13th International "Hiroshima" Symposium on the Development and Application of Semiconductor Tracking Detectors (HSTD13), Vancouver, Canada

Contribution ID: **111** Type: **Poster**

Design and Preliminary Characterization of a High-Speed Front-End Readout ASIC for CdZnTe Detectors

Nuclear radiation detection is an important technique for various fields such as medical imaging, homeland security, and space science. CdZnTe is a suitable semiconductor material for room-temperature nuclear radiation detection, which can directly convert X-ray or gamma-ray into charge signal, with high energy resolution and efficiency. However, it is limited by the hole tailing effect and charge trapping effect, which degrade its energy resolution and stability. To solve these problems, a high-speed front-end readout ASIC for CdZnTe detectors is proposed. The ASIC consists of a charge-sensitive amplifier (CSA), source-followers, a peak-hold circuit, and a comparator. The CdZnTe is AC coupling to the ASIC, avoiding the influence of semiconductor dark current on the circuit. The CSA converts the charge signal from the detector into a voltage signal, and uses a fast shaping technique to reduce the influence of hole tailing effect on the signal amplitude and shape. The output of the CSA is split into the source follower, the peak-hold circuit and the comparator. The source-follower acts as an intermediate stage, reducing the load pressure of the CSA and ensuring high bandwidth. The peak-hold circuit directly obtains the energy information of the signal, and uses dynamic threshold technique to reduce the influence of charge trapping effect on the signal energy resolution and stability. The comparator compares the output signal of the CSA with a dynamic threshold and generates a digital pulse, which can be used for fast particle counting.

The front-end ASIC has been manufactured in a 180nm CMOS process. The chip size is 1.2mm×1.1mm. Test results show that the counting rate can be up to 5×10ˆ6 counts/s with a power consumption of about 10mW and a noise of 762e-. A CdZnTe crystal has been coupled with the ASIC for detecting gamma-ray irradiation. The test is ongoing.

Submission declaration

Original and unplublished

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Track Classification: ASICs