

OPTICAL ENGINEER

Development of multiplexed Holographic Optical Tweezers

Laboratory: Transfer-Interface-Mixing (TIM) group, TBI – Toulouse Biotechnology Institute (INSA Toulouse, CNRS, INRAE)

Location: Toulouse, France

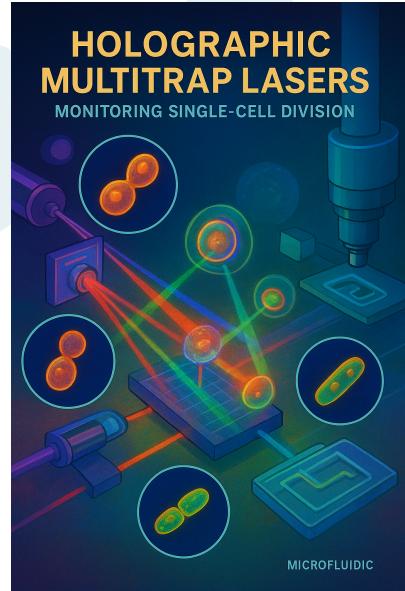
Duration: 13 months

Level: Master 2 (or equivalent engineering degree), 1-4 yr experience

Start date: January 2026 (flexible)

Supervisor: Mickaël Castelain – mickael.castelain@insa-toulouse.fr

Framework: SCUBA Project (2026–2029) ANR-25-CE51-7100-01



CONTEXT

Modern bioprocesses rely on a precise understanding of **cell-environment interactions** to optimize yield, robustness, and product quality. Yet, at the industrial scale, **imperfect mixing in bioreactors** generates fluctuating microenvironments (in pH, oxygen, temperature, or nutrient availability) that strongly influence microbial physiology.

The **SCUBA project (Exploring the Single Cell to Understand the Bioreactor)** aims to bridge the gap between **microscale cell behavior** and **large-scale bioreactor performance**. It develops a **novel experimental platform** combining **microfluidics**, **fluorescence imaging**, and **Holographic Optical Tweezers (HOT)** to study single microbial cells in real time under controlled and dynamic environmental conditions. We aim to reinforce our experimental capabilities by further developing and optimizing our **Holographic Optical Tweezers (HOT)** platform. This system enables the precise manipulation and characterization of individual cells under dynamic environmental conditions, providing a unique window into microbial physiology and population heterogeneity.

OBJECTIVES OF THE INTERNSHIP

We are seeking an **Optical Engineer (internship position)** to take a leading role in the **design, development, and implementation** of the next-generation Holographic Optical Tweezers platform. The successful candidate will:

- Design and align advanced optical architectures for holographic trapping and multi-beam manipulation;
- Integrate the HOT system with existing microfluidic and laser-induced fluorescence (LIF-I) setups;
- Develop real-time control and calibration algorithms for precise 3D trapping and force measurements;
- Collaborate with biologists and computational modelers to enable quantitative single-cell studies relevant to microbial bioprocesses;

- Contribute to the validation and dissemination of the system through scientific publications and presentations.

CANDIDATE PROFILE

- Master's degree (M2) or engineering school background in **Optical Engineering, Physics, Photonics**, or a related field;
- Strong interest and experience in **laser optics, beam shaping, or holography**;
- Knowledge of **optomechanical design, microfluidic integration**, and optical instrumentation;
- Programming skills (e.g., Python, MATLAB, or LabVIEW) for system control and data analysis;
- Interest in **biophysical applications, instrumentation, and interdisciplinary research**.

SUPERVISION AND ENVIRONMENT

The applicant will work within the **Transfer-Interface-Mixing (TIM)** group at the **Toulouse Biotechnology Institute (TBI)**. The TIM group gathers complementary expertise in **bioprocess engineering, fluid dynamics, microbiology, and optical manipulation**, fostering a multidisciplinary approach to biotechnological research.

The engineer will work closely with the **SCUBA team** and an **optical engineer** responsible for implementing the holographic optical tweezers upgrade, under the supervision of **Mickaël Castelain**. This application is embedded in the **SCUBA project (2026–2029)** ANR-25-CE51-7100-01.

APPLICATION

Please send the following documents in a **single PDF file** to mickael.castelain@insa-toulouse.fr

- Curriculum Vitae
- Motivation letter (max. 1 page)
- Academic transcripts (Master 1 and Master 2, if available)
- 2 letters of reference