# Master 2 Internship

## «Decoding cortical activity evoked by artificial retinal implants»

**Project:** Recent advances in neuroscience and microelectronics opens up the possibility of partially restoring vision to blind patients using retinal prostheses. This domain of research is however at an early stage compared to cochlear implants. Especially, the way an electric stimulation activates the visual cortex is still poorly understood. The group of F. Chavane (NeOpTo team at INT Marseille) has used mesoscopic recordings of cortical activity (optical imaging) to better understand the activity evoked by stimulation of the retina with implanted multi electrodes arrays (Roux et al 2016 eLife). Their results show that local stimulation of the retina evoked a cortical activity that is up to 10 times larger than what is expected based on the activity evoked by visual stimuli. This result is in line with known poor resolutions of percepts evoked by stimulation of artificial retinas implanted in blind patients. This observed spread of evoked cortical activity is presumably due to 4 effects: (i) an electric diffusion at the interface made by the complex electrode-retinal tissue (modeled by CEA); (ii) a spread of electric activity induced by the direct activation of retinal cells axons away from their somata; (iii) an electric diffusion in the visual cortex; (iv) the optical diffusion of the signal registered by optical imaging. Among these 4 effects (i), (iii), (iv) can be described by standard diffusion equations whereas (ii) is asymmetrical and should include a spread of activity induced within the retina's network. In Roux et al (2017) we started to account for those different factor in a preliminary form. More work is needed to disentangle these effects and their respective intensities from recorded data.

The goal of the internship is to analyse the data already obtained at NeOpTo team in order to quantify these effects and especially to analyse the role played by the retina's network in the spread of activity. The first step of the internship will to construct a model of the diffusion induced by (i), (iii), (iv) and to compare the expected results with experiments. If the discrepancy is important this means that (ii) plays a central role. A next step will then be to propose a neuronal network model characterizing the effect (ii).

The internship will be done in collaboration between F. Chavane (INT, CNRS, Marseille) and Bruno Cessac (Biovision, INRIA, Sophia-Antipolis). The duration is 6 months. Most part of this period will be spent at INT, but several stays at INRIA are scheduled.

**Profile**. The project is interdisciplinary so the candidate is expected to have a strong background in programming and skills in mathematics or physics. He/she must also have a great interest in the field of visual neuroscience, both for fundamental aspects of visual processing and clinical research.

**Contacts:**
**NeOpTo** frederic.chavane@univ-amu.fr
http://www.int.univ-amu.fr/spip.php?page=equipe&equipe=inVibe
**INRIA** bruno.cessac@inria.fr
Web page http://www-sop.inria.fr/members/Bruno.Cessac/

**Teams**
The team NeOpTo (Neuronal Operations in Topographic maps) at the Institut des Neurosciences de la Timone (INT-CNRS) aims at elucidating the neural computations that underlies active vision. Vision is a major sensory input for guiding our actions, perceiving our environment and conducting

cognitive
tasks. Yet the visual inputs that reach the brain represent a computational challenge: they are ambiguous, dynamical, segmented into a myriad of piecewise cues and constantly influenced by eye movements. To overcome this problem, our visual system must link sensory inputs with a priori knowledge at multiple spatial and temporal scales. To investigate how the visual system achieve such challenge, the NeOpTo team combines multiple expertises involving behavioral studies in both humans and monkeys, ophthalmologic clinical approaches, electrophysiological and real-time optical imaging studies in behaving monkeys and Bayesian modeling approaches.

The goal of the Biovision team is to investigate new solutions to help vision impaired people. Visual impairment affects some 285 million people in the world, mostly in developed countries: 85% have low vision, i.e., have remaining sight, and 15% are totally blind. It is predicted that the prevalence of visual disabilities will increase markedly during the next 20 years, owing largely to the aging. In this context, Biovision aims at developing fundamental research as well as technological transfer along two axes (i) development of high tech vision aid systems for low vision patients (ii) precise modeling of the visual system for normal and distrophic conditions, targeting applications for low vision and blind patients. These axes are developed in strong synergy, involving a large network of national and international collaborators with neuroscientists, physicians, and modellers.