27th International Conference on
Magnet Technology (MT27)
Fukuoka, Japan / 2021

Contribution ID: **137** Contribution code: **TUE-PO1-113-01**   Type: **Poster**

Conceptual Design of the HL-LHC Hollow electron lens superconducting magnet system

Tuesday 16 November 2021 13:15 (20 minutes)

The new HEL (Hollow Electron Lens) units are part of the upgrade baseline of the High-Luminosity LHC accelerator (HL-LHC) will be installed in the machine ring at point P4 on each counter-rotating LHC proton beamline during a long shutdown in 2025-2027 at CERN. The main goal is to achieve active control of the proton beam halo as a robust solution of risk mitigation to improve the collimation system performance by controlling beam energy loss in the beam halo.

The magnet system consists of two main 1.5 m long split 5 T superconducting solenoids equipped with steering dipole correctors and fringe field coils which compress the annular low energy e-beam (15 keV) generated from the e- gun cathode and provide a stable interaction region with the high energy proton beam (7 TeV). Other sets of superconducting solenoids up to 4.0 T are used for fine-tuning and guiding the electron beam at the extremities of the interaction region on both the gun and the collector side. A standalone dipole compensator is included to correct the net transverse field components up to 0.5 T.m responsible for a vertical kick onto the main proton beam.

The compact design of the cryostat operating at 4.5 K is challenging, and the quench protection scheme is complex as it houses multiple coils assembly with large inductances and mutual coupling. An essential feature of the main solenoid's system performances is the field quality requirements defined, in line with selected measurement technology options. In this paper, the design progress of the HEL magnet system is presented and discussed.

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Session Classification: TUE-PO1-113 HL-LHC Accelerator Magnets III: NbTi