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A High-Granularity Timing Detector for the Phase-II upgrade of the ATLAS Calorimeter system

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The expected increase of the particle flux at the high luminosity phase of the LHC with instantaneous luminosities up to L ⊠ 7.5 × 10^{34} cm^{−2} s^{−1} will have a severe impact on pile-up. The pile-up is expected to increase on average to 200 interactions per bunch crossing. The reconstruction and trigger performance for especially jets and transverse missing energy will be severely degraded in the end-cap and forward 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 cover the pseudo-rapidity range of 2.4 to about 4.2. Four layers of Silicon sensors, possibly interleaved with Tungsten, are foreseen to provide precision timing information for charged and neutral particles with a time resolution of the order of 30 pico-seconds per readout cell in order to assign the energy deposits in the calorimeter to different proton-proton collision vertices. Each readout cell has a transverse size of only a few mm, leading to a highly granular detector with several hundred thousand readout cells. The expected improvements in performance are relevant for physics processes, i.e, vector-boson fusion and vector-boson scattering processes, and for physics signatures with large missing transverse energy. Silicon sensor technologies under investigation are Low Gain Avalanche Detectors (LGAD), pin diodes, and HV-CMOS sensors. In this presentation, starting from the physics motivations and expected performance of the High Granular Timing Detector, the proposed detector layout and Front End readout, laboratory and beam test characterization of sensors and the results of radiation tests will be discussed.

Abstract submitted on behalf of the ATLAS Liquid Argon Speaker's Committee
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