REBCO Sample Testing at High Power X-band

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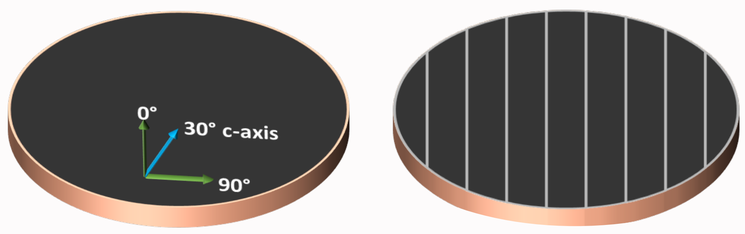
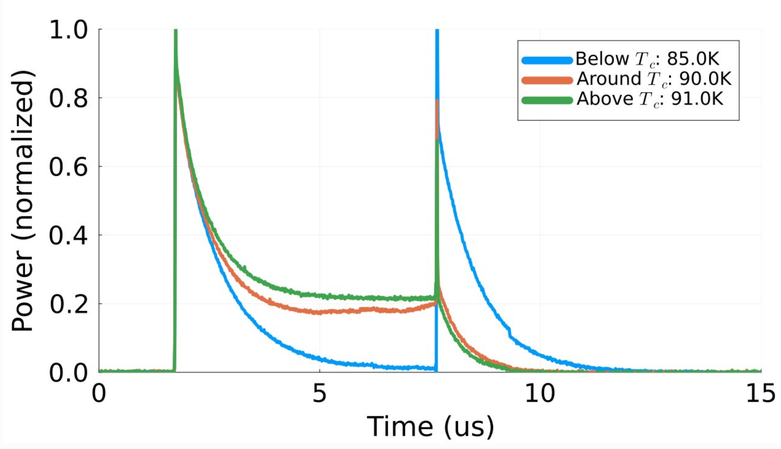
Motivation High temperature superconductors can provide extremely high quality factors at more accessible temperatures [1], but in order to do so their quenching mechanism during high power RF pulses must be studied for future designs.

Rare-earth barium copper oxide



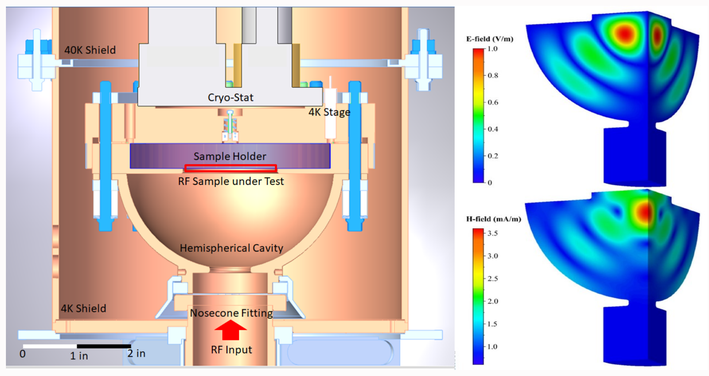
In our case this rare earth was yttrium (YBCO), and was deposited onto 2 inch copper pucks, both as a 600 nm thick film and as 12 mm wide tapes [2].

Quenching



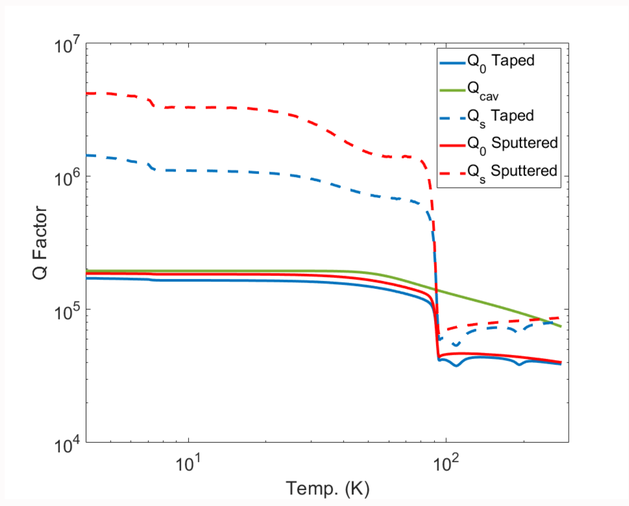
Quenching occurs when a superconductor forcibly transitions, either by critical current or temperature.

High Power Cryogenic Test Stand

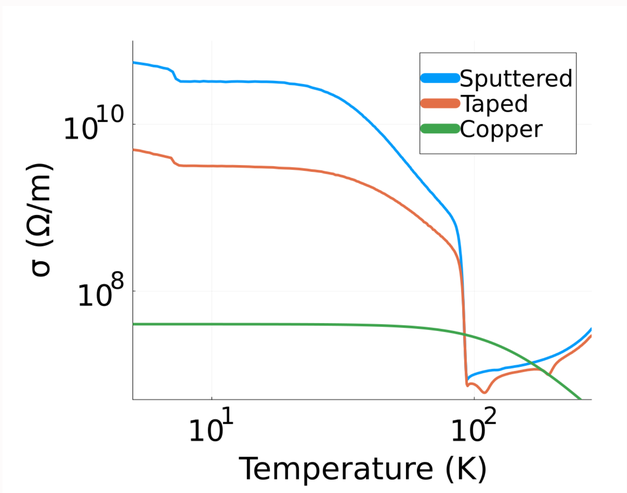


Cryostat is designed to couple power at 11.424 GHz into a TE mode that maximizes surface currents on sample region, which is interchangeable [3].

Low Power Tests

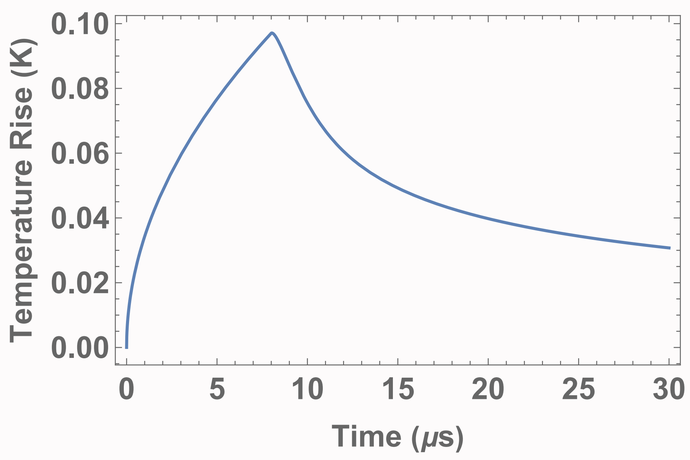


Low power measurements confirmed the high RF conductivity of YBCO till a critical temperature of 88 K [4].

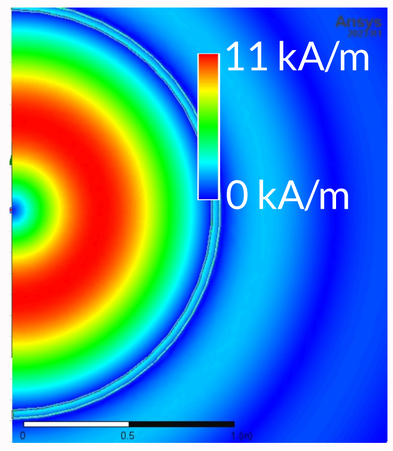


Conductivity of film samples at 4K was close to reference value of 43 GS/m. Tapes samples were measured to be closer to 15 GS/m.

High Power Tests

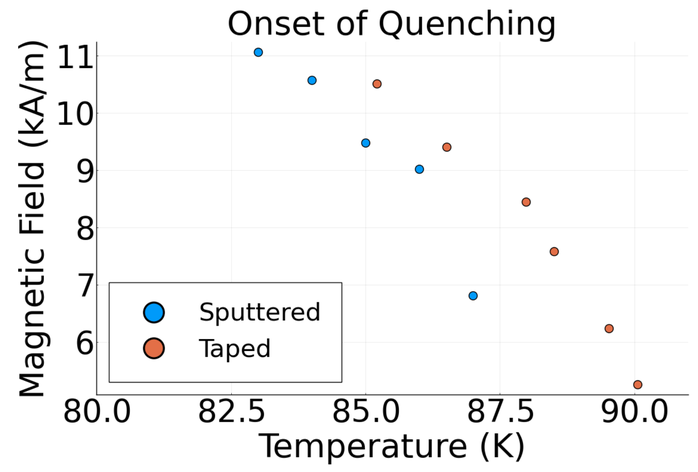


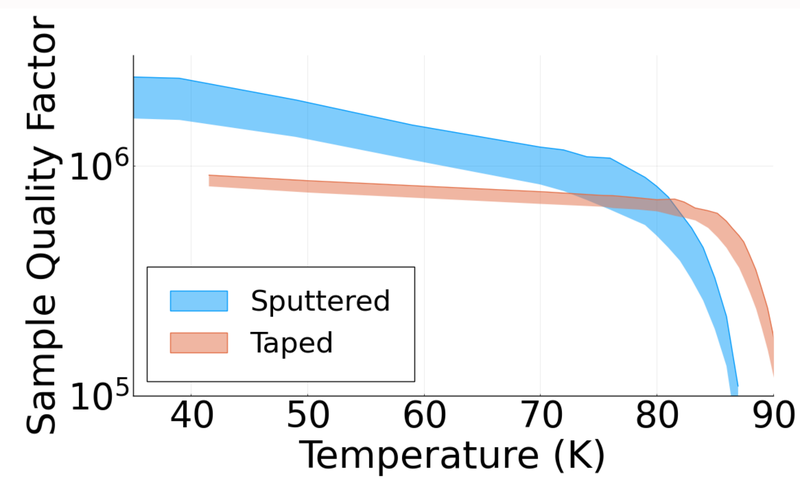
Calculations of the expected heat load from surface currents is well below 1 K, so quenching observed <87 K is likely not from pulsed heating.

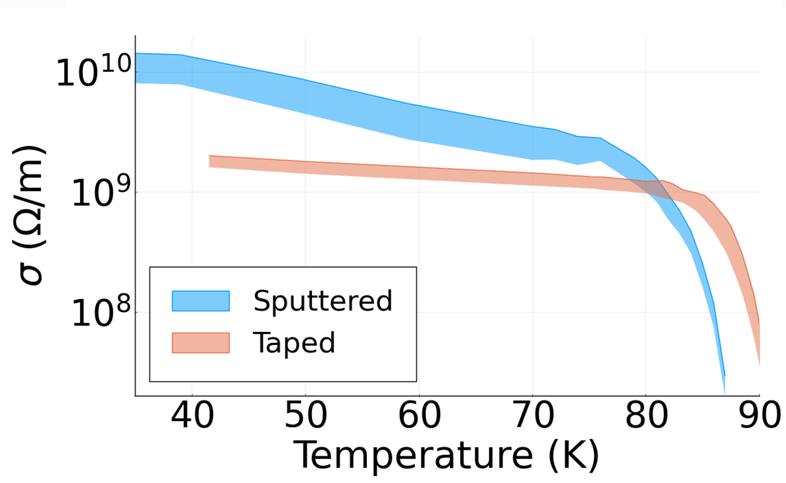


By carefully measuring where the exponential decay of the reflected power begins to deviate, the quench point as a function of surface field could be identified.

This point appears to occur sooner for the sputtered sample, and has a greater effect on its conductivity.







Acknowledgments

[1] A. Romanov,et. al, "High frequency response of thick REBCO coated conductors in the framework of the FCC study", Scientific reports, 10(1), 12325 (2020)
[2] W. Prusseit, et. al, Physica C: Superconductivity and its applications, 426, 866-871 (2005)
[3] P. B. Welander, et. al, "Cryogenic RF characterization of superconducting materials at SLAC with hemispherical cavities", Proceedings of SRF2015
[4] M. Schneider, et.al , REBCO Sample Testing for a HTS High Q Cavity, JACoW IPAC2023, WEPA183 (2023).

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