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Quench Protection Design of the HL-LHC Hollow Electron Lens System

Hollow electron lens systems are proposed for the depletion of particles in the halo of proton beams of modern high-energy accelerators such as the High-Luminosity upgrade of the LHC. The system allows for actively regulating the diffusion speed of particles as a complement to standard collimation systems already operating in today's particle accelerators. The High-Luminosity upgrade aims at doubling the beam intensity and increasing the peak luminosity of the LHC by an order of magnitude, which translates into a need for an improvement in the beam collimation in order to avoid highly populated beam tails in during fast failures and resulting beam movements. Studies are on-going to investigate if this can be achieved by the use of a hollow electron lens.

The design of the HL-LHC hollow electron lens system consists of a dozen superconducting magnets, grouped into several electrical circuits, for guidance and confinement of the electron beam. The quench protection strategy and parameters have been studied in order to guarantee safe operation in nominal condition as well as failure scenarios, by maintaining the maximum voltage and peak temperature below safe limits. To this end, we employ electrical, magnetic, and thermal numerical models of superconducting magnets, busbars, and circuits. Depending on the desired accuracy, models with growing fidelity (accuracy, completeness of physics representation) are considered. In this paper, we discuss the quench protection design along with results of an integrated numerical study at both magnet and circuit levels.

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