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### Operating instructions

 The unit complies  
with the corresponding  
EC guidelines.

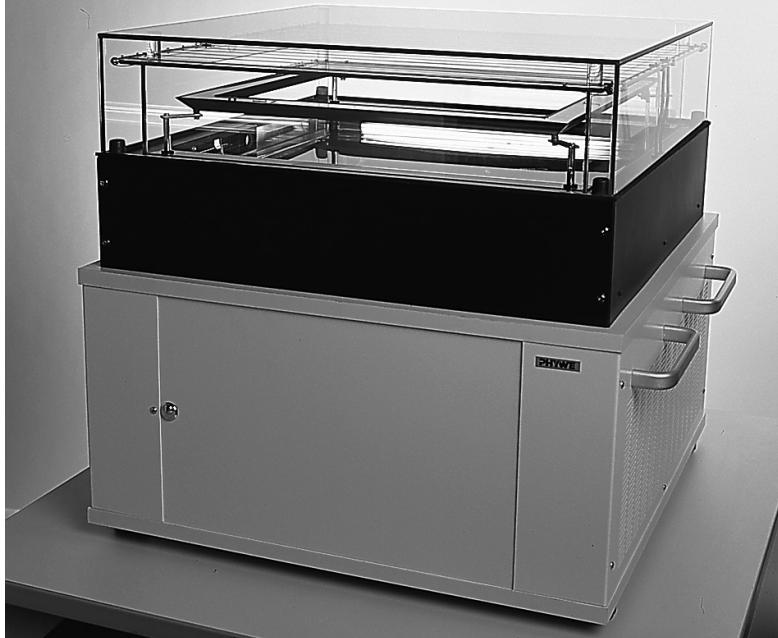


Fig. 1: Diffusion cloud chamber PJ45, 09046.93.

## 1 SAFETY PRECAUTIONS



- Carefully read these operating instructions completely before operating this instrument. This is necessary to avoid damage to it, as well as for user-safety.
- Only use the instrument for the purpose for which it was designed.
- Check that your mains supply voltage corresponds to that given on the type plate fixed to the instrument.
- Only use the instrument in dry rooms in which there is no risk of explosion.
- Do not operate the system when obvious damages or leaks are visible.
- Install the instrument so that the on/off switch and the mains connecting plug are easily accessible. Do not cover the ventilation slots.
- Only use an extension cable or a multiple socket when absolutely necessary.
- Wait at least 2 hours before putting the cloud chamber into operation to check that no faults have occurred to the refrigeration system during transport.
- Always unplug the mains plug before carrying out cleaning or maintenance work.

## 2 INTRODUCTION

Radioactivity is a subject in our society which has been playing an important role throughout politics, economy and media for many years now. The fact that this radiation cannot be seen or felt by the human being and that the effects of this radiation are not fully explored yet, causes emotions like no other scientific subject before.

The high-performance diffusion cloud chamber by PHYWE Systeme GmbH & Co. KG serves for making the tracks of cosmic and terrestrial radiation visible so that a wide range of natural radiation types can be identified. Furthermore, the diffusion cloud chamber offers the opportunity to carry out physical experiments with the aid of artificial radiation sources.

## 3 DESIGN AND OPERATION

The cloud chamber consists of a chamber base and the observation chamber. The chamber base comprises a cooling element, a power supply, an alcohol reservoir, an alcohol pump and a programmable time switch. The observation chamber is placed onto the chamber base.

The bottom of the observation chamber is formed by a massive, black metal plate (surface 45 cm x 45 cm) which is cooled over the whole surface to about -30°C by means of the cooling element.

The top plate and the side plates of the observation chamber consist of two glass hoods which are placed one into the other. A grid of fine heating wires (17) is placed between the upper two glass plates. These wires serve for heating this area of the chamber thus keeping the hood free from condensation. At the same time they are held at high voltage thus generating an electric field that attracts the ions.

The upper part of the glass hood includes an electrically heated gutter (15) which runs around the whole circumference. Iso-propyl alcohol flows through a bended tube (14) and drops into the gutter.

The alcohol evaporates and diffuses from the upper, warmer area of the chamber to the cold chamber bottom. There the alcohol is condensed into tiny droplets and flows back into the reservoir.

Right above the thin liquid layer covering the bottom a zone of oversaturated alcohol vapour is formed. It's in this area, and only in this area, that the charged material particles coming from the inside or from the outside produce ions along their trajectory. The tiny alcohol droplets preferably attach to these ions thus producing a visible cloud track. The length and the structure of the cloud track give information on the kind of ionizing particles.

#### 4 TRANSPORT OF THE CLOUD CHAMBER



##### Important!

It is vital to ensure the cloud chamber is not tilted ( $< 10^\circ$  from the vertical) during transport, as otherwise the refrigeration system will be irreparably damaged.

Transport of a cloud chamber (e.g. change in the place of installation) should not be carried out with an evaporating duct full of alcohol. A drain valve has now been additionally fitted into the cloud chamber for the draining of the alcohol from the evaporating duct. This drain valve can be regulated with a knob which is positioned above the milled screw for the regulation of the alcohol feed-in (11). Open the drain valve to allow alcohol to flow back into the alcohol container (12). Close the drain valve as soon as the evaporating duct is empty.

#### 5 INSTALLATION OF THE CLOUD CHAMBER

In order to guarantee an optimum view on the observation chamber, it is recommended to place the chamber onto a square table (border length about 90 to 100 cm) which should be about 60 cm high. Since the weight of the cloud chamber is 80 kg, the table must be massive enough to carry this load.

Please make sure that the ventilating slots (19) are not covered and that the cloud chamber is not subjected to direct light coming from above. A slightly darkened room would be perfect. Use the connecting cable supplied to connect the cloud chamber to mains. The mains connection (1) is located down on the back side. The corresponding mains socket should be protected for max. 16 A.

Adjust the cloud chamber on an absolutely horizontal level with the aid of the adjustable feet (16) in order to provide an even alcohol level in the gutter and thus a clear image.

#### 6 INITIAL OPERATION

The base of the cloud chamber can be accessed from two sides. Unlock the lock (2 or 3) to open the two sides, push the side plate a few centimeters to the right and then carefully pull it towards you thus lifting it out of the base.

On the front side you can now find a panel with the following components and operating elements:

- alcohol reservoir (removable) with a double tubing assembly which can be screwed off (12)
- main switch (4)
- switch „continuous operation - timer“ (5)
- switch „high voltage“ (6)
- knurled nut for alcohol supply (11)
- control knob for gutter heating (7)
- programmable time switch (8)
- safety cutout (9)

When you have connected the cloud chamber to mains and opened the front side, remove the alcohol reservoir (12) from its installation place and unscrew the union nut (13) of the double tubing assembly.

Fill the alcohol reservoir three quarters full (see section 7 "Notes on handling iso-propanol"), fit the double tubing assembly on again and the alcohol reservoir back in place).

Now activate the switches as follows:

main switch (4):	ON
mode (5):	continuous operation
high voltage(6):	ON

The knurled nut (11) serves for regulating the amount of alcohol dropping into the evaporating gutter. Turn the the knurled nut to the left and observe the alcohol flowing through the bended tube (14) and dropping into the gutter. When the gutter is filled to a liquid level of about 1 cm, reduce the alcohol supply to about 6 - 8 droplets per second. When the cloud chamber is being operated, the alcohol in the gutter should remain constant at this level. After about 5 minutes, the first white tracks should appear on the black observation surface. If, however, after 1 hour the tracks become a bit fuzzy and milky, you have to reduce the gutter heating by means of the control knob (7).

If the tracks are too weak, the heating of the gutter must be increased.

If you want to run the cloud chamber at automatic operation, set the markers of the programmable time switch to the desired switching time (red marker to switch the cloud chamber on, green marker to switch it off) and set the mode switch (5) to „timer“. For more detailed information see the instructions on the programmable time switch.

Now close the front side by inserting the plate (3) into the right side of the opening, pushing it back to the left stop position and locking it up.

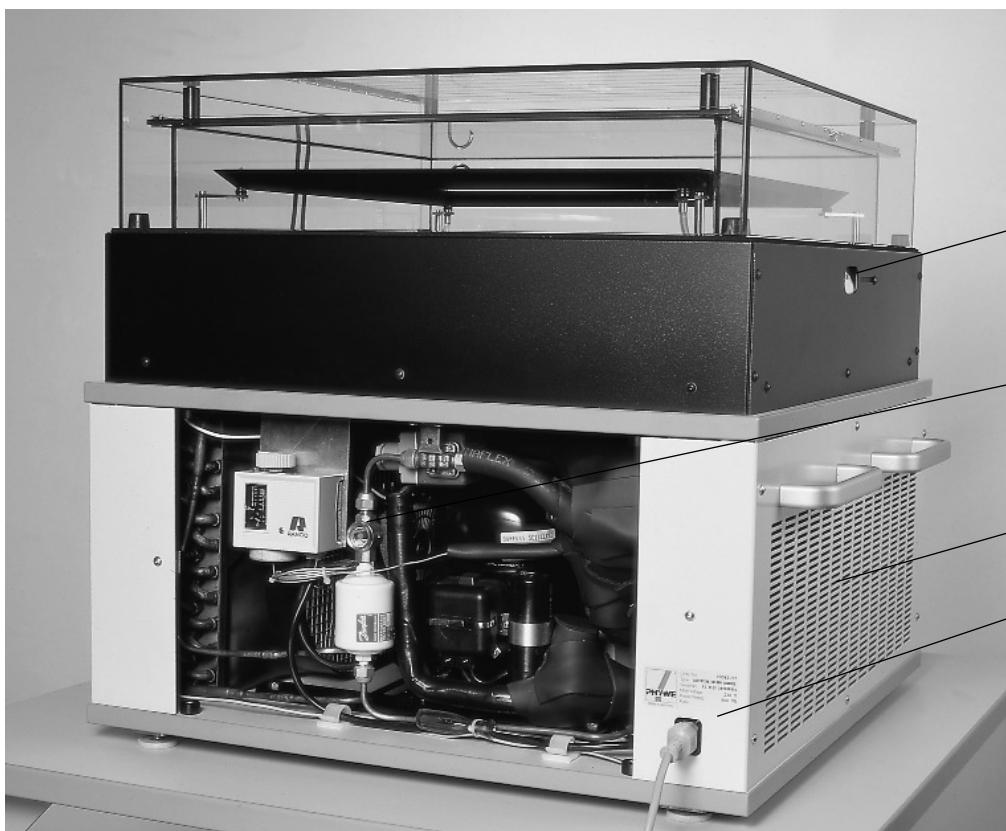
**How to open the back side:**



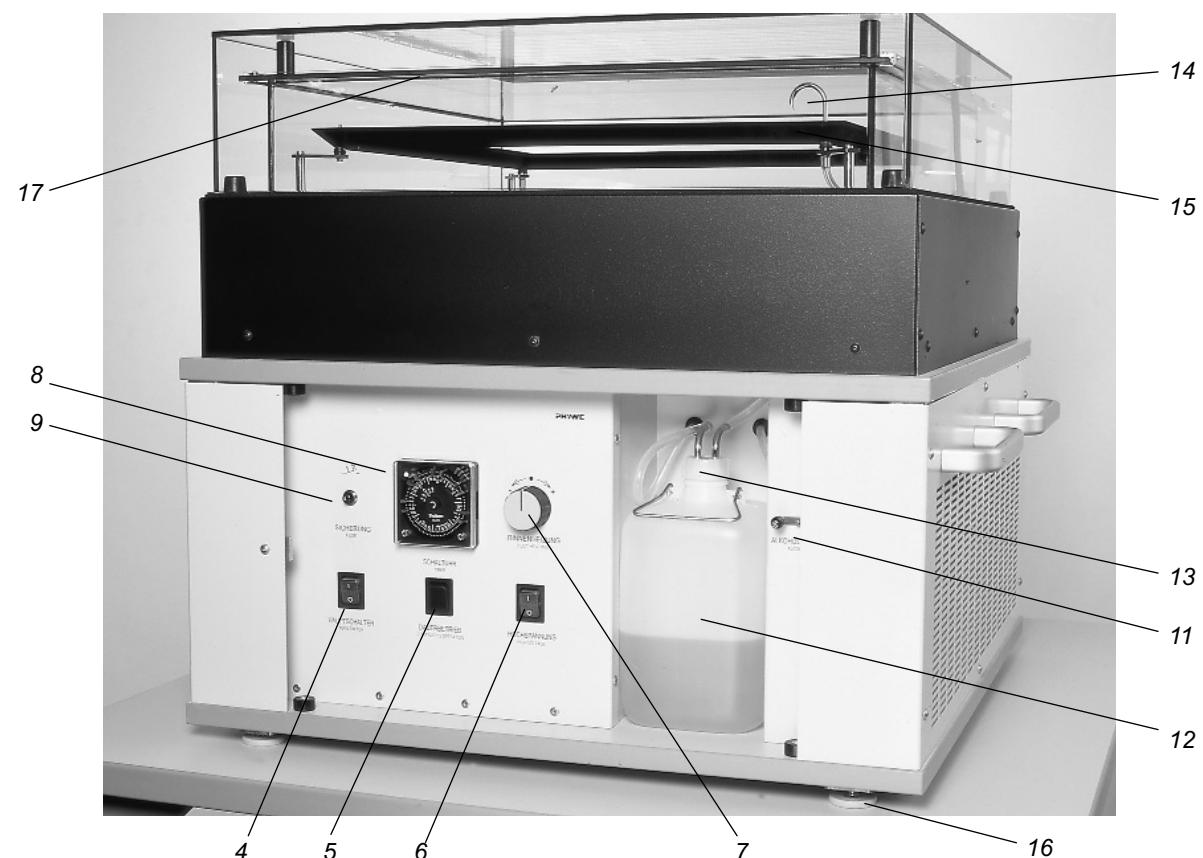
##### Important!

**It is only allowed to open the back front. by qualified personal.** The back side can be opened and closed just like the front side. Here you can see the cooling element, the thermostat and the inspection glass (21) for the cooling liquid. During the operation of the cloud chamber the inspection glass should always be filled with cooling liquid. Make sure that there are no bubbles in the glass.

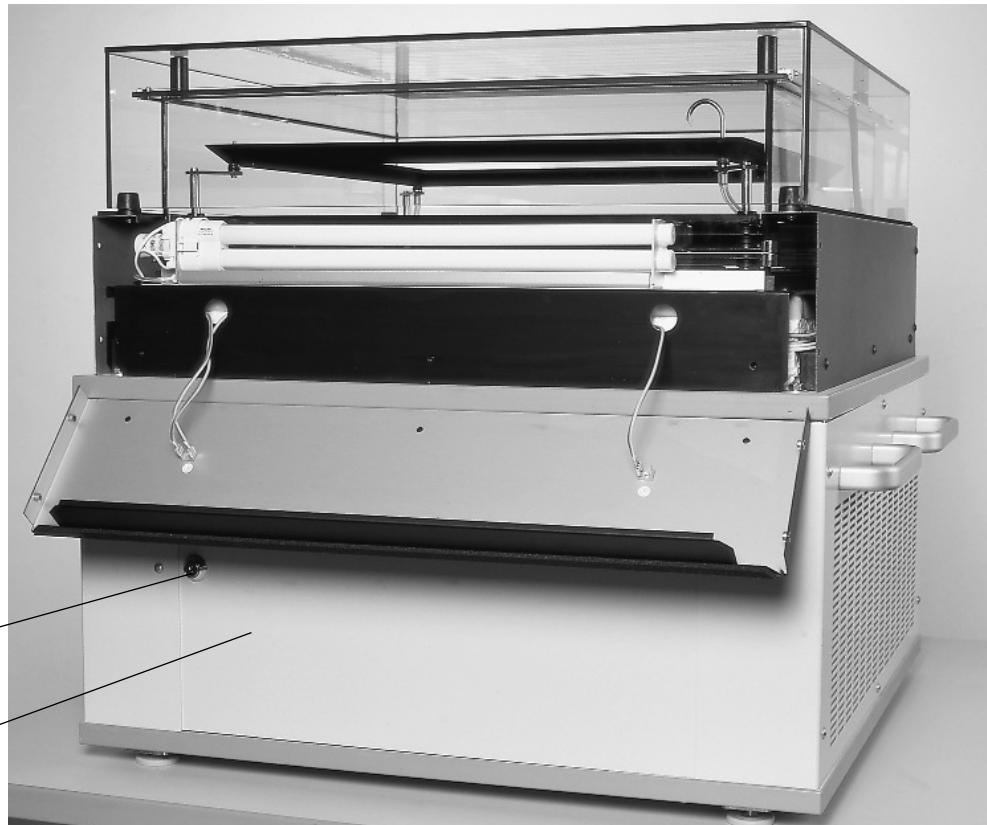
The thermostat comes supplied set to the optimum temperature. In the case of extreme room temperatures, it might become necessary to modify the setting by turning the knob on the upper part of the thermostat. **Please make sure that modifications on the cooling element are only carried out by authorized experts.**



Rear view



Front view



Illumination

#### **Artificial radiation sources**

On the left side of the chamber base there is an opening (20) which serves for introducing artificial radiation sources. Use the head of the screw to push the plate to the right. The ball with pin which is located behind the plate can be turned around with the aid of the pin until the opening towards the inner area becomes visible. Now you can insert an artificial radiation source like, for instance, the thorium source by PHYWE a few centimeters into the inner area of the chamber.

#### **Notes**

##### **A: General**

To avoid deposits on the inside surface of the inner glass cover, never disconnect the chamber from the mains supply nor switch it off at the main switch. This ensures that the heating circuit for the glass cover heating remains active even when the chamber itself - controlled by the timer - is inactive at night or over weekends. In this way, condensation of alcohol on the inside surface of the inner glass cover, and the contamination resulting from this, are avoided to a great extent.

Please read in detail the attached description of the thermostat.

##### **B: Cleaning**

Periodic cleaning of the glass covers with a commercially available glass cleaning agent is recommended.

**Important!**

The chamber must be disconnected from the mains supply (**by unplugging it!**) before the glass covers are taken off for cleaning.

##### Cleaning the outer cover:

Simply lift up the outer cover to take it off for cleaning.

##### Cleaning the inner cover:

Carry out the following succession of steps to take off the inner glass cover for cleaning:

- Lift the outer cover up and off
- Remove the spacer bolts fitted between the inner and outer glass covers
- Draw the connecting plug for the cover heating down and out
- Use the screwdriver provided to unscrew the side plate
- Take out the flat plug for the pane heating (on the side where the specimen is introduced)
- Take off the inner cover

##### **Removal and re-assembly of the heating wires:**

- Disconnect the connecting plug between the two heating segments
- To linearly expand the heating wires, which are under mechanical tension, use an external source of current to electrically heat each of the heating wire segments, one after the other, with 4.5 V/12 A. When the heating wires have been slightly lengthened in this way, carefully take out the track pair of a heating segment from the covering plate of the cover. Remove the leaf springs between the tracks and the glass plate.

- To replace the heating segments, first slide them back on the glass plate, then again lengthen the wires of the heating segments with an external source of current (as described above), so that finally the leaf springs can be inserted between the tracks and the edge of the glass plate to maintain the necessary mechanical tension in the heating wires.



### Important!

Because of unavoidable size tolerances in the covering glass plate, it is absolutely necessary to ensure that each of the two heating circuits is replaced in its original position.

### Assembly

After cleaning the glass covers, replace them in the same way as they were taken off, but in the reverse order.

### C: Changing lamps



### Important!

Disconnect the chamber from the mains supply (**disconnect the mains plug!**) before changing lamps.

To replace a blown lamp, unscrew the side cover plates with the screwdriver provided. After lamp replacement take care that the grounding conductor is properly connected when screwing the side cover plates back on.

### D: Alcohol consumption

The cloud chamber consumes very little alcohol, but despite of this, the stock of alcohol and the dropping speed should be regularly checked, in particular when the chamber is in permanent operation or in regular use with a weeklong programme.

Use exclusively 2-propanol (isopropyl alcohol) for topping up.

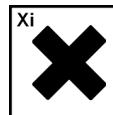
## 7 NOTES ON HANDLING ISO-PROPANOL

The handling of the alcohol iso-propanol (isopropanol, 2-propanol, propan-2-ol) is subject to the same rules for the avoidance of danger as is the handling of other chemicals, reagents and dye solutions. It is natural that such substances must be handled cautiously and carefully so that neither students and teachers nor others are exposed to unnecessary health hazards.

When handling iso-propanol, therefore, the directions must be observed that are given in the current up-dated data sheet (acc. to EC Directive 91/155/EEC), the valid accident prevention regulations and the directions that apply to the particular workplace.

Some of the most important handling regulations and general rules of behaviour are named here without any claim to completeness:

2-Propanol is a clear, highly flammable and somewhat oily liquid with an odour that is reminiscent of a mixture of ethanol and acetone. It mixes in all proportions with water and most organic solvents. The vapour from iso-propanol can form explosive mixtures with air.



**Risk phrases:** R 11-36-67

Highly flammable. Irritating to eyes. Vapour can make drowsy and dazy.

**Safety phrases:** S 7-16-24/25-26-39

Keep container tightly closed. Keep away from sources of ignition – No smoking. Avoid contact with eyes and skin. In the case of contact with eyes, rinse immediately with plenty of water and seek medical advice. Wear eye/face protection.

**First aid:** Immediately rinse contacted skin or eyes, with eyelids open, with plenty of water. On eye injury, seek medical advice immediately. In case of accident or if you feel unwell, seek medical advice immediately. After inhalation: Fresh air, keep airways free. On respiratory distress: Transport to doctor in half-sitting position.

**Waste disposal:** Collect combustible halogen-free organic solvents and solutions in a container labelled for them and pass to appropriate waste disposal.

## 8 TECHNICAL SPECIFICATIONS

Active layer	45 cm x 45 cm x approx. 1 cm
Chamber (B x D x H)	64 cm x 64 cm x 60 cm
Working liquid	2-Propanol, highest chemical purity (isopropyl alcohol)
Tank volume	2 litres
Illumination	Integrated fluorescent lamps
Time switch	7 x 24 hours (weekly program)

### Mains supply

The instrument corresponds to protection class I. It is only to be connected to a socket with an earth lead connection.

Connecting voltage (+6%/-10%)	see type plate
Mains frequency	50/60 Hz
Power consumption	900 VA
Fuse	see type plate
Weight	80 kg

## 9 CLOUD CHAMBER AND ACCESSORIES

Large Diffusion Cloud Chamber	09046.93
2-Propanol, 1 litre	30092.70
Artificial radioactive sources on request.	
The right of technical alterations is reserved.	

## 10 NOTES ON THE GUARANTEE

We guarantee the instrument supplied by us for a period of 24 months within the EU, or for 12 months outside of the EU. Excepted from the guarantee are damages that result from disregarding the Operating Instructions, from improper handling of the instrument or from natural wear.

The manufacturer can only be held responsible for the function and technical safety characteristics of the instrument, when maintenance, repairs and alterations to the instrument are only carried out by the manufacturer or by

personnel who have been explicitly authorized by him to do so.

## 11 WASTE DISPOSAL

The packaging consists predominately of environmentally compatible materials that can be passed on for disposal by the local recycling service.



Should you no longer require this product, do not dispose of it with the household refuse. Please return it to the address below for proper waste disposal.

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