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Fast X-ray pixel detectors for synchrotron radiation light sources

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This work focuses on the development of fast Charge-Coupled Devices (CCD) for X-ray detection at synchrotron radiation light sources. The presentation will first review the sensor and readout ASIC development that led to the construction of the LBNL Fast CCD (FCCD) and compact FCCD (cFCCD) camera systems, which have been successfully employed in experiments at the LBNL Advanced Light Source (ALS), the ANL Advanced Photon Source (APS) and at the SLAC Linac Coherent Light Source (LCLS). The (c)FCCD is based on a custom, multiport, fully-depleted CCD featuring 480×480 pixels of 30 μm pitch. The sensor has demonstrated excellent single photon sensitivity, high energy resolution and sub-pixel point spread function. The sensor back-plane is processed to allow back-illumination with sensitivity down to few hundred eV X-rays. A custom-designed readout IC provides fast digitization and enables readout at frame rates up to 200 fps. Stemming from the FCCD development, a 1k Frame Store CCD camera system is presently being commissioned, capable of reading a matrix of 1920×960 pixels at 100 fps, or to acquire a 960×960 pixel image at 200 fps in frame store mode. A dedicated DAQ system, based on Advanced Telecommunication Computing Architecture (ATCA), including integrated data processing and compression and capable of streaming to disk the large data bandwidth, will be introduced.

Further, the presentation will report on current R&D efforts aimed at the development of X-ray imaging systems for next generation light sources, with target frame rates of order 1000-10000 fps. The design of a fully column-parallel fast CCD and of the ancillary 65 nm CMOS readout ASIC will be presented. As the data volume generated by these sensors will be too large to be streamed to disk in its raw format, work is ongoing on modeling the camera system and studying compression algorithms that can reduce the data volume without loss of information. Results from these simulation studies will be reported.

Finally, progress on the R&D on thin windows for enhanced soft X-rays sensitivity will be reviewed, and results obtained from both in-house and commercial sensor back-plane processes will be highlighted.

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