Laser Interferometer Gravitational Wave Observatory

LIGO Laboratory / LIGO Scientific Collaboration

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Arm Cavity Baffle Installation Procedure

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Scope

This document covers the procedure for installation of the Arm Cavity Baffle (D0901376):

1. onto an overhead mechanical interface for testing (Section 2 of document)
2. onto the BSC ISI Stage-0 (D0900896) structure inside a BSC chamber (Section 1 of document)

NOTE: This procedure must be read before beginning the installation of an Arm Cavity Baffle.

Note that the installation of the Arm Cavity Baffle is one element of the Stray Light Control (SLC) subsystem. The installation plan for all SLC components is covered in "SLC and Viewports Installation plan", LIGO-E1000099.

Section 1 – Arm Cavity Baffle installation onto Test Stand (or STAGE-2 ISI Table)

1 Installation Preparation

1.1 Assembly of ACB Installation Stand (D1200575)

Need a procedure!

1.2 Insertion of ACB Suspension Assembly into ACB Installation Stand

1 - Position the **ACB Installation Stand** on the clean room floor on top of aluminum foil

D1200575 – used for BSC1 and BSC3

D1101957 – used for BSC4, BSC5, BSC9 and BSC10

2 - Remove the **Upper Clamp** (D1102062) - save the hardware for later use

3 - Remove both **Side Beams** (D1102026) - save the hardware for later use

4 - Place **ACB_Stage-0 Dog Clamp, End** on top of stand at the side nearest the three horizontal clearance holes in the side beam

D1101622 – used for BSC1 and BSC3

5 - Place **ACB_Stage-0 Guide Block** on top of stand on the other side

D1101610 – used for BSC1

D1101609 – used for BSC3

6 – Verify that the **Transport Locking Bracket** (D1101285) and the **Height Adjustment Bracket** (D1101578) are attached.

7 - Two people lift the **Arm Cavity Baffle Suspension Assembly** (D1001011), while a 3rd person holds the stand, and place the **Interface Plate** on top of the stand between the **Dog Clamp, End** and the **Guide Block** with the wide end of the interface plate supported by the **Guide Block**.

7 - Replace and fasten the **Upper Clamp** and the **Side Beams** with the saved hardware.

1.3 Installation Set-up

1.3.1 Items required for Installation Set-up, in order of use:

1 – lifting Table (D1002192)

3 – tall step stands for reaching to top of Test Stand

2 - "Wedge Lift, Baffle, Suspension Table" (D1101952) and hardware

1- Sled

1 - "Arm Cavity Baffle Box Assembly"

1 – Installation Stand with Suspension Assembly

1 - **Suspension Lift Assembly** (D1101953), with **Table, Secondary, Suspension** (D1101962) and four **Table Dog Clamps** (D1001376-2) attached with _____ SHCS. (What are the clamps used for on D1101971 drawing?)

2 - SHCS (¼-20 x .62")

2 - 3/16" Hex Allen tool of ¼-20 SHCS

2 - 5/16" Hex Allen tool of 3/8-16 SHCS

2 - Plain Grip Looped T-Handle Hex Key 3/16" Hex

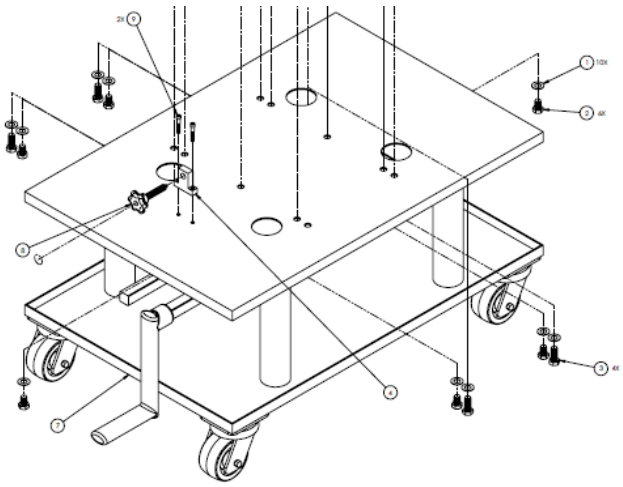
12 – Dog clamps and hardware for mounting to the Test Stand/STAGE-2 ISI Table

Verify all hardware and tools

1.3.2 **CHECK THE LEVEL OF THE MOUNTING SURFACE OF THE TEST STAND!** It is important that this surface be level to within 0.14 deg. This will ensure that the upper tube can be positioned after balancing to within 1 mm of the centerline position of the earthquake stop flange opening and allow a range of motion > 2 mm of the upper tube.

1.3.3 Set-up “Suspension Lift Table” (D1102061), with “Table, Secondary, Suspension” (D1101962) and four “Table Dog Clamps” (D1001376-2) attached, under Test Stand on top of the cranked lifting table (D1002192)) that will allow the Suspension Stand to be mated to the Test Stand ceiling. The Suspension Lift Table weighs about 62 lbs. and the Secondary Table weighs about 20 lbs. Note: orient the crank opposite to the “ACB Bend Fixture Holder Assembly” (D1102325) of the Suspension Assembly.

Note: the Table, Secondary, Suspension” (D1101962) needs to be modified so that the Installation Stand can be centered on the lifting table.



1.3.4 Adjust position of lifting Table (D1002192) to sit directly below Baffle attachment area on Test Stand.

1.3.5 Verify Jacks are in completely collapsed state.

2 Arm Cavity Baffle installation

2.1 Arm Cavity Baffle Suspension Assembly (D1001011) installation onto Test Stand

2.1.1 Items required for Arm Cavity Baffle Suspension Assembly Installation, in order of use:

1 - "ACB_Installation Stand" (D1101957), with "Arm Cavity Baffle Suspension Assembly" (D1001011), "ACB_Stage Zero Narrow_Guide Block" (D1101595) and "ACB_Stage Zero Narrow-Dog Clamp, End" (D1101613) installed.

NOTE: The Arm Cavity Baffle Suspension Assembly must have the following tooling attached: "ACB Bend Fixture Holder Assembly" (D1102325) with "Bend Fix Plate Handle" (D1102193-02) removed and attached to the Suspension Stand with wire, "Transport, Locking, ACB" (D1101285), and "Height, Adjustment, ACB" (D1101578).

NOTE: "ACB_Stage Zero Interface Fixture Mover" (D1101700) must **NOT** be installed.

2 - 3/16" Hex Allen tool of ¼-20 SHCS

2 - Plain Grip Looped T-Handle Hex Key 3/16" Hex

2 - 5/16" Hex Allen tool of 3/8-16 SHCS

5 - SHCS (3/8-16 x 2 1/2")

5 – 3/8" washers

4 - SHCS (3/8-16 x 2 1/2")

4 – 3/8" washers

2 - 3/16" Hex Allen tool of ¼-20 SHCS

3 – tall step stands (class B) to reach top of test stand table

4 – interface mounting D1001700, need 12 dog clamps 3/8/-24 lower design ?

2.1.2 Two people carry the **Arm Cavity Baffle Suspension Assembly**, which is secured in the expandable **Installation Stand** in its collapsed and locked configuration, and carefully place it on top of the **Secondary Table**; the orientation on the table should match the orientation of the ACB Box when it is installed later. Total weight is about 100 lbs. There are handles on the Installation Stand for lifting and carrying.

NOTE: Two people remain on each side of the Installation Stand.

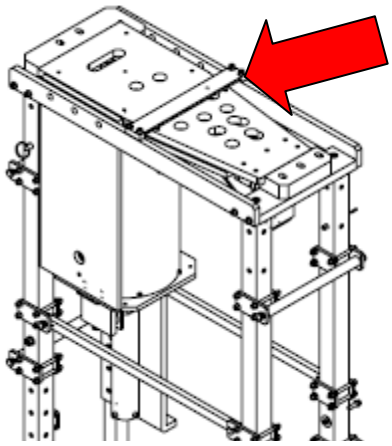
2.1.3 Secure **Installation Stand** to **Secondary Table** with four **Table Dog Clamps** attached to the table.

Note: We need to tap new holes on the Secondary Table so that the Installation Stand can be positioned at the middle of the Secondary Table for ease of access to the two lifting people.

2.1.4 Loosen **Table Dog Clamps** that secure the **Installation Stand** and align to placement location on Test Stand.

2.1.5 Tighten **Table Dog Clamps** to secure **Installation Stand**.

2.1.6 With **Installation Stand** secured, remove **Upper Clamp** from top of **Installation Stand**. Remove parts and set aside.



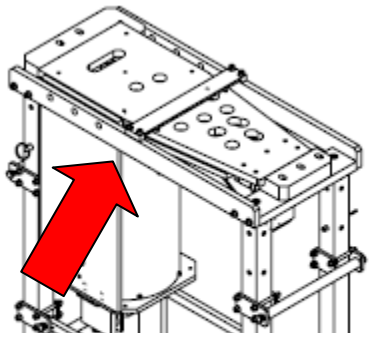
2.1.7 Crank the lifting table to the lowest position.

2.1.8 Two people grab the lifting bars on each side of the **Installation Stand** and a 3rd person removes the **Locking Pins** that secure the telescoping legs. Raise the installation stand to the nearest telescoping leg locking hole that brings the installation stand closest to the Test Stand mounting surface. Insert the locking pins and secure the telescoping legs.

Note: we need a better platform for the two lifting people to stand on during the lifting.

2.1.9 Slowly crank the lifting **Table** (D1002192) upwards and to lift the **Installation Stand** while positioning it to align the **Interface Mounting Plate** to the Test Stand plate mounting locations. Continue cranking until top of **Interface Mounting Plate** touches the Test Stand.

2.1.10 Remove **Side Beam** from **Installation Stand** from each side one at a time, clamping that side with **Dog Clamps** before removing the other side. Remove parts and set aside.



2.1.11 Slowly crank the lifting Table (D1002192) downwards with attached **Installation Stand**. Watch the **Suspension Assembly** for any possible obstruction. Note: Describe the rework needed to keep the installation stand from catching on the bolt heads of the dog clamps.

2.1.12 Loosen the four **Table Dog Clamps** on the **Secondary Table** securing the **Installation Stand**, rotate to release and tighten.

2.1.13 Carefully remove empty **Installation Stand** and set aside.

2.1.14 Remove the twelve 1/4-20 SHCS attaching the **Secondary Table** to the **Lift Table**. Set screws aside for use in next step.

2.1.15 Carefully remove the **Secondary Table** and set aside.

2.2 Arm Cavity Baffle Box Assembly installation onto Test Stand

2.2.1 Items required for Arm Cavity Baffle Box Assembly Installation, in order of use:

2 - Plain Grip Looped T-Handle Hex Key 3/16" Hex

2 - “Wedge Lift, Baffle, Suspension Table” (D1101952)

2 - 3/16” Hex Allen tool of ¼-20 SHCS

1 - “Slide, Baffle Carrier Assembly” (D1101958)

1 - “Arm Cavity Baffle Box Assembly” (D1000977)

1 - Shoulder Screw #10-24 (D1101293)

3 - #10 Flat Washers

1 - #10 Silver-Plated Nut

1 - 3/8” Wrench for #10 Shoulder Screw Nut

1 - 1/8” Hex L-Key tool for #10 Shoulder Screw

4 – SHCS (1/4-20 x 7/8”)

2.2.2 Use the lifting Table (D1002192) that was used for installation of the Suspension Assembly and crank it to the lowest level. Verify **Jacks** are in completely collapsed state.

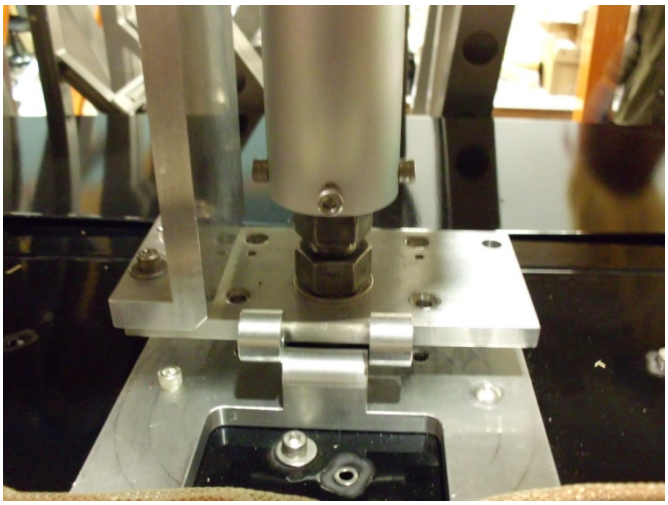
2.2.3 Attach the two **Wedge Lifts** (D1101952) to the **Jacks** with eight 1/4-20 SHCS from Step 2.1.14.

2.2.4 Set the **Baffle Carrier Slide Assembly** (D1101958) into guides on top of the **Table**.

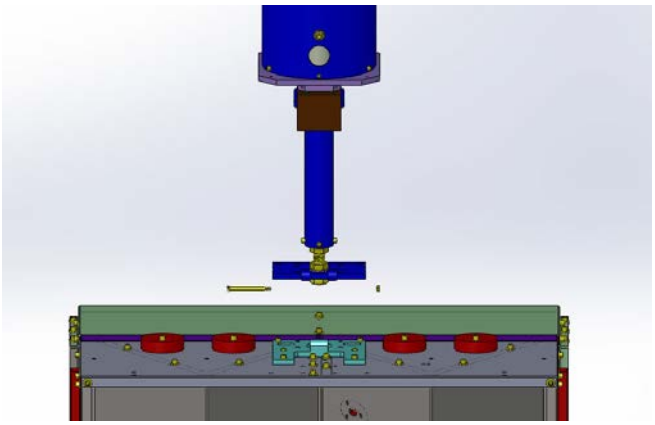
2.2.5 Four people must assist with the lift of the **Arm Cavity Baffle Box Assembly**. The **Baffle Box** weighs about 100 lbs. Carefully lift the **Baffle Box** and place centered onto **Slide Assembly** which is on the **Table** making sure the screws on the bottom of the **Baffle Box** clear the **Slide Assembly.**

2.2.6 Position the **Baffle Box** under the **Suspension Assembly**, stopping at the approximate location needed to raise and mate the **Baffle Box Assembly** with the **Suspension Assembly**.

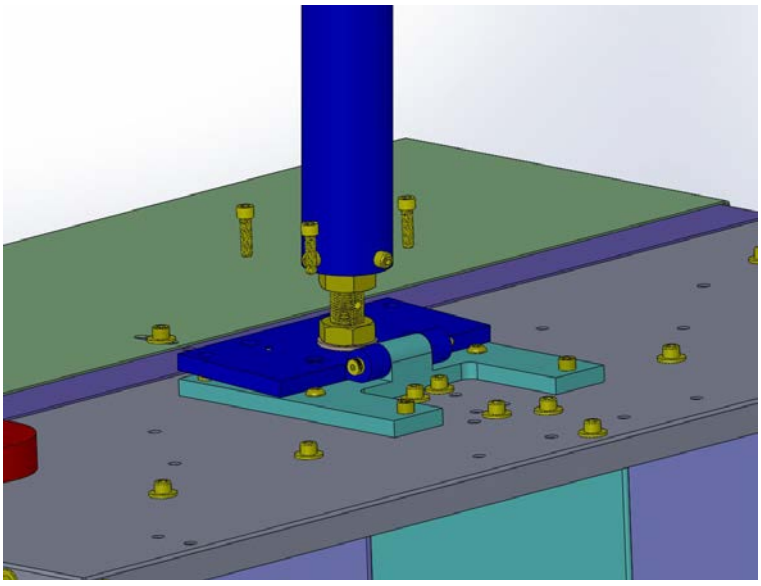
2.2.7 Crank lifting Table (D1002192) upwards to lift **Baffle Box Assembly** and align to **Top Hinge Plate** at bottom of **Suspension Assembly**. Adjust **Baffle Box** position by moving the cranked lower lifting table as needed for alignment. Continue lift until plates touch.

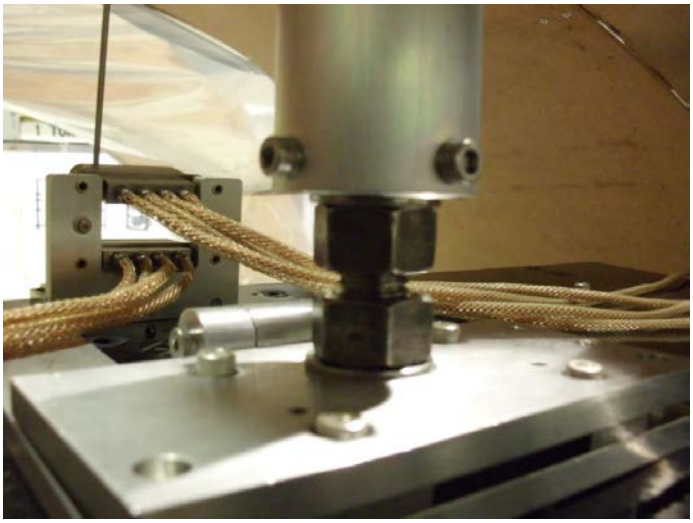


2.2.8 Attach **Baffle Box Assembly** to **Suspension Assembly** with **Shoulder Screw** (D1101293), three #10 Flat Washers, and one #10 Silver Plated Nut



2.2.9 Attach four 1/4-20 SHCS through **Top Hinge Plate** on **Suspension Assembly** to **Bottom Hinge Plate** on **Baffle Box Assembly**.





2.2.10 Slowly crank the lifting table downwards until the lifting table is approximately one inch below the bottom of the ACB box.

2.3 Initial Baffle Balance

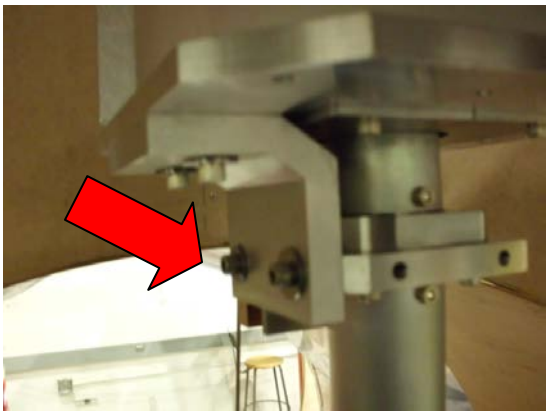
2.3.1 Items required for Baffle Balance, in order of use:

2 - 3/16" Hex L-Key tool for ¼-20 SHCS

Note: The following balancing steps are critically dependent upon the mounting surface of the Test Stand being level in Step 1.3.2!!

2.3.2 Determining the Magnitude of Balance Weights

2.3.2.1 Verify **Transport Locking Bracket** is in place. Loosen the two SHCS in the slotted holes of the **Transport Locking Bracket** attached to the **Lower Tube Connector Plate** (D1002618) so that the Lower Tube can slide freely in the vertical direction.



~~2.3.2.2 Remove "**Height, Adjustment, ACB**" (D1101578) and hardware. Set aside with hardware for Step 2.6.10.~~

2.3.2.3 Slowly lower the lifting table with the crank while watching to see if the **ACB Bend Fixture** (D1102325) pulls away from the interface plate.

2.3.2.3.1 If the **Bend Fixture** becomes free, stop!! Raise the lifting table with the crank until the bend fixture is again captured by the tip of the blade spring, proceed to Step 2.3.2.3.2. If the **Bend Fixture** does not become free, proceed to Step 2.3.2.3.5.

2.3.2.3.2 Remove some of the free balance weights and repeat Step 2.3.2.3, continuing to repeat this process and removing weights until there is a stable gap of approximately 0.010 between the **Bend Fixture** and the **Interface Plate** after the lifting table has been lowered so that it no longer supports the **ACB**. At this point, the proper amount of balance weight has been determined, proceed to Step 2.3.3.

2.3.2.3.3 If, after removing all of the free **Balance Weights**, the baffle is still hanging too low, as seen by observing the gap between the hole in the **Upper Tube** and the **Earthquake Rods**, proceed as follows:

1) Estimate the vertical offset of the **Upper Tube** within the earthquake stop rods, and note this dimension.

2) Verify that the **Bend Fixture** is in place.

3) Remove the ACB assembly from the Test Stand following the procedure of Section 3; disassemble the Suspension Assembly and repeat the assembly step described in E1100867 in which the length of the **Pivot Rod** was set by screwing it into the **Upper Tube**. However, this time insert the **Pivot Rod** into the **Upper Tube** by the additional amount noted in 2.6.3.4 to raise the **Upper Tube** within the **Earthquake Rod** holes.

4) After repeating re-assembly steps, start over at Step 2.1.

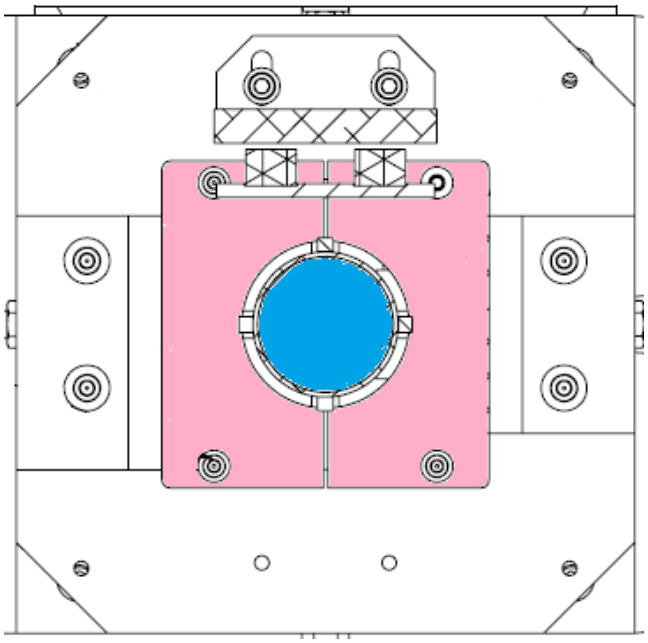
2.3.2.3.4 Add additional **Balance Weights** and repeat Step 2.3.2.3, continuing to repeat this process and adding weights until there is a stable gap of approximately 0.010 between the bend fixture and the interface plate after the lifting table has been lowered so that it no longer supports the ACB. At this point, the proper amount of balance weight has been determined, proceed to Step 2.3.3.

2.3.3 Remove the **Bend Fixture**.

2.3.4 Remove the **Transport Locking Bracket** and save parts and hardware for future use.

2.3.5 Balance the **ACB** in the axial and transverse directions by shifting the **Balance Weights** axially and laterally until the **SLC Baffle Tube Up Assembly** (D1002582) is evenly spaced inside **SLC Earthquake Stop Ring** (D1001120) circumference.

Note: DO NOT ROTATE THE ACB BOX WHILE THE **TRANSPORT LOCKING BRACKET** IS REMOVED!!



2.3.6 When balancing is complete, re-attach the **Transport Locking Bracket**.

NOTE: Do not re-insert **Bend Fixture**.

2.3.7 Loosen the **Anti-Rotation Bracket**. Slide it down the **Lower Tube** and attach to the **Top Hinge Plate**.

2.3.8 Attach the **Variable Height Bracket** to the **Anti-Rotation Bracket**.

3 Removal from Test Stand

3.1 Removal Preparation

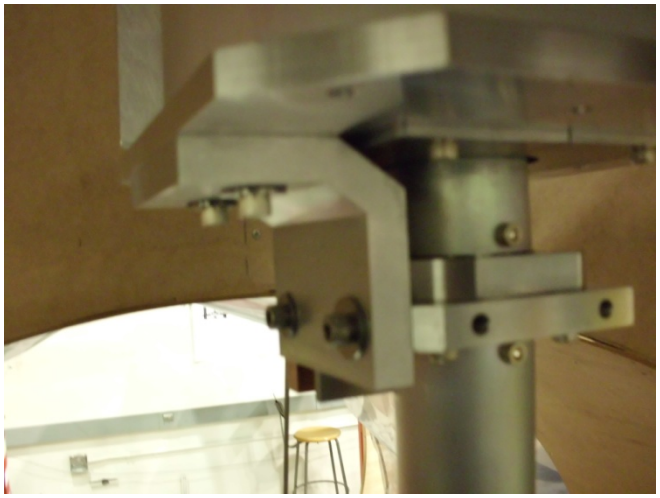
3.1.1 Items required for Removal Preparation, in order of use:

Tool for SHCS

Transport Locking Bracket

Variable Height Bracket

3.1.2 Verify **Transport Locking Bracket** is in place. Verify all SHCS are tight.



3.1.3 Verify **Variable Height Bracket** is in place. Verify all SHCS are tight.

3.1.4 Verify **Jacks** are in completely collapsed state.

3.1.5 Position **Slider** underneath the **Baffle Box**.

3.2 Baffle Box Removal

3.2.1 Items required for Baffle Box Removal, in order of use:

3.2.2 Use the lifting Table (D1002192) that was used for installation of the **Baffle Box** with the two **Wedge Lifts** attached to Jacks from Step 2.2.3.

3.2.3 Verify Jacks are in completely collapsed state.

3.2.4 Raise the lifting table with the crank until the table touches the bottom of the **Baffle Box** and partially supports it.

3.2.5 Remove the four 1/4-20 SHCS that attach the **Top Hinge Plate** on **Suspension Assembly** to **Bottom Hinge Plate** on **Baffle Box Assembly**.

3.2.6 Remove the **Shoulder Screw**, #10 Flat Washers, and #10 Silver Plated Nut that attach the **Baffle Box Assembly** to the **Suspension Assembly**.

3.2.7 Lower the lifting table with the crank until the **Baffle Box** is free from the **Suspension Assembly**.

3.2.8 Four people must assist with the lift of the **Baffle Box Assembly**. The **Baffle Box** weighs about 100 lbs. Carefully lift the **Baffle Box** and set aside.

3.3 Suspension Assembly Removal

3.3.1 Items required for **Suspension Assembly** removal, in order of use:

3.3.2 Use the lifting Table (D1002192) that was used for installation of the **Baffle Box** with the two **Wedge Lifts** attached to Jacks from Step 3.2.2.

3.3.3 Remove the **Wedge Lifts** from **Jacks**, set screws aside for use in next step.

3.3.4 Verify **Jacks** are in completely collapsed state.

3.3.5 Verify **Dog Clamps** are mounted on **Secondary Table**.

3.3.6 Attach **Secondary Ta**ble to **Lift Assembly** with screws from Step 3.3.3.

NOTE: Two people must remain beside the **Suspension Lift Assembly.**

3.3.7 Secure **Installation Stand** to **Secondary Table** with the four **Table Dog Clamps** attached to the **Table**.

3.3.8 Loosen **Table Dog Clamps** that secure the **Installation Stand** and align to suspended **Suspension Assembly**

3.3.9 Tighten **Table Dog Clamps** to secure **Installation Stand**

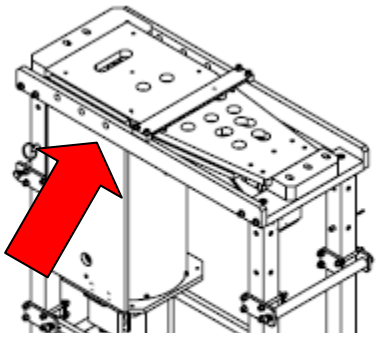
3.3.1 Verify **Upper Clamp** from top of **Installation Stand** and **Side Beams** are removed.

3.3.2 Crank the lift table to the lowest position. Two people grab the lifting bars on each side of the **Installation Stand** and a 3rd person removes the locking pins that secure the telescoping legs. Raise the installation stand to the nearest telescoping leg locking hole that brings the installation stand closest to the Test Stand mounting surface with the **Suspension Assembly** nested inside. Insert the locking pins and secure the telescoping legs.

3.3.3 Slowly crank the lifting table upwards until the **Suspension Assembly** rests on top of the **Installation Stand**.

NOTE: The **Guide Block** and **Dog Clamp, End** must be present in the **Stand**.

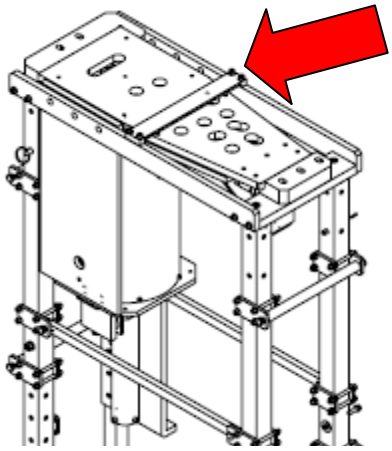
3.3.4 Remove **Dog Clamps** and attach the **Side Beams** to the **Installation Stand** on each side, one at a time. Remove parts and set aside.



3.3.5 Two people on each side of the Table uniformly lower the **Jacks** to completely collapsed state which causes the **Installation Stand** to lower in preparation for removal.

3.3.6 Then the two people on each side of the **Table** completely lower (collapse) the **Installation Stand** with the **Suspension Assembly** in side.

3.3.7 Attach the **Upper Clamp** to top of **Installation Stand**.



3.3.8 Slowly crank the lifting table downwards with attached **Installation Stand**. Watch the Suspension Assembly for any possible obstruction.

3.3.9 Loosen the four **Table Dog Clamps** on the **Secondary Table** securing **the Installation Stand**, rotate to release **Stand** and tighten.

3.3.10 Carefully remove **Installation Stand** with **Suspension Assembly** from Secondary Table and place in secure location.

Section 2 – Arm Cavity Baffle Installation onto the BSC ISI Stage-0

4 Installation Preparation

4.1 Requirements for Installation

4.1.1 BSC flooring must be in place before installation can begin.

4.1.2 QUAD must be secured and protected by SUS –

a) put at least the penultimate and final masses on their stops

b) attach the "face guard" (the plate attached to the frame in front of the optic -- not sure if this is it's proper name)

c) cover with a C3 fabric "sock"

4.2 Assemblies required for Installation

4.2.1 “Rail, ACB Assembly” (D1101724)

4.2.2 “Slide, Baffle Carrier Assembly” (D1101958)

4.2.3 “Arm Cavity Baffle Box Assembly” (D1000977)

4.2.4 “Suspension Lift Assembly” (D1101953), with “Table, Secondary, Suspension” (D1101962), refer to “Installation Suspension Table-Rail Assembly” (D1101971) drawing. Attach four “Table Dog Clamps” (D1001376-2) using four SHCS (1/4-20 x 2").

4.2.5 ACB Plumb Bob Alignment Assembly (D1102370)

4.2.6 “ACB_Installation Stand” (D1101957), with “Arm Cavity Baffle Suspension Assembly” (D1001011), “ACB_Stage Zero Narrow_Guide Block” (D1101595) and “ACB_Stage Zero Narrow-Dog Clamp, End” (D1101613).

NOTE: The Arm Cavity Baffle Suspension Assembly must also have the following tooling attached: “Transport, Locking, ACB” (D1101285), “Height, Adjustment, ACB” (D1101578), “Plate, Swingback, ACB” (D1101597), and “ACB_Stage Zero Interface Fixture Mover” (D1101700).

4.3 Other Vacuum Parts required for Installation

4.3.1 5 - SHCS (3/8-16 x 2 1/2")

4.3.2 5 – 3/8” washers

4.3.3 1 - Shoulder Screw #10-24 (D1101293)

4.3.4 3 - #10 Flat Washers

4.3.5 1 - #10 Silver Plated Nut

4.3.6 4 – SHCS (1/4-20 x 7/8”)

4.3.7 2 – “SLC Photodetector Cable Upper Assembly” (D1003117-2)

4.3.8 1 - pre-set Counter Weight Assembly, from Step 2.6.12.

4.3.9 6 - SHCS (1/4-20 x 1”)

4.3.10 12 – ¼” washers

4.3.11 6 – ¼-20 silver-plated Nuts

4.3.12 Cable Ties and Hardware

4.3.13 4 - “SLC Interface Mounting Clamps” (D1001700)

4.3.14 4 - SHCS (3/8-16 x 2 1/2")

4.3.15 4 - 3/8” washers

4.4 Other Non-Vacuum Parts required for Installation

4.4.1 1 - Teflon Mat

4.4.2 2 - “Wedge Lift, Baffle, Suspension Table” (D1101952)

4.4.3 2 - SHCS (¼-20 x .62”)

4.4.4 2 - “ACB_Interface Fixture Pusher-BSC” (D1101715)

4.4.5 4 – SHCS (3/8-16 x 1")

4.4.6 4 – 3/8” washers

4.4.7 4 - SHCS (3/8-16 x 2 1/2")

4.4.8 4 – 3/8” washers

4.4.9 1 - “Wire, Lifting, Arm Cavity Baffle” D1101443

4.5 Tools required for Installation

4.5.1 2 - Plain Grip Looped T-Handle Hex Key 3/16" Hex for Jacks

4.5.2 2 - 3/16” Hex L-Key tool for ¼-20 SHCS

4.5.3 2 - 5/16” Hex L-Key tool of 3/8-16 SHCS

4.5.4 1 – 3/8” Wrench for #10 Shoulder Screw Nut

4.5.5 1 - 1/8” Hex L-Key tool for #10 Shoulder Screw

4.5.6 2 – ¼” Hex L-Key tool for Pushers

4.5.7 2 - Stainless Steel Open-End Wrench for 1-1/8” Nuts

4.5.8 Tool to attach Cables

4.5.9 Torque Wrenches

5 Installation Procedure

5.1 Installation Set-up

5.1.1 Verify all items in **Section 4.2** have been fully assembled.

5.1.2 All ACB assemblies and installation tooling (for the BSC7, BSC8, BSC1, and BSC3) will be brought through the manifold tube leading to the respective chambers and staged in the manifold tube in the following order:

1) - "Suspension Lift Assembly" (D1101953), with "Table, Secondary, Suspension" (D1101962) and four "Table Dog Clamps" (D1001376-2) attached – about **115** pounds
2) "Rail, ACB Assembly" (D1101724)
3) - "ACB_Installation Stand" (D1101957), with "Arm Cavity Baffle Suspension Assembly" (D1001011), "ACB_Stage Zero Narrow_Guide Block" (D1101595) and "ACB_Stage Zero Narrow-Dog Clamp, End" (D1101613) installed – about 100 pounds
4) 2 - "Wedge Lift, Baffle, Suspension Table" (D1101952) – about 5 pounds each
5) "Arm Cavity Baffle Box Assembly" (D1000977) – about **100** pounds sitting on the "Slide, Baffle Carrier Assembly" (D1101958) – about 10 pounds
   Note: The photodetector cable assemblies and the cable wiring that will attach to the feed-through connector inside the BSC chamber must have been checked out during the assembly procedure to verify electrical continuity to each PD.
6) After bringing in the "Arm Cavity Baffle Box Assembly" (D1000977), the person carrying closest to the BSC chamber must also exit from the manifold by stepping around the ACB baffle assembly (this may require a tall person!)

NOTE: Order is reverse if entering from the Chamber.

5.1.3 Items required for installation in order of use and transport down tube:

Teflon mat

1 - "Suspension Lift Assembly" (D1101953), with "Table, Secondary, Suspension" (D1101962) and four "Table Dog Clamps" (D1001376-2) attached – about **115** pounds

2 - "ACB_Interface Fixture Pusher-BSC" (D1101715)

4 – SHCS (3/8-16 x 1")

4 – 3/8" Washers

2 - 5/16" Hex Allen tool of 3/8-16 SHCS

2 - ACB Plumb Bob Alignment Assembly (D1102370)

2 - Plain Grip Looped T-Handle Hex Key 3/16" Hex

1 - "ACB_Installation Stand" (D1101957), with "Arm Cavity Baffle Suspension Assembly" (D1001011), "ACB_Stage Zero Narrow_Guide Block" (D1101595) and "ACB_Stage Zero Narrow-Dog Clamp, End" (D1101613) installed – about 100 pounds

NOTE: The Arm Cavity Baffle Suspension Assembly **must** have the following tooling attached: "Transport, Locking, ACB" (D1101285), "Height, Adjustment, ACB" (D1101578), "Plate, Swingback, ACB" (D1101597), and "ACB_Stage Zero Interface Fixture Mover" (D1101700).

2 - 3/16” Hex Allen tool of ¼-20 SHCS

5 - SHCS (3/8-16 x 2 1/2"), CLASS A

5 – 3/8” washers, CLASS A

4 - SHCS (3/8-16 x 2 1/2")

4 – 3/8” washers

2 - “Wedge Lift, Baffle, Suspension Table” (D1101952) – about 5 pounds each

1 - “Rail, ACB Assembly” (D1101724) – about 36 pounds

2 - SHCS (¼-20 x .62”)

1 - “Slide, Baffle Carrier Assembly” (D1101958) – about 10 pounds

1 - “Arm Cavity Baffle Box Assembly” (D1000977) – about **100** pounds

1 - Shoulder Screw #10-24 (D1101293)

3 - #10 Flat Washers

1 - #10 Silver Plated Nut

1 – 3/8” Wrench for #10 Shoulder Screw Nut

1 - 1/8” Hex L-Key tool for #10 Shoulder Screw

4 – SHCS (1/4-20 x 7/8”)

1 - pre-set Counter Weight Assembly, from Step 2.6.12.

6 - SHCS (1/4-20 x 1”)

12 – ¼” washers

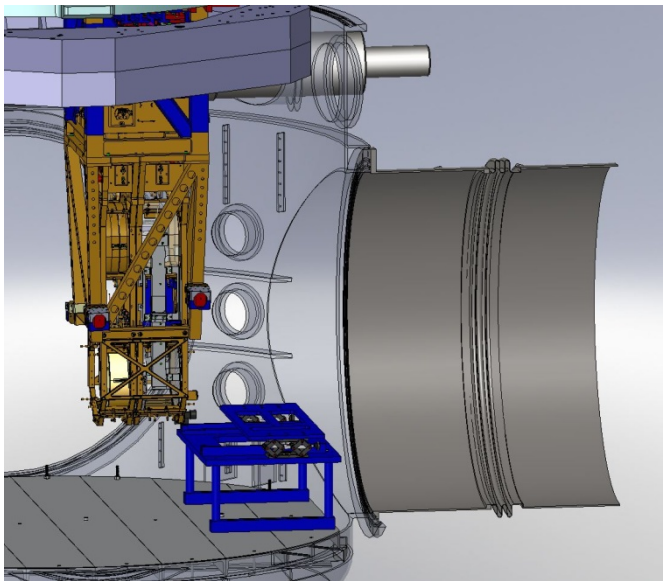
6 – ¼-20 silver-plated Nuts

2 - SLC Photodetector Cable Upper Assembly (D1003117-2)

Tool to attach Cables

Cable Ties and Hardware

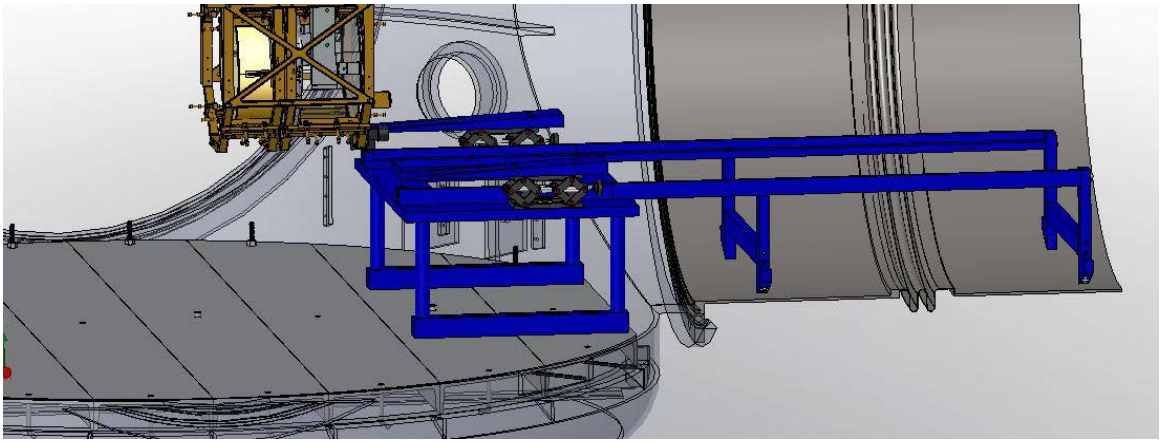
5.1.4 One person inside the spool piece will help pass the **Suspension Lift Assembly** with **Table, Secondary, Suspension** and 4 **Table Dog Clamps** attached, to two people inside the chamber; where they will place it beneath the Stage 0 position where the **ACB** will be attached. The **Lift Assembly** weighs about 115 lbs. and the **Secondary Table** weighs about 20 lbs.



5.1.5 Adjust position of installation tooling to sit secure and below baffle installation area.

5.1.6 Attach two "**ACB Plumb Bob Alignment Assembly**" (D1102370) to STAGE-0 at A15, B42 and A27, B40. Align the Table using the Plumb Bob Assembly. Remove the Plumb Bob Assembly after alignment is complete.

5.1.7 Verify **Jacks** are in completely collapsed state.



5.1.8 Attach the "**Rail, ACB Assembly**" (D1101724) to the "**Suspension Lift Assembly**" (D1101953) using two SHCS (¼-20 x .62").

5.2 Arm Cavity Baffle Suspension Assembly Installation (D1001011)

5.2.1 Items required for Arm Cavity Baffle Suspension Assembly Installation, in order of use:

1 - "ACB_Installation Stand" (D1101957), with "Arm Cavity Baffle Suspension Assembly" (D1001011), "ACB_Stage Zero Narrow_Guide Block" (D1101595) and "ACB_Stage Zero Narrow-Dog Clamp, End" (D1101613) installed.

> NOTE: The Arm Cavity Baffle Suspension Assembly **must** have the following tooling attached: "Transport, Locking, ACB" (D1101285), "Height, Adjustment, ACB" (D1101578), "Plate, Swingback, ACB" (D1101597), and "ACB_Stage Zero Interface Fixture Mover" (D1101700).

2 - 3/16" Hex L-Key tool for ¼-20 SHCS

2 - Plain Grip Looped T-Handle Hex Key 3/16" Hex

5 - SHCS (3/8-16 x 2 1/2"), CLASS A

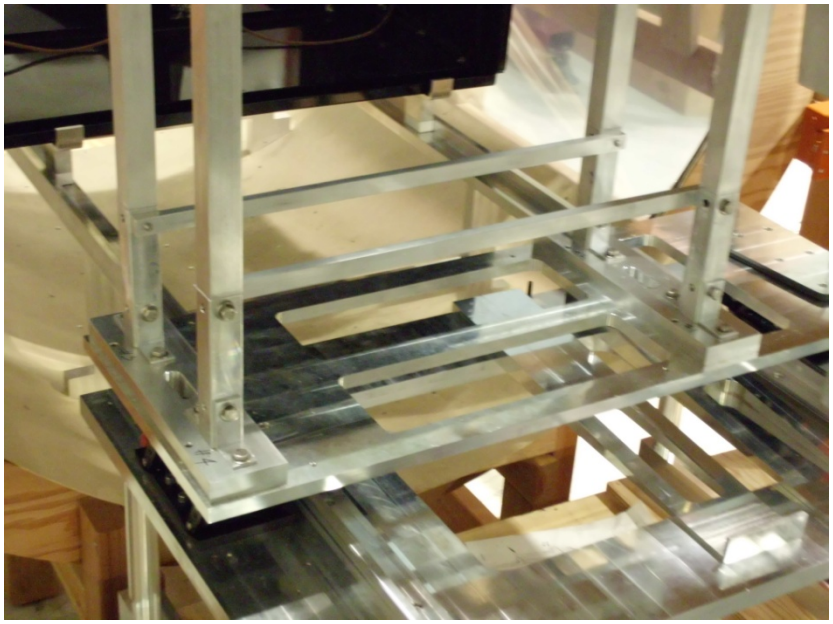
5 – 3/8" washers, CLASS A

2 - 5/16" Hex L-Key tool of 3/8-16 SHCS

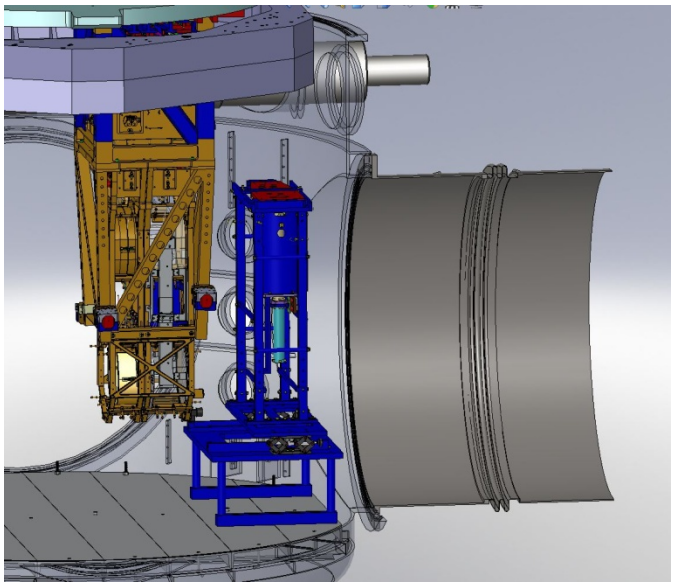
4 - SHCS (3/8-16 x 2 1/2")

4 – 3/8" washers

5.2.2 Two people will enter the spool and pass through into the manifold. They will lift and carry the **Arm Cavity Baffle Suspension Assembly**" (D1001011), which is secured in the expandable "**Installation Stand**" (D1101957) in its collapsed and locked configuration, from the manifold, into the spool, and help pass it to another person in the chamber. One person will exit the spool and help the person inside the chamber to carefully place it on top of the "**Table, Secondary, Suspension**" (D1101962). Total weight is about 100 lbs. There are handles on the Installation Stand for lifting and carrying.



5.2.3 The two people inside the chamber will adjust the **Table, Secondary, Suspension**" (D1101962) so that it is directly below the Stage 0 position where the ACB suspension will be attached.



5.2.4 One person (minimum) remains positioned inside the spool during the entire installation

5.2.5 Two people remain in the chamber, one on each side of the "**Suspension Lift Assembly**" (D1101953).

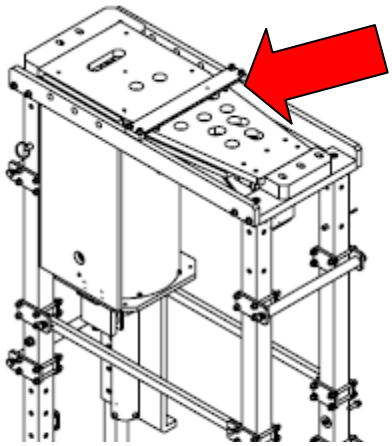
5.2.6 Secure **Installation Stand** to **Secondary Table** with the four **Table Dog Clamps** attached to the **Table**.

5.2.7 Loosen **Table Dog Clamps** that secure the **Installation Stand** to the Secondary Table. Either slide the **Suspension Lift Assembly**" (D1101953) on the Teflon mat, and/or loosen the dog clamps and move the **Installation Stand** to align "ACB_Stage Zero Narrow_Guide Block" (D1101595) and "ACB_Stage Zero Narrow-Dog Clamp, End" (D1101613) with the tip of the **Plumb Bobs**.

5.2.8 Tighten **Table Dog Clamps** to secure **Installation Stand.**

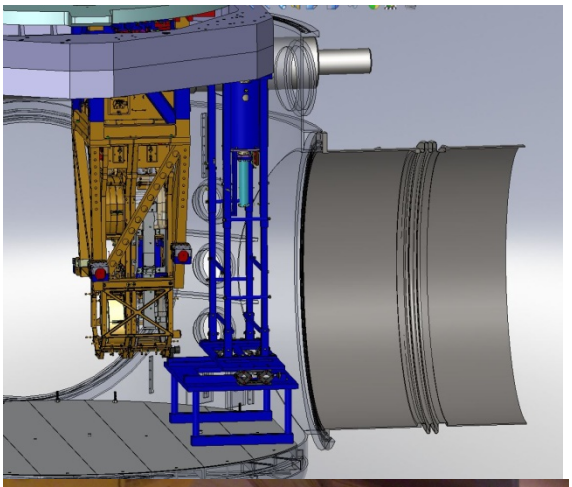
5.2.9 Disconnect both **Plumb Bobs** and remove from vacuum system.

5.2.10 With **Installation Stand** secured, remove four SHCS and "**Upper Clamp**" (D1102062) from top of **Installation Stand**. Remove parts from vacuum system.

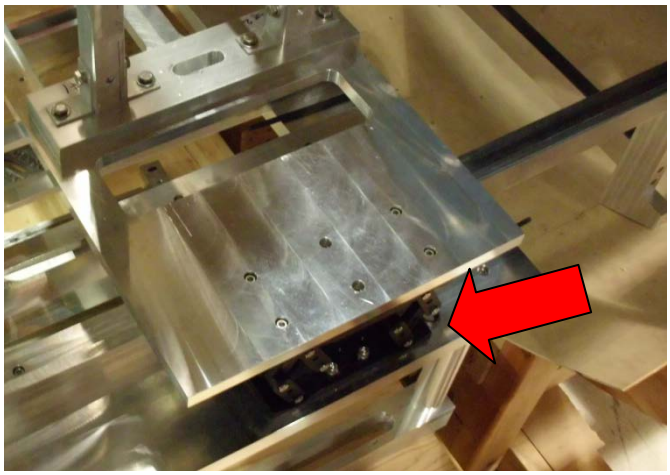


5.2.11 The person positioned in the spool pulls out the four **Locking Pins** in the **Installation Stand** legs.

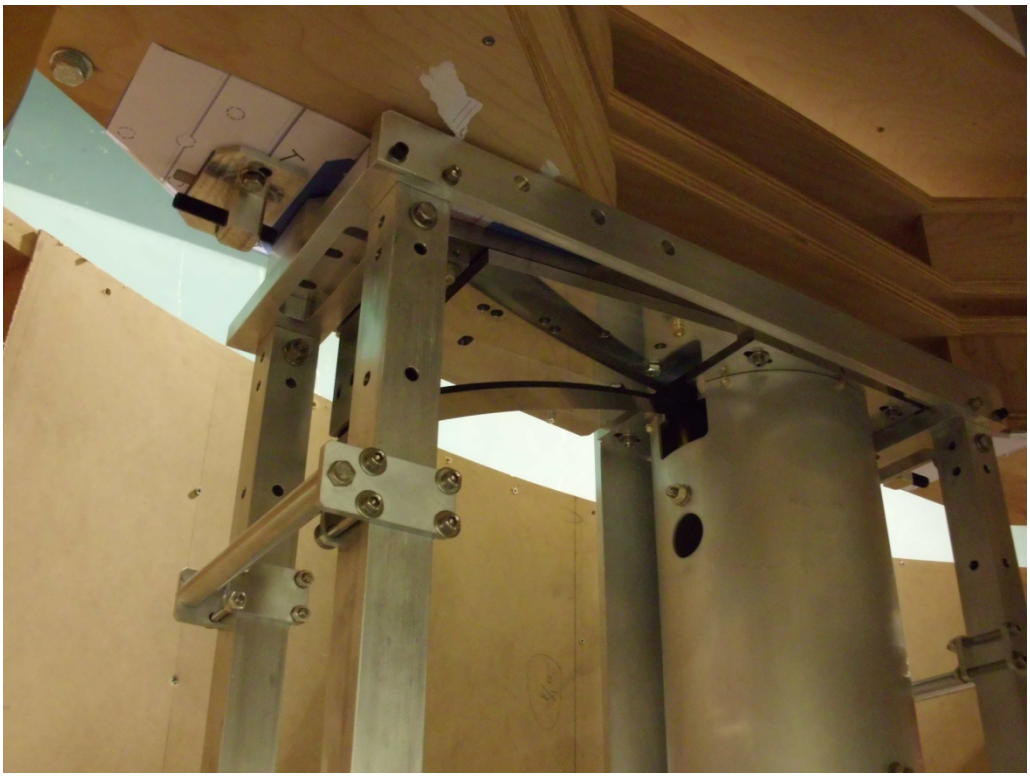
5.2.12 The two people on each side of the **Table** grasps the handles on **Installation Stand** and lifts the **Stand** until it nearly touch **STAGE-0**. The person in the spool locks the **Stand** into position by inserting the four **Locking Pins**. Some adjustment to the expansion height may be needed to align the holes for locking.



NOTE: There is approximately 8 inches between the **Installation Stand** and the **QUAD**.

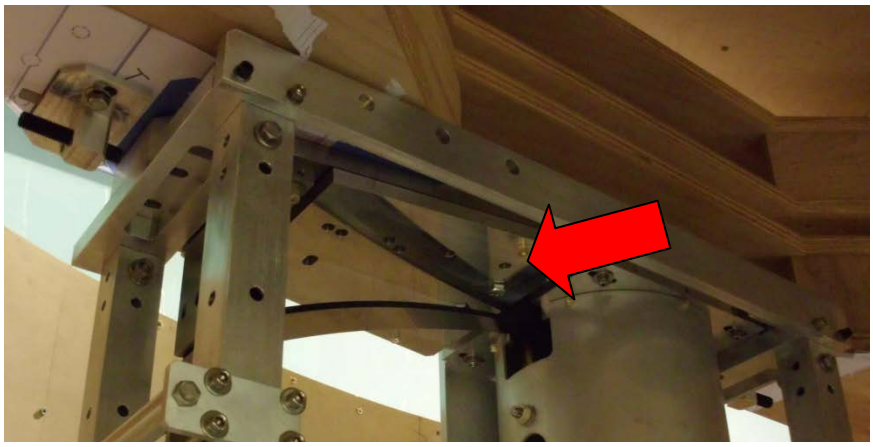


5.2.13 The two people on each side of the **Table** uniformly raise the **Jacks** to lift the **Installation Stand** and align **Interface Mounting Plate** to **STAGE-0** mounting locations. Continue until top of **Interface Mounting Plate** touches **STAGE-0**.

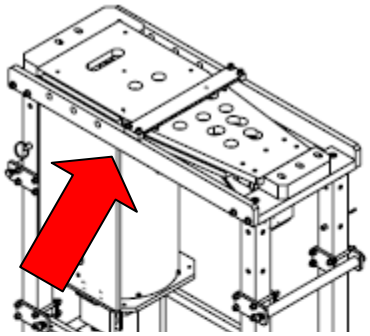


5.2.14 Attach "**ACB_Stage Zero Narrow_Guide Block**" (D1101595) and "**ACB_Stage Zero Narrow-Dog Clamp, End**" (D1101613) to STAGE-0 with five SHCS (3/8-16 x 2 1/2") and 3/8" washers.

5.2.15 Attach "**ACB_Stage Zero Interface Fixture Mover**" (D1101700), which is attached to the "**SLC ACB Interface Mounting Plate**" (D1001138), to **STAGE-0** with four SHCS (3/8-16 x 2 1/2") and 3/8" washers.



5.2.16 Remove four 1/4-20 SHCS and "**SIDE BEAM**" (D1102026) from **Installation Stand** on the side closest to the chamber wall. Remove from vacuum system.



5.2.17 The two people on each side of the **Table** uniformly lower the Jacks to their completely collapsed state which causes the **Installation Stand** to lower in preparation for removal. Watch the **Suspension Assembly** for any possible obstruction.

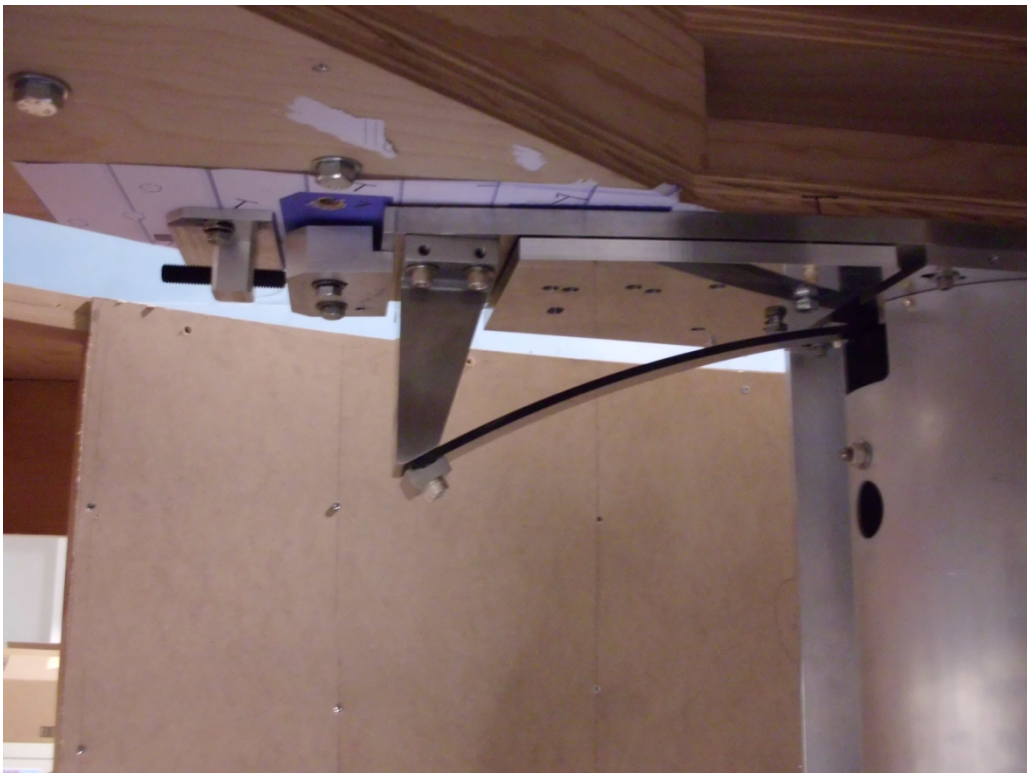
5.2.18 While the two people on each side of the **Table** grasps the handles on **Installation Stand**, the person positioned in the spool disengages the four **Locking Pins** in **Installation Stand** legs.

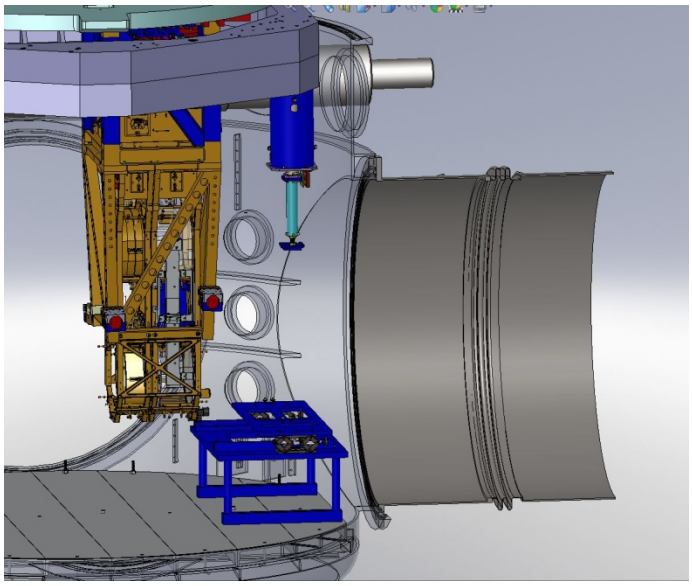
5.2.19 The two people grasping the handles slowly lower the **Installation Stand** until it returns to the completely collapsed position.

5.2.20 The person positioned in the spool then inserts the four **Locking Pins** into the **Installation Stand** legs.

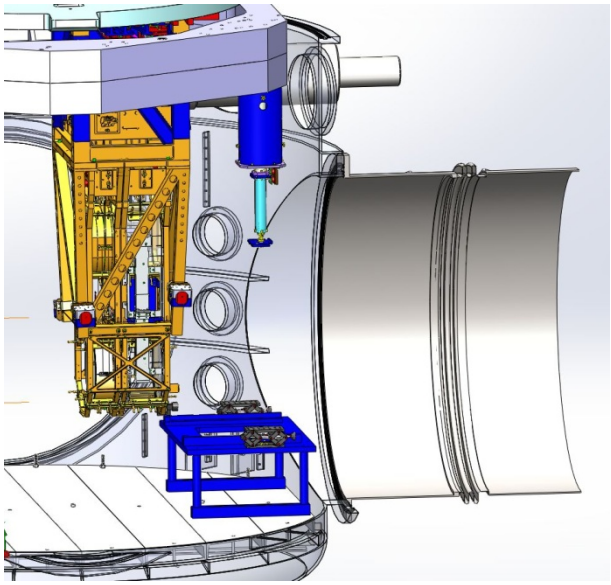
5.2.21 Loosen the four **Table Dog Clamps** on the **Table** securing the **Installation Stand**, rotate to release **Stand** and tighten.

5.2.22 Carefully remove the empty **Installation Stand** from the BSC through the chamber door.





5.2.23 Remove the twelve 1/4-20 SHCS attaching the **Secondary Table** to the **Suspension Lift Assembly**. Place SHCS on aluminum foil container in bottom of spool for use in next step. Carefully remove the **Secondary Table** from vacuum system.



5.3 Arm Cavity Baffle Box Assembly Installation (D1000977)

5.3.1 Items required for Arm Cavity Baffle Box Assembly Installation, in order of use:

2 - Plain Grip Looped T-Handle Hex Key 3/16" Hex

2 - “Wedge Lift, Baffle, Suspension Table” (D1101952)

8 - 1/4-20 SHCS from Step 5.2.23

3/16” Hex L-Key tool of ¼-20 SHCS

1 - “Rail, ACB Assembly” (D1101724)

2 - SHCS (¼-20 x .62”)

1 - “Slide, Baffle Carrier Assembly” (D1101958)

1 - “Arm Cavity Baffle Box Assembly” (D1000977)

1 - Shoulder Screw #10-24 (D1101293)

3 - #10 Flat Washers

1 - #10 Silver Plated Nut

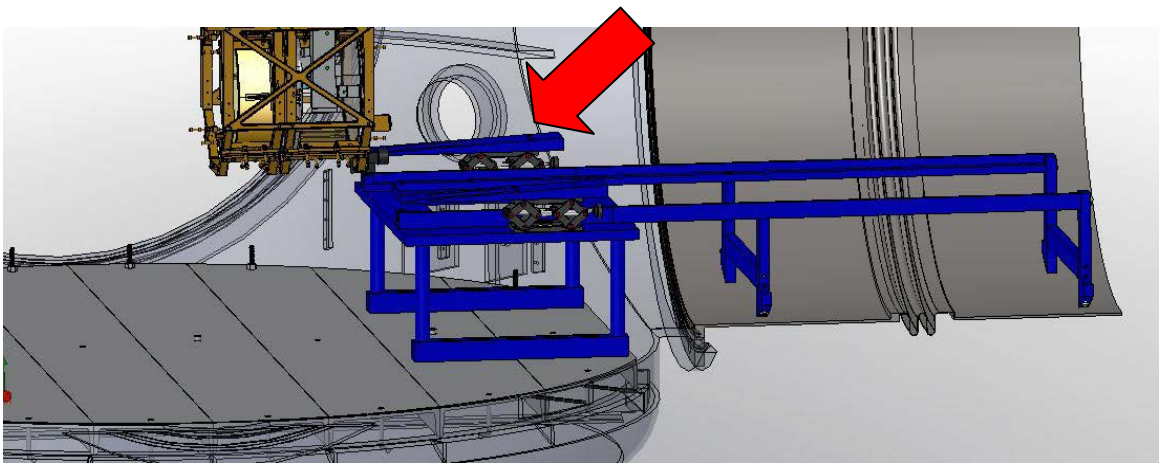
1 – 3/8” Wrench for #10 Shoulder Screw Nut

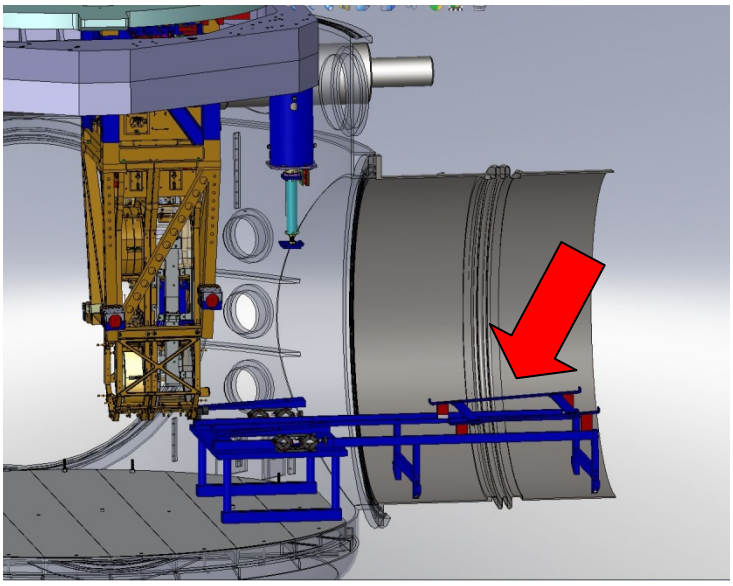
1 - 1/8” Hex L-Key tool for #10 Shoulder Screw

4 – SHCS (1/4-20 x 7/8”)

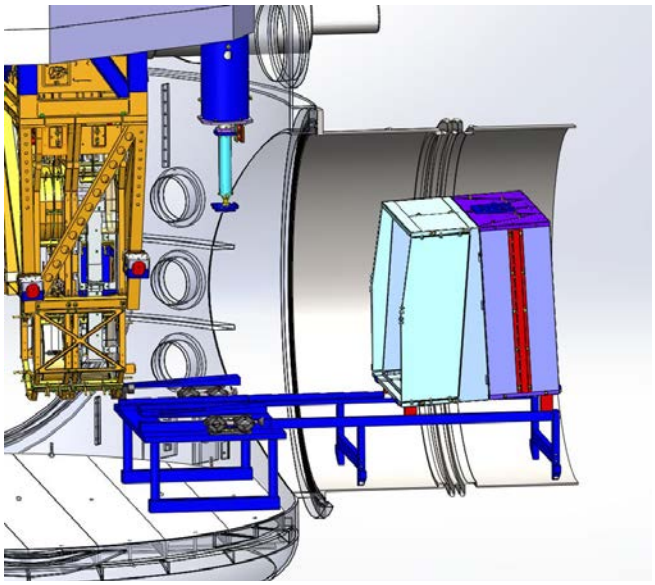
5.3.2 Verify **Jacks** are in completely collapsed state.

5.3.3 Attach the two “**Wedge Lift, Baffle, Suspension Table**” (D1101952) stored in manifold to Jacks with eight 1/4-20 SHCS from Step 5.2.23.



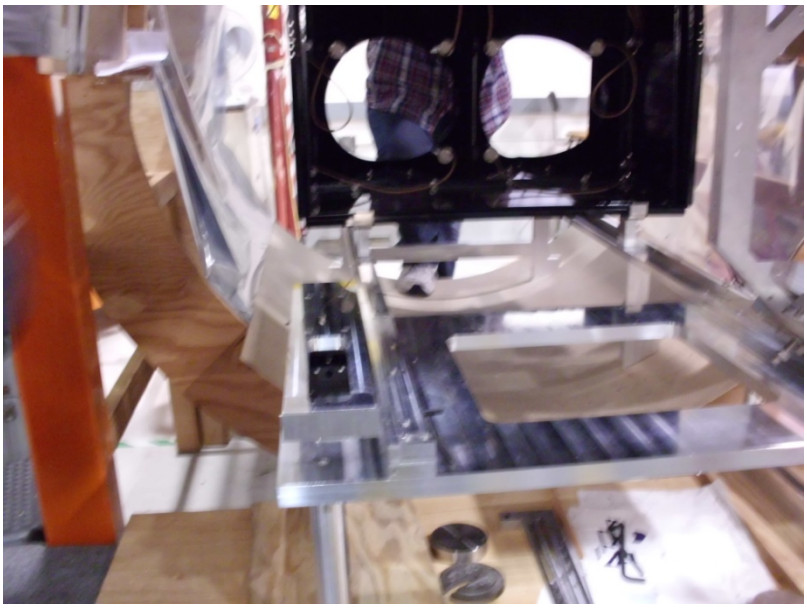


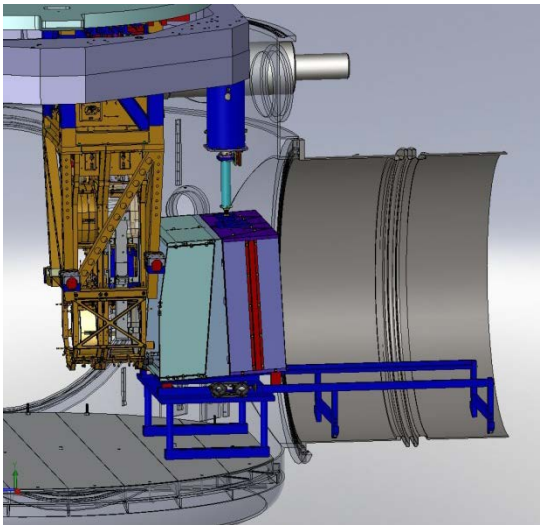
5.3.4 Using the "**Slide, Baffle Carrier Assembly**" (D1101958) and the "sedan chair" rods to lift the "**Arm Cavity Baffle Box Assembly**" (D1000977), which is stored in the manifold, two people will carry it and place the **Slide, Baffle Carrier Assembly** (supporting the baffle box) into the guides on top of "**Rail, ACB Assembly**" (D1101724); one person will be positioned in the spool behind the Baffle Box and another in front of the baffle box. The **Baffle Box** weighs about 100 lbs.

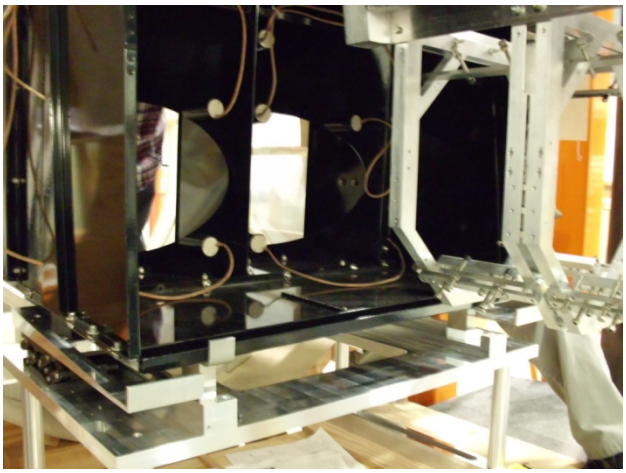


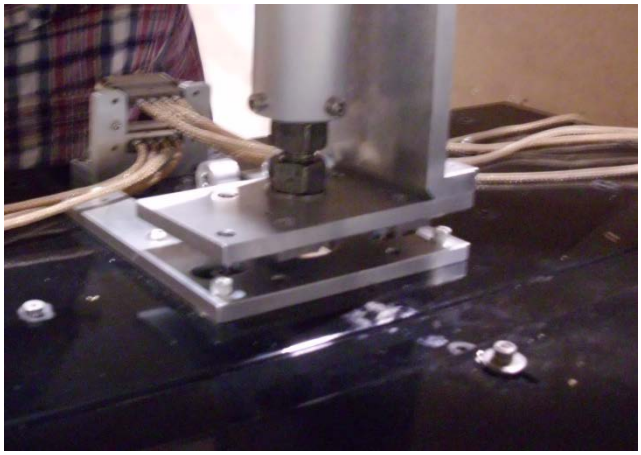
5.3.5 The **Slide Assembly** feet have Teflon pads that allow for an easy slide down the rail. There are blocks attached to the end of the rails to prevent travel past the **Table** end. Slide the **Baffle Box** toward the QUAD until it is positioned directly above the **Wedge Lift,**

Baffle, Suspension Table" (D1101952, stopping at the approximate location needed to raise and mate the **Baffle Box Assembly** with the **Suspension Assembly.**

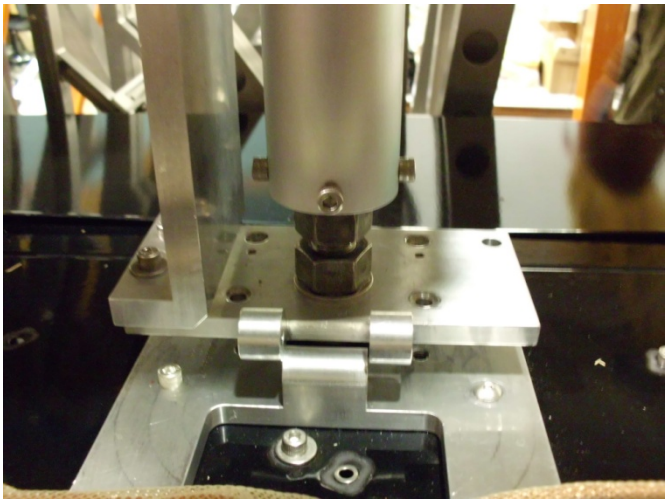




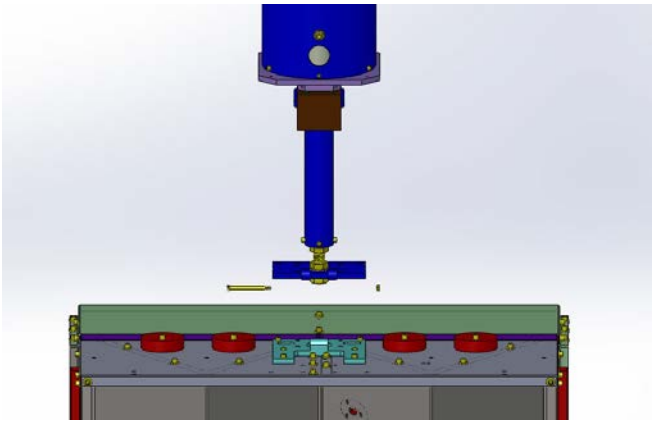


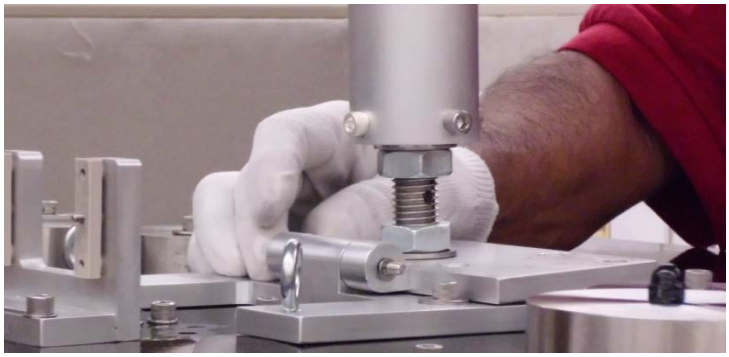


5.3.6 The two people on each side of the **Table** uniformly raise the **Jacks** to lift **Baffle Box Assembly** and align to top hinge plate at bottom of **Suspension Assembly**. Adjust **Baffle Box** position as needed for alignment. Continue lifting until hinge plates touch.

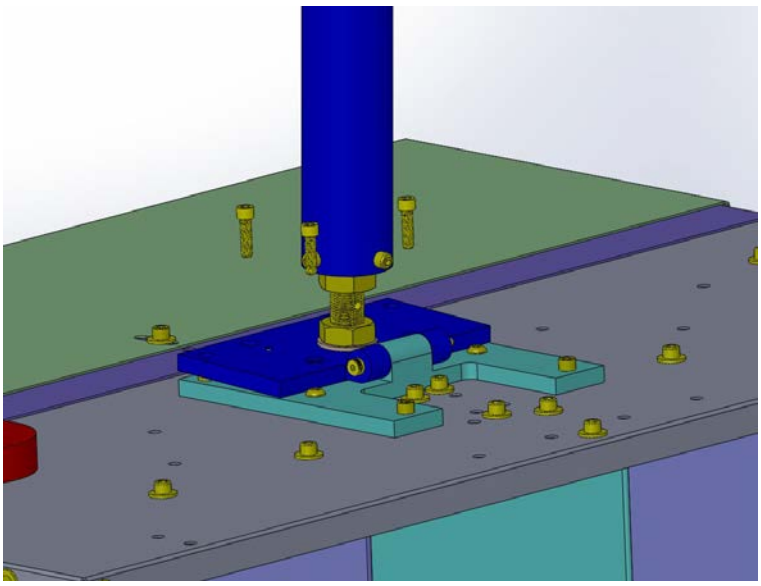


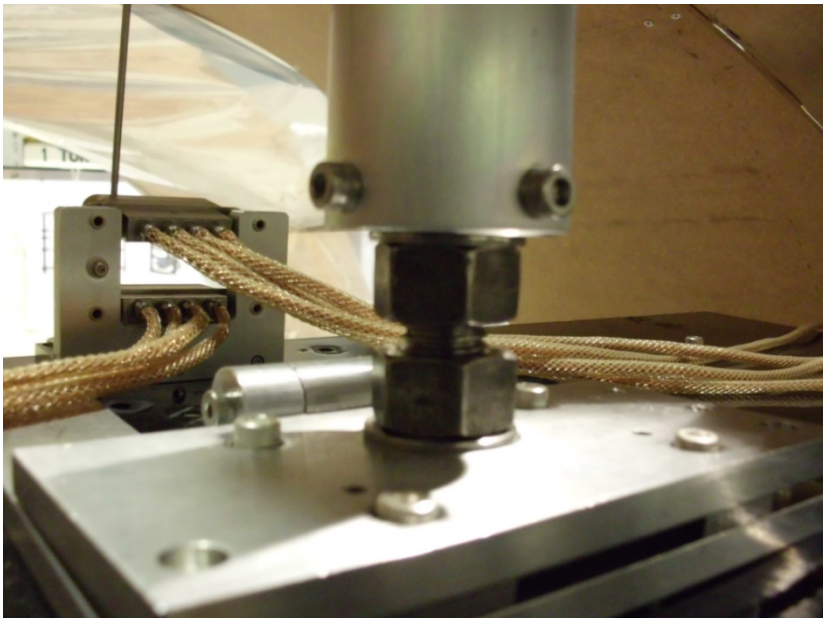
5.3.7 Attach **Baffle Box Assembly** to **Suspension Assembly** with one #10-24 Shoulder Screw (D1101293), three #10 Flat Washers, and one #10 Silver Plated Nut



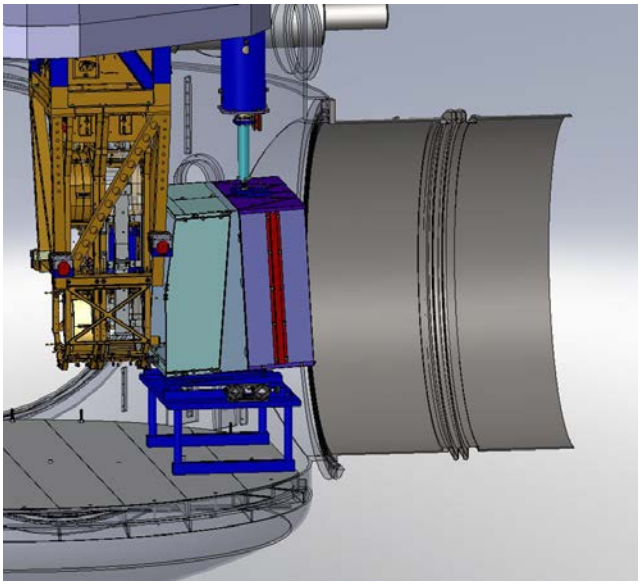


5.3.8 Attach four SHCS (1/4-20 x 7/8") through **Top Hinge Plate on Suspension Ass**embly to **Bottom Hinge Plate** on **Baffle Box Assembly**.

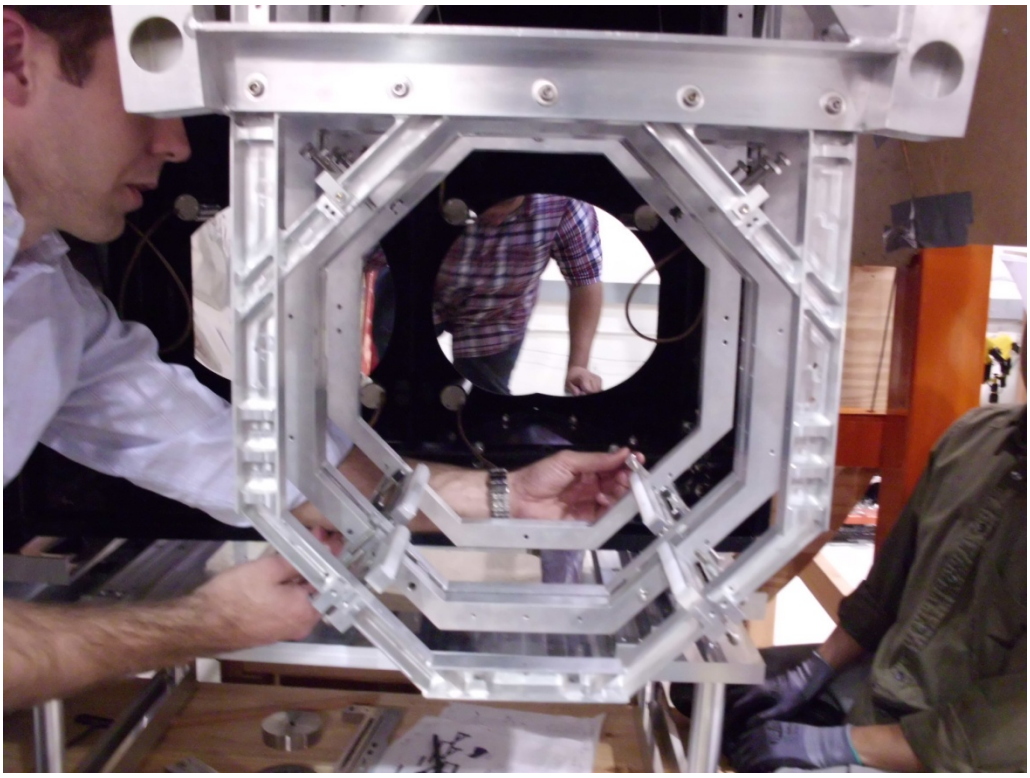




5.3.9 The two people on each side of the **Table** uniformly lower the **Jacks** completely.



5.3.10 Pull **Slide Assembly** along **Rail Assembly** to end toward spool, and leave it there until later removing through the manifold tube.



5.3.11 Detach **Rail Assembly** from **Table** and store in the manifold for later removal from vacuum system.

5.3.12 Remove **Table** from BSC through chamber door.

5.4 Photodetector Cable Connection

5.4.1 Items required for additional assembly to suspend baffle, in order of use:

1 - SLC Photodetector Cable Upper Assembly (D1003117-2)

Tool to attach Cables

Cable Ties and Hardware

5.4.2 Route cables to feedthrus.

5.4.3 Mate cables to feedthrus.

5.4.4 After the cable has been routed across the Stage 0 and connected to the feed-through at the inside of the BSC, use the continuity check procedure T1100637 to verify continuity to each photodetector from outside the BSC.

5.5 Baffle Alignment

5.5.1 Items required for Baffle Alignment, in order of use:

2 - 5/16” Hex L-Key tool of 3/8-16 SHCS

2 – ¼” Hex L-Key tool for Pushers

4 - “SLC Interface Mounting Clamps” (D1001700)

4 - SHCS (3/8-16 x 2 1/2")

4 - 3/8” washers

Tool for Bracket SHCS

Allen Tool in hole of “Screw #3/4-10 X 4” (D1001186)

2 - Stainless Steel Open-End Wrench for 1-1/8” Nuts

5.5.2 Theodolite Setup

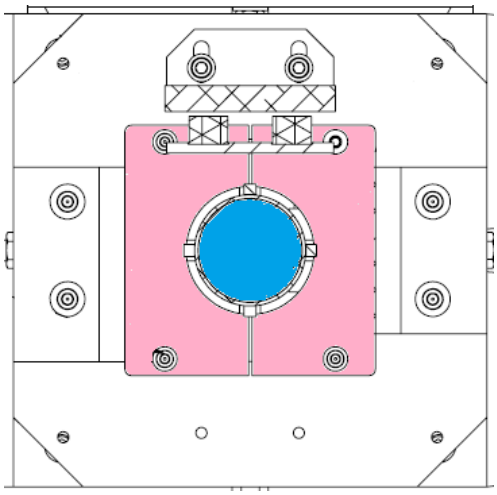
IAS group will set up theodolite from open end of manifold aligned with center of COC TM, according to procedure XXX?

5.5.3 Remove the two 1/4-20 SHCS attaching the **Interface Fixture Mover** to the **Interface Mounting Plate**. Remove from vacuum system.

5.5.4 Remove **Height Adjustment Variable** (D1102321) and **Bracket, Variable Height Adjustment** (D1102323) so that the Baffle can move freely. Save parts and hardware for future use.

5.5.5 Remove **Transport, Locking, ACB** (D1101285) and save parts and hardware for future use.

5.5.6 Verify balance of baffle. Shift balance weights as needed axially and laterally until the “**SLC Baffle Tube Up Assembly**” (D1002582) is evenly spaced inside “**SLC Earthquake Stop Ring**” (D1001120) circumference.



Lateral Alignment

5.5.7 Slightly loosen five SHCS attaching **STAGE-0 Guide Block** and **STAGE-0 Dog Clamp**

5.5.8 Slightly loosen four SHCS attaching "**ACB_Stage Zero Interface Fixture Mover**" (D1101700), which is attached to the **Interface Mounting Plate**, to **STAGE-0**

5.5.9 Manually position **Suspension Assembly** into **Guide Block and Clamp** so that it is flush with **Guide Block** corners.

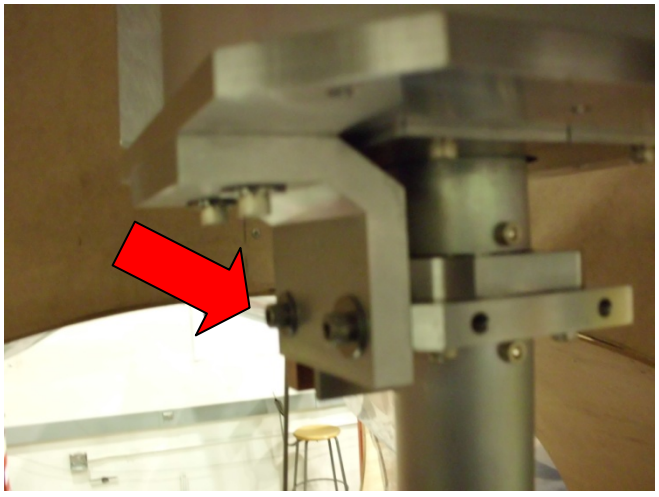
5.5.10 Move the **Interface Plate** by turning the **Threaded Thrust Screws** on the **STAGE-0 Guide Block** and **STAGE-0 Dog Clamp** to align the baffle laterally.

NOTE: DO NOT REMOVE THE LATERAL ALIGNMENT TOOLING UNTIL VERTICAL ALIGNMENT IS COMPLETE, IN CASE WE NEED TO ITERATE!

5.5.11 Tighten the five SHCS attaching **STAGE-0 Guide Block** and **STAGE-0 Dog Clamp** to **STAGE-0**.

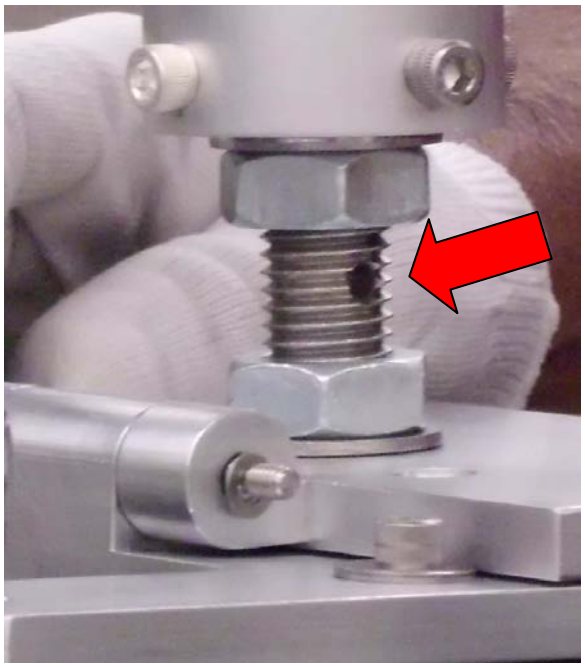
Vertical Alignment

5.5.12 Attach the "**Transport, Locking, ACB**" (D1101285). Tighten the two upper SHCS. Loosely attach the two lower SHCS in the slotted holes in order to keep the **Up Tube** from rotating, but allow vertical movement.



5.5.13 Attach the **Height Adjustment Variable** (D1102321) and **Bracket, Variable Height Adjustment** (D1102323) to the **Upper Hinge Plate** and **8" Diameter Tube Plate**. Tighten SHCS in slotted holes. Do not attach **Bracket** to the **Up Tube**.

5.5.14 Insert Allen Tool in hole of "**Screw #3/4-10 X 4**" D1001186



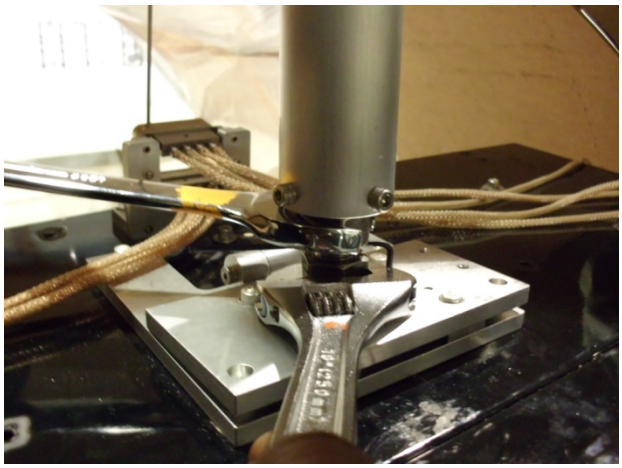
5.5.15 Loosen the SHCS of the **Variable Bracket Assembly** in the slotted holes, so that the ACB can move vertically when the height adjustment screw is turned.

5.5.16 Remove the screws that attach the **Anti-Rotation Bracket** to the **Top Hinge Plate**. Set screws aside for later use.

5.5.17 Loosen the screws securing it to the **Lower Tube.** Slide the assembly up the **Lower Tube**. Tighten the screws when there is clearance to perform the vertical adjustment.

5.5.18 Loosen both "**Nickel Copper Hex Nuts, ¾"-10**", D1102316.

5.5.19 Adjust baffle height by turning the #3/4-10 X 4" screw until the lateral edges of the baffle hole are centered with the center of the TM, as determined by the theodolite readings.



5.5.20 When correct height is obtained, tighten the SHCS of the **Variable Bracket Assembly** in the slotted holes.

5.5.21 Tighten both "**Nickel Copper Hex Nut, ¾"-10**", D1102316.

5.5.22 Remove Allen Tool in hole of "**Screw #3/4-10 X 4**" D1001186.

5.5.23 Loosen the screws securing the **Anti-Rotation Bracket** to the **Lower Tube.** Slide the assembly down the **Lower Tube**.

5.5.24 Attach the **Anti-Rotation Bracket** to the **Top Hinge Plate** with screws for Step 5.5.16.

Iteration of Alignment Steps

1) Remove the "**Transport, Locking, ACB**" (D1101285) so that the ACB hangs freely.
2) Remove the Height Adjustment Variable (D1102321) and Bracket, Variable height Adjustment (D1102323)
3) Verify alignment.
4) Repeat the lateral alignment starting at Step 5.5.7, and the vertical alignment starting at Step 5.5.12, as needed.

5.5.25 Attach the "Transport, Locking, ACB" (D1101285) and tighten all SHCS.

5.5.26 Attach Height Adjustment Variable (D1102321) and Bracket, Variable height Adjustment (D1102323).

5.5.27 Verify the "**STAGE-0 Guide Block"** (D1101595) and "**STAGE-0 Dog Clamp"** (D1101613) are securely holding the **Interface Mounting Plate**.

5.5.28 Tighten the five SHCS attaching "**STAGE-0 Guide Block"** (D1101595) and "**STAGE-0 Dog Clamp"** (D1101613)

5.5.29 Remove the **Mover Plate** with the four SHCS and washers attaching the **Mover Plate** to STAGE-0. Set SHCS and washers aside for re-use in next step. Remove the **Mover Plate** from vacuum system.

5.5.30 Attach **Interface Mounting Plate** to STAGE-0 with four "**SLC Interface Mounting Clamps**" (D1001700), four CLASS A SHCS (3/8-16 x 2") and four 3/8" washers.

5.5.31 Remove the five SHCS attaching "**STAGE-0 Guide Block"** (D1101595) and "**STAGE-0 Dog Clamp"** (D1101613). Remove from vacuum system.

5.5.32 Attach **Table Dog Clamps** to ends of **Interface Plate**.

6 Baffle Swingback to service QUAD

6.1 Swing-back Baffle

6.1.1 Items required for Baffle Alignment, in order of use:

Tool for Bracket SHCS

Variable Bracket

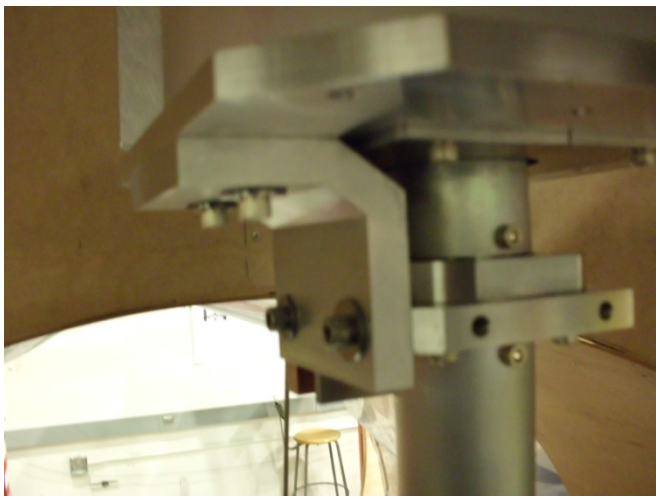
Storage container for Counter Weight Assembly

"Wire, Lifting, Arm Cavity Baffle" D1101443

Tool for Hinge Plate SHCS

6.1.1 Verify "**Plate, Swingback, ACB**" (D1101597) is in place.

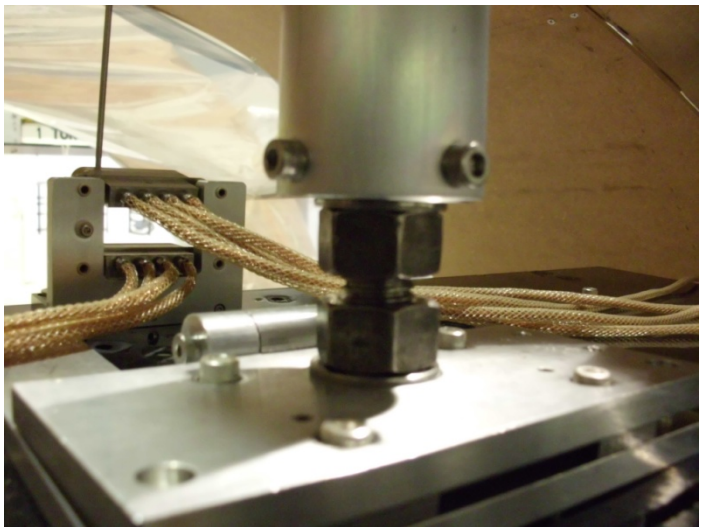
6.1.2 Verify "**Transport, Locking, ACB**" (D1101285) is in place. Verify all SHCS are tight.



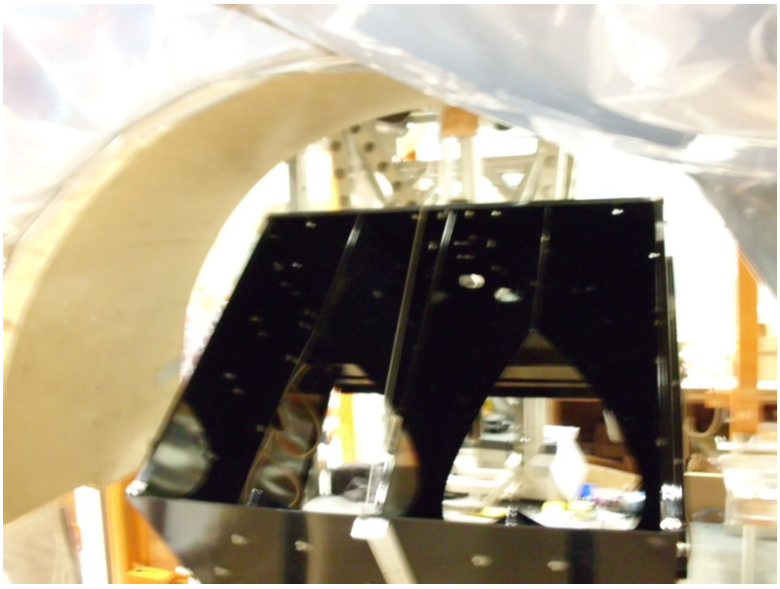
6.1.3 Verify **Variable Height Adjustment Bracket Assembly** is in place. Verify all SHCS are tight.

6.1.4 Insert "**Wire, Lifting, Arm Cavity Baffle**" D1101443 into eye bolt attached to

6.1.5 While two people on each side of the **Table** supports the baffle box, the other person inside the spool removes the 4 screws that attach **Upper Hinge Plate** to **Lower Hinge Plate**.



6.1.6 When all four screws have been removed, the two people on each side of the **Table** slowly swing baffle box back toward tube and the other person inside the spool attaches the wire to the center bracket at the bottom of the **Baffle Box**



6.2 Re-Position Baffle

6.2.1 While baffle box is being held on both sides by the two people positioned on each side of the **Table**, the other person inside the spool unhooks the "**Wire, Lifting, Arm Cavity Baffle**" D1101443 from the center bracket at the bottom of the Baffle Box and slowly allows baffle box to rotate back in position.

6.2.2 With baffle box supported at the bottom by the two people positioned on each side of the **Table**, the other person inside the spool attaches 4 screws from **Upper Hinge Plate** to **Lower Hinge Plate**.

6.2.3 Unhook wire from **Swingback Plate** and remove from vacuum system.

6.2.4 Unfasten three screws that attach **Swing-back Plate** to the **Suspension Assembly** and remove from vacuum system.

6.2.5 Unfasten **Variable Height Adjustment Bracket Assembly** and remove from vacuum system.

6.2.6 Remove "**Transport, Locking, ACB**" (D1101285)

6.2.7 Everyone carefully exits chamber.

7 Removal of Fixtures and Tooling

7.1 After Installation

7.1.1 Fixed Bracket

7.2 After Alignment

7.2.1 Pushers

7.2.2 Mover Plate

7.3 After Swingback/Commissioned baffle

7.3.1 Swingback Plate and Wire

7.3.2 Variable Height Adjustment Bracket Assembly

7.3.3 Transport, Locking, ACB (D1101285)