**LCLS-II LERF Cryomodule Temperature Bump Cryo Procedure**

DRAFT- v4 10/14/2018

1. Confirm that an ATLis entry for the temperature bump has been created and reviewed.
2. Plot the following signals (Tables 1 through 5) with the Maya Strip Chart on separate graphs. The Strip Chart (DEV) option will have to be used for the helium vessel temperatures.

**Table 1: CM1 Valves and Diodes**

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| --- | --- |
| **Description** | **PV** |
| Helium Pressure 0 – 5000 Torr | CPICM0114 |
| Helium Pressure 0 – 100 Torr | CPICM0113 |
| Cryomodule Liquid Level | CLLCM0113CLLCM0112 |
| Cavity 5 Helium Vessel Top | srfccon3A:cha |
| Cavity 5 HOM Copper Strap DS | srfccon3A:chc |
| Cavity 5 HOM Copper Strap US | srfccon3A:chd |
| Cryomodule Cooldown Valve | CPVCM01CD |
| Cryomodule JT Valve | CPVCM01JT |

**Table 2: CM2 Valves and Diodes**

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| --- | --- |
| **Description** | **PV** |
| Helium Pressure 0 – 5000 Torr | CPICM0212 |
| Helium Pressure 0 – 100 Torr | CPICM0211 |
| Cryomodule Liquid Level | CLLCM0211CLLCM0210 |
| Cavity 5 Helium Vessel Top | srfccon3B:cha |
| Cavity 5 HOM Copper Strap DS | srfccon3B:chc |
| Cavity 5 HOM Copper Strap US | srfccon3B:chd |
| Cryomodule Cooldown Valve | CPVCM02CD |
| Cryomodule JT Valve | CPVCM02JT |

**Table 3: Cryo Can Valves and Diodes**

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| --- | --- |
| **Description (Temperature Diodes)** | **PV** |
| Cryo Can Cooldown Valve | CEVCM03CD |
| GHRP Downstream | CTDCM0370 |
| GHRP Upstream | CTDCM0168 |

**Table 4: Vacuum Readings for temperature bump chart**

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| --- | --- |
| **Description** | **PV** |
| Beamline Vacuum | SRFCMTFBLVAC1 |
| Waveguide Vacuum | SRFCMTFWGVAC1 |
| Insulating Vacuum | SRFCMTFINSULVAC1 |

**Table 5: Magnet Field sensor signals**

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| --- |
| Srf-crio-cmtf:SRFMAG:10 |
| Srf-crio-cmtf:SRFMAG:11 |
| Srf-crio-cmtf:SRFMAG:12 |
| Srf-crio-cmtf:SRFMAG:13 |
| Srf-crio-cmtf:SRFMAG:20 |
| Srf-crio-cmtf:SRFMAG:21 |
| Srf-crio-cmtf:SRFMAG:22 |
| Srf-crio-cmtf:SRFMAG:23 |

1. Ensure manual cooldown valve CMVCM0366 is open.

**CM2 Temperature Bump**

1. Make a log entry in SRFLOG, CLOG and ATLis indicating that the CM2 temperature bump is ready to begin. Note the initial magnetic field measurements.
2. Bring the valves to the following positions:
	* 1. CPVCM01JT – Closed
		2. CPVCM02JT – Closed
		3. CPVCM01CD – Closed
		4. CPVCM02CD – Closed
		5. CEVCM0312 – Open
		6. CEVCM0313 − Open
		7. CEVCM03CD − Open
		8. CEVCM03RT − Closed
3. Inform the Cryo Group that the temperature bump is about to begin.
4. Request Cryo Group to open the SLinac CD manual valve MV100SCD.
	1. This allows flow from the SLinac transfer line cooldown header to recovery.
5. Ask the SME to connect the helium vessel and cooldown line heaters. Once ready, turn on the CM2 helium vessel heater to the max power of 100 W, and turn on the CM2 cooldown line heater to the max power of 150 W.
6. The liquid level in CM2 will begin to drop. Request Cryo Group to monitor the CHL Recovery Pressure (CPI0840) to ensure that it stays below 1.08 atm. If the level rises above 1.09 atm, lower the HV heater power until the pressure has stabilized. The HV heaters will turn off when the liquid level falls to 20%.
7. The cavities will now begin to warm up; the cavity 5 HV top diode (srfccon3B:cha) will be used to represent the cavity temperature. Note the rate of rise in the diode temperature.
8. To decrease the warming rate, CPVCM02CD may be opened slightly. The following should be noted:
	1. The cooldown heater will be heating all flow entering the helium vessel but it may be overwhelmed by too much cold flow from the 4.5 K Supply, reducing the warming rate.
	2. Reducing the flow will result in warmer gas entering the helium vessel, but also at a lower flow rate, also reducing the warming rate.
	3. With respect to the points above, adjust the CPVCM02CD valve until there is an optimum value.
9. When the Cavity 5 HV diodes (srfccon3B:cha) reach 40K, inform the cryo group that the fast cooldown of CM2 is ready to begin.
10. Switch off the cooldown heater.
11. Request that the Cryo Group monitor the SLINAC cold compressor speed during steps 15-17.
12. Fully open CPVCM02CD over a 1 minute period.
13. Note the rate (K/min) with which the HV diode (srfccon3B:cha) temperature crosses the transition temperature (~9 K).
14. When the cavity temperature reaches 4K, liquid will start to form in CM2 (CLLCM0211). When the liquid level (CLLCM0210) has reached an average value of 70%, the signal will be noisy.
15. Close CPVCM02CD and set the CPVCM02JT in order set liquid level CLLCM0210 at 80%.
16. Make a log entry in SRFLOG, CLOG and ATLis indicating that the temperature bump of CM2 is complete. Record the cooling rate through transition from Step 12 and the final magnetic field readings.

**CM1 Temperature Bump**

1. Close JT02
2. Make an entry ATList indicating that the CM1 temperature bump is ready to begin. Note the initial magnetic field measurements.
3. Turn on the CM1 helium vessel heater to the max power of 100W, and turn on the CM1 cooldown line heater to the max power of 122W.
4. The liquid level in CM1 will begin to drop. Monitor the CHL Recovery Pressure (CPI0840) to ensure that it stays below 1.08 atm. If the level rises above 1.09 atm, lower the HV heater power until the pressure has stabilized. The HV heaters will turn off when the liquid level falls to 20%.
5. The cavities will now begin to warm up; the cavity 5 HV top diode (srfccon3A:cha) will be used to represent the cavity temperature. Note the rate of rise in the diode temperature.
6. To decrease the warming rate, CPVCM01CD may be opened slightly. The following should be noted:
	1. The cooldown heater will be heating all flow entering the helium vessel but it may be overwhelmed by too much cold flow from the 4.5 K Supply, reducing the warming rate.
	2. Reducing the flow will result in warmer gas entering the helium vessel, but also at a lower flow rate, also reducing the warming rate.
	3. With respect to the points above, adjust the CPVCM01CD valve until there is an optimum value.
7. When the Cavity 5 HV diodes (srfccon3A:cha) reach 40K, inform the cryo group that the fast cooldown of CM1 is ready to begin.
8. Switch off the cooldown heater.
9. Request the Cryo Group monitor the SLINAC cold compressor speed during steps 29-31.
10. Fully open CPVCM01CD over a 1 minute period.
11. Note the rate (K/min) with which the HV diode (srfccon3A:cha) temperature crosses the transition temperature (~9 K).
12. When the cavity temperature reaches 4K, liquid will start to form in CM1. When the liquid level (CLLCM0112) has reached an average value of 70%, the signal will be noisy.
13. Close CPVCM01CD and set CPVCM01JT in order to set liquid level CLLCM0112 at 80%.
14. Close CEVCM03CD and incrementally open CEVCM03RT.
	1. Contact the Cryo Group for assistance in monitoring the return pressure and determining the rate for opening the valve.
15. Disconnect CEVCM01RT from controls
16. The pressure (CPICM0114 & CPICM0212) will start to drop. Switch from the 0 – 5000 torr transducers to the 0 – 100 torr transducers (CPICM0211 & CPICM0113). When the pressure has stabilized at a value below 0.040 atm (30 torr), the cavities are at 2 K. This will not be reflected in the cavity 5 HV diodes, which will remain at 4K.
17. Double-check guard vacuum.
18. Make a log entry in SRFLOG, CLOG and ATLis indicating that the temperature bump of CM1 is complete. Record the cooling rate through transition from Step 24 and the final magnetic field readings.
19. Set the valves to the following (overnight) settings until testing is ready to restart:

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| **CPVCM01JT** |
| **Quantity** | **Value** | **Quantity** | **Value** |
| **Max Pos** | 70.00 | **ST** | 20.000 |
| **Min Pos** | 10.00 | **Gp** | 75.000 |
| **Max Chg** | 2.000 | **Gi** | 0.080 |
| **Min Chg** | 0.100 | **Gd** | 0.050 |
| **Input** | CLLTC1 |
| **Set Value** | 90.00 |

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| **CPVCM02JT** |
| **Quantity** | **Value** | **Quantity** | **Value** |
| **Max Pos** | 70.00 | **ST** | 20.000 |
| **Min Pos** | 10.00 | **Gp** | 75.000 |
| **Max Chg** | 2.000 | **Gi** | 0.080 |
| **Min Chg** | 0.100 | **Gd** | 0.050 |
| **Input** | CLLTC2 |
| **Set Value** | 90.00 |