The combination of state-of-the-art microfluidics with small angle x-ray microscattering has been successfully used for dynamic investigations of complex fluids, such as the time evolution of the DNA condensation in the presence of polyamine dendrimers, self-assembly of intermediate filaments or the collagen microfibril formation in a pH-gradient [1].

The aim of these experiments was the marriage of microfluidics with X-ray Photon Correlation Spectroscopy (XPCS). Microfluidics provides the opportunity to generate different velocity profiles, to control the concentration of chemical reaction partners and mixing reactants with a high spatial resolution in the channels of microfluidic devices, as well as to apply additional shear stress on the (complex) fluids. In experiments with suspensions of charged colloidal particles, interacting via a screened Coulomb potential, we wanted to investigate the particles' interaction strength and its influence on their diffusion behavior in dependence on the spatial change of salt concentration. In further experiments we planed to introduce additional interactions by linking the colloidal particles with long chain DNA ("beads-spring-model").

By scanning along the flow direction (channel width ~ 10 μm) we wanted to determine the screening rate of the charged particles in dependence on the mixing with the added electrolyte. We expected an ongoing development of the particles interactions from pure, via screened Coulomb interactions to hard sphere like behavior and finally aggregated states.

We wanted to measure hydrodynamic modes with relaxation rates in the order of 10^{-3} s. Because of the quite fast time scale, Avalanche Photo Diode (APD) detectors were used at the beamline ID10A at the ESRF.

Unfortunately, for different experimental and set-up related reasons we were not able to perform reliable and reproducible XPCS measurements of colloidal particles in microfluidics.

- We could not use a microscopy-based alignment of the microfluidic samples prior to the X-ray experiments. Therefore, the positioning and alignment of the microchannels had to be performed with X-ray absorption measurements. This procedure was time consuming and induced adsorption of colloid particles at the microchannel walls, which led to clogging of the microchannels.
- The motorized sample stages were not completely reliable, therefore the positions had to be corrected several times.
- The detector stage could also not be moved in a reliable way in order to reach the exact *q*-values parallel and perpendicular to the streamlines.
- In the majority of our experiments, interactions of the X-ray beam with the colloid solutions in the microfluidics led to channel clogging or the formation of gas bubbles.

However, in one partly successful experiment we were able to test the photoncorrelation within microfluidic channels. Fig. 1 shows the photoncorrelation of a PMMA particle solution in microchambers (20 x 20 μm^2) with a pinhole of diameter of 10 μm in front of the sample and without a pinhole. In the setup without the pinhole, a decent correlation function can be obtained, suggesting that XPCS experiments can be performed in microfluidics under specific conditions without collimating slits.

XPCS of PMMA particles in microdevices with dimensions of the coherent length ξ

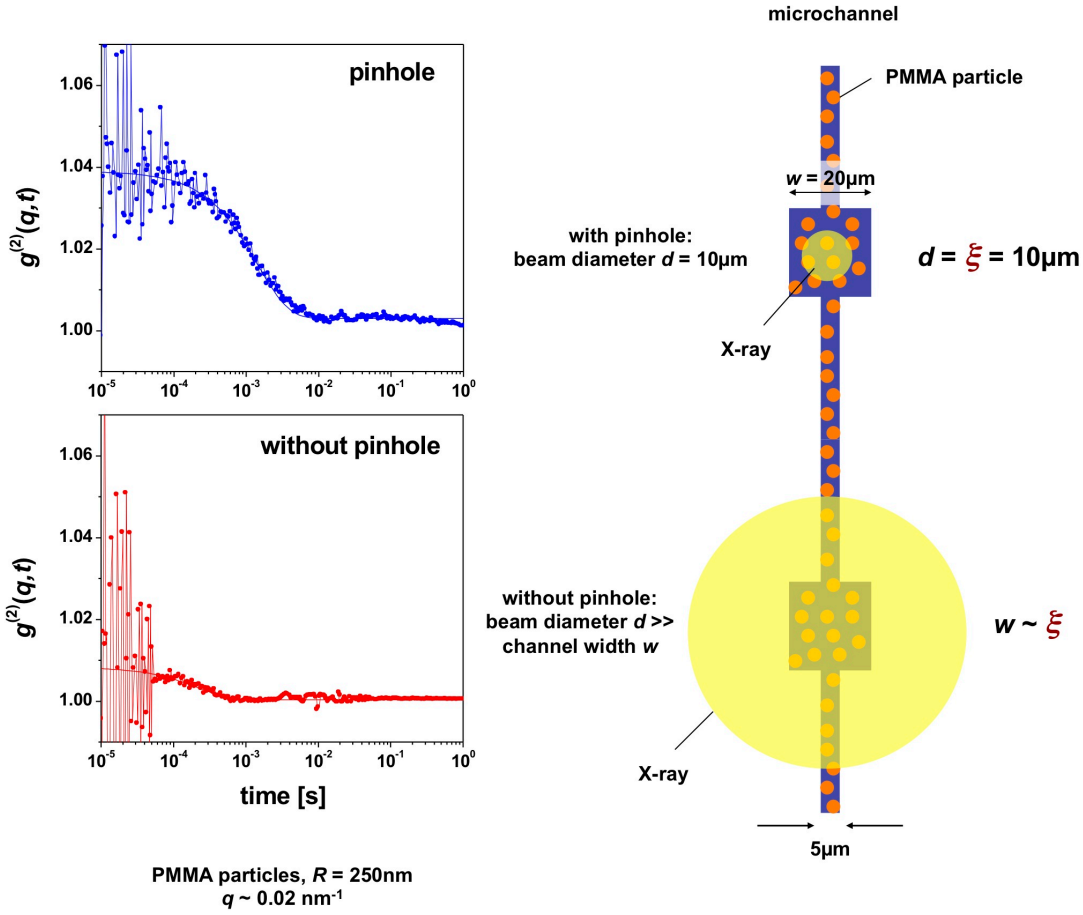

Fig. 1: Sketch of a microfluidics XPCS experiment. Photon-correlation between PMMA particles within a microchamber can be obtained with and without additional collimating slits/pinhole.

[1] Sarah Köster, Thomas Pfohl, Mod. Phys. Lett. B 26, 1230018 (2012)