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**.

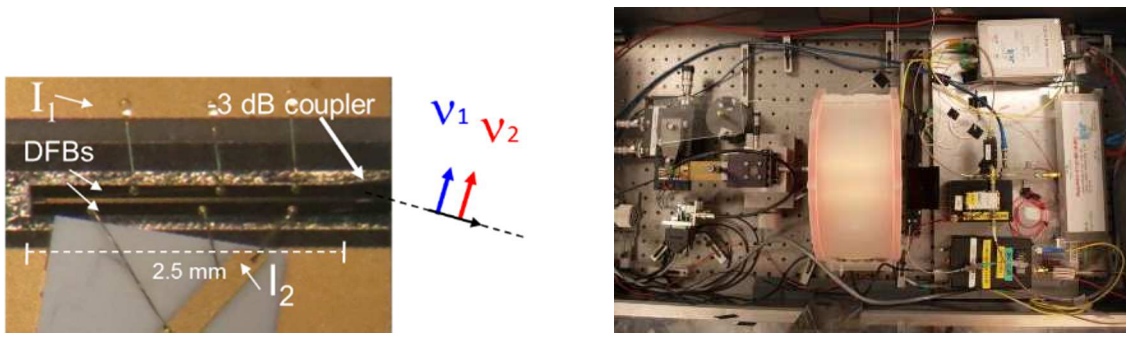
Programmable optical generation of radiofrequency & microwave signals

Microwave photonics links modeling

Performances of microwave photonics links for analogic signals transmission

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

Following our previous works on dual-frequency lasers, we develop new stabilization schemes with optical feedback on dual-frequency monolithic semi-conductor lasers. These laser chips, developed by the III-V Lab, produce tunable beatnotes between 0-20 GHz with a narrow linewidth below 1 MHz. By applying a frequency-shifted feedback on these lasers, we have demonstrated that it is possible to lock the beatnote frequency on a reference RF synthesizer [Wan14]. This technique, as well as other feedback architectures, lead to new opto-electronic oscillators schemes on integrated chips, with performances approaching those of our non integrated devices [Val16]. In parallel, the analysis of the dynamics of these lasers (taking into account kilometric delays) complements our previous studies on solid state lasers.



(a) (b)

Fig. 4: a) Monolithic two-frequency diode produced by III-V Lab. b) Optical feedback stabilization bench developed in the team.

Selected publications:

[Wan14] L. Wang, M. Romanelli, F. Van Dijk, and M. Vallet, "Photonic RF oscillator based on monolithic DFB lasers with frequency-shifted feedback," Electronics Letters, 50, 451-452 (2014).

[Val16] M. Vallet, M. Romanelli, G. Loas, F. van Dijk, M. Alouini, "Self-Stabilized Optoelectronic Oscillator Using Frequency-Shifted Feedback and a Delay Line," IEEE Phot. Technol. Lett. 28, 1088 (2016).

Optical control of antennas

Optical amplification

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 »*

Romain Cane

Salvatore Pes

Pepino Primiani

Collaboration:

Institut d'Electronique et Télécommunications de Rennes - IETR (Rennes)
Laboratoire d'Analyse et d'Architecture des Systèmes (Toulouse)
Laboratoire Aimé Cotton
III-V Lab (Palaiseau)
Thales Research and Technology (Palaiseau)
Thales Systèmes Aéroportés
Thales Air Defense
Drexel University, (USA)
Selex, (Italie)
Beijing Institute of Technology, (Chine)

Contacts :

M. Alouini F. Bondu M. Brunel G. Loas M. Romanelli M.Vallet

FOTON-DOP team

Head of the team : François BONDU
Tel : +33 223 235 156
francois.bondu@univ-rennes1.fr

Website: http://foton.cnrs.fr/v2016/spip.php?rubrique111

Institut FOTON - Équipe DOP
Université de Rennes 1 – CNRS UMR 6082
Campus de Beaulieu – Bat 11B
263 avenue du Général Leclerc
F-35042 RENNES CEDEX
FRANCE