Exploring the photosynthetic response to light

An example using the LI-6800 portable photosynthesis system to quantitatively explore photosynthesis

LI-COR®

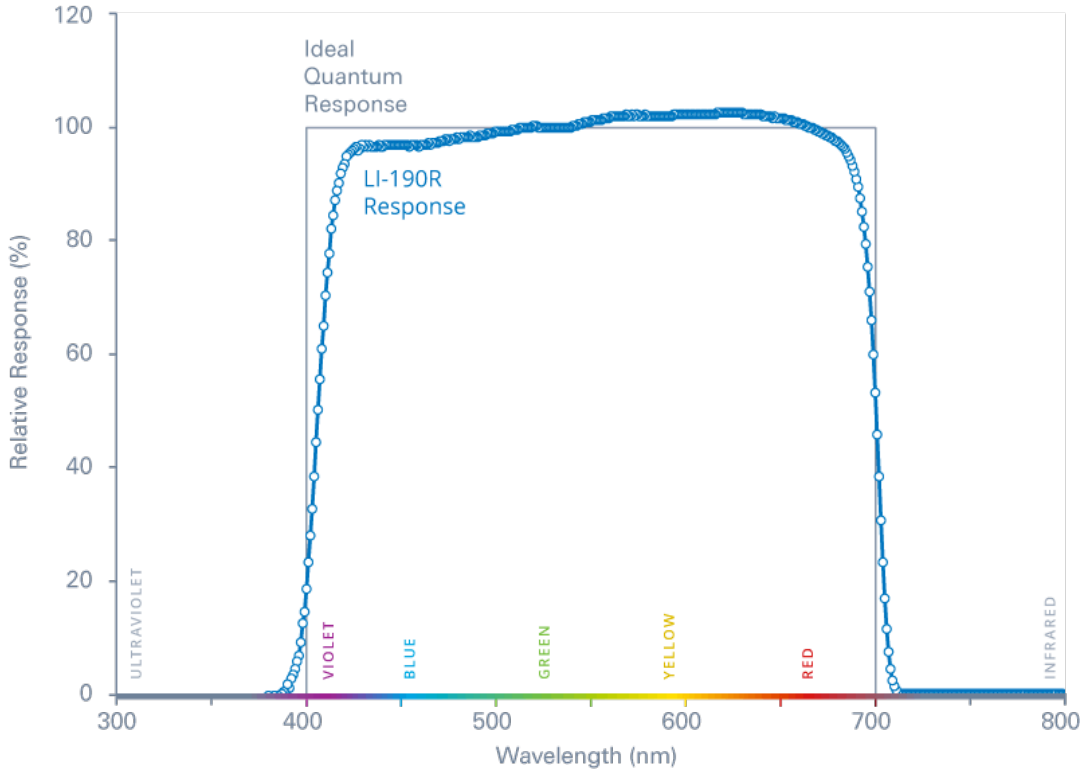
Agenda

- Review gas transport and photosynthetic pathways
- Review experimental protocol
- Measure photosynthetic response to light (AQ)
- Examine the data and fit light response parameters

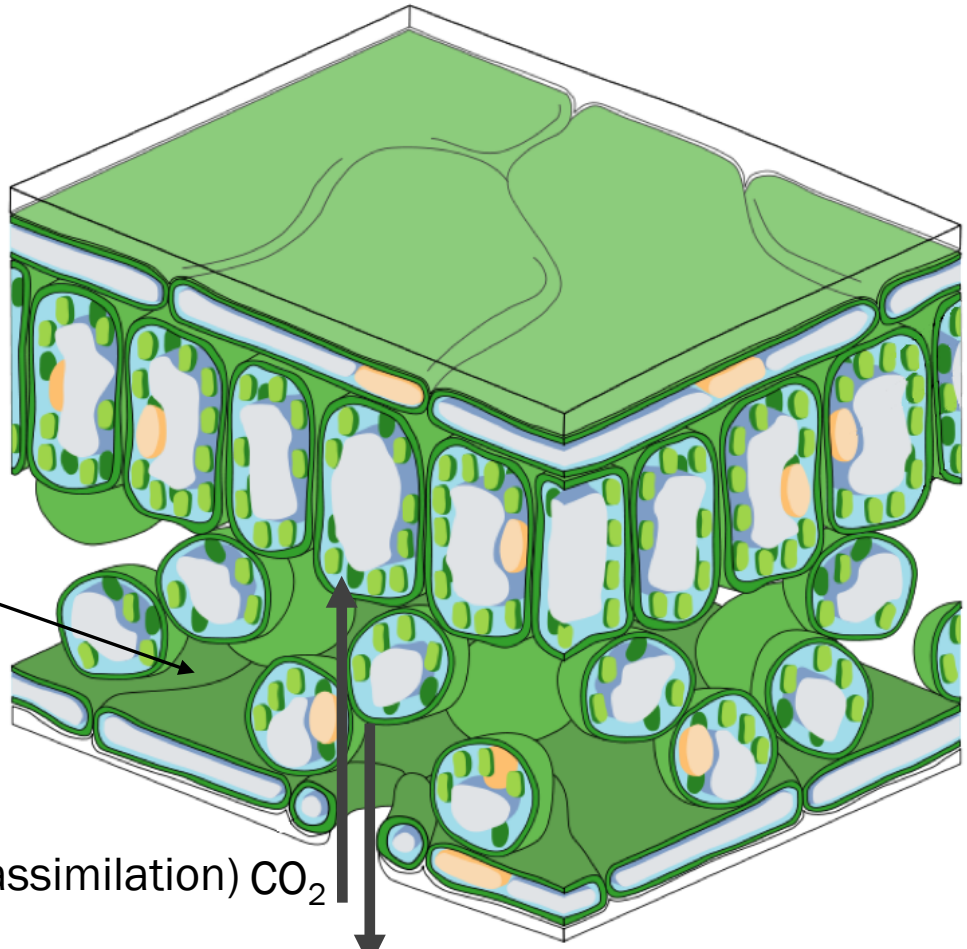
Don’t be shy, this is meant to be interactive! Ask me questions as we go, and answer questions when I ask them.

Photosynthetically Active radiation (PAR)

- The light that is used to drive photochemistry
- Expressed as a flux of photons per unit area
  - umol m^{-2} s^{-1}



Gas transport between the leaf and atmosphere



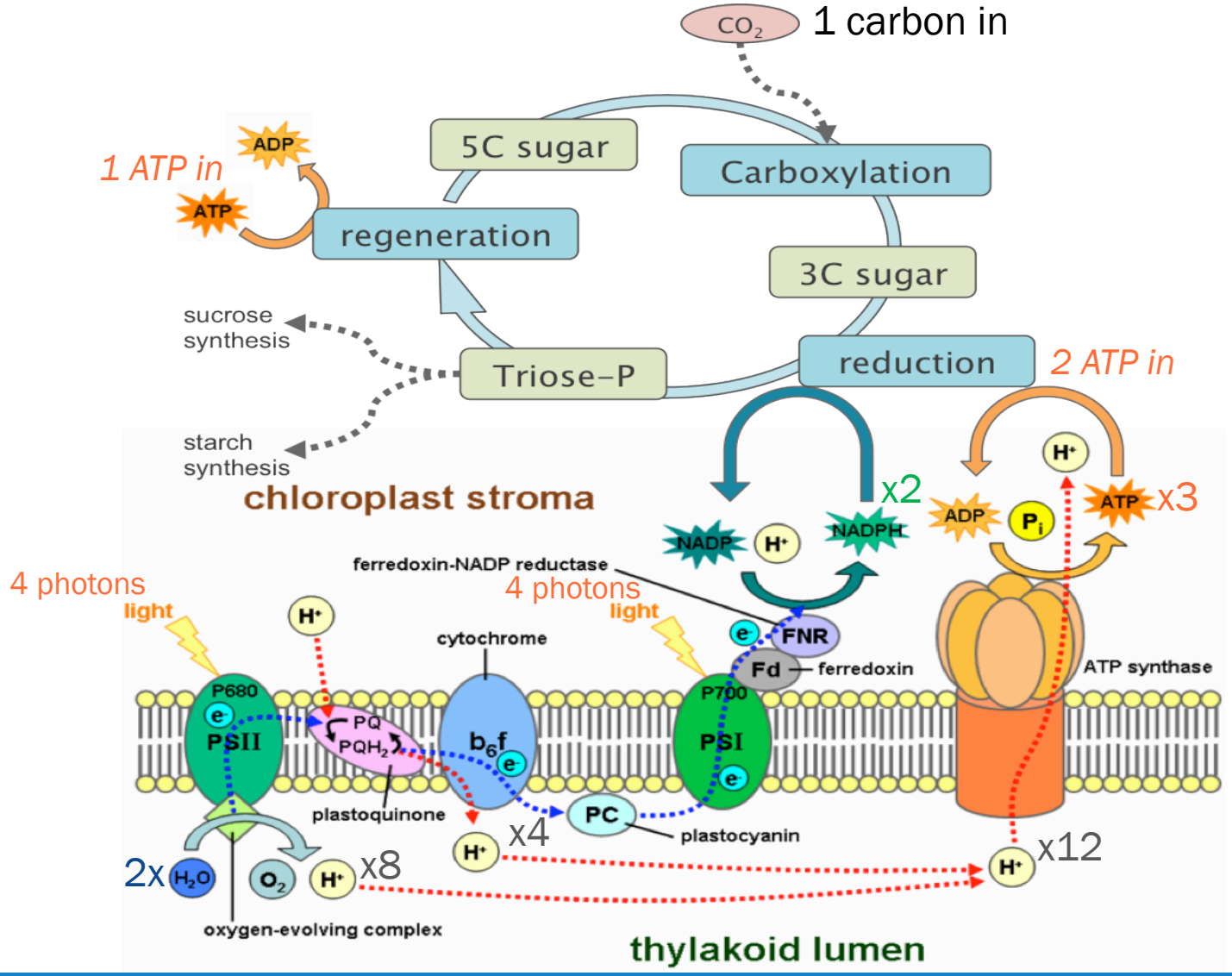
C_i: CO_2 concentration inside the leaf's inter cellular airspace

(A: assimilation) CO_2

H_2O (E: transpiration)

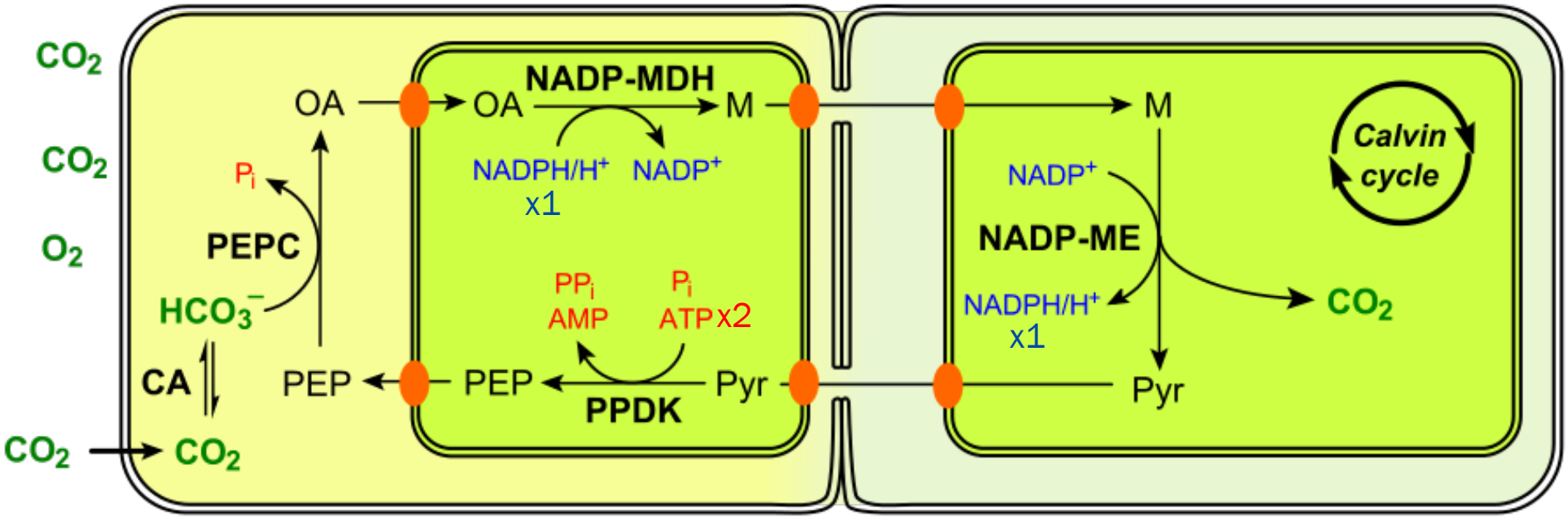
g_{sw}: Stomatal conductance to water vapor

The C3 carbon fixation pathway



The C4 carbon fixation pathway

- We add extra steps to carbon fixation in C4 plants
- These extra steps cost energy (2xATP) and concentrate CO_2 around the chloroplasts



NADP-ME type

The LI-6800 portable photosynthesis system

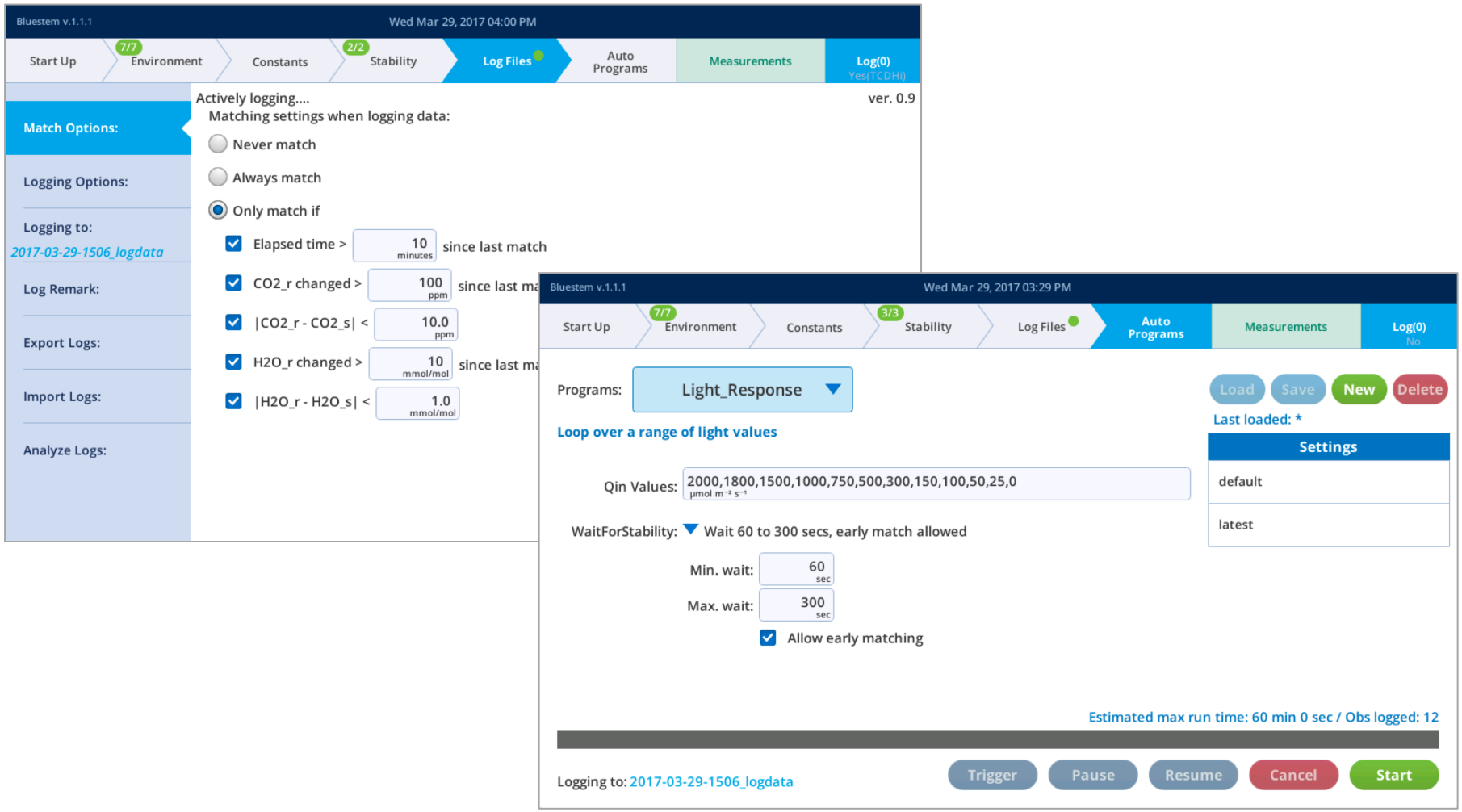
Review of lab procedure

- Your instructor has been pre-acclimating our plant material to full sun light
- You need to…
  - Verify that assimilation is at steady state
  - Open a log file
  - Configure the instrument to make the light response measurement sequence
  - Download and analyze the data

Measurement protocol

- Program:
  - Light_Respone
- Qin value:
  - 2000, 1500, 1200, 1000, 750, 500, 250, 100, 75, 50, 25, 10, 0
- Minimum wait time:
  - 120 seconds
- Maximum wait time:
  - 300 seconds
- Allow early matching

Configuring the light response curve



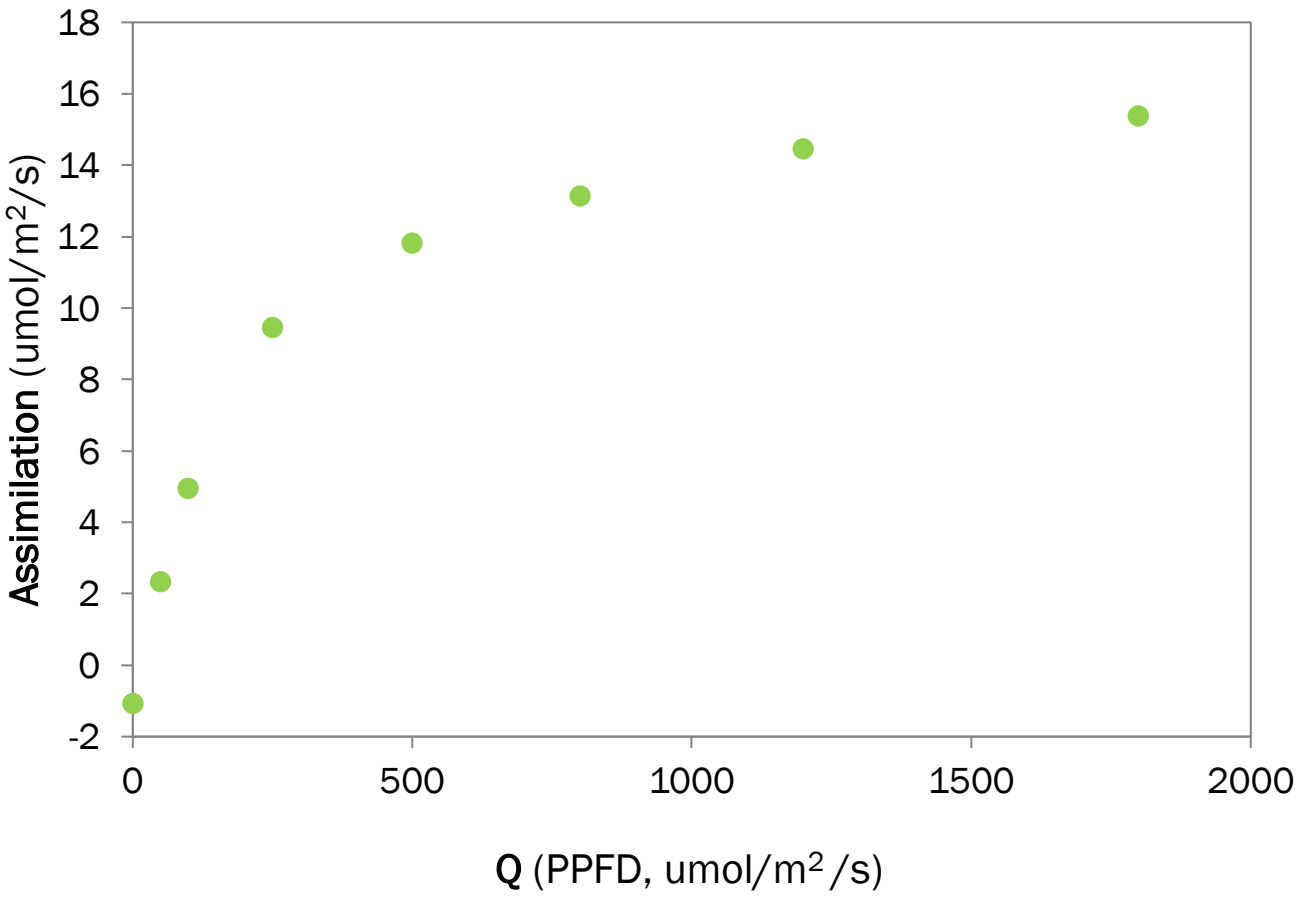
Some pre-measurement questions

- What might we expect the photosynthetic response to look like?
- Why do we start at high light intensity?

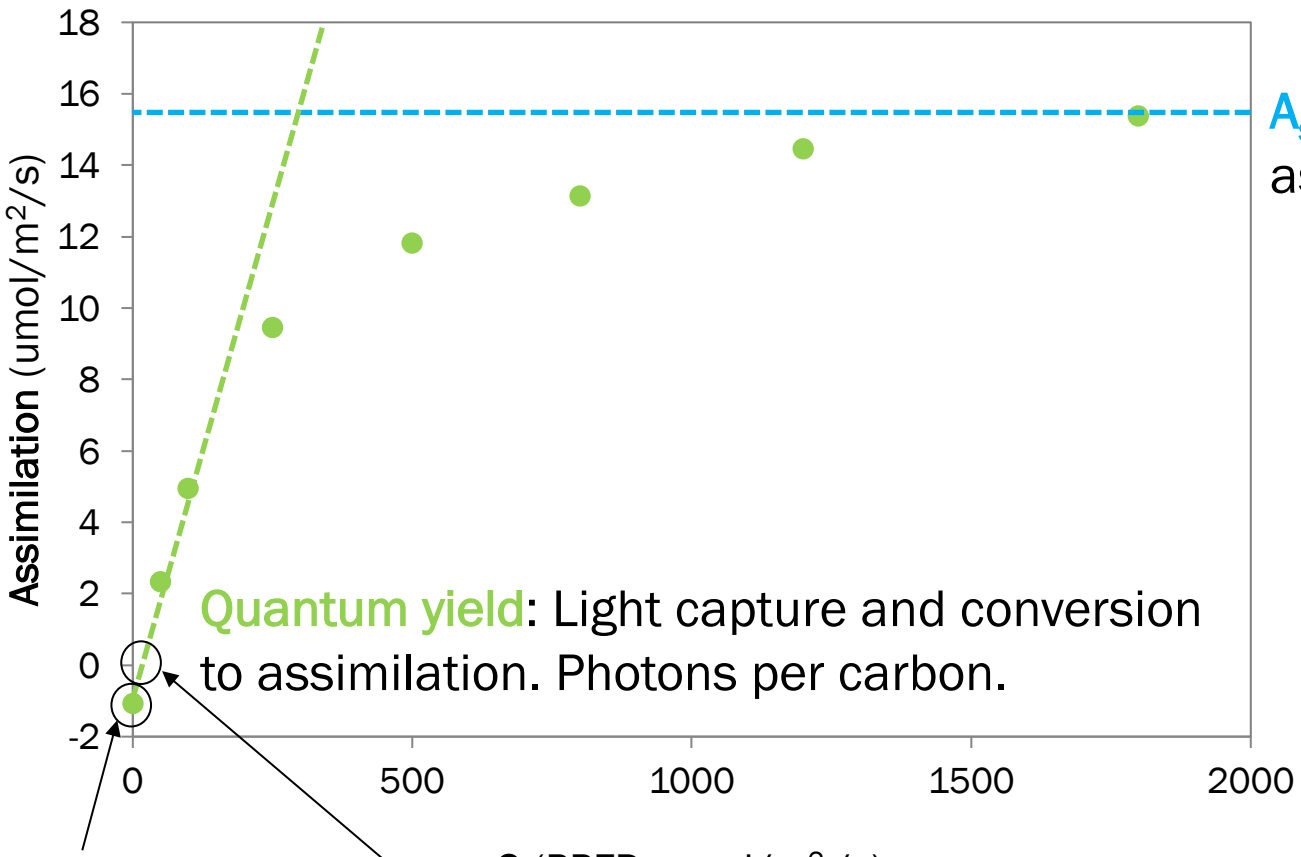
Let's do this!

- Volunteers?

AQ curve


18
16
14
12
10
8
6
4
2
0
-2
Assimilation (umol/m2/s)
0
500
1000
1500
2000
Q (PPFD, umol/m2/s)

Parameters from AQ response



A_{sat}: Light saturated assimilation rate.

Quantum yield: Light capture and conversion to assimilation. Photons per carbon.

R_d: Respiration rate

LCP: Light intensity where A=0.

Some questions to think about

- What was the quantum yield of carbon assimilation?
- What yield might we expect?
- Would we expect similar results in a C3 plant?
- What was the saturating light intensity and what was A_{sat}? What does this tell us?