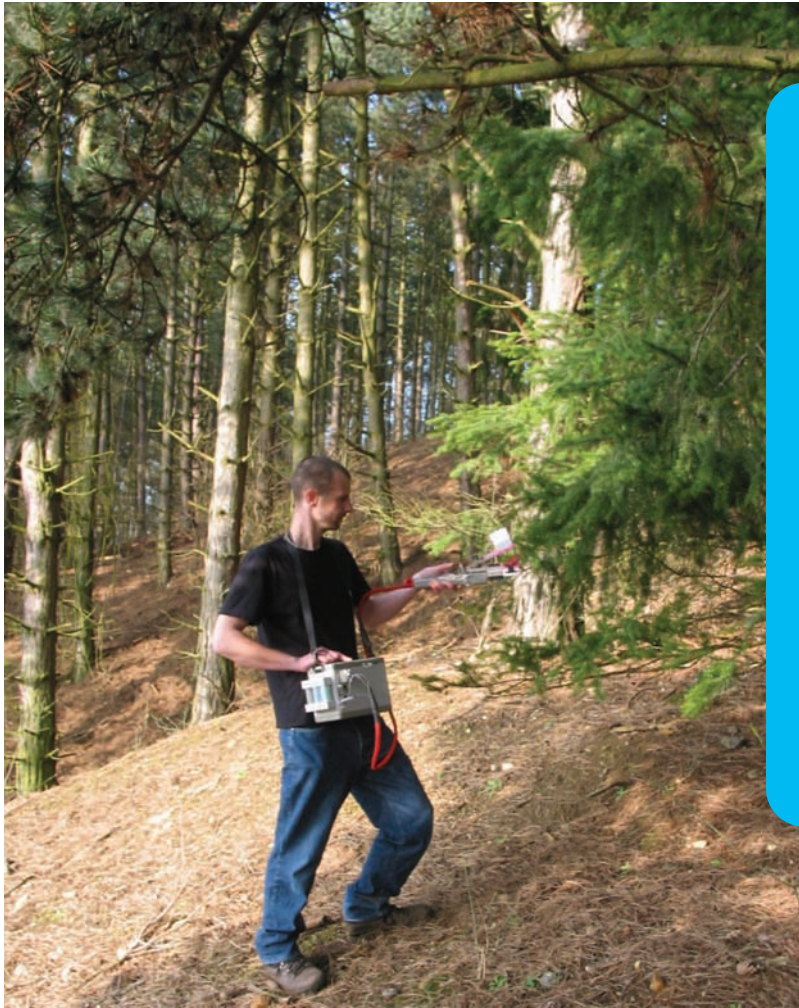




# LCpro-SD

The intelligent portable photosynthesis system



- True field portability
- Fully programmable environmental control
- Miniaturised analyser in chamber head
- Graphic display
- Advanced data capture and output capabilities
- Wide range of experimental applications
- Sophisticated research within your budget

**Because for fieldwork you need truly portable instrumentation**

Introducing **LCpro-SD** the latest generation of truly field portable photosynthesis systems developed and manufactured by ADC BioScientific.





**Hasan Maral, from Kahramanmaras Sutcu Imam University, Turkey using the LCpro+ for oat field trials.**

## Unparalleled portability

For over forty years, ADC's name has been synonymous with plant physiology and a world leader in plant gas exchange technology. During this time ADC has been at the forefront of technological development designed to make photosynthesis systems evermore portable and easy to use. Today the **LCpro-SD** confirms our "leaders in portability" status. The **LCpro-SD** is the smallest, lightest and most user-friendly gas exchange system with microclimate control ever developed.

### **Weighs only 4.5kg**

The **LCpro-SD** offers laboratory experimental performance in a truly portable device. Featuring ADC's highly accurate miniaturised infrared gas analyser and surface mount technology, the **LCpro-SD** is, at 4.5kg, less than half the weight and half the size of conventional systems offering environmental control. Full programmability, data/graphic display and capture is contained within the compact and rugged console.

The **LCpro-SD** plant leaf chamber fitted with full environmental control weighs less than 1kg.

A comfortable and adjustable strap is supplied so that the lightweight **LCpro-SD** can be easily carried and operated on the shoulder, even by petite researchers.

There is no requirement for an external PC, batteries or control units.

### **16 hour battery**

Powered by a single, small 12V rechargeable battery and incorporating the latest in low power consumption components, the **LCpro-SD** will function continuously for up to 16 hours, depending on the environmental controls being operated. Batteries can be easily changed in the field.

Designed for prolonged reliable operation in harsh field conditions, the **LCpro-SD** maintains optimal experimental performance even in high humidity and dusty climates. The control panel and display screen is membrane sealed.

## New & enhanced **LCpro-SD**

The **LCpro-SD** provides all the facilities and features required for sophisticated field experimentation, in the world's most portable format.

ADC BioScientific's **LCpro** and **LCpro+** systems have proved to be invaluable field research tools for plant scientists across the globe, with countless scientific publications referencing these instruments. The new **LCpro-SD** employs the latest advances in gas exchange and user interface technology to raise researchers' expectations and capabilities still further. The latest enhancements to the **LCpro-SD** include:

**Gas exchange performance:** Extended CO<sub>2</sub> measurement range, response times further reduced and enhancements made to minimise the effects of fluctuating background CO<sub>2</sub>.

**Environmental control:** Automatic temperature control ranges further extended, tracking of chamber temperature to ambient and easier elevated CO<sub>2</sub> cartridge replacement in the field.

**Data capture and output capabilities:** Data storage on removeable SD cards, data transfer now also via USB, expanded and enhanced graphing and data initiation functions.

**Experimental versatility:** Widest range of chambers for the widest range of applications.

**User interface:** New microprocessor improves interface response during programming and operation.

**Field reliability:** Increased use of long-life, lower power consumption components, maintaining performance even in harsh environments.



## LCpro-SD enhanced gas exchange performance

The new LCpro-SD provides researchers with several enhancements in gas exchange performance compared to previous generations of the LCpro photosynthesis series. These include:

**0-3000ppm CO<sub>2</sub> range:** supplied as standard with no loss in IRGA performance compared to earlier generation 0-2000ppm CO<sub>2</sub> range.

**Faster response time:** Auto-zero cycling time has been reduced to significantly improve system response without any loss in analyser stability.

**Minimised effects of ambient air fluctuations:** Redesigned gas circuit minimises the effects of fluctuations in CO<sub>2</sub> concentrations in ambient air. Thus reducing potential instability in gas exchange data, an inherent difficulty for all gas exchange systems.

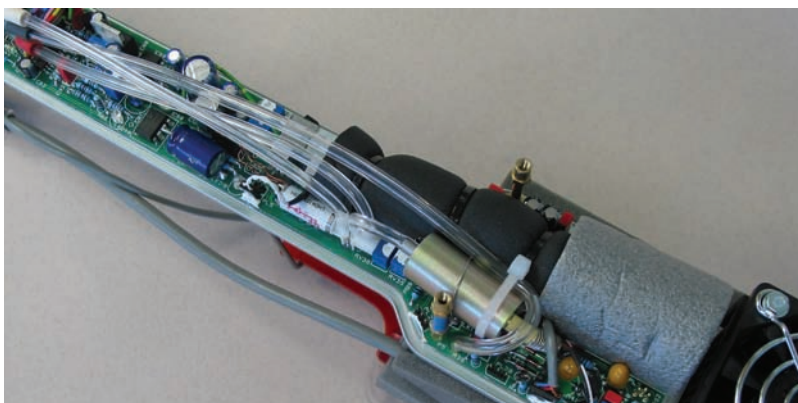
**Long-term field performance:** Incorporation of a new generation of long-life, durable components and sensors further enhance continued optimal performance, even in harsh field conditions.



## Miniaturised analyser in chamber head

For over four decades ADC have been world leaders in the design and manufacture of infrared gas analysers (IRGA). During this time ADC has constantly been an advocate of utilising the open mode of operation, a technique now accepted within the scientific community as the most accurate and versatile operating system for photosynthesis experimentation.

ADC BioScientific has now developed a miniaturised format of their proven portable IRGA. The gold-plated IRGA housed inside the LCpro-SD plant leaf chamber, provides accurate, fast, reliable and stable gas exchange performance. By housing the gas analyser directly in the leaf chamber head, response delays in either gas exchange measurements or environmental controls are effectively eliminated. The proximity of the chamber and the analyser also reduces the risk of gas hang-up or water vapour drop out in long lengths of gas tubing.



### Long-term stability

The miniaturised LCpro-SD IRGA carries out an automatic zero in the standard operational cycle, ensuring long-term measurement stability. All CO<sub>2</sub> measurements are automatically compensated for atmospheric pressure, temperature and the effects of water vapour broadening and dilution.

The novel differential in time IRGA design removes the need to constantly balance dual IRGA systems to prevent the calibration of the two cells drifting apart.

### High quality environmental sensors

To provide the researcher with full photosynthesis data the LCpro-SD plant leaf chamber encloses a number of high quality environmental sensors. Two highly accurate laser trimmed humidity sensors provide exceptionally reliable transpiration data, while high calibre sensors measure Photosynthetic Active Radiation (PAR) and chamber temperature.

The LCpro-SD offers the user a choice of accurate leaf temperature determination methods. An innovative self-positioning sensor is provided as standard in many chambers. Alternatively, a manual placement sensor can be employed or the proven Energy Balance equation can be used with any chamber.





## Complete environmental control as standard

The *LCpro-SD* provides complete and automatic environmental control within the chamber head as standard.

All environmental control facilities are contained within a single compact and lightweight console. Environmental parameters may be controlled at single or multiple concentrations. A single or combination of parameters may be controlled at any one time. The *LCpro-SD* internal battery powers all environmental control facilities. These controls have been specially designed using low power consumption components so maximising battery life. There is no requirement for an external PC, batteries or control units.

Housing the gas analysis system within the *LCpro-SD* leaf chamber head not only results in faster responses to leaf gas exchange changes, but also environmental control equilibration is reached more quickly and long-term stability is assured.

Full experimental programming is quick and uncomplicated to perform using the *LCpro-SD* user-friendly menu driven software.



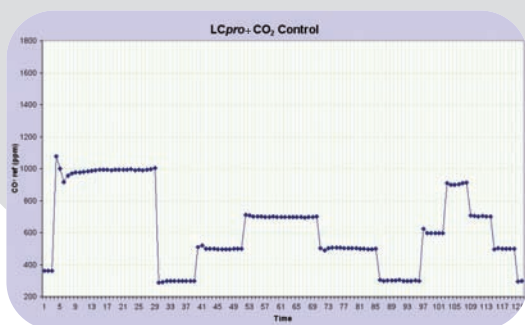
### CO<sub>2</sub> control

The *LCpro-SD* features a compact integral elevated CO<sub>2</sub> supply system as standard. This miniaturised regulatory system is internally housed and therefore protected from any potential environmental or physical damage.

A small pure CO<sub>2</sub> delivery cartridge is used to provide a stable elevated supply within the system. This is combined with ambient air stripped of CO<sub>2</sub> to accurately maintain the leaf chamber CO<sub>2</sub> at user-selected concentrations up to 2000ppm. The CO<sub>2</sub> cartridges are conveniently located for speed of exchange. Control is user-selectable to either the reference or analysis gas streams.

Automatic A/Ci curves may be easily performed by programming a number of sequential control levels with required dwell times and automatic data recording. A/Ci curves may be plotted in real time on the graphical display.

This highly efficient system enables a mini 4g CO<sub>2</sub> cartridge to provide up to 36 hours of continuous field experimentation. Partially used cartridges can be conveniently and safely exhausted via an external vent.

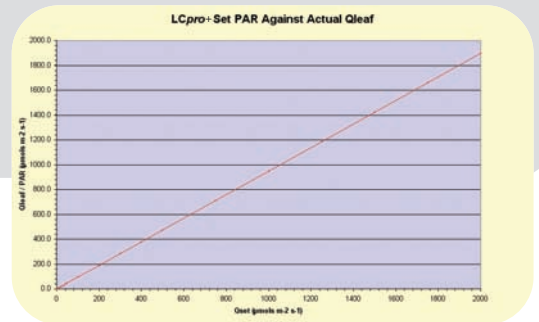


## PAR control

A lightweight, mixed Red/Blue LED array provides reliable, sequential control of light between 0-2000  $\mu\text{mol}$ s. The unit is designed to closely replicate the PAR spectrum evenly throughout the leaf chamber window. The use of a low power consumption LED array ensures that spectral quality is maintained over the whole intensity range with absolute minimal or no heating. A micro PAR sensor measures the light emitted from the LED array onto the leaf surface. The **LCpro-SD** can be easily programmed to generate automated light response curves.

To ensure the optimal light control on the widest possible number of plant species, many types of **LCpro-SD** chamber heads (Broad, Narrow and Conifer) are supplied with their own dedicated LED unit.

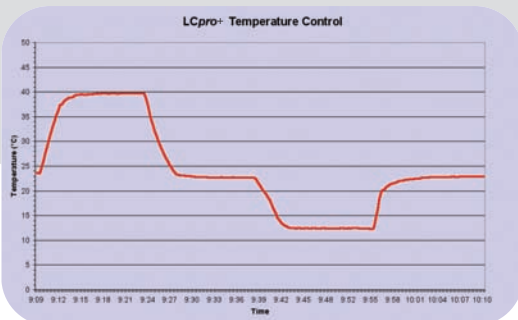
The light unit can be easily detached for ambient measurements.



## Temperature control

The **LCpro-SD** advanced, compact, peltier heat transfer system provides the most dynamic temperature control range available. Temperature inside the standard Broad leaf head can be automatically regulated  $\pm 14^{\circ}\text{C}$  from ambient. Other chamber heads with temperature control typically provides better than  $\pm 10^{\circ}\text{C}$  regulation from ambient. Temperature inside the **LCpro-SD** chamber head may also be programmed to track ambient temperature.

The **LCpro-SD** temperature control is both responsive and stable.



## H<sub>2</sub>O control

Individual or sequential control of H<sub>2</sub>O concentrations is achieved using on-board, self-indicating conditioning chemicals.

Humidifying the air is advantageous in experimental conditions that may excessively dry the environment within the chamber and thus affect transpiration activity. Drying the air inside the chamber can be useful when working with moist soils, to prevent condensation occurring inside the soil respiration chamber.





## Photosynthesis experiments made simple

ADC BioScientific has a reputation for designing the world's easiest to use gas exchange instrumentation. The **LCpro-SD** has been developed to provide researchers with the highest level of sophistication with the easiest to use interface. It is also simple to maintain with many serviceable parts easy to replace in the field.

Operation and experimental programming is fast and straight forward using the new **LCpro-SD** microprocessor. Complete functionality is achieved with just five keys driving a series of simple and intuitive menus. No separate "bolt on" PC or laptop is required.

Experienced researchers and novice users can quickly and easily program and perform sophisticated gas exchange experiments such as light response curves and A/Ci curves.

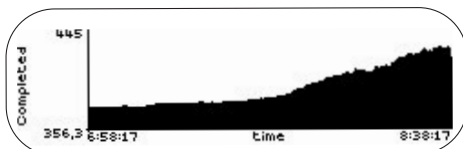
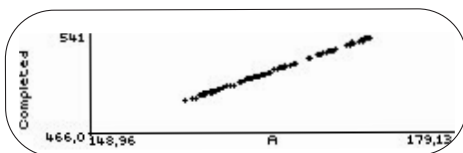
All real time photosynthesis data, calculations and graphs are clearly presented on a large, high definition, liquid crystal display.

In addition to classical photosynthesis and transpiration calculations, the **LCpro-SD** provides soil respiration calculations, including NCER, when the soil chamber is employed.

select		modify		next		previous	
Step#	Dwell	Temp	PAR	CO2	H2O	Opts	
1	50	22.2	2000	amb.	amb.	-R--	
2	50	20.0	1800	amb.	amb.	-R--	
3	50	20.0	1500	amb.	amb.	-R--	

Sequence File 'seq-002', 3 step(s).

climate		sequence		logging		record	
C <sub>ref</sub>	376	C <sub>an</sub>	351	Δc			25
E <sub>ref</sub>	12.2	E <sub>an</sub>	21.1	Δe			8.7
Q <sub>leaf</sub> (C)	1760	p	1001	T <sub>ch</sub>			25.0



## Unlimited data storage

The **LCpro-SD** features unlimited data storage. All experimental protocols, photosynthesis data and calculations are stored on easily exchangeable Secure Digital (SD) cards. Use of these widely available cards allows separate cards to be used for individual users or for specific experimental applications.

Data recording can be initiated both automatically and manually. Automatic data recording can be programmed to take place as part of a simple or detailed experiment, such as an A/Ci curve. Alternatively manual recordings can be made either via the keypad or the button on the chamber handle.

Data recording can be initiated by the **LCpro-SD** synchronised to the same point of the measuring cycle, thus providing even more stable and reliable results.

Stored experimental data may be reviewed on the display screen in the field. Downloading of data is directly from the SD cards, via RS232 or through the USB output.



## Graphic display

Experimental data can be presented on the real time graphic display. Parameters may be plotted against time or record number. Two parameters may also be plotted against each other, such as in the case of A/Ci curve experimentation.

The **LCpro-SD** features a number of new and expanded graphing functions further enhancing the versatility and interactivity of the system.



# Interchangeable chamber heads

The **LCpro-SD** is available with an expanded range of interchangeable heads for the widest range of experimental applications. These chambers are easily and quickly exchanged by hand in the field.

Boundary layer resistances and concentration gradients are minimised irrespective of which head is in use. Chamber materials have been carefully chosen to ensure that there is minimal interaction with CO<sub>2</sub> or water vapour. Chamber windows are silica coated to reduce scratching. On fitting, each chamber is autoconfigurable, removing the requirement for complex reprogramming whenever a different head is used.

The **LCpro-SD** chamber is simple to operate with a thumb trigger opening mechanism. All areas of the chamber are easily accessed for cleaning.

## Broad Leaf Chamber

The Broad leaf chamber is the most widely used chamber and the one most suited for the largest number of plant species. It features both a self-positioning leaf temperature sensor and a manual placement temperature sensor. The chamber window area is 6.25cm<sup>2</sup>.



## Narrow Leaf Chamber

This is designed specially for long grasses and narrow leaves under 1cm in width. For leaves wider than 1cm, we recommend the broad leaf chamber. The **LCpro-SD** narrow leaf chamber features both a self-positioning leaf temperature sensor and a manual placement sensor. The chamber window area is 5.2cm<sup>2</sup>.



## Conifer Leaf Chamber

Transparent cylindrical design, suitable for 3D plant tissue such as pine needles and conifers. The unique "staircase" design of the dedicated LED unit providing an even distribution of light throughout the whole chamber allowing automatic light response curves to be performed. It is also suitable for small fruits and composites of very small leaves. The total chamber volume is 175cm<sup>3</sup>.



## Arabidopsis/Small Leaf Chamber

The Small leaf chamber features a unique flexible arm that allows you to easily position the chamber onto the leaf, even when the leaf is close to the soil surface, without damaging the sample leaf or others in the proximity. The Small leaf chamber window diameter is 16.5mm.



## Small Canopy Chamber

Rugged cylindrical construction designed for turf grasses and small whole plants up to 55mm in height.



## Whole Arabidopsis Plant Chamber

Arabidopsis plants can be grown in sealed pots constructed from standard size soil waste pipes. Adapters are available that allow the direct connection to the Small canopy chamber.



## Fruit Chamber

Two part chamber with transparent upper compartment and sealed base for fruit. The chamber volume is 1l.



*The new LCpro-SD chambers are compatible with earlier LCpro and LCpro+ systems.*



### Soil Flux Measurements

The *LCpro-SD* can also be fitted with a high quality, field rugged, soil chamber with detachable collar. It features a pressure release valve that minimises any potential pressure gradients to provide accurate field soil flux measurements. The chamber volume is 1l.



### Fluorometer Adapter Chambers

For simultaneous gas exchange/chlorophyll fluorescence studies. The chambers feature a fibre optic cable adapter to allow use with chlorophyll fluorescence devices. Broad and Narrow leaf chambers are available that are compatible with the majority of commercially available fluorometers including the OS5p Portable pulse modulated fluorometer.

## ADC: Never compromise on quality

### “Quality of product and quality of service.”

From design to delivery, ensuring optimal performance and reliability is of paramount importance to our team of experienced engineers. Once in the field you are supported by our network of over 40 customer support centres worldwide.



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### Technical Specification

<b>Measurement range and technique:</b>	
CO <sub>2</sub> :	0-3000ppm, 1ppm resolution Infrared gas analysis, differential open system, auto zero, automatic atmospheric pressure and temperature compensation
H <sub>2</sub> O:	0-75mbar, 0.1mbar resolution Two laser trimmed, fast response water vapour sensors
PAR:	0-3000µmols m <sup>-2</sup> sec <sup>-1</sup> Silicon photocell
Chamber temperature:	-5°C to 50°C Precision thermistor +/- 0.2°C accuracy
Direct Leaf temperature:	-5°C to 50°C Self positioning microchip thermistor/Energy balance/manually positioned thermistor
<b>Flow rate to Leaf Chamber:</b>	100 to 500ml <sup>-1</sup> min <sup>-1</sup>
<b>Automatic environmental control:</b>	
Programming:	Internal <i>LCpro-SD</i> menu driven software. Automatic and independent control of environmental conditions within the leaf chamber. For automatic response curves, sequential control levels and dwell times may be set
CO <sub>2</sub> :	Up to 2000ppm CO <sub>2</sub> , by integral elevated CO <sub>2</sub> supply system
H <sub>2</sub> O:	Above and below ambient (dependent on ambient conditions), by on-board self-indicating conditioning chemicals
Temperature:	Micro-peltier element. Broad chamber typically +/- 14°C from ambient. Other chambers with temperature control better than +/- 10°C from ambient
PAR:	Up to 2000µmols m <sup>-2</sup> sec <sup>-1</sup> , (conifer up to 1500µmols m <sup>-2</sup> sec <sup>-1</sup> ) by high efficiency, low heat output, mixed red/blue LED array unit
<b>Warm up time:</b>	5 minutes @ 20°C
<b>Display:</b>	240 x 64 dot matrix super twist graphic LCD
<b>Recorded data:</b>	Removable SD cards typically store 16 million sets of data on a 1Gb card
<b>Battery:</b>	70Ah 12V lead acid battery Up to 16 hours between charges
<b>Battery charger:</b>	Universal input voltage Intelligent control
<b>Electrical outputs:</b>	
USB connection:	Mini-B Function as mass storage device
RS232 output:	9 Pin“D” type User-selectable rates of up to 230400 baud for computer or printer connection
<b>Operating temperature range:</b>	5°C to 45°C
<b>Dimensions H x W x D:</b>	
Console:	230 x 110 x 170mm
Plant Leaf Chamber:	300 x 80 x 75mm
<b>Weight:</b>	
Console:	4.5kg
Plant leaf chamber:	0.8kg