m-pea
multi-function plant efficiency analyser
chlorophyll fluorescence monitoring

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M-PEA

Multi-Function Plant Efficiency Analyser

- Advanced lab-based system for investigation of plant photosynthetic efficiency.
- M-PEA-1 variant for prompt fluorescence & P700+ modulated absorbance measurements.
- M-PEA-2 variant as M-PEA-1 with additional measurements of delayed fluorescence & leaf absorbtivity.
- Sophisticated sensor unit with all optical emitters & detectors in a robust, enclosed housing.
- USB connection to a Windows® PC.
- Comprehensive Windows® experimental design, data transfer & analysis software.

Overview

The M-PEA (**M**ulti-**F**unction **P**lant **E**fficiency **A**nalyser) combines high quality fast fluorescence kinetic and P700+ absorbance studies with ground-breaking Delayed Fluorescence measurements providing one of the most comprehensive systems for the investigation of plant photosynthetic efficiency available.

The M-PEA is a laboratory-based measurement system consisting of a control unit and sophisticated, robust sensor unit housing all optical emitters and detectors for all measurement elements. The system is controlled from a comprehensive Windows® software package (M-PEA+) which allows complex experiments to be designed, uploaded and executed by the M-PEA hardware. Recorded data is quickly downloaded to the software via a USB2.0 connection.

The control unit is of convenient size with minimal footprint allowing measurements to be made in a busy lab environment where bench space is critical. The front panel consists of a power switch and indicator LED, optical sensor connection and a 4 line LCD display. The rear panel provides input for a 12V DC power supply and a USB2.0 connection socket for interface to the M-PEA+ software running on a Windows® PC.

The optical sensor unit is a robust enclosure designed to incorporate sophisticated electronics which effectively controls all of the light sources and detectors. The M-PEA-1 sensor unit includes a high intensity red actinic source, a far-red light source, the prompt fluorescence detector and the modulated emitter/detector pair for P700+ absorbance measurements. M-PEA-2 additionally includes a high sensitivity delayed fluorescence detector and a detector to measure leaf absorbtivity.

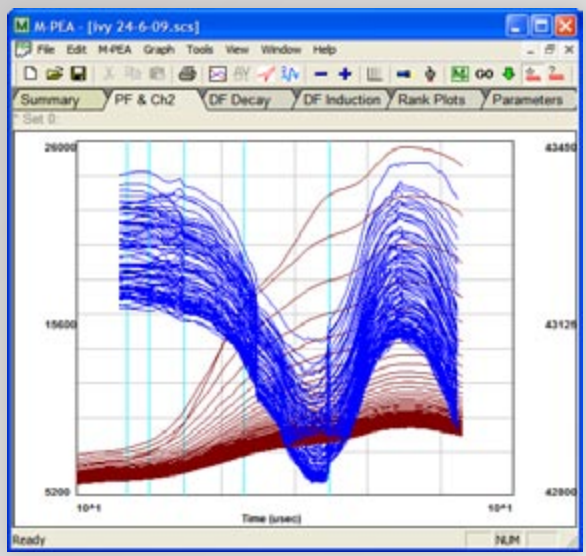
All the optics are located behind a quartz window which seals the sensor unit providing effective protection for the optical assemblies against dust, dirt and moisture.

M-PEA-1 Variant

M-PEA-1 features the following acquisition elements:

Prompt Fluorescence Measurements

The prompt fluorescence signal detection system for the M-PEA uses a high intensity red LED up to 5000 µmols m^{-2} s^{-1} at the sample surface for effective light saturation of the sample. The emitted fluorescence signal is captured by a low noise, fast response PIN photodiode with the detected signal being processed by a high performance 16 bit A/D converter for optimum resolution.



Modulated P700+ Absorbance Measurements

The M-PEA uses an optically filtered, modulated 820nm LED for high quality P700+ absorbance measurements. P700+ activity is recorded using an optimised low noise, fast response PIN photodiode and 16 bit A/D converter providing an excellent signal-to-noise ratio.

Measurements of prompt fluorescence and P700+ are plotted on the same axes in the M-PEA+ software.

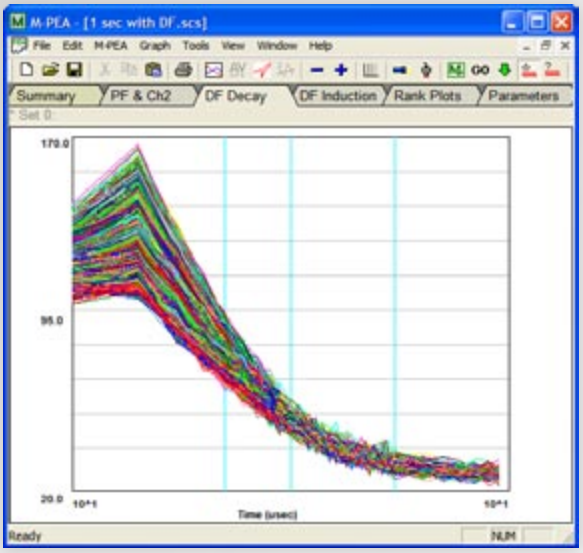
M-PEA-2 Variant

M-PEA-2 includes both the prompt and P700+ acquisition elements in conjunction with:

Delayed Fluorescence Measurements

Delayed fluorescence is light that is emitted from green plants, algae and photosynthesising bacteria for a short time after they have been exposed to light, but after the prompt fluorescence emission has decayed.

Delayed fluorescence occurs in the red-infra-red region of the spectrum (the same as prompt chlorophyll fluorescence). However, the intensity of the delayed fluorescence emission is lower than that of prompt fluorescence by at least two orders of magnitude therefore requiring extremely high sensitivity apparatus to measure the signal.



Delayed fluorescence was first discovered by Strehler and Arnold (1951) when they were attempting to use the firefly luminescence for the measurement of the light-induced accumulation of ATP in the green alga *Chlorella*. They found that even without the addition of luciferase and luciferin, there was a long-lived glow from algal cells and chloroplasts in darkness following illumination. The observed delayed fluorescence was characteristic of different photosynthesising samples used—leaves (Strehler and Arnold 1951), chloroplasts and photosynthesising bacteria (Arnold and Thompson 1956).

M-PEA features an optically filtered, highly sensitive wideband avalanche photodiode for the measurement of the delayed fluorescence signal. The system can be configured to make delayed fluorescence measurements at regular intervals during a prompt fluorescence recording or as a 5 second measurement at the end of a prompt fluorescence induction.

Leaf Absorptivity Measurements

The leaf absorptivity element is effectively a measurement of the "greeness" of the leaf, giving a relative indication of chlorophyll content. M-PEA uses the actinic, far-red and P700+ emitter light sources to give a relative absorptivity measurement.

Technical Specifications

M-PEA Control Unit

Electronics	1 x high performance 16 bit microcontroller 1 x enhanced flash 8 bit controller Dual channels: 1 x modulated, 1 x non-modulated 16 bit resolution A/D 10µs acquisition rate Dual 16 bit D/A light source controller
Memory	32 Mb internal memory storage
Display	4 line x 20 character LCD
Recording Duration	0.001 - 300 seconds (repeatable up to 100 times per protocol)
Communications	USB2.0 full speed (12 Mb/s)
Power Requirements	12V @ 1A DC
Operating Conditions	0 - 40°C
Dimensions	230 (w) x 190 (d) x 85mm (h). Weight 1.4kg

M-PEA-1 Optical Sensor Unit

Illumination Sources	Actinic: Focused ultra-bright LED with NIR short pass cut-off filter. Dominant λ 625nm. Spectral half-width 20nm. Max. intensity 5000 µmols m^{-2} s^{-1} Far-red: Focused ultra-bright LED with long pass filter. Max. intensity > 1000 µmols m^{-2} s^{-1} P700+: Optically filtered pulse modulated 820nm LED. Intensity 0 - 100% in 1% steps.
Detectors	Prompt fluorescence: Low noise, fast response PIN photodiode with 730nm (± 15nm) bandpass filter. P700+: Low noise, fast response PIN photodiode with optical bandpass filter.

M-PEA-2 Optical Sensor Unit

Illumination Sources	*As in M-PEA-1 sensor unit*
Detectors	*As in M-PEA-1 but with the additional:* Delayed fluorescence: High sensitivity wideband avalanche photodiode with 730nm (± 15nm) bandpass filter. Leaf aborptivity: Low noise, fast response PIN photodiode

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