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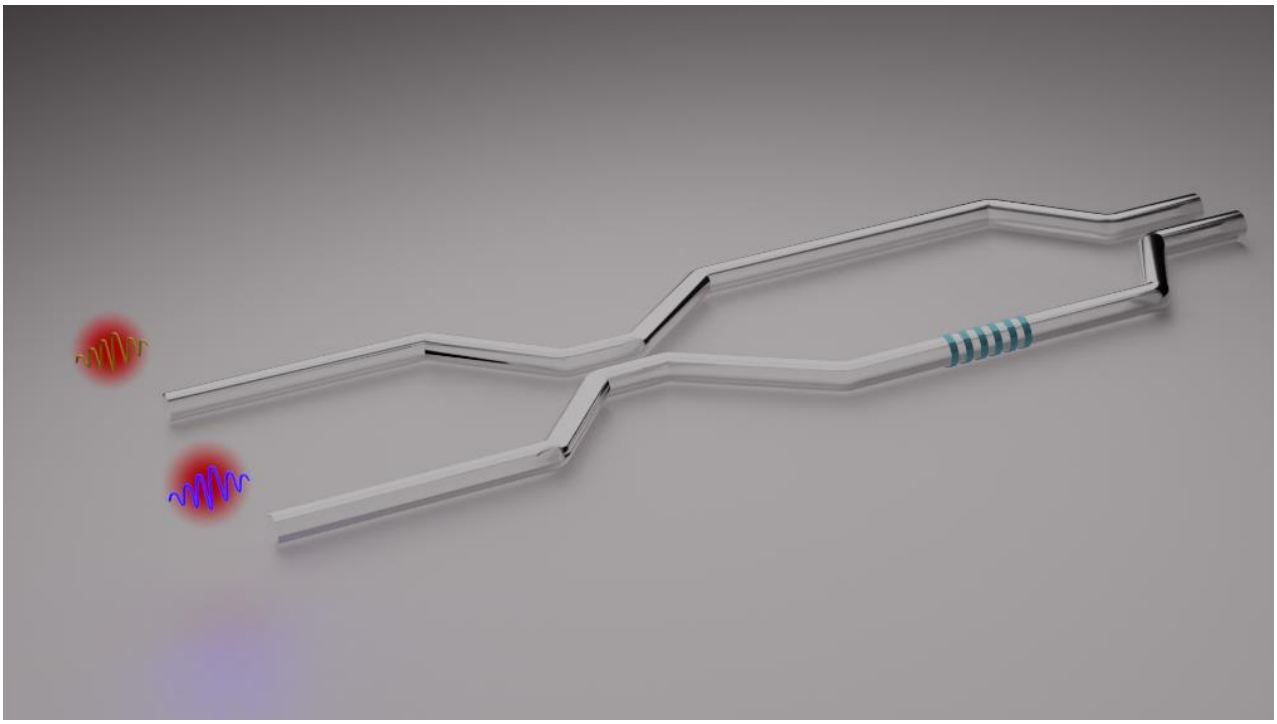
Quantum sensing with optical fibre systems

We are seeking candidates for a post-doc position funded by the European Commission in the framework of a large research project that involves 34 partner organisations from 8 European countries. The position will start approximately by July 2023 and lasts 2 years. The research will focus on quantum-enhanced optical fibre sensors to realize new systems able to detect and quantify vibrations, deformations, and rotations caused by ground movements and accelerations with ultra-high performance. It also involves developing sensing architectures that enable highly accurate navigation capabilities. The purpose of this activity is to enhance the performance of fibre-optic sensors taking advantage of quantum technology, which can improve their resolution and sensitivity beyond current limits.



Context and objectives

Quantum technologies have gained significant attention as a way to improve the performance of measurements aimed at metrological tasks. For instance, the achievable accuracy through interferometric measurements with classical schemes can be surpassed by quantum optical methods, e.g. using squeezed states or entangled photons, pointing to the so-called Heisenberg limit. While progress has been made with trapped atoms and standard optical interferometers [1], less attention has been given to the quantum advantage in measuring the phase shift caused by accelerations or rotations with fibre-optic systems [2]. Besides various technical noise sources that hamper the achievable performance of fiber-optic sensing apparatuses [3], the fundamental limitation come from the quantum fluctuations related to photon detection.

The primary aim of this research activity is to devise an optical fibre sensor architecture that benefits from the use of a non-classical light source, e.g. energy-time entangled photons, in the telecommunication range. The experimental work involves using custom-built interferometers as part of the sensor's design. The key concept behind this research is to compare the behaviour of a quantum approach versus a classical approach in terms of accuracy, bandwidth, and noise. In addition, the research team will focus on optimizing the sensitivity, integration and compactness of the sensors. Once a specific application is identified, such as navigation or seismic detection, the team will collaborate with other partners in the project consortium to provide a real proof of concept.

Candidate's profile:

The candidate must possess a PhD degree with a solid background in optics and/or fibre-optic sensing and/or spectroscopy. Additional expertise on quantum technology is desirable but not mandatory. The candidate should be able to provide valuable insights and actively contribute to the development of new experiments for the ongoing research project. A strong, side-by-side collaboration with project partners is also planned in order to implement the new optical architectures. The outcome of this project is expected to have significant international impact in the field of application of quantum technologies. The research activity will be carried out in the Optical Sensors Group of CNR-INO Naples unit, in Pozzuoli (Italy).
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Important dates:
Application deadline: July 24th, 2023
Interview: September 5th, 2023 (in person or on-line upon request)
Formal offer soon available on EURAXESS website

For information, please contact gianluca.gagliardi@ino.it.

References

[1] Polino, Emanuele, Mauro Valeri, Nicolò Spagnolo, and Fabio Sciarrino. 'Photonic Quantum Metrology'. AVS Quantum Science 2, 024703 (2020).
[2] Fink, Matthias, Fabian Steinlechner, Johannes Handsteiner, Jonathan P Dowling, Thomas Scheidl, and Rupert Ursin. 'Entanglement-Enhanced Optical Gyroscope'. New Journal of Physics 21, 053010 (2019).
[3] G. Gagliardi, M. Salza, S. Avino, P. Ferraro, P. De Natale, "Probing the Ultimate Limit of Fiber-optic Strain Sensing", Science 330, 1081 (2010)