Quench Analysis of Pancake Wound REBCO Coils with Low Resistance Between Turns

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The introduction of no-insulation (NI) technology is a milestone in superconducting magnet technology, raising the possibility of ultra-compact high field superconducting coils. There are significant problems yet to be resolved however, including resistive ramping losses and magnetic field drift. One area claimed to be solved by NI technology is quench protection of REBCO pancake wound coils. Data from a recent study by MagLab engineers appears to support this claim, showing that rapid quench propagation is a general characteristic of coils with low resistance (LR) between turns, which are a generalized model of NI coils.

Numerical analysis of a circuit model of LR coils shows in great detail a transition from (1) a thermal diffusion stage in which the radial bypass current acts to limit heating locally, to (2) a dynamic inductive stage with large transient circumferential currents and reverse radial currents that is self-propagating over the extent of the coil. Single coils of extremely high current density are seen to be self-protecting.

Quench protection is a critical core technology for future ultra-high-field superconducting magnets. *These calculations provide a means to understand LR coils, helping to establish that the technology represents a viable future direction for high field magnet design, and providing the basis to resolve the outstanding issues that LR coil technology presents.*

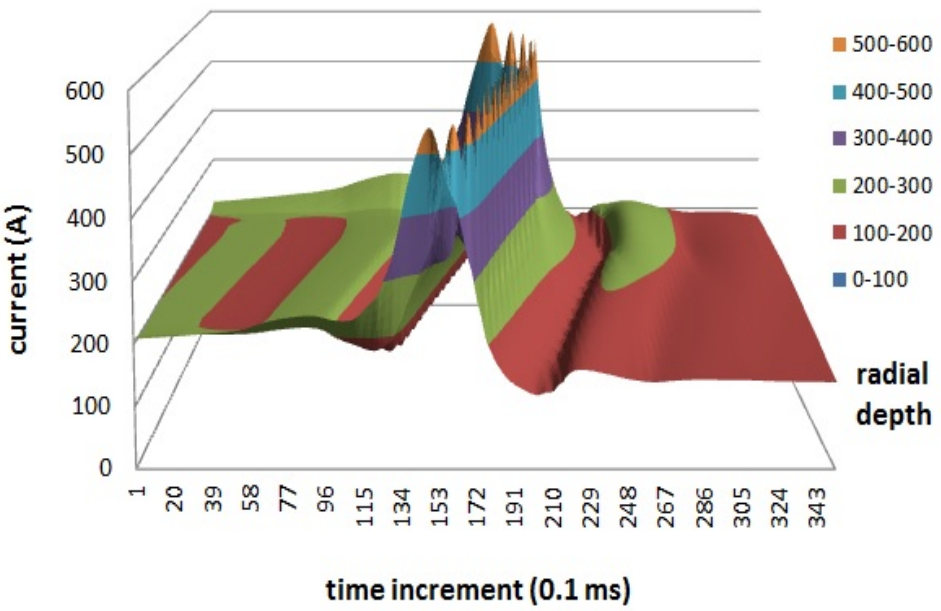

Figure 1. Transient circumferential solenoid current revealed by the analysis. The current forms a wave that rapidly propagates the length of a quenching coil with a sharp peak in amplitude that is several times the initial coil operating current.

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