

Internship/PhD project in biomedical optics

Multiphoton imaging of calcifying dermatoses.

Multiphoton microscopy has revolutionized three-dimensional (3D) imaging of biological tissues. Its main advantage, beyond its excellent penetration depth, is the ability to combine several signals based on different nonlinear optical processes and thus to image in parallel various components of interest in tissues. For instance, in the skin, we can image simultaneously and without any labeling (i) collagen fibers by their second harmonic generation signal (SHG), (ii) elastic fibers by their 2 photon excited fluorescence signal (2PEF) and (iii) pathological mineral deposits by their third harmonic generation signal (THG). This makes it possible to characterize the impact of a pathology on the micrometer-scale structure of a tissue, which is essential for improving its diagnosis, understanding its consequences on tissues and developing new therapeutic approaches.

In this context, a collaboration has been initiated between the Laboratory for Optics and Biosciences (LOB, Palaiseau) and the Rothschild Hospital (APHP, Paris) to study various calcifying dermatoses. The aim is to characterize the structural alterations of the elastic fibers during these pathologies, in connection with the associated mineral deposits and with the inflammatory state of the dermis. The aim of the internship is therefore to image healthy and pathological skin and to develop image analysis codes to obtain quantitative measurements of the observed structural alterations. These experiments will be conducted on histological slides from human biopsies and on intact biopsies of animal models of these calcifying pathologies. The multiphoton images will also be correlated with histological and immuno-histochemical images obtained on conventional microscopes. In case of continuation in PhD, other pathologies could be studied, in particular those associated with healing defects that affect the 3D distribution of collagen fibers.

This internship will be co-supervised by Marie-Claire SCHANNE-KLEIN, a physicist specialized in multiphoton microscopy and by Hester COLBOC, a dermatologist specialized in calcifying dermatoses and skin aging. Most of the experiments will take place on the microscopes of the LOB advanced microscopy pole, but part of the internship will take place at the Rothschild Hospital. This project requires skills in optics and coding for image analysis, and, most importantly, a strong interest in the interface with the biomedical field.

Related recent publications (see also <http://www.lob.polytechnique.fr/>) :

- [1] Bancelin et al, Nat. Commun. 5 (2014) - [10.1038/ncomms5920](https://doi.org/10.1038/ncomms5920)
- [2] Ducourthial et al, J. Biophot. 12, e201800336 (2019) - [10.1002/jbio.201800336](https://doi.org/10.1002/jbio.201800336)
- [3] Schmeltz et al, Optica (2020) - [10.1364/optica.399246](https://doi.org/10.1364/optica.399246)

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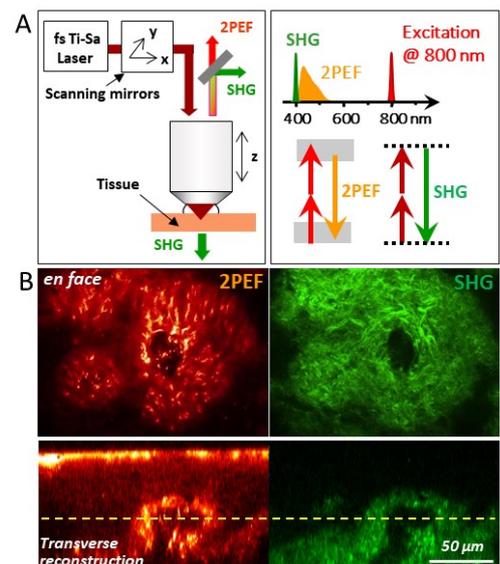


Fig. 1: Multiphoton imaging of human skin. (a) Experimental setup; (b) en face 2PEF and SHG images and transverse reconstructions.