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Advancing the JUNGFRAU detector towards low-energy X-ray applications

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The charge integrating hybrid silicon pixel detector JUNGFRAU has found widespread use for hard X-ray applications at free-electron laser (FEL) and synchrotron facilities. Equipped with three dynamic switching gains at pixel level, the most recent version of JUNGFRAU offers single photon resolution from at least 1.2 keV and a high dynamic range of 10^4 12 keV photons at a maximum frame rate of 2 kHz. The detector hardware is modular with a single module comprising 0.5 megapixels at a pixel size of 75×75 μm^2. Owing to the low noise performance, high dynamic range, position resolution, and easy scalability of the JUNGFRAU system, the detector is of high interest for applications in soft X-ray science.

Recently, a four-megapixel (4M) JUNGFRAU camera has been installed at the Maloja end station of the low energy beamline Athos of the Swiss free-electron laser (SwissFEL). The beamline operates at a photon energy range from 250 eV to 2 keV, making the current JUNGFRAU system applicable for experiments at the higher end of the available energy spectrum. At energies below ˜1 keV, the readout capacitance of the hybrid detector limits the capability of resolving single photons. Signal amplification at sensor level could overcome this limitation and allow the JUNGFRAU system to significantly extend its low energy range.

In this contribution, we present first results of the Maloja JUNGFRAU 4M system, demonstrating the capabilities of the current detector version for soft X-ray science, and provide an outlook on efforts to couple the JUNGFRAU readout ASIC with LGAD sensors to achieve single photon resolution at energies below 1 keV.

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