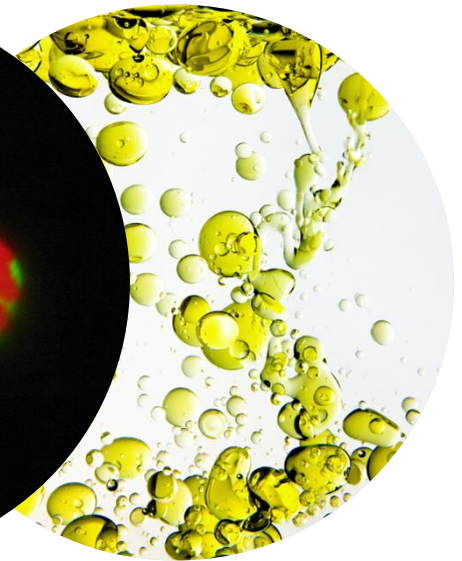
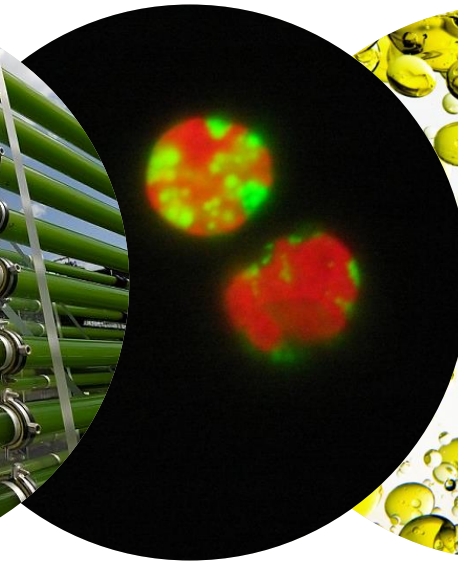
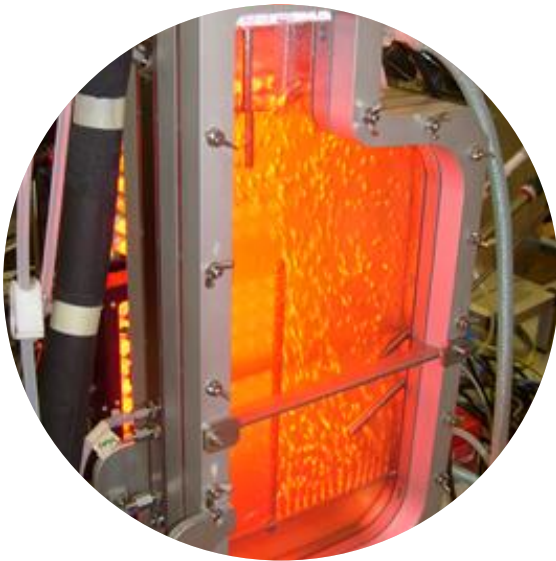


Simultaneous growth and lipid accumulation

Customising biomass composition in continuous microalgae production

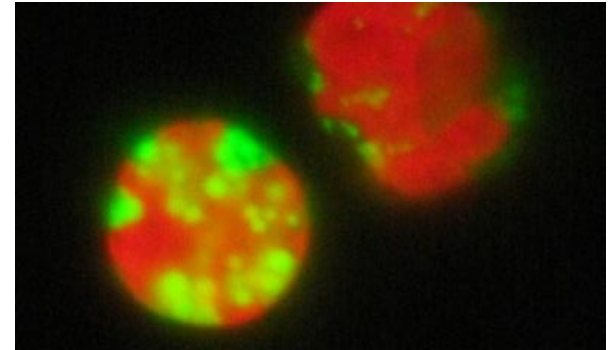
A.J. Klok, P.P. Lamers, D.E. Martens, R.H. Wijffels

2nd Young Algaeneers Symposium 2014, 5 April 2014



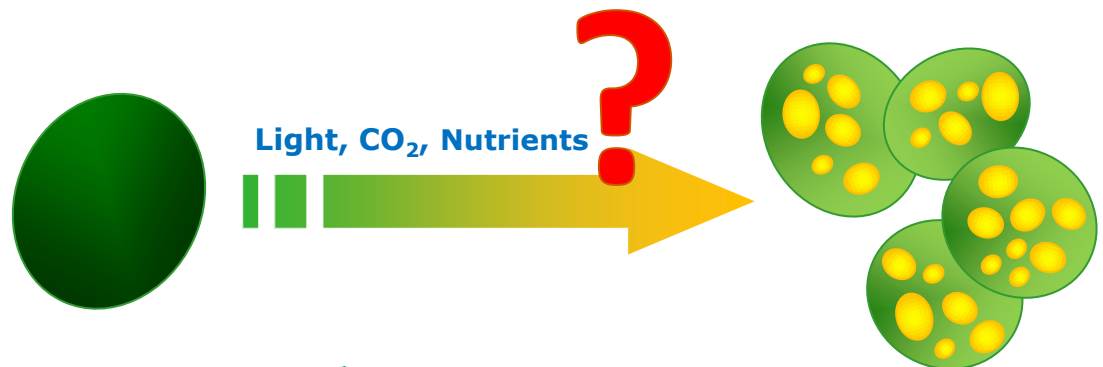
Why microalgal lipids?

- **Microalgae** can produce neutral lipids
 - Adverse growth conditions
 - Up to 60% w/w
 - Mainly Triacylglycerol (**TAG**)
 - Stored in 'lipid globules'
- **TAG...**
 - ... is the main constituent of vegetable oil
 - ... can be used for the production of biofuel

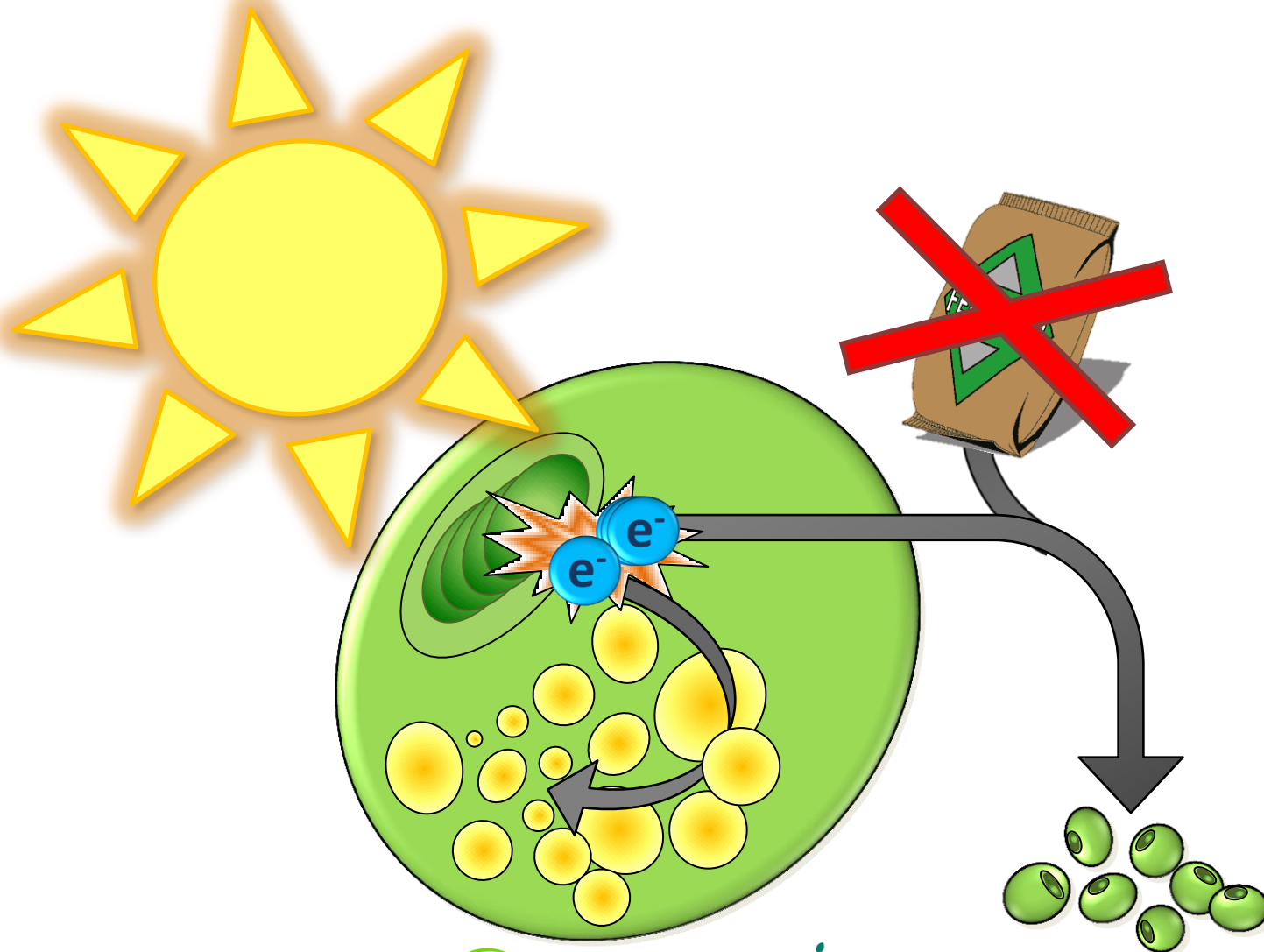


Why do algae accumulate TAG?

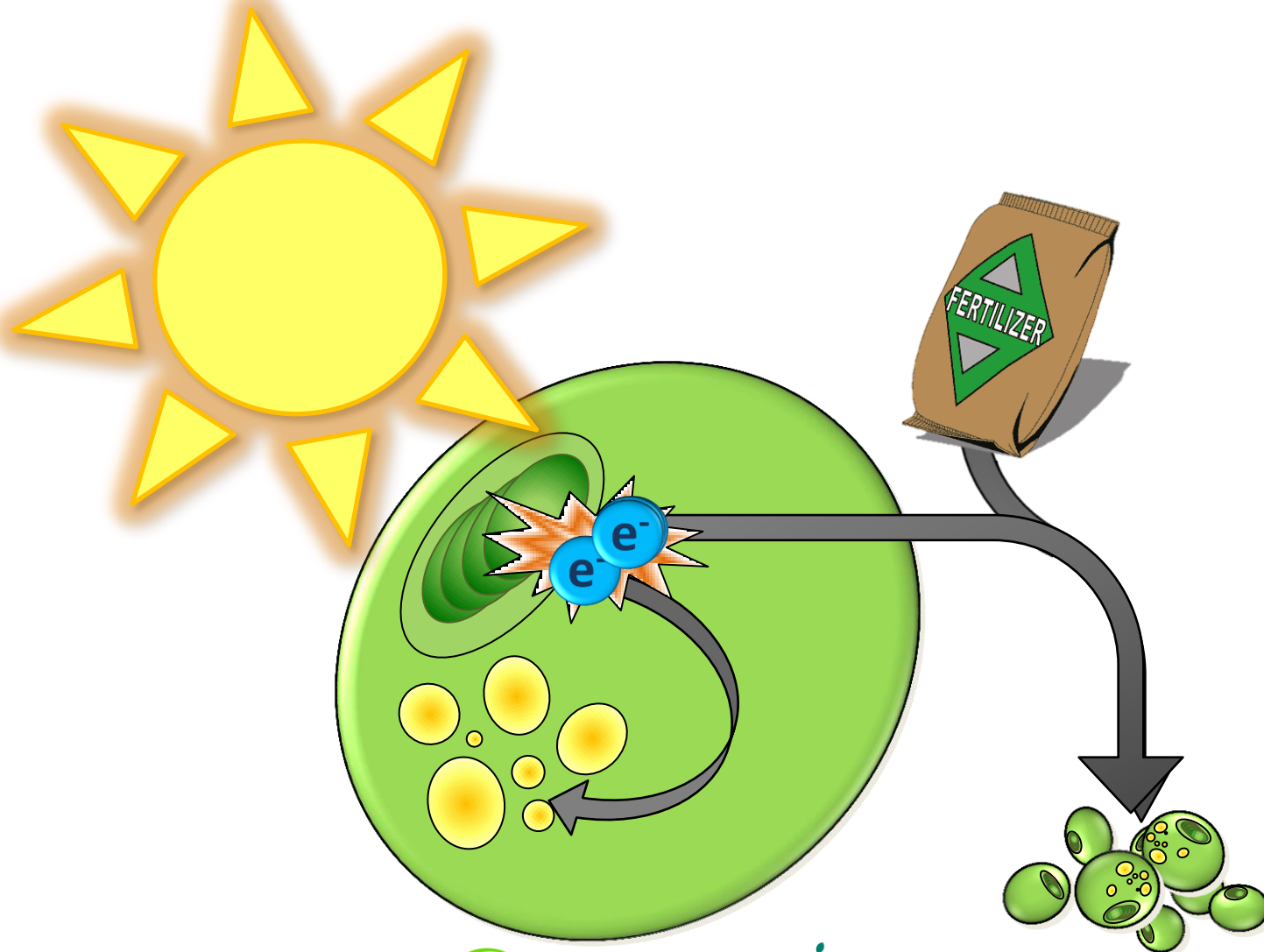
- Exact mechanism unknown
- Observations
 - TAG fraction increases when nutrients are depleted
 - Accumulation is more severe at increased light intensities
 - TAG accumulation and growth seem to exclude each other
- **Light** and **nutrients** are very important players in TAG accumulation
- Hypotheses:
 - Energy storage
 - Emergency route
 - Lipid turnover



Hypothesis: TAG act as electron sink



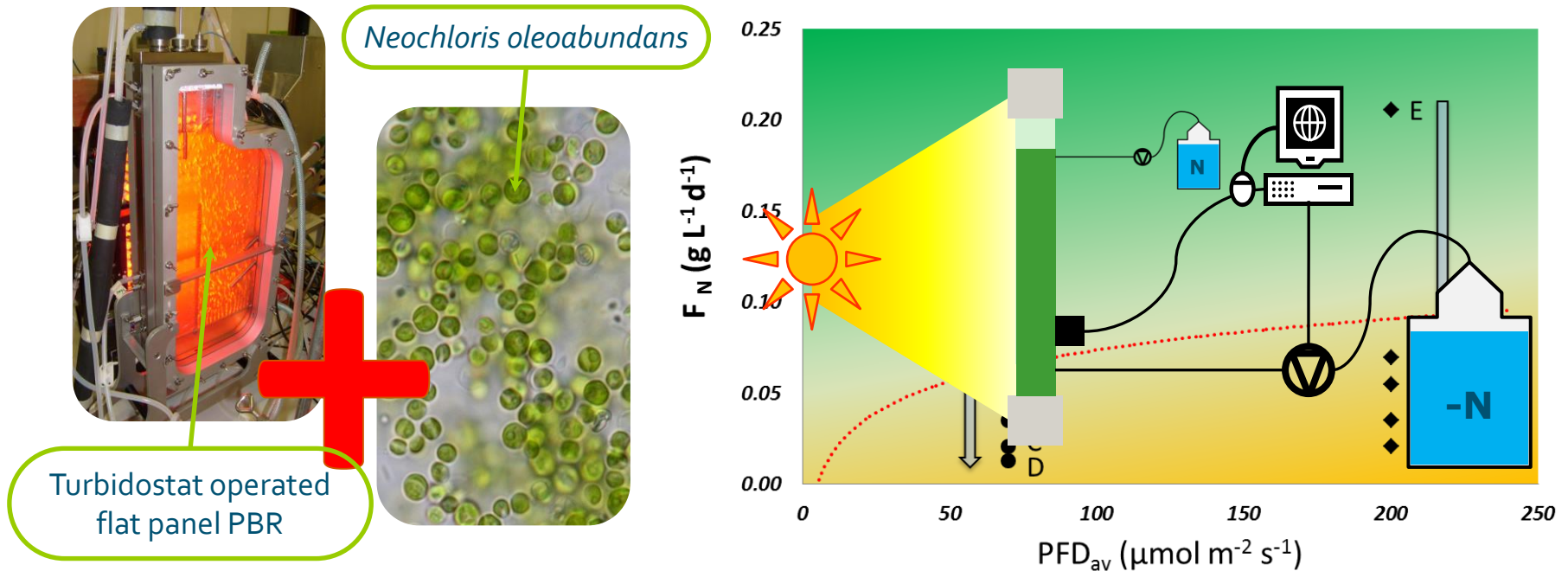
TAG accumulation: Playing around with metabolic fluxes



WAGENINGENUR
For quality of life

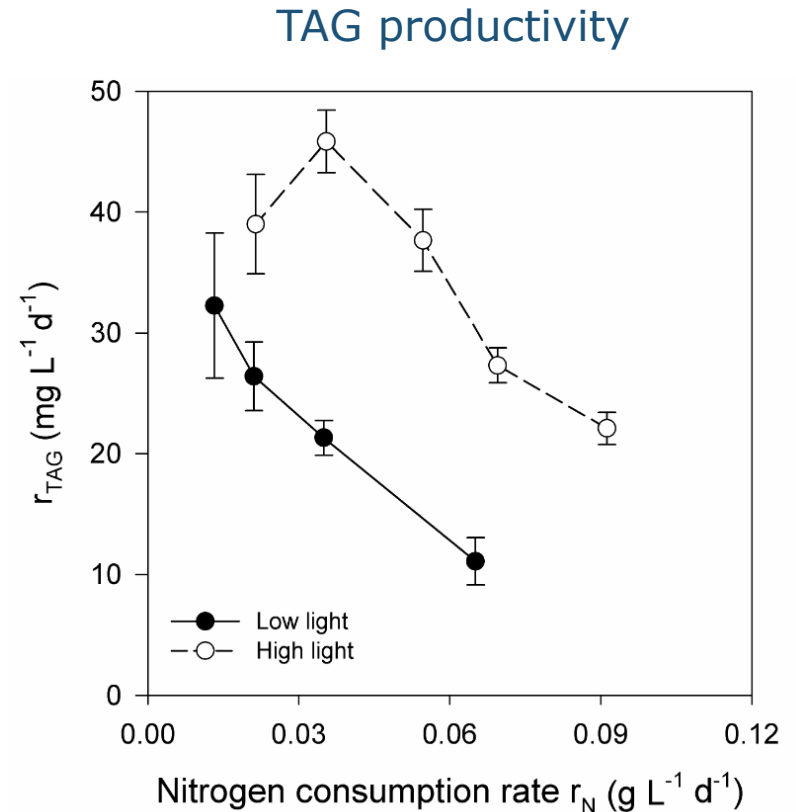
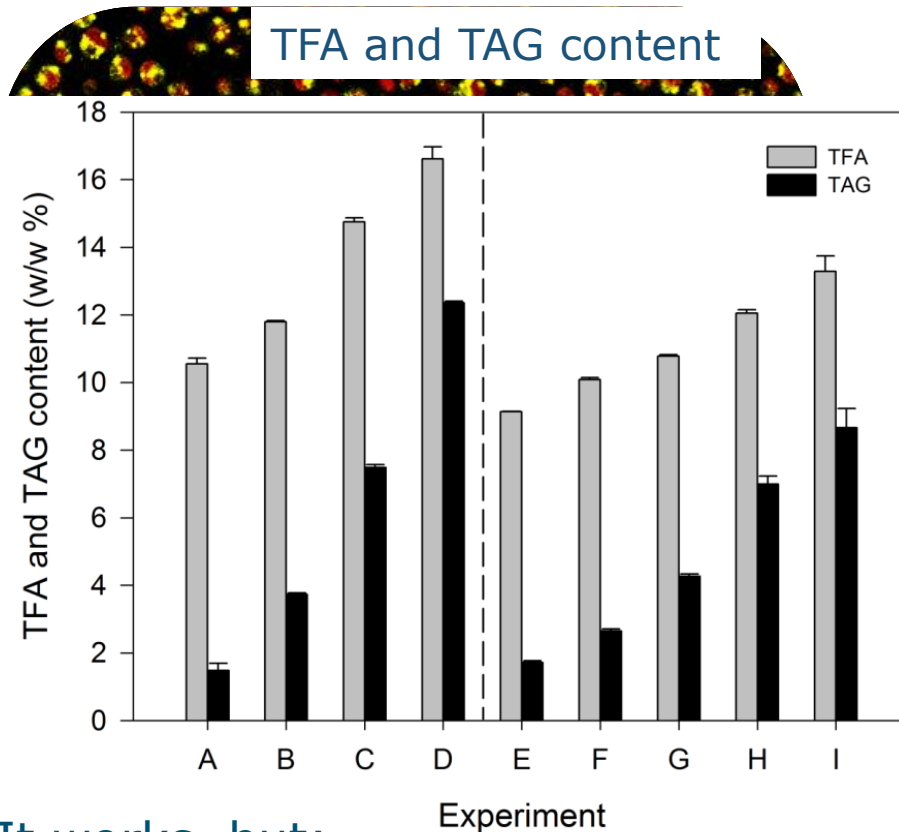


Simultaneous growth and TAG accumulation?!



- New approach: **nitrogen limitation** in **continuous operation**
 - Stable and constant light and nutrient supply rates
 - Easy to study separate effects of light and nitrogen on TAG accumulation

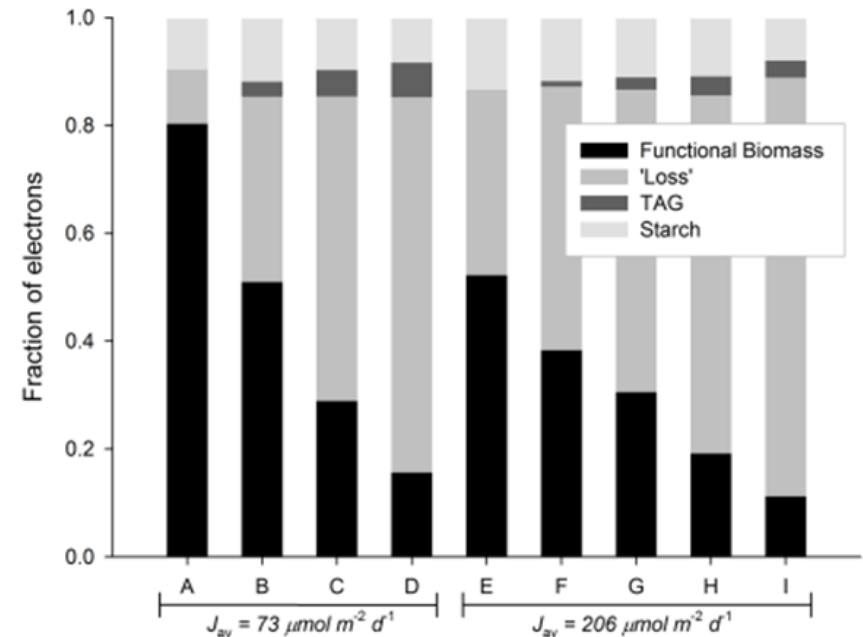
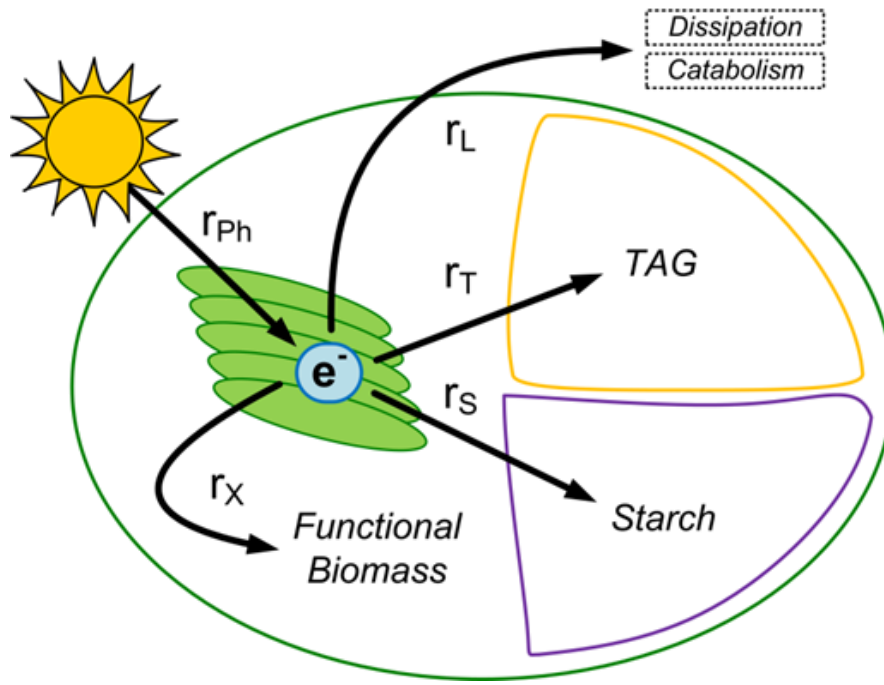
Simultaneous growth and TAG accumulation!



It works, but:

1. What is the biology behind it?
2. Is this a good TAG production strategy?

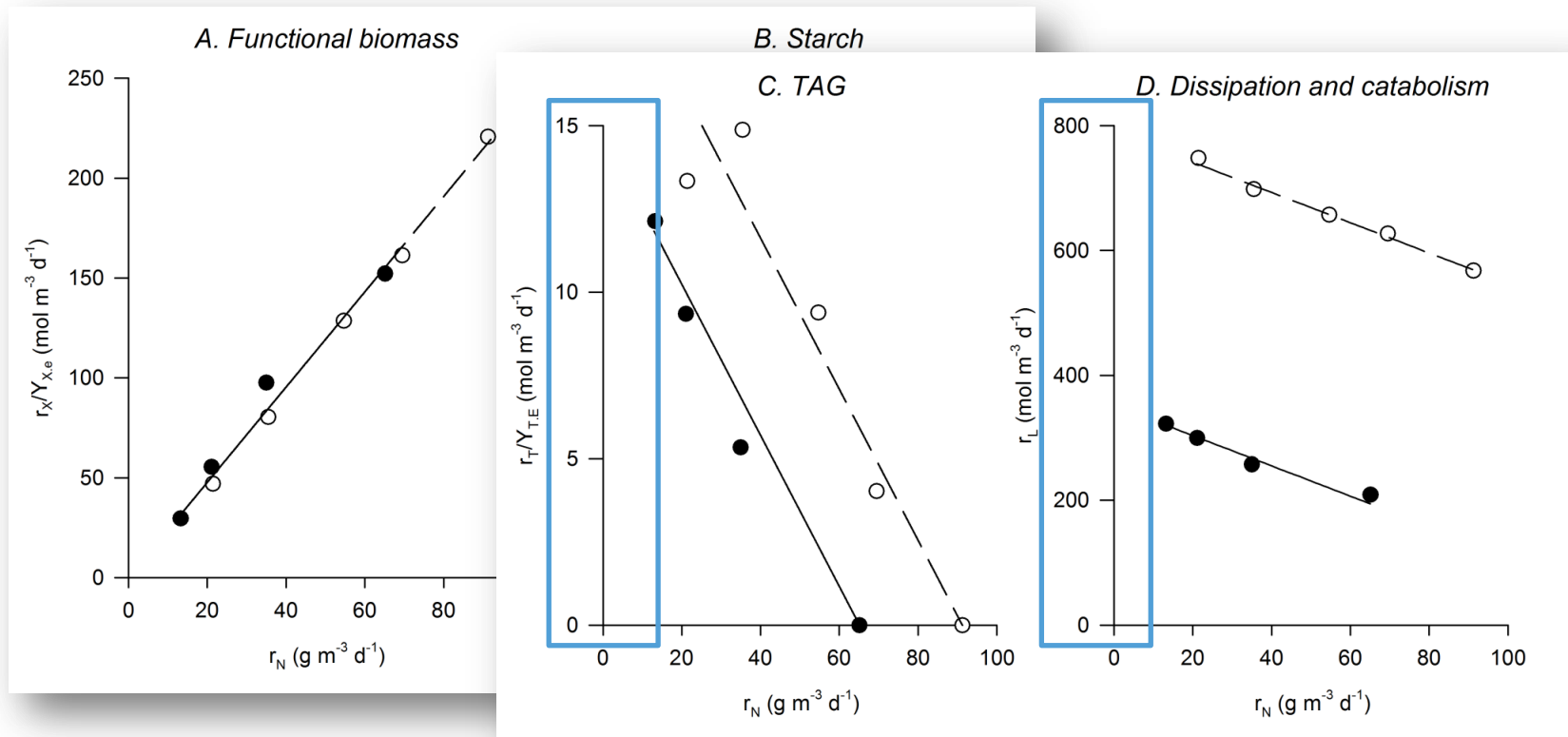
A kinetic model based on energy distribution



$$\frac{r_{Ph}}{Y_{Ph,e}} = \frac{r_X}{Y_{X,e}} + \frac{r_S}{Y_{S,e}} + \frac{r_T}{Y_{T,e}} + r_L$$

- Use observed trends to describe relations as a function of light absorption and nitrogen consumption rates.

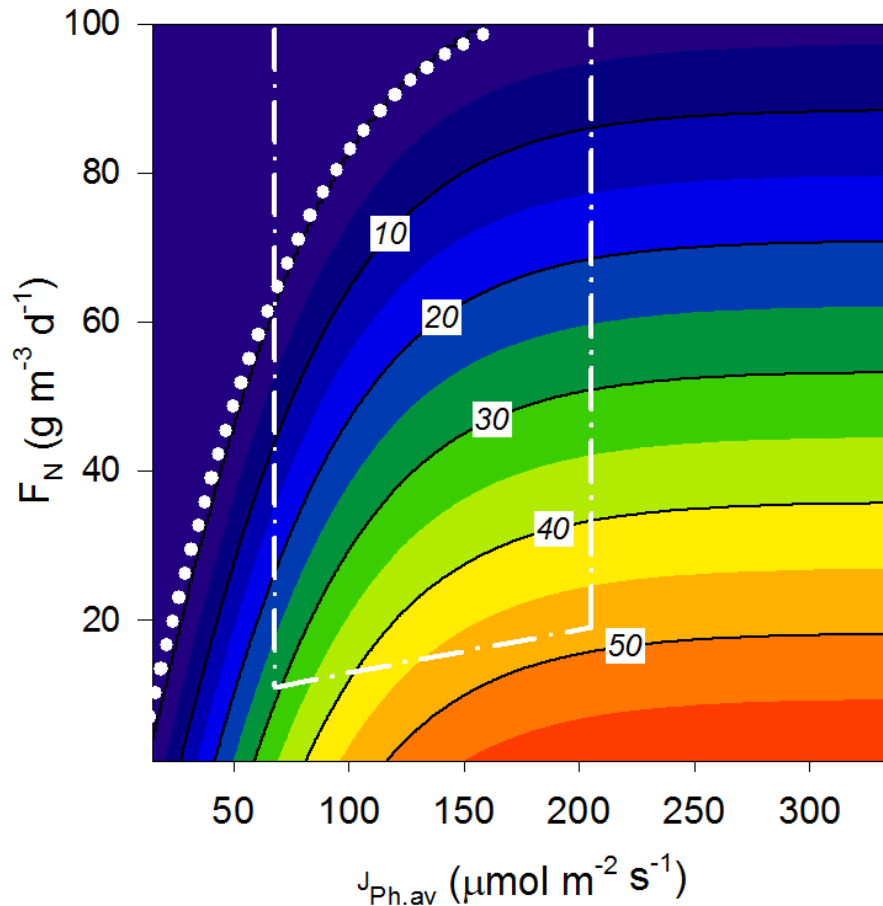
A kinetic model based on energy distribution



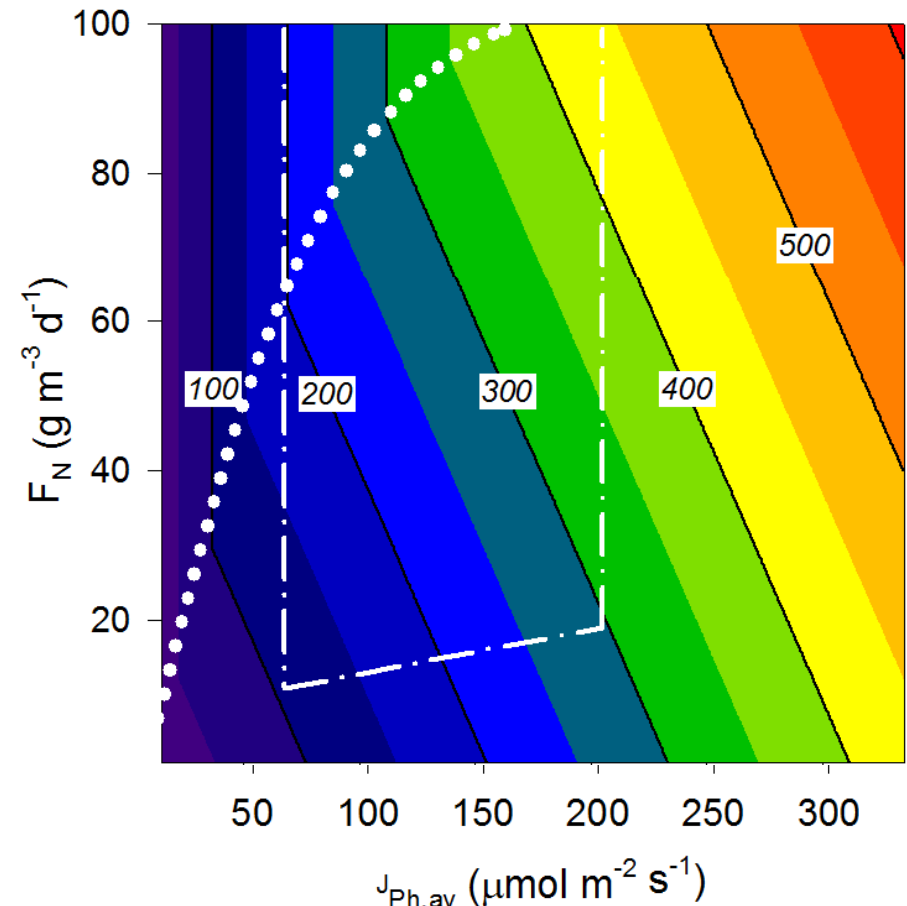
- Starch production rates decrease
- TAG accumulation scavenges only 8% of excess electrons

A kinetic model based on energy distribution

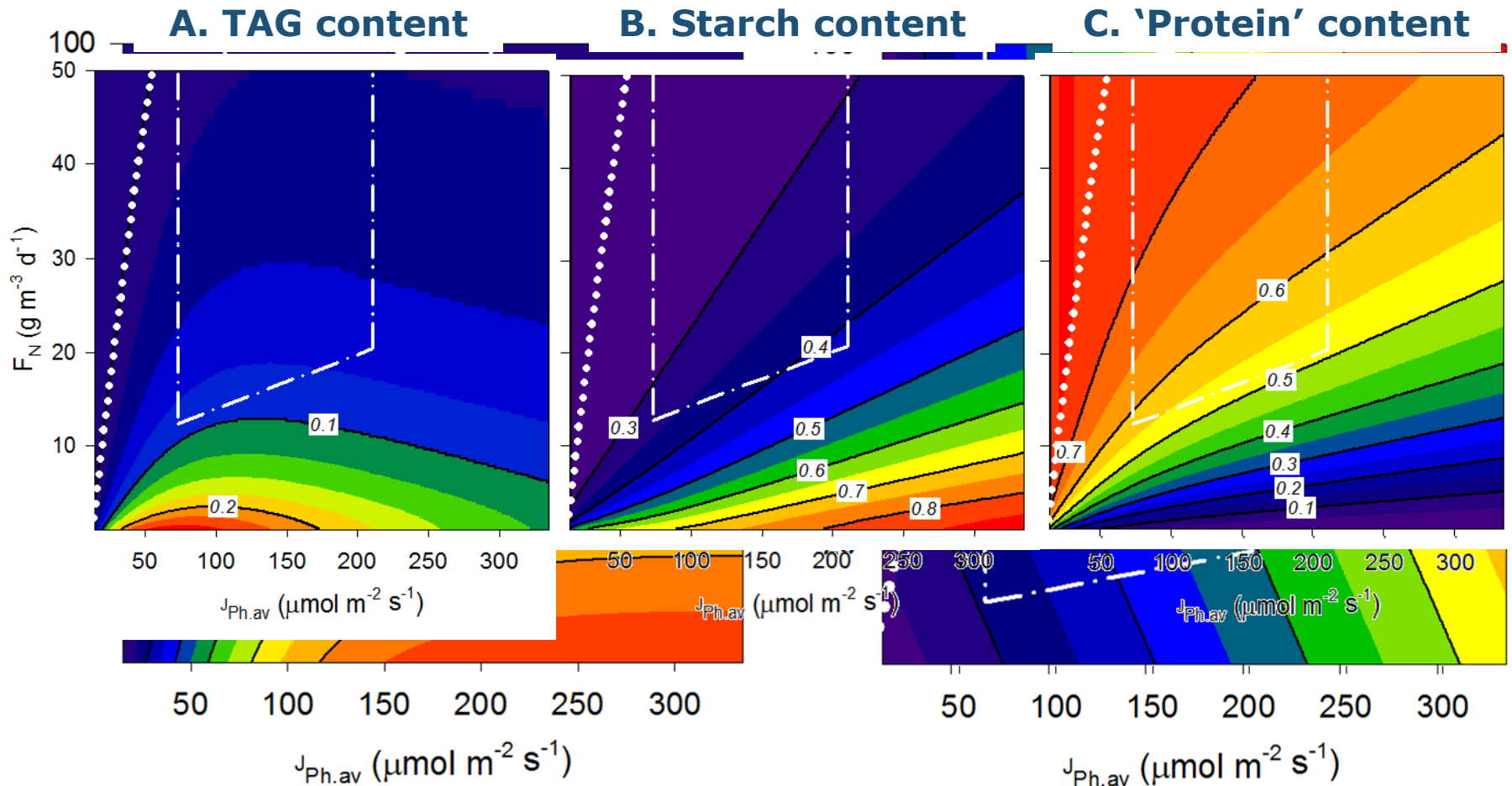
A. TAG productivity



B. Starch productivity



A kinetic model based on energy distribution



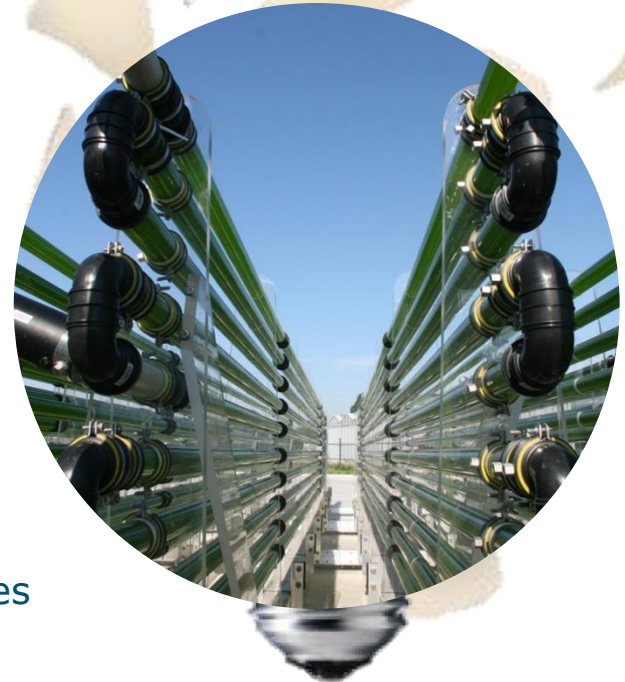
Simultaneous growth and TAG accumulation

1. What is the biology behind it?

- TAG accumulation contributes to 8% of electron scavenging
 - 'Emergency route' seems less likely: energy storage or lipid turnover
- Here, dissipation is prevailing mechanism to deal with energy imbalances
 - Screen for efficient microalgae

2. Is this a good TAG production strategy?

- Lower TAG content, productivity and yield
- Complex process
- ✓ Less down time
- ✓ Customized biomass composition
- ✓ Flexible control over outdoor TAG accumulation rates



Thank you for your attention!



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Klok, A.J., Martens, D.E., Wijffels, R.H., Lamers, P.P. (2013) *Simultaneous growth and neutral lipid accumulation in microalgae*. *Bioresource Technology*. 134, 233-243.

Klok, A.J., Verbaanderd, J.A., Lamers, P.P., Martens, D.E., Rinzema, A., Wijffels, R.H. (2013) *A model for customising biomass composition in continuous microalgae production*. *Bioresource Technology*. 146, 89-100.