ONYX-REVOLUTION
Compact Drop-In Cylindrical
Cathode Manual
Version 2.0

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Endblock Mounting

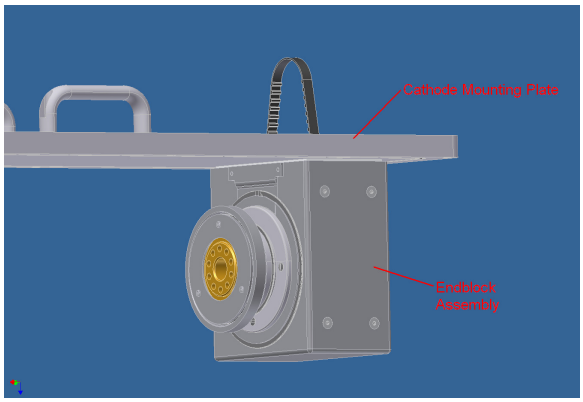
The Endblock is a mounting point and source of rotation for the Target, as well as for conducting power and flowing cooling water through the Target. The Endblock has a belt driven Drive Shaft that is used to rotate the Target at a variable speed via the motor controller. The cathode cooling water and power connections are made on an Interface Plate that is located on the atmosphere side of the chamber lid. The rotation speed is visible on a digital display that is also mounted on the same plate.

Your chamber lid should already have an opening ready to receive the cathode. The cathode will be mounted on a lid that will attach directly to the opening in your chamber. The following procedure describes the steps necessary to mount the cathode to your chamber for the first time or after maintenance.

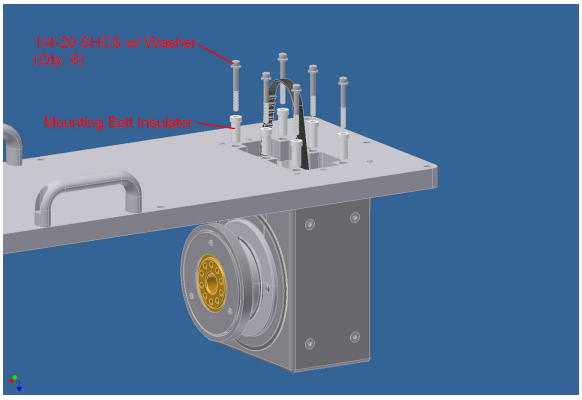
Safety:

- *To avoid electrical shock, always disconnect the power supply cable from the cathode before servicing it.*
- *AFTER turning the power supply OFF, avoid possible burns from working around a hot target surface by allowing the target to rotate for at least 15 minutes with cooling water flow.*
- *Before removing the Endblock, be sure to turn off the cooling water supply to the cathode. Remove as much excess water from the cathode as possible by blowing dry air through the water passage. Disconnect the water supply and return hose.*

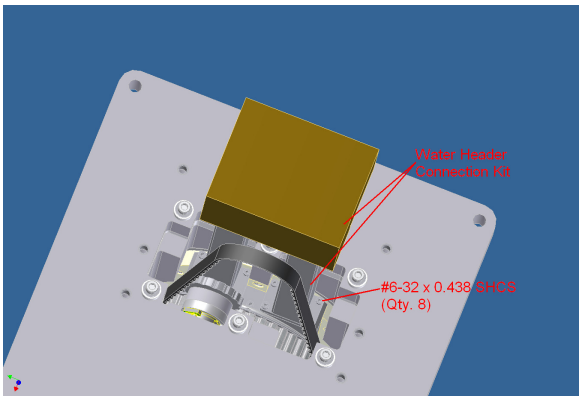
1. The Endblock assembly can be installed on the chamber lid as long as the Water Header Connection Kit is removed from the assembly, which can be seen in Steps 3-5, below. Also, if included, be sure that the Debris Shields are not mounted on the Drive Shaft, as they will need to be off in order to install the Target later. The lid should be supported on a stand or cart in order to perform this procedure. The first thing to do is check that the o-ring that seals to the chamber is clean as well as the o-ring groove and mating face. Next, the Endblock assembly can be lifted into place, aligning the mounting holes with the holes in the lid. This assembly will need to be supported here until it is bolted securely.



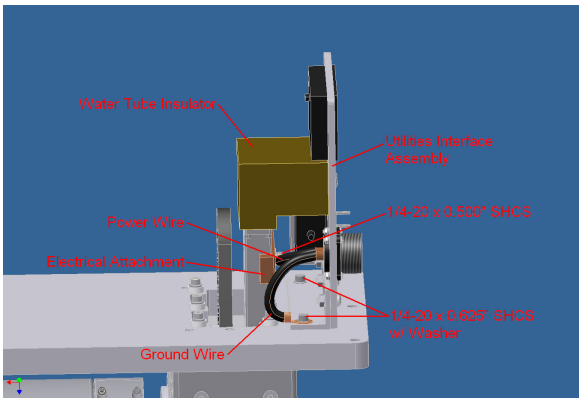
2. Now the (6) Mounting Bolt Insulators can be placed through the mounting holes in the lid and through the Endblock Insulator. With the insulators in place, the ¼-20 x 2.250" SHCS and washers can be installed and tightened. Be careful not to over tighten the fasteners or the insulators may be damaged. The Endblock is now securely attached to the chamber lid.



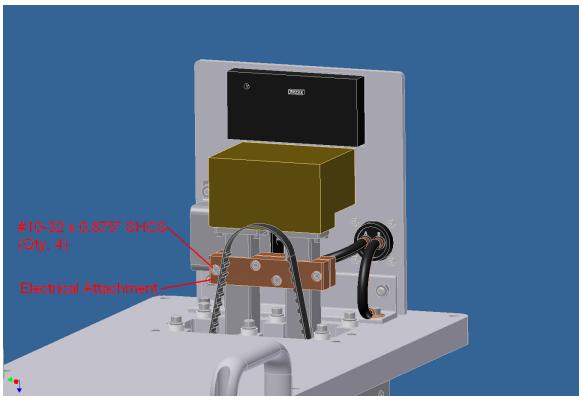
3. Make sure that the o-rings on the bottom of the rectangular water tubes are clean and lubricated (vacuum grease or marine grease is suitable because this is a water seal). The Water Header Connection Kit can be lowered into place. It may be easier to do so with the (8) #6-32 x 0.438" SHCS already in place. These fasteners will need tightened with a long, ball-point 7/64" Hex Driver or Allen Wrench. A hex driver should be provided, if not, one can be purchased from www.mcmaster.com, part number 5497A38.



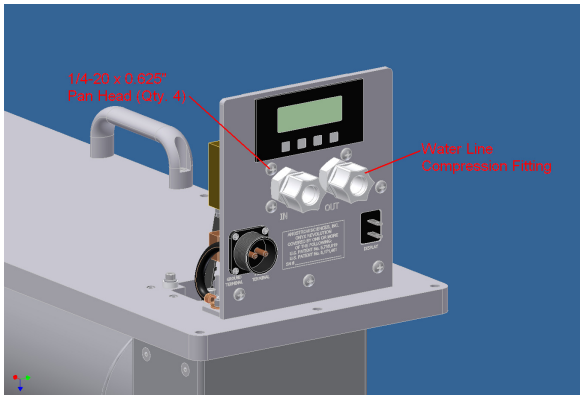
4. The Utilities Interface Assembly can be installed on to the lid using (2) ¼-20 x 0.625" SHCS with washers *(make sure that the Front Electrical Attachment is connected to the Power Cable before doing so)*. The threaded holes in the Water Tube Insulator should line up with the clearance holes on the Utilities Interface plate. At this time, the ground connection can be made from the Ground Wire to the one SHCS as shown in the picture.



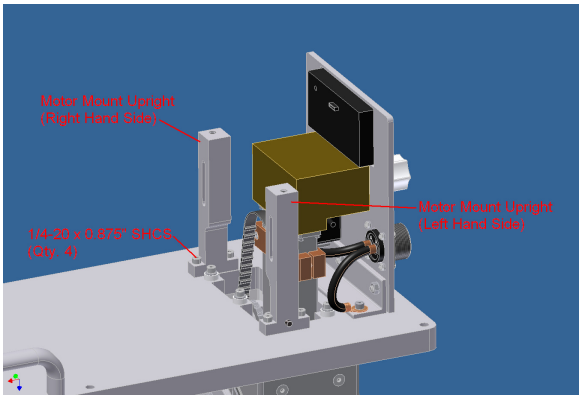
5. The Back Electrical Attachment can be bolted on to the water tubes using (4) #10-32 x 0.875” SHCS. These parts clamp together around the water tubes and should be mounted approximately ½” from the bottom of the Water Tube Insulator.



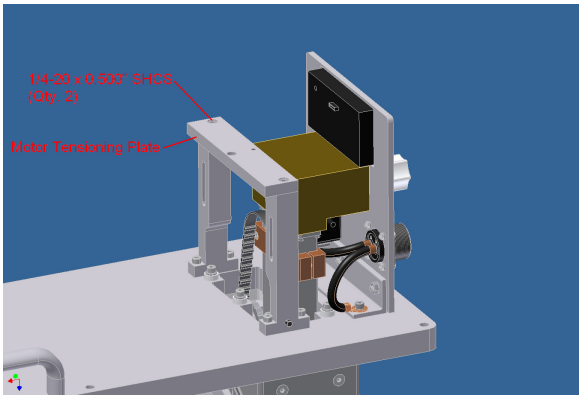
6. The (4) ¼-20 x 0.625” Pan Head Screws can be tightened into place to secure the Utilities Interface Assembly to the Water Tube Insulator. Then the (2) Water Line Compression Fittings can be threaded into the Water Tube Insulator.



7. The cathode Drive Motor can now be installed. Use (2) ¼-20 x 0.875” SHCS to secure each of the Motor Mount Uprights.

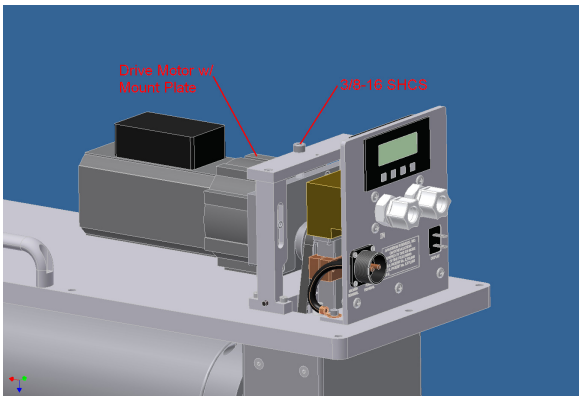


8. Next, attach the Motor Tensioning Plate to the Uprights with (2) ¼-20 x 0.500” SHCS.



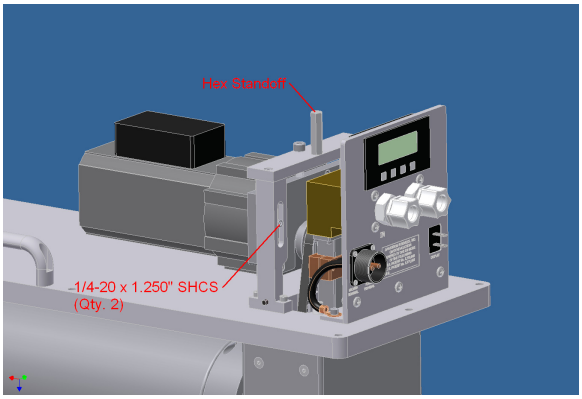
NOTE: At this point, it is important that the cable is attached to the encoder inside of the Endblock, as shown in step 1 of the Electrical Connections procedure, below.

9. Attach the Drive Motor by making sure that the belt is on the drive pulley and then hold the belt up to slide the motor pulley inside of it. Lift the Motor up to remove the slack in the belt and place a 3/8-16 x 1.500” SHCS through the Motor Tensioning Plate and tighten it into the Motor Mount Plate until there is very little slack in the belt (it should appear tight at rest, but deflect about ½” when pressed on by hand). As long as the belt doesn’t slip while rotating the target, it is tight enough.



NOTE: The motor is rated for operating temperatures of up to 180°C (356°F) while providing 296 in-lb of torque. If higher operating temperatures are experienced, then motor cooling will be needed and can be provided upon request.

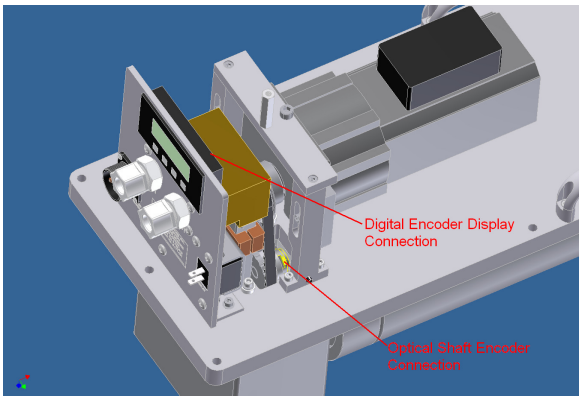
10. Install (2) ¼-20 x 1.250” SHCS through the slots in the Motor Mount Uprights into the Motor Mount Plate and tighten. Now screw the Hex Standoff into the tapped hole in the Motor Tensioning Plate. This will be used to mount the Utilities Shield.



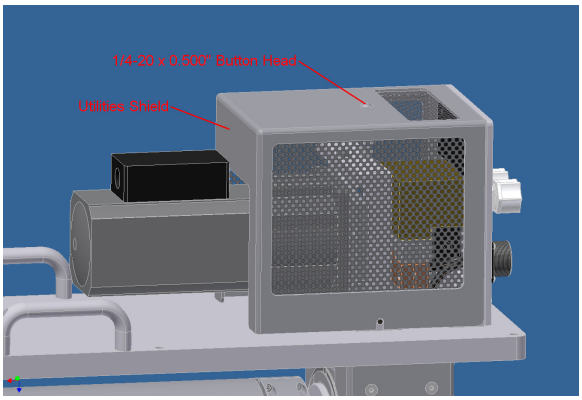
NOTE: If the belt slips but it appears tight, then the motor pulley may need aligned vertically with the drive shaft

pulley. To do so, remove the motor, loosen the set-screw in the motor pulley and slide the pulley in the necessary direction and retest. *The pulley face should be flush with the end of the motor shaft.*

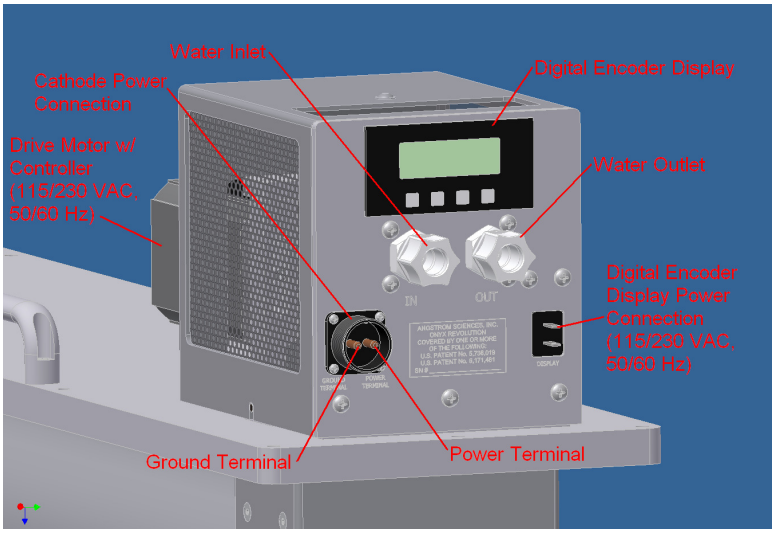
11. Now the cable for the Optical Shaft Encoder can be connected to the back of the Digital Encoder Display. Also, the power for the Display can be connected from the AC Adapter that is mounted on the Utilities Interface Assembly. These cables need to be routed in such a way that they will stay clear of the Utilities Shield and the belt and power cables during use. Use cable ties as necessary to hold the wires in place.



12. Install the Utilities Shield by sliding it over the Motor Mount Uprights and aligning the slots in the bottom with the pins. Then secure the shield to the Threaded Standoff with a ¼-20 x 0.500” Button Head Screw. Be careful to not pinch any wires while attaching the shield.



13. Cathode connections are shown in the picture to the right as well as engraved on the Interface Plate.



Magnet Kit Cooling Water Specifications

The cooling water flow requirements of the magnet kit are 1 gallon per minute (GPM) for every 4 kW of cathode power. It could also be stated as 0.25 GPM per 1 kW of power. In metric units the requirement would be 1 liter per minute (LPM) for every 1 kW of cathode power. For example, you would need 3 GPM (or 12 LPM) if you were running 12 kW of power.

It is recommended to connect a water flow meter with an alarm to signal when the water flow is too low for the cathode power level. This would be to prevent the cathode from overheating and damaging the unit.

The water connections use compression fittings and mate to ¾" OD tubing. The user may substitute different sized adapters, if necessary, to accommodate other cooling line diameters. Be sure to note that if the tubing size is decreased, then the water flow capabilities will also be decreased and therefore, cathode power will be limited.

Also, it may be helpful to install a tee fitting with a shutoff valve into the Water Inlet tubing in between the user's water shutoff valve and the inlet compression fitting. This would be used to blow compressed air through the cooling line to remove cooling water from the cathode before disconnecting the target.

Electrical Connections

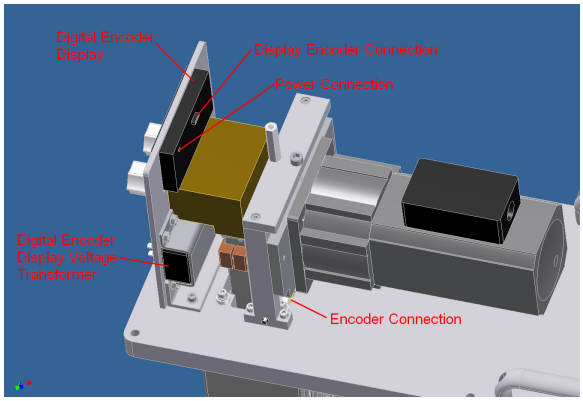
In order for the magnetron to sputter the target material, all of the electrical connections need to be properly made. There are two power connections located on the Utilities Interface Plate. First, the Digital Encoder Display should be connected in order to verify rotation speed. Second, the magnetron power supply needs to be connected to the cathode in order to sputter the target. Also, the drive motor controller has to be connected in order to rotate the target.

Safety:

- *To avoid electrical shock, make sure the cathode power supply input power is off.*
- *Be sure that the cooling water supply to the cathode is turned off before making any electrical connections.*

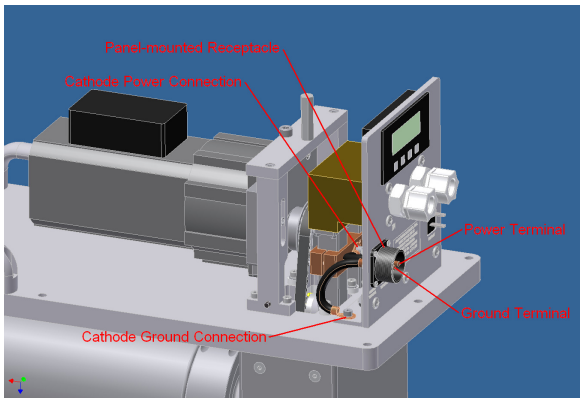
NOTE: The maximum rated isolation voltage of the cathode is 1500VAC.

1. The encoder cable connects to the supplied digital readout that displays rotation speed. This connection is made by plugging in the 5-pin finger-latching cable to the mating connector located on the display. The Display Voltage Transformer must be plugged into the power connector on the back of the display. The digital readout will then need to be plugged into a 115/230 VAC, 50/60 Hz power source. If this is not available, a voltage transformer may be necessary, refer to Addendum A for details.



   NOTE: The Digital Encoder Display also has the ability to connect to a relay to act as a rotation interlock. The supplied manual for the encoder shows a diagram of the relay pinouts on page 2. A 3-pin removable screw terminal is included with the display in order to connect a relay. The instructions for setting up the relay in tachometer mode are on page 11. On page 13 of the manual, there is a breakdown of the display's menu for reference. The manual can be found online at: http://www.usdigital.com/assets/datasheets/ED3_datasheet.pdf

2. Now the cathode power going from the cathode power supply to the Utilities Interface can be connected. This connection uses a panel-mounted receptacle to attach the power cable.



   The plug that mates to the receptacle will be provided and the power and ground cables will need to be soldered to it to ensure a good electrical connection. The receptacle and mating plug are rated for 120 Amps and there are (2) 4 AWG contacts. Be sure to use a cable that is rated to handle the maximum amount of power that will be applied. Multi-stranded and insulated copper wire is recommended.

   Make sure that the power (+) terminal from the cathode power supply is connected to the terminal that mates to the power terminal on the panel-mounted receptacle. Likewise, make sure that the ground (-) terminal from the cathode power supply is connected to the terminal that mates to the ground terminal on the panel-mounted receptacle.

3. The other power connection is for drive motor power. This connection is made by first connecting the controller cable to the motor receptacle (located on the back of the black box on top of the motor) and then plugging the supplied motor controller into a 115/230VAC, 50/60 Hz power source.

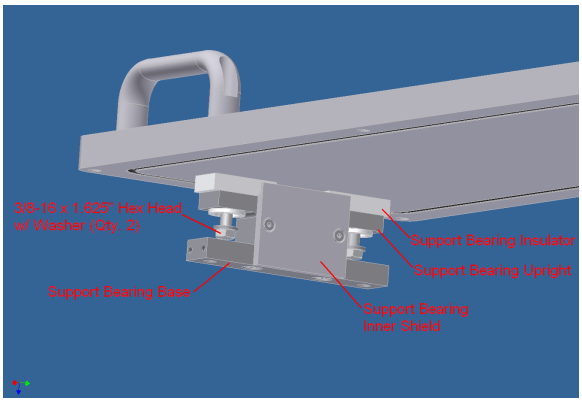
   If this power is not available, a voltage transformer may be necessary, refer to Addendum A for details. Also, if a controller was not supplied, then the motor will need to be wired to one and then connected to power according to the motor and controller wiring diagrams. In this case, the motor wiring diagram will be provided with the cathode for your reference.

   Note: A jumper (J2) inside of the enclosed motor controller must be changed in order to switch from 115 to 230 VAC input, or vice versa, otherwise the controller will be damaged.

Support Bearing Mounting

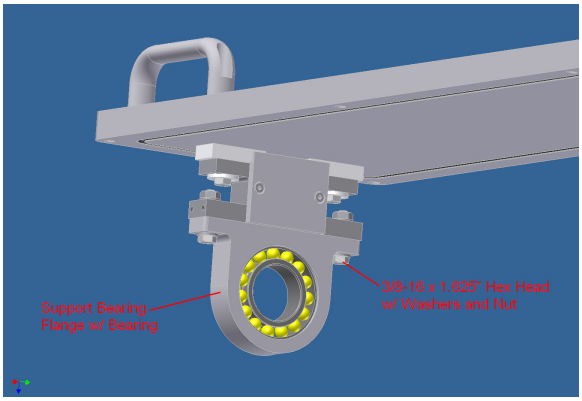
The end of the Target opposite the Endblock has an insulated support nose that is aligned and supported during rotation with a Support Bearing Assembly. The following steps describe how to mount this assembly.

1. The Support Bearing Assembly is mounted on the same face of the lid as the Endblock Assembly, but on the opposite end. There should be (2) 3/8-16 blind, tapped holes for mounting. The Support Bearing Base can be bolted to the Uprights with hex head bolts, washers and Insulators in place before attaching to the lid. Tighten the (2) 3/8-16 x 1.625" hex head bolts to the lid as shown, with the inner shield facing the endblock. Be sure that the Support Bearing Insulators are aligned flush with the Inner Shield.



If mounting the target without the magnet bar inside of the backing tube, skip step 2 below.

2. Depending on target mounting method (with the magnet bar inside of the backing tube) the Support Bearing Flange with Bearing can be bolted to the base with (2) sets of 3/8-16 x 1.625" hex head bolts with washers on both sides and nuts. The side of the Flange with the retaining ring is mounted away from the Endblock Assembly. The remaining shield is installed after the Target is mounted.

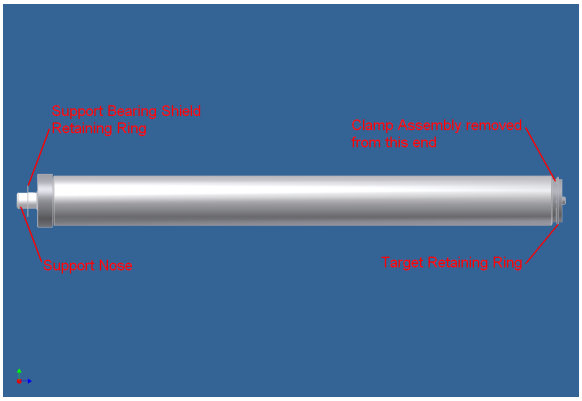


Target Mounting (for Cathodes without Debris Shields)

After the Endblock and Support Bearing Assemblies are installed, the Target Assembly can be mounted. The Target serves as the source of material to be sputtered onto the substrate. The following procedure will explain how to mount a Target Assembly that does not have debris shields to the cathode.

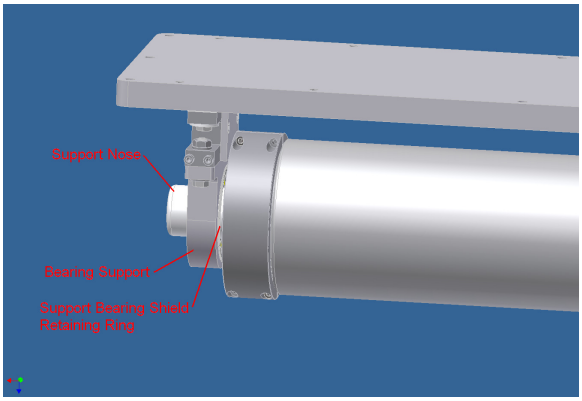
1. Prepare the Target Assembly for installation by making sure the Magnet Kit is inside the Backing Tube and the End Cap with Support Nose is attached. Make sure that the inside lip of the open end is clean so it will seal on the o-ring in the Drive Shaft.

   Also, be sure to slide the Support Bearing Shield Retaining Ring onto the Support Nose at this time.



   NOTE: On the open end, make sure the Target Retaining Ring is slid over the wire that is located in the groove on the OD of the Backing Tube. This locks the Target Retaining Ring onto the Backing Tube for clamping to the Drive Shaft.

2. Because of the size and weight of the Target assembly, it is recommended to use mechanical lifting device to support the Target and slide the Support Nose into the Bearing Support. The bearing is self-aligning to allow angular movement during assembly. Slide the Target all the way towards the Bearing to allow room for the drive-side to fit together.

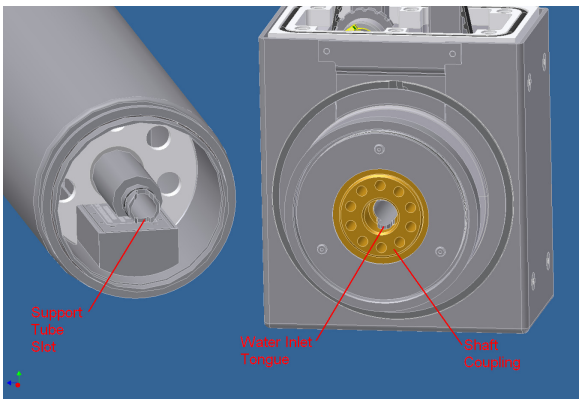


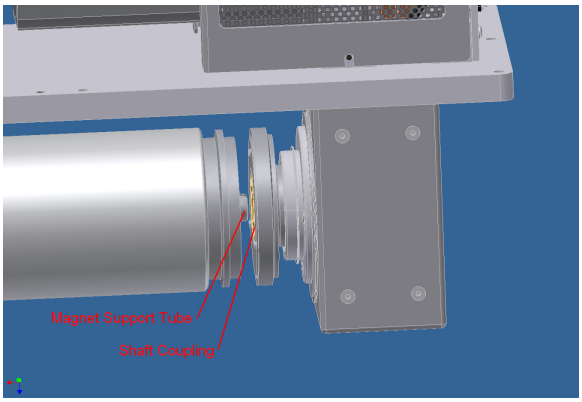
   If it is difficult to engage the Support Tube into the Drive Shaft Coupling (Step 3, below), then it may be necessary to remove the Target End Cap on the Support Nose side by reversing Step 5 of the Target Mounting Procedure, described below. The Bearing Support will also need to be unbolted from its mounts by the (2) hex head bolts and nuts. The magnet pack and support tube can be slid out of the target tube to reduce the weight and make installation easier.

Once the Target is attached to the drive side, the Magnet Support Tube can be reinstalled into the tube and inserted into the Drive Shaft Coupling. Be sure to verify that it is fully engaged so the Magnet Pack cannot rotate. Now the Target End Cap can be replaced and the Bearing support should be reattached to the mounts with the hex head bolts and nuts.

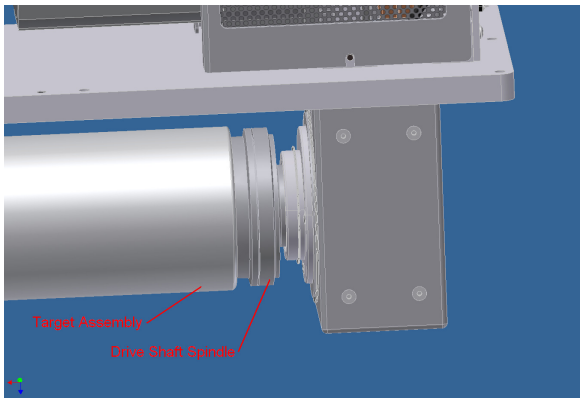
NOTE: If assistance is required to implement a mechanical lifting device for the target installation/changes, feel free to contact Angstrom Sciences with your request.

3. Now align the drive-side of the Target so that the Magnet Support Tube will slide into the Shaft Coupling inside of the Drive Shaft. The slot in the Magnet Support Tube should be vertical so that it will fit into the Water Inlet tongue and the magnets should be facing the direction of sputtering with respect to the Lid (the magnet pack can be located visually or by placing a magnetic item on the outside of the target).

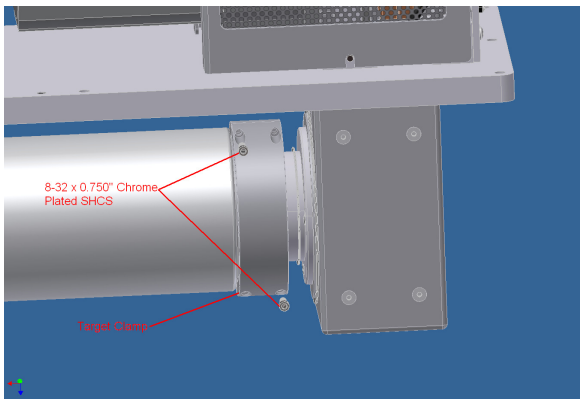




4. With the Target and Magnet Kit aligned, slide it into the Drive Shaft Spindle. Depending on the fit, you may need to push on the far end of the Target Assembly until the Backing Tube is seated inside of the Drive Shaft. A small amount of vacuum compatible grease may be applied to the inner lip of the Backing Tube to aid in installation. If it still cannot be assembled, then the o-ring in the Drive Shaft may be stretched and need to be replaced. Refer to Steps 4-5 in the Rotary Seals Maintenance Procedure to do so.



5. Now install the (2) Target Clamp halves on to the Target/Drive Shaft joint. The Target Clamp fastens together with (2) 8-32 x 0.750” SHCS located diagonally from each other. Usually, the Clamps need to be hit directly in the center with a *soft-faced mallet* to seat them onto the Target and Drive Shaft.



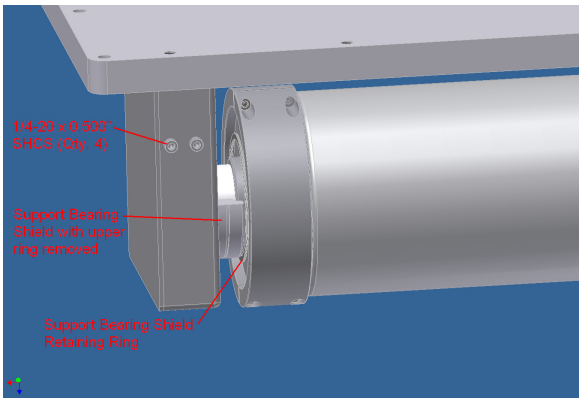
It is important to keep an even gap between the (2) clamp halves, so a screwdriver may be need to be placed in between one side or both, to help keep them even while hitting the Clamps with the mallet.

Note: Opposite the main holes are 2 counterbored, tapped holes that can accept 8-32 x 0.500” SHCS that are used to set the gap between the two clamps while tapping them together with the mallet. Once the clamps are seated and the screws are touching the clamps, remove them and then tighten the 8-32 x 0.750” SHCS evenly.

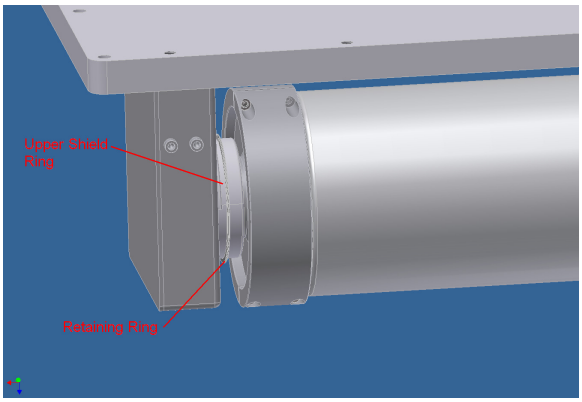
These tapped holes can also be used as jack-screw holes for removal of the Target Clamp. Otherwise, the clamp halves can be pried apart with a pry bar or screwdriver and then tap the other half off with a soft faced mallet.

NOTE: When fully tightened, there should be roughly a 0.06” (1.5 mm) gap between the 2 clamp halves. Try to keep this gap as evenly spaced as possible on both sides when tightening to avoid binding the screws.

6. With the retaining ring pushed all the way towards the target end cap, slide the Support Bearing Shield over the Support Bearing and attach it with (4) ¼-20 x 0.500" SHCS.

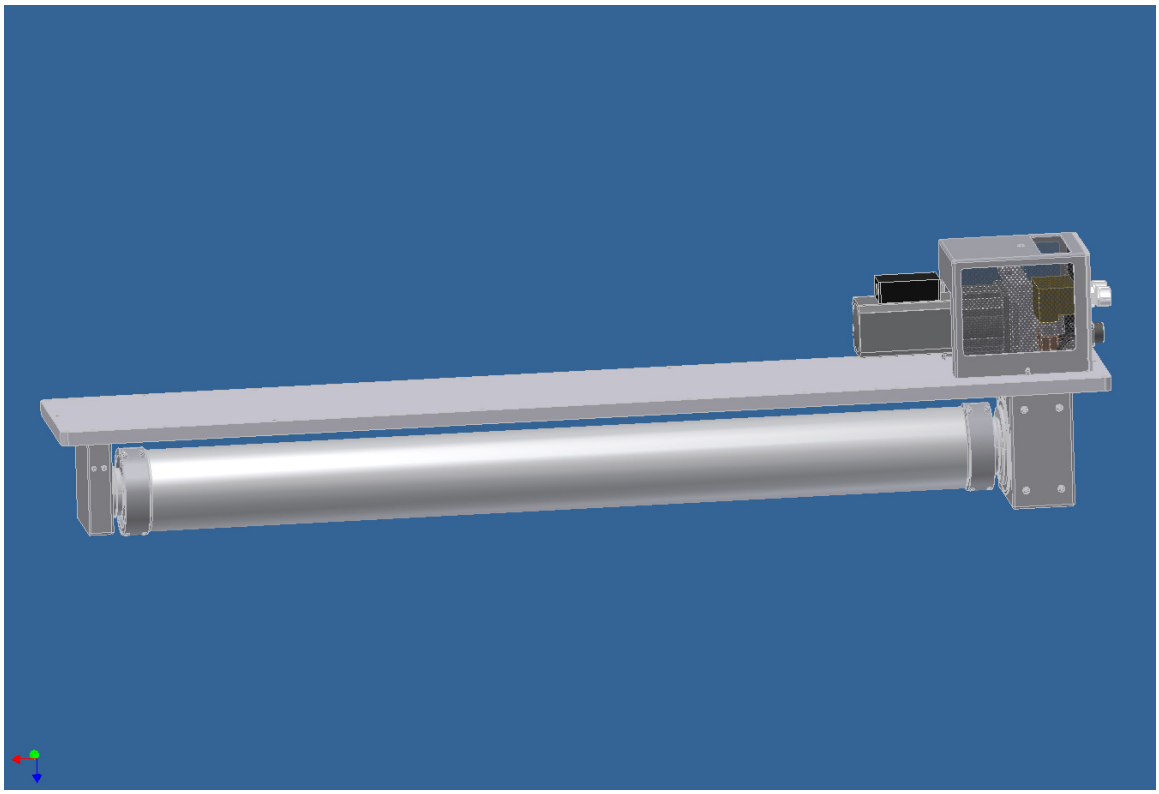


7. Place the Upper Shield Ring on the Lower Shield Ring, line up the retaining ring groove and then snap the retaining ring into place. A screwdriver may be needed to slide the retaining ring into the groove, as there isn't much room for hands.



8. Now the cathode connections can be made as shown in Step 13 of the Endblock Mounting Procedure and in the Electrical Connections Procedure. Then, before turning the water and rotation on, use an ohmmeter to verify the shields on the Endblock and Support Bearing are all electrically floating (open circuit) between the Target and ground. Also, verify that the entire cathode is electrically floating from the lid. If a short is found, check for any trapped debris or coated insulators for the shield in question.

   Next, turn the Target rotation on and check for rubbing of any parts, specifically, the Magnet Kit on the inside of the Backing Tube (especially if shims have been installed). If found, stop the rotation and troubleshoot the suspected area, take apart and remove shims if necessary and retest. After that, turn on the cooling water and let it run through the target to check for any water leaks. If found, turn off the water and troubleshoot the area at fault, checking any o-rings or connections. Also, turn on the Digital Encoder Display and confirm that it is reading out approximately 19 RPM at full speed on the Motor Controller. If not, recheck the cable connections. Once the cathode passes all of these tests, it is ready to be mounted in the chamber.



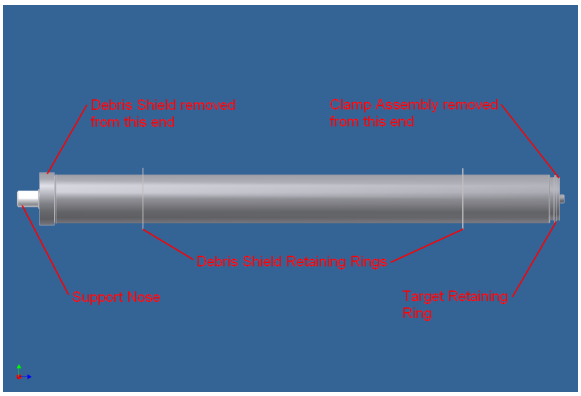
Finished Assembly

Target Mounting (for Cathodes with Debris Shields)

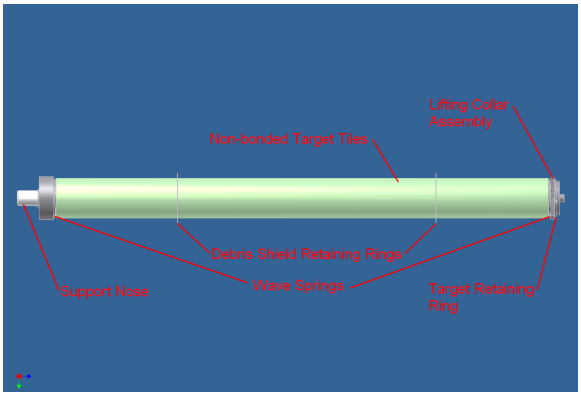
After the Endblock and Support Bearing Assemblies are installed, the Target Assembly can be mounted. Before it is installed, be sure that the Debris Shield Assembly is removed from the support end or it will not fit.

The Target serves as the source of the material to be sputtered onto the substrate. The ends of the Target are covered by Debris Shields, which prevent any material from being back-sputtered onto the Target itself. The following procedure will explain how to mount a Target Assembly that has debris shields to the chamber.

1. Prepare the Target Assembly for installation by making sure the Magnet Kit is inside the Backing Tube and the End Cap with Support Nose is attached. Make sure that the inside lip of the open end is clean so it will seal on the o-ring in the Drive Shaft.



For a non-bonded target setup, the assembly and installation is slightly different, as shown in the picture to the right. This setup requires a wave spring, target tiles, then another wave spring be slid on to the Backing Tube where the bonded target is otherwise.



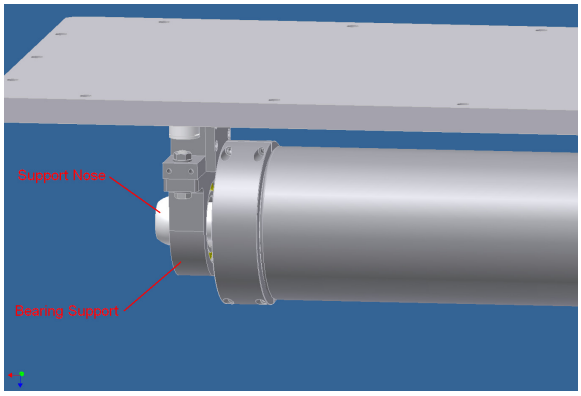
Because of the weight of this assembly and the strength of the target tiles, this Target Assembly cannot be lifted by or supported on the tiles or they could break. Therefore, a Lifting Collar Assembly is bolted onto the open end of the Backing Tube in between the wave spring and Target Retaining Ring.

This lifting collar has hooks on it so it can be suspended from a mechanical lift and handles for moving it by hand. The opposite end of the Target Assembly must be handled by the Support Nose. Take great care when installing a non-bonded target assembly so the target tiles do not break.

Also, be sure to slide the (2) Debris Shield Retaining Rings onto the Target at this time.

NOTE: On the open end, make sure the Target Retaining Ring is slid over the wire that is located in the groove on the OD of the Backing Tube. This locks the Target Retaining Ring onto the Backing Tube for clamping to the Drive Shaft.

2. Because of the size and weight of the Target assembly, it is recommended to use mechanical lifting device to support the Target and slide the Support Nose into the Bearing Support. The bearing is self-aligning to allow angular movement during assembly. Slide the Target all the way towards the Bearing to allow room for the drive-side to fit together.

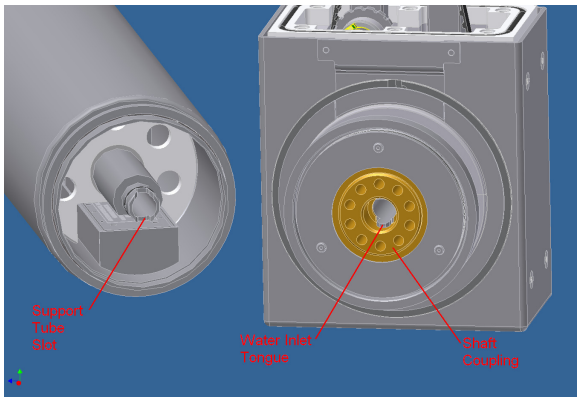


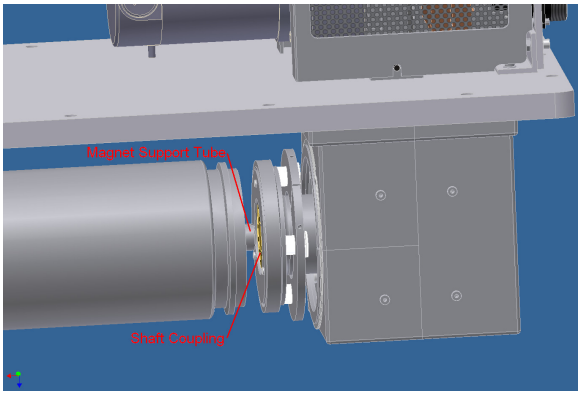
If it is difficult to engage the Support Tube into the Drive Shaft Coupling (Step 3, below), then it may be necessary to remove the Target End Cap on the Support Nose side by reversing Step 5 of the Target Mounting Procedure, described below. The Bearing Support will also need to be unbolted from its mounts by the (2) hex head bolts and nuts. The magnet pack and support tube can be slid out of the target tube to reduce the weight and make installation easier.

Once the Target is attached to the drive side, the Magnet Support Tube can be reinstalled into the tube and inserted into the Drive Shaft Coupling. Be sure to verify that it is fully engaged so the Magnet Pack cannot rotate. Now the Target End Cap can be replaced and the Bearing support should be reattached to the mounts with the hex head bolts and nuts.

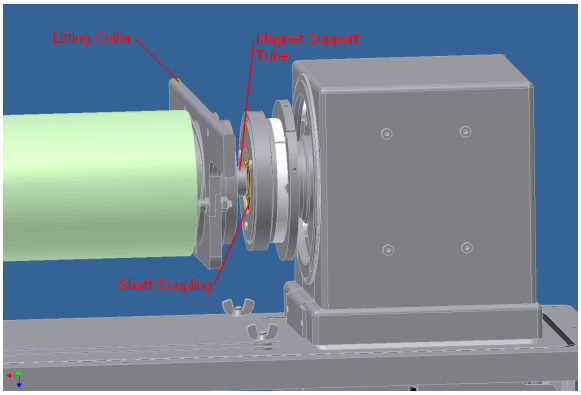
NOTE: If assistance is required to implement a mechanical lifting device for the target installation/changes, feel free to contact Angstrom Sciences with your request.

3. Now align the drive-side of the Target so that the Magnet Support Tube will slide into the Shaft Coupling inside of the Drive Shaft. The slot in the Magnet Support Tube should be vertical so that it will fit into the Water Inlet tongue and the magnets should be facing the direction of sputtering with respect to the Lid (the magnet pack can be located visually or by placing a magnetic item on the outside of the target).

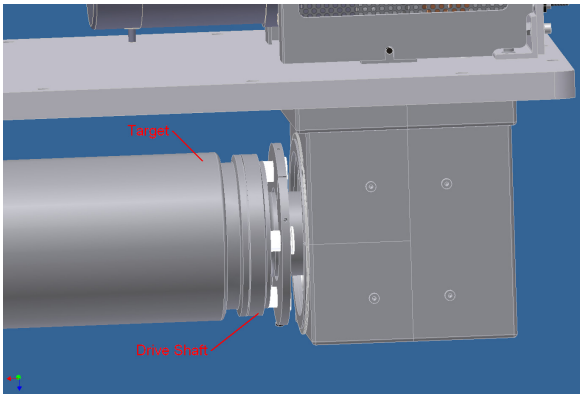




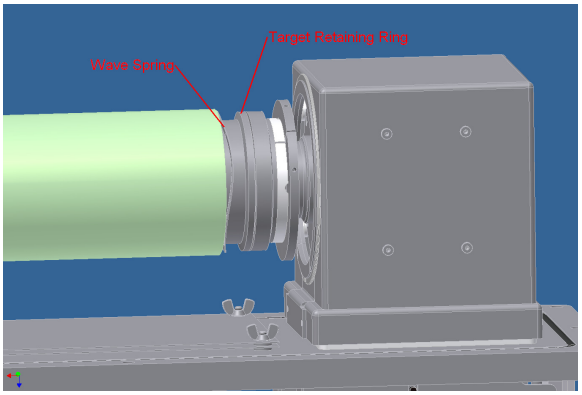
A non-bonded target assembly will require using the Lifting Collar**,** which is provided with a non-bonded target assembly, to guide the Magnet Support Tube into the Shaft Coupling.



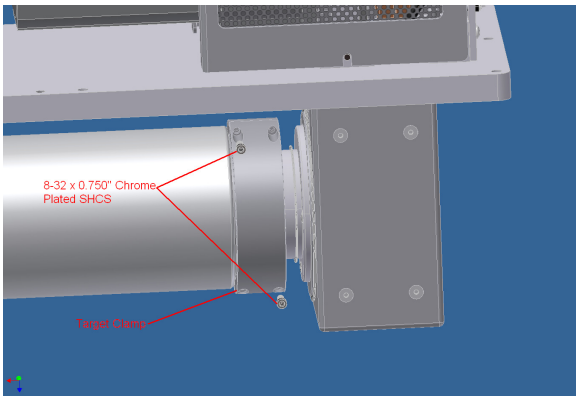
4. With the Target and Magnet Kit aligned, slide it into the Drive Shaft. Depending on the fit, you may need to push on the far end of the Target Assembly until the Backing Tube is seated inside of the Drive Shaft. A small amount of vacuum compatible grease may be applied to the inner lip of the Backing Tube to aid in installation. If it still cannot be assembled, then the o-ring in the Drive Shaft may be stretched and need to be replaced. Refer to Steps 4-5 in the Rotary Seals Maintenance Procedure to do so.



On a non-bonded assembly, the Lifting collar can now be removed. Notice the gap in between the wave spring and Target Retaining Ring, this is where the Target Clamp will be installed.



5. Now install the (2) Target Clamp halves on to the Target/Drive Shaft joint. The Target Clamp fastens together with (2) 8-32 x 0.750” SHCS located diagonally from each other. Usually, the Clamps need to be hit directly in the center with a *soft-faced mallet* to seat them onto the Target and Drive Shaft.



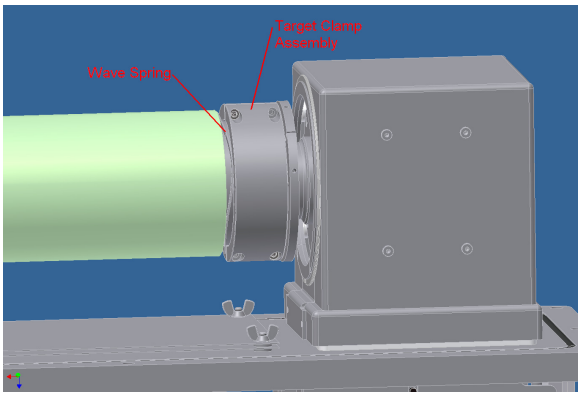
It is important to keep an even gap between the (2) clamp halves, so a screwdriver may be need to be placed in between one side or both, to help keep them even while hitting the Clamps with the mallet.

Note: Opposite the main holes are 2 counterbored, tapped holes that can accept 8-32 x 0.500” SHCS that are used to set the gap between the two clamps while tapping them together with the mallet. Once the clamps are seated and the screws are touching the clamps, remove them and then tighten the 8-32 x 0.750” SHCS evenly.

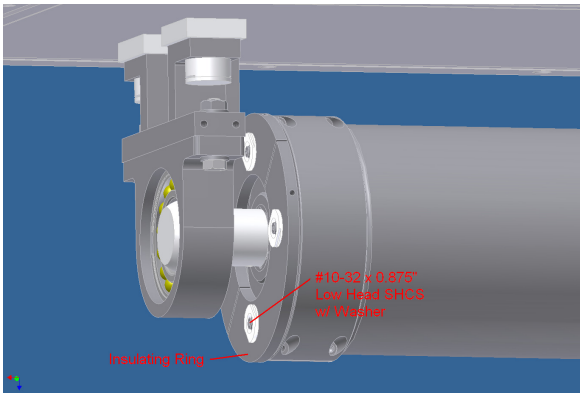
These tapped holes can also be used as jack-screw holes for removal of the Target Clamp. Otherwise, the clamp halves can be pried apart with a pry bar or screwdriver and then tap the other half off with a soft faced mallet.

For a non-bonded target assembly, the Target Clamp will fill the space left between the wave spring and Target Retaining Ring when installed.

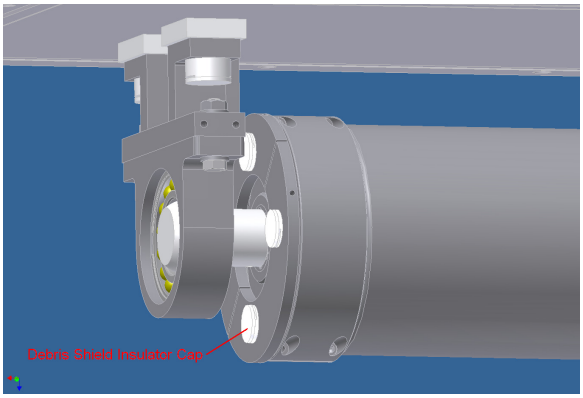
NOTE: When fully tightened, there should be roughly a 0.06" (1.5 mm) gap between the 2 clamp halves. Try to keep this gap as evenly spaced as possible on both sides when tightening to avoid binding the screws.



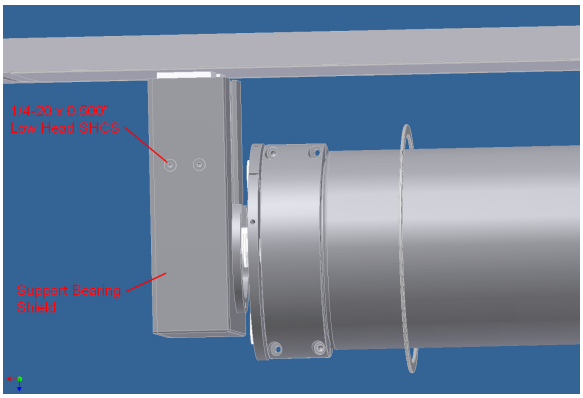
6. The Debris Shields can now be installed on the Target. On the Support end, fasten the (2) Insulating Rings to the End Cap with (2) sets of #10-32 x 0.875" low head SHCS and washers inside the insulators for each half. *The Target may need to be rotated to reach all of the fasteners.*



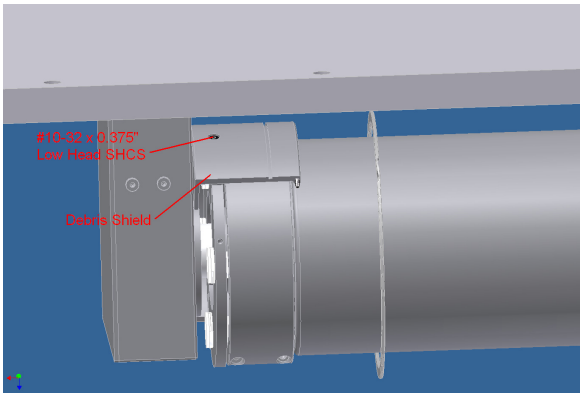
7. Next, press the (4) Debris Shield Insulator Caps into place. Notice there are small notches on the sides for prying them off with a screwdriver.



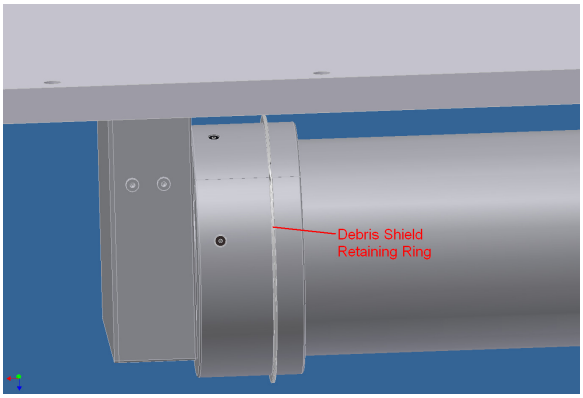
8. Slide the Support Bearing Shield over the Support Bearing and attach it with (4) ¼-20 x 0.500" SHCS.



9. Attach a Debris Shield (Support Side) half to an Insulating Ring using (2) #10-32 x 0.375" low head SHCS. Do not fully tighten these screws until the other half and the retaining ring is on.

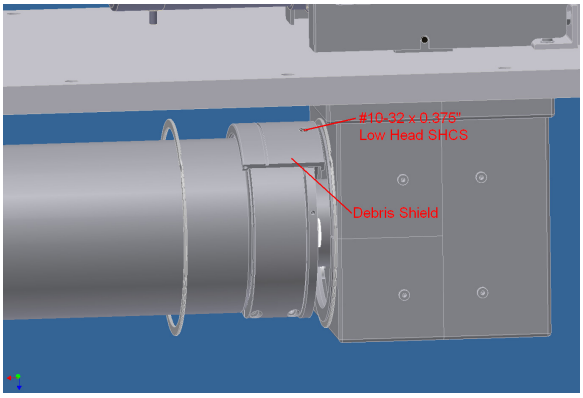


10. Attach the other Debris Shield (Support Side) to the Insulating Ring with (2) #10-32 x 0.375" low head SHCS. You must align the pins in the ends of the Shields in order for them to fit together. Then snap the Debris Shield Retaining Ring into place in the groove in the Debris Shield halves.

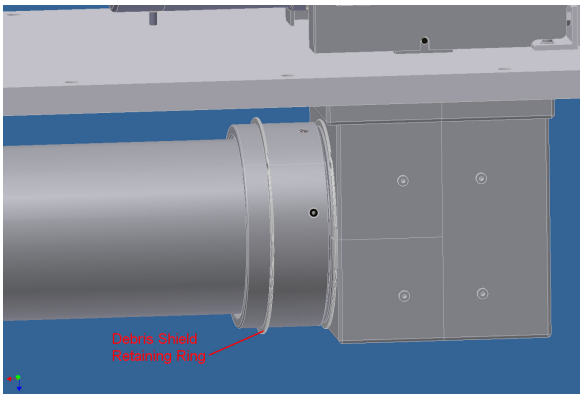


You may now need to rotate the Target to fully tighten all of the Debris Shield fasteners.

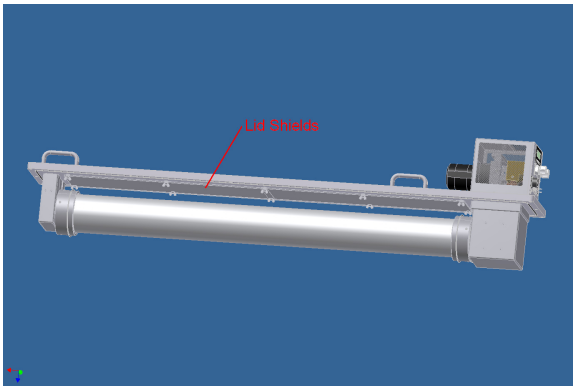
11. Now perform the same procedure for installing the Debris Shields on the drive side.



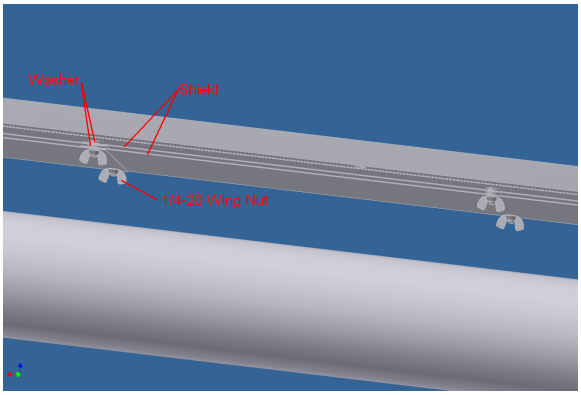
12. With both halves of the Debris Shield in place, snap the Debris Shield Retaining Ring into the groove in the Shields and fully tighten all of the Debris Shield fasteners. Target installation is now complete.



13. The Lid Shields can now be installed, if applicable. These are used to help keep debris off of the Lid because they can be removed and bead blasted or replaced as necessary.

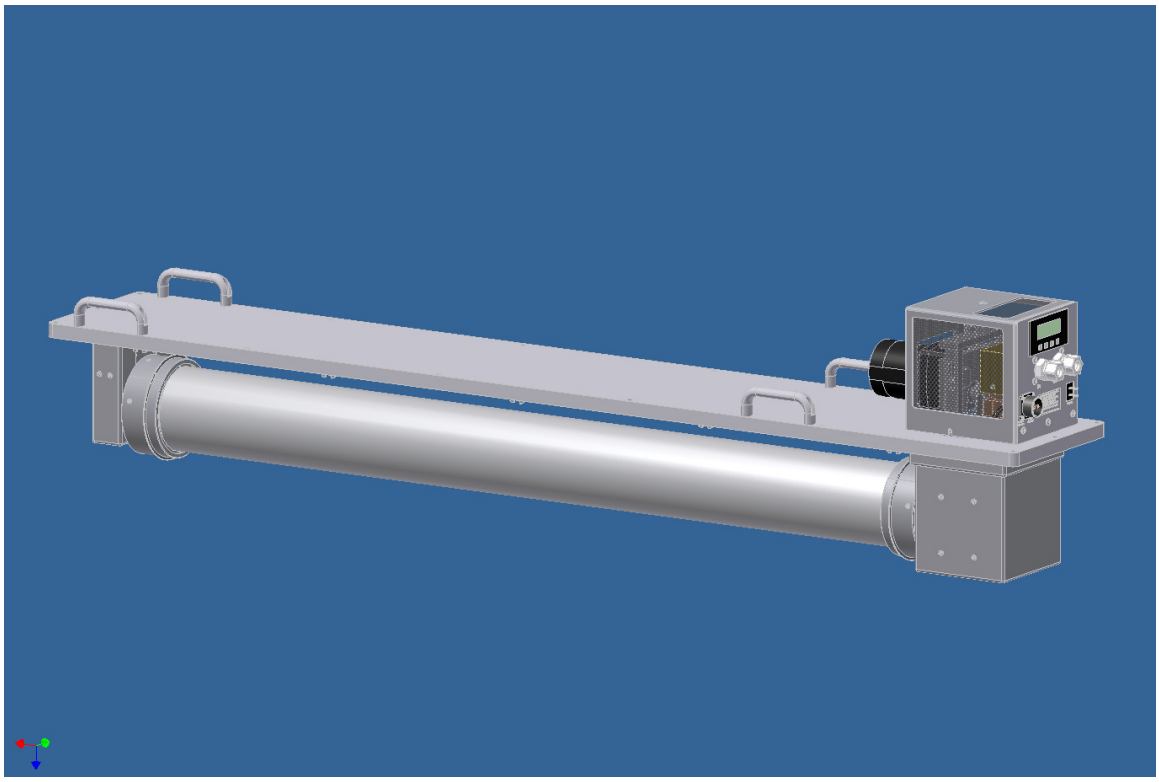


First, a washer goes over every threaded stud, then the first set of Shields are placed over the studs, making sure to overlap them at every joint. Washers are then placed over those Shields before a second set of Shielding is placed on to the studs. The Lid Shields are then secured with ¼"-20 wing nuts.



14. Now the cathode connections can be made as shown in Step 13 of the Endblock Mounting Procedure and in the Electrical Connections Procedure. Then, before turning the water and rotation on, use an ohmmeter to verify the shields on the Endblock, Support Bearing and Debris Shields are all electrically floating (open circuit) between the Target and ground. Also, verify that the entire cathode is electrically floating from the lid. If a short is found, check for any trapped debris or coated insulators for the shield in question.

    Next, turn the Target rotation on and check for rubbing of any parts, specifically, the Magnet Kit on the inside of the Backing Tube (especially if shims have been installed). If found, stop the rotation and troubleshoot the suspected area, take apart and remove shims if necessary and retest. After that, turn on the cooling water and let it run through the target to check for any water leaks. If found, turn off the water and troubleshoot the area at fault, checking any o-rings or connections. Also, turn on the Digital Encoder Display and confirm that it is reading out approximately 19 RPM at full speed on the Motor Controller. If not, recheck the cable connections. Once the cathode passes all of these tests, it is ready to be mounted in the chamber.



Finished Assembly

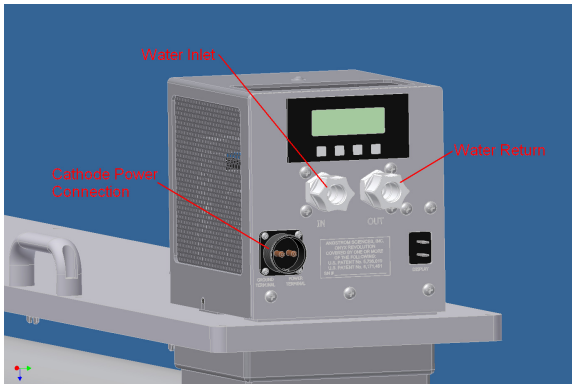
Target Removal

The following procedure will explain how to remove the target from the chamber.

Safety:

- *To prevent electrical shock, ensure that power to the cathode is OFF.*
- *To avoid possible burns from working around a hot target surface, allow the target to rotate for at least 15 minutes, with cooling water flow, AFTER turning the power supply OFF.*
- *To avoid the entrapment of tools, clothing and other materials which may cause either human or equipment damage, turn the target rotation OFF.*

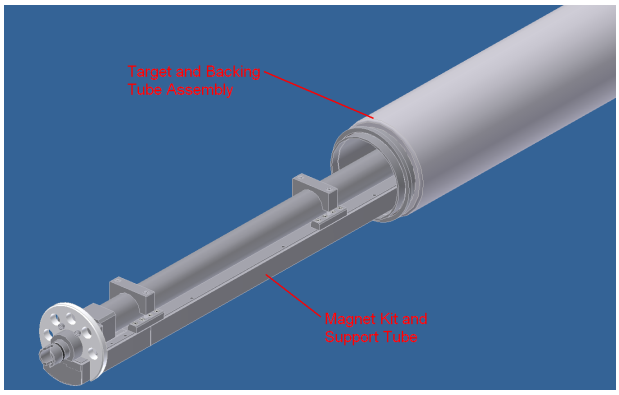
1. With the Target rotation stopped, turn off the cooling water flow through the cathode. Disconnect the inlet water tube to the cathode and blow compressed air through it to force the cooling water out of the target (or use a tee fitting as recommended in the Endblock Mounting Procedure above). This process will drain most of the water, but a small amount will still remain inside of the Target. Once the cooling water is drained from the Target, the outlet water tube may be also be disconnected.



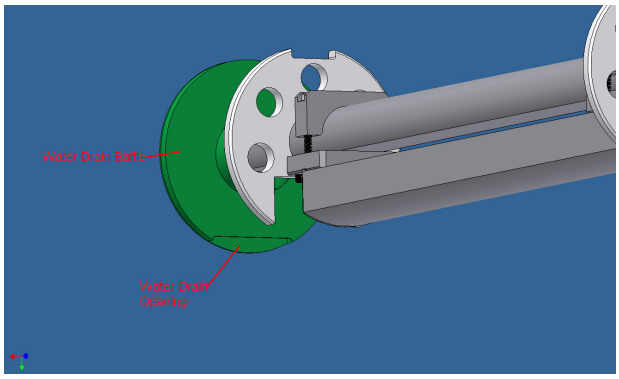
NOTE: When disconnecting the Target from the Drive Shaft, the Magnet Kit will need to be pried out of the Shaft Coupling inside the Drive Shaft in order to disengage the Target Assembly. Take care not to damage anything in this process.

2. Now remove the chamber lid and cathode assembly from the system and place it on a work cart/bench to perform the rest of the disassembly. Reverse the steps from the applicable Target Mounting Procedure above to remove the Target from the cathode. Keep in mind that some water will still be inside of the Target and will spill out when disconnecting it from the Endblock. It may be helpful to place a small container under the connection point to catch this water. A mechanical lifting system may is recommended to support the weight of the Target during this process.

3. The Magnet Kit and Support Tube can now be pulled out from inside of the Target.



4. When reinstalling the magnet tube be sure that the Water Drain Baffle opening is facing down.



5. For reassembly of the Target on to the cathode, slide the Magnet Kit back into the Target and then follow the applicable Target Mounting procedure above. To check successful reassembly, perform the last step of the Target Mounting procedure. If necessary, the Target can be wiped clean at this time.

Rotary Seals Maintenance

Performing maintenance on the rotary lip seals requires removal of the cathode from the chamber. This is done by first removing the Target, which requires following the Target Removal Procedure shown above. Then the Endblock must be removed by reversing the Endblock Mounting Procedure above.

Notes on Rotary Shaft Seals:

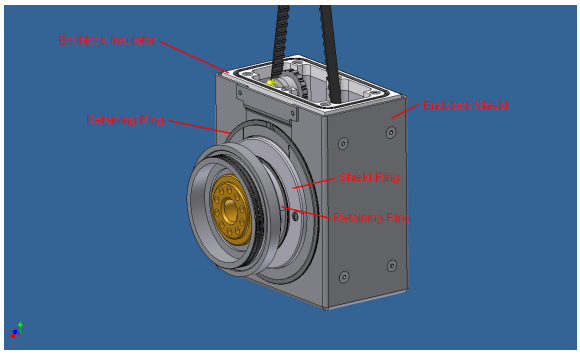
- *The rotary shaft seals used within the Endblock are expected to maintain service for a minimum of 24 months. The most common mode of failure for these dynamic seals is the lip interface to the shaft, specifically, any debris that might try to pass through the water-cooling system. For this reason it is recommended the user install a maximum of 75um water filtration in front of the cathode supply water connection.*
- *Rotary shaft seals such as those used by the Onyx Revolution are energized and maintain their seal by the pressure separating water from air or air from vacuum. When de-energized so that the pressure is equivalent on both sides of the seal, by turning off the water supply or venting the chamber, the seal will slightly relax and in some cases allow a small volume of the high pressure media to pass to the low pressure side. This is evident after venting the chamber, pumping down to Hi-Vacuum, and then turning on the cathode rotation. The volume of media passing through the seals is minor and very temporary. The user will see the base pressure return within seconds of initiating rotation. The same is true for the water seals when first energizing the seal with cooling water pressure.*

Safety:

- *To avoid electrical shock, disconnect the power supply cable from the cathode.*
- *After allowing sufficient time for a sputtered target to cool (< 10 min). Be sure to turn off the cooling water supply to the cathode, remove as much excess water from the cathode by blowing dry air through the water passage and disconnect the water supply and return hose.*

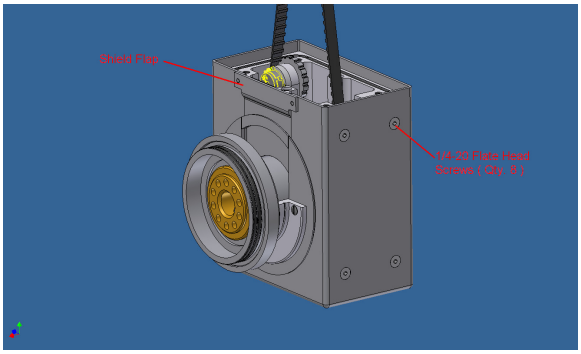
Once the Endblock is removed from the lid, it is possible to begin the process of replacing the (4) rotary shaft seals. Two of the seals are used between water and atmosphere, and the other two are used between vacuum and atmosphere.

1. The plastic Endblock Insulator sitting on top of the Endblock can be lifted off at this time. Then remove the Retaining Ring from the Shield Ring with a screwdriver and slide it forward to remove the top Shield Ring. Now remove the Retaining Ring from the Endblock Shield.

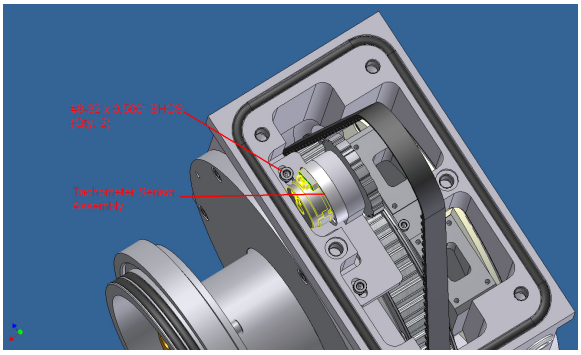


Note: All o-rings in the Endblock and Target assemblies should be cleaned as necessary and lubricated with vacuum compatible grease.

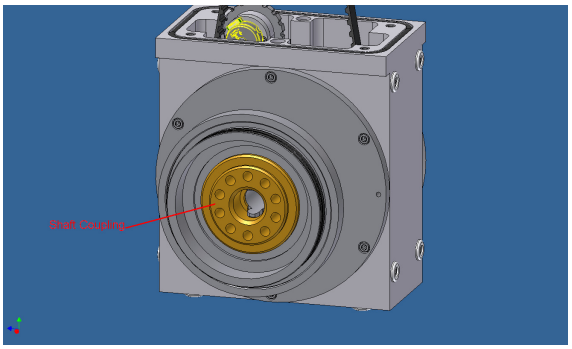
2. Now take the Shield Flap off (the 2 dowel pins should slide out of the holes). Then remove the (8) ¼-20 x 0.500" flat head screws that hold the Endblock Shield on and slide the shield off.



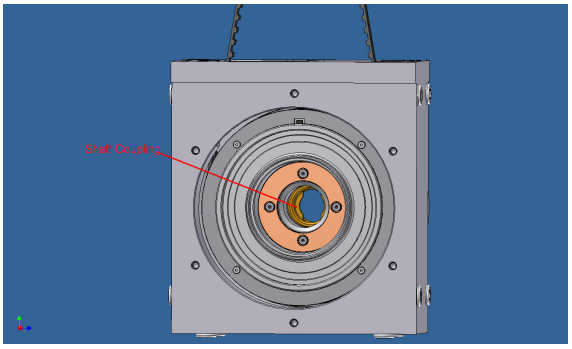
3. Take off the Tachometer Sensor Assembly by removing the (2) #8-32 x 0.500" SHCS and lifting the assembly out of the Endblock.



4. Shaft Coupling should come out with magnet tube if not complete steps 7 & 8 first.

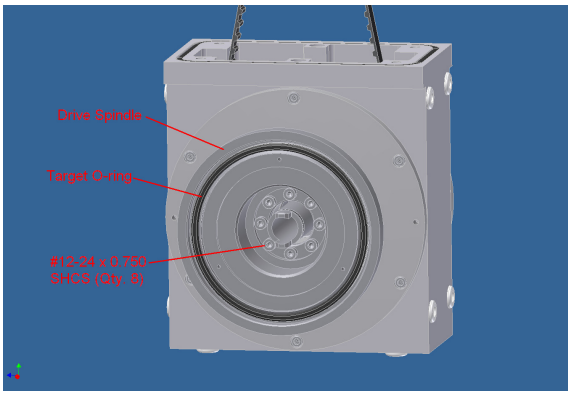


5. The Shaft Coupling can then be pushed out from the backside.



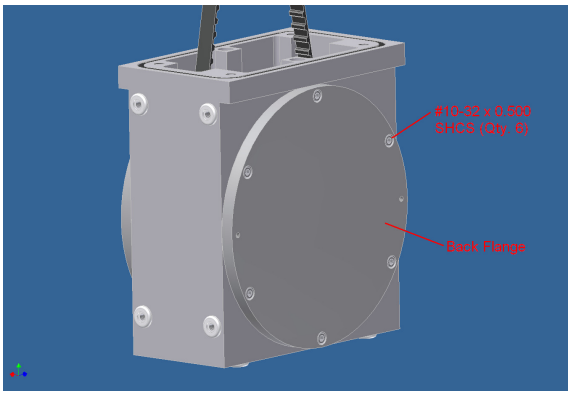
6. If the target o-rings are still in place, remove it now. Check the o-ring for flat spots and replace if necessary. Be sure to lubricate this o-ring with a generous amount of vacuum compatible grease.

   Note: The opposite end of the backing tube has the same o-ring setup and is serviced in the same manner once the Target Clamp is removed from that side.

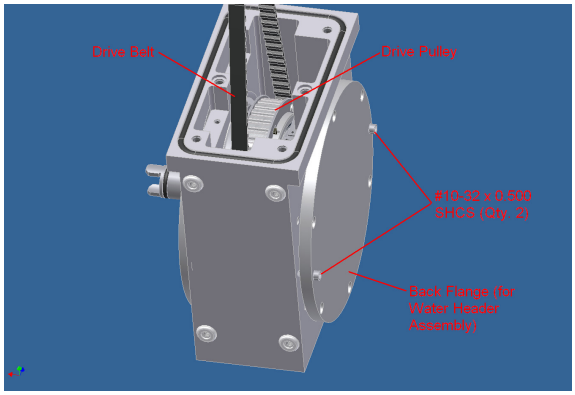


   Remove the (8) #12-24 x 0.750” SHCS that hold the Drive Spindle in place and pull it off of the Drive Shaft. This may require some force as it fits over (2) o-rings.

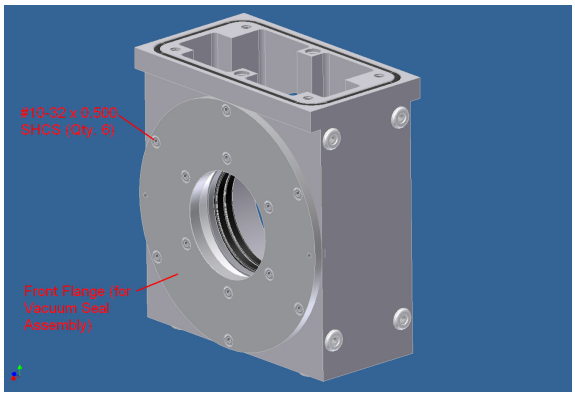
7. The Water Header Assembly, which contains the rotary shaft seals that seal between water and atmosphere, can now be taken out by first removing the (6) #10-32 x 0.500” SHCS from the Back Flange.



8. Next, use (2) of the #10-32 x 0.500” SHCS as jack-screws to evenly back out the Water Header and Drive Shaft Assembly. Once it is out far enough, it will easily pull out by hand. Slip the Belt off of the Drive Pulley and take it out of the top of the Endblock.

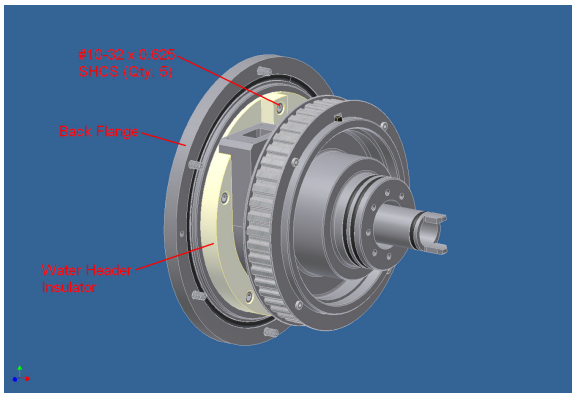


9. The Vacuum Seal Assembly is then removed by taking out the (6) #10-32 x 0.500” SHCS out of the Front Flange and then sliding the assembly out of the Endblock.

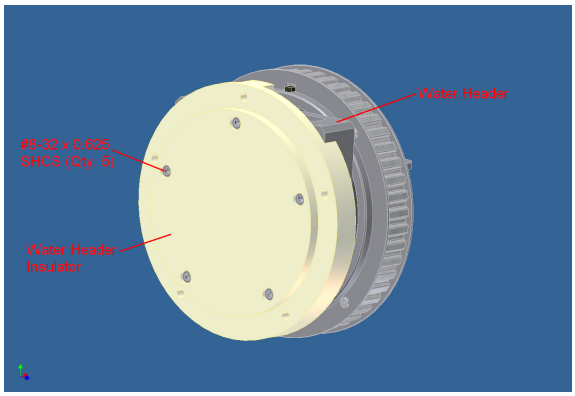


10. The Water Header and Drive Shaft Assembly can now be seperated. First, remove the (5) #10-32 x 0.625" SHCS from the Water Header Insulator to remove the Back Flange.

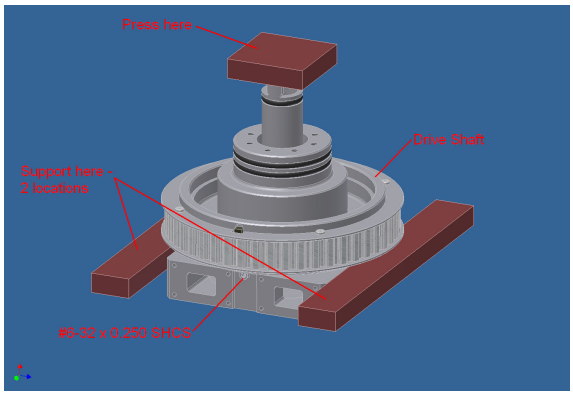
    Note: It is critical when reassembling the Back Flange to the Insulator that one of the (6) through holes aligns directly above the center of the (2) rectangular openings in the Water Header.



11. Next, remove the (5) #8-32 x 0.625" SHCS that hold the Water Header Insulator on and carefully pull it off of the Water Header.



12. Now the Water Header Assembly can be pressed out of the Drive Shaft Assembly. But first the #6-32 x 0.250" SHCS needs to be removed from the Water Header in order for the assemblies to come apart easily (since the screw is located between (2) rotary seals, it creates an air pocket between them).

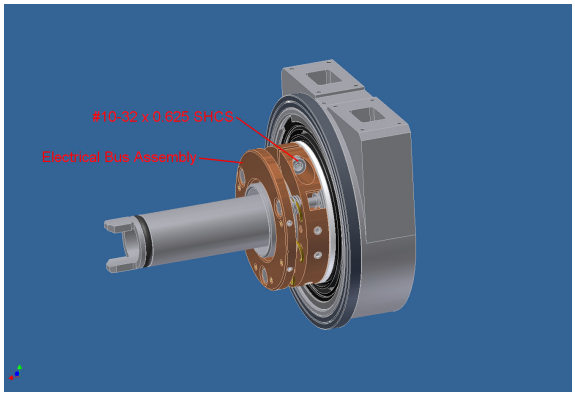


    Note the (2) locations for supporting the Drive Shaft Assembly are on the Drive Shaft itself, not on the pulley.

    Using a large arbor press or a hydraulic press, place the support blocks and the press block in the locations shown and carefully press the Water Header out and be sure to

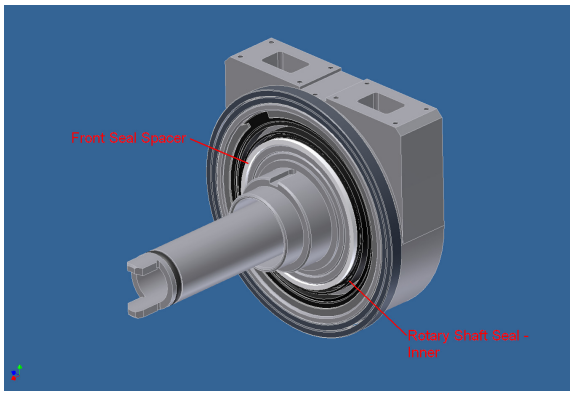
catch it so it doesn't fall. Make sure that the Water Header presses out evenly so the bearing between it and the Drive Shaft is not damaged.

13. On the Water Header Assembly it out, remove the #10-32 x 0.625" SHCS and slide the Electrical Bus Assembly off. Also, take the Key out of the slot so it does not get lost.

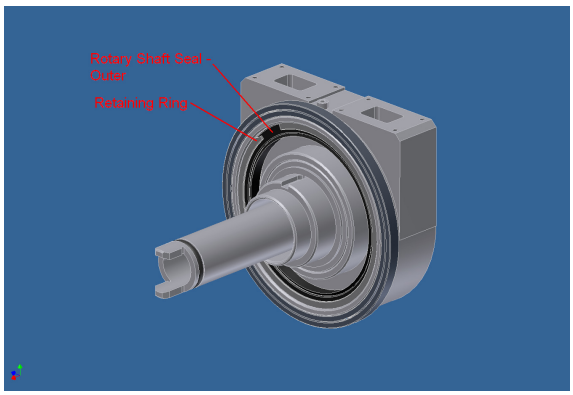


14. Now slide off the Front Seal Spacer, the inner Rotary Shaft Seal and the Back Seal Spacer.

    Make note of the direction that the flat side and cupped side of the Rotary Seals are facing for reassembly *(the cupped side of the inner seal should be towards the keyway and the flat side of the outer seal should be towards the keyway*).

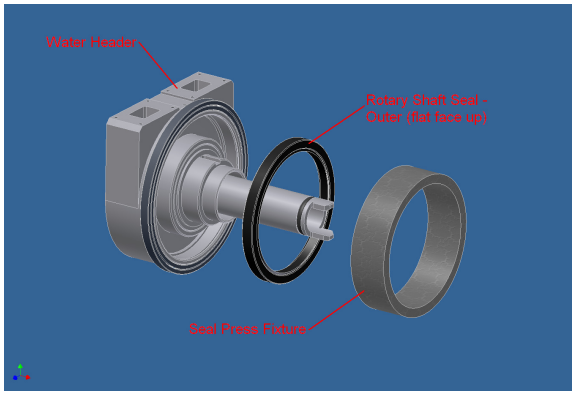


15. The outer Rotary Shaft Seal can now be removed, if necessary. It is important to note that disassembly of the outer Rotary Seal will usually cause distortion of the seal. So, prior to complete disassembly, be prepared with spare seals for replacement if this unit needs to be immediately returned to service.



    Use a small blade screwdriver to remove the Retaining Ring that is holding the Seal in place. A long handle screwdriver can be used to pry the seal out of the groove, *but be extra careful not to scratch the surface of the seal housing or it will no longer seal properly*.

16. Once the old Seal is removed, a new one can be lubricated with marine grease (make sure the inside lip is packed well and the outside is lubricated too).



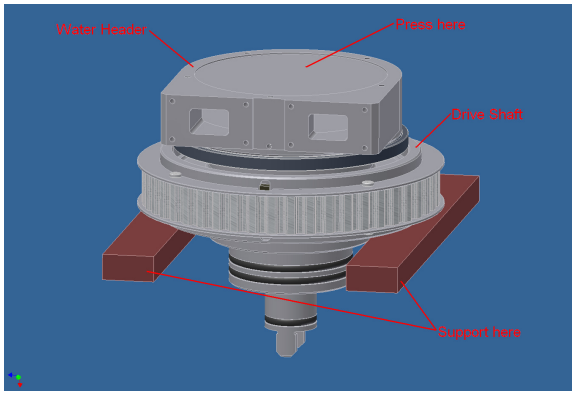
NOTE: All of the rotary seals in the Water Header Assembly are only sealing between water and atmosphere. Because there is no exposure to vacuum, the best lubrication to safely use is **marine grease**. This lubricant is water compatible and will offer a longer service life than vacuum compatible or standard grease.

Using the supplied plastic Press Fixture, the new Seal can be pressed into the Water Header housing with the cupped face of the seal going in first (the flat side faces up or towards the keyway). Make sure to keep the seal level and flat and only press it far enough so that the retaining ring can be reinstalled. Too much pressure could damage the seal. Be sure to replace the Retaining Ring that holds it in place.

Now lubricate a new Inner Seal with marine grease and place it in the Water Header Assembly, with the cupped side up, making sure that both spacers are replaced as well. Then the Electrical Bus Assembly can be replaced by reversing step 12.

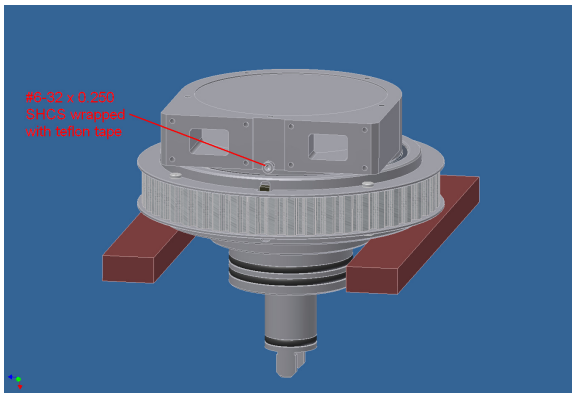
**Contact Angstrom Sciences if you need the press fixture to perform maintenance on the Endblock.*

17. Using a large arbor press or a hydraulic press, place the support blocks in the locations shown and carefully press the Water Header Assembly into the Drive Shaft Assembly. Make sure to keep them level and flat and only press them far enough so that the Bearing is just below flush with the face of the Drive Shaft. Too much pressure could damage the bearing.



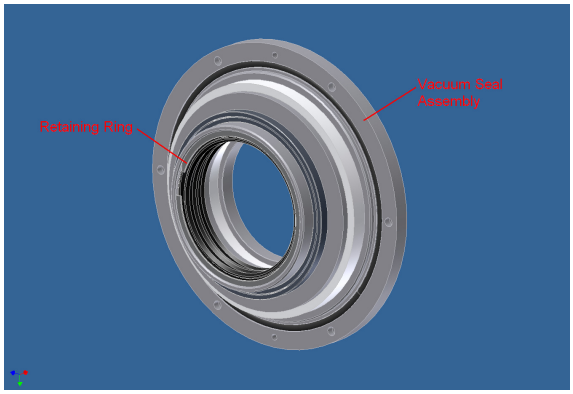
18. While keeping the Water Header pressed firmly into the Drive Shaft, replace the #6-32 x 0.250" SHCS back into the Water Header.

    NOTE: Make sure to wrap the #6-32 x 0.250" SHCS about 4 or 5 times with teflon tape prior to installation to ensure a leak-tight water seal.



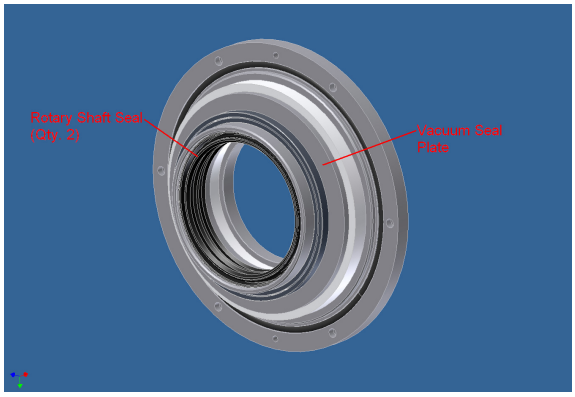
19. The Rotary Shaft Seals on the Vacuum Seal Assembly can now be serviced. Use a small blade screwdriver to remove the retaining ring that holds the rotary seals in place.

    It is important to note that disassembly of the Rotary Seals will usually cause them to distort. So, prior to complete disassembly, be prepared with spare seals for replacement if this unit needs to be immediately returned to service.

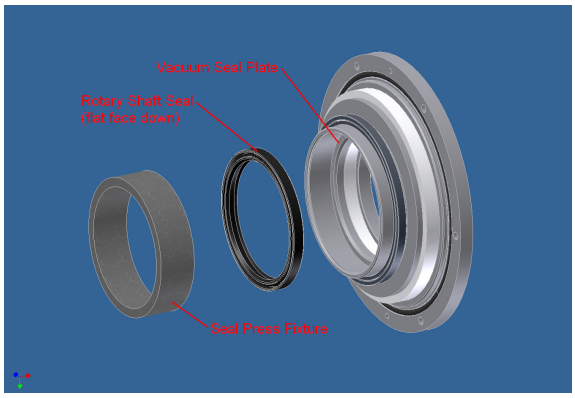


20. Now use a long handle screwdriver to pry each seal out of the groove, *but be extra careful not to scratch the surface of the seal housing or it will no longer seal properly*.

    NOTE: The cupped sides of the rotary shaft seals face towards the retaining ring in this picture (the flat sides are down).

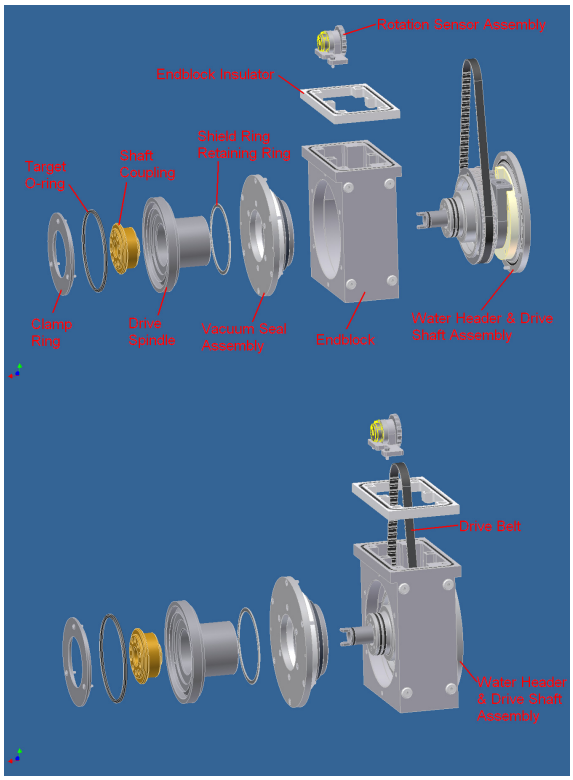


21. Using the supplied plastic Press Fixture, the new Seals can be pressed into the Vacuum Seal housing with the flat face of the seal going in first (the cupped side faces up or towards the retaining ring). Make sure to keep each seal level and flat and only press them far enough so that the retaining ring can be reinstalled. Too much pressure could damage the seals. Be sure to replace the Retaining Ring that holds them in place.



NOTE: These rotary seals are sealing between atmosphere and vacuum, so they must be lubricated with **Tribolube-15**, which is vacuum compatible (*do not use marine grease on these seals*).

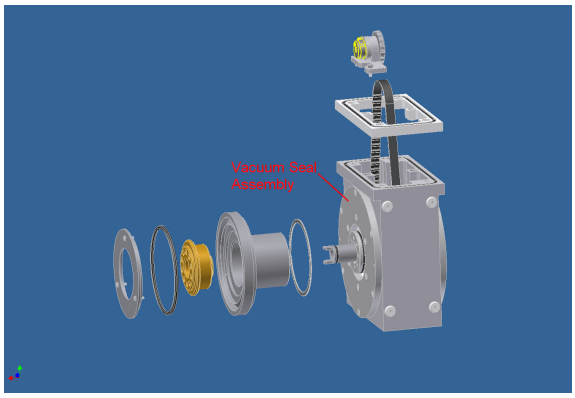
22. The picture to the right shows an exploded view of the subassemblies and various components as they fit into the Endblock. Before reassembling the Endblock, make sure everything has been cleaned and the proper lubrication used on all o-rings and seals.



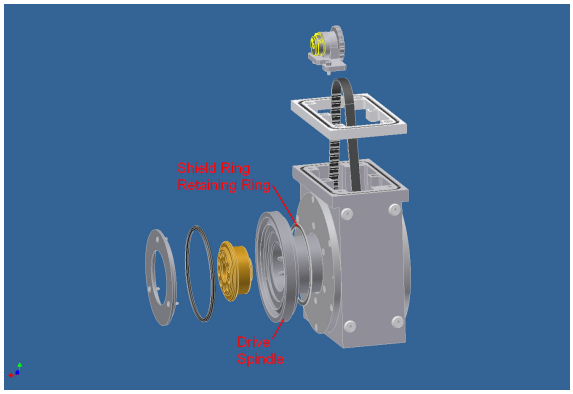
23. Now the Water Header and Drive Shaft Assembly can be installed into the Endblock. First, lay the Water Header and Drive Shaft Assembly flat on the Back Flange. Then take the belt and place it inside the Endblock from the top opening. Now hold the belt in the Endblock while placing the Endblock down over the Drive Shaft. Hold the Back Flange tight against the Endblock and sit it up in order to reinstall the (6) #10-32 x 0.500" SHCS.

Note: The (2) rectangular openings in the Water Header should be facing directly up so the Water Header Connection Kit can be attached.

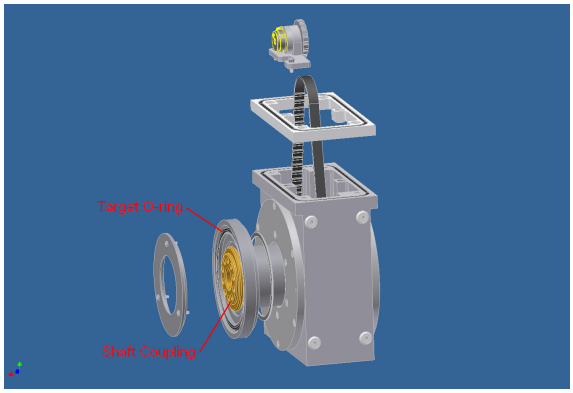
24. Now the Endblock assembly can be set flat on the Water Header Back Flange with the Water Tube facing up. Then carefully slide the Vacuum Seal Assembly over the Drive Shaft in order to reinstall the (6) #10-32 x 0.500" SHCS that secure it to the Endblock.



25. With the Endblock assembly still lying on the Back Flange, slide the Drive Spindle onto the Drive Shaft (it needs to be perfectly straight to go on because it is a tight fit). *Be sure to put the Shield Ring Retaining Ring on with the Drive Spindle or it will be difficult to do so later.* Now secure the Drive Spindle with the (8) #12-24 x 0.750" SHCS.

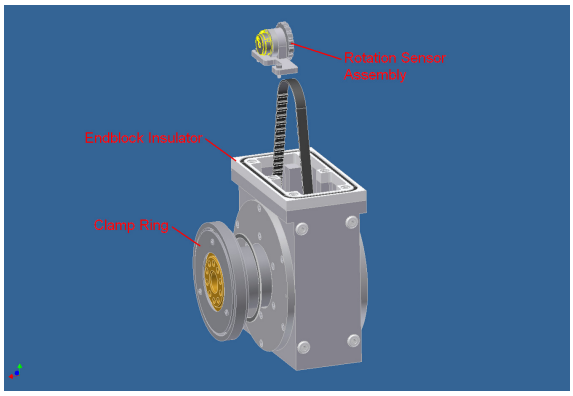


26. Now push the Shaft Coupling all the way into the Drive Spindle until it is firmly seated. Then the Target O-ring can be lubricated with a generous amount of vacuum grease and placed on the angled lip in the Drive Spindle.



27. The Clamp Ring should now be reattached with the (3) #6-32 shoulder bolts. Be sure that the o-ring is captured by the Clamp Ring, as the target seal is made when the Clamp Ring compresses inside of the Target and forces the o-ring to seal against the inside diameter of the Target tube.

    The Endblock Insulator can be set back on top of the Endblock now.

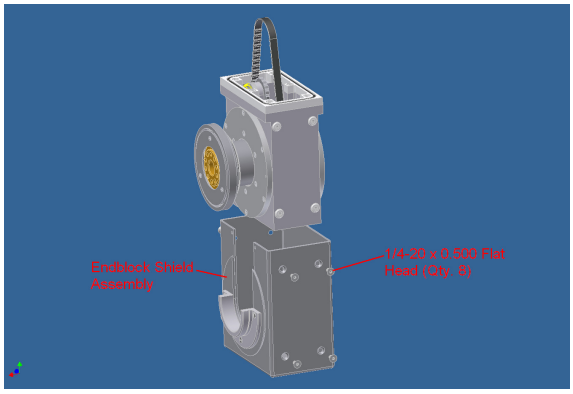


    Also, the Rotation Sensor Assembly needs to go back on using the (2) #8-32 x 0.500" SHCS.

    NOTE: The Tachometer Sensor Assembly is mounted in the center of the slots by default. Should the pulley happen to slip, it can be adjusted by loosening both SHCS, moving the assembly towards the belt and then retightening the SHCS. Take care not to make it too tight or that will put an unwanted load on the bearing for the tachometer sensor pulley and cause it to fail

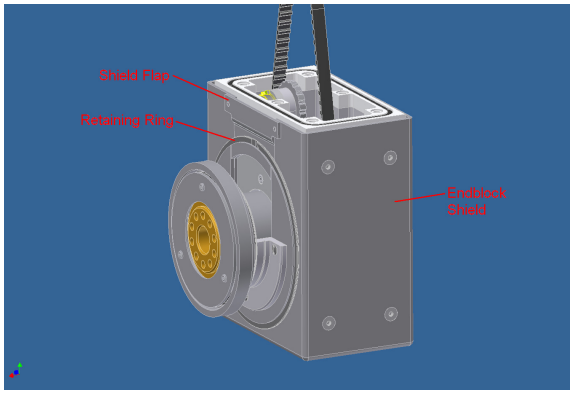
28. With the Endblock components reassembled, the shielding can be reattached.

    Note: If the shielding has coating buildup on it, it can be sandblasted clean before reassembly.

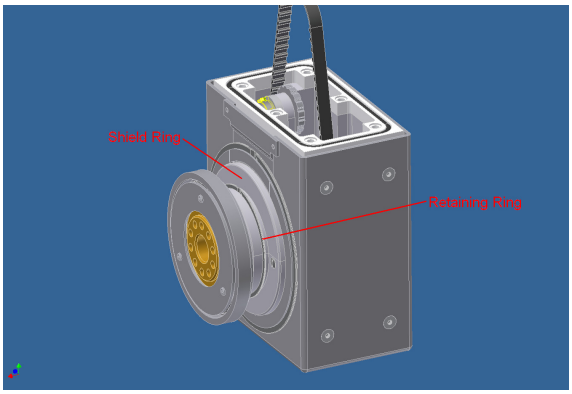


    Now the Endblock assembly can be lifted by the Drive Spindle and Belt, then set inside of the Endblock Shield Assembly and fastened on by the (8) ¼-20 x 0.500" flat head screws.

29. Next, the Shield Flap is attached by pushing the dowel pins into the holes in the Endblock Shield and then securing the flap with the Retaining Ring in the groove.



30. Finally, the Shield Ring should be placed on the lower ring and secured with the retaining ring. A screwdriver may be needed to slide the retaining ring into the groove, as there isn't much room for hands.



Debris Shield Cleaning

The main function of the Debris Shield is to capture any back-sputtered or gas phase scattered target material that would otherwise return to the Target surface. If the Debris Shields were not in place, this scattered material could lead to arcing on the Target surface, debris on the substrates, and even conductive electrical paths leading to ground and causing a short.

The Debris Shields are designed for easy removal and cleaning without the removal of the Target from the chamber or removal of the Target from the cathode body. Depending upon the amount of use and the deposition rate of the Target material, the Debris Shields may need to be cleaned as often as every 1-2 weeks. The following procedure will describe how to remove, clean and install the Debris Shield Assemblies.

Safety:

- *To prevent electrical shock, assure that power to the cathode is OFF.*
- *To avoid possible burns from working around a hot target surface, allow the target to rotate for at least 15 minutes, with cooling water flow, AFTER turning the power supply OFF.*
- *To avoid the entrapment of tools, clothing, or other materials that may cause either human or equipment damage, turn the target rotation OFF.*

1. To prevent the possibility of condensation on the target surface and reduce pumping times, turn OFF the cooling water flow through the cathode.

2. Remove the Debris Shields from the Cathode Assembly by reversing Steps 9-12 in the Target Mounting (for Cathodes with Debris Shields) procedure.

3. Once the Debris Shields are removed, they can be grit blasted for material removal. Many users have spare replacement debris shields assemblies that can be pre-cleaned and readily installed to reduce system downtime. At this time it is best to examine the SHCS and determine if they will need to be replaced when reattaching the Debris Shields.

4. For reassembly of the Debris Shields on to the Target Assembly, follow Steps 9-12 of the Target Mounting (for Cathodes with Debris Shields) procedure. To check successful reassembly, use an ohmmeter to check conductivity between the Debris Shield and the Target surface. This should be an OPEN (no contact) circuit. Then check each Debris Shield to the chamber or system ground. This also should be an OPEN circuit.

   For normal cleaning of the Debris Shields, the procedure is complete. If there is any conductivity found in Step 4, remove the Debris Shield and recheck the conductivity between the Debris Shield Insulating Rings and both the Target and ground.

Proceed to Step 5 if it is desired to clean the Insulating Rings or if electrical conductivity is found between the Insulating Rings and the Target/ground.

5. To access the Insulating Rings on the drive side of the cathode, first remove the Endblock Shield as shown in Steps 1-2 of the Rotary Seals Maintenance Procedure. Then the Insulating Rings can be removed by reversing Steps 6-7 of the Target Mounting (for Cathodes with Debris Shields) procedure on the drive side.

6. To take the Insulating Rings off of the support side of the cathode, reverse Steps 6-7 of the Target Mounting (for Cathodes with Debris Shields) procedure.

7. Once the Insulating Rings are removed, they can be grit blasted for material removal. At this time it is best to examine the plastic Insulators to determine if they will need to be cleaned or replaced before reattaching the Debris Shields. If there is trapped debris covering them, they can usually just be cleaned and reused. But, if there are signs of arcing or burning, then they will need to be replaced. Reassemble the Insulator Rings by reversing the above steps. Then check the Debris Shields for a short using an ohmmeter as described in Step 4 above.

Magnet Array Optimization Techniques

The following section explains the methods used to tune the magnet pack in order to achieve the desired performance. Instructions for physically adjusting the shims and shunts on a magnet kit are provided in the Magnet Kit Shimming and Magnet Kit Shunting sections, respectively.

Adjusting Uniformity with Shims and Shunts:

To assure repeatable performance, the magnet array should be tuned under the following process conditions:

- The thin film should be sputtered in 100% argon or other inert gas. Trying to adjust the uniformity under reactive gas conditions will not provide accurate results due to any non-uniformities in gas flow conditions.
- The target being tuned should be new. Tuning the uniformity produced by a used target only compensates for the erosion profile of the target surface being sputtered. Although a used target can be tuned, when a new target is installed the uniformity will change once again due to a different erosion profile at the target surface.

Shims:

The magnet array kit should include the following minimum quantity of shim thicknesses per shim location:

(1) 0.125” thick (only used in certain designs)
(1) 0.060” thick
(1) 0.030” thick
(1) 0.015” thick

The total sum of all shims placed in any single location should not exceed 0.125” (0.250” in certain designs). There is a danger of interference between the target ID and magnet pack, which could cause damage that is both costly in terms of finance and time.

There should be sufficient shim count to install them at every position where the magnet section is attached to the magnet support tube.

*Some of the shims may have been installed prior to shipment.

Shims are used to help tune large slopes in the uniformity profile, typically more than ½ meter in length. The basic rule is that 0.015” can compensate for ~ 2.0% in uniformity alignment. If your uniformity profile is thick at one end and 4% thin at the other, then the following options are available:

a. For the end that is too thick, remove 0.030” of shim stock
b. For the end that is too thin, insert 0.030” of shim stock
c. Remove 0.015” from the thick end and install 0.015” at the thick end

Shunts:

Like the use of shims, and for the same reasons, shunts are recommended to be inserted and used to tune the uniformity of new target tubes.

Shunts can be used to treat small areas of perturbation in the uniformity, typically 4-8”. For longer or shorter regions, the shunts can be cut or put next to one another. The shunt holders attach to the magnet array support tube and are capable of installing a shunt attached on either one or both sides of the magnet array.

Shunt adjustments:

- The shunts are slotted to allow adjustment based on the amount of non-uniformity to be corrected.
- Just installing 1 shunt where no shunts were previously located, at the lowest position, will change the uniformity in this region by 1-2%. Movement of one (1) shunt up towards the ID of the backing tube will change uniformity by ~ 1%/mm. Therefore if (2) shunts are moved, the change will be doubled.
- Shunts are used to reduce the local film thickness (where the non-uniformity is too thick!). They are not intended for increasing film thickness in a single location.

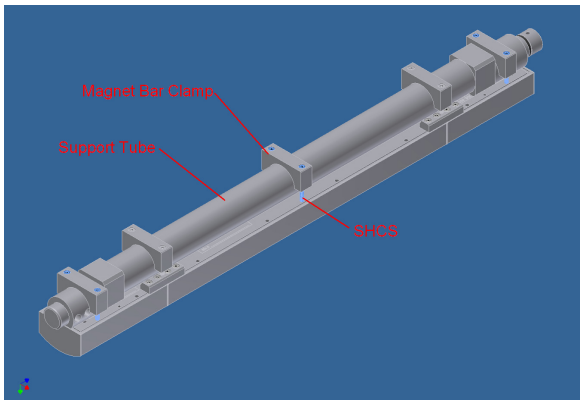
Magnet Kit Shimming

The Magnet Kit may be shimmed at various set locations in order to "dial-in" the uniformity by adjusting the magnetic field strength. For instance, if the coating thickness is too low along a given length of the bar, shims may be placed under the bar at the set locations to bring the magnets closer to the target surface and achieve better uniformity. Generally, a "run" is performed and the uniformity data is analyzed to determine the location and thickness of any necessary shims. The shims are then installed and the process is repeated until the desired uniformity is reached.

1. Remove the Magnet Kit and Support Tube from the target tube assembly.

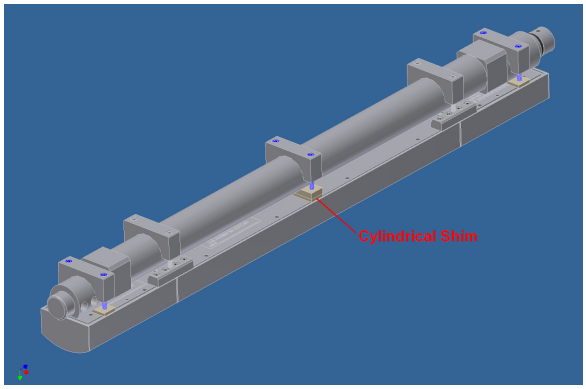
2. The shims are located by the SHCS that hold the Magnet Bar Clamps onto the Support Tube. Remove these SHCS and the Magnet Bar Clamps.

   *Be sure to note the distance from the end of the Support Tube to the end of the Magnet Kit on each side in order to reassemble properly.



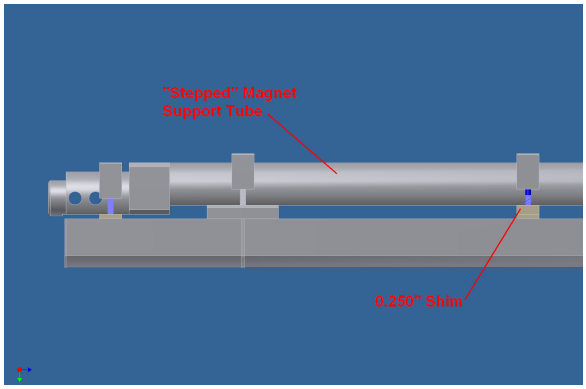
3. Insert the necessary shims as determined by analyzing the uniformity data and following the Magnet Array Optimization Techniques and replace the Target Clamps and SHCS.

   *Be sure to evenly tighten the SHCS on both sides of the Magnet Bar Clamps.



   Torque specs for fasteners:
   #8-32 SHCS = 20 in-lbs / 2.3 N-m
   #10-32 SHCS = 30 in-lbs / 3.4 N-m

NOTE: For a less common "stepped" Magnet Support Tube design, an additional 0.250" shim will need to be placed along the center section of the tube if it is not already there. The Magnet Kit is generally designed to be shimmed no more than 0.125" from the closest section of the Support Tube.



4. The Magnet Kit and Support Tube can now be installed back into the target tube assembly. After that, the Magnet Kit to target tube assembly clearance can be checked by rotating the Target (or Magnet Kit and Support Tube) and listening for any rubbing of the Magnet Kit on the inside of the Backing Tube. If no rubbing is detected, it is acceptable to run the target. Otherwise, shims must be removed until clearance is achieved between the Magnet Kit and Backing Tube.

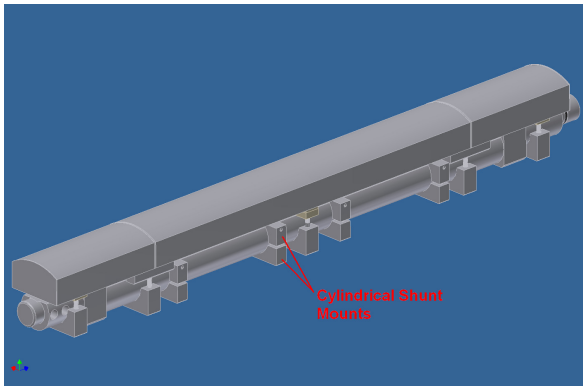
Magnet Kit Shunting

The Magnet Kit may also be shunted in order to "dial-in" the uniformity if the magnetic field needs to be decreased at specific locations along the bar. To do so, a "run" is performed and the uniformity data is analyzed to determine the location and strength of any necessary shunting. The shunts are then installed and the process is repeated until the desired uniformity is reached.

1. Remove the Magnet Kit and Support Tube from the target tube assembly.

2. Remove the Magnet Kit from the Support Tube by removing the SHCS and Magnet Bar Clamps from the Support Tube.

   *Be sure to note the distance from the end of the Support Tube to the end of the Magnet Kit on each side in order to reassemble properly.



3. Install the Shunt Mounts at necessary locations along the support tube as determined by following the Magnet Array Optimization Techniques described above.

   *Be sure to evenly tighten the SHCS on both sides of the Shunt Mounts.

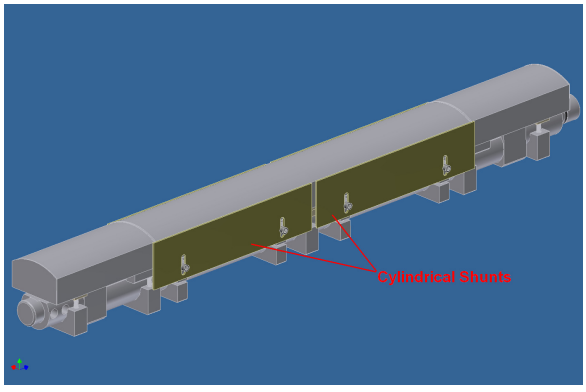
   Torque specs for fasteners:
   #8-32 SHCS = 20 in-lbs / 2.3 N-m
   #10-32 SHCS = 30 in-lbs / 3.4 N-m

4. Now the Magnet Kit can be reinstalled onto the Support tube with the Magnet Bar Clamps and SHCS that were removed earlier.

   *Be sure to evenly tighten the SHCS on both sides of the Magnet Bar Clamps.

5. Install the shunts on the mounts at the desired height as determined by the Magnet Array Optimization Techniques.

6. The Magnet Kit can now be replaced as described in step 4 of the Magnet Kit Shimming Procedure.



Maintenance Cycles

The following table lists the periodic maintenance that is recommended for the cathode. For detailed instructions on how to perform the maintenance, refer to that particular section of the manual.

Item	Frequency	Description
Water Seals	Every 24 months	Inspect and replace seals
Vacuum Seals	Every 24 months	Inspect and replace seals
Debris Shields	Every 1-2 weeks	Inspect and clean assembly

Warranty

The magnetron is covered by a 2-year warranty contingent upon regular execution of Drive Housing and Water Housing maintenance procedures. Angstrom Sciences offers "maintenance" options as outlined in the following "Maintenance / Rebuild Options" section.

Addendum A – Voltage Transformer

As stated in the Electrical Connections procedure, the motor controller and rotation display must be connected to a 115/230VAC, 50/60 Hz power source. If this is not available, a voltage transformer can be included with the cathode upon request. Otherwise, it will be necessary to obtain one in order to make the above electrical connections. The voltage transformer must convert to 115/230 VAC at 50/60 Hz. It is preferable to have (2) U.S. style outlets on the transformer or a compatible power strip (115/230 VAC, 10 Amps or greater) will also be needed. With the necessary hardware, it is now possible to connect the power strip to the transformer and then connect the motion controller and rotation display as described in the Electrical Connections procedure.