



ALLIANCE FOR THE CALIFORNIA INSTITUTE OF TECHNOLOGY
 MASSACHUSETTS INSTITUTE OF TECHNOLOGY

INSTALLATION SPECIFICATION

E000401-08-D

DOC NO. - REV. - GID

DATE: 12/12/00

1 SHEET **1** OF **13**

TITLE

LHO 4K LVEA IFO Installation & Alignment

| APPROVALS: | DATE | APPROVALS: | DATE |
|--------------------|---------|------------|----------|
| DRAWN: Larry Jones | 8/30/00 | CHECKED: | |
| CHECKED: | | CHECKED: | |
| CHECKED: | | DCN NO | APPROVED |
| CHECKED: | | | DATE |

1 SCOPE

Several tasks are to be performed in the LHO 4K IFO vertex section during the next vented period. The major tasks include core optics installation and IAS alignment, setup of optical levers, IOO installation and alignment and COS component installation and alignment (telescopes, IO baffle, beam dumps and PO mirrors) and COS alignment of MMT and MC optics. Also, standard chamber entry and exit tasks will be performed.

2 APPLICABLE DOCUMENTS

Listed below are all of the applicable and referenced documents for this task procedure. This list gives the latest revisions of the documents; within the installation steps, only the document number (and not the revision) is quoted.

| | |
|----------------------------|---|
| T970151-C | ASC Initial Alignment Procedures |
| T000065-05 | COS 4K IFO Alignment Procedure |
| T980072-01 | COS alignment telescope/autocollimator/projector system |
| M990034-B | Contamination Control Plan |
| E000062-C | LOS Installation Procedures for BSC Chambers |
| E000061-C | LOS Installation Procedures for HAM Chambers |
| E000116-00 | Procedure for Realignment of Large Suspended Optics |
| E000046-A | Beam Tube Opening and Closing Procedures |
| M980133-B | Vent Isolatable Volumes |
| E000119-A | Hanford Checklist - Vent Isolatable Volumes |
| E000121-A | Hanford Checklist - Spool Removal |
| M980101-B | Procedure for Isolatable Volume Pump Down |
| E000118-A | Hanford Checklist - Isolatable Volume Pump Down |
| M980136-A | HAM Chamber Access Door Removal Procedure (Note: no procedure currently exists for BSC door removal with the engine hoist; adapt this procedure in the meantime.) |



INSTALLATION SPECIFICATION

TITLE

LHO 4K LVEA IFO Installation & Alignment

| | |
|----------------------------|---|
| E000120-A | Hanford Checklist - BSC Door Removal |
| M980132-B | O-Ring Installation and Flange Assembly Procedure for HAM and BSC Doors |
| E000065-04 | Chamber Entry/Exit Checklist |
| M980086-A | Conflat Flange Assembly Procedure |
| D970308-B | Interferometer Optomechanical Layout Hanford Site |
| D990340-A | Arm Cavity Baffle, ETM Assembly |
| D990230-B | Cavity Beamdump Installation, sheet 1 through 5 |
| D000232-B | 4K Vertex Installation, Elevation View |
| D000231-B | 4K Vertex Installation, Plan View |
| D000068-A | Access Cable |

3 PRE-REQUISITES

- 1.
 - A BSC cleanroom (short-sided version) must be in place over BSC 1 (with clipped side to the west) and operable, pushed north.
 - A HAM cleanroom must be in place over HAM 4 and operable.
 - A BSC cleanroom must be in place over HAM 1 and operable.
 - A BSC cleanroom must be in place over HAMs 2 & 3, and operable.
 - A 6' x 12' cleanroom must be in place at the east door of BSC 3 and operable; this must be elevated on at least 24" high sawhorses, and the west side curtain must be "tented" to provide protection to the BSC 3 door when opened.
 These positions may require shifting of locations during installation.
- 2. The vacuum equipment purge air system must be operable before starting the task.
- 3. Add temporary purge air supply to BSC 1. (Worden)
- 4. Remove spool WBE-3B from between BSC 2 and HAM 4 and repair vacuum leak; replace spool. (Worden)
- 5. Perform laser safety walkthroughs per M990315 for unescorted workers in the LVEA, as required.
- 6. Prepare and check out new/modified satellite boxes.
- 7. Plan and prepare class 'B' alignment iris and hardware for COS autocollimator setup for targeting the MMT3. This target needs to be aligned by IAS (coordinate with M. Smith).
- 8. Confirm adaptor heights to place the COS. (M. Smith)



INSTALLATION SPECIFICATION

TITLE

LHO 4K LVEA IFO Installation & Alignment

- 9. Measure reflectivity and wedge angles of Core Optics using the theodolite in the Optics Lab.
- 10. Process and stage the following 4K large optics suspension systems: ITMx, ITMy, MMT3, RM and BS.
- 11. Prepare, check out and install ITMx optical lever transmitter and receiver (Note: the ITM optical levers will need to be steered blind through the arm cavity baffles. We may need to wait until the next incursion into the 2k IFO to steer the beams through the baffles.)
- 12. Prepare, check out and install ITMy optical lever transmitter and receiver (Note: the ITM optical levers will need to be steered blind through the arm cavity baffles. We may need to wait until the next incursion into the 2k IFO to steer the beams through the baffles.)
- 13. Prepare, check out and install RM optical lever transmitter and receiver.
- 14. Prepare, check out and install MMT3 optical lever transmitter and receiver.
- 15. Prepare, check out and install BS optical lever transmitter and receiver.
- 16. Procure new precision level(s) and calibrate. (Cook)
- 17. Assemble and align HAM 4 Faraday Isolator per T000083-00 (M. Smith/Ottaway)
- 18. Assemble and install PSL/IOO shutter between PSL table and HAM 1 (Ottaway)
- 19. Compute & provide initial alignment monument locations. (Mason)
- 20. Determine the placement clearances for IAS total station benches and fixture installation transfer platforms where spools will be pulled etc.
- 21. Setup initial alignment monuments. (Radkins)
- 22. Check out CAS systems for proper operation. (Radkins)
- 23. Remove CAS motors/stages, as appropriate, for clearance for spool WBE-2B removal. (Radkins)
- 24. Build up ISC tables and stage for placement as time permits. (Ottaway)



INSTALLATION SPECIFICATION

TITLE

LHO 4K LVEA IFO Installation & Alignment

4 PREPARATION

All preparation must be in accordance with the Contamination Control Plan (M990034).

- 25.
 - Clean the LVEA, particularly the floor; Particulates and dust should be removed by mopping with clean water.
 - Clean BSCs 1-3, including the floor in the vicinity of the chambers, well in advance of the opening of the vacuum system.
 - Clean each HAMS 1-4, including the floor in the vicinity of the chambers, well in advance of the opening of the vacuum system.
- 26. Insure that there are no large openings to the exterior or the beam tube enclosure where insects or dust can get into the LVEA.
- 27. Install particles counters under soft wall enclosures near open doors to vacuum chambers.



INSTALLATION SPECIFICATION

TITLE

LHO 4K LVEA IFO Installation & Alignment

28. Transport the following items to the LVEA:

CCC

- Appropriate cleanroom garb, including gloves, in-chamber booties.
- 2-3 flashlights, radios, batteries
- CO₂ gun and portable bottle and portable N₂ gun with ionizer
- Foil, Ameristat, and tape
- Belly Bars and utility brackets
- BSC work stool, cleaned & wrapped for entry.
- In-chamber vacuuming system
- Chamber cloth door covers: 2 BSC, 8 HAM, 8 Spool
- Digital Camera

LOS

- Six CLASS A Access Cables/Ground Strips (D000068)
- Six CLASS A 1/4-20x1/2" SHCS
- Counterweight screws
- RM Table Clamps
- LOS Viton tip replacements
- LOS Tie-back wire and wire cutters
- MMT3 Height Adaptor
- RM Height Adaptor
- ITM Height Adaptors (2)
- BS Height Adaptor
- Precision Bubble level(s)
- Oscilloscope and BNC cables
- LOS table clamps & fasteners
- LOS installation fixtures (Lazy Susan, Lift truck, straddle lift, etc.).

COS

- COS Tool pan (wrenches and allen keys)
- COS Table Clamps
- PO telescope assy's & optical train assy's, 4 required
- Faraday Isolator for HAM 4
- Cavity Beam Dump assy's for BSC 2, including hardware
- PO mirror assy's, including table clamps, 4 required
- APS telescope baffle
- PO telescope installation tools & fixture
- View port beam dump assy's
- HAM2 and HAM3 beam dump assy's
- HAM viewport alignment fixture
- COS COC alignment equipment



INSTALLATION SPECIFICATION

TITLE

LHO 4K LVEA IFO Installation & Alignment

- IR beam viewer
- Sony Nightshot Videocameras
- 3 Elliptical baffles
- Elliptical baffle counterweights (2 types)
- COS Iris
- LOS Lexan Target assy's
- Offset Viewports
- Conflat flange Hardware and Gaskets

IOO

- SOS targets
- IOO toolpans
- 6 SOS's
- HAM 1 Faraday Isolator
- IOO DLC Steering Mirror Assy's
- MC Baffle Assy
- MMT2 Riser Block
- MC2 Riser Block
- IOO Table clamps/fasteners
- IOO Beam Dumps
- TV Monitors
- Cameras

ISC

- Surveying equipment & laser autocollimator equipment
- PLX Assy.



INSTALLATION SPECIFICATION

TITLE

LHO 4K LVEA IFO Installation & Alignment

- 29.
 - Perform ‘Tilt zero point’ adjustment & ‘Collimation error’ adjustment on Sokkia Total Station per Sokkia Operator’s Manual and verify performance.
 - Perform “Verification and Realignment of Indicating Mirror” on the Brunson transit square per appendix 3 of T970151-C.
- 30. Check LAC operation with 2 reference flats at 90 deg.

5 TASK STEPS

All tasks must be in accordance with the Contamination Control Plan (M990034).

- 31. Close gate valves WGV1 & WGV2. Vent the vertex section per procedure [M980133-B](#); **remember to turn off the RGA and suspension controllers prior to venting.**
- 32. As the need for chamber access occurs in subsequent steps, carefully rotate ISC tables out of the way (as applicable), remove doors per [M980136-A](#) and [E000120-A](#) and perform chamber entry tasks per applicable steps of [E000065-04](#).
- 33. **NOTE!** It is very important that we limit exposure of the vacuum surfaces to atmospheric moisture, to minimize pumping time required before gate valves can again be opened. This is largely a function of purge air flow volume and the duration of chamber open times. This procedure is written to minimize the numbers of doors removed, and the durations of removal. Purge air should be adjusted to maximum flow. **Fabric door covers afford a surprising amount of shielding (with purge), so they should be installed whenever access through the door opening is not required within a short time period. This includes the practice of installing a cover when workers are inside a chamber. HAM tasks that require ongoing access shall utilize “belly bars” and utility brackets (normally used to mount instruments on the belly bar, used here to clamp the excess fabric cover) to minimize the area of the open section.**
- 34. Install the PSL flange and enclosure adapters, light pipes and shutter. (Parts from IOO/FL)
- 35. Close shutter on input beam from the PSL; lock & tag.
- 36. Install high quality viewports at the following locations: HAM1: PSL input, SPS, Mode cleaner WFS, PSL intensity stabilization; HAM3: ITMy PO output beam; and HAM 4: ITMx PO output beam, BS PO output beam, APS beam (REO AR coating).
- 37. Remove COS viewport/reducer assemblies (4 each) from HAM 1; remove the viewports from the zero length reducers and install the viewports on new, eccentric zero length reducers. Install these assemblies on the HAM 1 ports in accordance with [M980086-A](#).
- 38. Remove spool WBE-3A1 from between BSC 2 and HAM 3 using ‘C’ bar on crane hook and per [E000121-A](#) (supports the MMT3, RM and ITMx alignments). **Reminder: cover door openings when access is not being required!**



INSTALLATION SPECIFICATION

TITLE

LHO 4K LVEA IFO Installation & Alignment

- 39. Move the clean room that's over HAMS 2 & 3 as far north as practical; "tent" the north wall to BSC 2 flange to provide particulate shielding, and confirm performance with a particle detector.
- 40. Leveling techniques: use the following procedure whenever table leveling is called for in this checklist:
 - confirm that the amount of balance weights on the optics table is proper
 - always measure the same area of each table, for consistency (some tables are out of flat by as much as 0.015")
 - use a level capable of a sensitivity of at least 0.005"/ft (6" Starrett Model 98)
 - measure along both the X and Y axes
 - for each axis, take two readings (the second, 180° from the first) and average the two readings
 - shift balance weights to have each axis reading average show levelness to within 1/2 division or less
 - double check both axes after all balance weight movements are complete
- 41. Setup optical level on IAS bench in spool between HAM 3 and BSC 2.
- 42. Level BSC 2 optical table and set/record elevation using the optical level.
- 43. Remove CAS motors to enable step #71.
- 44. Set up total station and support bench at WBE-3A spool opening at IAS 53, with the autocollimator on global beam axis. (some cable tray displacement required)
- 45. Remove all doors from HAMS 1-3.
- 46. Remove mirror used for microsieismic measurement from HAM 3.
- 47. Level HAM 1-3 optical tables and set/record elevations using the optical level.
- 48. Install MMT3 in HAM 1 per [E000061-C](#) and [T970151-C](#). Be sure to remove the appropriate balance weights. **Reminder: cover door openings when access is not being required!** Install Access Cable D000068 on HAM 1 optical table. Measure and correct levelness of HAM 1 optical table. Confirm weights are bolted in place, and recheck MMT3 alignment.
- 49. Move total station to IAM 52 with LAC on global beam axis. Setup to allow vertical shift where both theodolite and LAC are on optic (~3"). Place the theodolite on the optical centerline.
- 50. Install COS Iris behind the RM location, at the front (vertex side) of HAM2 table, and align it using the theodolite.
- 51. Install foil on **XXXX** to serve as a beam block between IO activity and COC/COS activities.
- 52. Remove tag & lock from input beam shutter from PSL; open shutter as required for next step.



INSTALLATION SPECIFICATION

TITLE

LHO 4K LVEA IFO Installation & Alignment

- 53. Install IO components on HAM 1 table; measure and correct the levelness of the table. Be sure to remove the appropriate balance weights, and confirm weights are bolted in place. **Reminder: cover door openings when access is not being required!**
- 54. Install HAM 2 COS Beam Dump.
- 55. Install RM core optic in HAM 3 per [E000061-C](#) and [T970151-C](#), with elliptical baffle on the +X side. Be sure to remove the appropriate balance weights. Install Access Cable D000068 on HAM 3 optical table. Measure and correct levelness of HAM 3 optical table. Confirm weights are bolted in place, and adjust the PAM screws of the RM optic such that it is autocollimated with the beam from the IAS A/C.
- 56. Confirm LAC reading with optical autocollimator.
- 57. Align RM optical lever.
- 58. Remove BSC 3 East door.
- 59. Level BSC 3 optical table and set/record elevation using the optical level.
- 60. Insert BSC installation fixturing into BSC 3.
- 61. Move total station to IAM 52.1 (optional - TBD).
- 62. Install ITMx core optic (including its elliptical baffle) per [E000062-C](#) and [T970151-C](#). Be sure to remove the appropriate balance weights. **Reminder: cover door openings when access is not being required!** Install Access Cable D000068 on BSC 3 optical table. Measure and correct levelness of BSC 3 optical table.
- 63. Move the total station to IAM 54 above the optical center line.
- 64. Adjust the PAM screws of the ITMx optic such that it is autocollimated with the beam from the IAS A/C.
- 65. Confirm LAC alignment with optical autocollimator. (This will require repositioning the PLX.)
- 66. Move BSC installation fixturing into BSC 2 from BSC 3.
- 67. Remove BSC 1 door.
- 68. Level BSC 1 optical table and set/record elevation using the optical level. **Reminder: cover door openings when access is not being required!**
- 69. Remove mirror used for microsiesmic measurement from BSC 2.
- 70. Install PO mirrors in BSCs 1 & 2. Be sure to remove the appropriate balance weights.
- 71. Remove spool WBE-2B from between BSCs 1 & 2.



INSTALLATION SPECIFICATION

TITLE

LHO 4K LVEA IFO Installation & Alignment

- 72. Install total station bench and total station between BSCs 1 & 2, on IAM 7 beam axis, directed toward the BS position.
- 73. Move the clean room that's over BSC 1 as far east as practical; "tent" the east wall to BSC 2 flange to provide particulate shielding, and confirm performance with a particle detector.
- 74. Replace BSC 3 East door, and move 6' x 12' clean room out of the way of HAM 4 work.
- 75. Install BS core optic per [E000062-C](#) and [T970151-C](#) through spool entrance between HAM 3 and BSC 2. Be sure to remove the appropriate balance weights. Install Access Cable D000068 on BSC 2 optical table. Measure and correct levelness of BSC 2 optical table.
- 76. Align BS by adjusting PAM screws to retroreflect off of the free hanging RM.
- 77. Align BS optical lever transmitter and receiver.
- 78. Move the total station out of the way and transport the BSC installation fixtures from BSC 2 to BSC 1 across the spool opening.
- 79. Move the total station back to IAM 7 (optional - TBD).
- 80. Install ITMy core optic (including its elliptical baffle) per [E000062-C](#) and [T970151-C](#). Be sure to remove the appropriate balance weights. **Reminder: cover door openings when access is not being required!** Install Access Cable D000068 on BSC 1 optical table. Measure and correct levelness of BSC 1 optical table.
- 81. Move the total station to IAM 51 with both Optical and LAC on the optic.
- 82. Adjust the PAM screws of the ITMy optic such that it is autocollimated with the beam from the IAS A/C.
- 83. Confirm LAC alignment with optical autocollimation. This will require shifting the PLX.
- 84. Breakdown the theodolite and LAC, and remove the IAS bench from the spool area between BSC 1 and BSC 2.
- 85. Replace the spool between BSC 1 and BSC 2.
- 86. Remove BSC installation fixtures from BSC 1 through door.
- 87. Move the IAS bench to the spool opening between HAM 3 and BSC 2. Position the total station to IAM 52.
- 88. Place RM on its stops. Install COS autocollimator #1 in HAM 2, aligned with the center of the iris and autocollimating off of ITMx. Relevel the table. Check that the projected reticle pattern is centered on a scale in front of ITMx. Confirm that it autocollimates off of ITMy and is centered on a scale in front of ITMy. Do same check with the BS target. If the ITMx and ITMy retroreflections are not coincident, confer with Dennis Coyne.



INSTALLATION SPECIFICATION

TITLE

LHO 4K LVEA IFO Installation & Alignment

- 89. Remove doors from HAM 4 and level the optical table. Set/record elevation using the optical level.
- 90. Install the APS PO telescope in HAM 4. Be sure to remove the appropriate balance weights.
- 91. Align (after table leveling) APS telescope in HAM 4, using the COS autocollimator #1. Note: balance the optical table with the autocollimator #2 installed at the output flange of the telescope, before aligning it.
- 92. Install the pickoff mirror target in its BS position in HAM 4; align the two BS pickoff mirrors in BSC 1 to suit.
- 93. Move the pickoff mirror target to its ITM_x position in HAM 4; align the ITM_x pickoff mirror in BSC 2 to suit. **Reminder: cover door openings when access is not being required!**
- 94. Move the pickoff mirror target to its ITM_y position in HAM 3 and confirm the table is level; align the ITM_y pickoff mirror in BSC 2 to suit.
- 95. Install BS pickoff telescope and ITM_x pickoff telescope in HAM 4. Be sure to remove the appropriate balance weights.
- 96. Align (after table leveling) BS pickoff telescope in HAM 4.
- 97. Align (after table leveling) ITM_x pickoff telescope in HAM 4.
- 98. Install two cavity beam dumps and two plate beam dumps in BSC 2. Project COS reticle pattern from COS LAC on HAM 2 and use target to confirm positioning.
- 99. Install optical trains in HAM 4: APS, BS, and ITM_x, including the Faraday isolator. Be sure to remove the appropriate balance weights and check the table level.
- 100. Install COS HAM door fixture on HAM 4, with mirrors preset to match door viewports.
- 101. Align (after table leveling) APS pickoff optical train.
- 102. Align (after table leveling) BS pickoff optical train.
- 103. Align (after table leveling) ITM_x pickoff optical train.
- 104. Install HAM 4 viewport beam dumps.
- 105. Remove autocollimator #2 from HAM 4.
- 106. Install APS baffle; confirm HAM 4 optics table is level. This completes COS installation and alignment at HAM 4.
- 107. Place beam dump on HAM 3 table. Be sure to remove the appropriate balance weights; confirm HAM 3 optics table is level.



INSTALLATION SPECIFICATION

TITLE

LHO 4K LVEA IFO Installation & Alignment

- 108. Install ITMy pickoff telescope in HAM 3. Be sure to remove the appropriate balance weights and check the table level.
- 109. Align (after table leveling) ITMy pickoff telescope using the COS autocollimator #1. Note: balance the optical table with autocollimator #2 installed in the output flange of the telescope before aligning it. **Reminder: cover door openings when access is not being required!**
- 110. Install ITMy pickoff optical train. Be sure to remove the appropriate balance weights.
- 111. Install COS HAM door fixture on HAM 3, with mirror preset to match door viewport.
- 112. Align (after table leveling) ITMy pickoff optical train.
- 113. Install HAM 3 viewport beam dump. This completes COS installation and alignment at HAM 3.
- 114. Unclamp the RM and verify its alignment with the COS autocollimator #1. This completes COS installation and alignment in HAM 3.
- 115. Setup the total station on IAM 52.
- 116. Install and align the IO Baffle between HAM 2 and HAM 3 using the belly bar planks.
- 117. Remove the COS autocollimator #1 assembly from HAM 2. Place beam dump on HAM 2 table. Be sure to remove/replace the appropriate balance weights. Move the COS autocollimator #1 to the total station position on the optical axis at the WBE3-A1 spool piece at IAM 52.
- 118. Install MMT2 in HAM 2 per **XXXX**. Be sure to remove the appropriate balance weights. Install Access Cable D000068 on HAM 2 optical table. Measure and correct levelness of HAM 2 optical table.
- 119. Install MC 2 on HAM 2 table per **XXXX**; correct the levelness of the table. Be sure to remove the appropriate balance weights. Confirm weights are bolted in place.
- 120. After confirming that all groups working on the 4K IFO are ready, remove foil from **XXXX**.
- 121. Align the Mode Cleaner and IOO Faraday Isolator.
- 122. Align the COS autocollimator #1 with the RM HR, and project the reticle pattern through the iris onto a target centered on MMT3. check that MMT3 is centered. Confirm alignment to MMT3 target. Remove target and adjust MMT3 PAM screws to project the reticle pattern from MMT3 to a target centered on MMT2.
- 123. Project PSL beam onto MMT2 target. Replace the MMT3 target. Remove MMT2 target and adjust the MMT2 controller bias to center the PSL beam on the MMT3 target. (COS alignment procedure T000065-05-D). **Reminder: cover door openings when access is not being required!**
- 124. Verify the IOO Faraday Isolator alignment.



INSTALLATION SPECIFICATION

TITLE

LHO 4K LVEA IFO Installation & Alignment

- 125. Align MMT3 optical lever.
- 126. Remove total station and support bench; replace the spool between HAM 3 and BSC 2.
- 127. Confirm optical levers are still aligned and working properly on MMT3, RM & BS optics.
- 128. Chamber Exit Tasks: Close doors on BSC 1, HAM 1,2,3, and 4.
As each chamber/manifold volume is being exited, perform exit tasks in accordance with applicable steps of E000065.
Reinstall door.
Log all data in electrical and hard copy logs.
Label and file digital photos.
- 129. Pumpdown vacuum sections per M980101 and open gate valves as appropriate.