# Stimulated Raman scattering microscopy using boxcar detection

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Label-free optical microscopy plays an important role in biological research. Coherent Raman microscopy combines three-dimensional resolution and fast image acquisition with molecular selectivity based on the vibrational spectrum of the sample. During the last years, stimulated Raman scattering (SRS) microscopy has gained importance since it does not display an electronic nonresonant background signal which facilitates quantitative data analysis. The signal in SRS microscopy is commonly detected using lock-in amplification. To this end, high frequency modulation of one of the excitation beams from an Er:fiber laser is used and the signal is monitored as the stimulated Raman loss (SRL) of the pump beam or the stimulated Raman gain of the Stokes beam. In our implementation, we employed Nyquist frequency modulation of the Stokes beam and detected the SRL signal using boxcar averaging instead of lock-in amplification. We will discuss the differences between both approaches and demonstrate that improvements in the acquisition speed of approximately 3.5 times can be obtained when using boxcar averaging instead of conventional lock-in detection [1].

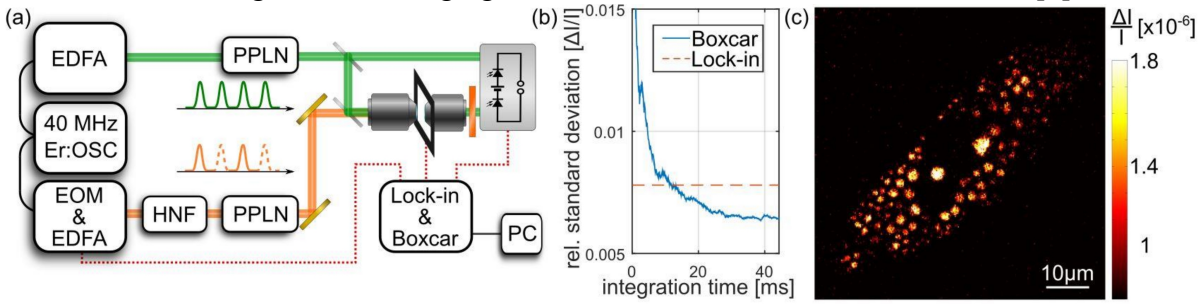


Fig. 1 (a) Schematic layout of the experimental system with the Stokes arm modulated at Nyquist-frequency of the oscillator. Er:OSC, Er:fiber oscillator; EOM, electro-optic modulator; EDFA, Er:doped fiber amplifier; PPLN, periodically poled lithium niobate. (b) Sensitivity level for boxcar signal recovery as a function of integration time compared to the sensitivity reached with lock-in detection after the full temporal window. (c) Boxcar detected SRS image of fixed human adipocytes at 2823 $cm^{-1}$.

## Reference

[1] P. Fimpel, C. Riek, L. Ebner, A. Leitenstorfer, D. Brida, A. Zumbusch "Boxcar detection for high-frequency modulation in stimulated Raman scattering microscopy", Appl. Phys. Lett., 112 (2018) 161101