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Optical and electrical characterization of Cadmium Telluride (CdTe) X-ray pad detectors

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For a long time, Cadmium Telluride (CdTe) and Cadmium Zinc Telluride (CdZnTe/ CZT) have been considered to be suitable materials for various high energy photon detection applications. Unlike elementary semiconductors such as silicon (Si) or Germanium (Ge), the control over the material quality (of CdTe and CZT), is substantially more complicated and is determined during the crystal growth, chip dicing, detector processing and the interconnections to the associated readout electronics. Consequentially, these process steps have influence onto the operation performance of the detector. The manifestation of shortcomings in the quality, are extended defects such as distributions of metallic inclusions/ precipitates, grain boundaries, multiple grains and multicrystallinity. These defects have widely been identified to be the major challenges in the scope of large scale detector applications of CdTe and CZT.
In this contribution, we report a fabrication process of several pad detectors, made of bulk CdTe crystals. Prior the processing the material quality and defect density of the CdTe was characterized by 3-dimensional (3D) infrared (IR) microscopy and spectroscopy. The advantage of the optical characterization is that it is a fast and non-destructive technique. Furthermore, minimum sample preparation and potentially detrimental handling is required. Each of the 1 cm^2 sized CdTe detectors were designed with nine pads at different positions. Additionally, the layout includes strip-like structures at different distances from the edges of the chip. The purpose of these strips is to study the detector sensitivity near the usually heavily damaged edges. The results of IR characterization are compared with leakage current probing and Transient Current Technique (TCT) analysis.

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