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Development of a 120-mm aperture Nb₃Sn dipole coil with stress management

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Large-aperture high-field magnets based on Nb₃Sn superconductor are needed for various accelerator systems of future hadron and muon colliders. High level of magnetic field and large aperture lead to significant Lorentz forces and mechanical strains and stresses, which can degrade or even permanently damage brittle Nb₃Sn coils. This paper describes a 120-mm-aperture two-layer dipole coil developed at Fermilab based on cos-theta coil geometry with stress management and Nb₃Sn Rutherford cable. The design and main parameters of the superconducting wire and cable, the coil stress management structure design and the coil FEA in the dipole mirror and dipole test configurations are presented and discussed. A plastic model of the coil support structure was printed using 3D printing technology and used for practice coil winding. The real coil support structure was printed using 316 stainless steel. The key fabrication steps of the Nb₃Sn coil, coil instrumentation, and assembly in a four-layer dipole mirror configuration with an additional 60-mm aperture Nb₃Sn insert coil are reported in the paper.

Primary authors: NOVITSKI, Igor (FERMILAB); ZLOBIN, Alexander (Fermilab); BARZI, emanuela (Fermilab); TURRIONI, Daniele (FNAL (US))

Presenter: NOVITSKI, Igor (FERMILAB)

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