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Characterisation, calibration and performance of single photon counting CdTe pixel detectors

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The PILATUS3 CMOS ASIC with instant retrigger technology is compatible with CdTe sensors in electron collection mode. Applying a special shaper mode allows for the measurement of higher energy X-rays.

Pixelated CdTe sensors were bumpbonded to PILATUS3 CMOS readout ASICs. A large area detector of 16.8cm x 3.4cm was built consisting of four 1mm thick CdTe sensors with an area of 4.2cm x 3.4cm each, resulting in a CdTe detector with 200k pixels. Another detector was built with a single 750um thick CdTe sensor with an area of 4.2cm x 3.4cm. Both detectors were calibrated and trimmed for X-ray energies between 8keV and 60keV. The detectors were characterized in terms of energy resolution, long term stability at low and high X-ray fluxes, count rate behaviour, quantum efficiency and point spread function as a function of energy. The measurements were done with an X-ray tube setup and at a synchrotron beamline (PTB laboratory at BESSY II). The performance of both sensor types is compared.

The CdTe sensor material was investigated under different irradiation fluxes and X-ray energies in order to study polarisation effects, defects and non-uniformities, typically arranged in a network of lines in CdTe. Optimal operation conditions as a function of temperature and bias voltage have been investigated and are compared for both types of sensors.

Comparing the 750um and the 1mm sensor showed that the thinner sensor is less affected by sensor polarisation and non-uniformities. Furthermore, a more negative bias voltage and a higher operation temperature have a positive influence on both effects.

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