A Stability diagram for YBCO Roebel Cables at 77 K with varying heat pulses and I/lc

Discussion of Results

The large temperature margins of HTS conductors will likely prevent epoxy cracking, friction from sudden mechanical motion, and flux jumps from initiating a quench [1]. Additionally, the large temperature margin will result in relatively long quench decision times on the order of seconds even under adiabatic conditions [2]. For these reasons, it may make more sense to approach HTS stability in terms of Minimum Quench Power (MQP) instead of MQE (Minimum Quench Energy) [3,4].

Using the Stekly criterion:

\[ \Delta T = \alpha \times \frac{I_{\text{ref}}^2}{A_{\text{ref}}} \]

above I, a Roebel Cable in LN2 should be exceedingly cryostable (\( \alpha < 0.027 \)). The Stekly criterion assumes an internally well-distributed heat perturbation (HP). An applied local HP, a heater in this experimental case, can create a much less stable situation. Below is the situation for when cold-end cooling is taken into account with a local HP.

\[ \Delta T = \alpha \frac{I^2}{A} \]

Where:
- \( A_{\text{ref}} = \) area of Cu-stabilizer in the cable cross-section
- \( I_{\text{ref}} = \) Critical Current at 77 K
- \( P_{\text{ref}} = \) Perimeter x the perimeter of all of the tapes in the Roebel cable
- \( h = \) surface area fraction being effectively used for cryogenic cooling
- \( k = \) thermal conductivity of the cable, \( h = \) heat-transfer coefficient to LN2
- \( A = \) electrical resistivity of cable in normal-state, \( \Delta T = T^2(T) - T^2(N2) \)
- \( A_{\text{ref}} = \) surface area of all tapes in the HP zone
- \( \eta = \) power heat-perturbation

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References:

From Left to Right: (1) Experimental stability response vs heat perturbation. (2) Two experimental data sets (= 0.66 and 0.84) compared to that predicted by theory. (3) Determination of Eta, i.e. the % of cable area efficiently utilized for cooling.