MRI CryoProbe

- Bruker User Manual

Site Planning

Version 001

Innovation with Integrity

MRI

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1 About

1.1 This Manual

This manual is intended to be a reference guide for operators and service technicians. It provides detailed information about the user level maintenance and service and overall use of the Bruker device.

The figures shown in this manual are designed to be general and informative and may not represent the specific Bruker model, component or software/firmware version you are working with. Options and accessories may or may not be illustrated in each figure.

Carefully read all relevant chapters before working on the device!

This manual describes parts and procedures relevant to the device version it is delivered with. For older hardware, please refer to the manual supplied at the time.

1.2 Policy Statement

It is the policy of Bruker to improve products as new techniques and components become available. Bruker reserves the right to change specifications at any time.

Every effort has been made to avoid errors in text and figure presentation in this publication. In order to produce useful and appropriate documentation, we welcome your comments on this publication. Support engineers are advised to regularly check with Bruker for updated information.

Bruker is committed to providing customers with inventive, high quality products and services that are environmentally sound.

1.3 Symbols and Conventions

Safety instructions in this manual are marked with symbols. The safety instructions are introduced using indicative words which express the extent of the hazard.

In order to avoid accidents, personal injury or damage to property, always observe safety instructions and proceed with care.

DANGER

This combination of symbol and signal word indicates an immediately hazardous situation which could result in death or serious injury unless avoided.

⚠ WARNING

This combination of symbol and signal word indicates a potentially hazardous situation which could result in death or serious injury unless avoided.

⚠ CAUTION

This combination of symbol and signal word indicates a possibly hazardous situation which could result in minor or slight injury unless avoided.

NOTICE

This combination of symbol and signal word indicates a possibly hazardous situation which could result in damage to property or the environment unless avoided.

This symbol highlights useful tips and recommendations as well as information designed to ensure efficient and smooth operation.

3 Introduction

BRUKER MRI CryoProbes™ offer a dramatic increase in the signal-to-noise ratio (SNR) by reducing the operating temperature of the NMR coil assembly and the preamplifier. An automatic closed-cycle cooling system controls all functions and guarantees excellent stability during short and long-term experiments. As a result, the system is easy to handle. MRI CryoProbes open new fields for MRI/MRS applications where SNR, the spatial resolution or measurement time are critical.

3.1 How to use this Site Planning Guide

This MRI CryoProbe Site Planning Guide provides information about a MRI CryoProbe system which can be used with an already existing or a new MRI system.

With the information of this document the Bruker BioSpin service representative can perform a Site Planning with the customer. After the Site Planning all information should be available to prepare a successful installation of the MRI CryoProbe system.

First an overview about the main parts of the MRI CryoProbe system with technical details is given in Chapter 3. The specifications of the MRI CryoProbe system is given within Chapter 4.

In Chapter 5 is the Site Planning procedure in 7 steps described which allows to check if an installation is possible. With the Questionnaire of Chapter 6 all details necessary for a successful installation are checked at the customer site. This information has to be send back to Bruker to allow for the final check.

Finally, the checklist is given, where the customer has to declare, that he provided the necessary infrastructure for an MRI CryoProbe installation.

Introduction

4 System overview

In the following sections details of the BRUKER MRI CryoProbe™ system setup will be given, as shown in Figure 4.1 and Figure 4.2. The difference in the setups is given by the Faraday cage marked in magenta in Figure 4.2.

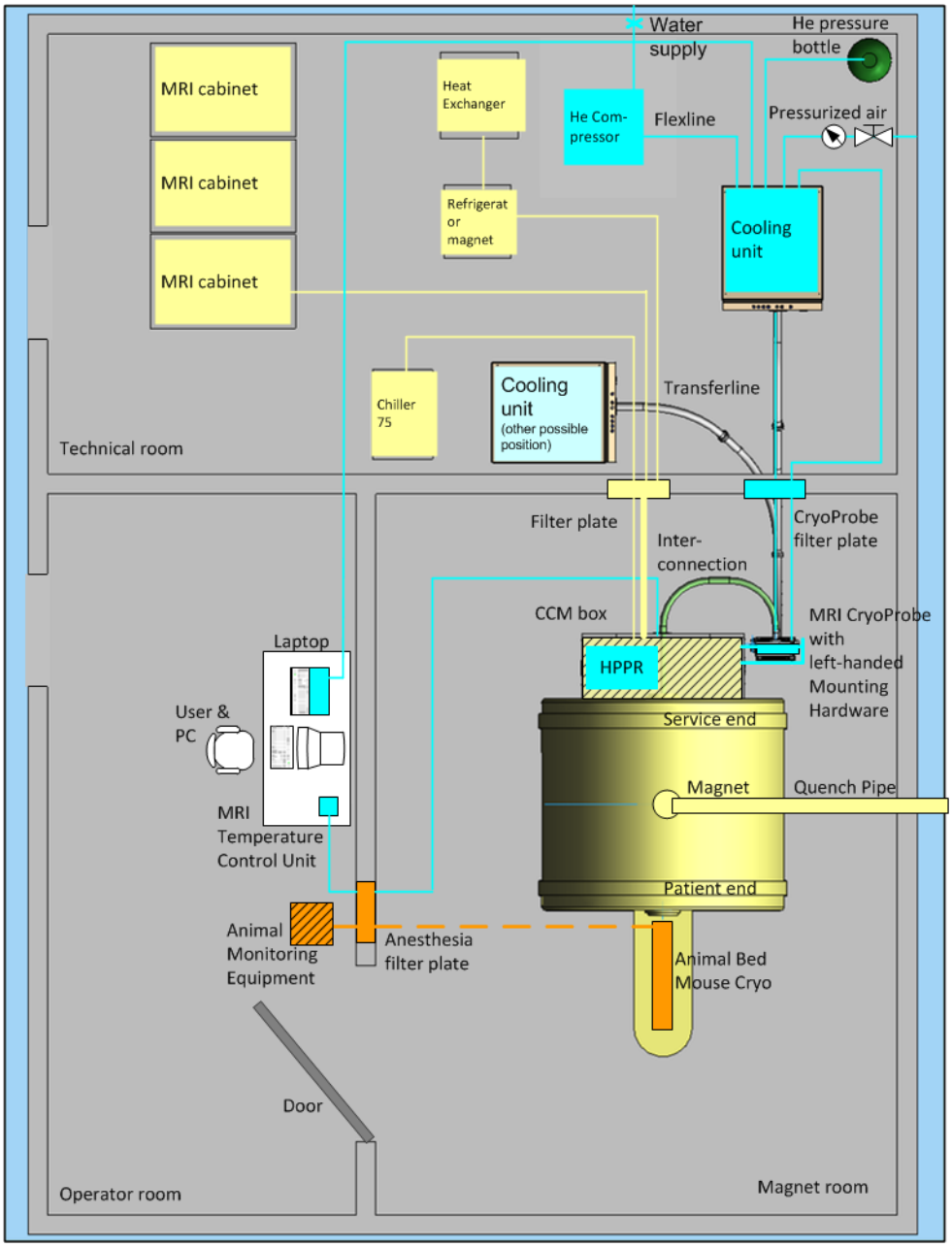


Figure 4.1: Principle outline of an MRI CryoProbe system without a Faraday cage. All system components of the MRI CryoProbe and the CryoPlatform are marked in blue, while the magnet and its supply are marked in yellow. The animal support components are highlighted in orange.

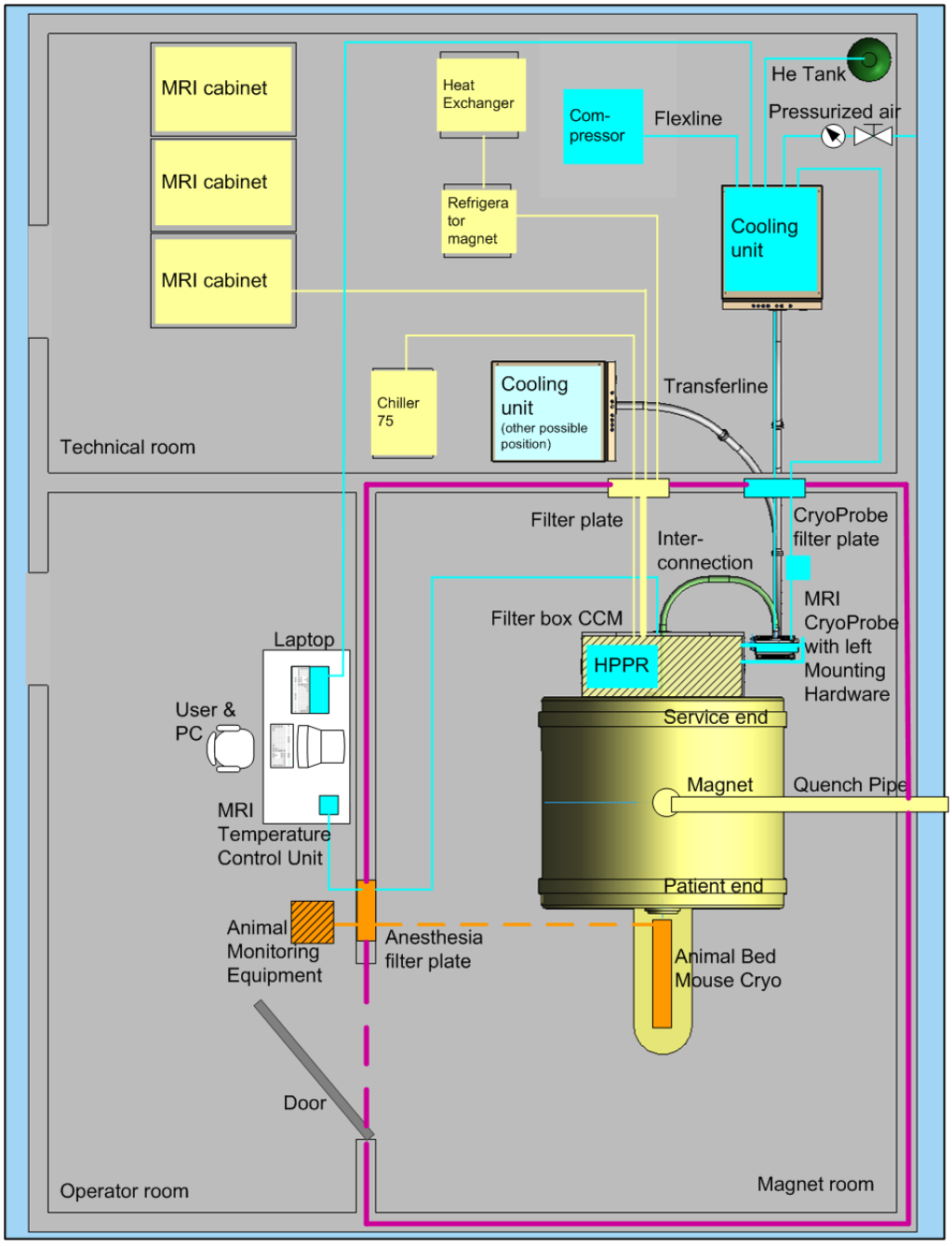
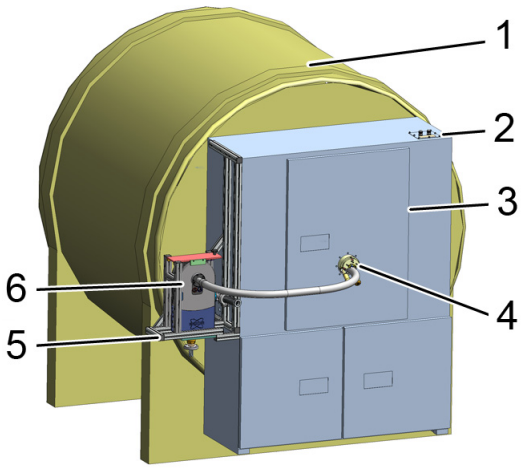


Figure 4.2: Principle outline of an MRI CryoProbe system with a Faraday cage marked in magenta. All system components of the MRI CryoProbe and the CryoPlatform are marked in blue, while the magnet and its supply are marked in yellow. The animal support components are highlighted in orange

The MRI CryoProbe Cryogenic preamplifier is mounted with a special mounting hardware on the right or left side of the CCM box which is attached at the back of the magnet (Figure 4.3). The Preamplifier is via the Interconnection connected to the RF CoilHead of the MRI CryoProbe. The RF CoilHead is positioned in the center of the magnet.



[1] Magnet

[2] Interface CCM box

[3] CCM box

[4] CCM box opening for MRI Cryo-Probe Transferline

[5] Mounting hardware

[6] MRI CryoProbe Cryogenic preamplifier

Figure 4.3: The MRI CryoProbe mounted at the CCM box at the back of the magnet.

4.1 MRI CryoProbe

The MRI CryoProbe™ is an MRI coil with the essential parts of the RF preamplifier integrated. Both the RF Coil and the cryogenic amplifier are cooled by cryogenic Helium (He) gas to achieve an extremely efficient operation of the coil assembly and to significantly reduce thermal noise. Thus, the overall signal-to-noise ratio (SNR) is dramatically enhanced. The main component within the MRI CryoProbe system is the probe itself, as shown in Figure 4.4.

The MRI CryoProbe consists of four parts: the Cryogenic preamplifier, the Interconnection, the RF sealing ring and the RF CoilHead. The Cryogenic preamplifier (Figure 4.5) contains the amplifier and interface electronics. The flexible, cryogenic Interconnection links the Cryogenic preamplifier to the RF Coil. The RF Coil is protected by a coil housing.

The RF sealing ring (Figure 4.4) is fixed at the Interconnection and is necessary when the MRI CryoProbe is mounted via the CCM filter box or another Filterbox in the magnet. This RF sealing also contains the connectors for the MRI Temperature Control Unit and the Bottom heater. The MRI CryoProbe is connected to the CryoPlatform with the standardized CryoCoupler and Transferline (He supply) for cooling as well as with several sensor cables.

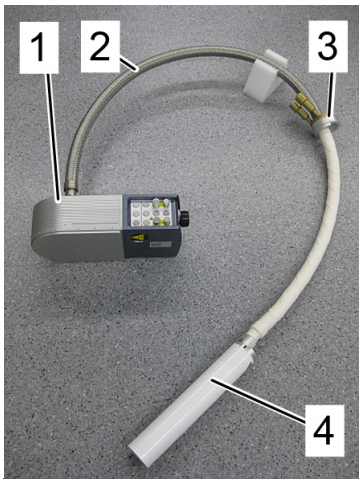


Figure 4.4: The MRI CryoProbe.

A MRI CryoProbe is shown with the following parts:

[1] Cryogenic preamplifier

[2] Interconnection

[3] The sealing ring to close the RF shielded CCM box with connectors:

- P1) Heater housing (10 pol Lemo socket for the MRI temperature control system) and
- P2) Heater Bottom (4 pol Lemo socket).

[4] RF CoilHead

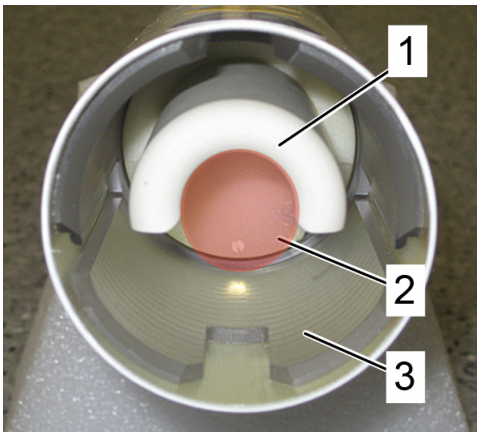


Figure 4.5: The RF CoilHead

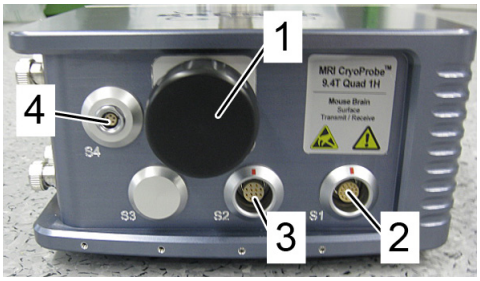
[1] Detailed view of the CoilHead containing the RF coil.

[2] The space marked in red below is called the measurement volume

[3] the locking device

Figure 4.6: The pressure release valve

The Cryogenic preamplifier has a pressure relief valves (1).



The Cryogenic preamplifier of the MRI CryoProbe has different connectors:

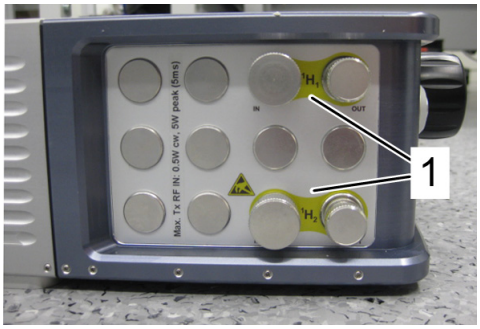
[1] CryoCoupler

[2] S1 connector

[3] S2 connector

[4] S4 connector (S1-S4 leading to the interface box (see 4.2.7)

Figure 4.7: The Cryogenic preamplifier



On the side of the Cryogenic amplifier the RF connections (1) are placed.

Figure 4.8: The RF connections

During operation, the RF CoilHead is inserted into the magnet bore, while the Cryogenic preamplifier remains outside the magnet. All cold parts inside the MRI CryoProbe are vacuum insulated. During operation, only the internal parts of the MRI CryoProbe are chilled to low temperatures, while all outer surfaces remain at room temperature.

4.1.1 MRI CryoProbe: Technical information

Cryo-compatible preamplifier assembly 'HPPR/2': The MRI CryoProbe system can be installed in an MRI system with an AVANCE systems introduced in 2000 of type AV (AVI), AVII and AVIII running ParaVision Version 5 and higher. Depending on the RF configuration of the MRI CryoProbe, the console has to have corresponding channels and hardware available. For example, a 1H Quadrature Transmitter Receiver MRI CryoProbe needs a HPPR/2 system with two 1H HPLNA modules.
A cryo-compatible HPPR/2 has to be installed for the MRI CryoProbes. THe HPPR/2 will be placed inside the CCM box at the service end of the magnet. Depending on the MRI CryoProbe type and console configuration an RF splitter Or/and combiner may be necessary.

There are different types of MRI CryoProbes available which have different coils and electronic components. For the availability of an MRI CryoProbe for a specific application you have please to contact your BRUKER representative.

The specification of the physical structure is the same for all of them, as given in Table 4.1. and Table 4.2. The Tuning and Matching System for each probe is given in relation to the order.

Parameter	
Dimensions	W: 19 cm, D: 36.5 cm, H: 9.5 cm
Overall length (flexible)	2-3 m depending on the chosen type and the magnet
Weight	12 kg

Table 4.1: Technical data of MRI CryoProbe

MRI CryoProbe	Connection to
Transferline	CryoCooling Unit for He (CryoCoupler)
Vacuumline	CryoCooling Unit for Vacuum
RF Connections	HPPR/2
Heater connection	Temperature Control Unit
CoilHead Heater	Cryo connector

Table 4.2: Connections to other equipment

The MRI CryoProbe is connected to the CryoPlatform with the standard CryoCoupler and He Transferline for cooling as well as with several sensor cables. It requires a special interface cable to the Temperature Control Unit, which is described in ***Manual No. Z31849***.

The length of the Transferline has to be determined during the Site Planning and can have a length of 3 - 6 m. The standard length of the Transferline is 4 m seems to be a standard length.

i No subsequent modifications, upgrades, or frequency changes are possible for an existing MRI CryoProbe

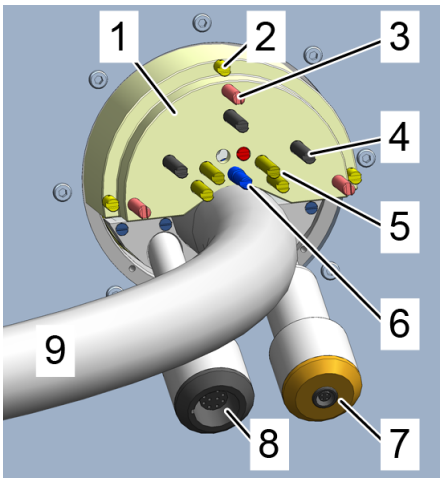
4.1.2 Tuning & Matching systems & RF filter cover

The MRI CryoProbe system has a Tuning/Matching (T/M) assembly (Figure 4.9). There are two system types availibale:

- a T/M system compatible with the CCM box
- a T/M system to connect directly at the Centering tube in case no CCM box is installed

In both cases a RF filter cover has to be attached at the Interconnection ring to shield the probehead.

4.1.2.1 Installation of T/M assembly in Magnet with the CCM box



[1] RF filter cover

[2] Fixation screws for the RF filter cover against the Centering tube

[3] Fixation screws for the RF filter cover against the Interconnection ring

[4] Fixation screws in the Centering tube

[5] T/M rods (golden)

[6] Blue rod

[7] Heater bottom (4 pol Lemo socket)

[8] Heater housing (10 pol Lemo socket)

[9] Interconnection

Figure 4.9: Tuning/Matching (T/M) assembly installed in magnet with CCM box.

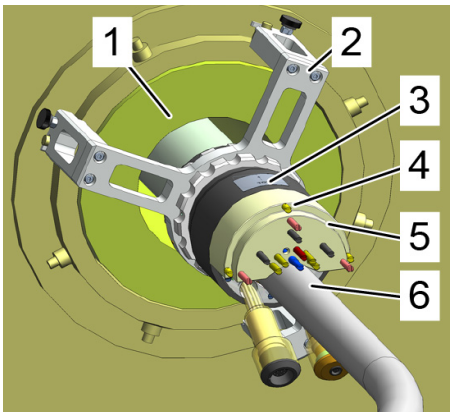
The tuning and matching system can be attached to the back of the RF Coil once it is installed through an opening in the RF sealing of the CCM filter box.

When the T/M assembly is completly inserted, the RF filter covers the T/M assembly. The cap itself can be fixated with screws at the door of the CCM box (Figure 4.9(2)).

If necessary, it is possible to adjust the tuning and matching of the system by turning the T/M rods (Figure 4.9 (5)).

4.1.2.2 Installation of T/M system in Magnet without the CCM box

Figure 4.10 shows the Centering tube mounted with a fixation claw (Figure 4.10 (2)) around the bore at the back of the magnet without touching the Gradient system (Figure 4.10 (1)) of the magnet. The T/M assembly can be pushed in until it reaches the stop position, the user will feel then the spring pressure.



[1] Magnet gradient system

[2] Fixation claw for the Interconnection

[3] Interconnection ring

[4] Fixation screws for the cap against the Centering tube

[5] Cap (here no RF filter function)

[6] Interconnection

Figure 4.10: Tuning/Matching (T/M) system in installation without a CCM box.

Then the cap ((Figure 4.10 (5)), here no RF filter function) has to put on the end of the

Centering tube and the silver rods have to be tightend just inside the Centering tube. Then the cap has to be positioned and the blue cap rod has to be tightend. The Interconnection (Figure 4.10 (6)) and the connectors for bottom heater and Temperature Control unit are accessible.

i The specification of the physical structure of the MRI CryoProbes is the same for all types. The Tuning and Matching System for each probe is given in relation to the order.

4.1.3 MRI Temperature Control Unit (TCU)

The temperature at the interface between the animal and the surface of the coil housing has to be kept precisely at a selected value (e.g. 32 - 38 °C) to avoid any discomfort to the animal. The MRI CryoProbe relies on active heating of the CoilHead in order to maintain the required temperature.

With the MRI Temperature Control Unit (TCU, shown in Figure 4.11) the temperature of the Animal/MRI CryoProbe interface can be monitored and kept at any required physiologically reasonable temperature value. The Unit is connected by a dedicated cable set (default length=10 m) to the MRI CryoProbe. The connection is designed to pass through the anesthesia filter plate between the magnet room and the operator room.

The MRI TCU has to be placed within the operator room so that the operator has visual and acoustic contact to it at all times. The unit provides an visual and acoustical alarm when specified limits at the Animal/MRI CryoProbe interface are exceeded.

The self-contained MRI TCU can be output to an external alarm system via a relay contact (potential free). Furthermore, the unit has two serial interface ports which can be used for data transfer to a computer, where the temperature data can be displayed and/or logged.

Figure 4.11: On the MRI Temperature Control Unit the left LED display shows the actual temperature at the interface, while the right LED display (normally covered) shows the temperature of a second independent sensor (for safety reasons).

In the event of a mains power failure (230 V), the MRI Temperature Control Unit will disengage itself and the temperature control of the animal will cease. This will typically result in a temperature decrease at the CoilHead surface to a value between 0..10 °C.

When the MRI TCU is connected to an external alarm system, it can be used in two operation modes:

- **Active external alarm mode:** For general safety reasons, the MRI Temperature Control Unit is designed in such a way that once the power has been interrupted, the unit will not resume operation by itself, but rather has to be re-engaged by the operator. In the case of a mains power failure all lights on the MRI Temperature Control Unit, including the LED that shows the actual temperature, will go out. Moreover, the acoustic alarm of the unit will stop functioning and the relays for the external alarm will also have no power in such an event. It must therefore be noted that there will be no power available to trigger an active alarm in the event of a mains power failure. Depending on which other systems are hooked up on the same phase, the power failure may or may not be detected. In the case of an undetected power failure during an animal measurement, a life-threatening situation for the animal may result.
- **Passive external alarm mode:** For installations which require an enhanced safety level, the MRI Temperature Control Unit can be configured for a passive alarm mode. In this configuration, the alarm is always active (even when the unit is turned off) except when the MRI Temperature Control Unit is operating and the temperature is within limits. In the passive operator mode, an alarm will be active when the unit is switched off or the heater is disabled. In this configuration, the connected external alarm system must be powered such that it will still function during a mains power failure, otherwise the advantage of using the passive mode will be lost.

Further details about the Temperature Control Unit can be found in the ***Temperature Control Unit User Manual (Z31849).***

4.1.3.1 Faraday installation

In case of a Faraday installation, the cable of the Temperature Control Uniwill use a 15 pin Sub-D connector to go through the anesthesia filter plate. Such a filtered connector has been made available.

The Temperature Control Unit Z106553 itself is explained in detail in the ***User Manual Z31849***. Within the installation it is only necessary to make sure that the user can observe the display and hear the acoustic alarm of the unit from his operating position.

4.1.4 Uninterruptable Power Supply (optional but highly recommended)

In general, Bruker recommends the use of an uninterruptable power supply system (UPS) to protect the MRI CryoProbe systems from mains power failure. Within an MRI CryoProbe system the Cooling unit and the MRI Temperature Control unit should be connected to the UPS.

4.2 CryoPlatform

A CryoPlatform™ as shown in is required per MRI CryoProbe in use. It provides the entire infrastructure for the operation of MRI CryoProbes. It is a push-button system which performs all operations needed for an entirely automatic cool-down, cold operation, and warm-up of the MRI CryoProbe.

A CryoPlatform consists of a CryoCooling Unit with an integrated He Transferline to the MRI CryoProbe, a separate He compressor with water (or air) cooling, Flexlines which connect the He compressor and CryoCooling Unit and a He steel-cylinder (He Tank in Figure 4.1) with regulator. The system is self-contained, but can be remotely controlled via a laptop for checking the cooling performance.

⚠ WARNING

Electrical hazard from electrical shock.

A life threatening shock may result when the housing is open during operation.

Therefore:

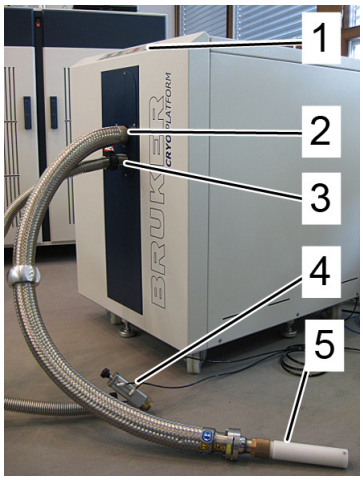
- ▶ It is the customer‘s responsibility to ensure that the electrical installation of the CryoPlatform is conform to all national and local electrical regulations.
- ▶ The housing must be closed during operation.

4.2.1 CryoCooling Unit

The most prominent part of the CryoPlatform is the CryoCooling Unit (CU) which is shown in Figure 4.12. The actual cooling device inside the CryoCooling Unit is the Coldhead. It is a two-stage Gifford-McMahon cycle cryo-refrigerator that uses compressed He for continuous closed-cycle refrigeration. Cold He is then circulated through the MRI CryoProbe via an insulated He Transferline. Vacuum pumps maintain insulation of the MRI CryoProbe and the CryoCooler.

All processes are performed and supervised autonomously by the CryoController which is located inside the CryoCooling Unit. Thus, the CryoCooling Unit does not rely on any external computer or software for its operation. However, an RS 232 interface is present that allows the connection to a laptop, running a data terminal and remote control. On the laptop the software package *CryoTool* is installed which allows the user to check the cooling performance. Additional functions are provided for the service engineers.

All connections from the Cooling unit pass the CryoProbe filter plate to the magnet room.Further details see section 4.3 The He compressor is connected to the Cooling unit.



[1] Push button panel to control the unit

[2] Transferline of the Cooling unit

[3] Vacuum line

[4] Vacuum connector to connect with the MRI CryoProbe

[5] CryoCoupler of the Transferline to be connected with the preamplifier

Figure 4.12: .Within the service room the CryoCooling Unit (CU) is installed which can be controlled via a Laptop (not shown)

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i **Acoustic noise:** The CryoPlatform comprises moving parts which are sources of acoustic noise (max. 42 dB(A) in 1 m distance). A characteristic periodic hiss of the Gifford-McMahon cooler is clearly audible from the CryoCooling Unit and the Flexlines despite their acoustic insulation. The He compressor and an optional water chiller are also noisy but can conveniently be located in an adjacent service room.

The CryoCooling Unit (Table 4.4) can be ordered with different lengths of Transferlines in dependency of the magnet type and the site arrangements. The CryoCooling Unit itself is the same but different length of Transferlines can be mounted. During Site Planning the BRUKER engineer should check whether the correct transferline length has been chosen. The criterion is that the CryoCooling Unit must be positioned outside of the 5 mT (50 Gauss) stray field, this implies in most installations that the Cooling Unit and the He compressor are placed in a service room. The Transferline is passing a Filter plate / cable bushing plate from the service room to the magnet room and is terminated with a BRUKER standard CryoCoupler.

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i In case the Site Planning shows the neccessity of a longer Transferline, please contact BRUKER for further details of possibilities.

Parameter	
Dimensions	W: 68 cm, D: 89 cm, H: 96 cm
Weight	400 kg
Voltage	AC 230 V ±10%, 1 phase, 50-60 Hz required external fuse upstream: T 10 A (T = time-lag fuse).
Power consumption	Peak: 0.8 kW, Average: 0.5 kW (systems which were produced before June 2005 had a peak power of 1.5 kW)
Acoustic noise	max. 42 dB(A) at a distance of 1 m
Maximum room ambient temperature	30 °C. No operation above this temperature is approved.
He Gas supply	A high-purity helium (He) gas cylinder (6 N = 99.9999% or better, maximum impurity concentration 1ppm)
Compressed Air or Nitrogen supply	with a pressure of >=4.5 bar.
Position	outside of 5 mT stray field

Table 4.3: Technical data for CryoCooling Unit

i The CryoCooling Unit includes the cryogenic cooling system, the vacuum system and the control electronics. The unit uses compressed air or nitrogen for the operation of internal pneumatic valves which control the high-pressure He gas flow within the system. In order to function correctly these valves require an uninterrupted compressed air supply. Significant compressed air or nitrogen consumption occurs only during cool-down or warm-up sequences.
The CryoCooling Unit complies with over voltage category II and its degree of protection is IP20. A 10 m mains cable is attached to it and equipped with a standard IEC 320 C4 plug (German ‘Schuko’ two-pole plug with dual ground-contacts) rated 10/16 A 250 V. Wire assignments are: brown = line (‘field’), blue = neutral (‘field’), yellow/green = ground.

MRI CryoProbe	Connection to
Transferline	CryoProbe CryoCoupler (std. length = 4m, possible length = 2 - 6 m)
Vacuumline	CryoProbe vacuum connector
Gas connectors	He supply/return Flexlines, self-sealing
He Supply	Helium cylinder
Schuko connector	Power supply

Table 4.4: Connectors of CryoCooling Unit

4.2.2 He compressor

The He compressor unit provides compressed He and electrical power to the Coldhead inside the CryoCooling Unit. It consists of a compressor capsule, a heat exchanger, and an adsorber. The He compressor compresses He gas to the pressure level used by the system. Since the He compressor has a high electric power consumption, its mains connection requires special attention (see Table 4.5).

⚠ WARNING

Electrical hazard from electrical shock.

A life threatening shock may result when the housing is open during operation.

Therefore:

- ▶ Local regulations apply and the installation needs to be carried out by a licensed electrician.
- ▶ In some parts of the world (e.g. Europe) a plugged connection is feasible and recommended, whereas in other regions (e.g. US) a fixed 'hardwiring' is mandatory.

NOTICE

An Indoor He compressor consists of one unit only. The electric power must be provided near this unit. These He-compressors are NOT designed NOR approved for outdoor operation! The power ratings of the indoor He compressors are as follows (Table 4.5).

Sumitomo Type		F-50L	F-50H
Type of Compressor		**Indoor Water**	
Dimension		W: 45 cm, D: 48.5 cm, H: 59.1 cm	
Weight		120 kg	
Voltage		3 x 200 V	3 x 400 V (380, 400, 415@50Hz or 460, 480@60Hz
Mainly delivered to		US / CA / JP	EU / CH
Operating Current		26 A	13 A
Min. Circuit Ampacity		35 A	17 A
Max Fuse Size		60 A	30 A
Compressor LRA		160 A	75 A
Power Requirement	**Minimum**	9 kVA	9 kVA
	Recommended	12 kVA	12 kVA
Power Consumption	**Cool Down max. 50 / 60Hz**	7.2 / 8.3 kW	7.2 / 8.3 kW
	Steady State max. 50 / 60Hz	6.5 / 7.5 kW	6.5 / 7.5 kW
Water supply to remove the heat load (cooling power > 8.3kW)		flow: 420 l/h temperature: 4-28°C water quality: pH 6.5-8.2 hardness: mg[$CaCO_3$]/l < 200 Molybdate-reactive silicate(mg/l) < 50 suspended matter (mg/l) < 10) max. pressure less than 7bar / 100 psi	
He Gas supply		A high-purity helium (He) gas cylinder (6 N = 99.9999% or better, maximum impurity concentration 1 ppm)	
Acoustic noise		max. 60 dB(A) 1m distant	
Ambient Operating Temperature		5 to 28°C (41 to 82.4°F)	

Table 4.5: Technical data for indoor water cooled He compressors.

4.2.3 Flexlines

These consist of two He Gas Pressure lines (Supply and Return) which connect the CryoCooling Unit to the He compressor, thus enabling a closed-loop circulation between the CryoCooling Unit and the He compressor. These He gas pressure lines transport pressurized helium gas with pressures of up to 25 bar. Both helium flows are at room temperature. Also provided are electrical control cables and electrical power cables which connect the CryoCooling Unit and the He compressor.

Indoor He Gas Pressure Lines

There are Indoor He Gas Pressure Lines up to 20 m for indoor compressors available. Only one Indoor He Gas Pressure Line package needs to be ordered. Please contact BRUKER BioSpin AG if another length (maximum 20 m for indoor) is necessary.

This configuration allows a remote installation of the He-compressor and offers the following benefits:

- It allows the installation of a CryoPlatform in very confined lab space by allowing the He compressor to be placed in another room.
- A remote installation eliminates any noise from the compressor in the lab.
- A remote installation may allow better and possibly safer connection to cooling water or the use of the waste heat to heat another room.
- For multiple CryoPlatform installations within one lab or building, it is possible to group all compressors in one room for easy connection and maintenance.
- It is not necessary to have a permanent access to the compressor during normal operation, since the compressor is remotely controlled and monitored by the CryoCooling Unit. The compressor is automatically switched on and off, depending on the current operation of the CryoPlatform. Any possible malfunctions are also automatically forwarded to the CryoCooling Unit, which takes the appropriate action and notifies the operator.

The remote installation will require large adequate openings between the corresponding rooms. Either one single hole of 130 mm in diameter or two holes with each 80 mm in diameter will be sufficient. Only one Indoor He Gas Pressure Line package needs to be ordered.

4.2.4 He Supply

NOTICE

Helium (He) gas Grade 6.0 (i.e. 99.9999 % or better, maximum impurity concentration 1 ppm, purity also named ‚electronic grade') is required, no inferior quality can be used. It is used for the flushing of the system before each cool-down and to compensate for small losses. The customer has to supply a full standard size cylinder (typically 50 L at 200 bar).

- The Helium cylinder must be secured in its wall mounting bracket according to the local regulations outside the 0.5 mT field of the magnet within the service room.
- Furthermore, the path for installation, removal, service or exchange has to be outside the 0.5 mT field.
- The transport path for exchanging the He steel cylinder should be placed within the service room and must also be outside the stray field.
- The He steel cylinder must be located within the service room (outside the 0.5 mT stray field).
- The He steel cylinder has to stay with the MRI CryoProbe System while in cold operation because the He system would be contaminated with air upon reconnecting. Consequently, this He steel cylinder cannot be used for any other purpose (e.g. magnet refill) while the MRI CryoProbe is cold.
- Since it is rather impractical to ship charged He-gas cylinders over long distances, the Platform does not include the He-gas cylinder itself. It must be provided by the customer. However, BRUKER BioSpin will be glad to assist the customer in finding a local supplier.

The He supply system delivered with the CryoPlatform comprises a He Regulator and a charging connection to a high pressure line. The adapter of the He cylinder is country specific and has to be specified during the Site planning.

An estimation of the He consumption for a standard size (50L at 200 bar) He steel cylinder indicates that there is sufficient He for at least 40 cool-down cycles (CU/4). The He-steel cylinder has to be exchanged when its pressure drops below 30 bar. During operation the loss of He is very small. Consequently, no provisions were made on the MRI CryoProbe System for hooking up a He recovery system.

4.2.4.1 He-gas cylinder connection

To establish the connection between the He-gas cylinder and the CryoCooling Unit a He-gas cylinder connection has to be ordered. The various types are listed in Table 4.6. The connection includes a flexible steel line and an adapter with a pressure regulator. The standard length of the line is 10 m. For some connectors 20 m, 40 m or even 60 m are available. Additional to this, a 20 m extension line (Z74362) needs to be ordered which can be combined with any connector of Table 4.6.

As it is sometimes impossible to determine the type of adapter needed for the He-gas pressure regulator during a Site Planning procedure, the He-gas cylinder country kit

(Z74012, see Figure 4.13) can be used to find out which one of the provided adapters fits the He-gas cylinder from the gas supplier. Z74012 is provided on loan only.

Countries	Norm	Max. pressure	Ordering No.
EU	DIN 477 No 6 SN 219 505 W 21.8 x 1/14“	200 bar	10 m => Z46261 20 m => Z49301 40 m => Z71782 60 m=> Z72992
EU, I, S, GB	CEN 300 bar W30x2, 15,9 / 20,1	300 bar	10 m => Z106105 20 m => Z106106
S, NL	NEN 3268 RU3 W24,32 x 1/14“R	200 bar	10 m => Z49488
GB	BSP 14 5/8“(22.92 mm)	200 bar	10 m => Z48484 20 m => Z72997
I	U.N.I 4412 W24.5 x 1/14“	200 bar	10 m => Z71561
US	CGA 5809 0.965“-14NGO	200 bar	10 m => Z48273 20 m => Z70353
J	W-20.9-14-OL 20.9 mm x 1/14	200 bar	10 m => Z48285 20 m => Z71894
RU	FDIN477 No 9 G3/4“-26.44 x 1 14“	200 bar	10 m => Z73687

Table 4.6: He-gas cylinder connection

(A) (B)

Figure 4.13: A) The content of the He-gas cylinder connection country kit Z74012 is shown, the shown adapters are only mock-ups. B) Special adapter from Z74012 used for connection of country specific He-gas cylinder and He Flexline.

4.2.5 CryoController

All processes are performed and supervised autonomously by the CryoController which is located inside the CryoCooling Unit. Thus, the CryoCooling Unit does not rely on any

external computer or software for its operation. However, an RS232 interface is present that can be connected to a laptop, that uses a special software. The software functions available on the laptop are solely for the purpose of remote control and monitoring.

4.2.6 Laptop & Software

The CryoCooling Unit (CU) is completely self-contained and a front panel at the CU allows the user to control it (e.g. cool down, warm-up).

In addition, a laptop is delivered together with the CU and serves as a data terminal and remote control. On the laptop the *CryoTool* software package is installed and offers the user two modes to control the CU. The user mode supports the monitoring of the status of the CU (cool down, warm-up) and the history of the system. Furthermore, status, warning and error messages are displayed, and log files of its entire operation history are continuously recorded. Additionally, the service mode, which is password-protected and only accessible by service engineers, allows detailed monitoring of the cooling performance as well as low-level diagnostic and control functions.

The laptop should be visible for the operator at all times, for this reason it should be placed in the operator room. It is connected to the CU with a RS232 cable (default length = 10m). This cable needs no shielding or filtering, since it connects the CU to the operator´s room, which are both located outside of the RF protected environment. In principle, the maximum stray field at the location of the laptop should not exceed 0.5 mT.

The RS232 cable connection between the two units must be established by going around the magnet room.

4.2.7 CRP Interface Box

Small box to interface Cooling Unit to the MRI CryoProbe. It supports the read out of the vacuum sensor and the internal temperatures of the MRI CryoProbe.

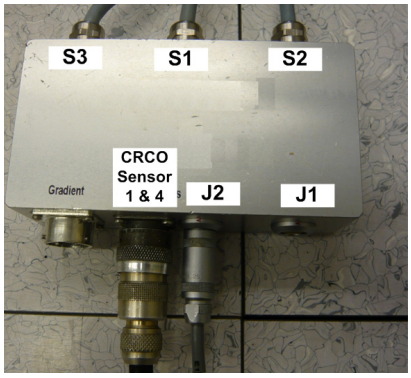


Figure 4.14: CRP Interface box

4.3 Filter Plates

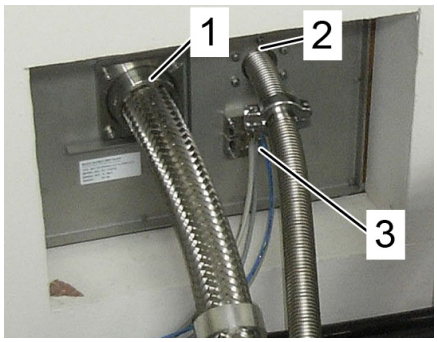
The installation of an MRI CryoProbe needs three filter plate connections:

Magnet system: The Filter plate (Figure 4.1) is placed between the magnet room and the service room. Here, all connections between the magnet and the magnet supply system in the service room have to pass through and will be filtered. These connections are RF sealed.

MRI CryoProbe system: The CryoProbe Filter Plate / cable bushing plate (Figure 4.15) is also placed between the magnet room and the service room. It has the size of W: 40 cm x H: 30 cm and provides three openings.

It has to be installed at least 15 cm above the floor. Depending on the arrangements of the specific case, the filter plate can be installed higher so that the Transferline can pass through in such a way that the bending radius is > 70 cm. The connections are RF sealed.

i **This CryoProbe Filter Plate / cable bushing plate will be installed at sites with or without Faraday rooms**.



[1] Transferline (d = 83 mm)

[2] Vacuumline (d = 42 mm)

[3] Supply cables (26 x 45 mm)

Figure 4.15: The CryoProbe Filter Plate / cable bushing plate with the RF shielded openings as seen from inside the magnet room.

MRI CryoProbe system: The Anesthesia filter plate (Figure 4.16) is of size 20 cm x 28 cm. This filter plate provides openings for the USV and the Temperature Control Unit connection. Furthermore are a lot of connector possibilities provided which can be used when needed by the customer.

i The Anesthesia filter plate has to be installed for MRI CryoProbes between the magnet room and the operator room **only in Faraday cage installations.**

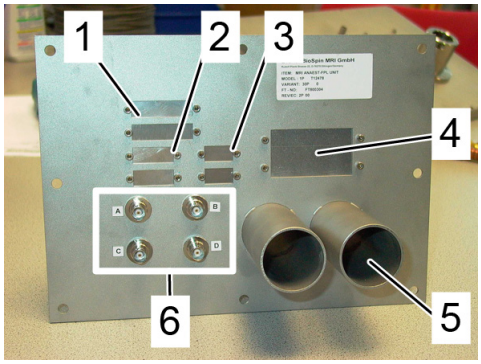


Figure 4.16: The Anesthesie filter plate

The Anesthesie filter plate provides different openings:

[1] 2 x 25 pol sub-D: 1 x female & 1 x male connector

[2] 2 x 15pol sub-D: 1 x female & 1 x male connector

[3] 2 x 9pol sub-D: 1 x female & 1 x male connector

[4] small signal filterbox

[5] tubes for cabeling supply

[6] 4 BNC connectors

4.4 Magnet & Lab

Please refer to the separate manuals for the specific magnet.

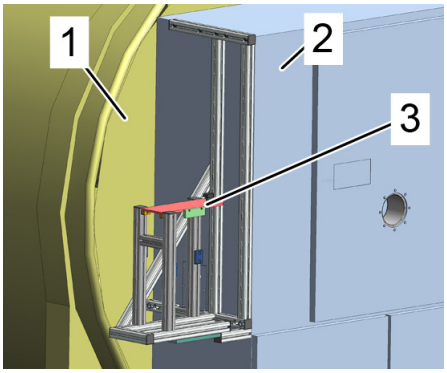
4.5 Mounting Hardware

In a standard magnet with CCM box installation: The Cryogenic preamplifier of the MRI CryoProbe is mounted with a special Mounting hardware (Figure 4.5) on the CCM box of the service end of the magnet.

Although, the MRI CryoProbe is installed with a CCM box a Filter Plate / cable bushing plate has to be ordered.

Device	
CCM box	W: 111 cm, D: 44.6 cm, H: 146 cm
Mounting hardware	W: 34 cm, D: 19 cm, H: 101 cm

Table 4.7: Technical data of MRI CryoProbe



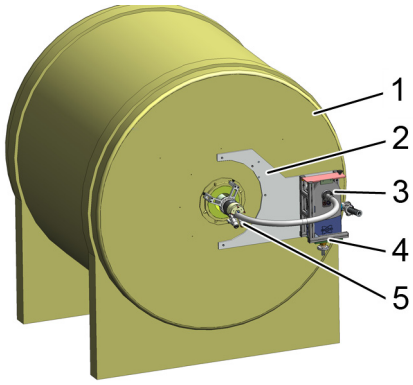
[1] Service end of the magnet

[2] CCM box

[3] Mounting hardware for the MRI CryoProbe

Figure 4.17: View at the service end.

In magnet installation without CCM box: The mounting hardware is attached to the magnet flange with an interface plate which takes over the carrying function and allows mechanical adaption to various magnets. This interface plate does not interfere with any parts of the shim system nor hinders the use of conventional coils. Once mounted, the MRI CryoProbe may remain attached to the magnet indefinitely (or if a site should have more than one MRI CryoProbe, until another one is mounted). In this position, it may be kept in the warm or cold state. In any case a Filter Plate / cable bushing plate has to be ordered.



[1] Service end of the magnet

[2] Interface plate

[3] MRI CryoProbe

[4] Mounting hardware with MRI CryoProbe preamplfier (body) installed

[5] MRI CryoProbe placed within the magnet bore

Figure 4.18: View at the service end of the magnet.

In magnet installation with Filterbox: A special Filter Box Door is necessary. In any case a Filter Plate / cable bushing plate has to be ordered.

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i **For all possible installations:** The MRI CryoProbe can be cooled down and warmed up outside the magnet which makes the scanner available during these periods. The complete cool-down process takes several hours (typically around four hours). Please consider this cool-down time in advance when you schedule the planned experiments with the MRI CryoProbe.

4.6 Animal support system

The animal support system consists of two main components: The Centering Tube and the Animal Bed (***Manual No Z31858***) which are both necessary to place the animal in the magnetic center of the magnet.

4.6.1 Centering Tube

When using an MRI CryoProbe system a Centering Tube has to be mounted within the magnet bore. Depending on the chosen or existing magnet the design of the Centering tube varies. The Centering Tube has to be adjusted to the dimensions of the magnet, and is usually a straight tube of the length of the magnet bore with pre-adjusted holders (Figure 4.19). During installation the Centering Tube is introduced to the magnet bore from the service end to allow for the correct positioning of the MRI CryoProbe CoilHead in the magnet center. This has to be checked within the Site Planning.

Whenever feasible, the Centering Tube is attached only at both magnet ends and should not directly or indirectly contact any of the gradient or shim systems. This allows for a very efficient insulation from any gradient induced vibrations.

This vibration free mounted Centering Tube has two functions:

- On the service end, the Centering Tube contains locking provisions which allow the fixation of the RF Coil in the magnet center with respect to all 6 degrees of freedom.
- On the patient end the inner tube allows the precise guidance of the Animal Bed towards the RF coil within the coil housing of the RF Coil.

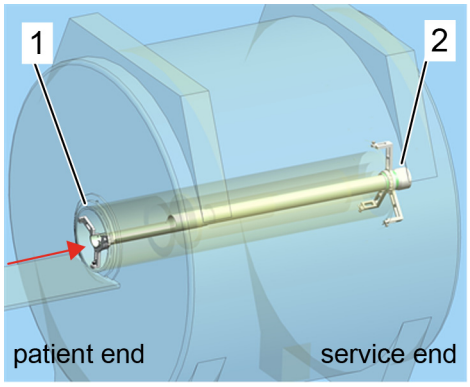
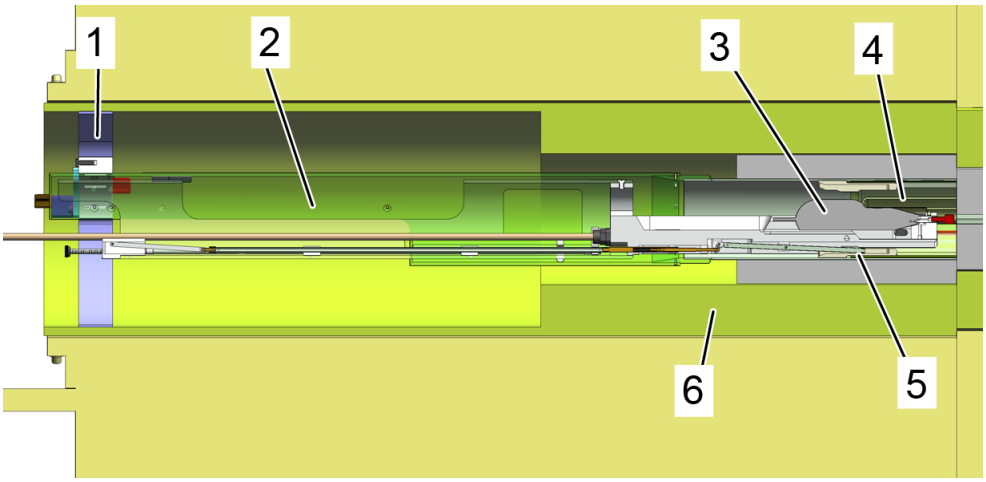


Figure 4.19: .Centering tube within the magnet fixated with pre-adjustebale holders (1 & 2).

4.6.2 Animal Bed Mouse Cryo

The Animal Bed Mouse Cryo (or Animal Bed for short) is used to insert a mouse into the magnet from the patient end (Figure 4.19). As shown in the cross section, the mouse has been placed and aligned in the front part of the Animal Bed and then positioned for the examination at the precise location corresponding to the measurement center under the coil housing of the RF Coil. A special mechanism ensures the optimal position of the mouse in relation to the CoilHead by lifting the Animal bed and lock it in this end position.



[1] Mounting ring of the Centering Tube

[2] Animal bed

[3] Animal

[4] CoilHead

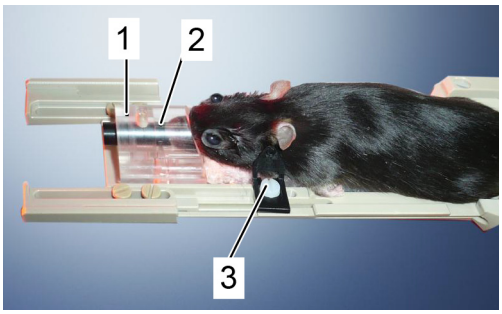
[5] Locking element of the Animal bed

[6] Gradient system of the magnet

Figure 4.20: The cross section of a typical Centering Tube is shown.

4.6.3 Animal Setup

i All animal experiments must be performed according to local regulation and approved by local animal care institutions.



Stereotactic mouse head fixation with:

[1] Nose cone

[2] Tooth bar

[3] Ear bars

Figure 4.21: The animal in the recommended setup in the Animal bed is shown.

The MRI CryoProbe setup includes a dedicated Animal bed which is optimized for the use with the Centering tube. It includes a temperature stabilizsation unit (water tubes which can be connected to external water reservoir), a nose cone for administration of

gasesous anesthesia, holding a tooth bar and ear pins for stereotactic fixation.

The Animal Bed systems can be ordered in several configurations, depending on the exact experimental setup required by the customer. A detailed descrip ti on is given in the ***Manual Z31858.***

4.6.3.1 Mouse Position Gauge

The Mouse Position gauge is a supportive device where the positioning of the Animal Bed Mouse Cryo system under the CoilHead can be tested. This allows a final check of the animal position outside the magnet bore.

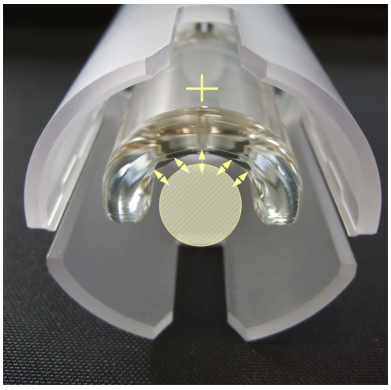


Figure 4.22: Mouse Position Gauge to check the position of the animal in the Animal bed against the CoilHead.

6 Important Data

6.1 *Technical Installation data for a MRI CryoProbe*

BioSpec Optional Component	Standard	Options
Available stainless steel tubes length: (Transferline and vacuum hose) Distance Cryo Cooling Unit Cryo Body: **Typical minimum distance between the:** - rear side of the magnet and the wall: - CCM box behind the magnet and the wall: **Transferline:** (laterally mounted on the CCM box) - Transferline caliber: - Minimum bending radius of tube: **Vacuum hose:** - Vacuum hose caliber: - Minimum bending radius of hose:	4 m 231 cm 125 cm 81 cm 55 mm 70 cm 33 mm 35 cm	4 / 5 / 6 m 331/ 431/ 531 cm
Heat dissipation into the air Typical operating phase	< 1.2 kW	-/-
Heat dissipation into water Typical operating phase Cooling down phase	 <6.5 kW (50Hz) <7.5 kW (50Hz)	 <7.5 kW (60Hz) <8.5 kW (60Hz)
Noise emission (at a distance of 1m) Water chilled refrigerator system Cryo Cooling Unit	 <60dB(A) in 1m <42dB(A) in 1m	 -- --
Required wall opening (W/H) (Dimensions of wall opening for mounting/ filter plate between magnet and technical room)	250 mm X 180mm	
Required compressed air (the cryo cooling unit needs it for operate) Pressure range: optimal Pressure: Typical consumption: Quality of the compressed air:	 > 4.5 bar < 8 bar 5-6 bar 20-50 l per hour Cleaned, cold, (oil and particle free)	
Required compressed He-gas cylinder (the cryo cooling unit needs it for operate) Minimum quality of He-gas: minimal working pressure: maximum working pressure: Typical consumption (per annum): A 200 bar / 50 liter gas cylinder suffices for:	 6N = 99,9999% 22 bar 25 bar approx. 30 liters 40 cool-down cycles	

Required water quality Water supply to remove the heat load (cooling power > 8.3kW)	flow: 420l/h temperature: 4-28°C water quality: pH 6.5-8.2 hardness: mg [$CaCO_3$]/l < 200 Molybdate-reactive silicate(mg/l) < 50 suspended matter (mg/l) < 10) max. pressure less than 7bar / 100psi	
Noise emission (at a distance of 1m) Water chilled refrigerator system Cryo Cooling Unit	 <60dB(A) in 1m <42dB(A) in 1m	 -- --
Required line connections Cryo-refrigerator, AC socket 16A: Cryo Cooling Unit, AC socket 16A: MRI Temp. Control Unit , AC socket 10A:	 CEE Form: 400/230 V CEE Form: 230 V Schuko socket: 230V	
Line consumption at 50 Hz. Cryo-refrigerator, AC socket: Cryo Cooling Unit, AC socket: MRI Temperature Control Unit	 <7,5 kW <0,8 kW <0,05 kW	 --
Required UPS for MRI-TCU (**U**ninterruptable **P**ower **S**upply; **MRI** **T**emperatur **C**ontrol **U**nit) MRI-TCU typical consumption:	 < 60 W	 -- --
Dimensions (L/W/H) Cryo-refrigerator for magnet Cryo Cooling Unit MRI Temperature Control Unit	 49 cm/45 cm/60 cm 89 cm/68 cm/96 cm 18 cm/30 cm/7 cm	
Weights Cryo-refrigerator for magnet Cryo Cooling Unit MRI Temperature Control Unit	 120 kg 400 kg 3.8 kg	

Table 6.1: Hardware installation data sheet for CryoProbe components.

7 Step-by-Step Site Planning

In Chapter 3 the components of the MRI CryoProbe system have been briefly described, technical specifications given and an overview, how they are arranged. The specifications of the system components are listed in Technical data. Considerations that have to be taken into account when performing a Site Planning for an MRI CryoProbe installation will be explained in the present Chapter. The major considerations and restrictions for the Site Planning are outlined. Since the positions of the units are interdependent, there is a preferred procedure for the Site Planning which will be explained in detail.

7.1 Main system components

The MRI CryoProbe system consists of two major components: the MRI CryoProbe and the CryoPlatform for the cryogenic cooling. The MRI CryoProbe consists of four parts:

- the Cryogenic preamplifier module (body with electronics components),
- an Interconnection,
- the RF sealing ring and
- the RF CoilHead which contains cryogenically cooled RF coils.

related components are:

- Centering tube
- Mouse Bed
- Mouse Position gauge

The CryoPlatform is made up of:

- CryoCooling Unit with control electronics
- Helium Compressor (along with any associated cooling equipment)
- Helium Gas Cylinder (for purging of the MRI CryoProbe)
- Helium Transferlines
- CryoProbe Filterplate / cable bushing plate

The CryoCooling Unit must be sited remotely in a separate room outside the 5mT field, where the Helium Compressor and Helium Gas cylinder may also be sited. The recommendation is to place the CryoPlatform in the Service room, as shown in Figure 7.1, where the support system for the magnet itself is placed.

NOTICE
Possible damage of system: All components of a MRI CryoProbe System are designed and specified strictly for indoor use.

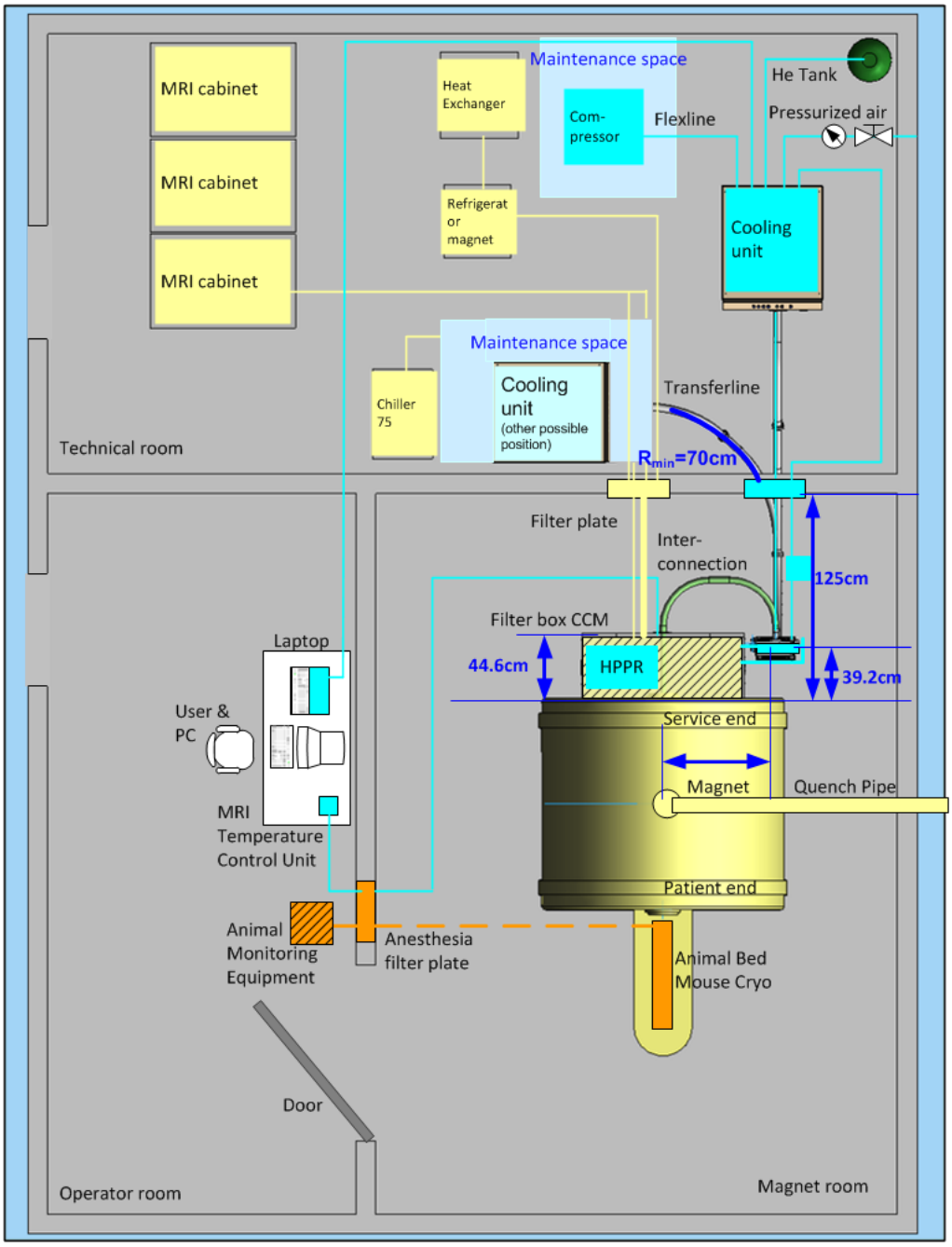


Figure 7.1: Principle outline of an MRI CryoProbe system without a Faraday cage. All system components of the MRI CryoProbe and the CryoPlatform are marked in blue, while the magnet and its supply are marked in yellow. The animal support components are highlighted in orange. The minimal distances which have to be taken into account during the Site Planning are marked in dark blue.

7.2 Compatibility

Consoles

The MRI CryoProbe system can be installed with an MRI system that has an AV1 or newer console types, running ParaVision Version 5 or higher. Depending on the RF configuration of the MRI CryoProbe, the console has to have the appropriate channels and hardware available. For example, a 1H Quadrature Transmitter Receiver MRI CryoProbe needs a HPPR/2 system with two 1H HPLNA modules.

(Bruker engineers can find further information in the Installation Manual).

A cryo-compatible HPPR/2 has to be installed for the MRI CryoProbes. The HPPR/2 will be placed inside the CCM box at the service end of the magnet during installation.

Magnets

A range of MRI CryoProbes are available to fit the great variety of magnets, for further up-to-date details please refer to the current version of the Ordering Information.

The MRI CryoProbe will be fixed to the magnet by a special Mounting Hardware which is attached to the magnet in the vicinity of the bore openings. This Mounting Hardware is highly specific to the magnet geometry. Careful selection of the proper choice and combination of the correct components which make up the Mounting Hardware is required.

The following information is necessary for the Site Planning:

- Magnet type
- Gradient type
- Shim system type
- Resonator type
- Is a filter backpack or a CCM box at the service end of the magnet installed?
- Is the magnet installed in an Faraday cage or not?
- Is the magnet bore accessible from the service end and from the patient end?
- Which diameter has the magnet bore and is it completely open?
- Room of the magnet and spatial situation around the magnet?

7.3 How to plan the position of the units

General important remark: All units must be installed and connected according to local safety standards and local requirements. Plan the layout of tubes and cables such that they will not cross the floor on a walkway. If a crossing cannot be avoided, bury or cover them.

Follow the next eight steps for the Site Planning and for placing the system in the laboratory. Respect the necessary requirements in order to run the system successfully.

7.3.1 Step 1 in the Site Planning: Spatial Arrangements in the Lab

Step 1 in the Site Planning involves reviewing the magnet itself as well as the gradient & shim system (see the points above). The review continues with the determination of the magnet area to see if there is enough space on the service end of the magnet so that an MRI CryoProbe can be mounted with the Mounting System and the CoilHead introduced in the magnet bore. Furthermore, it has to be checked if the Centering Tube can be introduced from the patient end of the magnet. If not, ways must be still found to achieve a satisfactory environment for the MRI CryoProbe installation.

In the case where a complete new magnet system has been ordered the Site Planning has to take into account that to a certain extent the positions of the components are mutually dependent.

In both cases the following four main restriction have to be taken into account:

- A. Space in front of the magnet (patient end).
  In order to accommodate an easy insertion of the Centering Tube, there should be a straight space in front of the magnet (patient end) of the length which is equivalent to the magnet bore length. In an open setup, this is most often met. If the magnet is in a small room or Faraday Cage this may be achieved by placing the entry door exactly opposite the patients end of the magnet bore. So that the foor can be opend while the Centering tube will be introduced or taken out of the magnet bore.
- B. Distance from the service end of the magnet to rear wall
  At the service end of the magnet the distance between the door in the back panel of the CCM box and the wall to the service room has to be > **81 cm** otherwise the MRI CryoProbe cannot be installed at the service end of the magnet nor can the CoilHead be inserted in the bore. **This applies to all configurations.**
- C. Position of Cryogenic preamplifier module on the magnet (left, right)
  The MRI CryoProbe will be installed either on the left or right side of the service end of the magnet. The Transferline leaves the Cryogenic preamplifier module in downward direction. In general, the choice between left and right position is given by the desirable location of the Cooling Unit and by consideration for other equipment at the rear of the magnet. Typically, the MRI CryoProbe will be mounted on the side closest to the service room, where the Cooling Unit will be installed.
- D. Distance from magnet/ccm box to side wall
  The distance of the magnetic center to the center of the Transferline connector (CryoCoupler) is defined as **77 cm** and the outer edge of the Mounting assembly is defined with 1m from the magnetic center. On the sides of the magnet, some space should be made available for the user to access the service end.

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i In the Site Planning for a standard installation of a MRI CryoProbe on a magnet with CCM box has to be a distance of **> 125 cm** respected between the magnet service end and the wall. This is consistent with a distance of **> 85 cm** between the CCM box door and the wall. In case of another solution for magnets without CCM box please contact the BRUKER for advice.

7.3.2 Step 2 in the Site Planning: Filter Plate / Cable Bushing Plate

Step 2 in the Site Planning implies where the Filter plate / cable bushing plate for MRI CryoProbes has to be placed. It has to be placed **in all installations (with or without Faraday cage** around the magnet room). Beside the fact that it has to be installed 15 cm above the floor, it has a size of W:H:30 x 40 cm. It provides three openings as shown in Figure 7.2:

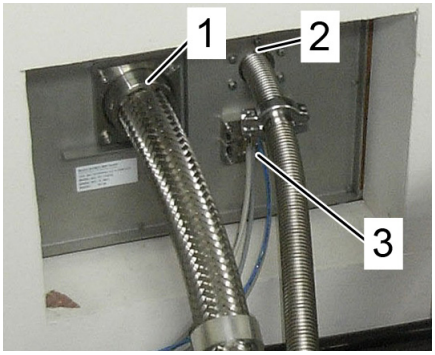

Figure 7.2: View from the service room towards the magnet room. The Filterplate has to be installed minimally 15 cm above floor level. (1) The round opening (d=83 mm) on the left side is forseen for the Transferline. (2) The smaller opening (d=42 mm) is for the Vacuumline. (3) The square opening on the right is used to carry through and clamp the other connections.

7.3.3 Step 3 in the Site Planning: Transferline

Step 3 in the Site Planning the routing of the Transferline between the CryoCooling Unit and the MRI CryoProbe has to be checked. Here the permissible bending radius of 70cm must not be compromised. The Transferline goes vertically down from the Cryogenic preamplifier module of the MRI CryoProbe, then bends and runs parallel to the floor for some distance. Then it goes up again and enters the Cooling Unit. The Transferline passes through the CryoProbe Filterplate for installations with or without a Faraday cage. The Transferline crosses the Filterplate, which has to be placed 15 cm above floor level. However, installations where the Transferline runs under a second floor are possible as well. **This applies to installations without or with a Faraday Cage.**

The Transferline is available with a standard length=4 m, but can be order from 3 m at the minimum up to 6 m in 1 m increments, (longer lengths available on request). The bending radius has to be larger than 70 cm. A possible arrangement is shown in Figure 7.3

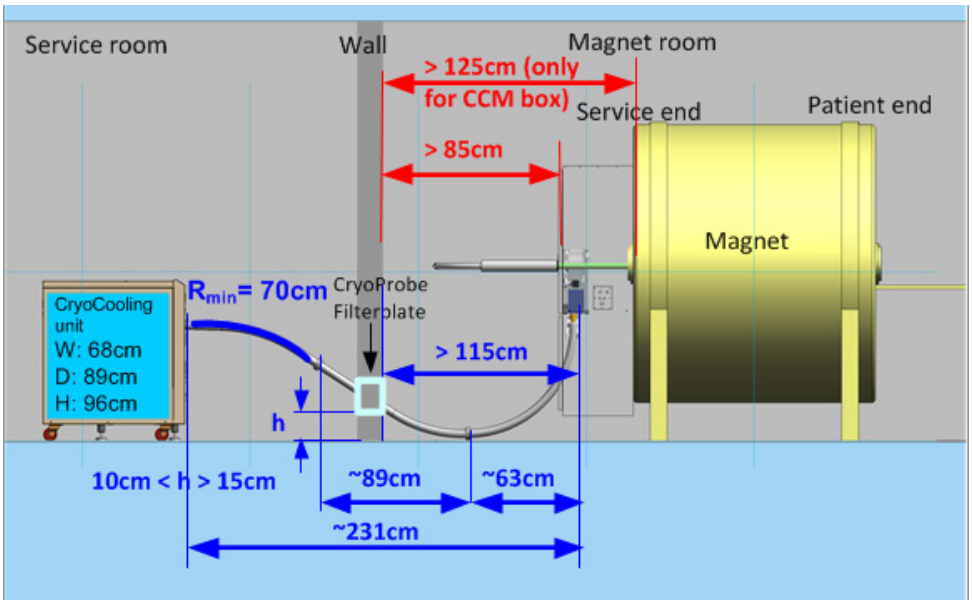

Figure 7.3: Principle outline of an MRI CryoProbe (3m) system mounted at the service end of the magnet seen from the side.

7.3.4 Step 4 in the Site Planning: Position of the Cooling Unit

Step 4 in the Site Planning contains the planning of the CryoCooling Unit position. The CryoCooling Unit has to be installed adjacent to the magnet outside the 5 mT stray field within the service room. The exact location of the Cooling Unit must be determined using the stray field data of the magnet and the entire system installation. Furthermore, the path for installation, removal, service or exchange has to be outside the 5 mT stray field. An example of a typical instrument layout is shown from the top view in Figure 7.1 and from the side in Figure 7.3. This siting will be used regardless of whether a Faraday cage is present or not, and regardless of whether there is a static strayfield or not. Typically, the Cooling Unit may be placed very close to the shield, allowing the shortest possible length for the Transferline. However, care must be taken to avoid local high field spots which may arise near the openings or edges of the iron cage.

One of the fundamental decisions in the site planning process is the determination of the length of the Transferline, so that the correct version of the CryoCooling Unit can be ordered and the exact positioning of the CryoProbe Filterplate defined. So it is absolutely important to determine the path of the Transferline as early as possible in the site planning process so that it can be accommodated in the preparation of the building.

The CryoCooling Unit has a size of W: 68 cm x D 89 cm, H: 96 cm and weighs around 400 kg. More details about the CryoCooling Unit can be found inTable 4.3 on page 20.

Behind and on the sides of the CryoCooling Unit some space has to be made available:

- depth of CU (89 cm) + 60 cm at back for connectors
- width of CU (68 cm) + 60 cm for air intakes, installation, and maintenance

⚠ WARNING

The CryoCooling Unit contains magnetic parts and it might be attracted by the magnet with potentially lethal consequences.

- ▶ The CryoCooling Unit must be placed outside the 5 mT field of the magnet within the service room.
- ▶ Furthermore, the path for installation, removal, service or exchange has to be outside the 5 mT field such that it can be brought to its final position and also removed from there.

While the CryoCooling Unit is completely self-contained, an external PC (Laptop computer) ist delivered together with the Cooling Unit, and serves as data terminal and remote control. It allows control of the Unit (cooldown/warm-up), and also monitoring its performance. In addition, status and warning messages are displayed, and continuous log files of the entire operation history of the system are recorded on the laptop

Laptop

This computer should be visible to the operator at all times. The computer is connected to the Cooling Unit by an RS 232 cable (default length = 10 m). This cable needs no shielding or filtering, since it connects the Cooling Unit to the operator‘s room, which are both outside of the RF protected environments. The only thing to observe is that the Cooling Unit and the laptop must be established outside the 5 mT field.

7.3.5 Step 5 in the Site Planning: Position Compressor

Step 5 in the Site Planning the location of the Helium compressor of the CryoCooling system has to be determined. Since the Helium Compressor generates a considerable amount of heat (7.5 kW average, 8.5 kW peak), it must be cooled to prevent overheating. BRUKER offers water cooled Helium compressors as shown in Figure 7.4. Furthermore, depending on the country, the compressors are available in two different versions of voltage supply ranges. For the US / CA and JP Helium compressors with 3 x 200 V main power supply are the standard while for EU and CH the He Compressor main power supply is specified with 3 x 400V (for further details see Table 4.5 on page 22.

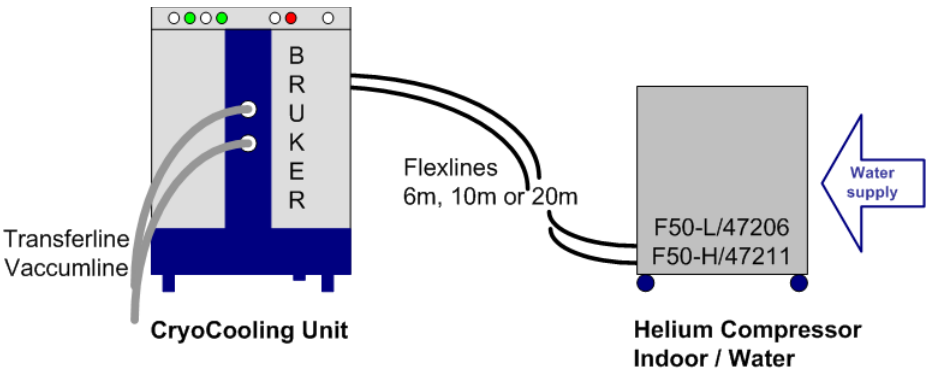

Figure 7.4: Principal setup with an indoor water cooled compressor.

Placing the compressor in a remote room or beside the CryoCooling Unit in the Service room adjacent to the magnet will keep the noise of the unit (> 60 dB(A)) out of the magnet room. The maximum permissible static stray field of the magnet at the location of the Helium compressor is 0.5 mT.

The bending radius of the Flexlines between CryoCooling Unit and He Compressor is 0.3 m, e.g. a 180° turn needs a diameter of at least 0.6 m. The use of extended Flexlines (20 m option instead of standard 6m) between the CryoCooling Unit and He Compressor allows the installation of the He Compressor in another, more remote room. This offers the following benefits:

- Acoustic noise from the He Compressor is further reduced or eliminated.
- For multiple CryoPlatform installations within one laboratory or building, all He Compressors may be concentrated in one room for easy connection and maintenance.

Permanent access to the He Compressor is not necessary during normal operation, since it is remotely controlled and monitored by the CryoCooling Unit. Any detectable malfunction is handled by the CryoController which takes the appropriate action and notifies the operator.

If the noise is a problem, and a remote location for the He Compressor is not feasible, it may be necessary to consider the installation which is not provided by BRUKER.

i Further details about the water cooled compressor type can be found in the A.1,and under the 7.3.0.3.

⚠ WARNING

The Helium compressor contains magnetic parts and it might be attracted by the magnet with potentially lethal consequences.

Therefore:

The Helium compressor must be placed outside the 0.5 mT field of the magnet within the service room. Furthermore, the path for installation, removal, service or exchange has to be outside the 0.5 mT field such, that it can be brought to its final position and also removed from there, Since the He-Compressor contains magnetic parts, it might be **attracted to the magnet with potentially lethal consequences!**

7.3.6 Step 6 in the Site Planning

Step 6 in the site planning is the positioning of the He Steel Cylinder. The He steel-cylinder is linked to the CryoCooling Unit by a flexible He pressure line (working pressure up to 25 bar, higher in case of malfunctions). The standard length is 10 m (20 m length on request).

A secure and serviceable path for the pressure line between the Cooling Unit and the site where the He-bottles are stored must be established during Site planning. The transport path for exchanging the He steel cylinder should be placed within the service room and must also be outside the stray field.

The Helium supply system delivered with the CryoPlatform comprises a He Regulator and a charging connection to a high pressure line. The adapter of the Helium cylinder is country specific and has to be specified during Site planning (for further details, please check Table 3.8 on page 38).

⚠ CAUTION

Any possibility of the pressure line being damaged during installation or later use (e.g. if on the floor) must be excluded.

Therefore:

- ▶ Attachment points at least every couple of meters should be provided.
- ▶ Without these precautions, a broken high-pressure line will exhibit extrem, uncontrolled movements which may lead to serious injuries.

⚠ WARNING

Since the He-cylinder is normally highly magnetic, it will be attracted to the magnet with potentially lethal consequences!

Therefore:

- ▶ The Helium cylinder must be secured in its wall mounting bracket according to the local regulations outside the 0.5 mT field of the magnet within the service room. Furthermore, the path for installation, removal, service or exchange has to be outside the 0.5 mT field.

7.3.7 Step 7 in the Site Planning: Temperature Control Unit

Step 7 in the Site Planning contains the positioning the Temperature Control Unit. This unit must be placed outside the 0.5 mT stray field and close to the operator such that there is visual and acoustic contact at all times. This allows constant monitoring of the temperature of the MRI CryoProbe outside which is in contact with the animal.

The heater is connected to the MRI CryoProbe by a 10 pin shielded 10 m long cable which has to pass the anesthesia filter plate installation with or without Faraday cage.

The Temperature Control Unit has outputs for an external alarm output (relays contact), which may be additionally be wired to an external alarm system. The Temperature Control Unit also has a serial interface which may be used if displaying or logging of the temperature data on a computer is required.

7.3.8 Step 8 in the Site Planning: Supply systems

7.3.0.1 Power Supplies

Power supplies must be installed in accordance with local regulations and have to fulfill the specifications of the chosen type of compressor as given in Table 3.7 on page 36. All plugged connections must be accessible at all times.

7.3.0.2 Air conditioning

The laboratory air conditioning requirements are a constant room temperature of 17 - 25°C with a variation of less than ± 1°C, an air humidity of 40 - 80%, and a low dust content. Operation at a room temperature above 30°C is not approved.

In case of an air-cooled He Compressor, provision should be made for a separate supply of fresh air. About 7.5 kW of heat are released by a He Compressor which would put a high additional load on any room air conditioning system. Depending on the location, it might be possible to recycle the heat energy.

The amount of heat released from the CryoCooling Unit cabinet itself is rather small and needs no special consideration.

The He Compressor unit must be operated in a dry room. They are neither designed nor approved for outdoor operation.

7.3.0.3 Cooling water

The Water supply to remove the heat load of a water cooled compressor has to fulfill the conditions listed in the following graphs:

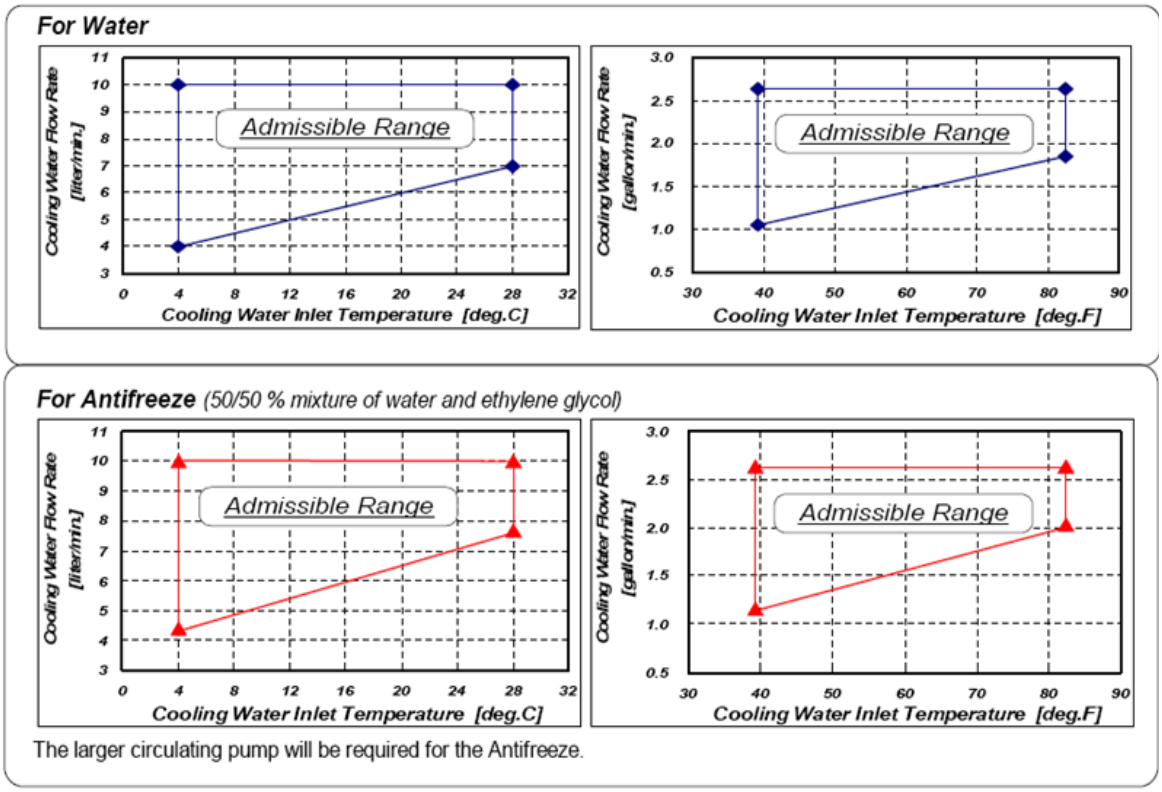

Figure 7.5: Temperature range of the cooling water with and without Antifreeze.

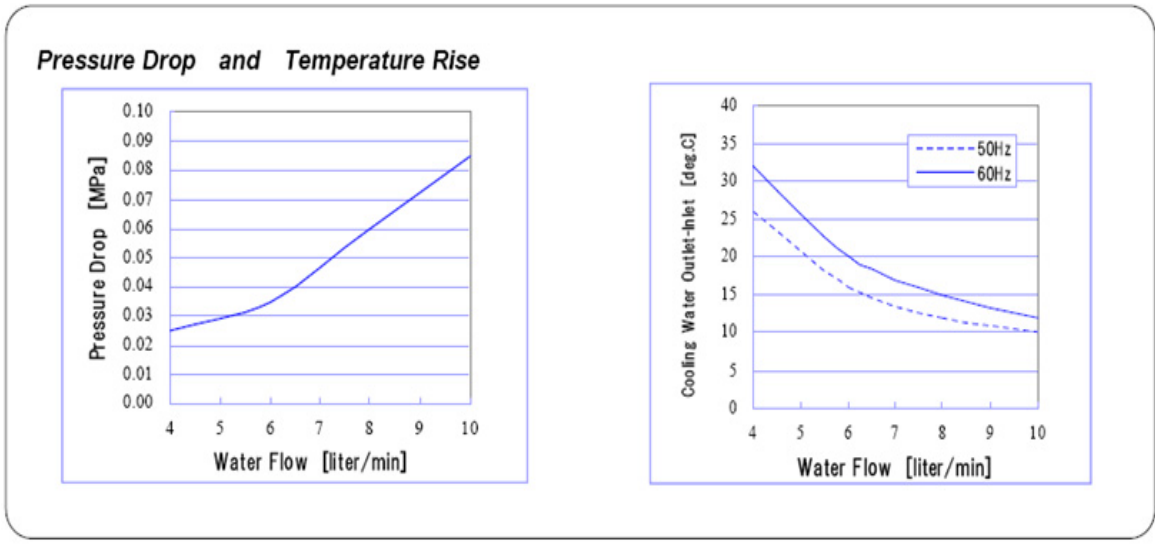

Figure 7.6: Pressure drop and temperature rise of the cooling water.

7.3.0.4 Pneumatic gas

The CryoCooling Unit requires a compressed air or nitrogen supply of 0.35 l/min with a pressure of at least 4.5 bar.

(The CryoCooling Unit uses compressed air or nitrogen for the operation of internal pneumatic valves which control the high-pressure He gas flow within the system. In order to function correctly these valves require an uninterrupted compressed air supply. Significant compressed air or nitrogen consumption occurs only during cool-down or warm-up sequences).

7.3.0.5 Helium gas

Helium gas (He) Grade 6.0 (i.e. 99.9999% purity, 'electronic grade') is required.

7.4 Optional: Uninterruptable Power Supply

i In general, Bruker recommends the use of an uninterruptable power supply system (UPS) to protect the MRI CryoProbe systems from mains power failure. Within an MRI CryoProbe system the Cooling Unit and the MRI Temperature Control unit should be connected to the UPS. In environments where power failures are a common occurrence, of course the entire lab, including the console, as well as the Cooling Unit and He Compressor should be backed up by a UPS. The following options are recommendations to secure the system against power failures.

⚠ CAUTION

In any case of power supply failures the animal should be taken out of the bore to prevent the animal from freezing during a longer power outage.

7.4.1 Safety Level 0, no power supply available

The following events can occur during a power failure within Safety Level 0 where no UPS is available.

- **MRI CryoProbe / Console / CryoPlatform:** Depending upon the duration of the power failure and the system state, the system either restarts in cold mode or goes into warm-up mode. The criteria for a recooldown after power outage depend on the internal temperatures of the different stages within the CryoPlatform system, e.g. coil temperature < 150 K. For a power failure of only 5 - 10 min and with a good vacuum, a restart in cold mode is possible. Occasonally, short power outage (e.g. 1 sec.) can occure. This can result in a warm-up depending on the length of the outage and the temperatures of the components. The coldstate may or may not

resume. Since a unnecessary warm-up / cool-down cycle is quite time consuming, any mains interrupts should be avoided.

- **Temperature Control Unit:** The MRI CryoProbe relies on active heating of the CryoProbe front end in order to maintain the required temperature (e.g. 38°C) at the animal interface. This is accomplished by the Temperature Control Unit. This unit is self-contained and is **only connected directly** to the MRI CryoProbe. If the mains power (230 V) to this unit fails, it will disengage itself, and the temperature controlling at the interface between probe surface and the animal will stop, normally resulting in a cooling of the surface to a value in the range of aprox. 0..10°C.

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i For general safety reasons, the Temperature Control Unit is designed in such a way that once the power has been interrupted, the unit will not resume operation by itself, but rather has to be re-engaged by the operator

---

- A power failure will manifest itself in that all lights on the unit will go out on the Temperature Control Unit, together with the LED display showing the actual temperature. However, at the same time, there is no power for an active alarm available anymore. Depending on which other systems are hooked up on the same phase, the power failure may or may not go undetected. If in the case of an undetected power failure the operator does not look carefully at the Temperature Control Unit, the failure of the air handling unit (AHU) might go unnoticed for some time as well.

⚠ CAUTION

If there is an animal being measured, this may lead to damages or even the death of the animal in case of a power failure.

Therefore:

▶ The animal should be taken out of the bore to prevent it from freezing during a longer power outage.

If for a planned installation, this scenario is possible and not acceptable, the AHU should be hooked up to a UPS. This requires only a very low power, of max 60 W.

Concerning the two cases above, either none, one, two separate, or one single UPS unit for both systems (CryoCooling Unit and Temperature Control Unit) may be considered.

7.4.2 Safety Level 1

A small UPS for the Cooling Unit and Temperature Control Unit (2 kVA; approx. 5 min bridging time).

- During a power breakdown the Console and He Compressor will fail.
- When the duration of the power failure is less than the UPS runtime, any probable desorption can still be pumped out, the vacuum remains stable and the time before the warm-up mode is required is somewhat longer than without UPS (Safety Level 0).

- The MRI measurement is aborted. A resumption in cold mode may be possible but cannot be guaranteed. When the power failure lasts longer than the UPS run-time then it is very likely that the system will go into warm-up mode once the power is restored. The criteria for a recooldown after power outage depend on the internal temperatures of the different stages within the CryoPlatform system, e.g. coil temperature < 150 K. For a power failure of bridging time plus 5 - 10 min and with a good vacuum, a restart in cold mode may be possible.

⚠ CAUTION

The animal has to be removed from the MRI CryoProbe CoilHead to prevent it from freezing during a longer power outage.

7.4.3 Safety Level 2

A large UPS for the Console, the Cooling Unit and the Temperature Control Unit (6 - 10 kVA depending on the console configuration to give approx. 20 min bridging time).

- During a power breakdown the He Compressor will fail.
- When the duration of the power failure remains within the UPS runtime, the console and so the MRI measurement continues in addition to the details described in the Safety Level 1 operation. However, the operator must stop the measurement immediately and remove the animal.

NOTICE

It is not permissible to continue measurements when the He Compressor is not working as the temperature of the RF coils will rise in an uncontrolled way, disrupting the proper operation of the MRI CryoProbe.

Thus:

▶ Operation may only be resumed after regular cold operation has been re-established.

7.4.4 Safety Level 3

Very large UPS for the console, the complete CryoPlatform and the Temperature Control Unit (3 - phase, 18 - 20 kVA depending on the console configuration to give approx. 20 min bridging time).

All systems remain running during the UPS runtime without restriction. When the duration of the power failure exceeds the UPS runtime, see Safety Level 0

NOTICE

For an indoor water-chilled He Compressor the UPS must be able to supply a starting current of 60 A (400 V compressor model) or 100 A (200 V compressor model) for a period of 500 ms.

When using an indoor water-chilled He Compressor the water supply must also be guaranteed during a power failure.

7.4.5 Safety Level 4

Large UPS for Console, Cooling Unit and Temperature Control Unit (6 - 10 kVA depending on the console configuration to give approx. 20 bridging time) and an additional emergency generator (3 - phase 20 kVA).

- The He Compressor fails briefly.
- During a power failure the console and the Cooling unit will continue to run using the UPS. The He Compressor will remain off until the emergency generator begins operation (approx. 1 min depending on the generator model).
- When the emergency generator is running the He Compressor can be automatically restarted by the Cooling unit. As the lack of power is only for a relatively short time the MRI CryoProbe will probably not heat up excessively.
- The MRI measurement will not be interrupted as the console is also fed by the emergency generator. The runtime is limited only by the fuel supply of the emergency generator.
- MRI data corruption is likely until the MRI CryoProbe temperature has stabilized again. Data have to be retaken. It can happen that desorption triggers a warmup of the Cryo Platform.

NOTICE

For an indoor water-chilled He Compressor the emergency generator must be able to supply a starting current of 60 A (400 V compressor model) or 100 A (200 V compressor model) for a period of 500 ms.

When using a indoor water-chilled He Compressor the water supply must also be guaranteed during a power failure.

7.4.6 Safety Level 5

Very large UPS for the console and the complete CryoPlatform and the Temperature Control Unit (3-phase, 18 - 20 kVA depending on the console configuration to give several minutes bridging time) and in addition an emergency power generator (3-phase 20 kVA).

NOTICE

For an indoor water-chilled He-compressor the emergency generator and the UPS must be able to supply a starting current of 60 A (400 V compressor model) or 100 A (200 V compressor model) for a period of 500 ms.

When using a water-chilled He-compressor the water supply must also be guaranteed during a power failure.

Longer UPS bridging times (e.g. level 3) are possible but are very costly. Depending on the duration of the desired UPS bridging time, the use of an additional emergency power generator may be a more favorable variant (level 5).

The UPS runtime can then be minimized (i.e. just enough time until the emergency generator provides a steady voltage supply).

7.5 Site Planning Questionnaire Remarks

i Before a definite MRI CryoProbe System *order* can be *accepted*, the latest MRI CryoPlatform Site Planning Questionnaire (available from the local BRUKER representative) must have been processed thoroughly: all questions answered by the customer, form sent to BRUKER, reviewed by BRUKER, and finally accepted.

Some details of the setup, such as the particular magnet type and size or obstructions, shim and Gradient system as well as unusual Filter Plate locations or available space in the magnet or service room may require a modification of the existing magnet installation or of the standard set-up of the MRI CryoProbe System. Therefore, it is mandatory to answer all questions carefully and to report all uncertainties or special circumstances to BRUKER as soon as possible.

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IInclude a site drawing of scale 1:50 of your laboratory if possible and also provide information about the existing magnet type, the gradient & shim system and the resonator. Your answers are needed to decide if your scanner configuration is suitable for hosting a MRI CryoProbe and which parts are required, as well as what preparations will have to be done at the lab.

The exact location and orientation of the magnet is of great importance for the site planning. It determines the alignment of the He Transferline between CryoCooling Unit and MRI CryoProbe and thus the position of the CryoCooling Unit.

8 Site Planning Questionaire

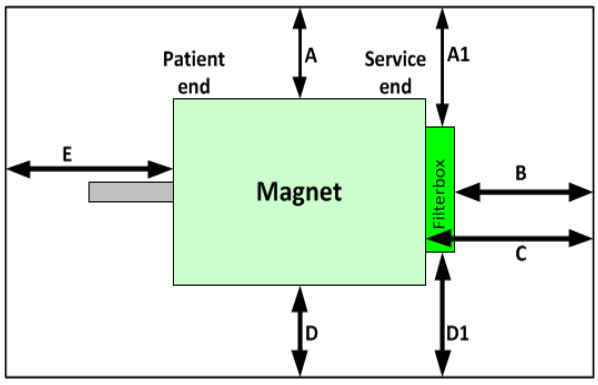
8.1 Site Planning Checklist

The intention of this document is to ensure that Bruker BioSpin and the end user have all the information to prove that a successful installation of the MRI CryoProbe system is possible. Please read the following questionnaire carefully and return/fax a signed copy of it to the sender (for address/fax number see cover letter). Detailed and full information concerning installation requirements is available in the Site Planning Information Manual enclosed with this questionnaire. Please note that we are not able to process your order or schedule installation before receiving this checklist in full.

Person responsible for installation at customer's site: Please return these pages marked for the attention of Bruker BioSpin no later than 10 months before the scheduled delivery indicated below	
Name:	_____
Position:	_____
Telephone:	_____Fax.:_____
Email:	_____
Delivery Information:	
Delivery address:	_____ _____ _____
Ordering Number of the MRI CryoProbe: (for clarification, please ask the Salesperson)	
Ordering Number of the MRI System (for existing or planned system): (for clarification, please ask the Salesperson)	
Scheduled delivery: (planned) or requested delivery date	
Return to this address: Bruker BioSpin AG Industriestrasse 26 CH-8117 Fällanden Switzerland	

Site Planning Questionaire

General Information		
Will this be a new MRI installation?	YES ☐	NO ☐
Will this be the first MRI CryoProbe installation?	YES ☐	NO ☐
Console		
Will there be a PharmaScan, BioSpec or ClinScan available?	YES ☐	NO ☐
Will there be an AVANCE1 or higher?	YES ☐	NO ☐
Part number		
EC level:		
Will there be a ParaVision 5 or higher available?	YES ☐	NO ☐
How many nuclei will be measured?	Quantity:	
How many transmit channels will be available?		
Will there be a HPPR/2 available?	YES ☐	NO ☐
Will there be one 1H HPLNA module available?	YES ☐	NO ☐
Will there be a second 1H HPLNA module available?	YES ☐	NO ☐
Magnet system		
Faraday room	YES ☐	NO ☐
New installation	YES ☐	NO ☐
Type of Magnet		
Manufacturer		
Field [T]		



A: A1:

Is B>81cm? YES ☐ NO ☐

If not, what is the effective distance?:

Is C>125cm? YES ☐ NO ☐

If not, what is the effective distance?:

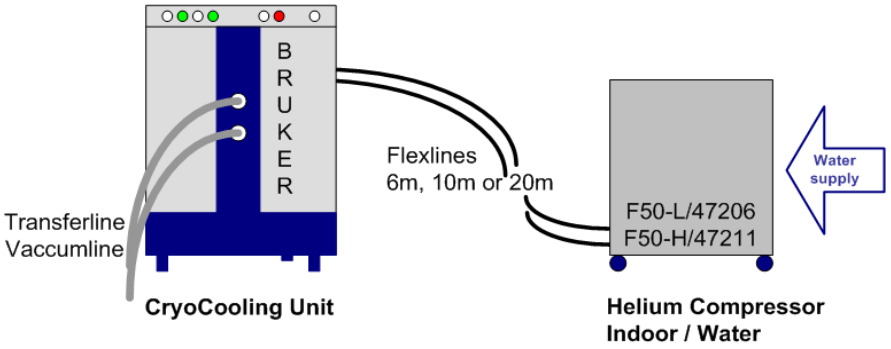
D: D1:

E:

Magnet system		
How many nuclei will be measured?	Quantity:	
How many receiver channels will be available?		
Will there be a HPPR/2 available?	YES ☐	NO ☐
Will there be one 1H HPLNA module available?	YES ☐	NO ☐
Will there be a second 1H HPLNA module available?	YES ☐	NO ☐
Ultra shield	YES ☐	NO ☐
Part Number of Magnet		
Serial Number of Magnet		
Shim system (please specify: Type, Part and Serial Number)		
Gradient (please specify: Type, Part and Serial Number)		
Resonator (please specify: Type, Part and Serial Number)		
Service end (looking from the rear end of the magnet)		
CCM box installed?	YES ☐	NO ☐
Old Filter box installed?	YES ☐	NO ☐
Mounting hardware is / or will be on the right or left side? (when looking from the service end of the magnet)	YES ☐	NO ☐
Patient end		
AutoPAC	YES ☐	NO ☐
Will there be a guide rail?	YES ☐	NO ☐
Please send images from the patient and the service end of the magnet.	YES ☐	

CryoProbe Filter Plate				
Does a Faraday cage wall opening for the CryoProbe Filterplate exists?			YES ☐	NO ☐
If yes, please send a drawing				
If no, please send distances, define location				
CryoPlatform				
Will electric power for the CryoCooling Unit (peak 1.5 kW, average 0.5k W) 230 V ±10%, 50 or 60 Hz at the MRI site be available and in accordance to local regulations? If there is only 200V available at the MRI site, a step-up voltage transformer 200 V to 230 V must be available at installation time to guarantee the 230 V operation of the CryoCooling Unit. Please ask your Salesperson for help.			YES ☐	NO ☐
Will electric power for the He-compressor (peak up to 9.2 kW, average up to 8.5 kW) at the site of the He-Compressor be available? For detailed information on power consumption, circuit ampacity and fusing see Chapter 4.			YES ☐	NO ☐
Voltage for the He-compressor (3 Phase) available and in accordance to local regulation:			YES ☐	NO ☐
if yes	☐ 200V / 60Hz or ☐ 200V / 50Hz	☐ 400V / 50Hz or ☐ 415V / 50Hz or ☐ 380V / 50Hz or ☐ 460V / 60Hz or ☐ 480V / 60Hz		
Will an uninterrupted supply of compressed air (or nitrogen gas), with a pressure of at least 4.5bar be available at the MRI site?			YES ☐	NO ☐
Is a high-purity Helium gas cylinder (purity 99.9999%, pressure > 30bar) available at the MRI site?			YES ☐	NO ☐
If no, please choose one version	☐ Helium gas will be organized by customer	☐ The customer wishes assistance from Bruker		

Siting of CryoPlatform		
Will the Cooling unit be placed in a separate (service) room?	YES ☐	NO ☐
Will the Cooling unit be placed outside the 5mT (50Gauss) line of the magnetic stray field?	YES ☐	NO ☐
Is the path for maintenance outside the 5mT (50Gauss) line?	YES ☐	NO ☐
Power dissipation average 0.5 kW. Will the maximum room temperature remain below 30°C, when the spectrometer, the CryoCooling Unit and any other equipment is running?	YES ☐	NO ☐
Space available for Cooling unit: 68cm x 89cm x 96cm (w x d x ht)? depth of CU (89cm) + 30cm at back for connectors width of CU (68cm) + 30cm for air intakes, installation, and maintenance	YES ☐	NO ☐
Floor is capable of supporting the weight of 400kg of the CU?	YES ☐	NO ☐
On which floor will the CryoCooling Unit be installed ☐ Underground (Basement) ☐ Ground Level (Level 0) ☐ Level 1 ☐ Higher, (please specify Level):_____		
Is the floor of the building on which MRI is located higher than ground floor and has the building structure any tendency to transmit vibrations?	YES ☐	NO ☐
Is a noise-sensitive area located on the floor below the MRI site?	YES ☐	NO ☐
Which length of Transferline (connection between CryoProbe and CryoCooling Unit) is necessary? ☐ 3m ☐ 4m (standard) ☐ 5m ☐ 6m ☐ other or not defined		
Is the bending radius of the Transferline >80cm?	YES ☐	NO ☐

Helium Compressor			
Will the He Compressor be placed in a separate (service) room beside the Cooling unit?		YES ☐	NO ☐
Will the He Compressor be placed outside the 0.5mT line of the magnetic stray field?		YES ☐	NO ☐
Is the path for maintenance outside the 0.5mT line?		YES ☐	NO ☐
Water cooled indoor compressor  			
Will a water cooled indoor compressor be used?		YES ☐	NO ☐
If yes, does the water supply fulfills the following properties? flow: 420l/h temperature: 4-28°C water quality: pH 6.5-8.2 hardness: mg [$CaCO_3$]/l < 200 Molybdate-reactive silicate(mg/l) < 50 suspended matter (mg/l) < 10) max. pressure less than 7bar / 100psi		YES ☐	NO ☐
if yes, is voltage for compressor available and in accordance to local regulation?		YES ☐	NO ☐
☐ 3 x 200V / 60Hz mostly used in US or J min. circuit ampacity 35A max fuse size 60A power consumption @60Hz max 8.3kW	☐ 3 x 400V / 50Hz mostly used in EU min. circuit ampacity 15A max fuse size 30A power consumption @ 50Hz max 7.2kW		
Space available for water cooled compressor: 55cm x 55cm x 68cm (w x d x h) depth of compressor (55cm) + 50cm on the front and rear end width of compressor (55cm) + 95cm for air intakes, installation, and maintenance		YES ☐	NO ☐
Floor is capable of supporting the weight of 125kg of the He Compressor?			

Which length of Flexline (connection between CryoCooling Unit and Compressor) is necessary? ☐ 6m (standard) ☐ 10m ☐ 20m		
Is the bending radius of the Flexline >30cm?	YES ☐	NO ☐
Floor is capable of supporting the weight of 140kg of the He Compressor?	YES ☐	NO ☐

Helium gas cylinder					
Which type of adapter is the Helium gas cylinder equipped with?		Required length of He hose?			
☐ EU	DIN477 No 6 SN 219 505 W21.8x1/14“	☐ 10m	☐ 20m		
☐ EU, I, S, GB	CEN 300 bar W30x2, 15,9/20,1	☐ 10m	☐ 20m		
☐ S, NL	NEN 3268 RU3 W24,32x1/14“R	☐ 10m	☐ 20m		
☐ GB	BSP 14 5/8“(22.92mm)	☐ 10m	☐ 20m		
☐ I	U.N.I 4412 W24.5x1/14“	☐ 10m	☐ 20m		
☐ US	CGA 5809 0.965“ - 14NGO	☐ 10m	☐ 20m		
☐ J	W-20.9-14-OL 20.9mm x 1/14	☐ 10m	☐ 20m		
☐ RU	FDIN477 No 9 G3/4“-26.44 x 1/14“	☐ 10m	☐ 20m		
☐ other:		☐ 10m	☐ 20m		
20m extension line is needed (same for all countries. Please specify the number of extension line which is needed:				YES ☐	NO ☐
Is there a fixation for the He-bottle according to the local regulations?				YES ☐	NO ☐
Is the access path for exchanging the He-bottle outside the 5 Gauss line?				YES ☐	NO ☐

Temperature Control Unit		
Will the Temperature Control Unit be placed within the operator‘s view?	YES ☐	NO ☐
Which cable length is necessary? ☐ 10m (magnet room) + 5m (operator room) ☐ 15m (magnet room) + 50m (operator room)	YES ☐	NO ☐
Will there be an external alarm panel?	YES ☐	NO ☐
Anesthesia Filterplate		
Will the Anesthesia filter plate be newly installed?	YES ☐	NO ☐
Is a D-Sub 15 pol male-female connector available for the Temperature Control unit connection between magnet room to operator room?	YES ☐	NO ☐
	YES ☐	NO ☐
	YES ☐	NO ☐

Topic
What application is planned (e.g. mouse brain)?

Declaration	
Site Planning done by Bruker BioSpin Representative:	Place, Date:
Name:	
As person responsible for site planning/ installation at the customer‘s site, I confirm the details regarding installation:	Place, Date:
Name: (in block letters)	
Signature:	
Remarks (from customer):	
Remarks (for Bruker BioSpin internal use):	

Please attach floor plan of the lab.

Site Planning Questionaire

7 Site Preparation

i In order to enable BRUKER to complete the installation of the MRI CryoProbe system, you are kindly requested to accomplish the described preparation steps after you received the equipment.
The supply of cooling water, helium gas and electric power lies in the responsibility of the customer, details will be given within this Chapter or ask your BRUKER representative if you need more information.
BRUKER can arrange for an installation visit only after the following preparation steps have been finished successfully.

Please note that incomplete preparation leads to longer installation times or the installation has to be rescheduled which will be charged according to the local service rates

7.1 Short list: Site Preparation Steps

1. Arrange a He Supply (quality: Grade 6.0, ‚electronic grade‘, 99.9999%)
2. Arrange for laboratory modifications such that cable ducts or holes for compressor connections are prepared.
3. Verify that the water quality meets the specifications described in Table 7.1 on page 65
4. Have a licensed professional connecting the mains power supply of both the He Compressor and the CryoCooling Unit.
5. Have a licensed professional provide IEC Standard Socket or a 'hardwired' solution in conformance with the applicable electricity regulations.
6. Fill out, date and sign the Checklist at the end of this Chapter. Remit it to your BRUKER office.
7. As soon as delivered: Verify that no shock or tilt watch attached to the shipping crates indicates careless handling otherwise send the boxes back according to ZFCO 0581. Unpack all units from their shipping crates.

7.2 Site Preparation Steps:

7.2.1 He Supply

The He cylinder has to be provided by the customer in accordance to the local regulations.

NOTICE

Helium (He) gas Grade 6.0 (i.e. 99.9999% or better, maximum impurity concentration 1 ppm, purity also named ‚electronic grade‘) is required, no inferior quality can be used. It is used for the flushing of the system before each cool-down and to compensate for small losses. The customer has to supply a full standard size cylinder (typically 50 L at 200 bar).

- ▶ The He cylinder must be provided by the customer. However, BRUKER BioSpin will be glad to assist the customer in finding a local supplier.
- ▶ The He cylinder must be secured in its wall mounting bracket according to the local regulations outside the 0.5 mT field of the magnet within the service room.
- ▶ The path for installation, removal, service or exchange has to be outside the 0.5 mT stray field.
- ▶ The transport path for exchanging the He cylinder should be placed within the service room and must also be outside the stray field.
- ▶ The He cylinder must be located in the service room (outside the 0.5 mT stray field).
- ▶ The He cylinder has to stay with the MRI CryoProbe System while in cold operation because the He system would be contaminated with air upon reconnecting. Consequently, this He cylinder cannot be used for any other purpose (e.g. magnet refill) while the MRI CryoProbe is cold.

7.2.2 Laboratory modifications: Cable ducts or holes

For an Indoor He Compressor:

NOTICE

- ▶ Provide a cable duct or holes through walls as defined in the Site Planning before the actual installation date is due.
  The two options are: One hole with Ø=130 mm or two holes with Ø = 80 mm to pass through two Indoor Flexlines, the two cables, as well as the hose of the He Regulator.
- ▶ Provide a place for the indoor unit of the compressor according to the requirements of its enclosed 'Technical Instruction' manual, which are:
  - Select an almost level and even area to install the Indoor unit.
  - Install the Indoor unit at a place where it is not effected by splashing water and/or dust.
  - An efficiently ventilated place is required to give the exhaust heat away.
  - A clean environment without dirt is recommended.
  - Do not place heat sensitive or flammable objects near the indoor unit.

For an Outdoor He Compressor:

NOTICE

- ▶ Provide a cable duct or holes through walls etc. as defined in the Site Planning before the actual installation date is due.
  The two options are: One hole with Ø=130 mm or two holes with Ø = 80 mm to pass through two Indoor Flexlines, two cables and the hose of the He Regulator.
- ▶ Provide the hole(s) in the wall(s) required for the connection of the Indoor and Outdoor Unit of the He Compressor. A hole Ø = 80 – 100 mm is necessary to pass through the two Outdoor Flexlines and the three compressor cables.
- ▶ Provide a solid mounting base for the outdoor unit of the compressor according to the requirements of its enclosed 'Technical Instruction' manual, which are:
  - The Outdoor unit must be placed on a level, even and strong build area.
  - Fix the Outdoor unit firmly on a concrete base using anchor bolts.
  - An efficiently ventilated area in the field is required to give the exhaust heat away.
  - A clean environment without dirt and oil mist is recommended otherwise the heat exchanger have to cleaned frequently.
  - Do not expose the Outdoor unit to the sun
  - In snowfall regions: Install a snow guard over the Outdoor unit.
  - Do not install any objects or obstacles near the ventilation fan and /or the heat exchanger.
  - Do not put heat sensitive or flammable objects near the Outdoor unit or Indoor unit.
  - Place the Outdoor unit such a way that the noise is no trouble for the neighbourhood.
  - Respect the specifications given in Table 7.2 on page 66.

7.2.3 Water quality (for water cooled compressor only)

i Check that the water quality meets the specifications described in Table 7.1 on page 65

- Let install the self-sealing water connectors which are necessary to attach the water-cooled He Compressor to the cooling water supply, e.g. a water chiller.
- Mount the water connectors with hose clamps to the water hoses of your cooling water supply. Use water hoses with an inner diameter of 19 mm (¾").
- Test your cooling water supply, e.g. the water chiller, in two steps:

- *1st step:* Short-circuit the out- and inlet of your cooling water supply (i.e. the water connectors you have just mounted) and activate the cooling water supply (i.e. switch on the water chiller or open the water supply). Check for leaks and for the correct direction of flow.
- *2nd step*: Connect the water hoses of the cooling water supply to the He Compressor and switch on the cooling water supply. Check its correct operation (sufficient flow, no leaks).

7.2.4 He Compressor

The He Compressor compresses He gas to the pressure level used by the system. Since the He Compressor has a high electric power consumption, its mains connection requires special attention.

⚠ WARNING

Electrical hazard from electrical shock.

A life threatening shock may result when the housing is open during operation.

Therefore:

- ▶ Local regulations apply and the installation needs to be carried out by a licensed electrician.
- ▶ In some parts of the world (e.g. Europe) a plugged connection is feasible and recommended, whereas in other regions (e.g. US) a fixed 'hardwiring' is mandatory.

NOTICE

- ▶ An Indoor He compressor consists of one unit only.
- ▶ The electric power must be provided near this unit.
- ▶ These He-compressors are NOT designed NOR approved for outdoor operation!
- ▶ The power ratings of the indoor He compressors are as follows (Table 7.1) and for outdoor He compressors (Table 7.2).

Sumitomo Type		F-50L	F-50H	CSA-71A
Type of Compressor		**Indoor / Water**		**Indoor / Air**
Dimension		W: 45 cm, D: 48.5 cm, H: 59.1 cm		W: 55 cm, D: 55 cm, H: 88.5 cm
Weight		120kg		140kg
Voltage		3 x 200V	3 x 400V (380, 400, 415@ 50 Hz or 460, 480 @ 60Hz	3 x 200V @ 50, 60 Hz US no plug supplied
Mainly delivered to		US / CA / JP	EU / CH	US / CA / JP
Operating Current		26 A	13 A	25 A
Min. Circuit Ampacity		35 A		
Max Fuse Size		60 A		
Compressor LRA		160 A		
Power Requirement	**Minimum**	9 kVA		
	Recommended	12 kVA		
Power Consumption	**Cool Down max. 50 / 60Hz**	7.2 / 8.3 kW		
	Steady State max. 50 / 60Hz	6.5 / 7.5 kW		
Water supply to remove the heat load (cooling power > 8.3kW)		low: 420 l/h temperature: 4 - 28 °C water quality: pH 6.5 - 8.2 hardness: mg[$CaCO_3$]/l < 200 Molybdate-reactive silicate(mg/l) < 50 suspended matter (mg/l) < 10) max. pressure less than 7 bar / 100 psi		
He Gas supply		A high-purity helium (He) gas cylinder (6 N = 99.9999% or better, maximum impurity concentration 1ppm)		
Acoustic noise		max. 60 dB(A) 2 m distant		
Ambient Operating Temperature		5 to 28°C (41 to 82.4°F)		30 °C
max. relative air humidity		85% RH		

Table 7.1: Technical data for indoor He Compressors

Sumitomo Type		**CNA-61C**		**CNA-61D**	
Type of Compressor		**Outdoor / Air**		**Outdoor / Air**	
Unit		**outdoor**	**indoor**	**outdoor**	**indoor**
Dimension		W: 91cm, D: 40cm, H:105cm	W: 27cm, D: 57cm, H:63cm	W: 91cm, D: 40cm, H:105cm	W: 27cm, D: 61cm, H:70.5cm
Weight		115kg	45kg	115kg	55kg
Voltage		3 x 200V		3 x 400V	
Mainly delivered to		US / CA / JP		EU / CH	
Operating Current		27A		13A	
Min. Circuit Ampacity		50A		30A	
Max Fuse / Circuit Breaker Size		50A		30A	
Compressor LRA designates the starting current during 500ms		156A		74A	
Power Requirement	**Minimum**	11kVA		11kVA	
	Recom-mended	14kVA		14kVA	
Power Con-sumption	**Cool Down max. 50 / 60Hz**	8.0/ 9.2kW		8.0/ 9.2kW	
	Steady State max. 50 / 60Hz	8.0/ 9.2kW		7.5 / 8.5kW	
Acoustic noise		max. 66dB(A) outdoor unit only			
Ambient Operating Tempera-ture		-30 to 45°C (-22 to 113°F)	5 to 28°C (41 to 82.4°F)	-30 to 45°C (-22 to 113°F)	5 to 28°C (41 to 82.4°F)

Table 7.2: Technical data for Outdoor He Compressors

7.2.5 IEC Standard Socket – ‘Schuko’ female

NOTICE

- An IEC Standard Socket is used for the CryoCooling Unit mains.
  The 'Line' and 'Neutral' pins are symmetric and not specifically labeled. They may be interchanged. If your electrical power system uses the 'Field-Field-Ground' convention, connect one 'Field' to the 'Line' pin and the other 'Field' to the 'Neutral' pin.
- In those countries where the original IEC plug of the CryoCooling Unit does not fit into the locally used wall outlet socket, you may consider:

  either exchanging the IEC plug against a plug in conformance with the applicable electricity regulations,

  or a 'hardwired' solution in conformance with the applicable electricity regulations. In this case you will not need the supplied IEC Standard Socket.

⚠ WARNING

Electrical hazard from electrical shock.

A life threatening shock may result when the housing is open during operation.

Therefore:

- Local regulations apply and the mains power connection of the CryoCooling Unit-installation needs to be carried out by a licensed electrician.
- In some parts of the world (e.g. Europe) a plugged connection is feasible and recommended, whereas in other regions (e.g. US) a fixed 'hardwiring' is mandatory.
- Do not try to supply the CryoCooling Unit from the mains sockets at the rear of the spectrometer cabinet. Those sockets are not suitable for this purpose.
- Follow specifications: 500 W average, 1500 W peak, 230 V AC, 1 phase, 50 / 60 Hz, must be fused upstream with at least T 10A (T = time-lag fuse).
- In case of 208V AC supply a step up transformer with a suitable power rating is required in order to guarantee a reliable operation.

7.2.6 Next Step

The further installation will be carried out by a BRUKER service engineer after you have prepared the site as described above and the installation of the specified electrical connections has been carried out by a licensed professional. Please complete the attached CryoProbe Site Preparation checklist and remit it to your BRUKER office. BRUKER will then organize the next steps of your CryoProbe installation.

Checklist: CryoProbe Site Preparations		
Customer / Institution:	BRUKER Order No:	
Material arrival date:		
Please complete the checklist and remit it signed to your BRUKER BIOSPIN office in order to organize the completion of your installation:		
⚠ CAUTION		
• Multiple electrical connections are required for the cryoprobe accessory. These electrical connections must be installed according to the manufacturers guidelines with attention to local and national electrical codes. This is to ensure the safety and proper function of the product as well as the safety of all personnel working on or around the equipment. • Severe damage to the cryoprobe system may result if the cooling water supply does not meet the requirements listed in the cryoprobe site planning guide! BRUKER BioSpin can not be held responsible for damage to the CryoProbe system resulting from inadequate water quality and / or flow rate. In such an event, we may: • Void the warranty on the entire CryoProbe system • Bill you at our standard service rate and zone travel charge for our services where cooling water quality and / or flow rate impedes the completion of the installation. • Reschedule the installation at our convenience after the water quality and / or flow rate problem is repaired.		
He gas cylinder Grade 6.0 installed		
He Regulator is compatible and installed		
Cables and Indoor Flexlines:	A cable duct is prepared or open installation, no ducts	
Option 1: ☐ Water cooled He Compressor	Water cooling is tested and o.k.	
Option 2: ☐ Air cooled outdoor He Compressor:	Outdoor Unit installed on solid base and Duct / Lead-trough ready	
Option 3: ☐ Air cooled indoor He Compressor		
Mains power supplies for both CryoCooling Unit and He Compressor are ready		
Signature:	Date:	

4 Contact

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

Contact

A.5 Index

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V

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Revision History List

Index:	Date:	Alteration Type:
00	09.05.2008	Pre-release of a new document, all pages have the draft status „Rev.:00“
01	25.1.2011	New manual Design in accordance with the specific form the Corporate Guid Line and the definition from the Bruker documentation group.

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Order No: Z31824