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Quantifying sources of charge variance in CdZnTe

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The performance of CdZnTe gamma spectrometers has dramatically improved over the years by the use of single-carrier detector designs, charge trapping correction methods, and reduction of gross material defects. However, substantial increases in electron mobility-lifetime (mu-tau) product reported recently have not resulted in further improvement of energy resolution for coplanar grid spectrometers[1]. Resolution in these devices is currently limited by inhomogeneous charge collection, which cannot be corrected by simple techniques. We report new analyses of charge collection variance in planar devices, which can in principle separate effects due to carrier statistics, band gap variation, inhomogeneous trapping, and direct electric field perturbations, to determine the dominant sources of peak broadening in gamma spectrometers. The method extends a detailed propagation of errors through the Hecht equation[2] to derive distinct field dependencies of these sources of charge variance in planar semiconductor devices. This analysis shows that variance due to electric field perturbations is more strongly dependent on the applied field than variance due to inhomogeneous mu-tau products. We have used this approach to study alpha particle induced pulses of CdZnTe samples produced by several growth methods. Our results show that many samples may be dominated by non-uniform fields, leading to spectrometer performance limited by a heretofore unrecognized source of peak broadening. Possible causes of electric field variance and methods to evaluate their magnitudes will be presented and discussed.

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