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.