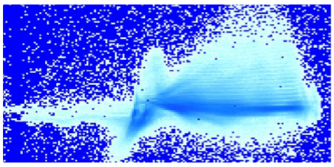

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Next Generation Detectors for High-Resolution Experiments with High-Energy Coherent Synchrotron Radiation

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High-resolution synchrotron experiments increasingly require advanced detection capabilities to address the challenges of high-energy coherent synchrotron radiation. Hybrid Photon Counting (HPC) X-ray detectors have emerged as pivotal tools in this context [1].The EIGER2 detector advances HPC technology with its 75 μm × 75 μm pixel size, kilohertz frame rates, negligible dead time (100 ns), and count rates up to 107 photons per pixel. Particularly for experiments aiming to exploit coherent radiation, such as Ptychography, Bragg Coherent Diffraction Imaging (BCDI) or X-Ray Photon Correlation Spectroscopy (XPCS) these advantages are crucial.

Upgrades to 4th generation synchrotron sources will significantly enhance the brilliance and coherence of X-ray beams. This increase will be most dramatic in the high-energy regime, resulting in an effective increase of coherent radiation of 2-3 orders of magnitude at X-Ray energies >20 keV or higher –depending on the synchrotron source [2,3]. Coherent scattering techniques that are so far established for X Ray energies below 12 keV will also start to become relevant at energies >20 keV which will likely enable new and groundbreaking science.

HPC detectors with high-Z sensor materials are essential for enabling these experiments. They combine (a) noise-free detection with no incoherent noise contribution, (b) fast, digital readout for fast correlation times and scanning speeds, (c) high-dynamic range to resolve both weak and strong signals simultaneously with (d) high detection quantum efficiency (DQE). Particularly for experiments carried out at >12 keV where Silicon sensors become increasingly transparent, the high DQE of high-Z sensors not only reduces the needed acquisition time, but also drastically reduces the effective X-Ray dose on the sample.

We report on the EIGER2 detectors paired with the high-Z sensor CdTe in coherent experiments, demonstrating their performance, stability and reliability. We present experimental results for both XPCS and Ptychography at >20 keV, giving a glimpse on the potential of next generation HPC detectors for future experiments utilizing high-energy coherent radiation. The presented measurements were performed at several synchrotron sources: ESRF (Grenoble, France), APS (Chicago, USA), and PETRA III (Hamburg, Germany).

References

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Primary author: Dr BURIAN, Max (Dectris Ltd.)

Co-authors: GRIMM, Sascha (Dectris Ltd.); BRANDSTETTER, Stefan (Dectris Ltd.)

Presenter: Dr BURIAN, Max (Dectris Ltd.)

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