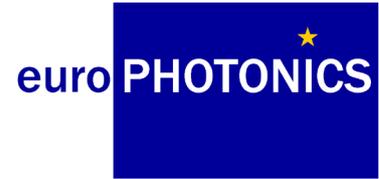




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# PHOTONICS - EUROPHOTONICS MASTER COURSE

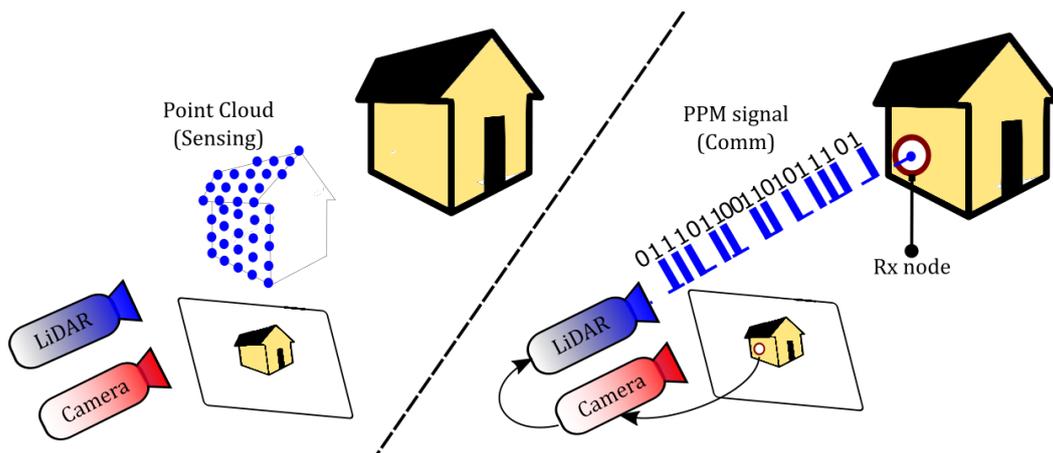
## PROPOSAL FOR A MASTER THESIS

Dates: February 1<sup>st</sup>, 2025 – September 30<sup>th</sup>, 2025

Laboratory: Centre for Sensors, Instrumentation and systems Development (UPC-CD6)  
City, Country: Terrassa, Spain

Title of the master thesis:

**OPTICAL PULSE MODULATION FOR A FSO 6G-COMMUNICATION LINK BASED  
ON JCAS LIDAR TECHNOLOGY**



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## Summary of the subject (maximum 1 page):

5G communication systems are currently being rolled out in the world now in technologies such as millimetre wave (mmWave), massive multiple-input multiple-output (massive MIMO), device-to-device (D2D) communications or edge computing. However, this technology is not enough for future demands in aspects like ultra-high throughput, ultra-high reliability, ultra-low power consumption, and ultra-low latency. In addition, the massive connectivity of IoT devices challenges the capacity of 5G networks. Therefore, researchers across the world have started working to bring a new generation of wireless networks, the so called beyond 5G (B5G) and 6G, expected to provide ubiquitous, human-centric, full band, strongly secure, and intelligent services. 6G will be a prominent player in the mid-term in several industries like vehicular technology, education or healthcare.

Within this context, the CD6 is developing the next generation of LiDAR sensors that not only are capable of sensing but also can send information through a Free-Space Optical (FSO) communication link. Sensors with Joint Sensing And Communication (JCAS) capabilities are crucial for the novel 6G-network to reduce complexity and costs.

You will join our research group, where you'll have support on the use of scanning lidars, firmware and software development, optical design and modelling, signal analysis, etc.

This thesis aims to study and to develop a Pulse Position Modulation (PPM) suitable in the current proprietary LiDAR devices to introduce the communication capabilities. The focus will be on three key areas:

- 1) **Modulation and system requirements:** Investigating the trade-offs between the modulation parameters to achieve maximum performance and the system capabilities in terms of modulation, pulse repetition rate, and other relevant parameters.
- 2) **Communication coding:** Determining the most suitable bit code to achieve the highest bandwidth with the lowest bit error rate.
- 3) **Implementation and testing:** Developing both the modulation control and the signal analysis and validating the communication system in an in-lab testing.

This project represents a breakthrough in LiDAR technology because, up to now, there are not devices with communication capabilities. Moreover, the 6G architecture is a real-world challenge that has just started to be tackled in the research community. Basic programming skills (fluent Matlab or Python) and basic knowledge of electronics and optical system design are desirable, but not strictly required.

**Keywords:** integration, metrology, autonomous vehicles, ROS, Python, deep learning, datasets

### Additional information :

\* Amount of the monthly allowance (if it is the case):  
To be discussed depending on the value of candidate.

\* Required skills:

Interest in application-driven experimental work for solving real-world problems.  
Basic concepts in optical metrology and optical engineering

Programming (C++ desirable, Python or Matlab minimum) and use of scientific software packages.

Search of resources, both scientific and technical

Self-motivated, objective-driven, capable of autonomous working within a multidisciplinary team.

\* Miscellaneous:

This thesis contents will be considered confidential due to its closeness to market.

International team with several years of experience in the topic proposed.

Multidisciplinary environment with electronics and mechanics workshops, and specialists and technicians in metrology, optics, mechatronics, and electronics.

Possibility of joining the Centre for a PhD/Project Manager career in case of common interest.

Early incorporation welcome.