**Titre de la thèse/Thesis title :** Machine Learning and Applications in Ultrafast Photonics

**Laboratoire d'accueil / Host Laboratory :** Institut FEMTO-ST

**Spécialité du doctorat préparé/Speciality :** Photonics

**Mots-clefs / Keywords :** Machine Learning. Ultrafast Photonics. Nonlinear Fibre Optics.

**Descriptif détaillé de la thèse / Job description**

This project aims to explore the intersection of machine learning with nonlinear ultrafast photonics, with particular focus on leveraging nonlinear effects in optical fibre waveguides to develop physical implementations of neural networks, such as Extreme Learning Machines. Research will involve fundamental photonics, computational modeling, and experimental validation, with the overall aim to contribute significantly to the development of photonic computing systems. Specific objectives include:

- Analysis of various nonlinear ultrafast processes in fibre waveguides (e.g., self-phase modulation, four-wave mixing, soliton dynamics), with aim to realize functionalities applicable to neural network elements. Theoretical and numerical studies (including using machine learning methods) of relevant nonlinear propagation dynamics.
- Design and analysis of possible physical architectures for neural networks, with emphasis on systems implemented using nonlinear fibre systems with e.g. spectral and temporal pulse shaping for encoding. Possible application of machine learning techniques to source optimization.
- Perform experimental characterization and validation of proposed designs in a laboratory setting, with suitable benchmark quantification.

This project will have impact in the emerging field of photonic machine learning, enabling high-speed, information processing systems. The results could influence the design of future neuromorphic hardware and all-optical computing platforms, with potential applications in communications, signal processing, and the broader field of physical layer artificial intelligence.

**Références bibliographiques / Bibliography**

[1] G. Genty, L. Salmela, J. M. Dudley et al., Nature Photonics **15**, 91–101 (2021)

**Profil demandé / Applicant profile**

The candidate will have a strong background in physics, photonics, electrical engineering, or a related field. Prior knowledge of nonlinear fibre optics and machine learning principles, particularly neural networks, is highly desirable. The ability to work in a team environment and broad experimental training in photonics and optical design is essential, as is experience with numerical simulations (e.g., Python, MATLAB) and instrumentation interfacing. Above all, the candidate must have curiosity in interdisciplinary research and a track record of broad interest across different areas of physics.

**Financement : MESRI Etablissement**

Dossier à envoyer pour le 10 May 2025
Début du contrat : 1 Octobre 2025
Salaire mensuel brut : 2200€ (à partir du 1er janvier 2026 : 2300€ brut)

**Direction de la thèse:/ Thesis Supervisor**

Professor John Dudley, john.dudley@univ-fcomte.fr

Applicants are invited to submit their application to the PhD supervisors.
Application must contain the following documents:

- CV
- Cover letter
- At least 1 reference letter