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PhD-thesis proposal

"Brain-inspired computing with neuromimetic spiking microlasers"

Neuromorphic photonics is a new field of research at the heart of recent progresses in analog computation and machine learning. Its goal is to investigate new ways to process optical information or to compute using brain-inspired concepts.

We propose to study coupled spiking photonic nodes in order to implement simple photonic artificial neural networks. Each spiking node is materialized by a micropillar laser with integrated saturable absorber, whose neuromimetic properties have already been explored in the team. In neurons, information is coded with spikes (electrical pulses) which are excited in an all-or-none fashion provided input stimuli to the neuron soma exceed a given threshold. This generic property is called excitability and has been demonstrated in micropillar lasers with optical spikes. Though, the optical spikes emitted by these latter are more than one millions times shorter in duration than biological action potentials. Hence, photonic neurons could in principle be interesting to build ultrafast artificial neural networks with low power consumption. The computing capability of optical neurons are enforced by the property of temporal summation also already demonstrated by us in micropillar lasers, and which provides universal computation capability.

The main objective of the thesis will thus be to take advantage of these neuromimetic properties to fabricate abd implement neuromorphic computing architectures and demonstrate ultrafast analog computation.

The thesis will take place at the C2N (Palaiseau) which hosts a first-class nanofabrication facility. The samples will fabricated in the C2N clean-room. This study will take place in the framework of the recently funded ANR ANACONDA project, with one partner in FEMTO-ST (Besançon) and one in CERCO (Toulouse).

The work will consist in the design and fabrication of the samples, running the experimental setup, modelling, and interacting with the project's partners.

The applicant is expected have a strong motivation, be rigourous and curious, with strong background in physics, optics, laser physics, semicondutor physics, and possibly semiconductor lasers and/or nonlinear dynamics and/or machine learning.