Contribution ID: **862**

Type: **Invited talk**

The CITIUS detector

Friday 30 August 2024 11:20 (20 minutes)

At the latest synchrotron radiation facilities featuring multi-bend achromat (MBA) storage rings, the current state-of-the-art photon-counting detectors are challenged by the intense X-rays impinging upon the detector. The pileup due to the slow in-pixel counting circuitries typically limits the count rate to around a few Mcps/pixel [1] and reduced further for several bunch modes [2]. To extend the dynamic range, we developed the CITIUS detector (Charge Integration Type Imaging Unit with high-Speed extended-dynamic-range) [3]. The novel integrating-type pixel structure, with a size of 72.6 μm square, enables detection of 945 Mcps/pixel at 10 keV, corresponding to 18 Tcps/cm^2, which is higher than any other detectors reported so far. It should be pointed out that the CITIUS integrating-type pixels sustain this dynamic range for any bunch modes. The extremely high dynamic range of CITIUS represents a significant advancement for coherent imaging applications such as Bragg CDI [4] and ptychography [5-7]. It also shows potential in high-speed and high-accuracy single crystal X-ray diffraction [8].

Unlike in-pixel photon counting pixels, which have non-sensitive areas at the corners of the pixels [9], the integrating-type pixels of CITIUS are free from such efficiency drops, thereby delivering higher uniformity and achieving a 100% fill factor. The CITIUS detector is equipped with a silicon sensor that is 650 micrometers thick, significantly thicker than typical photon-counting detectors. This combination of a 100% fill factor and a thicker sensor makes CITIUS especially useful for applications demanding higher sensitivity, such as quasielastic scattering spectroscopy [10]. In this case, an FPGA-based compression technique developed for CITIUS [11] was employed to compress data of 35 PBytes from week-long experiments with a compression ratio exceeding 1000.

Despite its high dynamic range, CITIUS maintains a low noise floor, allowing for the detection of single photons and even their photon energies. Recently, spectro-imaging with CITIUS has demonstrated higher data quality in laboratory-based computed tomography [12] and in fluorescence-yield XAFS. By operating in a multi-sampling mode, the noise floor can be further lowered to resolve photon energies with a resolution of 250 eV FWHM.

Moreover, the CITIUS detector, with 580 kpixels operating in an XFEL mode, has provided new scientific data at SACLA. A 20.2 Mpixel system has recently been installed at a SACLA beamline, and this talk will briefly report on its commissioning status [13].

References

[1] P. Denes, B. Schmitt, J. Synchrotron Rad., 21 (2014) 1006.
[2] Y. Imai, to be presented at this conferece. Y. Imai and T. Hatsui, J. Synchrotron Rad., 31 (2024) 295.
[3] SPring-8 II Conceptual Design Report, RIKEN SPring-8 Center, 2014
[4] M. Grimes, et.al, J. Applied Crystallography, 56 (2023) 1032.
[5] Y. Takahashi, et.al., J. Synch. Rad., 30 (2023) 989.
[6] J. Deng, et.al., J. Synchrotron Rad., 30 (2023) 859.
[7] K. Ozaki, to be presented at this conference.
[8] Y. Imai, to be presented at this conference.
[9] Ch. Broennimann, et.al., J. Synchrotron Rad. 13 (2006) 120.
[10] M. Saito, et.al., Phys. Rev. Lett., 132, (2024) Art. Num. 256901.
[11] H. Nishino et.al., Nucl. Inst. Meth. Phys. Res., A1057 (2023) Art. Num. 168710.
[12] V. Di Trapani et.al, presented at iWoRiD 2024.
[13] H. Nishino, to be presented at this conference.

I plan to submit also conference proceedings

No

Primary author: HATSUI, Takaki (RIKEN SPring-8 Center)

Presenter: HATSUI, Takaki (RIKEN SPring-8 Center)

Session Classification: Mikrosymposium 4/3: New Detector Developments

Track Classification: 4. New detector developments