Detector Developments at DESY for frontier Photon Science

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In order to exploit the full potential of the new photon sources, like Petra-III, FLASH and the European XFEL, DESY embarked on a program to develop new X-ray detectors. A brief overview of the ongoing developments will be given, with a special focus on a limited number of projects.

For PETRA-III, a significant part of the photon spectrum is above 25 keV, where the classical detectors which are based on silicon as their detector material, become increasingly inefficient. Therefore, DESY has started to work with industry to develop high-Z based semiconductor sensors out of Ge and GaAs, which will give one order of magnitude improvement in quantum efficiency at 50 keV. The current state of these developments will be presented.

The main part of the developments is currently driven by the requirements for the European Free Electron Laser. For imaging detectors there is a fundamental difference between storage ring sources and free-electron lasers. At storage ring sources, the number of scattered photons per bunch is very low and an image is generally acquired by integrating over many bunches. This means that one can count the individual photons arriving, giving near zero noise performance. At free-electron lasers, the number of scattered photons per bunch is enough to record a full image, meaning that many photons arrive at the same time, prohibiting photon counting, and leaving integrating detectors as the only alternative. At the same time single photon sensitivity is required. An additional challenge at the European Free Electron Laser stems from its highly non-uniform time structures with 10 bunch trains per second each containing 2700 bunches (at 4.5 MHz). As a consequence images acquired during the bunch trains have to be stored inside the detector head for readout between the trains. Finally a very high dynamic range is required for certain imaging experiments, requiring special gain designs.

The various ongoing development projects, which solve these requirements in different ways, will be presented.