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Transient Electro-Magnetic and Thermal Simulation of HTS Non-Insulated Coils

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In the last few years High Temperature Superconducting (HTS) non- and partially insulated coils have shown exceptional resilience towards quench and other disrupting effects in many practical experiments. These coils are therefore widely investigated as an approach towards larger high field HTS magnets for both Fusion and Particle Accelerator applications. One of the main concerns for these applications is the quench detection and protection. However, due to the complexity of the physics involved, only few models are capable of simulating the emergent behavior of these coils. To scale to much larger systems, it is necessary to gain a detailed understanding of the electro-magnetic and thermal behavior. To this aim a network model named Raccoon was developed. The model can simulate full-scale, non-, and partially insulated coils down to tape level detail. In this paper these numerical simulations are compared to experimental data that was acquired during quench tests on multiple solenoidal coils, further complemented by data from literature. The comparison is intended as validation, but it additionally provides a unique view of the normal zone propagation and corresponding current redistribution in HTS coils. Using the numerical results, a more theoretical approach will be devised that allows to explain many of the effects observed.

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