Job offers at « Institut de Neurosciences des Systèmes », Marseille, France

GALVANI ERC Synergy Project

Context

The GALVANI project (https://www.galvani-lab.eu/) is a European research project (ERC SYNERGY 2020) aiming at developing non-invasive brain transcranial current stimulation (tCS) in epilepsy. Cumulated prevalence of epilepsy is 3% and about one-third of patients are drug resistant. This situation leads to major handicaps and comorbidities. In focal DRE, epilepsy surgery may be indicated if a focal resection is possible, a decision often taken after invasive EEG recordings (Stereo-EEG, SEEG). However, epilepsy surgery is possible in only 20% of DRE patients and is facing a certain number of failures. In this context, tCS is a promising tool in patients with drug resistant epilepsy (DRE). Still, it is not yet indicated as a standard treatment due to major scientific limitations: unknown mechanisms of action, insufficient account for patient-specific factors, poor understanding of short- and long-term effects. The ambition of the GALVANI project is to transform the care of a large fraction of patients living with drug-resistant epilepsies by solving a fundamental problem: to efficiently target and control large-scale epileptic brain networks with tCS-induced neuromodulatory weak electric fields.

Scientific Environment

GALVANI involves three partners: LTSI-Inserm (Rennes), AMU-APHP (Marseille) and Neuroelectrics (Barcelona). It is intended to develop the next generation of brain stimulation solutions. GALVANI can be viewed as a distributed lab (Rennes-Barcelona-Marseille) working under a common policy to ensure coherence of research and intense collaboration and cross-fertilization. Fellows will be co-supervised in a unique, shared environment with exposure to science, technology and clinical experience.

Within the GALVANI project, the Marseille team is specialized in the management of epilepsy at Timone Hospital in the Epileptology and Cerebral Rhythmology department (Head Prof. F Bartolomei) with a strong expertise in SEEG explorations. The hospital department houses a research team from the Institut de Neurosciences des Systèmes (INS, INSERM AMU 1106, DYNAMAP team, dir C. Benar, https://ins-amu.fr/dynamap) specialized in the analysis of electrophysiological signals (SEEG, MEG, EEG).

We are looking for several candidates (PhD or Postdocs) that can complement and extend the DYNAMAP team’s expertise in the GALVANI Research project.

Contacts:

Christian Bénar (christian.benar@univ-amu.fr)

Fabrice Bartolomei (Fabrice.Bartolomei@ap-hm.fr)
Position 1: Post-doc/PhD “Interictal and Ictal Markers of the epileptogenic zone” (3y)

Planned recruitment: March 2020 (3y)

**Rationale:** Epilepsy is a disease of brain networks. It is increasingly recognized that investigation of pathological networks helps delineating the *epileptogenic zone*, i.e. the brain regions that need to be removed in order to abolish epileptic seizures. This is to be contrasted with the propagation zone, i.e. regions involved secondarily within the ictal discharges. The best methods for defining the network, as well as the type of activity (background, epileptic spikes, oscillations) remain to be defined. Within the Galvani project, network characterization will permit defining which nodes of the models are epileptic, as well as quantifying the impact of stimulation on pathological activity.

**Objectives:** Perform local and network measures based either on raw interictal signals or on event detections, and define which combination of measures best predict the epileptogenic zone.

**Methods:** Constitute an SEEG database with interictal measures, ictal activity, visual onset zone; surgery results. Define and compute epileptogenicity biomarkers: connectivity patterns, co-occurrence of detected events, time-frequency analysis of ictal signals. Evaluate markers by testing them versus the EZ defined visually or automatically.

**Required skills:** Electrophysiology, epilepsy, signal processing, programming in Matlab or Python. Good capacities to work in a team.

Position 2: Post-doc/PhD “Quantification of immediate impact of tDCS on brain activity” (3y)

Planned recruitment: Sept 2020

**Rationale:** The actual impact of brain stimulation on brain activity is poorly known. Intracerebral EEG performed in patients during presurgical evaluation of epilepsy give a formidable opportunity for measuring this impact directly within brain tissues.

**Objectives:** Perform tCS in patients with simultaneous recording of intracerebral stereotaxic EEG (SEEG) within a research protocol to be submitted to ethical committee. Measure the impact of stimulation on brain signals thanks to signal processing metrics.

**Methods:** SEEG signals will be acquired continuously during stimulation, with periods of rest. The signals during and directly after stimulation will be compared to signals before stimulation (baseline) thanks to the methods developed within Project 1 (local and network measures). Artefact subtraction methods will be applied to the SEEG signals in order to remove the influence of stimulation.

**Required skills:** Electrophysiology recording and analysis, epilepsy, signal processing, programming in Matlab or Python. Good capacities to work in a team.
Position 3: Post-doc/PhD “Non-invasive measures of brain excitability” (3y)

Planned recruitment: Jan 2021

Rationale: Magnetoencephalography (MEG) and electroencephalography (EEG) are complementary non-invasive measures for characterizing epileptic networks. MEG has high spatial specificity, being little influenced by skull conductivity (contrary to EEG), but is much less sensitive than EEG to radial sources than EEG. Within the GALVANI, MEG and EEG will provide a global view of brain activity. Moreover, improving the fusion of EEG and MEG with validation by SEEG will improve clinical practice in a general way.

Objectives: Perform EEG/MEG data fusion for localizing activity and charactering epileptic networks. Thanks to this fusion, the methods developed in projects 1 will be performed on simultaneous EEG/MEG for testing the impact of tCS on brain activity in a global way.

Methods: We will try several methods for localizing the nodes of epileptic activity with both EEG and MEG: Minimum norm, MUSIC, ICA and Maximum entropy on the mean (MEM). Then network measures will be performed on the estimated time course at each node. The results will be validated with SEEG and compared. The best method will be used to test the impact of tCS in the multicentric clinical trial launched in Galvani.

Required skills: Electrophysiology, magnetoencephalography or electroencephalography, epilepsy, signal processing, programming in Matlab or Python. Good capacity to work in a team.

Position 4: Software engineer “Software development for network measures” (5y)

Planned recruitment: March 2020

Objectives: Provide to projects 1, 2 and 3 the software tools and pipelines. Re-use existing software when possible, or program new building blocks within the pipelines. Implement localization and network measures pipelines, on both SEEG and MEG/EEG. Test the robustness of non-invasive chain with respect to source leakage. Construct simulations for testing and benchmarking methods. Ensure that data can be stored in a common framework (BIDS) and implement pipelines so as to be run in an automated way.

Required skills: Signal processing (source localization, time frequency analysis, connectivity measures). Programming in Matlab or Python. Good capacity to work in a team.

Position 5: Study engineer “Stimulation recording and analysis” (5y)

Planned recruitment: March 2020

Objectives: Development of specific analysis tools for per/post stimulation. Record data in patients, store the data in the BIDS format thanks to already existing pipelines. Analyse the data and compute statistics for charactering the epileptic nodes in given patients and the impact of stimulation.

Required skills: Acquisition of electrophysiology. Working with patients. Signal processing. Programming in Matlab or Python would be a plus. Good capacity to work in a team.
Job offers at « Institut de Neurosciences des Systèmes », Marseille, France

NEURO-SENSE ANR Technology for Health

Context

NEURO-SENSE is an ANR “Technology for health” project (https://anr.fr/Project-ANR-18-CE19-0013).

The objective of the NEURO-SENSE project is to increase the diagnostic value and routine use of high frequency oscillations on intracerebral EEG as a reliable marker of the epileptogenic zones (EZ). Pathological high-frequency oscillations (HFOs) are short-duration (a few tens of ms), low-amplitude signals occurring in intracerebral electroencephalographic recordings (stereoelectroencephalography, SEEG) in a specific frequency band (250-600 Hz). They can be characterized using signal processing techniques based on time-frequency analysis (Roehri et al 2016, 2017, 2018).

In the NEURO-SENSE project, we will develop novel extracellular electrodes can be designed in order to optimize the recording and the detection of pathological HFOs in brain signals. The first specific aim is to develop new “hybrid” computational models integrating biophysical information regarding the electrode form factor and electrode-tissue interface. The second specific aim is to build and test novel small-scale (10-100 µm) field electrodes optimized for HFO recording in vivo. The third specific aim is to propose high-performance detection algorithms to specifically extract pathological HFOs from local field potentials. This job offer concerns the third aim.

Scientific Environment

NEURO-SENSE involves three partners: LTSI-Inserm (Rennes), , BEL (Gardannes) and Aix-Marseille University (Marseille). This consortium combines unique expertise in signal processing and modelling in epilepsy, and drafting electrodes of a new generation.

The position will be located within the DYNAMAP research team (dir Ch Bénar, https://ins-amu.fr/dynamap) of the Institut de Neurosciences des Systèmes (INS, INSERM AMU 1106, dir V Jirsa). DYNAMAP is a multidisciplinary team grouping engineers and clinicians, and is specialized in the analysis of electrophysiological signals (SEEG, MEG, EEG) and characterization of epileptic networks. The team is strongly linked to the Epileptology and Cerebral Rhythmology department (Head Pr F Bartolomei) of the Timone hospital in Marseille with a strong expertise in SEEG explorations. The hospital department houses a research team from

We are looking for a candidate (PhD or Postdoc) that can complement and extend the DYNAMAP team’s expertise in the NEURO-SENSE project.

Position: Post-doc/PhD “Characterize epileptic oscillations at several scales” (3y)

Planned recruitment: March 2020

Rationale: The methods for detecting high frequency oscillations have been developed for intracerebral stereotaxic EEG (SEEG) at a spatial scale which is intermediate between micro contacts and surface EEG. The detection of micro scales HFOs as planned in the NEURO-SENSE project requires an adaptation of the existing for these new conditions of noise and artefacts. Moreover, the characterization of the link between the scales (micro and classical SEEG) requires developing network methods that measure the connectivity between the spatial scales (potentially at different frequencies).
**Objectives:** Adapt the existing time-frequency methods (Roehri et al IEEE TBME 2016) to the micro recordings. Characterize the oscillations on the data to be acquired in NEURO-SENSE (micro recordings with new electrodes in animal models)

**Methods:** We will use existing micro recordings data and simulations (Roehri et al Plos one 2017) to develop the new time-frequency algorithms. New connectivity measures will be developed, potentially including co-occurrence of detections (Bourien et al 2005, Malinowska et al 2014).

**Required skills:** Electrophysiology, epilepsy, signal processing, programming in Matlab or Python. Good capacities to work in a team.

**Contact:**

*Christian Benar (christian.benar@univ-amu.fr)*
# MEG Engineer

**Position – 1 year renewable**

<table>
<thead>
<tr>
<th>Place</th>
<th>Institut de Neurosciences des Systèmes, Marseille</th>
</tr>
</thead>
<tbody>
<tr>
<td>Supervisor</td>
<td>Jean-Michel BADIER</td>
</tr>
<tr>
<td>Missions</td>
<td>The engineer will work within the MagnetoEncephaloGraphy (MEG) platform of the Institute of Systems Neurosciences (INS) (<a href="https://ins-amu.fr/">https://ins-amu.fr/</a>), directed by V Jirsa. This platform also includes a researcher and an engineer. The MEG platform is open to the entire scientific community and participates in the clinical activity of the Epileptology and Cerebral Rhythmology department (F Bartolomei), in conjunction with the brain mapping team (C Bénar). MEG allows the recording of cerebral magnetic activity with excellent temporal resolution and very good spatial resolution (<a href="http://meg.univ-amu.fr">http://meg.univ-amu.fr</a>). The missions include data acquisition, data processing and implementation of experiments, in collaboration with the medical team and with clinical/cognitive neuroscience research teams.</td>
</tr>
</tbody>
</table>
| Main activities | • Data acquisition  
• Maintenance (liquid helium filling)  
  o Data processing (research and clinical)  
  o Advising Researchers and setting up of experiments  
• Training  
• Construction and installation of processing pipelines  |
| Knowledge   | • Signal Processing  
• Instrumentation  
• Matlab and Python programming  
• English and French  |
| Know-How    | • Data acquisition in electrophysiology  
• Understand the needs of researchers in order to setup appropriate pipelines  |
| Skills      | • Teamwork  
• Ease of interaction with patients and participants  
• Organizational capacities  |
| Profile     | Engineering degree or Master's degree in bioinformatics, biomedical engineering, instrumentation, signal processing. |