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Developing a CCD camera with high spatial resolution for RIXS in the soft X-ray range

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The Super Advanced X-ray Emission Spectrometer (SAXES) at the Swiss Light Source contains a high resolution Charge Coupled Device (CCD) based camera used for Resonant Inelastic X-ray Scattering (RIXS) [1]. Using the current CCD based camera system, the energy-dispersive spectrometer has an energy resolution (E/ΔE) of approximately 12000 at 930 eV [2]. A recent study [3] predicted that through an upgrade to the grating and camera system, the energy resolution could be improved by a factor of two. In order to achieve this goal in the spectral domain, the spatial resolution of the CCD must be improved to better than 5 um from the current 24 um spatial resolution (FWHM) [2].

The 400 to 1600 eV energy X-rays detected by this spectrometer primarily interact within the field free region of the CCD, producing electron clouds which will diffuse isotropically until they reach the depleted region and buried channel. This diffusion of the charge leads to events which are split across several pixels. Through the analysis of the charge distribution across the pixels, various centroiding techniques can be used to pinpoint the spatial location of the X-ray interaction to the sub-pixel level, greatly improving the spatial resolution achieved.

Using the PolLux soft X-ray microspectroscopy endstation at the Swiss Light Source, a beam of X-rays of energies from 200 to 1200 eV can be focused to a spot size of approximately 20 nm [4]. Scanning this spot across the 16 um square pixels allows the sub-pixel response to be investigated. Previous work has demonstrated the potential improvement in spatial resolution achievable by centroiding events in a standard CCD [5]. An Electron Multiplying-CCD (EM-CCD) has been used to improve the signal to readout noise ratio achieved. Centre of mass centroiding algorithms have been corrected for their non-linearity using a non-linear η algorithm [6]. Various non-linear correction algorithms have been investigated to optimise performance. The spatial resolution of an EM-CCD is demonstrated to be better than 2 um (FWHM) in a photon counting mode.

References:
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