Position Sensitivity Study of Double Sided Germanium Strip detector Using Coincidence Method

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Introduction

The development of highly segmented position sensitive germanium detectors have marked the advancement in the field of gamma spectroscopy experiments. The highly segmented detector arrays have striking features like gamma-ray tracking and Pulse Shape Analysis (PSA), which provides precise information of the gamma interaction location inside the detector from the comparison of pulses obtained for two orthogonal data sets [1]. For the characterization of such segmented detectors, it is necessary to record pulse shapes for each gamma interaction point inside the detector because of the complexity of pulses at various locations. The data set of stored pulses is compared with the pulse shapes obtained through experimental measurements performed for an unknown source. In the present work, the scanning facility at GSI has been used to characterize the Position Sensitive Planar Germanium (PSPGe) detector.

Experiment and Analysis

The scanner consists of a Position Sensitive Detector (PSD) which is made of Lutetium Yttrium Orthosilicate (LYSO) scintillator crystal coupled with the 16 X and 16 Y anodes mesh Photomultiplier tube [2]. The PSD has been well characterized, and the position resolution is of the order of ≈ 1-2 mm. The PSPGe is a position sensitive double sided orthogonal strip detector. It consists of 10 horizontal (DC coupled) and 10 vertical (AC coupled) strips at the two opposite faces [3]. The size of the detector is 6 x 6 x 2 cm^3. In the present analysis, the horizontal strips are numbered from DC0 to DC9, and vertical strips are numbered from AC16 to AC25.

The coincidences have been demanded between PSD and PSPGe detectors using positron annihilation employing a ^{22}Na source. After the process of pair annihilation, two 511 keV gamma-rays are emitted in opposite directions from each other. The charge collected in PSD is used to obtain 2-D image from the coincidence data. It has been achieved by using QDC to acquire the information of charge collected at X and Y anodes in PSD. The centroid fitting method has been used to find the centroid channel of charge collected at anode for the coincidence events. The 2-D image obtained from coincidence is shown in Fig. 1(a). The analysis has been performed to look for the position sensitive strips by gating on 511 keV photopeak energy. After demanding the coincidence events for every time any of the two horizontal (DC3 or DC8) or two vertical strips (AC19 or AC24) fires, the image obtained has been shown in Fig. 1(b).

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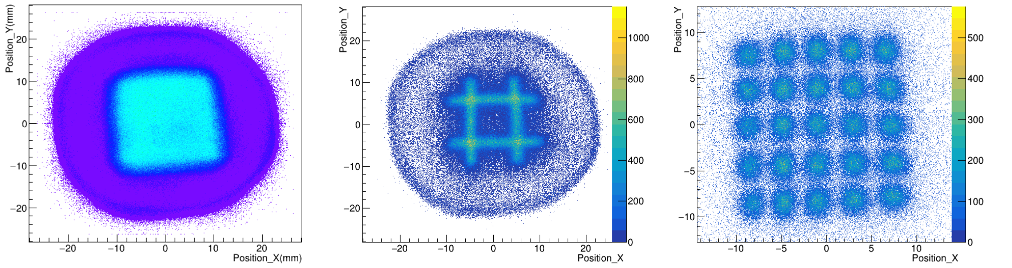

FIG. 1: (a) 2-D image obtained from PSD for coincidence setup showing (a) complete image (b) two selected strips in horizontal and vertical directions (c) voxel arrangement.

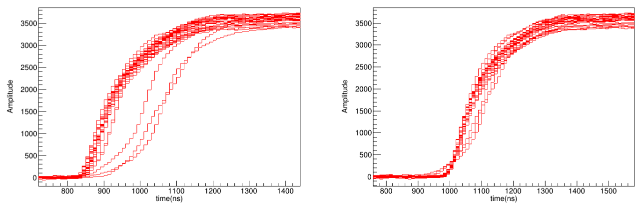

FIG. 2: Traces (a) before and (b) after time alignment.

The size of each strip is 6 mm. The above stated analysis has been further extended to look for voxels in the 2-D image. For this, the analysis gate was constructed for strips with a condition that a horizontal strip fires in coincidence with a vertical strip. The selected horizontal strips are DC0, DC2, DC4, DC6, and DC8. The vertical strips are AC16, AC18, AC20, AC22, and AC24.

The 2-D image has been used to study the charge collection properties of PSPGe detector. This has been performed by analysing the pulse shapes and energy obtained from SIS3316 digitizer for each strip in PSPGe detector. The pulses/traces collected are refined by performing baseline subtraction. Thereafter, the traces are normalized w.r.t. the maximum amplitude of pulse shape, and they are time aligned at 10% of the maximum amplitude. The traces before and after normalization have been represented in Fig. 2 (a) and (b), respectively.

From the above analysis, it may be stated that the PSPGe detectoris sensitive towards gamma-ray interaction. This can be studied by gating on a strip and further finding the time response using the rise-time information obtained from trace generated by the incoming gamma-ray event inside the detector. The future analysis to calculate position resolution of the PSPGe detector is in progress.

Acknowledgment

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