Compton Imaging with GFAG Scintillator with high time resolution ASIC

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Abstract

The 4-phi gamma-ray imaging is useful to find the location of radiative materials in a random position and can be used for various environmental applications. To develop the detector MPPC array combine with GFAG crystal and high time resolution front end electronic is used. The performance of the Compton detector simulated using Geant4.

Keywords: Gamma-ray imaging, Compton Imaging, GFAG Crystal, ASIC

1. Introduction

Compton camera system is an electronically collimated gamma-ray photon imaging device that can estimate the position and intensity of the radiation source. It can be applied to identify a hidden radioactive source in the decommissioning process and neutralize terrorism action using radioactive. In this research, we develop a sphere gamma-ray imager using the Compton principle. The detector uses a 64-pixel MPPC array by Hamamatsu and GFAG (Gadolinium Fine Aluminum Gallate) scintillator with a size of 3 mm x 3mm x 5 mm. The 64 channel ASIC (Application-Specific Integrated Circuit) was used for the front-end electronic circuit. Each channel on the ASIC has pre-amp, shaper, and TOT (Time-Over Threshold) circuits, which are used to change the analog output from MPPC to digital output.

3. Time resolution and Coincident event

The coincident time resolution measurement has been done. The setup for the time resolution is shown in Fig.1. The ^{22}Na was used to get a coincident event. The source was located in the center of the detector, where the distance between the detector is 10 cm. The detector was kept in a controlled chamber with a 20°C temperature. The result showed the detector system can give us a 345 ps (FWHM) time resolution. In order to estimate the optimum distance for the Compton detector, we simulate the detector efficiency using Geant4. In this simulation, the distance between scatter and absorber varied from 60 mm - 120 mm, setup is shown in Fig 2. The normalized graph on detector efficiency and coincident event from simulation is shown in Fig. 3. The number of events detected and coincidence event decrease as distance increase. The distance of 80 mm and 90 mm could be the optimum position for the Compton camera.

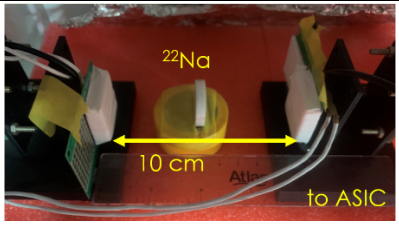

Fig. 1. Time Resolution Measurement

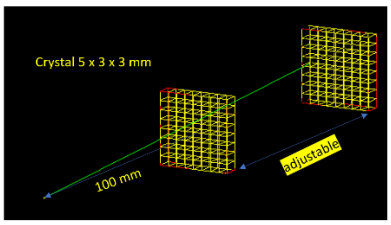

Fig. 2. Geant4 Simulation

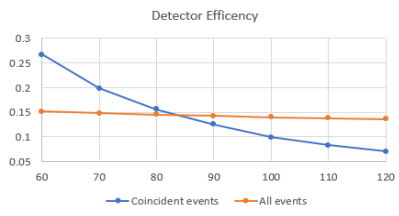

Fig. 3. Detector Efficiency

References

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