Research opportunity for a PhD Student

at the Institute of Biomedical Physics, Medical University of Innsbruck

Adaptive optics and multiphoton microscopy for deep brain imaging

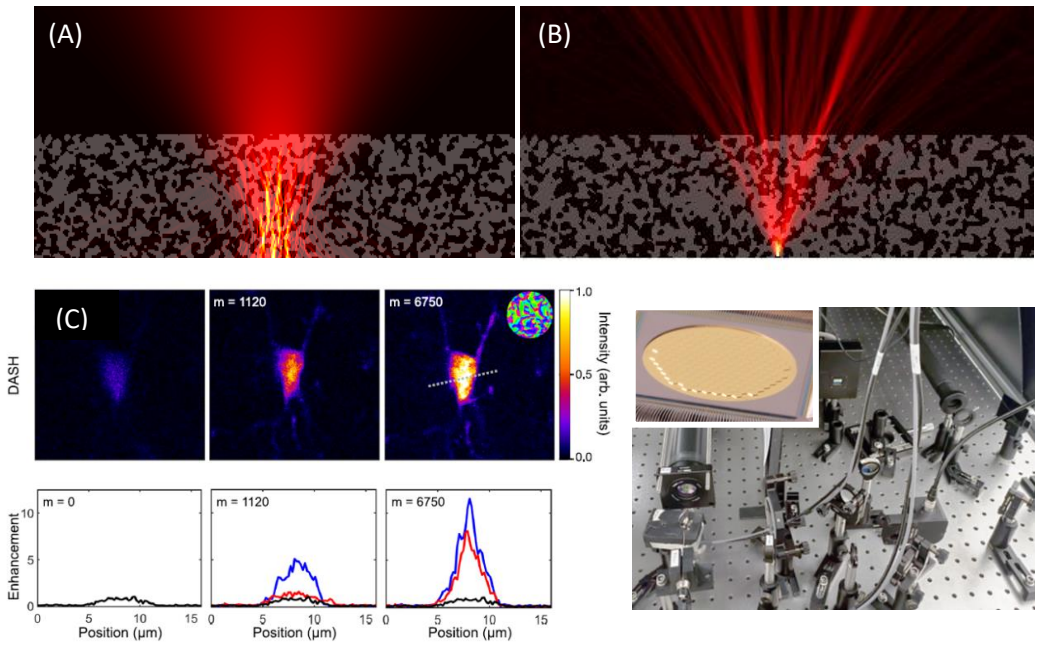
The Biomedical Physics group is hiring a PhD student to carry out research on an exciting interdisciplinary project that applies cutting-edge adaptive optics techniques to push the limits of nonlinear fluorescence imaging at the single cell level deep in living tissues.

Imaging the activities of cells deep inside the living brain is one of the most desired capabilities in the neurosciences, but faces significant challenges. Fluorescence imaging can provide high resolution images of brain cells such as neurons or microglia cells, like shown below in (C), but the image quality often degrades quickly when imaging structures even a few tens of microns (the width of a single hair) below the surface of the tissue. This degradation occurs because biological tissues are optically inhomogeneous and scatter the scanning laser beam as simulated in (A) below.

This project aims to compensate for this degradation to retrieve clear images deep in living tissues using a novel adaptive optics technique to precisely control the phase front of the ingoing laser beam. By pre-compensating for the effects of propagating through the scattering tissue, a sharp laser focus and image can be retrieved (B).

This experimental research project involves a range of activities including the design and construction of a 3-photon excited fluorescence scanning microscope, state-of-the-art adaptive optics hardware, computer automation, and numerical studies on the propagation of light through turbid media.

If you would like to learn more or apply for the position, please email Univ. Prof. Alexander Jesacher at **alexander.jesacher@i-med.ac.at** to arrange a meeting. Find more information on our webpage.



(A) An incident laser beam is scattered by a thick sample, making it difficult to image at great depths; (B) Adaptive optics seeks to find and shape optimal wavefronts so that the sample restores the focus rather than destroying it; (C) Iterative wavefront optimization can lead to drastic signal improvements; (D) home-built AO unit; the inset picture shows a segmented deformable mirror for shaping wavefronts.

Further information:

The work will be a continuation of our research project described here:

https://www.i-med.ac.at/dpmp/bmp/research/Adaptive-multi-photon-imaging/Adaptive-multi-photon-imaging.html

The ideal background would be a MSc. in Experimental Physics or Optical Engineering.

The main aims are the implementation of an adaptive optics aided 3-photon excited fluorescence scanning microscope and investigations on novel strategies for fast wavefront correction in deep tissue imaging.

We seek candidates with a strong interest in biological microscopy, optical system design and computational methods.

Ideally, the successful candidate has:

- a strong work motivation
- hands-on experience working in an optical lab, such as working with optical components and optomechanical hardware. This is necessary since the microscope will be a home-built system.
- Experience in Labview programming. This is required since the microscope hardware will be controlled via Labview.
- Experience in numerical programming languages such as Python, Matlab or Julia. This is required since the experimental work will be guided by numerical simulations.