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The DEPFET Sensor with Signal Compression: a High-Speed Large Format X-ray Imaging Detector for the European XFEL

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The DSSC detector system, which is currently under development for the European XFEL, will be able to record X-ray frames with 1 Megapixel at a rate of 4.5MHz. The system is based on a silicon pixel sensor with a newly developed DEPFET as the central amplifier structure. The sensor will have a size of 200x200 mm² and will be read out by 256 ASICs which are bump-bonded to the detector in order to provide full parallel readout. The signals from the sensor, after being processed by an analog filter, are digitized by 8-bit ADCs and locally stored in an SRAM. In order to fit the dynamic range of 10⁴ photons of 1 keV per pixel into the input range of the ASIC while simultaneously achieving single photon resolution at 1keV, a strong signal compression is required. This compression is achieved by a non-linear characteristic which is inherent to a new DEPFET structure that combines an enhanced charge handling capacity with the excellent noise performance of the DEPFET.

The main building blocks of the system will be discussed with a special emphasis on sensor development and simulations. Moreover, we will present measurements with prototype readout ASICs and standard DEPFETs that have shown a very low noise which makes it possible to achieve the targeted single photon resolution for 1keV photons at a frame rate of 4.5MHz.

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