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Design, Construction and Test of HTS/LTS Hybrid Dipole

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This paper presents the design, construction and test results of a hybrid dipole magnet built with inner coils made of High Temperature Superconductor (HTS) and outer coils of Low Temperature Superconductor (LTS). This is believed to be the first significant HTS/LTS hybrid R&D dipole magnet to be built and tested. The dipole is based on the common coil design with simple racetrack coils. The interest in HTS/LTS hybrid dipoles has risen recently as a way to provide very high fields for future high energy colliders such as the Future Circular Collider (FCC). The HTS "insert" coils were made with ReBCO tape and the LTS outer coils with Nb3Sn Rutherford cable. The outer coils were made over a decade ago for a magnet that reached 10.2 T at 10,800 A. The HTS and LTS coils were independently powered and protected using different power supplies. The HTS coils were quenched many times with no degradation in performance observed. HTS coils were independently ramped to 800 A and the LTS coils to 10,000 A. The hybrid field reached was ~8.6 T, limited by the stable operation of the LTS coil leads at 8000 A. With improved leads and instrumentation, this hybrid dipole is expected to produce over 13 T when the HTS coils are primarily aligned parallel to the field. One major purpose of this program was to perform magnetization studies in the coils made with the HTS tape. These measurements were performed at 77 K with the field either parallel to or perpendicular to the wide face of the HTS tape. In addition, measurements were also performed at 4 K in different background fields provided by the outer Nb3Sn coils. This paper will summarize the magnetization measurements and present the quenching experience of the HTS coils in this hybrid magnet system.

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