Soft X-ray detector development at PSI

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Soft X-ray applications still suffer from strong detector limitations including poor signal-to-noise ratio, reduced dynamic range, low quantum efficiency, slow readout. Thanks to the low electronic noise of novel charge integrating detectors developed at PSI [1, 2], the use of hybrid detectors could recently be extended to low energies, with the aim of obtaining similar performance in terms of high dynamic range, fast frame rate capability, stable and reliable performance as for hard X-rays.

In the last few years, several pilot experiments have been performed at low energies at the Swiss Light Source using the Mönch charge-integrating detector. The current 1x1cm^2 prototype features 160k 25µm pitch pixels and can run at a frame rate higher than 1 kHz. Taking advantage of the possibility of obtaining sub-pixel spatial resolution by means of interpolation [3], we have integrated Mönch in a tender X-ray Von Hamos spectrometer down to 2 keV at the PHOENIX beamline. Moreover, the fast frame rate capability allows ptychographic scans down to the Iron L3-edge and the large dynamic range has been exploited in resonant diffraction experiments on single crystals and artificially nanopatterned samples at the SIM beamline.

Compared to CCDs, hybrid detectors at low energies are radiation hard, simplify detector and beamline alignment procedures, avoid the need for a fast shutter and allow monitoring of the experiment with a high frame rate.

In this presentation, we will discuss these recent results and the efforts to design of a large area charge-integrating detector for soft X-ray experiments at synchrotrons and X-ray Free Electron Lasers, focusing on the challenges concerning the single photon resolution and the quantum efficiency at low energies.

In addition, we will report on the performance of position sensitive sensors with internal amplification (Low Gain Avalanche Detectors), which are paving the way towards the development of single photon counting detectors for soft X-rays [4].

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