CryoProbe Prodigy

- Bruker User Manual

Version 001

Innovation with Integrity

NMR

This manual was written by

Regina Mudra, Marc Schnell, Peter Tosin

Fällanden, Switzerland

P/N: Z31986

DWG-Nr.: Z4D11530 001

For further technical assistance on the CryoProbe Prodigy unit, please do not hesitate to contact your nearest BRUKER dealer or contact us directly at:

BRUKER Corporation
Industriestrasse 26
CH-8117 Fällanden
Switzerland

Phone:+ 41 825 97 97
FAX:+ +41 825 94 04
E-mail:cryoprobe.service@bruker.ch
Internet:www.bruker.com

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ATM - Automatic Tuning and Matching Motor Unit

CPP - CryoProbe Prodigy

LN2 - Liquid Nitrogen

MTM - Manual Tuning and Matching Adaptor

N2 - Nitrogen Gas

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1 About

1.1 This Manual

This manual enables safe and efficient handling of the Prodigy System.

This manual is an integral part of the Prodigy System, and must be kept in close proximity to the Prodigy System where it is permanently accessible to personnel.

Before starting any work, personnel must have read the manual thoroughly and understood its contents. Compliance with all specified safety instructions and operating instructions is vital to ensure safe operation.

In addition, local accident prevention regulations and general safety instructions must be observed for the operational area of the device.

Illustrations in this manual are intended to facilitate basic understanding, and may differ from the actual design.

This user manual must be kept with the Prodigy System. In addition to the user manual, instructions concerning labor protection laws, operator regulations, tools and supplies must be available and adhered to.

1.2 Limitation of Liability

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

The manufacturer assumes no liability for damages resulting from:

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

1.3 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.

1.4 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 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.

1.5 User Responsibilities

The user must obey the security advice and the rules for safety, accident prevention and environmental protection correctly for the Prodigy System

Furthermore, the user is responsible for keeping the Prodigy System in correct technical condition.

In particular:

- The user must determine additional dangers resulting from the working conditions at the site of the magnet system and provide applicable safety measures.
- The user must ensure that the site plan meets the specified conditions for operating the magnet system and supplied site planning document.
- The user must mark the danger area around the magnet system and post the corresponding instruction plates.
- The user must inform the local fire brigade about the special risks of the magnet system and how to react in the event of an incident.
- The user must clearly define the responsibilities for operation and maintenance.
- The user must ensure that all employees working with the magnet system have read and understood the manual.
- The user must provide the necessary personal protective equipment for his employee.
- The user must instruct his employee at regular intervals on hazards and safety measures.
- The user must instruct other persons not working on the magnet system but carrying out work in the same room, for instance cleaning staff.

1.6 Intended Use

The Prodigy System is an accessory for an NMR-spectrometer and consists of a CryoProbe Prodigy, a vacuum-insulated Transferline for liquid nitrogen, a dewar for liquid nitrogen (LN2 Dewar) with a permanent installed dewar adaptor and a Prodigy Unit for the control of the CryoProbe Prodigy.

The intended use comprises:

- Transport
- Installation
- Commissioning
- Measurements
- Maintenance
- Disposal

The Prodigy System is dedicated only for use with the specific NMR spectrometer.

Only approved persons ("Definition of Approved Persons" on page 15) shall use the Prodigy System.

1.7 Safety Requirements

1.7.1 Oxygen Monitors

An installed oxygen monitor is required inside the magnet room to observe the oxygen level in the room and to clearly warn of low oxygen levels. At a minimum the following sensors must be provided by the customer:

- One oxygen monitor above the magnet, to detect low oxygen levels caused by high helium gas concentration.
- One oxygen monitor approx. 30 cm off the floor of the magnet room to detect low oxygen concentration caused by high nitrogen gas (N2) concentration.
- One additional oxygen monitor approx. 30 cm off the bottom of the pit, in case the magnet is located inside the pit.

Oxygen monitors generally must be located outside the 0.5 mT (5 G) line. Check with original equipment manufacturer for information on the effects of magnetic fields on theses devices.

1.7.2 Fresh Air Supply

⚠ WARNING

Risk of suffocation

Therefore:

- ▶ The free room volume (exchangeable gas volume) must be ≥ 70m^3.
- ▶ The fresh air supply rate must be ≥ 200m^3 h^{-1}.
- ▶ During the LN2 refill the fresh air supply rate must be increased to ≥ 400m^3 h^{-1}.
- ▶ Windows and doors should be opend before starting the refill procedure.

1.7.3 Avoid Potential Risks with Personal Protective Equipment

The personal protective equipment must be worn at any time while working in situations of potential risk.

1.7.3.1 Symbols to Identify a Potential Risk

Risk of suffocation

Risk of cold burns

1.7.3.2 Personal Protective Equipment

Personal Oxygen monitors

Warns the user of low oxygen content in the lab.

Protective Goggles (DIN EN 166, 170 & 172)

Protect the eyes from injury due to flying cold gases, liquids and parts.

Protective Gloves (DIN EN 388, 420 & 511**)**

Protect the hands from injury caused by contact with extremely cold gases, liquids or surfaces and for protection from injury caused by rough edges.

Protective Clothes (DIN EN 342)

Protect the body from injury caused by contact with extremely cold gases, liquids or surfaces.

1.7.4 Summary of Safety Requirements

⚠ WARNING

Risk of suffocation.

Risk of injury due to very low temperatures of liquids & metal parts.

Contact with the skin may cause cold burns.

Contact with the eyes may cause blindness.

Therefore:

- The lab must have a free room volume of ≥ 70 m^3 with a steady fresh air supply rate of ≥ 200 m^3 h^{-1} for each CryoProbe Prodigy System.
- Before the LN2 refill process is started, the fresh air supply rate must be increased to ≥ 400 m^3 h^{-1}.
- Windows and doors must be opened before starting the LN2 refill.
- The lab must be equipped with oxygen monitors to detect a possible drop in the oxygen level. One oxygen monitor must be above the magnet and one oxygen monitor approx. 30 cm off the floor of the magnet room in order to detect low oxygen levels. Where the magnet is located inside a pit, an additional oxygen monitor located approx. 30 cm from the bottom of the pit must be fitted. All detectors should be located outside the 0.5 mT (5 G) line.
- Persons must not accompany a liquid nitrogen transport dewar inside an elevator (observe local regulations).
- The fill or refill procedure of the LN2 Dewar must be carried out by trained laboratory personnel or trained personnel from a nitrogen supply company.
- During the entire refill process protective gloves, goggles, apron and personal oxygen monitor must be worn.
- Never look directly into the openings of components without eye protection (e.g. the transferline) because liquid nitrogen droplets may spill out.
- The transport dewar for dispensing liquid nitrogen must be equipped with a safety pressure release valve, be non-ferromagnetic and must be placed outside the 0.5 mT (5 G) line.
- If the LN2 Dewar is placed on the scale (optional equipment): The scale must be positioned outside the 0.5 mT (5 G) stray field line of the magnet.

1.8 Risks and Warnings

1.8.1 Definition of Approved Persons

⚠ WARNING

Risk of injury and property damage from not approved persons.

Incorrect handling of the CryoProbe Prodigy from not approved persons may result in significant bodily injury and property damage.

Thus:

- Work must only be carried out by approved persons with appropriate qualifications.
- In case of doubt contact Bruker Service. Contact information can be found in "Contact" on page 83 of this document.

In this manual the following qualifications are referenced:

Bruker Service

As a result of professional training, experience and knowledge of applicable regulations they are approved to perform work on magnet systems. They are approved to self-identify dangerous situations and to take applicable measures.

Approved Persons

As a result of professional training, experience and knowledge of applicable regulations and instruction, this group of people is approved to perform the duties assigned to them. They are capable to recognize dangerous situations and to take applicable measures.

1.8.2 Safety Devices

⚠ WARNING

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

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

Thus:

- ▶ Do not block safety devices, in particular the pressure release valve and the vacuum safety valve.
- ▶ Do not remove safety devices.
- ▶ Avoid damage.
- ▶ Avoid contamination.

1.8.3 Spare Parts

⚠ WARNING

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

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

Thus:

- ▶ Use only original equipment manufacturer spare parts.
- ▶ Use only original equipment manufacturer accessories.

1.8.4 Signs and Labels

⚠ WARNING

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

Signs and labels may become not readable.

Thus:

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

1.8.5 Technical Risks

1.8.5.1 Magnetic Fields

⚠ WARNING

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

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

Thus:

- ▶ Mark the magnetic field of more than 0.5 mT (5 Gauss) before start up.
- ▶ The workplace must be outside the 0.5 mT area.
- ▶ Keep people with pacemakers and metal implants away from the identified area.
- ▶ Keep hard disks, credit cards and electronic devices away from the identified area.
- ▶ Do not use ferromagnetic tools or items within the identified area.
- ▶ Only use non-ferromagnetic transportation dewars for the cryogenic agents.
- ▶ Only use non-ferromagnetic ladders or steps.

1.8.5.2 Cryogenic Agents

⚠ WARNING

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

Risk of damage to life and limb due to incorrect handling of cryogenic agents. During evaporation the volume of cryogenic agents increases by a large amount. This can cause an explosion-like burst of closed dewars.

The evaporating cryogenic agents displace oxygen in the air. In case of not sufficient ventilation this may result in death by suffocation. Helium displaces oxygen in the upper part of the room, Nitrogen displaces oxygen in the lower parts of the room.

Liquid and gaseous cryogenic agents are extremely cold. Contact with liquid or gaseous cryogenic agents will lead to cold burns.

Thus:

- ▶ Only use cryogenic agents in well ventilated rooms. In case of doubt ask Bruker Service.
- ▶ Always wear protective equipment (goggles, gloves, apron and personal oxygen monitors) to prevent any skin contact with liquid or gaseous cryogenic agents.

1.8.5.3 Electricity

⚠ WARNING

Risk of damage to life and limb due to electricity.

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

Thus:

- ▶ Work on electrical equipment must be done by an approved electrical technician.
- ▶ Secure the Prodigy System with a residual current device (RCD) system.
- ▶ Keep the liquid and gaseous cryogenic agents away from the electronic and electric system components (including scale).
- ▶ Keep moisture away from all electrical lines and all system components to prevent short-circuits.
- ▶ Check the magnet system accidental ground before start up.
- ▶ Switch power off before working on the power supply or further equipment.
- ▶ Never measure with a not fully connected CryoProbe Prodigy. Make sure that the CryoProbe Prodigy is fully connected before starting NMR measurements.

1.8.5.4 Protection from Gases

⚠ WARNING

Excess of nitrogen gas leads to depletion of oxygen and causes suffocation

Evaporation of cryogenic liquids reduces the oxygen concentration in ambient air and leads to suffocation.

Nitrogen gas is especially dangerous near the floor level an in pits.

Excess of nitrogen gas can be generated from evaporating spills of liquid nitrogen or from leaks.

Thus:

- ▶ Make sure that the area is well ventilated and avoid working low down.
- ▶ Maintain cryogenic equipment properly.
- ▶ Handle cryogenic liquids carefully. Avoid spilling.

⚠ WARNING

Risk of flammability around the nitrogen gas separator

In oxygen-enriched atmospheres (>23.5% oxygen by volume), the reactivity of oxygen significantly increases the risk of ignition and fire.

Thus:

- ▶ Make sure that the area is well ventilated.
- ▶ Do not store flammable substances beside the nitrogen gas separator outlet.

1.8.5.5 Gas under Pressure

⚠ WARNING

Risk of injury due to gas under pressure inside the LN2 Dewar and Prodigy Unit.

The Nitrogen dewar may get sealed off due to ice formation inside the Nitrogen dewar adaptor in case of non-compliance with the instruction given in this manual. This may lead to overpressure and damage of the Nitrogen dewar.

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

Thus:

- The use, storage and handling of the liquid nitrogen (LN2) dewar and transport dewar must comply with the applicable regulations of the country where the Prodigy System is installed.
- It is the user‘s responsibility to have the LN2 Dewar regularly checked in compliance with local safety requirements.
- Do not fill the LN2 Dewar with LHe, LH2, LO2, LNe or LAr.
- In case of icing inside the Nitrogen dewar adaptor contact Bruker Service immediately.
- Release the pressure before working on components.
- Do not connect high pressure transport dewars for liquid cryogenic agents to the LN2 Dewar.
- Do not use high pressure gas packs.
- Completely eliminate the high pressure from the transport dewars before connecting and transferring.
- Never climb on the LN2 Dewar.

1.8.5.6 Low Temperatures

⚠ WARNING

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

Contact with the skin may cause cold burns.

Contact with the eyes may cause blindness.

Physical contact with extremely cold liquids (e.g. Liquid nitrogen has a temperature of -196°C) and metal parts may cause serious injuries.

Thus:

- ▶ Always wear protective goggles, protective gloves and personal oxygen monitors as well as protective clothes while handling liquid cryogenic agents.
- ▶ Never look directly in the openings of the components.
- ▶ Never touch unprotected Prodigy System equipment with white, cold surfaces.
- ▶ Do not work alone in the laboratory.
- ▶ Protect temperature sensitive components such as O-rings from contact with liquid cryogenic agents.

1.8.5.7 Spontaneous Ignition and Explosion

⚠ WARNING

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

Liquid oxygen can condense on the cold exterior surfaces of cryogenic containers, pipes and transfer lines. An explosive situation may result if this oxygen-rich liquid is allowed to soak any other material.

Together with oil it may form an explosive mixture and ignite spontaneously and can result in explosive combustion.

Thus:

- ▶ Keep lighters or matches or electrical sparks away from the Prodigy System
- ▶ Keep the environment around the magnet system clean (e.g. no oil or fat).
- ▶ Do not leave oily rags near the LN2 Dewar or magnet.

1.8.5.8 Risk of Slippage

⚠ WARNING

Risk of injury from slippage.

Handling of cryogenic agents often causes condensation of water on cold surfaces, often resulting in slippery conditions on ladders, on the floor or other equipment.

Thus:

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

⚠ CAUTION

Risk of tripping

The Prodigy System contains different components which are connected via cables.

Thus:

- Arrange the Prodigy system according to the Site Planning described in "Exemplary Site Layout of a CryoProbe Prodigy System" on page 29
- Mark the area with the Prodigy system.

1.8.5.9 Risk of Heavy Weights

⚠ WARNING

Risk of damage to life and limb caused by heavy moving weights.

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

Thus:

- Protect parts against falling.
- Especially in earthquake regions the system components must be secured (e.g. the LN2 Dewar have to be properly secured against the walls).

1.9 Description of Signs and Labels

Signs and labels are always related to their immediate vicinity. The following signs and

labels are found on the Prodigy System and in the vicinity.

Prohibition sign: No person with pacemakers!

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

Prohibition sign: No person with implants!

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

Prohibition sign: No watches, electronic devices or small metal parts!

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

Prohibition sign: No credit cards or other magnetic memory!

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

Prohibition sign: Do not touch! Do not block!

Do not touch or block the identified area.

Hazard warning sign: Strong magnetic field!

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

Emergency exit!

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

1.10 Behaviour in Danger and Emergency Situations

Preparations

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

In Case of Emergency

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

First Aid for Cold Burns

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

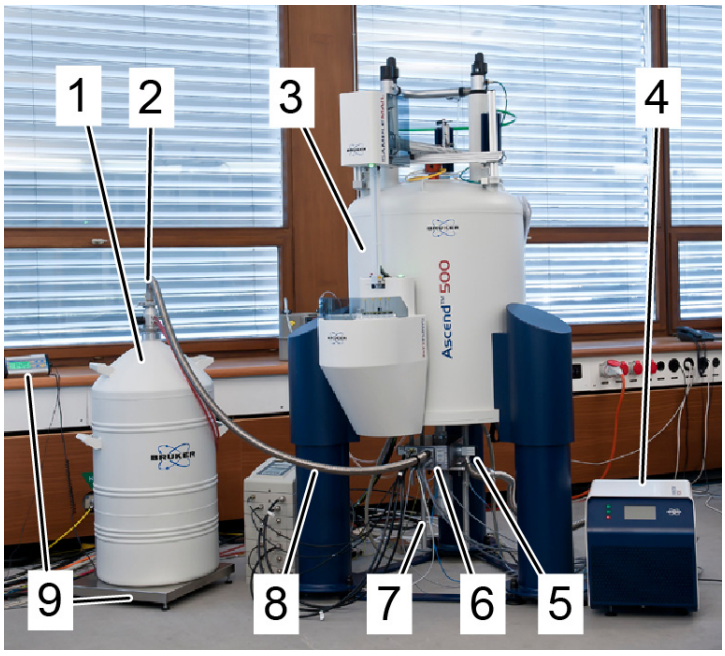
2 Introduction

2.1 Prodigy System Components

BRUKER CryoProbe™ Prodigy System is a CryoProbe system used for NMR spectroscopy where the cryoprobe is cooled with liquid nitrogen (LN2).

The NMR spectrometer consists of a magnet where the sample is placed within the shim system in the magnet bore. The CryoProbe Prodigy is used to perform the NMR measurement on the sample.

The CryoProbe contains the RF-coils which receive the nuclear spin signal of the sample. The electrical signal is amplified and transmitted to the console.



[1] LN2 Dewar
[2] LN2 Dewar Adaptor
[3] ASCEND Magnet
[4] Prodigy Unit
[5] Vacuumline
[6] CryoProbe
[7] Mounting Hardware
[8] Transferline
[9] Optional Scale

Figure 2.1 The Prodigy System.

The Prodigy System is installed at an ASCEND magnet (3). The CryoProbe (6) is placed within the mounting hardware. The CryoProbe Prodigy (6) is connected to the Prodigy Unit (4) via the vacuumline (5). The Prodigy Unit (4) controls the temperature, vacuum and nitrogen transfer. The LN2 Dewar (1) is connected to the CryoProbe via the Transferline (8). The Transferline is attached to the LN2 Dewar adaptor (2), which is mounted at the LN2 Dewar (1) itself. The fill level can be displayed by an optional scale (9).

System Components

The Prodigy System consists of two main components:

- the CryoProbe™ Prodigy (see Figure 2.1 (6))

- the CryoPlatform™ Prodigy with two sub-systems
  - the nitrogen supply system (LN2 Dewar (1), LN2 Dewar Adaptor (2), vacuum-insulated Transferline (8) and optional scale (9))
  - the Prodigy Unit (4)

2.2 Overview

2.2.1 The CryoProbe Prodigy

The CryoProbe™ Prodigy is a NMR probehead with integrated Cryo-preamplifiers. The NMR coil assembly and the Cryo-preamplifier are cooled by evaporation of liquid nitrogen (LN2). The advantage of this cooling method is to achieve extremely efficient operation of the NMR coil assembly and to significantly reduce thermal noise. These combined efforts drastically enhance the overall signal-to-noise ratio compared to room temperature NMR measurements.

LN2 is transferred to the probe from the LN2 Dewar via the LN2 Transferline. The CryoProbe is an open system, meaning that gaseous nitrogen is discharged into the atmosphere through an exhaust on the probe. A special exhaust heater is used to heat up and evaporate any excess LN2 droplets at the exhaust. The cold parts inside the probe are thermally insulated by vacuum, which is evacuated by a roughing and turbo pump located in the Prodigy Unit.

2.2.2 The CryoPlatform Prodigy

The CryoPlatform™ Prodigy consists of a Prodigy Unit, an LN2 Dewar with a mounted dewar adaptor, a vacuum insulated LN2 Transferline from the dewar adaptor to the CryoProbe, vacuum hoses, vacuum operator, exhaust heater and an interface cable for the VT unit and a Mounting Hardware at the magnet.

Mounting Hardware

A special fixture must be mounted to the bottom flange of the magnet to carry the weight of the CryoProbe. The Mounting Hardware is attached to the magnet flange with an interface plate which replaces the lower shim system attachment ring.

2.2.2.1 The Prodigy Unit

The Prodigy Unit generates the insulation vacuum in the CryoProbe Prodigy using a dry membrane pump and a turbo pump. The Prodigy Unit has an integrated touch screen and 4 LEDs for status display.

In case of malfunctions or non-conform use error messages guide the user back to normal operation of the Prodigy System.

The Prodigy Unit further offers an assisted warm-up of the CryoProbe and an assisted refill procedure of the LN2 Dewar.

2.2.2.2 The LN2 Dewar, Dewar Adaptor & Transferline

The LN2 Dewar is a vacuum insulated dewar for the storage of liquid nitrogen. It is a stationary dewar that has to be installed at its defined position before it is filled.

The dewar adaptor is factory mounted on the LN2 Dewar and serves as connection between the LN2 Dewar and the Transferline. The dewar adaptor contains the ports for filling LN2 and for connecting gas tubes to the Prodigy Unit.

The Transferline is a vacuum insulated flexible pipe that facilitates the transfer of liquid nitrogen from the LN2 Dewar to the CryoProbe. It is mounted on the dewar adaptor and can be coupled to the CryoProbe.

i The filling procedure of the LN2 Dewar must only be carried out by personnel trained to handle liquid nitrogen.

2.2.3 Transport Dewar

A non-magnetic transport dewar for liquid nitrogen is required to transport LN2 and to refill the LN2 Dewar

This transport dewar has to be supplied by the customer.

The typical refill pressure is 0.1-0.2 bar (1.5 - 3 psi), max. 0.35 bar (5 psi).

The transport dewar must be of the low pressure type for liquid withdraw only.

⚠ DANGER

Risk of suffocation

Therefore:

- ▶ Do not accompany the dewar in elevators (put the dewar in the elevator and take the stairs, make sure nobody else enters the elevator).
- ▶ Do not transport liquid nitrogen in a passenger elevator.
- ▶ Check local requirements regarding transport and storage of liquid nitrogen.
- ▶ Do not use high pressure gas packs!

2.3 Prodigy System Requirements

Equipment dimensions	
Prodigy Unit	60 x 40 x 46 cm3 (L x W x H); add 15cm for rear connections
LN2 Dewar	50 x 62 x 135 cm3 (L x W x H; W includes dewar handles)

Electrical requirements	
Prodigy unit	100-120 VAC+/-10% / 50-60Hz / max 10A / 0.6 kW max 220-230 VAC+/-10% / 50-60Hz / max 5A / 0.6 kW max
Optional weight scale	100-120 VAC or 220-240 VAC / 50-60 Hz

N2 Gas requirements	
Case 1: In-house N2 gas supply used as main N2 source	Pressurised N2 Gas: • N2 content > 95% by volume • Dew point < -60°C @ 1 bar • Pressure 6 - 10 bar • Oil content: < 0.005 ppm (0.00425 mg/m3) • Solid impurities: Use 1 micron filters. Filters should retain 99.99% of the specified particles Capacity: • Prodigy unit: 40 l/min (1.4 cfm) + VT gas: 11 l/min (0.4 cfm) • Sample protection option: Add 40 l/min (1.4 cfm) to above values
Case 2: Compressed air with dew point < -25 °C available	Use a Bruker-approved N2-gas separator to generate on site the required N2 gas (as specified in Case 1). *Please contact Bruker, if you need help choosing a suitable N2 gas separator.* Requirements for compressed air: • Pressure: 7 - 10 bar • Oil content: < 0.005 ppm (0.00425 mg/m3) • Solid impurities: Use 5 micron filters. Filters should retain 99.99% of the specified particles. • Capacity: > 200 l/min (7 cfm)
Case 3: Compressed air with dew point > -25 °C available	Use an additional Air dryer in order to obtain compressed air with a dew point <-25°C @ 1 bar (as specified in Case 2 above). *Please contact Bruker, if you need help choosing a suitable Air dryer.*
Backup N2 gas supply (optional; in addition to any of the main gas supply variants above)	Independent N2 gas source, e.g. a N2 gas cylinder fitted with a pressure reducing valve. Specifications: See Case 1 above.

Ventilation requirements	
Free room volume (interchangeable gas volume) $V_{free} = V_{room} - V_{furniture}$	≥ 70 m^3
Fresh air supply rate	≥ 200 m^3 h^{-1} During LN2 refill: ≥ 400 m^3 h^{-1}
Further local regulations may apply.	

2.4 Exemplary Site Layout of a CryoProbe Prodigy System

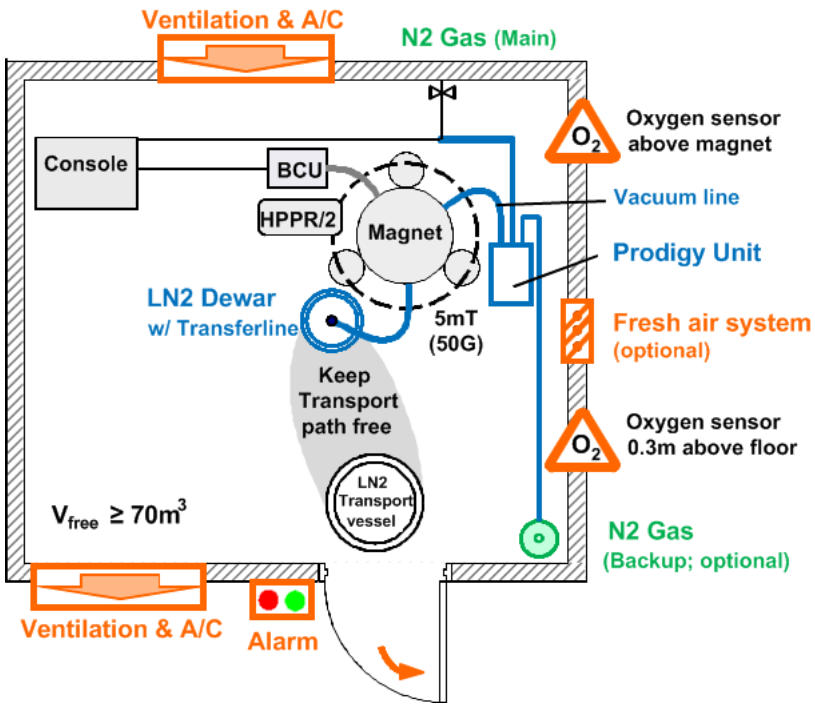


Figure 2.2 Example for a CryoProbe Prodigy Installation

2.5 Maintenance

During normal operation the LN2 Dewar needs to be refilled in regular intervals of 10 to 12 days.

Maintenance of the CryoPlatform Prodigy is required every 24 calender months (available for purchase separately).

3 Setting up the LN2 Dewar and Transferline and Scale

⚠ WARNING

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

Physical contact with extremely cold liquids (e.g. Liquid nitrogen has a temperature of -196°C / -321°F) and metal parts may cause serious injuries.

Contact with the skin may cause cold burns. Contact with the eyes may cause blindness.

Thus:

- ▶ Position the LN2 Dewar before filling.
- ▶ Do not move a filled LN2 Dewar.
- ▶ Always keep the LN2 Dewar in vertical position.
- ▶ Place it at the position as defined in the Site Planning. It is recommended to mark the position.
- ▶ Always wear protective goggles, protective gloves and personal oxygen sensor as well as protective clothes while handling with liquid cryogenic agents when carrying out the refilling procedure.
- ▶ Never hold the open Transferline end in front of you or other person eyes.
- ▶ Do not over bend the Transferline (minimal bending radius= 400 mm)
- ▶ Protect temperature sensitive components such as O-rings from contact with liquid cryogenic agents.
- ▶ Do not fill any other liquid than LN2 in the LN2 Dewar.

3.1 Setting up the Scale (optional)

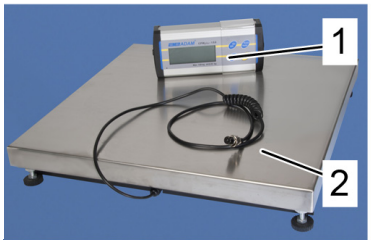


Figure 3.1: Scale unit

Scale equipment consists of:

1. Display unit
2. Scale with display connection cable

⚠ CAUTION

Risk of injury and damage due to electricity.

Moisture in electric components can cause short circuits.

Therefore

- ▶ Do Not spill liquid nitrogen over the scale or the display unit.
- ▶ Keep moisture away from the scale and the display unit.

Figure 3.2: LN2 Dewar positioned on scale.

[1] Position the scale beside the magnet.

NOTICE The scale must be placed outside the 0.5 mT (5 G) field.

[2] Place the LN2 Dewar on the scale.

3.1.1 Installation of the Transferline on the LN2 Dewar

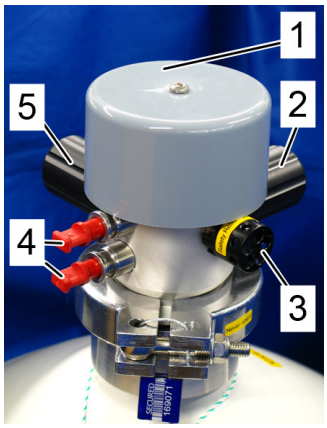
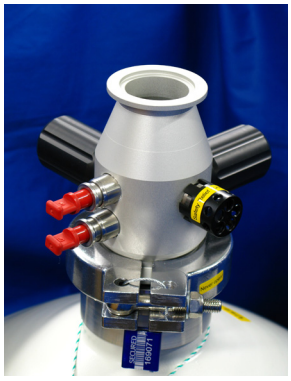


Figure 3.3 LN2 Dewar Adaptor with plastic cover.

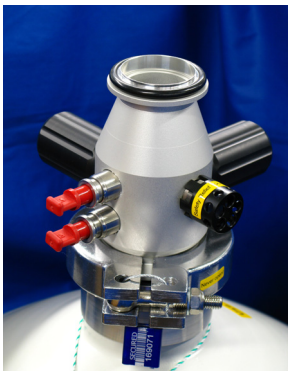
LN2 Dewar Adaptor:

1. Plastic cover
2. NITROGEN GAS OUT port with black cap
3. Overpressure relief valve with plastic cover
4. Connections for gas tubes (to Prodigy Unit) with red blind plugs
5. LIQUID NITROGEN IN port with black cap



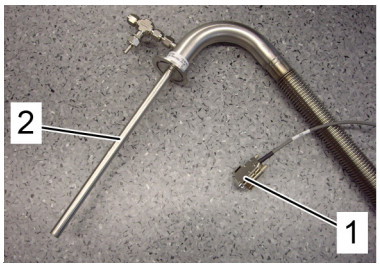
[1] Remove the plastic cover from the LN2 Dewar adaptor.

Figure 3.4 LN2 Dewar Adaptor open.



[2] Place the KF40-centering O-ring on the opening.

Figure 3.5 LN2 Dewar Adaptor with O-ring.

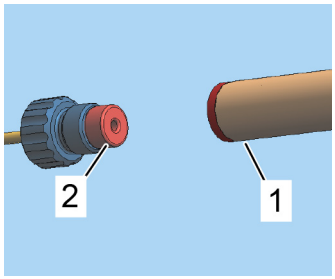


Prodigy Transferline - dewar end connector

1. Transferline ID cable (to Prodigy Unit)
2. Dewar end connector

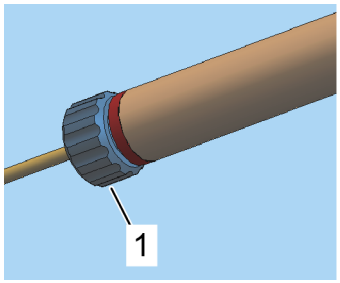
Figure 3.6 Transferline: dewar end connector and Transferline ID cable.

Figure 3.7 Extension piece with filter.



[3] Screw the extension on the dewar end connector of the Transferline.

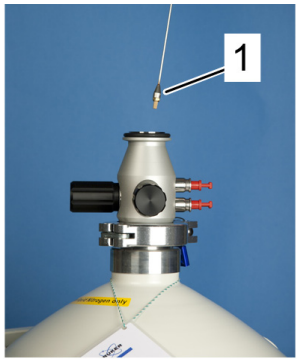
Figure 3.8 Connecting the extension to the Transferline.



NOTICE

Fragile, don‘t hold the Transferline on it‘s extension piece.

Figure 3.9 Connecting the extension to the Transferline.



⚠ CAUTION

Cold burns due to extremely cold liquid.

When inserting the extension piece into liquid nitrogen extremely cold liquid and gas is discharged from the dewar.

Therefore:

Wear goggles and gloves for the following step!

[4] Insert the extension piece (1) carefully into the LN2 Dewar.

Figure 3.10 Inserting the extension piece (1) into the LN2 Dewar.

⚠ WARNING

Extremely cold gases and liquids under pressure.

Hazardous pressure builts up in closed vessels.

Therefore:

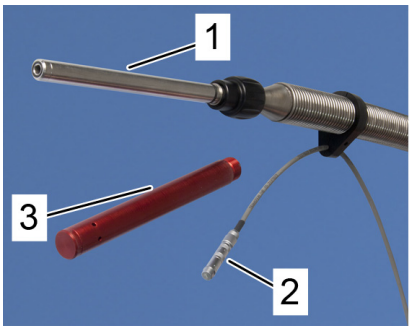
Open port caps after mounting the Transferline and never seal off the LN2 Dewar airtight.

[5] Fasten the Transferline to the LN2 Dewar Adaptor using the provided KF40 clamp.

NOTICE

Attach the laminated sheet *Quick Guide: "Refilling the LN2 Dewar"* around the dewar neck.

Figure 3.11: Fastening the Transferline with the KF40 clamp.



CryoProbe-side end (1) of the Transferline with Transferline ID cable (2) and red Transferline-cap (3).

The red Transferline-cap has to be taken off, when the Transferline is coupled to the CryoProbe. Always keep the red Transferline-cap attached, when the Transferline is disconnected.

NOTICE

Position the Transferline so that it does not impose a tripping hazard.

Figure 3.12: Transferline coupler with Transferline ID cable (2) and cap (1)

3.2 Mounting the Scale Display (optional)

[1] Attach the holding clip and the display unit to one handle of the LN2 Dewar.
Alternatively the holding clip can also be attached to the wall.

[2] Two cable ties can be used to attach the display unit to one handle of the LN2 Dewar.

NOTICE

Do not drill holes into the handles or other areas of the LN2 Dewar.

Figure 3.13: Holding clip of the display unit attached to one handle on the LN2 Dewar.

[3] Connect the display connection cable and the power supply of the scale to the display unit.

Figure 3.14: Holding clip of the display unit attached to one handle on the LN2 Dewar.

[4] Slide the display cover to the left and switch on the scale by pressing <ON/OFF>

[5] Press <Tare/Zero> to reset the indicated weight to zero.

[6] Slide the display cover back to the right in order to protect the buttons from unintentional manipulations.

NOTICE

100 l liquid nitrogen weigh 80 kg.

Figure 3.15: Activate tare function.

4 Fill Procedure of LN2 Dewar

4.1 Safety Instructions

⚠ WARNING

Risk of suffocation due to low oxygen concentration.
Risk of injury due to extremely cold surfaces.
Risk of injury due to extremely cold liquid and gas.
Contact with the skin can cause cold burns.
Contact with the eyes can cause blindness.

Therefore

- The lab must have a free volume of ≥ 70 m^3 and a steady fresh air supply rate of ≥ 200 m^3 per hour.
- The fresh air supply rate during the entire refill procedure must be increased to ≥ 400 m^3 per hour.
- Windows and doors must be opened during the entire refill procedure.
- The lab must be equipped with fixed installed oxygen monitors (floor level and ceiling level).
- Wear personal protective equipment:
  - Safety goggles
  - Cryo-gloves
  - Cryo-apron
  - Personal oxygen monitor
- Never look directly into the openings of components. Liquid nitrogen droplets may spill out.
- The refill procedure must only be carried out by personnel, specifically trained to handle cryogenic liquids.
- Do not use high pressure dewars.
- Persons must not accompany a LN2 Dewar inside an elevator. Respect local regulations.
- Do not obstruct safety relief valves.

NOTICE

- The transport dewar must be placed outside the 0.5 mT (5 G) line.
- Do not spill liquid nitrogen or cold gas over the vacuum safety valves of the LN2 Dewar and transport dewar. Damage of pressure safety equipment may result.
- Do not remove hoses during LN2 transfer.
- Make sure the transfer hose is not creased or kinked. Unregular flow of LN2 may result.
- Make sure the overflow hose of the LN2 Dewar points downwards, to lead excess N2-gas to the floor.
- Do not spill liquid nitrogen or cold gas over sensitive equipment. Damage may result.
- The transfer hose may shake vigorously during the transfer of LN2. This is a normal behaviour.
- When the LN2 Dewar has been empty for longer than 2 weeks, the evaporation rate during the initial filling of the dewar will be higher than during normal use and refill.

i For your safety please follow the procedure given in this manual and respect all safety warnings.

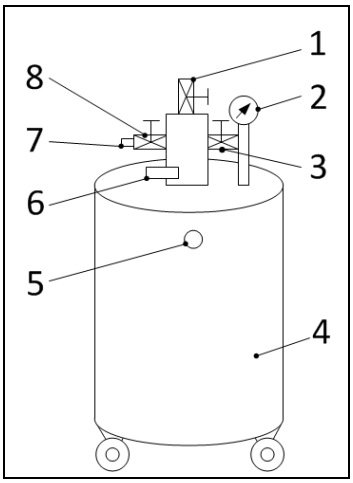
4.2 Necessary Equipment for the Refill

- A non-magnetic LN2 transport dewar (exemplary illustration in Figure 6.1) with LN2 is required for the fill procedures.
- TEFLON® hose (PTFE or PFA) of length of app. 1.5 m can be used as transfer hose between transport dewar and LN2 Dewar (available from Bruker).
- Silicone hose (length app. 0.5 m), to be used as overflow hose.
- Two short pieces (length app. 0.1 m) of silicone hose, to connect the transfer hose to the LN2 Dewar and the transport dewar. (available from Bruker).

Silicone hoses and PTFE hose can be individually cut to the desired length.

The transfer hose for the transfer of LN2 from the transport dewar to the LN2 Dewar is connected to the liquid nitrogen extraction port Figure 4.1 (8) using a short piece of silicone hose.

i There are various forms of transport dewars for LN2. In the following the characteristics are described which are valid for most transport dewars. Please refer to the manual instructions of each individual transport dewar for further details.



Typical LN_2 transport dewar for filling the LN2 Dewar:

1. gas release valve
2. pressure gauge
3. pressure generation armature
4. transport dewar body
5. vacuum safety valve
6. safety pressure release valve
7. liquid nitrogen extraction port
8. liquid nitrogen extraction valve

Figure 4.1: Transport dewar for liquid nitrogen (LN2)

4.3 Refill of the LN2 Dewar

This section describes the regular refill procedure of the LN2 Dewar. This refill procedure is usually carried out once a week.

For initially filling of the warm LN2 Dewar to 50 % refer to: "The 50 % Fill for Cooling Down the LN2 Dewar" on page 45

For filling up the LN2 Dewar after 12 hours cool down period refer to: "Filling Up the LN2 Dewar" on page 47.

⚠ WARNING

Risk of Suffocation - Open windows and doors and switch the room ventilation to 100% fresh air supply with a flow rate of ≥ 400 m^3 per hour.

⚠ WARNING

Risk of blindness, cold burns and injuries due to extremely cold liquids, gases and surfaces - Wear protective goggles, cryo-gloves and cryo-apron.

NOTICE

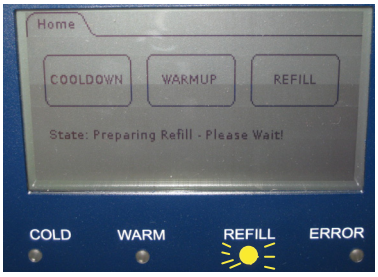
Supervise the entire filling procedure so that you can immediately intervene should the pressure in the transport dewar exceed 350 mbar or when the LN2 Dewar filling procedure is completed.

i

The entire refill procedure takes approximately 30 minutes.
The refill procedure can be carried out starting from both cold state or warm state of the CryoProbe.
During the refill process it is NOT possible to take NMR measurements.

Procedure:

[1] For your own safety: Open windows and doors and switch the room ventilation to 100% fresh air supply with a flow rate of ≥ 400 m^3 per hour. Put on protective goggles, gloves, apron and personal oxygen monitor.



[2] To start the refill procedure press <REFILL> on the Prodigy Unit display.

[3] Wait for several minutes while the pressure inside the LN2 Dewar is released. The yellow "Refill"-LED flashes and the message *"Preparing Refill - Please wait"* is shown on the display (Figure 4.2).

Figure 4.2 Prodigy Unit display: Prepare Refill (yellow LED flashing).

[4] When the pressure inside the LN2 Dewar is completely released the message *"Ready for Refill"* is shown on the display.
It is now safe to open the black caps on the dewar adaptor.

Figure 4.3 Prodigy Unit display: Ready for Refill

[5] Turn to the LN2 Dewar.

Figure 4.4: LN2 Dewar with adaptor.

[6] Remove the black port caps from LIQUID NITROGEN IN port (blue) (1) and NITROGEN GAS OUT port (red) (2) of the LN2 Dewar Adaptor by turning it counter-clockwise.

Figure 4.5 LN2 Dewar: LIQUID NITROGEN IN port (blue) (1) and NITROGEN GAS OUT port (red) (2)

Due to the continuous evaporation of LN2 in the dewar a minor amount of gas will exit from the ports.

[7] Connect the white silicone overflow hose with a length of approx. 0.5 m to the NITROGEN GAS OUT port (1).

[8] Make sure the loose end of the overflow hose points downwards to the floor, as indicated by the black arrow in Figure 4.6

Figure 4.6 LN2 Dewar: Connected white silicone overflow hose.

[9] On the transport dewar: Connect the PTFE transfer hose to the liquid nitrogen extraction port of the transport dewar using a short silicone hose of approx. 0.1 m.

Figure 4.7: Liquid nitrogen extraction port of the Transport dewar (exemplary illustration) with attached silicone hose and PTFE transfer hose

[10] Do not yet connect the loose end of the transfer hose to the LN2 Dewar.

[11] To remove moisture from the transfer hose and to prevent moisture from entering the LN2 Dewar the transfer hose has to be purged with dry nitrogen gas.

[12] To purge, follow the steps described below:

⚠ WARNING

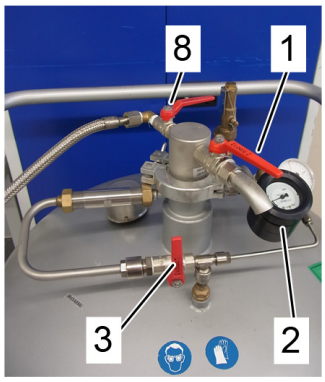
Cold nitrogen gas and droplets of liquid nitrogen exit from the hose during this purge procedure.
Therefore: Wear protective googles and gloves!
Furthermore do not spill liquid nitrogen over your feet.

NOTICE

Cold gas or droplets of LN2 can damage the sealing of the valve and lead to rupture of the insulation vacuum.

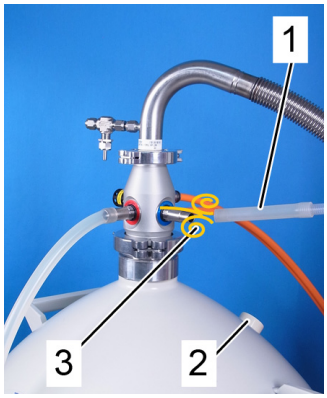
Therefore: Do not spill LN2 over the vacuum safety valve (Figure 4.9 (2))

- Hold the loose end of the transfer hose carefully away from yourself, away from other persons and away from sensitive equipment. Do not point towards the vacuum safety valve of the LN2 Dewar (Figure 4.9 (2)).



- Close the gas release valve (1) on the transport dewar and open the nitrogen extraction valve (8). Then slightly open the pressure generation armature (2) to create a gas flow through the transfer hose. (max. pressure ~50 mbar). Then close the pressure generation armature (2) again.
- The gas flow will displace the humid air inside the transfer hose. A hissing sound together with visible fog exiting from the hose is usually experienced during the purge process.

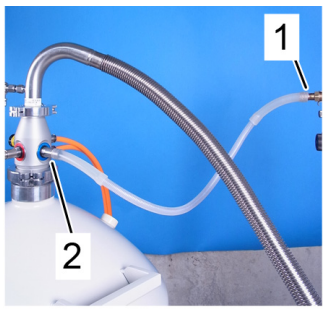
Figure 4.8 An example of a transport dewar with gas release valve (1), pressure generation armature (3) LN2 extraction valve (8) and pressure gauge (2). The numbers correspond to the numbers of the schematic in Figure 4.1



[13] After a few seconds close the liquid nitrogen extraction valve (8) of the transport dewar.

[14] Then carefully open the gas release valve (1) of the transport dewar to release pressure. A stream of cold gas is released from the transport dewar.

Figure 4.9 LN2 Dewar: Purge process

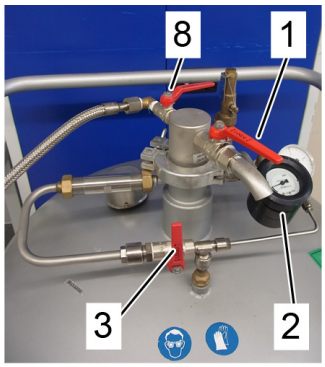


[15] Use the second short silicone hose of approx. 0.1 m to connect the PTFE transfer hose coming from the LN2 transport dewar (1) to the LIQUID NITROGEN IN (blue) port (2) of the LN2 Dewar.

i The silicone hose might cool during the purge process and become too stiff to connect it to the LIQUID NITROGEN IN port.
In this case wait until it has warmed up before connecting it. (Warming up takes less < 1 min).

Figure 4.10 LN2 Dewar: Connect the transfer hose to the LIQUID NITROGEN IN port of the LN2 Dewar.

[16] To start the fill process carry out the following steps on the LN2 transport dewar:



- Close the gas release valve (1)
- Open the LN2 extraction valve (8)
- Slowly open the pressure generation armature (2) until a pressure of 200 - 250 mbar is generated and the liquid nitrogen flow starts.

⚠ CAUTION

Do not exceed a filling pressure of 350mbar.

Figure 4.11 An example of a transport dewar with gas release valve (1), pressure generation armature (3) LN2 extraction valve (8) and pressure gauge (2). The numbers correspond to the numbers of the schematic in Figure 4.1

- Then close the pressure generation armature (3) again. The pressure can be regulated by partially opening and closing the gas release valve (4) for pressure decrease or by opening and closing the pressure generation armature (3) for pressure increase.

[17] If the flow of liquid nitrogen has stopped (before completion) re-open the pressure generation armature (3).

[18] Liquid nitrogen will now flow through the transfer hose into the LN2 Dewar. Excess gas exits from the dewar through the NITROGEN GAS OUT port.

[19] Stop the nitrogen flow immediately, when LN2 overflows and spills out through the overflow hose (Figure 4.12) or the scale indicates a weight difference of ~80 kg for a 100 L LN2 Dewar.

⚠ WARNING

Risk of blindness, cold burns and injuries due to extremely cold liquids and gases - Wear protective goggles, cryo-gloves and cryo-apron.

Figure 4.12 Overflow hose spilling liquid and gaseous nitrogen when the LN2 Dewar is completely full

[20] To stop the nitrogen flow:

- Close the LN2 extraction valve (8) on the transport dewar.
- Close the pressure generation armature (3) on the transport dewar.
- Carefully open the gas release valve on (1) the LN2 transport dewar. A stream of cold gas is released from the transport dewar.

[21] After the nitrogen flow has been stopped: Wait for approximately 10 min until the PTFE transfer hose and the silicone hose have warmed up.

⚠ CAUTION

Cold surfaces!
Therefore: Wear gloves!

[22] Remove the PTFE transfer hose, silicone hose and the overflow hose from the ports and remove the transport dewar.

NOTICE

Attach the black port caps.

Do not use any tools! Hand tight is sufficient!

[23] First attach the cap on the LIQUID NITROGEN IN port (blue)

Figure 4.13 LN2 Dewar: LIQUID NITROGEN IN port closed with port cap.

[24] Then attach the cap on the NITROGEN GAS OUT port (red)

Figure 4.14: LN2 Dewar Adaptor with both port caps attached.

[25] The Prodigy System can be kept in two states, either warm or cold.

- To keep the system in the warm state, please press the <WARMUP> button
- To start a cool down process, press the <COOLDOWN> button on the display of the Prodigy Unit and wait until the cool down process is completed (for details see "Cooling Down the CryoProbe Prodigy" on page 76).

[26] After the cool down process has completed, indicated by a continuously lit "COLD"-LED and the message "State: Cold", NMR measurements can be started.

Recording the filling dates and amounts allows to determine the average LN2 consumption of the Prodigy System.
Significant changes in the LN2 consumption are an indication that the Prodigy System might not work properly. In this case please contact Bruker Service.
Please find an example of a recording protocol on the next page. An extended copy of this page can be found in "Protocol for LN2 Refills of Prodigy System" on page 95. Please copy and attach it at the LN2 Dewar. Record each filling cycle.

PROTOCOL: LN2 REFILLS OF PRODIGY SYSTEM			
Date	**Amount of LN2 (kg) Before Refill**	**Amount of LN2 (kg) After Refill**	**Comments**

4.4 Filling a Warm LN2 Dewar

Filling the warm LN2 Dewar applies, when the LN2 Dewar is filled for the first time, or after a longer period of non-use (> 2 weeks) of an empty LN2 Dewar.

When filling a warm LN2 Dewar it has to be filled to approximately 50 % of the total volume and allowed to cool down at least 12 hours before topping up to 100 %.

Thermal stability will be reached only after 48 hours. For minimum LN2 losses, it is more advisable to top up the LN2 level three days after the 50 % filling.

If the LN2 Dewar is insufficiently pre-cooled, a high LN2 evaporation rate and higher pressure generation will result, until the thermal stability is reached.

4.4.1 The 50 % Fill for Cooling Down the LN2 Dewar

This section describes the procedure to fill up the LN2 Dewar to 50 %.

⚠ WARNING

Risk of Suffocation - Open windows and doors and switch the room ventilation to 100 % fresh air supply with a flow rate of ≥ 400 m^3 per hour.

⚠ WARNING

Risk of blindness, cold burns and injuries due to extremely cold liquids, gases and surfaces - Wear protective goggles, cryo-gloves and cryo-apron.

i Do not remove the red plugs from the pneumatic ports, yet.

Procedure:

[1] For your safety: Open windows and doors and switch the room ventilation to 100 % fresh air supply with a flow rate of ≥ 400 m^3 per hour. Put on goggles, gloves, apron and personal oxygen monitor.

[2] Remove the black port caps from NITROGEN GAS OUT port (red) and LIQUID NITROGEN IN port (blue).

Figure 4.15: LN2 Dewar with red plugs

[3] Follow the steps [8] to [18] of Chapter 4.3, (starting on page 41).

Figure 4.16: LN2 Dewar without red plugs

[4] Stop the nitrogen flow after 10 - 12 minutes, or when the optional scale indicates a LN2 weight of 40 - 45 kg.

[5] To stop the nitrogen flow close the LN2 extraction valve (8) on the transport dewar.

[6] Close the pressure generation armature (3) on the transport dewar.

[7] Carefully open the gas release valve (1) on the LN2 transport dewar. A stream of cold gas is released from the transport dewar.

Figure 4.17: LN2 Dewar with connected overflow hose and transfer hose.

[8] Wait for approximately 10 min until the PTFE transfer hose and the silicone hose have warmed up.

⚠ CAUTION

Cold surfaces!
Therefore: Wear gloves!

[9] Remove the PTFE transfer hose, silicone hose and the overflow hose from the ports and remove the transport dewar.

[10] Let the LN2 Dewar cool down for at least 12 hours with open ports.

[11] Do not re-attach the black port caps after the 50% fill procedure.

Cold gas will exit from the open ports and cause formation of ice and water droplets. After the LN2 Dewar is cooled down the ice and water droplet formation will stop. Excess water can be dried with tissues, until the thermal stability is reached.

4.4.2 Filling Up the LN2 Dewar

This section describes the procedure to fill up the LN2 Dewar to 100 %.

The LN2 Dewar can be filled to 100 % after a cool-down period of at least 12 hours. Thermal stability will be reached only after 48 hours. For minimum LN2 losses, it is more advisable to top up the LN2 level three days after the 50 % filling.

If the LN2 Dewar is insufficiently pre-cooled, a high LN2 evaporation rate and higher pressure generation will result until thermal stability is reached.

⚠ WARNING **Risk of Suffocation** - Open windows and doors and switch the room ventilation to 100 % fresh air supply with a flow rate of ≥ 400 m^3 per hour.

⚠ WARNING **Risk of blindness, cold burns and injuries** due to extremely cold liquids, gases and surfaces - Wear protective goggles, cryo-gloves and cryo-apron.

The red plugs are still plugged in the pneumatic ports.

Procedure:

[1] For your safety: Open windows and doors and switch the room ventilation to 100% fresh air supply with a flow rate of ≥ 400 m^3 per hour. Put on goggles, gloves, apron and personal oxygen monitor.

[2] Follow the steps [8] to [22] of Chapter 4.3 (starting on page 41).

[3] After removing the transfer hose and the overflow hose, remove the red plugs from the pneumatic connectors

Figure 4.18: Red plugs are removed from the pneumatic connector

[4] Plug in the orange 10mm twin gas tube. Connect the other end to the Prodigy Unit according to "LN2 Dewar" on page 53.

Figure 4.19: Orange 10 mm twin gas tube is connected.

NOTICE

Attach the black port caps.

Do not use any tools! Hand tight is sufficient!

[5] First attach the cap on the LIQUID NITROGEN IN port (blue).

Figure 4.20 LN2 Dewar: LIQUID NITROGEN IN port closed with port cap.

[6] Then attach the cap on the NITROGEN GAS OUT port (red)

Figure 4.21: LN2 Dewar adaptor with both port caps attached.

5 Setting Up the Prodigy Unit

5.1 Overview

The Prodigy Unit has an integrated touchscreen and 4 status LEDs for state display and messages. On the back of the Prodigy Unit there are the pneumatic connectors, the electric connectors, power supply and the vacuum port. A schematic of all cables and tube connections can be found in "Overview of Cable and Gas Tube Connections" on page 51.

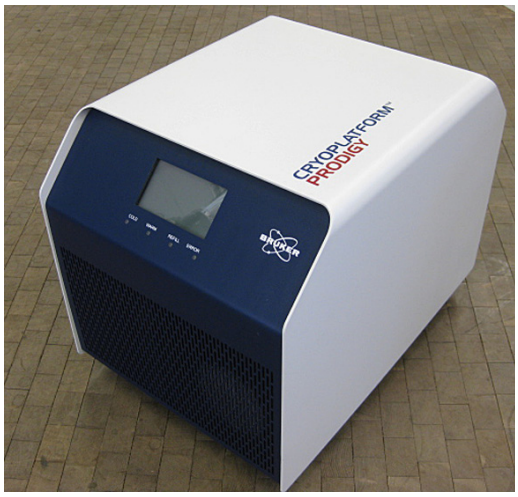


Figure 5.1 Front view of the Prodigy Unit.

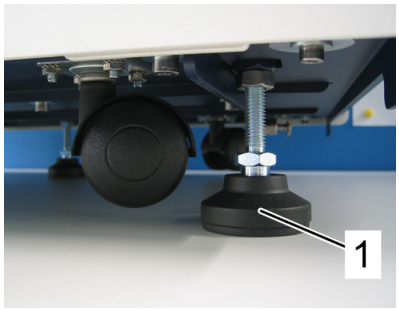
Figure 5.2: Prodigy Unit touch screen interface and LED display.

1. Vacuum connection
2. Exhaust heater connector
3. Bottom heater connector
4. Sample VT connector
5. Transferline ID connector
6. CryoProbe (CPP) Sensor connector
7. Auxilliary connector (do not connect. For future application)
8. LAN connector
9. Mains cable connector and power switch
10. Backup N2 6 - 10bar
11. Emergency VT
12. Warmup
13. LN2 Dewar
14. LN2 Dewar
15. Vacuum Operator
16. Emergency Lift
17. Main N2 6-10bar

Figure 5.3 Back view of the Prodigy Unit.

5.2 Positioning and Securing the Prodigy Unit

Place the Prodigy Unit accordingly to the Site Planning for e.g. "Example for a CryoProbe Prodigy Installation" on page 29



[1] Lower the three fixation stands (1) under the Prodigy Unit to prevent it from rolling off.

Figure 5.4 Prodigy Unit with its fixation stands lowered.

5.3 Overview of Cable and Gas Tube Connections

The schematic of Figure 5.5 shows the cable connections between the three main system components of the Prodigy System and the console marked in black.

The gas tube connections between the LN2 Dewar and the Prodigy Unit are highlighted in orange. The Main N2, the Backup N2 and the Emergency Lift gas tube connection are marked in red, while Vaccum Operator gas tube connection is shown in blue. Furthermore the VT-Gas adaptor gas tube connection is marked in black. Details about the relevant connectors and their position at the Prodigy Unit are given in the following sections.

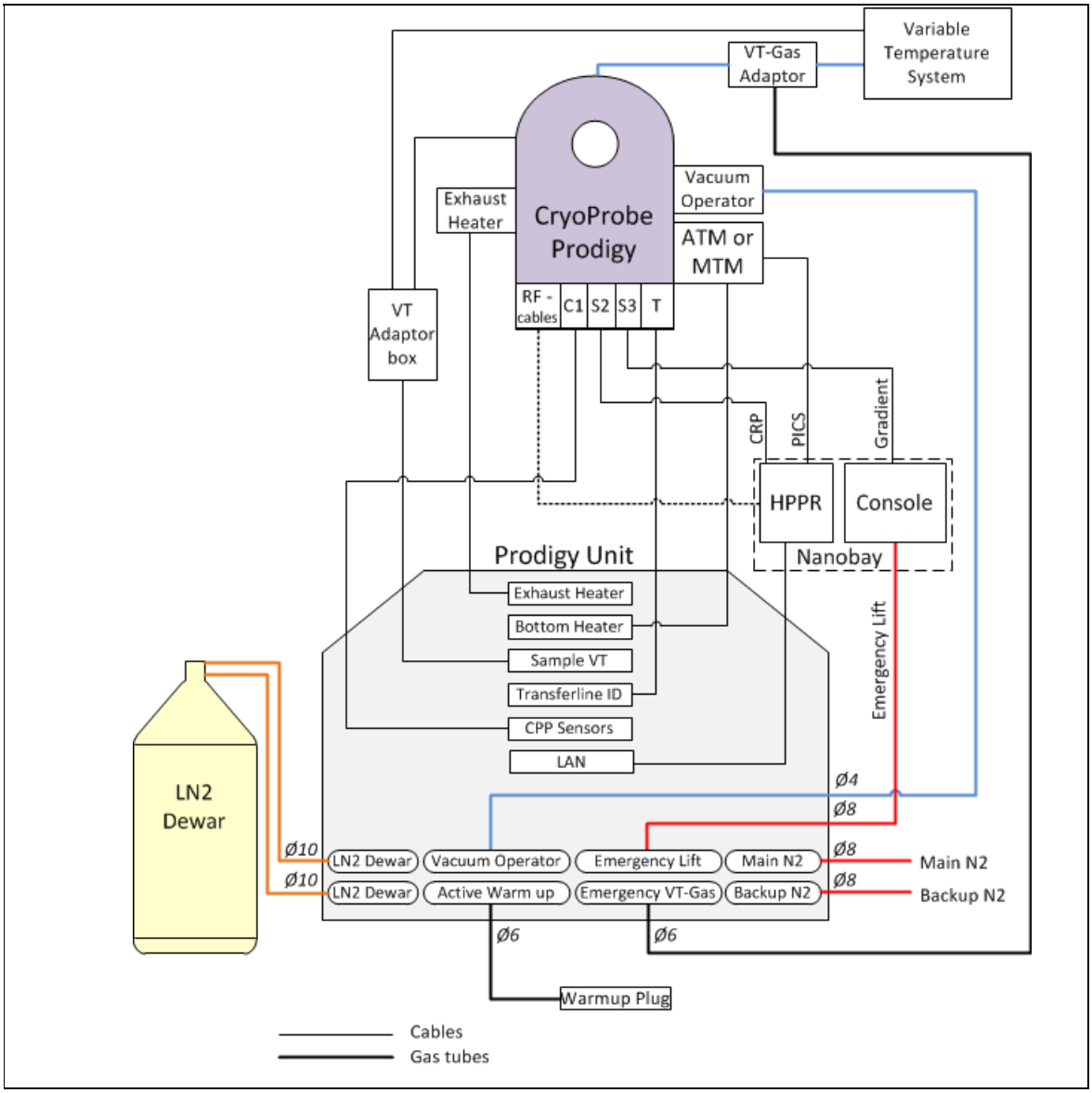


Figure 5.5 Cable and gas tube connections of the Prodigy System.

5.4 Gas Tube Connections

5.4.1 Main N2

Figure 5.6 Main N2 connection

[1] Connect the 8 mm red Main N2 supply tube.

[2] Connect the other end of the tube to the Main N2 supply in the laboratory.

5.4.2 Backup N2

Figure 5.7 Backup N2 connection

[1] Connect the 8 mm red Backup N2 tube (optional) (full functionality only with sample safety option).

[2] Connect the other end of the tube to the Backup N2 supply in the laboratory.

5.4.3 Vacuum Operator

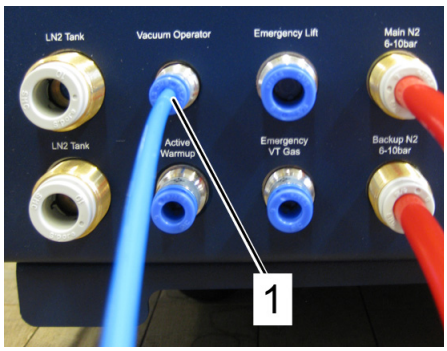


Figure 5.8 Vacuum Operator connection

[1] Connect the 4 mm blue gas tube for the Vacuum Operator.

[2] Connect the other end of the gas tube to the Vacuum Operator.

5.4.4 Active Warmup Plug

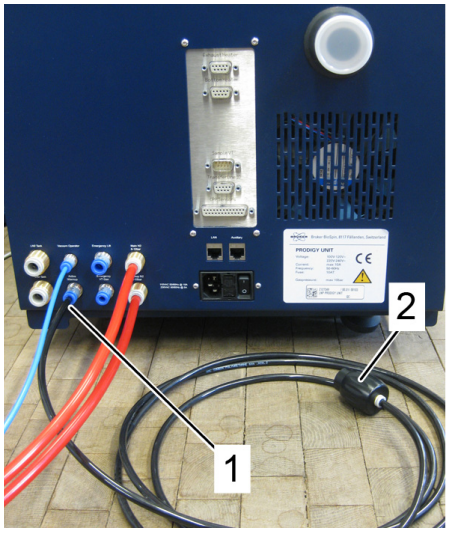


Figure 5.9 Active warmup plug connection.

[1] Connect the 6 mm gas tube (1) for the active warmup plug.

[2] Connect the other end to the warmup plug (2).

i the active warmup plug has to be connected to the Prodigy Probe before an active warmup process is started. For further details see "Warming Up the CryoProbe Prodigy" on page 77.

5.4.5 LN2 Dewar

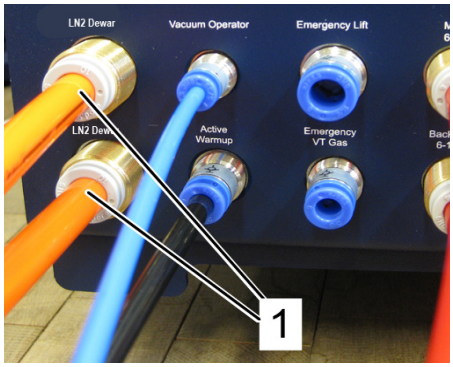


Figure 5.10 LN2 Dewar connection

[1] Connect the 10 mm orange twin gas tube (1).

[2] Connect the other ends of the orange twin gas tubes to the LN2 Dewar as described in "Refill of the LN2 Dewar" on page 39.

5.4.6 Optional Sample Safety

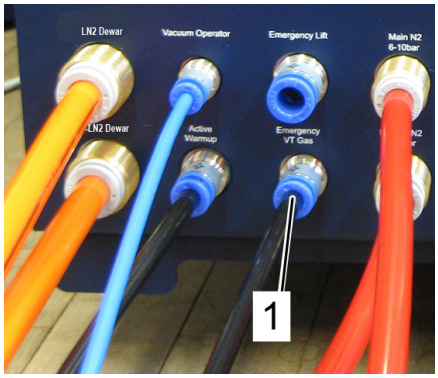


Figure 5.11 Emergency VT gas connection

[1] Connect the optional 6 mm black sample safety tube (1).

[2] The other end to the VT-gas adaptor is connected to the CryoProbe, see "Connect Variable Temperature (VT) Gas Adapter and Sample Heater Cable" on page 67.

i Optional sample safety feature has to be adjusted by a Bruker service engineer.

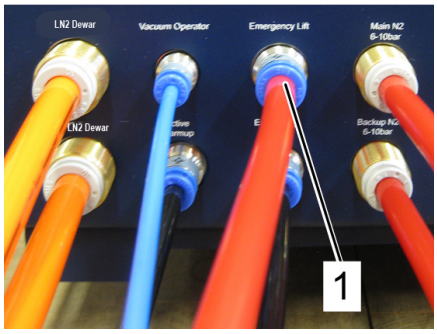


Figure 5.12 Emergency lift connection

[1] Connect the 8 mm red gas tube (1) for the emergency lift

[2] Connect the other end of the red gas tube to the Emergency Lift connector of the console.

i Emergency lift has to be adjusted by a Bruker service engineer.
If the console is equipped with a BSVT, make sure that the throttle valve for the emergency lift adjustment is inserted along this hose.

5.5 Cable Connections

⚠ WARNING

Risk of damage to life and limb due to electricity.

Thus:

- ▶ Never touch the pins of unconnected plugs.
- ▶ Never touch any connector pins at the back of the Prodigy Unit.

5.5.1 Exhaust Heater

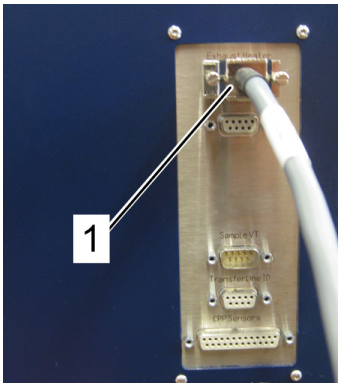


Figure 5.13 Exhaust Heater connector

[1] Connect the 9 pin Exhaust Heater plug (1).

[2] The Exhaust Heater itself will be later mounted at the CryoProbe as described in "Installation of Exhaust Heater" on page 64.

5.5.2 Bottom Heater

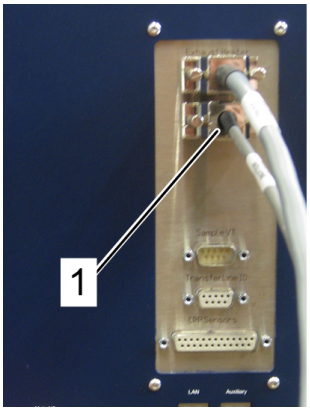


Figure 5.14 Bottom heater connector.

[1] Connect the 9 pin bottom heater plug (1).

[1] Connect the other end of the bottom heater cable to the bottom of the ATM unit, as described in "Installing the ATM unit" on page 68.

5.5.3 Sample VT to VT - Adaptor Box

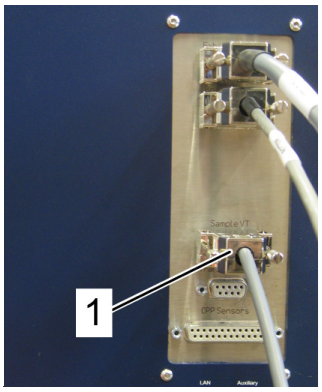


Figure 5.15 Sample VT connector

[1] Connect the 9 pin sample VT connector plug (1).

[2] Connect the other end of the sample VT cable to the VT gas adaptor, as described in "Connect Variable Temperature (VT) Gas Adapter and Sample Heater Cable" on page 67

5.5.4 Transferline ID

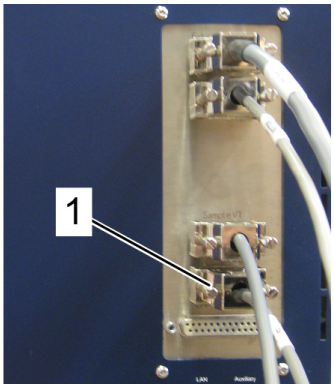


Figure 5.16 Transferline ID connector

[1] Connect the 9 pin Transferline ID connector plug (1).

[2] The other end of the Transferline ID cable will be later connected when the Transferline will be installed ("Connecting the Transferline" on page 73).

5.5.5 CryoProbe Sensor

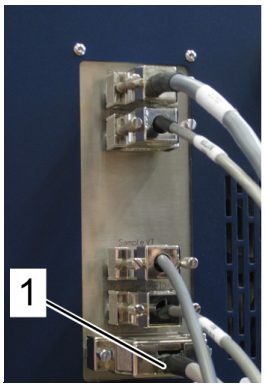


Figure 5.17 CryoProbe sensor connector

[1] Connect the 21 pin CryoProbe sensor connector plug (1).

[2] The other end of the C1 sensor cable will be later connected to the CryoProbe ("Connect the CryoProbe Prodigy Sensor Cables" on page 72).

5.5.6 LAN

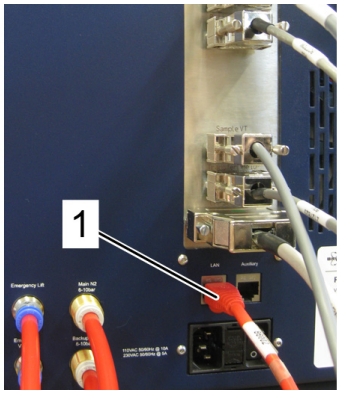


Figure 5.18 LAN connector

[1] Connect the LAN cable (1) to the LAN connector (also shown in Position [8] in "Back view of the Prodigy Unit." on page 50).

[2] Connect the other end of the LAN cable to the LAN port on the back of the HPPR.

5.5.7 Power Supply

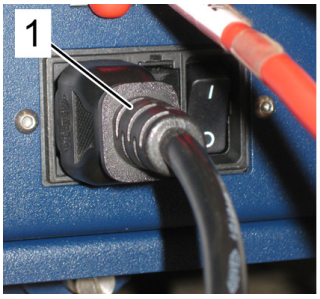


Figure 5.19 Power supply connector

[1] Connect the power supply cable (1) to the main cable connector.

[2] Connect the other end to a main power supply socket in the laboratory.

5.6 Vacuum Connection

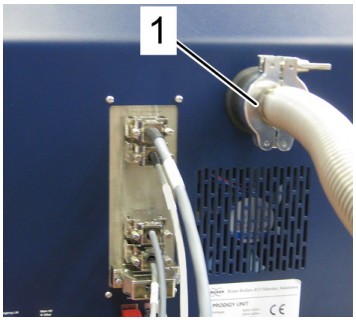


Figure 5.20 Vacuum connector

[1] Connect the vacuum line (1) with a KF25 centering O-ring and KF25 clamp.

[2] The vacuum line will be later connected to the vacuum operator ("Installation of Vacuum Operator" on page 65).

6 CryoProbe Prodigy Installation

6.1 Installation Notice

NOTICE

Before the CryoProbe Prodigy can be installed, the following pre-conditions have to be met:

[1] The CryoProbe mounting hardware is installed.

[2] Any necessary magnet modifications are completed.

[3] The Prodigy Unit has been set up (see “Operating the System: Cooldown, Warmup & Refill” on page 75.).

i To uninstall follow the steps described in this chapter in reverse order. BUT never dismount the CryoProbe in the cold state.

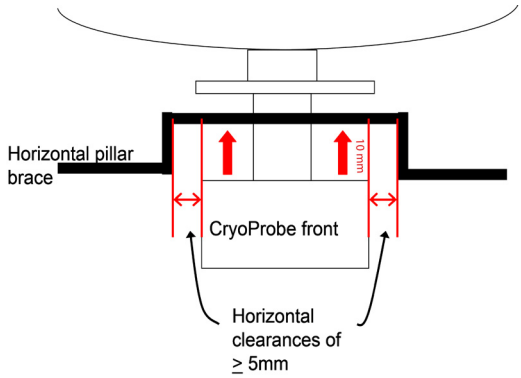
6.2 Mounting the CryoProbe Prodigy

⚠ CAUTION

Risk of damage to the CryoProbe Prodigy:

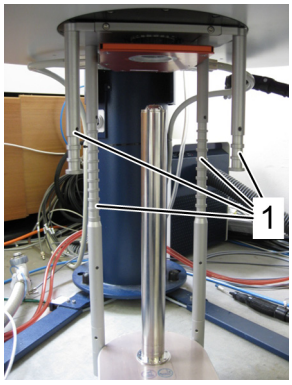
Thus:

- ▶ Wear your protective googles when working on the CryoProbe.
- ▶ Do not hold the CryoProbe by its tube! Always hold it by its body.
- ▶ Never touch the pins of the connectors and plugs.
- ▶ Two persons are recommended to mount the CryoProbe, which weighs ~10 kg.
- ▶ If an upper cranked pillar brace is present on the magnet stand, the CryoProbe has to be centred with respect to the pillar brace at all times (see figure below). If the CryoProbe is not correctly aligned, its body could touch the upper horizontal pillar brace when the magnet is lifted by about 10 mm onto its anti-vibration stand. The forces involved can **easily break the CryoProbe!**
  Before lifting the magnet, make sure there is a symmetric horizontal clearance of ≥ 5 mm between the CryoProbe and any fixed obstructions above its body.



[1] Hold the CryoProbe by its body and carefully take it out of its storage case. Remove all protective covers from the CryoProbe:

- Tube cover
- Vacuum port cover
- Exhaust port cover
- Transferline port cover
- Tuning/matching unit cover
- RF-port covers



[2] Make sure the four guiding rails (1) are attached to the CryoProbe mounting hardware (the two longer ones in the rear).

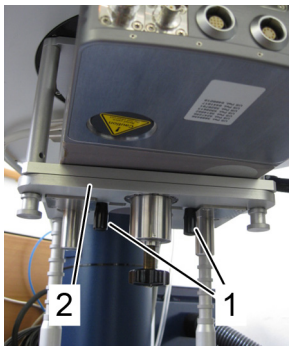
[3] Make sure the support plate [(2) in Figure 6.3] is removed from the mounting hardware. Keep it within reach.

[4] Place the CryoProbe under the magnet such that its back touches the two rear guiding rails.

Figure 6.1: CryoProbe with its back touching the rear guiding rails at customer's site (The installed mounting hardware might differ from the one shown in the Figures.)

[5] Align the tube of the CryoProbe with the shim system. With the help of a second person, carefully insert the CryoProbe all the way into the shim system, allowing the probe body to be guided by the rear guiding rails. The CryoProbe should enter the magnet bore straight and without any resistance.

Figure 6.2: Inserting the CryoProbe into the shim system.



[6] Hold the CryoProbe, take the support plate (2) and press the two black levers (1) together.

[7] Slide the support plate (2) into position underneath the CryoProbe.

[8] Snap the support plate into place. Verify the seating of all four support points.

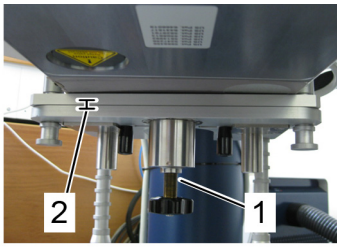
Figure 6.3: Support plate mounted on the guiding rails holding the CryoProbe.

NOTICE

There are several positions for the mounting hardware. It is rec-ommended to utilize the uppermost mounting position possible. This will increase the stability of the CryoProbe by reducing the amount it must be lifted to ensure proper positioning.

[9] Lock the support plate (2) in place with an audible click.

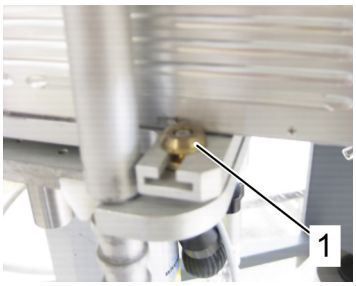
[10] Check the secure seating of the support plate.



[11] Turn the black screw (1) under the support plate to raise the CryoProbe Prodigy to its final position. Turn the screw until the gap (2) between the top and bottom support plates does not widen anymore.

i The black screw cannot overturn. It has a slipper clutch.

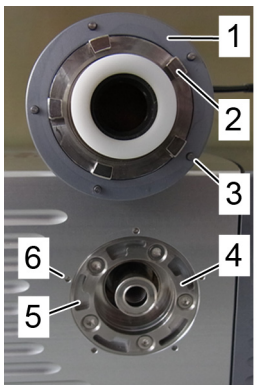
Figure 6.4: Raising the CryoProbe Prodigy to its final position.



[12] Adjust the two brass elements (1) on the support plate with an Allen key to fix the position of the probe. Leave a ~1-2 mm gap between the probe and the brass elements. This step only needs to be performed once during the first installation of the CryoProbe Prodigy.

Figure 6.5: Brass elements on the support plate.

6.3 Installation of Exhaust Heater and Vacuum Operator



Exhaust heater / Vacuum operator side:

1. Rotable mounting ring
2. Hook
3. Positioning pin

CryoProbe side:

4. Bayonet plate
5. Notch
6. Positioning hole

These numbers are used in the following explanaition.

Figure 6.6: Connecting components at Exhaust Heater/Vacuum Operator side and CryoProbe side.

The Exhaust Heater and the Vacuum Operator are installed following the same procedure.

i The next Figures show exemplary the installation and unmounting procedure of the Exhaust Heater. The Vacuum Operator is installed and unmounted following the same procedure as the Exhaust Heater.

6.3.1 General Mounitng Procedure of Exhaust Heater and Vacuum Operator

NOTICE

Do not damage the sealing ring of the vacuum Operator.

[1] Take the Exhaust Heater/Vacuum Operator with one hand. Use the other hand to hold the CryoProbe.

[2] Insert the Exhaust Heater/Vacuum Operator into the corresponding port of the CryoProbe. The Vacuum Operator might require some wiggling movement to overcome the friction of the sealing rings.

Figure 6.7: Insert and push in the Exhaust Heater.

[3] Turn the mounting ring (1) to align the hooks (2) with the notches (5) on the bayonet plate (4).

Figure 6.8: Aligning the hooks (2) with the notches (5) of the bayonet plate (4) by turning the mounting ring (1) of the Exhaust Heater.

[4] Now push the Exhaust Heater/Vacuum Operator all the way in untill it touches the stop edge.

[5] Turn the mounting ring (1) clockwise until the positioning pins (3) click into the positioning holes (6).

Figure 6.9: The mounting ring (2) is now turned clockwise until the positioning pins (3) click in place in the positioning holes (6).

NOTICE

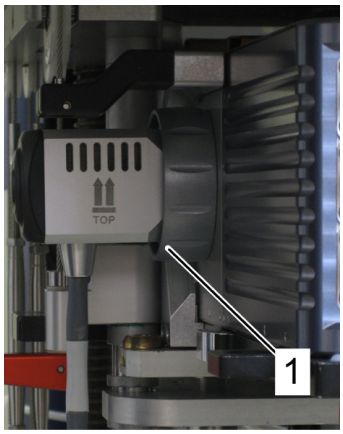
The mounting ring (1) can be slightly pulled to make turning easier.

Figure 6.10: Pulling the mounting ring (2) to make turning easier.

[6] Release the mounting ring (1). The Exhaust Heater/ Vacuum Operator is now installed.

Figure 6.11: Installed Exhaust Heater.

6.3.2 Installation of Exhaust Heater



[1] Mount the Exhaust Heater on the exhaust port at the left hand side of the CryoProbe. Follow the steps described in ”Installation of Exhaust Heater and Vacuum Operator” on page 62.

i Make sure the slots of the Exhaust Heater (1) point upwards.

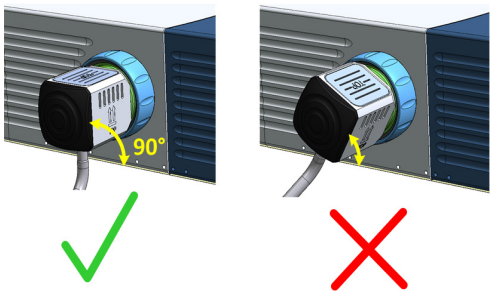


Figure 6.12: Mounted Exhaust Heater.

[2] Connect the Exhaust Heater cable to socket labeled *Exhaust heater* on the back of the Prodigy Unit (if not already done).

6.3.3 Installation of Vacuum Operator

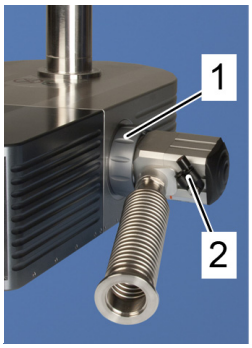


Figure 6.13: Mounted Vacuum Operator (when looking at the CryoProbe Prodigy from the front).

[1] Remove the white protective cover from the Vacuum Operator.

[2] Mount the Vacuum Operator on the vacuum port at the right hand side of the CryoProbe. Follow the steps described in ”Installation of Exhaust Heater and Vacuum Operator” on page 62.

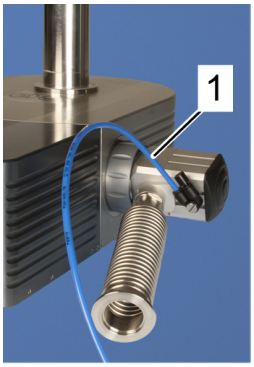


Figure 6.14: Mounted Vacuum Operator with gas tube connected.

[3] Connect the 4 mm blue gas tube to the Vacuum Operator (1)

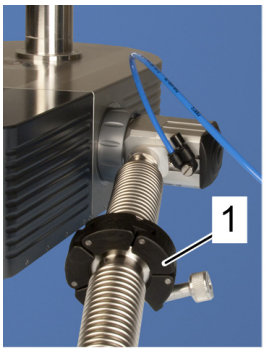


Figure 6.15: Attached vacuum hose.

[4] Align the short vacuum hose of the Vacuum Operator with the vacuum hose from the Prodigy Unit.

[5] Attach the vacuum hoses with the O-ring and clamp (1).

6.3.4 Unmounting Procedure

⚠ CAUTION

Risk of burns due to hot or cold surfaces of the Exhaust Heater.
In case of malfunctioning heaters the surface can be either hot or very cold.
Thus:

▶ Wear your protective gloves.

[6] Support the Exhaust Heater/Vacuum Operator with the palm and grab the mounting ring (1).

Figure 6.16: Supporting the Exhaust Heater with the palm and grabbing the mounting ring.

[7] Pull the mounting ring (1).

Figure 6.17: Pulling the mounting ring.

[8] Turn the mounting ring (1) counter-clockwise until there is a noticeable click or stop edge.

Figure 6.18: Pulling the mounting ring.

[9] The mounting ring (1) is now unlocked. Release the mounting ring

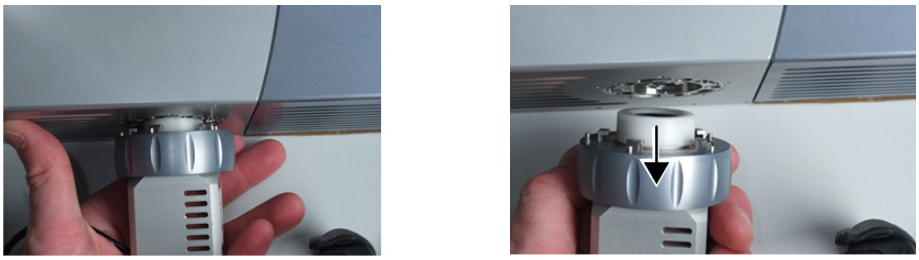


Figure 6.19: Mounting ring can be released. Pulling out the Exhaust Heater/vacuum Operator.

[10] Carefully pull out the Exhaust Heater/Vacuum Operator and remove it from the CryoProbe.

[11] Protect the O-rings of the Vacuum Operator with the white plastic cover, when it is unmounted.

NOTICE

Make sure the Vacuum Operator is closed (the red pin at the pneumatic connector must be inside). Pulling out the Vacuum Operator requires a higher force than the Exhaust Heater due to the lower vacuum pressure in the CryoProbe.

6.4 Connect Variable Temperature (VT) Gas Adapter and Sample Heater Cable

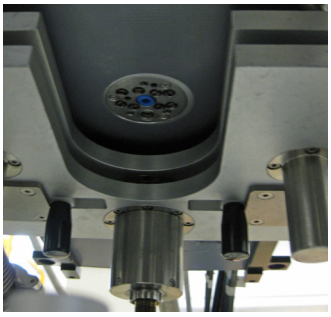
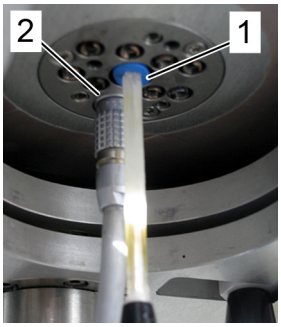


Figure 6.20: Connector on the CryoProbe.



i There are different versions of VT adaptors, depending on the installed Variable Temperature Gas System. (see Site Planning Guide and Manual Instructions of the installed VT-Gas System)

[1] Connect the VT sensor cable to the socket (2) on the bottom of the CryoProbe.

[2] Connect the other end of the VT sensor cable to socket labeled *Sample VT* on the back of the Prodigy Unit.

Figure 6.21: Mounted VT gas adaptor (1) and sample heater cable (2).

6.5 Installation of Tuning and Matching Accessoires

6.5.1 Installing the ATM unit

If an automatic tuning and matching (ATM) unit is available, install it according to the instructions. Detailed user information about the ATM unit can be found in the ***ATM Accessory User Manual***.

⚠ CAUTION

Risk of damage to the ATM unit and the CryoProbe Prodigy.

Thus:

- ▶ Move the ATM unit carefully near the magnet since it can be attracted to high magnetic fields.
- ▶ Do not apply excessive torque to the ATM unit's mounting screws.
- ▶ Do not use a screw driver or excessive force to turn the ATM unit's mounting screws.
- ▶ Make sure the ATM unit is fully and vertically mounted to the CPP. Make sure there is no gap between the ATM unit and the CPP.
- ▶ If the black insulated VT adaptor is used, take care not to bend its capillary more than 45° (see the adaptor's installation instructions for more information).

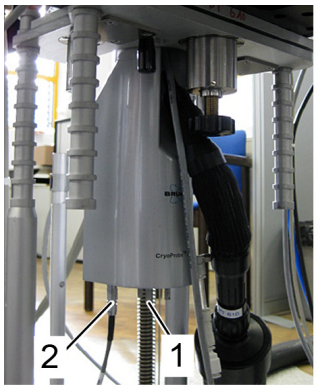


Figure 6.22: Mounted ATM unit.

[1] Keep the ATM unit firmly and fully pressed against the probe and fasten the three mounting screws (1) alternately by hand (2-3 turns each time).

i Do not force the screws to turn. They should turn smoothly and without any strong resistance.

[2] Connect the bottom heater cable (2) to the bottom of the ATM unit and connect the other end of the cable to the back of the Prodigy unit labeled *Bottom heater*.

[3] Connect the PICS cable (1) to the back of the ATM unit.

6.5.2 Uninstalling the ATM unit

In case of uninstallation directly after use or due to malfunction of the ATM unit.

⚠ CAUTION

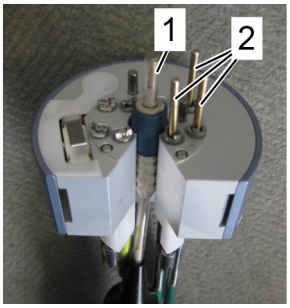
Risk of burns due to hot surfaces on ATM unit.
In case of malfunctioning heaters the surface can be hot.
Thus:

▶ Wear your protective gloves.

6.5.3 Installing the Manual Tuning and Matching Adaptor (MTM)

Instead of the ATM a manual tuning and matching adaptor (MTM) can be installed.

Mount the manual tuning and matching adaptor (MTM) to the bottom of the CryoProbe as follows:



[1] To install the MTM the slot of the MTM has to be centred around the VT adaptor (1) as shown in Figure 6.23. Please note that the VT adaptor and the sample heater cable are already connected to the bottom of the CryoProbe at this stage (Figure 6.24).

Figure 6.23: Illustration showing how to align the MTM with the already installed VT adaptor (1) at the bottom of the CryoProbe. The long pins (2) are used for aligning the MTM with the bottom of the CryoProbe.

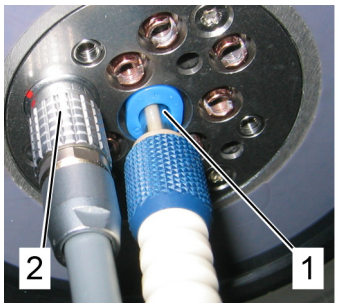
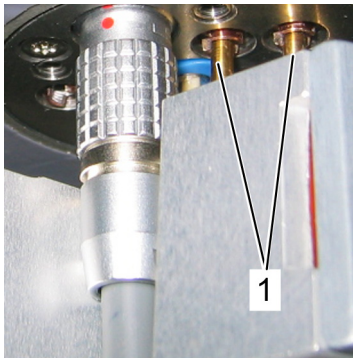


Figure 6.24: Bottom of CryoProbe with VT adaptor and sample heater cable.

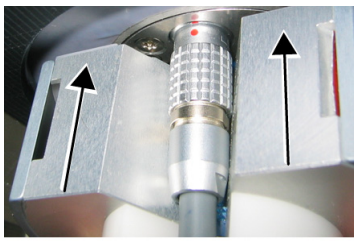
[2] Hold the MTM angled and slide it into place as shown.

Figure 6.25: Sliding in the MTM around the VT adaptor.



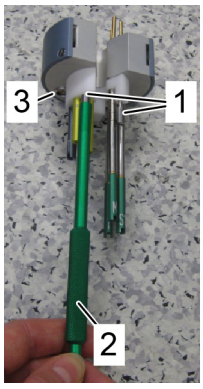
[3] Align the adaptor's bolts (the longer pins (2) in Figure 6.23) into their counterparts on the bottom of the CryoProbe Prodigy (Figure 4).

Figure 6.26: Align the longer pins and carefully move the MTM upwards.



[4] Press the MTM against the bottom of the CryoProbe.

Figure 6.27: Hold the MTM against the CryoProbe and fasten the screws, shown in next figure. Make sure that nothing is jammed between the MTM and the CryoProbe.



[5] Make sure that no cable or gas tube is jammed between the MTM and the CryoProbe.

[6] Tighten the three mounting screws (Figure 6.28 (1)), by turning them alternately using the special MTM tool (2).

[7] Do not force the screws to turn; they should turn smoothly without any strong resistance.

[8] Attach the bottom heater cable to the connector (Figure 6.28 (3)), on the MTM and connect the other end of the cable to the socket labelled "Bottom heater" on the back of the Prodigy Unit.

Figure 6.28: Mounting screws (1), MTM tool (2) and Bottom heater connection (3)

6.5.4 Uninstalling the Manual Tuning and Matching Adaptor (MTM)

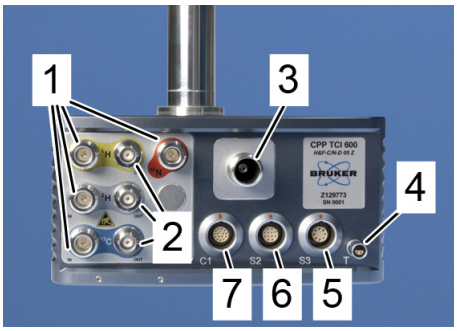
In case of uninstallation directly after use or due to malfunction of the MTM unit.

⚠ CAUTION

Risk of burns due to hot surfaces on MTM unit.
In case of malfunctioning heaters the surface can be hot.
Thus:

▶ Wear your protective gloves.

6.5.5 Connecting the Cables on the CryoProbe Prodigy



Overview about CryoProbe connector sockets:

1. RF N-sockets
2. RF BNC-sockets
3. Transferline coupler socket
4. Transferline ID socket
5. S3: Connector for Gradient
6. S2: Connector for CPP PICS
7. C1: Connector for CPP sensors

Figure 6.29: Sockets on the CryoProbe.

NOTICE

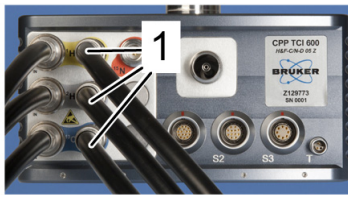
The actual layout of the connector sockets can be different depending on the type of CryoProbe.

6.5.6 Connect the RF-N Cables, RF-BNC Cables

[9] Connect the RF N-cables (1) to the left RF N-sockets on the front of the CryoProbe.

[10] Connect the other ends of the cables to the corresponding sockets on the HPPR/2.

Figure 6.30: Connecting the RFN cables.



[11] Connect the RF-BNC cables (1) to the RF BNC-sockets on the front of the CryoProbe.

[12] Connect the other ends of the cables to the corresponding sockets on the HPPR/2.

Figure 6.31: Connecting the RF-BNC cables.

[13] Connect the remaining RF cables (1) on the front of the CryoProbe.

[14] Connect the other ends of the cables to the corresponding sockets on the HPPR/2.

Figure 6.32: Connecting the RF-BNC cables.

6.5.7 Connect the CryoProbe Prodigy Sensor Cables

⚠ CAUTION

Risk of damage to life and limb due to electricity.

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

Thus:

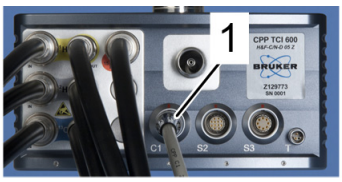
- ▶ Do not touch the pins of the S3 plug.
- ▶ Never start a NMR measurement when the CryoProbe is not connected.

NOTICE

Risk to damage connectors.

Thus:

- ▶ Do not turn the connectors while plugging or unplugging the connectors.



[1] Connect the **C1** sensor cable (1) to the CryoProbe Prodigy.

Figure 6.33: Connecting the C1 cable.

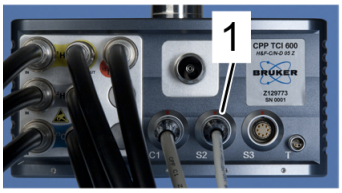


Figure 6.34: Connect the S2 cable.

[2] Connect the **S2** cable (1) to the CryoProbe Prodigy and the other end to the *CRP* connection on the back of the cover module of the HPPR. If the console is a Nanobay version 3 or newer, connect the other end of the S2 cable to the *CRP* connection on the DRU board.

Figure 6.35: Connect the S3 cable.

[3] Connect the CryoProbe Prodigy gradient cable (1) to the **S3** connector and to the gradient cable from the console.

6.5.8 Connecting the Transferline

⚠ WARNING

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

Contact with the skin may cause cold burns.

Contact with the eyes may cause blindness.

Physical contact with extremely cold liquids (e.g. Liquid nitrogen has a temperature of -196°C) and metal parts may cause serious injuries.

Thus:

- ▶ Never look directly into the openings of components without eye protection (e.g. the Transferline) because liquid nitrogen droplets may spill out.
- ▶ Do not over bend the Transferline (minimal bending radius= 400 mm)
- ▶ Protect temperature sensitive components such as O-rings from contact with liquid cryogenic agents.

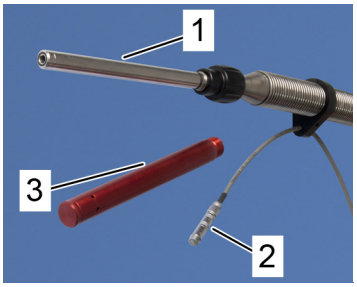
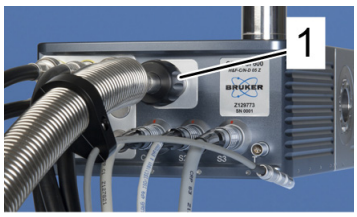


Figure 6.36: Transferline coupler (1) with Transferline ID connector (2) and red cap (3).

[1] Remove the red cap (3) from the Transferline coupler (1).



[2] Insert the Transferline (1) to the CryoCoupler on the CryoProbe. Hold the Transferline with one hand and fasten the nut with the other hand.

i Do not over-tighten the nut; hand-tight force is sufficient

Figure 6.37: Transferline coupler inserted into the CryoCoupler of the CryoProbe.

[3] Connect the Transferline ID cable (1) to the front of the CryoProbe.

Figure 6.38: Connecting the Transferline ID cable

7 Operating the System: Cooldown, Warmup & Refill

7.1 Description of the User Interface

The user interface of the Prodigy Unit consists of a display (touch screen) and 4 LEDs (Figure 7.1).

The display is activated by touching it. An activated display is indicated by the illuminated background lighting. If not in use the display automatically returns to sleeping mode.

The main menu (<Home> tab) on the display shows three buttons <COOLDOWN>, <WARMUP> and <REFILL>. By touching the buttons the corresponding process is started.

The display furthermore shows the current operation state of the system and error messages, if required.

Below the display four LEDs indicate the current state:

LED status	Message
COLD LED flashing blue	cooldown in process
COLD LED continuously lit blue	cold state
WARM LED flashing green	warmup in process
WARM LED continuously lit green	warm state
REFILL LED flashing yellow	preparing refill
REFILL LED continuously lit yellow	ready for refill
ERROR LED flashing red	an error has occured and the CPP is warming up
ERROR LED continuously lit red	an error has occurred and the CRP is warm

Table 7.1: State messages of the Prodigy Unit.

Figure 7.1: Prodigy Unit display and LEDs during startup.

7.2 Cooling Down the CryoProbe Prodigy

NOTICE

- CryoProbe is installed in the magnet according to "CryoProbe Prodigy Installation" Chapter 6
- VT gas must be connected. The flow rate and temperature must be adjusted in TopSpin™ according to the specifications of the CryoProbe.
- Sample heater must be switched on before cool down is started.
- Check, if exhaust Heater, vacuum Operator and Transferline are connected to the CryoProbe.

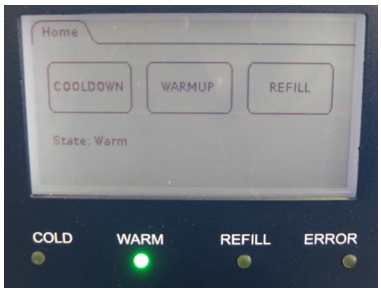


Figure 7.2: Prodigy Unit display: Startup state

[1] Turn ON the Prodigy Unit (see Figure 5.3 on page 50 to localise its power switch).

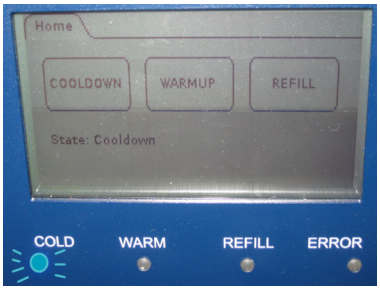
[2] After the Prodigy Unit has completed its self-test the green LED is lit and the display indicates "State: warm" (Figure 7.2)

[3] To start an automatic cooldown press <COOLDOWN> on the display.

The cooldown takes approximately 2 hours.
During the entire cooldown the blue LED flashes.

Figure 7.3: Prodigy Unit display: Preparing cooldown

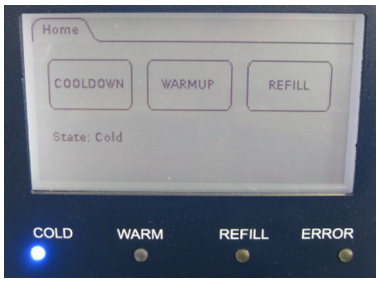
[4] After pressing <COOLDOWN> the displayed status changes to "State: Preparing cooldown" and the blue LED starts flashing Figure 7.3.



[5] During this process a series of checks is performed to ensure all components are operative. After these checks the state changes to "State: Cooldown". The pressure inside the LN2 Dewar is increased to start the LN2 supply.

[6] The blue LED continues flashing throughout the cooldown process (Figure 7.4).

Figure 7.4: Prodigy Unit display: Cooldown state



[7] Wait until the "Cooldown" process is completed, indicated by a continuously lit blue "Cold"-LED and the message "State: Cold"

[8] The system is now ready for NMR measurements.

Figure 7.5: Prodigy Unit display: Cooldown state

NOTICE

Normal effects which can be observed during cooldown and in the cold state:

- ▶ Misty flow exits from the Exhaust Heater continuously or batchwise.
- ▶ Clicking sounds from operating valves inside the Prodigy Unit.
- ▶ Hissing sounds caused by pressure release.
- ▶ Pressure changes in the LN2 Dewar.
- ▶ Sounds from the pumps in the Prodigy Unit.

7.3 Warming Up the CryoProbe Prodigy

7.3.1 Standard Warm Up Procedure

The warmup takes approximately 3.5 hours.
During the entire warmup process the "Warm"-LED flashes.

[1] Make sure the NMR sample has been removed from the magnet.

[2] Press <WARMUP> on the Prodigy Unit display to start the warmup process.

[3] The message "Warmup: Please Wait" is shown on the display and the green "Warm" - LED starts flashing (Figure 7.6).

Figure 7.6: Prodigy Unit display: State Warmup, wait.

[4] Wait until the pressure in the LN2 Dewar has been released and the message "Warmup: Connect Active Warmup" is shown.

i This may take up to several minutes depending on the amount of LN2 in the dewar.

Figure 7.7: Prodigy Unit display: Warmup pressure safe

⚠ CAUTION

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

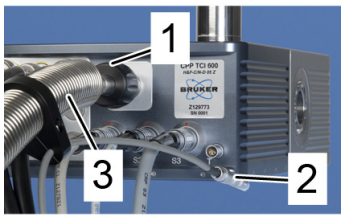
Contact with the skin may cause cold burns.

Contact with the eyes may cause blindness.

Physical contact with extremely cold liquids (e.g. Liquid nitrogen has a temperature of -196°C) and metal parts may cause serious injuries.

Thus:

- Never look directly in the openings of the components without eye protection (e.g. the Transferline) because liquid nitrogen droplets may spill out.
- Do not over bend the Transferline (minimal bending radius = 400 mm)
- Protect temperature sensitive components such as O-rings from contact with liquid cryogenic agents.

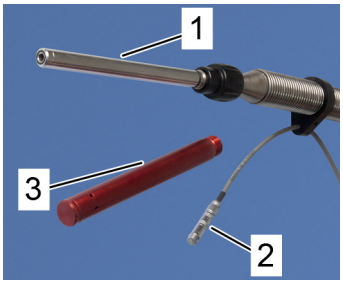


[5] Unplug the Transferline ID cable (Figure 7.8 (2))

[6] Disconnect the Transferline by holding the Transferline Figure 7.8 (3) with one hand and loosen the nut Figure 7.8 (1) with your other hand.

[7] Pull out the Transferline coupler from the CryoProbe.

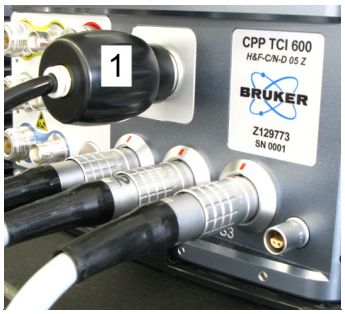
Figure 7.8: Disconnecting the Transferline- ID plug and Transferline coupler.



NOTICE

Moisture can block the Transferline - Therefore - Immediately cover the Transferline coupler (1) with the red Transferline cap (3). (Figure 7.9)

Figure 7.9: Attach the red Transferline cap (3) to the Transferline coupler (1), the Transferline ID (2) is unplugged.



[8] Connect the warmup plug (1) hand tight

[9] The flow of warmup N2 gas will start automatically after several minutes and warm up the CryoProbe.

[10] During warmup the gas flow might generate a hissing sound, recognizable at the Exhaust Heater.

Figure 7.10: Connecting the warmup plug (1)

---

i The warmup will take approximately 3 hours to complete.

---

[11] After the CryoProbe is completely warmed up:

- The warmup-gas flow stops automatically.
- The message "State: Warm" is displayed and the WARM LED is lit continuously green. (Figure 7.2)
- The Exhaust Heater switches off automatically.
- The Vacuum Operator closes and the pumps shut off automatically.

[12] After completed warmup:

- Remove the warmup plug
- Attach the Transferline cap for the Transferline coupler on the CryoProbe.

---

i After completed warmup the CryoProbe can be removed from the magnet (see chapter 6 in reverse order).

NOTICE

A minor pressure of 10 - 20 mbar in the LN2 Dewar is maintained by a relief valve in the Prodigy Unit. This prevents humidity from entering the System.

Thus:

- ▶ Do not open the port caps on the dewar adaptor of the LN2 Dewar.
- ▶ Do not remove the orange gas twin tubes from the dewar adaptor or the Prodigy Unit.

7.3.2 Error and Emergency Warmup (Passive Warmup)

In case of a malfunction the red ERROR LED is lit (or flashing) and an error message is shown on the display.

Furthermore the control unit of the Prodigy Unit will reach a safe state by releasing pressure from the LN2 Dewar to stop the LN2 supply.

This results in an emergency warmup (or: passive warm up), indicated by the error message "Emergency Warmup" (Figure 7.11):

- Passive warmup means that the CryoProbe is warmed up without the supporting flow of warmup gas.
- A passive warmup of the CryoProbe takes 12 - 24 hours.

[1] If this situation occurs check the error messages on the display.

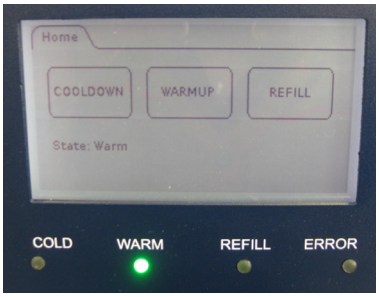
[2] Also check all gas tubes and electrical connections.

[3] After fixing the problem press <COOLDOWN> again in order to launch another cool-down..

[4] If the error remains, contact BRUKER Service.

Figure 7.11: Prodigy Unit display: Emergency Warmup

7.4 State: Warm



The warm state is indicated by the message "State: warm" on the display and the WARM LED continuously lit green.

In the State: *Warm* the CryoProbe can be safely dismounted from the magnet.

In the State: *Warm* the CryoProbe can also remain in the magnet.

In the State: *Warm* the Prodigy Unit can be switched off.

Figure 7.12: Prodigy Unit display: Warm state

To dismount the CryoProbe follow the steps described in "CryoProbe Prodigy Installation" Chapter 6 in reverse order.

7.5 Refill LN2

Press <REFILL> and refill the LN2 Dewar following the steps described in "Fill Procedure of LN2 Dewar" Chapter 4.

8 Turning Off the System

8.1 Turning Off the CryoProbe Prodigy System

To turn off the Prodigy System:

- Warmup and dismount the CryoProbe (see steps in ”CryoProbe Prodigy Installation” Chapter 6 on page 59 in reverse order),
- Attach all covers to the CryoProbe
- Store the CryoProbe safely.
- Attach the Transferline cap to the Transferline.
- Position the Transferline safely, so it does not obstruct any system component. (min. bending radius 400 mm)
- Switch off the Prodigy Unit.
- Keep all gas tubes connected to the Prodigy Unit and LN2 Dewar.
- Keep the Transferline installed on the LN2 Dewar.
- Keep the Prodigy Unit positioned at its location.
- Keep the LN2 Dewar positioned at its location.

LN2 can remain inside the LN2 Dewar when the system is turned off.
LN2 will continuously evaporate from the LN2 Dewar, even when the System is not in use.
To prevent pressure increase keep all gas tubes connected to Prodigy Unit and LN2 Dewar.
Do not obstruct the safety relief valve.
Do not completely seal off the LN2 Dewar with a flange or any other device, sealing it gastight
For further enquiries contact Bruker.

CAUTION

Risk of damage to the CryoProbe Prodigy:

Thus:

- ▶ Do not hold the CryoProbe by its tube! Always hold the probe by its body.
- ▶ Two persons should dismount the CryoProbe.
- ▶ Never dismount the CryoProbe in the cold state.
- ▶ Transferline min. bending radius 400 mm.

- ▶ Never seal off the LN2 Dewar with a flange or any other device, sealing it airtight.
- ▶ Do not obstruct safety relief valves

8.2 Unmounting the CryoProbe Prodigy

CAUTION

Risk of cold burns:

Thus:

- ▶ Do not unmount the CryoProbe in the cold state.

For unmounting the CryoProbe see ”CryoProbe Prodigy Installation” Chapter 6 on page 59 in reverse order.

8.3 Emptying the LN2 Dewar

Please contact Bruker.

8.4 Proper Disposal

In case of any request of disposal or replacement please contact Bruker.

CAUTION

Risk of cold burns:

Thus:

- ▶ Do not unmount the CryoProbe in the cold state.

9 Contact

NMR Hotlines

Bruker Corporation provides dedicated hotlines and service centers. 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

Contact our NMR service centers, so that our specialists can respond as quickly as possible to all your service requests, application questions, software or technical needs.

CryoProbe Prodigy Sales:

BRUKER Biospin AG
Industriestrasse 26
CH-8117 Fällanden
Switzerland
phone: + 41 44 825 91 11
fax: + 41 44 825 96 96
email: sales@bruker-biospin.ch
http://www.bruker.ch

BRUKER Instruments, Inc.
44 Manning Road
Billerica, MA 01821
U.S.A.
phone: ++1-978-667-9580
fax: ++1-978-667-0985
email: sales@nmr.bruker.com
http://www.bruker.com

CryoProbe services:

BRUKER AG
Service Departement
Industriestrasse 26
CH-8117 Fällanden
Switzerland
phone: + 41 44 825 97 97
fax: + 41 44 825 94 04
e-mail: cryoprobe.service@bruker.ch
http://www.bruker.ch

BRUKER Instruments, Inc.
44 Manning Road
Billerica, MA 01821
U.S.A.

phone: ++1-978-667-9580
fax:++1-978-667-0985
email: center@nmr.bruker.com
http://www.bruker.com

Contact

Appendix A

A.1 Warning Signs

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NOTICE

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A.3 Protocol for LN2 Refills of Prodigy System

Recording the filling dates and amounts allows to determine the average LN2 consumption of the Prodigy System.
Significant changes in the LN2 consumption are an indication that the Prodigy System might not work properly. In this case please contact Bruker Service.
Please copy this page and attach it at the LN2 Dewar. Record each filling cycle.

PROTOCOL: LN2 REFILLS OF PRODIGY SYSTEM			
Date	**Amount of LN2 (kg) Before Refill**	**Amount of LN2 (kg) After Refill**	**Comments**

Bruker Corporation

info@bruker.com
www.bruker.com

Order No: Z31986