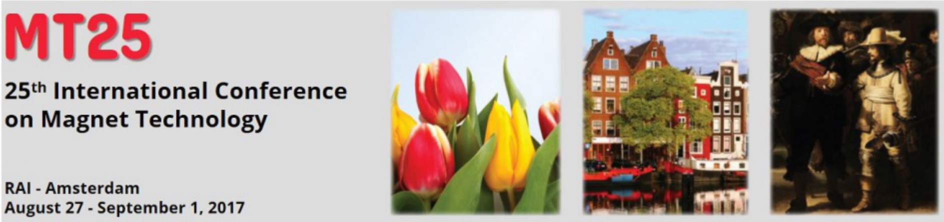

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Quench Protection of a Nb3Sn Superconducting Magnet System for a 45 GHz ECR Ion Source

Thursday, 31 August 2017 13:45 (1h 45m)

Lawrence Berkeley National Laboratory (LBNL) in collaboration with the Institute of Modern Physics (IMP) is developing a Nb3Sn based superconducting magnet system for a fourth-generation ECR source, with a goal of achieving the field required for operating at the microwave frequency of 45 GHz. The magnet system is composed of one sextupole magnet and three solenoids of different sizes manufactured using Nb3Sn round wire. Given the high stored energy density and relatively low wire copper section, the coils are not self protected in case of a quench. In order to avoid permanent damage due to overheating, an active quench protection system is required. The protection of each individual magnet is analyzed separately maintaining common requirements in terms of maximum allowed hot-spot temperature and voltage to ground. The study of the transient following a quench is carried out by means of the LEDET (Lumped-Element Dynamic Electro-Thermal) program, which includes a detailed simulation of the inter-filament coupling losses developing in the wire. The baseline quench protection strategy includes energy extraction systems protecting each of the four magnet coils under consideration. The resistances of the four extraction resistors are selected as a compromise between a quick current discharge, calling for high resistance, and a low voltage to ground, calling for a low resistance. Non-linear effects occurring in the magnet, such as quench-back and differential inductance reduction, have a significant impact on these magnets' protection. It is shown that energy extraction meets the quench protection targets for the four magnet coils. Furthermore, in order to enhance the redundancy of the quench protection system and reduce the peak voltages to ground, the implementation of a CLIQ (Coupling-Loss Induced Quench) system is under consideration.

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