Multimodal optical microscopy to characterize multiscale biomechanical properties of connective tissues

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Context - The mechanical properties of biological systems play a complex role in determining the physiological functions of tissues and appear to be dominant factors in many processes of development, homeostasis and pathology. Interestingly, tissues with properties as different as bone, skin or tendon are mainly composed of the same elementary units. Hence, their specific mechanical properties are directly linked to their sub-microscopic organisation. Nowadays, understanding the structure/function link in connective tissues faces the challenge of probing the multiple scales involved in constructing macroscopic properties from individual structures in highly complex samples. The advent of multiphoton microscopy, based on the nonlinear interaction between laser pulses and the constituents of biological samples, has revolutionised the way we observe living organisms. Notably, Second Harmonic Generation (SHG) microscopy has recently emerged as the gold standard for collagen imaging in thick samples, enabling label-free visualization of fibrillar distribution with high intrinsic specificity and sub-micron resolution.

Objective – In this context, the aim of the research project is to implement a multimodal imaging platform, compatible with simultaneous mechanical assay, to probe the multiscale morpho-mechanical properties of connective tissues. To that end, a nonlinear microscope, coupling second harmonic generation, Raman and Brillouin imaging, is currently being developed in the lab, which will enable to characterize and quantify the collagen architecture and viscoelastic properties at sub-micron scale. The aim of this project is to **develop and implement the detection path used for the Brillouin microscopy**. We will adopt a VIPA (Virtually Imaged Phase Array) configuration, to acquire Brillouin spectra in one shot, and develop a home-made analysis to extract the Brillouin shift and width. Upon operational, the proof-of-principle will be realized in **vocal folds biopsies** as well as on **bioprinted skin samples**.

Environment - This project will take place in the Nano-BioMicroscopy team at **LP2N** (**Institut d'Optique d'Aquitaine**). The team works at the crossroads between nanoscience, optics and bio-imaging to design and study innovative nanostructures and to investigate complex biological system at the nanoscale. In particular, the group has a well-known expertise in infrared imaging, super-resolution microscopy and single particle tracking.

Profile - This project is **primarily experimental** and involves aspects of optical system alignment, image acquisition, data analysis (ImageJ /Python/ Matlab) and basic tissue preparation. We are seeking for candidate with a background in **physics/experimental optics** and a strong motivation to work in an **interdisciplinary environment**. Experience with optical implementation and image/signal processing with Python would be an asset.

Three-years doctoral contract is available with **ANR funding**. To apply, please send a **CV**, a **motivation letter**, your **transcripts**, and reference letter to Stéphane Bancelin (stephane.bancelin@cnrs.fr).