Advanced LIGO UK
Project management meeting number 26
Telecon, Jan 13th 2006

Stuart Aston, Caroline Cantley, Justin Greenhalgh, Ian Wilmut

1 Participants

Justin Greenhalgh (chair)
Stuart Aston (SMA)
Caroline Cantley (CAC)
Tim Hayler (TMH)
Dave Hoyland (DH)
Ken Strain (KAS)
Ian Wilmut (IW)

2 Comments on minutes from last meeting

There were no comments on the minutes of the previous meeting.

3 Actions from previous meeting

These are noted under item 13 below.

4 UK/US interactions

4.1 Controls prototype design

Had been assembled and tested clean; some problems with OSEM failures. IW was due to visit Caltech for assembly tests in w/b 16th Jan.

ACTION 26.02 SMA to take up the OSEM failures with the US side and establish a strategy to demonstrate that the Birmingham OSEMs would not be subject to similar problems.

4.2 SUS telecon issues

The principle topic of interest to this group was the control tests at ETF which had shown that the controls prototype structure could be controlled on the seismic platform but with some degradation of performance which was significant for science. (See also 4.6 below.)

4.3 RODAs and MoU

Changes proposed by PPARC to the draft UK/US MoU had been sent to Carol Wilkinson in the US for approval.

See
http://www.ligo.caltech.edu/~coyne/AL/project_management/RODA/RODA_status.htm
for status of RODAs. RJSG had recently signed two RODAs:

- M050175-01 on optic coating
- MM050397-02-Y on optic sizes from the which the following table is extracted for information:

OPTIC	DIAMETER (mm) Measured from thickest to thinnest part of the optic. Not to be measured flat to flat.	THICKNESS (mm) Measured at the thickest point of the optic. The wedges will remove material from the optic.	MOUNTING FLAT LENGTH (mm)
TEST MASSES	340	200	95
BEAMSPLITTER AND FOLD MIRROR	370	64	95
RECYCLING MIRRORS	265	100	No mounting flats

4.4 Recent Weekly LIGO reports

Reports are to be found at http://www.ligo.caltech.edu/~weekly/.

Jan 05 2006:
New table of review dates from Carol Wilkinson including these of relevance to us:

~April '06	SUS	PDR, Review 3	Quad design	Completion of the quad controls prototype assembly; installation at LASTI	timely transfer, to RAL & UB efforts, of lessons learned from the controls prototype	Delayed until shipping to LASTI.
~April 06	SUS	PDR, Review 6	quad controls prototype test results ribbon process/design	completion of LASTI testing; may need to have partial review with quad PDR before end of testing	timely incorporation into final design effort on the noise prototype	

ACTION 26.03 CAC to discuss with JHR the significance of SUS PDR 6 for the Glasgow ribbon work.

4.5 Reviews

4.5.1 ICD review

RJSG had had a very useful telephone exchange with Dennis Coyne in which many outstanding ICD issues had been discussed. Dennis had undertaken to refine the ICDs is many areas.

4.5.2 Electronics review

Progress on resolving remaining issues was slower than had been hoped but was still not delaying any work in the UK. The lack of a definitive final outcome was disappointing.

ACTION 26.04 KAS, SMA and DH to discuss the implications for Birmingham of the new requirement to increase the OSEM force. The agreed to meet by telephone on Wednesday 18th Jan at 4pm.

4.5.3 Bonding/Ear/Ribbon/Fibre review

There were the four outcomes relevant to ALUK activities:

- ISC team to work with SUS to develop requirements for optic positioning.

CAC was awaiting input from the ISC team.

- Circulate calculations on the effect of violent impacts and what requirements there are for the earthquake stops in terms of spring constant

Janeen Romie had moved to restart work on the static discharge issues associated with the earthquake stops and Joe O'Dell had been briefed to begin the mechanical design. There were still questions as to the best way to demonstrate damage avoidance.

- Phil and Geppo should coordinate efforts on calculations of the impact of tapers, and on contacts with the Texas company that makes silica springs

ACTION 26.05 CAC to email Phil and Geppo to remind them of this.

- Explore issues related to transport and storage of silica suspensions to see if current plans are adequate

This was being undertaken as part of the work leading to the ribbon process PDR.

It was agreed to remove this review from the agenda of future meetings.

4.5.4 Noise prototype PDR

LIGO had requested a delay to the review of at least four months. RJSG had drafted a document setting out the consequences of delays of two, four or six months to the review. He requested that Glasgow and Birmingham supply text. It was agreed that the working assumption for OsC reports would be a delay of four months.

ACTION 26.06 CAC to provide text for the PDR delay document.
ACTION 26.07 AV to provide text for the PDR delay document.
ACTION 26.08 RJSG to set up a meeting to discuss best way forward with Coyne, KAS, Wilkinson.

4.6 Noise prototype interactions with the US

It was now accepted that the apparent performance anomalies with the "d" distances on the controls prototype were fully understood in terms of the refined understanding of blade-wire interaction.

Tests had been carried out on the controls prototype structure bolted to a seismic platform at the ETF at Stanford. For those with access to ELog, a summary by Brian Lantz is available here (password protected)
http://ligo.phys.lsu.edu:8080/LSC+SWG/81

This had been the basis of a telecon on 12 Jan at which the following points had emerged:

- It had proved possible to make the servo perform stably with the controls prototype structure in place but not with a large phase margin – the system would be sensitive to small changes.

- Even without the structure, there was a minor breach of the requirements by the seismic system in the region of 10 Hz. Having added the structure and modified the control system to cope with the resonances, this excursion was slightly worse.
- A rise in natural frequency of the structure of 10 to 20 Hz would make things significantly better.
- Efforts at RAL to improve the frequency had not so far yielded any dramatic results, and effort between Caltech, Glasgow and RAL to explain the difference between the FEA results and the tests results had also not yet borne much fruit. However, understanding was felt to be improving and there was optimism that modest changes to the frequency of the order 10-20 Hz would be achievable with further work.

Two very helpful suggestions were made. One was to make use of Iain Martin the CASE student who may be able to help with this work, the second was to exploit the imminent arrival in Glasgow of the second Controls prototype structure on which tests could be made.

ACTION 26.09 RJSG to contact Shiela Rowan to seek her agreement for the deployment of Iain Martin in this role.

4.7 Exchange of schedule information with LIGO

RJSG had had a short telephone discussion with Carol Wilkinson to discuss how best to report progress on UK areas in a way that can inform decision making in the US. As a starting point he had sent the latest schedules including the summary one used for the OsC.

4.8 LSC meeting

The LSC meeting was to be held at Hanford on March 20-22, with a suspensions workshop on 23 March, possibly extending to 24th.

Suggested attendances and talks were
CAC – update on Glasgow work etc
RJ – possibly but might also attend the workshop by telephone.
RJSG – could talk about blade/wire interactions to relieve IW
TMH – Structure frequency results
IW – Designs of masses, blades and clamps
JO – Ribbon stretching jug (aka mass catcher)
General discussion on assembly procedure
SMA – OSEM update, possibly interferometric sensor
DL (possible)
AV – science issues

Suggested travel plan: fly to Washington then drive ~ 4 hours to Hanford. Nearest local airport is Pasco (PSC) also called Tri-cities.

4.9 Visits and trips etc.

IW would be visiting Caltech w/b 16th Jan to learn about modifications to the assembly procedure and to carry out a programme of tests.

Jay Heefner was considering visiting Birmingham in the next month for face-to-face discussions.

5 OsC issues

Suggestions from previous OsC:

- Long-term tests on bonded joints.
    - The test started in August was still in progress. The next test planned included a weld of a fibre to the ear. CAC agreed to include in her OsC report a summary of all the tests done so far.
- Establish what is considered to be the largest risk for the advanced LIGO project as a whole and what processes are in place to manage risks.
    - RJSG had asked Dennis Coyne, who had passed the request to Carol Wilkinson. Carol had sent the following statement together with two fuller documents.

```
In response to your request for the Advanced LIGO Risk Management Plan:

The risk management plan for the Advanced LIGO project is not ready for
dissemination. I expect to have it ready in time for the expected NSF
baseline review in May. Risk management will be part of the Project
Execution Plan.

At present, the basis of estimate for Advanced LIGO project costs
includes a bottoms-up risk analysis for cost contingency. Each WBS
activity has a calculated risk factor based on estimated cost, schedule,
and technical risks. See attached .pdf files for risk definitions and the
SUS (implementation phase) risk factors in the basis of estimate.
Risk factors are based on how well the technologies are understood, the
quality of the cost estimates, and schedule impact. The calculated risk
is used to determine cost contingency. A Monte Carlo analysis on the
critical path durations will determine overall project schedule
contingency. The risk factors and contingencies are undergoing review at
the present time as we prepare the project baseline.

The risk management plan for the project (implementation phase) uses the
calculated risk factors and an estimated probability of occurence to
assign activities to values in a standard risk assessment table. Once the
high risk items have been identified, mitigation measures for the various
possibilities will be determined. These measures may include increased
efforts, scope reductions, back-up technologies, and other strategies.
High risk items will be tracked through two methods:
schedule and cost performance variances using commercial software
packages and periodic or timely reviews of technical performance. Items
that exceed pre-determined variance limits will require a mitigation
plan.

For the development phase, risk management is carried out in a slightly
less formal manner due to the intrinsically changeable nature of R&D
efforts. Development activities are tracked in a Primavera schedule
linked to the project schedule and in a cost book. Each activity has a
risk factor calculated from the project risk definitions. Critical path
items that drive the project schedule are on a watch list. Reviews of all
developmental designs occur on a periodic basis, such as for the
conceptual, preliminary, and final designs.  Additional reviews are
scheduled for downselects, evaluations of technical performance, or for
critical decision points. The Advanced LIGO project managers meet on a
weekly basis to discuss threats and mitigation strategies. Strategies to
date have included back-up development pathways, re-direction of efforts,
schedule re-organization, and re-balancing of shared performance
requirements.
```

I hope this explanation suffices until the Project Execution Plan is ready.

Specific actions were:

- An update on the investigations into the fault with the LIGO mirror should be included in the papers for the next meeting
  - This would be done.
- A verbal report on the Production Readiness Review of the Noise Prototype due in February 2006, should be included at the next meeting
  - It was almost certain that the review would be delayed at US request to April at least.
- The Collaboration should ensure that opportunities for spending some of the Working Allowance at the design and planning stages of the project are not missed. An itemised report on the use of the Working Allowance should be included in the papers for the next meeting.
  - RJSG had redrafted the list and incorporated recent changes suggested by KAS. He would be circulating it again ahead of the PAG.

The following timetable for PAG and OsC papers was agreed:

Text to RJSG from WP managers Jan 16th
Finance reports to RJSG Jan 20th
Draft OsC report to PAG Jan 27th
Updates to profile tables feb 1st
PAG meeting feb 3rd

6 PAG

RJSG proposed to invite Ian Wilmut to the PAG.

7 Finance

Two calls on working allowance were discussed. It was agreed to forward both to the PAG. The first was from RAL to cover increased design costs of around 2 months in the 18 months used in the period July to December; the second was from Birmingham also for increased effort costs over the same period but not yet quantifiable ahead of a finance meeting at Birmingham on Jan 16th.

It was also agreed to warn the PAG of likely future calls on WA for two areas. One was the ESD electronics to cover the water-cooling requirements and addition of an extra channel (see also under “changes” below). The second likely future call was for the FEA effort on the suspensions structures.

8 Changes

8.1 OSEM force requirements change

Peter Fritschel had written a document T050271 with the force requirements for the OSEMs, updating the data in G010086. The force requirements are higher than before. KAS had produced T060001, summarised in G060003, showing how the required increase may be achieved by a combination of larger magnets (which have to be mounted in balanced pairs), extra windings on the OSEMs and increased drive current. IW had studied

the possibility of mounting pairs of magnets and found no show-stoppers even on the penultimate masses. SMA had reported that doubling the number of windings on the OSEM should not be a problem (although some parts have already been made for the test OSEMs and these, as well as the winding machine, would need to be changed). Implementation of the larger drive current had not yet been studied. As noted above, KAS had agreed to speak further with the Birmingham team.

8.2 Violin mode dampers

This was an extension to the scope forced by the fact that the damping method assumed in the proposal had been subsequently shown not to work. N Lockerbie was working on sensor technologies that would be suitable. Some mechanical design would be required which it was hoped could be done at Glasgow. The procurement and purchase of the production sensors and their associated electronics would need to be funded from working allowance. There would be ICD implications because of the wiring over the structure, over the SEI and so to the electronics racks. It was hoped to produce a proposed ICD modification in a few weeks.

8.3 Suspension point interferometry

This idea had been floated at the systems working group. Neither of the currently preferred schemes would have any impact on ALUK work but there was a possibility of the need to mount a mirror of approximately 75mm diameter on the structure.

8.4 Electrostatic drive – eliminating the need for photon drive

The design of the ESD electronics had been so successful that with the addition of a sixth channel it was expected to outperform the proposed photon drive and so obviate the need for that system. This change, if accepted, would have a small cost impact for the UK but yield significant savings for the project overall.

9 Web sites etc

http://www.eng-external.rl.ac.uk/advligo/papers_public/ALUK_Homepage.htm.

Most recent updates:

- RAL 14 Oct 2005; ALUK 12 July 2005.
- Glasgow: 10th Nov
- Birmingham updated during December.

10 Activity/plans and document summaries

For each partner we discussed the plans given at the previous meeting and performance against Gantt charts. Included below is the **draft** OsC report text (the goals in particular will likely change as planning is carried forward).

10.1 Glasgow

10.1.1 Plans for the near future from the previous meeting

- Draft designs for the noise prototype penultimate and reaction masses will be completed and requests for quotation will be issued to three vendors.

    - RFQs will be issued soon. This work was delayed to allow for the additional feature required by the balancing magnets need by the OSEM force increase.
- Following completion of the FE stress modelling and design modifications further orders will be placed for revised test ears with inspection polish finish.
    - Orders will be placed soon.
- Ribbon development work (pulling, welding, characterization) will continue. Assembly of the final prototype CO_2 machine will continue.
    - ongoing
- Design of single ribbon suspension and multiple ribbon suspensions for ribbon and weld strength investigations will continue.
    - Ongoing
- The Glasgow schedule M040019-05 will be updated to Rev 6.
    - Will be done in the coming week once the RAL schedule has been updated
- Additional load tests on bonded ears.
    - Ongoing.

10.1.2 Progress against schedule

Progress had been delayed in selected areas as noted above. The schedule should be rewritten in the light of the proposed delay to the noise prototype PDR. It was agreed in addition that it would make sense to delay the start of the procurement on the "RAL" ribbon pulling and welding rig until the Glasgow design had been completed in March.

ACTION 26.10 RJSG to send updated RAL schedule to CAC
ACTION 26.11 CAC to produce an updated schedule.

10.2 Draft OsC text Work package 2 – optic ears and scientific input

10.2.1 Goals and concerns reported for previous period

Goals

Continue to provide scientific input and support
Status - Ongoing
Continue to collaborate with LIGO Lab and RAL on monolithic suspension developments including ears, ribbons and substrates
Status - Ongoing
Continue to blend WP2 with US/RAL schedules
Status - Ongoing
Complete the first phase and perform the second phase of bond strength tests in Glasgow in collaboration with Caltech. Order additional test ears for this second phase of testing.
Continue to develop detailed and long-term bonding/ear test plan in collaboration with Caltech.
Status – Ongoing. Refined ear design complete. Quotations in progress and orders will be placed shortly.
Complete construction of second phase of CO_2 laser welding and pulling machine and perform strength tests on laser fabricated ribbons and welds (this work does not form part of this grant however is related closely to the development of monolithic silica suspensions for Advanced LIGO).
Status – The final phase of machine development is progressing well. Construction complete and ribbon/welding development work continues to progress well.
No concerns reported

10.2.2 Commentary

Glasgow have continued to provide scientific input, advice and support in all areas of the UK project scope and scientific and engineering support in the extension of these designs to the main quadruple suspensions. We have also continued to support in the design of the associated control sensor/actuators (OSEMs & ESDs) and electronics. In collaboration with LIGO Lab we have continued to make good progress on the development of the bonded ears, ribbons and substrates for the monolithic final stage suspensions for Advanced LIGO.

We have also continued to provide significant engineering design and scientific input towards the development of the controls prototype quadruple suspension which is now in its final stages and continue to support in the design of the noise prototype which is now well underway.

The Bonding/Ears/Ribbon/Fibre Preliminary Design Review (PDR) took place in October 2005 as scheduled and this went well with only a few minor comments/suggestions raised by the review committee. All of the documentation associated with the review including technical reports can be found on the Glasgow UK Advanced LIGO Project webpage at:
http://www.physics.gla.ac.uk/igr/sus/index.html
by following the link for the “Bonding/Ears/Ribbon/Fibre PDR”.

Following initial testing of the “preliminary ears” the silicate bonds were found to have extremely high strength with loads of up to x 3.7 operating load applied without bond failure occurring (the operating load in Advanced LIGO is 10 kg per bond). It was identified during these early tests that the breaking stress of the ears themselves was lower than that of the bonds. It was decided to conduct some minor design refinements to further improve the strength of the ears to enable loads to be applied to produce bond failure. This involved some minor changes to the shape of the ears in the region where the welds are applied and an improvement in the surface quality finish of the ears to reduce the resulting stress concentration.

The refined ears are currently being fabricated and are due to arrive in April when a selection of them will be bonded to silica disks for additional strength tests. A second set of the ears will be used to form a trial suspension assembly of a heavy mass as a build-up to the production of a full blown mock silica suspension stage which itself will be a precursor to the noise prototype. A 12 kg mass (10 kg operating load + contingency) has been suspended from a bonded ear for the last few months as part of a long-term proof test of a loaded bond (bond loaded on 19th August). A single fibre monolithic suspension has also recently been set up incorporating a bonded preliminary ear and a laser welded fibre under a load of 12 kg.

Although outwith the scope of this project, development work for the CO_2 laser machine for pulling and welding of silica ribbons and fibres continues to progress well.

The Glasgow schedule is updated on an ongoing basis with an update released in January 2006. This revised schedule reflects the four month delay imposed by the US with various tasks being extended to milestones have been pushed backwards to optimize the use of the slack in the programme. The Glasgow schedule is fully integrated within the UK project

schedule and this in turn has been developed and is monitored in such a way as to be fully compatible with the US Advanced LIGO schedule.

10.2.3 Goals and concerns for next period

Goals
Continue to provide scientific input and support
Continue to collaborate with LIGO Lab and RAL on monolithic suspension developments including ears, ribbons and substrates
Continue to blend WP2 with US/RAL schedules
TO BE INVENTED
TO BE INVENTED

10.3 Draft OsC text: Work package 5 - optics

10.3.1 Goals and concerns reported for previous period

Goals
Ensure delivery of four optics substrates proceeds in December 05 as planned. Organise necessary agreements between US/UK for equipment transfer and organise shipping insurance
Status – Completed, four substrates delivered to Caltech in Dec 05/Jan06
No major concerns

10.3.2 Commentary

Glasgow will provide four 40 kg substrates of silica for the optics of one interferometer. Work relevant to polishing and coating of the blanks is excluded from this package.
Three of the substrates were delivered to Caltech in December 2005 with the delivery of the fourth and final substrate in January 2006. These are the first physical deliverables to LIGO Laboratory from UK Advanced LIGO. The substrates have been oversized in thickness to accommodate two stages of polishing so that they can be used for both initial testing of the optical properties and losses and for subsequent installation in one of the LIGO detectors. We will participate in the assessments of mechanical loss and assist in understanding the full implications of these and any measurements of optical loss carried out by LIGO Lab.

Purchase of the optic substrates during this financial year is in-line with the UK funding profile.

10.3.3 Goals and concerns for next period

Goals
The physical deliverables of the work package are complete. However, for the remainder of the project and on an ongoing basis we will continue to support the US in testing and characterisation of the substrates.
No major concerns

10.4 RAL

10.4.1 Plans for the coming month from the previous meeting

- Conclude on what adjustments are required where in the suspension chain, this will require the design and manufacture of a simple quad (next item)
    - A document on adjustments had been produced and w its conclusions were to be tested against the "marionette" chains (next item)
- Develop simple quad to allow us to try adjustment schemes, etc… Get a top mass built; Make a simple UI mass.
    - Parts on order, expected end of January.
- Complete wire and clamp tests.
    - This work had been delayed because new, improved sensing equipment (video extensometry) had been ordered by the RAL force testing team and it was hoped to use the new equipment and so reduce the effort required for the tets.
- Blade design and drawings
    - Design started
- Complete upper structure drawings
    - Done but may need to be changed to suit structure FEA
- Conclude FE work on bolted joints and work into lower structure design.
    - This was taking longer than hoped
- Further many documents and drawings toward review
    - Many documents had been produced including PDS documents and a compliance matrix.

10.4.2 Progress against schedule

The tasks leading up the review are mostly on track with the exception of the FEA on the structure. The review date itself is going to move around four months so a revised schedule will be required.

10.5 RAL OsC report draft text: Work package 3 – mechanical design

10.5.1 Goals and concerns reported for previous period

Goals	Status
Decision on use of drum-ended wires	Should be done soon
Complete review of interface documents to ensure implications understood	Done (assuming this meant the ICDs?)
Complete agreement on changes document between controls and noise prototype designs.	Should be done soon
List of documents required for the noise prototype pre-procurement review.	Complete
Designs complete for hanging masses and structure	Complete
Agreed date for pre-procurement review	Complete
Concerns	
Frequency response of lower structure	

10.5.2 Commentary

For much of the last six months the US lead "controls prototype" (the prototype suspension preceding the "noise prototype") has been incomplete. This has meant that progress made on the controls implementation has continued to influence the UK work on the noise prototype. Every new lesson learned by our colleagues in America has gained us additional

insights into desirable or undesirable features of the Controls design. This continuing trickle of information has ensured constant review of our decisions and has hopefully ensured a robust final product. The negative side of this has been that it is very hard to finish anything, since it is never clear that no more information will be forthcoming. In early February 2006 the Controls prototype was completed and shipped to LASTI (the test facility at MIT). This has at last ended the stream of desirable improvements and we can set about completing the noise design.

The most interesting areas of the Noise prototype design work can be split into four very un-equal sections:

10.5.2.1 Blade Springs

Over the last six months one area where this parallel relationship between the Controls and Noise prototype has been very fruitful is the design of the blade springs. When RAL became involved in the blade springs it was widely felt that their design was well understood, and the only real task remaining was to “productionise” the design and blade selection. It is evident from the work on the Controls prototype that this was not the case. We have spent considerable time considering the results collected from the Controls prototype, and modelling the blade performance in FEA. We now believe we have a model of the blade behaviour that has been validated by experiment, FEA and hand calculation. Two significant effects that have been discovered and quantified by RAL, these effects have then been proven in the US by experiment and studying the controls prototype. The two effects are as follows:

1. Blade softening created by a longitudinal force upon the blade: All previous design of blade springs has assumed an exclusively vertical loading upon the tip. This is a reasonable assumption so long as the loads are close to being vertical. The quad controls prototype has some quite dramatically angled wires these introduce a significant longitudinal force into the blade. This load has the effect of introducing a moment to the tip of the blade if the blade tip is not aligned horizontally with the clamped root. This moment causes the blade to deflect an additional amount, which has the effect of the blade being softer. This has been proved a real effect and can be observed in the controls prototype. Clearly this has real implications for the noise blade design. Now the effect is understood measures have been taken to ensure the noise design takes this into account.

2. Wire blade interactions: It has been shown that a loaded wire suspended below a rigid clamp will bend a fixed distance below the clamp. In the past it has been assumed that the wire below a blade will behave just as if it is rigidly clamped. Extensive FEA has demonstrated that this is not the whole story. What is much more significant is that the blade will deflect laterally when the wire is pulled sideways. This causes the blade tip to pull toward the force and twist. If this is considered for a range of sideways loads the wire flexure point can be seen to be a constant distance above the blade tip, not the few mm below that was expected. This has a profound effect on the stability of a suspension. This has also been demonstrated in the controls prototype, and we should now be in a position to ensure the noise prototype is as stable as intended.

10.5.2.2 Structures

The overall structure is proving to be a more difficult problem than was anticipated. This is aggravated by the fact that we have only recently (November) received the results from the resonance tests on the Controls prototype structure. The basic problem is that the measured resonances of the controls structure are considerably lower (40%) than the FEA predicted. Some time has been devoted in re-working the FEA model in an attempt to make the FEA consistent with the measured frequencies. At the time of writing the correlation is improving but as yet does not explain all the discrepancies. Clearly the concern is that if we can get a 40% error on one structure how can we have any confidence that the noise structure will be more reliable? The main focus of out attention is the bolted non-rigid nature of the bolted connections. This is hoped that adequate explanation can be found for these discrepancies. If it cannot we intend to design the best structure we can and then prototype it to have empirical results to move forward with.

10.5.2.3 Wires and Clamps

One of the goals from the last meeting was to conclude on the wire design. Would the noise prototype use drum ended wires? Much work has been done in this area. Most significant is that we have concluded that it is possible to make traditional wire clamps that are sufficiently strong to suspend an advanced LIGO suspension. This means we have two real options. The most significant difference between the two solutions is the question of noise. Noise is a subjective judgement in this case however since the only thing that will ever be sensitive enough to measure this is the working interferometer, which is clearly too late.

Because of this we can only argue in favour of one design or another, and perform experiments to ensure the wires perform adequately in every other respect. Presently it looks as if the traditional design could be considered adequately quiet if the clamped wire is bent around a silica ear after the wire clamp. This would provide a system as quiet as initial LIGO which would be sufficiently quiet one stage removed from the test mass. This suggests that the final decision between drum ended wires and traditional ones will be a purely economical decision. This can be made shortly once the strength and fatigue tests are completed.

10.5.2.4 Suspended components

All the suspended components are progressing well with no unexpected problems and are well on course to be ready for review in February. Many small improvements have been added to the design between the controls and noise stages, enough of the original has been maintained to allow confidence that the performance will not significantly differ from the controls.

10.5.3 Effort usage and estimates for RAL

Usage at RAL had been running slightly higher than BCWP but early estimates suggest that the earned value was still more than that incurred costs. However RJSG noted that the work currently being done on the structure design had not been anticipated in the plan and so was not contributing to earned value.

10.5.4 Goals and concerns for next period

Goals
Decision on use of drum-ended wires
Complete review of interface documents to ensure implications understood
Complete agreement on changes document between controls and noise prototype designs.
List of documents required for the noise prototype pre-procurement review.
Designs complete for hanging masses and structure
Agreed date for pre-procurement review
No major concerns

10.6 Birmingham and Strathclyde

10.6.1 Plans for the coming month

- Kick-off update of OSEM part drawings (using LIGO templates and adhering to the drawing requirements)
    - Held up by sudden retirement of the designer but now planned to carry out in the next two weeks.
- Circulate tech report on alternative (magnetic) flag mount
    - Expected soon on DL's return from leave
- Continue with electronics monitoring channel designs
    - In hand
- Consider OSEM manufacturing options given experience gained with external contractor and in-house production
    - Decided to do some parts in house and the rest outside.
- Continue with fabrication of a quantity of OSEM prototypes
    - Parts all made and in SMA's office.
- Consider OSEM assembly procedure with regards to cleanliness requirements (especially coil-winding)
    - Ongoing.

10.6.2 Progress against schedule

Some tasks, especially on the electronics design, had slipped and were up to three months late. DH to produce a revised Gantt chart.

10.7 OsC draft text: Work package 4 – electrical/electronic design

10.7.1 Goals and concerns reported for previous period

Goals	Status
Sign-off design of OSEM (mechanical parts) and begin manufacturing	Approaching completion
Sign-off design of OSEM electronics and begin manufacturing	Approaching completion
Sign-off design of OSEM electronics and begin manufacturing	Done
Concerns	
No major concerns	

10.7.2 Commentary

The Birmingham and Strathclyde groups have continued the work on the design and testing of the OSEMs, the relevant control electronics and the electronics for the electrostatic actuator (ESD). Miss Deepali Lodhia has joined the group at the University of Birmingham as "post-graduate technologist", providing additional manpower to the work package.

In the area of the OSEM mechanical design and fabrication, the design has been further refined on the basis of the experience gained with the fit and function tests carried out at Birmingham and Caltech based on the one-off prototype built in early Summer 2005. The group has now procured the required oversized taps from a UK supplier, aluminum stock material (6082), approved Macor stock material and carried out the refit of a coil-winding machine for clean room use. The fabrication of the next batch of 6 OSEM prototypes is now complete and awaiting cleaning and assembly before being tested and shipped to the interested parties (both in UK and US). However, at the beginning of January a new quad model analysis was carried out by Peter Fritschel and Ken Strain: the outcome strongly suggests the need for stronger actuators at the Upper Intermediate Mass (UIM). The group is therefore considering a modification of the coilformer in order to accommodate a larger coil, which in turn might delay by a month the shipment of the prototype OSEMs. The group has also continued to carry out the qualification of the necessary materials: Micro-D connectors and sensor devices have been qualified; test pieces of flexi-circuits (the only outstanding item) have been procured and forwarded to Caltech for vacuum qualification. Tests are currently ongoing, and so far there is no cause for concern. In addition a quantity of the LIGO 'large' magnets (10mm dia. x 10mm and 10mm dia. x 5mm) and of vac-seal have been procured. Work related to the OSEM mechanical design has also involved tests of the flag, in consultation with RAL. Alternative geometries have been considered as well as tests on the original vac-seal bonded assembly. In summary, although the PDR (July 12th, 2005) is not yet formally completed for the OSEM mechanical design, the last remaining issues are being worked out and it is hoped that the process will be formally concluded by the end of February.

On the electronics front, the remaining open issues regarding the requirements raised at the PDR (held on July 12th, 2005) have been closed. For the OSEM electronics, work is well underway for the design, fabrication and assembly of the prototype electronics boards for testing. A dedicated "Electronics Meeting" was held at Birmingham on 3rd-6th October 2005 with the participation of Jay Heefner (Caltech) to discuss electronics, monitoring and automated test equipment (this meeting involved detailed discussion of the ESD electronics

as well). The US has confirmed the OSEM pin-out, to ensure the compatibility between controls and noise prototype units as well as existing global control OSEMs. The flexi-circuit has been reworked to accommodate the latest OSEM geometry and the updated piu-out specification. Flexi-circuit parts have been procured for the next batch of OSEM prototypes.

The work on the ESD electronics design and fabrication is progressing well at Strathclyde. Following the PDR, a lengthy and fruitful discussion took place between the UK and US to tackle the open issues, all of which have now been resolved. In particular it was eventually decided, as originally suggested by Strathclyde, to adopt active water cooling, instead of passive cooling, whose design and manufacture was shown to be cumbersome and expensive. The new design has the advantage of using off-the-shelf EMC compliant enclosures and guarantees the appropriate level of cooling, which had been a source of concern for the project. The discussion has also involved the number of channels to be included which has changed since the original proposal: this item has also been agreed. The final design for the noise prototype and fabrication of the ESD electronics are now well underway and includes (at the request of the US) differential monitor outputs, sequenced power rails at power-up, sequence power rails (orderly switch-off) at power down (or on failure), power down on IC over-temperature event, and water flow monitors for the active cooling.

Manufacturing studies and re-costing have been carried out for all the three areas of the work-package: they are complete or very nearly completion for the OSEM mechanical parts and the ESD electronics, whereas for the OSEM drive electronics we plan to finalize them by the end of February.

10.7.3 Goals and concerns for next period

Goals
Fabrication and testing of 156 OSEMs (mechanical parts) noise prototype
Fabrication and testing of OSEM drive electronics for the noise prototype
Fabrication and testing of ESD electronics for noise prototype
No major concerns

11 Visits etc and absences planned for the coming months

	Jan	Feb	Mar
General		PAG Feb 3	LSC w/b Mar 20 OsC Mar 6
RJSG			LSC
AV			LSC
CAC			LSC
RAJ			?LSC
KAS	Last week in Germany	2nd half month in Germany	?LSC

TMH		A/L Feb 11 to Mar 5	LSC
IW			LSC
SMA	Last week training		LSC

12 AOB

None.

13 Summary of actions

13.1 Complete or superseded by events:

ACTION 24.03 RJSG to modify the risk register as described in the relevant slide of the OsC presentation. Drafted; needed further discussion with KAS and PAG.

ACTION 25.01 RJSG to check with Dennis Coyne what implications there might be for UK work (of the recent changes to the vacuum cleaning spec). this was being taken up as part of an ongoing discussion between Coyne and TMH about vacuum cleaning for the structure.

ACTION 25.02 RJSG to contact Dennis Coyne re the UK response to the ICDs M050438. Done.

ACTION 25.03 RJSG to encourage Mark Barton to publish the updated toolkit with the extra effects once they were finalised. Done.

13.2 Outstanding

ACTION 25.04 RJSG to contact Linda Turner to ask her to re-publicise any "M" documents that had been made hidden unnecessarily. Not done.

ACTION 25.05 Ian Wilmut to contact Dennis Coyne once the paper on flag mount design was published, and advertise our intention to use the magnetic-bonding design as suggested by the paper. Not yet done; awaiting DL's technical note. See ACTION 26.01

13.3 New

ACTION 26.01 SMA to chase DL for publication of the tech report on flag tests.
ACTION 26.02 SMA to take up the OSEM failures with the US side and establish a strategy to demonstrate that the Birmingham OSEMs would not be subject to similar problems.
ACTION 26.03 CAC to discuss with JHR the significance of SUS PDR 6 for the Glasgow ribbon work.
ACTION 26.04 KAS, SMA and DH to discuss the implications for Birmingham of the new requirement to increase the OSEM force. The agreed to meet by telephone on Wednesday 18th Jan at 4pm.
ACTION 26.05 CAC to email Phil and Geppo to remind them of the need to liaise on tapers.
ACTION 26.06 CAC to provide text for the PDR delay document.
ACTION 26.07 AV to provide text for the PDR delay document.

ACTION 26.08 RJSG to set up a meeting to discuss best way forward with Coyne, KAS, Wilkinson.
ACTION 26.09 RJSG to contact Shiela Rowan to seek her agreement for the deployment of Iain Martin in this role.
ACTION 26.10 RJSG to send updated RAL schedule to CAC
ACTION 26.11 CAC to produce an updated schedule.

14 Next meetings

Friday 10th March

Justin Greenhalgh with progress reports from the other authors.
14 Jan 2005