Spécialité de Master « Optique, Matière, Paris »

Stage de recherche (4 mois minimum, à partir de début mars)

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition : 2016/11/07

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Code d'identification : UMR9188 Organisme : CNRS/ENS CACHAN/UNIV. P-SUD

Site Internet / *web site*: http://www.lac.u-psud.fr/spip.php?rubrique79

Adresse / *address:* Bâtiment 505 – Campus d'Orsay

Lieu du stage / *internship place*: Laboratoire Aimé Cotton

Titre du stage / *internship title*: PHASE SENSITIVE AMPLIFICATION FOR MICROWAVE PHOTONICS APPLICATIONS

Résumé / *summary*

Microwave photonics links will play an important role in future microwave systems. They allow for example to carry signals or radar local oscillators on an optical carrier over long distances. They also carry out a number of functions such as phase shifts, the introduction of delays on real high-bandwidth, reconfigurable filtering of signals, or even more complex functions such as spectral analysis or the correlation of microwave signals. Like all microwave photonics systems, they are suffering from losses due to RF to optics conversion, or simply to propagation. The conventional amplifiers, based for example on erbium-doped fibers, semiconductors, or Raman effect in fibers, do not compensate for these losses without degrading the signal-to-noise ratio. Indeed, quantum mechanics tells us that the noise figure of such phase independent amplifiers, that is to say that amplify similarly all quadratures of the field, can not be less than 3 dB for a large gain. This thesis concerns the study and the experimental realization of optical phase sensitive amplifiers (PSA) in order to amplify these analog signals without adding noise and build new optoelectronic microwave oscillators.

To build such a PSA, we use four-wave mixing processes in a highly nonlinear fiber. Indeed, this third-order nonlinear effect amplifies one of the quadratures of the signal and de-amplifies the other one. This is expected to lead to noiseless amplification [1]. We have recently observed that such a PSA, in a single pump configuration, can indeed lead to noiseless amplification of microwave signal, with a low distortion [2].

Our aims now are the following:

- Find a configuration in which the signal and idler are degenerate, leading to the fact that the two pumps are no longer degenerate. The problem then is that the presence of two powerful pumps leads to cascaded four-wave mixing effects, which are detrimental to PSA operation. We have numerically isolated a good configuration [3] that we want to test experimentally.
- Understand theoretically how orthogonal polarizations can be used, and how signal distortion can be modeled. This will be performed using a model based on coupled nonlinear Schrödinger equation.
- Apply the degenerate configuration to the generation of a low-noise RF signal in an optoelectronic oscillator based on such a PSA.

[1] G. Ferrini, I. Fsaifes, T. Labidi, F. Goldfarb, N. Treps, and F. Bretenaker, JOSA B **31**, 1627 (2014).
This project will be conducted in collaboration with Thales Research & Technology.
[2] T. Labidi, I. Fsaifes, F. Goldfarb, and F. Bretenaker, OSA Nonlinear Photonics Meeting (Barcelona, 2014).
[3] W. Xie, I. Fsaifes, T. Labidi, and F. Bretenaker, "Investigation of degenerate dual-pump phase sensitive amplifier using multi-wave model," Optics Express **23**, 31897 (2015).

Toutes les rubriques ci-dessous doivent obligatoirement être remplies

Ce stage pourra-t-il se prolonger en thèse ? *Possibility of a PhD* **? : YES**

Si oui, financement de thèse envisagé/ *financial support for the PhD*: **EDOM Grant**

Lumière, Matière, Interactions	**YES**	Lasers, Optique, Matière	**YES**

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