

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
- LIGO -
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H1 Squeezing Experiment: Plans for the Installation of the Squeezer at LHO		
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Abstract**1 Lock PRMI + OMC**

Before modifying the HAM4 layout and installing the squeezer, we want to re-lock the well known PRMI configuration (short Michelson with power recycling) on RF signal, to be sure that everything is working fine after the shut-down in October 2010. We also want to test the handoff to DC readout.

This work can start once the H2 electronics building is in place (activity scheduled for April 28th, 2011), and no dirty operations are done in the LVEA. The H1 PSL is currently on, and the main beam is blocked before entering the IFO (LVEA still in safe laser mode).

1.1 Prep Work

- Locate MC2 driver with bigger range than the standard one

1. Vent
2. Unlock all optics in the LVEA, OMC included (8 days)
3. Check response of optics to PITCH and YAW
4. Unblock beam sent to the IFO
5. Lock IMC in air, check stability, record settings (1 day)
6. Block beam sent to the IFO
7. Pump down
8. Check mirror Qs and frequencies to confirm optics are correctly unlocked
9. Unblock beam sent to the IFO
10. Align and lock IMC
11. Record IMC settings, beam position in transmission to the IMC, OSEMS values, etc.
12. Align and lock PRMI using RF signal (2 days)
13. Align and lock OMC
14. Handoff to DC readout (1 day)
15. Measure sensitivity, confirm shot noise limit

16. Mark position of AS beam on ISCT4 (diode and camera), check if any difference with single bounce
17. Block beam sent to the IFO (1 day)
18. Vent again

The estimate time for performing all these operations is about **3 weeks**. About 1.5 weeks are required to unlock the optics, and 1.5 weeks for realigning and locking the PRMI (it might take less, but likely the LVEA can be in laser hazard mode only for a fraction of the time). The modifications to the HAM4 layout will be performed with the IFO in single bounce configuration (BS and IX or IY aligned). In order to do that, we need to lock the IMC in air. As this has been problematic in the past ¹ we want to test it as soon as the optics have been unlocked. The problem was related with having air-flow disturbing the IMC lock when taking a door off (HAM5-S in that specific case), so one might try to mitigate the effect by covering the door.

2 HAM5-N and HAM6-E Doors off

As the squeezer will be located on the south side of HAM4 and HAM5, we need to take the HAM5 North door off (and not the South door as usually done). The first thing to do when entering HAM5 is to remove the septum window, and to place it in the central viewport of HAM4. The reasons for doing that are multiple: the original purpose of this septum window was to separate HAM6 from the vertex vacuum, but this window is not adequate to handle the pressure difference, so it is useless; the AR coating of the septum is extremely good, and we need a very good AR/AR coating for the window used for the squeezed field injection; removing the septum window should make easier to re-position the HAM5 baffle.

2.1 Prep Work

- Find/check mounting structures for the septum window
- Assemble high legs (done)
- Order platform
- Unplug sqz electronics
- Define new ISCT4 layout with 29MHz diode for SQZ LO (it can be done even after in-vacuum work)
- Prepare 29MHz diode, electronics, cables from ISCT4 to SQZ electronics (it can be done even after in-vacuum work)

¹ These entries in the (old) H1 log by Mike and Keita are related with the OBS swap (from 50/50 to 95%) on February 12, 2009: OBS swap on HAM4 (Keita) H1 HAM4 BS swap (Mike L.)

2.2 Procedure

19. Take HAM5-N and HAM6 -E door off
20. Unblock beam sent to the IFO
21. Re-lock IMC in air with setting found before, check stability with door off, mitigate air flow if necessary
22. Block beam sent to the IFO
23. Remove septum window from HAM56
24. Check wedge orientation of the septum window, Install septum window in the central viewport of HAM4
25. Shift HAM5 baffle to the new predicted position (2 days)
26. Take a lot of pictures
27. Remove ISCT10 from high legs, and move the high legs in front of HAM4-S
28. Move the sqz table from the sqz area to its final position, on high legs in front of HAM4-S
29. Assemble platform or something similar to be able to work on the table
30. Reconnect electronics, check all loops (2 days)

The estimate time for performing all these operations is less than **1 week**.

3 In vacuum work: Modification of H1 AS path

The first part of the in-vacuum work will be dedicated to install the new Faraday at the AS port, and recover the alignment.

3.1 Prep Work

- The list of clean parts needed for in vacuum work are listed in table 3.1
- Tools needed for the in-vacuum work are listed in table 3.1
- Check new beam path to the OMC by considering the new BS location, and the absence of the septum window. Check TT0 range to compensate for it.
- Tube, or something like that, to connect sqz enclosure and viewport

Quantity	Type	Part	Status/Location
6 (4)	Class A	4" bh DLC mount fork and screws	Clean DLC mounts, Sqz cabinet Installed BS DLC mount available
3 (3)	Class A	3.5" bh DLC mount fork and screws	Clean DLC mounts Sqz cabinet Installed DLC mount available
9 (6)	Class A	2" REO mirrors	Already cleaned, in Sqz cabinet Some also in H1 DLC mounts
2 (1)	Class A	2" 99% BS	E1000076-v3, Keita's office Cleaning and baking as E000007
1	Class A	aLIGO Faraday	Cleaned at Caltech Clean test in optics lab
1	Class A	H2 eLIGO Faraday	Already cleaned** Beam dump
1	Class A	Black glass for Faraday beam dumps	

Table 1: List of parts needed for in-vacuum work

Quantity	Type	Part
1	Class B	bubble levels for table
1	Class B	Monkey Bar
1 set	Class B	allen wrenches
1	Class B	flashlights
2	Class B	iris, mount, fork
1	Class B	6" rules
2	Class B	IR card
1	Class B	IR viewer
1	Class B	Power meter
		Floor mounted floodlights
		GDS workstation
		Video monitor and connection

Table 2: List of tools needed for in-vacuum work

3.2 Procedure

31. Lock IMC in air
32. Align IFO optics in single bounce mode
33. Establish AS beam path to AS diode on ISCT4 (it will likely be different from path defined with IMC in vacuum)
34. Install and Align SQZ 29 MHz diode on ISCT4 (not required at this time)
35. Set-up two iris between SM2 and SM3, mark new beam position on camera on ISCT4. This will be the reference from now on.
36. Place level on HAM4 for balancing the table
37. Remove eLIGO OF (keep it clean!), 95% BS, and 3.5" DLC mount in front of the Faraday (SM1, keep it clean!), and replace these parts with the new ones for keeping the balancing more or less right
38. Install new SM1 at 4" beam height, adjust height of the bottom mirror of the periscope
39. Align aLIGO Faraday using SM1, check transmitted power with power meter
40. Install new 2" 99% beam splitter, check wedge orientation (need to be horizontal), dump ghost beam
41. Improve balancing
42. Check AS beam path in HAM6, center on TT0
43. Re-align AS path to ISCT4 using only translation and tilt of SM2
44. Final balancing
45. Re-align the OMC (It might require to shift TTs)
46. Take a lot of pictures

4 In-vacuum work: Alignment of SQZ path

The second part of the in-vacuum work will be dedicated to set-up the squeezed beam injection.

- Finish squeezer set-up with injection path: install PZT mirrors, install telescope, set p-polarization entering HAM4, establish and check stability of bright beam to be used for alignment (by considering that only 1% of the light reaches ISCT4);
47. Misalign IFO mirrors so as not to have light at the AS port
 48. Inject bright beam from Squeezer into HAM4 at the center of the central window

49. Establish Sqz path: Install and align 3.5" DLC mount with REO mirror (SM4), eLIGO Faraday, and steering mirrors (SM5 and SM6)
50. Check balancing of the table after each component is installed
51. Align the path by making sure that incident sqz beam on TFP is at Brewster angle, check losses
52. Re-align single bounce configuration
53. Confirm that Sqz beam is reflected back from IFO
54. Send the main beam to the IFO, check overlap between AS beam and sqz beam
55. Measure beam profile of Sqz and AS beams on ISCT4 (TBC)
56. Adjust lenses on Sqz table to optimize mode matching
57. Once Sqz path is established, install iris in front of central window, and bring the beam rejected by the sqz faraday out from HAM4 (by installing SM7 and SM8)
58. Mark on the wall the position of the rejected beam
59. Check balancing, ghost beams, and such, before closing

The all in-vacuum work should take not more than **1 week**.

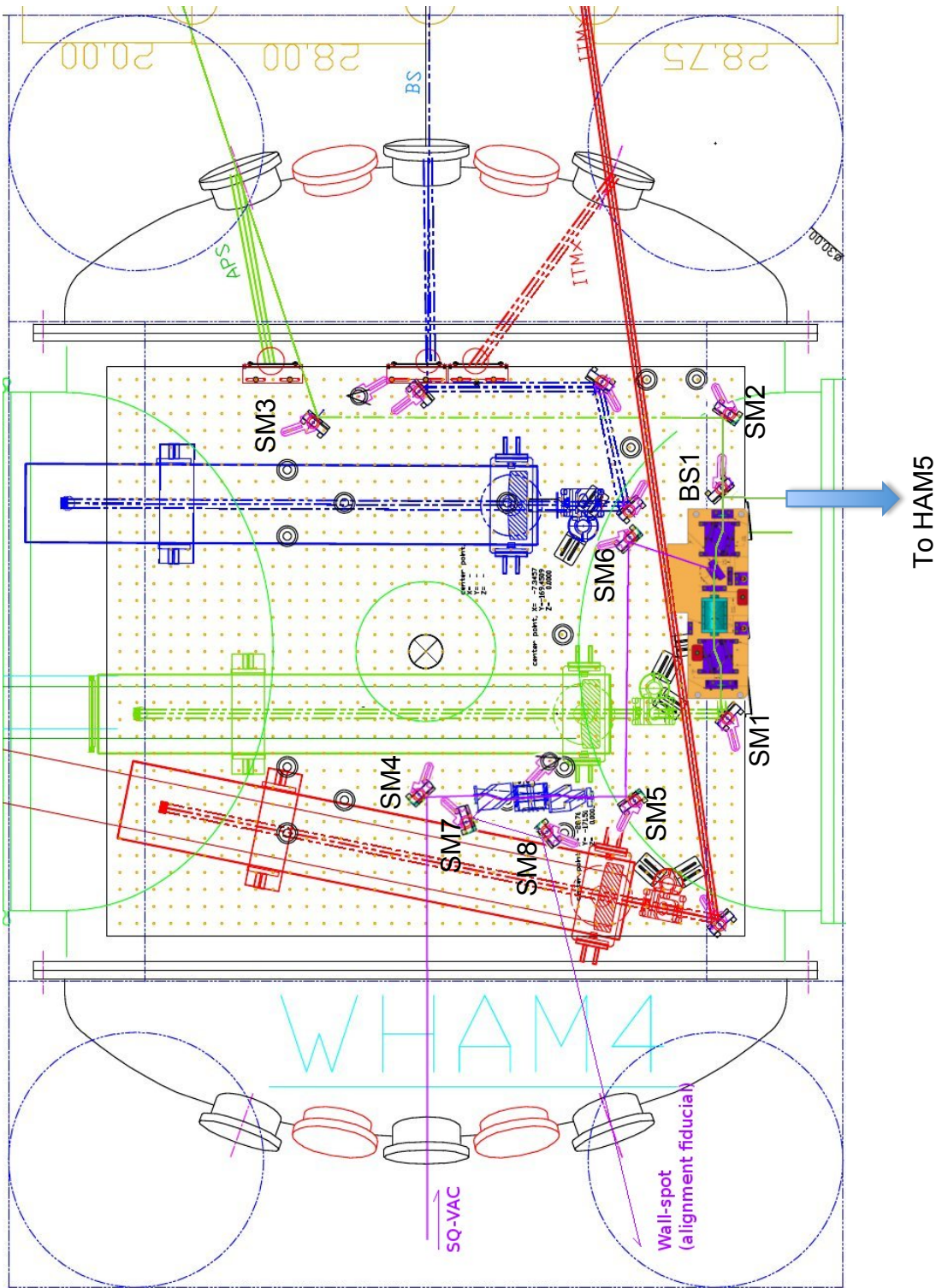


Figure 1: New HAM4 layout