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Analytical Method for the Prediction of Quench Initiation and Development in Accelerator Magnets

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The optimal design of the next generation of accelerator magnets calls for a high current density in the superconducting coil, which makes the magnet protection a challenge. Quenches in the high-field magnets for the High Luminosity LHC Upgrade typically develop within tens of ms, and the reaction time needs to be comparable, requiring active firing of heaters or other heat deposition techniques to increase the quench propagation velocity in the magnet. It is important to have a very good understanding of the behavior of a magnet during a quench. Practical scaling laws, and simplified methods, allow quick scans of design and operation parameters, and swift feedback based on experimental results once the magnet is in test.

In this paper we describe simplified methods to predict the quench initiation and development in accelerator magnets using active quench protection. We use data from the recent Nb3Sn R&D and model magnets for the High-Luminosity LHC as a benchmark for the method, discussing expected accuracy and the reasons for deviations.

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