



Master in Photonics – “PHOTONICS BCN” Master ERASMUS Mundus “EuroPhotonics”

MASTER THESIS PROPOSAL

Starting full time from April 2025

Presentation at the end of July or beginning of September 2025

Laboratory: Single Molecule Biophotonics (SMB)

Institution: Institut de Ciències Fotòniques (ICFO)

City, Country: Barcelona, Spain

Title of the master thesis: Live cell nanoscopy imaging of individual molecules under mechanical forces.

Name of the master thesis supervisor and co-supervisor:

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Keywords: mechanobiology, super-resolution microscopy, cell stretching, nanoscale organization

Summary of the subject (maximum 1 page):

Cells are constantly exposed to mechanical forces from both their extracellular environment and internal processes. Their ability to sense and respond to these forces is essential for critical cellular events, which is achieved by a complex machinery of mechanosensitive structures that operate with exquisite precision at the molecular level. Disruptions in these processes can lead to multiple diseases like cancer, fibrosis, and immune disorders. Despite recent advances in force measurement tools, visualizing the effects of these forces at the molecular level and in living cells remains challenging.

Our laboratory, in collaboration with the group of Pere Roca-Cusachs at IBEC, has recently developed an innovative cell stretching system compatible with super-resolution fluorescence microscopy and other advanced imaging techniques. This state-of-the-art device allows to exert mechanical stimulation in living cells in a controlled manner and visualize how cells adapt and respond to the forces in real time. Our system offers unprecedented potential to push the boundaries of cell mechanobiology, unravelling the molecular players and mechanisms that drive cellular responses to mechanical stimuli.

The Single Molecule Biophotonics (SMB) research group at ICFO, led by Prof. Dr. Maria Garcia-Parajo, is looking for a highly motivated graduate student who wish to enhance his/her scientific career in a friendly, international and stimulating environment within the fields of advanced fluorescence microscopy and mechanobiology.



Objectives:

The candidate will work with the newly developed devices to stretch living cells and image their responses to mechanical forces using Stimulated Emission Depletion STED super-resolution microscopy and other imaging techniques. The focus will be on studying mechanosensitive membrane proteins that form nanoscopic assemblies and initiate protein interaction cascades in response to mechanical stimuli.

Objective 1: Optimize cell-stretching and super-resolution imaging.

The candidate will culture mammalian cells in the stretching device, label force-sensitive proteins, and perform controlled cell stretching combined with STED imaging. The candidate will test different stretching schemes and force loads and explore several fluorescent dyes suitable for one colour and two-colour STED.

Objective 2: Investigate molecular responses to mechanical stimuli.

The candidate will conduct simultaneous stretching and super-resolution imaging experiments to analyse how external forces affect the organization and interactions of mechanosensitive proteins. Data analysis will be performed using specialized software to extract quantitative information from the super-resolution images.

Candidates with a background in physics, chemistry or biology are encouraged to apply. The student will work in an interdisciplinary group and will gain wet lab skills, hands-on experience in cell culture, fluorescence labelling of proteins, advanced super-resolution fluorescence microscopy techniques, image analysis and in writing and presenting the research results to a multidisciplinary audience.