Summary Report of Visit to LIGO, Caltech: November 3rd – December 5th 2002

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The primary aims of the visit were to assist in the initial development and design of the LASTI Recycling Mirror suspension and to aid in the implementation of upgrades to designs for the LASTI Mode Cleaner. Secondary aims of the visit were to learn about the design environment in which the LIGO engineering team works, further understand the use of imperial units in design drawings, and to work on assemblies, bill of materials and customised hardware in Solidworks.

Working in parallel with Calum Torrie, much time was spent expanding our knowledge of Solidworks in a number of areas that will help shorten the design time of the future Advanced LIGO pendulum suspensions and associated assemblies. The areas covered were as follows:

- Using with Solidworks Explorer to copy, rename and replace part, assembly and drawing files from the Mode Cleaner file structure into a similar Recycling Mirror file structure. All files created were renamed and numbered through the LIGO DCC. Now many new parts need no longer be designed, but can instead be adapted from existing MC designs. There is still work to be done before the designs are completed, as the modelling in Matlab is not yet finished, however this will form a reference set to work with once the modelling information is finalised.
- Programming the Solidworks Bill of Materials function to accurately suit the needs of LIGO and enable the automatic preparation of Bill of Materials and Drawing Trees documents directly from CAD assemblies. This will be submitted the to the DCC.
- Relating dimensions between parts in a 'Library of clamps' assembly so that the dimensions of the blade clamps and its alternatives will now change automatically when the blade dimensions are edited. This is a Solidworks feature that, once expanded to other areas of the suspension, will save many hours of future design work.
- Drawing templates were adapted and edited to form a uniform standard for all members of the design team and to counter problems that arise with the watermarking of drawings created or edited in the educational licenses of Solidworks used by Glasgow.
- Problems brought about by the toolbox function in Solidworks - where the nuts, bolts and washers are stored – led to it being centralised on the LIGO engmech server. Unfortunately this did not solve the problem of toolbox parts opening up the wrong size once sent across to Glasgow, as Glasgow are unable to access this file store. A solution for this has now been found and a set of customised hardware drawings are to be used. This will require further work on existing assemblies to remove all previous toolbox parts and replace these with the new customised hardware, but will again be a profitable exercise for the full integration of all teams working on the design of Advanced LIGO suspensions.
- A visit to Go Engineer, the LIGO Solidworks supplier, for a questions and answers session was invaluable in advancing the above areas of work, particularly the related dimensions and queries regarding difficulties with working with a toolbox from different workstations.

Both Mode Cleaner pendulums were suspended accurately during my visit, to the point where the global. This includes several upgrades that the Glasgow and Caltech suspensions team have been working on. Some redesign work of parts within this suspension was undertaken by myself and helped clarify the grey areas in my knowledge of designing in imperial units. This

was my first time seeing the latest Mode Cleaner and it is noticeable that the extra flexibility that has been applied in the design of this assembly is now allowing a much faster set-up time.

An analysis of the winch system for the upper blades was completed. This sub-assembly is one that allows for a complete suspension to be lifted should it be aligned too low in comparison with the optics. The information gained from the calculations and experimental test of this system will give a clear indication of what has to be done to accurately raise a suspension to the correct height. Furthermore, an upgraded and an adapted set of I-catcher assembly design and drawings were completed in Solidworks from the existing AutoCAD format. The I-catcher assembly is used to better understand the effects of the wire at the break-off points and to improve blade clamp design for future suspensions.