Suspensions/Isolation Working Group

LSC 13 August 98
David Shoemaker

Hanford LSC (March 98)

- volunteers to organize white paper: Gonzalez, Hough, Giaime, How, Johnson, Saulson, Shoemaker

Gatherings/activities since

- Perugia: Thermal Noise and low-frequency noise sources (June 98)
- LISA Symposium, Caltech (July 98)
- monthly phone calls with group above (and honorary member Eric Gustafson)

Common activities focussed around LIGO interferometer evolution

- '2004' LIGO II advanced subsystems (principal focus)
  - multiple pendulum suspension
  - moderate improvements in Q
  - associated control changes (e.g., external active system)
- Advanced LIGO
  - large masses, high Qs, low F seismic isolation
  - too early for conceptual designs
  - 'what is crossover frequency with gravity gradient limit?'

White paper

Sources and design guides or 'metrics'

- work with Sam Finn and his program to calculate Binary seeing distance vs. interferometer parameters
- further discussions, esp. with Kip Thorne; more later today
- difficult to make near-term solutions (2004) which see binaries often
- difficulty is clearly in thermal noise

Baseline for LIGO II

- LIGO I stacks to remain substantially in place
- fused silica best choice of materials
- test masses to stay roughly LIGO I size (25 cm dia, 11 kg)
- new substrates by necessity; provides opportunity for optics changes
- new system to be installed in 2004 after significant engineering testing

Strawman for LIGO II

- multiple pendulum at test mass; probably triple (to give needed vertical isolation)
- all fused-silica construction (test mass, fibers, connections) for bottom pendulum
- enough stiffness (4 fibers) to allow all quasi-static positioning/angles to be adjusted from previous pendulum stages
- an absolute minimum of actuation on the test mass (with hopes for zero), and certainly no magnets
- a pre-isolation system to reduce control-band noise before it gets to the stack (using independent sensors and feedback/forward)

Design process/parts

Top level requirements

- like the Science Requirements Document (SRD) Curve for LIGO I

Internal Requirements

- flow-down to Qs, isolation, control authority, etc.

Configuration/trade studies

- how many pendulums?
- what lengths?
- what kinds of actuators?

Controls research

- how to distribute the control authority

Thermal noise/excess noise research

- how to realize the potential of fused silica

Isolation design

- how to realize required vertical and horizontal GW-band isolation

System tests

- tests at LIGO-like sensitivity levels of performance
- tests for interfaces, installation
- no more than what is needed

Timeline, distribution of effort, groups/people

At this meeting

Integrate science and realities gathered at Workshop

- activities/groups neglected?
- new insights which change focus?

Deal with any redundancies/holes in research program

- discuss tasks one by one
  - > are they necessary? how do they fit into the overall plan?
  - > do we have the right (collaborative) effort applied?
- say no to repeated tasks, look for donors for uncovered ones
- check balance/focus of LIGO II vs LIGO III
  - > are we working on solutions with long lifetimes?
  - > are we preparing long-lead technologies?

Leave with a white paper draft ready for sharing with wide audience

- final draft of subsection for Sept 1