MINISTERIO
DE CIENCIA, INNOVACIÓN
Y UNIVERSIDADES

CSIC
CONSEJO SUPERIOR DE INVESTIGACIONES CIENTÍFICAS

# Position Offered: JAE PRE/MED

# Project: *Advanced Pulse Modulation Formats for distributed optical fibre sensing*

**Research fields:** Distributed Fiber-Optic Sensing, Optical Communications and Photonics, Signal Processing

**Location:** Madrid, Instituto de Óptica (https://www.io.csic.es/)

**Research Group/PI:** Non-linear and nanoscale guided optics (N2GO) / Hugo Fidalgo Martins

## PROJECT SUMMARY

This PhD project focuses on the development and optimization of distributed fiber-optic sensors (DFOS), specifically Distributed Acoustic Sensing (DAS) technology based on phase-sensitive optical time-domain reflectometry (φOTDR). Despite its rapid expansion into fields such as railway monitoring, geophysics, and infrastructure monitoring, the current state of the art has largely avoided the use of advanced modulation formats due to their high cost and complexity.

The main objective of the thesis is to design and validate advanced pulse modulation formats, combined with a substantial increase in sensor bandwidth, to significantly enhance overall system performance. The proposed approach will integrate matched-filtering techniques and increase the interrogation bandwidth from the current ≈1 GHz to ≈10 GHz.

The research will combine the use of a digital twin for high-fidelity simulations with an experimental implementation phase using state-of-the-art instrumentation, including narrow-linewidth lasers, optical modulation and detection systems with bandwidths of up to 20 GHz, and high-performance computing clusters.

A key aspect of the PhD project is its close connection with the FERMAT project, which aims to transform submarine telecommunication cables in the Gulf of Cádiz into a seismic monitoring and tsunami early-warning network integrated into the Spanish National Seismic Network. This will ensure not only significant scientific impact and a leading position for the N2GO group, but also direct technology transfer to the civil protection and industrial sectors.

The PhD candidate's training plan, within the framework of the PhD Programme in Physics at Universidad Complutense de Madrid (UCM), includes international research stays at leading institutions, training in transferable skills such as intellectual property and project management, and field trials during the final two years of the PhD to validate the developed architectures under real-world conditions.

## PROFESSIONAL PROFILE

### Minimum requirements:

-BsC in physics, telecommunication engineering, electric/electronic engineering or computer engineering (or related topics)
-MsC in photonics (or related topics)

### Other merits to be considered:

- Laboratory experience with optical and optoelectronic equipment
- Knowledge of optical communications (including high-bandwidth optical signal modulation and detection; fundamentals and operation of fiber-optic systems).
- Proficiency in MATLAB, Python, C++, or similar programming languages.
- Proficiency in English (reading, speaking, and writing).

## WHAT IS OFFERED

- **Comprehensive training and professional development:** The PhD candidate's training plan, within the framework of the PhD Programme in Physics at Universidad Complutense de Madrid (UCM), combines the acquisition of technical skills directly related to the project objectives with

transferable skills aimed at enhancing the candidate's professional development, including technology transfer, science communication, networking, and leadership.
- **State-of-the-art laboratory and instrumentation:** The PhD candidate will work with cutting-edge instrumentation in optics, telecommunications, and sensing, including high-frequency equipment with bandwidths of up to 20 GHz.- **Dynamic research environment:** The candidate will join an active research group, with several PhD projects running in parallel on complementary topics closely related to this technology.
- **Field measurements and real-world applications:** The PhD will be closely linked to the FERMAT project, which aims to transform submarine telecommunication cables in the Gulf of Cádiz into a seismic monitoring and tsunami early-warning network integrated into the Spanish National Seismic Network, providing access to field measurements and real-world deployments.
- **International research stays and scientific network:** The PhD candidate will undertake research stays at leading international laboratories and work directly with visiting international researchers conducting research stays within the group on topics closely related to the PhD project, providing access to a broad network of collaborators and a dynamic international research environment.
- **Industry engagement:** The PhD will be carried out alongside ongoing technology-transfer projects with companies specializing in distributed sensing, providing direct exposure to industrial applications and real-world needs.

## Contract conditions:

JAE PRE/MED: Predoctoral Researcher 4 years contract. Gross annual salary of 25.456,00€.

## Start date: before 15th December 2026

## PRINCIPAL INVESTIGATOR. CONTACT DETAILS

Email: hugo.martins@csic.es

Phone: 915 61 68 00 (ext. 442225)