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CdZnTe-based radiation detectors, a breakthrough for hadron physics experiments

In this work, we will present the potentialities of new quasi-hemispherical CdZnTe (CZT) detectors, recently developed at IMEM- CNR Parma (Italy), for high-resolution X-ray spectroscopy of intermediate mass kaonic atoms. Among the possible single-polarity electrode configurations, such as coplanar, pixelated, or virtual Frisch-grid geometries, quasi-hemispherical detectors are the most cost-effective alternative with comparable raw energy resolution in the high and low energy range. Furthermore, this latter contacts geometry allows the reading from a large volume of CZT (0.5 cm^3) with a single readout channel, facilitating coverage of relatively large detection areas with minimal readout channels. A fine optimization of the quasi-hemispherical CZT detectors was performed exploiting the first principle simulator developed by IMEM-CNR. The optimal configuration of the sensor in terms of dimension of the crystals and electrode specifications has been first determined by simulations, and successively validated with experimental measures. Spectra from different sources have been acquired to evaluate the detectors performances.

The readout electronics, engineered by the University of Palermo, entails an initial analog preamplification stage, followed promptly by signal digitalization. This setup enables the integration of sophisticated algorithms for extrapolating signal features and, combined with developed detectors, it yields high time and energy resolution. Results of the experiment performed at the DAΦNE collider in Frascati (Italy) will be presented highlighting the potentialities of CZT in X-ray spectroscopy of heavy kaonic atoms.

CZT's role in hadron physics holds exceptionally promising future prospects. The ultra-high energy resolution (FWHM of approximately 600 eV at 59.5 keV) and rapid signal shaping (approximately 30 ns) achieved in the last year with CZT detectors at room temperature, position this material as one of the most compelling candidate for investigating high-energy radiation relevant to the physics of kaonic atoms.

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