

Integrated rare-earth ion quantum memories on silicon nitride photonic circuits

Position: PhD

Duration: 36 months

Supervisors: C. Cornet (PR INSA Rennes), Y. Léger (CR CNRS HDR), F. Appas (CR CNRS)

Department : Optoélectronique, Hétéroépitaxie et Matériaux, located at INSA Rennes

Funding program: INSA Rennes doctoral fellowship

Key words: quantum communications, quantum technologies, integrated photonics, photon-pair sources, solid-state quantum memories

Subject:

Quantum networks relying on distribution of entanglement between stationary matter qubits are expected to enable powerful applications in computing, sensing, and secure communication. However, a major challenge is how to share quantum entanglement across long distances. Quantum repeaters have been proposed as a solution. They consist of two elementary building blocks: sources of non-classical light and quantum memories. In addition, to unlock potential real-life applications they need to be developed on an integrated physical platform allowing for reliable and large-scale fabrication. At Institut Foton, we propose to achieve this goal by combining, on the one hand, low-loss photonic circuits to perform nonlinear photon-pair generation and quantum gates and, on the other hand, chip-integrated rare-earth-ion ensembles in the solid-state acting as a quantum memory.

In the framework of this PhD, the student will carry out key steps towards building hybrid integrated rare-earth based quantum memories on silicon nitride photonic circuits. The roadmap of the project is:

Year 1

- Design and simulation of silicon nitride photonic circuits
- Fabrication in the nanoRennes cleanroom facilities (e-beam lithography, dry etching)

Year 2

- Bonding of rare-earth-doped membranes onto the fabricated chip
- Spectroscopic characterization of the device at cryogenic temperatures

Year 3

- Quantum storage of single-photon-level laser pulses
- Extension to multimode storage of path qubits

The project will benefit both from the well-established expertise of FOTON Institute at the national and European level in nonlinear integrated photonics and heterogeneous integration as well as an emerging research line on quantum technologies.

Student Profile

This PhD position is dedicated to M2 students with a background in photonics and quantum mechanics showing a strong interest in experimental research. Previous experience in an optics

laboratory is preferable. Due to the multicultural working environment, proficiency in English is required and knowledge of French is appreciated.

Research environment

The PhD will be located within the OHM department of FOTON institute, based at INSA Rennes. The student will join a dynamic team of two PhD students, as well as researchers, technicians and engineers working on the topic of nonlinear integrated photonics and quantum technologies.

Complementary information - application

Send your CV to:

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