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Field Quality Measurements of High-Temperature Superconducting Canted Cosine Theta Accelerator Magnets

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High-temperature superconducting (HTS) composites are being considered for use in high-field magnets for future particle accelerators, as they allow the development of very high field dipoles and quadrupoles. As part of the US Magnet Development Program, LBNL is developing Bi2212- and REBCO-based insert magnets towards 20 T hybrid dipole magnets. The field quality of the magnets is important to assess and limited reports on HTS accelerator magnet field quality measurements are available. Furthermore, drift in the field quality resulting from flux creep in HTS is an important consideration. Here we report on field quality measurements of insert magnets measured at 77 and 4.2 K. The coils were based on canted cosθ designs and were wound with Bi2212 Rutherford cables and CORC® wires. Hall sensors and rotating coil fluxmeters were used to measure the generated magnetic field harmonics and their temporal evolution. The Bi2212-based coils included a 2-layer, 16 turn magnet made from Rutherford cables. The magnet is 40 cm long and has a 3 cm diameter bore. Another coil reached a peak current of 4.1 kA with a field of 0.7 T in the bore. The REBCO-based magnet had 4 layers and 40 turns and reached a peak field of 2.9 T. The magnetization and decay data from M-μ0H measurements performed at 4 K on samples of cables of the HTS composites were used as inputs to finite element and analytical models to predict the field error of a magnet made from the cables. We compare the results of the field quality measurements to calculated results from models based on the short cable magnetization data results. The study allowed us to better understand the field quality issues in HTS magnets and provided important feedback on the conductor development and strategies to improve the field quality of emerging HTS accelerator magnets.

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