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Evaluation of Compton recoil electron tracking capability of fine-pitch pixel silicon detector with a Monte Carlo simulation

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Compton imaging can visualize a radioactive source visualization without any mechanical collimators based on the Compton scattering kinematics. The conventional imaging method confines the source location only on a conical surface with a calculated scattered angle from the energy depositions and interaction positions in a scatterer and an absorber. However, Compton cones causes an artifact in a reconstructed image and decreases the signal-to-background ratio (SBR). The measurement of recoil electron tracks is a promising technique to overcome this limitation because the source position can be estimated from on a conical surface to an arc surface.

We have developed fine-pitch pixel silicon detectors for electron tracking Compton imaging, which generate triggers to readout only radiation hit pixels. One is a silicon-on-insulator (SOI) pixel detector with pixel size of 36 μm × 36 μm, and the other is a hybrid detector of pixel silicon sensor and pixel application specific integrated circuit (ASIC) with pixel size of 18 μm × 18 μm. In this study, we have evaluated the capability of recoil electron tracking measurement of these detectors with a Monte Carlo simulation using GEANT4 toolkits. We will report on the simulated performance of electron tracking Compton imaging with 18 μm or 36 μm pitch pixel silicon detectors, such as detection efficiency, SBR, accuracy of incident direction measurement, and so on.

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