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Active Pixel Sensors for direct detection of Soft X-rays

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The imaging of soft X-ray images is typically performed with CCDs. However, these have limited readout speed, dynamic range and also require significant cooling to obtain the required signal to noise ratio.

Active pixel sensors (APS) are able to combine faster readout speeds and higher dynamic range with in-pixel intelligence to allow region of interest readout and adaptive gain. To obtain high detection efficiency and 100% pixel fill factor the sensor is back thinned and illuminated from the backside.

We report on the characterization of a back-thinned APS, (Vanilla); an array of 512 x 512 pixels of size 25 x 25 microns. The sensor has a 12 bit digital output for full frame mode, as well as being able to be readout in a fully programmable Region-Of-Interest (ROI) analogue mode. In full frame, the sensor can operate at a readout rate of more than 100 frames per second.

Characterization of the detector was carried out through the analysis of photon transfer curves to yield measurements of the full well capacity, noise levels, gain constants and device linearity.

A typical synchrotron experiment was performed at the Diamond Light Source (DLS) using Soft X-rays (˜700 eV) to produce a diffraction pattern from a permalloy sample. The pattern was imaged at a range of integration times, down to 0.05s, and a range of temperatures for both a back-thinned Vanilla and a Princeton PIXIS-XO: 2048B Charge Coupled Device. The results of which are compared.

The detection efficiency of the APS is shown to be the same as that of the CCD and its response is shown to be linear, with no charge blooming effects at the longest integration times. We conclude that the back-thinned Vanilla APS is a suitable starting point to design an APS for direct detection of soft X-rays for synchrotron applications.

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