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Development of Electron-Tracking Compton Imaging system using SOI Pixel Sensor with a 30-μm pitch

Compton cameras have been used for various applications including astronomical observations, radioactive waste management, and biomedical imaging. They have advantages over mechanical collimation imaging systems in wide field of view (FOV), suppression of background, and high detection efficiency. Compton cameras use the kinematics of Compton scattering to determine the incident angular of gamma rays. The source position is identified in the intersection of multiple cone traces through a large number of events.
We explore a new approach for advanced Compton imaging with the function of tracking recoiled electron by a combination of a silicon on insulator (SOI) pixel detector and a GAGG scintillator array coupled to MPPC on the other end. The ejected direction of a recoiled electron caused by Compton scattering is detected on the SOI pixel detector with a pitch of 30 μm. The incident direction of the gamma ray can be confined to arc, which can enhance the signal-to-noise ratio (SNR) and angular resolution.
The SOI detector consists of 144×144 pixels, and each pixel has a charge integration circuit and trigger circuit [1][2][3]. The GAGG array consists of 8×8 crystal with a size of 3 mm ×10 mm ×10 mm, and each crystal is individually coupled to a pixel of TSV-type MPPC. The signal of GAGG is amplified and converted to digital signal by dynamic time over threshold method (dToT method) [4]. The coincidence event is detected and determined by the trigger signal from SOI pixel detector and dToT wired-OR output from GAGG/MPPC detector using data acquisition FPGA.
The recoiled electron trajectories of Am-241 and Cs-137 were detected on 25×25 pixels in trigger-mode, and the charges caused by Am-241 were shared in around 4 pixels of SOI detector [5]. We will show the results of Electron-tracking Compton imaging using SOI pixel sensors.

References

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