

## Contrats doctoraux 2026

**Titre du projet de thèse :** Integration of theoretical and experimental physics approaches for the multiscale study of emergent properties in micro-tumors.

**Directeur de thèse :** Stefano Giordano

**Co-directeurs de thèse :** François Anquez (PhLAM) / Chann Lagadec (CANTHER, Lille)

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### Résumé du projet de thèse (en 20 lignes maximum) :

This PhD project aims to understand how stochastic fluctuations and cell–cell interactions govern the spatiotemporal self-organization of micro-tumors. At the interface between biophysics, non-equilibrium statistical physics and cancer biology, the goal is to relate phenotypic state-transition dynamics at the single-cell level to the collective properties of tumor structures.

We will focus on a biological system already characterized for its phenotypic plasticity. In this system, Anquez and collaborators have shown the spontaneous formation of cancer stem cell niches (Brulé, Pfeuty, Lagadec, Anquez, Stem Cell Research & Therapy 2025). A second mesenchymal/epithelial self-organization system will be used to study the emergence of spatial patterns of a different nature (Jain et al., Semin. Cancer Biol. 2023). Both systems are biologically relevant, since stem-like and mesenchymal phenotypes are involved in mechanisms of treatment resistance.

At PhLAM, the PhD student will design and implement an original two-photon light-sheet fluorescence microscopy setup dedicated to long-term 3D imaging of living micro-tumors.

In parallel, he/she will exploit existing microscopy platforms and methods for inferring dynamical laws from single-cell imaging data (Champion et al., PNAS 2019; Frishman & Ronceray, Phys. Rev. X 2020).

A key objective will be to extend these inference methods to volumetric 3D imaging in order to systematically confront data with modelling – and modelling with data.

At IEMN, we will develop non-equilibrium stochastic models (Langevin, Fokker–Planck, multi-state models) to describe state transitions coupled to neighbourhood interactions (Cannizzo et al., J. Phys. A 2021; Giordano, Soft Matter 2017; Benedito & Giordano, Phys. Rev. E 2018).

The joint inference of parameters and effective landscapes from 3D movies will make it possible to predict and test the emergence of collective regimes (phase coexistence, stable patterns, phase transitions).

The project is part of the CDP C<sup>2</sup>EMPI programme (Axis 1: dynamics of complex systems; Axis 2: modelling and simulation), with a natural connection to random and disordered structures in tumor tissues.

The PhD will be co-supervised by F. Anquez (PhLAM, advanced imaging / biophysics) and S. Giordano (IEMN, theoretical physics), as part of a nascent collaboration between their teams, in close interaction with C. Lagadec, cancer biologist at CANTHER.

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**Date de recrutement envisagée : 09/01/2026**

**Contact (adresse e-mail) : [francois.anguiez@univ-lille.fr](mailto:francois.anguiez@univ-lille.fr)**

**Remarques/commentaires supplémentaires :**