Laboratoire Hubert Curien
UMR ▪ CNRS ▪ 5516 ▪ Saint-Étienne

PhD position within the MOPERE team

Development of an optical fiber dosimeter based on Radiation-Induced Luminescence for γ-rays and neutrons discrimination

Duration: 36 months

Location: Saint-Etienne, France

Expected start date: before Oct 1st 2026

Description

Neutrons play a critical role in various domains of physics (nuclear interactions, symmetry and matter-antimatter), material science (diffraction, magnetism, radiography), medicine (Boron Neutron Capture Therapy, radioisotopes production), and sustainable energy solutions (fission or fusion based reactors). So, monitoring **neutron flux** and **fluence** is crucial, e.g. to ensure the stable and efficient operation of a reactor or to well design the shielding thickness for nuclear facilities or medical applications. To achieve this monitoring, fiber-based dosimeters possess clear advantages such as intrinsic electromagnetic immunity, flexibility, compactness (low weight and volume). Today, this technology exploits either the radioluminescence or the radiation-induced attenuation phenomena observed in certain types of silica-based optical fibers and it is more and more investigated to conceive reliable, in situ (or active) embedded point or distributed radiation detectors and dosimeters. However, up to now, the potential of this technology for neutron dosimetry remains a largely unexplored subject. Conceiving a **fiber-based neutron dosimeter** allowing accurate **real-time** measurements of the neutron flux and fluence is the aim of **DOLFIN** (Dedicated OpticaL FIbers for sensitive and selective Neutron dosimetry), an PRCE project founded by **ANR** (Agence Nationale de la Recherche), led by the PhLAM laboratory of University of Lille, in collaboration with the Laboratoire Hubert Curien of the University Jean Monnet and SODERN (an ArianeGroup company, world leader in neutron generators). The DOLFIN dosimeter will exploit the **radioluminescence** of inorganic and vitreous **silica** materials doped with **rare-earth ions**, as Gd^{3+} or Ce^{3+} ions, in a fibered geometry. However, the fibered dosimeters are sensitive to all types of particles and can measure nowadays the TID in a mixed field. However, without any additional functionalities, such sensor cannot **discriminate between γ-rays and neutrons**. This is the main object of this thesis, which will be based on a **multi-scale, multi-physics approach**, ranging from understanding of the interaction between glass/fibers with neutrons of various energies, for the sensitive probe optimization (composition and geometry), to experimental tests at the PETRA platform and, if possible, at the industrial site of SODERN.

The Materials for Optics and Photonics in Extreme Radiation Environments (**MOPERE) team** of the Hubert Curien Laboratory (University Jean Monnet UJM in Saint-Etienne, France) focuses on the study of optical materials operating in radiation environments. The PhD will be developed within this team, which is equipped with an Experimental Platform for Radiation Tests - PETRA.

This PhD topic is focused on the study of the inorganic and vitreous silica materials doped with rare-earth ions, with different compositions and geometry, to develop fiber-based neutron dosimeters allowing accurate real-time measurements of the neutron flux and fluence and able to discriminate between γ-rays and neutrons.

Topics and activities that are covered by this PhD

- Use of Monte Carlo (Geant4, PHITS or MNCPX) tools to model the interactions between material and neutrons of various energies and calculate the energy deposited (dose) in the sensitive volume, having various geometries and compositions, in order to optimize the design of the dosimeter probe;

- X-rays irradiation campaigns, using the irradiators of the PETRA platform at Laboratoire Hubert Curien, to test, pre-irradiate and/or calibrate the sensitive probes;

- Neutron irradiation campaigns, if possible, at SODERN or in other installations thanks to the collaborations of the MOPERE team;

- Characterization of the different investigated samples, by combining different spectroscopic techniques such as confocal microscopy, time-resolved photoluminescence, ...;

- Analysis of collected results.

The investigated phenomena will be tackled with a multi-scale approach, ranging from the understanding of radiation-matter interaction to irradiation tests.

This project will be supported by the ANR PRCE project DOLFIN. Work will be done in collaboration with the PhLAM Laboratory (University of Lille) and the company SODERN.

Requirements

We are looking for candidates who meet the following criteria:

- Master's degree or engineering diploma in applied physics, optics, photonics or materials science.
- Interest in multi-scale and multi-physics phenomena, combining modeling, theory and experimentations.
- Analytic and experimental skills proven by MSc-work or work experience.
- Good knowledge of scientific tools such as Python or Matlab.
- Positive attitude towards a multidisciplinary environment with multiple stakeholders.
- Good knowledge of the English language (oral and writing) and/or of French language.
- Good communications skills (soft skills), and the ability to work in collaboration with industry.
- Scientific curiosity and experimental rigor.
- Capability to synthesize and communicate scientific results for use in institutional and industrial projects.

The following additions would be a great asset:

- Experience in spectroscopy, optical measurements and fiber characterization techniques.
- A background in fiber optics and materials physics.
- Experience with Monte Carlo simulation tools such as PHITS, FLUKA, Geant4, MCNP.

The Hubert Curien Laboratory and the MOPERE team

The Hubert Curien Laboratory is a Joint Research Unit (UMR 5516) of the National Center for Scientific Research - CNRS and the Université Jean Monnet - UJM, located at 18 Rue Professor Benoît Lauras in Saint-Etienne, and administratively attached to the Faculty of Science and Technology of the UJM.

Additional information on the Hubert Curien Laboratory and its MOPERE team can be found on the following web page:

https://laboratoirehubertcurien.univ-st-etienne.fr/en/teams/materials-for-optics-and-photonics-in-extreme-radiation-environments.html

Deadline

Please contact us as soon as possible.

Contact

For further information on this position, please contact:

Prof. Adriana MORANA

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How to apply

Applicants should send the following documents directly to Prof. Adriana MORANA:

- A complete CV;
- A cover letter;
- A copy of a valid ID document (ID card, passport…)