JUNIOR-PAM

Teaching Chlorophyll Fluorometer

Miniaturized PAM Fluorometer for Undergraduate and Graduate Training

WALZ

JUNIOR-PAM

Teaching Chlorophyll Fluorometer

Pulse-amplitude modulated (PAM) chlorophyll fluorometry in combination with saturating pulse analysis of fluorescence quenching is now a standard technique to assess plant photosynthesis.

In the 1990s, the Walz Teaching-PAM fluorometer (PAM-200) carried PAM fluorometry into university classrooms. Since then, there has been considerable progress in LED and PC technology, enabling the development of a powerful and versatile, and at the same time compact teaching fluorometer: the JUNIOR-PAM.

FEATURES

The JUNIOR-PAM excels by its simplicity and ease of operation. The fluorometer does not require a separate power supply, as it is powered by the PC via the USB connector.

The JUNIOR-PAM is particularly well-suited for teaching classes and workshops, where availability of a larger number of reasonably priced instruments is essential for gaining hands-on experience.

Two different versions of the JUNIOR-PAM are available: the classical "JUNIOR-PAM" with blue (460 nm) power LED and the "JUNIOR-PAM/W" with white power LED. Both versions are equipped with a far red LED for specific PS I excitation.

The JUNIOR-PAM is controlled by the same WinControl-3 software as research PAM fluorometers like the MONITORING-PAM. In addition, a simplified edition of WinControl-3 has been developed to assist teaching in elementary courses.

Hardware Components
All optical and electronic hardware components are contained in a lightweight and compact aluminum box (11.5 x 6.5 x 3.0 cm).

A 50 cm long plastic fiber guides light from the JUNIOR-PAM to the sample and chlorophyll fluorescence from the sample to the JUNIOR-PAM. Fibers with 100 cm length are available.

Leaf Clips
Two different types of leaf-holders are provided: a 60° clip for measurements in ambient light and a magnetic leaf clip for F_V/F_M determinations as well as for fluorescence induction and light curve experiments.

Optional Monitoring Leaf-Clip JUNIOR-BD for measurement of photosynthetically active photon flux (PAR) and leaf temperature available.

Chlorophyll Fluorescence Analysis

PAM-Fluorescence
The JUNIOR-PAM detects only the fluorescence excited by its evenly pulsed measuring light: the instrument is insensitive to continuous light.

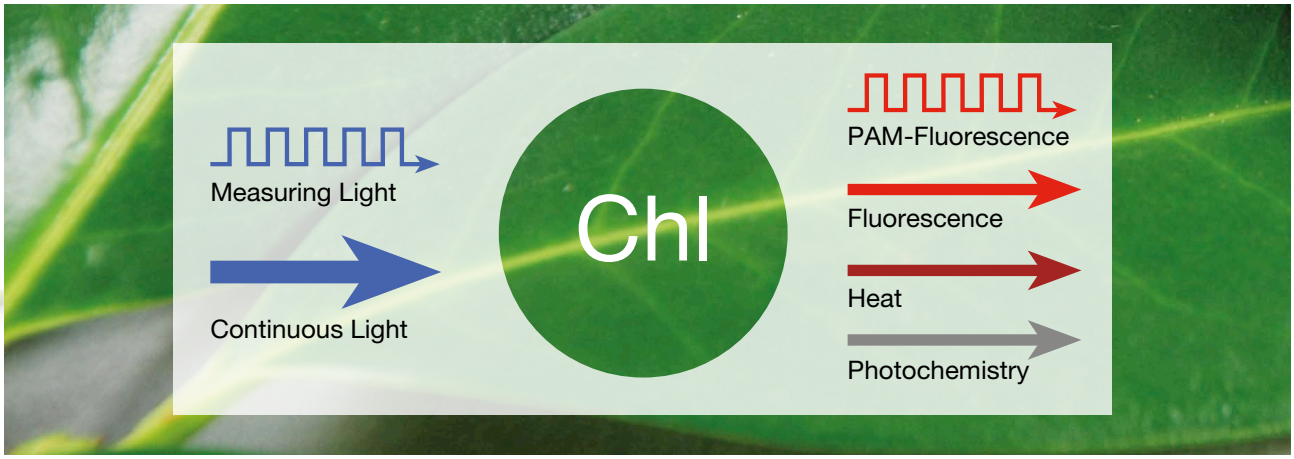
Hence, signal changes reflect changes in the **yield** of chlorophyll fluorescence, which is complementary to the yields of photochemistry and heat dissipation in photosystem II (PS II).

Saturating Pulse Quenching Analysis
The JUNIOR-PAM's low measuring light intensities and its ability to deliver strong light pulses permit determinations of $\mathbf{F_0}$ and $\mathbf{F_M}$, the minimal and maximal fluorescence yields of a pre-darkened sample, respectively.

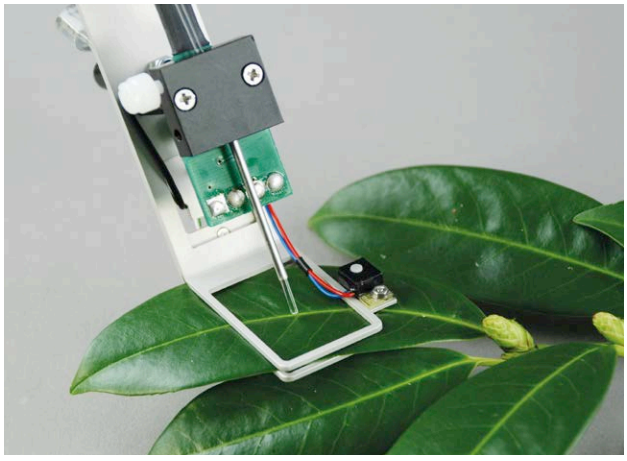
Repetitive application of saturating pulses allows monitoring of characteristic changes in PS II quantum yield and various fluorescence quenching parameters during acclimation of predarkened samples to light conditions (**Kautsky effect**).

Far-Red Illumination
The JUNIOR-PAM features a far-red (FR, max. 745 nm) LED for preferential excitation of photosystem I (PS I), which is essential for determination of the minimum fluorescence yield, $\mathbf{F_0}$', in light-acclimated samples.

Also, FR is useful for teaching the general principles of photosynthetic electron transport like the "**Blue-FR antagonism**" on fluorescence yield and "**state 1-state 2 transitions**".



Magnetic leaf clip with sample support



Optional Monitoring Leaf-Clip JUNIOR-BD

WINCONTROL-3 SOFTWARE

General Features and Graphical User Interface

General Features
The WinControl-3 software represents the latest version of the WinControl software family. WinControl-3 operates not only the JUNIOR-PAM but also a number of research fluorometers ranging from the WATER-PAM to the MONITORING-PAM.

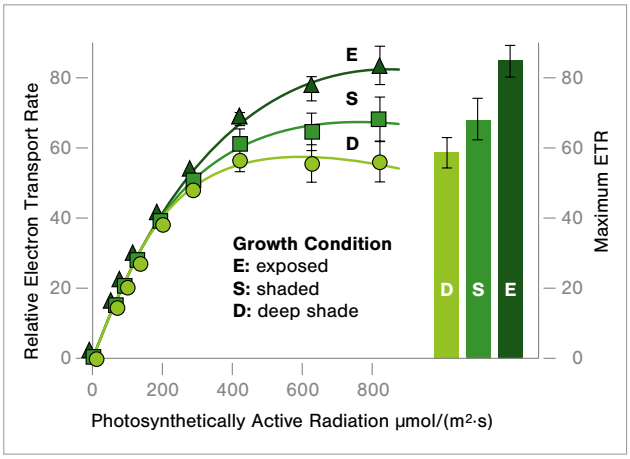
Data Evaluation
Saturating pulse analysis with automatic detection/calculation of standard fluorescence parameters: F_0, F_M, F_0' (measured or calculated), F_M', F_V/F_M, q_P, q_L, q_N, NPQ, Y(II), Y(NPQ), Y(NO), ETR.

Automated Routines
Repetitive triggering of many fluorometer functions (e. g., dark-light induction and dark recovery curves) by adjustable clock.

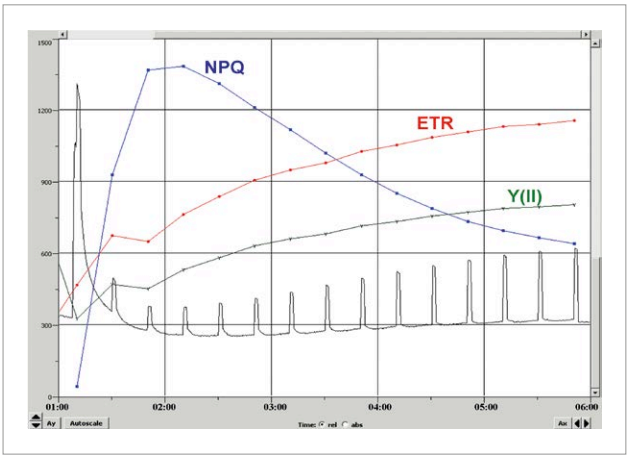
Light Response Curves (Rapid Light Curves)
Automatic execution of light exposure protocols and fitting of two different model functions to data of light response experiments.

Data Export
Export in CSV (comma-separated values) format of original fluorescence traces, saturating pulse analysis data and parameter estimates of light response curves.

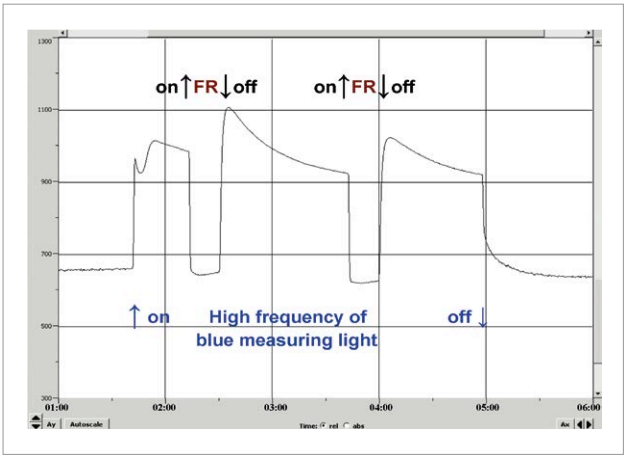
Customer-defined Measuring Protocols
Execution of customized experimental procedures using easily programmable batch files.



Data Export for Evaluation and Representation: Rapid Light Curves, *Hedera helix*



Dark-Light InductionCurve: *Prunus laurocerasus*, dark acclimated leaf



Effect of Far-Red (FR) light on PS II fluorescence:
Cotoneaster spec., low-light acclimated leaf

TECHNICAL SPECIFICATIONS

JUNIOR-PAM & JUNIOR-PAM/W

OPTOELECTRONIC UNIT JUNIOR-PAM (BLUE VERSION)

Modulated fluorescence excitation: Blue LED (wavelength of maximum emission: 445 nm). Modulation frequencies 5 to 25 Hz adjustable in increments of 5 Hz, and 100 Hz. Fluorescence at wavelengths greater than 630 nm is measured

Actinic light: Same LED as used for modulated light. PAR at 1 mm distance from the tip of the 50 cm JUNIOR-PAM light guide: 25 to 1500 µmol m^{-2} s^{-1}. Maximum PAR of saturation pulses, 7000 µmol m^{-2} s^{-1}

OPTOELECTRONIC UNIT JUNIOR-PAM/W (WHITE VERSION)

Modulated fluorescence excitation: White LED (wavelengths of maximum emission: 445 and 545 nm). Modulation frequencies 5 to 25 Hz adjustable in increments of 5 Hz, and 100 Hz. Fluorescence at wavelengths greater than 650 nm is measured

Actinic light: Same LED as used for modulated light. PAR at 1 mm distance from the tip of the 50 cm JUNIOR-PAM light guide: between 25 and 1500 µmol m^{-2} s^{-1}. Maximum PAR of saturation pulses, 4000 µmol m^{-2} s^{-1}

ITEMS INCLUDED

Light guide: 50 cm x 1.5 mm (length x diameter) plastic fiber

Sample clips: Open leaf clip (angle between incident radiation from JUNIOR-PAM and leaf surface, 60°) and magnetic leaf clip (angle between incident radiation from JUNIOR-PAM and leaf surface, 90°)

Fluorescence standard: 3 cm x 2 cm fluorescence foil

Polishing set: Set for fiber tips including various polishing pads

USB cable: A-B USB cable

Software CD: Including latest WinControl-3 software

Transport Case JUNIOR-T: Grey plastic box with handle. Interior: convoluted foam padding. Dimensions: 29 cm x 25 cm x 6 cm (L x W x H). Weight: 510 g

OPTOELECTRONIC UNIT JUNIOR-PAM AND JUNIOR-PAM/W

Housing: Aluminum housing with USB type B socket, M8 4-pole socket to connect the JUNIOR-PAM monitoring leaf clip (accessory), port for JUNIOR-PAM light guide, and swivel-mounted sample support

Far-red light: LED with 745 nm maximum emission wavelength for selective excitation of photosystem I

Fluorescence detection: PIN photodiode protected by long-pass filter. Selective window amplifier to measure pulse-amplitude modulated (PAM) fluorescence

Communication: Standard USB communication via 1.2 m USB-cable type A-B

Power supply: 5 V DC supplied by the USB cable type A-B used for communication

Power consumption: 100 mW at normal operation and 500 mW during saturation pulse

Dimensions: 11.5 cm x 6.5 cm x 3 cm (L x W x H)

Weight: 200 g

Operating temperature: 0 to + 40 °C

Operating humidity range: 35 to 85% RH (avoid condensation)

SOFTWARE WINCONTROL-3

Program: WinControl-3 System Control and Data Acquisition Program (Microsoft Windows XP/Vista/7/8/10) for operation of measuring system via PC, data acquisition and analysis

Saturation Pulse Analysis: Measured: F_t, F_0, F_M, F, F_0' (also calculated), F_M'. PAR, leaf temperature and relative humidity using Monitoring Leaf-Clip JUNIOR-BD. Calculated: F_0' (also measured), F_V/F_M and Y(II) (maximum and effective photochemical yield of PS II, respectively), q_L, q_P, q_N, NPQ, Y(NPQ), Y(NO) and ETR (electron transport rate)

Fitting Routines: Two routines for determination of the cardinal points, I_k and ETR_{MAX} of light curves

Programmability: Fully programmable using batch file language

Computer Requirements: 1 free USB socket. Processor, 1 GHz. RAM, 512 MB. Screen resolution, 1024 x 600 pixels. Interface, USB 2.0/3.0

ACCESSORIES

MONITORING LEAF-CLIP JUNIOR-BD

Micro quantum sensor: Selective PAR measurement, 0 to 2500 µmol m^{-2} s^{-1} PAR

Thermocouple: Ni-CrNi, -20 to +60 °C

Leaf temperature: -20 to +60 °C

Power supply: JUNIOR-PAM special socket

Cable length: 100 cm

Dimensions: 13 cm x 2.5 cm (max.) x 5.5 cm (max.) (L x W x H)

Weight: 162 g (including cable)

EXTRA-LONG LIGHT-GUIDE

100 cm x 1.5 mm (length x diameter) plastic fiber for difficult accessible samples or underwater measurements

DOWNLOADS

Free downloads are available on our website www.walz.com.

WINCONTROL-3 SOFTWARE

Full program and sample experimental data for offline use.

JUNIOR-PAM MANUAL

User's instruction in PDF format including an introduction to saturating pulse analysis and literature references.

2.155/09.2017 · Subject to change without prior notice · Printed in Germany on FSC certified paper, carbon-neutral

High Quality Instrumentation for Plant Sciences

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