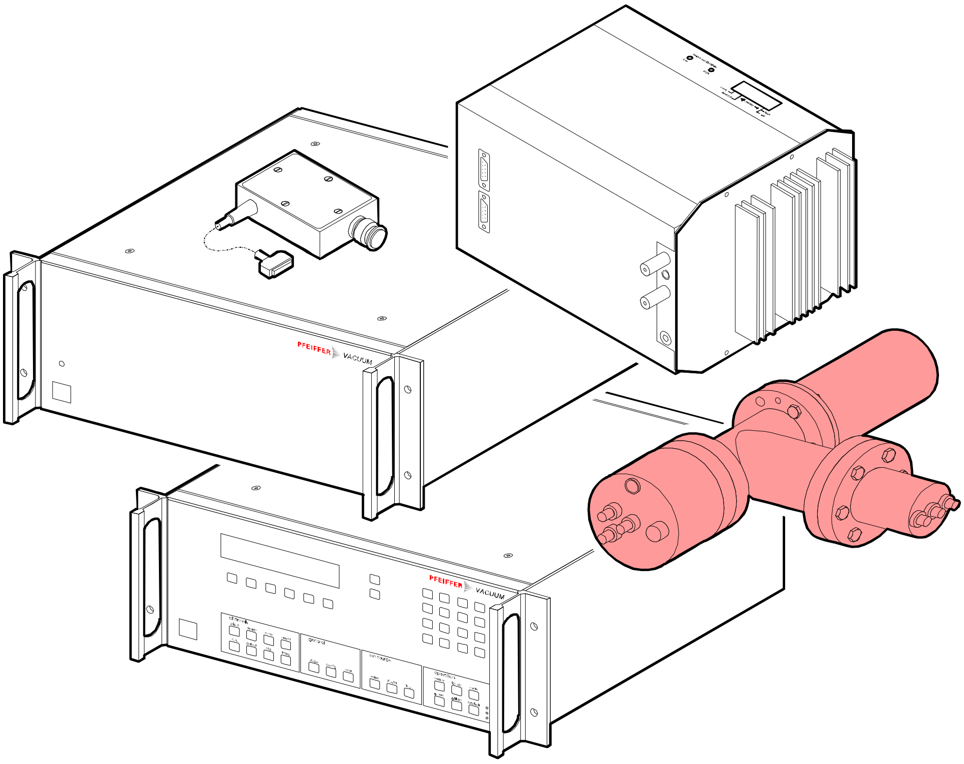

OPERATING INSTRUCTIONS

EN

Translation of the original instructions

QMG 700 ANALYZERS™

QMA 400, 410, 430™

PFEIFFER VACUUM

BG 5983 BEN / C (1605)

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Disclaimer

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Contents

1 Safety

1.1 Symbols

DANGER
Information on preventing any kind of physical injury.

WARNING
Information on preventing extensive equipment and environmental damage.

CAUTION
Information on correct handling or use. Disregard can lead to malfunctions or minor equipment damage.

1.2 Personnel Qualifications

NOTE
Information on correct handling or use. Disregard can lead to malfunctions or minor equipment damage.

1.3 General Safety Instructions

Process media

- Adhere to the applicable regulations and take the necessary precautions for the process media used.
- Consider possible reactions between the materials and the process media.
- Consider possible reactions of the process media due to the heat generated by the product.
- Post the warning signs required by the national and local regulations at the appropriate places.
- If toxic or flammable gases are measured with the QMA, the exhaust gases must be treated in accordance with the applicable regulations.

Safety measures

- Adhere to the applicable regulations and take the necessary precautions for all work your are going to do and consider the safety instructions in this document.
- Follow the instructions and consider the data given in the documentation of all system components.

Contamination

- Before beginning to work, find out whether any components are contaminated. Adhere to the relevant regulations and take the necessary precautions when handling contaminated products.
- Products returned to Pfeiffer Vacuum for service or repair should preferably be free of harmful substances (e.g. radioactive, toxic, caustic, or microbiological). Always enclose a completed and signed declaration of contamination.
- Adhere to the forwarding regulations of all involved countries and forwarding companies.

Communication of safety instructions

- Communicate the safety instructions to all other users.

1.4 Liability and Warranty

Pfeiffer Vacuum assumes no liability and the warranty becomes null and void if the end-user or third parties:

- disregard the information in this document
- use the product in a non-conforming manner
- make any kind of interventions (modifications, alterations etc.) on the product
- use the product with accessories, options, and add-ons not listed in the corresponding product documentation

The end-user assumes the responsibility in conjunction with the process media used.

CAUTION

Inappropriate use.

Inappropriate use of the product may lead to contamination or destruction of the cathode or secondary electron multiplier.

Adhere to the instructions in this manual to prevent such damages, which are not covered by the warranty.

NOTE

Pfeiffer Vacuum offers application, operating and maintenance courses for the best use of this product. Please contact your local Pfeiffer Vacuum representative.

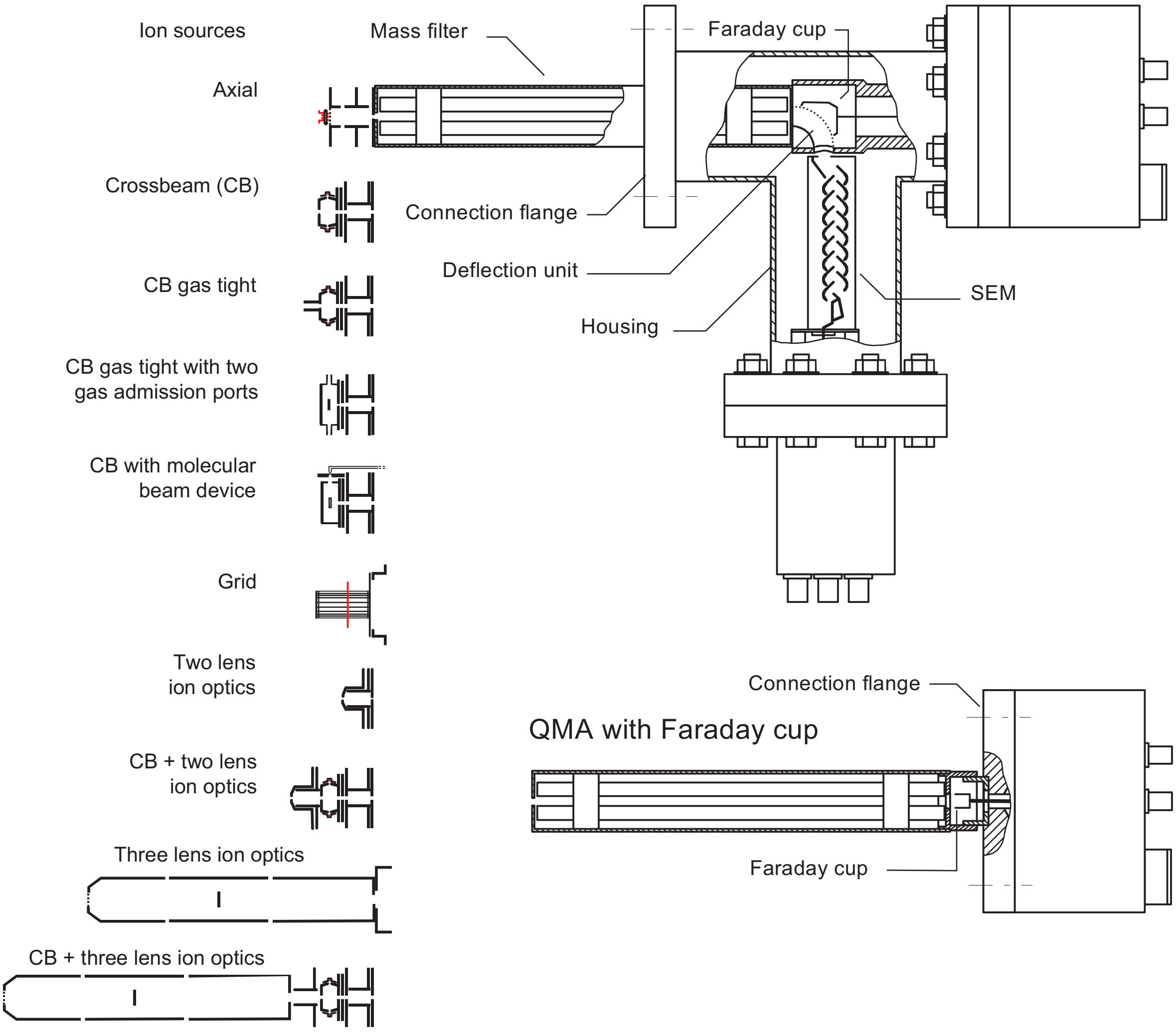
2 Description

2.1 Design

A quadrupole analyzer consists of:

- ion source and/or ion optics
- mass filter with rod system
- ion detector (SEM and ion deflection unit with Faraday or Faraday only)
- housing with flanges

QMA with 90° off-axis SEM



High mechanical precision combined with optimum cooperation between the ion source and rod system, forming the ion optical unit, yield high resolution and transmission with low mass discrimination.

The high resolution and wide mass range make this instrument suitable for analytical measurement problems.

A variety of designs, with Faraday cup or with 90° off-axis SEM plus Faraday cup, as well as the ample choice of ion sources and ion optics ensure an optimum adaptation to the individual measurement problem.

The open design and low degassing rate of the analyzers, conceived as immersing systems, allow exact partial pressures analyses from the high vacuum up to the extreme ultra high vacuum range (UHV).

Ion Sources

The ionization is achieved by electron impact. Electrons are thermally emitted by a cathode and focused by electrical extraction fields so that they reach the ionization area.

The ionization process is crucial for the overall quality of the analysis. Errors occurring in this part of the process are virtually irreversibly. Therefore, the ion source must be selected very carefully.

Closed (gas tight) ion sources allow gas analyses with a minimum contribution from the residual vacuum. They are virtually fractionation-free, have a high signal to noise ratio, a low gas consumption, and a small time constant.

Vacuum ion optics are used for focusing ions which are produced independently of the QMA (e.g. plasma technology, laser, SIMS, thermal desorbed ions) to the mass filter.

Mass Filter

The proper material selection and very precise manufacturing methods ensure a high measure of linearity and reproducibility.

QMA 430:	For masses up to 300 amu the economic 8 mm rod system made of stainless steel can be used.
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.
QMA 410:	The 16 mm molybdenum rod system is used for this analyzer. At constant frequency, the transmission increases as a function of the rod diameter while the mass range narrows. In parallel, the impact of the filtered ions on the rod surfaces and thus the contamination of the rod system is reduced.

Secondary Electron Multiplier

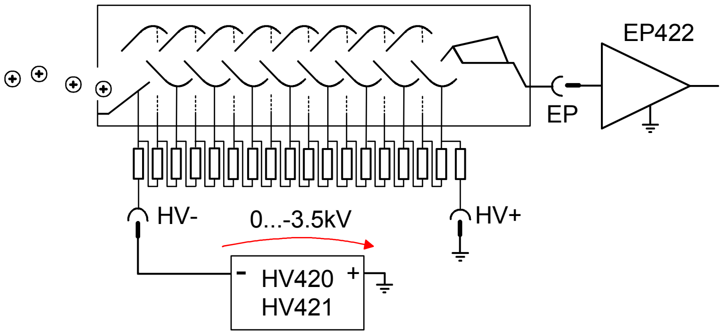
The secondary ion multiplier with its 17 discrete stages and focusing dynode geometry is a fast ion current amplifier between the quadrupole filter and the preamplifier.

The high gain of the SEM allows to operate the succeeding electrometer amplifier with a lower gain. The time constants become thus smaller, permitting measurement of fast signals with low intensity.

SEV 217

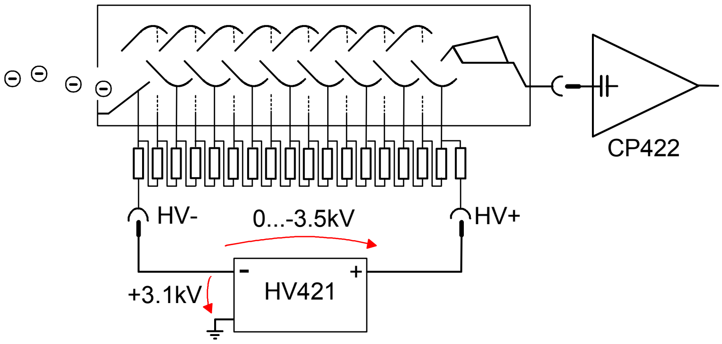
Positive ions are detected in normal operation with a negative high voltage applied to HV- and ground connected to HV+ of the secondary electron multiplier SEV 217.

The operating voltage "SEM Voltage" determines the gain and is at the same time the energy for additionally accelerating the ions.



Negative ions

For detection of negative ions, +3.1 kV supplied by the HV 421 are applied to the first dynode (HV-) (-3.1 kV for positive ions). This means that up to 6.6 kV are applied to the HV+. In this case, the ion counter must be used instead of the electrometer amplifier.

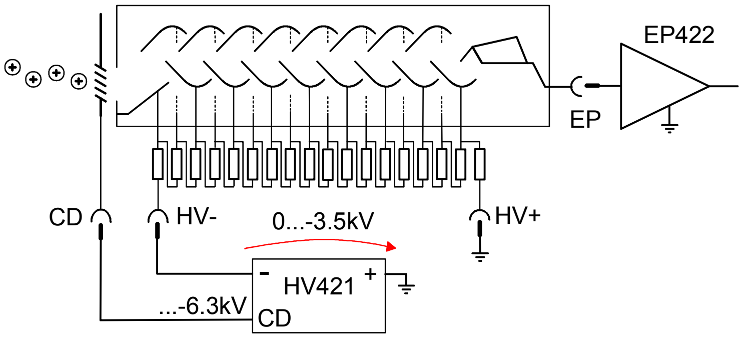


In counting mode, ions of 1 pulse per 10 s (which corresponds to an ion current of 10^{-20} A) up to 10^{7} pulses per s can be detected.

In this case, the energy for additional acceleration is independent of the operating voltage and thus from the gain setting.

SEV 218

The SEV 218 corresponds to the SEV 217. Additionally, it has a conversion dynode, which is separate from the dynode chain and fed by an invariable high voltage source (-6.3 kV at the CD connector of the HV 421), which is independent of the operating voltage of the secondary electron multiplier.



The gain of the SEM can be selected independent of the additional acceleration.

The high additional acceleration allows for a strong reduction of possible mass discrimination due to the conversion. The independent setting of conversion rate and gain has also considerable advantages for ratio measurements (e.g. isotopes) with high dynamics.

2.2 Versions

Cathode Materials

The ion sources can be equipped with cathodes (filaments) which are best suited for the planned application. Certain cathode materials are not available for all source types.

Rhenium

In contrast to tungsten (W), rhenium (Re) does not form any stable carbides, since no CO_2 cycle as known with W takes place. In addition, Re is not embrittled by recrystallization.

The vapor pressure of Re is approximately 50 times higher than that of W, and the filament life is accordingly shorter. Getter effects may occur due to the evaporation rate.

Tungsten

Tungsten is used when the higher vapor pressure of rhenium is undesirable, when a long filament life is required, or when the advantages of Re are not important to the application.

Yttrated iridium

Since yttrated iridium (YOx-Ir) does not form oxides, it is quite insensitive to air inrushes.

The emission temperature of yttrated iridium cathodes is lower than that of Re and W cathodes. Reactions with residual gas are weaker because the ion source temperature remains low.

The contamination may be stronger when substances with a low vapor pressure are admitted.

Electron Collimation Magnet

The crossbeam ion source can be equipped with a magnet unit. This is recommended for applications in high mass ranges, for molecular beam detection, and in the QMA 410 for separating He and D2.

The magnet increases the electron density in that part of the volume of the ion source, from which ions can be easily focused into the mass filter.

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 critical locations of the formation area. However, the linearity (measurement signal vs. pressure) is reduced.

Analyzers with integrated collimation magnets may only be baked to 300°C.

90° Deflection

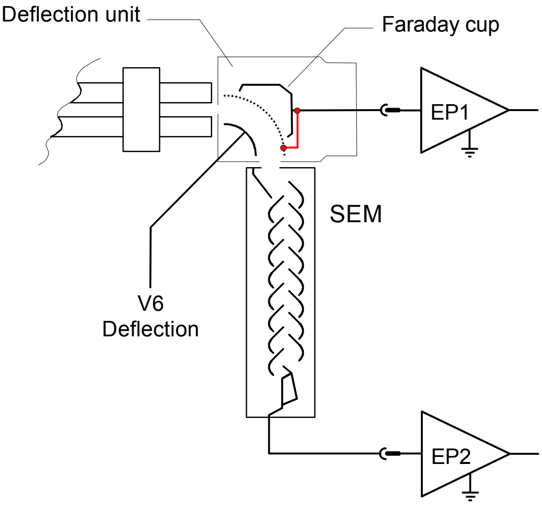
The 90° off-axis arrangement of the secondary electron multiplier has a very low signal background because the electrostatic 90° deflection prevents fast or excited neutrals and photons from hitting the SEM.

There are two deflection versions:

One deflection voltage

Normal version (axial, crossbeam, grid ion source, possibly ion optics).

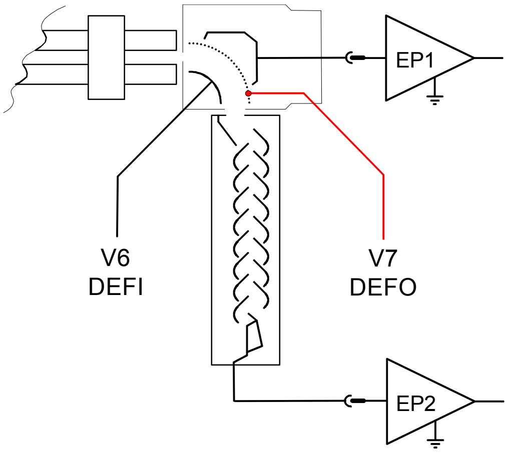
The inner deflection plate is on potential V6 "Deflection", the outer deflection plate is directly connected to the Faraday cup and electrometer amplifier EP1 and is thus on ground potential. If there is no EP1 in the configuration, a shorting connector is used.



Two deflection voltages

Special versions (mostly with ion optics, → enclosed diagram of the QMA).

The inner deflection plate is on potential V6 "DEFI", the outer deflection plate is on potential V7 "DEFO". The Faraday cup is isolated from the deflection plate and connected to the electrometer amplifier EP1.



Depending on the application, the deflection of this version is more efficient, as accelerating potentials are applied to both deflection plates.

In Faraday operation, the sensitivity is slightly lower than with one deflection voltage because less ions reach the Faraday cup.

Faraday Cup

Faraday cup operation (QMA with Faraday or SEM types operated in Faraday mode) reduces system related conversion errors of the SEM (e.g. mass discrimination).

Faraday operation can also be used for error detection.

The drawback of Faraday operation is the lower sensitivity, which requires a higher gain and thus limits the response speed.

Isolated Design

Some versions (e.g. with ion optics) have an isolated design i.e. the filter housing and thus ion optics, mass filter, and deflection unit are isolated from ground. A potential can be applied to the filter housing in order for ions formed close to the ground potential (e.g. in a plasma) to be transferred through the fringe fields with sufficient velocity.

These versions may have an additional SHV connector for the corresponding voltage on the QMA:

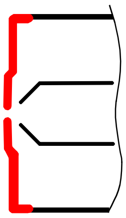
- BIAS as input
- TARGET as output for SIMS analyzers

DANGER
Shock hazard.
The voltages of the IS 420 and the additional voltage can be extremely hazardous.
Consider the technical specifications of the IS 420 and use only properly made cables.

Vacuum Annealed QMA

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

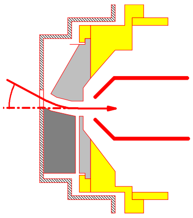
Extraction Hood



For extracting ions from a plasma, an extraction hood can be installed.

As the versions with extraction hood are customized, a corresponding description is enclosed with the test protocol.

Beam Deflection Device

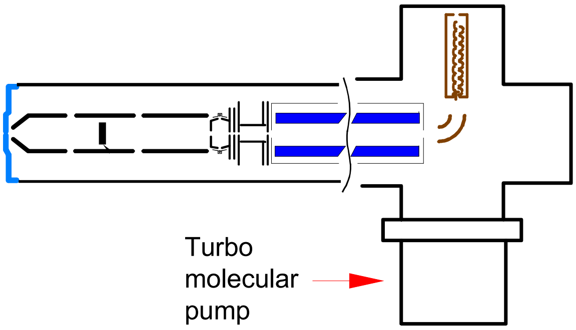


For detecting ions which are not focused in the axis of the analyzer, a beam deflection device is installed. It is based on a sector field and can be combined with an extraction hood. There is a variety of possible detection angles.

As the versions with beam deflection device are customized, a corresponding description is enclosed with the test protocol.

Differential Pumping

If the pressure of the gas or plasma to be analyzed exceeds the admissible maximum pressure of the QMA, the analyzer is differentially pumped with a turbomolecular pump.



The T-piece of the housing is replaced with a crosspiece. Diaphragm glands having a much smaller conductance than the orifice are used as seals.

The pressure drops because of the limited conductance of the entrance orifice, the extraction hood, or the beam deflection device.

The pressure range can be expanded with a dual-stage differential pump system (process pressures up to 1 bar can be reached).

3 Technical Data

Overpressure

Maximum admissible overpressure	2 bar (absolute)

Vacuum

Maximum operating pressure	
with Faraday	1×10^{-4} mbar in the ion source
with SEM	1×10^{-5} mbar in the ion source

Sensitivity

Smallest detectable partial pressure	
with Faraday	$<10^{-11}$ mbar
with 90° off-axis SEM and ion counter electronics	$<10^{-15}$ mbar
Sensitivity for air	
with Faraday	$>3 \times 10^{-4}$ A/mbar
with SEM	>200 A/mbar
Applies to QMA 400 without SEM, crossbeam ion source with magnet, emission 1 mA, $\Delta M_{10} = 1$ u. [a] Refer to the test protocol for your individual configuration.	

[a] Peak width = 1 u on 10% of peak height

Mass filter

	QMA 400	QMA 410	QMA 430
Rod diameter	ø 8 mm	ø 16 mm	ø 8 mm
Rod length	200 mm	300 mm	200 mm
Rod material	molybdenum	molybdenum	stainl. steel

SEV 217

Gain (new)	$>10^{8}$ at 3.5 kV
Operating voltage	1 … 3.5 kV
Bias voltage	max. ±3.2 kV at SEM–
Number of stages	17
Voltage divider	18 MΩ
Max. admissible output voltage	10^{-5} A
Max. bakeout temperature	400 °C
of dynode material	Cu-Be

SEV 218

As SEV 217, however, with separate conversion dynode CD	
CD voltage	max. – 6.3 kV

Connection flange

QMA 400	DN 63 CF
QMA 410	DN 100 CF
QMA 430	DN 63 CF

Bakeout temperatures

Without cables and connector plates	max. 400 °C
With electron collimation magnet	max. 300 °C
With cables and connector plates	max. 180 °C
With preamplifier or electrometer	max. 50 °C

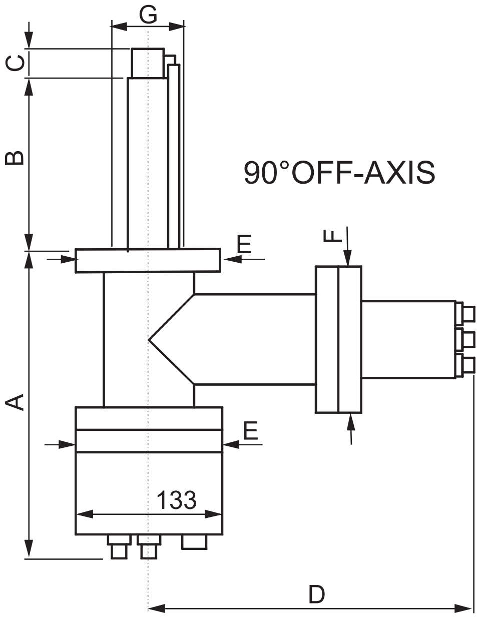
Materials in vacuum

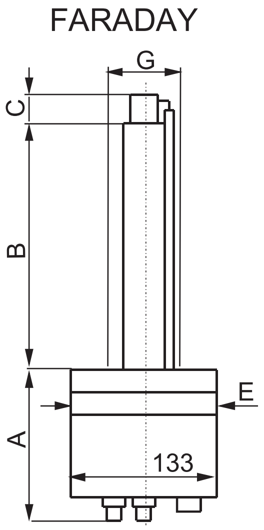
Stainless steel, Mo, Al_2O_3, Cu-Be, Ni, W, Re, yttrated iridium

Filament life

Rhenium	>2,000 h
Tungsten	>10,000 h
Yttrated iridium	>10,000 h
Valid for $p < 10^{-5}$ mbar, emission 1 mA and electron energy ≥70 eV in a non-oxidizing atmosphere	

Dimensions and weight





(The illustrations are not to scale.)
NOTE: Dimensions are shown in mm.

	90° off-axis			Faraday	
	QMA 400	**QMA 430**	**QMA 410**	**QMA 400**	**QMA 410**
A	244	244	245	104	245
B	162	162	267.5	223	269.2
D	251	251	251	—	—
E	DN63CF	DN63CF	DN100CF	DN63CF	DN100CF
F	DN63CF	DN63CF	DN63CF	—	—
G	ø63	ø63	ø100	ø63	ø100
Weight	10.7 kg	10.7 kg	17.2 kg	2.9 kg	6.5 kg

Ion sources	**C**	**H**
Axial	26	—
Crossbeam (CB)	35.5	23.5
CB gas tight [1]	48 [2]	23.5
Grid	27	—
2 lens ion optics	17.5	—
CB with 2 lens optics	43.5	23.5
3 lens ion optics	129	—
CB with 3 lens optics	171	23.5

H — Distance to the center of the sensitive volume.

[1] With axial gas connection.

[2] Without gas admission line (outer diameter of gas admission line 3 mm).

Gas connections	
CB gas tight with 1 axial connection	Bore in glass ceramic for tube with outer diameter 3 mm
CB gas tight with 2 lateral connections	2 gas admission lines according to drawing BK 355 107 -Z are enclosed
CB with molecular beam device	DN16CF with Swagelok fitting ø ¼"

4 Installation

4.1 Preparation

DANGER

Hazardous electrical voltages.

Hazardous voltages up to 600 V are applied to the QMA.

Make sure the QMA, the vacuum chamber, and the whole system are always correctly connected to ground.

If accidental contact to the QMA is possible when the vacuum system is opened, additional protective measures have to be taken, for instance:

- Mechanical protection against accidental contact.
- Forced disconnection of the QMS 422 from the mains power source through door contact.

DANGER

Hazardous electrical voltages.

Under unfavorable conditions (arcs, plasma, vacuum problems), voltages up to 600 V can be fed to other equipment in the vacuum chamber (e.g. gauges).

If there is a possibility that such pieces of equipment become sources of shock hazard (consider also the conductors and connected equipment!) they must be arranged or protected in such a way that any risk of accidental contact, arcs, or flow of charged particles is excluded.

DANGER

Hazardous external voltages.

Under unfavorable conditions (arcs, plasma, vacuum problems), voltages of other equipment installed in the vacuum system (e.g. ionization gauges, plasma sources, electron beam evaporators etc.) can be supplied to the QMA. Open connectors, connected equipment and cables are potential sources of shock hazard.

If there are such potential sources of shock hazard in the vacuum system, protective measures have to be taken (layout, grounding, shielding etc.) to prevent such influences.

The QMS 422 must also be permanently connected to ground (not via a connector). The contact is inside, behind the mains plug. Make a grounding conductor of yellow/green stranded copper wire if necessary:

- 2.5 mm^2 if mechanically protected (according to DIN VDE 110 T540)
- 4.0 mm^2 if not mechanically protected

Consider the specific standards of your system.

Mounting orientation

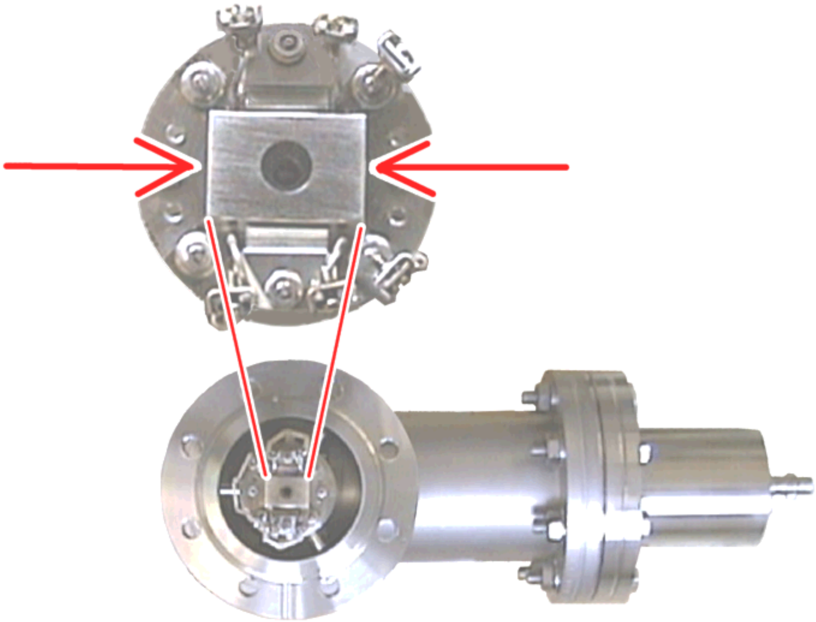
In most cases, the mounting orientation can be chosen irrespective of the function. Select the mounting orientation which is best suited to the arrangement of the radio frequency generator, QM,H and cables.

The position of the ion source should be selected according to the requirements of the analytical task. For instance, reliable residual gas analysis is not possible if the analyzer is connected to the measuring chamber only via a tube with a small diameter.

Gas inlet system

Prepare the gas inlet system (if necessary) in order to ensure easy connection to the ion source.

The crossbeam ion source might have to be aligned with the gas inlet system. In that case mark the correct mounting orientation (direction of the arrows) on the flange of the QMA and the system.



Installing the mounting plate

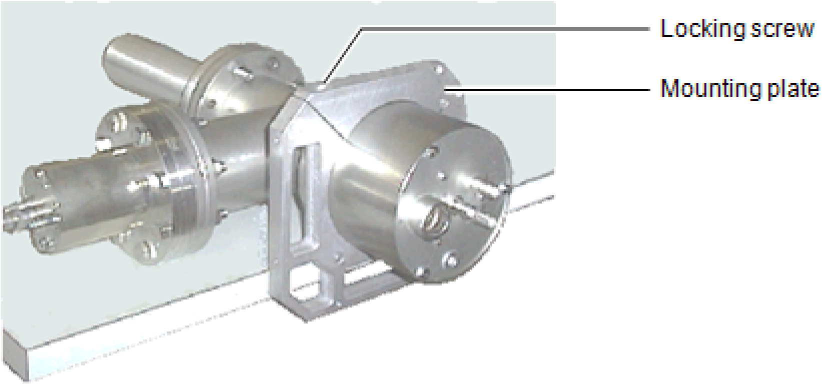
1 Place the analyzer on the edge of a workbench (see illustration)

2 Unfasten the locking screw on the mounting plate with a screw driver No. 6

3 Slide the mounting plate on the analyzer flange.

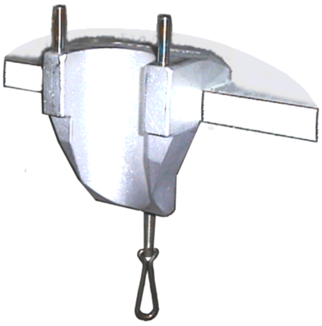
4 Position the mounting plate so that you can easily hold the analyzer and introduce it into the vacuum system in its correct orientation.

5 Tighten the locking screw.

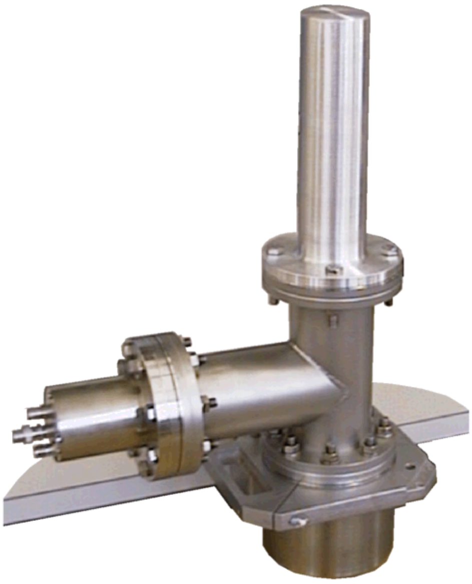


Using the assembling trestle

1 Mount the assembling trestle to a stable workbench.



2 Insert the analyzer with the installation plate into the assembling trestle.



Removing the protective tube

1 Remove the three screws

2 Remove the protective tube.

Removing the transport protection

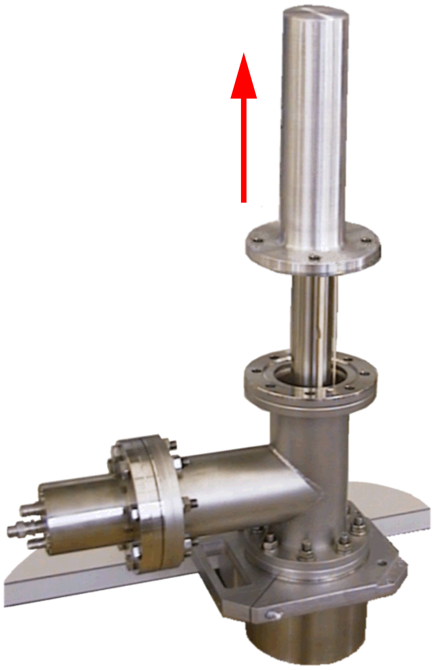
CAUTION

Dirt sensitive area.

Touching the product with bare hands causes distortion of the measurement results. Always wear clean, lint-free gloves and use clean tools when working in this area.

1 Carefully remove the transport protection and keep it for later use.

2 Check the inside for damages and short circuits of the wiring.



Installing the Electron Collimation Magnets

The magnet unit of the crossbeam ion source is delivered in a separate package. If the conditions for use are fulfilled mount it on the ion source as described below.

CAUTION

Dirt sensitive area.

Dirt causes malfunctions or failures.

Always wear clean, lint-free gloves and use clean tools when working in this area.

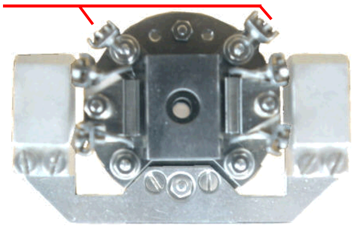
CAUTION

The magnets are aligned.

If the magnets are detached from the installation plate, correct alignment is no longer possible.

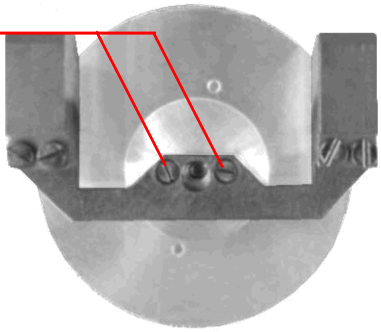
Do not detach the magnets from the installation plate!

1 Position the analyzer so that the magnet unit can easily be mounted.

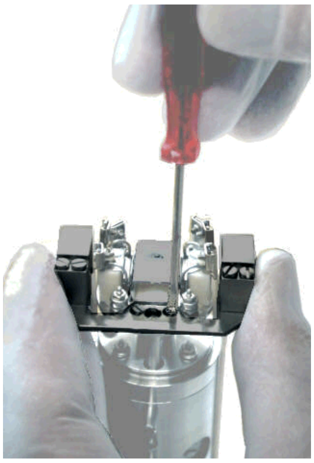


2 Unfasten the two screws without removing them.

3 Remove the magnet unit and the screws from the package.



4 Mount the magnet unit onto the ion source.



4.2 Installation

1 Make sure the installation area is unobstructed.

NOTE

Depending on the installation angle it might be difficult to mount the magnet assembly.

In order to prevent installation damages, have a second person assist you.

2 Insert an OFHC copper seal into the analyzer or system flange.

NOTE

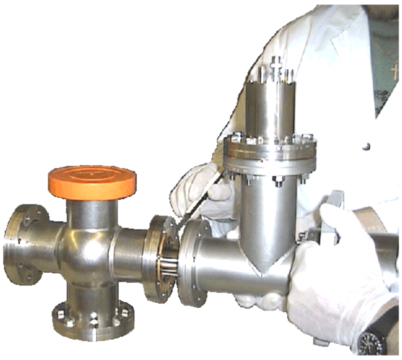
Vertical seals easily drop out of the groove and thus damage the ceramic capillaries of the wiring.

Hold the vertical seal stationary when installing the magnet assembly!

Holding the seal

Hold the vertical seal stationary with a knife blade.

Making the flange connection



1. Carefully introduce the analyzer into the vacuum system. The ion source and wiring must not touch any parts.
2. Insert one of the upper screws and tighten it with your fingers.
3. Insert the screw on the opposite side and tighten it with your fingers.
4. Insert the remaining screws and tighten them with your fingers.
5. Tighten all screws properly.

Evacuating the system

Evacuate the system and check that the expected vacuum is reached.

4.3 Gas Inlet System

If the ion source is to be equipped with a gas inlet system connect the latter properly. The admission line must be electrically isolated from the ion source.

DANGER
Hazardous gases.
Process gases can be detrimental to health.
Before admitting the process gas, check that the connection is leak tight.
Make sure the exhaust system is suited for the admitted gases.

4.4 QMH 400/410

Install the RF generator.

4.5 EP 422

Connect the electrometer preamplifier EP 422 to the Faraday cup connector EP(FARAD) on the QMA if applicable.

Mount the second electrometer preamplifier EP 422 to the SEM collector connector EP(SEM) if applicable.

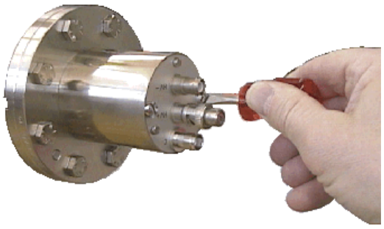
4.6 CP 400

Install the ion counter preamplifier CP 400 if applicable.

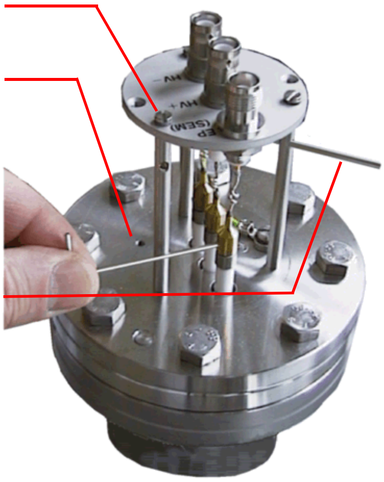
Before installing the CP 400 remove the SEM connector plate of the QMA or the cover if it is not equipped with a SEM connector plate.

Removing / Installing the SEM Connector Plate

1. Turn the equipment off and disconnect the EP 422 and cable from the connector plate
2. Remove the two big screws.
3. Remove the protective tube.



4. Remove the three screws.
5. Unfasten the three hex socket screws (size 1.5 mm) by ½ turn.
6. Detach the cable lug of the yellow/green ground conductor from the flange.
7. Detach the connector plate.
8. Unscrew the three studs using a suitable pin.



Keep all parts because they will be needed when the equipment is converted for electrometer operation.

Reassemble the equipment by performing the above steps in reverse order. Do not forget to reinstall all lock washers at the appropriate places.

4.7 Mounting the Protective Tubes

DANGER
Hazardous electrical voltages.
The voltages under the connector plates are extremely hazardous.
Before installing the cables mount all protective tubes.

4.8 Cabling

For special ion sources (for example, optics), please see the additional notes in the corresponding chapters.

5 Operation

5.1 First Time Operation

1 Before switching the equipment on check that all components are correctly installed and wired.

DANGER
Hazardous electrical voltages. The voltages under the connector plates are extremely hazardous. Before putting the equipment into operation make sure the protective tubes are installed.

CAUTION
Gas discharge. Make sure the high frequency generator is switched off at a total pressure 10^{-4} mbar. Otherwise, between the rods of the analyzer, a gas discharge could be ignited, causing severe contamination of the mass filter.

CAUTION
Magnetic fields. High-intensity magnetic fields caused by electrical motors or generators or similar sources in close proximity to the ion source, channeltron or SEM can lead to malfunctions of the instrument. Protect the instrument from the influence of high-intensity magnetic fields by arranging the system components appropriately or by installing magnetic shields. Make sure the instrument is not affected by any magnetic objects.

2 Only when the pressure in the system is below the highest admissible total pressure
- 10^{-4} mbar with Faraday,
- 10^{-5} mbar with SEM

the control unit may be switched on, however, the emission must not be switched on yet.

3 Check that the values stored in the unit correspond with the supplied test protocol (which indicates the optimum values for your analyzer). If the values differ, make the appropriate settings via the software or directly with the unit. If you do not have a test protocol at hand, activate the default settings of your ion source and optimize them according to the following chapters.

NOTE: If your system has been delivered as a complete assembly, the radio frequency generator has been adjusted to the analyzer at the factory.

4 Select the "Det. Type: Faraday" (except if you use only an ion counter as detection unit). If you have only one EP 422 mount it to the EP(FARAD) connector and to the EP(FARAD) connection of the QMH.

5 Switch the emission on and measure a few spectra with the Faraday.

6 If you have only one EP 422 and no CP 400 mount the EP 422 to the EP(SEM) connector and attach it to the EP(SEM) connection of the QMH.

7 When the pressure in the system is below the highest admissible total pressure for SEM operation (10^{-5} mbar), switch the SEM on.

8 Measure a few spectra with "Det. Type: SEM" with the EP 422 or CP 400.

9. Check the "tune" adjustment of the RF generator.
10. If your analyzer was not delivered together with the RF generator, optimize the "Resolution" setting. If no regular peak width is achieved for small and large masses, adjust the peak width on the QMH. Additionally calibrate the mass scale if necessary.

Do only modify the factory parameter settings if required for your application.

5.2 High Temperature Operation

The analyzer can be heated to a maximum of 180 °C during operation, but the temperature of the EP 422, CP 400, and QMH 400 / 410 must not exceed 50 °C.

For this reason the electrometer amplifier EP 422 and RF generator are removed and placed outside the heating zone for bakeout.

A 0.5 m Teflon cable is supplied to make the connection to the socket EP of the connector plate.

The RF cables between QMA and QMH must not be extended under any circumstances.

At a baking temperature >150 °C the SEM can be operated only with 1000 V.

5.3 Baking the Analyzer

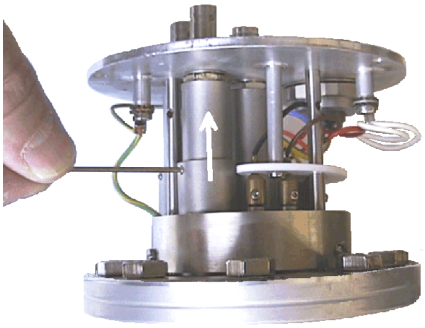
The analyzer can be baked at up to 400 °C.

The EP 422 and CP 400 have to be removed for that purpose. They can only be mounted when the flange has cooled down to <50 °C.

For baking temperatures >200 °C remove the connector plates as follows:

Removing the Connector Plates

1. If you have a 90° SEM, remove the connector plate, however, leave the three studs in place.
2. Remove the protective tube from the large connector plate.
3. Loosen the hex socket screws (size 1.5 mm) of the shielding sleeves by ½ turns each.
4. Slide the shielding sleeves up to the connector plate and fasten them in that position.
5. Do not remove the protective ring and the studs.



Mounting the Connector Plates

1. Check that the three studs are screwed in firmly.
2. Carefully position the connector plates so that the connectors fit the corresponding feedthroughs.
3. Secure the connector plates using the three screws and lock washers.
4. Carefully tighten the hex socket screws at all connectors, however, without applying force to the feedthroughs.
5. Slide the shielding sleeves over the feedthroughs (they must slide into the countersink of the flange) and tighten their screws.
6. Reinstall the protective tubes.

5.4 Assessing the Sensitivity

The supplied test protocol shows how the sensitivity has been assessed at the factory (with and without SEM).

It is indicated in A/mbar for a reference gas. N2 or air is recommended as test gas.

For air, use 80% of the total pressure as N2 pressure and add the ion currents of masses 14 and 28.

Subtract the corresponding residual gas peak levels unless they are negligible.

Make sure the reference pressure is correctly measured, e.g. with an ionization gauge installed at an appropriate place (please note the gas type dependence).

5.5 Secondary Electron Multiplier SEM

The gain and thus the sensitivity can be roughly adjusted with the SEM high voltage "SEM Volt". Avoid values below 1 kV as well as ion currents >1 mA for more than a few minutes, as in these ranges the gain is not stable.

Contamination

When the gas composition is unfavorable (hydrocarbons and other organic vapors), prevent contamination of the SEM by operating it with a low current.

Operate the equipment in Faraday mode, if that makes sense for your application.

Low Partial Pressures

At very low partial pressures (very small peaks) the ion current consists of single pulses. At a very high SEM gain setting, these pulses can overmodulate the stage of the electrometer preamplifier and thus cause measurement errors (e.g. nonlinearity) 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 Volt", select a less sensitive "Range" or use "Range-L" to lock the most sensitive measurement ranges.

With the ion counter, this problem does usually not occur.

Gain Factor

Register the range to be considered of the mass spectrum in SEM and Faraday mode. The ratio of the currents of two corresponding peaks is the gain with the current operation settings.

With this method, the influence of the 90° ion deflection device is taken into consideration.

5.6 Surface Ions

Due to electron impacts on the ion source surfaces, adsorbed contaminants are desorbed as so-called EID ions, which are represented in the spectrum, e.g. with masses 16 (O+), 19 (F+), 23 (Na+), 35/37 (Cl+) and 39/41 (K+).

EID ions appear especially under UHV conditions. 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 field axis voltage "Field Axis". The peak level of normal ions is thus strongly reduced whereas the peak level 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.

5.7 Degas

Degas is chiefly intended for UHV measurements (with a grid ion source). Degas must not be activated at pressures >10^{-7} mbar as otherwise, the ion source will be contaminated.

Consider the specifications of the individual ion sources.

Optimize the filament protection "Protect" for the degas mode.

To lock the degas mode, set "Protect" to 0 A.

6 Optimization

For certain applications the factory settings should be modified. The following sections explain how to determine the optimum parameter values.

With increasing contamination or after revision work, the settings should be modified according to the following sections.

The potentials and their denominations are listed in "Technical Data".

It should be possible to measure a spectrum with the default values of the equipment (Appendix A) – except for the "SPEC(ial)" ion source type. The values should always be optimized for the analyzer used.

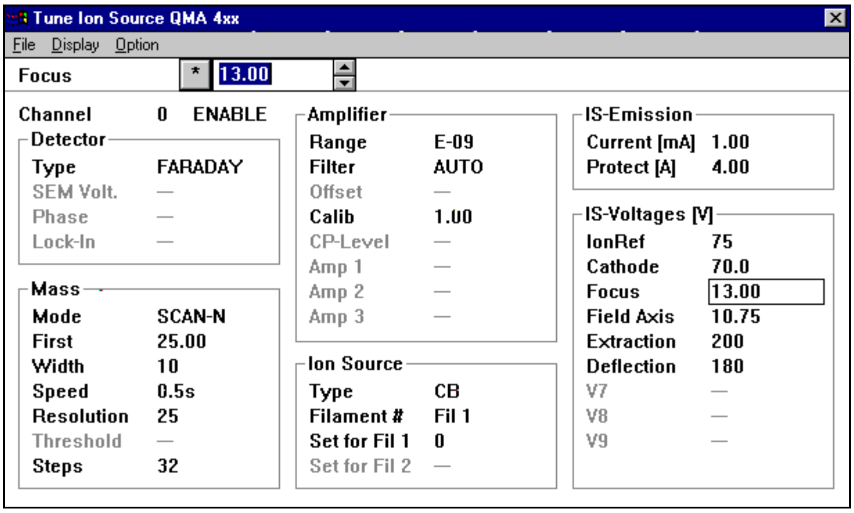
The objective of the ion source parameters is to achieve a high sensitivity, a good peak shape, and a low mass discrimination. Possibly, other conditions should be fulfilled, too (see below).

This chapter applies to virtually all ion sources; certain potentials are not needed for all ion sources.

Please refer to the information on the individual ion sources.

6.1 Recommended Operating Modes

For optimizing the settings, use the TUNE ION SOURCE program of the Quadstar® Software.



Focus 13.00

Channel 0 ENABLE

Detector
Type FARADAY
SEM Volt. —
Phase —
Lock-In —

Mass
Mode SCAN-N
First 25.00
Width 10
Speed 0.5s
Resolution 25
Threshold —
Steps 32

Amplifier
Range E-09
Filter AUTO
Offset —
Calib 1.00
CP-Level —
Amp 1 —
Amp 2 —
Amp 3 —

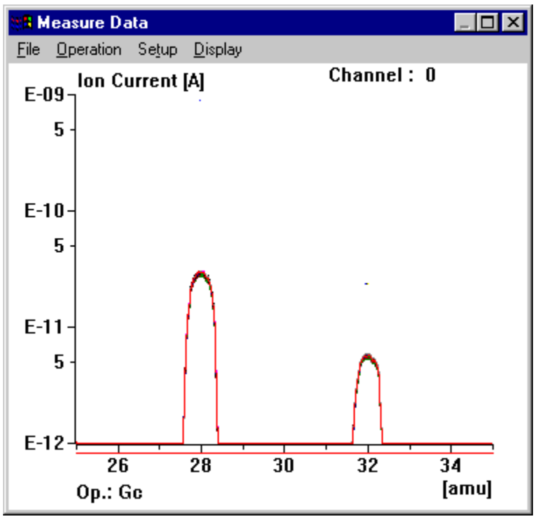
Ion Source
Type CB
Filament # Fil 1
Set for Fil 1 0
Set for Fil 2 —

IS-Emission
Current [mA] 1.00
Protect [A] 4.00

IS-Voltages [V]
IonRef 75
Cathode 70.0
Focus 13.00
Field Axis 10.75
Extraction 200
Deflection 180
V7 —
V8 —
V9 —

- For optimization the "Mode SCAN-N" mode is best suited because in this mode, the peaks are not filtered.
- Set the "Amplifier Range" to AUTO.
- Select a small "Width" (5 … 10 u).
- Activate "Display Measured Data" and position the two windows so that parameters settings can be made while the measurement data are visible.

- Use "Steps": 64 if you like to optimize for a low contribution to the neighboring mass.
- Adjust "First" so that the peaks you are interested in are in the center of the displayed range.
- In the three-decade representation of the ion current showed in the illustration the resolution, peak shape, and peak height are clearly visible.
- Depending on the objective of the optimization, linear or logarithmic representation, for instance over six decades, may be preferable.



- First optimize with "Det. Type: FARADAY" and only then with "SEM". After that, only the deflection voltage ("Deflection V6 / V7") and possibly the "Field Axis" have to be adjusted.
- Before optimization, allow the equipment to warm up for about 30 minutes with the emission switched on. At the beginning, a degassing process is to be expected.

6.2 Test Gas

Admit a suitable gas with a pressure of 5×10^{-6} mbar.

If you like to optimize the analyzer for higher masses, your test gas should contain the corresponding components. Otherwise, air will do.

If you cannot admit a gas, optimize with a suitable residual gas peak. Note variation in the degassing due to parameter changes, e.g. when using H_2O.

For sensitivity optimization, frequently gas admission systems are used in which the pressure in the ion source is higher than the pressure in the environment. Definition of the sensitivity in A/mbar does not make sense in these cases.

6.3 Ion Source Parameters

Emission

A typical emission "Current" is 1 mA, which is the maximum value for ion sources with yttrated cathodes.

In certain 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, volume charge effects might be expected.

Consider the specifications of your individual ion source type.

At a low electron energy setting ("Cathode" e.g. <50 V), reduce "Emission" to 0.1 … 0.2 mA or lower to prevent overloading of the cathode.

At pressures >10^{-5} mbar, reduce "Emission" to e.g. <0.2 mA to improve the measurement linearity (ion current versus partial pressure).

When modifying the emission ("Current"), adjust "Protect" as well.

Protection

When the pressure in the ion source rises, the heating current of the filament rises, too. This effect is used to turn the cathode off when the pressure rises.

"Protect" defines the switching off threshold. To achieve optimum protection set the threshold as low as possible. The setting is optimal if you can just switch on the emission without triggering the protection (see Filament protection).

If it is not possible to turn on the emission, the "Protect" threshold setting might be too low.

V1 IonRef

"IonRef" is the nominal potential on which the ions are formed. The actually effective potential is somewhat lower because of the penetration coefficient of the extraction field and the electron volume charge.

"IonRef" is the reference potential for all other potentials (see "Technical Data").

In general, the "IonRef" 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 no electrons are emitted to the environment. This prevents interference with the Faraday cup of the system and nearby measurement equipment (e.g. ionization manometer). Moreover, gases adsorbed in the environment could be emitted through electron impact, which could influence the measurement.

"IonRef" 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. Moreover, interference due to nearby ionization manometers is effectively prevented.

The following effects of the "IonRef" 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, whereas the maximum sensitivity for higher masses is reached with higher values.
- The higher the "IonRef" setting the lower the mass discrimination, i.e. the sensitivity decreases with higher mass numbers.
- These relationships become even clearer with higher mass ranges and smaller filter dimensions.
- If you like to minimize the mass discrimination, select a peak with the highest possible mass for optimizing the ion source parameters.
- For the ion optics select an "IonRef" value which is slightly lower than the energy of the (positive) ions to be detected.

V2 Cathode

The cathode voltage determines the acceleration voltage of the electrons and thus the nominal ionization energy. The actual 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), less double charged ions are formed. This prevents for instance contribution of 36Ar++ to mass 18, which would complicate the detection of water vapor traces in argon.

CAUTION
Overloading of the cathode. At a reduced ionization energy ("Cathode" e.g. 40 eV) the cathode temperature required for the emission rises and the filament could thus burn out. In that event reduce the emission to e.g. 0.1 mA and adjust "Protect" ("Filament protection").

V3 Focus

Adjust "Focus" to the maximum peak level.

If there are several maxima, select the one with the lowest voltage value while considering the information which applies to your ion source.

When "Focus" is modified "Extraction" must be optimized accordingly (if applicable).

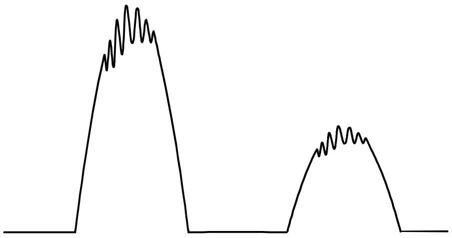
V4 Field Axis

The field axis voltage is the potential difference between the ionization area (Ion Ref) and the quadrupole mass filter. The field axis voltage, therefore, defines the kinetic energy (velocity) of the ions in the rod system.

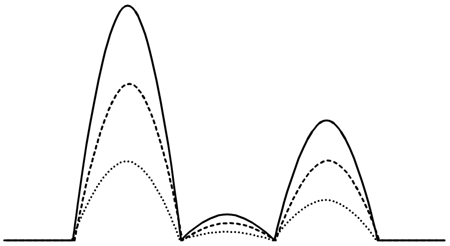
The optimum value of "Field Axis" depends, among other factors, on the frequency (QMH Type) and the QMA type. Lower frequencies (higher mass ranges) or shorter rod systems require lower ion energies because the ions must stay longer in the mass filter to be resolved.

The higher the value, the higher the peaks. However, the resolution is lower and the peak shape deteriorated.

Exceedingly high "Field Axis" values result in "frayed" peaks.



If with "Resolution" the resolution is not improved and the peak level is decreased, lower the "Field Axis" value.



The combined optimization of "Field Axis" and "Resolution" should result in a maximum peak level with the desired resolution and a sufficiently good peak shape.

If an insufficient 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 tilted).

Chapter "Surface ions" shows how to distinguish between normal and so-called EID ions by means of "Field Axis".

V5 Extraction

The extraction voltage (V5-Extraction) accelerates the ions from the ionization area towards the rod system. If the extraction voltage is modified, "Focus" must also be optimized.

V8 Reserve

The potential V8 is used for special cases (e.g. in combination with certain optics).

V9 Wehnelt

The Wehnelt voltage is only used for the axial ion source.

6.4 V6 / V7 Deflection

The deflection voltages ("Deflection", "DEFI" and "DEFO") direct the ions through the 90° deflection condensator.

In the QMG 422, 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 ions are accelerated from the mass filter to the deflection unit and directed to the SEM.

There are two deflection versions:

One deflection voltage

The inner deflection plate is on potential "V6 Deflection", outer is directly connected to the Faraday cup and the electrometer amplifier EP1 and is thus on ground potential.

The optimum value is determined by the ion formation potential "IonRef" and to a certain extent by the SEM voltage.

Approximate values:	IonRef	120 V	40 V
	Deflection	300 V	200 V

Adjust "Deflection" so that a normal peak level is reached.

When the "SEM Volt" is modified, the "Deflection" has to be adjusted, too.

Two deflection voltages

The inner deflection plate is on V6 and the outer on V7.

Alternately, adjust "DEFI" and "DEFO" to the maximum peak level.

If the "SEM Volt" is modified, the two potentials have to be adjusted, too.

6.5 Resolution

Do not select a better "Resolution" than required for the measurement task. The wider the peaks are, the better the sensitivity and stability of the measured values.

Consider the interdependence of "Field Axis" and "Resolution".

If the peak width is irregular over the whole mass range it can be corrected by adjusting the settings of the radio frequency generator QMH.

6.6 RF Cable Polarity

The resolution and peak shape might be improved by interchanging the RF cables at the analyzer. Optimize with both polarities and choose the better version.

Before exchanging the RF cables, set "First" to 0 and "Mode" to "SAMPLE".

If by reversing the polarity, the sensitivity is improved or deteriorated by more than 50%, there is contamination or a mechanic fault.

7 Ion Sources

7.1 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 so that excellent resolution, high sensitivity, and good linearity are achieved.

The open design allows registration of rapid changes in the partial pressure with minimum distortion due to outgassing and surface reactions.

Standard filament material: Re, W, and YO_x-Ir filaments are also available.

Application examples

- General gas analyses
- Residual gas analysis

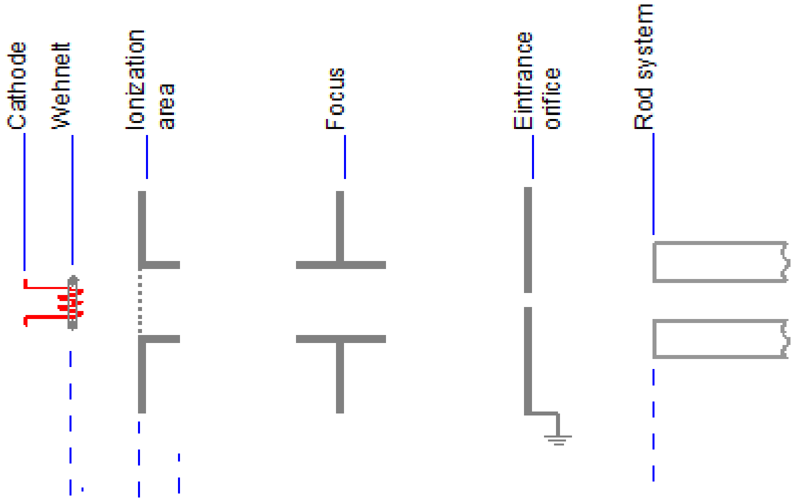
Function

The electrons emitted by the cathode are accelerated toward the grid of the ionization area. The Wehnelt 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.

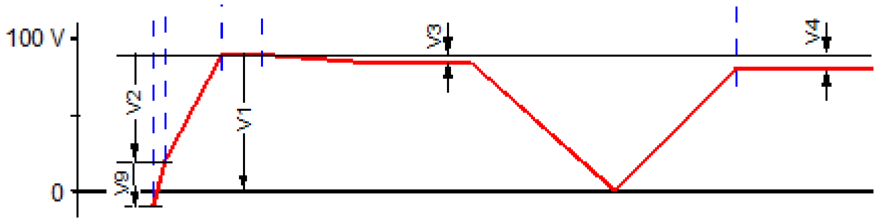
The ions produced by electron impact are drawn by the focus and entrance orifice and focused to the mass filter. The grid prevents the ions from being drawn to the cathode.

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 (velocity) when they enter the mass filter and therefore, remain there much longer. They are separated out almost completely.

Electrode arrangement



Potentials



Typical values

	Emission	1 mA [1]
V1	IonREF	90 V
V2	Cathode	70 eV [2]
V3	Focus	20 V
V4	Field Axis	10 V [3]
V6	Deflection	300 V
V9	Wehnelt	30 V (max. 40)
	Protection W	4.2 A
	YO_x-Ir / Re	3.5 A

[1] At p $>5\times10^{-6}$ mbar reduce to 0.1 mA.

[2] Before reduction of V2 to < 50 eV reduce the "Emission" to 0.1 mA and V9 to <20 V, in order to prevent overload of the cathode.

[3] 5 V at mass range 1024 or 2048.

Adjustment

Start with the values which previously yielded good results, with the values in the test protocol or otherwise with the values of the previous table.

1. Adjust "Focus" to the maximum peak level.
2. Adjust "Wehnelt" to the maximum peak level (if "Cathode" <50 V maximum =20 V!).
3. Search the combination of "Field Axis" and "Resolution" which yields the best peak level and shape.
4. Try which is the better RF cable polarity.

Degas

With Degas, the outgassing rate of the axial ion source is reduced.

Pressure:	$\leq 10^{-8}$ mbar
Emission:	≤10 mA (at 550 V)
Time:	5 minutes

7.2 Crossbeam Ion Source

The open design of the crossbeam ion source allows quick reaction to changes in the gas composition.

The crossbeam ion source has two filaments and has a long service life.

Standard filament material: W. YO_{x}-Ir also available.

Molecular beams can be injected through the sensitive volume perpendicularly and parallel to the system axis.

Gas tight version

The ionization chamber of the gas tight crossbeam ion sources is sealed.

The conductance to the vacuum chamber is ≈1 l/s. Set the operating pressure in the vacuum chamber to $<10^{-6}$ mbar.

Molecular beam device

The molecular beam device injects a collimated gas beam into the ionization area. Ideally, the gas beam transits the ionization area without hitting the ion source. This prevents condensation and interaction with the hot filament.

Using an electron collimation magnet is recommended.

Recommended inlet pressure: 0.5 mbar

Application examples

- Analysis of particle beams and general gas analysis.
- Qualitative and quantitative gas analyses (composition and time behavior)
- Analysis of reactive and aggressive gases (with special accessories)
- Detection of contaminants/impurities in gases
- Isotope measurements
- Residual gas analysis in vacuum processes (e.g. plasma etching)
- Process monitoring / process control (e.g. control of the gas composition or control of evaporation sources)
- Molecular beam applications
- Analysis of not easily volatilized substances (with inlet device for solids)

Because of their minimal gas consumption, low defractionation and small time constant, gas tight ion sources are ideal for:

- Measurement of gases and solvents in liquids
- Respiration analyses
- Analyses of gas mixtures
- Trace analyses with little influence of residual gases
- Analyses of corrosive or toxic gases

Function

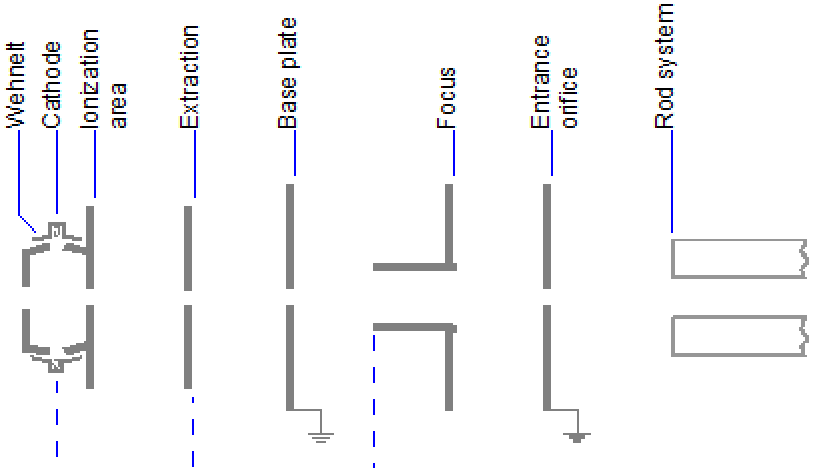
The electrons emitted by the cathode and focused by the Wehnelt electrode, which is connected to the cathode, enter the ionization area perpendicularly to the system axis through a gap and ionize the gas in the ionization area.

The ions are drawn out by the extraction electrode and focused into the mass filter through the ion lens (Focus).

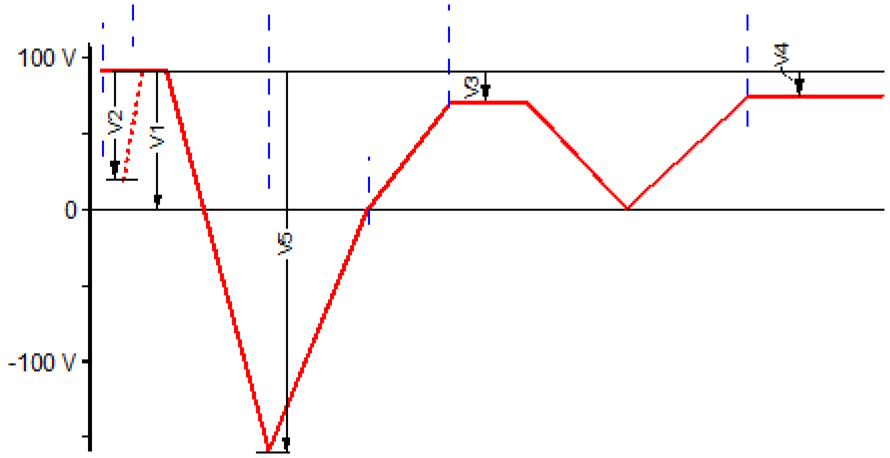
The electron beam, particle beam (if a molecular beam is admitted) and ion extraction are arranged perpendicularly to each other.

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.

Electrode arrangement



Potentials



Typical values

	Emission	1 mA [1]
V1	IonRef	90 V
V2	Cathode	70 eV [2]
V3	Focus	20 V
V4	Field Axis	15 V [3]
V5	Extraction	250 V
V6	Deflection	300 V
	Protection W YO_x-Ir / Re	4.2 A 3.5 A

[1] With magnet 0.7 mA. / At p >5×10^{-6} mbar reduce to 0.1 mA.

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

[3] 5 V at mass range 1024 or 2048.

Adjustment without magnet

Start with the values which previously yielded good results, with the values in the test protocol or otherwise with the values of the previous table.

1 Increase the "Field Axis" value by 1.5 V.

2 Increase the "Resolution" by approx. 15%.

3 Alternately adjust "Focus" and "Extraction" to the maximum peak level.

4 Decrease "Field Axis" until the peak level drops by approximately 10% and assess the peak shape and resolution.

5 Adjust "Resolution" so that it just suffices for the intended purpose. If the resolution is set higher than necessary, the sensitivity and stability may be reduced.

6 If the peak shape is unsatisfactory (spikes, tailings), try to improve it by lowering the "Field Axis".

7 Try to improve the sensitivity by gradually adjusting the "IonRef" setting (in steps of 5 V). After each step, readjust all other parameters. Proceed systematically and record the parameter settings with the corresponding peak levels and shapes.

8 Repeat the procedure for the second cathode. After activating the cathode, wait until thermal stability is reached. If the sensitivity of the two cathodes is quite different, there might be mechanical deformation.

9 Try which is the better RF cable polarity.

Adjustment with magnet

For analyses with different pressures we recommend removing the magnet unit or reducing the emission to 0.1 mA.

For low emissions (up to 0.1 mA) follow the procedure in section "Adjustment without magnet".

At a higher emission and for achieving maximum sensitivity, proceed as follows to find the best emission setting:

1 Set the pressure in the system to the value for which you like to optimize your ion source. This value should remain constant for all adjustments.

2 Set the "Field Axis" to 16 V and "Emission" to 0.5 mA.

3 Alternately adjust "Extraction" and "Focus" several times on the highest peak level.

4 Note the peak level and the corresponding values of "Emission", "Extraction" and "Focus".

5 If the emission is <1 mA, increase it by 0.1 mA and repeat the procedure from step **3**.

6 In the data records, look for the point with the highest peak and make the corresponding parameter settings.

7 Make the "Field Axis" and "Resolution" setting as described in section "Adjustment without magnet".

8 Determine which is the most favorable "IonRef" value and better cable polarity as described in section "Adjustment without magnet".

9 Increase "Extraction" until the sensitivity is 5% lower; the stability becomes thus better.

10 The ion source is now optimized for the current pressure. For other pressures, it usually suffices to adjust "Extraction" and "Focus".

Degas

Degassing of the crossbeam ion source is recommended only for special cases.

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

7.3 Grid Ion Source

Because of its open design the grid ion source has an extremely low outgassing rate and is easily degassed. It emits only a few surface ions.

It is always equipped with two W filaments.

Application examples

- Residual gas analysis in UHV
- Desorption measurements

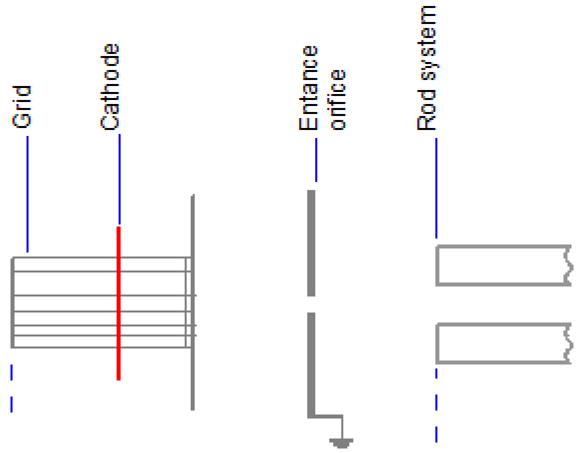
Function

The two electrons which are emitted by the ring cathode are accelerated toward the grid and mainly pass through the grid.

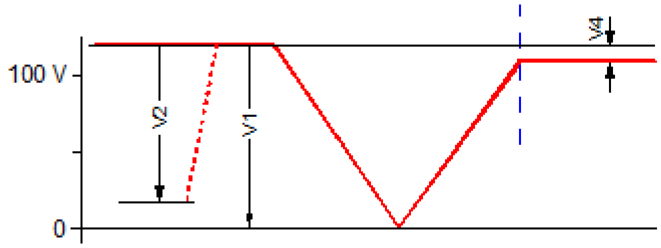
The ions formed inside the grid are drawn to the mass filter by the grounded entrance orifice.

The cathode is connected in the middle. Each half of it can thus be operated separately. In "Fil1+2" mode, the second half is heated so that a high desorption rate is avoided when "Fil2" is activated.

Electrode arrangement



Potentials



Typical values

	Emission	2 mA 1)
V1	IonREF	120 V
V2	Cathode	100 eV 2)
V4	Field Axis	10 V 3)
V6	Deflection	200 V
	Protection W YO_x-Ir / Re	4.2 A 3.5 A

1) At p>5×10^{-6} mbar reduce to 0.2 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.

Adjustment

Start with the values which previously yielded good results, with the values in the test protocol or otherwise with the values of the above table.

1. Adjust "IonRef" to the maximum peak level, however, below the "Cathode" value as otherwise, electrons hit grounded components and desorb ions.
2. Increase "Field Axis" until the peaks "fray" and then reduce that value again until a clear peak shape is reached.
3. Make the desired "Resolution" setting, ideally unit resolution $\Delta M_{10} = 1$.
4. Repeat steps **2** and **3** if necessary.
5. Try which is the better RF cable polarity.

Degas

With Degas the outgassing rate of the grid ion source and the desorption of surface ions is reduced.

Pressure	$\leq 10^{-7}$ mbar
Emission	$\leq$20 mA (at 550 V)
Time	10 … 15 minutes

During the degassing process, operate both filaments (Fil1+2) to prevent adsorption on the cold part.

Recommendation:

1. Degas 10 … 15 minutes.
2. Wait until the final pressure is reached.
3. Check the spectrum.
4. Repeat the procedure if necessary.

7.4 Two Lens Ion Optics

The two lens ion optics does not produce any ions. It transmits ions emitted elsewhere to the mass filter.

The ions can be emitted from a flat surface (e.g. solid surface) or a small volume.

The two lens optics are often combined with an isolated design. In some cases, both deflection voltages are operated at the same time. To check which version you have, please refer to the supplied schematic drawing and additional sheets possibly enclosed with the test protocol.

Application examples

- Thermal desorbed ions
- Electron induced desorption
- Ions from plasmas

Installation

Place the entrance orifice centered at a distance of 5 mm (longer distances are admissible, however, they reduce the sensitivity) from the center of the emitting surface, which need not be perpendicular to the QMA axis. The beam, which excites the emission, should hit the desired spot without colliding with the optics.

If there is a TARGET connector at the QMA, connect the available voltage to your target.

If there is a BIAS connector at the QMA, connect the provided bias voltage there.

DANGER
Shock hazard. The voltages of the IS 420 as well as the additional BIAS and TARGET voltages can be extremely hazardous. Consider the technical specifications of the IS 420 and use only properly made cables.

Function

From the spot where they are emitted 1 (illustration below, e.g. solid surface), the ions to be analyzed reach the inside of the optics via the entrance orifice 2.Their shapes and potentials have a combined effect, oscillating ions are focused to the entrance orifice of the mass filter.

Positive ions are detected in "SPEC+" mode, negative ions in "SPEC-" mode (in combination with the ion counter).

V1 is the surface potential of the sample, which can deviate from the connected potential due to surface charges.

The entrance energy of the ions is:

$E_i = E_o + eV1$ where:

E_o = Initial energy of the ions (defined by the emitting mechanism)

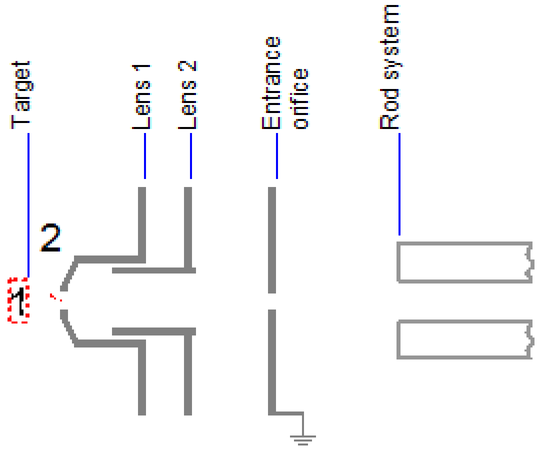
V1 = Potential on which the ions are emitted

For secondary ions Eo is not constant. For each kind of secondary ion, there is another probability of occurrence. 5 to 10 eV is a reasonable thumb value.

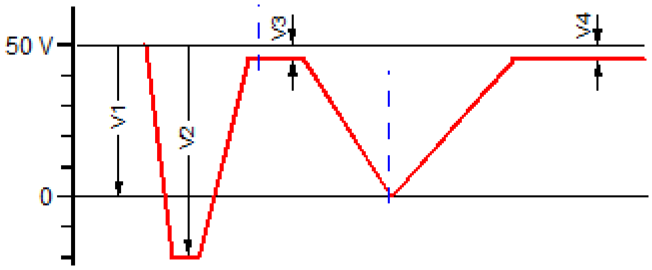
The potentials V2 and V3 are selected as a function of the energy of the entering ions and the desired energy interval of the ions which should pass.

Depending on the potential setting, certain energy ranges are discriminated. For quantitative analysis, comparison to other standards is necessary.

Electrode arrangement



Potentials



Typical values

The values and adjustment apply to ions, emitted on a target. For other applications, they may be quite different. Please note the values for your individual application in the table below.

V1	IonRef	50 V / Target [1)]
V2	Lens 1	70 V
V3	Lens 2	5 V
V4	Field Axis	5 V
V5		
V6	DEFI	350 V
V7	DEFO	120 V
V8		
V9		

[1)] Emission potential of the ions, e.g. connected to SIMS target.

Adjustment

Start with the values which previously yielded good results, with the values in the test protocol or otherwise with the values of the above table.

1. Adjust V1 to the maximum peak level (depending on target distance).
2. Alternately adjust V2 and V3 to the maximum peak level.
3. Adjust the V4 "Field Axis" setting so that a good peak shape and the resolution ΔM_{10} = 1 are reached. If the peaks are still "frayed", reduce V1 and adjust V2 and V3.
4. Adjust V7 "DEFO" to the maximum peak level.
5. Find out which is the better RF cable polarit.

7.5 CB Ion Source with Two Lens Ion Optics

This version offers the features of two lens optics combined with those of the crossbeam ion source. It is used to detect foreign ions and neutral particles that are ionized in the crossbeam ion source.

The crossbeam ion source with two lens ion optics is often combined with the insulating base; in some instances, both defection voltages are also in operation. Please refer to the diagram enclosed with the delivery and any additional pages of the test protocol.

Adapter AS 400 belongs to the scope of supply.

Application examples

- Thermal ion desorption
- Electron stimulated desorption
- Ions from plasmas
- If a short distance between gas source and ionization chamber is necessary
- Detection of unstable (thermally excited) particles

Function

Adapter AS 400 changes to several potentials (see the following Table) depending on whether it is the crossbeam operation or optics operation. The change to optics operation takes place by selecting the ion source type "SPEC+ / SPEC-" and "Emission = Off."

Installation

Place the center of the inlet opening 5 mm (larger distances are permissible, however, the sensitivity declines then) in front of the center of the emitting surface. This must not be perpendicular to the QMA axis. The emission excitation beam is supposed to reach the desired position without a collision with the optics.

Adapter AS 400 is built into the control unit and is inserted into the line between IS 420 and QMA (for subsequent installation).

DANGER

Live voltages.

The voltages of the IS 420, AS 400 and QMA are potentially life-threatening.

Follow the technical data of the IS 420 and use only cables properly prepared by a qualified professional.

There are 3 SHV connectors on the AS 400:

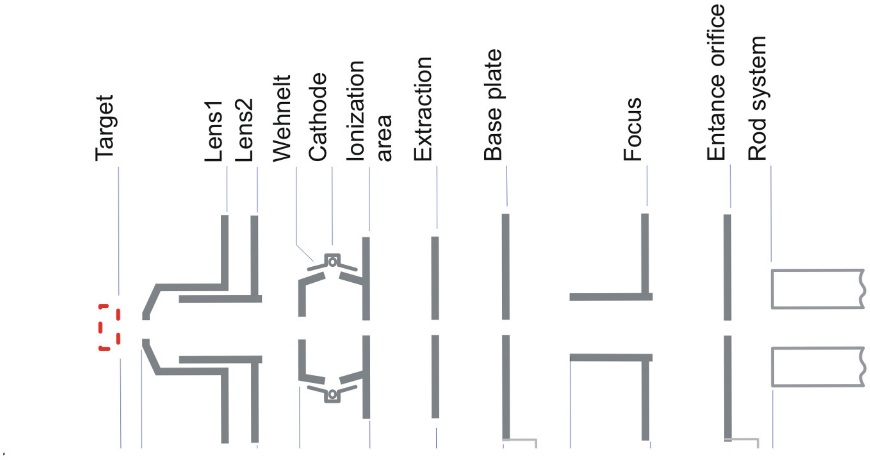
X10 BIAS IN:	Input for an external voltage to elevate the entire ion source supply during optics operation (200 V maximum); during crossbeam operation the supply is at ground potential
X11 BIAS:.	Output with voltage to elevate the "insulating base". V3 "Focus" during opticsc operation, ground potential during crossbeam operation.
X12 Target:.	Output with V1 "Ionref". Attach the target here (e.g. during SIMS).

If the TARGET connector is present on the QMA, the voltage available there (enclosed diagram) can also be applied to the target; generally it is not identical with the voltage at X12.

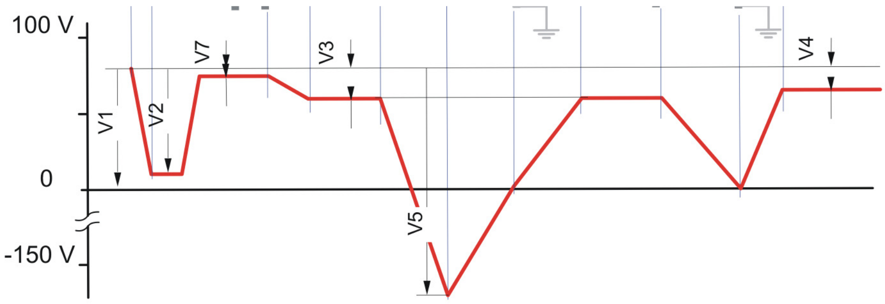
If the BIAS connector is present on the QMA, connect it to the X11 BIAS connector of the AS 400. If you do not use the BIAS connector of the QMA, please attach a short circuit plug.

Electrode arrangement

Optics operation is depicted, for crossbeam operation.



Potentials



Typical Values

The values and the setting process apply to ions released at a target. Other applications may vary greatly. Please note the values that apply to your application in the table.

	Operating mode SPEC**+/-**	
	Emission	OFF
V0	X10 BIAS IN	0 V (short-circuit plug)
V1	X12 Target [1)]	80 V
V2	Lens 1 // Cathode	70 V
V3	Focus // Ionization area // X11 BIAS	20 V
V4	Field Axis	15 V
V5	Extraction	250 V
V6	Deflection	300 V
V7	Lens 2	5 V
V8	Target (QMA)	---
V9	---	---

[1)] Emission potential of the ions, e.g. connected to SIMS target.

Adjustment

Start with the values which previously yielded good results, with the values in the test protocol or otherwise with the values of the previous table.

1. First optimize for crossbeam mode and use the corresponding values for V3, V4, V5.
2. Adjust V1 to the maximum peak level (depending on distance of target).
3. Alternately adjust V2 and V7 to the maximum peak level.
4. If the peak shape is not satisfactory ("frays") or if the resolution $\Delta M_{10} = 1$ is not reached, reduce V1 and readjust V2 and V7.
5. Adjust V6 "Deflection" to the maximum peak level.

7.6 Three Lens Ion Optics

The three lens ion optics with beam stop are suited for detecting both positive and negative ions. Fast neutrals are eliminated by the beam stop.

The three lens ion optics are used as ion transfer optics and energy filter. For energy filtering purposes, a setting of approx. 1.5 eV (FWHM = Full width half maximum) should be chosen. Three lens ion optics are used in a variety of analyzers (sometimes also in differentially pumped systems). Their functional principle is described below in the section on SIMS applications.

For information on other versions, please refer to the supplied schematic drawing and additional sheets possibly enclosed with the test protocol.

Application examples

- Secondary ion emission (SIMS)
- Analysis of thermal desorbed ions
- Detection of ions generated by photoionization
- Analysis of electron induced desorption
- Detection of positive and/or negative ions from plasmas
- Analysis of ion beams
- Energy analysis of ions from plasmas (PPM 400)

Installation (for SIMS applications)

Place the entrance orifice centered at a distance of 5 mm (longer distances are admissible, however, they reduce the sensitivity) from the center of the emitting surface, which need not be perpendicular to the QMA axis. The beam, which excites the emission, should hit the desired spot without colliding with the optics.

If there is a TARGET connector on the QMA, connect the supplied voltage to your target.

If there is a BIAS connector on your QMA, connect the bias voltage of 0 … 200 V there.

If there is a EXTR connector on the QMA, connect the voltage for the extraction hood 0 … 60 V there.

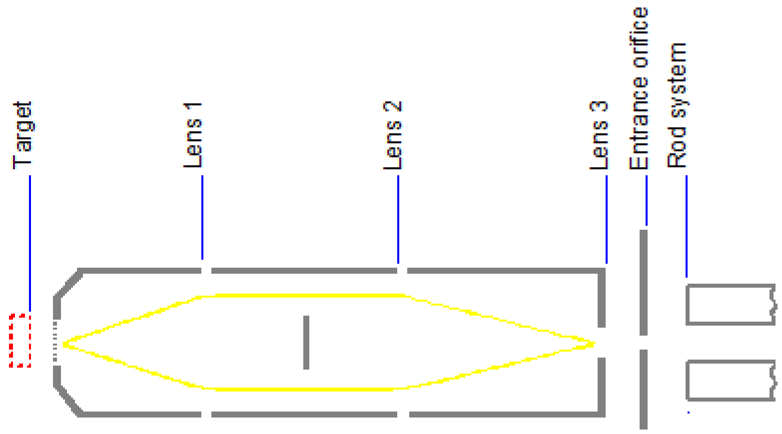
DANGER
Shock hazard!
The voltages of the IS 420 as well as the additional BIAS, TARGET and EXTR voltages can be extremely hazardous.
Consider the technical specifications of the IS 420 and use only properly made cables.

Function

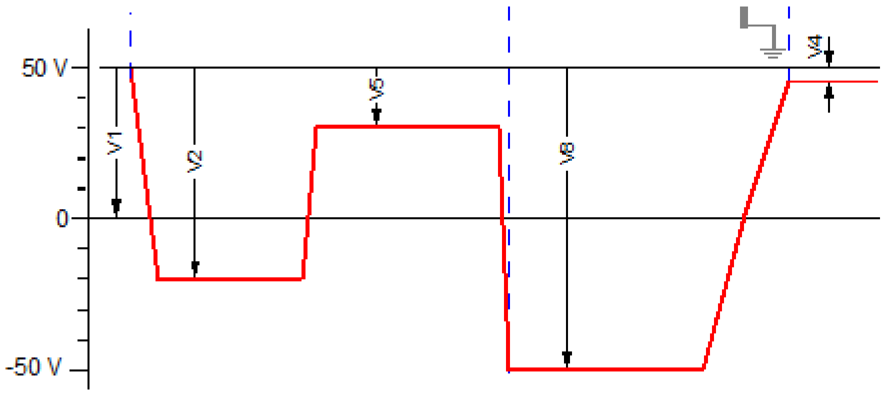
The ions to be analyzed pass from the formation area through the entrance orifice of Lens 1. The optics concentrate the diverging ions to the entrance orifice of the mass filter.

Fast neutrals and photons are eliminated by the beam stop within Lens 2 and thus do not contribute to the background signal.

Electrode arrangement



Potentials



Typical values

The values and adjustment apply to SIMS measurements. The values for other analyses may be quite different. Please note the values for your individual application in the table below.

V1	IonRef	50 V / Target (1)
V2	Lens 1	70 V
V3	---	---
V4	Field Axis	5 V
V5	Lens 2	20 V
V6	DEFI	350 V
V7	DEFO	100 V
V8	Lens 3	100 V
V9		

(1) Emission potential of the ions, e.g. connected to a SIMS target.

Adjustment

Start with the values which previously yielded good results, with the values in the test protocol or otherwise with the values of the above table.

1 Adjust V1 to the maximum peak level (depending on the target distance).

2 Alternately adjust V2 and V5 to the maximum peak level.

3 Set V4 "Field Axis" so that a good peak shape and resolution $\Delta M_{10} = 1$ are reached. If the peaks are still "frayed", reduce V1 and readjust V2 and V5.

4 Adjust V8 to the maximum peak level.

5 Adjust V7 "DEFO" to the maximum peak level.

6 Try which is the better RF cable polarity.

7.7 Crossbeam Ion Source With Three Lens Ion Optics

This version combines the characteristics of the three lens ion optics with the features of the crossbeam ion source. It is used for detecting foreign ions and neutral particles ionized in the crossbeam ion source.

The crossbeam ion source with three lens ion optics is often combined with the isolated design. In some cases, both deflection voltages are operated at the same time. To check which version you have, please refer to the supplied schematic drawing and additional sheets possibly enclosed with the test protocol.

The AS 400 adapted is included in the scope of delivery.

Application examples

- Secondary ion emission (SNMS / SIMS)
- Analysis of thermal desorbed ions
- Detection of ions generated by photoionization
- Analysis of electron induced desorption
- Detection of positive and/or negative ions from plasmas
- Analysis of ion beams
- Energy analysis of ions from plasmas

Function

The AS 400 adapter converts some potentials (see the following table) depending on whether the equipment is operated in crossbeam or ion optics mode. The ion optics mode is activated by selecting the ion source type "SPEC+ / SPEC-" and "Emission = Off".

Installation

Place the entrance orifice centered at a distance of 5 mm (longer distances are admissible, however, they reduce the sensitivity) from the center of the emitting surface, which need not be perpendicular to the QMA axis. The beam, which excites the emission, should hit the desired spot without colliding with the optics.

The AS 400 adapter is incorporated in the control unit and is connected between the IS 400 and the QMA.

DANGER
Shock hazard!
The voltages of the IS 420, AS 400 and QMA are extremely hazardous.
Consider the technical specifications of the IS 420 and use only properly made cables.

There are three 3 SHV connectors on the AS 400 :

X10 BIAS IN:	Input for external voltages for biasing the whole ion source supply in ion optics mode (maximum 200 V); in crossbeam mode, the supply is on ground potential.
X11 BIAS:.	Output with bias voltage for the "isolated design". V3 "Focus" in ion optics mode, ground potential in crossbeam mode.

X12 Target:. . . . . .Output with V1 "Ionref". Connect the target here (e.g. for SIMS).

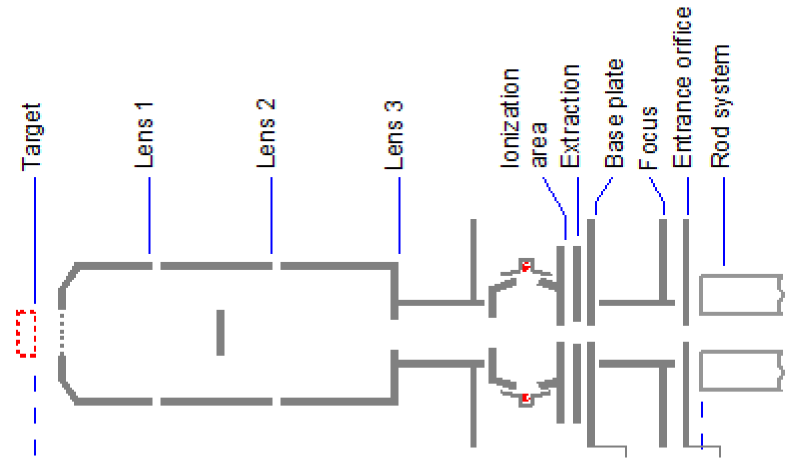
If there is a TARGET connector on the QMA, the voltage available there (supplied diagram) can be applied to the target; in general, it is not identical with the voltage at X12.

If there is a BIAS connector on the QMA, connect it to the X11 BIAS connector of the AS 400. If you are not using the BIAS connector of the QMA, plug in a shorting connector.

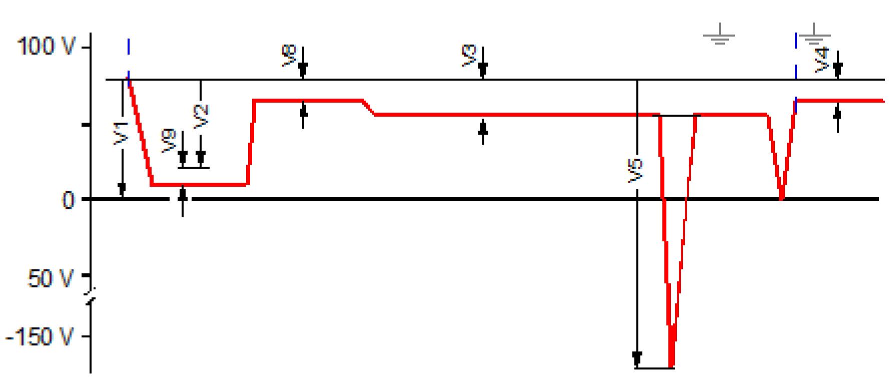
If there is an EXTR connector on the QMA, connect the voltage for the extraction hood (0 … 60 V) there.

Electrode arrangement

The ion optics mode is shown here; for crossbeam operation.



Potentials



Typical values

The values and adjustment apply to SIMS measurements. The values for other applications may be quite different. Please note the values for your individual application in the table below:

	Operating mode SPEC+/-	
	Emission	OFF
V0	X10 BIAS IN	0 V (shorting connector)
V1	X12 Target [1]	80 V
V2	(Cathode)	60 V
V3	Lens 3 // Focus // Ionization area // X11 BIAS	25 V
V4	Field Axis	15 V
V5	Extraction	250 V
V6	DEFI	350 V
V7	DEFO	100 V
V8	Lens 2	10 V
V9	Lens 1	10 V [2]

[1] Emission potential of the ions, e.g. connected to SIMS target.

[2] Lens 1 is on V1 - (V2 + V9).

Adjustment

Start with the values which previously yielded good results, with the values in the test protocol or otherwise with the values of the above table.

1. First, optimize for crossbeam operation and use the corresponding values for V3, V4, V5.
2. Adjust V1 to the maximum peak level (depending on the target distance).
3. Alternately adjust V2+V9 and V8 to the maximum peak level.
4. If the peak shape is unsatisfactory ("frays") or if the resolution $\Delta M = 1$ is not reached, reduce V1 and readjust V2 + V9 and V8.
5. Adjust V6 "Deflection" to the maximum peak level.

8 Disposal

DANGER

Contaminated parts.

Contaminated parts can be detrimental to health.

Before beginning to work, find out whether any parts are contaminated. Adhere to the relevant regulations and take the necessary precautions when handling contaminated parts.

WARNING

Substances detrimental to the environment.

Products, operating fluids etc. may require disposal in accordance with special regulations.

Dispose of such substances in accordance with the relevant local regulations.

Separating the components

After disassembling the product, separate its components according to the following criteria:

Contaminated components

Contaminated components (radioactive, toxic, caustic, or biological hazard etc.) must be decontaminated in accordance with the relevant national regulations, separated according to their materials, and recycled.

Other components

Such components must be separated according to their materials and recycled.

A Appendix

A.1 Literature

www.pfeiffer-vacuum.com
Operating Instructions
QMH 400-1, -5, QMH 410-1, -2, -3
BG 5982 BEN
Pfeiffer Vacuum GmbH, D-35614 Asslar

www.pfeiffer-vacuum.com
Operating Instructions
QMG 700
BG 5400 BEN
Pfeiffer Vacuum GmbH, D-35614 Asslar

CE

Declaration of Conformity

We hereby declare that the product cited below satisfies all relevant provisions according to the following **EC directives**:

- **Low Voltage Directive 2014/35/EU**
- **Electromagnetic Compatibility 2014/30/EU**
- **Restriction of the use of certain Hazardous Substances 2011/65/EU**

QMA 400, 410, 430™

QMG 700 Analyzers

Harmonised standards and national standards and specifications which have been applied:

Safety:	EN 61010-1:2010
Emissions:	EN61326-1:2013 EN 55011:2009 + A1:2010 / CISPR 11:2009 + A1:2010 Radiated and Conducted Electromagnetic Emissions FCC Title 47 Part 15 Class B emission requirements ICES-001 Issue 4 ISM emission requirements
Immunity:	EN 61326-1:2013 (General EMC) Class A EMC - Measurement, Control & Laboratory Equipment
RoHS:	Due to the classification of this product it is currently exempt from the RoHS directive until 2017.

Signatures:

Pfeiffer Vacuum GmbH
Berliner Straße 43
35614 Asslar
Germany

(Dr. Ulrich von Hülsen)
Managing Director

2016-05-18

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