

Operating Instructions

ARTAX™



Bruker AXS Microanalysis GmbH
Schwarzschildstraße 12
D-12489 Berlin

Telephone +49 (0) 30 67 09 90-0
Fax +49 (0) 30 67 09 90-30
E-mail sales@roentec.de
Internet www.bruker-axs-microanalysis.com

Status: Edition 01/2006 (editorial deadline 10.03.2006)
valid for ARTAX Rev.3 from delivery September 2005

© 2006 Bruker AXS Microanalysis GmbH

This operating instructions document is not subject to revision control. Distribution and duplication of these operating instructions and all associated documents, as well as the use and communication of its contents, is forbidden unless expressly granted in writing by Bruker AXS Microanalysis GmbH. Compensation for damages is binding for non-compliance.

All rights reserved for registration of patent, utility patent and design.

Directory of Contents

1	Introduction	8
1.1	About these operating instructions.....	8
1.2	User Information	8
1.3	Intended Usage.....	9
1.4	Guarantee and liability	10
2	Safety Instructions.....	12
2.1	Norms and regulations.....	12
2.2	Fundamental safety precautions.....	13
2.3	Safety requirements during installation	13
2.4	Safety requirements for start-up.....	15
2.5	Requirements of personnel.....	16
2.6	Safety requirements of the gas supply.....	17
2.7	Safety equipment.....	18
2.8	Warning labels and name plates.....	24
2.8.1	on the electronics unit and terminal	24
2.8.2	on the measuring head and XYZ positioning unit	25
3	Product description	27
3.1	Main components.....	27
3.2	Principle of operation	28
3.3	Product variants	30
4	Technical details	31
5	Technical description	35
5.1	Overview of modules	35
5.2	Functional description	37
5.2.1	Electronics unit with terminal	37
5.2.2	X-ray source	39
5.2.3	X-ray detector	43
5.2.4	Measuring head	45
5.2.5	Collision sensor.....	47
5.2.6	EMERGENCY STOP button and door switch	48
5.2.7	XYZ drive mechanism and swivel joint.....	49
5.2.8	Gas flushing.....	50

5.2.9	Measurement computer and video converter	52
5.2.10	Tripod for ARTAX™ 400 and 800.....	52
5.2.11	Tripod for ARTAX™ 200.....	54
5.3	Connections.....	55
5.3.1	Mains supply and auxiliary supplies	55
5.3.2	Connections on measurement computer.....	55
5.3.3	Connections on electronics unit.....	56
5.3.4	Connections on XYZ stage unit.....	58
5.3.5	Connections on the measuring head.....	59
5.4	Software device specification	60
6	Transportation.....	61
7	Assembly.....	63
7.1	Unpacking and setting up components.....	63
7.2	Assembling tripod for ARTAX™ 400 and 800.....	64
7.3	ARTAX 200 tripod assembly.....	66
7.4	Assembling electronics unit on ARTAX™ 400 and 800.....	68
7.5	Installation of the ARTAX™ 200 electronics unit	69
7.6	Installation of the XYZ adjustment unit, ARTAX™ 400 and 800.....	70
7.7	Installation of the measuring head.....	71
7.8	Measurement computer.....	71
7.9	Connecting components.....	72
7.10	Installation of external door switch.....	72
8	Getting started and operation.....	75
8.1	Getting ready	75
8.1.1	Power on	75
8.1.2	Perform reference run	77
8.1.3	Check position of measuring head axes.....	77
8.1.4	Positioning.....	79
8.1.5	Gas feed.....	85
8.2	Carrying out a measurement	86
8.3	Exchanging components	87
8.3.1	X-ray source	87
8.3.2	Filter slide	89
8.3.3	Collimator	90

9	Shutting down and dismantling.....	93
9.1	Powering off	93
9.2	Dismantling	93
9.2.1	Measuring head	93
9.2.2	XYZ adjustment unit.....	93
9.2.3	Electronics unit.....	94
9.2.4	Tripod.....	94
9.2.5	Measurement computer	96
9.3	Packing into transport boxes.....	96
10	Disposal.....	97
	Index	98

List of Figures

Fig. 1:	Safety equipment on the ARTAX™ Version 400 and 800	22
Fig. 2:	Safety equipment on the ARTAX™ 200 tripod	22
Fig. 3:	Warning labels and labelling on the electronics unit and terminal of ARTAX™	24
Fig. 4:	Warning labels and name plates on the tube housing.....	25
Fig. 5:	Warning labels and name plates on the measuring head of the ARTAX® ...	26
Fig. 6:	ARTAX Main Components	28
Fig. 7:	Principle of operation of excitation and positioning.....	29
Fig. 8:	Block diagram ARTAX without tripod	35
Fig. 9:	Terminal, for description see Tab. 5.....	38
Fig. 10:	Effect of an excitation filter	41
Fig. 11:	Cross-section through an SDD X-ray detector	43
Fig. 12:	Mode of operation of an SDD-X-ray detector	44
Fig. 13:	Component configuration on the measuring head.....	45
Fig. 14:	Collision sensor	47
Fig. 15:	EMERGENCY STOP button and door switch	48
Fig. 16:	Helium cylinder with connection components for helium flush	51
Fig. 17:	Tripod components and axes for ARTAX™ 400 and 800.....	53
Fig. 18:	Components and axes for the ARTAX™ 200 tripod	54
Fig. 19:	Connections on measurement computer.....	55
Fig. 20:	Connections on electronics unit	56
Fig. 21:	Connections on XYZ stage unit.....	58
Fig. 22:	Connections on the measuring head.....	59
Fig. 23:	Tripod foot, partially opened up.....	64
Fig. 24:	Tripod foot with tripod support.....	65
Fig. 25:	Tripod with cantilever and floating arm attached	65
Fig. 26:	Tripod roller	66
Fig. 27:	Tripod completely assembled with cantilever and measuring head holder..	67
Fig. 28:	Installation of the electronics unit holder	68
Fig. 29:	Attaching and locking into place of electronics unit.....	69
Fig. 30:	ARTAX 200 measuring station	69
Fig. 31:	Installation of XYZ adjustment unit.....	70
Fig. 32:	Installation of measuring head	71

Fig. 33:	Connection plan.....	73
Fig. 34:	Powering on ARTAX™	76
Fig. 35:	Verification of the start with the "Enable Beam" button on the terminal	78
Fig. 36:	Congruency of X-ray beam, laser positioning spot and crosshairs	79
Fig. 37:	Measuring head correctly aligned.....	80
Fig. 38:	Height adjustment of the tripod support on the ARTAX™ 400, 800.....	82
Fig. 39:	Adjustment points on the tripod for cantilever and floating arm	82
Fig. 40:	Swivelling the measuring head	83
Fig. 41:	Distance setting via triangulation	84
Fig. 42:	Congruence of the optic axes in the camera image.....	85
Fig. 43:	Remove tube housing and filament cable.....	87
Fig. 44:	Undo the fastening screw of the tube housing.....	88
Fig. 45:	Remove tube housing.....	88
Fig. 46:	Exchanging filter slide.....	89
Fig. 47:	Exchanging collimator.....	91
Fig. 48:	Fold in floating arm and secure	94
Fig. 49:	Tripod foot with tripod support	95
Fig. 50:	Tripod foot, partially folded	95

List of Tables

Tab. 1:	Lead equivalents	14
Tab. 2:	Safety equipment on the ARTAX™ 200, 400 and 800	21
Tab. 3:	Warning labels and labelling on the electronics unit and terminal	24
Tab. 4:	Warning labels and name plates on the measuring head.....	25
Tab. 5:	Technical parameters of ARTAX™ 200, 400 and 800.....	32
Tab. 6:	Dimensions and weights of ARTAX 200, 400 and 800.....	34
Tab. 7:	Connection values and operational conditions	34
Tab. 8:	Electronics unit modules	37
Tab. 9:	Terminal controls.....	38
Tab. 10:	X-ray source modules	39
Tab. 11:	Connections on measurement computer.....	56
Tab. 12:	Connections on electronics unit	57
Tab. 13:	Connections on the XYZ unit.....	58
Tab. 14:	Connections on measuring head.....	59
Tab. 15:	Standard filter slides.....	90
Tab. 16:	Collimator sizes	90

1 Introduction

1.1 About these operating instructions

These operating instructions are intended to familiarize you with the operation of the ARTAX™ X-ray analysis machines models 200,400 and 800 from Bruker Microanalysis GmbH. The instructions allow you to get started quickly and include all information necessary to operate the machine safely and competently.

These instructions cover functionality, configuration and operation of the ARTAX™ hardware. Please refer to “Spectra Program Description“ for all information necessary in operating the Spectra control software. Section 3 provides an overview of the ARTAX machine models and product components.

A solid understanding of these instructions is mandatory for the operation of the ARTAX X-ray analysis machine from Bruker AXS Microanalysis GmbH. Please familiarize yourself with the contents and follow the safety instructions, particularly those regarding the handling of the product. This way you can be sure of taking full advantage of the capabilities of the product. We reserve the right to make product changes which enhance technical advancement.

1.2 User Information

The user information is divided up into 10 sections and 5 appendices. The section heading is in the header on each page. The status of the operation instructions (as an edition date and page number) is in the footer.

Various cross-references are included in the operating instructions to ease navigation within the document and to change to external documentation. In these cases, cross-references include the description of the external documentation to which they refer, e.g. see “Spectra Program Description Version“.

When working with documentation in electronic form, left-click the mouse once to move to the referenced location. You may also jump to the required location from the Directory of Contents and List of Figures.

The following warning symbols and informational symbols and signal words are used in these operating instructions:

**DANGER**

Warning of a potential danger to life and limb

**DANGER**

Warning of a potential danger to life and limb from electrical current

**DANGER**

Warning of a potential danger to life and limb from X-ray radiation

**DANGER**

Warning of a potential danger to life and limb from exposure to poison

**CAUTION**

Warning of possible material damage or damage to machinery

**NOTE**

Tips on usage and useful information

**NOTE**

Information on protecting the environment

1.3 Intended Usage

The ARTAX X-ray analysis machine from Bruker AXS Microanalysis GmbH may only be used for determination of element composition of materials in the fields of archeometry and material science.

The ARTAX may only be operated by trained and authorised personnel in compliance with all safety instructions covered in these operating instructions. Safe, accurate operation can not guaranteed unless the machine is used as intended as defined by these operating instructions.

Intended use also requires the following:

- The presence of at least one person in charge during operation. This person is trained, certified, has a technical qualification in the field of X-ray technology, is in possession of evidence, in writing, and has been trained by the manufacturer in the handling of the machine.
- Fundamental knowledge of the “Spectra” software
- Fundamental knowledge of all applicable documents (“Spectra Program Description” in particular)

Any other use beyond that described is considered as non-intended usage. The operator, not the manufacturer, assumes sole liability for all personal injury and material damage arising from not-intended usage.

The following applications are explicitly excluded from the definition of intended usage:

- Medical and biological applications of any sort
- Radiographical applications
- Online process analytical applications in industry and research
- Analysis of aggressive chemical or radioactive substances

1.4 Guarantee and liability

The general conditions of sale and supply as passed to the operator of the ARTAX™ X-ray analysis device by Bruker AXS Microanalysis GmbH strictly apply. Guarantee and liability claims for personnel and material damage are excluded if they are a result of one or more of the following:

- Non-intended usage of the ARTAX™
- Improper start-up, installation, packaging or operation of the ARTAX™
- Structural changes to the ARTAX™
- Operation of the ARTAX™ whilst protective housing not completed closed or safety equipment faulty or not properly attached.
- Non-compliance of the safety regulations and instructions within this document
- Improper connection and improper cabling of the ARTAX™ and its safety equipment
- Use of control software other than the “Spectra” software included in the delivery
- Use of computer technology other than that included in the delivery or the measurement computer authorised by the manufacturer.

2 Safety Instructions

X-ray energy levels (up to 50 keV) in the excitation beam, such as those in the ARTAX™, cause damage to tissue and bone as a result of high levels of radiation. Poorly healing wounds and, in extreme cases, loss of individual limbs (e.g. fingers) could result. In contrast to “accidental radiation” with a high dose over a short period, there is an increased risk of cancer from a lower radiation load over a longer period .

All information pertaining to safety in this document applies to current, valid, national laws and the Ordinance of the European Union. In other countries, applicable laws and national regulations must be complied with.

In addition to the safety instructions in this document, general, valid, regulations regarding accident prevention and the protection of the environment must also be observed and complied with. All information in these operating instructions must be followed unreservedly at all times.

In order to safely operate X-ray machines such as the ARTAX™ X-ray analysis machine, norms, directives and regulations are defined for safety and radiation protection. These must be adhered to by both manufacturer and users alike.

2.1 Norms and regulations

Under the terms of the X-ray Ordinance, the ARTAX™ is consummate with a fully protected device in terms of its technical data pertaining to radiation protection and radiation load of personnel when shutter is closed (Appendix III X-ray Ordinance).

The following safety features are amongst those incorporated into the design of the ARTAX™ :

- The protective housing completely encloses the X-ray emitter when the shutter is closed
- When the shutter is closed, the dose rate is less than 7.5 µSv/h at a distance of 10cm from the touchable surface
- All key, safety-relevant functions operate independently of the measurement computer
- Redundancy is provided for all vital safety equipment
- The high voltage supply is switched off if the measurement program crashes
- All safety circuits function as wired
- Mains voltage can only be applied using a key switch

- Powering-on of the high voltage supply and opening of the shutter are only possible from the “Spectra” control software supplied as part of the delivery

The CE-marking and declaration of conformity attest to the safety of the ARTAX™.

2.2 Fundamental safety precautions

The following fundamental safety precautions must be observed at all times:

- X-ray radiation must never be pointed at people.
- The ARTAX™ may only be used as intended.
- All persons exposed to potential radiation must be dosimetrically monitored.
- Smoking, eating and drinking near the machine is not permitted.
- Persons who are overtired, or under the influence of alcohol or medication, are not permitted to operate the machine. Operating personnel must not be suffering from any type of physical or mental condition which could negatively impact their concentration or judgment capability either in the short-term or permanently. The ARTAX™ must not be operated unsupervised whilst X-ray radiation is being emitted. Unauthorised persons must not have access to the machine.
- Looking into the beam emission aperture is not permitted.
- Sufficient warning signs must be provided for the area around the X-ray emitter.
- The proper condition of the safety equipment is to be checked on a regular basis.
- The device may only be operated once all the safety equipment, such as the protective housing, is present and fully functional.
- All safety instructions in this document and in all other applicable documents must be observed and complied with.
- The operating instructions must be accessible to personnel at all times.

2.3 Safety requirements during installation

The measurement principle of the ARTAX mobile RFA spectrometer is based on the use of an open and freely positionable X-ray beam. At the same time, this X-ray beam presents the biggest potential danger to health. Note the direction and potential effect of the X-ray beam when positioning the measuring head and sample. The X-ray beam is either completely absorbed or allowed though practically unweakened, depending on the type of sample.

Since the effect of the sample on the attenuation of the radiation can not always be determined, care must be taken to ensure that the radiation is never pointed at persons, i.e. they are safely shielded by taking appropriate safety precautions. Pay particular attention to structural conditions and the locality of the measurement computer.

The following safety considerations must be observed when installing the ARTAX™ :

- All radiation active components of the device must be steady and be securely installed or mounted.
- The measuring head must be securely attached and be protected against mechanical damage.
- The device must be installed such that unauthorised persons have no access to the device (e.g. in lockable rooms).
- Operating personnel must be protected from radiation load from scattered radiation by using suitable protection equipment, such as the radiation protection screen supplied . As a minimum, strong lead plating, at least 0.3mm thick, is required. Ideally, the measurement computer should be installed in a separate room away from any other equipment. Access to the installation room is then to be secured by an external interlock, such as a door switch.
- 1mm lead plating or an equivalent absorber must be used as a protective shield for primary radiation which goes straight through the sample. In this case, there is to be an adequate shielding effect for all possible operational parameters of the device. The lead equivalent can be used for the determination of an equivalent absorber. The lead equivalent is a material thickness which specifies how thick another material must be to attain the same shielding effect.

The following lead equivalents may be used for a maximum photon energy of 50 keV:

Material	Same shielding as 1mm lead using a material thickness of
Iron	6.5 mm
Concrete	130 mm
Solid brick	200 mm
Plasterboard	290 mm
Foamed concrete	480 mm

Tab. 1: Lead equivalents

- ❑ When analysing samples which are located against a wall, care must be taken to ensure that the brickwork to the neighbouring room has adequate protection against radiation. Otherwise the area within the neighbouring room within a 5 metre radius of the sample must be cordoned off.
- ❑ Material at which X-ray radiation is pointed must not exhibit any changes in their surface or their structure as a whole whilst being subjected to radiation.
- ❑ After every deployment of the ARTAX™, visual and functional checks are to be made to determine whether any safety relevant changes have occurred with the device. This also includes inspection of the safety equipment as per the checklist.
- ❑ After every deployment of the ARTAX™, the radiation load when the shutter is closed must be checked with a radiation protection device (sensitivity 10 KeV upwards). The measurement is to be made in all directions in space at a clearance of 10cm from the touchable surface of the measuring head. The value of the local dose is not to exceed 7.5 µSv/h. If this value is exceeded, the device must be taken out of service immediately and the manufacturer informed.
- ❑ The area within a 5 metre radius of the device must be cordoned off. In smaller rooms, the room itself must be locked. Sufficient warning signs must be used to mark the area cordoned off.
- ❑ When using the machine, a minimum distance of 3 metres must be maintained between X-ray source and measurement computer (between X-ray source and desk area of personnel).

2.4 Safety requirements for start-up

The following safety considerations must be observed when starting up of the ARTAX™:

- ❑ Under the terms of § 3 X-ray Ordinance, a license application is to be made with the regulatory authority responsible (e.g. Factory Inspectorate, Regional Authority for Occupational Health and Safety, etc.) prior to every start-up of the device. The following documents are to be enclosed with the license application:
 - Application for authorisation to operate the X-ray spectrometer
 - Evidence of conformance to specifications on radiation protection by the ARTAX™ in the form of an official test notification from an authorised assessor
 - Disclosure of the appointee(s) in regard to radiation protection and evidence of the required technical qualification on radiation protection from at least one person



NOTE

The X-ray Ordinance authorisation procedure applies for Germany. Always observe national safety regulations applicable in your country.

- ❑ Fresh acceptance from an appointee is required prior to every start-up following an alteration which impacts long-term radiation exposition, such as an upgrade of the device.
- ❑ Prior to every start-up, the operator of the ARTAX™ commits to reassuring himself on the safe and proper condition of the device, including all safety equipment, as per the checklist.

2.5 Requirements of personnel

The following requirements are made of the operating personnel of the ARTAX™ :

- ❑ Under the terms of the X-ray Ordinance, the ARTAX™ must only be operated by highly competent personnel expert in the field of X-ray technology. Personnel must be in possession of evidence of an X-ray technical qualification. At least one operator must have undergone training from the manufacturer in the technical and safe interaction with the ARTAX™. This responsibility is not transferable.
- ❑ Operating personnel must not be suffering from any type of physical or mental condition which could negatively impact their concentration or judgment capability either in the short-term or permanently.
- ❑ Personnel must be monitored dosimetrically during operation. In accordance with the X-ray Ordinance, a dosimeter must be worn on the front side of the torso at breast height.
- ❑ The ARTAX™ may only be installed, started up and operated by qualified personnel trained in safety-relevant issues.
- ❑ Personnel must have fundamental knowledge of the following operational procedures, regulations, behaviour and components:
 - Operational procedures during the operation of the ARTAX™
 - Safety equipment on the ARTAX™ and its correct function
 - Fundamentals of X-ray beam protection and behaviour in the X-ray area
 - Restriction, securing and marking of the X-ray area
 - Necessary and intended use of the safety equipment
 - Potential dangers from X-ray radiation present
 - Behaviour and precautionary measures should a dangerous situation arise
- ❑ In accordance with the X-ray Ordinance, the operator must provide annual training for operating personnel on working with X-rays. Signatory evidence is required.

- Every person authorised to install, start up and operate the ARTAX™ must have read and fully understood all of the operating instructions.
- Servicing and alignment of the ARTAX™ may only be carried out by servicing personnel from Bruker AXS Microanalysis GmbH.

In order to ensure the safe working with the ARTAX™, the personnel commits to the following:

- An inspection of the safety equipment, as per the checklist, must be made following every set-up and prior to every start-up.
- The installation site of the device must be monitored during operation.
- Should any dangers be detected which could result in harm to personnel, the ARTAX™ must be turned off immediately using the EMERGENCY STOP button.

2.6 Safety requirements of the gas supply

The ARTAX also supports a He gas flush for the excitation and detection beam channel. The purpose of this is to improve excitation and detection of elements with lower atomic numbers. Gas is usually supplied from compressed gas cylinders or built-in gas supply equipment. Special safety regulations must be observed when working with compressed gas.



NOTE

The operator of the ARTAX™ assumes responsibility for the gas supply. It is the operator, not the manufacturer, who assumes sole liability for all personal and material damage arising as a result of non-intended use of the gas supply

The following safety requirements are made of the gas supply:

- Gas cylinders may only be serviced by specialist personnel.
- Gas cylinders must be protected from excess pressure by appropriate safety equipment, including safety valves and rupture diaphragm. A red mark on the manometer must be used to indicate the highest permitted operational pressure.
- Gas cylinders may only be pressurized if they are approved as pressure vessels (indicated by a nameplate)
- The maximum pressure specified on the nameplate may not be exceeded under any circumstances.
- Gas cylinders must not be exposed to increased thermal, chemical or mechanical load at any time.

- ❑ The gas feed must not be opened until the connection on the gas cylinder is connected tightly to the respective connectors on the ARTAX™ using the appropriate piping. Uncontrolled escape of gas must be prevented at all times.
- ❑ The gas cylinder is to be fitted with a pressure regulator limiting the maximum pressure at the outlet of the gas supply to **5 bar**.



DANGER

The gas supply must never be connected directly to the control device of the ARTAX without a pressure regulator!

2.7 Safety equipment



DANGER

There is a danger of injury on malfunctioning of safety equipment. The ARTAX may only be operated if the safety equipment is fully functional. All safety equipment must be inspected as per the checklist and deemed fully functional prior to every start-up.

On the ARTAX, X-ray radiation with a max. energy of 50 keV is generated with a maximum tube rating of 50W (refer also to the datasheet of the X-ray tube). All possible constructive measures have been taken to prevent endangering personnel from X-ray radiation.

The other risks are danger from direct X-ray radiation when the shutter is open (primary radiation) and radiation scattered by the sample.

These risks can be addressed by taking the following steps:

- ❑ Nobody is allowed near the direct X-ray beam.
- ❑ Only trained and authorised personnel are permitted within the area of potential scattered radiation (within a radius of approx. 2m). The area is to be secured effectively against unauthorised access.
- ❑ A radiation-proof protective screen (radiation protection screen) is to be positioned between measuring head and personnel.
- ❑ A sufficiently large and thick lead plate (or comparable absorber) is to be positioned below/behind the sample.

The ARTAX is fitted with the following safety equipments

see **Fig. 1:** Safety equipment on the ARTAX™ Version 400 and 800 and

see **Fig. 2:** Safety equipment on the ARTAX™ 200 tripod

Pos. no.	Safety Device	Function
1	Warning light: Red Yellow	Flow monitored indicator which lights up when X-ray radiation is being emitted On malfunction, shutter is closed (and may not be opened) Flow monitored indicator which lights up when high voltage is present On malfunction, high voltage is turned off (and may not be turned on)
2	Fixing mechanism on the ARTAX 400 and 800 tripod:	Positioning fixing of the tripod and measuring head
2a	Catch on swivel joint of the XYZ unit	Incremental fixing of the swivel position
2b	Retainer on floating arm	prevents lowering of the floating arm
2c	Clamping for electronics	Attachment of the electronics unit
2d	Fixing screw on the cantilever	Fixing of the cantilever on the tripod support
2e	Catch and fixing screw on crank	Fixing of the support position
2f	Fixing screws for tripod foot	Stabilising of the tripod by lowering the tripod feet
2g	Fixing screw for tripod support	Fixing of tripod support on tripod foot support
16	Fixing mechanism on ARTAX 200 tripod	
16a	Clamp screw on the swivel joint of the cantilever	Fixing of the cantilever
16b	Clamp screw on swivel joint	Fixing of the measuring head after angle change
16c	Retainer on the tripod support	Fixing of the tripod support
16d	Retainer on the cross-stiffeners	Fixing of the tripod legs
16e	Retainer on tripod legs	Lengthwise fixing of the tripod legs
16f	Rubber lugs	Connection of the tripod legs with the tripod roller
16g	Central retainer on tripod roller	Fixing of the tripod roller bars
16h	Footrests	Fixing of the tripod roller on the surface underneath

Pos. no.	Safety Device	Function
3	<p>External security circuits</p> <p>Door switch</p> <p>EMERGENCY STOP</p> <p>external warning lamp red yellow</p>	<p>3 coded connectors</p> <p>Integration of a door switch into the security circuit. Door may be opened when shutter of tube housing is closed. When shutter is open, opening of the door leads to closing of the shutter and to powering-off of the high voltage supply</p> <p>Opening of the security contact results in total shutdown of the device</p> <p>ON when X-ray radiation being emitted ON when high voltage present</p>
4	Sleeve nut on high voltage cable	Secure fixing of HV cable in the X-ray generator
5	Primary switch (key switch)	Connects mains adapter of electronics to mains voltage. Other electronic circuits remain without power
6	<p>Terminal</p> <p>Control and warning lamps "Power" (green) "X-ray" (yellow) "Beam" (red) Button "ON" (green) "OFF" (rot) "Enable Beam" (green) "Emergency STOP"</p>	<p>To indicate electronics are ON To indicate HV is ON To indicate radiation is being emitted</p> <p>Power-on of electronic circuits Power-off of electronic circuits Button to activate "Start message" software command Emergency switch-off of device should a danger situation arise</p>
7	<p>Software control displays: Red symbol Yellow symbol</p>	<p>ON when X-ray radiation is being emitted ON when high voltage present See SPECTRA software description</p>
8	Red LED row on tube housing	<p>Flow monitored indicator which is ON when radiation is being emitted On malfunction, shutter is closed (any can not be opened)</p>
9	Radiation protective housing	Protective housing for shielding of X-ray tube (primary radiation protection)

Pos. no.	Safety Device	Function
10	Control lamps next to the X-ray optics "Beam" (red) "X-ray" (yellow)	Flow monitored display which is ON when X-ray radiation is being emitted On malfunction, shutter is closed (any can not be opened) Flow monitored display which is ON when high voltage present On malfunction, high voltage is switched OFF (any can not switched ON again)
11	Electro-mechanical shutter	Opens beam channel when required and only if all safety equipment is working correctly
12	X-ray optics: collimator (ARTAX™ 200 and 400) X-ray mini lens (ARTAX™ 800)	Restriction of beam channel (protection from scattered radiation)
13	Fastening screw for X-ray emitter	Fixes X-ray emitter on measuring head
14	Lead plate (below/behind sample)	Shielding of the primary beam behind the sample (primary beam protection)
15	Protective screen	Protection from X-ray scattered radiation

Tab. 2: Safety equipment on the ARTAX™ 200, 400 and 800

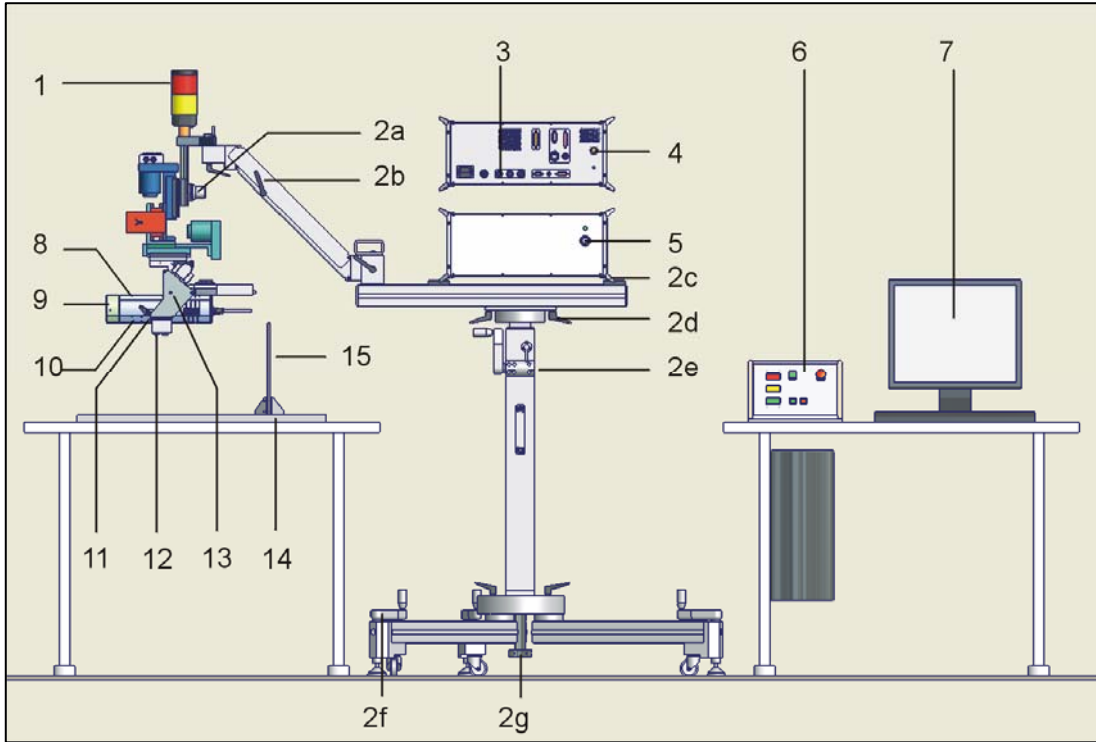


Fig. 1: Safety equipment on the ARTAX™ Version 400 and 800

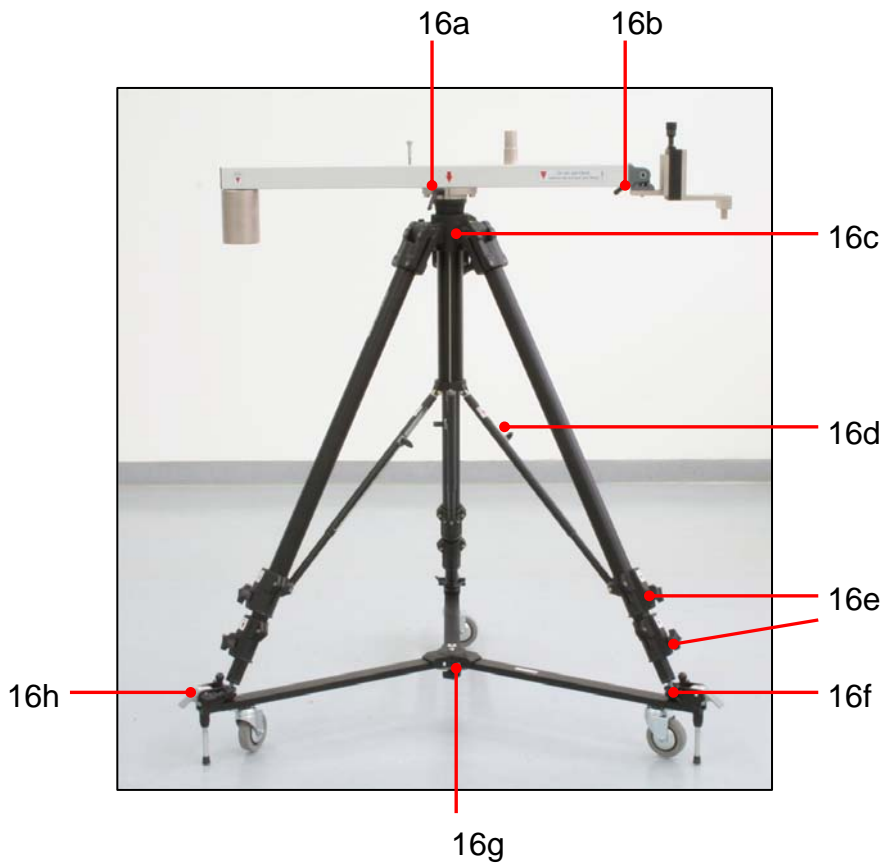


Fig. 2: Safety equipment on the ARTAX™ 200 tripod

External door switch:

**DANGER**

Danger of injury from X-ray radiation.

The external door switch provides additional security against inadvertent radiation loads. For this reason, the use of the external door switch during stationary measurement is strongly recommended.

**DANGER**

Danger of injury from X-ray radiation.

The external door switch does not represent a protective function for those people in the measurement room. Therefore all persons must leave the measurement room during every measurement and the measurement computer must be set up outside the measurement room.

The external door switch is part of an additional security circuit with a particular mode of operation. In contrast to the external interlock contact, opening of the door switch does not automatically result in the switching-off of the high voltage supply and the closing of the shutter. This only occurs when the door is opened during a measurement. The door switch also prevents the starting of a measurement if the door is open.

Only components authorised by Bruker AXS Microanalysis may be used for door switches. Appropriate door switches may be order from the manufacturer (Appendix B).

**DANGER**

Danger of injury from X-ray radiation.

Bruker AXS Microanalysis GmbH assumes no liability for damage resulting from the use of non-authorized components.

The installation of the external door switch is described in section 7.10.

2.8 Warning labels and name plates

2.8.1 on the electronics unit and terminal

Pos. no.	Module	Function
Fig. 3		
1	Electronics front panel	Product name
2	Electronics front panel	Company logo
3	Electronics rear panel	Name plate
4	Electronics rear panel	Yellow "High Voltage" warning label
5	Electronics rear panel	Informational sign for additional earth contacts
6	Underside of terminal	Name plate

Tab. 3: Warning labels and labelling on the electronics unit and terminal

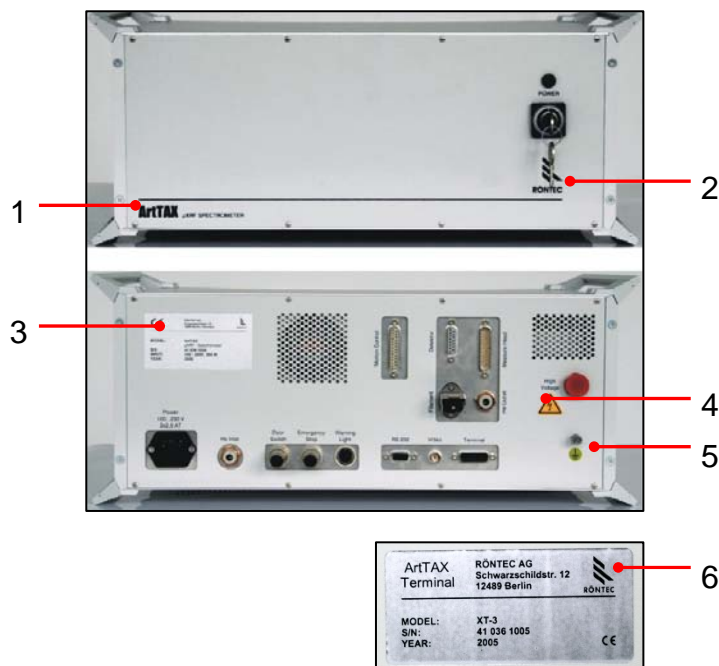


Fig. 3: Warning labels and labelling on the electronics unit and terminal of ARTAX™

2.8.2 on the measuring head and XYZ positioning unit

Pos. no.	Module	Function
Fig. 4		
1	Tube housing	Name plate of tube housing
2	Tube housing	"Beam" und "X-ray" warning labels on the underside of the tube housing
3	Tube housing	Yellow warning label with pictograms and safety instructions on poison, X-ray radiation and high voltage at the tube housing
4	Tube housing	White warning label with pictogram on radiation danger whilst shutter is open
5	Tube housing	Target type of X-ray tube
6	Tube housing	High Voltage warning label on the rear side of the tube housing
Fig. 5		
7	XYZ positioning unit	Name plate
8	Measuring head	Red "Fix" warning label for the fastening screw of the tube housing
9	Measuring head	Name plate of detector
10	Measuring head	Name plate of the measuring head
11	Measuring head	Yellow "X-ray radiation" warning triangle on the X-ray optics of the ARTAX™ 800
12	Measuring head	Yellow "Laser radiation" warning triangle

Tab. 4: Warning labels and name plates on the measuring head

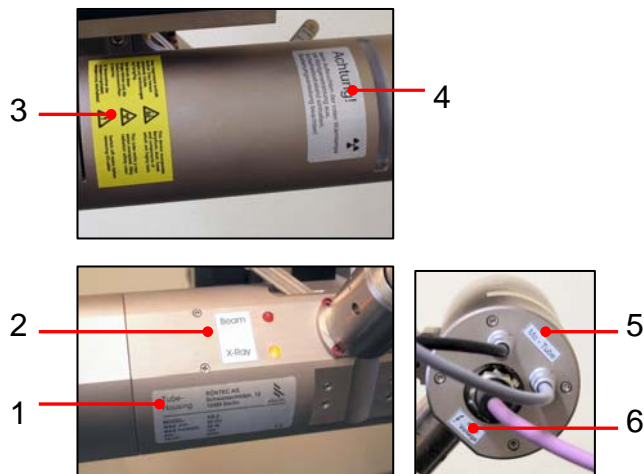


Fig. 4: Warning labels and name plates on the tube housing

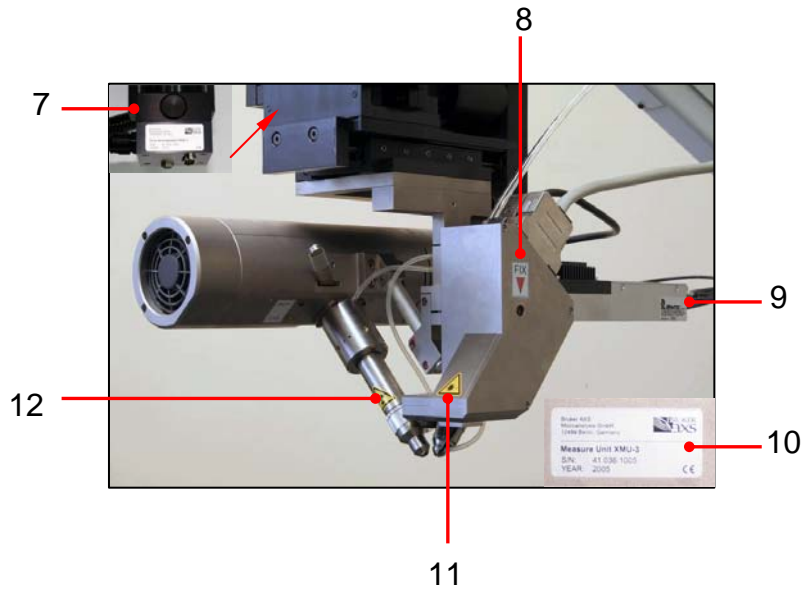


Fig. 5: Warning labels and name plates on the measuring head of the ARTAX®

3 Product description

The ARTAX™ X-ray analysis device is used for the determination of element composition with the help of energy dispersive X-ray Fluorescence Analysis (EDXRF).

The ARTAX™ can be used in the following fields:

- Archeometry
- Quality control
- Material science

Examinations in the fields of archeology and historical art as well examination of modern artifacts in visual arts have proven to be particularly successful.

A list of some of the items the ARTAX™ is able to examine:

- Scriptures
- Paintings
- Frescos
- Jewellery
- Sculptures and monuments
- Handcraft and historical building objects

The ARTAX™ is a portable system which can be set up on-site and be ready for use within 30 minutes. Just a standard mains connection is required to operate the device. This benefit allows the investigating engineer to install the device right next to the object under examination. This eliminates the need for expensive and risky transportation of large and valuable objects and also means that samples need not be taken.

The quick and easy functionality of the ARTAX is available by using the “Spectra” control and analysis software. All functions, from the precise positioning of the measuring head and image capture/processing, to actual analysis, are effectively combined with one another and are intuitive to use.

3.1 Main components

The ARTAX™ comprises of the following main components (see Fig. 6)

- measuring head with:
 - X-ray radiation source
 - detector
 - X-ray optics
 - CCD camera
 - laser pointer
 - collision sensor

- XYZ adjustment with swivel joint and warning light
- tripod with arm and floating arm
- electronics unit
- terminal
- measurement computer

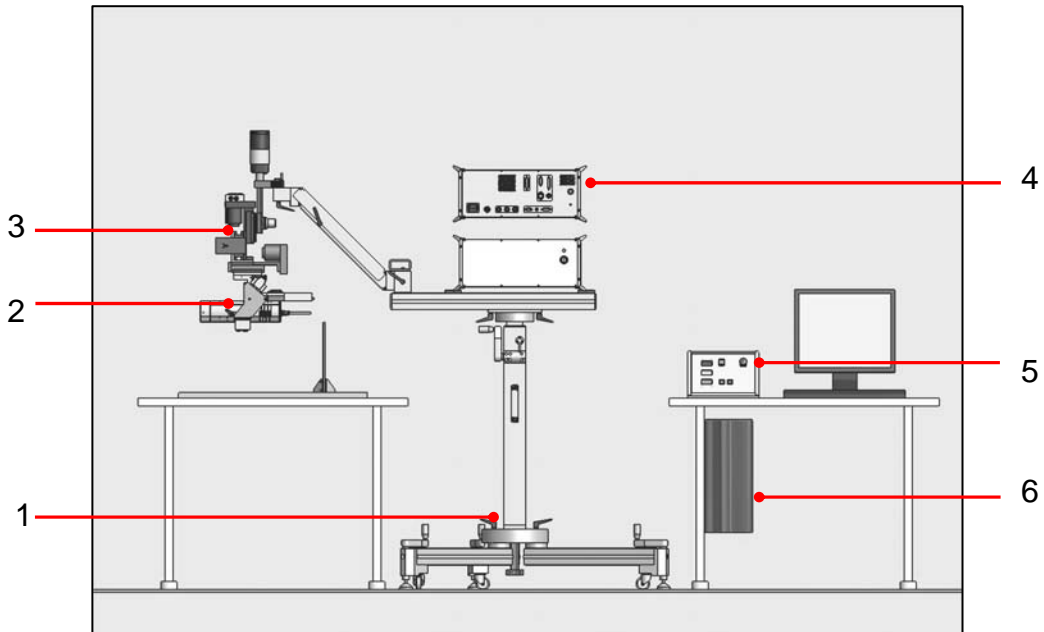


Fig. 6: ARTAX Main Components

- | | |
|--------------------|------------------------|
| 1 Tripod | 4 Electronics unit |
| 2 Measurement head | 5 Terminal |
| 3 XYZ adjustment | 6 Measurement computer |

3.2 Principle of operation

Depending on the X-ray optics used, the object to be examined is irradiated by a collimated X-ray beam between 200 and 1500 μm (ARTAX™ 200 and 400) or with a focussed X-ray beam of approx. 100 μm diameter (ARTAX™ 800). This high-energy radiation incites element-specific X-ray fluorescence radiation (Fig. 10) in the sample. The intensity of this characteristic radiation is a measure of the quantity of the respective element in the sample.

A cooled semi-conductor detector receives this characteristic X-ray radiation and converts it into current pulses which are amplified and digitised in the pre-amplifier and XSPV. The XDSP signal processor transfers the digital signals over the serial interface to the measurement computer where they are stored.

The monitor of the measurement computer can be used to display the pulse trains returned by the detector as an intensity/energy relationship, the spectrum. The software computes the relative element composition of the sample taking into account the excitation energy, the detector effectiveness and the spectral intensity distribution of the fluorescence lines.

The measuring head can be positioned using a 3-axis control unit with step motors, The software allows automatic measuring cycles along a specified line (line scan) or over an area (mapping) of up to 45 x 45 mm².

The principle of optical triangulation is used for the adjustment of the working distance between sample and measuring head (Fig. 7). The excitation beam and optical axis of the detector meet at the measuring point of the sample precisely when, in the video image, the cross-hairs meet the laser spot at the same measuring point of the sample.

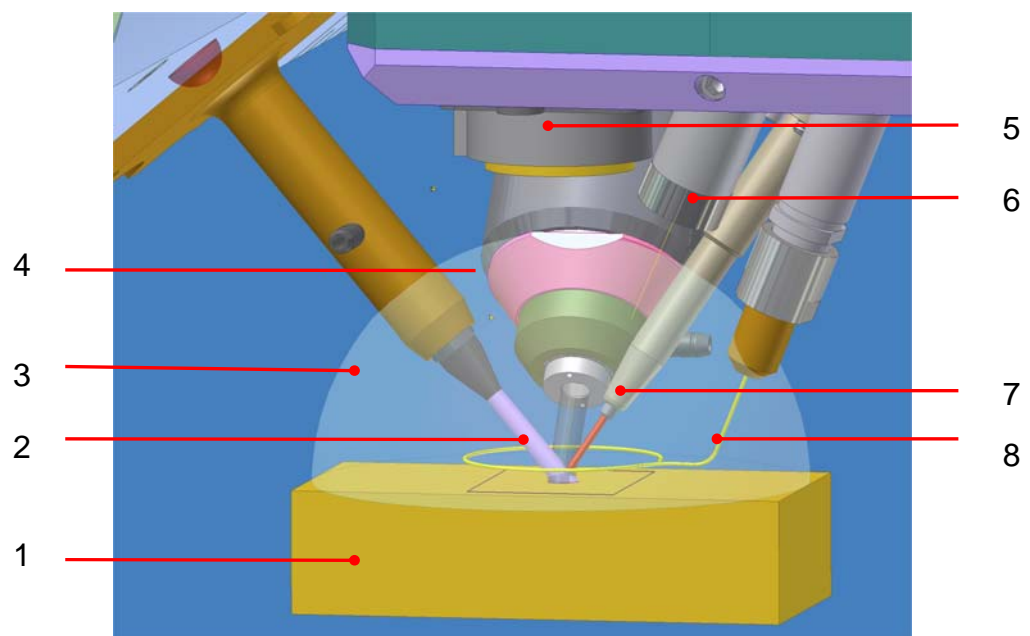


Fig. 7: Principle of operation of excitation and positioning

- | | |
|----------------------------------------------|---------------------------------|
| 1 Sample | 5 CCD camera |
| 2 X-ray excitation beam | 6 Sample lighting |
| 3 X-ray fluorescence and scattered radiation | 7 Laser pointer for positioning |
| 4 Radiation registered by detector | 8 Collision sensor |

3.3 Product variants

Differences in sample types, analytical issues and measurement conditions necessitate a varied array of device configurations.

Bruker AXS Microanalysis GmbH offers the ARTAX in three basic versions:

- ❑ ARTAX™ 200
 - Basis device with collimator optics, lightweight tripod and manual measuring head positioning

- ❑ ARTAX™ 400
 - universal device with collimator optics for mid lateral resolutions between 0.2mm and 1.5mm and step motor positioning

- ❑ ARTAX™ 800
 - Variant with focussed X-ray optics for lateral resolutions < 100 µm at high excitation intensity and step motor positioning

The difference between the ARTAX™ 400 and 800 measurement systems is just the excitation source. This comprises of one X-ray tube with housing and the appropriate X-ray optics.

Versions 400 and 800 can be interchanged in just a few minutes by exchanging the X-ray source.

The ARTAX™ 400 has a mini focus tube (1.2 x 0.1 mm²) with collimator optics. The X-ray beam on the sample has a diameter of between 200µm and 1500µm, depending on the collimator size. The collimators may be exchanged at will (see section 8.3.3).

The ARTAX™ 800 has a micro-focus tube (0.05 x 0.05 mm²) as the X-ray source and a polycapillary lens (filled with He) as focusing X-ray optics. The excitation spot has a diameter of 50 or 100µm on the surface of the sample, depending of lens type and photon energy. The high excitation intensity in a very small excitation volume is a considerable benefit when compared to collimator optics.

Both X-ray sources can also be fastened to the same measuring head by using a precision mechanism. This includes detector, sample lighting, collision sensor, laser pointer and CCD camera.

The manual positioning of the measuring head and the use of a considerably less heavy tripod are particular features of the ARTAX™ 200. An excitation source with polycapillary lens is not provided on the ARTAX™ 200 because of the limited stability.

All versions of the device can be supplied with various tube targets, depending on the analytical issues.

4 Technical details

Technical parameters:

Parameter	ARTAX 200	ARTAX 400	ARTAX 800
X-ray tube			
Type	Metal ceramic, air-cooled	Metal ceramic, air-cooled	Metal ceramic, air-cooled
Target	Mo, W, Rh, Cu	Mo, W, Rh, Cu	Mo, W, Rh, Cu
Focal spot	1.2 x 0.1 mm ²	1.2 x 0.1 mm ²	0.05 x 0.05 mm ²
Target angle	6°	6°	12°
Window	100 µm Be	100 µm Be	100 µm Be
max. HV	50 kV	50 kV	50 kV
max. current	1000 µA	1000 µA	600 µA
max. power	50 W	50 W	30 W
X-ray optics			
Type	Collimator	Collimator	Mini-lens, filled with He
lateral resolution [mm]	0.20 mm 0.65 mm 1.00 mm 1.50 mm	0.20 mm 0.65 mm 1.00 mm 1.50 mm	Varies with lens type: e.g. 75 µm for 15-20 keV
Gain	none	none	e.g. 2500 for 15-20 keV
Helium flush			
Type	none	Regulated via flow controller	Regulated via flow controller
Setting	none	via software	via software
Flush	none	Flush of collimator and flush of detector nozzle	Flush between lens and tube, lens and sample, detector nozzle and sample, lens He-filled
Detector			
Type	SDD, peltier cooled	SDD, peltier cooled	SDD, peltier cooled
Area	10 mm ²	10 mm ²	10 mm ²

Parameter	ARTAX 200	ARTAX 400	ARTAX 800
Resolution	<155 eV at 10 kcps	<155 eV at 10 kcps	<155 eV at 10 kcps
max. count rate	>100 kcps	>100 kcps	>100 kcps
CCD Camera			
Type	¼" CCD	¼" CCD	¼" CCD
Active pixel	500 x 582 PAL	500 x 582 PAL	500 x 582 PAL
Sensitivity	<0.5 Lux	<0.5 Lux	<0.5 Lux
Magnification (dependent on monitor)	approx. 20	approx. 20	approx. 20
Signal	Composite	Composite	Composite
Digitalisation	fire wire converter	fire wire converter	fire wire converter
Measuring head angle adjustment			
Type	manual	manual	manual
Range	0 .. 90°	-10° ...100°	-10° ...100°
Resolution	15°	6°	6°
XYZ positioning			
Type	manual	step motor	step motor
Range	Z pos. Manual linear drive ±18 mm, X,Y pos. via tripod	±22 mm	±22 mm
Resolution	50 µm	10 µm	10 µm

Tab. 5: Technical parameters of ARTAX™ 200, 400 and 800

Dimensions: Measuring head		
Length	mm	450
Length with cable	mm	500
Width	mm	150 (ver. 400) 200 (ver. 800)
Height	mm	230
Weight	kg	5.2
XYZ adjustment unit, ARTAX 400, 800		
Width (X)	mm	280
Depth (Y)	mm	265
Height (Z)	mm	325
Weight	kg	8,0
Elektronics unit		
Width (with handle)	mm	590
Height	mm	210
Depth	mm	345
Weight	kg	23,1
Transport box 1		
Length	mm	
Width	mm	
Depth	mm	
Total weight	kg	
Tripod, ARTAX 400 and 800		
Maximum working height: vertical	mm	1230
horizontal	mm	1650
Minimum working height: vertical	mm	450
horizontal	mm	870
Transport box: Length	mm	
Width	mm	
Height	mm	
Total weight	kg	65

ARTAX 200 tripod		
Maximum working height:		
vertical	mm	1130
horizontal	mm	1560
Minimum working height:		
vertical	mm	870
horizontal	mm	1300
Transport box:		
Length	mm	
Width	mm	
Height	mm	
Weight	kg	

Tab. 6: Dimensions and weights of ARTAX 200, 400 and 800

Connection values		
Voltage	V Hz	100–230 V ±10 % 50/60
Maximum power	W	300
Connection	Protective contact plug 1P+N+PE as per DIN 49441	
Operational conditions		
Ambient temperature	°C	10–30
relative humidity (non-condensing)	%	10–80
Ambient air	Free of corrosive vapours Free of large dust exposure	

Tab. 7: Connection values and operational conditions

5 Technical description

5.1 Overview of modules

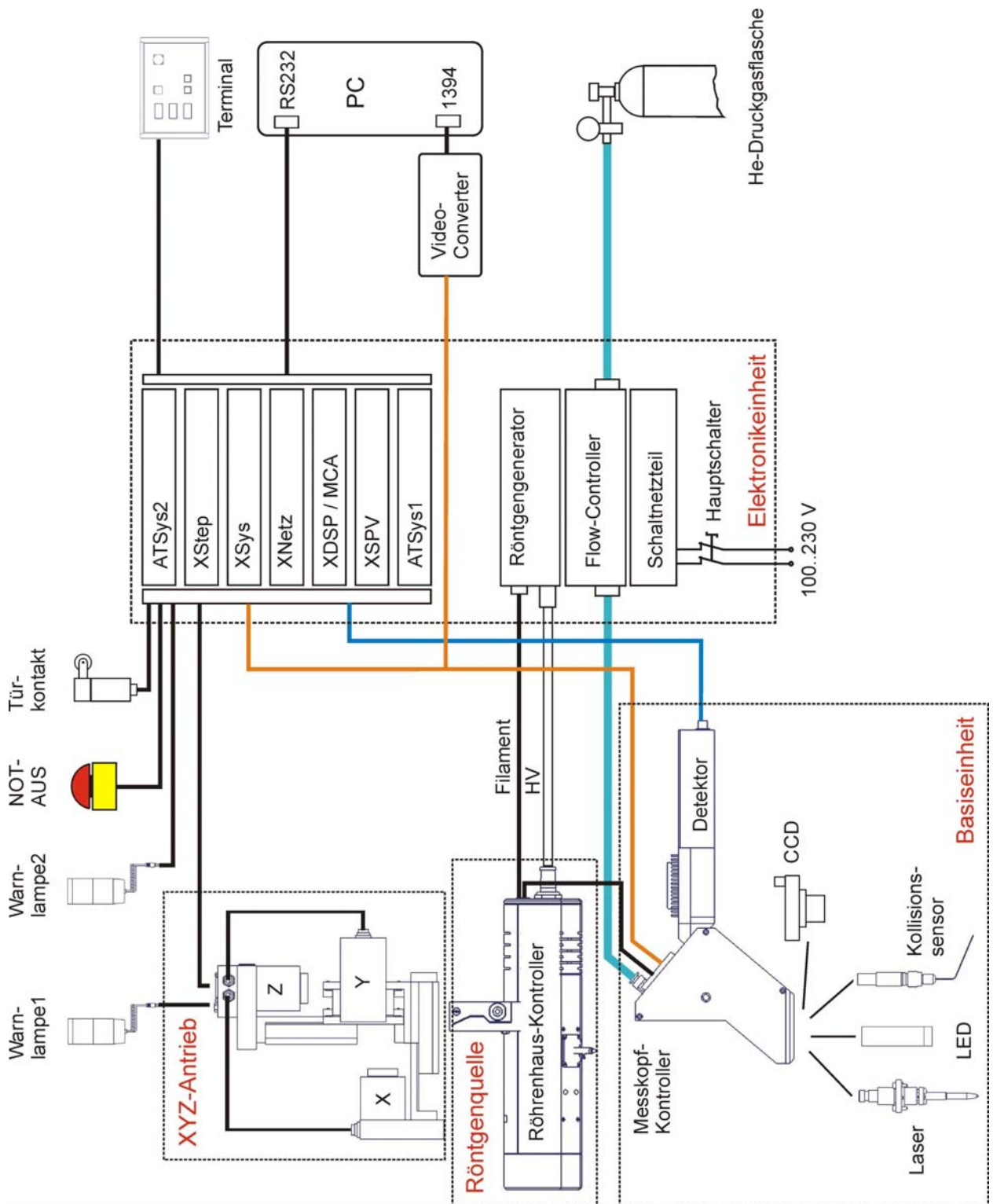


Fig. 8: Block diagram ARTAX without tripod

Fig. 8 shows the main block diagram of the device. The individual connections between the modules should clarify their functional relationship. This is not an electrical circuit diagram.

The device can be divided into the following main electronic modules:

- Electronics unit with
 - terminal
 - HV generator
 - flow controller
 - signal processing
 - security interface

- Base unit of measuring head with
 - measuring head controller
 - detector
 - CCD
 - collision sensor
 - LED
 - laser pointer

- X-ray radiation source with:
 - X-ray tube
 - X-ray housing controller

- Measurement computer with
 - video converter

- XYZ drive

- External security features such as
 - warning lamps
 - EMERGENCY STOP
 - door switch

5.2 Functional description

5.2.1 Electronics unit with terminal

The electronics unit comprises of the following sub-modules:

Pos. no.	Module	Function
1	Mains adapter	Conversion of mains voltage into the internal device voltages
2	Flow controller	Controller of the He flow
3	HV generator	Generation of the X-ray tube power supply
4	ATSys1	Machine protection switch, monitoring of external warning lamps and activation of flow controller,
5	XSPV	Spectroscopic signal amplifier
6	XDSP	Primary processor for measurement, control, regulation and communication
7	XNetz	Generation of all supply voltages for devices, temperature regulation of detector
8	XSys	Signal processing of limit switch XYZ
9	XStep	Step motor output for XYZ
10	ATSys2	Analysis of diverse safety contacts, analysis of shutter status, activation of high voltage generator and shutter, monitoring of warning lamps on tube housing and terminal.
11	Mains input	Connection to the local power supply
12	Key switch	Switch-on of mains voltage

Tab. 8: Electronics unit modules

The terminal is a freely positionable operator console with the most important control and display functions. It is usually positioned right next to the measurement computer on the workbench. Switching-on of the device and opening of the shutter are only possible from the terminal.

After turning the key switch, a low functional voltage is generated for the devices, supplying both the machine protection circuitry and the device fans.

This is indicated by the green control lamp on the front panel of the electronics unit and the lighting up of the "ON" button on the terminal. Voltage is applied to the rest of the electronics (via special safety relays) by pressing the ON button. This is indicated by "ON" being switched off and the lighting up of the "OFF" button .

Pos. no.	Module	Function
1	"POWER" (green)	ON when electronics switched on
2	"X-RAY" (yellow)	Lights up yellow when high voltage supply switched on
3	"BEAM" (red)	Lights up red if shutter is open
4	"ENABLE BEAM"	Must be pressed at same time as "START" software command to open shutter for measurement
5	"EMERGENCY STOP"	EMERGENCY STOP button with locking mechanism
6	"OFF"	Button for switching off operational voltage
7	"ON"	Button for switching on operational voltages

Tab. 9: Terminal controls

Pressing the "OFF" button isolates the electronic circuit from the functional low voltage. The Emergency Stop button at the terminal (or the external emergency stop button) can also be used for this. The electronic circuitry does not switch itself on again when the EMERGENCY STOP button is unlocked. This is only possible by pressing the "ON" button.

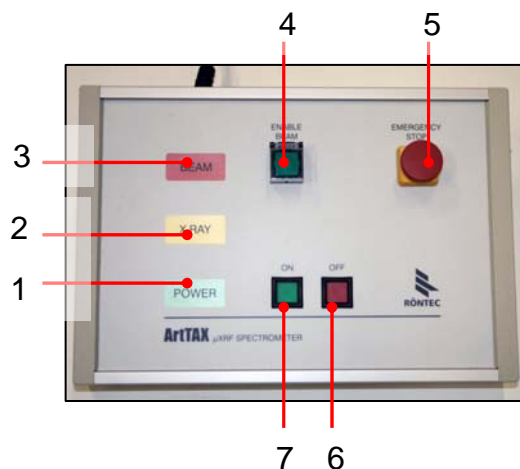


Fig. 9: Terminal, for description see Tab. 5

5.2.2 X-ray source

The X-ray source comprises of the following sub-modules:

Pos. no.	Module	Function
1	Tube housing	Mechanical integration of all components, Routing of cooling air, secondary X-ray protection
2	X-ray tube	X-ray radiation source
3	Tube and cooling element	Primary shield, heat dissipation, positioning of the tube
4	Shuttermodule	Release of the excitation beam during the measurement, shield
5	Filter slide	Modification of the excitation spectrum
6	Tube housing controller	Temperature regulation, transfer of operating parameters
7	Fans	Cooling of the X-ray tube
8	Mechanical interface	Attachment and positioning of the X-ray source on the base block
9	Warning lamps	Display of operational status
10	X-ray optics	Definition of beam geometry

Tab. 10: X-ray source modules

The ability to change the X-ray source on the ARTAX™ is one of its key benefits. There is a distinction between two basic versions of excitation source, both defining a basic configuration of the ARTAX™.

ARTAX™ 400:

- A mini-focus tube is used for the X-ray tube.
- the X-ray beam is restricted by a collimator.
- The X-ray beam on the surface of the sample has a diameter between 200 µm and 1500 µm, depending on the type of collimator used.

ARTAX™ 800:

- a micro-focus tube is used for the X-ray tube.
- A focussed X-ray mini-lens is positioned between the X-ray tube and the sample and is filled with Helium.
- The excitation X-ray beam on the surface of the sample has a diameter between 60µm and 100µm, depending on the mini-lens used.

ARTAX™ versions 200 and 400 have the same excitation type.

The monitoring of all important operational parameters by an internal control module is one of innovative features of the X-ray source. All important X-ray source parameters are stored in the memory area of this controller. After the X-ray source is connected to the base block of the measuring head, these parameters are automatically read out by the control software and used during operation of the X-ray tube. The following parameters are monitored/read out.

- max. high voltage
- max. power
- current/voltage characteristic curve
- target temperature
- target material
- serial no.
- operational hours
- date of manufacture
- X-ray optics

The controller monitors the operational temperature of the X-ray tube and regulates the cooling air during operation.

In order to improve excitation conditions for elements with lower fluorescence energy, the excitation beam channel can be flushed with helium. With collimator optics, the beam channel is flushed over the collimator holder. With lens optics, flushing is in front of and behind the lens. The lens itself is encapsulated and filled with He. The connection of the He flush on the X-ray housing is automatic via the mechanical interface.

Filter slide

X-ray tubes emit a polychromatic beam whose spectral characteristics are determined primarily by the element of the X-ray target and the value of the high voltage present. After the interaction of the X-ray radiation with the object under examination, the spectrum registered contains not only the sample specific fluorescence radiation, but also a considerable share of scattered primary radiation.

Whilst the fluorescence radiation contains the interesting information on the constitution of the sample, the scattered excitation radiation is generally a disturbance signal. Monochromatisation of the excitation radiation – suppression of particular ranges within the excitation spectrum - is one way of suppressing this effect.

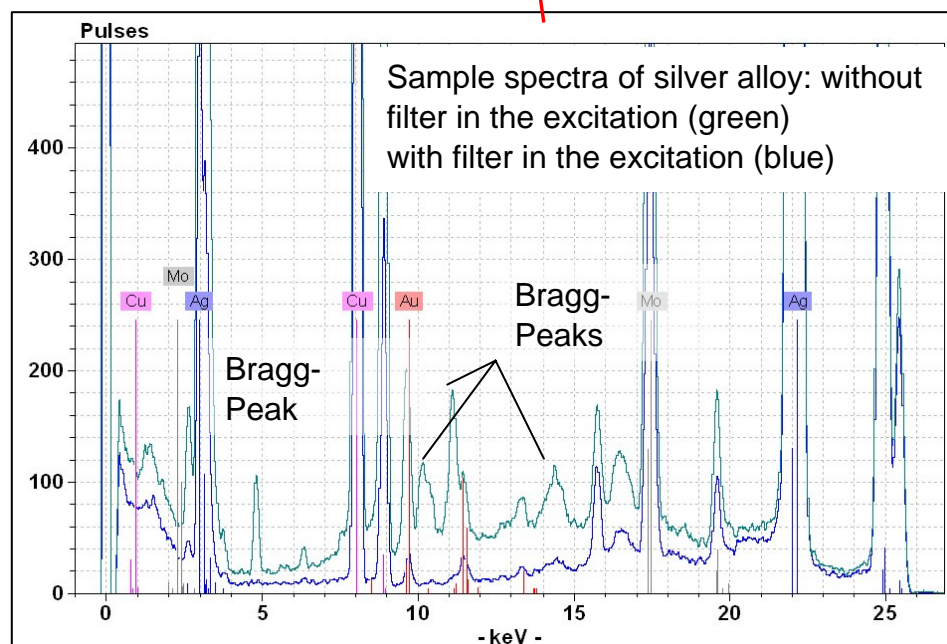
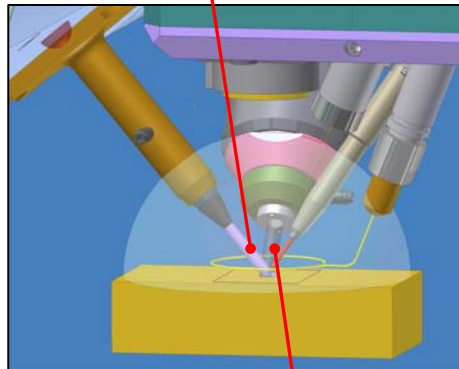
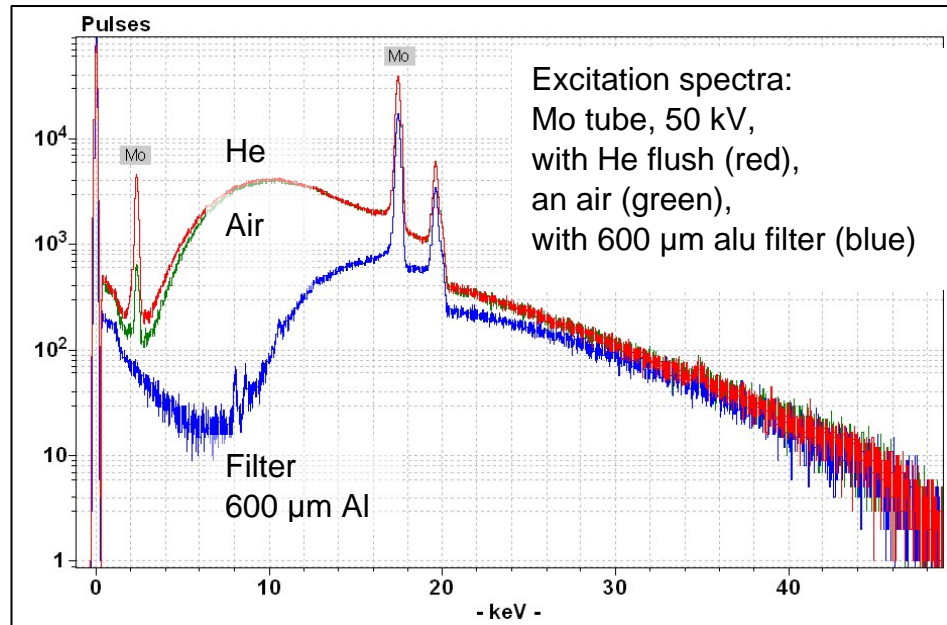


Fig. 10: Effect of an excitation filter

Filters made of thin metal foil are used for this purpose. These filters absorb certain low-energetic ranges or emission lines of the excitation spectrum.

Fig. 10 shows various excitation spectra of a Mo X-ray tube in the upper section. It is apparent as to how the He flush clearly improves the transmission of the Mo-L line and how an AL filter contributes to a weakening of a low-energetic part of the excitation spectra. Therefore filters always have the effect of a reduction of the subsurface in the spectrum. At the same time, a filter means the reduction of the excitation intensity and hence a lowering of the fluorescence intensity.

The lower part of Fig. 10 illustrates the effect of an Al filter (in the excitation radiation channel) on the measured spectrum of a silver alloy. Many Bragg peaks are seen in the sample spectrum without a filter. The cause of these lies in an energy selective reflection of the excitation radiation at micro-crystalline ranges of the silver sample. If the corresponding ranges are removed from the excitation spectrum of the X-ray source, they can not be reflected (blue spectrum).

The ARTAX™ has an exchangeable filter slide with three positions. Position 1 is usually empty. Positions 2 and 3 are occupied with metal foil of different thicknesses. The filter changer has three distinct rest positions for precise positioning. The selection of the right filter is dependent on the respective analytical task and the device configuration available. A basic set of filters, synchronized to the excitation source, is included in the delivery of the device. Other filter types can be ordered on request or configured yourself.

Operational mode

In normal mode the X-ray tube always operates with the operational parameters set. A shutter keeps the tube housing closed if no measuring process is running, guaranteeing radiation protection. The shutter is opened at the start of a measurement and the X-ray radiation used for excitation arrives through the X-rays optics onto the sample. Characteristic X-ray radiation emerges in the excited sample volumes which is emitted in all directions from the sample and is registered by the detector (see Fig. 7).

**NOTE**

At maximum tube power, the mini lens in the ARTAX™ 800 is aligned to the state of thermal equilibrium. The intensity and spectral distribution of the excitation radiation emitted from the lens is dependent on the alignment. A running-in period for the tube, 80% full load for at least 30 mins., is required to attain reproducible values.

**NOTE**

The prerequisite for attaining good local resolution is the observance of the distance of the sample/measuring head to the object. This means a positioning distance in a range of optimal value ± 0.1 mm.

5.2.3 X-ray detector

The characteristic X-ray radiation emitted by the sample is passed to a semiconductor detector which works according to the drift chamber principle (SDD) (see Fig. 11).

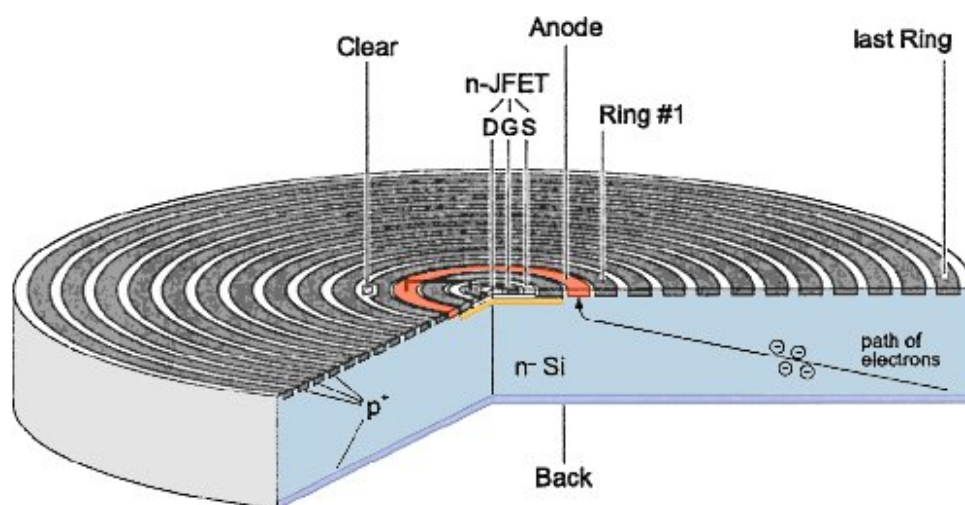


Fig. 11: Cross-section through an SDD X-ray detector

Each X-ray quantum in the active volume of the detector generates a charge carrier cloud which is fed to an electrode through an internal high voltage field where it generates a burst (see Fig. 12) his pulse is amplified by a pre-amplifier and passed on to the digital signal processor by the XSPV spectroscopic amplifier.

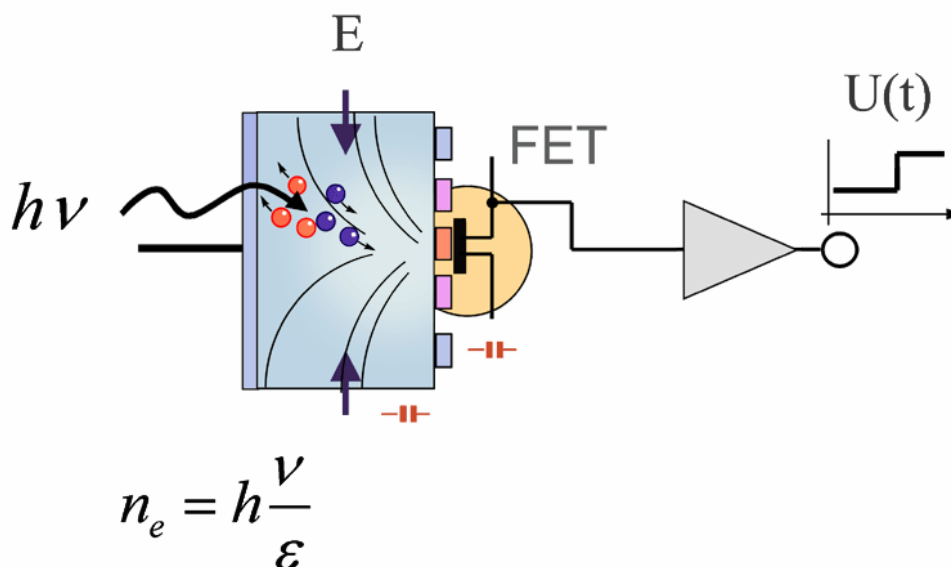


Fig. 12: Mode of operation of an SDD-X-ray detector

The digital output signals are processed further by the XDSP digital signal processor, combined into complete spectra and passed on to the measurement computer over the RS-232 interface.

The semi-conductor detector is cooled electro-thermally so as to minimize noise. The Xnetz module is used for the provision of the auxiliary voltages and the regulation of the cooling regime.



NOTE

The energy channel calibration of the measured spectra of the ARTAX is stable over a long period of time.

But the detector and the sensitive input stages of the signal electronics require a certain time after power-on to reach a stable thermal equilibrium which impacts this energy channel calibration. Maintaining a running-in period of at least 30 min. for the electronic circuitry with detector connected is recommended prior to a measurement.

The area between the surface of the sample and the beryllium inflow window of the detector can be flushed with helium (He) if required. This reduces considerably the absorption of the low-energetic X-ray fluorescence radiation in the detection radiation channel. The detection sensitivity for elements Na to Cl can be increased considerably this way .

5.2.4 Measuring head

The measuring head is the central functional component of the ARTAX™. In addition to the detector described in section 5.2.3, the measuring head includes the following components:

- CCD camera
- laser pointer
- collision sensor
- sample lighting
- mechanical and electrical interface to the tube housing
- measuring head controller
- signal interface to the electronics unit

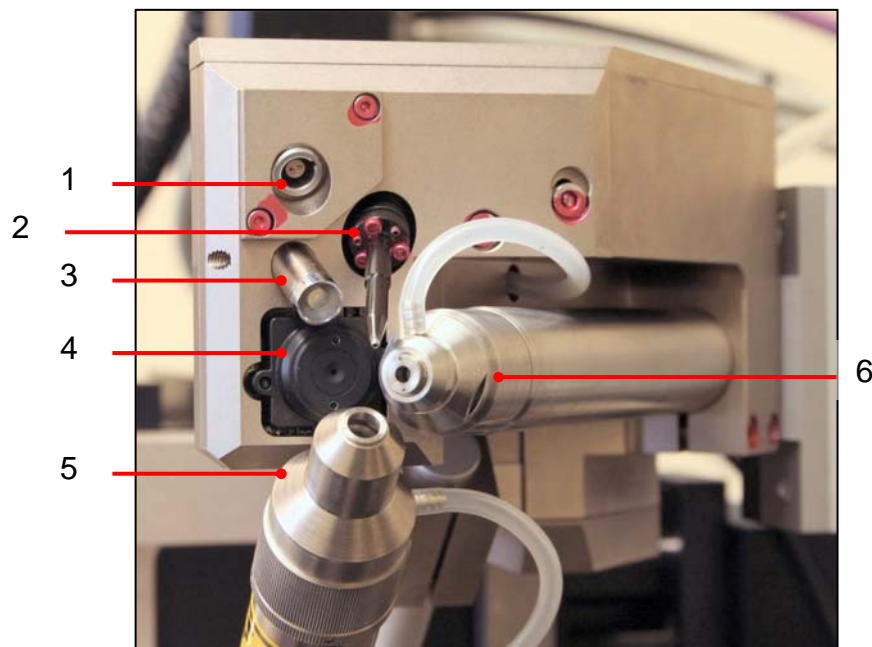


Fig. 13: Component configuration on the measuring head

- | | | | |
|---|-----------------------------|---|----------------------------|
| 1 | Collision sensor connection | 4 | CCD camera |
| 2 | Laser pointer | 5 | X-ray optics with He flush |
| 3 | Sample lighting | 6 | Detector with He flush |

Fig. 13 shows the most important components at the front section of the measuring head. In addition to the numerous signal and control functions, the measuring head is also mainly used for the correct positioning of all components relative to each other. The measuring head controller is located in the measuring head housing.

This is used for communication with the controller of the X-ray radiation source, the electronics unit and the control unit for the laser pointer and sample lighting.

A CCD camera is used for visualising the sample and has two main tasks in the measuring process. Firstly, it is used for the optical analysis of the sample and the selection of the measuring point. Secondly, and in conjunction with a laser spot and crosshairs on the video display, it allows the reproducible settings of the measuring distance.

The CCD camera on the ARTAX™ generates an analogue composite video signal which is digitised by a Fire-wire converter and read into the measurement computer.

The camera displays an area of approx. 12 x 6 mm² of the sample surface on the measurement computer monitor. A magnification factor of around 20 is possible on a 19" TFT display with 100% scaling of the video image. This factor can vary depending on the display type and the pixel resolution setting.

The measuring head has an additional sample light (in the form of a white-light LED) for optimisation of the display conditions. The lighting intensity can be adjusted using a regulator in the Spectra software. Since the camera has automatic gain control, higher lighting intensity does not automatically mean higher picture brightness. The video image functions of the Spectra software can be used to make real-time changes in brightness, contrast and colour saturation.

The exact distance between measuring head and surface of the sample is reached once the middle of the red laser positioning spot on the surface of the sample is congruent with the crosshairs of the video image on the monitor.

Crosshairs and laser sport can be made congruent by changing the distance between sample and measuring head.



NOTE

Crosshairs and laser spot only appear on the sample area excited by the X-ray beam if they cover each other in the video image!

The camera lens is set such that the centre of the image is in focus with the correct sample distance .

As with the sample lighting, the intensity of the red laser spot is adjustable using the appropriate regulator in the video image of the Spectra software.

5.2.5 Collision sensor

The intended use of the ARTAX™ entails the analysis of extremely valuable objects. The primary danger for such objects under examination is the collision of the measuring head with the surface of the sample.



CAUTION

During the positioning of the measuring head with the XYZ drive, the user of the device is to maintain visual contact with the object under examination.

The measuring head of the ARTAX has been fitted with a collision sensor 1>(see Fig. 14) so as to prevent potential damage to the sample. The use of this sensor is optional. It can be easily connected/disconnected via the plug connector in the base unit. The presence of the collision sensor is detected by the electronic circuitry. An appropriate warning is display if no sensor is detected on starting the software. The user of the device then has the option of connecting the sensor or to carry on without this "safety net".



Fig. 14: Collision sensor

The collision sensor comprises of a feeling sensor in the form of a wire loop and a contactor. The collision sensor works in all directions, albeit with varying sensitivity. A bending of the sensing device by 2 ..5mm results in an EMERGENCY STOP of the step motor drive.



CAUTION

A minimum force is required to activate the collision sensor. Particularly sensitive or very small objects may be damaged by the collision sensor.

After an EMERGENCY STOP, the collision sensor must be released manually by moving the sample or measuring head. The axes can be used again afterwards.



NOTE

Following an EMERGENCY STOP, another reference run of the XYZ axes must be carried out.

5.2.6 EMERGENCY STOP button and door switch

The safety concept of the ARTAX™ makes provision for an (optionally) freely positionable EMERGENCY STOP button and a door switch. Two connectors are provided on the rear panel of the electronics unit. If safety devices are not installed, they must be replaced with appropriate dummy connectors (supplied).

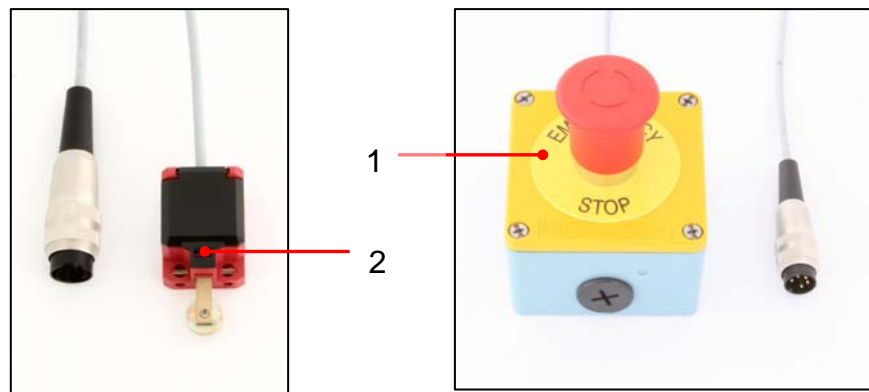


Fig. 15: EMERGENCY STOP button and door switch

- 1 EMERGENCY STOP ("Emergency Stop") button
- 2 Door switch

The two safety switches differ in their mode of operation. The optional EMERGENCY STOP button has the same function as the EMERGENCY STOP button on the terminal. Pressing it isolates the low voltage from the electrical components. The fans in the electronic housing and the connection of the primary power adapter to the mains supply are not affected.

The EMERGENCY STOP button is locked when pressed. The button can be unlocked by turning it anti-clockwise.

After the dangerous situation has been cleared, the electronics need to be re-started from the terminal and the software needs to be re-started.

The door switch is typically used in stationary operation of the device in a separate laboratory room. It can then be used for access monitoring of the restricted access area.

**NOTE**

The functionality of the door switch must be activated in the device configuration file by the manufacturer.

The particular feature of the door switch is that it is only effective in one particular danger situation. If the door is opened during a measurement, the shutter is closed. The door can be opened without any problem if the shutter is closed.

**DANGER**

The door switch function has no control over whether a person is inside or outside the restricted area.

Prior to every measurement, a check must be made to see whether there is anybody in the restricted area.

5.2.7 XYZ drive mechanism and swivel joint

A special feature of the ARTAX™ 400 and 800 is the extremely easy positioning of the measuring head using a motorized XYZ drive mechanism.

The linear slides are based on a sliding bearing guide with spindle drive. The step motor drives are connected to the spindle shaft via a gearing mechanism so as to achieve both the necessary torque and a sufficient enough resolution. The dimensions of the drive mechanism are such that, in every position of the measuring head, it can absorb the resulting forces and can position the analysis spot precisely.

The relative positioning accuracy of the axes is 0.01mm. The absolute positioning accuracy is largely dependent on the stability of the tripod base and any potential vibration. The design necessitates reversal play for the linear drive mechanisms, i.e. after a change of direction of the step motors, the directional change of the linear slides does not take effect until after a delay. With scans and mappings, this effect is accounted for and compensated for in software.

The basic requirement for the function of step drive is a reference run of all axes after starting the software. Using this procedure, the zero position of the axes is determined by a run of the slide against a micro-switch in the reference position.

The positioning mechanism of the ARTAX™ 400 and 800 has a manually adjustable swivel joint. Using this mechanism, the measuring head can, together with the XYZ drive mechanism, be adjusted in increments of 6° between a vertical and horizontal measurement position.

The ARTAX™ 200 has a considerably simpler positioning mechanism. A manual linear slide is used for setting the distance to the sample. The resolution is better than 50µm.

The swivel joint on the measuring head of the ARTAX™ 200 allows adjustment in increments of 15° between vertical and horizontal measuring position.

5.2.8 Gas flushing

On the ARTAX™, the weakening of the X-ray radiation by air absorption can be considerably reduced with a He atmosphere. Without this procedure, analysis of elements with lower atomic numbers is practically impossible.

The following distances must be flushed with helium during the measurement:

- between X-ray emission window and X-ray optics
- between X-ray optics and surface of sample
- between surface of sample and detector



NOTE

For effective light element excitation, there must be an empty filter slide in the excitation radiation channel.

With collimator optics on the ARTAX 200 and 400, the beam channel is flushed above the collimator holder. With lens optics on the ARTAX 800, flushing is in front of and behind the lens. The lens itself is encapsulated and filled with He. The connection of the He flush on the X-ray housing is automatic via the mechanical interface on the basis unit of the measuring head.

The X-ray detector on the ARTAX has a specially shaped nozzle (see Fig. 13) with He connector for the flushing of the detector beam channel.

The user of the device assumes responsible for the provision of the He gas supply. Fig. 16 shows a typical configuration using a compressed gas cylinder. It is beneficial to have two separate manometers for the display of the cylinder pressure and the pre-pressure at the connection of the supply line. This can be set with the adjusting screw on the pressure regulator.

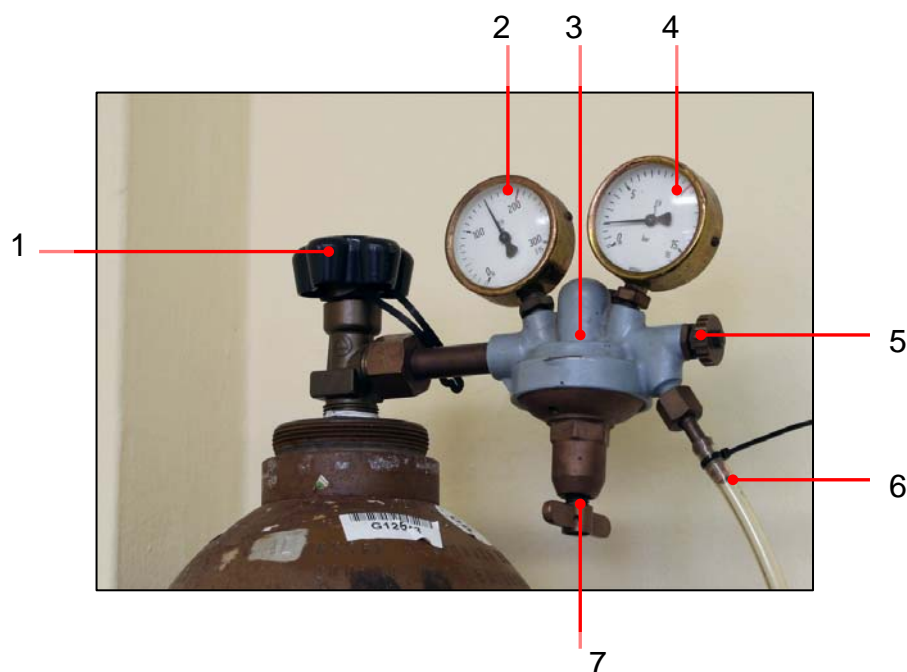


Fig. 16: Helium cylinder with connection components for helium flush

- | | |
|------------------------------------|-------------------------------------------|
| 1. Hand-wheel on cylinder valve | 5. Shut-off valve |
| 2. Manometer for cylinder pressure | 6. He connection line to electronics unit |
| 3. Pressure regulator | 7. Thumbwheel on pressure regulator |
| 4. Manometer for pre-pressure | |

The flow controller for control and regulation of the gas flow is inside the electronics unit (see Fig. 8).

A flexible hose is used to connect the gas supply to the "He inlet" on the rear side of the electronics unit. The "He gas outlet" is connected to the measuring head.



CAUTION

The input pressure at the flow controller of the electronics unit must not exceed **5 bar**.

The "Gas flush" option is selected from the "Atmosphere" dialogue in the software. Afterwards, at the start of a measurement, the flushing option is opened up and a flow rate of approx. 1.5 l/min is set. To guarantee sufficient gas saturation, the measurement starts with a slight time delay in opening the valve. If the flow falls below the target value as a result of e.g. an empty gas cylinder, an error message is generated and the measurement is aborted.



NOTE

All gas cylinder connections, along with the connections on the electronics unit and the measuring head, should be inspected for correct fit and tightness after transportation and assembly of the ARTAX

5.2.9 Measurement computer and video converter

Standard PCs or notebooks running the Windows XP operating system are used as measurement computers. The use of computers tested and supplied by Bruker AXS Microanalysis is strongly recommended since this is the only way functional reliability is guaranteed.

The "Spectra" software package is used for data exchange, control of devices and analysis/visualisation of spectra. There are two communication paths between the measurement computer and the device. A serial interface is used for the control of the devices and for data exchange. The video signal of the CCD camera is mapped onto the Firewire interface of the PCs by the external video converter.

5.2.10 Tripod for ARTAX™ 400 and 800

Fig. 17 shows the tripod for versions 400 and 800. Assembly and operating instructions are detailed in sections 7 and 8.

The tripod has been designed in such a way so as to offer a maximum degree of flexibility in positioning whilst attaining a very high level of damping against vibration.

In addition to being able to transport the tripod over a long distance using the rollers, a total of 5 different axes and directions is available for positioning (see Fig. 17).



CAUTION

After being moved, the tripod support and floating arm must be secured using the appropriate retainers.

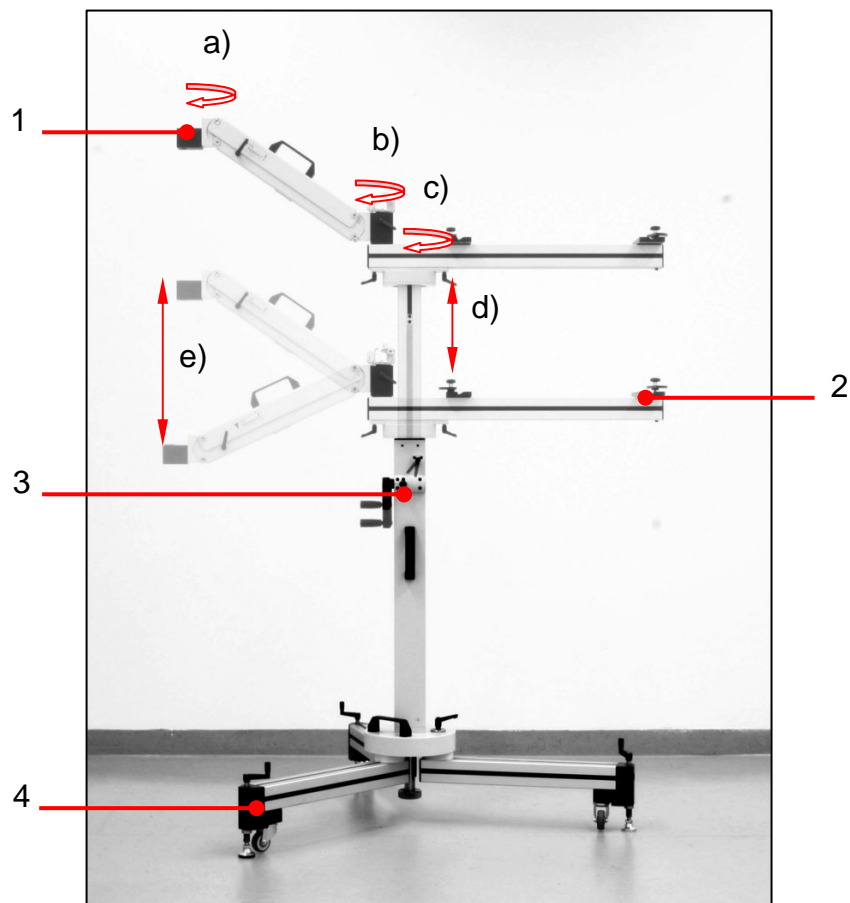


Fig. 17: Tripod components and axes for ARTAX™ 400 and 800

- | | |
|------------------------------------------|-------------------------------------------|
| 1 Floating arm | a) Rotation axis of XYZ mounting |
| 2 Cantilever | b) Rotation axis of floating arms |
| 3 Tripod support with crank | c) Rotation axis of cantilever |
| 4 Tripod foot with rollers and retainers | d) Telescopic extension of tripod support |
| | e) Vertical adjustment of floating arm |

5.2.11 Tripod for ARTAX™ 200

Fig. 18 shows the tripod for the ARTAX 200. This tripod has been designed for maximum mobility - in contrast to maximum convenience for versions 400 and 800.

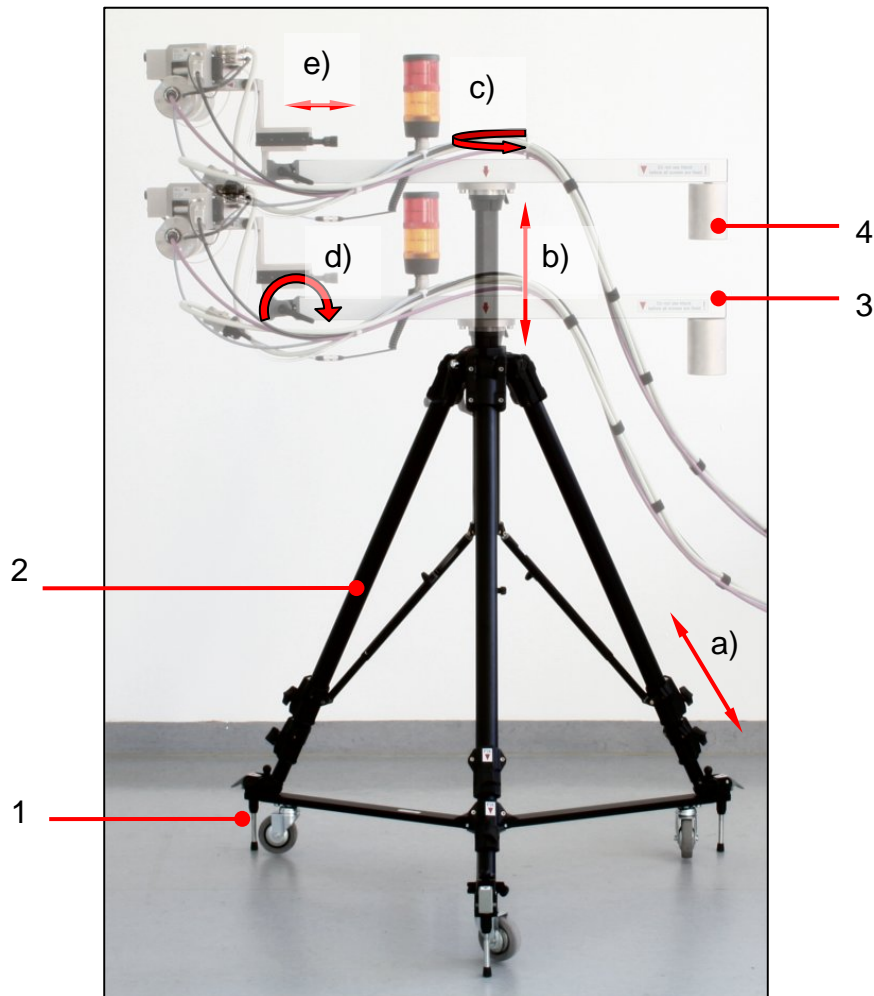


Fig. 18: Components and axes for the ARTAX™ 200 tripod

- | | |
|------------------------------------------|-----------------------------------------|
| 1 Tripod foot with rollers and retainers | a) Telescopic extensions of tripod legs |
| 2 Tripod | b) Telescopic extensions of tripod |
| 3 Cantilever | c) Rotation axis of cantilever |
| 4 Counterweight | d) Rotation axis of swivel joint |
| | e) e manual Z adjustment |



CAUTION

Because of its low weight, the ARTAX™ 200 tripod does not have the same inherent stability as the heavy tripod of the ARTAX™ 400 and 800. Furthermore, the high degree of positioning flexibility of this tripod represents an additional risk. Special care must therefore be taken when setting up this tripod.

5.3 Connections

5.3.1 Mains supply and auxiliary supplies

The ARTAX™ runs off a mains supply of 100 ... 230 V~, max. 300VA. A low voltage is generated in an internal switching power supply.

All other components are either supplied directly, via the backplane or via the auxiliary voltage supply of the X-Netz component.

The X-Netz component also includes the temperature regulation for the semi-conductor detector.

5.3.2 Connections on measurement computer

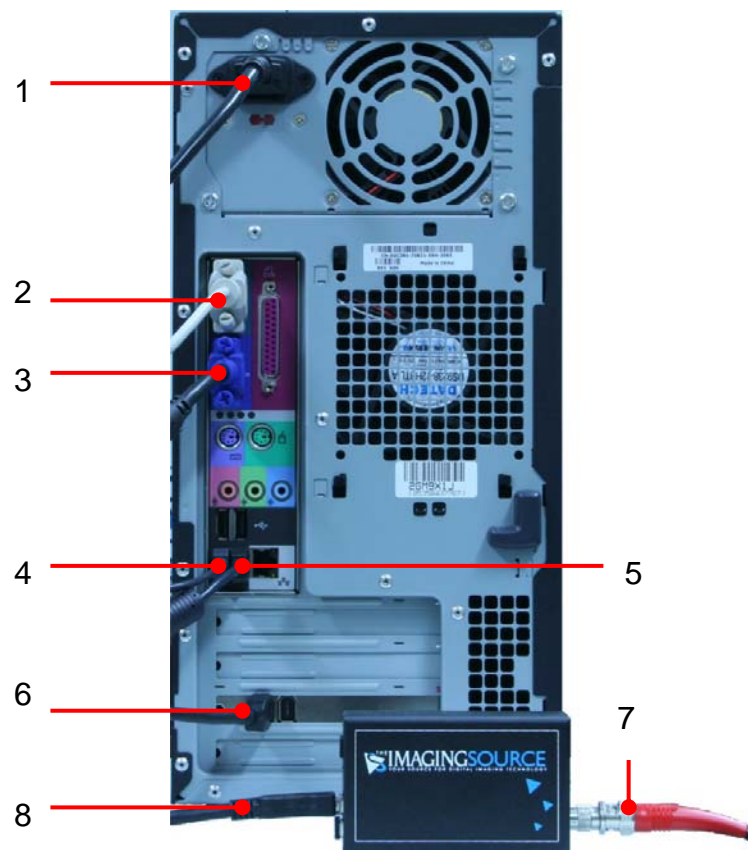


Fig. 19: Connections on measurement computer

Pos. no.	Connection	Function/components
1	Mains connector	Measurement computer mains connector
2	RS-232 "COM1" interface	Device control and data exchange
3	Monitor	Video signal for TFT display
4	Mouse	USB connector for mouse
5	Keyboard	USB connector for keyboard
6	Fire Wire (1394)	Fire Wire input, measurement computer
7	Video	Video signal input of video converter
8	Fire Wire (1394)	Fire Wire output of video converter

Tab. 11: Connections on measurement computer

5.3.3 Connections on electronics unit

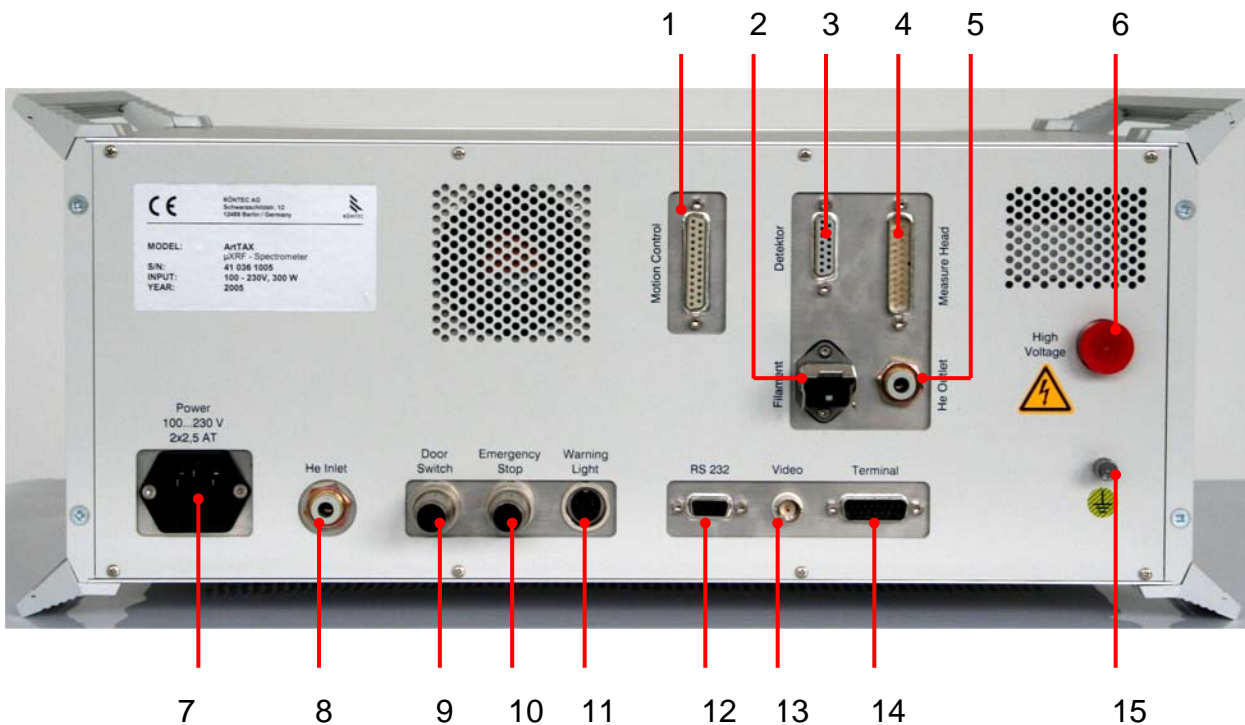


Fig. 20: Connections on electronics unit

Pos. no.	Connection	Function/components
1	Motion Control	Step motor signals for XYZ, "Beam" and "X-ray" signal for warning lamp on measuring head
2	Filament	X-ray tube cathode connection
3	Detector	Pre-power supplies for detector and peltier cooler Transfer of spectroscopic signals between electrical unit and measuring head
4	Measure Head	Communication with tube housing and measuring head controller, interlock signals for X-ray housing, video signal, operational voltages
5	He outlet	He connection to measuring head
6	High voltage	X-ray tube high voltage connections
7	Power	Mains connection (100...230V) Fuse sockets for mains connection
8	He inlet	He connection to supply cylinder
9	Door switch	Door contact connection
10	Emergency stop	Connection for the EMERGENCY STOP button
11	Warning light	Connection for 2 nd warning lamp
12	RS-232	Transmission of spectrum and actual measurement values from XDSP to the measurement computer Accepting of target values for the X-ray control unit and control of the measurement process
13	Video	Video signal for frame grabber or Fire Wire video converter
14	Terminal	Terminal connection, Power ON/OFF of electronics unit, EMERGENCY STOP , warning lamps, Verification for shutter opening
15	Ground	Additional connection for ground potential

Tab. 12: Connections on electronics unit

5.3.4 Connections on XYZ stage unit

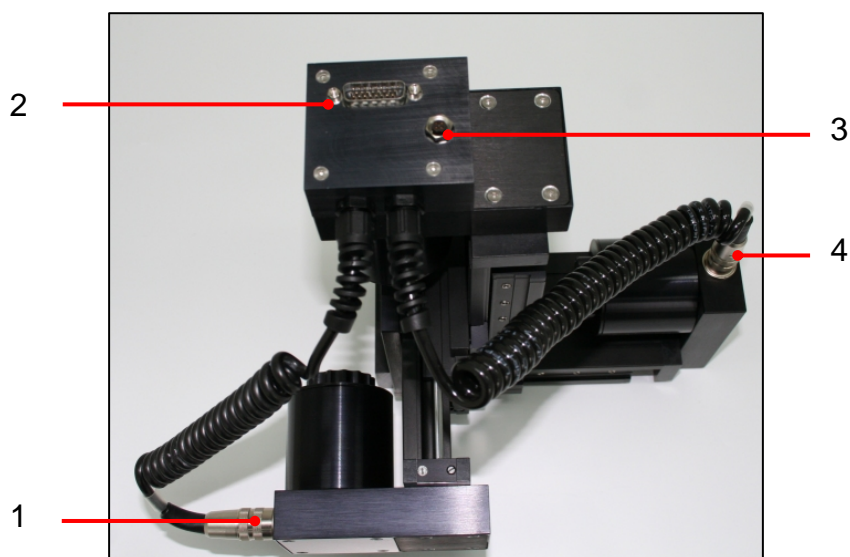


Fig. 21: Connections on XYZ stage unit

Pos. no.	Connection	Function/components
1	Y-axis pin-and-socket connector	Connection to distributor for Y-axis
2	Primary connector on distributor box of "XYZ" adjustment unit	Electronics unit step motor control to "XYZ" adjustment unit, "Beam" and "X-ray" signal for warning lamp 1
3	Warning lamp connector	Warning lamp connector for "Beam" and "X-ray"
4	Connector for X-axis	Connection to distributor box for X-axis

Tab. 13: Connections on the XYZ unit

5.3.5 Connections on the measuring head

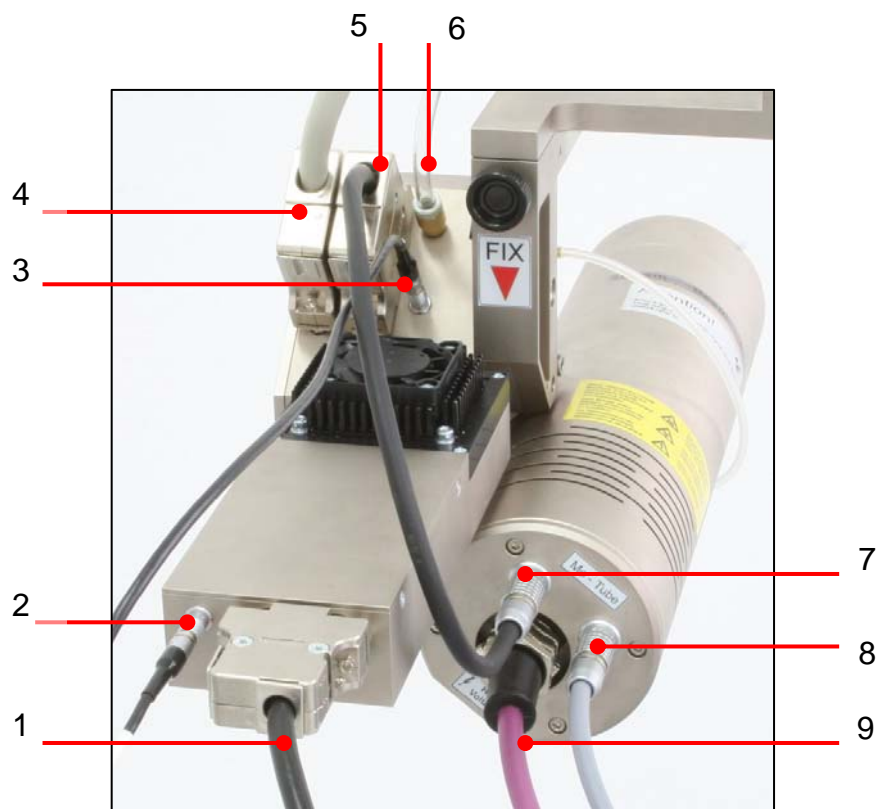


Fig. 22: Connections on the measuring head

Pos. no.	Connection	Function/components
1	Detector	Detector signals and operation voltages
2 and 3	Detector fan	Power supply for detector fan
4	Connector A,	Connection to the "Measure Head" connector of the electronics unit, Signals from and for CDD, laser pointer, lighting, controllers
5 and 7	Connector B	X-ray housing connector, warning lamps, fuse contacts
6	He	He connector, comes from "He Outlet" connector on electronics unit
8	Filament	X-ray tube cathode supply
9	HV	X-ray tube high voltage connection NOT DETACHABLE!

Tab. 14: Connections on measuring head

5.4 Software device specification

The operation of the ARTAX™ is based upon the universal “Spectra” software. The “Spectra” software incorporates all the functionality for the following 3 device systems from Bruker AXS Microanalysis:

- ARTAX
- PICOFOX
- CrysoTAX

The 3 different device systems are summarised in the “Spectra Program Description” universal handbook.

A device specific configuration file is generated for each installation of one of the 3 device systems. This configuration file defines the customer-specific appearance of the software. This means that only that functionality which has any significance for the intended application is generated and displayed. The naming of the software in the measurement computer and the functionality are device-specific. The underlying program is, however, always the same.

Please refer to the "Spectra Program Description" chapter for more detailed information.

6 Transportation



DANGER

Danger of injury from falling transport boxes.

The total gross weight of the individual transport boxes currently exceeds 25kg. For this reason, transport boxes must be picked up and carried by 2 persons.



CAUTION

Danger of device damage as a result of improper handling, low temperatures and moisture.

Great care must be taken during transportation. The device must not be subject to high levels of vibration or shock. The device is to be protected from moisture and temperatures below -10°C during transportation and storage.

The ARTAX™ is supplied in at least 2 packaging units :

- Transport box with tripod
- Transport box with measuring head, XYZ adjustment unit and electronics unit

The transport boxes also contain the accessories included as part of the supply (see Appendix **Fehler! Verweisquelle konnte nicht gefunden werden.**).

7 Assembly

7.1 Unpacking and setting up components

**DANGER**

Danger of injury from X-ray radiation.

Direct exposure to X-ray radiation emitted by the ARTAX™ during a measurement can result in considerable short-term damage to biological tissue and bone material. Exposure to smaller doses over a long period results in increased risk of cancer. For this reason, all of the safety requirements described in section 2.3 regarding the set-up of the equipment are to be observed strictly at all times.

**DANGER**

Danger of injury from X-ray radiation.

After every deployment of the ARTAX™, the radiation load when the shutter is closed must be checked with a radiation protection device (sensitivity 10 KeV upwards). The measurement is to be made in all directions in space at a clearance of 10cm from the touchable surface of the measuring head. The value of the local dose must not exceed 7.5 µSv/h. If this value is exceeded, the device must be taken out of service immediately and the manufacturer informed.

**DANGER**

Danger of injury from X-ray radiation.

Adequate protection measures must be taken when setting up the ARTAX™, e.g. provision of a radiation screen to effectively protect personnel from primary and scattered radiation load.

The ARTAX™ is a laboratory device and intended for use within closed, temperature-maintained rooms. To achieve good measurement results, a natural light source and uniform illumination of rooms is advisable. Setting up the device near the sample so as to avoid long positioning runs is recommended.

ARTAX™ components are unpacked in sequence from the transport boxes and set up. The tripod is assembled first. Then the electronics and XYZ adjustment units are mounted onto the tripod. The measuring head is then attached to the XYZ adjustment unit. The measurement computer is set up separately and at a minimum distance of 2 metres away from the X-ray source.

**CAUTION**

Danger of damage to the device components.

When unpacking, all ARTAX components are to be placed on suitable underlays and be prevented from falling down or rolling.

7.2 Assembling tripod for ARTAX™ 400 and 800

1. Open tripod transport box, remove components one at a time and lay them down carefully.



NOTE

To prevent the tripod foot from rolling when attaching the tripod support, it is useful to fix the tripod feet to the underlay using the appropriate crank.

2. Undo retainer on the tripod foot , open up tripod foot and secure with cranks (see Fig. 23).

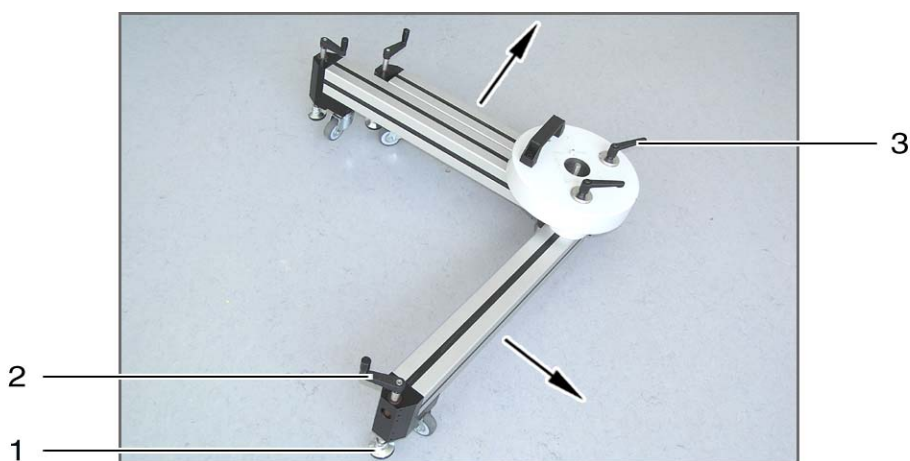


Fig. 23: Tripod foot, partially opened up

- 1 Tripod foot
- 2 Crank for tripod foot
- 3 Retainer

3. Attach tripod support onto tripod foot and hand-tighten fixing screw (see Fig. 24).

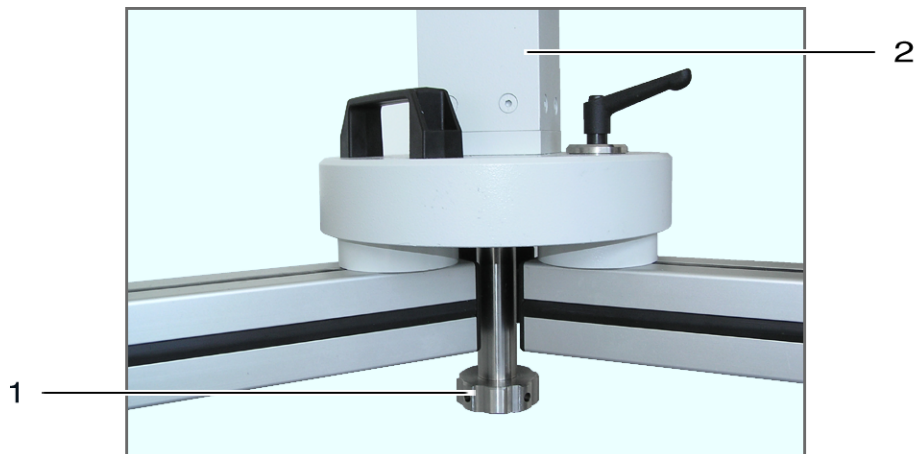


Fig. 24: Tripod foot with tripod support

- 1 Hand-wheel
- 2 Tripod support

4. Push cantilever with floating arm as far as it will go into the seating of the tripod support (see Fig. 22) and secure with the 2 retainers (see Fig. 25, pos. 3).

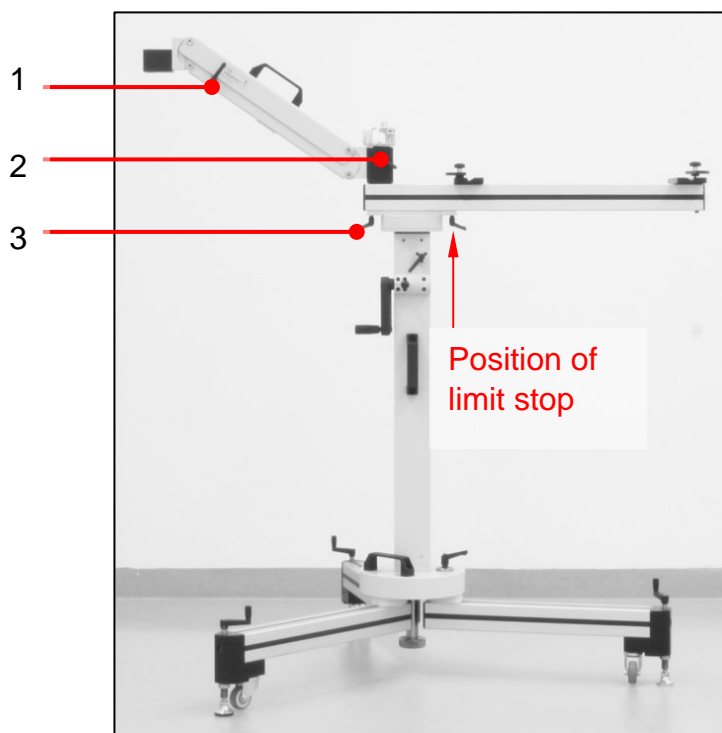


Fig. 25: Tripod with cantilever and floating arm attached

- 1 Retainer for floating arm
- 2 Retainer for swivel joint of floating arm
- 3 Retainer for cantilever



CAUTION

The position of the cantilever on the tripod support is defined by a limit stop in the cantilever guide. The position of this limit stop must not be changed. Once all components have been installed, the position of the cantilever defines the position of the centre of gravity of the tripod and hence the stability of the system as a whole.

5. After installation of the tripod, the floating arm is attached using the appropriate retainers (see Fig. 25, pos. 1 and 2).
- ✓ The tripod is now assembled.

7.3 ARTAX 200 tripod assembly

1. Remove tripod parts from transport box and place carefully on the floor.
2. Open up tripod roller and lock into place with clamping screw (see Fig. 26, pos. 3). Then press down retainer (see Fig. 26, pos. 1).

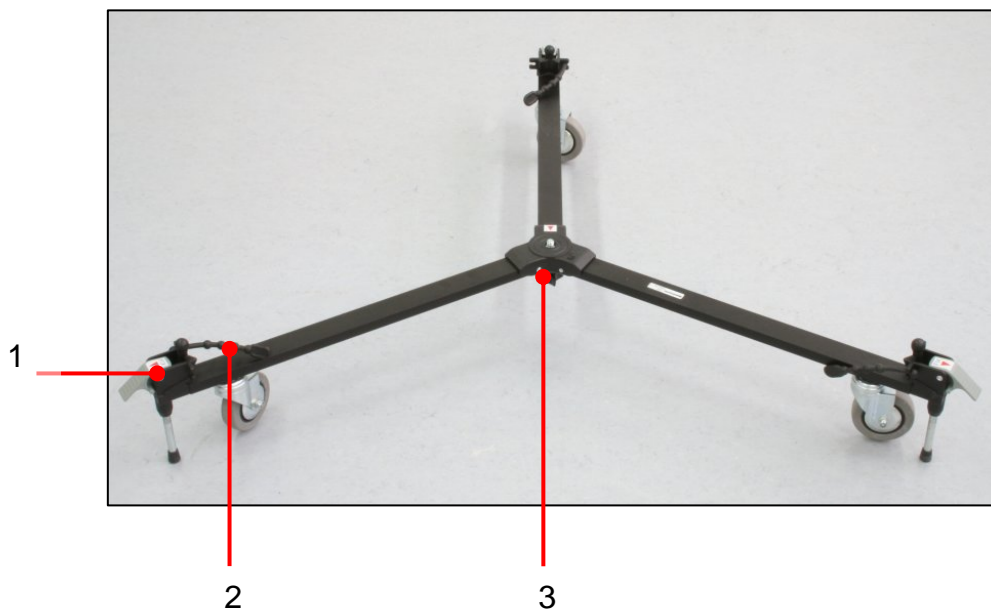


Fig. 26: Tripod roller

- 1 Retainer
- 2 Rubber lug
- 3 Clamping screw

3. Fold out tripod legs, position into the vertex of the tripod roller and secure with the rubber lugs (see Fig. 26, pos. 2).
 4. Tighten fastening screws of the tripod legs and stiffeners (see Fig. 27, pos. 1 and 2).
 5. Attach cantilever on the swivel joint (see Fig. 27, pos. 4) of the tripod with two hexagon sockets (see Fig. 27, pos. 5).
 6. Push in counterweight at the end of the cantilever (see Fig. 27, pos. 3) and attach at the fixed position.
 7. Lock into place and secure measuring head holder with Z-stage on the swivel joint (see Fig. 27, pos. 6).
- ✓ The tripod is now assembled.

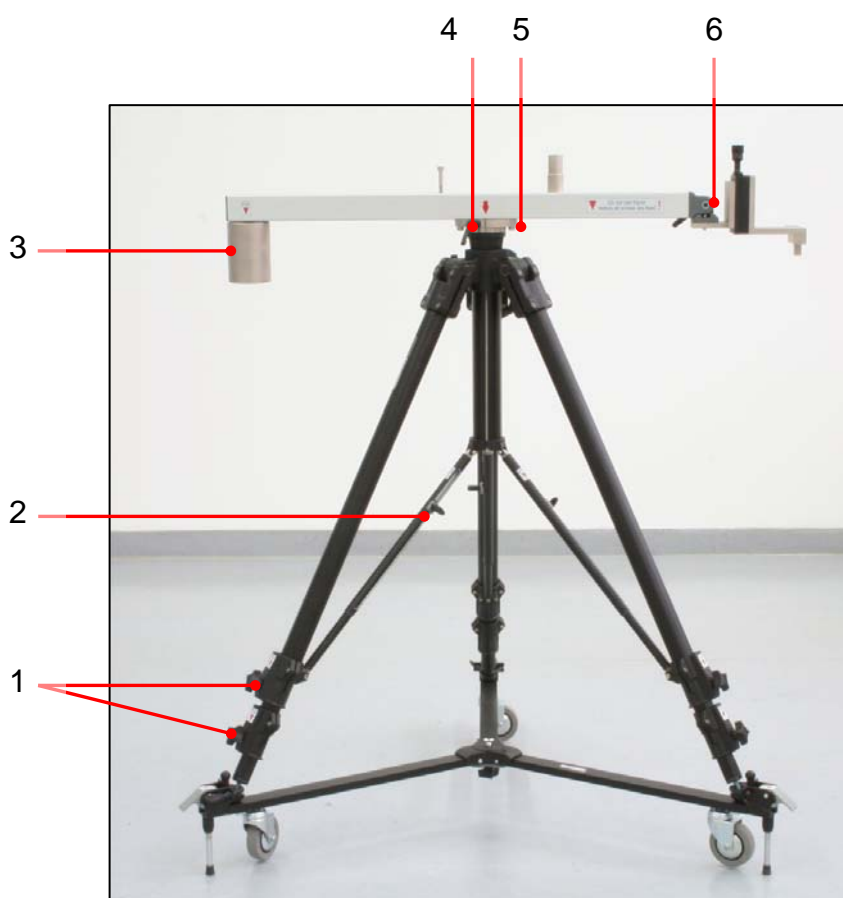


Fig. 27: Tripod completely assembled with cantilever and measuring head holder

- | | |
|--------------------------------|-------------------------------------------|
| 1 Retainer for telescopic legs | 4 Retainer for swivel joint of cantilever |
| 2 Retainer for stiffener | 5 Fastening screws for cantilever |
| 3 Counter balance | 6 Measuring head holder swivel joint |



CAUTION

Danger of damage to the device components.

To ensure adequate stability of the measurement system, all clamping screws must be tightened and the counterweight on the cantilever attached at the right place.

7.4 Assembling electronics unit on ARTAX™ 400 and 800



DANGER

Tipping over of the tripod presents a danger of injury. For stability reasons, the electronics units must be mounted on the tripod before the XYZ adjustment unit.



DANGER

The falling of the electronics unit presents a danger of injury. Note the heavy weight when installing the electronics unit. The unit may only be lifted by 2 persons.

1. Open transport box, remove components one at a time and lay them down carefully.
2. Secure clamp holder on the upper side of the cantilever into the threaded hole provided using the hexagon socket (see Fig. 28, pos. 1),
3. Take hold of electronics unit with both handles, insert into the clamp holder (see Fig. 29, pos. 2) and lock into place with the retainers (see Fig. 29, pos. 1).

✓ The electronics unit is now installed.

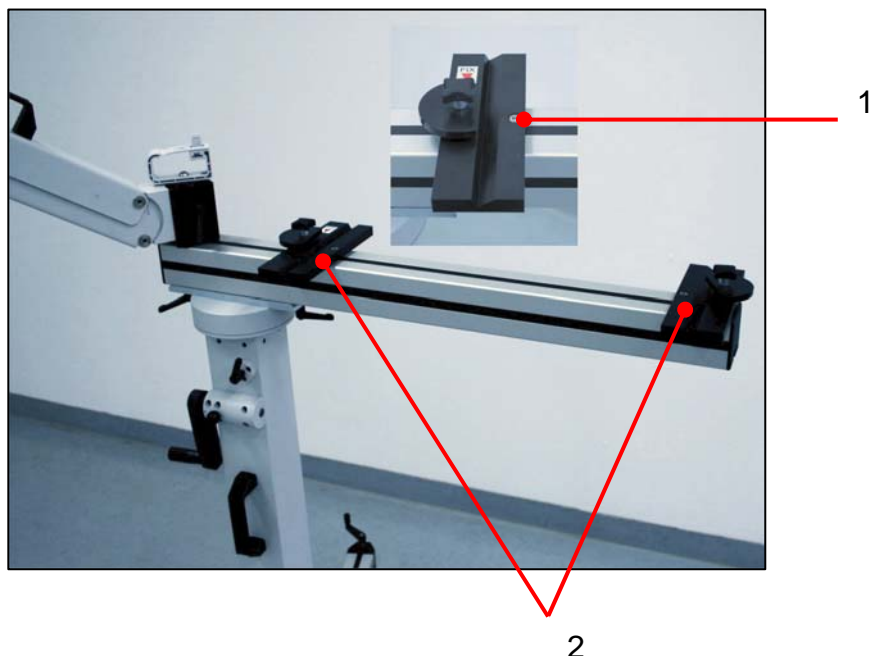


Fig. 28: Installation of the electronics unit holder

- 1 Hexagon socket
- 2 Clamp holder for electronics unit



1

Fig. 29: Attaching and locking into place of electronics unit

1 Retainer

7.5 Installation of the ARTAX™ 200 electronics unit

The electronics unit on the ARTAX™ 200 is not mounted on the tripod but placed on a suitable tabletop near the tripod (see Fig. 30).



CAUTION

Danger of damage to the device components.

The ARTAX™ 200 electronics unit must under no circumstances be placed onto the tripod roller.

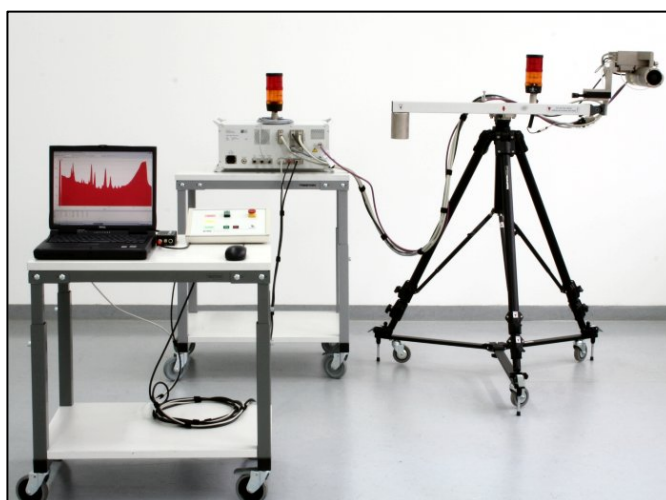


Fig. 30: ARTAX 200 measuring station

7.6 Installation of the XYZ adjustment unit, ARTAX™ 400 and 800



DANGER

Tipping over of the tripod presents a danger of injury. For stability reasons, the electronics units must be mounted on the tripod before the XYZ adjustment unit.



NOTE

To save space, the swivel joint of the XYZ adjustment unit is folded in during transportation and must be folded out for installation.

1. Open transport box 1, remove components one at a time and lay them down carefully.
2. Pull out catch (see Fig. 31, pos. 3) on the swivel joint of the XYZ adjustment unit and position XYZ attachment parallel to the Z-axis.
3. Insert the XYZ adjustment unit in the direction of the arrow into the seating on the floating arm and tighten retainer (see Fig. 31, pos. 1, 2 and 5)
4. Affix warning lamp onto the holder and connect up (see Fig. 31, pos. 4)
 - ✓ The XYZ adjustment unit is now installed.

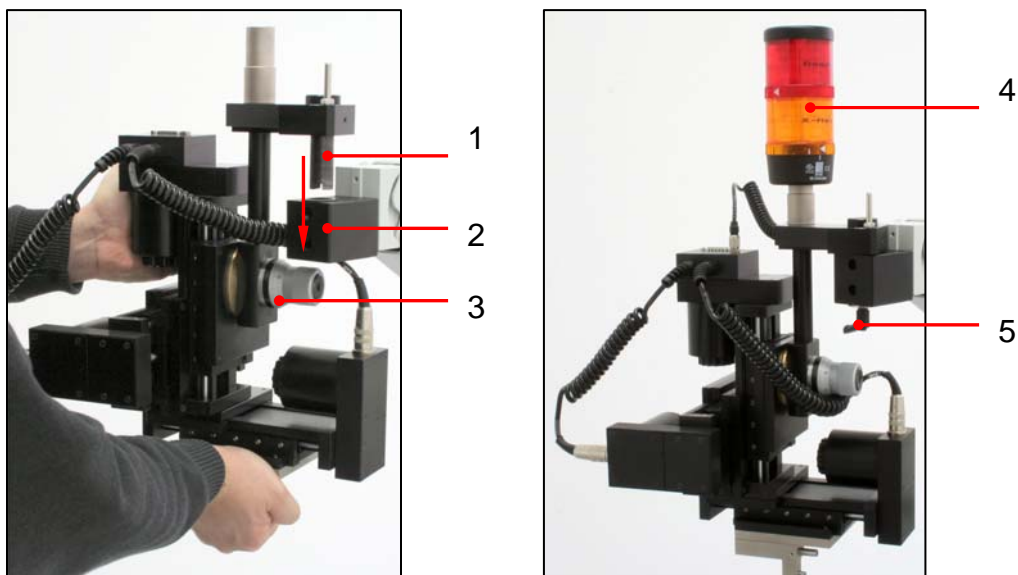


Fig. 31: Installation of XYZ adjustment unit

- | | |
|-----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|
| <ul style="list-style-type: none"> - 1 pin F 2 Seating on floating arm 3 Swivel joint with catch | <ul style="list-style-type: none"> 4 Warning lamp 5 Retainer |
|-----------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------|

g

7.7 Installation of the measuring head

Installation of the measuring head is identical for all three device variants.

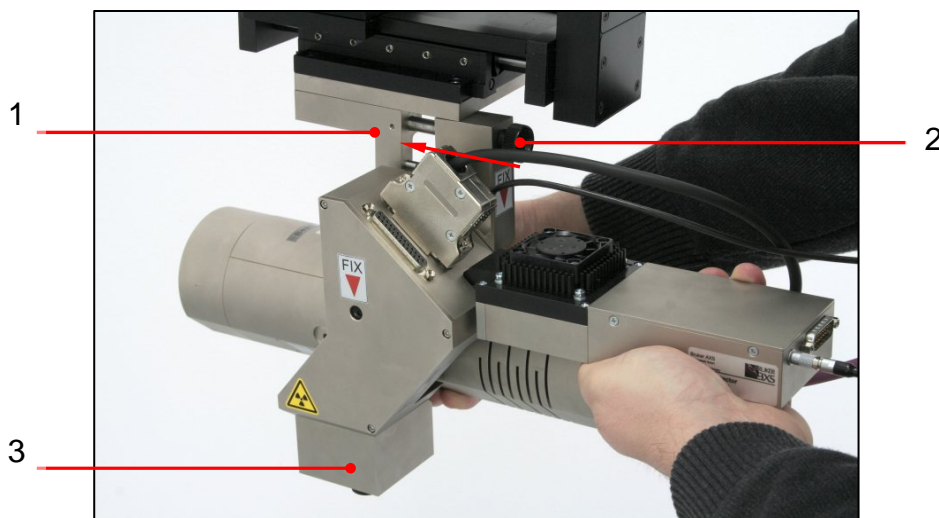


Fig. 32: Installation of measuring head

- 1 Measuring head holder on XYZ
- 2 Knurled screw
- 3 Transportation lock

1. Hook in the measuring head into the XYZ holder in the direction of the arrow and tighten fastening screw (see Fig. 32, pos. 1 and 2)

✓ The measuring head is now installed.



NOTE

The transportation lock (see Fig. 32, pos. 3) on the measuring head remains in place for the time being for inspection of the positioning of the measuring head axes (see section 8.1.3).

7.8 Measurement computer

1. Remove the measurement computer components from the transport box
2. Set up and connect screen, computer, mouse and keyboard.



NOTE

For safety reasons, it is recommended to set up the screen of the measurement computer such that the ARTAX is always in the field of view.

7.9 Connecting components



DANGER

Danger of injury from voltage.

All other components must be connected correctly before power is applied to the electronics unit.

The computer is first to be connected (but not powered on). Then the computer is connected to the electronics unit with the RS-232 cable and video cable. Now all other components can be connected. This procedure guarantees potential equalisation of components during installation.



DANGER

The cabling represents a danger of tripping and falling.

All cabling must be laid and/or secured in such a way that there is no danger of this occurring.

The connection diagram (see Fig. 33) is to be used for cabling. Please refer to section 5.3 for connections to individual ARTAX™ components.

The operator provides the helium supply for the measuring head. The connection diagram is to be used for cabling (see Fig. 33). Please refer to section 5.2.8 for set-up and functionality of the gas supply.

"Door Switch" and the second "Emergency Stop" button are optional. They must be replaced with appropriate dummy connectors if not used.

7.10 Installation of external door switch

The function of the external door switch is covered in section 5.2.6. In contrast to the Emergency Stop button (also optional), the door switch requires software activation in the device configuration file, ARTAXCTRL.dev. This activation can only be performed by the manufacturer. Two configuration files must be defined if the system is changed between laboratory and mobile use. Activation of the door switch gives rise to a special safety scenario. After powering on the device and starting the software, the user is prompted to open the door and then to close it. The device can only be used once this process has completed successfully and the door switch has been deemed effective.

- ✓ The device is now connected.

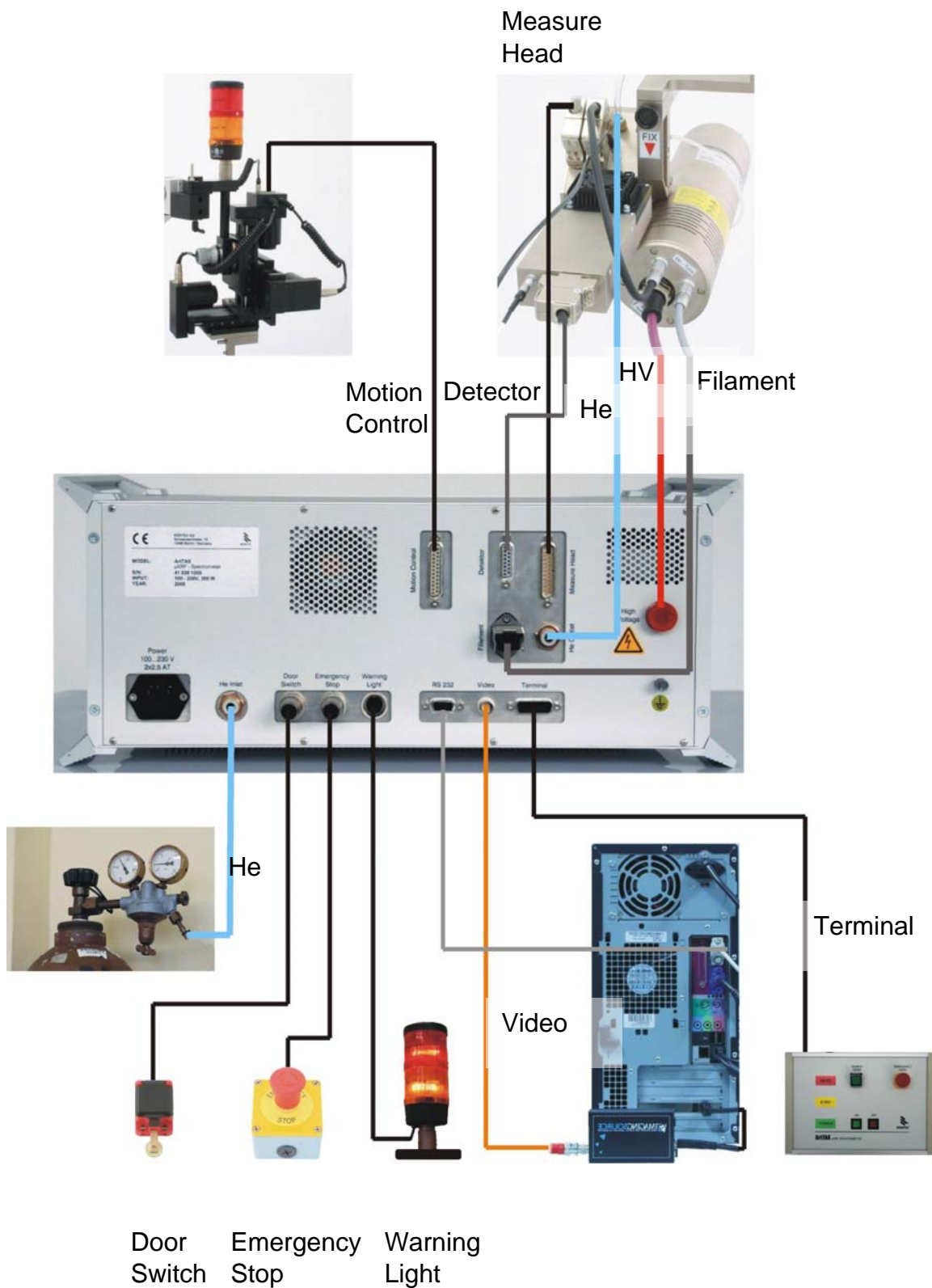


Fig. 33: Connection plan

8 Getting started and operation



DANGER

Danger of injury from X-ray radiation.

Opening the shutter if there is no sample available or the presence of personnel in the direct vicinity of the tube protective housing with shutter open represents a danger to health from radiation harm. For this reason, all of the safety requirements described in section 2 are to be strictly observed at all times.

8.1 Getting ready

The following describes all necessary preparatory steps which must be taken before a measurement can be started. The sequence specified here must be adhered to.

8.1.1 Power on



DANGER

There is a danger of injury on malfunctioning of a safety device.

The checklist (Appendix E) must be used to check the operational safety of the ARTAX™ before the device is powered on.



CAUTION

Damage to the device from build up of condensate.

After transportation or storage in a cold environment, the device must be warmed up to room temperature before being powered on.

Proceed as follows to power on:

1. Switch on the primary mains supply with the key switch on the electronics unit. The green control lamp "**Power**" (see Fig. 34) on the electronics unit and the green lamp on the "ON" switch at the terminal (see Fig. 34) both light up.
 2. Press the ON key at the terminal. The POWER indicator at the terminal lights up green and the OFF button lights up red. The ARTAX electronic system is now ON.
-



DANGER

There is a danger of injury on malfunctioning of a safety device.

Before starting up the system every day, a test must be made of the correct operation of the EMERGENCY STOP button on the terminal and, if available, the optional EMERGENCY STOP button.

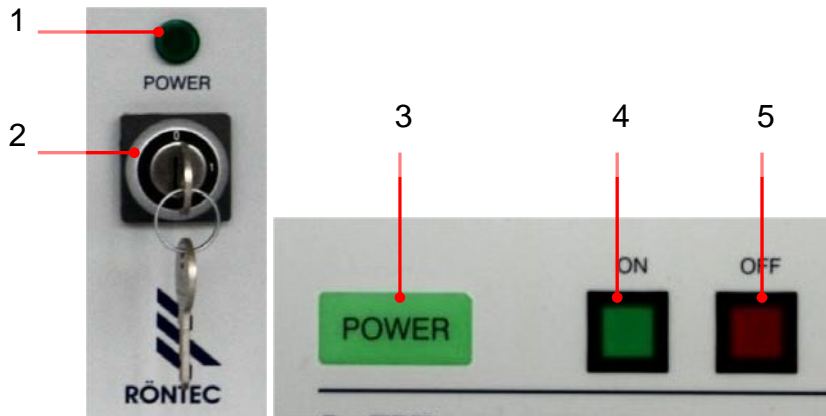


Fig. 34: Powering on ARTAX™

1 Power	4 Power ON switch on terminal
2 Key switch	5 Power OFF switch on terminal
3 Power lamp on terminal	

3. Press the EMERGENCY STOP button on the terminal. The green Power indicator must go out. Then unlock the button and re-press ON at the terminal. The test must be repeated for the optional EMERGENCY STOP button if available.
4. Power on measurement computer
5. Start the "Spectra" software.
If the door switch is installed, the user is prompted to open and close the door



NOTE

The error message "Error transmission to device" (see "Spectra Program Description") is displayed if the software is started prior to powering on the electronics.

6. Manual configuration of high voltage and tube current or selection of a method with appropriate hardware parameters
 7. Switch on high voltage supply
-



DANGER

Danger of injury from high voltage.
Once the high voltage is powered on, the voltage in the high voltage cable represents a danger to life. The cable must not be bent, trapped or damaged.

**NOTE**

A warm-up of the X-ray tube is performed at start-up and is dependent on the off-time of the device. i.e. the values for high voltage and current are increased, with a delay, up to the target values. This procedure contributes to long service life of the X-ray tube.

**NOTE**

Reproducible measurements can not be run until after a warm-up phase of about 30 min.

8.1.2 Perform reference run

**CAUTION**

Collision danger from moving measuring head.

Before the reference run can be started, care must be taken to ensure that there are no spurious obstacles or objects within a distance of 20cm of the measuring head.

A reference run must be performed to determine the zero position of XYZ linear units. The "Reference" command in the step motor dialogue of the software (see "Spectra Program Description") is used to start the reference run. The axes are automatically brought to the mid-position after the reference run has completed successfully. The position indicator of the axes is then normally 25mm.

8.1.3 Check position of measuring head axes

The position of the measuring head axes (optics, laser, CCD, detector) is aligned correctly at the factory. However, misalignment may occur during transportation or set-up of the ARTAX™. Therefore the measuring head axes must be checked for correct positioning before a measurement.

The optical axes of the laser spot, the X-ray beam, the crosshairs in the video image and the X-ray detector must intersect in the measuring plane at the same point (see Fig. 36). An X-ray fluoroscopic system is integrated into the transport lock to check the axes. This X-ray fluoroscopic system is exactly in the pre-defined measuring plane.

Proceed as follows to carry out the check:

1. Remove the filter slide from the measuring head
2. Switch off the high voltage supply from software
3. Start measurement. The "Enable Beam" (see Fig. 35) button on the terminal must first be pressed for this. The measurement can then be started with the software command. The button must be released after starting the measurement.



Fig. 35: Verification of the start with the "Enable Beam" button on the terminal



NOTE

If the "Enable Beam" button is pressed for too long, this is interpreted as a malfunction of a safety function and the high voltage supply is switched off.

4. If may be necessary to set the sample lighting, the tube current and the laser positioning spot (see Fig. 36) such that the brightest possible X-ray focal spot is visible in the camera image.
5. Using the camera image in software, check whether the axis and field of vision with crosshairs lie above one another congruently (see Fig. 36)
6. Stop measurement and remove transport lock.

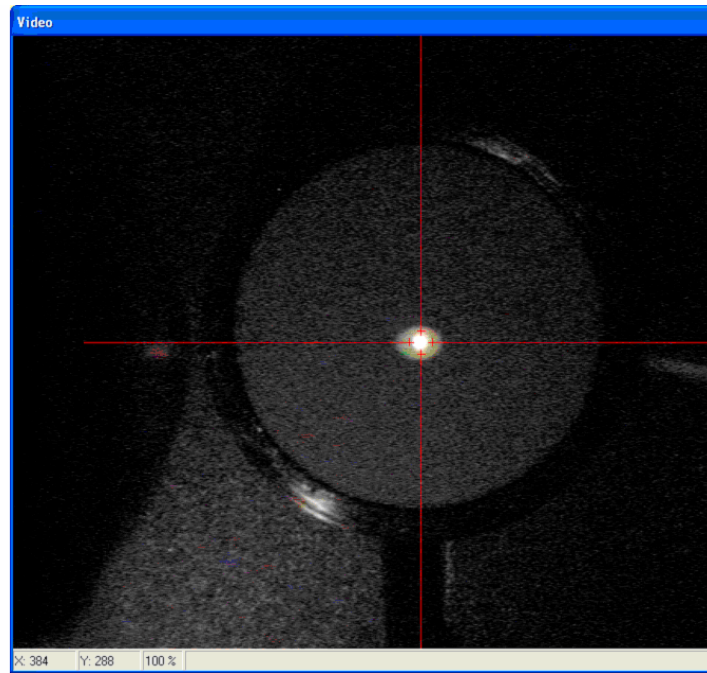


Fig. 36: Congruency of X-ray beam, laser positioning spot and crosshairs



NOTE

If axes and field of vision do not lie above one another congruently, the position of the measuring head is misaligned and must be corrected by service personnel from Bruker AXS Microanalysis GmbH.



NOTE

The transport lock must be removed after checking the position of the measuring head axes.

- ✓ The device is now ready to perform measurements.

8.1.4 Positioning

A major prerequisite for the use of the analytic possibilities of the ARTAX™ RFA spectrometer is the correct relative positioning of the measuring head to the sample. Incorrect positioning can severely limit the effectiveness of the device and can lead to incorrect analysis results.

The following key issues need to be addressed when aligning the measuring head:

- ❑ The measuring head must be pointed vertically downwards onto the surface of the object under examination.
- ❑ The measuring head must be at the correct distance from the surface.

The Z-axis of the XYZ adjustment unit is used for orientation of the vertical alignment. The axis must point vertically onto the surface of the measuring point. A Z-axis displacement then automatically leads to a change in distance between object and measuring head.

Fig. 37 shows the ARTAX™ measuring head aligned correctly to the surface of a painting.

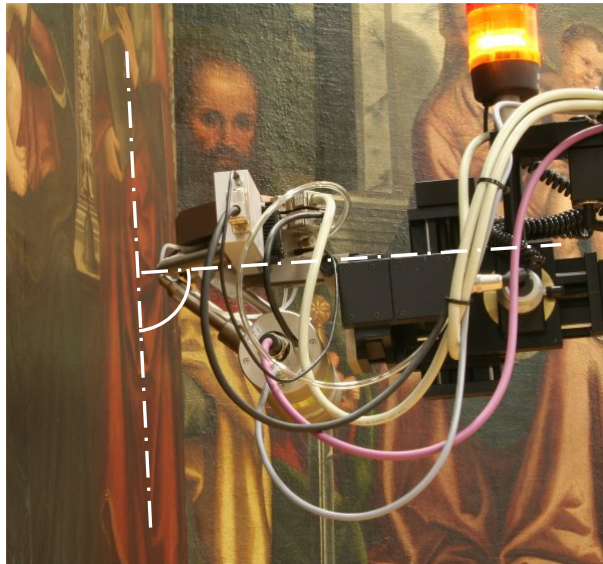


Fig. 37: Measuring head correctly aligned

Approximate positioning

Positioning depends on the type of sample. First an approximation of the positioning is made. Sample and measuring head are aligned to each other approximately by swivelling and turning the tripod and the measuring head. Fine positioning is then carried out by software during which the measuring head is positioned relative to the sample with the step motors (ARTAX™ 400, 800) of the XYZ adjustment unit, setting the correct working distance to the sample. On the ARTAX™ 200, adjustment of the distance is carried out using the manual Z-drive.

Smaller objects can be aligned approximately to the measuring head by using an adjustable sample holder, such as a folding table.

For larger objects, the entire device can be moved to the required location using the rollers on the tripod base. The tripod support is height adjustable and the tripod cantilever with floating arm can be shifted horizontally and turned 360°. The floating arm is both swivel-mounted and rotatable.

The measuring head can also be twisted and swilled such that the X-ray beam is emitted horizontally or vertically. Further measuring positions are available in increments of 6° .



NOTE

It is recommended that approximate positioning is carried out such that the horizontal, vertical and lateral working distances between measuring head and sample are >1cm. This ensures that the sample in the camera view is visible in software and that an optimal degree of fine positioning is achieved.



DANGER

Danger of injury from X-ray radiation.

The shutter must always be shut when performing approximate and fine positioning.



CAUTION

Tipping over of the device presents a danger of damage.

Adequate stability of the device is paramount whenever positioning it. The device may only be moved slowly and over short distances. Component cabling must not be stretched taut or become detached from connectors. After positioning, all retainers on the tripod must always be re-locked into position.

ARTAX™ 400 and 800**Adjust tripod height (see Fig. 38):**

Loosen the retainer, push the crank catch in the direction of the arrow (see Fig. 38) and use the crank on the tripod support to adjust to the required height. After reaching the required height, the crank catch must be relocked into place and the retainer tightened.

**Turn and move cantilever with floating arm
(see Fig. 39, pos. 4):**

The rotation pin of the cantilever on the tripod support is freely movable and has no retainer.

Turn and swivel floating arm (see Fig. 39, pos. 3):

Loosen the retainer on the joint of the floating arm, turn and swivel it into the required position and retighten the retainer.

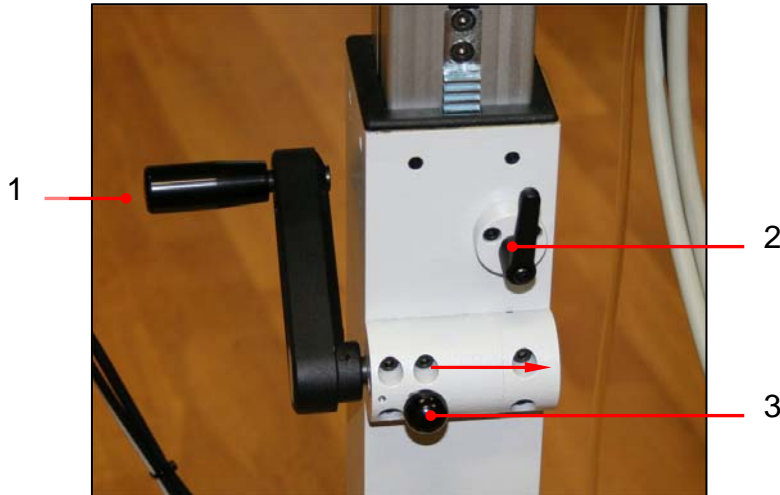


Fig. 38: Height adjustment of the tripod support on the ARTAX™ 400, 800

- 1 Crank
- 2 Retainer
- 3 Crank catch

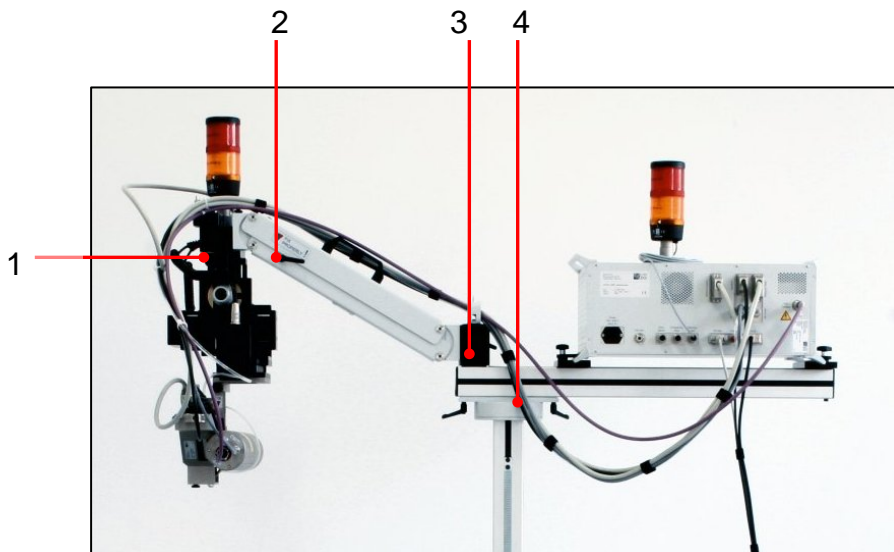


Fig. 39: Adjustment points on the tripod for cantilever and floating arm

- 1 Retainer on XYZ attachment
- 2 Retainer on floating arm
- 3 Retainer on floating arm joint
- 4 Swivel joint of cantilever

Raise and lower floating arm (see Fig. 39, pos. 2):

Loosen the retainer on the floating arm, raise and lift the floating arm into the required position and retighten the retainer.

Turn measuring head (see Fig. 40, pos. 1):

Loosen the retainer on the mounting, turn the measuring head into the required position and retighten the retainer.

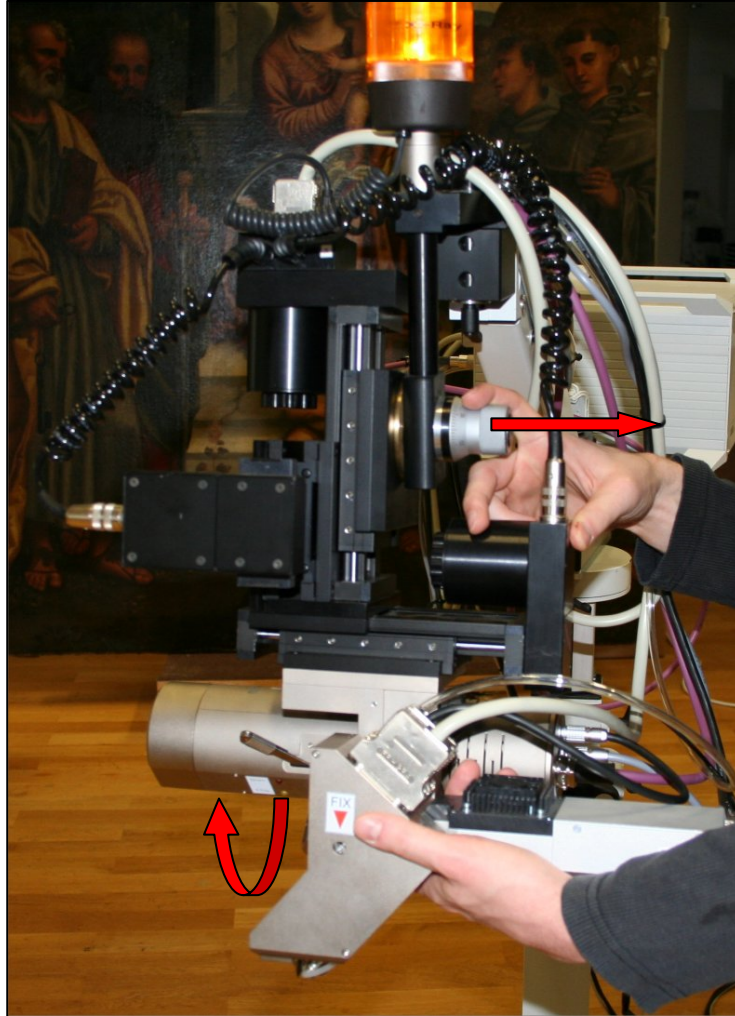


Fig. 40: Swivelling the measuring head

Swivelling measuring head (see Fig. 40):

Pull the catch out to the limit stop in the direction of the arrow. Swivel the measuring head in the correct direction and relock the catch.

Fine positioning



CAUTION

Danger of measuring head collision.

When fine positioning, care must be taken to ensure that no spurious obstacles or objects are in the vicinity of the measuring head. A collision can result in damage to the measuring head.

When fine positioning, the measuring head is positioned relative to the sample with the step motors of the XYZ adjustment unit. Software buttons or key combinations (see “Spectra Program Description”) can be used to operated the step-motor controlled XYZ axes . The maximum positioning distance for the three axes is 46mm.

The particular objective of fine positioning is the setting of the correct working distance to the sample, requiring that the optical axes of the ARTAX™ lie congruently above one another. The device has already been set up at the factory such that all axes cross at one point (see section 8.1.3). Correct position has been achieved when this point corresponds with the measuring point of interest on the surface of the object to be examined. Fig. 41 shows the axes of the ARTAX™ 400 measuring head crossing.

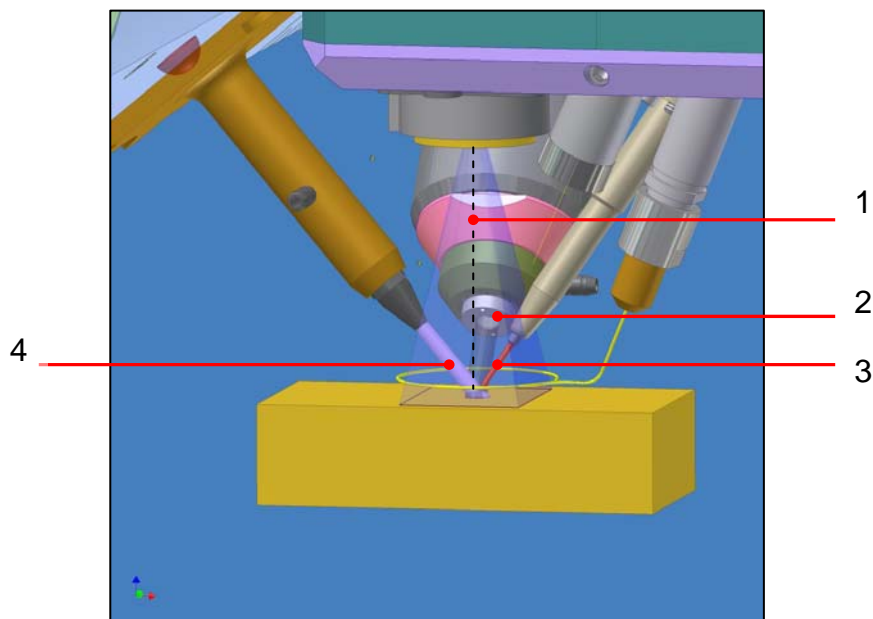


Fig. 41: Distance setting via triangulation

- 1 Optical axis of CCD camera
- 2 Optical axis of detector
- 3 Laser positioning spot
- 4 Excitation beam

The correct distance setting between cross-over point of the axes and the measuring point of interest can easily be worked out by using a laser positioning spot and a CCD camera. Cross-hairs are displayed in the camera image of the measuring head by software..

By varying the distance of the Z-axis with the step motors, the laser positioning point can be lined up congruently with the cross-hairs within the video image of the CCD (see Fig. 42). This then indicates correct setting of the working distance.

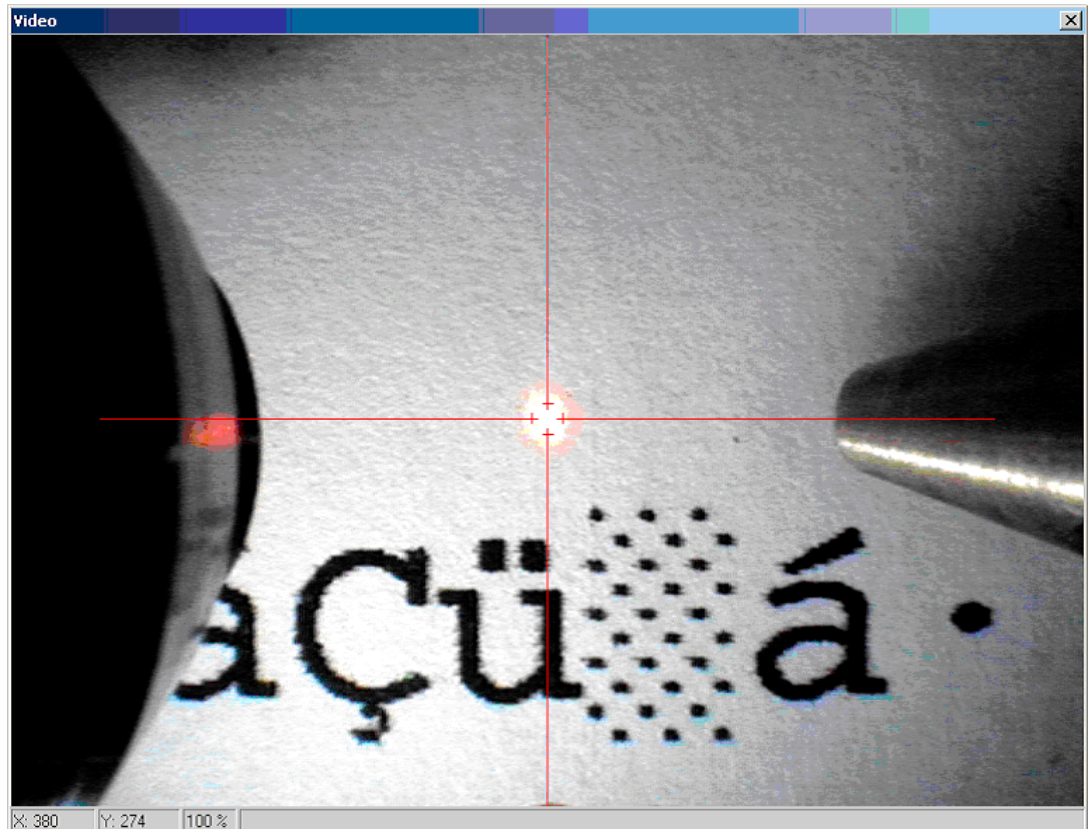


Fig. 42: Congruence of the optic axes in the camera image

8.1.5 Gas feed



DANGER

Danger of injury from pressurised gas.

The gas cylinder is a pressurised vessel which must be handled with appropriate care. The highest permissible operational pressure must not be exceeded. Observe the regulations from the manufacturer of the gas supply unit.

The helium flush of the measuring head is automatically activated if the “He” option is selected under the “Atmosphere” measurement parameter in the Spectra software.

The supply must be connected and opened prior to using the He flush. If the supply is from a cylinder, the cylinder valve is opened first. A manometer can then usually be used to read off the cylinder pressure. A pressure regulator is used to set the supply pressure to between 1 bar and 5 bar. The shut-off valve is then opened (see Fig. 16).



CAUTION

Danger of injury from excess pressure.

The output pressure of a gas cylinder is far too high to be used directly by the ARTAX. A pressure regulator is therefore an absolute necessity for the provision of a gas supply < 5 bar.

8.2 Carrying out a measurement



DANGER

Danger of injury from X-ray radiation.

Direct exposure to X-ray radiation emitted by the ARTAX™ during a measurement represents an acute danger to health. Additionally, long-term exposure to smaller doses results in increased risk of cancer. For this reason, all of the safety requirements described in section 2 are to be observed strictly at all times.



DANGER

Danger of injury from high voltage.

Once the high voltage is powered on, the voltage in the high voltage cable represents a danger to life. The cable must not be bent, trapped or damaged.

The measurement is started from the “Spectra“ control software. The “Spectra Program Description“ contains all information regarding the carrying out of the measurement .

In order to prevent starting the measurement inadvertently, the “Enable beam“ button at the terminal must also be pressed to authorize the running of the software command.

8.3 Exchanging components

8.3.1 X-ray source

A particular benefit of the ARTAX transportable spectrometer is the ability to exchange X-ray sources. An X-ray with polycapillary lens may be selected, or one with exchangeable collimator. Additionally, there is also the option of selecting different X-ray targets for both these base versions.

X-ray sources can be exchanged quickly and easily.

Proceed as follows:

1. Power off the ARTAX™
2. Undo the filament and the tube housing cable on the rear of the tube housing (see Fig. 43). The red high voltage remains tightly connected to the tube housing.



Fig. 43: Remove tube housing and filament cable



NOTE

The use of the transport box provided for the tube housing is recommended for storage purposes.

3. Use an Allen key to undo the fastening screw of the tube housing at the measuring head (see Fig. 44).

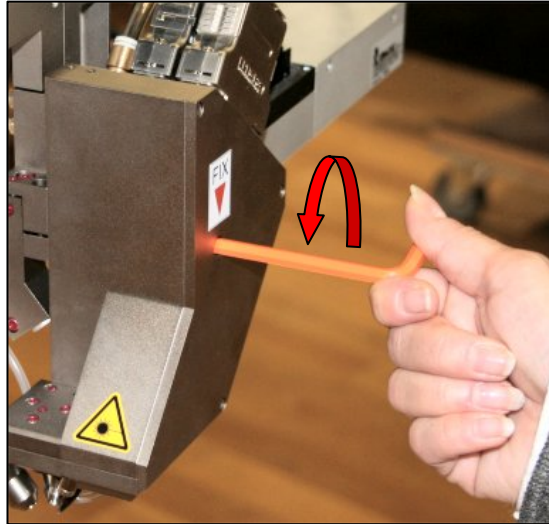


Fig. 44: Undo the fastening screw of the tube housing

4. Remove tube housing from measuring head (see Fig. 44) and store in transport box.



Fig. 45: Remove tube housing

To install the new tube housing, follow the procedure in the reverse order.

1. Insert the tube housing into the measuring head
2. Tighten fastening screw
3. Re-connect tube housing and filament connector
4. Power on device

The parameters are read out from the tube housing controller after power-on and software restart. Alignment of the threshold values for the tube control unit is carried out automatically.

8.3.2 Filter slide

The ARTAX™ has an exchangeable filter slide with three positions. Position 1 is usually empty. Positions 2 and 3 are occupied with metal foil of different thicknesses. The filter changer has three distinct rest positions for precise positioning.

Proceed as following to change the filter slide:

1. Close the shutter via software
2. Push the filter slide into the aperture on the measuring head (see Fig. 46) and rest it in the required position



NOTE

The resting positions must be engaged precisely. If the filter slide is pushed in between two positions, the beam channel is closed and the sample does not become excited.

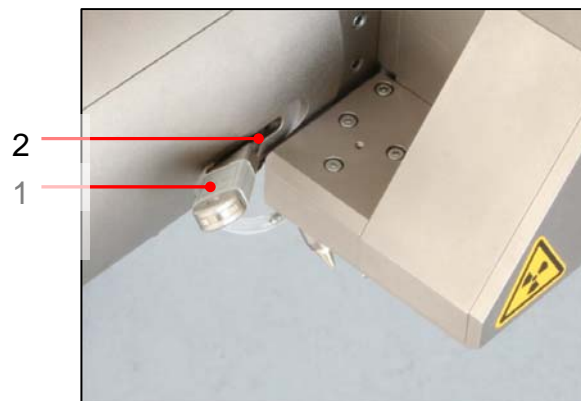


Fig. 46: Exchanging filter slide

- 1 Filter slide
- 2 Aperture for filter slide in the measuring head

The standard filter slides supplied are dependent on the tube target (see **Fehler! Verweisquelle konnte nicht gefunden werden.** for order no.):

No.	Mo tube	W tube	Rh tube
1	0	0	0
2	12 μm Mo	10 μm Ni	300 μm Al
3	25 μm Mo	20 μm Ni	600 μm Al

Tab. 15: Standard filter slides

Please contact Bruker AXS Microanalysis GmbH at the following address for information on availability of other filter assemblies:

Bruker AXS Microanalysis GmbH
Schwarzschildstraße 12
D-12489 Berlin

8.3.3 Collimator



DANGER

Danger of injury from X-ray radiation.

Direct exposure to X-ray radiation emitted by the ARTAX™ during a measurement can result in considerable short-term damage to biological tissue and bone material. Exposure to smaller doses over a long period results in increased risk of cancer. For this reason, the shutter must be closed when exchanging collimator.

A collimator is used on the ARTAX™ 400 for the definition of the beam geometry. The diameter of the collimator defines the size of the analysis spot on the surface of the sample.

The following four different collimator sizes are available for selection (see Fehler! Verweisquelle konnte nicht gefunden werden. for order no.):

Collimator size	Diameter	Sample area excited
1	0.20mm	0.03 mm ²
2	0.65mm	0.33mm ²
3	1.00mm	0.79mm ²
4	1.50mm	1.77mm ²

Tab. 16: Collimator sizes

Since analytical issues and sample types vary, the user of the device must make a compromise between lateral resolution and intensity of the measurement signal. The lateral resolution of collimator 1 is higher than that of collimator 4 by a factor of 7.5. However, the sample area excited is

smaller than with the largest collimator - by a factor of 59. If a satisfactory measurement signal were to be attained with this one after only 10s, 590s would have to be measured for the same signal quality using the smallest collimator.

The collimators have a fine thread and can be screwed in and out of the collimator holder with the special key .

Proceed as follows to exchange collimator:

1. Close the shutter via software
2. Screw out collimator using the special key and screw in replacement collimator

It might be helpful to place the collimator into the special key before screwing the collimator in.

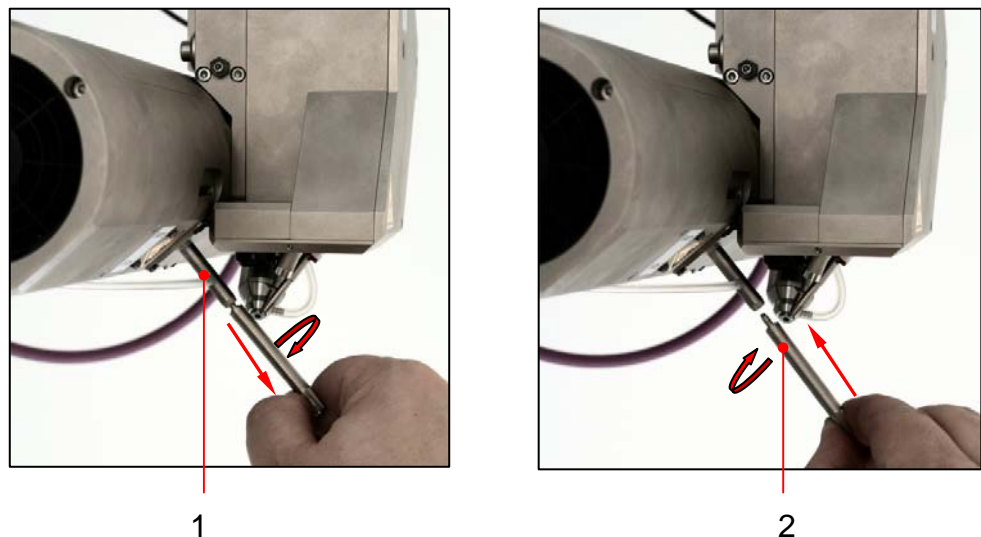


Fig. 47: Exchanging collimator

- 1 Collimator holder
- 2 Special key

9 Shutting down and dismantling

9.1 Powering off

Proceed as follows to power off:

1. Stop measurement. The shutter is closed and the high voltage supply switched off. Close measurement program.
2. Shut down measurement computer and switch off
3. Switch off ARTAX™ using the OFF button at the terminal. Isolate from the mains supply using the key switch on the electronics unit.

9.2 Dismantling

Dismantle the ARTAX™ components one at a time and pack into transport boxes.

When dismantling the device, follow the reverse order as with assembly:



CAUTION

Danger of damage to the device components.

When dismantling, all ARTAX components are to be placed on suitable underlays and be prevented from falling down or rolling.

9.2.1 Measuring head

1. Secure transportation lock on the measuring head
2. Undo all cabling from the electronics unit
3. Undo and pack detector cable, measuring head cable and filament cable from the measuring head
4. Undo and pack XYZ motion control cable
5. Undo warning lamp connection, remove warning lamp and pack
6. Undo measuring head at the mounting and place in transportation packaging

9.2.2 XYZ adjustment unit



NOTE

To save space, the swivel joint of the XYZ adjustment unit is folded in during transportation.

7. Undo retainer on XYZ mounting, lift out XYZ from the mounting and screw in retainer

8. Pull out catch on swivel joint of the XYZ adjustment unit and fold in swivel joint

- ✓ The XYZ adjustment unit is now disassembled and can be packed in the transport box provided

9.2.3 Electronics unit



DANGER

The falling of the electronics unit presents a danger of injury. Note the heavy weight when disassembling the electronics unit. The unit may only be lifted by 2 persons.

9. Undo clamp on the holders for the electronics unit. Lift up electronics unit and pack.

9.2.4 Tripod

10. Undo retainer on the floating arm, fold in floating arm and secure retainer (see Fig. 48)



Fig. 48: Fold in floating arm and secure

11. Undo the 2 retainers on the tripod support (see Fig. 25, pos 3) and remove the cantilever with floating arm from the rail.

**NOTE**

To stop the tripod foot from rolling whilst pulling out the tripod support, it may be helpful to position the tripod foot in a secure position using the stand feet.

12. Undo fastening screw and remove tripod support from tripod foot in the direction of the arrow (see Fig. 49)

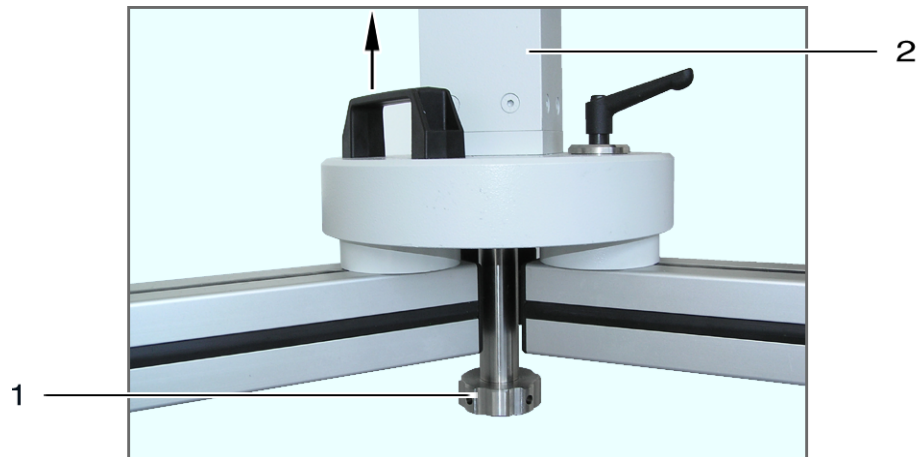


Fig. 49: Tripod foot with tripod support

- 1 Fastening screw
- 2 Tripod support

13. Undo retainer on tripod foot and fold up tripod foot (see Fig. 50)

- ✓ The tripod is now disassembled and can be packed in the transport box provided

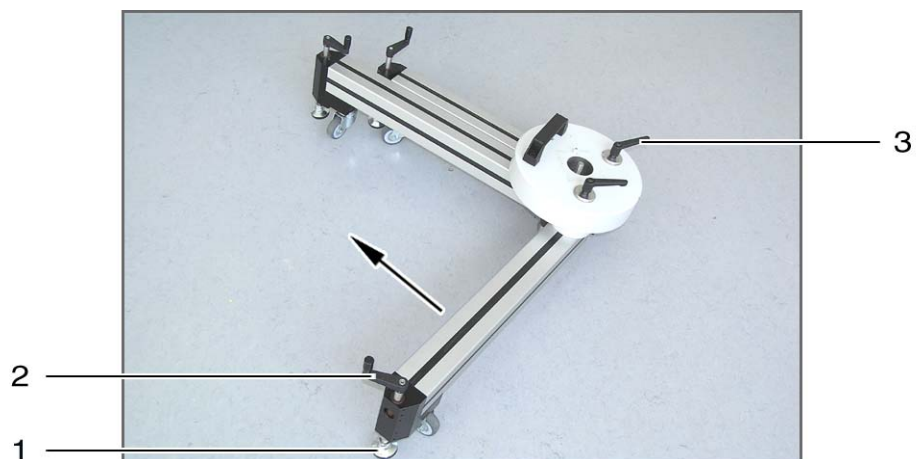


Fig. 50: Tripod foot, partially folded

- 1 Stand foot
- 2 Crank for stand foot
- 3 Retainer

9.2.5 Measurement computer

1. Isolate measurement computer from mains
2. Disconnect screen, computer, mouse and keyboard and pack in the transport box provided.

9.3 Packing into transport boxes



NOTE

The number of transport boxes, and how the ARTAX™ components are divided amongst the transport boxes, can vary depending on certain technical features.

The ARTAX™ components are packed in special transport boxes . Each transport box has moulded parts into which individual components must be laid so as to fit perfectly. Accessories are divided between transport boxes depending on available space.

The ARTAX™ components are packed as follows:

Transport box 1:

- Tripod
 - tripod foot
 - tripod support
 - tripod cantilever with floating arm

Transport box 2:

- electronics unit
- XYZ adjustment unit
- measuring head
- second X-ray source
- cable set

10 Disposal



NOTE

All used ARTAX[®] components are to be either recycled or disposed of in line with environmental regulations.



WARNING

Danger of beryllium poisoning.
The X-ray tube and detector contain the poisonous substance beryllium.
Disposal of these components must be left to the manufacturer.

With the exception of X-ray tube and detector, ARTAX components are regarded as hazardous waste and are to be disposed of accordingly. The X-ray tube and detector contain the poisonous substance beryllium and can therefore be returned to the manufacturer.

Return the X-ray tube and detector components to be disposed of to the following address:

Bruker AXS Microanalysis GmbH
Schwarzschildstraße 12
D-12489 Berlin

Index

A		D	
Absorber	15	Detector	44
Accidental radiation.....	13	Distance setting	87
Alignment.....	82	Door switch	51
Analysis software.....	31	Dose rate	13
Analysis spot.....	92	Dosimeter.....	17
Appointee(s) for radiation protection ..	16	Dosimetric monitoring	17
ARTAX 200 tripod	56	E	
ARTAX 400/800 tripod	54	Electronics unit.....	39
ARTAX™ 400	32, 41	Element composition.....	31
ARTAX™ 800	41	EMERGENCY STOP button	50
ARTAX™ 800	32	Enable beam.....	80
Axes	86	Error message	78
Axes, crossing.....	86	Excitation radiation.....	44
B		Excitation spectra.....	44
Beam geometry.....	92	External interlock.....	24
Beryllium	101	F	
Block diagram	37	Filter slide.....	42
C		Flow controller.....	53
Cabling.....	74	Focussed X-ray beam	30
CCD camera	48	Fully protected device	13
Characteristic X-ray radiation.....	30	G	
Collimated X-ray beam.....	30	Gas flushing	52
Collimator.....	32	Gas supply	18
Collimator holder.....	93	Guarantee and liability claims	11
Collision sensor.....	49	H	
Conditions of sale	11	Helium atmosphere	52
Conditions of supply.....	11	Helium supply	74
Configuration file	62	I	
Control software.....	31	Informational symbols	10
Cordoning off	16	Interlock, external.....	24
Cross-hairs.....	87		
Cross-over point.....	87		

L

Lead equivalent	15
Lead plating	15
Liability claims	11
License application	16
Light source	65
Line scan	31
Local dose	16

M

Mains supply	57
Mapping	31
Measurement	88
Measurement computer	54
Measurement signal	92
Measuring head	47
Measuring position	83
Minimum distance	16, 65
Misalignment	79
Monochromatisation	42

P

Packaging units	63
Polychromatic X-ray beam	42
Positioning	81

R

Radiation load	13
Radiation protection device	16
Radiation protection screen	15
Resolution, lateral	92
Rest positions	44, 91
Risk of cancer	13

S

Safety precautions	14
Sample area	92
Sample distance	48, 82
Sample holder	82
SDD	45
Security circuit	24
Semiconductor detector	45
Shutter	44
Signal words	10
Special key	93
Spectra	62
Spectrum	31
Step motors	31, 86
Swivel joint	52

T

Terminal	39
Transport boxes	98
Transportation lock	73

W

Warm-up phase	79
Warning symbol	10
Working distance	83, 86

X

X-Netz component	57
X-ray radiation, characteristic	44, 46
XYZ axes	86
XYZ drive mechanism	51

Z

Zero position	79
---------------------	----