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Characterisation of GaAs:Cr Detector Systems for High Flux X-Ray Imaging

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The STFC Rutherford Appleton Laboratory (UK), Tomsk State University (Russia), the Diamond Light Source (UK) and SLAC LCLS (USA) have been working together to develop, characterise and commission detector systems based on chromium-compensated gallium arsenide (GaAs:Cr) semiconductor material for high flux X-ray imaging at next generation light sources.

In this talk an overview of the STFC's work characterising this material will be presented using measurements made with a variety of different ASIC technologies. The STFC HEXITEC and PIXIE ASICs have been used to study the charge transport and spectroscopic performance of the material [1] while, working with the Diamond Light Source, detectors produced using the Medipix 3RX ASIC have been used to characterise the imaging performance at fine pixel pitches.

Most recently GaAs:Cr sensors have been bonded to the STFC LPD ASIC [2] and have been tested at the SLAC LCLS FEL (USA) to explore their suitability for use in high flux and high frame rate imaging systems at Free Electron Lasers (FEL). Results from these measurements have demonstrated that at lower fluxes (˜ 1 MeV mm-2 per pulse) the GaAs:Cr performs well but under direct irradiation (> 500 MeV mm-2 per pulse) polarisation leads to non-uniformity in the detector response.

References

[1] Veale et al, "Chromium compensated gallium arsenide detectors for X-ray and g-ray spectroscopic imaging", Nuclear Instruments and Methods A, 752, pg. 6-14, 2014. [https://doi.org/10.1016/j.nima.2014.03.033]

[2] Veale et al, "MHz rate X-ray Imaging with GaAs:Cr sensors using the LPD detector system", Journal of Instrumentation, 12, P02015, 2017. [https://doi.org/10.1088/1748-0221/12/02/P02015]

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