Contribution ID: **213** Type: **Poster**

Long-drift position-sensitive virtual Frisch-grid CdZnTe detectors for gamma ray imaging and spectroscopy

Wednesday 29 June 2022 16:43 (1 minute)

Long-drift position-sensitive virtual Frisch-grid CdZnTe detectors for gamma ray imaging and spectroscopy

A. Bolotnikov1,*, G. Carini1, A. Dellapenna1, J. Fried1, G. Deptuch1, J. Haupt1, S. Herrmann1, A. Moiseev2, G. Pinarolia1 M. Sasaki2, L. Smith2, E. Yates2

1. Brookhaven National Laboratory, Upton, NY 11793, USA
2. CRESST/NASA/GSFC and University of Maryland, College Park, MD 20771, USA
3. Corresponding author, bolotnik@bnl.gov

Arrays of 3D position-sensitive virtual Frisch-grid (VFG) CdZnTe (CZT) detectors are very attractive for spectroscopy and imaging of gamma-rays in many fields including space and nuclear security applications [1]. The long electron lifetime in today's CZT crystals allows for making practical CZT drift detectors with a drift length up to 30-40 mm. Here, we report on the results from testing of position-sensitive bar-shaped detectors with length up to 32 mm and cross-sections up to 10x10 mm2 and the arrays prototype that have been considered for the two future gamma-ray telescopes, AMEGO and GECCO [2]. The VFG arrays allow for the flexibility to scale-up the dimensions of the detectors for the desired instrument dimensions and efficiency, while the position information along with precise energy measurement make them usable as Compton telescope. Also, position resolution allows for correcting the detectors'response non-uniformity caused by crystal defects and devices geometry, thereby reducing the instrument cost, and making them more feasible for emerging applications in gamma-ray astronomy, nonproliferation, portal screening and nuclear safeguards, where large detector arrays are often required.
We report on the results from testing 6x6x20 mm3 and 8x8x32 fabricated from recently available large volume CZT crystals developed by Redlen Technologies, Inc. The cross-section areas and thicknesses are much greater than those previously used in conventional VFG detectors. The VFG detector design was found to provide economical fabrication and the flexibility to extend the dimensions of the crystals for producing more efficient detection, while correcting the detector response non-uniformity, thereby offering an approach to overcome one of the principal technological barriers limiting the application of CZT detectors. The readout system allowed us to capture the signals from individual cathodes, anodes and pads. To calculate the normalized X and Y coordinates, we used the center of gravity method. For the Z coordinate we used the C/A ratio. As we described it previously [3], this approximation is sufficient to for correcting the response non-uniformity. The measured XYZ values constitute a configuration space, which correlates to the spatial variations in the measured anode signals. Fig. 1 shows 8x8x32 mm3 position sensitive virtual Frisch-grid detector and 4x4 array prototypes.

[1] A. E. Bolotnikov, G. S. Camarda, E. Chen, S. Cheng, Y. Cui, R Gul, R. Gallagher, V. Dedic, G. De Geronimo, L. Ocampo Giraldo, J. Fried, A. Hossain, J. M. MacKenzie, P. Sellin, S. Taherion, E. Vernon, G. Yang, U. El-hanany and R. B. James, "CdZnTe Position-Sensitive Drift Detectors with Thicknesses Up to 5 cm", Appl. Phys. Lett. 108, p. 093504 (2016).
[2] A. A. Moiseev et al., A new mission concept: Galactic Explorer with a Coded Aperture Mask Compton Telescope (GECCO), 2021 International Cosmic Ray Conference (Berlin, 2021), PoS (ICRC2021) 648.
[3] L. Ocampo Giraldo, A. E. Bolotnikov, G.S. Camarda, S. Cheng, G. De Geronimo, A. McGilloway, J. Fried, D. Hodges, A. Hossain, K. Ünlü, M. Petryk, V. Vidal, E. Vernon, G. Yang, R. B. James, "Arrays of Position-Sensitive Virtual Frisch-Grid CdZnTe Detectors: Results From a 4x4 Array Prototype," in IEEE Transactions on Nuclear Science, vol. 64, no. 10, pp. 2698-2705, Oct. 2017.

The authors acknowledge support from the U. S. Department of Energy, Office of Defense Nuclear Nonproliferation Research & Development (DNN R&D), and BNL's Technology Maturation Award. The manuscript has been authored by Brookhaven Science Associates, LLC under Contract No. DE-SC0012704 with the U. S. Department of Energy. The efforts of A. Moiseev and M. Sasaki are supported by NASA awards 80GSFC21M0002 and 80NSSC20K057. The efforts of E. Yates and L. Smith are supported by NASA award 80NSSC20K057

Primary authors: BOLOTNIKOV, Aleksey (Brookhaven National Laboratory); Dr MOISEEV, Alexander (bUniversity of Maryland, College Park); Dr DELLAPENNA , Alfred (Brookhaven National Laboratory); Dr YATES, Eric (University of Maryland, College Park); CARINI, Gabriella; PINAROLI, Giovanni (Brookhaven National Laboratory); DEPTUCH, Grzegorz; Dr FRIED, Jack (Brookhaven National Laboratory); Dr HAUPT, Justine (Brookhaven National Laboratory); Dr SMITH, Lucas (University of Maryland, College Park); Dr SASAKI, Makoto (University of Maryland, College Park); Dr HERRMANN, Sven (Brookhaven National Laboratory)

Presenter: PINAROLI, Giovanni (Brookhaven National Laboratory)

Session Classification: Poster