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Characterisation of HEXITEC MHz –a 1 MHz continuous frame rate spectroscopic X-ray imaging detector system

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The HEXITEC$_{MHz}$ detector system is the latest generation of the STFC's HEXITEC spectroscopic X-ray imaging detector systems. When coupled to Cd(Zn)Te sensor material, the original HEXITEC system delivers high-resolution X-ray spectroscopy (50 electrons RMS) per 250 µm pitch pixel for hard X-rays with energies 2 - 200 keV. However, a 9.1 kHz frame rate and the need to identify charge-sharing events limits its application to photon fluxes of ~10^4 ph s^{-1} mm^{-2}. With many photon light sources undergoing major upgrades to diffraction-limited storage rings, these expected increases in flux have motivated the development of the next generation of the HEXITEC technology. This demand has also been driven by spectroscopic X-ray imaging techniques such as Hyperspectral X-ray Tomography, which require operation under a high incident X-ray flux for time-resolved measurements.

The HEXITEC$_{MHz}$ system is targeted at delivering the same high-resolution spectroscopy as the original ASIC whilst targeting higher photon fluxes. Whilst the ASIC maintains the same 250 µm pixel pitch, the new integrating Front End architecture, in-pixel digitisation and high-speed serialisers deliver a 1 MHz frame rate. This enables operation at fluxes of >10^6 ph s^{-1} mm^{-2} for spectroscopic X-ray imaging applications.

A 300 µm thick p-type Si HEXITEC$_{MHz}$ detector was characterised on the B16 Test Beamline at the Diamond Light Source and are the first measurements taken at a 1 MHz frame rate. At 10 keV and 15 keV the device displayed average FWHM of 656 eV and 682 eV respectively, with minimal changes in spectroscopic performance over ~8 h. Analysis of charge-sharing events show low charge loss and a linear energy-signal response. Higher-flux measurements illustrated the capability of HEXITEC$_{MHz}$ to operate as a photon-counting device, capable of measuring 30 × 10 keV photons in a single frame. Results from a high-flux CdZnTe device will also be shown.

Your name

Ben Cline

Institute

UKRI STFC

Email address

ben.cline@stfc.ac.uk

Author: VEALE, Matthew

Co-authors: Mr DAVIS, Adam (UKRI STFC); SCHNEIDER, Andreas; DAY, Chris; Mr SOLE, David (UKRI STFC); Mr BANKS, Dominic (UKRI STFC); CHURCH, Ivan (STFC - Rutherford Appleton Lab. (GB)); Mr HOLDEN, John (UKRI STFC); LIPP, John (Science and Technology Facilities Council STFC (GB)); NOBES, Joseph (UKRI STFC); Mr HARRIS, Josh (UKRI STFC); Mr SAWHNEY, Kawal (Diamond Light Source); JONES, Lawrence; FRENCH, Marcus Julian (Science and Technology Facilities Council STFC (GB)); PRYDDERCH, Mark Lyndon (Science and Technology Facilities Council STFC (GB)); Mr ROBERTS, Matt (UKRI STFC); HART, Matthew (STFC); WILSON, Matthew (STFC); GHORBANIAN, Navid; Mr FOX, Oliver (Diamond Light Source); SELLER, Paul (RAL); CROSS, Simon (Rutherford Appleton Laboratory); Mr PRADEEP, Sooraj (UKRI STFC); BELL, Stephen (Science and Technology Facilities Council); GARDINER, Thomas; NICHOLLS, Tim (STFC (RAL)); Mr DHAMGAYE, Vishal (Diamond Light Source); HELSBY, William Ian (STFC Daresbury Laboratory (GB))

Presenters: CLINE, Ben; VEALE, Matthew

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