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Single Photon Counting Integrated Circuit with multiple energy thresholds and charge sharing compensation

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Single photon counting systems offer good position resolution and operation with high X-ray flux, so making a pixel size smaller is a general tendency in such systems. Thanks to the detector technology development based on high Z materials (GaAs, CdTe, CZT, etc.), the hybrid pixel detectors with direct photon–to–charge conversion become more and more popular, even in medical applications. Nowadays, the usual requirement for the pixel size is the range from 50 μm to 200 μm. However, for small pixel size the charge sharing effect can significantly distort measured energy spectrum of incoming photons [1].

We propose the new algorithm for charge sharing compensation –the Multithreshold Pattern Recognition algorithm, being an extension of the PR algorithm which allows for simultaneous allocation and energy measurement of a photon in the presence of charge sharing [2-3]. It uses multiple energy thresholds to determine the energies of individual photons and to increase the allocation accuracy at the same time. The algorithm was implemented in a readout circuit of a pixel architecture in the CMOS 130 nm technology. The circuit is designed for operation with wide energy-range X-ray radiation and it has four energy thresholds. The implementation details and preliminary measurement results will be presented on the conference.

Fig. 1. A concept of Multithreshold Pattern Recognition implementation in a pixel.

1. V. Di Trapani et al., "Characterization of noise and efficiency of the Pixirad-1/Pixie-III CdTe X-ray imaging detector,"2018 JINST 13 C12008
2. P. Otfinowski, A. Krzyżanowska, P. Gryboś and R. Szczygieł "Pattern Recognition algorithm for charge sharing compensation in single photon counting pixel detectors,"2019 JINST 14 C01017.
3. A. Krzyżanowska, P. Otfinowski, P. Gryboś, "Simulations of High Count Rate Performance of Hybrid Pixel Detectors with Algorithms Dealing with Charge Sharing,"2018 International Conference on Signals and Electronic Systems (ICSES).

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