AXIAL ELECTROKINETIC TRAPPING OF SINGLE PARTICLES AT KHZ FEEDBACK RATES

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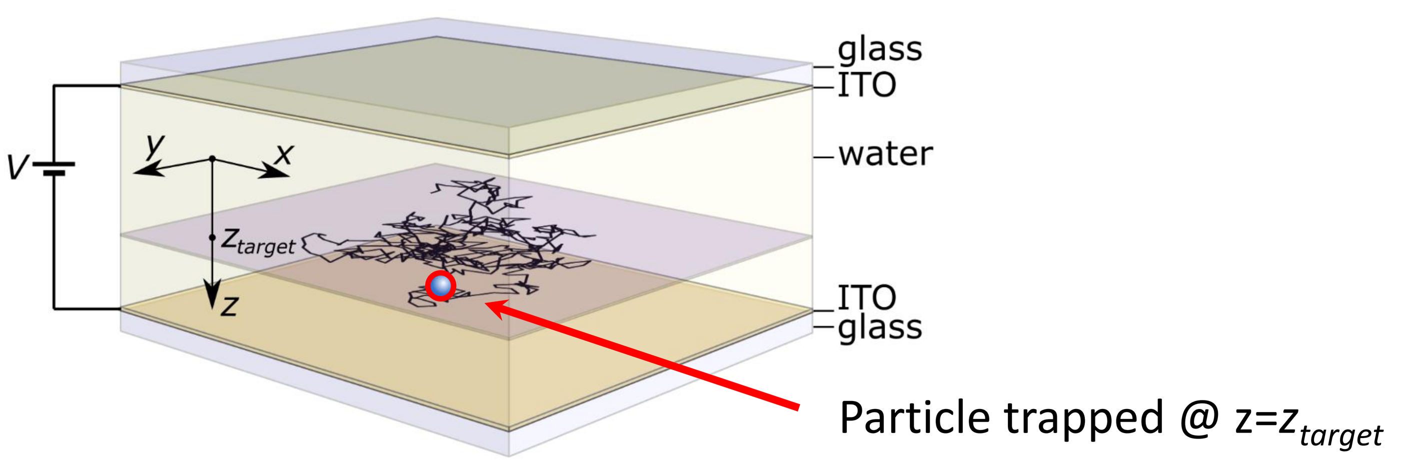
Abstract

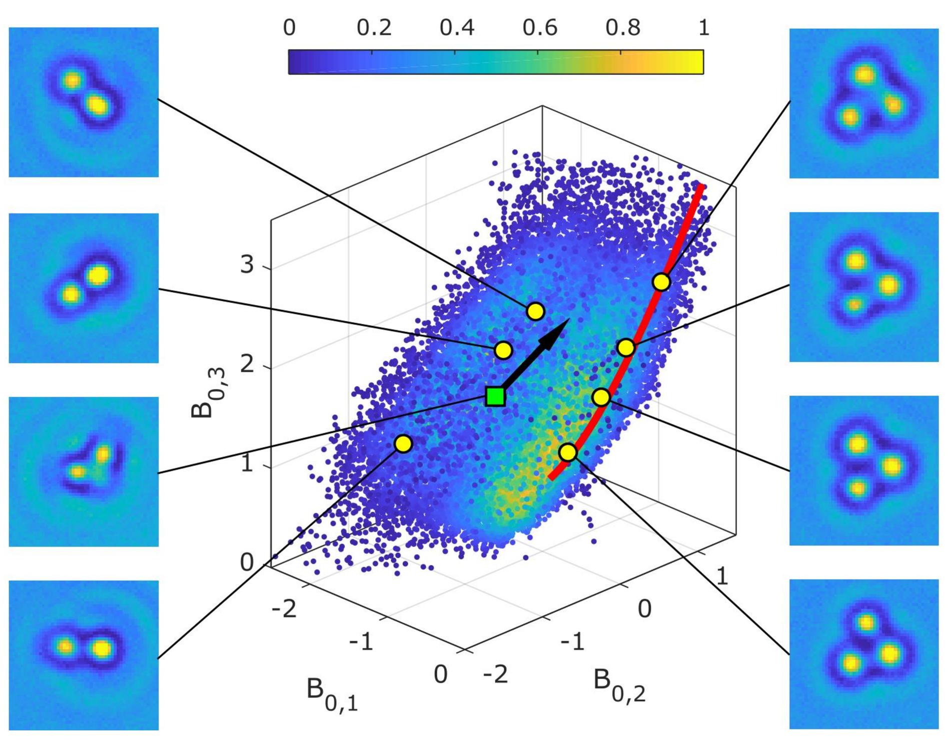
Anti-Brownian Electrokinetic (ABEL) trapping [1,2] has proven to be a valuable novel tool for analysis at the single-nanoparticle level. In previous work, we explored **axial** (in the *z*-direction only) **ABEL trapping** with planar ITO electrodes based on video image analysis [3]. In this work, we improve the method by using **total-internal-reflection** (TIR) in combination with a **single-photon-counting module**. This allows us to axially trap single nanoparticles with a **homogeneous field** at **feedback rates of several kHz** such that screening of the electric field becomes negligible.

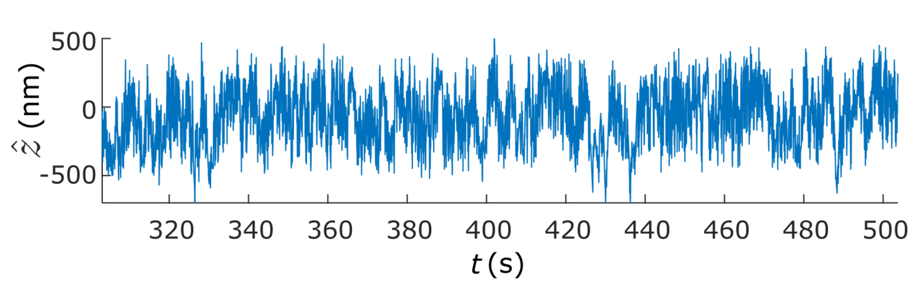
[1] Wang, Q. & Moerner, W. E. Nat Methods 11, 555–558, (2014).
[2] Kayci, M. & Radenovic,. Sci Rep-Uk 5, (2015).
[3] F. Strubbe, B. Robben, J. P. George, Í. Amer Cid, F. Beunis & K. Neyts. Sci. Rep. 9, 2806 (2019).

ABEL trapping

- **Anti-Brownian Electrokinetic (ABEL) trapping** [1,2] is a method to trap single nanoparticles in solution and to measure the diffusion coefficient and electrophoretic mobility. This allows to investigate inter-particle interactions and to perform other detailed measurements in the native liquid environment.
- **Axial ABEL trapping** focuses on trapping in the z-direction. In previous work [3] Fourier-Bessel image decomposition has been used to automatically trap arbitrarily shaped microparticles:



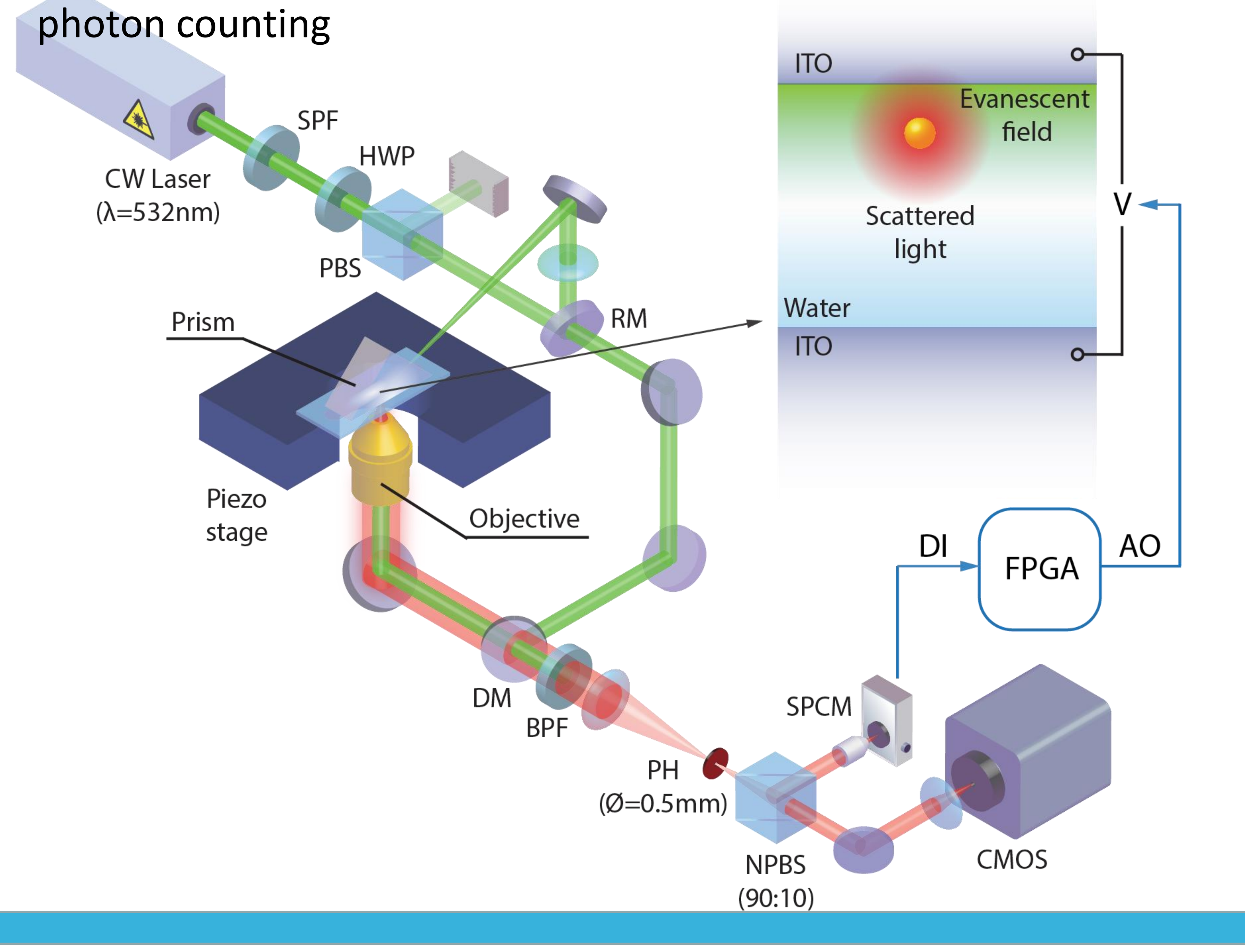




Example of an axially trapped triplet of PS particles. The scatter plot shows 3 coefficients obtained from particle image decomposition. For a detailed analysis of particle mobility and field dynamics, see [3].

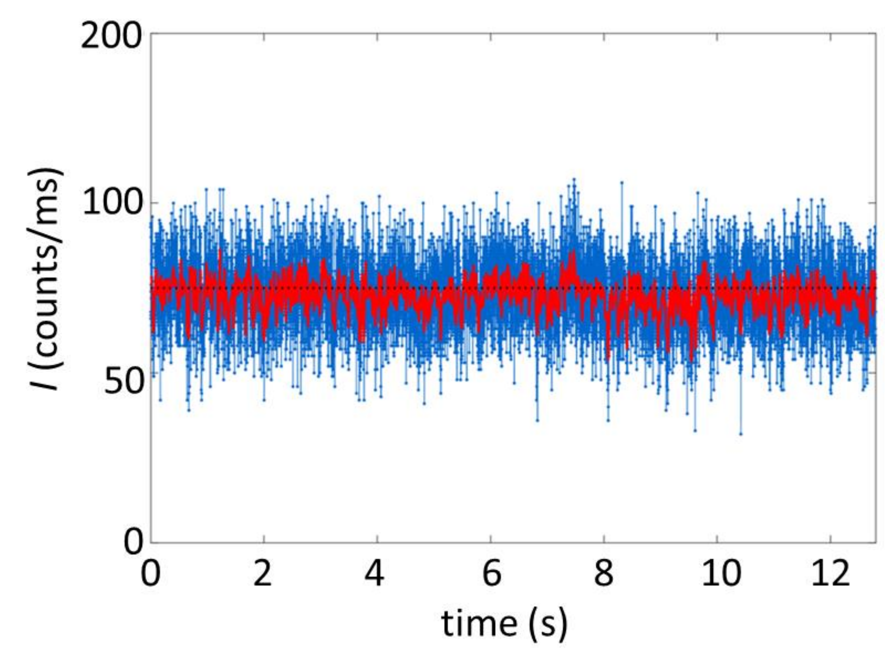
Setup

- Setup for axial trapping based on TIR microscopy and single photon counting

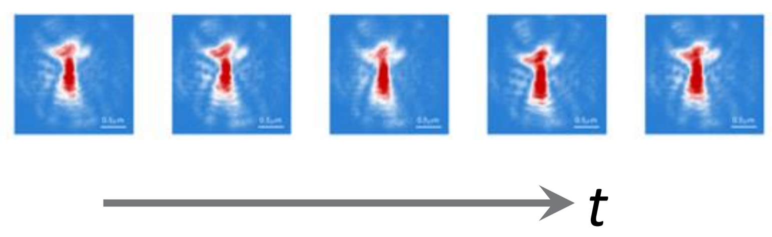


Results

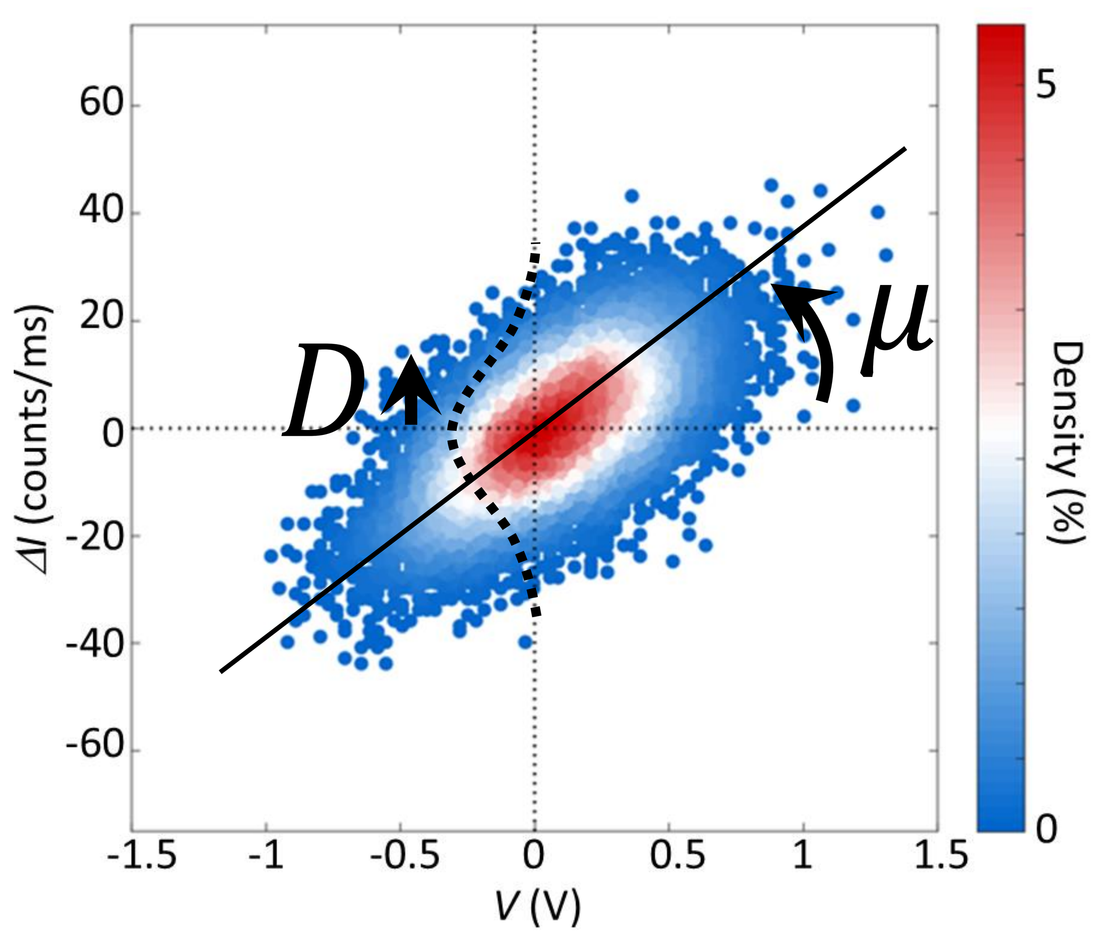
- Axial trapping of a 500-nm PS particle in DI water for 12 s, with electrode gap 10 µm at a feedback rate of 1 kHz:



video images of scattering pattern:



- Correlation between applied voltage and changes in intensity confirm **ABEL trapping**:



Data analysis results in **electrophoretic mobility**:

$\mu = 1.1 \times 10^{-9}$ m²/Vs

Conclusions & Prospects

- Axial ABEL trapping of a single nanoparticle is achieved at a 1 kHz feedback frequency in a homogeneous electric field.
- Dark field configuration (TIR) allows to trap and analyze scattering (i.e. non-fluorescent) nanoparticles.
- This configuration can be miniaturized to the micrometer-scale, integrated on-chip, and improved by introducing structured illumination

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