Confining a specimen in a light line illumination by hollow core optical fibers

R. Förster[1], T. Wieduwilt[1], S. Weidlich[1], M. Nissen[1], S. Jiang[1] and M. A. Schmidt[1,2,3]

1 Leibniz Institute of Photonic Technology, Albert-Einstein-Str. 9, 07745 Jena, Germany
2 Otto Schott Institute of Materials Research (OSIM), Friedrich Schiller University Jena, Fraunhoferstr. 6, 07743 Jena, Germany
3 Abbe Center of Photonics and Faculty of Physics, Friedrich-Schiller-University Jena, Max-Wien-Platz 1, 07743 Jena, Germany

Imaging, tracking and analyzing the diffusion and Brownian motion of viruses, proteins or artificial nanoparticles via fluorescent microscopy is a standard technique in life- and material science. However, imaging scattered light is superior to fluorescent labeling, which is invasive and bleaches gradually. However, the scattering cross-section of a nanoparticle drops heavily with the particle diameter.

Thus, an evaluable scattering signal can only be achieved by a high illumination intensity, which requires a small illuminated area. However, the smaller the illuminated area, the smaller the field-of-view, limiting the time particles can be observed. The ideal configuration is a light line illumination, because the beam has a small diameter and illuminates a wide field-of-view at the same time. However, a free particle can leave the light line and will be dark again.

Hollow core optical fibers solve this problem by confining the solved specimen inside its air-filled channel of a few microns, which guides the light line illumination. Although the particle is confined in two dimensions, it is free in the third along the fiber channel, which is sufficient to evaluate its diameter out of the tracked Brownian motion. The presented approach is able to measure the diameter of gold and dielectric particles such as viruses down to a diameter of 10 nm and 26 nm, respectively [1], with a temporal resolution of around 1 ms and can observe the specimen over minutes and thousands of frames.

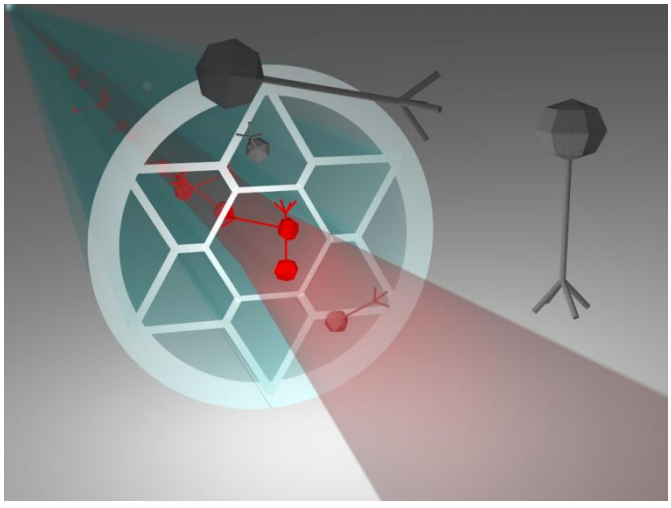

Figure 1: 70nm lambda phages in a hollow core fiber

1. S. Faez, Y. Lahini, S. Weidlich, R. F. Garmann, K. Wondraczek, M. Zeisberger, M. A. Schmidt, M. Orrit, and V. N. Manoharan, "Fast, Label-Free Tracking of Single Viruses and Weakly Scattering Nanoparticles in a Nanofluidic Optical Fiber," ACS Nano **9**, 12349–12357 (2015).