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Wed-Af-Or2-04: Field Collapse of a No-Insulation REBCO Coil During a Quench: Numerical Study

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Advancements in high-temperature superconductors (HTS), particularly REBCO coated conductors, have catalyzed breakthroughs in ultra-high field magnet technology. However, significant challenges remain, with quench protection being a critical unresolved issue. The no-insulation (NI) winding technique offers a promising approach to mitigate these challenges. By allowing turn-to-turn bypass currents, NI coils exhibit intrinsic "self-protection"against localized overheating, enabling tolerance of minor defects in the conductor and temporary current overloading. Despite these advantages, quench still happened to many NI REBCO magnets, causing unexpected severe damages.

This study investigates the quench dynamics of NI REBCO coils through numerical modeling. While NI coils are known for their long charging time constants, quench events often result in rapid field collapse, posing significant challenges for timely detection and effective protection. To understand and address these phenomena, we model the quench in a small-scale NI REBCO magnet triggered by a localized defect. Two numerical methods are employed to allow cross-checking of the results: (1) a 2D axisymmetric model using the H-formulation with rotated anisotropic resistivity, and (2) a 3D model utilizing the open-source FiQuS/Pancake3D framework. These models are used to analyze the dynamic behavior during quench events, including inter-turn current sharing and intra-turn screening currents. Based on the numerical results, we discuss the implications for protection strategies and potential methods to enhance the reliability of NI REBCO magnets in high-field applications.

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