Postdoctoral Research Position (24 months)

Development of Quantum Light Experiments for Propagation Studies in Marine Environments.

Laboratories: LOA (CNRS UMR 7639) & Lab-STICC (CNRS UMR 6285)
Location: ENSTA campuses in Palaiseau and Brest
Supervisors: D. Boschetto, A. Coatanhay, and A. Drémeau

- **Application Deadline :** As soon as possible.
- **Start Date :** First quarter of 2026.

1 Labs Description

LOA (Laboratory of Applied Optics) d'optique appliquée
is a CNRS joint research unit (UMR 7639) affiliated with ENSTA and École Polytechnique.
LOA is a renowned research institution in applied optics using femtosecond laser systems. Positioned at the intersection of fundamental research and technological innovation, **LOA** conducts diverse research activities in optics, photonics, laser science, and materials science.
A major research area is laser physics and ultrafast optics. The lab investigates the fundamental properties of lasers and their interactions with matter, aiming to advance the understanding of laser phenomena and develop new laser sources with improved performance, efficiency, and functionalities. This research supports breakthroughs in high-power lasers, ultrafast lasers, laser spectroscopy, and laser-based material characterization.

Lab-STICC (Laboratory of Information, Communication and Knowledge Sciences and Techniques)
is a CNRS joint research unit (UMR 6285), bringing together teams from three engineering schools and two universities in Brittany: ENSTA, IMT Atlantique, Bretagne INP, UBS, and UBO.
Lab-STICC covers a broad range of scientific fields in digital sciences, enabling it to address various disciplines (from microwave device design to human-machine interfaces) and numerous application domains including defense and civilian industries such as aerospace, maritime, health, and security.

2 Context and Motivation

High-resolution environmental imaging is often achieved using LIDAR systems, which benefit from the coherence, directivity, and signal-to-noise advantages of laser-based techniques. In marine environments, LIDAR is effective primarily in clear, shallow waters, with propagation ranges typically limited to a few tens of meters.

The **SQuaLi (Sub-marine Quantum LiDAR)** project—jointly led by Lab-STICC and LOA, and funded by the **Interdisciplinary Centre for the Sea and Ocean (CIMO)**—aims to investigate the behavior of quantum light (e.g., entangled photons and squeezed states) in underwater settings. The objective is to evaluate the potential of quantum-enhanced LIDAR technologies for improving performance in marine environments.

A multidisciplinary team is being assembled, including permanent researchers, an engineer, a PhD student, and a postdoctoral researcher.

3 Job Description

The postdoctoral researcher will work closely with the project team, particularly with the PhD student, and will lead experimental efforts divided into two parts:

Quantum Entanglement in free space (air & water)

- Design and implementation of an experimental setup to characterize entangled photons in air.
- Use of a femtosecond laser (1040 nm) and establish benchmark protocols for measuring quantum properties.
- Use single-photon detectors and coincidence counting modules to assess quantum robustness under diffusion and absorption phenomena.
- Theoretically extend (simulations) this study to a controlled aquatic environment simulating seawater conditions.
- Analyze the influence of turbidity, salinity, temperature, and water motion on entanglement degradation.

Squeezed State Light (SSL) generation and study of the propagation in water

- Based on prior publications, contribute to the development and adaptation of an SSL generator at 532 nm.
- Conduct quantitative propagation studies under varying water conditions (e.g., salinity, turbidity).

Work will be conducted on both ENSTA campuses in Palaiseau and Brest. Flexibility in work location can be discussed with the selected candidate.

4 Candidate Profile

The candidate, who holds a PhD degree, must have serious knowledge in quantum optics but more technically in experimental implementation.

Scientific support will be available from team members for the project's specific scientific challenges. However, the position requires a motivated candidate who enjoys collaborative work within an innovative research project.

5 How to Apply

Interested candidates should submit a **CV** and a **letter of motivation**. Additional documents that support the application are welcome. All application materials may be sent to the following addresses:

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6 References

[1] Claus Weitkamp, “LIDAR”, EDP Springer, 2005

[2] Bernard Cagnac et Jean-Pierre Faroux, “Lasers”, EDP Sciences, CNRS Édition, 2002

[3] Guoqing Zhou et al., “Overview of Underwater Transmission Characteristics of Oceanic LiDAR“, *IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing*, vol. 14, pp. 8144-8159, 2021.

[4] H.-A. Bachor and T. C. Ralph, “A Guide to Experiments in Quantum Optics”, Wiley-VCH, 2019, 3ème édition.