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Integrating Pixel Array Detector Development[1]

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X-ray experiments are very frequently detector limited at storage ring synchrotron radiation sources, and will be even more so at future x-ray free electron laser and energy recovery linac sources. Limitations most frequently arise from the inability of detectors to efficiently collect and process data at the rates at which the data can be generated. Two bump-bonded silicon pixel array detectors (PADs) are being developed at Cornell University that will greatly enhance data collection capabilities. In these PADs x-rays are converted to electrical signals in a pixelated layer of high resistivity silicon, each pixel of which is connected by a metal solder "bump" to a corresponding pixel in a CMOS silicon integrated circuit. Each CMOS pixel contains its own data handling and processing electronics. Since all pixels operate in parallel, the PAD is capable of handling extremely high data throughput. The PAD pixels feature integrating analog front-end electronics which allow extremely high instantaneous count-rates, yet sufficiently high signal-to-noise to be able to detect single x-ray photons. The first PAD is designed for coherent x-ray imaging experiments at the Linac Coherent Light Source (LCLS) at SLAC. This detector frames continuously at the LCLS rate of 120 Hz, where the data for each frame can arrive in femtoseconds. The second detector, a result of a collaboration with the Area Detector Systems Corporation, is designed for high throughput protein crystallography experiments. Both detectors are described, and test data is provided. The capabilities of the detectors suggest a variety of new applications, some of which will be discussed.

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