

The New PILATUS3 ASIC with Instant Retrigger Capability

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A novel photon counting method for non-paralyzable counting and its implementation in the new PILATUS3 ASIC are presented. Pulse pile-up significantly affects the observed count rate at high photon fluxes in single-photon counting x-ray detectors and can lead to complete paralyzation of the counting circuit. In PILATUS single-photon counting hybrid-pixel x-ray detectors, count rate correction is applied in order to compensate for the counting loss at high count rates. However, counter paralyzation limits the maximum usable count rate of the PILATUS2 ASIC to typically $2 \cdot 10^6$ photons per second and pixel. In order to overcome this limitation, instant retrigger capability is introduced as a new photon counting method that results in non-paralyzable counting and achieves improved high-rate counting performance. The instant retrigger capability re-evaluates the pulse signal after a predetermined dead time interval after each count and potentially retriggers the counting circuit in case of pulse pile-up. The respective dead time interval is adjustable and accounts for the width of a single photon pulse. As a result, the counting becomes non-paralyzable and enhanced count rate correction can be applied in order to achieve improved data quality at high count rates. The new PILATUS3 ASIC features instant retrigger capability with adjustable dead time. The implementation of this new approach and experimental results are presented. The new ASIC additionally features counter overflow handling, improved pixel uniformity, reduced crosstalk, reduced readout time, and compatibility with CdTe sensors. With the new design, higher count rates can be measured and better data quality is achieved up to rates of more than 10^7 photons per second and pixel.

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