EIGER2 Upgrade: New Features for Advanced X-Ray Diffraction Experiments

Max Burian[1], Tilman Donath[2], Stefan Brandstetter[3]
[1]DECTRIS Ltd. [2]DECTRIS Ltd., [3]DECTRIS Ltd.
max.burian@dectris.com

Hybrid photon counting (HPC) X-ray detectors are crucial ingredients for cutting-edge synchrotron research [1] by providing noise-free detection with advanced acquisition modes. In this regard, the latest HPC detector generation EIGER2 is setting new performance standards that push current horizons in X-ray science. These detectors combine all advantages of previous HPC detector generations while offering (i) 75 µm × 75 µm pixel size, (ii) kilohertz frame rates, (iii) negligible dead time (100 ns), and (iv) count rates of more than 107 photons per pixel.

The electronics within each pixel of the EIGER2 detector are optimized for the best-possible signal-to-noise measurements at the ultimate speed. In the EIGER2, each pixel acts as an independent photon-counting detector with (i) two separate energy thresholds for simultaneous, energy selective detection, (ii) separate retrigger units that ensure ideal counting linearity over the full dynamic range, and (iii) two digital counters for fast and noise-free readout. Particularly for time-resolved X-Ray diffraction experiments, this architecture of two digital counters per threshold results in a negligible readout dead-time with duty cycles of >99.99 %, making sure that no photons arriving on the detector are lost. And while these benefits advance established methods like crystallography and small-angle X-ray scattering, the EIGER2 can do more.

Here, we evidence how the recently announced feature upgrade extends the capabilities of the EIGER2 and enables faster and cleaner crystallography experiments. We present how the detector enables powder diffraction experiments at up to 100 kHz, capturing transitions in-situ with <100 microsecond time resolution. Further, we show how to make use of the EIGER2s' two energy thresholds to reduce unwanted scattering contributions from higher-harmonics radiation, leading to cleaner and more unambiguous diffraction data. Supported by experimental data from multiple beamlines around the world, these results evidence how the new EIGER2 acquisition features will advance X-ray diffraction experiments for both static and time-resolved crystallography.