Excited state dynamics of Photosystem I core complex

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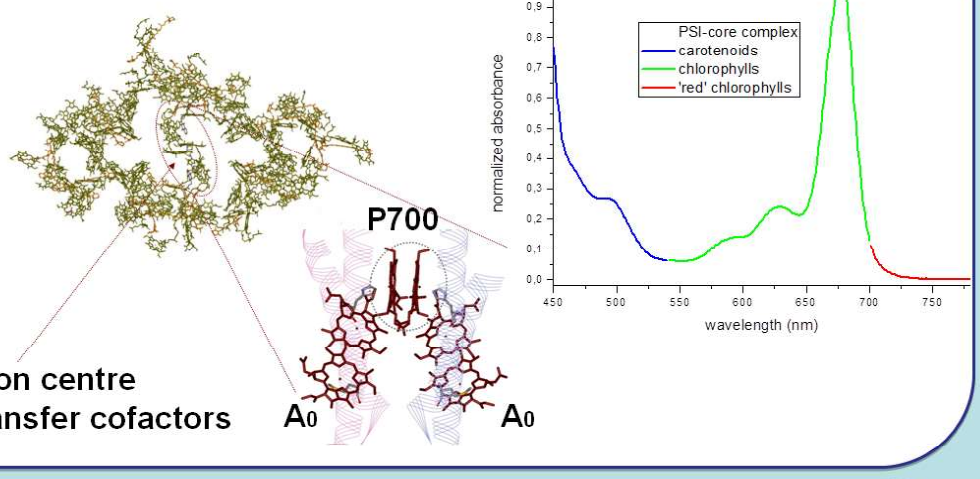
Introduction

• **Photosystem I (PS I)** of oxygenic photosynthetic organisms is a membrane-bound pigment-protein complex that transport electrons from plastocyanin or cytochrome c_6 to ferredoxin.

• **The PSI-core complex** include inner antennas, and the pigments of chlorophylls and carotenoids. Also the primary electron donor called P700 is originated in there, a chlorophyll dimer with an absorption maximum at 700 nm. In this complex the LHCI outer antenna is absenced.

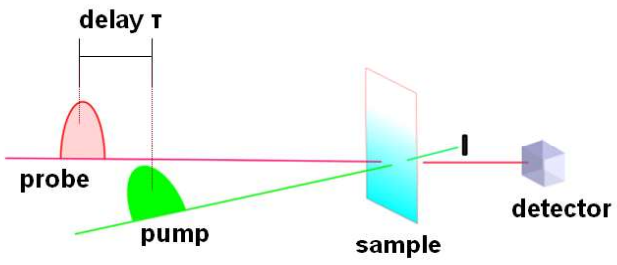
• We analyze the **pump-probe** data performing a global fit
(i) At **490nm** pump wavelength, selectively excite the carotenoids
(ii) At **630nm** pump wavelength, unselectively excite the vibronic transition bands of the chlorophylls.

PSI-CORE COMPLEX



Experiment

Pump-probe technique



• Sub-100fs pulse width
• Energy:
• Frequency: 10KHz

Decay Associated Spectra (DAS)

$$\Delta A(\lambda, t) = \sum_i (DAS)_i(\lambda) exp(-\frac{t}{\tau_i})$$

Compartmental Model

• $\frac{dc_{(t)}}{dt} = \hat{K} c_{(t)}$ $\quad c_{(t)} = [c_{1(t)} \cdots c_{n_{comp}(t)}]^T$

Matrix of the decay rates

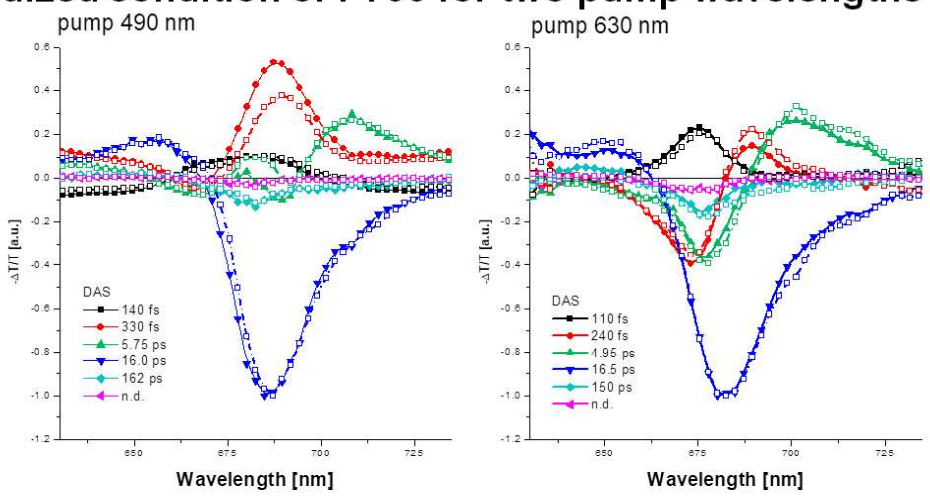
• The solution is: $c_{(t)} = \sum_i V_i exp(t\xi_i)$

Eigenvalues of **K**

Eigenvectors of **K**

Results

Oxidized condition of P700 for two pump wavelengths



full symbols: no FeCy, open symbols: +2mM FeCy

• The effect of FeCy is minimal at most of the investigated trace, this indicates that the reaction centre is 'closed' under our experimental conditions

• There is an intense dependency of the pump wavelength on the DAS at the fast components before 5ps.

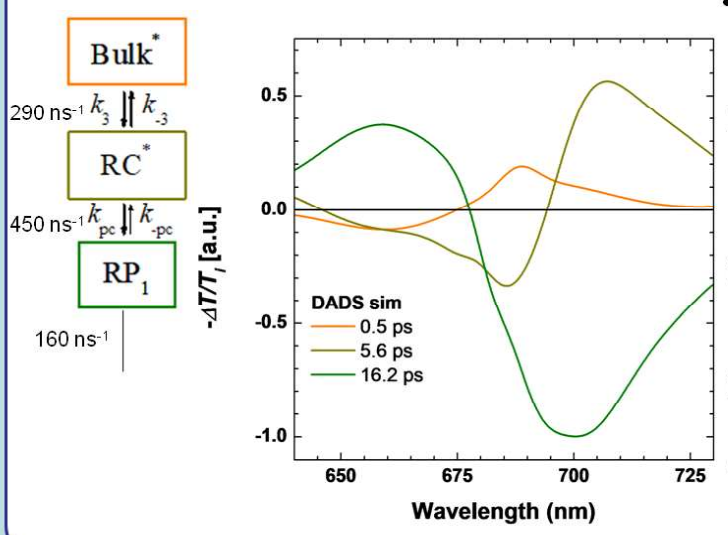
• This intermediate 5ps- component has a transfer to 700nm region feature, irrespectively of the pump.

• Absence of the long lived red chlorophylls which originate in LHCI

Results

Compartmental model analysis

PSI-core complex



i) Similar rates and simulated lifetimes, but not identical, for the similar path in the two models.

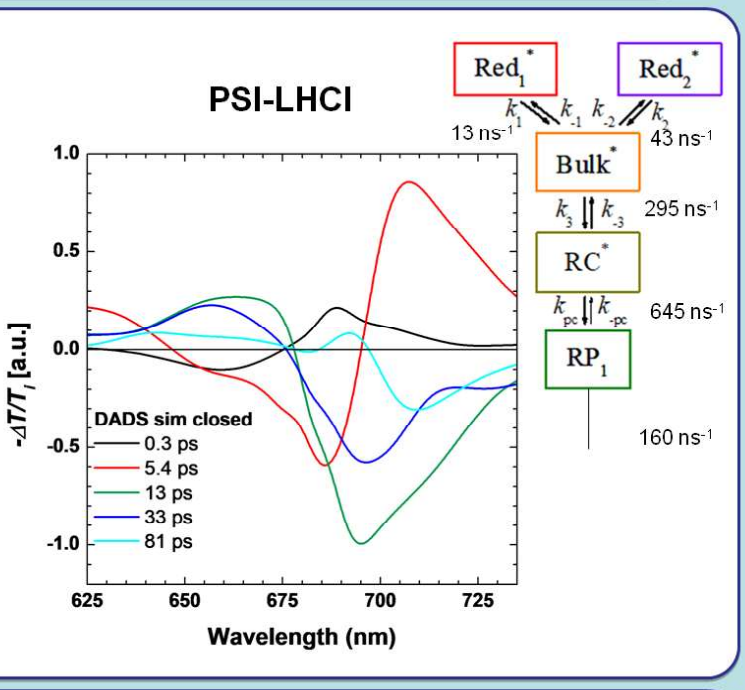
) The lifetimes of **33** and **81ps** are associated with the red species which originate in LHCI and are absenced in the PSI-core complex.

i) The lifetime of **0.5ps** corresponds to the energy transfer from the bulk to the reaction centre.

ii) The **5.6ps** component has an energy transfer character to the RC*

v) The **16.2ps** component is associated with the recombination of the RP to the ground state.

PSI-LHCI



Conclusion

• In the dynamics, the FeCy has little effect overall which indicates that the P700 state is oxidized.

• The pump wavelength has an important dependency to the dynamics. The 5ps-component has a transfer to 700nm region feature, irrespectively of the pump. This is coming out also from the compartmental model analysis.

• Absence of the long lived red chlorophylls above 710nm which originate in LHCI, so it turns out that the tail at the 700-715nm region on the DAS spectra comes from 'red' chlorophylls of inner antenna

References

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