Master internship
Modelling and characterizing ultrafast tunable filters

We are seeking enthusiastic and talented candidates to develop innovative imaging strategies combining optics and acoustics to study neuronal activity deep inside the brain.

Context

Spectral filtering of optical waves is crucial to many fields, from biomedical imaging to satellite communication. In fluorescence microscopy for instance, precisely designed filters are required to separate the faint fluorescence emission from the strong excitation light. Yet, most filters are created through thin film (metallic or dielectric) deposition and are therefore passive meaning their optical properties are constant in time. Moreover, the spectral transfer function is usually uniform across the entire filter surface. Spatially variable filters can be manufactured using gradient masks during the deposition process, but more complex shapes remain beyond the reach of current fabrication techniques.

In this project we aim at creating a new generation of filters whose properties can be dynamically controlled in space and time. These new active filters will be based on a Fabry-Pérot cavity coupled to ultrasound transducers. A multi-wave process can indeed tune the local property of the cavity to alter its optical filtering, allowing different wavelengths to go through at different positions on the filter.

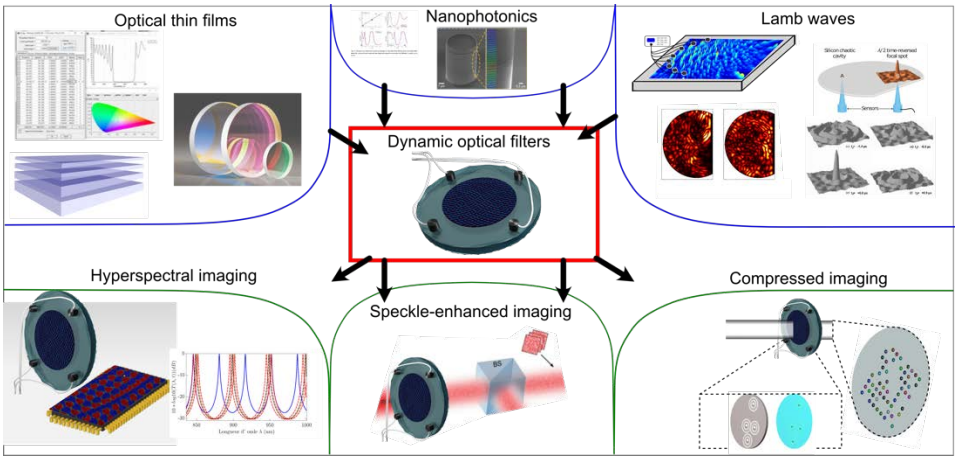

Figure 1 : These dynamically reconfigurable optical filters combine concepts from a wide range of research fields. They hod great potential, as they are likely to impact a wide range of applications.

Research program

1) Modelling and numerical simulation: multiphysics simulation (using softwares such as Matlab and Comsol) will be performed to understand the coupling of the acoustic wave to the different parts of the system.

2) Experimental work: a first model experiment will be built to validate the simulation results and ensure maximum excitation of the acoustic modes of interest in the optical component. The system will then be installed on an existing optical imaging setup to demonstrate that the optical response of the component can be manipulated by controlling the ultrasound signals.

Host lab and advisors
The project will be carried out at the Fresnel Institute in Marseille, between the MOSAIC and the RCMO groups. The candidate will be supervised by two researchers: Thomas Chaigne (MOSAIC group, CNRS) and Samuel Métais (RCMO group, McF Ecole Centrale Med).

Requirements
Candidates with a strong background in physics, optics, some experience in optical imaging or any related field are encouraged to apply. This project being exploratory, curiosity and the potential to develop new ideas and ways to test them would be greatly appreciated. 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).

Why you should apply
By joining our research group at the Fresnel Institute in Marseille, you will gain hands-on experience in cutting-edge optical imaging. We are seeking enthusiastic and motivated candidates to participate in groundbreaking research.
This is a unique opportunity to gain experience in a wide range of skills, from numerical simulations and clean room fabrication to optical and electrical instrumentation, along with image reconstruction and processing.
You will work closely with our team of experts, learn how to use state-of-the-art equipment, and develop programming skills (Matlab or Python). The two host groups regularly welcome students from a variety of backgrounds to join us.
On top of a thrilling research environment, the city of Marseille offers a high quality of life, with limited living costs and a unique combination of a culture and nature.


Left: the Fresnel Institute (30 minutes by bike or public transportation from the city center); Middle: the city center and old harbour, heart of Marseille; Right: the calanques, less than an hour by public transportation from the city center

Application procedure:
Please send a detailed CV, cover letter, transcripts, as well as contact details of two academic references to thomas.chaigne@fresnel.fr and samuel.metais@fresnel.fr. Make sure to mention “[Application]” in the email object.
We look forward to hearing from you!