SONO-OPTICAL TRAPPING DEVICE FOR TOMOGRAPHIC OPTICAL IMAGING OF MICRO-ORGANISMS AND ORGANOIDS

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We demonstrate the capabilities of a fully reconfigurable sono-optical approach [1] in terms of contact-free 3D manipulation and imaging of sensitive, live biological samples up to a millimeter in size. In our 'sono-optic' system, a MHz ultrasonic resonator provides confinement and alignment of the object in a liquid-filled micro-chamber. Tunable holographic optical tweezers enable us to refine the acoustic trapping on a finer spatial scale, for instance to induce controlled rotations.

We show that the device can be applied for the label-free 3D reconstruction of the structural properties for a large variety of sub-mm-sized biological samples, such as swimming micro-organism, large pollen grains, cancer spheroids or organoids: The optical and/or acoustic forces are tuned to induce a continuous rotation, and the recorded videos are used as input for reconstruction by optical diffraction tomography [2]. In contrast to the standard tomographic situation, however, the rotational parameters (rotation angle and axis as a function of time) is not known *a priori*, and have to be retrieved, for instance by means of deep learning based on convolutional neural networks.

Figure 1: Live tardigrade or 'moss piglet' trapped in 3D in the hybrid acoustic-optical trap.

[1] G. Thalhammer, R. Steiger, M. Meinschad, M. Hill, S. Bernet, and M. Ritsch-Marte: „ Combined acoustic and optical trapping ", *Biomedical Optics Express*, **2**, 2859-2870 (2011)

[2] P. Müller and J. Guck: „The theory of diffraction tomography", arXiv:1507.00466. (2015)