# 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 : November 22, 2014*


**Responsable du stage** / *internship supervisor*:

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**Nom du Laboratoire** / *laboratory name*: **Institut d'Electronique Fondamentale (UMR 8622)**

Code d'identification : UMR 8622 Organisme : Université Paris-Sud / CNRS

Site Internet / *web site*: **http://silicon-photonics.ief.u-psud.fr/**

Adresse / *address:* Bâtiment 220 de l'Université Paris-Sud

Lieu du stage / *internship place*: Orsay, IEF


Résumé / *summary* **"Modeling of FWM optical nonlinear processes in silicon slot waveguides including extreme mode confinement and/or slow wave phenomena"**


Silicon photonics has raised an increasing interest in the last years due to the foreseen possibility of merging electronics and photonics on the same chips using large scale wafers and well-established technologies. Significant breakthroughs have been demonstrated on optical waveguides and passive optical devices to distribute light, filter optical signals, add-drop individual wavelength around $\lambda$=1.5µm, etc, as well as in the field of active structures for light emission, modulation, and detection. The main potential applications of this silicon (on insulator: SOI) photonics technology are optical interconnects within CMOS chips, optical telecommunications, and biophotonics.

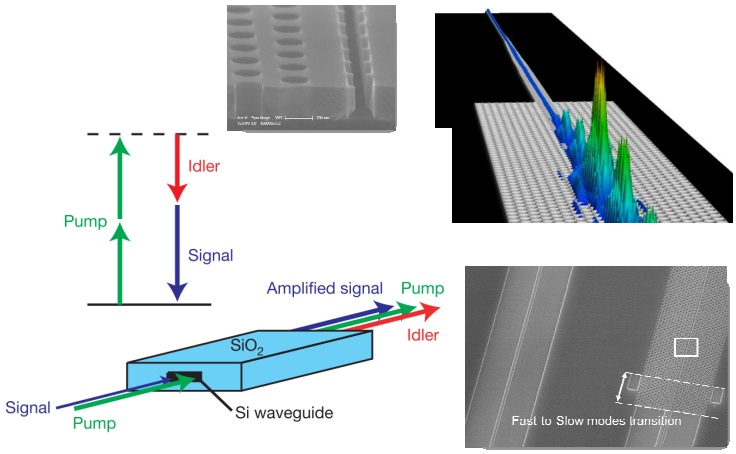
The main forthcoming challenges are to increase the data bit rates of active components beyond 40Gbits.s$^{-1}$, significantly reduce their power consumption, reduce the footprint of photonic structures, manage the temperature dependence of SOI devices, and improve the sensitivity of SOI-based bio-sensors. For all these items, the use of **non-linear optical phenomena** is perceived as an interesting opportunity.

In this context, **the proposed internship topic is focused on the physical and numerical investigation of a key breakthrough in silicon photonics: for the future demonstration of the high gain parametric amplification going beyond the present state-of-the-art**:

http://www.nature.com/nature/journal/v441/n7096/abs/nature04932.html

Slot waveguides are empty-core planar waveguides that can be filled by non-linear optical materials will be considered for this. The strong electromagnetic field confinement provided by these waveguides is significantly enhanced by the slowing down factor provided by the periodical corrugation of PhC waveguides when operating in the slow light regime. Alternatively, slot photonic crystal waveguide cavities with ultra-small modal volumes and high quality factors can be designed and fabricated. In recent papers, a new design of slot PhC waveguides has been proposed, theoretically studied, and experimentally characterized in our group [1,2]. Currently, strong efforts are made to push the theoretical understanding and experimental study of non-linear optical effects in such slotted slow light waveguides and cavities.

The Master/Engineer student will be involved in this on-going research activity, mainly at the modelling level. The main internship aim will be to extend the resolution of the **NonLinear Schrödinger Equation** (NLSE) code already existing in our group, and then to couple it to electromagnetic numerical calculations to predict the light amplification properties in silicon slot waveguides around $\lambda$=1.5µm and evaluate the main physical limits and devices properties of the envisaged structures



[1] C. Caer, X. Le Roux, V. Khanh Do, D. Marris-Morini, N. Izard, L. Vivien, D. Gao, E. Cassan, "*Dispersion engineering of Wide Slot Photonic Crystal Waveguides by Bragg-like Corrugation of the Slot*", Photonics Technology Letters, vol. 23, n°18, pp. 1298-1300, 2011.

[2] C. Caer, X. Le Roux, E. Cassan, "*Enhanced localization of light in slow wave slot photonic crystal waveguides*", Optics Letters, vol. 37, n°17, pp. 3660-3662, 2012.


***(We will be happy to provide you the pdf versions of these papers and discuss with you if you are interested in)***

**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***: Ecole Doctorale STITS**

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| Lasers, Optique, Matière | **YES** | Lumière, Matière, Interactions | **YES** |
| Plasmas : de l'espace au laboratoire | **NO** | | |