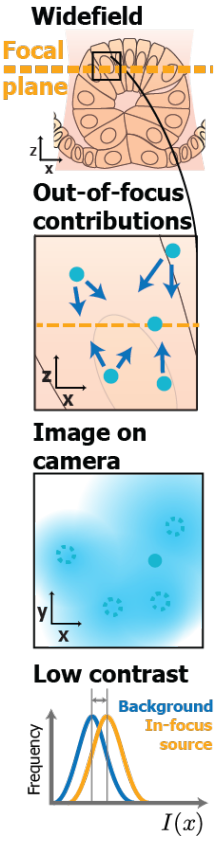
M2 Internship

LightScout

Statistical benchmarking of structured illumination for robust particle tracking in living tissues

Master 2 internship project (with extension possible for fully funded PhD)



Host team

The Bioimage Mining group, led by Philippe Roudot at Institut Fresnel and CENTURI (Aix-Marseille University), develops computational methods for capturing the molecular and cellular dynamics that govern living tissues. Our research lies at the interface of statistical signal processing, machine learning, computational imaging, and quantitative biology.

Technological and computational challenge

We still know very little about the **nanometric machinery** that **drives** our physiology and **diseases**. Tracking small fluorescent objects inside living tissues is difficult because signals are weak and background fluorescence is strong (see Figure on the right).

Structured illumination can improve image contrast by separating background from in-focus sources. However, reconstruction requires multiple images. The sample must therefore remain effectively unchanged during acquisition, which restricts these approaches to fixed samples or sufficiently slow particle dynamics.

The central bottleneck tackled by LightScout is to bring this high sensitivity to moving objects. LightScout explores statistical approaches to preserve detection and tracking sensitivity for moving objects under structured illumination.

Internship objective

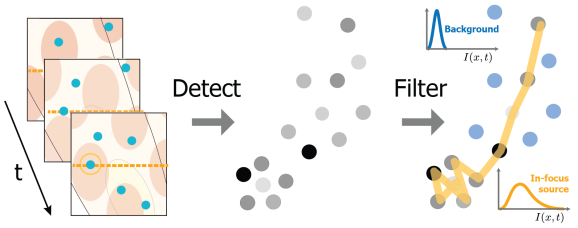
The student will implement a benchmark and estimator for a single-particle setting. A simulation framework will generate trajectories with known positions and motion parameters, reproducing the main sources of variability in structured illumination microscopy. An estimator will then be developed to estimate particle positions and intensities. A conventional tracking baseline applied to data acquired under uniform illumination will be compared with the estimator designed for structured illumination.

Perspective

The internship opens the door to an exciting PhD project within the EndoTrack Project, led by P. Roudot and C. Collinet (IBDM). The project focuses on quantifying molecular trafficking in living embryos. It has been selected for funding by the PEPR Math-Vives.

Candidate profile

We are looking for a Master 2 student in applied mathematics, signal processing, statistics, machine learning or a related field, with scientific programming skills. We especially value curiosity, intellectual rigor and clear communication.



Research environment

The student will work in an interdisciplinary environment of the Phyti team at Fresnel Institute, combining expertise in signal processing, computational microscopy, imaging, and access to the quantitative biology community at CENTURI.

Training during the internship

The student will gain experience in state-space modeling, Bayesian estimation and trajectory reconstruction. Training will also cover the basics of modeling of fluorescence microscopy. The internship will develop research skills in computational experiment design, scientific visualization, writing, and oral communication.

The subsequent PhD will explore how transformer models can be integrated with state-space modeling and Bayesian inference. This will place learning within a rigorous statistical framework, with systematic evaluation of uncertainty.

Application

Applicants should send a CV, a short cover letter and, if available, examples of academic or programming work to Philippe Roudot at philippe.roudot@univ-amu.fr.

Practical information: Level: Master 2 internship, Duration: 5–6 months, Starting date: early 2027, Internship allowance: approximately 650 €/month. Subsequent PhD: 2,300 € gross/month (current CNRS salary scale).