Sujet de thèse

Laboratoire: Institut Fresnel
Directeur de thèse : Serge Monneret
Co-directeur de thèse : Thomas Chaigne
Email : serge.monneret@fresnel.fr
thomas.chaigne@fresnel.fr

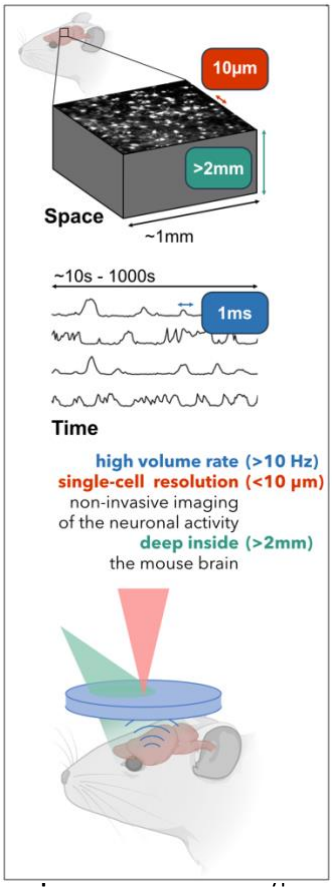
Adresse : Institut Fresnel, Domaine Universitaire de Saint Jérôme, 13397 Marseille
Tel : 0413945475

Title: Photoacoustic imaging of neuronal activity in mice

Research program

The study of large scale neuronal circuits throughout the brain is currently one of the biggest challenge in neurobiology. Non-invasive imaging of neuronal activity with single cell resolution is however currently limited to shallow depths, due to prominent light scattering beyond one millimeter. Photoacoustic imaging, a fascinating technique relying on ultrasound generation upon the absorption of a light pulse, has been developed to overcome this issue, enabling to probe optical absorption contrast at large depths in biological tissue. To achieve cellular resolution, the detected ultrasound bandwidth must be as large as 100 MHz, which is beyond the reach of conventional piezo-electric based sensors.

The project aims at developing an *all-optical photoacoustic imaging* setup to non-invasively *access neuronal activity at large depths* ($\gtrsim$ 2 mm) in the *mouse brain*. The candidate will design and fabricate Fabry-Perot cavities for the optical interferometric detection of ultrasound. To provide high temporal resolution as required for neuronal activity imaging, the candidate will investigate wide-field interrogation strategies of these cavities. In particular, he/she will implement data acquisition and image reconstruction approaches based on compressive sensing. These techniques will be applied to perform calcium imaging in mice.



scales involved: (Space) 10 µm-diameter neurons lying several millimeters deep inside the brain (Time) exchange information by sending 1ms long electrical pulses, or action potentials. The goal of this project is to image this activity at high frame rate, single-cell resolution, at large depth. This will be achieved by using all-optical photoacoustic imaging.

Collaborations

As dealing with advanced optical fabrication and neurobiology, this project will be carried out in close collaboration with other groups from Marseille (RCMO group at Fresnel Institute, Cossart group at Inmed).

Requirements

Candidates with a strong background in physics, optics, electrical engineering, neuroscience (with some experience in optical imaging) or any related field are encouraged to apply. As this project is tightly linked to its applications in biology, the candidates are expected to have a strong interest for neuroscience and biology. Programming skills (or a strong will to develop them) are essential (Matlab or Python), as well as a certain taste for tinkering. As they will be evolving in an international environment, the candidates must be fluent in English, and exhibit excellent communications capabilities (written and spoken).

Host lab

The project will be carried out at the Fresnel Institute in Marseille, within the MOSAIC group. Gathering more than 40 people from around the world, this interdisciplinary group is working at the crossroad of physics and biology.

Application procedure

Please send a detailed CV, a cover letter, as well as names and contact details of two references to thomas.chaigne@fresnel.fr. Make sure to mention "[Application]" in the email object.