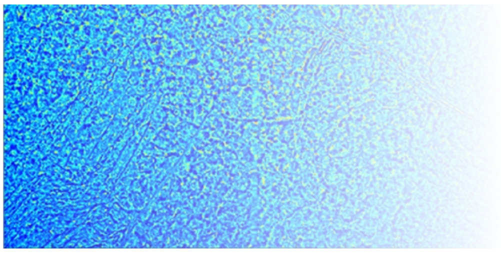

Science & Technology Facilities Council | UK Research and Innovation

Rutherford Appleton Laboratory
21st – 22nd March 2019

Contribution ID: **20** Type: **not specified**

High-Z sensors in combination with the low noise, charge-integrating pixel detector JUNGFRAU at PSI

Thursday, 21 March 2019 15:00 (1 hour)

The most common sensor material for detectors at synchrotron sources and free electron lasers is silicon due to its outstanding material quality in terms of homogeneity and charge carrier transport properties. However, the low atomic number of silicon (Z=14) is the reason for a relatively low absorption efficiency at energies above 20 keV. Sensors with high atomic number material, so-called high-Z sensors, provide absorption efficiencies that are significantly higher. The usability of different high-Z sensor materials (GaAs, CdTe, CZT) at synchrotron sources has been evaluated in combination with the JUNGFRAU readout chip as a possibility to widen the usable energy range of the detector systems.
High-Z sensors show their best performance in electron collection mode. The current version of JUNGFRAU having a pixel pitch of 75 x 75 μm2 was designed for hole collection and, therefore, has to be operated in fixed gain mode (high, medium or low). When operated in fixed high gain the noise performance is 79 e- ENC (or 0.34 keV) and the available dynamic range is around 120 keV (CdTe (e- Schottky) sensor at room temperature, sensor bias voltage: -500 V, integration time: 5 μs).
Charge-integrating detectors offer interesting insights into the sensor properties as each pixel provides a direct measure of the collected charge of a well-defined area as output. On the other hand, each pixel is very sensitive to temporal as well as spatial sensor effects, which affect the charge collection (e.g. fluorescence, dislocation lines, detrapping of charge carriers etc.).
The Detector Group of the Swiss Light Source (SLS) at the Paul-Scherrer-Institut (PSI) will report on their current results of the dynamic behavior (like signal stability, polarization, afterglow) in high-Z sensors when being irradiated with photon fluxes up to 1010 ph/(mm2·s). Furthermore, recent improvements in understanding of the implications stemming from the short lifetime of holes in the GaAs:Cr sensors will be presented and discussed ("Crater effect") as this severely affects the usability of GaAs:Cr together with charge-integrating readout chips. In a second part, preliminary basic system characterization of CZT will be presented as well as Jungfrau chip related consideration in data treatment and processing for efficient and effective data handling.

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