Developing adaptive optics tools for functional imaging of brain organoids

Thématique : Nouvelles méthodes optiques pour le vivant

Laboratoire LuMIn – Interface Physique/Biologie

Context of the project

Brain organoids represent an emerging model for studying neuronal development and connectivity. When combined with advanced microscopy systems, they enable 3D and real-time visualization of neuronal activity of early stages of human brain development. However, their density and size ($\approx$ 2 mm) generate optical aberrations, reducing the signal-to-noise ratio at depth. To address this challenge, adaptive optics corrects these aberrations, thereby improving image quality and facilitating the analysis of neuronal signals.

This project first aims to develop **adaptive optics algorithms for light-sheet microscopy**, optimizing organoid imaging. It then seeks, on a longer time scale, to study the emergence and evolution of neuronal activity over several weeks. This interdisciplinary approach, at the intersection of optical microscopy, signal processing, and neuroscience, aims to develop innovative methodological tools for investigating the early stages of brain development and neuronal communication mechanisms. Focused on instrumental development in microscopy (adaptive optics) and signal analysis, the project addresses a key challenge in modern neuroscience. It also opens up applied perspectives for the study of neuronal pathologies, an active research area within our laboratory.

Objectives

— Develop adaptive optics algorithms specific to brain organoids

— Implement this system on an existing wavefront sensor

— Conduct microscope tests and demonstrate signal improvement through aberration correction

Work environment

The project is part of the **"Biophotonics - Neuroscience"** theme at **LuMIn**, at the interface between physics and biology. The group explores fundamental questions and medical applications across scales ranging from the nanometric to the macroscopic.

Project keywords

— Scientific curiosity for the interface between biology and physics

— Strong interest in image analysis and coding

— Opportunity to engage in optical instrumentation and experiments

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