Application of High Energy Fiber Lasers for High Throughput Multiphoton Microscopy

Multi-photon excitation microscopy (MPEM) is a powerful tool to analyze biological systems. In comparison to standard microscopy, MPEM has a few advantages. One of the most interesting and compelling distinction of MPEM is better depth discrimination. This is due fundamental properties of nonlinear light-matter interaction. Standard approach for MPEM is to use confocal configuration and fast scanning of the laser beam. This approach works well for fixed *in vitro* samples, but is not optimal for *in vivo* imaging due to the very high peak intensity of the light and the resulting photo-degradation of the sample.
An alternative approach - wide field MPEM – was recently demonstrated at EPFL. In comparison to confocal MPEM this method allows much faster image acquisition with lower peak intensities and therefore has great potential for *in vivo* imaging with much lower sample degradation.

Available laser sources with required parameters is one of main factors limiting practical applications of wide field MPEM. For efficient and flexible multiphoton imaging ultrashort (~100fs) laser pulses with widely tuneable spectrum (700-1800nm) are required. High repetition rate (~100MHz) optical parametrical oscillators (OPOs) pumped by solid state or fiber laser oscillators are well suited for confocal MPEM. These sources have reached maturity and are quite practical. At lower repetition rates (<1MHz) optical parametrical amplifiers (OPAs) typically pumped by femtosecond solid state regenerative amplifiers are mainly used. These systems are very complex, expensive, require maintenance and infrastructure.

The Project The goal of this PhD project would be to develop a practical tuneable ultrafast laser source at low repetition rate optimized for wide field MPEM and to integrate this laser source into working microscope. The scope of the project would consist of two parts. Firstly, the candidate will take part in efforts at Ltd Ekspla to develop femtosecond fiber laser pumped OPA which would be specifically tailored for wide field MPEM and could be conveniently integrated into a compact and practical imaging system. Candidate will design and assemble different fiber laser and OPA configurations, optimizing both output parameters as well as stability of the system. Secondly, the candidate will take part in further development of wide field MPEM at EPFL. The main efforts will be directed towards integration of the laser source and optical system into single mechanical platform optimization of the optical system to allow *in vivo* imaging, as well as experiments with different type of detectors (EMCCD, CMOS) for further optimization. Work of the project will be carried out primarily at Ekspla (70% of all time).

Ekspla is a company suited in Vilnius, Lithuania. It has 30 years of experience developing cutting edge pulsed laser systems. Fiber laser R&D group at Ekspla consists of 8 young researchers taking on different aspects of developing ultrafast laser systems. Experiments at EPFL are also part of the project. The successful candidate will be enrolled at the doctoral school in photonics of EPFL and employed at Ltd Ekspla for the duration of the project. The salary will be in accordance with Marie Skłodowska-Curie financing rules.

The candidate should have a Master degree or equivalent in a field related to optics. Experimental work with lasers as well as background in opto-mechanical system design is considered an advantage.

The Application Procedure Applications should include a motivation letter, detailed CV, transcripts of diplomas as well as three letters of reference. In conjunction to the application the candidate should apply to one of the doctoral schools: photonics, materials science, or bioengineering (http://phd.epfl.ch/page-19793-en.html).

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