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Spectroscopic Hard X-ray Imaging at MHz Frame Rates

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The High Energy X-ray Imaging Technology (HEXITEC) camera system was developed by the Science & Technology Facilities Council (STFC) in the late 2000's with the aim of delivering fully spectroscopic (colour) X-ray imaging at energies 2 –200 keV. The original system has a pixel pitch of 250μm, 80×80 pixels, each with an energy resolution of ~ 800eV running at 10kHz. To correct for sensor effects such as charge sharing, the system is run at <10% occupancy which limits it's use to photon fluxes of ~ 10^4 ph s^{-1} mm^{-2}. The original camera has been used in a broad range or fields, from battery[1] and materials science[2] at synchrotrons to medical imaging[3], these flux restrictions have limited its applications in some areas, like colour CT. Prompted by a new generation of diffraction limited storage rings, STFC have developed a new generation of the technology that can operate at fluxes in excess of 10^6 ph s^{-1} mm^{-2} without compromising spectroscopic performance.

The HEXITEC-MHz ASIC runs at a continuous 1 million frames per second which, when coupled to high-flux-capable CdZnTe material, delivers per pixel spectroscopy for hard X-rays in the range 2 –300 keV with a resolution of < 1keV for polychromatic sources up to fluxes of 2×10^6 ph s^{-1} mm^{-2} [4]. The capabilities of the camera system enable the use of techniques such as full colour X-ray CT for dynamic systems on time scales of <1s at synchrotron facilities and beyond. The integrating architecture also means that, where a monochromatic source is in use, the system can be used up to fluxes of 2×10^8 ph s^{-1} mm^{-2} (assuming 30keV X-rays).

A summary of recent testing using lab-based sources and the Diamond Light Source will be presented. These include measurements with monochromatic 20keV X-rays that have confirmed the excellent per-pixel energy resolution of the system of 0.8keV for HF-CdZnTe sensors and 0.6keV for p-type Si sensors at a flux of 10^6 ph s^{-1} mm^{-2} [5].

[1] C. Leung et al., https://doi.org/10.1016/j.mtener.2022.101224
[2] S. Feng et al., https://doi.org/10.1557/mrs.2020.270
[3] S. Mandot et al., https://doi.org/10.1109/TMI.2023.3348791
[4] M. Veale et al., https://doi.org/10.1088/1748-0221/18/07/P07048
[5] B. Cline et al., https://doi.org/10.1016/j.nima.2023.168718

I plan to submit also conference proceedings

Yes

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