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Performance studies of Low Gain Avalanche Detectors for the ATLAS High Granularity Timing Detector

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The High Granularity Timing Detector (HGTD) is designed for the mitigation of pile-up effects in the ATLAS forward region and for bunch per bunch luminosity measurements. HGTD, based on Low Gain Avalanche Detector (LGAD) technology and covering the pseudorapidity region between 2.4 and 4.0, will provide high precision timing information to distinguish between collisions occurring close in space but well-separated in time. Apart from being radiation resistant, LGAD sensors should deliver 30 ps time resolution per track for a minimum-ionising particle (35 ps per hit) at the start of lifetime, increasing to 50 ps per track (70 ps per hit) at the end of HL-LHC operation. In this talk, we will present the performances of several neutron irradiated LGAD sensors from different vendors studied using charged-particle beams in 2022 at CERN SPS and DESY. This study covers the promising results in terms of collected charge, time resolution and hit efficiency of LGADs. A time resolution of < 70 ps is observed in most cases for highly irradiated sensors ($2.5e15$ neq/cm^2), while integrating timing information to the EUDET system allows for a surface resolution of less than 50 µm. The triggering architecture, picosecond synchronisation scheme and analysis logic will also be presented as well as application-specific electronics and components.

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