



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

MASTER THESIS PROPOSAL

Full time from April 2026 (it can start part time from February 2026)
Presentation date to be chosen: end of July or beginning of September 2026

Note: The main Master Thesis supervisor has to be a professor of the Master in Photonics program. One co-supervisor (internal or external) can be defined. Main Supervisor is responsible for the subject of the proposal and has to give continuous support to the student (research development, Report writing and presentation preparation). For external proposals a co-supervisor from the Master program and a collaboration agreement with UPC are needed. You can find all information about the Master Thesis process in [our webpage](#).

Laboratory: Optoelectronics group (<https://www.icfo.eu/research-group/15/optoelectronics/home/>)
Institution: ICFO - The Institute of Photonic Sciences
City, Country: Castelldefels (Barcelona), Spain

Title of the master thesis: Synchronization of SPAD-cameras: hardware for high-dimensional quantum technologies

Name and affiliation of the master thesis supervisor: Prof. Dr. Valerio Pruneri (supervisor)
Name and affiliation of the co-supervisor (if any): Dr. Jorge Fuenzalida, Dr. Robin Camphausen (for external proposals a co-supervisor chose among the Master Program professors and a collaboration agreement with UPC is needed)
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Mail address:

Keywords: Quantum entanglement, spatial correlations, SPAD camera

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

Quantum technologies, a frontier of innovation, have the potential to transcend classical limits in applications across communication and information processing. These technologies, primarily powered by quantum entanglement, face a significant challenge in increasing the dimensionality of systems, a demanding task in quantum physics. Moreover, there is a lack of quantum hardware such as detectors for carry on measurement of high-dimensional quantum states.

The project consists of the synchronization between two single-photon avalanche diode (SPAD) cameras. This technique will become pivotal for quantum technologies since will allow the measurement of correlations between two optical fields in a multi-mode scenario. The project considers measuring spatial entanglement using these cameras.



The student will form part of the Optoelectronics group at ICFO, led by Prof. Valerio Pruneri, working closely with members of the quantum imaging team in order to take advantage of the group's expertise in quantum optics.

References:

- [1] Baptiste Courme, Chloé Vernière, Peter Svihira, Sylvain Gigan, Andrei Nomerotski, and Hugo Defienne, "Quantifying high-dimensional spatial entanglement with a single-photon-sensitive time-stamping camera," *Opt. Lett.* 48, 3439-3442 (2023).
- [2] Bruno Eckmann, Bänz Bessire, Manuel Unternährer, Leonardo Gasparini, Matteo Perenzoni, and André Stefanov, "Characterization of space-momentum entangled photons with a time resolving CMOS SPAD array," *Opt. Express* 28, 31553-31571 (2020).

2. Objectives (maximum 1 page):

- 1) Understanding of quantum optics experiments, including quantum spatial correlations
- 2) Manipulation of SPAD cameras

Additional information (if needed):

* Required skills:

- Familiarity with programming using Python programming language (common scientific computing libraries such as NumPy, etc)
- Motivation to work and passion for quantum physics
- Previous experience with optics laboratory setups would be a bonus

* Miscellaneous:

Stipend: yes, for details please enquire when applying