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Quench Analysis of the DEMO CS1 Coil

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The European DEMOnstration Fusion Power Plant (EU-DEMO) is being designed as an intermediary stage between the ITER experimental reactor and future commercial fusion power plants. The EU-DEMO is based on the tokamak concept with a fully superconducting magnet system. The Central Solenoid (CS) coil of the EU-DEMO will consist of five modules, namely CSU3, CSU2, CS1, CSL2 and CSL3, located vertically one above the other. The central CS1 module will be subjected to the most demanding operating conditions (the highest magnetic field and mechanical loads). Two concepts of the CS1 winding pack (WP) are being designed by CEA IRFM (France) and EPFL-SPC, (Switzerland) teams. The pancake wound WP proposed by CEA is based on Wind & React Nb_3Sn Cable-in-Conduit Conductor, whereas the hybrid WP developed by EPFL-SPC consist of 10 sub-coils, layer-wound using: HTS (RE-123), React & Wind Nb_3Sn and NbTi conductors in the high, medium and low field sections, respectively. Each design iteration undergoes comprehensive electromagnetic, mechanical and thermal-hydraulic analyses aimed at verification if it fulfills the design performance criteria. Our present work is focused on the quench analysis of all the hybrid CS1 sub-coils, aimed at the assessment of the maximum hot-spot temperature. The analysis, based on the iteration of the hybrid design proposed in 2017, is performed using the THEA CryoSoft code. We assume that quench is initiated at the beginning of premagnetization phase and include in our model the realistic magnetic field distribution along each conductor computed with 2D axi-symmetrical finite element model in ANSYS. We study the effect of taking into account heat transfer between neighboring turns and heat generation due to AC losses during the fast discharge on the value of the hot spot temperature.

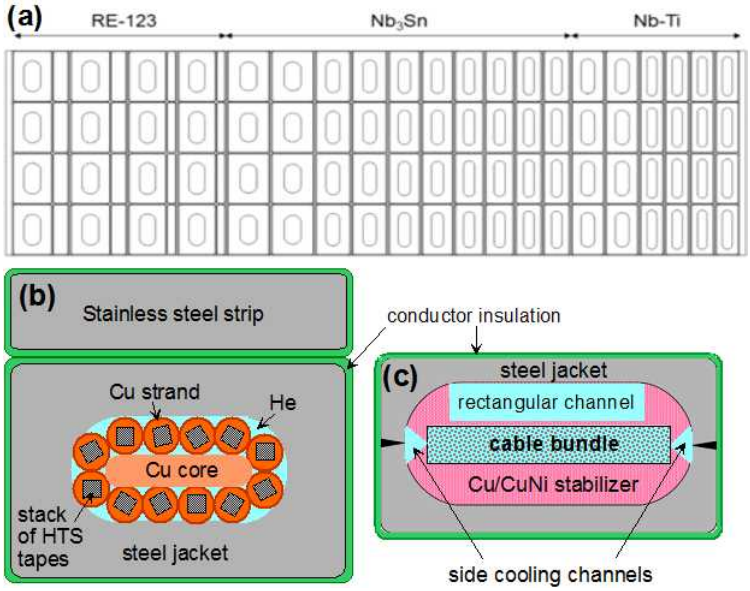

Fig. (a) Layout of the four conductor rows in the CS1 winding pack and schematic cross section of the (b) HTS and (c) LTS conductor.

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