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Oxford Heliox 3He insert

User manual for
3He stick
in BNL magnet
and 70mm orange cryostat

Julia Scherschligt and Tiffany Bass, September 2009.

Specs

- Designed to be used in Oxford BNL magnet
  - Use vacuum can with long, slender finger
  - Use gold-plated copper sample finger with threaded hole.

- Can be adapted for use in 70mm ILL cryostat
  - Baffle extenders must be used, remember to put adapter collar and ladish flange on the stick BEFORE attaching baffle extenders
  - Use small vacuum can with Mylar shield.

- Base Temperature < 300 mK, relies on mechanical thermal contact between sample and 3He pot. Take care when mounting your sample to ensure maximum thermal contact!

- Relies on exchange gas contact with 1K pot to pre-cool 3He pot
  - If cooling seems slow, try adding more exchange gas to magnet VTI or cryostat sample well.

- Controlling above about base temperature of 1K pot, add tiny amount (one "thumbful") of exchange gas to sample space and control with 1K pot.

- Controlling below base temperature of 1K pot, remove exchange gas with turbo pump and control with 3He pot.

- Stick has no reliable thermometry above 6 K, use 1K pot temp.

- Below 6K, use 3He "sensor 2," and know that your actual sample temperature will be slightly higher (50mK or so if you've mounted your sample properly).

- Additional wiring available at sample position. Currently (Sept '09) configured to read Cernox temperature sensor. Connection made in frig via 25-way MDM socket connector (Oxford part number A8-401). Connection at feedthrough made via Fischer connector.

Sample Mounting instructions

- Wrap sample in Al foil and then wire securely to sample holder. Ensure the best possible thermal contact with holder.

- **For use in BNL Magnet:**
  Make sample holder with male threads so that it can be directly attached to gold-plated sample finger. If possible, make holder out of copper. The distance from the bottom of the 3He pot to beam center is 400mm
  *For most samples, use long finger. Long finger is 369mm long, and has a M6 tapped hole (6mm deep) for mounting sample. Your sample holder should be 31mm from shoulder to sample center.
  *A short finger is also available. It is 180mm long and has a 1/4-20 tapped hole (0.5 inches deep)

  Holder must be AT MOST 17mm in diameter, and extreme care must be taken to prevent any part of the sample or sample mount from touching the walls of the vacuum can.

- **For use in 70mm ILL cryostat:**
  Make sample holder with a 5/16-18 tapped hole and attach it using small copper adapter.

  It must be no more than 1.1 inches in diameter, and the height from end of holder to sample center should be 70mm (2.76 inches).

Assembly Instructions

For use in BNL magnet

- Remove baffle extenders (if any)
- Remove collar (if present)
- Use brass and aluminum height adapters above upper flange at top of stick.

- Attach gold-plated finger to bottom of fridge
- Attach sample to end of finger, verify sample center is 40cm from bottom of 3He pot.
- Connect turbo pump to IVC port and open IVC valve
- Put generous amount of red sealing paste on stick taper (not on can!) and smooth evenly around.
- Turn on turbo pump
- Carefully slide long slender can onto stick and twist slowly and steadily in one direction until vacuum forms and can can no longer twist easily.

- Wait one hour before putting stick in magnet.
- To plug in cables, match numbers 1 and 2 on connectors.

Assembly Instructions

For use in Orange Cryostat

- Slide ladish flange onto stick, 
-  then slide collar onto stick. The end with 4 holes goes up, the end with 6 holes (shown) goes down. Attach to stick with screws.
- Attach baffle extenders. This is long and painful to do. The extenders with extra vent holes are meant to go above the sorb. 
- Use brass height adapter above upper flange at top of stick. Do not use the aluminum height adapter
- Attach small copper extender to bottom of 3He pot, attach sample to adapter. 
- Connect turbo pump to IVC port and open IVC valve
- Put generous amount of red sealing paste on stick taper (not on can!) and smooth evenly around.
- Turn on turbo pump
- Carefully slide short fat can onto stick and twist slowly and steadily in one direction until vacuum forms and can can no longer twist easily. 
- Wait one hour before putting stick in cryostat.
- To plug in cables, match numbers 1 and 2 on connectors.

Cooling

The Process of cooling is the same whether you're using the magnet or a cryostat. In these instructions the term "1K pot" refers to either the VTI of the magnet, or the annulus temperature (usually channel B) of the cryostat.

- Wait at least an hour (preferably overnight) for the red paste to cure before putting the stick into a cold cryostat/magnet. As always with cryogenic systems, take all precautions to prevent air getting into the well.

- When the IVC has pumped down to the mid 10^{-5} torr range, stop pumping on the sample space and add the smallest possible amount of 4He to the IVC. Remember that it is easier to pump out while warm.

- If not already cold, cool the cryostat/magnet as usual.

- Once the 3He pot (sensor 2 on Oxford controller) is around 4 K, start pumping the exchange gas back out of the IVC. The pressure in the IVC should pump down to the 10^{-5} torr scale fairly quickly.

- Adjust the needle valve and pump on the 1K pot. The 1K pot temperature needs to be less than 2K to condense 3He, preferably 1.4K or less.

- Set the sorb heater (sensor 1 highlighted on the ITC display) to 30K. **Note**: you may need to ramp the heat up manually if power shuts itself off when you put it in auto mode.

- Once the sample temperature (sensor 2) reads less than the 1Kpot temperature, 3He liquid is condensing. Let it condense for about one hour.

- After condensing for about an hour, turn off sorb heater. The sorb and sample temperatures should drop rapidly to base, if not, you may need to adjust the 1K pot. Base temperature in the magnet is about 280 mK and in the cryostat its about 300 mK. Note that the actual sample temperature will be somewhat higher than the reported temperature.

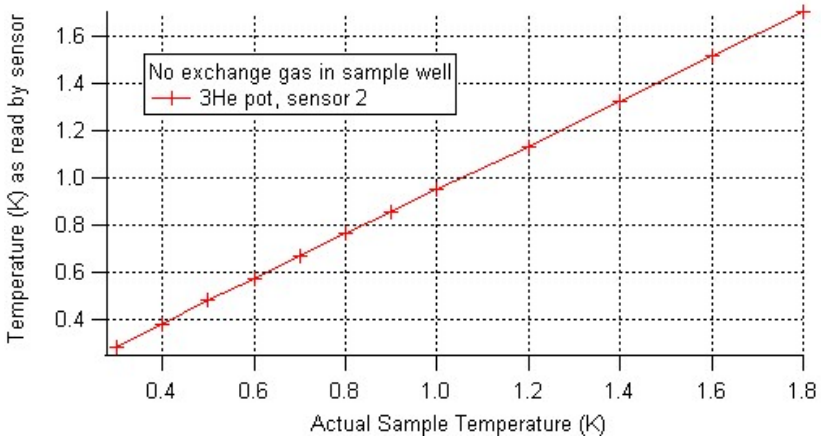
Temperature Control

Below ~ 1.6 K

There are two temperature ranges, control is very different between these ranges, and there is practically no overlap between them. Note that the high-T 3He pot sensor (sensor 3 on ITC) is poorly calibrated and should not be used. The low-T 3He pot sensor (sensor 2) goes up to 7K.

Below the temperature of the 1K pot (about 1.6 K) cooling is provided by sorption pumping 3He, and controlled by heaters on the 3He pot and sorb. Condense 3He and set ITC to control on sensor 2.

IVC evacuated, controlling on 3He pot (sensor 2).



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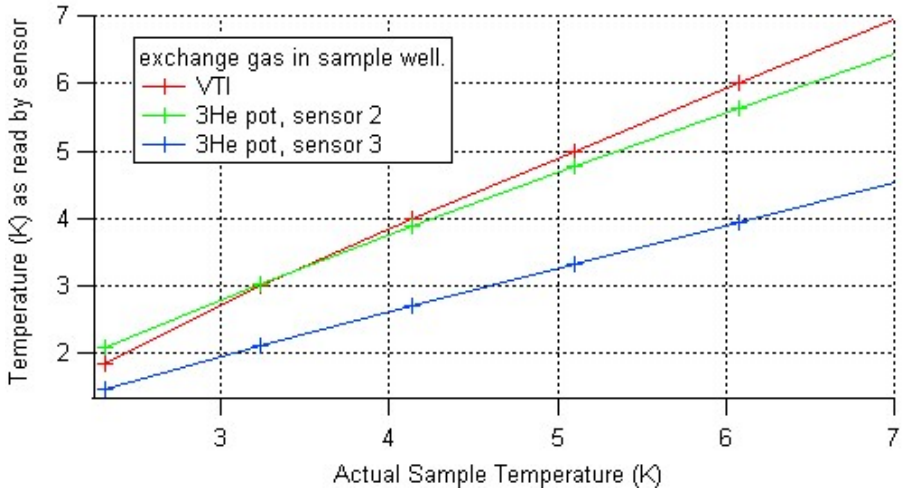
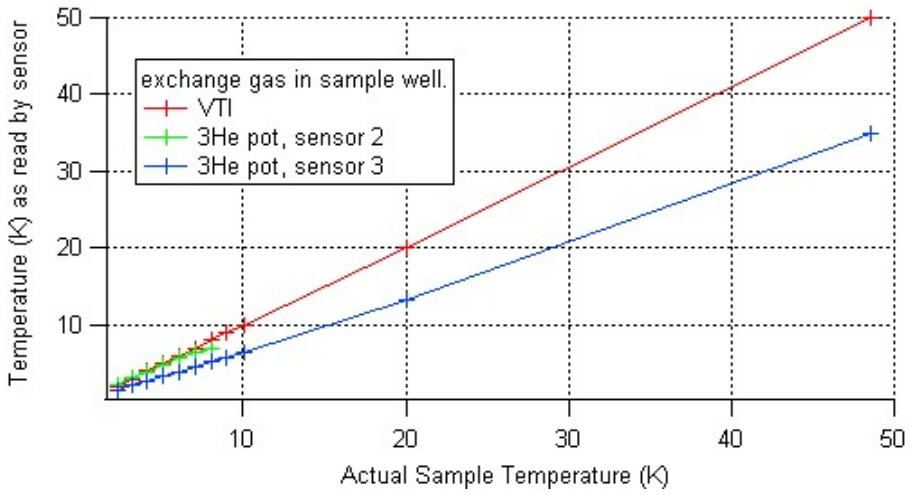
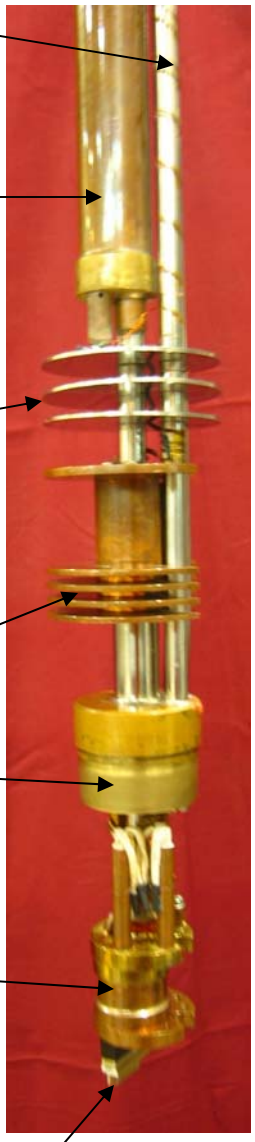
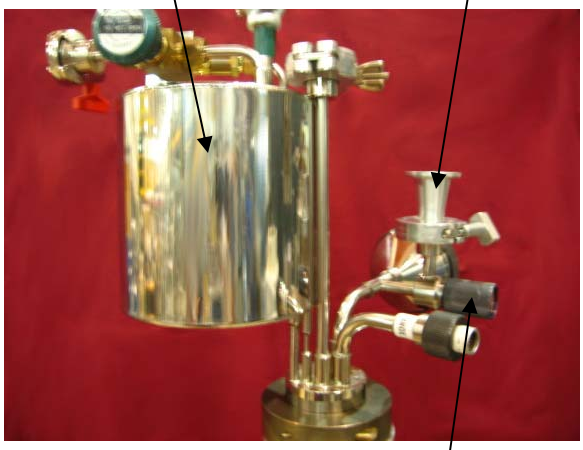
Above the temperature of the 1K pot (~1.6 K), add a tiny amount of exchange gas to IVC and control on 1K pot.





What's what





Definitions

IVC is the inner vacuum chamber, the space below the stick taper when vacuum can is on.

VTI is the central well of the BNL Magnet

ITC is the Oxford Instruments temperature controller, located on the BNL magnet instrument rack.