

Proposal for a Master 1 or 2 internship or Engineering at INPHYNI (Nice): : “Noise properties of single frequency 2- μm optical fibre lasers”.

Context :

Single-frequency fibre lasers (SFFL) operating at 2- μm wavelength are of great interest for applications such as atmospheric sensing and high resolution spectroscopy [1,2]. Further, to overcome some current limitations of gravitational waves detectors (GWD) caused by a combination of noise sources, new technologies like silicon test masses [3] are considered to reduce the impact of thermal noise at mirrors. This requires replacing classical 1- μm lasers with 2- μm lasers. This transition introduces several challenges, notably limited availability, high complexity and high cost. The development of high-power fibre lasers for use as the main interferometer beam in GWD [4] and LIDARs [1], **highlights the need to demonstrate, characterize and mature a low-cost technology for 2- μm sources with very low noise and narrow linewidths**. SFFL are promising candidates to meet this need. Two architectures are available, DFB and DBR (Fig. 1), each with distinct advantages and limitations. A collaboration has been initiated in 2026 between INPHYNI-Nice, Artemis (Observatoire de la Côte d'Azur) and two institutes abroad (UFES-Braslis and NTU-Singapore), with the aim to characterize the intensity- and frequency-noises of thulium-doped SFFL (TDSFFL) operating around the 2- μm wavelength.

Internship:

The tasks of this experimental internship are: build the fibre laser cavities and characterize them. If time allows, the measurement of intensity- and frequency-noises of the lasers will be initiated. The Tm-doped fibers will be fabricated at INPHYNI by the *Specialty Optical Fibre* facility, the special FBGs will be inscribed by fs-laser at UFES, and Artemis will contribute to the noise measurements. All the internship will be performed at INPHYNI.

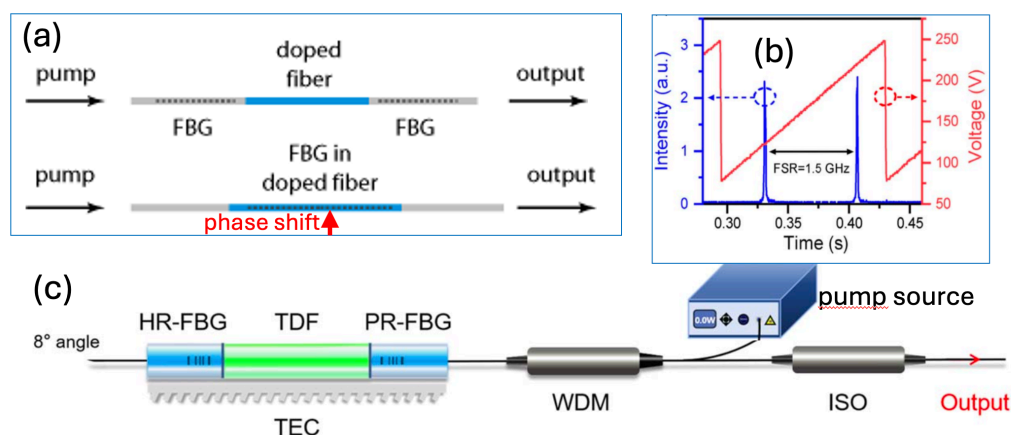


Fig.1: (a) Principle of DBR (top) and DFB (bottom) fibre lasers. A DBR cavity is made of a short doped fibre that is fusion-spliced between two fibre bragg gratings (FBG) whose reflectivity is set to the operating wavelength. The DFB cavity is formed by inscribing a grating directly on a doped fibre, with a phase-shift near the middle of the grating. (b) Typical measurement of single frequency operation of a SFFL using a Fabry-Perot interferometer scanned with a potential (red curve). From [2]. The peaking (bleu curve) at intervals equal to the free spectral range (FSR) of the interferometer is a proof of a single longitudinal mode operation. (c) Schematic of a SFFL setup. HR- and PR-FBG: highly- and partially-reflective FBG, respectively; TDF: Tm-doped fibre; TEC: thermo-electric controller; WDM: wavelength division multiplexer; ISO: optical isolator.

Required profile :

The candidate will be in Master 1 or Master 2 or in the final year of engineering school in physics/photronics. We are looking for a rigorous, curious personality, with good written and oral communication skills. Knowledge of French is not required. In this case, a level in English B2 is required.

Duration : 3 months from April (1st year Master) or 5-6 months from February (2nd year Master or final of eng. school)

Internship stipend : ~680 €/month. **PhD follow-up**: possible under application to doctoral school [EDSFA](#).

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1 J. Lahyani, et al., "2.05- μm all-fiber laser source designed for CO₂ and wind coherent lidar measurement," *Appl. Opt.* **60**, C12 (2021).

2 K. Wu, et al. "An efficient long-wavelength single-frequency DBR Tm³⁺-doped fiber laser at 2.1 μm based on 1610nm in-band pumping", *Appl. Phys. Exp.* **18** (2025) 052001.

3 R. X. Adhikari et al. "A Cryogenic Silicon Interferometer for Gravitational-wave Detection", <https://arxiv.org/abs/2001.11173>

4 F. Meylahn, B. Willke, "Characterization of Laser Systems at 1550 nm Wavelength for Future Gravitational Wave Detectors". *Instruments* **2022**, *6*, 15.