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CdZnTe radiation detector applications

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CNowadays, ionizing radiation detectors are widely employed across several application fields. These include medical imaging (such as CT and SPECT), environmental monitoring (e.g., background radiation control and detection of contaminated areas), homeland security (cargo and luggage inspection), synchrotron science, particle physics, and astrophysics (for the study of X- and γ-ray emissions from celestial sources). Over the past decades, the use of semiconductor-based detectors has become increasingly important, progressively replacing classical scintillator-based systems in many of these fields. Semiconductor detectors offer significant advantages, such as superior energy resolution due to the direct conversion of ionizing radiation into electrical signals. Furthermore, they enable higher spatial resolution in imaging systems compared to scintillators, making them the most advanced technology currently available for detecting X- and γ-photons in the energy range of 1 keV to 10 MeV.

Among compound semiconductors, Cadmium Zinc Telluride (CdZnTe or CZT) stands out as one of the most promising materials for radiation detection. It offers an excellent balance between key performance parameters such as high atomic number, large resistivity, energy resolution, and the ability to operate at room temperature. Thanks to these properties, high-performance CZT-based detectors can be fabricated with excellent energy resolution, high detection efficiency, and without the need for cryogenic cooling.

In this work, we present several applications where CZT detectors are used, highlighting their versatility and performance across different radiation detection scenarios. Particular attention is given to the results obtained using custom-fabricated CZT detectors, designed and optimized for specific measurement conditions. We discuss their performance when coupled with state-of-the-art readout electronics and advanced digital pulse shape analysis techniques, which further enhance their spectroscopic capabilities. The combination of high-quality CZT material, optimized detector geometry, and advanced signal processing enables impressive precision in energy measurement, timing, and event classification. These results confirm CZT detectors as a powerful tool for both scientific research and practical applications in radiation detection.

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