



***MÖBIUS™* Recycler**
**Condensing Liquid Nitrogen
HPGE Detector Cooling System**

User's Manual

MÖBIUS-PT, MÖBIUS-ST, MÖBIUS-B

WARRANTY

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Repair Service

If it becomes necessary to return this instrument for repair, it is essential that Customer Services be contacted in advance of its return so that a Return Authorization Number can be assigned to the unit. Also, ORTEC must be informed, either in writing, by telephone [(865) 482-4411], or by facsimile transmission [(865) 483-2133], of the nature of the fault of the instrument being returned and of the model, serial, and revision ("Rev" on rear panel) numbers. Failure to do so may cause unnecessary delays in getting the unit repaired. The ORTEC standard procedure requires that instruments returned for repair pass the same quality control test that are used for new-production instruments. Instruments that are returned should be packed so that they will withstand normal transit handling and must be shipped PREPAID via Air Parcel Post or United Parcel Service to the designated ORTEC repair center. The address label and the package should include the Return Authorization Number assigned. Instruments being returned that are damaged in transit due to inadequate packaging will be repaired at the sender's expense, and it will be the sender's responsibility to make claim with the shipper. Instruments not in warranty should follow the same procedure and ORTEC will provide a quotation.

Damage in Transit

Shipments should be examined immediately upon receipt for evidence of external or concealed damage. The carrier making delivery should be notified immediately of any such damage, since the carrier is normally liable for damage in shipment. Packing materials, waybills, and other such documentation should be preserved in order to establish claims. After such notification to the carrier, please notify ORTEC of the circumstances so that assistance can be provided in making damage claims and in providing replacement equipment, if necessary.

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ADDITIONAL WARRANTY AND SAFETY NOTICES

There are no serviceable parts in or on the MÖBIUS except those specified in this manual, e.g., the mains power cord, fuses, and filter. Opening the rear panel or otherwise accessing the interior components, attempting to detach the level monitor or remote status display leads, or performing operations other than those described in this manual (e.g., inserting/removing the mechanical cooler's protective foam block, adding/removing liquid nitrogen, and inserting/withdrawing detector cryostats into/from the dewar) may void the warranty.

Using this equipment in a manner not specified in this manual may impair the protection the equipment provides.

Changes to valving, tubing, or other components of the MÖBIUS system can result in damage to equipment, injury, or death. Modifications to any system components must be made in consultation with ORTEC technical support personnel and authorized in writing in advance of such modifications.

SAFETY INSTRUCTIONS AND SYMBOLS

This manual contains up to three levels of safety instructions that must be observed in order to avoid personal injury and/or damage to equipment or other property. These are:

- DANGER** Indicates a hazard that could result in death or serious bodily harm if the safety instruction is not observed.
- WARNING** Indicates a hazard that could result in bodily harm if the safety instruction is not observed.
- CAUTION** Indicates a hazard that could result in property damage if the safety instruction is not observed.

Please read all safety instructions carefully and make sure they are understood fully before attempting to use this product.

In addition, the following symbol might appear on the product:



ATTENTION – Consult the manual in all cases where this symbol is marked in order to determine the nature of the potential hazards and any actions that must be taken to avoid them.



DANGER – Hazardous voltage



Protective earth (ground) terminal

Please read all safety instructions carefully and make sure they are understood fully before attempting to use this product.

MÖBIUS-B w/ HJ-style
cryostat



MÖBIUS-PT w/ PopTop®
cryostat



MÖBIUS-B w/ PopTop®
cryostat



1. INTRODUCTION

The ORTEC MÖBIUS Recycler integrates a Sunpower® CryoTel® Stirling-cycle cryocooler with a specially designed 25-liter liquid nitrogen (LN2) dewar to yield a high-reliability HPGe detector cooling system. This is especially useful for counting laboratories that have periodic power failures. The MÖBIUS fits easily under standard lead shields with the same footprint as a regular dewar. The remote status display can be mounted outside the lead shield for easy visibility.

A continuously operating MÖBIUS requires refilling only once every two (2) years — a major savings in worry, time, money, and exposure to LN2 handling risks. During a power failure, the MÖBIUS performs as a standard dewar. After power is restored, check the LN2 level and top it off if necessary — that's all it takes to return the system to maximum performance.

The MÖBIUS supports ORTEC's Streamline and PopTop® detector lines, and horizontal as well as vertical dipstick-type cryostats. In addition, several non-ORTEC cryostats and detectors are supported; contact an ORTEC representative for more information. If a detector has been purchased in addition to a MÖBIUS, all detector-specific information is included in the detector's data sheet and user manual.

1.1 HOW MÖBIUS WORKS

The MÖBIUS has a computer-controlled pressure system that maintains a constant and stable 0.5 psi (3.5 kPa) in the vapor space of the dewar. A pressure transducer feeds the pressure in the dewar to the onboard computer, which controls the rate at which the Sunpower cryocooler re-condenses the nitrogen vapor to liquid. The cryocooler operates only when a cryostat is installed and the two fill/vent valves are closed (i.e., when the system is pressurized). This evaporation/re-condensation process is illustrated in Figure 1.

The fill collar has redundant pressure relief valves designed to open if the pressure exceeds 1 psi (6.9 kPa). In the event of power loss, the cryocooler stops, the pressure inside the vapor space starts increasing, and nitrogen vapor slowly begins escaping into the atmosphere via the pressure relief valves. However, if power remains on and the system is operating in an uninterrupted steady state, there is no LN2 loss, and the system can operate indefinitely without an LN2 refill.

The LN2 level monitor calculates the level of liquid nitrogen in the dewar, giving ample opportunity to schedule maintenance.

1.2 UPS INTEROPERABILITY

The MÖBIUS is designed to run on ac mains power. However, during a power failure it acts as a conventional dewar and can keep a detector cold for 200 hours or more, depending on the level of LN2 in the dewar. When power is restored, the unit's cryocooler restarts, and it resumes recycling nitrogen gas boil-off as before.

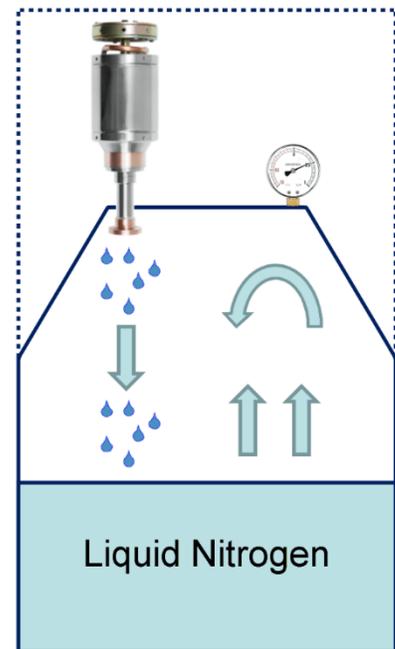


Figure 1. Evaporation/Re-Condensation Process

The unit can be connected to an uninterruptable power supply (UPS) to sustain operation during short-duration power failures. Fully cooled, it draws about 150 watts of power from a UPS without a “smart” capability. Alternatively, the MÖBIUS can run off a “smart” UPS with a dry contact relay interface, such as the APC SMT750C UPS equipped with their optional AP9613 dry contact management card. In this configuration, if power fails the UPS signals the MÖBIUS to enter its power-saving mode to conserve UPS battery life. The cryocooler turns off, reducing power consumption to less than 10 watts, while the remote status display continues to provide all status readouts including the liquid nitrogen level in the dewar.

1.3 SPECIFICATIONS

1.3.1 Performance

- **Refill Period** After the detector is cool and the LN2 is topped off, the MÖBIUS system can run for 2 years or longer without filling. This is based on the sealing technology and assumes system operation in uninterrupted, steady-state conditions.
- **Maintenance** Wash or replace inlet air filter every 3 months (replacements available from ORTEC). No other maintenance is required.
- **Remote Status Display** Readout unit with hardwired umbilical cord can be remotely mounted to improve visibility when the detector is placed in a lead shield. The display registers the liquid nitrogen level in the dewar, power level being supplied to the cooler, pressure level within dewar and general status of the system.
- **Internal Controller** Control electronics, power supply, and cooler electrically isolated from the dewar and protected from LN2 spillage.
- **LN2 Level Sensing** Capacitance level sensor provides continuous measurement of the LN2 level from 0 - 100% full. Sensor displays levels over 100%. This is an indication the system is filled greater than nominal fill levels. This does not affect the performance of the unit.
- **Use with UPS** The MÖBIUS has a small onboard computer that can receive an input, via the rear-panel I/O connector, in the event of power loss. The input causes the system to enter power saving mode and turn off the cryocooler. With the cryocooler turned off, the onboard computer can be powered by a small UPS.
- **LN2 Loss Rate** Approximately 2 - 3 L/day with non-PopTop cryostats when cooler is off (same as for conventional dewar); loss rate will vary depending on ambient conditions and detector size. With PopTop cryostat typical consumption can be as high as 4L/day when cooler is off.
- **Spectroscopic Performance**
 - For new ORTEC detectors purchased with the MÖBIUS: at energies above 15 keV we certify no degradation of the detector resolution warranted on the detector data sheet, and below 15 keV, less than 10% of the warranted resolution.
 - For existing ORTEC detectors in dipstick cryostats, where the MÖBIUS replaces an existing dewar or X-Cooler®, resolution degradation is based on the existing detector performance. It is expected that the detector will have similar performance compared to using a standard LN2 dewar. Some degradation may occur depending on the detector's age and configuration. Note: Detector in a PopTop cryostat requires a 1.50 inch in diameter dipstick when converting from X-Cooler® to MÖBIUS.
 - MÖBIUS can be used with existing non-ORTEC detectors in dipstick cryostats having 1.25- or 1.50-inch diameter. It is expected that the detector will have similar performance

compared to using a standard LN2 dewar. Some degradation may occur depending on the detector's age and configuration.

1.3.2 Mechanical

- **Dewar Capacity** 25 L, excluding detector dipstick volume.
- **Cooler** AMETEK SUNPOWER with passive vibration dampening.
- **Auxiliary Cooling** Internal fan.
- **Audible Noise** Less than 60 dB (A) at 1 m fully operational, below 30°C ambient.
- **Electrical Supply** 100-240 Vac, 50 Hz or 60 Hz.
- **Normal Power Consumption** 125 W typical, 350 W maximum.
- **Dimensions** (excluding HPGe detector) 25.8 in. H x 17.2 in. Diam (65.4 cm x 43.7 cm).
- **Operating Temperature** 0-40°C, 20-90% relative humidity, non-condensing.

1.3.3 CE

- Intended for indoor use.
- Intended for altitude up to 2000 m (6562 ft).
- Mains supply voltage fluctuations up to +/-10% of the nominal voltage.
- Transient overvoltages up to the levels of overvoltage category II.
- Pollution degree 2.

1.4 INSPECTION FOR SHIPPING DAMAGE

If the shipping carton(s) arrives with externally visible damage, **do not unpack it**. Notify the carrier and make arrangements to file a damage claim. ***In all cases of shipping damage, it is the customer's responsibility to file a damage claim.***

If, during unpacking, concealed damage is found, **notify the carrier, and file a claim**. Be sure to save all packing materials, waybills, and other such documentation to establish claims.

Contact ORTEC's Global Service Center or an ORTEC representative for further instructions.

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2. SYSTEM OVERVIEW

2.1 CONTENTS OF THE SHIPPING CARTON¹

When the MÖBIUS is received, its shipping carton(s) will contain the following components at minimum:

- MÖBIUS cryocooler/dewar main assembly with integrated LN2 fill collar, hardwired remote status display, and adhesive-backed hook-and-loop strip for attachment of remote display.
- Universal power cord kit (contains a universal ac mains power cord and a set of region-specific outlets).
- Fuse kit (contains fuse block and fuses; use the included 250 V/6.3 A time-delay [slo-blo] fuses).
- Acoustic damping foam shim pack with plywood platform and anti-vibration pad.
- User manual and documentation package.

Options will typically be packaged separately and will include their own instructions.

2.2 THE MÖBIUS

Figure 2 through Figure 5 illustrates the main features of the MÖBIUS.

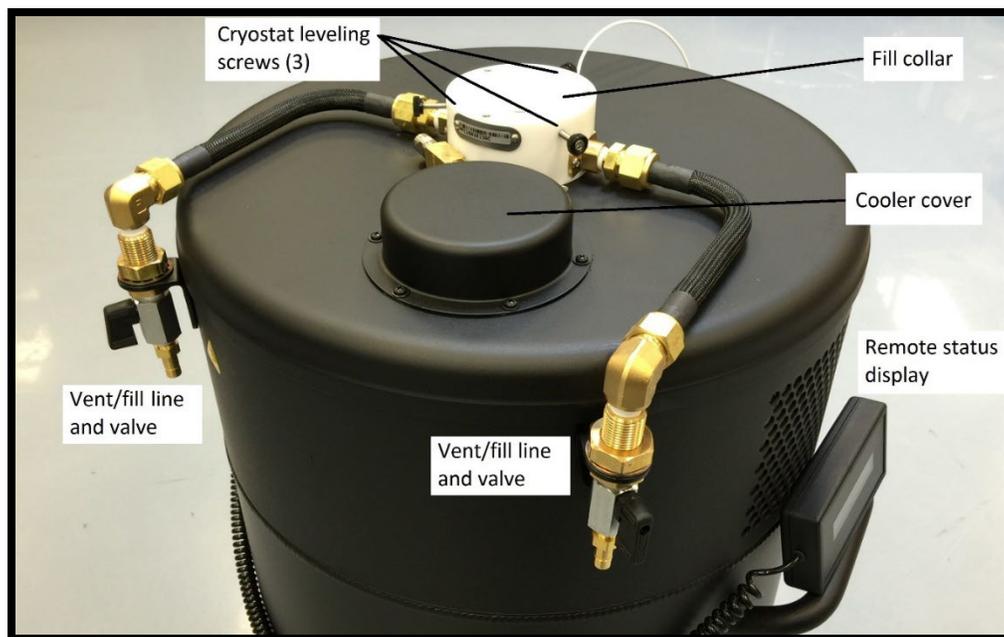


Figure 2. MÖBIUS Top Panel Features (Part 1)

¹ All system components and specifications subject to change without notice.

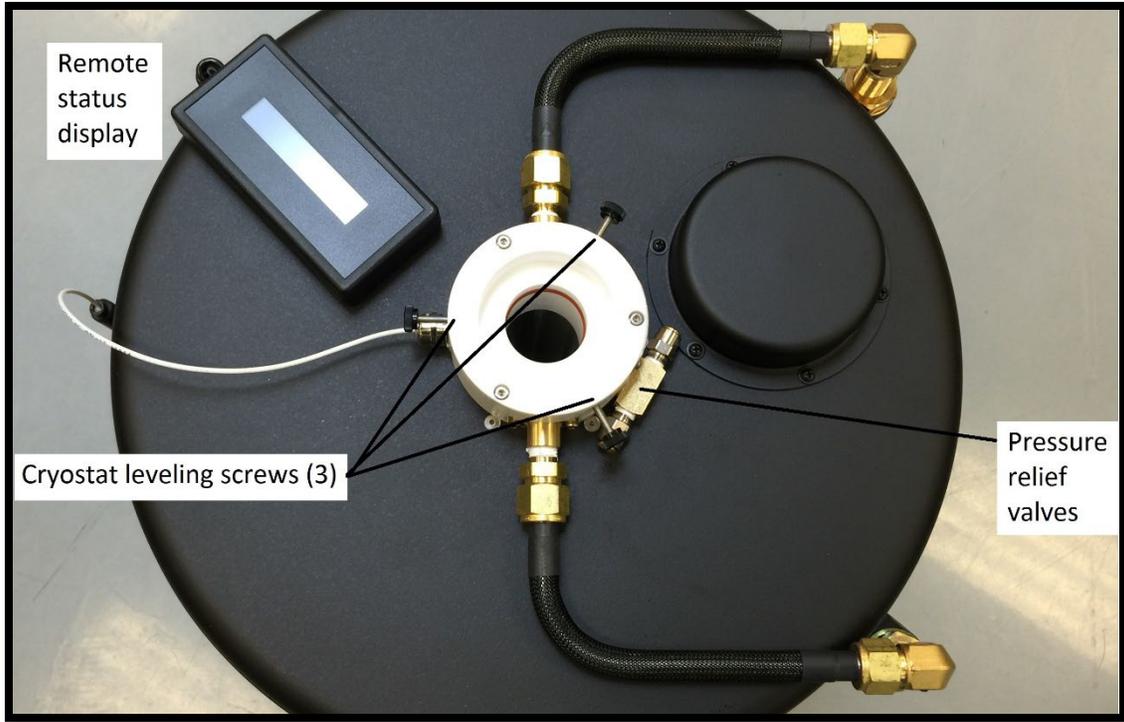


Figure 3. MÖBIUS Top Panel Features (Part 2)

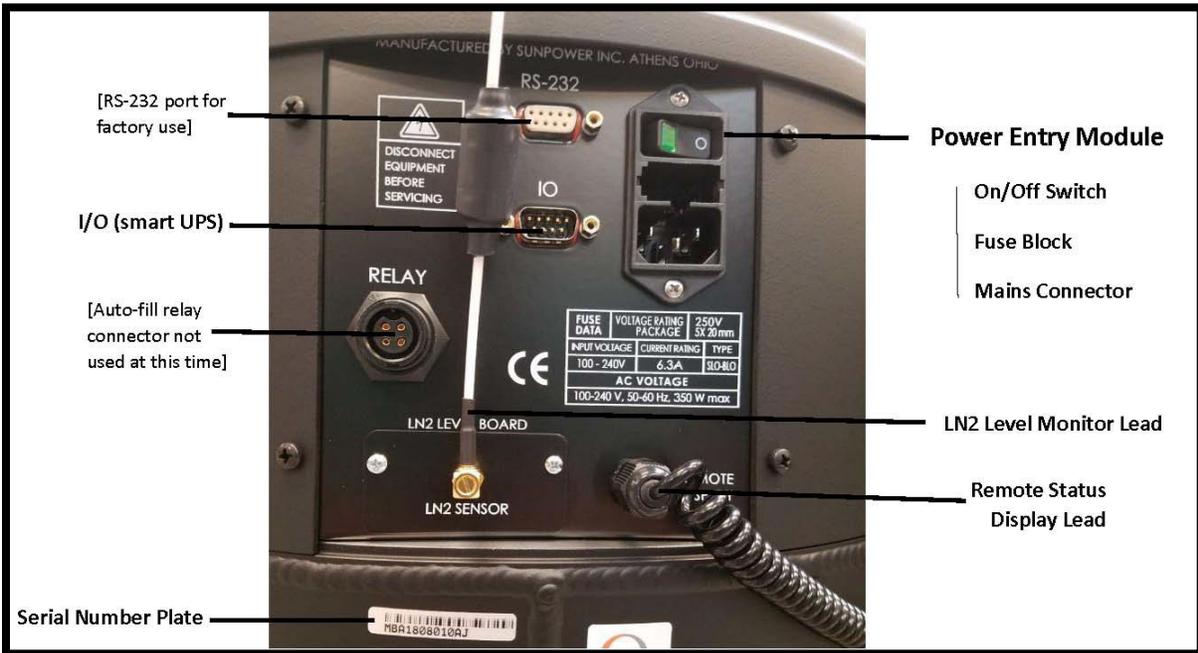


Figure 4. Rear Panel Features



Figure 5. Top Plug for MÖBIUS-B Models Only

2.3 PREPARING THE MÖBIUS FOR USE

1. Unpack the dewar and make sure the dewar and vent/fill valve tube stems are empty of any packing material.
2. As shipped from the factory, the cryogenic cooler is protected from damage by a foam block inserted under the black cooler cover beside the fill collar (Figure 6). This foam must be removed before using the MÖBIUS.
 - Using a #1 Phillips screwdriver, remove the screws from the cooler cover and set them aside.
 - Lift off the cooler cover, then remove the caution tag.
 - Remove the foam block and **keep it with along with all other shipping materials** for transporting the MÖBIUS, returning it to the factory for service, etc.

CAUTION When the foam block is not in place under the cooler cover, keep the MÖBIUS upright or the cooler may be damaged. See Section 4.3.

Do not operate the MÖBIUS without the cover installed; it is required for proper air flow to the cooler.

- Replace the cover and tighten the screws just enough that they will not vibrate loose. *Do not overtighten*. This seal is intended as an air dam, not a pressure seal, so tighten the screws just enough to establish uniform, snug contact with the gasket.



Figure 6. MÖBIUS with Protective Foam Block and Caution Tag Under Cooler Cover Being Removed

3. Next, the fuses must be installed. As shipped, the fuse block and fuses are packaged in zippered plastic bags. Install the fuses in the block, turn the block until the key tab faces down (Figure 7), and push it into the power entry module until both sides snap positively into place (Figure 8).



Figure 7. Keyed Underside of Fuse Block



Figure 8. Inserted Keyed Side Down, Snap Both Sides into Place

4. The universal power cord adapts for almost any mains power configuration. Simply choose the plug that matches the local outlet (Figure 9) and press it onto the power cord. The other end is a standard female IEC connector that plugs into the MÖBIUS power entry module.

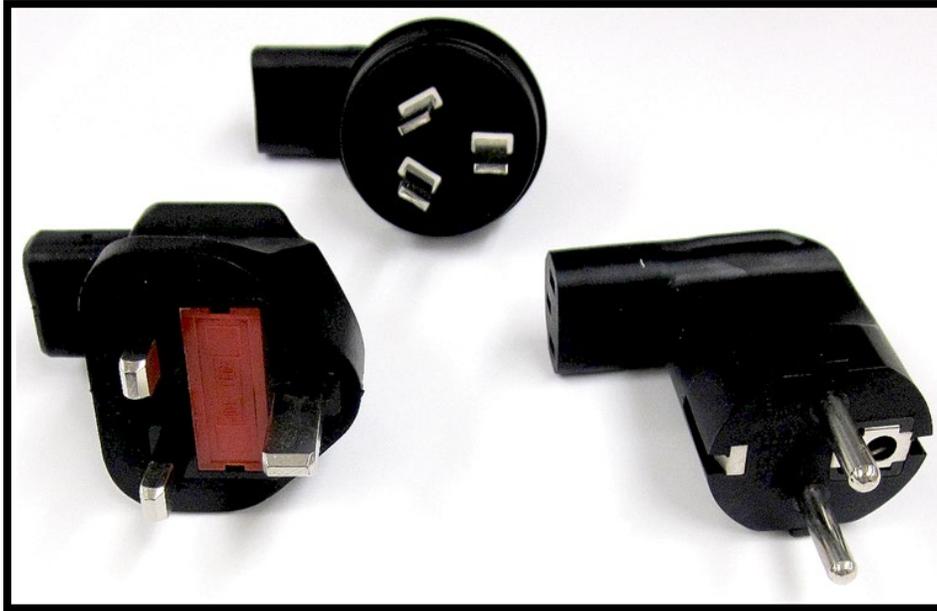


Figure 9. Universal Power Cord Adaptors

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3. INSTALLATION

Installation requires at least two people (better still, three) and a stepstool. Specific shield configurations call for specific installation methods. However, installing the MÖBIUS is essentially no different than installing a standard 30 L dewar because the two are very similar in size. The detector/cryostat assembly should be dry and warm and the MÖBIUS empty.

The mounting surface must be flat and horizontal. The shield and/or MÖBIUS must not be positioned so that it is difficult to disconnect the MÖBIUS from the electrical supply. Orient the dewar so its ventilation openings and filter are not blocked.

Figure 10 is an exploded diagram of a typical spectroscopy system with a PopTop detector, PV4 vertical dipstick cryostat, Model HPLBS shield with split center plug, and MÖBIUS.

Figure 11 shows a typical MÖBIUS installation under an HPLBS shield. Setting the detector height involves the interplay of shield height (adjustment typically requires a hydraulic jack and wrench), the thickness of acoustic damping material and/or other spacers under the dewar, and the insertion depth of the cryostat cooling rod in the dewar.

Note the arrangement of damping and spacer materials under the dewar necessary to bring it to the correct height. Various thicknesses of foam are used on the bottom (i.e., contacting the floor). The foam is followed by the plywood spacer, and the anti-vibration pad is on top. *Order is important for the various spacers:* Foam on the bottom, followed by the plywood, followed by the anti-vibration mat.

For installations where there is not enough room for all three layers, *omit the foam first, then the plywood, then the anti-vibration mat as a last resort.*

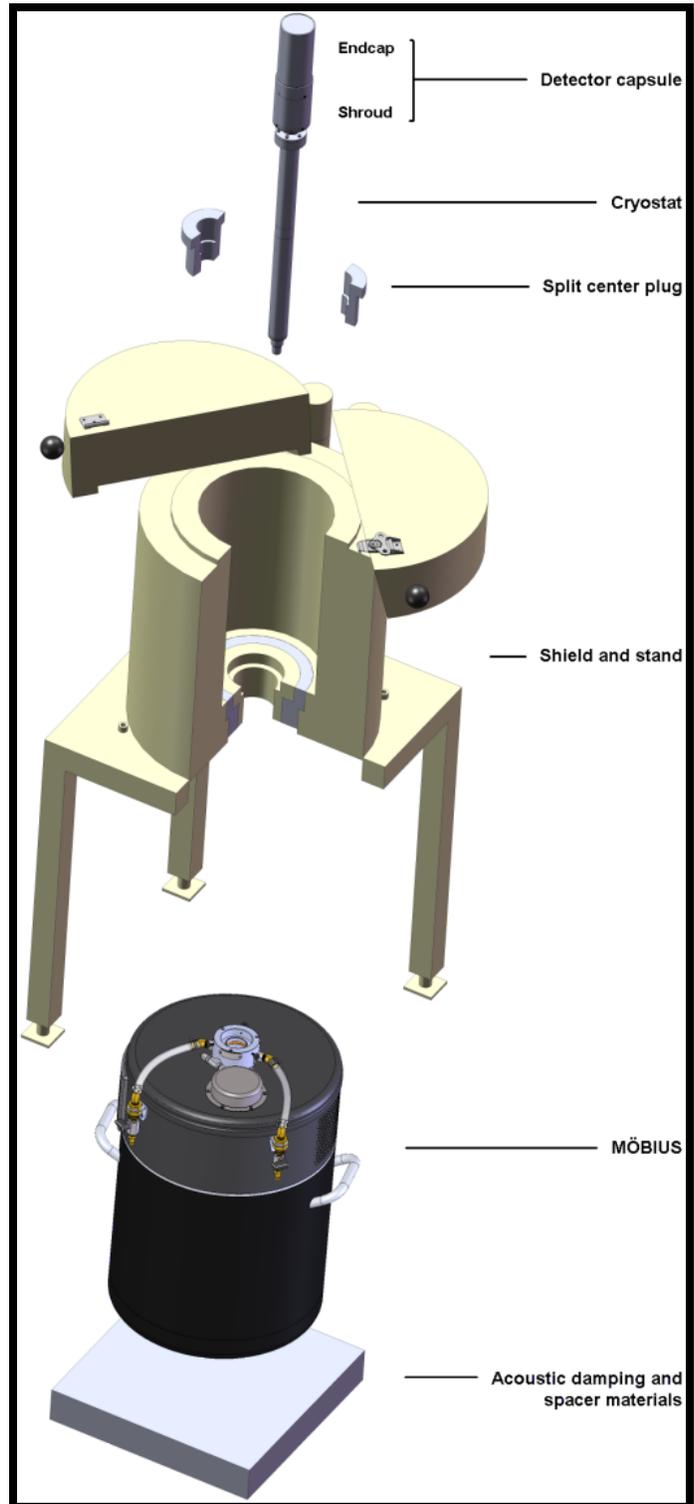


Figure 10. MÖBIUS Installation Exploded Diagram

The detector can also be raised by adjusting the collar position on the cryostat. This is useful when using a center plug to reduce floor shine. Note however that this adjustment lifts the cryostat cooling rod out of the LN2 column, reducing the effective capacity of the dewar. In such cases, the detector begins to warm as soon as the LN2 level falls below the cold tip rather than when the dewar is empty. One solution for this problem is to use a cooling rod extender such as the ORTEC Model CRE-1, which adds up 4 inches of cold tip to the cryostat.



Figure 11. The MÖBIUS Installed on Foam, Plywood, and Anti-Vibration Pad

3.1 ASSEMBLING THE SYSTEM

1. Before installation, it may be desired to assemble the spacers, damping materials, MÖBIUS, and detector/cryostat assembly beside the shield to make preliminary height estimates, cryostat and shield height adjustments, etc. Otherwise, place the MÖBIUS under the shield first with no spacers under it.
2. Holding the detector/cryostat assembly by the preamplifier shroud or under the detector capsule base, lower the cooling rod through the bottom of the shield — feeding the detector cabling through first — and through the fill collar into the dewar.

CAUTION Keep the cabling and connectors from being pinched, kinked, deformed, or otherwise damaged as they and the cooling rod pass through the bottom of the shield.

3. If using the split center plug, put the two halves carefully in place before fully lowering the cooling rod through the bottom of the shield. To avoid ground loops, position the detector high enough inside the shield that its base plate does not touch the top of the center plug.
4. Finally, the damping materials and spacers can be inserted under the MÖBIUS. It is easiest to have two helpers lift the MÖBIUS while a third person slides the spacer stack underneath.
5. Now is a good time to choose a location for the status display and mount it with the hook-and-loop strips provided with the system. Make sure to position it where the readout is clearly visible (for example, on the shield table as in Figure 11).

3.2 FILLING WITH LN2

This procedure requires cryoprotective gloves and eye protection.

NOTE Pressure from the refill dewar should not exceed 22psi (152 kPa).

1. Before filling the MÖBIUS with LN2, *be sure to read all cautions in Section 3.3.*
2. For MÖBIUS-B Models, *ensure the supplied top plug is secure (see Figure 5) and the detector is properly installed on the cryostat before filling.*
3. The MÖBIUS is now ready for power-up. Connect the mains power cord to a properly grounded electrical supply and set the power switch to the “On” position. The remote status display will light up and show **LN2: 0%**, **Pwr: 0%** indicating that the dewar is completely empty and cooler power is off. If dewar is partially filled, then display will show X% depending on the level of LN2 currently in the dewar.
4. With the remote status display clearly visible, open the two fill/vent valves on the front of the dewar (Figure 2). This will depressurize the system. The status display will now show pressure PSIG: 0.0 and fill level LN2: 0% (or X% if dewar is partially filled). Display should look as follows:

LN2: 0%	PSIG: 0.0
Pwr: 0%	Vented

Figure 12. Status Display Showing Zero Pressure and LN2

5. Connect the transfer hose from the supply dewar to the MÖBIUS. Its two fill/vent valves are identical to one another, hence, interchangeable (i.e., if the supply dewar is connected to the left connection, the right connection becomes the vent, and vice versa). Although not specifically required for protection of the MÖBIUS, an exit line can be connected to the vent valve to route gas and liquid that escapes during filling to a safe location. Suitable transfer and vent hoses are available separately from ORTEC. Pressure from the refill dewar should be between 5 and 22 psi. *Pressure from the refill dewar should not exceed 22 psi (152 kPa).*
6. Open the valve on the supply dewar to start the flow of LN2 into the MÖBIUS. Cold nitrogen gas will immediately begin blowing out of the vent side and will condense moisture in the air, creating a clearly visible fog. *If this fog is not observed, turn the supply dewar valve off immediately and ensure that both valves on the front of the Mobius are open.*

- As the liquid level in the MÖBIUS rises, the liquid nitrogen fill readout on the status display will increase until the dewar is full and the readout indicates 100%. Fill time depends very much on supply dewar pressure but is typically between 10 and 30 minutes for a completely empty MÖBIUS. Once filled, display would look as follows:

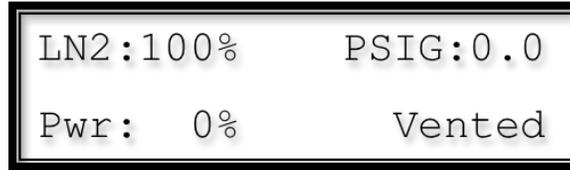


Figure 13. Status Display Showing Zero Pressure and Full LN2

- Frost will form on the fill and vent tubing, fittings, and other cold surfaces as the LN2 flows. The frost serves as a warning that these surfaces that are very cold and should not be touched without suitable gloves. It is not unusual for the valve on the supply dewar to frost over during the fill process, so be sure to have gloves handy so the supply valve can quickly be closed as soon as the MÖBIUS is full. The frost also provides additional thermal insulation to the lines so do not wipe it off during LN2 transfer.

NOTE The fill and vent valves on the MÖBIUS should not be operated (opened or closed) until they are at room temperature.

- When the MÖBIUS status display indicates LN2: **100%**, watch the fog exiting the vent tube very closely for signs of small LN2 droplets first, then large droplets. *Immediately close the supply valve as soon as these droplets are observed, otherwise the MÖBIUS system electronics and seals could incur damage.*
- Leave the fill and vent lines connected until all frost on the lines and fittings has thawed (this typically takes just a few minutes). Only when all signs of frost are gone can the lines be removed safely. Cold gaseous nitrogen will continue to exit the vent as the detector continues to cool. The system should be left undisturbed overnight to allow the detector and MÖBIUS to completely cool down. During cooldown *leave the MÖBIUS fill/vent valves open.*
- A warm detector causes a significant amount of LN2 to boil off at first. Once the detector is cold, it is a good idea to top off the LN2 level in the MÖBIUS. After top-off, remove any attached hoses and close the fill/vent valves. The system will begin to pressurize as LN2 in the dewar vaporizes. The MÖBIUS will sense this pressure increase and turn on its cryogenic cooler to begin re-condensing the evaporating LN2. Between PSIG values of 0 and 0.2 system will indicated *Vented* status. Between PSIG values of 0.45 and 0.55 status will indicate *OK* status. Between PSIG values of 0.65 and 1.4 status will indicate *Cooling* status. At first, the cooler and its cooling fan will run at high power. While cooling, MÖBIUS display should look as follows:

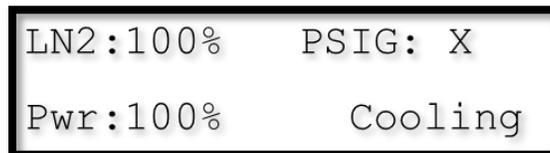


Figure 14. Status Display Showing X Pressure and Full LN2

where X should have a value between 0.0 and 1.0 psi. Note that LN2 may indicate value slightly below 100% at this point.

NOTE Two safety valves will vent excessive pressure if pressure exceeds approximately 1 psi.

12. After about 2 hours the system will stabilize so the cooler and its cooling fan are running just at the power level necessary to maintain a constant pressure of 0.5 psi (3.5 kPa; 104.4 kPa absolute pressure) inside the MÖBIUS dewar. Once the system is stabilized, power consumption level will vary while pressure is maintained around 0.5 psi. It is normal for cooler to turn off occasionally when pressure drops below 0.50 psi. A display example of a pressurized, cooled down MÖBIUS would look as follows:

```
LN2: 98%    PSIG: 0.50
Pwr: 65%    System OK
```

Figure 15. Status Display Showing 0.5 PSIG Pressure and 98% LN2

13. At this point, the MÖBIUS is a closed system that is designed to contain all nitrogen vapor. The system is now ready to connect the detector cable to the detector and multichannel buffer.

NOTE MÖBIUS is designed to operate without liquid nitrogen refilling for up to two years under normal, continuous operating conditions (e.g., no power loss). The display will blink when the LN2 level drops below 85%. This value was established to alert the user that the LN2 level in the MÖBIUS is not sufficient to provide cooling for a full seven days upon an extended power outage.

3.3 SAFETY AND EQUIPMENT WARNINGS

3.3.1 Liquid Nitrogen Safety

Before filling the MÖBIUS, be sure to read the following LN2 advisories as well as the information in Section 3.3.2.

DANGER

- The large expansion ratio of LN2 from liquid to gas (1 to 692) can generate high pressures if the dewar does not have adequate venting or pressure relief provisions.
- When filling the MÖBIUS, it may be tempting to use dry nitrogen gas to pressurize the supply dewar. **ORTEC STRONGLY RECOMMENDS AGAINST THIS PRACTICE.** Instead, only the self-generated pressure of the supply dewar should be used. Compressed gases (even purportedly dry “house” nitrogen) may contain moisture, oil, and oxygen. **Any oxygen will liquefy at LN2 temperatures (77 K), creating an explosion hazard. In addition, the moisture and oil can freeze, making the safety valves inoperable.** Use a pressure relief of 22 psi (152 kPa) on the supply dewar to avoid over-pressurization in the event of ice blockage. **A blockage can rupture the dewar and/or expel the detector/cryostat with explosive force.**

- If the MÖBIUS dewar becomes contaminated with oil, the unit must be returned to ORTEC for service. **Do not use a degreaser or attempt any other remediation unless authorized to do so by the ORTEC Global Service Center.**
- If water accumulates in the dewar, remove the LN2; obtain a cylinder of high-purity, oil-free, dry nitrogen gas (not “house” nitrogen); and stream the gas at very low pressure through the dewar until all water has evaporated.
- Piping or transfer lines should always be constructed so as to avoid trapping LN2 in the line. Evaporation can result in pressure buildup and eventual explosion of the line. If all lines cannot be emptied, install safety relief valves and rupture discs. Also keep in mind that some materials become brittle and fracture when exposed to LN2 temperatures. For advice on selecting materials for use in storing and transferring LN2, contact ORTEC or a LN2 supplier. Other sources of information include the *CRC Handbook of Laboratory Safety* and the American Society of Mechanical Engineers’ *Boiler and Pressure Vessel Code, Section VIII*.
- Nitrogen gas can pose an asphyxiation hazard by displacing air. **Transfer LN2 only in a well-ventilated area.** Vent storage containers to a well-ventilated area or to the outside to avoid buildup of nitrogen gas in the work area.

WARNING

- On contact with skin, LN2 causes burns similar to thermal burns or frostbite. Eyes are especially vulnerable to this type of exposure. Avoid wearing anything capable of trapping or holding spilled liquid nitrogen close to the skin (for instance, mesh-top running shoes). An impervious apron or coat, cuffless trousers, and high-topped shoes are recommended. Wear safety glasses or, better yet, full-face protection. Remove all watches, rings, bracelets, or other jewelry. When gloves are used to handle containers or cold metal parts, they should be impervious and sufficiently large to be easily tossed off the hand in case of a spill.
- Before removing a detector/cryostat assembly from a MÖBIUS, always vent the system by opening both the fill and vent valves (Figure 2). Failure to do so may result in the entire contents of the dewar spewing dangerously out of the fill collar as the cryostat is removed. Redundant relief valves on the MÖBIUS fill collar reduce this risk, but it is always best to eliminate the risk by first opening the fill and vent lines.

CAUTION

- The detector electronics **must be protected from excessive cold.** Avoid spilling LN2 on the cryostat or electronics, and vent cold gas away from the system being filled. **A cold detector must not be enclosed in any thermally insulating materials at any time.** Following these precautions will prevent damage to the vacuum seals or system electronics from excessive chilling.
- Never attempt to fill the MÖBIUS by manually pouring LN2 through the fill collar. **Always install the detector before filling and use a fill dewar.** The recommended filling procedure described in Section 3.2 presents minimal risk to the unit and users.

3.3.2 Other Precautions

3.3.2.1 Handling PopTop Detector/Cryostat Assemblies

- Grasp the assembly just beneath the base of the detector capsule, where the cable exits the base plate; or by the preamplifier shroud (see Figure 16). **Do not touch any cryogenically cooled surfaces (if moving a cryostat that is already cold), and do not hold the detector by the endcap!**



Figure 16. Where To Hold a PopTop

- If the detector is cold, at the same time the user lifts or lowers the assembly, turn it slightly clockwise (as viewed from above the endcap, i.e., turn it in the direction that tightens the PopTop capsule to the cryostat). **Applying counterclockwise force to a cold detector will rupture the capsule's vacuum seal, and the unit must be returned to ORTEC for repair.**

3.3.2.2 Electrical Cautions

- Ensure the unit is fused for the proper voltage — 250 V/6.3 A time-delay — before connecting the power cord to ac mains power. Replace blown fuses with the same model and performance specifications. Never short circuit a blown fuse.
- Always disconnect the power cord from the MÖBIUS before performing any maintenance.
- If the mains power cord is damaged or lost, contact ORTEC for the correct replacement cord. **Do not replace with an inadequately rated cord.**

3.3.2.3 Unintended Detector Warm-Up

If, for any reason, the detector warms up enough that the HV shuts down (e.g., loss of LN₂) or if for any other reason the detector warms for more than 10 minutes, it should be warmed to room temperature before re-cooling. Typical warm-up time for most detectors is 24 hours. For higher-efficiency detectors (>70%), allow 36 hours warmup time.

To determine if the detector is cool enough to be operated, attempt to turn on the detector bias (high voltage). If the detector is still too warm, the bias shutdown circuit will prevent high voltage from being applied. If the detector is cold enough, the bias will turn on. Be sure to allow the voltage to stabilize 15–30 minutes before taking data with an HPGe detector.

If the detector remains in shutdown mode after 36 hours of continuous cooling, contact a local ORTEC representative or ORTEC's Global Service Center.

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4. MAINTENANCE

4.1 CLEANING OR REPLACING THE MÖBIUS FILTER

The efficiency of the cryogenic cooler depends on the cooling fan's ability to remove heat from the system. The cooling fan pulls air through a filter on the left side of the unit and exhausts that air on the right side of the unit. As the filter becomes clogged with dust, the cooler becomes less efficient. A less-efficient cooler means the system must run at higher power levels, which can adversely affect detector performance due to increased vibration. Therefore, ORTEC recommends cleaning the filter every 3 months (more often in areas with higher-than-normal dust levels).

1. Remove mesh screen and filter by hand, as shown in Figure 17, by grabbing the mesh screen and filter in the center and pulling away from the MÖBIUS.



Figure 17. Removing the Mesh Screen and Filter

2. Clean the air filter thoroughly using dish soap and water. If the air filter is damaged or so dirty that it cannot be well cleaned, discard and replace it with a new one, available from ORTEC (part number - **9-300112**).
3. Push the air filter back into the bracket on both sides.



Figure 18. Installing the Filter

Once the air filter is inserted, push the mesh screen back in the bracket as in Figure 19.



Figure 19. Installing the Mesh Screen

4.2 EMPTYING AND WARMING THE MÖBIUS

CAUTION *Do not tip the MÖBIUS and pour the LN2 out of the fill collar!* Doing so will damage the cooler and may breach the dewar's vacuum seal.

Turn the MÖBIUS rear-panel power switch to the "Off" position, open the fill and vent valves to depressurize the dewar, and remove the detector/cryostat assembly according to Section 4.54.5. Then remove the LN2 with one of the following methods:

- **Slower** — Obtain a cylinder of high-purity, oil-free, dry nitrogen gas (not “house” nitrogen). Connect to the fill valve and stream at very low pressure to gently boil off the LN2 and evaporate any water from inside the dewar.
- **Faster** — Use the ORTEC Model WD/30 LN2 withdrawal device (Figure 20) to transfer the LN2 to another dewar. The WD/30 uses the pressure buildup in the dewar vapor space to push the LN2 up the tube and out a transfer line. Attaching the WD/30 requires removing the fill collar. Contact ORTEC for more details.

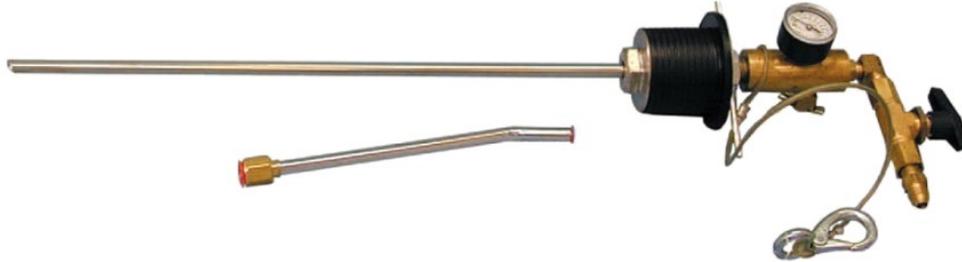


Figure 20. ORTEC Model WD/30.

4.3 TRANSPORTING OR SHIPPING THE MÖBIUS

NOTE Any time the MÖBIUS is transported or handled in such a way that the unit might accidentally be inverted or placed on its side, it must be emptied of LN2, and the foam block shown in Figure 6 must be reinstalled under the cooler cover; *otherwise, the cooler may be damaged*. Remove the foam when the MÖBIUS is relocated and ready for refilling.

Do not operate the MÖBIUS without the cover installed; it is required for proper air flow to the cooler.

1. Empty and warm the MÖBIUS according to Section 4.2.
2. Using a #1 Phillips screwdriver, remove the screws from the cooler cover and set them aside.
3. Grasp the cooler cover firmly and pull up or push sideways on it to break the friction grip of the cover gasket (which is very “sticky”). The gasket is affixed to the top of the MÖBIUS, not the underside of the cover flange. If necessary, *carefully* insert a thin, flat-blade screwdriver under the cover flange — *not under the gasket!* — and gently lift the cover until the seal breaks. While doing so, take care not to deform the edge of the flange, damage the gasket, or mar the dewar’s finish.
4. Insert the foam block, recessed side down, on the cooler.
5. Replace the cover and tighten the screws just enough that they will not vibrate loose. *Do not overtighten*. This seal is intended as an air dam, *not a pressure seal*, so tighten the screws only enough to establish uniform, snug contact with the gasket.

4.4 DETECTOR WARM-UP

To warm a detector to room temperature, turn the MÖBIUS rear-panel power switch to the “Off” position, open the fill and vent valves to depressurize the system, and remove the detector/cryostat assembly according to Section 4.5. It takes approximately as much time to warm up a detector as it does to cool down, e.g., 12 to 36 hours or more.

4.5 REMOVING THE DETECTOR/CRYOSTAT ASSEMBLY

This procedure requires two people and a stepstool. If the detector is still cold, the person working beneath the shield stand must wear cryogenic gloves and eye protection. If removing a PopTop detector, be sure to read Section 3.3.2.1 and the PopTop user manual first.

- **No center plug** — As user 1 lifts the detector/cryostat from above, user 2 helps lift the assembly and pulls the transfer collar's RTV piece free of the mouth of the dewar. Optionally, user 2 may use a methanol squirt bottle on the cooling rod at the top of the fill collar, to lubricate the cooling rod is pulled up into the shield. As the detector cable is pulled up through the bottom of the shield, ensure that no connectors are pulled loose or otherwise damaged.
- **With center plug** — As user 1 lifts the detector/cryostat from above, user 2 helps lift the assembly of the mouth of the dewar (optionally using methanol as in the preceding paragraph). As user 1 continues lifting the detector/cryostat with one hand, user 2 pushes up one of the center plug pieces until user 1 can lift it out or until it falls aside into the bottom of the shield. As the detector cable is pulled up through the bottom of the shield, ensure that no connectors are pulled loose or otherwise damaged.

Place the cold detector/cryostat assembly on an *uninsulated flat surface* (such as a lab bench or cart) or in a cryostat stand. *If it is placed on a surface such as a bench, chock it so it cannot roll! If placed in contact with insulating materials such as foam, the o-ring in the detector capsule may freeze and breach the capsule vacuum.*

4.6 DECOUPLING A POPTOP CAPSULE FROM THE CRYOSTAT

CAUTION Attempting to remove the PopTop capsule that has not fully warmed to room temperature will result in vacuum bellows damage. The damage may breach the vacuum, causing catastrophic failure of the detector's crystal. Bellows damage will void the detector warranty. Refer to the PopTop manual for detailed instructions.