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Investigation of low-fluence proton and neutron irradiation on n-type LGADs

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Low Gain Avalanche Detectors build on n-type substrate (nLGADs), developed by IMB-CNM, are optimized for the detection of low-penetrating particles such as soft X-rays, low-energy protons, and UV photons. Their design features a n-type gain layer that enables efficient charge multiplication for charge generation near the surface, making them suitable for applications in medicine, industry, and scientific research. Studying radiation effects on nLGADs not only provides insight into the fundamental physics of donor removal, gain suppression and hole amplification in the n-type gain layer, but also offers synergies with current HEP developments, including novel, radiation tolerant concepts such as the compensated LGAD.
In this study, we present the investigation of radiation-induced degradation in nLGADs irradiated with 60 MeV protons and reactor neutrons, up to maximum fluences of $1{\cdot}10^{14}$ particles/cm2. This extends our previous work on high-energy (23 GeV) proton irradiation to lower energies and different particle types. Electrical characterization including current-voltage (IV) and capacitance-voltage (CV) measurements are used to study changes in the effective doping concentration leading to space charge sign inversion (SCSI) and altered depletion behavior with irradiation. These effects were observed in nLGADs irradiated with 23 GeV protons already at fluences considerably lower than those commonly tested in the HEP sensor community, and are now investigated in more detail. Additionally, annealing studies are conducted to investigate the extent of reverse annealing effects after irradiation. Transient Current Technique (TCT) with different laser wavelengths is employed to probe gain degradation, gain suppression and donor removal, while Two-Photon Absorption TCT (TPA-TCT) is used to give insight into the evolution of electric fields in the nLGADs with irradiation.

Type of presentation (in-person/online)

in-person presentation

Type of presentation (I. scientific results or II. project proposal)

I. Presentation on scientific results

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