LBRC Special Seminar

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Nanoscopy-on-a-photonic-chip: multi-modality nanoscopy over millimeter scale

Present optical nanoscopy techniques use a complex microscope for imaging and a simple glass slide solely to hold the sample. We propose the inverse configuration: a complex, a waveguide chip, or photonic integrated circuit (PIC) is used both for holding the sample and for generating the required illumination pattern needed to acquire super-resolved images and a standard low cost optical microscope to acquire the image. Waveguides are made of high refractive index contrast material serve two purposes: they provide a strong evanescent field that is used for single molecule switching and fluorescence excitation and thus enable chip-based single molecule localization microscopy. Additionally, multi-mode interference patterns inside waveguide induce spatial fluorescence intensity variations that opens the opportunity to perform another nanoscopy technique on an integrated platform i.e. fluctuation-based super-resolution imaging.

By illumination through a PIC, we are completely liberating the illumination from the detection path. This enables imaging to be performed using different NA objective lens, generating super resolution images with a varying field of view (FOV). By using 60X 1.2 N.A. water immersion objective lens optical resolution of 45-50 nm is achieved over 50x 50 um^2 region. While, a 20X 0.4 N.A objective lens provides optical resolution of 130 nm over 0.5x0.5mm^2 region. The proposed chip-based optical nanoscopy will surpass the technical capability of present day optical nanoscopy in speed, resolution, cost, compactness and for imaging over large field of view.

The compatibility of PIC with off-the-shelf optical fiber components, allows easy multiplexing of channels enabling multi-color super resolution imaging. Standard techniques for attaching biological material to the waveguides are used in the same way as for conventional cover-glass/glass-slides. The integrated nanoscopy platform makes combinations with different lab-on-a-chip methods, e.g. microfluidics, optical trapping or other sensing techniques now straightforward to implement.