Contribution ID: **131** Type: **Oral**

Qualification and Modeling of the Non-Linear Response of the First Large-Area DEPFET Pixel Sensors with Internal Signal Compression

Tuesday 28 June 2022 09:40 (20 minutes)

A novel design of the Depleted P-Channel Field Effect Transistor (DEPFET) with non-linear response is at the heart of the 1 Mpixel DSSC camera (DEPFET Sensor with Signal Compression) currently being developed for ultra-fast imaging of soft X-rays at the European XFEL. The simultaneous requirement of single-photon detection down to 0.5 keV and dynamic range up to 104 photons/pixel/pulse is here solved by introducing a non-linear compression of the DEPFET transistor response while the readout electronics is kept linear [1, 2]. The first full-size sensors produced by PNSensor GmbH have been mounted to give birth to the first ladder (128x512 pixel), one of the 16 independent units forming the DSSC camera.

Now the calibration of a 1 Mpixel DEPFET sensor with signal compression is the key to reach the desired performances but also the major challenge, due to the need to accurately qualify the full response of each pixel in different conditions [3]. The aim of this work is to discuss the general calibration strategy and to present the experimental results of the first calibration campaigns on the DSSC ladder.

X-ray spectra were acquired using a pulsed X-ray source (PulXar) in order to assess gain and noise performances in the linear region of the DEPFET response. PulXar can in fact provide trains of X-ray pulses with duration as short as 25 ns at high burst rate (up to 4.5 MHz) which effectively mimics the time structure of the beam at XFEL.

To qualify the full non-linear response of each pixel, from the linear region to the high intensity end, we conducted a dedicated test at the SQS beam line where we can produce intense shots of monochromatic photons (soft X-rays) with a smooth spatial distribution to allow irradiation of a whole quadrant of the camera. The XFEL beam hits an Aluminum target and the DEPFET ladder is at 90-degree to collect fluorescence photons (Al Ka 1.48 keV).
The XFEL beam intensity is accurately monitored and the linear relationship between the production of fluorescence and the beam intensity has been previously qualified with a silicon drift detector.
The presentation will focus on the evaluation of the DEPFET ladder performance with low energy photons and on the measurement technique, modelling and parametrization of the non-linear response in different gain conditions. The achieved results confirm the possibility to reach noise levels below 20 electrons rms and an input range of deposited energy of several MeV/pixel/pulse.

[1] M. Porro et al., IEEE TNS , vol. 68, no. 6, pp. 1334-1350, June 2021
[2] S. Aschauer, et al. Journal of Instrumentation, Volume 12, November 2017
[3] A. Castoldi, et al., 2020 IEEE NSS/MIC Conf. Records

Primary authors: CASTOLDI, Andrea (Politecnico di Milano, INFN sez. Milano); GUAZZONI, Chiara (Politecnico di Milano, INFN, sez. Milano); HANSEN, Karsten (DESY); MAFFESSANTI, Stefano (DESY); ASCHAUER, Stefan (PNSensor GmbH); STRUEDER, Lothar (PN Sensor GmbH); OVCHARENKO, Yevheniy (European XFEL GmbH); LOMIDZE, David (European XFEL GmbH); PORRO, Matteo (European XFEL GmbH)

Presenter: CASTOLDI, Andrea (Politecnico di Milano, INFN sez. Milano)

Session Classification: Sensors