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Measurements of charge sharing in a hybrid pixel photon counting CdTe detector.

Hybrid pixel radiation detectors working in single-photon counting mode have gained increasing attention due to their noiseless imaging and high dynamic range. Due to the fact that sensors of different materials can be attached to the readout circuit, they allow operation with a wide range of photon energies. The performance of the single photon counting detectors is limited by pile-up. To allow a detector to work under the high flux conditions, the pixel size is reduced, which minimizes detector dead time. However, with smaller pixel size the charge sharing effect - a phenomenon that deteriorates both spatial resolution and the detection efficiency is more profound [1]. The influence of charge sharing on the detector performance can be quantified using parametrization of the s-curve obtained in the spectral response measurements as well as calculation of the Edge Spread Function (ESF) and Modulation Transfer Function (MTF).

The article presents the measurements of the ESF and the response function of a hybrid pixelated photon counting detector for certain primary energy, which corresponds to the probability for detecting a photon as a function of its energy deposition. The measurements were carried out using an X-ray tube by performing a threshold scan during illumination with x-ray photons of a 1.5mm thick CdTe detector. The charge size cloud depends on the sensor material, the bias voltage, and the sensor thickness. Therefore, the experimental data from a sensor biased with different bias voltage are compared to the theoretical results based on a cascaded model of a single-photon counting segmented silicon detector.

The study of the charge sharing influence on the spatial resolution of the CdTe detector will serve for a further study of the possible implementations of the algorithms achieving subpixel resolution, in which the charge sharing becomes the desired effect, since the charge division in the pixels is used to interpolate the photon interaction position [2].

[1] J. Marchal, "Theoretical analysis of the effect of charge-sharing on the Detective Quantum Efficiency of single-photon counting segmented silicon detectors,"J. Instrum., vol. 5, no. 01, p. , 2010.
[2] A. Krzyzanowska, A. Niedzielska, and R. Szczygieł, "Charge sharing simulations for new digital algorithms achieving subpixel resolution in hybrid pixel detectors,"J. Instrum., vol. 15, no. 2, 2020.

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