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Cryogenic irradiation of REBCO tapes for fusion magnet

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The deuterium-tritium reaction is the most promising source of fusion energy for power plants but generates high-energy neutrons that compromise reactor components - from the plasma-facing walls to fusion magnets. In compact, high-field REBCO-based fusion devices, radiation damage will limit the lifespan. Simulating the fusion environment in test facilities is challenging but essential to predict REBCO tape degradation.

We developed a cryogenic ion irradiation facility to inflict radiation damage at 20 K, the operating temperature of REBCO fusion magnets. We used it to irradiate REBCO tapes with 1.2 MeV protons, while measuring in-situ the superconducting properties. Results show that 20 K irradiations degrade transition temperature, critical currents, and n-value—by ˜40% more than irradiations at 300 K, suggesting prior room-temperature studies overestimated the radiation tolerance of REBCO tapes.

To achieve a fusion-like environment, we currently implement at the 6 MW MIT reactor a setup for fast neutron irradiation at 20 K with in-situ transport measurements in fields up to 14 T. In 2025, this facility will provide high-fidelity data on the radiation resistance of REBCO tapes.

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