



UNIVERSITÀ
di **VERONA**

Dipartimento
di **BIOTECNOLOGIE**

Aumento della produzione di biomassa, biocarburanti e prodotti ad elevato valore aggiunto tramite il miglioramento e l'efficienza fotosintetica in colture di microalghe: obiettivi e metodologie del progetto SOLENALGAE

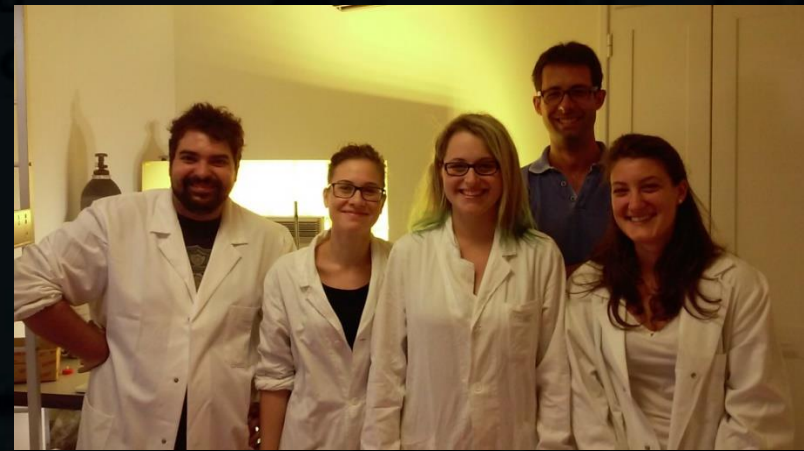
Prof. Matteo Ballottari

**University of Verona,
Department of Biotechnology**



European Research Council

Established by the European Commission



ERC. Agenzia per la ricerca della comunità europea

PROGETTO FINANZIATO ERC- STG 2015 SOLENALGAE

**Improving photosynthetic Solar
Energy conversion in microalgal
cultures for the production of
biofuels and high value products**

Budget: 1.441.875 Euro

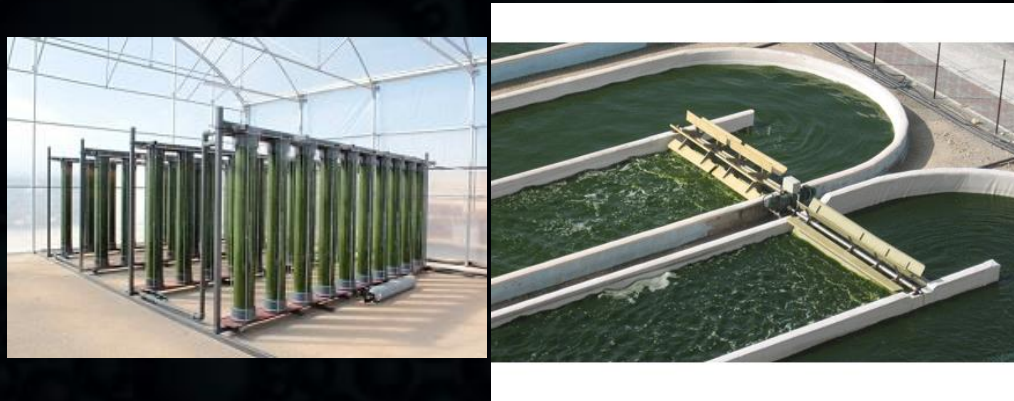


Area di SCIENZE e INGEGNERIA - Università degli Studi di Verona

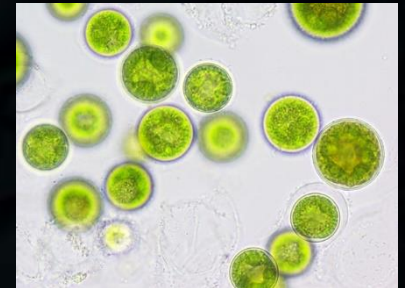
LIMITE DELLA COLTIVAZIONE DI MICROALGHE: produzione in molti casi non sostenibile

NECESSITA' DI AUMENTARE LA PRODUZIONE!!!!

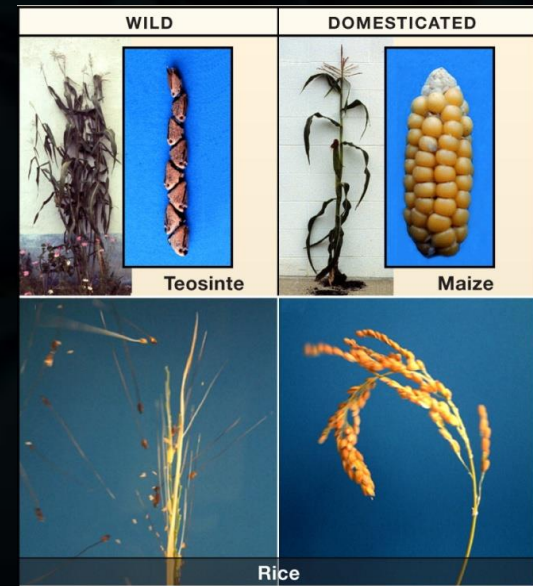
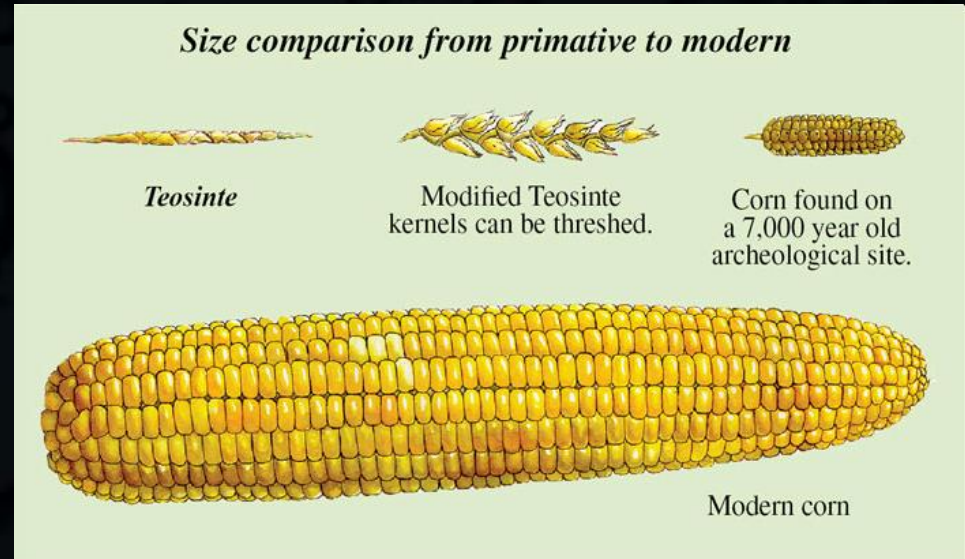
SISTEMI DI COLTIVAZIONE PIU' EFFICIENTI



**SELEZIONE DI CEPPI /
MIGLIORAMENTO GENETICO**



Tutte le piante agricole dono state “addomesticate” nel corso dei secoli: ANCHE LE MICROALGHE DEVONO ESSERE ADDOMESTICATE

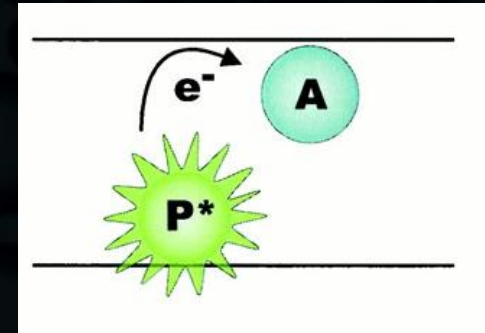


Photosynthetic Solar Energy conversion

Solar Energy is the most abundant renewable energy source available for our Planet



Photosynthesis



LIGHT ENERGY → **CHEMICAL ENERGY**

BIOMASS



Photosynthetic Solar Energy conversion

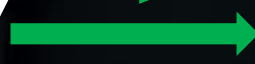
When Light is in excess: saturation of photosynthesis and
Reactive Oxygen Species formation



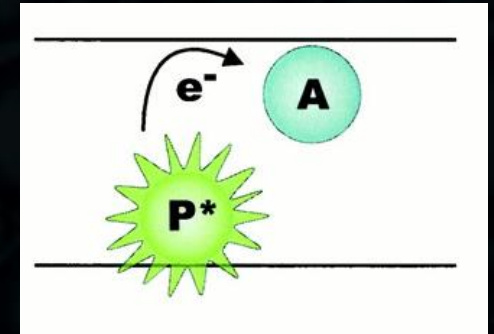
HIGH LIGHT

LIGHT ENERGY

Photosynthesis



CHEMICAL ENERGY



O_2



ROS



BIOMASS



Photosynthetic Solar Energy conversion

NPQ activation: reduction of Photosynthetic energy conversion efficiency



HIGH LIGHT

LIGHT ENERGY

Photosynthesis

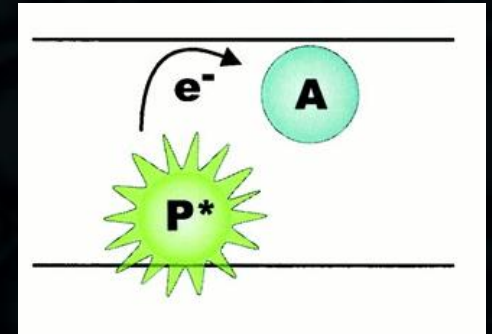


CHEMICAL ENERGY

Photoprotective
mechanisms

HEAT

(up to 80% of energy loss)



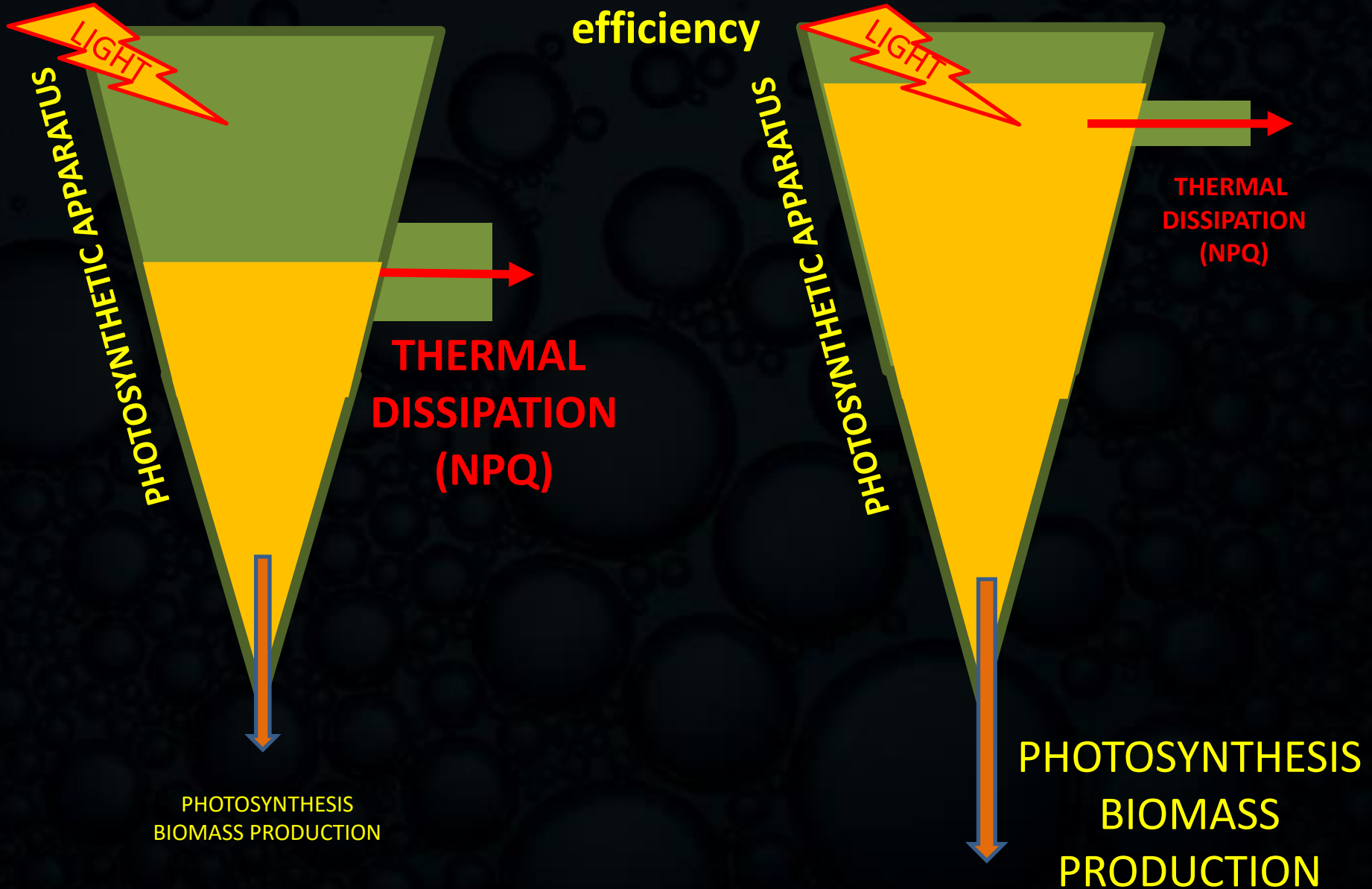
BIOMASS



NPQ: Non Photochemical Quenching

Photosynthetic Solar Energy conversion

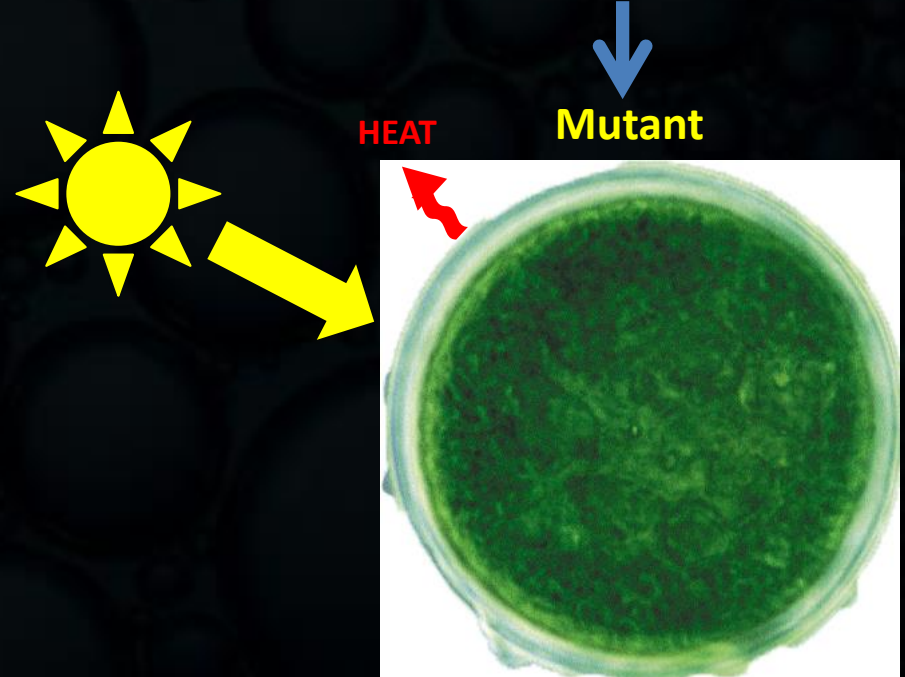
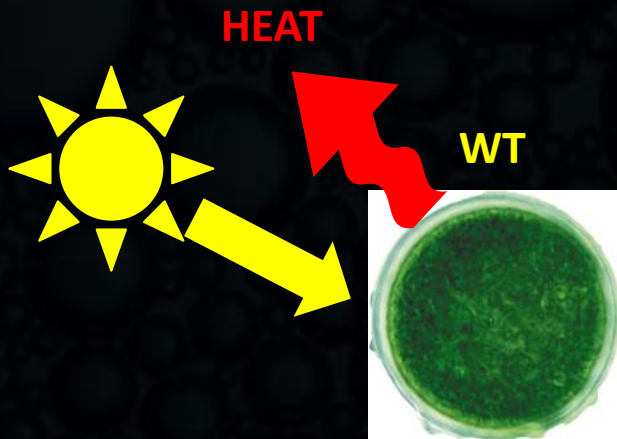
NPQ activation: reduction of Photosynthetic energy conversion efficiency



The SOLENALGAE proposal:

- 1) Investigate the molecular basis for light energy dissipation
- 2) Increase the biomass production in microalgae by tuning NPQ

Can we increase the light use efficiency of a microalgae cell tuning NPQ? How?



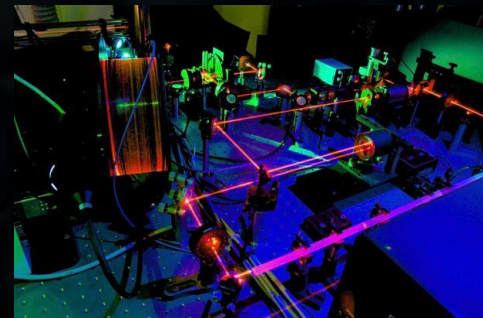
1) Understanding the molecular basis for the activity of the proteins involved in NPQ

In vitro and *in vivo* biochemical, spectroscopic and physiological investigation

Strains with altered NPQ activation



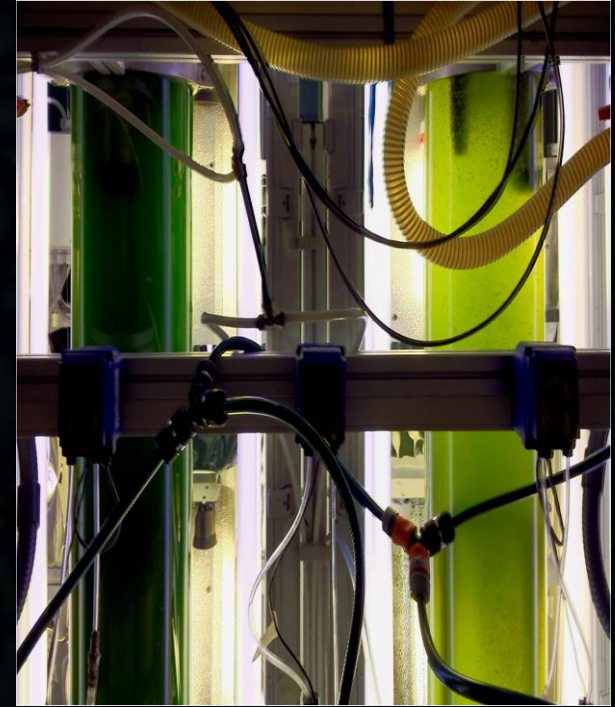
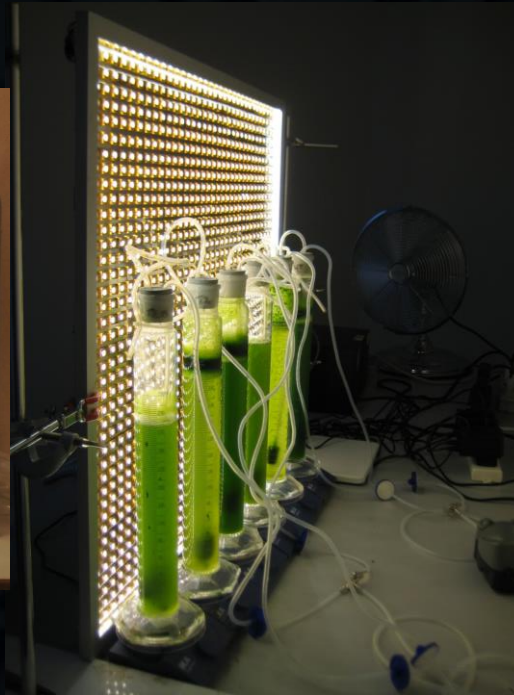
Politecnico of Milan:
Fast spectroscopy facilities



Determination of the molecular details of
NPQ activation

2) Investigation of the biomass productivity of *C. reinhardtii* strains with modulated LHCSR activity

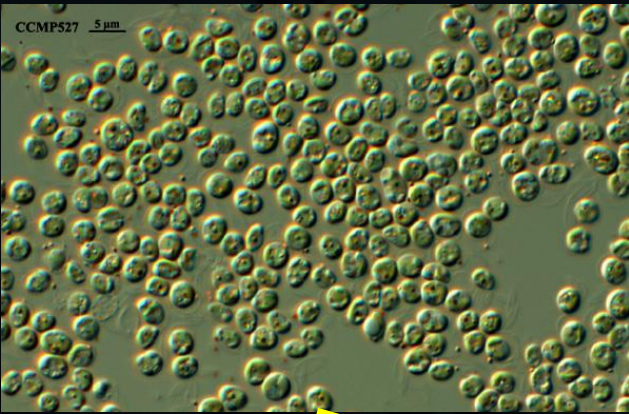
- Productivity of mutant in different photobioreactors (from 100ml to 60L)



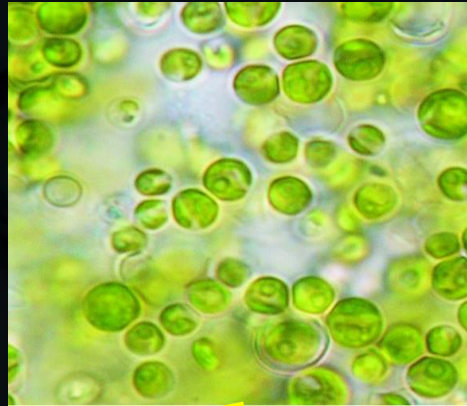
- Influence of NPQ on productivity
- Determination of mutations improving light use efficiency

3) Genetic manipulation of selected microalgae species in order to increase the biomass productivity by reducing the heat dissipation of the light absorbed.

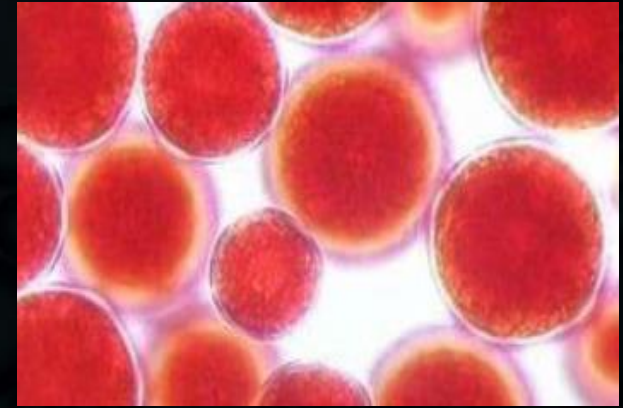
Nannochloropsis



Chlorella



Haematococcus



**Fast growing
High lipid content**

- ✓ Genome
- ✓ Transformation report

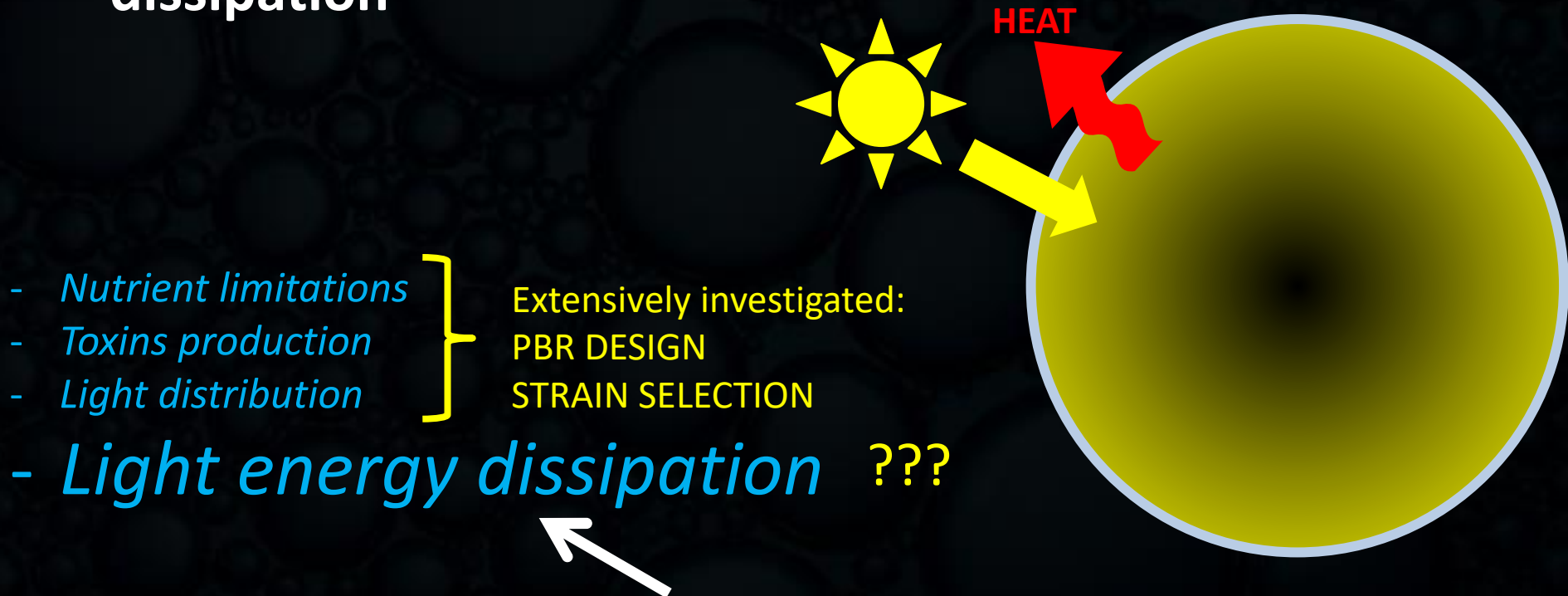
- ✓ Transformation report
- ✓ Genome under sequencing

**High carotenoid
content
(astaxanthin)**

- ✓ Transformation report
- ✓ Genome under sequencing

Innovative aspects of the Proposal:

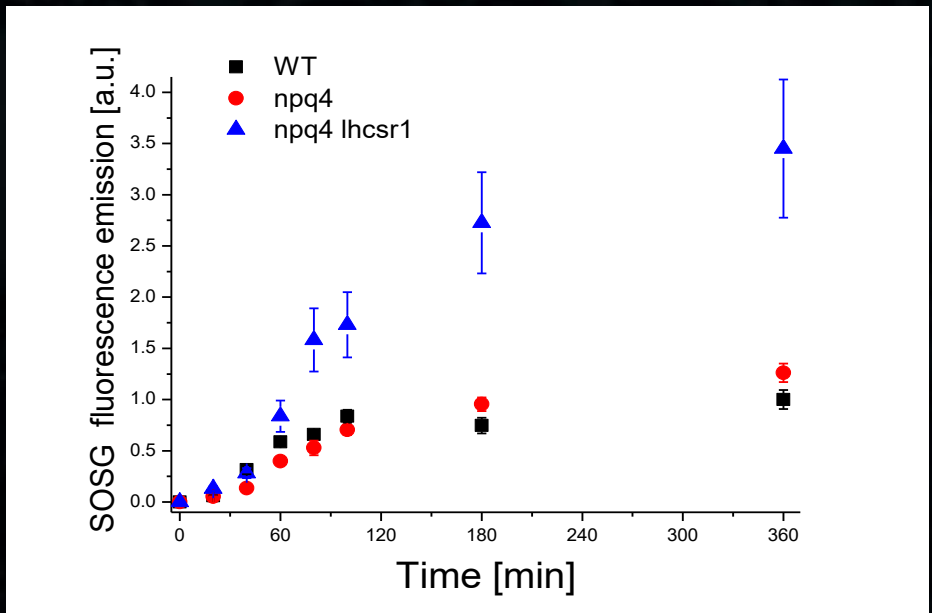
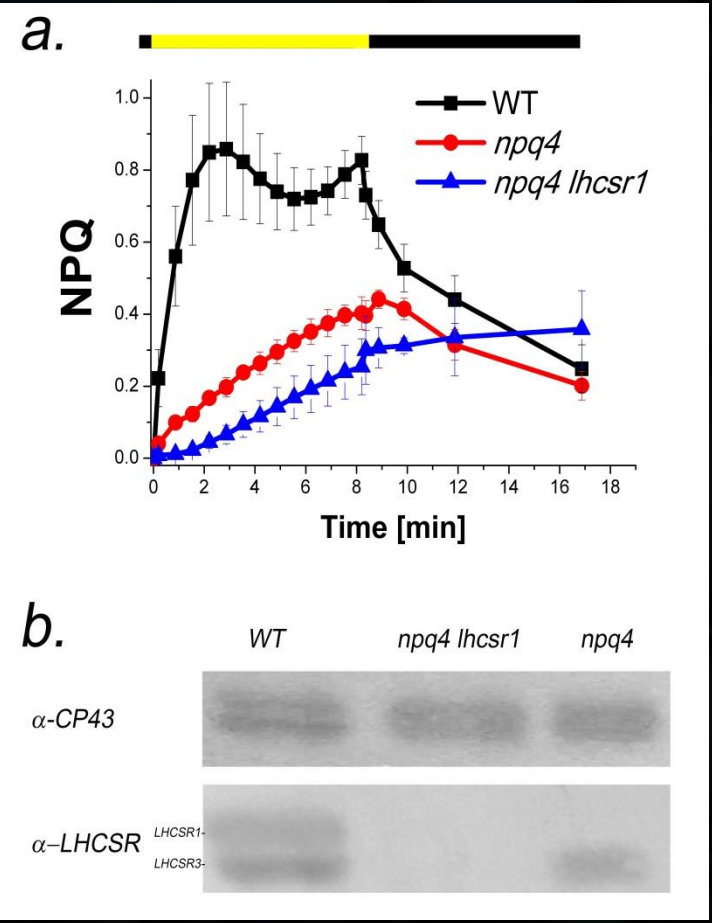
- Combined *in vivo* and *in vitro* mutagenesis approaches
- Improvement of biomass yield by reducing heat dissipation



Preliminary results: reduction of NPQ improves photosynthetic efficiency and biomass yield

In *Chlamydomonas reinhardtii* mutants are available with reduced NPQ: mutants on LHCSR genes

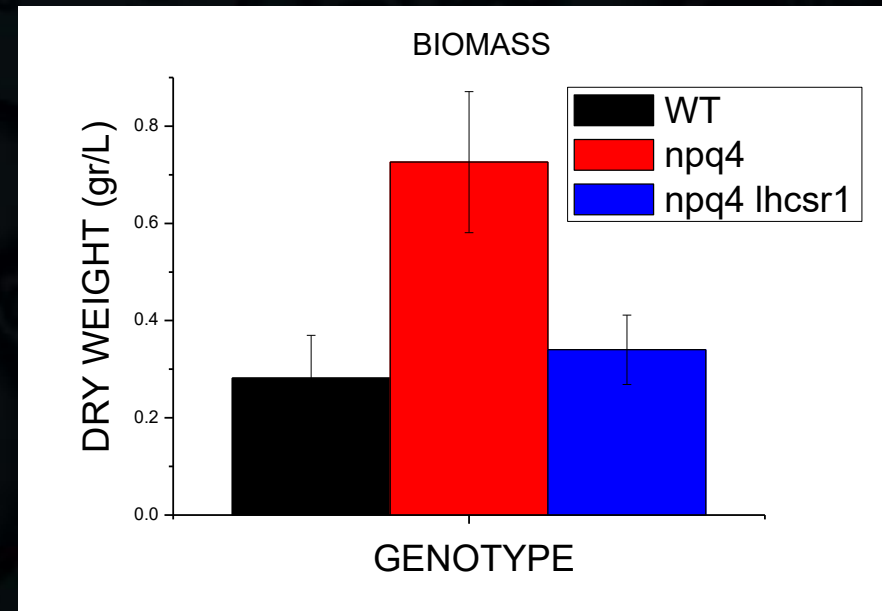
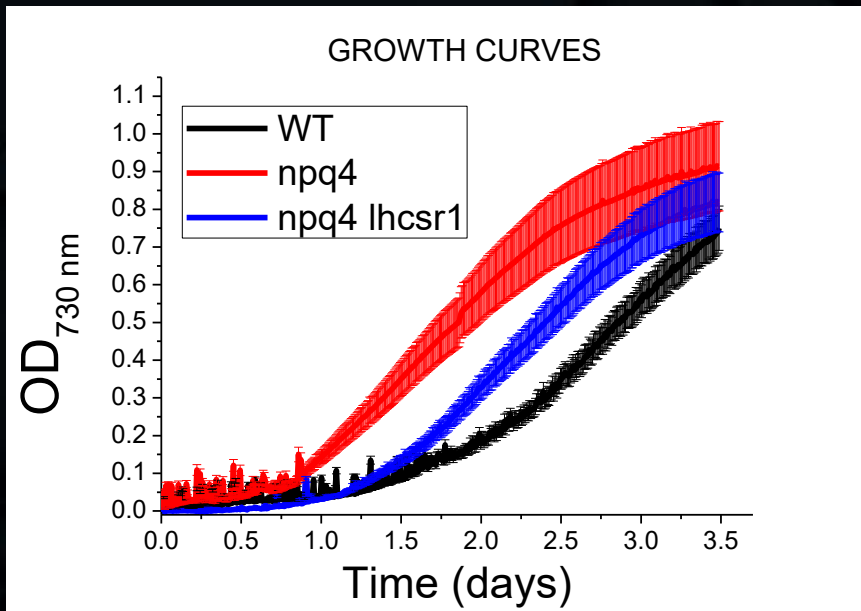
LHCSR proteins: chlorophyll binding proteins which are responsible for NPQ induction in green algae



WT is not more photoprotected compared to *npq4*: NPQ is induced in excess

Preliminary results: reduction of NPQ improves photosynthetic efficiency and biomass yield

In *Chlamydomonas reinhardtii* mutants are available with reduced NPQ: mutants on LHCSR genes

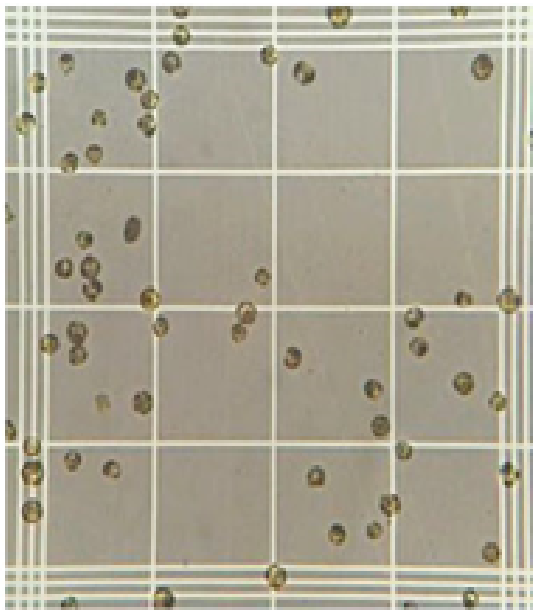


By tuning NPQ it is possible to increase biomass productivity

Preliminary results: reduction of NPQ improves photosynthetic efficiency and biomass yield

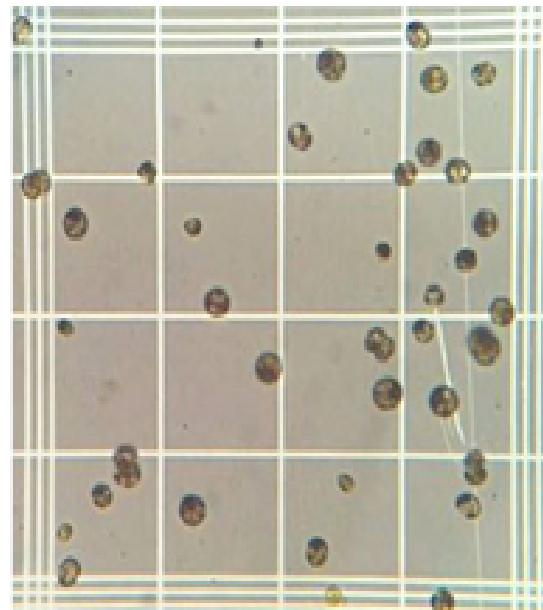
In *Chlamydomonas reinhardtii* mutants are available with reduced NPQ: mutants on LHCSR genes

WT - CC425



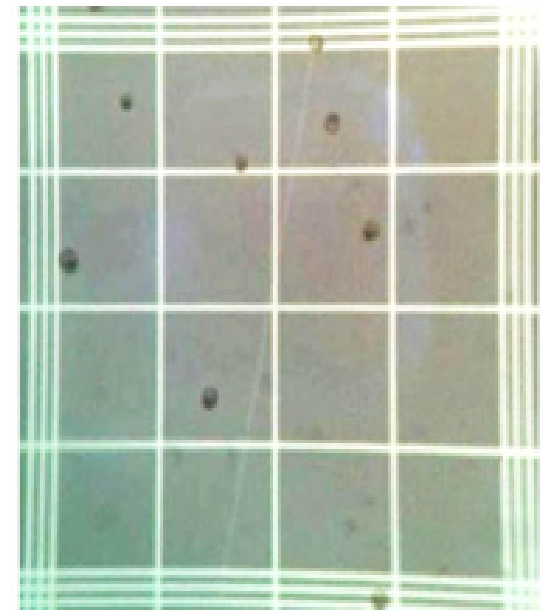
0,2 mm

npq4



0,2 mm

npq4 lhcsr1



0,2 mm

Reduced NPQ: BIGGER CELLS

At end of SOLENALGAE project:

Major scientific achievements:

- **Determination of the molecular mechanisms of NPQ in microalgae**
- **Evaluation of the possibility to increase light use efficiency by reducing NPQ**
- **Engineering algal strains of different species, domesticating natural organisms, for high production in photobioreactors or open ponds**

**Application in different
industry sectors**





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