Institute of Scientific Instruments The Czech Academy of Sciences, v. v. i.
Královopolská 147, 612 64 Brno, Czech Republic
phone: +420 541 514 111
fax: +420 541 514 402
e-mail: institute@isibrno.cz
www.isibrno.cz

PROJECT 2 PhD/WP2

Non-linear microscopy through a multimode fiber endoscope

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 we aim to implement multi-photon fluorescence and non-linear Raman microscopy (SRS or CARS) at the end of a multimode fiber endoscope. Initially, the student will study the frequency dependent light transmission in graded index fibers (experiments and theory), with the aim to allow delivery of femtosecond pulses with a specific chirp to the imaging area.
Once this is achieved, we will apply this to multi-photon imaging and investigate the possibility of non-linear Raman imaging. We will evaluate which method (SRS or CARS) is more suitable for imaging through a multimode fiber. Towards the end of the project we hope to demonstrate label-free non-linear imaging in tissue. This has potential use in diagnosing tumours in situ without performing a biopsy.
The project is mainly experimental with only some (<20%) theoretical modelling. The student will learn basic modelling of light propagation in an optical fiber (the advanced modelling is done elsewhere in the main project), adaptive optics, microscopy and imaging, programming for instrument control, femtosecond pulse characterization techniques. 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 *with the possibility of full-time employment*. The PhD student will be a part of the research project "Gate2mu: Holographic endoscopy for *in vivo* applications", reg. 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 (PHD students, postdocs and several senior researchers).

Supervisor: Johanna Traegaardh; johanna@isibrno.cz
Consultant: Tomáš Tyc; tomtyc@isibrno.cz

Literature:
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[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] E. O. Potma and X. S. Xie, CARS Microscopy For Biology and Medicine, Optics & Photonics News, p 40, (2004)

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