



## PhD open position at “Institut FOTON”

### *Laser-based and integrated photonic systems for advanced quantum sensing*

A 36 months duration PhD will start at “Institut FOTON”, to develop innovative experimental photonic solutions targeting new generations of diamond NV centers quantum sensors.

**PhD starting:** between 1<sup>er</sup> October 2023 and 1<sup>er</sup> December 2023

**Duration:** 36 months

**PhD supervisor:** Paul Huillery **PhD co-supervisor:** Mathieu Perrin

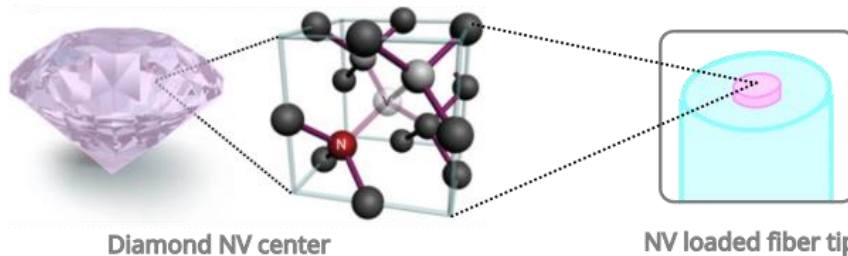
**Funding:** ANR-CPJ Quant-it

**Involved Institut FOTON groups:** OHM, localized at INSA Rennes

**Keywords:** Quantum sensing, Diamond NV centers, Integrated photonics, Laser Physics.

### PhD context

Quantum sciences are currently being turned into technological devices that exploit quantum properties of fundamental particles to push further the socially impactful fields of computing, communication or sensing. Among the impressive diversity of quantum systems that are investigated in this context of quantum technologies, diamond Nitrogen-Vacancy (NV) centers play a prominent role. Thanks to a singular interplay between optical and spin degrees of freedom, NV centers proved themselves particularly relevant in the field of quantum sensing. During the last decade, NV centers have been employed to build sensitive magnetometers having an unprecedented nanometric spatial resolution<sup>1</sup>. The room temperature operation of NV-based quantum sensors together with its solid-state packaging – the diamond – augur further development of a broad range of sensing applications going from biomedical sciences to industrial nondestructive testing.



To fully realize the huge potential of NV-based quantum sensors and develop new applications, current challenges are to decrease sensors sensitivity down to spin projection noise<sup>2</sup>, to miniaturize their size or again to develop new sensing modalities such as endoscopic or network sensors. Photonic sciences, acting as an enabling technology, represent a clear path to address those challenges. This research direction, which has been recently started at the “Institut FOTON”, is the general context of this PhD.

<sup>1</sup> Maze et al. *Nature* **455**, 644–647 (2008)

<sup>2</sup> Barry et al. *Rev. Mod. Phys.* **92**, 015004 (2020)

Specifically, new spin-readout techniques, alternative to the conventional photoluminescence detection, based on the laser effect will be explored experimentally through the realization of free-space diamond-filled laser cavities<sup>3,4</sup>. Integration of diamond materials onto photonic devices using state-of-the-art cleanroom technologies will also be investigated. First development will consist in the integration of diamond microdisks on the tip of optical fibers to realize endoscopic sensors (see figure). Depending on the successful candidate's interests and skills, as well as the fundings that will be obtained during the PhD, one or more of those directions will be pursued during the PhD.

## About the PhD candidate

The candidate should justify a master's or engineering degree. Strong basis in optics is required and basis in atomic physics, quantum mechanics and/or nanotechnologies would be desirable. The applicant should have a strong interest in experimental work together with the ability to perform numerical and analytical simulations. Fluency in English is required (written and spoken).

## Partnership

The project will benefit from all the already existing national and international collaborations of the group. This includes the members of the equipex+ e-Diamant (coord. J.F. Roch) and in particular the group of Jocelyn Achard (LSPM) for quantum grade diamond fabrication. Our group is also collaborating with the startup Wainvam-e, world leader in NV based quantum sensors, offering ideal conditions for the valorization of the PhD work.

## About "Institut FOTON" laboratory

"Institut FOTON" is a research unit of the French National Centre for Scientific Research (CNRS) associated to University of Rennes and the National Institute for Applied Sciences (INSA) of Rennes. This thematic research institute covering the broad and flourishing field of Photonics is composed of three research teams: the "Optoelectronics, Heteroepitaxy and Materials" team, the "laser Dynamics, microwave photonics, Polarimetry, terahertz, imaging" team located in Rennes, and the "Photonic Systems" team located in Lannion. The successful candidate will carry out research the OHM team in Rennes, in particular within the clean room and technological platform NanoRennes, member of the Renatech+ network. More information about FOTON can be found at: <http://foton.cnrs.fr>

## Contact & How to apply

For any further information and to submit your application, please send an e-mail at your earliest convenience to:

[paul.huillery@insa-rennes.fr](mailto:paul.huillery@insa-rennes.fr)

Your application should include:

- Motivation letter
- Detailed curriculum vitae (CV)
- Educational grades and marks (at university level)
- Publication list if applicable
- Recommendation letters or references of people to contact for recommendation.

Candidates from any nationality, gender or ethnical origin are welcome to apply.

<sup>3</sup> Jeske et al. *New Journal of Physics* **18**, 013015 (2016)

<sup>4</sup> Dumeige et al. *Optics express* **27**, 1706-1717 (2019)