



# High-Magnetic-Field Quality Assurance of High-Temperature-Superconducting Modules

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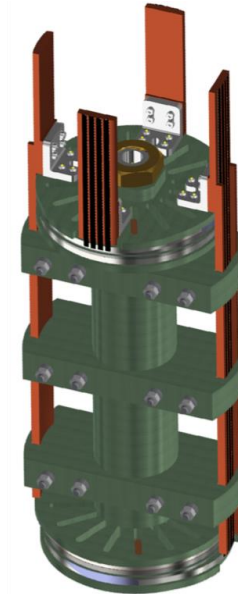
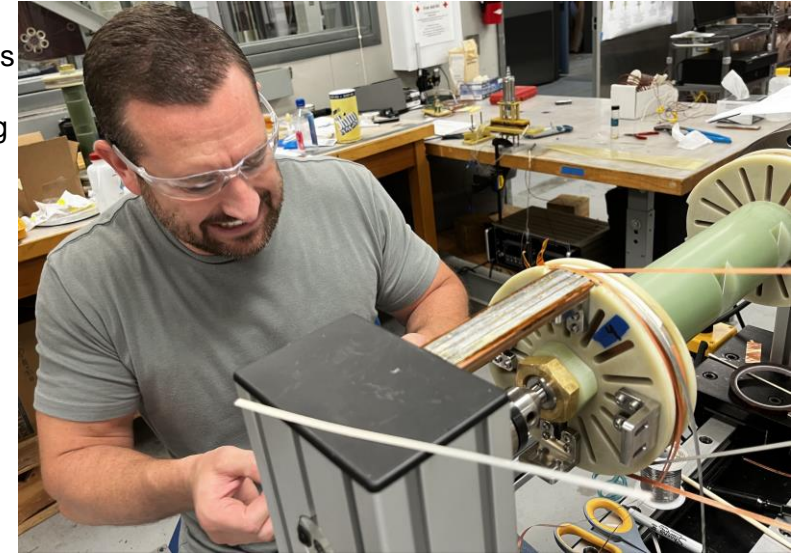
The National High Magnetic Field Laboratory (MagLab) is presently engaged in a five-year project to design a 40T all-superconducting magnet using Rare Earth – Barium – Copper – Oxygen (REBCO) superconducting tape. This tape is wound into double layer coils, called “double layer pancake modules” because their geometrical dimensions resemble those of a pancake. These modules are then stacked and interconnected to form larger test coils and, eventually, the final high-field user magnet.

The REBCO tape must be characterized by measuring the superconducting critical current ( $I_c$ ) as a function of temperature, magnetic field applied to the tape, and the angle at which the magnetic field is applied to the tape. The REBCO tape is then assigned to specific pancake modules in a test coil stack according to its performance during characterization. The pancake modules are then wound, stacked to form the test coil, compressed, interconnected via joints and attachment of coil terminations, and covered with diagnostic instrumentation. During this multi-step winding and stacking of the pancake modules, REBCO tapes may be damaged and, until now, there have been no intermediate quality assurance procedures between the characterization of the REBCO tape and the expensive and time-consuming testing of the full test coil.

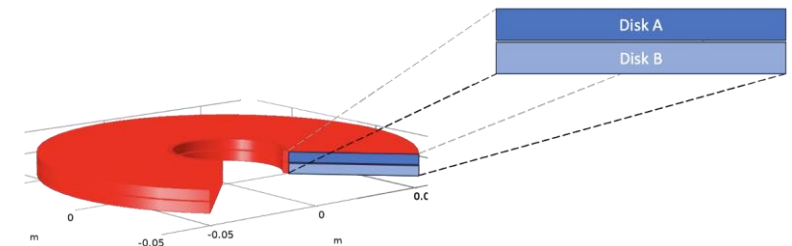
To mitigate the risk of installing an underperforming pancake module into the expensive full test coil, an intermediate testing protocol has been developed to test REBCO-wound double pancake modules individually at 4.2K to ensure that the modules are not damaged after winding.

The individual modules are tested in sets of two in a background 6T magnetic field provided by a superconducting coil while cooled in liquid helium. Modules are offset from the midplane of the background field to expose the modules to high radial fields, allowing the REBCO to be tested nearer its  $I_c$ . In this way, the individual modules can be tested beyond 70% of their  $I_c$  as a means to verify they are acceptable for insertion into the full test coil.

**Figure right:** MS&T Technician Brent Jarvis connecting a pancake module to the Dual Rig for Pancake Module Testing



**Figure above:** Fully assembled Dual Rig for Pancake Module Testing



**Figure above:** Cross section of a double layer pancake module as analyzed via 2-D axisymmetric numerical modeling.

Image credits: Ernesto Bosque, MagLab

**Facilities:** HTS Winding Shop, Cell 4 of the DC Magnet Facility, and the 6T LTS testbed Petten magnet.

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Screening current rotation effects: SCIF & strain I REBCO magnets, **Superconductor Science and Technology**, 34, 095004 (2021)

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