OA3.4 - Development of Electrochromic Shift measurements in the cyanobacterium *Synechococcus elongatus* PCC7942

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In cyanobacteria, the thylakoid membranes harbour both the photosynthetic and the respiratory electron transfer chains, which also share some of the electron carriers and of the electron donor and acceptor pools. This complex interplay renders it difficult to estimate the relative contribution of the different electron pathways, especially the linear and cyclic photosynthetic fluxes, under physiological steady-state conditions. Photosynthetic fluxes can be estimated by comparing the turnover rate of the two photosystems (PSII and PSI), but traditional methods as fluorescence and P_{700} absorption measurements are not well suited to do this. Indeed, the two observables they measure cannot be quantitatively compared and might be biased by changes in antenna sizes and by an acceptor side limitation of PSI.
In plants, microalgae and some photosynthetic bacteria, the Electrochromic Shift (ECS) of photosynthetic pigments is one of the most powerful tools used to reliably quantify the activity of the photosynthetic complexes. Light-induced ECS signals give a direct measurement of the transmembrane electric field generated by the activity of the photosynthetic complexes. In cyanobacteria, though, a single observation of ECS signals has been reported so far, and the method has never been established for physiological studies.

We have been able to identify an ECS signal in the model cyanobacterium *Synechococcus elongatus* PCC7942 and to spectrally de-convolute it from other spectral components, mostly attributable to oxidized-minus-reduced absorption changes of cytochromes and P_{700}. We applied, for the first time in cyanobacteria, the ECS method, in combination with other classical measurements, to investigate: i) the turnover rates of the photosynthetic complexes under steady-state conditions, ii) the relative contribution of the linear and cyclic electron pathways, iii) the participation of the respiratory complexes to the flash-induced slow electrogenic phase and to the modulation of the light-dependent electron fluxes. For this purpose we also generated a *S. elongatus* mutant lacking the respiratory NDH-1 complex.

The possibility of performing Electrochromic Shift measurements in cyanobacteria could represent a major breakthrough for the study of the complex electron fluxes taking place in these organisms. Ultimately, this powerful tool could also help us to have a better understanding of how photosynthesis and respiration can function in an inter-dependent manner.

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