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Investigation of soft X-ray detection using iLGAD sensors

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Inverse Low Gain Avalanche Diodes (iLGAD) can improve the signal-to-noise ratio for X-ray detection in photon science applications. PSI collaborates with FBK for the development of iLGAD sensors with a thin entrance window (TEW) targeting soft X-rays. For this development a first batch of wafers, consisting of diodes and pixelated sensors, was fabricated and is currently under test.
In this talk, we will present measurements performed in the photon energy range from 200 eV to 1000 eV at the Surface/Interface Microscopy (SIM) beamline at the Swiss Light Source (SLS).
Quantum efficiency measurements were exploited to determine the thickness of the passivation layers and to estimate the charge collection efficiency. From the measurements of the average gain of the iLGAD diodes, the multiplication factor was also modeled as a function of the photon absorption depth.
In addition, soft X-ray detection with iLGAD sensors bump-bonded to the Mönch readout chip has been investigated. The spectral response shows double peaks due to the dependence of the multiplication factor on the position where the photon is absorbed. Namely, if the absorption occurs before the gain layer, the avalanche is initiated by holes that drift to the readout side, resulting in a lower multiplication factor. If the photon is absorbed after the gain layer, the avalanche is induced by electrons drifting to the backplane, leading to a higher multiplication factor.
The origin of the observed spectrum has been confirmed with Monte Carlo simulations. The simulations consider photon absorption, drift and diffusion of carriers, as well as charge multiplication. In particular, the model used for the multiplication factor as a function of the absorption depth has been extracted from the iLGAD diodes. The results have been compared to the measurements, providing not only a qualitative, but also a quantitative interpretation of the spectrum.

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