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Characterization and Monte Carlo simulation of single ion Geiger mode avalanche diodes integrated with a quantum dot nanostructure PETER SHARMA, J. B. S. ABRAHAM, G. TEN EYCK, K. D. CHILDS, E. BIELEJEC, M. S. CARROLL, Sandia National Laboratories — Detection of single ion implantation within a nanostructure is necessary for the high yield fabrication of implanted donor-based quantum computing architectures. Single ion Geiger mode avalanche (SIGMA) diodes with a laterally integrated nanostructure capable of forming a quantum dot were fabricated and characterized using photon pulses. The detection efficiency of this design was measured as a function of wavelength, lateral position, and for varying delay times between the photon pulse and the overbias detection window. Monte Carlo simulations based only on the random diffusion of photo-generated carriers and the geometrical placement of the avalanche region agrees qualitatively with device characterization. Based on these results, SIGMA detection efficiency appears to be determined solely by the diffusion of photo-generated electron-hole pairs into a buried avalanche region. Device performance is then highly dependent on the uniformity of the underlying silicon substrate and the proximity of photo-generated carriers to the silicon-silicon dioxide interface, which are the most important limiting factors for reaching the single ion detection limit with SIGMA detectors. Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-AC04-94AL85000.

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