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Challenges of test infrastructures for fusion in the US (MIT, CFS)

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Oral presentation (20 min) + Q&A (10 min)

The Superconducting Magnet Test Facility (SMTF) at MIT's Plasma Science and Fusion Center provides a range of capabilities to support development of HTS magnet technology. Constructed between 2019-2021 around the SPARC Toroidal Field Model Coil (TFMC) –a non-insulated HTS magnet –it has subsequently been upgraded and employed to service a broader range of test objectives, including those of insulated magnet systems. The main facility provides a large cryostat with power supply and binary HTS current leads capable of continuous operation at 50 kA. Cooling is provided by a closed-loop supercritical helium cryogenic infrastructure that provides ~600 W of cooling at 20 K. The facility also provides a large amount of instrumentation for data acquisition and control. The SMTF has been used to test the SPARC toroidal and central solenoid model coils, as well as a smaller forerunner to the CSMC, and will host the “Magnet 0” test coil of Type One Energy in 2025. In support of these later experiments, a quench detection and fast discharge system has been deployed, with response times on the order of 100 ms. Presently, discharges are limited to 125 V, with further hardening of the system desired to increase this ceiling. Moreover, proposals have been prepared to install a set of pulsed power supplies at 800 V and 16 kA, together with new current leads and other ancillary systems.

A satellite facility services testing in liquid nitrogen. A 16 kA, 10 V power supply is available for testing a wide variety of coils, cables, and other samples. Several liquid nitrogen cryostats host these samples, and custom cryostats may be built for form factors that exceed the parameters handled by these, while direct connection to a 26000-liter (7000 gallon) LN2 tank provides for substantial volumes of liquid nitrogen for long-duration, large-scale tests. Desired upgrades to this facility include an expansion of the instrumentation and control system, the addition of a small cryostat and helium circulation loop for test articles of a scale not appropriate to the larger facility, and a further increase in available voltage and fast discharge capabilities.

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