Contribution ID: **34** Type: **poster**

IBEX: New Pixelated Photon Counting ASIC for X-ray Imaging

We carried out a comprehensive characterization of an innovative hybrid photon counting (HPC) detector with a CdTe sensor for spectral imaging applications. The detector features the IBEX ASIC, developed at DECTRIS Ltd., with either a pixel size of 75 µm×75 µm and two thresholds per pixels, or a pixel size of 150 µm×150 µm with four thresholds. The front-end electronics is compatible with both the hole and electron collection mode required by Silicon and High-Z sensors, respectively, and the input dynamic range extends up to a threshold of 140 keV. A double-buffered counter allows for a continuous read-out with a sub-µs dead-time. The instant retrigger technology enables non-paralyzable counting achieving count rates well above 10^7 cts/pixel/s. The chip dimensions are 2 cm×2 cm and large-area detectors can be designed by tiling chips together with minimal dead area.
We investigated detectors of 75 µm×75 µm pixel size both in our in-house laboratory and at synchrotron facilities over a wide range of energies.
Quantum efficiency (QE), energy and spatial resolution and the count rate capabilities were measured.
The QE reflects the properties of the sensor material. For CdTe it is close to 100% at energies below the Cd and Te K-edges, where it suddenly decreases. It is however 60% at 95 keV for a 1mm-thick sensor.
The energy resolution at 20 keV lies at 2.3 keV FWHM and worsens slightly for incoming energies above the K-edges.
Modulation transfer functions (MTF) were measured with direct x-ray W-tube beam in the range 40-60 kVp using the slanted-edge technique. In virtue of the direct photo-conversion the spatial resolution exceeds the resolution of a CMOS flatpanel detector with similar pixel size by a large factor.
Finally, the instant retrigger technology –which allows for a non-paralyzable counting mode –extends a prompt count rate above 10^7 cts/s/pixel, corresponding to an incoming flux of above 1.7·10^9 cts/s/mm2 for 75 µm pixels.

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