Quantum Design

PPMS Application Note 1099-205

Magnet Ramping Guidelines for an EverCool Dewar

Quantum Design has found that some early PPMS EverCool systems (those shipped before October, 2003) had problems reaching and holding full field (9 tesla). Quantum Design has addressed the potential for such issues by redesigning the hardware and developing some general operating guidelines that will help you increase the effectiveness of your PPMS EverCool system.

You will find that your PPMS EverCool system performs best when you follow our guidelines and standardize your operating procedures. Our suggestions are especially helpful for preventing magnet quenches, which primarily occur when the pressure in the EverCool dewar[1] becomes too high. The pressure in the dewar is directly related to the temperature of the liquid helium bath, on the macroscopic level, by the vapor pressure curve for helium. When the temperature of the liquid helium bath becomes too high, the magnet quenches. Therefore, you can prevent magnet quenches by regulating the pressure in the EverCool dewar.

There are three aspects to improving pressure (and temperature) regulation in the PPMS EverCool system—system operations, system configuration, and operating procedures—as is explained below. Refer to the *PPMS Hardware Manual* and the *PPMS EverCool Option User's Manual* for detailed explanations about each item. If you have further questions, please contact Customer Service at Quantum Design.

SYSTEM OPERATIONS

Verify that the components of the EverCool dewar are operating correctly.

- The values shown by the dewar thermometers should be close to the temperature of liquid helium (~4.2 K) and within 0.4 K of each other.
- The cold head should be running when the pressure in the EverCool dewar is above 14 kPa.
- The limits for the Helium-Level Control should be set at 75% (high) and 70% (low).

SYSTEM CONFIGURATION

Verify that the system is configured correctly and has the most recent EPROMS and magnet leads.

EPROMs

The most recent EPROMS (version 1.910 or higher) have additional controls that help regulate the EverCool dewar pressure, including control loops, a dewar vent limit, and new default settings. The control loops help monitor and adjust the pressure in the EverCool dewar. The dewar vent limit starts the dewar venting to atmosphere when the dewar pressure reaches 23 kPa (~3 psi), and stops the dewar venting when the pressure drops below 20 kPa (~3 psi). The new default settings exhaust vacuum-pump output to the atmosphere when the dewar pressure reaches 20 kPa (~3 psi) and recirculate the vacuum-pump output when the pressure drops below 15 kPa (~2 psi).

Use the steps below to verify that the EPROMs in the Model 6000 are version 1.910 or higher.

[1] All dewar pressures mentioned in this document are above ambient pressure.

1. Start the Mon6000 utility by double-clicking on `Mon6000.exe`, which is located in `C:\QdPpms\Tools`.
2. When the **Mon6000** dialog box opens, type *rev?* in the command text box, then press the **ENTER** (or **RETURN**) key on your keyboard.
3. If the EPROM version is less than 1.910 or you have any questions, please contact Customer Service at Quantum Design.

Magnet Leads

Verify that your EverCool uses the newest type of magnet leads, which are made of gas-cooled superconducting wire. These leads are thermally anchored to the neck-baffle assembly, which is between 50 and 60 K.

Use the steps below to verify the type of magnet leads in your EverCool system

1. Stabilize the magnetic field at zero.
2. Remove the sidecar cover of the red Lemo connector.

   Note: More recent EverCool systems do not have a red Lemo sidecar. If you do not have one, your magnet leads are up-to-date, and you do not need to proceed further.
3. Examine the top plate of the dewar to see if it has two gold-plated posts coming through it. The newest leads have heat sinks that pass through the dewar top plate into the red Lemo sidecar, so if you see the gold-plated posts, you have the new leads.
4. If you have a red Lemo sidecar and do not see the gold-plated posts, please contact Customer Service at Quantum Design.

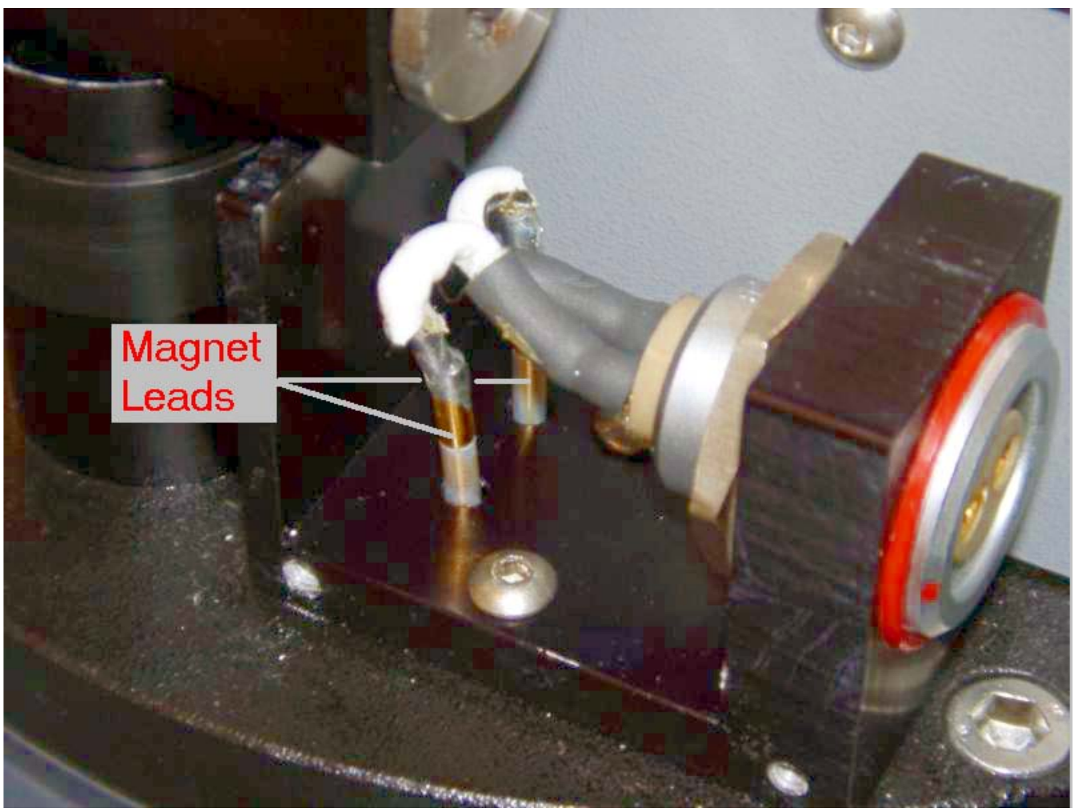

Figure 1. Most recent version of the heat sinks and magnets for PPMS EverCool systems

OPERATING PROCEDURES

You can cause magnet quenches by the way you use the system, even when the equipment is operating correctly and configured properly. As noted earlier, the primary cause of magnet quenching in an EverCool dewar is that the temperature of the helium bath rises so high that the magnet is no longer superconducting. Below we discuss usage guidelines that will help you prevent magnet quenches by maintaining acceptable dewar pressures and liquid helium temperatures.

Helium Levels

Maintain the level of liquid helium in the dewar at higher than 70% when you ramp the magnet to full field. The helium level is critical to preventing magnet quenches because of the high pressures that can develop in the EverCool dewar. Helium levels higher than 70% provide the best cooling because the magnet is completely submerged in liquid helium. Countless observations indicate that helium levels higher than 70% allow most systems to ramp from +9 T to –9 T multiple times before the pressure rises too high for proper magnet operations.

Changing Field

When you are measuring at successive fields, put the magnet into persistent mode at each target field and wait for the dewar pressure to drop below 15 kPa (~2 psi) before you make the next field change. This technique prevents the Joule heating of the persistent switch[2] that creates excessive dewar pressure when the magnet is ramped at full rate (~4.5 V), and is especially important when you are performing high field ramps. Typically, it only takes 10–15 minutes before the pressure drops enough so that you can set the next field change.

To prevent magnet quenches while you sweep the magnet, you can slow down the ramp rate, which helps reduce the Joule heating effect. For example, to sweep the field up to +9 tesla, set up your sequence to first sweep to +8 tesla at full field (~4.5 V), then to sweep to +9 tesla at 100 Oe/s (~1 V charging rate).

Changing Temperature and Field

Avoid ramping the magnet and cooling the sample space at the same time. The sample-space cooling process increases the pressure in the EverCool dewar. If you must cool and ramp at the same time, you can prevent the dewar pressure from becoming too high by reducing the rate at which you cool the sample space and ramp the magnet, as is explained below.

1. Let the system stabilize at the target temperature.
2. Wait for the EverCool dewar pressure to drop below 15 kPa (~2 psi) before you set the next temperature and field. Most systems will be ready for new settings within 10–15 minutes.

[2] The Joule heating of the persistent switch is proportional to the square of the charging voltage divided by the resistance of the switch.