SPATIAL LIGHT MODULATION AS A VERSATILE TOOL FOR SENSORLESS ABERRATION CORRECTION IN FLUORESCENCE MICROSCOPY AND NANOSCOPY

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Spatial (phase-only) light modulators (SLMs) have successfully been used for different tasks in microscopy, one prominent example being the doughnut beam shaping in STED nanoscopy [1]. Once implemented into the laser beam path of a microscopic imaging system, its free programmability makes the SLM a versatile instrument for multiple uses. Aberration correction in such a retrofitted system, for example, is readily realized by introducing compensating phase functions into the pupil [2,3].

We propose and demonstrate a new approach for sensorless aberration and misalignment measurement that uses the integrated SLM in combination with the detector system of the laser scanning (STED) microscope as central part of a diagnostic tool for alignment optimization and for aberration correction. Using a single fluorophore as a "guide star" our method minimizes the light stress to the reference fluorophore by using special phasemasks addressed to the SLM and detecting residual light intensities resulting from aberrations present in the system. Here, we demonstrate straightforward and robust aberration sensing and correction up to the third order of Zernike polynomials in simulations and real experiments. Being free of complex image analysis and thus easily automated the approach can be used for adaptive optics confocal microscopy and improved STED nanoscopy. A lateral STED resolution of ~20 nm is demonstrated for our confocal microscope after changing from an easySTED configuration [4] to SLM-STED and application of aberration correction.

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