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Luminosity measurement at the HL-LHC with the ATLAS detector: Strategy and prototyping

Tuesday 28 March 2023 10:00 (20 minutes)

The physics program at the High Luminosity LHC (HL-LHC) calls for a precision in the luminosity measurement of 1%. A larger uncertainty would represent the dominant systematic error in several precision measurements, including in the Higgs sector. To fulfil this requirement in an environment characterized by up to 140 simultaneous interactions per bunch crossing (200 in the ultimate scenario), ATLAS will rely on multiple, complementary luminosity detectors, covering the full range of HL-LHC beam conditions from the low-luminosity, low-pileup regime of the van der Meer (vdM) calibrations to the high-luminosity environment typical of physics running.

The ATLAS luminometer coverage at HL-LHC will extensively build on the experience obtained in the current third running period of the LHC. The interplay of several luminometers, based on different technologies is essential for a high-precision luminosity measurement. The HL-LHC successor of LUCID-2 - the reference ATLAS luminometer since the beginning of the second running period of the LHC - is LUCID-3. Both devices are based on small acceptance photomultiplier tubes (PMTs) whose quartz entrance window serve as a Cerenkov radiator. Two different prototypes for LUCID-3 are installed in the ATLAS cavern and have been taking data since the beginning of the 2022 LHC run. Diamond- and silicon-pad technology are used in, respectively, the BCM'detector, inspired by the present ATLAS Beam Conditions Monitor, and the BMA ("Beam Monitor for ATLAS"). The latter is optimized for a highly linear response in the intermediate- and high-luminosity regimes, and had an early prototype installed and recording its first data in 2022. The Pixel-cluster-counting (PCC) technique is exploited by two very different luminometers: the Si- based pixel-luminosity ring (PLR), integrated in the very forward section of the upgraded inner tracker (ITk), and the HGTD (High Granularity Timing Detector), based on LGAD technology. The full ITk will also be used for track- and PCC-based offline-luminosity measurements. The upgraded ATLAS calorimeters will provide luminosity measurement through the LAr-gap current in the end-cap and forward electromagnetic calorimeters, and the PMT currents of the TILE hadronic calorimeters, both of which play an essential role in reducing systematic biases in luminosity measurements.

The presentation will outline of the ATLAS strategy for luminosity determination at the HL-LHC, discuss the plans for the luminometer upgrades, the status of the existing prototypes and their first results.

Submitted on behalf of a Collaboration?

Yes

Participate in poster competition?

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