Research Opportunity at Institut Fresnel and UNIS
Internship in Biomedical Optics for Neurosciences: Optical modelling tools to determine input properties in acute brain slices

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Applications are invited for an **internship** in **Biomedical Optics for Neurosciences** at the *Institut Fresnel (CNRS/AMU) and UNIS (Unité de Neurobiologie des canaux Ioniques et de la Synapse, INSERM/AMU)*, Aix-Marseille University, France.

➔ Background: In human, the majority of brain neurons are found in the cerebellum where they are strikingly organized with geometric features. This geometry, conserved in all vertebrates, optimizes the input integration and presumably the information storage capacity, which relies on synaptic plasticity (Dean et al., 2010). The abundant granule cell to Purkinje cell synapse is where plasticity is expected to occur. The investigation of plasticity mechanisms at this synapse has largely benefited from in vitro electrophysiological and imaging studies, notably from acute brain slices from rodent, a preparation of choice where local circuit properties are preserved and experimental conditions tightly controlled (Bouvier et al., 2016). In acute slices, synaptic transmission is evoked by the direct stimulation of neuronal inputs, a non-physiological pattern whose impact plasticity mechanisms has been underappreciated. The finding that synaptic plasticity mechanisms are critically dependent on the spatial pattern of inputs (Marcaggi and Attwell, 2005, 2007) has questioned conclusions from most studies which did not provide any data on input properties. An accurate description of the activated input is a prerequisite to future synaptic plasticity investigations in acute slices. The geometrical cerebellar organization enables convenient mapping, by fluorescence imaging, of granule cell inputs in acute sagittal slices (Bergerot et al., 2013). In order to convert this mapping into the exact input distribution and density, a realistic description of the fluorescent signal produced by a typical single input, i.e. a truncated axon perpendicular to the slice plane, is required. This will enable to deconvolve fluorescent signals arising from stimulation protocols commonly used in slices and to obtain an accurate reading of input properties, which will be valuable to future investigations of synaptic plasticity mechanisms.

➔ Research program: The internship (and the subsequent PhD study program) can contain two aspects that can be implemented separately according to the skills of the candidate:

- Experimentally, a collection of data will be obtained from the fluorescence imaging system at UNIS.
- Theoretically, forward model simulations will be implemented at the Institut Fresnel and validated with experiments. A forward solver simulating propagation of light through turbid media (brain tissues) with realistic geometry has been developed in our group. The solver is based on Monte Carlo (MC) simulations, which is the most general method to solve this type of problems.

➔ Qualifications: The project is highly multidisciplinary. Applicants must be in the last semester of a master-granting program in Bioengineering, Physics, or other related areas of science and engineering. Applicants are expected to have a strong interest in working in a multi-disciplinary environment.

References:

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Dean, P., Porrill, J., Ekerot, C.F., and Jorntell, H. (2010). The cerebellar microcircuit as an adaptive filter: experimental and computational evidence. Nat Rev Neurosci 11, 30-43.

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