NONLINEAR LENSLESS ENDOSCOPY – TWO-PHOTON IMAGING THROUGH OPTICAL FIBERS

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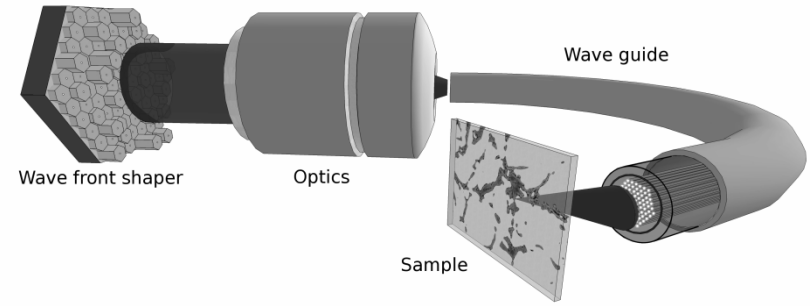
Typical endoscopes need optical or micromechanical components attached to their tip in order to form an image. These components limit miniaturization of the endoscope probe to around a few millimeters. The novel concept of using optical fibers in conjunction with adaptive optics, called "lensless endoscopes" [1-2], have allowed us to overcome these size restrictions down to the size of the fiber itself. This ability to control the wavefront at the distal end of a fiber would enable imaging at depths inaccessible to conventional nonlinear microscopes.



In this talk, we will highlight the inherent constraints of nonlinear imaging through optical fibers. Particular emphasis will be placed on the delivery of ultrashort laser pulses through fibers. In particular, multi-core fiber bundles (MCF) are demonstrated to be suitable candidates for two-photon imaging. In such MCF, each individual core acts as a pixel of the composite wavefront exiting the fiber and can be employed to generate and scan a focal spot purely by controlling the wavefront at the proximal end of the fiber with a deformable mirror. We demonstrate an extended field-of-view [3] together with pixelation-free 3D-resolved widefield imaging [4] using aperiodic MCFs. In addition, we present a novel technique, the Group Delay Controller (GDC), to compensate for the inter-core group delays in these fibers and to demonstrate temporal control of the ultrashort pulse at the distal end of the fiber. This complete spatio-temporal control of field at the end of the fiber permits us to perform two photon imaging on labelled samples.

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