Use of short X-ray pulses to probe the structural dynamics of the orange carotenoid protein (OCP)

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To protect themselves from detrimental light energy excess, cyanobacteria synthesize a small dimeric photoactive Orange Carotenoid Protein (OCP) capable of quenching and dissipating into heat the excess of energy arriving to the cyanobacteria light-harvesting centers. Upon photon absorption, this pigment-encasing two-domain protein, undergoes a transition from a compact orange "non-active" state (OCP°) to an extended red "photoactive" state (OCP^r) associated with a migration of the carotenoid pigment from the interface between the two domains into the effector N-terminal domain (NTD) of the protein. However, it remains elusive how the energy absorbed by the carotenoid is funneled into the protein scaffold and how the protein structure varies during photoactivation. Using time-resolved (TR) X-ray scattering, we studied the µs-ms photo-triggered structural dynamics of dimeric OCP in solution. We also used Serial Synchrotron Crystallography (SSX) to shed light on the first intermediate leading to the OCP^r photoactive state. Altogether, our results illustrate how initially localized changes on the ps timescale may trigger global protein structural dynamics of the µs-s timescale and how the structure of this protein has evolved to enable photoactivation only in case of very strong irradiance, despite the use of one of nature's most potent chromophore.

References

[1] – D. Kirilovsly & Kerfeld C.A., Nature Plants **12**, 16180 (2016)