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Thu-Mo-Spec1-03: [Invited] A review of the tools for quench simulation and protection for large REBCO coils

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This presentation aims to provide a concise overview of the current modeling capabilities and highlight critical gaps in simulation and protection strategies for large REBCO coils. High Temperature Superconductors (HTS) are revolutionizing the design of magnetic confinement systems for nuclear fusion and beyond, offering compactness and efficiency through their ability to generate high magnetic fields at cryogenic temperatures. REBCO tapes have emerged as a leading candidate for large-scale high field magnets. However, the successful integration of REBCO into large magnets presents significant challenges, among which quench protection.

This review explores the diverse landscape of computational tools available for modeling quench dynamics and protection of REBCO coils. These range from simplified yet highly informative 0D models to intricate 3D simulations, where intuition alone often falls short. While complex models offer detailed insights into quench propagation and magnet behavior under fusion-relevant conditions—such as high magnetic fields, intense mechanical stresses, and cryogenic environments—simplified models frequently reveal the power of computational efficiency and conceptual clarity. Both approaches are essential, depending on the specific needs, from early feasibility assessments to advanced design optimization.

More than just a review, it seeks to foster discussion within the community: What tools are we using, and how do they shape our understanding? What are we missing? By exchanging perspectives, we can refine our collective approach and better steer the development of robust, scalable solutions for HTS integration into next-generation high-field systems.

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