# Optofluidic Force Induction as Process Analytical Technology

Marko Šimić[1,2,3], Gerhard Prossliner[2,3], Ruth Prassl[3], Christian Hill[2,3], Ulrich Hohenester[1]
[1]*University of Graz, Graz, Austria,*
[2]*Brave Analytics GmbH, Graz, Austria,*
[3]*Medical University of Graz, Graz, Austria*

**Background, Motivation and Objective**

Momentum transfer from light to matter provides the basic principle of optical tweezers, which have been awarded the Nobel Prize in Physics 2018 (Ashkin, 1997). Most studies have hitherto employed this principle for trapping and manipulation of single nanoparticles. However, in a microfluidic channel one can also monitor the effect of optical forces exerted on ensembles of dielectric nanoparticles, to acquire knowledge about various nanoparticle parameters, such as size, concentration or material distributions.

**Statement of Contribution/Methods**

In this paper we present an optofluidic force induction scheme (OF2i) for real-time, on-line optical characterization of large ensembles of nanoparticles (Hill, 2020). Our experimental setup builds on precisely controlled fluidics as well as optical elements, in combination with a focused laser beam with orbital angular momentum. By monitoring the single-particle light scattering and nanoparticle trajectories, we obtain detailed number-based information about the properties of the individually tracked particles.

**Results/Discussion**

We analyse the trajectories using a simulation approach based on Maxwell's equations and Mie's theory, in combination with realistic laser fields and fluidic forces (Kiselev & Plutenko, 2014). We discuss the basic physical principles underlying the OF2i scheme and demonstrate its applicability using standardized Latex particles with a pre-determined size distribution as calibration reference. Our measurement scheme is applied to different particle systems and evaluated within our theoretical framework, where we also monitor evolutionary processes over large time scales . This dynamic approach allows for real-time particle sizing feedback which can be used to adapt process parameters. Our results prove that OF2i provides a flexible work bench for numerous pharmaceutical and technological applications.

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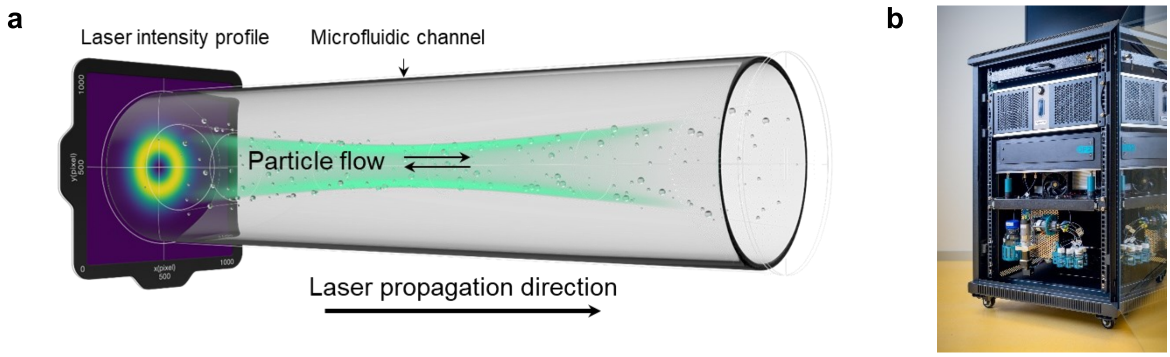


Fig. 1. Schematics of the OF2i setup. (a) Particles are immersed in a fluid and are pumped through a microfluidic channel. A weakly focused Laguerre-Gaussian laser beam propagates in the same direction as the particle flow and exerts optical forces on the nanoparticles. By monitoring the light scattered by the particles through a microscope objective, one obtains information about the scattering cross sections and via particle tracking the velocities of individual particles. (b) Shows an OF2i prototype with a sample preparation and dilution system.