Double-Helix PSF Universal Module for 3D Localization

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The Double-Helix Point Spread Function technique engineers the response of a microscope such that the image of each point emitter is in the form of two lobes. The center of the pair of lobes determines the lateral position of the emitter and the angle between the lobes determines the axial position. We present an implementation of the Double Helix phase mask technology integrated into an optical module - SPINDLE™ - that extends the imaging capabilities of most microscopes to nanometer scale 3D localization for imaging[1]–[3] and tracking[4].

The SPINDLE™ has been designed to seamlessly integrate with existing microscopes. Compact in size and optimized for every emission wavelength, the SPINDLE™ attaches directly to the camera and microscope using standard C-mounts. No adjustment to existing set ups is required for operation. Interchangeable phase masks enable for optimal control of the PSF based on parameters such as z-range, emission spectrum, signal-to-noise ratio, etc.

The imaging software, capable of resolving overlapping emitters, has been optimized for processing and analyzing captured images to provide detailed 3D information and full structure datasets for analysis[5].

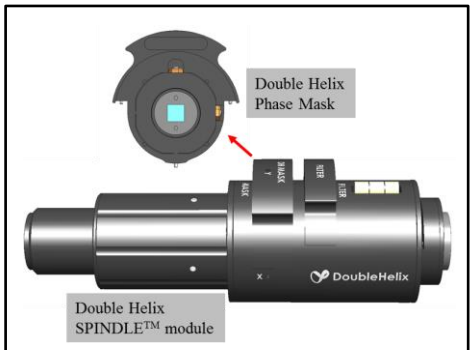

Fig. 1 Schematic of the SPINDLE module with the Phase Mask Holder.

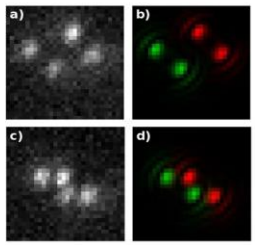

Fig. 2 Overlapping emitters resolved in 3D tracking experiment

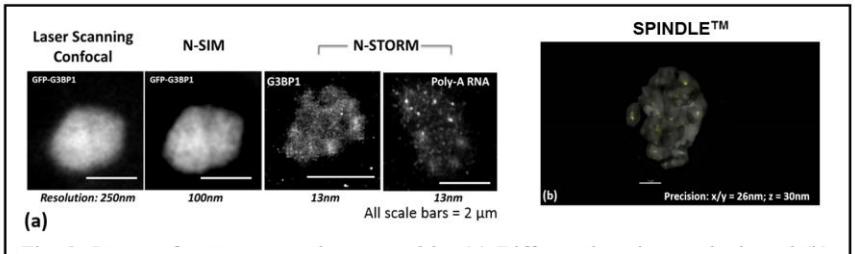

Fig. 3 Image of a stress granule captured by (a) Different imaging methods and (b) SPINDLE™. The 3D precision/depth combination provided by the SPINDLE™ enabled detailed information about the 3D core structures of the stress granule for the first time.

References

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