Laboratoire d'Optique et Biosciences

INSERM U1182 - CNRS UMR7645
ECOLE POLYTECHNIQUE
ROUTE DE SACLAY, 91128 PALAISEAU, FRANCE

Palaiseau, 27/09/2024

M2+PhD in quantitative imaging for developmental neurobiology

Profile: M2 in data science, AI/ML, quantitative biology or biophysics
Date: internship in spring/summer 2025 with follow-up 3yrs PhD funding
Localization: Ecole polytechnique, Palaiseau (30-45 min south of Paris) in close collaboration with the Institut de la Vision (IDV, Paris)
Web:https://lob.ip-paris.fr/recherche/advanced-microscopies-and-tissue-physiology
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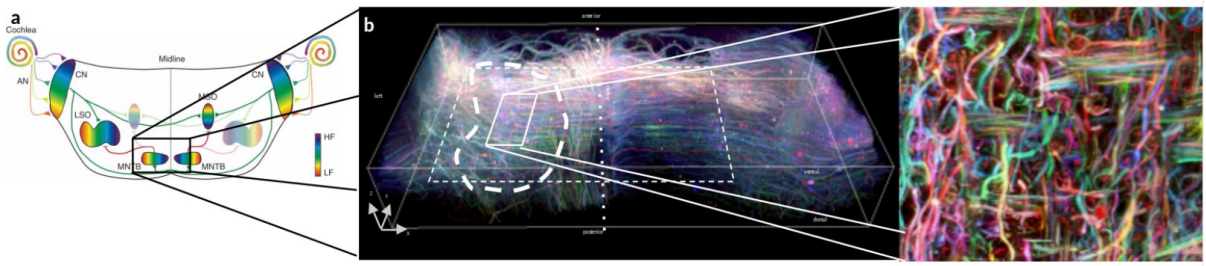

Fig. 1: ***a)*** *Auditory pathway in the mouse brain;* ***b)*** *Rendering of a 150Gb multi-photon microscopy volume showing incoming axons from the Cochlear Nucleus (CN) innervating the Median Nucleus of the Trapezoid Body (MNTB);* ***c)*** *zoom on one image plane*

Context

The development of the brain implies the correct proliferation, differentiation and migration of neuronal and glial cells of dozens of types. It also imply the correct wiring of the connectome, i.e. the establishment in the mouse of thousands of synapses across 10^8 neuron in a stochastic yet reliable and reproducible way. To study this process we are using the development of the Median Nucleus of the Trapezoid Body (MNTB) in mice, a nucleus of a few thousand cells that invert signal coming from the Cochlear Nucleus (CN) linked to the ear on one side toward the contra-lateral auditory nuclei (Fig. 1.a). Through innovative labeling, imaging and analysis of mouse brain on the one hand and modeling and simulations on the other we are studying quantitatively the development of that circuit aiming for a mechanistic, integrated understanding in health and diseases.

Project

We are seeking a motivated and independent student to work on the data analysis part of that program. Mouse brain with axons from the CN to the MNTB labeled with stochastic color with Brainbow [1] will be imaged using large scale ChroMS microscopy [2] (Fig. 1.b and c). Starting from the 100s of Gb to Tb volumes, we will trace hundreds of single axons (Fig 2.)

and analyze the resulting arbors and curves to extract quantitative characteristics of the MNTB across its development. Preliminary semi-automated tracing workflows and analysis pipeline have been setup that will need to be adapted and augmented [3,4]. Further work, most likely pursued during the PhD, include contributing to modeling the connection establishment process and linking intelligently data and models.
A ideal candidate would have experience in image analysis, very good coding skills in python and an open mind ready to be integrated into a very interdisciplinary collaboration. Knowledge and/or strong interest in biology is a must.

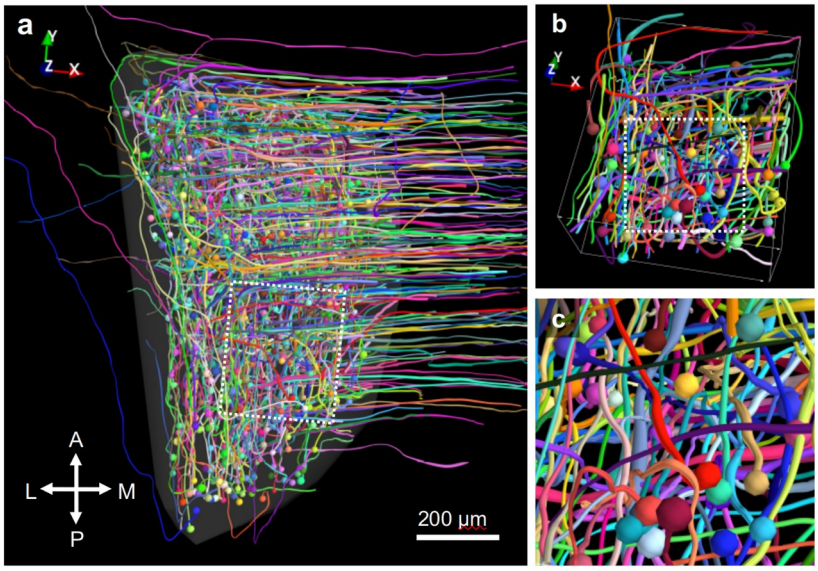

Fig 2: ***a)*** *more that a 1000 axons manually traced from their synapses at the MNTB for as long as possible.* ***b) and c)*** *successive zoom onto the traces.*

Environment
This position is to be part of a long running interdisciplinary collaboration between biologist, physicist and computational scientist, between Laboratoire Optique et Bioscience at Ecole polytechnique near Paris and Jean Livet's team at Institut de la Vision in Paris, and is funded from an ANR grant involving those two partners.

References
[1] K. Loulier et al., Neuron. 81, 505–520 (2014).
[2] L. Abdeladim et al., Nat Commun. 10, 1662 (2019).
[3] M. S. Phan, K. Matho, E. Beaurepaire, J. Livet, A. Chessel, PLOS Computational Biology. 18, e1010211 (2022).
[4] M.-S. Phan, A. Chessel, F1000Res. 9, 1374 (2021)