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Addressing of imperfection of hybrid pixel sensors for X-ray detection through corrections of gains and DC offsets mismatch in a circuit for charge sharing cancellation.

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A developing trend in the design of event-driven sensors for X-ray detection are hybrid pixel detectors working in the single photon counting mode. The factors limiting detector performance, especially for small pixel sizes, include among others, mismatch of circuit components due to process variations, electronic noise and charge sharing. Charge sharing in a hybrid pixel detector occur when the charge generated in X-ray photon interaction with a sensor is collected by more than one pixel. Charge sharing effect may significantly impair the detector energy resolution and result in counting extra events or missing some of the events. The impact of the charge sharing increases with a decrease of the pixel sizes. The small pixel size is a desired feature of a novel hybrid X-ray detector, as it allows better spatial resolution and helps overcoming the high count rate limits by accepting more photons per unit area. Therefore, the charge sharing effect must be dealt with by a dedicated readout IC or processed off-chip.
Minimization of the analog parameters dispersion in the pixel matrix is crucial for the circuits designed for charge sharing cancellation. The DC offsets and gains spread can be optimized using correction circuits and dedicated trimming algortihms. The correction algortihms implemented in a readout integrated circuit with an inter-pixel communication for charge sharing cancellation are presented. The chip's sensitivity to the analog parameters spread and mitigation of the performance achieved with the digital correction blocks are studied. Detection efficiency in case of charge sharing for the corrected and uncorrected pixel matrix is addressed. The simulation results as well as pencil beam measurements using synchrotron radiation are presented.

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