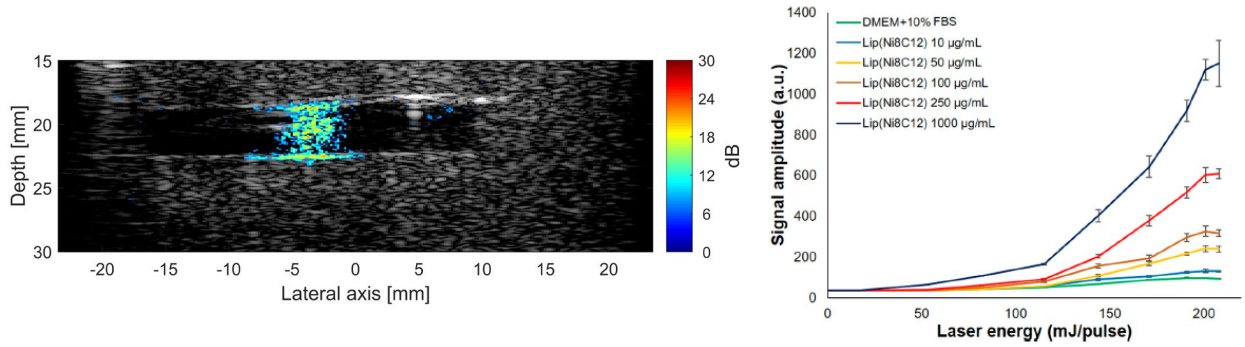
# Master/PFE Internship
# Evaluation of new photo-thermal therapeutic nano-agents from multispectral photoacoustic imaging

Photoacoustic (PA) imaging is a recent medical imaging modality that combines an optical excitation and acoustic detection [1], [2]. A short (~nanosecond) and high-energy optical excitation through the investigation medium generates the acoustic signal. Indeed, the local optical absorber captures this optical pulse and leads to an automatic heating and cooling of the absorber. Such physical effect dilates and compresses the medium, creating the acoustic wave. Finally, classical scanners receives these echoes. The PA imaging is a functional imaging modality, as the generated imaging is not based on impedance evolution (classical ultrasound imaging) but on optical absorber changes, which are medium dependant. To investigate this functional aspect, the wavelength of the excitation have to be change to record different answer of the medium under different excitation optical pulses.

In Creatis, a photoacoustic platform was built since 2014 and exploits a Nd:Yag laser source coupled with an Optical Parametric Oscillator (OPO) to produce wide range of excitations [3]. Then, a Vantage 256 (Verasonics Inc.) system acquires the PA signal after a specific synchronization [4]. The use of such advance ultrasound scanner allows acquiring the completely raw PA signal and conducts our own beamforming.

This internship project is part of a collaboration with a chemistry team in Rennes. Indeed, this team develops new photo-thermal therapeutic nano-agent [5]. The objective of the project is then to investigate the ability of this nano-agent to play a role of bio-imaging marker.




(a) (b)

Figure 1 – (a) Illustration of the hybrid PA imaging of a Lip(Ni8C12) at 500µg/mL nano-agent complex. (b) First characterisation of this nano-agent at a single wavelength but for various energy and concentration.

The proposed objectives of the internship is to work on such PA platform in the context of bio-imaging. Typically, these aspects could be identify:

- Update the used Verasonics pipeline for advance PA imaging: advance control on the beamformed image, compensation for attenuation, advance beamforming.
- Reflexion on the calibration of the recorded photoacoustic signal: optical energy measurement (with and without OPO), fantome design to record the acoustic energy level in function of the depth…
- Evaluation of nano-agent provided by the Rennes teams on the Creatis platform for various concentration and wavelength excitation.
- Evaluation of the best nano-agent on a pre-clinical platform with fixed energy deposit and post-processing techniques.
- Depending of the advancement of the project, the therapeutic behaviour of the nano-agent could be activate and their photoacoustic answer before/after activation could be investigated.

Profile/Skills: Student from a top engineering school or university (generalist or EEA profile) with a speciality in image and signal processing. Previous knowledge on photoacoustic/ultrasound imaging is a plus.

Keywords: signal processing, optics, instrumentation, experimental skills

Programming skills: Matlab.

Start and duration of the internship: as soon as possible for a duration of 6 months.

## How to apply

Send CV + cover letter + M1/M2 or engineering school transcripts to:

François Varray, Associate Professor, francois.varray@creatis.insa-lyon.fr

## References

[1] J. Yao et L. V. Wang, « Photoacoustic tomography: fundamentals, advances and prospects », *Contrast Media Mol. Imaging*, vol. 6, n° 5, p. 332-345, oct. 2011, doi: 10.1002/cmmi.443.

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[3] M. Vallet, F. Varray, M. A. Kalkhoran, D. Vray, et J. Boutet, « Enhancement of photoacoustic imaging quality by using CMUT technology: Experimental study », in *Ultrasonics Symposium (IUS), 2014 IEEE International*, sept. 2014, p. 1296-1299. doi: 10.1109/ULTSYM.2014.0320.

[4] L. Petrusca *et al.*, « Fast Volumetric Ultrasound B-Mode and Doppler Imaging with a New High-Channels Density Platform for Advanced 4D Cardiac Imaging/Therapy », *Appl. Sci.*, vol. 8, n° 2, p. 200, févr. 2018, doi: 10.3390/app8020200.

[5] M. Ciancone *et al.*, « Liposomes Containing Nickel–Bis(dithiolene) Complexes for Photothermal Theranostics », *Langmuir*, vol. 35, n° 47, p. 15121-15130, nov. 2019, doi: 10.1021/acs.langmuir.9b01296.