A fast 2D detector for X-Ray Photon Correlation Spectroscopy

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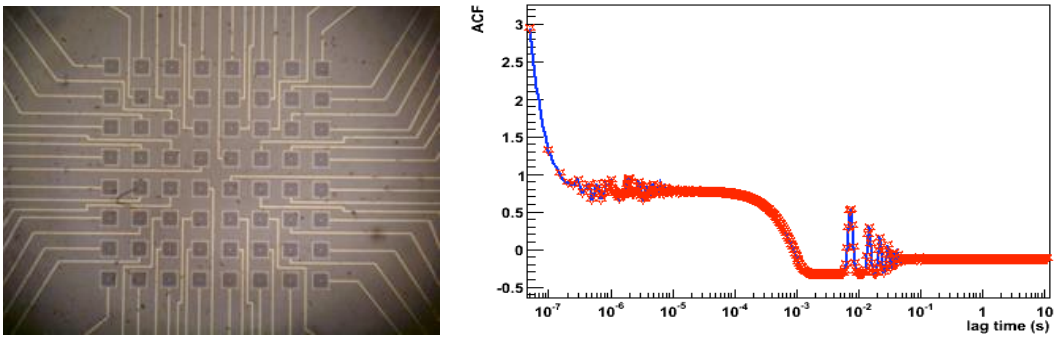
A fast (MHz) 2D X-ray detector will greatly improve our ability to probe weakly scattering, rapidly fluctuating soft matter systems with X-ray photon correlation spectroscopy (XPCS). XPCS probes the dynamics of a material by analyzing the temporal correlations among photons scattered by the material. Visible light PCS has been a valuable technique for studying the long wavelength hydrodynamics of fluids, including simple liquids, liquid mixtures, liquid crystals, polymers, and colloids. However, visible PCS cannot probe the short wavelength dynamics of materials or opaque materials. The new field of XPCS offers an unprecedented opportunity to extend the range of length scales over which a material's low frequency (10^1 to 10^6 Hz) dynamics can be probed down to interatomic spacings.

A two-dimensional detection system would increase the efficiency of such experiments by a few orders of magnitude, however currently available 2D detectors cannot provide frame rates of considerably more than 10-100 Hz. We are developing a 20 MHz frame rate, 2D X-ray detector using an 8x8 array of Geiger mode avalanche photodiodes (GMPDs), shown in Fig. 1. The combination of this array with a scintillation crystal, that partly converts the X-ray energy into visible photons, is sensitive to X-rays with energies from a few keV to tens of keV.



Left: 8x8 GMPD array (100 x100 μm^2 pixels). Right: First cross correlation measurement with this detector. The harmonic structure near 7 ms was induced by a beam chopping fan wheel.

This detector, the readout scheme, and the first auto-correlation and cross-correlation measurements will be the focus of this presentation.