Simulation of Quench Behaviour of the 11 T Superconducting Dipole for HL-LHC

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Abstract

As part of the High Luminosity Large Hadron Collider a number of magnets is to be installed for the purpose of enhancing the performance of the Large Hadron Collider. The 11 T superconducting dipole is a magnet type that utilizes the Nb3Sn superconductor. A number of these magnets will replace NbTi-based main dipoles that hold the beam in their circular trajectory during operation.

To understand the behaviour of these magnets during a quench, a special magnet model is prepared in COMSOL Multiphysics® using the Sigma model generation tool in combination with the COMSOL Server™. This model calculates the current as a function of time, also considering the temperature- and magnetic-field-dependent properties of the magnet. Three different protection mechanisms are considered, which are quench heaters, the coupling-loss induced quench (CLIQ) system, and external energy extraction. Internally, thermal propagation, eddy currents in the wedges, and inter-filament coupling losses are included in the model. The model results are compared to experimental observations on a double-aperture short model magnet. The consistency between the simulation and experimental observations demonstrates that this model is a useful tool for understanding the quench-related behaviour of superconducting magnets.