PHYWE
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XR 4.0 expert unit, X-ray unit, 35 kV

09057-99

PHYWE Systeme GmbH & Co. KG
Robert-Bosch-Breite 10
37079 Göttingen
Germany

Tel +49 (0) 551 604-0
Fax +49 (0) 551 604-107
E-mail info@phywe.de

Fig. 1: 09057-99, XR 4.0 expert unit, X-ray unit, 35 kV

Operating Instructions

CE The unit complies with the applicable EC regulations.

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1 SAFETY INSTRUCTIONS

- Read the operating instructions thoroughly and completely prior to starting the unit. This is important for your own protection and for avoiding damage to the unit.
- Use the unit solely for its intended purpose.
- The unit is intended for use in dry and dust-free rooms where there is no risk of explosion.
- Prior to connecting the unit to the mains power supply, ensure that the protective conductor of the power supply unit is correctly connected to the protective conductor of the mains power supply network. The mains power plug may only be plugged into a mains power socket that is equipped with a protective conductor. Do not eliminate this protective effect by using an extension lead without a protective conductor.
- Ensure that the mains voltage that is stated on the type plate of the unit matches the mains voltage of your power supply network.
- When setting the unit up, ensure that the mains power switch and the device plug are freely accessible. Ensure also that the venting slots of the unit are not covered or blocked.
- Do not connect any devices to the unit other than the ones that are intended for this purpose.
- The XR 4.0 X-ray Direct Digital Image Sensor II (XRIS II) 09057-41 and XR 4.0 X-ray CT Z-Rotation Unit 09057-42 must not be plugged in or unplugged during operation. There is a risk of damage despite software protection.
- Attention: Disconnect the unit from the power supply prior to loosening, replacing, or removing any of the cable connections!

- Ensure that no liquids or objects penetrate the unit through the venting slots.
- Do not start the unit if the mains power cable or the unit itself are damaged.
- Switch the unit off after using it. Continuous operation is not permissible. The maximum runtime per day is 10 hours. It is not a syfety risk if you the tube for longer intervals but this could reduce the lifetime of the tube.
- Start the unit at least twice per year and check its safety functions. The tests that are included in the checklist at the end of this document must be performed.

  If damaged, the unit must be returned to the manufacturer for repair. Only the manufacturer or a certified company that has been appointed by the manufacturer are authorised to repair and maintain the unit.

- Since X-ray units generate dangerous radiation that is hazardous to health, only trained and qualified persons are authorised to start the X-ray unit in accordance with the local, country-specific rules and regulations.
- In Germany: When working with the X-ray unit, the mandatory measures and duties that are outlined in the German X-ray ordinance (Röntgenverordnung, RÖV) must be strictly complied with.
- The requirements of the certificate are to be followed
- In particular, the operator must ensure that
  - the X-ray unit is protected against access by unauthorised persons;
  - the unit is not in use longer than necessary;
  - persons working with the unit do not remain in the direct vicinity of the unit longer than absolutely necessary.
- The use of the unit is prohibited if
  - the sliding door that is made of lead-containing acrylic glass and that is used for opening the experiment chamber, or the other protective glass windows that are used to observe the X-ray unit and the experiment chamber, are damaged;
  - the fan at the X-ray plug-in side inside the unit is inoperative (acoustic check);
  - the safety circuits for interrupting the X-ray operation when the sliding door is opened do not operate properly.
- How to clean:
  - Do not use diluter/thinner!
  - Clean with cloth and appropriate cleaning agent.
- **Transport**
  - **Do not stress the drawer during transport. The device should stand only on its feet.**
  - **During transport make sure that the sliding door is not locked with the lock bar. If so, unlock the door using button IV, Fig 5 (switch on the device to use the button). The door should not be open either – fix it with the S-LOCK.**

2 OPERATING INSTRUCTIONS

- The device fulfils the technical requirements that are summarised in the current guidelines of the European Community. The characteristics of the product entitle it to bear the CE mark.
- The unit must be used under the supervision of an expert and in the electromagnetically controlled environment at research, teaching, and training facilities (schools, universities, institutes, and laboratories).
- This means that, in such an environment, radio transmission devices, e.g. mobile phones, should not be used in the direct vicinity of the unit. The connected cables must not be longer than 2 m.
- Electrostatic charges or similar electromagnetic phenomena (HF, bursts, indirect lightning discharge, etc.) may affect the unit so that it will not work within the specified data range.

  Occuring interfering signals may result in an automatic shutdown of the high voltage during measurement! In this case please follow section 6.6.

  The following measures reduce or eliminate potential interferences: avoid carpets; provide equipotential bonding; perform the experiments on a conductive, earthed surface; use shields and shielded cables. Do not use radiofrequency transmitters (radio sets, mobile phones) in the direct vicinity of the unit. After a total exit by actuating the mains power switch, perform a reset.

This unit corresponds to class A of the standard DIN EN 61326 and may be used without any restriction only in non-residential areas. If – although the use of the unit is restricted to special classrooms in a school or another training facility – electromagnetic interferences occur in the surrounding residential area, the operator can be required to take the appropriate measures (e.g. shielding, long distance with regard to sensitive equipment, short periods of use, use of the shortest possible connecting cables, etc.) and to pay for these measures.

3 INSTRUCTIONS OF THE GERMAN X-RAY ORDINANCE

In Germany, the operation of the X-ray unit is subject to the regulations that are outlined in the X-ray ordinance (Röntgenverordnung, RöV). In accordance with this ordinance, the unit fulfils the mandatory requirements of an X-ray unit for schools as well as those of a full-protection device.

In Germany, the operation of the unit is not subject to approval, but to reporting. Thus, report the unit to the appropriate controlling institution.

For reporting, the test certificate and a copy of the design approval must be submitted to the responsible authorities. Only specifically trained and instructed personnel is authorised to operate the unit. When this unit is used as an x-ray device for schools a radiation protection officer must be authorized.

If the unit operates at the maximum operating data, the local dose rate at a distance of 0.1 m from the parts of the housing that can be touched is less than 1 µSv/h.

Two independent safety circuits monitor the opening of the sliding door that leads to the experiment chamber.

X-rays can only be generated when the sliding door is properly locked. The safety circuits also prevent the maximum permissible operating values of the tube from being exceeded.

Do not use the device if the X-ray unit is manipulated in a way that is not necessary for its set-up or for performing experiments. It is absolutely forbidden to loosen the safety screws of the sheet steel housing or to tamper with the windows. Only the manufacturer is authorised to repair the unit.

For any operation of the unit outside of Germany, the applicable local rules and regulations must be complied with.

4 PURPOSE AND CHARACTERISTICS

4.1 Purpose of the unit

The X-ray unit is a demonstration unit as well as a unit for laboratory courses. It has been specially developed to fulfil the requirements of education at schools and universities. In addition to its use in the education of physics, it can also be used for education in the medical sector and the related technical disciplines. A particularly noteworthy distinguishing feature of this microprocessor-controlled compact unit is the quick-change feature of the X-ray tubes that enables the performance of experiments with different X-ray tubes and, thereby, different anode materials.
The following X-ray tubes, which are integrated in special, ready-to-use plug-in units, are available:

- Plug-in unit with a Cu X-ray tube order no. 09057-51
- Plug-in unit with a Mo X-ray tube order no. 09057-61
- Plug-in unit with a Fe X-ray tube order no. 09057-71
- Plug-in unit with a W X-ray tube order no. 09057-81

Do not use other plug-ins (predecessors 09057-50 / -60 / -70 / -80 are still compatible).

Apart from simple fluoroscopic experiments and experiments on dosimetry, the integrated rate meter and the additional goniometer enable spectroscopic experiments on atomic physics and solid-state physics.
The operating and control parameters are set either directly on the unit or with a computer via USB.

A colour TFT display in the control panel is used for the direct control of the unit (and for displaying all of the operating and control parameters as well as the measurement values). The keys around the display in the control panel enable the complete operation and control of the unit in its basic functions.

4.2 Overview of the possible experiments

The following experiments can be performed with the unit and the corresponding additional components:

- Radiography of objects and observation with the aid of a fluoroscopic screen
- Preparation of X-ray images of irradiated objects
- Detection of the ionising effect of X-rays (dosimetry)
- Detection of Bragg reflection
- Characterisation of X-ray spectra
- Determination of the characteristic X-ray lines of various anode materials (Cu, Mo, Fe, and W), thereby verifying Moseley's law
- Detection of the characteristic lines $K\alpha_1$ and $K\alpha_2$ in higher order diffraction
- Monochromatisation of X-rays with the aid of monocrystals or metal foil
- Crystal analysis with the aid of X-ray spectroscopy and Laue and Debye-Scherrer methods
- Determination of Planck's quantum of action from the short-wave limit of the bremsspectrum (Duane-Hunt law of displacement)
- Determination of the Rydberg constant
- Determination of the absorption coefficients as a function of the thickness and atomic number of the absorber material and of the photon energy
- Detection of absorption edges
- Demonstration of the effects of contrast media in medical applications
- Compton scattering

5 FUNCTIONAL AND OPERATING ELEMENTS

5.1 XR 4.0 X-ray expert unit

The XR 4.0 X-ray expert unit includes the following main components (see Fig. 2 and Fig. 3).

5.1.1 Experiment chamber
For performing experiments and for holding additional equipment, such as a goniometer or other experiment material.

5.1.2 Control panel
For setting the operating values and control quantities as well as for displaying all of the available measurement values.

5.1.3 Tray for accessories
For storing additional components.

5.1.4 Tube plug-in unit with a plug-in bay
Module in which the X-rays are generated.

5.1.5 Socket panel in the experiment chamber
For connecting various components, either for the connection to the XR 4.0 X-ray expert unit or for the connection to other peripheral equipment via the socket panel on the outside on the right-hand side of the unit.

5.1.6 External Socket panel
The external socket panel on the right-hand side of the unit is the counterpart of the socket panel inside the experiment chamber.

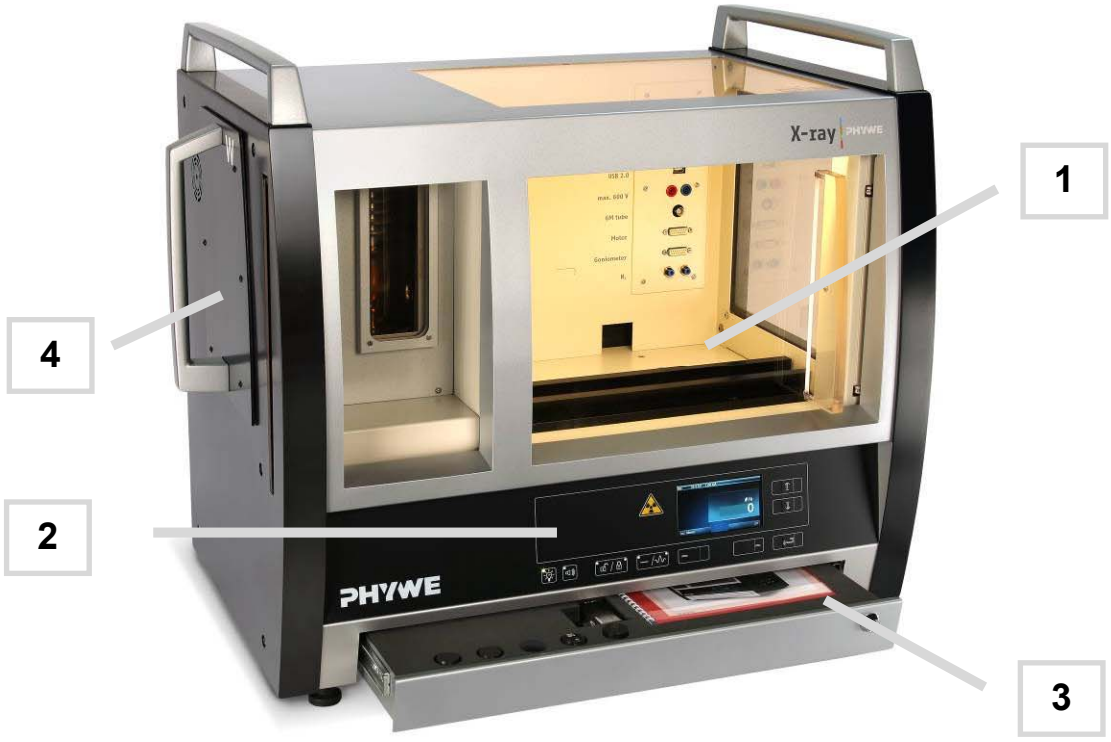

Fig. 2: Front view of the XR 4.0 X-ray expert unit (09057-99) including X-ray tube

Fig. 3: View from the right side XR 4.0 X-ray expert unit (09057-99)

5.2 Experiment chamber (*1*)

The experiment chamber (Fig. 4) includes the following functional elements:

5.2.1 Sliding door (A)

Made of lead-containing acrylic glass. The door is permanently monitored by a safety circuit and it is either locked or released via an actuator.

For monitoring the position of the sliding door (open/closed), two independent encoders are connected to the central safety unit of the XR 4.0 X-ray expert unit. If the sliding door is closed and the unit is in a safe state, the operator can lock the sliding door via the control panel. The position of the actuator for this purpose is monitored by two additional independent encoders that are also connected to the central safety unit.

In order to open the sliding door,push it first against the stop on the right-hand side.The S-Lock is now unlocked and the door can be opened.

X-rays can only be generated when the door is locked.

5.2.2 X-ray outlet (B)

The X-ray outlet is located on the left-hand side of the experiment chamber. It is used to hold metal tubes with circular double-apertures for generating a beam of rays that is suited to the experiment in question.

5.2.3 Socket panel in the experiment chamber (C)

Socket panel for the connection of devices that are located inside the experiment chamber, e.g. a goniometer. The sockets connect the devices either with the X-ray unit itself or they lead to the external socket panel that is located on the right-hand side of the unit (looping-through). This enables, for example, the control or read-out from the outside of a digital camera that is located inside the experiment chamber.

5.2.4 Working channel (D)

The working channel is located on the back wall of the experiment chamber, at the bottom on the right-hand side. It ends on the right-hand side outside of the unit and, thereby, forms a connection through which, for example, a contrast medium can be fed into the experiment chamber through hoses during the operation of the unit. The shape and cross-section of the working channel ensure that no X-radiation can escape.

5.2.5 Optical bench (E)

An optical bench is fastened to the bottom of the experiment chamber along the optical axis of the X-rays. The adapters that are required for the experiments can be attached to, and shifted on, this optical bench.

5.2.6 Temperature monitoring system

The temperature of the air inside the experiment chamber is monitored and controlled via a fan system.

5.2.7 Interior lighting

The linear LED lighting for illuminating the experiment chamber can be activated as required.

5.2.8 Holder for the goniometer

The goniometer 09057-10 is magnetically secured inside the experiment chamber via magnetic foil and has an electrical connection to the XR 4.0 X-ray expert unit (plug & measure).

5.3 Control panel at the front of the unit (*2*)

The control panel at the front of the unit is shown in Fig. 5 and described in Table 1.

5.4 Tray for accessories (*3*)

The lower part of the XR 4.0 X-ray expert unit includes a tray with moulds for the following components (for example):

- Geiger-Müller counter tube
- X-ray energy detector
- Diaphragms

Fig. 4: experimentation chamber

Fig. 5: Control panel at the front of the unit

Table 1: Overview of the functional elements of the control panel

No.	Name/Type	Function	Lighting colour: function activated
I	Triangular warning symbol “X-rays”	X-ray status indication	Bright yellow (2 LEDs)
II	Lighting (button)	For switching the light in the experiment chamber on/off	Green
III	Loudspeaker (button)	Acoustic indication of the pulses	Green
IV	Door status (button)	For locking and unlocking the door	White: not lockable Left LED green: door can be locked right LED green: door locked
V	X-rays (button)	For activating the X-radiation	White: it is not possible to swith on the unit Left LED green: X-ray can be activated right LED green: X-ray is activated
VI	Button (no name)	The selection of the menu function will be displayed on the screen above (on the bottom on the left-hand side)	White
VII	Button (no name)	The selection of the menu function will be displayed on the screen above (on the bottom on the right-hand side)	White
VIII	Arrow key “up” (button)	For setting experiment parameters and for scrolling through the menu	White
IX	Arrow key “down” (button)	For setting experiment parameters and for scrolling through the menu	White
X	Enter (button)	For confirming the selected value	White
XI	TFT display	For displaying the menus for the manual control of the unit (77 mm x 50 mm)	Polychrome

5.5 X-ray plug-in unit (*4*)

Plug-in unit for holding the adjusted X-ray tube in a sheet steel housing with a carrying handle, ready for use in the X-ray XR 4.0 X-ray expert unit. The housing of the tube has a catch lock and two safety contact pins that enable the tube operation only if the plug-in unit has been installed correctly.

Fig. 6: X-ray plug-in unit on the left-hand side of the unit

The bay for receiving the X-ray plug-in unit is equipped with coupling sockets and subsequent safety switches. These are connected to the central safety monitoring system of the XR 4.0 X-ray expert unit.

The following ready-prepared plug-in units are available:

- Plug-in unit with a Cu X-ray tube order no. 09057-51
- Plug-in unit with a Mo X-ray tube order no. 09057-61
- Plug-in unit with a Fe X-ray tube order no. 09057-71
- Plug-in unit with a W X-ray tube order no. 09057-81

The plug-in units consist of a sheet steel housing with a factory-adjusted X-ray tube. In order to prevent them from overheating, the tubes are enclosed in a Duran glass cylinder. This glass cylinder has side connecting pieces through which forced air cooling via a fan in the XR 4.0 X-ray expert unit is ensured.

The plug-in units also have an HV plug and a plug for the tube cathode heating so that the operating values can be taken over from the corresponding sockets of the XR 4.0 X-ray expert unit.

Make sure that the plug-in is inserted completely. Otherwise, it is not going to work.

Handle the plug-ins with care!

5.6 Socket panel inside the experiment chamber (*5*)

Fig. 7: Socket panel inside the experiment chamber

The socket panel at the back wall of the experiment chamber (Fig. 7) includes the following sockets for the connection of components in the experiment chamber. The names that are stated inside the unit are printed in italics.

From the top down:

- ***X RED:*** For connecting the X-ray energy detector 09058-30 to the multi-channel analyser 13727-99; BNC signal cable, supply cable (direct connection to the external socket panel on the right-hand side of the unit).
- ***Aux:*** Multi-pole socket for connecting various devices in the experiment chamber (direct connection to the external socket panel on the right-hand side of the unit).
- ***USB 2.0:*** Socket for connecting digital cameras etc. (direct connection to the external socket panel on the right-hand side of the unit).
- ***Max 600 V***: 2 mm x 4 mm sockets, e.g. for charging the capacitor plates (order no. 09057-05) for dosimetry experiments (direct connection to the external socket panel on the right-hand side of the unit).
- ***GM tube:*** BNC socket for connecting the Geiger-Müller counter tube, type B 09005-00.
- ***Motor:*** Socket for connecting the rotating stage XRstage 09057-42 of the computed tomography set XRCT 4.0 X-ray 09180-88.
- ***Goniometer:*** Connecting socket for the goniometer 09057-10.
- ***N_2:*** For feeding in protective gas or for the connection to a vacuum pump (direct connection to the external socket panel on the right-hand side of the unit).

5.7 External socket panel on the right-hand side (*6*)

The external socket panel (Fig 8) on the right-hand side of the unit is the counterpart of the socket panel inside the experiment chamber.

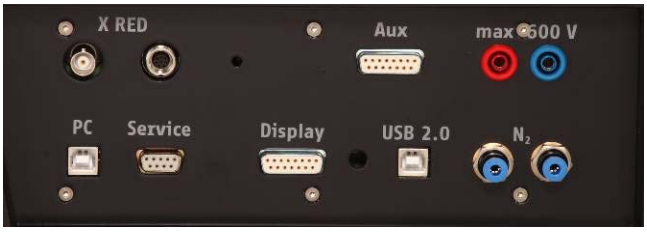

Fig. 8: External socket panel on the right-hand side of the unit

Here, the following components can be connected. The names that are stated on the unit are printed in italics.

Lower line of the socket panel:

- ***PC:*** For the connection to the control PC via the "measure" USB 2.0 port.
- ***Service***: For the connection of a specially configured PC for updating the device settings and for diagnosis purposes (for authorised specialist personnel only).
- ***Display:*** For the connection of a "Display Connect" RF adapter (09057-19). It is used to display measurement values and device parameters on the large-scale display unit (07157-93).
- ***USB 2.0:*** Socket for connecting digital cameras etc. (direct connection to the socket panel inside the experiment chamber).
- ***N_2:*** For feeding in protective gas or for the connection to a vacuum pump (direct connection to the socket panel inside the experiment chamber).

Upper line of the socket panel:

- ***X RED:*** For connecting the X-ray energy detector 09058-30 to the multi-channel analyser 13727-99; BNC signal cable, supply cable (direct connection to the socket panel inside the experiment chamber).
- ***Aux:*** Multi-pole socket for connecting various devices in the experiment chamber (direct connection to the socket panel inside the experiment chamber).
- ***Max 600 V***: 2 x 4-mm-sockets, e.g. for charging the capacitor plates (order no. 09057-05) for dosimetry experiments (direct connection to the socket panel inside the experiment chamber).

6 OPERATION

This section describes the start-up of the unit and provides an overview of its operation. Please read this section carefully in order to avoid problems or malfunctions.

6.1 Transport

- Do not stress the drawer during transport. The device should stand only on its feet.
- During transport make sure that the sliding door is not locked with the lock bar. If so, unlock the door using button IV, Fig 5 (switch on the device to use the button). The door should not be open either – fix it with the S-LOCK.

6.2 Start-up

Connect the unit to the power supply via the supplied power cable with an IEC connector. The socket for this purpose is located at the back of the unit (see Fig. 9).

Fig. 9: Back of the unit with the socket for the power cable and the central ON/OFF switch

6.3 Starting the unit

The central ON/OFF switch of the unit is located at the back of the unit (Fig. 9). Actuate this switch to switch the unit on. After the start, the unit will perform an automatic self-test (safety test). For this purpose, the operator must open the sliding door completely one time and then close it again. The device status that is thus determined will be indicated on the display unit in the control panel via the colours of the buttons IV and V.

In order to open the sliding door, push it first against the stop on the right-hand side.The S-Lock is now unlocked and the door can be opened.

If the unit had been switched off with the door being locked, the door will be automatically unlocked once the unit is switched on. The operator must then open the radiation protection door once and close it again (check of the safety circuit; described in the operating instructions and on the display unit).

If the X-ray plug-in is completely inserted and the door is closed with the use of the SLOCK the left LED of button IV is glowing in green. All other LEDs are enlighted in white. Now, the unit is ready for use.

If this is not the case, contact the Service of PHYWE for help.

Caution:

- It is only possible to lock the sliding door, if the plug in with the X-ray tube is completely inserted into the device.
- if you switch off the device while it is locked you have to switch it on again to unlock the door.

When used for the first time, the X-ray tubes should not run at full power. Instead, we recommend letting the tubes run for approximately 10 minutes at the maximum beam current, but with an acceleration voltage that is limited to 25 kV maximum. This procedure must also be repeated if a tube has not been used for several weeks.

Table 2: Overview concerning the three possible operating states

	Status/X-radiation	Description	Button IV	Button V	Sign ☢ panel (Fig. 5, I)	Sign ☢ Display (Fig. 11)
1	Cannot be switched on	The sliding door is not closed and not locked.	white	white	off	off
2	Cannot be switched on	The sliding door is closed but not locked	Left LED green	white	off	off
3	Can be switched on	The unit is in a safe state and the X-radiation can be activated.	Right LED green	Left LED green	on	off
4	On	The unit is in a safe state and the X-radiation is active.	Right LED green	Right LED green	on	on

The unit has four device statuses that are listed in Table 2.

Depending on the status, the unit can be controlled entirely via the buttons on the control panel together with the graphical representation.

Fig. 10: Screen for controlling the unit at the front of the unit. The x-radiation is not activated.

Fig. 11: Screen for controlling the unit at the front of the unit. The x-radiation is active. Sign ☢ appears on the screen.

The change of the representation and the control of the unit via the menu are performed via the buttons VI–X (Fig. 5).

As soon as the x-radiation is activated a yellow symbol appears on the screen (See Fig. 11).

6.4 Menu structure

On the main level, the menu structure of the unit includes the following items:

1. X-ray parameters
2. Goniometer
3. Timer
4. Settings
5. Info
6. Large Display

The buttons VI–X on the control panel are used to navigate through the menu, to change the settings, and to quit the menu.

6.4.1 X-ray parameters

This menu is used to set the high voltage and the beam current. By selecting the submenus for the high voltage or beam current and by pressing the dynamic buttons on the right of the display unit, the high voltage of the tube can be set to a value between 0.0 kV and 35.0 kV and the emission current to a value between 0.00 mA and 1.00 mA.

6.4.2 Goniometer

Menu and parameterisation of the goniometer (09057-10). The operation of the goniometer in the X-ray unit is described in the operating instructions for 09057-10.

6.4.3 Rotation stage

Menu and parameterisation of the rotation stage XRstage (09057-42). The operation of the rotation stage inside of the X-ray unit is described un the operating instructions for 09057-42.

6.4.4 Timer

This menu is used to define the start and stop conditions for the experiments (X-radiation ON/OFF).

6.4.5 Settings

This menu is used to define certain fundamental settings.

6.4.6 Info

Menu for status information concerning the unit.

6.4.7 Large Display

If a sender (09057-09) is connected to the XR 4.0 expert unit and transfers date to a large display in this part of the menu the parameter for the display can be set.

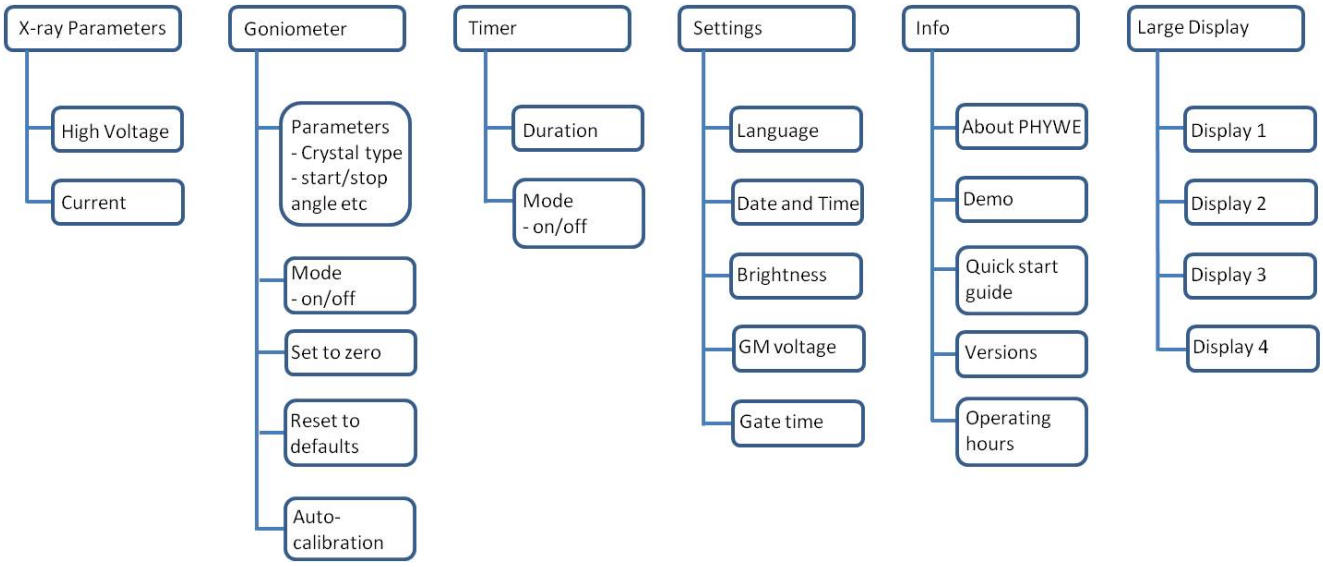

Fig. 12: Menu structure of the unit – overview

6.5 Control via a PC with "measure"

As an alternative with regard to the direct control of the unit via the control panel, the control of the unit and the representation of the measurement values can also be realised with the aid of a PC and the "measure" software (14414-61).

6.6 Automatic shutdown of high voltage in case of failure

In case of interfering signals in the mains supply, the high voltage will automatically be cut off in means to protect the device from defects (introduced with firmware V 2.1). This can be discerned by the fact that the x-ray tube stops to gleam.

Running measurements eventually will not stop during the shutdown, so they probably have to be restarted.

After removing the source of interference, check the door status button IV and lock the door, if necessary (LED has to be green). Afterwards, the device can be put into operation again by pressing the X-ray button V. Thus, the high voltage is switched on again and the measurement can be repeated. If the device is controlled via a PC, the USB connection has to be unplugged and plugged in, anew.

7 CHECKLIST

According to this list the device should be checked at least two times per year:

1. Check if the device shows any damage.
2. All glass panes must be undamaged.
3. Start the x-ray device according to chapter 6.1, 6.2 of this operating instruction. Perform a functional test of the status indications, e.g.:
   - Do all LEDs work porperly?
   - Is symbol „I" enlighted in operating state 3 (Table 3)?
4. Check all functionalities according to table 2 of this operating instruction:
   - In operating state 1 and 2 it is not possible to activate the x-radiation.
   - In operating state 3 the x-radiation is not active, the door is locked.
   - Only in operating state 4 the x-radiation is active. Does sign ☢ appear on the screen (Fig. 11)?
   - If you activate the x-radiation with the following parameters: anode current 1 mA, anode voltage 35 kV, the x-ray tube should gleam brightly.

The device is only ready for use if the tests are performed in the right way and successfully. Even if **only one** test fails the device must not be used. Please contact the Phywe service in this case. (service@phywe.com).

8 TECHNICAL DATA

- Operating temperature range: 5–40 °C, typically 25 °C
- Rel. humidity < 70 %
- Microprocessor-controlled XR 4.0 X-ray expert unit with a central safety monitoring system and two independent monitoring circuits for the door position and two independent monitoring circuits for the actuator of the door locking system
- 4 X-ray tubes that are visible during the operation (Fe, Cu, Mo, and W)
- Lead enforced acrylic class windows, safe according to DIN EN 61010
- Integrated display unit for displaying measurement values and device parameters
- "Display Connect" interface for the connection of a large-scale display unit
- Experiment chamber accessible during the operation via a working channel
- Integrated LED line for interior lighting (can be activated as required)
- Internal and external socket panel for easy cabling
- Loudspeaker for the acoustic indication of measurements with the Geiger-Müller counter tube
- N_2: max 5 bar
- Lockable tray for storing accessories
- High voltage: 5.0–35.0 kV
- Emission current: 0.0–1.0 mA
- counter tube voltage: 100–600 V
- Counting time: 0.5–100 s
- Exposure time: 0–100 minutes

- With an additional goniometer: (not included in the XR 4.0 X-ray expert unit)
  - Angular increment: 0.1–10°
  - Rate: 0.5–100.0 s/increment
  - Sample rotation range: 0–360°
  - Counter tube rotation range: −10 … +170°
  - PC control via Sub-D socket
- Housing (mm³ without feet and handles): 682 x 562 x 446 (W x H x D)
- Experiment chamber (mm³): 440 x 345 x 354 (W x H x D)
- Connection: 110/240 V~, 50/60 Hz
- Power consumption: 200 VA
- Mass: 63.2 kg; with tube: 68.2 kg
- PC control via USB 2.0

9 SCOPE OF SUPPLY

- 09057-99 XR 4.0 expert unit, X-ray unit, 35 kV
- Mains power cable
- USB cable
- “measure X-ray” software (14414-61)

10 ACCESSORIES

An extensive range of packages and accessories for the X-ray unit is available:

- 09057-51 XR 4.0 X-ray Plug-in Cu tube (predecessor 09057-50 compatible)
- 09057-61 XR 4.0 X-ray Plug-in Mo tube (predecessor 09057-60 compatible)
- 09057-71 XR 4.0 X-ray Plug-in Fe tube (predecessor 09057-70 compatible)
- 09057-81 XR 4.0 X-ray Plug-in tungsten tube (predecessor 09057-80 compatible)
- 09057-10 XR 4.0 X-ray goniometer
- 09057-26 XR 4.0 X-ray fluorescent screen
- 14414-61 XR 4.0 Software measure X-ray
- 09057-18 XR 4.0 X-ray optical bench
- 09057-49 XR 4.0 X-ray protection cover
- 01200-02 Handbook Physics X-Ray Experiments
- 09056-05 XR 4.0 X-ray Lithium fluoride crystal, mounted
- 09056-01 XR 4.0 potassium bromide (KBr) crystal, mounted
- 09056-02 XR 4.0 X-ray Absorption set for X-rays
- 09057-01 XR 4.0 X-ray Diaphragm tube d = 1 mm
- 09057-02 XR 4.0 X-ray Diaphragm tube d = 2 mm
- 09057-03 XR 4.0 X-ray Diaphragm tube d = 5 mm
- 09056-03 XR 4.0 X-ray Diaphragm tube w. nickel foil
- 09058-03 XR 4.0 X-ray Diaphragm tube w. zirconium foil
- 09057-04 XR 4.0 X-ray Compton attachment f.x-ray-unit
- 09058-01 XR 4.0 X-ray NaCl-monocrystals, set of 3
- 09056-04 XR 4.0 X-ray Chemical set for edge absorption
- 09058-11 XR 4.0 X-ray Crystal holder for Laue-pattern
- 09058-09 XR 4.0 X-ray holder for powder probes (diffractometry)
- 09057-08 XR 4.0 X-ray film holder
- 09058-02 XR 4.0 X-ray Univ. crystal holder f. x-ray-unit
- 09058-30 XR 4.0 X-ray energy detector (XRED)
- 13727-99 Multi channel analyser - extended version
- 09058-31 XR 4.0 X-ray Specimen set metals for X-ray fluorescence
- 09058-32 XR 4.0 XRED cable 50 cm
- 07157-93 Large-scale display, digital
- 09057-19 XR 4.0 Display-Connect, set of transmitter and receiver

Fig. 13: XR 4.0 Display Connect module

For display of measured values and device parameters, the large-scale display can be connected via the Display Connect set. For this purpose, the TX adapter of the Display Connect module must be connected to the external socket panel ("Display” socket). The RX adapter must be connected to the large-scale display. The values are selected via the menu on the control panel.

Sets

- XRE 4.0 X-ray expert set 09110-88
- XRW 4.0 X-ray wireless demonstration upgrade set, 09115-88
- XRP 4.0 X-ray solid state upgrade set, 09120-88
- XRC 4.0 X-ray characteristics upgrade set, 09130-88
- XRS 4.0 X-ray structural analysis upgrade set, 09140-88
- XRI 4.0 X-ray imaging upgrade set, 09150-88
- XRM 4.0 X-ray material analysis upgrade set, 09160-88
- XRD 4.0 X-ray dosimetry and radiation damage upgrade set, 09170-88
- XRCT 4.0 X-ray Computer Tomography upgrade set, 09180-88

11 WARRANTY

We give a warranty of 24 months for units supplied by us inside the EU, and a warranty of 12 months outside the EU. Any damage that is due to non-compliance with the operating instructions, improper use, or natural wear is excluded from the warranty.

The manufacturer can only be held liable for the function and safety-relevant properties of the unit, if the maintenance, service, and modifications of the unit are performed solely by the manufacturer or by an institution that is expressly authorised by the manufacturer.

12 DISPOSAL

The packaging mainly consists of environmentally-friendly materials that should be returned to the local recycling stations.

Do not dispose of this product with normal household waste. If this unit needs to be disposed of, please return it to the address that is stated below for proper disposal.

PHYWE Systeme GmbH & Co. KG
Customer Service
Robert-Bosch-Breite 10
37079 Göttingen
Germany

Telephone +49 (0) 551 604-274
Fax +49 (0) 551 604-246

13 APPENDIX

Symbols

Warning

Warning, radioactive substance or ionising radiation.

General map to fill the tray for accessories:

space	Art. no.	Name	Included in XRE
1	09057-26	XR 4.0 X-ray fluorescent screen	x
2	09005-00	Counter tube, type B	
3		free for e.g. 14608-00 Data cable USB, plug type A/B	x
4		Allen key	x
5	09057-15	XR 4.0 X-ray Adapter for digital camera	
6	09057-21	XR 4.0 X-ray external optical bench	
7	08286-00	Slide mount for optical profile-bench	x
8	09057-29	XR 4.0 X-ray slide for external optical bench	
9	08286-01	Slide mount for optical bench, h = 30 mm	x
10	09058-04	XR 4.0 X-ray Compton attachment for x-ray-unit	
11	08286-01	Slide mount for optical bench, h = 30 mm	x
12	09057-01	XR 4.0 X-ray Diaphragm tube d = 1 mm	
	09057-02	XR 4.0 X-ray Diaphragm tube d = 2 mm	
	09057-03	XR 4.0 X-ray Diaphragm tube d = 5 mm	
	09056-03	XR 4.0 X-ray Diaphragm tube with nickel foil	
	09058-03	XR 4.0 X-ray Diaphragm tube with zr foil	
13	09058-30	XR 4.0 X-ray energy detector (XRED)	
14	09058-11	XR 4.0 X-ray Crystal holder for Laue-pattern	
15	09056-05	XR 4.0 X-ray Lithium fluorid crystal, mounted	
	09056-01	XR 4.0 X-ray Potassium Bromide Crystal, mounted	
16	09824-00	Table with stem	x
17	09058-02	XR 4.0 X-ray Universal crystal holder for x-ray-unit