Stabilisation of quasi stable states by flash turnover of photosystem II core complexes from higher plants. Back reaction kinetics

P.J. Smith, B. Bataituti, Lu. Jin, E. Krausz and R.J. Pace, Research School of Chemistry, College of Science, Building 33 Science Rd, Australian National University, ACT 2601, Australia.

The smallest functionally active, stable photosystem II (PSII) complexes are termed core complexes, where the inner components of the multipeptide PSII complexes are isolated by detergent solubilization from the thylakoid membrane and outer light harvesting systems. Functional membrane bound PSII from higher plant and PSII core complexes from oxygenic thermophilic cyanobacteria appear to retain dimer functionality (Kern *et al.*, 2005; Guskov *et al.*, 2009). The isolation of PSII core complexes from higher plants follows a different isolation procedure to that of thermophilic cyanobacteria (Smith *et al.*, 2002). The isolation of higher plant PSII cores leads to fully active complexes that may be mostly monomer in functional unit morphology. Although fully active, collaborations to generate flash turnover of higher plant cores had resulted in capture of only 10% of centres in the S2 state (Thapper *et al.*, 2009). We have examined single laser flash illumination turnover of higher plant PSII core complexes and measured the kinetics of the presence of S2 multiline signal after flash - delay, then rapid freeze to liquid nitrogen (77K). The temperature dependence of the S2 Multiline signal decay kinetics were measured for temperatures between 6°C and 20°C (280K and 293K). Conditions for full multiline signal intensity were recorded for a number of added quinone (artificial acceptor) : PSII core complex ratios (0 to 90 quinones per core complex on mole : mole basis).

The activation energy for the S2 multiline / S1 back reaction measured from an Arrhenius plot of the decay was 55kJ.mol^{-1} (0.6eV). The magnitude of this activation energy is of the same order as that reported for the S2 multiline / S1 back reaction kinetics for PSII membrane samples (Seeliger, Kurreck & Renger, 1997). The time course for the loss of S2 multiline signal in higher plant PSII core complexes was observed to be two orders of magnitude faster than for the loss of multiline signal in PSII membrane samples. This very rapid back reaction is hypothesized to arise from the solution status of PSII core complexes as compared to the large membrane fragments associated with sub thylakoid PSII preparations. Such solution properties of the core complexes allow collisional dismutation of acquired and stabilized charge separation during the S1 to S2 turnover.

Kern J, Loll B, Zouni A, Saenger W, Irrgang KD, Biesiadka J. (2005) *Photosynthesis Research* **84:** 153–159.

Guskov A, Kern J, Gabdulkhakov A, Broser M, Zouni A, Saenger W. (2009) *Nature Structural & Molecular Biology* **16:**334-342.

Smith PJ, Peterson S, Masters VM, Wydrzynski T, Styring S, Krausz E, Pace RJ. (2002) *Biochemistry* **41:** 1981–1989.

Thapper A, Mamedov F, Mokvist F, Hammarström L, Styring S. (2009) *The Plant Cell* **21:** 2391-401.

Seeliger AG, Kurreck J, Renger G. (1997) *Biochemistry* **36:** 2459–2464.