

Protection Concepts and Simulation Tools for REBCO Magnets

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Abstract—This talk provides an overview of several protection concepts and simulation tools, specific to REBCO coils, that are currently under development within the TE-MPE group at CERN. Capacitive discharge and more efficient variants of the Coupling Loss Induced Quench method will be presented as promising new protection methods. While simulation tools for LTS magnets are well developed and validated, similar tools for REBCO coils, wound from a single tape or a multi-tape cable, require a completely different approach. This is primarily due to the slow quench propagation, which often necessitates three-dimensional simulations, and the highly anisotropic behavior of the tape which complicates homogenization. In the context of non-insulated (NI) or metal-insulated (MI) coil designs, the introduction of additional current paths between turns necessitates detailed modelling at microscopic scale. Furthermore, the large magnetization effects and turn-to-turn currents resulting from these designs can significantly increase the local Lorentz force during a quench, thereby necessitating the co-simulation of thermos-electro-magnetic and mechanical models.

This presentation introduces several simulation tools, developed as part of the STEAM framework, tailored for both insulated and NI/MI magnet types. It highlights methods to reduce the computational cost, such as conductor homogenization, thin-shell approximation, reduced order and multiscale modelling, and showcases the simulation outcomes that illustrate the intricate nature of quench development in REBCO coils.

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