Journey from organs to cells: In *vivo* imaging by Spatio-Temporal Optical Coherence techniques

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One of the most appealing and still unsolved problems in biological and medical imaging is the possibility of non-invasive visualization of tissue in vivo with an accuracy of microscopic examination. It is especially emphasized nowadays in era of novel microscopic techniques, which have ability for optical depth sectioning without need of processing samples.

The main physical limitation of the in vivo microscopic imaging is associated with light scattering introduced by irregular and often discontinuous distribution of refractive index. Scattering of light limits the number of ballistic photons delivered to and received from the sample. As a consequence, the contrast of reconstructed images is compromised dramatically by increased noise. Another side effects of uneven distribution of the refractive index are significant deformations of images. Additionally, in case of coherent illumination with laser light there is a disturbing presence of so-called speckles – strong fluctuations of intensity caused by interference of mixed transverse modes of the laser beam. Speckle noise also degrades system resolution and reduces image quality. Adding all of these effects results in severe loss of imaging information.

In our work we try to solve these fundamental physical limitations by developing new optical coherence imaging techniques, which utilize spatio-temporally partially coherent light with access to intensity and phase of detected radiation. In our research activity we focus on developing new optical methods that enable to image biological objects in vivo and in minimally invasive way. We went long way covering significant spectrum of various sizes of objects – from organ-size scale up to internal structure of a single cell.