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| Traveler Title | SNSPPU Cavity String Assembly Traveler |
| Traveler Abstract | SNSPPU Cavity string assembly traveler |
| Traveler ID | SNSPPU-CLNRM-CST-ASSY |
| Traveler Revision  | R1 |
| Traveler Author | Kurt Macha |
| Traveler Date | 29-Jul-2019 |
| NCR Informative Emails |  |
| NCR Dispositioners |  |
| D3 Emails |  |
| Approval Names | Kurt Macha | Danny Forehand | Mark Wiseman |  |
| Approval Signatures |  |  |  |  |
| Approval Dates |  |  |  |  |
| Approval Title | Author | Reviewer | 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. |
| [Coupler Installation](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201210/Coupler%20installation%201.JPG) | [String Assembly Legend](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201211/String%20Assembly%201.pdf) | [104211500-M8U-8200-A001](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201218/104211500-M8U-8200-A001_-_PDF_1.pdf) | [SNSPPU Coupler installation onto the cavity](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201328/CP-SNSPPU-CST-COUP-INST.docx) | [CP-SNSPPU-CST-TOOL-PREP](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201330/CP-SNSPPU-CST-TOOL-PREP.docx) |
| [Return warm to cold beam pipe tooling](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201337/Gate%20valve%20return.pdf) | [Supply warm to cold beam pipe tooling](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201339/Supply%20warm%20to%20cold%20beam%20pipe%20tooling.pptx.pdf) | [Bellows restraint and ion pump support tooling](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201342/Bellows%20restraint%20and%20ion%20pump%20support%20tooling.pptx.pdf) | [104211900-M8U-8200-A000---CLEAN ROOM STRING TOOLING](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-212727/104211900-M8U-8200-A000---CLEAN%20ROOM%20STRING%20TOOLING.pdf) |  |

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

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| Step No. | Instructions | Data Input |
| 1 | Coordinate all activities required for the cavity string assembly. Record the cavity string serial number.Ensure the string tooling is cleaned and staged for cavity string assembly.[CP-SNSPPU-CST-TOOL-PREP](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201330/CP-SNSPPU-CST-TOOL-PREP.docx)**Note:** Ensure four cavities with helium vessel have been tested and qualified ready for string assembly. Ensure all components including couplers, beam line components, Ion pump manifold and hardware are staged and ready for assembly. Schedule facilities appropriately for the duration of the cavity string assembly. | [[CSTSN]] <<CSTSN>>[[InitiateComments]] <<COMMENT>>[[InitiateDate]] <<TIMESTAMP>>[[Initiate\_SRF]] <<SRF>> |
|  | Four cavities with helium vessels must be qualified and ready for string assembly. (One must have Liquid Level Probes)Four couplers must be qualified, staged and ready for the string assembly. | [[ReadyComment]] <<COMMENT>>[[CavitiesReady]] <<YESNO>>[[CouplersReady]] <<YESNO>>[[Staged\_SRF]] <<SRF>> |
| 2 | Record the first cavity (Location #1) serial number that received high-pressure rinsing for string assembly. Ensure the cavity has liquid level probes and is the one for location #1 was rinsed and dried. **Note: The cavity should have been allowed to dry overnight.**Cover the two beam-line flanges and install the alignment cover on the coupler flange. Prepare the bellows by cleaning with ionized nitrogen and cover one side with proper cleaned cover and gasket. Install the three bellows stiffeners.Rotate the cavity so the proper end to receive the bellows is located in the down position. **Note: Refer to the legend or cavity string drawing to ensure the bellows is being installed at the proper side of the cavity for the location it is going to be in the string.** Install the bellows with metal seal onto the cavity bottom beam line flange and torque the hardware.Install a coupler onto the cavity as per [SNSPPU Coupler installation onto the cavity](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201328/CP-SNSPPU-CST-COUP-INST.docx) procedure.Remove the cavity from the coupler assembly location. Install the first cavity in the string lollipop at location #1 of the cavity string. See the [String Assembly Legend](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201211/String%20Assembly%201.pdf). The first cavity will be supported on both ends at the cavity flange. Secure the beam line flange into both lollipops using the two bolts at the top mounts. The cavity alignment will be self-aligning due to the lollipop tooling design.Lock the cavity at the rail so it cannot slide on the rail. | [[CAVSN1]] <<CAVSN>>[[OneWithLLProbe]] <<YESNO>>[[Comments]] <<COMMENT>>[[Technician]] <<SRF>> |
| 3 | **Sub-Assemble the return warm to cold beam pipe assembly:**See: [Return warm to cold beam pipe tooling](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201337/Gate%20valve%20return.pdf)Clean all components with ionized nitrogen and use standard clean assembly practices.Prepare the return gate valve for assembly:* Clean with ionized nitrogen and cycle the valve while cleaning.
* Use temporary covers on the valve to keep it clean

Install the gate valve onto the return warm to cold beam line tooling and align properly. Alignment shall include rotating the valve to the proper assembly angle. Align the valve to the cavity beam line flange at location #1. Clinch the valve into place using the tooling screws so it will stay aligned.Install the bellows weldment onto the tooling. Ensure the tooling slide track is set to leave an opening between the bellows flange and the gate valve.See: Using the tooling adjustment, rough align the large flange of the bellows sub-assembly to be roughly centered with the gate valve flanges (At beam center). The only alignment feature important is the large flange bolt orientation in relation to the cavity beam line flange. This should be self-aligning due to the design of the tooling. Alignment should be verified using a level and bolt hole pins. The alignment features on the tooling are used to help make the bellows flange easy to assemble to the valve. **Caution: The rotation of the large flange in relation to the valve is important.**Install the copper gasket and mate the bellows flange to the gate valve. The slide track on the tooling will allow the bellows weldment to be moved in place. Install all hardware and snug the bolts so the flanges are secure. Do not tighten to ensure the valve stays in alignment. After this step is complete double check the valve alignment.After Ionized nitrogen clean the entire sub-assembly. Install a 4 5/8” blank CF flange with gasket onto the bellows weldment CF flange. Secure with two bolts. This is temporary in place of the ion pump manifold. The ion pump manifold will be installed after the valve is bolted to the cavity. |   |
| 4 | **Return warm to cold beam line assembly to the first cavity:** Remove the gate valve temporary cover flange. Install the metal seal gasket in the valve and hold it in place using the gasket holding tool. Remove the cavity beam line cover and slide the return beam-line sub-assembly into place. Bolt and torque the two flanges.Torque all hardware on the return warm to cold beam pipe assembly. Install the ion pump sub-assembly and tighten all flanges.See: [Return warm to cold beam pipe tooling](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201337/Gate%20valve%20return.pdf) |  |
| 5 | Record the second (Location #2) cavity serial number that received high-pressure rinsing for the cavity string. Ensure the appropriate cavity without liquid level probes is selected.**Note: The cavity should have been allowed to dry overnight.**Cover the two beam-line flanges and install the alignment cover on the coupler flange. Prepare the bellows by cleaning with ionized nitrogen and cover one side with proper cleaned cover and gasket. Install the three bellows stiffeners.Rotate the cavity so the proper end to receive the bellows is located in the down position. **Note: Refer to the legend or cavity string drawing to ensure the bellows is being installed at the proper side of the cavity for the location it is going to be in the string.** Install the bellows with metal seal onto the cavity bottom beam line flange and torque the hardware.Install a coupler onto the cavity as per [SNSPPU Coupler installation onto the cavity](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201328/CP-SNSPPU-CST-COUP-INST.docx) procedure. | [[CAVSN2]] <<CAVSN>>[[TwoWithLLProbe]] <<YESNO>> |
| 6 | Install the second cavity in the string lollipop at location #2 of the cavity string. See the [String Assembly Legend](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201211/String%20Assembly%201.pdf). The second cavity will be supported on the FP end at the top of the lollipop. The coupler end will be supported by the tooling at the helium vessel. Secure the beam line flange into the lollipop using the bolt at the bottom of the top mount. Measure the lollipop supported beam line flange of cavity location #1. (Measure the supply end beam line flange) Use the dial indicator tooling to reference the flange to the rails. Move the dial indicator tooling to the helium vessel supported beam line flange and position it using the tooling to match the reference flange. Remove the cavity cover flanges and install the gasket. Hold the gasket using the gasket holding tools. Slide cavity #2 into position, install and torque the hardware.Install the second half of the lollipop fork section. Remove the bellows stiffeners an install the bottom bolt into cavity #2 beam line flange. Retorque the beam line flange hardware.Remove the helium vessel support tooling. |  |
| 7 | Record the third cavity (Location #3) serial number that received high-pressure rinsing for the cavity string. Ensure the appropriate cavity without liquid level probes is selected.**Note: The cavity should have been allowed to dry overnight.**Cover the two beam-line flanges and install the alignment cover on the coupler flange. Prepare the bellows by cleaning with ionized nitrogen and cover one side with proper cleaned cover and gasket. Install the three bellows stiffeners.Rotate the cavity so the proper end to receive the bellows is located in the down position. **Note: Refer to the legend or cavity string drawing to ensure the bellows is being installed at the proper side of the cavity for the location it is going to be in the string.** Install the bellows with metal seal onto the cavity bottom beam line flange and torque the hardware.Install a coupler onto the cavity as per [SNSPPU Coupler installation onto the cavity](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201328/CP-SNSPPU-CST-COUP-INST.docx) procedure. | [[CAVSN3]] <<CAVSN>>[[ThreeWithLLProbe]] <<YESNO>> |
| 8 | Install the third cavity in the string lollipop at location #3 of the cavity string. See the [String Assembly Legend](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201211/String%20Assembly%201.pdf). The third cavity will be supported on the Coupler end at the top of the lollipop. The FP end will be supported by the tooling at the helium vessel. Secure the beam line flange into the lollipop using the bolt at the bottom of the top mount. Measure the lollipop supported beam line flange of cavity location #2. (Measure the supply end beam line flange) Use the dial indicator tooling to reference the flange to the rails. Move the dial indicator tooling to the helium vessel supported beam line flange and position it using the tooling to match the reference flange. Remove the cavity cover flanges and install the gasket. Hold the gasket using the gasket holding tools. Slide cavity #3 into position, install and torque hardware.Install the second half of the lollipop fork section. Remove the bellows stiffeners and install the bottom bolt into the cavity #3 beam line flange. Retorque the beam line flange hardware.Remove the helium vessel support tooling. |  |
| 9 | Record the forth cavity serial number that received high-pressure rinsing for the cavity string. Ensure the appropriate cavity without liquid level probes is selected.**Note: The cavity should have been allowed to dry overnight.**Cover the two beam-line flanges and install the alignment cover on the coupler flange. Install a coupler onto the cavity as per [SNSPPU Coupler installation onto the cavity](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201328/CP-SNSPPU-CST-COUP-INST.docx) procedure. | [[CAVSN4]] <<CAVSN>>[[FourWithLLProbe]] <<YESNO>> |
| 10 | Install the forth cavity in the string lollipop at location #4 of the cavity string. See the [String Assembly Legend](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201211/String%20Assembly%201.pdf). The forth cavity will be supported on FP end at the top of the lollipop. The coupler end will be supported by the tooling at the helium vessel. Secure the beam line flange into the lollipop using the bolt at the bottom of the top mount. Measure the lollipop supported beam line flange of cavity location #3. (Measure the supply end beam line flange) Use the dial indicator tooling to reference the flange to the rails. Move the dial indicator tooling to the helium vessel supported beam line flange and position it using the tooling to match the reference flange. Remove the cavity cover flanges and install the gasket. Hold the gasket using the gasket holding tools. Slide cavity #4 into position, install and torque hardware.Install the second half of the lollipop fork section. Remove the bellows stiffeners and install the bottom bolt into cavity #4 beam line flange. Retorque the beam line flange hardware.Remove the helium vessel support tooling. |  |
| 11 | **Sub-Assemble the supply warm to cold beam pipe assembly:**See: [Supply warm to cold beam pipe tooling](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201339/Supply%20warm%20to%20cold%20beam%20pipe%20tooling.pptx)Clean all components with ionized nitrogen and use standard clean assembly practices.Prepare the supply gate valve for assembly:* Clean with ionized nitrogen and cycle the valve while cleaning.
* Use temporary covers on the valve to keep it clean

Install the gate valve onto the supply warm to cold beam line tooling and align properly. Alignment shall include rotating the valve to the proper assembly angle. Align the valve to the cavity beam line flange at location #4.Clinch the valve into place using the tooling screws so it will stay aligned.Install the bellows weldment onto the tooling. Ensure the tooling slide track is set to leave an opening between the bellows flange and the gate valve.Using the tooling adjustment, rough align the large flange of the bellows sub-assembly to be centered with the gate valve flanges (At beam center). The only alignment feature important is the large flange bolt orientation in relation to the mating cavity beam line flange. This should be self-aligning due to the design of the tooling. Alignment should be verified using a level and bolt hole pins. The alignment features on the tooling are used to help make the bellows flange easy to assemble to the valve. **Caution: The rotation of the large flange in relation to the valve is important.**Install the copper gasket and mate the bellows flange to the gate valve. The slide track on the tooling will allow the bellows weldment to be moved in place. Install all hardware and snug the bolts so the flanges are secure. Do not tighten to ensure the valve stays in alignment. After this step is complete double check the valve alignment.Assemble the isolation valve flange onto the bellows weldment. |  |
| 12 | Check all flanges for proper torque. Install the bellows supports at both warm to cold beam line assemblies.Remove the warm to cold beam pipe assembly tooling at each end of the cavity string.Install the ion pump support tool by bolting it to the end lollipop and adjust the tooling to fix the 1 ½” tee located on the ion pump assembly. See: [Bellows restraint and ion pump support tooling](https://jlabdoc.jlab.org/docushare/dsweb/Get/Document-201342/Bellows%20restraint%20and%20ion%20pump%20support%20tooling.pptx.pdf)The cavity string is ready for slow pumping and leak test. |  |