

# NÉEL INSTITUTE Grenoble

## Topic for Master 2 internship – Academic year 2022-2023

### Quantum memory integration of rare-earth doped crystals

#### General Scope :

Rare-earth ions because of their unique 4f electronic configuration form well isolated systems when embedded in solids. They have long coherence time at low temperature making them highly promising qubits for the development of quantum technologies: as solids, they offer perspectives of integration, while keeping atomic properties (narrow lines) when interacting with light (optical or RF). Erbium is particularly appealing in this prospect because its optical transition falls in the telecom range, and can naturally be used as a support for optical quantum memories and more generally as a fast and versatile element of control on the qubit.

#### Research topic and facilities available :

The main objective is to integrate erbium doped materials into a photonic platform and perform a demonstration of quantum storage using this device. Most of the realizations have involved so far bulk crystals, namely oxides compounds containing yttrium. As compared to glass, silicon or lithium niobate, rare-earth activated samples are not commercially available as a photonic platform. Based on a recognized national consortium (see below), we propose firstly to fabricate elementary wafer supporting rare-earth doped crystals. After a secondary integration/fabrication step to produce a waveguide, we will benefit from the light confinement to enhance the interaction. We therefore propose to perform a quantum memory demonstration using this unique device.

The internship will focus on the first steps of the project, combining fabrication processes (polishing and surface adhesion), mechanical characterization of the samples at cryogenic temperatures and elementary spectroscopy of the ions embedded in the structure to evaluate the local strain.

#### Possible collaboration and networking :

- [Institut de Microélectronique Electromagnétisme et Photonique et le Laboratoire d'Hyperfréquences et de Caractérisation](#) (IMEP-LAHC)
- [Institut de Physique de Nice](#)
- [Institut de Recherche de Chimie Paris](#)
- [Laboratoire Kastler Brossel](#)

#### Possible extension as a PhD : Yes – Grant already available

#### Required skills:

Experimental skills in one the domains are highly recommended : optics, laser, atomic spectroscopy.

General interest in the optimization of fabrication processes would be appreciated.

Education background in quantum physics and general optics, non-linear optics or light-matter interaction is demanded.

**Starting date** : First semester 2023

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