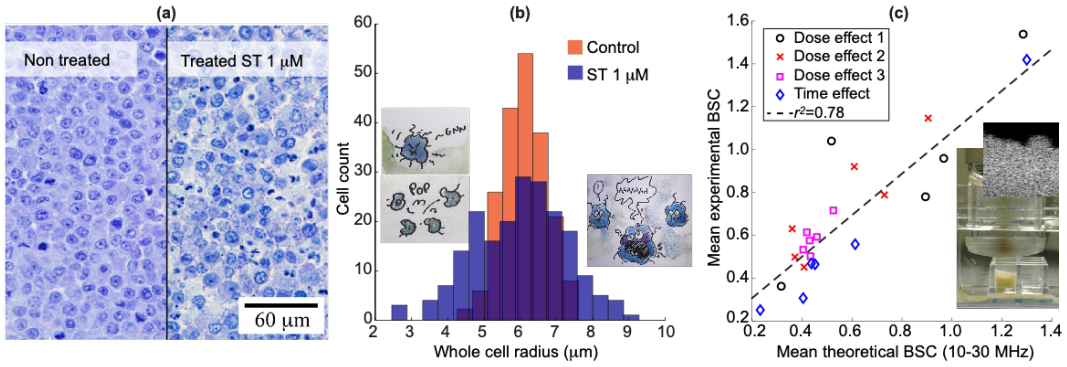
18 months Post-doctoral position at LMA Marseille

Quantitative ultrasound techniques for assessing thermal ablation

High intensity focused ultrasound (HIFU) is a non-invasive thermal ablation technique that uses externally applied ultrasound energy to induce necrosis by coagulating biological tissue. Clinical applications of HIFU have expanded rapidly over the past 20 years. However, the development of a non-invasive and effective modality to guide HIFU therapies remains necessary. In the framework of the NIFU ITMO Cancer project, our objective is to develop a new method for real-time guidance and monitoring during HIFU therapy, based on spectral-based quantitative ultrasound (QUS) imaging of tissue microstructure. This technique is based on the frequency analysis of the backscattered signals from tissues and allows to estimate QUS structural parameters (size, concentration and spatial organization of scatterers/cells). Spectral-based QUS technique has already been studied *in vitro* and *in vivo* to monitor cell death index (apoptosis and/or necrosis) [1][2] and is therefore a promising tool to monitor HIFU.

The Post-doc objective is **to monitor HIFU treatment on breast cancer samples using spectral-based QUS techniques**, and **to understand which are the cellular structural changes during coagulative necrosis that cause the changes in the backscattered signals during thermal ablation**. To that aim, the candidate will perform high frequency (10-80 MHz) ultrasonic experiments on *in vitro* breast cancer samples treated by thermal ablation, perform the QUS analysis of RF data and study the correlations between QUS parameters and histological observations. Specifically, high frequency backscatter measurements will be analyzed by using an ultrasonic scattering model, namely the structure factor model, adapted to dense and polydisperse medium to estimate QUS parameters [1]. Computational acoustic models using 2D impedance maps (derived from 2D histological slices) will be used to predict the ultrasound backscattering from complex tumoral microstructures before and after thermal ablation [3].

The work will be carried out at the Laboratory of Mechanics and Acoustics (LMA, Marseille) in the Waves and Imaging team. The project will benefit from the collaboration with D. Melodelima (expert in HIFU therapy from LabTAU, Lyon).



(a) Histological images of HT29 cell pellet biophantoms treated and non treated with chemotherapy. **(b)** Corresponding cell size distribution. **(c)** Comparison between measured backscatter coefficients and those predicted by the polydisperse structure factor model [1].

Profile: We are looking for a highly motivated candidate with strong experimental skills and having a PhD in acoustics/physics. Matlab or python programming skills are also required. The position is funded for 18 months at the Laboratory of Mechanics and Acoustics (LMA, Marseille), preferably beginning in the fall of 2023, although earlier or later appointments are possible.

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References

[1] Franceschini E, Balasse L, Roffino S, Guillet B, Probe the cellular size distribution from cell samples undergoing cell death, Ultrasound Med. Biol., 45(7) 1787-1798, 2019

[2] Sannachi L, Tadayyon H, Sadeghi-Naini A, Tran W, Sonal G, Wright F, Oelze M, Czarnota GJ. Non-invasive evaluation of breast cancer response to chemotherapy using quantitative backscatter parameters. Med. Image Anal. 20 224–236, 2015

[3] Tamura K, Mamou J, Yoshida K, Yamaguchi T, Franceschini E, Quantifying scattering from dense media using two-dimensional impedance maps, J. Acoust. Soc. Amer. 148(3) 1681-1691, 2020