Instruction Guide

PHOTON SYSTEMS INSTRUMENTS

PlanTherm PT 200

Please read the Guide before operating this product

Manual Version: 2023/11

www.psi.cz

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1 SAFETY

Read this manual carefully before operating the device. If you are not sure about something in the manual, contact the manufacturer for clarification.

	By accepting the device, the customer agrees to follow the instructions in this guide.

Always follow corresponding manuals while working with the device or doing the maintenance.
It is forbidden to interfere with the hardware or software in any way without previous agreement with the manufacturer.

The following table presents basic highlight symbols used in this manual:

Symbol	Description
	Important information, read carefully.
	Complementary and additional information.

Tab. 1 Used symbols.

2 INTRODUCTION

The small compact device PlanTherm PT 200 (Fig. 1) enables fast and easy estimation of heat tolerance of various plants, plant suspension cells, algae, and cyanobacteria (Bednarikova et al., 2020, Chen et al., 2023, Ilik et al., 2018, Zhang, et al., 2019). The instrument's function is based on a widely accepted idea that the heat stress leads to disintegration of cell membranes and so to increased ion leakage from cytosol to solvent. PlanTherm PT 200 simultaneously monitors conductivity and fluorescence of the analyzed sample during its gradual heating (Ilik et al., 2018). Whereas the change in conductivity is related to the cell membrane thermostability, fluorescence change is connected to thermostability of thylakoid membranes and function of the photosystem II. The heating process is controlled, recorded and evaluated by PC with intuitive ProfileCon software.

Fig. 1 The set-up of PlanTherm PT 200.

PlanTherm PT 200 can be used **in basic photosynthetic research, in agriculture, and horticulture** for:

- fast estimations of both the constitutive and inducible heat tolerance of plants, algae and cyanobacteria
- quick measurements of thermal stability of cell membranes
- studies of stress tolerance and acclimation responses - detection of organism's resistance or susceptibility to given stress factors, detection of biotic and abiotic stress
- screenings of transgenic lines

References:

1. Bednarikova, M., Folgar-Camean, Y., Kucerova, Z., Lazar, D., Spundova, M., Hajek, J., Bartak, M. (2020). Analysis of K- and L-band appearance in OJIPs in Antarctic Lichens in Low and High Temperature. Photosynthetica 58 (SI): 646-656.
2. Chen, H., Liu, X., Li, S., Yuan, L., Mu, H., Wang, Y., Li, Y., Duan, W., Fan, P., Liang, Z., Wang, L. (2023). The Class B Heat Shoch Factor HSFB1 Regulates Heat Tolerance in Grapevine. Horticulture Research 10: uhad001, doi: 10.1093/hr/uhad001.
3. Ilik, P., Spundova, M., Sicner, M., Melkovicova, H., Kucerova, Z., Krchnak, P., Furst, T., Vecerova, K., Panzarova, K., Benediktyova, Z., Trtilek, M. (2018) Estimating Heat Tolerance of Plants by Ion Leakage: A New Method Based on Gradual Heating New Phytologist, 218, 1278-1287.
4. Zhang, S. B., Deng, Q. L., Hao, Y. J. (2019). Effects of High Temperature and High Light on Photosystem II activity in Leaves of Two *Bauhinia* Species. Photosynthetica 57: 1094-1099.

3 TECHNICAL SPECIFICATIONS

Parameters	
Thermoregulation system	200 W Peltier element
Regulation	1°C below ambient temperature - 75°C
Control accuracy	0.1°C
Regulation accuracy	±0.3°C (<60°C), ±0.5°C (60°C - 75°C)
Standard rate of heating	1 - 3°C
Time of heating (25°C to 75°C)	17 min (3°C/min), 25 min (2°C/min), 50 min (1°C/min)
Thermoregulator Unit	
Capacity	1 chamber for a 6-ml cuvette
Size (h × l × d)	117 mm × 252 mm × 260 mm, 3.25 kg
Communication port	USB-C
Thermo sensor	PT 1000
Conductivity sensor	Gryf HB, VEL 356
Fluorescence sensor	FluorPen FP 100 with Blue light (470 nm) or Red-orange light (630 nm)
PC Requirements	
Operating system	Windows 10 or 11
Communication port	USB-C
Recommended configuration	Memory RAM 12 GB, Storage 256 GB SSD + 1 TB HDD, Processor > i3
Software	
ProfileCon v3 GUI	For control of PlanTherm PT 200 and data handling: • Heating of the sample for automatic control of the user defined regulation course • Tempering of the sample (1s – 60 min) • Recording of data • Data analysis and saving
Technical Data	
Electrical	85 - 264 V/AC
Max. power consumption	max. 240 W
Operating temperature	5°C - 1°C above Start temperature (max. 30 °C)
Operating humidity	0 to 80% (non-condensing)
Accessories	
Glass cuvette	6 ml, Operating volume 4 ml
Magnetic stirring bar	2 × 7 mm
Leaf holder	2 parts, plus a hex key for opening

4 General Information

The **PlanTherm PT 200** allows fast and easy estimation of heat stability of plants, plant cell suspensions, algae, and cyanobacteria. Typical samples are plant leaf segments immersed in deionized water (further called a water bath) or cells resuspended in deionized water. Each sample is linearly heated from 25 to 75 °C. The standard rate of heating is 1 - 3°C/minute which corresponds approximately to 15 – 50 minutes of heating. During heating, changes in the conductivity and fluorescence of the sample are continuously monitored. The measured conductivity-temperature curve (called conductivity curve in the following text) enables the determination of the threshold temperature (TCC, T_{COND}) of the leakage of ions from cells. This critical temperature is taken as a measure of the heat stability of plants, algae, or cyanobacteria. Simultaneous detection of minimal Chlorophyll *a* fluorescence intensity (called F_t curve in the following text) during the heating provides information on heat stability of primary photosynthetic processes in the studied material (T_F). The temperature course is defined manually by a user in the **ProfileCon** software on PC.

4.1 Device Description

PlanTherm PT 200 is designed to precisely increase the temperature of the analyzed sample in the glass cuvette and to record conductivity a fluorescence of the sample during heating. The PlanTherm PT 200 is controlled by ProfileCon software installed on PC. The connection is provided by USB-C cable.

The set-up (Fig. 2) consists of:

- **PlanTherm PT 200 with Peltier element and built-in FluorPen**
- conductivity and temperature probe
- PC with **ProfileCon** software
- USB-C cable
- power cable
- glass cuvette 402.000-OG, 10 mm (6 ml) and magnetic stirring bar 2 × 7 mm
- sample clamp holder and two sample clamps

Fig. 2 The set-up of PlanTherm PT 200.

A) the PlanTherm unit. B) the conductivity and temperature probe. C) the PC with ProfileCon GUI. D) a USB-C cable. E) a power cord. F) a glass cuvette with a magnetic stirring bar. G) a sample holder with two sample clamps.

4.2 Device Installation

To assemble the PT 200 device please follow the instructions below:

- Connect the device to the power socket with the power cord plugged in the Power connector in the PlanTherm Unit's rear panel (Fig. 3-1). Input: 110-240V.
- Plug the conductivity and temperature probe into the 6 PIN DIN socket of the PlanTherm unit (Fig. 3-2).
- Connect the PlanTherm PT 200 with the PC by USB-C cable (Fig. 3-3).
- Switch on the PlanTherm PT 200 device and the PC.
- Launch the ProfileCon software on your PC.
- See following chapters for operating instructions.
- Be careful! The rear panel of the PlanTherm PT 200 can be hot.

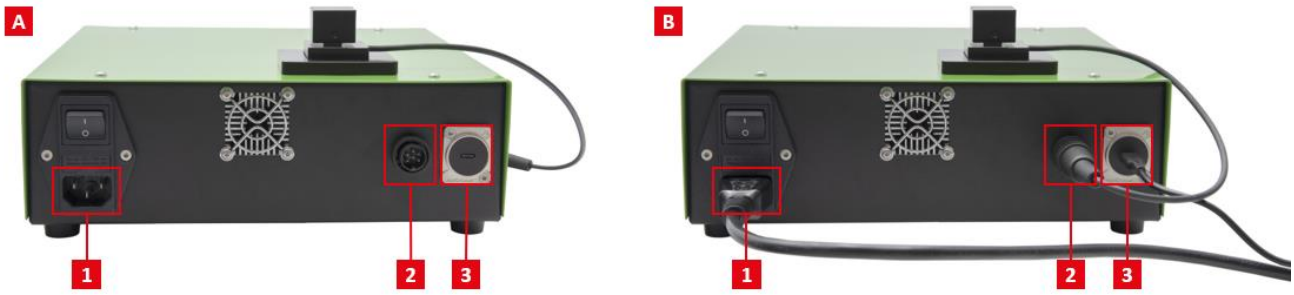

Fig. 3 The rear panel of the PlanTherm Unit.

A) the rear panel alone – 1)-Power connector. 2)- Sensor connector. 3)- USB-C connector. B) the rear panel with the plugged power cord 1), the sensor cord 2), and the USB-C cable 3).

4.3 LED Signaling

The front panel of the PlanTherm PT 200 contains digital display showing the current temperature, and 3 LEDs that show the operation status of the device:

- the green LED means "**POWER**"–device is switched on
- the blue LED means "**COOLING**"–device is cooling the sample to target temperature
- the red LED means "**HEATING**"–device is heating the sample to target temperature

Fig. 4 LED signaling: A) green LED for switched on device, B) blue LED for cooling, and C) red LED for heating.

5 PROFILECON SOFTWARE

PSI.ProfileCon

The PlanTherm PT 200 is fully dependent on the software control and shows only the temperature reading in the display. The ProfileCon software is launched by a mouse double click on the ProfileCon icon in the Desktop. The ProfileCon software is functionally divided into three tabs which are described in details in following chapters: the **Control tab**, the **Data Viewer** and the **About tab** (Fig. 5-1). The **Control tab** in ProfileCon indicates the proper connection of the PlanTherm PT 200 device (Fig. 5-2), controls all its actions and shows instantaneous readings of temperature, conductivity and fluorescence of the sample and their progress in plots (Fig. 6-1). Moreover, the Control Tab enables analysis and saving of current data. The **Data Viewer** enables viewing and analysis of saved files. The **About tab** is informative.

When you switch on the PlanTherm PT 200 device and launch ProfileCon software, carefully check signaling related to the connection status (Fig. 5-2). All three parts are connected by a single USB-C cable which virtually behaves as three different COM ports. Whereas temperature and conductivity sensors are activated just after switching on the PlanTherm device, the FluorPen becomes active anytime when the device is connected to running PC as it is powered through the USB-C cable. **Please note: when the switched-on PlanTherm device is connected to the running PC with launched ProfileCon, the temperature, conductivity and fluorescence readings are done twice per second regardless of the measuring status.** The data are not recorded unless the measurement is running.

Fig. 5 View to the upper right corner of the ProfileCon Software.

1) ProfileCon tabs: the Control tab, Data Viewer tab, and the About tab, 2) the connection status of the PlanTherm PT 200 device.

	Good to know: • The ProfileCon software is user-friendly and intuitive. The parameters can be entered directly as numbers. • The plots can be zoomed in or out by the mouse wheel. • The double-click brings the plot to the optimal window-fit zoom.

5.1 THE CONTROL TAB

The largest space of the Control tab belongs to **graphs** monitoring temperature, conductivity and fluorescence during thermal heating. (Fig. 6-1). The data are recorded twice per second after the heating starts and their range automatically influences the scale of the Y axis. Plots can be zoomed in or out by a mouse wheel. The double-click brings the chart to the optimal window-fit zoom. The pictograms above graphs indicate whether the **lid** is closed (i.e., conductivity and temperature sensors are inserted into the analyzed sample) and whether the sample is **stirred** (Fig. 6-2 and Fig. 6-3, respectively). Whereas the lid must be closed manually before the heating starts, the stirrer is activated automatically when needed. However, also stirring can be started manually by a click on Start Stirrer button. The next space is dedicated to the **measuring status and its progress**, possibly with the indicator of heating/cooling (Fig. 6-4). When the status is unavailable, the device is probably disconnected. Other states are following: ready for measurement, starting, measuring or stopping.

When the stopping status is indicated, the data from the measurement are not recorded anymore and so they can be saved and/or analyzed. The actual readings of temperature, conductivity and fluorescence are displayed next to the connection status (Fig. 6-5).

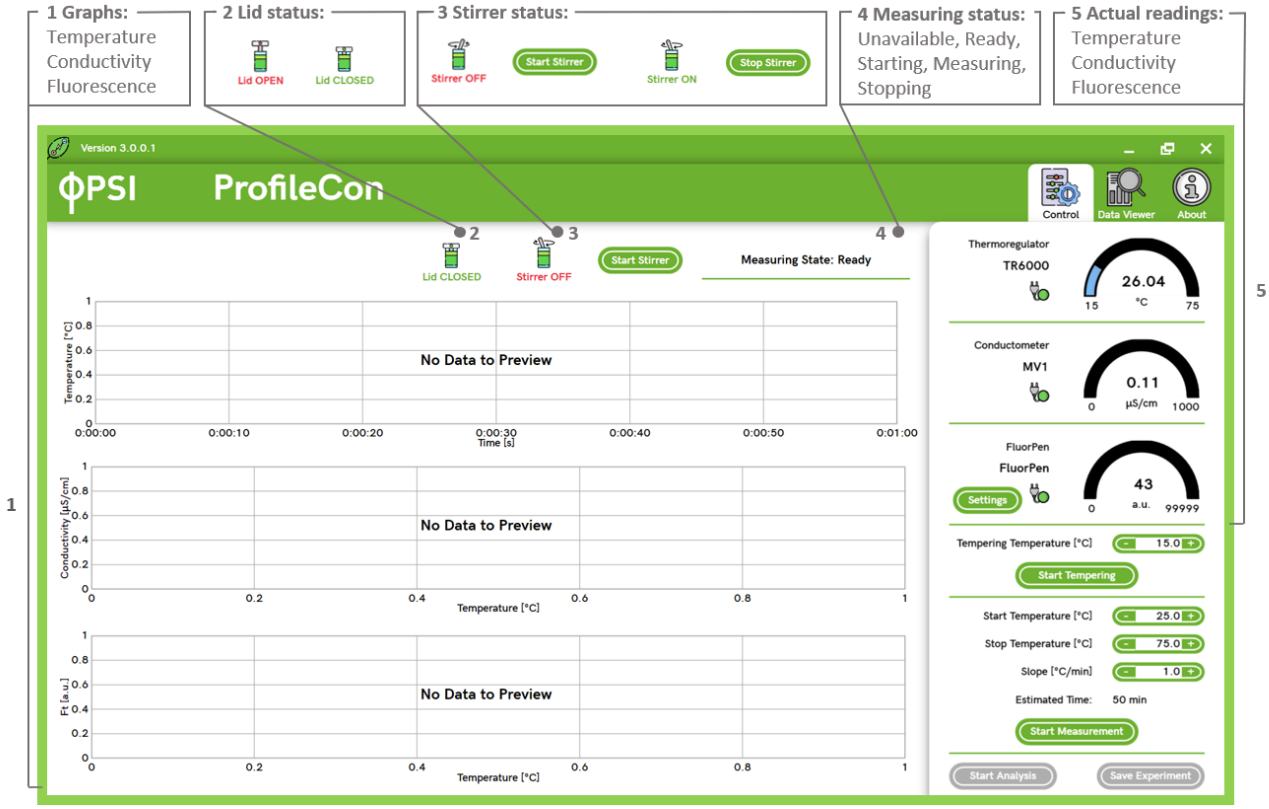

Fig. 6 The Control Tab of the ProfileCon Software before a measurement.

1) graphs monitoring temperature, conductivity and fluorescence during thermal heating, 2) lid status, 3) stirrer status, 4) measuring status, possibly with indicator of heating/cooling and its progress, 5) actual readings of temperature, conductivity and fluorescence.

The **Settings** button next to the connection status of **FluorPen** enables settings of the FluorPen measuring flashes (Fig. 7-1). The recommended intensity is 30%.

For quick cooling or heating the sample or a short-time incubation, the **tempering settings** can be used (Fig. 7-2). It is recommended to set lower temperature than required and combine it with a manual stop. For example, 15 °C should be set for quick cooling of the sample to the ambient temperature with the manual stop applied when the temperature reaches the ambient temperature. During the incubation at set temperature, the temperature in the cuvette is oscillating around the given temperature until the tempering is manually stopped.

The required heating parameters can be set in the Heating settings (Fig. 7-3, marked by the red frame). The recommended slope is 1 – 3° C/min. Stop Temperature must be higher than Start Temperature. Readings for measurements with the slope higher than 3 °C/min cannot be analyzed what is marked by the yellow warning next to the Start Measurement button.

Fig. 6 shows how the Control tab should look like when the device is prepared for measurement:

- The device is properly connected (Fig. 5-2, Fig. 6)
- The lid is closed (Fig. 6-2)
- Current temperature is close to the Start Temperature
- The FluorPen is set to detect some fluorescence signal (Fig. 7-1)
- There is no warning (Fig. 6, Fig. 7-3) for set heating parameters

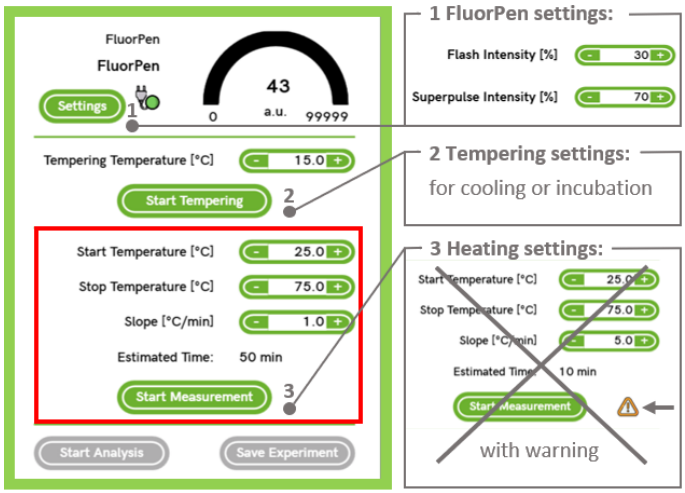

Fig. 7 View to the down right corner of the Control tab.

1) FluorPen settings of the light intensity, 2) tempering settings for quick cooling or short-time incubation of the sample, and 3) heating settings for the required measurement. The heating parameters can be set in the Heating settings marked by the red frame. If selected parameters are not suitable, the yellow warning appears next to the Start Measurement button.

The Fig. 8 depicts how the Control tab changes when the measurement starts. The estimated time of the measurement is shown above the Stop Measurement button (Fig. 8-3).

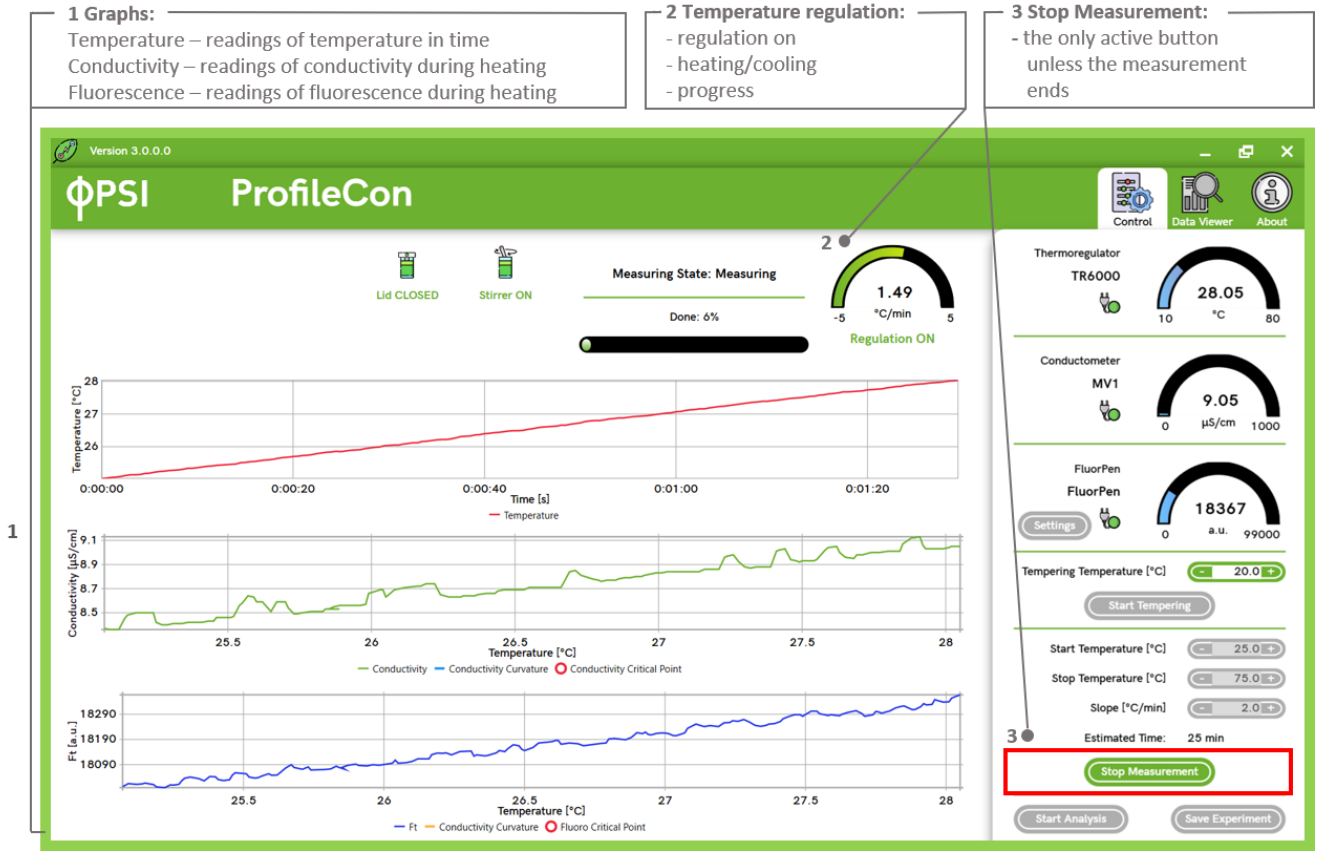

Fig. 8 The Control tab of the ProfileCon Software during the measurement.

1) graphs of temperature, conductivity and fluorescence readings in time during heating, 2) the indicator of temperature regulation, and 3) the Stop Measurement button. The Stop Measurement button is the only active button during the heating/measurement, it is marked by the red frame in the picture.

When temperature in the cuvette reaches the predefined Stop Temperature, thermoregulator starts to cool down the cuvette medium back to Start Temperature. The experiment is finished at this time and data logging stopped. The Control Tab shows only the currently measured data. The obtained data can be analyzed and saved using Start Analysis and Save Experiment buttons, respectively (Fig. 9). **If the user does not save the data, the data will be lost for future use.** If saved, the data is stored as a text file. The user can add a note, a name or select a header format before the saving data in the output textual file (Fig. 9-2). In case the user cannot analyze collected data as the following error message appears: 'Analysis failed', the used heating rate should be checked. It should not exceed 3°C/min (Fig. 7). The calculated points of curvature curves are plotted in the conductivity and fluorescence graphs. The maximum curvature-point temperature of the conductivity curve (Conductivity Critical Point, T_{COND}) and of the Fluorescence curve (Fluorescence Critical Point, T_F) are marked and showed as red dots with calculated values (Fig. 9-3 and Fig. 9-4).

Fig. 9 The Control tab of the ProfileCon Software.

A) before the analysis, and B) after the analysis -1) the Start Analysis button, 2) the Save Experiment button, 3) the Conductivity Critical Point, 4) the Fluorescence Critical Point. The buttons required for analysis and data saving are marked by the red frame in the picture. The data can be saved in a form of a text file as soon as the heating of the sample and so the data readings have been finished. Unless saved, data will be lost for future use.

5.2 The Data Viewer Tab

The text files saved with ProfileCon (version 3) can be later open and analyzed in the Data Viewer tab (Fig. 10-4). If the following error message appears: 'Analysis failed', probably higher temperature rate than 3°C/min was used for the experiment and the data cannot be analyzed (Fig. 7). Also here, the calculated points of curvature curves are plotted in the conductivity and fluorescence graphs. The maximum curvature-point temperature of the conductivity curve (Conductivity Critical Point, T_{COND}) and of the Fluorescence curve (Fluorescence Critical Point, T_F) are marked and showed as red dots with calculated values (as in Fig. 9-3 and Fig. 9-4). The user can also

view the raw data in the Measured Data subtab (Fig. 10-2) in the format: Time [hh:mm:ss.f], Temperature [°C], Conductivity [µS/cm], (Fluorescence) Ft [a. u.]. The Full Text Subtab shows raw data including header with notes, the date and time of the measurement, settings and results of the analysis (Fig. 10-3).

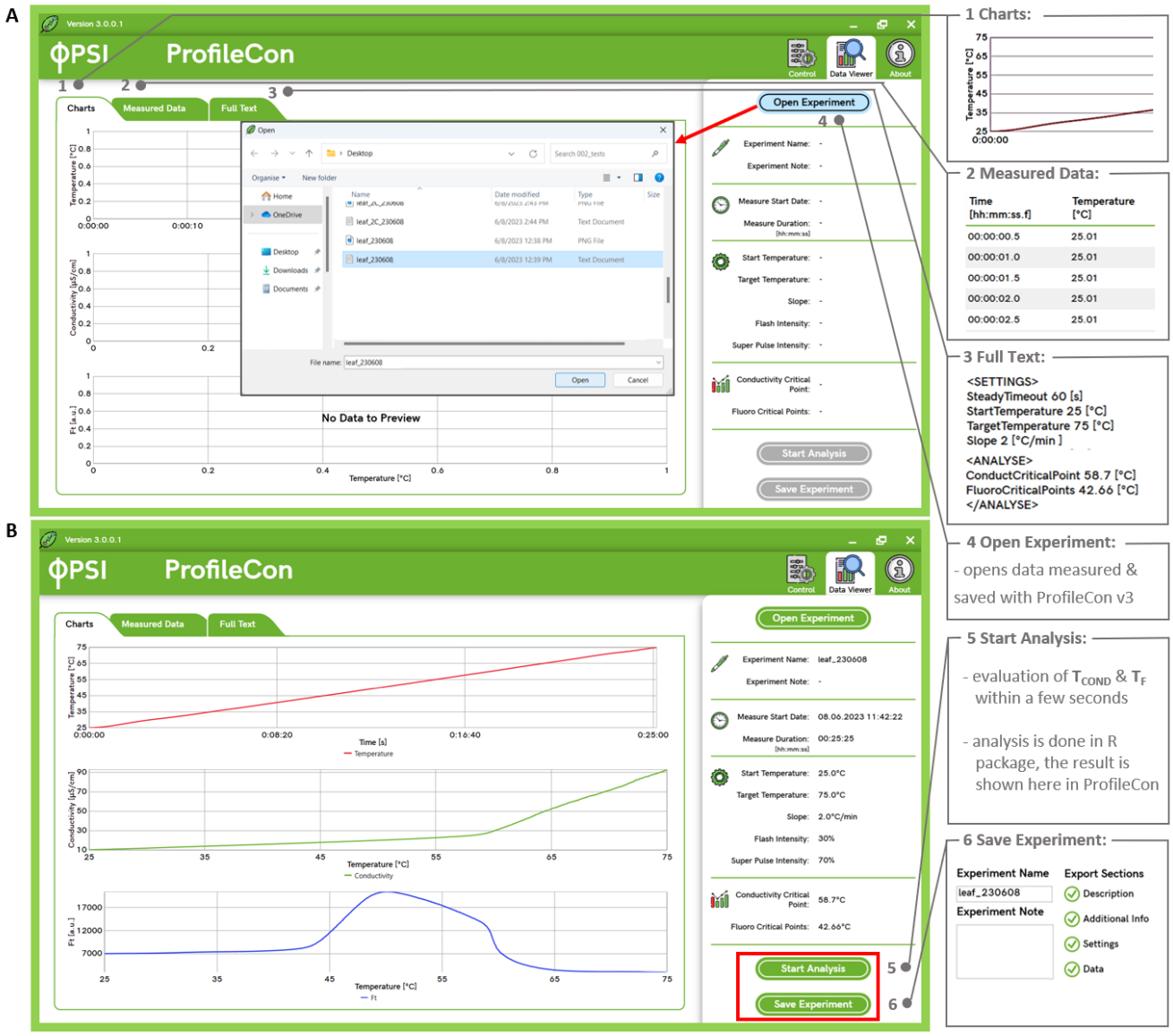

Fig. 10 The Data Viewer Tab of the ProfileCon Software.

A) before the opening a file, and B) with the open file - 1) the Charts subtab 2) the Measured Data subtab, 3) the Full Text subtab, 4) the Open Experiment button and the corresponding Open dialogue box (marked by the red arrow), 5) the Start Analysis button, 6) the Save Experiment button. The buttons required for analysis and data saving are marked by the red frame in the picture. The data are saved in a form of a text file.

5.3 The About Tab

The tab About shows applications logs (Fig. 11-A) such as connection status of temperature and conductivity sensors or FluorPen, the speed of stirrer or the lid status, and the Change log connected to the updates of the software version of ProfileCon (Fig. 11-**Error! Reference source not found.**B).

A

B

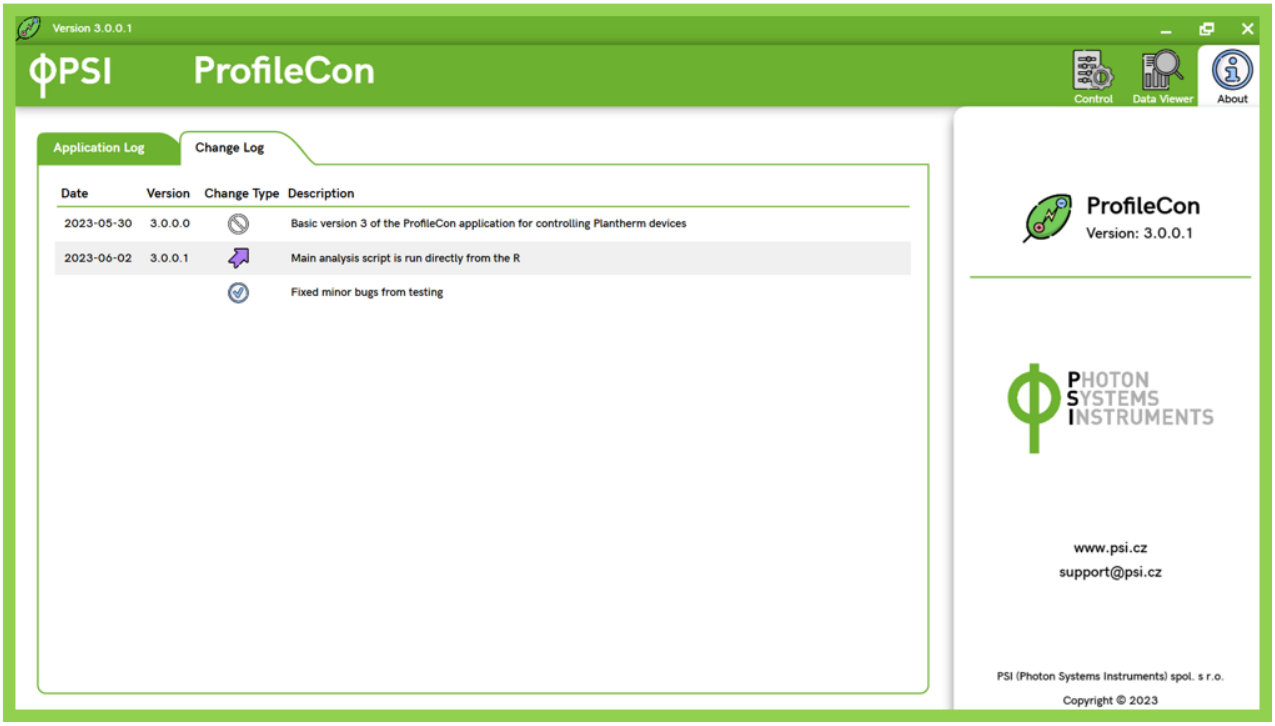

Fig. 11 The tab About of the ProfileCon Software.

A) the Application log, and B) the Change log Subtabs.

5.4 Installation Package of ProfileCon Software

The installation package of ProfileCon software contains 2 folders: a folder called **R** and a folder called **PSI.ProfileCon. R**-folder contains *exe file for the installation of program R environment required for PlanTherm analysis. **PSI.ProfileCon** folder contains original installation of the PlanTherm control software.

It is important to proceed the installation process according to the following instructions:

1. Run R-3.1.1-win.exe file from folder R. The *exe file can be executed directly from the compressed folder, directly from the USB flash drive.
2. Make a new folder called ProfileCon. We recommend to locate this folder on a local disc C:\PSI\ProfileCon. But the location of the ProfileCon can be anywhere on the PC local disc.
3. Copy all files form PSI.ProfileCon folder to C:\PSI\ProfileCon.
4. Execute file ProfileCon.exe file to run the application of control PlanTherm software, ProfileCon.

	In case of problems, please contact: support@psi.cz.

	The installation package contains all necessary configuration for fluent ProfileCon installation and run. In case of communications problems or non-functional data analysis, you may check the configuration of the ProfileCon software in the configuration file: **PSI.ProfileCon.exe.config. Please, do not modify anything without consultation with PSI IT specialist!**

The configuration file is located in the application startup folder. It can be opened in a text editor such as Notepad.
The important items to check in the configuration file are:

- Port settings for individual devices: thermoregulator, conductivity sensor MV1 and fluorometer FluorPen according to their actual assignment by an actual computer. The incorrect port settings take effect as a very slow connection of the devices or an indication of the status that the device is not connected.
- Correctly set path for the R environment files. Incorrectly set R-path takes effect as the inability to launch the application or run the analysis.

```
<!-- thermoregulator settings-->
<thermoregulatorConfig>
  <!-- konfigurace zarizeni (real/fake)-->
  <device mode="real" />
  <!-- konfigurace modulu thermoregulatoru (teplota v °C, rate v °C/min, stirrer v rozsahu 5-40)-->
  <module id="1" name="TR6000" serialPort="COM9" minTemperature="15" maxTemperature="75" minRate="-5" maxRate="5" stirrerSpeed="12" />
</thermoregulatorConfig>
<!-- conductometer settings-->
<conductometerConfig>
  <!-- konfigurace zarizeni (real/fake)-->
  <device mode="real" />
  <!-- konfigurace modulu conductometru (vodivost v µS/cm)-->
  <module id="1" name="MV1" serialPort="COM7" minConductivity="0" maxConductivity="1000" baudRate="2400" />
</conductometerConfig>
<!-- fluorpen settings-->
<fluorpenConfig>
  <!-- konfigurace zarizeni (real/fake)-->
  <device mode="real" />
  <!-- konfigurace modulu fluorpenu (bez jendotky)-->
  <module id="1" name="FluorPen" serialPort="COM8" minFt="0" maxFt="99999" baudRate="19200" flashIntensity="5" superPulseIntensity="5" ojipEnabled="false" />
</fluorpenConfig>
<!-- experiment settings (cas v s, teplota v °C)-->
<experimentConfig>
  <timeout steady="60" />
  <temperature tolerance="2" upperOverlap="2" />
</experimentConfig>
<!-- analysis settings-->
<analysisConfig>
  <r path="C:\Program Files\R\R-3.1.1\bin\x64\R.dll" exePath="C:\Program Files\R\R-3.1.1\bin\Rscript.exe" />
  <filterWindow conductivity="100" fluorescence="100" />
  <thresholdTemperatures>
    <temperature value="40" />
    <temperature value="50" />
    <temperature value="60" />
  </thresholdTemperatures>
</analysisConfig>
```

Fig. 12 The configuration file. The set serial ports and the correctly set path are marked by red boxes.

6 Operation

6.1 Control Measurement

1. Before you start measurements with your samples, check the device settings with deionized water. Fill 4 ml of pure deionized water into the cuvette. Its background conductivity should be below 10 µS/cm. Higher background conductivity lowers the absolute conductivity changes at the critical temperature and accuracy of further analyses (smaller change in the conductivity slopes before and after critical temperature).
2. Do not forget to throw the included stirrer bar 7 × 2 mm into the cuvette. This bar maintains the homogeneous temperature in the whole volume of the cuvette. Stirrer bar should stabilize its circulation at the bottom of the cuvette within few seconds. Magnetic stirrer is located under the aluminum block inside the device.
3. Plug the conductivity probe into the cuvette. Four corner guides help with this operation. Temperature sensor is located at the backside of the conductivity probe. Plugging the conductivity probe into the proper position is announced by the Lid status (Fig. 6-2).
4. Check the FluorPen (Fig. 7-2) and Heating (Fig. 7-3) settings. The recommended flash intensity is 30%. Then start measurement. Thermoregulator controls the temperature of the aluminum block as soon as the regulation is started. The experiment will end automatically as soon as the cuvette is cooled down to the Start temperature. Obtained data must be analyzed and saved by the user.
5. Current temperature, conductivity and fluorescence (F_t) values are presented in the Control tab of the ProfileCon software.

6.2 Preparation of Liquid Samples

1. Prepare the fresh sample. At first, measure the OD_{680} of your culture. Calculate the volume to collect into a clean Falcon tube to reach theoretic OD_{680} of 0.5 in the at least 4-ml final sample after dissolving the centrifuged pellet in the distilled water. Then move the calculated volume of your culture in a clean Falcon tube and centrifuge the sample (<5,000 rpm, 10 min). Carefully remove the supernatant. Dissolve the centrifugation pellet in required volume of distilled water just before measurement. Mix the sample gently and move 4 ml of the sample into the 6-ml cuvette for the measurement (Fig. 13).

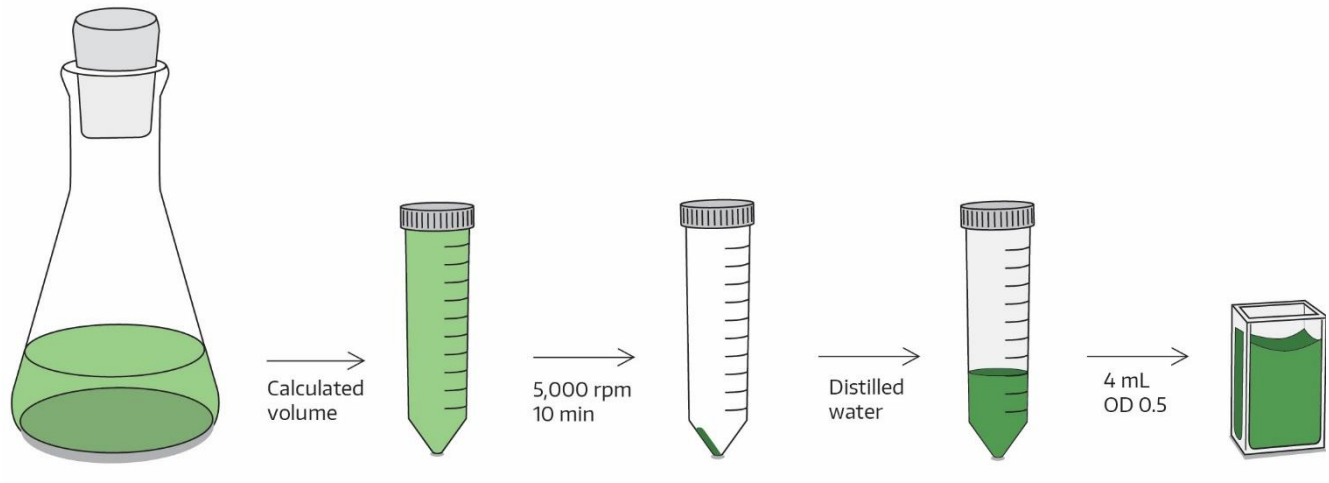

Fig. 13 Preparation of a liquid sample.

	Example: If the Chlorella vulgaris culture has OD_{680} 0.3, then transfer 10 ml of the culture into a tube and centrifuge. After that, dissolve the pellet in 6 ml of distilled water just before measurement to get the theoretical OD_{680} of 0.5. Use only 4 ml of sample for a measurement in the PlanTherm PT 200.

2. Add the stirrer bar, plug the conductivity probe, check the setting and run the experiment similarly as in the case of the control measurement.

6.3 Preparation of Leaf Samples

1. Fill 4 ml of pure deionized water into the cuvette (Fig. 14-A). Conductivity of this water (background conductivity) should be below 10 µS/cm.

Fig. 14 Measurement with a leaf segment requires.

A) cuvette with a distilled water and a stirrer bar, B) conductivity and temperature probe, and C) leaf holder with a leaf sample oriented by the adaxial side to the light source.

2. Leaf segment of the approximate size of the sample holder should be cut from the examined plant (Fig. 15). The optimal tool for shaping is a pair of scissors, which creates a very narrow cutting edge. Thin leaves are recommended for analysis - the smaller the heat capacity, the smaller error coming from non-homogeneous temperature scaling of the temperature inside the leaf. Keep the same orientation of the leaves for different measurements.

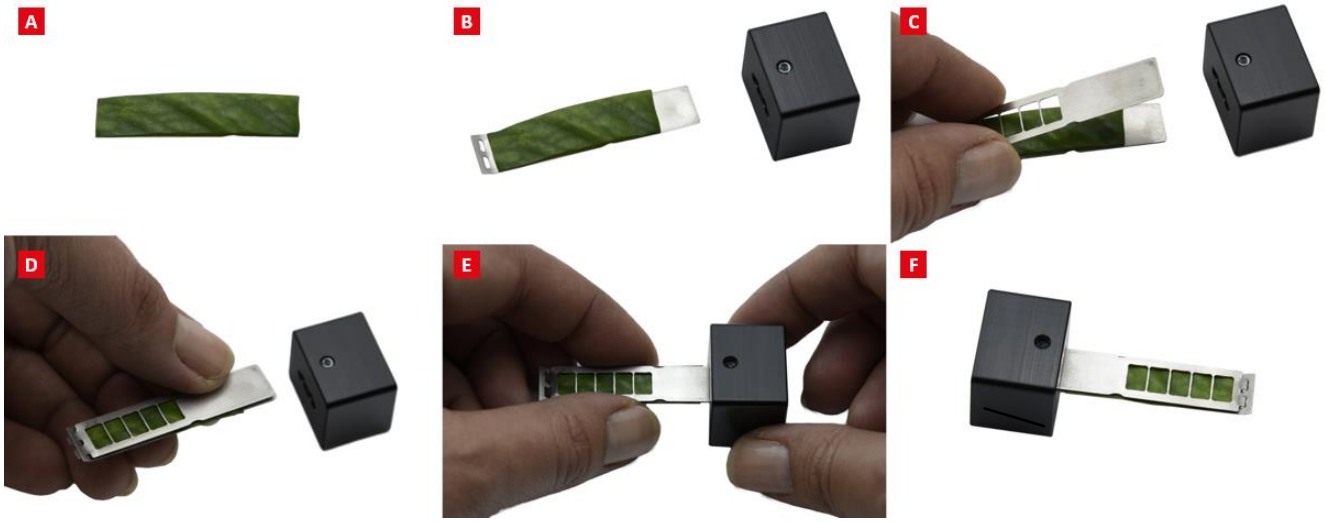

Fig. 15 Preparation of a leaf sample.

A) the leaf segment is cut and B)-E) inserted into the leaf holder. F) Assembled holder with visible abaxial (bottom) part of the leaf.

3. Add the stirrer bar, plug the conductivity probe (Fig. 14-B) and insert the holder with the leaf segment (Fig. 14-C). The holder must be inserted in proper orientation (Fig. 16-B). Then check the setting similarly as for the control measurement.

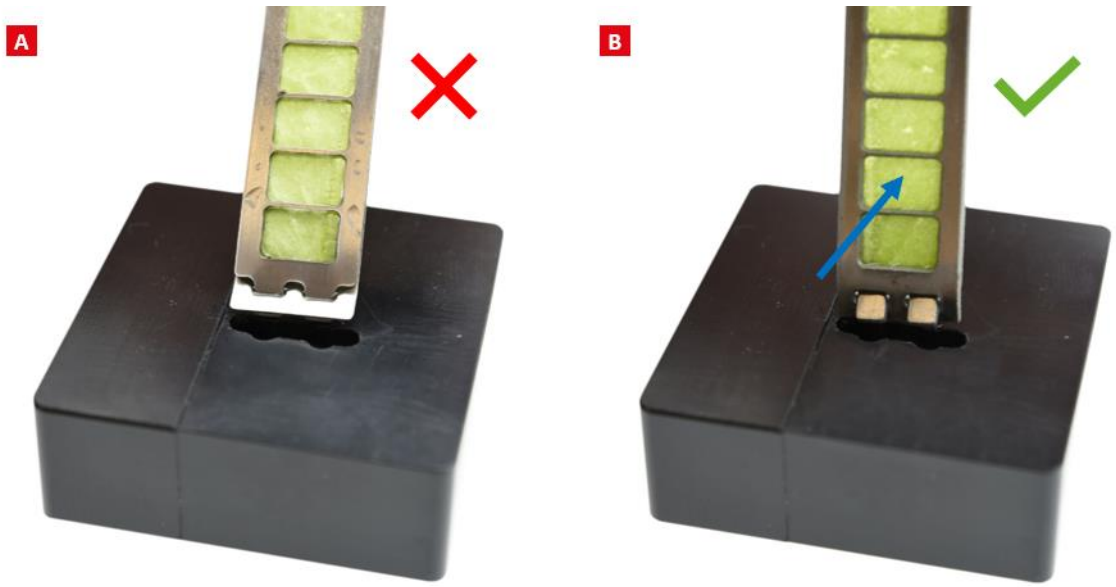

Fig. 16 The orientation of the leaf holder.

A) the wrong orientation where the holder does not match the opening in the probe, B) the proper orientation. In this proper orientation, the adaxial (upper) part of the leaf is directed to the light source. The blue arrow depicts where the blue light from the FluorPen interacts with the leaf.

7 WARRANTY TERMS AND CONDITIONS

4. This Limited Warranty applies only to the PlanTherm PT 200 device. It is valid for one year from the date of shipment.
5. If at any time within this warranty period the instrument does not function as warranted, return it and the manufacturer will repair or replace it at no charge. The customer is responsible for shipping and insurance charges (for the full product value) to PSI. The manufacturer is responsible for shipping and insurance on return of the instrument to the customer.
6. No warranty will apply to any instrument that has been (i) modified, altered, or repaired by persons unauthorized by the manufacturer; (ii) subjected to misuse, negligence, or accident; (iii) connected, installed, adjusted, or used otherwise than in accordance with the instructions supplied by the manufacturer.
7. The warranty is return-to-base only and does not include on-site repair charges such as labor, travel, or other expenses associated with the repair or installation of replacement parts at the customer's site.
8. The manufacturer repairs or replaces faulty instruments as quickly as possible; the maximum time is one month.
9. The manufacturer will keep spare parts or their adequate substitutes for a period of at least five years.
10. Returned instruments must be packaged sufficiently so as not to assume any transit damage. If damage is caused due to insufficient packaging, the instrument will be treated as an out-of-warranty repair and charged as such.
11. PSI also offers out-of-warranty repairs. These are usually returned to the customer on a cash-on-delivery basis.
12. Wear & Tear Items (such as sealing, tubing, padding, etc.) are excluded from this warranty. The term Wear & Tear denotes the damage that naturally and inevitably occurs as a result of normal use or aging even when an item is used competently and with care and proper maintenance.

8 LIST OF FIGURES