LCLS-II 3.9 GHz Cryomodule Prep and Shipping to SLAC - WS6 (RFCH)

464422 Rev. NONE

Series	Serial No.	Job No.	Task No.	Released By	Released Date	Status
RFCH	RFCH001-0	584	See Job Page	Richard Motill	2/11/2020 3:17:13 PM	Open

1.0 Abstract Top

1.1 This traveler is to be used for the LCLS II 3.9 GHz Cryomodule preparation and shipping to SLAC (RFCH) at ICB post testing and transport from CMTF.

2.0 General Notes Top

2.1 Personnel shall perform all tasks in accordance with current applicable ES&H guidelines and those specified within the step. All the appropriate personal protective equipment shall be worn as necessary for the task and conditions.

2.2 All personnel performing or assisting in steps in this traveler must have documented training for tasks this traveler and associated operating procedures demand.

2.3 Discrepancy Reports (known as DRs) are used to document non-conformances in the traveler. They are the equivalent to what is known as Non-Conformance Reports (NCRs) for some manufacturers. There is no limit on how many DRs can be generated per sub step or per traveler. DRs are always associated with a specific sub step. For instructions on anything DR related go to the Vector Home Page and click on the "Help" hyperlink in the upper left hand corner and then click on the hyperlink "Discrepancy Reports."

2.4 DRs can be created, comments and/or uploads can be inserted and already entered data can be modified on any step by clicking the blue hyperlink for that step and choosing the desired function from the menu that appears.

3.0 Supporting Documentation Top

3.1 Electronically attach all appropriate memos, specific instructions, digital photographs, discrepancy reports and other documentation in the appropriate step in this traveler.

3.2 Operating Procedures:

Installation of the Support Post Shipping Restraint

3.3 Reference Drawing:

ASSEMBLY, 3.9 GHz CRYOMODULE LCLS-II - F10014857.

4.0 Process Readiness Verification Top

4.1 Verify that the Cryomodule has been accepted by Technical Division from Accelerator for preparation and shipping to SLAC having completed all testing by Accelerator Division and successful transport to ICB.

Responsible Authority/Designee: ***Charles Grimm*** *Date:* ***2/13/2020***

4.2 Visually inspect the Cryomodule surfaces for damage and defects. Inspect painted surfaces for defects. Record any abnormal findings in the comment box and upload pictures of abnormal findings.

Is the condition ok?

(●) *Yes* ( ) *No*

Photos: Upload File

Comments: ***Yes looks acceptable***

Responsible Authority/Designee: ***Charles Grimm*** *Date:* ***2/13/2020***

4.3 Review and upload the shock-log/vibration data post-transportation from CMTF to ICB.

Shock-log data Upload File

Responsible Authority/Designee: [ ] *Date:* [ ]

4.4 Verify the current location of the Cryomodule for tracking purposes.

Current location of Cryomodule ***ICB***

Responsible Authority/Designee: ***Charles Grimm*** *Date:* ***2/13/2020***

5.0 Post CMTF ICB Activities Top

5.1 Use Traveler 464410 to perform RF checks and attach that completed traveler to this step.

Technician: [ ] *Date:* [ ]

5.2 Perform a final magnetic hygiene check and upload fluxgate data.

Fluxgate data: Upload File

Technician: [ ] *Date:* [ ]

Responsible Authority/Designee: [ ] *Date:* [ ]

5.3 Perform final instrumentation checks and upload checkout files for Heaters, Liquid Level, Stepper Motors, Piezo and RTD sensors.

Heaters Checkout Upload File

Technician: [ ] *Date:* [ ]

Liquid Level Checkout Upload File

Technician: [ ] *Date:* [ ]

Stepper Motor Checkout Upload File

Technician: [ ] *Date:* [ ]

Piezo Checkout Upload File

Technician: [ ] *Date:* [ ]

RTD Sensors Checkout Upload File

Technician: ☐ *Date:*

Responsible Authority/Designee: ☐ *Date:*

5.4 Install the downstream and upstream beamline components to the approved configuration for shipping to SLAC. Contact a responsible authority for the detailed steps for the process that applies to this particular cryomodule.

Technician: ☐ *Date:*

Responsible Authority/Designee: ☐ *Date:*

5.5 Record the cavity string vacuum level when it is removed from the stand. The 2-gauge readings can be found in document F10051111.

Cavity string vacuum gauge #1 (Torr)

Cavity string vacuum gauge #2 (Torr)

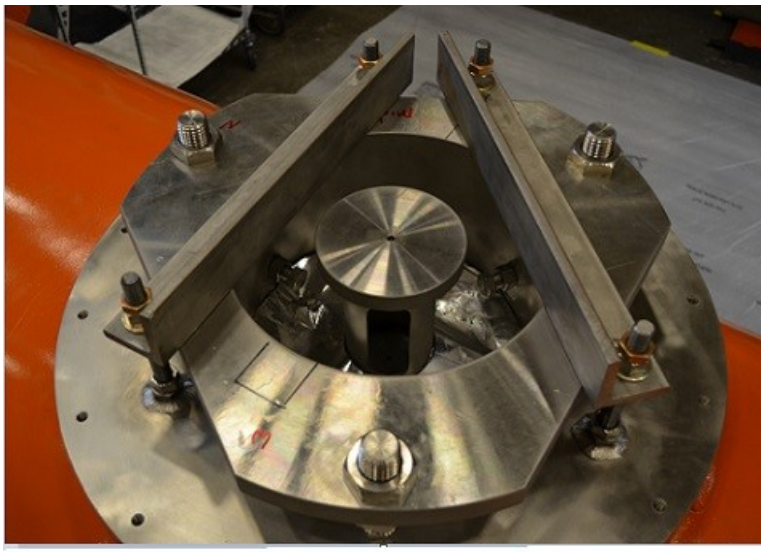
Technician: ☐ *Date:*

6.0 Cryomodule Shipping Restraints Top

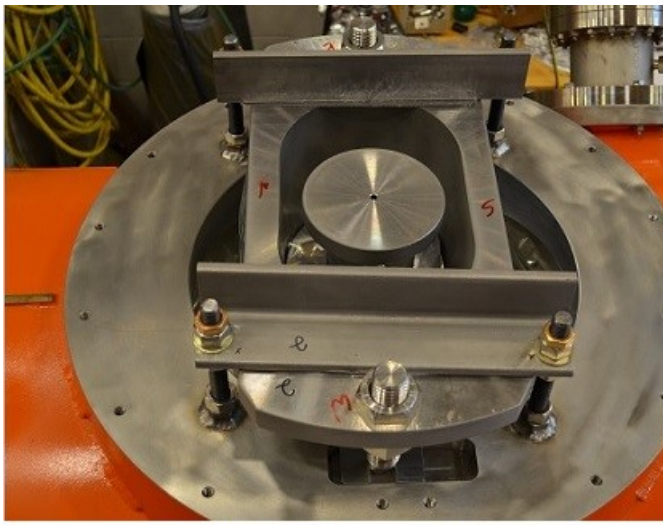
Consult Procedure:

Installation of the Support Post Shipping Restraint

6.1 Attach the center and two end post clamps to the top hat flanges.

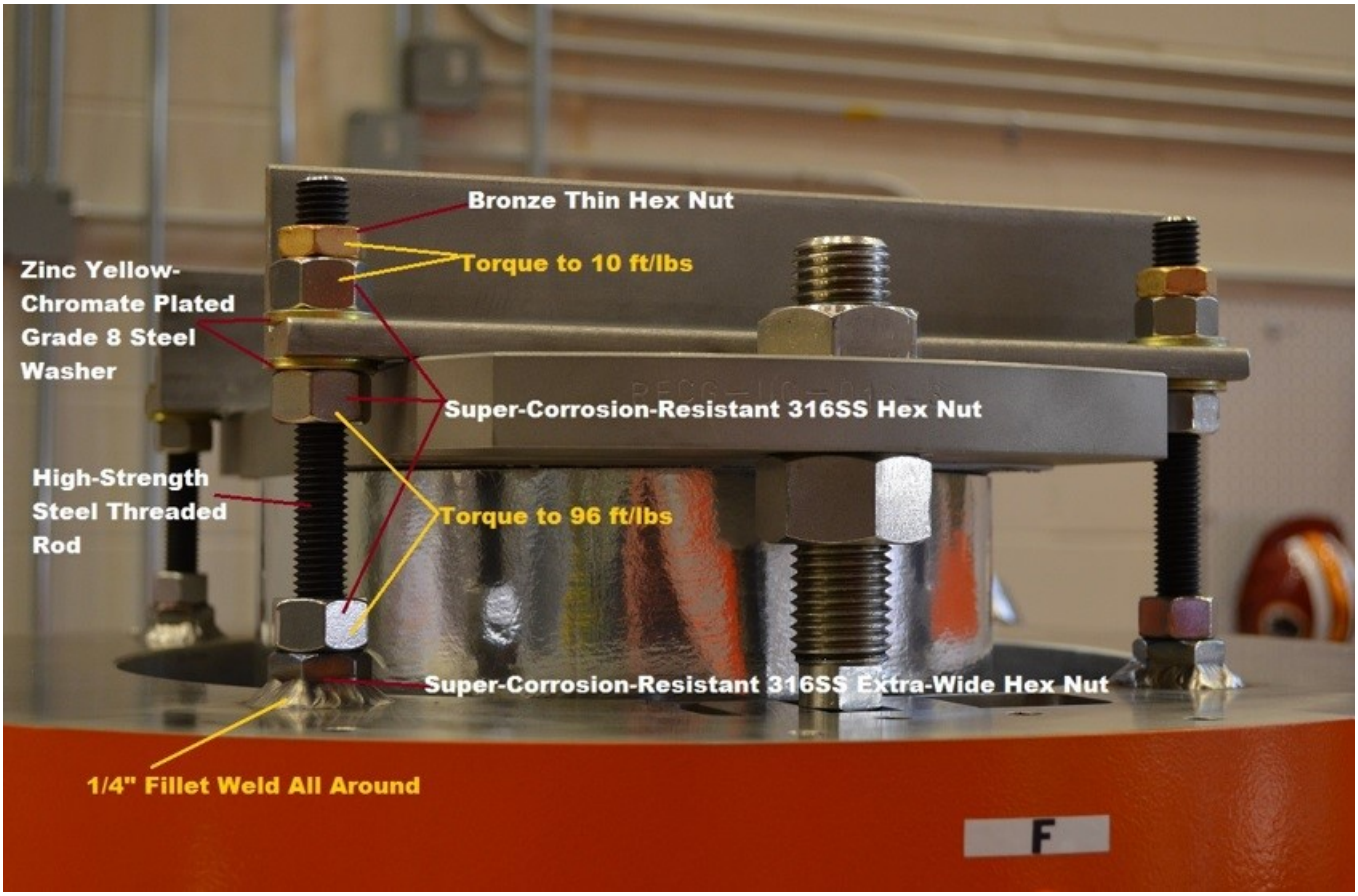


Center Post Clamps (long)



End Post Clamps (short)

6.1.1 The process is the same for all three clamps. For each clamp, line up the four Super-Corrosion-Resistant 316 Stainless Steel Extra-Wide Hex Nuts to their proper location. Perform a 1/4" inch fillet all around and repeat for the other three locations. Insert the threaded Rods and add the Super-Corrosion-Resistant 316 Stainless Hex Nut, washers and Bronze Thin Hex Nut. Torque as shown below.



Responsible Authority/Designee: ***Charles Grimm*** *Date:* ***2/13/2020***

6.2 Add a total of 4 pieces of foam, two in each end cap.

6.3 Take pictures of the cryomodule before the end caps are installed and upload.

Cyryomodule pictures Upload File

6.4 Install shipping restraints on the bearing block holders on the upstream and downstream ends.

Ryan Thiede --- 2/13/2020 7:56:27 AM

This does not happen for 3.9

Technician: *Date:*

6.5 Alignment and Metrology group should perform an alignment of the cryomodule and upload the data below.

Alignment data Upload File

Responsible Authority/Designee: *Date:*

7.0 Transport Preparation Top

Note: Begin with the attachment of the Downstream (DS) (Quadrupole end).

7.1 Attach shock log devices on Upstream (US) and DS Beam valves and activate by depressing the button for one second or more.

Technician: ☐ *Date:* ☐

7.2 Ensure that the cryomodule internal insturmentation has been activated and check out is complete.

Technician: ☐ *Date:* ☐

7.3 Component Preparation


7.3.1 Clean all seals

7.3.2 Clean all surfaces

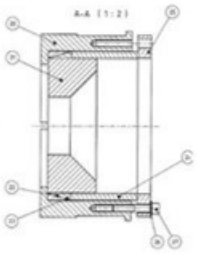
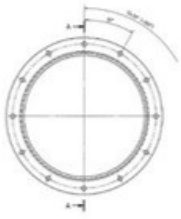
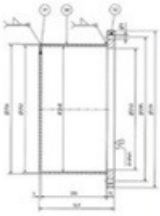
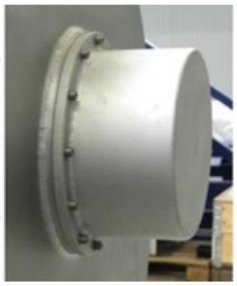
7.3.3 Clean, lubricate and organize all bolts

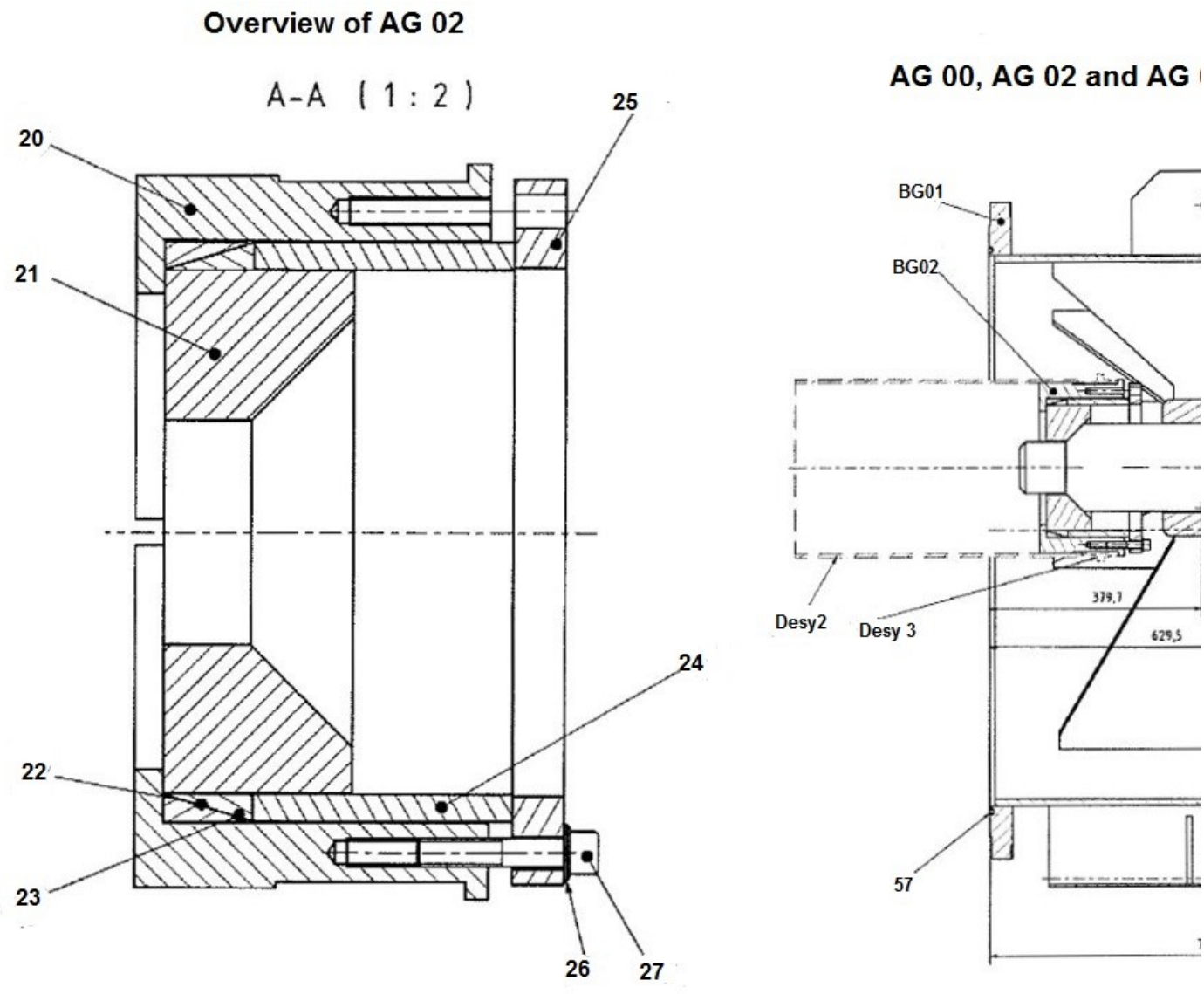
7.3.4 Coat all cryo-clamp threads with Loctite C5-A Copper Anti-Seize to prevent galling.

7.4 Installation of Downstream End Cap

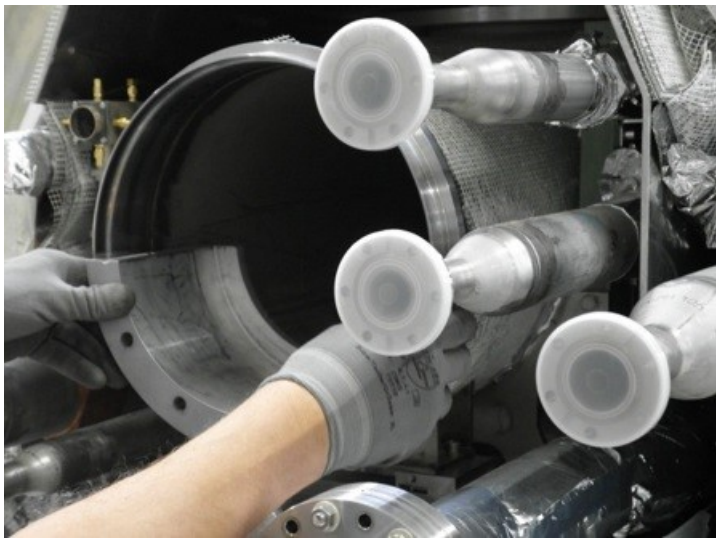
Assembly Groups (AG)

AG 00: Transport End Cap Assembly
AG 01: Transport End Cap
AG 02: GHRP Insert
AG 03: Shipping Cap Cover

Assembly Overview (AG 00, AG 01, AG 02 and AG 03) for DS End Cap	
AG 00	
AG 01	
AG 02	  
AG 03	  

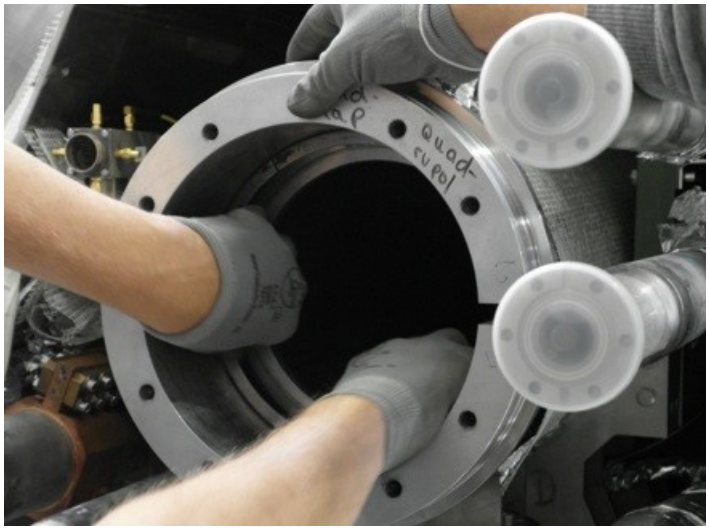


7.4.1 Insert the bottom half shell (Part 20).



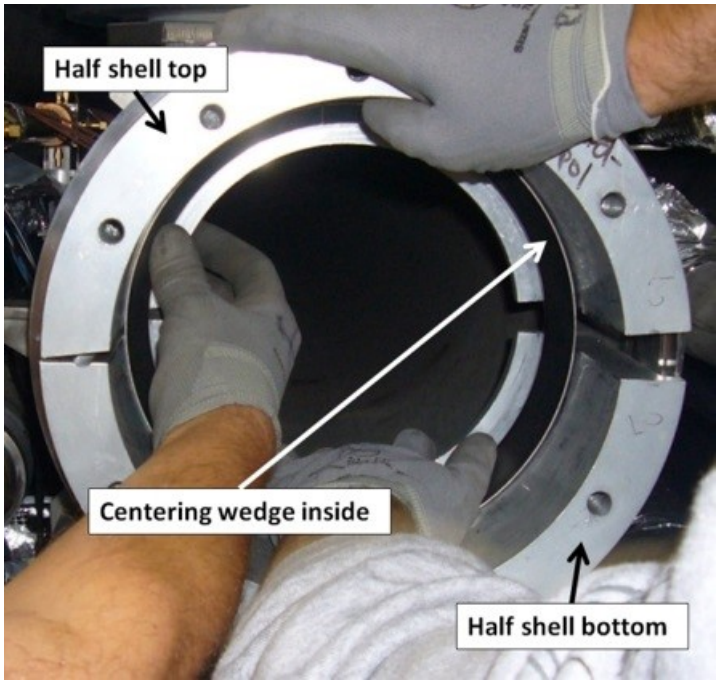
7.4.2 Insert the top half shell (Part 20).

7.4.3 Insert the two centering wedges (Parts 22 and 23) in the orientation shown in the following four sub steps.

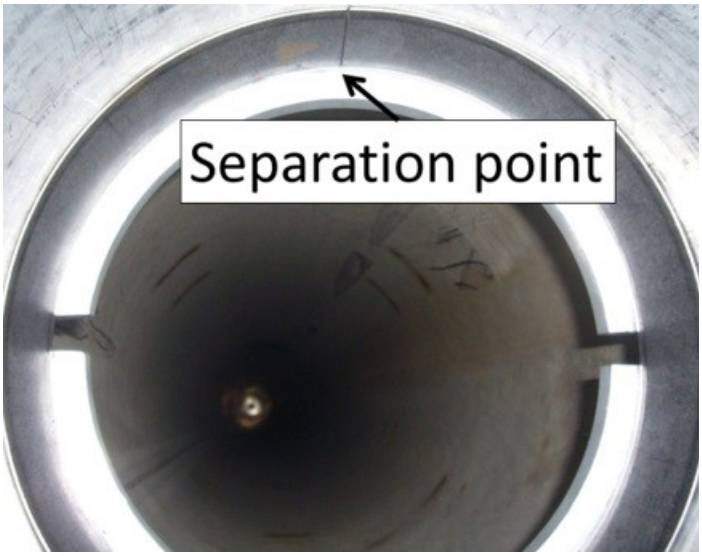


Technician: ☐ *Date:* ☐

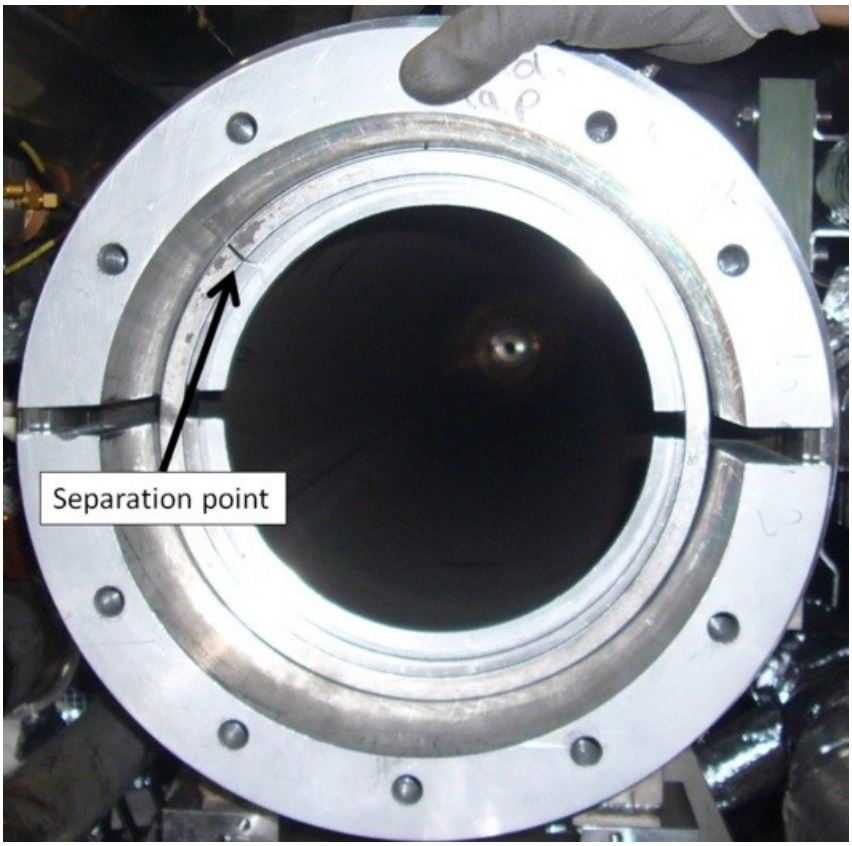
7.4.3.1 First insert the inner centering wedge (Part 22).



7.4.3.2 Important : Ensure that the slot on the inner centering wedge is at the 12 o'clock position as shown in the image.

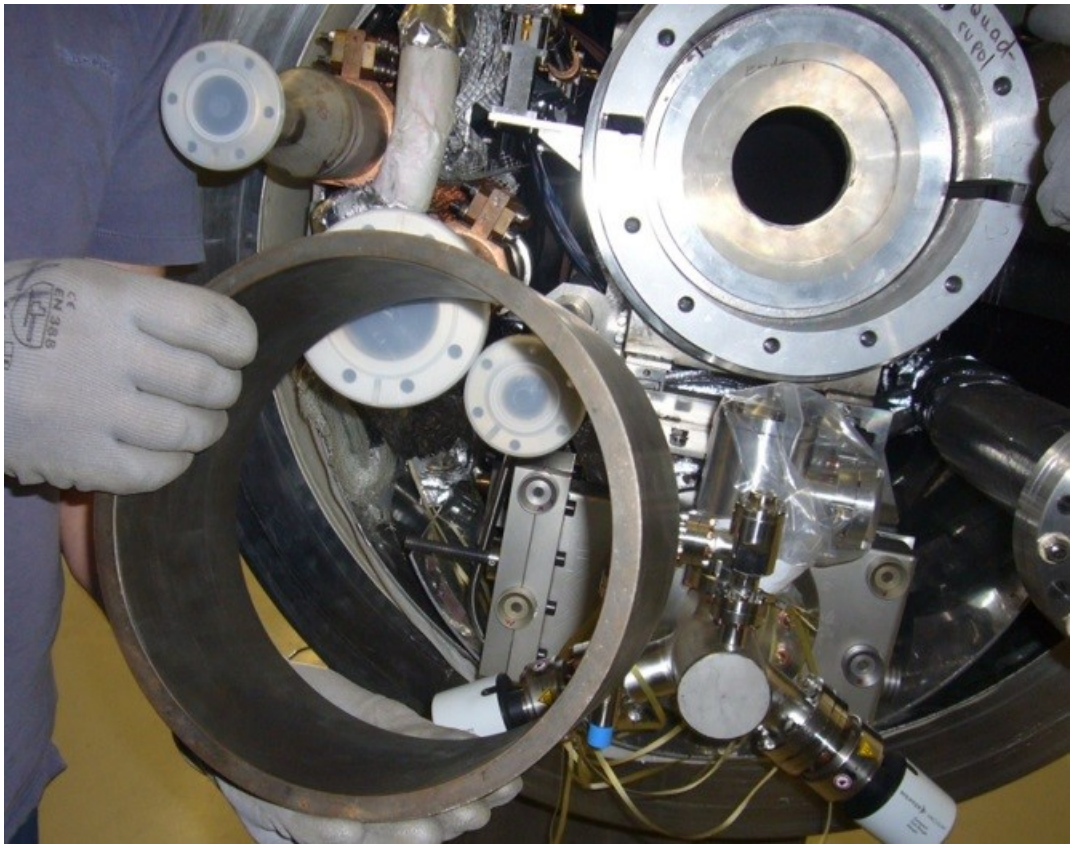


7.4.3.3 Insert the outer centering wedge (Part 23) with its slot 45 degrees offset from the lot on the inner centering wedge.

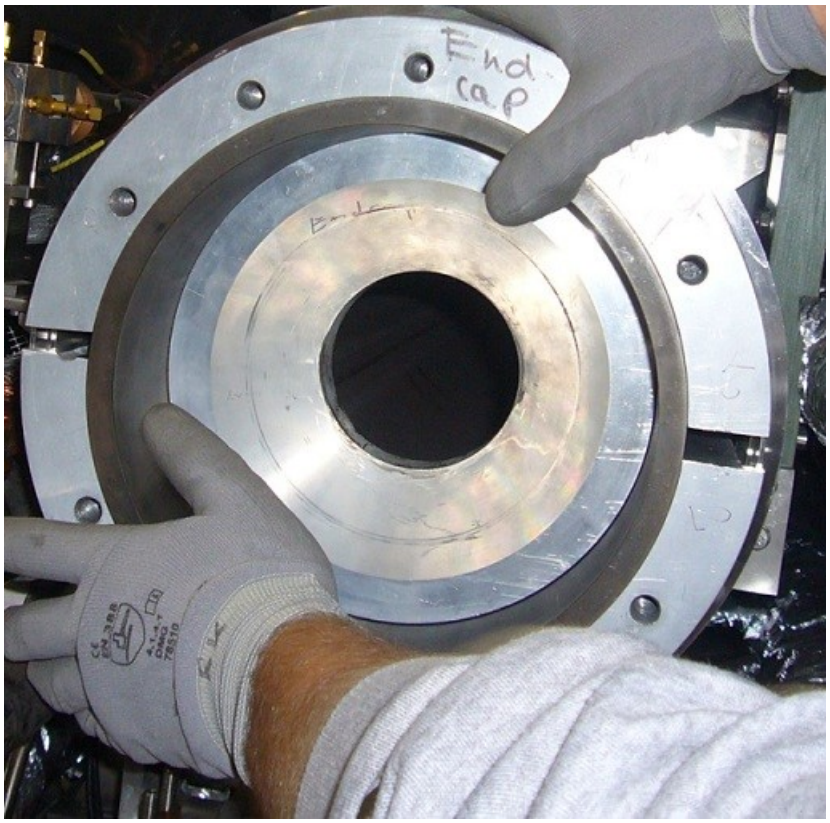


7.4.4 Insert centering stop (Part 21).

7.4.5 Insert the centering tube (Part 24).

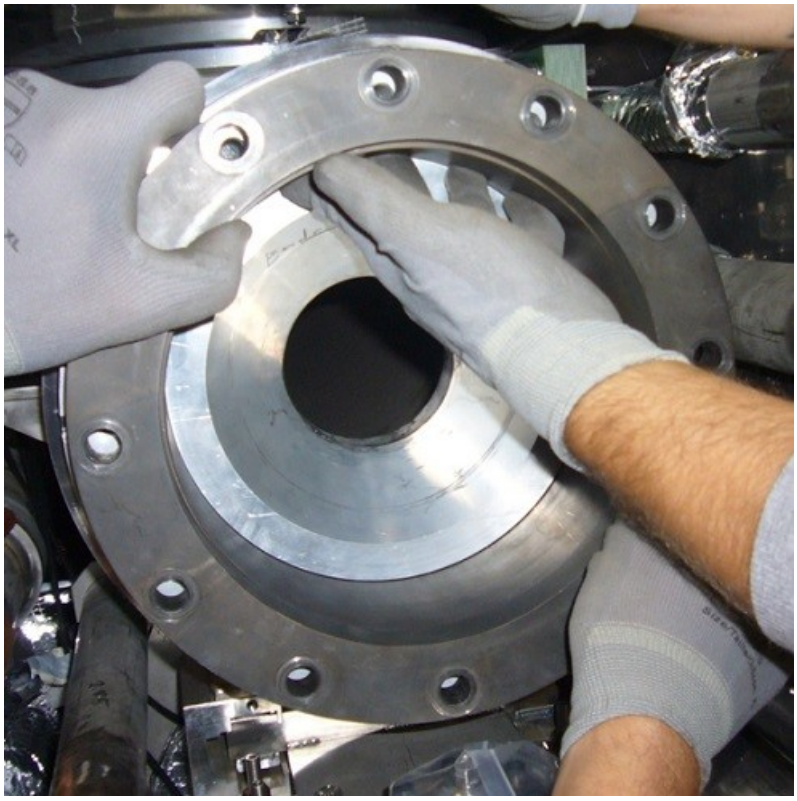


7.4.5.1 The centering tube is shown in its installed condition.



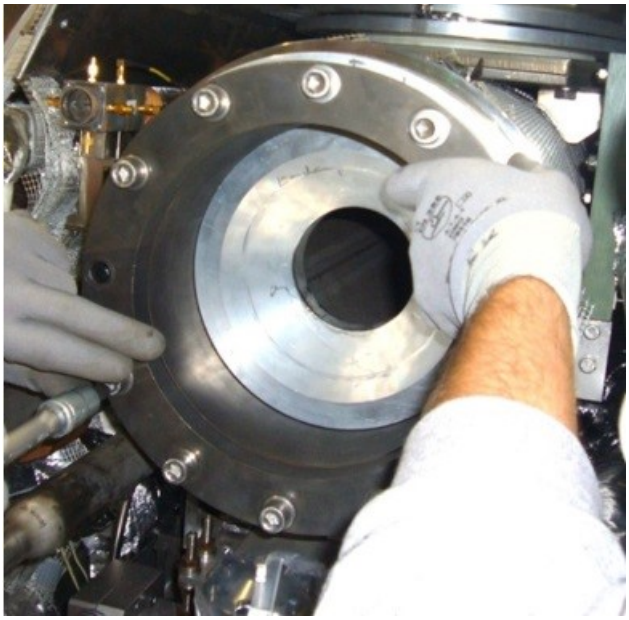
7.4.6 Install centering flange (Part 25).

7.4.6.1 Position the centering flange as shown.

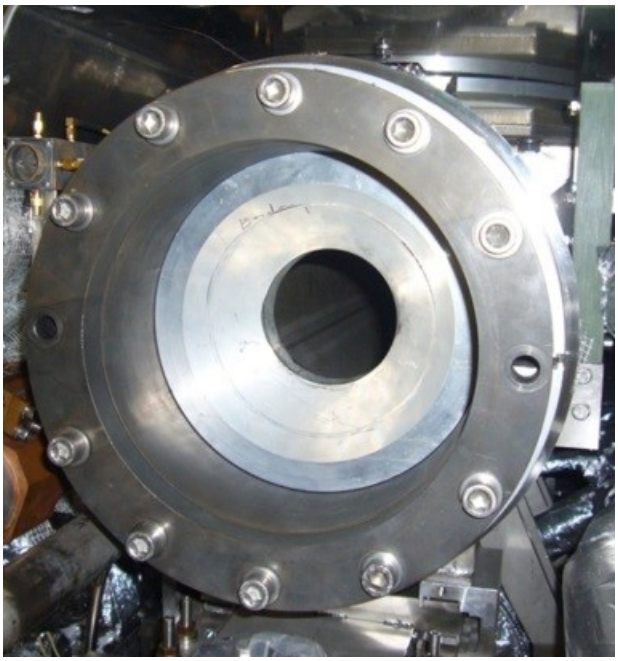


7.4.6.2 Secure the centering flange with the M12-65 SHCS and washers through the centering flange holes except at the 3 o'clock and 9 o'clock positions.

Note: Steps 7.4.6.2 to 7.4.6.4 are for parts 26 and 27



7.4.6.3 Finger tighten all 10 screws.



7.4.6.4 Torque SHCS to 50 Nm (37 ft-lbs.) using a star pattern. Continue to tighten until torque is even on all SHCS

Technician: *Date:*

7.4.7 Transport Cap Installation

7.4.7.1 Clean and apply Dow Corning silicone vacuum grease (Fermi stockroom P/N 2150-320000) to all transport cap O-rings. Clean all sealing surfaces.

7.4.7.2 Attach a scale to the crane and shackle to the lifting lug on the shipping cap. Record the weight of the cap.

Downstream cap weight **LBS**

7.4.7.3 Adjust the M145 screw (Part 42) so that it is retracted (amount retracted TBD for next traveler revision). Ensure the Belleville washers are installed on the M145 Screw according to prints F10104116 and F10104118 (Procedure for this TBD for next traveler revision). Torque HHCS Part 50 to 80 N-m (60 ft-lbs.).

Note: When tunring, make sure the bolthead stays stationary.

Technician: ☐ *Date:* ☐

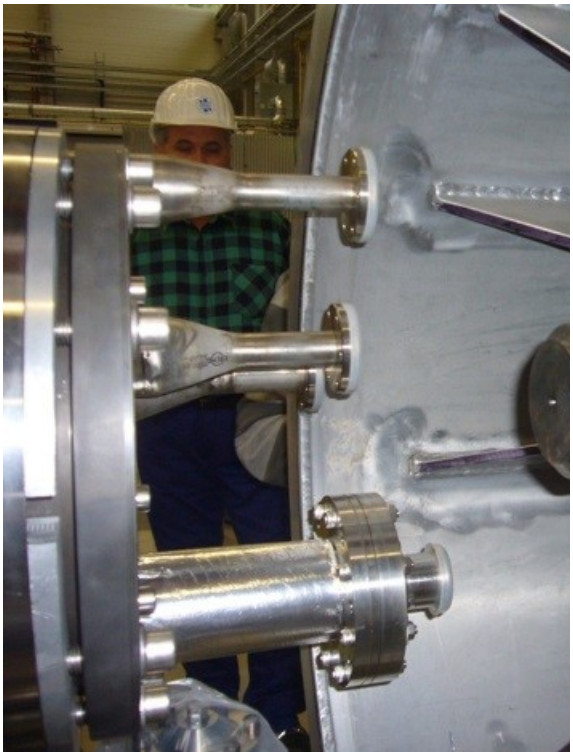
7.4.7.4 Check end cap for level condition after adjusting the spindle extension. Add weight into the foot area as required to bring cap level. Bring the shipping cap within range of the cryomodule. Measure the height to the bottom of the spindle extension. Measure the distance of the bottom of the GHRP Insert. Use the crane to bring them level to the greatest extent possible.

7.4.7.5 Connect the cables for the vacuum gauges to the feedthrough on the shipping cap port.

Note: If any interference is detected, stop and assess the interference before proceeding.

7.4.7.6 Move the shipping cap towards the US end of the cryomodule, aiming the spindle (Part 40) to the center of the GHRP Insert (AG 02). Make full contact with both flanges. Tighten the M145 screw until the flanges begin to separate and pivoting of the cap around the GHRP insert is felt. Manually push the endcap to the cryomodule and hold. Monitor the scale readout. If the weight increases, it means that the central section of the spindle is touching the top of the conical surface of the GHRP insert (AG 02), and the cap should be lowered slightly via the crane. If the weight decreases, the cap should be raised slightly. The weight should remain +/- 60lbs of the original value.

Caution: Be sure to avoid contact between the piping/instruments in the cryomodule and the shipping cap gussets when positioning the cap. Note: XFEL piping is shown in the image and does not reflect exact LCLS-II piping.



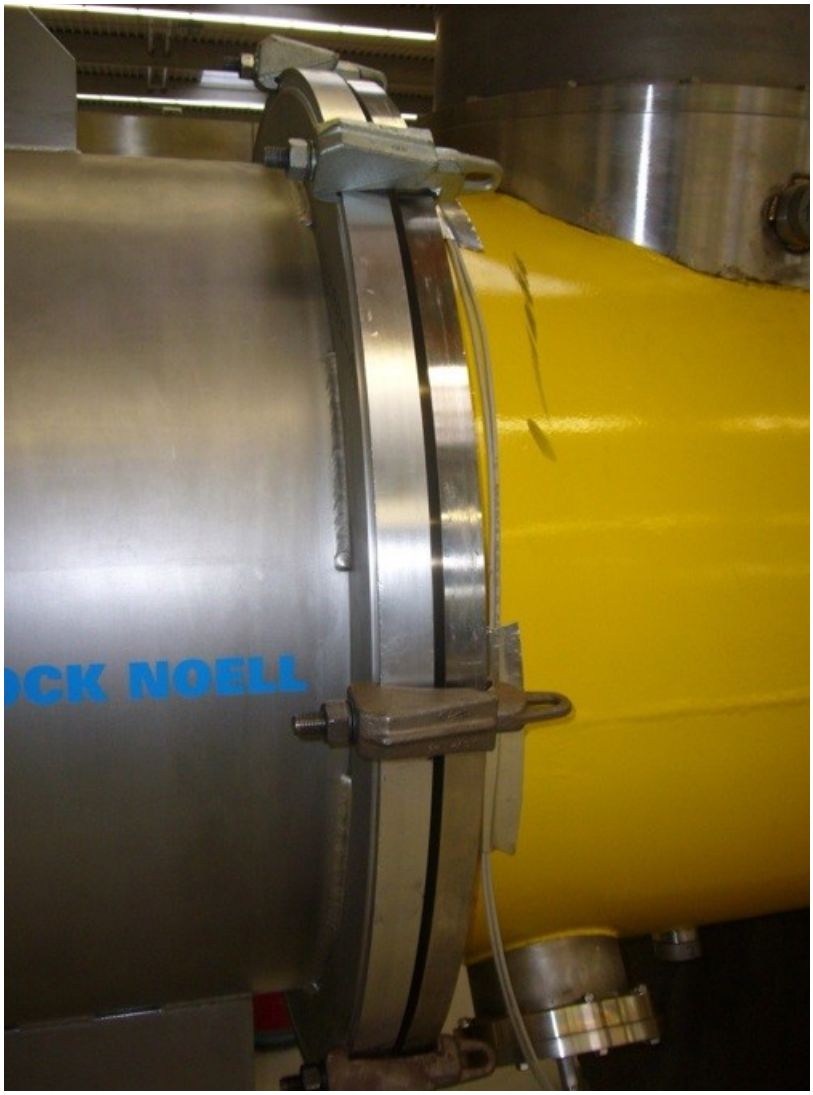
7.4.7.7 Insert two screw clamps at the 3 o'clock and 9 o’clock positions and hand tighten. Retract the M145 screw while hand tightening the two fasteners. Once the flanges are in contact, stop retracting the M145 screw and snug the screw clamps using tools to hold the flanges in contact. Add 2 more screw clamps at the 12 o’clock and 6 o’clock positions and

snug enough to prevent movement of the shipping cap.

Note: This task requires 3 people. One person on each side of the cap and one person inserting the screw clamps.

7.4.7.8 Loosen the M145 screw approximately two turns after the screw touches the hex head to pull the spindle away from the HGRP insert. Make sure the hex head bolt head doesn't start turning while backing out the screw. Add the remaining fasteners and snug.

7.4.7.9 Torque the screw clamps to 60 ft.-lbs. Once complete, disengage the crane.

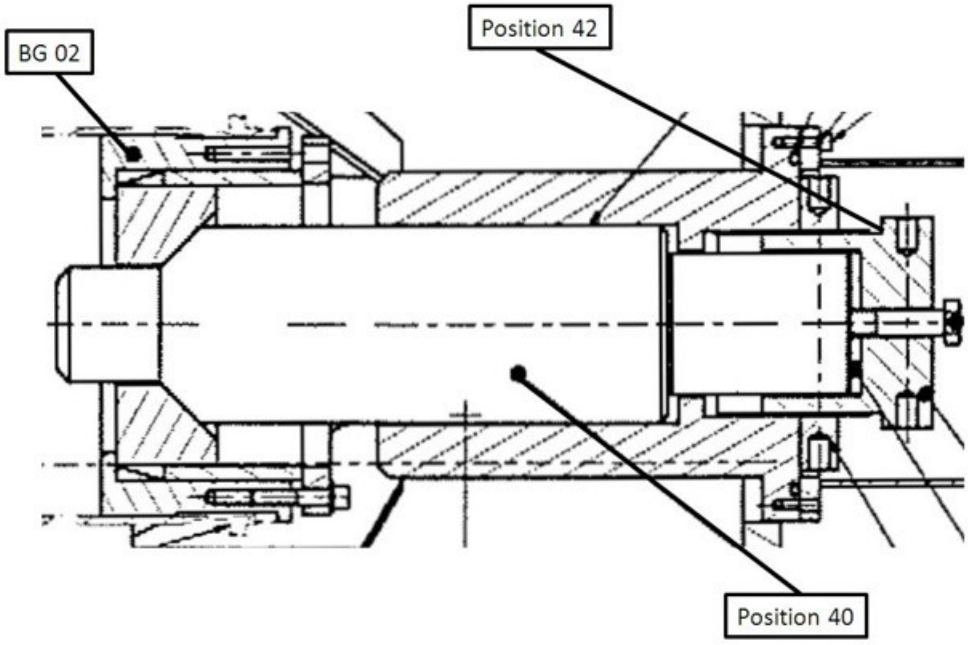


Technician: ☐ *Date:* ☐

7.4.7.10 Hand-tighten the M145 screw (Part 42) until the Belleville washer start to compress.

Technician: ☐ *Date:* ☐

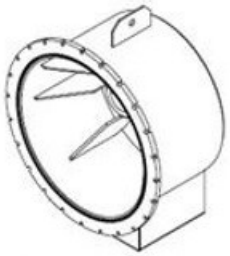
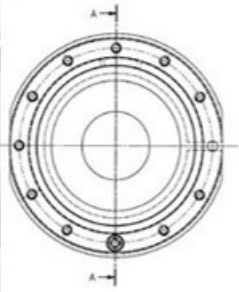
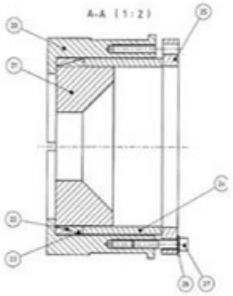
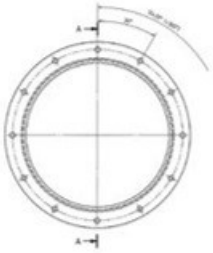
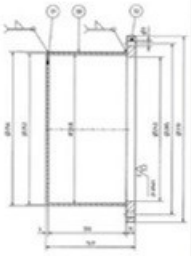
7.4.7.11 The spindle (Part 40) is now up to the bearing surface of the conical ring in the AG 02.

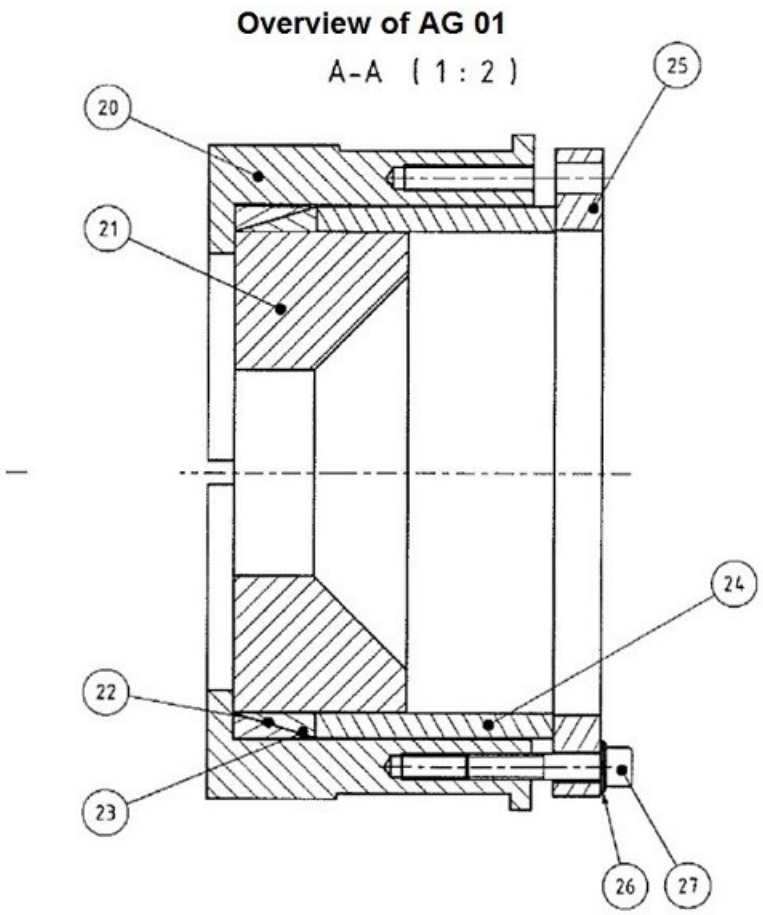


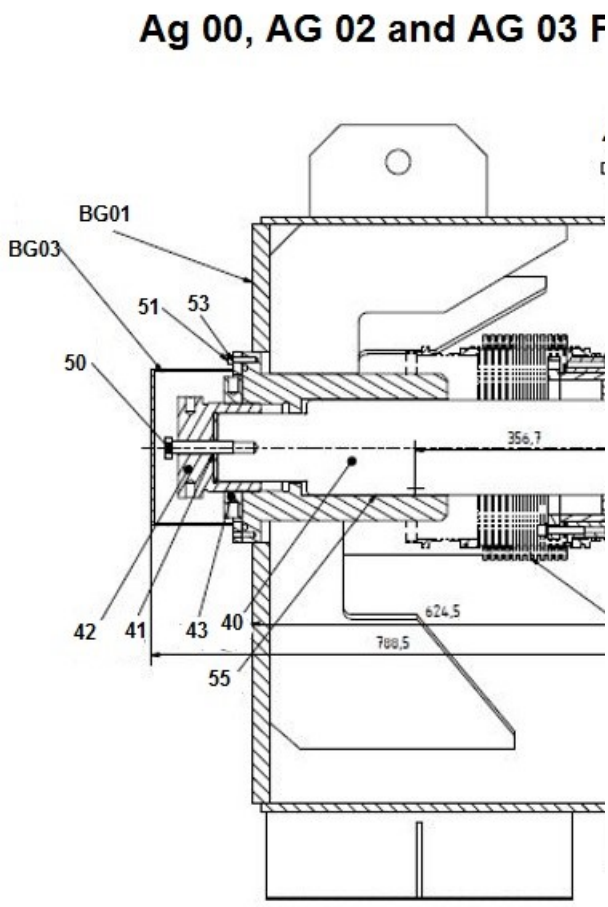
7.5 Installation of Upstream End Cap

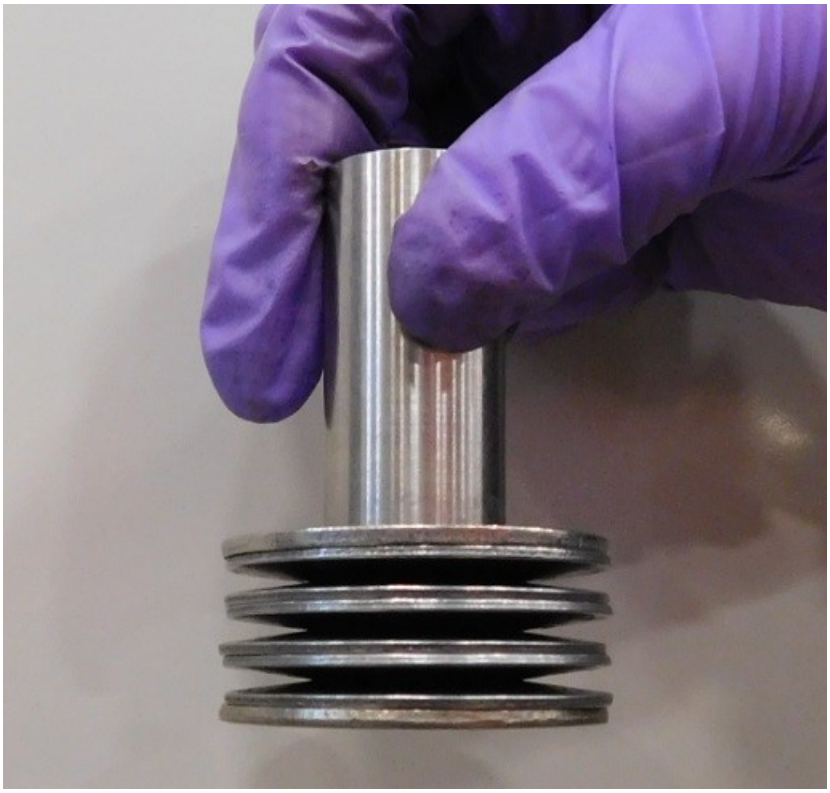
Assembly Groups (AG)

AG 00: Transport Feed Cap Assembly
AG 01: Transport Feed Cap
AG 02: GHRP Insert
AG 03: Shipping Cap Cover

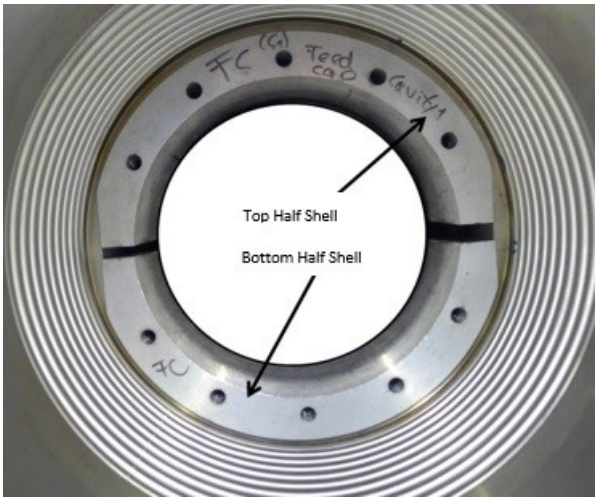
Assembly Overview (AG 00, AG 01, AG 02 and AG 03) for US Feed Cap	
AG 00	
AG 01	
AG 02	  
AG 03	  



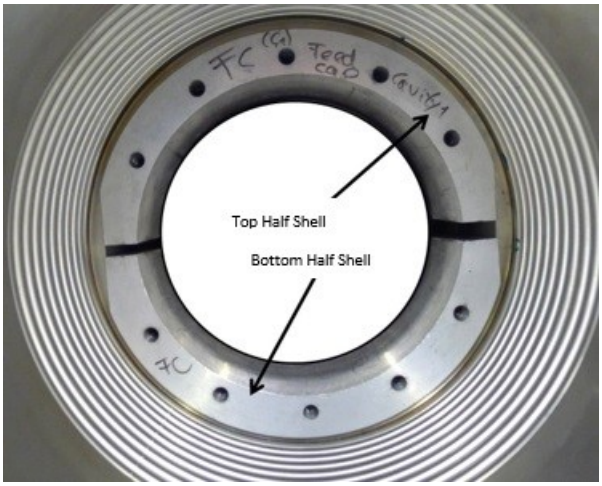




7.5.1 Position plastic sheetings to protect the bellows convolutions (not shown). Insert the bottom half shell (Part 20).



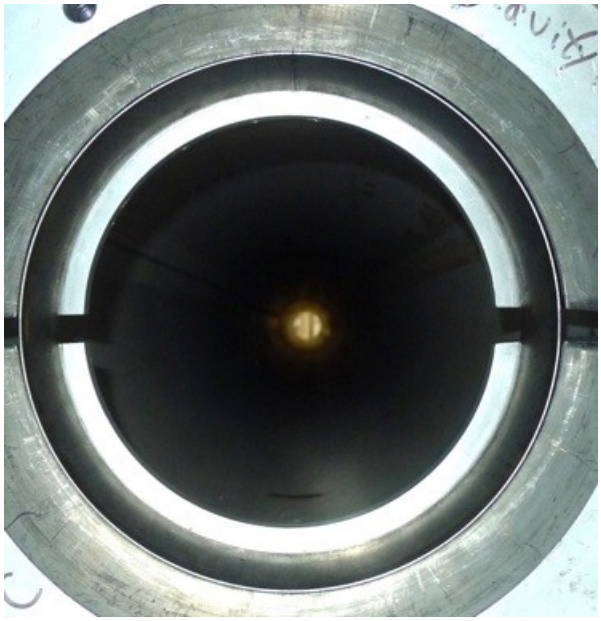
7.5.2 Insert the top half shell (Part 20)



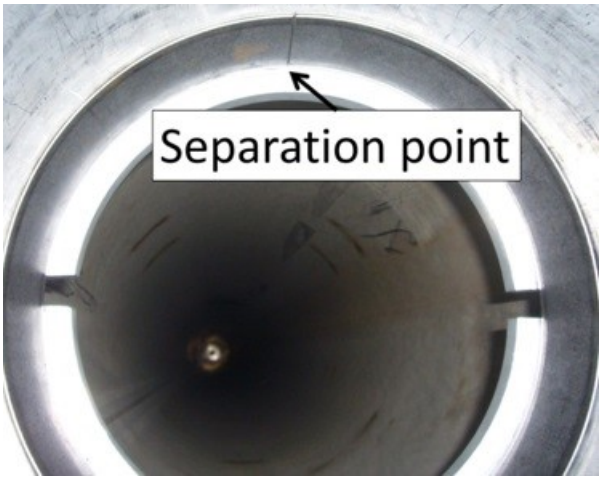
7.5.3 Insert the two centering wedges (Parts 22 and 23) in the orientation shown in the following four sub steps.

Technician: *Date:*

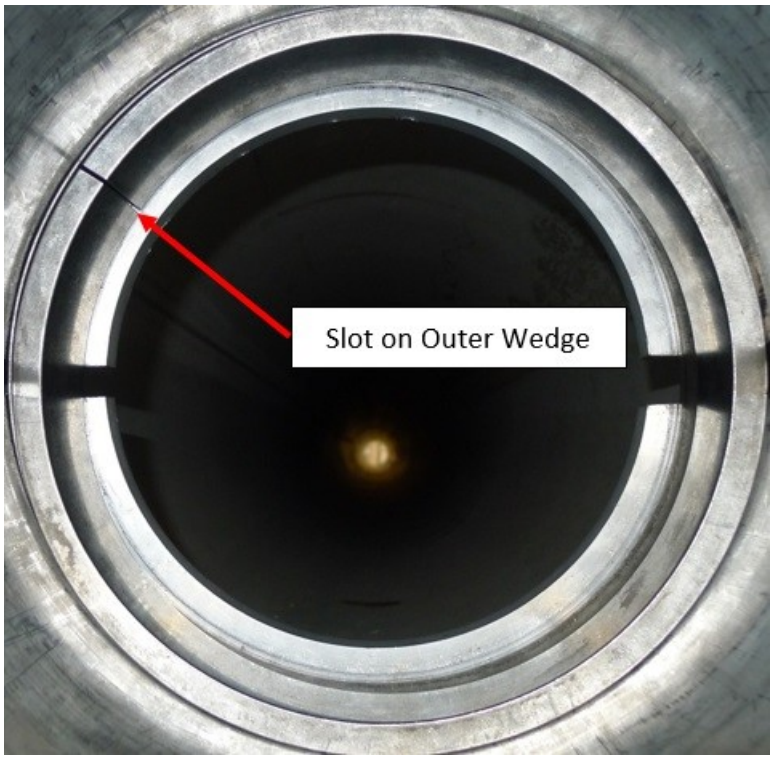
7.5.3.1 First insert the inner centering wedge (Part 22) .



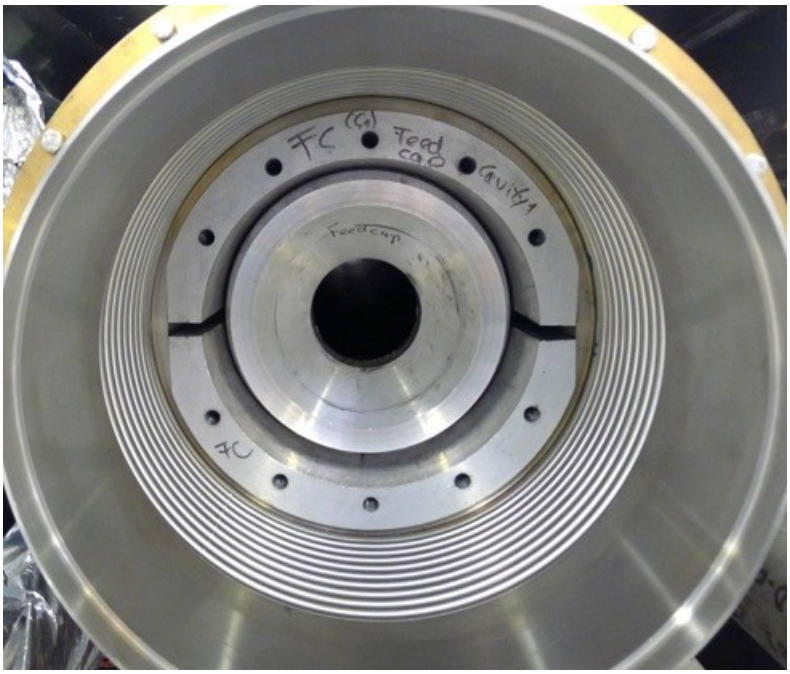
7.5.3.2 Important : Ensure that the slot on the inner centering wedge is at the 12 o’clock position as shown in the image.



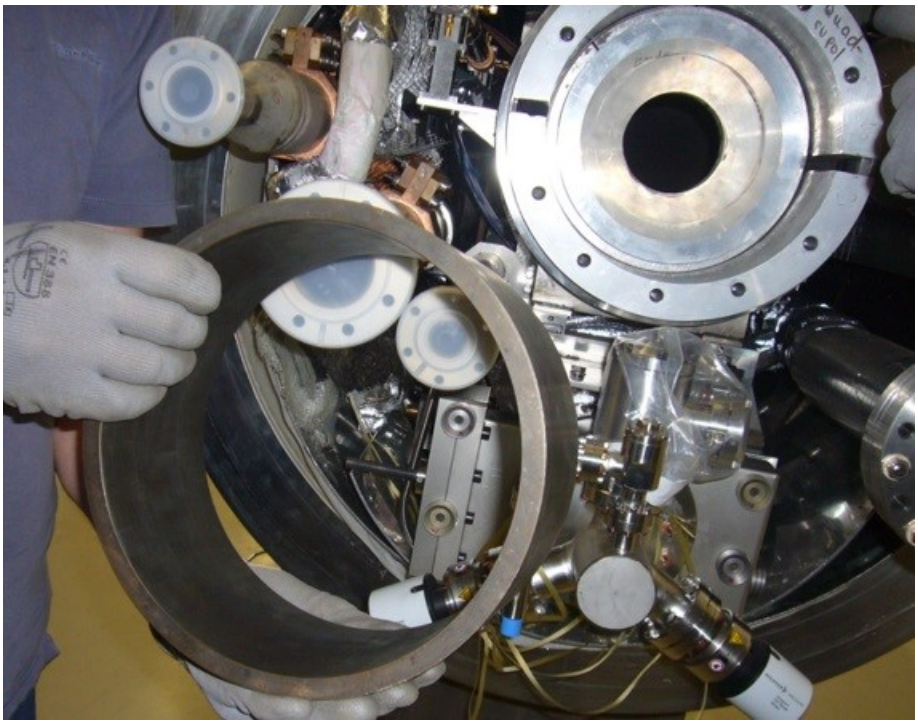
7.5.3.3 Insert the outer centering wedge (Part 23) with its slot 45 degrees offset from the lot on the inner centering wedge.



7.5.4 Insert centering stop (Part 21).



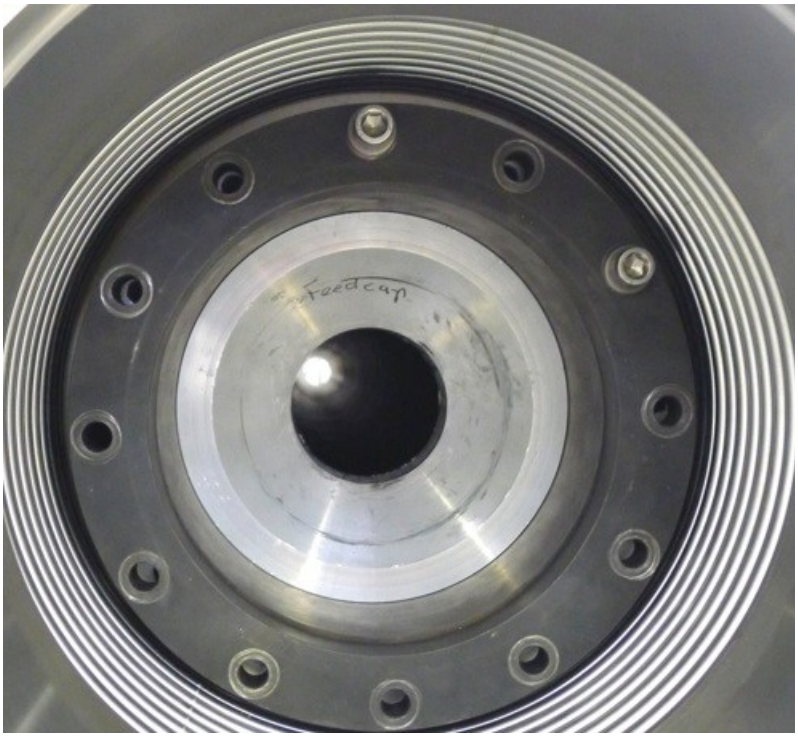
7.5.5 Insert the centering tube (Part 24).



7.5.5.1 The centering tube is shown in its installed condition.

7.5.6 Install centering flange (Part 25).

7.5.6.1 Position the centering flange as shown.

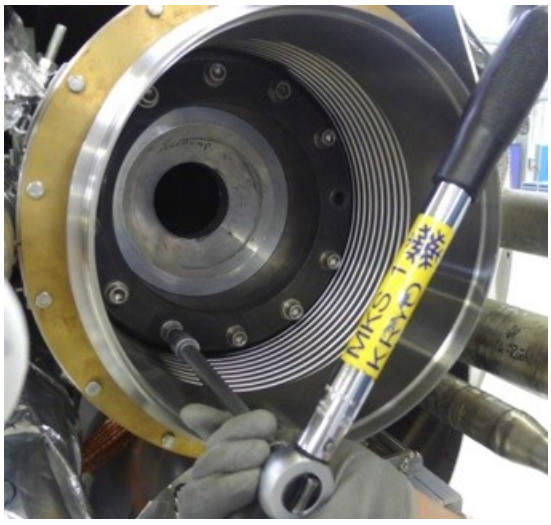


7.5.6.2 Secure the centering flange with the M12-65 SHCS and washers through the centering flange holes except at the 3 o'clock and 9 o'clock positions.

Note: Steps 7.5.6.2 to 7.5.6.4 are for parts 26 and 27

7.5.6.3 Finger tighten all 10 screws.

7.5.6.4 Torque SHCS to 50 Nm (37 ft-lbs.) using a star pattern. Continue to tighten until torque is even on all SHCS.



Technician: ☐ *Date:* ☐

7.5.7 Transport Cap Installation

7.5.7.1 Clean and apply Dow Corning silicone vacuum grease (Fermi stockroom P/N 2150-320000) to all transport cap

O-rings. Clean all sealing surfaces.

7.5.7.2 Attach a scale to the crane and shackle to the lifting lug on the shipping cap. Record the weight of the cap.

Upstream cap weight ☐ **LBS**

7.5.7.3 Adjust the M145 screw (Part 42) so that it is retracted (amount retracted TBD for next traveler revision). Ensure the Belleville washers are installed on the M145 Screw according to prints F10104116 and F10104118 (Procedure for this TBD for next traveler revision). Torque HHCS Part 50 to 80 N-m (60 ft-lbs.).

Note: When tunring, make sure the bolthead stays stationary.

Technician: ☐ *Date:* ☐

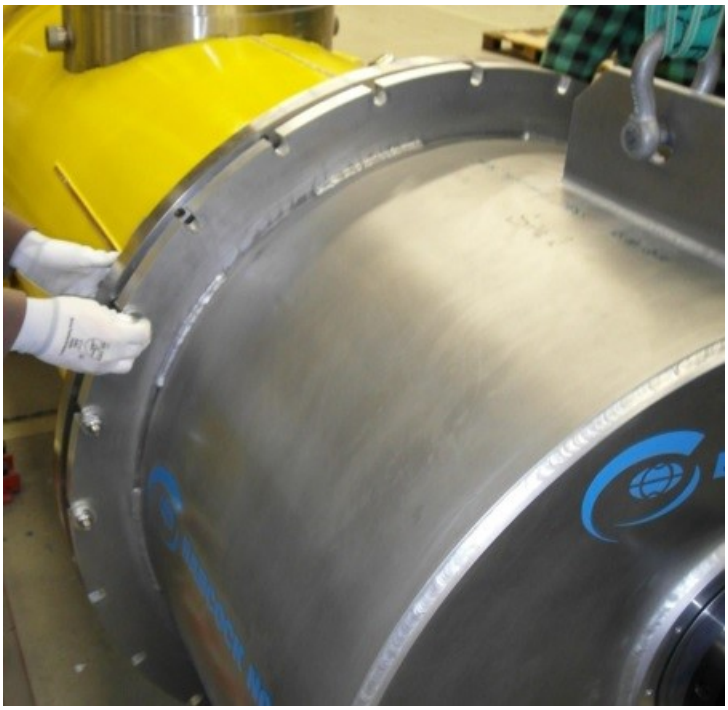
7.5.7.4 Check end cap for level condition after adjusting the spindle extension. Add weight into the foot area as required to bring cap level. Bring the shipping cap within range of the cryomodule. Measure the height to the bottom of the spindle extension. Measure the distance of the bottom of the GHRP Insert. Use the crane to bring them level to the greatest extent possible.

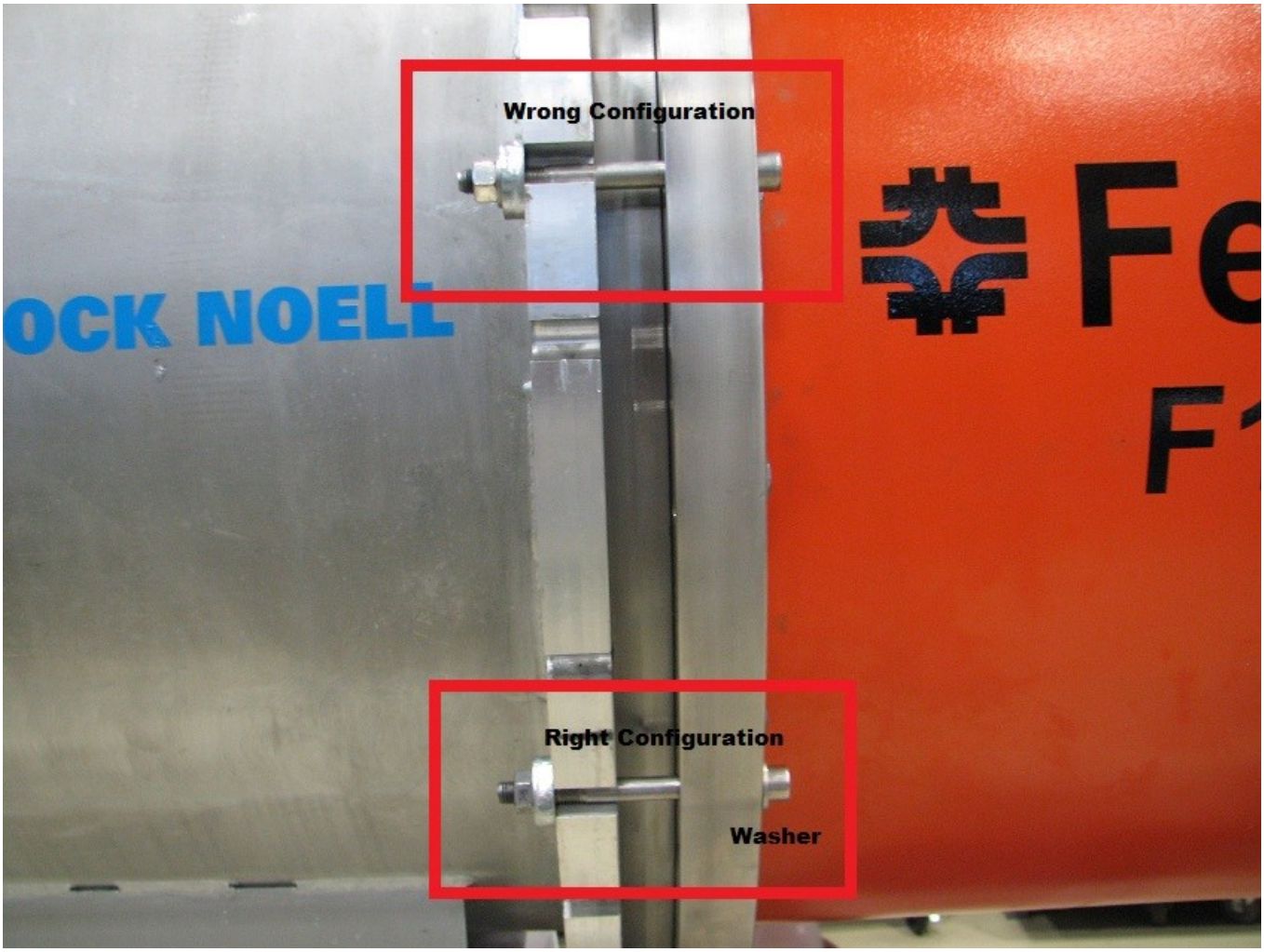
7.5.7.5 Move the shipping cap towards the US end of the cryomodule, aiming the spindle (Part 40) to the center of the GHRP Insert (AG 02). Make full contact with both flanges. Tighten the M145 screw until the flanges begin to separate and pivoting of the cap around the GHRP insert is felt. Manually push the endcap to the cryomodule and hold. Monitor the scale readout. If the weight increases, it means that the central section of the spindle is touching the top of the conical surface of the GHRP insert (AG 02), and the cap should be lowered slightly via the crane. If the weight decreases, the cap should be raised slightly. The weight should remain +/- 60lbs of the original value.

Caution: Be sure to avoid contact between the piping/instruments in the cryomodule and the shipping cap gussets when positioning the cap. Note: XFEL piping is shown in the image and does not reflect exact LCLS-II piping.

7.5.7.6 Insert two screws the at 3 o'clock and 9 o’clock positions and hand tighten. Retract the M145 screw while hand tightening the two fasteners. Once the flanges are in contact, stop retracting the M145 screw and snug the screws using tools to hold the flanges in contact. Add 2 more screws at the 12 o’clock and 6 o’clock positions and snug enough to prevent movement of the shipping cap.

Note: This task requires 3 people. One person on each side of the cap and one person inserting the screws.





7.5.7.7 Loosen the M145 screw approximately two turns after the screw touches the hex head to pull the spindle away from the HGRP insert. Make sure the hex head bolt head doesn't start turning while backing out the screw. Add the remaining fasteners and snug.

7.5.7.8 Torque the M12x135 SHCS to 50 ft.-lbs. Once all SHCS are torqued, the crane may be disengaged.

Technician: ☐ *Date:* ☐

7.5.7.9 Hand-tighten the M145 screw (Part 42) until the Belleville washer start to compress.

7.6 Tighten M145 screws

7.6.1 Perform a distance measurement for the Belleville washer engagements. (Limits to be added on traveler revision)

Upstream measurement 1 ☐ **mm**
Upstream measurement 2 ☐ **mm**
Upstream measurement 3 ☐ **mm**
Downstream measurement 1 ☐ **mm**
Downstream measurement 2 ☐ **mm**
Downstream measurement 3 ☐ **mm**

7.6.2 Ensure that both caps are installed before tightening M145 screws.

7.6.3 Tighten the M145 screw in synchronized quarter turns between the upstream and downstream side until the Belleville's are bottomed out.

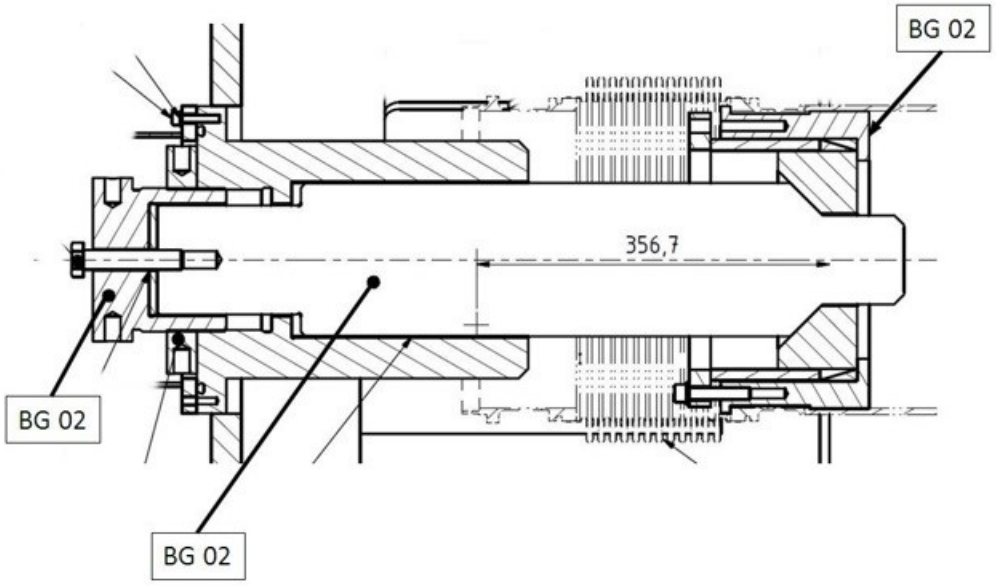
Note: When the bellevilles bottom out there will be a significant increase in torque.

7.6.4 Torque the M145 screw (Part 42) to 80 Nm (60 ft.-lbs.).

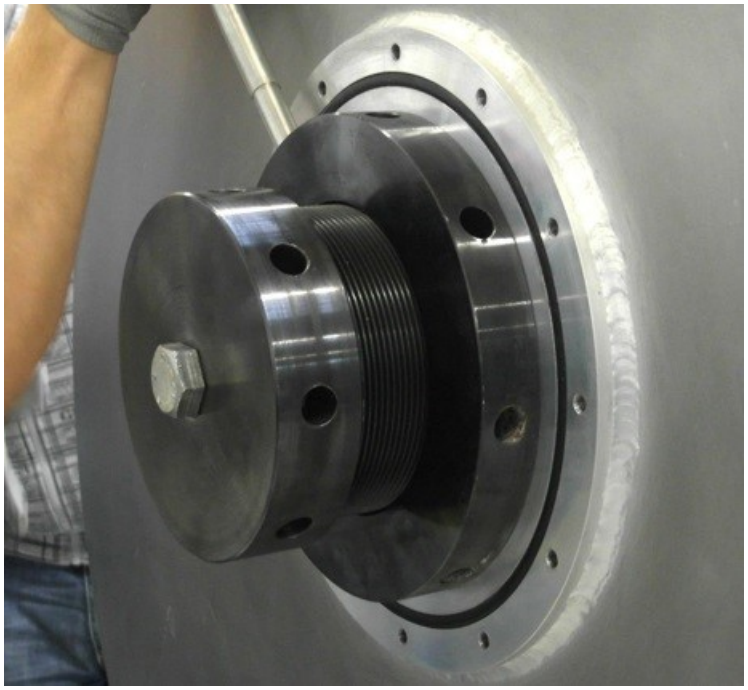
Note: this is for both Upstream and Downstream ends.

Technician: ☐ *Date:* ☐

7.6.5 The spindle (Part 40) is now up to the bearing surface of the conical ring in AG 02.



7.6.6 Tighten the nut (Part 43) using the Φ14mm rod. Torque the center bolt to (Part 50) to 80 N-m (60 ft-lbs.).

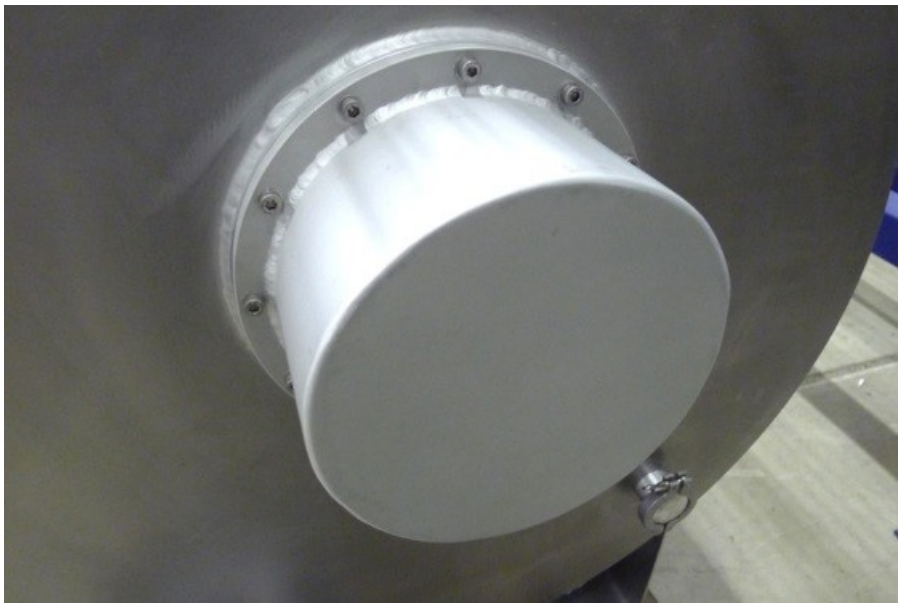


Technician: ☐ *Date:* ☐

7.6.7 Perform a distance measurement for the Belleville washer engagements. (Limits to be added on traveler revision)

Upstream measurement 1 ☐ **mm**
Upstream measurement 2 ☐ **mm**
Upstream measurement 3 ☐ **mm**
Downstream measurement 1 ☐ **mm**
Downstream measurement 2 ☐ **mm**
Downstream measurement 3 ☐ **mm**

7.6.8 Install the Upstream and Downstream shipping cap covers (AG 03) with screws and washers. (Parts 51 and 53). Torque the SHCS to 16 ft.-lbs.



7.6.9 Verify Downstream Cap installation is complete.

Technician: ☐ *Date:* ☐

7.6.10 Verify Upstream End Cap installation is complete.

Technician: ☐ *Date:* ☐

7.7 Purge insulating vacuum volume with dry nitrogen.

7.7.1 Attach pressurizing manifold to US transport cap via KF-40 fitting. Open manual right angle valve on pressurizing end

7.7.2 Open manual right angle valve on opposite end from pressurizing manifold (referred to as vent end).

7.7.3 Carefully engage Dewar regulator, open regulator valve and begin purge with dry nitrogen. Set regulator to 40 psi.

7.7.4 Continue purge for 1 hour.

Technician: ☐ *Date:* ☐

7.7.5 Close regulator valve then close manual right angle valve on vent end.

7.7.6 Slowly open regulator valve to pressurize the insulating vacuum space to 1050 mBar (0.5 psig). Record pressure on the gauge.

Insulating vacuum (psig) ☐

Technician: ☐ *Date:* ☐

7.7.7 Close regulator valve then close manual right angle valve on pressurizing end.

7.7.8 Remove the pressurizing manifold and the vent manifold from the US and DS transport caps.

Technician: ☐ *Date:* ☐

7.8 Use Traveler 464410 to perform RF checks and attach that completed traveler to this step.

Technician: ☐ *Date:* ☐

8.0 Transport Frame Preparation Top

8.1 Arrange for Transport Driver and Tractor.

8.2 Arrange for FNAL enclosed trailer to be delivered to ICB by completing an MMR and notifying Dispatch at x2445 (License # E 01025 T).

8.3 Back transport (tractor with trailer) into ICB East highbay and close overhead door.

8.4 Disconnect FNAL tractor and leave the trailer. FNAL tractor can leave.

8.5 Retraction of trailer enclosure (tarp).

8.5.1 Beginning at aft end of trailer, Unsecure and roll-up aft end cover and leave on top of enclosure. It is not necessary to remove the rolling rod.

8.5.2 Release the ratcheting straps (by pulling inner latch down and rotating the ratchet handle upward until it releases) and then remove hook attaching aluminum support post from enclosure assembly.

8.5.3 Remove aluminum support posts from trailer bed and place them aside.

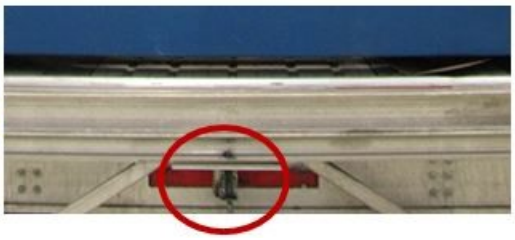
8.5.4 Move to the forward end of trailer.

8.5.5 Begin with the neutralization of the pneumatic system by moving the 3-way air valve from the engaged position (most left) to the neutral (mid) position.

8.5.6 Notice that when the air is exhausted both pneumatic cylinders retract and the cams move upward, releasing the seal between the trailer bulkhead and the enclosure assembly or interface.

8.5.7 The enclosure is now longitudinally free from the trailer.

8.5.8 Release the swing out rails from the aft of the trailer. Roll up the aft cover.

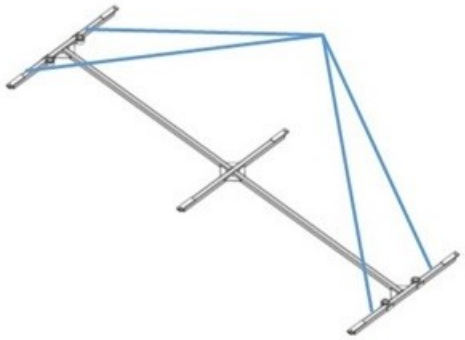


8.5.9 Swing out the arm rails until they are inline with the trailer rails. Pull/push the cover off the trailer on to the rails at the rear of the trailer.

8.5.10 Remove all (6) quick release pins from upper truss found on the transport frame.

8.6 Use of hard hats (by all in the area) is a requirement while operating overhead crane.

8.7 Attach slings to upper truss.



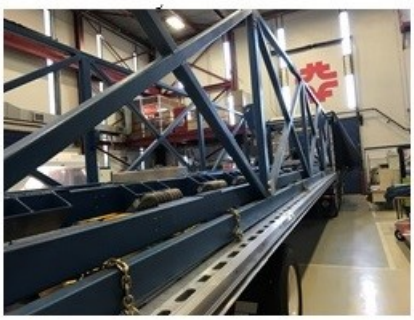
8.8 Carefully lift the upper truss straight upward and place onto cribbing.

8.9 Carefully climb into the frame on each side.

8.10 Note that securing Nylon straps are already in place for the Transport Frame to the air-ride flatbed trailer.

8.11 Ensure that the 4x4 shims are in place between the frame and the trailer.

8.12 Remove and prepare attachment (support) plates.



9.0 Cryomodule Installation to Frame Top

WAIT FOR TRANSPORT TRACTOR TO ENGAGE TRAILER BEFORE CRYOMODULE INSTA

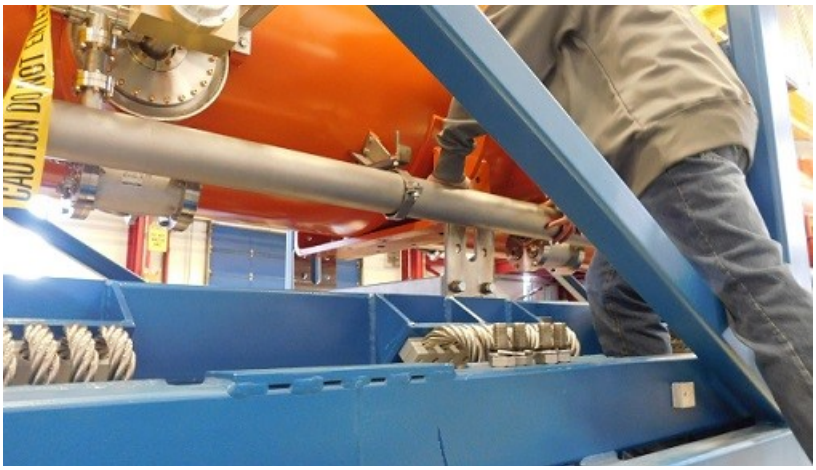
9.1 With yellow strongback fixture pre-attached, connect 30-ton crane to strongback and carefully lift.

9.2 Move cryomodule with strongback over to transport frame using (2) tag-lines with spotters.

9.3 Once centered properly over the isolation fixture, carefully lower assembly.

9.4 Lower carefully until within an inch of resting the cryomodule onto the aluminum blocks.

9.5 Ensure proper alignment of cryomodule with respect to the isolation fixture attachments.



9.6 Carefully lower cryomodule onto the aluminum blocks and secure using attachment plates.

9.7 Torque lower HHCS ¾”-10 x 2-3/4” long bolts evenly to 84 ft-lb.

Technician: ☐ *Date:* ☐

9.8 Torque upper HHCS M24 x 3 mm x 50 mm long bolts evenly to 130 ft-lb.

Technician: ☐ *Date:* ☐

9.9 Disconnect yellow strongback fixture from cryomodule.

9.10 Adjust yellow strong-back fixture's C.G. (from red line (CM attached) to black line (CM off)) through wheel mechanism.

9.11 Lift and move yellow strongback fixture to a separate area and set on cribbing.

9.12 Reattach upper truss to frame.

9.13 Secure the upper truss with straps and 6 quick release pins.

9.14 Attach instrumentation. At minimum 1 device on the cryomodule vacuum vessel and 1 device on the outer transport frame.

9.15 Activate instrumentation.

Technician: ☐ *Date:* ☐

9.16 Activate the beamline vacuum monitoring and logging. Record the vacuum level.

Cryomodule beamline vacuum level (Torr) ☐

Technician: ☐ *Date:* ☐

9.17 Ensure that the cryomodule external insturmentation (Accelerometers, GPS, Remote Vacuum Monitoring) have been activated and check out is complete. Upload the checklist and configuration sheet from procedure TID-N-1130 and attach a paper copy to be delivered to SLAC.

Checklist upload Upload File

Technician: ☐ *Date:* ☐

9.18 Ensure the straps holding the frame to the trailer are tight.

9.19 Secure enclosure (tarp) for transport.

Technician: ☐ *Date:* ☐

9.19.1 Secure enclosure system by rolling the tarp system forward onto the trailer.

9.19.2 Begin with the engagement of the pneumatic system by moving the 3-way air valve from the neutral (mid) position to the engaged position (most left).

9.19.3 Notice that when the air is engaged both pneumatic cylinders engage and the cams move downward engaging the seal between the trailer bulkhead and the enclosure assembly or interface.

9.19.4 Swing the aft rails in to the trailer and lock in place.

9.19.5 Attach aluminum support posts and secure enclosure assembly by ratcheting the straps.

9.19.6 Roll down the aft end cover and secure using Velcro strips and rubber cords.

9.20 Verify the Cryomodule is ready for transport.

Responsible Authority/Designee: *Date:*

10.0 Production Completeness Verification Top

10.1 Responsible Authorities MUST ensure the Traveler is complete, all specifications are met and the Cryomodule is ready for shipment to SLAC.

○ *Pass* ○ *Fail*

Comments:

Responsible Authority/Designee: *Date:*

10.2 For tracking purposes, select the next destination for the Cryomodule. If the option "Other" is chosen from the drop box, please type the location in the text field below the drop box.

Cyromodule next destination

Other:

Responsible Authority/Designee: *Date:*

11.0 Process Complete Top

11.1 Process Engineering verify that the traveler is accurate and complete. This shall include a review of all steps to ensure that all operations have been completed and signed off and that all deviations from the outlined process have been documented.

Comments:

Process Engineering/Designee:

Date: