Data processing and image reconstruction methods for pixel detectors

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Semiconductor single particle counting pixel detectors offer many advantages for radiation imaging: high detection efficiency, energy discrimination, noiseless digital integration (counting), high frame rate and virtually unlimited dynamic range. All these properties allow to achieve high quality images. Examples of transmission images and 3D tomographic reconstruction using X-rays and slow neutrons will be presented demonstrating effects that can affect the quality of images.

A number of obstacles can limit detector performance if not handled. The pixel detector is in fact an array of individual detectors (pixels), each of them has its own efficiency, energy calibration and also noise. The common effort is to make all these parameters uniform for all pixels. However an ideal uniformity can be never reached. Moreover it is often seen that the signal in one pixel affects neighbouring pixels due to various reasons (charge sharing, crosstalk ...). All such effects have to be taken into account during data processing to avoid false data interpretation.

The main intention of this contribution is to summarize techniques of data processing and image correction to eliminate residual drawbacks of pixel detectors. It will be shown how to extent these methods to handle further physical effects such as hardening of the beam, scattering and edge enhancement by deflection. Besides, more advanced methods of data processing such as model fitting and tomographic 3D reconstruction will be discussed. All methods will be demonstrated on real experiments from biology, medicine, archaeology and material science performed mostly with the Medipix2 pixel device.

A brief view to the future of pixel detectors and their applications including also spectroscopy, tracking and dosimetry will be given too.