# Ascend SB WB SWB

Service Manual

Version 04

Innovation with Integrity

NMR

This manual was written by

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Faellanden, Switzerland

ZTKS0177 / Z31977 / 04

For further technical assistance on the NMR Magnet System, please do not hesitate to contact your nearest BRUKER dealer or contact us directly at:

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# 0 Contact

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Please refer to the Model No., Serial No. and Internal Order No. in all correspondence regarding the NMR system or components thereof.

# Contact

# 1 Introduction

## 1.1 General Information

This manual contains important information about the handling of the supplied magnet system used for NMR spectroscopy and its components. The compliance with all safety and handling instructions, the applicable local accident prevention and general safety regulations are necessary for safe work.

This manual is part of the product. It must be kept nearby the magnet system and free access must be ensured at any time. Read the manual carefully before handling the magnet system or its components.

## 1.2 Limitation of Liability

The information in this manual will take into account the current state of the technology.

The manufacturer assumes no liability for damages resulting from:

- non-compliance with the instructions and all applicable documentation,
- use for purposes not intended,
- not sufficiently approved persons,
- arbitrary changes or modifications and
- use of not approved spare parts or accessories.

## 1.3 Customer Service

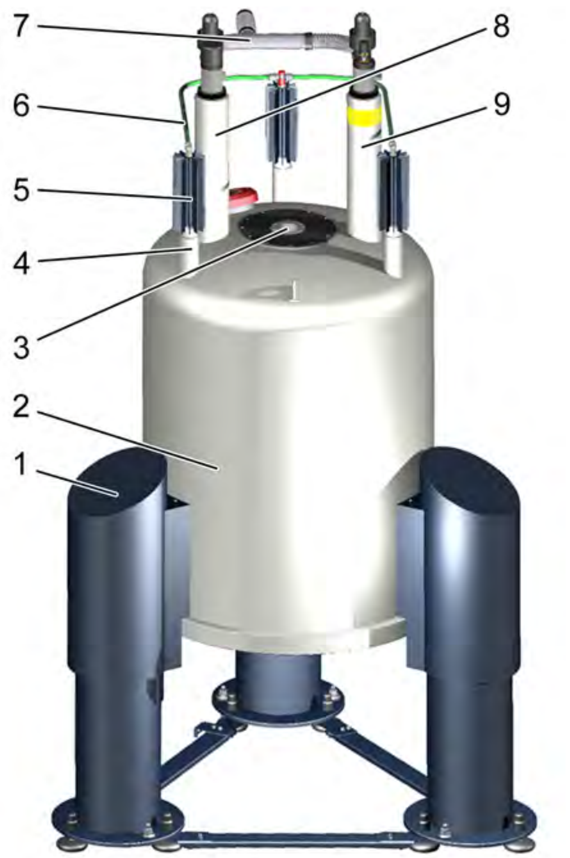
Technical support is provided by Bruker Service via telephone or e-mail. For contact information see page 9 of this document.

## 1.4 Warranty

The warranty terms can be found in the sales documents of the magnet system and in the Terms and Conditions of Bruker BioSpin AG.

## 1.5 Copyright

## 1.6 General View




1 Magnet Stand
2 RT Vessel
3 RT Bore
4 Nitrogen Turrets
5 Heat Exchanger
6 Nitrogen Flow System
7 Helium Flow System
8 Current Lead Turret
9 Helium Fill-in Turret with helium fill-in port


Figure 1.1: General View of a Magnet System with 2 Helium Turrets

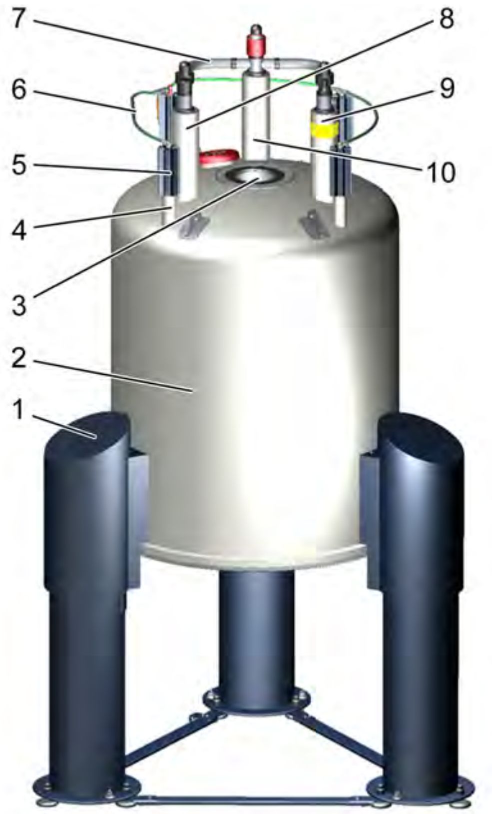
The heart of the NMR magnet system is a superconducting magnet located inside the helium vessel, which is filled with liquid helium. The helium vessel is surrounded by a nitrogen vessel filled with liquid nitrogen. The outer casing, the room temperature (RT) vessel (2), contains the helium vessel and the nitrogen vessel. The vacuum in the RT vessel reduces thermal conduction. The RT bore (3) allows the access to the magnetic center. RT vessel, inner vessels, turrets, flow systems and the RT bore together build the cryostat of the magnet system.

The cryostat is mounted on a magnet stand (1). The isolators in the magnet stand absorb floor vibrations. Different heights and isolators are available optionally.

The nitrogen turrets (4) connected with the nitrogen flow system (6) and the heat exchangers (5) are the interface to the nitrogen vessel. The nitrogen fill-in turret is marked with a green label.

The helium turrets (8, 9) connected with the helium flow system (7) are the interface of the helium vessel and the magnet coil. The helium fill-in turret (9) is marked with a yellow label.

The current lead turret (8) is the interface for energizing the magnet coil and for diagnostic. At cryostats with three helium turrets the high current lead turret (10) builds the interface for energizing the magnet coil while the current lead turret (8) is for diagnostic only.




1 Magnet Stand
2 RT Vessel
3 RT Bore
4 Nitrogen Turrets
5 Heat Exchanger
6 Nitrogen Flow System
7 Helium Flow System
8 Current Lead Turret
9 Helium Fill-in Turret with helium fill-in port
10 High Current Lead Turret


Figure 1.2: General View of a Magnet System with 3 Helium Turrets

# 2 Safety

The supplied cryostat and further equipment of the magnet system were designed and manufactured according to best available technical knowledge and practice, achieved in over 50 years of experience of the Bruker Corporation. International standards for quality and approval recommended for cryostats of superconducting magnets were certified.

Nevertheless non-compliance with the following instructions and safety advice may cause serious hazards and property damage.

## 2.1 Approved Persons

Bruker BioSpin AG identifies the following qualifications for personnel performing tasks on the magnet system or its components:

**Approved Customer Personnel**

As a result of professional training by Bruker Service Personnel, experience and knowledge of applicable regulations these persons are qualified to perform the specific tasks on the magnet system and its components assigned to them in this manual. Approved Customer Personnel are qualified to identify possible hazards and risks associated with the tasks assigned to them and to perform all possible steps to eliminate or minimize these risks.

**Bruker Service Personnel**

These persons are qualified by appropriate qualification and professional training and experience (including all necessary knowledge of applicable regulations and regulatory requirements) to perform specific tasks on the magnet system and its components. Bruker Service Personnel are qualified to identify possible hazards and risks and to perform all possible steps to eliminate or minimize these risks.

## 2.2 Customer Responsibilities

The customer must obey the security advice and the rules for safety, applicable local accident prevention and environmental protection correctly for the magnet system. Furthermore, the customer is responsible for keeping the magnet system in good technical condition.

**In particular:**

- The customer must identify additional dangers resulting from the working conditions at the site of the magnet system and provide applicable safety measures.
- The customer must ensure that the site plan meets the specified conditions according to the site planning document for operating the magnet system.
- The customer must clearly mark the danger area around the magnet system and post the corresponding instruction plates.
- The customer has to ensure the intended use of the magnet system.
- The customer has to inform the local fire brigade about the special risks of the magnet system and how to react in the event of an incident.
- The customer must clearly define the responsibilities for operation and maintenance.
- The customer must ensure that all employees working with the magnet system have read and understood the manual.
- The customer has to provide the necessary personal protective equipment for his employees.
- The customer has to instruct his employees at regular intervals on hazards and safety measures.
- The customer has to instruct other persons not working on the magnet system but carrying out work in the same room, for instance cleaning staff or guards about the possible danger at the site of the magnet system.
- The customer must ensure that maintenance is performed according to the schedule listed in chapter **”Maintenance Timetable” on page 92**.

## 2.3 Key Words

| DANGER |
|---|
| **Indicates a hazardous situation which, if not prevented, will result in death or serious injury.** |

| WARNING |
|---|
| **Indicates a hazardous situation which, if not prevented, could result in death or serious injury.** |

| CAUTION |
|---|
| **Indicates a hazardous situation which, if not prevented, may result in moderate or minor injury.** |

| *NOTICE* |
|---|
| **Hazard, which could result in property damage.** |

Information and links for efficient and trouble-free handling and operation.

## 2.4 Residual Risks

In the following chapter the residual risks from the risk analysis according ISO 14971 are summarized. To prevent health hazards and hazardous situations obey all safety instructions and warnings in the manual.

### 2.4.1 Persons

**WARNING**

**Risk of injury and property damage due to handling by not approved persons.**

Incorrect handling of the magnet system by not approved persons may result in significant bodily injury and property damage.

Thus:

- Work must only be carried out by approved persons with applicable qualifications. The necessary qualifications are specified in the beginning of the relevant chapter.
- In case of doubt, contact Bruker Service. Contact information see page 9 of this document.

### 2.4.2 Intended Use

The supplied magnet system is designed and intended for NMR spectroscopy only.

**WARNING**

**Risk of damage to life and limb by incorrect use of the magnet system.**

Incorrect use of the magnet system can lead to life-threatening situations and destruction of the magnet system.

Thus:

- Only use the magnet system as intended.
- Do not change the magnet system.
- Do not exceed specified values for operating the magnet system.
- Do not use inserts inside the RT bore not approved by Bruker Service.

Damage claims from damages caused by other than the intended use of the magnet system are excluded and the customer is held liable.

## 2.4.3 Safety Devices

**⚠ WARNING**

**Risk of damage to life and limb due to not sufficient safety devices.**

Several safety devices ensure safe operation of the magnet system. They must always be in correct working condition.

Thus:

- Do not block safety devices.
- Do not remove safety devices.
- Check the operational reliability of the safety devices before working on the magnet system.

## 2.4.4 Spare Parts

**⚠ WARNING**

**Risk of injury and property damage from using incorrect or defective spare parts and accessories.**

Incorrect or defective spare parts can cause serious injuries. They may cause damaging, malfunctioning and the destruction of the magnet system.

Thus:

- Only use original equipment manufacturer spare parts.
- Only use original equipment manufacturer accessories.

### 2.4.5 Signs and Labels

**⚠ WARNING**

**Risk of damage to persons and property due to not readable signs and labels.**

Signs and labels with advice may become not readable.

Thus:

- Maintain signs and labels in a readable state.
- Replace damaged or not readable signs and labels immediately. New signs and labels can be ordered from Bruker Service.

### 2.4.6 Technical Risks

**Magnetic Field**

**⚠ WARNING**

**Risk of damage to life and limb due to high magnetic fields.**

A magnetic field of more than 0.5 mT (5 Gauss) is life-threatening for people with pacemakers or active metal implants. Exposure to more than 8 T can cause damage to health. Duration of exposure (8 h/day) above the limit of 200 mT can cause damage to health. Ferromagnetic tools in the magnetic field are significantly hazardous. Disks and electronic devices may be damaged.

Thus:

- Mark the magnetic field of more than 0.5 mT (5 Gauss) before start up.
- Keep people with active medical implants away from the 0.5 mT (5 Gauss) area.
- The permanent workplace of employees must be outside the 0.5 mT (5 Gauss) area.
- Do not stay or work at magnetic fields of more than 8 T.
- Prevent exposure of more than 200 mT for more than 8 h/day.
- Keep disks, credit cards and electronic devices away from the identified area.
- Do not use ferromagnetic tools or items within the identified area.
- Only use non-ferromagnetic transportation dewars or pressure cylinders for the cryogenic agents.
- Only use non-ferromagnetic ladders or steps.

### Cryogenic Agents

**WARNING**

**Risk of damage to life and limb due to cryogenic agents.**

Risk of damage to life and limb due to not correct handling of liquid cryogenic agents. Within the transition from liquid to gas, helium and nitrogen expand their volume, causing closed vessels or transportation dewars to burst. The evaporating cryogenic agents will displace the breathing air. Helium displaces the breathing air in the upper part of the room, nitrogen displaces the breathing air in the lower parts of the room. In case of not sufficient ventilation this may result in death by suffocation.

Liquid and gaseous cryogenic agents are extremely cold. Contact with liquid or gaseous cryogenic agents will lead to cold burns. Contact with the eyes may cause blindness. Refer to Warning: Low Temperature on page 21.

Thus:

- Only use cryogenic agents in well ventilated rooms. In case of doubt ask Bruker Service.
- Wear an oxygen monitor on the body during service and maintenance work.
- Prevent any skin contact with liquid or gaseous cryogenic agents.

### Electricity

**WARNING**

**Risk of damage to life and limb due to electricity.**

Risk of damage to life and limb due to contact with electrical lines and damaged insulation.

Thus:

- Work on electrical equipment must be done by an approved electrical technician.
- Keep moisture away from electrical lines to prevent short-circuits.
- Check the magnet system electrical grounding before start.
- Switch the power OFF before working on the Bruker Power Supply or further equipment.

### Quench

**⚠ WARNING**

**Risk of suffocation during a quench of the magnet system.**

A quench is the very fast de-energizing of the magnet by loss of its superconductivity. The stored magnetic energy is converted into heat and thus large quantities of helium evaporate. The evaporating helium will displace the breathing air. In case of not sufficient ventilation this may result in death by suffocation.

Thus

- The magnet system site must be well ventilated. In case of doubt contact Bruker Service.
- The evaporating gas may resemble smoke. Never pour water on the magnet system.

### Gas under Pressure

**⚠ WARNING**

**Risk of injury due to gas under pressure inside the cryostat and further equipment.**

The helium or the nitrogen vessel of the cryostat may get sealed off due to ice formation inside the helium or the nitrogen turrets in case of non-compliance with the instruction given in this manual. This may lead to overpressure and damage of the helium or the nitrogen vessel.

Manipulations of components with gas under pressure may lead to injury and property damage.

Thus:

- In case of icing inside the helium or the nitrogen turrets contact Bruker Service immediately.
- Release the pressure to the recommended value before working on components with gases under pressure.
- Do not seal cryogenic agent vessels of the magnet system or the transportation dewars.
- Do not connect high pressure transportation dewars to the magnet system. Completely eliminate the high pressure from the transportation dewars before connecting and transferring cryogenic agents.

### Low Temperatures

**WARNING**

**Risk of injury due to low temperatures of liquids and metal parts.**

Physical contact with extremely cold liquids and metal parts may cause serious injuries. Contact with the skin may cause cold burns. Contact with the eyes may cause blindness.

Thus:

- Always wear protective goggles, protective gloves and protective clothes while handling with liquid cryogenic agents or metal parts in contact with liquid cryogenic agents.
- Protect temperature sensitive components such as O-rings from contact with liquid cryogenic agents.

### Spontaneous Ignition and Explosion

**WARNING**

**Risk of injury from spontaneous ignition and explosion caused by liquid oxygen.**

Pure oxygen condenses on extremely cold metal pieces. Together with oil it may ignite spontaneously. In case of fire the pure oxygen may cause an explosion.

Thus:

- Do not smoke near the magnet system.
- Do not use open flames near the magnet system.
- Keep the environment around the magnet system clean.
- Do not leave oily rags near the magnet system.

### Risk of Slippage

**WARNING**

**Risk of injury from slippage.**

The accumulation of condensed water on the floor and ladders causes slippery surfaces.

Thus:

- Always wear safety shoes with an anti-slip sole.
- Be careful using ladders.
- Clean floor and ladders regularly.

### Risk of Tilting

**WARNING**

**Risk of injury due to tilting of the magnet system.**

The magnet system is very sensitive to lateral forces. It may tilt.

Thus:

- Do not climb onto the magnet system.
- Do not lean items against the magnet system.
- Do not lean against the magnet system.
- Do not move the magnet system on your own.

### Heavy Weights

**WARNING**

**Risk of damage to life and limb caused from heavy weights.**

Lifting heavy weights is life-threatening due to falling or moving parts.

Thus:

- Do not stay or work under a lifted magnet system.
- All lifting equipment in use must be approved to carry the weight.
- Do not use damaged lifting equipment.
- Do not use lifting equipment without updated check tag.
- Lifting only with approved qualification.
- Obey ergonomic guidelines while lifting heavy parts.
- Protect parts against falling.
- Always wear safety shoes with approved toe caps.

**Transportation**

**CAUTION**

**Risk of injury and property damage due to incorrect transportation.**

The boxes may tilt, movement may get out of control. Thus persons may get injured and the contents or further equipment may be damaged.

Thus:

- Be careful while unloading and moving the boxes.
- Do not move the boxes arbitrarily.
- Pay attention to all symbols on the boxes.
- Pay attention to sharp edges and spikes of boxes and parts by using protective gloves while moving.
- Move the boxes in an upright position.
- Do not tilt the boxes.
- Prevent crossing thresholds, even if they are only a few millimeters high.
- Clean the transportation way before moving the box.
- Unpack shortly before assembling.
- The contents or further equipment must be protected from rain and other bad weather conditions during transportation.
- Exclusively move the cryostat in its original box.
- Do not remove the tightening straps inside the box until assembling.
- Only use the provided attachment points.
- Ensure that the cryostat is always leveled during any transportation.
- Transportation only with attached transportation locks.
- Do not move the evacuated cryostat.
- Do not move the cryostat after cool down.

## 2.5 Personal Protective Equipment

The personal protective equipment must be worn at any time while working on the magnet system and further equipment to prevent health hazards.

**Protective Goggles**

Used to protect the eyes from injury due to flying cold liquids and parts.

**Protective Gloves**

Used to protect the hands from injury caused by contact with extremely cold liquids or surfaces and for protection from injury caused by rough edges.

**Protective Clothes**

Used to protect the body from injury caused by contact with extremely cold liquids or surfaces and for protection from wounds.

**Safety Shoes**

Used to protect the feet from injury from falling of heavy objects. An anti-slip sole protects from injury caused by slipping and falling on slippery floor and steps. Only use safety shoes with non-ferromagnetic toe caps.

**Portable Oxygen Monitor and Alarm**

Used to warn against low oxygen concentrations in surrounding air.

## 2.6 Description of Signs and Labels

Signs and labels are always related to their immediate vicinity. The following signs and labels are found on the magnet system and in the vicinity.

**Prohibition sign: No person with pacemakers!**

People with pacemakers are endangered in the identified area of 0.5 mT (5 Gauss) and are not allowed to enter these areas.

**Prohibition sign: No person with implants!**

People with metallic implants are endangered in the identified area of 0.5 mT (5 Gauss) and are not allowed to enter these areas.

**Prohibition sign: No watches or electronic devices!**

Watches and electronic devices may be damaged in the identified area of 0.5 mT (5 Gauss).

**Prohibition sign: No credit cards or other magnetic memory!**

Credit cards and magnetic memory may be damaged in the identified area of 0.5 mT (5 Gauss).

**Prohibition sign: Do not touch! Do not block!**

Do not touch or block the identified area.

**Hazard warning sign: Strong magnetic field!**

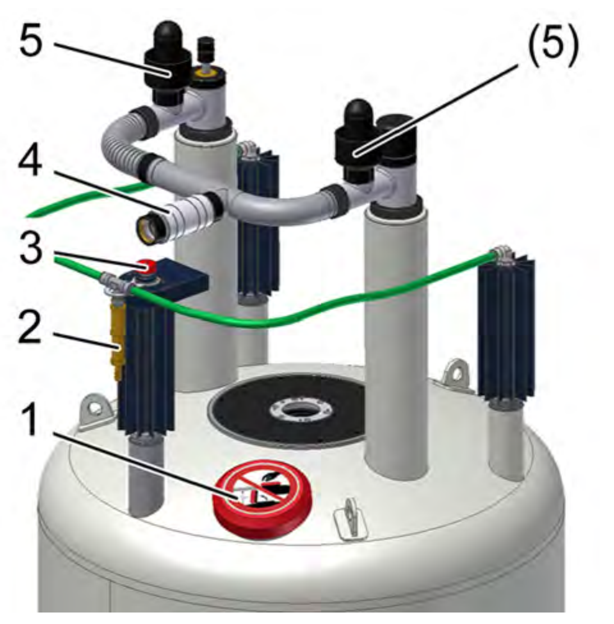
- No magnetic memory.
- No jewelry.
- No metallic items.

**Emergency exit!**

- Always keep the emergency exit clear.
- Follow the arrows if necessary.
- Doors must pushed open in escape direction.

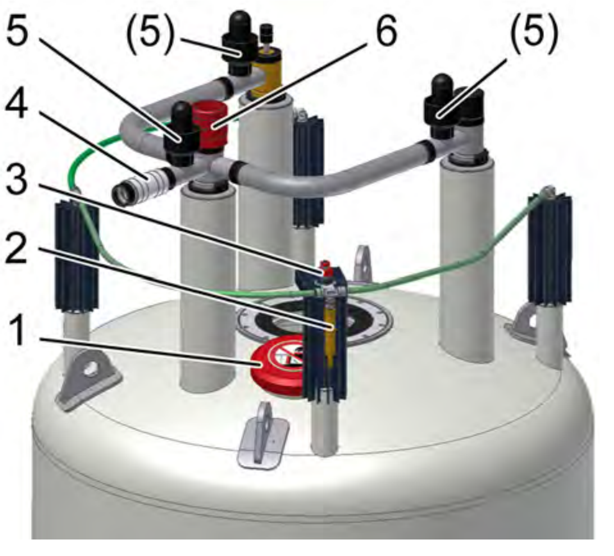
## 2.7 Safety Devices

The supplied cryostat of the magnet system is equipped with the following safety devices:




1 Drop-off Plate
2 One-way Valve of the nitrogen vessel
3 Safety Valve of the nitrogen vessel
4 One-way Valve of the helium vessel
5 Quench Valves

Figure 2.1: Safety Devices of the Cryostat with 2 Helium Turrets




1 Drop-off Plate
2 One-way Valve of the nitrogen vessel
3 Safety Valve of the nitrogen vessel
4 One-way Valve of the helium vessel
5 Quench Valves
6 Bursting Disc

Figure 2.2: Safety Devices of the Cryostat with 3 Helium Turrets

### Quench Valve

The quench valves (5) are the safety devices of the helium vessel. They open with a defined pressure. In case of an accidental overpressure in the helium vessel the quench valves will release the pressure smoothly.

### Safety Valve

The safety valve (3) is the safety device of the nitrogen vessel. It opens with a defined pressure. In case of an accidental overpressure in the nitrogen vessel the safety valve will release the pressure smoothly.

### Drop-off Plate

The drop-off plate (1) is a safety device of the RT vessel. If the vacuum breaks, the drop-off plate will open. In case of an accidental overpressure in the RT vessel the drop-off plate will release the pressure smoothly.

### Bursting Disc

The bursting disc (6) is another safety device of the helium vessel only at cryostats with 3 helium turrets. It opens with a defined pressure. In case of an accidental overpressure in the helium vessel the bursting disc will release the pressure. It has to be replaced after an accident.

### One-way Valves

The one-way valves of the nitrogen flow system (2) and the helium flow system (4) keep air and moisture from entering the helium or the nitrogen vessel in case of an accidental underpressure inside the vessels.

## 2.8 Behavior in Danger and Emergency Situations

**Preparations**

- Keep the emergency exits free at all times.
- Prepare and maintain an up-to-date list of emergency telephone numbers in the magnet system area.

**In Case of Emergency**

- Leave the danger zone immediately.
- Check for sufficient ventilation in the room before entering, especially if people are showing symptoms of suffocation.
- Rescue persons from the danger zone.
- Provide medical attention for people with symptoms of suffocation.
- Start first aid immediately.
- Call the responsible contact.
- Call for medical assistance.
- Call the fire department.

**First Aid for Cold Burns**

- Help the injured persons to lie down comfortably in a warm room.
- Loosen all clothing which could prevent blood circulation in the injured area.
- Pour large quantities of warm water over the affected parts.
- Cover the wound with dry and sterile gauze.
- In case of contact of liquid cryogenic agents with the eyes rinse thoroughly with clean water.
- Call for medical assistance.

## 2.9 Fire Department Notification

- Inform the fire department about the technical risks of a magnet system, like danger due to ferromagnetic rescue equipment near the magnet system.
- Laboratory windows which are accessible during an emergency should be clearly identified with warning signs, visible from the outside.
- Inform the fire department about the characteristics of a quench to prevent confusion with smoke.
- Never pour water over the magnet system during a quench!

# 3 Transportation

## 3.1 Safety

The transportation is carried out by Bruker Service or approved persons. However, it may happen that other persons have to receive the delivery of the shipping boxes. In this case it is essential to obey the instructions in this chapter and to inform these persons before.

**WARNING**

**Heavy Weights** (see page 24)

**CAUTION**

**Transportation** (see page 25)

## 3.2 Packaging

The cryostat is supplied in a wooden box on a pallet. It is secured inside with straps against tilting and moving.

Accessories such as the flow systems, level sensors and bore tubes are in the side compartment of the box.

The Magnet Stand is supplied in a wooden box on a pallet.

Figure 3.1: Packaging (without surrounding panels)

### 3.2.1 Disposal

Keep the original boxes for future transportation.

If no further transportation is planned, dispose of the boxes according to environmentally friendly regulations.

## 3.3 Transport Inspection

Investigate the delivery with regard to visible damage and completeness of delivery.

**Transport control systems**

The shipping and handling monitors (“Shock Watch“, “Tilt Watch“) on the boxes show if the boxes were kicked or tilted during transportation.

**Checks**

Shock Watch: Follow instructions on the label.

Tilt Watch: Follow instructions on the label.

**In case of damage**

- Accept delivery with reservation.
- Make a documentation of all observable damage and add it to the transportation documents.
- Start complaint process.
- Contact Bruker Service before installation.

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The claim for damage expires after the fixed period.

Thus:
Report damages to Bruker Service immediately after detection of damage. For contact information see page 9 of this document.

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## 3.4 Transportation by Fork Lift / Pallet Jack

A fork lift is recommended for transporting the boxes to the installation site.

**Approved Persons**: Approved forklift / pallet jack operator

**Precondition**: The fork lift / pallet jack must be approved for the transportation weight (refer to the supplied Sales Information).

**Transport**


Figure 3.2: Transportation by Forklift - front side

1. Check the route of transport for the minimal height and width.
2. Check sufficient floor capacity on the route of transport. In case of doubt ask a stress analyst.
3. Check sufficient carrying capacity while using an elevator.
4. Position the forks between the bars of the box as shown in the figure. Make sure the side towards the operator is the one with the labels on it.

Figure 3.3: Transportation by Forklift - rear side

5. Make sure the forks of the fork lift are longer than the box and projects out of the back of the box as shown in the figure.
6. Now lift the fork and move the box to the site.

## 3.5 Transportation with a Crane

A crane is recommended for lifting the cryostat out of the box.

**Approved Persons**: Approved crane operator

**Precondition**: The crane must be approved for the transportation weight (see **Appendix, Technical Data**).

**Attachment Points**

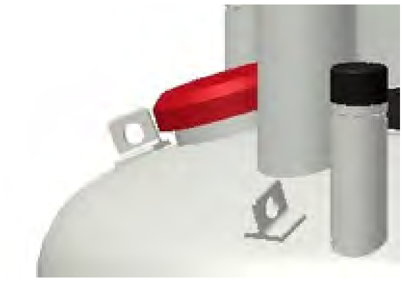

Figure 3.4: Attachment Points for Lifting Equipment

1. Exclusively use the marked eyelets as attachment points for the lifting equipment.
2. Use **all** eyelets for the lifting equipment.

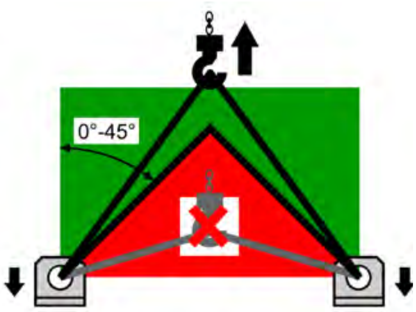


Figure 3.5: Instruction Label for Lifting Equipment

3. Follow the instructions on the label on top of the cryostat. This label gives important information about correct attachment and transportation.
4. Check for correct fastening of the lifting equipment before lifting the cryostat.
5. Make sure that any movement of the crane is as slowly as possible to avoid any damage due to acceleration.
6. Check for correct leveling of the cryostat while hanging on the crane.

## 3.6 Storing

If it is necessary to store the cryostat and accessories before installation obey the following instructions:

- Store the boxes in a closed, dry and dust-free room.
- Store the boxes upright.
- Do not tilt the boxes.
- Do not unpack the supplied boxes.
- Prevent mechanical vibrations to the boxes.
- Storage temperature: 5 - 40 °C.
- Storage humidity: less than 50% @ 23 °C.

## 3.7 Disposal

For disposal after the life cycle please contact Bruker Service for further information. For contact information see page 9 of this document.

# 4 Assembling

## 4.1 Safety

**Approved Persons: Bruker Service only**

**⚠ WARNING**

**Magnetic Field** (see page 20)

**Cryogenic Agents** (see page 21)

**Electricity** (see page 21)

**Gas under Pressure** (see page 22)

**Spontaneous Ignition and Explosion** (see page 23)

**Heavy Weights** (see page 24)

**Personal Protective Equipment**

- Protective goggles
- Protective gloves
- Protective clothes
- Safety shoes
- Portable oxygen monitor and alarm

**Necessary Tools and Equipment**

- Alignment tool 1.8 mm
- Bruker Vacuum Valve (Material No. Z53420)
- Vacuum pumping unit
- Bruker Power Supply
- Bruker ACD (Automatic Cooling Device)
- Precooling tube ("L-tube")
- Helium transfer line
- Torque wrench 5 - 50 Nm
- Clean gloves
- Ethanol
- Polyester tape
- Vacuum grease
- Screw grease MOLYKOTE P1000 (supplied with the magnet stand)

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i Check if there is sufficient free space above the cryostat to mount the bore tubes and the Helium Level Sensor.

If not sufficient, mount the cryostat according following instructions at a place with sufficient ceiling height, remove the magnet stand after assembling and transport the cryostat to the site using the transportation box.
If this is not possible, mount the magnet stand supports. For work at the bottom of the cryostat attach the magnet stand pillars. For inserting the bore tubes or the Helium Level Sensor remove the magnet stand and lower the cryostat.
Contact Bruker Service for further information.

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## 4.2 Assembling Workflow

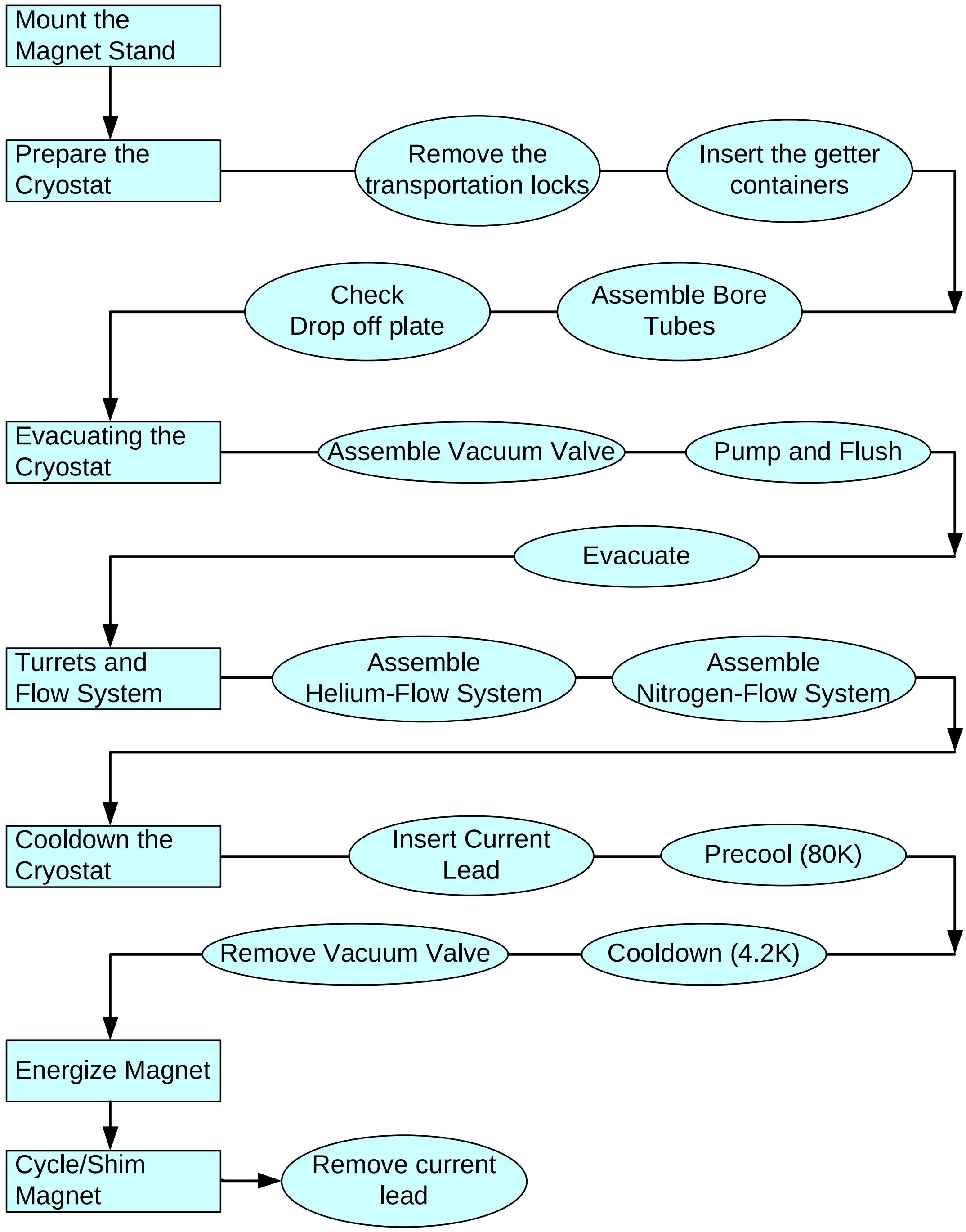



Figure 4.1: Assembling Workflow

# 4.3 Assembling Work

## 4.3.1 Preparing the Cryostat

Figure 4.2: Preparing the Cryostat

1. Remove the top and side panels of the box.
2. Loosen the fixing straps from the cryostat.
3. Lift the cryostat out of its box.

**WARNING: Heavy Weights**

4. Mount the magnet stand to the cryostat. Follow the instructions in the manual of the supplied magnet stand respecting the warnings given there.

### 4.3.1.1 Removing the Transportation Locks

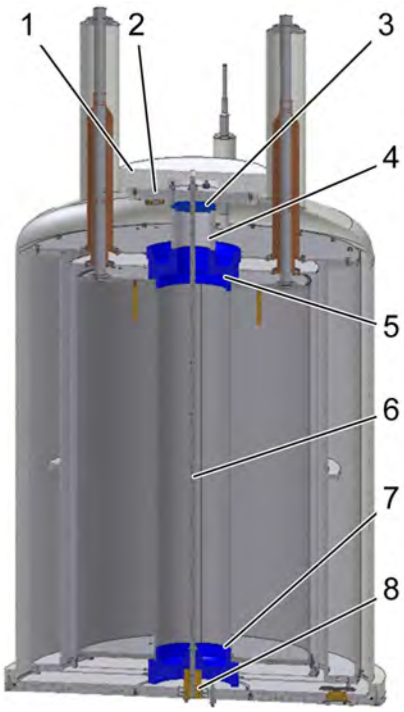
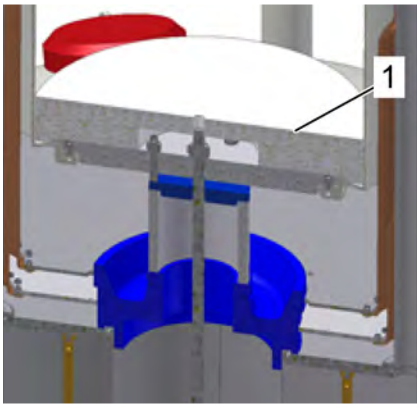



Figure 4.3: Overview Transportation Locks

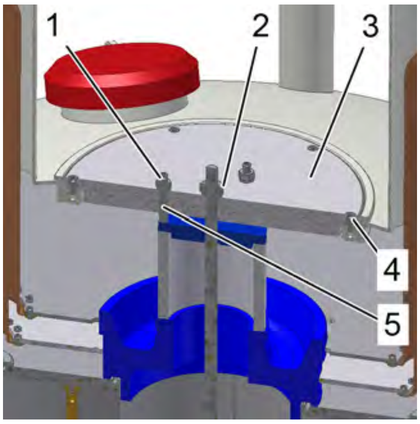
1 Protection cover
2 Transportation top plate
3 Short top fixture flange
4 Intermediate flange
5 Top fixture flange
6 Threaded bar
7 Lower fixture flange
8 Brass nut

### Removing the upper Transportation Lock



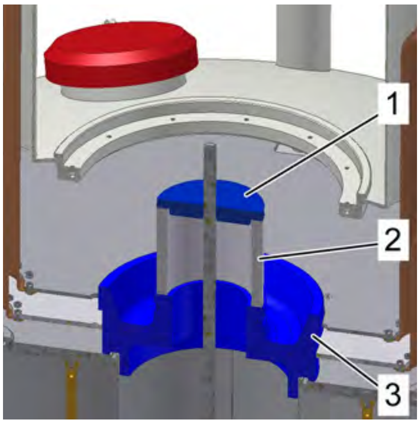

1. Remove the protection cover (1).

Figure 4.4: Removing the Transportation Lock - step 1




2. Remove the two M 12 nuts (1) and washer.
3. Release the three M 8 nuts (2).
4. Remove the three M 8 bolts (5).
5. Remove the six M 5 x 14 screws (4).
6. Remove the transportation top plate (3).

Figure 4.5: Removing the Transportation Lock - step 2




7. Remove the short top fixture flange (1).
8. Remove the intermediate flange (2).
9. Remove the top fixture flange (3).

Figure 4.6: Removing the Transportation Lock - step 3

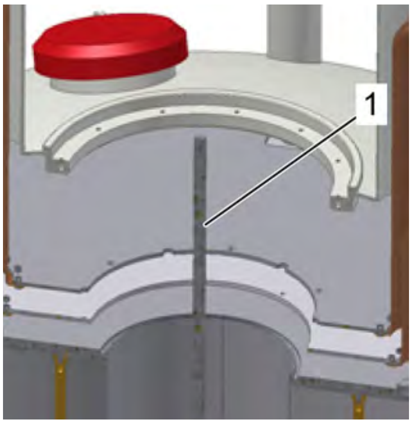



Figure 4.7: Removing the Transportation Lock - step 4

10. The threaded bar (1) remains until the lower transportation lock is removed. Afterwards remove the threaded bar from the top.

**Removing the lower Transportation Lock**

11. Remove the three M 8 nuts (2).
12. Remove the M 8 bolts (1).

**WARNING: Heavy Weights**

13. Loosen the twelve M 5 x 12 screws at the lower transportation lock plate (3). Secure the lower transportation lock plate against falling.
14. Remove the lower transportation lock plate (3), the brass nut (4) and the lower fixture flange (5).
15. Loosen the threaded bar from the brass nut (4).

Continue on top of the cryostat:

16. Remove the threaded bar from the top.

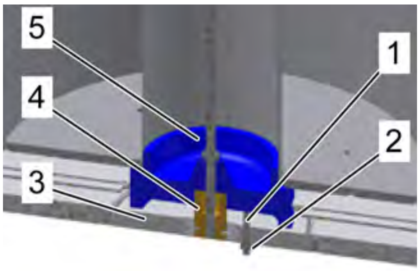



Figure 4.8: Removing the Transportation Lock - step 5

Keep all transportation lock parts for future transportation.
For storage use the compartment of the shipping box of the cryostat.

### 4.3.1.2 Mounting the Getter Container

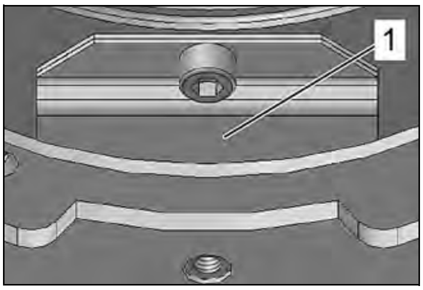



Figure 4.9: Checking the Getter Container

1. Check if the getter container (1) is:

- mounted correctly and
- not damaged.

### 4.3.1.3 Assembling the Nitrogen Tube

**Bottom of the Cryostat**

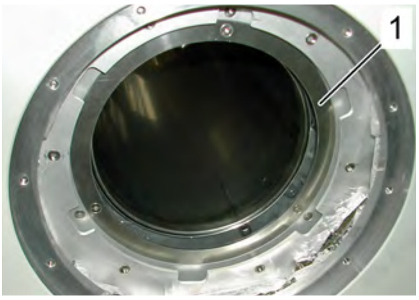



Figure 4.10: Assembling the Nitrogen Tube - step 1

1. Mount the lower RS reduction flange (1) to the radiation shield clips.

**Top of the Cryostat**


Figure 4.11: Assembling the Nitrogen Tube - step 2

2. Mount the upper RS reduction flange (1) to the radiation shield clips.

**Bottom of the Cryostat**

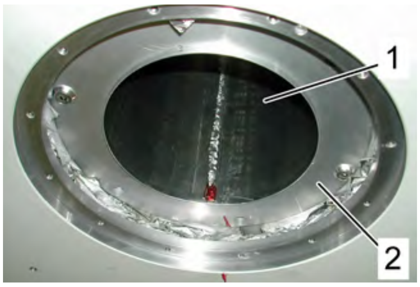



Figure 4.12: Assembling the Nitrogen Tube - step 3

3. Insert and fix the lower nitrogen contact flange (2). Be careful with the super insulation.
4. Clean the nitrogen tube with ethanol. Use clean gloves to prevent any contamination (finger prints, dirt) to the nitrogen tube surface. Handle the nitrogen tube carefully to prevent any damage (scratches, buckling).
5. Insert the nitrogen tube (1) from the top.

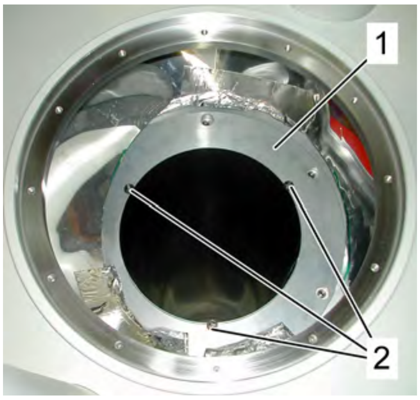

Figure 4.13: Assembling the Nitrogen Tube - step 4

6. Check the distance between the nitrogen and helium vessel by inserting the alignment tool (1) into the three check holes of the nitrogen contact flange (2). The insertion and the extraction of the alignment tool (1) should be smooth.


Figure 4.14: Assembling the Nitrogen Tube - step 5

7. If the alignment tool can not be moved smoothly, remove the nitrogen tube and the lower nitrogen contact flange and adjust the alignment with the alignment rods (1) (loosen/tighten).
8. Remount the nitrogen tube and nitrogen contact flange and check the alignment.
9. If the alignment is correct, fix the nitrogen contact flange.

**Top of the Cryostat**




10. Mount the upper nitrogen contact flange (1).
11. Adjust the distance between the nitrogen and helium vessel by inserting the alignment tool into the three check holes of the nitrogen contact flange (2).
12. Mount the nitrogen clamp ring.
13. Fix the upper nitrogen contact flange (1) and the nitrogen clamp ring.
14. Check the alignment tool (2) for free movement. Remove the alignment tool.
15. Close the cuts of the super insulation with polyester tape without taping the insulation to other surfaces.

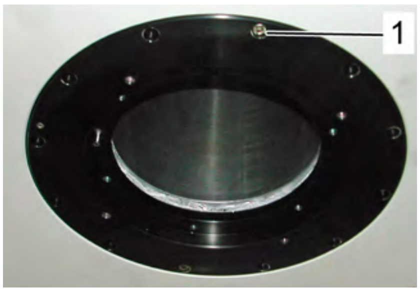
Figure 4.15: Assembling the Nitrogen Tube - step 6

### 4.3.1.4 Assembling the RT Tube

**Bottom of the Cryostat**


1. Check the O-ring slot (1) of the bottom RT reduction flange.
2. Remove scratches, if necessary.
3. Clean the O-ring slot with ethanol.
4. Clean the O-ring with ethanol.
5. Grease the O-ring with vacuum grease and place it into the O-ring slot. Prevent contamination with dust and dirt.

Figure 4.16: Assembling the RT Tube - step 1




6. Grease the twelve M 5 x 12 screws (1) with screw grease.
7. Insert the bottom RT reduction flange. Check the index: the bottom RT reduction flange can be inserted in only one position.
8. Fix the bottom RT reduction flange with the twelve screws (torque 12 Nm).

Figure 4.17: Assembling the RT Tube - step 2

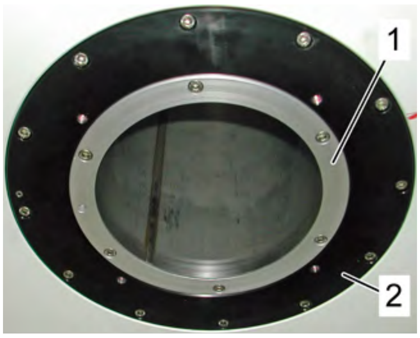



Figure 4.18: Assembling the RT Tube - step 3

9. Check the alignment of the nitrogen tube and the bottom RT reduction flange with a view through the nitrogen tube from the top. If the alignment is not correct, remove the bottom RT reduction flange and adjust the alignment with the three alignment rods (loosen/tighten).
10. Insert the bottom RT closure flange (1) to the RT reduction flange (2) without the O-ring. Check the index: the bottom RT closure flange can be inserted in only one position.
11. Fix it with only three of the six M 5 x 12 screws.

Figure 4.19: Assembling the RT Tube - step 4

12. Clean the RT tube with ethanol. Use clean gloves to prevent any contamination (finger prints, dirt) to the RT tube surface. Handle the RT tube carefully to prevent any damage (scratches, buckling).
13. Insert the RT tube from the top.
    ● In case the RT tube is insulated handle it carefully and prevent damage to the insulation.
    ● In case the RT tube is not symmetrically respect the correct position. Align the marks at the inner side of the RT tube with the mark at upper RT reduction flange. Refer to the supplied manual of this RT tube for further information.

**Bottom of the Cryostat**

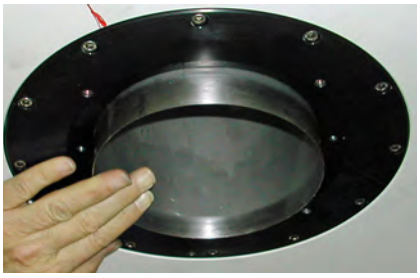


Figure 4.20: Assembling the RT Tube - step 5

14. Clean the O-ring of the bottom RT closure flange with ethanol.
15. Grease the O-ring with vacuum grease.
16. Carefully remove the bottom RT closure flange. Secure the RT bore tube against falling.
17. Check the O-ring slot at the bottom RT closure flange and clean it with ethanol. Remove scratches if necessary.

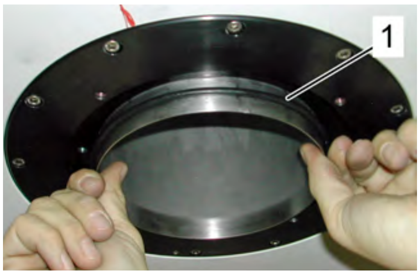



Figure 4.21: Assembling the RT Tube - step 6

18. Mount the O-ring (1) to the RT tube.

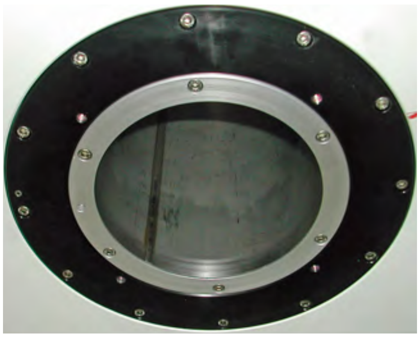


Figure 4.22: Assembling the RT Tube - step 7

19. Grease six M 5 x 12 screws with screw grease.
20. Mount the bottom RT closure flange to the end of the RT tube. Push the RT closure flange with the RT tube inside the cryostat. Check the index: the bottom RT closure flange can be inserted in only one position.
21. Fix the bottom RT closure flange with the six screws (torque 12 Nm).

### Top of the Cryostat

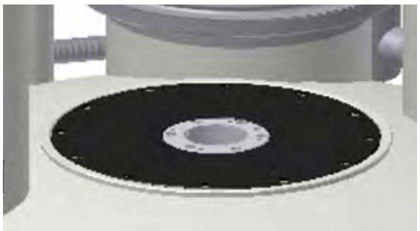


Figure 4.23: Assembling the RT Tube - step 8

22. Grease twelve M 5 x 12 screws with screw grease.
23. Fix the upper RT reduction flange with the twelve M 5 x 12 screws (torque 12 Nm). Respect the correct position of the upper RT reduction flange if an eccentrically upper RT reduction flange was used. Align the marks at the RT vessel and the upper RT reduction flange.
24. Grease six M 5 x 12 screws with screw grease.
25. Fix the upper RT closure flange with the six M 5 x 12 screws (torque 12 Nm).

### 4.3.1.5 Checking and Fitting the Drop-off Plate

Figure 4.24: Checking and fitting the Drop-off Plate

1. Open the drop-off plate.
2. Clean the flange of the RT vessel and the O-ring with ethanol.
3. Grease the O-ring with vacuum grease.
4. Close the drop-off plate.
5. Check the drop-off plate is assembled correctly.

## 4.3.2 Evacuating the Cryostat

For evacuating the cryostat use the Bruker Vacuum Valve, Material No. Z53420.

**i** Be careful handling the Vacuum Valve. Tilting of the Vacuum Valve during insertion may damage the O-ring or required edges and surfaces of the Vacuum Valve. Thus pay attention to the axis during insertion of the Vacuum Valve.

### 4.3.2.1 Mounting the Vacuum Valve

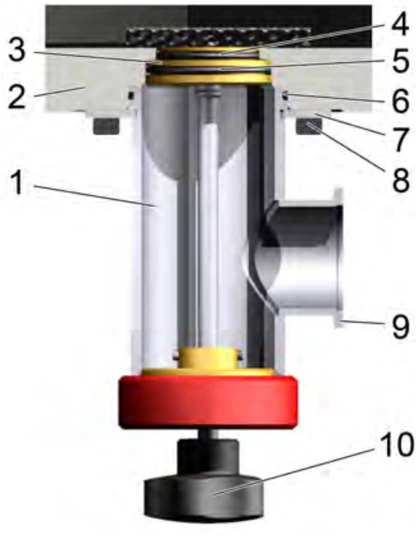


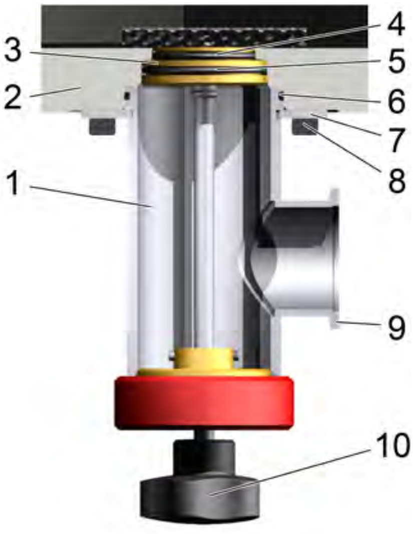


Figure 4.25: Mounting the Vacuum Valve

1. Remove the protection cap of the vacuum flange at the bottom plate (2) of the cryostat.
2. Install the valve stem (10) onto the sealing plug (3) and tighten it slightly. Do not fix the valve body (1) to the cryostat yet.
3. Pull out the sealing plug (3) off the bottom plate at the valve stem (10).
4. Clean the sealing plug.
5. Check the sealing plug and the O-rings for damage.
   Replace damaged O-rings.
   - (4) O-ring 36.14 x 2.5 (Material No. 40692)
   - (5) O-ring 44 x 2.5 (Material No. 40693)
   - (6) O-ring 57 x 2.5 (Material No. 40695)
6. Grease the O-rings with vacuum grease.
7. Pull out the valve stem (10) of the valve body (1) until it snaps into place. The snapping is well defined and will be heard and felt.
8. Check if the sealing plug (3) inside the valve body is fully inserted.
9. Insert the Vacuum Valve into its seat inside the bottom plate (2).
10. Turn the Vacuum Valve in the desired position (KF 40 flange (9) looking outwards).
11. Insert the two half rings (7) as shown into the slots of the valve body (1).
12. Fix the two half rings (7) each with two M 6 x 12 screws (8).

### 4.3.2.2 Mounting the Vacuum Valve at the Evacuated Cryostat

The sealing plug can not be moved until a correct vacuum was applied at the KF 40 flange at the Vacuum Valve.




1. Remove the protection cap of the vacuum flange at the bottom plate (2) of the cryostat.
2. Install the valve stem (10) onto the sealing plug (3) and tighten it slightly.
3. Turn the Vacuum Valve in the desired position (KF 40 flange (9) looking outwards).
4. Insert the two half rings (7) as shown into the slots of the valve body (1).
5. Fix the two half rings (7) each with two M 6 x 12 screws (8).

Figure 4.26: Mounting the Vacuum Valve at the evacuated cryostat

#### 4.3.2.3 Generating Vacuum

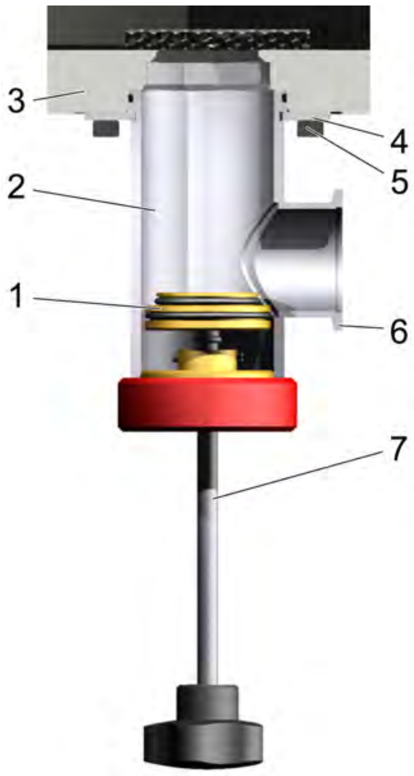



Figure 4.27: Generating Vacuum

1. Connect the vacuum pumping unit with the KF connector to the KF 40 flange (6) of the Vacuum Valve (2). Use a short pump line with large diameter.
2. Pull out the valve stem (7) of the valve body (2) to release the sealing plug (1) out of the bottom plate (3).
   The sealing plug (1) snaps into place. The snapping is well defined and will be heard and felt. The cryostat is open after this procedure.
3. Pump and flush five times with dry nitrogen gas (only necessary for generating vacuum for the first time).
4. Generate a vacuum of $10^{-1}$ mbar with the roughing pump.
5. Generate a vacuum of less than
   $5 \times 10^{-5}$ mbar with a turbo pump (up to 48 hours).
6. Operate the pumping unit until filling with liquid helium starts, respectively until the magnet inside is at a temperature of 77 K.
7. At the end of the helium filling procedure push the valve stem (7) slightly and fully into the valve body (2) to insert the sealing plug (1) in the vacuum flange at the bottom plate (3).
   The sealing plug (1) snaps in. The snapping is well defined and will be heard and felt.
8. Stop pumping.

### 4.3.2.4 Rebuilding Vacuum

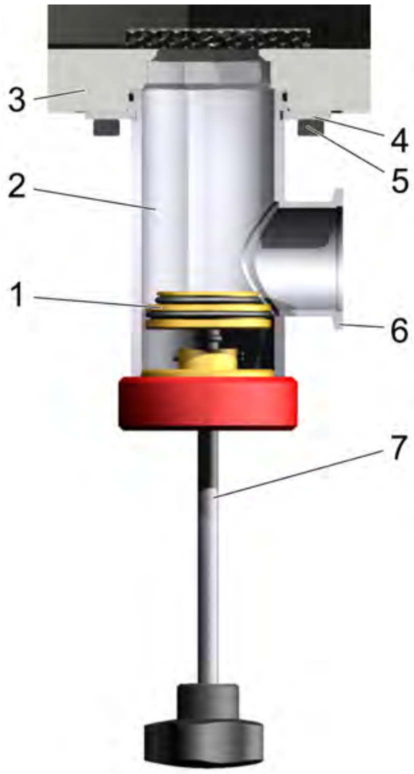



Figure 4.28: Rebuilding Vacuum

1. Connect the vacuum pumping unit to the KF 40 flange (6) of the Vacuum Valve (2). Use a short pump line with large diameter.
2. Generate a vacuum of $10^{-1}$ mbar with the roughing pump.
3. Generate a vacuum of less than $5 \times 10^{-5}$ mbar with a turbo pump.
4. Pull out the valve stem (7) of the valve body (2) to release the sealing plug (1) out of the bottom plate (3).
   The sealing plug (1) snaps into place. The snapping is well defined and will be heard and felt. The cryostat is open after this procedure.
5. Continue generating a vacuum of less than $5 \times 10^{-5}$ mbar (up to 48 hours).
6. Push the valve stem (7) slightly and fully into the valve body (2) to insert the sealing plug (1) into the bottom plate (3).
   The sealing plug (1) snaps in. The snapping is well defined and will be heard and felt.
7. Stop pumping.

### 4.3.2.5 Removing the Vacuum Valve

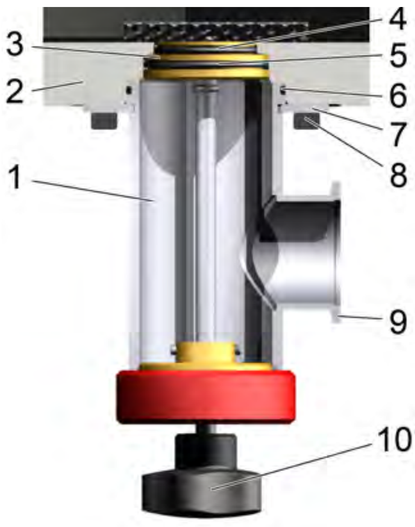



Figure 4.29: Removing the Vacuum Valve

1. Ventilate the pump line at the pumping unit.
2. Remove the pump line at the KF 40 flange (9).
3. Release the valve stem (10) from the sealing plug (3) and pull out the valve stem (10) until it snaps in.
   The snapping is well defined and will be heard and felt.
4. Remove the four M 6 x 12 screws (8) from the two half rings (7).
5. Remove the two half rings (7) and the Vacuum Valve (1).
6. Mount the protective cap on the vacuum flange at the bottom plate (2) of the cryostat.

## 4.3.3 Mounting the Flow Systems

### 4.3.3.1 Mounting the Helium Level Sensor


Figure 4.30: Mounting the Helium Level Sensor - step 1

1. Clean the O-ring (1) of the helium fill-in turret with ethanol.
2. Grease the O-ring (1) with vacuum grease.
3. Clean the sealing surface for the O-ring.
4. Mount the O-ring (1) into the sealing surface.

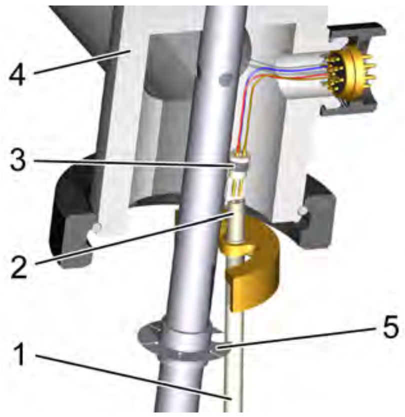



Figure 4.31: Mounting the Helium Level Sensor - step 2

5. Insert the Helium Level Sensor (1). Make sure the Helium Level Sensor is inserted into the correct hole of the siphon.
6. Connect the connector (2) of the Helium Level Sensor (1) with the connector (3) of the helium flow system (4).
7. Insert the Helium Level Sensor (1) into the gap of the baffles (5) and insert the assembly into the helium fill-in turret.

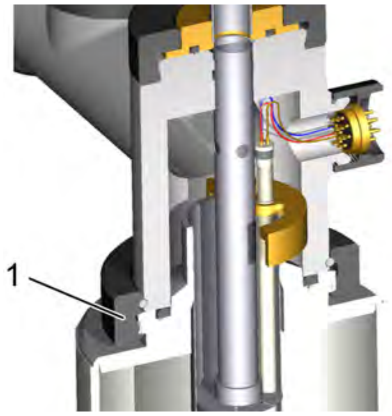



Figure 4.32: Mounting the Helium Level Sensor - step 3

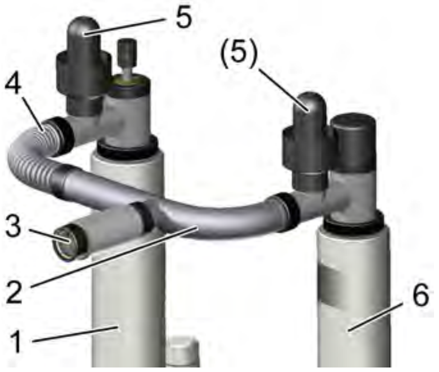
8. Fix the black nut (1).
9. Calibrate the Helium Level Sensor in the MICS. Refer to the MICS manual.

### 4.3.3.2 Mounting the Helium Flow System


1. Clean the O-ring of the current lead turret (1) with ethanol.
2. Grease the O-ring (1) with vacuum grease.
3. Clean the sealing surface for the O-ring.
4. Mount the O-ring (1) into the sealing surface.

Figure 4.33: Mounting the Helium Flow System - step 1

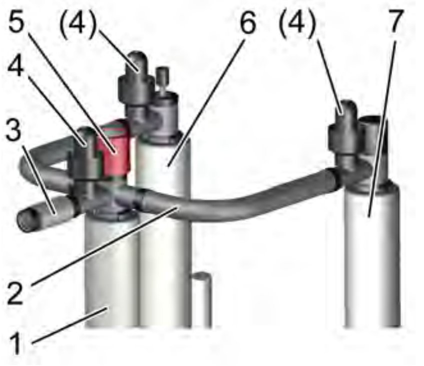
**Cryostat with 2 helium turrets:**




1. Mount the Helium Flow System (2) as shown with the one-way valve (3) showing backwards and the flexible side (4) at the helium fill-in turret (1).
2. Check the correct position of the globes in the quench valves (5) of the helium fill-in turret (1) and the current lead turret (6).
3. If supplied mount the Atmospheric Pressure Device according to its manual.

Figure 4.34: Mounting the Helium Flow System - 2 helium turrets

**Cryostat with 3 helium turrets:**




1. Mount the Helium Flow System (2) as shown with the one-way valve (3) showing backwards.
2. Mount the bursting disc (5) on top of the current lead turret (1).
3. Check the correct position of the globes in the quench valves (4) of the helium fill-in turret (6), the current lead turret (1) and the high current lead turret (7).
4. If supplied mount the Atmospheric Pressure Device according to its manual.

Figure 4.35: Mounting the Helium Flow System - 3 helium turrets

### 4.3.3.3 Removing the Nitrogen Vessel Transportation Lock

**Only for cryostats with 3 helium turrets.**

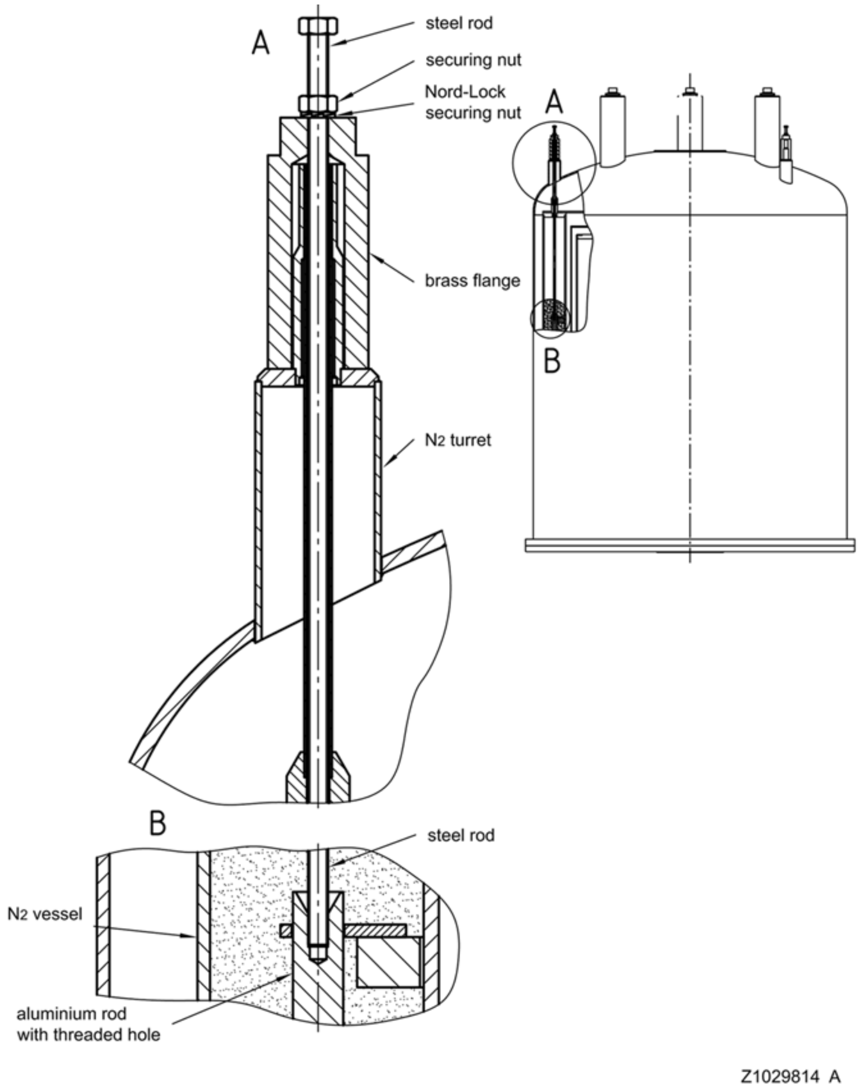
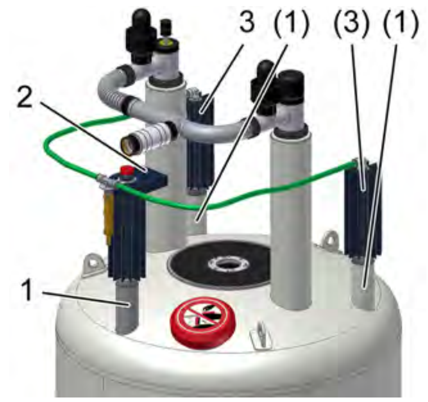



Figure 4.36: Removing the Nitrogen Vessel Transportation Lock - general view

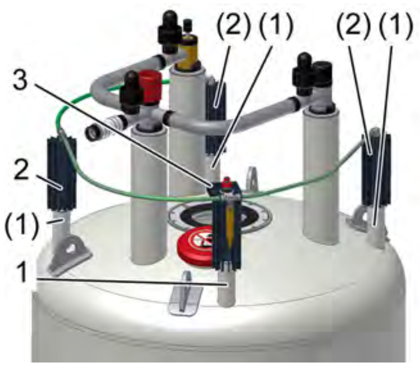
1. Loosen the securing nut.
2. Remove the steel rod.
3. Remove the brass flange
4. Keep all transportation lock parts for future transportation.
   For storage use the compartment of the transportation box of the cryostat.

### 4.3.3.4 Mounting the Nitrogen Flow System




1. Insert Nitrogen Level Sensor (2) into the rear nitrogen turret (1).
2. Mount the heat exchangers (3) to the other nitrogen turrets (1) as shown.

Figure 4.37: Mounting the Nitrogen Flow System - 2 helium turrets - step 1

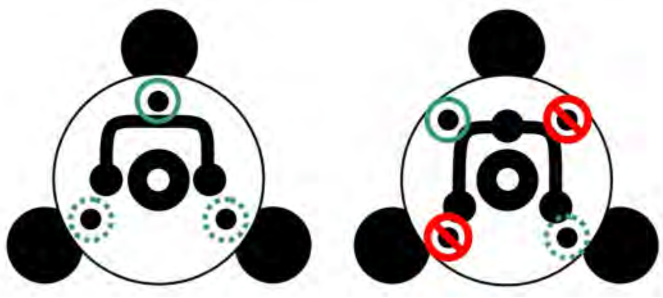



1. Insert Nitrogen Level Sensor (3) into the rear left nitrogen turret (1).
2. Mount the heat exchangers (2) to the other nitrogen turrets (1) as shown.

Figure 4.38: Mounting the Nitrogen Flow System - 3 helium turrets - step 1

---

ℹ The Nitrogen Level Sensor is inserted in the recommended nitrogen turret (green solid line).
However it might be necessary (like site restrictions) to insert the Nitrogen Level Sensor in another nitrogen turret. In that case consider the following restrictions:
green dotted line: alternative position; red crossed out: forbidden position



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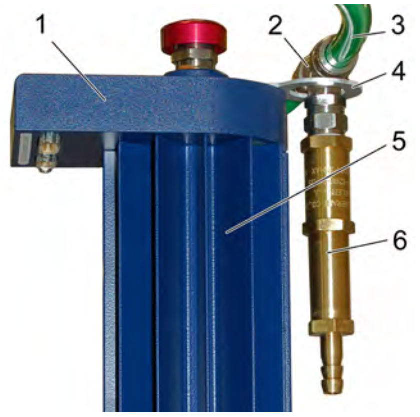


Figure 4.39: Mounting the Nitrogen Flow System - step 2

3. Insert the green tubes (3) into the connectors on top of the heat exchangers (5) and the connector at the one-way valve (2).
4. Insert the one-way valve (6) into the support (4) of the Nitrogen Level Sensor (1).

### 4.3.4 Cooling down from 300 K to 80 K

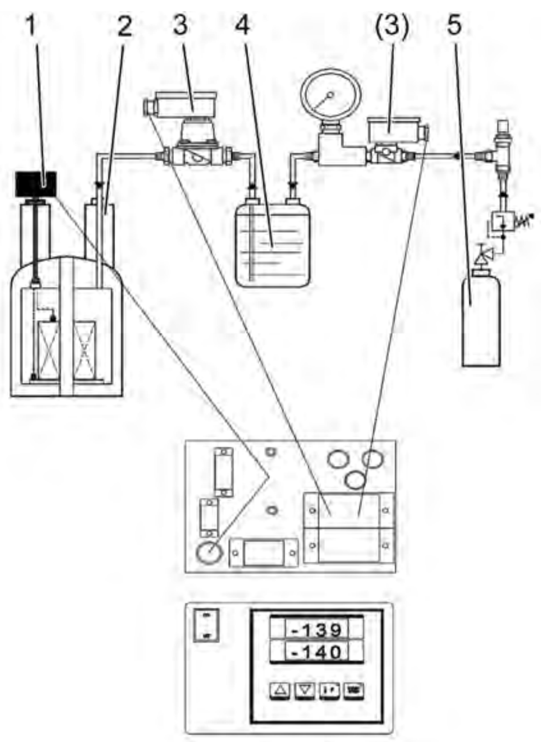
**WARNING**

**Cryogenic Agents** (see page 21)

**Gas under Pressure** (see page 22)

**Preconditions**

- Magnet stand mounted (refer to the manual of the magnet stand).
- Helium flow system mounted (see chapter **"Mounting the Helium Flow System" on page 54**) and Helium Level Sensor operating.
- Nitrogen flow system mounted (see chapter **"Mounting the Nitrogen Flow System" on page 56**) and Nitrogen Level Sensor operating.
- Vacuum pumping unit is connected; cryostat is evacuated with vacuum less than 5 x $10^{-5}$ mbar.
- Pressure cylinder with sufficient dry and warm nitrogen gas.
- ACD (Automatic Cooling Device) mounted on a transportation dewar with sufficient liquid nitrogen.




1 Current lead turret
2 Helium fill-in turret
3 ACD (Automatic Cooling Device)
4 Transportation dewar with liquid nitrogen
5 Pressure cylinder with warm nitrogen gas

Figure 4.40: Assembly for cooling down from 300 K to 80 K with ACD

**Procedure precooling the helium vessel**

1. Check the correct setting of the globes inside the quench valves.
2. Check the helium flow system is mounted correctly.
3. Check the one-way valve is mounted.
4. Remove the plug out of the turret cap of the helium fill-in turret (right turret)
5. Insert the auxiliary shorting plug into the helium fill-in turret.
6. Remove the turret cap of the current lead turret (left turret).
7. Remove the shorting plug out of the current lead turret using the shorting plug tool.
8. Insert the current lead into the current lead turret respecting the correct position. The current lead can only be inserted in one position.
9. Remove the auxiliary shorting plug out of the helium fill-in turret.
10. Close the turret cap of the helium fill-in turret with the plug.
11. Connect the ACD with the current lead.
12. Connect the current lead to the Bruker Power Supply.
13. Check the resistance of the magnet coils and shims at room temperature (see **Appendix Technical Data**).
14. Check the temperature of the lower and upper PT100 temperature sensor (see **Appendix Technical Data**).
15. Check the zero reading of the Helium Level Sensor.
16. Check the connection between the PT100 connector at the current lead and the ACD. The display of the ACD must show approximately room temperature (~293 K).
17. Remove the plug on top of the helium fill-in turret.
18. Insert the precooling tube into the helium fill-in turret carefully. Check the precooling tube is completely inserted. Check the O-ring sealing the precooling tube properly.
19. Connect the precooling tube with the pressure cylinder with nitrogen gas.
20. Pump and flush the helium vessel several times at room temperature with nitrogen gas to make sure that the helium vessel is dry before cooling down.
21. Connect the precooling tube with the liquid nitrogen transportation dewar.
22. Adjust the pressure of the liquid nitrogen transportation dewar to 0.2 - 0.3 bar.

    ➪ Liquid nitrogen transfer starts.

---

**i** Precooling with liquid nitrogen reduces the consumption of liquid helium during cooling down.

---

**i** Time for cooling down to 80 K with liquid nitrogen will take 18 to 24 hours.

---

23. Check the two PT100 temperature sensors for monitoring the cooling down are operating (decreasing values).
24. The ACD will stop the liquid nitrogen transfer automatically at a temperature of 80 K to prevent the accumulation of liquid nitrogen inside the helium vessel. The magnet's temperature monitored with the two PT100 temperature sensors should be between 80 K and 90 K.

**In case of cooling down without ACD:**
- connect the two PT 100 temperature sensors to a measuring device (not supplied)
- check the PT 100 temperature sensor: temperature difference between the upper and lower temperature sensor maximal 25 K. Adjust the cooling speed with the liquid nitrogen flow.
- stop liquid nitrogen transfer at a temperature of 80 K at the lower PT 100 temperature sensor.

25. Switch off the ACD and remove the connection to the liquid nitrogen transportation dewar at the precooling tube.
26. Remove the one-way valve from the helium flow system and connect the pressure cylinder with nitrogen gas to the helium flow system.
27. Blow in nitrogen gas with a pressure of 100 - 150 mbar and check if liquid nitrogen spills out of the precooling tube. In case of liquid nitrogen spilling out warm up the vessel to 90 K to make sure that no liquid nitrogen is left inside the helium vessel.
28. Check the temperature of the PT100 temperature sensors.
29. Remove the pressure cylinder with nitrogen gas at the helium flow system and remount the one-way valve.
30. Remove the precooling tube from the helium fill-in turret.
31. Close the helium fill-in turret immediately with the plug.

Keep the helium flow system closed at all times if the cryostat is below room temperature to prevent moisture entering the helium vessel. If necessary open the helium flow system as short as possible. Do not open both helium turrets simultaneously.

**Procedure cooling down the nitrogen vessel**

1. Check the correct installation of the nitrogen flow system.
2. Fill the nitrogen vessel with liquid nitrogen according to the Bruker Refilling Procedure respecting the warnings and instructions given there.
3. Write down the filling data (see **Appendix, Technical Data** or MICS).

### 4.3.5 Cooling down to 4.2 K

**Preconditions**

- Helium vessel filled with nitrogen gas.
- Nitrogen vessel filled with liquid nitrogen.
- Current lead inserted into the current lead turret.
- Bruker Power Supply connected to the current lead.
- Upper and lower PT100 temperature sensors show 80 - 90 K.
- Vacuum pumping unit is connected; cryostat evacuated with vacuum less than 5 x $10^{-5}$ mbar.
- Pressure cylinder with sufficient dry and warm helium gas ready.
- Transportation dewar with sufficient liquid helium ready.

**Procedure**

1. Remove the one-way valve of the helium flow system and connect the pressure cylinder with helium gas to the helium flow system.
2. Pump and flush the helium vessel in five steps to replace the cold nitrogen gas in the helium vessel with dry helium gas:
   - Pump the helium vessel in five steps to reach the following pressures:
     800 mbar, 500 mbar, 300 mbar, 100 mbar, <10 mbar.
   - After each pumping step flush with dry helium gas until the quench valves open.
   - Use short flushing times!
3. Remount the one-way valve at the helium flow system. If available connect a helium recovery system.
4. Check the zero reading of the Helium Level Sensor.
5. Insert the transportation dewar side of the helium transfer line into the helium transportation dewar slowly. Fast insertion of the warm transfer line causes evaporation of helium and may cause overpressure inside the transportation dewar.
6. Allow the transfer line to cool down until liquid helium is coming out at the open end of the transfer line, looking like a bluish flame.
7. Insert the magnet side of the helium transfer line completely into the helium fill-in turret.
8. Adjust a pressure of 50 - 100 mbar at the helium transportation dewar.

   ➪ Liquid helium transfer starts.

---

**i** Time for cooling down to 4.2 K with helium will take 4 to 6 hours.

---

9. Use the IBT temperature sensor to monitor the cooling down (see **Appendix Technical Data**).
10. Stop the helium transfer at a helium level of 100 % at the Helium Level Sensor and 4.2 K at the IBT temperature sensor.
11. Remove the pumping unit and the Vacuum Valve (refer to **"Removing the Vacuum Valve" on page 52**).

---

i If the magnet system will be energized during the next 24 h, the current lead can remain in the current lead turret. Otherwise continue.

---

12. Remove the plug out of the turret cap of the helium fill-in turret.
13. Insert the auxiliary shorting plug into the helium fill-in turret.
14. Remove the current lead out of the current lead turret.
15. Insert the shorting plug into the current lead turret with the shorting plug tool respecting the correct position. The shorting plug can only be inserted in one position.
16. Close the current lead turret with the baffle tube, O-ring and screw cap.
17. Remove the auxiliary shorting plug out of the helium fill-in turret.
18. Close the helium fill-in turret immediately with the plug of the turret cap.
19. Write down the filling data (see **Appendix, Technical Data** or MICS).

# 5 Operation

## 5.1 Safety

**Approved Persons**

Bruker Service, Approved Customer Personnel

**⚠ WARNING**

**Magnetic Field** (see page 20)

**Cryogenic Agents** (see page 21)

**Electricity** (see page 21)

**Gas under Pressure** (see page 22)

**Personal Protective Equipment**

- Protective goggles
- Protective gloves
- Safety shoes
- Portable oxygen monitor and alarm

**Necessary Tools and Equipment**

- Bruker Power Supply
- Auxiliary Shorting Plug
- Current Lead
- Shorting Plug Tool
- High Current Lead (recommended for magnet systems with 3 helium turrets only)
- DNP sweep current lead (recommended for DNP configuration only)
- DNP sweep current lead mounting device (recommended for DNP configuration only)

## 5.2 Energizing

**Precondition**

- Cryostat at 4.2 K for at least 12 hours.
- Helium level at the Helium Level Sensor is above the "minimum level during energizing" (see **Appendix Technical Data**, Figure A.4: Helium Level Graph of the supplied User Manual).
- Both PT 100 temperature sensors show the same set value.

### 5.2.1 Inserting the Current Lead

1. Prepare the Bruker Power Supply and main power cable.
2. Remove the plug out of the turret cap of the helium fill-in turret.
3. Insert the auxiliary shorting plug into the helium fill-in turret.
4. Remove the shorting plug out of the current lead turret with the shorting plug tool.
5. Insert the dry warm current lead into the current lead turret respecting the correct position. The current lead can only be inserted in one position.

**For NMR magnet systems with 3 helium turrets:**

6. Remove the shorting plug out of the high current lead turret with the shorting plug tool.
7. Insert the dry high current lead into the high current lead turret.

**For all NMR magnet systems:**

8. Connect the main power cable and control cables of the Bruker Power Supply with the current lead.
9. Connect the short circuit cable to the main power cable until energizing.
10. Remove the auxiliary shorting plug out of the helium fill-in turret.
11. Close the helium fill-in turret with the plug of the turret cap.
12. Switch the Bruker Power Supply ON.

### 5.2.2 Energizing Procedure

1. Check the helium level is above "minimum level during energizing" (see **Appendix Technical Data**, Figure A.4: Helium Level Graph of the supplied User Manual) regularly during energizing. Refill the helium vessel if necessary.
2. Check the settings (current and inductivity) of the Bruker Power Supply:<br>- Check the main heater current. The current of the main heater must be the same for the magnet coil and the Bruker Power Supply.<br>- Check the shim heater current. The current of the shim heater must be the same for the shim heater and the Bruker Power Supply.

3. Make the main coil heater switch test.
4. Open the main coil heater switch.
5. Start the shim heater automatic.
6. Switch the $Z^2$-Shim heater ON.
7. Set the sense voltage to the first value of the energizing assignment (see **Appendix Technical Data** of the supplied User Manual).
8. Set the current to the first value of the energizing assignment (see **Appendix Technical Data** of the supplied User Manual).
9. Wait until the sense current at the Bruker Power Supply is 0 V.
10. Continue in the same way with the other values and the overshoot of the energizing assignment.
11. Check the sense voltage is exactly 0 V for 5 seconds.
12. Close the main coil heater switch.

Wait 5 minutes.

➪ Main coil heater switch is closed. Main coil is now persistent.

13. Set the current to 0 A at the Bruker Power Supply.
14. Wait until the Bruker Power Supply shows 0 A.
15. Remove the main power cable from the Bruker Power Supply and short-circuit it.
16. The shim automatic must remain switched ON for 12 h after energizing.

Recommended for magnet systems of 500 MHz and more: Continue with cycling, see chapter **”Cycling Procedure” on page 5-66**.

**Interrupt Energizing**

1. Set the current of the Bruker Power Supply to the value of the coil current.
2. Wait until the voltage is 0 V.
3. Close the main heater switch.

Wait 5 minutes.

➪ Main heater switch is closed. Main coil is now persistent.

**Continue Energizing**

1. Set the current of the Bruker Power Supply to the value of the coil current. Wait until the current of the Bruker Power Supply is reached.
2. Open the main heater switch.
3. Set sense voltage to 30 mV.
4. Shim heater automatic: $Z^2$ heater ON.
5. Continue according to the energizing assignment.

### 5.2.3 Cycling Procedure

ℹ Cycling only recommended for magnet systems of 500 MHz and more.

1. Check the time between energizing and cycling (see **Appendix Technical Data** of the supplied User Manual).
2. Check the helium level is above "minimum level during energizing" (see **Appendix Technical Data**, Figure A.4: Helium Level Graph of the supplied User Manual). Refill the helium vessel if necessary.
3. Cycle all Z shims with currents according the cycling assignment (see **Appendix Technical Data** of the supplied User Manual).
4. Allow the shims 2 minutes to hold these currents.
5. Discharge shims.
6. After energizing/de-energizing the shims at least two times start the shim automatic.
7. Stop shim automatic if procedure has been completed.

Continue with shimming, see chapter **”Shimming Procedure” on page 5-66**.

### 5.2.4 Shimming Procedure

1. Check the time between cycling was at least 12 hours.
2. Check the settings (current and inductivity) of the Bruker Power Supply. The current must be the same for the shim coil and the Bruker Power Supply.
3. Switch the shim heater ON.
4. Wait 5 seconds (default setting of the Bruker Power Supply).
5. Set the shim currents according to the shimming assignment (see **Appendix Technical Data** of the supplied User Manual).
6. Wait until the current is reached.
7. Leave the shim heater open for 1 minute with the correct shim current before closing it.
8. Switch the shim heater OFF.
9. Wait 5 seconds (default setting of the Bruker Power Supply).
10. Set the current to 0 A.
11. Wait until the supply current is 0 A.
12. Continue in the same way with all shims.

## 5.2.5 Removing the Current Lead

**For NMR magnet systems with 2 helium turrets:**

1. Check the helium level is above "minimum level during energizing" (see **Appendix Technical Data**, Figure A.4: Helium Level Graph of the supplied User Manual). Refill the helium vessel if necessary.
2. Insert the auxiliary shorting plug into the helium fill-in turret.
3. Check the current at all Bruker Power Supply cables is 0 A.
4. Switch the Bruker Power Supply OFF.
5. Remove all cables from the current lead.
6. Remove the current lead as quickly as possible.
7. Insert the dry warm shorting plug with the shorting plug tool into the current lead turret respecting the correct position. The shorting plug can only be inserted in one position.
8. Close the current lead turret with the turret cap. Be careful with the baffles.
9. Remove the auxiliary shorting plug out of the helium fill-in turret.
10. Close the helium fill-in turret immediately with the plug of the turret cap.

**For NMR magnet systems with 3 turrets:**

1. Check the helium level is above "minimum level during energizing" (see **Appendix Technical Data**, Figure A.4: Helium Level Graph of the supplied User Manual). Refill the helium vessel if necessary.
2. Insert the auxiliary shorting plug into the helium fill-in turret.
3. Check the current at all Bruker Power Supply cables is 0 A.
4. Switch the Bruker Power Supply OFF.
5. Remove all cables from the current lead.
6. Remove the current lead as quickly as possible.
7. Insert the dry warm shorting plug with the shorting plug tool into the current lead turret respecting the correct position. The shorting plug can only be inserted in one position.
8. Close the current lead turret with the turret cap. Be careful with the baffles.
9. Remove the high current lead as quickly as possible.
10. Insert the shorting plug into the high current lead turret with the shorting plug tool.
11. Close the high current lead turret with the turret cap.
12. Remove the auxiliary shorting plug out of the helium fill-in turret.
13. Close the helium fill-in turret immediately with the plug of the turret cap.

**For magnet systems with DNP configuration:**

1. Check the helium level is above "minimum level during energizing" (see **Appendix Technical Data**, Figure A.4: Helium Level Graph of the supplied User Manual). Refill the helium vessel if necessary.
2. Insert the auxiliary shorting plug into the helium fill-in turret.
3. Check the current at all Bruker Power Supply cables is 0 A.
4. Switch the Bruker Power Supply OFF.
5. Remove all cables from the current lead.
6. Remove the current lead as quickly as possible.
7. Insert the dry warm sweep current lead with the sweep current lead mounting device into the current lead turret (1) respecting the correct position. The sweep current lead can only be inserted in one position.
8. Remove the sweep current lead mounting device.
9. Insert the connector (5) with the cable (3) of the sweep current lead into the baffle tube (2).
10. Insert the baffle tube (2) into the current lead turret (1). Be careful with the cable (3).
11. Connect the connector (5) from the sweep current lead with the connector (4) of the turret cap (7).
12. Mount the turret cap (7) on top of the current lead turret (1).
13. Fix the turret cap (7) with the black nut (8) with the socket (6) showing outwards.

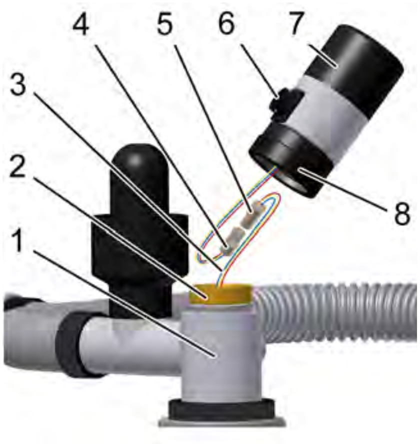



Figure 5.1: Mounting the Sweep Current Lead (DNP only)

14. Connect the sweep current lead at the socket (6) to the Sweep Power Supply with the supplied cable.
15. Remove the auxiliary shorting plug out of the helium fill-in turret.
16. Close the helium fill-in turret immediately with the plug of the turret cap.
17. Check the settings of the Sweep Power Supply (see **Appendix Technical Data,** Table A.19 of the supplied User Manual) and according to the site restrictions. If not correct refer to the supplied manual of the Sweep Power Supply.

## 5.2.6 Complete Energizing

1. Refill helium to a minimum value of 95% at the Helium Level Sensor.
2. Check the helium and nitrogen flow system are mounted correctly.

## 5.3 Sweep Procedure (DNP only)

1. Check the settings of the Sweep Power Supply (see **Appendix Technical Data**, Table A.15 of the supplied User Manual). If necessary change settings (refer to the supplied manual of the Sweep Power Supply).
2. Set the output current at the Sweep Power Supply to 0 A.

**WARNING**

**Risk of a quench (see page 20) if currents at the Sweep Power Supply and sweep coil are different.**

If the output currents at the Sweep Power Supply and the set current of the sweep coil are different a quench can occur during heating the persistent switch heater.

Thus:

- Save the set output current to an applicable file for the next sweep procedure (0 A if first energizing).
- Check the set output current and adjust it if necessary.

3. Switch the persistent switch heater ON.
4. Wait until the persistent switch heater delay is over.
5. Set the necessary output current.
6. Wait until the output current is reached.
7. Leave the sweep coil switch open until the persistent switch heater delay is over.
8. Switch the persistent switch heater OFF.
9. Wait until the persistent switch heater delay is over.
10. Set the output current to 0 A at the Sweep Power Supply.
11. Wait until the output current is 0 A.
12. Save the set output current to an applicable file for the next sweep procedure.
13. Switch the Sweep Power Supply OFF.

## 5.4 Set into Operation

Mount the further equipment of the supplied magnet system respecting their manuals.


Figure 5.2: Start the Magnet Stand

If the magnet system is equipped with a magnet stand with pneumatic isolators:

Set the magnet stand into operation by switching the pneumatic controller to UP position.


Figure 5.3: Stop the Magnet Stand

For any work at the magnet system like maintenance or refill of cryogenic agents stop the magnet stand by switching the pneumatic controller to DOWN position.

# 6 Troubleshooting

Troubleshooting must be performed only with approved qualification.

In case of doubts or problems not specified in the following list contact Bruker Service immediately. For contact information see page 9 of this manual.

## 6.1 Safety

**Approved Persons**

Bruker Service, Approved Customer Personnel

**WARNING**

**Magnetic Fields** (see page 20)

**Cryogenic Agents** (see page 21)

**Electricity** (see page 21)

**Gas under Pressure** (see page 22)

**Spontaneous Ignition and Explosion** (see page 23)

**Personal protective equipment**

Protective goggles

Protective gloves

Protective clothes

Safety shoes

## 6.2 Problem

### 6.2.1 During Transportation

| Indicator | Possible reason | Solution | By |
|---|---|---|---|
| Tilt Watch / Shock Watch activated. | Careless transportation. | 1. Accept delivery with reservation.<br>2. Remark the extent of damage in the transportation documents.<br>3. Start complaint process. | Approved Customer Personnel |
| Visible damage. | Careless transportation. | 1. Accept delivery with reservation.<br>2. Remark the extent of damage in the transportation documents.<br>3. Start complaint process. | Approved Customer Personnel |

### 6.2.2 During Assembling

| Indicator | Possible reason | Solution | By |
|---|---|---|---|
| Ceiling height too low for assembling on magnet stand. | Site does not meet the required conditions. | Choose another site that meets the required conditions. | Bruker Service |
| Ceiling height too low for inserting the Helium Level Sensor | Site does not meet the required conditions. | Insert the Helium Level Sensor before mounting the magnet stand. | Bruker Service |
| Helium bore tube and radiation shield are not concentric. | Alignment is not correct. | Check fixation of the alignment rods. | Bruker Service |

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| Indicator | Possible reason | Solution | By |
|---|---|---|---|
| Helium bore tube and radiation shield are not concentric. | Alignment rod is loose or broken. | Replace alignment rod [a]. | Bruker Service |
| | Reduction flange is not concentric. | Check orientation. | Bruker Service |
| Vacuum Valve collides with the magnet stand. | Vacuum Valve collides with the magnet stand. | Turn the Vacuum Valve. Be careful if the RT vessel is evacuated. | Bruker Service |
| Vacuum in RT vessel does not reach $5 \times 10^{-5}$ mbar in 48 hours. | O-rings may be damaged. | Check and clean O-rings and slots; replace O-rings if necessary:<br>• of the Vacuum Valve<br>• of the drop-off plate<br>• of the reduction and sealing flanges<br>• of the bottom plate [a] | Bruker Service |
| | Defective pumping unit or pumping line. | Check pumping unit and pumping line:<br>A vacuum less than $10^{-6}$ mbar must be reached with a closed sealing plug.<br>Replace if necessary. | Bruker Service |
| | Room temperature bore tube has scratches or dust on the sealing surfaces. | Check sealing surfaces on the room temperature bore tube: No scratches and no dust should be visible. | Bruker Service |
| | Moisture in the RT vessel. | Pump and flush the RT vessel several times with dry nitrogen gas. | Bruker Service |
| Super insulation touches RT vessel or bore tube or radiation shield. | Super insulation was not fixed correctly during assembly. | Fix super insulation on the outer radiation shield with polyester tape [a]. Carefully prevent any connection between different vessels or bore tubes in the cryostat. | Bruker Service |

a. For this work the bottom plate has to be removed. Check the suspension tubes of the helium vessel are not broken. Install the safety device for fall protection (not supplied). Contact Bruker Service for further information.

### 6.2.3 During Cooling Down

| Indicator | Possible reason | Solution | By |
|---|---|---|---|
| Cooling with liquid nitrogen continues too slowly. | Empty transportation dewar. | Refill or replace transportation dewar. | Bruker Service |
| | Transfer pressure too low. | Increase transfer pressure slightly (max. pressure 0.3 bar). | Bruker Service |
| | Transportation dewar is leaky; no transfer pressure can be applied. | Check transportation dewar and replace if necessary. | Bruker Service |
| Precooling with liquid nitrogen continues too quickly. | Transfer pressure too high. | Stop cooling. Adjust correct transfer pressure. | Bruker Service |
| Vacuum in RT vessel does not reach $5 \times 10^{-5}$ mbar in 48 hours. | O-rings may be leaky. | Check and clean O-rings and slots; replace O-rings if necessary:<br>• of the Vacuum Valve<br>• of the drop-off plate<br>• of the reduction and sealing flanges<br>• of the bottom plate [a] | Bruker Service |
| | O-rings may be frozen due to contact with liquid nitrogen. | 1. Stop cooling.<br>2. Warm up O-ring with warm air<br>3. Wait until the vacuum is recovered.<br>4. Prevent liquid nitrogen from splashing on O-rings. | Bruker Service |
| | Defective pumping unit or pumping line. | Check pumping unit and pumping line:<br>A vacuum less than $10^{-6}$ mbar must be reached with a closed sealing plug. Replace if necessary. | Bruker Service |

a. see note on page before

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| Indicator | Possible reason | Solution | By |
|---|---|---|---|
| RT vessel becomes cold and wet. | Vacuum is broken or less than $10^{-3}$ mbar. | • Do not remove pumping unit until liquid helium fill-in is finished.<br>• Continue as in problem *Vacuum in RT vessel does not reach* $10^{-6}$ *mbar* | Bruker Service |
| | Cold leak after transportation. | 1. Stop cool down.<br>2. Warm up cryostat. | Bruker Service |
| Cold spot in the RT-bore. | Alignment not correct. | 1. Stop cool down.<br>2. Warm up cryostat.<br>3. Align the vessels. | Bruker Service |
| The helium flow system becomes very cold and icy during flushing with helium gas. | Liquid nitrogen remains in the helium vessel, boiling off strongly during flushing. | 1. Stop flushing.<br>2. Carefully remove all liquid nitrogen using the precooling tube.<br>3. Check with the dipstick to be sure that the helium vessel is completely empty (no liquid nitrogen or frozen nitrogen). | Bruker Service |
| After some intervals of flushing it is not possible to reach a vacuum in the range of 1 mbar. | The globes in the quench valves are not fitting correctly in the O-rings and thus the quench valves are leaky. | 1. Stop pumping.<br>2. Remove frozen air and frozen moisture with warm helium gas.<br>3. Slightly grease the O-rings and check the position of the globes.<br>4. Check with the dipstick to be sure that the helium vessel is completely empty (no liquid nitrogen or frozen nitrogen). | Bruker Service |
| | Liquid nitrogen remains in the helium vessel, boil-ing off strongly dur-ing flushing. | 1. Stop pumping.<br>2. Carefully remove all liquid nitrogen using the precooling tube.<br>3. Check with the dipstick to be sure that the helium vessel is completely empty (no liquid nitrogen or frozen nitrogen). | Bruker Service |

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| Indicator | Possible reason | Solution | By |
|---|---|---|---|
| Nitrogen ice in the helium vessel. | Times between pumping and flushing were too long; remaining nitrogen was boiling off during pumping and got frozen dur-ing flushing. | 1. Warm up the magnet coil with warm helium gas through the precooling tube until the whole coil is at 90 K or above.<br>2. Repeat pumping and flushing and carefully check with the dipstick to be sure that the helium vessel is completely empty (no liquid nitrogen or frozen nitrogen). | Bruker Service |
| Transfer of liquid helium does not start. | Empty transpor-tation dewar . | Refill or replace transportation dewar. | Bruker Service |
| | The transfer pressure in the transportation dewar is too low. | Increase the transfer pressure. | Bruker Service |
| | The transportation dewar is leaky, no transfer pressure built up. | Check the transportation dewar for leakage. Re-tighten all connections. | Bruker Service |
| | The siphon or the helium transfer line are blocked with ice. | Check the siphon and helium transfer line for blockages, remove ice with warm helium gas. | Bruker Service |
| The cooling down of the magnet coil does not continue although helium is transferred. | The helium transfer line is defective. | Check the helium transfer line for icing. If there are cold spots visible, replace the helium transfer line. | Bruker Service |
| | The extension piece is not mounted on the helium transfer line. | Mount the extension piece on the helium transfer line. Check the helium transfer line to be inserted completely into the siphon. | Bruker Service |

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Continued from page before

| Indicator | Possible reason | Solution | By |
|---|---|---|---|
| The zero reading of the Helium Level Sensor can not be adjusted at the beginning of cooling down with liquid helium. | The Helium Level Sensor is not connected correctly with the connector in the helium flow system. | Check the connection in the helium fill-in turret between Helium Level Sensor and connector. | Bruker Service |
| | The Helium Level Sensor is defective. | Check the Helium Level Sensor with the 0% calibration plug. | Bruker Service |
| The helium level does not reach 100% after cooling down. | Empty transpor-tation dewar, helium transfer stopped. | Refill or replace transportation dewar. | Bruker Service |
| | The Helium Level Sensor is disturbed by the transfer line's extension piece. | 1. Stop the liquid helium transfer.<br>2. Remove the transfer line.<br>3. Measure the helium level after some minutes without the transfer line. | Bruker Service |
| After cooling down the helium boil off is higher than specified (up to 5 times). | Usual behavior. A few days are necessary for the radiation shields and the insulation to reach scheduled temperatures. | Wait a few days and check helium boil off.<br>The presence of the current lead in the current lead turret during energizing and shimming helps to cool down the radiation shield due to higher helium flow. | Bruker Service |

### 6.2.4 During Energizing and Shimming

| Indicator | Possible reason | Solution | By |
|---|---|---|---|
| The current lead can not be inserted completely into the connector. | The connector is covered with ice (frozen moisture or nitrogen ice). | Carefully remove the ice with warm helium gas.<br>Use the dipstick or the precooling tube as tubing for the warm helium gas to remove small ice spots. | Bruker Service |
| | The shorting plug was not removed. | Remove the shorting plug with the shorting plug tool. | Bruker Service |
| | The orientation of the current lead is not correct. | Turn the current lead carefully until it can be inserted correctly into the connector. | Bruker Service |
| Main coil heater test fails. | Defective Power Supply. | Replace the Power Supply | Bruker Service |
| | Connector or cables defective. | Clean connectors or replace cables if necessary. | Bruker Service |
| Setting of sense voltage fails. | The main coil heater switch is "OFF". The main coil switch is not opened. | Switch the main coil heater to "ON" and check the main coil heater current to be adjusted correctly. | Bruker Service |
| | The main coil heater current is not correct. The main coil switch is not opened. | Adjust main coil heater current correctly. | Bruker Service |
| | The auxiliary shorting plug is inserted in the current lead turret by mistake and makes a short circuit across the main coil. | Remove the auxiliary shorting plug and insert it in the helium fill-in turret. | Bruker Service |
| Current lead can not be removed. | The connector is covered with ice (frozen moisture or nitrogen ice). | Carefully remove the ice with warm helium gas over the helium flow system. Use the dipstick or the precooling tube as tubing for the warm helium gas to remove small ice spots from the connector. | Bruker Service |

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| Indicator | Possible reason | Solution | By |
|---|---|---|---|
| Shorting plug can not be removed. | The connector is covered with ice (frozen moisture or nitrogen ice). | Carefully remove the ice with warm helium gas. Use the dipstick or the precooling tube as tubing for the warm helium gas to remove small ice spots from the connector. | Bruker Service |
| The magnet system quenches. | Loss of superconductivity. | See chapter **”After a Quench” on page 85**. | Bruker Service |
| | The helium level was too low for energizing, cycling, shimming, de-energizing or sweeping. | See chapter **”After a Quench” on page 85**. | Bruker Service |
| | The Power Supply is defective. The main current is oscillating. | Replace the Power Supply. | Bruker Service |
| The main coil switch can not be closed on field. | The helium level is too low for energizing. The main coil switch is not covered with liquid helium. | Never try to energize the magnet with less than the "minimum level during energizing" in the helium vessel. | Bruker Service |
| | The Power Supply is defective. The main current is oscillating. | Replace the Power Supply. | Bruker Service |
| Shim current can not be set correctly. | The control cable is not connected correctly to the current lead or to the Power Supply. | Connect the control cable correctly to current lead and power supply. | Bruker Service |
| | Switch „Main Coil/ OFF/Shim Coil“ in wrong position. | Change the switch position. | Bruker Service |
| Shims do not affect the NMR signal. | Shim heater current is not correct. The shim switches are not opened. | Set the shim heater current to the specified value (see **Appendix Technical Data**). | Bruker Service |

Continued on next page

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| Indicator | Possible reason | Solution | By |
|---|---|---|---|
| Magnet system does not reach specification. | Magnetic material inside RT bore tube. | Carefully clean the RT bore tube. | Bruker Service |
| | Large ferromagnetic parts near the magnet system. | 1. Keep the maximum possible distance between the magnet system and ferromagnetic parts.<br>2. Repeat shimming. | Bruker Service |

## 6.2.5 During Operation of the Magnet Stand

In case of doubt contact Bruker Service and refer to the manual of the Magnet Stand.

| Indicator | Possible reason | Solution | By |
|---|---|---|---|
| The NMR spectrum shows massive disturbances. | Pneumatic controller is in DOWN position. | Switch pneumatic controller to UP position. | Approved Customer Personnel |
| | Magnet system has direct mechanical contact with the floor via accessories or cables. | Identify and eliminate contact point. Arrange cables in loose S- or U-shapes. | Approved Customer Personnel |
| | | If the problem is still not solved, contact Bruker Service. | Approved Customer Personnel |
| | Magnet system has physical contact to the magnet stand. | Check leveling; adjust if necessary. | Bruker Service |
| | Piston of the isolator is not centric or touches its casing. | Align magnet stand. | Bruker Service |
| | T-safety bracket touches the pillar. | Align magnet stand. | Bruker Service |
| | Floor vibrations in vertical direction. | Replace elastomeric isolators with air damped isolators. | Bruker Service |
| | Floor vibrations in horizontal and vertical direction. | Replace air damped isolators with air piston isolators. | Bruker Service |

Continued on next page

Continued from page before

| Indicator | Possible reason | Solution | By |
|---|---|---|---|
| The pneumatic isolator of the magnet stand does not reach the operating position. | Pneumatic controller in DOWN position. | Switch pneumatic controller to UP position. | Approved Customer Personnel |
| | The pressure of the gas supply is too low. | Check the pressure of the pneumatic supply. It must be in the range of 5 to 8 bar (70 to 112 psi). | Approved Customer Personnel |
| | | If the problem is still not solved, contact Bruker Service. | Approved Customer Personnel |
| | The magnet system is not leveled correctly. | Stop the pneumatic isolators. Check the leveling of the cryostat. | Bruker Service |
| | Defective leveling valve. | Replace leveling valve or isolator. | Bruker Service |
| | Defective mem-brane of an isolator. | Replace leveling valve or isolator. | Bruker Service |
| Magnet system achieves working position jerkily. | Piston is not centric or touching its casing. | Align magnet stand. | Bruker Service |
| Audible loss of gas. | Defective membrane or defective leveling valve of an isolator. | Replace leveling valve or isolator. | Bruker Service |
| | Hose connector is defective or loose. | Insert hoses correctly and tighten screws. | Bruker Service |
| Velocity of lifting or lowering too high. | Wrong adjustment of the flow control valve. | Close restrictor of the flow control valve completely; then open it a half turn. | Bruker Service |

### 6.2.6 During Standard Operation

| Indicator | Possible reason | Solution | By |
|---|---|---|---|
| The helium boil off decreases to zero. | The atmospheric pressure is increasing. | Usual behavior.<br>Watch helium boil off daily. | Approved Customer Personnel |
| | The helium flow system is covered with ice. | Contact Bruker Service immediately! Do not try to remove ice of the helium flow system! | Approved Customer Personnel |
| | | **WARNING:**<br>**Cryogenic Agents**<br>**Quench** | |
| | The helium flow system or the suspension tubes are blocked with ice. | Blow in warm helium gas carefully through an applicable tube. Do not insert it more than 600 mm from the top of the helium turrets. | Bruker Service |
| The helium boil off is too high. | The Helium Level Sensor is permanently on (service mode) or used often. | Switch off Helium Level Sensor. Reduce frequency of helium level measurement (during measuring of the helium level an amount of helium boils off due to the heat input of the Helium Level Sensor). | Approved Customer Personnel |
| | The atmospheric pressure is decreasing. | Usual behavior.<br>Watch helium boil off daily. | Approved Customer Personnel |
| | | If the problem is still not solved, contact Bruker Service. | Approved Customer Personnel |

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| Indicator | Possible reason | Solution | By |
|---|---|---|---|
| Continue of:<br>The helium boil off is too high. | Vacuum reduced. | Rebuild vacuum, see chapter **"Rebuilding Vacuum" on page 52** | Bruker Service |
| | The radiation baffles are not inserted in the current lead turret. | Insert the radiation baffles into the current lead turret. | Bruker Service |
| Quench. | Loss of supercon-ductivity. | See chapter **"After a Quench" on page 85**<br>Contact Bruker Service immediately! | Approved Customer Personnel |
| Cold spots within the RT bore. | Alignment of the vessels not correct. | Contact Bruker Service. | Approved Customer Personnel |
| RT vessel is wet and cold. | Vacuum reduced. | Contact Bruker Service immediately! | Approved Customer Personnel |
| Not correct helium level warning out of MICS. | Helium Level Sensor defective. | Contact Bruker Service immediately! | Approved Customer Personnel |
| Helium level at constant level, no change during days. | Helium Level Sensor defective. | Contact Bruker Service immediately! | Approved Customer Personnel |
| | | **WARNING:**<br>**Low Temperature** | |
| Not correct helium level warning out of MICS. | Helium Level Sensor defective. | Replace Helium Level Sensor (see chapter **"Replacement of the Helium Level Sensor" on page 87**) | Bruker Service |
| Helium level at constant level, no change during days. | Helium Level Sensor defective. | Replace Helium Level Sensor (see chapter **"Replacement of the Helium Level Sensor" on page 87**) | Bruker Service |

### 6.2.7 During De-energizing and Warming up

| Indicator | Possible reason | Solution | By |
|---|---|---|---|
| The magnet system quenches during de-energizing. | The helium level was too low for de-energizing. | Refill helium at least to the minimum allowed level (see **Appendix, Technical Data**). | Bruker Service |
| | The Power Supply is defective. | Replace Power Supply. | Bruker Service |
| | The main current is oscillating. | Replace Power Supply. | Bruker Service |
| The shim current can not be set correctly. | The control cable is not connected correctly to the current lead and/or the Power Supply. | Connect the control cable to the current lead and to the Power Supply correctly. | Bruker Service |
| | The switch "Main Coil/OFF/Shim Coil" is not on the "Shim Coil" position. | Switch "Main Coil/OFF/Shim Coil" on the "Shim Coil" position. | Bruker Service |
| High helium flow after breaking vacuum. | Remaining cryogenic agents in the vessels. | Remove liquid cryogenic agents. | Bruker Service |
| Vacuum still remains after 12 hours. | Vacuum Valve is closed. | Open the Vacuum Valve. Block it if necessary. | Bruker Service |
| RT vessel is wet and cold. | Cryostat is still cold. | Wait until RT vessel is dry and warm.<br>Check PT100 temperature sensors. | Bruker Service |
| RT bore wet and cold before disassembling. | Cryostat is still cold. | Wait one more day.<br>Do not open a cryostat before the room temperature bore tube is warm and dry! | Bruker Service |

## 6.3 Troubleshooting Work

### 6.3.1 After a Quench


Figure 6.1: Quench Picture

A quench is the very fast de-energizing of the magnet by loss of its superconductivity. The stored magnetic energy is converted into heat, which promotes rapid evaporation of large quantities of helium.
After an appearance of a quench contact Bruker Service immediately.

**WARNING**

**Cryogenic Agents** (see page 21)

**Quench** (see page 22)

**Quench while in persistent mode:**

1. Wait until the quench valves are closed and no helium evaporates out of the quench valves.
2. Wait until there is no helium vapor visible in the room or the ceiling to make sure there is sufficient oxygen in the room.
3. If equipped with switch the Atmospheric Pressure Device OFF.
4. Check the globes in the quench valves for their correct position.
5. Only at magnet systems with 3 helium turrets: check the bursting disc at the helium flow system. If destroyed close the socket with the supplied plug to prevent air from entering the helium flow system or vessel.
6. Remove probe and shim system to prevent icing of the shim system.
7. Check the nitrogen turrets for icing.
8. Start the refill with liquid helium as soon as possible after the quench (within one hour after the quench; refer to the supplied Refilling Procedure).
9. Contact Bruker Service immediately.

ℹ If the quench occurs unattended or helium transfer was not possible within one hour after the quench, it is recommended to warm up the system to 90 K.

**Procedure to warm up to 90 K:**

1. Insert the precooling tube into the helium fill-in turret and connect it to the pressure cylinder with helium gas.
2. Blow warm helium gas into the helium vessel.
3. At 90 K pump and flush the helium vessel with helium gas several times.
4. Continue following the instruction according the cooling down procedure (see chapter **”Cooling down to 4.2 K” on page 61**).

**Quench during energizing:**

1. Set the sense voltage to 0 V.
2. Set the charge current to 0 A.
3. Switch OFF the shim automatic.
4. Close all superconducting switches.
5. Switch the Bruker Power Supply OFF.
6. Insert the auxiliary shorting plug into the helium fill-in turret.
7. Remove the current lead out of the current lead turret.
8. Insert the shorting plug into the current lead turret.
9. Close the current lead turret with the cap immediately.
10. Remove the auxiliary shorting plug out of the helium fill-in turret.
11. Wait until the quench valves are closed.
12. Check if the helium vessel is properly closed to prevent moisture entering.
13. Check the helium flow system and the nitrogen flow system for damage.
14. Check the quench valves for the correct position.
15. Start refill with liquid helium as soon as possible after the quench (within 1 hour after the quench; refer to the supplied Refilling Procedure).
16. Wait at least 6 hours before energizing the magnet again.

### 6.3.2 Replacement of the Helium Level Sensor

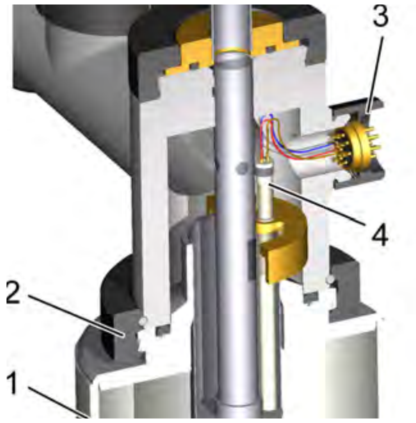
**WARNING**

**Cryogenic Agents** (see page 21)

**Quench** (see page 22)

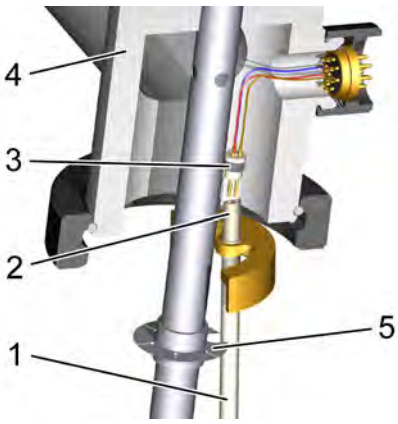
**Low Temperature** (see page 23)

**Risk of Slippage** (see page 23)




1. Check sufficient room height for removing the Helium Level Sensor. Contact Bruker Service in case of not sufficient.
2. Prepare the new Helium Level Sensor.
3. If equipped with switch the Atmospheric Pressure Device OFF.
4. Disconnect the connector at the helium fill-in turret (1).
5. Release the black nut (2) from the helium fill-in turret (1).
6. Remove the assembly carefully out of the helium fill-in turret until the connector of the Helium Level Sensor (4) becomes visible.

Figure 6.2: Changing the Helium Level Sensor - step 1




7. Disconnect the connector (2) of the Helium Level Sensor (1) from the connector (3) of the helium fill-in turret.
8. Remove the assembly with the baffle (4, 5) fully and lay it down carefully.
9. Remove the Helium Level Sensor (1) out of the helium fill-in turret (length approximately 1 m) and lay it down carefully.

Figure 6.3: Changing the Helium Level Sensor - step 2

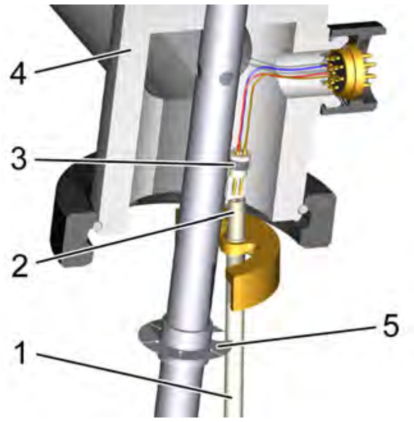



Figure 6.4: Changing the Helium Level Sensor - step 3

10. Insert the new Helium Level Sensor (1) carefully and slowly to its final position, respecting the orientation.
11. Connect the connector (2) of the Helium Level Sensor (1) with the connector (3) of the helium fill-in turret.
12. Insert the Helium Level Sensor (1) into the gap of the baffle (5) and insert the assembly (4, 5) into the helium fill-in turret.

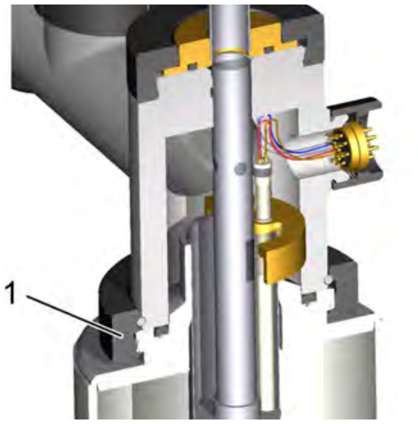



Figure 6.5: Changing the Helium Level Sensor - step 4

13. Fix the black nut (1).
14. Calibrate the Helium Level Sensor in MICS. Refer to the manual of MICS.

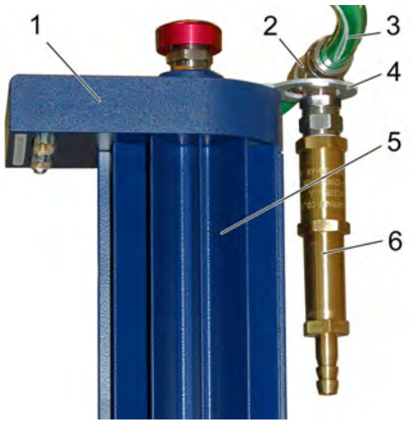
### 6.3.3 Replacement of the Nitrogen Level Sensor

**WARNING**

**Cryogenic Agents** (see page 21)

**Low Temperature** (see page 23)

**Risk of Slippage** (see page 23)




1. Remove the green tubes (3) out of the connector at the one-way valve (2).
2. Remove the one-way valve (6) out of the support (4) of the Nitrogen Level Sensor (1).
3. Disconnect the cables.
4. Remove the Nitrogen Level Sensor out of the nitrogen turret gripping the heat exchanger (5).
5. Insert the new Nitrogen Level Sensor carefully and slowly into the nitrogen turret.
6. Insert the one-way valve (6) into the support (4) of the Nitrogen Level Sensor (1)
7. Insert the green tubes (3) into the connector at the one-way valve (2).
8. Connect the cables.

Figure 6.6: Replacement of the Nitrogen Level Sensor

# 7 Maintenance

Maintenance must be performed only with approved qualification.

In case of doubt contact Bruker Service. For contact information see page 9 of this document.

## 7.1 Safety

**Approved Persons**

Bruker Service, Approved Customer Personnel

**WARNING**

**Magnetic Field** (see page 20)

**Cryogenic Agents** (see page 21)

**Electricity** (see page 21)

**Gas under Pressure** (see page 22)

**Low Temperatures** (see page 23)

**Spontaneous Ignition and Explosion** (see page 23)

**Personal protective equipment**

Protective goggles

Protective gloves

Safety shoes

## 7.2 Cleaning

**Procedure**

- Clean the RT vessel of the magnet system and the magnet stand with a dry or slightly damp cloth.
- Only use water and neutral detergents.
- Do not use volatile cleaning solvents.

## 7.3 Maintenance Timetable

| Interval | Device | Work | By |
|---|---|---|---|
| daily | Cryostat | Check the helium flow. | Approved Customer Personnel |
| daily | Cryostat | Check the nitrogen flow. | Approved Customer Personnel |
| weekly | Cryostat | • Check the helium level.<br>• Refill liquid helium if necessary according to the supplied Refilling Procedure respecting the warnings and instructions given there.<br>• Record the filling session. Deviation from estimated consumption may be used for identification of troubles. In this case contact Bruker Service. | Approved Customer Personnel |
| weekly | Cryostat | • Check the nitrogen level.<br>• Refill liquid nitrogen if necessary according to the supplied Refilling Procedure respecting the warnings and instructions given there.<br>• Weekly refill is recommended.<br>• Record the filling session. Deviation from estimated consumption may be used for identification of troubles. In this case contact Bruker Service. | Approved Customer Personnel |

Table 7.1: Maintenance Timetable

# 8 Disassembling

## 8.1 Safety

**Approved Persons: Bruker Service only**

**⚠ WARNING**

**Magnetic Field** (see page 20)

**Cryogenic Agents** (see page 21)

**Electricity** (see page 21)

**Gas under Pressure** (see page 22)

**Spontaneous Ignition and Explosion** (see page 23)

**Heavy Weights** (see page 24)

**Personal Protective Equipment**

Protective goggles

Protective gloves

Protective clothes

Safety shoes

**Necessary Tools and Equipment**

Bruker Power Supply

Current Lead

Shorting plug tool

Precooling tube

Liquid nitrogen blow out tube

Bruker Vacuum Valve (Material No. Z53420)

Vacuum pumping unit

Flow Device (Material No. Z57350)

Clean gloves

Boxes for transportation (Cryostat box, Magnet Stand box)

## 8.2 Disassembling Work

### 8.2.1 De-energizing

**Procedure**

1. Check the "minimum level during energizing" (see **Appendix Technical Data**). Refill helium if necessary.
2. Insert the auxiliary shorting plug into the helium fill-in turret.
3. Remove the shorting plug out of the current lead turret with the shorting plug tool.
4. Insert the current lead (see chapter **”Inserting the Current Lead” on page 64**).
5. Connect the main power cable to the Bruker Power Supply.
6. Switch the Bruker Power Supply ON.
7. Check the settings (currents and inductivity) of the Bruker Power Supply.
8. De-energize the shims:
   Set the shim current according to the data given in the **Appendix Technical Data**.
   Switch the shim heater switches ON and reduce the shim current slowly to 0 A.
   Switch the shim heater switches OFF.
9. Start the shim heater automatic ($Z^2$ shim heater ON).
10. Set the final main coil current according to the energizing assignment.
11. Wait until the current is reached at the Bruker Power Supply.
12. Open the main heater switch.
13. Set the first current of the de-energizing assignment.
14. Wait until the current is reached.
15. Continue in the same way for the other values of the de-energizing assignment until the magnet is completely de-energized.
16. Close the main heater switch.
17. Wait 5 minutes.

    ➪ Main heater switch is closed.
18. Set the sense voltage to 0 V.
19. Wait until 0 V is reached.
20. Remove the current lead.
21. Insert the shorting plug into the current lead turret.
22. Switch the Bruker Power Supply OFF.

**For magnet systems with DNP configuration only:**

**Procedure**

1. Check the "minimum level during energizing" (see **Appendix Technical Data**). Refill helium if necessary.
2. Check the settings of the Sweep Power Supply. The output current of the Sweep Power Supply and the sweep coil must be the same.
3. De-energize the sweep coil.
4. Switch the Sweep Power Supply OFF.
5. Insert the auxiliary shorting plug into the helium fill-in turret.
6. Remove the sweep current lead with the sweep current lead mounting device.
7. Insert the current lead (see chapter **"Inserting the Current Lead" on page 64**).
8. Connect the main power cable to the Bruker Power Supply.
9. Switch the Bruker Power Supply ON.
10. Check the settings (currents and inductivity) of the Bruker Power Supply.
11. De-energize the shims:
    Set the shim current according to the data given in the **Appendix Technical Data**.
    Switch the shim heater switches ON and reduce the shim current slowly to 0 A.
    Switch the shim heater switches OFF.
12. Start the shim heater automatic ($Z^2$ shim heater ON).
13. Set the final main coil current according to the energizing assignment.
14. Wait until the current is reached at the Bruker Power Supply.
15. Open the main heater switch.
16. Set the first current of the de-energizing assignment.
17. Wait until the current is reached.
18. Continue in the same way for the other values of the de-energizing assignment until the magnet is completely de-energized.
19. Close the main heater switch.
20. Wait 5 minutes.

    ➪ Main heater switch is closed.
21. Set the sense voltage to 0 V.
22. Wait until 0 V is reached.
23. Remove the current lead.
24. Insert the shorting plug into the current lead turret.
25. Switch the Bruker Power Supply OFF.

## 8.2.2 Warming up from 4.2 K to 300 K

**Procedure**

1. Check the helium flow during the entire warm up procedure.
2. Check the helium and the nitrogen flow systems and turrets are not blocked with ice. If necessary remove blockage with warm helium gas.
3. If available connect a nitrogen recovery system to one of the nitrogen turrets.
4. Insert the nitrogen blow out tube into another of the nitrogen turrets.
5. Connect a pressure cylinder with nitrogen gas to the nitrogen blow out tube. Apply a pressure of less than 180 mbar to the nitrogen vessel.

   ➪ Liquid nitrogen will be blown out of the vessel.
6. Remove the precooling tube out of the nitrogen turret.
7. Remount the nitrogen flow system to prevent moisture entering the vessel.
8. If available connect a helium recovery system to the one-way valve of the helium flow system.
9. Insert the precooling tube into the helium fill-in turret.
10. Connect a helium gas dewar to the precooling tube. Apply a pressure of less than 0.18 bar to the helium vessel.
11. Remove liquid helium by feeding dry helium gas into the precooling tube.

    ➪ Liquid helium will be blown out of the vessel.

---

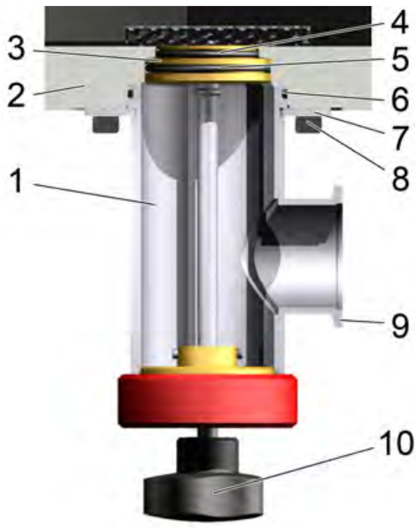
**i** Do not use nitrogen or pressurized air for removing helium out of the helium vessel. This will lead to ice formation inside the flow systems and the helium vessel. Use dry helium gas only.

---

12. Check with the precooling tube if liquid helium is in the helium vessel. Remove any liquid helium out of the helium vessel.
13. Remount the helium flow system to prevent moisture entering the vessel.

### 8.2.3 Breaking the Vacuum

1. Check with the precooling tube if there is liquid helium in the helium vessel. Blow out the liquid helium with warm helium gas through the precooling tube if necessary.
2. Check the helium and the nitrogen flow for at least three hours after breaking the vacuum.




3. Remove the protection cap of the vacuum flange at the bottom plate (2) of the cryostat.
4. Install the valve stem (10) onto the sealing plug (3) and tighten it slightly. The sealing plug can not and should not be moved until a correct vacuum was applied at the KF 40 flange at the Vacuum Valve to prevent air entering the cryostat.
5. Turn the Vacuum Valve in the desired position (KF 40 flange (9) looking outwards).
6. Place the two half rings (7) as shown into the slots of the valve body (1).
7. Fix the half rings (7) with four M 6 x 12 screws (8).

Figure 8.1: Mounting the Vacuum Valve at the Evacuated Cryostat

8. Connect the pumping unit with the special flow device (Material No. Z57350) without a clamping device to the KF 40 flange of the Vacuum Valve.
9. Evacuate the pump line and valve operator body to a vacuum of 5 x $10^{-5}$ mbar.
10. Pull down the sealing plug (3) with the valve stem (10) until it snaps in. The snapping is well defined and will be heard and felt.
11. Close the connection at the flow device to the pumping unit and stop pumping.
12. Connect a pressure cylinder with nitrogen gas to the flow device.
13. Open the needle valve slightly. The vacuum chamber must be at atmospheric pressure after 10 hours.

.

14. The KF 40 connection at the Vacuum Valve will open, if the RT vessel of the cryostat is at atmospheric pressure.
15. Wait until the RT Bore is no longer cold and wet (approximately 3 - 5 days).
16. Remount the current lead and check the temperature inside with the PT100 sensors. If they are at room temperature remove the current lead, the pumping unit, the flow device and the vacuum valve.
17. Close the cryostat at the vacuum flange with the protection cap.

## 8.2.4 Removing the Helium Flow System

Follow the procedure in chapter **”Mounting the Helium Flow System” on page 54** in reverse order.

Restore the helium flow system to its original box.

## 8.2.5 Removing the Nitrogen Flow System

Follow the procedure in chapter **”Mounting the Nitrogen Flow System” on page 56** in reverse order.

Restore the nitrogen flow system to its original box.

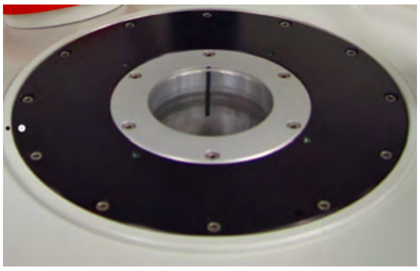
## 8.2.6 Removing the RT Tube and the Nitrogen Tube

**Bottom of the Cryostat**


Figure 8.2: Disassembling the RT Tube - step 1

1. Loosen the screws at the bottom RT closure flange (1) a little **without** removing anything.

### Top of the Cryostat



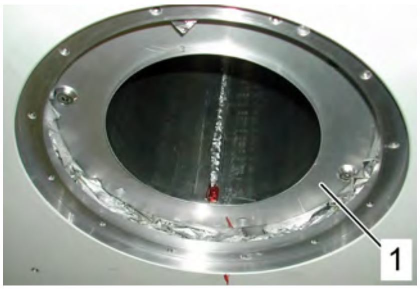
2. Loosen the upper RT closure flange a little **without** removing it.
3. Remove the upper RT reduction flange and closure flange.
4. Remove the RT tube from the top carefully. Use clean gloves to prevent any contamination (finger prints, dirt) to the RT tube surface. Handle the RT tube carefully to prevent any damage (scratches, buckling). Restore it in its original box.

Figure 8.3: Disassembling the RT Tube - step 2


5. Remove the upper nitrogen contact flange (1).
6. Remove the nitrogen tube from the top. Use clean gloves to prevent any contamination (finger prints, dirt) to the nitrogen tube surface. Handle the nitrogen tube carefully to prevent any damage (scratches, buckling). Restore it in its original box.
7. Remove the RS reduction flange.

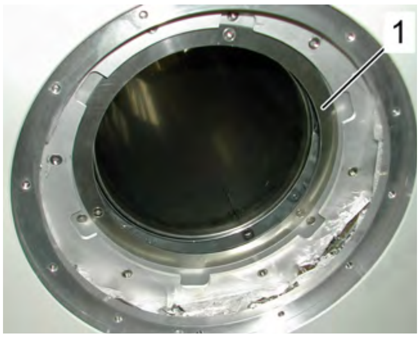
Figure 8.4: Disassembling the Nitrogen Tube - step 1

### Bottom of the Cryostat




8. Remove the bottom RT closure flange and the bottom RT reduction flange. Do not disassemble it.
9. Remove bottom nitrogen contact flange (1).

Figure 8.5: Disassembling the Nitrogen Tube - step 2

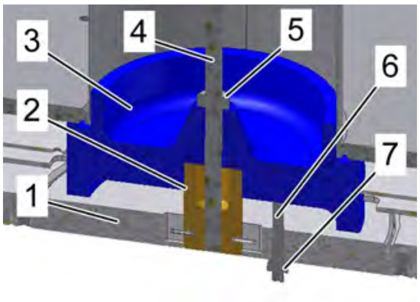



10. Remove the bottom reduction flange (1).
11. Remove the three getter containers.

Figure 8.6: Disassembling the Nitrogen Tube - step 3

## 8.2.7 Assembling the Transportation Lock

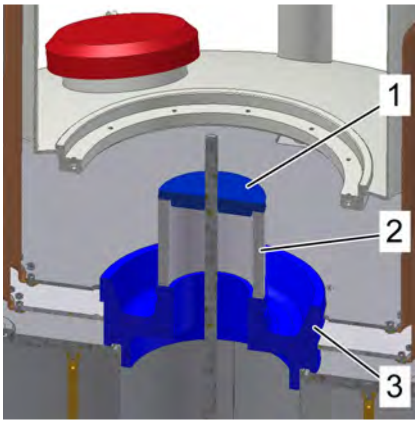
### Bottom of Cryostat




1. Insert the brass nut (2) into the transportation bottom plate (1).
2. Attach the bottom fixture flange (3) onto the brass nut (2).
3. Insert the threaded bar (4) from the top.
4. Screw the threaded bar (4) into the brass nut (2).
5. Fix the lock nut (5).
6. Insert the assembly of the lower transportation lock into the helium bore tube. Prevent clamping the super-insulation with the transportation lock.
7. Fix the transportation bottom plate (1) with twelve M 5 x 12 screws (torque 6 Nm).
8. Insert and fix the three M 8 bolts (6) (torque low, same on all three bolts).
9. Fix the three M 8 nuts (7) (torque12 Nm).

Figure 8.7: Assembling the Transportation Lock - step 1

### Top of the Cryostat




10. Insert the top fixture flange (3).
11. Insert the intermediate flange (2).
12. Insert the short top fixture flange (1).

Figure 8.8: Assembling the Transportation Lock - step 2

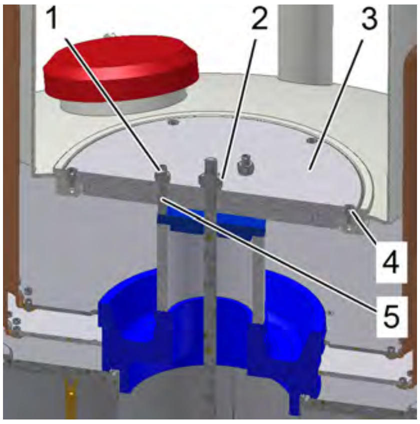



Figure 8.9: Assembling the Transportation Lock - step 3

13. Mount the transportation top plate (3).
14. Fix the transportation top plate (3) with six M 5 x 12 screws (4) (torque 6 Nm).
15. Insert and fix the three M 8 bolts (5).
16. Fix the three M 8 nuts (1) (torque 12 Nm).
17. Fix the two M 12 nuts (2) with washers.

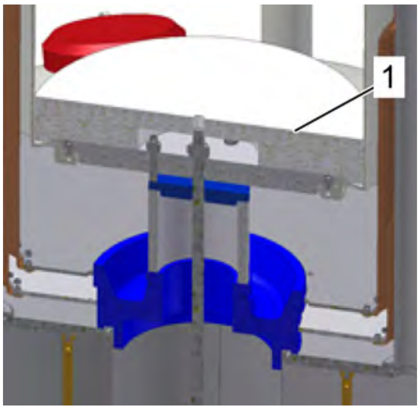



Figure 8.10: Assembling the Transportation Lock - step 4

18. Fix the protection cover (1).

### 8.2.8 Disassembling the Magnet Stand

Follow the instructions according to the manual of the Magnet Stand respecting the warnings given there.

Restore the parts of the Magnet Stand in their original boxes.

### 8.2.9 Preparing the Cryostat for Transportation

1. Put the cryostat in its original box. See chapter **”Packaging” on page 31**.
2. Fasten the straps inside the box to fix the cryostat.
3. Put the accessories such as the flow systems, level sensors and bore tubes into the side compartment of the box.
4. Close the box.

In case of subsequent storage refer to chapter **”Storing” on page 35**.

# A Appendix

Warning Signs

Figures

Tables

Glossary / Abbreviations

Technical Data

Index

## A.1 Warning Signs

### Danger



### Warning



### Caution



### Notice

## A.2 Figures

## A.3 Tables

## A.4 Glossary / Abbreviations

| Glossary | Description |
|---|---|
| Box | Any kind of package used to protect sensitive parts during transportation. |
| Cryostat | The collective of all parts providing a temperature of 4 K inside for the superconducting magnet. The cryostat also provides the safety devices and the access ports for the cryogenic agents and electricity. The superconducting magnet inside the cryostat is not energized. |
| Dewar | Any kind of package used for transporting cryogenic agents like liquid helium or nitrogen. |
| Pressure Cylinder | Any kind of package used for transporting gaseous agents with a pressure up to 200 bar. |
| Magnet System | The collective of all parts necessary for the intended use. The superconducting magnet inside the cryostat is energized. |

| Abbreviations | Description |
|---|---|
| ACD | Automatic Cooling Device |
| DNP | Dynamic Nuclear Polarization |
| MICS | Magnet Information and Control System |
| NMR | Nuclear Magnetic Resonance |
| RS | Radiation Shield |
| RT | Room Temperature;<br>used as prefix of parts which are at room temperature |

# A.5 Technical Data - Standard

**For further Technical Data please refer to the supplied manual of the Magnet Systems for the User.**

## Environmental conditions

| | Value | Unit |
|---|---|---|
| Minimum surrounding temperature | 7 | °C |
| Maximum surrounding temperature | 38 | °C |
| Maximum relative humidity up to 31°C | 80 | % |
| Maximum relative humidity between 31°C and 40°C linear decreasing | 80-50 | % |

Table A.1: Environmental conditions

## Identification Plate

The identification plate is on the right back side of the cryostat fixed at the bottom plate.

**Contents of the identification plate:**

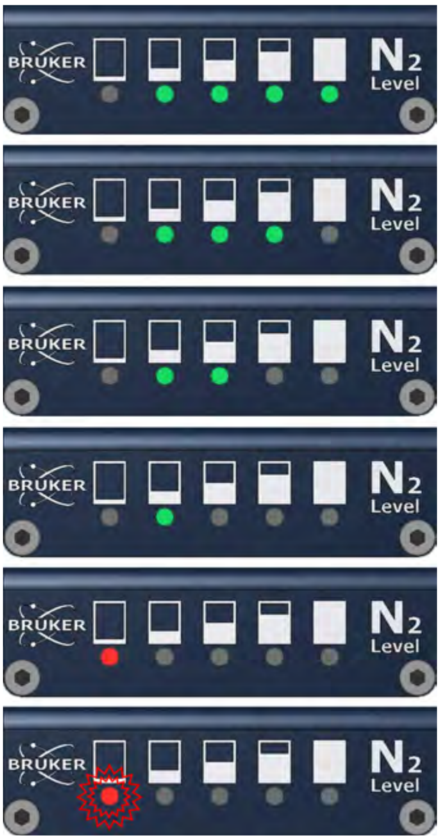
- Address of the Manufacturer
- Magnet System Identifier
- Type
- Identification Number
- Magnet Identifier
- Serial Number
- Year of Construction
- Cryostat Identifier
- Specification Helium Vessel
- Specification Nitrogen Vessel
- Specification Vacuum Chamber
- Weight total (empty / full)

## Nitrogen Level Sensor

The Nitrogen Level Sensor is inserted in the recommended nitrogen turret. Six lights diplay the nitrogen level. For further information refer to the supplied User Manual.

| Nitrogen Level Sensor | Material No. | Value | Unit |
|---|---|---|---|
| Level Sensor Type | specific item | | |
| Diameter | | | mm |
| Overall length | | | mm |
| Active length | | | mm |

Table A.2: Nitrogen Level Sensor




Nitrogen level at:

more than 90 %

70 % - 90 %

50 % - 70 %

30 % - 50 %

10 % - 30 %
Schedule Refill

less than 10 %
Refill immediately

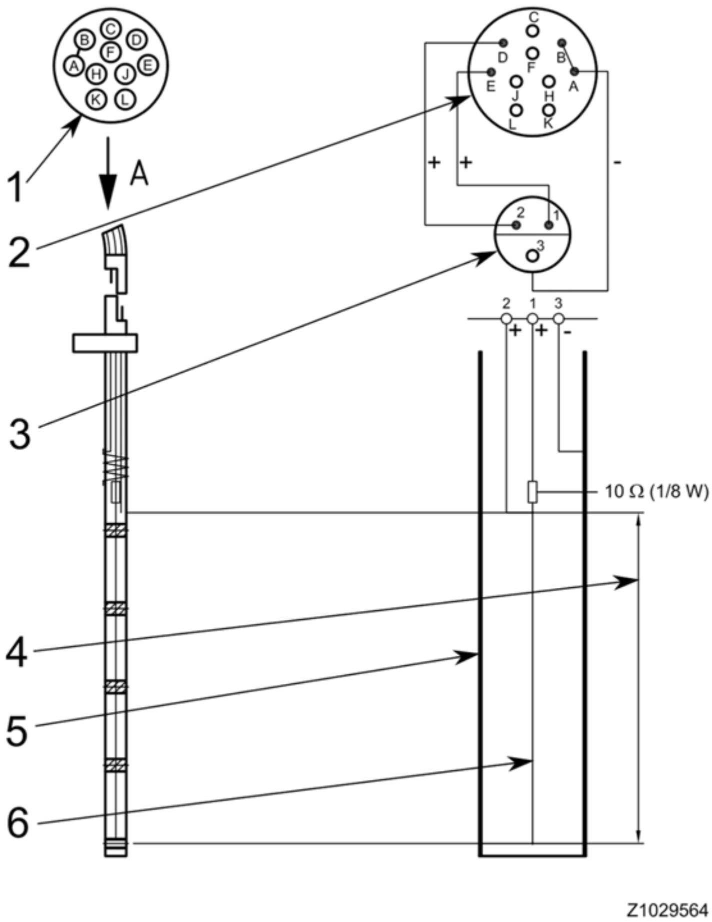
Figure A.1: Nitrogen Level Sensor Display

## Helium Level Sensor

The Helium Level Sensor is inserted in the helium fill-in turret. For further information refer to the supplied User Manual.

| Helium Level Sensor | Material No. | Value | Unit |
|---|---|---|---|
| Level Sensor Type | specific item | | |
| Overall length | | | mm |
| Active length | | | mm |
| Calibration 0 %, Calibration resistor | | | Ω |
| Calibration 100 %, Calibration resistor | | | Ω |

Table A.3: Helium Level Sensor




1 Pin-Side
2 Solder-Side
3 Pin connector
4 Active length
5 Sensor tube
6 Superconductor

Figure A.2: Helium Level Sensor

## Temperature Sensors

The temperature sensors (PT 100 and IBT) will be used to monitor the temperature of the magnet during cooling down and warming up of the magnet system.

### PT 100

Measure the resistance of the PT 100 with a maximum current of 1 mA.

| | Temperature | Unit | Resistance | Unit |
|---|---|---|---|---|
| Room Temperature | 293 | K | 107.8 | Ω |
| | 273 | K | 100.0 | Ω |
| | 250 | K | 91.0 | Ω |
| | 200 | K | 71.1 | Ω |
| | 150 | K | 50.9 | Ω |
| | 100 | K | 30.0 | Ω |
| Liquid Nitrogen | 77 | K | 20.1 | Ω |

Table A.4: Characteristic Data of the PT 100 sensor

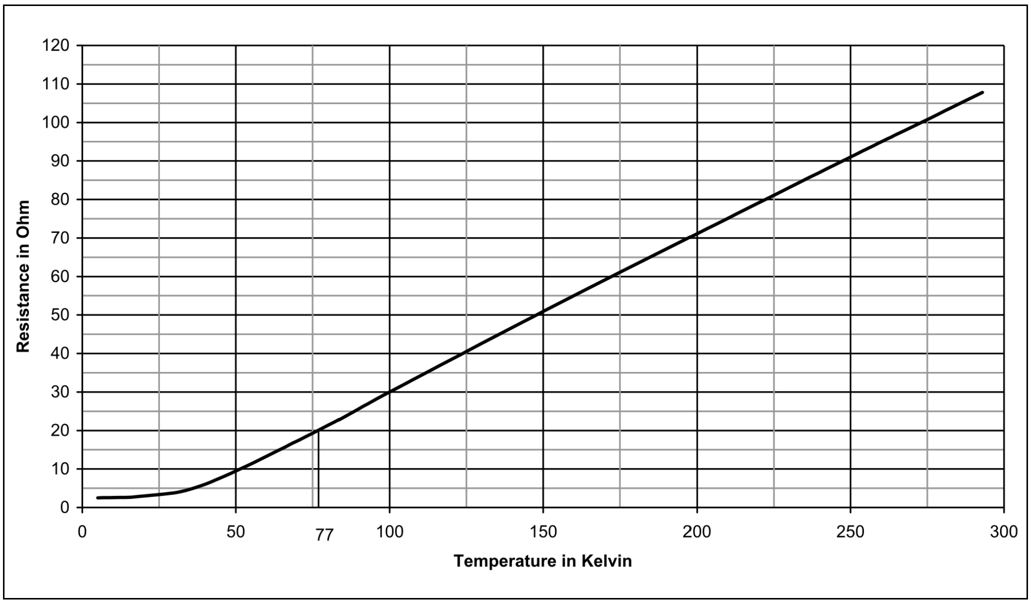



Figure A.3: Characteristic Curve of a PT 100 sensor

## IBT Carbon Resistor

Measure the resistance of the IBT sensor with a maximum current of 0.1 mA.

| | Temperature | Unit | Resistance | Unit |
|---|---|---|---|---|
| Room Temperature | 300 | K | 220 | Ω |
| Liquid Nitrogen | 77 | K | 265 | Ω |
| | 40 | K | 300 | Ω |
| | 20 | K | 350 | Ω |
| | 10 | K | 420 | Ω |
| | 8 | K | 450 | Ω |
| | 6 | K | 500 | Ω |
| | 5 | K | 540 | Ω |
| Liquid Helium | 4.2 | K | 575 | Ω |

Table A.5: Characteristic Data of an IBT sensor

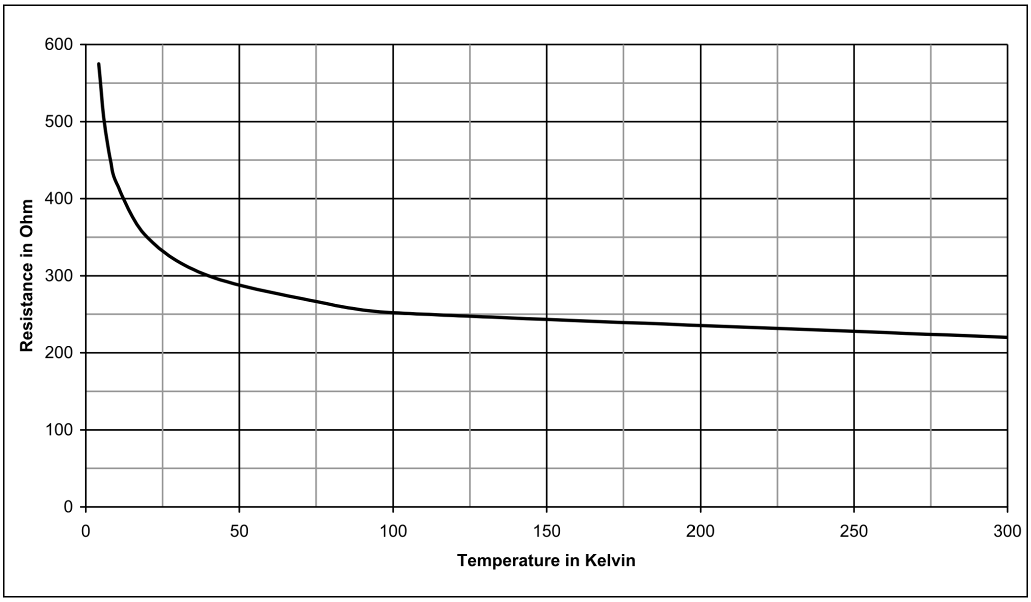



Figure A.4: Characteristic Curve of an IBT sensor

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## Nitrogen Refill Report

| Nitrogen level before refill [%] | Nitrogen level after refill [%] | Refill Volume [ l ] | Date, Time | Signature |
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## Helium Refill Report

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## A.6 Index

## O



## P



## Q



## R



## S



## T



## V



## W

## Revision History List

| Index: | Date: | Alteration Type: |
|---|---|---|
| 00 | March 2011 | First release. |
| 01 | September 2011 | Update including DNP option. |
| 02 | March 2012 | Minor changes in layout and wording. |
| 03 | September 2012 | Update and released fringe field data and related directives. |
| 04 | June 2013 | Update including precondition Helium Level Sensor and Nitrogen Level Sensor operating during cooling down. |
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