AXIAL ELECTROKINETIC TRAPPING OF SINGLE PARTICLES AT KHZ FEEDBACK RATES

Yera Ye. Ussembayev, Vincent De Clercq and Filip Strubbe

Electronics and Information Systems Department and Center for Nano and Biophotonics, Ghent University, Technologiepark 126, 9052, Ghent, Belgium

Email: Filip.Strubbe@ugent.be http://lcp.elis.ugent.be

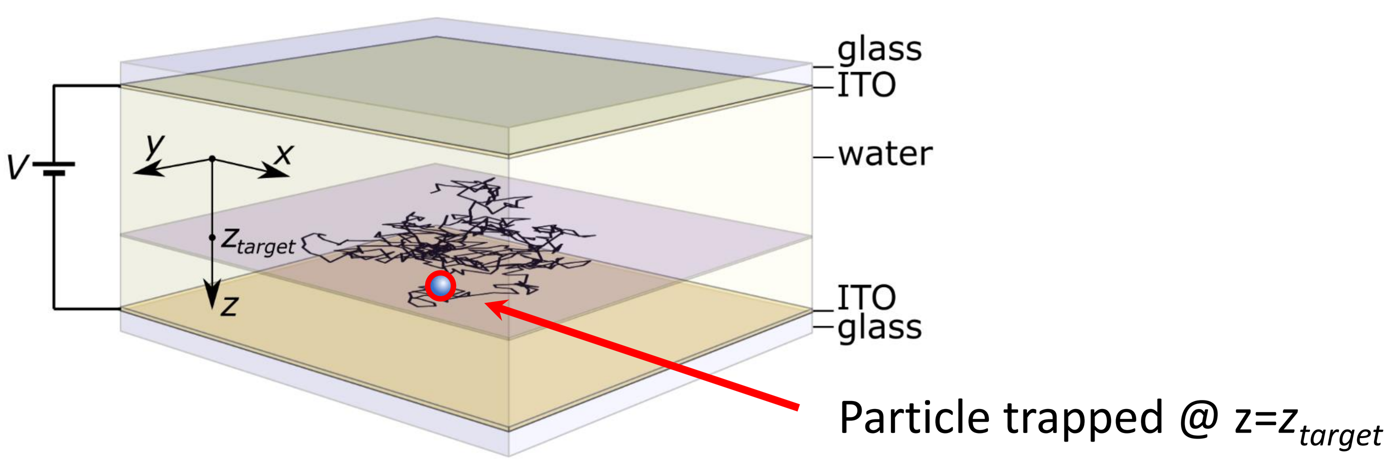
Abstract

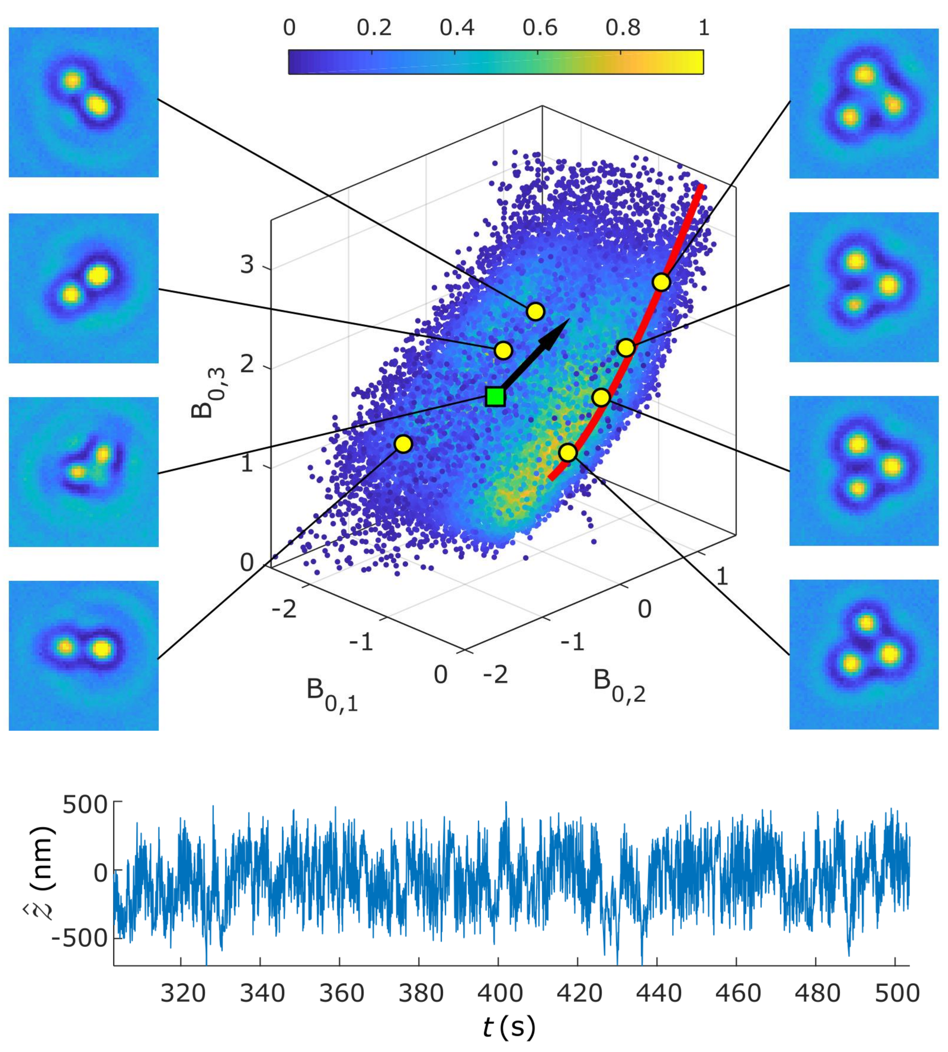
Anti-Brownian Electrokinetic (ABEL) trapping [1,2] has proven to be a valuable novel tool for analysis at the single-nanoparticle level. In previous work, we explored **axial** (in the *z*-direction only) **ABEL trapping** with planar ITO electrodes based on video image analysis [3]. In this work, we 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:

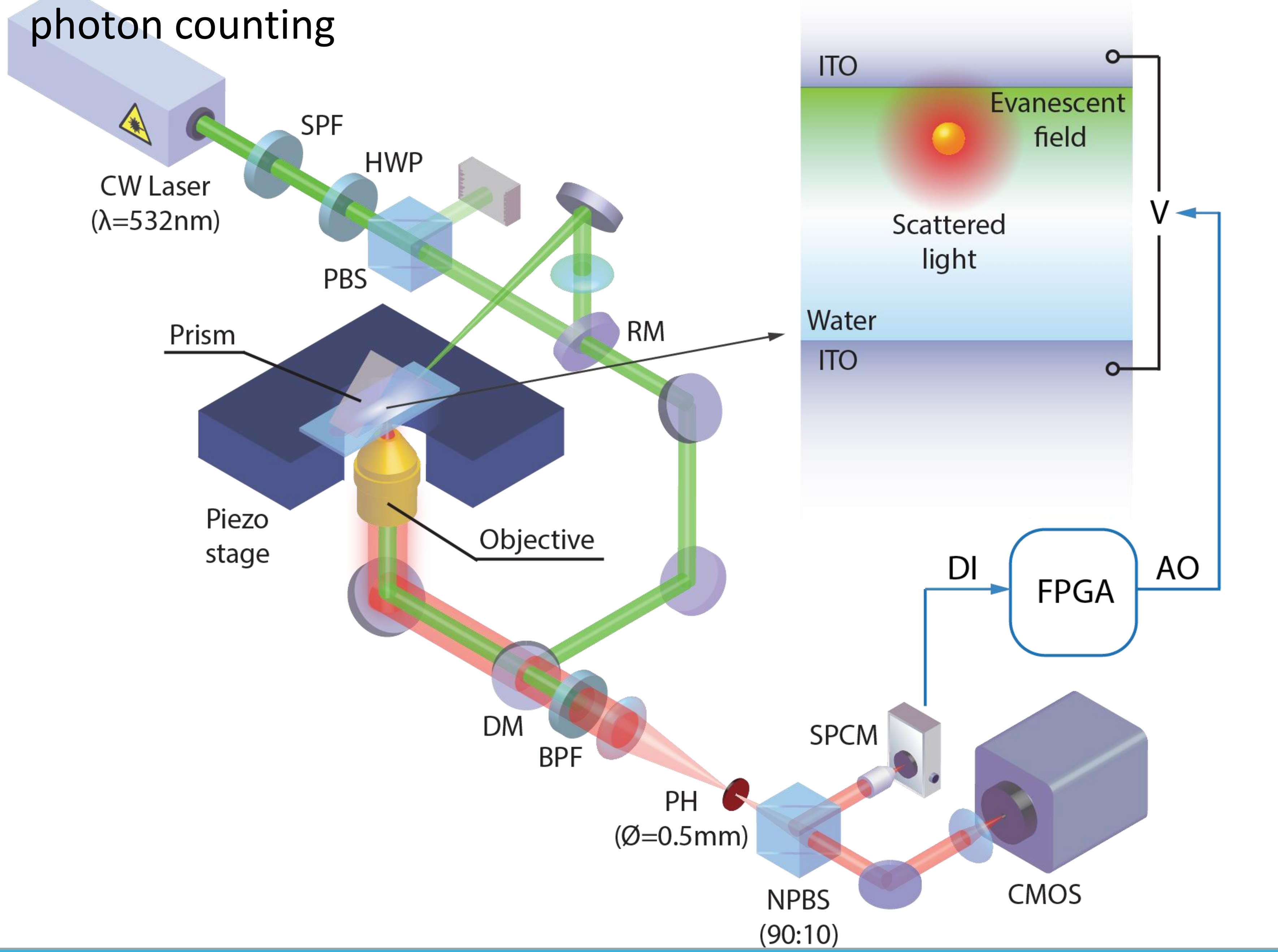




Example of an axially trapped triplet of PS particles. The scatter plot shows 3 coefficients obtained from particle image decomposition. For a detailed analysis of particle mobility and field dynamics, see [3].

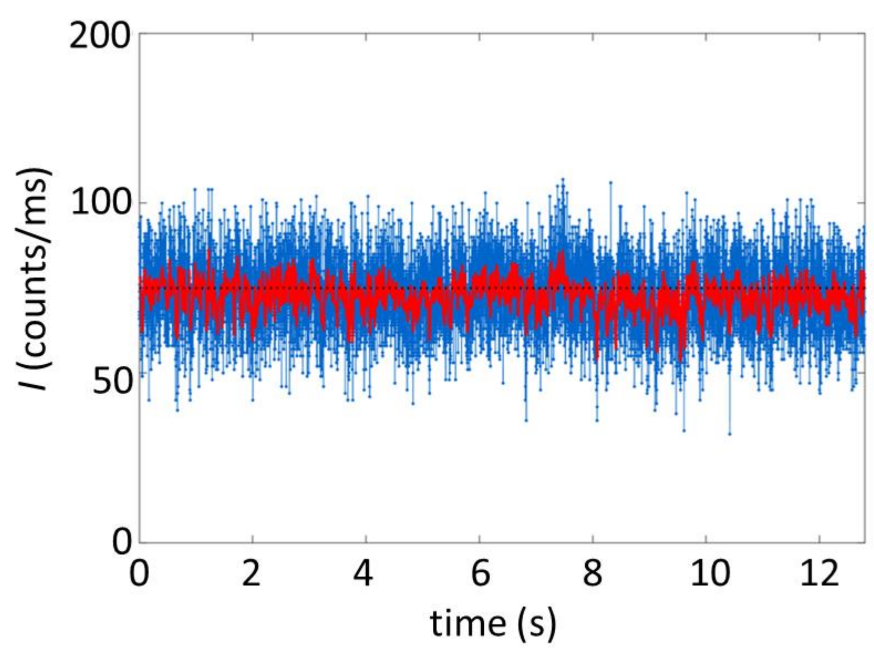
Setup

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

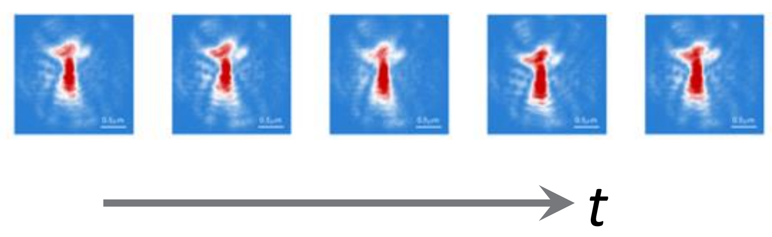


Results

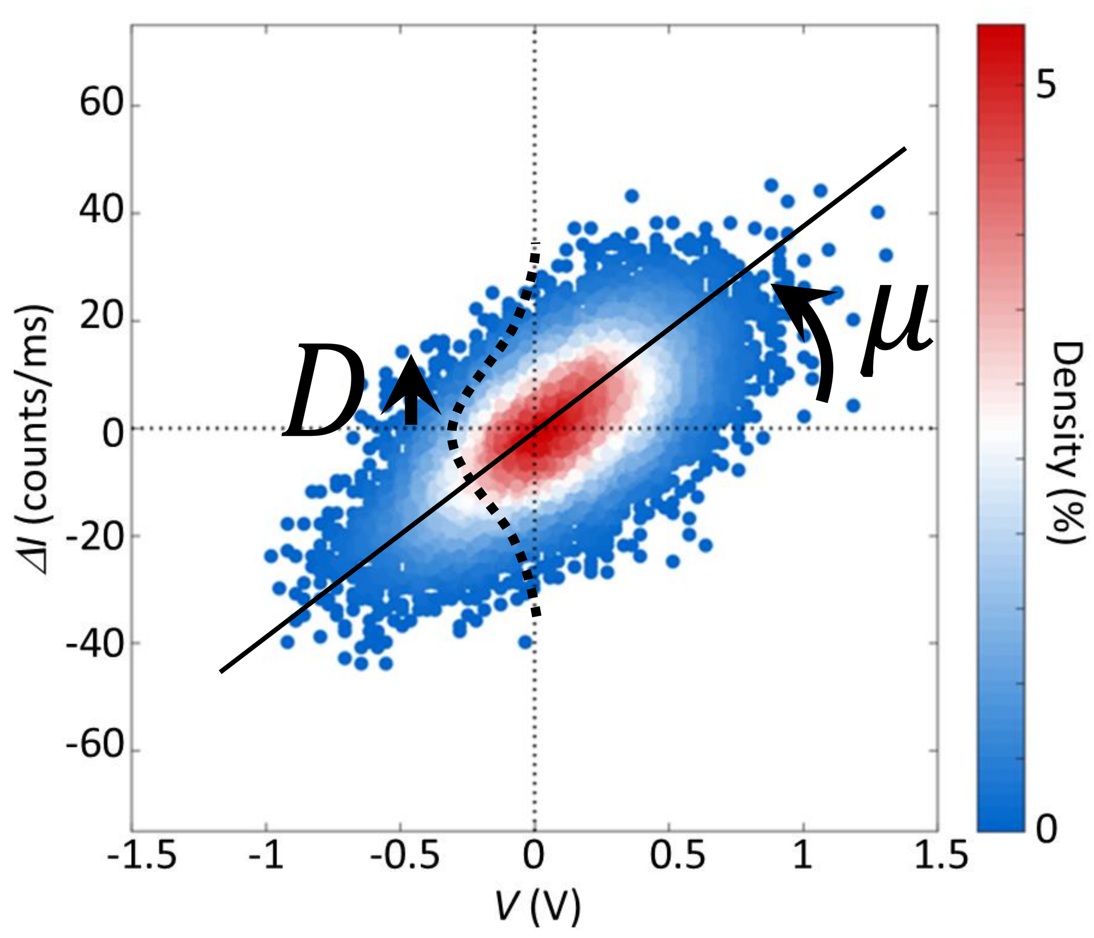
- Axial trapping of a 500-nm PS particle in DI water for 12 s, with electrode gap 10 µm at a feedback rate of 1 kHz:



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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