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A novel model for Minimum Quench Energy calculation of impregnated Nb3Sn cables and verification on real conductors

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In light of the ongoing conductor research at CERN for the planned LHC upgrades, minimum quench energy (MQE) of the latest Nb3Sn conductors is investigated using spot heaters. These conductors are used in high field accelerator magnets, which are prone to training quenches emanating from small energy depositions (wire movement, epoxy cracks) in the conductor during ramps. To improve the understanding of the thermal stability mechanisms, the experimental results are compared to a novel numerical model of an impregnated Rutherford cable. The model can then be used to extrapolate the values of the MQE to ranges that are not measurable due to practical limitations. Additionally, the model can be used to predict the optimal set of parameters to attain maximum stability, decreasing the number of training quenches.
This paper will describe the numerical model and the concepts behind it. It is a transient simulation, taking into account the heat and current flows and the local properties of the conductor depending on the temperature. Aside from an external heat pulse to simulate the energy deposition, the model assumes the cable to be perfectly adiabatic. The size of the heat pulse is varied over several simulation runs to find the transition point where the conductor can recover or not. The results of the model are then compared to actual MQE measurements and will be used to map the thermal stability margin in the cross section of a coil that is build with this cable.

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