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Keynote 3, Prof. Richard Neutze: Time-resolved diffraction experiments at X-ray free electron lasers reveal ultrafast structural changes in photosynthesis

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X-ray free electron lasers (XFEL) have sparked the development of time-resolved serial femtosecond crystallography (TR-SFX), which is a completely new experimental approach to understanding protein structural dynamics. We have used TR-SFX at the LCLS (an XFEL in California) to probe light-driven structural changes from picoseconds to microseconds in a bacterial photosynthetic reaction centre. These integral membrane proteins harvest sunlight in order to transfer electrons from a special pair of bacteriochlorophylls to quinone molecules that are located on the opposite side of an energy transducing biological membrane. Coupled redox reactions balance the charges and this leads to a net effect of two pumped protons per photon absorbed. TR-SFX studies at the LCLS revealed structural changes on the picosecond time-scale near the special pair (which is photo-oxidized by light) and the tightly bound menaquinone (which accepts an electron from the special pair). These structural results provide novel chemical insight into how protein structural dynamics are able to help to stabilize the charge separated state. With the extension of serial crystallography to synchrotron radiation sources, I argue that time-resolved diffraction studies will become more common in the future as new approaches allow new biological systems to be probed.

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