HB650 U-Tube Insertion & Isolation Procedure

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**Purpose**: This procedure is to outline the steps for u-tube insertion, pump & backfill, and isolation for the HB650MHz cryomodule through the 650 Cryogenic Transfer Line.

*Note:*

*Insertion and removal of u-tubes is a* ***two-person*** *operation.*

*If PIPII-IT Transfer line is stung into the 650 CTL, keep u-tube stung and skip the PIPII-IT TL to 650CTL U-tube insertion steps in this procedure.*

**PID Reference**:

F10042446- PIPII-IT Transfer Line Pixie Cryogenics

F10101087- HB650MHz Cryomodule.

**Definitions**

PIPII IT- Proton Improvement Plan Injection Test transferline

650 CTL- 650 Cryogenic Adapter Transfer Line

HB650 CM- High Beta 650MHz Cryomodule

**Assumptions**: PIPII-IT transfer line is cold. HB650 cryomodule and 650 CTL are 300K. 650 CTL is not connected to PIPII-IT Transfer line.

**Insertion/Pump & Backfill:**

1. Ensure the following valves are CLOSED in the PIPII-IT transfer line. Note: PV valves are in REMOTE & DISABLED via Synoptic
   * PV-604-H (2K Return)
   * MV-608-H (2K Return)
   * PV-605-H (5K Supply)
   * MV-610-H (5K Supply)
   * PV-606-H (8K Return)
   * MV-612-H (8K Return)
   * PV-607-H (40K Supply)
   * MV-614-H (40K Supply)
   * PV-608-H (80K Return)
   * MV-616-H (80K Return)
   * MV-712-H (High Pressure Helium supply WU/CD)
   * Roof Blocks are off to prevent ODH scenario
2. Ensure the following valves are OPEN to 100% in REMOTE & DISABLED via Synoptic

in HB650MHz Cryomodule

* + PV-JT
  + PV-CD

1. Ensure the following valves are CLOSED in HB650MHz Cryomodule
   * MV-030 (5K Inlet)
   * MV-034 (40 K Inlet)
   * MV-044 (80K Outlet)
   * MV-040 (8K Outlet)

**40/80K Circuit**

1. 80K RETURN Circuit- PIPII-IT TL to 650 CTL
   * Sting in the 80K SUPPLY PIPII-IT TL to CTL U-tube
     + Place U-tube on MV-616-H and MV-804-H with flow direction arrow toward MV-804-H
     + Simultaneously open MV-616-H and MV-804-H and drop the u-tube in
     + Tighten Goddard fittings
     + Note: No gas should be flowing at this time. If there is gas, alert the coordinating engineer.
2. 40K SUPPLY Circuit- HB650 CM to 650 CTL
   * Sting in the 40K SUPPLY HB650 CM to 650 CTL U-tube
     + Place U-tube on MV-034 and MV-803-H with flow direction arrow toward MV-034
     + Simultaneously open MV-034 and MV-803-H and drop the u-tube in
     + Tighten Goddard fittings
     + Note: No gas should be flowing at this time. If there is gas, alert the coordinating engineer.
3. 80K RETURN Circuit- HB650 CM to 650 CTL
   * Sting in the 40K SUPPLY HB650 CM to 650 CTL U-tube
     + Place U-tube on MV-044 and MV-805-H with flow direction arrow toward MV-805-H
     + Simultaneously open MV-044 and MV-805-H and drop the u-tube in
     + Tighten Goddard fittings
     + Note: No gas should be flowing at this time. If there is gas, alert the coordinating engineer.
4. 40K & 80K pump & back fill
   * Sting in pump and purge fixture into MV-804-H
   * Backfill with helium to 10 psig
   * After pressure holds for 1 min, close pressurizing valve.
   * Pump circuit to -29 inH2O.
   * Close vacuum pump valve. Monitor pressure remains at -29 inH2O for 1 min.
   * Pressurize circuit to 10 psig.
   * Repeat pump and purge cycle 4 more times. Once complete leave circuit pressurized to 10 psig.
   * Un-sting Pump & Purge fixture, Close MV-804-H quickly to leave pressure inside the 40/80K circuit.
5. 40K SUPPLY Circuit- PIPII-IT TL to 650 CTL
   * Sting in the 40K SUPPLY PIPII-IT TL to CTL U-tube
     + Place U-tube on MV-614-H and MV-802-H with flow direction arrow toward MV-802-H
   * Have the Coordinating engineer open PV-616-H (PIPII-IT TL)
     + Compressor suction backflow will be used to purge the final U-tube.
   * Open MV-616-H half way and verify gas is flowing through the U-tube.
     + Flow Helium through the U-tube for 3 minutes
   * Fully OPEN MV-616-H and MV-802 and sting in U-tube
   * Tighten Goddard Fittings on both bayonets.

**5/8K Circuit**

1. 5K SUPPLY- 650 CTL to HB650MHz cryomodule
   * Sting in the 5K SUPPLY 650CTL to HB650 CM U-tube
     + Place U-tube on MV-610-H and MV-030 with flow direction arrow toward MV-030-H
     + Simultaneously open MV-610-H and MV-030-H and drop the u-tube in
     + Tighten Goddard fittings
     + Note: No gas should be flowing at this time. If there is gas, alert the coordinating engineer.
2. 8K RETURN Circuit- HB650 CM to 650 CTL
   * Sting in the 5K SUPPLY HB650 CM to 650 CTL U-tube
     + Place U-tube on MV-801-H and MV-040 with flow direction arrow toward MV-610-H
     + Simultaneously open MV-610-H and MV-040 and drop the u-tube in
     + Tighten Goddard fittings
     + Note: No gas should be flowing at this time. If there is gas, alert the coordinating engineer.
3. 2K PUMPING- HB650MHz CM – 2K Header
   * Sting in the 2K RETURN HB650MHz CM to 2K Header U-tube
     + Place U-tube on MV-608-H and MV-045-H with flow direction arrow toward MV-608-H
     + Simultaneously open MV-608-H and MV-045-H and drop the u-tube in
     + Tighten Goddard fittings
     + Note: No gas should be flowing at this time. If there is gas, alert the coordinating engineer.
4. 5K & 8K pump & back fill
   * Sting in pump and purge fixture into MV-800-H
   * Backfill with helium to 10 psig
   * After pressure holds for 1 min, close pressurizing valve.
   * Pump circuit to -29 inH2O
   * Close vacuum pump valve. Monitor pressure remains at -29 inH2O for 1 min.
   * Pressurize circuit to 10 psig.
   * Repeat pump and purge cycle 4 more times. Once complete leave circuit pressurized to 10 psig.
   * Un-sting Pump & Purge fixture, Close MV-800-H quickly to leave pressure inside the 40/80K circuit
5. 8K Return- PIPII-IT TL to 650 CTL
   * Sting in the 8K SUPPLY PIPII-IT to 650 CTL U-tube
     + Place U-tube on MV-612-H and MV-800-H with flow direction arrow toward MV-612-H
   * Have the Coordinating engineer open PV-616-H
     + Compressor suction backflow will be used to purge the final U-tube.
   * Open MV-612-H half way and verify gas is flowing through the U-tube.
     + Flow Helium through the U-tube for 3 minutes
   * Fully OPEN MV-612-H and MV-800 and sting in U-tube
   * Tighten Goddard Fittings on both bayonets.

**Isolation**:

1. Ensure the following valves are CLOSED (to 0% in the case of PV valves) in the PIPII-IT transfer line. Note: PV valves are in REMOTE & DISABLED via Synoptic. Additionally, isolate air to all PV valves.
   * PV-604-H 2K Return
   * MV-608-H 2K Return
   * PV-605-H 5K Supply
   * MV-610-H 5K Supply
   * PV-606-H 8K Return
   * MV-612-H 8K Return
   * PV-607-H 40K Supply
   * MV-614-H 40K Supply
   * PV-608-H 80K Return
   * MV-616-H 80K Return
   * MV-712-H (High Pressure Helium supply WU/CD)
   * Roof Blocks are off to prevent ODH scenario
   * Cryomodule is warm, check with coordinating engineer.
2. 5K Circuit- 650 CTL to HB650 CM
   * Crack OPEN MV-801T-H (5K Circuit Bleed valve) to lower pressure inside HB650 5K circuit
   * Remove 5K circuit U-tube
   * Close manual immediately
     1. MV-801-H
     2. MV-040
     3. MV-801T-H
   * Place U-tube in a safe place.
   * Move to the next circuit
3. 40K Circuit
   * Depressurize circuit pressure
     1. Have coordinating engineering open PV-615-H, 2% as to not overwhelm the compressors
     2. Once pressure reaches suction pressure, close PV-615-H
   * Crack OPEN MV-805T-H (40K Circuit Bleed valve) to lower pressure inside HB650 5K circuit
   * Remove 40K circuit U-tube
   * Close manual immediately
     1. MV-805-H
     2. MV-034
     3. MV-805T-H
   * Place U-tube in a safe place.
   * Move to the next circuit
4. 80K Circuit
   * Crack OPEN MV-803T-H (5K Circuit Bleed valve) to lower pressure inside HB650 5K circuit
   * Remove 5K circuit U-tube
   * Close manual immediately
     1. MV-803-H
     2. MV-044
     3. MV-803T-H (bleed valve)
     4. MV-802-H (bleed valve
   * Place U-tube in a safe place.
   * Move to the next circuit
5. 2K Circuit
   * Remove 2K circuit U-tube
     1. Crane may be needed during this operation
   * Close manual immediately
     1. MV-609
     2. MV-045
   * Place U-tube in a safe place.