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CdTe photon counting detector: a discriminator threshold study

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Photon-counting detectors with CdTe sensors and a small pixel size suffer from a charge sharing effect which can induce multiple counts from a single interacting photon. In addition, fluorescence photons contribute to the detected signal if the energy of the incident radiation is higher than the Cd K-edge (26.7 keV). Both effects not only degrade the energy resolution, but also the spatial resolution (1). Multiple counts can be eliminated by adjusting the discriminator threshold, which should be optimised for the application.
A photon-counting CdTe detector based on the Dectris Eiger chip is now available at the Imaging and Medical beamline (IMBL) of the Australian Synchrotron and it is planned to be used in the clinical breast CT study (2).
A characterisation of the Eiger detector for biomedical imaging applications with synchrotron radiation has been carried out at the ESRF (Grenoble, France) by Fardin at al. (3); In their paper, the authors always set the discriminator threshold to half the photon energy to minimise the occurrence of multiple counts of a single photon at the interface between pixels.
In the present study, flat field and slanted edge images were acquired at IMBL using monochromatic beams between 23 keV and 60 keV at different values of the discriminator threshold, corresponding to an energy range between 5 keV and 60 keV. The first set of images was used to obtain the differential counts distributions as a function of the threshold energy, while the MTFs were calculated from the second set of images (slanted edge).
The Eiger detector installed at IMBL consists of 6 horizontally aligned elements. Analysis of the differential counts shows a very consistent calibration of the threshold across the whole detector. The full-energy peak, corresponding to the incident beam energy, is always visible and data obtained using energies above the Cd and Te K-edges show additional signals due to fluorescence and escape peaks corresponding to [illegible] = 23.1 keV and E–[illegible] , E–[illegible] respectively.
Figure 1 shows the MTF's of 23 keV and 40 keV. In each panel, the pink line is obtained from data acquired at a very low threshold (5 keV), which allows multiple counts and severely degrades the spatial resolution, the orange line is from data obtained with the threshold set to half the photon energy, the green line is the ideal MTF. The black vertical line represents the Nyquist frequency of Eiger detector.
Due to the rejection of charge-sharing induced multiple counts, the MTF obtained at 23 keV beam energy and 12 keV threshold is close to the ideal, pixel size-limited MTF. However, when the incident radiation is at 40 keV, the MTF obtained by applying the threshold at 20 keV is still far from the ideal MTF due to the presence of florescence photons.
In this poster presentation, the whole analysis across different X-ray energies and threshold, as well as the differential counts distribution, will be presented and discussed with the aim of offering guidance for optimization in various applications.

References

1) Di Trapani et al. Nuclear Inst. and Methods in Physics Research, A 955 (2020) 163220
2) IMPACT Medical Imaging: https://impact-mi.sydney.edu.au
3) Fardin et al. Physica Medica 108 (2023) 102571

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