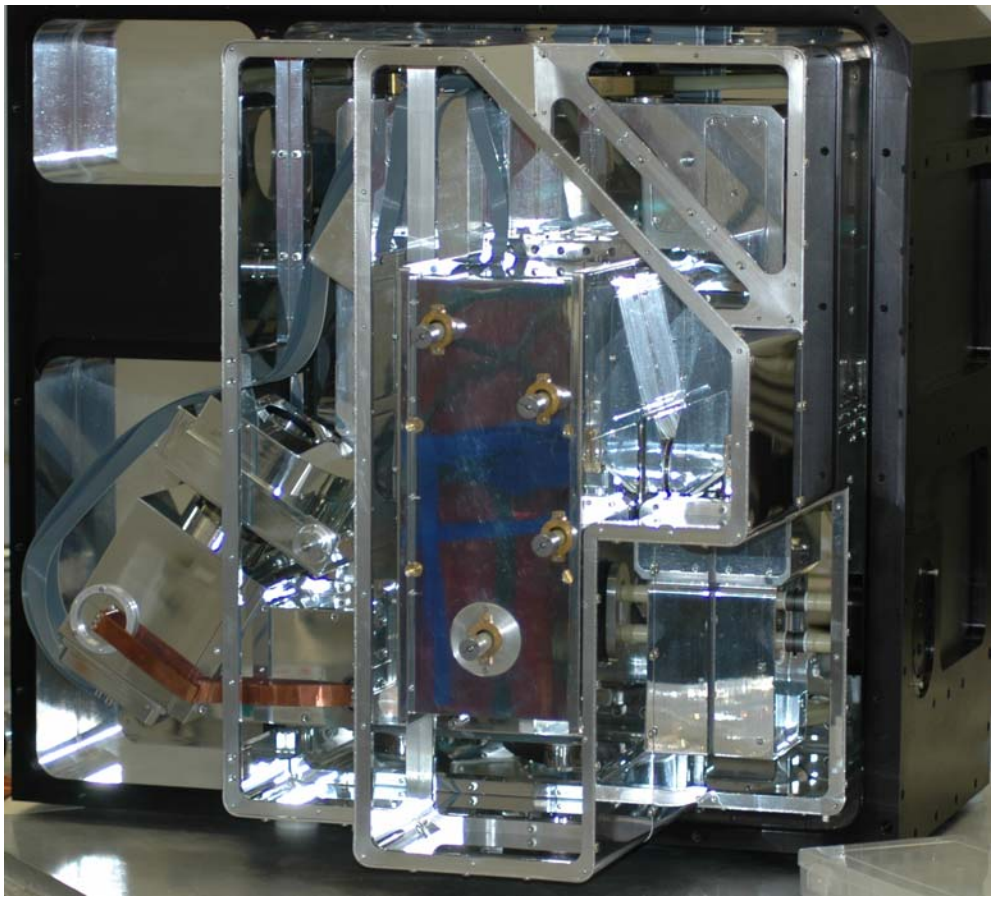
NICI Cryostat Assembly Procedure

11/17/04



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1.0 General Guidelines

The procedure outlined in this document is just one way that the instrument can be assembled. The main purpose of this document is to define the order of assembly and identify and hidden issues.

1.1 Safety issues

Refer the the NICI safety document before performing any operation on NICI.

NICI is a large instrument with individual elements weighting more than 200 Lbs. A very strong table must be used for assembly. Two overhead cranes are required for some operations. Lifting straps rated for 2,000 lbs are recommended.

NICI contains static sensitive elements. Proper static procedures must be followed or valuable detectors and circuits can be damaged.

NICI contains high quality optical elements that cost up to $25,000. Extreme care must be taken not to damage the optical element surfaces.

NICI uses many Orings and has many oring surfaces that have been careful polished. Care must be taken not to damage these oring surfaces.

NICI has many highly polished surfaces inside the cryostat. Gloves should be worn at all times when working in the cryostat.

1.2 Screw Torques

Specifying screw torques is very difficult. Maximum torque is dependent on the type of screw, the type of head on the screw, how clean the screw is, what material the screw is screwed into, whether a washer is used and the length of engagement as well as other issues. Additionally NICI has plain screws, vented screws and captive screws.

Realistically NICI is assembled primarily without torque wrenches because they will not fit in many places and they do not allow tactile feedback. Most instruments like NICI are assembled by experience technicians who feel how a screw is tightening and know when to stop. Indeed no screws were broken in NICI during assembly. However it is reasonable to ask what is an appropriate maximum torque for the different screws in NICI. To answer this question we did an experiment. The experiment tested two parameters. To what torque are screws tightened in NICI by the technician and at what torque will the screws break. The results are shown in the table below. The recommended torque column is from web literature. We compared our torques with what we found in the literature and were surprised that our torques were substantially

higher than recommended torques. We rechecked the experiment and believe that our results are correct. We believe that the difference is that the screws are very clean, much cleaner than normal conditions and going into aluminum with no washers. These issues greatly increase the friction on the screw threads and head and increase the torque.

This table should be used as a guideline. There really is no substitute for an experienced technician for assembly.

Screw Torque Table

screw size	screw type	length inches	recommended torque *	measured actual torque	measured breaking torque	torque units
2-56	non-vented	3/8	3.8	8	10	in lbs
2-56	vented	3/8		8	10	in lbs
2-56	captive	3/8		6	8	in lbs
2-56	captive vented	3/8		4	6	in lbs
4-40	non-vented	3/8	6	14	18	in lbs
4-40	vented	3/8		12	15	in lbs
4-40	captive	3/8		12	14	in lbs
4-40	captive vented	3/8		12	14	in lbs
6-32	non-vented	3/8	15	28	38	in lbs
6-32	vented	1/2		28	38	in lbs
6-32	captive	1/2		22	30	in lbs
6-32	captive vented	1/2		22	30	in lbs
6-32	black(alloy steel)	1/2	28	46	54	in lbs
8-32	non-vented	5/8	2.3	5	8	ft lbs
8-32	vented	1/2		5	8	ft lbs
8-32	captive	1/2		5	8	ft lbs
8-32	captive vented	1/2		5	8	ft lbs
8-32	black(alloy steel)	1/2	4.1	10	wrench broke	ft lbs
10-32	non-vented	1/2	3.3	8	12	ft lbs
10-32	vented	3/4		8	12	ft lbs
10-32	captive	1/2		8	10	ft lbs
10-32	captive vented	1/2		8	10	ft lbs
1/4-20	non-vented	5/8	7.9	18	22	ft lbs
1/4-20	vented	7/8		18	22	ft lbs
1/4-20	captive	1/2		18	22	ft lbs
1/4-20	captive vented	3/4		18	20	ft lbs
1/4-20	black(alloy steel)	1 1/4	12.5	22	35	ft lbs
3/8-16	non-vented	1 1/4	25.1	45	60	ft lbs
3/8-16	vented	1		45	50	ft lbs
1/2-13	non vented	2	62.5	80	120	ft lbs

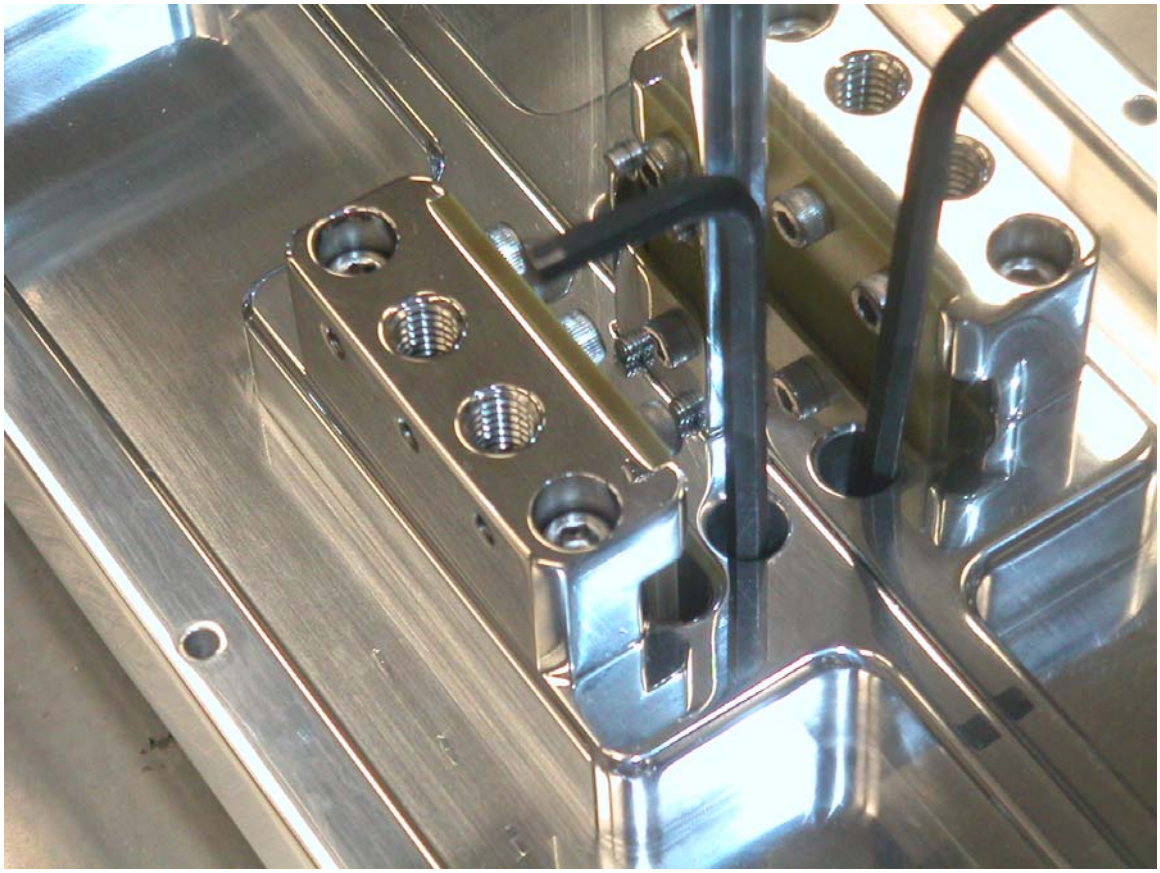
* http://www.smithfast.com/ssshcsinfo.htm data for torque stainless screws
http://www.spstech.com/aero/prod_lit/socket_brochure.pdf data for alloy steel screws

2.0 Full Instrument Assembly

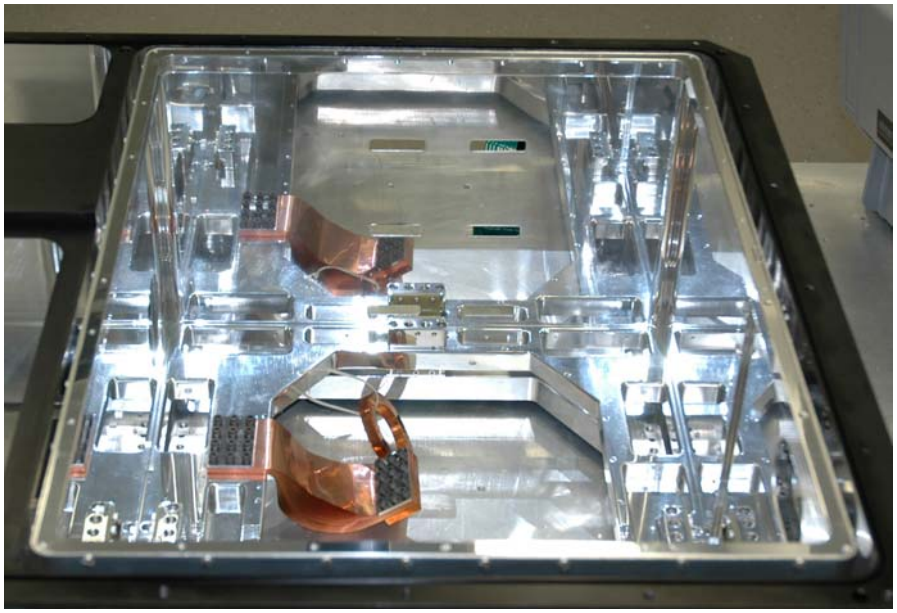
This section documents the full assembly procedure of the cryostat. This procedure will rarely if ever be necessary since most needed service can be done without this level of disassembly. Later sections will document the expected service issues. This procedure assumes that the cryostat is fully disassembled but that the mechanism subassemblies have been assembled as specified in the assembly drawings. NICI drawings have been given the 89-MKIR-4150-XXXX designation. When a part number is referred to just the last four digits will be used.

Installation of radiation shield main shield (#4808) into vacuum jacket main body (#9406)

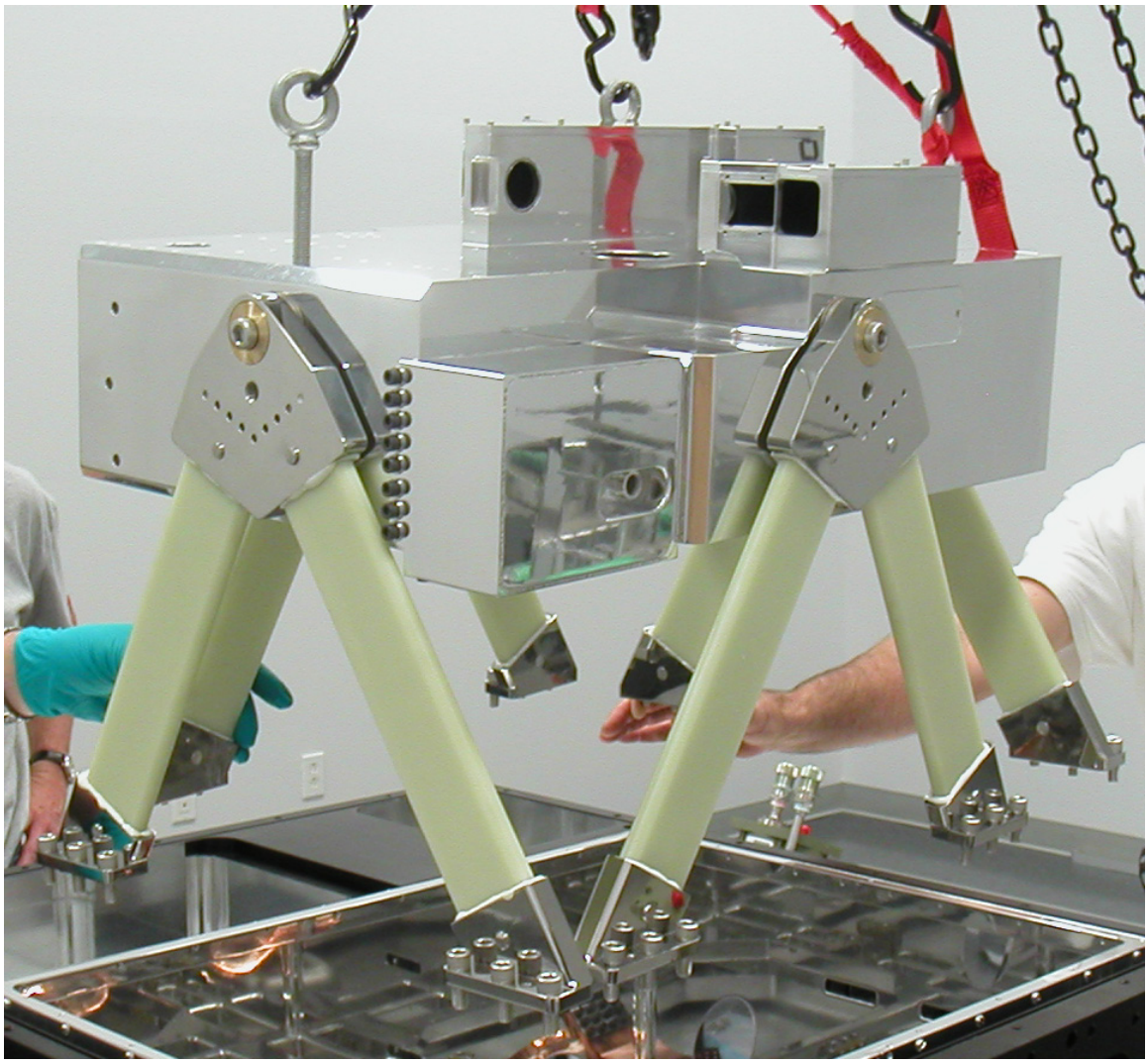
Install four fiberglass shearweb # 4810 with feet #4811 onto the main shield.
With the vacuum jacket main body flat on a sturdy table lower the radiation shield into the vacuum jacket.



Screw Radiation shield shearweb blocks to the vacuum jacket through holes in the radiation shield.



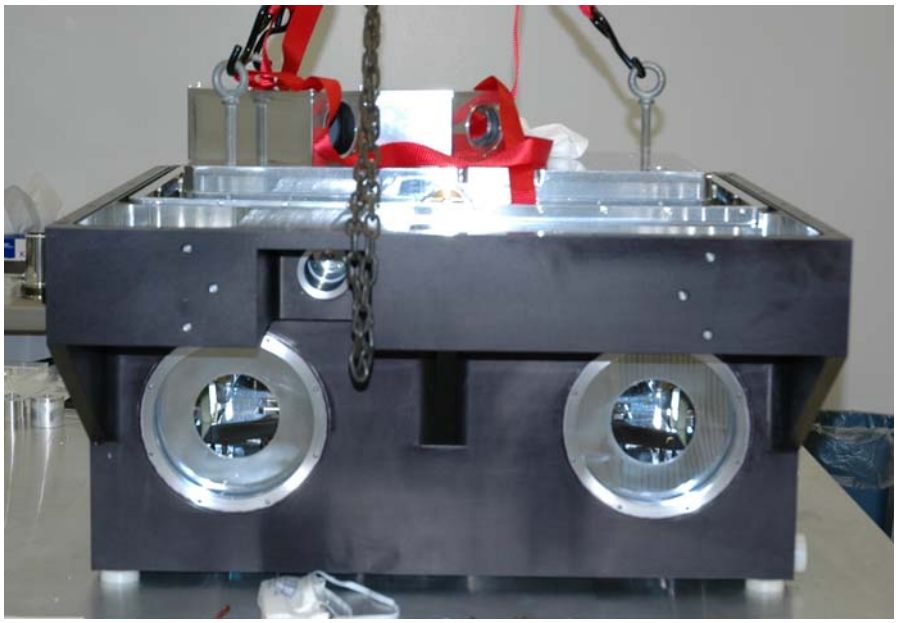
Install Multi-layered Cold Shield Strap to the radiation shield.

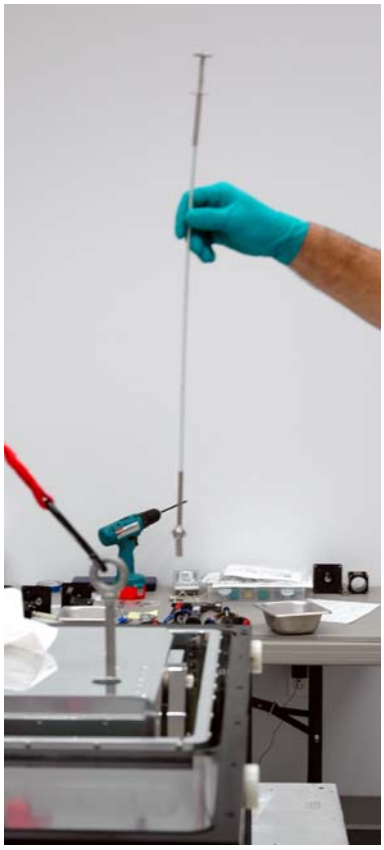


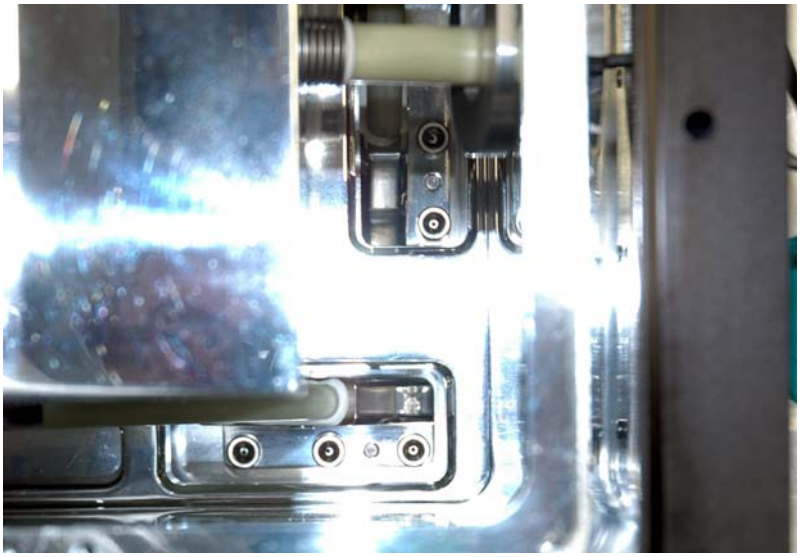
Hang the cold structure # 5100 using an overhead crane and three straps to the three eye bolts. Install v-trusses onto cold structure with the screws slightly loose. Although the picture shows the screws already installed in the truss feet these should be left out until the trusse pins are engaged with the vacuum jacket.

The prechare can must be bolted into the cold structure before it is inserted into the vacuum jacket. This is showing in the front corner.

Slowly lower the cold structure and trusses into the radiation shield/vacuum jacket the v-trusses must be manually positioned so that the dowel pins align. Two people are required for this.







Insert the screws using a long grabber. Screws can then be tightened using a long wrench.

Tighten the V-truss apex screws using the special NICI v-truss apex screw wrench.

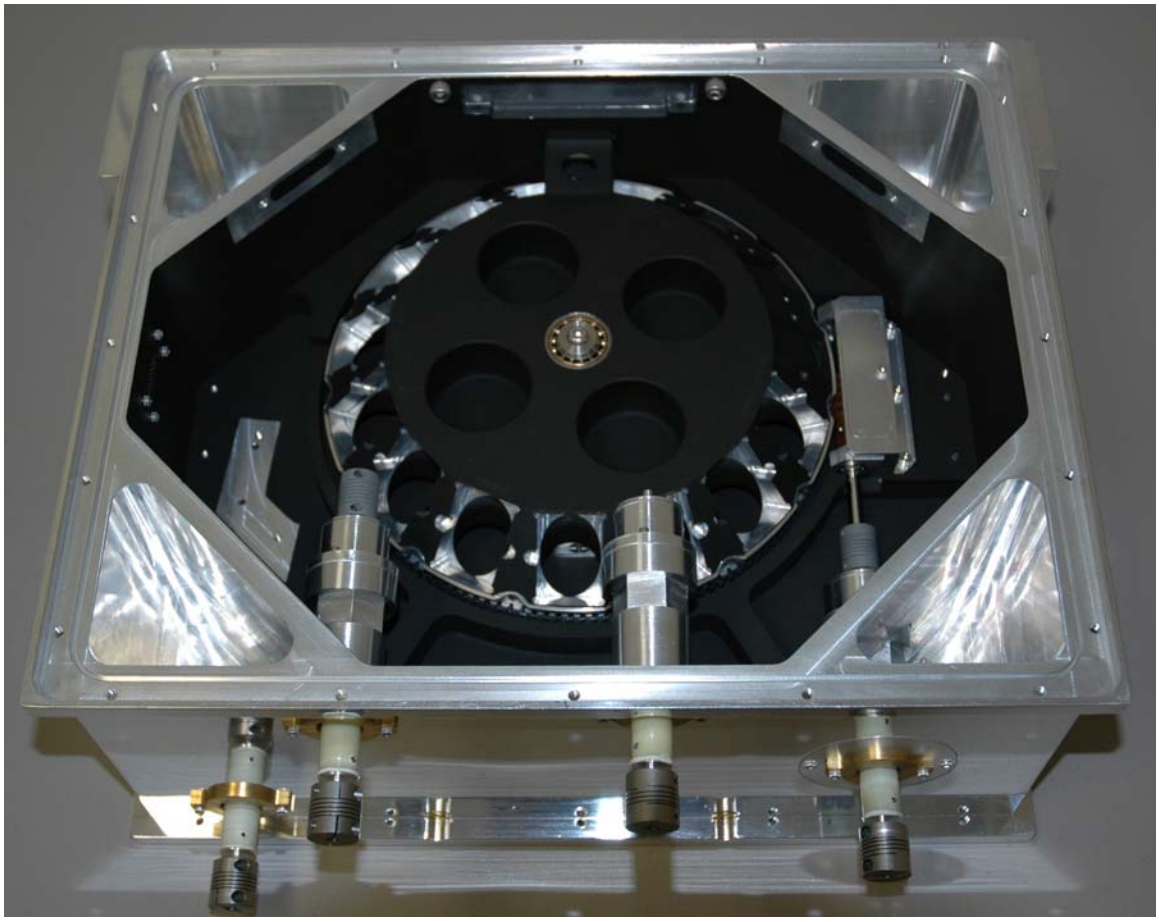
Install the Precharge can flange (no picture)

Next the Mechanism box must be assembled before it is integrated.
Starting with the Red filter wheel.
Preassemble the fixed rollers, flex rollers, detent assembly, drive assembly, dichroic wheel outrigger assemblies and light tight feed through.

Installation is in the following order:
Light tight feedthrough
Worm drive assembly
Fixed rollers
Dichroic wheel outrigger assemblies
Red Filter wheel
Flex rollers
Detent assembly

Adjust the position of the flex rollers to give the desired preload on the wheel. Preload should be greater than the wheel mass.

Filpping the mechanism box over the dichroic wheel is next.

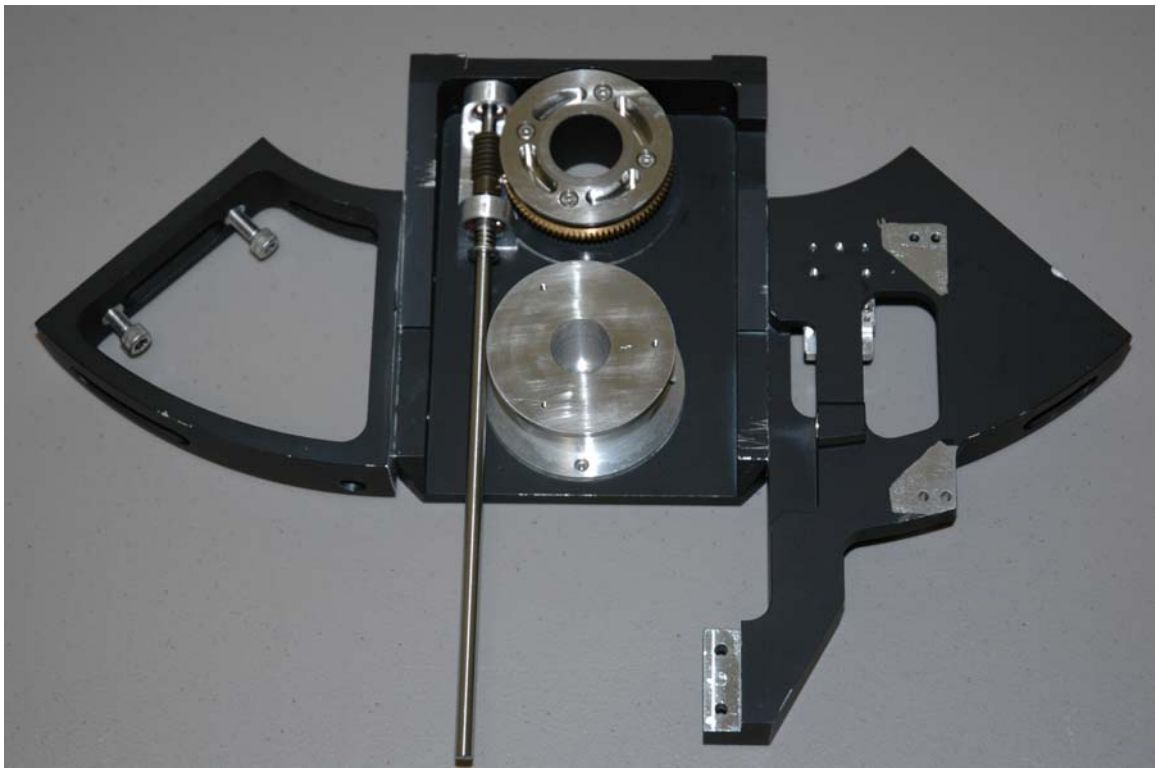


Install the center shaft and then the dichroic wheel. Pay special note to the order of the bearings, spacers and shims as defined in the assembly drawing.

The dichroic wheel is a critical mechanism since it can steer the beam. The height of the outriggers and the bearing spacers have been carefully adjusted so that the wheel runs true and is preloaded so that it will not tilt when the instrument is tilted. If diassembled it must re reassembled exactly as it was in order to work correctly.

Next install the worm drive and light tight feedthrough and then the detent assembly.

Assemble upper mechanism Support Bracket #7114 and install pupil wheel bearing assembly.



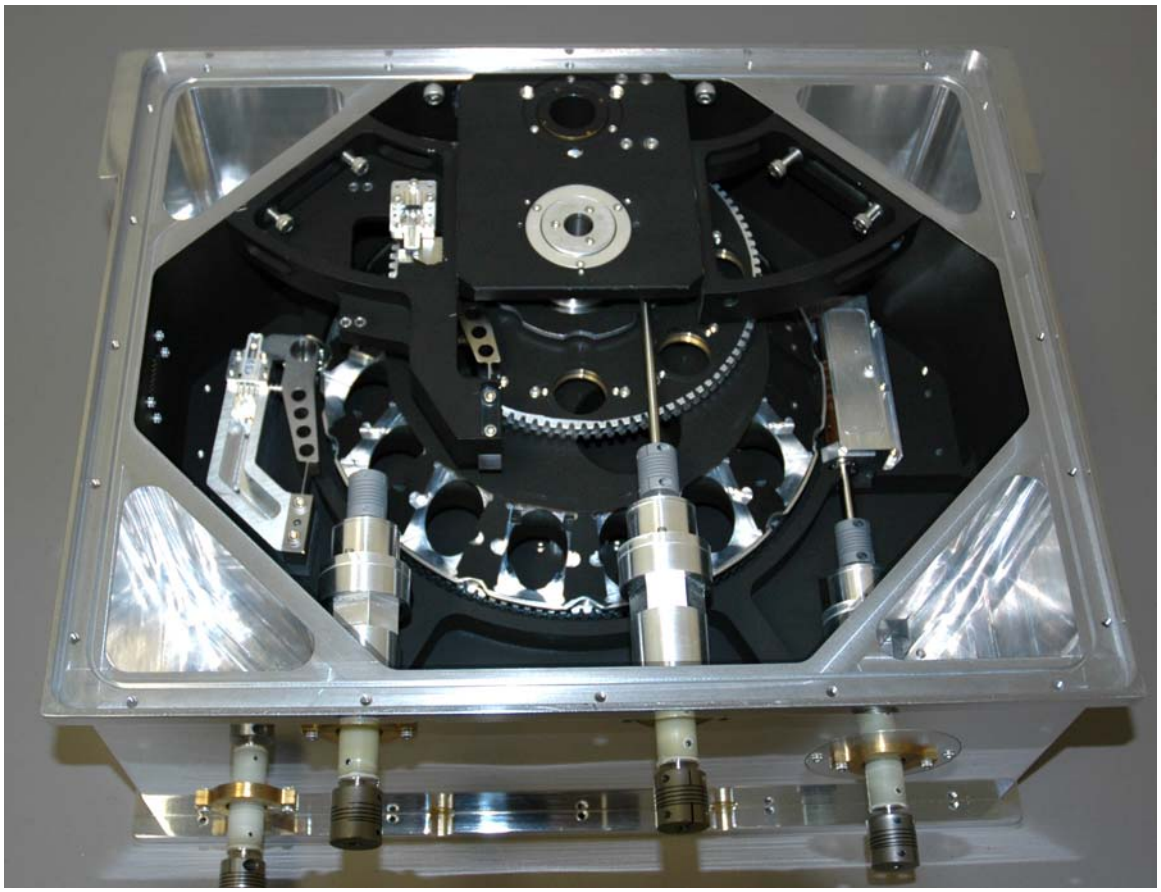
Install the spider mask rotator assembly #9100 and then the spider mask worm drive #9200.

Next install the pupil wheel detent assembly.

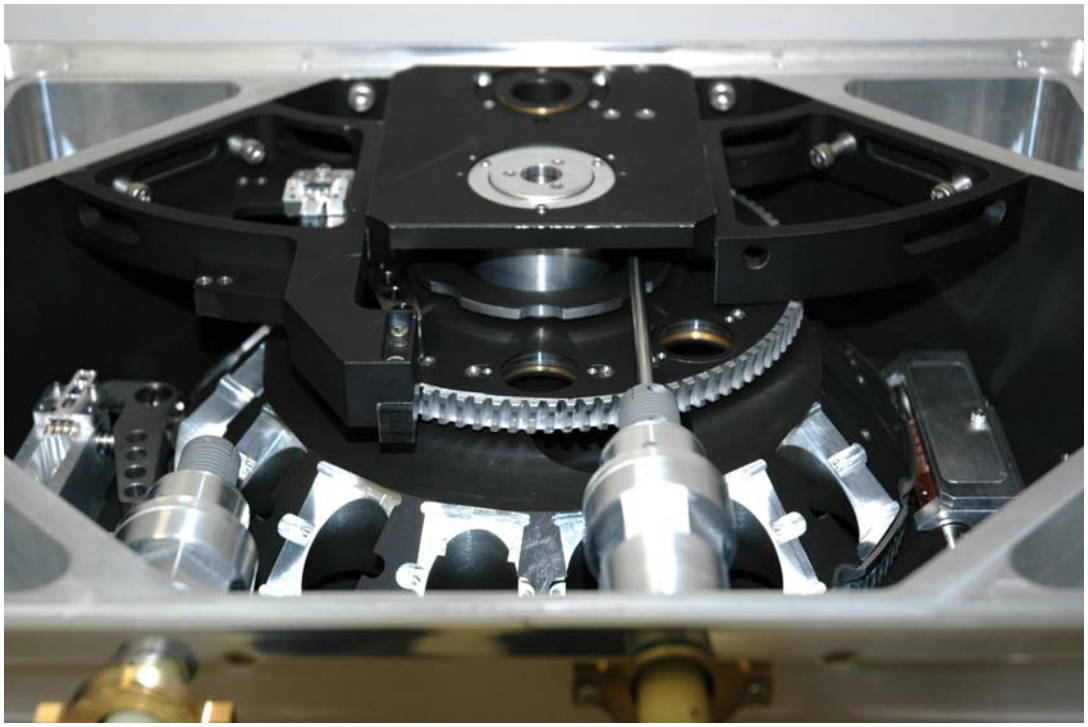
Next install the pupil wheel. Note the punch mark on the wheel that needs to line up the a punch mark on the bearing assembly for proper alignment. Install the pupil wheel detent ring.

This shows the position of the mark on the bearing assembly.

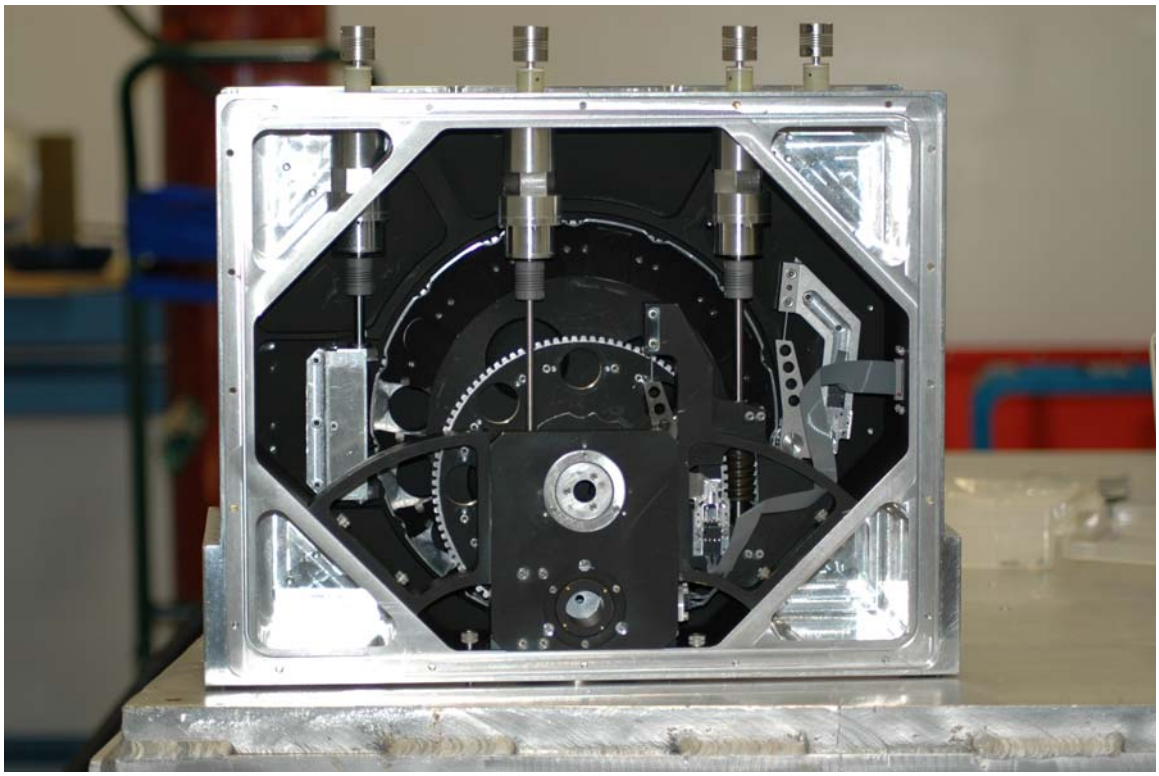
Install the pupil mask wheel on to the bearing assembly. The detent will have to be pulled out to do this.



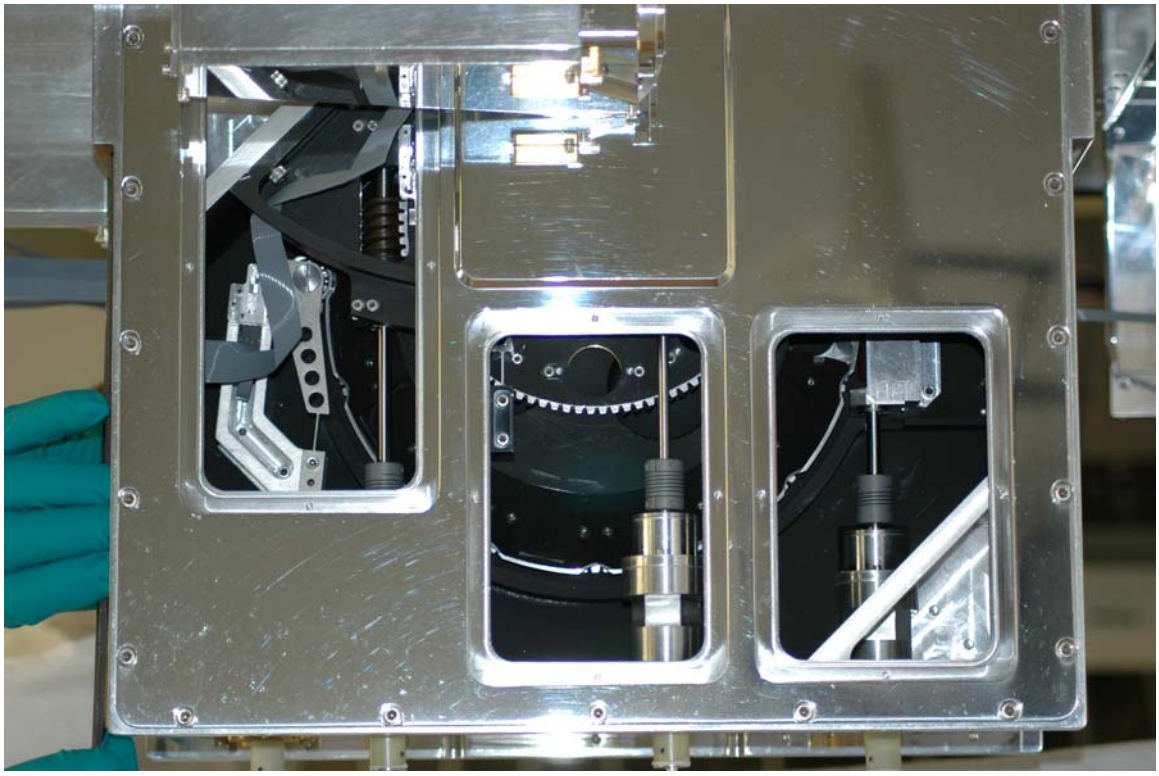
Insert pupil mask wheel, spider mask rotator and support bracket into the mechanism box.

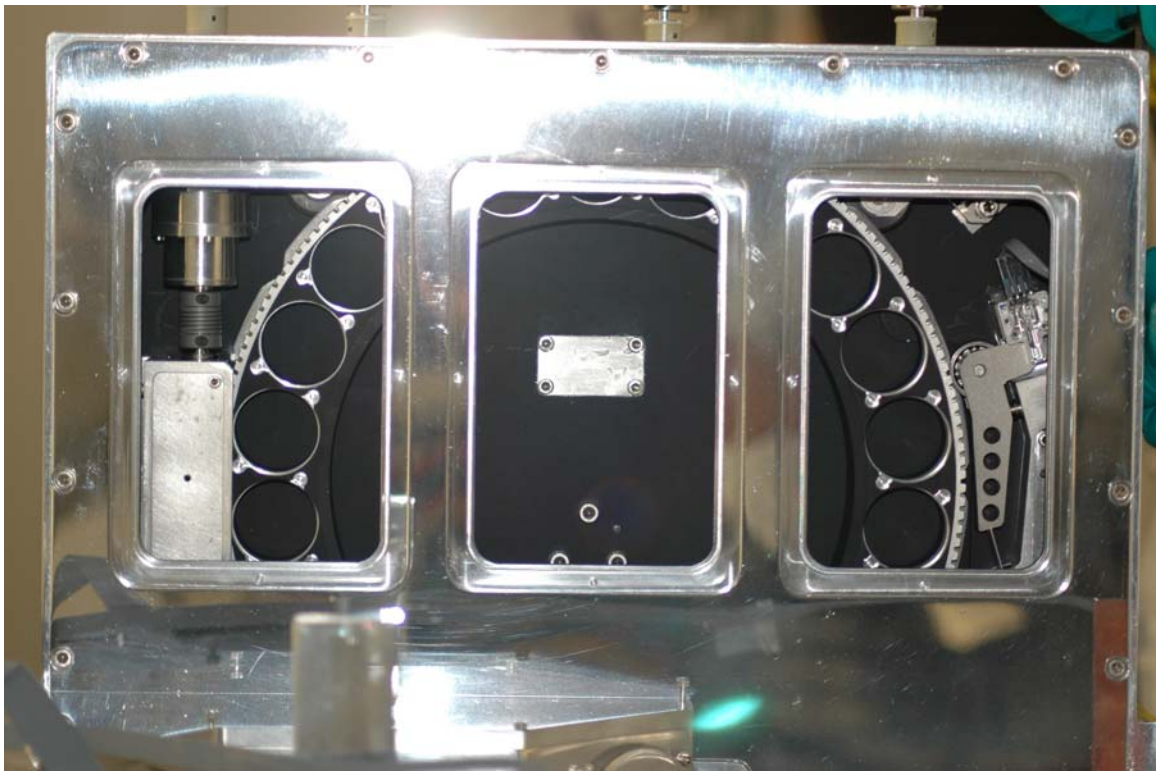


Install the pupil wheel worm drive assembly.

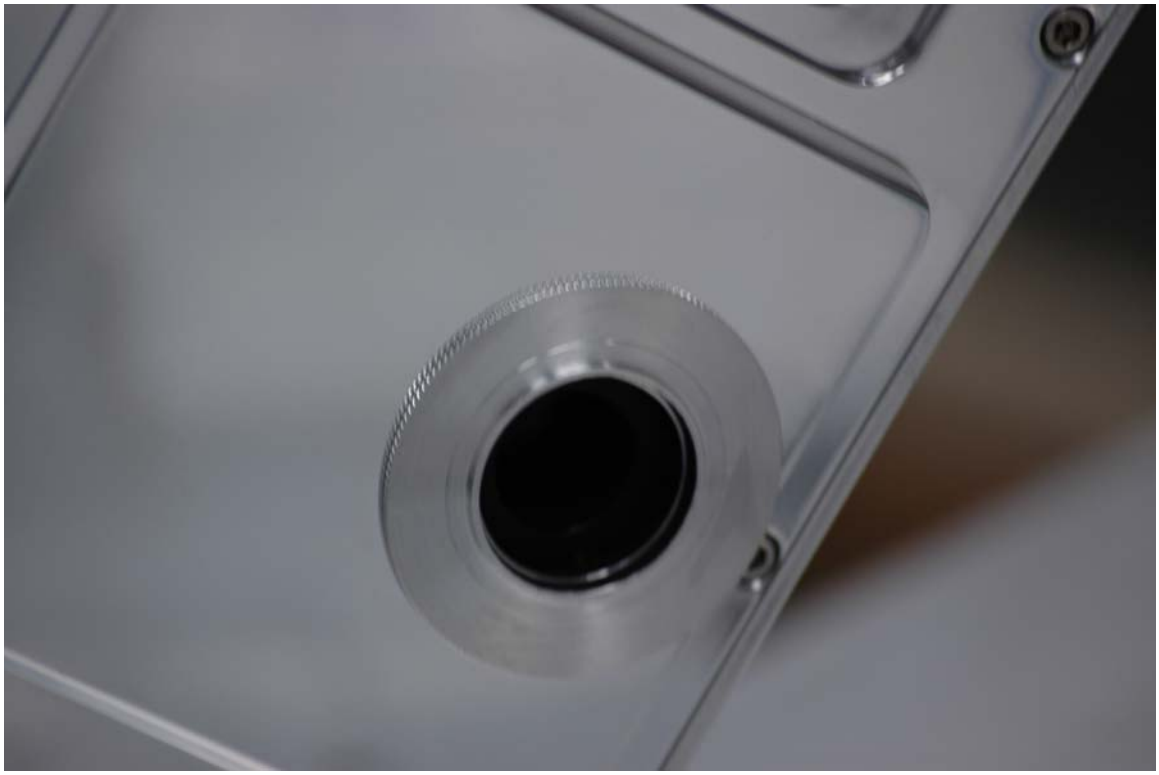


Completed Mechanism Box

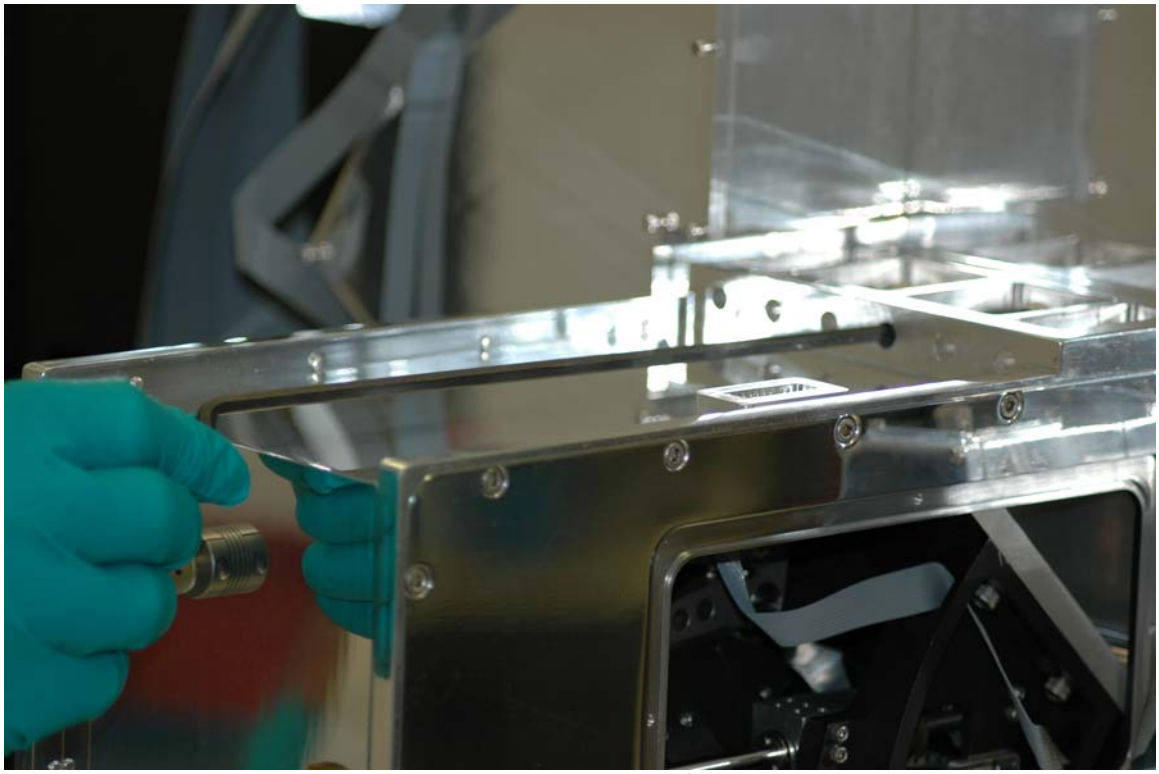




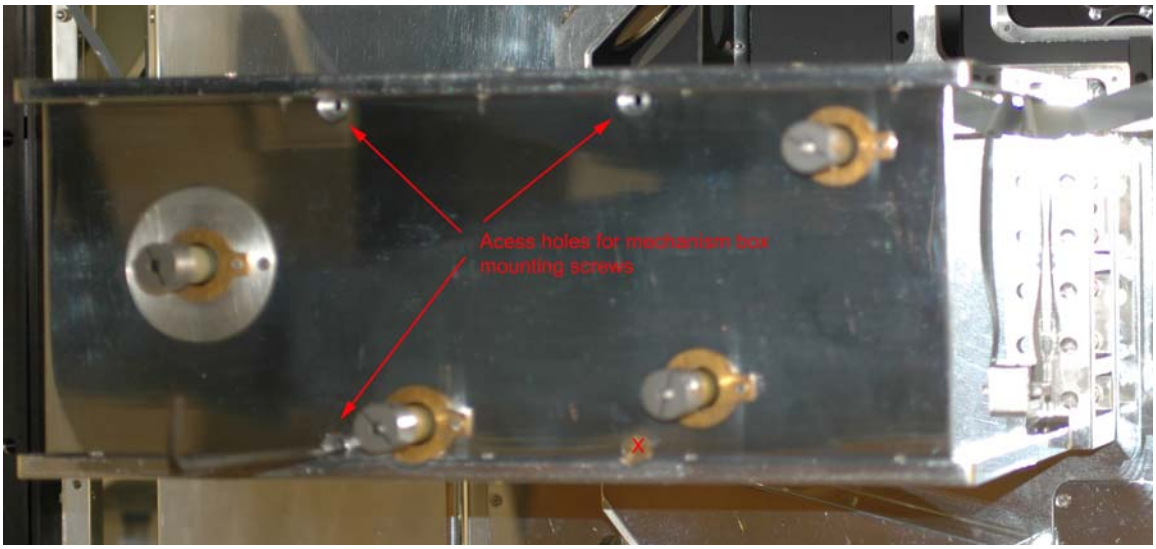
Install the mechanism Box covers and the sub covers(not shown).



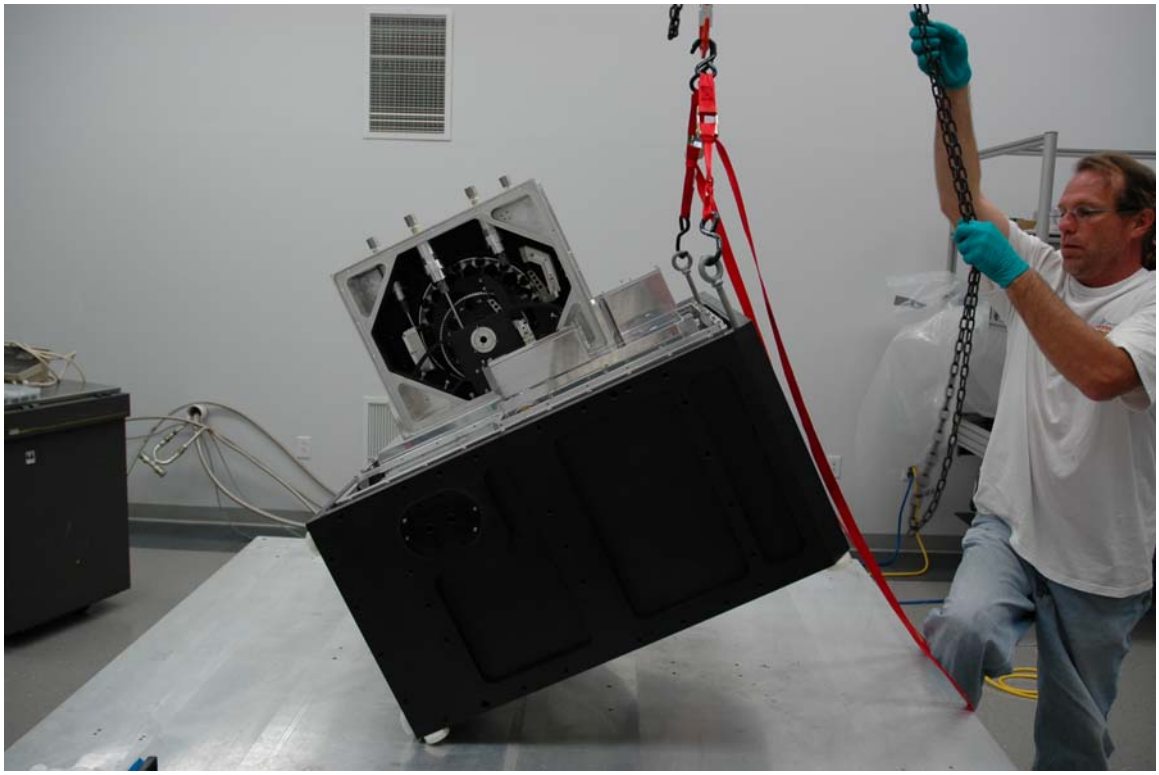
The mechanism box is equipped with two threaded light seals, one on each side. These seals have a tongue that engages with a groove in the cold structure. To install the mechanism box onto the cold structure these seals must be screwed all the way into the mechanism box until the mechanism box is bolted in place and then unscrewed until they stop to make the light seal.



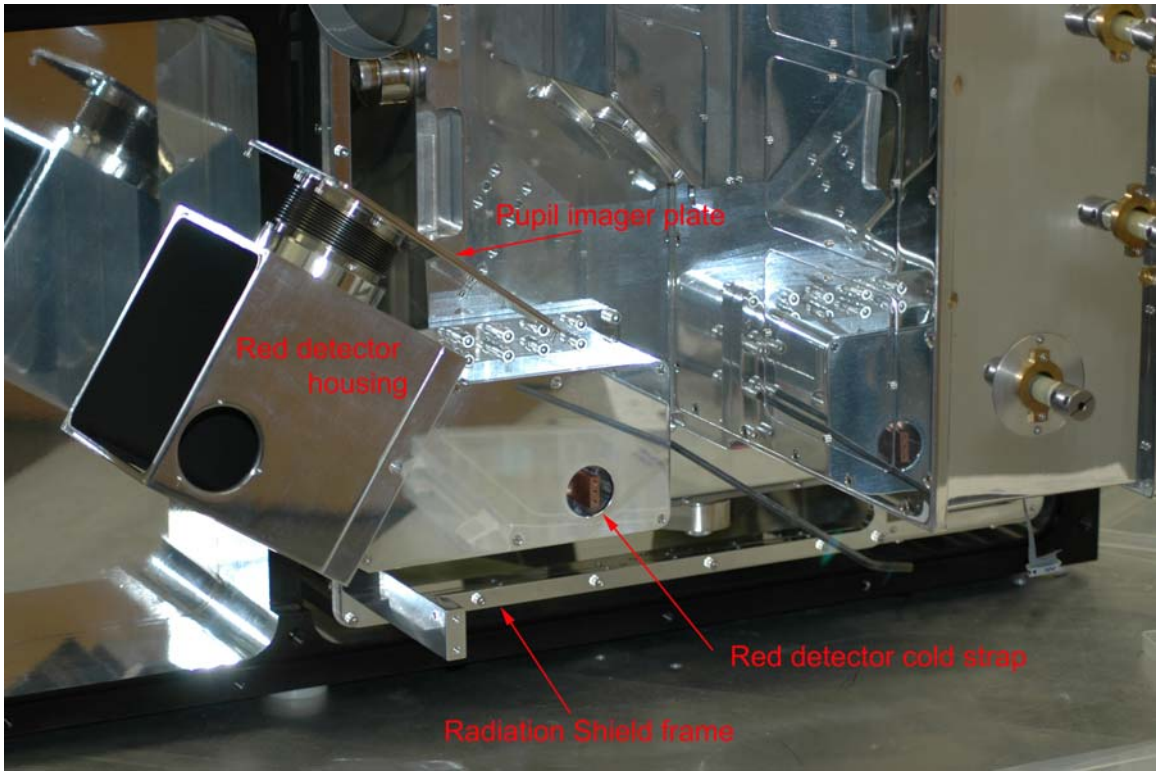
Mount the mechanism box on the cold structure and use a long wrench to tighten the screws.



There are three extra screws for securing the mechanism box to the cold structure that are accessed through the three holes indicated above that are covered with a brass screw. The fourth mounting screw is not used.

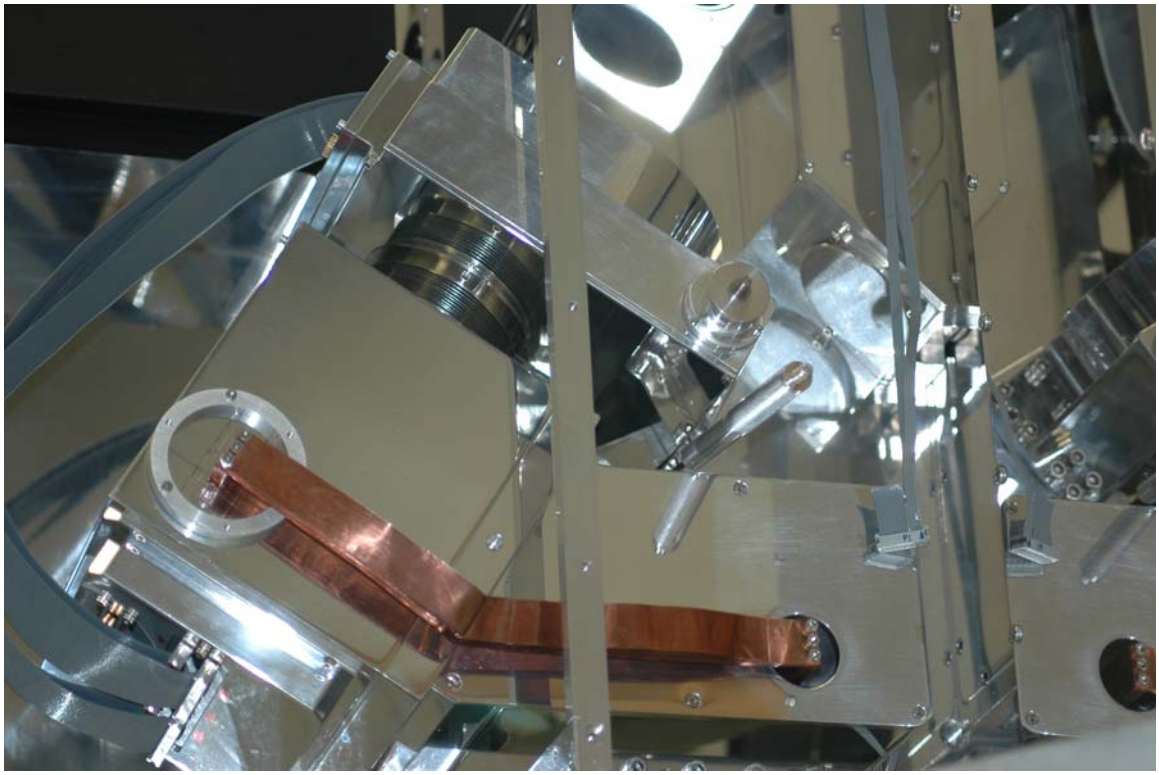


With the mechanism box assembled and mounted the cryostat is tipped to the vertical for the next stages of assembly using the screw eyes in the holes in the vacuum jacket.

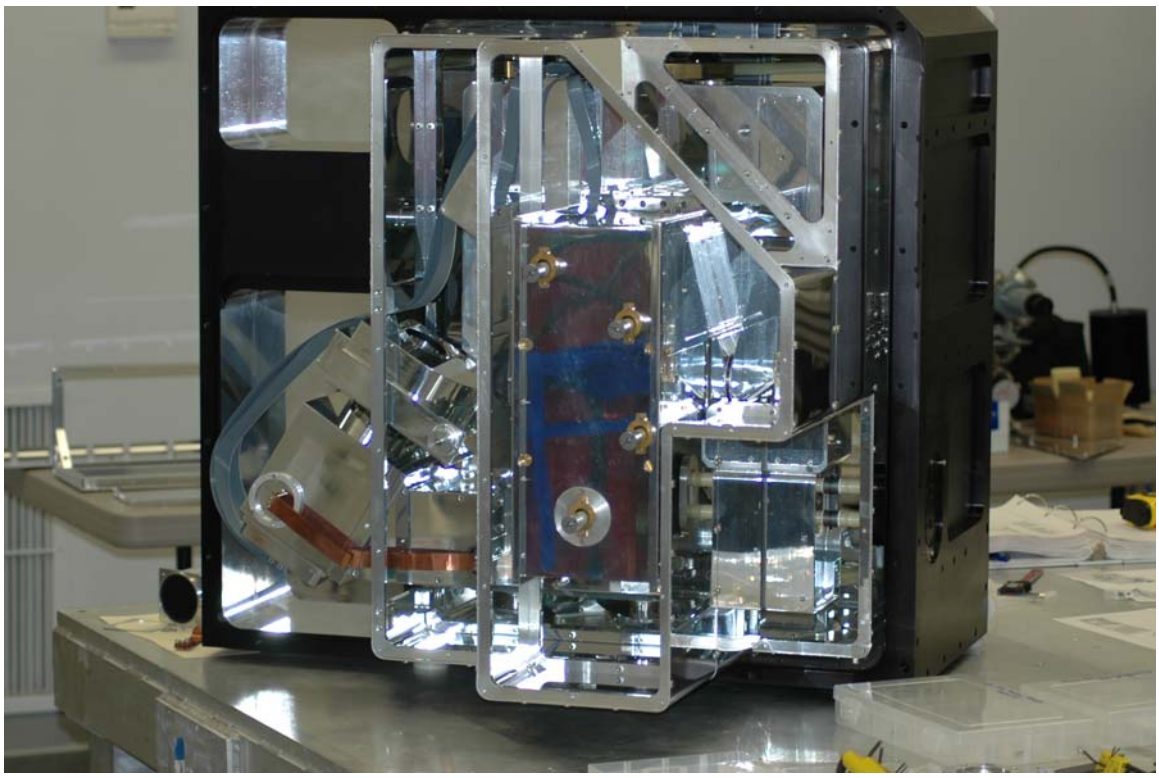


Install the red detector thermal strap (red bus bar #8305)
Install the Spacer shield frame1 #5004
Install the Red detector mount bracket #8201
Install the red detector housing

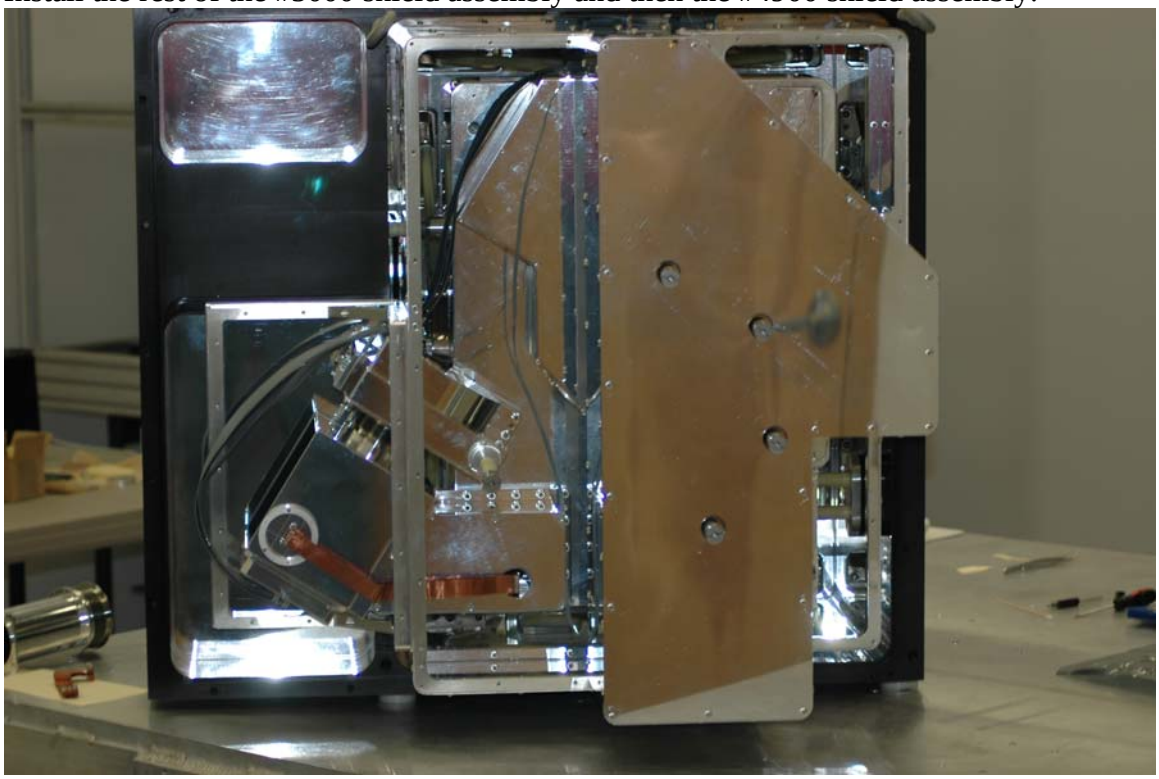
There is a bellows used between the red detector housing and the pupil imager so that the pupil imager can be removed without removing the detector assembly. The screws in these bellows are very hard to get to. Mounting the bellows and the pupil imager cover #7505 to the detector housing before installing the detector housing assembly onto the cold structure is much easier than trying to get to the screws after it is installed.

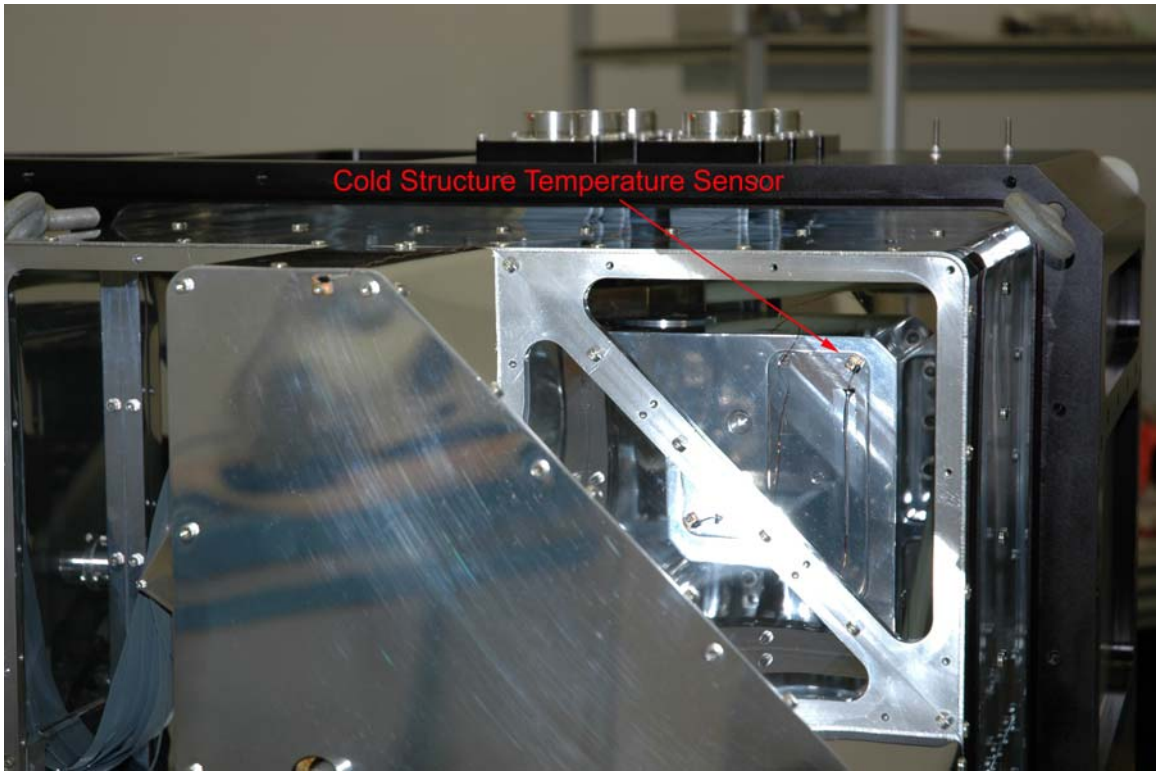


Install the Red detector cold strap.
Install the pupil imager assembly by compressing the bellows and inserting the pupil imager.

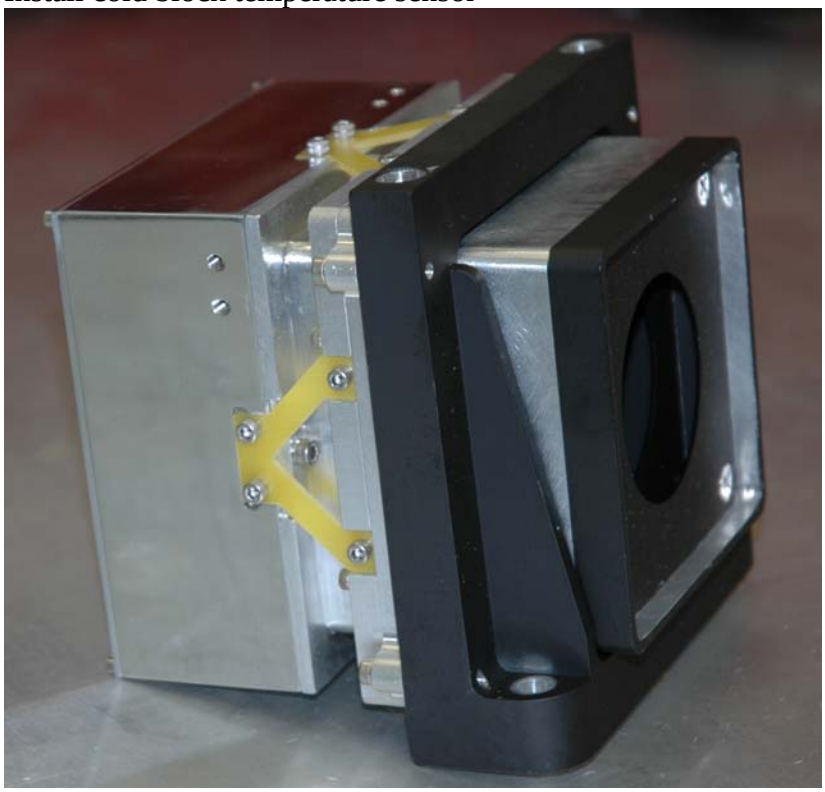


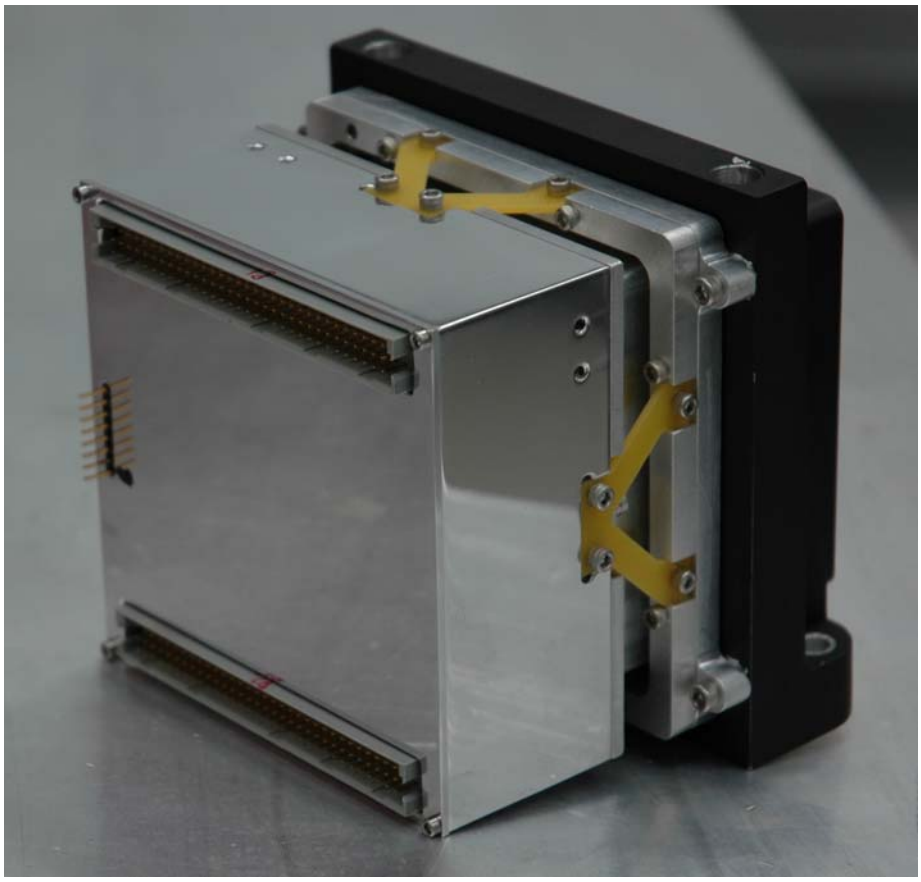
Install the rest of the #5000 shield assembly and then the #4900 shield assembly.

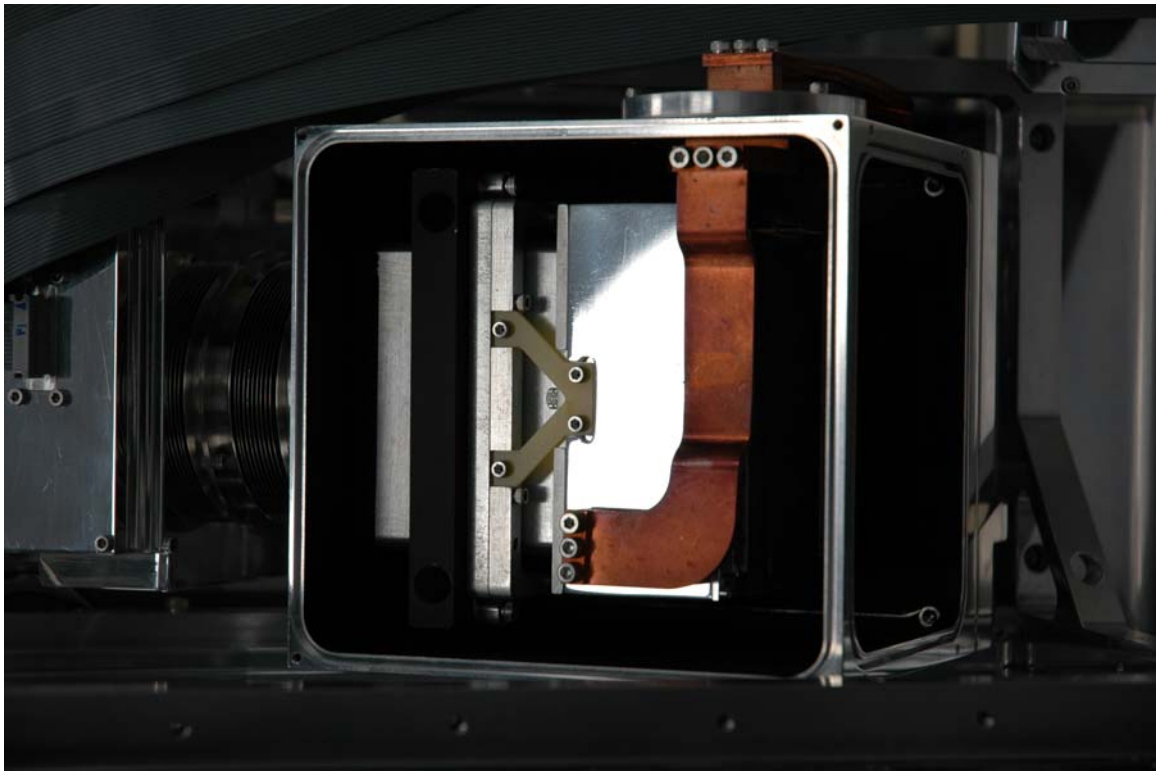




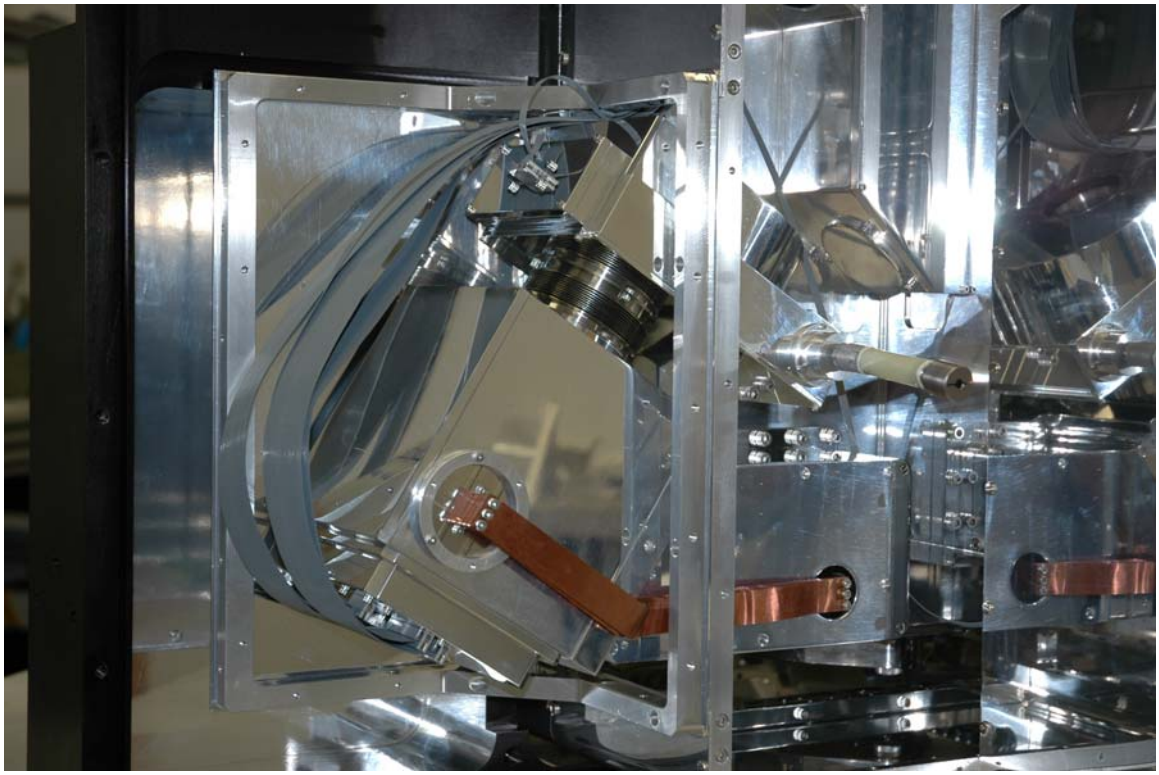
Install cold block temperature sensor





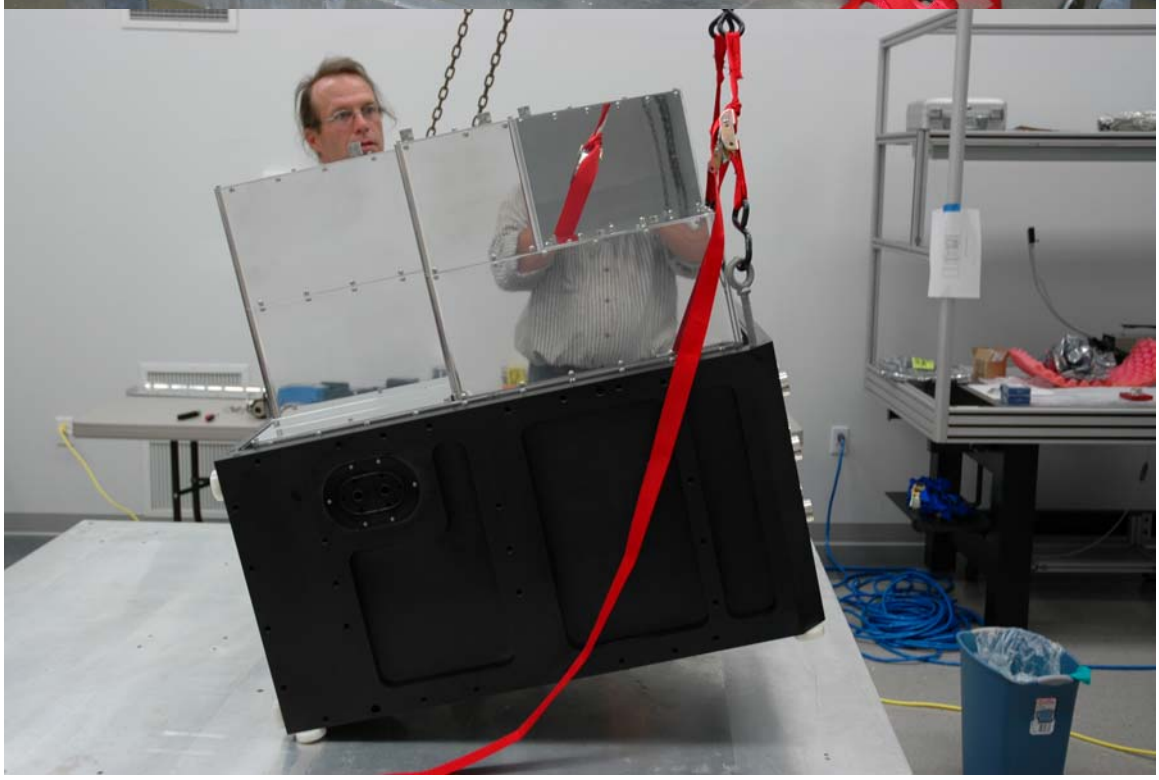


Install detector assembly into the red detector housing

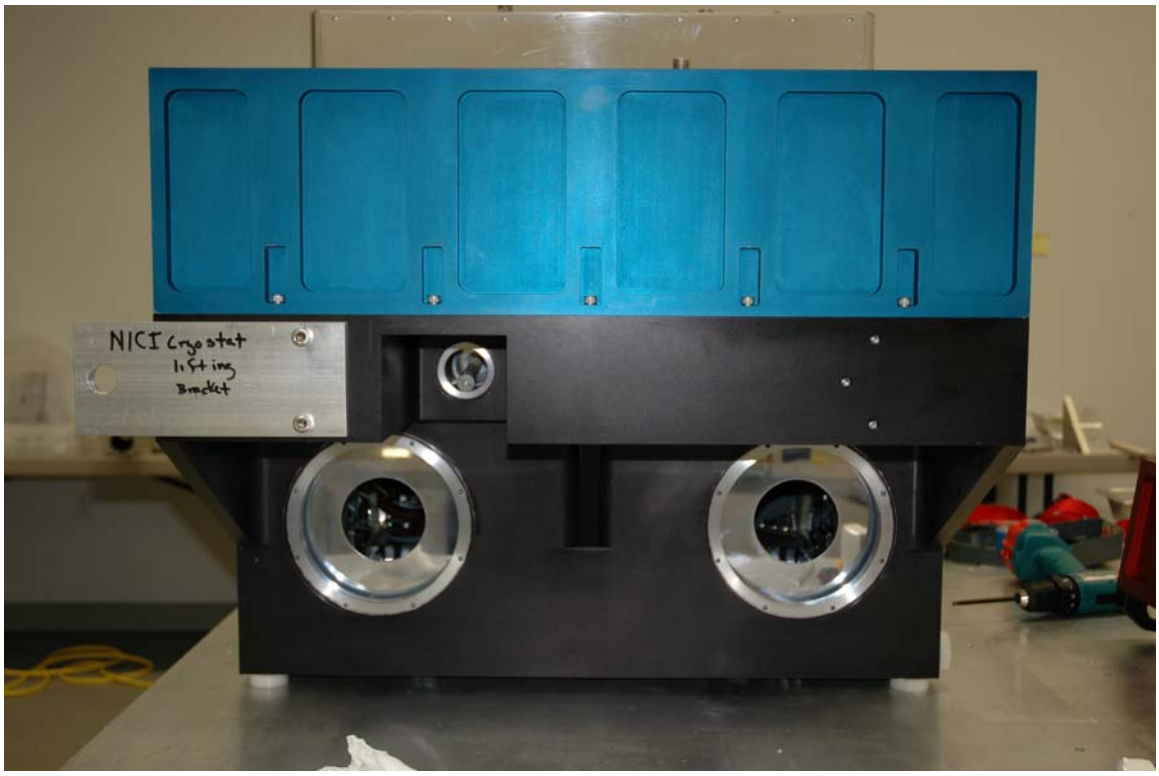


Install detector housing covers and detector wiring.

With the Red side internal assembly complete tilt the cryostat back on the blue detector side for installing the vacuum jacket pieces.

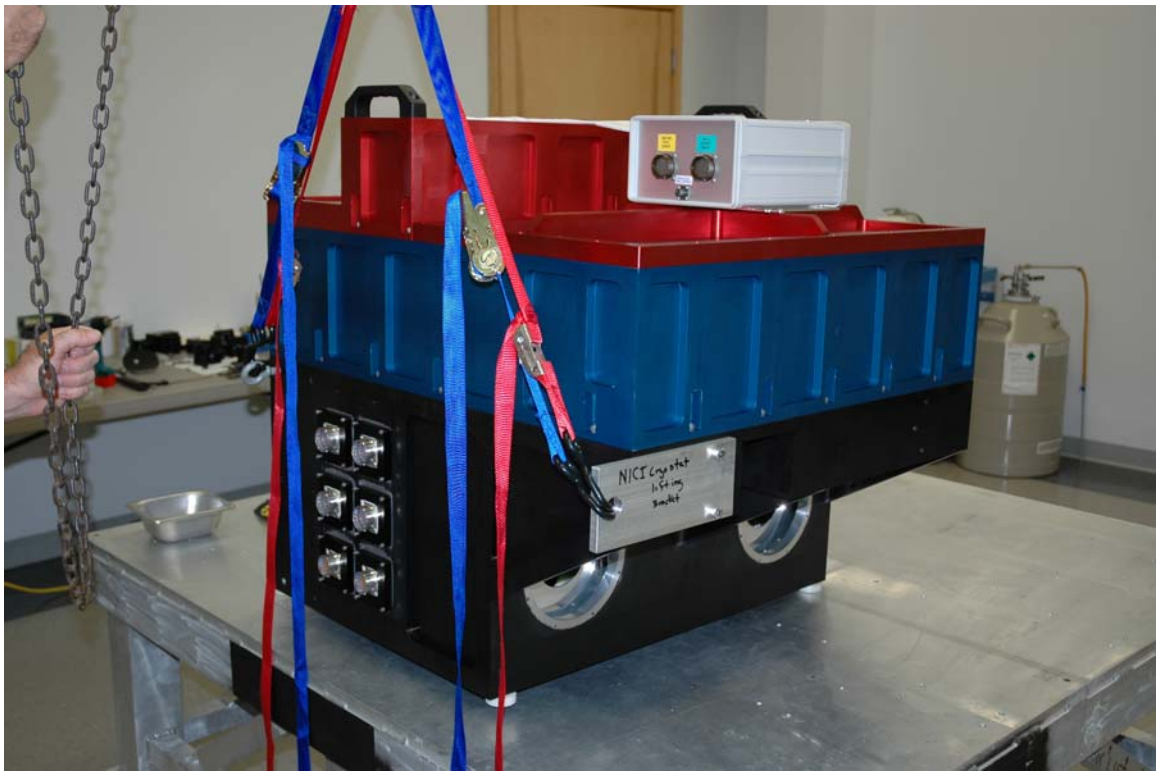


Install the blue vacuum jacket spacer #9408.

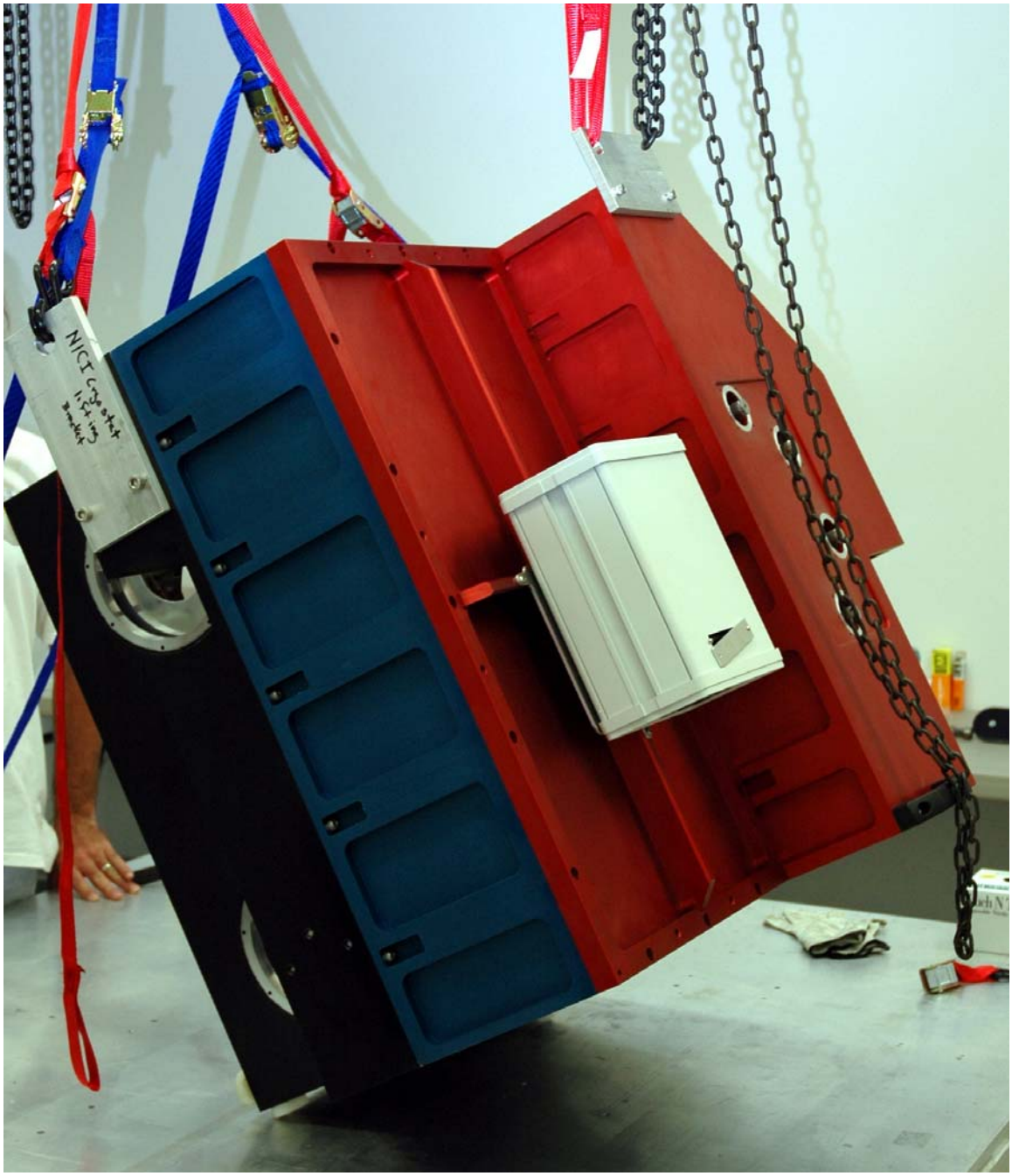


Install the cryostat lifting bracket.

Install the Red Access vacuum jacket cover.

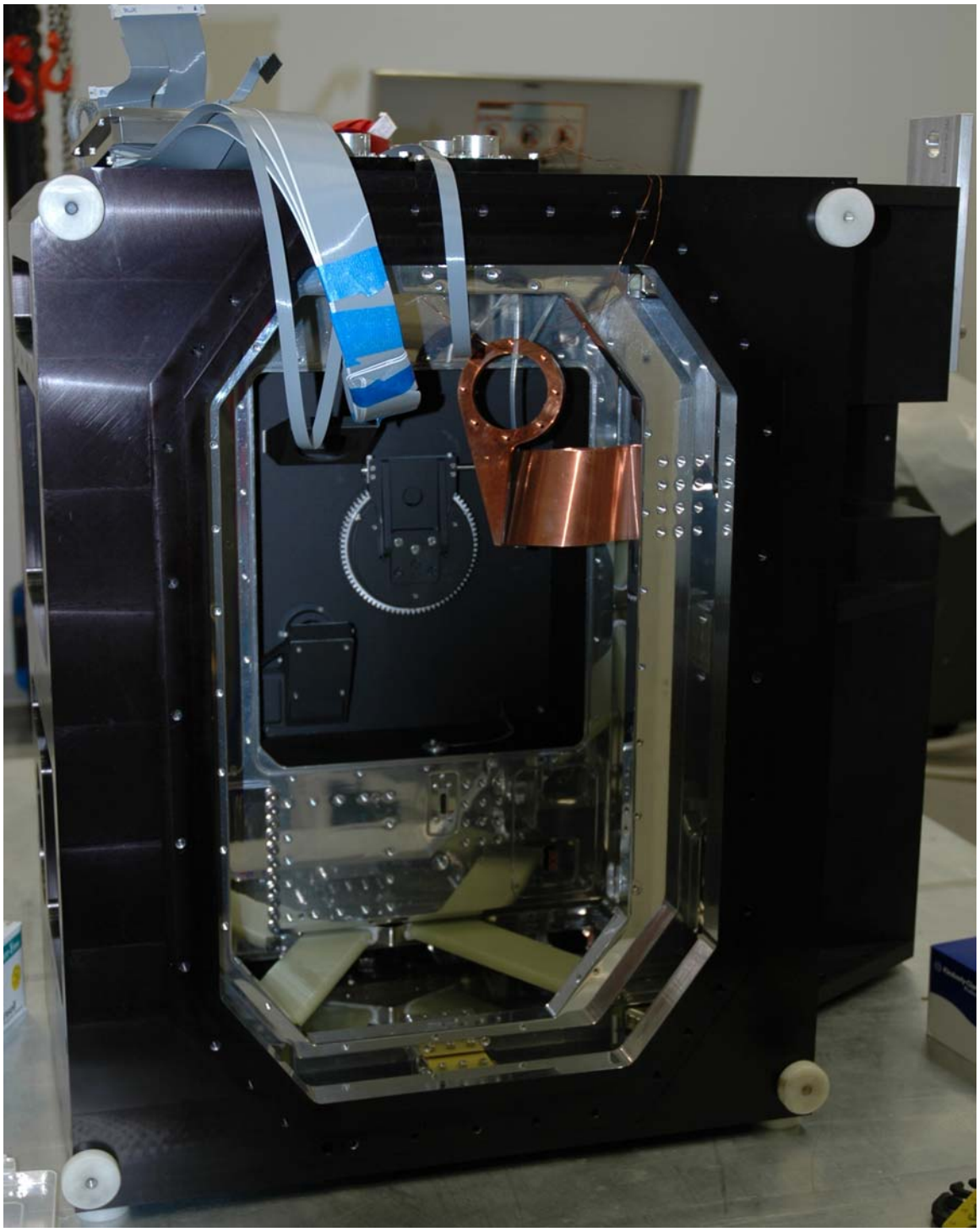


Install the Access Cover Red Detector Vacuum jacket cover.

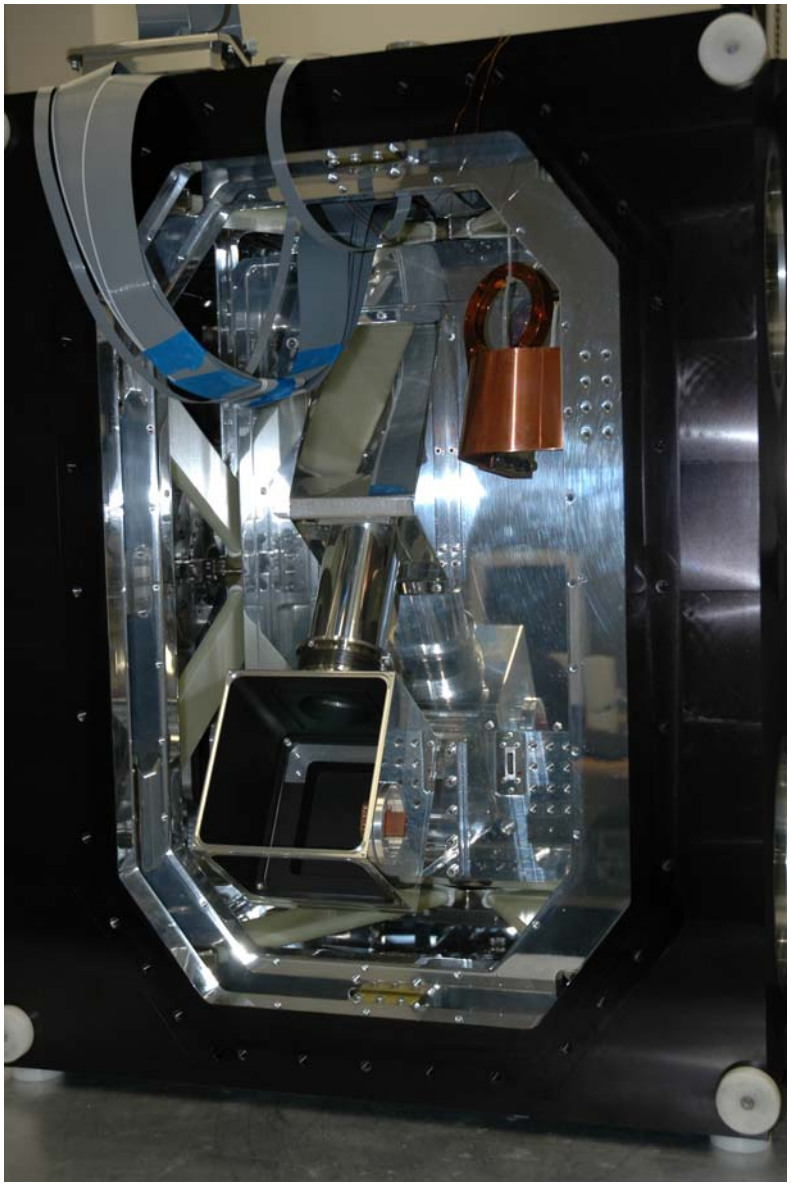


Tilt the cryostat back up using the two lifing plates and the screw eye. Two chain hoists are used and two people recommended.

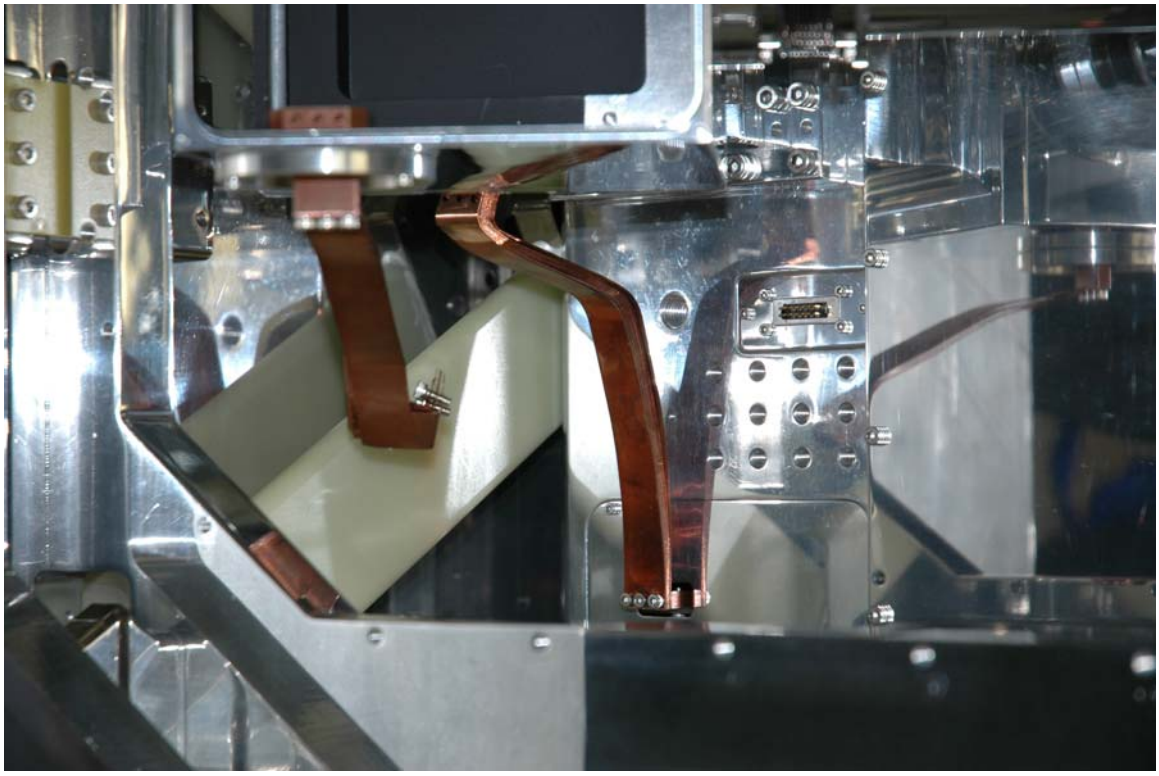
A small spacer is inserted under the red cover to prevent the cryostat from rocking.



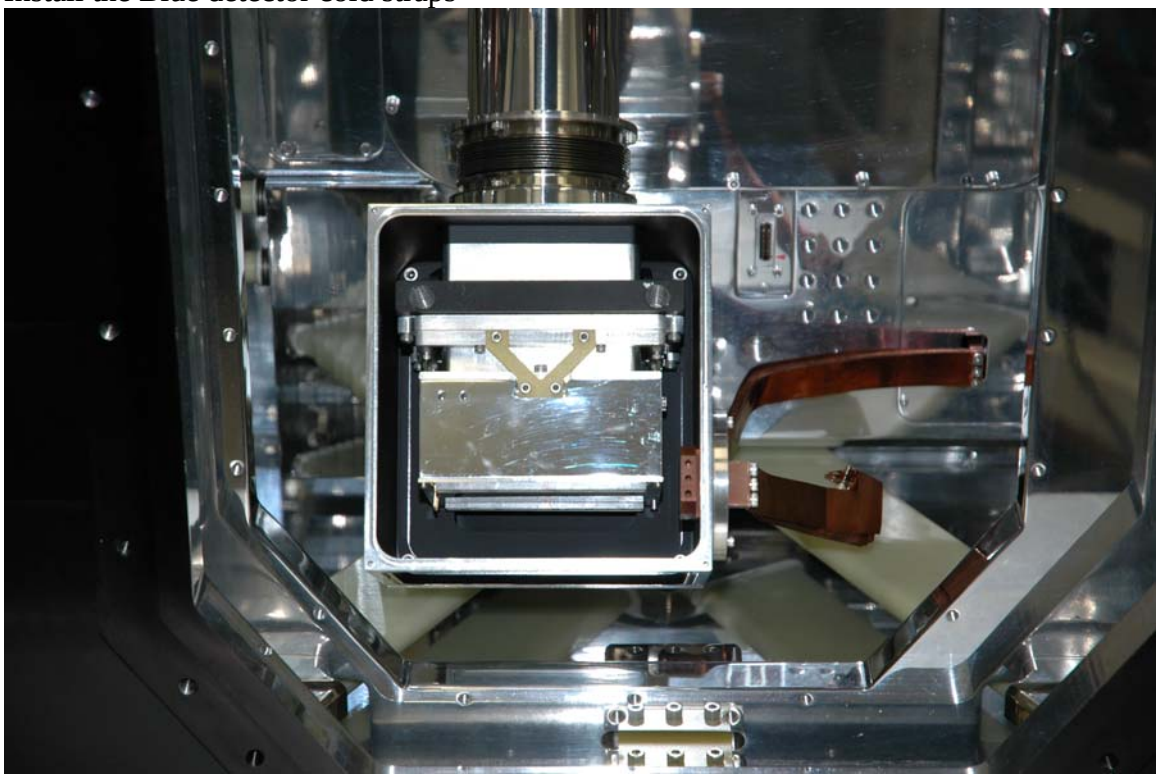
The back side now looks like this. The Blue filter wheel has been installed much like the red filter wheel and then the bulkhead cover attached. Then the worm drive and the Fold 2 mirror and baffle.



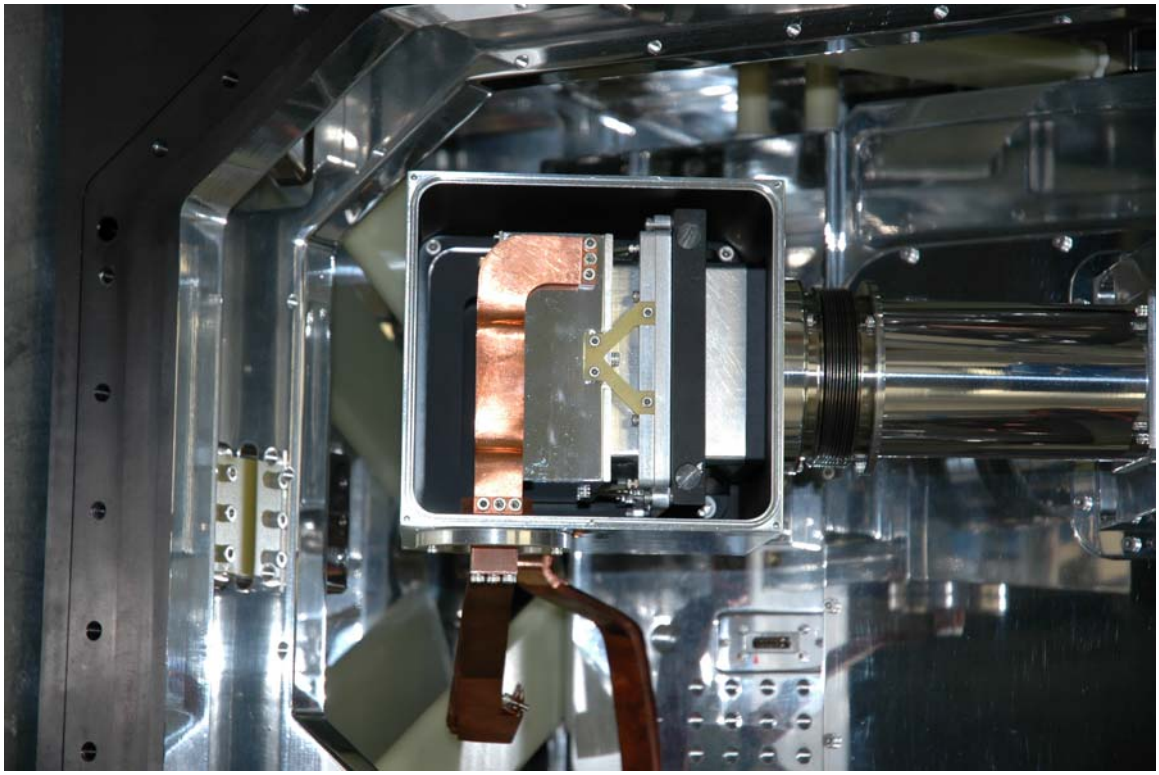
Install the Blue cover on the cold structure #5202.
Install the blue baffle adaptor # 3201
Install the blue baffle tube and bellows #3300 and #3206
Install the flue detector bracket # 3401
Install the blue detector housing #3403



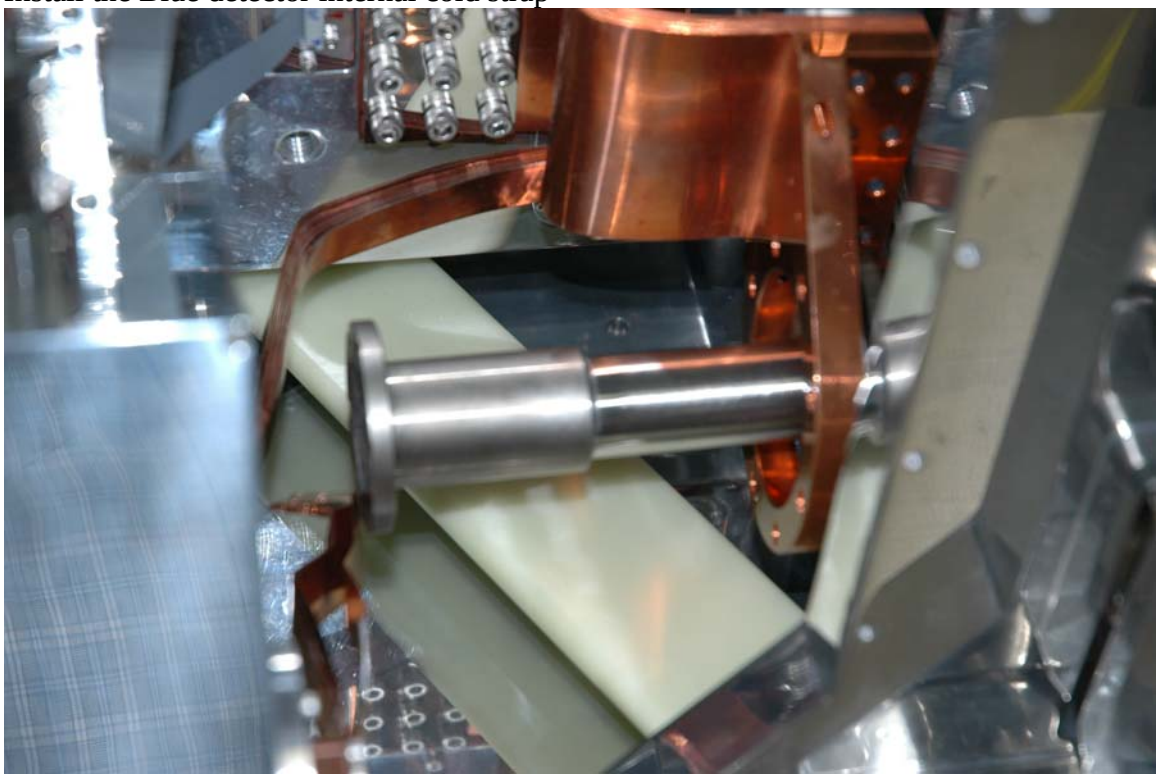
Install the Blue detector cold straps



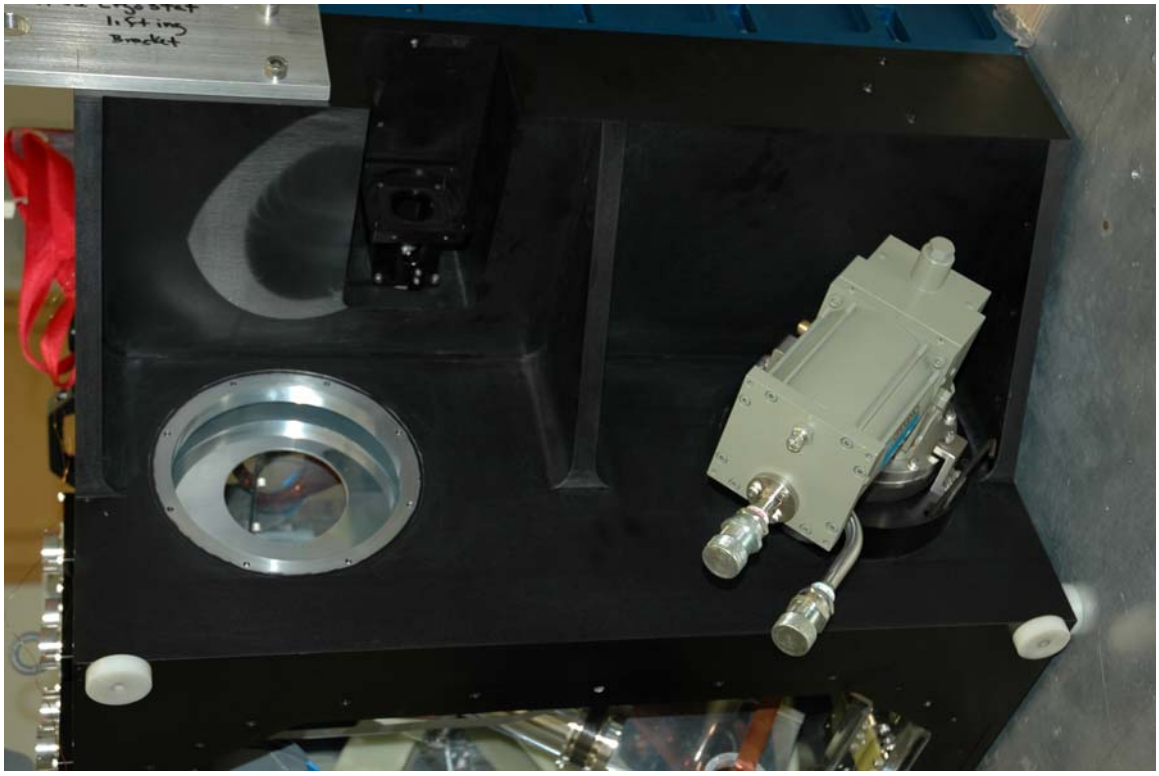
Install the blue Detector Assembly



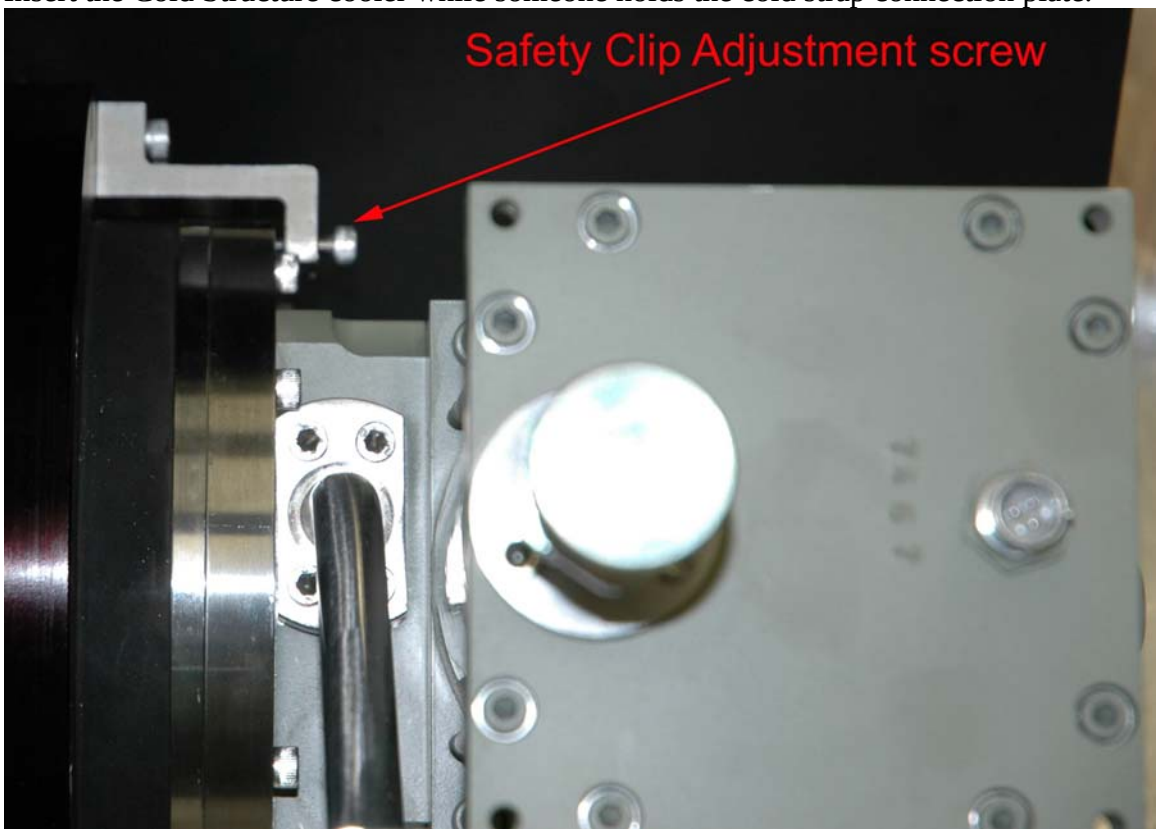
Install the Blue detector internal cold strap



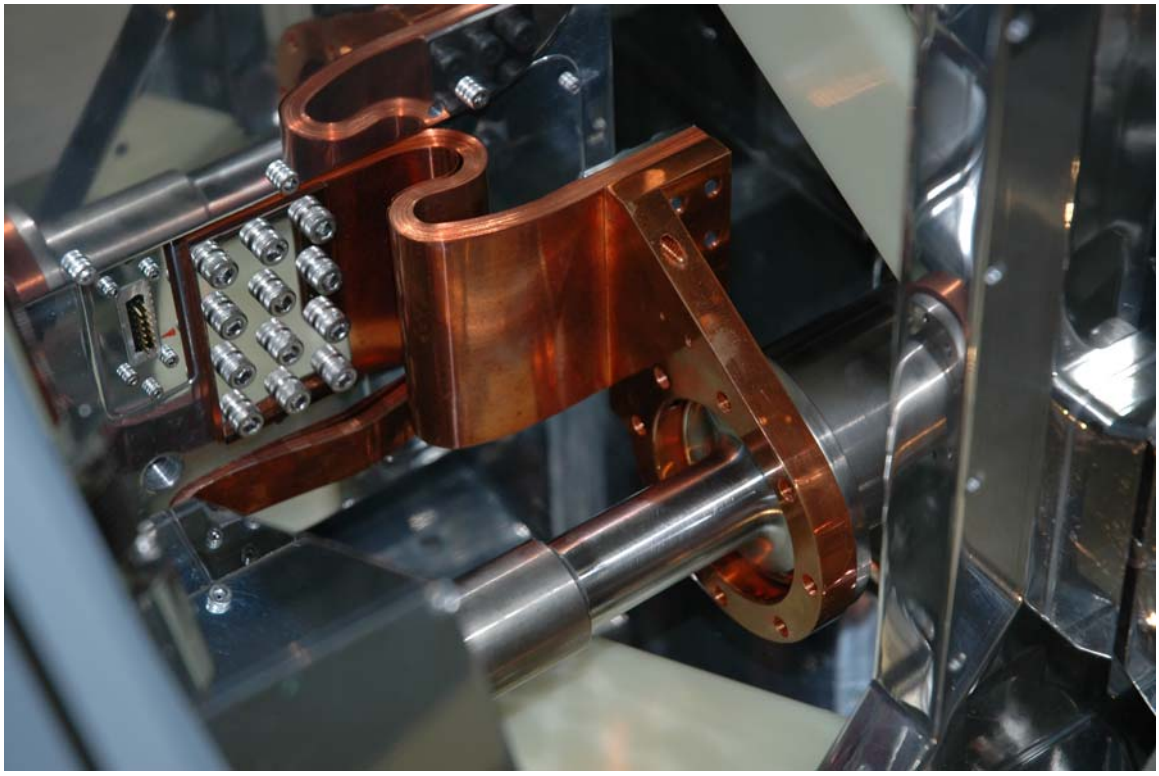
Install the cold structure cold strap bolting to the cold structure(before installing the cooler)



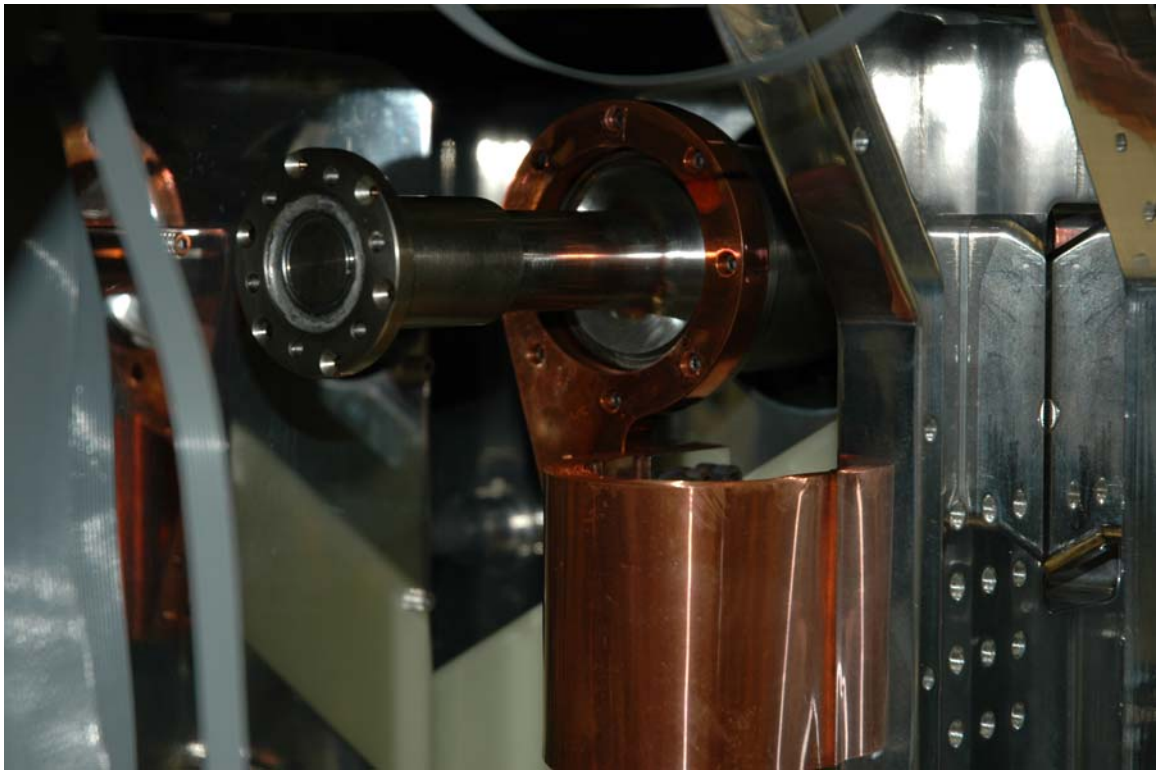
Insert the Cold Structure cooler while someone holds the cold strap connection plate.



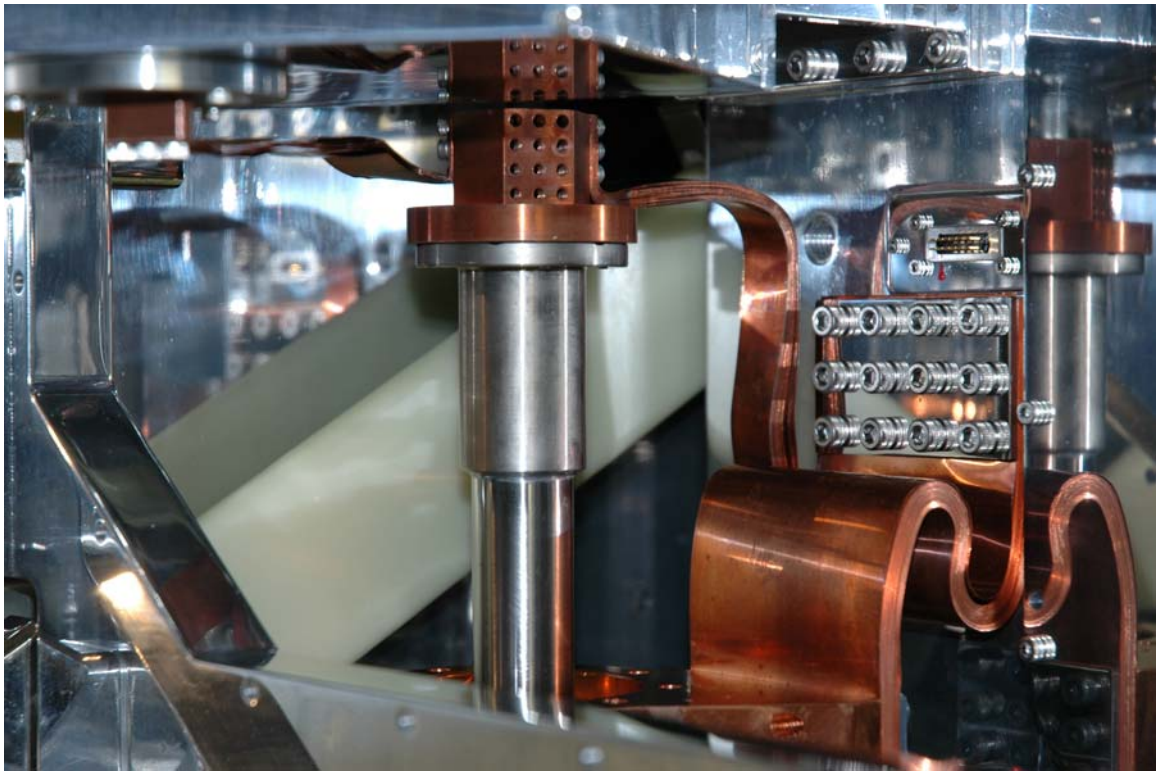
The safety clip protects the CCC bellows when not under vacuum. It should touch when there is no vacuum present but not when there is a vacuum.



Attach cold structure cold strap to cooler. Black screws are used with maximum torque of ~ in-lbs.

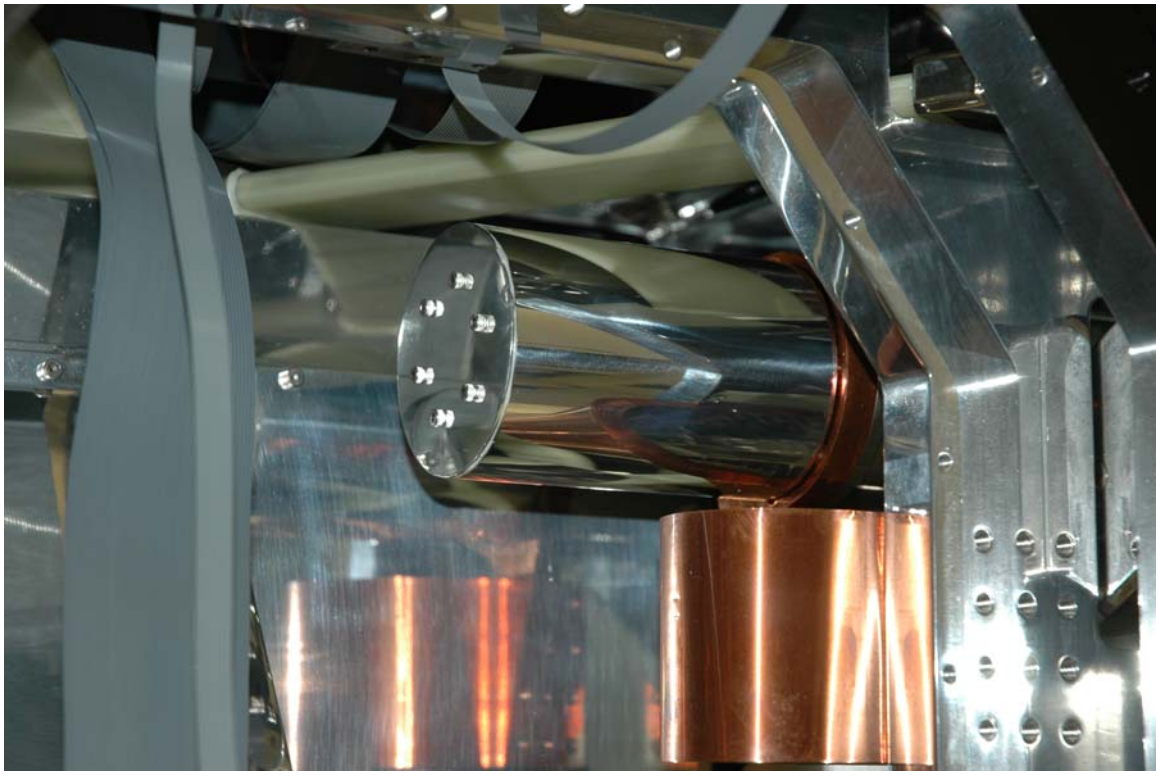


Insert upper cooler and attach to radiation shield cold strap.

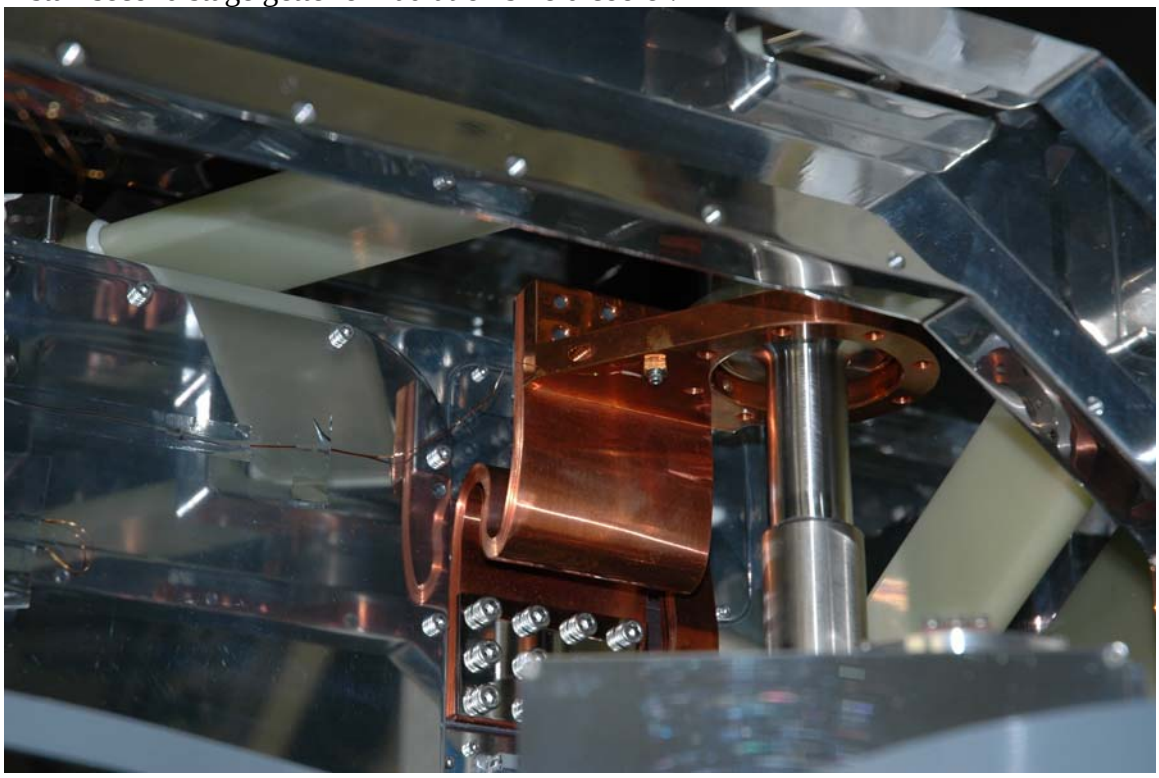


Attach Blue detector cold straps to the second stage.

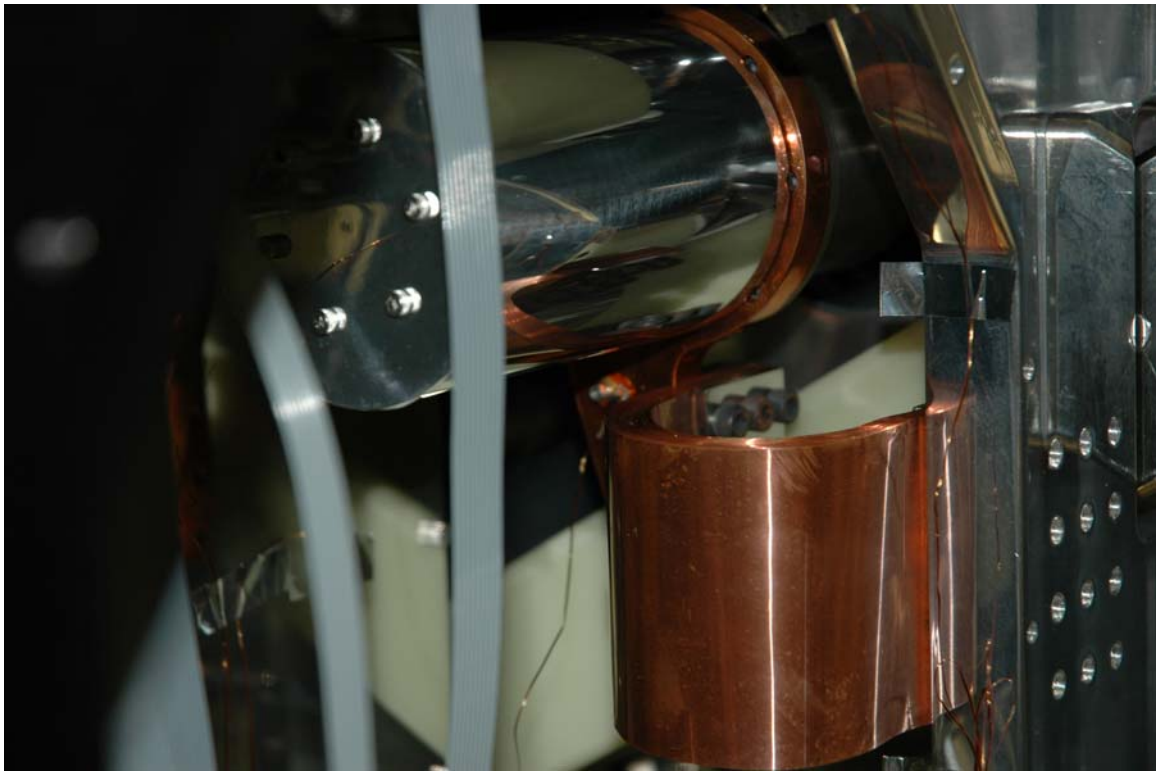
This is the correct cooler orientation.



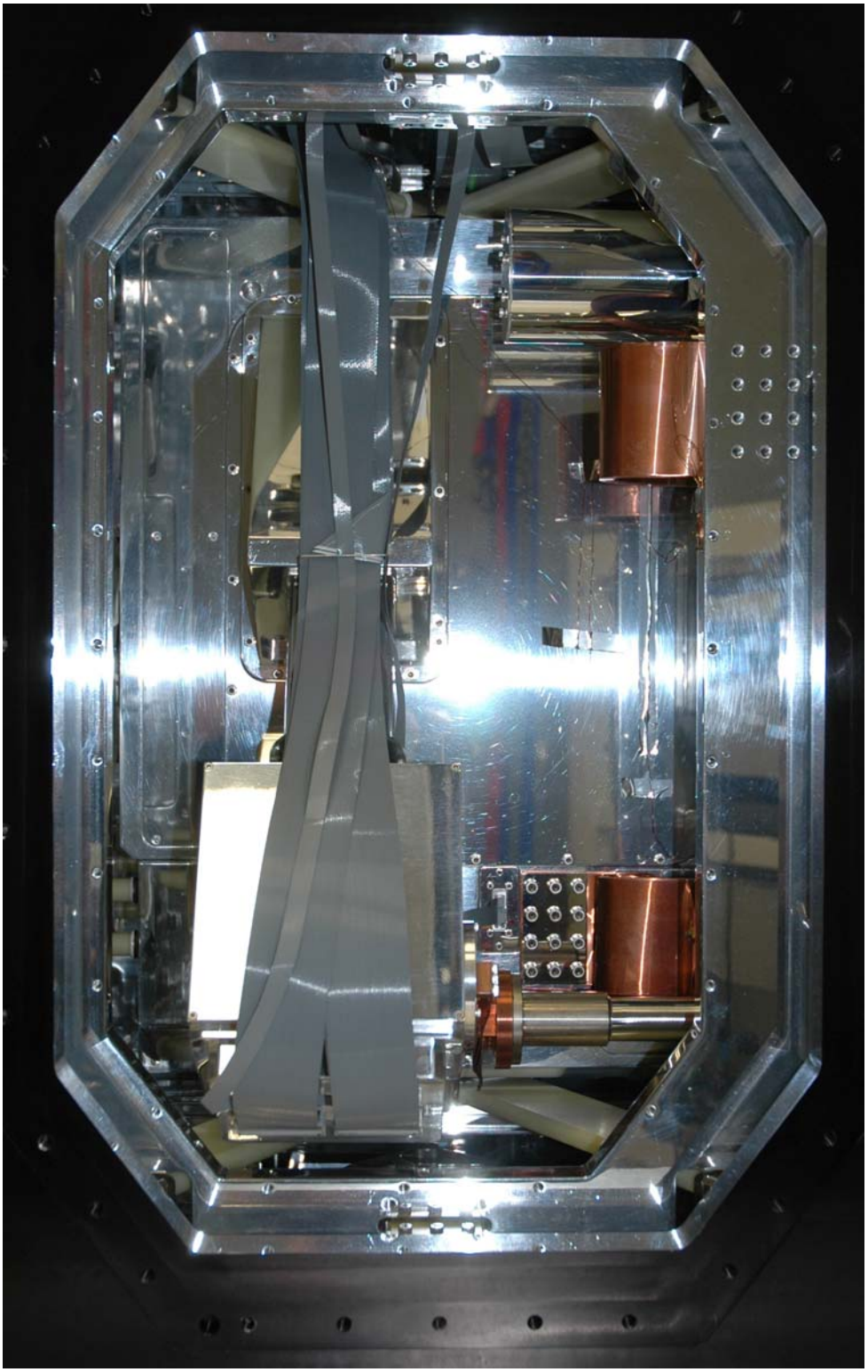
Install second stage getter on radiation shield cooler.



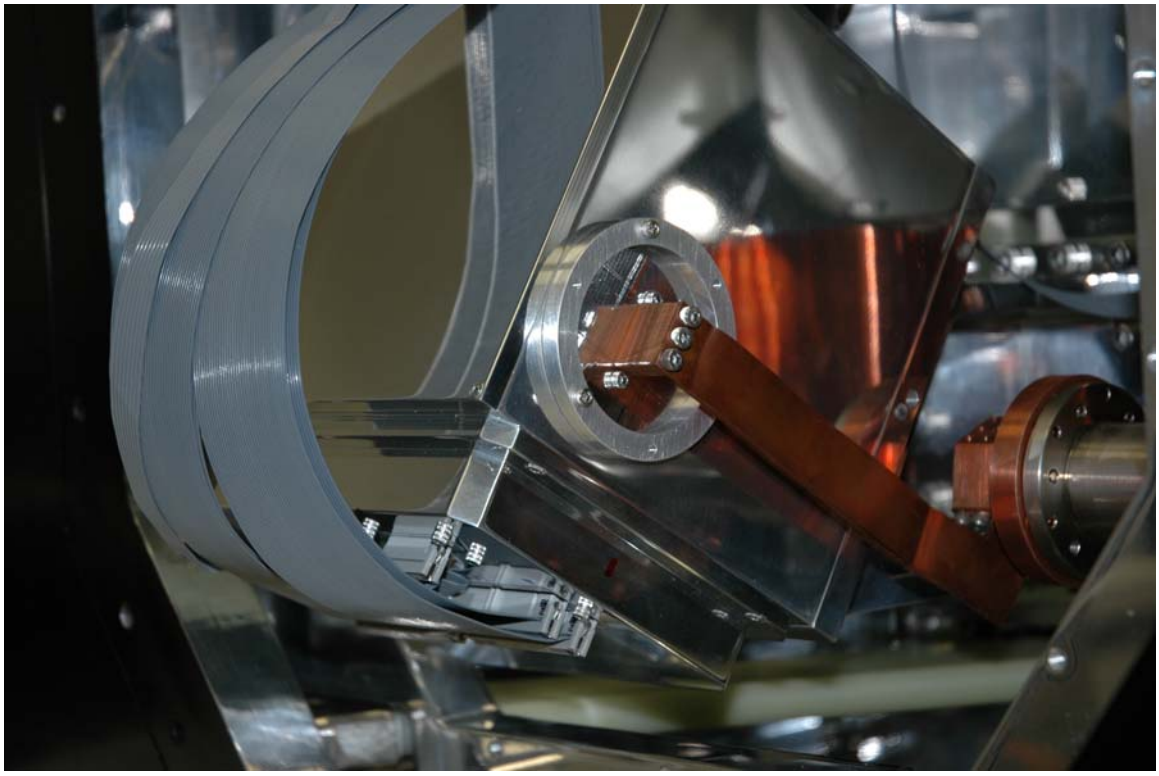
Install temperature sensor on first stage of cold structure cooler.



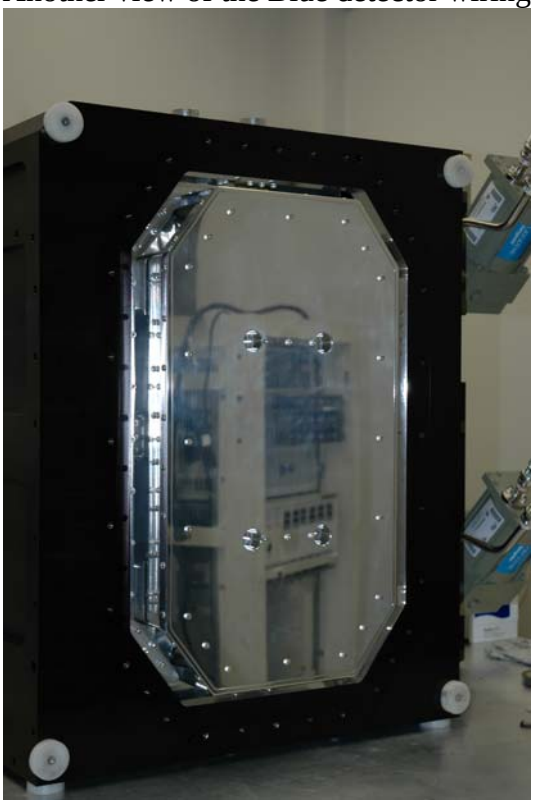
Install temperature sensor on first stage of radiation shield cooler.



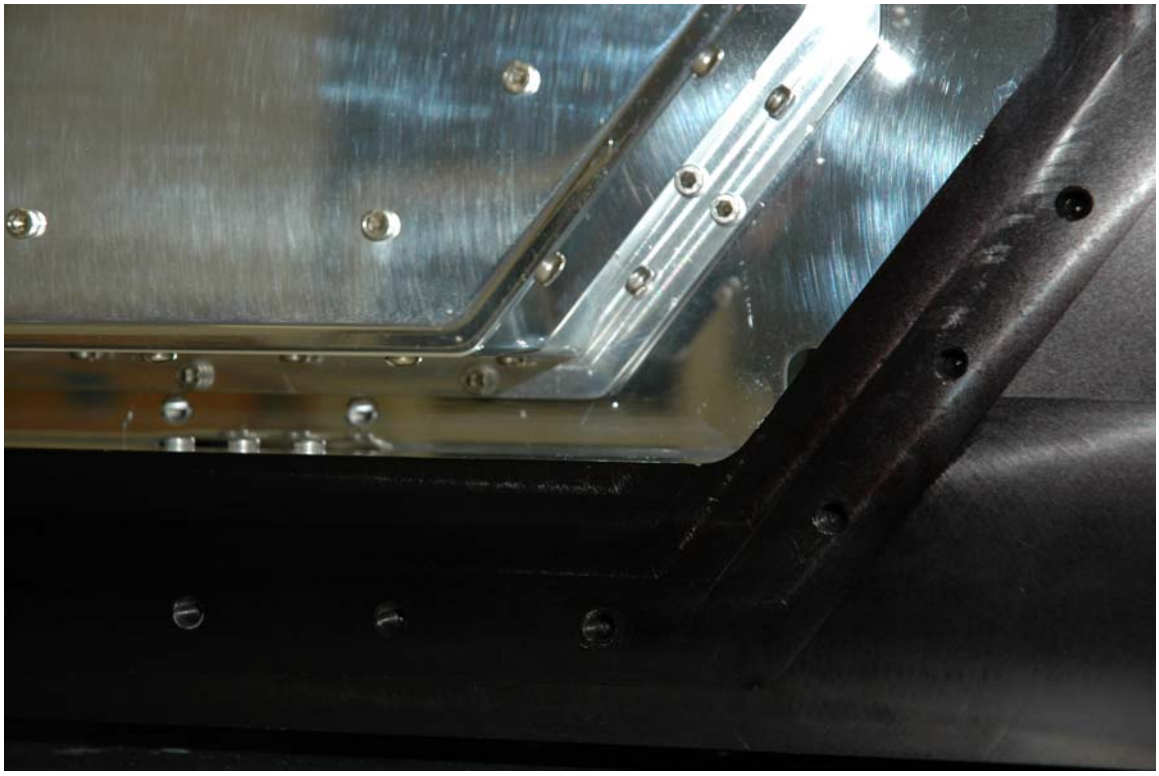
Install Blue detector wiring.



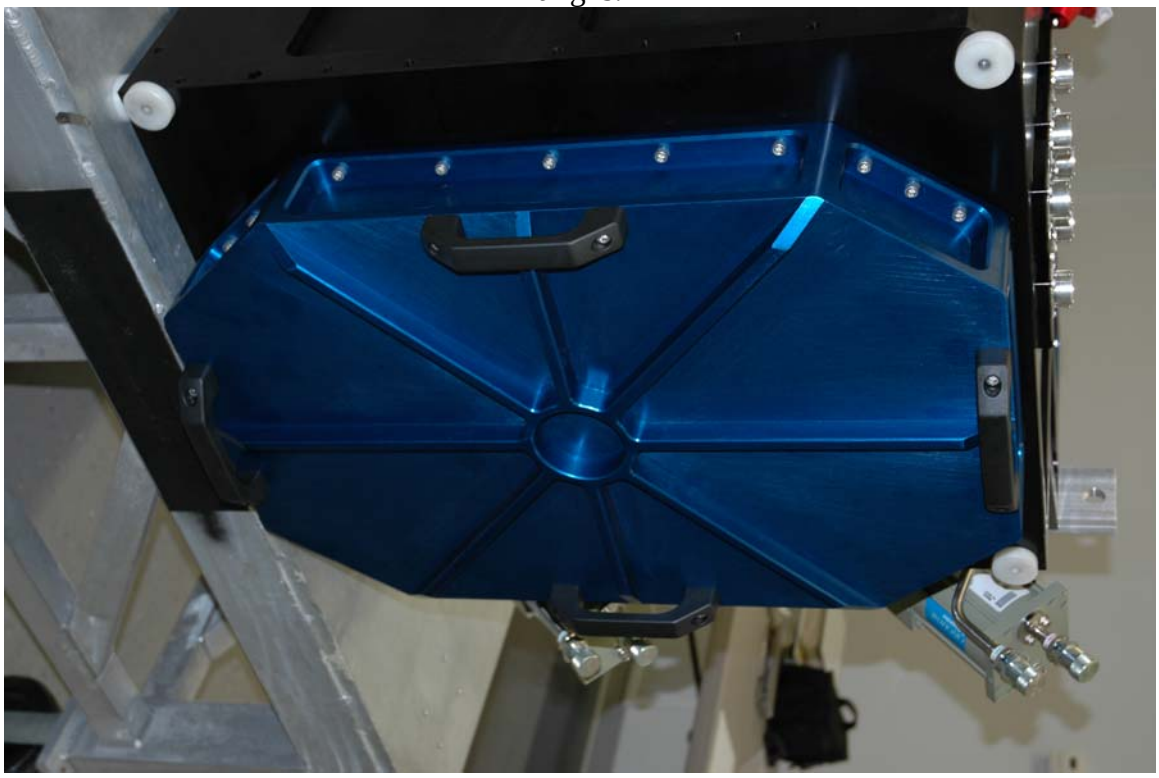
Another view of the Blue detector wiring



Install Blue Access radiation shield cover.



Note there are punch marks to show how this cover aligns.



Install Blue Detector Access vacuum jacket cover.

This shows the precharge can cover with check valve.

install all of the motor mounts. There is a small access cover in the mount to allow access to the flex coupling clamp screw.

There is one motor mount behind the closed cycle coolers for the Blue filter wheel.