

MAGNET SWAP ETMS – VENT PLAN ETMX

APPROVALS	DATE	REV	DCN NO.	BY	CHECK	DCC	DATE
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DCC RELEASE							

1 SCOPE

This is the AS-BUILT procedure for replacement of NdFeB face magnets on H1 ETMx with physically compatible SmCo magnets as part of the ELI upgrade. Our objective is to mitigate upconversion noise due to excessive Barkhausen effect associated with the NdFeB magnet formulation. Replacement of Flourel-tipped earthquake stops with silica tipped kinematic replacements (procedure T070257) is incorporated as the final stage to take advantage of the vent opportunity. The earthquake stops were swapped in the lab while the optic is removed from the LOS. Only face magnets on ETMx were replaced for each 4km interferometer. Side magnets, wire standoffs etc., were not disturbed. The existing side magnet is used as a geometric reference to insure new face magnets are installed in the correct relative positions.

BSC9 remained vented for the duration of the ETM work. The door got hung loosely such that purge flow was efficient and the chamber remains dry for the many days it was up to atmosphere. The ETMx was reinstalled using the optical lever system. As well, an autocollimator was setup inside of the chamber in order to snapshot the ETMx alignment, as a backup.

Task 1 – Optic Surface Inspection

Task 2 – Photon Calibration Measurements

Task 3 – LOS removal - restrain the optic in its LOS cage, and remove the assembly to the site optics lab.

Task 4 – De-installed the optic from the suspension. Remove existing NdFeB face magnets and standoffs using a solvent that attacks cured epoxy resin. Replacement SmCo magnets are pre-bonded to new standoffs and will be attached using a subset of the COC/LOS initial build procedure. The mirror is then re-suspended in its LOS.

Task 5 - Scatter light inspection.

Task 6 - Removal of Arm Cavity Baffles from the spool volume.

Task 7 – Vacuum chamber surfaces with new Class B vacuum equipment – particulate control.

Task 8 - Reinstall and align the ETM LOS according to the original interferometer build procedure.

Estimated Time Line and Task Leaders

Task 1 - Cheryl

Task 2 - Rick/Evan

Task 3 - Doug

Task 4 - Betsy/Doug

Task 5 - Robert

Task 6 – Robert

Task 7 – Cheryl

Task 8 – Doug

Vacuum related Tasks – Kyle/John

Time estimate: 2 weeks

2 APPLICABLE DOCUMENTS

Listed below are the applicable documents and references for this procedure.

LIGO E000062	BSC Installation document Note: Update E000062 to include OSEM/PAM iterations and better contamination controls.
LIGO M990034	LHO Contamination Control Plan

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LIGO M020131	LHO Laser Safety Plan
LIGO M020130	LHO 10 Watt Laser SOP
LIGO M980133	Vent Isolatable Volume
LIGO M980101	Procedure For Isolatable Volume Pump Down
LIGO M980136	HAM Chamber Access Door Removal
LIGO M980132	O-Ring Installation and Flange Assembly Procedure for HAM and BSC Doors
LIGO E000065	Chamber Entry and Exit Lists
LIGO E970154	Large Optic Suspension Balancing

3 Pre-Requisites

- File work permits
- Clean and airbake tools/Class B hardware. Betsy
- Assemble SmCo magnet/standoff sets. Betsy
- Stage installation EQ at end stations. Ski
- Clean end stations (damp mop, wipe down chambers) Terry
- Prep Optics Lab balancing bench (ensure level) Betsy
- Set up autocollimator assy on bench in optics lab
- Zero ETMx optical levers
- Test purge air compressor and roughing pumps Kyle
- Ensure cranes are parked nominally
- Ensure clean rooms are over BSC9 and are in working order Ski
- Setup mobile dust monitors at end stations, just below door flanges Ski
- Ensure CDS computer is working at end stations
- Get SUS damping controls working in optics lab
- Beam Dump Photon Cal. And transition to Laser Safe

- Install and zero ETMx Auxiliary Optical Lever – Record position
Pitch 2.077mm, Yaw 0.4753mm 9:46am

- Record ETMx Sensors and SUSPIT/YAW values (or attach snapshot) – Pitch -0.235, Yaw -0.506

4 PREPARATIONS

Staging

Orange LOS Installation Case II	Stage at End Stations
CLASS B tools	Garb room
In-chamber bubble level	Staging cleanroom
TFE Highways	Engine Hoist
TFE pads	Lazy Susan
CLASS B C-Clamps	Lift Table
CLASS B Dog Clamps to mark existing ITM tower	Straddle
LOS Table clamps	Roller Table
CLASS A tie back wire	Orange LOS case
CLASS B TFE EQ stop caps	Pallets
Elliptical Baffle Counterweight	BSC Door Covers
Installation adapter plate	BSC O-ring Protectors
CLASS A ¼-20 stock	Garb
Flashlights/Batteries	Mobile Dust Monitor

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Digital cameras	Foil/ Wipes/ Alcohols
3 Oscilloscopes and BNC cable sets	200 lbs of counterweights and assoc. screws
Octopus box and BNC cables	Backup Autocollimator Assy w/scope
Auxiliary Optical Lever Setups	BSC mounting brackets for AC assy.

5 TASK STEPS

Complete the following between 7:00AM and 10:00AM 03/24/08:

1. Put a freeze on any 4K IFO work effecting this operation Control Room
2. Close gate valves
3. Slow vent (~1 hr to minimize static build up on optics) per M980133.
 - a. Turn off RGA and 4K ETMx SUS controller high voltages. Kyle
4. Break bolts on BSC9 E door – leave all but 4
5. Pull BSC9 E door (Install O-Ring protectors and soft covers).
6. Turn on SUS controllers
7. Setup oscilloscope equipment to monitor aux. optical lever readout
8. Record ETMx Sensors and SUSPIT/YAW values (or attach snapshot) – COMPARE WITH RECORDS ABOVE. LOOK FOR DISCREPANCIES WHICH MAY INDICATE CHARGE.

Looks OK. After door with cover: Pitch -0.188, Yaw -0.491

9. Zero and record ETMx Auxiliary Optical Lever Position

Pitch 2.092, Yaw 0.490

Task1 - Optic Surface Inspection

10. Entrance chamber checks (pictures, contamination control **NOTE – Barrel stops very close LR back and LL Front less than 0.5mm from optic.**)
11. Place ETMx optic on earthquake stops (TFE caps on 4 bottom stops)
12. Optic Surface Inspection

Task2 - Photon Calibration Measurements

13. See T080005

Task3 - ETMx LOS removal from chamber

14. Install lazy Susan and transfer table.
15. Install lift table.
16. Verify the table level using a bubble level and record the values.
 - i. North/South **centered**; East/West **centered**

17. Record PAM gaps. (inches)

UL: 1.969, 0.930 s/n 003	UR: 1.969, 0.943 s/n020
LL: 2.000, 1.009 s/n010	LR: 1.969, 0.962 s/n004 SIDE s/n152

18. Install Autocollimator setup in front of ETMx, mounting to BSC wall gussets
19. Retroreflect off of ETMx HR, then zero autocollimator and scope – DO NOT TOUCH SETUP...

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20. Place 3 each class 3 dog clamps against ETMx structure height adaptor for dead stops.
21. Remove the OSEMs and mark the wire connector locations and directions.

Plugin to J connectors in standard configuration.

22. Place TFE highway and adaptor plate under structure.
23. Raise Lift Table and match the tapered pins into the SUS tower holes.
24. Remove the Tower dog clamps and leave them inside.
25. Pull ETMx with structure.
 - a. DO NOT REMOVE HEIGHT ADAPTOR
26. Remove the installation adaptor plate.
27. Install 200 lbs of counterweights at LOS table location.
28. Wrap tower and transport to optics lab maintaining contamination controls.
29. Rehang BSC9 door loosely so that the purge can keep the chamber as dry as possible.

Task4 - ETM magnet swap

30. Record all processes below in optics traveler and file with DCC when completed.
31. Place ETMx LOS on level optics bench. – [Removed adaptor plate at this point.](#)
32. Unclamp optic and record balance angle with autocollimator. [2min DOWN](#)
33. Clamp optic.
34. Remove optic from LOS, leaving wire in place. Utilize the optic carrier fixture.
35. Transfer optic to cleaning area.
36. Weigh Optic [10,338g](#)
37. With optic standing in carrier fixture, remove face magnets by continually wetting magnet/optic glue joint with Dynasolv 165 (methylene chloride). Work on the bottom 2 face magnets first. This may take many hours. Be patient. Using the typical 2 person optic flip, turn the optic upside down in the carrier fixture so that the remaining 2 face magnets are at the bottom of the optic. Remove these magnet sets via the continual wetting process with Dynasolv 165.
38. Replace each of the 8 Barrel EQ Stops with the new silica tipped version, one at a time maintaining clamping of optic.
39. Replace each of the 8 Chamfer EQ Stops with the new silica tipped version, one at a time maintaining clamping of optic.
40. Unclamp optic for final time – set stop gaps to 1/2mm.
41. Clean areas where magnets were removed with methanol.
42. Clean full surface of mirror via drag wiping technique.
43. Transfer optic to magnet gluing ring fixture and base plate and glue new SmCo magnet sets to face of optic via E970154 LOS Balancing Specification. Use existing side magnets to help register fixture in place.
44. Vacuum Bake ETMx.
45. Re-suspend ETMx and verify balance angle with autocollimator.
46. TAKE CARE TO NOT DAMAGE EXISTING WIRE
47. If balance is found to be off, remove side guide rod and work through E970154 to rebalance the optic. This will require an additional vacuum bake of the optic since more vacseal will be applied.
48. Reset PAMs in OSEMs to nominal 5/8” setting (from under PAM screw head to top TFE surface of OSEM)
49. Check OSEM voltages and functioning in lab.
50. Clamp Optic
51. Wrap LOS and transport to X-End for installation

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Task 5 - Scatter Light Inspection

52. Robert has a look around inside BSC 9

Task 6 – Arm Cavity baffle Removal

53. Disassemble the Arm Cavity Baffle which is located in the beam tube manifold on the vertex side of BSC 9.
54. Carry all pieces and tools out through BSC 9 – BE VERY CAREFUL NOT TO DISTURB AUTOCOLLIMATOR ASSY
55. Wrap parts

Task 7 – Vacuum chamber – particulate contam. control

56. Vacuum Chamber - BE VERY CAREFUL NOT TO DISTURB AUTOCOLLIMATOR ASSY

Task 8 – Reinstallation of ETMx at end stations (starting with ETMy)

57. Ensure that ETMx SUS and IFO alignment biases are ZERO.
58. Place the ETMx onto the adaptor plate and dog it down.
59. Transfer ETMx onto the Straddle lift TFE highway.
60. Remove 200 lbs of temporary counterweights.
61. Install ETMx per LIGO E000062
 - a. (Use as a guideline with modifications pertaining for this special installation)
62. Dog the tower to the table against the dead stops.
63. Replace the bottom earthquake stops with Flourel tips.
64. Install elliptical baffle counter weight.
65. CHECK TABLE LEVEL
66. Plug in OSEMS to 50% OLV and damp optic
67. Release all earthquake stops.
68. Adjust PAMs and OSEMs to maintain 50% open light voltages and to align to Auxiliary Optical Lever/AC.
 - i. MANUALLY YAW the tower as necessary (and very likely at this point).
69. Place optic onto earthquake stops.
70. Remove the elliptical baffle counter weight and install the elliptical baffle.
71. Verify the table level using a bubble level and record the values.
72. North/South **same as above**; East/West **same as above**
73. Release all earthquake stops.
74. Adjust PAMs and OSEMs to maintain 50% open light voltages and to align to Auxiliary Optical Lever/AC.
75. Place optic onto earthquake stops.
76. Remove Lift Table and Lazy Susan
77. Remove monitoring hardware/AC assy. from in situ.

Task2 - Photon Calibration Measurements (AGAIN)

78. See T080005
79. Perform the BSC9 chamber exit checklist.
80. Record PAM measurements [See Traveler E080108](#)
81. Release all earthquake stops on ETMx.
82. Replace the door on BSC9
83. **Turn off SUS controller high voltage**
84. Begin pump down per E000118.