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Pragmatic method for fast programming of Hybrid Photon Counting Detectors

It is now been over 15 years since Hybrid Photon Counting Detectors (HPCD) became one of the standard position-sensitive detectors for synchrotron light sources and X-ray detection applications [1]. This is mainly due to their single-photon sensitivity over a high dynamic energy range and electronic noise suppression thanks to energy thresholding [2]. To reach those performances, all HPCD pixels must feature the same electrical response against same photon energy. From the analysis of a monochromatic beam, in case of an ideal HPCD detector, it would be sufficient to apply a fixed voltage threshold, positioned at a fraction of the mean pulse amplitude, and the counting of each photon above the threshold, for each pixel. However, in practical cases, it must be considered that noise baselines from all pixels are not always strictly located at the same voltage level but can be spread over some voltage ranges. To address this kind of issue, most of all HPCDs apply a conventional offset correction, also called threshold equalization [3], that mainly relies on three steps; the setting of a global threshold at an arbitrary value, the identification of pixels noise baseline around that global threshold through an in-pixel threshold trimmer, and the computation of the required threshold offsets for setting all pixels at their own noise baseline at the same time.
In case of a first-time use of an HPCD, the offset correction might be biased by a wrong choice of parameters for certain pixels. Those biases can sometimes be characterized by the inability to localize some pixel noise baselines, which could be outside the voltage range of the threshold trimmer. By referring to the 'classical' offset correction, the recovery of those biased pixels could be performed by changing the position of the global threshold, or by increasing the voltage range of the threshold trimmer. Unfortunately, both solutions could be very time consuming; on one hand because changing blindly the position of the global threshold do not ensure the direct recovering of missing noise baselines, on the other hand because increasing the voltage range of the threshold trimmer has the effect of increasing the voltage steps of the threshold trimmer, leading to a reduced accuracy of noise baselines localization. In order to overcome this issue in a reasonable time, this work introduces a pragmatic method that can be applied to HPCDs for an early and effective identification of appropriate pixels'parameters, avoiding the need to test a high number of pixels configurations. The application of this method, at the early stage of the HPCD calibration, may drastically reduce the investigation time for finding the best operating point of HPCDs (Figure 1).

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