Advances in ultrafast laser technology for faster and deeper imaging and manipulation in biological imaging

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Infrared ultrafast laser technology has played a big role in advancing live imaging in the biological sciences by providing single cell resolution deep into living tissues. Ultrafast laser sources have enabled techniques such as two-photon excited fluorescence, three-photon excited fluorescence, second/third harmonic generation, and Raman imaging. These laser sources are used in advanced microscopes for optogenetic stimulation, calcium and voltage readout, and structural imaging deep inside of live tissue. This allows real time visualization and control of activation and interactions at a cellular level. We present the latest advances in ultrafast laser sources and their architectures for various biological imaging modalities and present relevant examples and images illustrating their impact in biological science. In particular, we will discuss the use of ultrafast lasers for multimodal, optogenetic, and three-photon in vivo imaging in neuroscience.