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Experimental investigation of the imaging capabilities of a DEPFET ladder of the DSSC X-ray camera at the European XFEL

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The European XFEL is a state-of-the-art research facility capable of producing both soft and hard X-rays with an unprecedented brightness, pulse duration and coherence. It delivers up to 2700 X-ray pulses with 220 ns interspacing, enabling operation at a maximum frame rate of 4.5 MHz. These unique temporal characteristics of XFEL empower scientists to conduct time-resolved experiments in research fields like chemistry, physics, and biology faster than ever before, thus providing access to previously unexplored areas. However, to take full advantage of the XFEL's capabilities, advanced X-ray detectors are essential.

Several X-ray detectors based on cutting-edge technology with MHz frame rate readout capabilities are available for users at the European XFEL. Additionally, a new X-ray imaging detector prototype, a module of the DSSC detector based on DEPFET sensor technology, is currently undergoing commissioning. DSSC stands for DEPFET Sensor with Signal Compression; the detector can record up to 800 images at a maximum frame rate of 4.5 MHz. It has been specifically developed by an international consortium to fulfill the exceptional characteristics of the European XFEL facility, the repetition rate in particular. The final detector is in the assembly phase and will feature an active area of 1 Mpixels.

The preliminary findings recently obtained from the data collected with one DEPFET ladder of the DSSC camera at SQS (Small Quantum Systems), one of the XFEL instruments, demonstrates the impressive imaging performance of the DSSC ladder in various aspects, including the sensor non-linear response to the input signal, precise detection of single photons with a signal-to-noise ratio exceeding 50, and a high dynamic range of approximately 3100 Aluminum ka photons of 1.48 keV, while keeping noise at about 8 ENC (Equivalent Noise Charge). The DSSC copes well with the rigorous requirements specified by the facility, namely high repletion rate and high dynamic range with very low noise, thereby opening up new imaging possibilities relevant for investigating samples with nanosecond time-scale resolution.

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