Post-doctoral proposal

Therapeutic ultrasound: development of a low-intensity ultrasound stimulator for bone cells.

Supervisors

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Context

Bone tissue is a complex biological tissue, capable of adapting to its mechanical environment by optimizing its structure, a process called bone remodeling. Low-intensity ultrasound (LIUS) stimulation of bone regeneration was discovered in the 1950s and has been widely studied ever since. However, the underlying mechanotransduction mechanisms (translation of mechanical stimuli into biological response) remain poorly identified and this lack of knowledge fuels controversy, preventing the development of efficient and optimized therapeutic tools. The characterization and quantification of mechanical stresses induced by LIUS stimulation on bone cells are essential to understand these mechanisms. To gain insight into this multiscale and multiphysic phenomena, the development of *in vitro* studies on cell culture dishes is a key step. A first *in vitro* experimental device has been developed and tested on 2D cell cultures (i.e., inside cell culture dishes). This LIUS-stimulator enables serial cell cultures to be stimulated in a fully automated way, inside an incubator (simultaneous processing of up to 20 (5x4) independent cell culture dishes), while controlling the acoustic dose delivered to the cells.

Objectives

The objectives of the proposal are to

1 - improve the serial LIUS stimulator to make it more flexible to use and more ergonomic

2 - optimize acoustic conditions for 2D and 3D cell cultures: ultrasonic field and intensity control,

3 - integrate live imaging of LIUS effects in 2D and 3D cell cultures

Profile required

The candidate, who holds a Ph.D. or equivalent, must have academic knowledge and/or experience in one or more disciplinary areas: acoustics, fluid and/or solid mechanics. Additional skills in computer science (programming and processing) as well as electronics (ex. Arduino prototyping) and electroacoustics (ex. transducers and arrays) are also required. Numerical modeling skills would be an additional advantage. He/she will have to show synthesis, communication, rigor and methodology to be able to invest in the various aspects of the work requested. Programming (software) development tools: Matlab™, Python™, Comsol Multiphyscis™.

Environment

The successful candidate will be co-advised by Philippe Lasaygues (acoustics engineering and experiments, electroacoustic, signal processing) from the LMA, and Cécile Baron, (theoretical and numerical acoustics and mechanics) from the IRPHé. The candidate will conduct his/her research at the LMA, which offers the ultrasound and imaging platforms with a ultrasonic and µCT scanners, with the support of the Fédération de Mécanique Fabri de Peiresc (https://www.federation-peiresc.cnrs.fr).