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Integrated quench protection model for Nb3Sn high field accelerator magnets

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Reliable quench protection of long high-field Nb3Sn accelerator magnets requires optimization of the present state-of-the-art protection heater technology. The heater geometry and materials must be designed to provide enough multiple normal zones along the winding to ensure fast and uniform dissipation of the stored magnetic energy. At the same time, voltages in the windings and heater temperatures must be kept at an acceptable low value. An integrated design tool is being developed for this purpose as part of the high-field Nb3Sn magnet modeling effort at LBNL. The model is based on numerical computation of thermal heat transport in the cables, which is used to analyze the coil temperature and voltage for different quench origins and heater layouts. In order to have a flexible multi-physics tool adaptable to various magnet and protection schemes, a modular approach is chosen where the coil geometry and magnetic field map are imported from external sources and coupled with the core program for the thermal and electrical computation. This initial stage of the model development relies on simplifying assumptions of the quench initiation and propagation. The principles of theory and development status of the code as well as benchmarking with existing quench computation codes regarding hot spot temperature and MIITs computation are presented.

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