

Output Mode Cleaner Mechanical Lessons Learned

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This document details the mechanical lessons learned from assembling the first output mode cleaner (OMC). It also includes the OMC task list that has been our way of tracking the changes needed.

- **Optical Bench Interface**

The Enhanced LIGO schedule forced the SUS design of the suspension and associated metal bench to take place in parallel with the design and layout of the ISC optical bench. As ISC developed their layout, we modified our metal bench to meet their requirements. Wire breakoff concepts for the interface of the optical bench to the clamp/wire/clamp assembly were discussed among the group and with the glass vendors. A metal bench with cylinders slotted through from the short sides of the bench around which the wire was looped was prototyped first, see bench drawing D070027 at link on the review wiki page. From discussions with glass vendors it became clear that this design would not be easy to fabricate in glass. A second design was agreed upon, which had counter bored holes in the optical bench as opposed to four long, transverse holes with a big slot at the end as the first design had. The second metal bench has a traditional clamp/wire/clamp assembly with a washer to allow for use with the counter bore in the optical bench. This concept was detailed by Calum Torrie in his document entitled OMC Wire Clamp with Glass Bench Assembly, on the review wiki page. The glass vendor assured the ISC group that this was a better approach as well from their standpoint. Inspection of the glass bench is required before the washer (called a spacer) design is finalized and this will be done very soon.

- **Structure Weldment**

The OMC structure design is loosely based on the aluminum quad upper structure, which meets the minimum 150 Hz first natural mode requirement. However welding of such a structure to meet vacuum requirements and at the same time satisfy the stiffness requirements has not proved easy, and several design concepts were explored before we reached the current design. This is fully discussed in T070205, on the review wiki page, also see the welding wiki page, created in part, to address these issues,

<http://lhocds.ligo-wa.caltech.edu:8000/advligo/UHVWelding>

- **Blade Platform (aka diving board)**

In the original design concept, the plate upon which the upper blade assemblies were mounted, was to be welded to the structure. When welding difficulties arose, it was

decided to bolt on a blade platform. A preliminary design proved less stiff than desirable. Another, stiffer design was developed and will be assembled into the next build.

- Shorting cables and cable routing.

During the first assembly and test, it was found that some OSEM cable wiring had shorted. Also, cable routing and clamping (to provide strain relief and reduce cable stiffness) was not optimum. Engineers met to determine the best routing and clamping approaches. These will be implemented in the next build with the optical bench.

As far as the problem with shorting, it was an incorrectly crimped shield that cut into one or several of the wires. The solution is to completely redo the design per Rich Abbott's revised method and equipment. As part of that redo we have eliminated the shield from the design. A revised design of in-vacuum wiring is being studied. Images of suitable in-vacuum wiring may be found at the following link, http://lhocds.ligo-wa.caltech.edu:8000/advligo/OMC_In-vacuum_Wiring

- Tablecloth and blade platform movement

Construction in the lab in which the OMC was being tested forced the movement of the OMC assembly, with the masses and blades clamped in place, from one bench to another. When the suspension was moved back, it was seen that the tablecloth had moved with respect to the OSEM magnets on the top mass. Dowel pins to provide stability will be added to the tablecloth brackets. Also, brackets were designed for the short sides of the tablecloth to the structure to provide more stability. These are presently not in place. In addition movement of the blade platform caused rotation of the upper mass between clamping and unclamping. This effect and that of the tablecloth motion served as reminders that bolts need to be well tightened and that required torques should be included in the assembly procedure.

- Blade guard

The initial blade guard for the top blades proved less stiff than desired. It was redesigned to improve stiffness, and kept to a design with relatively easy pieces to machine.

The OMC task list is included below. It is updated each week.

Overall Output Mode Cleaner Tasks

13 July 2007

updated 20 July 2007

updated 10 Aug 2007

updated 16 Aug

Calum's 3 July OMC Task List

Note - *action* *required* - *names* - *status*

1) The spacer, LIGO-D070068, that interfaces between the glass bench and the clamp wire clamp assembly - may need to be modified for the glass bench - **Sam and Calum**

action. This needs to wait until glass bench is inspected. A new spacer will be needed to be fabricated. Chris mentioned that this can be done now that the optical bench is in. One glass bench is in. Chris will make the drawing for this one bench. Modification of existing spacer. Calum will check and release ownership of spacer drawing in vault.

2) LIGO-D070XXX ? - We need to order 3 more magnet holders - Chris – action. RFQ ready. Chris reports that they're done, not installed yet. DONE

3) LIGO-D070XXX ? -We need to order 4 more magnet assemblies - Chris – action. RFQ ready. Chris reports that 3 more are made, not installed yet. DONE

4) Diving board re-work - ongoing - Chris - in progress. In shop now. 2 weeks due. Done. Chris had 4 made. An FEA needs to be done on this and on the tablecloth. Chris will get to this in the next few weeks.

5) Down stops - modify design - Chris - DONE!

6) Vent holes and vent grooves - need to be added to top mass and T-block- Chris Echols - wait for disassembly. Chris to track these changes. DONE, documented.

7) Order 1/4-20 Ag-SST Set Screws x 1/4" Long. Due at Caltech 11 July. DONE

8) Cable ties for wires fixed to suspended mass – Discussed at 12 July OMC meeting. Chris & Rich will work up a metal strain relief w/ potting compound. Chris to track needed holes in suspended mass. Chris had a meeting on this, Rich proceeding with this. Rich provided sample to Dennis, who Oked.

9) Viton spacer assembly to isolate OSEM cable from structure – Discussed at 12 July OMC meeting. Chris & Rich will work up a metal strain relief with potting compound. Ongoing. Cable wires are Teflon insulated.

10) 25 pin holder, LIGO D070052 - need a total of 3 modified e.g. holes & groove opened up and part cut down - Chris to do. One at machine shop, other four are downstairs. Chris still has to modify these. With reworks.

11) Wire Jig parts - updated by Calum - parts with Chris to go to Aero shop. Status? DONE

12) Optical bench - Dimension check - Chris & Calum - DONE!

13) Need to add hole in table cloth for access to blade stops and replace screws with longer ones - Chris - wait for dis-assembly. Chris is keeping track of all needed changes. Ready to go.

14) Consider building feet for structure to be used during assembly procedure and design U section for lab jack. Norna & Dennis conferred. Considering mini lab jacks at the

corners with a range of 4cm. Alejandro has not found little lab jacks. Janeen will look for a strong vertical stage with a cantilevered arm. Ongoing.

15) order wrench for 1/4-20, 4-40 and 8-32 nut. 1/4", 11/32" and 7/16" wrenches at Caltech 9 July. DONE

16) E-stop review wrt assembly - ref #14 and lock down experience from lab. Change assembly steps, add a blade stop. Chris will keep track of these needed changes.

17) New holes in structure for cable ties/washers, etc ... (Also need holes in L plates for counter sink SSTL screws and need to order screws!) - wait for dis-assembly. Chris will track all needed holes in the structure. Chris to inform Janeen of needed screws. Janeen to order Helicoils. Chris thinks we're OK for cable ties. 1/4-20 Helicoils ordered.

18) Footprint with respect to diving boards and OSEMS – Dennis will confirm that the footprint is acceptable. Chris will submit this as part of the review. Probably not a problem for HAM5. Low priority. Chris will make joined part & put it on the vault for Dennis to review.

Calum's 10 July OMC Task List

- Blade Wire clamps (top and bottom) need to order spares – Chris to order. He's writing up the RFQ now (20 July). DONE.
- Betsy Targets – beam targets (two different heights) should be in room 056. Osem targets are not obvious. Helena has been asked. Janeen to get new ones fabricated. Mike G. got order Friday, 10 Aug.
- Dog clamps – Some in lab. Norna will e-mail Janeen with bottom flange thickness. Janeen will check if Initial LIGO clamps will work for installations. Yes. DONE
- +/- mass - need to discuss ability to add remove mass from top mass to change overall height. Calum & Chris discussed. The default is no cylinders. You can add cylinders to increase length. Made mass itself is low, so only + mass. Utilized the capability of the negative mass.
- washers (ref e-mail from Stuart) – NAS 620-5L washers due at Caltech 11 July. DONE
- 3-32 ball driver – 2 sets of ball drivers at Caltech 11 July. DONE

Also as per my e-mail yesterday we also need: -

- 1/32" dowel pins x 7/16" long – stainless dowels due at Caltech 11 July, hardened steel dowels due at Caltech 25 July. DONE
- SST SHCS 2-56 x (something smaller than 1/4"?) – 2-56 x 1/8", 3/16" and 1/4" long due at Caltech 11 July. DONE
- Ag-SST SHCS in similar lengths? – 3/16" and 1/8" lengths due at Caltech 25 July. DONE

13 July Tasks

Model in string lengths of cable – Chris action. Haven't started it yet. DONE

20 July Tasks

Catalog all new bench parts – Alejandro & Calum DONE

Make up new clamp-wire-clamp assemblies – Mike G. should have made parts as well as Lutrell. Alejandro & Calum will make sure the jig is ready. DONE

Add pins to structure for tablecloth bracket vertical stability, Chris. He added pins to align in the vertical direction. We want a bracket in the other direction. DONE

Determine torque requirements for screws and document. Chris & Janeen. Still to do.