



## **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:** Optoelectronics Group

**Institution:** ICFO

**City, Country:** Barcelona, Spain

**Title of the master thesis:** 3D imaging by pulsed light interference and machine learning techniques

**Name of the master thesis supervisor and co-supervisor:** Supervisor – Dr. Prof. Valerio Pruneri;  
Co-supervisor – Dr. Álvaro Cuevas

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**Keywords:** Ranging, 3D imaging, pulsed lasers, deep learning, neural networks

#### **Summary of the subject:**

Depth imaging is a very important tool in a variety of science-applied fields, ranging from monitoring of industrial fabrication to aerial topography and automotive environment visualization, among others. Standard techniques cover two well separated dynamic ranges, one below the micron scale known as phase imaging, and another one above the mm or cm scales enabled by lidar-like technologies. Developing a technique that covers the above-mentioned gap has big potential implications in a variety of fields.

The objective of the project consists in the development of a ranging system (3D imager for distant objects), with depth error on the [ $\mu\text{m}$ ] scale and tuneable dynamic range beyond the [ $\text{mm}$ ] scale. In order to do it, the student will utilize deep learning and/or neural networks as key ingredients for recognition of patterns in 2D image data, provided by a unique optical system that combines standard consumer devices. The main tasks will consist in; i) designing the more suitable neural network for the system; ii) to train it with real and simulated data; iv) to reconstruct 3D object shapes, v) to computationally simulate optical aspects of the imaging protocol, vi) to manipulate and optimize the experimental system depending on the target sample and environmental conditions. The selected candidate will have the opportunity to work within a sociable and multidisciplinary team of experts, to utilize cutting edge-technology, to be regularly supervised, to develop a proactive attitude and to improve his/her self-regulation skills.



### Objectives:

1. To build and train an optimized neural network, able to recognize 1D depth patterns from a set of 2D images.
2. To acquire expertise in the manipulation of experimental equipment, by mounting and optimizing an optomechanical setup.
3. To get full 3D image reconstruction of a distant object.

### Additional information:

#### \* Required skills:

- Medium programming experience in more than one language, including Python
- Knowledge in machine learning, deep learning or neural network

#### \* Optional skills (beneficial for the candidate to have):

- Knowledge in optics
- Knowledge in photonics and quantum optics
- Knowledge in imaging and sensing