Contribution ID: **14** Type: **ORAL**

A 200 Frames per Second, 1-Megapixel, Frame Store CCD camera for X-ray imaging

Tuesday 4 September 2012 09:40 (20 minutes)

At the Advanced Light Source (ALS) at Lawrence Berkeley National Laboratory (LBNL) several experiments are performed in the soft X-ray regime with energy ranging from a few hundred to a few thousand electron volts (eV). In such applications, back-illuminated, direct detection in silicon using conventional microelectronics silicon wafer thicknesses (up to 650um), is close to 100% efficient for energies lower than 8 keV. At higher energies, detector thickness limits efficiency as silicon becomes increasingly transparent, and at lower energies, the thickness of the inert (contact) layer sets a low energy cutoff. This paper describes the performance of a 1MPixel Frame Store CCD camera for soft X-ray applications at synchrotron light sources. The camera can be operated in frame store mode with a 1Mpixel imaging area running at 200 frames per second (fps), or in full frame mode with a 2Mpixel imaging area running at 100fps. The CCD outputs are serviced by custom-designed integrated circuits for gain selection and enhancement, correlated double-sampling signal processing and digitization. The digitized data is acquired by a custom made image aquisition and camera controller board based on the Advanced Telecommunication Computing Architecture (ATCA) and later sent to off-line processing or data storage. With the exception of the image acquisition and controller board, the rest of the system is built using commercial off the shelf components. The presentation will describe the various components of the camera head, readout system and the cooling system for in-vacuum operation.The performance of the system (gain, linearity, noise, data throughput and others) has been characterized at a dedicated detector development beamline at the ALS using fluorescence X-rays from thin metal foils. We will discuss the image processing algorithm used to extract these parameters and its impact on energy resolution performance. The preliminary results show an energy resolution of 150eVrms at 8keV, with a noise of 90eVrms equivalent to 25e-.

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Session Classification: Session3

Track Classification: X-ray imaging applications - Material Science