

## PhD Proposal 2021

### Nonlinear acousto-mechanical imaging for aging memory effects of complex biological media

#### 1. Scientific framework

Our group develops acousto-mechanical methods for processing and analysis of aging of complex medium and materials (bone, skin, tooth, brain, bio-materials, polymers and elastomeric materials). For example, the acousto-mechanical characterization of the human skin is a challenging task where innovation aspects increases for pharmacology and cosmetic applications. As known by the scientific community, the generation of nonlinear signature are directly related to the presence of aging and memory processes induced by microdamage in material, or degeneracy in biological medium.

#### 2. Position context

The PhD student will join [U1253 Inserm "Imaging and Brain : iBrain"](#) unit, in the team "Imaging, Biomarkers and Therapy". The team develops numerous collaborations with other groups in France and worldwide, related to ultrasound, nonlinear mechanics and signal processing for medical and Non Destructive Testing & Evaluation (NDT&E). The associated research project is presently supported by four partners, including international research centers and the [Cosmetic Valley](#), international cluster of cosmetics. The research position will be located at the Blois Campus Research Center located within INSA Centre Val de Loire Institute of Applied Sciences.

#### 3. Job description and missions

The PhD student will be involved in the development carried out for handling a new multimodal characterization of skin and brain aging and their memory properties, within the framework of bio-mechanics and signal processing. More specifically, experimental Time Reversal (TR) based Nonlinear Elastic Wave Spectroscopy (NEWS) techniques will be developed around 40 MHz including bio-mechanical fatigue tests and correlation based image processing. Several nonlinear techniques have been developed and are continuously further defined including multi-modal acousto-mechanical approaches. The PhD student will have to contribute to the project. The project aims at developing experimental and theoretical techniques for nonlinear acoustic imaging of human brain under complex ageing processes. A transfer from techniques frequently used for nonlinear characterization of complex materials is proposed in order to evaluate biomechanical aging properties of the human media. The thesis aim at developing innovative experimentation of [TR-NEWS](#)[1] based techniques. The experimental set-up will be completed by using modern ultrasonic memosducer components aim at describing neuromorphic systems and memristive devices [2]. Candidates with a particular interest in signal processing, imaging and radar systems are encouraged to apply for this position. Experience with applied electromagnetics using numerical programming software, such as MATLAB and Python, would be highly desirable.

#### Références :

[1] [Dos Santos S.](#), *Advanced Ground Truth Multimodal Imaging Using Time Reversal (TR) Based Nonlinear Elastic Wave Spectroscopy (NEWS): Medical Imaging Trends Versus Non-destructive Testing Applications*. In: [Dos Santos S.](#), [Maslouhi M.](#), [Okoudjou K.](#) (eds) *Recent Advances in Mathematics and Technology. Applied and Numerical Harmonic Analysis*. Birkhäuser, Cham (2020)

[2] [Serge Dos Santos](#) and Zdenek Prevorovsky. *Imaging of human tooth using ultrasound based chirp-coded nonlinear time reversal acoustics*. *Ultrasonics*, **51**(6) :667–674, 2011.

[3] [S Dos Santos](#), [S Furui](#), *A memristor based ultrasonic transducer: the memosducer*, *Ultrasonics Symposium (IUS)*, 2016 IEEE International, 1-4(2016), <https://doi.org/10.1109/ULTSYM.2016.7728885>

[4] Online resources : [ORCID](#) : [ResearcherID](#) : [Researchgate](#) : [Scopus ID](#) : [Google Scholar](#) : [Linkedin](#) :

#### 4. Profile

We are looking for highly self-motivated candidates with a master's degree in a discipline related to wave physics (e.g., applied electromagnetics, physics, instrumentation, electronics, acoustics, signal and image processing). Attention will be paid to academic record, motivation for the particular position, and personal projects. Autonomy, open-mindedness and motivation, as well as good English speaking/writing skills, are also expected. The position is opened to all nationalities, but the working language should be either French or English (English communications skills are mandatory).

#### 5. Contact and additional information

A candidacy folder including a CV, a motivation letter as well as letters of recommendations, is to be sent to :

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