

Self-Protected High-Temperature Superconducting Demonstrator Magnets for Particle Detectors

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A high temperature superconducting (HTS) demonstration magnet has been developed in the frame of the Experimental Physics Department Research and Development program on Experimental Technologies at CERN. Two small partially insulated, radiation transparent demonstrator coils were successfully built using additive manufacturing technology (3D-printing) applied to the aluminium alloy support structure. The first HTS coil, with five turns and an open bore diameter of 230 mm, was measured to be superconducting at 4.4 kA and up to 40 K. The second demonstrator coil has a larger bore diameter of 390 mm, with 15 turns corresponding to 19 meters of a HTS conductor consisting of a stack of four ReBCO tapes. The characteristics of the coils were measured at 77 K and 4.2 K.

We have experimentally and numerically validated that using an aluminium alloy as a stabiliser for HTS tapes can result in a stable, lightweight and transparent magnet.

This detector magnet technology may be used in future particle detector magnets, such as the AMS-100 solenoid, where one of the key design requirements is a passive self-protection by partial-insulation which ensures continuous operation and stable magnetic field even with a locally damaged conductor.

Primary authors: VASKURI, Anna (CERN); VAN DEN EIJDEN, Joep (Eindhoven Technical University (NL))

Co-authors: DUDAREV, Alexey (CERN); CURE, Benoit (CERN); MENTINK, Matthias (CERN)

Presenters: CURE, Benoit (CERN); MENTINK, Matthias (CERN)

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