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Characterisation of the Performance of High-Flux CdZnTe at MHz XFEL Pulse Repetition Rates

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Xray Free Electron Lasers (XFELs) produce extremely high intensity pulses of photons with ultrashort duration. Planned upgrades to these facilities will increase photon energies above 20keV as well as increasing pulse repetition rates to greater than 1MHz. At these energies silicon has poor quantum efficiency and is susceptible to radiation damage, so new detector materials must be used. CdZnTe is the most promising alternative for XFEL applications but its performance under these challenging conditions is not yet fully understood.

Three 1.5mm thick HF-CdZnTe sensors were bonded to the Large Pixel Detector (LPD) ASIC, each sensor consists of a 16×32 array of 400µm×250µm pitch pixels. Two 500µm thick Hamamatsu silicon LPD sensors, each with 128×64 pixels on a pitch of 500µm, were mounted alongside the HF-CdZnTe to provide a reference.

Measurements were taken at the European XFEL on the FXE instrument. The pulse repetition rate was set to 1.1MHz with 44 pulses per train and an X-ray energy of 9.3keV. The sensors were placed at 90° to a copper target generating a flat field of 8.0keV fluorescence photons. The detectors were read out at 2.25MHz, twice the pulse repetition rate, using the LPD DAQ system. The intensity of the X-ray pulses was varied using beam line attenuator foils, exposing the pixels to flux levels ranging from 10ˆ0 to 10ˆ4 photons per pulse.

In this paper results will be presented for the linearity of HF-CdZnTe as a function of flux, its response time compared to the silicon sensors and the effect of the sensor bias voltage.

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