

High-resolution Imaging Calorimeter based on position-sensitive virtual Frisch-grid CdZnTe detectors for gamma-ray space instruments

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We will present a conceptual design for an Imaging Calorimeter for space instruments based on a 3-dimensional position-sensitive virtual Frisch-grid CdZnTe (CZT) detectors. The calorimeter aims to measure photons with energies from 50 keV to 20 MeV with energy resolution of $< 1\%$ FWHM at 662 keV, and the photon interaction sites location accuracy of < 1 mm in all 3 dimensions. Each detector is a crystal bar with dimensions of $8 \times 8 \times 30$ mm³. The bars are arranged in 4×4 modules that can be integrated into a larger array of any shape. The 3D corrections approach solves a long-standing problem of CZT detectors associated with material non-uniformities that hamper their performance and limit their thicknesses. In addition, it allows us to relax the requirements to the quality of the crystals, while maintaining good performance, and reduce the instrument cost. Such imaging calorimeter can be used in space instruments as a standalone Compton telescope, and as focal plane detectors for a Coded Aperture Mask telescope with the superior angular resolution for imaging gamma-ray sources. This calorimeter can provide suitable energy resolution to enable spectroscopic measurements of gamma-ray lines from nuclear decays. We will present the test results for the calorimeter prototype. This imaging calorimeter combined with the Coded Aperture Mask is the heart of the Galactic Explorer with a Coded Aperture Mask Compton Telescope, GECCO, and can also be adopted for All-Sky Medium Energy Gamma-ray Observatory AMEGO.

Keywords

CdZnTe; CZT; position sensitive detectors; gamma rays; Compton telescope; virtual Frisch-grid detectors

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