meadowlark optics
polarization solutions

PSF Engineering

Overview: With the recent award of the Nobel Prize to Betzig and Moerner there has been a significant increase in awareness of point spread function (PSF) engineering. In this case the SLM is placed in the emission arm of a microscope. Moerner demonstrated use of PSF engineering with a Meadowlark Optics SLM for super-resolution imaging and 3D localization of fluorescence emitters. PSF engineering has been demonstrated to enable a microscope to image a sample using multiple imaging modalities simultaneously change between modalities non-mechanically. This allows for imaging of structures with a weak refractive index, and for quantitative measurement of phase structures. Imaging modalities that have been demonstrated include: spiral phase imaging, dark field imaging, phase contrast imaging, differential interference contrast imaging, and extended depth of field imaging.

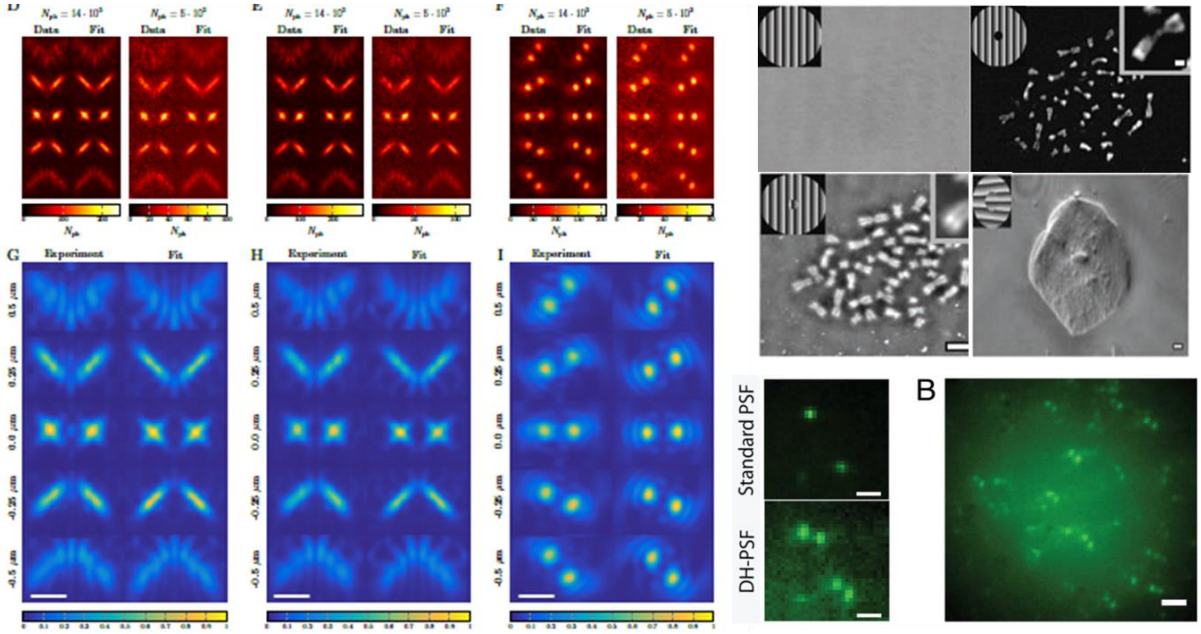

Figure 1 (left) Siemons, M., Hulleman, C. N., Thorsen, R. Ø., Smith, C. S., & Stallinga, S. (2018). High precision wavefront control in point spread function engineering for single emitter localization. *Optics express*, *26*(7), 8397-8416. (right top) Maurer, Christian, et al. "What spatial light modulators can do for optical microscopy (right bottom) Pavani, Sri Rama Prasanna, et al. "Three-dimensional, single-molecule fluorescence imaging beyond the diffraction limit by using a double-helix point spread function."

Critical requirements: For this market it is important that the SLM minimize optical losses. PSF engineering uses a SLM to manipulate the wavefront in the emission path of the microscope. There is a lack of signal in fluorescence imaging without adding losses. Use of a SLM with a high fill factor minimizes losses to diffraction. High resolution SLMs are ideal for creating the complex phase functions required for 3D localization, and high speed allows for real time deep tissue super-resolution imaging.

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