IPS-141
Sensory and Physiological Ecology of Plants

x: Stomata and gas-exchange

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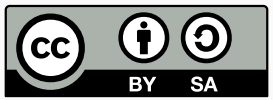


Outline

Stomata

Stomata, responses to light

Measurement of leaf conductance

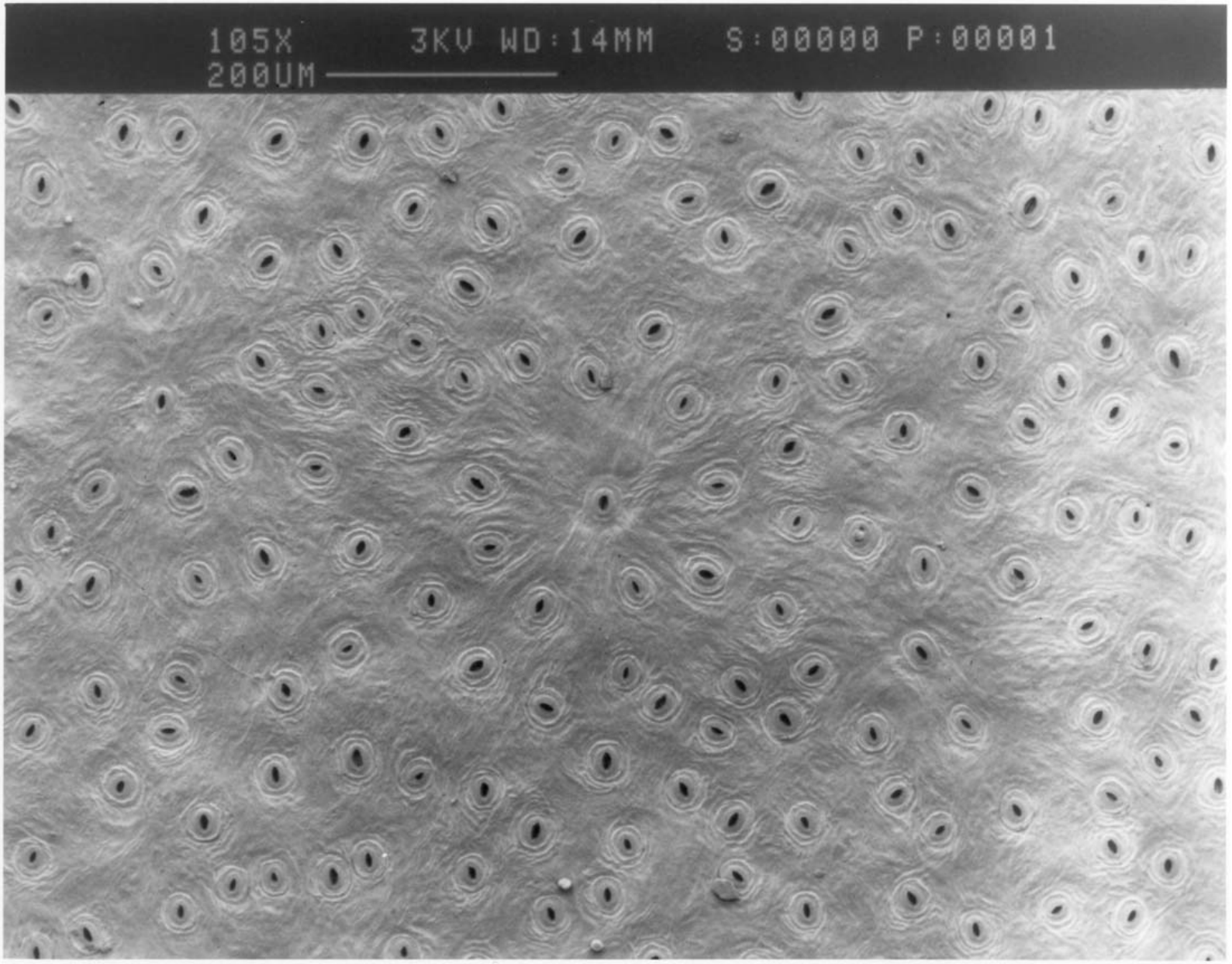
Thermography and non-contact sensors

Measurement of spectral irradiance

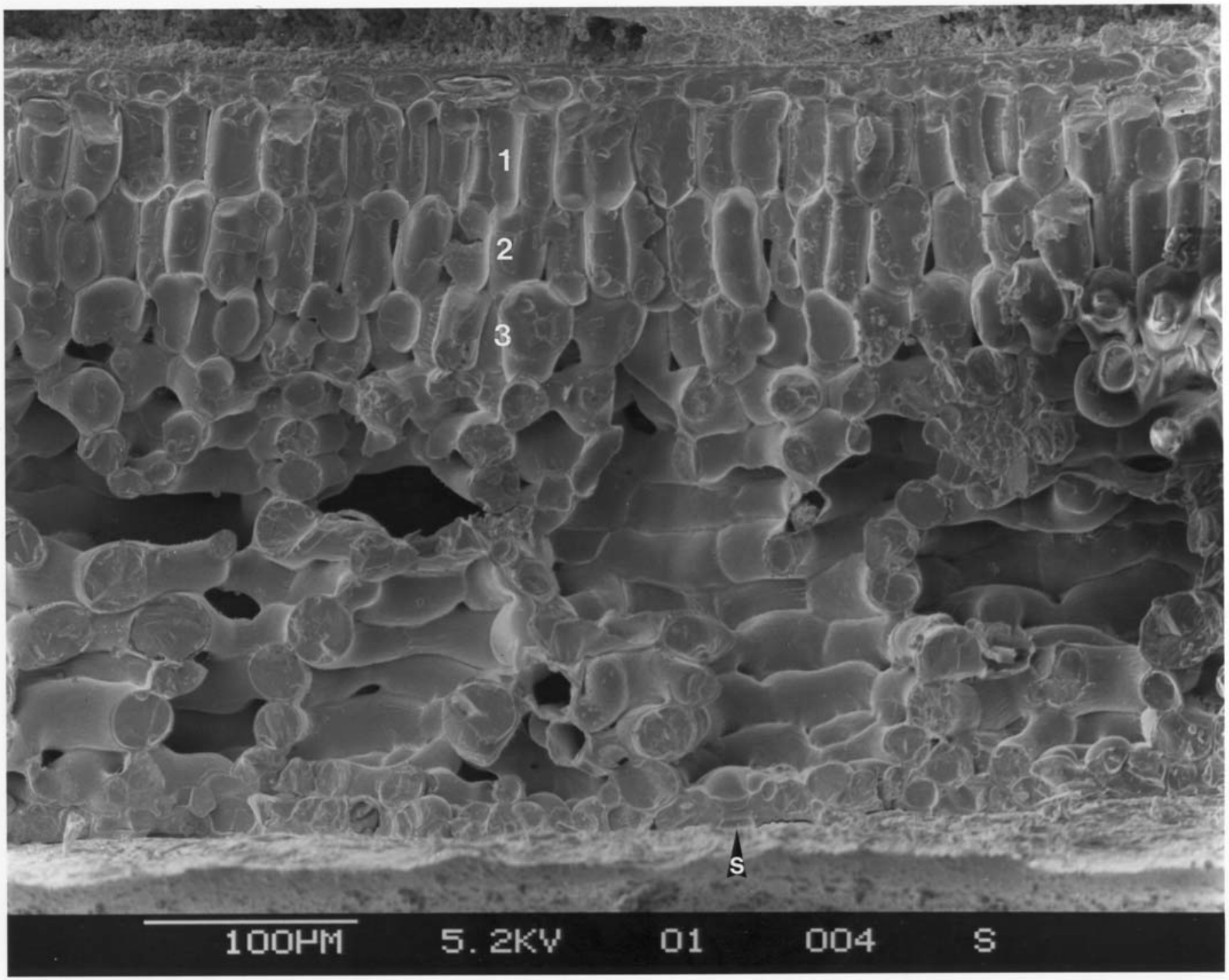
Measurement of gas-exchange

Stomata

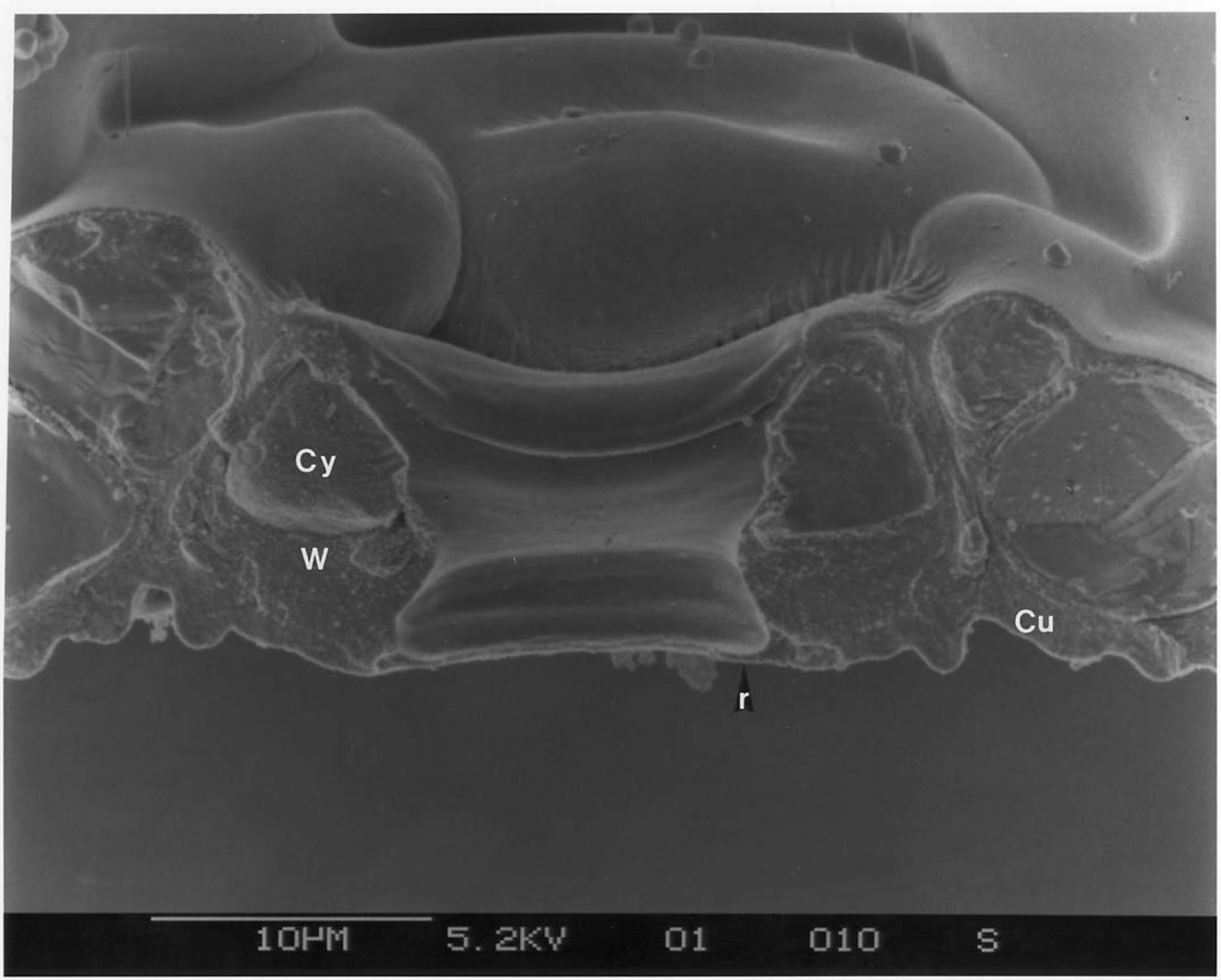
Stomata on the abaxial epidermis (*Hedera helix* L.)



Cross-section of a juvenile leaf (*Hedera helix* L.)



Cross-section of a stoma (*Hedera helix* L.)

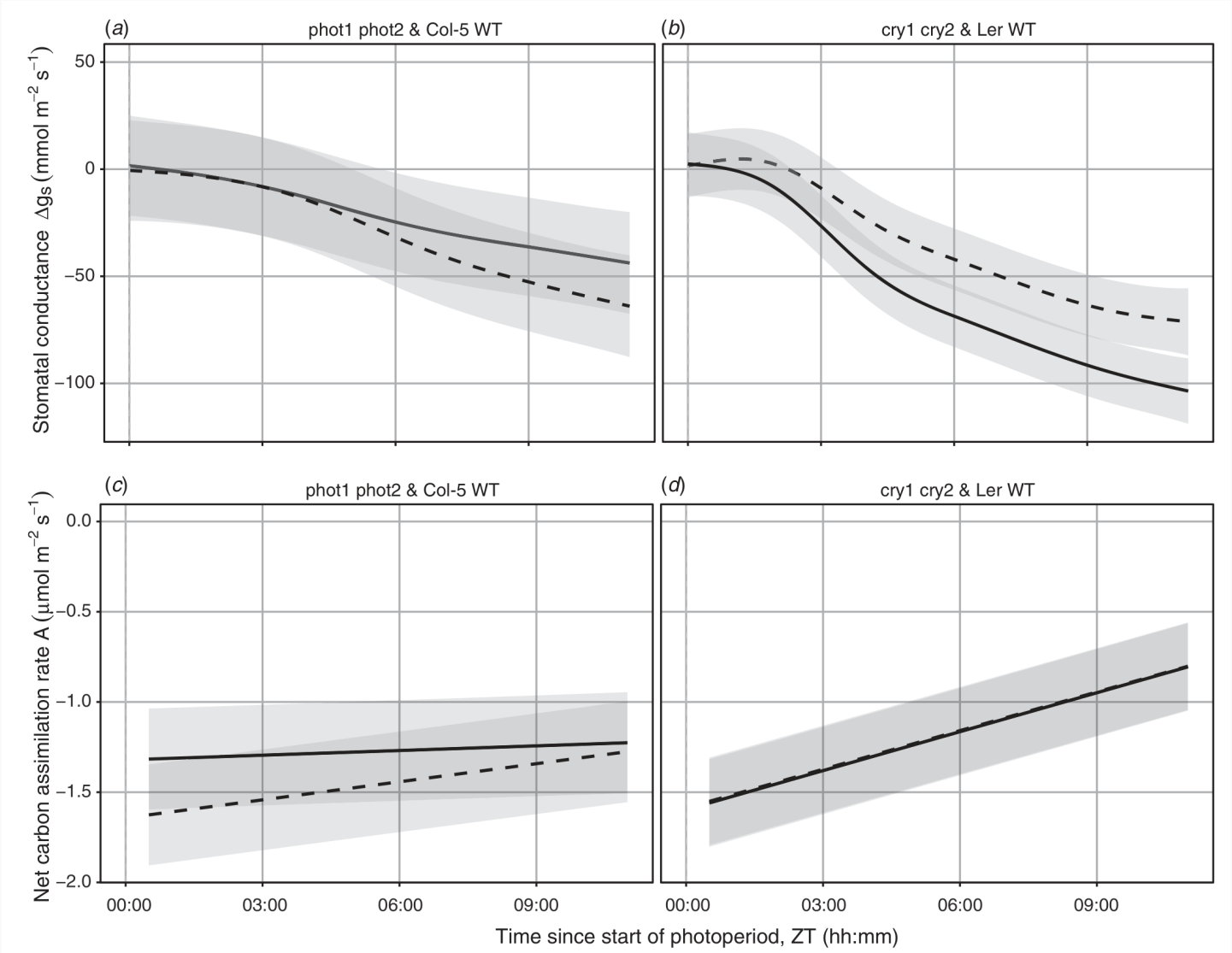


Stomata, responses to light

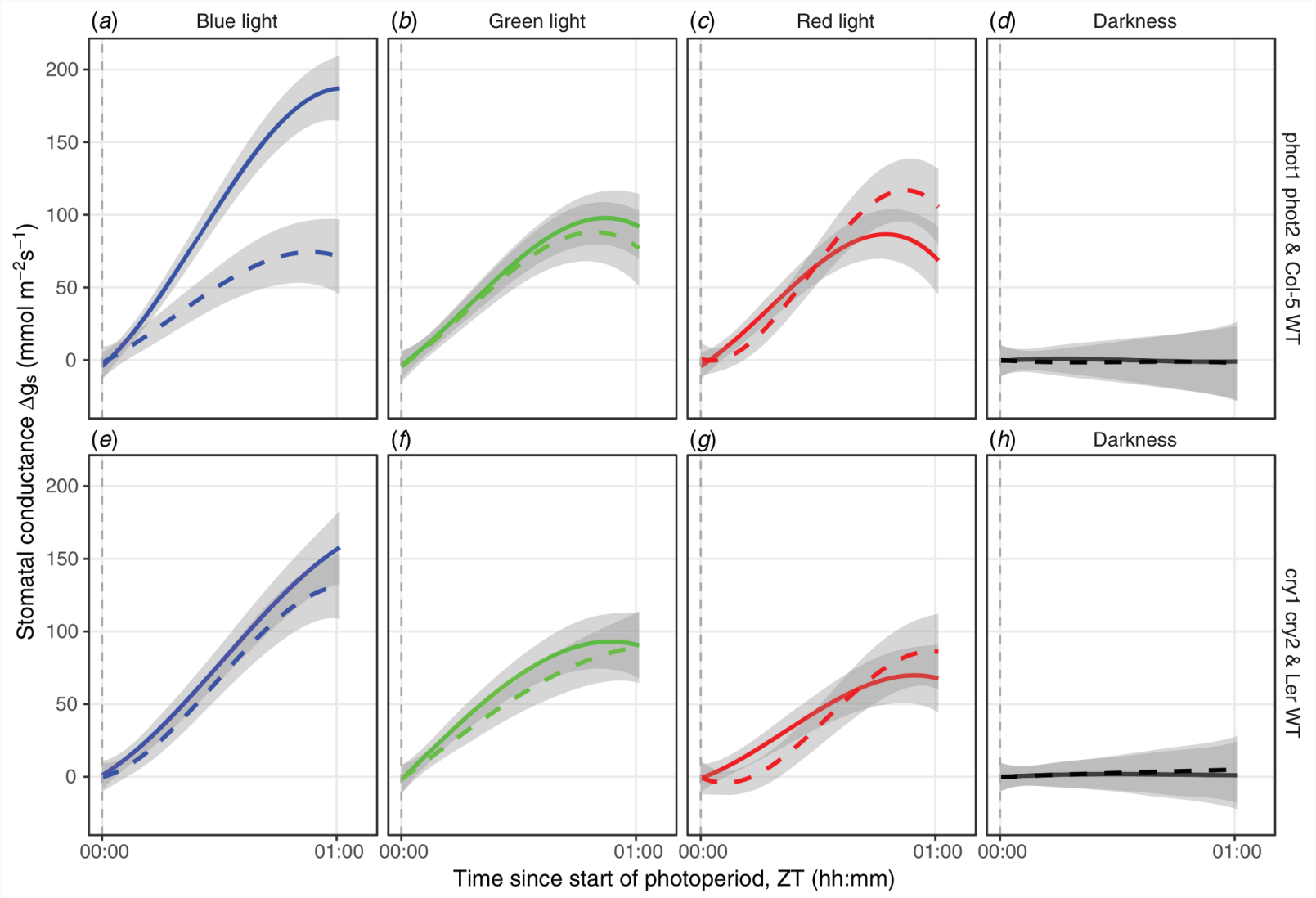
Time course of $g_{\mathrm{s}}^{\mathrm{w}}$ (*A. thalina*)

- Experiment with *phot1 phot2* and *cry1 cry2* mutants plus two WTs.
- Growth under photoperiod 12 h, 200 $\mu\mathrm{mol}\,\mathrm{m}^{-2}\,\mathrm{s}^{-1}$ PAR from white light.
- Gas-exchange measured continuously for 23 h in whole rosettes (1 rosette at a time).
- Measurements in same photoperiod, 200 $\mu\mathrm{mol}\,\mathrm{m}^{-2}\,\mathrm{s}^{-1}$ PAR from red, green or blue light from LEDs, and in darkness.
- (**Wang2020**)

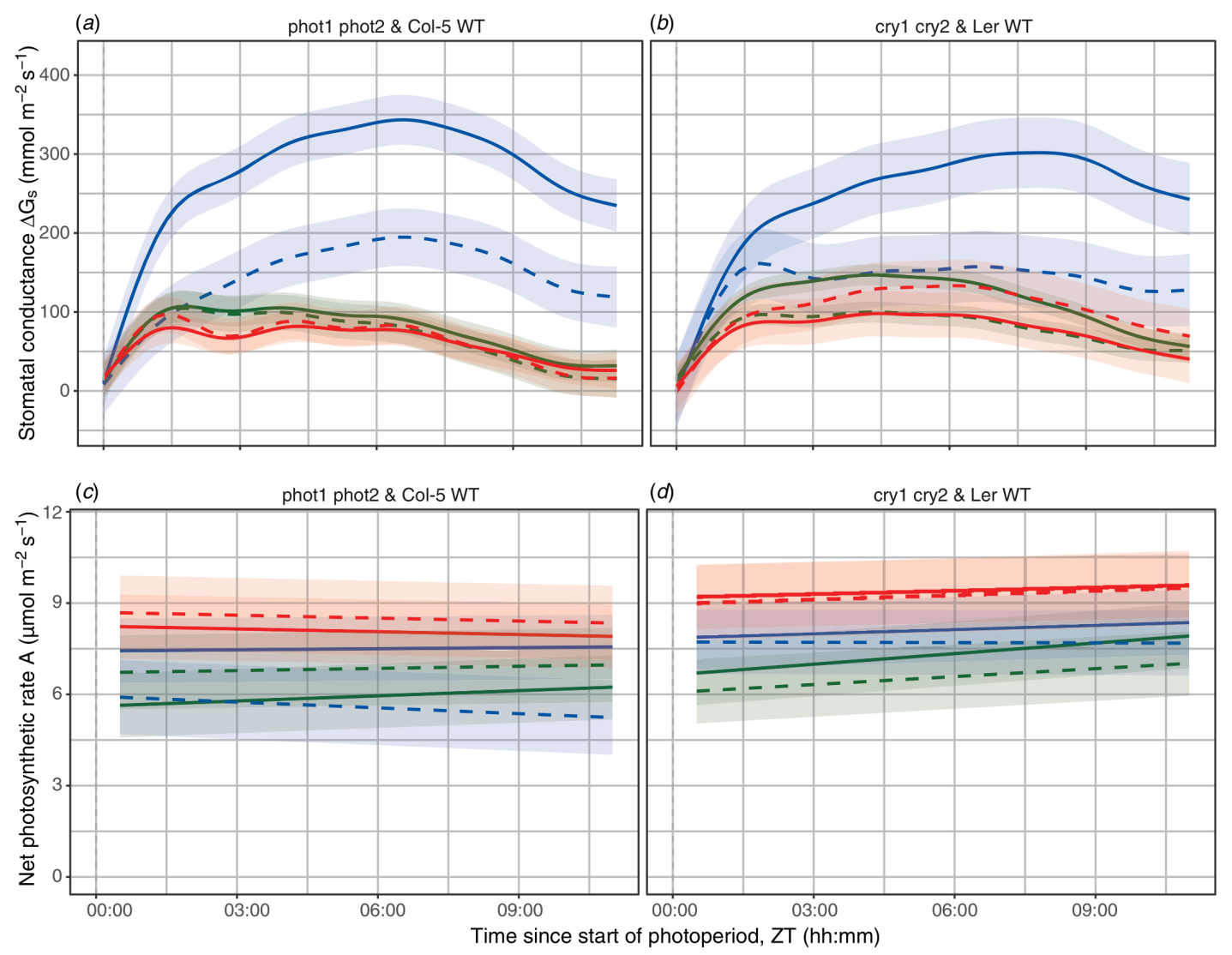
Time course of g_s^w (*A. thaliana*)



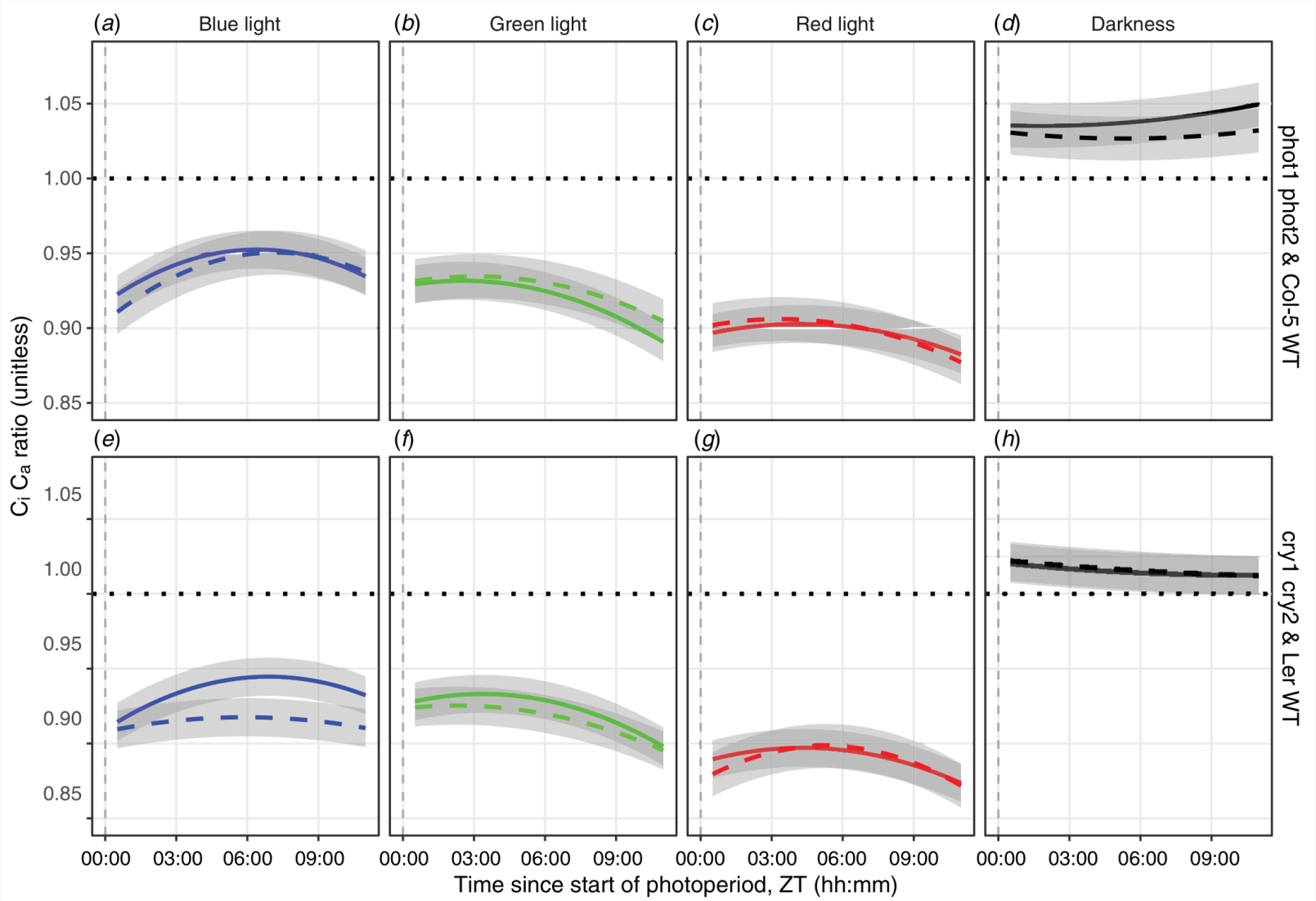
Time course of g_s^w (*A. thalina*)



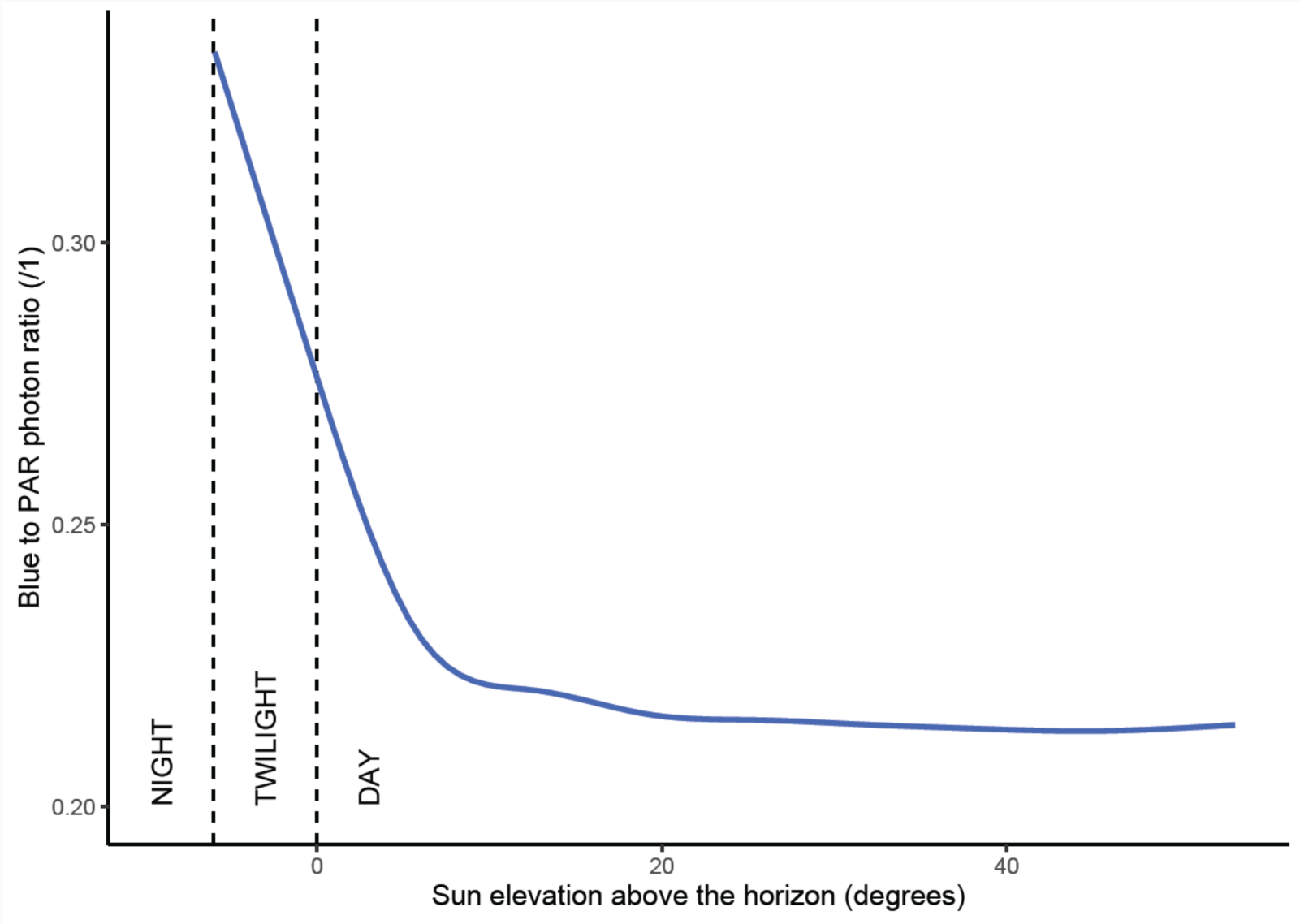
Time course of g_s^w (*A. thalina*)



Time course of g_s^w (*A. thalina*)



Blue component of sunlight



Measurement of leaf conductance

Transient porometer

Video describing the AP4 porometer from Delta-T

Thermography and non-contact sensors

Thermal camera

from Optris

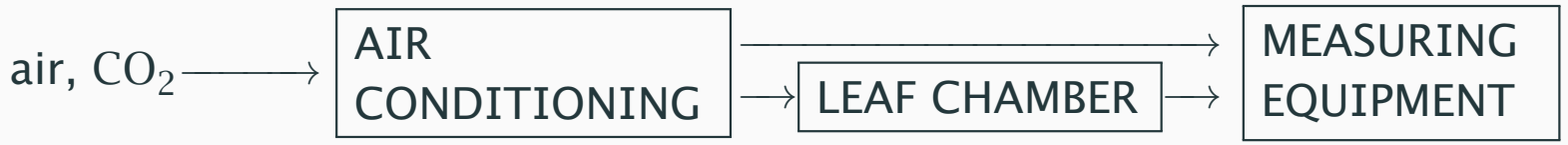
Measurement of spectral irradiance

Spectroradiometer

Video describing a spectrometer from Ocean Insight

Measurement of gas-exchange

Open gas-exchange system



- Most current gas-exchange systems used for measuring photosynthesis are open systems in which air flows at a constant rate through a chamber where a leaf in enclosed.
- The flow rates and the differences in concentration of CO_2 and water vapour between the air entering the chamber and that coming out of the chamber are used to calculate the flows in or out of the leaf.
- From the flows of CO_2 and water in or out of the leaf, and the enclosed leaf area, the CO_2 and water fluxes per unit leaf area can be calculated.

Open vs. closed systems

Open system: Environmental conditions in the chamber do not vary during measurement.

Closed system: Environmental conditions in the chamber change during measurement. With transpiration humidity increases, with photosynthesis CO_2 concentration decreases.

Units

- Modern: using moles

  $\mathrm{CO_2}$ $\mu\mathrm{mol\,m^{-2}\,s^{-1}}$

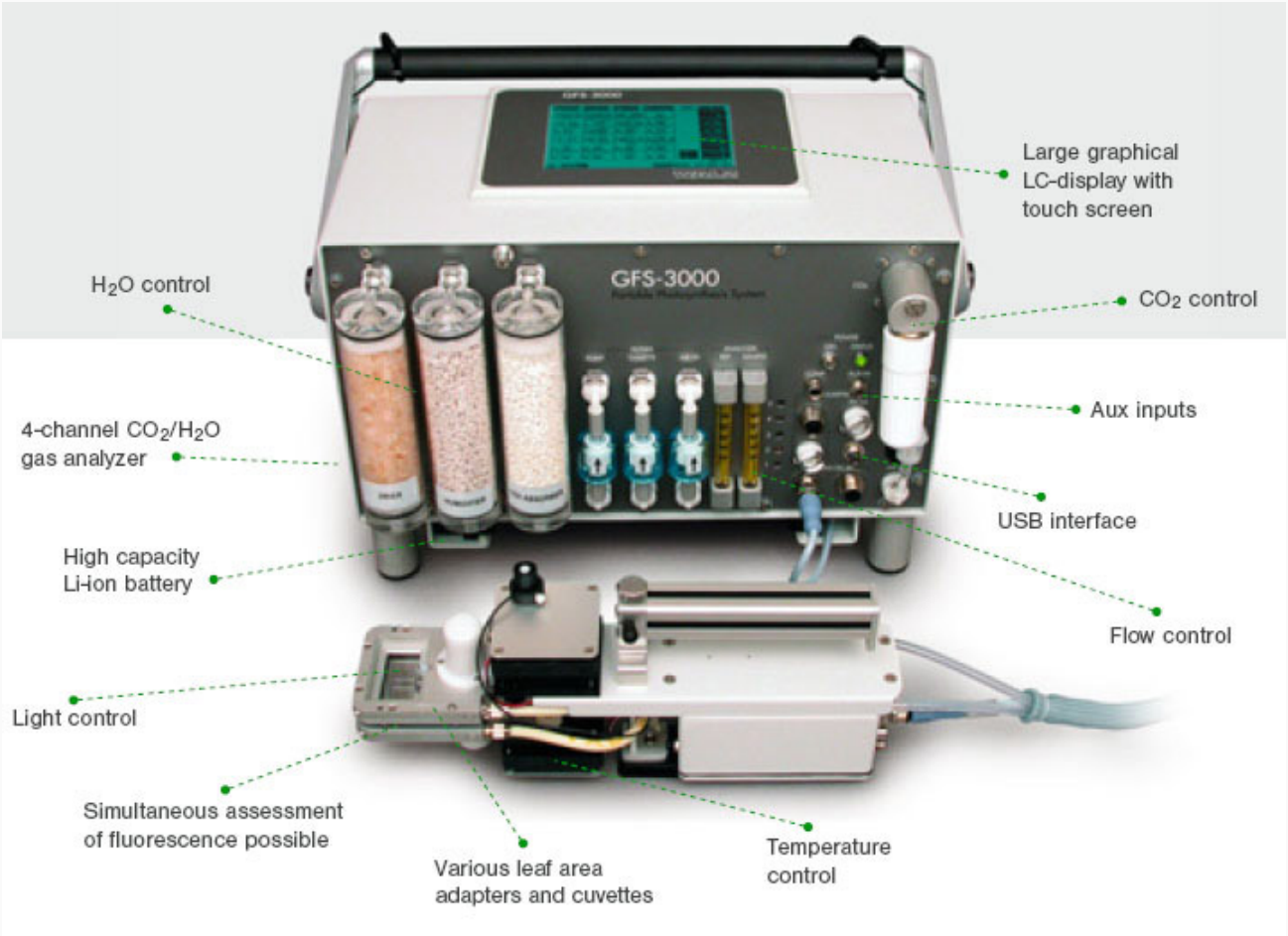
  Water vapour $\mathrm{mmol\,m^{-2}\,s^{-1}}$

- Old: mass

  $\mathrm{CO_2}$ mg cm^{-2} min^{-1} etc.

  Water vapour g cm^{-2} min^{-1} etc.

Gas-exchange system



GFS-3000 (Walz, Germany) (http://www.walz.com/).

Measuring

from http://www.walz.com/.

Measuring

from http://www.walz.com/.

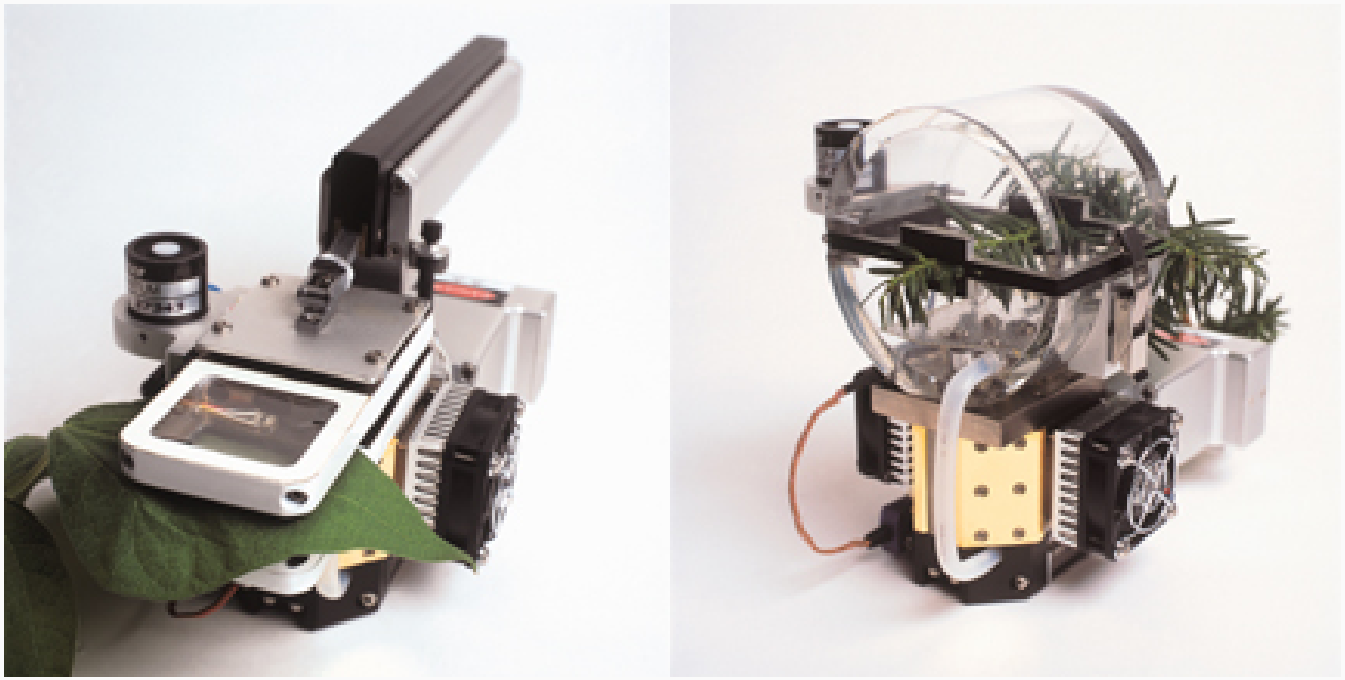
Chamber

from http://www.walz.com/.

Chamber (measuring)

from http://www.walz.com/.

Standard and conifer chambers



Standard chamber (for flat leaves) and conifer chamber (for twigs) for the LI-6400 gas-exchange system (Li-Cor, USA) (from http://www.licor.com/).

References

References

 Kotilainen, T., P. Aphalo, C. Brelsford, H. Böök, S. Devraj, A. Heikkilä, R. Hernández, A. Kylling, A. Lindfors and T. Robson (2020). “Patterns in the spectral composition of sunlight and biologically meaningful spectral photon ratios as affected by atmospheric factors”. In: *Agricultural and Forest Meteorology* 291, p. 108041. DOI: 10.1016/j.agrformet.2020.108041.