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

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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) \cite{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 \cite{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

\cite{1} N. G. Horton \textit{et al.}, “\textit{In vivo} three-photon microscopy of subcortical structures within an intact mouse brain,” \textit{Nat. Photonics} 7, 205-209 (2013).