Although, lasers are here for almost 50 years, their development happily continues. Some special attention can be attracted by lasers which are the sources of ultrashort pulses (some 10^{-13}-10^{-14} of a second). These extremely short pulses allow observation of ultrafast processes such as these in chemical reactions, as well as precise microfabrication of elements such as solar cells. They also find their use in medicine.

A proper fashionable pulsed laser should be stable, produce high energetic pulses with high repeatability and high frequency. Additionally the possible price reduction is always an advantage. Fiber lasers bring a hope for fulfillment of all these requirements.

In fiber lasers the light is effectively separated from the outside world – it propagates inside the fiber core. The fiber can be heated, cooled, shaken and even to some extent bended, all without much influence on the laser pulse inside. The situation is completely different in traditional lasers, where the light propagates in air and reflects from mechanically controlled mirrors. From the point of view of resistance to environmental conditions these lasers will not stand a chance in comparison to fiber lasers.

Today's fiber lasers have however problem with the energy. Pulses with energies of only a few nanojoules plugged into tiny core of a fiber can efficiently force glass molecules into vibrations (Raman scattering). As a result the pulse gradually change its color from infrared (~ 1,03 um in case of Ytterbium laser) to even more infrared (~ 1,07 um). The worst thing, however, is the fact that before the pulse leaves the perturbed area of vibrating molecules it is perturbed by itself. The pulse is no longer stable.

This is a clear disappointment – what advantage of environmental stability is there if the laser pulses themselves are destabilized by vibrations? The problem definitely requires a good solution. The first option is to reduce the pulse energy. This works perfect, but we've already been there before. The next step is connected with the present project.

The efficiency of the Raman process, efficiency of vibration enforcement depends on intensity of light. That is on combination of pulse duration, energy and the area it has to squeeze through – the fiber core area. The bigger the area the smaller the vibrations influence. And this is the answer to the problem – use fibers with larger area. Sound as simple, however, nobody tried that before. Why? First, the fiber core sizes are small for a reason, unless one uses specially designed large core fibers, the laser pulse will split into a few pulses travelling at different velocities (fiber modes) in a fiber with the large core. Therefore, it is essential to use these specially designed fibers. Second the fiber laser construction is quite complicated and it is favorable to use computer simulations to establish the right lengths of fibers and parameters of the fiber combiners and filters which are also present in the laser cavity.

This will not be our first fiber laser – we have some good experience in this topic. We know how to measure various parameters of ultrashort pulses and how to model fiber constructions. We, therefore, expect to break some energy records and to understand the fiber laser physics even better.