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Maximization of the magnetic flux generated by a DEMO CS coil using HTS conductors

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The present work is performed within the framework of the EUROfusion DEMO project. Previously, it was demonstrated that for a maintained magnetic flux the use of HTS conductors at highest magnetic field in a layer-wound CS coil would allow the reduction of its outer radius by around 0.5 m as compared to the DEMO reference design using only Nb₃Sn conductors. Alternatively, the superior high field performance of HTS conductors can be used to maximize the magnetic flux of a CS coil with a given outer diameter, which could significantly prolong the duration of plasma burn phase and thus the overall power plant efficiency. In the present study, the maximization of the magnetic flux, generated by a layer-wound CS coil of fixed outer radius, is considered. HTS conductors are envisaged to be used at highest field, while Nb₃Sn and NbTi are foreseen to be used in intermediate and low field layers, respectively. The inner radius of the CS coil is optimized with respect to the generation of a maximum flux taking into consideration the superconductor properties, the hoop stress and the axial stress. In order to provide reasonable starting values for the finite element analysis, first a simplified model with layer-dependent current densities, however, without stainless steel grading will be considered. In the final outline design of the CS coil a superconductor and stainless steel grading will be implemented.

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