DEFORMABLE MIRROR BASED WAVEFRONT CORRECTION IN 3D SUPER-RESOLUTION MICROSCOPY

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Recent advances in optical microscopy have allowed surpassing the diffraction limit of optical resolution in biological imaging. Techniques based on stochastic switching of fluorophores such as photoactivated localization microscopy (PALM) and stochastic optical reconstruction microscopy (STORM), and their extensions to three dimensions, have proven to reach resolutions of tens of nanometers in both lateral and axial directions. However, aberrations induced by optical inhomogeneities in biological specimens limit imaging depths to 10-20µm. Here we present a technique combining super-resolution microscopy with adaptive optics methods to both correct sample-induced aberrations and to introduce a controlled wavefront distortion, enabling 3D super-resolution imaging deep into biological tissues. Our approach is based on introducing a deformable mirror in an open loop configuration, without wavefront sensing, in the imaging path of a standard PALM or STORM setup. This allows to correct aberrations induced in both the sample and the optical system, and at the same time to engineer the point-spread function to implement 3D extensions to PALM and STORM imaging. This is illustrated in Figure 1, where we show a slice of the experimental point-spread-function of a fluorescent bead with (a) and without (b) wavefront correction. We will also show 3D super-resolution images of a biological specimens obtained with our approach, and point out other systems where this technique might be applicable.

Figure 1: Point spread function vs depth (top) and horizontal slice (bottom) with (a) and without (b) wavefront correction