Suspensions/Isolation Working Group

LSC 4 March 99
David Shoemaker

JILA LSC (August 98) and shortly thereafter

- grueling coordination sessions
- white paper iterated, completed

Common activities focussed around LIGO interferometer evolution

- '2004' LIGO II advanced subsystems (principal focus)
  - baseline of LIGO I isolation system (with possible modifications)
  - multiple pendulum suspension
  - fused silica fibers/attachments
  - moderate improvements in Q
  - little/no actuation on test mass
  - associated control changes (e.g., external active system)
- Advanced LIGO
  - large masses, high Qs, low F seismic isolation
  - possibly cryogenics
  - 'what is crossover frequency with gravity gradient limit?'

Research plan and practice

Top-level requirements

- White paper sensitivity curve
- at present, an ‘ad-hoc’ approach coordinated by group leaders

Internal requirements

- flow-down to Qs, isolation, control authority, etc.
- fundamental noise sources ‘flowed-up’ to obtain white paper curve
- rough, rough draft exists; will work on this at this meeting

Configuration/trade studies

- how many pendulums? what lengths? what kinds of actuators?
- GEO/Stanford looking from experience and in the abstract

Controls research

- how to distribute the control authority
- Advanced feedforward and feedback control design for active isolation systems (Stanford)
- practical tests (GEO), exploration of sensors actuators (LIGO/MIT, Stanford, Syracuse)
- 6DOF active interferometer control platform (Stanford)

Research plan and practice

Thermal noise/excess noise research:

Fused Silica Q measurements (Syracuse)

- very high Qs seen in thin (3-6 mm) slabs (2e7) of fused silica
- monotonic decrease in Q for thinner pieces
- various surface treatments do not improve Q
- anelastic release: measurements at 3e-7 loss level
- design of experiment to measure coating losses (thin coated slab)

Sapphire Q measurements (LIGO/CIT)

- large mass has Qs 5e6-2e7
- improved polish around circumference may be needed

YAG Q measurements (Stanford)

- 2e7 Q values measured on first-try sample

Direct measurement of thermal noise (LIGO/CIT)

- vacuum, laser, mode cleaner all set up individually
- all optics are in hand and work underway on test mass suspensions

Research plan and practice

Isolation/suspension design:

Fiber pulling (LIGO/CIT)

- fiber pulling lathe received; new lab set up and installtion of lathe underway

Long-period vertical isolation (LIGO/CIT)

- design of balanced-force vertical isolation stages (VIRGO-like)
- tests on two elements show good agreement of ω_0 with model

Suspensions (PSU)

- penultimate stage of LIGO II suspension built up
- wires, magnets; ‘shakers’ for excitation

Suspensions (GEO)

- construction of GEO fused silica suspensions
- work on fiber attachment means
- additional large-mass suspension in fab for test at LIGO/MIT

Suspensions (Stanford)

- Second generation of the 5-wire suspension being fabricated

Cryogenic suspensions (LSU)

- design/construction of test of cryogenic wire violin and pendulum Q

Research plan and practice

System tests

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

LIGO Advanced System Test Interferometer (LIGO/MIT)

- vacuum system installed and accepted
- seismic isolation components in fabrication

Engineering Test Facility (Stanford)

- clean rooms set up
- vacuum system nearing completion of fabrication
- ETF design completed

GEO 600 (GEO)

- first article suspension successfully tested

Characterization of LIGO I

- many involved in tests on first HAM stack at Hanford
- transfer functions characterized, good agreement with models

At this meeting

Review of technical progress (Friday morning)

- David Shoemaker: assessment of our white paper plan
- Peter Saulson: materials losses update
- Sheila Rowan: YAG as a test mass material
- Geppo Cagnoli: recent fiber work in GEO
- Virginio Sannibale/Riccardo DeSalvo: isolation element development
- Joe Giaime: update on LIGO Advanced System Test Ifo
- Brian Lantz: Stanford Engineering Test Facility
- Jon How/Jim Hough: configurations

Requirements (Friday afternoon)

- Gabriela Gonzalez: detailed working session to hammer out parameters and values
- from top-down (requirements) and bottom-up (fundamental and technical limits)

Plan Design summit for LIGO II isolation/suspension system

- planned for late Early May, MIT
- ~3 days to attach requirements to conceptual design