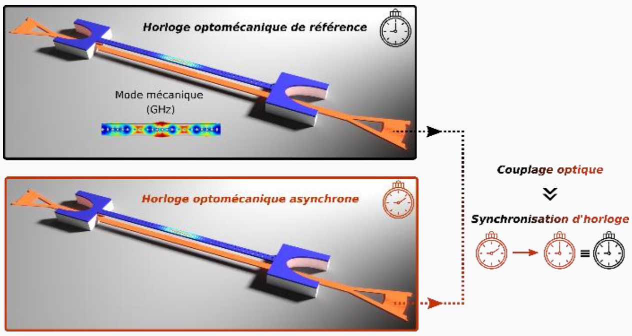
Centre de Nanosciences & de Nanotechnologies

Post-doctoral position

Synchronised optomechanical oscillators: Towards complex signal processing

The rise of microwave photonics, where optical communications technologies are used for analog microwave signal processing, has greatly benefited from advances in bandwidth, low propagation losses and immunity to interference of electromagnetic fields. A central element of these architectures is the generation and distribution of a local oscillator on an optical carrier, that is to say of ultra-pure microwave modulation of the optical carrier. The main advantage is the simplicity of its distribution within a system (radar, communication or metrology system). Such a "clock" can be obtained from an opto-electronic loop produced from an optical carrier modulated by positive electronic feedback. This is done with an optical fiber (approximately 1 km long) to achieve the long delay (µs) of the feedback. Due to the conceptual simplicity of their architectures, Opto-Electronic Oscillators (OEO) have been the source of many scientific advances over the past 25 years, both from a fundamental point of view - non-linear dynamic effects such as chaos - and from an applied and technological point of view - generation of ultra-stable microwaves, generation of random numbers and photonic reservoir computing.

Here, this project, based on concepts of integrated photonics, optomechanics and acoustics, proposes to follow a radically new technological approach to answer, at the same time, the two main problems in the engineering of microwaves OEOs : (i) the integration of the device to achieve a small footprint and low sensitivity to the environment by its monolithic character and (ii) the generation of a direct modulation at high frequency (~3 GHz) with a high spectral purity, inaccessible by traditional methods.



To meet these challenges, an innovative platform based on piezoelectric III-V semiconductor optomechanical crystal embedding at the same time optical and mechanical modes has been developed on silicon photonic circuit. These optomechanical resonators can self-oscillate (OMO) and thus convert the energy of the laser into a microwave signal without a feedback loop and with low phase noise. Beyond a single oscillator, the development of this platform makes it possible to envision a new architecture addressing several oscillators on the same chip or even on separate chips to multiplex or synchronize several optomechanical oscillators. The objective would be the distribution of a reference clock directly in the GHz range and the synchronization of different clocks. This opens up new application perspectives for on-chip optomechanics, in particular towards the generation or the analog processing of signals directly in the GHz frequency range.
These novelties will allow disruptive performance enhancement in signal synthesis and control unveiling not only new capabilities for optomechanical oscillators but also complex signal processing and in a near future “reservoir computing” and potential optomechanical time metrology.

Post-doctoral fellow will be involved in numerical simulations, nanofabrication in C2N clean-room. She/he will be involved in the opto-mechanical experiments in order to achieve on-chip synchronous clocking.

Contact : remy.braive@c2n.upsaclay.fr