P05

Single-Layer Compton Camera Based on High-Z Hybrid Pixel Detectors

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ABSTRACT.

The Compton camera is a novel γ-camera paradigm that relies upon the kinematics of Compton scattering for image reconstruction. A Conventional Compton camera uses two layers of sensors - the Absorber and the Scatterer. This work reports the proof of concept of a single-layer Compton camera (SLCC) where simultaneous Compton pairs events are registered in a single High-Z semiconductor sensor. The Hybrid pixel detector (HPD) is 1 mm thick, 256 × 256 square pixels with 55 µm pixel pitch CdTe sensor bonded to a Timepix3 readout ASIC. The superior spectroscopic imaging and fast timing capabilities of the Timepix3 readout ASIC coupled with a microscopic and highly pixelated CdTe enable simultaneous event detection of multi-energies occurring at multiple positions. The concept was exemplified by measuring the 122 KeV γ-ray emitted from a 57Co radioisotope source at two positions. Data were captured in the Timepix3 data-driven mode with the KATHERINE readout system via Gigabyte Ethernet data transfer. A bespoke Compton kinematics criterion algorithm implemented in Python 3 IDE was used for data analysis and Compton's image reconstruction. Numerous events (5.2 million) were captured for 30-minute acquisitions. However, due to the thin nature of CdTe, fewer events (≈ 0.01 %) met the Compton kinematics criteria. Nevertheless, the algorithm accurately pinpointed the radioisotope's location, demonstrating proof of concept of the SLCC system