

Demonstration of Technology Suitable for an All-Superconducting 40 T Magnet through Testing of a Large-Scale REBCO Coil



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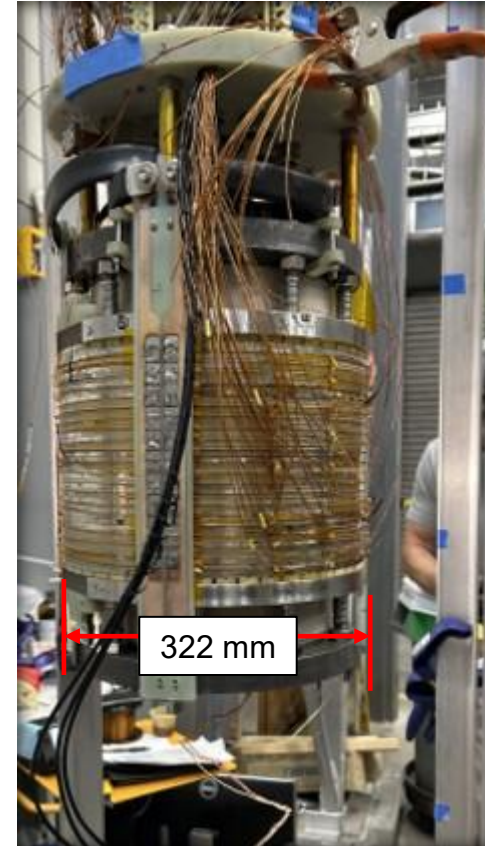
A solenoid test coil fabricated with REBCO high temperature superconductor was designed with features and stresses representative of the proposed 40 T all-superconducting magnet. This coil with a 260 mm inner diameter, has a relatively high stored energy of 0.2 MJ and contains 3.7 km (2.3 miles) of superconducting tape. Testing of the coils was performed in a background field to see if it could attain its designed maximum operational current, if it could be protected from quench, and if the internal joints could withstand the high operational strains.

The coil was tested in the MagLab's DC Field Facility using the outer superconducting coils of the 45 T Hybrid magnet to provide a magnetic environment of 11.4 T in a 4.2 K cold bore of 353 mm diameter. The REBCO coil reached its target current of 645 A which created a $\Delta B = 5$ T, for a total central field of 16.4 T. This is the first coil of its kind to reach 70% of its short-sample critical current, a vital requirement for compact high-field coils. The coil was also subjected to seven forced quenches to find weak points in its design. Finally, field control experiments were performed to qualify techniques to improve field stability.

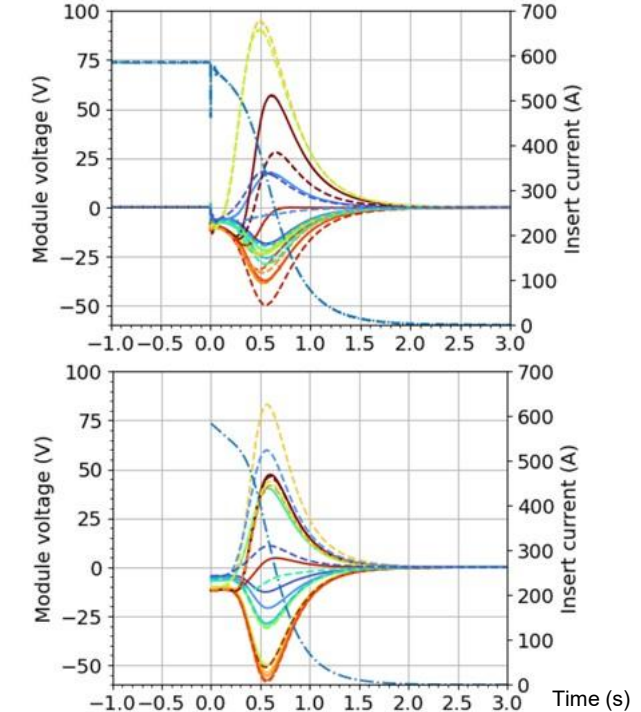
The REBCO coil will now be disassembled and inspected to search for internal damage. This information will be used for design improvements. The measured voltages developed during quench and measured strains during operation will be evaluated and numerical models adjusted where necessary to further refine our predictive capabilities for the final 40 T all-superconducting system.

Facilities and instrumentation used: DC Field Facility 45 T Hybrid.

Citation: Bai, H.; Bird, M.D.; Cooley, L.; Dixon, I.R.; Kim, K.L.; Larbalestier, D.C.; Marshall, W.S.; Trociewitz, U.P.; Weijers, H.W.; Abraimov, D.V.; Boebinger, G.S., *The 40 T Superconducting Magnet Project at the National High Magnetic Field Laboratory*, **IEEE Transactions on Applied Superconductivity**, **30** (4), 1-5 (2020) doi.org/10.1109/TASC.2020.2969642



Large-Scale REBCO Coil



Measured voltages (top) during quench – when magnetic stored energy rapidly converts to heat in the coil – showed excellent agreement with simulations (bottom). Agreement is essential for designing the quench protection system for the final 40 T magnet.