Contribution ID: **315** Type: **Oral presentation (15min)**

Minimum Quench Energy and Propagation Velocity in Superconductoring Cables with Longitudinal Lateral Cooling

Thursday, 10 July 2014 15:30 (15 minutes)

Superconducting cables operating in a significant longitudinal temperature gradient with forced flow cooling by cryogenic gases, currently investigated for certain specialised applications such as the cold-powering of the high luminosity upgrade of the LHC, have a potentially wider use because of their flexible temperature margins. While superconducting cables and bus-bars in cryogenic liquids are relatively stable, local disturbance induced quench can be a significant issue with gas cooling. The present work extends our recent results on the minimum quench energy (MQE) of power-law superconductors to account for (a) the effects of lateral cooling along the cable and (b) the influences of the longitudinal temperature gradient. The former correlates the heat transfer coefficient to MQE enhancements and the latter involves the interplay between a lower thermal capacity at the cold side and operating in a higher proportion of the critical current at the warm side. Theoretical analysis and quench measurements have been carried out and compared for helium gas cooled MgB2 cables operating between 4.2K and 30K. The influences of stabilisation matrix, heat transfer coefficient and radial propagation across sub-cables are carefully examined. Proposals to quench detection and faster propagation are presented.

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Session Classification: Thu-Af-Oral Sessions 15

Track Classification: M-04: MgB2 processing and properties