Description for the general public

In most cases, **the human eye cannot be regarded as a perfect optical instrument** since it is usually affected by the **aberrations** that cause blurring of the retinal image. In addition to that, the quality of vision can be also degraded by the **scattering** during light propagation inside the eye. Although generally the ocular components are transparent, age-related changes affect intraocular light scattering that manifests as opacification. In particular, the crystalline lens tends to become less transparent (more opaque) with age, which is often called **cataract** – the condition that in advanced stage leads to blindness and affects more than half population of 75+ yo. **Cataract is diagnosed by subjective analysis of the slit lamp image. However, objective determination of scattering inside the eye seems to be an effective measure of the level of lens opacification.** Therefore, development of reliable modalities for intraocular scattering assessment may enable early cataract detection and proper cataract surgery management.

This project attempts to check if the three-dimensional imaging of back-scattered light enables objective quantitative assessment of ocular opacification and early detection of cataracts. The objective of this project is to **investigate intraocular light scattering in different age groups using novel approaches in eye imaging technologies**: whole eye optical coherence tomography (OCT) with focus tunable lens and straylight measurement with double-pass instrument. We also would like to understand the relation between back- and forward-scattering during light propagation through the ocular media.

The proposal is structured along **two main interconnected and complementary packages** which are defined by the following **specific aims**:

1) To assess the ability of **novel full eye optical coherence tomography (OCT) imaging with tunable focus** to extract quantitative information on intraocular back-scattering,
2) To correlate back-scattered light measurement with forward scatter from **double-pass method**.

The studies will be performed in patients with age-related cataract of different stages and grades who will be imaged with the combined instrument allowing for back- and forward scattering measurements. Advanced processing of three-dimensional OCT images based on developed model will be used to quantify back-scattering in different components of the eye. The operation principle of OCT is the interferometric measurement of back-scattered light from the tissue. Additionally, the results will be correlated with forward-scattering assessment based on the analysis of the point source image at the retina in the double-pass system.

The proposed project will be realized by the Nicolaus Copernicus University in Torun in cooperation with the Laboratory of Optics at the University of Murcia (Prof. Pablo Artal). The project will bring important scientific benefits since it will allow for **understanding the fundamental issues of optics of ageing eyes**. The results will also serve as a key step in validating the methodology for objective grading the ocular opacifications.