

McGraw Hill 1.3m Aluminization Procedures

2017May09 - Eric Galayda (update 2017Aug14)



This document assumes that both mirrors are being removed and aluminized. This is not always the case. Steps related to action on the secondary mirror should only be performed if an aluminization of the secondary mirror is advisable. Secondary mirror coatings tend to last much longer as the mirror is downward-facing.

Preparation:




It is worthwhile to read through this document in its entirety prior to attempting to remove the telescope optics.

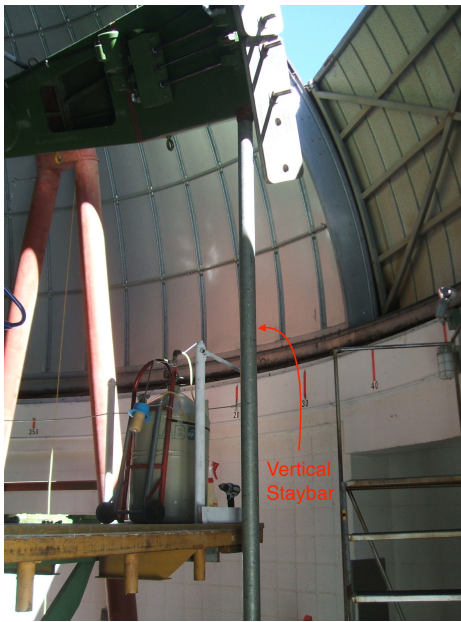
Find and borrow, with appropriate permissions, the Davidson collimator and fixture (seen left) from NOAO. It is typically stored on the 2nd floor at the 4m telescope on the summit. Pull mirror box and cover (or cover pieces) from the garage (or under the telescope platform) and prep/clean it. Also clean foam that will be placed under the mirror in the box.

Gather the following tools and equipment to be used in the procedures:

- Platform: for pulling secondary
- Secondary cover panel
- HA stay bar and chain fall
- Dec stay bar
- Dog ears (2): attach to primary cell for lowering/lifting cell from telescope
- C-fixtures (2): attach to truss support above primary for lowering/lifting cell
- Chain stays (2): for lowering/lifting cell from telescope
- Large socket drivers & ratchets (2): for removing cell bolts
- 1/2" wrenches (2)
- 5/16" driver
- Cheat bar
- Roll-around cart for instrument rotator

- Roll-around cart for mirror cell
- Lifting fixture
- Hoist and hand paddle
- Flatbed truck (contact NOAO to have them bring it to the telescope). Make sure the long straps are included for tying mirror down to bed.
- Install and test lifting hoist prior to pulling the mirror.

Day 1	Day 1
	Place primary mirror box on the flatbed truck.
Adjust vertical weights downward by an appreciable amount and place movable HA weight at inward limit. If a 4th small weight is on the HA counter arm, remove it as well.	
Stay telescope as described below. When stayed, values should be ~ HA -00:00:41 & Dec +31:59:27.4	



Install vertical stay bar. This will likely take extra hands (contact NOAO staff as necessary) and will noticeably change telescope balance, making it potentially difficult to move the telescope.

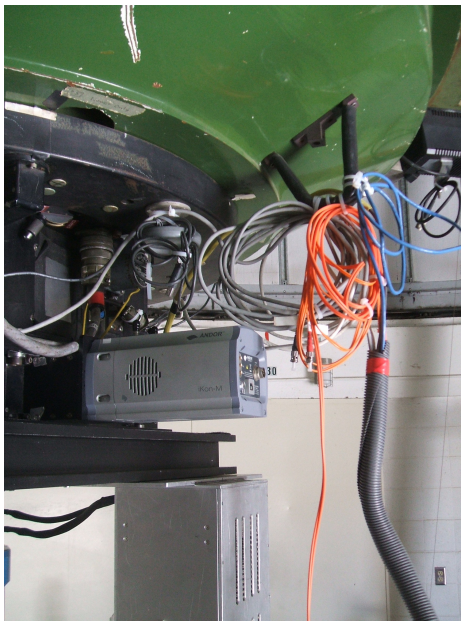


Install chain fall between the outer eye-bolt on the HA counter arm and the chain on the floor near the pier. Tighten to slight tension.



Install dec stay bar, first on secondary ring, then on eye-bolt on HA counter-arm.

Remove installed instrument.



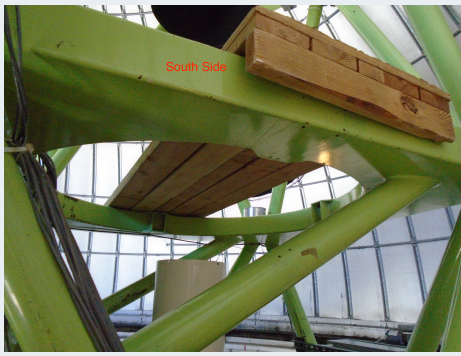
De-cable MIS and remove cable wrap from being connected to the bottom of the mirror cell.



Remove MIS. Use blue hydraulic table to carry MIS. It is likely worthwhile to simply "split" the MIS upper and lower halves, leaving the lower half connected to the filter wheel. This may save the helicoils used to bolt the filter wheel to the MIS.



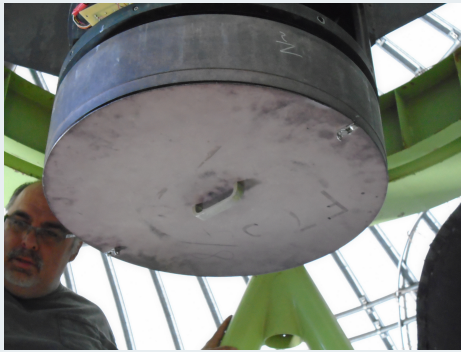
Install Davidson collimator and fixture. Verify secondary mirror collimation translation and tip/tilt. Remove collimator and fixture. Be sure to note orientation of collimator eyepiece so it can be similarly aligned when assembling.



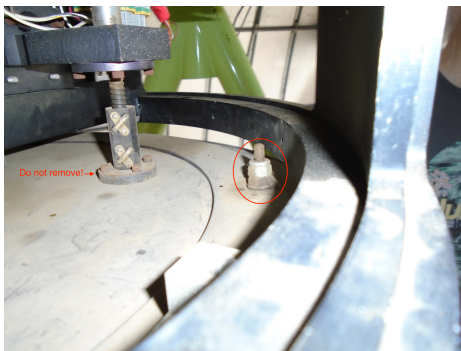
Install platform above the primary mirror covers.



Loosen hose clamps and gently remove secondary mirror baffle downwards. A 5/16" socket driver works well to loosen the hose clamps.



Install cover panel over the secondary mirror. Make sure both clips are securely fastened.



Locate the three sets of bolts with nuts and lock-nuts attached. Remove all three lock-nuts. With someone underneath the secondary, supporting it, loosen the three nuts. When ready, remove the three nuts and delicately lower the secondary to the platform.



Carefully remove the mirror from the platform. It is critical to have help from at least two other people for this step. There is currently no satisfying way to lower the mirror, although options are being explored.



Carry the mirror into the 1.3m shop and place on the benches. Straddle two of the benches, placing the handle for the cover plate in the space between.



Unscrew and remove the fixing ring from behind the mirror. If tight, you may need to use a 2x4 to break it free. It is fine-threaded and takes numerous turns to release (~6.5 turns)



Place foam on tabletop. Gently tilt the mirror cell over while supporting the mirror from behind. Do this until the mirror is laying on the foam. Once on the foam, gently and evenly lift the cell up, off the mirror. Verify that all three shims are still appropriately fixed in place inside the cell.



Place mirror in storage box and load it into an MDM vehicle for eventual transport to the summit.

Remove platform from above the primary mirror covers.



Set rotator angle to 1° and remove bolts holding rotator to mirror cell. Use cart to carry rotator.



Set up ramps and remove MIS and rotator carts from platform. Be sure to place weights under three posts on east side, from south to north. This allows adequate height to ultimately roll the primary cell off the platform.



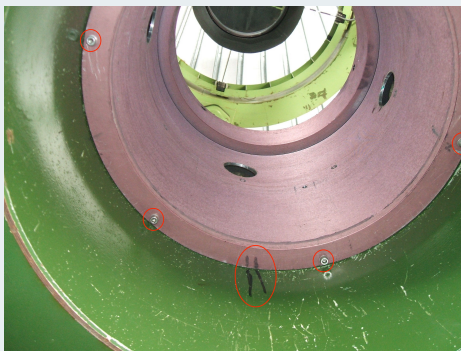
While standing on the mirror cell structure, pull out white baffle using a back-and-forth motion. Use extreme caution while standing on telescope structure, particularly above the mirror.

Open mirror covers using the manual control located on the side of the telescope, above the cell.



Using the clamping fixtures, remove the baffle mount after removing the 3 bolts. Fixtures need to be placed opposite of each other.

Close mirror covers.



Lower the platform and remove the inner baffle. 6 bolts hold baffle in place. Remove all but two. With one person holding baffle from below, a second person should remove the final bolts.



Raise the platform and remove mounting bolts and connecting rods for the mirror cover assembly. Remember to remove the cover drive belt as well as the appropriate cable going into the drive electronics.



Cover assembly rod-joint pins should be left in place, opting instead to remove the bolts. Lift assembly carefully and place to the side, being sure not to rotate the bars.



Remove the 'mirror cover closed' limit switch, located to the north. Be sure mounting position is clearly marked to ease replacement when installing.



Remove the 'mirror cover open' limit switch, located to the south. It is easily removed by unscrewing a single bolt.



Install dog ears on mirror cell using the three associated bolts for each. Note that one is specific to the northerly side and the other specific to the southerly side. Install clevis hardware, making sure that the eye-bolt end of the bolts is on the inside, allowing clearance as the cell is lowered (see image two below).



Install chain stay brackets in the NW & SE corners of the truss assembly. Install clevis hardware.



Install chain falls and place them under tension.



Pull mirror cell bolts, using a cheater bar and start to lower the mirror cell.

As the cell is being lowered, use care when getting the chain falls through the telescope structure. Lower the platform iteratively. Lower cell onto transfer cart.



Remove mirror cover ring bolts. Lift and stow the mirror cover assembly off to the side. Remove dog ears.

Unscrew bolts holding mask ring. Carefully remove the ring and place to the side.



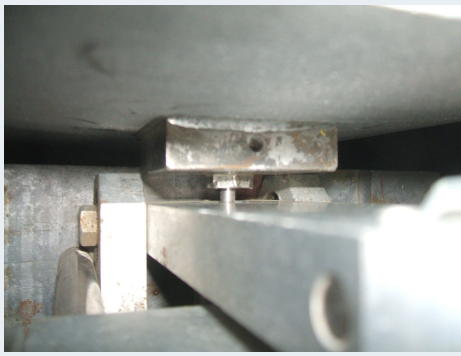
Carefully remove the seismic clip bolts (2 bolts/clip, 3 clips). Clips must be supported to ensure they do not slip down onto the mirror surface!

End of Day 1

Day 2



Carefully remove the alignment fixtures from inside the mirror cell using the shaved 9/6" wrenches, the spanner wrench and a screwdriver.



While holding the spanner in the barrel nut, iterate between turning the head nut at the puck (on side of mirror) and turning the screw pin within the barrel nut assembly until both, the head nut and pin are free from the puck.



This can be frustrating. Be patient and take your time, being careful to not get the pin or head nut jammed up. There are a total of 6 of these assemblies spaced radially around the mirror.



Gently roll the cell down ramps onto the loading dock, trying to avoid sudden start/stops. It is advisable to get help from NOAO staff for this step. One person at the handle, one in front and two in back.



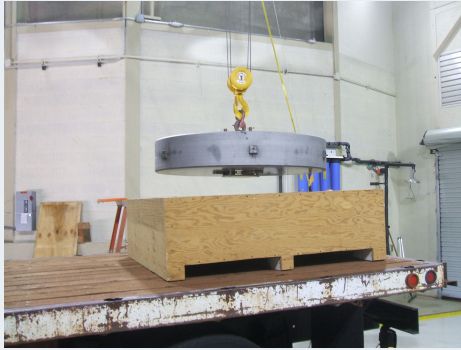
Ensure that the mirror crate is clean and foam is placed appropriately within.



Install the lifting fixture and hoist hook. A clevis will also be required. Remove mirror from cell and transfer to crate.



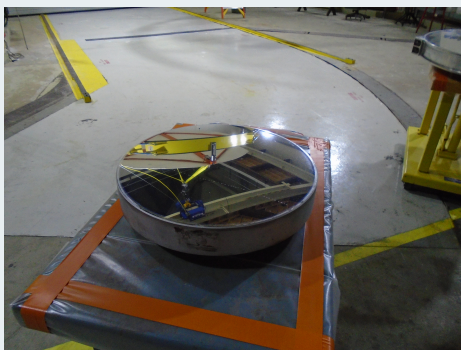
With mirror in crate, place the cover on top. If needed, use screws to fix cover to crate. Strap the crate to the truck bed using long straps, which are provided by NOAO.



The mirror is then transported to the summit via NOAO staff, keeping truck speed to ≤ 10 mph. Follow in an MDM vehicle, bringing any necessary equipment, including lifting fixture and crated secondary.



Once the truck is at the 4m, remove the crate top and install the lifting fixture. Lift the mirror out of the crate. Transport truck will be driven out of the garage. Lower the mirror onto the three NOAO-provided stands.



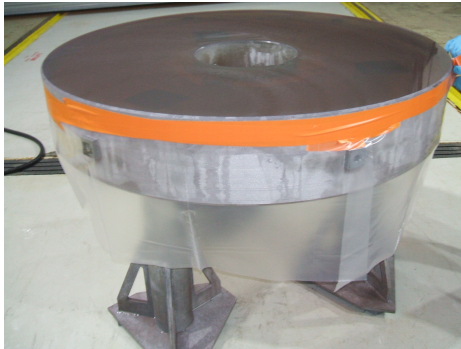
Remove secondary mirror from crate and place on a plastic-covered cart with wood beneath.



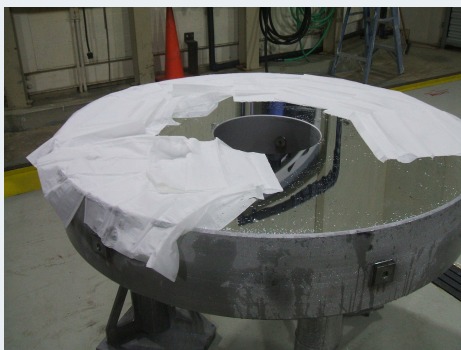
Have NOAO staff take reflectivity & scatter measurements of the dirty mirrors.



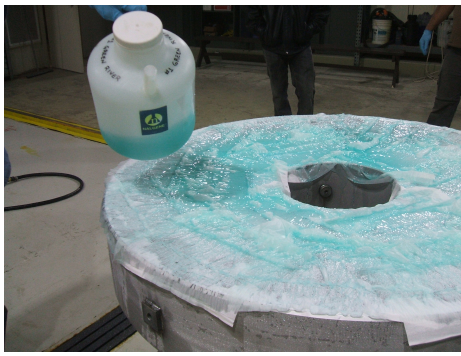
Perform a standard wet-wash and repeat measurements. These will be used as the standard of comparison once the mirror is recoated.



Use plastic and floor-marking tape to create a skirt in order to protect mirror pucks from cleaning chemicals.



Place Kim Wipes evenly across the entire mirror surface.



Pour on "Green River" (HCl & copper sulfate).



Perform the same cleaning techniques for the secondary.

Gently pat Kim Wipes down onto mirror surface. After 5 minutes, wash the mirror with the soaked Kim Wipes until all of the aluminum has been stripped.



Hose down the mirror with filtered water.

At this point, anyone working with the mirror and stripping solvents should suit up in appropriate boots, trousers and jacket. Appropriate gloves should be used. Sleeves should be taped off at wrists. Tape can also be wrapped around the waist to keep the jackets from making contact with the mirror surface.

Powder the surface with calcium carbonate.

Using potassium hydroxide and Kim Wipes, 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 as necessary.

Repeat calcium carbonate/potassium hydroxide application
then rub the surface with Kim Wipes.

Hose down the mirror with filtered water.

Repeat calcium carbonate/potassium hydroxide application
then rub the surface with Kim Wipes.

Hose down the mirror with filtered water.

Pour nitric acid onto mirror surface.

Lightly wipe around the mirror surface twice with Kim Wipes.



Hose down the mirror with
filtered water for ~5 minutes to
remove all acid.

Carefully remove taped skirt from mirror circumference.



Rinse with distilled water,
contained in 5-gallon bottles.

Dry the mirror using Technicloth (609's). Grab cloth by corner
and swipe cloth from inner edge outward. Only one swipe
per cloth!

Dry off the sides and bottom of the mirror.

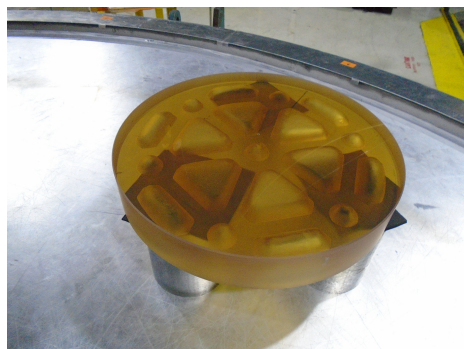


Clean off the back side of the mirror blank with acetone and make sure it is thoroughly dried. Ensure inside the "Cass-hole" is thoroughly dry as well.

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 using the smaller cylindrical stands.

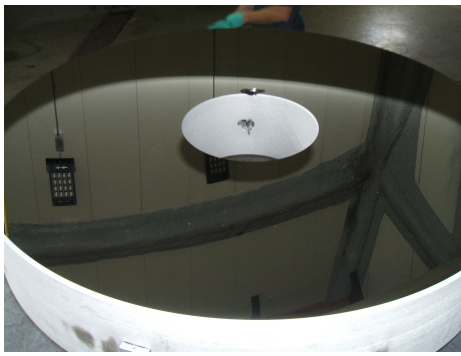


Snow-clean and wipe down the mirror surface with alcohol immediately prior to closing the chamber. One last snow-cleaning may be performed right after the alcohol wipe as well if desired.

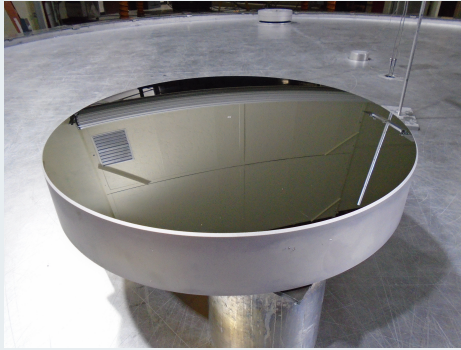
Chamber is closed up and pumped down in preparation of firing. If all goes well, the new coating may be applied that afternoon.

End of Day 2

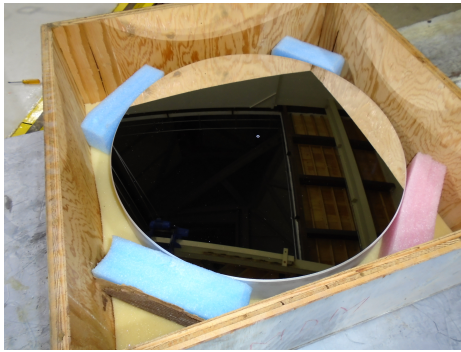
Day 3



The chamber should be fully vented and ready to be opened within the first hour of the day. Truck mirror(s) out and inspect coating. Coatings should have a thickness of 950-1150Å.



Take reflectivity & scatter measurements.



Hand-lift the secondary mirror and place in crate.



Using plastic sheeting, cover and staple. Replace and screw on cover. Place to the side, or in an MDM vehicle for eventual transport back to the 1.3m.



Install lifting fixture and lift the primary mirror off the handler.



With mirror raised, handler can be moved back into chamber area and the three stands set back up on the floor.



Lower mirror onto stands and inspect. Snow clean if desired.



Lift mirror back up and remove stands from floor. Back truck in under the mirror, lining it up with the crate. Make sure padding is still sitting properly in crate, then lower mirror back into crate.



Using plastic sheeting, cover and staple.



Place wood cover or cover pieces on and screw down as needed.



Place lifting fixture in truck and return to MDM.



Install lifting fixture and cautiously raise the mirror out of the crate. Position the mirror over the cell and carefully align and place the mirror down into the cell, ensuring that the pucks align with the centering mechanisms.

Gently roll the mirror cell transport back into the dome to get it out of the sun. Use NOAO staff to assist with moving the cell.

Take time and care in installing the centering fixtures back into the pucks along the circumference of the mirror cell. This step will take appreciable time and effort. Iterate between points. Slowly iterate between screwing in the pin screw and screwing on the head bolts, all while holding the barrel assembly in place. It may be necessary to screw the barrel assemblies in/out enough to allow a wrench to seat onto the head nut. When completed, all nuts should be fully screwed into their associated pucks.

Install seismic clips, ring, mirror covers and dog ears.

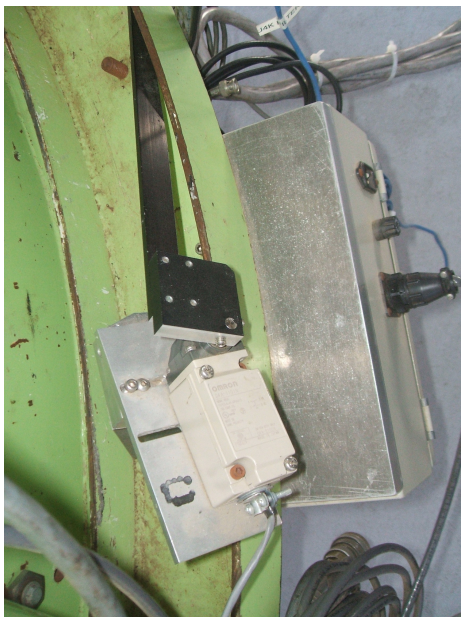


Connect chain falls, clevis IN. Lift mirror cell back into the telescope structure. Bolt into place.

Day 3 ends.

Day 4

Raise platform and pull chain falls. With chains removed, pull top fixtures and dog ears as well.



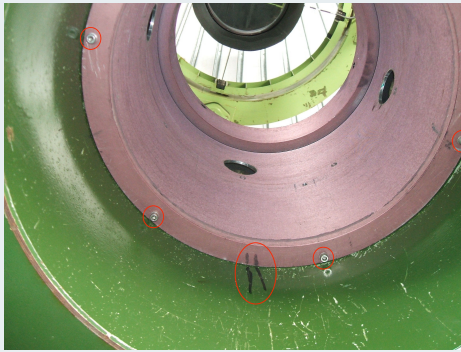
Replace mirror cover "open" limit switch on the south.



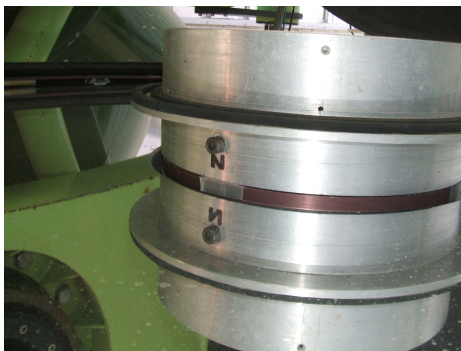
Place mirror cover frame assembly back into place and bolt back together. Remember to reconnect the cable (W1) and replace the drive belt.



Replace mirror cover "closed" limit switch on the north.



From below the cell, install the inner baffle (6 bolts). Make use of reference marks.

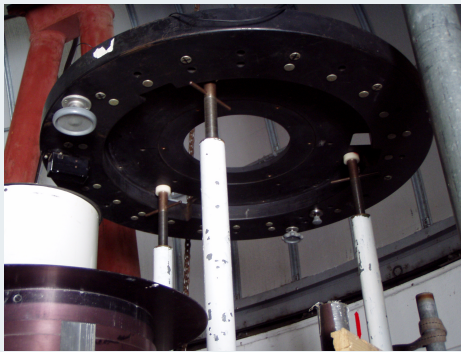


Carefully align and set baffle mount. Use bolt holes as reference for alignment, noting the 'N' fiducial as well. Use a rubber mallet and 2x4 to knock the mount into place. Once close, a screwdriver can be used to finely align bolt holes. Carefully screw in 3 setting bolts.



Standing on the telescope structure, push the baffle back into place, wiggling it back and forth.

Roll rotator, filter wheel and MIS out onto the loading dock then set up the ramps. Roll all carriers onto the platform.



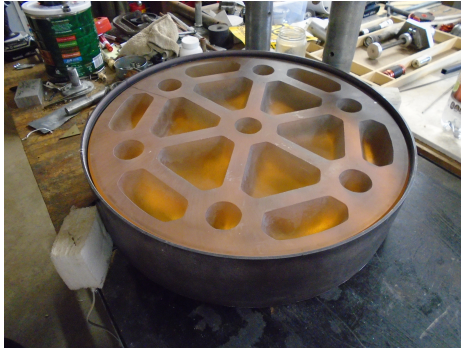
Install rotator. Adjust angle to 002°.



Install Davidson Collimator. Replace platform above the primary mirror and prepare to install the secondary mirror.



Bring the secondary mirror into the shop. Remove the cover and plastic, then remove the mirror from the crate and place on 2x4s or foam.



Be sure that all three shims are adequately installed inside the mirror cell. Very carefully lower the cell down onto the mirror, aligning fiducials. With the cell placed over the mirror, carefully lift and flip over the assembly, taking care to keep the mirror from shifting or moving. Place face down on the bench. (This step can be done with or without the mirror cover in place.)



Install the back-ring onto the mirror cell. Due to the fine threads, it is advisable to start with a CCW rotation until the threads "click in" place. It should take ~6.5 turns to tighten.



It is critical that the orange tape marks align with the deepest portions of the rear of the mirror. This allows clearance for the jack screws when increasing focus.

Carefully carry the mirror assembly out to the dome.



With assistance from NOAO staff (~4 people total is useful), carefully lift the mirror assembly onto the platform and set in place under the secondary mounting point.

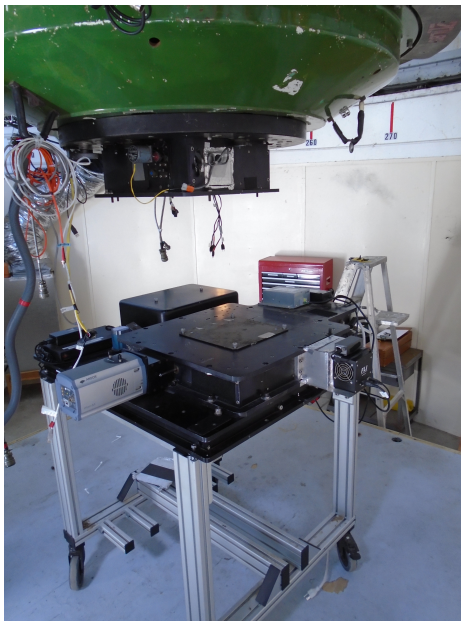


Lift mirror and set the three bolts through the associated holes. With one person underneath holding the mirror assembly, have one or two others quickly tighten the nuts onto the bolts.

Once the mirror is roughly in place, use the Davidson collimator to adjust mirror alignment. Since the three bolts act to affect translation as well tip/tilt, this process can be highly tedious and iterative. Once collimation is acceptable, screw on the lock nuts above the adjustment nuts and verify once more that the collimation looks good.



Install the baffle, tightening the hose clamps with a 5/16" socket driver.



Remove the Davidson collimator and fixture. Install the MIS and filter wheel.

Install the desired detector for collimating. I like to use the Andor (direct).

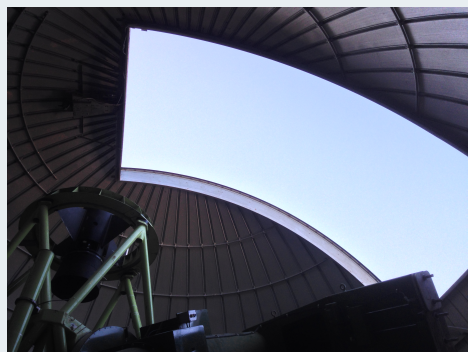


Remove Dec stay bar.



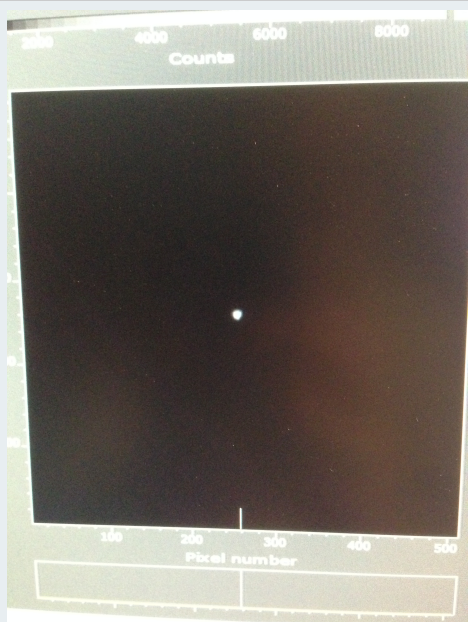
Adjust weights if necessary. Remove chain stay. Telescope could very likely be in a bound state. In order to remove the vertical (HA) stay bar, it will be necessary to move the telescope west. Do whatever is necessary to get the telescope to move while additional hands work to unscrew the stay bar. Try to get at least 4 people around for this step.

With telescope free, adjust weights to the proper balance for the chosen detector configuration. Make sure telescope procedures are all functioning. This includes checking mirror cover limit switch adjustments!

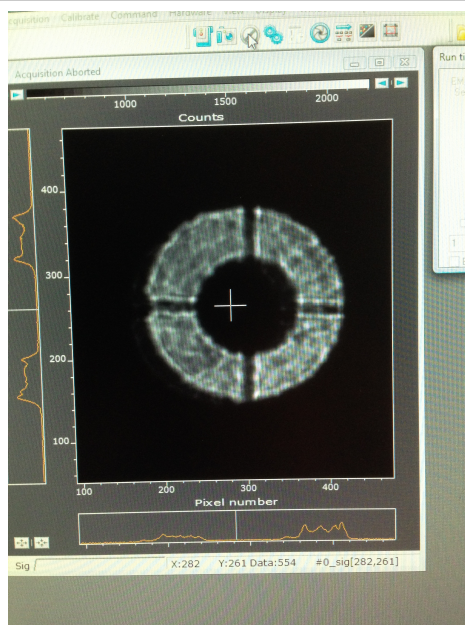


Wait until night, then open and prepare to collimate.

Using JSkyCalc, go to a star located near zenith. Touch up RA/Dec readouts if necessary. Choose a star from on the display and press 'h' to read the coordinates. Then slew to coordinates.



Hopefully the star appears somewhat in focus.



Adjust focus to "in" and "out" from nominal focus position. Using a long screwdriver, making any necessary adjustments to the contact points on the underside of the mirror cell. Telescope is collimated when the 'donut' appears symmetrical.

Move to various stars around the sky and check collimation. Put telescope back to nominal focus. Stow telescope and close dome.

Be sure to return all borrowed equipment to the summit and notify appropriate NOA staff.