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Multi-port CCD detector family at SACLA: six-year operation status and future outlook

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We review our six-year operation from 2011 to 2017 of the multi-port charge-coupled device (MPCCD) detector family at the X-ray Free-Electron Laser (XFEL) facility SACLA. We first summarize the architecture and performance with three types of sensors with 50 [1] and 300 micrometer thick MPCCDs, in combination with the first generation camera system [1] and upgraded compact camera system. The major performance figures are at the modest level compared with the recent detector developments [2], but yielded a variety of scientific results [3]. In this presentation, we take two examples, namely, non-linear X-ray optics [4,5], and time-resolved protein crystallography [6,7] to show the link of these results to the detector performance figure.

Through the experiences of the MPCCD detector deployment, we determine that the robust operation with low calibration cost have been one of the critical feature for the rapid science development. In this paper, we discuss with particular emphasis on the sensor behavior upon X-ray radiation degradation and its link to the calibration cost. Calibration cost is more tangible for high-speed imaging detectors for XFELs and diffraction limited storage ring (DLSR) sources because high-speed framing demands large number of amplifiers in the X-ray illumination area. We present our target performance figures of our detector development plan for DLSR (SPring-8-II) with a route to mitigate the calibration cost.

[1] T. Kameshima et.al., Review of Scientific Instruments 85, 033110 (2014).

[2] References in the review, T. Hatsui and H. Graafsma IUCrJ, Vol. 2, p. 371 (2015).

[3] Publications can be found at <http://xfel.riken.jp/eng/research/indexnne.html>.

[4] K. Tamasaku, et.al., Phy. Rev. Lett., 111 (2013) Art.No. 043001.

[4] H. Yoneda, et.al, Nature 524 (2015) 446.

[5] M. Suga, et.al., Nature 543 (2017) 131.

[6] E. Nango, et.al. Science 354 (2016) 1552.

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