

Rev B



PRIMARY MIRROR BLOCK REPAIR PROCEDURE

IH 10-19-2011

Discussion: If an attempt is made to translate the primary mirror in the cell, the mirror blocks are designed to break loose from the primary mirror to prevent more serious damage to the mirror or supports. Follow this procedure to realign the primary mirror in the cell and then reattach the loose mirror blocks.

If the mirror has not lost position in the cell, a loose mirror block can be reattached with the mirror and cell in place on the telescope.

Gather the following tools and equipment:

1. Primary mirror insert tool (dwg. 621-189-1).
2. RA and DEC lock pins.
3. "L" ball end Allen wrench set.
4. MCLA (Mirror Cell Lifting Assemblies) (dwg. G48-086). These tools are stored in a wooden crate supplied by DFM.
5. 2 threaded 1/4" guide pins.
6. 2 threaded 3/8" guide pins.
7. Wide base depth micrometer with 5"-6" rod.
8. Axial hardpoint wrench (dwg. 621-155-1)
9. .003" feeler gage and handle.
10. 1/2" combination wrench.
11. 6" dial caliper.
12. Feeler-gage set.
13. 3/8" nut driver.
14. DFM Engineering maintenance drawing package.
15. Clean tissue.
16. Masking tape.
17. Devcon 5 minute epoxy or similar.
18. Small flat screwdriver (to spread the epoxy)
19. Pad of clean notepaper.
20. #120 or coarser grit sandpaper.
21. Glue guides (dwg. 621-155-3) as required.

Become familiar with the following drawings in the DFM maintenance drawing package:

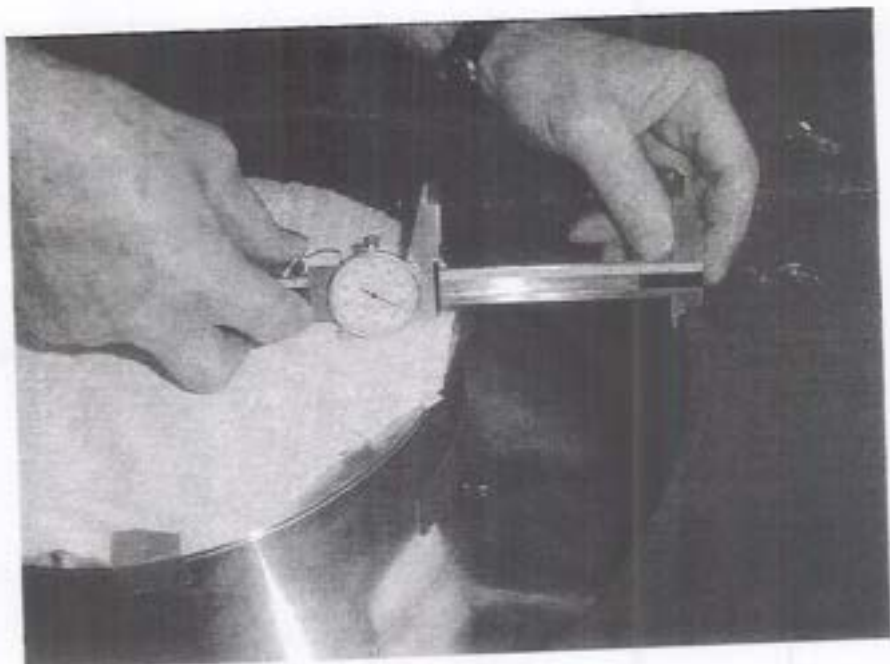
- 621-011 Primary Mirror Cell Assembly.
- 621-155-1 Front Defining Bracket Assemblies.
- 621-156 Mirror Support Assemblies.
- 621-186 Mirror Cell Lifting Assembly.

4.6.1 PRIMARY MIRROR

- 1. Drive the telescope to the zenith and install the lock pins.
- 2. Close the mirror doors.
- 3. Remove the instrument, SAG, and mirror cell weights from the back of the primary mirror cell.
- 4. Remove the field corrector assembly and primary light shield.
5. Remove the light shield from the field corrector cell assembly and protect the field corrector with clean tissue.
- 6. Verify that the 3 axial and 2 radial dial indicator assemblies are installed and active.
- 7. Write down the readings of the 5 indicators. Note that the dial indicator assemblies are stamped to define their position on the cell: "N"= North, "W"= West, "NEB"= Northeast bottom, "WB"= West bottom and "SB"= South bottom. (621-011) (621-155-1)
- 8. Remove the 4 Invar rod bolts and 3 mirror retainer nut covers from the bottom of the mirror cell.
- 9. Gently tighten the 4 primary mirror radial supports 1/2 of 1 wrench flat (1/12th of a turn) while watching the radial dial indicator assemblies. Do not translate the primary mirror in the cell.
- 10. Use the 3/8" nut driver to loosen the 3 retainer nuts (dwg 621-155-1, item 3) 4 turns each
- 11. Raise the 3 axial hardpoint screws until they just contact the bottom of the mirror. Watch the 3 axial dial indicators to see mirror motion when the hard points contact the mirror but do not raise the mirror more than .0005 inches. (Refer dwg 621-011 & 621-155-1)
12. Hold a 1/8" Allen wrench by the short leg to loosen (unscrew) the 36 back support screws 3 turns each. Start by adjusting a back support counterweight assembly near the center of the mirror cell. Refer to drawing 621-156 and look through the center hole in the primary mirror cell to see the workings of the mechanism. Remove the axial support part
Ref dwg - 621-156
- ✓ 13. Remove the north and west radial dial indicator assemblies.
- ✓ 14. Install both MCLAs onto the center section and mirror cell. Use the 1/4" guide pins to help install the upper MCLA pad first.
- ✓ 15. Take some load with the MCLAs.
- ✓ 16. Loosen the 12 mirror cell flange bolts ² turns each. Replace 2 opposing mirror cell bolts with 3/8 guide pins.
- ✓ 17. Verify that the MCLAs are supporting the mirror cell, then remove the 10 remaining mirror cell flange bolts.
- 18. Lower the cell with the MCLAs. 2 persons should turn the MCLA handles, counting turns to keep the mirror cell level.

Place the top of the mirror on the cell flange to protect the mirror

- ✓ 19. Lower the mirror cell onto the mirror insert tool so that the bottom of the cell is resting centered on the 3 posts of the mirror insert tool. *DO NOT insert the legs of the tool into the holes in the cell.*
- ✓ 20. Unscrew the 4 radial support push screws 3 turns each. (621-011) #25
- ✓ 21. Raise and secure the earthquake guards as high as the mounting holes will allow. *Remove the North MCLA*
- ✓ 22. Install the 2 radial indicator assemblies and set them to "0". *(Remove one MCLA parts North side for m dial indicator covers and)*
- ✓ 23. Identify the mirror blocks that need to be reattached. Remove the pins from the mirror blocks and remove them from the cell.
- ✓ 24. Install the light shield flange and corrector cell (without the light shield) into the bottom of the primary mirror cell.
- ✓ 25. Use a 3/16" Allen wrench to reach through the slots in the functioning radial counterweight assembly covers on the primary mirror cell and check the radial counterweights: Gently push each of the radial counterweights in and out to verify that none of the radial counterweights will contact the mirror cell or counterweight cover during the following adjustments.



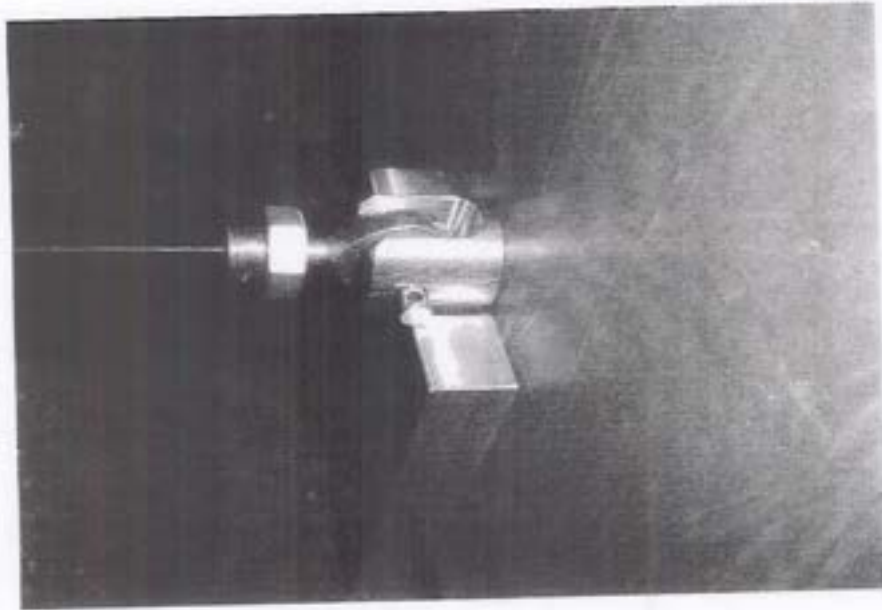
- ✓ 26. Use the 6" dial caliper to measure the gap between the inside diameter of the primary mirror and the outside of the field corrector cell at approximately north, south, east and west. Use the radial supports to center the primary mirror in the cell until the gap between the mirror ID and field corrector OD are uniform to within .002" ± .005
- ✓ 27. Reset the 2 radial dial indicators to "0".
- ✓ 28. Remove the primary light shield flange, remove the protective tissue on the field corrector, and re-assemble the primary light shield onto the flange. Place the primary shield assembly aside.

NEB .005
SEB .002
W .002

- ✓ 29. Refer to DFM drawing 621-011 to find the desired primary mirror height in the cell.
- ✓ 30. Use the depth micrometer to measure the distance from the mirror cell flange down to the edge of the front surface of the primary mirror near each axial hardpoint screw.
- ✓ 31. Write down the 3 mirror dimensions for future reference. (5.92 ± 0.00)

Note: The primary mirror must be returned to the design height in the mirror cell to insure that the mirror blocks get attached to the primary mirror at the proper height.

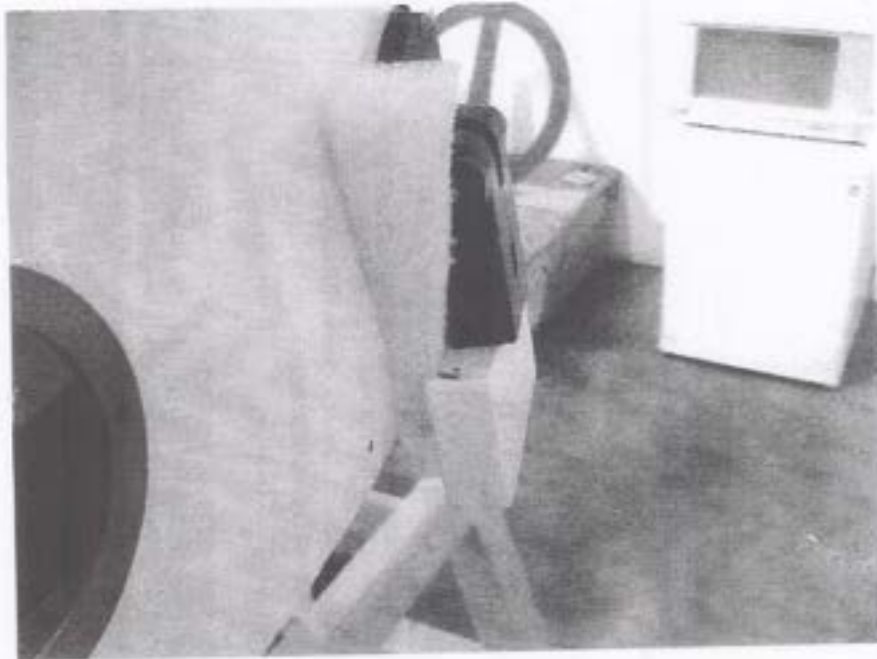
- ✓ 32. Use the 3 axial hardpoint screws to set the mirror height to within .001" of the designed primary mirror height. Be careful not to adjust any one hardpoint screw more than .010" (1/4 turn) each iteration, to avoid tipping the mirror and damaging the back support counterweight assemblies.
- ✓ 33. Set the 3 axial dial indicator assemblies to zero. These assemblies can now be used as a reference for the primary mirror location along the optical axis.
- ✓ 34. Remove the radial counterweight cover from each assembly that is to be repaired.
- ✓ 35. Cut white packing foam into pieces 2 or 3" wide and about 4" long. Roll the foam strips and tape them into tubes with a 1" hole in the center. These strips will be used as springs between the mirror cell and radial counterweight to gently load the mirror blocks against the mirror while the epoxy cures.
- ✓ 36. Place a clean sheet of #120 or coarser sandpaper on a flat tabletop. Sand the flat surface of each loose mirror block to create a clean, rough surface to carry the epoxy.
- ✓ 37. Remove the loose epoxy from the side of the primary mirror and clean each glue site and mirror block thoroughly with acetone or lacquer thinner.
- ✓ 38. Refer to drawing 621-155-3 to identify the glue guides. Clean the glue guides.
- ✓ 39. Secure the mirror blocks to the connecting rods with the clevis pins, omit the safety rings.



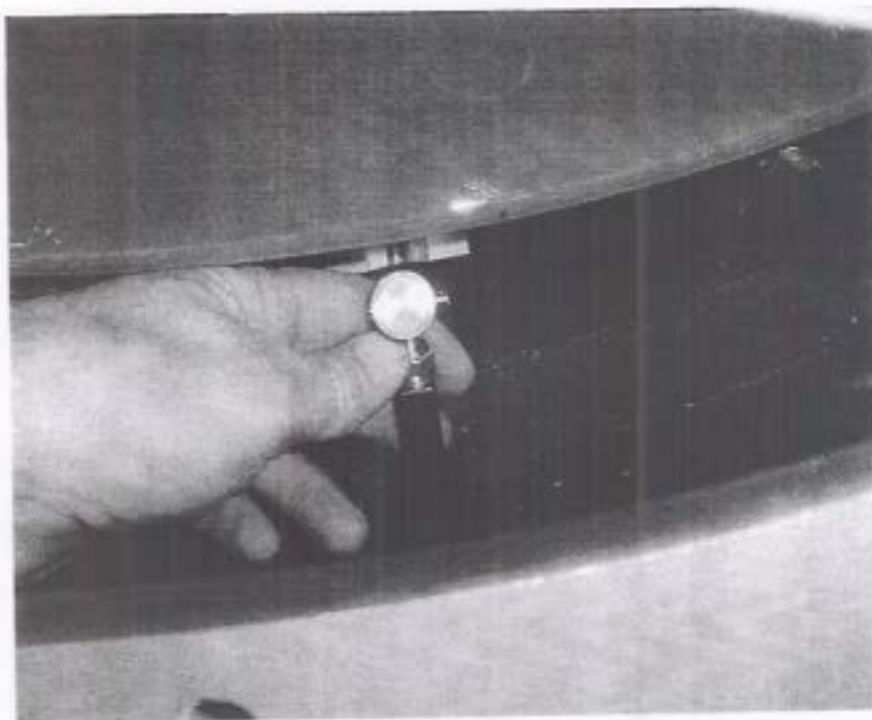
- ✓ 40. Set the glue guides in the mirror cell where each mirror block is to be attached. Wiggle the glue guides while pushing down on the mirror blocks to settle the mirror blocks and guides in place. Move each glue guide so that each clevis pin is horizontal and that there is .005-.010 clearance on both sides of the connecting rod end in the mirror block.

Two alternative foam springs:





- ✓ 41. Slip a foam spring into place between the mirror cell and the radial counterweight to test the fit of the glue guides and mirror blocks. Adjust the foam springs to apply minimal pressure between the mirror blocks and the mirror.
- ✓ 42. Select a radial counterweight assembly to practice on: Remove the foam spring and push the radial counterweight towards the mirror cell to retract the mirror block away from contact with the primary mirror. Raise the mirror block to expose the mating face and simulate applying epoxy to the mirror block. With the mirror block fully retracted, seat the mirror block against the mirror and in the glue guide as before. Insert the foam spring to keep the mirror block in light contact with the mirror. Practice this step several times.



- ✓ 43. Thoroughly mix a small batch of epoxy on the notepad for a minimum of 30 seconds. Repeat step 38 with epoxy on the affected radial support assemblies. When the epoxy starts to become more viscous, set the batch aside and mix a new batch.
- ✓ 44. Make sure the mirror blocks are seated in the glue guides properly. Excessive pressure from the foam springs will force the mirror blocks to slide up out of position.
- ✓ 45. Let the epoxy cure for 12 hours above 20 deg C.
- ✓ 46. Carefully remove the glue guides. It may be necessary to raise the mirror .005 with the axial hardpoint screws. Do not adjust the radial hardpoint screws more than .001 at a time.
- ✓ 47. Remove the foam springs, and replace the radial counterweight covers.
- ✓ 48. Use a 3/16" Allen wrench to reach through the slot in the 16 radial counterweight assembly covers and check the travel of the radial counterweights. Gently push each of the 16 radial counterweights inboard and outboard to verify that none of the radial counterweights will contact the mirror cell or cover. If any radial counterweights come near their travel limits adjust them for mid travel. If coarse adjustment of the radial counterweight assemblies is needed, remove the clevis pins and adjust the threads of the rod ends or nuts as required, then re-install the clevis pins and safety rings.

efficient height
that glue
ids can be
removed)

test epoxy joints with load cell

- ✓ 49. Set the primary mirror height to the dimensions previously noted. *move the mirror*
- ✓ 50. Gently and uniformly tighten the 4 radial supports. *check the radial in 1 dir and tighten the oppos*
~~indicators to avoid translating the primary mirror.~~
- ✓ 51. Repeat step ~~48~~ ⁴⁸ to insure the radial counterweights are centered. *radial support + bring the mirror back to cen*

- 4" Radial indicator extensions - & 2 more radial indicators.
- send 1/8 drift ~~prch.~~ & instructions for removing part # 25 from radial ~~surface~~

- ✓52. Raise the primary mirror cell with the MCLAs, engaging first the invar rods and then the 3/8 guide pins. Continue raising the cell to within 1/4" of the center section. Start 10 mirror cell flange bolts.
- ✓53. Use the MCLAs to raise the cell into contact with the center section. Replace the 2 guide pins with mirror cell flange bolts, then tighten the 12 mirror cell flange bolts with the long leg of the 5/16" Allen wrench.
- ✓54. Remove the MCLA assemblies and pack them away in their crate.
- ✓55. Install the 4 lower Invar rod bolts on the bottom of the primary mirror cell *and verify settings*
- ✓56. Install the 2 radial dial indicator assemblies *and set them to zero*
- ✓57. Loosen the 4 radial support screws *1/4 turn. in steps to prevent the primary mirror from de-centering more than .002*
- ✓58. Check that the 3 axial dial indicator assemblies still read zero (or the previously noted settings).

Note: Follow a systematic approach to adjusting the 36 axial counterweight assemblies so as not to overlook individual assemblies. Start adjusting the inner ring of 6 assemblies, then the middle ring of 12, then the outer ring of 18.

- ✓59. Hold a 1/8" Allen wrench by the short leg to adjust the 36 back support screws. Start by adjusting a back support counterweight assembly near the center of the mirror cell, look at the assemblies through the central hole in the mirror cell to see the workings of the mechanisms. Tighten each back support screw until a slight increase in load is felt as the counterweight lifts up off the bottom of the cell. After 1/2 turn of the wrench the counterweight will contact the bottom of the primary mirror and the wrench will stop. From this position, unscrew back support screw 1/4 turn. This will set the back support counterweight to mid travel.
- ✓60. As the back support assemblies become active the primary mirror will float up off the axial hardpoint screws approximately .010" as shown by the axial indicator assemblies.
- ✓61. Lower (unscrew) the 3 axial hardpoint screws 1 turn each.

Note: While the back support counterweight assemblies are active, never adjust the height of the primary mirror more than .010 inches without re-adjusting all 36 back support counterweight assemblies.

- ✓62. Use the 3/8" nut driver to gently tighten the 3 mirror retainer nuts evenly until the primary mirror floats down .005" as shown by the 3 axial dial indicator assemblies.
- ✓63. Repeat step ~~56~~ ⁵⁹ to reset the back support counterweight assemblies to mid travel.
- ✓64. Use the 3/8" nut driver to tighten the 3 retainer nuts until the primary mirror is pulled down to zero position as shown by the 3 axial indicator assemblies
- ✓65. Tighten the 4 radial support screws 1/2 of one wrench flat (1/12 turn) beyond where the load stops the screw, take care not to translate the

see step 59 again