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Design of CCT6: a large-aperture, 12 T, Nb₃Sn Dipole Magnet

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We present the design of a four-layer, Canted Cosine Theta (CCT) Nb₃Sn dipole magnet as part of the general R&D program for high field superconducting magnets supported by the US Magnet Development Program (US-MDP). Future testing with HTS inserts in a hybrid configuration motivates the design's large clear aperture of 120 mm and target operating dipole field of 12 T. First, we show results from a 2D scaling study leading to the selection of an initial cable and cross-section that reaches design targets. Then, a 3D magnetic and mechanical design study around this point is described, which leads to a final design satisfying short-sample margin and conductor stress criteria in 3D. We explore the implications of this design for fabrication of the magnet winding mandrels, and present initial prototyping results along this direction. Finally, we demonstrate compatibility of the CCT6 design with a large utility structure, based on key and bladder technology, currently considered for use within multiple US-MDP high-field magnet programs.

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