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DepFET Direct Electron Detectors for time-resolved imaging applications

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Carrying out ultrafast electron diffraction (UED) experiments capturing the motion of molecules or the dynamics of biological systems at very short time scale require the availability of ultrafast, ultrabright electron sources and high performance imaging detectors. There has been tremendous progress in the field of semiconductor based X-ray detectors driven by the needs and demands of existing and upcoming fee-electron laser sources or related experiments.
While direct hit detectors are the standard choice for any application involving the detection of photons, there use is only marginally when it comes to the detection of electrons, as required in any ultrafast electron diffraction (UED) experiment or the wide field of electron microscopy applications (e.g. Transmission Electron Microscopy).
Most camera systems employed in such experiments are rather slow in terms of frame rate and use an indirect process by means of a scintillator to retrieve the electron intensity distribution by detecting the optical photons created in the scintillator.
This work reports on the development of novel ultrafast direct-electron-hit silicon detectors using DEPFET technology. These systems allow for a high signal-to-noise ratio and the capability to discriminate single electrons with high statistical probability. For UED experiments we are developing systems providing 1kHz frame rates and therefore single shot capabilities. A second (related) detector system will run at frame rates up to 80 kHz, and is mainly intended for recording the dynamics of non-periodic (biological) samples in real space and real time by use of dynamic electron microscopy.

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