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Investigation of pixel detector designs for X-ray Photon Correlation Spectroscopy by computer simulations

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The European XFEL, currently under construction at DESY in Hamburg, will produce coherent X-ray pulses every 222 ns in a bunch train of up to 2700 pulses. In conjuction with the fast 2D area detectors currently under development, it will be possible to perform X-ray photon correlation spectroscopy (XPCS) on microsecond timescales.

In XPCS experiments using pixel detectors usually the intensity autocorrelation function is calculated on a per pixel basis yielding information about the underlying interactions in the sample. The large number of individual pixels allows for acquisition of multiple q vectors at once while simultaneously enabling ensemble averaging, which allows to study non-ergodic systems (i.e. systems where time and spatial average differ). In this way equilibrium fluctuations in e.g. colloid suspensions can be directly studied or non-equilibrium processes using a pump-probe approach.

A case study for the AGIPD detector at the European XFEL employing the intensity autocorrelation technique was performed using computer simulations. The study compares the AGIPD (pixel size of 200 um) to a possible apertured version of the detector and to a hypothetical system with 100 um pixel size.

Simulations have been performed within the IDL framework using the detector simulation tool HORUS. Computer simulations are presented showing the impact of an excessively large pixel size, as well the influence of aperturing the pixels to a smaller effective size. It is shown under which circumstances aperturing is beneficial and what the limitations of the aperturing technique are.

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