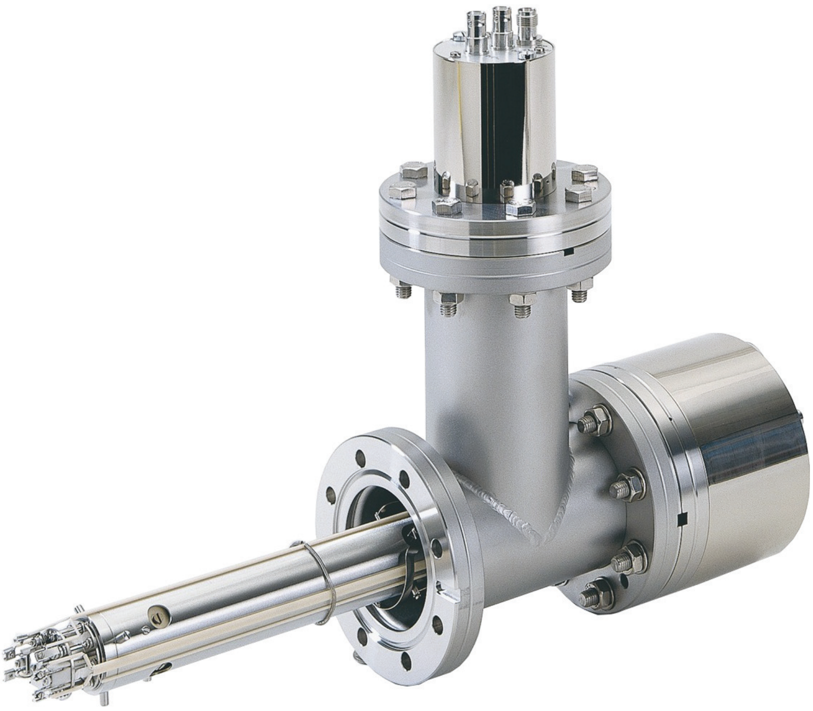


OPERATING INSTRUCTIONS

EN

Translation of the Original

QMA 4X0

Quadrupole analyzer for QMG 800 HiQuad® Neo

PFEIFFER VACUUM

Dear Customer,

Thank you for choosing a Pfeiffer Vacuum product. Your new quadrupole analyzer should support you in your individual application with full performance and without malfunctions. The name Pfeiffer Vacuum stands for high-quality vacuum technology, a comprehensive and complete range of top-quality products and first-class service. From this extensive, practical experience we have gained a large volume of information that can contribute to efficient deployment and to your personal safety.

In the knowledge that our product must avoid consuming work output, we trust that our product can offer you a solution that supports you in the effective and trouble-free implementation of your individual application.

Please read these operating instructions before putting your product into operation for the first time. If you have any questions or suggestions, please feel free to contact info@pfeiffer-vacuum.de.

Further operating instructions from Pfeiffer Vacuum can be found in the Download Center on our website.

Disclaimer of liability

These operating instructions describe all models and variants of your product. Note that your product may not be equipped with all features described in this document. Pfeiffer Vacuum constantly adapts its products to the latest state of the art without prior notice. Please take into account that online operating instructions can deviate from the printed operating instructions supplied with your product.

Furthermore, Pfeiffer Vacuum assumes no responsibility or liability for damage resulting from the use of the product that contradicts its proper use or is explicitly defined as foreseeable misuse.

Copyright

Table of contents

List of tables

List of figures

1 About this manual

IMPORTANT
Read carefully before use.
Keep the manual for future consultation.

1.1 Validity

This document describes the function of the products listed in the following and provides the most important information for safe use. The description is written in accordance with the valid directives. The information in this document refers to the current development status of the products. The document retains its validity assuming that the customer does not make any changes to the product.

1.1.1 Applicable documents

Designation	Document
Operating instructions for QMG 800 HiQuad Neo	BG 6013
Operating instructions for EP 822 electrometer pre-amplifier	
Operating instructions for IO 820 input-output module	
Operating instructions for QMH 800-x "high-frequency generator"	BG 6016
PV MassSpec Software Documentation	A component of the software
Declaration of conformity	A component of these instructions

Tbl. 1: Applicable documents

You can find these documents in the Pfeiffer Vacuum Download Center.

1.1.2 Variants

This document applies to products with the following article numbers:

Article number	Designation
PT M22 1xx	QMA 400
PT M22 2xx	QMA 430

You can find the part number on the rating plate of the product.

Pfeiffer Vacuum reserves the right to make technical changes without prior notification.

The figures in this document are not to scale.

Dimensions are in mm unless stated otherwise.

1.2 Target group

These operating instructions are aimed at all persons performing the following activities on the product:

- Transportation
- Setup (Installation)
- Usage and operation
- Decommissioning
- Maintenance and cleaning
- Storage or disposal

The work described in this document is only permitted to be performed by persons with the appropriate technical qualifications (expert personnel) or who have received the relevant training from Pfeiffer Vacuum.

1.3 Conventions

1.3.1 Instructions in the text

Usage instructions in the document follow a general structure that is complete in itself. The required action is indicated by an individual step or multi-part action steps.

Individual action step

A horizontal, solid triangle indicates the only step in an action.

- ▶ This is an individual action step.

Sequence of multi-part action steps

The numerical list indicates an action with multiple necessary steps.

1. Step 1
2. Step 2
3. ...

1.3.2 Pictographs

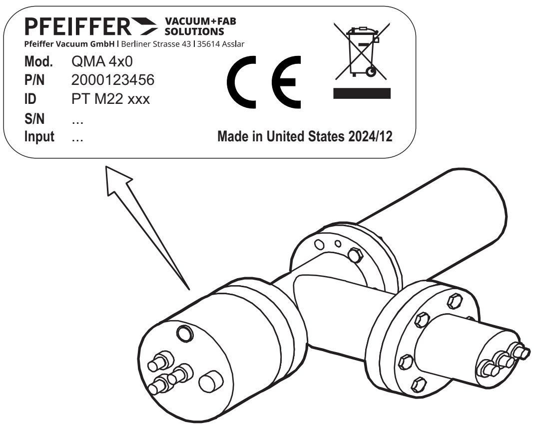
Pictographs used in the document indicate useful information.

Note

Tip

1.3.3 Labels on product

This section describes all the labels on the product along with their meanings.



Rating plate

The rating plate is located on the side of the unit.

1.3.4 Abbreviations

Abbreviation	Explanation
CB	Crossbeam
CD	Conversion dynode
EID	Electron impact desorption
IO	Input/Output
IQ	Ion source
MSL	Mean sea level
OFHC	Oxygen-free high thermal conductivity
QMA	Analyzer
QMH	High-frequency generator

Abbreviation	Explanation
SEM	Secondary electron multiplier
SEM	Secondary electron multiplier
W	Tungsten
XHV	Extreme ultra-high vacuum
YO_x-Ir	Yttriated iridium

Tbl. 2: Abbreviations used

1.4 Trademark proof

- HiQuad® is a registered trademark of Pfeiffer Vacuum GmbH.

2 Safety

2.1 General safety information

The following 4 risk levels and 1 information level are taken into account in this document.

⚠ DANGER
Immediately pending danger
Indicates an immediately pending danger that will result in death or serious injury if not observed.
▶ Instructions to avoid the danger situation

⚠ WARNING
Potential pending danger
Indicates a pending danger that could result in death or serious injury if not observed.
▶ Instructions to avoid the danger situation

⚠ CAUTION
Potential pending danger
Indicates a pending danger that could result in minor injuries if not observed.
▶ Instructions to avoid the danger situation

NOTICE
Danger of damage to property
Is used to highlight actions that are not associated with personal injury.
▶ Instructions to avoid damage to property

i	Notes, tips or examples indicate important information about the product or about this document.

2.2 Safety instructions

i	**Safety instructions according to product life stages** All safety instructions in this document are based on the results of a risk assessment. Pfeiffer Vacuum has taken into account all the relevant life stages of the product.

Risks during installation

⚠ DANGER
Danger to life caused by electric voltage on the analyzer
During operation, dangerous voltage is present on the electrode system of the QMA analyzer. Components in the vacuum system are dangerous to touch under certain conditions. There is danger to life due to electric voltage.
▶ Protect installed parts, connected units and lines against galvanic connections, flashover or charge carrier flow. ▶ Make sure that the QMA, vacuum chamber, and entire apparatus always have a proper connection to protective ground. ▶ Provide additional protection if the user can touch the analyzer when the vacuum system is open. ▶ Ensure mechanical protection against contact of the analyzer and the parts installed. ▶ Ensure compulsory separation of the current supply when opening the system (using a door contact, for example).

⚠ DANGER

Danger to life due to dangerous contact voltage

The voltages of the IS 816, the HV 801 and the BIAS, TARGET, and EXTR auxiliary voltages are life threatening.

- Observe the technical data of the IS 816 and the HV 801.
- Only use professionally made cables.

⚠ DANGER

Danger to life from electric shock

The voltages under the connector plates are life threatening. Operation is not permitted if the protective pipes have been removed.

- Re-install all removed protective pipes before connecting the cables.
- Pay attention to the additional information in the corresponding chapters for special ion sources.

Risks during operation

⚠ CAUTION

Health risks and environmental damage due to the process gases used

Gases used (process gases) represent a health risk and damage to the environment.

- Check the leak tightness of the connections before introducing the process gas.
- Make sure that the exhaust gas system is suitable for the gases supplied.
- Consider potential interactions between the materials and process gases.
- When handling the gases used, observe the applicable guidelines.
- Observe the protective measures.

Risks during maintenance

⚠ WARNING

Health hazard through poisoning from toxic contaminated components or devices

Toxic process media result in contamination of devices or parts of them. During maintenance work, there is a risk to health from contact with these poisonous substances. Illegal disposal of toxic substances causes environmental damage.

- Take suitable safety precautions and prevent health hazards or environmental pollution by toxic process media.
- Decontaminate affected parts before carrying out maintenance work.
- Wear protective equipment.

Risks when shipping

⚠ WARNING

Risk of poisoning from contaminated products

Where products that contain harmful substances are shipped for maintenance or repair purposes, the health and safety of service personnel is at risk.

- Comply with the notices for safe shipment.

Risks during disposal

⚠ WARNING

Health hazard through poisoning from toxic contaminated components or devices

Toxic process media result in contamination of devices or parts of them. During maintenance work, there is a risk to health from contact with these poisonous substances. Illegal disposal of toxic substances causes environmental damage.

- ▶ Take suitable safety precautions and prevent health hazards or environmental pollution by toxic process media.
- ▶ Decontaminate affected parts before carrying out maintenance work.
- ▶ Wear protective equipment.

2.3 Safety precautions

The product is designed according to the latest technology and recognized safety engineering rules. Nevertheless, improper use can result in danger to operator all third party life and limb, and product damage and additional property damage.

Duty to provide information on potential dangers

The product holder or user is obliged to make all operating personnel aware of dangers posed by this product.

Every person who is involved in the installation, operation or maintenance of the product must read, understand and adhere to the safety-related parts of this document.

Infringement of conformity due to modifications to the product

The Declaration of Conformity from the manufacturer is no longer valid if the operator changes the original product or installs additional equipment.

- Following the installation into a system, the operator is required to check and re-evaluate the conformity of the overall system in the context of the relevant European Directives, before commissioning that system.

General safety precautions when handling the product

- ▶ Observe all applicable safety and accident prevention regulations.
- ▶ Check that all safety measures are observed at regular intervals.
- ▶ Pass on safety instructions to all other users.
- ▶ Do not expose body parts to the vacuum.
- ▶ Always ensure a secure connection to the earthed conductor (PE).
- ▶ Never disconnect plug connections during operation.
- ▶ Observe the above shutdown procedures.
- ▶ Keep lines and cables away from hot surfaces (> 70 °C).
- ▶ Do not carry out your own conversions or modifications on the device.
- ▶ Observe the unit protection degree prior to installation or operation in other environments.
- ▶ Provide suitable touch protection, if the surface temperature exceeds 70 °C.
- ▶ Inform yourself about any contamination before starting work.

2.4 Proper use

The QMG 800 HiQuad quadrupole mass spectrometer system is used for gas analysis in the high vacuum range.

Use the product according to its intended purpose

- ▶ Install, operate and maintain the product only in accordance with these operating instructions.
- ▶ Comply with the limits of use.
- ▶ Observe the technical data.

2.5 Foreseeable improper use

Improper use of the product invalidates all warranty and liability claims. Any use that is counter to the purpose of the product, whether intentional or unintentional, is regarded as improper use; in particular:

- Use outside the limits of use in accordance with the technical data
- Use for measurements whose results determine the safety of persons or large values
- Use with corrosive or explosive media
- Use outdoors
- Use after technical changes (inside or outside on the product)
- Use with replacement or accessory parts that are not suitable or not approved

2.6 Responsibilities and warranty

Pfeiffer Vacuum shall assume no responsibilities and warranty if the operating company or a third party:

- disregards this document
- does not use the product for its intended purpose
- carries out any modifications to the product (conversions, changes, etc.) that are not listed in the corresponding product documentation
- operates the product with accessories that are not listed in the corresponding product documentation

The operator is responsible for the process media used.

2.7 Operator requirements

Safety-conscious work

1. Only operate the product in a technically flawless state.
2. Operate the product in line with its intended purpose, safety and hazard-conscious as well as when observing the operating instructions.
3. Fulfill the following guidelines and monitor their observation of the following guidelines:
   - Proper use
   - Generally applicable safety instructions and accident prevention regulations
   - International, national and locally applicable standards and guidelines
   - Additional product-related guidelines and regulations
4. Only use original parts or parts approved by Pfeiffer Vacuum.
5. Keep the operating instructions available at the place of installation.
6. Ensure personnel qualification.

2.8 Personnel qualification

The work described in this document may only be carried out by persons who have appropriate professional qualifications and the necessary experience or who have completed the necessary training as provided by Pfeiffer Vacuum.

Training people

1. Train the technical personnel on the product.
2. Only let personnel to be trained work with and on the product when under the supervision of trained personnel.
3. Only allow trained technical personnel to work with the product.
4. Before starting work, make sure that the commissioned personnel have read and understood these operating instructions and all applicable documents, in particular the safety, maintenance and repair information.

2.8.1 Ensuring personnel qualification

Specialist for mechanical work

Only a trained specialist may carry out mechanical work. Within the meaning of this document, specialists are people responsible for construction, mechanical installation, troubleshooting and maintenance of the product, and who have the following qualifications:

- Qualification in the mechanical field in accordance with nationally applicable regulations
- Knowledge of this documentation

Specialist for electrotechnical work
Only a trained electrician may carry out electrical engineering work. Within the meaning of this document, electricians are people responsible for electrical installation, commissioning, troubleshooting, and maintenance of the product, and who have the following qualifications:

- Qualification in the electrical engineering field in accordance with nationally applicable regulations
- Knowledge of this documentation

In addition, these individuals must be familiar with applicable safety regulations and laws, as well as the other standards, guidelines, and laws referred to in this documentation. The above individuals must have an explicitly granted operational authorization to commission, program, configure, mark, and earth devices, systems, and circuits in accordance with safety technology standards.

Trained individuals
Only adequately trained individuals may carry out all works in other transport, storage, operation and disposal fields. Such training must ensure that individuals are capable of carrying out the required activities and work steps safely and properly.

2.8.2 Personnel qualification for maintenance and repair

Advanced training courses
Pfeiffer Vacuum offers advanced training courses to maintenance levels 2 and 3.

Adequately trained individuals are:

- **Maintenance level 1**
  - Customer (trained specialist)
- **Maintenance level 2**
  - Customer with technical education
  - Pfeiffer Vacuum service technician
- **Maintenance level 3**
  - Customer with Pfeiffer Vacuum service training
  - Pfeiffer Vacuum service technician

2.8.3 Advanced training with Pfeiffer Vacuum

For optimal and trouble-free use of this product, Pfeiffer Vacuum offers a comprehensive range of courses and technical trainings.

For more information, please contact Pfeiffer Vacuum technical training.

2.9 Operator requirements

Observing relevant documents and data

1. Read, observe and follow this operating instruction and the work instructions prepared by the operating company, in particular the safety and warning instructions.
2. Install, operate and maintain the product only in accordance with these operating instructions.
3. Carry out all work only on the basis of the complete operating instructions and applicable documents.
4. Comply with the limits of use.
5. Observe the technical data.
6. Please contact the Pfeiffer Vacuum Service Center if your questions on operation or maintenance of the product are not answered in these operating instructions.
   - You can find information in the Pfeiffer Vacuum service area.

3 Product description

3.1 Design, construction

A quadrupole analyzer consists of:

- Ion source
- Mass filter with quadrupole rods
- Ion detector (SEM and deflection unit with Faraday, or only Faraday)
- Housing with flanges

Through high mechanical accuracy and the optimization of the ion-optic unit of ion source and rod system, the analyzers achieve a high resolution, high transmission and low mass discrimination. The good resolution and high mass range are prerequisites for using the devices to solve analytical measuring problems. The different versions with Faraday cup or with 90° off-axis SEM and Faraday cup, as well as the wide selection of ion sources, allow optimal adjustment to the respective measuring problem. The open design and the low outgassing rate of the analyzers, which are designed as immersion systems, enable exact partial pressure analyses, from high vacuum to extreme ultra-high vacuum (XHV).

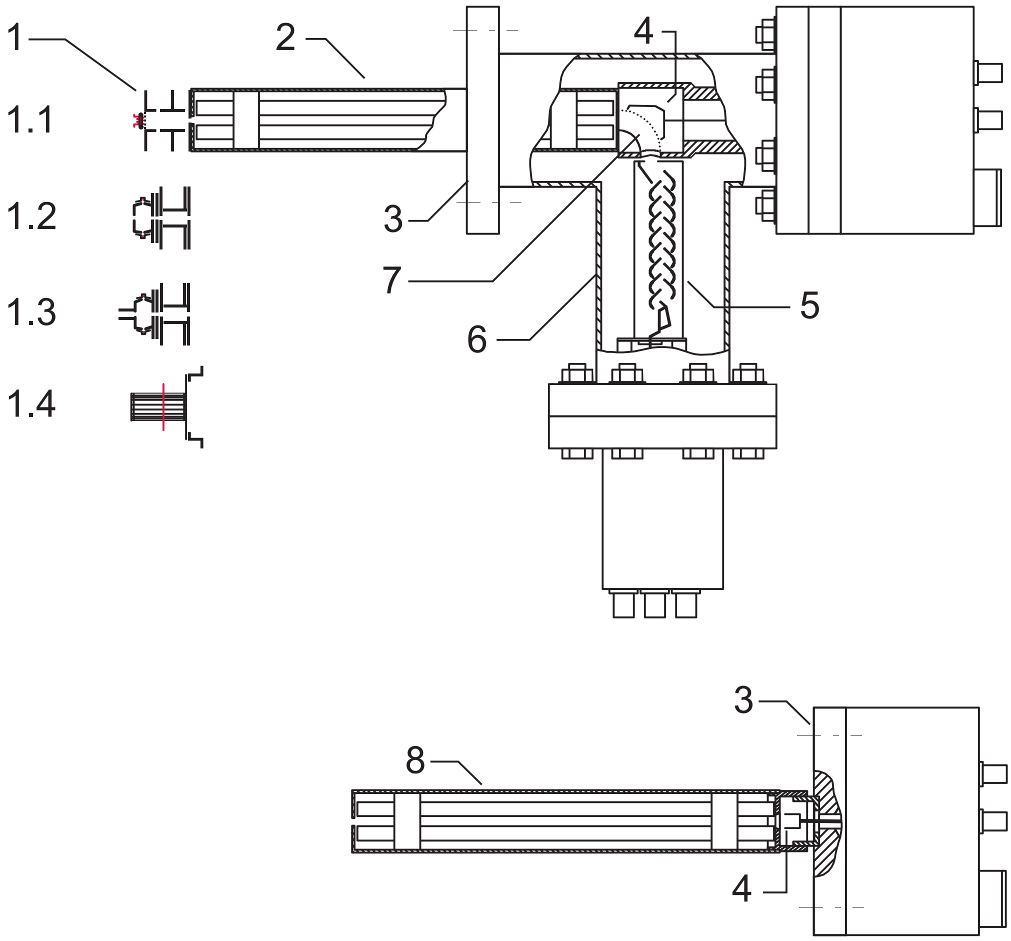


Fig. 1: QMA with 90° off-axis SEM

1	Ion source (variants)	3	Connection flange
1.1	Axial	4	Faraday cup
1.2	Crossbeam (CB)	5	SEM
1.3	Crossbeam (gas tight)	6	Housing
1.4	Grille	7	Deflection unit
2	Mass filter	8	QMA with Faraday cup

3.2 Ion sources

Ionization is achieved through ion impact. Thermal emission causes electrons to leave a heated wire and electrical attraction fields focus them toward the ionization area. The ionization process is the most decisive factor for the quality of the entire analysis. Errors in this part of the process can largely not be corrected in the later steps. Choosing the correct ion source is crucial. Closed (gas-tight) ion sources allow gas analysis with minimal contribution of the residual vacuum. They exhibit practically no de-mixing, have a high signal-to-ground ratio, low gas consumption and a low time constant.

3.2.1 Axial ion source

By focusing the ions in axial direction, the axial ion source supplies ions with a narrow energy distribution and a small speed component transversely to the axis. Excellent resolution, high sensitivity, and good linearity are thus achieved. The open design allows recording of rapid changes in the partial pressure, with minimum distortion due to self-outgassing and surface reactions.

Standard filament
W, with YO_x-Ir also being available.

Application examples
- General gas analysis
- Residual gas analysis
- Desorption measurements

Function
The electrons emitted by the cathode are accelerated toward the grid of the ionization area. The Repeller electrode, which is negative to the cathode, focuses the electrons. Most of the electrons pass through the grid and reach the lens (focus) or return to the grid. The ions produced by electron impact are drawn out by the focus and entrance orifice and focused to the mass filter. The grid prevents the ions from being drawn to the cathode. The field axis potential is a few volts below the potential of the ionization area, so that mainly ions from the ionization area enter the mass filter. Ions emitted outside the ionization area have a lower kinetic energy when they enter the mass filter. They therefore remain in the mass filter significantly longer. Such ions are separated out almost completely.

Degas
With degassing, the outgassing rate of the axial ion source can be reduced.
- Pressure: ≤ 10^{-8} hPa
- Emission: ≤ 10 mA (at 550 V)
- Time: ≤ 5 minutes

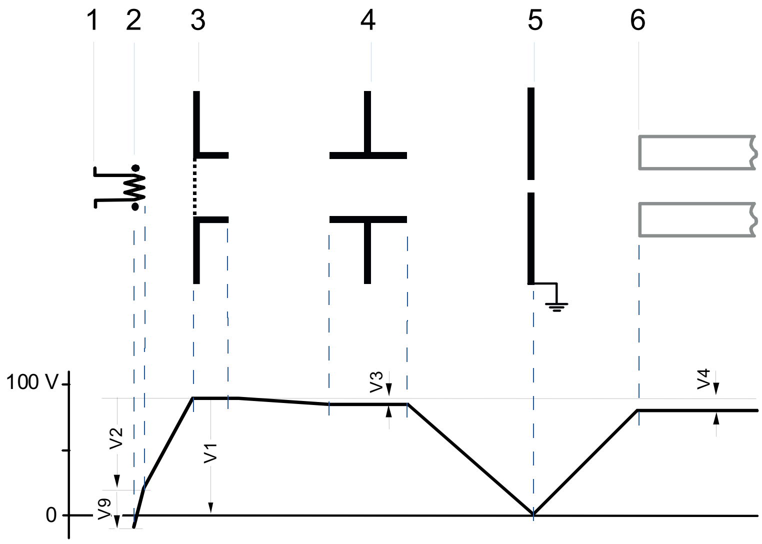


Fig. 2: Electrode arrangement and potential curve of the axial ion source

1 Cathode
2 Wehnelt
3 Ionization area
4 Focus
5 Entrance orifice
6 Rod system

Emission		1 mA 1)
V1	Ion Reference	90 V

V2	Cathode	70 eV [2]
V3	Focus	20 V
V4	Field Axis	10 V [3]
V6	Inner Deflection	300 V
V9	Wehnelt	30 V (max. 40)
Protection Current	W YO_x-Ir	4.2 A 3.5 A

Tbl. 3: Typical values of the axial ion source

3.2.2 Crossbeam ion source

The open design of the crossbeam ion source allows quick reaction to changes in the gas composition. It has a long service life and is equipped with two filaments. The crossbeam ion source allows the direct passage of molecular beams perpendicular and parallel to the system axis.

Standard filament
W, with YO_x-Ir also being available.

Gas-tight versions
In the case of gas-tight crossbeam ion sources, the ionization area is sealed. The conductance to the vacuum chamber is approx. 1 l/s.

Selecting operating pressure for gas-tight versions

► Select an operating pressure of $<10^{-6}$ hPa in the vacuum chamber.

Application examples

- Analysis of particle beams and general gas analysis
- Qualitative and quantitative gas analyses (composition and chronological sequence)
- Analysis of reactive and aggressive gases (with special accessories)
- Detection of contamination in gases
- Isotope measurements
- Residual gas analysis on vacuum processors (e.g. plasma etching)
- Process monitoring / process control (e.g. closed-loop control of gas composition or of vaporization sources)
- Molecular beam applications

Thanks to their minimal gas consumption, low de-mixing and low time constant, the gas-tight versions are particularly suitable for:

- Measuring gases and solvents in fluids
- Respiration analysis
- Analysis of gas mixtures
- Trace detection thanks to less influence from the residual gas
- Corrosive or toxic gases

Function
The electrons emitted by the cathode and focused by the Wehnelt that is connected to the cathode enter the ionization area through a gap and perpendicular to the system axis. In the ionization area, the electrons ionize the gas. The ions are drawn out by the extraction electrode and focused into the mass filter through the ion lens (focus). The electron beam, particle beam (if a molecular beam is admitted) and ion extraction are perpendicular to each other. The field axis potential, which is a few volts below the potential of the ionization area, mainly focuses ions from the ionization area into the mass filter.

Degas
Degassing the crossbeam ion source is only recommended in exceptional cases.

1) At $p > 5 \times 10^{-6}$ hPa, reduce to 0.1 mA.

2) Before reducing V2 to < 50 eV, reduce the "Emission" to 0.1 mA and V9 to < 20 V to prevent overloading of the cathode.

3) 5 V at mass range 1024 or 2048

- Pressure: ≤ 10^{-8} hPa
- Emission: ≤ 10 mA (at 550 V)
- Time: ≤ 5 minutes

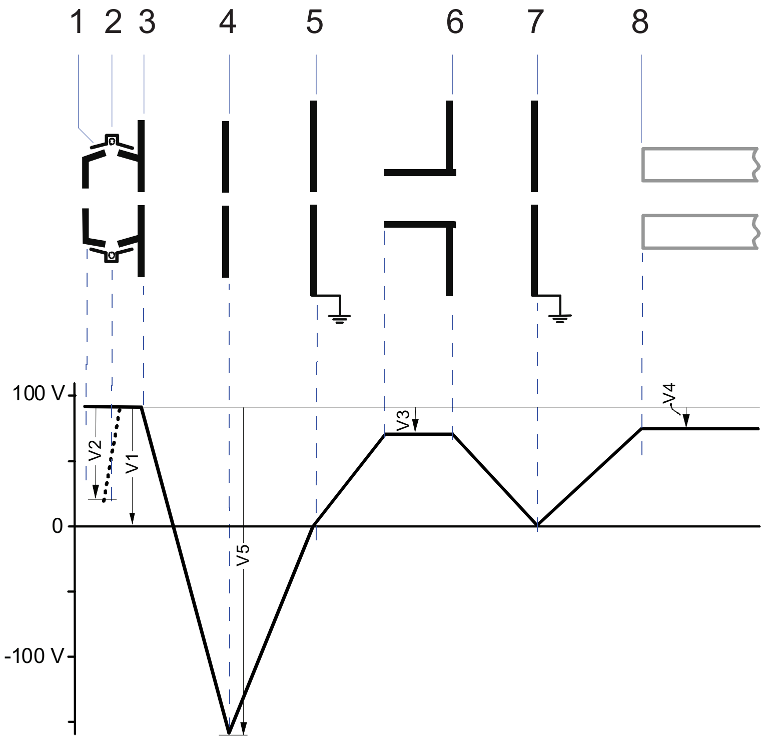


Fig. 3: Electrode arrangement and potential curve of the crossbeam ion source

1 Wehnelt
2 Cathode
3 Ionization area
4 Extraction
5 Base plate
6 Focus
7 Entrance orifice
8 Rod system

Emission		1 mA [4)]
V1	Ion Reference	90 V
V2	Cathode	70 eV [5)]
V3	Focus	20 V
V4	Field Axis	15 V
V5	Extraction	250 V
V6	Inner Deflection	300 V
Protection Current	W YO_x-Ir	4.2 A 3.5 A

Tbl. 4: Typical values of the crossbeam ion source

3.2.3 Grid ion source

The grid ion source has a very open design, has an extremely low outgassing rate and can be degassed easily. It emits only a few surface ions. It is always equipped with two tungsten filaments.

Application examples

- Residual gas analysis in UHV
- Desorption measurements

4) With magnet 0.7 mA / At p > 5 × 10^{-6} hPa, reduce to 0.1 mA.

5) Before reducing V2 to < 50 eV, reduce the "Emission" to 0.1 mA and V9 to < 20 V to prevent overloading of the cathode.

Function

The two electrons which are emitted by the ring cathode are accelerated toward the grid and mainly pass through the grid. The ions formed inside the grid are drawn to the mass filter by the grounded entrance orifice. The cathode is connected in the middle; each half of it can thus be operated separately.

Degas

With the degas function, the outgassing rate of the grid ion source and the desorption of surface ions is reduced.

- Pressure: ≤ 10^{-7} hPa
- Emission: ≤ 20 mA (at 550 V)
- Time: 10–15 minutes

Degassing recommendations for the grid ion source

1. Perform degassing for 10 – 15 minutes.
2. Wait for the final pressure.
3. Check the spectrum.
4. Repeat the operation if needed.

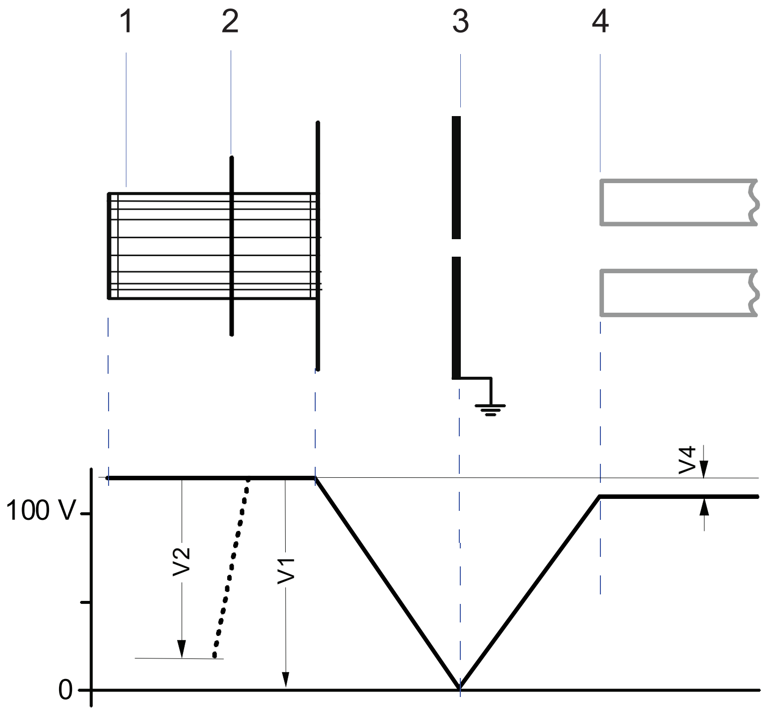


Fig. 4: Electrode arrangement and potential curve of the grid ion source

1 Grid
2 Cathode
3 Entrance orifice
4 Rod system

Emission		2 mA [6)]
V1	Ion Reference	120 V
V2	Cathode	100 eV [7)]
V4	Field Axis	10 V
V6	Inner Deflection	200 V
Protection Current	W YO_x-Ir	4.2 A 3.5 A

Tbl. 5: Typical values of the grid ion source

6) At p > 5 × 10^{-6} hPa, reduce to 0.2 mA.

7) Before reducing V2 to < 50 eV, reduce the "Emission" to 0.1 mA and V9 to < 20 V to prevent overloading of the cathode.

3.3 Mass filter

The correct material selection and highly precise manufacturing methods ensure a high degree of linearity and reproducibility.

3.3.1 QMA 430

The 8 mm rod system made of stainless steel can be used up to mass number 300.

3.3.2 QMA 400

For higher mass ranges as well as optimum stability and reproducibility, 8 mm molybdenum rods are used, because of the superior electrical and thermal properties of the material.

3.4 Secondary electron multiplier SEV 217

The multiplier consisting of 17 discrete stages with focusing dynode geometry is a fast ion current amplifier that is located between the mass filter and electrometer pre-amplifier. Thanks to its high amplification, the downstream electrometer pre-amplifier can be operated with a lower amplification; this results in smaller time constants and thus make it possible to measure fast signals with low intensity.

In normal operation, with negative high voltage at HV- and ground at HV+ of the SEV 217 secondary electron multiplier, the SEV 217 detects positive ions. The "SEM Voltage" parameter for the SEM operating voltage determines the amplification and is simultaneously the post-acceleration energy of the ions.

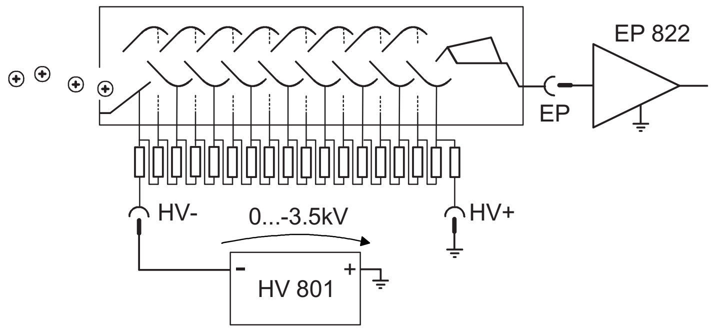


Fig. 5: SEV 217

3.5 Overview of the variants

3.5.1 Cathode materials

Tungsten (W) is the standard cathode material. Thanks to the very low vapor pressure, it is particularly suitable for UHV applications. However, at high carbon concentrations, tungsten forms carbides in the gas mixture to be measured, which leads to unstable emission conditions (CO_2 cycle).

Yttriated iridium (YOx-Ir) is relatively insensitive to air ingress, as iridium does not form oxides. The emission temperature of oxide cathodes is lower than that of tungsten. Reactions with residual gas are weaker because the ion source temperature remains low. The susceptibility to contamination can be stronger when substances with a low vapor pressure are admitted.

Selecting cathode material

- ► Equip the ion source with cathodes (filaments) made of the most suitable material for the respective application.
  - – Not all materials are available for all ion source types.

3.5.2 Electron collimation magnet

Pfeiffer Vacuum recommends equipping the crossbeam ion source with a magnet unit for applications in high mass ranges and for molecular beam detection. The magnet increases the real path length of the electrons and thus the ion yield. This results in higher sensitivity and better injection conditions. In addition, the magnet prevents the majority of the electrons from hitting locations of the formation area that are less critical with regard to ion optics. However, the linearity (measuring signal vs. pressure) is reduced.

Baking out analyzers with integrated magnets

▶ Heat analyzers with integrated magnets to max. 300 °C.

3.5.3 90° deflection

The 90° off-axis arrangement has a very low signal background because the electrostatic 90° deflection prevents fast or excited neutrals and photons from hitting the SEM.

3.5.4 90° deflection with deflection voltage

The inner deflection plate is on potential V6 "Deflection", the outer deflection plate is directly connected to the Faraday cup and electrometer pre-amplifier EP1 and is thus on ground potential. If no EP1 is present, use a jump plug.

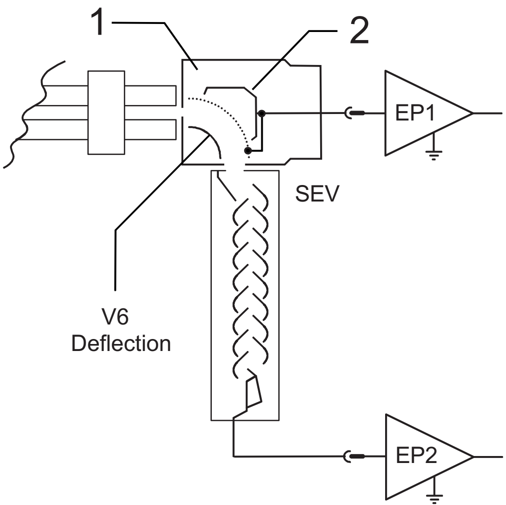


Fig. 6: 90° deflection with deflection voltage

1 Deflection unit
2 Faraday cup

3.5.5 Faraday cup

Faraday cup operation (QMA with Faraday or SEM types operated in Faraday mode) reduces systematic conversion errors of the SEM (e.g. mass discrimination). Faraday operation can also be used for malfunction diagnosis. The drawback is the lower sensitivity, which requires a higher amplification and thus limits the response speed.

3.5.6 Vacuum-annealed QMA

The QMA with the vacuum-annealed grid ion source has a very low self-outgassing and desorption rate (<10^{-10} hPa l/s).

3.6 Identifying the product

You will need all the data from the rating plate to safely identify the product when communicating with Pfeiffer Vacuum.

▶ To ensure clear identification of the product when communicating with Pfeiffer Vacuum, always keep all of the information on the rating plate to hand.

3.7 Scope of delivery

- QMA analyzer
- Test log

Unpacking the product and checking completeness of the shipment

1. Unpack the product.
2. Remove the transport fasteners, transport protection etc.
3. Store the transport fasteners, transport protection etc. in a safe place.
4. Check that the shipment is complete.
5. Ensure that no parts are damaged.

4 Transport and storage

4.1 Transporting product

NOTICE

Damage caused by incorrect transport

Transport in unsuitable packaging or failure to install all transport locks can result in damage to the product.

- ▶ Comply with the instructions for safe transport.

Packing

We recommend keeping the transport packaging and original protective cover.

Safe transport of the product

- ▶ Observe the weight specified on the transport packaging.
- ▶ Where possible, always transport or ship the product in the original transport packaging.
- ▶ Always use dense and impact-proof transport packaging for the product.
- ▶ Remove the existing protective cap and transport protections only immediately prior to installation.
- ▶ Reattach transport locks and transport protections prior to each transport.

4.2 Storing product

NOTICE

Damage caused by improper storage

Improper storage will lead to damage to the product.

Static charging, moisture, etc. will lead to defects on the electronic components.

- ▶ Comply with the instructions for safe storage.

Packing

We recommend storing the product in its original packaging.

Safe storage of the product

- ▶ Store the product in a cool, dry, dust-free place, where it is protected against impacts and mechanical vibration.
- ▶ Always use dense and impact-proof packaging for the product.
- ▶ Where possible, store the product in its original packaging.
- ▶ Store electronic components in antistatic packaging.
- ▶ Maintain the permissible storage temperature.
- ▶ Avoid extreme fluctuations of the ambient temperature.
- ▶ Avoid high air humidity.
- ▶ Seal connections with the original protective caps.
- ▶ Protect the product with the original transport protection (where available).

5 Installation

5.1 Preparing analyzer for installation

⚠ DANGER

Danger to life caused by electric voltage on the analyzer

During operation, dangerous voltage is present on the electrode system of the QMA analyzer. Components in the vacuum system are dangerous to touch under certain conditions. There is danger to life due to electric voltage.

- ▶ Protect installed parts, connected units and lines against galvanic connections, flashover or charge carrier flow.
- ▶ Make sure that the QMA, vacuum chamber, and entire apparatus always have a proper connection to protective ground.
- ▶ Provide additional protection if the user can touch the analyzer when the vacuum system is open.
- ▶ Ensure mechanical protection against contact of the analyzer and the parts installed.
- ▶ Ensure compulsory separation of the current supply when opening the system (using a door contact, for example).

NOTICE

Damage to the analyzer caused by external voltages and magnetic fields

Never expose the analyzer electrode system to external voltages that are hazardous in the event of contact, as a result of galvanic connections, contact, flashover, plasma, ion or electron beams, etc. If such danger sources exist in the vacuum chamber, you must provide protective measures that safely rule out such influences. Even smaller external voltages acting on the analyzer will lead to damage to the electronics and unreliable measuring results.

- ▶ Meet appropriate protective measures against external voltages (for example, better arrangement, shielding, earthing, etc.).
- ▶ Do not mount the analyzer near to magnetic fields with > 0.2 mT.
- ▶ Ensure mechanical protection against contact of the analyzer and the parts installed.
- ▶ Ensure compulsory separation of the current supply when opening the system (using a door contact, for example).
- ▶ Observe the standards applicable for the vacuum system.

5.1.1 Choosing mounting orientation

In many cases, the mounting orientation of the analyzer does not affect its function. The position of the ion source has to match the analytical task. For example, no reliable residual gas measurement is possible when only a pipe with a small cross section connects the analyzer with the measurement chamber.

Procedure

- ▶ Choose a mounting orientation where a good arrangement of QMH high-frequency generator and cables can be achieved.

5.1.2 Preparing gas inlet system

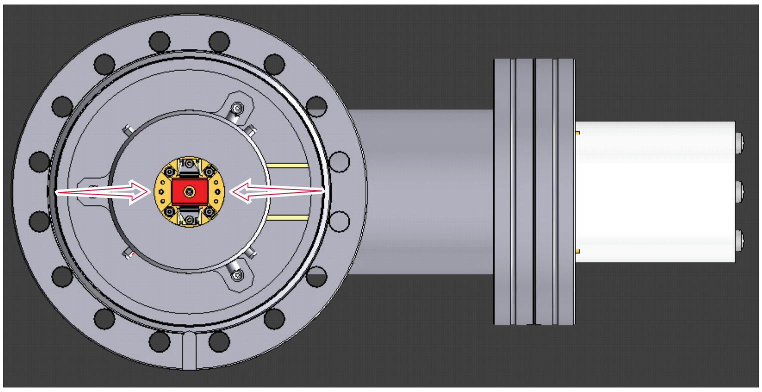


Fig. 7: Correct alignment on the flange of the QMA with C/B ion source

Procedure

- ► Prepare the gas inlet system as necessary to enable easy connection to the ion source afterward.
- ► Mark the correct alignment (arrow direction) on the flange of the QMA and of the system, if the crossbeam ion source has to be aligned to the gas supply.

5.1.3 Installing support plate

Required tools

- Screwdriver, **no. 6**

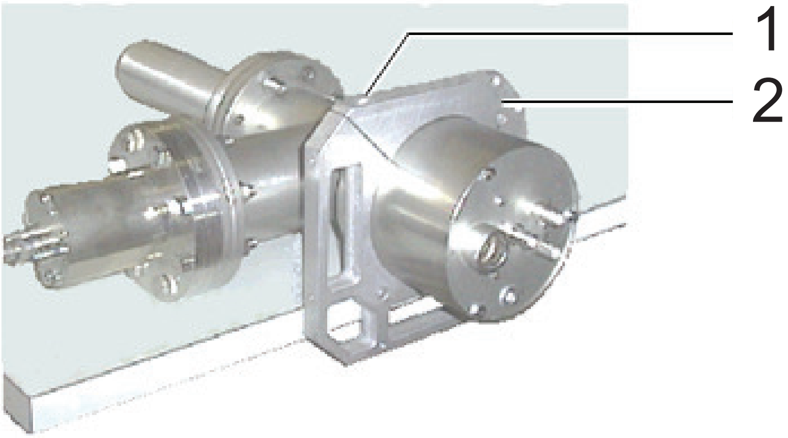


Fig. 8: Installing support plate

1 Clamping screw on the side 2 Support

Procedure

1. Place the analyzer on the edge of the table.
2. Use the screwdriver to loosen the clamping screw on the side of the support plate.
3. Push the support plate onto the analyzer flange.
4. Align the support plate in such a way that you are able to easily hold the analyzer to guide it into the vacuum system with the correct orientation.
5. Tighten the clamping screw with the screwdriver.

5.1.4 Using assembling trestle

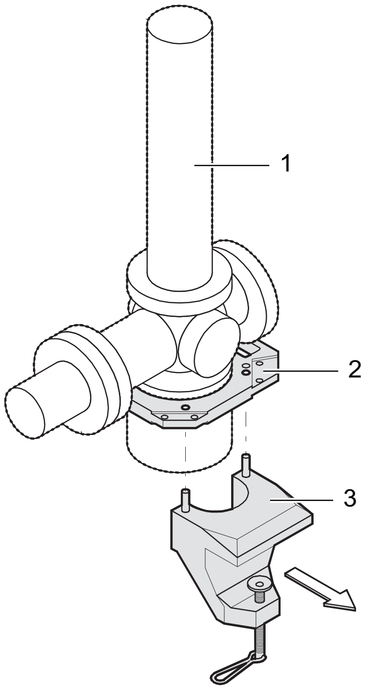


Fig. 9: Analyzer on the assembling trestle

1 Analyzer
2 Support
3 Assembling trestle

Procedure

1. Clamp the assembling trestle onto a stable table.
2. Place the analyzer with the support on the assembling trestle.

5.1.5 Removing transportation protection

NOTICE

Impairment from contamination and damage

Touching the devices or components with bare hands increases the desorption rate and leads to incorrect measurements. Dirt (e.g. dust, fingerprints, etc.) and damage impair the function.

- ► During assembly and maintenance work on high or ultra high vacuum systems, always wear clean, lint-free and powder-free laboratory gloves.
- ► Only use clean tools.
- ► Make sure that the connection flanges are free of grease.
- ► Remove protective caps and protective covers from flanges and connections only when necessary.
- ► Remove the analyzer's transport protection only when necessary.
- ► Carry out all work in a well lit area.

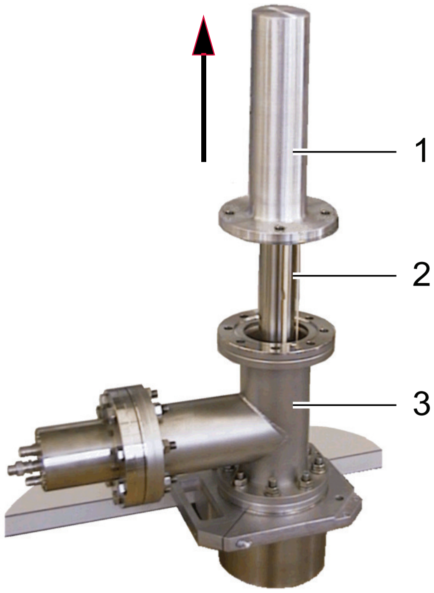


Fig. 10: Removing transportation protection

1 Transport protection
2 Mass filter
3 Analyzer housing

Procedure

1. Carefully remove the transportation protection and store it for future use.
2. Check the inside for damage and wiring short-circuits.

5.1.6 Removing protective pipe

Prerequisites

- Device is switched off
- All cables have been disconnected from the analyzer

Required tools

- Screwdriver

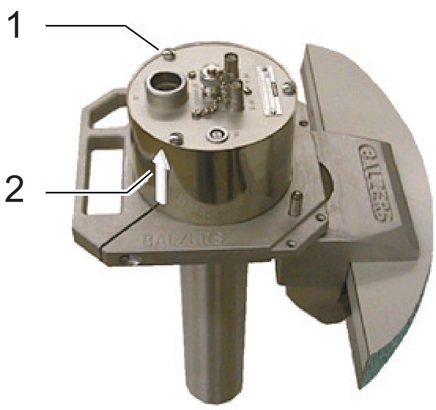


Fig. 11: Removing protective pipe

1 Screw (3×)
2 Protective pipe

Procedure

1. Remove the 3 outer screws.
2. Pull off the protective pipe.

5.1.7 Installing electron collimation magnets

NOTICE

Impairment from contamination and damage

Touching the devices or components with bare hands increases the desorption rate and leads to incorrect measurements. Dirt (e.g. dust, fingerprints, etc.) and damage impair the function.

- ▶ During assembly and maintenance work on high or ultra high vacuum systems, always wear clean, lint-free and powder-free laboratory gloves.
- ▶ Only use clean tools.
- ▶ Make sure that the connection flanges are free of grease.
- ▶ Remove protective caps and protective covers from flanges and connections only when necessary.
- ▶ Remove the analyzer's transport protection only when necessary.
- ▶ Carry out all work in a well lit area.

NOTICE

Incorrect magnet alignment

The magnets have been aligned. Removing the magnets from their mounting plate destroys the alignment.

- ▶ Do not remove the magnets from the mounting plate.

Pfeiffer delivers the magnetic unit of the crossbeam ion source in separate packaging.

Prerequisite

- Operational conditions fulfilled

Required tools

- Screwdriver

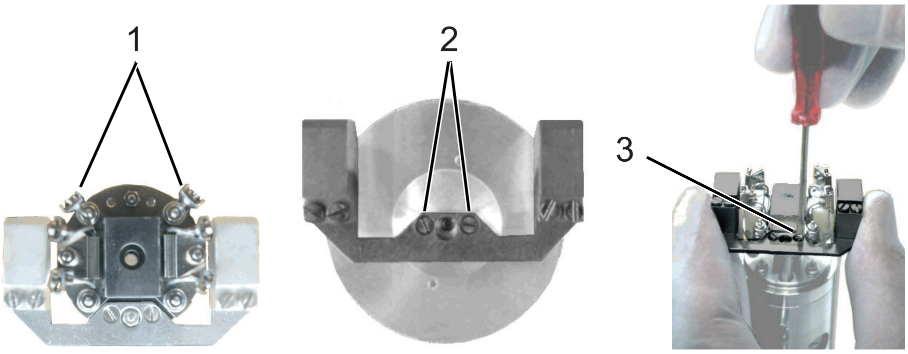


Fig. 12: Installing electron collimation magnets

1 Connections
2 Screws
3 Installing magnetic unit

Procedure

1. Position the analyzer in such a way that you can easily install the magnetic unit.
2. Loosen the two screws, but do not remove them.
3. Take the magnetic unit out of the packing, together with the screws.
4. Install the magnetic unit on the ion source.

5.2 Installing analyzer

NOTICE

Damage from vertical seal falling out

Vertically positioned seals can easily fall out of the groove and damage the ceramic capillaries of the wiring.

► During installation, hold the vertical seal stationary with a knife blade.

Perform installation work as a 2-person team

Depending on the installation position, the work can be difficult.

Pfeiffer Vacuum recommends letting a second person assist, to prevent damage.

Prerequisite

- Installation area free of obstacles

Required tools

- Knife (box cutter)
- Wrench

Required material

- OFHC copper gasket

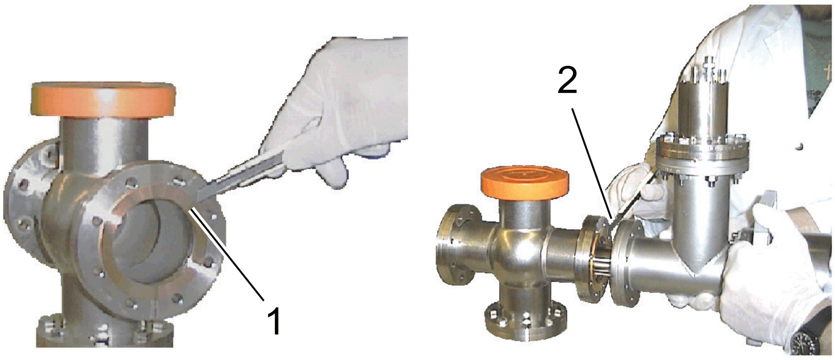


Fig. 13: Holding vertical seal with knife blade

1 OFHC copper gasket
2 Holding in place with a knife blade

Procedure

1. Insert an OFHC copper gasket into the analyzer or system flange.
2. During installation, hold the OFHC copper gasket stationary with a knife blade.
3. Carefully insert the analyzer into the vacuum system.
   – The ion source and wiring must not touch any parts.
4. Insert one of the upper screws and hand-tighten it.
5. Insert the screw on the opposite side.
6. Insert the remaining screws.
7. Tighten all screws properly.
8. Evacuate the vacuum system and check whether the expected vacuum is achieved.

5.3 Connecting the gas inlet system

⚠ CAUTION

Health risks and environmental damage due to the process gases used

Gases used (process gases) represent a health risk and damage to the environment.

- ▶ Check the leak tightness of the connections before introducing the process gas.
- ▶ Make sure that the exhaust gas system is suitable for the gases supplied.
- ▶ Consider potential interactions between the materials and process gases.
- ▶ When handling the gases used, observe the applicable guidelines.
- ▶ Observe the protective measures.

Procedure

- ▶ In the case of ion sources with gas inlet system, professionally connect the gas inlet system.
- ▶ Electrically insulate the conductor against the ion source.

5.4 Installing HF generator QMH 800-x

You will find information on installing the QMH 800-x HF generator in the operating instructions for the QMH 800-x.

5.5 Installing EP 822 electrometer pre-amplifier on analyzer

For information on installing the EP 822 electrometer pre-amplifier, refer to the QMG 800 HiQuad Neo operating instructions.

5.6 Removing/installing SEM connector plate

⚠ DANGER

Danger to life from electric shock

The voltages under the connector plates are life threatening. Operation is not permitted if the protective pipes have been removed.

- ▶ Re-install all removed protective pipes before connecting the cables.
- ▶ Pay attention to the additional information in the corresponding chapters for special ion sources.

Prerequisites

- Device is switched off
- All cables have been disconnected from the analyzer

Required tools

- Allen key, **WAF 1.5**
- Screwdriver
- Pin

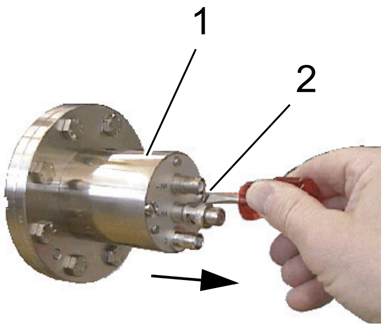


Fig. 14: Protective pipe

1 Protective pipe 2 Large screws (2×)

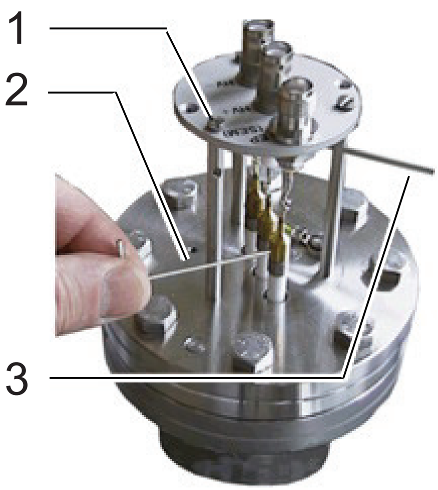


Fig. 15: SEM connector plate

1 Screw (3×)
2 Hexagon socket screw (3 ×, WAF 1.5 mm)
3 Pin

General approach

- ► To remove the SEM connector plate, remove the EP 822.

Removing SEM connector plate (SEM connector)

1. Disconnect all cables from the electronic SEM connector plate.
2. Remove the two large screws.
3. Take off the protective pipe.
4. Remove the three screws.
5. Loosen the three hexagon socket screws (1.5 mm WAF) by 1/2 a turn each.
6. Disconnect the cable lug of the yellow/green grounding conductor from the flange.
7. Remove the connector plate.
8. Unscrew the three studs using a suitable pin.
9. Keep all the parts.
   – You will need these parts again when switching to electrometer operation.

Installing SEM connector plate (SEM connection)

1. Install the three studs using a suitable pin.
2. Put on the connector plate.
3. Connect the cable lug of the yellow/green grounding conductor to the flange.
4. Tighten the three hexagon socket screws (1.5 mm WAF).
5. Insert the three screws.
6. Make sure that you have installed all lock washers in the correct positions again.
7. Put the protective pipe in place.
8. Install the two large screws.
9. Connect all cables with the SEM connector plate.

5.7 Establishing cable connections of components

For information on the cable connections of the components, refer to the QMG 800 HiQuad Neo operating instructions.

6 Commissioning

NOTICE

Contamination of the mass filter caused by gas discharge

If the high-frequency generator is switched on at a total pressure of >10^{-4} hPa, there is risk of a gas discharge igniting between the rods of the analyzer, which could lead to severe contamination of the mass filter.

- ▶ When the total pressure is at >10^{-4} hPa, make sure that the high-frequency generator has been switched off.

NOTICE

Malfunctions caused by magnetic fields

Strong magnetic fields in close proximity to the ion source, channel electron multiplier or SEM, e.g. caused by cold cathode gauges, tools, magnetic clamps, etc., can lead to malfunctions.

- ▶ Prevent influence from high-intensity magnetic fields by arranging the system components appropriately or by installing magnetic shields.
- ▶ Remove magnetic objects from the area of influence.

Factory setting of the parameters

Change the factory setting of the parameters only if this is necessary for your application.

Calibrating high-frequency generator

Contact Pfeiffer Vacuum Service if the high-frequency generator needs to be calibrated.

Switching on the instrument for the first time

1. Before switching on, check that all parts and cables are correctly installed.
2. Switch on the control unit if the pressure is below the maximum permissible total pressure, but do not switch on the emission yet.
   - 10^{-4} hPa with Faraday
   - 10^{-5} hPa with SEM
3. Check whether the values saved in the device match the supplied test log.
   - The test log indicates the optimal values for your analyzer.
4. If the saved values do not match, use the software to configure them.
5. If you do not have the test log any more, activate the default setting for your ion source and optimize it.
   - In complete systems, Pfeiffer Vacuum factory-calibrated the high-frequency generator specifically for the analyzer.

7 Operation

7.1 Adjusting ion source

7.1.1 Adjusting axial ion source

Procedure

1. Start with the last values that provided good results, the values from the test log or, if nothing better is available, with typical values.
2. Adjust "**Focus**" to maximum peak height.
3. Adjust “**Repeller**" to maximum peak height (at "**Cathode**" < 50 V maximum 20 V).
4. Look for the combination of "**Field Axis**" and "**Resolution**" that provides the best peak height with a good peak shape.
5. Determine the best HF cable polarity.

7.1.2 Adjusting crossbeam ion source

Setting the crossbeam ion source without magnet

1. Start with the last values that provided good results, the values from the test log or, if nothing better is available, with typical values.
2. Increase the value of "**Field Axis**" by 1.5 V.
3. Increase the "**Resolution**" by approx. 15%.
4. Alternately adjust "**Focus**" and "**Extraction**" to maximum peak height.
5. Decrease the "**Field Axis**" until the peak height drops approx. 10% and evaluate the peak shape and resolution.
6. Set the "**Resolution**" to a value that is just high enough to suffice for your purposes.
   – Using an unnecessarily good resolution means forfeiting sensitivity and stability.
7. If the peak shape is not good enough (spikes, tailing), try improving it by reducing the "**Field Axis**" parameter.
8. Try new values for "**IonRef**" (in steps of 5 V) to achieve better sensitivity.
   – At each step, reconfigure all other parameters anew. Proceed systematically and record the parameters, as well as the respective peak height and shape achieved.
9. Repeat the process for the second filament. After switching, wait for thermal stability to be established.
   – A large difference in the sensitivity between the two filaments indicate a mechanical deformation.
10. Determine the best HF cable polarity.

Setting the crossbeam ion source with magnet

For analyses at different pressures, Pfeiffer Vacuum recommends removing the magnetic unit or reducing the emission to 0.1 mA. At low emission levels (up to 0.1 mA), the procedure described in the "Setting without magnet" section applies. At higher emission levels, and if you want to achieve the maximum sensitivity, look for the most favorable emission setting, as described below.

1. Set the pressure in the system to the value for which you want to optimize.
   – The pressure has to stay constant during the entire process of configuring the settings.
2. Set "**Field Axis**" to 16 V and "**Emission**" to 0.5 mA.
3. Adjust the "**Extraction**" and "**Focus**" alternately and repeatedly, to the greatest peak height.
4. Make a note of the peak height and the associated values for the "**Emission**", "**Extraction**" and "**Focus**".
5. If the emission is <1 mA, increase it by 0.1 mA and return to step 3.
6. In the noted data, look for the point with the highest peak height and set the parameters to the associated values again.
7. Adjust the "**Field Axis**" and "**Resolution**" as described in the "**Setting without magnet**" section.
8. Determine the most favorable value for "**IonRef**" and the best cable polarity as described in the "**Setting without magnet**" section.
9. Increase the "**Extraction**" until the sensitivity is reduced by 5%; this increases the stability.

The ion source has now been optimized for the current pressure. For other pressures, it is usually sufficient to optimize "**Extraction**" and "**Focus**" again.

7.1.3 Adjusting grid ion source

Procedure

1. Start with the last values that provided good results, the values from the test log or, if nothing better is available, with typical values.
2. Adjust the "**IonRef**" to maximum peak height, however the value always has to be higher than the "**Cathode**" value, else electrons can get onto earthed parts and desorb the ions there.
3. Increase the "**Field Axis**" value until the peak tips "fray" and reduce it again, until a clean peak shape is achieved.
4. If necessary, repeat steps 3 and 4.
5. Determine the best HF cable polarity.

7.2 Operating analyzer at high temperature

Procedure

- ▶ The analyzer can be heated to a maximum of 180°C during operation.
- ▶ The EP 822 and HF generator can be heated to max. 50°C.

7.3 Removing/installing connector plates

Remove the connector plates for bakeout temperatures >200 °C.

Required tools

- Allen key, **WAF 1.5**

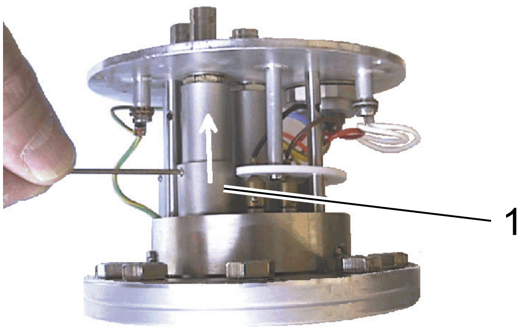


Fig. 16: Connector plates

1 Screening sleeves

Removing connector plates

1. On the 90° version, remove the SEM connector plate, but leave the three studs in place.
2. Remove the protective pipe of the large connector plate.
3. Loosen the hexagon socket screw (1.5 mm WAF) of the screening sleeve by ½ a turn.
4. Push the screening sleeves up to the connector plate and fasten them there.
5. Unfasten the hexagon socket screws (1.5 mm WAF) on all plugs.
6. Unfasten the yellow/green ground conductor.
7. Carefully remove the connector plate.
8. Do **not** remove the guard ring and studs.

Installing connector plates

1. Check that the three studs are securely fastened.
2. Carefully position the connector plates so that the plugs fit onto the associated feedthroughs.
3. Fasten the yellow/green ground conductor.
4. Fasten the connector plates with three screws and lock washers.
5. On all plugs, slightly tighten the hexagon socket screws (1.5 mm WAF), but take care not to apply force to the feedthroughs.
6. Push the screening sleeves over the feedthroughs and tighten their screws.
   – The screening sleeves have to slide into the countersink in the flange.
7. Fit the protective pipe again.

7.4 Baking out analyzer

Prerequisites

- Connector plates removed for bakeout temperatures > 200°C.
- EP 822 and HF generator removed from analyzer prior to bakeout
- EP 822 and HF generator outside bakeout zone

Procedure

- ► Bake out the analyzer up to max. 400°C.
- ► Operate the SEM only with 1000 V at a bakeout temperature of > 150°C.
- ► Let the flange cool to < 50°C before you mount the EP 822 and HF generator again.

7.5 Assessing sensitivity

Pfeiffer Vacuum determines the sensitivity with and without SEM in the factory. The test log included in the delivery of the product contains the values that were determined. The sensitivity is specified in A/hPa for a reference gas. It is recommended to use N_2 or air to check the sensitivity.

Procedure

1. For air, use 80% of the total pressure as N_2 pressure and add the ion currents of masses 14 and 28.
2. Subtract the corresponding residual gas peak heights, if they are not negligible.
3. Make sure the you have measured the reference pressure correctly, e.g. with an ionization gauge installed at an appropriate place (please note the gas type dependence).

7.6 Secondary electron multiplier (SEM)

Setting amplification

- ► With the "**SEM Voltage**" parameter for the SEM high voltage, set the amplification, and thus the sensitivity, using very large thresholds.
- ► Avoid both values below 1 kV and ion currents above >1 µA for a longer period (> several minutes), because the amplification is not stable in these ranges.

Avoiding contamination

- ► When working with an unfavorable gas composition (hydrocarbons and other organic vapors), use as low a current as possible.
- ► Work in Faraday mode if this is expedient.

Low partial pressures

At very low partial pressures (very small peaks), the ion current consists of individual impulses. At a very high SEM amplification, these pulses can overmodulate the input stage of the electrometer preamplifier and thus cause measurement errors (e.g. non-linearity) which are not obvious. Considerable deviations (> 10%) of the values measured within various electrometer ranges, discontinuities of the measured value curves in autorange mode, flattened peaks, incorrect isotope ratios, etc. may be due to this effect. In such cases, reduce the "**SEM Voltage**", select a less sensitive "**Detector Range**" or use "**AUTO DOWN**" um to lock the most sensitive measuring ranges.

Determining amplification factor

- ► Record the range of interest of the mass spectrum in SEM operation and in Faraday operation.

The ratio of the currents of two corresponding peaks is the amplification that applies for the operating conditions entered. This method incorporates the influence of the 90° ion deflection.

7.7 Surface ions

Under the electron bombardment in the ion source, adsorbed contaminations are desorbed as so-called EID ions, which then appear in the spectrum, e.g. with masses 16 (O+), 19 (F+), 23 (Na+), 35/37 (Cl+) and 39/41 (K+). EID ions mainly become apparent during UHV measurements. They can be reduced by degassing (degas or temporary operation with high emission). In order to distinguish between EID ions and ions from the volume, reduce the value of the field axis voltage at the "**Field Axis**" parameter. This significantly reduces the peak height of normal ions. That of EID ions is less affected as they are formed on the highest potential. Therefore, to prevent suppression of the normal ions, do not select a too low "**Field Axis**" value.

7.8 Using degas function

The degas function is intended in particular for UHV measurements with grid ion source.

Procedure

- Observe the information on the individual ion sources.
- Do not switch on the degassing at pressures >10^{-7} hPa, as this can cause severe contamination of the ion source.
- Optimize the "**Protection Current**" filament protection for degas operation.
- If you don't want to use the degas function, or if it is impermissible, set the "**Protection Current**" to 0 A, to block degas operation.

7.9 Determining optimal parameter values

For some applications, it is necessary to deviate from the factory setting. As the contamination increases, or after overhauls, it is recommended to optimize the settings as described in the following sections. For a schematic overview of the potentials and their designations, refer to the "Technical Data" section. With the standard values for the various ion sources that are integrated into the device, a spectrum should be measurable. However, the values always have to be optimized for the analyzer used. The goal of optimizing the ion source parameters is to achieve a high sensitivity, good peak shape and low mass discrimination. Sometimes other conditions also have to be met. This chapter by and large applies to all ion sources; some potentials are not needed with for all ion sources.

Procedure

- Observe the detailed information on the individual ion sources.

7.9.1 Optimization with test gas

Procedure

1. Let a suitable gas with a pressure of **5 × 10^{-6} hPa** flow in (for special ion sources).
   - To optimize for higher masses, corresponding components have to be included, else air is adequate.
2. If you cannot let in gas, perform the optimization with an appropriate residual gas peak.
   - Pay attention to outgassing changes that occur as a result of parameter changes, e.g. regarding H_2O.

Frequently, to improve the sensitivity, inlet procedures are used in which the pressure in the ion source is higher than in the environment. In these cases, determining the sensitivity in A/hPa does not make sense.

7.9.2 Configuring "Emission" ion source parameter

"**Current**": The typical emission current is 1 mA. For yttriated cathodes, this is the maximum value. In some cases (e.g. grid ion source), the sensitivity is higher with 2 mA. However, sometimes, the maximum sensitivity is reached at lower emission settings, e.g. for crossbeam ion sources with electron collimation magnets. This is caused by space charge effects. Observe the detailed information for your ion source type. Recommendation: If you change the "**Emission Current**" value, also optimize the "**Protection Current**" value.

Working with low electron energy and high pressures

- At a low electron energy setting ("**Cathode**" e.g. <50 V) set "**Emission Current**" to 0.1 – 0.2 mA or lower, to avoid filament overload.
- At pressures >10^{-5} hPa, for example, reduce the "**Emission Current**" value to 0.2 mA, to improve the linearity of the measurement (ion current versus partial pressure).

7.9.3 Configuring "Protection Current" ion source parameter

If the pressure rises in the ion source, the heating current of the filament increases. This effect is used to turn the cathode off when the pressure rises. "**Protection Current**" determines the switch-off threshold. If it is not possible to turn on the emission, the reason is usually that the "**Protection Current**" setting is too low.

Procedure

- ► To achieve optimum protection, set the switch-off threshold as low as possible.
  - – The setting is optimal if you are just barely able to switch on the emission without triggering the protection circuit (filament protection).

7.9.4 Configuring "V1 Ion Reference" ion source parameter

"**Ion Reference**" is the nominal potential on which the ion source forms the ions. The effective potential is somewhat lower because of the penetration coefficient of the extraction field and the electron space charge. "**Ion Reference**" is the reference potential for all other potentials (see the technical data). "**Ion Reference**" is the highest positive voltage. This causes virtually all negative particles (mainly electrons) to travel to the ionization area. Desorption induced by electron impact can thus only take place there, if at all. Interference due to nearby ionization gauges is also effectively prevented. In general, the "**Ion Reference**" value should be set slightly higher (approx. 20 V) than the electron energy ("**V2 Cathode**"). The cathode is thus on a positive potential with regard to ground, so that the ion source does not emit any electrons to the environment. This prevents interference with the Faraday cup of the system and nearby measurement instruments (e.g. ionization gauges). Moreover, gases adsorbed in the environment could be emitted through electron impact, which could influence the measurement.

The following effects of the "**Ion Reference**" setting are also influenced by the mechanic tolerances, e.g. by the exact cathode position:

- At low values (25 – 40 V), the sensitivity for lower masses is higher. For higher masses however, the maximum sensitivity is at higher values.
- The higher the "**Ion Reference**" setting, the lower the mass discrimination, i.e. the sensitivity decreases with as the mass numbers increases.
- These relationships become even clearer with higher mass ranges and smaller filter dimensions.
- If you would like to minimize the mass discrimination, select a peak with the highest possible mass for optimizing the ion source parameters.

7.9.5 Configuring "V2 Cathode" ion source parameter

NOTICE

Overloading of the filament

At a reduced ionization energy setting ("**Cathode**" e.g. 40 eV), the filament temperature required for the emission increases. The filament burns out.

- ► In this case, reduces the emission to 0.1 mA, for example.
- ► Calibrate "**Protection Current**" (filament protection).

The cathode voltage determines the acceleration voltage of the electrons and thus the nominal ionization energy. The effective ionization energy deviates slightly from that value, for instance, due to the extraction field. Calibration measurements are required for applications for which the exact ionization energy has to be known. The reference data in spectra libraries are usually referenced to 70 eV. At lower electron energies (e.g. 40 V), fewer double charged ions are formed by the ion source. This prevents for instance contribution of 36Ar++ to mass 18, which would complicate the detection of water vapor traces in argon.

7.9.6 Configuring "V3 Focus" ion source parameter

Procedure

1. Adjust "**Focus**" to maximum peak height.
2. If several maximums occur, select the one with the lowest voltage value, but observe the section applicable for your ion source.
3. Also optimize the "**Extraction**" parameter (if present) when changing the "**Focus**".

7.9.7 Configuring "V4 Field Axis" ion source parameter

The field axis voltage is the potential difference between the ionization area (Ion Reference) and the quadrupole mass filter. The field axis voltage therefore defines the kinetic energy (velocity) of the ions in the rod system. The optimum value for "**Field Axis**" depends, among other factors, on the frequency (QMH type) and the QMA type. Lower frequencies (higher mass ranges) or shorter rod systems require lower ion energies because the ions must stay in the mass filter longer to be resolved. The higher the value, the greater the peak height. However, the resolution is lower and the peak shape potentially deteriorated. Excessively high "Field Axis" values result in "frayed" peaks.

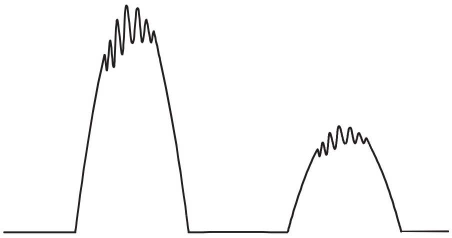


Fig. 17: Frayed peaks

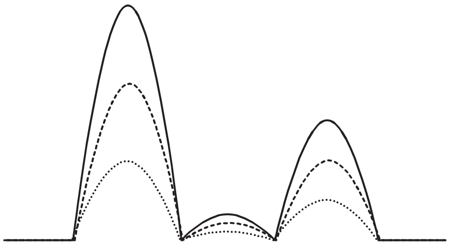


Fig. 18: Reducing "Field Axis"

Reducing "Field Axis"

► Reduce the "**Field Axis**" value if, instead of improving the resolution, adjusting the "**Resolution**" parameter only causes the peak height to decrease.

The aim of the mutual optimization of "**Field Axis**" and "**Resolution**" is to achieve the maximum peak level with the desired resolution and a sufficiently good peak shape. If a bad peak shape cannot be improved by reducing the "**Field Axis**" value, there may be contamination or mechanical problems (e.g. ion source not correctly centered, or assembled in a tilted position). The "Surface ions" chapter shows how normal and so-called EID ions can be differentiated with the aid of the "**Field Axis**" parameter.

7.9.8 Configuring "V5 Extraction" ion source parameter

The extraction voltage (V5 Extraction) accelerates the ions from the ionization area toward the rod system.

Procedure

1. Adjust "**V5 Extraction**" to maximum peak height.
2. Also optimize the "**Focus**" value if the value of "**V5 Extraction** is changed.

7.9.9 Configuring “V6 Deflection” ion source parameters

The deflection voltages ("**Deflection**") direct the ions through the 90° deflection capacitor. In the QMG, in Faraday operation, they are automatically switched to ground potential. The two deflection plates are on positive potential for negative ions and on negative potential for positive ions respectively. The mass filter accelerates the ions to the deflection unit and directs them to the SEM.

One deflection voltage

The inner deflection plate is on potential **"V6 Deflection**", the outer deflection plate is directly connected to the Faraday cup and electrometer pre-amplifier EP1 and is thus on ground potential. The optimum value is determined by the ion formation potential "**Ion Reference**" and to a certain extent by the SEM voltage.

Reference values

- Ion Reference: 120 V | 40 V
- Inner Deflection: 300 V | 200 V

Procedure

► Adjust the "**Deflection**" until the maximum peak height is achieved.

► Optimize the "**Deflection**" again whenever you change the "**SEM Voltage**" value.

7.9.10 Configuring “V9 Repeller” ion source parameters

The Repeller voltage is only used with the axial ion source.

7.9.11 Adapting HF cable polarity

Procedure

- ► Try to improve the sensitivity or peak form by interchanging the HF cables on the analyzer.
  - – Only reverse the polarity of the HF cables when the QMG is switched off.
- ► Perform the optimization with both polarities and then select the best variant.

If reversing the polarity changes the sensitivity by more than 50%, this indicates contamination or mechanical errors.

8 Shipping

⚠ WARNING

Risk of poisoning from contaminated products

Where products that contain harmful substances are shipped for maintenance or repair purposes, the health and safety of service personnel is at risk.

- ► Comply with the notices for safe shipment.

Decontamination subject to charge

Pfeiffer Vacuum decontaminates products not clearly declared "Free of contamination" at your expense.

Safe shipping of the product

- ► Do not ship microbiological, explosive or radioactively contaminated products.
- ► Observe the shipping guidelines for the participating countries and transport companies.
- ► Highlight any potential dangers on the outside of the packaging.
- ► Download the explanation for contamination at Pfeiffer Vacuum Service.
- ► Always enclose a completed declaration of contamination.

9 Recycling and disposal

⚠ WARNING

Health hazard through poisoning from toxic contaminated components or devices

Toxic process media result in contamination of devices or parts of them. During maintenance work, there is a risk to health from contact with these poisonous substances. Illegal disposal of toxic substances causes environmental damage.

- ▶ Take suitable safety precautions and prevent health hazards or environmental pollution by toxic process media.
- ▶ Decontaminate affected parts before carrying out maintenance work.
- ▶ Wear protective equipment.

Environmental protection

You **must** dispose of the product and its components in accordance with all applicable regulations for protecting people, the environment and nature.

- Help to reduce the wastage of natural resources.
- Prevent contamination.

9.1 General disposal information

Pfeiffer Vacuum products contain materials that you must recycle.

- ▶ Dispose of our products according to the following:
  - Iron
  - Aluminium
  - Copper
  - Synthetic
  - Electronic components
  - Oil and fat, solvent-free
- ▶ Observe the special precautionary measures when disposing of:
  - Fluoroelastomers (FKM)
  - Potentially contaminated components that come into contact with media

9.2 Dispose of a mass spectrometer system

Pfeiffer Vacuum mass spectrometer systems contain materials that you must recycle.

1. Dismantle the housing parts.
2. Dismantle all individual components.
3. Dismantle the electronic components.
4. Decontaminate the components that come into contact with process gases.
5. Separate the components into recyclable materials.
6. Recycle the non-contaminated components.
7. Dispose of the product or components in a safe manner according to locally applicable regulations.

10 Service solutions by Pfeiffer Vacuum

We offer first-class service

High vacuum component service life, in combination with low downtime, are clear expectations that you place on us. We meet your needs with efficient products and outstanding service.

We are always focused on perfecting our core competence – servicing of vacuum components. Once you have purchased a product from Pfeiffer Vacuum, our service is far from over. This is often exactly where service begins. Obviously, in proven Pfeiffer Vacuum quality.

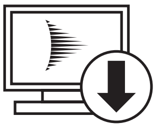
Our professional sales and service employees are available to provide you with reliable assistance, worldwide. Pfeiffer Vacuum offers an entire range of services, from original replacement parts to service contracts.

Make use of Pfeiffer Vacuum service

Whether preventive, on-site service carried out by our field service, fast replacement with mint condition replacement products, or repair carried out in a Service Center near you – you have various options for maintaining your equipment availability. You can find more detailed information and addresses on our homepage, in the section.

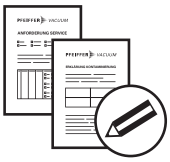
You can obtain advice on the optimal solution for you, from your Pfeiffer Vacuum representative.

For fast and smooth service process handling, we recommend the following:

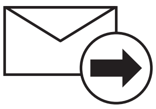


1. Download the up-to-date form templates.
   - Explanations of service requests
   - Service requests
   - Contamination declaration

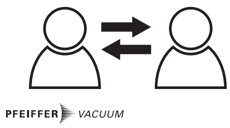
a) Remove and store all accessories (all external parts, such as valves, protective screens, etc.).
b) If necessary, drain operating fluid/lubricant.
c) If necessary, drain coolant.



2. Complete the service request and contamination declaration.



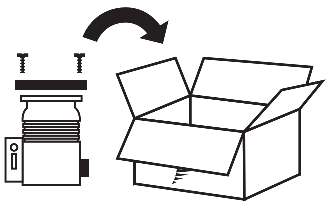
3. Send the forms by email, fax, or post to your local Service Center.



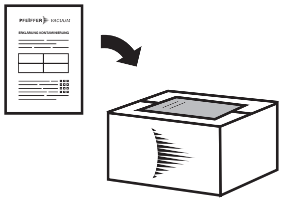
4. You will receive an acknowledgment from Pfeiffer Vacuum.

Submission of contaminated products

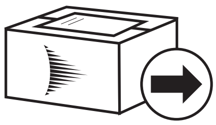
No microbiological, explosive, or radiologically contaminated products will be accepted. Where products are contaminated, or the contamination declaration is missing, Pfeiffer Vacuum will contact you before starting service work. Depending on the product and degree of pollution, **additional decontamination costs** may be incurred.



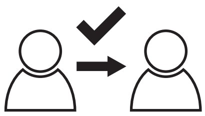
5. Prepare the product for transport in accordance with the provisions in the contamination declaration.
   a) Neutralize the product with nitrogen or dry air.
   b) Seal all openings with blind flanges, so that they are airtight.
   c) Shrink-wrap the product in suitable protective foil.
   d) Package the product in suitable, stable transport containers only.
   e) Maintain applicable transport conditions.



6. Attach the contamination declaration to the **outside** of the packaging.



7. Now send your product to your local Service Center.



8. You will receive an acknowledgment/quotation, from Pfeiffer Vacuum.

Our sales and delivery conditions and repair and maintenance conditions for vacuum devices and components apply to all service orders.

11 Ordering information

11.1 Ordering parts

Ordering spare parts, accessories or optional components

▶ Always specify the following details when ordering spare parts, accessories or optional components:
- all details according to the rating plate
- description and order number according to the parts list

11.2 Ordering spare parts

Description	Order number
Filament units	
Filament unit for axial IS (yttrated iridium)	PT 168 112
Filament unit for axial IS (tungsten)	PT 168 111
Filament unit for crossbeam IS (yttrated iridium)	PT 168 122
Filament unit for crossbeam IS (tungsten)	PT 168 121
Filament unit for grid IS (tungsten)	PT 168 161
Ion sources	
Axial IS (yttrated iridium)	PT 168 212
Axial IS (tungsten)	PT 168 211
Crossbeam IS (yttrated iridium)	PT 168 222
Crossbeam IS (tungsten)	PT 168 221
Crossbeam IS (yttrated iridium), with magnets	PT 168 232
Crossbeam IS (tungsten), with magnets	PT 168 231
Crossbeam IS (yttrated iridium), gas tight	PT 168 242
Crossbeam IS (tungsten), gas tight	PT 168 241
Crossbeam IS (yttrated iridium), gas tight, with magnets	PT 168 252
Crossbeam IS (tungsten), gas tight, with magnets	PT 168 251
Grid IS (tungsten)	PT 168 261
Wiring sets	
Wiring set for axial IS	PT 168 310
Wiring set for crossbeam IS	PT 168 320
Wiring set for grid IS	PT 168 360
System components	
EP 822	PT 168 500
SEM 217	PT 168 400
Cable	
Ion source cable IS 816 - QMA 4x0, 1.5 m	PT 168 511 -T
Ion source cable IS 816 - QMA 4x0, 3 m	PT 168 512 -T
Ion source cable IS 816 - QMA 4x0, 10 m	PT 168 513 -T
High voltage cable, 1.5 m	PT 168 521 -T
High voltage cable, 3 m	PT 168 522 -T
High voltage cable, 10 m	PT 168 523 -T
Field axis cable	PT 168 550 -T
HF connection QMH 800-x – QMA 4x0	PT 168 560 -T
Connection QC 800 – QMH 800-x, 1.5 m	PT 168 531 -T
Connection QC 800 – QMH 800-x, 3 m	PT 168 532 -T
Connection QC 800 – QMH 800-x, 10 m	PT 168 533 -T
LAN 2 connection QC 800 – QMH 800-x, 1.5 m	PT 168 541 -T

Description	Order number
LAN 2 connection QC 800 – QMH 800-x, 3 m	PT 168 542 -T
LAN 2 connection QC 800 – QMH 800-x, 10 m	PT 168 543 -T
Upgrade sets	
Upgrade set 300 u	PT 444 770 -T
Upgrade set 512 u	PT 444 771 -T
Assembly block	
Assembly block	PT 168 600

Tbl. 6: Spare parts for QMA 4x0

12 Technical data and dimensions

12.1 Technical data

Parameter	Value
Overpressure	
Permissible overpressure	≤ 2000 hPa (absolute)
Vacuum	
Operating pressure (Faraday)	≤1 × 10^{-4} hPa in the ion source
Operating pressure (SEM)	≤1 × 10^{-5} hPa in the ion source
Sensitivity [8) 9)]	
Smallest detectable partial pressure (Faraday)	<10^{-11} hPa
Smallest detectable partial pressure (with 90° SEM and electronic counter)	<10^{-15} hPa
Sensitivity for air (Faraday)	>3 × 10^{-4} A/hPa
Sensitivity for air (SEM)	> 200 A/hPa
Mass filter	
QMA 400	
Rod diameter	8 mm
Rod length	200 mm
Rod material	Molybdenum
QMA 430	
Rod diameter	8 mm
Rod length	200 mm
Rod material	Stainless steel
SEV 217	
Amplification (new)	> 10^{8} at 3.5 kV
Operating voltage	1 – 3.5 kV
Bias voltage	≤ ±3.2 kV on SEM
Number of stages	17
Voltage divider	18 MΩ
Admissible output current	≤10^{-5} A
Bakeout temperature for dynode material	≤ 400°C CuBe
Connection flange	
QMA 400	DN 63 CF
QMA 430	DN 63 CF
Gas connections (CB ion sources)	
Crossbeam (gas tight), with an axial connector	Bore in glass ceramic for tube with outer diameter 3 mm
Bakeout temperature	
Without cables and connector plates	≤ 400°C
With electron collimation magnet	≤ 300°C
With cables and connector plates	≤ 180°C
With pre-amplifier or electrometer	≤ 50°C
Materials in vacuum	
Stainless steel, Mo, Al_2O_3, CuBe, Ni, W, yttriated iridium	

8) Valid for QMA 400 without SEM, CB-IQ with magnet, emission 1 mA, ΔM_{10} = 1 u

9) Peak width = 1 u at 10% of the peak height

Parameter	Value
Filament life 10)	
Tungsten	>10000 h
Yttriated iridium	>10000 h
Weight	
QMA 400 (Faraday)	2.9 kg
QMA 400 (90° SEM)	10.7 kg
QMA 430 (90° SEM)	10.7 kg

Tbl. 7: Technical data

12.2 Dimensions

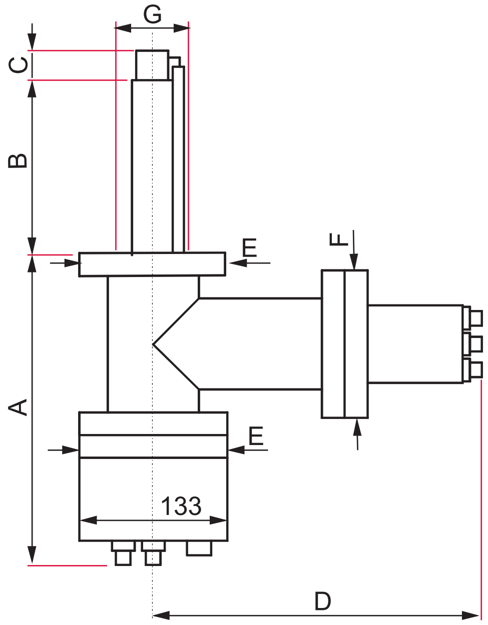


Fig. 19: Dimensions with 90° off-axis SEM

Dimensions in mm

Dimension	[mm]
A	244
B	162
D	251
E	DN 63 CF
F	DN 63 CF
G	Ø 63

Tbl. 8: Dimensions

Ion source	C [mm]	H [mm] 11)
Axial	26	-
Crossbeam	35.5	23.5

10) Valid for $p < 10^{-5}$ hPa, emission 1 mA and electron energy ≥ 70 eV in a non-oxidizing atmosphere

11) Distance to the center of the sensitive volume

Ion source	C [mm]	H [mm] [11]
Crossbeam (gas tight) [12]	48 [13]	23.5
Grille	27	-

Tbl. 9: Dimensions of the ion sources

11) Distance to the center of the sensitive volume
12) With an axial gas connection
13) Without gas inlet line / supply line: External diameter 3 mm

EU Declaration of conformity

This declaration of conformity has been issued under the sole responsibility of the manufacturer.

Declaration for product(s) of the type:

Analyzer

QMA 4x0

We hereby declare that the listed product satisfies all relevant provisions of the following **European Directives**.

Low voltage 2014/35/EU

Electromagnetic compatibility 2014/30/EU

Restriction of the use of certain hazardous substances, 2011/65/EU (Article 2, number 4 d, e, and j)

Harmonized standards and applied national standards and specifications:

DIN EN 61010-1:2011-07

DIN EN 61326-1:2013-07

DIN EN 55011:2009 + A1:2010 (Class A)

Signature:

Pfeiffer Vacuum GmbH
Berliner Straße 43
35614 Asslar
Germany

(Daniel Sälzer)
Managing Director

Asslar, 2023-07-19

CE

PFEIFFER VACUUM

UK Declaration of Conformity

This declaration of conformity has been issued under the sole responsibility of the manufacturer.

Declaration for product(s) of the type:

Analyzer
QMA 4x0

We hereby declare that the listed product satisfies all relevant provisions of the following **British Directives**.

Electrical Equipment (Safety) Regulations 2016

Electromagnetic Compatibility Regulations 2016

The Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment Regulations 2012

Applied standards and specifications:

EN 61010-1:2010 + A1:2019 + A1:2019/AC:2019

EN IEC 61326-1:2021

EN 55011:2016 + A1:2017 + A11:2020 + A2:2021

The manufacturer's authorized representative in the United Kingdom and the authorized agent for compiling the technical documentation is Pfeiffer Vacuum Ltd, 16 Plover Close, Interchange Park, MK169PS Newport Pagnell.

Signature:	Pfeiffer Vacuum GmbH Berliner Straße 43 35614 Asslar Germany
(Daniel Sälzer) Managing Director	Asslar, 2022-11-01

UK CA

PFEIFFER VACUUM

VACUUM SOLUTIONS FROM A SINGLE SOURCE

Pfeiffer Vacuum stands for innovative and custom vacuum solutions worldwide, technological perfection, competent advice and reliable service.

COMPLETE RANGE OF PRODUCTS

From a single component to complex systems:
We are the only supplier of vacuum technology that provides a complete product portfolio.

COMPETENCE IN THEORY AND PRACTICE

Benefit from our know-how and our portfolio of training opportunities!
We support you with your plant layout and provide first-class on-site service worldwide.

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Are you looking for a perfect vacuum solution? Please contact us

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