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Diagnostics at pulsed radiation sources using a hyperspectral, high framerate HEXITEC camera system

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Hyperspectral X-ray systems such as those based on the HEXITEC[1] ASIC typically employ high readout framerates in order to capture single photon events. Each of these frames is also fully digitized using ADCs, rather than comparators and counters, which provides a full wideband deposited energy measurement for each pixel in each frame. The HEXITEC specifically has 80 × 80 pixels at 250 µm pitch, read out at over 9 kHz, an operational energy range of 4 keV to 200 keV, and with an energy resolution better than 1 keV FWHM at 60 keV.

Because of this combined availability of sub-millisecond time resolution, good spectral resolving performance over a wide energy range without fixed thresholds, and spatial information at 250 µm resolution, it is an ideal camera system to investigate the temporal, spatial and spectral profile of pulsed radiation sources.

In this work the authors present the capabilities, limitations, and required developments when using a HEXITEC sensor at pulsed neutron sources. On the hardware side only minimal changes are required compared to normal operation, with good synchronization between camera and beamline master clock defining the temporal performance and jitter. In terms of software, the developments on top of the SpeXIDAQ[2] framework are presented which enable efficient and precise processing and storage of the 4D datasets (XY-position, energy, time).

The full raw output of a HEXITEC ASIC running at 9 kHz requires around 1 Gbit/s of processing and storage bandwidth, which can be challenging to manage over longer measurements. By carefully matching the processing strategy to the specific observables required for further analysis, the demand placed on storage and ease of this subsequent analysis is improved significantly.

[1] Veale, Matt .C. "HEXITEC: A High-Energy X-ray Spectroscopic Imaging Detector for Synchrotron Applications."Synchrotron Radiat. News 2018, 31, 28–32.
[2] Van Assche, Frederic, et al. "The Spectral X-ray Imaging Data Acquisition (SpeXIDAQ) Framework"Sensors 21(2) (2021): 563

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Primary authors: Mr VAN ASSCHE, Frederic (Radiation Physics, Dept. of Physics and Astronomy, Ghent University, Ghent, BE); VEALE, Matthew C. (STFC, Rutherford Appleton Laboratory, Harwell Science and Innovation Campus, Oxfordshire, UK); Dr POOLEY, Daniel E. (STFC, Rutherford Appleton Laboratory, Harwell Science and Innovation Campus, Oxfordshire, UK); BOONE, Matthieu N. (Radiation Physics, Dept. of Physics and Astronomy, Ghent University, Ghent, BE)

Presenter: Mr VAN ASSCHE, Frederic (Radiation Physics, Dept. of Physics and Astronomy, Ghent University, Ghent, BE)

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