# Internship offer

**Laboratory: MPQ (in the framework of a collaboration with STMicroelectronics and C2N)**

**Director: C. Ciuti**

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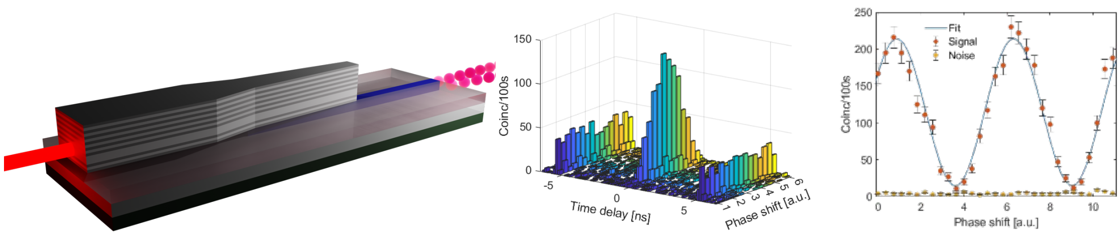
## *Hybrid III-V/SOI photonic devices for quantum information*

**Scientific project:**

The miniaturization of quantum information components is one of the key challenges for the widespread diffusion of quantum information technologies. Among the various platforms currently under development, semiconductors stand out for their strong potential in terms of integration, reconfigurability, and scalable fabrication of quantum photonic devices [1]. In this context, hybrid devices are emerging as a promising approach to harness the complementary strengths of different material systems. For instance, III-V semiconductors have proven to be excellent quantum light emitters, while silicon-based passive photonic circuits have reached a high level of technological maturity, thanks to advances in CMOS fabrication processes [2].

Building on recent progress in the realization of hybrid III-V/SOI quantum photonic devices capable of emitting energy-time entangled photons [3], this project aims to demonstrate electrical injection into these sources and to implement on-chip manipulation of the quantum state, taking advantage of the well-developed catalogue of SOI components.

The project is carried out in the framework of a collaboration between three internationally recognized partners: the QITe team (MPQ), specialized in the development of III-V quantum light sources [3]; the Center for Nanoscience and Nanotechnology (C2N), which has expertise in all stages of device fabrication, including heterogeneous integration of III-V materials on silicon [4]; and STMicroelectronics, a global leader in silicon-based electronics and photonics. This collaboration leverages the strengths of both material platforms, paving the way for innovative and densely integrated optoelectronic devices for quantum computing and secure quantum communication.




*Left: Sketch of the hybrid device enabling the generation of photon pairs in an AlGaAs waveguide and their adiabatic transfer to an underlying SOI waveguide. Right: Demonstration of the energy-time entanglement of photons at the device output: the transition from one material platform to the other preserves a high level of entanglement.*

[1] E. Pelucchi et al. *The potential and global outlook of integrated photonics for quantum technologies* Nature Reviews Physics **4**, 194 (2022).
[2] J. Adcock et al, *Advances in Silicon Quantum Photonics*, IEEE Journal of Selected Topics in Quantum Electronics, **27**, No. 2, (2021)
[3] J. Schuhmann, L. Lazzari et al., *Hybrid III/V-Silicon quantum photonic device generating broadband entangled photon pairs'* PRX Quantum **5**, 040321 (2024)
[4] G. Crosnier et al. *Hybrid indium phosphide-on-silicon nanolaser diode* Nat. Photonics 11, 297 (2017)

**Methods and techniques: numerical simulations, clean-room fabrication, classical and quantum optical measurements**

**Possibility to go on with a PhD? YES**
**Envisaged fellowship? CIFRE, QuantEdu Project, DIM SIRTEQ, Doctoral School**