

Master 2 Internship at 'Institut FOTON'

Photonic Quantum Magnetometry

Position : Master 2 internship

Duration : 4 to 6 months

Supervisor : Paul Huillery, junior professor at FOTON, INSA Rennes

Department : Optoelectronics, Heteroepitaxy and Materials (OHM), located at INSA Rennes

Key words : Quantum sensors, Diamond NV center, Nanotechnologies, Quantum control

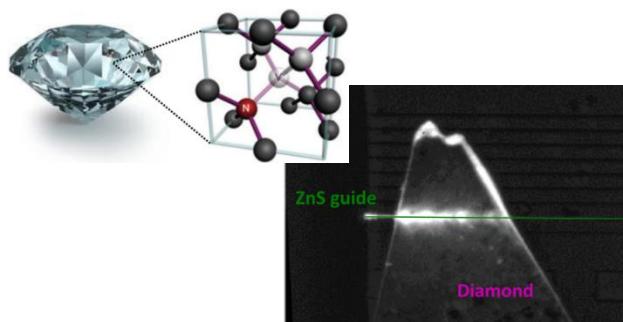
Possibility of continuing with a PhD thesis : Yes

Subject of the internship

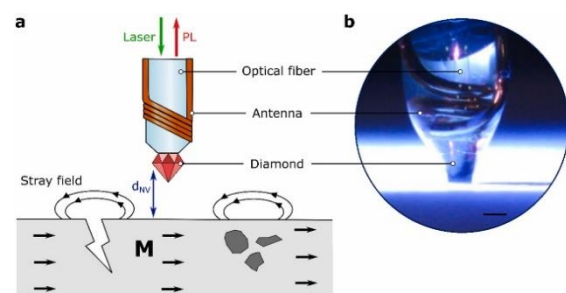
In the exciting field of quantum technologies, the diamond NV center has established itself as a leading qubit for quantum sensing thanks to advantageous properties that include room temperature operation¹. Building on the success of single-spin diamond sensors that enable magnetic imaging with nanometric resolution^{2,3}, the use of NV-ensembles, which allow to improve sensitivity at the price of reduced spatial resolution⁴, has the potential to further address a broad range of applications in fields such as biomedical sciences, navigation, geological prospecting, non-destructive testing (NDT), and fundamental research.

In this context, and following the mastery of NV-doped diamond production processes leading to the recent commercialization of these diamonds by a few specialized companies, technology transfer associated with NV sensors is booming. However, it currently faces technological barriers related to the integration of diamond material into functional optoelectronic devices for the various targeted applications.

As a laboratory specialized in photonic sciences, the FOTON institute is currently investing on this research direction with the ambition to develop innovative photonic solutions to open new applications to NV-ensemble based sensors.



Diamond NV center and hybrid ZnS/Diamond device



NV-endoscope used for NDT⁶

Using a dedicated setup for NV center electron spin manipulation involving laser and pulsed-microwave excitation controlled with a computer interface. The purpose of the internship will be to perform magnetometry measurements on photonic devices that are fabricated in our lab, in particular ZnS/diamond structures and functionalized fiber endoscopes. The latter are developed in collaboration

with the company Kwantek and shall find applications for cancer surgery⁵ and for NDT⁶ in aeronautic, energy (nuclear, transport of hydrogen) or metallurgic industries.

Main tasks

In the framework of the internship, the student will be fully involved in this research program and will be carrying out the following tasks:

- Run and improve the NV electron spin manipulation setup, both from hardware and software perspectives.
- Perform magnetometry measurements on photonic devices.
- Analyze the metrological performances of the devices.

Research environment and partnership

Institut FOTON⁷ (UMR 6082) is a research unit of the French National Centre for Scientific Research (CNRS) associated to the University of Rennes and the National Institute for Applied Sciences (INSA) of Rennes. The FOTON institute is composed of three research departments: the 'Optoelectronics, Heteroepitaxy and Materials (OHM)' and 'Coherent Optics and microwave Photonics (DOP)' departments located in Rennes and the 'Photonic Systems (SP)' department located in Lannion.

The successful candidate will work in the OHM department within a team composed of 1 PhD student and a postdoctoral researcher, together with researchers, technicians and engineers working on the topic of integrated photonics and quantum technologies.

The project will benefit from all existing collaborations of the group which is part of the Equipex+ e-Diamant (coordinator: J. F. Roch, LUMIN) and ANR SINFONIA (coordinator: J. Achard, LSPM) consortiums. In particular, the group is actively collaborating with Kwantek⁸, one of the leading startups dedicated to diamond quantum sensing. This environment is ideal for the transfer of the research results and offer the opportunity for the candidate to continue on a PhD under a CIFRE grant.

About the student

A solid background in physics is required as well as skills in experimental optics and programming. Notions of quantum mechanics and atomic physics are desirable. The student should have a deep interest for experimental research and the ability to perform numerical analysis and simulations. Autonomy, creativity, critical thinking and ability to work in a team are required as well as fluency in spoken and written English.

Application – complementary information

To apply or get more information on the internship, please contact Paul Huillery:

paul.huillery@insa-rennes.fr

Applications should contain:

- A detailed CV
- A cover letter
- Contact of, or letter from, at least two past lecturers/scientific advisors for reference.

¹ Gruber et al. *Science* **276**, 2012-2014 (1997)

² Maze et al. *Nature* **455**, 644–647 (2008)

³ Cazola et al. *Nature Reviews Materials* **3**, 1-13 (2018)

⁴ Barry et al. *Rev. Mod. Phys.* **92**, 015004 (2020)

⁵ Newman et al. *Phys. Rev. Applied* **24**, 024029 (2025)

⁶ Vindolet et al. *NDT & E International* **155**, 103439 (2025)

⁷ <https://www.institut-foton.eu>

⁸ <https://www.kwan-tek.com>