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Wed-Af-Po.08-03: Multiphysics Model for Analysis and Real-Time Operations of HTS Magnets

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Advanced automation tools are promising wide-range solutions for the various problems still affecting High-Temperature Superconducting (HTS) magnets, including Non-Insulated (NI) ones. State-of-the-art techniques have the potential to enable online monitoring and control of these devices, significantly enhancing their operational robustness to the extent of entirely preventing quench events, shifting the paradigm of magnet protection.
Previously, we proposed an electromagnetic model reduced using Proper Orthogonal Decomposition (POD), demonstrating its ability to preserve the accuracy of the full model while requiring only a fraction of the computational effort. We now integrate a finite-element thermal model with nonlinear material properties and introduce a novel approach to describe the hysteresis of cryogenic bath cooling. Experimental campaigns conducted on small coils in liquid nitrogen are used to validate this model.
The thermal model is then coupled with the electromagnetic model, and the coupled model is processed with model order reduction techniques. We discuss how the reduced model can effectively run with a computation time not exceeding the simulated time, i.e. in real-time. We conclude discussing some of the most relevant automation applications for the model.

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