



## **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:** Optimized Quantum Key Distribution with Non-Orthogonal States

**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. Evelyn A. Ortega (for external proposals a co-supervisor chose among the Master Program professors and a collaboration agreement with UPC is needed)

**Email address:** [jorge.fuenzalida@icfo.eu](mailto:jorge.fuenzalida@icfo.eu)

**Phone number:** +34 935534142

**Mail address:**

**Keywords:** Quantum key distribution, quantum communications

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

Quantum communications deliver unbreakable security between certified users, which is possible through the generation of random bits using quantum states. This field has reached a point of maturity where today efforts are focused on making protocols more efficient, and to reach longer distances.

On the one hand, quantum communications can be performed with only two non-orthogonal states (B92 protocol) [1], which reduces the set of prepared states. On the other hand, the discrimination between two non-orthogonal states can be optimized using positive operator-valued measure (POVM) [2]. This way, a POVM optimizes the B92 protocol.



The project consists in the construction of the receiver for the optimized B92 protocol. This will be later employed in a 20 km free-space link in the metropolitan area of Barcelona. The student will be 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] C. H. Bennett, "Quantum cryptography using any two nonorthogonal states," Phys. Rev. Lett. **68**, 3121 (1992).
- [2] I. D. Ivanovic, "How to differentiate between non-orthogonal states," Phys. Lett. A **123**, 257 (1987).

**2. Objectives (maximum 1 page):**

- 1) Understanding of quantum optics experiments, including quantum key distribution
- 2) Construction of a displaced Sagnac interferometer

**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

\* Miscellaneous:

Stipend: yes, for details please enquire when applying