INT Symposium on “Advanced Photonic Imaging in Neuroscience”

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Walther Akemann is currently a postdoctoral researcher in the group of Laurent Bourdieu at the Biology Department of École Normale Supérieur in Paris. He received his PhD from Heinrich-Heine University of Duesseldorf (Germany), performed postdoctoral studies at the Helmholtz Research Center in Juelich (Germany), at the CEA Research Center in Saclay (France) and at the University of Paris-Sud (Paris XI), before becoming a staff scientist at the RIKEN Brain Science Center in Wako-City (Japan). Walther’s interests include molecular probing, cellular electrophysiology and behavior-associated computations in neural circuits. Since 2013, Walther is working with Laurent Bourdieu, Jean-Francois Léger, Vincent Villette and Stéphane Dieudonné to develop optical methods for fast functional brain imaging in mice.

S1-L4 ‘*Fast optical acquisition of neuronal activity in 3D microcircuits of mouse cortex.*’

Optical probing of brain circuits is hampered by the rapidity of electrical signaling between neurons and by the scale of intra-cellular connectivity as found in the mammalian brain. While genetically-encoded fluorescence indicators of calcium concentration (GECIs) or membrane voltage (GEVIs) are able to report electrical cellular potentials of neurons, in particular action potentials, the questions remains how to efficiently read these signals from large numbers of cells in-vivo at sufficient time resolution and with sufficient localization of the cellular sources within the 3D structure of the gray matter. With this challenge in mind, we recently developed a new type of 2-photon microscope permitting acousto-optic modulation of the excitation beam at 40 kHz along two perpendicular directions. The microscope is capable of addressing at random positions in 3D space by adding phase tilt and defocus to individual laser pulses. In addition, individual pulses are holographically patterned into grid-like arrays of multiple focal spots toggling, shot-to-shot, between a grid targeting a cell body and a grid targeting its surrounding neuropil. I will explain the optical principals of the new design and how the design impacts the speed and signal-to-noise of the acquisition. As an application, I will show data from GCaMP6f simultaneous recordings from neurons in layer 2/3 and 5A of primary visual cortex in response to moving contrast-gratings while the mice were free to move on a treadmill under head-fixation.