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A new six-sensor HEXITEC readout incorporating the WiggleCam technique

Larger field of view hybrid photon counting detectors are commonly constructed using multiple distinct sensor tiles, keeping costs and process yields within reasonable parameters. It is however practically impossible to make these multiple tiles form one gapless active detection surface, especially if uniformly sized pixels are desired. While multiple existing techniques and technologies aim at either reducing the size of these gaps or filling in missing information using various algorithms, some tiling artefacts are hard to avoid without other drawbacks or high device costs.

A novel technique, WiggleCam, has been developed by the authors to fill any inactive regions (due to tiles or faulty pixels) with real measured photons using precise movement of the sensors. This technique completely removes tiling artefacts with no overhead placed on the user. While this technique has been successfully demonstrated using a HEXITEC 2x2 camera[1] mounted on an external movement stage, further refinement and mechanical miniaturisation is required for applied use.

In parallel to this, the SpeXIDAQ[2] software framework for hyperspectral X-ray cameras has been developed at Ghent University. In order to benefit maximally from both the WiggleCam technique and the SpeXIDAQ framework, a custom designed readout platform is being designed, incorporating six HEXITEC ASICs in a 2x3 tiled array setup. By opting for a 10 Gbps fibre connection, the full 9kHz design framerate can be transferred and processed simultaneously for all six ASICs, an improvement over the 6.3kHz limit of the USB3 connection used in the existing HEXITEC 2x2 readout. Moving the WiggleCam motion system into the camera itself reduces the amount of mass that needs to be moved, and increases the precision of the system as a whole. It also makes for a much more compact camera system, able to be mounted at beamlines and lab facilities the same way a conventional photon counting camera would be.

Additionally, this readout platform serves as a testbed for on-FPGA processing and compression techniques to be developed in tandem with the SpeXIDAQ framework. This hardware-assisted processing of hyperspectral X-ray camera data will greatly benefit the implementation of readout systems for future much higher bandwidth hyperspectral ASICs, which will see single sensor output rates approaching 100 Gbps. Any reduction of the required output bandwidth and off-camera processing power would be favourable for applications of these next-generation ASICs, if cheaper data transfer technologies and processing hardware can be considered without loss of performance.

[1] Wilson, Matthew D., et al. "Multiple module pixelated CdTe spectroscopic X-ray detector"IEEE Transactions on nuclear science 60.2 (2013): 1197-1200
[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 author: Mr VAN ASSCHE, Frederic (Ghent University)

Co-authors: VANHEULE, Sander; VEALE, Matthew (STFC Rutherford Appleton Laboratory); WILSON, Matthew (STFC); BOONE, Matthieu (Universiteit Gent)

Presenter: Mr VAN ASSCHE, Frederic (Ghent University)

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