A TUTORIAL ON WAVEFRONT SHAPING WITH SPATIAL LIGHT MODULATORS FOR ADVANCED MICROSCOPY

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This tutorial gives an overview on the various uses liquid-crystal based spatial light modulators (SLMs) have in optical microscopy. It starts with a brief introduction on SLMs in general and their working principle. A first, important application is phase-manipulation in a Fourier plane behind a microscopic sample. The SLM can act as a programmable Fourier filter, emulating contrast mechanisms, such as bright field, dark field, or (spiral) phase contrast [1].

Differential interference contrast (DIC), which uses incoherent light, may also be implemented by SLMs. Here the flexibility of the "synthetic holography", where the Wollaston prisms are replaced by diffractive structures displayed on the SLM, brings a huge advantage, since the SLM pattern may be calculated as to deliver several images with different settings (e.g. shearing) in one single exposure for "single-shot quantitative DIC". SLM-based holographic multiplexing may also be applied to target different layers inside a thick transparent sample in "depth-of-field-multiplexing".

Secondly, SLMs can also be used to control or shape the *illumination* beams in a microscope. And applying wavefront control twice, either with two SLMs of two halves of one SLM panel, it is even possible to play special tricks with matching illumination shaping and phase filtering, which may be utilized, for instance, to suppress halos in Zernike phase contrast. The tutorial concludes with summarizing the overall advantages and limitations for incorporating an SLM panel into an optical microscope set-up.

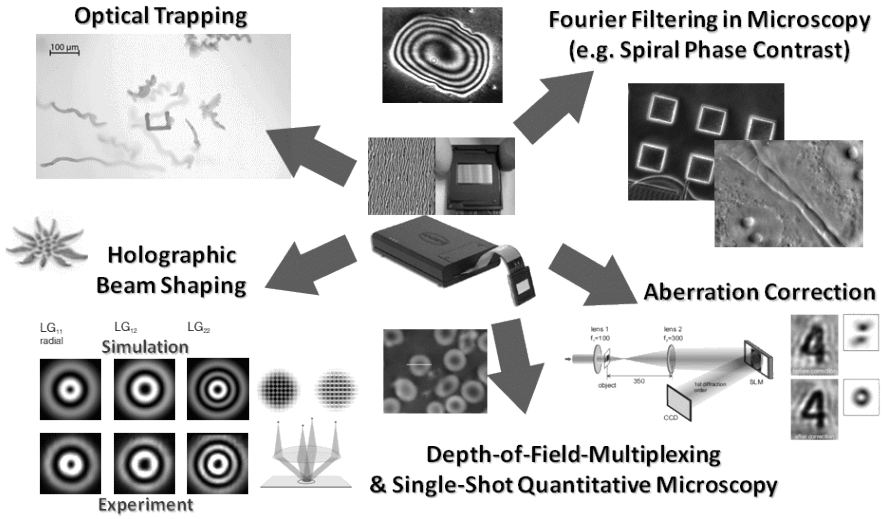

Figure 1: Overview on uses of SLM-wavefront-shaping in optical microscopy.

[1] C. Maurer, A. Jesacher, S. Bernet, and M. Ritsch-Marte: „SLM-Microscopy: What spatial light modulators can do for microscopy", *Lasers and Photonics Reviews*, **5**, 81-101 (2011)