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PROJECT 3 – PhD/WP3

Advanced applied microscopy through a multimode fiber endoscope

Discipline keywords: Applied Physics, Fiber optics, Endoscopy, Raman spectroscopy, Bio-imaging

Imaging at several millimetres depth in tissue, while maintaining the sub-micron resolution available in standard light microscopes, requires new types of endoscopes. Multimode fibers have shown promise as flexible endoscopes, but advanced adaptive optics is needed to overcome the phase offsets between the propagation modes in the fiber, which scrambles the image.
In this project the student will work on advanced applied microscopy through a multimode fiber. Possible avenues are linear Raman imaging for label-free imaging with chemical contrast at the tip of a fiber, further developing existing methods for fiber-based light-sheet imaging using specialized probes, and possibly combining this with Raman spectroscopy.
Imaging with chemical contrast has potential use in, for example, diagnosing tumours in situ without performing a biopsy and imaging lipid distribution in cells (relevant for cell metabolism and related disease conditions). The student will collaborate with researcher working with in-vivo imaging, delivering solutions for their imaging needs, as well as with researcher developing technology for various imaging modalities.
The project is mainly experimental with only some (<20%) theoretical modelling. The student will learn basic modelling of light propagation in an optical fiber, adaptive optics, microscopy and imaging, programming for instrument control. Knowledge of optics is central to the project. Some knowledge of a programming language (Matlab, LabView or similar) would be useful.
The work will take place at the Institute of Scientific Instruments of the Academy of Sciences of the Czech Republic. The PhD student will be a part of the research project “Gate2mu: Holographic endoscopy for *in vivo* applications", project number CZ.02.1.01/0.0/0.0/15_003/0000476, which is currently running at this institute. The whole Gate2mu project will consist of ca 15 people (post-grads, postdocs and several senior researchers).

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Literature:
[1] T. Cizmar, and K. Dholakia, Shaping the light transmission through a multimode optical fibre: complex transformation analysis and applications in biophotonics, Optics Express 19 18871 (2011)
[2] S. Mekhail, G. Arbuthnott, and S. Nic Chormaic, Advances in Fibre Microendoscopy for Neuronal Imaging, Opt. DataProcess. Storage 2:30–42 (2016), (DOI:10.1515/odps-2016-0003)
[3] M. Plöschner et al., Multimode fibre: Light-sheet microscopy at the tip of a needle, Scientific Reports 5:18050 (2015) (DOI: 10.1038/srep18050)

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