Project 3.1. High-speed multicolor Stimulated Raman Scattering microscopy based on widely-tunable all-fiber laser source.

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Background:
High resolution optical imaging has enabled exciting applications in biology and medicine, allowing to explore the structure and dynamics of cells and tissues, hence to diagnose numerous diseases. Raman microscopy techniques offer new opportunities for bio-imaging, including non-invasive and label-free character, rapid measurement, no need for sample preparation, high spatial resolution, and high chemical selectivity. Stimulated Raman Scattering (SRS) is an emerging technique allowing for much stronger signal and thus higher imaging speed over spontaneous Raman scattering. SRS has also improved image contrast and spectral fidelity compared to coherent anti-Stokes Raman scattering. It requires, at least, two, temporally and spatially overlapped, high power beams with properly set difference of central frequencies to drive a molecular motion of the sample in a coherent way. Until quite recently, achieving these conditions has typically required free-space optics and solid-state, water-cooled lasers that are bulky, costly and environmentally sensitive, thus not suitable for use in a clinical environment. The latest advances in fiber laser technology has recently allowed to develop novel fiber-based tunable, and environmentally insensitive, ultrafast dual-wavelength sources for SRS microscope [1, 2]. The topic is currently under strong research interest motivated by the need to provide a low-cost and compact SRS based device well-adapted for clinical implementation.

Aim:
To develop a new compact laser source for SRS microscopy for application to leukemic diagnosis. The SRS source will be based on the all-fiber ultrafast Ytterbium mode-locked oscillator realized in polarization-maintaining fibers. The objective is to achieve a high-speed tunability of the Stokes wavelength and thus high-speed multicolor imaging, as well as to extend the range of Raman shift below a typical 2800-3200cm-1 values down to 1000cm-1. The system will be further used for measuring biological samples with SRS microscopy. The work will include experiments and numerical modelling.

Requirements:
- Master's degree in Physics or related field
- knowledge in the field of optics, nonlinear optics, fiber optics, laser, Raman spectroscopy, or related
- scientific curiosity
- strong motivation for research work, in particular for experimental work (experience in laboratory work will be appreciated)
- ability to work independently and in a team
- strong communication skills
- fluent English