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Thu-Mo-Po.08-01: Current Sharing and Quench in ReBCO based superconducting cables for Accelerator Dipole Magnets: Modelling and Measurement

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This work analyzed current sharing and quench evolution in REBCO based superconducting cables intended for use in the High Energy Physics (HEP) accelerator dipole magnets. Current sharing was explored for simple tape stack cables using FEM modelling. Summaries are given for finite element work performed on various number of stacked tape cables, in 3D configurations while varying interstrand contact thermal and electrical resistance, for fixed thermal boundary conditions, as well as several different values of defect densities. We focused on determining the point of thermal runaway, which can be considered a measure of current sharing, and found it to be dependent on interstrand and intra-strand electrical and thermal contact resistances, including, e.g., the effects of oxide surface layers on the outsides of the tapes, and buffer layers inside of the tapes, and also the number of defects per unit length in the tape and their distribution. It was seen that it is possible to develop a simple equation for current sharing which incorporates both inter- and intra-strand electrical and thermal resistances. This was compared to an analytic/lumped model approach, and developed expressions for the approach to the current for thermal runaway for liquid cooled cables with sparse defects. To do so we coupled simple thermal and electric expressions, and showed explicitly, (under simplifying assumptions) that the total current that can pass through a mildly defected superconducting cable is determined by its cooling boundary conditions, its inter-tape resistivity, the tape stacks thermal conductivity, and the distance between defects. These results were compared to a series of simple experiments using three tape cables with defects intentionally introduced. Measurements in this case were performed in self-field in LN2. We compared soldered and "as received"(untreated) stacks of tapes with different defects patterns, and with different cooling boundary conditions (access to the LN2).

Authors: COLLINGS, Edward (The Ohio State University); SUMPTION, Michael; MAJOROS, Milan; JIANG, Minzheng

Presenter: SUMPTION, Michael

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