Laser Interferometer Gravitational Wave Observatory (LIGO) Project

Advanced LIGO

Technical Memorandum	LIGO-T010081-00-D
To:	LIGO-2 Systems Group
Author:	Dennis Coyne
Date:	7/13/2001
Title:	**Minutes: Advanced LIGO Systems Meeting (7/13/2001)**

Attendess: GariLynn Billingsley, Jordan Camp, Dennis Coyne, Peter Fritschel, Jim Hough, Peter King, Norna Robertson, Janeen Romie, Ken Strain, Dave Tanner, Calum Torrie, Hiro Yamamoto

1. Suspension Design Issues

Peter F. discussed a number of open suspension system issues:

1. Should all of the suspension modes be sensed?
2. Should we have the capability to excite all of the suspension modes?
3. Do we need the capability for active damping control even if passive (eddy current) damping can achieve the Detection Mode requirements? e.g. in Alignment Mode in air do we need an augmented active damping capability?
4. Should the MC optics be made smaller than the current baseline of 20 cm diameter x 7 kg (a 3 kg mass is adequate to reduce the radiation pressure to acceptable limits)?
5. Given that the local and global actuators are separated in advanced LIGO (unlike initial LIGO), should the electronics for global actuation be subsumed into the ISC subsystem?

It may be physically difficult to incorporate all of the sensing and actuation that (1) and (2) above require in addition to addy current dampers; Might be able to be clever in packaging to reduce physical size of the sensing & coil actuation elements. Due to the inherent cross-coupling of the eddy current dampers, it may be that one does not need one per axis.

Suspension sensor noise to date is ~10^{-10} m/rHz at 10 Hz, which is ~10 x greater than the expected residual motion of the SEI platform. Do we need better sensors, or can we just lightly damp (low gain) in the active damping control? SEI residual rms is expected to be ~100 nm (~1/10 of the microseism). We should use LIGO-1 and GEO (pending) experience in locking the arm cavities, plus modeling, to determine the maximum residual test mass velocity required for locking and the required actuator force to accomplish this level.

Historically the mode cleaner mirrors were chosen to be 20 cm diameter by 7 kg to be identical to the recycling mirrors, at a epoch in the design when the test masses were 30 kg. We have since baselined 40 kg test masses and the recycling mirrors are now 26.5 cm diameter. To reduce the radiation pressure to acceptable limits (consistent with the PSL intensity noise requirements in the systems requirements document, T010075) we only need ~3 kg MC optics. Norna suggests that the GIF (?) suspensions for GEO, which use a 5 in diameter x 4 in thick, 3 kg optic, may be readily adapted for the advanced LIGO mode cleaner suspension (requires transmission at 45 deg); Norna will pursue this further.

On the issue of suspension global control electronics being moved from suspension subsystem scope to ISC subsystem scope, there was no discussion; The thought was simply raised to the group.
Post meeting note by Dennis: This issue will be discussed and resolved by LIGO management.

2. Quad Pendulum Prototype

Norna gave a status report on the quadruple pendulum prototype work currently in progress at the MIT LIGO lab. Calum, Norna, Janeen, Ken etc. have been assembling the quad prototype adjacent to the old PNI vacuum chamber into which it will be craned when completed. They had a triple until this morning, when adding the 4th mass caused a wire failure at the clamp to the top mass, for reasons yet unknown. A number of small modifications have been made (e.g. stiffening the aluminum supports for the blade flexures). Progress is good.

3. Core Optics/Sapphire Status

GariLynn's polishing status report:

1. Will receive an a-axis sapphire piece by the end of July for inhomogeneity testing
2. Will measure inhomogeneity in another c-axis piece (from Shiela) soon. Have never seen striations in the optical inhomogeniety to date for c-axis pieces.
3. Goodrich has measured the wear rate for m-axis. They will provide a quote for the compensating polish for our large sapphire piece in a week or two. Schedule for it's completion is unknown as yet.
4. CSIRO has started their compensating techniques – nothing to report as yet.
5. VIRGO/SMA has the transmission phase map and is considering what they can do with a compensating coating

Jordan's status report:

1. Crystal Systems is commissioning a new annealing oven which will allow a higher temperature (1800-1900C) in the hope of further reducing bulk absorption
2. SIOM is building a large furnace for boule sizes to support 40 kg test masses. They expect to provide 40 kg, m-axis samples by ~6/02. SIOM can't grow large c-axis pieces.
3. SIOM will also send some YAG samples for thermophysical property and absorption measurement. YAG is unlikely to be attractive due to poorer thermophysical properties.

4. Recap of recent Gingin facility technical review committee discussion

Jordan conducted the first Gingin review committee meeting this week. The Australians have proposed using their Gingin facility for high power testing in support of advanced LIGO. (BTW a request for a copy of their proposal(s) has been made and will be made available when received.) The principal focus would be:

1. test IO components
2. locking at high power
3. servo stability at high power
4. thermal deformation at high power
5. check Melody against experimental results
6. demonstrate the active thermal compensation system

LIGO has committed to providing two 15 cm diameter x 8 cm thick sapphire optics (with 50-80 ppm/cm absorption and without an inhomogeneity compensating polish) for an arm cavity, one recycling mirror and 3 mode cleaner mirrors. If the defintion of these optics is given soon, then LIGO can deliver the optics to Gingin in 3Q02

A high power (~200 W) laser is expected from Adelaide by early 2003.

The suggestion was made to concentrate the initial noise studies on spatial optical effects and defer temporal noise studies to later in the development when the interferometer has had significant commissioning time. Also start with 1 cavity first and then add a second cavity for serious differential noise studies. The suggestion was made to make the cavities as long as the facility will support (80m) as opposed to starting with short arms in the central vertex area.

An more detailed experiment plan is needed, with Melody runs to support the design. This will be pursued in the coming weeks with assistance from LIGO. In particular the notion of testing a scaled version of the active thermal compensation system has not been fleshed out and coordinated with Mike Zucker as yet.