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Performance of a Photon Counting CdTe detector for different pixel sizes

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Hybrid Photon Counting (HPC) detector technology is envisaged to open a new era on the field of X-ray medical imaging. Numerous applications in medical imaging require the use of high flux and high X-ray tube voltages, exceeding 100kV. This motivates the use of Cadmium Telluride (CdTe) for HPC as a sensor material.

In order to develop a novel HPC detector system with focus on medical imaging, we have bump-bonded CdTe sensors to the new IBEX single photon counting ASIC developed at DECTRIS. The new IBEX ASIC offers compatibility with different pixel sizes, a wide energy range up to 150 keV, and a new multi-threshold feature, which essentially yields four images containing the counts above the corresponding thresholds. Additionally, its instant retrigger functionality allows for a non-paralyzable counting mode and extends a prompt count rate above 10^7 cts/s/pixel. With this design the new system is especially interesting for the medical imaging field.

The characterization campaign of the new system as a Hybrid Photon Counting detector was carried out both at our in-house laboratories and at the BAMLine at BESSYII Synchrotron in Berlin in collaboration with the Physikalische Technische Bundesanstalt (PTB) group. Its performance has been evaluated with different pixel sizes (150um x 150um, 300um x 300um) in order to assess the impact of the pixel size on the detector performances.

The (prompt) count rate capabilities were measured at 60 keV both in paralyzable and non-paralyzable counting mode. In this last case the maximum allowed incoming rate can be well above 23.5 Mcts/s/pix (1 Gcts/s/mm^2) and 18.18 Mcts/s/pix (0.21 Gcts/s/mm_2) for the 150 and 300um pixels, respectively. The energy resolution was measured in the range 10-60 keV for different chip settings and at 40 keV it can be as low as 1.7 and 2.4 keV FWHM for the two pixel sizes. These results will be presented in the talk. Additionally, we have studied how charge sharing effects and the fluorescence arising above the Cd and Te K-edges at 26.73 and 31.82 keV affect the spectral response. This was done by investigating the quantum efficiency (QE) and a newly-introduced and more straight forward quantity called spectral efficiency (SE). The SE dependence on the incoming photon flux was also measured up to several Mcts/s/mm^2 and it will be discussed.

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