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| Traveler Title | L2HE Cavity String Assembly |
| Traveler Abstract | This traveler provides instructions for L2HE Cavity String Assembly with Cleanroom Purge System |
| Traveler ID | L2HE-CLNRM-CST-ASSY |
| Traveler Revision  | R1 |
| Traveler Author | Tiffany Ganey |
| Traveler Date | 8-Feb-22 |
| NCR Informative Emails | dreyfuss,areilly,hogan,ganey,hannesv |
| NCR Dispositioners | forehand,kwilson,kdavis |
| D3 Emails | forehand,dreyfuss,kdavis,ganey,hannesv,kwilson,hogan,areilly |
| Approval Names | Tiffany Ganey | Danny Forehand | Peter Owen | John Hogan  |
| Approval Signatures |  |  |  |  |
| Approval Dates |  |  |  |  |
| Approval Title | Author | Work Center Lead | Purge System Owner | Project Manager |

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| References | List and Hyperlink all documents related to this traveler. This includes, but is not limited to: safety (THAs, SOPs, etc.), drawings, procedures, and facility related documents. |
| [F10023864](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-240000/Cavity%20Drawing%20Package%20F10023864_rev_M_drawing_package.pdf)[Production Cavity Assembly Drawing](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-240000/Cavity%20Drawing%20Package%20F10023864_rev_M_drawing_package.pdf) | [F10127865](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-252521/F10127865_C_DWG1.pdf)[LCLS-II HE Cavity String Assembly Drawing](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-252521/F10127865_C_DWG1.pdf) | [F10040886](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-248684/F10040886_C_DWG1.pdf) [LCLS-II CM Faraday Window Manifold](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-248684/F10040886_C_DWG1.pdf) | [F10092047](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-252116/F10092047--_1-FARADAY%20WINDOW%20COVER.stl)[Faraday Window Cover](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-252116/F10092047--_1-FARADAY%20WINDOW%20COVER.stl) |  |
| L2HE-PR-CLNRM-GV1SA-ASSYUpstream Gate Valve Sub-Assembly and Installation | [L2HE-PR-CLNRM-GV2SA-ASSY](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-251394/L2HE-PR-CLNRM-GV2SA-ASSY-R1.pdf)[Downstream Gate Valve / BPM Sub-Assembly and Installation](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-251394/L2HE-PR-CLNRM-GV2SA-ASSY-R1.pdf) |  |  |  |
| [SRF-MSPR-CLNRM-TOOL-SPCLMP](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-250845/SRF-MSPR-CLNRM-TOOL-SPCLMP-R1.pdf)[Nitrile Glove Covering of Spring Clamp](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-250845/SRF-MSPR-CLNRM-TOOL-SPCLMP-R1.pdf) | [SRF-MSPR-CLNRM-LEAK](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-250698/SRF-MSPR-CLNRM-LEAK-R1.pdf)[Leak testing with an RGA Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-250698/SRF-MSPR-CLNRM-LEAK-R1.pdf) | [SRF-MSPR-CLNRM-CST-IONCLN](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-250935/SRF-MSPR-CLNRM-CST-ION-R1.pdf)[Ionized Nitrogen Cleaning Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-250935/SRF-MSPR-CLNRM-CST-ION-R1.pdf) | [SRF-MSPR-CLNRM-PUMP](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-251963/SRF-MSPR-CLNRM-PUMP-R1.pdf)[Clean Room Production Pump System Operation](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-251963/SRF-MSPR-CLNRM-PUMP-R1.pdf) |  |

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| Revision Note |  |
| R1 | Initial release of this Traveler. |

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| **Section** | **Traveler Page Number** |
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| **Step No.** | **Instructions** | **Data Input** |
| Definitions:

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| **Ionized Nitrogen (N2) Parts Cleaning Specifications** |
| Spec 1 | Particle counts are to be zero on all scales except 0.3 um, which can be zero or 1 in five seconds. |
| Spec 2 | Particle counts are to be one count per second or less on the 1 um scale. This is equivalent to particle counts </= 10 counts per 10 second cycle on the 1 um scale. |
| **Purge System Components** |
| MFC1[White Line] | Mass Flow Controller #1: Connected to the cavity string upstream valve on the Faraday Window Manifold. This Line typically does not include a pump cart. |
| MFC2 [Blue Line] | Mass Flow Controller #2: Moves to each cavity during assembly to the cavity string. This Line is connected to a pump cart with a turbo only at minimum; a slow pump cart may be used. |
| MFC3 [YELLOW LINE] | Mass Flow Controller #3: Connected to the cavity string downstream NEG pump sub-assembly right angle valve. This Line shall be connected to a slow pump cart to assist with final string slow pump down. |
| MFC Isolation Valve | Isolation valve installed on the Purge table. There is one per MFC Line. Typically remains open throughout string assembly. |
| MFC Needle Valve | Needle valve installed on the Purge table. There is one per MFC Line. Typically remains open throughout string assembly. |
| Spool | An elbow with welded VCR fitting or tee with CF flanges that connects to the purge system (vacuum Line and gas Line) to the Cavity String Right Angle Valve. |
| Spool Valve | Valve on the Spool piece, between the filter and Swagelok fitting. Typically remains open, but is closed for final string pump down. This valve may or may not be installed on the Spool for cavity assemblies to the string. This valve shall be installed on the Spool for the downstream sub-assembly. |
| **Purge Software** |
| Standby | Closes the pneumatic valve and MFC (under the floor), and does not allow gas to flow |
| Blowout | Opens the pneumatic valve and opens the MFC fully to allow for gas flow at approximately 7 L/min |
| Backfill | Opens the pneumatic valve and opens the MFC to allow for gas flow at approximately 300 SCCM |
| Purge | Opens the pneumatic valve and opens MFC to allow for gas flow at approximately 1000 SCCM |
| Interlock | 50 mbar above atmosphere (baratron reading = 50 mbar) |

 |
| 1. | **Prepare for String Assembly**1. Select the serial number of the cavity string to be assembled. | [[CMSN]] <<CMSN>> |
| 2. Eight cavities have been qualified in the VTA and are deemed ready for cavity string assembly. The cavities shall be under vacuum with test hardware still installed.* Inspect the cavity for dents and damage. Pay particular attention to the bellows.
* Check HOM connectors for electrical shorts.
* Verify that all cavities have been cleaned by Chemistry, including removal of all tape residue and wipe down of external surfaces. Pay particular attention to flange areas.
 | [[CavitiesPrepped]] <<YESNO>>[[CavityPrepComment]] <<COMMENT>> |
| 3 Sub-Assemblies are ready:* An upstream gate valve sub-assembly [GV1SA] is assembled, leak checked, backfilled to atmospheric pressure, and ready for installation on the rail in accordance with L2HE-PR-CLNRM-GV1SA-ASSY.
* A BPM magnet sub-assembly [GV2SA] is assembled, leak checked, under vacuum, and staged on the mini-rail in accordance with L2HE-PR-CLNRM-GV2SA-ASSY.
 |  |
| 4. Cavity string components of F10127865 have been cleaned and are verified to be ready as needed for completion of the string.* 8 couplers
* All cavity string fasteners and gaskets
* 7 inter-cavity bellows
 |  |
| 5. Cavity string tooling has been cleaned and setup in the production cleanroom ready for cavity string assembly.* Bridge level
* Dial indicator tooling for cavity positioning
* Coupler holder and adjustable table
* Bellows, restraints, holder and adjustable table
* Upstream purge holder and adjustable table, if available
* Alignment blanks
 |  |
| 6. Purge system hardware is cleaned and ready for use as needed.* 1-1/3 CF fasteners and gasket for GV1SA.
* 2-3/4 CF fasteners and gaskets for Cavity and GV2SA. Use large-bore gaskets for all purge system spool assemblies, when available.
 |  |
| 7. Purge system is ready for cavity string assembly.* The purge system is connected to the cleanroom N2 supply.
* The pump cart with isolation valve is staged near the rail.
* The MFC1 [White Line] Needle valve and Isolation valve are open.
* The MFC2 [Blue Line] Needle valve and Isolation valve are open.
* The MFC3 [Yellow Line] Needle valve and Isolation valve are open.
* The Spool valve is open.
 |  |
| 8. Magnetic hygiene has been completed on components. | [[MagneticHygieneComplete]] <<YESNO>> |
| 9. Record the date the string prep is complete. | [[StringPrepComment]] <<COMMENT>>[[StringPrepCompleteTime]] <<TIMESTAMP>>[[StringPrepVerificationTech]] <<SRFCVP>> |

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| Step No. | Instructions | Data Input |
| 2. | **Upstream Gate Valve Sub-Assembly [GV1SA] Prep**1. Record upstream gate valve serial number. | [[AMGVSN1]] <<AMGVSN>> |
| 2. Record upstream bellows serial number. | [[BLBUSN]] <<BLBUSN>> |
| 3. If available, record Faraday Window Manifold serial number. | [[FWMSN]] <<FWMSN>> |
| 4. Transfer GV1SA on to the lollipop system.* Verify that the gate valve handle is facing the power coupler direction and the gate valve flange marked with a triangle is installed on the string side.
 |  |
| 5. Blow down GV1SA with ionized N2 to Spec 1 in accordance with the Ionized Nitrogen Cleaning Procedure.  |
| 6. Prepare the MFC1 [White Line] Spool for assembly to the Faraday Window Manifold right angle valve.* Set the purge software to "Standby" for MFC1 [White Line].
* Verify the baratron for MFC1 [White Line] is reading approximately 0.
* Wipe the MFC1 [White Line] Spool flange and reducer with a prewet IPA wipe.
* Remove the blank, gasket, and all fasteners from the MFC1 [White Line] Spool.
* Wipe bolt holes with an IPA dipped Q-tip.
* Wipe flange sealing surface with prewet IPA wipe.

**Note**: One technician shall hold the Spool and point opening away from the string, people, and any other critical components such as a cavity bays and prepared / cleaned parts. Angle the opening towards the floor until the Spool is ready to be installed onto the right angle valve. A second technician shall perform the purge system set up and particle counts.* Set the purge software to "Blowout" for MFC1 [White Line].
* Verify the purge turns on.
* Flow N2 through the Spool until Spec 1 is reached for two full cycles.
* Set the purge software to "Purge" for MFC1 [White Line].
 |
| 7. Install the MFC1 [White Line] purge system Line to the Faraday Window Manifold right angle valve.* Blow down the Faraday Window Manifold right angle valve, including the flange, bolt holes, and inside the valve up to the valve stem.
* Place a new cleaned [Spec 1] gasket on the MFC1 [White Line] Spool.
* Install two pre-cleaned [Spec 1] studs in a star pattern and snug with a wrench.
* Install the four remaining studs continuing the star pattern.
* Torque all studs to 53 in-lbs using a standard torque pattern for a round flange.
* Repeat the final torque sequence twice and then go around all the studs at least twice or until there is no movement of the nuts.
* If the purge system does not shut off, increase torque wrench up to 84 in/lbs or until the flanges go metal-to-metal.
* Verify the purge turns off.
 |
| 8. Slowly open the Faraday Window Manifold right angle valve. The GV1SA is now connected to the purge system. * Leave the software set to "Purge" for MFC1 [White Line].
 | [[GV1SAPrepComment]] <<COMMENT>>[[GV1SAPrepTime]] <<TIMESTAMP>>[[GV1SAPrepTech1]] <<SRFCVP>> |

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| Step No. | Instructions | Data Input |
| 3. | **Cavity 1 Prep**1. Record Cavity 1 serial number. | [[CAVSN1]] <<CAVSN>> |
| 2. Put the cavity on the rail tooling with the blank flange facing the upstream gate valve sub-assembly [GV1SA] and the FPC facing the southeast corner of the cleanroom. |  |
| **Note: There will be some movement of flange location and/or cavity level every time something is adjusted. Several iterations of the cavity alignment will be required before the cavity will be perfectly level and have both beamline flanges in place.****Note**: **The upstream flange of Cavity 1 will dictate the location on all the cavities in the string.**3. Align the cavity and GV1SA. The cavity shall be aligned with the flange alignment tool to locate the beamline flange in the proper location.* Verify the location of the flange is near the center of the range of the tooling to accommodate the alignment of all the cavities in the string.
* After both flanges of the cavity are in the same position - relative to the rail - set the roll of the cavity level using a precision level on the leveling tool, which is attached to the other set of helium vessel blocks.
* Place the upstream bellows flange, which is part of the upstream gate valve sub-assembly [GV1SA], at the same height and location from the rail as that of the cavity flanges.
* Level the valve body using the precision level (within 0.25 degrees from level before assembly). Lock the valve lollipop in place with rail locks.
 |
| 4. Set the roll of the cavity rotationally using the rotational alignment bridge and the "A" frame. Verify all four frame studs and "A" frame studs are tight when finished. |
| 5. Blow down the cavity with ionized N2 in accordance with the Ionized Nitrogen Cleaning Procedure.* General cavity to Spec 2.
* Cavity flange, bolt holes, and inside the right angle valve up to the valve stem to Spec 1.
 |
| 6. Prepare the MFC2 [Blue Line] Spool for assembly to the cavity right angle valve.* Set the purge software to "Standby" for MFC2 [Blue Line].
* Verify the baratron for MFC2 [Blue Line] is reading approximately 0.
* Wipe the MFC2 [Blue Line] Spool with a prewet IPA wipe.
* Remove the blank, gasket, and all fasteners from the MFC2 [Blue Line] Spool.
* Wipe bolt holes with an IPA dipped Q-tip.
* Wipe flange sealing surface with prewet IPA wipe.

**Note**: One technician shall hold the Spool and point opening away from the string, people, and any other critical components such as a cavity bays and prepared / cleaned parts. Angle the opening towards the floor until the Spool is ready to be installed onto the right angle valve. A second technician shall perform the purge system set up and particle counts.* Set the purge software to "Blowout" for MFC2 [Blue Line].
* Verify the purge turns on.
* Flow N2 through the Spool until Spec 1 is reached for two full cycles.
* Set the purge software to "Purge" for MFC2 [Blue Line].
 |
| 7. Install the MFC2 [Blue Line] purge system Line to the cavity right angle valve.* Place a new cleaned [Spec 1] gasket on the MFC2 [Blue Line] Spool. Use a large-bore gasket if available.
* Install two pre-cleaned [Spec1] studs in a star pattern and snug with wrench.
* Install the four remaining studs continuing the star pattern.
* Torque all studs using a standard torque pattern for a round flange.
* Repeat the final torque sequence twice and then go around all the studs at least twice or until there is no movement of the nuts. Stop if the flanges go metal-to-metal.
* Verify the purge turns off.
 |
| 8. Pump down the purge line to the cavity right angle valve.* Set the purge software to "Standby" for MFC2 [Blue Line].
* Pump down the purge header to the closed right angle valve on the cavity. Allow the header to pump to the mid E-5 mbar range.
* Close the pump isolation valve.
 |
| 9. While monitoring the cavity pressure, slowly open the cavity right angle valve. If the cavity pressure reads at the mid E-4 mbar range or higher, notify the cleanroom supervisor. | [[CAV1VacuumOK]] <<YESNO>> |
| 10. Set the purge software to "Backfill" for MFC2 [Blue Line] and slowly backfill the cavity. |  |
| 11. When the cavity has been backfilled to the interlock value (50 mbar), change the purge software to "Purge" for MFC2 [Blue Line]. | [[CAV1PrepComment]] <<COMMENT>>[[CAV1PrepTime]] <<TIMESTAMP>>[[CAV1PrepTech]] <<SRFCVP>> |
| 4. | **Cavity 1 FPC Installation**1. Gather the following components for the connection of the cold end coupler to the cavity. Verify the components are cleaned and ready for installation.* 1 inspected and accepted FPC body
* 1 FPC body flange alignment blank
* 2 clean spring clamps
* Fasteners
* 1 hex seal gasket
* Retainer clips
* Wrenches
 |  |
| 2. Record the FPC Serial Number. | [[FPCSN1]] <<FPCSN>> |
| 3. Use the FPC body holding tool to hold and spray the FPC to Spec 1.4. When all the N2 spraying is complete, carefully place the alignment tooling over the probe tip and onto the FPC body flange. Clamp in place with two spring clamps.* Open the clamps down and away from the cavity.

5. Install the FPC onto the installation tooling and spray to Spec 1. |  |
| 6. Verify the purge software is set to "Purge" for MFC2 [Blue Line].4. Remove 4 of the 8 studs in the cavity FPC flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 studs in a star pattern from the cavity flange and check the purge system.
* Remove 2 additional studs from the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

7. Install 2 pre-cleaned [Spec 1] studs in the open holes on the cavity and torque to 10 ft-lbs.8. Continue to remove original studs on the cavity flange 2 at a time from the cavity flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 studs in a star pattern from the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.
* Continue fastener removal until all of the original fasteners have been removed and only the two pre-cleaned studs remain installed.

9. [Two person] Remove the pre-cleaned studs on the cavity coupler flange and carefully remove test coupler and gasket from cavity. Verify the purge starts.10. Install FPC alignment blank on cavity flange with spring clamps.* Open the clamps down and away from the cavity.
 |  |
| 11. Install the FPC alignment table on the lollipop.12. Align FPC to open holes on alignment blank.13. Move FPC back as far as possible on the FPC table.14. Remove the FPC coupler cover.15. Install the FPC gasket with retaining clips to hold the gasket in place on the FPC. Verify the clips are placed in the horizontal position. |
| 16. Remove the alignment blank from the cavity.17. [Two person] Move FPC into place, remove the gasket clips, and install 2 pre-cleaned [Spec 1] studs in a star pattern to secure coupler. Snug studs with wrench.18. Install 2 additional pre-cleaned [Spec 1] studs continuing the star pattern and snug with wrench.19. Install remaining 4 studs in pairs continuing the star pattern on FPC flange. |
| 20. Torque all fasteners to 60 in/lbs using a standard torque pattern for a round flange.21. Increase the torque wrench setting to 10 ft-lbs [120 in/lbs] and torque all fasteners using a standard torque pattern for a round flange.22. Repeat the final torque sequence twice and then go around all the fasteners at least twice or until there is no movement of the nuts. Verify the purge stops. | [[FPC1InstallComment]] <<COMMENT>>[[FPC1InstallTime]] <<TIMESTAMP>>[[FPC1InstallTech]] <<SRFCVP>> |
| 23. Remove coupler alignment table from lollipop and install FPC support arm. | [[FPC1SupportArmInstalled]] <<YESNO>> |
| 5. | Upstream Gate Valve Sub-Assembly to Cavity 1 Assembly1. Gather the following components. Verify the components are cleaned and ready for installation.* 2 bellows flange alignment blanks
* 1 beamline gasket
* 4 covered spring clamps
* Fasteners
* Retainer clips
* Wrenches
 |  |
| **Prepare the Upstream Gate Valve Sub-Assembly [GV1SA] Bellows Flange**2. Verify the purge software is set to "Purge" for MFC1 [White Line].3. Remove 8 studs from the GV1SA bellows end flange in a star pattern. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

4. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.5. Remove final 4 original studs 2 at a time from the flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

6. Remove the 4 pre-cleaned studs from the bellows flange. Carefully remove the blank and gasket. Verify the purge starts.7. Flow purge gas through the GV1SA until Spec 1 is reached for two full cycles.8. Carefully place an alignment blank onto the bellows flange. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the bellows.
 |
| **Prepare the Cavity 1 Upstream Flange**9. Verify the purge software is set to "Purge" for MFC2 [Blue Line].10. Remove 8 studs from the cavity upstream end flange in a star pattern. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

11. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.12. Remove final 4 original studs 2 at a time from the flange continuing the star pattern. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

13. Remove the 4 pre-cleaned studs from the cavity flange and carefully remove the blank and gasket. Verify the purge starts.14. Carefully place an alignment blank on the cavity flange. Verify that the alignment pins on the cavity flange do not line up with the alignment pins on the bellows. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the cavity.
 |
| **Align GV1SA Bellows and Cavity End Flanges**15. Slowly slide the cavity towards the bellows to check flange alignment. The nipples on the alignment blanks should move freely into the indents of the flanges. A slight rotation of the bellows flange can be performed if necessary during the alignment process.16. Move the cavity away from the bellows flange.17. Carefully remove the alignment blanks from the cavity and bellows. |
| **Install Cavity to GV1SA Bellows**18. Install the beamline gasket with retaining clips to hold the gasket in place on the bellows flange. Verify the clips are placed in the horizontal position.19. [Two person] Slowly slide the cavity back into place against the gasket. Remove the gasket clips.20. One technician shall hold the flanges tightly together, preventing the flanges from rotating or moving away from each other. This technician shall hold the flanges until the first 4 studs have been snugged tight with a wrench.21. A second technician shall place 4 pre-cleaned [Spec 1] studs in a star pattern in the cavity flange and snug them with a wrench.22. The second technician shall place the remaining fasteners on the flange continuing the star pattern and snug all of them with a wrench.23. Verify the level of both the cavity and GV1SA before torquing the fasteners. 24. Torque the fasteners to 15 ft-lbs using a standard torquing pattern for a round flange.25. Increase the torque and torque all the fasteners to 31 ft-lbs using a standard torquing pattern for a round flange.26. Repeat the final torque sequence twice and then go around all of the fasteners at least twice or until there is no movement of the nuts. Verify the purge system turns off.27. Install rail locks on the cavity and valve to lock it in place. | [[GV1SA\_CAV1Comment]] <<COMMENT>>[[GV1SA\_CAV1Time]] <<TIMESTAMP>>[[GV1SA\_CAV1Tech1]] <<SRFCVP>>[[GV1SA\_CAV1Tech2]] <<SRFCVP>> |
| **Remove Purge System Hose from Cavity 1**28. Verify the purge software is set to "Purge" for MFC1 [White Line].29. Set the purge software to "Standby" state for MFC2 [Blue Line]. This will close MFC2 [Blue Line] and MFC2 [Blue Line] will not open under any circumstance. If a drop in pressure occurs, the purge will initiate from MFC1 [White Line].30. Slowly close the cavity right angle valve.31. Remove the purge system hose from the cavity.32. Put a blank on the Spool with two studs using the same gasket. |  |

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| Step No. | Instructions | Data Input |
| 6. | **Cavity 2 Prep**1. Record Cavity 2 serial number. | [[CAVSN2]] <<CAVSN>> |
| 2. Put the cavity on the rail tooling with the blank flange facing the upstream gate valve sub-assembly [GV1SA] and the FPC facing the southeast corner of the cleanroom. |  |
| **Note: There will be some movement of flange location and/or cavity level every time something is adjusted. Several iterations of the cavity alignment will be required before the cavity will be perfectly level and have both beamline flanges in place.****Note**: **The upstream flange of Cavity 1 will dictate the location on all the cavities in the string.**3. Align Cavity 2 and the upstream flange of Cavity 1. The cavity shall be aligned with the flange alignment tool to locate the beamline flange in the proper location.* Verify the location of the flange is near the center of the range of the tooling to accommodate the alignment of all the cavities in the string.
* After both flanges of the cavity are in the same position - relative to the rail - set the roll of the cavity level using a precision level on the leveling tool, which is attached to the other set of helium vessel blocks.
 |
| 4. Set the roll of the cavity rotationally using the rotational alignment bridge and the "A" frame. Verify all four frame studs and "A" frame studs are tight when finished. |
| 5. Blow down the cavity with ionized N2 in accordance with the Ionized Nitrogen Cleaning Procedure.* General cavity to Spec 2.
* Cavity flange, bolt holes, and inside the right angle valve up to the valve stem to Spec 1.
 |
| 6. Prepare the MFC2 [Blue Line] Spool for assembly to the cavity right angle valve.* Set the purge software to "Standby" for MFC2 [Blue Line].
* Verify the baratron for MFC2 [Blue Line] is reading approximately 0.
* Wipe the MFC2 [Blue Line] Spool with a prewet IPA wipe.
* Remove the blank, gasket, and all fasteners from the MFC2 [Blue Line] Spool.
* Wipe bolt holes with an IPA dipped Q-tip.
* Wipe flange sealing surface with prewet IPA wipe.

**Note**: One technician shall hold the Spool and point opening away from the string, people, and any other critical components such as a cavity bays and prepared / cleaned parts. Angle the opening towards the floor until the Spool is ready to be installed onto the right angle valve. A second technician shall perform the purge system set up and particle counts.* Set the purge software to "Blowout" for MFC2 [Blue Line].
* Verify the purge turns on.
* Flow N2 through the Spool until Spec 1 is reached for two full cycles.
* Set the purge software to "Purge" for MFC2 [Blue Line].
 |
| 7. Install the MFC2 [Blue Line] purge system Line to the cavity right angle valve.* Place a new cleaned [Spec 1] gasket on the MFC2 [Blue Line] Spool. Use a large-bore gasket if available.
* Install two pre-cleaned [Spec1] studs in a star pattern and snug with wrench.
* Install the four remaining studs continuing the star pattern.
* Torque all studs using a standard torque pattern for a round flange.
* Repeat the final torque sequence twice and then go around all the studs at least twice or until there is no movement of the nuts. Stop if the flanges go metal-to-metal.
* Verify the purge turns off.
 |
| 8. Pump down the purge line to the cavity right angle valve.* Set the purge software to "Standby" for MFC2 [Blue Line].
* Pump down the purge header to the closed right angle valve on the cavity. Allow the header to pump to the mid E-5 mbar range.
* Close the pump isolation valve.
 |
| 9. While monitoring the cavity pressure, slowly open the cavity right angle valve. If the cavity pressure reads at the mid E-4 mbar range or higher, notify the cleanroom supervisor. | [[CAV2VacuumOK]] <<YESNO>> |
| 10. Set the purge software to "Backfill" for MFC2 [Blue Line] and slowly backfill the cavity. |  |
| 11. When the cavity has been backfilled to the interlock value (50 mbar), change the purge software to "Purge" for MFC2 [Blue Line]. | [[CAV2PrepComment]] <<COMMENT>>[[CAV2PrepTime]] <<TIMESTAMP>>[[CAV2PrepTech]] <<SRFCVP>> |
| 7. | **Cavity 2 FPC Installation**1. Gather the following components for the connection of the cold end coupler to the cavity. Verify the components are cleaned and ready for installation.* 1 inspected and accepted FPC body
* 1 FPC body flange alignment blank
* 2 clean spring clamps
* Fasteners
* 1 hex seal gasket
* Retainer clips
* Wrenches
 |  |
| 2. Record the FPC Serial Number. | [[FPCSN2]] <<FPCSN>> |
| 3. Use the FPC body holding tool to hold and spray the FPC to Spec 1.4. When all the N2 spraying is complete, carefully place the alignment tooling over the probe tip and onto the FPC body flange. Clamp in place with two spring clamps.* Open the clamps down and away from the cavity.

5. Install the FPC onto the installation tooling and spray to Spec 1. |  |
| 6. Verify the purge software is set to "Purge" for MFC2 [Blue Line].4. Remove 4 of the 8 studs in the cavity FPC flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 studs in a star pattern from the cavity flange and check the purge system.
* Remove 2 additional studs from the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

7. Install 2 pre-cleaned [Spec 1] studs in the open holes on the cavity and torque to 10 ft-lbs.8. Continue to remove original studs on the cavity flange 2 at a time from the cavity flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 studs in a star pattern from the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.
* Continue fastener removal until all of the original fasteners have been removed and only the two pre-cleaned studs remain installed.

9. [Two person] Remove the pre-cleaned studs on the cavity coupler flange and carefully remove test coupler and gasket from cavity. Verify the purge starts.10. Install FPC alignment blank on cavity flange with spring clamps.* Open the clamps down and away from the cavity.
 |  |
| 11. Install the FPC alignment table on the lollipop.12. Align FPC to open holes on alignment blank.13. Move FPC back as far as possible on the FPC table.14. Remove the FPC coupler cover.15. Install the FPC gasket with retaining clips to hold the gasket in place on the FPC. Verify the clips are placed in the horizontal position. |
| 16. Remove the alignment blank from the cavity.17. [Two person] Move FPC into place, remove the gasket clips, and install 2 pre-cleaned [Spec 1] studs in a star pattern to secure coupler. Snug studs with wrench.18. Install 2 additional pre-cleaned [Spec 1] studs continuing the star pattern and snug with wrench.19. Install remaining 4 studs in pairs continuing the star pattern on FPC flange. |
| 20. Torque all fasteners to 60 in/lbs using a standard torque pattern for a round flange.21. Increase the torque wrench setting to 10 ft-lbs [120 in/lbs] and torque all fasteners using a standard torque pattern for a round flange.22. Repeat the final torque sequence twice and then go around all the fasteners at least twice or until there is no movement of the nuts. Verify the purge stops. | [[FPC2InstallComment]] <<COMMENT>>[[FPC2InstallTime]] <<TIMESTAMP>>[[FPC2InstallTech]] <<SRFCVP>> |
| 23. Remove coupler alignment table from lollipop and install FPC support arm. | [[FPC2SupportArmInstalled]] <<YESNO>> |
| 8. | Cavity 2 Assembly to Cavity String, including Bellows installation between Cavity 1 and Cavity 21. Gather the following components. Verify the components are cleaned and ready for installation.* 2 bellows flange alignment blanks
* 1 beamline gasket
* 4 covered spring clamps
* Fasteners
* Retainer clips
* Wrenches
 |  |
| **Prepare the Bellows**2. Place the bellows alignment table on the upstream lollipop for Cavity 2.3. Place the bellows in the alignment fixture and align the two flanges.4. Install the bellows restrain blocks onto the bellows, using 2 bolts per restraint. Use Ionized N2 to clean the bellows to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.5. Install the bellows in the alignment fixture. Use Ionized N2 to clean the bellows to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.6. Carefully place an alignment blank on both ends of the bellows. Clamp in place with two covered spring clamps per flange.* Open the clamps down and away from the bellows.
 | [[BLBPSN1\_2]] <<BLBPSN>> |
| **Prepare the Cavity 2 Upstream Flange**7. Verify the purge software is set to "Purge" for MFC2 [Blue Line].8. Remove 8 studs from the cavity upstream end flange in a star pattern. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

9. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.10. Remove final 4 original studs 2 at a time from the flange continuing the star pattern. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

11. Remove the 4 pre-cleaned studs from the cavity flange and carefully remove the blank and gasket. Verify the purge starts.12. Carefully place an alignment blank on the cavity flange. Verify that the alignment pins on the cavity flange do not line up with the alignment pins on the bellows. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the open cavity flange.
 |  |
| **Align the Bellows Non-Rotatable Flange and the Cavity 2 Upstream Flanges**13. Carefully place the cleaned bellows holder with the bellows on the alignment table. The bellows not-rotatable flange shall be facing Cavity 2.14. Slowly slide the bellows towards Cavity 2 to check flange alignment. The nipples on the alignment blanks should move freely into the indents of the flanges. A slight rotation of the bellows flange can be performed if necessary during the alignment process.15. Move the cavity away from the bellows flange. |
| **Install the Bellows to Cavity 2**16. Carefully remove the alignment blanks from the bellows non-rotatable flange and the cavity.17. Install the beamline gasket with retaining clips to hold the gasket in place on the bellows flange. Verify the clips are placed in the horizontal position.18. [Two person] Slowly slide the cavity back into place against the gasket. Remove the gasket clips.19. One technician shall hold the flanges tightly together, preventing the flanges from rotating or moving away from each other. This technician shall hold the flanges until the first 4 studs have been snugged tight with a wrench.20. A second technician shall place 4 pre-cleaned [Spec 1] studs in a star pattern in the cavity flange and snug them with a wrench.21. The second technician shall place the remaining fasteners on the flange continuing the star pattern and snug all of them with a wrench.22. Torque the fasteners to 15 ft-lbs using a standard torquing pattern for a round flange. Do not increase torque at this time. Final torqueing will be performed after both ends of the bellows have been attached to the cavities.23. Remove the bellows holder and adjustable table from the lollipop. |
| **Prepare Cavity 1 Downstream Flange**24. Verify the purge software is set to "Purge" for MFC1 [White Line].25. Remove 8 studs from the cavity downstream end flange in a star pattern. After the removal of each pair of studs, check the status of the purge system. The 4 remaining studs shall be located every third hole in the flange.* Remove 2 studs on opposite sides on the cavity flange and check the purge system.
* Remove 2 additional studs 90 degrees from the open bolt holes on the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

26. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.27. Remove final 4 original studs 2 at a time from the flange continuing the star pattern. After the removal of each pair of studs, check the status of the purge system. * Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

28. Remove the 4 pre-cleaned studs from the cavity flange and carefully remove the blank and gasket. Verify the purge starts.29. Carefully place an alignment blank on the cavity flange. Verify that the alignment pins on the cavity flange do not line up with the alignment pins on the bellows. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the cavity.
 |  |
| **Align the Bellows Rotatable Flange and Cavity 1 Downstream Flange**30. Slowly slide Cavity 2 towards Cavity 1 to check bellows rotatable flange alignment. The nipples on the flange alignment covers should move freely into the indents of the flanges. A slight rotation of the bellows flange can be performed if necessary during the alignment process. A bolt on each bellows restraint block can be loosened to allow for the rotatable flange to be adjusted if needed.31. Move Cavity 2 away from Cavity 1.32. Carefully remove the alignment covers from the bellows rotatable flange and Cavity 1. |
| **Install the Bellows to Cavity 1**33. Carefully remove the alignment blanks from the bellows rotatable flange and the cavity.34. Install the beamline gasket with retaining clips to hold the gasket in place on the bellows flange. Verify the clips are placed in the horizontal position.35. [Two person] Slowly slide the cavity back into place against the gasket. Remove the gasket clips.36. One technician shall hold the flanges tightly together, preventing the flanges from rotating or moving away from each other. This technician shall hold the flanges until the first 4 studs have been snugged tight with a wrench.37. A second technician shall place 4 pre-cleaned [Spec 1] studs in a star pattern in the cavity flange and snug them with a wrench.38. The second technician shall place the remaining fasteners on the flange continuing the star pattern and snug all of them with a wrench.39. Torque the fasteners to 15 ft-lbs using a standard torquing pattern for a round flange. |
| **Final Torquing of Bellows Flanges to Cavities**40. Torque all the fasteners on the Cavity 2 side of the bellows to 31 ft-lbs using a standard torquing pattern for a round flange.41. Torque all the fasteners on the Cavity 1 side of the bellows to 31 ft-lbs using a standard torquing pattern for a round flange.42. On the Cavity 2 side, repeat the final torque sequence twice and then go around all of the fasteners at least twice or until there is no movement of the nuts.43. On the Cavity 1 side, repeat the final torque sequence twice and then go around all of the fasteners at least twice or until there is no movement of the nuts.44. Verify the purge system turns off.45. Install rail locks on Cavity 2 to lock it in place. | [[Bellows1\_2\_Comment]] <<COMMENT>>[[Bellows1\_2\_Time]] <<TIMESTAMP>>[[Bellows1\_2\_Tech1]] <<SRFCVP>>[[Bellows1\_2\_Tech2]] <<SRFCVP>> |
| **Remove Purge System Hose from Cavity 2**46. Set the purge software to "Standby" state for MFC2 [Blue Line]. This will close MFC2 [Blue Line] and MFC2 [Blue Line] will not open under any circumstance. If a drop in pressure occurs, the purge will initiate from MFC1 [White Line].47. Slowly close the cavity right angle valve.48. Remove the purge system hose from the cavity.49. Put a blank on the Spool with two studs using the same gasket.  |  |

|  |  |  |
| --- | --- | --- |
| Step No. | Instructions | Data Input |
| 9. | **Cavity 3 Prep**1. Record Cavity 3 serial number. | [[CAVSN3]] <<CAVSN>> |
| 2. Put the cavity on the rail tooling with the blank flange facing the upstream gate valve sub-assembly [GV1SA] and the FPC facing the southeast corner of the cleanroom. |  |
| **Note: There will be some movement of flange location and/or cavity level every time something is adjusted. Several iterations of the cavity alignment will be required before the cavity will be perfectly level and have both beamline flanges in place.**3. Align Cavity 3 and the upstream flange of Cavity 2. The cavity shall be aligned with the flange alignment tool to locate the beamline flange in the proper location.* Verify the location of the flange is near the center of the range of the tooling to accommodate the alignment of all the cavities in the string.
* After both flanges of the cavity are in the same position - relative to the rail - set the roll of the cavity level using a precision level on the leveling tool, which is attached to the other set of helium vessel blocks.
 |
| 4. Set the roll of the cavity rotationally using the rotational alignment bridge and the "A" frame. Verify all four frame studs and "A" frame studs are tight when finished. |
| 5. Blow down the cavity with ionized N2 in accordance with the Ionized Nitrogen Cleaning Procedure.* General cavity to Spec 2.
* Cavity flange, bolt holes, and inside the right angle valve up to the valve stem to Spec 1.
 |
| 6. Prepare the MFC2 [Blue Line] Spool for assembly to the cavity right angle valve.* Set the purge software to "Standby" for MFC2 [Blue Line].
* Verify the baratron for MFC2 [Blue Line] is reading approximately 0.
* Wipe the MFC2 [Blue Line] Spool with a prewet IPA wipe.
* Remove the blank, gasket, and all fasteners from the MFC2 [Blue Line] Spool.
* Wipe bolt holes with an IPA dipped Q-tip.
* Wipe flange sealing surface with prewet IPA wipe.

**Note**: One technician shall hold the Spool and point opening away from the string, people, and any other critical components such as a cavity bays and prepared / cleaned parts. Angle the opening towards the floor until the Spool is ready to be installed onto the right angle valve. A second technician shall perform the purge system set up and particle counts.* Set the purge software to "Blowout" for MFC2 [Blue Line].
* Verify the purge turns on.
* Flow N2 through the Spool until Spec 1 is reached for two full cycles.
* Set the purge software to "Purge" for MFC2 [Blue Line].
 |
| 7. Install the MFC2 [Blue Line] purge system Line to the cavity right angle valve.* Place a new cleaned [Spec 1] gasket on the MFC2 [Blue Line] Spool. Use a large-bore gasket if available.
* Install two pre-cleaned [Spec1] studs in a star pattern and snug with wrench.
* Install the four remaining studs continuing the star pattern.
* Torque all studs using a standard torque pattern for a round flange.
* Repeat the final torque sequence twice and then go around all the studs at least twice or until there is no movement of the nuts. Stop if the flanges go metal-to-metal.
* Verify the purge turns off.
 |
| 8. Pump down the purge line to the cavity right angle valve.* Set the purge software to "Standby" for MFC2 [Blue Line].
* Pump down the purge header to the closed right angle valve on the cavity. Allow the header to pump to the mid E-5 mbar range.
* Close the pump isolation valve.
 |
| 9. While monitoring the cavity pressure, slowly open the cavity right angle valve. If the cavity pressure reads at the mid E-4 mbar range or higher, notify the cleanroom supervisor. | [[CAV3VacuumOK]] <<YESNO>> |
| 10. Set the purge software to "Backfill" for MFC2 [Blue Line] and slowly backfill the cavity. |  |
| 11. When the cavity has been backfilled to the interlock value (50 mbar), change the purge software to "Purge" for MFC2 [Blue Line]. | [[CAV3PrepComment]] <<COMMENT>>[[CAV3PrepTime]] <<TIMESTAMP>>[[CAV3PrepTech]] <<SRFCVP>> |
| 10. | **Cavity 3 FPC Installation**1. Gather the following components for the connection of the cold end coupler to the cavity. Verify the components are cleaned and ready for installation.* 1 inspected and accepted FPC body
* 1 FPC body flange alignment blank
* 2 clean spring clamps
* Fasteners
* 1 hex seal gasket
* Retainer clips
* Wrenches
 |  |
| 2. Record the FPC Serial Number. | [[FPCSN3]] <<FPCSN>> |
| 3. Use the FPC body holding tool to hold and spray the FPC to Spec 1.4. When all the N2 spraying is complete, carefully place the alignment tooling over the probe tip and onto the FPC body flange. Clamp in place with two spring clamps.* Open the clamps down and away from the cavity.

5. Install the FPC onto the installation tooling and spray to Spec 1. |  |
| 6. Verify the purge software is set to "Purge" for MFC2 [Blue Line].4. Remove 4 of the 8 studs in the cavity FPC flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 studs in a star pattern from the cavity flange and check the purge system.
* Remove 2 additional studs from the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

7. Install 2 pre-cleaned [Spec 1] studs in the open holes on the cavity and torque to 10 ft-lbs.8. Continue to remove original studs on the cavity flange 2 at a time from the cavity flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 studs in a star pattern from the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.
* Continue fastener removal until all of the original fasteners have been removed and only the two pre-cleaned studs remain installed.

9. [Two person] Remove the pre-cleaned studs on the cavity coupler flange and carefully remove test coupler and gasket from cavity. Verify the purge starts.10. Install FPC alignment blank on cavity flange with spring clamps.* Open the clamps down and away from the cavity.
 |  |
| 11. Install the FPC alignment table on the lollipop.12. Align FPC to open holes on alignment blank.13. Move FPC back as far as possible on the FPC table.14. Remove the FPC coupler cover.15. Install the FPC gasket with retaining clips to hold the gasket in place on the FPC. Verify the clips are placed in the horizontal position. |
| 16. Remove the alignment blank from the cavity.17. [Two person] Move FPC into place, remove the gasket clips, and install 2 pre-cleaned [Spec 1] studs in a star pattern to secure coupler. Snug studs with wrench.18. Install 2 additional pre-cleaned [Spec 1] studs continuing the star pattern and snug with wrench.19. Install remaining 4 studs in pairs continuing the star pattern on FPC flange. |
| 20. Torque all fasteners to 60 in/lbs using a standard torque pattern for a round flange.21. Increase the torque wrench setting to 10 ft-lbs [120 in/lbs] and torque all fasteners using a standard torque pattern for a round flange.22. Repeat the final torque sequence twice and then go around all the fasteners at least twice or until there is no movement of the nuts. Verify the purge stops. | [[FPC3InstallComment]] <<COMMENT>>[[FPC3InstallTime]] <<TIMESTAMP>>[[FPC3InstallTech]] <<SRFCVP>> |
| 23. Remove coupler alignment table from lollipop and install FPC support arm. | [[FPC3SupportArmInstalled]] <<YESNO>> |
| 11. | Cavity 3 Assembly to Cavity String, including Bellows installation between Cavity 2 and Cavity 31. Gather the following components. Verify the components are cleaned and ready for installation.* 2 bellows flange alignment blanks
* 1 beamline gasket
* 4 covered spring clamps
* Fasteners
* Retainer clips
* Wrenches
 |  |
| **Prepare the Bellows**2. Place the bellows alignment table on the upstream lollipop for Cavity 3.3. Place the bellows in the alignment fixture and align the two flanges.4. Install the bellows restrain blocks onto the bellows, using 2 bolts per restraint. Use Ionized N2 to clean the bellows to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.5. Install the bellows in the alignment fixture. Use Ionized N2 to clean the bellows to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.6. Carefully place an alignment blank on both ends of the bellows. Clamp in place with two covered spring clamps per flange.* Open the clamps down and away from the bellows.
 | [[BLBPSN2\_3]] <<BLBPSN>> |
| **Prepare the Cavity 3 Upstream Flange**7. Verify the purge software is set to "Purge" for MFC2 [Blue Line].8. Remove 8 studs from the cavity upstream end flange in a star pattern. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

9. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.10. Remove final 4 original studs 2 at a time from the flange continuing the star pattern. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

11. Remove the 4 pre-cleaned studs from the cavity flange and carefully remove the blank and gasket. Verify the purge starts.12. Carefully place an alignment blank on the cavity flange. Verify that the alignment pins on the cavity flange do not line up with the alignment pins on the bellows. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the open cavity flange.
 |  |
| **Align the Bellows Non-Rotatable Flange and the Cavity 3 Upstream Flanges**13. Carefully place the cleaned bellows holder with the bellows on the alignment table. The bellows not-rotatable flange shall be facing Cavity 3.14. Slowly slide the bellows towards Cavity 3 to check flange alignment. The nipples on the alignment blanks should move freely into the indents of the flanges. A slight rotation of the bellows flange can be performed if necessary during the alignment process.15. Move the cavity away from the bellows flange. |
| **Install the Bellows to Cavity 3**16. Carefully remove the alignment blanks from the bellows non-rotatable flange and the cavity.17. Install the beamline gasket with retaining clips to hold the gasket in place on the bellows flange. Verify the clips are placed in the horizontal position.18. [Two person] Slowly slide the cavity back into place against the gasket. Remove the gasket clips.19. One technician shall hold the flanges tightly together, preventing the flanges from rotating or moving away from each other. This technician shall hold the flanges until the first 4 studs have been snugged tight with a wrench.20. A second technician shall place 4 pre-cleaned [Spec 1] studs in a star pattern in the cavity flange and snug them with a wrench.21. The second technician shall place the remaining fasteners on the flange continuing the star pattern and snug all of them with a wrench.22. Torque the fasteners to 15 ft-lbs using a standard torquing pattern for a round flange. Do not increase torque at this time. Final torqueing will be performed after both ends of the bellows have been attached to the cavities.23. Remove the bellows holder and adjustable table from the lollipop. |
| **Prepare Cavity 2 Downstream Flange**24. Verify the purge software is set to "Purge" for MFC1 [White Line].25. Remove 8 studs from the cavity downstream end flange in a star pattern. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

26. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.27. Remove final 4 original studs 2 at a time from the flange continuing the star pattern. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

28. Remove the 4 pre-cleaned studs from the cavity flange and carefully remove the blank and gasket. Verify the purge starts.29. Carefully place an alignment blank on the cavity flange. Verify that the alignment pins on the cavity flange do not line up with the alignment pins on the bellows. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the cavity.
 |  |
| **Align the Bellows Rotatable Flange and Cavity 2 Downstream Flange**30. Slowly slide Cavity 3 towards Cavity 2 to check bellows rotatable flange alignment. The nipples on the flange alignment covers should move freely into the indents of the flanges. A slight rotation of the bellows flange can be performed if necessary during the alignment process. A bolt on each bellows restraint block can be loosened to allow for the rotatable flange to be adjusted if needed.31. Move Cavity 3 away from Cavity 2.32. Carefully remove the alignment covers from the bellows rotatable flange and Cavity 2. |
| **Install the Bellows to Cavity 2**33. Carefully remove the alignment blanks from the bellows rotatable flange and the cavity.34. Install the beamline gasket with retaining clips to hold the gasket in place on the bellows flange. Verify the clips are placed in the horizontal position.35. [Two person] Slowly slide the cavity back into place against the gasket. Remove the gasket clips.36. One technician shall hold the flanges tightly together, preventing the flanges from rotating or moving away from each other. This technician shall hold the flanges until the first 4 studs have been snugged tight with a wrench.37. A second technician shall place 4 pre-cleaned [Spec 1] studs in a star pattern in the cavity flange and snug them with a wrench.38. The second technician shall place the remaining fasteners on the flange continuing the star pattern and snug all of them with a wrench.39. Torque the fasteners to 15 ft-lbs using a standard torquing pattern for a round flange. |
| **Final Torquing of Bellows Flanges to Cavities**40. Torque all the fasteners on the Cavity 3 side of the bellows to 31 ft-lbs using a standard torquing pattern for a round flange.41. Torque all the fasteners on the Cavity 2 side of the bellows to 31 ft-lbs using a standard torquing pattern for a round flange.42. On the Cavity 3 side, repeat the final torque sequence twice and then go around all of the fasteners at least twice or until there is no movement of the nuts.43. On the Cavity 2 side, repeat the final torque sequence twice and then go around all of the fasteners at least twice or until there is no movement of the nuts.44. Verify the purge system turns off.45. Install rail locks on Cavity 3 to lock it in place. | [[Bellows2\_3\_Comment]] <<COMMENT>>[[Bellows2\_3\_Time]] <<TIMESTAMP>>[[Bellows2\_3\_Tech1]] <<SRFCVP>>[[Bellows2\_3\_Tech2]] <<SRFCVP>> |
| **Remove Purge System Hose from Cavity 3**46. Set the purge software to "Standby" state for MFC2 [Blue Line]. This will close MFC2 [Blue Line] and MFC2 [Blue Line] will not open under any circumstance. If a drop in pressure occurs, the purge will initiate from MFC1 [White Line].47. Slowly close the cavity right angle valve.48. Remove the purge system hose from the cavity.49. Put a blank on the Spool with two studs using the same gasket. |  |

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| Step No. | Instructions | Data Input |
| 12. | **Cavity 4 Prep**1. Record Cavity 4 serial number. | [[CAVSN4]] <<CAVSN>> |
| 2. Put the cavity on the rail tooling with the blank flange facing the upstream gate valve sub-assembly [GV1SA] and the FPC facing the southeast corner of the cleanroom. |  |
| **Note: There will be some movement of flange location and/or cavity level every time something is adjusted. Several iterations of the cavity alignment will be required before the cavity will be perfectly level and have both beamline flanges in place.**3. Align Cavity 4 and the upstream flange of Cavity 3. The cavity shall be aligned with the flange alignment tool to locate the beamline flange in the proper location.* Verify the location of the flange is near the center of the range of the tooling to accommodate the alignment of all the cavities in the string.
* After both flanges of the cavity are in the same position - relative to the rail - set the roll of the cavity level using a precision level on the leveling tool, which is attached to the other set of helium vessel blocks.
 |
| 4. Set the roll of the cavity rotationally using the rotational alignment bridge and the "A" frame. Verify all four frame studs and "A" frame studs are tight when finished. |
| 5. Blow down the cavity with ionized N2 in accordance with the Ionized Nitrogen Cleaning Procedure.* General cavity to Spec 2.
* Cavity flange, bolt holes, and inside the right angle valve up to the valve stem to Spec 1.
 |
| 6. Prepare the MFC2 [Blue Line] Spool for assembly to the cavity right angle valve.* Set the purge software to "Standby" for MFC2 [Blue Line].
* Verify the baratron for MFC2 [Blue Line] is reading approximately 0.
* Wipe the MFC2 [Blue Line] Spool with a prewet IPA wipe.
* Remove the blank, gasket, and all fasteners from the MFC2 [Blue Line] Spool.
* Wipe bolt holes with an IPA dipped Q-tip.
* Wipe flange sealing surface with prewet IPA wipe.

**Note**: One technician shall hold the Spool and point opening away from the string, people, and any other critical components such as a cavity bays and prepared / cleaned parts. Angle the opening towards the floor until the Spool is ready to be installed onto the right angle valve. A second technician shall perform the purge system set up and particle counts.* Set the purge software to "Blowout" for MFC2 [Blue Line].
* Verify the purge turns on.
* Flow N2 through the Spool until Spec 1 is reached for two full cycles.
* Set the purge software to "Purge" for MFC2 [Blue Line].
 |
| 7. Install the MFC2 [Blue Line] purge system Line to the cavity right angle valve.* Place a new cleaned [Spec 1] gasket on the MFC2 [Blue Line] Spool. Use a large-bore gasket if available.
* Install two pre-cleaned [Spec1] studs in a star pattern and snug with wrench.
* Install the four remaining studs continuing the star pattern.
* Torque all studs using a standard torque pattern for a round flange.
* Repeat the final torque sequence twice and then go around all the studs at least twice or until there is no movement of the nuts. Stop if the flanges go metal-to-metal.
* Verify the purge turns off.
 |
| 8. Pump down the purge line to the cavity right angle valve.* Set the purge software to "Standby" for MFC2 [Blue Line].
* Pump down the purge header to the closed right angle valve on the cavity. Allow the header to pump to the mid E-5 mbar range.
* Close the pump isolation valve.
 |
| 9. While monitoring the cavity pressure, slowly open the cavity right angle valve. If the cavity pressure reads at the mid E-4 mbar range or higher, notify the cleanroom supervisor. | [[CAV4VacuumOK]] <<YESNO>> |
| 10. Set the purge software to "Backfill" for MFC2 [Blue Line] and slowly backfill the cavity. |  |
| 11. When the cavity has been backfilled to the interlock value (50 mbar), change the purge software to "Purge" for MFC2 [Blue Line]. | [[CAV4PrepComment]] <<COMMENT>>[[CAV4PrepTime]] <<TIMESTAMP>>[[CAV4PrepTech]] <<SRFCVP>> |
| 13. | **Cavity 4 FPC Installation**1. Gather the following components for the connection of the cold end coupler to the cavity. Verify the components are cleaned and ready for installation.* 1 inspected and accepted FPC body
* 1 FPC body flange alignment blank
* 2 clean spring clamps
* Fasteners
* 1 hex seal gasket
* Retainer clips
* Wrenches
 |  |
| 2. Record the FPC Serial Number. | [[FPCSN4]] <<FPCSN>> |
| 3. Use the FPC body holding tool to hold and spray the FPC to Spec 1.4. When all the N2 spraying is complete, carefully place the alignment tooling over the probe tip and onto the FPC body flange. Clamp in place with two spring clamps.* Open the clamps down and away from the cavity.

5. Install the FPC onto the installation tooling and spray to Spec 1. |  |
| 6. Verify the purge software is set to "Purge" for MFC2 [Blue Line].4. Remove 4 of the 8 studs in the cavity FPC flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 studs in a star pattern from the cavity flange and check the purge system.
* Remove 2 additional studs from the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

7. Install 2 pre-cleaned [Spec 1] studs in the open holes on the cavity and torque to 10 ft-lbs.8. Continue to remove original studs on the cavity flange 2 at a time from the cavity flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 studs in a star pattern from the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.
* Continue fastener removal until all of the original fasteners have been removed and only the two pre-cleaned studs remain installed.

9. [Two person] Remove the pre-cleaned studs on the cavity coupler flange and carefully remove test coupler and gasket from cavity. Verify the purge starts.10. Install FPC alignment blank on cavity flange with spring clamps.* Open the clamps down and away from the cavity.
 |  |
| 11. Install the FPC alignment table on the lollipop.12. Align FPC to open holes on alignment blank.13. Move FPC back as far as possible on the FPC table.14. Remove the FPC coupler cover.15. Install the FPC gasket with retaining clips to hold the gasket in place on the FPC. Verify the clips are placed in the horizontal position. |
| 16. Remove the alignment blank from the cavity.17. [Two person] Move FPC into place, remove the gasket clips, and install 2 pre-cleaned [Spec 1] studs in a star pattern to secure coupler. Snug studs with wrench.18. Install 2 additional pre-cleaned [Spec 1] studs continuing the star pattern and snug with wrench.19. Install remaining 4 studs in pairs continuing the star pattern on FPC flange. |
| 20. Torque all fasteners to 60 in/lbs using a standard torque pattern for a round flange.21. Increase the torque wrench setting to 10 ft-lbs [120 in/lbs] and torque all fasteners using a standard torque pattern for a round flange.22. Repeat the final torque sequence twice and then go around all the fasteners at least twice or until there is no movement of the nuts. Verify the purge stops. | [[FPC4InstallComment]] <<COMMENT>>[[FPC4InstallTime]] <<TIMESTAMP>>[[FPC4InstallTech]] <<SRFCVP>> |
| 23. Remove coupler alignment table from lollipop and install FPC support arm. | [[FPC4SupportArmInstalled]] <<YESNO>> |
| 14. | Cavity 4 Assembly to Cavity String, including Bellows installation between Cavity 3 and Cavity 41. Gather the following components. Verify the components are cleaned and ready for installation.* 2 bellows flange alignment blanks
* 1 beamline gasket
* 4 covered spring clamps
* Fasteners
* Retainer clips
* Wrenches
 |  |
| **Prepare the Bellows**2. Place the bellows alignment table on the upstream lollipop for Cavity 4.3. Place the bellows in the alignment fixture and align the two flanges.4. Install the bellows restrain blocks onto the bellows, using 2 bolts per restraint. Use Ionized N2 to clean the bellows to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.5. Install the bellows in the alignment fixture. Use Ionized N2 to clean the bellows to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.6. Carefully place an alignment blank on both ends of the bellows. Clamp in place with two covered spring clamps per flange.* Open the clamps down and away from the bellows.
 | [[BLBPSN3\_4]] <<BLBPSN>> |
| **Prepare the Cavity 4 Upstream Flange**7. Verify the purge software is set to "Purge" for MFC2 [Blue Line].8. Remove 8 studs from the cavity upstream end flange in a star pattern. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

9. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.10. Remove final 4 original studs 2 at a time from the flange continuing the star pattern. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

11. Remove the 4 pre-cleaned studs from the cavity flange and carefully remove the blank and gasket. Verify the purge starts.12. Carefully place an alignment blank on the cavity flange. Verify that the alignment pins on the cavity flange do not line up with the alignment pins on the bellows. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the open cavity flange.
 |  |
| **Align the Bellows Non-Rotatable Flange and the Cavity 4 Upstream Flanges**13. Carefully place the cleaned bellows holder with the bellows on the alignment table. The bellows not-rotatable flange shall be facing Cavity 4.14. Slowly slide the bellows towards Cavity 4 to check flange alignment. The nipples on the alignment blanks should move freely into the indents of the flanges. A slight rotation of the bellows flange can be performed if necessary during the alignment process.15. Move the cavity away from the bellows flange. |
| **Install the Bellows to Cavity 4**16. Carefully remove the alignment blanks from the bellows non-rotatable flange and the cavity.17. Install the beamline gasket with retaining clips to hold the gasket in place on the bellows flange. Verify the clips are placed in the horizontal position.18. [Two person] Slowly slide the cavity back into place against the gasket. Remove the gasket clips.19. One technician shall hold the flanges tightly together, preventing the flanges from rotating or moving away from each other. This technician shall hold the flanges until the first 4 studs have been snugged tight with a wrench.20. A second technician shall place 4 pre-cleaned [Spec 1] studs in a star pattern in the cavity flange and snug them with a wrench.21. The second technician shall place the remaining fasteners on the flange continuing the star pattern and snug all of them with a wrench.22. Torque the fasteners to 15 ft-lbs using a standard torquing pattern for a round flange. Do not increase torque at this time. Final torqueing will be performed after both ends of the bellows have been attached to the cavities.23. Remove the bellows holder and adjustable table from the lollipop. |
| **Prepare Cavity 3 Downstream Flange**24. Verify the purge software is set to "Purge" for MFC1 [White Line].25. Remove 8 studs from the cavity downstream end flange in a star pattern. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

26. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.27. Remove final 4 original studs 2 at a time from the flange continuing the star pattern. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

28. Remove the 4 pre-cleaned studs from the cavity flange and carefully remove the blank and gasket. Verify the purge starts.29. Carefully place an alignment blank on the cavity flange. Verify that the alignment pins on the cavity flange do not line up with the alignment pins on the bellows. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the cavity.
 |  |
| **Align the Bellows Rotatable Flange and Cavity 3 Downstream Flange**30. Slowly slide Cavity 4 towards Cavity 3 to check bellows rotatable flange alignment. The nipples on the flange alignment covers should move freely into the indents of the flanges. A slight rotation of the bellows flange can be performed if necessary during the alignment process. A bolt on each bellows restraint block can be loosened to allow for the rotatable flange to be adjusted if needed.31. Move Cavity 4 away from Cavity 3.32. Carefully remove the alignment covers from the bellows rotatable flange and Cavity 3. |
| **Install the Bellows to Cavity 3**33. Carefully remove the alignment blanks from the bellows rotatable flange and the cavity.34. Install the beamline gasket with retaining clips to hold the gasket in place on the bellows flange. Verify the clips are placed in the horizontal position.35. [Two person] Slowly slide the cavity back into place against the gasket. Remove the gasket clips.36. One technician shall hold the flanges tightly together, preventing the flanges from rotating or moving away from each other. This technician shall hold the flanges until the first 4 studs have been snugged tight with a wrench.37. A second technician shall place 4 pre-cleaned [Spec 1] studs in a star pattern in the cavity flange and snug them with a wrench.38. The second technician shall place the remaining fasteners on the flange continuing the star pattern and snug all of them with a wrench.39. Torque the fasteners to 15 ft-lbs using a standard torquing pattern for a round flange. |
| **Final Torquing of Bellows Flanges to Cavities**40. Torque all the fasteners on the Cavity 4 side of the bellows to 31 ft-lbs using a standard torquing pattern for a round flange.41. Torque all the fasteners on the Cavity 3 side of the bellows to 31 ft-lbs using a standard torquing pattern for a round flange.42. On the Cavity 4 side, repeat the final torque sequence twice and then go around all of the fasteners at least twice or until there is no movement of the nuts.43. On the Cavity 3 side, repeat the final torque sequence twice and then go around all of the fasteners at least twice or until there is no movement of the nuts.44. Verify the purge system turns off.45. Install rail locks on Cavity 4 to lock it in place. | [[Bellows3\_4\_Comment]] <<COMMENT>>[[Bellows3\_4\_Time]] <<TIMESTAMP>>[[Bellows3\_4\_Tech1]] <<SRFCVP>>[[Bellows3\_4\_Tech2]] <<SRFCVP>> |
| **Remove Purge System Hose from Cavity 4**46. Set the purge software to "Standby" state for MFC2 [Blue Line]. This will close MFC2 [Blue Line] and MFC2 [Blue Line] will not open under any circumstance. If a drop in pressure occurs, the purge will initiate from MFC1 [White Line].47. Slowly close the cavity right angle valve.48. Remove the purge system hose from the cavity.49. Put a blank on the Spool with two studs using the same gasket. |  |

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| Step No. | Instructions | Data Input |
| 15. | **Cavity 5 Prep**1. Record Cavity 5 serial number. | [[CAVSN5]] <<CAVSN>> |
| 2. Put the cavity on the rail tooling with the blank flange facing the upstream gate valve sub-assembly [GV1SA] and the FPC facing the southeast corner of the cleanroom. |  |
| **Note: There will be some movement of flange location and/or cavity level every time something is adjusted. Several iterations of the cavity alignment will be required before the cavity will be perfectly level and have both beamline flanges in place.**3. Align Cavity 5 and the upstream flange of Cavity 4. The cavity shall be aligned with the flange alignment tool to locate the beamline flange in the proper location.* Verify the location of the flange is near the center of the range of the tooling to accommodate the alignment of all the cavities in the string.
* After both flanges of the cavity are in the same position - relative to the rail - set the roll of the cavity level using a precision level on the leveling tool, which is attached to the other set of helium vessel blocks.
 |
| 4. Set the roll of the cavity rotationally using the rotational alignment bridge and the "A" frame. Verify all four frame studs and "A" frame studs are tight when finished. |
| 5. Blow down the cavity with ionized N2 in accordance with the Ionized Nitrogen Cleaning Procedure.* General cavity to Spec 2.
* Cavity flange, bolt holes, and inside the right angle valve up to the valve stem to Spec 1.
 |
| 6. Prepare the MFC2 [Blue Line] Spool for assembly to the cavity right angle valve.* Set the purge software to "Standby" for MFC2 [Blue Line].
* Verify the baratron for MFC2 [Blue Line] is reading approximately 0.
* Wipe the MFC2 [Blue Line] Spool with a prewet IPA wipe.
* Remove the blank, gasket, and all fasteners from the MFC2 [Blue Line] Spool.
* Wipe bolt holes with an IPA dipped Q-tip.
* Wipe flange sealing surface with prewet IPA wipe.

**Note**: One technician shall hold the Spool and point opening away from the string, people, and any other critical components such as a cavity bays and prepared / cleaned parts. Angle the opening towards the floor until the Spool is ready to be installed onto the right angle valve. A second technician shall perform the purge system set up and particle counts.* Set the purge software to "Blowout" for MFC2 [Blue Line].
* Verify the purge turns on.
* Flow N2 through the Spool until Spec 1 is reached for two full cycles.
* Set the purge software to "Purge" for MFC2 [Blue Line].
 |
| 7. Install the MFC2 [Blue Line] purge system Line to the cavity right angle valve.* Place a new cleaned [Spec 1] gasket on the MFC2 [Blue Line] Spool. Use a large-bore gasket if available.
* Install two pre-cleaned [Spec1] studs in a star pattern and snug with wrench.
* Install the four remaining studs continuing the star pattern.
* Torque all studs using a standard torque pattern for a round flange.
* Repeat the final torque sequence twice and then go around all the studs at least twice or until there is no movement of the nuts. Stop if the flanges go metal-to-metal.
* Verify the purge turns off.
 |
| 8. Pump down the purge line to the cavity right angle valve.* Set the purge software to "Standby" for MFC2 [Blue Line].
* Pump down the purge header to the closed right angle valve on the cavity. Allow the header to pump to the mid E-5 mbar range.
* Close the pump isolation valve.
 |
| 9. While monitoring the cavity pressure, slowly open the cavity right angle valve. If the cavity pressure reads at the mid E-4 mbar range or higher, notify the cleanroom supervisor. | [[CAV5VacuumOK]] <<YESNO>> |
| 10. Set the purge software to "Backfill" for MFC2 [Blue Line] and slowly backfill the cavity. |  |
| 11. When the cavity has been backfilled to the interlock value (50 mbar), change the purge software to "Purge" for MFC2 [Blue Line]. | [[CAV5PrepComment]] <<COMMENT>>[[CAV5PrepTime]] <<TIMESTAMP>>[[CAV5PrepTech]] <<SRFCVP>> |
| 16. | **Cavity 5 FPC Installation**1. Gather the following components for the connection of the cold end coupler to the cavity. Verify the components are cleaned and ready for installation.* 1 inspected and accepted FPC body
* 1 FPC body flange alignment blank
* 2 clean spring clamps
* Fasteners
* 1 hex seal gasket
* Retainer clips
* Wrenches
 |  |
| 2. Record the FPC Serial Number. | [[FPCSN5]] <<FPCSN>> |
| 3. Use the FPC body holding tool to hold and spray the FPC to Spec 1.4. When all the N2 spraying is complete, carefully place the alignment tooling over the probe tip and onto the FPC body flange. Clamp in place with two spring clamps.* Open the clamps down and away from the cavity.

5. Install the FPC onto the installation tooling and spray to Spec 1. |  |
| 6. Verify the purge software is set to "Purge" for MFC2 [Blue Line].4. Remove 4 of the 8 studs in the cavity FPC flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 studs in a star pattern from the cavity flange and check the purge system.
* Remove 2 additional studs from the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

7. Install 2 pre-cleaned [Spec 1] studs in the open holes on the cavity and torque to 10 ft-lbs.8. Continue to remove original studs on the cavity flange 2 at a time from the cavity flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 studs in a star pattern from the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.
* Continue fastener removal until all of the original fasteners have been removed and only the two pre-cleaned studs remain installed.

9. [Two person] Remove the pre-cleaned studs on the cavity coupler flange and carefully remove test coupler and gasket from cavity. Verify the purge starts.10. Install FPC alignment blank on cavity flange with spring clamps.* Open the clamps down and away from the cavity.
 |  |
| 11. Install the FPC alignment table on the lollipop.12. Align FPC to open holes on alignment blank.13. Move FPC back as far as possible on the FPC table.14. Remove the FPC coupler cover.15. Install the FPC gasket with retaining clips to hold the gasket in place on the FPC. Verify the clips are placed in the horizontal position. |
| 16. Remove the alignment blank from the cavity.17. [Two person] Move FPC into place, remove the gasket clips, and install 2 pre-cleaned [Spec 1] studs in a star pattern to secure coupler. Snug studs with wrench.18. Install 2 additional pre-cleaned [Spec 1] studs continuing the star pattern and snug with wrench.19. Install remaining 4 studs in pairs continuing the star pattern on FPC flange. |
| 20. Torque all fasteners to 60 in/lbs using a standard torque pattern for a round flange.21. Increase the torque wrench setting to 10 ft-lbs [120 in/lbs] and torque all fasteners using a standard torque pattern for a round flange.22. Repeat the final torque sequence twice and then go around all the fasteners at least twice or until there is no movement of the nuts. Verify the purge stops. | [[FPC5InstallComment]] <<COMMENT>>[[FPC5InstallTime]] <<TIMESTAMP>>[[FPC5InstallTech]] <<SRFCVP>> |
| 23. Remove coupler alignment table from lollipop and install FPC support arm. | [[FPC5SupportArmInstalled]] <<YESNO>> |
| 17. | Cavity 5 Assembly to Cavity String, including Bellows installation between Cavity 4 and Cavity 51. Gather the following components. Verify the components are cleaned and ready for installation.* 2 bellows flange alignment blanks
* 1 beamline gasket
* 4 covered spring clamps
* Fasteners
* Retainer clips
* Wrenches
 |  |
| **Prepare the Bellows**2. Place the bellows alignment table on the upstream lollipop for Cavity 5.3. Place the bellows in the alignment fixture and align the two flanges.4. Install the bellows restrain blocks onto the bellows, using 2 bolts per restraint. Use Ionized N2 to clean the bellows to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.5. Install the bellows in the alignment fixture. Use Ionized N2 to clean the bellows to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.6. Carefully place an alignment blank on both ends of the bellows. Clamp in place with two covered spring clamps per flange. * Open the clamps down and away from the bellows.
 | [[BLBPSN4\_5]] <<BLBPSN>> |
| **Prepare the Cavity 5 Upstream Flange**7. Verify the purge software is set to "Purge" for MFC2 [Blue Line].8. Remove 8 studs from the cavity upstream end flange in a star pattern. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

9. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.10. Remove final 4 original studs 2 at a time from the flange continuing the star pattern. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

11. Remove the 4 pre-cleaned studs from the cavity flange and carefully remove the blank and gasket. Verify the purge starts.12. Carefully place an alignment blank on the cavity flange. Verify that the alignment pins on the cavity flange do not line up with the alignment pins on the bellows. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the open cavity flange.
 |  |
| **Align the Bellows Non-Rotatable Flange and the Cavity 5 Upstream Flanges**13. Carefully place the cleaned bellows holder with the bellows on the alignment table. The bellows not-rotatable flange shall be facing Cavity 5.14. Slowly slide the bellows towards Cavity 5 to check flange alignment. The nipples on the alignment blanks should move freely into the indents of the flanges. A slight rotation of the bellows flange can be performed if necessary during the alignment process.15. Move the cavity away from the bellows flange. |
| **Install the Bellows to Cavity 5**16. Carefully remove the alignment blanks from the bellows non-rotatable flange and the cavity.17. Install the beamline gasket with retaining clips to hold the gasket in place on the bellows flange. Verify the clips are placed in the horizontal position.18. [Two person] Slowly slide the cavity back into place against the gasket. Remove the gasket clips.19. One technician shall hold the flanges tightly together, preventing the flanges from rotating or moving away from each other. This technician shall hold the flanges until the first 4 studs have been snugged tight with a wrench.20. A second technician shall place 4 pre-cleaned [Spec 1] studs in a star pattern in the cavity flange and snug them with a wrench.21. The second technician shall place the remaining fasteners on the flange continuing the star pattern and snug all of them with a wrench.22. Torque the fasteners to 15 ft-lbs using a standard torquing pattern for a round flange. Do not increase torque at this time. Final torqueing will be performed after both ends of the bellows have been attached to the cavities.23. Remove the bellows holder and adjustable table from the lollipop. |
| **Prepare Cavity 4 Downstream Flange**24. Verify the purge software is set to "Purge" for MFC1 [White Line].25. Remove 8 studs from the cavity downstream end flange in a star pattern. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

26. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.27. Remove final 4 original studs 2 at a time from the flange continuing the star pattern. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

28. Remove the 4 pre-cleaned studs from the cavity flange and carefully remove the blank and gasket. Verify the purge starts.29. Carefully place an alignment blank on the cavity flange. Verify that the alignment pins on the cavity flange do not line up with the alignment pins on the bellows. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the cavity.
 |  |
| **Align the Bellows Rotatable Flange and Cavity 4 Downstream Flange**30. Slowly slide Cavity 5 towards Cavity 4 to check bellows rotatable flange alignment. The nipples on the flange alignment covers should move freely into the indents of the flanges. A slight rotation of the bellows flange can be performed if necessary during the alignment process. A bolt on each bellows restraint block can be loosened to allow for the rotatable flange to be adjusted if needed.31. Move Cavity 5 away from Cavity 4.32. Carefully remove the alignment covers from the bellows rotatable flange and Cavity 4. |
| **Install the Bellows to Cavity 4**33. Carefully remove the alignment blanks from the bellows rotatable flange and the cavity.34. Install the beamline gasket with retaining clips to hold the gasket in place on the bellows flange. Verify the clips are placed in the horizontal position.35. [Two person] Slowly slide the cavity back into place against the gasket. Remove the gasket clips.36. One technician shall hold the flanges tightly together, preventing the flanges from rotating or moving away from each other. This technician shall hold the flanges until the first 4 studs have been snugged tight with a wrench.37. A second technician shall place 4 pre-cleaned [Spec 1] studs in a star pattern in the cavity flange and snug them with a wrench.38. The second technician shall place the remaining fasteners on the flange continuing the star pattern and snug all of them with a wrench.39. Torque the fasteners to 15 ft-lbs using a standard torquing pattern for a round flange. |
| **Final Torquing of Bellows Flanges to Cavities**40. Torque all the fasteners on the Cavity 5 side of the bellows to 31 ft-lbs using a standard torquing pattern for a round flange.41. Torque all the fasteners on the Cavity 4 side of the bellows to 31 ft-lbs using a standard torquing pattern for a round flange.42. On the Cavity 5 side, repeat the final torque sequence twice and then go around all of the fasteners at least twice or until there is no movement of the nuts.43. On the Cavity 4 side, repeat the final torque sequence twice and then go around all of the fasteners at least twice or until there is no movement of the nuts.44. Verify the purge system turns off.45. Install rail locks on Cavity 5 to lock it in place. | [[Bellows4\_5\_Comment]] <<COMMENT>>[[Bellows4\_5\_Time]] <<TIMESTAMP>>[[Bellows4\_5\_Tech1]] <<SRFCVP>>[[Bellows4\_5\_Tech2]] <<SRFCVP>> |
| **Remove Purge System Hose from Cavity 5**46. Set the purge software to "Standby" state for MFC2 [Blue Line]. This will close MFC2 [Blue Line] and MFC2 [Blue Line] will not open under any circumstance. If a drop in pressure occurs, the purge will initiate from MFC1 [White Line].47. Slowly close the cavity right angle valve.48. Remove the purge system hose from the cavity.49. Put a blank on the Spool with two studs using the same gasket.  |  |

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| Step No. | Instructions | Data Input |
| 18. | **Cavity 6 Prep**1. Record Cavity 6 serial number. | [[CAVSN6]] <<CAVSN>> |
| 2. Put the cavity on the rail tooling with the blank flange facing the upstream gate valve sub-assembly [GV1SA] and the FPC facing the southeast corner of the cleanroom. |  |
| **Note: There will be some movement of flange location and/or cavity level every time something is adjusted. Several iterations of the cavity alignment will be required before the cavity will be perfectly level and have both beamline flanges in place.**3. Align Cavity 6 and the upstream flange of Cavity 5. The cavity shall be aligned with the flange alignment tool to locate the beamline flange in the proper location.* Verify the location of the flange is near the center of the range of the tooling to accommodate the alignment of all the cavities in the string.
* After both flanges of the cavity are in the same position - relative to the rail - set the roll of the cavity level using a precision level on the leveling tool, which is attached to the other set of helium vessel blocks.
 |
| 4. Set the roll of the cavity rotationally using the rotational alignment bridge and the "A" frame. Verify all four frame studs and "A" frame studs are tight when finished. |
| 5. Blow down the cavity with ionized N2 in accordance with the Ionized Nitrogen Cleaning Procedure.* General cavity to Spec 2.
* Cavity flange, bolt holes, and inside the right angle valve up to the valve stem to Spec 1.
 |
| 6. Prepare the MFC2 [Blue Line] Spool for assembly to the cavity right angle valve.* Set the purge software to "Standby" for MFC2 [Blue Line].
* Verify the baratron for MFC2 [Blue Line] is reading approximately 0.
* Wipe the MFC2 [Blue Line] Spool with a prewet IPA wipe.
* Remove the blank, gasket, and all fasteners from the MFC2 [Blue Line] Spool.
* Wipe bolt holes with an IPA dipped Q-tip.
* Wipe flange sealing surface with prewet IPA wipe.

**Note**: One technician shall hold the Spool and point opening away from the string, people, and any other critical components such as a cavity bays and prepared / cleaned parts. Angle the opening towards the floor until the Spool is ready to be installed onto the right angle valve. A second technician shall perform the purge system set up and particle counts.* Set the purge software to "Blowout" for MFC2 [Blue Line].
* Verify the purge turns on.
* Flow N2 through the Spool until Spec 1 is reached for two full cycles.
* Set the purge software to "Purge" for MFC2 [Blue Line].
 |
| 7. Install the MFC2 [Blue Line] purge system Line to the cavity right angle valve.* Place a new cleaned [Spec 1] gasket on the MFC2 [Blue Line] Spool. Use a large-bore gasket if available.
* Install two pre-cleaned [Spec1] studs in a star pattern and snug with wrench.
* Install the four remaining studs continuing the star pattern.
* Torque all studs using a standard torque pattern for a round flange.
* Repeat the final torque sequence twice and then go around all the studs at least twice or until there is no movement of the nuts. Stop if the flanges go metal-to-metal.
* Verify the purge turns off.
 |
| 8. Pump down the purge line to the cavity right angle valve.* Set the purge software to "Standby" for MFC2 [Blue Line].
* Pump down the purge header to the closed right angle valve on the cavity. Allow the header to pump to the mid E-5 mbar range.
* Close the pump isolation valve.
 |
| 9. While monitoring the cavity pressure, slowly open the cavity right angle valve. If the cavity pressure reads at the mid E-4 mbar range or higher, notify the cleanroom supervisor. | [[CAV6VacuumOK]] <<YESNO>> |
| 10. Set the purge software to "Backfill" for MFC2 [Blue Line] and slowly backfill the cavity. |  |
| 11. When the cavity has been backfilled to the interlock value (50 mbar), change the purge software to "Purge" for MFC2 [Blue Line]. | [[CAV6PrepComment]] <<COMMENT>>[[CAV6PrepTime]] <<TIMESTAMP>>[[CAV6PrepTech]] <<SRFCVP>> |
| 19. | **Cavity 6 FPC Installation**1. Gather the following components for the connection of the cold end coupler to the cavity. Verify the components are cleaned and ready for installation.* 1 inspected and accepted FPC body
* 1 FPC body flange alignment blank
* 2 clean spring clamps
* Fasteners
* 1 hex seal gasket
* Retainer clips
* Wrenches
 |  |
| 2. Record the FPC Serial Number. | [[FPCSN6]] <<FPCSN>> |
| 3. Use the FPC body holding tool to hold and spray the FPC to Spec 1.4. When all the N2 spraying is complete, carefully place the alignment tooling over the probe tip and onto the FPC body flange. Clamp in place with two spring clamps.* Open the clamps down and away from the cavity.

5. Install the FPC onto the installation tooling and spray to Spec 1. |  |
| 6. Verify the purge software is set to "Purge" for MFC2 [Blue Line].4. Remove 4 of the 8 studs in the cavity FPC flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 studs in a star pattern from the cavity flange and check the purge system.
* Remove 2 additional studs from the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

7. Install 2 pre-cleaned [Spec 1] studs in the open holes on the cavity and torque to 10 ft-lbs.8. Continue to remove original studs on the cavity flange 2 at a time from the cavity flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 studs in a star pattern from the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.
* Continue fastener removal until all of the original fasteners have been removed and only the two pre-cleaned studs remain installed.

9. [Two person] Remove the pre-cleaned studs on the cavity coupler flange and carefully remove test coupler and gasket from cavity. Verify the purge starts.10. Install FPC alignment blank on cavity flange with spring clamps.* Open the clamps down and away from the cavity.
 |  |
| 11. Install the FPC alignment table on the lollipop.12. Align FPC to open holes on alignment blank.13. Move FPC back as far as possible on the FPC table.14. Remove the FPC coupler cover.15. Install the FPC gasket with retaining clips to hold the gasket in place on the FPC. Verify the clips are placed in the horizontal position. |
| 16. Remove the alignment blank from the cavity.17. [Two person] Move FPC into place, remove the gasket clips, and install 2 pre-cleaned [Spec 1] studs in a star pattern to secure coupler. Snug studs with wrench.18. Install 2 additional pre-cleaned [Spec 1] studs continuing the star pattern and snug with wrench.19. Install remaining 4 studs in pairs continuing the star pattern on FPC flange. |
| 20. Torque all fasteners to 60 in/lbs using a standard torque pattern for a round flange.21. Increase the torque wrench setting to 10 ft-lbs [120 in/lbs] and torque all fasteners using a standard torque pattern for a round flange.22. Repeat the final torque sequence twice and then go around all the fasteners at least twice or until there is no movement of the nuts. Verify the purge stops. | [[FPC6InstallComment]] <<COMMENT>>[[FPC6InstallTime]] <<TIMESTAMP>>[[FPC6InstallTech]] <<SRFCVP>> |
| 23. Remove coupler alignment table from lollipop and install FPC support arm. | [[FPC6SupportArmInstalled]] <<YESNO>> |
| 20. | Cavity 6 Assembly to Cavity String, including Bellows installation between Cavity 5 and Cavity 61. Gather the following components. Verify the components are cleaned and ready for installation.* 2 bellows flange alignment blanks
* 1 beamline gasket
* 4 covered spring clamps
* Fasteners
* Retainer clips
* Wrenches
 |  |
| **Prepare the Bellows**2. Place the bellows alignment table on the upstream lollipop for Cavity 6.3. Place the bellows in the alignment fixture and align the two flanges.4. Install the bellows restrain blocks onto the bellows, using 2 bolts per restraint. Use Ionized N2 to clean the bellows to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.5. Install the bellows in the alignment fixture. Use Ionized N2 to clean the bellows to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.6. Carefully place an alignment blank on both ends of the bellows. Clamp in place with two covered spring clamps per flange.* Open the clamps down and away from the bellows.
 | [[BLBPSN5\_6]] <<BLBPSN>> |
| **Prepare the Cavity 6 Upstream Flange**7. Verify the purge software is set to "Purge" for MFC2 [Blue Line].8. Remove 8 studs from the cavity upstream end flange in a star pattern. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

9. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.10. Remove final 4 original studs 2 at a time from the flange continuing the star pattern. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

11. Remove the 4 pre-cleaned studs from the cavity flange and carefully remove the blank and gasket. Verify the purge starts.12. Carefully place an alignment blank on the cavity flange. Verify that the alignment pins on the cavity flange do not line up with the alignment pins on the bellows. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the open cavity flange.
 |  |
| **Align the Bellows Non-Rotatable Flange and the Cavity 6 Upstream Flanges**13. Carefully place the cleaned bellows holder with the bellows on the alignment table. The bellows not-rotatable flange shall be facing Cavity 6.14. Slowly slide the bellows towards Cavity 6 to check flange alignment. The nipples on the alignment blanks should move freely into the indents of the flanges. A slight rotation of the bellows flange can be performed if necessary during the alignment process.15. Move the cavity away from the bellows flange. |
| **Install the Bellows to Cavity 6**16. Carefully remove the alignment blanks from the bellows non-rotatable flange and the cavity.17. Install the beamline gasket with retaining clips to hold the gasket in place on the bellows flange. Verify the clips are placed in the horizontal position.18. [Two person] Slowly slide the cavity back into place against the gasket. Remove the gasket clips.19. One technician shall hold the flanges tightly together, preventing the flanges from rotating or moving away from each other. This technician shall hold the flanges until the first 4 studs have been snugged tight with a wrench.20. A second technician shall place 4 pre-cleaned [Spec 1] studs in a star pattern in the cavity flange and snug them with a wrench.21. The second technician shall place the remaining fasteners on the flange continuing the star pattern and snug all of them with a wrench.22. Torque the fasteners to 15 ft-lbs using a standard torquing pattern for a round flange. Do not increase torque at this time. Final torqueing will be performed after both ends of the bellows have been attached to the cavities.23. Remove the bellows holder and adjustable table from the lollipop. |
| **Prepare Cavity 5 Downstream Flange**24. Verify the purge software is set to "Purge" for MFC1 [White Line].25. Remove 8 studs from the cavity downstream end flange in a star pattern. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

26. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.27. Remove final 4 original studs 2 at a time from the flange continuing the star pattern. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

28. Remove the 4 pre-cleaned studs from the cavity flange and carefully remove the blank and gasket. Verify the purge starts.29. Carefully place an alignment blank on the cavity flange. Verify that the alignment pins on the cavity flange do not line up with the alignment pins on the bellows. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the cavity.
 |  |
| **Align the Bellows Rotatable Flange and Cavity 5 Downstream Flange**30. Slowly slide Cavity 6 towards Cavity 5 to check bellows rotatable flange alignment. The nipples on the flange alignment covers should move freely into the indents of the flanges. A slight rotation of the bellows flange can be performed if necessary during the alignment process. A bolt on each bellows restraint block can be loosened to allow for the rotatable flange to be adjusted if needed.31. Move Cavity 6 away from Cavity 5.32. Carefully remove the alignment covers from the bellows rotatable flange and Cavity 5. |
| **Install the Bellows to Cavity 5**33. Carefully remove the alignment blanks from the bellows rotatable flange and the cavity.34. Install the beamline gasket with retaining clips to hold the gasket in place on the bellows flange. Verify the clips are placed in the horizontal position.35. [Two person] Slowly slide the cavity back into place against the gasket. Remove the gasket clips.36. One technician shall hold the flanges tightly together, preventing the flanges from rotating or moving away from each other. This technician shall hold the flanges until the first 4 studs have been snugged tight with a wrench.37. A second technician shall place 4 pre-cleaned [Spec 1] studs in a star pattern in the cavity flange and snug them with a wrench.38. The second technician shall place the remaining fasteners on the flange continuing the star pattern and snug all of them with a wrench.39. Torque the fasteners to 15 ft-lbs using a standard torquing pattern for a round flange. |
| **Final Torquing of Bellows Flanges to Cavities**40. Torque all the fasteners on the Cavity 6 side of the bellows to 31 ft-lbs using a standard torquing pattern for a round flange.41. Torque all the fasteners on the Cavity 5 side of the bellows to 31 ft-lbs using a standard torquing pattern for a round flange.42. On the Cavity 6 side, repeat the final torque sequence twice and then go around all of the fasteners at least twice or until there is no movement of the nuts.43. On the Cavity 5 side, repeat the final torque sequence twice and then go around all of the fasteners at least twice or until there is no movement of the nuts.44. Verify the purge system turns off.45. Install rail locks on Cavity 6 to lock it in place. | [[Bellows5\_6\_Comment]] <<COMMENT>>[[Bellows5\_6\_Time]] <<TIMESTAMP>>[[Bellows5\_6\_Tech1]] <<SRFCVP>>[[Bellows5\_6\_Tech2]] <<SRFCVP>> |
| **Remove Purge System Hose from Cavity 6**46. Set the purge software to "Standby" state for MFC2 [Blue Line]. This will close MFC2 [Blue Line] and MFC2 [Blue Line] will not open under any circumstance. If a drop in pressure occurs, the purge will initiate from MFC1 [White Line].47. Slowly close the cavity right angle valve.48. Remove the purge system hose from the cavity.49. Put a blank on the Spool with two studs using the same gasket. |  |

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| --- | --- | --- |
| Step No. | Instructions | Data Input |
| 21. | **Cavity 7 Prep**1. Record Cavity 7 serial number. | [[CAVSN7]] <<CAVSN>> |
| 2. Put the cavity on the rail tooling with the blank flange facing the upstream gate valve sub-assembly [GV1SA] and the FPC facing the southeast corner of the cleanroom. |  |
| **Note: There will be some movement of flange location and/or cavity level every time something is adjusted. Several iterations of the cavity alignment will be required before the cavity will be perfectly level and have both beamline flanges in place.**3. Align Cavity 7 and the upstream flange of Cavity 6. The cavity shall be aligned with the flange alignment tool to locate the beamline flange in the proper location.* Verify the location of the flange is near the center of the range of the tooling to accommodate the alignment of all the cavities in the string.
* After both flanges of the cavity are in the same position - relative to the rail - set the roll of the cavity level using a precision level on the leveling tool, which is attached to the other set of helium vessel blocks.
 |
| 4. Set the roll of the cavity rotationally using the rotational alignment bridge and the "A" frame. Verify all four frame studs and "A" frame studs are tight when finished. |
| 5. Blow down the cavity with ionized N2 in accordance with the Ionized Nitrogen Cleaning Procedure.* General cavity to Spec 2.
* Cavity flange, bolt holes, and inside the right angle valve up to the valve stem to Spec 1.
 |
| 6. Prepare the MFC2 [Blue Line] Spool for assembly to the cavity right angle valve.* Set the purge software to "Standby" for MFC2 [Blue Line].
* Verify the baratron for MFC2 [Blue Line] is reading approximately 0.
* Wipe the MFC2 [Blue Line] Spool with a prewet IPA wipe.
* Remove the blank, gasket, and all fasteners from the MFC2 [Blue Line] Spool.
* Wipe bolt holes with an IPA dipped Q-tip.
* Wipe flange sealing surface with prewet IPA wipe.

**Note**: One technician shall hold the Spool and point opening away from the string, people, and any other critical components such as a cavity bays and prepared / cleaned parts. Angle the opening towards the floor until the Spool is ready to be installed onto the right angle valve. A second technician shall perform the purge system set up and particle counts.* Set the purge software to "Blowout" for MFC2 [Blue Line].
* Verify the purge turns on.
* Flow N2 through the Spool until Spec 1 is reached for two full cycles.
* Set the purge software to "Purge" for MFC2 [Blue Line].
 |
| 7. Install the MFC2 [Blue Line] purge system Line to the cavity right angle valve.* Place a new cleaned [Spec 1] gasket on the MFC2 [Blue Line] Spool. Use a large-bore gasket if available.
* Install two pre-cleaned [Spec1] studs in a star pattern and snug with wrench.
* Install the four remaining studs continuing the star pattern.
* Torque all studs using a standard torque pattern for a round flange.
* Repeat the final torque sequence twice and then go around all the studs at least twice or until there is no movement of the nuts. Stop if the flanges go metal-to-metal.
* Verify the purge turns off.
 |
| 8. Pump down the purge line to the cavity right angle valve.* Set the purge software to "Standby" for MFC2 [Blue Line].
* Pump down the purge header to the closed right angle valve on the cavity. Allow the header to pump to the mid E-5 mbar range.
* Close the pump isolation valve.
 |
| 9. While monitoring the cavity pressure, slowly open the cavity right angle valve. If the cavity pressure reads at the mid E-4 mbar range or higher, notify the cleanroom supervisor. | [[CAV7VacuumOK]] <<YESNO>> |
| 10. Set the purge software to "Backfill" for MFC2 [Blue Line] and slowly backfill the cavity. |  |
| 11. When the cavity has been backfilled to the interlock value (50 mbar), change the purge software to "Purge" for MFC2 [Blue Line]. | [[CAV7PrepComment]] <<COMMENT>>[[CAV7PrepTime]] <<TIMESTAMP>>[[CAV7PrepTech]] <<SRFCVP>> |
| 22. | **Cavity 7 FPC Installation**1. Gather the following components for the connection of the cold end coupler to the cavity. Verify the components are cleaned and ready for installation.* 1 inspected and accepted FPC body
* 1 FPC body flange alignment blank
* 2 clean spring clamps
* Fasteners
* 1 hex seal gasket
* Retainer clips
* Wrenches
 |  |
| 2. Record the FPC Serial Number. | [[FPCSN7]] <<FPCSN>> |
| 3. Use the FPC body holding tool to hold and spray the FPC to Spec 1.4. When all the N2 spraying is complete, carefully place the alignment tooling over the probe tip and onto the FPC body flange. Clamp in place with two spring clamps.* Open the clamps down and away from the cavity.

5. Install the FPC onto the installation tooling and spray to Spec 1. |  |
| 6. Verify the purge software is set to "Purge" for MFC2 [Blue Line].4. Remove 4 of the 8 studs in the cavity FPC flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 studs in a star pattern from the cavity flange and check the purge system.
* Remove 2 additional studs from the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

7. Install 2 pre-cleaned [Spec 1] studs in the open holes on the cavity and torque to 10 ft-lbs.8. Continue to remove original studs on the cavity flange 2 at a time from the cavity flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 studs in a star pattern from the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.
* Continue fastener removal until all of the original fasteners have been removed and only the two pre-cleaned studs remain installed.

9. [Two person] Remove the pre-cleaned studs on the cavity coupler flange and carefully remove test coupler and gasket from cavity. Verify the purge starts.10. Install FPC alignment blank on cavity flange with spring clamps.* Open the clamps down and away from the cavity.
 |  |
| 11. Install the FPC alignment table on the lollipop.12. Align FPC to open holes on alignment blank.13. Move FPC back as far as possible on the FPC table.14. Remove the FPC coupler cover.15. Install the FPC gasket with retaining clips to hold the gasket in place on the FPC. Verify the clips are placed in the horizontal position. |
| 16. Remove the alignment blank from the cavity.17. [Two person] Move FPC into place, remove the gasket clips, and install 2 pre-cleaned [Spec 1] studs in a star pattern to secure coupler. Snug studs with wrench.18. Install 2 additional pre-cleaned [Spec 1] studs continuing the star pattern and snug with wrench.19. Install remaining 4 studs in pairs continuing the star pattern on FPC flange. |
| 20. Torque all fasteners to 60 in/lbs using a standard torque pattern for a round flange.21. Increase the torque wrench setting to 10 ft-lbs [120 in/lbs] and torque all fasteners using a standard torque pattern for a round flange.22. Repeat the final torque sequence twice and then go around all the fasteners at least twice or until there is no movement of the nuts. Verify the purge stops. | [[FPC7InstallComment]] <<COMMENT>>[[FPC7InstallTime]] <<TIMESTAMP>>[[FPC7InstallTech]] <<SRFCVP>> |
| 23. Remove coupler alignment table from lollipop and install FPC support arm. | [[FPC7SupportArmInstalled]] <<YESNO>> |
| 23. | Cavity 7 Assembly to Cavity String, including Bellows installation between Cavity 6 and Cavity 71. Gather the following components. Verify the components are cleaned and ready for installation.* 2 bellows flange alignment blanks
* 1 beamline gasket
* 4 covered spring clamps
* Fasteners
* Retainer clips
* Wrenches
 |  |
| **Prepare the Bellows**2. Place the bellows alignment table on the upstream lollipop for Cavity 7.3. Place the bellows in the alignment fixture and align the two flanges.4. Install the bellows restrain blocks onto the bellows, using 2 bolts per restraint. Use Ionized N2 to clean the bellows to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.5. Install the bellows in the alignment fixture. Use Ionized N2 to clean the bellows to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.6. Carefully place an alignment blank on both ends of the bellows. Clamp in place with two covered spring clamps per flange.* Open the clamps down and away from the bellows.
 | [[BLBPSN6\_7]] <<BLBPSN>> |
| **Prepare the Cavity 7 Upstream Flange**7. Verify the purge software is set to "Purge" for MFC2 [Blue Line].8. Remove 8 studs from the cavity upstream end flange in a star pattern. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

9. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.10. Remove final 4 original studs 2 at a time from the flange continuing the star pattern. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

11. Remove the 4 pre-cleaned studs from the cavity flange and carefully remove the blank and gasket. Verify the purge starts.12. Carefully place an alignment blank on the cavity flange. Verify that the alignment pins on the cavity flange do not line up with the alignment pins on the bellows. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the open cavity flange.
 |  |
| **Align the Bellows Non-Rotatable Flange and the Cavity 7 Upstream Flanges**13. Carefully place the cleaned bellows holder with the bellows on the alignment table. The bellows not-rotatable flange shall be facing Cavity 7.14. Slowly slide the bellows towards Cavity 7 to check flange alignment. The nipples on the alignment blanks should move freely into the indents of the flanges. A slight rotation of the bellows flange can be performed if necessary during the alignment process.15. Move the cavity away from the bellows flange. |
| **Install the Bellows to Cavity 7**16. Carefully remove the alignment blanks from the bellows non-rotatable flange and the cavity.17. Install the beamline gasket with retaining clips to hold the gasket in place on the bellows flange. Verify the clips are placed in the horizontal position.18. [Two person] Slowly slide the cavity back into place against the gasket. Remove the gasket clips.19. One technician shall hold the flanges tightly together, preventing the flanges from rotating or moving away from each other. This technician shall hold the flanges until the first 4 studs have been snugged tight with a wrench.20. A second technician shall place 4 pre-cleaned [Spec 1] studs in a star pattern in the cavity flange and snug them with a wrench.21. The second technician shall place the remaining fasteners on the flange continuing the star pattern and snug all of them with a wrench.22. Torque the fasteners to 15 ft-lbs using a standard torquing pattern for a round flange. Do not increase torque at this time. Final torqueing will be performed after both ends of the bellows have been attached to the cavities.23. Remove the bellows holder and adjustable table from the lollipop. |
| **Prepare Cavity 6 Downstream Flange**24. Verify the purge software is set to "Purge" for MFC1 [White Line].25. Remove 8 studs from the cavity downstream end flange in a star pattern. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

26. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.27. Remove final 4 original studs 2 at a time from the flange continuing the star pattern. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

28. Remove the 4 pre-cleaned studs from the cavity flange and carefully remove the blank and gasket. Verify the purge starts.29. Carefully place an alignment blank on the cavity flange. Verify that the alignment pins on the cavity flange do not line up with the alignment pins on the bellows. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the cavity.
 |  |
| **Align the Bellows Rotatable Flange and Cavity 6 Downstream Flange**30. Slowly slide Cavity 7 towards Cavity 6 to check bellows rotatable flange alignment. The nipples on the flange alignment covers should move freely into the indents of the flanges. A slight rotation of the bellows flange can be performed if necessary during the alignment process. A bolt on each bellows restraint block can be loosened to allow for the rotatable flange to be adjusted if needed.31. Move Cavity 7 away from Cavity 6.32. Carefully remove the alignment covers from the bellows rotatable flange and Cavity 6. |
| **Install the Bellows to Cavity 6**33. Carefully remove the alignment blanks from the bellows rotatable flange and the cavity.34. Install the beamline gasket with retaining clips to hold the gasket in place on the bellows flange. Verify the clips are placed in the horizontal position.35. [Two person] Slowly slide the cavity back into place against the gasket. Remove the gasket clips.36. One technician shall hold the flanges tightly together, preventing the flanges from rotating or moving away from each other. This technician shall hold the flanges until the first 4 studs have been snugged tight with a wrench.37. A second technician shall place 4 pre-cleaned [Spec 1] studs in a star pattern in the cavity flange and snug them with a wrench.38. The second technician shall place the remaining fasteners on the flange continuing the star pattern and snug all of them with a wrench.39. Torque the fasteners to 15 ft-lbs using a standard torquing pattern for a round flange. |
| **Final Torquing of Bellows Flanges to Cavities**40. Torque all the fasteners on the Cavity 7 side of the bellows to 31 ft-lbs using a standard torquing pattern for a round flange.41. Torque all the fasteners on the Cavity 6 side of the bellows to 31 ft-lbs using a standard torquing pattern for a round flange.42. On the Cavity 7 side, repeat the final torque sequence twice and then go around all of the fasteners at least twice or until there is no movement of the nuts.43. On the Cavity 6 side, repeat the final torque sequence twice and then go around all of the fasteners at least twice or until there is no movement of the nuts.44. Verify the purge system turns off.45. Install rail locks on Cavity 7 to lock it in place. | [[Bellows6\_7\_Comment]] <<COMMENT>>[[Bellows6\_7\_Time]] <<TIMESTAMP>>[[Bellows6\_7\_Tech1]] <<SRFCVP>>[[Bellows6\_7\_Tech2]] <<SRFCVP>> |
| **Remove Purge System Hose from Cavity 7**46. Set the purge software to "Standby" state for MFC2 [Blue Line]. This will close MFC2 [Blue Line] and MFC2 [Blue Line] will not open under any circumstance. If a drop in pressure occurs, the purge will initiate from MFC1 [White Line].47. Slowly close the cavity right angle valve.48. Remove the purge system hose from the cavity.49. Put a blank on the Spool with two studs using the same gasket.  |  |

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| Step No. | Instructions | Data Input |
| 24. | **Cavity 8 Prep**1. Record Cavity 8 serial number. | [[CAVSN8]] <<CAVSN>> |
| 2. Put the cavity on the rail tooling with the blank flange facing the upstream gate valve sub-assembly [GV1SA] and the FPC facing the southeast corner of the cleanroom. |  |
| **Note: There will be some movement of flange location and/or cavity level every time something is adjusted. Several iterations of the cavity alignment will be required before the cavity will be perfectly level and have both beamline flanges in place.**3. Align Cavity 8 and the upstream flange of Cavity 7. The cavity shall be aligned with the flange alignment tool to locate the beamline flange in the proper location.* Verify the location of the flange is near the center of the range of the tooling to accommodate the alignment of all the cavities in the string.
* After both flanges of the cavity are in the same position - relative to the rail - set the roll of the cavity level using a precision level on the leveling tool, which is attached to the other set of helium vessel blocks.
 |
| 4. Set the roll of the cavity rotationally using the rotational alignment bridge and the "A" frame. Verify all four frame studs and "A" frame studs are tight when finished. |
| 5. Blow down the cavity with ionized N2 in accordance with the Ionized Nitrogen Cleaning Procedure.* General cavity to Spec 2.
* Cavity flange, bolt holes, and inside the right angle valve up to the valve stem to Spec 1.
 |
| 6. Prepare the MFC2 [Blue Line] Spool for assembly to the cavity right angle valve.* Set the purge software to "Standby" for MFC2 [Blue Line].
* Verify the baratron for MFC2 [Blue Line] is reading approximately 0.
* Wipe the MFC2 [Blue Line] Spool with a prewet IPA wipe.
* Remove the blank, gasket, and all fasteners from the MFC2 [Blue Line] Spool.
* Wipe bolt holes with an IPA dipped Q-tip.
* Wipe flange sealing surface with prewet IPA wipe.

**Note**: One technician shall hold the Spool and point opening away from the string, people, and any other critical components such as a cavity bays and prepared / cleaned parts. Angle the opening towards the floor until the Spool is ready to be installed onto the right angle valve. A second technician shall perform the purge system set up and particle counts.* Set the purge software to "Blowout" for MFC2 [Blue Line].
* Verify the purge turns on.
* Flow N2 through the Spool until Spec 1 is reached for two full cycles.
* Set the purge software to "Purge" for MFC2 [Blue Line].
 |
| 7. Install the MFC2 [Blue Line] purge system Line to the cavity right angle valve.* Place a new cleaned [Spec 1] gasket on the MFC2 [Blue Line] Spool. Use a large-bore gasket if available.
* Install two pre-cleaned [Spec1] studs in a star pattern and snug with wrench.
* Install the four remaining studs continuing the star pattern.
* Torque all studs using a standard torque pattern for a round flange.
* Repeat the final torque sequence twice and then go around all the studs at least twice or until there is no movement of the nuts. Stop if the flanges go metal-to-metal.
* Verify the purge turns off.
 |
| 8. Pump down the purge line to the cavity right angle valve.* Set the purge software to "Standby" for MFC2 [Blue Line].
* Pump down the purge header to the closed right angle valve on the cavity. Allow the header to pump to the mid E-5 mbar range.
* Close the pump isolation valve.
 |
| 9. While monitoring the cavity pressure, slowly open the cavity right angle valve. If the cavity pressure reads at the mid E-4 mbar range or higher, notify the cleanroom supervisor. | [[CAV8VacuumOK]] <<YESNO>> |
| 10. Set the purge software to "Backfill" for MFC2 [Blue Line] and slowly backfill the cavity. |  |
| 11. When the cavity has been backfilled to the interlock value (50 mbar), change the purge software to "Purge" for MFC2 [Blue Line]. | [[CAV8PrepComment]] <<COMMENT>>[[CAV8PrepTime]] <<TIMESTAMP>>[[CAV8PrepTech]] <<SRFCVP>> |
| 25. | **Cavity 8 FPC Installation**1. Gather the following components for the connection of the cold end coupler to the cavity. Verify the components are cleaned and ready for installation.* 1 inspected and accepted FPC body
* 1 FPC body flange alignment blank
* 2 clean spring clamps
* Fasteners
* 1 hex seal gasket
* Retainer clips
* Wrenches
 |  |
| 2. Record the FPC Serial Number. | [[FPCSN8]] <<FPCSN>> |
| 3. Use the FPC body holding tool to hold and spray the FPC to Spec 1.4. When all the N2 spraying is complete, carefully place the alignment tooling over the probe tip and onto the FPC body flange. Clamp in place with two spring clamps.* Open the clamps down and away from the cavity.

5. Install the FPC onto the installation tooling and spray to Spec 1. |  |
| 6. Verify the purge software is set to "Purge" for MFC2 [Blue Line].4. Remove 4 of the 8 studs in the cavity FPC flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 studs in a star pattern from the cavity flange and check the purge system.
* Remove 2 additional studs from the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

7. Install 2 pre-cleaned [Spec 1] studs in the open holes on the cavity and torque to 10 ft-lbs.8. Continue to remove original studs on the cavity flange 2 at a time from the cavity flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 studs in a star pattern from the cavity flange and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.
* Continue fastener removal until all of the original fasteners have been removed and only the two pre-cleaned studs remain installed.

9. [Two person] Remove the pre-cleaned studs on the cavity coupler flange and carefully remove test coupler and gasket from cavity. Verify the purge starts.10. Install FPC alignment blank on cavity flange with spring clamps.* Open the clamps down and away from the cavity.
 |  |
| 11. Install the FPC alignment table on the lollipop.12. Align FPC to open holes on alignment blank.13. Move FPC back as far as possible on the FPC table.14. Remove the FPC coupler cover.15. Install the FPC gasket with retaining clips to hold the gasket in place on the FPC. Verify the clips are placed in the horizontal position. |
| 16. Remove the alignment blank from the cavity.17. [Two person] Move FPC into place, remove the gasket clips, and install 2 pre-cleaned [Spec 1] studs in a star pattern to secure coupler. Snug studs with wrench.18. Install 2 additional pre-cleaned [Spec 1] studs continuing the star pattern and snug with wrench.19. Install remaining 4 studs in pairs continuing the star pattern on FPC flange. |
| 20. Torque all fasteners to 60 in/lbs using a standard torque pattern for a round flange.21. Increase the torque wrench setting to 10 ft-lbs [120 in/lbs] and torque all fasteners using a standard torque pattern for a round flange.22. Repeat the final torque sequence twice and then go around all the fasteners at least twice or until there is no movement of the nuts. Verify the purge stops. | [[FPC8InstallComment]] <<COMMENT>>[[FPC8InstallTime]] <<TIMESTAMP>>[[FPC8InstallTech]] <<SRFCVP>> |
| 23. Remove coupler alignment table from lollipop and install FPC support arm. | [[FPC8SupportArmInstalled]] <<YESNO>> |
| 26. | Cavity 8 Assembly to Cavity String, including Bellows installation between Cavity 7 and Cavity 81. Gather the following components. Verify the components are cleaned and ready for installation.* 2 bellows flange alignment blanks
* 1 beamline gasket
* 4 covered spring clamps
* Fasteners
* Retainer clips
* Wrenches
 |  |
| **Prepare the Bellows**2. Place the bellows alignment table on the upstream lollipop for Cavity 8.3. Place the bellows in the alignment fixture and align the two flanges.4. Install the bellows restrain blocks onto the bellows, using 2 bolts per restraint. Use Ionized N2 to clean the bellows to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.5. Install the bellows in the alignment fixture. Use Ionized N2 to clean the bellows to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.6. Carefully place an alignment blank on both ends of the bellows. Clamp in place with two covered spring clamps per flange.* Open the clamps down and away from the bellows.
 | [[BLBPSN7\_8]] <<BLBPSN>> |
| **Prepare the Cavity 8 Upstream Flange**7. Verify the purge software is set to "Purge" for MFC2 [Blue Line].8. Remove 8 studs from the cavity upstream end flange in a star pattern. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

9. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.10. Remove final 4 original studs 2 at a time from the flange continuing the star pattern. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

11. Remove the 4 pre-cleaned studs from the cavity flange and carefully remove the blank and gasket. Verify the purge starts.12. Carefully place an alignment blank on the cavity flange. Verify that the alignment pins on the cavity flange do not line up with the alignment pins on the bellows. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the open cavity flange.
 |  |
| **Align the Bellows Non-Rotatable Flange and the Cavity 8 Upstream Flanges**13. Carefully place the cleaned bellows holder with the bellows on the alignment table. The bellows not-rotatable flange shall be facing Cavity 8.14. Slowly slide the bellows towards Cavity 8 to check flange alignment. The nipples on the alignment blanks should move freely into the indents of the flanges. A slight rotation of the bellows flange can be performed if necessary during the alignment process.15. Move the cavity away from the bellows flange. |
| **Install the Bellows to Cavity 8**16. Carefully remove the alignment blanks from the bellows non-rotatable flange and the cavity.17. Install the beamline gasket with retaining clips to hold the gasket in place on the bellows flange. Verify the clips are placed in the horizontal position.18. [Two person] Slowly slide the cavity back into place against the gasket. Remove the gasket clips.19. One technician shall hold the flanges tightly together, preventing the flanges from rotating or moving away from each other. This technician shall hold the flanges until the first 4 studs have been snugged tight with a wrench.20. A second technician shall place 4 pre-cleaned [Spec 1] studs in a star pattern in the cavity flange and snug them with a wrench.21. The second technician shall place the remaining fasteners on the flange continuing the star pattern and snug all of them with a wrench.22. Torque the fasteners to 15 ft-lbs using a standard torquing pattern for a round flange. Do not increase torque at this time. Final torqueing will be performed after both ends of the bellows have been attached to the cavities.23. Remove the bellows holder and adjustable table from the lollipop. |
| **Prepare Cavity 7 Downstream Flange**24. Verify the purge software is set to "Purge" for MFC1 [White Line].25. Remove 8 studs from the cavity downstream end flange in a star pattern. After the removal of each pair of studs, check the status of the purge system. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

26. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.27. Remove final 4 original studs 2 at a time from the flange continuing the star pattern. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

28. Remove the 4 pre-cleaned studs from the cavity flange and carefully remove the blank and gasket. Verify the purge starts.29. Carefully place an alignment blank on the cavity flange. Verify that the alignment pins on the cavity flange do not line up with the alignment pins on the bellows. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the cavity.
 |  |
| **Align the Bellows Rotatable Flange and Cavity 7 Downstream Flange**30. Slowly slide Cavity 8 towards Cavity 7 to check bellows rotatable flange alignment. The nipples on the flange alignment covers should move freely into the indents of the flanges. A slight rotation of the bellows flange can be performed if necessary during the alignment process. A bolt on each bellows restraint block can be loosened to allow for the rotatable flange to be adjusted if needed.31. Move Cavity 8 away from Cavity 7.32. Carefully remove the alignment covers from the bellows rotatable flange and Cavity 7. |
| **Install the Bellows to Cavity 7**33. Carefully remove the alignment blanks from the bellows rotatable flange and the cavity.34. Install the beamline gasket with retaining clips to hold the gasket in place on the bellows flange. Verify the clips are placed in the horizontal position.35. [Two person] Slowly slide the cavity back into place against the gasket. Remove the gasket clips.36. One technician shall hold the flanges tightly together, preventing the flanges from rotating or moving away from each other. This technician shall hold the flanges until the first 4 studs have been snugged tight with a wrench.37. A second technician shall place 4 pre-cleaned [Spec 1] studs in a star pattern in the cavity flange and snug them with a wrench.38. The second technician shall place the remaining fasteners on the flange continuing the star pattern and snug all of them with a wrench.39. Torque the fasteners to 15 ft-lbs using a standard torquing pattern for a round flange. |
| **Final Torquing of Bellows Flanges to Cavities**40. Torque all the fasteners on the Cavity 8 side of the bellows to 31 ft-lbs using a standard torquing pattern for a round flange.41. Torque all the fasteners on the Cavity 7 side of the bellows to 31 ft-lbs using a standard torquing pattern for a round flange.42. On the Cavity 8 side, repeat the final torque sequence twice and then go around all of the fasteners at least twice or until there is no movement of the nuts.43. On the Cavity 7 side, repeat the final torque sequence twice and then go around all of the fasteners at least twice or until there is no movement of the nuts.44. Verify the purge system turns off.45. Install rail locks on Cavity 8 to lock it in place. | [[Bellows7\_8\_Comment]] <<COMMENT>>[[Bellows7\_8\_Time]] <<TIMESTAMP>>[[Bellows7\_8\_Tech1]] <<SRFCVP>>[[Bellows7\_8\_Tech2]] <<SRFCVP>> |
| **Remove Purge System Hose from Cavity 8**46. Set the purge software to "Standby" state for MFC2 [Blue Line]. This will close MFC2 [Blue Line] and MFC2 [Blue Line] will not open under any circumstance. If a drop in pressure occurs, the purge will initiate from MFC1 [White Line].47. Slowly close the cavity right angle valve.48. Remove the purge system hose from the cavity.49. Put a blank on the Spool with two studs using the same gasket.  |  |

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| Step No. | Instructions | Data Input |
| 27. | **Downstream Gate Valve Sub-Assembly [GV2SA] Prep**1. Record downstream gate valve serial number. | [[AMGVSN2]] <<AMGVSN>> |
| 2. Record downstream bellows serial number. | [[BLBSSN]] <<BLBSSN>> |
| 3. Record BPM serial number. | [[BPMSN]] <<BPMSN>> |
| 4. Transfer GV2SA on to the lollipop system.* Verify that the gate valve handle is facing the power coupler direction.
 |  |
| 5. Perform an alignment of GV2SA.* After the GV2SA beamline flanges are in the same position - relative to the rail - set the roll of GV2SA level using a precision level on the BPM leveling bridge.
* Lock GV2SA in place with the leveling studs of the gate valve holder.
 |
| 6. Blow down GV2SA with ionized N2 to Spec 2 in accordance with the Ionized Nitrogen Cleaning Procedure.  |
| 7. Prepare the MFC3 [Yellow Line] Spool for assembly to the GV2SA right angle valve.**Note**: The MFC2 [Blue Line] can be used for GV2SA instead of MFC3 [Yellow Line] if needed. The Spool isolation valve shall be installed between the filter and the Swagelok fitting prior to starting this step if MFC2 [Blue Line] will be used.**Note**: A slow pump system shall be used for GV2SA assembly.* Verify that the Spool has an isolation valve installed between the filter and Swagelok fitting.
* Verify that the Spool is connected to a slow pump system.
* Set the purge software to "Standby" for MFC3 [Yellow Line].
* Verify the baratron for MFC3 [Yellow Line] is reading approximately 0.
* Wipe the MFC3 [Yellow Line] Spool flange and reducer with a prewet IPA wipe.
* Remove the blank, gasket, and all fasteners from the MFC3 [Yellow Line] Spool.
* Wipe bolt holes with an IPA dipped Q-tip.
* Wipe flange sealing surface with prewet IPA wipe.

**Note**: One technician shall hold the Spool and point opening away from the string, people, and any other critical components such as a cavity bays and prepared / cleaned parts. Angle the opening towards the floor until the Spool is ready to be installed onto the right angle valve. A second technician shall perform the purge system set up and particle counts.* Set the purge software to "Blowout" for MFC3 [Yellow Line].
* Verify the purge turns on.
* Flow N2 through the Spool until Spec 1 is reached for two full cycles.
* Set the purge software to "Purge" for MFC3 [Yellow Line].
 |
| 8. Install the MFC3 [Yellow Line] purge system Line to the Faraday Window Manifold right angle valve.* Blow down the Faraday Window Manifold right angle valve, including the flange, bolt holes, and inside the valve up to the valve stem.
* Place a new cleaned [Spec 1] gasket on the MFC3 [Yellow Line] Spool.
* Install two pre-cleaned [Spec 1] studs in a star pattern and snug with a wrench.
* Install the four remaining studs continuing the star pattern.
* Torque all studs to 53 in-lbs using a standard torque pattern for a round flange.
* Repeat the final torque sequence twice and then go around all the studs at least twice or until there is no movement of the nuts.
* If the purge system does not shut off, increase torque wrench up to 84 in/lbs or until the flanges go metal-to-metal.
* Verify the purge turns off.
 |
| 9. Pump down the purge line to GV2SA right angle valve.* Set the purge software to "Standby" for MFC3 [Yellow Line].
* Pump down the purge header to the closed right angle valve on GV2SA. Allow the header to pump to the mid E-5 mbar range.
* Close the pump isolation valve.
 |  |
| 10. While monitoring the GV2SA pressure, slowly open GV2SA right angle valve. If the GV2SA pressure reads at the mid E-4 mbar range or higher, notify the cleanroom supervisor. | [[GV2SA\_VacuumOK]] <<YESNO>> |
| 11. Set the purge software to "Backfill" for MFC3 [Yellow Line] and slowly backfill GV2SA. |  |
| 12. When GV2SA has been backfilled to the interlock value (50 mbar), change the purge software to "Purge" for MFC3 [Yellow Line]. | [[GV2SAPrepComment]] <<COMMENT>>[[GV2SAPrepTime]] <<TIMESTAMP>>[[GV2SAPrepTech1]] <<SRFCVP>> |
| 28. | **Downstream Gate Valve Sub-Assembly to Cavity 8 Assembly** 1. Gather the following components. Verify the components are cleaned and ready for installation.* 2 bellows flange alignment blanks
* 1 beamline gasket
* 4 covered spring clamps
* Fasteners
* Retainer clips
* Wrenches
 |  |
| **Prepare the Downstream Gate Valve Sub-Assembly (GV2SA) Bellows Flange**2. Verify the purge software is set to "Purge" for MFC3 [Yellow Line].3. Remove 8 studs from the GV2SA bellows end flange in a star pattern. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

4. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.5. Remove final 4 original studs 2 at a time from the flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

6. Remove the 4 pre-cleaned studs from the bellows flange. Carefully remove the blank and gasket. Verify the purge starts.7. Carefully place an alignment blank onto the bellows flange. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the bellows.
 |
| **Prepare the Cavity 8 Downstream Flange**1. Verify the purge software is set to "Purge" for MFC1 [White Line].2. Remove 8 studs from the cavity downstream end flange in a star pattern. The 4 remaining studs shall be located every third hole in the flange.* After the removal of each pair of studs, check the status of the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

4. Install 4 new pre-cleaned [Spec 1] studs in every third open hole to ensure equal pressure on the gasket. Torque these pre-cleaned studs to 23 ft-lbs.5. Remove final 4 original studs 2 at a time from the flange. After the removal of each pair of studs, check the status of the purge system.* Remove 2 fasteners from the flange and check the purge system.
* Remove 2 additional studs and check the purge system.
* If the purge systems begins to purge at any time, continue with the clean disassembly of the fasteners but do not clean with IPA dipped Q-tip and do not N2 spray bolt holes.
* If the purge system is not purging, clean bolt holes with IPA dipped Q-tip and use ionized N2 to clean open bolt holes to Spec 1 in accordance with the Ionized N2 Parts Cleaning Procedure.

6. Remove the 4 pre-cleaned studs from the cavity flange. Carefully remove the blank and gasket. Verify the purge starts.7. Carefully place an alignment blank onto the bellows flange. Clamp in place with two cleaned spring clamps.* Open the clamps down and away from the cavity.
 |
| **Align GV2SA Bellows and Cavity End Flange**8. Slowly slide GV2SA towards the cavity to check flange alignment. The nipples on the alignment blanks should move freely into the indents of the flanges. A slight rotation of the bellows flange can be performed if necessary during the alignment process.9. Move GV2SA away from the cavity flange.10. Carefully remove the alignment blanks from the cavity and bellows. |
| **Install Cavity to GV2SA Bellows**11. Install the beamline gasket with retaining clips to hold the gasket in place on the bellows flange. Verify the clips are placed in the horizontal position.12. [Two person] Slowly slide the cavity back into place against the gasket. Remove the clips.13. One technician shall hold the flanges tightly together, preventing the flanges from rotating or moving away from each other. This technician shall hold the flanges until the first 4 studs have been snugged tight with a wrench.14. A second technician shall place 4 pre-cleaned [Spec 1] studs in a star pattern in the cavity flange and snug them with a wrench.15. The second technician shall place the remaining fasteners on the flange continuing the star pattern and snug all of them with a wrench.16. Torque the fasteners to 15 ft-lbs using a standard torquing pattern for a round flange.17. Increase the torque and torque all the fasteners to 31 ft-lbs using a standard torquing pattern for a round flange.18. Repeat the final torque sequence twice and then go around all of the fasteners at least twice or until there is no movement of the nuts. Verify the purge system turns off.19. Install rail locks on the cavity and valve to lock them in place. | [[CAV8\_GV2SAComment]] <<COMMENT>>[[CAV8\_GV2SATimeStamp]] <<TIMESTAMP>>[[CAV8\_GV2SATech1]] <<SRFCVP>>[[CAV8\_GV2SATech2]] <<SRFCVP>> |

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| Step No. | Instructions | Data Input |
| 29. | **Cavity String Final Torque**All fasteners on the string shall be re-torqued to the following torque values:* Beamline fasteners: 31 ft-lbs
* FPC flange fasteners: 10 ft-lbs
* Field Probe and HOM fasteners: 40 in/lbs
 | [[FinalTorqueComment]] <<COMMENT>>[[FinalTorqueTimeStamp]] <<TIMESTAMP>>[[FinalTorqueTech1]] <<SRFCVP>>[[FinalTorqueTech2]] <<SRFCVP>> |
| 30. | **Cavity String Final Flange Alignment and Lock Lollipops**1. Verify the cavity flange alignment on all cavities.2. Verify the distance between cavities using the alignment tooling that rests on the cavity FPC flanges. Nominal distance is 1384.3 mm.3. Set the lollipop locking turnbuckles and lock them in place with the lock nut.4. Place rail brakes in several locations to prevent the carriages from moving in either direction. | [[FinalAlignComment]] <<COMMENT>>[[FinalAlignTimeStamp]] <<TIMESTAMP>>[[FinalAlignTech1]] <<SRFCVP>>[[FinalAlignTech2]] <<SRFCVP>> |
| 31. | **Close Upstream Gate Valve Sub-Assembly [GV1SA] Right Angle Valve**1. Set the purge software to "Standby" state for MFC1 [White Line].2. Close the MFC1 [White Line] Spool valve.3. Slowly close the GV1SA right angle valve. Leave the upstream gate valve open. | [[GV1SA\_RAV\_Closed]] <<YESNO>> |
| 32. | **Slow Pump Down Cavity String from Downstream End**1. Set the purge software to "Standby" for MFC3 [Yellow Line].2. Close the MFC3 [Yellow Line] Spool valve3. Verify that both VAT string isolation gate valves are open.4. Verify that the calibrated leak is open before pumping.5. Start slow-pumping process in accordance with [the Clean Room Slow Pump Cart Procedure](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-251963/SRF-MSPR-CLNRM-PUMP-R1.pdf).6. After the cavity string pressure is below 5E-6 mbar range, close the pump isolation valve and the GV2SA right angle valve.7. Open the isolation valve to the RGA. If the pressure is below 1E-3 mbar, slowly open the pump isolation valve.8. Allow the vacuum to recover to its original pressure. Open the GV2SA right angle valve and continue pumping. | [[CalibratedLeakOpen]] <<YESNO>>[[SlowPumpStartTime]] <<TIMESTAMP>>[[SlowPumpComment]] <<COMMENT>>[[SlowPumpTech1]] <<SRFCVP>> |
| 33. | **Bag Cavity String for Leak Check**While the string is pumping, place one large leak check bag around every joint between each set of cavities and include the FPC.* Place a bag around the upstream gate valve sub-assembly [GV1SA] and Cavity 1.
* Place a bag around the downstream gate valve sub-assembly [GV2SA] connection to Cavity 8.
* Place a bag around the entire pump manifold and GV2SA right angle valve connection.
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| Step No. | Instructions | Data Input |
| 34. | **Turn on RGA**1. Allow the string to pump approximately 48 hours after starting the turbomolecular pump, or until the vacuum reading at the pump cart gauge is a minimum of 2E-7 mbar before turning on the filament and the electron multiplier of the RGA.2. Allow the filament to warm up for a minimum of 20 minutes before starting the trace.3. Allow the trace to run for approximately 15 minutes.4. Close the calibrated leak. | [[RGAComment]] <<COMMENT>>[[RGAStartTime]] <<TIMESTAMP>>[[RGATech1]] <<SRFCVP>> |
| 35. | **Cavity String Leak Check**1. Set up the RGA and perform the cavity string leak check.2. Begin leak checking each bag, starting at the upstream end of the string (furthest away from pump).3. Watch the trace as He is placed into each bag.4. Record the trace time when each bag begins to be filled with He. The trace time is located on the x-axis of the trace.5. Allow 10 minutes before filling the next bag in Line. 6. If a leak is detected in any bag:* Place a nitrogen purge in that bag until the trace recovers, and then continue the leak check.
* Initiate a D3 to record troubleshooting actions and leak check file.

7. After troubleshooting is complete, purge all of the bags with N2 and start a new trace. Begin the leak check process again from the beginning.8. Attach the leak check file. | [[Bag1StartTime]] <<FLOAT>>[[Bag2StartTime]] <<FLOAT>>[[Bag3StartTime]] <<FLOAT>>[[Bag4StartTime]] <<FLOAT>>[[Bag5StartTime]] <<FLOAT>>[[Bag6StartTime]] <<FLOAT>>[[Bag7StartTime]] <<FLOAT>>[[Bag8StartTime]] <<FLOAT>>[[Bag9StartTime]] <<FLOAT>>[[Bag10StartTime]] <<FLOAT>>[[StringLeakCheck]] <<FILEUPLOAD>>[[Bag1StartTimeA]] <<FLOAT>>[[Bag2StartTimeA]] <<FLOAT>>[[Bag3StartTimeA]] <<FLOAT>>[[Bag4StartTimeA]] <<FLOAT>>[[Bag5StartTimeA]] <<FLOAT>>[[Bag6StartTimeA]] <<FLOAT>>[[Bag7StartTimeA]] <<FLOAT>>[[Bag8StartTimeA]] <<FLOAT>>[[Bag9StartTimeA]] <<FLOAT>>[[Bag10AStartTime]] <<FLOAT>>[[StringLeakCheckA]] <<FILEUPLOAD>>[[LeakCheckComment]] <<COMMENT>>[[StringLeakTight]] <<YESNO>>[[LkCheckTech1]] <<SRFCVP>>[[LkCheckTech2]] <<SRFCVP>>[[LeakCheckTime]] <<TIMESTAMP>> |
| 36. | **Final Beamline Vacuum**Pump the beamline to the 1E-8 Torr range. Record the beamline vacuum level achieved. | [[FinalBeamlineVacuum\_Torr]] <<SCINOT>> (Torr)[[FinalBeamlineVacuum\_Time]] <<TIMESTAMP>>[[FinalBeamlineVacuum\_Tech]] <<SRFCVP>> |

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| 37. | **Final NEG Pump Activation****Note**: Steps and References in [L2HE-PR-CLNRM-NEG-PREP](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-251396/L2HE-PR-CLNRM-NEG-PREP-R1.pdf) can be used as a guide for NEG pump activation. The [SIP POWER ION Pump Controller User Manual](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-249701/SIP%20POWER%20User%20Manual%5B1%5D.pdf) and [NEXTorr Z200 Pump Operating Instructions](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-249702/operating%20instructions%20NEXTorr%20Z200.pdf) are available in DocuShare.1. Record the beamline pressure. | [[NegActivation\_InitalBeamlinePressure]] <<FLOAT>>  |
| 2. Close the downstream gate valve.3. Connect the NEG POWERMINI power supply and the SIP POWER ION pump power supply to the NEG. Do not start activation yet.Verify the pressure at the NEG Pump Assembly is in the 3E-6 Torr range. The turbo pump is kept actively pumping throughout the activation process.4. Turn on the NEG POWER MINI power supply. The power supply should be set as shown. Note: the "Pump temp" will not show any readings.Graphical user interface  Description automatically generated5. Rope off the area with "HOT Surface" Keep Out signs.6. Once the power supply is ready, press the start/stop button to begin activation. Activation should take about an hour. During this time, the NEG pump and spool will reach high temperatures. Be careful not to burn yourself. Do not touch the pump, spool, or flanges during an activation cycle. | [[NegActivationCycle1Complete]] <<TIMESTAMP>> |
| 7. After the activation cycle is complete, turn on the SIP POWER ION pump supply and activate the ION pump by pressing the start/stop button to verify the functionality of the ION pump. After 2 seconds, press the start/stop button to turn off the ION pump.Graphical user interface, application  Description automatically generated8. Once the ION pump has been verified:* Turn off the SIP power supply.
* Set the purge software to "Purge" for MFC2 [Blue Line]. Fully open the MFC2 [Blue Line] isolation valve and needle valve. Backfill the NEG Pump Assembly to approximately atmospheric pressure using the purge system.
* Set the purge software to "Standby" for MFC2 [Blue Line]. Fully close the MFC2 [Blue Line] isolation valve and needle valve.

9. Pump the NEG Pump Assembly again and repeat the activation cycle and verify the ION pump functionality a second time. Do not backfill. | [[NegActivationCycle2Complete]] <<TIMESTAMP>> |
| 10. Pump the NEG Pump Assembly until the pressure is at least the pressure recorded above.11. Close the GV2SA right angle valve.12. Slowly open the downstream gate valve. | [[GV2SA\_RAV\_Closed]] <<YESNO>>[[NegActivationTech1]] <<SRFCVP>> |
| 38. | **Remove Purge System from Cavity String****Remove Purge System Hose from GV1SA**1. Verify the purge software is set to "Standby" for MFC1 [White Line].2. Remove the purge system hose from GV1SA. 3. Put a blank on the Spool using the same gasket and all of the fasteners.4. If available, install filter ([F10040886](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-248684/F10040886_C_DWG1.pdf), part number 4) on the Faraday Window Manifold right angle valve. If the filter is not available, install a blank. Use a new gasket and pre-cleaned [Spec 2] fasteners.5. Install the Faraday Window Cover (F10092047). | [[Faraday\_RAV\_Cover]] {{Filter,Blank,Other}} <<SELECT>>[[Faraday\_RAV\_Other]] <<COMMENT>>[[UpstreamHoseRemoved]] <<YESNO>> |
| **Remove Purge System Hose from GV2SA**6. Verify the GV2SA right angle valve is closed.7. Open the MF3 Spool Isolation valve.8. Set the purge software to "Purge" for MFC3 [Yellow Line] to bleed up the purge hose to the closed GV2SA right angle valve.9. When the hose is at atmospheric pressure, set the purge software to "Standby" state for MFC3 [Yellow Line] and close the MFC2 Spool Isolation valve.10. Remove the purge system hose from GV2SA.11. Put a blank on the Spool using the same gasket and all of the fasteners. | [[MFC2\_SetToStandby]] <<YESNO>>[[DownstreamHoseRemoved]] <<YESNO>> |
| **The Cavity String is now ready for rollout.** | [[CST\_ReadyForRollout]] <<TIMESTAMP>> |