# Pocket PEA

## Rapid screening continuous excitation chlorophyll fluorimeter

Hansatech Instruments

# Pocket PEA

## Rapid screening continuous excitation chlorophyll fluorimeter

- Ultra-portable chlorophyll fluorescence measurement system
- Rapid screening capability with single button operation & storage of up to 200 full data sets
- Automatic calculation of parameters including Fv/Fm & OJIP analysis
- Robust enclosure with sealed, high-intensity optics
- 100kHz sampling frequency with 16-bit resolution
- Bluetooth wireless data transfer as standard
- Powerful Windows® data transfer & analysis software included

# Pocket PEA chlorophyll fluorimeter

The Pocket PEA chlorophyll fluorimeter is suitable for teaching, research and a wide variety of commercial applications. The robust yet compact hand-held design provides ease of use and reliable operation.

Samples are conveniently dark adapted prior to measurement using the leafclips supplied. Single key operation fully automates the complete measurement process from data capture through to calculation and display of the key Fv/Fm and Performance Index (PI) chlorophyll fluorescence parameters.

The rapid 1 second measurement capability and 200 measurement memory capacity make the Pocket PEA an invaluable tool in large-scale plant screening programs.

The chlorophyll fluorescence signal received by the sensor during recording is digitised in the control unit using a fast 16 bit Analogue/ Digital converter ensuring excellent precision and repeatability of results. The fluorescence signal is digitised at different rates dependent upon the different phases of the induction kinetic. Initially, data is sampled at 10µs intervals for the first 300 µseconds. This provides excellent time resolution of Fo and the initial rise kinetics. The time resolution of digitisation is then switched to slower acquisition rates as the kinetics of the chlorophyll fluorescence signal slow. This process provides excellent time resolution of the overall measurement whilst minimising the size of the data set and thus maximising memory capacity.

Bluetooth wireless transfer conveniently allows records to be transferred in the field from the Pocket PEA to a suitable Bluetooth enebled PC for detailed review and analysis using our custom Windows® PC software.

The Pocket PEA optical interface is mounted directly on to the front of the Pocket PEA control unit. It consists of a single high intensity focused LED which is positioned vertically above the sample and provides up to 3500 µmols m-2s-1 intensity with a peak wavelength of 627nm at the sample surface. The light emitted from the LED is filtered using an NIR filter to block any infra red content which could be seen by the detector (known as optical breakthrough). An optical feedback circuit monitors and corrects changes in the output intensity of the LED which are caused by internal heat build up in the LED itself. The circuit also compensates for intensity changes caused by variation in ambient temperature.

The detector is a highly sensitive PIN photodiode and associated amplifier circuit. The optical design and filtering ensure that it responds maximally to the longer wavelength fluorescence signal and blocks the reflected shorter wavelength LED light used as the source of illumination. The entire optical assembly is sealed behind a clear glass window which creates a barrier against moisture and dirt which are inherent problems for field based instruments.

The latest Lithium Polymer battery technology ensures a full day of field usage and the convenience of rapid (<4hrs) recharge to full capacity using either the mains charger provided or an optional 12v DC vehicle charger.

## Leafclips and Sample Dark Adaptation

Continuous excitation fluorescence systems rely on the use of a suitable leafclip system with 2 functions. Firstly, the leafclip sheilds the fluorescence detector from ambient light which would otherwise “blind” the sensor due to the comparatively high levels of red/ infra-red light within the same waveband as fluorescence itself. Secondly, the leafclip pre-conditions or dark adapts a section of the sample prior to the measurement.

Any measurement of the maximum photochemical efficiency of Photosystem II (Fv/Fm) requires the sample to be fully dark adapted prior to measurement. During dark adaptation, all reaction centres within the sample are fully oxidised making them available for photochemistry and any latent chlorophyll fluorescence yield is quenched. This process takes a variable amount of time and depends upon plant species, light history prior to the dark transition and whether or not the plant is stressed. Typically, 15 – 20 minutes may be required to dark adapt effectively.

Handy PEA+ leafclips are constructed from white plastic making them small and lightweight. The locating ring (which interfaces with the Handy PEA+ sensor) is positioned over the required area of sample and has a central 4mm diameter hole which is covered using a shutter plate. During measurement, this shutter slides back to expose the dark adapted sample to the focussed LED’s and fluorescence detector. A silvered underside reflects incident light minimising the build-up of heat on the sample and ensuring that the measurement is unaffected when measuring in high ambient light conditions.

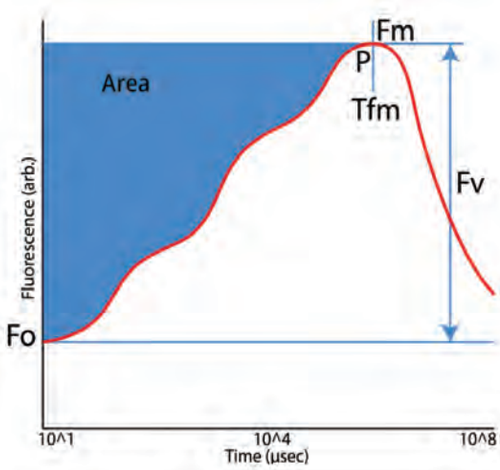
## Common Parameters Measured

Fo - The Fo parameter is thought to represent emission by excited chlorophyll a molecules in the antennae structure of Photosystem II. The true Fo level is only observed when the first stable electron acceptor of Photosystem II called Qa is fully oxidised. This requires thorough dark adaptation.

Fm - This is the maximum chlorophyll fluorescence value obtained for a continuous light intensity. This parameter may only be termed as maximum fluorescence if the light intensity provided by the chlorophyll fluorimeter is fully saturating for the plant and the electron acceptor Qa is fully reduced.

Fv - The Fv parameter indicates the variable component of the recording and relates to the maximum capacity for photochemical quenching. It is calculated by subtracting the Fo value from the Fm value.

Fv/Fm - Fv/Fm is a parameter widely used to indicate the maximum quantum efficiency of Photosystem II. This parameter is widely considered to be a sensitive indication of plant photosynthetic performance with healthy samples typically achieving a maximum Fv/Fm value of approx. 0.85. Values lower than this will be observed if a sample has been exposed to some type of biotic or abiotic stress factor which has reduced the capacity for photochemical quenching of energy within PSII. Fv/Fm is presented as a ratio of variable fluorescence (Fv) over the maximum fluorescence value (Fm).




Tfm - Tfm is a parameter used to indicate the time at which the maximum fluorescence value (Fm) was reached. This parameter may be used to indicate sample stress which causes the Fm to be reached much earlier than expected.

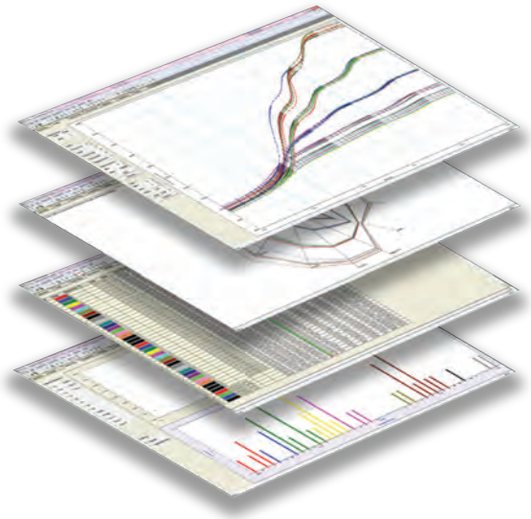
Area - The area above the fluorescence curve between Fo and Fm is proportional to the pool size of the electron acceptors Qa on the reducing side of Photosystem II. If electron transfer from the reaction centres to the quinone pool is blocked such as is the mode of action of the photosynthetically active herbicide DCMU, this area will be dramatically reduced.

## PEA Plus software

PEA Plus is a multi-function Windows® program supplied with Pocket PEA for system configuration, data acquisition and analysis.

Several different data presentation techniques have been combined in order to effectively demonstrate subtle differences in the fluorescence signature of samples which could be indicative of stress factors affecting the photosynthetic efficiency of the plant.

PEA Plus allows simple configuration of both measurement duration and light intensity accessed via the easy to use menu structure.



The software makes establishing a Bluetooth® connection quick and easy and data is tranferred in seconds.

Once the data has been uploaded to PEA Plus there are several different data presentation and analysis tools to select. Data may be presented in graphical, tabulated or radial plots which can all be tailored to display any number of the 58 parameters measured by Pocket PEA.

PEA Plus will run on all supported Microsoft operating systems.

## Time Marks Parameters

The PEA Plus and M-PEA Plus software packages extract chlorophyll fluorescence values from the recorded data from Handy PEA, Pocket PEA and M-PEA chlorophyll fluorimeters at 5 pre-defined Time Marks. The times are:

> T1 = 50 microseconds
> T2 = 100 microseconds
> T3 = (K step) 300 microseconds
> T4 = (J step) 2 milliseconds
> T5 = (I step) 3 milliseconds

Chlorophyll fluorescence values at these Time Marks are used to derive a series of further biophysical parameters, all referring to time base 0 (onset of fluorescence induction), that quantify the photosystem II behaviour for (A) The specific energy fluxes (per reaction centre) for:

> Absorption
> Trapping
> Dissipation
> Electron transport ()

and (B) the flux ratios or yields:

> Maximum yield of primary photochemistry
> Efficiency with which a trapped exciton can move an electron into the electron transport chain further than QA-
> Quantum yield of electron transport

## System Components

Pocket PEA systems are supplied with the following components

- > PPEA:Pocket PEA Control Unit
- > PPEA/LC: Pocket PEA Leaf clips x 20
- > Protective Carry Bag
- > USB Drive containing PEA Plus software and Manuals

## Technical Specifications

### Pocket PEA Fluorimeter

| | |
|---|---|
| Dimensions: | 175 (l) x 75 (w) x 35mm (d). Weight: 250g |
| Communications: | Bluetooth wireless communications |
| Operating Conditions: | 0 - 40°C. Non-condensing humidity |
| Battery: | Environmentally friendly (0% lead, cadmium mercury) lithium polymer 3.7V, 570 mAhr |
| Battery Charger: | Integral switch mode charger 8-13.5V input (nominal 12V input) |
| Display: | 2 line x 12 character LCD display |
| Illumination: | Optically stabilised, focused, ultra-bright red LED with NIR short pass cut-off filters. Peak wavelength 627nm. |
| Max. intensity at leaf surface: | Up to 3500 µmol $m^{-2}$ $s^{-1}$ |
| Detector: | Fast response PIN photodiode with RG9 long pass filter |
| Electronics: | High performance 16 bit microcontroller, 16 bit resolution A/D 10 µsec acquisition rate, 8 bit DAC for light source control, real time clock |
| Record Length: | 1, 3 or 10 seconds |
| Memory: | 512Kbits non-volatile memory. Sufficient for up to 200, 10 second duration recordings with full trace data |

**Hansatech Instruments is a British company that has been developing high quality scientific instrumentation for over 40 years. Our systems are used widely for teaching & research in cellular respiration & photosynthesis programs in more than 100 countries throughout the world. We have gained an enviable reputation for quality, reliability & excellent price/performance.**

**Our product range consists of a range of modular solutions for the measurement of oxygen using Clark type polarographic sensors. We also develop chlorophyll fluorescence measurement systems using both continuous excitation & pulse-modulated measurement techniques with further optical instrumentation for the measurement of sample chlorophyll content.**

**Purchasers of Hansatech Instruments products can be assured of ongoing support & prompt & efficient attention to enquiries at all times. Support is available both directly & from our global distributor network. Customers are encouraged to register their instruments on our website which allows access to our Support Ticketing System in addition to instruments manuals & software upgrades.**

Hansatech Instruments Ltd
Narborough Road, Pentney, King's Lynn, Norfolk PE32 1JL, UK
Tel: +44 (0)1760 338877 Fax: +44 (0)1760 337303
info@hansatech-instruments.com
www.hansatech-instruments.com

Hansatech Instruments