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A High-Granularity Timing Detector for the Phase-II upgrade of the ATLAS Calorimeter system: detector concept description and first beam test results

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The expected increase of the particle flux at the high luminosity phase of the LHC (HL-LHC) with instantaneous luminosities up to L ⊠ 7.5 × 10ˆ{34} cmˆ{−2} sˆ{-1} will have a severe impact on the ATLAS detector performance. The pile-up is expected to increase on average to 200 interactions per bunch crossing. The reconstruction and trigger performance for electrons, photons as well as jets and transverse missing energy will be severely degraded in the end-cap and forward region, where the liquid Argon based electromagnetic calorimeter has coarser granularity compared to the central region. A High Granularity Timing Detector (HGTD) is proposed in front of the liquid Argon end-cap calorimeters for pile-up mitigation at Level-0 (L0) trigger level and in the offline reconstruction.

This device should cover the pseudo-rapidity range of 2.4 to about 4.2. Four layers of Silicon sensors are foreseen to provide a precision timing information for minimum ionizing particle with a time resolution better than 50 pico-seconds per readout cell in order to assign the particle to the correct vertex. Each readout cell has a transverse size of 1.3 mm × 1.3 mm leading to a highly granular detector with more than 6 millions of readout electronics channels. Low Gain Avalanche Detectors (LGAD) technology has been chosen as it provides an internal gain good enough to reach large signal over noise ratio needed for excellent time resolution.

The requirements and overall specifications of the High Granular Timing Detector at the HL-LHC will be presented as well as the conceptual design of its mechanics and electronics. Beam test results and measurements of irradiated LGAD silicon sensors, such as gain and timing resolution, will be shown.

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