

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY
-LIGO-
CALIFORNIA INSTITUTE OF TECHNOLOGY
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Procedure	LIGO-E1200453-V3	7/May/2012
Fine Initial Alignment Procedure of the Transmission Monitor Telescope		
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1. References

1. “SOP for Arm Length Stabilization Setup in LVEA and VEA”, [M1100040v6](#).

2. Tools Required

- One laser sensor card to be used inside the chamber. The card should be wiped thoroughly clean and the part where the worker holds should be wrapped with aluminum foil. Make sure to double fold the foil edge so no aluminum shedding falls inside the chamber.
- One laser sensor card to be used outside the chamber.
- One green laser pointer for misc. work.
- Assortment of class B Allen keys.
- An iris on a small post and post holder. **If a sensor card with a 3 to 4 mm diameter hole is available, it is convenient to mount the card on a post and use it as an iris.**

3. Check Before Starting

- Rough initial alignment of the TMS to the ETM should have been done by IAS group outside of the chamber under the test end.
- Fine initial alignment of the ETM should have been done by IAS inside the chamber. **(Make sure that HEPI didn't move after ETM alignment was done.)**
- TMS suspension system should be working, i.e. the TMS should be freely hanging with OSEM damping, and the OSEMs should react to various offsets.
- ISC frontend should be working, i.e. green QPDs on the TMS ISC table should be connected to the ADCs, h2iscey should be monitoring these QPDs and MEDM screen should be available for this.
- All the tools should be available.

4. Man power needed

This is a four-persons' job.

- One person to work inside the chamber.
- One person to work as a support outside of the chamber.
- One person to work on the ALS table.
- One person to work on the CDS workstation.

5. Procedure

1. Transition the VEA to laser hazard as per SOP.
2. Turn the laser on.
3. Remove the ALS table panel behind the green beam periscope.
4. Place an iris at a convenient place between the top periscope mirror and the partial mirror splitting the Hartman and the ISC beam path on the ALS table. Exact position doesn't matter, but it should be at a comfortable position for the worker to look at both sides.
5. Free and damp the TMS if it's not.
6. Completely remove the First Contact **both** on ERM and ETM **(the weight of the first contact is large enough to tilt ETM in PIT significantly)**. **Ask SUS people for help.**

7. Confirm that the ETM and ERM are both free and damped. **Ask SUS people for help.**
8. Adjust the offset of the green QPDs so the output of all four quadrants become zero when no beam is hitting the QPD.
9. Inject the green beam into the chamber via the West viewport **on the South door for EY, or the North viewport on the East door for EX.**
10. Adjust the periscope mirror on the ALS table so the beam hits the center of the first steering mirror in the green beam path on the TMS ISC table.
11. Look at the beam position on the viewport. Adjust the table position along the arm until the beam is about 1 inch above the center and centered horizontally.
12. Repeat 10. and 11. until the beam is centered on the first steering mirror and roughly 1 inch above the center and centered horizontally on the viewport.
13. Steer the first steering mirror on the TMS ISC table until the beam hits both of the QPDs.
14. Try to exactly center the beam on two QPDs by slightly adjusting the beam position on the first steering mirror on TMS ISC table and realign. It might not be possible to do this easily, so give up if it takes too much effort. **For anything except the first build (i.e. H2 EY), it's worth trying to enable QPD centering servo by copying the servo matrix elements from H2 EY. Note that you might have to flip the sign of YAW loops.**
15. At this point, the TMS beam should already be hitting the ETM. Observe how the beam is coming back from the ETM.
16. Move the TMS by adjusting the TMS SUS offset so the beam is roughly retro reflected by the ETM. **The forward and the backward propagating beam should meet at the same spot on the secondary mirror.**
17. The above step changes the relative alignment of TMS in relation to the ALS table. Repeat steps 10 to 13 until the beam is roughly retro reflected by the ETM while the QPDs are reasonably centered. "Reasonably centered" means that the beam is not on a single quadrant.
18. At this point, look at the iris. Repeat steps 12 to 16 until the retro reflected beam is centered in the iris.
19. Confirm that the beam is still roughly at the position specified in step 11. If not, you need to go back to step 10 and follow all the steps after that again.
20. At this point, the main beam path **should be** in a good shape. **The beam doesn't have to be exactly centered on any of the telescope mirrors, but excessive offsets on the secondary and/or the primary might indicate that something is wrong.**
21. Look at the beam position on the top periscope mirror of HWS pick-off path on the TMS ISC table. It's OK if it's somewhat off-centered, but if it looks really bad (e.g. ¼ inches off from the center) you need to adjust the bottom periscope mirror on the TMS ISC table.
22. Adjust the top periscope mirror of the HWS pick-off path **ON THE TMS ISC TABLE** so the pick-off beam hits the center of the HWS top periscope mirror **ON THE ALS TABLE.**
23. Look at the HWS pick-off beam position on the viewport. If it's too far off from the center, adjust the top HWS periscope mirror position on the ALS table and repeat.

24. At this point, the HWS pick-off beam path is in a good shape.

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Worker Name:

Date:

QPD1 values:

QPD2 values:

Main beam position on the viewport:

HWS pick-off beam position on the viewport: