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Strand level modeling on AC loss, current distribution and quenching of CICC conductors

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Cable-In-Conduit Conductors (CICCs) for fusion magnets are subjected to fast changing magnetic fields during the plasma-operating scenario. In order to anticipate to the limitations of the conductors under the foreseen operating conditions, it is essential to have a quantitative assessment of the stability margin of the magnets. In the last decade ITER has launched a campaign for characterization of several types of NbTi and Nb3Sn CICCs comprising quench tests. The conductors are subjected to a singular sine-wave fast magnetic field pulse and relatively small amplitude with respect to the ITER plasma operation scenario. The Minimum Quench Energy (MQE) tests, performed in the SULTAN facility, were reproduced and analyzed using JackPot-ACDC, an electromagnetic-thermal model for CICCs, developed at the University of Twente and THEA (Thermal, Hydraulic and Electric Analysis of Superconducting Cables). The code JackPot-ACDC is used to model the conductor geometry and to study the electro-magnetic behavior on strand level. The experimental results are used to calibrate and benchmark the simulations.

The analysis of coupling loss and current distribution shows the impact of the magnetic field orientation on the rectangular shape of some recent CICC designs, focused on possible issues on the stability and performance of the conductors.

The results provide a good basis for further investigation of conductor stability and extrapolative scaling for different magnetic field pulses, with lower ramp rate and higher amplitude, more similar to the magnet operation scenario's.

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