The JPK NanoTracker™

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In Photonic Force Microscopy (PFM), an optical tweezers set up (optical trap) is combined with high resolution 3-D position detection of the trapped bead and high precision sample positioning. Optical tweezers have first been introduced by A. Ashkin and allow for trapping and manipulating of individual nano-particles (e.g. dielectric beads, live bacteria or viruses) in the variable 3-D trapping potential of a laser focus. In the passed 10-15 years, optical tweezers have been established as a standard tool in biophysics. For example, optical tweezers with 3-D position detection have been extensively used to study single biomolecules, especially molecular motors. Introducing the dynamic measurement of thermal position fluctuations of a trapped particle under the influence of its local environment formed the basis for advancing optical tweezers towards PFM.

With the JPK-Nanotracker™ single trapped beads of sizes ~50 nm (or less) – 5000 nm can be manipulated in a fluidic chamber or a Petri dish. Introducing the 3-D detection system for bead position with respect to the trapping potential, position changes of the bead can be tracked with nanometer precision and dynamic forces acting on the bead (e.g. due to a bound motor protein) can be measured with sub-piconewton precision on a time scale of sub-milliseconds.

Together with the PFM, other microscope techniques can be used in the JPK-Nanotracker™. This includes but is not limited to DIC and darkfield contrast as well as widefield and confocal fluorescence microscopy. All sample holders will allow for experiments at temperatures ranging from room temperature to 40 °C and perfusion with culture medium as well as CO_2. Apart from single molecule studies, this set up forms an instrument platform for investigating individual living cells as well as dynamics of local cell-particle interactions.

The set up of the JPK-NanoTracker™ will be presented and possible applications are discussed.