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Feasibility study of the algorithm for identifying multiple gamma-ray scattering sequence in a pixelated CdZnTe detector

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Cadmium Zinc Telluride (CZT) detectors have been of interest for X-ray and gamma-ray spectroscopy operating room temperature [1]. The use of CZT detectors has helped to increase both efficiency and effectiveness of detector performance in many applications, such as nuclear medical imaging and industrial imaging systems. However, the performance of the pixelated CZT detectors in the imaging applications is often limited not only by the inefficient charge collection within the detector [2] but also by the intrinsic spatial resolution based on the geometric size [3]. Moreover for the pixelated CZT detector as a component of the gamma-ray imaging device, such as a Compton camera, multiple scattering of gamma rays in the CZT material results in poor image resolution and image sensitivity. Generally only single-pixel photo-peak events are used in the imaging resolution, multiple gamma-ray events in the image reconstruction are not included even those events are dominant for the pixelated CZT detector [4]. To overcome this problem, multiple gamma-ray scattering sequence in the pixelated detector should be known.

In this work we present the algorithm for identifying multiple gamma-ray scattering sequence to improve the energy resolution and determine the interaction positions in a 16-pixellated CZT detector with dimensions of 5.9 mm x 5.9 mm x 5mm which has an array of 4 x 4 pixels with a pitch of 1.1 mm manufactured by eV Products. Two-pixel events were selected for the gamma-ray tracking from the Monte Carlo simulation studies using a GEANT4 simulation toolkit [5]. In order to determine the interaction depth in the detector, we used the correlation function between the pulse rise-times and the depths in the analysis. Two neighboring anode pulse shapes were digitally recorded with a 64-channel 62.5 MS/s digitizer (v1740B) manufactured by CAEN. By using data obtained for gamma rays emitted from a 22Na standard source, we were able to conduct depth sensing and determining gamma-ray sequences.

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