

Protecting a Full-Scale Nb₃Sn Magnet with CLIQ, the New Coupling-Loss Induced Quench System

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Abstract — A new protection system for superconducting magnets called CLIQ (Coupling Loss Induced Quench system), was recently developed at CERN. Recent tests on Nb-Ti coils showed that CLIQ is a valid, powerful and promising method for the protection of high field magnets. However, the protection of new generation high magnetic field Nb₃Sn based superconducting accelerator magnets is even more challenging due to the much higher stored energy per unit volume and to the significantly larger enthalpy needed to initiate and propagate a normal zone in such coils. Now the CLIQ system is tested for the first time on a Nb₃Sn magnet in the CERN magnet test facility in order to investigate its performance in practice thereby validating the method for this type of superconducting magnets as well. Measurement results of discharges at various current levels are presented and compared to discharges obtained by quenching the magnet using conventional quench heaters and an energy extraction system. Furthermore, a dedicated simulation model of the magnet is developed to reproduce the measured transients and simulate CLIQ discharges under varying operating parameters. Finally, the implementation of a CLIQ based protection system for full size Nb₃Sn magnets is discussed. The advantages and drawbacks of using multiple CLIQ units on a single magnet as well as the simultaneous use of CLIQ and classical quench heaters are thoroughly discussed.