Cyanobacteria are responsible for large part of global photosynthesis, and moreover they are probably the origin of primary oxygen in Earth's atmosphere which emerged in so called "Great oxidation event", about 2.3 billion years ago. Orange Carotenoid Protein (OCP) is a photoactive protein with carotenoid molecule embedded inside, which performs photoprotective function in cyanobacteria. After illumination by green-blue light OCP undergoes complex conformational transformations and changes into a red, active form, which has ability to attach to phycobilisomes. This process can be reversed by another protein, called Fluorescence Recovery Protein (FRP), which causes OCP to disattach from phycobilisome, and accelerates back reaction to orange, inactive form. Thus OCP can adapt to rapidly changing conditions (figure 1). When a very high intensity of light irradiates the phycobilisomes, which are subunits responsible for light harvesting in cyanobacteria, there is a risk that excessive energy will cause a photooxidative stress by generating toxic reactive oxygen species (ROS). Light-activated red form of OCP can effectively quench phycobilisomes and dissipate this energy. The big advantage of this mechanism is selectivity, because it is activated only during excessive exposure to light. So, presence of OCP protects photosynthetic apparatus, but not at the expense of efficiency. However machinery of this natural efficient photo-protection is still not fully understood.

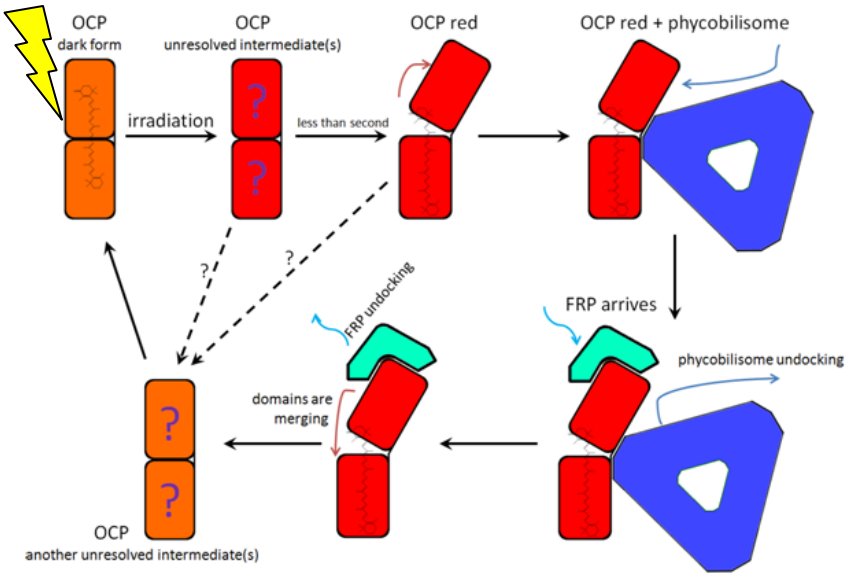

Figure 1. Scheme of OCP photoactivation. OCP^R after attaching to phycobilisome, can quench excessive excitations.

Figure 2. Unstable red form OCP^R generated by irradiation and orange form OCP^O before irradiation (stable in the dark).

Then the important target of this project is to elucidate precisely the photo-dynamics of orange carotenoid proteins (OCP). State of art of time-resolved optical spectroscopies will be used to investigate processes taking place from femtoseconds (1fs = 10^{-15} s) to hours after irradiation. Different modes of irradiation: 100fs or 5ns single pulse, multi-pulse train excitation or continuous light will allow to get insight into events that control the efficiency of conversion from orange to red form and to provide information about nature of photoactivation in conditions close to natural.

This project address thus a fundamental question concerning photosynthesis: how photosynthetic organisms can survive harsh irradiation conditions without damage done to delicate light harvesting subunits like reaction centres? Getting insight into how photosynthesis works in very intense light is also important because depletion of ozone layer, which allows UV radiation reach Earth's surface much easier.

Exploration of topics raised by this project should lead to the development of new OCP and OCP-like variants for which photo-physical properties can be tuned and that can be used in optogenetics and artificial photosynthetic systems.