Description for the general public

The human eye is a complex and dynamic optical structure enabling visual perception. Vision loss has a severe impact on the quality of life since **90% of the information that we receive from the world is visual**. With ageing, most people face problems related to inadequate vision. Vision loss becomes a global social issue since the number of people with visual impairments will rise significantly due to longer human life-span. The main causes of vision impairment and blindness include: uncorrected refraction errors, cataracts (lens opacifications), glaucoma (optic neuropathy due to elevated intraocular pressure), and presbyopia (loss of accommodation).

However, the eye can be also regarded as a mechanical system with the biomechanical properties enabling both functionality and integrity of the eye. **Biomechanics** is the research field that aims at explaining the mutual relation between forces and functions in living organisms at different levels of biological organization (e.g. organelles, cells, tissues, organs etc.). The implementation of biomechanical issues in ophthalmology is still in its infancy due to several challenges in measuring of biomechanical properties in vivo. In particular, the modalities measuring biomechanics of the crystalline lens in vivo are limited. However, ocular biomechanics is a clinically significant factor linked to the age-related diseases affecting vision such as cataract and presbyopia

Despite the high prevalence of above-mentioned conditions, **current diagnosis and treatment rely only on morphological measurements of the eye, and do not consider biomechanical properties**. Therefore there is a need for novel solutions for diagnostics that incorporates also biomechanical data. The biomechanics can be assessed indirectly by the analysis of tissue response to well-defined mechanical stimulus. The resulting more accurate clinical interventions are expected to significantly contribute to improved eye care and decrease the social and economic burden of ocular conditions.

This project attempts to investigate how macroscopic air-pulse induced deformation of the structures in the eye is correlated with the stage of development of age-related ocular disorders. **The objective of this project is to assess the biomechanics of human ocular structures in-vivo by measuring their dynamic response to the mechanical stimulus (air-puff) with a novel optical modality.** In particular, we aim at understanding those effects in patients with age-related diseases like presbyopia and cataract. The studies will be performed on human subjects in vivo, and we will use a prototype optical ocular biometer based on optical coherence tomography to reveal the dynamics of all ocular structures during mechanical stimulus.

The studies proposed in this project are divided into four **specific parts:**

1) We will adapt the existing set-up to clinical studies.
2) We will determine the impact of the intraocular pressure on the dynamics of ocular structures in human eyes.
3) We will characterize in vivo air-puff-induced response of human ocular structures in cataract patients.
4) We will assess the relation between crystalline lens reaction to air pulse and the accommodative status in presbyopic eyes.

The project realization will move us closer to in-depth understanding the fundamental issues of ocular biomechanics and its relation to the ophthalmic pathologies.