Revolutionizing Superconductor Testing for Next-Gen Magnet Technologies

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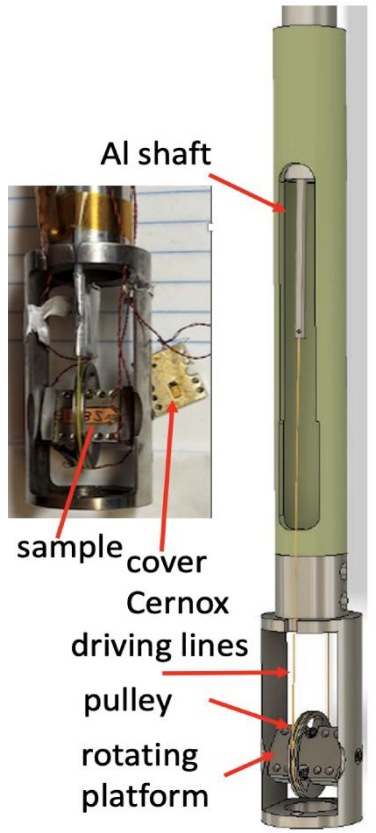
REBCO (rare earth–barium–copper–oxide) superconducting tapes are front-runners for high-field magnet applications, including fusion energy systems, advanced research magnets, and high-energy physics experiments. However, conventional transport measurements of their high critical currents are often impractical in the extreme magnetic fields where these materials must operate, creating a bottleneck in their development and qualification.

To address this, MagLab researchers have developed a fast, economical method based on torque magnetometry. When a magnetic field is applied to an anisotropic superconducting tape, it induces a screening current that produces a torque proportional to the tape's critical current. This enables high-throughput, non-contact characterization across a range of temperatures and field orientations — without the need to apply large currents at cryogenic temperatures.

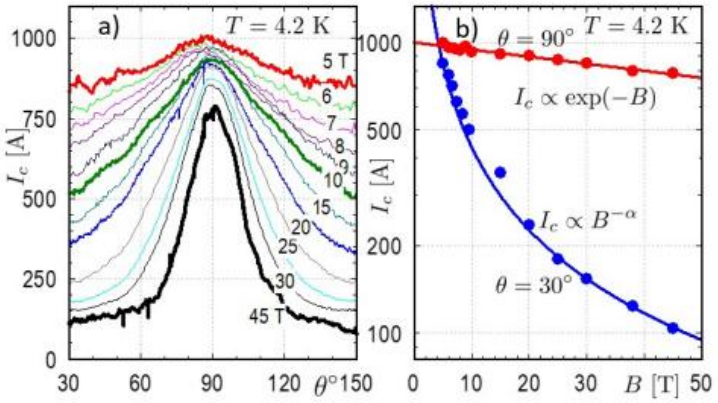
The method is compatible with both resistive and superconducting magnets and has already been used to evaluate hundreds of tapes, revealing key insights into flux pinning, magneto-thermal stability, and material inhomogeneity. It has attracted strong interest from both academic and industrial partners — including Commonwealth Fusion Systems, Tokamak Energy, the UK Atomic Energy Authority, and several manufacturers — as a powerful tool for accelerating the deployment of next-generation superconducting magnets.

Facilities: 45T hybrid magnet and 31 T resistive magnets

Citation: [1] Jaroszynski, J; Constantinescu, AM; Kolb-Bond, D; Francis, A.; Xu, A.; Ries, R.; Bradford, G.; Bang, B.; Lee, J. and Larbalestier, D., *Critical Current, Lengthwise Fluctuations, and Flux Jumps in REBCO CC: A Torque Magnetometry Study up to 45 T*, **https://arxiv.org/abs/2502.02706**, (Feb 11 2025)
[2] Jaroszynski, J.; Constantinescu, A. M.; Larbalestier, D. and Miller, G., *"Magnetometer For Large Magnetic Moments With Strong Magnetic Anisotropy"*, US Patent No. 12,181,540 (2024)
UCGP: J. Jaroszynski PI, Fast fatigue and transport current assessment in REBCO coated conductors



Figures 1 left. *Torque magnetometer: a platform with a sample is rotated in magnetic field by servo motor, actuator and driving shaft/lines.. The load cell measures tension of the line, which is proportional to the torque. The torque is proportional to critical current in the sample*



Figures 2 above. *a) Angular critical current assessed using torque in R&D sample from SuperPower Inc. with 15 % BZO, measured at T = 4.2 K within a magnetic field range of 5 to 45 T. b) Critical current as a function of field for the field in the ab plane and at θ = 60 deg off the ab plane.*