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Application of Medipix detectors for full field hard X-ray imaging

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Medipix2 and Medipix3 single photon-counting pixel detectors are currently applied to overcome the limitations of the indirect detectors used in hard X-ray imaging applications, based on the use of either laboratory or synchrotron X-ray sources. In hard X-rays imaging schemes, the X-rays photons are registered by the so-called indirect detectors, direct conversion CCD detectors or also flat panels. Such detectors have usually very low efficiency for high magnifications and suffer from relatively large point spread function (PSF), which depends on the scintillating material thickness. For the high resolution X-ray imaging with the effective pixel size below 1 um the PSF is limiting the spatial resolution to about 1 μm. Another drawback of the CCD detectors is the presence of the noise, which consists of the readout noise, dark current and some other sources. Such noise is limiting the signal to noise ratio especially for weak signals. Medipix single photon counting detectors overcome the problem of the noise because they allow threshholding the noise by setting available energy thresholds. It is also possible to obtain the spectroscopic information in one shot by setting energy thresholds using for example Medipix3 (8 thresholds available) and register X-ray photons in separated energy windows simultaneously. The hybrid design of the Medipix2/3 [1, 2] detector allows the usage of different detector materials (Si, GaAs or CdTe) depending on the energy of the incoming X-rays. In the current work we present recent results obtained from laboratory as well as from synchrotron radiation facilities (Diamond, ANKA, Spring 8) using Medipix detectors GaAs single chip detector (256x256 pixels, 55x55 μm²) and Si HEXA hexa module with an array of 3x2 of single Medipix chips and showing the potential of Medipix detectors in hard X-ray imaging. In the laboratory experiments we focused our attention to compare the performance of Medipix detector with the indirect and direct CCD detectors and also we obtained spectroscopic information using grating interferometry setup [3]. We present also the application of Medipix detector for high resolution X-ray holographic imaging in combination with the Bragg Magnifier [4], which is used to highly magnify the X-ray (up to 250x) reaching the spatial resolution of about 0.4 μm.

References:

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