SINGLE PHOTON AVALANCHE DIODE ARRAYS FOR SINGLE PLANE ILLUMINATION FLUORESCENCE CORRELATION SPECTROSCOPY

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To obtain information about the vital transport and reaction processes in living cells, we use fluorescence correlation spectroscopy (FCS) measurements. In FCS, the time-dependent fluorescence fluctuations, due to particles entering and leaving a small observation volume, are analyzed by means of an autocorrelation analysis. This yields diffusion coefficients and particle concentrations of the observed molecules.

To also gain insight into the spatial distribution and organization of proteins in a cell, we use a single plane illumination microscope (SPIM), which allows us to perform thousands of FCS measurements simultaneously in a 2-D slice of the sample.

The current state of the art detectors for single-spot FCS are single-photon avalanche diodes (SPADs). They can be seen as solid state photo-multipliers and allow count rates in the MHz regime. In the last years, 2-dimensional SPAD arrays with thousands of pixels have become available, which reach frame rates of 100,000fps and above in a camera-like device.

Our custom built SPIM uses such a SPAD array as image sensor. The SPAD array is read out using reconfigurable logic chips (field programmable gate arrays (FPGA)). Additionally, the underlying multi-tau correlation algorithm is also implemented directly in the custom hardware [1].

We will present current results using a most recent SPAD array with 512x128 pixels [2]. As the sensor is equipped with micro-lenses, this sensor overcomes the low photon detection efficiency previous detectors suffered from. The performance of this new detector is compared to different SPAD arrays and other SPIM-FCS image sensor [3], such as fast EMCCD cameras.

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