

Hybrid pixel detectors are segmented devices used for particles detection. They consist of a sensor and readout electronics consisting often millions of transistors. A sensor and a matching readout integrated circuit are fabricated independently. They are connected together in the final production step using bonding technique, which establish electrical and mechanical connection between each detection segment and its matching readout channel, as presented in Fig.1. This approach allows individual optimization of a sensor and an integrated readout circuit, and e.g. different sensors may be connected to the same readout circuit depending on the application.

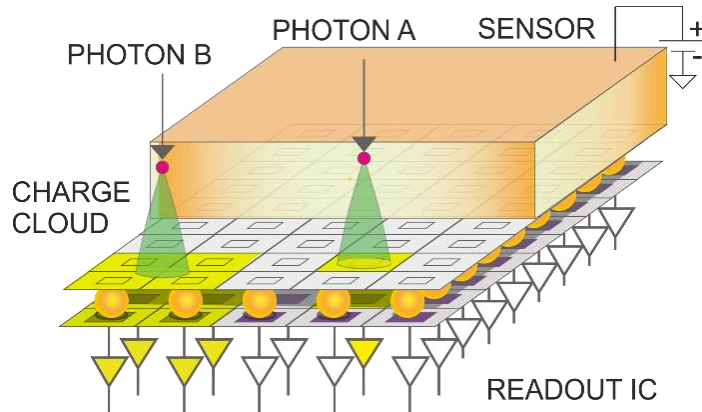


Fig. 1 Hybrid pixel detector and charge sharing effect.

X-ray hybrid pixel detectors find their application in various scientific and industrial areas like synchrotron experiments, material science or medical imaging. To improve their resolution and allow registration of millions of photons per second, a pixel size is reduced. However, with decreasing pixel size, a charge sharing effect is more significant. The charge sharing effect occurs if charge generated during the photon-sensor interaction drifts towards pixel electrodes and spreads due to diffusion and repulsion. If the interaction occurs at the border between pixels, the charge may be collected not by a single electrode (like in case of photon A in Fig.1), but by two or more neighboring pixels (like in case of photon B). As a consequence, a fractional signal is induced and processed in several readout channels instead of one. To detect a photon irrespectively of the charge sharing effect, the total photon energy should be reconstructed from fractional signals.

Therefore, the algorithms dealing with charge sharing aim at signal reconstruction as if the charge was deposited in a single channel. The simultaneous task is hit allocation to one of the pixels, preferably to this which collected majority of charge. Detailed studies and simulations of known solutions lead to a conclusion that even though anti-charge-sharing algorithms allow to reconstruct the initial photon energy and allocate the hit to a proper pixel, they do not allow to work with bright photon sources and the resolution of a detector is limited by the pixel size, which must be large enough to fit all the functionality required by the complex algorithms.

The purpose of the project is development of alternative solutions which can improve both spatial resolution and the high count rate performance using digital or analog signal processing. The proposed new solutions include:

- improving spatial resolution. The algorithms using charge weighting or center of gravity calculation can be developed. In this approach, charge sharing becomes the desired effect, since the information on the proportions of charge collected by the pixels can be used to estimate the photon interaction position with subpixel resolution.
- using digital signal processing for charge summing which is much faster in comparison to analog summing algorithms and does not put additional constraints on the front-end readout channel processing speed.