Recent development in advanced, high power femtosecond lasers for multi-photon functional brain imaging

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Well over 50% of all installed multiphoton microscopes are used for some form of brain imaging. The wide adoption first of genetically encoded imaging probes, followed by the incredibly rapid development of genetically encoded functional probes (calcium and voltage indicators, opsins) are transforming brain studies from simple observation to stimulation and tracking of neurotransmission both at microscopic and behavioral level.

Unique among optical imaging techniques, multiphoton microscopy has enabled brain imaging at single neuron level in model animals to depths exceeding 1 mm [1] and functional studies on populations of tens of neurons [2].

The quest for imaging how individual neurons respond to stimulations and interacts among them is driving the development of new laser sources and non-conventional multi-photon probing formats. In this presentation we will describe a number of femtosecond laser sources providing high power, high energy and tunability across a wavelength domain of 700-1,600 nm that enable simultaneous imaging, optogenetic photoactivation and signaling studies in live model animals.

[1] N. G. Horton, K. Wang, D. Kobat, C. G. Clark, F. W. Wise, C. B. Schaffer and C. Xu, "In vivo three-photon microscopy of subcortical structures within an intact mouse brain", *Nature Photonics*, 7, 205–209 (2013)

[2] A. M. Packer, L. E. Russell, H. W. P. Dalgleish and M. Häusser, "Simultaneous all-optical manipulation and recording of neural circuit activity with cellular resolution in vivo", *Nature Methods*, 12, 140–146 (2015)