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Validation of Quench Protection simulations in High-Field Nb3Sn magnets by comparison with measurements.

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The Future Circular Collider is at the conceptual design phase and one of the main components are the high-field Nb3Sn dipole magnets targeting 16 T of bore field. With very high current densities and high stored energy, the quench protection is an essential part of the magnet design. The quench protection design relies largely on simulations and naturally, the reliability of the software is crucial. The aim of this paper is to validate the simulation tools with measurements on existing high-field Nb3Sn magnets, namely the MQXFS, 11T-models and RMC racetrack models. We consider those experiments where the protection relies on quench protection heaters.
We consider the following simulation approaches (and their combinations): 1. adiabatic model with thermally independent coil turns and heater delays simulated before experimental validation 2. The model using experimental input for the heater delays, longitudinal quench propagation, fit parameters for turn-to-turn propagation, and quench delay caused by the ac-losses, and 3. scaling law deduced from a few measurement points and magnet's parameters for predicting quenches over the whole range of operation conditions.
The results of the study will be used to assess the suitability of different simulation approaches, and finally to what level of current density and stored energy the designed magnets for FCC can be protected with quench heaters.

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