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X-ray imaging of moving objects using on-chip TDI and MDX methods with single photon counting CdTe hybrid pixel detector

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X-ray imaging of moving objects by using line detectors stays the most popular method of object content and structure examination with a typical resolution limited to 0.4 -1 mm. Higher resolutions are difficult to obtain as for the detector in the form of a single pixel row, the narrower the detector is, the lower the image Signal to Noise Ratio (SNR). This is because, for smaller pixel sizes, fewer photons hit the pixel in each time unit for given radiation intensity.
To overcome the trade-off between SNR and position resolution, a two-dimensional sensor, i.e., pixel matrix can be used. Imaging of moving objects with pixel matrix requires time-domain integration (TDI). Straight forward TDI implementation is based on the proper accumulation of images acquired during consecutive phases of object movement. Unfortunately, this method is much more demanding concerning data transfer and processing. Data from the whole pixel matrix instead of a single pixel row must be transferred out of the chip and then processed.
The alternative approach is on-chip TDI implementation. It takes advantage of photons acquired by multiple rows (higher SNR) but generates the same data amount as a single pixel row and does not require data processing out of the chip.
In this paper on-chip TDI is described and verified by using single photon counting two-dimensional (matrix of 128 x 192 pixels) CdTe hybrid X-ray detector with 100 um x 100 um pixel size with up to four energy thresholds per pixel. The spatial resolution verification is combined with Material Discrimination X-ray (MDX) imaging method.

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