Testing the critical current of high-temperature-superconducting REBCO cables using a superconducting transformer

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Large high-magnetic-field superconducting magnets often require high-current superconducting cables to reduce the inductance of the magnet. *Developing high-current superconducting cables requires a testbed facility capable of providing a high magnetic field, B, in a large sampling volume, along with an electrical current of tens of kiloamps*. A superconducting transformer (SCT) can provide high currents at the test site, while maintaining compatibility with the low-current leads into the test cryostat that are necessary to minimize helium consumption.

This collaboration had previously co-developed an SCT, successfully testing it to an output current of 45kA in zero magnetic field [1]. Subsequently this SCT was installed to the 12T split-solenoid superconducting magnet at the MagLab and calibrated by measuring the known critical current of a reference superconducting cable, i.e., a NbTi Rutherford cable designed for the large hadron collider at CERN [2].

A MagLab user collaboration grant program (UCGP) project funded the fabrication of a REBCO Conductor-On-Round-Core (CORC) cable and probe by Advanced Conductor Technologies LLC (ACT), a long-time MagLab user and collaborator. The electric field - current (E-I) curves are measured in the split magnet up to 12T (**Figure a**). The critical current versus B is presented in **Figure b**, in which the data are fitted with $B^{-\alpha}$ where $\alpha \sim 0.52$.

This work demonstrates the successful application of a superconducting transformer in superconducting cable critical current measurements, an important enhancement in the MagLab's ability to serve users who are developing superconducting cables.

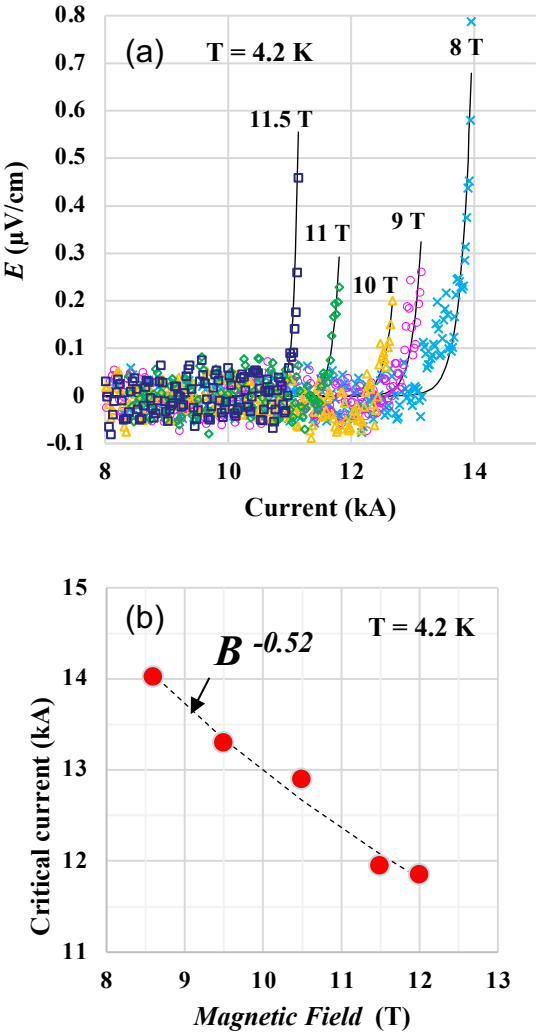

Figure (a) *E-I* curves of the CORC cable at various magnetic fields. **(b)** Critical current versus magnetic field. The dash line is a fit to the critical current: $I_c \sim B^{-0.52}$.

Facility used: Division of Magnet Science and Technology

Citations:

[1] Yu, H.; Lu, J., *Superconducting Transformer for Superconducting Cable Testing up to 45 kA,* **IEEE Transactions on Applied Superconductivity**, **30** (4), 5500204 (2020) doi.org/10.1109/TASC.2020.2972502

[2] Yu, H.; Levitan, J.W.; Lu, J., *Calibration of a superconducting transformer by measuring critical current of a NbTi Rutherford cable,* **Superconductor Science and Technology**, **34** (8), 085019 (2021) doi.org/10.1088/1361-6668/abf623