

Handheld nonlinear microscope system comprising a 2 MHz repetition rate, mode-locked Yb-fiber laser for *in vivo* biomedical imaging

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Abstract: A novel, Yb-fiber laser based, handheld 2PEF/SHG microscope imaging system is introduced. It is suitable for *in vivo* imaging of murine skin at an average power level as low as 5 mW at 200 kHz sampling rate. Amplified and compressed laser pulses having a spectral bandwidth of 8 to 12 nm at around 1030 nm excite the biological samples at a ~1.89 MHz repetition rate, which explains how the high quality two-photon excitation fluorescence (2PEF) and second harmonic generation (SHG) images are obtained at the average power level of a laser pointer. The scanning, imaging and detection head, which comprises a conventional microscope objective for beam focusing, has a physical length of ~180 mm owing to the custom designed imaging telescope system between the laser scanner mirrors and the entrance aperture of the microscope objective. Operation of the all-fiber, all-normal dispersion Yb-fiber ring laser oscillator is electronically controlled by a two-channel polarization controller for Q-switching free mode-locked operation. The whole nonlinear microscope imaging system has the main advantages of the low price of the fs laser applied, fiber optics flexibility, a relatively small, light-weight scanning and detection head, and a very low risk of thermal or photochemical damage of the skin samples.

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OCIS codes: (140.7090) Ultrafast lasers; (170.1870) Dermatology; (180.4315) Nonlinear microscopy.

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