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20 T Hybrid Nb₃Sn-HTS Block-coil Design for a Future Particle Collider

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Future high energy particle colliders are under study, with a first goal of 16 T dipoles, which is believed to be the practical limit of Nb₃Sn magnets. Another more ambitious goal is to aim for 20 T dipoles. This very high field would require High Temperature Superconductors (HTS), such as Bi2212 or REBCO. Their substantially higher cost necessitate anyways the use of Nb₃Sn for an affordable accelerator application. Therefore, hybrid designs can be proposed, where the HTS are used in the high field (16-20 T) area, and Nb₃Sn are used in the low field (<16T) area. Rectangular block-coil designs are particularly well adapted to this concept, since the separation between high field and low field can be made parallel to the cable turns, inside each layer of the coil. However, the large forces accumulating on the cable turns generate a high transverse stress detrimental to the coil. The paper presents a conceptual Hybrid Nb₃Sn-HTS design generating 20 T in the bore with margin, using a block-coil concept. Several conductor options are discussed. The design also proposes stress-management solutions to deal with the large stress developing in the coils.

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