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Development of 20.2 Mpixel CITIUS detector for the XFEL facility SACLA

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CITIUS is an integrating-type detector developed for synchrotron and XFEL applications. CITIUS operates at the maximum frame rate of 26.1 kframes/s for full image recording in a spectro-imaging mode, and the associated data rate is 140 Gbps at the physical layer from a single chip. In this talk, we report recent progress in the development of 20.2M CITIUS detector for Serial Femtosecond Crystallography (SFX) at the X-ray free electron laser (XFEL) facility, SACLA. The detector operates in an XFEL mode of CITIUS and runs at a maximum frame rate of 5 kHz. At SACLA operating at 60 pulses/s, the detector is configured to run at 960 frames per second, where 16 frames are recorded for each pulse at 60 Hz (multi-sampling). This mode reduces the noise floor down to 25 e-rms, which is equivalent to 0.015 photons (rms) at 6 keV, while the detector's peak signal is 17,000 photons. The detector generates 107 GB/s of data. We have developed a dedicated set of servers to record, calibrate, transfer, and compress the data. Data-framing boards (DFBs) with three Arria10 FPGAs for each were installed in the servers. DFBs reduce the data rate to 15 GB/s by accumulating the 16 frames. The detector was placed in an experimental hutch of SACLA in April 2024. In July 2024, we will conduct the first experiment using XFEL beams. This talk outlines the results obtained in the first experiment and future plans of CITIUS for the other applications, where some have a maximum data rate of 10 Tbps.

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