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Data Reduction on FPGAs

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Increasing brightness of new generation light sources and developments in X-ray detectors allow faster experiments and higher data rates. Reducing data first before storing them is one of the most effective strategies of dealing with expanding data volumes. The effective and real time data reduction is also imperative to near-real time experiment feedback, dynamical events selection and data filtering. Field-programmable gate arrays (FPGAs) are very common hardware used for data acquisition, in particular detector readout, but they perform usually rather simple compute operations. With recent developments in computer science (synchronous message exchange, high level synthesis) these computer chips are also available for scientific programmers and the number of applications is increasing, including applications related to photon science experiments: spot-finding, tomographic reconstructions, simulations of small angle scattering patterns or azimuthal integration (AZINT). This contribution deals mainly with the last application of AZINT on FPGAs. Modern "compute" FPGAs can be equipped with large memory and hosted in a computer the same way as graphical processing units (GPUs). They are excellent candidates for processing high throughput detector data. All the tasks of receiving, decompressing the detector image stream and the final AZINT computation can be handled on a single device providing fixed and extremely short latencies of data processing. Optimized software allows beside others power costs reductions. Even space application can profit from the latter and from a good radiation tolerance of FPGAs. The computer software performing AZINT on FPGAs is available in the Intel DevCloud and compute infrastructure of MAX IV synchrotron laboratory. It is demonstrated the FPGA implementation can process several (>6) Giga-pixels per second on the mid-range cost and energy-effective FPGAs. That matches well the maximum frame-rates of detectors at synchrotron facilities nowadays and scales to needs of future detectors. The solution 1 allows seamless integration with standard software, in particular Python, including examples using Jupyter notebooks.

1 Z. Matěj et al., https://gitlab.com/MAXIV-SCISW/compute-fpgas/bincount

I plan to submit also conference proceedings

Yes

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