Photosynthetic and respiratory gas exchange characteristics of Synechocystis PCC 6803 ndhD(1-4) mutants

L. Cournac, G. Guedeney, E. Aubert-Jousset
CEA Cadarache

J. Appel*, B. Forberich, S. Künzel
University of Kiel
*present address : Arizona State University

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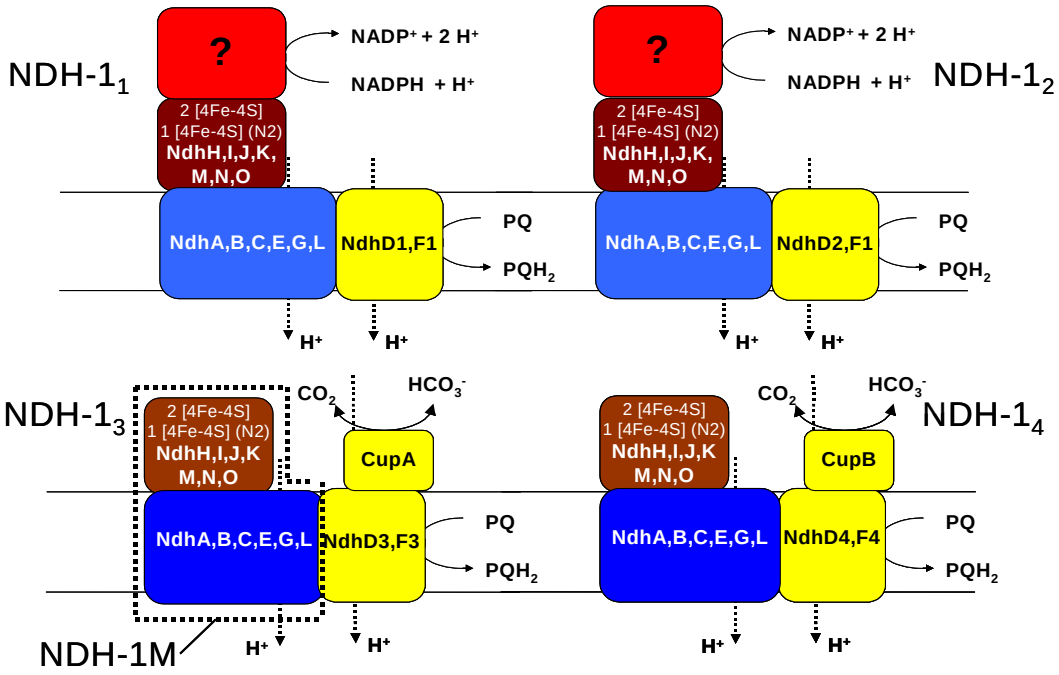
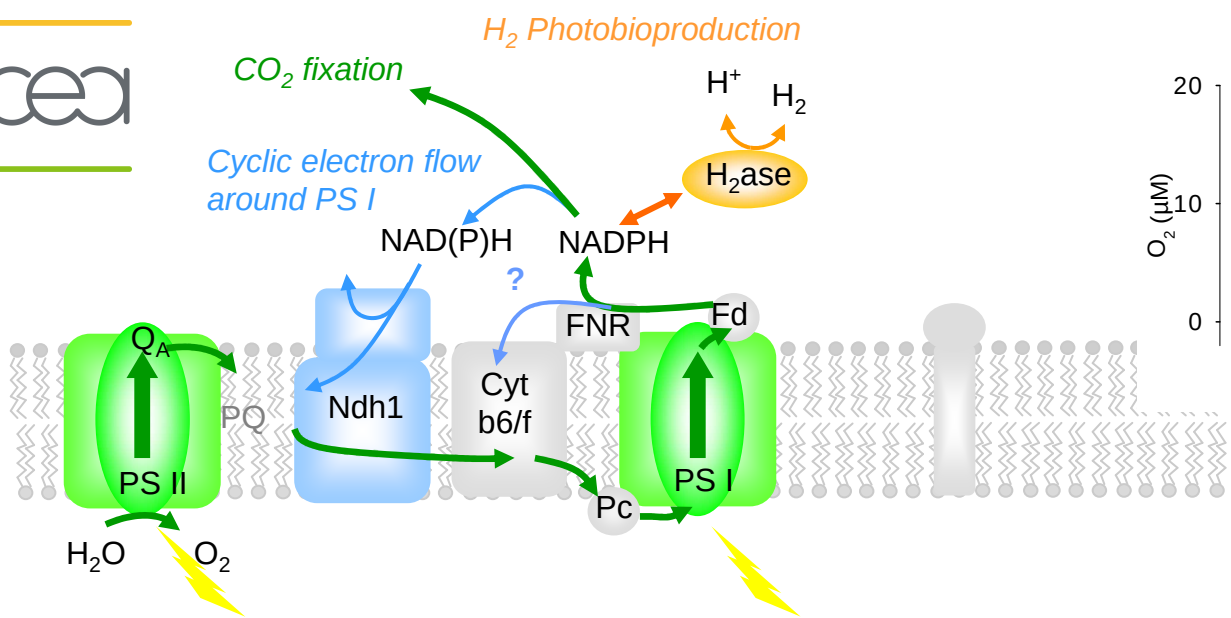


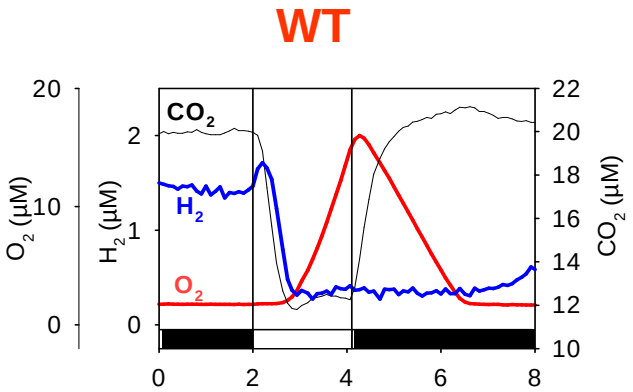
D1 and D2 (F1)
NAD(P)H oxidation

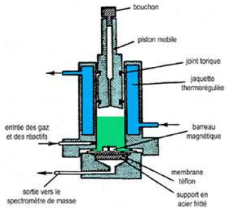
D3 and D4
CO_2 uptake

D5 and D6
?????????

H_2, CO_2 and O_2 exchange in *Synechocystis* PCC 6803

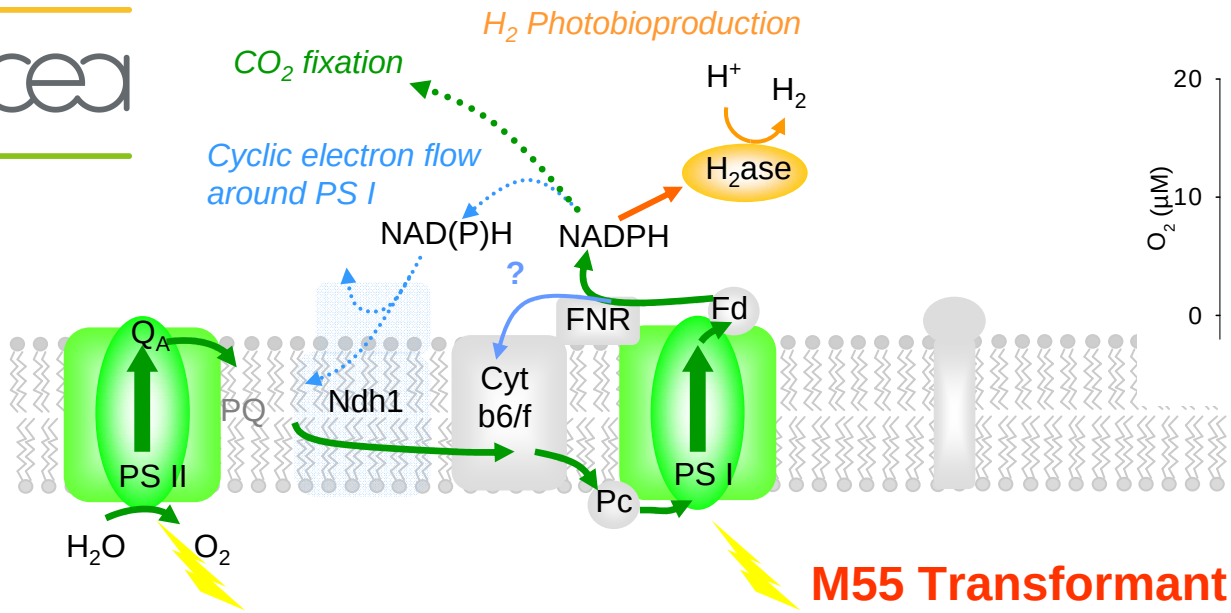




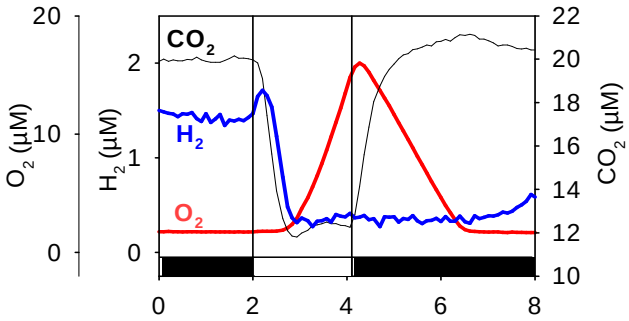


Liquid phase – Membrane inlet – Real-time online monitoring
(H_2, O_2, CO_2)

H_2, CO_2 and O_2 exchange in *Synechocystis* PCC 6803



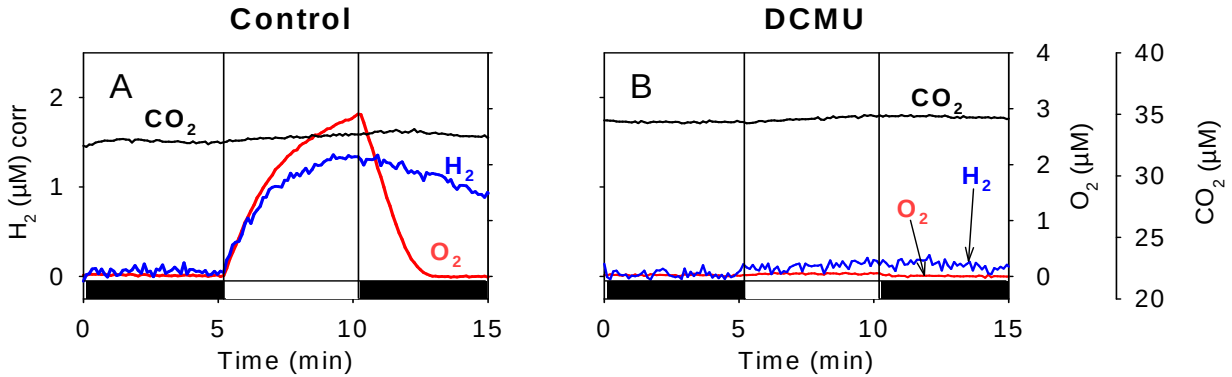
WT



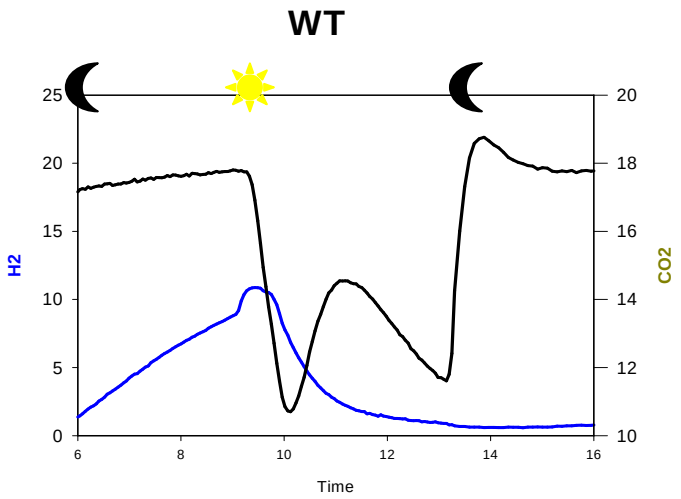
M55 Transformant – deleted ndhB

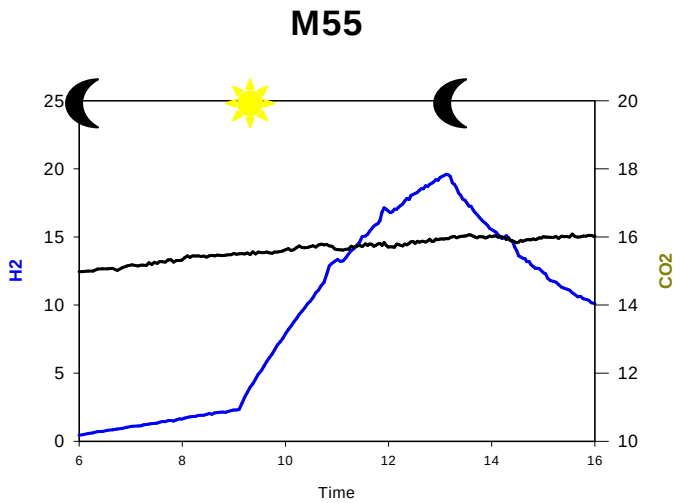
(Cournac et al. J Bact 2004)

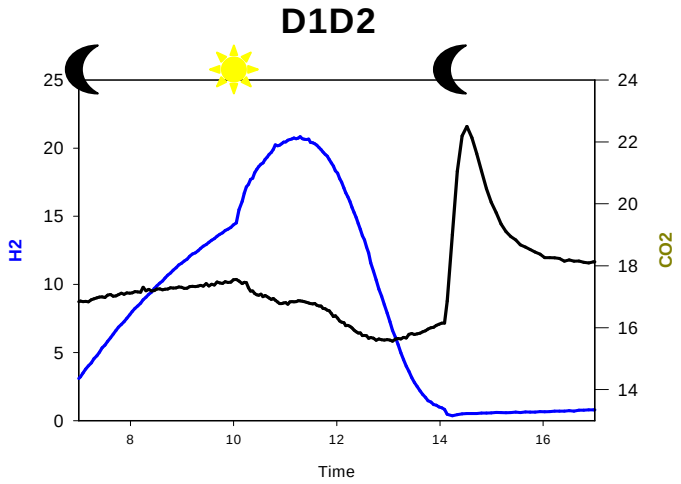
Influence of the different NDH complex types?

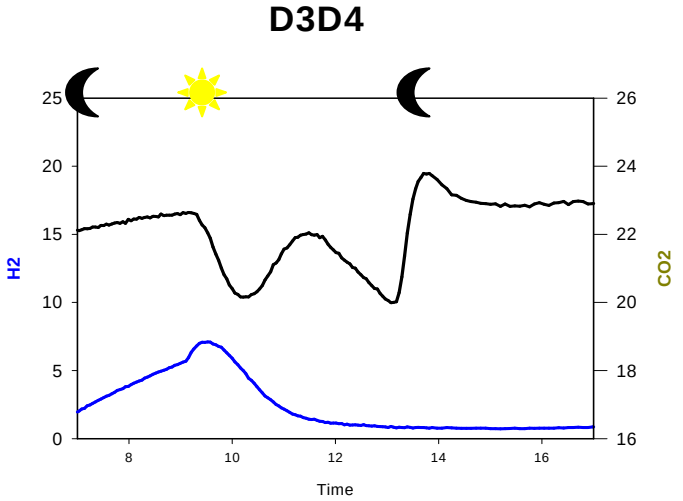


Hydrogen and CO_2 exchange in ndh mutants

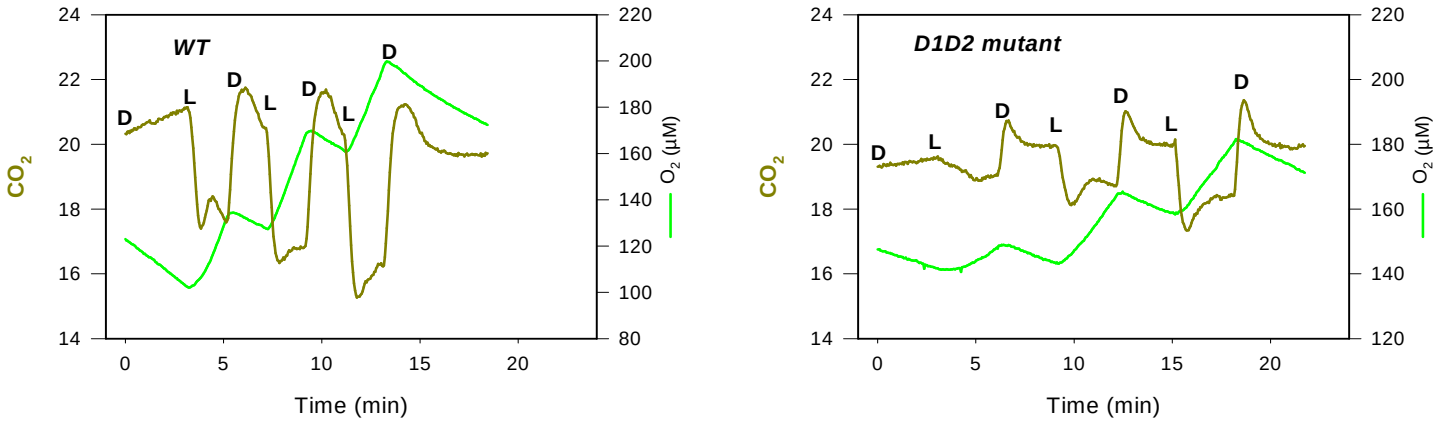




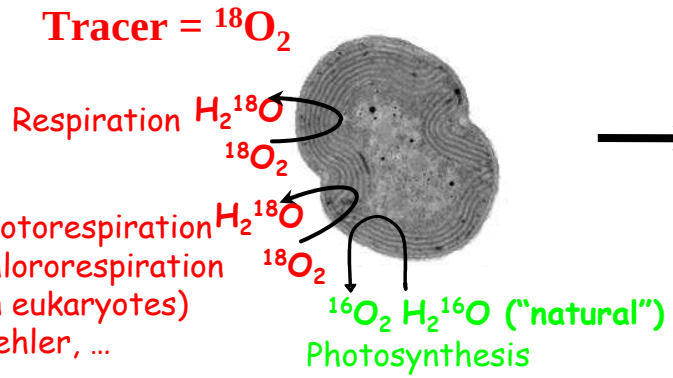




Delay in CO_2 uptake induction of dark-adapted Δ*ndhD*1,2 mutant



Mass spectrometric analysis of photosynthetic and respiratory gas exchange – Isotopic tracing



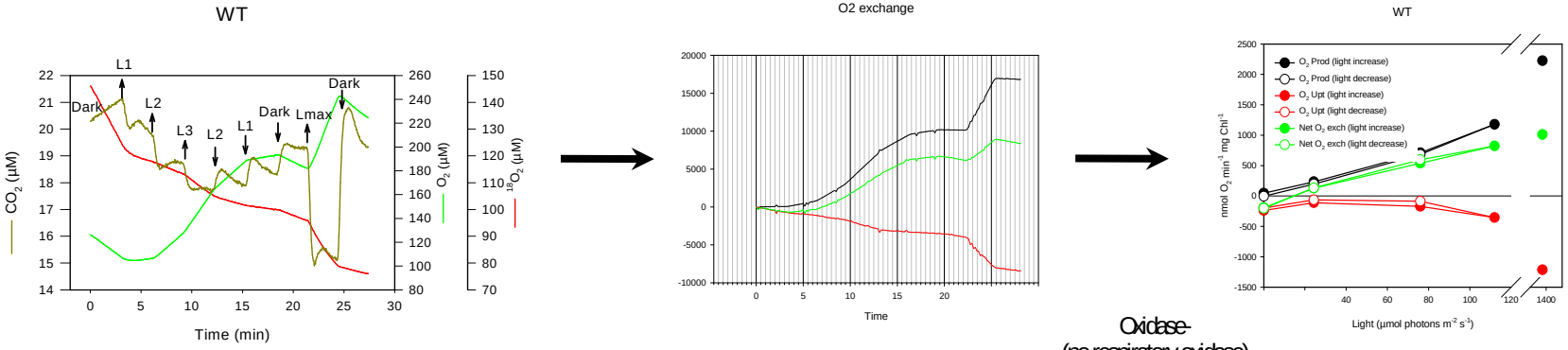
$^{16}O_2$: *uptake, production*

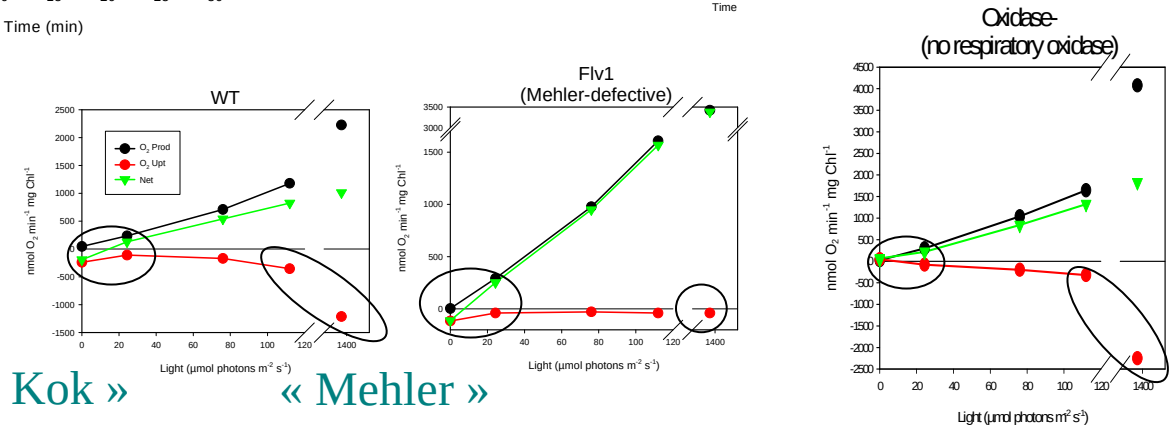
$^{18}O_2$: *uptake*

$$Uptake = -\frac{d^{18}O_2}{dt} \cdot \frac{^{16}O_2 + ^{18}O_2}{^{18}O_2}$$

$$Production = \frac{d^{16}O_2}{dt} + Uptake \cdot \frac{^{16}O_2}{^{16}O_2 + ^{18}O_2}$$

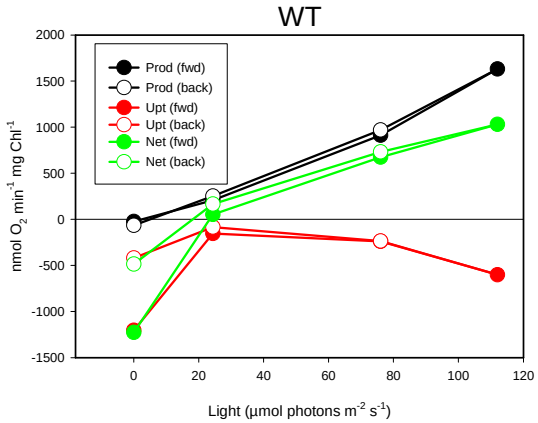
$$Net\ exchange = Production - Uptake = \frac{d^{16}O_2}{dt} + \frac{d^{18}O_2}{dt}$$

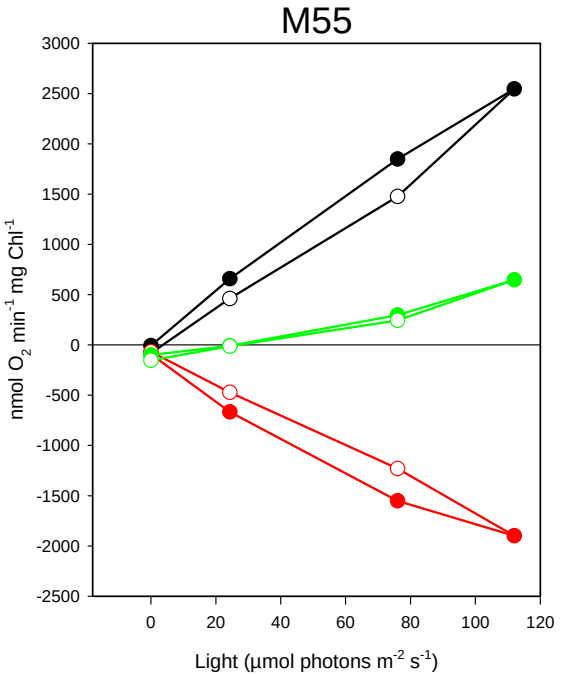


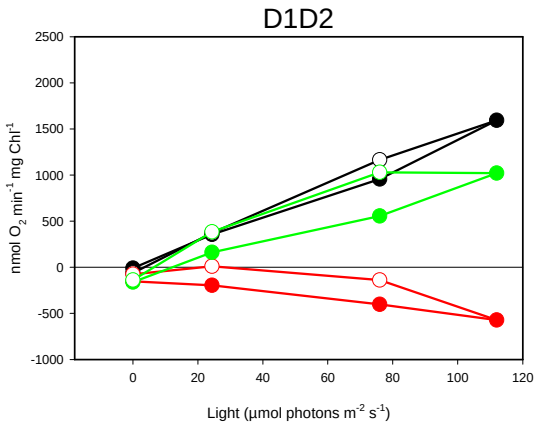


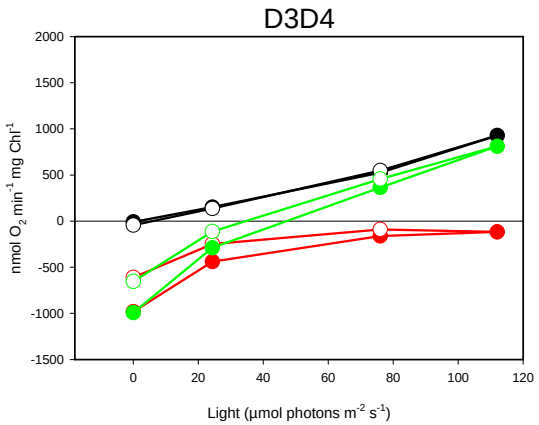
« Kok » « Mehler »

Light response of oxygen exchange rates in ndhDx mutants



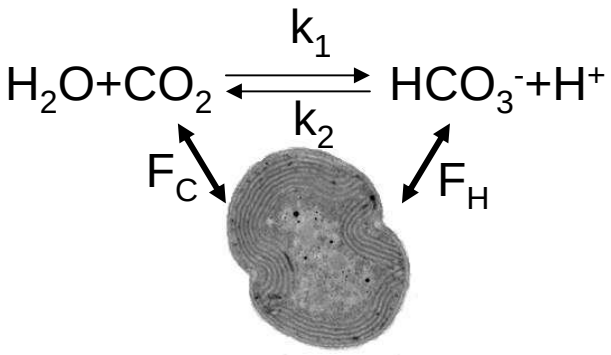




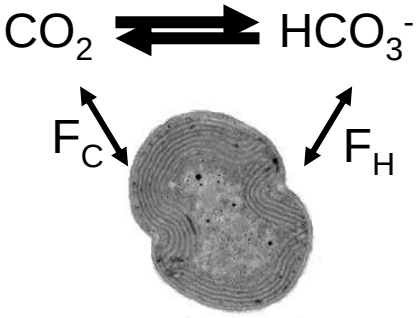


Mass spectrometric analysis of CO_2 and HCO_3^- exchange
Carbonic anhydrase addition

No CA, slow equilibrium



+ CA, fast equilibrium



$k_1 \approx 0.06\ s^{-1}$ at 30°C

$k_2 = k_1/(10^{pH-pKa})$

$[HCO_3^-]/[CO_2]=k_1/k_2$

WT

F_C and F_H equivalent wi

$Ct=[HCO_3^-]_{-CA}+[CO_2]_{-CA}$

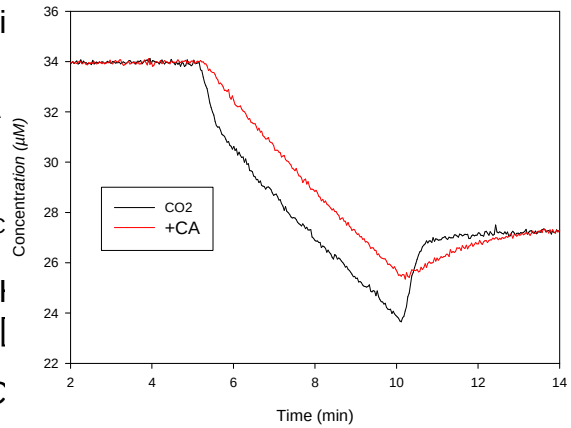
$d(Ct)/dt=F_C+F_H$

$[HCO_3^-]_{-CA}= Ct - [CO_2]_{-C}$

$F_C= d([CO_2]_{-CA})/dt - k_2.[I$

$F_H=[HCO_3^-]_{-CA})/dt + k_2. [$

Possible difference in C

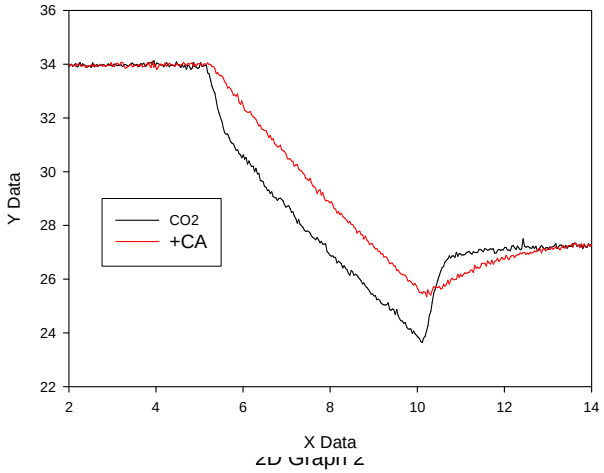


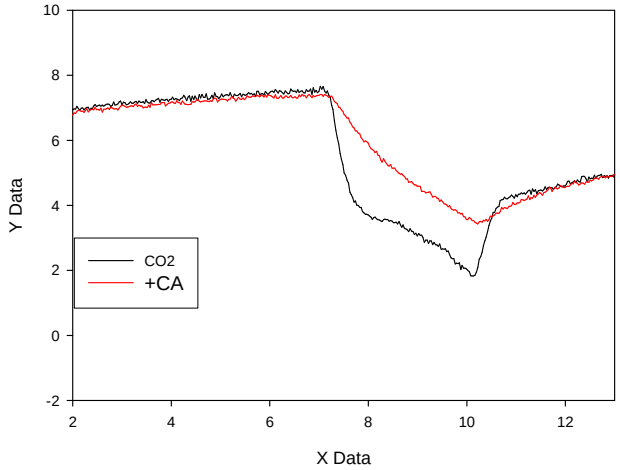
$+10^{pH-pKa})$

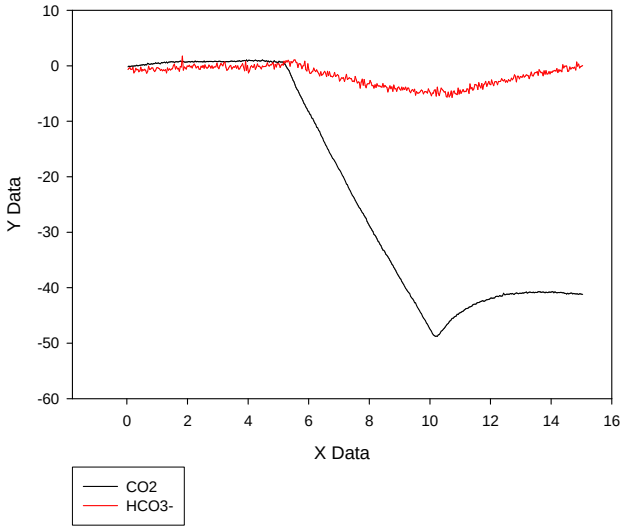
mpact fluctuations in F_C and F_H

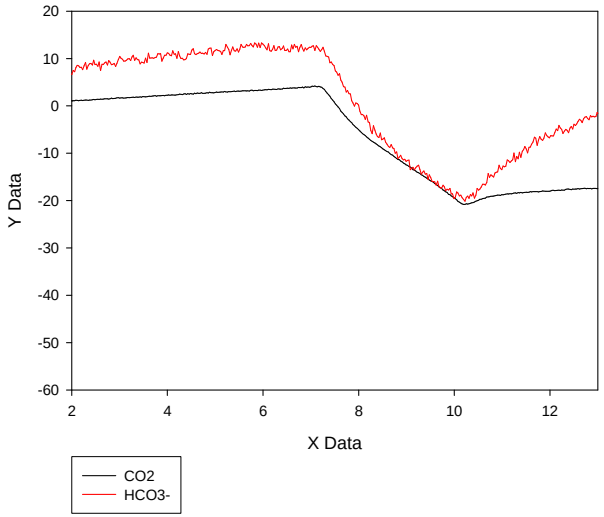
Observed concentrations – Reconstructed CO_2/HCO_3^- fluxes

WT pH 7 *(grown pH 8.3)* WT pH 7.5

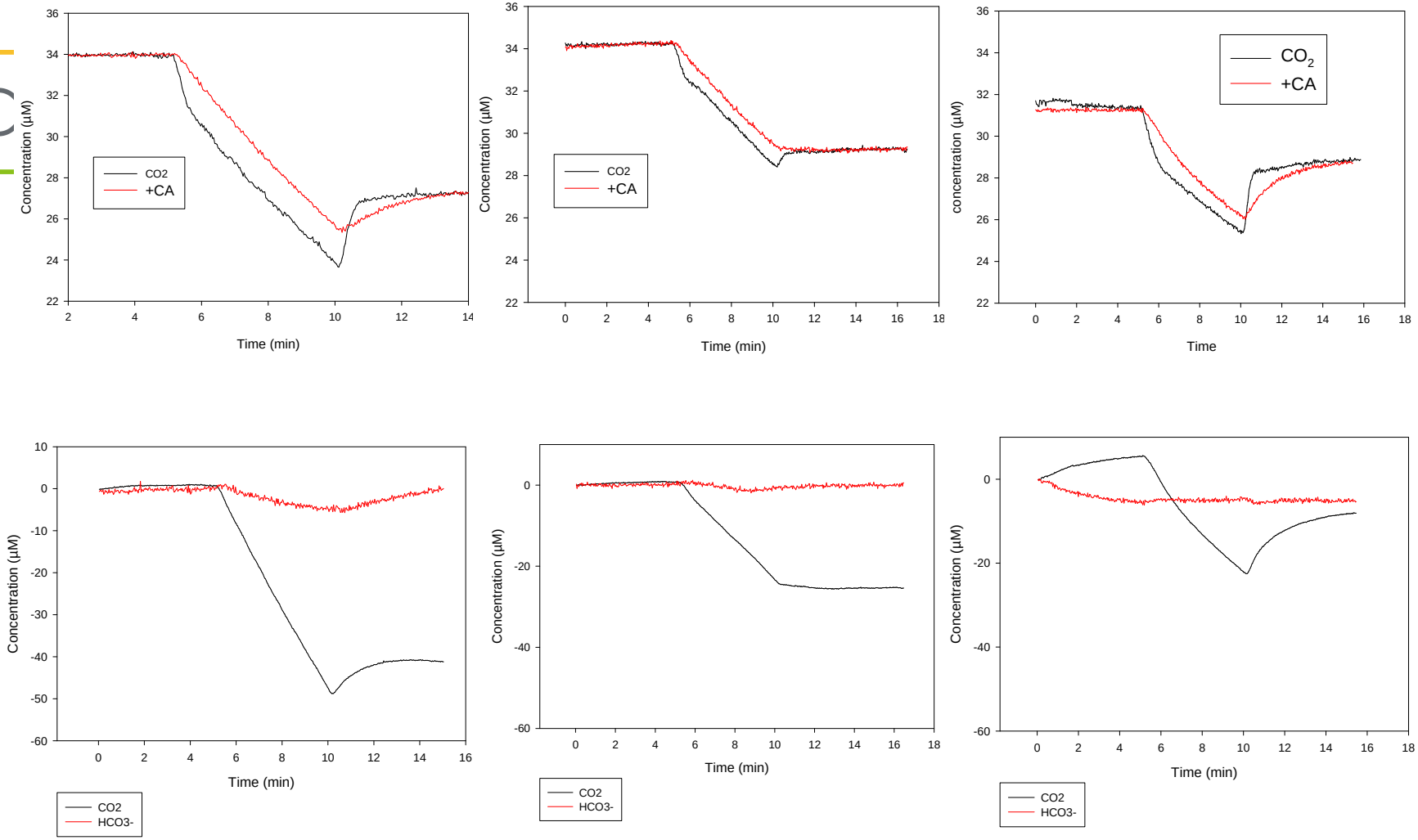








WT D34 D12



CONCLUSIONS - QUESTIONS

-Deletions in ndhD3/D4 slightly affect photosynthesis or H_2 exchange. A decrease in “Mehler” reaction rate has been observed. Link with Flv?

-Deletions in ndhD1/D2 exhibit the stronger effects: as previously described, they affect respiration. In the light, O_2 uptake is stimulated (opposite to D3D4 mutant…): compensate for cyclic transfer impairment? Delayed induction of carbon uptake mechanisms and of photosynthetic activity (redox state-dependent?). In anoxia, H_2 production is stimulated.

- A new methodology for real-time estimation of CO_2 and HCO_3^- exchange rates has been set up and is to be challenged in future experiments.