Femtosecond source widely tunable from 1.3 to 1.7 μm for three-photon microscopy

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KEY WORDS: fiber laser, femtosecond laser sources, nonlinear light microscopy

Three-photon microscopy is becoming an enabling tool in biomedical research because of the optical sectioning capability and larger penetration depth for deep tissue imaging at two water penetration windows (~1.3 and ~1.7 μm) [1, 2]. To date, ultrafast sources that can cover this wavelength range with >1-nJ pulse energy remain challenging to implement. In this submission, we demonstrate a high power femtosecond laser source by properly spectral filtering of the leftmost/rightmost spectral lobes of an optical spectrum broadened by fiber-optic self-phase modulation [3]. Based on a home-built 5-W Er-fiber laser with 31-MHz repetition rate, we obtained femtosecond (97-182 fs) pulses continuously tunable from 1.3 to 1.7 μm with >4-nJ pulse energy. We are further energy scaling the laser source and applying it to three-photon microscopy.

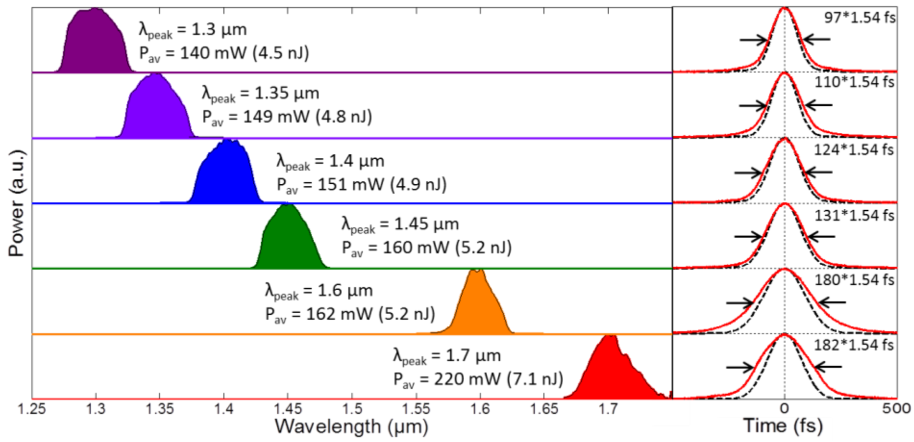

Fig. 1. Er-fiber laser based, widely tunable femtosecond source. Left column: typical optical spectra labeled with peak wavelength, average power, and pulse energy. Right column: corresponding autocorrelation traces showing that the resulting pulses are 100-200 fs in duration.

References

[1] N. G. Horton *et al*., "*In vivo* three-photon microscopy of subcortical structures within an intact mouse brain," *Nat. Photonics* 7, 205-209 (2013).
[2] K. Wang *et al*., "Advanced fiber soliton sources for nonlinear deep tissue imaging in biophotonics," *IEEE J. Sel. Topics in Quantum Elec.* **20**(2), 6800311 (2014).
[3] W. Liu *et al*., "Self-phase modulation enabled, wavelength-tunable ultrafast fiber laser sources: an energy scalable approach," *Opt. Express* **24**(14), 15328-15340 (2016).