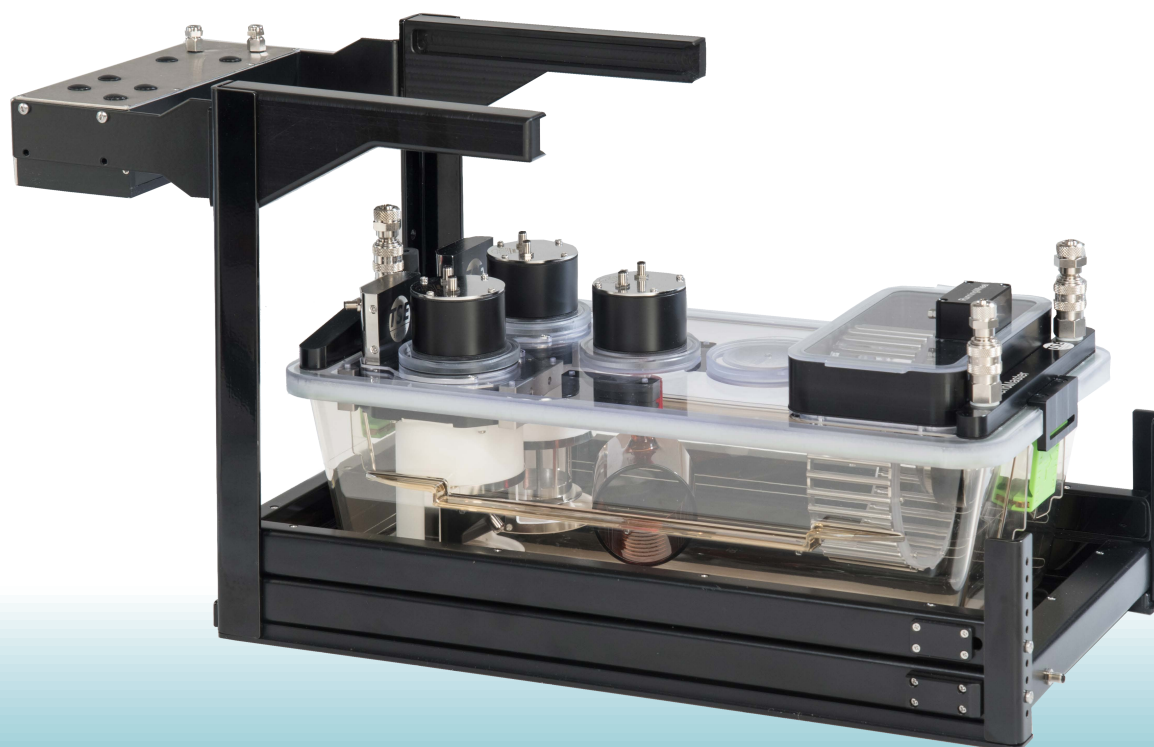


# PhenoMaster

## Hardware Operating Instructions

### Core Modules ©



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# TSE PhenoMaster System for small Laboratory Animals

## 1. Introduction

### System configuration

These operating instructions describe devices and features of the PhenoMaster Phenotyping Research Platform of TSE Systems. Some devices and features may not be available on your system. For your individual system configuration, please refer to your order confirmation. If you have questions or need assistance, please contact [TSE Service](#).

The TSE system - a modular animal research platform - is designed to measure locomotor activity, metabolic performance, drinking and feeding behavior, and wheel activity of small laboratory animals during an experiment. The use of the different functional features according to the investigator's requirements is possible.

**Activity measurements via sensor frames** can be done in the extended version with both, animal cages for mice and those for rats plus a single sensor frame system. A reduced version is for use with animal cages for a single species only. The systems differ in the size of their sensor frames, among other things.

The activity function registers the locomotor activity of the animal in the animal cage. Special frames are equipped with IR sensors, each sensor consists of an IR receiver and the corresponding IR emitter, which produces infrared light beams intersecting in the animal cage.

The frames can be supplied with light beams in the X, Y, and Z level according to the system configuration.

Various parameters can be used for determining the locomotor activity of the animals.

The software registers the number of beam interruptions caused by the animal's movement. Beam breaks are divided into ambulatory and fine movements whose sum provides the total number of interrupted light beams. According to the system configuration, the parameters listed below can be measured.

ActiMot2 Result Parameters	
Parameter	Description
"XT", "YT"	Breaks X-beam total (is equivalent to XA + XF) Breaks Y-beam total (is equivalent to YA + YF)
"XF", "YF"	Breaks X-beam, fine movements Breaks Y-beam, fine movements
"XA", "YA"	Breaks X-beam, ambulatory movements Breaks Y-beam, ambulatory movements
"Z"	Breaks Z-beam, rearing
"Z2"	Breaks Z2-beam, rearing
"CenT", "PerT"	Sum central and peripheral, ambulatory and fine movement
"CenA", "CenF"	Central ambulatory and central fine movement
"PerA", "PerF"	Peripheral ambulatory and peripheral fine movement

Fig. 1 ActiMot2 result parameters (table data, binary data)

The operator can define a part of the sensors as the 'center'. This allows the measurement area to be adapted to suit animal cages with different sizes as well as the definition of two different measuring ranges (central and peripheral).

To avoid counting scratching or tail flipping, a refractory period can be defined, during which an additional interruption of a beam will not be counted within a certain period of time.

**The CaloSys module** is operated as an open circuit measuring system for determining the parameters O<sub>2</sub> consumption, CO<sub>2</sub> production, Respiratory Exchange Rate (RER), heat, difference O<sub>2</sub> (reference air O<sub>2</sub> - Box O<sub>2</sub>), and difference CO<sub>2</sub> (Box CO<sub>2</sub> - reference air CO<sub>2</sub>). All these parameters may be calculated both, offline and online by the system software, and can be displayed as required by the investigator. The following values can be stored per measuring interval and serve as a basis for the calculation of the above mentioned parameters:

- Date and time,
- O<sub>2</sub>, CO<sub>2</sub>, concentration, reference (surrounding air);
- Per measuring place: O<sub>2</sub> or CO<sub>2</sub> concentration, flow, and temperature (optional)

The other parameters are calculated and displayed as required (Graph and Table). This means that the operator can assemble the required parameters both, in the Table and in the Graph display, print them out or export them as a \*.csv file that can be read, e.g., into spreadsheet or database software. This is possible both, online with the running data file and also offline.

Calorimetry Result Parameters			
Parameter	Description	Unit	Remarks
"Flow"	Flow	l/min	
"Temp"	Temperature	°C	Measurement in the box.
"O <sub>2</sub> "	Concentration	%	Reference and per box.
"CO <sub>2</sub> "	Concentration	%	Reference and per box.
"dO <sub>2</sub> "	Difference	%	Reference O <sub>2</sub> - Box O <sub>2</sub> .
"dCO <sub>2</sub> "	Difference	%	Reference CO <sub>2</sub> - Box CO <sub>2</sub> .
"VO <sub>2</sub> "	O <sub>2</sub> consumption	ml/(kg x h) or ml/h	
"VCO <sub>2</sub> "	CO <sub>2</sub> production	ml/(kg x h) or ml/h	
"RER"	Respiratory Exchange Rate		VCO <sub>2</sub> /VO <sub>2</sub>
"H"	Heat	kcal/(kg*h) or Kcal/h	Also possible in W/kg

Fig. 2 Calorimetry result parameters

\*According to system configuration

The standard CaloSys module is available for small animals and consists of the following principal devices:

- Special animal cages adapted to the system configuration.
- An air supply pump.
- Control Units containing the necessary equipment for measuring O<sub>2</sub> and CO<sub>2</sub> concentrations, flow, and temperature (optional).
- A Sample Switch Unit to draw air samples from the cages.
- A Calibration Control Unit.
- An Air Drying Unit.
- Special control interfaces.
- CaloSys module of the system software package.

The numbers and versions of devices correspond with the information given in the order confirmation.

**The drinking and feeding behavior** of the animals is registered with special drinking and feeding sensors and the appropriated mounting devices. The standard configuration is the dual-sensor system with one feeding and one drinking station.

The drinking stations consist of a vessel containing the liquid and a sensor for measuring the amount of liquid removed through the drinking nipple.

A feeding station consists of a food dispenser suspended from a sensor. The dispenser can hold different standard food pellets.

Access to the food is given via a round stainless steel wire basket. The animals can gnaw off pieces of food through the steel bars in the same way as they do with the ordinary food cribs.

An upper and a lower limit for liquid or food removal can be entered in the "Setup" menu. Within these limits, the amounts of liquid and feed removed will be registered. Measured values that lie outside these limits, e.g., those caused by knocking the dispenser against the sensor or by the animal lifting the dispenser, will not be taken into account.

**Activity measurements via InfraMot sensors** can be done for rapidly and easily determining the gross activity of mice, rats, and other small laboratory animals via an infrared sensor.

These sensors register the activity of one or more subjects by sensing the body heat image, i.e. infrared radiation and its spatial displacement over time. In this way, movement within the cage can be reliably determined. This even includes brief movement events of a few milliseconds duration only.

A **voluntary wheel** can be included in the system in order to obtain further activity parameters. The voluntary wheel can be used to measure the spontaneous activity of the test animal. The number of turns that the wheel makes clockwise or counterclockwise will be registered.

## 2. Instructions for safe Operation

### 2.1. Notes for the Operator

This system has been manufactured in accordance with the latest technological developments and is operationally safe. However, it may nevertheless represent a potential hazard, particularly if it is operated by not suitably trained personnel, or if it is improperly used for other than its intended purpose.

- The operator must prepare written instructions for the operation of system in a reasonable form, based on the safety and operating instructions, the safety data sheets, and the applicable technical guidelines.
- These written instructions must be announced in the language of the operating personnel.
- In order to operate the system in a laboratory, the operator must carry out a risk assessment and determine the specific risks arising from the typical setup at the location and the operator-specific operation of the system. The users must be informed of this and appropriately trained. Risk assessment is a method for evaluating the health and safety hazards for employees at their workplaces.
- Use these operating instructions to familiarize the service and cleaning personnel with the functions, operation, and maintenance of the system.
- The national rules and regulations concerning the operation and handling of this system must always be observed.
- The contents of the operating instructions are subject to change without further notice.
- These instructions, or parts of these instructions, should only be translated into other languages by a qualified technical translator. TSE Systems should be informed about this in advance. TSE Systems cannot be made responsible for a faulty translation. Liability claims resulting from a faulty translation are to be made against those responsible for the faulty translation.
- Save all instructions. Keep these operating instructions close to the system so that safety instructions and important information are always accessible.
- If the product is passed on to a third party, then the operating instructions must also be passed on.

Should you encounter problems concerning components of TSE Systems, please contact [TSE Service](#) for your own safety. For contact data, please see last page.

### 2.2. Warranty

TSE Systems warrant the operational safety and the operability of the system only under the condition that...

- ...the system is operated exclusively in accordance with its intended purpose - taking particular notice of the safety information - and as described in these operating instructions and is properly serviced and maintained;
- ...the system isn't modified by the operator.
- ...original spare parts and accessories that have been approved by TSE Systems are used only. If you have questions or need assistance, please contact [TSE Service](#).
- ...inspections and maintenance work are performed at the specified intervals.

The warranty is valid from the date of delivery of the system to the operator.



### **Exclusion of warranty**

The warranty becomes null and void...

- ...if inspections and maintenance work are not performed at the specified intervals.
- ...if device housings are removed by unauthorized personnel.

## 2.3. Notes for the User

Prior to the initial operation of the system, read these operating instructions carefully to ensure that you can fully exploit the advantages of the system and to protect personnel, animals, and the environment against possible damage:

- These operating instructions describe the TSE PhenoMaster system.
- Images in these instructions show standard devices; depending on the system specifications these may differ from the devices actually supplied.
- The system is to be operated by qualified and suitably trained personnel only.
- If the system is to be operated with devices from other manufacturers, then these will be described in separate instructions provided by the manufacturer of the particular device.
- Any repairs to the system must be performed by members of the Technical Service of TSE Systems only, or by suitably trained and authorized expert personnel.


### **Test run**

We recommend to perform a test run before the system is used for the first time in order to familiarize yourself with its operation and to make the necessary settings for the particular series of experiments.

## 2.4. Explanation of Symbols

### 2.4.1. Warnings, Safety Messages, and Symbols

The following section contains information about the use of the safety symbols and explanations about how they are to be understood. Please read it through carefully and observe the described measures in order to protect yourself and others from injury or death.

 <b>WARNING</b> <a href="#">Safety alert symbol</a> <a href="#">Indicates potential hazard</a>	<b>Toxic substances</b> <a href="#">Identification of hazard</a>
<b>Health hazards by toxic substances.</b> <a href="#">Probable consequences of not avoiding the hazard</a> <ul style="list-style-type: none"> <li>• In cases of doubt, take appropriate safety measures.</li> <li>• Wear protective clothing, e.g., safety goggles, safety gloves.</li> </ul> <a href="#">Measures: how to avoid the hazard</a>	

\*Blue-colored text passages provide short explanations.

### Safety alert symbol



This is the safety alert symbol. It is used to alert you to potential physical injury hazards. Obey all safety messages that follow this symbol to avoid possible death or injury.

**Signal word**

The signal word indicates the hazard seriousness.

**DANGER****Will lead to death or severe injuries!**

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

**WARNING****May lead to death or severe injuries!**

Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.

**CAUTION****May lead to minor or moderate injuries!**

Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury.

**Embedded safety message**

This warning is used to indicate risks that could occur during handling sequences.

- Instructions with Dos and Don'ts
- **WARNING!** Here the description of the hazard follows.
- Instructions with Dos and Don'ts....

In this case a warning is associated with operating steps that follow.

or

- Instructions with Dos and Don'ts  
Instructions with Dos and Don'ts  
**WARNING!** Here the description of the hazard follows.
- Instructions with Dos and Don'ts

In this case a warning is associated with the particular operating step that precedes it.

**Notice**

"Notice" is used to address damages not related to physical injury, e.g., property damage.

**NOTICE - Rubber Stoppers****Rubber stoppers can be used for the leak test.**

Do not use rubber stoppers during operation of the exposure system.


**Additional information**

Is used for application hints and useful information.

**2.4.2. Warnings and Labels on the System**


In this section the warning information given on the components of the PhenoMaster system is explained. The warnings on the components correspond to those in these instructions.

## Warning illustration

 <b>WARNING</b>	<b>Toxic substances</b>
<b>Toxic substances can escape by diffusion, condensation.</b> <ul style="list-style-type: none"> <li>• In cases of doubt, take appropriate safety measures.</li> <li>• Wear protective clothing such as safety goggles, gloves.</li> </ul>	


This warning is given on the instrument in position XXXX.

Shorter warnings may be given for space reasons:

 <b>WARNING</b>	<b>Toxic substances:</b> Test substances can represent a health hazard by exposure.
--	---

The further information given in these instructions must be observed.

Warnings given on instruments if the information is too voluminous, or if too many warnings need to be given.

 <b>WARNING</b>	For safe operation, see Operating Instructions.
--	---

Removed, missing, damaged or difficult to read or illegible warnings must be replaced immediately. Please contact [TSE Service](#).

The presence and legibility of warnings must be checked every 6 months at the latest and replaced as necessary.

### 2.4.3. Conformity

This product and its accessories conform to the requirements of the Low-Voltage Guideline 73/23/EEC as well as the EMC Directive 89/336/EEC and are accordingly marked with the CE symbol. For conformity with the standard, it is essential that the details in the instructions are strictly observed during operation.

## 2.5. General Safety Instructions

### 2.5.1. Proper Use

The TSE PhenoMaster is a system, which can be used to determine the metabolic performance, the animal activity via sensor frames or infrared sensor(s), the drinking & feeding behavior as well as wheel activity of small laboratory animals during an experiment. Your individual system configuration can be found in the order documentation.

#### General

- The device/system...
  - ...is designed and intended to be operated by skilled professionals whose background and training qualify them to do so.
  - ...has been specially designed and constructed for research purposes and is intended for laboratory use only.

- ...is intended for use in laboratories equipped in accordance with the relevant safety regulations, valid standards, and guidelines.
- ...is intended for use with the specified animal; if different animals are used, then incorrect results could be obtained.
- ...is intended for use with a max. number of animals at the same time - according to the order documentation.
- ...is normally intended for measurements with a single animal per animal cage.
- ...can be controlled by a combination of the TSE Control Units and the associated hardware and software only.
- The system devices can be operated in the given setup only.
- If only individual components or parts of a system have been supplied by TSE Systems and the user makes up a complete system by using components from other manufacturers, then it is the user's responsibility to ensure that the individual components are properly matched to one another and that the system - taking safety regulations into special consideration - functions perfectly.
- The system has been tested with English and German MS Windows operating system versions only. If a different Windows operating system version is used, then TSE Systems cannot guarantee that the system will function perfectly.

#### **Activity measurements via sensor frames (ActiMot2)**

- The sensor frames are, depending on their specification, intended to register the activity in the X, Y, or Z direction only. They should not be interchanged and should be mounted in accordance with these instructions.
- The system isn't intended to register distances covered for determining the exact location of the animal.
- The sensors for measuring the activity should be free from contamination, and the beam path should not be hindered by solid objects in the vicinity of the sensors.

#### **Calorimetry measurements**

##### **NOTICE - Reduced lifetime!**

**If Calorimetry Process Control Units and Air Pumps are powered ON without operating the system, this may reduce lifetime of devices.**

- Always run system software when devices are powered ON.
- Power OFF devices after use.

##### **NOTICE - Reduced lifetime!**

**If excess heat produced by the Air Drying Units cannot dissipate to the outside, this may reduce lifetime.**

Ensure that the device is properly ventilated:

- Min. distance:
  - Air Drying Unit - Wall:  $\geq 150 \dots 200 \text{ mm}$  ( $\geq 5.91 \dots 7.87 \text{ inch}$ )
  - Air Drying Unit - Other devices:  $\geq 150 \dots 200 \text{ mm}$  ( $\geq 5.91 \dots 7.87 \text{ inch}$ ).

##### **NOTICE - Reduced lifetime!**

**If Calorimetry Process Control Units and Air Pumps are powered ON while there is a leakage in the sample line, this may reduce lifetime of devices.**

- After you have discarded condensed water, carefully reconnect collection vessel to 1x Air Drying Unit and reconnect separating bottle to tubing.
- Select "Status/Calo" and check for proper "SampleFlow" on "Calo Current Values" dialog (see Software Operating Instructions - Calorimetry, Section "Status Menu, Calo").

**NOTICE - Reduced lifetime!**

**If Calorimetry Process Control Units and Air Pumps are powered ON while there is a leakage in the sample line, this may reduce lifetime of devices.**

- Never remove collection vessels from the 4x Air Drying Unit. Drain off condensed water via collection vessel tubing only.
- After you have discarded condensed water of separating bottle, carefully reconnect bottle to tubing.
- Select "Status/Calo" and check for proper "SampleFlow" on "Calo Current Values" dialog (see Software Operating Instructions - Calorimetry, Section "Status Menu, Calo").
- The test area should be limited by a door or similar so no rapid alteration in the CO<sub>2</sub>/O<sub>2</sub> concentration of the reference air can take place during the measurement.
- A warmed-up calorimetry system should be used for an experiment only. The warming-up period should be at least 2 hours.
- Exactly specified gases with a test certificate should be used for calorimetric calibration only. Calibration gases (O<sub>2</sub>, CO<sub>2</sub>) which concentration is known accurately to two decimal places should be available.
- The calorimetry sensors should be calibrated under the same conditions that are to be used for the measurement (e.g. room temperature, pressure, location).
- The calorimetry devices of the system should be leak-free, as otherwise the measurements will be inaccurate.
- The setting of the flowmeter (Calorimetry Master Control Unit) for the measurement should be the same as for the calibration process.
- For better comparability of test data, the room conditions, particularly temperature and humidity, should be kept as constant as possible.
- Air pumps (push principle respirometry, overpressure principle)
  - The pump is designed for pumping air only. The performance values can be found on the pump label.
  - Ensure that the operating air temperature is within the range -10...+40°C (14...104°F)
  - Ensure that humidity is <90%.
- Vacuum pumps (pull principle respirometry, underpressure principle)
  - The pump is suitable exclusively for air and NOT for pumping liquids or gases. Max. permissible humidity <90%.
  - The ambient temperature must not fall below -5°C (23°F) and must not exceed +40°C (104°F). You are NOT allowed to operate the pump close to explosive liquids or on potentially explosive premises.
  - Unusual noises may indicate that a diaphragm has broken. In this case, unplug device from mains supply and contact [TSE Service](#).
- When the High-Speed Sensor Unit is in operating mode, ensure that the OxyMat sensor is supplied with reference air (scavenging air) to protect the device against contamination.

**NOTICE - Reduced lifetime!**

**If High-Speed Sensor Unit is powered ON without operating the system, contamination may damage the sensors.**

- During operating mode of High-Speed Sensor Unit, ensure that...
  - ...its sensors are supplied with air from reference gas cylinder continuously.
  - ...all other devices of the CaloSys module entered operating mode as well.
  - ...PhenoMaster software is running.
- Power OFF High-Speed Sensor Unit after use.

**Drinking and Feeding measurements**

- The drinking and feeding sensors can be used with the dispensers supplied by TSE only - if others are used, measuring errors will occur.
- (Re)assembly of rod drinking nipples

**NOTICE - Dehydration hazard!**

If the O-ring of the valve rod is positioned in the false orientation, flow through the opening of the extension cap is always blocked and animals can die of thirst.

- Position O-ring onto the gasket so that its smaller base is orientated towards the gasket.
- After (re)assembly, always perform a test to ensure that liquid can flow throughout the nipple.

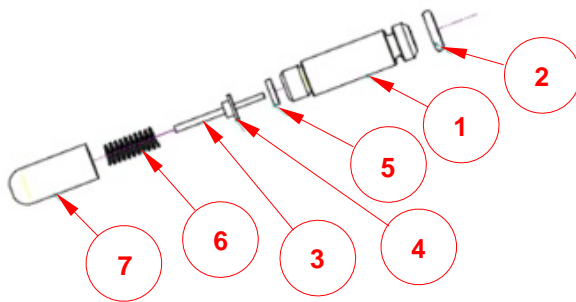


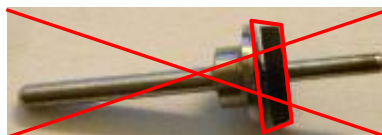
Fig. 3 Hardware layout - Rod nipple

- 1 Nipple receiver
- 2 O-ring, NBR (nipple receiver)
- 3 Valve rod
- 4 Gasket
- 5 O-ring, rubber (valve rod)
- 6 Pressure spring
- 7 Extension cap

- Position O-ring (valve rod) onto gasket (shorter end of valve rod). The smaller base of the O-ring must be orientated towards the gasket, as otherwise flow through the opening of the extension cap is always blocked and animals can die of thirst!



Correct



Incorrect

Fig. 4 Positioning of O-ring (valve rod)

**How to test the operability, i.e. flowability, of the drinking nipple?**

- Fill dispenser with water.
- If not already done, attach drinking cap including nipple.
- Suspend dispenser from sensor.
- Wait approx. 20s until water and air are in equilibrium.
- With a moistened finger, touch the tip of the nipple slightly (thereby moving the valve rod to the side). It should be possible to "pull off" a drop. If not, a check for potential sources and remedies, respectively, has to be made.

**Activity measurements via infrared sensors (InfraMot)**

- Infrared sensors supplied by TSE should be used only.
- There should be no external heat source in the measuring area of the sensor - and no persons should stand directly in front of the cage.

**Activity measurements via voluntary running wheels**

- The voluntary running wheels are designed for measuring the spontaneous wheel activity of small laboratory animals only.

**2.5.2. Improper Use**

- No constructional alterations should be made to the system without the explicit written authorization of the manufacturer.
- The system must NOT be used...
  - ...in an explosive environment.
  - ...with dirty and contaminated device components. Do NOT store the system when it is still contaminated.
- Do NOT obstruct any ventilation openings.

**Computer system (PC, PC monitor, Process Control Units, etc.)**

- Only those programs described in the instructions should be installed on the PC in order to rule out software incompatibility.
- Windows internal programs and memory resident software should be deactivated, e.g., screensaver, automatic switch OFF, etc.

**Animal cages**

The animal cages should be assembled and connected as described in these instructions only, as otherwise inaccurate results will be obtained.

If calorimetry measurements are to be made without the presence of the drinking dispensers / feeding dispensers, the corresponding openings should be closed off.

**Sensors**

- The sensors are intended to register the specified measured values only and are to be used for this purpose only. For proper use, the calorimetry and the drinking & feeding & body weight sensors should be calibrated.
- The drinking and feeding sensors must always be handled carefully. Do NOT drop them. When not in use, they should be stored in transport boxes.
- The infrared sensors for measuring the activity should be free from contamination, and the path should NOT be hindered by solid objects in the vicinity of the sensors.

**Calorimetry measurements**

- Air supply pumps (push principle respirometry, overpressure principle)
  - The air supply pump supplied must be used for generating the required air flow only. Oil-operated compressed air generators will destroy the sensitive measuring and control equipment.
  - The pump must NOT be installed in area that is subject to explosion hazard.
  - The following media must NOT be allowed to enter the air intake: dangerous gas mixtures (e.g. combustible gases, explosive gases or vapors), extremely humid air, water vapour, any liquids, aggressive gases, oil traces or oil mist, and grease.



- Vacuum pumps (pull principle respirometry, underpressure principle)
  - Under no circumstances you should grease or oil the pump!
  - Choking the air flow by reducing the outlet or closing it leads to premature wear of the pump. If the air flow fails, the windings overheat and burn.
- Mass Flow Controllers  
The mass flow controllers of the Control Units are intended for measuring and controlling air only. Oil-free air must be used only. The pump supplied must be used only; do NOT use compressed air generators.
- Reference air
  - No rapid alteration in the CO<sub>2</sub> or O<sub>2</sub> concentration of the reference air should take place during the measurement, as this will cause inaccurate results.
  - No O<sub>2</sub> consumers or CO<sub>2</sub> generators should be located in the air from which the reference air is taken.
  - The reference air should be taken from the same location as that used for the air supply pump.
- When the High-Speed Sensor Unit is in operating mode, ensure that sensors are supplied with reference gas to protect device against contamination.

## 2.6. Ambient Conditions

The system must be operated in locations only which satisfy the following ambient conditions.

- Setup in a closed room.
- Fresh air supply required.
- Dry location; don't store liquids above the system devices. Keep all surfaces (e.g. floors) dry.
- Protect against water splashes.
- Solid, level, and nonflammable support.
- The ambient temperature must be  $\geq 15^{\circ}\text{C}$  ( $\geq 59^{\circ}\text{F}$ ) and  $\leq 25^{\circ}\text{C}$  ( $\leq 77^{\circ}\text{F}$ ). The animal cages alone can be placed in a climate chamber with temperatures  $\geq 3^{\circ}\text{C}$  ( $\geq 37.4^{\circ}\text{F}$ ) and  $\leq 30^{\circ}\text{C}$  ( $\leq 86^{\circ}\text{F}$ ) but the Control Units and the PC must be placed outside close to that chamber under normal environmental conditions.

### **NOTICE - Measurement errors!**

**If the air is very humid, this will affect the measuring accuracy of the MFC.**

Do NOT operate Process Control Units and Air Drying Unit with non-ambient temperatures ( $< 15^{\circ}\text{C}$  ( $< 59^{\circ}\text{F}$ ) or  $> 25^{\circ}\text{C}$  ( $> 77^{\circ}\text{F}$ )).

- The relative humidity of the surroundings must NOT exceed 60% (non-condensing).
- The system must NOT be exposed to direct sunlight or radiated heat.
- The system must NOT be located directly beside or above sources of heat.
- The system must NOT be exposed to dust.

## 2.7. Room Requirements

- The room must permit connection to a grounded mains supply which is in accordance with the local safety standards.
- The mains connection fuse is adequate for the number of amperes required by all the system devices.



- We recommend the use of a specially protected system for connecting the hardware in order to prevent overvoltage surge damage, e.g., by a lightning strike, together with a system that ensures an uninterruptible power supply.
- For calorimetric measurements, we recommend that the system is installed in a separate room, in which the room climate does not alter during the measurement. The room conditions, particularly temperature and humidity, should be kept as constant as possible for all the runs in a test series.

### 2.7.1. Loudness in Laboratory

For behavior studies, you need a room with a noise level below 65dB. In the laboratory, the noise level could amount to approx. 70dB from air conditioning, lighting, general lab noise, etc. Most of this loudness is below 1kHz and is therefore in a frequency range, which mice cannot hear, and which is in the lower audible range for rats if the sound pressure level exceeds 60dB.

The CaloSys module produces approx. 42dB - from the air pumps, PC fan, and Air Drying Units.

It should also be taken into consideration that the animals are inside cages, which also reduce noise. This means that the loudest noise that the animals can hear will be approx. 40dB from the air pump of the system.

It is important that your animal test laboratory isn't subject to regular public traffic, that neither doors nor windows are opened and closed at frequent intervals, and that persons don't enter or leave the room frequently.

## 2.8. Setting up System

- The support surfaces for the cages must ensure vibration-free operation, as otherwise the sensitive measurement technique could be negatively affected.
- If shelving systems are used for setting up the cages, you should ensure that they are not located beneath the illumination or in front of an air-conditioning inlet, as otherwise the test and keeping conditions will differ between the animals, which could cause considerable differences between the single measurements.
- With shelving systems that are intended for use with both, rat and mouse cages, remember that the rat cages are higher and require a greater distance between the shelves.
- Shelving systems used for setting up the cages should be horizontal so that, in eating and drinking tests in particular, the dispensers hang freely without touching.
- Mobile support surfaces, e.g., on casters, must have the casters locked when the system is in use.
- The support surfaces should be easy to clean, e.g., smooth stainless steel surfaces - if possible, grids or benchtops with joints should not be used.
- The cages must be placed on a stable, horizontal base (bench top) at a convenient working height (no sagging shelves!).

Ensure that there is sufficient distance between the cages! Under no circumstances should occurrences in one cage interfere with the measurements made in neighbouring cages!

### 2.8.1. Space Requirements

When setting up the system, ensure that...

- ...all the devices for controlling and operating the system are freely accessible.

- ...the device ventilation slots are NOT blocked.
- ...information and safety warnings are NOT covered up.

## **2.9. Transport in Laboratory**

- Transport the system devices only when...
  - ...they are powered OFF.
  - ...the cables have been unplugged.
  - ...the tubing connections have been removed.
- Lift the system devices by their housings and not by their cables.
- Drinking and feeding dispensers must not be attached at the sensor hooks.
- The sensor frames should be transported only in a dismantled condition in order to avoid distortion of the individual devices by shearing forces.

## **2.10. Disposal**

Discarded devices or worn device components contain reusable material.



**Recycling!**

All the components of the device can be disposed of in accordance with statutory waste management procedures after appropriate cleaning (decontamination if necessary).

### 3. Operating Principle

The system permits a customer-specific arrangement of individual measuring modules. Registration of activity using sensor frames, calorimetric measurement, registration of drinking and feeding behavior or body weight, as well as determining the activity by using infrared sensor or a voluntary wheel are possible.

**For activity measurements via sensor frames**, the animal cage is inserted in frames containing light beams. No calibrations are needed for the light beams. Depending on the system configuration, activity in the X and/or Z, X and Y, or X, Y and Z direction can be registered. An infrared sensor is located every 5mm (0.20inch); this consists of an IR emitter and an IR receiver.

If the animal moves in one of the three spatial axes - providing that the system has the max. number of light beams - and if one of the light beams is interrupted that was previously uninterrupted, then the system will register a count. This means that interruptions that are linked with a movement will be registered only. Permanently interrupted light beams will not be taken into account.

Movements that are repeated at short intervals, e.g., tail flicking, can be ignored by defining a refractory period, i.e. if short-term movements are detected within this defined period, then no count will be registered.

The operator can define a part of the light beams as the 'center'. This allows the measurement area to be adapted to suit animal cages with different sizes as well as the definition of two different measuring ranges (central and peripheral).

**The calorimetry measuring module** can be configured to run with up to eight special animal cages per Calorimetry Control Unit. Each cage is continuously provided with fresh air from an air pump via the Control Unit. For a 16-place system, one Master Control Unit and one Slave Unit are required, which each have eight connections for the air supply (to the cages) and the temperature sensors.

The Master Control Unit also contains the standard sensors for O<sub>2</sub> and CO<sub>2</sub> measurement in addition to the ports for data transmission with the PC. For high speed O<sub>2</sub>/CO<sub>2</sub> measurements, a separate measuring Unit is required. Master and Slave Control Unit are connected to each other via a further data cable. With the help of a Sample Switch Unit, air samples are taken in defined intervals from the animal cages and are being analyzed.

The samples are transferred to the Master Control Unit, where O<sub>2</sub> as well as CO<sub>2</sub> gas concentrations are measured. The sample concentrations are compared to a fresh air reference.

With the help of temperature sensors, the temperature in the test cage can be measured and registered during the specified experiment time.

Moisture that could be deposited on the O<sub>2</sub> and CO<sub>2</sub> sensors is removed from the sample flow by an Air Drying Unit.

**The drinking and feeding behavior** of test animals as well as their body weight can be measured with high precise sensors located on the cage lids. The removal of liquid or food pellets from the dispensers is registered by the weight sensors and the alterations are registered by the software.

Limit values for the range, in which removals are to be registered can be entered here; values that are too high, e.g., those caused by the animal lifting the dispenser, will then no longer be registered.

By using a trial monitor, the amount removed during the trial can be followed; this makes it easier to recognize the necessity of refilling the dispenser.

**For activity measurements via infrared sensors (InfraMot)**, passive infrared sensors are used. These sensors register the activity of one or more subjects by sensing the body heat image, i.e. infrared radiation and its spatial displacement over time. In this way, movement within the cage can be reliably determined. This even includes brief movement events of a few milliseconds duration only. The standard sensor assembly includes a stainless steel sensor housing and is designed to be mounted on top of a home cage. The sensor unit is available as a stand-alone version or can be mounted to other cage types such as a drinking and feeding cage. In calorimetry systems, the sensor is mounted air-tight on the cage cover.

The registered area depends on the setting in the factory and on the height, at which the sensor unit is mounted.

Activity can be measured under any lighting conditions. Measurements can even be made in complete darkness.

The software registers the counter totals during a measuring interval. This measuring data provides a relative measure of the duration and intensity of the activity. This allows general statements about the activity of the animal to be made.

**Activity measurements via running wheels** can measure the spontaneous activity of the animal, e.g., in a home cage. The animal itself sets the running wheel in motion (voluntary running wheel).

### 3.1. System Description

The system is arranged modularly, i.e. depending on the system configuration, the required devices are present only. The devices, their installation and functions are described in the corresponding sections.

References Hardware Module	
Measurements	Reference
Activity behavior via sensor frames	
Calorimetry	Hardware Operating Instructions - Calorimetry
Drinking/Feeding/Urine/Feces/Body Weight	
Activity behavior via running wheel	
Activity behavior via infrared sensors	Hardware Operating Instructions - InfraMot

Fig. 5 Reference Hardware module

In the following sections, information about carrying out a measurement, maintenance, cleaning and decontamination of the system is given.

Software is described in the Software Operating Instructions.

## 4. PC Requirements

- An AT-compatible PC. CPU and RAM specification according to the system configuration, please contact [TSE Service](#).
- The PC should have at least four built-in USB ports; the use of a USB hub in an exceptional case is possible.
- The control interfaces require free PCI slots according to the system configuration, please contact [TSE Service](#).
- Ensure that the PC fulfils the min. requirements for the selected operating system.
- The PC should be used for programs involving the system only as resources should be available for error-free data acquisition.
- System software operates with Windows7/Windows10.
- Solid-state drives (SSDs) should be used as the data disk drive, please contact [TSE Service](#).
- If the PC is connected to a computer network, this connection should be disabled before working with the system. Please contact your system administrator. If a network connection is absolutely essential, please contact [TSE Service](#).
- Systems operated with Windows10: Generally, it is not recommended to connect the PC to the Internet. If an Internet connection is absolutely essential, please contact [TSE Service](#).
- Remove any programs that are resident in the PC memory. If you use antivirus software, observe instructions in Section 4.1.
- In the BIOS settings of the PC, all options that allow PC to step down CPU clock to save energy should be disabled.

If a dialog with the message "Error within Query Performance\* functions, please restart / switch off PC! If this returns: disable EIST/CIE processor feature in BIOS" pops up, check BIOS settings of the PC.

### **NOTICE - Instrument damage!**

**Improper BIOS settings can damage PC. In the BIOS settings, all options that allow PC to step down CPU clock to save energy should be disabled.**

Without prior consulting your system administrator AND [TSE Service](#), do NOT alter BIOS settings of PC.

### 4.1. Malware Scanner

If a malware scanner is used, ensure that the software is configured so that the PC isn't scanned while a measurement is made.

### **NOTICE - Program crash!**

**If a malware scan takes place during a measurement, a program crash could result.**

- Do NOT allow malware scanner to run while the system software is running.
- Running of malware scanner software is permitted immediately after the initialization of MS Windows only.
- Running of malware scanner software is permitted only when peripheral devices (e.g. USB memory stick, external hard disk drive) are connected to the system.
- Malware scanner software updates are permitted immediately after the start of the PC only.

## **NOTICE - Data loss!**

**Malware scans of system data can result in a data loss.**

Do NOT allow malware scanner software to scan settings files, results files or log files (see Section 4.1.1).

### **4.1.1. Whitelist**

The following directories and files should be excluded from virus scans.

#### **4.1.1.1. System Software**

##### **Directories**

- C:\Documents and Settings\All Users\Application Data\TSE\PhenoMaster
- C:\ProgramData\TSE\PhenoMaster
- C:\Program Files\TSE\PhenoMaster
- C:\Program Files (x86)\TSE\PhenoMaster

##### **Files**

- Analyse.set
- CalibrLogFile.log
- GasMeasCalibrData.set
- log.txt
- PhenoMaster.cal
- PhenoMaster.set
- Threadlog.log
- \*.AlySet
- \*.bin
- \*.dat
- \*.evt
- \*.par
- \*.tim
- \*\_ACT.raw
- \*\_CALO.bin
- \*\_DFT.bin
- \*\_EVENTS.bin
- \*\_FW.bin
- \*\_TELE.bin
- \*\_TM.bin
- \*\_WHEEL.bin
- \*\_WHEEL.raw

## 5. Installation Drivers, Interface, Software

Normally, the software is pre-installed by TSE so that the system is ready-to-use.

### **NOTICE - Config loss!**

**Overwriting of software may change settings. Software installed on PC is already pre-configured for your system.**

Without prior consulting [TSE Service](#), do NOT overwrite pre-installed software.

Without prior consulting your system administrator AND TSE, do NOT alter BIOS settings of PC!

### 5.1. Interface Driver

Drivers (PCIS-DASK) are designed for Windows7/Windows10.

Supplied on DVD.

#### **i Installation sequence**

First install driver, then install hardware.

#### **i Number of drivers required**

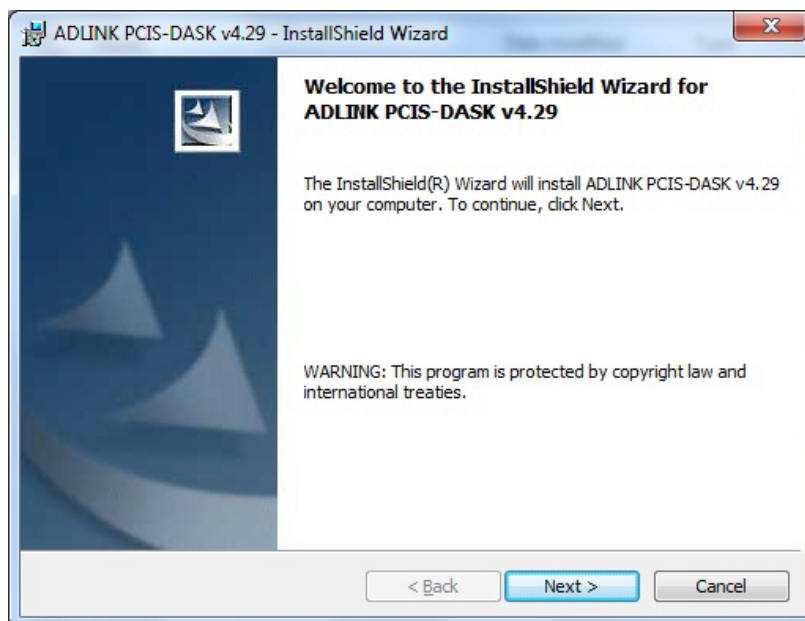
With PCI interfaces from ADLINKTech, it is sufficient to install a single appropriate driver for ALL interfaces.

#### **i Driver version**

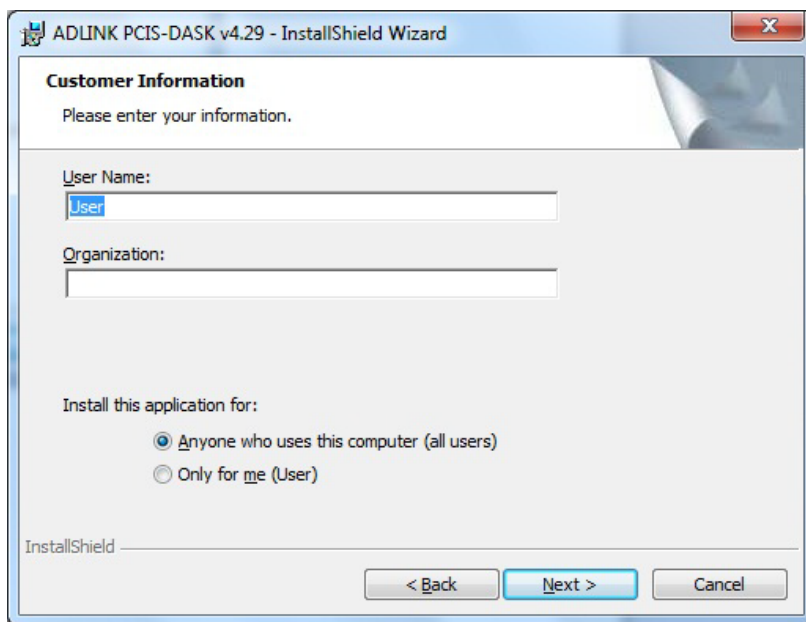
For Windows7, >= v4.28 required.

For Windows10, >=v5.21 required.

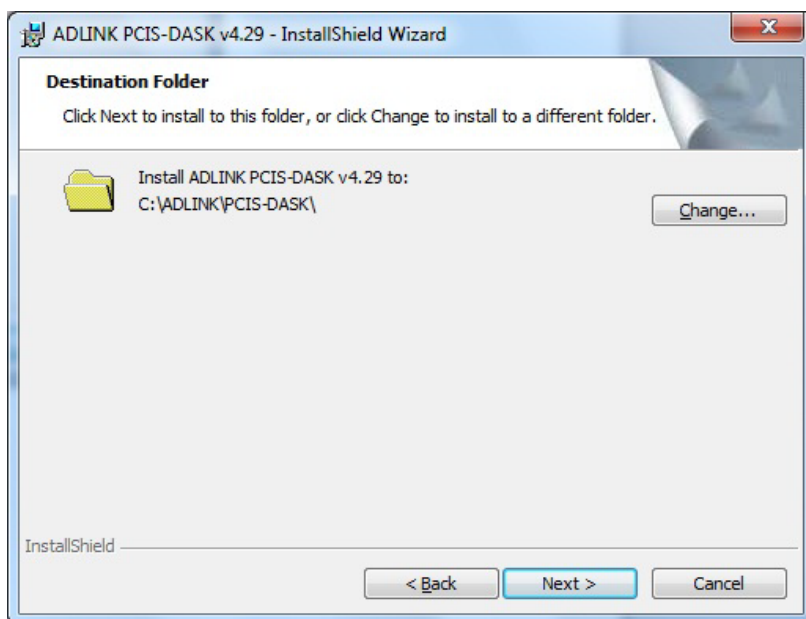
- Double-click on "setup.exe"
- Press "Next".



- Enter name and organization and press "Next".

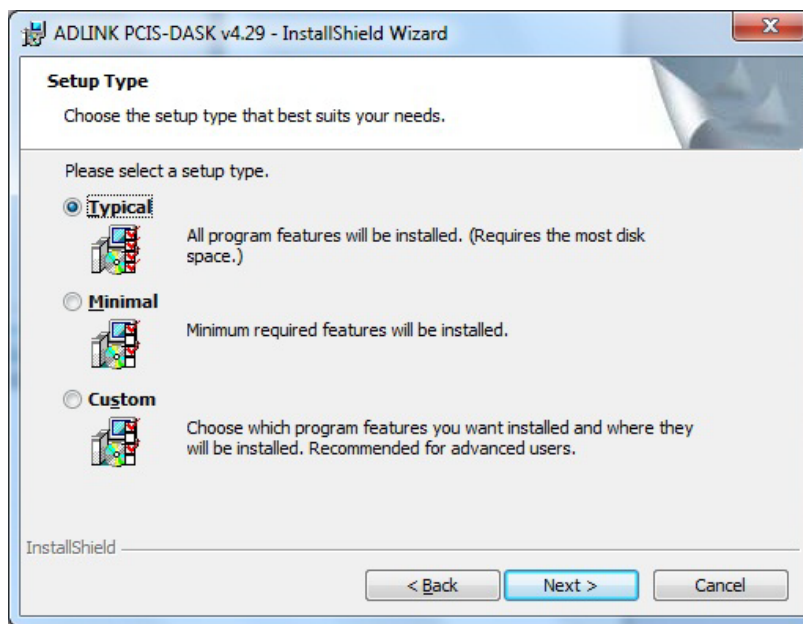


- Press "Next" to confirm the default destination directory. Without prior consulting [TSE Service](#), the default destination directory should not be altered.

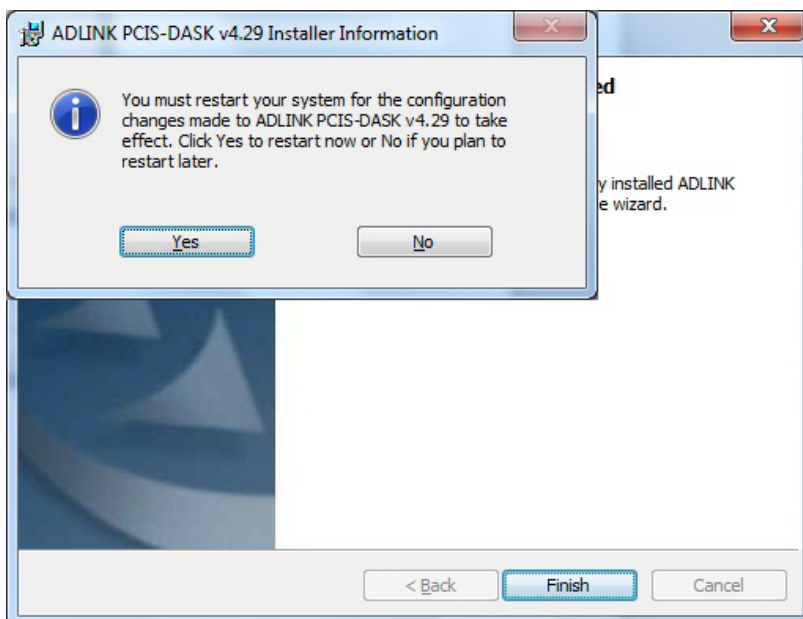




- Press "Next" to confirm "Setup Type" default "Typical".



- On "Ready to Install the program" dialog, press "Install" to confirm settings.
- On "InstallShield Wizard Completed" dialog, press "Finish".



- Press "Yes" to reboot the PC.
- Shut down Windows again and power OFF PC.

Proceed to interface installation (see Section 5.6).

## 5.2. Interface Installation

### **NOTICE - Instrument damage!**

**Static electricity or touching the circuitry can damage the interface.**

- Be sure you are grounded before touching the interface. Briefly touch a grounded, unpainted metal object or surface to be grounded.
- Avoid touching circuitry on the interface board.

The system requires a PC with a min. of two or three neighboring PCI slots (according to the system configuration) and should run under Windows7/Windows10.

Two types of calorimetry interfaces could be provided:

- Calorimetry interface1, 37-pin Sub-D jack with an extension to an additional slot piece carrying a 25-pin Sub-D jack.
- Calorimetry interface2, 37-pin Sub-D jack.

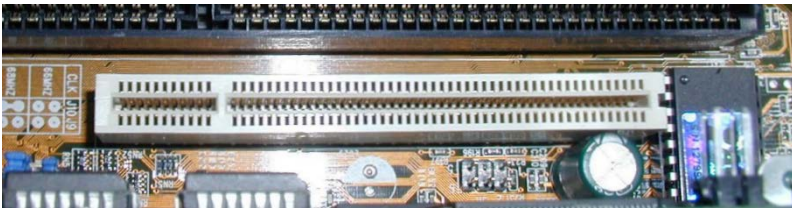


Fig. 6 PCI slot - PC mainboard

### **i** **Space requirements**

Depending on the system, it may be necessary to remove a further slot cover for a 25-pin connection leading from the interface board.

- Ensure that the PC is powered OFF.
- Disconnect all peripheral devices from the PC.
- Open the PC housing. Insert the interface(s) into a free PCI slot.
- Reclose the housing and secure the slot bracket of the interface with retaining screws.
- Connect monitor, mouse, and keyboard with the PC.
- Power ON the PC.

## **5.3. System Software**

See Software Operating Instructions - Core Modules, Section "General, Setup Installation".

### **5.3.1. Creating a Short-Cut**

It is also possible to create a short-cut after the installation of the program.

- In data manager, change to the "PhenoMaster" directory.
- With the right-hand mouse key, click "PhenoMaster.exe".
- Drag the file onto the desktop with the right-hand mouse key.
- In the context menu, select "Create short-cut here".

## **5.4. Windows Settings**

### **5.4.1. Power Options Properties**

- In all the drop-down menus of "Power Schemes" tab, select "Never".

- If necessary, the inactivation should be carried out in the BIOS of PC.

## NOTICE - Instrument damage!

**Improper BIOS settings can damage the PC. BIOS settings that allow to alter power management to save energy should be disabled.**

Without prior consulting your system administrator AND [TSE Service](#), do NOT alter BIOS settings of PC.

- The hard disk should also NOT be switched OFF after a certain time.
- Don't use a screensaver.

### 5.4.2. Disabling Parameter "Automatically adjust clock for daylight saving changes"

Some regions have the daylight saving time. If so, the parameter "Automatically adjust clock for daylight saving changes" has to be deactivated in order to prevent running experiments to be shut down when the adjustment occurs.

- Windows7
  - With the right mouse-key, click on the time display on the Windows task bar.
  - In the context menu, select "Adjust date/time".
  - Select the "Date and Time" tab.

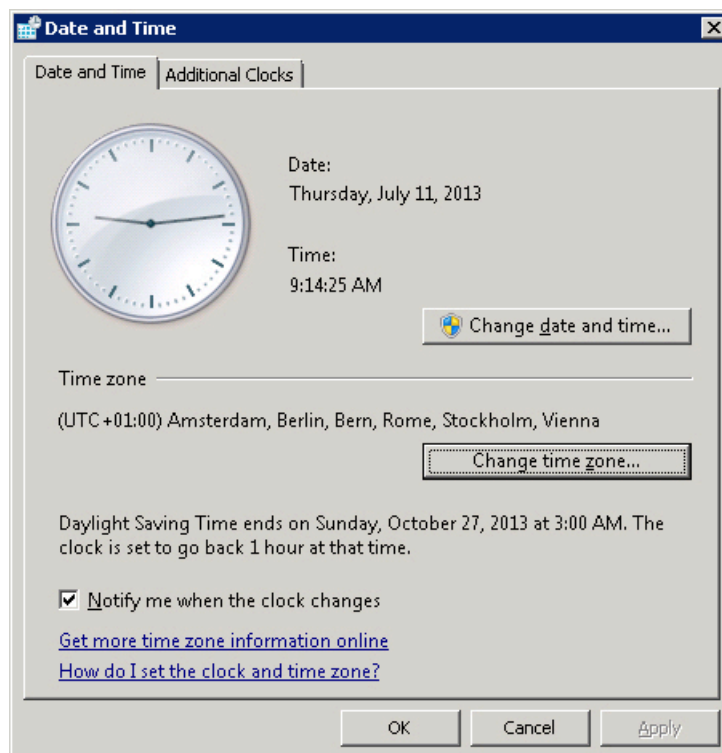


Fig. 7 Date and Time tab (Windows7)

- Press "Change time zone..."

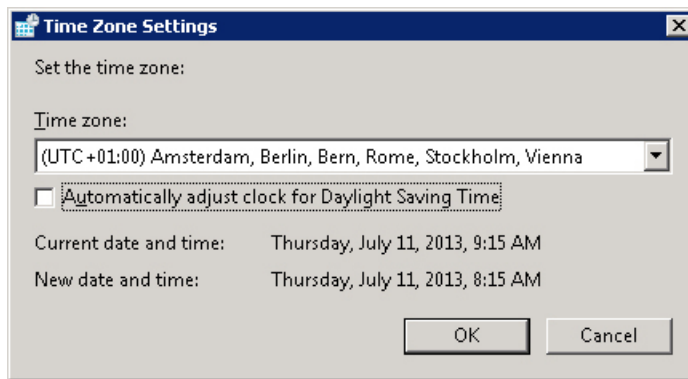


Fig. 8 Time Zone Settings (Windows7)

- Uncheck "Automatically adjust clock for Daylight Saving Time".
- Press "OK".

## 6. Connecting Devices - General

### **NOTICE - Instrument damage!**

**If current-carrying connections are broken during operation, voltage peaks may be produced; these could destroy electrical assemblies.**

Do NOT pull out any plugs from electronic devices such as the PC, Control Unit, etc. while a test is running or when the devices are powered ON.

### **NOTICE - Instrument failure!**

**If the devices are not connected properly, incorrect functions could occur when the system is started.**

- Lay the cables so that they cannot be mixed up and cannot trip people up.
- For error-free operation, all cable connections should be properly secured - either by screwing the actual connector or the fixing screws, as otherwise measuring errors could occur or data transmission could be interrupted.
- Before carrying out a new test, system devices must be freed from all residues of the previous test.
- Place the animal cages on a stable support that ensures vibration-free operation, as otherwise the sensitive sensor measuring technique could be interfered with. Do not place the cages on the same support surface as the Control Units as these vibrate slightly.

## 7. Cage Rack / Cage Lid Holder

For a secure stand and simple operation, the system cages can be placed in a rack specially designed for them.

A holder is provided for every calorimetry cage to take its lid when it is removed from the cage.

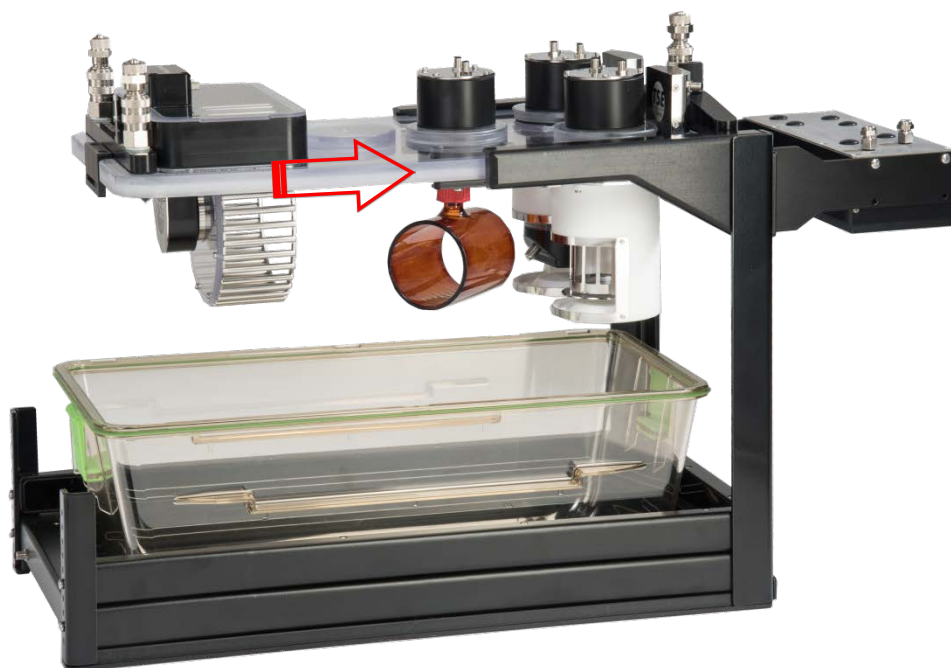


Fig. 9 Cage lid holder w/ inserted lid

## 8. System Software

The software controls the experimental procedure and collects the measuring data. The program can be operated either online or offline. A data table and graph display are used to manage the measured values.

Export functions are used to prepare the data so that user-specific analysis is possible.

The system software is arranged modularly, i.e. depending on the system configuration the software functions that are necessary are enabled only. Functions that are disabled are either shown in gray or they are concealed.

For further instructions, see Software Operating Instructions.

## 9. Performing a Measurement

It is assumed that...

- ...automatic switch OFF, screensaver etc. of PC have been deactivated.
- ...calibration for the sensors (drinking, feeding, body weight, calorimetry) has been carried out.
- ...>=2h prior to the test or a calibration of the sensors, all electronic calorimetry devices have been powered ON.
- ...all entries have been made in "Setup" menu.
- ...all the settings for the individual measuring modules have been made.
- ...event markers have been defined.



### **DANGER**

### **Electric shock**

**Faulty or improperly connected system devices could cause severe damage to persons or objects.**

- Before starting up the system, check that it is in proper operating condition.
- Faulty system devices must NOT be used; they must be replaced.

#### **General**

- Used cages should be enabled in the software only.
- Electrical connections are in proper working condition.
- All current-carrying cables are in proper working condition.
- Don't touch the hardware during an experiment.
- Switch OFF the monitor during a trial so that adjacent cages are not illuminated during the dark phase.



#### **Removal of residues**

After each test, suitable measures must be taken to ensure that no residues remain in the system that could falsify the results of subsequent tests.

We recommend that animals are allowed to habituate with test cages before the tests, e.g., in special training cages in order to avoid incorrect results due to stress.

In drinking and feeding systems, the use of the drinking nipple and food dispensers by the animal should be checked. It may be necessary to first train the animal. Preliminary tests should be carried out to ensure that the drinking and feeding behavior in the test cage is normal.

#### **Activity measurements via sensor frames**

Ensure that...

- ...the light beam sensor openings are clean. Dirty sensors can cause incorrect measurements.
- ...all sensor frames detect properly (for function test, see Software Operating Instructions - Activity, Section "Status Menu, Activity").
- ...no foreign bodies are located in the beam path during a measurement, e.g., cables or operator's hands.



### **Light beam interruption**

If there is too much litter, material can be used for building a nest and therefore may permanently interrupts the light beams at this position, i.e. no activity can be measured.

### **Calorimetry measurements**

Prior to start-up, ensure that...

- ...the calorimetry system has no leaks.
- ...tubing, seals, connections are in proper working condition.
- ...the animal cages are in perfect condition (seals and closures in particular).
- ...the opening for the temperature sensor in the animal cage cover is closed off if not required.
- ...test series are carried out under identical conditions, e.g., temperature, humidity.
- ...no errors occur during the measurement as a result of rapid alterations in the 'room climate' (e.g. opening doors, entering the room, etc.).
- ...the temperature in the test area does not cause the animal to have an unwanted excessive metabolism.
- ...the setting of the setting knob "MFC Sample" of the (Master) Control Unit has not been altered - otherwise a new calibration is necessary.
- ...the Air Drying Unit temperature is set correctly.

### **NOTICE - Instrument damage!**

**Dusty animal litter may destroy the sensitive measuring and control equipment.**

Do NOT use dusty animal litter.

Proceed as follows during start-up:

- Three hours prior to the test, power ON electronic devices.
  - Start PC.
  - Start software.
  - Power ON Control Unit.
- Weigh the animals and insert them into their animal cages.

### **NOTICE - Instrument damage!**

**If animals are kept in sealed cages without a supply of fresh air for a long time, they may be asphyxiated. The first indication of an improper fresh air supply could be condensation on the cage walls.**

- The air pump must be powered ON before inserting animals in cages.
- The system software must be started.
- Set local alarm, see Software Operating Instructions - Calorimetry, Section "Setup Menu, Calo".
- If available, use Alarm module to allow for remote alarm, see Software Operating Instructions - Calorimetry, Section "Setup Menu, Calo".
- Close the animal cages.
- Enter the animal weights in the software.
- Depending on the test requirements, provide some habituation time.
- Start measurement. If necessary, exit room and close the door.
- During the measurement, check the procedure at reasonable intervals.
- Remove condensate in the Air Drying Unit system as required.
- After the measurement, remove the animals from the cages first and then only power OFF the air pump.

- We recommend that after an experiment has been stopped, the system is allowed to continue running for about 30min in order to replace the test air at the O<sub>2</sub> and CO<sub>2</sub> sensor by fresh air and to prevent contaminants from being deposited on the sensor.
- Make a backup of the measured data.

## **NOTICE - Instrument damage!**

**In long-term experiments, the animals will require at least liquids. Contact between the litter material and the animal's secretions could generate CO<sub>2</sub>.**

- Supply the animals with the necessary amount of water. Connect a drinking bottle if required.
- Use suitable litter materials and exchange as required.

## **Drinking and feeding measurements**

- As a result of the construction of the drinking nipple mounted on the drinking vessel, which can be different from other drinking bottles, it is recommended that the animals are trained on the apparatus for one or two days before the first test is carried out.
- The drinking and feeding dispensers are filled, and the sensors are calibrated.
- When refilling before or during an experiment, the drinking/feeding dispenser may be removed from the sensor. However, we recommend that the dispenser is left attached to the hook during this process. This means that it isn't necessary to readjust the position of the sensor or dispenser. To refill the dispenser, select the "Refill Sensor" menu in the system software.
- The easiest way to refill food is to use a small scoop to fill it into the basket attached to the sensor. Care should be taken that the pieces of food are large enough so that they don't fall through the basket mesh.

## **Activity measurements via InfraMot sensors**




- The InfraMot sensor must NOT be used where it is subject to the effects of heating, cooling, or ventilation devices.
- Closed materials (sheets of plastic, glass, etc.) prevent heat detection. This means that - provided that the assembly height is suitable - animals (= sources of heat) in adjacent cages don't interfere with the registration. However, in order to completely rule out any interference, we recommend that the cages are placed about 10cm apart. Individual tests should be carried out to determine a suitable distance.
- The wide detection angle of the sensors and the great thermal mass of human bodies means that movements by the operator could also be detected. This depends upon the way, in which the individual experiment is set up. Additional shielding may be necessary.
- If large sensor unit mounting heights are necessary, it is possible to increase the sensitivity of the sensor within certain limits. However, a higher sensitivity means that the interference from other heat sources also increases. Please contact [TSE Service](#) to discuss a suitable configuration.

## **Activity measurements via running wheel**

Ensure that...

- ...no litter can penetrate the area around the rotary sensor.
- ...the sensor cable is attached in such a way that it cannot be damaged by the animal.

## 10. Maintenance and Cleaning

 <b>DANGER</b>	<b>Electric shock</b>
<p><b>If current-carrying devices come into contact with water or other liquids, this could cause a short-circuit.</b></p> <ul style="list-style-type: none"> <li>• Liquid must NOT be allowed to penetrate into the interior of the devices. Do NOT use spray detergents.</li> <li>• Unplug the mains supply before carrying out any cleaning work.</li> </ul>	
 <b>WARNING</b>	<b>Cleaning personnel hazard</b>
<p><b>Untrained personnel cannot recognize the possible risks, which could occur when cleaning a device.</b></p> <p>Cleaning personnel must be instructed about device care and the necessary safety measures.</p>	
 <b>WARNING</b>	<b>Bio hazard</b>
<p><b>Animal excrement and other secretions could contain microorganisms, which represent a health hazard.</b></p> <ul style="list-style-type: none"> <li>• Contaminated devices must be purified/treated according to the safety regulations.</li> <li>• System devices that have not been completely decontaminated, or that have not been freed from test residues must NOT be returned to TSE Systems under any circumstances.</li> </ul>	

### NOTICE - Instrument damage!

**Parts of the system are made of plastic materials. Alcohol or other solvents can dissolve plastic and render it useless.**

Do NOT clean the device and, in particular, its plastic components with solvents containing hydrocarbons or alcohol unless they are approved as a disinfection method for the particular component.

If damage has occurred, detergents or decontaminants could penetrate the devices and damage them irreversibly. Please contact [TSE Service](#).

If you return contaminated system devices to TSE Systems, TSE Systems reserves the right to return any such device to your address immediately and will charge you for the dispatch costs. Should a contaminated device represent a health hazard, then we retain the right to take legal action.

### 10.1. General

To carry out bio-decontamination efficiently, all adhering dirt should first be removed by a preliminary cleaning process, as otherwise microorganisms could survive in the contaminated areas.

If detergents or chemicals are used on the devices, these should be completely removed before further decontamination steps, e.g., autoclaving, are carried out. There should be no residues on the devices.

Ensure that all noxious and odorous substances can evaporate sufficiently so that the animals are not subjected to any irritations.

**H2O2 Gas Plasma Sterilization**

- Gassing must be done according to guidelines and protection measures provided by the manufacturer of the decontamination unit.
- Gassing type must be adjusted in accordance with the guidelines for gassing of laboratory devices including sensitive electronic equipment.
- After gassing, allow for a outgassing time  $\geq 24$ h.
- Systems that contain porous materials (e.g. foamed material, insulation, plastics) should be allowed an elongated outgassing time ( $\geq 72$ h) to ensure that no traces of H2O2 remain. Otherwise, there is a risk that animals could be impaired by H2O2 residues. Please Do NOT touch equipment without wearing protective gloves before outgassing time has been elapsed.
- Prior to gassing, all air inlets and air outlets of Calorimetry Control Units / High-Speed Sensor Units must be sealed to protect O2/CO2 sensors from exposure to gas.
- All system devices must be powered OFF (Exception: Intense gassing of climate chambers. In that case, fans may keep running.)

**NOTICE - Instrument damage!**

**If devices consist of different materials that could not be dismantled and separated (e.g. a metallic screw thread screwed onto plastic material) prior to sterilization, this may reduce lifetime of devices.**

- The operator has to take additional material properties (e.g. coefficient of expansion) into consideration.
- Different material properties during heating may exclude such a device from sterilization, as otherwise fractures in the material could occur. Taking only individual material properties into consideration is NOT sufficient! TSE isn't responsible for any device damages during sterilization due to different material properties!
- Observe sterilization instructions supplied by the sterilization device manufacturer! If you have questions or need assistance, please contact your safety administrator.

For further information, please refer to:

[http://www.gv-solas.de/fileadmin/user\\_upload/pdf\\_publication/5\\_AK\\_KAB\\_e2016.pdf](http://www.gv-solas.de/fileadmin/user_upload/pdf_publication/5_AK_KAB_e2016.pdf)

**10.2. Cage****10.2.1. Cage Lid****General**

The lids should be wiped off with a moistened soft, lint-free cloth or tissue to remove any adhering dirt. A pH-neutral detergent solution can also be used for moistening. Detergent residues should then be wiped off.

**10.2.1.1. Plastic Cage Lid**

The plastic lids must be decontaminated with a method approved for use on the plastic material (hints, see table below).

For instructions about the decontamination of calorimetry cage lids, see Section Hardware Operating Instructions - Calorimetry, Section "Maintenance and Cleaning, Calorimetry Cage Lid".

<b>Decontamination Plastic Cage Lid</b>				
Material	Autoclave	Gas Sterilization Ethylene Oxide (ETO)	H2O2 Gas Plasma Sterilization	Disinfectants
Polycarbonate (e.g. Makrolon®)	Autoclave temperature: ≤121°C (≤249.8°F) Sterilization temperatures >125°C (>257°F) during autoclaving can deform Makrolon® shaped parts. Generally, Makrolon® shaped parts can be sterilized several times before the mechanical stability will be reduced - due to the increasing chemical degradation - to a level isn't sufficient for miscellaneous applications.	Applicable sterilization procedures use undiluted ETO as well as mixings including carbon dioxide or inert gas - 10...20% ETO / 90...80% other gas. Sterilization temperature ≤65°C (≤149°F). With increasing number of sterilization procedures, a slight embrittlement associated with fissuring may occur.	Applicable	2% Peracetic acid applicable for Makrolon® shaped parts.
Polycarbonate, glued	Not specified. Depends on (1) glue and (2) gluing procedure.	Not specified. Depends on (1) glue and (2) gluing procedure.	Not specified. Depends on (1) glue and (2) gluing procedure.	Not specified. Depends on (1) glue and (2) gluing procedure.
H-Temp Polysulfone (PSU)	≤134°C (≤273.2°F)	Not specified	Not specified	Not specified

### 10.2.1.2. *Metallic Cage Lid*

Metallic cage lids should be wiped off, if required, with a moistened soft, lint-free cloth or tissue to remove any adhering dirt. A stainless steel cleaning agent can also be used to remove any stubborn dirt. Detergent residues should then be wiped off.

The metallic cage lids of the home cages - without sensors and dispensers - must be decontaminated with a method approved for use on the cage lid material (hints, see table below).

<b>Decontamination Metallic Cage Lid</b>				
Material	Autoclave	Gas Sterilization Ethylene Oxide (ETO)	H2O2 Gas Plasma Sterilization	Disinfectants
Stainless steel	Autoclave temperature: ≤121°C (≤249.8°F)	Applicable	Applicable	(1) 70% Ethanol or (2) Ethanol/Isopropanol 70/30 applicable

### 10.2.1.3. *Cage Body (Home Cage)*

The lower part of the animal cages can be preliminarily cleaned in a dishwasher using a detergent that is approved for use with plastics.



#### **Removal of residues**

In order to ensure efficient sterilization and to avoid cage damage, no residues from the cleaning process must remain on the cages.

### **NOTICE - Instrument damage!**

**If alkaline detergent residues or dried residues of softened water remain adhering to polycarbonate cages, material degradation could occur.**

- Thoroughly rinse the cages to remove any detergent residues.
- Remove auxiliary detergents completely.

- When the cages are dry, no residues should be visible.
- Carry out a visual check before sterilization.

After cleaning and drying, the lower part of the cage can be autoclaved according to the cage material, see table below.

The information about the material from which the home cage has been manufactured can be found embossed on the base or one of the sides of the cage. If you are still not certain, please contact the cage manufacturer.

### **NOTICE - Instrument damage!**

**If cages consist of unknown material and are exposed to  $\geq 121^{\circ}\text{C}$  ( $\geq 249.8^{\circ}\text{F}$ ), this may reduce lifetime of cages.**

Animal cages for use in laboratories that are without any material identification must NOT be autoclaved at temperatures  $\geq 121^{\circ}\text{C}$  ( $\geq 249.8^{\circ}\text{F}$ ).

Cages where material information has been provided can normally be autoclaved at the temperatures given in the table below.


<b>Decontamination Cage Body (Home Cage)</b>				
Material	Autoclave	Gas Sterilization Ethylene Oxide (ETO)	H2O2 Gas Plasma Sterilization	Disinfectants
Polycarbonate (e.g. Makrolon®)	Autoclave temperature: $\leq 121^{\circ}\text{C}$ ( $\leq 249.8^{\circ}\text{F}$ ) Sterilization temperatures $> 125^{\circ}\text{C}$ ( $> 257^{\circ}\text{F}$ ) during autoclaving can deform Makrolon® shaped parts. Generally, Makrolon® shaped parts can be sterilized several times before the mechanical stability will be reduced - due to the increasing chemical degradation - to a level, which isn't sufficient for miscellaneous applications.	Applicable sterilization procedures use undiluted ETO as well as mixings including carbon dioxide or inert gas - 10...20% ETO / 90...80% other gas. Sterilization temperature $\leq 65^{\circ}\text{C}$ ( $\leq 149^{\circ}\text{F}$ ). With increasing number of sterilization procedures, a slight embrittlement associated with fissuring may occur.	Applicable	2% Peracetic acid applicable for Makrolon® shaped parts.
Polycarbonate, glued	Not specified. Depends on (1) glue and (2) gluing procedure.	Not specified. Depends on (1) glue and (2) gluing procedure.	Not specified. Depends on (1) glue and (2) gluing procedure.	Not specified. Depends on (1) glue and (2) gluing procedure.
H-Temp Polysulfone (PSU)	$\leq 134^{\circ}\text{C}$ ( $\leq 273.2^{\circ}\text{F}$ )	Not specified	Not specified	Not specified


## **10.3. Control Unit, PC, Monitor, and Keyboard**

Organic solvents must not be used for cleaning purposes. Avoid the use of cleaning sprays, spray disinfectants, or strong detergents, as they could damage the device.

If necessary, the Process Control Units, PC, monitor, and keyboard can be wiped clean with a clean soft lint-free cloth, which can, if required, be moistened with water or a pH-neutral detergent. Detergent residues should then be wiped off.

After cleaning the above-mentioned devices, they can be decontaminated with H<sub>2</sub>O<sub>2</sub> vapor before they are brought into the test laboratory.  
Clean dust filter of PC every three months.

 <b>WARNING</b>	<b>Health hazard</b>
<p><b>Locations that are contaminated, e.g., by dust, cannot be effectively sterilized by all sterilization routines. Thoroughly clean surfaces can be adequately sterilized only.</b></p> <ul style="list-style-type: none"> <li>• If there is a risk of inadequate sterilization, then you must continue to observe all the necessary safety measures.</li> <li>• Dust deposits inside devices can result in ineffective sterilization.</li> </ul>	

 <b>DANGER</b>	<b>Hazardous voltage</b>
<p><b>Penetration of liquids will cause a short-circuit.</b> Keep liquids away from the ventilation openings.</p>	

This warning is given on instrument's server rack housing, attached onto the front glass door.

### **NOTICE - Instrument damage!**

**Process Control Units have openings in their housing. Boards inside Process Control Units can be damaged by contact with liquids.**

- Use moistened wipes only, i.e. wipes that are not saturated or dripping, for cleaning of the Process Control Units!
- Never use disinfectant sprays.

### **NOTICE - Instrument damage!**

**Sensors can be damaged by contact with H2O2.**

Units with gas sensors (e.g. O<sub>2</sub>, CO<sub>2</sub>) must have their test air inlets and outlets sealed.

## **10.4. Cable**

Organic solvents must not be used for cleaning purposes. Avoid the use of cleaning sprays, spray disinfectants, or strong detergents, as they could damage the cables.

The cables can be wiped clean with a clean soft lint-free cloth, which can, if required, be moistened with water or a pH-neutral detergent. Detergent residues should then be wiped off.

The cables can be decontaminated with H<sub>2</sub>O<sub>2</sub> vapor before they are brought into the test laboratory.

## **10.5. Rack**

Racks should be wiped off, if required, with a moistened soft, lint-free cloth or tissue to remove any adhering dirt. A stainless steel cleaning agent can also be used to remove any stubborn dirt. Detergent residues should then be wiped off.

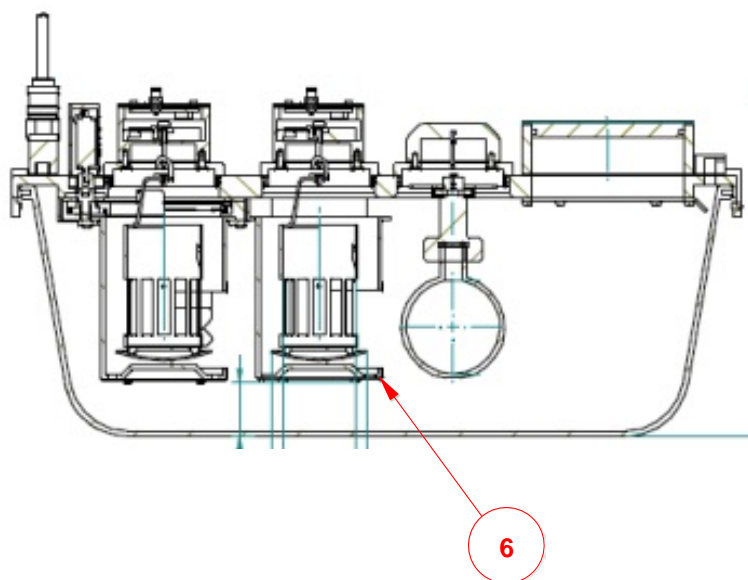
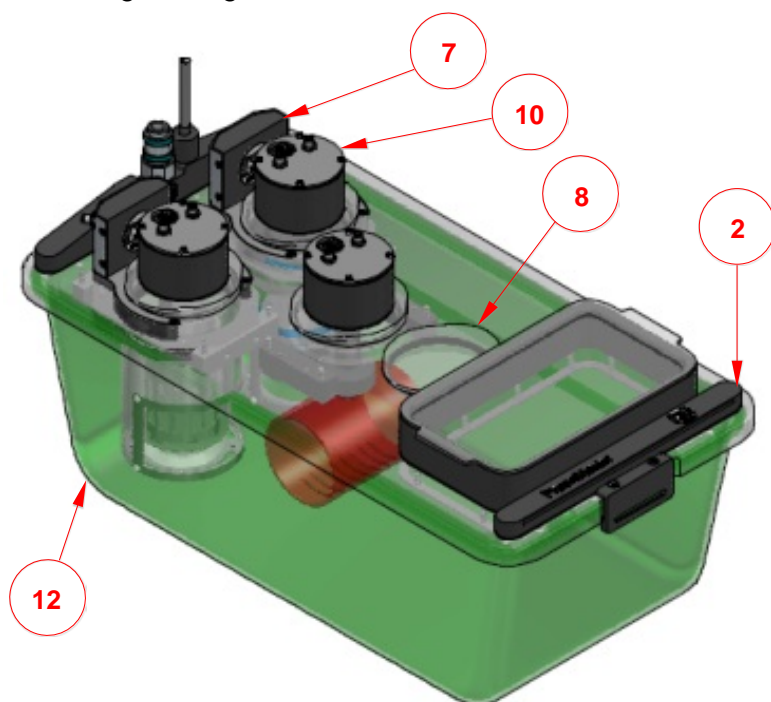
After cleaning, the shelves can be decontaminated with H<sub>2</sub>O<sub>2</sub> vapor.



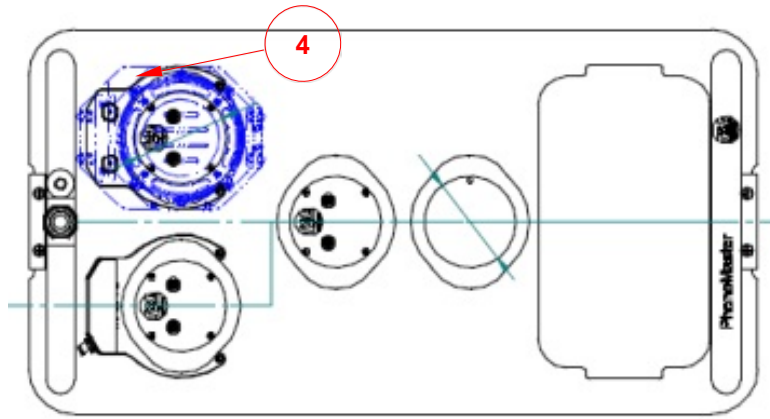
## Appendix

### A. Example configurations

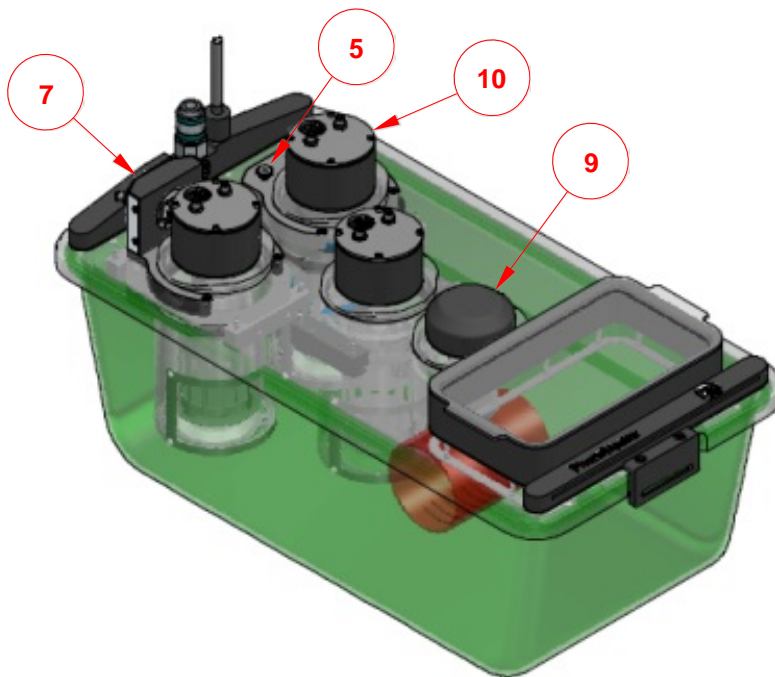
#### Home cage configuration



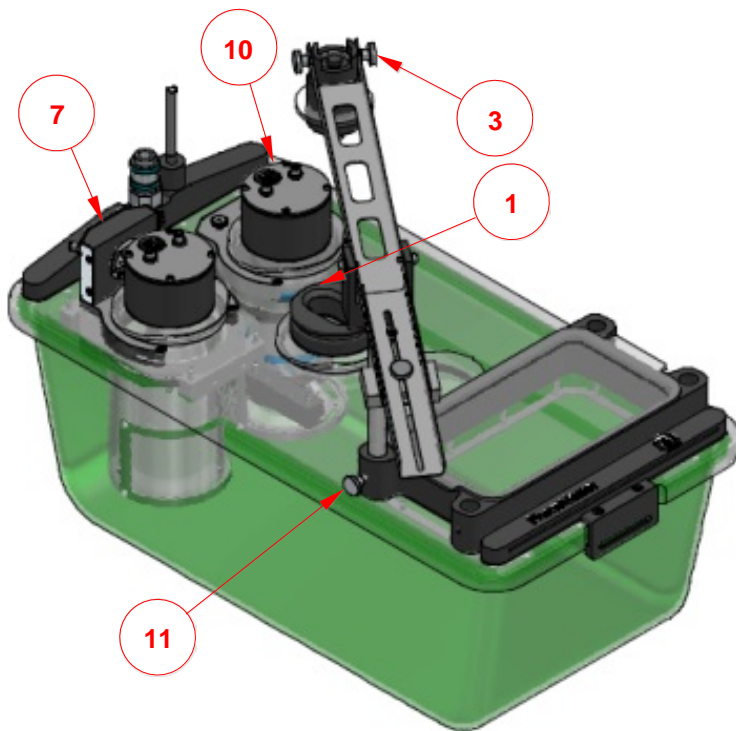




Calorimetry cage w/ 2x Access Control, 1x Drink, 1x Feed, 1x Body Weight



Calorimetry cage w/ 1x Access Control, 1x Drink, 1x Feed, 1x Body Weight (w/o sensor)



Calorimetry cage w/ 1x Access Control, 1x Drink, 1x Feed, 1x Swivel mount

- 1 Assembly group calorimetry cage lid for swivel
- 2 Assembly group calorimetry cage lid\*
- 3 Assembly group swivel mount
- 4 Assembly group Access Control dummy \*
- 5 Assembly group blind adapter
- 6 Assembly group hood
- 7 Assembly group Access Control
- 8 Assembly group blind adapter
- 9 Assembly group blind adapter w/ suspension
- 10 Assembly group sensor housing mouse
- 11 Knurled screw M3x8 stainless steel
- 12 Home Cage

**B. Cage body specifications**

	Type II
Floor area [cm²]	501
Overall dimension (W x D x H)	391 x 199 x 160mm (15.39 x 7.83 x 6.3inch)
Plastic Type	H-Temp Polysulfone (PSU)

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