From Eye to Insight

Leica
MICROSYSTEMS

OPERATING MANUAL
EM TIC 3X

167190032 Version 07/17

Important Note

Leica Mikrosysteme GmbH reserves the right to change technical specifications as well as manufacturing processes without prior notice. Only in this way is it possible to continuously improve the technology and manufacturing techniques used to provide our customers with excellent products.

Issued by:

Leica Mikrosysteme GmbH
Hernalser Hauptstrasse 219
A-1170 Vienna

Leica EM TIC 3X

Operating Manual

Leica EM TIC 3X Serial Number:

Date of purchase:

For the instrument serial number, please refer to the name type label on the back of the instrument!

Please read this operating manual carefully before operating the instrument.
For Research use only!

Foreword

This operating manual is intended to provide essential information about the proper operation and servicing of the Leica EM TIC 3X Triple Ion Beam Cutter system. The appendix helps with specific processing of solid samples for subsequent investigation with an electron microscope (EM) or light microscope (LM).

This operating manual describes commissioning of the Leica EM TIC 3X Triple Ion Beam Cutter system, phased testing and adjustment of all components and movement sequences, and restoring the basic functionality.

Service and operating staff must familiarize themselves with all components of the system before commissioning. Particular attention must be paid to the aspect of safety.

This operating manual must be retained for future reference.

It should be noted that this operating manual does not constitute a part of any existing, prior agreement or covenant or legal relationship.

All obligations are derived from the purchase agreement, which is also the sole document of record regarding the terms of the warranty. Contractual provisions are not affected by the operating manual.

The documentation issued by the respective suppliers shall apply in addition to this manufacturer's documentation (see attachment).

In addition, all generally applicable legal and otherwise binding regulations for preventing accidents and protecting the environment must be observed and communicated.

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1. Introduction

In order to ensure the safety of service technicians and operators, and to prevent any damage to the Leica EM TIC 3X Triple Ion Beam Cutter system, it is essential to read this manual carefully before beginning any work with the system.

This operating manual is intended to help the user to understand the system more completely, to use it within the specified limits of its working capabilities, and to maintain and service it in accordance with its physical parameters.

This operating manual includes important information regarding proper and economical installation, operation, servicing, troubleshooting and repair. Following these instructions will help to prevent hazards, reduce repair and downtime costs, and prolong the system's service life.

In certain chapters, a certain symbol refers to the function or respective section of text and is relevant for the operation or maintenance of the system, or indicates important descriptions or additional remarks:

Symbols in this manual and their meaning:

Danger!
All paragraphs in the operating manual that contain instructions regarding possible hazards are identified with this symbol. Failure to observe these alerts may result in serious injury! Users of the instrument must comply with instructions at all times.

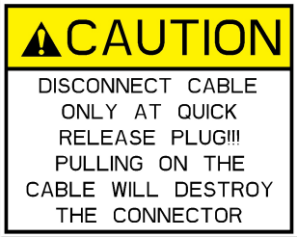
Caution!
This symbol alerts the user to important information which may endanger staff or result in damage to the system if it is ignored.

Note!
This symbol indicates further information relating to a previous explanation, which does not have a safety-critical function. However, it is important to follow this information to ensure that the system functions optimally.

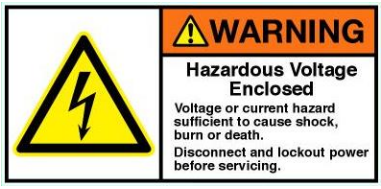
This symbol indicates the necessary work processes for scheduled and unscheduled maintenance with consideration of the safety equipment. Another symbol indicates the qualification that is required in order to carry out such work.

Wear work gloves!

Symbols and indications on the instrument and their meaning:



The plug is equipped with a locking mechanism. Please do not pull on the cable! Grasp the knurled part of the plug and retract for disconnecting the cable.



Hazardous Voltage! Enclosed Voltage or current hazard is sufficient to cause shock, burn or death. Disconnect and lockout power before servicing.

Danger of pinching the fingers when closing the flange (stage).

Hot surface during and right after processing the sample. Allow to cool before servicing the ion source.

LN_2 is used to cool down the sample. To avoid serious burns or frostbite, follow safety information before disconnecting fluid lines.

Lifting hazard. The volume of the LN_2 Dewar is 25 l. Single person lift could cause injury. Use assistance when moving or lifting the Dewar.

This Dewar contains LN_2, follow safety procedures when handling with liquid nitrogen.

Warning! Improper use of the instrument can cause serious harm. Read the manual before operating the system.

LN_2
(left side of the instrument)

LN_2 connection for the LN_2 tube from the LN_2 pump in case the system is equipped with the cooling device.

Connection for ring LED or coaxial LED illumination.

Port to connect a <= 16GB USB memory stick for data up and download.

This product has been tested to the requirements of CAN/CSA C22.2 No. 61010-1, second edition, including Amendment 1, or a later version of the same standard incorporating the same level of testing requirements.

1.1 Identification

1.1.1 Product

Leica EM TIC 3X Triple Ion Beam Cutter system

1.1.2 Name and address of the manufacturer

Leica Mikrosysteme GmbH
Hernalser Hauptstrasse 219
A-1170 Vienna

Tel.: +43 1 488 99-0
Fax: +43 1 488 99-350

Internet: http:// www.leica-microsystems.com

2. Product description

2.1 Field of application and proper use

The Leica EM TIC 3X Triple Ion Beam Cutter system is used for precise processing of samples for subsequent examination with an electron microscope (EM) or light microscope (LM). For this purpose, a cross-section or ion beam polished surface of a sample is created with the Leica EM TIC 3X Triple Ion Beam Cutter system.

The samples are processed with ion beams in a vacuum. The system generates ions in the energy range from 1 keV to 10 keV.

A variety of sample preparation equipment (stages) can be used to adapt the Leica EM TIC 3X to the application needs (e.g. cryo stage). Hence, almost any material can be processed, e.g. semiconductors, metals, rocks, ceramics, polymers, rubber, paper, environment sensitive and even biological material.

Please refer to separate operating manuals of stages you ordered!

The ion energy causes the temperature of the sample to increase during processing. The operator must ensure that this does not cause the sample's state of aggregation to change. If so, using the cooling stage is recommended.

The Leica EM TIC 3X must not be used beyond the limits specified in its technical data sheet.

An inert gas, preferably argon, is used as the working gas. If other gases are used for reactive processing of samples, the appropriate safety measures (purging, removal of exhaust air) must be put in place, not only for the working gas, but also for the reaction by products created during processing. To make sure the system will be suitable for other gases than argon please contact the Leica representative prior to use.

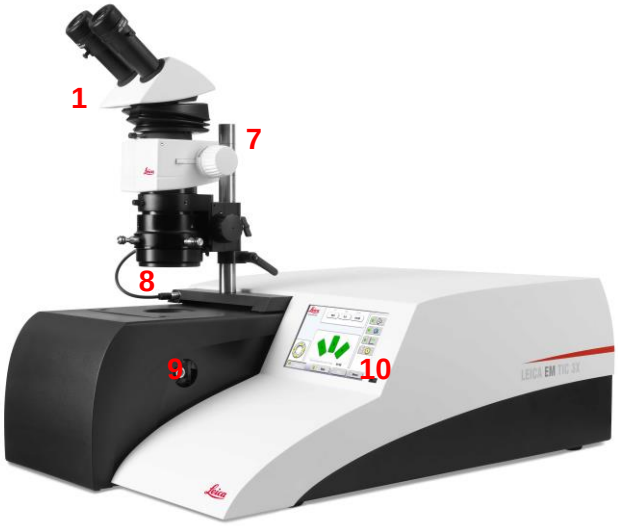
When hazardous substances (e.g., radioactive, toxic or explosive substances) are processed **the substance-specific safety precautions must** be implemented. It is forbidden to process substances that release corrosive or poisonous gases when they are cut with an ion beam. When hazardous substances have been processed the system (chamber) must be decontaminated before servicing the instrument.

Applications other than those described are inconsistent with proper use and are therefore prohibited. If the system is used incorrectly, all claims under warranty will be not accepted.

In cases of doubt, please consult your local Leica representative.

2.2 Instrument overview

1. Stereo Microscope
2. Drawer unit to load the sample in the vacuum chamber
3. Touch sensitive control panel
4. Instrument table
5. LN_2 pump (optional)
6. LN_2 Dewar (optional)



7. Microscope support column
8. LED illumination
9. Access to E-W traverse knob. Opposite side is sample Z-movement
10. USB port

2.3 Dimensions and weight

Dimensions of the system with without light microscope and sound suppressor:

Width: 500 mm
Height: 485 mm
Depth: 738 mm
Weight: approx. 62 kg

Dimensions of the shipping container:

Width: 650 mm
Height: 820 mm
Depth: 950 mm

The weight of the transport-ready system is about 90 kg.
Volume of LN_2 Dewar: 25 l

2.4 Electrical and gas requirements

Voltage:	100 – 230 VAC, 50/60 Hz
Mains supply fluctuations:	± 15% of the nominal voltage
Fuses:	4 AT
Working gas:	preferably 99.999 % (Ar 5.0)
Gas flow:	<1 sccm/ion source with automatic control

2.5 Energy consumption, energy conditions

Power consumption:
Maximum: 300 W

2.6 Sound emissions

The continuous sound level emitted by the Leica EM TIC 3X Triple Ion Beam Cutter system is about 50 dB (A).

2.7 IP code of the electrical devices

The electrical devices are equipped with housings and covers, and are therefore designed to provide **degree of protection IP 20** (contact protection: blocking finger access; protection from foreign bodies: protected from foreign bodies > d = 12 mm, no special water protection).

2.8 Environmental conditions and limits for operation and storage

Operating temperature: +15 °C to +30 °C
Storage temperature: +5 °C to +40 °C

Atmospheric humidity for operation and storage: max. 80 % RH; non-condensing
Protection from dust and aggressive media must be provided during operation and storage.

2.9 Safety information

2.9.1 General instructions

Danger!
The Leica EM TIC 3X Triple Ion Beam Cutter system can be handled safely and easily provided it is operated in accordance with the instructions in this manual.

Non-observance of these safety instructions may endanger people and the system.

2.9.2 Design safety measures

All electronic components are protected by covers (doors, panels, etc.). These covers must not be opened except for servicing by authorized Leica representative.

Caution!
There is a danger of electric shock when the cover is removed.

Injuries may be sustained that could lead to death.

The Leica EM TIC 3X Triple Ion Beam Cutter system must not be operated unless all covers are properly in place.

Caution!
Some of the components inside the system may become hot and present a danger of injury.

Burns may be sustained.

The Leica EM TIC 3X Triple Ion Beam Cutter system must not be operated unless all covers are properly in place.

Caution!
When working with liquid nitrogen (LN_2) please bear in mind LN_2 is extremely cold. It boils at -196 °C. Nitrogen gas (GN_2) escapes at very low temperature from the boiling LN_2. Both LN_2 and GN_2 as well as cooled elements (e.g. pipes, valves, hoses, containers or stoppers) can cause severe frost bite and burns to the skin and eyes.

Please pay particular attention to the safety information about the use of LN_2!

2.9.3 Safety measures at the installation site

The following measures must be implemented to prevent incorrect use at the installation site:

- The electrical and gas connections for the system must be carried out by qualified technicians.
- Gas bottles must be stood up securely and connected professionally. The system must be connected to the operator's mains supply by qualified technicians.
- The system must not be operated except by trained and authorized personal.
- Repairs may only be made by authorized staff of Leica representatives.
- If the Leica EM TIC 3X Triple Ion Beam Cutter system is installed incorrectly, the system may be damaged.

2.9.4 Safety measures before use

The Leica EM TIC 3X Triple Ion Beam Cutter system must be installed by authorized staff of Leica representatives.

Note!
The system should be switched off for maintenance and servicing only, not at the end of a work session.

The system must be installed correctly before it is commissioned by the technical service. The supply of power and gas must be assured according requirements described at point 3.

2.9.5 Qualification of operating personnel

The operating personnel must be familiar with and follow the recognized provisions for safety at work.

The operating personnel must be trained and familiar with the duties that have been assigned to them and for which they are responsible.

The professional profiles for operating personnel responsible for the system are outlined in the following.

Operator
Personnel with technical training, able to perform simple tasks, i.e., operate the Leica EM TIC 3X Triple Ion Beam Cutter system and load / unload samples.

Administrator
Staff with technical training, able to perform the tasks of qualification 2, and also typical simple maintenance, adjustment and start-up activities with protective devices switched off as well as restarting the system.

Manufacturer's service technician
Trained technician provided by the Leica representative, who is able to carry out more complex work in exceptional situations or in cases where such has been agreed with the user.

2.9.6 Residual hazards

The Leica EM TIC 3X Triple Ion Beam Cutter system represents the latest technology and conforms to recognized safety regulations: even so, hazards still exist.

If the Leica EM TIC 3X Triple Ion Beam Cutter system is damaged or malfunctioning, all use of the system should be suspended until the malfunction or damage has been corrected.

All modifications and conversions to the system are prohibited and leads to exclusion of guarantee!

2.9.7 Emergency procedure

If unusual operating conditions or unaccustomed noises occur, the system must be switched off using the main switch on the system if necessary.

If firefighting measures are called for, a CO_2 fire extinguisher must be used.

The Technical Service must be consulted before resuming work with the system.

2.9.8 Liquid Nitrogen (LN_2) used for the cooling stage (optional)

The volume of the LN_2 Dewar is 25 l. When working with liquid nitrogen (LN_2) please bear in mind LN_2 is extremely cold. It boils at -196 °C. Nitrogen gas (GN_2) escapes at very low temperature from the boiling LN_2. Both LN_2 and GN_2 as well as cooled elements (e.g. pipes, valves, hoses, containers or stoppers) can cause severe frost bite and burns to the skin and eyes.

When LN_2 evaporates, it expands in a ratio of 1:700. 1 litre LN_2 produces almost 1 m^3 of GN_2. Care should therefore be taken to ensure that when large quantities of nitrogen evaporate (e.g. when transferring LN_2), the room should always be well ventilated.

Removing LN_2 waste: dump LN_2 into an outdoor pit or container filled with gravel, where it will evaporate rapidly and safely.

GN_2 is odourless and tasteless and will be inhaled like air. GN_2 is non-toxic, but a high GN_2 content in the air (> 78%) reduces the oxygen-content (< 21%) and produces immediate fainting and deep unconsciousness without any previous symptoms.

When there is doubt about the adequacy of ventilation, use an oxygen analyser (0 to 25% scale) to check for oxygen. The content of oxygen must not drop below 18%.
If an unconscious person stays in a low oxygen environment then death may occur.
If breathing stops, apply artificial respiration at once and notify doctor and ambulance immediately!

For the reasons given above, never put LN_2 Dewars in a closed storage room or chamber. The evaporation rate from Dewar vessels can rise to several litres a day if they are defective due to improper handling or to natural wear over many years of use.

Always keep the working area well ventilated.

Bring objects at room temperature carefully into contact with LN_2. Initially an insulating gas layer is formed preventing a large transfer of heat. During this initial period little LN_2 evaporates. However, once the object has cooled down there may occur unexpected strong boiling and spurting of LN_2.

In the case of burns from LN_2 splashes, rinse the affected skin immediately with plenty of water at hand temperature. For serious burns arrange for a skin specialist to see them at once.

In the case of LN_2 affecting the eyes, rinse immediately with water at hand temperature and arrange for an eye specialist to see it at once.

Never use glass Dewar vessels in the lab (especially glass Dewars larger than 2 litres capacity) without complete metal envelope: Glass Dewars often burst for no obvious reason or due to unintentional mishandling (e.g. contact with metal instruments etc.). Never work without open protective glasses when using LN_2 in a glass Dewar.

Estimation of lethal GN_2 – concentration in closed rooms.
Full-load values (10 kV, 3.5 mA, -150 °C), room temperature ~25 °C

Size of the room [m^3]	***10***	***21***	***31***	***42***	***52***	***62***	***73***	***83***	***94***	***104***
Time to achieve critical concentration [h]	***1***	***2***	***3***	***4***	***5***	***6***	***7***	***8***	***9***	***10***

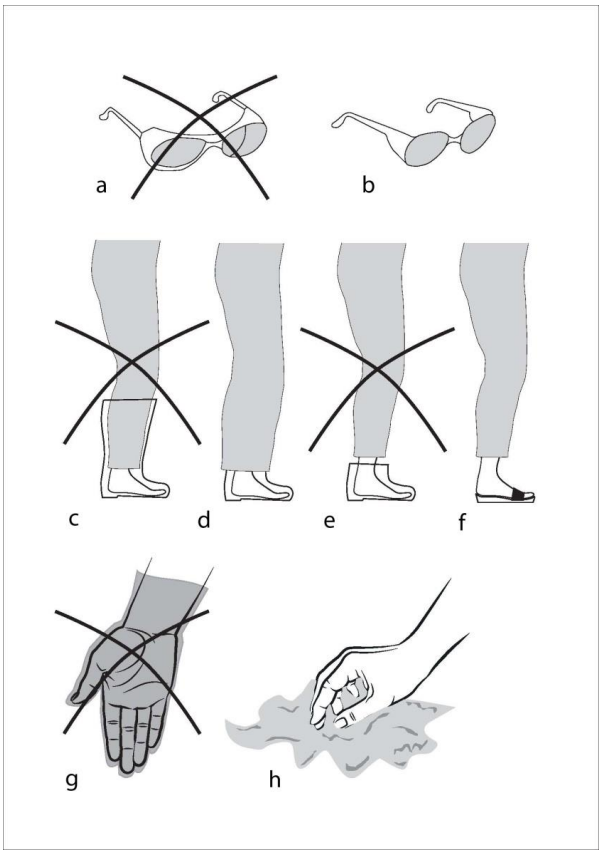


Fig.1.1: When working with LN_2 for refilling the Dewar avoid protective glasses (a), boots (c), walking shoes (e) and protective gloves (g) out of which the LN_2 cannot easily escape if entered. LN_2 splashing into the closed protective glasses (a), open boots (c), shoes (e) or protective gloves (g) evaporates suddenly and can cause serious burns.

Always use protective glasses (b) with side protection which are open at the top and at the bottom. Only use boots if you have loose (not narrow) trousers coming outside the boots (d) and completely covering the gap. Wear only open slip-on sandals (f) in the lab, no walking shoes or court shoes. Always wear cuffless trousers if you wear slip-on sandals. Never wear protective gloves when pouring LN_2 or when putting the Dewar head on the Dewar vessel. Just use an open flannel cloth (h) to protect your hands from the cold. Gloves should be used only to grasp dry cold parts. They are unsuitable for LN_2 work.

Only use metal Dewars specifically designated for storage of LN_2, since only containers of this kind exclude risks during storage. For routine cryo-preparation metal troughs (1 cm Styrofoam insulation), Styrofoam containers or plastic troughs are eminently suitable and ensure low risk cryo-preparation.

Check the evaporation rate of your metal Dewar regularly every three months and compare these rates with the rate given by the manufacturer. The evaporation rate of an undamaged metal Dewar should be well below 1 litre of LN_2 per day. Defective Dewar vessels with higher evaporation rates are a safety risk, and should be taken out of work or repaired.

Do not leave LN_2 standing in open vessels where it can exchange with the room atmosphere. The boiling point of LN_2 (-196 °C) is lower than liquid oxygen's boiling point (-183 °C). When the exchange surfaces are extensive enough, oxygen from the

air will be taken up in exchange for nitrogen. LN_2 with high liquid oxygen content has a faintly bluish colour. Concentrated liquid oxygen promotes vigorous burning!

Make sure that your Dewar vessel is filled only with LN_2. Apply a note in the central distribution place stating clearly

ONLY LIQUID NITROGEN

or similar if different liquefied gases are delivered from there. Check the colour of cryogen: Bluish colour indicates the presence of a high percentage of liquid oxygen.
The concentration of liquid oxygen increases during long periods of storage as its boiling point (-183 °C) is higher than the boiling point (-196 °C) of LN_2.

Main supply must be assured: 100 – 240 VAC, 50 / 60 Hz.
The instruments are equipped with protected ground. Before connecting it to the local electrical supply make sure that the mains has the required ground and that the instrument is connected to it according to the local regulations.
Unplug the instrument before installing or changing fuses.

HAZARD WARNING

LIQUID NITROGEN, LN_2

Suffocation

- Any vessel containing LN_2 is a potential hazard
- One litre LN_2 produces 700 litres N_2 gas
- N_2 gas is odourless and tasteless
- Oxygen levels can quickly drop in confined spaces due to displacement of oxygen
- by N_2 when using or dispensing large volumes of LN_2
- This can cause immediate fainting and unconsciousness
- Always use LN_2 in well-ventilated areas
- Treat it with respect!

Storage

- For reasons mentioned above do not store full LN_2 Dewars in confined spaces

Burns

- LN_2 boils at -196 °C. It is extremely cold and can cause serious burns. Please read the safety instructions provided with all Leica products for the correct handling of liquid nitrogen!

3. Installation and set up

3.1 Transportation and storage conditions

The Leica EM TIC 3X Triple Ion Beam Cutter system is delivered properly packed and in the semi-assembled state. The customer must check the condition of the system upon delivery and file a damage report with the shipping company if the equipment is damaged. The customer must immediately inform the Leica representative of any possible damage in transit.

The system must be positioned upright for transporting.

The overall weight including packaging is approx. 90 kg.

The packed equipment must be stored in clean, dry areas at temperatures between 5° and 40 °C. It must not be exposed to aggressive or corrosive substances.

3.2 Installation requirements

3.2.1 Working area conditions

A working area of about 150 mm must be maintained all around the system, to allow the supply connections to be made, and also to enable access for essential servicing activities. The Leica TIC 3X must be set up on a stable laboratory workbench with a surface area of at least 800 mm x 900 mm.

When selecting a setup location, bear in mind that the system weighs approx. 62 kg.

The instrument has to be placed on a stable laboratory workbench or other stable instrument table; otherwise vibrations from the roughing pump can be transferred to the system via the instability of the table, which effects vibration free observation during the ion etching process.

The instrument must be placed on the bench in such a manner to get access to the switch and mains plug at any time!

3.2.2 Connections requirements

The following connections must be assured:

Electricity supply:	100 – 230 V, 50/60 Hz
Argon:	
reduced pressure:	200-800 mbar (overpressure)
purity:	min. 99.999 % (Ar 5.0)

3.3 Installing, assembling and commissioning

3.3.1 Unpacking and installing on a table

The Leica EM TIC 3X Triple Ion Beam Cutter system should be transported with a forklift truck.

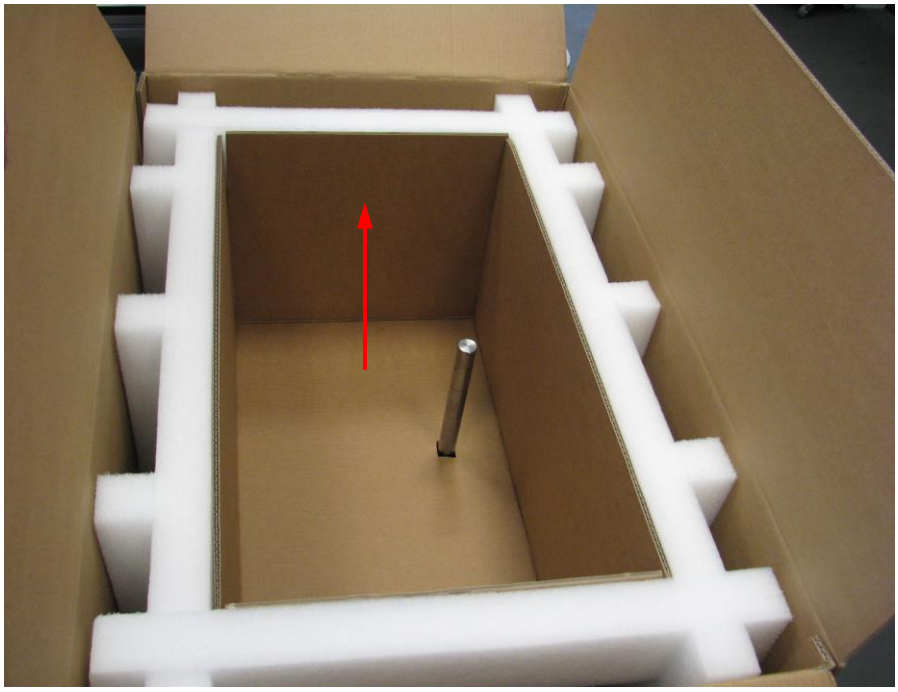
After selecting the installation location, remove and store the outer packaging. Check the disassembled components that are secured on the housing, to ensure that nothing is missing or damaged.

To unpack the system, proceed as follows:

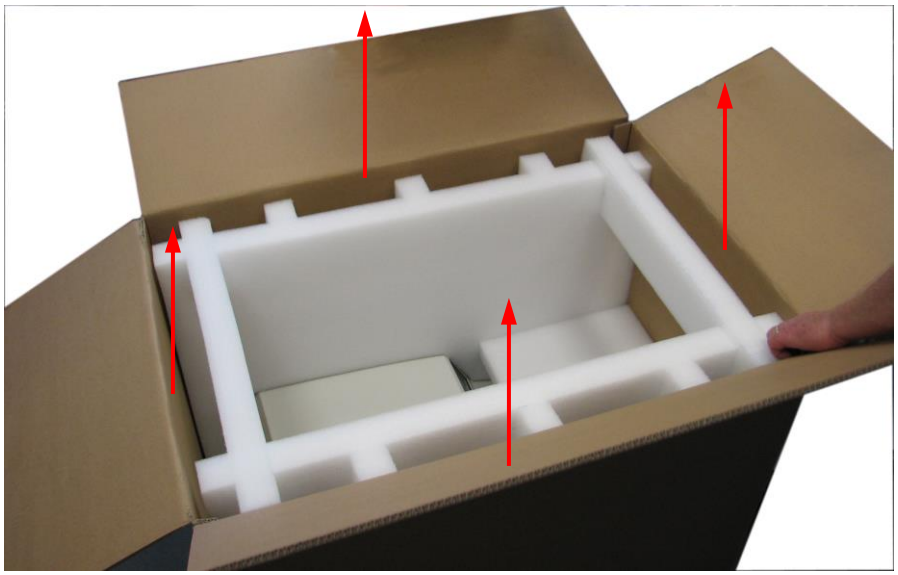
1. Remove the packaging straps around the crate containing the Leica EM TIC 3X Triple Ion Beam Cutter system.

2. Open the crate and remove the packing material.

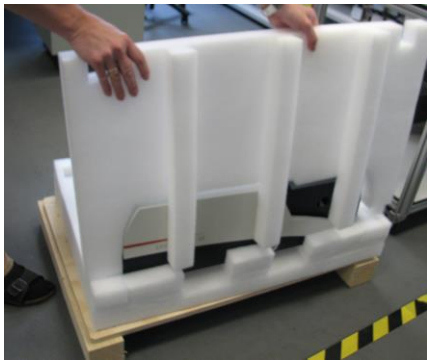
3. Carefully remove the boxes of the accessories.
4. Remove the inner cover of the packaging.



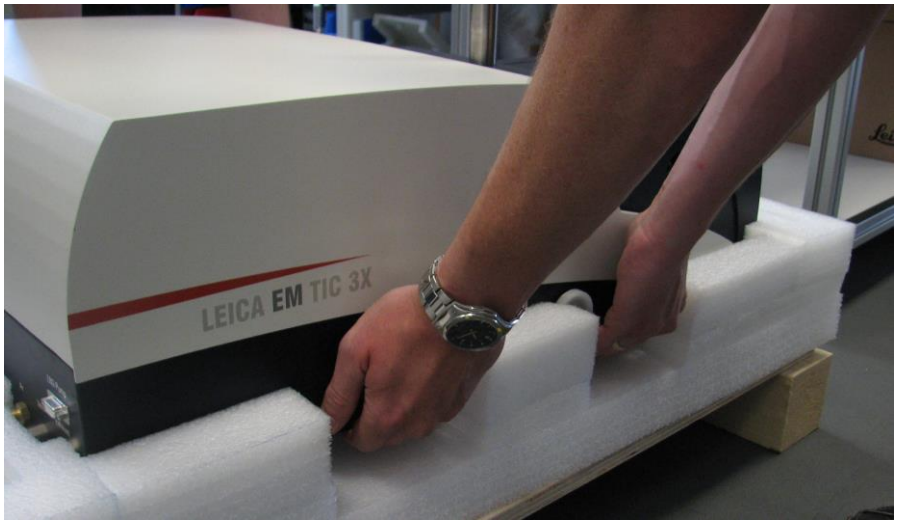
5. Lift the shipping crate up off the pallet.



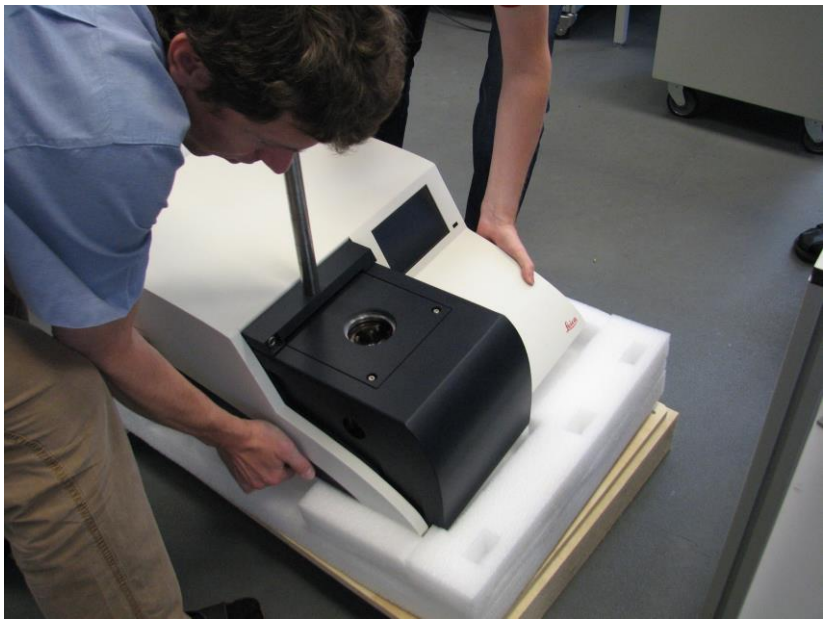
6. Remove the foam shipping protection around the Leica EM TIC 3X.



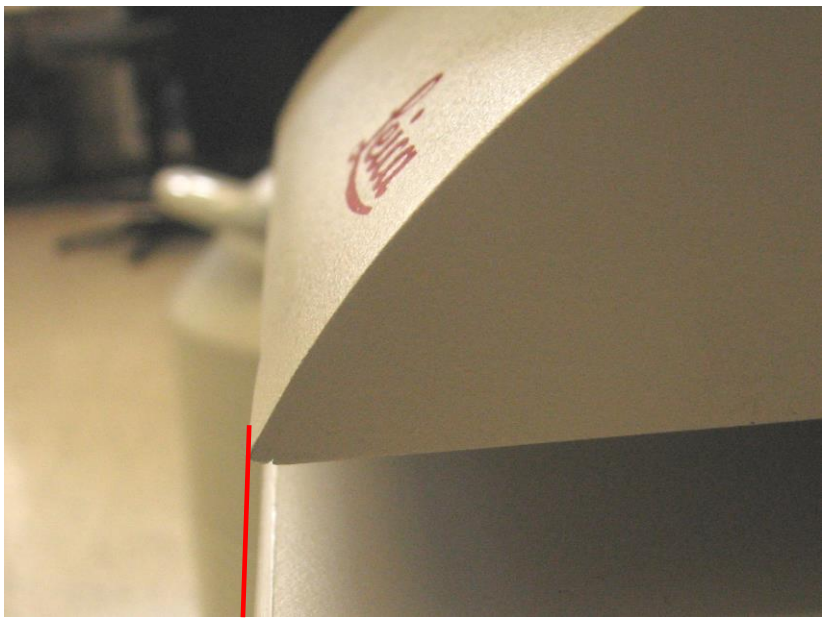
7. Remove the Leica EM TIC 3X from the foam material on the pallet. Grip the instrument from the recesses of the foam.



8. Two persons should lift up the instrument and place it on the stable table.



9. To get free access for exchanging the stages the front edge of the instrument should be coincident with the edge of the table.

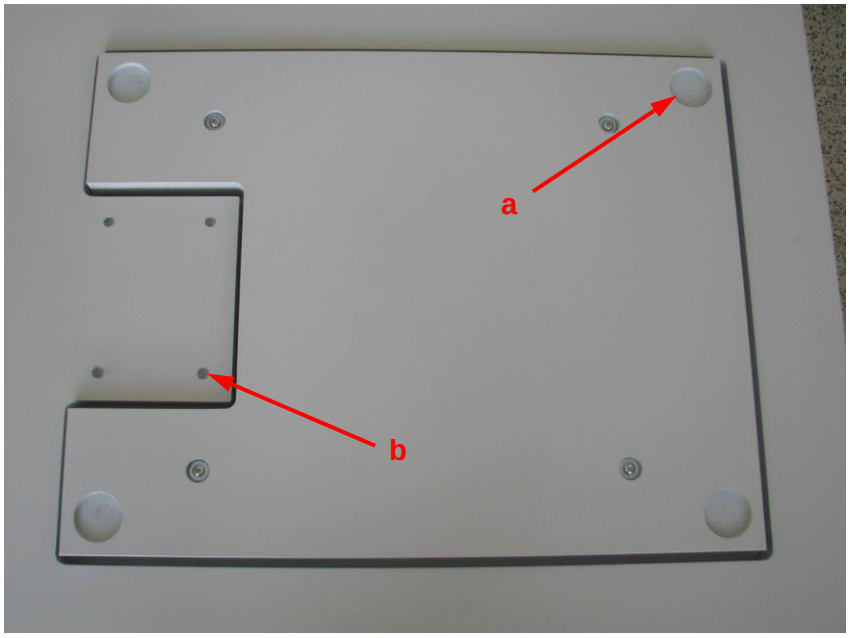


The roughing pump is decoupled when the feet are not in direct contact with the chassis of the instrument. The feet of the roughing pump are placed on the instrument table and should not contact the base plate of the instrument, which might be the case when moving the instrument to its final position. Slightly lift up the instrument vertically and lower it to its final position again. Now, the feet of the roughing pump should not be in contact with the base plate.

3.3.2 Installing the Leica EM TIC 3X on Leica instrument table

1. After placing the table in its position the rear leg has to be adjusted to compensate for unevenness of the floor (use spirit level). This adjustment has to be carried out before putting the instrument on the table.

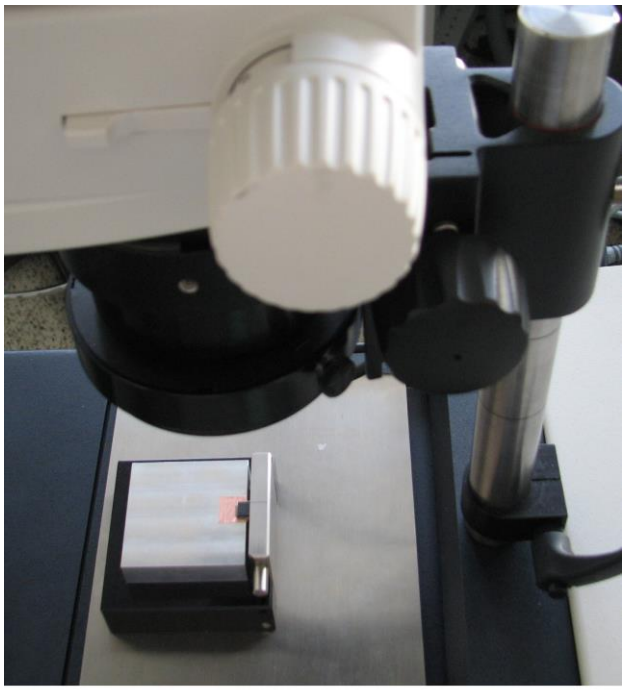
2. The Leica instrument table has four recesses (a) to position the feet of the instrument (a). In addition, four recesses to position the feet of the roughing pump (b). When setting up the instrument, make sure all feet are properly positioned in their recesses.



3. Once the instrument is placed on the table, check whether the feet of the roughing pump are not in contact with the base plate of the instrument. If so, slightly lift up the instrument vertically in order the feet of the roughing pump will not interfere with the base plate.

3.3.3 Installing the arm rests of the Leica instrument table

1. When placing the work plate on top of the chamber the stereo microscope of the instrument can be used to manipulate the sample. To provide a comfortable posture, arm rests can be attached to the front of the instrument table.



2. Mount the arm rests in such a manner that the tongue rests on the groove of the guide bar. Clamp the arm rest with the star-handle against the screw nut.

3. Adjustment screws of the arm rest: star handle for longitudinal and lever for height adjustment.

3.3.4 Clamping device (Argon bottle, LN_2 pump) of the instrument table

1. The instrument table is equipped with holders for the Argon gas bottle (a) and the LN_2 pump (b).

2. Use the safety-belt to clamp the Argon gas bottle. To secure the LN_2 pump, lift up the holder until it securely clamped by the clamping mechanism. Latch the holder with the folding lever.

3.3.5 Assembling the stereo microscope S9E

Note!
For detailed information about the stereo microscope see enclosed manual of the stereo microscope.

1. Move the clamping ring on the column of the stereo microscope. This ring is used to hold the stereo microscope in its height position when it is swivelled.

2. Move the stereo microscope carrier on the column as shown in the picture.

3. Insert the stereo microscope into the carrier.

4. Clamp the microscope with the clamping screw.

5. Insert the eyepieces.

6. Place and clamp the ring LED on the stereo microscope. The clamping screw should be located at the 2 o’clock position. Thus the segments of the illumination are in the right position.

7. Connect the ring LED to the port on the left side of the carrier of the column and finger tighten the screw.

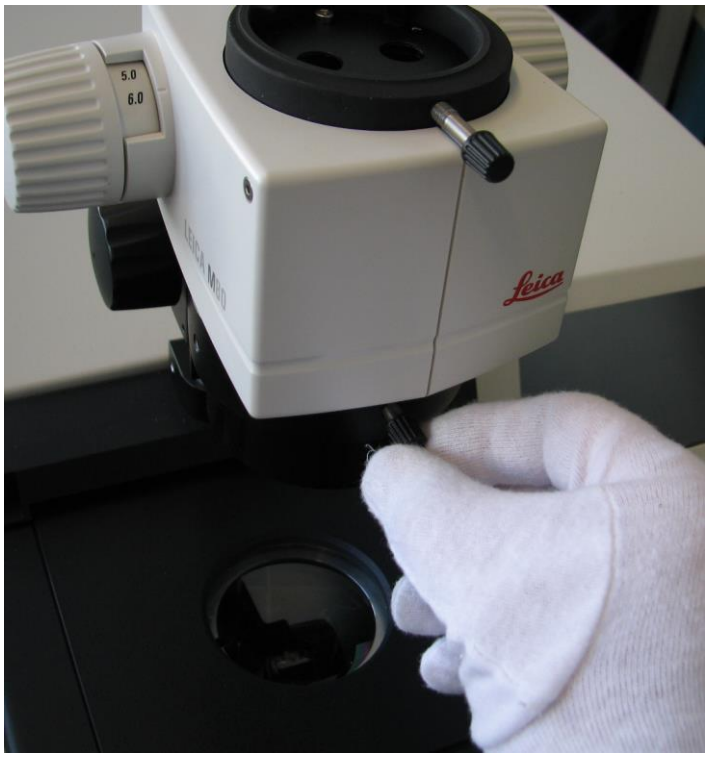
3.3.6 Assembling the stereo microscope M80 (with 0.8x objective)

1. Move the clamping ring on the column of the stereo microscope. This ring is used to hold the stereo microscope in its height position when it is swivelled.

2. Move the stereo microscope carrier on the column as shown in the picture.

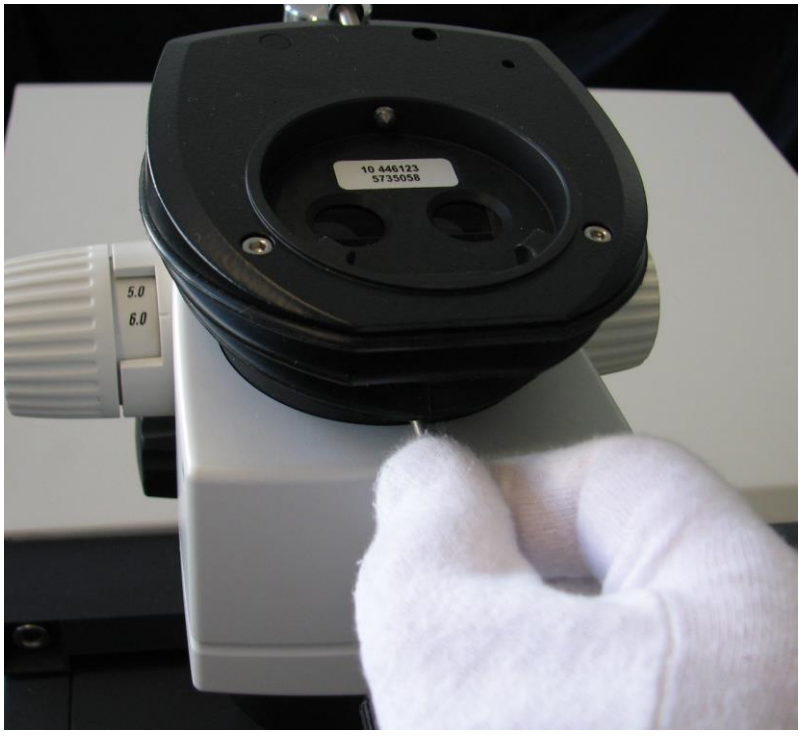
3. Insert the stereo microscope into the carrier.

4. Clamp the microscope with the clamping screw.

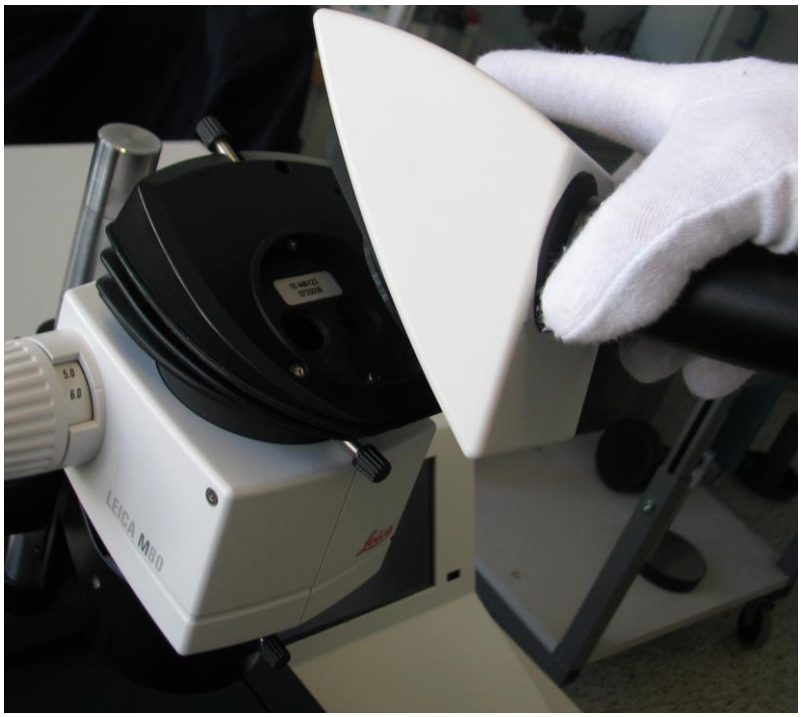


5. Place the Ergo Wedge onto the microscope body.

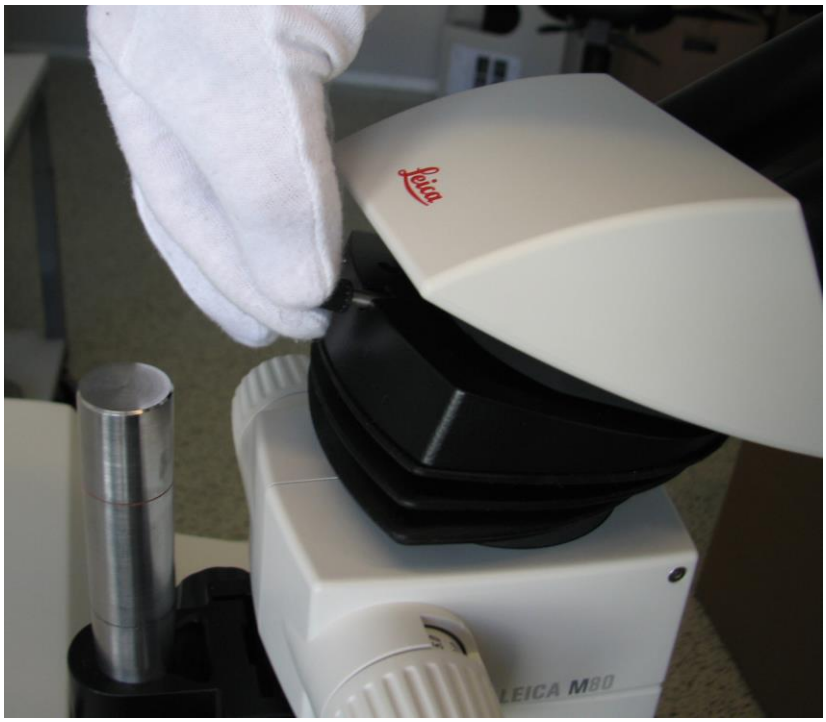
6. Clamp the Ergo Wedge with the screw on the front side of the Ergo Wedge.



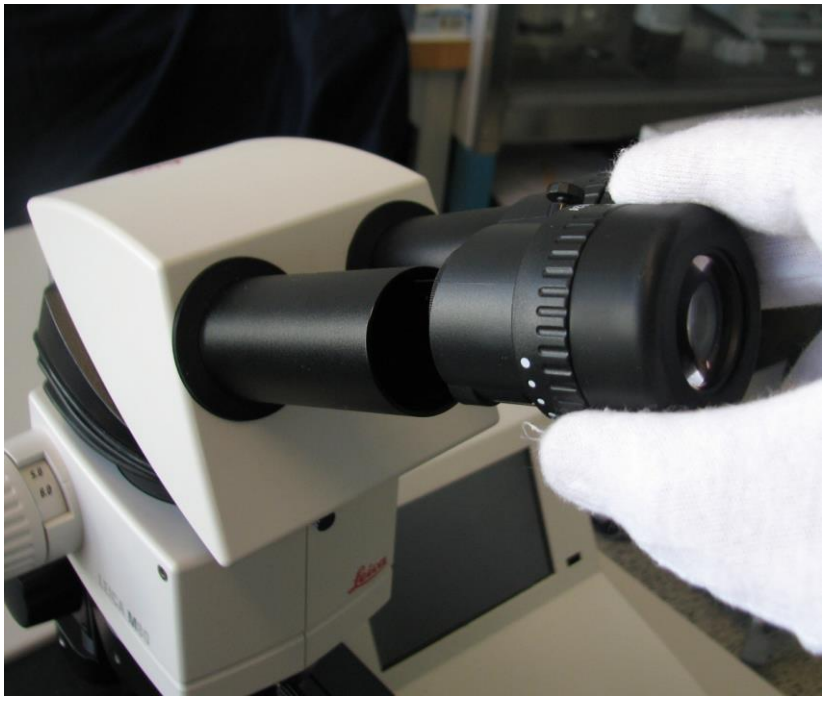
7. Place the binocular tube onto the Ergo Wedge.



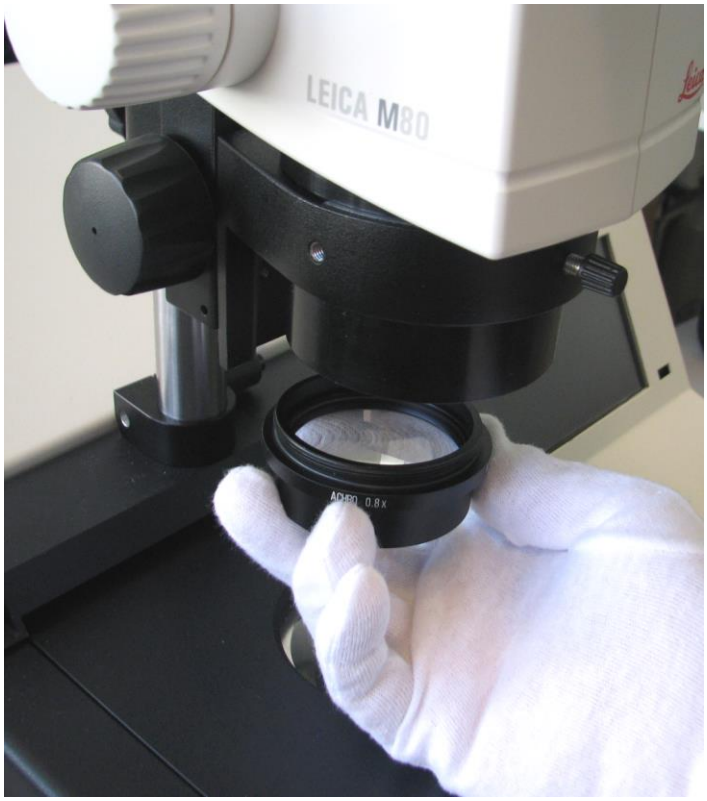
8. Clamp the binocular tube with the screw on the rear side of the binocular tube.



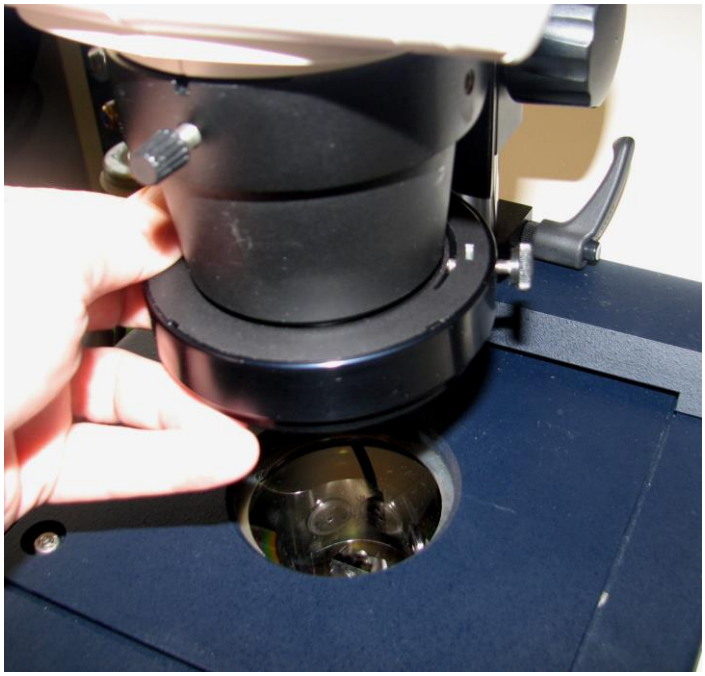
9. Insert the eyepieces.



10. Mount the 0.8x objective onto the microscope body.



11. Place and clamp the ring LED on the 0.8x objective. The clamping screw should be located at 2 o'clock position. Thus the segments of the illumination are in the right position.



12. Connect the ring LED to the port of the left side of the carrier of the column and finger tighten the screw.

3.3.7 Assembling the stereo microscope M80 (highest magnification)

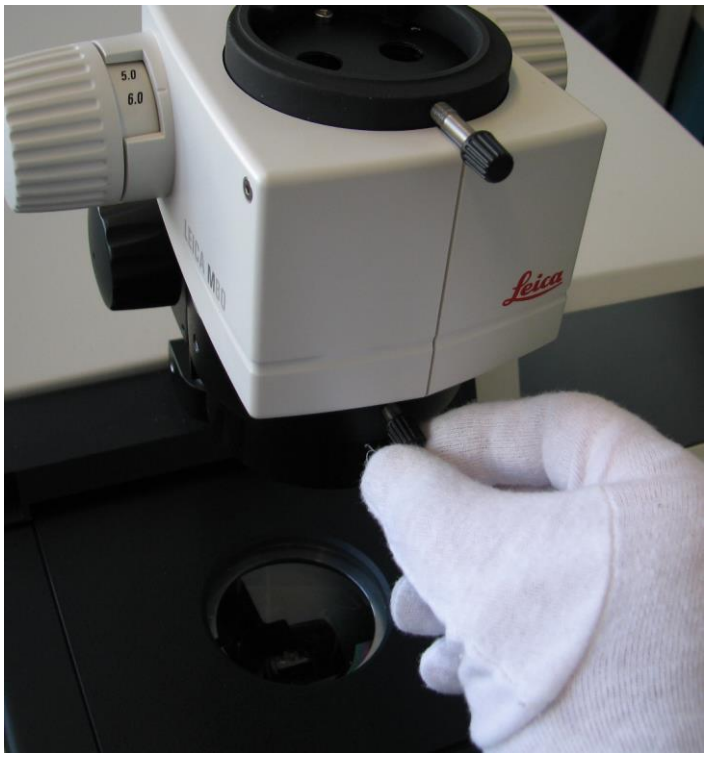
Note!
The observation flange is equipped with an optical grade viewing port and a protective glass produced at a lower quality level. In order to utilize the full optical quality of the M80 (highest magnification setting) it is recommended to remove the protective glass. For doing so please refer to chapter 5.6.

1. Move the clamping ring on the column of the stereo microscope. This ring is used to hold the stereo microscope in its height position when it is swivelled.

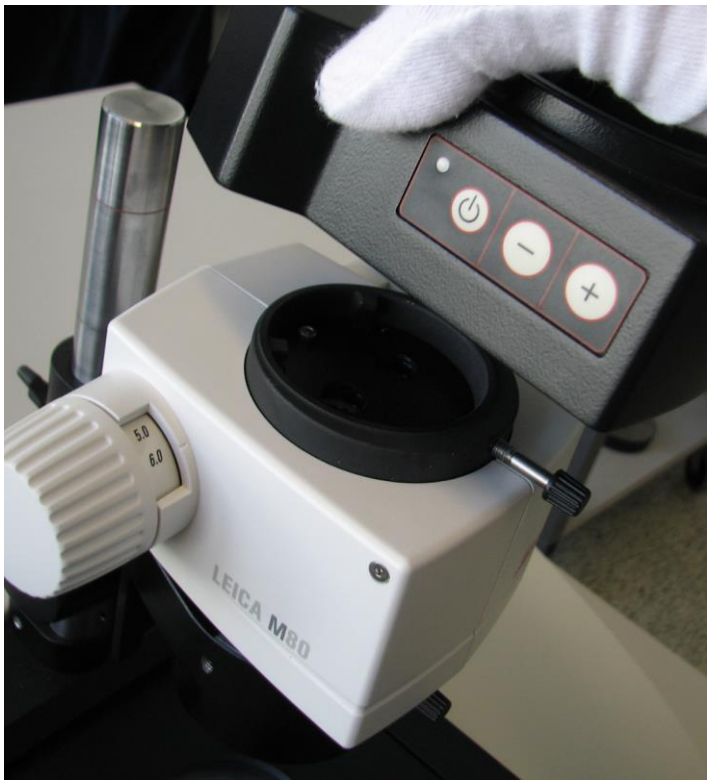
2. Move the stereo microscope carrier on the column as shown in the picture.

3. Insert the stereo microscope into the carrier.

4. Clamp the microscope with the clamping screw.

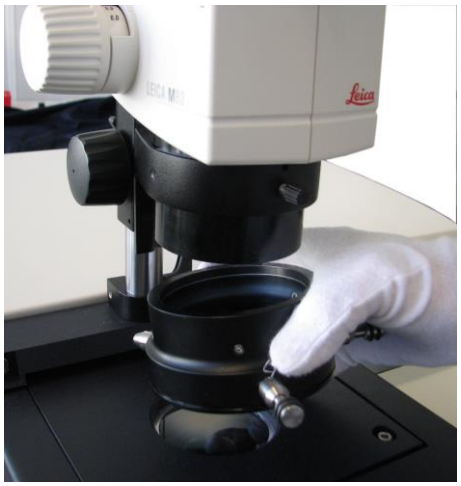


5. Place the coaxial LED illumination onto the microscope body and clamp it with the clamping screw.



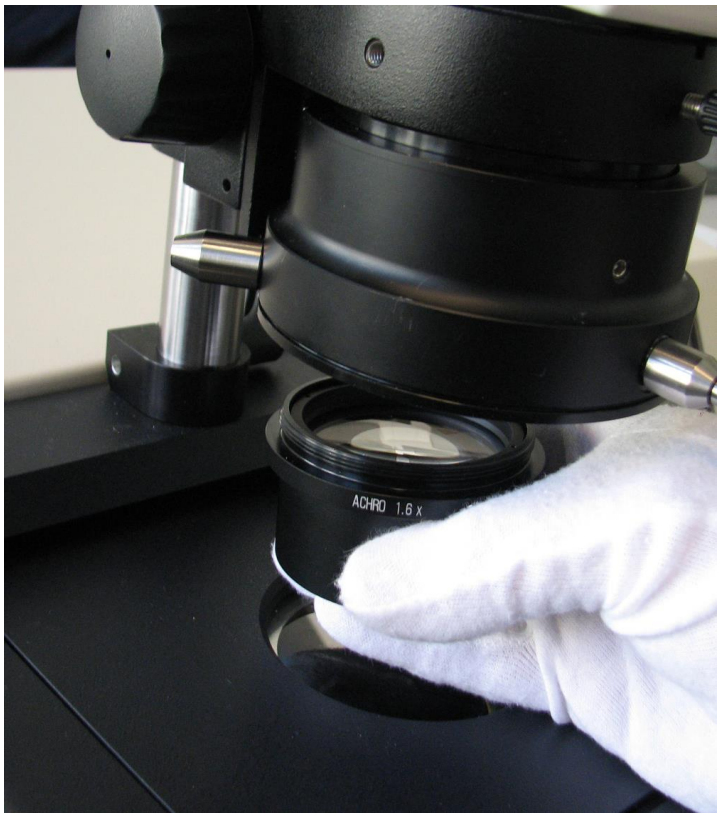
6. Place the Ergo Wedge onto the coaxial LED illumination and attach the binocular tube. Insert the eyepieces in the binocular tube.

7. Move the movable lens adapter on the microscope body until it touches the end stop.



8. Orientate the lens adapter in such a manner that the set screws are in 3 and 6 o'clock position. Clamp the adapter with the two grub screws.

9. Mount the 1.6x objective onto the moveable lens adapter.



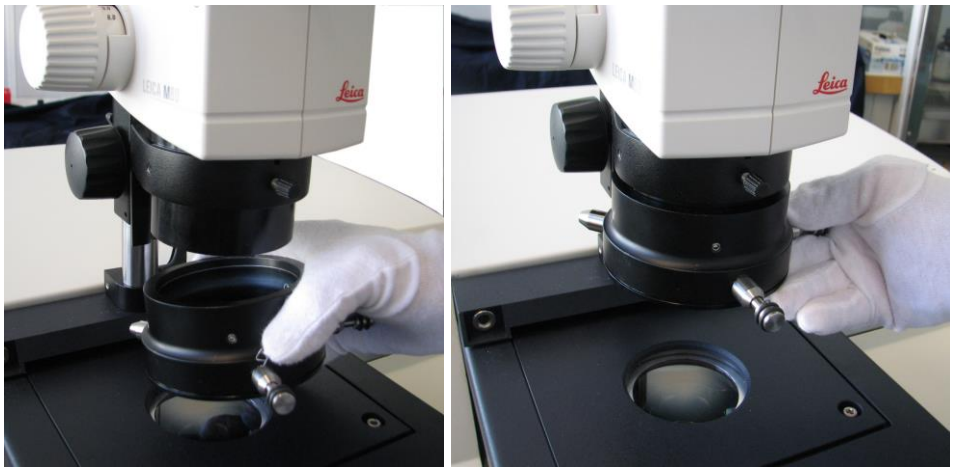
10. Connect the cable on the rear side of the coaxial LED illumination.

11. Connect the other end to the port of the left side of the carrier of the column and finger tighten the screw.

3.3.8 Assembling the movable lens adapter for M80 objectives

The movable lens adapter is a helpful device to set the sample detail into the centre of the field of view. Hence, it is recommended to use the adapter for the 0.8x objective as well.

1. Move the movable lens adapter on the microscope body until it touches the end stop.



2. Orientate the lens adapter in such a manner that the set screws are in 3 and 6 o'clock positions. Clamp the adapter with the two grub screws.

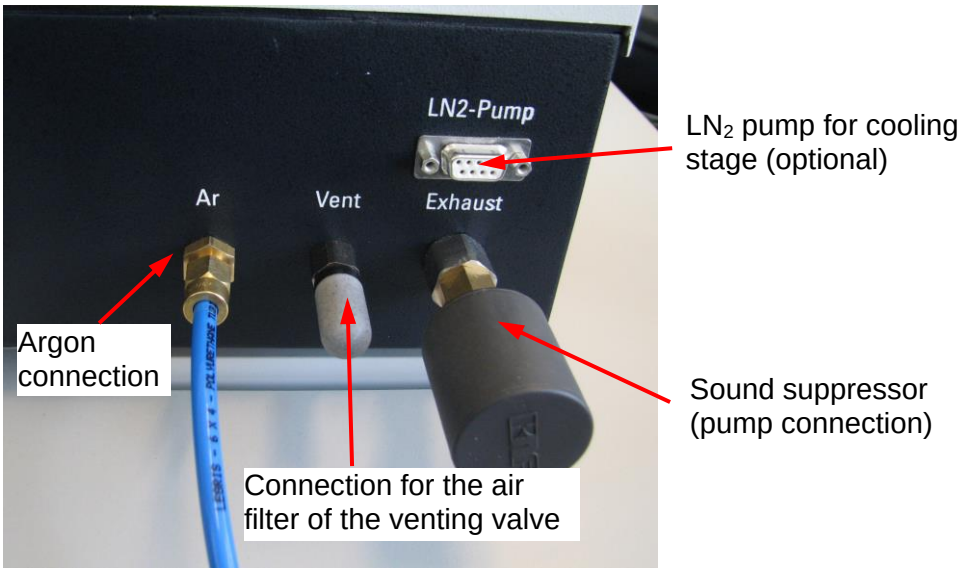
3.3.9 Safe storage of the packing material

The packing material for the Leica EM TIC 3X Triple Ion Beam Cutter system should be retained for future use in case the instrument needs to be transported. Damage to the system may occur if it is not transported in the original packaging. The packaging material is designed for transportation of the instrument.
To transport the Leica EM TIC 3X, repack the system in reverse order (see 3.3.1 Unpacking); please evacuate chamber before transporting the instrument.

3.3.10 Electrical and gas connections

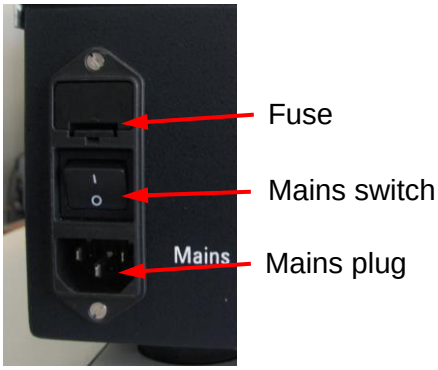
The electrical and gas connections must be set up on the back of the Leica EM TIC 3X Triple Ion Beam Cutter system by qualified technicians.

Electrical and gas connections on the system:



Secure argon connecting line with size 12 open-end wrench. Use delivered argon tube, or tubing without plasticizer only!
Screw in the air filter for the venting valve by hand (or connection for a nitrogen line).
Finger tighten sound suppressor on pump connection.

Electrical connection of the system:



3.3.11 Initial operation

Caution!
Danger may be caused by commissioning the system incorrectly.
This may cause personal injury and damage to the system.

The Leica EM TIC 3X Triple Ion Beam Cutter system must not be commissioned by anyone except employees of Leica representatives and specially trained and authorized technicians.

Before you start working with the system, you must have carried out the following commissioning steps:

1. Unpacking the Leica EM TIC 3X Triple Ion Beam Cutter system (see 3.3.1 Unpacking)
2. Confirm receipt of all parts and accessories with reference to the order.
3. Draw up an acceptance report with a list of defects and missing parts, if necessary.
4. Install the system (see 3.3).
5. Connect the system (see 3.3.10)
6. Start the system and the pump system (see 4.4).
7. Test the vacuum. The system should reach its basic pressure of $< 5 \times 10^{-5}$ mbar after the pump has been working for about an hour.
8. Purge the argon lines and the gas supply control (see 4.3.9).
9. Check that the ion source is functioning correctly (see also 5.6.2 Triple ion source)

3.4 Repacking to prevent damage during transportation

see chapter 3.3.9

3.5 Storage location for the instructions

The user manual and associated supplementary documentation (e.g., documentation for suppliers' components) must be kept close to the Leica EM TIC 3X Triple Ion Beam Cutter system for fast access.

4. Operating instructions

4.1 Introduction

The ion cutting process is performed using argon. Argon ions that have been ionized and accelerated by high voltage collide with the sample and displace surface atoms.

4.2 Main components of the Leica EM TIC 3X Triple Ion Beam Cutter

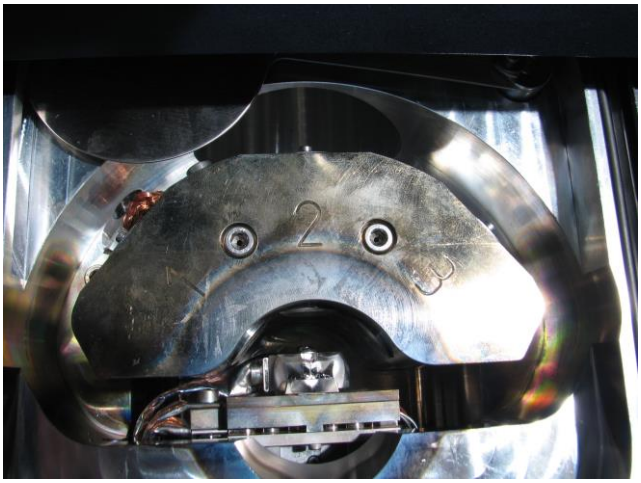
The Leica EM TIC 3X Triple Ion Beam Cutter system includes the following main functional units:

1	Chamber
2	Vacuum system (turbomolecular pump, diaphragm pump, vacuum measuring cell)
3	Table flange with sample stage (exchangeable)
4	Triple ion source
7	LCD control panel
8	Optical microscope with sample illumination
9	Housing

4.3 Functional description

4.3.1 Chamber

The chamber is a high-vacuum chamber with a volume for purging of approx. 1.4 l.



4.3.2 Vacuum system

The vacuum system consists of a roughing pump and a turbomolecular drag pump. The roughing pump is a two-stage diaphragm pump. The turbomolecular drag pump is connected to the rear of the vacuum chamber by a flange. It is equipped with an air cooling system.

The vacuum system creates an ultimate vacuum < 1 x 10^{-5} mbar (1 x 10^{-3} Pa).

Pressure is monitored by ion pressure measurement tubes (Pirani for low vacuum, and cold cathode for high vacuum).

4.3.3 Standard sample stage (optional)

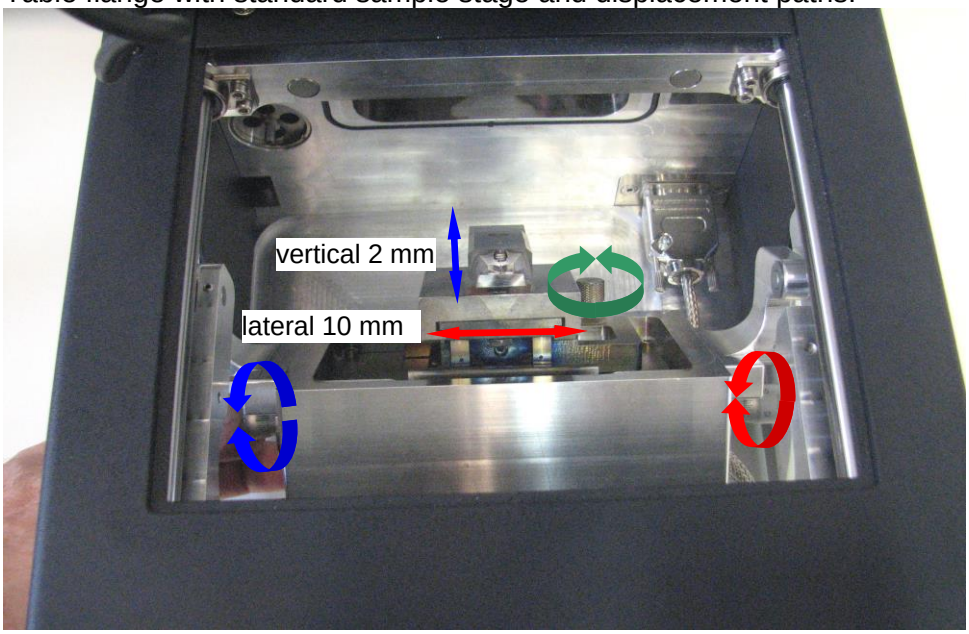
The sample is shielded by the mask, so that a 90° cut (cross-section) is created into the sample.

The stage is used for loading the system with the sample and must be opened in order to change samples. The standard stage supports both the mask holder with the mask and the sample stage, which can be moved in three axes using micrometer screws. The following displacements can be carried out for the individual axes:

- lateral: 10 mm
- vertical: 2 mm
- travel range between mask and sample: 6 mm

The stage can be tilted through 90° to adjust the sample.
The sample is secured on a removable sample tray. The standard stage includes two sample holders each for sample thicknesses from 0 to 5 mm and from 5 to10 mm. The maximum sample size is 50 x 50 mm.

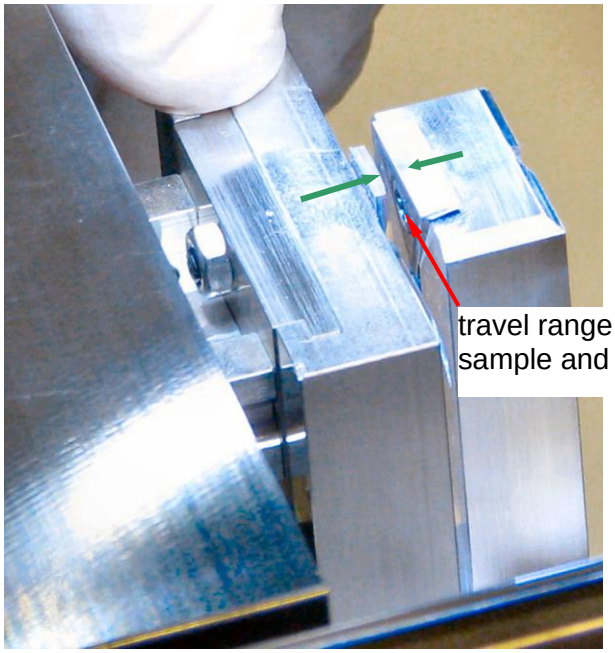
Table flange with standard sample stage and displacement paths:



vertical position is set using the left hand set screw

lateral position is set using the right hand set screw

Distance between sample and mask



distance between sample and mask is set using the center set screw

Please refer to the operating manual of the standard stage for proper usage.

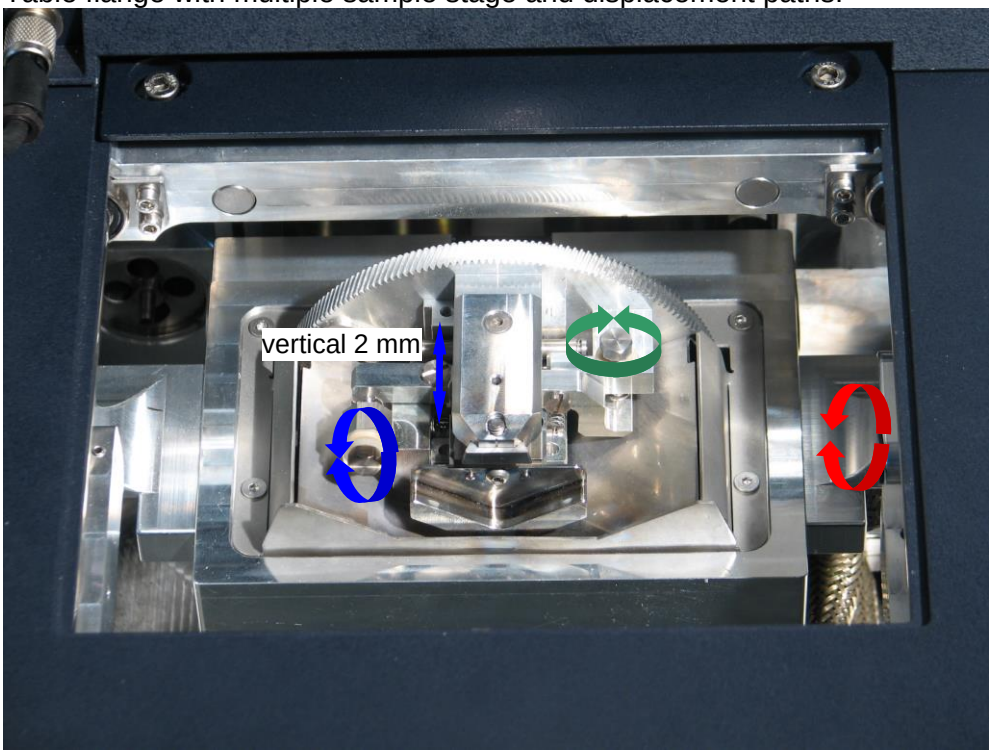
4.3.4 Multiple sample stage (optional)

The multiple sample stage is used to load up to three samples. All samples can be processed in one session. Two types of sample holders are available:

for sample size: 10 x 10 mm and 0 to 3 mm thickness

for sample size: 10 x 10 mm and 2.5 to 6 mm thickness

Table flange with multiple sample stage and displacement paths:



vertical position is set using the left hand set screw

distance between sample and mask is set using the right hand set screw (travel range: 4 mm)

Please refer to the operating manual of the standard stage for proper usage.

4.3.5 Cooling stage (optional)

The cooling stage is used to prepare heat sensitive samples. The sample holder and the mask can be cooled down to -160 °C using LN_2 supplied from an external 25 l Dewar. Heating up of the sample can only be done under vacuum conditions, thus water contamination on the sample is avoided.

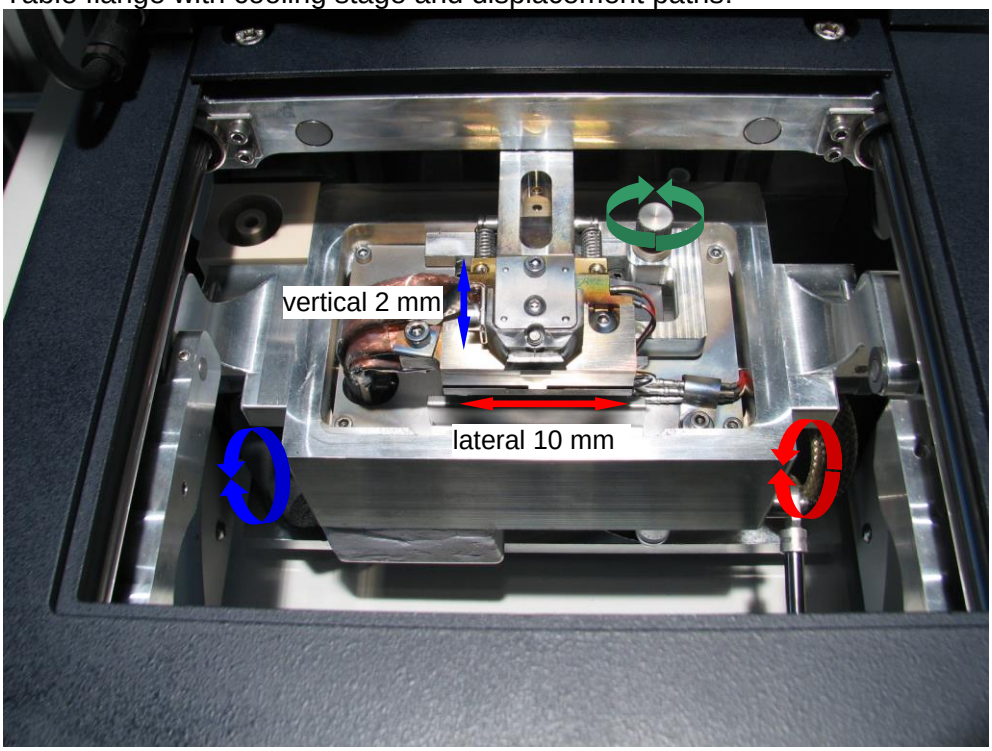
Three types of gold plated copper sample holders are available:

for sample size: 10 x 10 mm and 0 to 4 mm thickness

for sample size: 10 x 10 mm and 2 to 7 mm thickness

for sample size: 25 x 25 mm and 0 to 5 mm thickness

Table flange with cooling stage and displacement paths:



vertical position is set using the left hand set screw

lateral position is set using the right hand set screw

distance between sample and mask is set by using the centre set screw (travel range: 6 mm)

Connection of the LN_2 hose to the instrument

Connect the LN_2 hose with its threaded connection to the instrument.

Remove the yellow protective cup from the lower end of the pump. Slowly lower the pump into the Dewar filled up with LN_2. Hold the pump for a while until the strong boiling decreases and carefully lower the pump until it is completely immersed.

The clean Dewar vessel has to be filled with LN_2 according to the safety precautions.

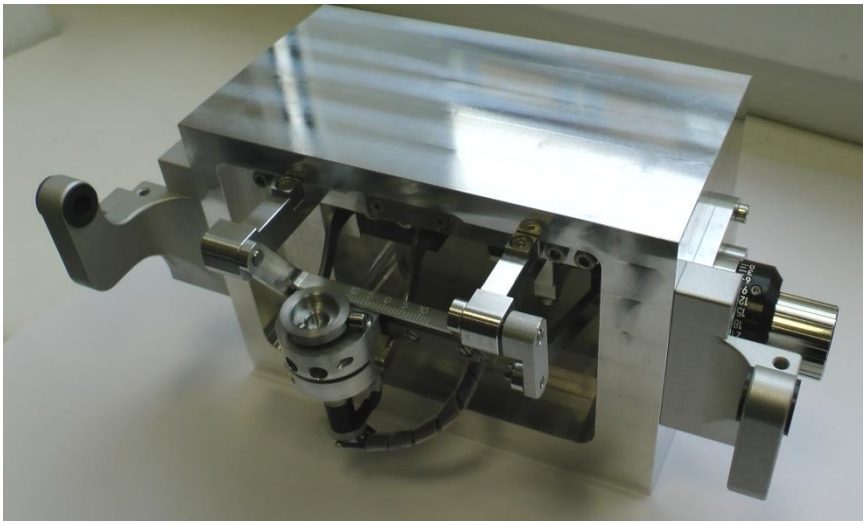
Connect the LN_2 hose with its threaded connection to the LN_2 pump. Open the shutter by pushing the lever before connecting the hose.

Please refer to the operating manual of the standard stage for proper usage.

4.3.6 Rotary Stage (optional)

The rotary stage is used to perform an Ion beam polishing step which is used to improve a mechanically or chemically polished surface of the sample e.g. to remove fine scratches, abrasive material and smearing artefacts. **To achieve the highest surface quality using ion beam polishing it is mandatory to pre-prepare the sample surface to a high quality** e.g. mechanically polishing with fine grain size (<0.5 µm) of the abrasive material.

Furthermore a special insert for the rotary stage allows to perform cross sectioning of a sample using the triple ion beam technique.



Specifications for ion beam polishing:

Max. sample diameter:	38 mm
Max. Ion beam prepared area:	Ø 25 mm
Max. sample height:	12 mm
Lateral movement:	+/- 12.5 mm
Lateral speed:	0.1 to 2 mm/sec
Incident angle:	0° to 48° (1.5° increments)
Rotation speed:	Low (~4 rpm), Medium (~7 rpm), High (~10 rpm)
Oscillation:	20°, 45°, 90°, 180°, 360°

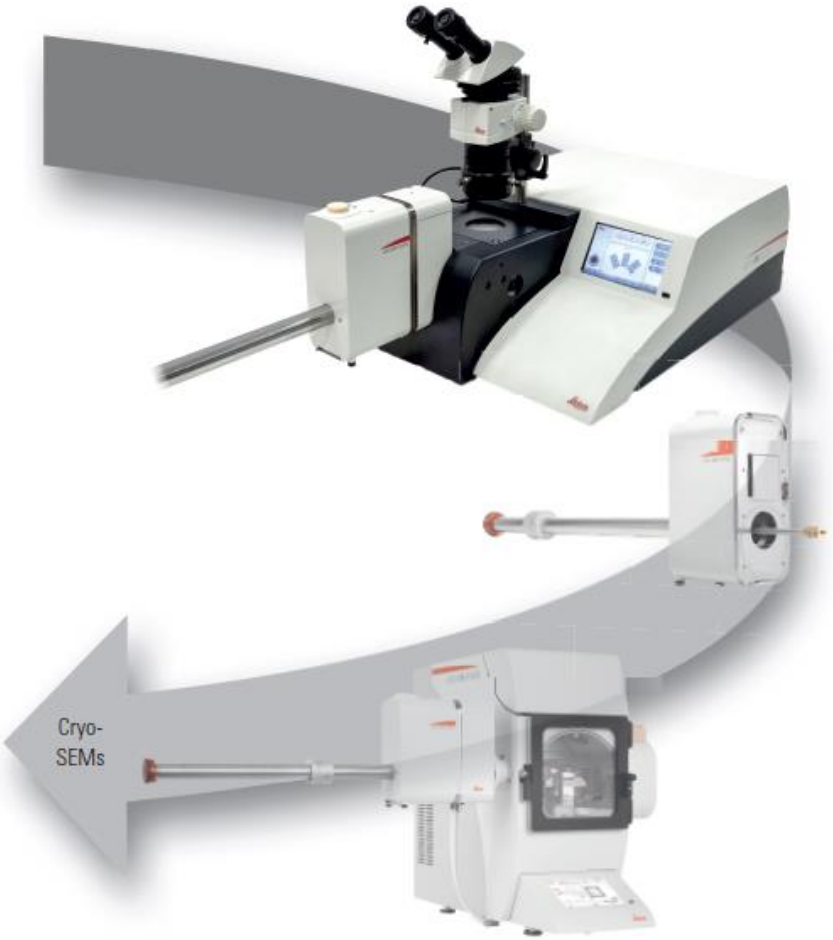
Specification for ion beam cross sectioning insert:

Max. sample thickness:	4 mm
Max. sample height:	7 mm
Max. sample width:	10 mm
Max. lateral movement:	+/- 3 mm (for wide area preparation)
Lateral speed:	0.1 to 2 mm/sec
Max. incident angle:	12°
Rotation speed:	Low (~4 rpm), Medium (~7 rpm), High (~10 rpm)
Highest oscillation angle:	45°

Please refer to the operating manual of the standard stage for proper usage.

4.3.7 Leica EM VCT500 docking port (optional)

The Leica EM TIC 3X can be equipped with a load lock system in order to transfer the prepared sample directly into the coater Leica EM ACE600 (if needed) and subsequently into the (Cryo-) SEM und optimal environmental condition using the transfer shuttle of the Leica EM VCT500 (vacuum/cryo – transfer system).



Specification for ion beam cross sectioning holders:

Max. sample thickness:	4 mm
Max. sample height:	7 mm
Max. sample width:	10 mm

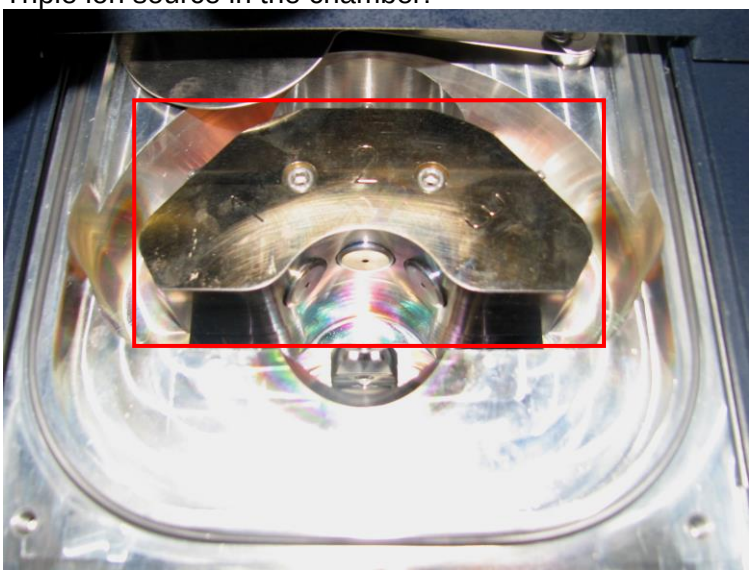
Holders for high pressure frozen samples:
Available for 3 mm and 6 mm diameter carriers in vertical and horizontal positions.

Please refer to the operating manual of the standard stage for proper usage.

4.3.8 Triple Ion source

The triple ion source consists of a source body with three independently controllable saddle field ion sources. The sources are arranged at a fixed angle of 50° relative to each other. The crossover of the three ion beams is at the edge of the mask. The triple ion source operates in a high voltage range from 1 …10 kV with source currents from 0.5 … 4.5 mA.

Triple ion source in the chamber:



Ion gun disassembled from system:

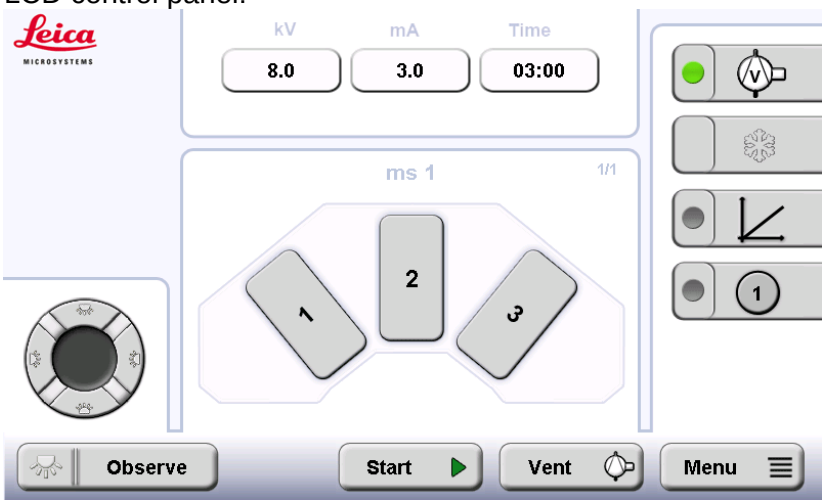
4.3.9 Gas supply control

The working gas (argon) must be supplied under a pressure of 200-800 mbar (overpressure). The gas may be supplied optionally via a fixed line or from a gas bottle. The gas must be 99.999 % pure.

4.3.10 LCD touch control panel

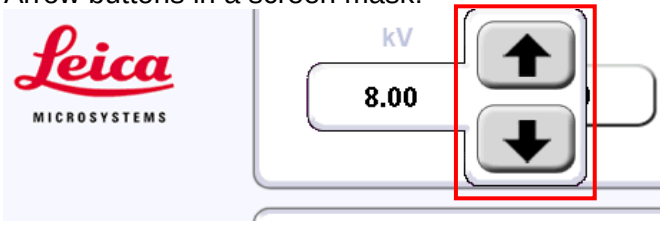
The LCD control panel is used for communicating with the Leica EM TIC 3X Triple Ion Beam Cutting system, and for data input and output.

LCD control panel:



The LCD control panel operates on its own software. Parameters for the cutting process are input via this software. The touch screen on the LCD panel serves as the input device. The desired values can be entered using arrow buttons which appear automatically in the software screens when certain functions are called.

Arrow buttons in a screen mask:



The software can be updated by the customer using a USB stick. During the update the instrument must not be switched off otherwise malfunctioning of the system may be possible.

For further information about operating the software, please refer to the operating manual of the different stages.

4.3.11 Stereo microscopes

There are three configurations of the stereo microscope available for observing and adjusting the sample. Highest visual magnification (~230x) can be achieved with the Leica M80 stereo in conjunction with the 1.6x objective, movable lens adapter and coaxial illumination. M80 in conjunction with the 0.8x objective provides about 77x visual magnification. The magnification with the S9E is around 40x. In addition to the alignment process of the sample inside the chamber all microscopes can be used to manipulate the sample outside the chamber by placing the working plate on top of the chamber. In order to set the stereo microscope in the correct observation position there are different coloured rings on the column of the stereo microscope.

Scales of the cross hair reticule built in one eyepiece:

S9E: one increment corresponds to ~ 25 µm at the highest zoom magnification

M80 (77x): one increment corresponds to ~ 15 µm at the highest zoom mag.

M80 (230x): one increment corresponds to ~ 5 µm at the highest zoom mag.

Stereo microscope M80 with the moveable lens adapter, 0.8x objective and ring LED illumination.

The microscope is fixed on the slide rails on the table flange and moves with it. In this way, it is always centred on the sample.

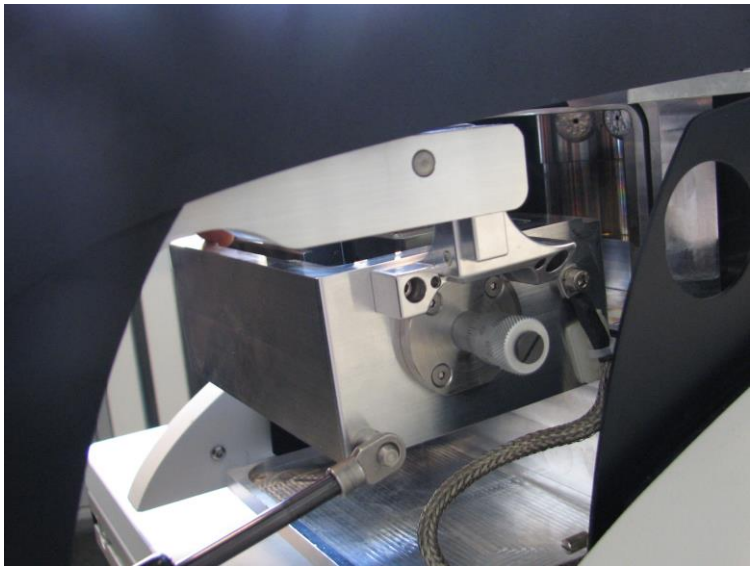
Note!
For detailed information about the microscope, please refer to the user manual (Leica Stereomicroscope) included in the delivery.

4.4 Principle operating and display functions

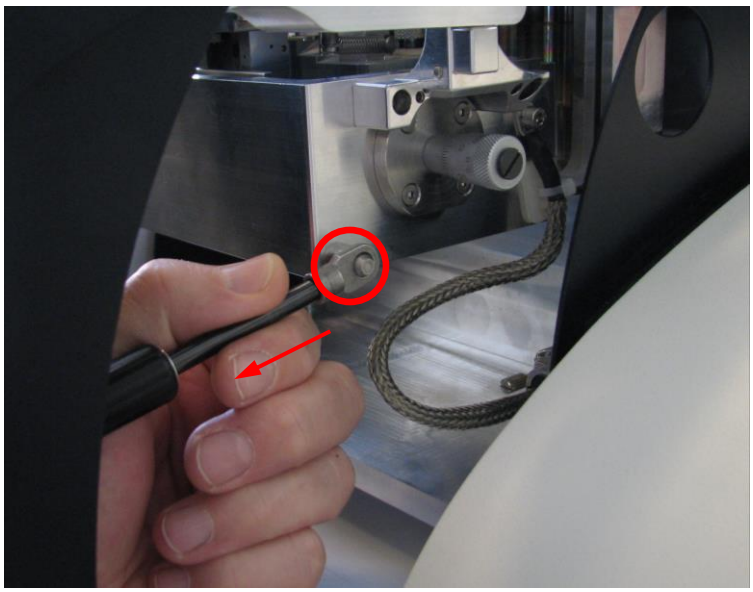
4.4.1 Exchanging the stages (when different stages are ordered)

The instrument will be delivered with one stage built into the instrument. To exchange the stage please proceed as follows.

1. Open the flange and swivel the stage in its horizontal position.



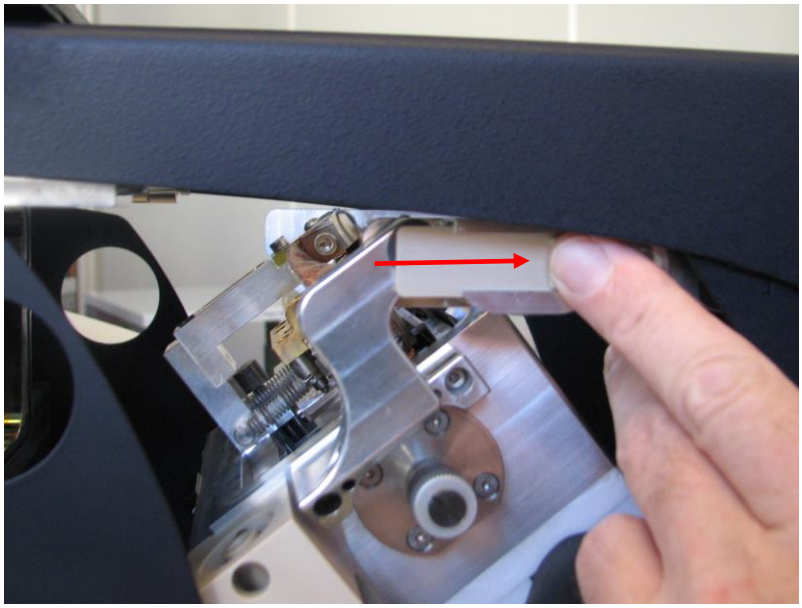
2. Retract and unhinge the flap damper.



3. Disconnect the plug.

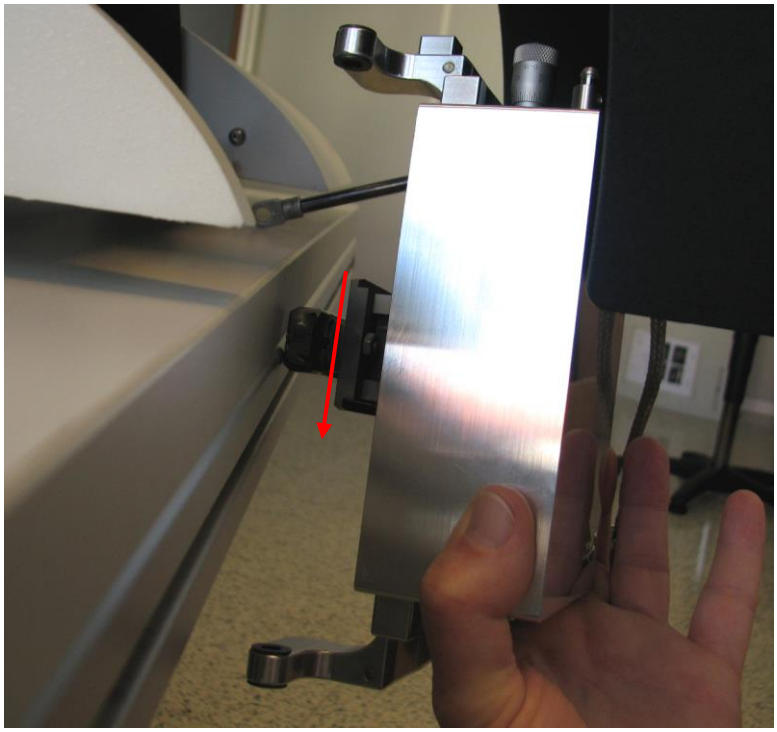
The plug is equipped with a locking mechanism. Please do not pull on the cable! Grasp the knurled part of the plug and retract for disconnecting the cable!

4. Slide the preventer until the bearing is completely visible.



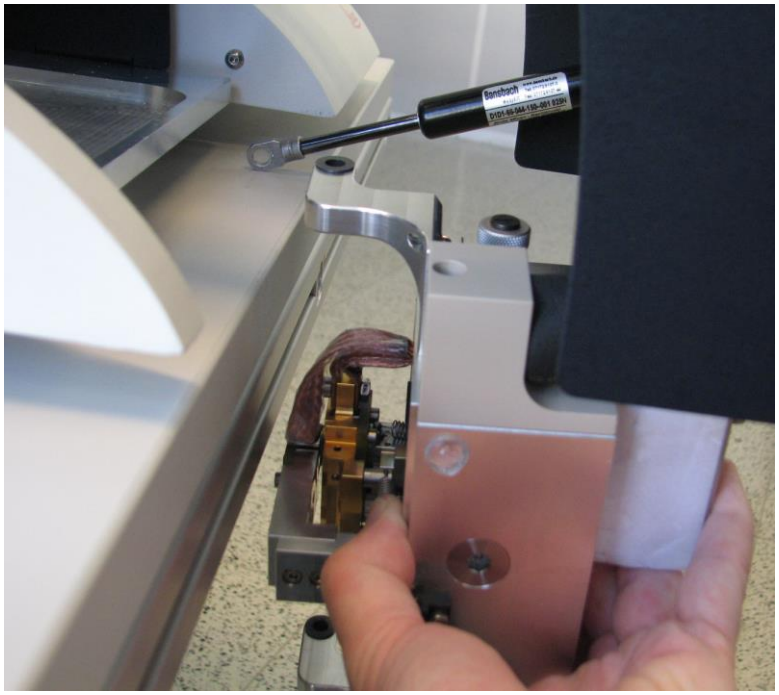
5. Move the complete stage to the left.

6. Turn the stage 90° and withdraw it in the vertical direction.

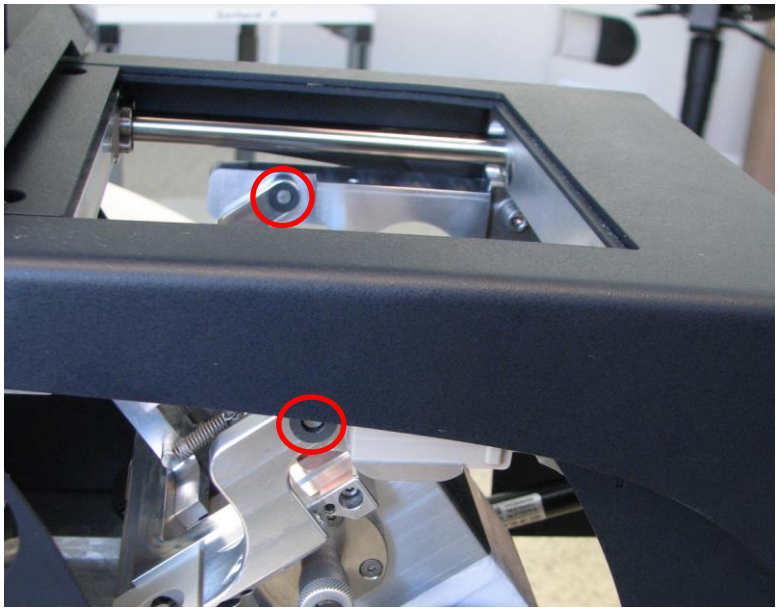


7. Place the stage into the designated storage box. This is used to protect the flange surface from scratches which might influence the sealing and evacuating the chamber.

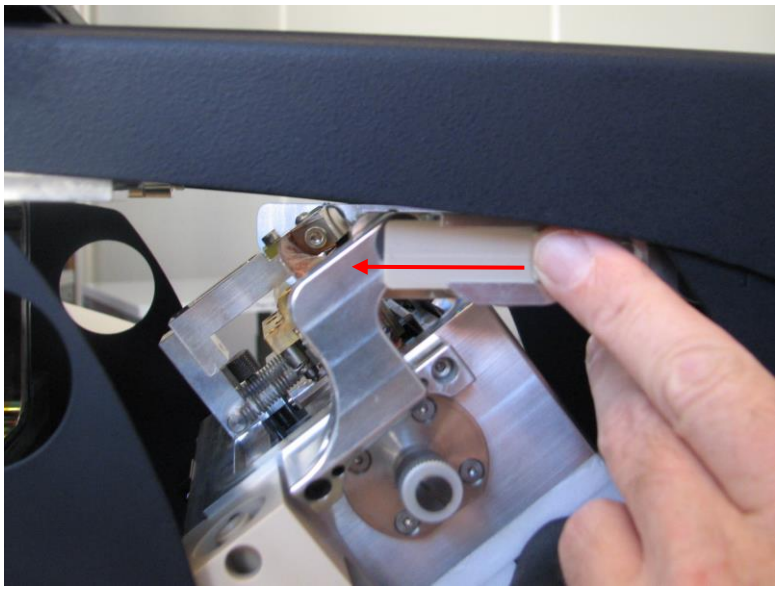
8. Insert the other stage in the vertical position.



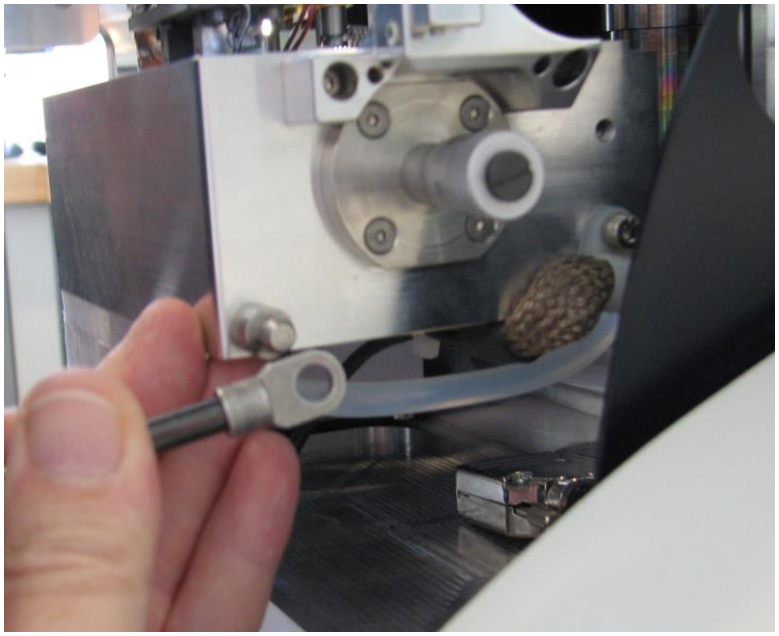
9. Hinge the stage on its two bearings.



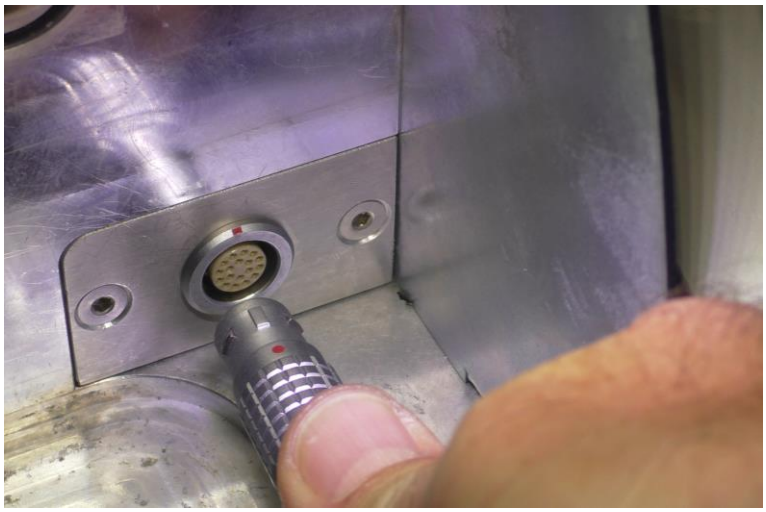
10. Slide the preventer to cover the bearing completely before you make any other connections.



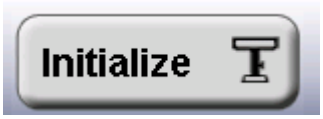
11. Swivel the stage in its horizontal position, slightly retract the flap damper and hinge it.



12. Connect the plug of the stage.



13. In case the instrument is switched on during the stage exchange, select Menu followed by Setup and initialize the stage.



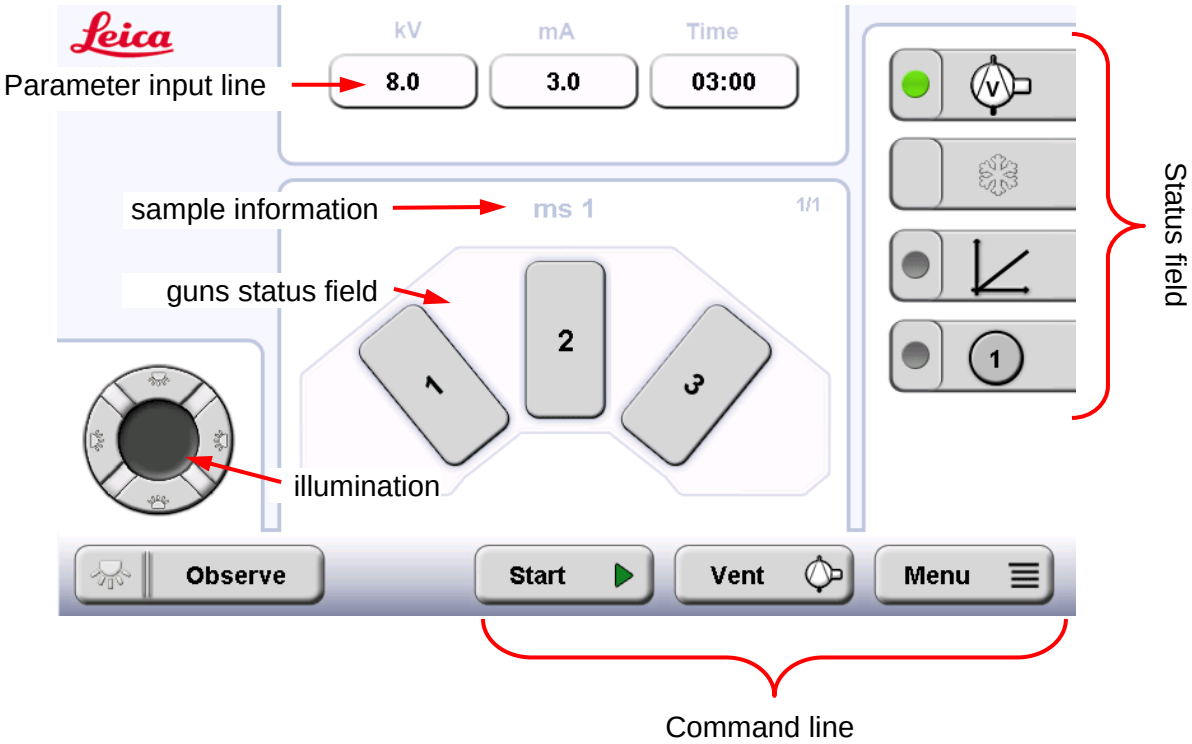
Initialization must be performed every time the stage or the light has been exchanged if the instrument is switched on. When the instrument is switched off the stage (or light) will be initialized when switching on the instrument.

4.4.2 User Interface

After switching on the instrument with the mains switch (rear side) the system starts initialization.

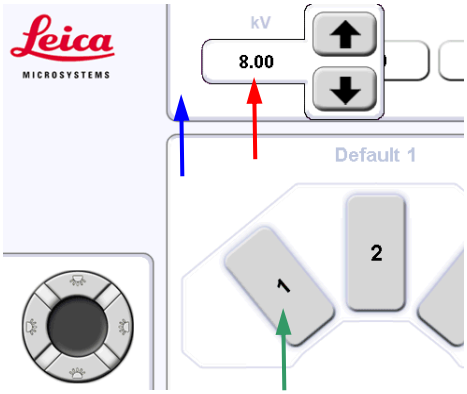
Switching on the instrument. Initialization screen after switching on the instrument.

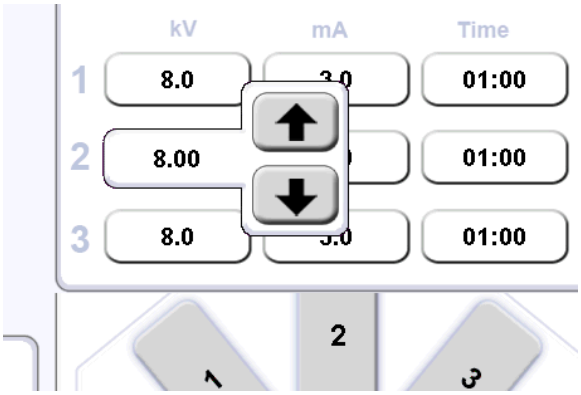
Layout of the user interface



4.4.2.1 Setting the parameters

By pushing directly the parameter field (red arrow), the value of all three guns can be changed simultaneously using the arrow buttons. This can be done for kV, mA and time settings.

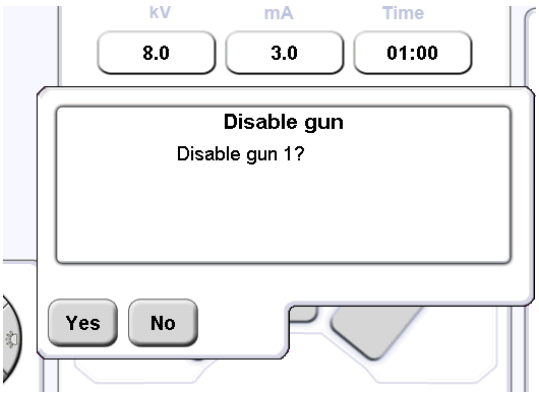


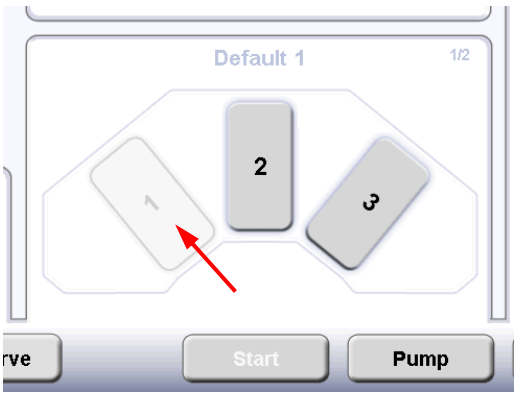


By pushing in the parameter field (blue arrow), the values can be changed for each gun individually using the arrow buttons.

The optimum source current for the selected voltage is set automatically by changing the voltage value. However, the current could be automatically tuned by the software at different values as well. This could be necessary to stabilize the guns at low kV settings if gun lifetime is more than 100 hours.

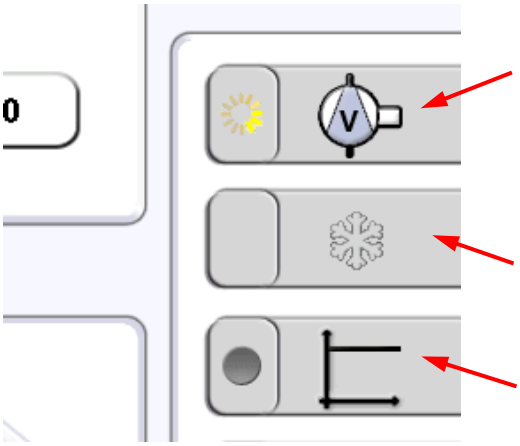
Each gun can be disabled or enabled by pushing directly on the gun symbol (green arrow).





The disabled gun then fades to grey and is set out of operation.

4.4.2.2 Status information and programming



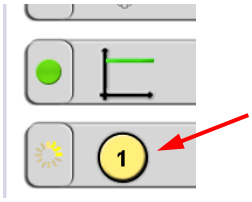
As soon as the PUMP button is pressed the system starts evacuating the chamber down to < 1 x 10^{-5} mbar. The rotating yellow sign indicates evacuation in progress. As soon as the working vacuum is reached the sign turns green.

Cooling status is activated as soon as the cryo-stage is connected and initialized.

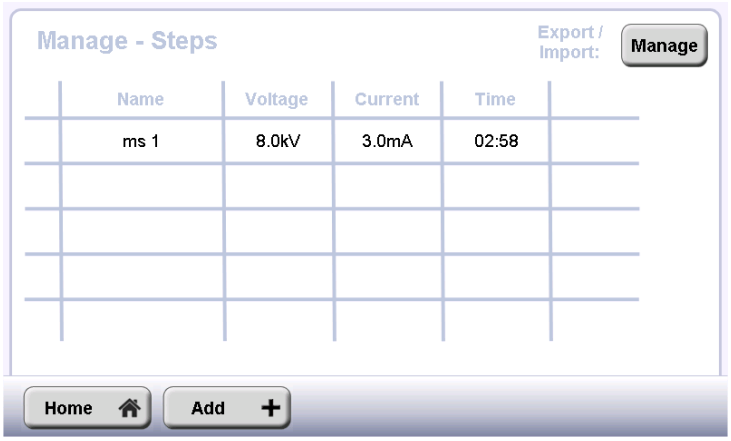
As soon as the set voltage is reached the sign in the HV field turns from a rotating yellow (in progress) to green.

When the cutting process has started with a set voltage higher than 8 kV, the cutting voltage is increased from 8 kV in increments of 0.5 kV until the voltage entered is reached. The dwell time for each voltage increment depends on the stability of the ion source. If the source current is within the tolerance range of the set point for 20 s, the voltage is increased by 0.5 kV. This ramp-shape increase in the cutting voltage helps to stabilize the ion source at higher voltages and prevents contamination caused by sparking.

Once the process has started, the sign in the Load-Up line turns to yellow (in progress). It becomes green as soon as the process is finished.

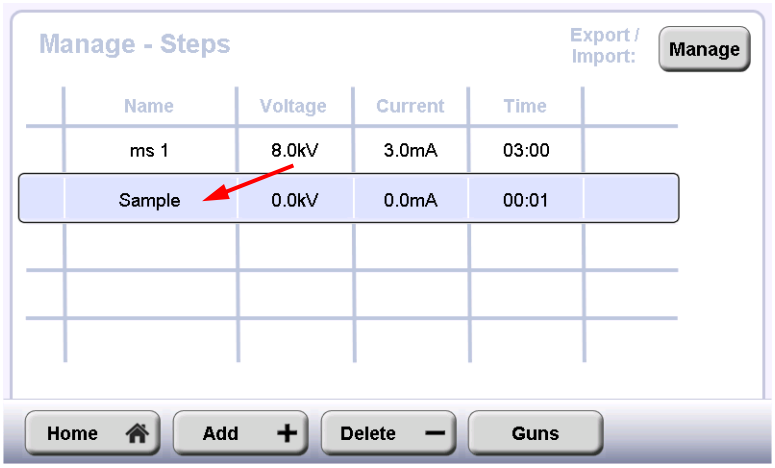


Before starting the ion etching process the sample name and gun settings can be edited and further processing steps can be added. Press the Load-Up button and choose the following options.



Add +: up to 50 additional processing steps can be added

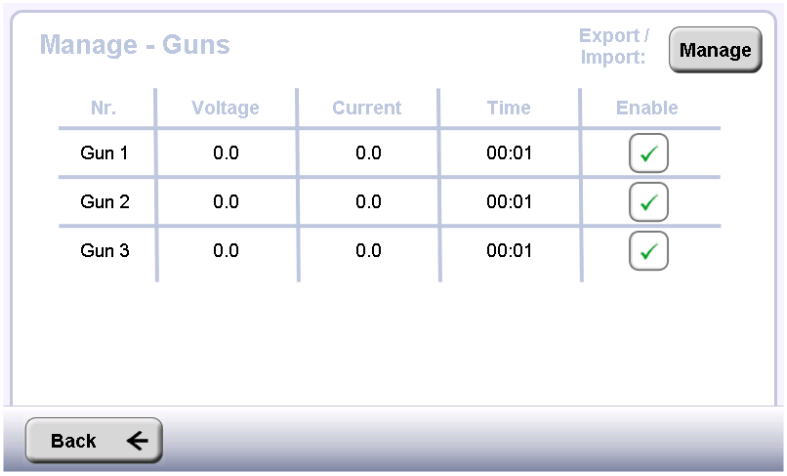
When pushing the step line the steps can be moved in different order. Furthermore, the sample or the guns can be edited by pushing into the desired field of selected step line.

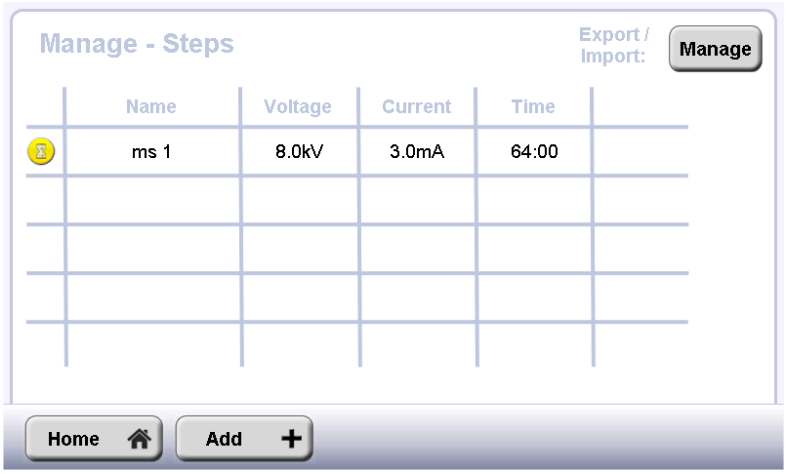


Delete - : the selected step can be removed

As soon as the recipe consists of more than one step the sign in the Load-Up line will change to a multiple step indication. The amount of steps is indicated in the sample information line (e.g., 1 sample, 3 steps). The last program is active for the next sample process, even when changing the parameters on the main screen. This change will affect the first step only. The instrument will continue according to the program.

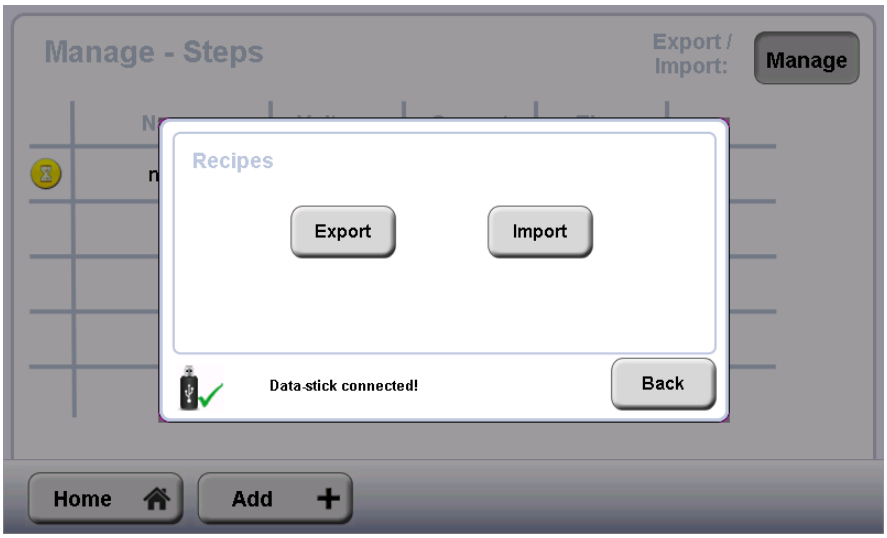
Guns edit:
The gun parameters can be set differently for each step. A star symbol beside the values (kV, mA, Time) in the parameter input line appears when selecting different gun parameters.



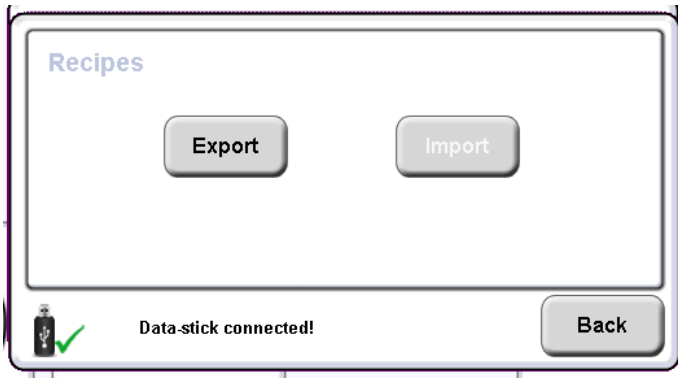


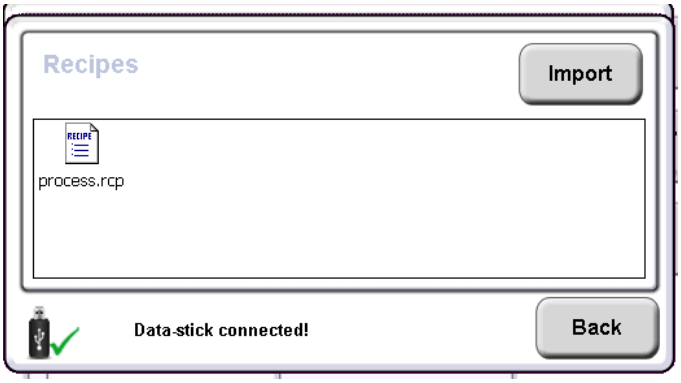
The progress of the recipe can be recalled by pushing the Load Up line: yellow sign = in process, green = finished process.

Manage:
The existing recipe can be up-loaded to a USB data-stick or a recipe from the data-stick can be down-loaded to the instrument.



There is no database available in the instrument. Hence, different recipes can only be selected from the USB data-stick.

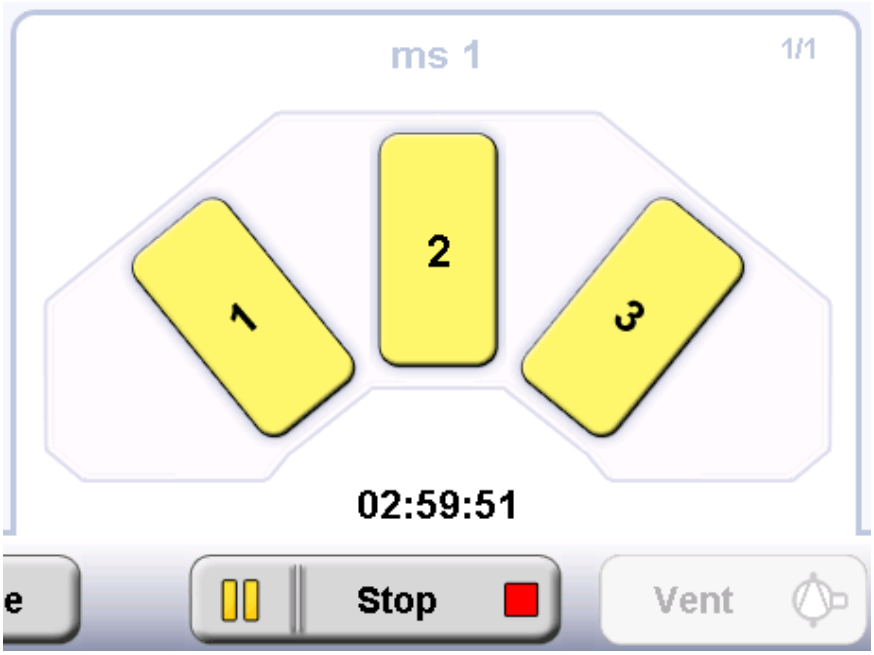




4.4.2.3 Guns status

As soon as the process starts the grey color of the gun symbol becomes yellow which means the set voltage and current values are not achieved yet. The color of the gun becomes green as soon as the set voltage and current values are achieved. In case of a short circuit the color of the gun becomes red (see chapter maintenance and service).

The remaining process time of the step is displayed below the gun symbols. In case different gun times are selected, the remaining process time shows the longest process time (gun with longest process time).



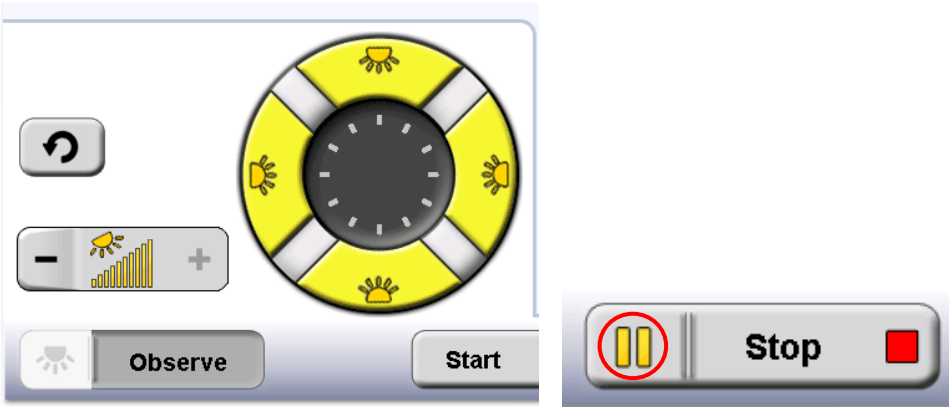
Auto-Purge:
When the ion source becomes instable, the process will be interrupted and an automatic Ar-purge will be performed. During the auto-purge and restart procedure the following message will be displayed:

"One time auto purge and process restart executed!"

Auto-Current-Tuning:
The TIC 3X ion source has certain couples of voltage and current for stable operation. Optimal current values will be set and displayed automatically for each voltage and can be changed manually. However, depending on the ion source's age and contamination the optimal current values may change. The TIC 3X is equipped with an auto-current function, which is tuning the source current of each gun separately in case of an instable ion source until stability has been reached. During process the corrected value will be displayed in the ion source set window. After the process has been finished the auto-current will reset to the original value.
Tuned values are related to the internal current of the ion sources and have no significant influence on the milling rate and on the heat impact on the sample.

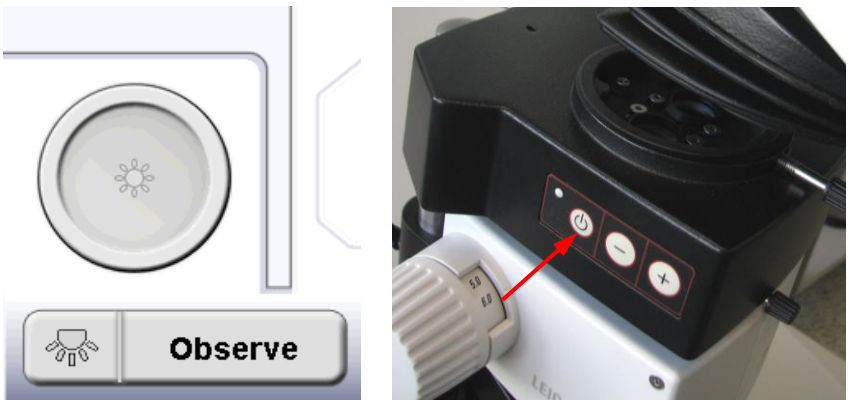
4.4.2.4 Illumination

Two illuminations are available, a ring LED illumination and a coaxial illumination, both have different symbols.



By pushing the ring LED illumination symbol the brightness of the segments can be adjusted using the + and – buttons. Different segments can be selected by touching the segment symbol. The selected segment can be rotated using the arrow button. This is helpful when adjusting the sample towards the mask edge.
The light can be switched on and off using the light symbol button without opening the shutter when using the stereo microscope to mount the next sample onto its holder. To save lifetime (intensity) of the LEDs, the light automatically switches off after 12 minutes.
Pushing the “Observe” button, the light will be switched on and the shutter will be opened in order to observe the sample during the process. The shutter will be automatically closed and the light goes off after one minute during sample processing.
For long-term observation the process can be paused (guns not active) by pushing the pause symbol. This feature is used to avoid deposition onto the viewing glass.

As soon as the coaxial illumination is connected and initialized the light symbol changes. The coaxial illumination operates with the shutter once a process has been started. Pushing the “Observe” button opens the shutter and the light switches on to observe the sample during the process. If no process has been started the light can only be switched on and off directly at the coaxial illumination. The brightness needs to be set with the + - button on the coaxial illumination as well.



4.4.2.5 Command line, Start/Pump/Vent

By pushing the Pump button, the system starts evacuating the chamber (see status information) and the Start button can be activated subsequently. Therefore, it is not necessary to stay in front of the instrument until the working vacuum is achieved. The system starts automatically as soon as the working vacuum is reached.

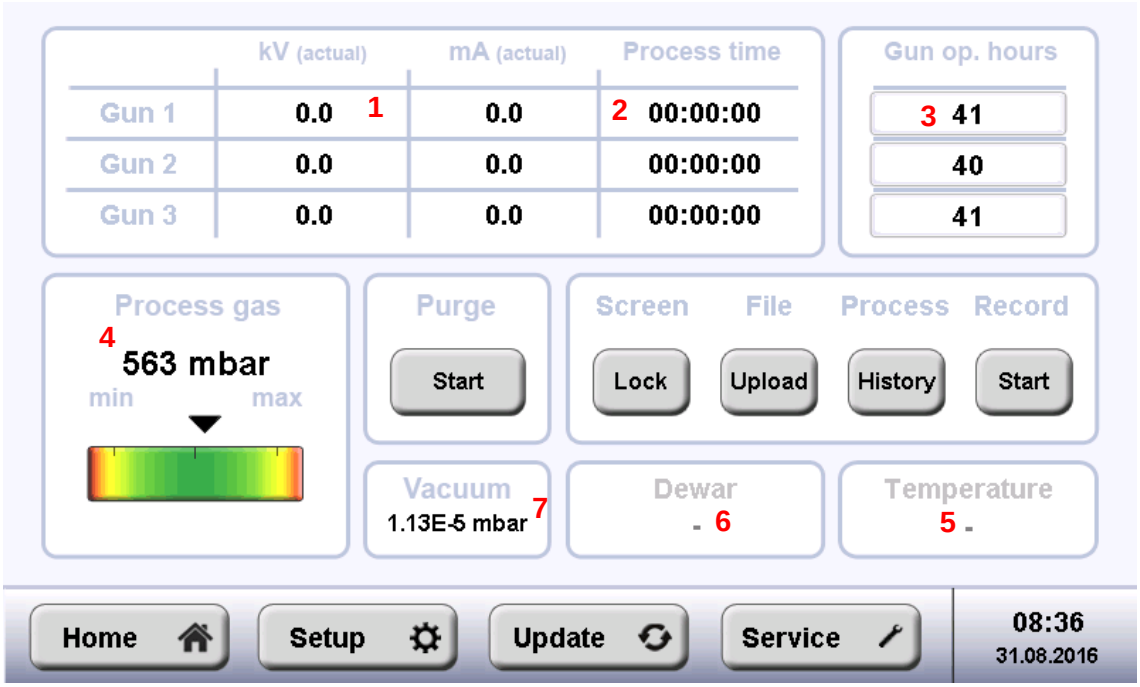
Once the pumping process has been started the button indication changes to Vent. This button is used to ventilate the camber after the sample has been processed and needs to be removed.

To avoid humidity inside the chamber, the chamber should be kept under vacuum even when the system is not in use. Please press "Pump" even when no further sample needs to be processed. You may switch off the mains switch when a long break is expected (longer than three months). The vacuum is kept at a certain level.

In order to prevent the surfaces becoming contaminated during venting, and particularly while the surfaces are heated, it is recommended to vent the system with nitrogen. To do this, connect a nitrogen gas bottle (or a fixed nitrogen supply line) to the venting valve connector on the back of the system instead of the air filter (3.3.10 Electrical and gas connection). Using nitrogen for venting helps to improve the vacuum conditions and prolongs the service life of the ion source.

4.4.2.6 Menu

By pushing the Menu button following the information are available:



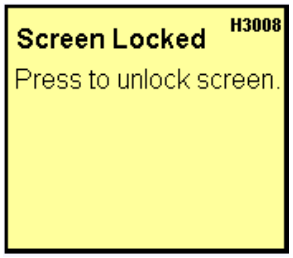
1. actual gun parameter and
2. process time
3. guns operation time (by pushing the displayed value the operation time can be set to zero
4. pressure of process gas (should be adjusted within the green area)
5. temperature (in conjunction with the cooling stage)
6. LN_2 level of the Dewar (in conjunction with the cooling stage)
7. Vacuum value

Purge:

After installing the instrument, replacing the Argon bottle, or in case of unstable guns, the Argon lines and the valves should be purged. Purging can only be done when the working vacuum is reached. Press the Start button to perform the purging process. After pushing the button, purging will be done for one minute. You may interrupt the purging process at any time by pushing the button again or when leaving the menu.

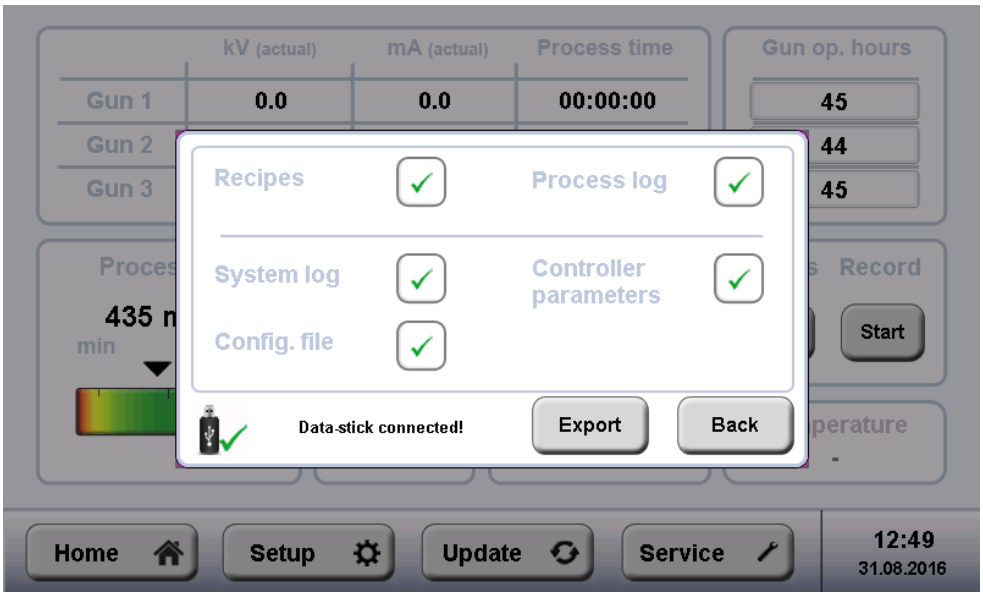
Screen Lock:

To avoid accidental operation of the system the screen can be locked by pushing this button. The screen can be unlocked by pushing the yellow field on the main screen. A user password can be set in the Setup menu. The factory set password is 0000, you may change this password in the setup menu.



File Upload:

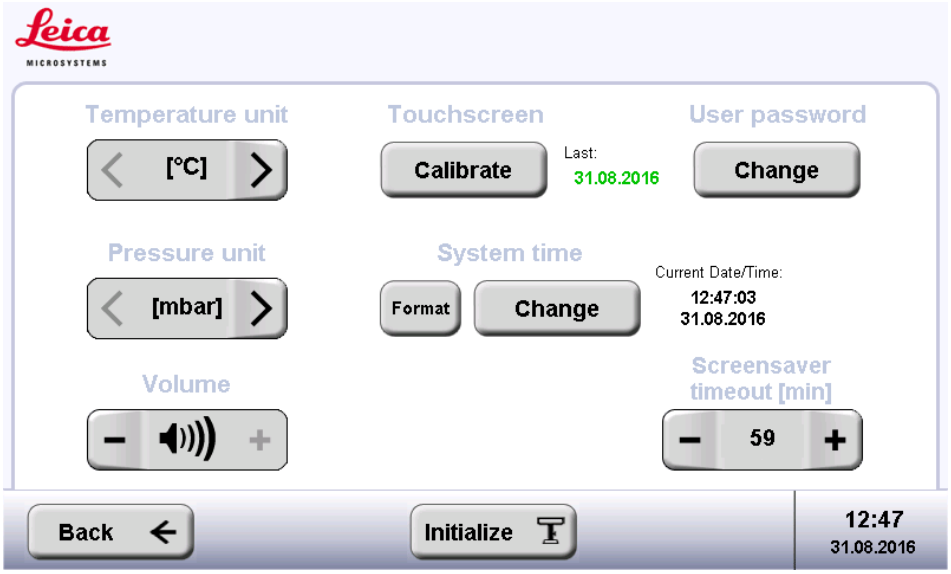
As soon as a USB data-stick is connected the existing recipe, process parameter as well as reports for service call can be uploaded onto the data-stick.



By uploading the existing recipe, it can be stored as a .xls file. On the USB stick a folder is created: "TICexport" open the folder and open the file: "process.rcp". Import this file by using the stylesheet: "TIC3X.xsl". It might be necessary to change the security settings to execute the macros.

The History button is used to recall the complete last process and can be observed directly on the screen.

By pushing the Setup button personal settings can be performed; stage and light can be initialized.



Initialize button has to be used when stage or light has been exchanged when the system was switched on.

For calibration of the screen use stylus to press within the calibration point. Calibration is not recommended unless absolutely necessary.

Service button in the Menu is used to enter in the service menu. The service menu is password protected and can only be entered by an authorized Leica service engineer.

5. Maintenance and service

5.1 General

The purpose of these activities is to

- Maintain the optimal operating conditions of the Leica EM TIC 3X;
- Minimize or reduce downtime;
- Provide standard maintenance schedule.
- Deal with malfunctions

Malfunctions during operation of the Leica EM TIC 3X Triple Ion Beam Cutter system are reported in an information window. A clear text error message provides information about the cause of the malfunction and its remedy.
Some causes of malfunctions can be corrected using the instructions in 6.2. Malfunction.

For further questions regarding malfunctions and how to correct them, please contact Technical Service from Leica representative.

5.2 Safety measures during maintenance and service

Caution!
Danger may be caused by servicing and cleaning the system incorrectly.

This may cause personal injury and damage to the system.

Maintenance operations on the Leica EM TIC 3X Triple Ion Beam Cutter system must not be performed except by the specially trained administrator or a technician designated by the manufacturer!

5.3 General instructions for maintenance and cleaning

There is danger from external elements (dust, dirt, etc.)

Contamination, particularly of the interior (pressurized) surfaces, may cause the vacuum system to malfunction.

When working on the interior of the Leica EM TIC 3X Triple Ion Beam Cutter system, it is therefore essential to observe the principles of vacuum hygiene. Gloves must be worn when disassembling and assembling assemblies and components in the vacuum area, and also for all adjustment work.

All work must be carried out in a clean, dust-free environment.

5.4 Daily maintenance activities before beginning work

Activities before beginning work with the Leica EM TIC 3X Triple Ion Beam Cutter system:

- Check that the argon feed line is open.
- Check that the base pressure in the vacuum chamber is < 5E-5 mbar.
- Purge the gas supply control.

5.5 Daily maintenance activities after ending work

No special maintenance activities are necessary after the system has been used. If necessary, shut off the argon feed and leave the system closed under vacuum with the pump system running (standby).

5.6 Components requiring maintenance

5.6.1 View port

Due to the image quality when the high magnification stereo microscope (230x) is used the instrument is delivered with a viewing port consisting of an optical grade window without protective glass which would influence the image quality. However, when a low magnification stereo microscope (< 77x) is used a protective glass (optional) can be inserted with less effect to the image quality due to the reduced magnification.

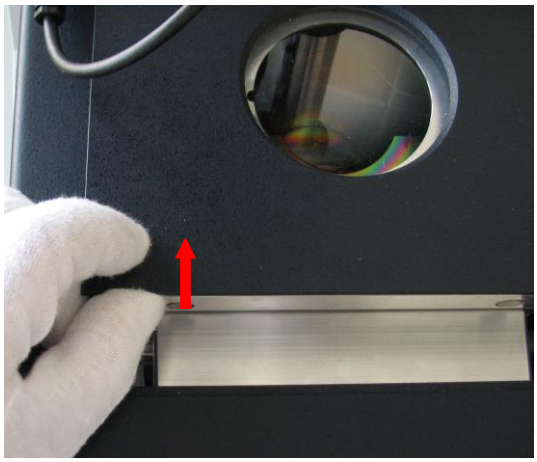
Cleaning or replacing the protective glass

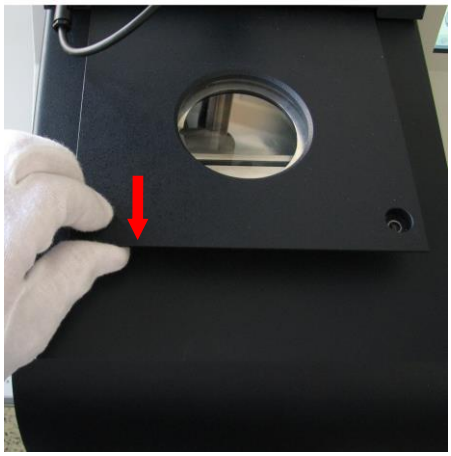
Assembly	Task	Cycle
Protective glass (optional)	Clean or replace	as necessary

The protective glass should be cleaned with acetone or a fine polishing paste with grain size < 1 µm. The protective glass must be removed from the cover flange for cleaning.

1. ***Unscrew all four screws on the cover and slightly open the table flange. Carefully lift up the cover and draw it towards you to remove it from the chamber. Store the screws in a clean, safe place.***

   Lifting-off the cover flange:





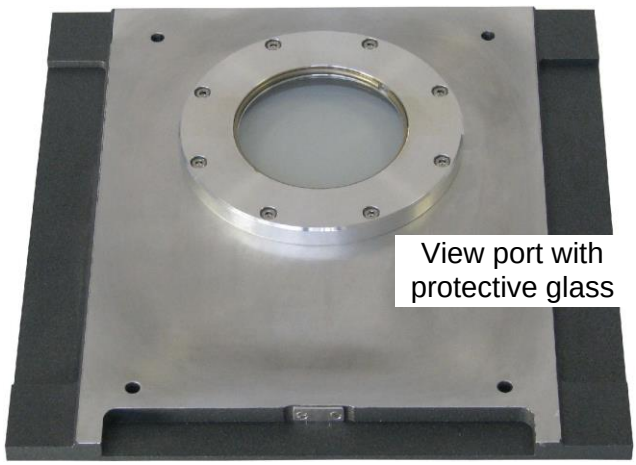
2. Place the cover flange on a clean underlay with the inside facing upwards.

Caution!
There is a danger of damaging or contaminating the sealing face on the inside of the cover flange. Parts of the interior of the cover flange serve as a sealing face.

The system, particularly the vacuum system (vacuum leak), may be damaged.

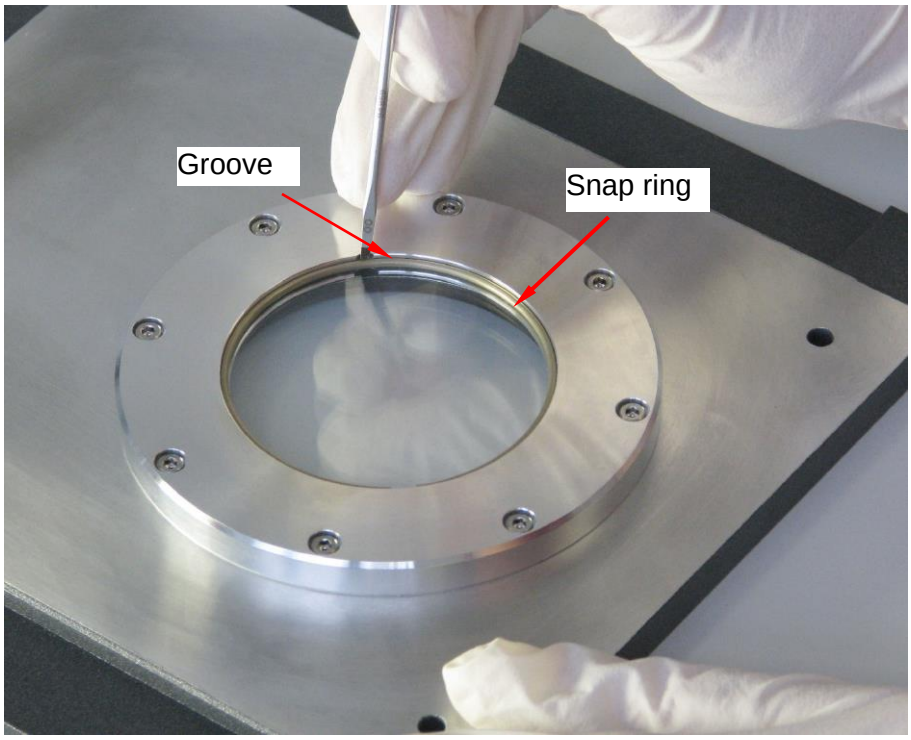
Protect the entire inside surface from scratches or dirt. Always place the cover flange on a soft, dust-free surface.

Inside of the cover flange:



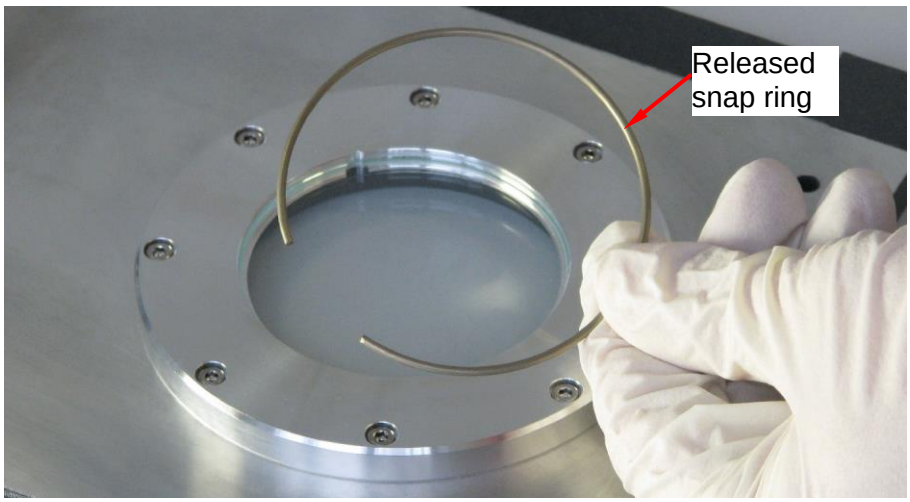
3. Use a pointed object, e.g. the screwdriver included in the delivery, to carefully release the snap ring. Insert the tool in the groove and carefully lever the snap ring out.

   Releasing the snap ring:



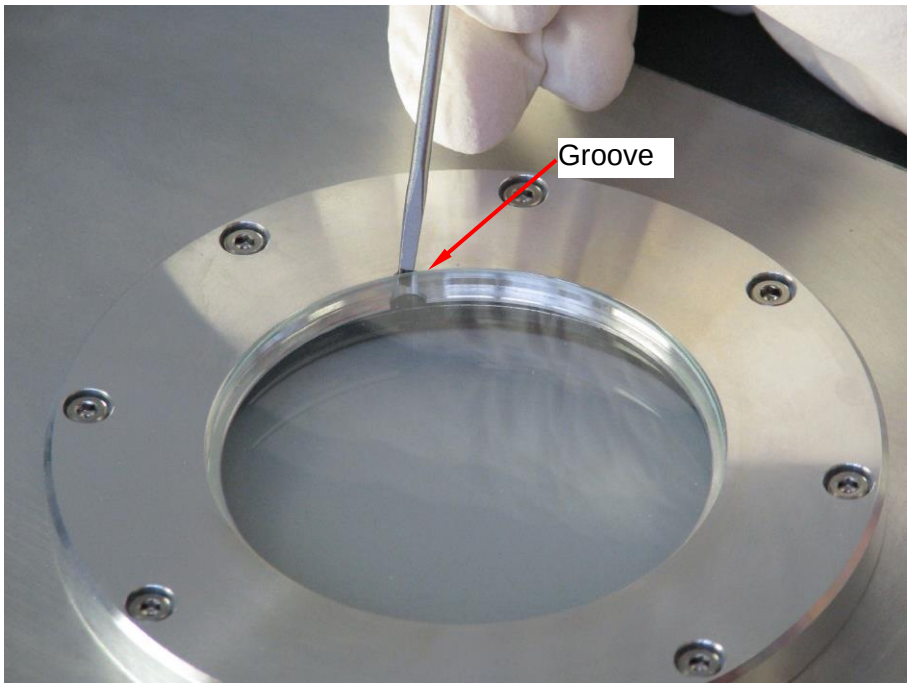
4. Store the snap ring in a clean, safe place.

   Removing the snap ring:

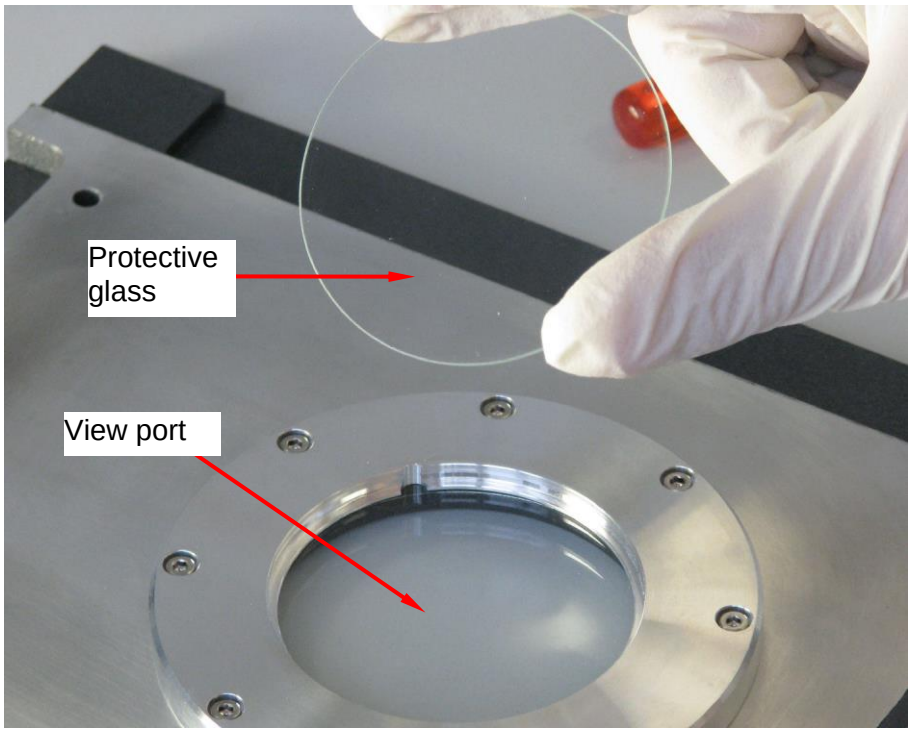


5. Use a pointed object, e.g. the screwdriver included in the delivery, to carefully pry-out the protective glass. Insert the tool in the groove.

   Carefully lift-out the protective glass:

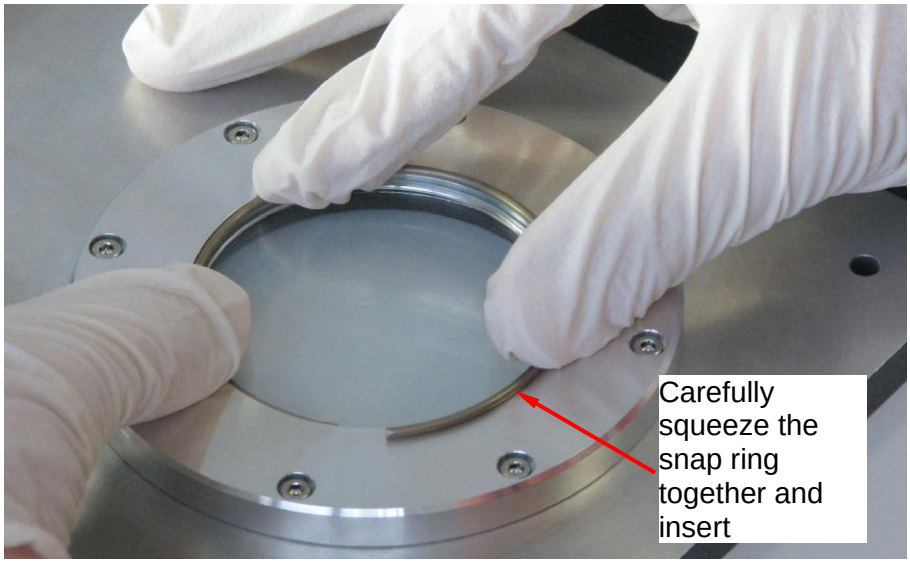


   Protective glass has been removed:



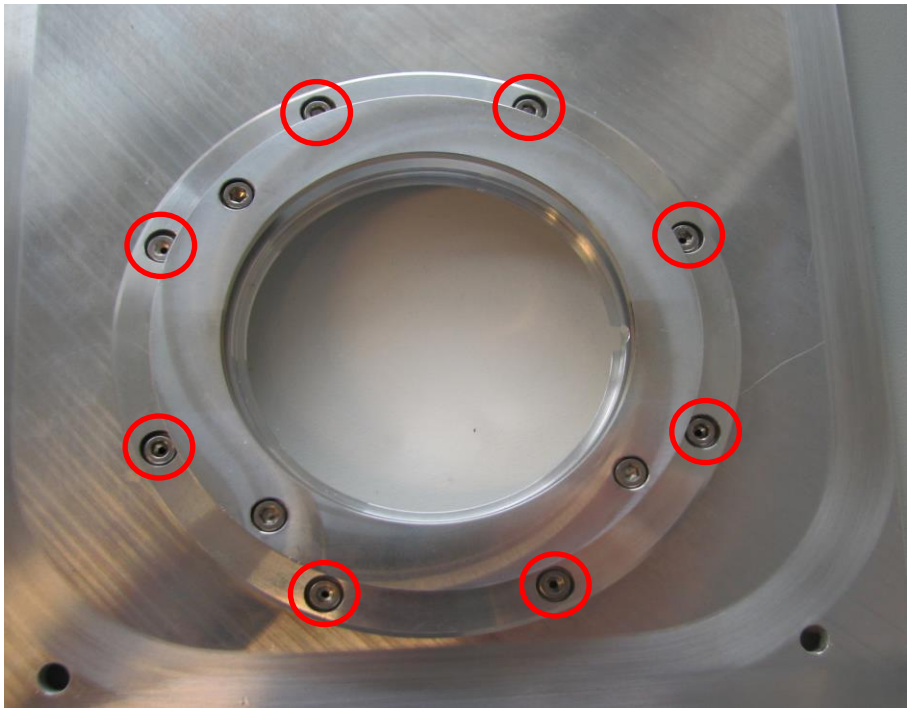
6. Clean the protective glass or replace it.
7. Refit the cleaned or new protective glass if required.
8. Refit the snap ring.

   Fitting the snap ring:



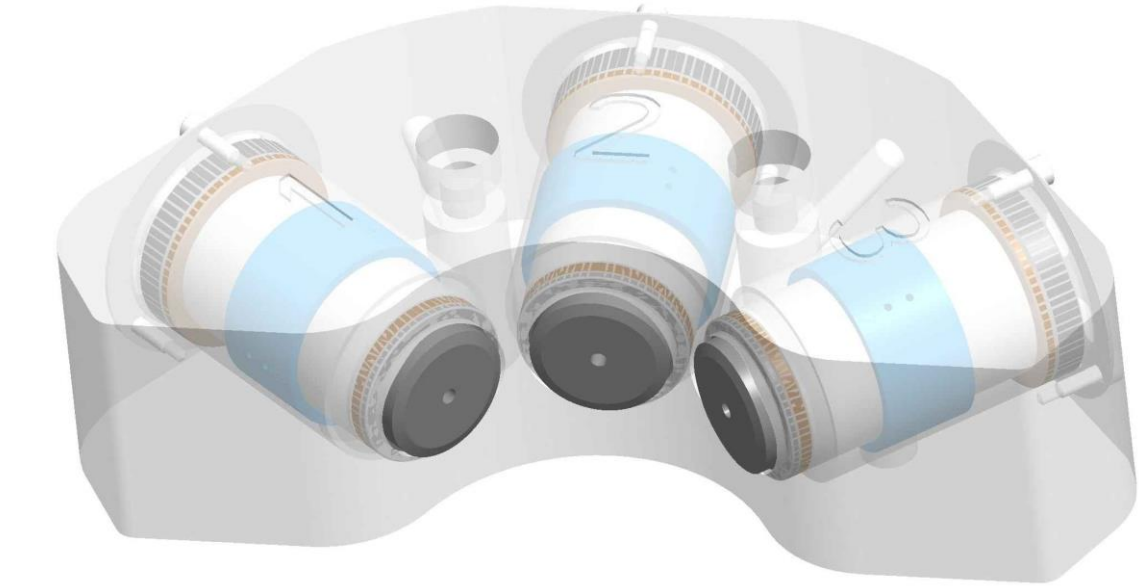
Replacing the optical grade viewing glass

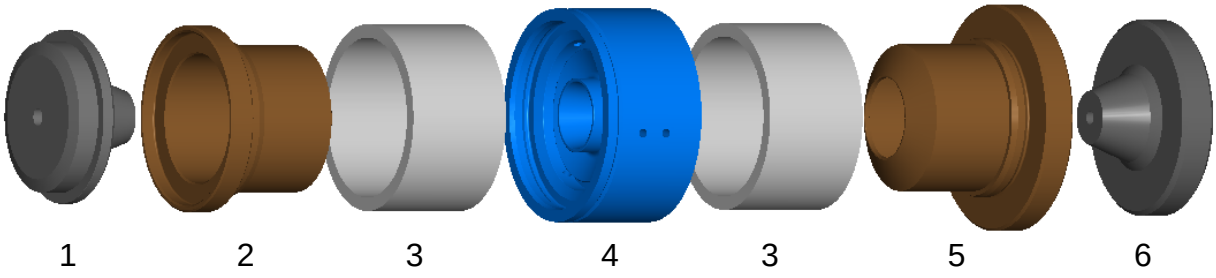
Open all eight hex screws to exchange the optical window. Please make sure the sealing ring is well positioned when mounting the window fitting again.



5.6.2 Triple ion source

5.6.2.1 Assembly





Parts of the ion source cartridge:

1 - Front Side Cathode
2 - Front Side Wehnelt Cylinder
3 - Ceramic Isolators
4 - Anode
5 - Rear Side Wehnelt Cylinder
6 - Rear Side Cathode

5.6.2.2 Function

The triple ion source consists of 3 independent controllable saddle-field ion guns. The ion energy is adjustable between 1 … 10 keV. The ion source will be fed with a process gas, preferable Argon. A high voltage (1 … 10 kV) will be applied on the anode. The cathodes and Wehnelt cylinders are on earth potential. Due to the electrical field between anode and cathode the process gas will be ionised (Ar^+) and the plasma ignites. Positive charged ions will be accelerated towards the cathodes and generate electrons. This bombardment leads to an abrasion of the cathode. Negative charged electrons will be accelerated towards the anode. On this way they collide with gas atoms and generate ions. Due to the shape of the electrical field between anode and Wehnelt cylinders (saddle field) 2 ion beams are built and accelerated towards both cathodes. One beam is blocked by the (blind) rear side cathode. The other beam will be lead through the beam exit at front side cathode. The energy of the ions came out matches to the acceleration voltage.

5.6.2.3 Ion Source Lifetime vs. Replacement Cycle

The ion source lifetime defines the lifetime of the cathodes only. The lifetime of cathodes is limited because of the structure and physics of the saddle-field-configuration. Due to permanent abrasion (sputtering) of cathode material, they will worn-out after time of use. Depending on the used beam energy, the lifetime of aluminium cathodes is approx. 350 hours at 8 kV.

Depending on the process parameter (e. g. voltage, process time) and the environment (e. g. Ar purity, vacuum level, residual gas, sample material) replacement or cleaning of the ion source might be required earlier. Additionally the sputtered Al from the cathodes forms a layer on the anodes and Wehnelt cylinders. The adhesion of that Al-layer strongly depends on impurities and layer thickness. For example short process times in combination with high energies yield to a multi-layer system of thin and highly stressed Al-films, which leads to delamination and short circuits. This effect can be enhanced by impurities inside the Al-layers caused by residual gas or contaminated process gas (leak).

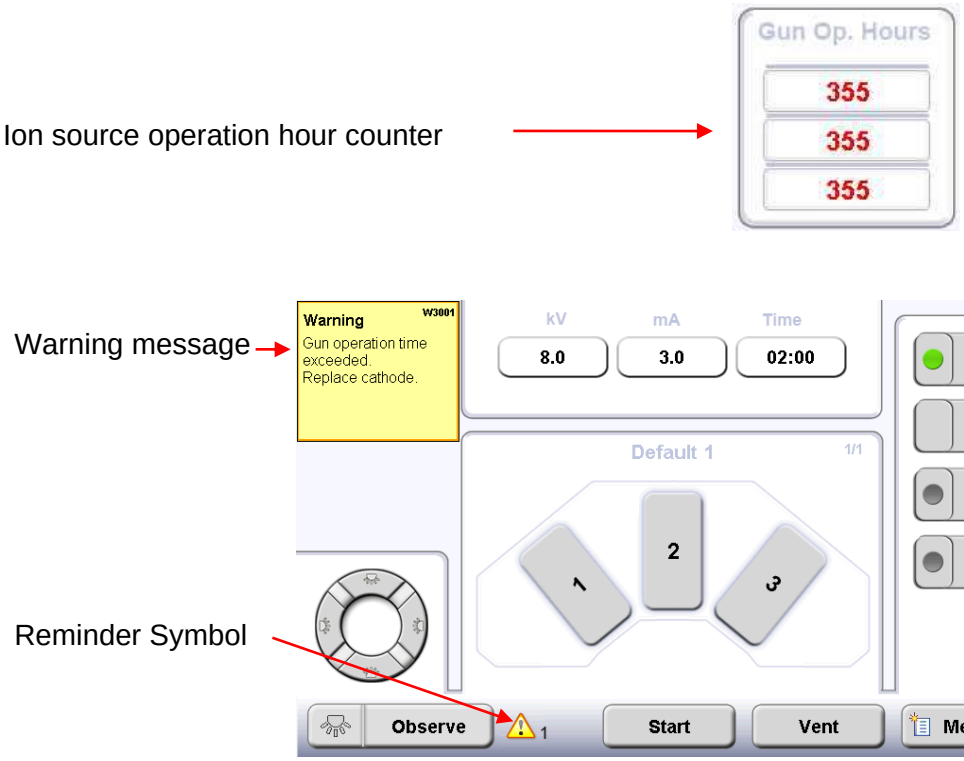
The following items advance ion source contamination and lead to shorter cleaning cycles:

- Short process times (< 10 min) in combination with high process energies (> 8 kV)
- Contaminated or low order process gas (purity less than 5.0)
- Long open times with vented chamber
- Insufficient basic chamber pressure (residual gas in chamber)
- Out gassing sample materials
- Sample materials including hydrocarbons, oxygen and water

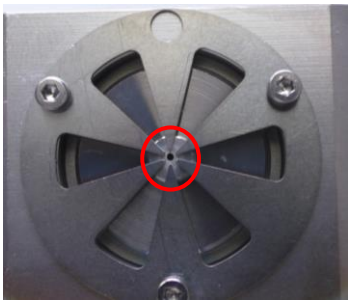
5.6.2.4 Replacement of Ion source

Depending on the used beam energy, the cathodes lifetime is approx. 350 hours at 8 kV. Using higher process energies shorten the lifetime, using lower energies extend the lifetime, respectively.

The operation time is monitored by the ion source operation hour counter. If 350 hours have been reached a warning message appears. After confirming, the warning is still present in background, indicated by a symbol in the taskbar. By pressing the symbol the warning message can be re-opened. The warning message and symbol will be deleted after reset of ion source operation hour counter. Operation times > 350 hours will be displayed red in the operation hour counter.



Do not use ion sources longer than 350 hrs if mainly voltages above 8kV were used. At least check if the rear cathode broken through. Otherwise damages of the system might occur!



In general it is recommended to exchange the ion sources or service the components once the warning message appears.

After maintenance of the ion sources, push the counter indication in the menu window and set the counter to zero.

5.6.2.5 Maintenance of the ion source

To reduce the downtime during maintenance it is recommended to use a second fully equipped Triple Ion Source, hence the instrument will be ready to use within 10 minutes by exchanging the complete Triple Ion Source component.

Following parts should be checked respectively replaced or cleaned

Assembly	Task	Cycle
Ion Source components of the cartridge system	Replace cathodes and anode or replace complete ion source cartridge (~15min downtime)	350 h as indicated by operating hours counter
	Clean all components of the ion source	350 h
	Clean the ion source	- as necessary - if ion source is unstable - in the event of short-circuit

Worn cathodes and anode impair the cutting power of the system!

5.6.2.6 Dismantling the ion source

Caution – avoid contamination from external elements (dust, dirt, etc.)

The ion source may malfunction due to contamination.

Protective gloves must be worn for all work carried out on the ion sources!

All work must be carried out in a clean, dust-free environment.

Caution!

There is a danger due to high temperatures > 65 °C around the ion source during operation.

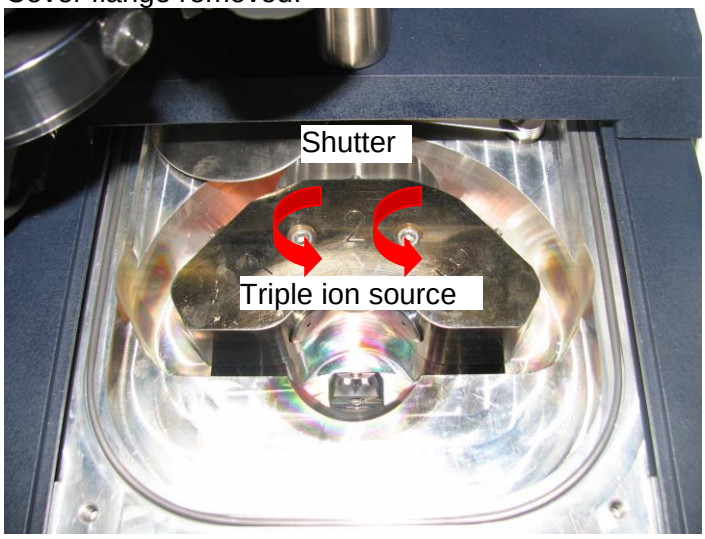
Personal injury (e.g. burns) may occur.

You must wait until the ion source has cooled down sufficiently before beginning any work on it.

To dismantle the ion source form the system, proceed as follows:

1. Swivel the microscope aside.
2. Remove the cover flange as described in chapter 5.6.2.6

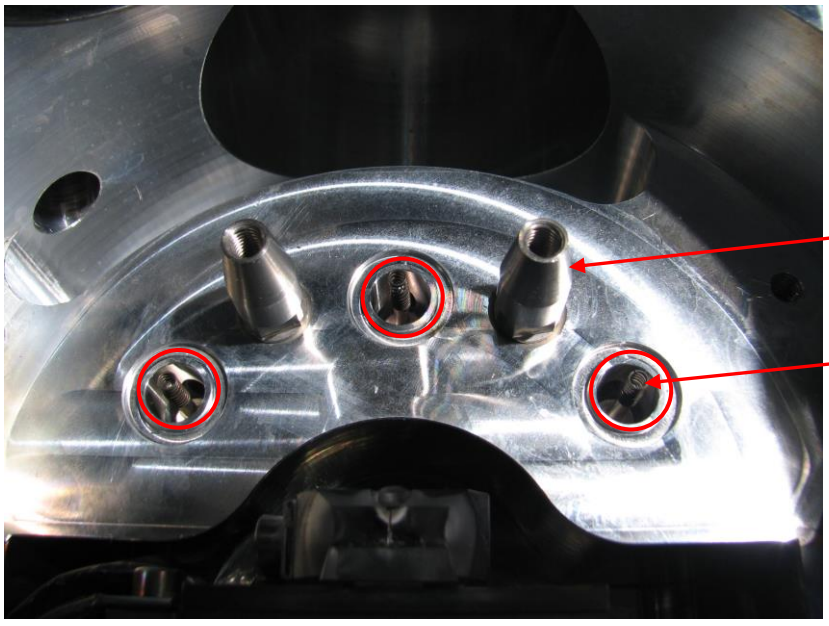
   Cover flange removed:



3. Unscrew the two screws (with a centre hole) on the ion source with a hex screw driver.
4. Place the screws on a clean cloth.

5. Carefully lift the ion source vertically out of the system and place it on a clean cloth.

Ion source is removed:



To reinstall the ion source carry out the steps above in the reverse order. Make sure screws with the center hole are used for tightening the ion source. Remove (blow with oil- and water-free air) loose particles from the recess. Make sure that no loose particles are into the recess of the HV- connection area (red circles).

5.6.2.7 Disassembling and assembling the triple ion source

Take precaution to avoid contamination from external elements (dust, dirt, etc.)

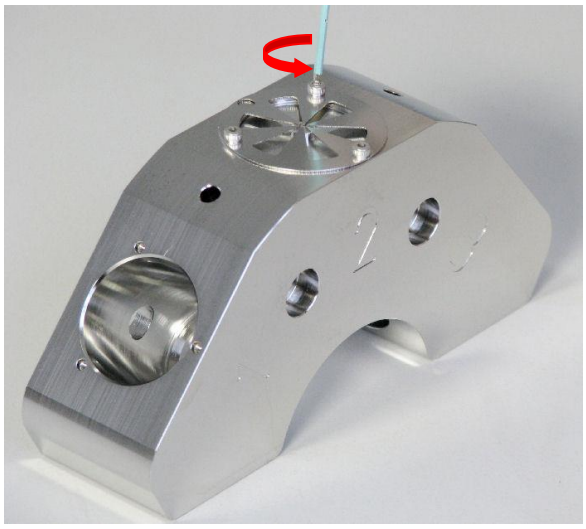
The ion source may malfunction due to contamination.

Protective gloves must be worn for all work carried out on ion source components!

All work must be carried out in a clean, dust-free environment.

Disassembling the ion source

1. Unscrew the screws on an ion source and remove the spring with tweezers. Place the parts on a clean underlay.



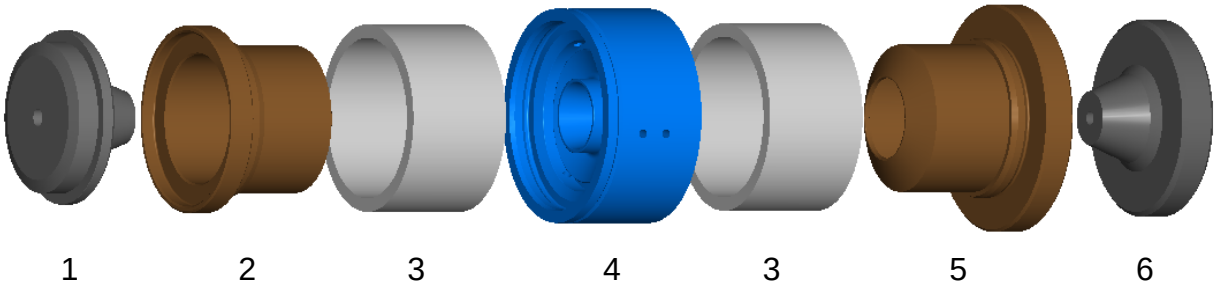
Hex screwdriver, size 1.5

2. Carefully shake the source components out.

3. Place the source components on a clean underlay in the order in which they were removed.

4. Repeat for the other sources.

Internal construction of the ion source cartridge

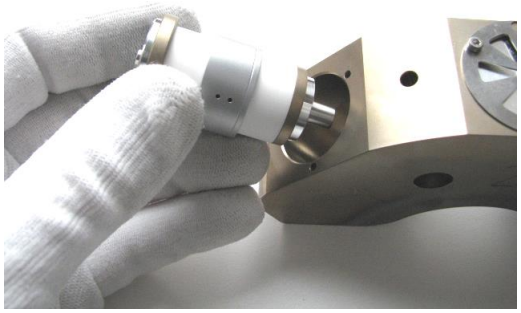


1 - Front Side Cathode
2 - Front Side Wehnelt Cylinder
3 - Ceramic Isolators
4 - Anode
5 - Rear Side Wehnelt Cylinder
6 - Rear Side Cathode

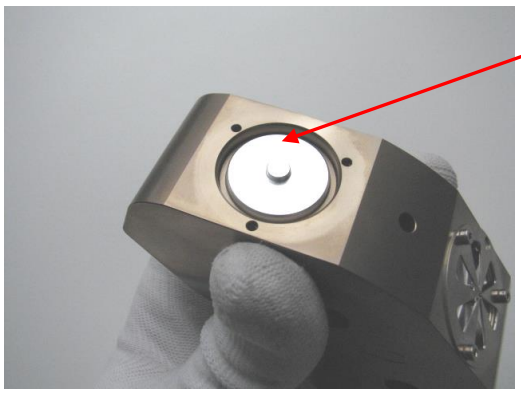
5.6.2.8 Exchange of the complete ion source

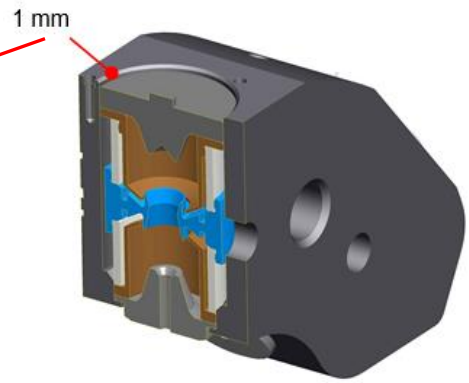
Unpack ion source cartridge of the sealed bag using scissors.

Insert cartridges in the ion source housing.

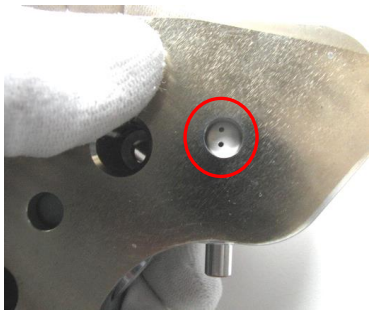
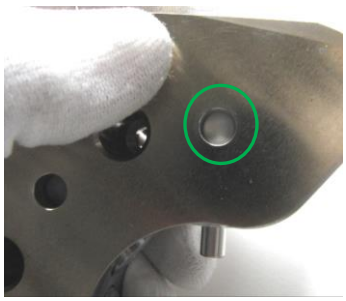


Check the right assembling. The edge of rear side cathode must be 1 mm lower than the edge of ion source housing.



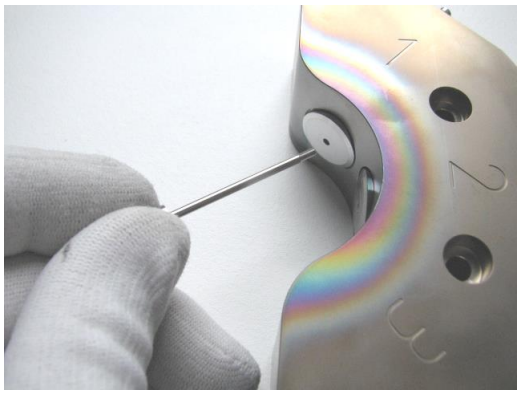


Make sure gas inlet holes are not visible in the clearance hole, if visible turn ion source cartridge ~120 °. Hint: Orient the gas inlet holes in line with the thread holes of the holding spring while inserting the cartridge.


Lock parts with holding spring and screws.

Unscrew and remove locking screw and insert ion source housing in the instrument.



To reinstall the ion source carry out the steps 5.6.2.6 in the reverse order.

Reset the operation hour counter of the ion source!

5.6.2.9 Cleaning the ion source components

In case of an error message asking for cleaning ion source proceed as following:

1. Disassemble ion source as described in chapter 5.6.2.7

2. Check the source components for dirt. Discoloration of steel parts, which is caused by high temperatures, will not impair the function of the ion source.

3. Replace worn cathodes and anode once the operation hours exceeds 350 h.

4. Remove dust and dirt particles from the Wehnelt cylinders with a wooden stick and with pressurized air containing no oil or water. Or (recommended) use potassium- or sodium- hydroxide under the fume hood over night or at least as long as no more hydrogen gas formation is observed.

Attention: Alkaline solution! Danger of alkali burn. Protect skin and eyes!

5. Residual contamination of the Wehnelt cylinder can be removed by using sandblasting (if available) or sandpaper or similar.

6. Clean all steel parts (Wehnelt cylinders) with isopropanol in an ultrasonic bath for 10 minutes.

7. Clean the cathode with isopropanol in an ultrasonic bath for 10 minutes or replace it.

8. Clean the ceramic components with isopropanol but **not** in the ultrasonic bath. To remove soiling in the pores of the material, heat them for at least 1 hour at min. 800 °C.

9. Clean the source body with isopropanol in an ultrasonic bath.

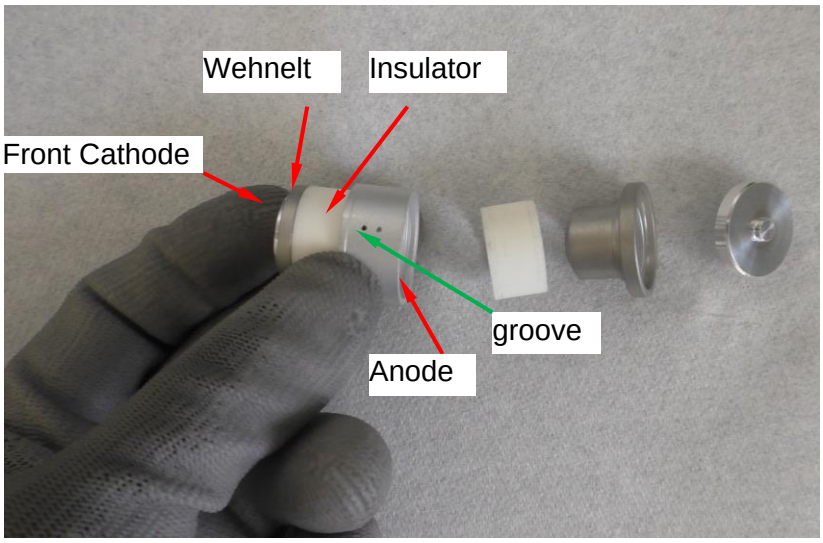
10. Heat all cleaned parts for about an hour in an oven at a temperature of 400°C to evaporate any remaining isopropanol residue.

If the contaminations are not completely removed, means residual particles or layers are left on the gun parts; the next maintenance cycle will be shorter. The guns will be contaminated earlier than complete cleaned or new guns.

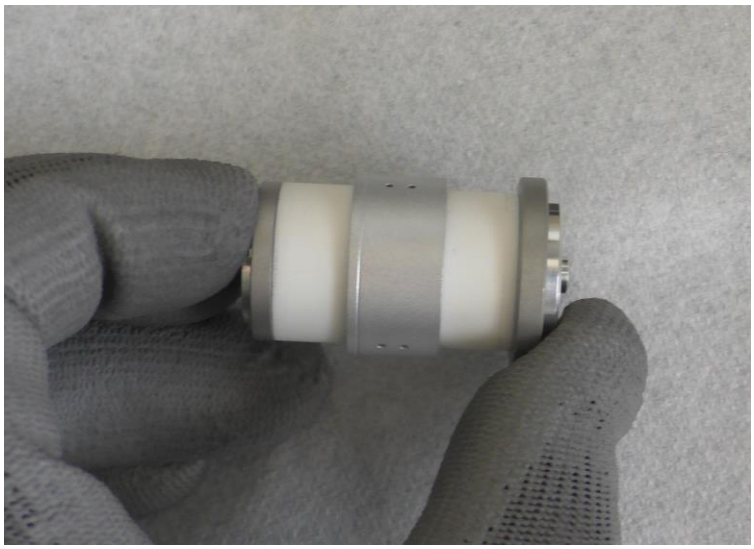
Assembling the ion source

1. Assembly all components of the ion source.

Groove of the anode must point to the front cathode!

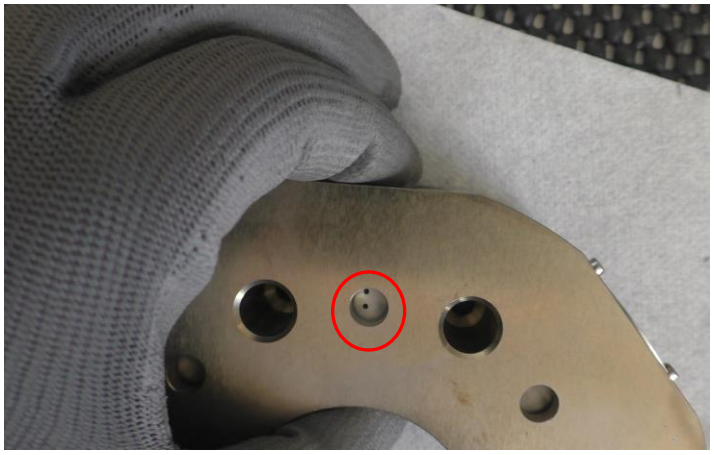


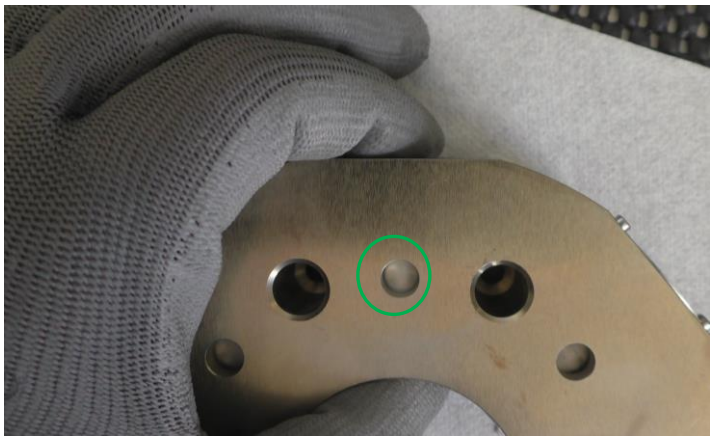
Components should solidly seat to its rest.



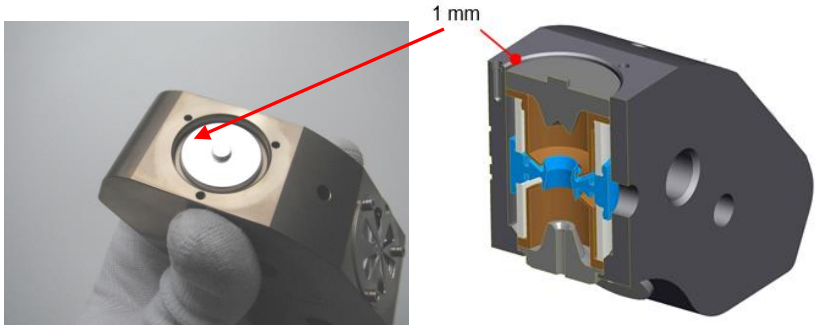
2. Insert ion source in the locating hole of the ion source gun housing by holding the housing in upright position. Make sure that the ion source components are firmly kept together.

3. Turn gun housing in vertical position and check if gas inlet holes are visible. Turn ion source ~120 ° to set gas inlet holes in correct position.

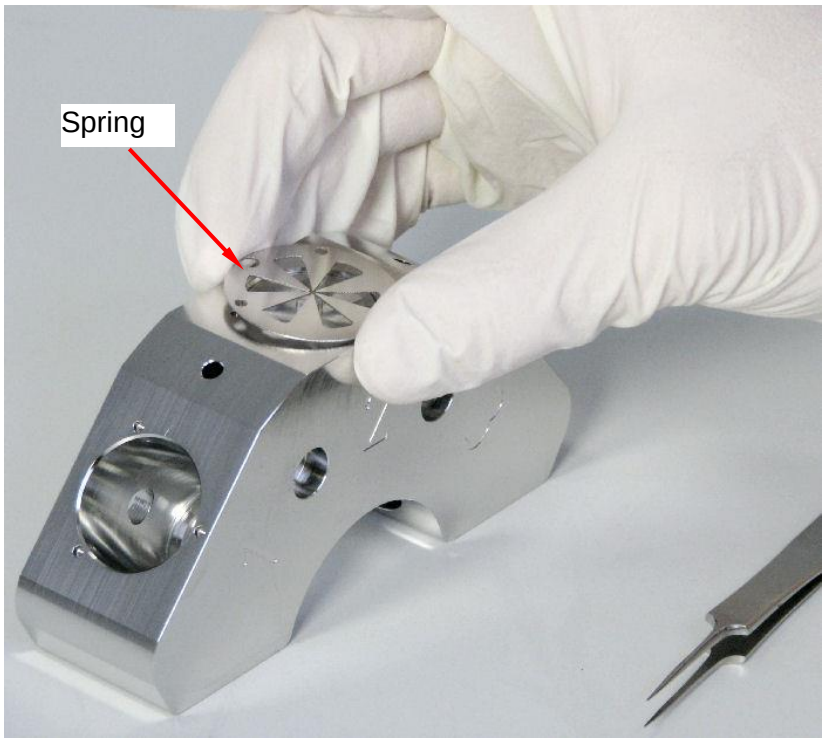




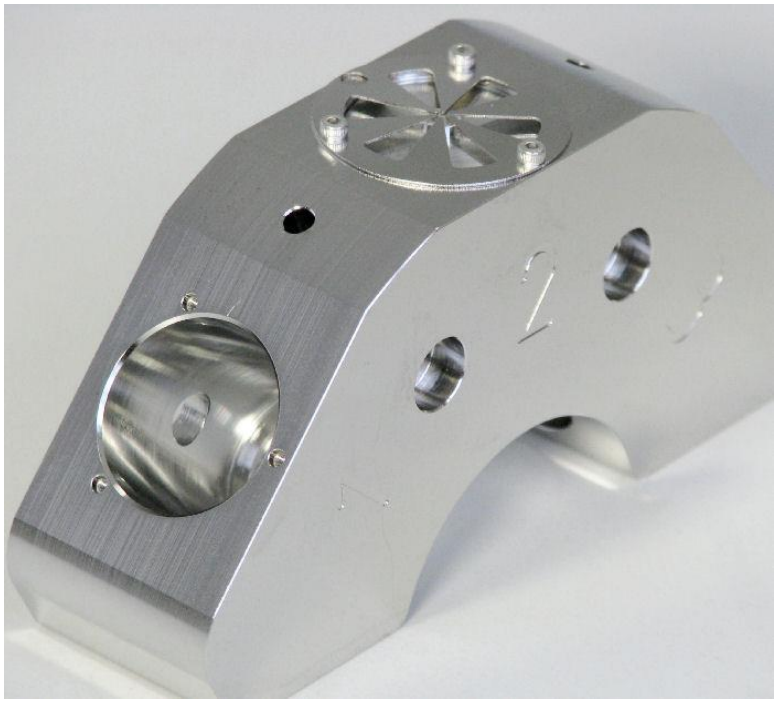
4. Check the right assembling. The edge of the rear side cathode must be 1 mm lower than the edge of the ion source housing.



5. Fit the spring on the mounted ion source.



6. Secure each spring with three screws. Use a hex screwdriver, size 1.5.



7. Now install the other two ion sources. Follow steps 1-6 of the procedure described above.

The diameter tolerances of the gun parts are small. Hence, inserting the gun parts must be done carefully to avoid the parts getting jammed. Once the gun is assembled check the correct fitting by shaking the gun. There must be no rattling noise audible.

5.6.2.10 Instability of the ion source with a high life time and low kV setting.

Due to the nature of the saddle field ion gun type the material of the cathodes is permanently removed. This material removal changes the electrical field characteristic and can cause instable ionisation inside the gun at a life time higher than ~100 hrs and low voltages between 1 and 4 kV using the default value of the current. If instabilities are noticeable please adapt the current manually in steps of 0.2 mA as long as stable ionisation can take place.
For example: stability of 3 kV (default 1 mA) can be achieved by manual adaption of the current to 3 mA.

Since the adaption of the current is related to the current between anode and cathode the ion current will be not influence. Hence, sample temperature will not increase.

5.6.3 Exchanging fuses

If a fuse needs to be replaced (fuse faulty) (particularly if it fails repeatedly), try to discover the reason for the failure of the fuse. If necessary, contact the Service department.

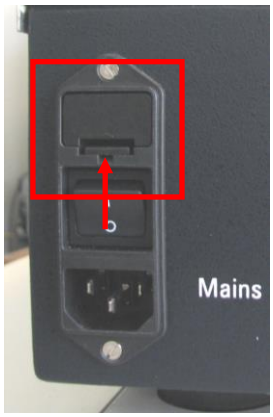
There is danger if wrong fuses are installed.

This may cause personal injury due to electric shock and damage to the system.

Only fuses with the appropriate rating must be used.
Exchanging the main fuse

1. Switch off the system at the main switch and remove the power cable.

2. Use a screwdriver to release the main fuse from its holder, as shown in the illustration.



3. Remove the main fuse and replace it with a new one.

5.7 Cleaning the Leica EM TIC 3X

All surfaces can be cleaned with a damp lint-free cloth moistened with either aqueous cleaning agents or 50% ethanol (ethanol:water 1:1). Do NOT use ACETONE!

The LCD control panel should be cleaned with standard commercial screen cleaner when the system is switched off.

Accidentally deposition of solvents (e.g. acetone, isopropanol or ethanol) must be removed immediately with damp lint-free cloth moistened with either aqueous cleaning agents or 50% ethanol.

5.8 Maintenance schedule (summary)

Assembly	Task	Cycle
Viewing glass	Clean or replace	As necessary
Protective glass	Clean or replace	As necessary
Ion source	Replace cathodes and anode or complete ion source cartridges	350 h as indicated by operating hours counter
	Clean components of the ion source	350 h
	Clean the ion source	- If ion source is unstable - In the event of short-circuit
Turbo pump	Performed by Leica service engineer	Every 3 years (monitored by operating hours counter)
Booster pump	Performed by Leica service engineer	As necessary
	Performed by Leica service engineer	Yearly (monitored by operating hours counter)
LN_2 Pump	Clean valves	- if LN_2 flow is to low - if cooling rate becomes too slow.

6. Troubleshooting

6.1 Error messages

In case of an error a message about the error and remedy suggestion will be displayed on the screen.

6.2 Malfunction

Malfunction	**System does not start when switched on**
Cause	The cable is not connected to the mains power supply
Remedy	Connect to the mains power supply
Cause	Fuse on the main switch is faulty
Remedy	Replace fuse
Malfunction	**Turbo pump does not reach setpoint speed**
Cause	Vacuum leak
Remedy	Check for leak, first at the door and cover flange Check the gas line connection

Malfunction	**Coaxial light can't be switched by the touch screen**
Cause	It is only possible when a process is running
Remedy	Switching without processing can only be done directly on the coaxial light
Malfunction	**Ion guns unstable**
Cause 1	Contaminated gas or gas line
Remedy	Clean gas line, check gas quality (Ar 5.0)
Cause 3	Contamination in ion guns
Remedy	Clean ion gun
Cause 4	Cathodes burned out
Remedy	Replace cathodes and anode

7. Servicing and repair by Customer Service

The Leica EM TIC 3X is covered by a WARRANTY in accordance with the conditions of sale. If functional errors should occur or if the components of the system sustain damage that is subject to warranty coverage during the warranty period, the manufacturer will repair or replace the faulty components following examination thereof.

The manufacturer warrants for the system in its original configuration.

Only original replacement parts may be used. The manufacturer accepts no liability for damage caused by use of other replacement parts.

Caution!
There is danger due to overloaded or defective components.
This may cause personal injury and damage to the system.
The environmental conditions that were agreed contractually and determined at the time of installation must be maintained.

The manufacturer will not accept liability for damage caused by misuse of the system or its use for purposes other than the intended use, nor for damage caused by work on the system that is not described in this manual. For all of these reasons, it is recommended that our customers consult our Customer Service department regularly.

Purpose:

- Restoring to target condition
- Detecting and evaluating causes of malfunction
- Initiating corrective measures
- Correcting malfunctions according to expertise specified in the maintenance concept

EC Declaration of Conformity

EG Konformitätserklärung

Déclaration CE de Conformité

Leica Mikrosysteme GmbH
Hernalser Hauptstrasse 219
A-1170 Vienna/Wien/Vienne,
Austria/Österreich/Autriche

declares in exclusive responsibility that the product erklärt in alleiniger Verantwortung, dass das Produkt déclare sous sa responsabilité que le produit	
Model/Modell/modèle	Leica EM TIC3X
Type/Typenbezeichnung/type	EM TIC3X
to which this declaration relates is in conformity with the following standards: auf das sich diese Erklärung bezieht, mit den folgenden Normen übereinstimmt: auquel se réfère cette déclaration est conforme aux normes:	EN 61010-1 EN 61326-1

following the provisions of directive gemäß den Bestimmungen der Richtlinie conformément aux dispositions de directive	
(Electromagnetic compatibility) (Elektromagnetische Verträglichkeit)	2014/30EU
(Low Voltage Equipment) (Niederspannungsrichtlinie)	2014/35EU
(RoHS directive) (RoHS Richtlinie)	2011/65/EU

ppa

Vienna/Wien/Vienna, 21/07/2017

Dr. Paul Wurzinger
Entwicklungsleiter/R&D Manager/Chef du service développment

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