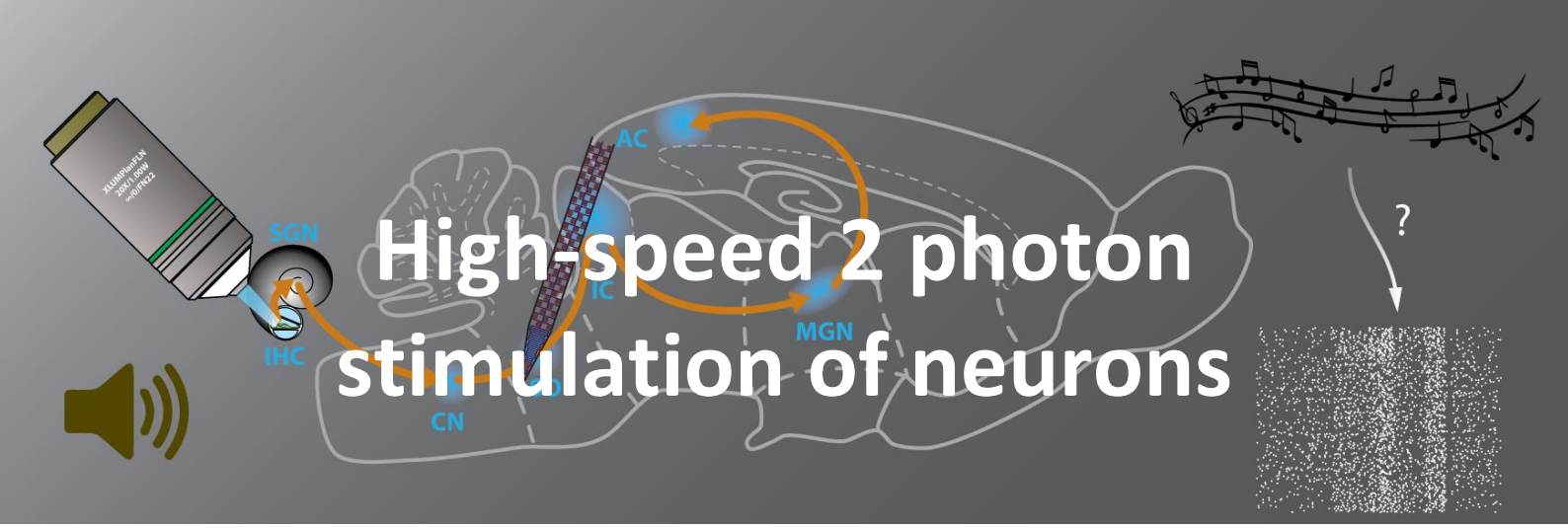

High-speed 2 photon stimulation of neurons

Lab's description

The lab develops methods to study auditory processing and specifically how information about sound frequency is propagated from the auditory periphery to the cortex. To understand how sound features are encoded in the brain we would need to vary specific parameters of the input and measure how it affects neuronal firing in the brain. Recent progress in optogenetics have allowed to activate neuronal circuits precisely. In the lab, we use these tools to control signals sent by the cochlea by activating optogenetically cochlear hair cells *in vivo*. Optical methods allow to focalize the beam of a laser onto several cellular targets and rapidly update the temporal pattern of stimulation. This approach necessitates to build a custom 2 photon microscope that can target simultaneously (but independently) several regions of interest at the cellular level and at high speed. The design of the setup is based on holographic light patterning coupled to a digital micromirror device to maximize temporal resolution.

Project summary

The student will finalize the construction of the microscope and realize the first characterization of the setup using cultures of neurons expressing a light-activated channel. Specifically, we will determine the spatial and temporal resolution of the optical stimulation by combining intracellular recordings of single neuron and optogenetic activation at the sub-cellular level. The student will learn techniques from optics, microscopy, holography, electrophysiology (patch-clamp), cell culture, and data analysis.

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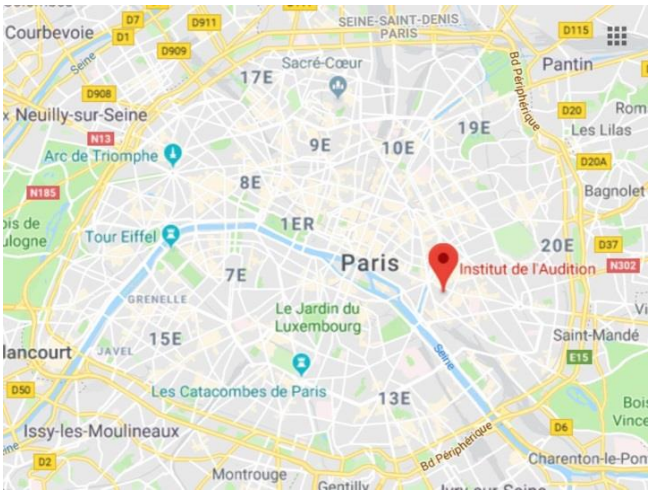

General publications about the research subject

Yizhar, O., et al., Optogenetics in neural systems. **Neuron**, 2011. 71(1): p. 9-34.

Ronzitti, E., et al., Recent advances in patterned photostimulation for optogenetics. **Journal of Optics**, 2017. 19(11).

Selected publications from the supervisor:

Barral J, Wang XJ, and Reyes AD (2019). Propagation of temporal and rate signals in cultured multilayer networks. **Nature Communications** 10(1):3969

Barral J, Jülicher F, and Martin P (2018). Friction from transduction channels' gating affects spontaneous hair-bundle oscillations. **Biophysical Journal** 114(2) : 425-436

Barral J and Reyes AD (2017) Optogenetic stimulation and recording of primary cultured neurons with spatiotemporal control. **Bio-Protocol** 7(12): e2335

Barral J and Reyes AD (2016). Synaptic scaling rule preserves excitatory/inhibitory balance and salient neuronal network dynamics. **Nature Neuroscience** 19 :1690-1696

Barral J and Martin P (2012). Phantom tones and suppressive masking by active nonlinear oscillation of the hair-cell bundle. **P.N.A.S.** 109 : E1344-51

Barral J, Dierkes K, Lindner B, Jülicher J, and Martin P (2010). Coupling a sensory hair-cell bundle to cyber clones enhances nonlinear amplification. **P.N.A.S.** 107 : 8079-8084