LIGO - T030220-01 MAY 2002

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ADVANCED LIGO SUSPENSIONS

VIST TO RUTHERFORD APPLETON LABORATORY

J.GREENHALGH, MATERIALS LAB, ENGINEERING DEPARTMENT

REVISION 00: - INITIAL REPORT
REVISION 01: - INCLUDES EMAIL FROM JUSTIN

Summary

The Engineering department at Rutherford has 4 main groups: -
MATERIALS GROUP: - contribute testing facilities and understanding of materials science.
CRYOGENIC GROUP: - are also vacuum experts and could provide input in that area
DESIGN GROUP: - will contribute a mechanical designer for the proposed 2 month project, see below.
ANALYSIS GROUP: - - are currently under strength and recruiting fast - would be able to do any specialist FEA required.

Overview

TIME	ACTIVITY
2:30pm	Arrival at Rutherford Lab.
3:00pm	Initial meeting with Justin Greenhalgh
3:15pm	Presentation by Calum: introducing examples of work to give Justin a good feel for the current status and dynamics of the design activity in relation to gravitational wave detectors
3:45pm	Introductory tour of premises
4:00pm	Computer Laboratory: discussion relating to file transferral between SolidWorks (our default package) and Pro-E (their default package). Also FEA preferences: ANSYS. (ALGOR *not* rated)
4:30pm	Tour: CRYOGENICS LAB. An example of the successful advanced precision engineering Rutherford Appleton Lab can produce
5:00pm	*Private meeting with Justin: discussion of possible topics of collaboration
6:15pm	Brief tour of Workshop: similar capabilities to our own, with the exception of 3 very interesting machines. 1) Tensile testing machine: 10 tonne capacity* 2) Automotive CNC machine 3) 3D precision mapping machine
6:30pm	END OF VISIT

Specifics

The early discussion and tour gave us a valuable look at the background and capabilities of their department.

Likewise, from Justin's point of view, Calum's laptop presentation (which included animations, images and engineering drawings), obviously gave vital insight into our work and methods. Essentially, this was all a good way to build up to the main meeting at 5pm.

During this meeting with Justin Greenhlagh at five o'clock, we discussed the possibility of collaboration** on the following topics:

- Bladework: Blade Deflection Adjuster
- Bladework: In-depth spring analysis using FEA
- Blade wire clamp: creep and fatigue considerations
- Passive Eddy Current Damping of a Triple Pendulum

*** Jim Hough is keen to bring Rutherford in at the design stage. This will probably be in the form of the Institute in Glasgow paying for 2 months of an engineer at Rutherford.*

There are possibilities within each of these headings, and Justin is keen to discuss all options with his colleagues.

Bladework: Blade Deflection Adjuster

With the possible arrival of Caroline in the department, and the interest she has expressed in the engineering development of this topic, this would appear a lesser priority issue. There are however obvious engineering issues relating to the design optimisation that they could easily assist with. (E.g. creep testing / fatigue testing)

Bladework: In-depth spring analysis using FEA

In relation to the workshop tour, it was also discussed that the 10 tonne tensile test machine could be used to test Maraging Steel samples. This could give us invaluable insight into the true physical properties of the blades we get back from the manufacturers (i.e. Accurate data for UTS, Yong's modulus etc.).
This new data could be used as a backbone for new FEA runs, under the advice of Rutherford Labs.

Blade wire clamp: creep and fatigue considerations

It was suggested that this same tensile test machine could be used to test blade wire clamp assemblies. Possibility to develop our understanding of the long-term behaviour of the wire and clamps used in terms of creep and fatigue.

Passive Eddy Current Damping of a Triple Pendulum

It was proposed that work on 'Passive Eddy Current damping' *might* be most beneficial considering the timescale. On this front, we explained that we already have one concept. With the help of Alistair Grant, we have a design that is ready to test here in Glasgow.

It comprises an adjustable arm that allows the current eddy current dampers to be repositioned in the *x*, *y*, and *z* directions, as well as allowing rotation in the *x*-*y* plane. Admittedly this design may be somewhat cumbersome.
It was discussed that it may be sensible that together we generate and test further concepts relating to the adjustable arm, from which we can select and filter the most efficient through to the production phase. A realistic view of what is possible within time limits is an important and decisive factor.
This demonstrates that there are many possible avenues for collaboration on current work.

Final Notes

Workshop

There have been have no new machines bought for their workshop in the past ten years. A lot of work is subcontracted locally to10 RAL accredited local manufacturing contacts.
Of the three machines mentioned previously (Tensile testing machine, Automotive CNC machine, 3D precision mapping machine) it is clear that there are several possibilities to utilise the tensile machine in particular.

Quality Assurance Documentation

Justin was obviously interested in LIGO's approach to design work. QA documentation to a large extent defines a design framework, and has important cost implications. For example, he was keen to hear about the approach to documentation and the review system employed throughout the process.

As a result of this, Justin requested that we provide him with examples of the following:

- Specification documents (PDS) / Design Requirements Documents
- Conceptual Design Documents
- Engineering drawing examples: BLADES
- PowerPoint Presentation files: as were used by Calum in the introductory meeting – this will aid communication with his colleagues as to project background
- Exchange of SolidWorks files to test transferral to and from Pro-E

Next communication will be done via email, with all of the above supplemented.
Email from Justin to explain the breakdown of the Engineering department and what is available, also see attached organogram: -

Hi Calum, I am glad you liked what you saw here. Sadly our organogram is not yet on the web although we are working on it. I attach a copy in which I have highlighted the groups likely to be involved in Advanced LIGO. My own group will contribute testing facilities and understanding of materials science; the cryogenics group are also vacuum experts and could provide input in that area, and the design group will contribute a mechanical designer (I am due to talk to my preferred choice today or tomorrow). The analysis group - who are currently under strength and recruiting fast -

would be able to do any specialist FEA required. I am afraid that chart won't look too good in outlook... Cheers - Justin.

All in all, this was an interesting and successful visit. END