Self-trapped solitonic switching of ultrafast pulses in dual-core high index contrast optical fibers

Nowadays optical fibers constitute a useful tool for high speed data transfer, which approaches already the Tb/s rates. It allows not only a faster and broader band data transmission than the copper cable, but it is also durable and low loss, enabling even intercontinental connections. Therefore, optical fibers represent the “backbone” of the net, which surrounds already the whole world. However, the high-speed potential of the optical signal can improve even our everyday internet experience if the electrical based switching, routing, buffering devices would be exchanged for optical ones. For example, the maximum download speed of a copper based ADSL link is currently 20 Mbit/s, while an optical fiber connection (FFTH) can support already 300 Mbit/s.

The novelty of this project is a fiber based approach, which can ensure the switching of an optical signal at 1000 times higher rates than the mentioned FFTH standard. The general principle of a switch is to redirect the input signal between two or more output ports by a control signal. The simplest form to realize it in the optical domain is an optical fiber containing two parallel cores with signal transfer capability between them. As shown in Fig. 1, propagation of the optical pulses through such device can be controlled by the input energy.

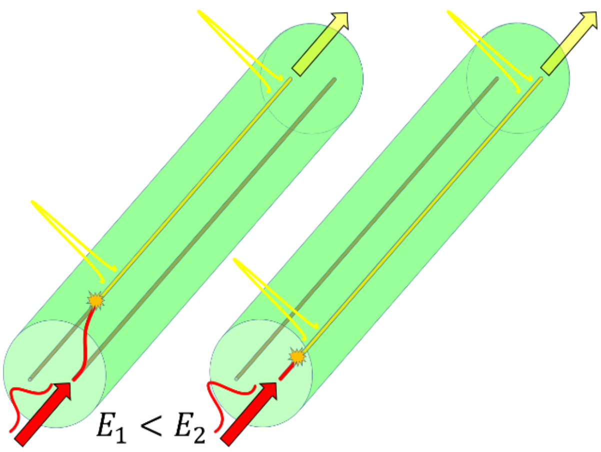

Figure 1. The concept of self-trapped solitonic switching: low energy pulses are directed to the non-excited core and they propagate further way.

Following this concept, we have engineered a dual-core fiber from special glasses, in which, according to our calculations, the low energy pulses switch to the left core, while the higher energy ones remain in the right one. This is possible by taking advantage from the self-trapping mechanism.

Due to the extremely short pulse at the level of 10^{-13} s and due to the “strange” channel inside the fiber the signal is “stacked” inside one of the core and it cannot move to the other one anymore. Due to this special trapping of the pulse, called *solitonic*, it can propagate further nearly without changing its shape through the whole fiber length. Moreover, the calculations show this possibility already at few centimeter fiber length and at very low pulse energy level. This pulse energy level is compatible with the optical signals, which are used in the recent long distance optical data transfers.

In the frame of this project, we would like to show, that this concept is practically realizable. We plan to manufacture the proper fiber and then use it in an ultrafast laser based experiment to demonstrate the switching effect, which can be used for extremely high speed data transformation.

Beside the unique dual-core fiber, we promise the utilization of a unique measurement technique, which is able to display the shape of the extremely short pulses. If the pulse shape will be preserved during the switching process, it will confirm that our proposed system has potential to be practically implemented in usable high speed all-optical data processing devices.