

BSI sCMOS Sensors for Soft X-ray Applications at SOLEIL: Experience and Performance

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Soft X-ray detection at modern synchrotron and free-electron laser facilities presents key challenges, particularly in achieving high quantum efficiency (QE) at low photon energies, maintaining low noise and high dynamic range, supporting fast frame rates, and ensuring radiation hardness under intense photon flux. Conventional detectors such as back-illuminated CCDs or micro-channel plates (MCPs) often fall short in simultaneously addressing these requirements.

Recent advances in commercial back-side illuminated scientific CMOS (BSI sCMOS) detectors provide a viable and cost-effective alternative. In particular, GSENSE BSI sensors (e.g. GSENSE400BSI) combine high QE up to ~90% in the soft-Xray range, readout noise below 2e- rms, large full-well capacity of ~80 ke- and frame rates up to several tens of Hz - features that are critical for synchrotron applications [1, 2].

At SOLEIL, we have integrated and vacuum-adapted several GSENSE-based BSI sCMOS cameras with different sizes and geometries tailored to beamline requirements. These detectors have demonstrated excellent performance in demanding experiments, including Fourier Transform Holography (FTH), soft X-ray Ptychography, and Resonant Inelastic X-ray Scattering (RIXS). This presentation will provide an overview of the architectures and geometries of GSENSE-based BSI sCMOS detectors, their measured characteristics and achieved performance. In addition, we will share our practical experience and lessons learned from using these detectors over several years in diverse soft X-ray experiments. Perspectives on new cameras under development, as well as longer-term needs for soft X-ray detection will also be discussed.

[1] Desjardins et al., AIP Conf. Proc. 2054, 060066 (2019)

[2] Desjardins et al., J. Synchrotron Rad. 27, 1579 (2020)

Authors: Dr NICOLAOU, Alessandro (SOLEIL Synchrotron); DAWIEC, Arkadiusz (SOLEIL Synchrotron); Dr POPESCU, Horia (SOLEIL Synchrotron); Mr DESJARDINS, Kewin (SOLEIL Synchrotron); Dr JAOUEN, Nicolas (SOLEIL Synchrotron); Dr BELKHOU, Rachid (SOLEIL Synchrotron); Dr STANESCU, Stefan (SOLEIL Synchrotron); Dr SWARAJ, Sufal (SOLEIL Synchrotron)

Presenter: DAWIEC, Arkadiusz (SOLEIL Synchrotron)

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