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Development of a Deep Junction LGAD for Soft X-rays

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Recent developments in X-ray technology have highlighted a significant gap between the advancements in X-ray facility capabilities and the corresponding limitations in detector technologies, especially in the soft X-ray energy range (200 eV to 2 keV). While hybrid pixel detectors are the standard for higher-energy X-ray applications (2–20 keV), their implementation in the soft X-ray regime remains underexplored despite their high frame rates, dynamic range, and excellent signal-to-noise ratios. Low Gain Avalanche Diodes (LGADs), characterized by moderate internal gains in the range of 5–10, have emerged as a promising solution for addressing the signal-to-noise ratio limitations inherent in soft X-ray detection. However, several challenges remain in optimizing LGAD technology for this lower energy range. This work introduces an innovative sensor architecture, the Deep Junction LGAD (DJ-LGAD), which incorporates a specialized charge-absorbing region and a gain layer to enable efficient signal amplification. We present the detailed design of the device, along with the results of simulations and preliminary experimental data. Additionally, we discuss the various challenges encountered during the fabrication process and underscore the potential of DJ-LGADs as a promising solution for advancing next-generation soft X-ray detection technologies.

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