Summary Report of Visit to LIGO, Caltech: February 17th – March 15th 2003

Michael Perreur-Lloyd.

On my second visit to LIGO at California Institute of Technology the primary aims were to be on hand for the design of upper, intermediate and test mass assemblies for the recycling mirror triple suspension. Having already learned the working practices and met the various people, relevant to the work in which I was involved, on my previous visit to the LIGO Lab, I was basically able to pick up where things where left off.

Working with Janeen Romie, Norna Robertson (Stanford) and again in parallel with Calum Torrie, the development of the Recycling mirror into a manufacturable design was set in motion. The key goals set and completed during my visit were as follows:

- Using SolidWorks, create a three-dimensional layout of the suspension.
- Design the Recycling Mirrror structure and catchers around this layout, ensuring that all parts can be fully integrated within the footprint of 400x300mm.
- Interface the suspension with the structure and preparing the structural design for FEA by Janeen/Caroline
- Begin the Creation engineering drawings of RM parts for manufacture.

The design of the three masses and their associated attachments was completed around the end of February – mid way through my visit. The design of this is now very much an iterative process, the approximate steps involved are as follows:

- Working from numbers for mass, moment of inertia and approximate dimensions from Norna's mathematical Matlab model of a triple suspension, an initial 3-dimensional model is developed in SolidWorks.
- The mass and moment numbers calculated by SolidWorks are then entered back into the Matlab model to check that all masses of the triple suspension couple together well giving predictable modes and dynamic movement when suspended.
- The model is then developed further making appropriate cutaways for blades to fit and adding all accessories including nuts and bolts. Again the mass and moments are run through Matlab to confirm that it still conforms to the specifications. In the situation that it doesn't, further editing is done to bring it in line.

The design of the suspension was developed to the point where some of the manufacturing drawings were drawn up however issues regarding SolidWorks[1] and the desire to further develop a quad design stalled this substantially[2].

Finally, the design of the structure was also analysed and soon after assembling the layout of the RM suspension, it was apparent that in a 400x300mm footprint there was lack of space around the RM masses to allow for catchers, coils and earthquake stops. It was decided to push for a larger footprint that would facilitate assembly. Following approval by Dennis Coyne, the structure in it's new footprint of 480x300 was designed in it's raw form, i.e. including accurate placement of legs, cross-struts, top plate and base plate, however no detail of holes for attaching the catchers, coil holders, earthquake stops, etc has yet been added. The RM structure was left in its raw form so that an initial FE modal analysis could be completed thus ensuring that the design matched the earlier specification.

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[1] Around this time an upgrade to SolidWorks 2003 was being done, however there were problems with its compatibility with student licences. A considerable amount of time was spent trying to remedy these problems.

[2] The Advanced LIGO seismic team are currently involved in the detailed design of damping equipment and for their benefit it was important for the Suspensions team to confirm that the footprints and overall payloads specified in earlier plans could be met.