

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 $\sim 10^4 \text{ ph s}^{-1} \text{ mm}^{-2}$. 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 $>10^6 \text{ ph s}^{-1} \text{ mm}^{-2}$ 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 $\sim 8 \text{ h}$. 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 $30 \times 10 \text{ keV}$ photons in a single frame. Results from a high-flux CdZnTe device will also be shown.

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