The application of Double-sided Silicon Strip Detector in Compton camera

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Abstract

Compton camera can be used in a wide range of area regarding gamma ray detection. We proposed the use of Double-sided Silicon Strip Detector as the scatterer in Compton camera. Its unique structure allows a significant save on readout electronics. We used an Application Specified Integrated Circuit (ASIC) to read and process the signal from the detector, which implements the slew-rate time-over-threshold (ToT) technique. We evaluated the performance of the detector and ASIC. For the 20×20 mm2 detector we tested, the leak current is less than 0.5 μA under depletion voltage. When measured with a test pulse, the ToT signal from the ASIC shows good linearity. The spectrum of the DSSD detector shows a good potential to be used as the scatterer in Compton camera system.

Keywords: DSSD, Compton Camera

1. Introduction

Compton camera is widely used in areas of gamma ray detection. We propose the use Silicon detectors as the scatterer in the system to replace the scintillator scatterer that is currently being used. We decided to use the Double-sided Silicon Strip Detector (DSSD), which allows a great save on readout electronics and has a theoretically higher energy resolution than the scintillators. We choose to use the Application Specified Integrated Circuit (ASIC) developed in our lab to do the pre-process of the signal from the detector, and then use the DAQ system to process the digital signal. The ASIC implements the time-over-threshold (ToT) technique to complete the analog-digital conversion.

The evaluation of the ASIC is done. By using a test pulse to inject charges into the input, we find that the linearity of ToT signal is good (r^2 = 0.9999). Then measurement is done for single channel of the detector using radioactive isotopes. The DSSD detector has a low efficiency for gamma ray compared with scintillators. It's hard for the detector to catch full energy of 662 keV photon from Cs-137. When Am-241 is used, the 60 keV peak can be seen, although the resolution is not good enough. It turns out that the electronic noise is the main interference in the setup and work is still being done.

Currently we are trying to integrate the detector and make full use of all channels to get the spatial information of incident irradiation. Future work is mainly about integrating DSSD scatterer with scintillator absorber to test the performance of the whole Compton camera module.

Reference

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