

INTERNSHIP PROPOSAL

Laboratory name: MPQ
 CNRS identification code: UMR7162
 Internship director's surname: DUCCI Sara
 e-mail: sara.ducci@u-pariscite.fr
 Internship location: 10 rue A. Domon et L. Duquet 75013 Paris

Thesis possibility after internship: YES
 Funding: NO Funding plan: Doctoral School, QuanTEDU-France, DIM QuanTip

AlGaAs chips for quantum communications and hybrid quantum networks

Future quantum networks will interconnect quantum nodes through photonic links operating over existing telecommunications fiber infrastructure. Realizing these networks requires advances in two key areas: direct interfaces between heterogeneous quantum platforms, combining long-lived matter qubits with low-loss telecom photons, and the development of entangled-photon sources and synchronization techniques compatible with real-world deployed networks. The QITE team develops AlGaAs quantum photonic chips, a III–V semiconductor platform that combines a strong second-order optical nonlinearity, enabling efficient photon-pair generation, with a direct bandgap that allows on-chip laser pumping at room temperature [1]. Recent achievements include the distribution of broadband polarization-entangled photons over a deployed fiber link connecting the campuses of Université Paris Cité and Sorbonne Université [2], as well as the development of a deep-learning-based design tool for non-degenerate AlGaAs photon-pair sources interfacing trapped 88Sr⁺ ions with the telecom C-band [3]. Building on these advances, this project brings together integrated quantum photonics, hybrid matter–photon interfaces, and deployed quantum communication through three complementary research directions:

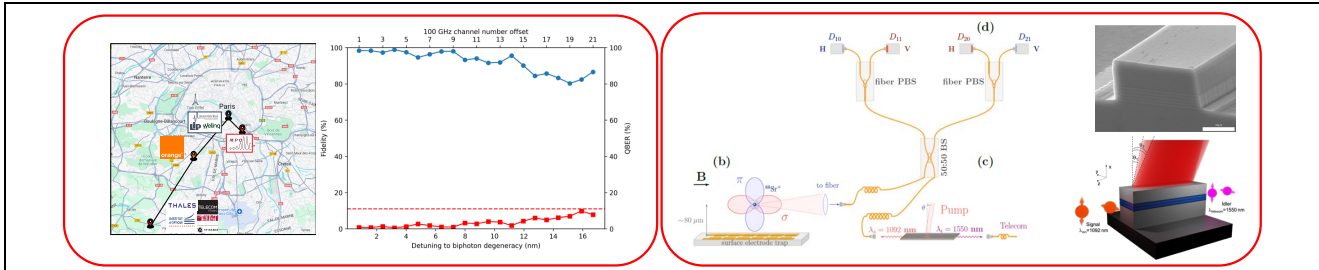


Figure. Left: deployed fibered network in Île-de-France; fidelity to the Bell state Ψ^+ and QBER vs telecom channel in the link between UPCité and SU. Right: scheme of entanglement swapping between an 88Sr⁺ ion and a telecom photon; SEM image of AlGaAs waveguide and pump geometry for non-degenerate entangled photon-pair generation

Quantum photonic device design, fabrication, and characterization. Several chip designs targeting different applications will be developed, fabricated, and characterized. These will include sources for ion–photon interfaces and entangled-photon generation in both the telecom C and O bands. Devices will be characterized in both classical and quantum regimes, from their optical properties to their quantum performance. This work will benefit from our long-standing collaboration with the epitaxy team at the Centre de Nanosciences et de Nanotechnologies (C2N).

Hybrid ion–photon quantum links. In collaboration with the trapped-ion group at MPQ, we will investigate entanglement swapping between a trapped ion and a telecom photon. A Bell-state measurement involving the 1092 nm photon generated by the source and a photon emitted by the ion will project the ion and the remaining telecom photon into an entangled state, establishing a key building block for connecting matter-based quantum memories to fiber-optic quantum networks [4].

Deployed quantum networks and multi-user communication. In collaboration with the QI team at LIP6, we will implement multi-user, entanglement-based quantum communication protocols that combine industry-grade multiplexing technologies [5] with advanced synchronization techniques, notably White Rabbit, to support coordinated operation across multiple network nodes [6]. This effort will build on the collaboration recently established with colleagues from the REFI-MEVE infrastructure [7], bringing laboratory-developed quantum technologies closer to practical network deployment. The internship will focus on the quantum characterization of novel photonic devices and on hands-on training in the experimental implementation of quantum communication protocols over a deployed fiber link. The internship is intended for students interested in pursuing a PhD and offers an opportunity to contribute to research at the intersection of quantum photonics, quantum interfaces, and quantum networking. This research is carried out within the framework of the national Quantum Communication Testbed PEPR project and the European Quantum Secure Networks Partnership.

- [1] F. Baboux, G. Moody and S. Ducci, *Optica Mini-Review* 10, 917 (2023)
- [2] C. Smaï, M. J. Díaz Sánchez et al., poster communication GDR TeQ (2026)
- [3] I. P. De Simeone et al., *arXiv:2603.12846* (2026)
- [4] M. A. Zalewski et al., *Phys. Rev. A* 113, 012615 (2026)
- [5] F. Appas et al., *npj Quantum Information* 7, 118 (2021)
- [6] J. Serano et al. <https://cds.cern.ch/record/1743073> (2013)
- [7] <https://www.refimeve.fr/en/refimeve-2/our-expertise/time-and-frequency-transfer-via-white-rabbit/>

Condensed Matter Physics: YES	Soft Matter and Biological Physics: NO
Quantum Physics: YES	Theoretical Physics: NO