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High-Energy 3D Calorimeter for Use in Gamma-ray Astronomy based on position-sensitive virtual Frisch-grid CdZnTe (CZT) detectors

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We will present a concept for a calorimeter based on a novel approach of 3D position-sensitive virtual Frisch-grid CZT detectors. This calorimeter aims to measure photons with energies from ˜100 keV to 20- 50 MeV. The expected energy resolution at 662 keV is better than 1% FWHM, and the photon interaction position-measurement accuracy is better than 1 mm in all 3 dimensions.
Each CZT bar is a rectangular prism with typical cross-section of 6x6 mm2 and length of 2-4 cm. The bars are arranged in modules of 4 x 4 bars, and the modules themselves can be assembled into a larger array. The 3D virtual voxel approach solves a long-standing problem with CZT detectors associated with material imperfections that limit the performance and usefulness of relatively thick detectors (i.e., > 1 cm). Also, it allows us to relax the requirements on the quality of the crystals, while maintaining the same energy resolution and significantly reducing the instrument cost.
Such a calorimeter can be successfully used in space telescopes that use Compton scattering of gamma rays, such as AMEGO, serving as part of its calorimeter and providing the position and energy measurement for Compton-scattered photons (like a focal plane detector in a Compton camera). Also, it could provide suitable energy resolution to allow for spectroscopic measurements of gamma-ray lines from nuclear decays. Another viable option is to use this calorimeter as a focal plane to conduct spectroscopic measurements of cosmic gamma-ray events. In combination with a coded-aperture mask, it potentially could provide mapping of the 511-keV radiation from Galactic Center.

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