Spécialité de Master « Optique, Matière, Plasmas »

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

Proposition de stage (ne pas dépasser 1 page)

Date de la proposition :

Responsable du stage / *internship supervisor*:			
Nom / *name*:	BRETENAKER	Prénom/ *first name* :	Fabien
Tél : 0169352154		Fax :	
Courriel / *mail*:	Fabien.Bretenaker@u-psud.fr		

Nom du Laboratoire / *laboratory name*: LABORATOIRE AIME COTTON

Code d'identification :UPR3321 Organisme :CNRS

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

Adresse / *address:* Bâtiment 505 Campus d'Orsay. 91405 Orsay Cede

Lieu du stage / *internship place*: LABORATOIRE AIME COTTON

Titre du stage / *internship title*: Phase sensitive amplification of optically carried RF signals

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 in order to amplify these analog signals without adding noise and build new optoelectronic microwave oscillators.

It is indeed well known that conventional optical amplification systems, used for example for telecommunications and based on stimulated emission, such as fiber amplifiers doped with erbium (EDFA) or semiconductor amplifiers (SOA), as well as those based on the Raman effect, induce a minimum noise penalty of 3 dB. One way to overcome this problem of noise inherent in all these amplification systems, which has been proposed theoretically by Caves in 1982, is to achieve a phase-sensitive amplifier. By imposing a condition on the phase of the signal to be amplified so you can choose to amplify one of the quadratures of the field while de-amplifying the other quadrature. The total level of noise in the amplifier output is then identical to the initial noise. We can in principle amplify a signal while remaining limited by shot noise.

When talking about phase dependent amplification, it is natural to think of nonlinear amplification processes because in these parametric processes, the direction of energy transfer between beams depends on their relative phase. The optical fibers do not have a second order non-linear coefficient. However, we can use the third order nonlinear coefficient in a fiber and thus to the four-wave mixing process with, e.g., two pump photons annihilation to generate a signal photon and an idler photon. This four-wave mixing can be degenerate or nondegenerate. This has already been used to amplify propagating pulses and solitons. However the conventional silica fibers have a low nonlinearity which limits the possibilities of use. This problem was solved in the early 2000s with the advent of highly nonlinear fiber (HNLF) that possess nonlinear coefficients at least ten times higher than conventional fibers. HNLF fibers having very low propagation losses are commercially available and one can choose the position of zero dispersion, the slope of the dispersion curve and possibly the polarization-maintaining nature.

The objectives of this thesis are to achieve a phase-sensitive amplifier based on such fibers and used for opto-microwave links, then use it in an optoelectronic oscillator with low noise.

This project will be conducted in collaboration with Thales Research & Technology, the Laboratoire Kastler-Brossel, and the Physics Institute of Rennes

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 or CIFRE**

Lasers, Optique, Matière	X	Lumière, Matière : Mesures Extrêmes	X
Plasmas : de l'espace au laboratoire			

Fiche à transmettre (fichier pdf ***obligatoirement****) sur le site http://stages.master-omp.fr*