Master 2 “Photonics, Complex and Quantum Systems (PhoCQS)”: Research Training 2025-2026
Master 2 “Matter Molecules and their Environment (MME)”: Research Training 2025-2026

Appel à sujet de stage recherche / Call for research training subject

Laboratory: PhLAM

Supervisor: Serge Bielawski

Tél : 03.20.43.44.23, E-mail : serge.bielawski@univ-lille.fr

Collaborator(s): Christophe Szwaj (PhLAM), Eléonore Roussel (PhLAM), Bernd Steffen (DESY, Hamburg). FELBE Free-Electron Laser facility team (Dresden). Max Planck for the Physics of Light (Erlangen).

Topic: Photonics, Ultrafast measurements, Terahertz science, Free-Electron Lasers

Master 2: select the master and the most appropriate option

X Master 2 PhoCQS (GP-IKS)	□ Master 2 MME (GP-SCP)
X Option Complex and Quantum Systems	□ Option Condensed Matter
	□ Option Condensed Matter/Pharma
	□ Option Dilute Matter and Spectroscopy
	□ Option Atmospheric Sciences
	□ Option Modeling at the molecular & atomic scales
Return subject to : christophe.szwaj@univ-lille.fr	Return subject to : sebastien.merkel@univ-lille.fr

Ultrafast measurements, associating nonlinear optics and novel data analysis concepts : Intership 2

Note that the context is the same for “Internships 1 and 2”

Collaboration context: Free-Electron Lasers (FELs) are large instruments, that use relativistic electrons to generate coherent light. Although such light sources are delivering high intense pulses in various domains (from the THz to the X-rays), controlling their dynamical behaviors still present challenges from the applied and fundamental points of view. The PhLAM is involved in a collaboration program with DESY (Hamburg) and with the FELBE Free-Electron Laser group in Dresden, aiming at finding and testing new ideas allowing ultrafast recordings and control at these facilities.
Scientific context: More generally, recording fast optical signals (e.g., evolving at THz speed) is an open challenge, when the measurement has to be made in a “single-shot”, as is the case for non-repetitive phenomena or single-events. The general principle relies on using a nonlinear interaction between a femtosecond laser pulse, with the signals of interest to generate “copy” of the signal (typically in the infrared or visible), and to analyze this copy. An important effort is made by several laboratories in the world to find the key ideas, for advancing much further in the field.

Internship 2 description: This internship will focus on open problems in nonlinear optics, that are motivated by this project. Recording an optical signal (in one shot, including envelope and carrier) is now possible (e.g., using the technique known as *photonic time-stretch*). However recording speed is still limited to frequencies up to few Terahertz, which is hampering many applications in spectroscopy, laser dynamics, and accelerator physics. In this internship, the aim is to find and test novel nonlinear optical strategies, that may allow ultratfast measurement to be performed with "record speed". The project will involve experimental nonlinear optics (using femtosecond lasers), as well as theory and/or numerical simulations for the design of the ultrafast measurement systems. The team includes researchers from the PhLAM, and the DESY and FELBE research facilities in Germany.

Key words:
Nonlinear optics, femtosecond lasers, photonics, fibers, ultrafast, accelerators, Free-Electron Lasers.