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Development of the DEPFET Sensor with Signal Compression: a Large Format X-ray Imager with Mega-Frame Readout Capability for the European XFEL

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We present the development of the DSSC: an ultra-high speed detector system for the European XFEL in Hamburg. The DSSC will be able to record X-ray images with a maximum frame rate of 4.5MHz. The system is based on a silicon pixel sensor with a DEPFET as a central amplifier structure and has detection efficiency close to 100% for X-rays from 0.5 keV up to 10keV. The sensor will have a size of 210x210 mm² composed of 1024x1024 pixels. 256 readout ASICs are bump-bonded to the detector in order to provide full parallel readout. The signals coming from the sensor are processed by an analog filter, digitized by 8-bit ADCs and locally stored in a SRAM. In order to fit the dynamic range of 10⁴ photons of 1keV per pixel into a reasonable output signal range, achieving simultaneously single 1keV photon resolution, a strongly non-linear characteristic is required. The proposed DEPFET provides dynamic range compression at the sensor level. The most challenging property is that the single 1keV photon resolution and the high dynamic range are accomplished within the 220ns frame rate. The main building blocks and properties of the system will be discussed. The experimental characterization of first non-linear DEPFET will be presented. New experimental results obtained coupling this newly fabricated DEPFET prototype to an ASIC prototype which comprises the complete readout chain from the analog front-end to the ADC and the memory will be shown.

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