Poster

PILATUS4 Hybrid Photon Counting Detectors for Efficient and Fast X-ray Diffraction

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Hybrid photon counting (HPC) X-ray detectors have emerged as crucial tools in synchrotron research due to their ability to provide noise-free detection and rapid readout capabilities [1-3]. The PILATUS4 detectors, designed as successors to the PILATUS3 series [4,5], offer a combination of a large active area and high frame rates, essential for various scientific applications.

The PILATUS4 detectors feature up to 4 million pixels with a 150 µm pixel size, covering an active area of 311 x 327 mm². With frame rates of up to 2,000 Hz in 16-bit mode and 4,000 Hz in 8-bit mode, and a minimal dead-time of 100 ns, these detectors enable efficient data acquisition with a duty cycle exceeding 99.9%. Additionally, their compatibility with both silicon and cadmium telluride sensors allows detection across energy ranges from 5-40 keV and 8-100 keV, respectively.

The CdTe-based version of PILATUS4 facilitates fast time-resolved and scanning powder diffraction experiments, particularly in chemical and engineering applications such as battery research and catalysis. Test experiments conducted at multiple synchrotrons using a PILATUS4 CdTe two-module prototype demonstrate its efficacy in these areas. The silicon-based PILATUS4 detectors are very suitable for time-resolved small-angle X-ray scattering (SAXS), with ongoing preparation for a test and anticipated presentation of results at the conference.

In this presentation, we will discuss the technical specifications of PILATUS4 detectors, including performance metrics and compatibility with various experimental setups. Additionally, we will present the results from experiments conducted using prototype PILATUS4 detectors, highlighting their impact on advancing scientific research at modern synchrotron facilities.

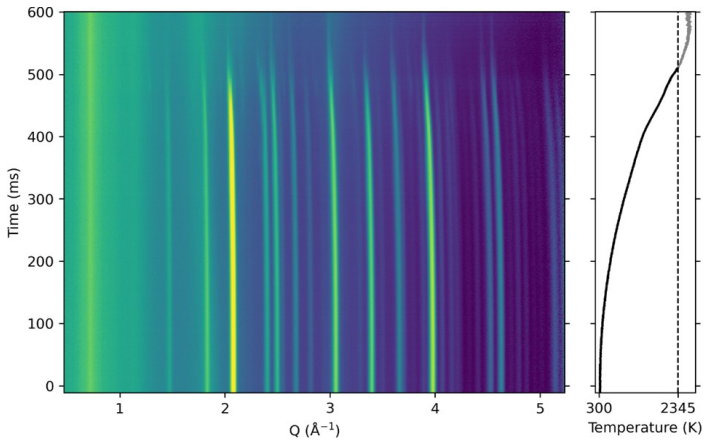

Figure 1. *In situ* calcination of Yttrium aluminum garnet (YAG) at 4 kHZ time resolution. Studied by X-ray powder diffraction at MAX IV-DanMAX beamline using PILATUS4 CdTe detector in 8-bit mode. Heatmap (left) with temperature profile (right).

[1] Förster, A., Brandstetter, S. & Schulze-Briese, C. Transforming X-ray detection with hybrid photon counting detectors. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* **377**, 20180241 (2019). https://doi.org/10.1098/rsta.2018.0241

[2] Brönnimann, C. & Trüb, P. Hybrid Pixel Photon Counting X-Ray Detectors for Synchrotron Radiation. in Synchrotron Light Sources and Free-Electron Lasers (eds. Jaeschke, E. J., Khan, S., Schneider, J. R. & Hastings, J. B.) 995–1027 (Springer International Publishing, Cham, 2016). https://doi.org/10.1007/978-3-319-14394-1_36

[3] Donath, T. et al. EIGER2 hybrid-photon-counting X-ray detectors for advanced synchrotron diffraction experiments. *J Synchrotron Rad* **30**, (2023). https://doi.org/10.1107/S160057752300454X

[4] Brönnimann, Ch. et al. The PILATUS 1M detector. *Journal of Synchrotron Radiation* **13**, 120–130 (2006) https://doi.org/10.1107/S0909049505038665

[5] Donath, T. DECTRIS White Paper: PILATUS3 CdTe Detector Technology and its Applications. (2020) https://doi.org/10.5281/zenodo.10890580