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Synchrotron light source X-ray detection with Low-Gain Avalanche Diodes

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Low Gain Avalanche Diodes (LGADs) represent the state-of-the-art in timing measurements, and will instrument the future Timing Detectors of ATLAS and CMS for the High-Luminosity LHC. While initially conceived as a sensor for charged particles, the intrinsic gain of LGADs makes it possible to detect low energy X-rays with good energy resolution and excellent timing (tens of picoseconds). Using the Stanford Synchrotron Radiation Lightsource (SSRL) at SLAC, several LGADs designs were characterized with energies from 10 to 70 keV. The SSRL provides 10 ps pulsed X-ray bunches separated by 2 ns intervals, and with an energy dispersion ΔE/E of 10^{-4}. LGADs from Hamamatsu Photonics (HPK) and Brookhaven National Laboratory (BNL) with different thicknesses ranging from 20 µm to 50 µm and different gain layer designs were read out using fast amplification boards and digitized with a high bandwidth and high sampling rate oscilloscope. PiN devices from HPK and AC-LGADs from BNL were characterized as well. A systematic and detailed characterization of the devices' energy linearity, resolution and timing resolution as a function of X-ray energy was performed for different biasing voltages at room temperature and will be reported in this presentation. The charge collection and multiplication mechanism were simulated using GEANT4 and TCAD Sentaurus, providing an important handle for interpreting the data.

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