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Quench Protection of a 20 T Dipole Magnet with HTS Insert

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The design of a 20 T dipole magnet constituted by an LTS outer coil and a HTS insert is analyzed from a quench protection standpoint.
Protection of such a magnet in the case of a quench brings several challenges. The very high stored energy density requires an effective mean to quickly discharge the transport current and homogeneously distribute the magnet's energy in the winding pack after a quench. The different characteristics of the superconductors used in the insert and outsert coils, in particular their current densities and their energy-margins to quench, make it even more difficult to achieve a uniform ohmic heating in the cross-section. The voltages induced by the magnetic coupling between the insert and outsert coils and the different resistance per unit length in their conductors can generate an unbalanced voltage distribution in the magnet.
Several options for the protection of this outsert-insert magnet system based on quench heaters, CLIQ (Coupling-Loss Induced Quench), or combinations of these are investigated. The electro-magnetic and thermal transient occurring during the magnet discharge is simulated with a model developed using the software TALES (Transient Analysis with Lumped-Elements of Superconductors).
Goal of the design study is the development of an effective quench protection scheme which allows maintaining the coil's hot-spot temperature and the peak internal voltages within acceptable limits. Key parameters of the analyzed protection systems are identified and their impact on the quench performance are assessed.
This study is also relevant for future test facilities where high-field inserts are tested in the background field of a large aperture LTS dipole.

Primary author: Dr RAVAIOLI, Emmanuele (LBNL)

Presenter: Dr RAVAIOLI, Emmanuele (LBNL)

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