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Correction for pile-up effect based on pixel-by-pixel calibration for tomography with Medipix3RX detector

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The dispersion of individual pixels parameters are widely studied in the field of hybrid pixel detectors for X-ray detection. CERN is developing methods of thresholds equalization to correct for threshold dispersion between pixels of the Medipix3RX readout chip. In this paper, we focus on the complex problem of pixel-to-pixel dead time dispersion, which cannot be corrected by simple flat field normalization, contrary to the residual threshold dispersion after equalization. In tomography, dead time inhomogeneity is responsible for ring artefacts, in addition to global underestimation of the attenuation coefficients due to pile-up. While the main methods of ring artefact correction are purely mathematical, our strategy was to develop a method based on dead time calibration to be able to remove ring artefacts and at the same time to restore the correct quantitative attenuation coefficients. Our original correction method is based on a calibrated dead time map associated to an iterative correction on the sinograms. We performed a fine analysis of dead time dispersion and compared it to our model of photonic noise propagation to validate the calibration step. The results of the pile-up correction with a single Medipix3RX ASIC bump bonded to 200 microns Silicon sensor using a standard X Ray generator showed quantitative improvements of transmission images of Al filters, increasing by a factor 3 the signal-to-noise ratio after pile up correction within the flux range [5E3 –2E5] photons/pixel/s. We are currently validating the method on the tomographic beam line of the Brazilian Synchrotron (LNLS).

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