# Master internship
# EIC european project at the Université de Lyon

# Automatic co-registration of intraoperative optical images and MRI volumes for the validation of functional brain identifications in intraoperative neuroimaging

As part of a recently awarded EIC Pathfinder european Grant (`www.hyperprobe.eu`) we are looking for a master student. **EIC supports projects that research and develop emerging breakthrough technologies**. The main goal of our project consists in **transforming brain surgery by advancing functional-guided neuronavigational imaging.**

**Intraoperative neuroimaging** is developing as an indispensable means of **assistance for surgical procedures**. We are working on the development of innovative **optical imaging** methods for **translational medical applications**. These works are based on clinical collaborations with **Jacques Guyotat** (Neurosurgery department of Lyon University hospital HCL) and **Fabien Schneider** (Radiology department of Saint Etienne University hospital) for the development of **new intraoperative optical imaging strategies** inspired from fMRI (functional Magnetic Resonance Imaging) [1, 2].

## Scientific context

Non-invasive functional brain mapping is an imaging technique that allows the locating of functional areas of the patient's brain. This technique is used during brain tumor resection surgery to indicate to the neurosurgeon the cortical tissues which should not be removed without cognitive impairment. Functional magnetic resonance imaging (fMRI) [3] is the preoperative gold standard for identifying the patient's functional areas. fMRI is rarely used during neurosurgery since it complicates the surgical procedure. During neurosurgery, electrical brain stimulation [4] is the gold standard, but this technique is mainly limited by its low spatial resolution and has the potential risk to trigger epileptic seizures.

Optical imaging is a perfect complement to electrical brain stimulation since this technique is contact-less, non-invasive, non-ionizing and has a low traumatic impact for the patient. Optical imaging also has the potential to be used in real time in an interventional environment with very high spatial resolution ($50 - 100$ $\mu$m). Moreover, the analysis of the light absorption allows monitoring the brain activity in brain cortex[5, 6].

In order to validate this new imaging method, fMRI and optical maps will be compared to the electrical brain stimulation identifications performed by the neurosurgeon. In this project, the work will be based on preliminary studies conducted with the collaboration of Jacques Guyotat, which have generated several publications [5, 7, 8, 6, 9]. The internship work will also rely on the expertise of Fabien Schneider on the analysis of brain connectivity at rest [10, 11]. A proof of concept has already been developed during Charly Caredda PhD thesis, see Fig. 1.

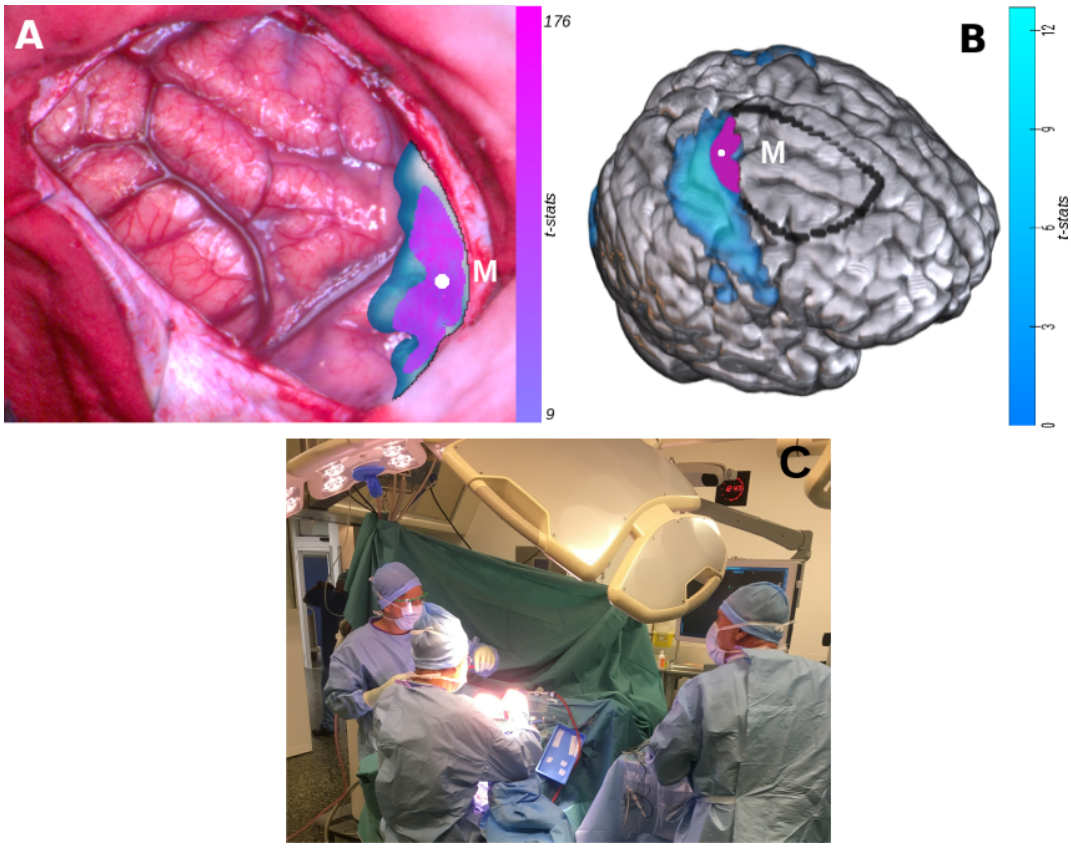


FIGURE 1 – Identification of the cerebral motor area related to patient's left-hand movement, identified by fMRI (blue map) and optical imaging (magenta map). The contour of the surgical window of image A is represented in black in image B. The letter M indicates the motor area identified by the neurosurgeon. C - Neurosurgery operating room in Hospices Civils de Lyon.

## Internship objectives and candidate profile

The objective of this internship is the automatic co-registration of intra-operative optical images and MRI volumes. For this purpose, different approaches of image segmentation and slice to volume registration will be tested. This would allow the comparison of pre-operative fMRI with identifications provided by optical imaging in the operative room. A proof of concept has already been developed, but a robust automatization is required.

The person recruited will mainly work on image segmentation, slice to volume registration algorithms and signal/image processing. Strong Python programming skills are expected, as well as good written and oral English skills. Previous experience in image registration is appreciated. He/she will take part in *in vivo* experiments on humans in a neurosurgery operating room at the Hospices Civils de Lyon. The prerequisites are therefore those of a physicist and/or engineer with a specialization in modelling and/or signal processing, with a strong attraction for multidisciplinary in the medical and biomedical fields.

## Selection process

The paper documents are continuously assessed and fitting candidates complying with the requirements are invited for interviews as soon as possible. Applicants should provide the following information in their application :

1. Cover Letter (including motivation, qualifications and possible synergy with the project)

2. A detailed CV including technical / analytical skills and a list of publications
3. Transcript of marks during the academic curriculum
4. Contact information of two referees

## Scientific environment

The supervision committee will be composed of specialists in each component of this research subject :
— Clinical medical optical setup (Bruno Montcel and Charly Caredda)
— Data analyses and processing (Eric Van-Reeth)
— Radiology (Fabien Schneider)
— Neurosurgery (Thiébaud Picart)

## Contact


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## Références


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