Agriculture	Bioproducts Research Unit/Western Regional Research Center	USDA - Department of Agriculture		2030-24-1410-022D	P19457	Determination of isoprenoid pathway metabolites in bioengineered guayule	Biology, Biochemistry, Biophysics	1	0.33
Catherine Brewer (S)	C		New Mexico State University, Main Campus	Chemical and Materials Engineering	New Mexico State University Agricultural Experiment Station	US College and University						
Mostafa Dehghanizadeh (G)	C		New Mexico State University, Main Campus	Chemical and Materials Engineering								
Claudia Galvan (T)	C		New Mexico State University, Main Campus	Plant and Environmental Science								
F. Omar Holguin (S)	C		New Mexico State University, Main Campus	Department of Plant and Environmental Science								
Jackie Jarvis (S)	C		New Mexico State University, Main Campus	Plant and Environmental Sciences								

Participants (Name)	Role	Org.	Dept.	Funding Agency	Division	Award #	Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Dante Placido (P)	C	U.S. Department of Agriculture	Bioproducts Research Unit/Western Regional Research Center								
Sergei Shalygin (G)	C	New Mexico State University, Main Campus	Plant and Environmental Science								
Ryan Rodgers (S)	PI	National High Magnetic Field Laboratory	ICR	No other support			P19464	Understanding of Emulsion Formation from Photo-Oxidized Crude Oils	Chemistry	1	5.75
Joseph Frye (G)	C	National High Magnetic Field Laboratory	CIMAR								
Alan Marshall (S)	C	National High Magnetic Field Laboratory	ICR								
Mary Zeller (P)	PI	Leibniz Institute for Baltic Sea Research Warnemünde	Department of Marine Geology	Deutsche Forschungsgemeinschaft	Non US Foundation	GRK 2000/1	P19474	Linking the carbon and sulfur cycles in the regeneration process of a historically brackish diked peatland	Chemistry	2	0.5
Michael Böttcher (S)	C	Leibniz Institute for Baltic Sea Research Warnemünde	Geosciences								
Anna-Kathrina Jenner (G)	C	Leibniz Institute for Baltic Sea Research Warnemünde	Geochemistry and stable Isotope Geochemistry								
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Catia Milene von Ahn (G)	C	Leibniz Institute for Baltic Sea Research Warnemünde	Marine Geology								
Jon Hawkings (P)	PI	Florida State University	Earth, Ocean and Atmospheric Sciences	European Research Council	Non US Council	793962	P19475	Glacial influence on organic matter export in polar watersheds	Chemistry	1	0.14
Nathan Bramall (S)	C	Leiden Technology LLC	Technology								
Kathryn Bywaters (S)	C	Honeybee Robotics	.								
Brent Christner (S)	C	University of Florida	Microbiology & Cell Science								
Peter Doran (S)	C	Louisiana State University	Geobiology and Geophysics								
Ashley Dubnick (P)	C	Montana State University	Earth Sciences								
Anne Kellerman (P)	C	Florida State University	Earth, Ocean and Atmospheric Science								
Matthew Marshall (G)	C	University of Bristol	School of Geographical Sciences								
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Jay Nadeau (S)	C	Portland State University	Physics								
Mark Skidmore (S)	C	Montana State University	Department of Earth Sciences								
Carl Snyder (G)	C	Portland State University	Physics								
Robert Spencer (S)	C	Florida State University	Earth, Ocean & Atmospheric Science								
Jemma Wadham (S)	C	University of Bristol	School of Geographical Sciences								
Diego Cobice (S)	PI *	Ulster University	Biomedical Sciences	Department for the Economy (DfE) Randox Laboratories Ltd.	Other	Case number : 2018133NI	P19498	Spatial distribution of reactive aldehydes and discovery of potential tissue lipids markers in type 2 diabetes mouse kidney by MSI	Biology, Biochemistry, Biophysics	1	6.17
Simon Brockbank (S)	C	Randox Laboratories Ltd	R&D								
Carla Harkin (G)	C	Ulster University	Mass spectrometry								
Tara Moore (S)	C	Ulster University	Biomedical Sciences								
Donald Smith (S)	C	National High Magnetic Field Laboratory	ICR								
Karl Smith (P)	C	National High Magnetic Field Laboratory	ICR								
Ryan Rodgers (S)	PI	National High Magnetic Field Laboratory	ICR	No other support			P19499	Molecular Characterization of Water-Soluble Photooxidation	Chemistry	1	5.33
Martha Chacon (S)	C	National High Magnetic Field Laboratory	Ion Cyclotron Resonance								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Thomas Ennis (S)	C		City of Austin, Texas	Watershed Protection Department					Products from Coal Tar Sealant and Asphalt Emulsion Sealant to Determine Anthropogenic Effects on the Built Environment			
Taylor Glattke (G)	C		Florida State University	ICR								
Steve Greason (O)	C		Sitelab Corporation	Lab Dept.								
Sarajeen Saima Hoque (G)	C		Florida State University	Civil and Environmental Engineering								
Ishwar Kohale (G)	C		Massachusetts Institute of Technology	Koch Institute								
Forest White (S)	C		Massachusetts Institute of Technology	Biological Engineering								
James McClelland (S)	PI		University of Texas at Austin	Marine Science Institute	NSF	OPP - Office of Polar Programs	OPP1656026	P19500	Leaching and Biolability of Dissolved Organic Matter from Eroding Permafrost along the Alaska Beaufort Sea Coast	Chemistry	1	0.25
Megan Behnke (P)	C		University of Alaska Southeast	Natural Science	NSF	OPP - Office of Polar Programs	OPP1938820					
Emily Bristol (G)	C		University of Texas, Austin	Marine Science								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Robert Spencer (S)	C		Florida State University	Earth, Ocean & Atmospheric Science								
Calvin Mukarakate (S)	PI		National Renewable Energy Laboratory	National Bioenergy Center	DOE	BETO - Bioenergy Technologies Office	DE-AC36-08-GO28308	P19502	Impacts of Biomass Feed, Catalyst, and Operating Conditions on Molecular Transformations during Catalytic Fast Pyrolysis Oil	Chemistry	1	0.83
Martha Chacon (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
Kristiina Iisa (S)	C		National Renewable Energy Laboratory	Catalytic Carbon Transformation and Scale-Up Center								
Steven Rowland (S)	C		National Renewable Energy Laboratory	National Bioenergy Center								
Jack Ferrell (S)	PI	*	National Renewable Energy Laboratory	Catalytic Carbon Transformation & Scaleup Center	DOE	BETO - Bioenergy Technologies Office	DE-AC36-08-GO28308	P19503	Impact of Aging on Catalytic Fast Pyrolysis Oils	Chemistry	1	0.33
Martha Chacon (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
Kristiina Iisa (S)	C		National Renewable Energy Laboratory	Catalytic Carbon Transformation and Scale-Up Center								
Calvin Mukarakate (S)	C		National Renewable Energy Laboratory	National Bioenergy Center								
Steven Rowland (S)	C		National Renewable Energy Laboratory	National Bioenergy Center								
Alexandre Anesio (S)	PI	*	Aarhus University	Environmental Science	European Research Commission	Other	856416	P19510	Glacial biomarkers: searching for source-specific glacial algae proxies	Biology, Biochemistry, Biophysics	1	0.75
Eva Doting (G)	C		Aarhus University	Environmental Science	Danish Ministry of Higher Education and Science	Non US Ministry	9096-00101B					
Anne Kellerman (P)	C		Florida State University	Earth, Ocean and Atmospheric Science								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Robert Spencer (S)	C		Florida State University	Earth, Ocean & Atmospheric Science								
Yang Lin (S)	PI	*	University of Florida	Soil and Water Sciences	No other support			P19511	Chemical characterization of dissolved deep podzolized carbon	Biology, Biochemistry, Biophysics	1	0.5
Allan Bacon (S)	C		University of Florida	Soil and Water Sciences								
Daniel Colopietro (G)	C		University of Florida	Soil and Water Sciences								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Benjamin Gilbert (S)	PI	*	Lawrence Berkeley National Laboratory	Energy Geoscience	NSF	EAR - Earth Sciences	EAR1854875	P19512	Light- and Iron-Sensitized Oxidation of Dissolved Organic Matter	Chemistry	1	0.83
Claresta Joe-Wong (P)	C		Lawrence Berkeley National Laboratory	Earth and Environmental Sciences								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Robyn Conmy (S)	PI	*	Environmental Protection Agency	Office of Research and Development	EPA			P19519	High Resolution Analysis of Hydrocarbons to Advance Oil Spill Science	Chemistry	2	0.48
Mace Barron (S)	C		Environmental Protection Agency	Oil Spill Response Research Area								
Martha Chacon (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Kiara Lech (S)	C	Environmental Protection Agency	Oil Spill Response Research Area								
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Ryan Rodgers (S)	C	National High Magnetic Field Laboratory	ICR								
Devi Sundaravadivelu (S)	C	Pegasus Technical Services Inc	On-Site Contractor to U.S. EPA								
Patrick Tomco (S)	PI	University of Alaska Anchorage	Chemistry Department	NSF	OIA - Office of Integrative Activities	1929173	P19522	Photochemically Mobilized Dissolved Organic Matter from Crude Oil, Refined Fuels, and Herded Burn Residue in High Latitudes	Chemistry	1	4.17
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
David Podgorski (S)	C	University of New Orleans	Department of Chemistry								
Zachary Redman (P)	C	University of Alaska, Anchorage	Chemistry								
Elizabeth Whisenhant (G)	C	University of Alaska, Anchorage	Chemistry								
Phoebe Zito (S)	C	University of New Orleans	Chemistry								
Rene Boiteau (S)	PI	Oregon State University	College of Earth, Ocean, Atmospheric Sciences	NSF	OCE - Ocean Sciences	OCE1829761	P19547	Deciphering the sources of trace element binding organic ligands in coastal sediments.	Chemistry	1	14.67
Peter Chace (G)	C	Oregon State University	College of Earth, Ocean and Atmospheric Science								
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Zeljka Popovic (G)	C	Florida State University	Ion Cyclotron Resonance								
Clare Reimers (S)	C	Oregon State University	College Earth, Ocean and Atmospheric Sciences								
Chad Weisbrod (S)	C	National High Magnetic Field Laboratory	ICR								
Chris Hendrickson (S)	PI	National High Magnetic Field Laboratory	Ion Cyclotron Resonance Program	No other support			P19548	Analytical Method Development for FT-ICR MS	Chemistry	6	429
Lissa Anderson (S)	C	National High Magnetic Field Laboratory	ICR	UCGP							
Greg Blakney (S)	C	National High Magnetic Field Laboratory	ICR	NIH	NIGMS - National Institute of General Medical Sciences	GM037537					
David Butcher (P)	C	National High Magnetic Field Laboratory	ICR								
Donald Hunt (S)	C	University of Virginia	Chemistry								
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR								
Leah Schaffer (G)	C	University of Wisconsin, Madison	Chemistry								
Jeffrey Shabanowitz (S)	C	University of Virginia	Chemistry								
Michael Shortreed (S)	C	University of Wisconsin, Madison	Chemistry								
Lloyd Smith (S)	C	University of Wisconsin, Madison	Chemistry								
Chad Weisbrod (S)	C	National High Magnetic Field Laboratory	ICR								
Brett Poulin (S)	PI	University of California, Davis	Environmental Toxicology	NSF	CAREER - Faculty Early Career Development Program	1945388	P19575	Tracing agricultural sulfur inputs to the environment using advanced dissolved organic sulfur characterization	Chemistry	1	0.14
Thomas Borch (S)	C	Colorado State University	Soil and Crop Science	NSF	EAR - Earth Sciences	EAR1629698					
Anna Hermes (G)	C	University of Colorado, Boulder	Institute of Arctic and Alpine Research	University of Colorado Boulder Center for Water, Earth Science and Technology	US College and University						
Eve-Lyn Hinckley (S)	C	University of Colorado, Boulder	Institute of Arctic and Alpine Research								
Merritt Logan (G)	C	Colorado State University	Chemistry								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Livia Schiavinato Eberlin (S)	PI	*	University of Texas, Austin	Chemistry	NIH	NCI - National Cancer Institute	CA229068	P19585	Identification of a Molecular Biomarker of Thyroid Tissue	Biology, Biochemistry, Biophysics	2	4
Lissa Anderson (S)	C		National High Magnetic Field Laboratory	ICR	Welch Foundation Development of Ambient Ionization Ion Mobility Mass Spectrometry Imaging for Spatial and Chemical Lipids Analysis in Biological Samples	Other	F-1895					
Martha Chacon (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance	Cancer Prevention and Research Institute of Texas CPRIT - IIRACT	Other	RP180381					
Rachel DeHoog (G)	C		University of Texas, Austin	Chemistry	The Gordon and Betty Moore Foundation	Other US Federal Agency	Moore Inventor Fellow					
Karl Smith (P)	C		National High Magnetic Field Laboratory	ICR	UTA	US Foundation	20-000069					
Chad Weisbrod (S)	C		National High Magnetic Field Laboratory	ICR								
Ercan Cakmak (S)	PI	*	Oak Ridge National Laboratory	Materials Science and Technology	DOE	Other	N/A	P19586	High Resolution Molecular Characterization of Industrially Relevant Coals using ESI and FI/FD FT-ICR MS	Chemistry	1	0.67
Martha Chacon (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
David Eaton (S)	C		University of Kentucky	Center of Applied Energy Research								
Stephan Irle (S)	C		Oak Ridge National Laboratory	Computational Sciences and Engineering Division								
Gang Seob Jung (S)	C		Oak Ridge National Laboratory	Computational Science and Engineering Division								
Edgar Lara-Curzio (S)	C		Oak Ridge National Laboratory	Materials Science & Technology Division								
Jonathan Mathews (S)	C		Pennsylvania State University	Energy and Mineral Engineering								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Matthew Ryder (S)	C		Oak Ridge National Laboratory	Materials Science and Technology Division								
Frederic Vautard (S)	C		Oak Ridge National Laboratory	Advanced Materials								
Pilsun Yoo (S)	C		Oak Ridge National Laboratory	Materials and Chemical Engineer								
Changchun Huang (S)	PI	*	Nanjing University	School of Geography	Nanjing Normal University	Non US College and University		P19601	Molecular-level insights into the degradation and transformation processes of dissolved organic matter in sediment and fluvial ecosystems	Chemistry	1	1.67
Anne Kellerman (P)	C		Florida State University	Earth, Ocean and Atmospheric Science								
Shuaidong Li (G)	C		Nanjing University	School of Geography								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Robert Spencer (S)	C		Florida State University	Earth, Ocean & Atmospheric Science								
Archana Agarwal (S)	PI		University of Utah	Department of Pathology/ARUP Laboratories	NSF	DMR - Division of Materials Research	DMR1644779	P19602	Characterization of beta thalassemia on 21T FT-ICR MS with the application of proton transfer reduction	Biology, Biochemistry, Biophysics	1	0.73
Lissa Anderson (S)	C		National High Magnetic Field Laboratory	ICR								
Yuan Lin (G)	C		Florida State University	Department of Chemistry and Biochemistry								
Alan Marshall (S)	C		National High Magnetic Field Laboratory	ICR								
Hui Pu (S)	PI	*	University of North Dakota	Petroleum Engineering	Ecopetrol			P19603	High Resolution Compositional Characterization of Degraded Crude Oils Using Petroleomics	Chemistry	2	3.83
Humberto Carvajal-Ortiz (S)	C		Core Laboratories	Geoscience Operations US								
Martha Chacon (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Thomas Gentzis (S)	C		Core Laboratories	Petroleum Services								
Miguel Jimenez Jacome (G)	C		University of North Dakota	Petroleum Engineering								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Jorge Orrego-Ruiz (S)	C		Ecopetrol	Upstream laboratory								
Fernando Rojas Ruiz (S)	C		Ecopetrol	Upstream laboratory								
Katrina Counihan (S)	PI	*	Alaska SeaLife Center	Research	No other support			P19625	Photoenhanced toxicity of crude oil to juvenille Coho salmon	Chemistry	1	0.5
Rana Ghannam (G)	C		University of New Orleans	Chemistry								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Phoebe Zito (S)	C		University of New Orleans	Chemistry								
Ryan Rodgers (S)	PI		National High Magnetic Field Laboratory	ICR	iC2MC grant (IPA-5923)	Non US College and University		P19648	Biofuels derived from Algae and Wood / Plastic Pyrolysis	Chemistry	1	4.08
Brice Bouyssiere (S)	C		University of Pau and Pays de l'Adour	IPREM								
Martha Chacon (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
Pierre Giusti (S)	C		Total	Research & Technology								
Caroline Mangote (S)	C		Total	Research & Technology								
Michael Timko (S)	PI		Worcester Polytechnic Institute	Chemical Engineering	DOE	BETO - Bioenergy Technologies Office	DE-EE0008513	P19652	Comprehensive Mass Spectrometer Analysis of Real Food and Lignocellulosic Waste Hydrothermal Liquefaction and Upgrading Products	Engineering	1	1.33
David Kenney (G)	C		Worcester Polytechnic Institute	Chemical Engineering								
Heather LeClerc (G)	C		Worcester Polytechnic Institute	Chemical Engineering								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Ronish Shrestha (G)	C		Worcester Polytechnic Institute	Chemical Engineering								
Andrew Teixeira (S)	C		Worcester Polytechnic Institute	Chemical Engineering								
Robert Spencer (S)	PI		Florida State University	Earth, Ocean & Atmospheric Science	NSF	GRFP - Graduate Research Fellowship Program	GRFP1000284	P19660	Tracing organic matter signatures in the Arctic Ocean: do terrestrial inputs persist?	Biology, Biochemistry, Biophysics	1	0.33
Anne Kellerman (P)	C		Florida State University	Earth, Ocean and Atmospheric Science								
Anna Khreptugova (G)	C		Lomonosov Moscow State University	Chemistry								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Irina Perminova (S)	C		Lomonosov Moscow State University	Chemistry Department								
Sommer Starr (G)	C		Florida State University	Earth, Ocean, and Atmospheric Science								
Alan Marshall (S)	PI		National High Magnetic Field Laboratory	ICR	No other support			P19662	Electron Transfer Dissociation with Beam-collision Activated Dissociation for Improved Fragmentation of Intact Proteins	Biology, Biochemistry, Biophysics	1	4.33
Lissa Anderson (S)	C		National High Magnetic Field Laboratory	ICR								
Yuan Lin (G)	C		Florida State University	Department of Chemistry and Biochemistry								
Hadi Mohammadigoushki (S)	PI	*	Florida State University	Chemical and Biomedical Engineering	Florida State University Planning Grant	Other		P19663	Probing adsorption of monoclonal antibodies at the oil-water interface	Engineering	1	3.5
Lissa Anderson (S)	C		National High Magnetic Field Laboratory	ICR								
Jamini Bhagu (G)	C		Florida Agricultural and Mechanical University	Chemical ENG								
Samuel Grant (S)	C		National High Magnetic Field Laboratory	Chemical & Biomedical Engineering								
Zeljka Popovic (G)	C		Florida State University	Ion Cyclotron Resonance								
Qing-Xiang "Amy" Sang (S)	PI	*	Florida State University	Chemistry & Biochemistry	No other support			P19666	Top-Down Proteomic Analysis of	Chemistry	1	2

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Lissa Anderson (S)	C		National High Magnetic Field Laboratory	ICR					Microplastics Exposed Human Lung Cells			
Alexander Mazzorana (U)	C		Florida State University	Department of Chemistry and Biochemistry								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Carley Reid (G)	C		Florida State University	Chemistry and Biochemistry								
Mengqiang Zhu (S)	PI		University of Wyoming	Ecosystem Science and Management	NSF	DEB - Division of Environmental Biology	DEB2027284	P19667	Identifying Mineral Surface Properties Controlling Magnitude of Molecular Fractionation by Adsorption on Minerals	Engineering	1	2.45
Zhen Hu (G)	C		University of Wyoming	COLLEGE OF AGRICULTURE AND NATURAL RESOURCES								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Carson Thompson (G)	C		University of Wyoming	Dept. ECOSYSTEM SCIENCE AND MANAGEMENT								
Tullis Onstott (S)	PI	*	Princeton University	Dept. of Geosciences	NSF	EAR - Earth Sciences	EAR1917682	P19668	Abiotic Organic Chemistry in an Ancient South African Hypersaline Brine	Biology, Biochemistry, Biophysics	1	0.33
Martha Chacon (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Devan Nisson (G)	C		Princeton University	Geosciences								
Ryan Rodgers (S)	C		National High Magnetic Field Laboratory	ICR								
Clifford Walters (S)	C		University of Texas, Austin	Bureau of Economic Geology								
Jeffrey Stryker (S)	PI	*	University of Alberta	Chemistry	University of Alberta	Non US College and University	CFREF - T09-C01	P19669	Hydrogen-free, Low-temperature, Electrocatalytic Upgrading of Bitumen Asphaltenes to Hexane-soluble Maltenes	Chemistry	1	2.17
Martha Chacon (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
Ryan Rodgers (S)	C		National High Magnetic Field Laboratory	ICR								
David Scott (P)	C		University of Alberta	Chemistry								
Sebastian Doetterl (S)	PI	*	ETH Zurich	Environmental Systems Science	ETH Zurich	Non US College and University		P19672	The effect of temperature on quantity and quality of dissolved soil organic carbon	Chemistry	1	0.33
Samuel Bode (P)	C		Ghent University	alsotope Bioscience Laboratory–ISOFYS								
Pascal Boeckx (S)	C		Ghent University	Applied analytical and physical chemistry								
Martin Kurek (G)	C		Florida State University	Earth, Ocean, and Atmospheric Science								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Robert Spencer (S)	C		Florida State University	Earth, Ocean & Atmospheric Science								
Daniel Wasner (G)	C		Swiss Federal Institute of Technology in Zurich	Department of Environmental Systems Science								
Erick Zagal (S)	C		University of Concepcion	Soils and Natural Resources								
Robert Spencer (S)	PI		Florida State University	Earth, Ocean & Atmospheric Science	NSF	GRFP - Graduate Research Fellowship Program	GRFP1000284	P19692	The impacts of permafrost thaw and peatland cover on DOM composition in west Siberian watersheds	Biology, Biochemistry, Biophysics	1	1.08
Karen Frey (S)	C		Clark University	Graduate School of Geography	NSF	DEB - Division of Environmental Biology	DEB2029585					
Martin Kurek (G)	C		Florida State University	Earth, Ocean, and Atmospheric Science	NSF	OPP - Office of Polar Programs	OPP2124464					
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Romy Chakraborty (S)	PI		Lawrence Berkeley National Laboratory	Ecology	DOE	BER - Biological and Environmental Research	DE-AC02-05CH11231	P19706	Characterizing transformation of natural organic matter by key indigenous microorganisms	Chemistry	1	0.92
Sara Gushgari-Doyle (P)	C		Lawrence Berkeley National Laboratory	Earth & Environmental Sciences	Lawrence Berkely Lab	US Government Lab	ENIGMA-Ecosystems and Networks Integrated with Genes					

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
							and Molecular Assemblies		interrestrial subsurface sediments			
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Xiaoqin Wu (S)	C		Lawrence Berkeley National Laboratory	Department of Ecology								
Amie Lund (S)	PI	*	University of North Texas	Biological Sciences - Advanced Environmental Research Institute	NIH	NIEHS - National Institute of Environmental Health Sciences	ES026795	P19719	Top-Down Proteomics Analysis of Alterations in Protein Expression and Modification in the Liver of C57Bl/6 Mice in Response to Mixed Vehicle Emissions and/or High Fat Diet Consumption.	Biology, Biochemistry, Biophysics	1	5.5
Lissa Anderson (S)	C		National High Magnetic Field Laboratory	ICR								
Leah Schneider (G)	C		University of North Texas	Department of Biological Sciences								
Ryan Rodgers (S)	PI		National High Magnetic Field Laboratory	ICR	Various			P19743	OMICS LLC	Chemistry	1	0.25
Martha Chacon (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
Chris Hendrickson (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance Program								
Murray Gray (S)	PI	*	Alberta Innovates	Advanced Hydrocarbons	NSF	DMR - Division of Materials Research	DMR1644779	P19753	Molecular Characterization of Carbon Fiber Feedstocks Derived From Oilsands Bitumen	Chemistry	1	2.5
Paolo Bomben (S)	C		Alberta Innovates	Advanced Hydrocarbons								
Martha Chacon (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
Ryan Rodgers (S)	C		National High Magnetic Field Laboratory	ICR								
Christopher Rüger (S)	C		University of Rostock	Interdisciplinary Faculty, Department Life, Light & Matter								
Francesca Kerton (S)	PI	*	Memorial University of Newfoundland	Chemistry	Natural Sciences and Engineering Research Council (NSERC)	Non US Foundation		P19754	Analytical methods for biochar characterization by FT-ICR MS	Chemistry	1	1.83
Martha Chacon (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance	Canada Foundation for Innovation	Non US Foundation						
Huan Chen (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance	Provincial Govt of Newfoundland and Labrador	Other Non US Federal Agency						
Stephanie MacQuarrie (S)	C		Cape Breton University	Chemistry	Memorial University of Newfoundland (MUN)	Non US College and University						
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Juliana Vidal (G)	C		Memorial University of Newfoundland	Chemistry								
Roderich Süssmuth (S)	PI	*	Technical University of Berlin	Institut für Chemie	Proposal is not subject to external funding	Other Non US Federal Agency		P19769	First Large-Scale Proteomic Analysis of Viperine Venoms by 21T FT-ICR MS	Biology, Biochemistry, Biophysics	1	2
Lissa Anderson (S)	C		National High Magnetic Field Laboratory	ICR								
Maik Damm (G)	C		Technical University of Berlin	Department of Chemistry								
Benjamin-Florian Hempel (P)	C		Humboldt University of Berlin	BCRT								
Ayse Nalbantsoy (S)	C		Ege University	Bioengineering								
Youneng Tang (S)	PI		Florida State University	Civil and Environmental Engineering	Hinkley Center for Solid and Hazardous Waste Management			P19776	Non-Thermal Plasma Degradation of Per- and Polyfluoroalkyl Substances from Landfill Leachate	Engineering	1	10
Radha Krishna Murthy Bulusu Raja (G)	C		Florida State University	Chemical and Biomedical Engineering								
Karam Eeso (U)	C		Florida State University	Chemical Engineering								
Rachel Gallan (G)	C		Florida State University	chemical engineering								
Bruce Locke (S)	C		Florida State University	FAMU-FSU College of Engineering								
Mojtaba Nouri Goukeh (G)	C		Florida State University	Civil and Environmental engineering								
Robert Wandell (S)	C		Florida State University	Chemical and Biomedical Engineering								
Viji Sitther (S)	PI		Morgan State University	Biology	NSF	CBET - Chemical, Bioengineering,	CBET1900966	P19779	Oxidative stress induced impact of cell-	Chemistry	1	15

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
					Environmental, and Transport Systems			penetrating nanoparticles on cellular constituents in a cyanobacterial model			
Huan Chen (S)	C	National High Magnetic Field Laboratory	Ion Cyclotron Resonance								
Samson Gichuki (G)	C	Morgan State University	Department of Biology								
Mst Sayadujjhara (G)	C	Morgan State University	Biology								
LaDonna Wyatt (U)	C	Morgan State University	Biology								
Yavuz Yalcin (P)	C	Morgan State University	Biology								
Robert Spencer (S)	PI	Florida State University	Earth, Ocean & Atmospheric Science	NSF	OPP - Office of Polar Programs	OPP2029585	P19786	Tracing Permafrost Thaw DOM on the Peel Plateau, Canada	Chemistry	1	0.95
Steven Kokelj (S)	C	Northwest Territories Geological Survey	Geochemistry	NSF	OPP - Office of Polar Programs	OPP2124464					
Amy McKenna (S)	C	National High Magnetic Field Laboratory	ICR	NSF	DEB - Division of Environmental Biology	DEB2029585					
Megan Moore (G)	C	Florida State University	Earth, Ocean, and Atmospheric Sciences								
Jaedyn Smith (G)	C	University of Alberta	Biological Sciences								
Suzanne Tank (S)	C	University of Alberta	Department of Biological Sciences								
Marina Taskovic (G)	C	University of Alberta	Biological Sciences								
								Total Proposals:	Experiments:		Days:
								75	91		794

5. NMR FACILITY

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Myriam Cotten (S)	PI	College of William and Mary	Applied Science	NSF	MCB - Molecular and Cellular Biosciences	MCB1716608	P17425	Investigating Host Defense Mechanisms at Biological Membranes	Biology, Biochemistry, Biophysics	3	77.5
Riqiang Fu (S)	C	National High Magnetic Field Laboratory	NMR								
Zhehong Gan (S)	PI	National High Magnetic Field Laboratory	NHMFL	No other support			P17597	Development of 1.5 GHz NMR using 36T Series-Connected-Hybrid (SCH) Magnet	Magnets, Materials	1	8
William Brey (S)	C	National High Magnetic Field Laboratory	NMR								
Kuizhi Chen (P)	C	National High Magnetic Field Laboratory	NMR								
Po-Hsiu Chien (G)	C	Florida State University	Chemistry and Biochemistry								
Tim Cross (S)	C	National High Magnetic Field Laboratory	NHMFL/Chemistry & Biochemistry								
Ivan Hung (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Ilya Litvak (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Joana Paulino (P)	C	National High Magnetic Field Laboratory	CIMAR								
Jeffrey Schiano (S)	C	Pennsylvania State University	Electrical Engineering								
Bruce Bunnell (S)	PI	Tulane University	Pharmacology	NIH	NINDS - National Institute of Neurological Disorders and Stroke	NS102395	P17628	In vivo tracking of cell therapy to treat stroke: Cell migration & 23Na MRI	Biology, Biochemistry, Biophysics	25	51
Frederick Bagdasarian (G)	C	Florida State University	College of Engineering								
Cesario Borlongan (S)	C	University of South Florida	College of Medicine, Neurosurgery								
Shannon Helsper (G)	C	National High Magnetic Field Laboratory	NMR								
Teng Ma (S)	C	Florida State University	Chemistry & Biomedical Engineering								
Jens Rosenberg (S)	C	National High Magnetic Field Laboratory	AMRIS								
Xuegang Yuan (G)	C	Florida State University	Chemical & Biomedical Engineering								
Kwang Hun Lim (S)	PI	East Carolina University	Chemistry	NIH	NINDS - National Institute of Neurological Disorders and Stroke	NS097490	P17630	Molecular Basis of Distinct Tau Strains and their Prion-like Propagation	Biology, Biochemistry, Biophysics	4	33
Anvesh Kumar Reddy Dasari (G)	C	East Carolina University	Chemistry								
Sungsool Wi (S)	C	National High Magnetic Field Laboratory	NMR								
Bo Chen (S)	PI	University of Central Florida	Department of Physics	NSF	MCB - Molecular and Cellular Biosciences	MCB1856055	P17687	Molecular basis of tunable iridescence of cephalopods	Biology, Biochemistry, Biophysics	1	7
Zhehong Gan (S)	C	National High Magnetic Field Laboratory	NHMFL								
Ivan Hung (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Lucio Frydman (S)	PI	National High Magnetic Field Laboratory	NMR	NSF	CHE - Chemistry	CHE1808660	P17754	Three-Spins Solution State DNP	Biology, Biochemistry, Biophysics	1	5
Adewale Akinfaderin (G)	C	Florida State University	Physics								
Thierry Dubroca (S)	C	National High Magnetic Field Laboratory	EMR								
Stephen Hill (S)	C	National High Magnetic Field Laboratory	EMR								
Krishnendu Kundu (P)	C	National High Magnetic Field Laboratory	EMR								
Murari Soundararajan (P)	C	National High Magnetic Field Laboratory	CIMAR, NMR								
Johan van Tol (S)	C	National High Magnetic Field Laboratory	EMR								
Sungsool Wi (S)	C	National High Magnetic Field Laboratory	NMR								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Sabyasachi Sen (S)	PI	University of California, Davis	Chemical Engineering and Materials Science	NSF	DMR - Division of Materials Research	DMR1855176	P17811	Investigation of the atomistic basis of structural relaxation and viscous flow in supercooled chalcogenide liquids by high field dynamical NMR spectroscopy	Condensed Matter Physics	6	37
Zhehong Gan (S)	C	National High Magnetic Field Laboratory	NHMFL								
Ivan Hung (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Yiqing Xia (G)	C	University of California, Davis	Materials Science								
Bing Yuan (G)	C	University of California, Davis	Engineering								
Weidi Zhu (G)	C	University of California, Davis	Materials Science & Engineering								
Jeffrey Schiano (S)	PI	Pennsylvania State University	Electrical Engineering	NIH	NIGMS - National Institute of General Medical Sciences	GM122698	P17819	Flux Regulation for Powered Magnets	Engineering	1	3
William Brey (S)	C	National High Magnetic Field Laboratory	NMR								
Ilya Litvak (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Xinxing Meng (G)	C	Pennsylvania State University	Electrical Engineering								
Waroch Tangbampensountorn (G)	C	Pennsylvania State University	Electrical Engineering								
Gang Wu (S)	PI	Queen's University at Kingston	Chemistry	No other support			P17856	Development of solid-state NMR methods for applications at high-field and the 36 T SCH magnet	Chemistry	23	144
David Bryce (S)	C	University of Ottawa	Department of Chemistry and Biomolecular Sciences	NIH	NIGMS - National Institute of General Medical Sciences	GM122698					
Kuizhi Chen (P)	C	National High Magnetic Field Laboratory	NMR	NSF	DMR - Division of Materials Research	DMR1855176					
Po-Hsiu Chien (G)	C	Florida State University	Chemistry and Biochemistry								
Tim Cross (S)	C	National High Magnetic Field Laboratory	NHMFL/Chemistry & Biochemistry								
Petr Gor'kov (S)	C	National High Magnetic Field Laboratory	CIMAR								
Robert Griffin (S)	C	Massachusetts Institute of Technology	Chemistry								
Ivan Hung (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Sabyasachi Sen (S)	C	University of California, Davis	Chemical Engineering and Materials Science								
Amrit Venkatesh (G)	C	Iowa State University	Chemistry								
Yijue Xu (P)	C	National High Magnetic Field Laboratory	solid-state NMR								
Jeffery White (S)	PI	Oklahoma State University	Chemical Engineering	NSF	CHE - Chemistry	CHE1764116	P17925	Elucidating H+/Al Siting and Chemical Structures in Zeolites by Ultra-High Field NMR	Chemistry	4	18
maryam Abdolrahmani (G)	C	Oklahoma State University	Chemistry								
Kuizhi Chen (P)	C	National High Magnetic Field Laboratory	NMR								
Zhehong Gan (S)	C	National High Magnetic Field Laboratory	NHMFL								
Sarah Horstmeier (G)	C	Oklahoma State University	Chemistry								
Ivan Hung (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Gang Wu (S)	PI	Queen's University at Kingston	Chemistry	NSERC of Canada	Other Non US Federal Agency		P17926	Probing the hydrogen nuclear wavefunction in OHO low-barrier hydrogen bonds by 1H-17O double resonance NMR	Chemistry	2	11
Zhehong Gan (S)	C	National High Magnetic Field Laboratory	NHMFL								
Ivan Hung (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Dylan Murray (S)	PI	University of California Davis	Chemistry	No other support			P17941	Molecular Determinants for the Assembly of Low Complexity Protein Domains	Biology, Biochemistry, Biophysics	5	25
Ivan Hung (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Robert Schurko (S)	PI	Florida State University	Chemistry	NSF	CHE - Chemistry	CHE2003854	P17946	Multinuclear Solid-State NMR of Quadrupolar Nuclei in Active Pharmaceutical Ingredients	Biology, Biochemistry, Biophysics	83	319
Christer Aakeroy (S)	C	Kansas State University	Chemistry and Biochemistry	State of Florida	Other	n/a					
Louae Abdulla (G)	C	University of Windsor	Chemistry	State of Florida	Other						
Adam Altenhof (G)	C	Florida State University	Chemistry and Biochemistry	NSERC	Non US Council	n/a					
Jochen Autschbach (S)	C	University of Buffalo	Chemistry	nserc	Non US Council	NSERC RGPIN-2016_06642					
Matthew DeJong (U)	C	Florida State University	Chemistry	NSERC	Other Non US Federal Agency	NSERC RGPIN-2016_06642					
Zach Dowdell (G)	C	Florida State University	Chemistry								
Carl Fleischer (G)	C	Florida State University	Chemistry								
Tomislav Friscic (S)	C	McGill University	Chemistry								
Lucio Frydman (S)	C	National High Magnetic Field Laboratory	NMR								
Zhehong Gan (S)	C	National High Magnetic Field Laboratory	NHMFL								
Adrian Gonzalez-Nelson (P)	C	Delft University of Technology	Chemical Engineering								
Anthony Hoffman (G)	C	Florida State University	Chemistry and Biochemistry								
Sean Holmes (P)	C	Florida State University	Chemistry and Biochemistry								
James Hook (S)	C	University of New South Wales	Chemistry								
Ivan Hung (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Igor Huskic (P)	C	McGill University	Chemistry and Biochemistry								
Michael Jaroszewicz (G)	C	University of Windsor	Chemistry								
James Kimball (G)	C	Florida State University	Chemistry								
Danielle Laurencin (S)	C	University of Montpellier	Institut Charles Gerhardt de Montpellier								
Frederic Mentink (S)	C	National High Magnetic Field Laboratory	NMR Division								
Thomas-Xavier Métro (S)	C	Institut des Biomolécules Max Mousseron	Equipe Chimie Verte et Technologies Innovantes								
Karthik Nagapudi (S)	C	Genentech Inc.	Small Molecule Pharmaceutical Sciences								
Austin Peach (G)	C	Florida State University	Chemistry and Biochemistry								
Jeremy Rawson (S)	C	University of Windsor	Department of Chemistry and Biochemistry								
Jasmin Schoenzart (G)	C	Florida State University	Chemistry and Biochemistry								
Robert Smith (G)	C	National High Magnetic Field Laboratory									
Robert Smith (G)	C	Florida State University	Chemistry and Biochemistry								
Jessica Spackova (P)	C	University of Montpellier	Chemistry								
Albert Stiegman (S)	C	Florida State University	Chemistry								
Tony Stiegman (S)	C	Florida State University	Chemistry and Biochemistry								
Monique van der Veen (S)	C	Delft University of Technology	Chemical Engineering								
Cameron Vojvodin (G)	C	Florida State University	Chemistry and Biochemistry								
Lara Watanabe (G)	C	University of Windsor	Chemistry and Biochemistry								
Kendra Frederick (S)	PI	University of Texas, Southwestern	Biophysics	NIH	NINDS - National Institute of Neurological Disorders and Stroke	NS111236	P17968	Protein conformation determined in native cellular environments	Biology, Biochemistry, Biophysics	2	15
Whitney Costello (G)	C	University of Texas, Southwestern	Biophysics	NSF	CAREER - Faculty Early Career Development Program	1751174					
Jaka Kragelj (P)	C	University of Texas, Southwestern	Biophysics								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Frederic Mentink (S)	C	National High Magnetic Field Laboratory	NMR Division								
Yiling Xiao (P)	C	University of Texas, Southwestern	Biophysics								
Sungsool Wi (S)	PI	National High Magnetic Field Laboratory	NMR	NSF	CHE - Chemistry	CHE1808660	P18056	Solution State Overhauser DNP at 14 T	Chemistry	2	24
Thierry Dubroca (S)	C	National High Magnetic Field Laboratory	EMR								
Jonathan Marbey (G)	C	National High Magnetic Field Laboratory	EMR								
Naresh Dalal (S)	PI	National High Magnetic Field Laboratory	Chemistry	NSF	CHE - Chemistry	CHE1464955	P18094	Study of molecular dynamics on metal organic framework [(CH3)2NH2]Mg(HCOO)3] using solid state NMR spectroscopy	Chemistry	3	16
Riqiang Fu (S)	C	National High Magnetic Field Laboratory	NMR								
Sanath Kumar Rama Krishna (G)	C	Florida State University	Condensed Matter Physics								
Neeraj Sinha (S)	PI	Centre of Bio-Medical Research (CBMR)	Bio-medical department	SERB	Non US Foundation	EMR/2015/001758	P18099	Structural and interaction study of collagen protein in native bone and cartilage through dynamic nuclear polarization	Biology, Biochemistry, Biophysics	5	30
Richa Dubey (G)	C	Centre of Biomedical Research	Department of Advanced Spectroscopy and Imaging	Council of Scientific and Industrial Research (CSIR)	Non US Foundation						
Nidhi Tiwari (G)	C	Centre of Biomedical Research	NMR	Science and Engineering Research Board, Government of India	Other Non US Federal Agency	EMR/2015/001758					
Sungsool Wi (S)	C	National High Magnetic Field Laboratory	NMR	Science and Engineering Research Board, Government of India	Non US Foundation	EMR/2015/001758					
Victor Schepkin (S)	PI	National High Magnetic Field Laboratory	CIMAR	No other support			P18100	Non-invasive assessment of rat glioma using 17O labeled glucose	Biology, Biochemistry, Biophysics	3	6
William Brey (S)	C	National High Magnetic Field Laboratory	NMR								
Shannon Helsper (G)	C	National High Magnetic Field Laboratory	NMR								
Cathy Levenson (S)	C	Florida State University	Biomedical Sciences								
Steven Ranner (T)	C	National High Magnetic Field Laboratory	Instrumentation & Operations								
Lothar Schad (S)	C	Heidelberg University	Computer Assisted Clinical Medicine								
A. Dean Sherry (S)	C	University of Texas, Southwestern	Advanced Imaging Research Center								
Robert Silvers (S)	PI	Florida State University	Chemistry and Biochemistry	Florida State University	US College and University	STARTUP	P19107	Development of ssNMR methods for structural elucidation of RNAs and RNPs	Biology, Biochemistry, Biophysics	2	4
Yimin Miao (P)	C	Florida State University	Chemistry & Biochemistry								
Yan-Yan Hu (S)	PI	Florida State University	Chemistry & Biochemistry	Solid Power			P19111	Structure-property correlation in Cl-doped tetragonal Na3PS4 (t-Na3PS4)	Chemistry	12	251
Michael Brady (G)	C	University of Southern California	Department of chemistry								
Eric Gabriel (G)	C	Boise State University	Materials Science and Engineering								
Lina Gao (G)	C	Florida State University	Department of Chemistry & Biochemistry								
Liangbin Hu (S)	C	University of Maryland, College Park	Department of Materials Science and Engineering								
Xueqian Kong (S)	C	Zhejiang University	Chemistry								
Yutao Li (P)	C	University of Texas, Austin	Materials Science and Engineering Program and Texas Materials Institute								
Brent Melot (S)	C	University of Southern California	Department of chemistry								
Pengbo Wang (G)	C	Florida State University	Chemistry								
Hui Xiong (S)	C	Boise State University	Materials Science and Engineering								
Chunpeng Yang (P)	C	University of Maryland, College Park	Department of Materials Science and Engineering								
Lina Zhou (G)	C	University of Cambridge	Chemistry Department								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Michael Harrington (S)	PI	Huntington Medical Research Institutes	Molecular Neurology	NIH	NINDS - National Institute of Neurological Disorders and Stroke	NS201072	P19167	Evaluating Brain Dysfunction in Migraine	Biology, Biochemistry, Biophysics	15	61
Nastaren Abad (G)	C	Florida State University	Chemical-Biomedical Engineering								
Hannah Alderson (U)	C	Florida State University	Chemical & Biomedical Engineering								
Samuel Grant (S)	C	National High Magnetic Field Laboratory	Chemical & Biomedical Engineering								
Samuel Holder (G)	C	Florida State University	Chemical & Biomedical Engineering								
Linda Petzold (S)	C	University of California, Santa Barbara	Computer Science								
Dayna Richter (G)	C	Florida State University	Chemical & Biomedical Engineering								
Yan-Yan Hu (S)	PI	Florida State University	Chemistry & Biochemistry	NSF	DMR - Division of Materials Research	DMR1720139	P19169	In-situ and Operando MRI studies of All-solid-state Batteries	Chemistry	6	16.5
Samuel Grant (S)	C	National High Magnetic Field Laboratory	Chemical & Biomedical Engineering								
Haoyu Liu (G)	C	Florida State University	Chemistry								
Adam Veige (S)	PI	University of Florida	Chemistry	NSF	CHE - Chemistry	CHE1808234	P19170	Quantification of End Groups in Cyclic vs. Linear Polyacetylenes by Carbon-13 Magic Angle Spinning Nuclear Magnetic Resonance Spectroscopy	Biology, Biochemistry, Biophysics	2	12
Clifford Bowers (S)	C	University of Florida	Chemistry								
Alec Esper (G)	C	University of Florida	Chemistry								
Zhihui Miao (G)	C	University of Florida	Department of Chemistry								
Brent Sumerlin (S)	C	University of Florida	Chemistry								
Sossina Haile (S)	PI	Northwestern University	Materials Science and Engineering, and Chemistry	NSF	DMR - Division of Materials Research	DMR1720139	P19180	Multinuclear Solid-state NMR Investigations of Oxyhalides, Oxynitrides and Chalcohalides	Biology, Biochemistry, Biophysics	13	49
Jaye Harada (G)	C	Northwestern University	Chemistry								
Yan-Yan Hu (S)	C	Florida State University	Chemistry & Biochemistry								
Mercouri Kanatzidis (S)	C	Northwestern University	Chemistry								
Haoyu Liu (G)	C	Florida State University	Chemistry								
Tobin Marks (S)	C	Northwestern University	Chemistry								
Shobhit Pandey (G)	C	Northwestern University	Chemistry								
Sawankumar Patel (G)	C	Florida State University	Chemistry								
Kenneth Poeppelmeier (S)	C	Northwestern University	Chemistry								
Sheel Sangvi (G)	C	Northwestern University	Chemistry								
Pengbo Wang (G)	C	Florida State University	Chemistry								
Joseph Noel (S)	PI	Salk Institute for Biological Studies	Chemical Biology and Proteomics	Harnessing Plants Initiative, Salk Institute for Biological Studies	Other		P19225	Structural, Quantitative and Genetic Characterization of Plant Biopolymers by Solid-state NMR	Biology, Biochemistry, Biophysics	2	12
Thach Can (P)	C	Salk Institute for Biological Studies	Chemical Biology and Proteomics								
Riqiang Fu (S)	C	National High Magnetic Field Laboratory	NMR								
Suzanne Thomas (P)	C	Salk Institute for Biological Studies	Chemical Biology and Proteomics								
Frederic Mentink (S)	PI	National High Magnetic Field Laboratory	NMR Division	NIH	NIGMS - National Institute of General Medical Sciences	GM122698	P19241	Improving biradicals for MAS-DNP at high field: a combined approach of Spin-Dynamics theory, DFT and high-field EPR	Chemistry	2	18
Gael De Paepe (S)	C	The French Alternative Energies and Atomic Energy Commission	Institute for Nanoscience and Cryogenics	Icelandic Research Fund	Other	163393-052					
Thomas Halbritter (P)	C	University of Iceland	Chemistry								
Manoj Vinayaka Hanabe Subramanya (G)	C	Florida State University	Physics								
Rania Harrabi (G)	C	The French Alternative Energies and Atomic Energy Commission	DRF/IRIG/MEM/RM								
Sabine Hediger (S)	C	The French Alternative Energies and Atomic Energy Commission	Institute for Nanoscience and Cryogenics								
Daniel Lee (S)	C	University of Grenoble Alpes	INAC/MEM								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Subhradip Paul (T)	C		The French Alternative Energies and Atomic Energy Commission	DRF/IRIG/MEM/RM								
Elvin Salerno (P)	C		National High Magnetic Field Laboratory	EMR								
Snorri Sigurdsson (S)	C		University of Iceland	Chemistry								
Jan Rainey (S)	PI		Dalhousie University	Biochemistry & Molecular Biology	Natural Sciences and Engineering Research Council of Canada	Non US Council	RGPAS/507805-2017	P19288	Solid-state NMR characterization of spider wrapping and pyriform silks	Biology, Biochemistry, Biophysics	3	25
Ivan Hung (S)	C		National High Magnetic Field Laboratory	CIMAR/NMR	Natural Sciences and Engineering Research Council of Canada	Non US Council	RGPIN/05907-2017					
Frederic Mentink (S)	C		National High Magnetic Field Laboratory	NMR Division								
Jeffrey Simmons (G)	C		Dalhousie University	Department of Biochemistry & Molecular Biology								
Pingchuan Sun (S)	PI		Nankai University	College of Chemistry	National Natural Science Foundation of China	Other		P19331	Probing the Transesterification Reaction and Topology Freezing Transition Temperature in Vitrimer by VT 17O and 13C Chemical Exchange SSNMR	Chemistry	2	13
Riqiang Fu (S)	C		National High Magnetic Field Laboratory	NMR								
Zhehong Gan (S)	C		National High Magnetic Field Laboratory	NHMFL								
Fenfen Wang (P)	C		Nankai University	College of Chemistry								
Thomas Borch (S)	PI	*	Colorado State University	Soil and Crop Science	DOE	Other	SC0021349	P19338	Forest fire-impacted soil organic matter chemistry	Chemistry	1	4
Martha Chacon (S)	C		National High Magnetic Field Laboratory	Ion Cyclotron Resonance	DOE	Other	DE-SC0020205					
Jim Ippolito (S)	C		Colorado State University	Soil and Crop Sciences	US Dept of Argriculture	Other US Federal Agency	1025233					
Eugene Kelly (S)	C		Colorado State University	College of Agricultural Sciences								
Merritt Logan (G)	C		Colorado State University	Chemistry								
Amy McKenna (S)	C		National High Magnetic Field Laboratory	ICR								
Frederic Mentink (S)	C		National High Magnetic Field Laboratory	NMR Division								
Amelia Nelson (G)	C		Colorado State University	Soil and Crop Sciences								
Sydney Niles (G)	C		National High Magnetic Field Laboratory	Chemistry								
Charles Rhoades (S)	C		U.S. Department of Agriculture	Rocky Mountain Research Station								
Holly Roth (G)	C		Colorado State University	Chemistry								
Mike Wilkins (S)	C		Colorado State University	College of Agricultural Sciences								
Geoffrey Strouse (S)	PI		National High Magnetic Field Laboratory	Chemistry	NSF	DMR - Division of Materials Research	DMR1905757	P19372	Multinuclear solid-state NMR investigation of plasmonic and photoluminescent nanocrystals	Chemistry	10	22
Adam Altenhof (G)	C		Florida State University	Chemistry and Biochemistry								
Nhat Nguyen Bui (P)	C		National High Magnetic Field Laboratory	CMS								
Carl Conti (G)	C		Florida State University	Chemistry & Biochemistry								
Riqiang Fu (S)	C		National High Magnetic Field Laboratory	NMR								
Zhehong Gan (S)	C		National High Magnetic Field Laboratory	NHMFL								
Ivan Hung (S)	C		National High Magnetic Field Laboratory	CIMAR/NMR								
Jason Kuszynski (G)	C		Florida State University	Chemistry								
Frederic Mentink (S)	C		National High Magnetic Field Laboratory	NMR Division								
Anant Paravastu (S)	C		Georgia Institute of Technology	School of Chemical & Biomolecular Engineering								
Robert Schurko (S)	C		Florida State University	Chemistry								
Robert Smith (G)	C		National High Magnetic Field Laboratory									
Robert Smith (G)	C		Florida State University	Chemistry and Biochemistry								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Likai Song (S)	C	National High Magnetic Field Laboratory	EMR								
Cameron Vojvodin (G)	C	Florida State University	Chemistry and Biochemistry								
Hadi Mohammadigoushki (S)	PI	Florida State University	Chemical and Biomedical Engineering	NSF	CBET - Chemical, Bioengineering, Environmental, and Transport Systems	CBET1942150	P19421	Probing in situ structure of monoclonal antibodies at water-air and water-oil interfaces via high field nuclear magnetic resonance spectroscopy	Engineering	7	41.5
Jamini Bhagu (G)	C	Florida Agricultural and Mechanical University	Chemical ENG	Florida State University-CRC	Other						
Samuel Grant (S)	C	National High Magnetic Field Laboratory	Chemical & Biomedical Engineering	Florida State CRC - Planning Grant	US College and University						
Alfredo Scigliani (G)	C	Florida State University	Chemical & Biomedical Engineering	Florida State Planning Grant	Other						
Liliya Vugmeyster (S)	PI	University of Colorado, Denver	Chemistry	NIH	NIGMS - National Institute of General Medical Sciences	GM111681	P19439	Variant-specific dynamics of amyloid-beta fibrils by solid-state deuteron NMR.	Biology, Biochemistry, Biophysics	4	9
Alexander Greenwood (S)	C	University	Department of Chemistry								
Dmitry Ostrovsky (S)	C	University of Alaska, Anchorage	Mathematics								
Elan Eisenmesser (S)	PI	University of Colorado, Denver	Biochemistry & Molecular Genetics	NSF	CHE - Chemistry	CHE1807326	P19441	SARS-CoV Nucleocapsid protein dynamics and their role in host protein interactions.	Biology, Biochemistry, Biophysics	7	201
Kilsia Mercedes (G)	C	University of Colorado, Denver	Biochemistry and Molecular Genetics								
Isabelle Marcotte (S)	PI	University of Quebec at Montreal	Chemistry	NSF	MCB - Molecular and Cellular Biosciences	MCB1942665	P19442	Chlamydomonas reinhardtii cell-wall and whole cell glycan architecture studied by high-field and DNP Solid-State NMR	Biology, Biochemistry, Biophysics	9	60
Liyanage Fernando (G)	C	Louisiana State University	Chemistry	DOE	Office of Science - ECRP - Early Career Research Program	DE-SC0021210					
Fabien Deligey (P)	C	Louisiana State University	Chemistry	NIH	NIAID - National Institute of Allergy and Infectious Diseases	R21AI149289					
Zhehong Gan (S)	C	National High Magnetic Field Laboratory	NHMFL	DOE	Office of Science - BES - Basic Energy Sciences	DE-SC0021210					
Ivan Hung (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Alex Kirui (G)	C	Louisiana State University	Chemistry								
Frederic Mentink (S)	C	National High Magnetic Field Laboratory	NMR Division								
Alexandre Poulhazan (G)	C	University of Quebec at Montreal	Chemistry								
Faith Scott (P)	C	National High Magnetic Field Laboratory	Biochemistry & Molecular Biology								
S. Shekar (P)	C	Louisiana State University	chemistry								
Tuo Wang (S)	C	Louisiana State University	Chemistry								
Hui Yang (S)	C	Pennsylvania State University	Department of Biology								
Wancheng Zhao (G)	C	Louisiana State University	Chemistry								
Ashley Blue (T)	PI	National High Magnetic Field Laboratory	NHMFL	No other support			P19456	NMR System Maintenance	Magnets, Materials	23	280.5
Riqiang Fu (S)	C	National High Magnetic Field Laboratory	NMR								
Zhehong Gan (S)	C	National High Magnetic Field Laboratory	NHMFL								
Samuel Grant (S)	C	National High Magnetic Field Laboratory	Chemical & Biomedical Engineering								
Frederic Mentink (S)	C	National High Magnetic Field Laboratory	NMR Division								
Sungsool Wi (S)	C	National High Magnetic Field Laboratory	NMR								
Robert Silvers (S)	PI	Florida State University	Chemistry and Biochemistry	Florida State University	Other	Start-up	P19461			1	1

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Blaine Gordon (G)	C	Florida State University	Chemistry and Biochemistry					Structural and Functional Characterization of La-Related Proteins	Biology, Biochemistry, Biophysics		
David Fenning (S)	PI	University of California, San Diego	Nanoengineering	NSF	CAREER - Faculty Early Career Development Program	1848371	P19478	137Ba and 127I NMR of Halide Perovskite Solar Materials FABaxPb1-xI3	Magnets, Materials	12	47
John Goodenough (S)	C	University of Texas, Austin	Mechanical Engineering								
Yan-Yan Hu (S)	C	Florida State University	Chemistry & Biochemistry								
Sawankumar Patel (G)	C	Florida State University	Chemistry								
Xueying Quinn (G)	C	University of California, San Diego	Nanoengineering								
Rivera de la Rosa (S)	PI	Autonomous University of Nuevo León	Chemical Engineering	Facultad de Ciencias Qui´micas, Universidad Auto´noma de Nuevo Leo´n (UANL)	Non US Foundation	02-084347-PST-14/105	P19479	The role of phosphorus in the self-pillared pentasil siliceous zeolite catalyst used for the dehydra-decyclization reaction of tetrahydrofuran in producing 1,3-butadiene	Magnets, Materials	2	17
Carolina Solis Maldonado (S)	C	Veracruzan University	Chemical Sciences	Fondo Sectorial de Investigacio´n para la Educacio´n SEP-CONACYT	Non US Foundation	A1-S-37606					
Carlos Garcia (S)	C	Clemson University	Chemistry	Universidad Autonoma de Nuevo Leon (UANL)	Non US College and University	02-084347-PST-14/105					
Francisco José Morales-Leal (S)	C	Autonomous University of Nuevo León	Chemical Sciences	Fondo Sectorial de Investigacion para la Education SEP-CONACYT	Non US Foundation	A1-S-37607					
Sungsool Wi (S)	C	National High Magnetic Field Laboratory	NMR								
Ildefonso Marin-Montesinos (S)	PI	University of Aveiro	Chemistry	Universidade de Aveiro	Non US College and University		P19491	Disclosing brewers spent yeast cell wall polysaccharides: an in deep structural characterization and network assignment	Biology, Biochemistry, Biophysics	2	13
Ana Rita Bastos (G)	C	University of Aveiro	Chemistry								
Elisabete Coelho (S)	C	University of Aveiro	Chemistry								
Manuel A. Coimbra (S)	C	University of Aveiro	Department of Chemistry								
Luís Mafra (S)	C	University of Aveiro	Chemistry								
Frederic Mentink (S)	C	National High Magnetic Field Laboratory	NMR Division								
Mariana Sardo (S)	C	University of Aveiro	Chemistry								
Sungsool Wi (S)	PI	National High Magnetic Field Laboratory	NMR	No other support			P19492	Utilization of 1H-1H correlation schemes for the structural study of perdeuterated/non-perdeuterated 13C and/or 15N-labeled biosolids	Biology, Biochemistry, Biophysics	16	132
Adam Altenhof (G)	C	Florida State University	Chemistry and Biochemistry	NIH	NINDS - National Institute of Neurological Disorders and Stroke	NS097490					
Lucio Frydman (S)	C	National High Magnetic Field Laboratory	NMR	The European Research Council under the European Union's Seventh Framework Programme	Non US Council	ERC 639907					
Michael Jaroszewicz (G)	C	University of Windsor	Chemistry	The European Research Council under the European Union's Seventh Framework Programe	Non US Foundation	639907					
James Kimball (G)	C	Florida State University	Chemistry								
Adam Lange (S)	C	Leibniz-Forschungsinstitut für Molekulare Pharmakologie, Berlin	Department of Molecular Biophysics								
Józef Lewandowski (S)	C	University of Warwick	Chemistry								
Kwang Hun Lim (S)	C	East Carolina University	Chemistry								
Yining Huang (S)	PI	University of Western Ontario	Chemistry	NSERC of Canada	Other		P19515	17O and 91Zr solid-state NMR of metal-organic frameworks at 35.2 T	Chemistry	17	109
Zhehong Gan (S)	C	National High Magnetic Field Laboratory	NHMFL								
Ivan Hung (S)	C	National High Magnetic Field Laboratory	CIMAR/NMR								
Vinicius Martins (G)	C	University of Western Ontario	Chemistry								
Wanli Zhang (G)	C	University of Western Ontario	Chemistry								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Tim Cross (S)	PI		National High Magnetic Field Laboratory	NHMFL/Chemistry & Biochemistry	NIH	NIAID - National Institute of Allergy and Infectious Diseases	AI119178	P19516	Structural Characterization of SARS-CoV-2 E protein in lipid bilayer with Solid-State NMR	Biology, Biochemistry, Biophysics	54	407
Riqiang Fu (S)	C		National High Magnetic Field Laboratory	NMR	NIH	NIGMS - National Institute of General Medical Sciences	GM122698					
Huajun Qin (T)	C		Florida State University	Chemistry & Biochemistry								
Rongfu Zhang (P)	C		National High Magnetic Field Laboratory	NHMFL								
Danielle Laurencin (S)	PI		University of Montpellier	Institut Charles Gerhardt de Montpellier	European Research Council	Other		P19531	Identification of interfacial bonding environments in functional nanomaterials and biomaterials using high resolution solid state NMR at (ultra)-high fields	Chemistry	1	2
Christian Bonhomme (S)	C		Pierre and Marie Curie University	Laboratoire de Chimie de la Matière Condensée								
Zhehong Gan (S)	C		National High Magnetic Field Laboratory	NHMFL								
Christel Gervais (S)	C		Sorbonne University	Laboratoire de Chimie de la Matière Condensée								
Ieva Goldberga (P)	C		French National Center for Scientific Research	Institut Charles Gerhardt de Montpellier								
Ivan Hung (S)	C		National High Magnetic Field Laboratory	CIMAR/NMR								
Danielle Laurencin (S)	PI		University of Montpellier	Institut Charles Gerhardt de Montpellier	ERC	Non US Council		P19532	Identification of interfacial bonding environments in functional nanomaterials and biomaterials using high resolution solid state NMR at (ultra)-high fields	Chemistry	9	48
Chia-Hsin Chen (P)	C		French National Center for Scientific Research	Institut Charles Gerhardt de Montpellier	ERC	Other						
Zhehong Gan (S)	C		National High Magnetic Field Laboratory	NHMFL	ERC	Other	772204					
Ieva Goldberga (P)	C		French National Center for Scientific Research	Institut Charles Gerhardt de Montpellier	CNRS	Other						
Ivan Hung (S)	C		National High Magnetic Field Laboratory	CIMAR/NMR								
César Leroy (P)	C		French National Center for Scientific Research	ICGM - UMR 5253								
Cesario Borlongan (S)	PI	*	University of South Florida	College of Medicine, Neurosurgery	NIH	NINDS - National Institute of Neurological Disorders and Stroke	NS102395	P19565	In vivo assessment of cell-derived therapies for treatment of stroke: 23Na MRI and 1H MRS	Biology, Biochemistry, Biophysics	24	35.5
Jacob Athey (U)	C		Florida State University	Chemical & Biomedical Engineering	NIH	NINDS - National Institute of Neurological Disorders and Stroke	NS115490					
Bruce Bunnell (S)	C		Tulane University	Pharmacology								
Shannon Helsper (G)	C		National High Magnetic Field Laboratory	NMR								
David Hike (G)	C		Florida State University	Chemical and Biomedical Engineering								
Hedi Mattoussi (S)	C		Florida State University	Chemistry & Biochemistry								
Alfredo Scigliani (G)	C		Florida State University	Chemical & Biomedical Engineering								
Xuegang Yuan (G)	C		Florida State University	Chemical & Biomedical Engineering								
Jun Xu (S)	PI		Wuhan Institute of Physics & Mathematics, Chinese Academy of Sciences	Wuhan NMR center	NSF	DMR - Division of Materials Research	DMR1644779	P19568	Study of active sites on heterogeneous catalysis using High field NMR spectroscopy	Chemistry	2	14
Zhehong Gan (S)	C		National High Magnetic Field Laboratory	NHMFL	The National Natural Science Foundation of China	Other	U1932218					
Ivan Hung (S)	C		National High Magnetic Field Laboratory	CIMAR/NMR								
Qiang Wang (T)	C		Wuhan Institute of Physics & Mathematics, Chinese Academy of Sciences	Wuhan NMR center								
Leonard Mueller (S)	PI		University of California, Riverside	Chemistry	NIH	NIGMS - National Institute of General Medical Sciences	GM137008	P19571	DNP-Enabled Solid-State NMR of PLP Enzymes: Tyrosine Phenol Lyase	Chemistry	5	27

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Maria Luiza Caldas Nogueira (P)	C		University of Florida	Biochemistry and Molecular Biology	NSF	CHE - Chemistry	CHE1710671					
Rittik Ghosh (G)	C		University of California, Riverside	Chemistry	NIH	NIGMS - National Institute of General Medical Sciences	GM097569					
Joanna Long (S)	C		University of Florida	Biochemistry & Molecular Biology	NIH	NIGMS - National Institute of General Medical Sciences	GM122698					
Frederic Mentink (S)	C		National High Magnetic Field Laboratory	NMR Division								
Lauren Schaffer (U)	C		Oberlin College	Chemistry								
Faith Scott (P)	C		National High Magnetic Field Laboratory	Biochemistry & Molecular Biology								
Michael Famiano (S)	PI	*	Western Michigan University	Physics	Moore Foundation	US Foundation	7799	P19582	Applications of NMR to Astrobiology: Measurement of Shielding Tensor Components of Chiral Molecules	Biology, Biochemistry, Biophysics	1	13.5
Shiva Agarwal (G)	C		Western Michigan University	Physics								
Sonjong Hwang (S)	C		California Institute of Technology	Chemistry and Chemical Engineering								
Gellert Mezei (S)	C		Western Michigan University	Chemistry								
Sungsool Wi (S)	C		National High Magnetic Field Laboratory	NMR								
Kwang Hun Lim (S)	PI		East Carolina University	Chemistry	NIH	NINDS - National Institute of Neurological Disorders and Stroke	NS097490	P19589	Characterization of Structural Features of Cytotoxic Transthyretin Oligomers and their Interaction with Membranes	Biology, Biochemistry, Biophysics	9	79
Anvesh Kumar Reddy Dasari (G)	C		East Carolina University	Chemistry								
Zhehong Gan (S)	C		National High Magnetic Field Laboratory	NHMFL								
Ivan Hung (S)	C		National High Magnetic Field Laboratory	CIMAR/NMR								
Sungsool Wi (S)	C		National High Magnetic Field Laboratory	NMR								
Isabelle Marcotte (S)	PI		University of Quebec at Montreal	Chemistry	German Research Foundation	Non US Foundation	MA 4147/7-2	P19600	Study of the Euperipatoides rowelli velvet worm slime and its unique high molecular weight phosphonated proteins by DNP Solid-State NMR	Biology, Biochemistry, Biophysics	2	9
Alexander Baer (P)	C		University of Kassel	Zoology								
Matthew Harrington (S)	C		McGill University	Department of chemistry								
Georg Mayer (S)	C		University of Kassel	Zoology								
Frederic Mentink (S)	C		National High Magnetic Field Laboratory	NMR Division								
Alexandre Poulhazan (G)	C		University of Quebec at Montreal	Chemistry								
Stephan Schmidt (S)	C		Heinrich Heine University Düsseldorf	Institut für Organische Chemie und Makromolekulare Chemie								
Aaron Rossini (S)	PI		Iowa State University	Chemistry	NSF	CBET - Chemical, Bioengineering, Environmental, and Transport Systems	CBET1916809	P19606	High-Field Solid-State NMR of Heterogeneous Catalysts and Inorganic Materials	Chemistry	2	5
Rick Dorn (G)	C		Iowa State University	Chemistry								
Zhehong Gan (S)	C		National High Magnetic Field Laboratory	NHMFL								
Ivan Hung (S)	C		National High Magnetic Field Laboratory	CIMAR/NMR								
Ercan Cakmak (S)	PI	*	Oak Ridge National Laboratory	Materials Science and Technology	DOE	Other	N/A	P19640	Solid State C13 NMR Measurements of Industrially Relevant Coals to Aid in the Development of Advanced Coal Molecular Models with Predictive Capabilities	Chemistry	7	84
Stephan Irle (S)	C		Oak Ridge National Laboratory	Computational Sciences and Engineering Division	DOE	Other	N/A FEAA155					
Gang Seob Jung (S)	C		Oak Ridge National Laboratory	Computational Science and Engineering Division								
Edgar Lara-Curzio (S)	C		Oak Ridge National Laboratory	Materials Science & Technology Division								
Jonathan Mathews (S)	C		Pennsylvania State University	Energy and Mineral Engineering								
Bo Chen (S)	PI		University of Central Florida	Department of Physics	NSF	MCB - Molecular and Cellular Biosciences	MCB1856055	P19664			2	14

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Zhehong Gan (S)	C		National High Magnetic Field Laboratory	NHMFL					Molecular Basis of Tunable Iridescence of Cephalopods	Biology, Biochemistry, Biophysics		
Ivan Hung (S)	C		National High Magnetic Field Laboratory	CIMAR/NMR								
Md Imran Khan (P)	C		University of Central Florida	Physics								
Jun Yang (S)	PI	*	Institute of Physics, Chinese Academy of Sciences	Wuhan Institute of Physics and Mathematics	NIH	NIGMS - National Institute of General Medical Sciences	GM122698	P19677	Structural characterization of AqpZ protein at 35.2T magnet	Biology, Biochemistry, Biophysics	1	5
Riqiang Fu (S)	C		National High Magnetic Field Laboratory	NMR								
Rongfu Zhang (P)	C		National High Magnetic Field Laboratory	NHMFL								
Katherine Henzler-Wildman (S)	PI	*	University of Wisconsin, Madison	Biochemistry	NIH	NIGMS - National Institute of General Medical Sciences	GM141748	P19681	17O NMR of Ion Channels	Biology, Biochemistry, Biophysics	2	3
Vilius Kurauskas (P)	C		University of Wisconsin, Madison	Biochemistry								
Biyi Xu (P)	PI	*	University of Texas, Austin	Materials Science and Engineering Program and Texas Materials Institute	DOE	EERE - Energy Efficiency and Renewable Energy	DE-EE0007762	P19686	Structural investigation of LiTa2PO8 (LTPO) solid-state electrolyte upon contacting lithium	Magnets, Materials	1	2
Po-Hsiu Chien (G)	C		Florida State University	Chemistry and Biochemistry								
Ivan Hung (S)	C		National High Magnetic Field Laboratory	CIMAR/NMR								
Lothar Schad (S)	PI		Heidelberg University	Computer Assisted Clinical Medicine	Heidelberg University	Non US College and University		P19689	Characterization of sodium MR environments based on T1 and T2 TQ signals	Biology, Biochemistry, Biophysics	2	3
Eric Gottwald (S)	C		Karlsruhe Institute of Technology	Institute for Biological Interfaces (IBG 5)	DAAD - Germman Academic Exchange Service	Other Non US Federal Agency						
Dennis Kleimaier (G)	C		Heidelberg University	Computer Assisted Clinical Medicine								
Simon Reichert (G)	C		Heidelberg University	Medical Faculty Mannheim								
Victor Schepkin (S)	C		National High Magnetic Field Laboratory	CIMAR								
Jeffrey Reimer (S)	PI	*	University of California, Berkeley	Chem and BioM Engineering	DOE	BER - Biological and Environmental Research	DE-AC02-76SF00515	P19732	Zeolite templated single atom catalysts for propane dehydrogenation	Biology, Biochemistry, Biophysics	1	7
Zhehong Gan (S)	C		National High Magnetic Field Laboratory	NHMFL								
Frederic Mentink (S)	C		National High Magnetic Field Laboratory	NMR Division								
Frederic Mentink (S)	PI		National High Magnetic Field Laboratory	NMR Division	NIH	NIGMS - National Institute of General Medical Sciences	GM122698	P19765	P41 MAS-DNP probe development	Biology, Biochemistry, Biophysics	4	22
Terry Gullion (S)	C		West Virginia University	Chemistry								
Thomas Halbritter (P)	C		University of Iceland	Chemistry								
Joanna Long (S)	C		University of Florida	Biochemistry & Molecular Biology								
Thorsten Maly (S)	C		Bridge12, Technologies, Inc.	R&D								
Faith Scott (P)	C		National High Magnetic Field Laboratory	Biochemistry & Molecular Biology								
Snorri Sigurdsson (S)	C		University of Iceland	Chemistry								
Ayyalusamy Ramamoorthy (S)	PI		University of Michigan	Chemistry & Biophysics	NIH	NIGMS - National Institute of General Medical Sciences	GM351395	P19766	Measurement of 17O Residual Quadrupolar Couplings in Small Molecules Using Lipid Nanodiscs	Chemistry	3	13
Riqiang Fu (S)	C		National High Magnetic Field Laboratory	NMR								
Sam McCalpin (G)	C		University of Michigan	Chemistry								
Gang Wu (S)	C		Queen's University at Kingston	Chemistry								
Rongfu Zhang (P)	C		National High Magnetic Field Laboratory	NHMFL								
Robbie Iuliucci (S)	PI	*	Washington and Jefferson College	Chemistry	No other support			P19772	NMR Crystallography of Pharmaceuticals and Biologically Relevant Nanocrystals Augmented	Chemistry	2	6
Sean Holmes (P)	C		Florida State University	Chemistry and Biochemistry								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Rosalynn Quiñones (S) Robert Schurko (S)	C C		Marshall University Florida State University	Chemistry Chemistry					by Multinuclear High Field Solid-State NMR			
Myriam Cotten (S) Riqiang Fu (S) Mary Rooney (G)	PI C C		College of William and Mary National High Magnetic Field Laboratory College of William and Mary	Applied Science NMR Applied Science	NSF NIH	MCB - Molecular and Cellular Biosciences NIGMS - National Institute of General Medical Sciences	MCB1716608 GM126527	P19777	Leveraging Solid-State NMR to Investigate Host Defense Mechanisms at Biological Membranes	Biology, Biochemistry, Biophysics	4	36
Eric Breynaert (S) Adam Altenhof (G) Clifford Bowers (S) Zhehong Gan (S) Samuel Grant (S) Robert Schurko (S)	PI C C C C C	*	University of Leuven Florida State University University of Florida National High Magnetic Field Laboratory National High Magnetic Field Laboratory Florida State University	M2S Chemistry and Biochemistry Chemistry NHMFL Chemical & Biomedical Engineering Chemistry	FWO Vlaanderen FWO Vlaanderen	Non US Foundation Non US Foundation	V401721N G083318N	P19796	NMR for Convergence Research with focus on Nanoporous materials, Molecular Water Science, Energy and Food and Health Science	Chemistry	3	7
Xiaodan Gu (S) Adam Altenhof (G) Riqiang Fu (S) Robert Schurko (S) Robert Smith (G)	PI C C C C	*	University of Southern Mississippi Florida State University National High Magnetic Field Laboratory Florida State University National High Magnetic Field Laboratory	Polymer Science and Engineering Chemistry and Biochemistry NMR Chemistry	DOE	Office of Science - BES - Basic Energy Sciences	DE-SC0022050	P19855	Illuminating the Rigid Amorphous Fraction of Conjugated Polymers and its Pivotal Influence on Optoelectronic Behavior	Magnets, Materials	1	5
Zhehong Gan (S) William Brey (S) Ivan Hung (S) Ilya Litvak (S) Wenping Mao (P) Robert Schurko (S) Yijue Xu (P)	PI C C C C C C		National High Magnetic Field Laboratory National High Magnetic Field Laboratory National High Magnetic Field Laboratory National High Magnetic Field Laboratory National High Magnetic Field Laboratory Florida State University National High Magnetic Field Laboratory	NHMFL NMR CIMAR/NMR CIMAR/NMR NMR Chemistry solid-state NMR	No other support			P19856	Development and implementation of solid-state NMR methods at high magnetic fields	Chemistry	3	13
Jeffrey Schiano (S) William Brey (S) Ilya Litvak (S) Waroch Tangbampensountorn (G)	PI C C C		Pennsylvania State University National High Magnetic Field Laboratory National High Magnetic Field Laboratory Pennsylvania State University	Electrical Engineering NMR CIMAR/NMR Electrical Engineering	NIH	NIGMS - National Institute of General Medical Sciences	GM122698	P19858	Flux Regulation for Powered Magnets	Engineering	1	3
									Total Proposals: 66		Experiments: 490	Days: 3,091.00

6. PFF FACILITY

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Masashi Miura (S)	PI	Seikei University	Graduate School of Science and Technology	DOE	Office of Science - BES – Basic Energy Sciences	LANLE8L5	P16306	V-I curves in pulsed fields to study vortex matter	Condensed Matter Physics	1	10
Maxime Leroux (S)	C	French National Center for Scientific Research	LNCMI								
Boris Maiorov (S)	C	Los Alamos National Laboratory	MPA-MAGLAB								
Ivan Nekrashevich (P)	C	CMMS	MPA								
Jens Haenisch (S)	PI	Karlsruhe Institute of Technology	Institute for Technicla Physics	UCGP			P17518	Anisotropic electrical transport in pinning-enhanced Fe-based and HTS superconducting thin films	Condensed Matter Physics	1	10
Pablo Cayado (P)	C	karlsruhe institute of technology	Institute for Technical Physics (ITEP)								
Kazumasa Iida (S)	C	Nagoya University	Dep. of Materials Physics, Graduate School of Engineering								
Jan Jaroszynski (S)	C	National High Magnetic Field Laboratory	CMS								
Mayraluna Lao (P)	C	Karlsruhe Institute of Technology	Institute of Technical Physics								
Sven Meyer (G)	C	Karlsruhe Institute of Technology	Institute for Technical Physics								
Chiara Tarantini (S)	C	National High Magnetic Field Laboratory	Applied Superconductivity Center								
Priscila Ferrari Silveira Rosa (P)	PI	Los Alamos National Laboratory	MPA-CMMS	DOE	Office of Science - BES – Basic Energy Sciences	F101	P17682	Pulsed field measurements on topological semi-metals	Condensed Matter Physics	2	15
Eric Bauer (S)	C	Los Alamos National Laboratory	MST-10	DOE	Office of Science - BES – Basic Energy Sciences	F101, XWVM					
Mun Chan (S)	C	National High Magnetic Field Laboratory	Pulsed field Facility								
Neil Harrison (S)	C	National High Magnetic Field Laboratory	Physics								
Satya Kushwaha (P)	C	Los Alamos National Laboratory	MPA-MAG								
Ross McDonald (S)	C	National High Magnetic Field Laboratory	Physics								
Takao Ebihara (S)	PI	Shizuoka University	Physics	Japan society for the promotion of science	Non US Foundation	under applying	P17751	Quantum oscillation in heavy fermion system at high magnetic fields	Condensed Matter Physics	1	3
Neil Harrison (S)	C	National High Magnetic Field Laboratory	Physics								
Marcelo Jaime (S)	C	National High Magnetic Field Laboratory	Physics								
Neil Harrison (S)	PI	National High Magnetic Field Laboratory	Physics	Los Alamos Seaborg Institute	US Government Lab		P17768	Electronic Structure and Equation of State of Plutonium	Condensed Matter Physics	1	5
John Singleton (S)	C	National High Magnetic Field Laboratory	Physics								
Paul Tobash (P)	C	National High Magnetic Field Laboratory	MPA-cmms								
Mark Wartenbe (P)	C	Los Alamos National Laboratory	MST-16								
Laurel Winter (S)	C	National High Magnetic Field Laboratory	Physics								
Jiun-Haw Chu (S)	PI *	University of Washington	Physics	NSF	DMR - Division of Materials Research	DMR1719797	P17782	Tunable three-dimensional Dirac Fermions in high magnetic field	Condensed Matter Physics	3	15
Qianni Jiang (G)	C	University of Washington	Physics	DOE	Office of Science - ASCR - Advanced Scientific Computing Research	DE-SC0019443					
Zhaoyu Liu (P)	C	University of Washington	Department of Physics	DOE	Office of Science - EFRC - Energy Frontier Research Centers	635930					
Paul Malinowski (G)	C	University of Washington	Physics	Gordon and Betty Moore Foundation	US Foundation	GBMF6759					
Joshua Mutch (G)	C	University of Washington	Physics								
Arkady Shehter (S)	C	Los Alamos National Laboratory	LANL MPA-MAGLAB								
Qi Li (S)	PI	Pennsylvania State University	Physics	DOE	Office of Science - BES – Basic Energy Sciences	DE-FG02-08ER46531	P17849	Shubnikov de Haas oscillation of two	Condensed Matter Physics	1	9

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Autumn Heltman (U)	C		Pennsylvania State University	Physics					dimensional electron gases with strong spin-orbit coupling at transition metal oxide interfaces			
Zhu Lin (P)	C		Pennsylvania State University	Physics								
Ziqiao Wang (G)	C		Pennsylvania State University	Physics								
Laurel Winter (S)	PI		National High Magnetic Field Laboratory	Physics	LANL	US Government Lab	20200680PRD1	P17875	High Magnetic Field Studies of the Field Induced Phases of Graphite	Condensed Matter Physics	1	7
Ross McDonald (S)	C		National High Magnetic Field Laboratory	Physics								
Johanna Palmstrom (P)	C		Los Alamos National Laboratory (LANL)	MPA-MAG								
James Analytis (S)	PI		University of California, Berkeley	Physics	DOE	Office of Science - BES – Basic Energy Sciences	DE-AC02-05CH11231	P17891	High field magnetic phase transitions in intercalated transition metal dichalcogenides	Condensed Matter Physics	1	5
Shannon Haley (G)	C		University of California, Berkeley	Physics	Gordon and Betty Moore Foundation	US Foundation	GBMF9067					
Nikola Maksimovic (G)	C		University of California, Berkeley	Physics								
Vikram Nagarajan (G)	C		University of California, Berkeley	Physics								
Nityan Nair (G)	C		University of California, Berkeley	Physics								
John Singleton (S)	C		National High Magnetic Field Laboratory	Physics								
Minhyea Lee (S)	PI		University of Colorado, Boulder	Physics	DOE	Office of Science - BES – Basic Energy Sciences	DE-SC0021377	P17906	Investigation on unusual magnetic responses in quantum magnets	Condensed Matter Physics	2	15
Gang Cao (S)	C		University of Colorado, Boulder	Department of Physics.								
Ian Leahy (G)	C		University of Colorado, Boulder	Physics								
Ross McDonald (S)	C		National High Magnetic Field Laboratory	Physics								
Christopher Pocs (G)	C		University of Colorado, Boulder	Physics								
Arkady Shehter (S)	C		Los Alamos National Laboratory	LANL MPA-MAGLAB								
Peter Siegfried (P)	C		George Mason University	Physics and Astronomy								
Chris Palmstrom (S)	PI	*	University of California, Santa Barbara	ECE-Material Science	DOE	Office of Science - BES – Basic Energy Sciences	DE-SC0014388	P18013	Revealing topological properties of Heusler compounds via magneto-transport under high magnetic field.	Condensed Matter Physics	1	5
Shouvik Chatterjee (P)	C		University of California Santa Barbara	Electrical & Computer Engineering								
Connor Dempsey (G)	C		University of California, Santa Barbara	ECE								
Aranya Goswami (G)	C		University of California, Santa Barbara	ECE								
Hadass Inbar (G)	C		University of California, Santa Barbara	Materials								
Tony McFadden (G)	C		University of California, Santa Barbara	ECE								
Johanna Palmstrom (P)	C		Los Alamos National Laboratory (LANL)	MPA-MAG								
Dan Read (S)	C		University of California, Santa Barbara	Materials								
Laurel Winter (S)	PI		National High Magnetic Field Laboratory	Physics	No other support			P18062	Testing and development of pulsed field probes	Magnets, Materials	2	14
You Lai (P)	C		National High Magnetic Field Laboratory	Physics	DOE	Office of Science - EFRC - Energy Frontier Research Centers	DE-AC02-07CH1135					
Boris Maiorov (S)	C		Los Alamos National Laboratory	MPA-MAGLAB	LANL -- LDRD	US Government Lab						
Christopher Mizzi (P)	C		Los Alamos National Laboratory	MPA-MAGLAB: MPA-MAG LAB NHMFL GROUP								
Rongying Jin (S)	PI	*	University of South Carolina	Department of Physics and Astronomy	DOE	EPSCoR - Established Program to Stimulate Competitive Research	DE-SC0012432	P19126	Investigating quantum oscillations in TaSe3 and PtTe2 under high magnetic field	Condensed Matter Physics	1	4
Ramakanta Chapai (P)	C		Argonne National Laboratory	Materials Science Division								

Participants (Name, Role, Org., Dept.)				Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Ahmad Ikhwan Us Saleheen (P)	C	Louisiana State University	Physics and Astronomy								
Neil Harrison (S)	PI	National High Magnetic Field Laboratory	Physics	DOE	LDRD - Laboratory Directed R&D	DE-RE20-18ER20180	P19131	Science of High MagneticFields	Biology, Biochemistry, Biophysics	4	35
Ryan Baumbach (S)	C	National High Magnetic Field Laboratory	CMS	DOE	Office of Science - BES - Basic Energy Sciences	LANLF101					
Scott Crooker (S)	C	National High Magnetic Field Laboratory	Nat High Magnetic Field Lab	DOE	Office of Science - BES - Basic Energy Sciences	F101					
Priscila Ferrari Silveira Rosa (P)	C	Los Alamos National Laboratory	MPA-CMMS	DOE	LDRD - Laboratory Directed R&D	DE-XW50-0_______					
Daniel Jackson (P)	C	National High Magnetic Field Laboratory	MPA/MAG	DOE	Office of Science - BES - Basic Energy Sciences	LANLF100					
Marcelo Jaime (S)	C	National High Magnetic Field Laboratory	Physics								
Satya Kushwaha (P)	C	Los Alamos National Laboratory	MPA-MAG								
Ross McDonald (S)	C	National High Magnetic Field Laboratory	Physics								
Christopher Mizzi (P)	C	Los Alamos National Laboratory	MPA-MAGLAB: MPA-MAG LAB NHMFL GROUP								
Joonbum Park (P)	C	Helmholtz-Zentrum Dresden-Rossendorf (HZDR)	Dresden High Magnetic Field Laboratory								
William Phelan (S)	C	Los Alamos National Laboratory	MST-16								
Lucas Pressley (G)	C	Johns Hopkins University	Chemistry								
Katherine Schreiber (P)	C	National High Magnetic Field Laboratory	NHMFL Pulsed Field Facility								
John Singleton (S)	C	National High Magnetic Field Laboratory	Physics								
Mark Wartenbe (P)	C	Los Alamos National Laboratory	MST-16								
Vivien Zapf (S)	C	National High Magnetic Field Laboratory	Physics								
Hsinhan Tsai (P)	PI	Los Alamos National Laboratory	MPA-11	DOE	LDRD - Laboratory Directed R&D	DE-AA00-00AA00000	P19141	New 2D perovskites for high temperature multiferroics	Magnets, Materials	2	9
Minseong Lee (P)	C	Los Alamos National Laboratory	MPA-MAG	DOE	Office of Science - BES - Basic Energy Sciences	0					
Wanyi Nie (S)	C	Los Alamos National Laboratory	MPA-11								
Magdalena Owczarek (P)	C	Los Alamos National Laboratory	CINT								
Vivien Zapf (S)	C	National High Magnetic Field Laboratory	Physics								
Krzysztof Gofryk (S)	PI	Idaho National Laboratory	Fuel Performance & Design	DOE	LDRD - Laboratory Directed R&D	DE-AC07-05ID14517	P19145	Transport and magnetic properties of selected d- and f-electron topological materials in high magnetic fields	Condensed Matter Physics	1	5
Neil Harrison (S)	C	National High Magnetic Field Laboratory	Physics								
Narayan Poudel (P)	C	Idaho National Laboratory	Nuclear Materials								
Vivien Zapf (S)	PI	National High Magnetic Field Laboratory	Physics	DOE	Office of Science - BES - Basic Energy Sciences	Quantum Science Center	P19182	Magnetic field-induced spin liquids and quantum phase transitions in Kitaev materials	Condensed Matter Physics	2	8
Marcelo Jaime (S)	C	National High Magnetic Field Laboratory	Physics	DOE	Office of Science - BES - Basic Energy Sciences	0					
Minseong Lee (P)	C	Los Alamos National Laboratory	MPA-MAG								
David Mandrus (S)	C	University of Tennessee, Knoxville	Materials Science and Engineering								
Rico Schoenemann (P)	C	Los Alamos National Laboratory	MPA-MAG								
Jamie Manson (S)	PI	Eastern Washington University	Chemistry and Biochemistry	NSF	DMR - Division of Materials Research	DMR1703003	P19233	New topologies in Ni(II) quantum magnets with XY anisotropy	Condensed Matter Physics	2	6
Paul Goddard (S)	C	University of Warwick	Department of Physics								
John Singleton (S)	C	National High Magnetic Field Laboratory	Physics								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Robert McQueeney (S)	PI		Ames Laboratory	physics & astronomy	DOE	Office of Science - BES - Basic Energy Sciences	No. DE-AC02-06CH11357	P19250	Investigation of exotic topological states using high magnetic fields	Condensed Matter Physics	1	3
You Lai (P)	C		National High Magnetic Field Laboratory	Physics								
Ross McDonald (S)	C		National High Magnetic Field Laboratory	Physics								
Dmitry Yarotski (S)	C		Los Alamos National Laboratory	Center for Integrated Nanotechnologies								
Vivien Zapf (S)	PI		National High Magnetic Field Laboratory	Physics	DOE	Office of Science - EFRC - Energy Frontier Research Centers	Center For Molecular Magnetic Quantum Materials	P19265	Magnetization of giant torus at the interface of quantum and classical magnetism	Condensed Matter Physics	1	3
Garnet Chan (S)	C		California Institute of Technology	Physics								
Hai Ping Cheng (S)	C		University of Florida	Physics								
George Christou (S)	C		University of Florida	Chemistry								
Minseong Lee (P)	C		Los Alamos National Laboratory	MPA-MAG								
Janice Musfeldt (S)	PI		University of Tennessee, Knoxville	Department of Chemistry	NSF	DMR - Division of Materials Research	DMR1707846	P19343	High field spectroscopy of materials with broken symmetry and strong spin-orbit coupling	Chemistry	1	6
Kendall Hughey (G)	C		University of Tennessee, Knoxville	Chemistry								
Minseong Lee (P)	C		Los Alamos National Laboratory	MPA-MAG								
Vivien Zapf (S)	C		National High Magnetic Field Laboratory	Physics								
Eugenio Coronado (S)	PI	*	University of Valencia	Chemistry	European Research Council	Other	H2020-ERC-788222	P19393	Experimental identification of new topological materials: the case of Pt5Se4, a predicted line topological semimetal.	Condensed Matter Physics	2	15
Fedor Balakirev (S)	C		National High Magnetic Field Laboratory	PFF								
José J. Baldoví (P)	C		University of Valencia	Instituto de Ciencia Molecular (ICMol)								
Carla Boix-Constant (G)	C		University of Valencia	ICMol								
Samuel Mañas-Valero (G)	C		University of Valencia	ICMol (Institute for Molecular Science)								
John Singleton (S)	C		National High Magnetic Field Laboratory	Physics								
John DiTusa (S)	PI		Louisiana State University	Department of Physics and Astronomy	DOE	EPSCoR - Established Program to Stimulate Competitive Research	DESC0012432	P19403	Investigating the angular dependence of dHvA oscillations in chiral compound PdGa	Condensed Matter Physics	1	8
Ronald Pagano (G)	C		Louisiana State University	Physics and Astronomy								
John Singleton (S)	C		National High Magnetic Field Laboratory	Physics								
James Analytis (S)	PI		University of California, Berkeley	Physics	DOE	MSE - Materials Science and Engineering	DE-SC0014039	P19409	Breaking Kondo hybridization with magnetic field in heavy fermion superconductors	Condensed Matter Physics	3	21
Ella Lachman (P)	C		University of California, Berkeley	Physics	DOE	Office of Science - BES - Basic Energy Sciences	No. DE-AC02-05CH11231					
Nikola Maksimovic (G)	C		University of California, Berkeley	Physics								
Vikram Nagarajan (G)	C		University of California, Berkeley	Physics								
Lu Li (S)	PI		University of Michigan	Physics	DOE	Office of Science - BES - Basic Energy Sciences	DE-SC0020184	P19528	Search for novel electronic and magnetic state in ultraintensive magnetic fields	Condensed Matter Physics	6	42
Aaron Chan (G)	C		University of Michigan	Department of Physics	NSF	DMR - Division of Materials Research	DMR2004288					
Kuan-Wen Chen (P)	C		University of Michigan	Physics								
David Mandrus (S)	C		University of Tennessee, Knoxville	Materials Science and Engineering								
Yuji Matsuda (S)	C		Kyoto University	Physics								
Emilia Morosan (S)	C		Rice University	Physics and Astronomy								
Ziji Xiang (P)	C		University of Michigan	Physics								
Dechen Zhang (G)	C		University of Michigan	Department of Physics								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Guoxin Zheng (G)	C		University of Michigan	Department of Physics								
Rico Schoenemann (P)	PI		Los Alamos National Laboratory	MPA-MAG	UCGP			P19530	Magnetoelastic and magnetocaloric properties of a topological superconductor candidate	Condensed Matter Physics	1	10
Priscila Ferrari Silveira Rosa (P)	C		Los Alamos National Laboratory	MPA-CMMS								
Marcelo Jaime (S)	C		National High Magnetic Field Laboratory	Physics								
Sean Thomas (T)	C		Los Alamos National Laboratory	CMMS								
Vivien Zapf (S)	C		National High Magnetic Field Laboratory	Physics								
Matthew Coak (P)	PI	*	University of Warwick	Department of Physics	European Research Council	Non US Council	681260	P19533	High-field properties of two-dimensional magnetic van-der-Waals materials	Condensed Matter Physics	1	5
Geetha Balakrishnan (S)	C		University of Warwick	Physics								
Paul Goddard (S)	C		University of Warwick	Department of Physics								
John Singleton (S)	C		National High Magnetic Field Laboratory	Physics								
Mun Chan (S)	PI		National High Magnetic Field Laboratory	Pulsed field Facility	DOE	LDRD - Laboratory Directed R&D	DE-XX00-00______	P19534	Unconventional superconductivity in nickelates and cuprates	Condensed Matter Physics	2	10
Rubi Km (P)	C		Los Alamos National Laboratory	MPA-MAGLAB	DOE	LDRD - Laboratory Directed R&D	DE-ER21-20AA22222					
Boris Maiorov (S)	C		Los Alamos National Laboratory	MPA-MAGLAB								
Christopher Mizzi (P)	C		Los Alamos National Laboratory	MPA-MAGLAB: MPA-MAG LAB NHMFL GROUP								
Magdalena Owczarek (P)	PI	*	Los Alamos National Laboratory	CINT	DOE	LDRD - Laboratory Directed R&D	DE-AA00-00AA00000	P19535	Investigation of magnetic field-induced spin crossover transition in Fe(II) coordination complex	Condensed Matter Physics	1	10
Minseong Lee (P)	C		Los Alamos National Laboratory	MPA-MAG								
Wanyi Nie (S)	C		Los Alamos National Laboratory	MPA-11								
Vivien Zapf (S)	C		National High Magnetic Field Laboratory	Physics								
Huibo Cao (S)	PI	*	Oak Ridge National Laboratory	Neutron scattering	DOE	Office of Science - ECRP - Early Career Research Program	KC0402010	P19536	Magnetic plateaux in a triangular-lattice magnet	Condensed Matter Physics	2	9
Lei Ding (P)	C		Oak Ridge National Laboratory	Neutron scattering division								
Marcelo Jaime (S)	C		National High Magnetic Field Laboratory	Physics								
Minseong Lee (P)	C		Los Alamos National Laboratory	MPA-MAG								
Rico Schoenemann (P)	C		Los Alamos National Laboratory	MPA-MAG								
Vivien Zapf (S)	C		National High Magnetic Field Laboratory	Physics								
Kathrin Goetze (P)	PI	*	Deutsches Elektronen-Synchrotron DESY	FS-US	European Research Council Consolidator Grant	Non US Council	681260	P19537	Fermi surface investigations on pyrochlore iridates using delayed current application across an insulator-metal transition in pulsed magnetic fields	Condensed Matter Physics	1	10
Andrew Boothroyd (S)	C		University of Oxford	Physics								
Paul Goddard (S)	C		University of Warwick	Department of Physics								
Dharmalingam Prabhakaran (S)	C		University of Oxford	Physics								
John Singleton (S)	C		National High Magnetic Field Laboratory	Physics								
Joseph Checkelsky (S)	PI		Massachusetts Institute of Technology	Physics	NSF	DMR - Division of Materials Research	DMR1231319	P19540	High Field Studies of Novel Layered Materials	Condensed Matter Physics	3	25
Aravind Devarakonda (P)	C		Columbia University	Physics	NSF	DMR - Division of Materials Research	DMR1554891					
Minyong Han (G)	C		Massachusetts Institute of Technology	Physics								
Caolan John (G)	C		Massachusetts Institute of Technology	Physics								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
Paul Neves (G)	C		Massachusetts Institute of Technology	Physics								
Joshua Wakefield (G)	C		Massachusetts Institute of Technology	Physics								
Junbo Zhu (G)	C		Massachusetts Institute of Technology	Physics								
Zhiqiang Mao (S)	PI		Pennsylvania State University	Department of Physics	DOE	Office of Science - BES – Basic Energy Sciences	DE-SC0019068	P19544	Studies of exotic quantum phenomena near the quantum limit in Dirac semimetals AMnSb2 (A=Sr, Ba and Yb)	Condensed Matter Physics	1	6
Ross McDonald (S)	C		National High Magnetic Field Laboratory	Physics	DOE	Office of Science - BES – Basic Energy Sciences	DE-SC0014208					
Lujin Min (G)	C		Pennsylvania State University	Department of Physics	DOE	EPSCoR - Established Program to Stimulate Competitive Research	DE-SC0012432					
Johanna Palmstrom (P)	C		Los Alamos National Laboratory (LANL)	MPA-MAG	LANL	US Government Lab	20200680PRD1					
Priscila Ferrari Silveira Rosa (P)	PI		Los Alamos National Laboratory	MPA-CMMS	DOE	Other	20210064DR	P19549	High field exploration of topological superconductivity in actinide compounds	Condensed Matter Physics	1	9
You Lai (P)	C		National High Magnetic Field Laboratory	Physics								
Ross McDonald (S)	C		National High Magnetic Field Laboratory	Physics								
Philip Moll (S)	C		Ecole Polytechnique Federale de Lausanne	Institute of Materials								
Valentin Taufour (S)	PI	*	University of California, Davis	Physics Department	University of California, Davis	US College and University		P19616	High Magnetic Field Studies of Co-based Materials	Condensed Matter Physics	1	10
Eun Sang Choi (S)	C		National High Magnetic Field Laboratory	Physics Department								
Audrey Grockowiak (S)	C		National High Magnetic Field Laboratory	DC Field/CMS								
Neil Harrison (S)	C		National High Magnetic Field Laboratory	Physics								
Yunshu Shi (G)	C		University of California, Davis	Department of Physics and Astronomy								
Cui-Zu Chang (S)	PI	*	Pennsylvania State University	Physics	NSF	DMR - Division of Materials Research	DMR1847811	P19621	Interfacial Superconductivity in Bi2Te3/FeTe Heterostructures under High Magnetic Fields	Condensed Matter Physics	1	5
David Graf (S)	C		National High Magnetic Field Laboratory	DC Field CMS								
Seng Huat Lee (S)	C		Pennsylvania State University	Physics								
Zhiqiang Mao (S)	C		Pennsylvania State University	Department of Physics								
Hemian Yi (P)	C		Pennsylvania State University	Department of physics								
Yi-Fan Zhao (G)	C		Pennsylvania State University	Physics								
Filip Ronning (S)	PI		Los Alamos National Laboratory	MPA-CMMS	DOE	Office of Science - BES – Basic Energy Sciences	E1FR	P19631	Magnetically frustrated f-electron intermetallics	Condensed Matter Physics	2	10
Eric Bauer (S)	C		Los Alamos National Laboratory	MST-10								
Neil Harrison (S)	C		National High Magnetic Field Laboratory	Physics								
Yu Liu (P)	C		Brookhaven National Laboratory	Condensed Matter Physics								
Ross McDonald (S)	C		National High Magnetic Field Laboratory	Physics								
Vivien Zapf (S)	C		National High Magnetic Field Laboratory	Physics								
James Wampler (P)	PI	*	Los Alamos National Laboratory	MPA-MAG	DOE	Other	00-000000000	P19634	In search of quantum spin liquid states in 5f compounds	Condensed Matter Physics	2	15
Priscila Ferrari Silveira Rosa (P)	C		Los Alamos National Laboratory	MPA-CMMS								
Marcelo Jaime (S)	C		National High Magnetic Field Laboratory	Physics								
Rico Schoenemann (P)	C		Los Alamos National Laboratory	MPA-MAG								
Vivien Zapf (S)	C		National High Magnetic Field Laboratory	Physics								

Participants (Name, Role, Org., Dept.)					Funding Sources (Funding Agency, Division, Award #)			Proposal #	Proposal Title	Discipline	Exp. #	Days Used
James Wampler (P)	PI	*	Los Alamos National Laboratory	MPA-MAG	DOE	Office of Science - EFRC - Energy Frontier Research Centers	DE-SC0019330	P19635	Investigation of the field-driven Spin Crossover Transition in a tautomeric Co complex	Condensed Matter Physics	2	10
Minseong Lee (P)	C		Los Alamos National Laboratory	MPA-MAG								
Michael Shatruk (S)	C		National High Magnetic Field Laboratory	Department of Chemistry and Biochemistry								
Ping Wang (P)	C		Florida State University	physics								
Vivien Zapf (S)	C		National High Magnetic Field Laboratory	Physics								
Rongying Jin (S)	PI	*	University of South Carolina	Department of Physics and Astronomy	NSF	DMR - Division of Materials Research	DMR1504226	P19637	Search for field-induced new quantum phenomena in EuZn2As2, TaSe3, PtBi2-x, and IrSn4	Condensed Matter Physics	1	10
Joanna Blawat (G)	C		University of South Carolina	Physics and Astronomy								
Roshan Nepal (P)	C		Louisiana State University	Physics and Astronomy								
Johanna Palmstrom (P)	C		Los Alamos National Laboratory (LANL)	MPA-MAG								
John Singleton (S)	C		National High Magnetic Field Laboratory	Physics								
Smita Speer (G)	C		Louisiana State University	Physics & Astronomy								
Nitin Samarth (S)	PI	*	Pennsylvania State University	Physics	NSF	DMR - Division of Materials Research	DMR1539916	P19651	High magnetic field measurements of superconductivity in high Tc FeSe films	Condensed Matter Physics	1	10
Scott Crooker (S)	C		National High Magnetic Field Laboratory	Nat High Magnetic Field Lab								
Yanan Li (G)	C		Pennsylvania State University	Physics Department								
Ross McDonald (S)	C		National High Magnetic Field Laboratory	Physics								
Nicholas Butch (S)	PI		National Institute of Standards and Technology MD	NIST Center for Neutron Research	National Institute of Standards and Technology	US Government Lab		P19704	Studies of high-field states of UTe2	Condensed Matter Physics	1	10
Sylvia Lewin (P)	C		University of Maryland, College Park	Physics								
Laurel Winter (S)	C		National High Magnetic Field Laboratory	Physics								
Emilia Morosan (S)	PI		Rice University	Physics and Astronomy	NSF	DMR - Division of Materials Research	DMR1903741	P19747	Determining the Berry phase in BaGa2 and SrGa2 single crystals using high magnetic fields	Condensed Matter Physics	1	5
									Total Proposals:		Experiments:	Days:
									43		69	457

2021

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