Microwave photonics

This scientific activity aims at generating and stabilizing microwave signals on optical carriers. High-stability frequency references generation in the microwave range can indeed lead to applications such as optical distribution of clocks or analogic signals for all-optical radar processing. In parallel, the theoretic and experimental study of microwave photonics links - as the one inserted in most recent radar architectures - is another field of research. Lastly, this research field aims at designing new architectures for highly tunable opto-electronic oscillators.

The studies conducted in this domain are closely related to other research fields investigated by the team, such as **Laser dynamics**, **TeraHertz and metrology**, but also to some of our developments in **Advanced imaging**.

Programmable optical generation of radiofrequency & microwave signals

Microwave photonics links modeling

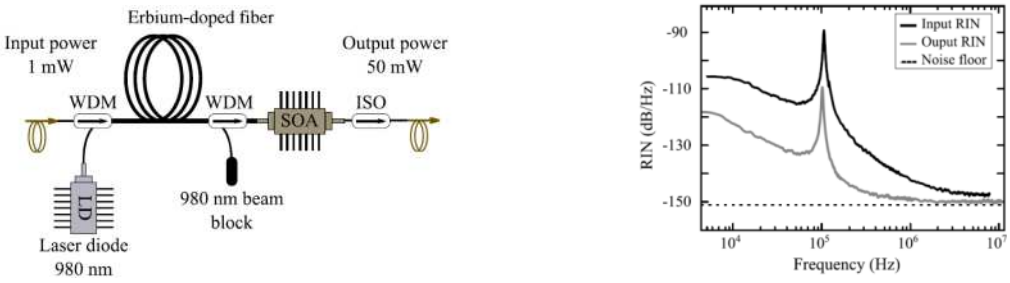
Performances of microwave photonics links for analogic signals transmission

Hybrid oscillators with opto-electronic feedback semi-conductors bi-lasers

Optical control of antennas

Optical amplification

The important know-how of the FOTON-DOP team in the design and realization of optical amplifiers allows us to develop, for our own needs as well as for our partners', very specific optical amplifiers unavailable through commercial means. As a result, most of the amplifiers used in our experiments were designed in the laboratory. For instance, we have recently developed an amplifier to enhance signals from the nano-lasers produced by our partner LPN, by frustrating the spontaneous emission of the amplifier while actively following the laser line. Also, a hybrid EDFA-semiconductor amplifier was designed using coherent population oscillations to amplify dual-frequency lasers while reducing their noise at relaxation oscillation frequency [Dan14]. A Raman amplifier dedicated to complex radar waveforms distribution has also been realized. These developments naturally go along with research activities on phase-sensitive amplification and slow light effects in semiconductor amplifiers [Per11].



(a) (b)

Fig. 7: a) Schematic of the hybrid EDFA-SOA amplifier enabling amplification of a laser, while reducing its relative intensity noise (RIN). b) Observation of the noise reduction at the relaxation oscillations frequency [Dan14].

Selected publications:

[Dan14] G. Danion, F. Bondu, G. Loas, and M. Alouini, "GHz bandwidth noise eater hybrid optical amplifier: design guidelines," Optics Letters, 39, 4239-4242 (2014).

[Per11] P. Berger, J. Bourderionnet, F. Bretenaker, D. Dolfi, M. Alouini, "Time delay generation at high frequency using SOA based slow and fast light," Opt. Express 19, 21180 (2011).

PhD theses (past / ongoing):

Antoine Rolland, « Oscillateurs ultrastables millimétrique et teraHertz par boucle à verrouillage de phase optoélectronique », 2013

Gwennaël Danion, « Oscillateur micro-onde à teraHertz ultra-stable », 2015

Lucien Pouget, « Contribution à l'augmentation des performances de liaisons optiques-hyperfréquences : non-linéarités et bruit »

Gael Kervella, « Circuits intégrés photoniques in InP pour la génération de signaux hyperfréquences », 2015

Thong Tien Pham, *« Étude et conception d'antennes réseaux transmetteurs millimétriques à reconfiguration par voie optique »*

Aurélien Thorette, *«Structures de polarisation dans les lasers et réinjection : application à la génération de faisceaux opto-hyper »*

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III-V Lab (Palaiseau)
Thales Research and Technology (Palaiseau)
Thales Systèmes Aéroportés
Thales Air Defense
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