Spécialité de Master « Optique, Matière, Plasmas »

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

Proposition de stage

Date de la proposition : 8 Décembre 2014

Responsable du stage : *Valentina EMILIANI*

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Nom du Laboratoire / *laboratory name*: **Laboratoire de Neurophotonique**

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Aberration correction of temporally focused holographic beams

An important technological revolution is underway in the field of neuroscience as we begin the 21st century. The era of electricity is gradually transitioning into the era of light. The combination of optical methods with genetically encoded photosensitive tools (optogenetics) and caged compounds offers the opportunity to quickly probe and monitor arbitrarily large numbers of events at user defined regions of interest. This ongoing revolution has motivated the development of new optical methods permitting light delivering with high temporal and spatial resolution.

The *Wave front engineering microscopy* group has been focused in the last years to the development of a specific class of optical techniques where light distribution is engineered *via* phase modulation of optical wave-fronts by making use of liquid crystal spatial light modulators. These techniques include computer generated holography (CGH) generalized phase contrast (GPC), and temporal focusing (TF) to generate shaped single- and two-photon (2P) excitation volumes into neural tissue. We demonstrated that with these approaches efficient 2P stimulation of single and multiple cells expressing optogenetics proteins, can be achieved (1). Furthermore, we have recently shown that temporally focused shapes propagate deep into scattering brain tissue with high spatial fidelity at depths up to 500μm (2). In this research project we plan to further improve the propagation of wave front shaped beams through scattering media with the use of adaptive optics (AO). This approach has been largely used to improve the quality of the illumination spot in different nonlinear techniques including 2P microscopy and second harmonic generation. However its combination with a system combining TF and CGH has not yet been demonstrated and presents few challenges (3). In this project, we will test different strategies to combine TF, CGH and AO. Once the optimal design will be reached, we will test the capabilities of the system on living samples including mice brain slices and zebrafish larvae.

(1) Papagiakoumou, E., et al., *Scanless two-photon excitation of channelrhodopsin-2.* Nature Methods, 2010. **7**(10): pp. 848-54.

(2) Papagiakoumou, E., et al., *Functional patterned multiphoton excitation deep inside scattering tissue.* Nature Photonics, 2013. **7**(4): pp. 274-278.

(3) Hernandez O. * and Guillon M. * and Papagiakoumou E. * and Emiliani V. * , *Zero-order suppression for two-photon holographic excitation,* Optics Letters, 2014 39 pp. 5953–5956

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/ Contrats**

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