LABTAU
LABORATOIRE THÉRAPIE
ET APPLICATIONS ULTRASONORES

Master / Engineering student internship project - 6 months

Sonic Solutions: Harnessing Focused Ultrasound for Targeted Neurostimulation Studies

Context: Focused ultrasound (FUS) neurostimulation is an exciting and rapidly expanding field for the treatment of neurological and psychiatric disorders such as epilepsy, Parkinson's disease and depression, among others. Despite the rapid growth of this promising field, a fundamental understanding of the underlying mechanisms is necessary to further accelerate its transfer to the clinic. In recent years, our group has conducted preclinical studies exploring the immediate and causal stimulation effects of FUS, down to single FUS pulses[1-5]. This project will consist in the investigation of the physical, biological and chemical mechanisms involved in this phenomenon. The experimental platforms designed and operated by the candidate will integrate FUS stimulation systems and techniques commonly used in the study of neural models of increasing anatomical and physiological complexity. These "hybrid" platforms will be used to describe the electrochemical and electrophysiological responses produced by application of FUS sequences on different neural models ranging from *in vitro* neural cultures, to *in vivo* giant axons of the common earthworm, to *in vivo* full brain studies on rodent models. The techniques that will be used to explore the biological activity of FUS-treated neural models will include real-time *in vitro* fluorescence imaging, electrophysiological and electrochemical measurements of neural activity, and medical imaging systems.

1. Vion-Bailly et al. A causal study of the phenomenon of ultrasound neurostimulation applied to an *in vivo* invertebrate nervous model. *Scientific Reports*. 2019, *9*(1): 1-12. https://doi-org.docelec.univ-lyon1.fr/10.1038/s41598-019-50147-7
2. Suarez-Castellanos et al. Spatiotemporal characterization of causal electrophysiological activity stimulated by single pulse Focused Ultrasound: an ex vivo study on hippocampal brain slices. *Journal of Neural Engineering*. 2021. 18(2), 026022. https://doi-org.docelec.univ-lyon1.fr/10.1088/1741-2552/abdfb1
3. Aubier et al. Mixed Focused UltraSound (FUS) / fluorescence imaging platform for characterization of the spatial-temporal dynamics of FUS-evoked calcium fluxes in an in-vitro human cell model. *Proceedings of the IEEE IUS International Symposium*, p1-4. Virtual Meeting. 11-16 Sept. 2021 (poster). **DOI** : 10.1109/IUS52206.2021.9593676
4. Vion-Bailly et al. *Neurostimulation success rate of repetitive-pulse focused ultrasound in an in vivo giant axon model: An acoustic parametric study. Medical Physics.* 2022, 49(1), 682-701. https://doi-org.docelec.univ-lyon1.fr/10.1002/mp.15358
5. N'Djin et al. Causal neurostimulation by focused ultrasound: down to the effect of a single-pulse. *Brain Stimulation Symposium, Lisbon, Portugal, Feb. 19-22, 2023. Brain Stimulation: Basic, Translational, and Clinical Research in Neuromodulation*, 2023. *16*(1), 152-153. http://dx.doi.org/10.1016/j.brs.2023.01.117

Mission: The aim of this master's or engineering's degree internship will be to study current hypotheses of neural signal generation and transmission across neural networks as a result of FUS stimulation. In addition to operating and fine tuning the aforementioned hybrid platforms, the candidate will be expected to analyze and display acquired data in such a manner as to address the project's objectives and hypotheses.

Activities:

- Design and execute experiments with *in vitro* and *in vivo* neural models.
- Data collection and analysis.
- Bibliographic studies, training, disseminations and valorizations of the results.

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Requirements:

- Desirable qualifications: Foundational understanding of biology and neuroscience.
- Preferred qualifications: Solid grasp of physics and mathematics.
- Previous experience with electrophysiological systems and/or imaging techniques.
- Proficiency in MATLAB programming or other coding languages such as Python.
- Appreciation for experimental work, and analysis of experimental datasets.
- Competitive academic profile for a potential participation at the University of Lyon's doctoral scholarship contests.

Additional information: This project is funded by national research agency (ANR) grants, among other funding sources. The successful candidate will conduct the project's research work at the Laboratory of Therapeutic Applications of Ultrasound (LabTAU, Inserm U1032) located in the Grange-Blanche area, in Lyon, France. The duration of the internship will be 6 months. Remuneration will be assigned according to national standards: 4.35 euro per hour. For application or additional information, please send an updated CV and motivation letter by e-mail to W. Apoutou N'DJIN (apoutou.ndjin@inserm.fr) or Ivan SUAREZ (ivan.suarez@inserm.fr).