Popular science summary of the project

According to the last global survey completed in 2010 by the World Health Organization, 246 million people, i.e. over 4% of the global population, were visually impaired, i.e. had visual acuity (VA) between 6/18 and 6/120 (metric Snellen chart). 39 million people were blind, i.e. had VA from 6/120 down to no light perception, of which 82% were older than 50 years of age. In the European region, 26 million people were visually impaired and 2.7 million were blind. In the developing and developed countries, the main causes of blindness are glaucoma (global prevalence 8%), age related macular degeneration (AMD, 5%) and diabetic retinopathy (1%). All three are listed as priority diseases in the "Prevention of Blindness and Visual Impairment" WHO programme and are considered as potential threats to the status of sight in populations of developing and developed countries. Medically, all three diseases have a vascular component which manifests as changes in the blood circulation and changes in the vascular morphology. Therefore, the research directions for better understanding of the disease development and for better clinical diagnosis must include studies on the vascular systems of the eye. Development of methods for noninvasive, *in vivo* imaging and analysis of the ocular blood circulation is essential in this research, especially when human subjects are involved.

In this project, a state-of-the art swept source Optical Coherence Tomography (ssOCT) technology will be used to develop methods for *in vivo* imaging of the human choroid. OCT angiography methods will be developed for visualization of the vascular networks, and OCT velocimetry techniques will be implemented to estimate blood flow velocity in selected choroidal vessels. Image analysis methods will be introduced to enable quantitative analysis of the choriocapillaris architecture and to model the blood circulation this meshwork of vessels. To achieve these goals, a swept source OCT system will be designed and constructed with the use of a Fourier domain mode locked (FDML) laser emitting light at 1065nm center wavelength, and operating at a record-speed of 1.6 million sweeps per second. However, the 1.6 MHz imaging rate is not merely an incremental progress in the speed at which OCT imaging of the eye fundus can be performed. Our initial tests show that such imaging systems enable break-through in the *in vivo* imaging of the human choroid. For the first time possibilities open to image *in vivo* and visualize architecture of the intricate meshwork of choriocapillaris and to develop methods for its quantitative analysis. Similarly, the vessels of deeper choroid can be visualized and information about blood flow velocity extracted.

We will develop experimental and data analysis methods, and conduct an exploratory imaging study in human eyes, in which the possibilities provided by the state-of-the-art swept source OCT imaging system will be utilized to further the knowledge about the structure and function of the choroid in healthy and disease affected eyes. We will assess what are the typical features characterizing different vascular layers of the choroid (choriocapillaris, Sattler's and Haller's layer) and estimate what are the typical values of metrics describing the vascular networks architecture and their variability in the normal eyes. We will identify disease-specific changes in the appearance and in the morphometric parameters of the choroid in patients diagnosed with a variety ocular disorders, in particular with different types and stages of age related macular degeneration (AMD). We will also search for correspondence between the choroidal features visualized in FDML ssOCT imaging and disease-specific findings recognized in standard clinical diagnostics, e.g. different types of drusen or changes in the retinal pigment epithelium, observed in fundus photography, fluorescein angiography and commercial OCT systems.

In the past two decades, Optical Coherence Tomography technique has transformed the ophthalmic diagnosis and clinical research by providing high-resolution three-dimensional images of the human retina. In the last decade, new OCT imaging methods have emerged enabling visualization and measurement of the retinal blood circulation. There is a growing number of reports demonstrating the advantages of these methods in the diagnosis of diseases causing retinal vascular impairments. The proposed project promises the next break-through in the ophthalmic diagnosis and research by developing imaging system and methods to provide so far inaccessible information about the structure and function of the human choroid.