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Development of Next Generation sub-MeV and MeV Gamma-ray Detector

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Now we are in the era of multi-messenger astronomy including neutrinos and gravitational waves.
However, the observational window for gamma rays between 100 keV to a few tens of MeV is still closed.
This energy band can bring a key information on astrophysical phenomena such as the nuclear decaying gamma-ray lines from stellar explosions, e^-e^+ annihilation line, MeV dark matter and so on.
The connection between MeV and GeV/TeV gamma rays is important for the understanding of particle acceleration in gamma-ray emitting objects such as blazars and pulsar wind nebulae.

In order to measure sub-MeV and MeV gamma rays, Compton cameras are ideal instruments.
With current generation of Compton cameras, we can detect only the energy, position and time of interaction of an incoming photon.
The sensitivity of these cameras can be significantly improved by measuring the momentum vector of recoiled electrons.
To measure electron trajectories, we developed Si-CMOS hybrid detectors with 20 μm pixel sizes in collaboration with Hamamatsu Photonics.
Moreover, we developed a new prototype Compton camera using them, and have demonstrated successfully that measurements of electron momentum vectors improve both the sensitivity of the camera and the signal-to-noise ratio.
The resulting angular resolution and energy resolution are 1.75 degrees and the order of 1%, respectively, for 1.3 MeV gamma rays.
These achievements will shed light on sub-MeV and MeV gamma-ray astrophysics in the future.

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