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Sat-Af-Mem1-06: Development of high-field dipole and solenoid magnets using the latest generation of CORC® cables and wires

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Dipole magnets that approach or surpass magnetic fields of 20 T for use in future particle circular accelerators, and high-field solenoids that operate at 20 K, such as envisioned in a multi-TeV muon collider, require the use of high-temperature superconductors (HTS). Several prototype magnets based on high-current HTS CORC® cables and wires, wound from REBCO coated conductors, have been demonstrated in recent years. Although considered one of the most flexible HTS cables, previous-generation CORC® wires degraded by 20 -30 % when bent to a 30 mm radius. The limited bending flexibility required rather conservative magnet designs, limiting the magnetic field generated by these early prototype magnets.

Advanced Conductor Technologies (ACT) has recently developed CORC® wires with improved bending flexibility that now allow bending to a 20 mm radius without significant degradation. Very-high current CORC® cables were also developed that have an expected critical current (Ic) of over 30 kA at 10 T at a temperature of 20 K, or at 20 T at 4.2 K. Although the cable contains 96 REBCO tapes of 4 mm width, it allows bending to a 125 mm radius.

The much higher bending flexibility of CORC® conductors allows for more efficient CORC®-based dipole magnets that would ultimately generate 20 T, such as canted-cosine-theta (CCT) magnets under development at Lawrence Berkeley National Laboratory (LBNL) and Conductor on Molded Barrel (COMB) magnets under development at Fermilab. An overview will be provided of the dipole magnet development at both laboratories in support of which ACT will deliver a total length of 225 meters of CORC® wire in the coming months. The improved bending flexibility and in-field performance of CORC® conductors also allows for the development of low-inductance, high-field solenoids. An overview is presented of the initial designs of 35 - 40 T solenoids in which several series-connected CORC®-based inserts are operated within a low-temperature superconducting (LTS) outsert, or as a stand-alone HTS solenoid. An overview of the initial design of a 1.2 meter bore 20 T target solenoid for the muon collider, wound from very-high current CORC® cables, will also be provided.

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