Sujet de thèse

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Titre :

Photoacoustic imaging of neuronal activity in mice

Description :

The study of large scale neuronal circuits throughout the brain is currently one of the biggest challenge in neurobiology. Non-invasive optical imaging of neuronal activity with single cell resolution is however limited to shallow depths, due to prominent light scattering beyond one millimeter. Even the most advanced non-linear microscopy techniques fail to reach about 90% of the rodent brain, which constitutes a major hurdle for the study of the brain as a whole.

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. Conventional ultrasonic detectors based on piezoelectric elements however fail to recontruct images with cellular resolution (~10 µm), due to their limited bandwidth (< 50 MHz).

The PhD 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*. To provide a sufficient detection bandwidth and hence achieve quasi cellular resolution, the *acoustic field will be optically detected* using custom-made Fabry-Pérot cavities.

This framework yet lacks the intrinsic parallel measurement of the ultrasonic field over large fields-of-view with multi-elements ultrasonic probes. We will circumvent this limitation by developing wide-field interrogation strategies based on compressed sensing. This shall yield the high temporal resolution (frame rate > 10 Hz) required for neuronal activity imaging. We will apply these techniques to perform calcium imaging in mice.

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 the Fresnel Institute, Grosso group from IM2NP, various neurobiology groups from INT and Inmed).