Fourier

Site Planning

User Manual

Version 003

Innovation with Integrity

NMR

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1 Introduction

This manual contains information about site planning and preparation prior to delivery of a Bruker BioSpin Fourier system. The manual should be read through carefully as mistakes made initially may be costly to remedy at a later stage.

The system covered by this manual is for a Fourier spectrometer at 300 MHz.

The chapters in this manual deal with various points that need to be considered for successful system operation. They have been included to familiarize you with general principles of successful site planning.

Appendix A contains an example sample room layout for a Fourier 300 MHz system.

For specific questions that may not be addressed in this manual, or for further information on a topic, do not hesitate to contact your local Bruker BioSpin office.

NOTE: Site planning is not only relevant for the installation of a new system, rather also by any changes in the equipment or devices, and by any renovations or room changes!

1.1 Units Used Within This Manual

The SI Unit **Tesla** (mT) is used throughout this manual whenever magnetic field strengths are discussed. Some readers may however be more familiar with the **Gauss** (G) Unit.

Likewise the unit **kilowatt** is used for the measure of heat energy (e.g. amount of heat generated by a device per hour). Some readers may be more familiar with these measurements in **BTU/hour**.

Wherever possible both the metric and U.S. Standard measure units have been used throughout this manual. When compared to metric measurements, the U.S. Standard measurement units are often indicated by „**in USA**“. This does not mean that the measurements are only limited to the United States, but rather are for all countries in **North America** and **South America** that use the U.S. Standard System.

In most cases the weights and measures have been rounded upwards where necessary. The following table offers the common metric to U.S. conversion factors used in this manual:

Measure	SI Units	U.S Standard Units	Conversion Factor (rounded to nearest hundredth)
Linear	**meter (m)** **centimeter (cm)**	**feet (ft.)** **inch (in.)**	**1 m = 3.28 ft.** **1 m = 39.37 in.** **1 cm = 0.394 in.**
Distance	**kilometer (km)**	**mile (mi)**	**1 km = 0.62 mi**
Area	**square meter (m^2)**	**square foot (ft^2)**	**1 m^2 = 10.76 ft^2**
Volume	**cubic meter (m^3)** **liter (l)**	**cubic foot (ft^3)** **quart (qt)**	**1 m^3 = 35.32 ft^3** **1 l = 1.06qt (liquid)**
Weight	**kilogram (kg)**	**pounds (lbs.)**	**1 kg = 2.21 lbs.**
Preasure	**bar**	**pounds/square inch (psi)** **atmosphere (ATM)**	**1 bar = 14.51 psi** **1 bar = 0.99 ATM (standard)**
Flow (e.g. gas flow	**cubic meter/minute (m^3/min.**	**cubic feet/minute (ft^3/min.)**	**1 m3/min. = 35.32 ft3/min.**
Temperature	**^{0}C**	**^{0}F**	**F = C x 1.8 + 32**
	^{0}F	**^{0}C**	**C = (F - 32) / 1.8**
	^{0}C	**K**	**K = C + 273.15**
	K	**^{0}C**	**C = K - 273.15**
	^{0}F	**K**	**K = (F + 459.67) / 1.8**
	K	**^{0}F**	**F = K x 1.8 - 459.67**
Magnet Field Strength	**Tesla (T)**	**Gauss (G)**	**1 T = 10^4 G**
Heat Energy	**BTU/hour**	**kW**	**1 BTU/hour = 0.000293 kW**
(BTU = British Thermal Unit which is the required heat to raise 1 pound of H2O by 1 degree Fahrenheit) **SI = International System of Units**			

Table 1.1: Conversion table for units used in this manual

2 Safety

2.1 Introduction

In terms of safety the presence of a relatively strong magnet is what differentiates NMR spectrometers from most other laboratory equipment. When designing an NMR laboratory, or training personnel who will work in or around the laboratory, no other feature is of greater significance. As long as correct procedures are adhered to, working in the vicinity of superconductive magnets is completely safe and has no known harmful medical side effects. Negligence however can result in serious accidents. It is important that people working in the vicinity of the magnet fully understand the potential hazards. Of critical importance is that people fitted with cardiac pacemakers or metallic implants should never be allowed near the magnet.

The magnet is potentially hazardous due to:

- The large attractive force it exerts on ferromagnetic objects.
- The large content of liquid Nitrogen and Helium.

2.2 Magnetic Safety

A Magnetic Field surrounds the magnet in all directions. This field (known as the stray field) is invisible, hence the need to post warning signs at appropriate locations. Objects made of ferromagnetic materials, e.g. iron, steel etc. will be attracted to the magnet. If a ferromagnetic object is brought too close, it may suddenly be drawn into the magnet with surprising force. This may damage the magnet, or cause personal injury to anybody in the way!

The Fourier 300 super conducting magnet is actively shielded. The following must be understood when working with such a shielded magnet.

- The active shielding of the super conducting coil reduces the stray magnetic field and therefore its effect. The **5 Gauss** line in the horizontal direction extends **26.5 cm** around the outside of the magnet. In the vertical direction it extends about **24 cm** out of the can at the middle but it does not go above the helium stacks or below the floor.
- In spite of the active shielding, the stray magnetic field immediately adjacent to the bore of the magnet is very high and the attractive forces on ferromagnetic objects are very strong!

2.3 Cryogenic Safety

The magnet contains relatively large quantities of liquid helium and nitrogen. These liquids, referred to as cryogens, serve to keep the magnet core at a very low temperature.

Because of the very low temperatures involved, **gloves, a long sleeved shirt or lab coat** and **safety goggles** should always be worn when handling cryogens. Direct contact with these liquids can cause frostbite. The system manager should regularly check and make sure that evaporating gases are free to escape from the magnet, i.e. the release valves must not be blocked. Do not attempt to refill the magnet with helium or nitrogen unless you have been trained in the correct procedure.

2.3.1 What is a Quench?

A magnet **quench** is the spontaneous breakdown of superconductivity in a partially or fully energized magnet. The stored field energy is transformed into heat, leading to a fast evaporation of liquid helium. During a quench, an extremely large quantity ,**~40 m^3** (**1,400 ft^3**) of helium gas is produced within a short time.

Helium and nitrogen are non-toxic gases. However, because of a possible **magnet quench,** where upon the room may suddenly fill with evaporated gases causing potential danger of suffocation. Adequate ventilation must always be provided and it is recommended that any person should leave the room.

2.4 Emergency Planning

Due to the strong magnetic fields and presence of cryogens when using NMR systems, it is important to define and communicate what to do in case of problems or an emergency. An **Emergency Plan** can be defined as a documented set of instructions on what to do if something goes wrong. Emergency Plans are often defined as part of the Standard Operating Procedures (SOP), or as a stand-alone document. In any case every NMR laboratory should have an Emergency Plan in effect in case of problems or emergencies.

As every organization has its own policies and procedures, as well as varying laboratory layouts, an Emergency Plan should be individually defined for each laboratory as appropriate. Upon request Bruker can provide useful information on emergency planning.

2.5 Fire Department Notification

It is recommended that the magnet operator introduce the fire department and/or local authorities to the magnet site. It is important that these organizations be informed of the potential risks of the magnet system, i.e. that much of the magnetic rescue equipment (oxygen-cylinders, fire extinguishers, axes etc.) can be hazardous close to the magnet system. On the other side, their expertise and experience can be invaluable in creating an Emergency plan.

- Within a NMR laboratory CO_2 magnetic fire extinguishers must NOT be used. Breathing equipment which uses oxygen tanks made out of magnetic material can be life threatening when used close to a magnet system which still has a magnetic field present.
- Helium gas escaping from the system must not be mistaken for smoke. Instruct the fire department and technical service not to extinguish the magnet system with water. The outlet valves could freeze over and generate excess pressure within the system.

- NMR laboratory windows which are accessible during an emergency must be clearly marked with warning signs, visible from the outside.

2.6 Earthquake Safety

In regions where there is a potential risk of earthquakes, additional measures must be taken to reduce the chance of personal or property damage through movement or tipping of the magnet.

Many countries or regions have documented regulations, including building codes, regarding earthquakes. Before installing a magnet system, it is highly advisable that you check with local authorities on whether your area is prone to earthquakes and if there are any regulations in effect.

If your area is regarded as an earthquake area there are several shock absorbing measures or riggings available to reduce the likelihood of damage during an earthquake. Please contact Bruker for more information on earthquake securing equipment.

2.7 Country-specific Safety Regulations

In addition to the above safety precautions, any country-specific safety regulations for operating NMR systems must be fulfilled. These may include, for example, regulations on:

- Facilities of a controlled access area around the magnet.
- Working conditions at computer stations.

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3 Magnet Access and Rigging

3.1 Introduction

The magnet is very fragile, thus requires special consideration during delivery and movement to its final installation point. It can be like other components of the spectrometer system (console, BMPC, etc.) typically be removed from delivery trucks with forklift and be positioned in the NMR lab with a pallet jack. Specifications for these components are also included in this chapter for planning purposes.

3.2 Considerations for Off-loading on Site

When planning for off loading the magnet and console during delivery, the following factors must be considered.

3.2.1 Delivery Area

There must be sufficient space in the driveway or parking area for the delivery truck and in case a fork-lift has to be used to unload the crates.

3.2.2 Transport Weight

The Fourier system is shipped in 3 package units:

Unit	Weight
Magnet with crate	313 kg
Console, Cables, Filter, Manual	65 kg
PC, Monitor, Probe	65 kg

Table 3.1: Transport weight of the Fourier system

The shipment may contain other package units:

Unit	Weight
SampleXpress Light if included in the order	40 kg
UPS if included in the order	40 kg
Tripod	35 kg

Table 3.2: Transport weight of additional components

3.2.3 Equipment Requirements

Small rigging devices can be used to off-load the magnet and other boxes.

- **Fork-lift**: It may be feasible to use a fork-lift to pick the magnet and other boxes from the truck and lower it to a flat surface.
- **Pallet-jack**: If a loading dock is available, a pallet-jack can be used to upload the magnet and other boxes from the truck.

3.3 Considerations for Transport to the NMR Room

Before delivery, one must ensure that the site provides adequate access for delivery of the system and magnet. The following factors must be considered.

3.3.1 Accessibility to the NMR Room

- The **access clearance** (height and width) and **floor loading capacity** must be checked along the entire route that the magnet and console will take from the loading dock to the NMR room (see **3.2.2 Transport Weight**).
- **Elevator capacity** and dimensions must be considered if applicable.
- The transport will also be affected by **floor level** and presence of **steps**.
- The **turning radius** can also be a factor if for example corners must be navigated.

3.3.2 Equipment Requirements

Depending on the situation it may be necessary to utilize a pallet-jack or a fork-lift to transport the magnet and other boxes over floors and through passageways. The magnet and other boxes must be moved in **upright position**.

3.4 Considerations for Assembling the Magnet

3.4.1 General Requirements

All the requirements discussed in this manual considering room layout must be met before taking delivery of the system. The type of equipment used for assembly will ultimately depend on any limiting factors, such as **ceiling height**.

3.4.2 Equipment Requirements

- **Lifting Hook:** Lifting the magnet inside the NMR room for assembly purposes requires either a fixed lifting hook or a tripod gantry capable of handling the magnet load with the given ceiling height requirements.
- **Fixed Lifting Gantry (A-frame)**: If a hook can not be provided, the fixed lifting gantry may be used instead.

Bruker can provide rigging equipment, such as Chain Hoist, Tripod or Gantry A-frame at many sites upon request.

3.5 Checklist for Magnet Access and Rigging

Determine if there is sufficient space in the drive way or parking for the forklift and for the delivery truck.	
Determine if sufficiently leveled area is available for uncrating the magnet.	
Determine if the elevation of the magnet room is different from the delivery area and make provision for overcoming this obstacle if necessary.	
Determine if suitable leveled slab (area) is available in front of the access doors for the transport device. Is the slab capable of handling the size and weight of the magnet.	
Determine if masonite sheets are needed to correct imperfection and protect flooring.	
Determine if adequate clearance is available along the access path from the delivery area to the NMR room.	
Verify the load bearing capacity along the access path.	
Verify fork-lift or pallete-jack accessibility.	
Determine if there is adequate height clearance for rigging to lift the magnet in the NMR room. If a hook is used determine if hook height and lifting load is adequate.	

Table 3.3: Magnet Access and Rigging checklist

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4 Lab Requirements

4.1 Room Layout

The Fourier system can be placed in to a small room area but certain requirements have to be met. There should be a clear path, free of obstacles, to bring in containers to service the magnet with liquid Nitrogen and Helium. The console can be placed close to the magnet but it is recommended that the work station should be placed a minimum distance away from the magnet. As a room layout example, the Fourier system with the optional SampleXpress Lite is shown in Figure 4.1 below.

Figure 4.1: Room layout example of an installed Fourier system

4.2 Ceiling Height

A **minimum ceiling height of 2.74 m (9 feet)** is required for the clearance needed above the magnet for assembly, energizing and filling liquid Helium.

4.2.1 Checklist for Ceiling Height Requirements

Determine if ceiling height is adequate for lifting the magnet into place in the NMR room.	
Determine if height is adequate for energizing based on type of transfer lines used.	
Determine if height above He transport dewar (for refilling) is adequate.	

Table 4.1: Minimum ceiling height checklist

4.3 Footprint

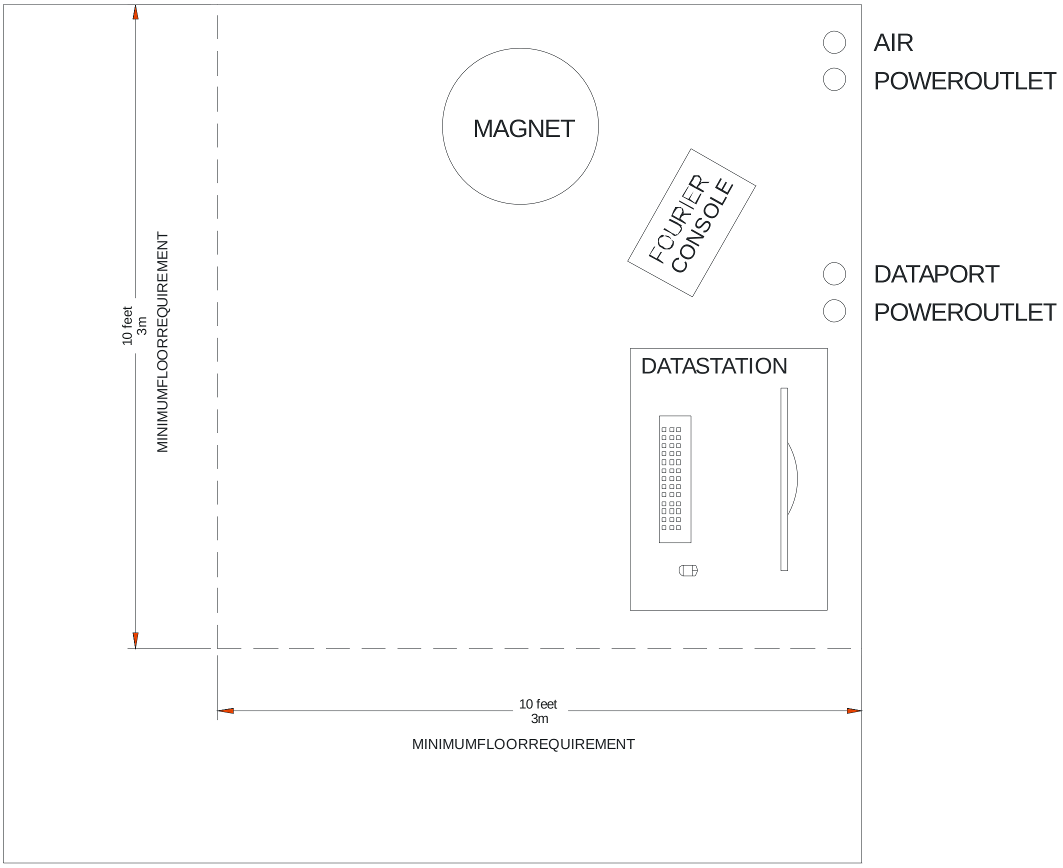

Figure 4.2: Floor Layout

4.4 Minimum Floor Capacity

The floor must be sufficiently strong to support the mass of the equipment, plus the weight of any installation devices such as pallet-jack, tripod, hoist etc.

A **minimum floor capacity of 431 kg/m^2** is required to support all the above devices.

4.5 Floor Types

Generally a liquid nitrogen resistant floor material must be used, such as PVC or wood that has been painted or varnished.

Many of the system components contain highly sensitive electronic devices that must be protected from Electrostatic Discharge (ESD) by proper floor covering and grounding practices.

4.6 Vibration Isolation

External vibrations may cause field modulations in the sample cavity. This could result in vibration sidebands, matched NMR signals that appear on either side of a main signal peak.

Normally spectrometers at a field of 300 MHz magnets, such as the Fourier normally do not require anti-vibration devices. In case this becomes necessary, Bruker Biospin offers vibration isolation devices.

4.6.1 Sources of Vibrations

- Random vibrations may be caused by moving chairs, doors, tables etc. in or around the magnet room. This type of vibration is usually controllable, but when planning the site you will need to take into consideration activities in rooms adjacent to the magnet room.
- Sources of more regular vibrations are generators, compressors, fans, machinery etc. Compressors must not be located in the NMR room and, if close enough, you should consider mounting such items on vibration damping material. Air vibration can be caused by ventilation or fans, windows in the magnet room must be located and constructed in such a way that no sudden pressure fluctuations are produced by winds.
- Vibrations from external sources such as cars, trains, airplanes, building sites etc. Here the critical factor is the distance from the source to the NMR site, as well as the type of ground over which the vibrations are transmitted.

4.7 Electromagnetic Interference

Electromagnetic Interference (EMI) can be defined as any electromagnetic disturbance that interrupts, obstructs, or otherwise degrades the effective performance of electrical equipment. Possible sources of interference are power lines which may carry fluctuating loads, heavy duty transformers, large electric motors, air conditioning systems, power transformers, etc.

The fluctuating electromagnetic fields arising from such devices can interfere with the magnet homogeneity. Of particular concern are sudden changes in load as may be produced by elevators, trams, subways etc. Some laboratory equipment such as mass spectrometers and centrifuges will also give rise to fluctuating fields. Other sources of interference include radio and television stations, satellites and other RF transmitters that may operate in the vicinity of NMR frequencies of interest.

If you suspect that you have a source of interference located near the proposed magnet site then you should contact Bruker Biospin for a site survey.

Types of EMF Interference

- DC Interference
- 50/60 Hz Interference
- Radio Frequency (RF) Interference

4.7.1 DC Interference

DC interference generally comes from devices operated on DC, such as elevators, trains, subways, trams, etc. The locations of both the device and its power supply & lines relative to the proposed NMR site are essential to the amplitude and orientation of DC fields and how they may interfere with the NMR system. DC feeder lines are just as disturbing as a subway, and they do not run necessarily parallel to the track.

4.7.1.1 Measuring DC Fluctuating Fields

DC EMF measurements should be conducted using a **fluxgate magnetometer**. The fluxgate sensor is capable of accurately measuring magnetic field changes below 1mG. The sensor is connected to a magnetometer, and the voltage output from the meter is then converted into digital form. The magnetic field is recorded and plotted on a computer display in real time.

4.7.1.2 Reducing DC Interference

The amplitude of the “full external perturbation” (peak-to-peak) is measured with the fluxgate magnetometer at the proposed magnet location but in the absence of the magnet. There are two levels of compensation against these external DC field perturbations:

- First, the magnet screens itself against external perturbations, hence only a fraction of the full perturbation is left at the magnet center. We call this residual field perturbation after magnet screening. It’s value is relevant to NMR experiments without lock and experiments using gradients which require lock hold.
- Second, the advanced digital NMR lock further minimizes the interference after magnet screening.

4.7.1.3 Guidelines: DC Interference

When determining the effect of fluctuating magnetic fields, two parameters are important: the size of the fluctuation and the rate of change (gradient).

- **Field changes of between 0-5 mG**, regardless of the gradient, are generally considered harmless for standard NMR work. Likewise with Ultra Shield magnets (only), field changes up to 10 mG are considered harmless. The effect of such changes would be observable in only the most critical of experiments such as NOE difference experiments.
- For field changes **larger than 5 mG** the lock system will compensate the fluctuation, as long as the gradient is less than 5 mG/sec.
- For field gradients **greater than 5 mG per second**, NMR performance may be affected.

Table 4.2 lists the minimum distances between the source of interference and the magnet center.

Source of Interference	Recommended Minimum Distance from Ultra Shield Magnet
DC Trams, Subways*	100 m
Elevators, Fork-lifts**	8 m
*Trams and Subways are also a source of vibrational interference. **Depends on the lift geometry and material, these specifications may vary.	

Table 4.2: Minimum Distance from Electromagnetic Interference Sources

4.7.2 16-2/3 Hz and 50/60 Hz Interference

Interference from 16-2/3 Hz generally comes from modern electric trains and/or streetcars that run at 16-2/3 Hz. Likewise, interference from 50/60 Hz generally comes from electrical wiring, transformers and fluorescent lights in the magnet system area. The magnetic field further modulates these interferences, increasing the likelihood of disturbances.

4.7.2.1 Measuring 16-2/3 Hz and 50/60 Hz Fluctuating Fields

16-2/3 and 50/60 Hz EMF measurements should be conducted in the proposed NMR room with power lines active using a hand-held meter. Specific locations that must be checked include:

- Magnet area.
- Console area.
- Along the wall inside the NMR room at 5 cm (~2“) from the wall, and 10 cm (4“) from the wall.
- Approximately 5 cm (~2“) below existing lights in the room.
- Near the main outlets 100 to 240 VAC locations in the room.

4.7.2.2 Reducing 16-2/3 Hz and 50/60 Hz Interference

The general goal of reducing 16-2/3 and 50/60 Hz interference is to shield the source of the interference from the magnet system. Soft iron has been found to be effective in reflecting this interference, and thus providing an effective shield for the magnet. Bruker provides planning for shielding using various metals and shielding techniques, please contact your Bruker office for further information.

4.7.2.3 Guidelines: 16-2/3 Hz and 50/60 Hz Interference

The amplitude threshold for causing interference is approx. 200 nT (2 mG RMS) for unshielded magnets and 500 nT for shielded magnets, based on laboratory tests. Thus, acceptable limits must be well below this whenever possible.

The magnet must not be placed within a 6.1 m (20’) radius of a normally-sized transformer. If there is a large transformer adjacent to the proposed magnet location, measurements will be required to determine if the transformer will adversely affect NMR spectra.

The magnet must also not be placed directly under fluorescent lights, which may cause some 50/60 Hz EMF, and more importantly may switch off temporarily during a quench.

4.7.3 RF Interference

The NMR instrument is effectively a very sensitive radio frequency receiver. Possible sources of interference are local radio or television broadcasts, low Earth orbit satellite systems, and signals emitted by personal paging systems. Of particular concern will be interference at frequencies at which NMR experiments are carried out. Although the interference effects will depend greatly on the strength of the transmitter, as a rule of thumb only broadcasting transmitters located within a radius of approximately 5 kilometers (3 miles) are likely sources of interference.

RF interference may also occur between two or more spectrometers located in close proximity and operating at the same nominal 1H resonance frequency.

4.7.3.1 Measuring RF Fluctuating Fields

Radio Frequency interference measurements should be conducted using a **spectrum analyzer**. The analysis should be done for the resonance frequency of each of the nuclei of interest (proportional to the 1H resonance frequency of the spectrometer). The minimum frequency sweep is 400 kHz. Any peaks with RF fields above -80 dBm should be recorded, as well as any broad frequency ranges with any level of RF signals.

Table 4.3 contains a list of the most common studied nuclei at the corresponding frequencies for 300 MHz NMR systems.

Nuclei	NMR Frequency (MHz)
1H	300.000
2H	46.072
13C	75.468

Table 4.3: List of studied Nuclei and corresponding Resonance Frequencies

4.7.3.2 Reducing RF Interference

Screening a site for possible RF Interference is complicated and expensive. Shielding of the NMR room with a Faraday cage is a possible solution, though having to take such measures is quite rare.

When designing and manufacturing the Bruker BioSpin spectrometers, care is taken to provide adequate shielding and the instruments rarely suffer from interference in normal RF environments. Furthermore, the advanced digital lock system included with in the Fourier spectrometers allows a shift in the 2H lock frequency with certain limits. This may allow enough variation in the absolute magnet field strength to shift the NMR signal away from that of local broadcasting frequencies.

RF interference may occur between two or more spectrometers located in close proximity and operating at the same nominal 1H resonance frequency. These problems can be avoided by energizing the different magnets at slightly different fields, such that their operational frequencies are separated by ~ 200 kHz of the nominal 1H resonance frequency.

4.7.3.3 Guidelines: RF Interference

As a general guideline the level of any RF interference must be less than an electrical field strength of -65 dBm at the side of the magnet. However, past experience has shown that broadband RF fields having smaller intensity (about - 80 dBm) may interfere with the NMR experiments. Therefore, it is important to make a note of any measurements exceeding -80 dBm.

4.7.4 Checklist for EMF Interference

Determine if any trains, Subways, Trams or assiated CD power lines are present within 150 meters from the magnet center.	
Determine if any mass spectrometers are located in the room or adjacent spaces.	
Measure DC EMF with fluxgate magnetometer.	
Determine if any large transformers, AC power lines or powerful lighting is in close proximity to the magnet.	
Measure AC EMF.	
Determine if any TV/Radio stations, cellar phone towers and antennas, or other possible sources of RF are in the building or within a radius of 5 kilometers.	
Determine if any other NMR or MRI systems present operating at the same frequency	

4.8 Utilities

4.8.1 Electrical Power Requirement

4.8.1.1 General Power Requirements

- When planning the electrical power requirements of the NMR room, make provision for extra equipment which you may install, e.g. Personal Computers, workstations, air conditioning systems etc.
- Separate outlets should be reserved near the magnet for plugging in devices during the installation such as vacuum pumps and power supply to charge the magnet. The pumps and the power supply operate using either, a line voltage of **110 V / 20 A** or **208 V / 20 A** single phase or **230 V / 15 A** single phase. The Fourier can use any of those voltages, and requires a maximum of **400 W** of power. The workstation computer also requires a maximum of **400 W**.
- The Fourier console is supplied with a spare electrical outlet. Since the Fourier can operate using a line voltage of **110 V**, **208 V** or **230 V**, the spare outlet will provide a voltage accordantly. This outlet should be reserved for a spectrometer accessory such as the optional sample changer which can work on any of those voltages.

4.8.1.2 Other Power Requirement Consideration

- If line voltage fluctuations exceed -5% to +10% a **voltage stabilizer** must be used. The lifetime of the various electrical components in the spectrometer will also be lengthened when a voltage stabilizer is used. Contact your local Bruker BioSpin office for more information on voltage stabilizers.

- Where total interruption of power occurs frequently, you should consider installing a **UPS** (Uninterrupted Power Supply) possibly linked to an automatic cut-in generator. This is particularly advisable when long-time experiments are to be run.
- The power supply to the spectrometer must be “**clean**” (no spikes), i.e. it must not share with air conditioners, compressors, etc.
- All **grounding** for mains in the lab must be connected together to avoid differences in earth potential.

4.8.2 Checklist for Power Requirements

Determine if the NMR room has 110VAC, 208VAC or 230VAC of power outlets.	
Determine if there are enough power outlets in the NMR room.	

Table 4.4: Power requirement checklist

4.9 Compressed Gas Requirements

Compressed air or Nitrogen is needed for lifting, spinning, VT work and for an optional sample changer to operate a NMR system.

4.9.0.1 General Gas Requirements

- **Compressed gas line**: The Fourier system requires one compressed gas line with oneregulated outputs.
- **Regulators**: pressure range **0-8.6 bar (0 - 125 psi)**, with gauge head included.

4.9.0.2 Gas Requirements for Accessories

- The use of an optional sample changer (SampleXpress Light) requires a T-split from the supply line.
- The use of optional vibration isolation units may require a second regulator.

4.9.0.3 Compressed Gas Specifications

- **Oil Content**: has to be **<0.005 ppm (0.005 mg/m^3)**.
- **Water Content**: For room temperature work and higher, a DEW Point of **<4^0 C (39.2^0 F)** is desirable.

4.9.1 Checklist for Utility Requirements

Provision must be made for any additional electrical power requirements for extra equipment that will be installed.	
Additional electrical outlets are required for turbo-pumps and magnet power supply during installation and service.	
A voltage stabilizer must be available if the line voltage fluctuation exceeds -5% to +10%.	
An UPS should be considered if power outages are frequent.	
The power supply to the spectrometer should be clean.	
A minimum of one compressed gas line with one regulated output must be available.	
Provision must be made for gas requirements of any accessories used.	

Table 4.5: Utility requirement checklist

5 Installation

All general requirements such as power supply, compressed air supply, etc. which were discussed in the preceding chapters must be arranged first before taking delivery of the system. It must be stressed that any installation requirements listed below such as cryogen supplies, are ***in addition*** to those needed for normal system operation.

5.1 Overview

The spectrometer will arrive at the site in several boxes. The boxes must not be opened by the customer as this must be done by a Bruker BioSpin engineer. The commissioning of the magnet involves several stages as outlined in ***Table 5.1***.

Duration	Procedure
ca. 3-6 hours	Transport fixtures are removed. Cryostate is assembled.
1 day	The magnet is evacuated and flushed through with Nitrogen.
1 day	Cool down the magnet with liquid Nitrogen (precooling).
1 day	Cool down the magnet with liquid Helium.
1 day	Charging the magnet
1 day	Cryo-shimming the magnet

Table 5.1: Installation timetable

5.2 Installation Procedures

The following sections will address some of the details of the various steps outlined in ***Table 5.1***.

5.2.1 Magnet Assembly

The magnet is delivered in a cardboard box with a wooden base. Do not unpack the box! This must be done by the installation engineer. The assembly area must be clean, dry and free of dust.

The assembly may require that the engineer works beneath the magnet and thus special rigging equipment is required. Refer to ***3.4 Considerations for Assembling the Magnet*** for special equipment requirements for assembly.

5.2.2 Magnet Evacuation and Flushing with Nitrogen Gas

Once the magnet has been assembled and placed in the magnet room, rough pumping of the cryostat can begin. At the same time the cryostat is flushed through with dry Nitrogen gas. The customer **must** provide a 50l/200 bar cylinder of dry Nitrogen gas (99.99% purity). The cylinder must be fitted with a secondary regulator valve to deliver a pressure of 0.5 bar. For some installations the customer is asked to provide a roughing pump, e.g. rotary pump capable of reducing pressures within the cryostat to 10^{-2} mbar.

Further pumping of the cryostat is then carried out to reduce the internal pressure to 10^{-6} mbar. It is convenient, particularly for foreign installations, if the customer can provide a suitable pump such as a diffusion or turbo pump. If such a pump is available the customer must contact Bruker BioSpin to confirm its suitability. Where no such pump is available, it will be supplied by Bruker BioSpin.

5.2.3 Cooling the Magnet to Liquid Nitrogen Temperatures

This next stage involves filling the magnet with liquid Nitrogen. The quantity of liquid nitrogen required is **150 Liters**. To transfer the nitrogen a transport dewar is required. This must have a minimum volume of 50 Liters with fixture for pressurizing and transferring via a rubber hose of 10 mm diameter.

5.2.4 Cooling the Magnet to Liquid Helium Temperatures

- For this procedure the customer must provide:
- One cylinder of helium gas: 50 l / 200 bar (99.996% purity) with secondary regulator valve to deliver pressure of max 0.2 bar.
- The quantities of liquid helium is 150 l.
- Liquid Helium dewar: 50 l, 100 l or 250 l. Type SHS with NW25 flange or suitable outlet compatible with the 9.6 mm helium transfer line.

When ordering the helium the customer must arrange to have it delivered immediately before the installation. Otherwise losses due to evaporation must be taken into account.

5.2.5 Charging the Magnet

The final stage involves bringing the magnet to field. During the charging there is a possibility that the magnet may quench. A minimum quantities of liquid helium is required to allow at least for one quench. It is important that the customer ensures that, if required, extra supplies of liquid helium are available.

Note: Many suppliers will buy back any unused cryogens!

5.3 Checklist of Installation Requirements

One cylinder of Nitrogen gas.	
One cylinder of Helium gas.	
Quantities of liquid Helium and Nitrogen in transport dewars.	
Three power sockets (230 V / 16 A single phase or 208 V / 20 A single phase or 110 V / 20 A). The power outlets will be used to run a vacuum pump, a heat gun and a power supply unit. These power outlets must be available in addition to the power source used to run the spectrometer.	
Step ladder (non-magnetic e.g. aluminum or wood).	
Where possible the customer should provide a heat gun or powerful handheld air dryer (min. 800 W), a roughing pump (10^{-2} mbar) and a pair of insulated gloves. If those items can not be provided by the customer, then Bruker can provide them.	

Table 5.2: Installation requirement checklist

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6 Contact

Manufacturer:
Bruker BioSpin NMR
Silberstreifen
D-76287 Rheinstetten
Germany
Phone: +49 721-5161-0
http://www.bruker-biospin.com

NMR Hotlines

Contact our NMR service centers.

Bruker BioSpin NMR provide dedicated hotlines and service centers, so that our specialists can respond as quickly as possible to all your service requests, applications questions, software or technical needs.

Please select the NMR service center or hotline you wish to contact from our list available at:

http://www.bruker-biospin.com/hotlines_nmr.html

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