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Novel Detector developments for the European XFEL

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The source properties of the European XFEL to be built in Hamburg impose extremely demanding requirements for the X-ray detectors that will be used in the experiments. The high luminosity of European XFEL, with many more pulses per second as compared to the American and Japanese projects, is one of the strong points that for sure will be used to the advantage in the experiments. The time structure is however such that the pulses are not distributed uniformly in time but are delivered in bunch trains (with up to 3000 bunches in a train) of 0.6 msec followed by 99.4 msec with no beam. This means that up to 3000 images will have to be recorded during the bunch train of 0.6 msec. This can only be achieved by temporarily storing the images in the detector, and reading them out during the 99.4 msec intervals. Furthermore, for every pulse of less than a 100 fsec a complete image has to be recorded, one can not use photon counting ("all photons arrive at the same time"), and one has to use integrating detectors, that record the total deposited X-ray energy, but with sufficiently low noise, so that one is able to distinguish between 0, 1, 2, 3, ... photons. On top of this one also wants to be able to record up to 10^4 photons, meaning a true dynamic range of more than 10^4, which is far from trivial. I will show various experimental examples, illustrating the specific detector challenges that follow from the above requirements. I will also discuss one solution, currently under development, which is the Adaptive Gain Integration Pixel Detector (AGIPD) project (DESY, PSI, Uni-Bonn, Uni-Hamburg). This detector is based on a classical Hybrid pixel array detector with a dynamically switcheable gain stage to cope with the dynamic range, and an analogue pipeline to store the recorded images during the 0.6 msec bunch train. Two other projects, LPD, and DEPFET will also be mentioned briefly.