BioSpec 47/40 USR

- Site Planning Information

  with Magnet B-C 47/40 USR V2

  Version V020

Innovation with Integrity

Preclinical Imaging

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1 Introduction

This manual provides support for the system owner when planning installation and meeting the installation requirements of an MR system by specifying planning data.

1.1 About this Manual

This manual is to be used by the System Owner (responsible body) and planning offices that have been entrusted with the site planning of the installation of the MR instrument. It provides the installation requirements of the MR instrument.

This manual does not intend to provide instructions for installation. A MR instrument is only to be installed by Bruker Service or by personnel authorized by Bruker.

1.2 Overview

Chapter *Safety [▷ 9]* provides safety instructions for the System Owner (responsible body) for the installation procedure. There are also references to safety instructions that are not relevant for carrying out installation itself, but which should be heeded during subsequent operation and may have repercussions on installation planning. Regulatory standards of the MR instrument are provided in the **Chapter** *Standards [▷ 21]*.

Chapter *Installation Schedule [▷ 23]* provides instructions on the operational sequence of the planning and installation and describes the necessary prerequisites and responsibilities of the System Owner, which must be met, before installation by Bruker Service may start.

Chapter *Laboratory infrastructure and interactions [▷ 27]* describes the general and infrastructure specifications for the installation site within a laboratory. Aspects relating to a subsequent smooth operating procedure and to interactions with other laboratory facilities and the building are discussed here.

Chapter *Planning Details [▷ 37]* provides specific and detailed specifications for the various installation areas of the MR instrument, e.g. required space, cooling water, and electrical connection data.

Chapter *Seismic safety specifications [▷ 57]* therein provides instructions associated with installation under specific environmental conditions such as e.g. seismic regions.

Chapter *Delivery and Transport [▷ 79]* lists the prerequisites and conditions for the delivery and transport of the MR instrument.

Chapter *Checklist in Preparation of the Installation [▷ 89]* provides a check list that must be used for installation planning.

1.3 Additional Documents

The existing manual supplements the documentation of the BioSpec® MR instrument for the sole purpose of planning the installation.

The installation of a MRI CryoProbe™ or Inline PET requires additional installation planning and additional installation requirements. Please contact your local Bruker office.

1.4 Responsibilities

The responsibility for planning installation and for correctly implementing the installation requirements lies with the MR System Owner, also if the System Owner has outsourced planning services to external provider. Unless otherwise stipulated in the individual case by the contract of sale, Bruker can only provide information to the System Owner.

The transfer of risk is established in the general business terms and/or in the "Terms and Conditions" of the respective contract of sale and must accordingly be taken into account when the MR instrument owner plans the installation.

If there is a delay of receipt on the part of the System Owner after readiness for shipment has been sent to Bruker, the System Owner may be charged for the resulting additional costs. The regulations on a delay of receipt are established in the General Business Terms and the "Terms and Conditions" of the respective contract of sale.

1.5 Validity

This information represents the technical status of the installation requirements at the time of publication.

Technical modifications that are established in the general business conditions and in the “Terms and Conditions” of the contract of sale may require modifications in the installation requirements.

Any instrument configurations shown in this manual are typical examples. However, the final configuration of the ordered instrument is solely defined by the corresponding contract.

2 Safety

2.1 Safety during the Installation Phase

Unless not subcontracted to third parties, the System Owner (responsible body) is responsible for the safety during the installation phase. Follow the safety notices below and plan in advance to have measures to reduce risks already in place prior to the installation phase. Risks arise for people, buildings, and equipment.

NOTICE

Installation, initial commissioning, retrofitting, repairs, adjustments or dismantling of the device must only be carried out by Bruker Service or personnel authorized by Bruker. Damage due to servicing that is not authorized by Bruker is not covered by your warranty.

⚠ WARNING

Warning of personal injury and/or damage to the MR Instrument and/or building.

Transport, storage, and placement of the MR instrument must be carried out with particular care. Only trained, qualified, and authorized personnel is allowed to handle the MR instrument. Occupational standards and minimum safety distances between building structures and heavy loads must be fulfilled along the entire transport route. The load-bearing capacity of all transport routes, storage facilities, and installation areas of the equipment components must be checked and released by professional personnel.

If operations are performed by unqualified personnel, the following risks exist:

- ▶ Personal injury when transporting heavy loads
- ▶ Significant damage to the MR instrument due to inappropriate handling
- ▶ Structural damage to buildings due to heavy loads

⚠ CAUTION

Heavy load.

This service action requires handling of heavy loads.

- ▶ Ensure compliance with worker protection regulatory limits.
- ▶ Potentially, hire professional staff trained in handling heavy loads.

⚠ WARNING

Danger of injury from electrical shock.

A life threatening shock may result when housings or cabinet doors are opened and covers or components are removed while connected to the line power.

Only authorized and electrically qualified personnel should carry out work.

- ▶ Switch instrument/component OFF and disconnect from line power.
- ▶ Prevent reconnection.
- ▶ Test for absence of harmful voltages.

⚠ WARNING

Risk of personal injury or death due to effects originating from strong magnetic fields: Establish and maintain a Controlled Access Area.

Approaching a strong magnetic field bears various risks that can lead to serious injuries. It is the responsibility of the System Owner (responsible body) to establish and maintain a Controlled Access Area which is defined by the three dimensional region where the magnetic field exceeds 0.5 mT (5 Gauss). People with medical implants or pacemakers or people carrying magnetic parts must not enter the Controlled Access Area.

- ▶ Establish a Controlled Access Area with minimum size of the 0.5 mT region.
- ▶ Train and authorize all personnel that needs to enter the Controlled Access Area. Do not forget to inform facility management, cleaning personnel, or potentially local fire brigade.
- ▶ Check authorization regularly and refresh training on safety.
- ▶ Refuse and prevent actively people carrying medical implants entering the Controlled Access Area.
- ▶ Refuse and prevent actively non-authorized and or non-trained personnel entering the Controlled Access Area. Inform visitors on the potential risk originating from the high magnetic field. Do not leave visitors unattended.
- ▶ It is good practice to establish a standard procedure when entering the Controlled Access Area and depose all personal accessories outside that might be affected or become dangerous projectiles.

⚠ WARNING

Risk of severe personal injury or explosion

- ▶ Only Bruker Magnet Service may perform work on the magnet.
- ▶ Do not open or remove any safety valves and/or burst disks of the magnet dewar.

⚠ WARNING

Risk of asphyxiation or severe burns by cryogen liquids

The handling of cryogen liquids bears potential risk of severe personal injuries like burns or asphyxiation. Rapidly escaping helium or nitrogen as it occurs during the filling process of a magnet can possibly displace the air in the magnet room and can therefore be a potential risk for asphyxiation.

- ▶ Only authorized and trained personnel may refill cryogen liquids.
- ▶ Always have a second person supervising from outside while handling liquid cryogens.
- ▶ Wear suitable protective gloves and eye protection.
- ▶ Use only non-magnetic dewars and carts.
- ▶ Store cryogen liquids in sufficiently ventilated rooms only.
- ▶ No humans are permitted inside an elevator (or any other insufficient and closed room) that hosts dewars with cryogen liquids.

2.2 Instructions to plan a safe and compliant MR Site

Laboratory infrastructure and operation of the MR instrument must be safe and compliant with regulatory. The following safety aspects need to be considered when planning the MR site.

2.2.1 Magnetic Field

The super-conducting magnet of the MR instrument continually produces a very strong magnetic field inside of and outside of the magnet. The magnetic field outside of the magnet typically extends much further than the magnet housing to the surrounding area. To minimize hazards due to unawareness of the influence of strong magnetic fields, access to this area must be restricted. The System Owner (responsible body) has to establish a Controlled Access Area.

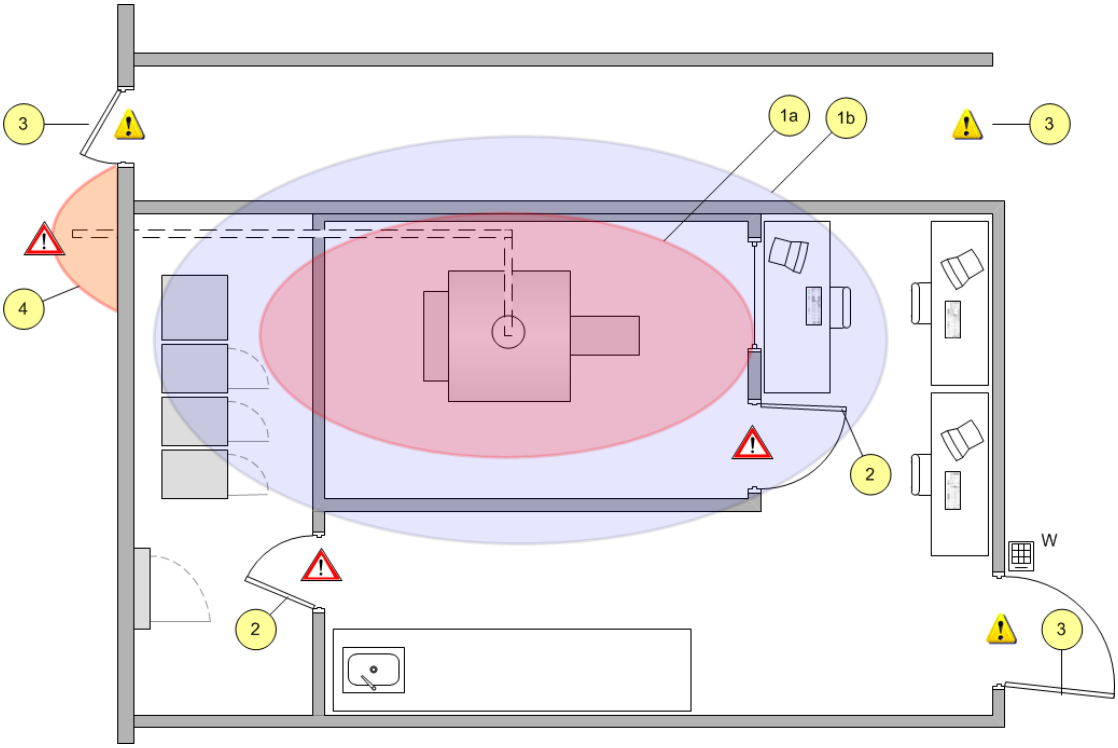


Figure 2.1: Hazardous Zones

1a Controlled Access Area

1b Exposed area

2 Access to the Controlled Access Area

3 Access to the exposed area

4 Gas exhaust discharge area

2.2.1.1 Controlled Access Area

The Controlled Access Area is the three-dimensional area in which the magnetic field strength is 0.5 mT and higher. It is defined by the 0.5 mT magnetic stray field line of the magnet. The contour maps of the magnetic stray field are provided in the System Owner Manual.

System owner or authorized personnel must ensure that individuals entering the Controlled Access Area must put down all loose ferromagnetic objects and must be questioned about their medical history (e. g. with respect to pace-makers, surgical implants, metal splinters, etc.).

Individuals with implants (e.g. cardiac pacemakers, clips, prostheses, etc.) are not allowed to enter the Controlled Access Area and pass beyond this 0.5 mT contour line.

It is the responsibility of the system owner to inform all users about applicable national and local regulations and occupational standards.

⚠ WARNING

Risk of personal injury or death due to effects originating from strong magnetic fields.

Entering the Controlled Access Area bears various risks that can lead to serious injuries. People with medical implants or pacemakers must not enter the Controlled Access Area.

- ▶ Refuse and prevent actively people carrying medical implants entering the Controlled Access Area.
- ▶ Refuse and prevent actively non-authorized and or non-trained personnel entering the Controlled Access Area. Inform visitors on the potential risk originating from the high magnetic field. Do not leave visitors unattended.
- ▶ Be familiar with the extension of the 0.5 and 3 mT region within the Controlled Access Area.
- ▶ Always reflect and be aware of the potential risks when entering the Controlled Access Area. Accidents occur often by being unthoughtful or careless during routine work in the Controlled Access Area.
- ▶ It is good practice to establish a standard procedure when entering the Controlled Access Area and depose all personal accessories outside that might be affected or become dangerous projectiles.

⚠ WARNING

Risk of personal injury or death

The magnetic field of the superconducting magnet remains on even when the MR instrument is powered off.

- ▶ All safety measures associated with the Controlled Access Area have to be observed even when the MR instrument is powered off.

NOTICE

Malfunction of laboratory equipment sensitive to magnetic fields

Within the Controlled Access Area, the MR instrument can

1. interfere with electronic devices so that they might not work as intended
2. be influenced by electronic devices so that image quality can be affected

▶ Always check accessories located in the Controlled Access Area for MR compatibility.

2.2.1.2 Exposed Area

The exposed area is the three-dimensional area in which the magnetic field strength is between 0.1 and 0.5 mT. It is defined by the corresponding stray field lines of the particular magnet types. The exposed area is not a general area of risk.

NOTICE

Malfunction of laboratory equipment sensitive to magnetic fields

Within the Exposed Area, sensitive equipment may still experience impairment of functionality, disturbance, or defects.

2.2.1.3 Exhaust system

To rule out the risk of asphyxiation or injury during a quench of the magnet (unwanted discharge of the magnet with high amount of cold Helium gas escaping rapidly), the magnet can only be installed and energized if a correctly designed and installed exhaust vent system is in place.

When planning the exhaust vent, attention should be paid to the following:

- The exhaust vent and the discharge area need to fulfill their function permanently.
- The helium gas leaving in the exhaust vent into the discharge area is very cold so that within an area of about 3 m distance, no access for persons must be possible. The helium gas itself does not constitute a risk for people, animals, or objects.
- A room ventilation is also required even when the magnet is cold but not energized.

2.2.2 Cryogenic Fluids and Gas

Cryogenic fluids (liquid helium, for some magnets also nitrogen) are used in the magnet to maintain superconductivity. The handling and storage of these extremely cold fluids requires compliance with the safety measures described in the chapter *Instructions to plan a safe and compliant MR Site [▷ 12]* and may only be carried out by authorized personnel.

If storage facilities for cryogenic fluid containers are foreseen, these rooms must meet the safety regulations for storing these gases. Attention must be paid when planning these rooms to ensure that:

- The room's ventilation system guarantees a fresh air exchange rate of at least 1.5 times the rooms volume per hour
- The proper function of the ventilation system is monitored continuously and appropriate safety precautions are taken to indicate a failure of the ventilation system
- Escape routes cannot be blocked by situations in which overpressure may occur

⚠ WARNING

Blocking of escape routes from overpressure

Escape routes and emergency exits must be designed such that they work reliably under overpressure conditions.

⚠ WARNING

Failure of ventilation system

The correct function of the ventilation system in the magnet room and in cryogenic fluid container transport and storage locations is a general prerequisite for the safe handling of cryogen fluids. Therefore, the ventilation system needs to be maintained and its operation monitored continuously.

2.2.3 Oxygen Supervision

The correct function of the ventilation system in the magnet room and in cryogenic fluid container transport and storage locations is a general prerequisite for the safe handling of cryogen fluids. Therefore, the ventilation system needs to be maintained and its operation monitored continuously

In order to establish a second safety level, most important for magnets that contain also N2, Bruker BioSpin MRI recommends the installation of an oxygen (O2) supervision and alarm system in the magnet room and in storage locations for cryogen fluid containers.

An O2 supervision unit is not part of the delivery of the MR instrument. It is the responsibility of the System Owner to decide on the usage of O2 supervision and to install and maintain it. MR compatible O2 supervising units can be obtained from various commercial providers.

2.2.4 Emergency Plan

The conduct of staff and external parties in case of emergency must be included in the installation planning and must be communicated. Appropriate emergency access to the Control Acess Area must be tolerated. Therefore, the following organizations must be trained accordingly:

- Building administrators
- Fire department
- Police
- Emergency paramedics
- Building security

Attention must be paid in planning the facility to ensure that non-magnetic emergency equipment is available, or that it is possible to use the equipment safely within the Control Access Area:

- Provision & labeling of non-magnetic fire extinguishers
- Use of emergency lighting suitable for magnetic fields (see Chapter *Lighting system [▷ 69]*)
- Prevention of use of ferromagnetic oxygen cylinders by emergency personnel

- Clarify the use of defibrillators in the Controlled Access Area.

In addition, consider that in case of emergency other exits than those intended may be used in panic. Therefore, design

- Exits and emergency routes to work during over- or underpressure conditions.
- Label potential areas and routes that may also be used and avoid inappropriate escape routes.

2.2.5 Fire Prevention

The MR instrument does not require any dedicated fire prevention. If fire prevention apparatus is to be used at the installation site, the following notices should be heeded when planning installation:

- Many smoke detectors react to escaping helium gas. Already small amounts which may be released during maintenance work on the magnet may trigger a false alarm. To avoid inadvertent false alarms, detectors that are heat triggered should be used instead.
- Heat detectors and sprinklers often require access for regular maintenance work. Attention should be paid to ensure that these access points are not located in the area above the magnet, since maintenance is not possible there while the magnet is on field.
- To prevent damage to the magnet and to the MR instrument's control electronics due to false alarms, Bruker BioSpin MRI recommends to use so-called pre-action sprinklers.

2.2.6 Biological Safety

In relation to the health and safety of employees and laboratory animals, we refer to compliance with national standards and regulations.

Repairs by Bruker BioSpin MRI can only be carried out after decontamination of equipment has been demonstrated in writing and any damage to the health of Bruker BioSpin MRI employees has been ruled out.

Appropriate aids, access, and procedures that rule out any damage to the health of service personnel must therefore be provided for maintenance, service, and repair of the MR instrument.

- Measures and aids for cleaning and decontaminating hardware and accessories.
- Depending on biosafety level, site planning needs potentially consider a physical separation between hazard areas and other parts of the MR instrument, e.g. the technical room where separate access through a non-hazardous area may be reached.

2.2.7 Seismic Safety

Installations in areas at seismic risk require additional planning and potentially MR instrument modifications to be compliant with safety requirements. Siting and building construction constraints require early individual planning. Provisions are not within the scope of the MR instrument's standard delivery. See chapter *Seismic safety standards [▶ 57]* and contact your local Bruker BioSpin MRI planning office.

2.2.8 Safety at Work

Safety at work is in the responsibility of the System Owner and needs to be in compliance with the national regulations. Additional aspects arising from the installation of the MR instrument are typically:

- Exposure time to static and electromagnetic fields.

- High noise levels originating from the magnet room and the technical room.
- Ventilation in the magnet room, see *Ventilation and air conditioning [▶ 69]*, *Oxygen Supervision [▶ 15]*.
- Extraction of anesthetic gases where applicable, see *Anesthetic gas extraction [▶ 71]*.

Appropriate countermeasures are to be considered in an early planning phase.

See also

- USER WORK SAFETY DS - Isoflurane - Rev0 [▶ 18]

USER WORK SAFETY **Data Sheet**

Isoflurane

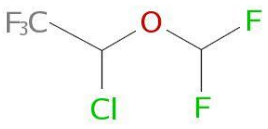
Anesthesia Gas

1-Chloro-2,2,2-Trifluoroethyl Difluoromethyl Ether; 2-Chloro-2-(Difluoromethoxy)-1,1,1-trifluoro Ethane; Forane

The substance/gas, **ISOFLURANE**, carries the **CAS-no. 26675-46-7**, regulated by the European **REACH regulation 1907/2006**. Isoflurane, a halogenated anesthetic gas, is a potential health hazard and safety procedures should be followed before/during its use to reduce risks (**see MSDS of supplier**)!

General Information:

EC#	:	247-897-7
CAS#	:	26675-46-7
OSHA IMIS #	:	F118
ICSC #	:	1435
RTECS #	:	KN6799000
Molecular Formula	:	$C_3H_2ClF_5O$



for Europe:

Within all EU member states, the European Work Safety Regulations must be followed:

- *see: **The European Commission Website – Health, Hygiene, Safety at work***

WAG - Waste Anesthetic Gas: *extract from: "UGA IACUC Isoflurane Safety Guidelines" / 2011*

Isoflurane is commonly used to anesthetize research animals. While safer than previous generations of halogenated anesthetic agents, efforts must be made to limit exposure risks to the user.
People working with **Isoflurane** and other volatile anesthetics can be exposed to waste anesthetic gas (WAG), especially in certain situations frequently encountered when anesthetizing rodents:

1. When using a nose cone/face mask that does not form a tight seal around the animal's face. WAG can leak around the mask into the room!
2. When using an induction chamber. Opening the charged chamber to retrieve the induced animal releases WAG into the room. Sliding induction chambers are safer than hinged.
3. When using an open system (bell jar, conical tube) rather than a vaporizer with scavenging.
4. When using a sterotaxic surgery device. WAG is released below the animal's head.
5. When a non-rebreathing system is not used, which allows more waste gas to be released from the supply tubing.

Signs of acute exposure: nausea, vomiting, nose/throat/respiratory irritation, headache, dizziness, drowsiness, skin irritation

Signs of chronic exposure: hypotension (low blood pressure), tachycardia (increased heart rate), respiratory depression, elevated blood glucose.

OSHA: OSHA has not established a permissible exposure limit (PEL) yet, but it is recommended that no worker should be exposed to greater than 2ppm of any halogenated anesthetic agent, such as **isoflurane**. Some European countries already have set PEL/MAK values!

Summary: Work Safety requirements towards Engineering Controls demand the following:

- *To take care before initial use*: **Isoflurane must only be used in a well-ventilated room from which there is no recirculation of exhaust air !**

2.2.9 Infrastructure Supervision and Messaging

In order to increase reliability and safety a supervision network may be considered that is interfaced to a central alarm network or messaging system. Consider:

- Smoke detectors.
- Access supervision of restricted areas.
- Process water supply for cooling system.
- Magnet room ventilation system (must).
- O2 supervision.
- Magnet status supervision via the magnet monitoring unit interlock signal (see technical room)

It is in the responsibility of the System Owner to decide and install appropriate measures such as

- acoustic and/or visual alarm signs within the MR and laboratory rooms.
- suitable alarm signals to a central supervision or alarm network of the building.
- automatic messaging for example via email or phone message to the supervising headquarter and/or staff in charge.

Bruker BioSpin MRI is not responsible for the connection to the supervision network or messaging system and not liable for failures or any possible damage caused when connecting the MR instrument to this system.

Suitable alarm notifying pathways and procedures must be established that also take into account absence of laboratory staff during week-end or vacation periods.

3 Standards

3.1 Standards

The device complies with the standard

- IEC 61010-1 and with UL 61010-1 / CSA C22.2 No. 61010-1-04 Safety Requirements for Electrical Equipment for Measurement, Control, and Laboratory Use
- IEC 61326-1 Electromagnetic Compatibility (EMC)

Upgraded instruments may not be EMC compliant.

Bruker does not guarantee compliance with electromagnetic compatibility for upgraded MR instruments that maintain old reused parts.

3.2 Environmental Conditions

The following environmental conditions must be fulfilled to maintain **electrical safety** at the installation site.

General conditions

- Indoor use
- Height up to 2000 m above sea level.
- Temperature range 5°C to 40°C
- Highest relative humidity 80% for temperatures up to 31°C, declining thereafter linearly to 50% relative humidity at 40°C
- Degree of pollution II

Electrical network specifications

- IP classification 20
- Power supply fluctuations no greater than +/- 10%
- Transient overvoltages as they normally occur in the main power supply

To achieve operational qualification of the instrument, the performance specifications of the different room areas must be met in addition to the environmental conditions. See Chapter *Planning Details [▸ 37]*.

3.3 National Standards Operating MR Instruments

Compliance with all national standards for operating MR instruments is in the responsibility of the System Owner (responsible body). The references to national standards listed in this document should not be regarded as complete or as generally valid.

Standards

4 Installation Schedule

4.1 Installation planning overview

Planning for a BioSpec® installation comprises the following subject areas:

- Characterization the planned installation site in terms of its suitability for MR
- Planning the laboratory structure and operational procedures
- Planning the structure of rooms and buildings
- Planning electronics and cable trays
- Planning air conditioning, water supply and room ventilation
- Planning safety devices

The main components of an installation should be included in the following rooms:

- Air-conditioned and sound-proofed magnet room, potentially with RF shielding
- Temperized technical room for the MR system's electronics
- Operating area and animal preparation area

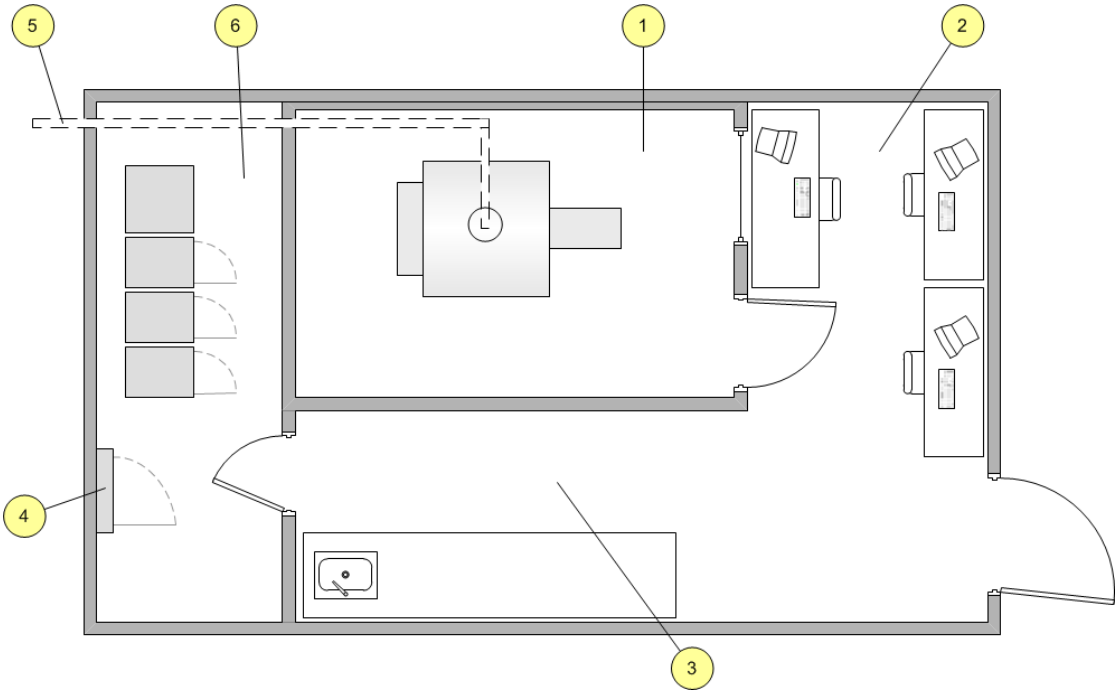
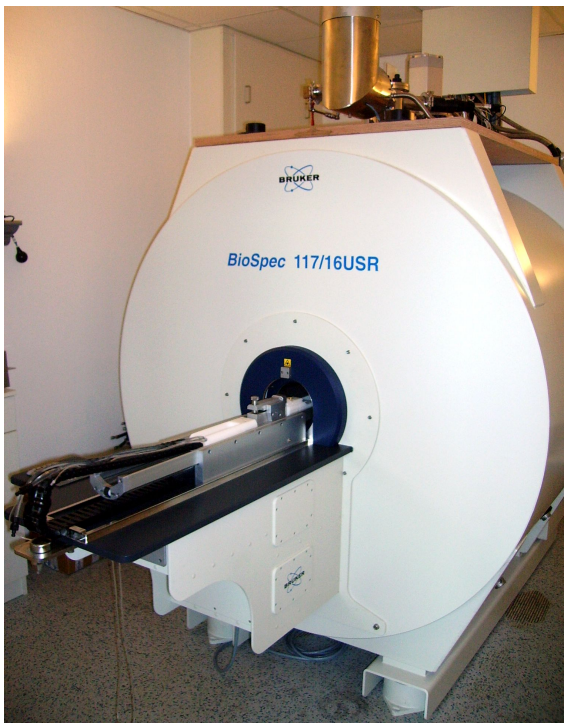
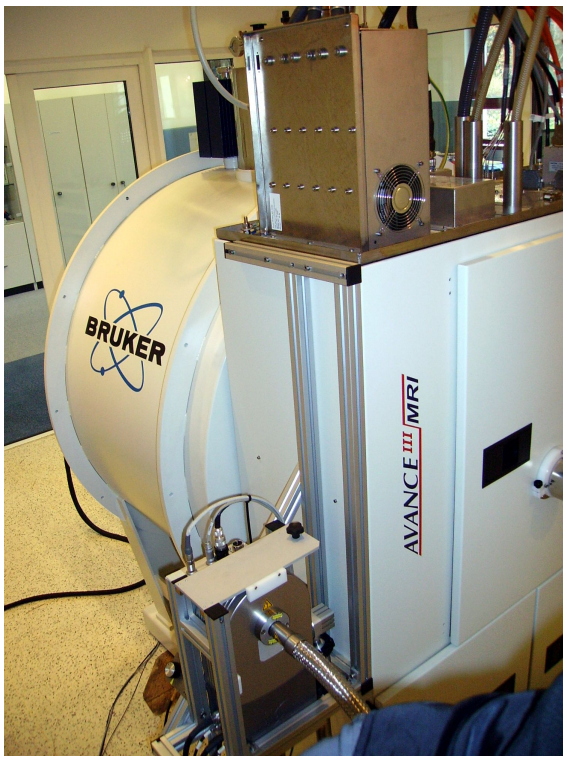


Figure 4.1: Installation planning overview

1	Magnet room	4	Power distribution panel
2	Operating area	5	Exhaust line and vent
3	Preparation area	6	Technical room





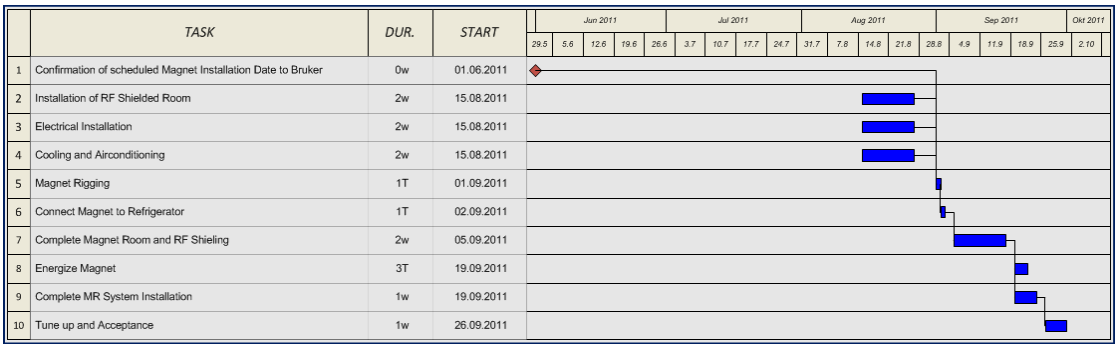
Top left	Magnet front view fitted with the AutoPac™ positioning system
Top right	Rear view of the magnet with CCM and an installed MRI CryoProbe™
Bottom left	Control electronics of an MR system with three cabinets (no cooling cabinet)
Bottom right	Cooling unit, compressor and gas cylinder of the MRI CryoProbe™ in the technical room

4.2 Planning aids

It makes sense for external expert planners to assist with installation planning and the conversion of plans into structural measures. Due to their many years of experience, Bruker BioSpin MRI and/or their local branch is able actively to support these. Contact the planning office of your local Bruker BioSpin MRI branch for this assistance.

4.2.1 Installation Schedule

The chronological sequence of a complete system installation is shown in the following illustration. The deadline for transferring the magnet planned at the outset and agreed with Bruker BioSpin MRI must be confirmed as binding to Bruker BioSpin MRI **12 weeks at the latest** prior to actual transfer. See chapter *Giving notice of readiness for shipment [▶ 25]* .



	TASK	DUR.	START
1	Confirmation of scheduled Magnet Installation Date to Bruker	0w	01.06.2011
2	Installation of RF Shielded Room	2w	15.08.2011
3	Electrical Installation	2w	15.08.2011
4	Cooling and Airconditioning	2w	15.08.2011
5	Magnet Rigging	1T	01.09.2011
6	Connect Magnet to Refrigerator	1T	02.09.2011
7	Complete Magnet Room and RF Shieling	2w	05.09.2011
8	Energize Magnet	3T	19.09.2011
9	Complete MR System Installation	1w	19.09.2011
10	Tune up and Acceptance	1w	26.09.2011

4.3 Prerequisites for delivery

4.3.1 Giving notice of readiness for shipment

Readiness for shipment is given on this basis of the *checklist for preparation for system installation [▶ 89]*. This needs to be signed by the MR system owner **12 weeks at the latest prior to the scheduled delivery** and sent to the local Bruker BioSpin MRI branch.

The delivery date stated therein is binding in the case of a delay in acceptance.

4.3.2 Prerequisites for Delivery

The following prerequisites must be fulfilled on the day the system is delivered:

- The storage sites must comply with the general *environmental conditions [▶ 21]*.
- The System Owner can provide qualified documents that all transportation routes are certified for heavy loads.
- All transport routes are openly accessible and meet the specifications for transport routes.
- Tools and materials for system transportation and storage are available in their entirety.
- If during temporary storage, the period between delivery and scheduled initial operation exceeds the permitted storage times of the magnets, the MR System Owner must organize maintenance of the magnet with cryogenic liquids (see *maximum shipment time [▶ 80]*). The temporary storage location of the cold magnet needs sufficient safety means for the storage of liquid cryogens, i.e. a suitable ventilation system.

4.3.3 Prerequisites for Operation

The following prerequisites must be fulfilled for before the system can be put into operation:

- A contact person who can continuously be reached must be named by the MR system owner.
- Access to the installation site must generally satisfy the local safety specifications that apply to MR systems.
- During the installation period, it must be guaranteed that only people authorized by the Bruker employee have access to the installation site.
- The Bruker employee needs to obtain a key allowing access the installation site. If necessary, he must be allowed access to adjacent rooms and/or buildings and circuit diagrams, as well as facilities and systems in the building.
- All technical specifications for the different areas must be met in full.
- All safety specifications must be met in full.
- The rooms must be clean and ready for occupancy. They must meet the specifications of environmental conditions/pollution level at the installation site.
- All necessary house connections for installation are available and operational.
- No construction work in progress at the installation site.
- Tools and materials needed to put the system into operation are available in their entirety.

It is explicitly pointed out that non-fulfillment of the technical and/or relevant safety specifications may lead to the stop of the system being put into operation and may be regarded as a delay in acceptance.

5 Laboratory Infrastructure and Interactions

The following chapters will describe the **planning factors**, which concern the operational procedure and possible interactions between the MR instrument and its surroundings.

5.1 Operational Workflow

Workflow is increased when using an MR instrument by including all operational procedures. Important topics are:

- Avoid long ways between magnet, preparation and operating area.
- Provide visibility between operating area and magnet opening.
- Optimize door swings to allow a smooth closing.
- Consider appropriate lighting in the different areas.
- Include storage areas for RF coils and accessories

In addition to the daily operating procedures, service activities should be considered:

- Cleaning the laboratory rooms.
- Maintenance of the MR instrument and access to the control electronics.
- Exchange of components or instrument upgrades.
- Interactions with other maintenance work in the laboratory infrastructure, e.g. servers or cooling systems.

5.2 IT Structures

The MR operating console can be incorporated into a local network using DHCP or a fixed IP address. Incorporation is not necessary to operate the MR instrument, but it does facilitate the procedures of:

- Data archiving on central servers.
- Data exchange between the operator console and analysis consoles.

If it is possible to connect externally to the Internet, support of operators by Bruker Service & Lifecycle Support is improved:

- Data exchange between operator and hotline
- Remote online support through direct access to the local workstation via WebEx or TeamViewer Services.

If mobile telephone connection is impossible in the operating and technical room, a standard telephone with international service needs to be provided.

5.3 Interactions

The MR instrument and its surrounding may affect each other based on the following interactions:

- magnetic interactions
- electromagnetic interactions
- building vibrations and impact noise
- room air and cooling systems

We distinguish

- **Standard Specifications:** Specifications for the MR instrument and the facility to be compliant with regulatory standards. The compliance guarantees the safe operation of the MR instrument. See chapter *Standards [▷ 21]*.
- **Functional Specifications of the MR instrument**: Compliance with the Functional Specifications is necessary to maintain the Operational Qualification of the MR instrument for example with regard to MR image quality. These specifications are usually more stringent than the Standard Specifications.

The following sections outline the interactions and the **Functional Specifications** originating thereof.

5.3.1 Magnetic interactions

5.3.1.1 Ferromagnetic mass

The quality of the magnetic field of the MR system is negatively influenced by ferromagnetic materials located in the immediate vicinity of the magnet.

This interference is generally caused by magnetic building materials in the immediate vicinity of the magnet. All ferromagnetic materials in the building structure must be considered, e.g.:

- Steel reinforcements in floors and walls
- Pipelines
- Structural steel and reinforcements
- Heating elements
- Steel doors and steel window frames
- Crane rails and hanging trolleys
- Sub-structures

Limit of ferromagnetic mass density:

If there are floors or walls in areas that lie within the area defined by the 0.5 mT stray field strength, the ferromagnetic mass density must not exceed 50 kg/m^2.

If possible, non-magnetic materials such as e.g. stainless steel or fiberglass reinforcements should be used in load-bearing structures for new builds. The structural designs for old buildings and those being converted must be analyzed by a technical specialist. If the ferromagnetic mass density exceeds the limit value, an alternative installation site should be considered.

In exceptional cases, installation can be carried out despite high ferromagnetic mass density. Discuss the situation and possible counter-measures with the planners from your local Bruker BioSpin office.

5.3.1.2 Mobile sources of magnetic disturbance

The quality of the results of the MR system is negatively influenced by moving sources of magnetic interference in the vicinity of the magnet.

Mobile sources of magnetic disturbance can be caused by the following:

- Underground trains/subways
- Elevators
- Forklifts or cranes
- Cars

Definitions

The minimum distance to mobile sources of magnetic disturbance is indicated as the distance to the position of the reference stray field line of the magnet.

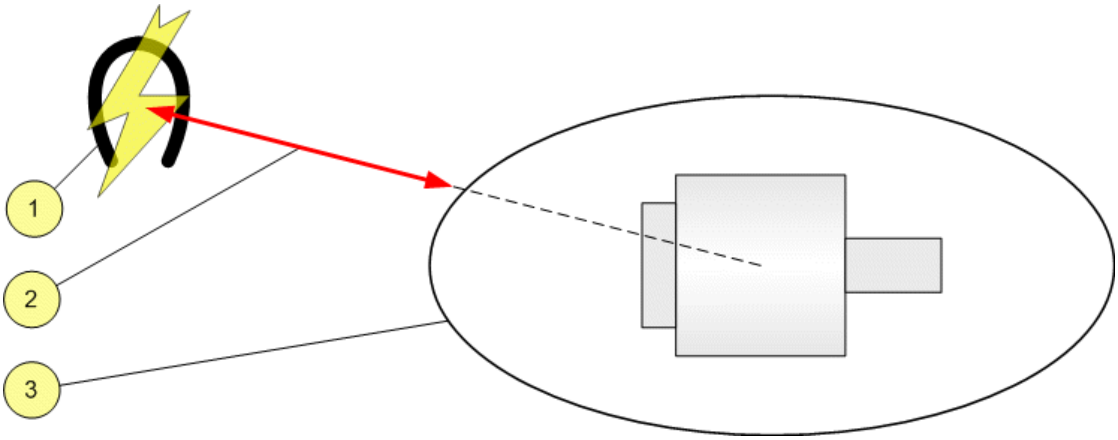


Figure 5.1: Mobile sources of magnetic interference

1 Mobile sources of magnetic disturbance

2 Minimum distance of mobile sources of magnetic disturbance

3 Spatial extent of the stray field reference

There should be no mobile magnetic sources of disturbance within the magnet area as indicated by **Table** *Table 5.1 [▶ 29]*. If this cannot be avoided, counter-measures should be taken by the builder, e.g. by shielding with soft-magnetic iron. Consult your local Bruker BioSpin MRI branch on the use of counter-measures.

Minimum distance [m]	Mobile sources of magnetic disturbance
0	ferromagnetic objects < 1 kg
0	ferromagnetic objects < 25 kg

Minimum distance [m]	Mobile sources of magnetic disturbance
2	ferromagnetic objects < 250 kg
4	ferromagnetic objects < 500 kg
6	ferromagnetic objects < 5000 kg
9	ferromagnetic objects > 5000 kg
40	subways, trucks, trains

Table 5.1: Limit values of magnetic disturbances

5.3.1.3 Effect of MR system to other equipment

The stray field of the MR system can lead to sustained disturbance of sensitive equipment in the vicinity of the system and to irreversible damage.

The following table gives threshold values on acceptable disturbance of some equipment. Before using equipment in the stray field of the magnet, check the acceptable fields in the manual or consult the manufacturer of the equipment.

Disturbance level (mT)	Equipment and systems
5	MR system electronics
3	Electric motors, cameras, mechanical clocks
1	Hard drives and mobile data media, credit cards, oscilloscopes
0.5	Medical implants, pacemakers, insulin pumps, neurostimulators, X-ray equipment
0.3	Ultrasound equipment, video cameras
0.2	CT scanners
0.1	CRT monitors, particle accelerators, electron microscopes, mass spectrometers, EEG equipment
0.05	X-ray image intensifier, gamma cameras

Table 5.2: Interference fields of equipment

5.3.1.4 Remote magnetic effects

The magnetic field of the MR system interacts with ferromagnetic materials built into the building. The interaction leads to magnetization of the ferromagnetic materials, which in turn may lead to an unexpected higher local magnetic field strength at distant sites.

A check must therefore be made as to whether there are ferromagnetic structures at the magnet's installation site, which may lead to the aforementioned effects at distant sites. If such structures exist, these areas must be measured, labeled or shielded separately after the magnet has been installed.

5.3.2 Electromagnetic interactions

In the event of faulty installation or incorrect operation of an MR system, electromagnetic interference to other equipment in the vicinity of the MR system can occur.

Electromagnetic disturbances to the MR system have a negative impact on the disturbance-free operation of an MR system.

Electromagnetic disturbances are either associated with conducted disturbances or transmitted by electromagnetic fields. It can be split into the following categories:

- DC interference, e.g. due to transient DC consumers
- Low frequency interference, e.g. in a frequency range between 1Hz and 1kHz
- High frequency interference, e.g. in a range of clock frequencies or NMR resonance frequencies

The disturbances may be of magnetic and/or electrical origin. Both types of disturbance are relevant for MR systems. Different measures must be considered for the different categories and different types of disturbance when the electromagnetic shielding is implemented.

5.3.2.1 DC and LF interference

DC interference is produced e.g. by elevators or subways. Very strong electromagnetic disturbance fields can thereby generated in the immediate vicinity of the DC conductor. Long-range, weak magnetic fields are generated in sections of the area spanned by the DC conductor that are to some extent far away.

Low frequency (LF) disturbance is often caused by transformers (50/60 Hz), ventilation motors (approx. 30-100 Hz), lighting facilities, or by railway lines (16 2/3 Hz).

Low frequency and DC interference are measured using a fluxgate magnetometer. Measurements must have a minimum accuracy of 100 nT and be carried out in the following places:

- **Magnet room**: In the area of the magnet volume, the z components of the field disturbance (parallel to the magnetic field axis) must be measured
- **Technical room** In the area of the electronics cabinet, all components of field disturbance must be measured

The course of the magnetic field disturbance must be logged and analyzed at different times of the day and over several hours.

Type of disturbance	Limit value
Disturbance over hours and days with constant progression	5 µT/h
Jumps and short-term disturbance	0.5 µT
50/60Hz disturbances as well as all higher harmonics	0.5 µT
Periodic disturbance up to 10 kHz	0.5 µT
Field disturbance due to lighting systems, measured at a distance of 5 cm from the source	0.5 µT

Table 5.3: Disturbance in the magnet room

Type of disturbance	Limit value
50/60 Hz disturbance as well as all higher harmonics	0.5 µT
Periodic disturbance up to 10 kHz	0.5 µT

Table 5.4: Disturbance in the technical room

The table below displays **experimental values** for different sources of disturbance and the typical minimum distances. This table does not, however, replace the measurement of local disturbance.

Type of disturbance	Typical minimum distance
DC/AC trains	40 m
Transformers > 1500 kVA	15 m
Transformers > 500 kVA	10 m
Transformers: > 100 kVA	6 m
electric lines: > 500 A	6 m
electric lines > 100 A	2 m

Table 5.5: Disturbance in the vicinity

Countermeasure

The safest countermeasure is the avoidance of sources of disturbance in the immediate vicinity of the magnet. If this cannot be avoided, countermeasures with in the building can also be taken, e.g. by using an active shield (MACS) in the HF shielding cabin or by shielding with soft-magnetic iron. Contact the planning office of your local Bruker BioSpin MRI branch.

5.3.2.2 RF interference

High-frequency disturbance can be produced among others by the following objects in the vicinity of the MR instrument:

- Local transmitting stations for wireless analog or digital transmission of media or telecommunications signals, e.g. digital television transmitters or mobile telephones.
- Computer processors
- Satellite systems
- Other MR instruments.

If the frequencies of transmission are in the range of the system's operating NMR frequencies, massive disturbances with the operation of the system must be anticipated.

High-frequency interference is measured using a calibrated spectrum analyzers and a calibrated antenna. The measuring equipment must have an accuracy of at least 5 dBµV/m and the measurement must take place at the planned installation site.

The following table gives an overview of the various frequency ranges for commonly used NMR nuclei. Every area must be scanned with a sweep width of <400 kHz and with sufficient accumulation.

Magnetic flux density	19F-1H	X nuclei (15N-31P)
3.0 T	120 – 129 MHz	12 – 53 MHz
4.7 T	187 - 202 MHz	18 – 83 MHz
7.0 T	281 – 302 MHz	28 – 123 MHz
9.4 T	375 – 402 MHz	39 – 164 MHz
11.7 T	470 – 502 MHz	49 – 204 MHz
15.2 T	611 – 652 MHz	64 – 265 MHz

Table 5.6: Frequency ranges for commonly used NMR nuclei

The following disturbance levels should be taken into account:

19F–1H	X nuclei (15N-31P)
30 dBµV/m	30 dBµV/m

Table 5.7: Maximum disturbance level

If increased disturbance is observed in this area, the frequency range concerned must be analyzed more precisely and one of the following counter-measures taken when planning installation:

Countermeasure

The safest countermeasure is the installation of an MR system in an HF shield. The following table provides a recommendation for the general use of an HF shielding measure for the different types of magnets.

Shielding measure 47/40 USR V2	
Recommended RF shielding	Faraday cage
Possible HF shielding	
Option Faraday Cage	Yes
Option AUTOPAC	Yes

Table 5.8: BioSpec RF shielding measure

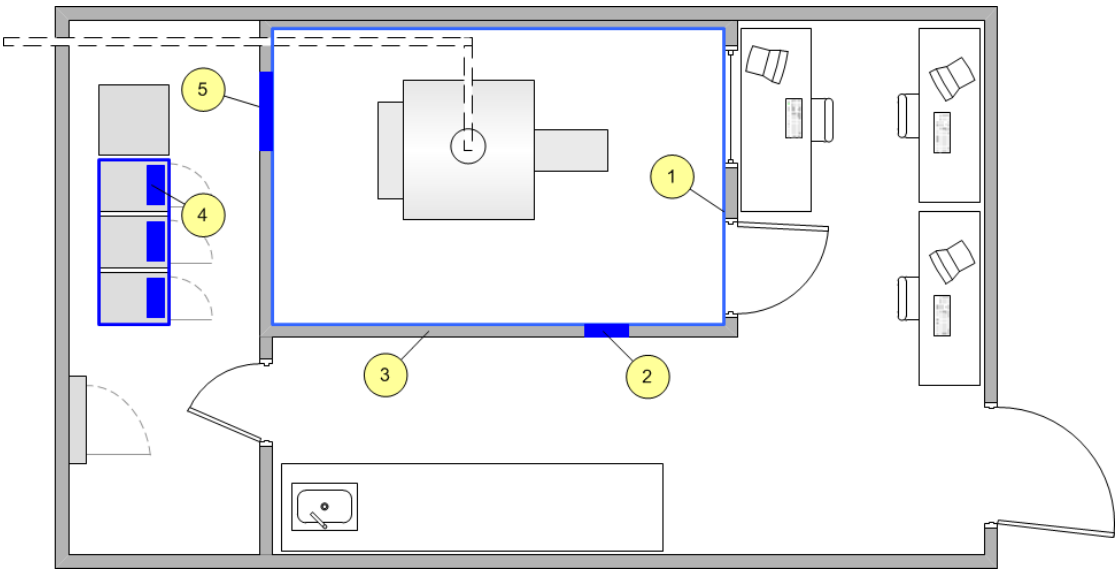


Figure 5.2: Installation in an RF shielded cabin (Faraday cage)

1 Faraday cage with windows and doors

2 Anesthesia filter plate

3 Acoustic insulation

4 RF shielded electronics cabinets

5 RF filter plate for installation of supply lines and wiring

The RF shielded areas and the RF shields are marked in blue

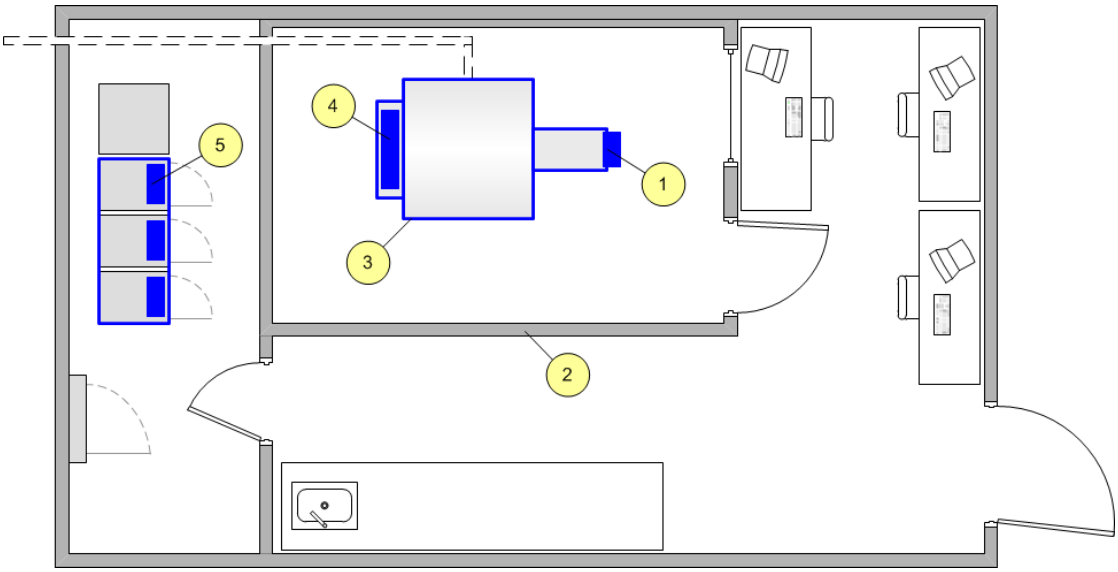


Figure 5.3: Installation with an AutoPac™ RF shield

1	RF shielding at the user end of the magnet
2	Acoustic insulation
3	RF shielded magnet housing
4	RF shielding at the service end of the magnet
5	RF shielded electronics cabinets
—	The magnet itself is RF shielded. Other shielded areas are marked in blue

5.3.3 Mechanical interactions

5.3.3.1 Ground and building vibrations

Increased mechanical vibrations at the magnet's installation site negatively influence the quality of the measurement results of an MR system. All MR systems are therefore installed with passive vibration absorbers.

Possible sources causing strong floor vibrations are:

- Railways and subways in the vicinity of the installation site
- Elevators, doors, and transport routes in the immediate vicinity of the magnet area
- Ventilation motors and compressors in the vicinity of the installation site
- Building vibrations on higher floors

Building vibrations are measured using a calibrated accelerometer in a frequency range between DC and 200 Hz. The measuring equipment must be accurate to within 0.05 mm/s^2. Measurements are taken at the planned installation site of the magnet.

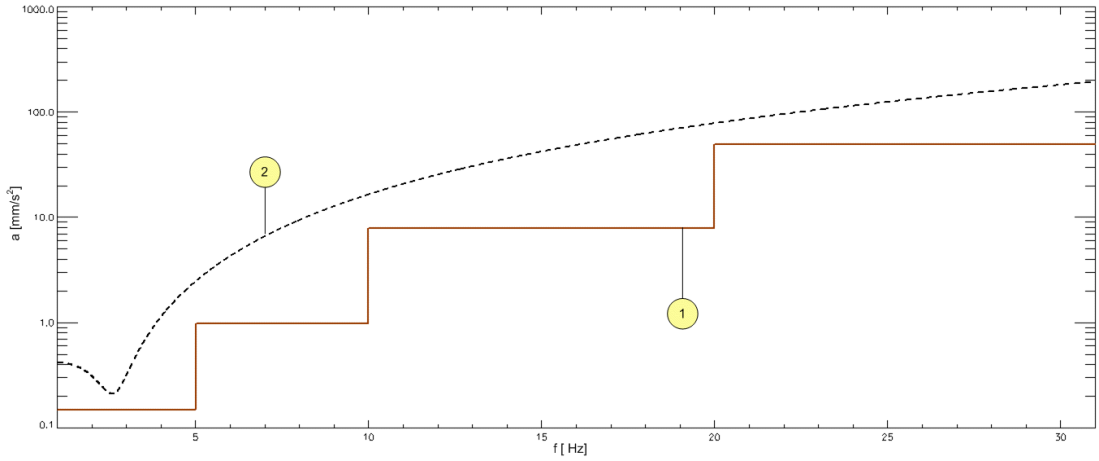


Figure 5.4: Limit values of the floor vibrations

1 Maximum acceptable floor vibrations at the installation site

2 Typical distribution of a magnet system's tolerance to floor vibrations

Frequency range	max. acceptable acceleration (mm/s2)
0 – 5 Hz	0.15 mm/s^2
5 – 10 Hz	1.00 mm/s^2
10-20 Hz	8.00 mm/s^2
> 20 Hz	50.0 mm/s^2

Table 5.9: Max. acceptable accelerations within different frequency ranges

Countermeasure

The safest countermeasure is the avoidance of increased floor vibrations at the magnet's installation site. If this cannot be avoided, countermeasures concerning the building structure and floor construction can also be taken by the builder.

The following points have proven to be advantageous when selecting a suitable installation site:

- The magnet foundation should be firmly connected to the floor
- Floor plates and ceilings that span large areas are prone to higher floor vibrations, therefore installation in corners of buildings is beneficial
- Installations on lower floors can be achieved uncritically compared with installations on higher levels
- Avoid areas of non-decoupled elevators and heavily used transport routes within the building
- Railway/subway lines should be more than 40 m away from the building

If none of the alternatives mentioned can be realized, additional passive or active vibration decoupling must be evaluated by the builder. Please contact an engineering firm specializing in building vibrations for this and contact your local Bruker BioSpin MRI branch.

5.3.3.2 Impact noise

No significant coupling of impact noise into the building is to be expected due to the installation of the MR magnets on passive absorbers.

5.3.3.3 Acoustic

Increased sound levels occur in the following areas of an MR system:

- **Technical area**, due to cooling units and ventilators, up to 70 dB(A) depending on the system type.
- **Magnet room,** due to switching of field gradients, levels of 85 to 100 db(A) depending on the type of measurement can occur in the magnet area. The sound level of a measurement ultimately depends on the method selected by the user and the time it takes.

To comply with the local guidelines for safety at work, we recommend that appropriate acoustic absorption is provided for both areas. The necessary acoustic insulation depends on the local limit values and cannot therefore generally be specified.

The following points have proven to be appropriate measures for reducing the noise level:

- **Acoustic insulation should decrease the noise level between the magnet area and the operating area of the system by 35-40 dB(A)** . Standard Faraday cages provide sufficient acoustic absorption in their side walls and ceiling.
- A structural separation with common sound insulation is sufficient between the **technical area** and **operating area** of the system.

6 Planning Details

Details of preparation of various parts of the installation are provided in the following chapters. Due to the fact that multiple specialists are involved in the planning, the contents are divided accordingly.

6.1 Measurements and room dimensions

6.1.1 Overview

The **room dimensions** and the **distances** between the different areas of an MR system are in accordance with the following criteria:

- the local amount of planning freedom
- according to the constraints indicated by the manufacturer

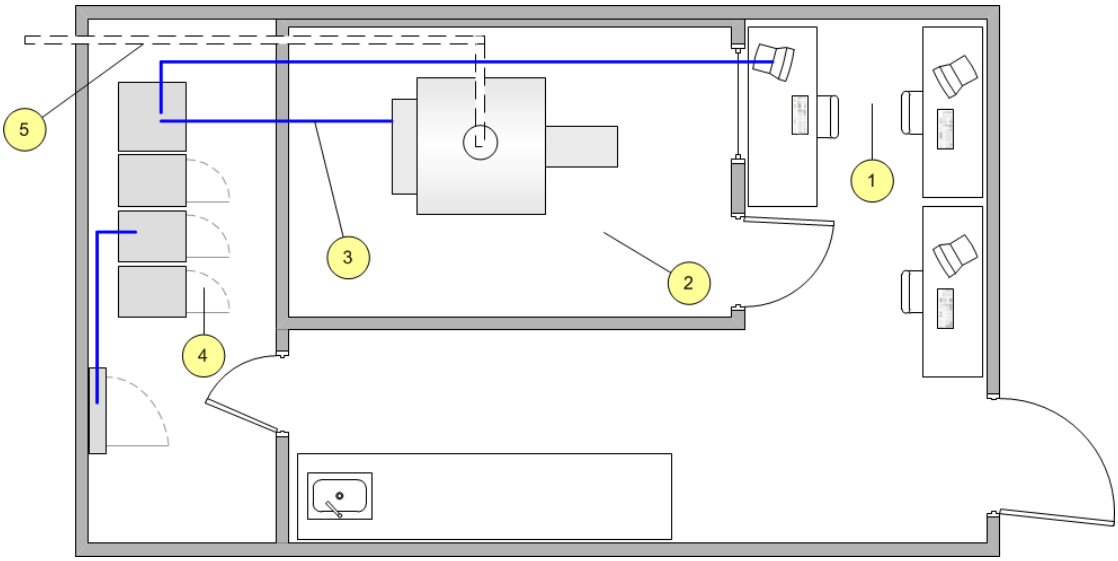


Figure 6.1: Diagram of the manufacturer's room constraints.

1 Space required in the operating area

2 Space required the magnet area

3 Available cable lengths between magnet area, operating area, and technical area

4 Space required in the technical area

5 Maximum length of the exhaust system

6.1.2 Operating area

The minimum amount of space required in the operating area is indicated by the size of the laboratory furniture. This must allow installation of a PC control computer with monitor and peripherals. Additional specifications for the space required may result from local guidelines for organizing the work place, from the number of MR datastations planned and from the operational procedures and routes planned.

6.1.3 Magnet Area

The minimum amount of space required for the magnet area is determined by the magnet's dimensions, its stray field, and by the optional use of a Faraday Cage.

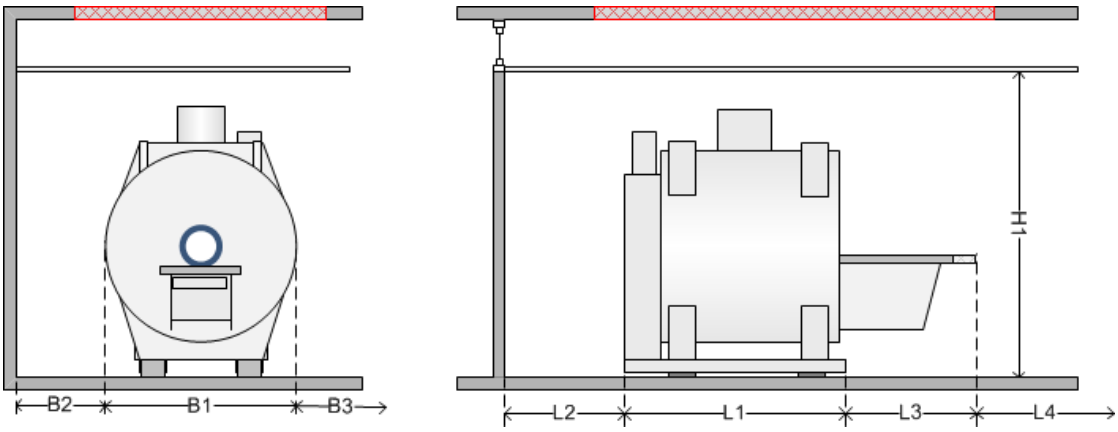


Figure 6.2: Magnet area and dimensions. No fire-prevention facilities requiring regular maintenance work may be incorporated in the areas shaded red above the magnet.

Space required 47/40 USR V2	Dimensions	Value
Magnet length (including CCM/CCM-light, excluding magnet table)	L1	190 cm
Magnet width	B1	165 cm
Minimum ceiling height	H1	285 cm
Minimum distance to wall on the servicing end of the magnet (from CCM)	L2	82 cm
Length of standard table at user end	L3	138 cm
Length of AutoPac™ table at user end	L3	136 cm
Minimum distance between wall and table at the user end	L4	50 cm
Minimum distance from wall	B2	Defined by the ferromagnetic density of the wall and the stray field plot
Minimum opening at the side	B3	typically approx. 100 cm
Proposed floor space (L x W)		4.8 m x 2.9 m

Space required 47/40 USR V2	Dimensions	Value
Access door, minimum width for He refill can		100 cm

Table 6.1: Minimum space required for magnets 47/40 USR V2

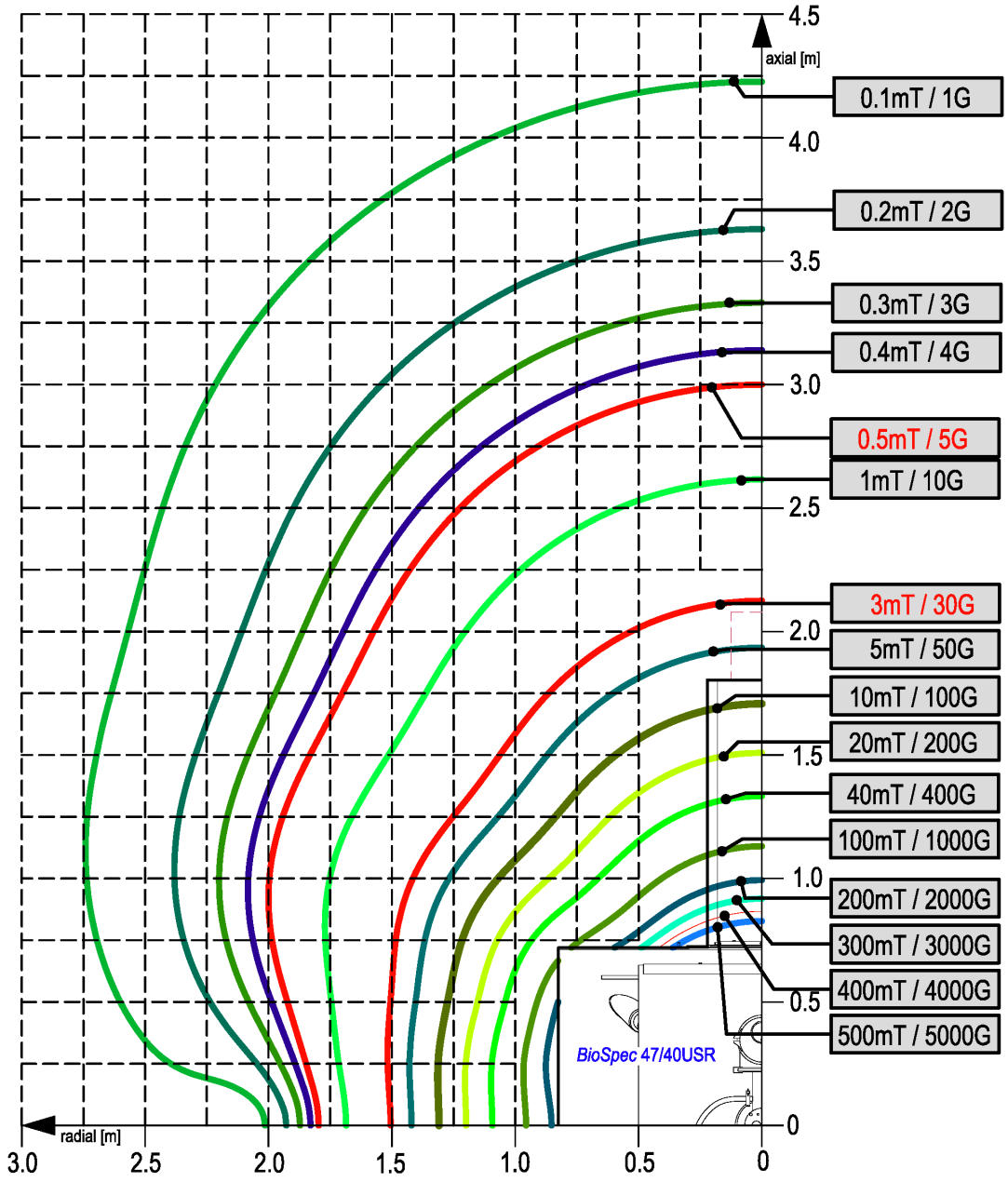


Figure 6.3: Stray field of BioSpec® based on magnet 47/40 USR V2.

RF shielded cabin (Faraday Cage)

Use of a Faraday Cage increases the size of the building shell needed for the magnet area in each direction by at least 30-40 cm. The height of the ceiling may be increased depending on the design by up to 65 cm. Further details on planning a Faraday cage are given in the chapter on Faraday cages.

6.1.4 Technical area

The minimum space required in the technical area is determined by the basic configuration and the options selected. When planning the floor space, access to the units must be taken into account.

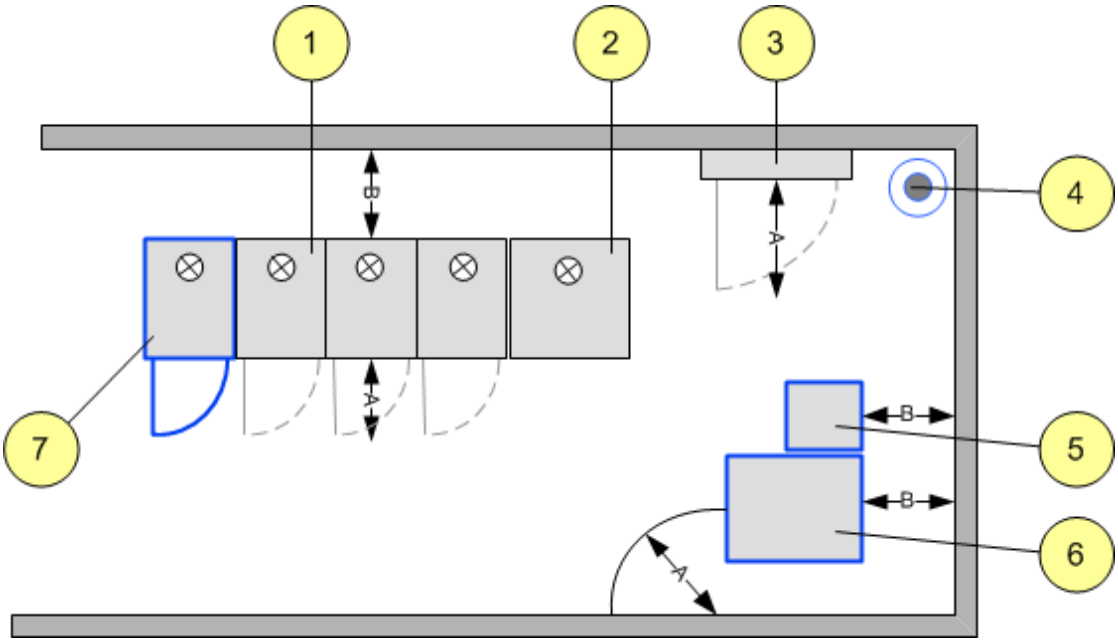


Figure 6.4: Minimum space required in the technical area

1	Electronic cabinets, connections on top
2	Magnet and gradient cooling, including magnet compressor, connections on top
3	Line Power Distributor, connections on bottom
4	Optional for MRI CryoProbe™: Helium tank, connections on top
5	Optional for MRI CryoProbe™: Compressor, connections on the front and back
6	Optional for MRI CryoProbe™: Cooling unit, connections on the front and back
7	Optional for MRI Parallel Transmit™ Electronic cabinet, connections on top
A	Minimum space required in **front** of the various units
B	Minimum space required **behind** the various units
	Optional extensions to an MRI instrument

Unit	Number	Size (width x length x height)	A	B
Electronic Cabinets	2	each 60 x 80 x 200 cm	90 cm	55 cm
High Power Gradient Cabinet	1	60 x 90 x 200 cm	90 cm	45 cm
Cooling Unit (DLHE)	1	80 x 80 x 200 cm	90 cm	55 cm
Line Power Distributor (wall assembly)	1	76 x 22 x 76 cm	85 cm	-/-

Table 6.2: Measurements of objects in the technical area

Unit	Number	Size (width x length x height)	A	B
CRP Cooling Unit	1	75 x 79 x 98 cm	70 cm	30 cm
CRP Compressor	1	45 x 49 x 59 cm	30 cm	30 cm
CRP Helium Tank	1	50 liter tank	-/-	-/-

Table 6.3: Measurements of the MRI CryoProbe™ units in the technical area

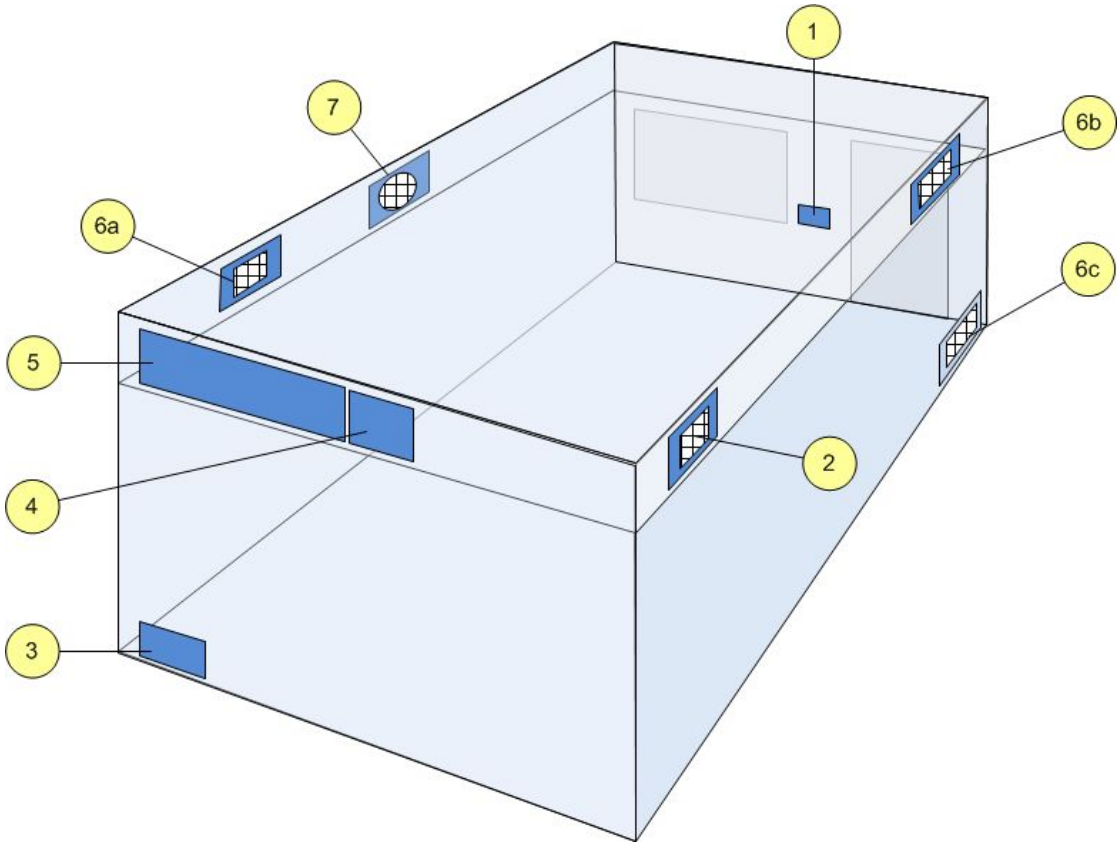
6.2 RF Shielded Room

The purpose of a RF shielded room (Faraday Cage) is to shield the inner room of the cage from disturbing RF electromagnetic radiation. The fundamental prerequisite for this is that:

- the room is designed to be free of unfiltered power lines and uncontrolled electromagnet radiation penetration.
- the room is earthed solely at the central earth point of the MR instrument and is otherwise electrically insulated and thereby free of ground loops.

6.2.1 Filter plates

When planning the Faraday cage, the following openings should be provided for **filter plates** and shielded **exhaust vents** these openings depend on the system's configuration.



Schematic overview of the positions of the filter plates of an Farady cage corresponding to the example of the room layout in Fig. 6.2.

1	in-vivo filter plate	free positioning
2	Anesthetic gas filter plate	free positioning
3	MRI CryoProbe™ filter plate	recommended position
4	magnet filter plate	recommended position
5	electronics filter plate	recommended position
6	cabin ventilation filter plate	free positioning
7	magnet exhaust gas filter plate	recommended position

Filter plate (supplier)	Use	Supplier
electronic filter plate	feed of power lines of the control electronics	• contained in the basic equipment • supplied by Bruker
magnet filter plate	feed for USR magnets	• contained with USR magnets • supplied by Bruker

Filter plate (supplier)	Use	Supplier
anesthetic gas filter plate	anesthetic gas extraction at the magnet	• contained in the RF cabin option • supplied by Bruker
magnet exhaust gas filter plate	opening for the magnet's gas extraction system	• contained in the RF cabin option • supplied by Bruker
MRI CryoProbe™ filter plate	Feed for MRI CryoProbe™:	• contained in the RF cabin & MRI CryoProbe™ option • supplied by Bruker
in-vivo filter plate	feed for lines for animal monitoring	• optional order from Bruker
cabin ventilation	RF filters for ventilation and fresh air supply to the Faraday cage	• contained in the RF cabin option • supplied by Bruker

Table 6.4: Use of filter plates

In order to be able to upgrade the system easily at a later date, it is recommended that the initial planning allow the openings in the Faraday cage to be compatible with potential extensions of the system and that these currently unused openings be sealed with suitable covers until needed.

If a suspended ceiling is used in the Faraday cage, the filter plate should be located therein in its entirety. All power lines therefore run above the ceiling, which leads to a clean looking installation.

The RF seal of the Faraday cage must be guaranteed when inserting the filter plates. Two installation variants can be applied:

- **Use of an installation frame:**
  this design is preferred for all filter plates that may possibly be repeatedly de and reinstalled, e.g. *in-vivo* filter plate.
- **Directly screwed to the box:**
  This design is applied to all permanent filter plates of the cabin infrastructure, e.g. cabin ventilation.

Care should be taken in both cases to ensure that the supporting and contact surfaces are absolutely plane. The contract surfaces must be sealed prior to assembly of the filter plate with HF sealing tape.

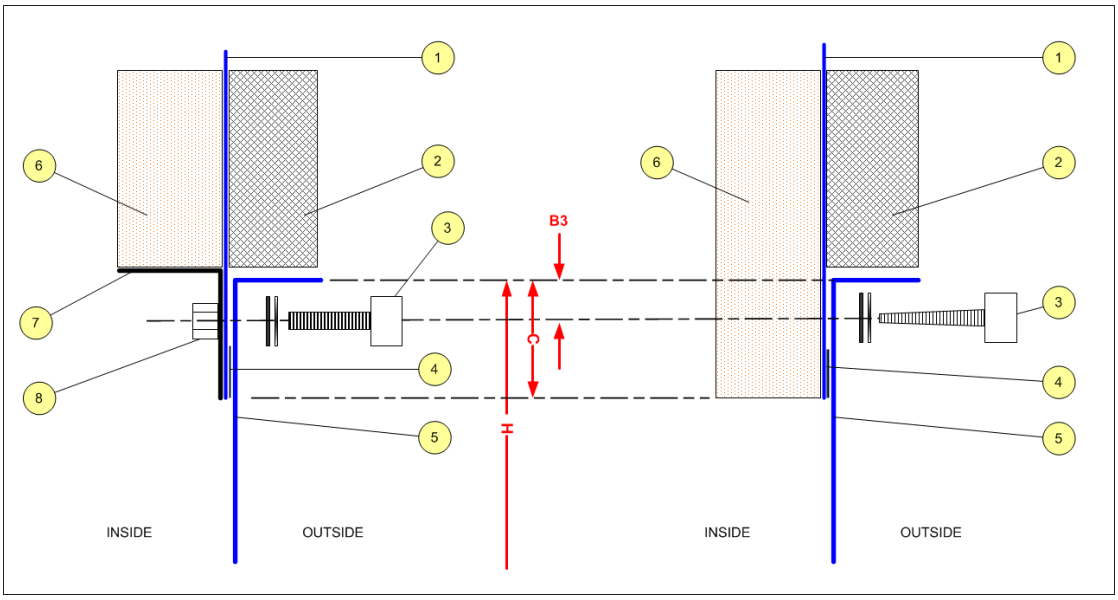


Figure 6.5: Assembly of filter plates with an installation frame (right) and directly screwed to the cage (left)

1	sheet copper of the Faraday cage
2	external insulation of the shielding box
3	Allen screw with spring ring and washer
4	RF sealing tape
5	filter plate
6	inner lining and inner frame of the filter plate opening
7	aluminum frame on which to place the filter plate
8	press nut
H	Height of the filter plate
C	Width of the supporting surface
B3	Distance to bore hole

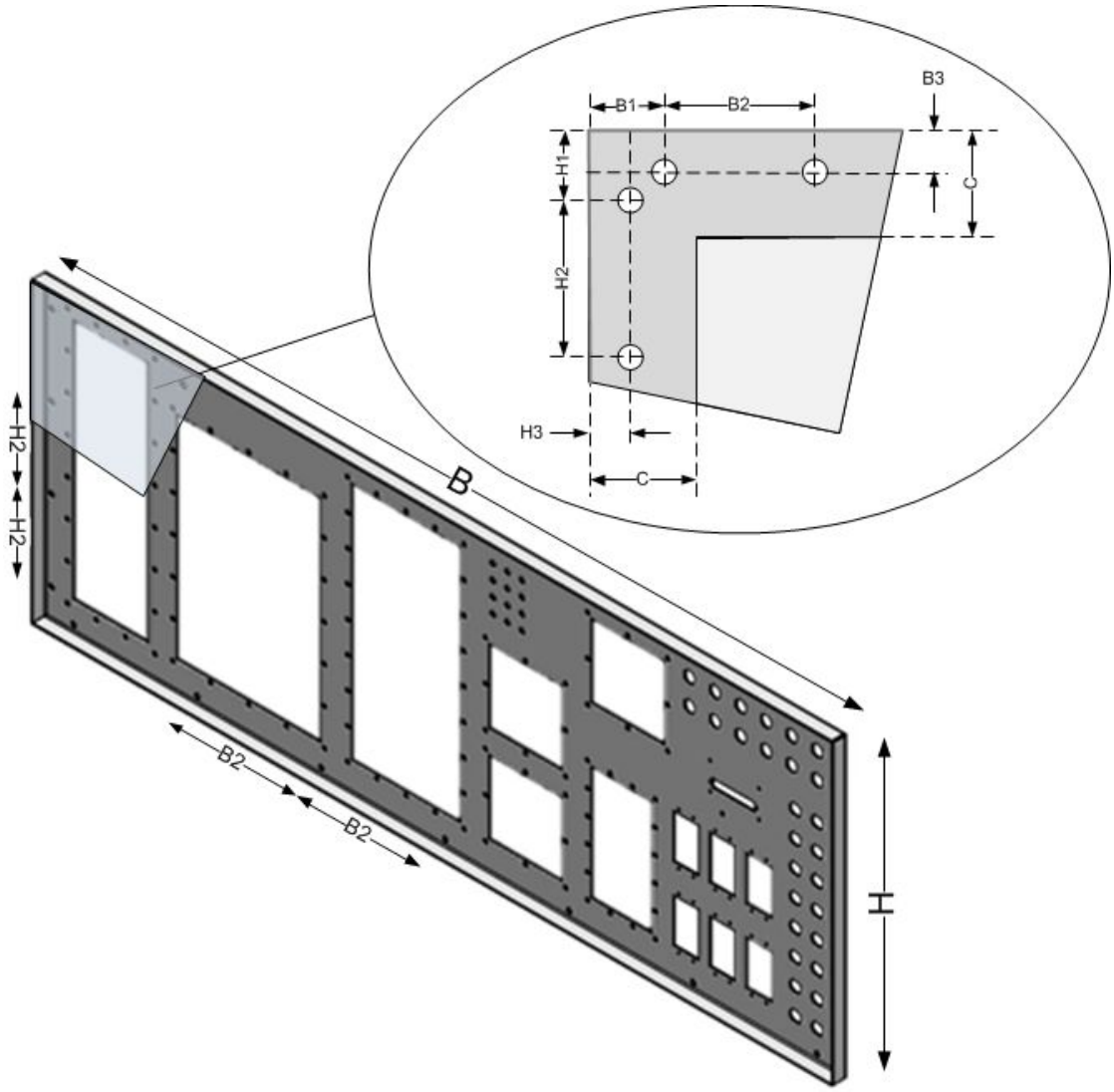


Figure 6.6: Dimension diagram of filter plates

H	Height
B	Width
D	Diameter of the bores
B1	Horizontal distance to first hole
H1	Vertical distance to first hole
B2	Horizontal distance between holes
H2	Vertical distance between holes
B3	Horizontal distance from edge of filter plate to center of bore hole
H3	Vertical distance from edge of filter plate to center of bore hole
C	Maximum frame width

If there are no detailed drawings for the filter plates described below, the measurements to be used are those found in the following table.

Filter plate	H	B	D	B1	H1	B2	H2	B3	H3	C
	[mm]									
Electronics	410	1100	7	40	40	170	110	10	10	22
Magnet	220	450	7	45	50	120	120	7	7	22
Anesthetic gas extraction	195	195	7	10	10	87,5	87,5	10	10	22
Magnet exhaust vent	260	260	6,5	10	10	80	80	10	10	22
MRI CryoProbe™	270	340	5	12,5	12,5	105	122,5	12,5	12,5	22
In-vivo	200	280	7	10	10	130	90	10	10	22
Ventilation	See chapter *Filter plate for Faraday cage ventilation [▶ 48]*									

Table 6.5: Measurements of the individual filter plates

Example calculation for the wall opening of the magnet filter plate:

Wall opening magnet filter plate (width): B – 2*C = 450 – 2*22 = 406 mm

Wall opening magnet filter plate (height): H – 2*C = 220 – 2*22 = 176 mm

6.2.1.1 Electronic filter plate

Position, alignment, and assembly

- In a horizontal position approx. 5 cm below the ceiling of the Faraday cage.
- The ideal position is on the wall adjacent to the technical room, as close as possible to the service end of the magnet. If another position is selected, unnecessarily long cable lengths must be anticipated.
- The electronic filter plate is assembled in an installation frame.

6.2.1.2 Magnet filter plate

Position, alignment, and assembly

- In a horizontal position approx. 5 cm below the ceiling of the Faraday cage. The magnet filter plate is assembled directly beside the electronic filter plate.
- The ideal position is on the wall adjacent to the technical room, as close as possible to the service end of the magnet. If another position is selected, unnecessarily long cable lengths must be anticipated.
- The magnet filter plate is assembled in an installation frame.

6.2.1.3 Filter plate for anesthetic gas exhaust

Position, alignment, and assembly

- Beneath the ceiling of the Faraday cage
- The ideal position is directly above the service end of the magnet, above the CCM
- The anesthetic gas filter plate is assembled in an installation frame or directly screwed to the cage

For further details, please see chapter *Anesthetic gas extraction [▶ 71]*.

6.2.1.4 Filter plate for magnet exhaust system

Position, alignment, and assembly

- On the ceiling or on the side wall beneath the ceiling of the Faraday cage.
- The ideal position is determined by the position of the external outlet of the exhaust vent. The position should be selected so that the length between magnets and outlet is minimal and can be produced with as few bends as possible (see chapter *Exhaust system [▶ 14]*)
- The gas filter plate is assembled in an installation frame or directly screwed to the cage.

The installation of the exhaust system at one of the side walls of the magnet area is advantageous in terms of possible future upgrades of the magnet.

6.2.1.5 MRI CryoProbe™ filter plate

Position, alignment, and assembly

- Near the floor.
- The ideal position is determined by the position of the cryo-coolers. The position should be selected in such a way that the distance between the MRI CryoProbe™ preamplifier and the cryo-refrigerator cooler is the absolute minimum possible. The minimum bending radius of the MRI CryoProbe™ transfer lines of 70 cm must be taken into account at the planning stage.
- The MRI CryoProbe™ filter plate is assembled in an installation frame.

6.2.1.6 In-vivo filter plate

Position, alignment, and assembly

- At a comfortable working height.
- The ideal position is determined by the position of the animal monitoring units in the animal preparation area.
- The *in-vivo* filter plate is assembled in an installation frame or directly screwed to the cage

6.2.1.7 Filter plate for Faraday cage ventilation

Position, alignment, and assembly

- Fresh and ventilation in the ceiling area, exhaust in the floor area
- The ideal position is determined by the position of the air conditioning system connections. Air ducts should not blow directly on to the magnet.
- The filter plate for the fresh air supply is assembled in an installation frame or directly screwed to the cage.

6.3 Exhaust system

The magnet may only be installed or operated with a **gas extraction system for cryogenic gases (quench pipe)**. In the case of a quench, large volumes of cryogenic gases are safely removed outside using the gas extraction system.

⚠ WARNING

Warning of injury by cryogenic gases

The gas extraction's outlet to the outdoors must be designed in such a way that no one is able to come into contact with cold gases.

⚠ CAUTION

Danger of fire due to liquid oxygen

In the event of a quench, condensation of oxygen may occur along a thermally non-insulated exhaust vent. To avoid the resulting risk of fire, the exhaust vent must be thermally insulated.

The exhaust vent is not an integral part of the delivery of the system and is a structural service which must be provided by the System Owner.

The connection point is:

- the outlet on the magnet, if installation occurs without an RF shielded room

or

- the pipe connection of the galvanic insulated feed through of the RF shielded room, if the shielded RF room was ordered from Bruker BioSpin.

The following criteria must be met when designing the exhaust vent:

- Vent routing and pressure drop
- Position of the connection point in the magnet room
- Vent outlet design
- Electrical grounding

Your local Bruker BioSpin office will be happy to help you with planning the exhaust vent and is able to supply you on request with suitable quench pipe components.

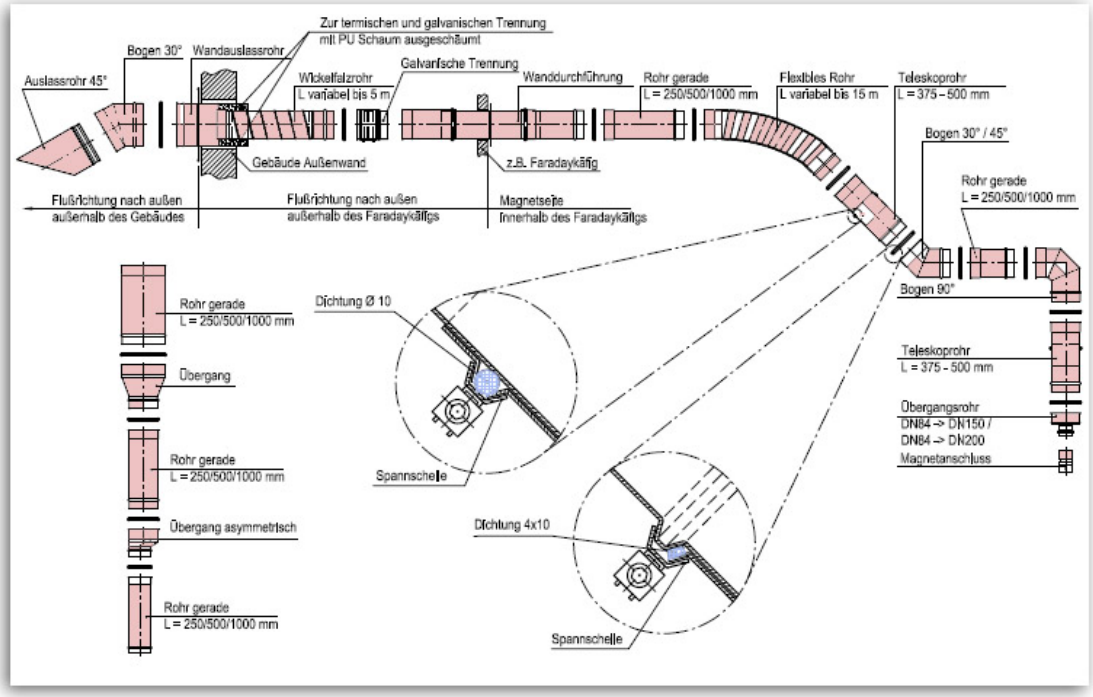


Figure 6.7: Example of an exhaust vent system.

6.3.1 Design criteria of the exhaust system

The exhaust system must be designed and calculated in such a way that:

- The connection of the exhaust vent is immediately above the magnet's outlet point.
- The maximum pressure drop along the line does not exceed 400 mbar.
- A bursting pressure of at least 500 mbar is guaranteed.
- No magnetic materials are applied in the vicinity of the magnet.
- The exhaust vent must be gas-proof within the building.
- The exhaust vent must be thermally insulated with a non-flammable material at least 40 mm thick including a vapor barrier.
- horizontal vent routings provide a downgrade that prevents liquids running into the magnet system.
- The outlet into the open air is designed such that there is no risk to people in the event of a quench within a radius of 3 m. The gas temperature when leaving the magnet is – 269 degree Celsius. It increased typically only by 3 (thin wall) to 5 (thicker wall) degree Celsius per meter of the exhaust line. Thus, at the outlet of the exhaust line, preventions have to be taken to avoid contact with extremely cold gas.
- The outlet into the open air prevents penetration by animals and/or water.

If parts of the exhaust vent are electrically grounded on the building side, a galvanic insulation must be used between the external grounding point and the connection point on the magnet. The galvanic insulation must be located as close as possible to the magnet. In the event of installation in a RF shielded room, galvanic insulation must located immediately after the duct through the Faraday Cage.

The galvanic insulation must be installed in each case to avoid ground loops or RF couplings.

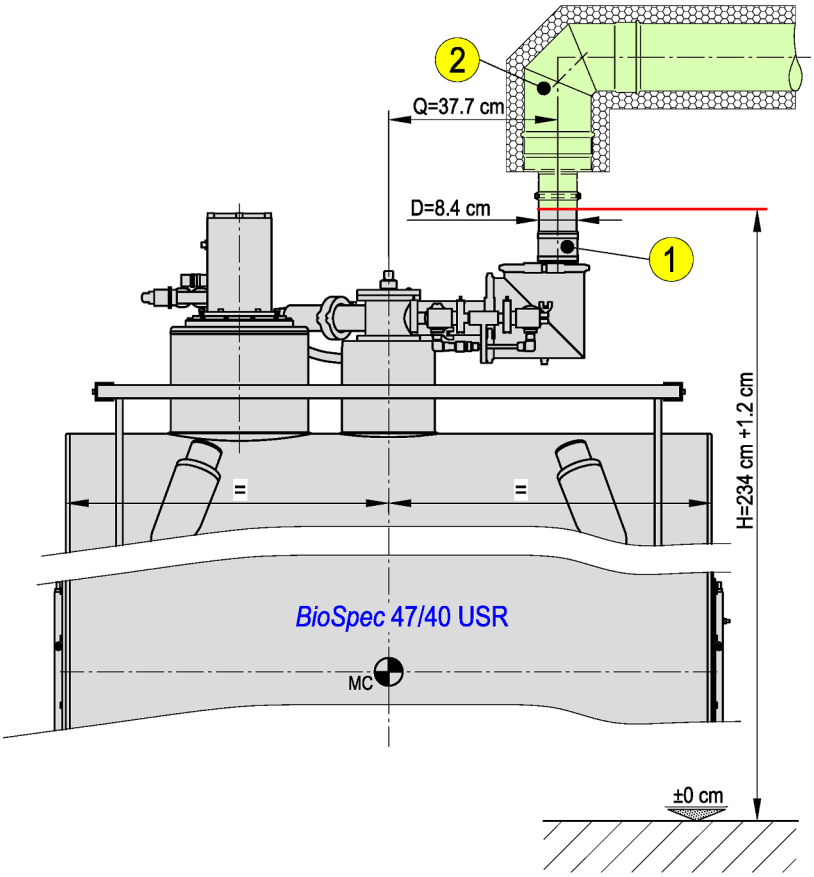


Figure 6.8: Drawing of the magnet exhaust outlet (1) and the exhaust system (2). Note that (1) is supplied by Bruker and (2) is to be installed by the System Owner.

Position of the connection point between the magnet exhaust outlet and the exhaust system for 47/40 USR V2		
Q	Distance of the magnet exhaust outlet from the center of the magnet dewar.	37.7 cm
D	Diameter of the magnet exhaust outlet at the connection point.	8.4 cm
H	Height where the exhaust system provided by System Owner has to end. Please note the minimum height and maximum tolerance (see also drawing) to ensure appropriate connection to the magnet exhaust outlet.	234 +1.2 cm

6.3.2 Calculating the exhaust system

The following aspects must be considered when calculating the exhaust system:

- effects of force in the event of quenching
- Pressure drop along the duct

The following table provides the effects of force on 90° bends for different pipe diameters. The exhaust vent must be installed so that it is able to withstand the forces listed in the event of quenching.

Quench pipe diameter:	DN 150	DN 200	DN 250	DN 300
Cross-sectional area, A:	176 cm²	314 cm²	490 cm²	706 cm²
Action of force on a 90° bend located within 100 cm distance to the exhaust vent: (Mass flow: 1.0 kg per second)	640 N	360 N	231 N	160 N

Table 6.6: Effects of force

The pressure drop of the duct routing depends on the magnet (the diameter of the duct) and can be calculated using the table below. To avoid high pressure drops, the length and the number of 90° bends should be minimized whenever possible. The *exhaust vent calculation [▷ 53]* graphics show and ex-ample for calculating and installing the exhaust vent.

Exhaust vent elements (smooth inside) mass flow 1 kg/s	Pressure drop in cable elements in relation to the distance to the magnet (mbar)							
	0-5 m	5-10 m	10-15 m	15-20 m	20-25 m	25-30 m	>30 m	
Straight section 150 mm in diameter	6.4	12.8	19.2	25.6	32	38.4	44.8	per meter
90° bends, 150 mm in diameter	80	160	240	320	400	480	560	
Straight section 200 mm in diameter	1.4	2.8	4.2	5.6	7.0	8.4	9.8	per meter
90° bends, 200 mm in diameter	20	40	60	80	100	120	140	
Straight section 250 mm in diameter	0.34	0.68	1.02	1.36	1.7	2.04	2.38	per meter
90° bends, 250 mm in diameter	7.2	14.4	21.6	28.8	36	43.2	50.4	
Straight section 300 mm in diameter	0.175	0.35	0.525	0.7	0.875	1.05	1.225	per meter
90° bends, 300 mm in diameter	2.8	5.6	8.4	11.2	14	16.8	19.6	

Table 6.7: Pressure drop in USR magnet cable elements: 47/40, 70/30, 94/20, 117/16; and magnets 117/11 and 152/11

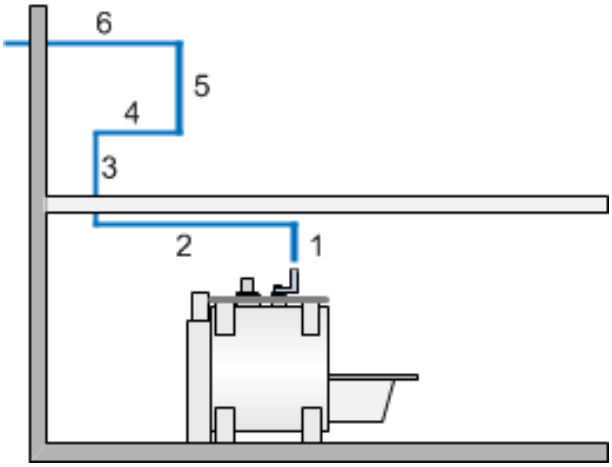


Figure 6.9: Schematic of the exhaust vent.

Segment	L [m]	D [mm]	Pos [m]	DP [mbar]
1	0.5	200	0	0.5 x 1.4 = 0.7
1a	90° bends	200	0.5	20.0
2	1.8	200	0.5	1.8 x 1.4 = 2.52
2a	90° bends	200	2.3	20.0
3	3.5	200	2.3	3.5 x 1.4 = 4.9
3a	90° bends	200	5.8	40
4	2.0	200	5.8	2 x 2.8 = 5.6
4a	90°bends	200	7.8	40
5	4.0	200	7.8	4 x 2.8 = 11.2
5a	90°bends	200	11.8	60
6	4.0	200	11.8	4 x 4.2 = 16.8
	Total			**221.72**

The illustration *Figure 6.9 [▶ 53]* and table *Calculating the exhaust system [▶ 53]* provide an example for calculating the pressure drop of an exhaust vent. The position corresponds to the entire length from the magnet to the start of the respective segment. The respective standard values for the pressure drop for a pipe diameter of 200 mm have been taken from the table *Table 6.7 [▶ 52]*.

6.4 Floor construction

A suitable floor construction must take into account the following specifications:

- adequate load-bearing capacity and load distribution
- floor and building vibrations
- impact sound decoupling
- ESD tolerance

6.4.1 Footprint and weights

In order to guarantee the load-bearing strengths for the installation and operation of the instrument, the system owner must perform a professional calculation and verification of the authorized surface load at the installation site and all transport routes.

This analysis can be performed on the basis of the sizes, transport and operation weights of the different components:

Device	Footprint	Transport weight	Operation weight
Magnet	See chapter *Magnet foundation [▶ 55]*	4500 kg	5250 kg
Main Cabinet	120 x 80 cm	~ 820 kg	~ 700 kg
Gradient Cabinet	60 x 90 cm	~ 770 kg	~ 650 kg
Cooling Cabinet	80 x 80 cm	max. 390 kg	max. 460 kg
Options			
Parallel Transmit Cabinet	60 x 80 cm	~ 420 kg	~ 300 kg
Cryoprobe Platform:			
Cryo Cooling Unit	75 x 79 cm	~ 370 kg	~ 250 kg
Cryoprobe Refrigerator	45 x 49 cm	~ 150 kg	~ 120 kg

Table 6.8: Footprint and weights

Additional weights to be considered during transport / operation.

Please note that the given transport weights do not include any transport equipment and staff. This must be considered in addition.

Please note that the given operation weights do not include the seismic safety option which must also be considered in addition.

For further information please contact your local Bruker BioSpin MRI office.

Note that in addition to the footprint given in the table, additional space to access and operate the components is required (see the corresponding chapters within this document).

Specific solutions are possible in special cases for achieving load distribution in existing buildings. These solutions should be analyzed in relation to their vibration behavior. Discuss the situation and possible counter-measures with the planners from your local Bruker BioSpin MRI office.

6.4.2 Magnet foundation

The ferromagnetic density should not exceed 100 kg/m^2 in the area of the magnet foundation. If this limit cannot be maintained for new buildings, non-magnetic reinforcement materials (e.g. high-yield austenitic steels) should be considered.

The magnet foundation must be constructed in the form of a bonded screed. If a RF shielded room is used, the bonded screed must extend at least over the surface area of the box. The detailed construction is to be defined by the local building construction engineer.

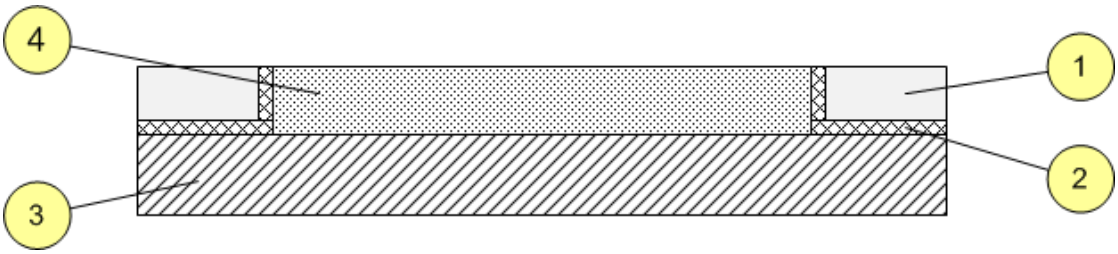


Figure 6.10: Construction example for the magnet foundation, if the original floor construction at the magnet installation site is based on a floating floor.

1 accessible flooring, constructed as a floating floor

2 absorption for sound impact decoupling

3 base plate of the building

4 magnet foundation, constructed as bonded screed

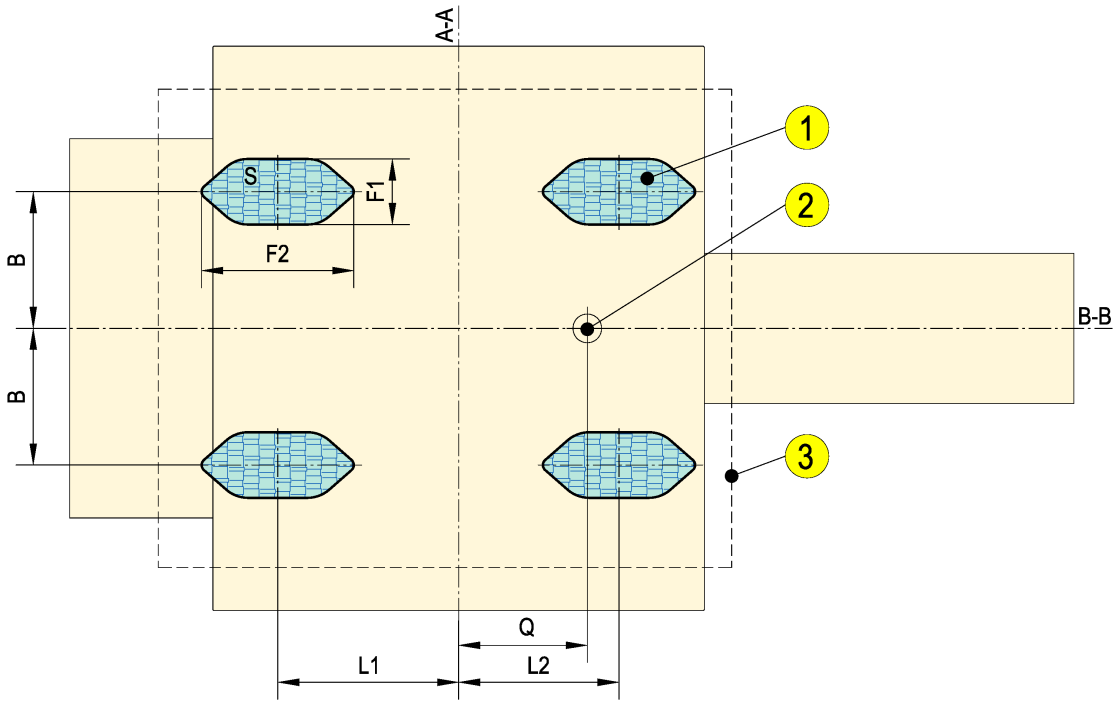


Figure 6.11: Schematic drawing of the footprint of the magnet: (1) Position and size of the vibration absorbers supporting the magnet. (2) Position of the magnet exhaust vent. (3) Magnet foundation: the size of the foundation as well as the exact position of the magnet on the foundation need to be determined by the local building construction engineer. A-A and B-B refer to the geometrical center of the magnet dewar.

Size and positions of the vibration absorber elements for magnet 47/40 USR V2		
F1	Width of one vibration absorber element.	19.2 cm
F2	Length of one vibration absorber element.	44.6 cm
S	Supporting surface of one vibration absorber element.	665 cm^2
B	Position left/right.	40 cm
L1	Position towards service end.	55.0 cm (configuration dependent)
L2	Position towards user end.	47.0 cm
Q	Position of exhaust outlet.	37.7 cm

6.4.3 Electrostatic discharge

The MR instrument does not require any special ESD specifications for the floor coverings in the different installation areas of the system. The use of floor coverings with conductivity of less than 100 kΩ is recommended to avoid electrostatic discharges.

6.4.4 Seismic safety standards

The MR system can be installed with a seismic safety option and thus allows for installation in hazardous areas. When installation is completed correctly, seismic safety is verified by statistical calculations in these cases up to the limit values listed below. Copies of the verified calculations can be requested from the local Bruker BioSpin MRI office.

⚠ WARNING

Warning of serious injury due to uncontrolled moving objects during an earthquake.

If the requirements to install a MR instrument in areas at risk of earthquakes are more stringent, these must be taken into account during planning and construction:

- Verification of building statistics.
- More stringent specifications for the floor construction.
- More stringent specifications for floor strength.
- Exclusive use of authorized seismic protection of the MR system.

The system of protection for the magnet consists of four additional floor anchors that are firmly anchored to the floor. When running normally, the anchoring device permits authorized decoupling from floor vibrations. In the event of an earthquake, it prevents the magnet from moving or tilting up to the following accelerations:

Magnet 47/40 USR V2	
Maximum acceleration (m/s^2)	configuration dependent
Parts number of the basic seismic protection unit.	T12047

Table 6.9: Maximum underground acceleration with seismic protection

If installed in an RF shielded room, the kit T12306 must also be ordered and assembled to avoid RF radiation. In order to reach these limit values, the floor construction and the construction of the anchor-age must satisfy the following criteria:

Properties	Specification
Reinforced concrete state	cracked concrete, normally reinforced
Category of resistance to pressure for concrete	C 20/25
Minimum floor thickness	300 mm
Maximum height of the floor construction	50 mm

Properties	Specification
Floor anchor type	exclusive use of the high-performance anchor supplied by type: Fischer HFB IL AL4
Floor anchor assembly	installation according to the assembly instructions of the anchor type listed

Table 6.10: Floor construction and anchorage for seismic safety

Figure 6.12: Seismic protection system in a RF shielding box with "Faraday Cage Connection Kit.

Figure 6.13: Seismic protection system at the magnet.

6.5 Electrical installations

6.5.1 Overview

Electrical installation comprises the following planning and work package:

- Preparation of the electrical house connection
- Preparation of a local equipotential bonding in the technical area
- Provision of infrastructure for the operating area (mains, telephone, LAN)
- Installation and connection of the central Line Power Distributor of the MR instrument
- Assembly of cable trays between technical area and magnet room
- Lighting system

6.5.2 Mains Supply

An MR instrument is connected via the Line Power Distributor. The Line Power Distributor is an integral part of the supply and carries national authorization for CE/UL/CSA. The TN-S network (DIN 57100 Part 300) is used as the network configuration with separate neutral and protective conductors from the transformer to the consumer. The mains supply from the Line Power Distributor must run over a 5-core shielded cable and should be loaded only through the MR instrument.

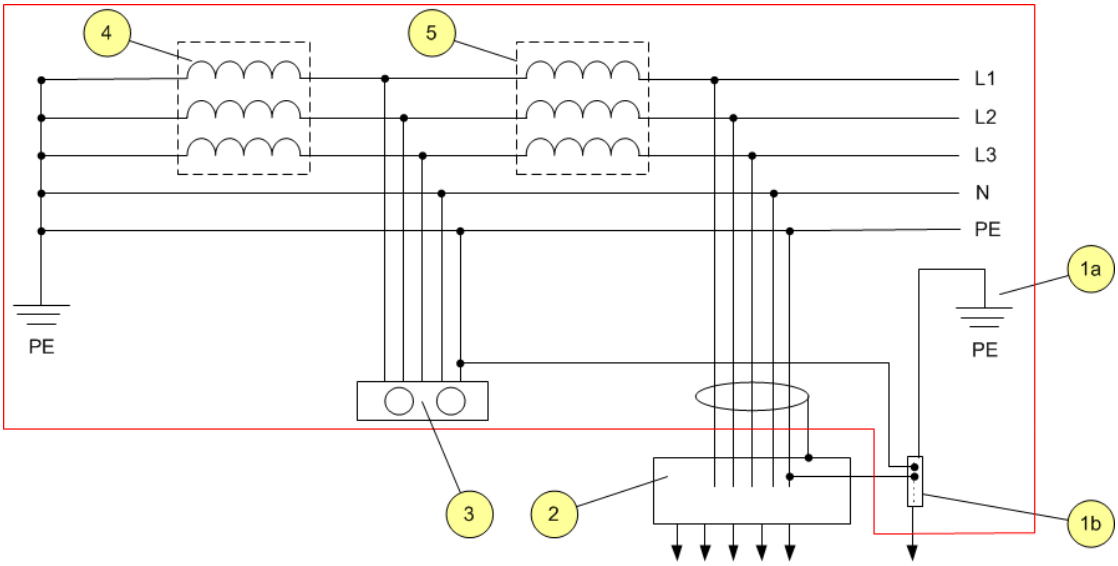


Figure 6.14: TN-S connection diagram of the MR instrument (60Hz)

1a	Earthing point of the building to be connected to the Bruker Line Power Distributor (2) directly, or via an additional equipotential bonding bar (1b).
1b	Additional equipotential bonding bar to connect additional equipment other than MR instrument components.
2	Bruker Line Power Distributor providing outgoing line power to all MR instrument consumer components and equipotential bonding.
3	Power connection
4, 5	Generator or transformer of the building to provide the mains voltage required.
—	These units must be provided by the System Owner (responsible body).

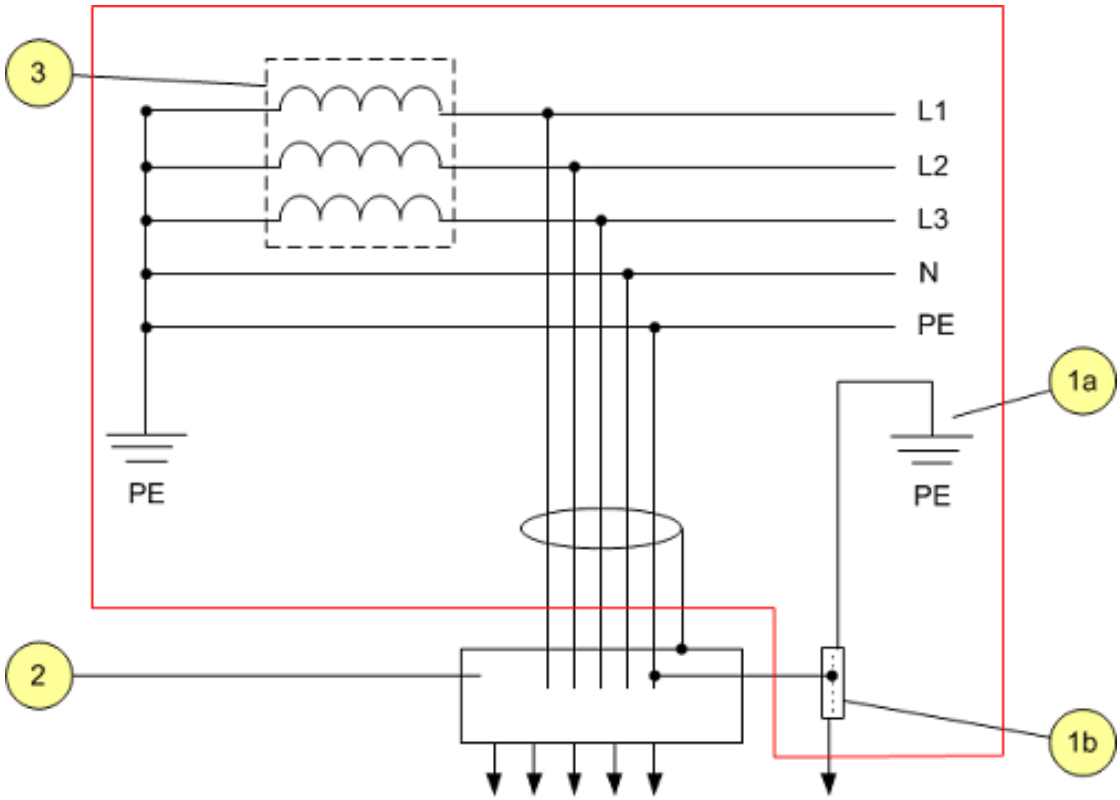


Figure 6.15: TN-S connection diagram of the MR instrument (50 Hz)

1a Earthing point of the building to be connected to the Bruker Line Power Distributor (2) directly, or via an additional equipotential bonding bar (1b).

1b Additional equipotential bonding bar to connect additional equipment other than MR instrument components.

2 Bruker Line Power Distributor providing outgoing line power to all MR instrument consumer components and equipotential bonding.

3 Generator or transformer of the building to provide the mains voltage required.

— These units must be provided by the System Owner (responsible body).

Connection values for 47/40 USR V2

Technical room	Specification
Mains supply to the Line Power Distributor	5 x 35 mm^2 (AWG 2) shielded, max. 100 m long
Nominal voltage	400/230 V, +/- 10%, 3 N~
Frequency	50 or 60 Hz
Fuse	80 A

Table 6.11: Connection values in the technical room

The Line Power Distributor provides the following connection points, which should be used solely for operating the MR instrument:

Voltage/CEE form	Fuse	Use
400/230V 50/60 Hz	25 A (1F4)	Spare Gradient Cabinet Option

Voltage/CEE form	Fuse	Use
400/230V 50/60 Hz	25 A (2F4)	Dual Loop Heat Exchanger for magnet and gradients, incl. magnet compressor
400/230V 50/60 Hz	16 A (3F4)	Gradient cabinet
400/230V 50/60 Hz	16 A (4F4)	Main Cabinet (control electronics)
400/230V 50/60 Hz	16 A (5F4)	CRP compressor or Parallel Transmit Cabinet
230V 50/60 Hz	16 A (1F5)	Spare 1
230V 50/60 Hz	10 A (2F5)	Spare 2
230V 50/60 Hz	10 A (2F5)	Spare 3
230V 50/60 Hz	10 A (3F5)	CRP Platform
230V 50/60 Hz	10 A (2F6)	Service

In addition to the sockets listed, the Line Power Distributor contains 2 outgoing circuits with a terminal connection for lighting and mains voltage in the magnet room.

6.5.3 Equipotential Bonding

The MR instrument requires an equipotential bonding supply from the main ground that is to be connected to the equipotential bonding within the Bruker Line Power Distributor (LPD). From the LPD, all components of the MR instrument are supported. No other equipment may be connected to the Bruker LPD.

If additional equipment is to be connected, a separate equipotential bonding bar has to be added typically in the technical room.

Equipotential bonding	Specification
Maximum resistance to main ground	< 1.0 Ohm
Cable cross-section	35 mm^2 (AWG2) up to 200 m long

Table 6.12: Equipotential bonding specifications

6.5.4 Electrical connections in the magnet room

For service activities, at least two national standard power AC outlets are required inside the magnet room.

6.5.5 Electrical connections in the operating room

National standard AC sockets are required in the operating area for the MR operating console, for computer peripherals and for MR accessory.

Operating room	Specification
Ratings for PC and peripherals	230/110 V, 50/60 Hz, 10 A
Number of national standard AC sockets	min. 8

Table 6.13: AC Sockets in the operating room

6.5.6 Line Power Distributor

The installation of the Line Power Distributor and the connection to the main power supply is the System Owner's task. In order to be able to finish the electrical installation before installation of the MR instrument begins, the Line Power Distributor can be delivered in advance.

The Line Power Distributor is assembled in a suitable position on the wall in the technical room (weight 57 kg).

The maximum distance between Line Power Distributor and the electronics cabinets of the MR instrument is 8 m.

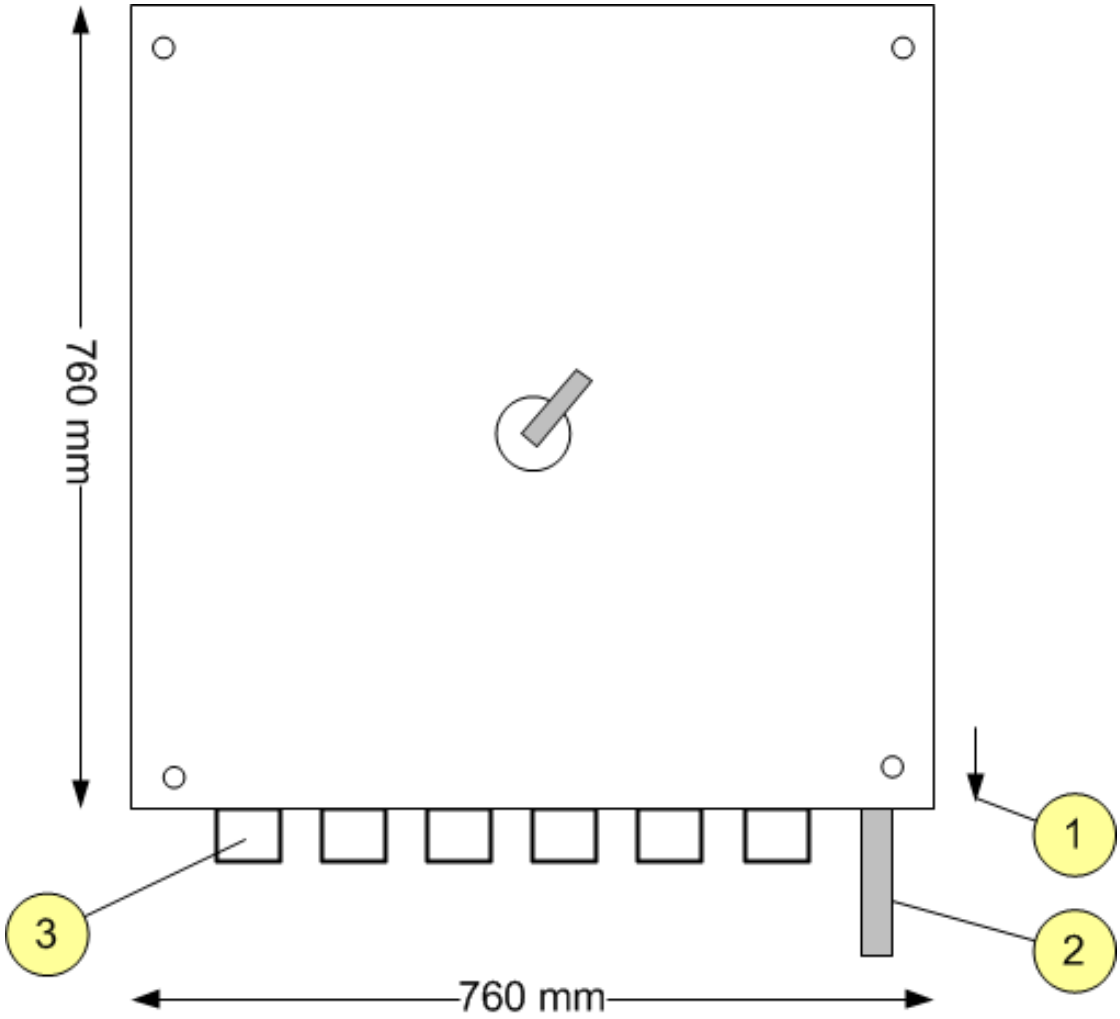


Figure 6.16: Schematic diagram of the Line Power Distributor.

1 Horizontal assembly position: approx. 1200 mm above the floor

2 Mains connection line on the building side

3 Outgoing circuits for the MR instrument’s consumers

6.6 Supervision signals

The operation state of the magnet can be remotely supervised using the remote alarm connection of the magnet monitoring unit (BMU). The connection to a remote supervising and alarm system of the building is done via a male 4 pin Amphenol connector of type C091A 4M. The BMU provides two different alarm signal types with the following potential free pin assignment:

Alarm type	Pin	Alarm states
Normally closed	Pin 1 and 2	Contact closed in normal operating state, open during alarm
Normally open	Pin 3 and 4	Contact open in normal operating state, closed during alarm

It is the responsibility of the system owner to decide on the usage of this feature and to realize the connection between the BMU and the central alarm system of the building.

6.7 Cable lengths and routing

All connections between the cabinets in the technical room and the MR system in the magnet room and/or in the operating area are made via the external cable set. The external cable set contains electricity cables, lines for cryogenic gases, and refrigeration lines.

Detailed planning of cable lengths and compliance to these plans during the final installation is a basic prerequisite for smooth installation of an MR system.

The local project leader must immediately notify Bruker BioSpin MRI of any change to the cable lengths required during the planning stage. Changes to construction of the installation, which only become known during installation of the system, lead to enormous time delays.

The relocation of the external line set is subject to specifications relating to:

- Compliance with the maximum cable lengths between components in the technical room and the magnet cabinet (CCM) as well as the operating area.
- Compliance with the minimum bending radii of the different cables
- Cable routing with strain relief on cable trays at ceiling height

Cable routing with minimum distances is an advantage and should be strived for in every case. The available RF power for MR signal excitation compared to the nominal output power of the RF transmitter is reduced when long distances are used. Other than this, no further constraints should be expected. The lengths of the cryogenic transfer line between the cryo-platform and the MR CryoProbe™ has a strong influence on the signal to noise ratio of the CryoProbe and must be minimized in every case by direct line routes. See chapter *Additional Documents [▶ 7]*.

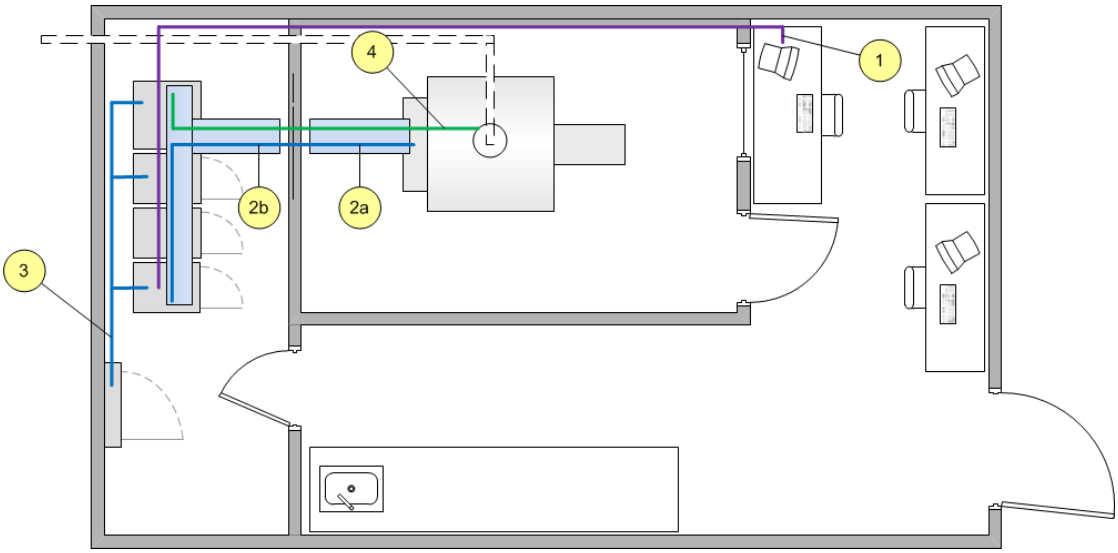


Figure 6.17: Overview of the external line set

1 (*) Control cables to the operating room. Cables are routed through a cable duct (min 10 cm diameter) or on a small cable tray that the customer must provide.

2a Scanner control line: Cable set in the shielded cabin. Cables are routed on a cable tray assembled at ceiling height.

2b Scanner control line: Cable set outside of the shielded cabin. Cables are routed on a cable tray assembled at ceiling height.

3 Main connection to the central electrical distributor

4 Control line and cryogenic gas line to the magnet. Lines are routed on a cable tray assembled at ceiling height.

(*) Alternatively, a permanently installed CAT 6 cable with sockets in the technical and operator area can be provided by the system owner.

If no RF shielded room is used, the cable set 2a runs directly to the filter plate of the CCM and cable set 2b is not required.

No.	Connection	Minimum bending radius	Available lengths
1	Control line to the operating room.	10 cm	25 m
2a	Control lines between cabinets and filter plate	20 cm	6, 10, 14, 18 m
2b	Control lines between filter plate and CCM	20 cm	6, 10 m
3	Main connection between electrical distributor and all the cabinets	20 cm	12 m
4	Control line and cryogenic gas lines	40 cm	8, 16 m

Table 6.14: Available cable lengths of the electrical connections

The external cable set is run along the open cable trays assembled at ceiling height. The customer must have the cable trays installed and completely finished before installation of an MR system begins on site. Access for placing cables in the cable tray must be freely available during installation of an MR system.

- Typical width: 40 cm
- minimum and maximum distance of the cable platform in front of and after the filter plate: 30 – 50 cm
- Typical installation height: 240 cm – 280 cm
- Adequate possibility to fix and relieve strain at the outlets above the cabinets and above the CCM must be provided.
- no sharp edges, provide authorized edge protection if necessary

When determining the actual cable lengths, the course of the cable routing within the cable trays must be fully taken into account.

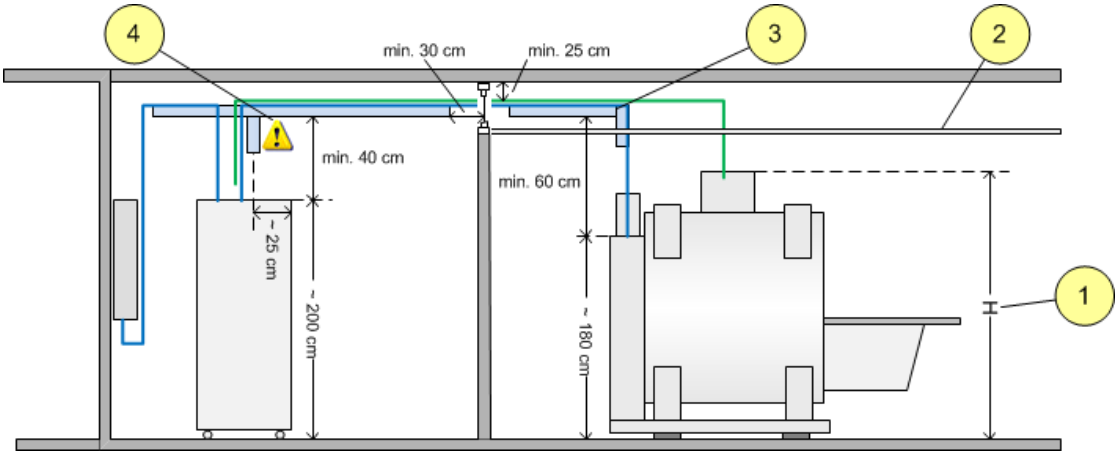


Figure 6.18: Cable routing between technical room and magnet room

1 The height of the connection point of the cryogenic gas lines to the magnet depends on the type of magnet.

2 Suspended cabin ceiling (optional), which covers the cables of the MR system in a more elegant manner.

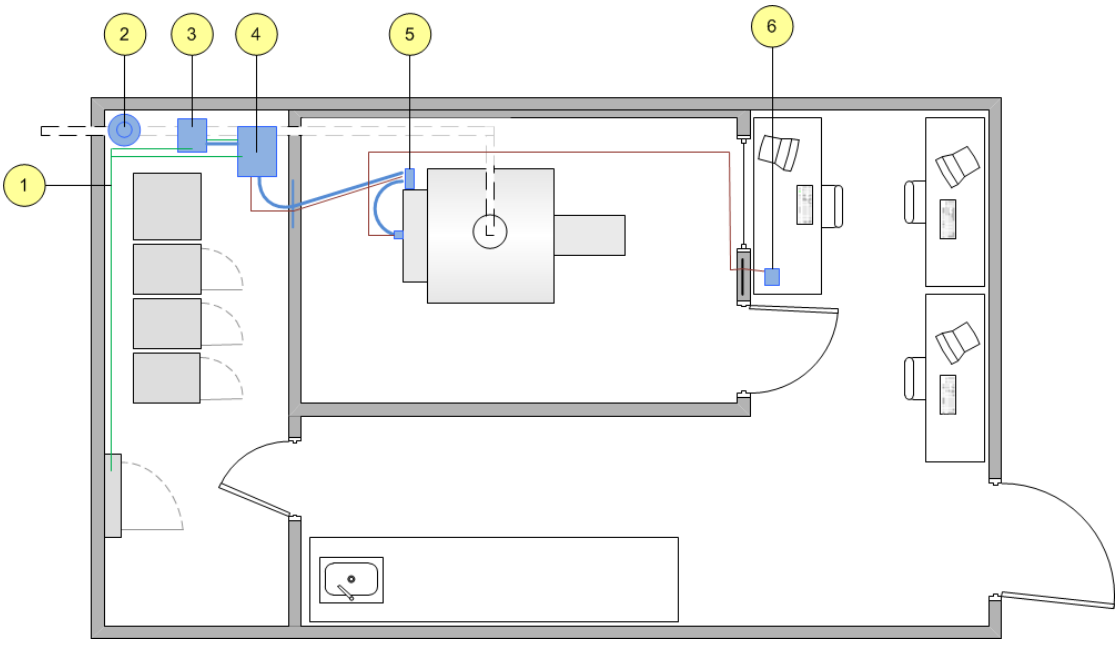
3 Cable trays with strain relief

4 When planning the position of the cable trays, be sure to maintain the minimum bending radii and provide adequate opportunity for strain relief.

Figure 6.19: Construction of cable carrying system

6.7.1 Line lengths for the MRI CryoProbe

The following additional components must be considered when planning the cable routes when an MRI CryoProbe™ is planned to be used. See Table *Table 6.3 [▶ 42]*



1 Power supply for CRP components
2 Helium gas cylinder
3 CRP compressor
4 CRP cooling unit
5 CRP preamplifier
6 CRP temperature control unit

The following cable lengths are available:

Connection	Minimum bending radius	Available lengths
Connection cable for electrical distributor(*) - CRP compressor	20 cm	7 m
Connection cable for electrical distributor - CRP cooling unit	10 cm	10 m
Helium transfer line for compressor - CRP cooling unit	30 cm	6, 10, 20 m
Helium transfer line for CRP cooling unit - CRP preamplifier	70 cm	3, 4, 5, 6 m
Control cable for CRP preamplifier - CRP temperature unit	10 cm	15 m
He cylinder gas tubes	20 cm	10, 20 m

(*) installations at 60 Hz require a pre-switched transformer for connection to the electrical distributor

6.8 Lighting system

The lighting facility is not an integral part of the supply and must be finished by the customer before installation begins.

There are no system specific requirements for the operating and technical rooms. When selecting the lighting facility in these areas, the country specific specifications and requirements for work place lighting must be met (occupational standards).

In the area of the magnet room, lighting facilities must not be below the minimum distances to an MR system listed in the chapter *Measurements and room dimensions [▶ 37]*. When selecting lighting methods, their compliance with magnetic stray fields must be noted. The use of combinational circuit parts, transformers, and dimmers is not permitted in the immediate vicinity of the magnet. The operating areas in front of and behind the magnet should be very well lit.

If an MR system is installed in an HF shielded room, the magnet room lighting and any AC sockets for additional equipment must be connected to the central electrical power distributor at the connection points provided for this purpose. All supply lines into the HF shielded room must pass through appropriate filter plates.

No additional ground loop should be established by the lighting system. When there is disconnected ground at the electrical power distributor, there must be infinitely large resistance between each ground contact of the lighting facility and all conducting points within the HF shielded room.

6.9 Ventilation and air conditioning

6.9.1 Overview

The following areas and units must be fitted with a cooling system available for operating the MR system on the building side:

Unit	Type of cooling system	Cooling performance
Electronics cabinets in the technical room (*)	Air conditioning unit	~ 7.5 - 15 kW
Cooling circuits for magnet and gradient	Cold water supply	~ 11.5 kW
MR system in the magnet room	Air-conditioning system	~ 0.5 kW
Anesthetic gas extraction in the magnet room	Gas extraction	no
Operating room (*)	General room air ventilation system	~ 0.5 kW

Table 6.15: Overview of the types of cooling system

(*) the real requirement depends on the configuration of the instrument

6.9.2 Air conditioning systems

It must be noted when planning the outlet openings of the space cooling that the air flow produces **indirect cooling**. The cold air flow must **not be directly** aimed at parts of the MR system. All details listed reflect operation within the system's permitted limits.

Air-conditioning system for the magnet room	Cooling performance
Cooling performance	~ 0.5 kW
Room temperature	22 +/- 2°C
Humidity	40 – 80 %
Maximum temperature drift rate	1°C/hour
Fresh air exchange rate	1.5 x the room volume/hour

Table 6.16: Cooling performance of the air-conditioning system in the magnet room

⚠ WARNING

Failure of ventilation system

The correct function of the ventilation system in the magnet room and in storage locations is a basic assumption for the safe usage of superconducting magnets and for the handling of cryogen liquids. Therefore, the correct function of the ventilation system needs to be monitored and supervised continuously.

The room cooling and air-conditioning system must be able to maintain constant working conditions within the prescribed limits in order to meet the MR system's functional specifications. Rapid changes in temperature or cold air blowing directly on to the MR equipment must be avoided. Attention must be paid to the often small room volumes when planning cooling systems in order to avoid unrealistically high air exchange numbers, for example, in the magnet room. A sensible compromise must be made between the air exchange volume and the air supply inlet temperature. Volumes of air exchanged in the magnet room are typically approx. 10 to 15 at 600 to 800 m³ per hour. If the inlet temperature of the air supply is below the 20°C limit large air outlets on the ceiling which effectively swirl the cool air supply help to achieve the room temperature required.

Cooling for the technical room	Cooling performance
Cooling performance	~ 7.5 kW (standard) - 18 kW (including options, see below)
Room temperature	22 +/- 3°C
Humidity	40 – 80 %
Maximum temperature drift rate	2°C/hour
Room air exchange rate	No particular specifications

Table 6.17: Performance of the space cooling in the technical room

The following additional cooling performances in the technical room must be taken into account when selecting options for a standard configuration.

Equipment options: Additional requirements for the space cooling for the technical room	Additional cooling performance
Option: High Power Gradient Amplifier	7 kW
Option: MRI CryoProbe™	1.2 kW
Option: Parallel Transmit Cabinet	2.0 kW

Table 6.18: Additional requirements for the space cooling in the technical room

6.9.3 Anesthetic gas extraction

If anesthetic gases are to be used, attention must be paid to the local regulations on maximum work place concentrations of anesthetic gases (occupational standards) and these regulations must be adhered to.

Therefore, the installation of a waste anesthetic gases (WAG) extraction system is strongly recommended. The MR instrument provides a connection point to which it can be connected.

Within the MR instrument, gases are extracted in the vicinity of the test object in the magnet bore and discharged to the gas extraction system via a 3 m long hose with an inner diameter of 25 mm.

The connection point of the hose to the gas extraction system of the building needs to be located above the CCM at the service end of the magnet. A suction capacity of about 15 m^3/h of extraction will be required.

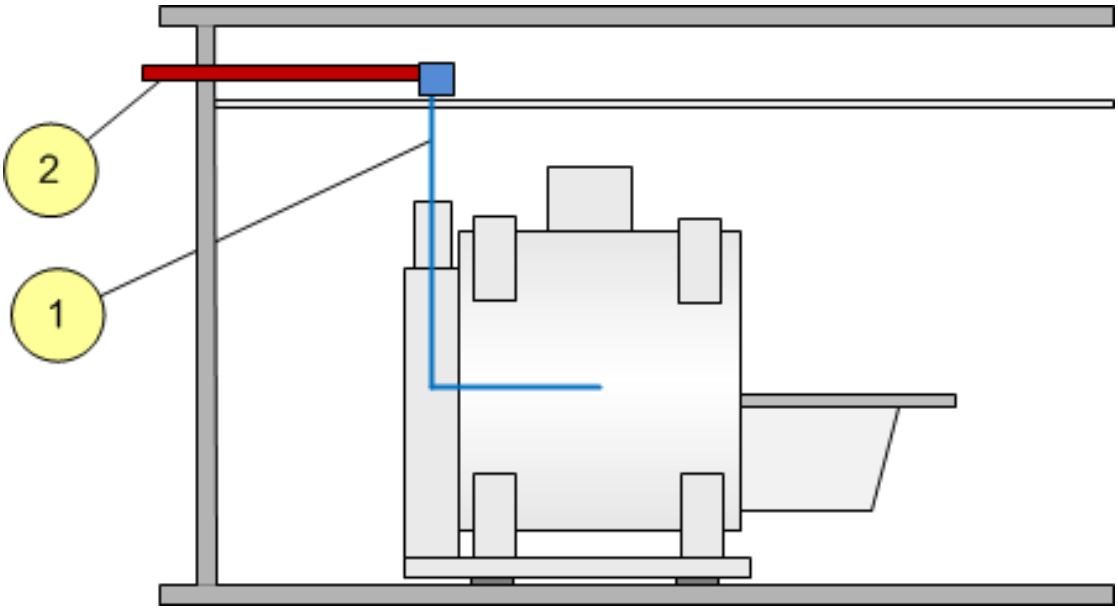
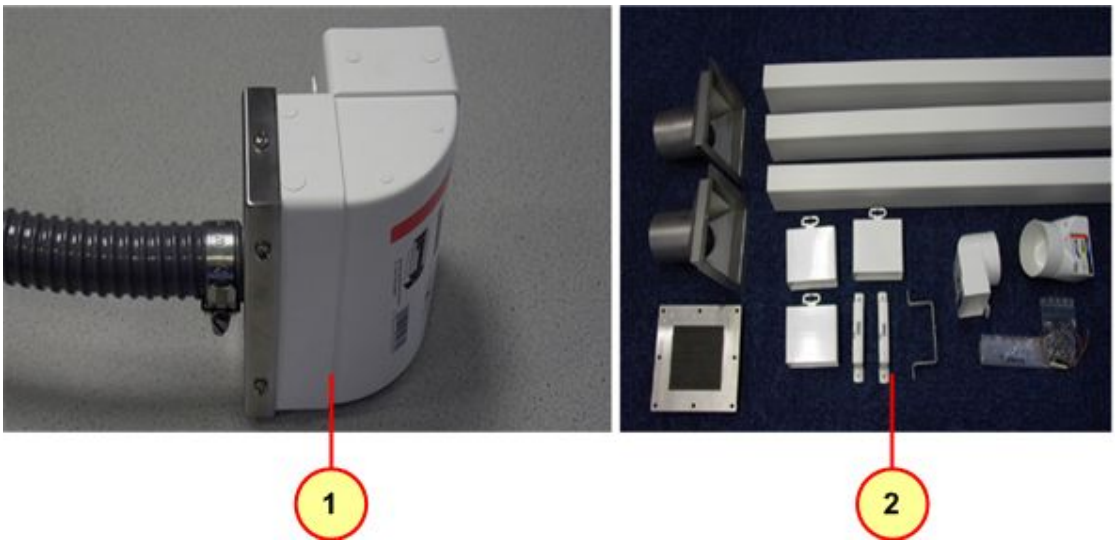


Figure 6.20: Anesthetic gas extraction.

1 Extraction hose (3 m length, 25 mm inner diameter) provided within the delivery of the MR instrument.

2 The connection needs to be provided by the installation site.



1 Extraction hose for anesthetic gas (3 m long hose with inner diameter of 25 mm) and connection to the white plastic duct 90° bend with inner diameter of 110 x 54 mm provided within the delivery of the MR instrument.

2 Set for anesthetic gas extraction. The set shown in the figure above may be purchased from Bruker upon request (part number T11976).

If the instrument is installed within an HF shielded room, suitable connectors, extensions, and HF filtered feed through elements can be purchased from Bruker, part number T11976.

6.10 Cold Water Supply

Part of the heat dissipated from the MR instrument is released via a heat exchanger to a cold water supply system (Primary Water Circuit). Check in the early site planning phase whether the cold water requirements can be fulfilled.

	Standard configuration	MRI CryoProbe™ option
Max. heat dissipated into the water	12 kW	Additional ~ 8.5 kW
Supply temperature	8 – 12 °C	8 – 24 °C
Maximum pressure	8 bar	7 bar
Minimum pressure difference (see * below)	0.5 bar	0.7 bar
Minimum flow	18 l/min	7 l/min
Recommended particle filter	400 µm	400 µm

Table 6.19: Requirements for cold water supply including safety margin. Compare diagram next page.

(*) Minimum required pressure difference may increase depending on hoses and fittings used to support the Cooling Cabinet.

Beside standard configuration and CryoProbe option there are no further options that require cold water from the cold water supply system.

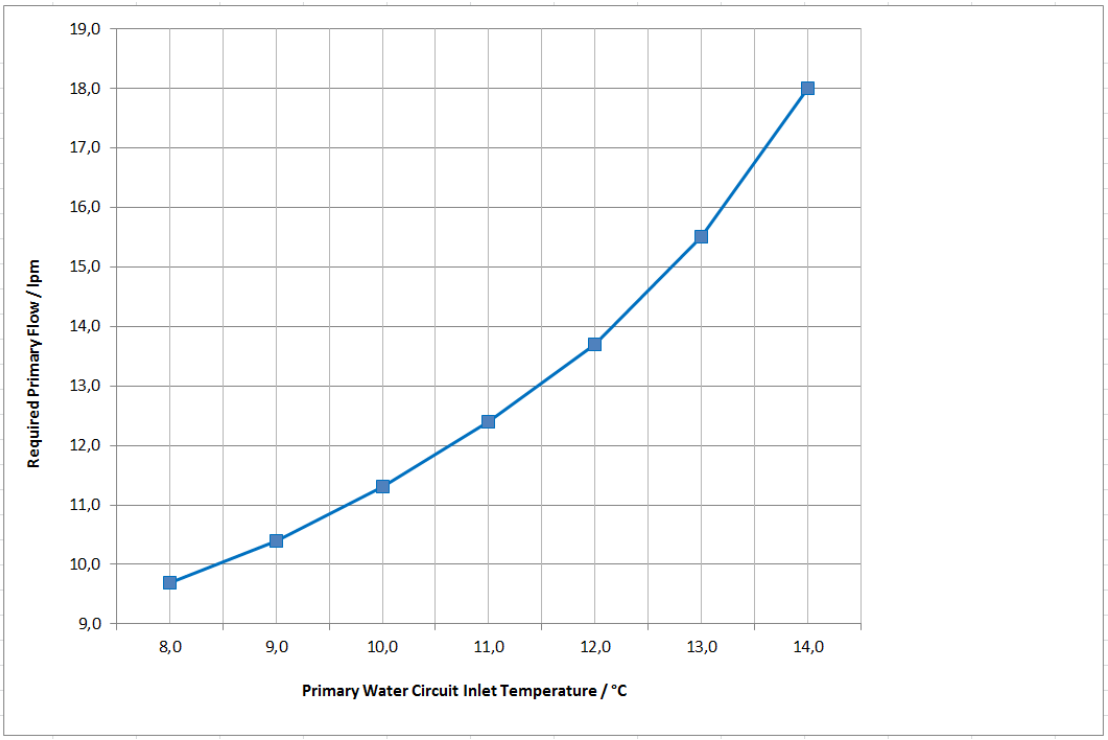


Figure 6.21: Relation between the Primary Water Circuit inlet temperature and the required Primary Flow for the maximum cooling requirement of 12 kW (standard configuration without CryoProbe option).

Water quality	Specification
pH range	6.5 – 8.2
hardness	5.6 – 11.2 °d
maximum proportion of glycol in the water	30 %
chloride	less than 100 mg/l
solid floating particles	less than 10 mg/l
maximum particle size	less than 400 µm

Table 6.20: Specifications for the water quality

6.10.1 Connections and installation

The basic system's chiller cabinet is connected to the local cold water system via two ¾“ pressure hoses with hose clamps. If the MRI CryoProbe™ is used, two additional parallel connections must be planned and provided. The maximum distance between the connection points of the cold water system of the MR system and the installation site of the chiller cabinet may not exceed 6 m.

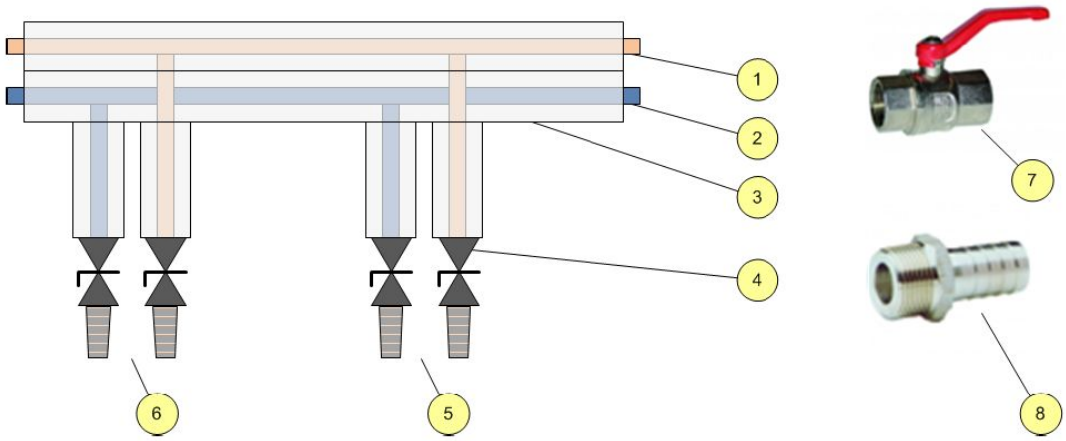


Figure 6.22: Water supply installation in the technical room (bypass potentially required not shown).

1	Backflow (warm)
2	Forward flow (cold)
3	Insulation to prevent condensation
4	Lock valves with 3/4" tube nipples
5	Connection to the standard MR Instrument
6	MRI CryoProbe™ option: An additional parallel connection is required
7	shut-off valve
8	tube nipple
n. s.	potentially a bypass (not shown) is needed in case the MR instrument cooling system reduces or stops the flow through.

Each connection point must be provided with a ¾" **shut-off valve** and **tube nipple** at a height of about 2.2 m. The cold water system lines of the building side must have a cross-section of at least 1" and be thermally insulated.

Bruker BioSpin MRI recommends on-site installation of a temperature and pressure probe/ regulation for monitoring the properties of the cold water system going to the MR system.

Also, depending on installation, a bypass might be required for cases where the cooling system of the MR instrument does not request cold water and will reduce or stop flow through the heat exchanger of the MR instrument.

NOTICE

Water in the area of the electrical systems due to condensation

To avoid water collecting in the technical room due to condensation, the cold water pipes must have suitable thermal insulation. Dripping water at the connections points must be captured using appropriate collection containers.

If no in-house cold water system is available at the installation site, a local fixed, decentralized cold water production system (inside or outdoors) can be included in the plans.

These systems are to be planned, installed, and maintained by local refrigeration technology firms. Bruker BioSpin can help with planning and supplying these systems if necessary, but not with installing and maintaining them.

Emergency cooling with drinking water

The supply of the MR system with cold water for operating the magnet is required continually and without interruptions. In the event of a sustained breakdown of the mains cold water supply, water from the **drinking water supply can be used temporarily** to cool the magnet refrigerator. This can guarantee operation of the magnet over several days. For this reason, Bruker BioSpin recommends installation of equivalent connection points for drinking water in the technical room in the event of an emergency.

6.11 Cryogenic Fluids

For installation and operation of the instrument, the following cryogenic fluids are required.

Initial magnet installation:

Cryogenic Fluid	Filling quantity (liter)
Liquid He	800-1200
Liquid N2	not required/nicht erforderlich

Table 6.21: Filling quantity cryogenic fluid

Normal operation:

During normal operation of the magnet, no cryogenic fluid is required.

For the Planned Magnet Maintenance with cold head service up to **500 l He** may be required and filled by Bruker Magnet Service.

6.12 Helium Gas and Compressed Air Supply

For the MR instrument, no helium gas or compressed air supply is required. However, both are required for installation and operation of the optional MRI CryoProbe™.

6.12.1 MRI CryoProbe™

Installation and operation of the MRI CryoProbe™ require compressed air and a helium gas supply in the Technical Area.

Requirements for the compressed air

- Quality of compressed air: cleaned, cold, free of oil and particles.
- Minimum pressure: 6 bar
- Connection in the technical room with pressure control and lock valve.
- Consumption: about 10 l/hour.

Requirements for the helium gas supply

- A Helium gas bottle of typically 50 liter @ 200 bar (2900 psi) with grade 6.0 = 99.9999% needs to be provided in the Technical Area by the installation site.
- He regulator (regulates pressure to 22-25 bar, 320-360 psi) and charging hose are country specific and need to be ordered from Bruker and configured when ordering the CryoProbe™. Please provide information on He gas bottle. Common outlet types are:

Standard	Designation	Dimension	Thread
DIN 477 AFNOR	No. 6	21.8 mm × 1/14”	right, external
BS 341	No. 3, 5/8” BSP 14	22.92 mm	right, external
ANSI	NGO 14	0.965” (24.51 mm)	right, external
JIS	W-20.9-14	20.9 mm × 1/14”	right, external

- Consider the He hose connection between Cryo Platform and He gas supply in the Technical room during installation planning.
- Information: Estimated He gas consumption is about a 50 liter bottle/year, depending on the use of the CryoProbe™. The He connection must not be detached while in cold operation.

6.13 Laboratory Furnishings

6.13.1 Laboratory Furniture

The laboratory furniture is not supplied by Bruker.

At the time the MR instrument is delivered, a sufficiently large desk for the workstation and an office chair must be provided by the System Owner.

⚠ CAUTION

Injury by attracting magnetic objects

Only non-magnetic furnishings should be used within the Controlled Access Area.

7 Delivery and Transport

Magnet and electronics installation must always be planned and carried out in close cooperation with the local Bruker office. On the day the magnet is placed, a Bruker employee must be on site. Planning of delivery and transport must comprise the following items:

- Magnet transport to installation site, e.g. air and/or road transport with suitable transport methods.
- Unloading area and magnet transport within the building.
- Appropriate intermediate storage, if necessary.
- Transport and installation of the electronics cabinets and accessories.

⚠ WARNING

Warning of personal injury and/or damage to the MR Instrument and/or building.

Transport, storage, and placement of the MR instrument must be carried out with particular care. Only trained, qualified, and authorized personnel is allowed to handle the MR instrument. Occupational standards and minimum safety distances between building structures and heavy loads must be fulfilled along the entire transport route. The load-bearing capacity of all transport routes, storage facilities, and installation areas of the equipment components must be checked and released by professional personnel.

If operations are performed by unqualified personnel, the following risks exist:

- ▶ Personal injury when transporting heavy loads
- ▶ Significant damage to the MR instrument due to inappropriate handling
- ▶ Structural damage to buildings due to heavy loads

If the organization of transportation and placement are not carried out by Bruker, it is the System Owner's responsibility to take the necessary safety and preventative measures when transporting and storing the MR instrument and to ensure that there is adequate liability insurance.

Damage during transportation and loss of transport insurance services:

Before the magnet is unloaded from the truck, the condition of the shock indicators must be checked and documented.

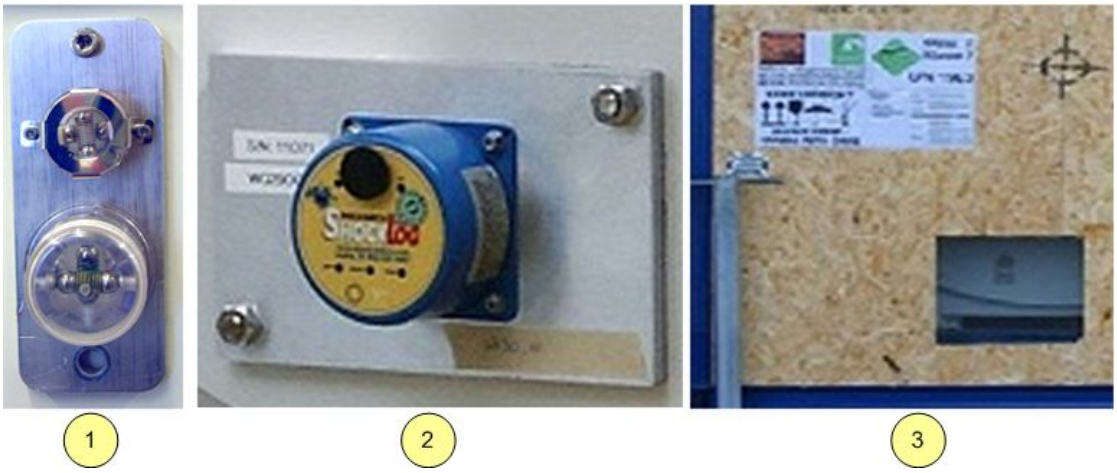


Figure 7.1: Shock indicators

1 Shock indicator, mechanical version

2 Shock indicator, electronic version with storage function

3 Air freight pallet with shock indicator inspection window

7.1 Maximum transport time

The magnet is transported and delivered cold. This therefore results in a **maximum transport time of 10 days** between the time that the magnet is picked up at Bruker and installation at the customer's. If it can be predicted at the planning stage that this maximum time span cannot be adhered to, appropriate intermediate storage must be planned which includes liquid helium filling of the magnet. Please make prompt contact with the local Bruker BioSpin MRI office if this is the case.

7.2 Packaging

The MR instrument is usually delivered as the following individual parts:

- Main instrument in the magnet crate , see below.
- Gradient Coil crate
- Magnet Compressor crate
- Depending on the configuration, 2 - 3 transport crates for the electronic cabinets.
- Depending on the configuration, 1 - 2 transport crates for a accessories.
- 4 transport boxes for magnet installation sent separately or within an accessory crate above.

The Airfreight Crate for transporting the magnet by plane and the magnet accessory boxes must be returned to the manufacturer.

Packaging of RF Coils are in typically stored for a save return of devices in case of a repair. The packaging of other components may be disposed by the System Owner after instrument acceptance or temporarily stored during an initial phase.

Figure 7.2: Transport pallets for air freight

7.3 Magnet Transport

Magnets are highly sensitive and very heavy structures filled with cryogenic liquids and gases. They may only be transported when they are not at magnetic field and with special transport devices and in no case may they be subject to high acceleration or jolts. All cryogenic gas and liquid openings must be sealed during transportation with magnet specific pressure valves. Only companies qualified to carry out specialized forms of transportation may be used and the Handling Instructions specified by Bruker are to be followed.

7.3.1 Transport method and limitations

The different transport sections must be considered separately when transporting the magnet.

Long-distance transport can take place by air and/or exclusively on tractors of a truck fitted with pneumatic shock absorber systems. The tractors of trucks fitted with pneumatic shock absorber systems must meet the specifications of IEC standard 60721. Transport in parts of the truck that are connected to the front axle via hitchs is not possible.

- Other transport methods, particularly rail, is prohibited.
- The magnet must be placed on the tractor such that the magnet axes is perpendicular to the direction of travel.

Transport over **short distances** is divided into:

- Reloading between different transport methods may only take place with a suitable crane. **Fork-lift trucks and other transport methods are not allowed.**
- The magnet may only be lifted with hangers for heavy loads that are long enough for strong sideways forces not to have any impact on the crane hooks. Alternatively, a special heavy load frame can be used to lift the magnet.
- Moving on tank steel rollers or air pads within a building.

– The load-bearing capacity must be checked and guaranteed along the entire transport route.
– The transport route must be smooth, free of joints and steps, and not have only a small slope at most.

The following transport limitations should not be exceeded during any transport procedures:

transport restrictions 47/40 USR V2	Limit
Maximum horizontal acceleration	2.0 g
Maximum vertical acceleration	3.0 g
Maximum duration during maximum acceleration	20 ms
Maximum tilt angle	10°
No sliding on loading surfaces.	--
No contact with other transport goods	--
Only gentle placement	--
No tilting by more than 10° from vertical	--
Maximum inclination along the transport route	15 mm/m

Table 7.1: Transport limitations

If heavy duty rollers are used to transport the magnet in the air transport frame over short distances, these must be secured by bolts in the holes provided on the transport frame.

Figure 7.3: Transportation using heavy duty rollers

7.4 Transporting Electronic Cabinets

The electronics cabinets contain sensitive and sometimes very heavy assemblies. Sometimes the cabinets have a high center of gravity and are therefore in danger of tipping. The cabinets may **not be tipped** during transportation, they may **not get wet** and they may **not be subject to high acceleration** and **jolting**.

7.5 Moving into the building

Before the MR instrument can be delivered and moved to the installation site, the load-bearing capacity along the transport route must be calculated and verified by a qualified structural engineer.

The building dimensions along the entire transport routes must be carefully checked and must allow the transportation according to the transport requirements given below.

For that purpose, the transport weights of magnet and cabinets are provided in chapter *Footprint and weights [▶ 54]*, the transport dimensions of the magnet are given in the figure below.

⚠ CAUTION

Risk of personal injury during transportation within buildings.

Occupational standards and minimum safety distances between building structures and heavy loads must be fulfilled along the entire transport route to avoid squeezing of hands or feet.

▶ Only trained, qualified, and authorized personnel must transport the MR instrument on the transport routes from unloading to final destination within the building.

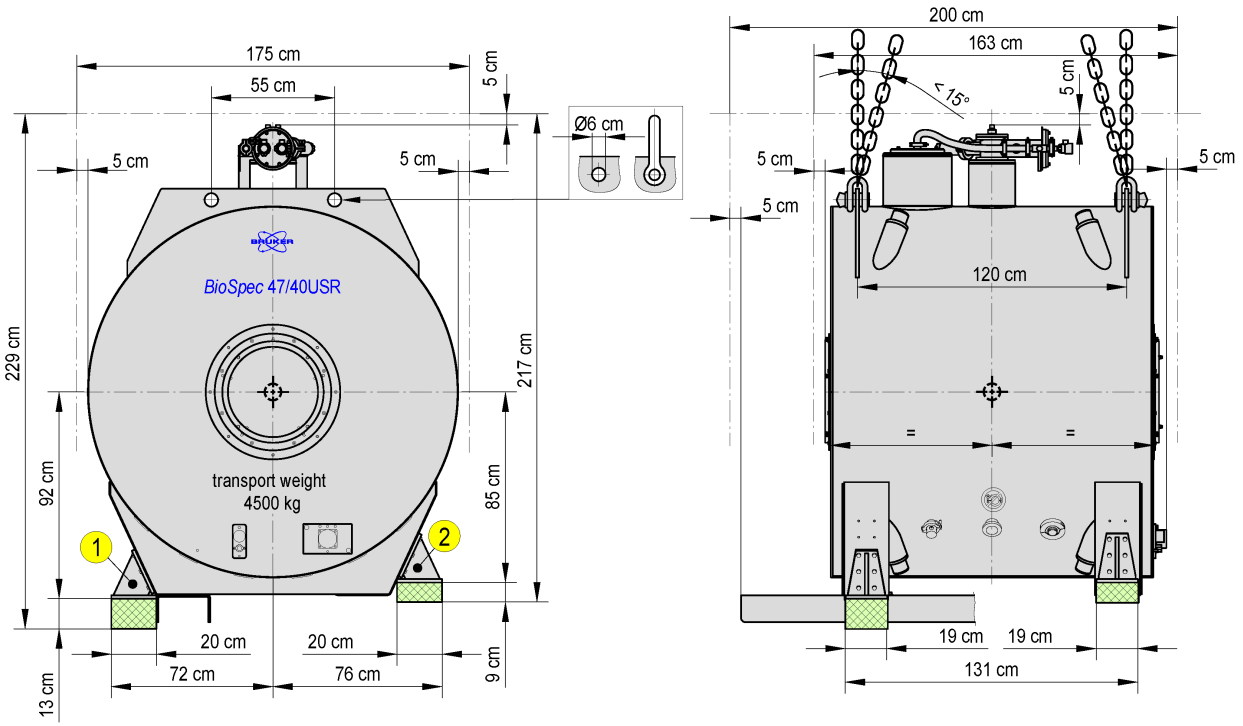


Figure 7.4: Transport dimension of the magnet 47/40 USR V2 . If shown in the figure and where applicable, alternative transport holdings exist: (1) standard transport situation and (2) for the case, when the U-rails are removed. (3) and (A) are additional transport options that are only available for 11 cm magnets.

Additional weight to be considered during transport.

Please note that the given transport weights do not include any transport equipment and staff. This must be considered in addition.

If necessary, the magnet's U-rails can be removed for transport in the building.

Figure 7.5: Unloading situation of transport by lorry

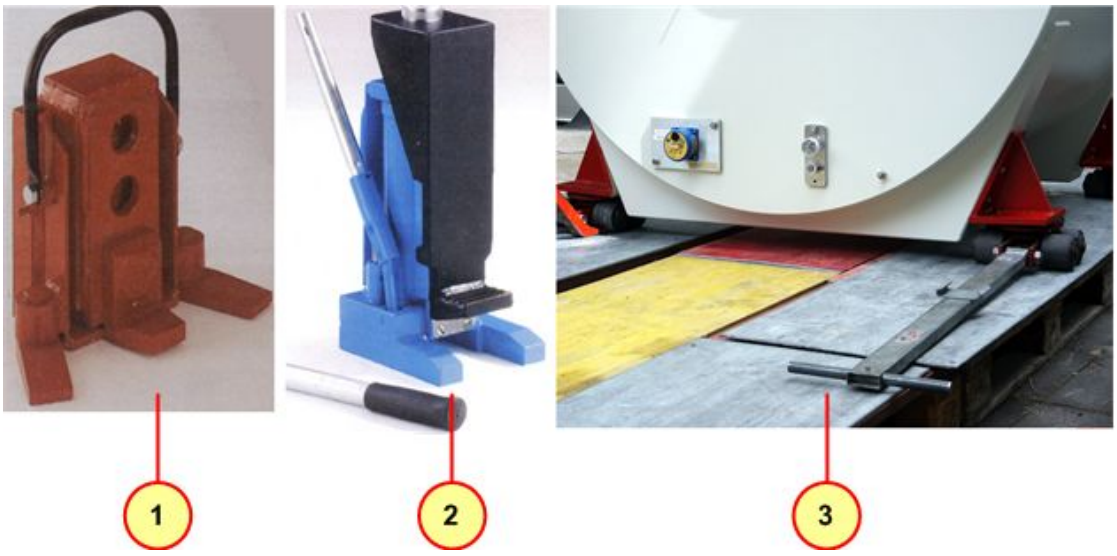
The magnet and electronics must be unloaded from the particular means of transport at the installation site with a crane and this requires adequate free surfaces in the entrance area.

The transport route must have the following features along its entire stretch:

- free of barriers
- openly accessible
- free of steps
- maximum incline of 15 mm/m.
  If larger inclinations are to be overcome, special transport aids must be planned.
- firm underground, no sinking of transport rollers

Only suitable tools should be used to lift the magnet.

The magnet should only be lifted and transported on steel tank rollers on which there are transport hooks for this purpose.



1, 2 Hydraulic hoists for heavy loads

3 Moving with steerable transport rollers

7.6 Moving under special circumstances

If there are no suitable transport routes within the building to the magnet's installation site, special procedures for moving it may be used.

In these instances, please contact the local Bruker BioSpin MRI office to plan the best solution together with them.

Figure 7.6: separatable transport container

8 Moving or Dismantling the MR Instrument

Dismantling or moving the MR instrument requires careful planning. The same safety measures and conditions must be maintained for this as are for installing the MR instrument.

The MR instrument may only be dismantled or moved by qualified personnel.

⚠ CAUTION

Personal injury and/or risk to damage the MR instrument

- ▶ The magnet must not be moved while energized.
- ▶ Transport fixation needs to be in place.
- ▶ Suitable pressure valves must be mounted.

Disposal of an MR instrument must be compliant with local regulations.

Contact the planning office of your local Bruker BioSpin MRI branch.

Residual magnetization in the building

Increased residual magnetization in the building's ferromagnetic materials can remain after an MR system has been dismantled.

Moving or Dismantling the MR Instrument

9 Checklist in Preparation of the Installation

In order to install the MR instrument in time as planned, the following check list must be completed in full latest 6 weeks prior to the scheduled installation date and sent, signed, to your Bruker BioSpin MRI branch.

If the completed check list does not reach the local Bruker BioSpin MRI branch in time, installation on the scheduled date may be canceled or postponed.

9.1 Customer information

Person responsible for the MR system at the customer site	
NAME:	
POSITION:	
TELEPHONE:	
FAX:	
EMAIL:	

DELIVERY INFORMATIONEN:	
DELIVERY ADRESS:	
DATE OF DELIVERY:	

9.2 Magnet installation

Transport of magnet and electronic cabinets to installation site:		
If a firm order for special transportation?	**YES** ☐	**NO** ☐
Is the transportation company adequately insured against transport damage so that the value of the MR system is covered? (Transport from the loading ramp at Bruker BioSpin MRI to the installation site.)	**YES** ☐	**NO** ☐
Did the transport company visit the installation site and did they discuss the installation and delivery procedures with the responsible Bruker BioSpin MRI employee?	**YES** ☐	**NO** ☐
Is there an appropriate unloading or delivery area?	**YES** ☐	**NO** ☐
Is an appropriate crane available? Required capacity in necessary pivoting range.	**YES** ☐	**NO** ☐
If yes, what weight can be lifted? _____ **kg**		
Is a pallet jack with fork length > 90 cm available for moving within the building?	**YES** ☐	**NO** ☐
If yes, what is its length and capacity? Fork length _____ **cm**, _____ **kg**		
Lowest load bearing capacity of the floor/ground along the transport route? _____ **kg**		
Smallest doorway or tightest spot along the transport route? (width/height) _____ **cm /** _____ **cm**		
Are there steps or hindrances along the transport route?	**YES** ☐	**NO** ☐
If yes, how many? How high are they? (Please detail on a separate page.) _____ / _____ **cm**		
Is an elevator available?	**YES** ☐	**NO** ☐
If yes, what weight can be transported? _____ **kg**		
If yes, how large is the door? (width/height) _____ **cm /** _____ **cm**		
If yes, how large is the transport surface? (width/length) _____ **cm /** _____ **cm**		

Installation of the system:		
Have all safety issues been cleared and responsible departments informed? Have protection measures been taken and are barriers available to close off the area?	**YES** ☐	**NO** ☐
Are ladders, brooms, and other possible objects that may be necessary available? Is it possible to call upon the facility manager, handicraftsmen, janitors, or other people whose assistance might be needed?	**YES** ☐	**NO** ☐
Is a separate and lockable room close to the MR system available that can be used solely by Bruker BioSpin MRI during the installation?	**YES** ☐	**NO** ☐
Are the installation rooms (MR area) lockable and the key force, also regulated to prevent theft?	**YES** ☐	**NO** ☐

9.3 Laboratory rooms features

Magnet room, area where the magnet is located:		
Will the magnet room be finished on time?	**YES** ☐	**NO** ☐
Will the floor be finished on time?	**YES** ☐	**NO** ☐
Will the ceiling be finished on time?	**YES** ☐	**NO** ☐
Will the electrical installations be finished on time?	**YES** ☐	**NO** ☐
Are the cable trays installed?	**YES** ☐	**NO** ☐
Will the air conditioning or ventilation be ready for operation at the time of delivery?	**YES** ☐	**NO** ☐
Is a separately controllable exhaust planned for anesthesia and will this be installed on time?	**YES** ☐	**NO** ☐
If not, can the existing suction guarantee an extraction of 15 m^3 air per hour?	**YES** ☐	**NO** ☐
Are pictures or drawings of the magnet room or Faraday cage attached to this checklist?	**YES** ☐	**NO** ☐
If not, what are the inner dimensions of the magnet room? `(width × length × height)` _____ **x** _____ **x** _____ **cm**		
What is the minimal distance between the magnet and each wall? _____ /_____/_____ **cm**		
What is the load bearing capacity of the floor? _____ **kg/m²**		
Is a Faraday cage planned for the magnet room?	**YES** ☐	**NO** ☐
If yes, will it be finished at the time of delivery?	**YES** ☐	**NO** ☐
If yes, is it guaranteed that the residual moisture in the floor is less than 3% at the time of the installation of the Faraday cage?	**YES** ☐	**NO** ☐
If yes, is it guaranteed that the room temperature will be at least 18° Celsius during the installation and up to the time of the installation of the magnet?	**YES** ☐	**NO** ☐

Checklist in Preparation of the Installation

Magnet room, area where the magnet is located:		
Is the quench line correctly calculated and installed, accordingly?	**YES** ☐	**NO** ☐
Due to the safety aspect of the quench line, the System Owner (responsible body) has to verify the correct installation of the quench line. Has the System Owner verified the quench line installation?	**YES** ☐	**NO** ☐
Is at least one line power socket available for service tools?	**YES** ☐	**NO** ☐

Operating area, area of the MR operating workstation:		
Will the operating area be finished on time?	**YES** ☐	**NO** ☐
Will the ceiling be finished on time?	**YES** ☐	**NO** ☐
Will the floor be finished on time?	**YES** ☐	**NO** ☐
Will the electrical installations be finished on time?	**YES** ☐	**NO** ☐
Are at least two line power sockets available (recommended 8)?	**YES** ☐	**NO** ☐
Is the distance that the system cables must span to the electronic cabinets less than 25 meters?	**YES** ☐	**NO** ☐
Is the ventilation system operational?	**YES** ☐	**NO** ☐
Are pictures or drawings of the operating area attached to this checklist?	**YES** ☐	**NO** ☐
If not, what are its inner dimensions? `(width × length × height)` _____ **x** _____ **x** _____ **cm**		
Will a desk and a chair be there at the time of installation?	**YES** ☐	**NO** ☐

Technical room, area of the electrical cabinets:		
Will the technical room be finished on time?	**YES** ☐	**NO** ☐
Will the floor be finished on time?	**YES** ☐	**NO** ☐
Will the electrical installations be finished on time?	**YES** ☐	**NO** ☐
Will the cold water supply be ready for operation?	**YES** ☐	**NO** ☐
Will the cooling system for the room be ready on time?	**YES** ☐	**NO** ☐
Are pictures or drawings of the technical room attached to this checklist?	**YES** ☐	**NO** ☐
If not, what are its inner dimensions `(width × length × height)` _____ **x** _____ **x** _____ **cm**		
What is the length of the system cables between the electronic cabinets and the magnet or the filter plate?	**< 10 m**	**< 18 m**
Will all cable trays be installed at the time of the magnet installation?	**YES** ☐	**NO** ☐

9.4 Declaration

As the person named responsible for the MR instrument by the customer, I hereby confirm the details given beforehand:

Place, date: _____

Name: _____
(in block letters)

Signature: _____

Checklist in Preparation of the Installation

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