Research proposed in this project aims at description of new type of vision based on nonlinear optical process which takes place in living human eye – two photon absorption in human photoreceptors. Two photon vision allows to see short-pulsed laser beams in near infrared range. The beams are perceived as having color roughly half of applied wavelength.

The explanation of mechanism of observed phenomenon by experimental results of four research group of different expertise have been reported in paper [1]. This project aims at comprehensive characterization of different aspects of two-photon vision based on psychophysical measurements of sensitivity threshold – the minimal beam power causing the visual perception.

Proposed research will extend the existing knowledge on visual cycle and on its course after starting by two-photon process. Observed differences in comparison to one-photon vision allows for indication of potential clinical applications. There are many factors disturbing the dark adaptation process: vitamin A deficiency, Oguchi disease, Stargardt macular dystrophy, age related changes in visual cycle. Sensitivity threshold assessment and dark adaptation recovery measurements for two-photon vision could be convenient and useful diagnostic method of early defects in visual cycle.

Experiments proposed in this project will provide also better understanding of the interaction of short pulsed laser light with living eye. The results are greatly important in the context of development of new imaging methods in ophthalmology which are based on optical nonlinear processes. Lately there is primarily need for methods providing both: structural and functional information of the eye. Imaging based on non-linear optical processes is considered as promising for the functional imaging. In this context interaction of short-pulsed laser beam with visual pigments which is present in two-photon vision is very interesting and forward-looking.

Super-resolved microperimetry probing the single cones is a tool for expanding the knowledge of mechanisms of our perception. Vision based on nonlinear optical effects has potentially at least two advantages for such kind of application: spatial confinement – the stimulation will occur only in focal zone of the beam and chromatic dispersion will be small because wavelength of stimulating beam slightly differs from imaging one. Investigations of visual acuity of two-photon vision aims to verify the usefulness of two-photon vision in precise microperimetry.

1. G. Palczewska, F. Vinberg, P. Stremplewski, M. P. Bircher, D. Salom, K. Komar, J. Zhang, M. Cascella, M. Wojtkowski, V. J. Kefalov, and K. Palczewski, "Human infrared vision is triggered by two-photon chromophore isomerization," Proceedings of the National Academy of Sciences of the United States of America **111**, E5445-5454 (2014).