2.4m Aluminization Procedure: Day 1

2017Mar09 – Eric Galayda

Preparation:

Please read through this entire document prior to mirror removal, as well as the document for handling the mercury band.

Find and borrow, with appropriate permissions, the Davidson collimator and fixture from NOAO. It is typically stored on the 3rd floor at the 4m telescope on the summit. There are two different collimor fixtures that appear to work.

Find the following equipment on-site:

- Block & Tackle, hoist
- T-bar
- RA & Dec bracing equipment and stay bars
- Secondary mirror lifting fixture
- RA jack mounts & hydraulic jacks (2)
- Primary mirror jacks (3)
- Primary mirror cell supports (3)
- Mercury band containment vessel

Clean out the 2.4m primary mirror box and gather all foam and materials for accepting placement of the mirror. Clean any materials that may come into contact with the mirror glass.

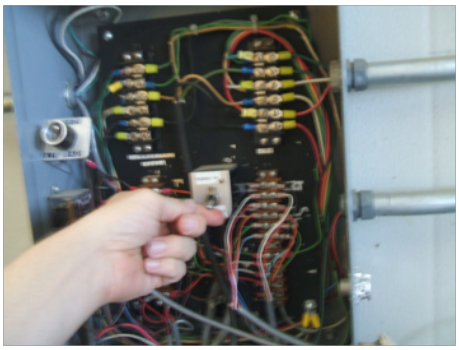
Find and clean (with alcohol) mirror fixture.

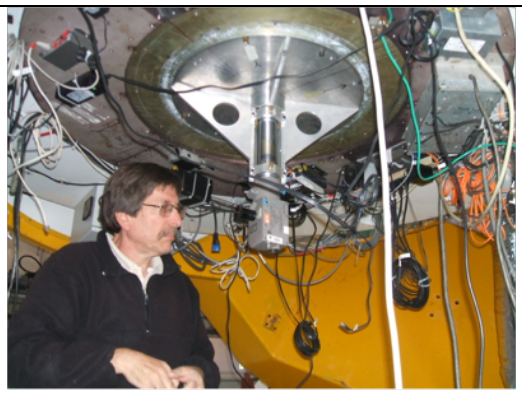
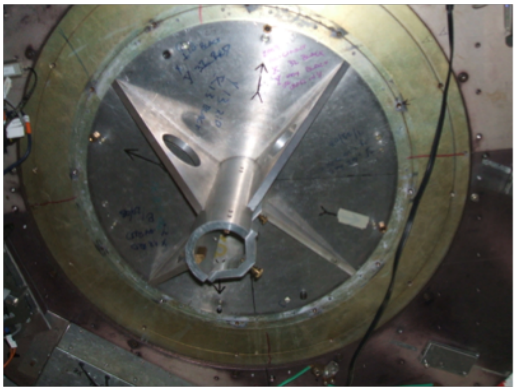
Get the NOAO flatbed truck delivered and staged. Make sure the long straps are including for strapping down the mirror box. Place the primary mirror box on the truck.

Remove the screening that is located behind the roll-up door so the mirror can be trucked out to the crane.

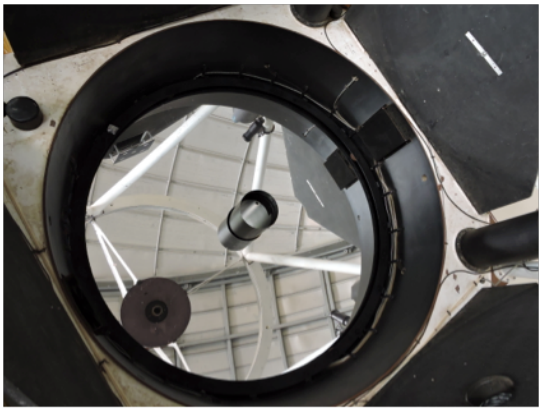
Procedure:

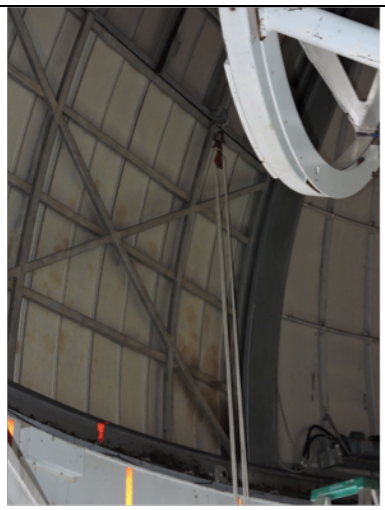
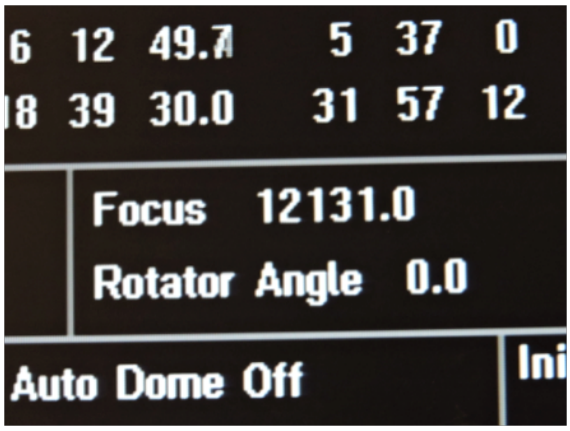
Day 1:

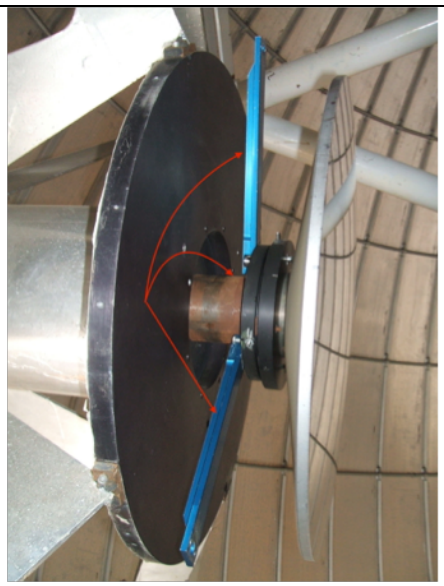
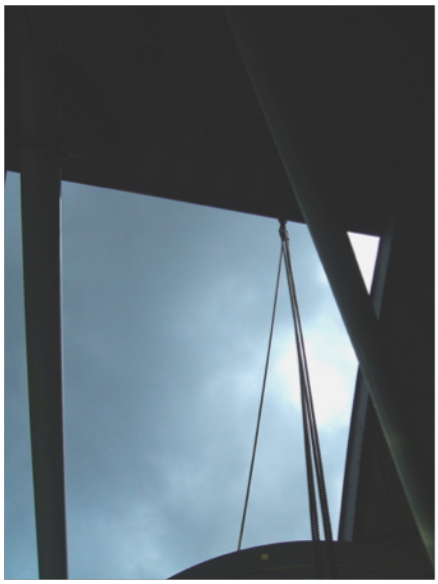
	Remove detector, instruments and MIS unit.
	Set balance weights: Verticals @ 800, horizontal @ 1,300.
	Put the telescope limits into "Override".

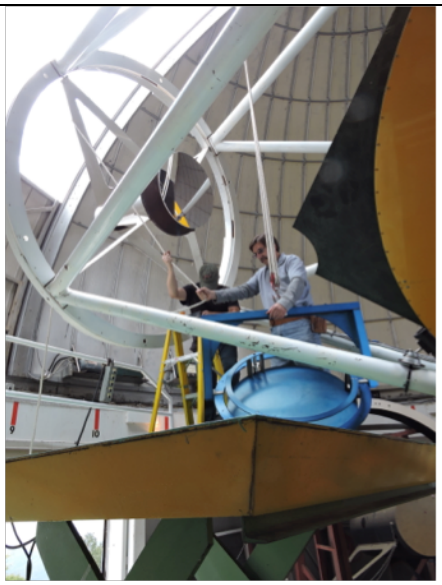
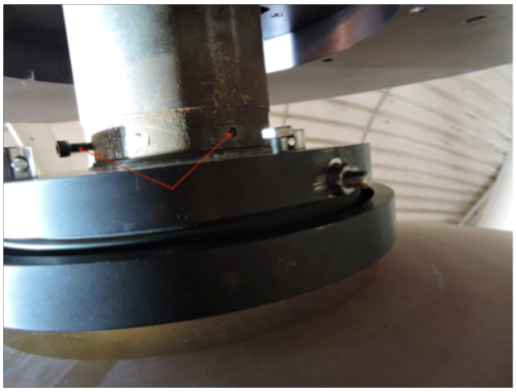
	Install the Davidson collimator and verify secondary mirror collimation.
	Remove the Davidson collimator.
	Open the mirror covers and remove the north mirror AC hose.

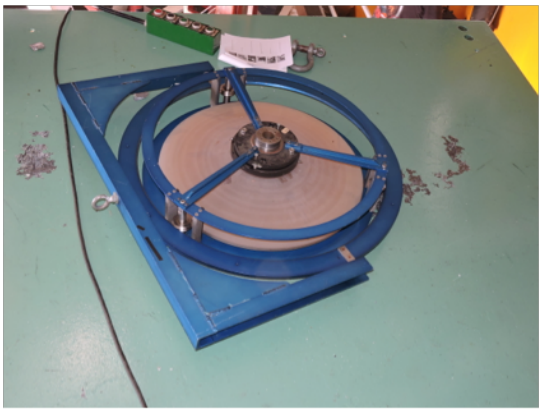
	Slew the telescope to the east and south.
	Install the declination stay bar.
	Install the RA brace, noting that it will only screw into 2 of the 4 mounting holes.

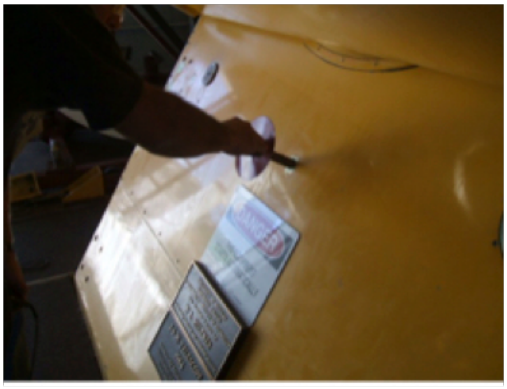
	Remove the outer baffle by releasing the clips (3).
	Using the T-bar, unscrew and remove the inner baffle
	Plug in the dome emergency power cord.

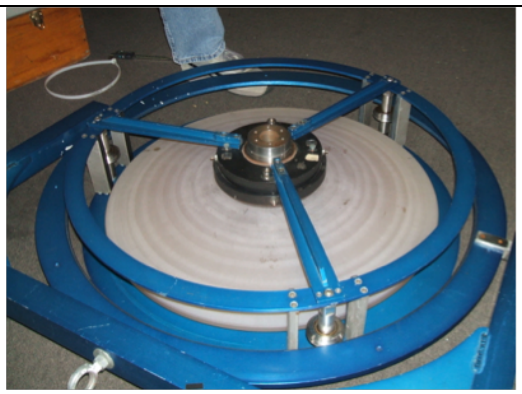
	Rotate dome shutter around to the east and install the hoist to the shutter.
	Remove the screws from the secondary baffle and pry off baffle.
	Adjust telescope focus “in” to allow for better access behind the secondary mirror. Something around 12-13K works.

	Install the handler arms (3) onto the rear of the secondary.
	Remove the temperature sensor for the secondary.
	Open the shutter and adjust positioning so that the hoist is in line with the secondary. Be cautious that the rope does not contact the mirror surface.

	Carefully lower the hoist and attach the secondary mirror-lifting fixture.
	Remove the set screws (2) on the secondary focusing ram.
	Lift the handling fixture into place and attach to the handler arms (3).

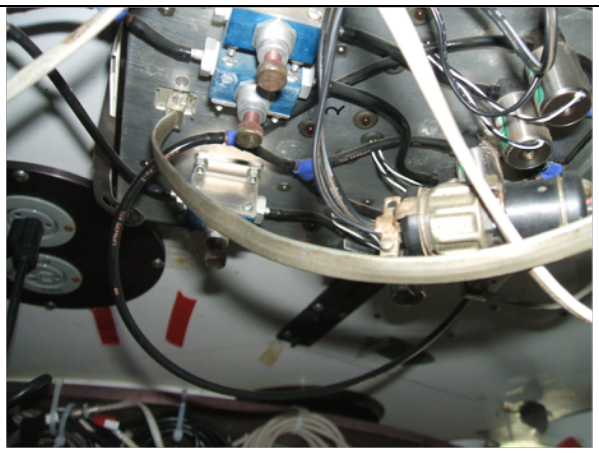
	While supporting the fixture assembly and mirror, unscrew the secondary from the focusing ram.
	Lower fixture and mirror onto the platform.
	Raise the hoist to clear from telescope and close the shutter. Leave the hoist in place for later.

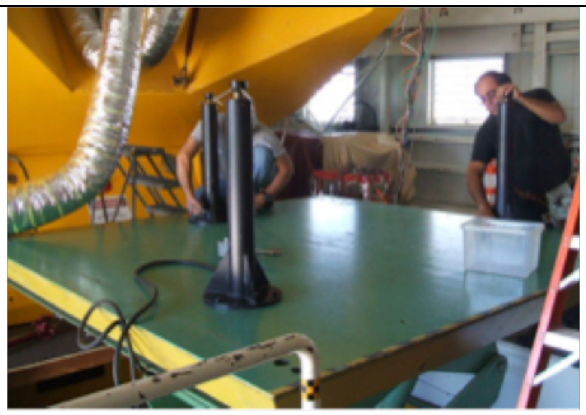
	Remove the dome emergency power cable.
	Remove RA brace.
	Remove declination stay bar.
	Slew telescope to zenith and install RA safety pin.

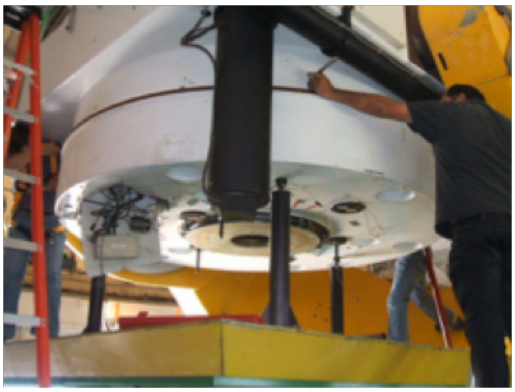
	Move the secondary fixture assembly off the platform.
	Install the declination stay bar.
	Turn the telescope limit bypass switch “OFF”.
	Install the RA jack mounts (2).

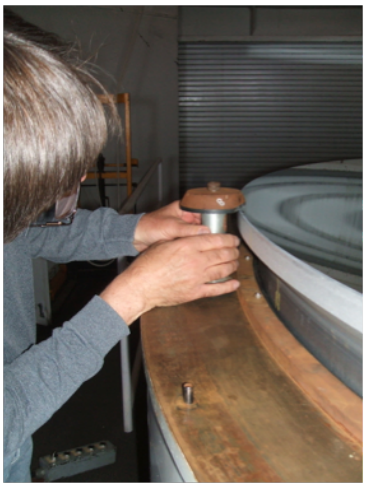
	Install the telescope jacks (2) and pressurize to 2,000 psi.
	Remove inner primary baffle.
	Deflate airbags by typing *cl* then *qq* on the computer.
	Break for lunch.

	Remove rotator cabling and plates (4).
	Disconnect the temperature sensor cable from hole on the lower south side of the mirror cell.
	Disconnect the power cable, air-line and instrument rotator control cables on the lower north side of the mirror cell.

	Disconnect RJ11 and power cable for the airbag support electronics.
	Install the mirror jacks (3) into the mirror cell.
	Hand-tighten the jacks so they just touch the bottom of the mirror. Then, using a wrench, turn each by ¼-turn.

	Install the primary mirror cell supports (3) on the platform.
	Move the hydraulic platform out by ~2” and up to the mirror cell.
	Ensure that the cell support heads are tightened against the bottom of the cell.

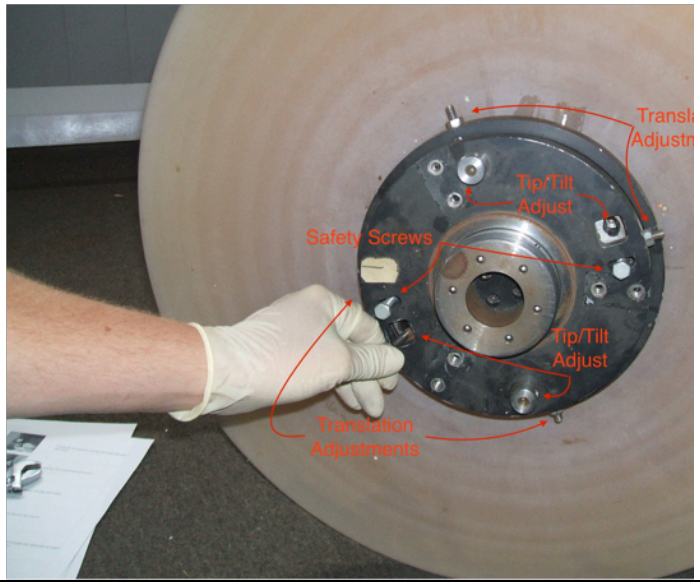
	Adjust the hydraulic platform to SLOW speed.
	Unbolt the primary mirror cell from the telescope.
	Lower the mirror cell by a few inches, allowing for enough clearance to remove the temperature sensor from the mirror's side (south side). Pull out all cables removed on the north and south side as well.

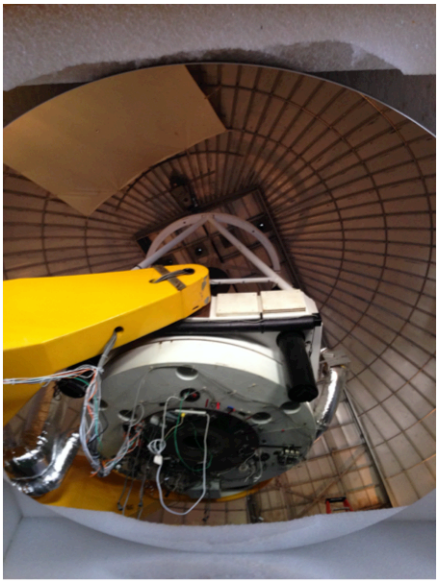
	Continue to lower the cell while paying attention to not let the cabling come into contact with the mirror.
	Remove the earthquake clamps (3).
	Remove the bolts for the mercury band retention clips and remove the clip sections (4).

	Remove the mercury band and store it in the containment vessel in the shop. See Hg-band doc.
	Remove the mirror box lid and place on ground behind the flatbed. Verify that the inside is still clean.
	Drive the platform and mirror out to the crane.

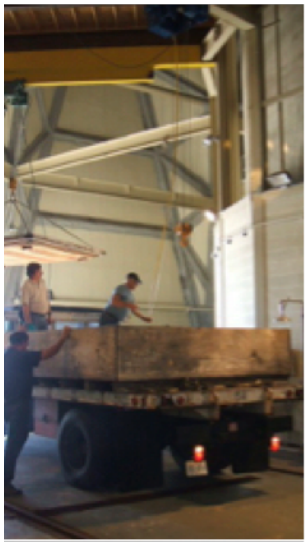
	Install the lifting fixture. It is helpful to have someone lay under the cell to center up the fixture.
	Lift the mirror and rotate to the truck.
	Lower the mirror into the mirror box.

	Remove the lifting fixture and place it in MDM vehicle for transport to the 4m.
	Lift the mirror box cover and reinstall. Remove the lifting straps and stow the crane.
	Call KPNO to transport the mirror to the 4m.

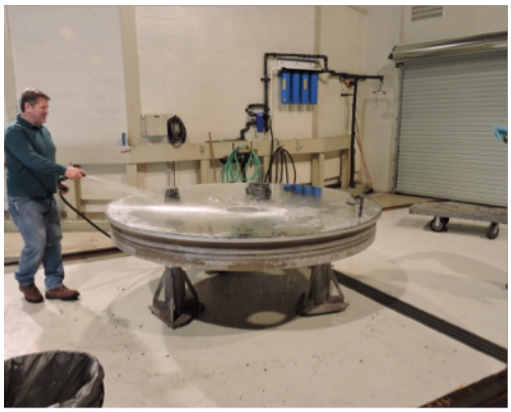
	Move platform and cell back into dome.
	On the secondary mirror, remove the outer 6 bolts from the fixture.
	Stand the mirror up on its edge.
	Remove the handler brackets.
	Study and disassemble the secondary mounting fixture. Refer to supplemental documentation on secondary mounting fixture.

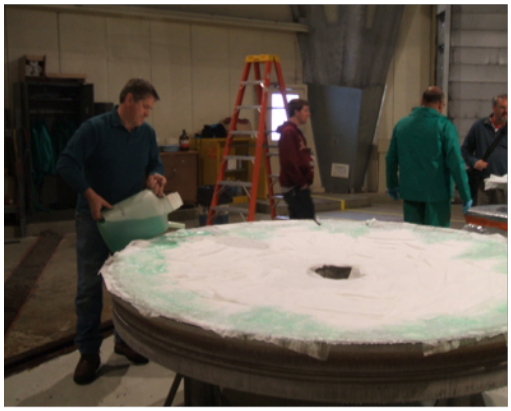
	Place the secondary mirror in its box.
	End of day 1.

Day 2:

	Transport secondary mirror and primary lifting fixture to the 4m.
	Remove lid from mirror box using the first crane.
	Move the truck under the second crane and attach mirror-lifting fixture.
	Lift mirror and move the truck back under the box lid. Replace lid.

	Lower the mirror onto the three stands.
	Remove the mirror-lifting fixture.
	Place secondary mirror on stand.

Mirror-Cleaning Procedure	Perform Procedure for Primary and Secondary Mirrors
	Hose down the mirror with filtered water.
	Spray with soap.
	Spray a natural sea sponge with soap and clean the mirror using light pressure and circular motions. Never let the sponge stop moving while in contact with the mirror surface.
	Hose down the mirror with filtered water.

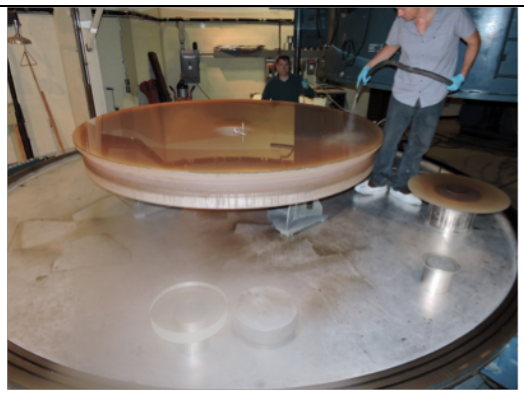
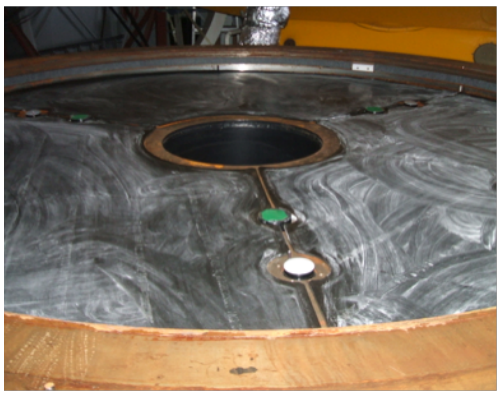
	Have reflectivity and scatter measurements taken.
	Blot with KimWipes.
	Pour on “Green River” (HCl & copper sulphate).

	Pat KimWipes down onto mirror surface.
	After five minutes, wash the mirror with the soaked KimWipes until all of the aluminum has been stripped.
	Hose down the mirror with filtered water.
	Powder the surface with calcium carbonate.

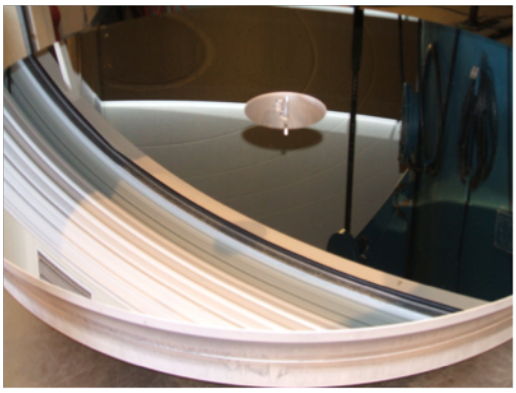
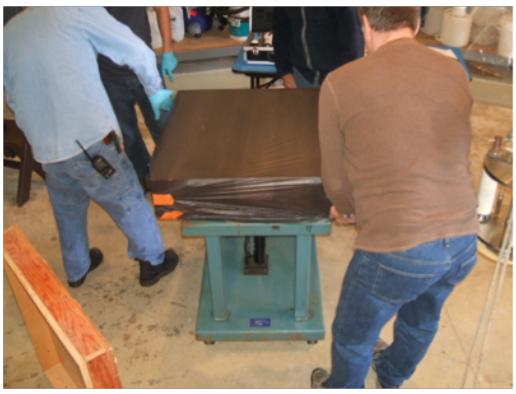
	Using potassium hydroxide and KimWipes, vigorously rub the surface to remove any remaining aluminum.
	Hose down the mirror with filtered water.
	Inspect the mirror and remove any remaining imperfections.
	Hose down the mirror with filtered water.
	Powder the surface with calcium carbonate and pour on potassium hydroxide.
	Rub the surface with KimWipes.
	Hose down the mirror with filtered water.
	Powder the surface with calcium carbonate and pour on potassium hydroxide.

	Rub the surface with KimWipes.
	Hose down the mirror with filtered water.
	Pour on nitric acid.
	Lightly wipe around the mirror surface twice with KimWipes.
	Hose down the mirror with filtered water for 5 minutes to remove all acid.
	Rinse with distilled water.

	Dry the mirror using Technicloth (609's). Grab cloth by corner and swipe cloth from inner edge outward.
	Dry off the sides and bottom of the mirror.
	Cover the surface with KimWipes.
	Lower the lifting-fixture into the primary mirror and lift.
	Drive the vacuum chamber handler under the mirror and lower the mirror onto it.
	Remove the lifting fixture.
	Place the secondary mirror onto the handler.
	Remove the KimWipes from the mirrors.

	NOAO staff will snow-clean and wipe down the mirror surfaces with alcohol immediately prior to closing the chamber.
Back at MDM:	
	Wipe down mercury band and prep with light coating of talc powder.
	Wipe down airbags and mirror cell. Apply light coating of talc powder to airbag surfaces.
	End of Day 2

Day 3:

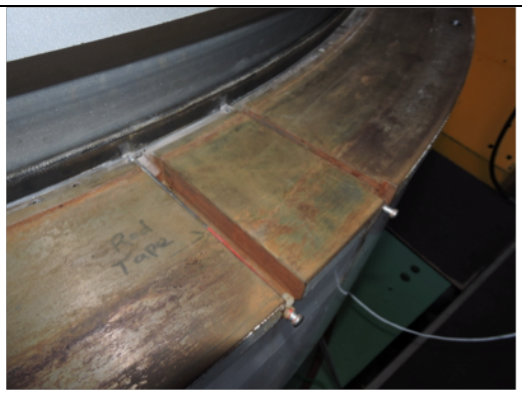
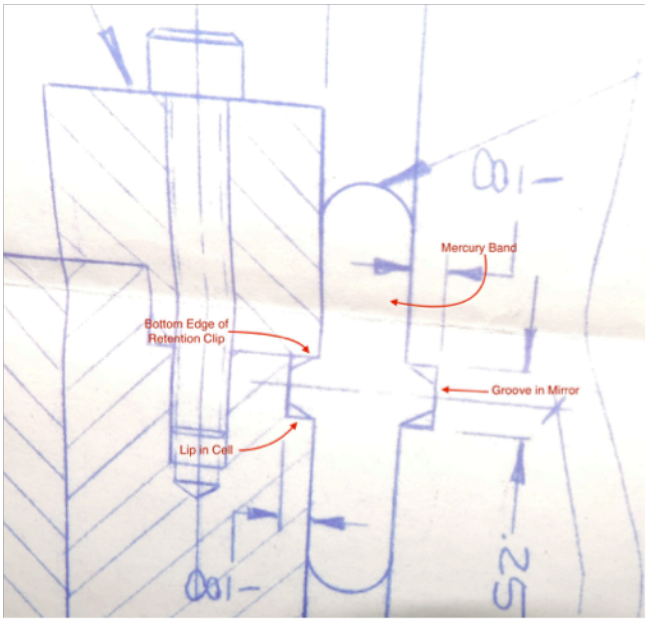
	Drive the vacuum cart out of the chamber and inspect mirrors.
	Cover up the primary mirror with KimWipes.
	Place secondary mirror in storage box.
	Cover the secondary mirror with taut plastic wrap and lid.
	Back in the truck and remove the primary box lid.

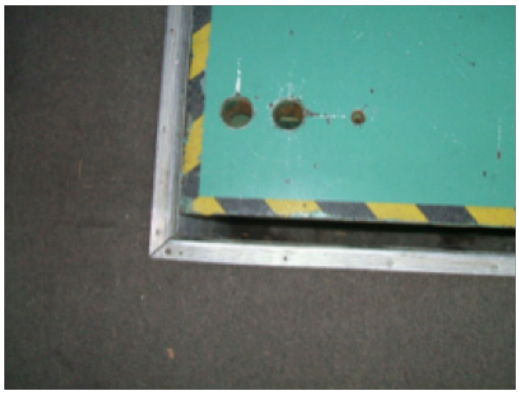
	Lower the lifting fixture into place.
	Lift the mirror and move the handler cart back towards the chamber.
	Place mirror on raised stands and inspect bottom of mirror. Clean as needed.
	Raise mirror, back in truck and lower mirror into the box.
	Remove the lifting fixture and move the truck back under the box lid.

	
	Install the lid and transport to MDM.
	Move the mirror cell outside.
	Lift the mirror box lid and place on the ground.

	Install the mirror-lifting fixture.
	Lift the mirror out of the box and rotate to the cell.
	Lower into the cell, making sure it is centered and aligned (“north” fiducial lines).

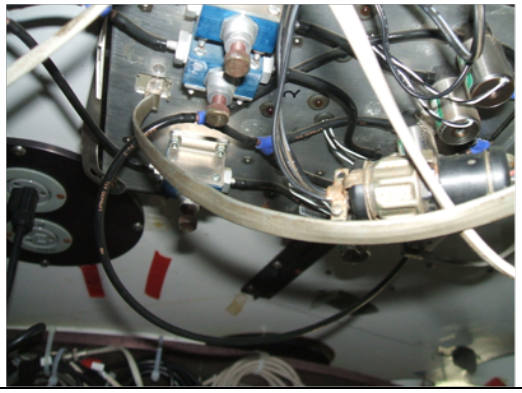
	Remove the lifting fixture.
	Move the mirror cell back into the dome.
	Cover primary mirror box, remove from truck and stow.
	Break for lunch.

	Install the mercury band with the red port to the left, making sure it sits in the groove. See Hg-band doc.
	Carefully inspect the alignment of the mercury band, ensuring that it is aligned to rest on the groove along the side of the mirror as well as the lower lip of the cell.
	

	Install the four mercury band retention clips and bolt down. Check alignment if install does not feel smooth.
	Install the earthquake clamps with ~1/4” clearance.
	Move the platform out by 2”.

	Install North alignment pin.
	Install South alignment pin.

	Raise the mirror cell to within 4” of the telescope and feed cabling (north and south) through the cell port. Reattach the primary mirror temperature sensor on the south side.
	Raise the cell all the way, keeping a close eye on the earthquake clamp clearances. Make sure alignment pins seat correctly.
	Remove the alignment pins and install the mirror cell bolts. Torque to 115 ft-lbs.
	Connect all cabling on the north and south sides of the mirror cell.
	Adjust hydraulic platform speed back to normal by turning regulator ~ ¼ turn. Lower platform.

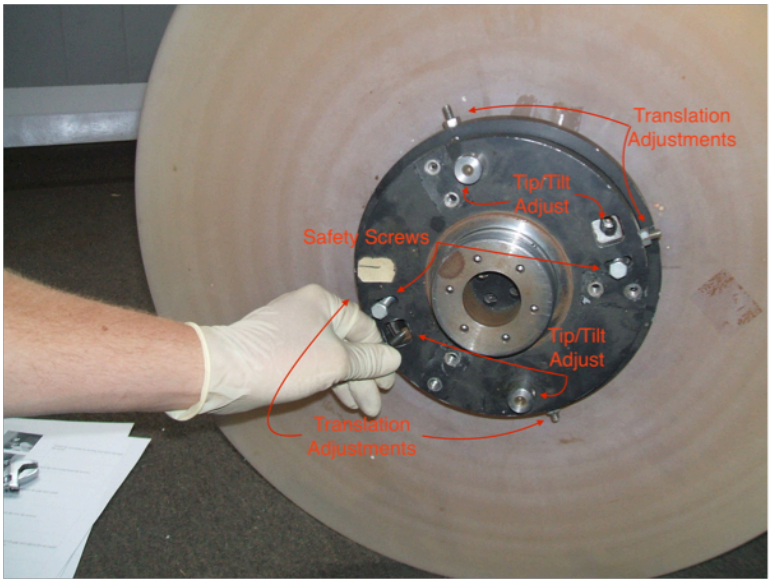
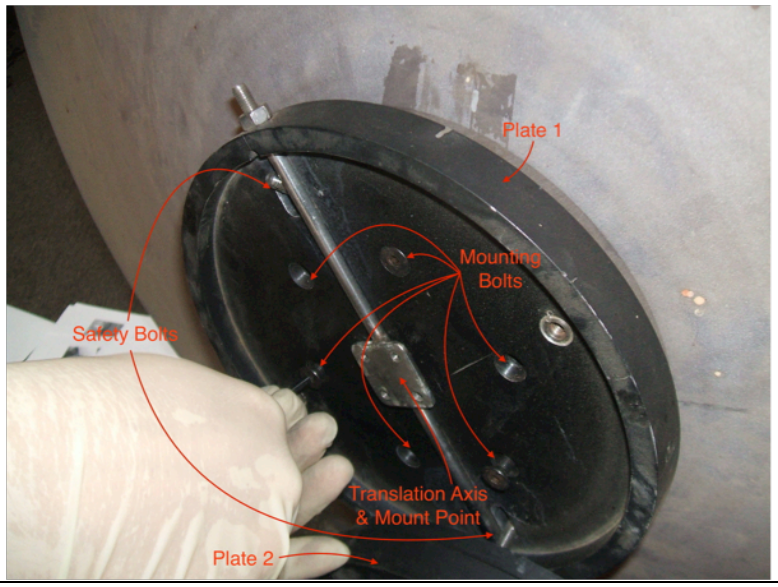
	Install center baffle.
	Remove the mirror cell stands (3).
	Remove the mirror jacks (3) by turning each ¼-turn followed by one full turn. Remove them from the mirror cell.
	Connect the airbag control system cabling.

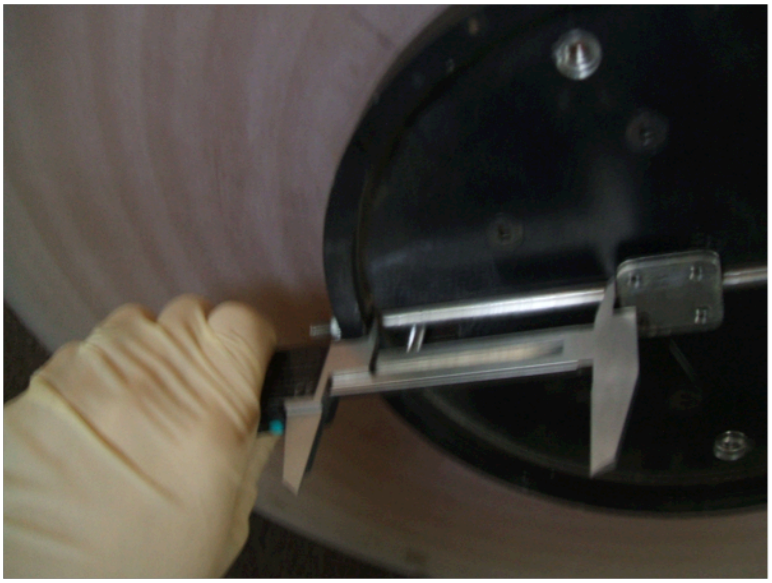
	Turn on the airbag computer. Hard point sensors should stabilize at ~30 pounds.

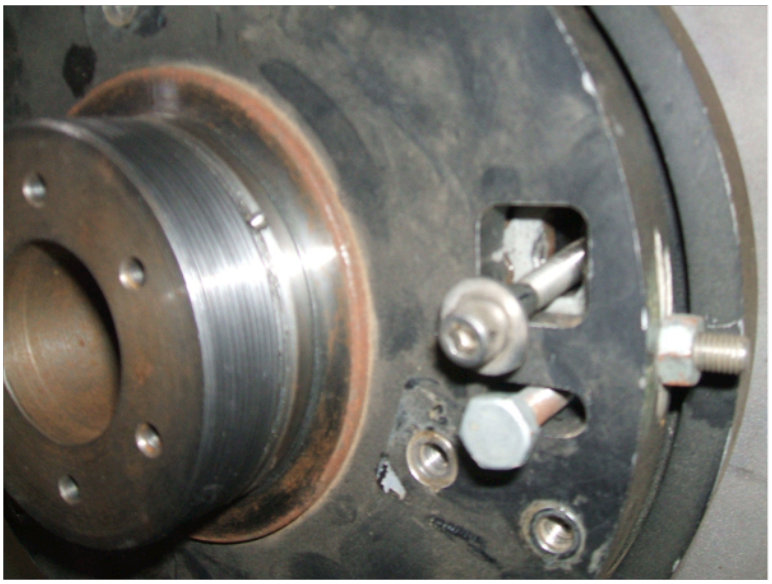
Day 4:

	Install the rotator plates (4), cabling & electronics.
	Remove the telescope jacks and brackets.
	Remove the declination stay bar.

	Remove the RA pin.
	Open mirror covers and reattach the north AC line. Close covers.
	Bring vertical weights up to 1,800 (from 1,000).

	Move the telescope around to bed the primary mirror into place. Start with small motions, iteratively getting larger.
	Reassemble the secondary mirror mount.
	Attach the first plate using the bolts (6) and make sure that the two bolts are inserted into the rear slots.

	Center the tilt plate translation.
	Install the next plate and attach it onto the rear bolts (2).
	Center up the fixture.

	Attach the next plate with bolts (4) through the center.
	Measure and center gap around fixture.
	Attach the tip cap-head screws (2).
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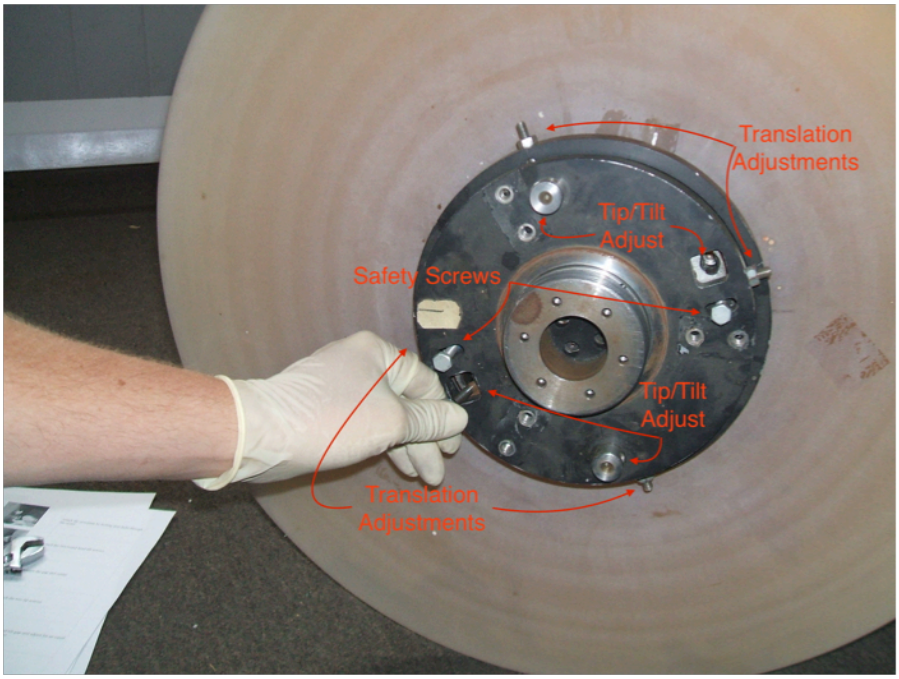
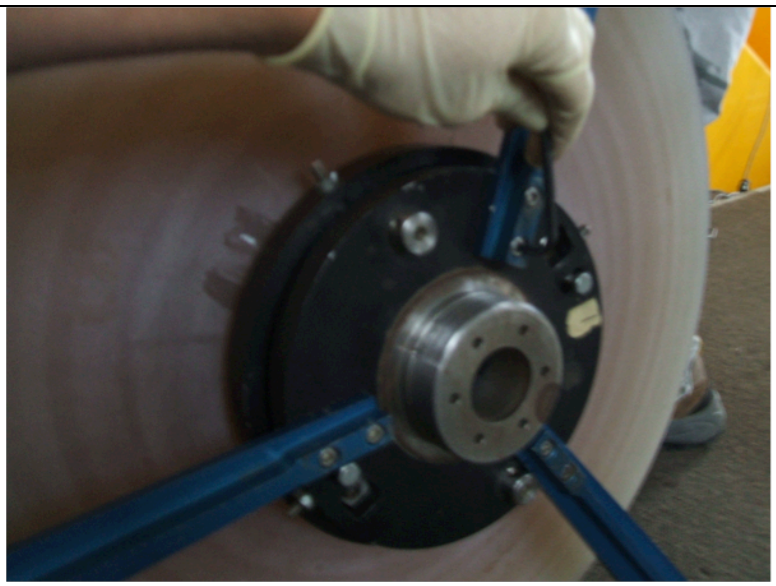
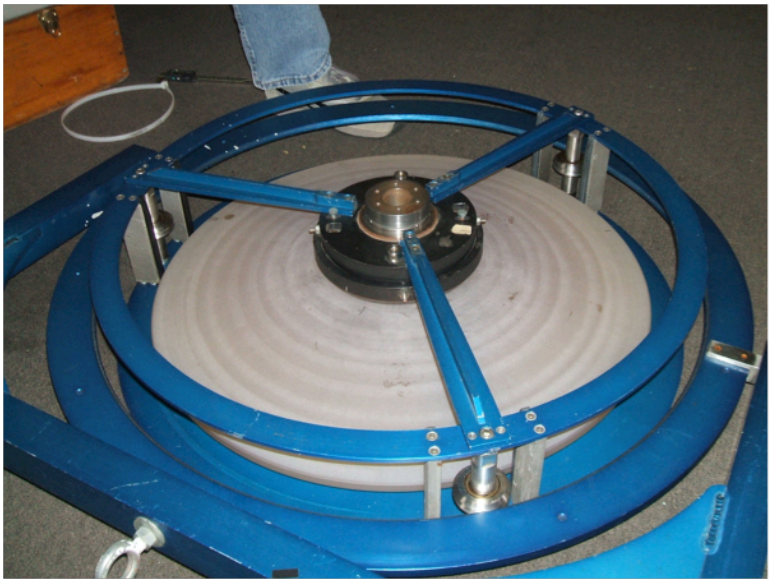
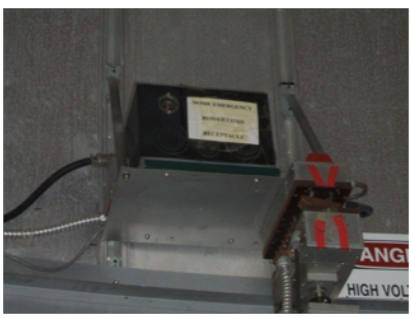
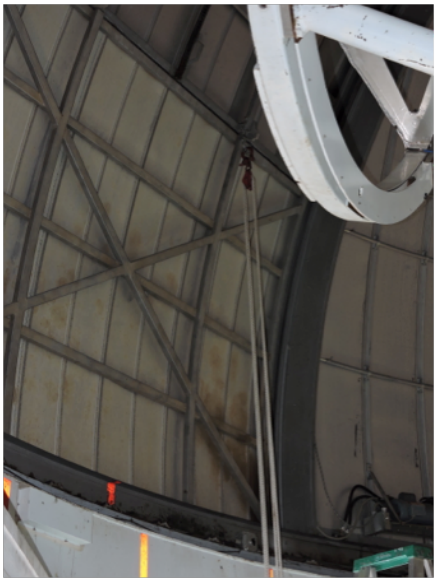
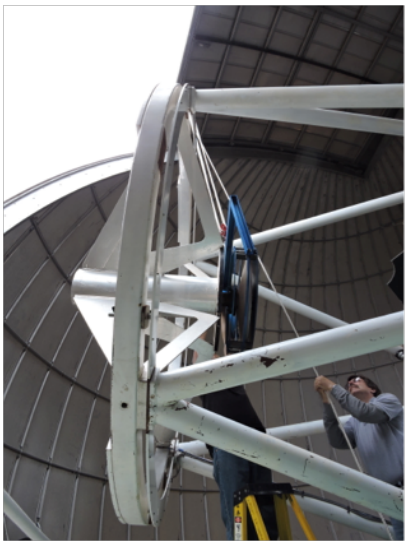
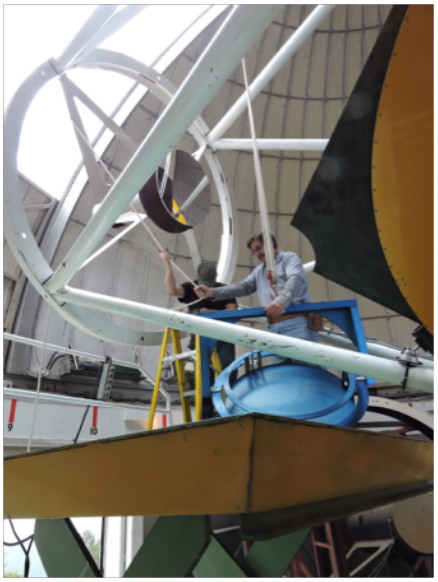
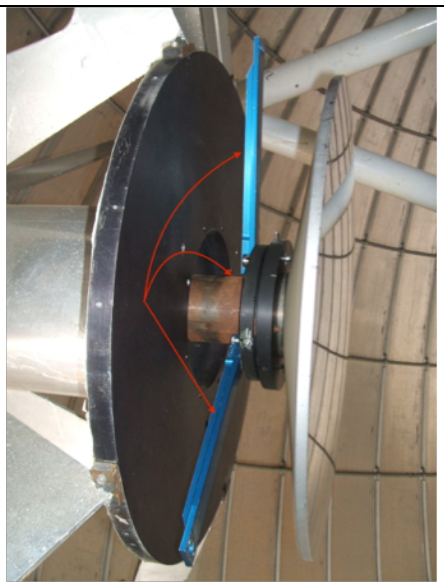
	Install the two safety hex head bolts.
	It should look like this when assembly is complete.

	Install the three handling brackets.
	Install the secondary into the handler and bolt into place (6 bolts).
	Open mirror covers and drive the telescope East and South to access secondary.

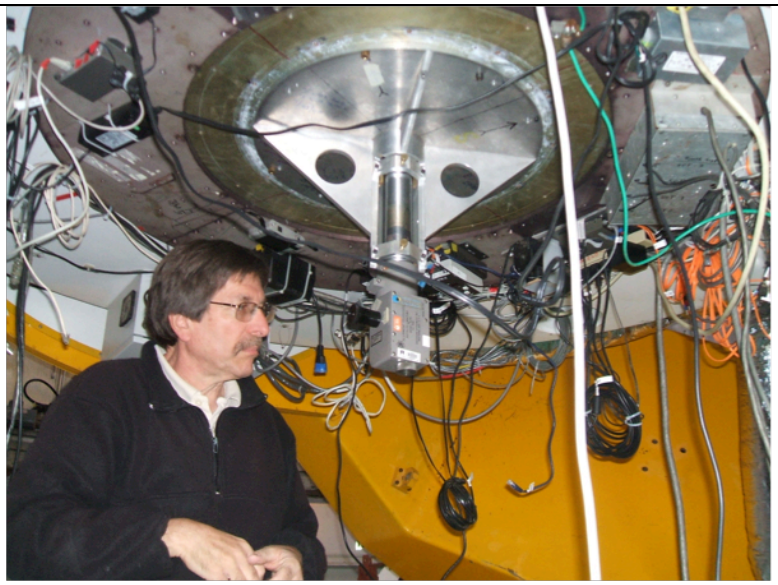
	Install RA safety brace.
	Install the declination stay.
	Turn the telescope power off.
	Plug in the dome emergency power cord.

	Move the block & tackle into position.
	Lift the secondary into position.

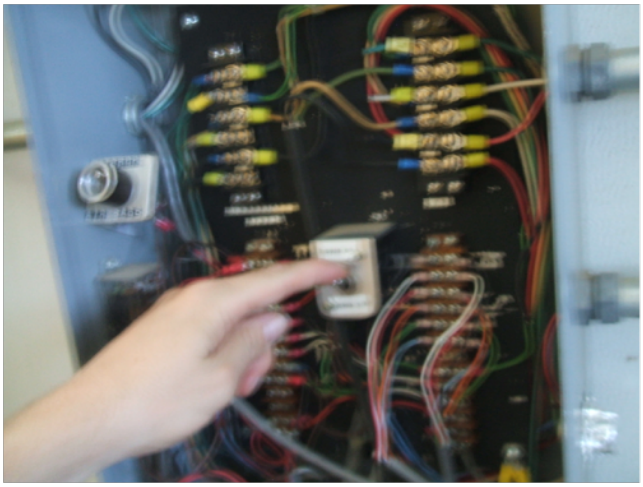
	Rotate the secondary onto the threads and tighten.
	Remove the brackets (3) from the handler.
	Remove the handler.
	Close the shutter.

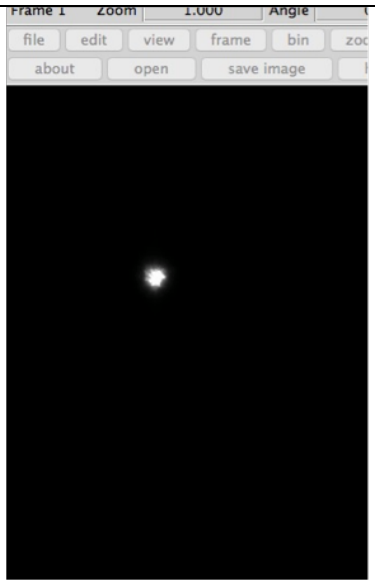
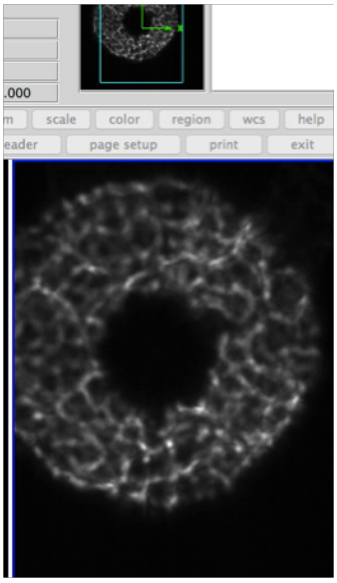
	Remove the lifting fixture arms (3).
	Install the secondary temperature sensor.
	Install the middle baffle using the T-bar.
	Install the outer baffle and clip (3) into place.
	Remove the emergency power cord.

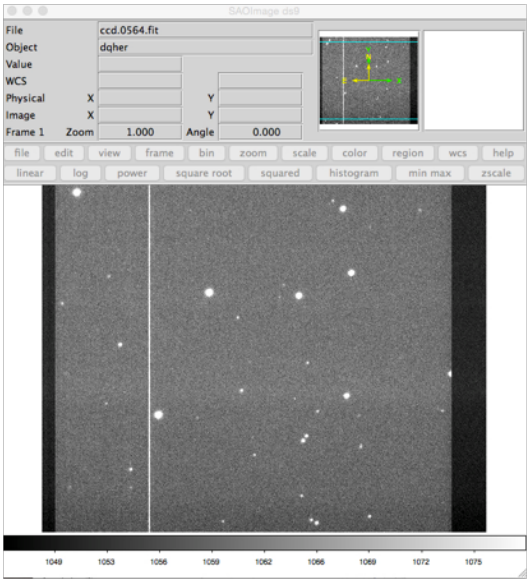
	Remove the declination stay.
	Remove the RA stay.
	Stow telescope at zenith and close the mirror covers.
	Pin RA axis.

	Install the Davidson collimating fixture.
	Drive the telescope South. Adjust translation, tip & tilt.
	Refer to secondary collimation docs.
	Iterate to zenith and check for alignment.
	Remove the collimator and fixture.

	Install the instrument (Andor, Templeton).
	Drive telescope East and install the secondary baffle.
	Bring telescope focus back down to a roughly in-focus value.

	Open the dome around sunset.
	Open instrument.
	Bypass telescope limits.
	Move to a bright star and take an image.

	Center up the star then move the guider to the center of the field.
	Connect to the guide camera from out in the dome using a laptop.
	Defocus the telescope, moving the focus “In” until you get a nice donut (~50 counts?).

	Using the ½” bent wrench and a 15/16” standard wrench, adjust hard points.
	Center and symmetrize the donut.
	Take an in-focus image to confirm collimation.