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Investigation of Breakdown and Timing Performance in Post-Irradiated Multiple JTE-Guarded 4H-SiC LGADs Using TCAD

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Low Gain Avalanche Detectors (LGADs) based on 4H-Silicon Carbide (SiC) are promising for fast timing applications in high radiation environments, offering advantages over traditional Si LGADs due to their superior material properties. A key challenge remains the design of robust edge termination that maintains high breakdown and stable gain after heavy irradiation. In this work, we present detailed TCAD simulations for 4H-SiC LGAD structure using multiple Junction Termination Extensions (JTEs) with deep p+ guard implants, comparing different sensor thicknesses. The electric field profiles, charge collection, and timing resolution before and after irradiation are evaluated. In addition, we simulate thermal annealing cycles and quantify their effect on defect removal and field recovery. The results of this study provide design guidance and post-irradiation treatment to maximize SiC-LGAD lifetime and timing precision for HL-LHC or future collider experiments.

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