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Basis Pulse Shape Analysis using planar HPGe semiconductor detectors

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We present an approach of applying Pulse Shape Analysis to preamplifier charge pulses from a planar High Purity Germanium (HPGe) semiconductor γ-ray detector to improve interaction position resolution through depth. This leads to an improvement in the quality of images reconstructed by Compton camera systems that are comprised of such detectors. Algorithms that achieve this and recent experimental data is discussed.

Digital ADCs allow charge pulses to be stored for each γ-ray interaction in the detector. By scanning the detector using a collimated source a database of reference pulses can be built corresponding to specific interaction sites. Experimental pulses can be compared to this database using a chi-squared minimisation method to extract position information beyond the raw granularity of the detector.

This method was tested using a planar HPGe semiconductor
detector with an active volume of 60mm x 60mm x 20mm, electronically segmented to give raw position resolution of 5mm x 5mm x 20mm. Database pulses were recorded at 1mm intervals both across the face of the detector (x) and through depth (y) with FWHM values of ≤ 2.5mm for y positions at all given x positions. This was compared to datasets from a Compton camera experiment using the same detector and CAEN V1724 digital ADCs where Cs-137 and Na-22 measurements were taken in various positions and configurations. Experimental pulses were digitized and compared to the database to form a histogram of interaction depths. By comparing this to the expected exponential attenuation of γ-rays as predicted by theory this concept can be validated. Results from this investigation will be presented in the context of a γ-ray Compton imaging device being developed for a nuclear decommissioning application.

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Oral

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