



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

MASTER THESIS PROPOSAL

Starting full time from April 2025

Presentation at the end of July or beginning of September 2025

Laboratory: Quantum Communications UB / ICCUB Technological Unit

Institution: University of Barcelona

City, Country: Barcelona, Spain

Title of the master thesis: Using SiPM detectors in a entangled photons Bell test

Name of the master thesis supervisor and co-supervisor: Daniel Guberman, Jose Maria Gomez Cama, Bruno Julia Diaz

(for external proposals a co-supervisor from the Master program and a collaboration agreement is needed)

Email address: daniel.guberman@icc.ub.edu

Phone number: 934039926.

Mail address: Marti i Franques 1, 08028 Barcelona

Keywords: Single photon detectors, SiPM, Bell test

Summary of the subject (maximum 1 page):

State of the art developments in quantum optics rely on single-photon detectors. In particular, they play a crucial role in any setup developed to certify entanglement. An important example of those is a Bell test. In this case, for instance, pairs of photons entangled in polarization are measured in different axes to test the existence of violations to CHSH inequalities.

The main goal of this project is to study the feasibility of using silicon photomultiplier (SiPMs) in quantum communications. One of the main features that make SiPMs attractive for this application is that they have the capability to resolve and quantify events triggered by more than one photon in a single detector. Besides, they offer a higher detection efficiency and a larger sensitive area than standard photodetectors. On the other hand, SiPM noise can limit the signal-to-noise ratio (SNR).

In the quantum communication lab there is a setup that produces pairs of entangled photons by means of two BBO crystals. The student shall replace the sensors that are currently mounted in the setup by SiPMs, using the electronic readout that was developed at ICCUB

The work is experimental and multidisciplinary, as the student shall interact with physicists and engineers from different backgrounds (quantum physics, high-energy astrophysics). It involves the design and development of optical setups, the operation of detectors and their electronics and software development to perform data analysis. The student will learn about optics, the detection of single photon events, and electronics.



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Objectives:

- Build a Bell test using SiPMs for the single photon detection
- Study correlations between events of more than one photon per channel

Additional information (if needed):

- * Required skills:
- * Miscellaneous: