Procedure to Install the 2.5m Primary Mirror

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Last modified on 2007-08-30 at 16:41:17

- Cautionary Notes
- Equipment Required
- Initial State of Telescope
- Procedure
- Document History

Cautionary Notes

- **This operation requires 6 people.**
- **Nobody may go up on the PSS unless they have emptied out all of their pockets and are not carrying anything that could fall and damage the mirror.**
- **If the telescope runs away at any time, engage an e-stop button immediately.**
- **Set up barriers to control personnel traffic.**
- **Determine lead person and review procedure with crew before commencing.**
- **The following weather conditions must be met:**
    - No threat of precipitation
    - Sustained wind speed < 35 MPH for 15 minutes
    - Wind gusts for instrument changes < 25 MPH
    - Dew point depression: >= 4°F or 2°C
    - Dust count < 10,000 units
    - Check for condensation regularly when the dew point depression is less than 8°F or 6°C. Close the enclosure if condensation is found on rails, building skin, or the top of the doghouse.
    - Do not push the dust limit and the dew point limit at the same time. If the dust counts are near the stated limit, it is best to have a dew point depression of > 18°F or 20°C.
- Safety wear (recommended): rubber-soled shoes, hard hat.
- Only people trained by observatory staff may execute this procedure.

Equipment Required

- M1, properly crated, with the lifting spider in the center.
- M1 Hard Covers, white plywood panels located in the 3.5m enclosure ground level.
- M1 Guide Rods, located in the 3.5m enclosure observing level (multi-section threaded rods, approx. 5' long when assembled).
- M1 Support Pedestals and Pads, located in the 3.5m enclosure ground level (black steel with white foam pads).
- 6 pieces of 4" x 6" wood approx. 6' long, located in the garage.
- Scaffolding platform.
- Work Light for the person in the center of M1.
- 4 Flashlights, rubber-coated, for use above M1.
- Common Corrector, properly crated, with corrector cover installed.
- Hydraset, located in the 3.5m enclosure ground level (black, on rollers).
- Astigmatism Corrector Tools, located in the storage trailer on site (L-shaped tool and rod puller).
- 50 feet of 1/2" Braided Rope, located in the storage trailer on site.
- Rigging straps, located in the 2.5m enclosure storage cabinets.
- Plastic guide strips: 3/16" x 2" x ~30" white vinyl

Initial State of Telescope

- All instruments (excluding the spectrographs) removed and safely stowed.
- Spectrograph corrector removed and safely stowed.
- Telescope pinned at zenith.
- Wind baffle, secondary mirror and secondary truss removed.
- Wind baffle frame turnbuckled to PSS.

Procedure

1. Set up barriers to control personnel traffic.

2. Determine lead person and review procedure with crew before commencing

3. Prepare the PSS to receive M1:

    A. Home M1 actuators A, B and C (see the Galil Mirror Controller manual for instructions).

B. Make sure the transverse vertical actuator (actuator D) has been removed.

C. Make sure the transverse vertical Mitutoyo linear gauge (Y axis gauge) has been removed.

D. Make sure the M1 ends of the lateral links are out of the way.

E. Remove the protective cylinders from the axial actuator quills.

F. Verify that all transverse bellofram pistons are retracted.

G. Verify that all wiring and air lines are safely routed and out of the way.

H. Prepare the axial Mitutoyo linear gauges. If the extensions rods are removed, attach them. If the extension rods are still attached but protected (e.g. by plastic cylinders), remove the protection.

I. Turn the rotator to angle 0°.

J. Check that the lateral Mitutoyo linear gauges are OK.

K. Vacuum out the PSS interior.

L. Verify that all metal stops are removed.

4. Uncrate M1:

A. Position the three M1 support pedestals, setting them on pairs of 4x6s to distribute the weight on the floor.

B. Bring M1, in its crate to the telescope (back the truck up to the edge of the concrete apron).

C. Open both roll-up enclosure doors.

D. Roll the enclosure over the M1 crate.

E. Use the crane to remove the M1 crate lid and set it on the truck bed.

F. Remove all packing material from the M1 crate and any fixturing that holds M1 or the M1 lifting spider.

G. Inspect M1 and make sure it is in proper condition to be lifted.

H. Attach the Hydraset to the crane hook.

I. Adjust the Hydraset so it is nearly fully compressed (piston within body).
This is so we can use the Hydraset to lower the mirror, when the time comes.

J. Attach the M1 lifting fixture to the Hydraset (which is attached to the crane hook).

K. Using the crane, raise the lifting fixture, until it contacts the mirror. **IMPORTANT: make sure it is seated correctly (aligned with rubber cushions) on the glass and that there is no interference between the lifting fixture and the glass. Any error could crack the glass.**

Important note: when lifting the mirror, watch the Hydraset at all times. It should read approximately 2250 lb. when the mirror is raised.

L. Use the crane to raise M1 out of the crate.

M. Use the enclosure and the crane to move M1 westward, over the support pedestals.

N. Use the crane (not the enclosure) to lower M1 onto the support pedestals.

O. Lower the M1 lifting fixture to the floor (it will actually sit on the 4x6s and/or pedestals) and unhook the lifting fixture from the Hydraset.

P. Use the crane to set the Hydraset into its cart.

Q. Unhook the Hydraset from the crane.

R. Use the crane to put the M1 crate lid back on the M1 crate.

S. Reattach the Hydraset to the crane hook.

T. Reattach the M1 lifting fixture to the Hydraset.

U. Carefully raise the M1 lifting fixture until it comes in contact with M1. **IMPORTANT: make sure it is seated correctly (aligned with rubber cushions) on the glass and that there is no interference**

between the lifting fixture and the glass. Any error could crack the glass.

V. Gradually increase the lifting force to 1200 Lb.

W. Leave 1200 Lb. of force on the crane hook until you are ready to lift M1 again.

5. Inspect M1 for damage. Use a light to look for cracks in the glass.

6. Thank Larry that we don't have to install the frisbees anymore.

7. Perform a final inspection of M1. Make sure the back and sides of the mirror are clean and free of obstructions.

8. Perform a final inspection of the PSS.

   A. Make sure the area is clean, free of tools and other obstructions and ready to receive the M1.

   B. Make sure the transverse belloframs are retracted.

   C. Make sure the hardware around the periphery is in an appropriate state--nothing extra attached, nothing sticking out.

   D. Make sure the rotator is at angle 0°.

9. Attach two tag lines around the circumference of M1, one at the west end, one at the east.

10. Position one person on the ground with the east tag line, another person on the PSS with the west tag line, and a third person to watch the Hydraset.

11. **Important: when lifting the mirror, watch the Hydraset at all times. It should read approximately 2250 lb. when the mirror is raised.**

12. Hoist the mirror above the level of the wind baffle support frame.

13. Use the crane to move M1 over the PSS.

14. Position four people with flashlights and guide strips at the corners of the PSS, near the earthquake bumpers. Have two of these people hold the tag lines.

15. Position the crane operator in the center of the PSS, with a work light.

16. Correct the east/west position and lower M1 until it is a few inches above the PSS.

17. Make sure the angular orientation of M1 is correct.

18. Attach the two M1 guide rods to the M1 lifting spider.

19. Inspect the PSS again to make sure everything is clear and ready for M1.

20. Have the people on the PSS hold guide strips between M1 and the earthquake bumpers. As the mirror is lowered, watch carefully and move the strips around to detect obstructions.

21. Lower M1 until it is about a foot above the floor of the PSS, watching the sides and bottom very carefully.

22. Attach all 4 thermometer cables to M1.

23. Carefully lower M1 until it is an inch above the rubber pads on the axial belloframs.

24. Inspect the PSS again. Look for anything sticking up that will interfere with M1 sitting on the rubber pads on the belloframs.

25. Attach the lateral links to M1.

26. Lower M1 onto the rubber pads on the axial belloframs.

27. Lower the M1 lifting fixture onto the PSS.

28. Bolt the M1 lifting fixture to the PSS.

29. Remove the M1 guide rods.

30. Install the captive bolts that will hold the M1 light baffle. Just screw them in to capture them; they will be tightened later.

31. Install hardware around the front circumference of M1:

    A. Install top earthquake bumpers. This requires a 1/8" Allen wrench.

B. Install the witness samples and aperture stop/earthquake ring. The aperture stop is in four pieces and requires a 5/32" Allen wrench. Be careful not to touch the fronts of the witness samples.

32. Install one M1 hard cover on the south side of M1.

33. Position the support platform on the south side of the PSS.

34. From the center of M1, detach the M1 spider from the lifting fixture.

35. Move the spider east of the telescope and detach it from the Hydraset.

36. Detach the Hydraset from the crane hook.

37. Install the common corrector mounting ring (black cylinder in center of M1):

A. Rig the common corrector mounting ring to the crane using an 8 ft. strap through holes on the ring.

B. Using the crane, hoist the common corrector mounting ring into position on the PSS.

C. Rotate the common corrector mounting ring to the correct orientation. The "W" mark should point west.

D. Bolt the common corrector mounting ring to the rotator.

38. Install the common corrector:

A. Have the crane operator wear a non-scratchy hat or cap, to protect the common corrector.

B. Attach the crane hook to the common corrector cover (with common corrector attached) using 3-point suspension.

C. Position the brass spacer washers that go between the common corrector and its mounting ring (if they are not permanently attached).

D. Using the crane, lower the common corrector until it is a few inches above the common corrector mounting ring.

E. Rotate the common corrector to the correct orientation: the "W" mark should point west.

F. Lower the common corrector onto the common corrector mounting ring.

G. Bolt the common corrector to the common corrector mounting ring.

H. Detach the corrector cover from the common corrector, retrieving the bolts and Delrin washers.

I. Using the crane, remove the common corrector cover.

J. Stow the corrector cover, bolts and Delrin washers in the common corrector crate.

39. Install the M1 light baffle:

A. Rig the M1 light baffle to the overhead crane using an 8 ft. strap.

B. Rotate the rotator until the light baffle bolts are visible by looking through access holes in the common corrector mount.

C. Using the crane, hoist the M1 light baffle onto its mounting points on the common corrector's frame.

D. Bolt down the M1 light baffle (captive bolts).

40. Remove the support platform from the PSS.

41. Install the remaining two M1 hard covers.

42. Attach the two lateral Mitutoyo linear gauge hard points (the blocks the gauges touch).

43. Install the transverse Mitutoyo linear gauge (Y axis gauge).

44. Install the transverse actuator (actuator D).

45. Install the astigmatism corrector actuators and rods:

A. Turn the rotator as needed to expose access panels for the various astigmatism corrector actuators.

B. Attach the astigmatism corrector rod to the mirror.

C. Attach the astigmatism corrector actuator to the rod.

D. Attach the astigmatism corrector actuator to the PSS (squeeze the fingers to mount).

Document History

2002-03-07 R. Owen. First public release.
2002-03-22 G. Van Doren Add header and time stamp; verify links