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Characterisation of Redlen HF-CdZnTe at >10^6 ph s^{-1} mm^{-2} using HEXITEC$_{\mathrm{MHz}}$

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4$^{\mathrm{th}}$ generation light sources will see many facilities upgrade to Diffraction Limited Storage Rings, providing brighter photon beams with greater coherence over a larger energy range. For example, Diamond-II will result in a 10-100× decrease in the electron horizontal emittance alongside an increase in the electron-beam energy from 3 to 3.5 GeV. One driver highlighted within the facility's Science Case is a flux increase within the hard X-ray regime (>20 keV), driven by feedback from the imaging and diffraction communities. The availability of high-Z detector materials with excellent quantum efficiencies at high X-ray energies, capable of operating at the targeted fluxes, is key to this aim.

The material currently showing most promise for these applications is High-Flux CdZnTe (HF-CZT), a CZT grade designed by Redlen Technologies for medical applications at <200 keV X-ray fluxes of ≤10^9 ph s^{-1} mm^{-2} [1]. In this paper, results are presented from the characterisation of this material hybridised to the HEXITEC$_{\mathrm{MHz}}$ ASIC, a novel spectroscopic imaging ASIC running at a continuous 1 MHz frame rate [2-4]. The characterisation was completed at the DLS B16 Test Beamline using monochromatic X-rays of energies 10-20 keV. These tests indicate the existence of an 'excess league-current'phenomenon, with a shift in the dark level of irradiated pixels that results in a flux-dependent shift of the X-ray photo peaks in the uncorrected spectrum to higher ADU (channel) numbers. Datasets taken to analyse the effect's dynamics showed it to be highly localised and flux-dependent, with the excess leakage current generated equivalent to per-pixel shifts of ˜543 pA (8.68 nA mm^{-2}) at a flux of 1.26 × 10^7 ph s^{-1} mm^{-2}. The effect of parameters such as the incident X-ray energy, ASIC temperature and applied bias voltage is also examined. A comparison to results from a p-type Si HEXITEC$_{\mathrm{MHz}}$ device suggests this 'excess leakage-current'effect is unique to HF-CZT and it is hypothesised that it originates from trapping at the electrode-CZT interface and a temporary modification of the potential barrier between the CZT and metal electrode.

[1] K. Iniewski, CZT detector technology for medical imaging, J. Instrum. 9 (2014) C11001.

[2] M.C. Veale et al., HEXITEC: A high-energy X-ray spectroscopy imaging detector for synchrotron applications, Synchrotron Radiat. News 31 (2018) 28.

[3] M.C. Veale et al., Preliminary characterisation of the HEXITEC$_{\mathrm{MHz}}$ spectroscopic X-ray imaging detector, J. Instrum. 18 (2023) P07048.

[4] B. Cline et al., HEXITEC: Characterisation of HEXITEC$_{\mathrm{MHz}}$ –A 1 MHz continuous frame rate spectroscopic X-ray imaging detector system, Nucl. Instrum. Method. A 1057 (2023) 168718.

Author: CLINE, Ben

Co-authors: DAVIS, Adam (RAL); Mr SOLE, David (UKRI STFC); Mr BANKS, Dominic (UKRI STFC); Dr GIMENEZ-NAVARRO, Eva (Diamond Light Source); CHURCH, Ivan (STFC - Rutherford Appleton Lab. (GB)); MATHESON, John (Science and Technology Facilities Council STFC (GB)); NOBES, Joseph (UKRI STFC); Mr HARRIS, Josh (UKRI STFC); Dr SAWHNEY, Kawal (Diamond Light Source); Mr ROBERTS, Matt (UKRI STFC); WILSON, Matt; HART, Matthew; VEALE, Matthew; Dr FOX, Oliver (Diamond Light Source); SCULLY, Shane (Diamond Light Source); Mr PRADEEP, Sooraj (UKRI STFC); NICHOLLS, Tim (STFC (RAL)); Dr DHAMGAYE, Vishal (Diamond Light Source)

Presenter: CLINE, Ben

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