PORTABLE NONLINEAR ENDOSCOPE DRIVEN BY AN OPTIMIZED COMPACT FEMTOSECOND FIBER-BASED LASER SOURCE AT 930NM

Sven Dobner[1], Carsten Cleff[1], Victor Tsvirkun[2], Vasyl Mytskaniuk[2], Hervé Rigneault[2], Michael Mei[1] and Ronald Holzwarth[1]
[1]Menlo Systems GmbH, Am Klopferspitz 19a, 82152 Martinsried, Germany
[2]Aix Marseille Univ, CNRS, Centrale Marseille, Institut Fresnel, Marseille, France
Email: s.dobner@menlosystems.com

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In the past decades, femtosecond Ti:Sa-based laser systems were the dominating light source for multiphoton imaging applications, but are known for their complexity and demands in lab space and infrastructure. Recent advancements in fiber-based laser technology remedy these disadvantages, offering a compact, low-cost, robust and maintenance-free alternative, as called for by the widespread use of nonlinear microscopy. These advantages are particularly beneficial for new imaging applications, like portable nonlinear endoscopy systems [1], capable of imaging neuronal activity in live animals in an unprecedented flexible way. Fiber-based laser systems moreover present new opportunities to improve signal generation efficiency in multiphoton imaging, as e.g. the pulse repetition frequency can be flexibly chosen over a large range. Often the thermal damage threshold of a sample inhibits to increase the incident average power to increase signal generation. However, reducing the repetition frequency allows increasing the peak power and thus the generated nonlinear signal, while keeping the thermal load on the sample constant.

We present a nonlinear endoscope, equipped with a compact femtosecond fiber-based laser with a central wavelength of 930nm, for optimal two-photon fluorescence excitation of GFP and generating microscopy images with various contrast mechanisms (see Figure 1). We demonstrate the impact of different repetition frequencies on the signal generation efficiency. Quantitative comparisons reveal a superior performance at a reduced repetition frequency of 50MHz, compared to traditional Ti:Sa-based systems at 80MHz. Additionally, prospects are discussed, including the extension of the endoscope with a dual-color laser of other common excitation wavelengths, such as 780nm and 1040nm, which are available from compact fiber-based sources as well.

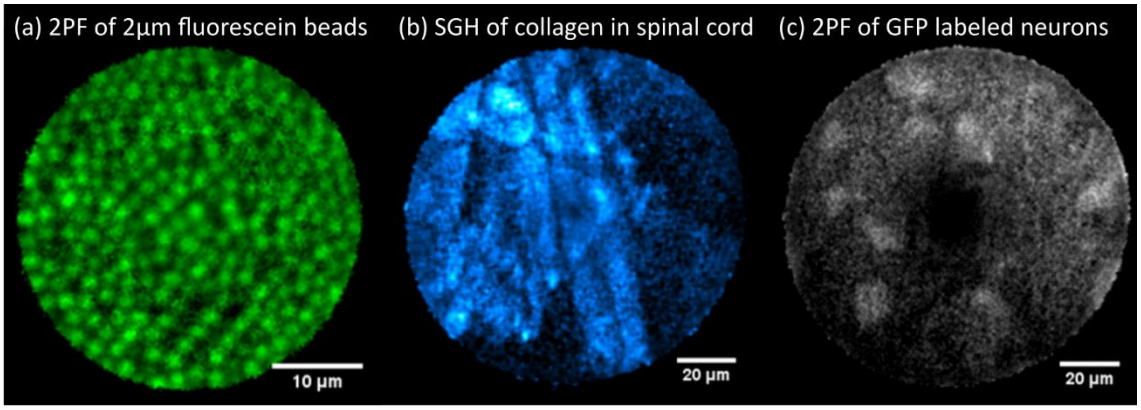

Figure 1: Nonlinear images taken with the endoscope, using our 930nm fiber-based laser.

References:

[1] A. Lombardini et al., "High-resolution multimodal flexible coherent Raman endoscope", *Light: Science & Applications*, **7**:10 (2018).