Integrated Coil Form Technology for Ultra High Magnetic Fields

Thomas Painter, Kwangmin Kim, Mike White, Robert Stanton
National High Magnetic Field Laboratory, Florida State University

Funding Grants: G.S. Boebinger (NSF DMR-1157490); T.A. Painter (EPSRC EP/R016615/1)

REBCO (Rare Earth Barium Copper Oxide) tape has the high current density and high strength needed to enable ultra-high field high-temperature superconducting (HTS) magnets. To minimize the cost and maximize the usefulness of these magnets, one typically wants the magnet to be as small as possible and to reach full field as quickly as possible. While several REBCO coil-fabrication technologies have been proposed in recent years, *the MagLab recently tested a new technology, the Integrated Coil Form (ICF), which shows potential for realizing both smaller HTS magnets and faster sweep rates*.

In an ICF solenoid, several strands of REBCO tape are wound without twisting onto a helical steel coil-form. Multiple ICF solenoids are nested concentrically together to form a test coil. This results in a high-current HTS cable with high current density and strength. However, it is well known that Low Temperature Superconducting (LTS) cables must be twisted to avoid quenching due to ac loss heating and uneven current sharing during ramping. The high aspect ratio of REBCO tape (4 mm wide by 0.1 mm thick) means that while twisted architectures are possible, all cables built to date display inefficient packing, low strength, and/or high manufacturing costs **[1,2]**. In contrast, *the ICF concept for HTS cabled magnets provides very high current density and strength at modest cost*.

A recently tested ICF coil featured nine tapes in parallel and demonstrated high ramp rates without quenching. During testing at 77K, it reached 700A independent of ramp rate as shown in figure. Further, the projected critical current density of this test coil in a 14T background field is 516A/mm^2, approximately three times that of the best solenoid test coil using HTS twisted cable **[3]**, a recent success from a MagLab/private sector collaboration.

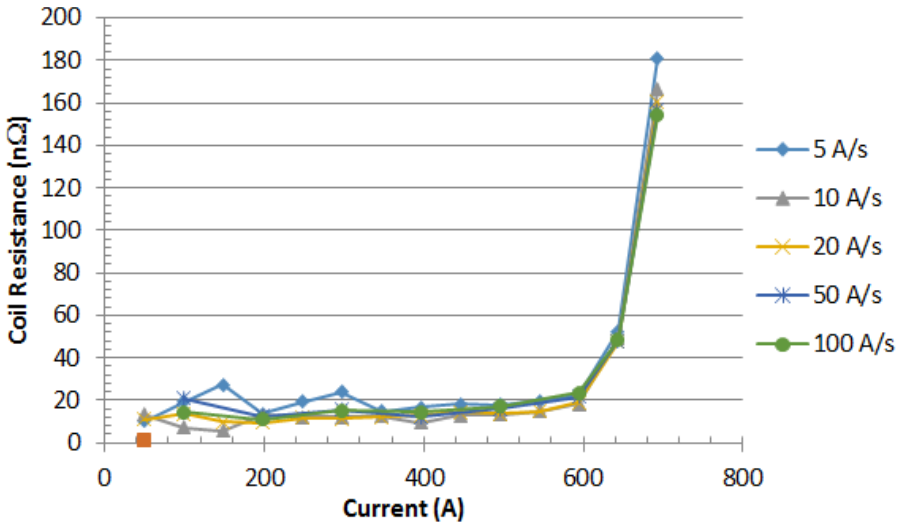

Figure: The transition from the superconducting to resistive state in this Integrated Coil Form Test Coil occurs at around 700A, independent of that ramp rate that ranges from 5A/s to 100A/s

Facilities and instrumentation used: DC Field Facility, Cell 4.
Citation: Data are not yet published.

References:

[1] W. Fietz, *et al*, *"High-Current HTS Cables: Status and Actual Development"*, **IEEE Trans. App. Sup. Vol. 26,** No. 4, June 2016.
[2] N. Bykovsky, *et al*, *"Strain Management in HTS High Current Cables"*, **IEEE Trans. App. Sup. Vol. 25**, No. 3, June 2015,
[3] van der Laan, D. et al, *"A CORC cable insert solenoid: the first high-temperature superconducting insert magnet tested at currents exceeding 4kA in 14T background magnetic field"* , D.C. van der Laan, *et al.* **Superconductor Science and Technology**, **33** (5), 05LT03 (2020) doi.org/10.1088/1361-6668/ab7fbe