



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

MASTER THESIS PROPOSAL

Starting full time from April 2024

Presentation at the end of July or beginning of September 2024

Laboratory: Single Molecule Biophotonics

Institution: ICFO – Institut de Ciències Fotòniques

City, Country: Barcelona, Spain

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

Name of the master thesis supervisor and co-supervisor:

Supervisor: Prof. Dr. Maria Garcia Parajo; Co-Supervisor: Dr. Joaquim Torra

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Keywords: mechanobiology, super-resolution microscopy, cell stretching, protein nano-organization

Summary of the subject (maximum 1 page):

Cells in our body are subjected to mechanical forces generated by the extracellular environment and intracellular processes. Their ability to detect, apply and transmit forces is critical for the correct function of fundamental cellular events, which is achieved by a complex machinery of mechanosensitive structures that operate with exquisite precision at the molecular level. During the last years, smart methods and tools have been developed to generate and quantify forces in cells at different spatiotemporal scales, however, visualizing the effects of mechanical forces on individual molecules in living cells remains particularly challenging.

Our laboratory, in collaboration with the group of Pere Roca-Cusachs in IBEC, is currently developing and applying an innovative cell stretching system that enables the simultaneous application of forces while imaging the organization and interactions of mechanosensitive proteins at the nanoscale. Specifically, our cell stretching devices now allow live cell imaging and are fully compatible with a super-resolution fluorescence microscopy technique called STED (Stimulated Emission Depletion Microscopy). Our device is a powerful and unique tool with tremendous potential for unveiling the nanoscopic secrets of cell mechanobiology.

The Single Molecule Biophotonics 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 Mechano-Biology.



Objectives:

The candidate will work with the newly developed devices to stretch living cells in a controlled manner and image how cells respond and adapt to the forces using STED super-resolution microscopy. In particular, we are interested in the study of key cell membrane mechanosensitive proteins that are capable to sense and transmit forces by forming nanoscopic assemblies and triggering a cascade of protein interactions.

The objective in the first place is to optimize the conditions for both cell stretching and super-resolution imaging experiments. For this, the candidate will learn how to culture mammalian cells and label different proteins of interest in the stretching device, and to perform controlled cell stretching and STED imaging. He/she will test different stretching schemes and force loads that cells tolerate and explore several fluorescent molecules suitable for one colour and two-colour STED.

The second objective is to perform simultaneous cell stretching and nanoscopic imaging in order to characterize the effects of external forces on the mechanosensitive proteins. The candidate will test selected combinations of fluorescently labelled proteins to assess changes in the nanoscale organization of the proteins and identify new interactions induced upon the application of forces. He/she will use specialized software to analyse the super-resolution images and extract quantitative data.

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