First Characterization of the DECTRIS JUNGFRAU hybrid charge-integrating ASIC for High-Flux Time-Resolved X-ray Applications

We present the first characterization results of a single-chip prototype of the DECTRIS JUNGFRAU detector, a hybrid charge-integrating readout ASIC based on the original concept developed at the Paul Scherrer Institut (PSI) [1]. The prototype features 75 µm pitch pixels in a 256×256 array, for an active area of 2×2 cm², bump-bonded to a 450 µm p-on-n Si sensor. Designed specifically for high-intensity and time-resolved X-ray experiments at synchrotrons, the ASIC delivers high dynamic range, noise levels compatible with medium energy X-ray detection, and fast frame rates. These properties are critical for quantitative measurements in high-flux environments typical of e.g., serial crystallography, coherent diffraction imaging (CDI), and Bragg CDI [2,3]. Based on charge integration, JUNGFRAU can provide accurate measurements under high instantaneous photon fluxes and enable the precise recording of intense diffraction peaks independently from the beam time structure, thus overcoming the limitations imposed by the finite count-rate of traditional counting detectors [4].

The chip features a continuous frame rate of up to 2 kHz, with integration times from 1 to 480 µs, and a dynamic range up to 12,000 photons per pixel at 12 keV. Each pixel includes a three-level gain-switching mechanism that dynamically adjusts the gain frame-by-frame, based on the incoming flux. This capability ensures precise detection across a wide range of intensities, from low-flux regions with single-photon accuracy, to high-intensity diffraction spots, without saturation.

In this contribution, we present the characterization results of early single-chip prototypes, such as noise performances, single-photon sensitivity, linearity, dynamic range, temperature dependence, and the calibration concept of the chip. These preliminary results from laboratory and synchrotron measurements at BESSY and DESY validate its potential for experiments requiring accurate intensity recording under high instantaneous flux, establishing the DECTRIS JUNGFRAU ASIC as a robust building block for next-generation X-ray detectors at 4th generation synchrotron facilities.

[1] Mozzanica, A., et al., Synchrotron Radiation News, 31(6), 2018.

[2] Orlans, J., et al., Commun. Chem., 8(1), 2025.

[3] Leonarski, F., et al., IUCrJ, 10(6), 2023.

[4] Fröjdh et al., Front. Phys. 12 (2024): 1304896

Workshop topics

Front-end electronics and readout

Authors: BARUFFALDI, Filippo (Dectris AG); Dr BOTTINELLI, Sergio (Dectris AG); Dr COMMICHAU, Sebastian (Dectris AG); Dr DUDINA, Alexandra (Dectris AG); HEMPEREK, Tomasz (DECTRIS Ltd.); MONTEMURRO, Giuseppe; Dr RYMASZEWSKI, Piotr (Dectris AG); Mr SCHNYDER, Roger (Dectris AG)

Presenter: BARUFFALDI, Filippo (Dectris AG)