Master de Sciences et Technologies
Mention Biologie Intégrative et Physiologie
Parcours : Neurosciences
Responsable : Professeur Régis Lambert

Internship Proposal
Academic Year 2019-2020

1. **Host team:**

Research Unit: **Department of Integrative and Computational Neuroscience (ICN), Neuro-PSI, CNRS Gif-sur-Yvette**
Research Unit Director: **Philippe Vernier**
Research Team Director: **Daniel Shulz**
Team name: **Sensorimotor processing and plasticity**

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Supervisor of the Research Intern for this project: **Isabelle Ferezou**
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2. Internship project title:

Fribroscopy for large scale imaging of cortical dynamics during active sensing in freely behaving mice.

3. Internship Description:

The team is specialized in integrative neuroscience, using the tactile somatosensory pathway from whiskers to cortex in rodents as model system. Our research is centered on the study of neuronal processes responsible for the coding of tactile sensory information and perception, as well as their regulation through the interaction of the animal with the environment. By means of electrophysiology and functional imaging in anesthetized rats and mice, we have shown that the primary somatosensory cortex can extract emergent properties of a complex multiwhisker tactile stimulation, such as the global direction of a multiwhisker stimulus generating an apparent motion across the whiskerpad (Jacob et al., 2008, Vilarchao et al., 2018).

However, because the acquisition and processing of tactile sensory information is an active process that requires close interactions between movement and sensation, it is essential to study such integration mechanisms in the awake animal. Nowadays, neurophysiologists generally address this type of questions by working with awake "head-fixed" mice, in other words with animals that have been accustomed to be held by the head (with implants fixed on the skull) under conventional optics. It is indeed possible, in this configuration, to train animals to perform simple behavioral tasks, while imaging large assemblies of neurons. These experiments, however, remain highly restrictive and limit the behavioral repertoire that can be studied.

On the contrary, we aim to work with freely moving animals in conditions allowing the development of operant conditioning tasks where the mice have to extract the properties of an object through the use of their whiskers. We are currently developing a method of fibroscopy allowing to study the cortical dynamics in freely moving mice at the mesoscopic scale (with a field of view covering the cortical representation of all the macrovibrissae within the primary somatosensory cortex). This is made possible by using voltage sensitive dye imaging, which offers excellent spatial and temporal resolution, through a fiber bundle interface, which provides sufficient flexibility and lightweight properties to disrupt minimally the behavior of the animal (Ferezou et al., 2006).

Using this experimental approach, the proposed project aims at characterizing the cortical spatiotemporal dynamics evoked in the primary somatosensory cortex while a mouse touches tactile patterns of different orientations with its whiskers upon running in the central alley of a maze.
It will contribute deciphering the cortical dynamics governing the extraction of global properties of an object from complex sequences of multivibrissal contacts.

Jacob V, Le Cam J, Ego-Stengel V, Shulz DE. Emergent properties of tactile scenes selectively activate barrel cortex neurons. Neuron. 2008 60(6):1112-25.
Vilarchao, M.E., Estebanez, L., Shulz, D.E., Férézou, I. Supra-barrel Distribution of Directional Tuning for Global Motion in the Mouse Somatosensory Cortex. 2018 Cell Rep. 22, 3534-3547.
Ferezou I, Bolea S, Petersen CC. Visualizing the cortical representation of whisker touch: voltage-sensitive dye imaging in freely moving mice. Neuron. 2006 50(4):617-29.