Frozen Spin Target Manual
Document 6: How to Remove the 3He/4He Mash

C Keith
rev. March 11, 2008

This documents describes the preferred method to remove the 3He/4He mash circulating through the dilution refrigerator and pump it into the storage tanks.

Risk Assessment
No risk to personnel.

Hazard Control
Not applicable.

A. Overview
The mixture of 3He and 4He condensed in the dilution refrigerator is commonly called the "mash". The total inventory of mash consists of about 80 liters of 3He gas and about 400 liters of 4He gas (both are *NPT* liters of gas.) The 3He is stored in the 80 liter 3He tank and the 4He in two 200 liter tanks (the latter two are connected in parallel). IMPORTANT: when the dilution refrigerator is running and the mash is condensed, the valves on these three tanks must be left OPEN.

It is highly beneficial to keep the 3He and 4He separated (as well as can be done) when the mash is removed from circulation. The following describes a method whereby nearly all the 3He is removed from circulation with little 4He contamination. It is assumed that the proper amount of mash is already condensed in the refrigerator and that the mixing chamber temperature is below 100 mK. It is important to watch the RGA which monitors the percentage of 3He in circulation.

B. Removing the 3He from Circulation
1. Confirm that the valves located on the 3He and 4He (MV8367B and MV8368B/C) are OPEN. Confirm that the valve (MV8360V) between the L70s exhaust line and check valve CV8360V is CLOSED.
2. From the EPICS control screen FROST.adl, apply 50 mW to the still heater and 10 mW to the mixing chamber heater. The mixer should warm to 100 – 150 mK. More importantly, the percentage of 3He in circulation (according to the RGA) should increase to over 90%.
3. Once the 3He percentage is higher than 85 – 90%, OPEN MV8367A and MV8367B and turn ON the Edwards scroll pump (the "recoup" pump). OPEN the gas panel valve to the 3He storage tank, MV8367A.
4. CLOSE MV8364. The 3He tank pressure, PI8367A should start to increase.

5. Monitor the 3He percentage via the RGA. It should remain above 85% until the 3He tank pressure reaches nearly 1000 mbar. After that the percentage will drop rapidly.
6. Continue until the 3He tank pressure is about 1100 mbar, then CLOSE both MV8367A and MV8367B. Proceed to recover the 4He in circulation.

B. Removing the 4He from Circulation

1. OPEN MV8368B, the gas panel valve leading to the 4He storage tanks.
2. Increase the still heat to 1 W and increase the mixing chamber heat to 1 W. The 4He tank pressure PI8368A should begin to increase. If the still manometer pressure rises above 1 torr, the large blowers will trip off. If it appears that this is going to happen, try turning down the still heater.
3. Continue to recover the 4He until the tank pressure is about 950 -- 1000 mbar. It is important to watch the thermocouple vacuum gauge at the inlet of the large blowers, PI8360B. During recovery the pressure will be greater than 100 mtorr. When all the gas has been removed from the dilution refrigerator, this pressure will drop below 10 mtorr. Keep recovering the gas for at least 10 minutes after the thermocouple gauge has dropped below 10 mtorr. It will typically "burp" once or twice.
4. When you are confident that all the gas has been recovered (PI8368A is about 980 mbar, fridge temperatures above 10 K and thermocouple gauge below 10 mtorr), switch OFF the recoup pump, CLOSE MV8370A/B, and CLOSE MV8368A/B/C (the latter two are the valves on the 4He storage tank). Set both the still and mixing chamber heaters to 0 W. Please record the value of the still level probe. Empty, it's value (as read by EPICS) should be about -95% while the lock-in amplifier should say +95%.

Once all the 3He/4He mash has been recovered you now probably want to perform one of three following actions. Choose the appropriate document in order to:

1. **Remove the target stick**.
2. **Condense pure 4He** in the refrigerator and run at 1K.
3. **Warm the fridge to room temperature**.