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Mon-Mo-Po1.03-04 [25]: Analysis of quench in the HL-LHC 11 T dipole model magnets with 1-D and 2-D models

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The HL-LHC Project at CERN requires the installation of 11 T Nb3Sn dipole magnets to upgrade the collimation system. Given the high operating field and current density, the quench protection of these magnets is particularly challenging. The baseline protection scheme of the 11 T dipoles is based on the quench heaters technique.
Dedicated quench tests were carried out at CERN on short samples of the 11 T dipole magnets, in which the quench heaters were fired either individually or simultaneously. The aim of these tests was to measure the quench energy and quench location in the coils, in response to heat depositions of different amplitude. The tests were carried out at transport currents in the range from 11.85 and 12.85 kA; the applied heat flux densities were increased stepwise between 5.9 and 12 W/m until a quench was detected.
Two different modeling approaches were developed to analyze the test results. The first model is based on a simplified 1-D representation of the magnet components along a line crossing radially the middle plane of one quadrant of the magnet cross section. To improve the description of heat exchange with superfluid helium, this model was also applied to analyze dedicated tests carried out in the cryogenic facility of CERN.
The second model represents in detail all magnet components in the 2-D cross section of one dipole quadrant. The model allows one to identify the parts of the magnet which are more thermally solicited in the quench tests, and therefore the most probable quench initiation locations.
The paper presents a detailed description of the models, their validation by comparison with the experimental results, and their application to analyze the details of the quench propagation in the magnet cross section.

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