LIGO ADVANCED SYSTEMS TEST INTERFEROMETER (LASTI)

LASTI Progress and Plans

LSC Meeting, LLO

Dave Ottaway/Richard Mittleman

March 2007

LIGO-G070184-00-Z

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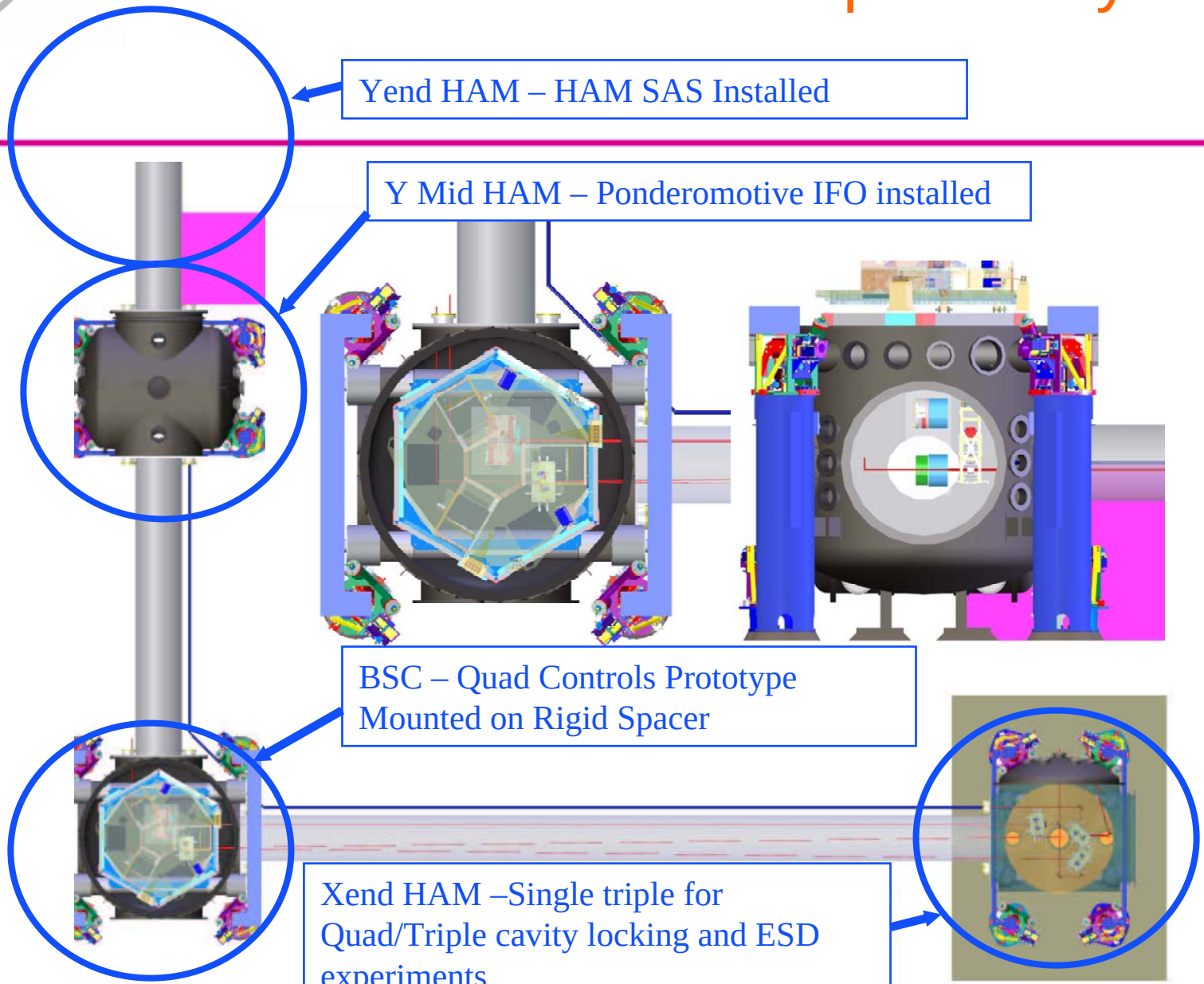
Talk Overview

1. LASTI Introduction
2. Status of Current Experiments
3. Proposed Experimental Plan for the next two years
4. Conclusions

LASTI Detailed Optical Layout



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Other Relevant LASTI LSC Talks

- Wednesday 3:40 -3:55pm Nergis, Squeezing (AIC)
- Thursday 11:30-11:45 Justin Greenhalgh, SUS Noise Prototype Update
- Thursday 11:45-12:00 S. Penn/G. Harry, Initial and Enhanced LIGO suspension thermal noise
- Thursday 12:00-12:15 Rich Mittleman, LASTI BSC prototype update
- Thursday 12:15-12:30 Riccardo DeSalvo, HAM SAS update

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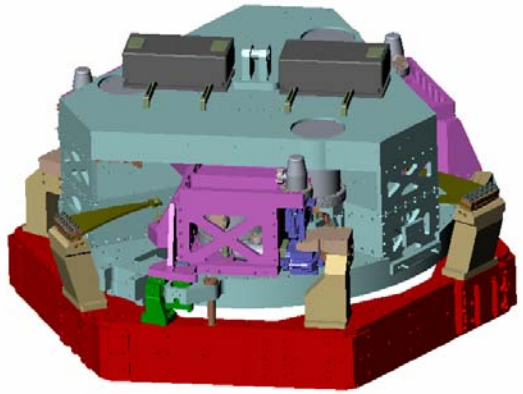
General LASTI Update

- Coming to the end of a three month long vent to install major updates to HAM SAS, Ponderomotive Experiment and Quad/ Triple cavity experiment
- Expected to be under vacuum within a week
- Significant effort now required to prepare for the clean ISI and Quad Noise prototype

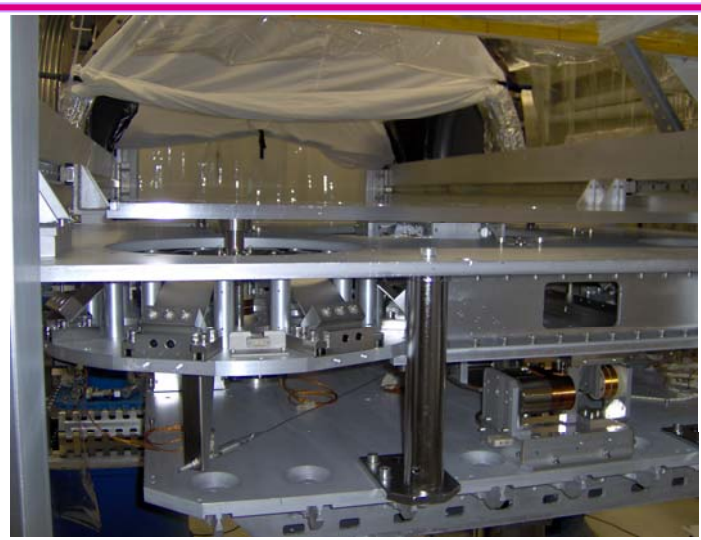
ISI Testing at Lasti

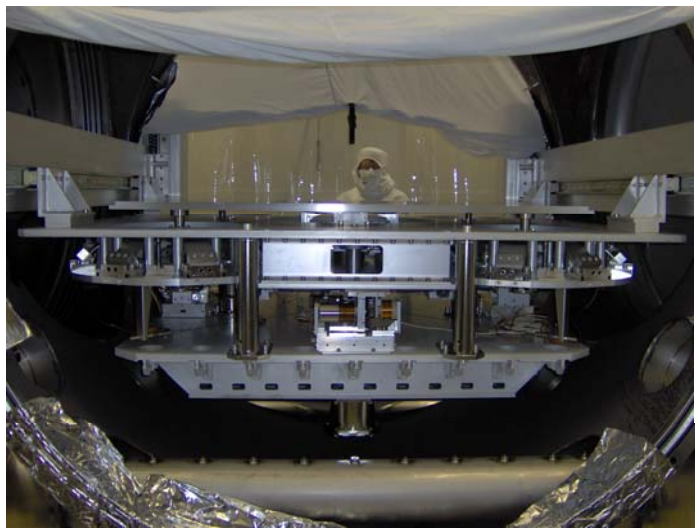
- The Assembly went reasonably smoothly
- The were some tooling issues that are being worked on
- There were a few minor issues
  - A few hard to reach screws
  - One bad set of holes
- The were some tooling issues that are being worked on
- One major issue, the stage 1-2 Actuators were at the wrong height. There has been a redesign of the bracketry and this should be fixed
- The system is currently being disassembled and being shipped out for cleaning



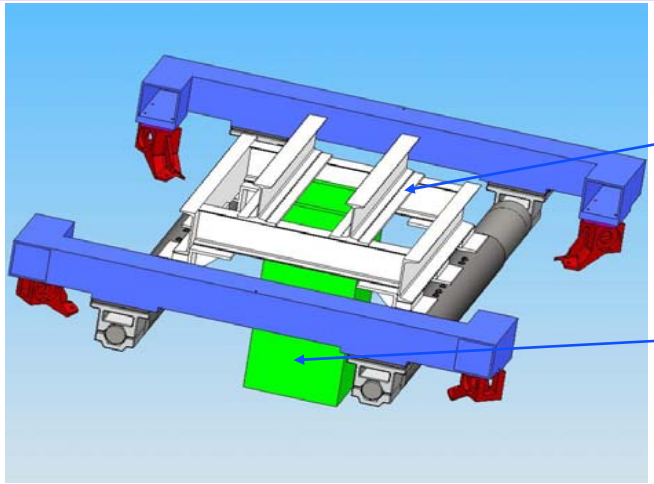
HAM SAS

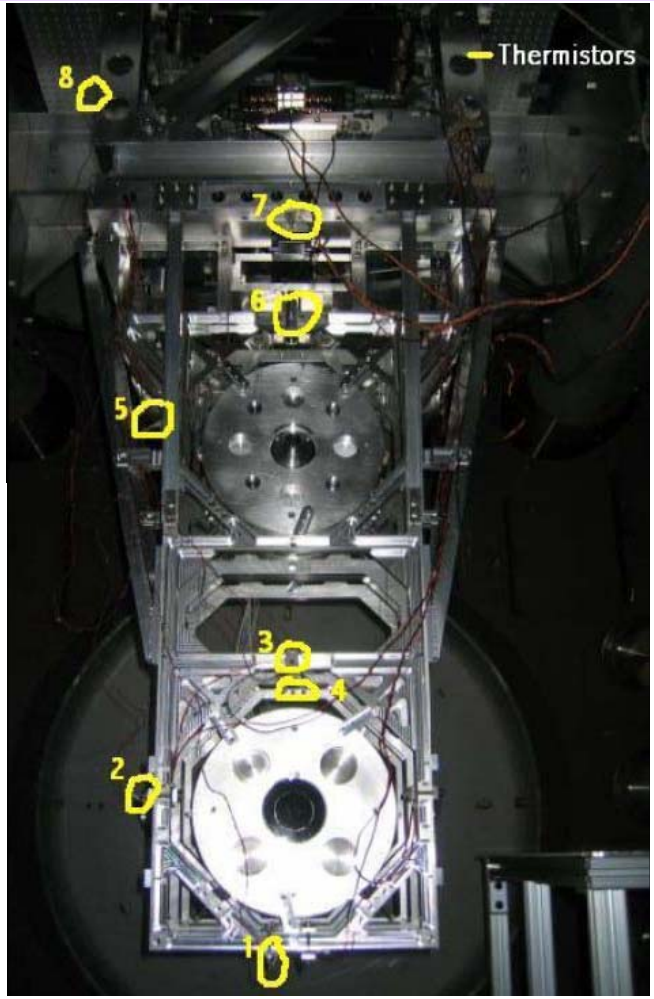
- HAM SAS successfully installed in LASTI Yend
  - » Included coarsely aligned triple – not released from stops
- Achieved low frequency modes
  - » Vertical 190 (Bounce), 136 and 239 mHz
  - » Reduced bounce to 30 mHz with EM neg spring
  - » Horizontal modes are 39, 54 and 74 mHz
- Control
  - » Implemented DC control and damping in both modal and local basis
- Isolation Performance
  - » Not yet measured
  - » Excess noise observed – suspect air currents
  - » Need vacuum to remove (Should be available this week)





Quad Suspensions Controls Prototype





- All original test plan items finished
  - » Fit test, structure frequencies, active damping, eddy current damping, sys-id
  - » Sys-id proved some pitch frequencies do not match. Likely due to wire break-off positions. Verification in progress.
  - » Moment of Inertia Updates
- Additional tests
  - » Thermal loading – Complete
    - – Affect of thermal loading smaller than predicted
    - – 20 W predicted to increase temperature by 26C. Test measured 12.5C

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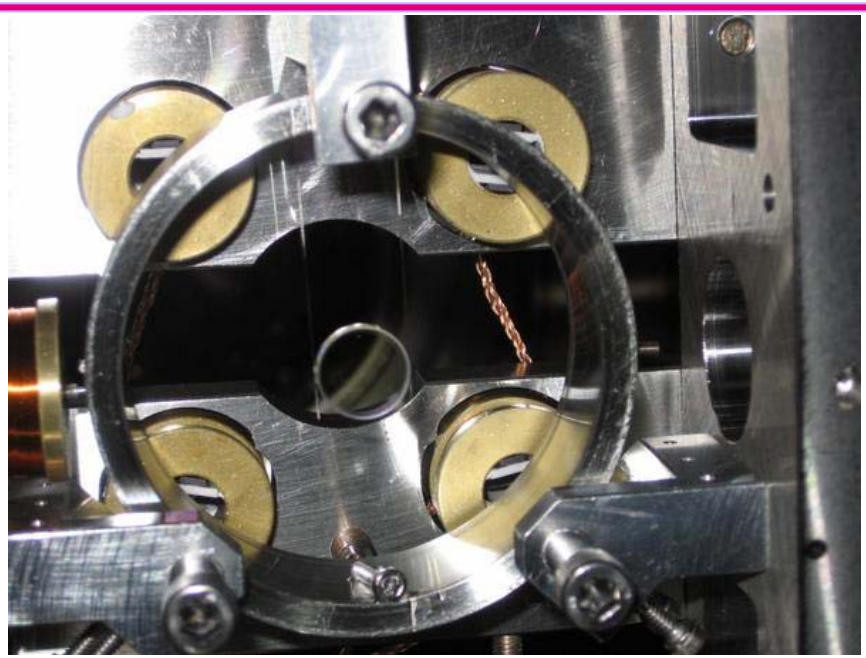
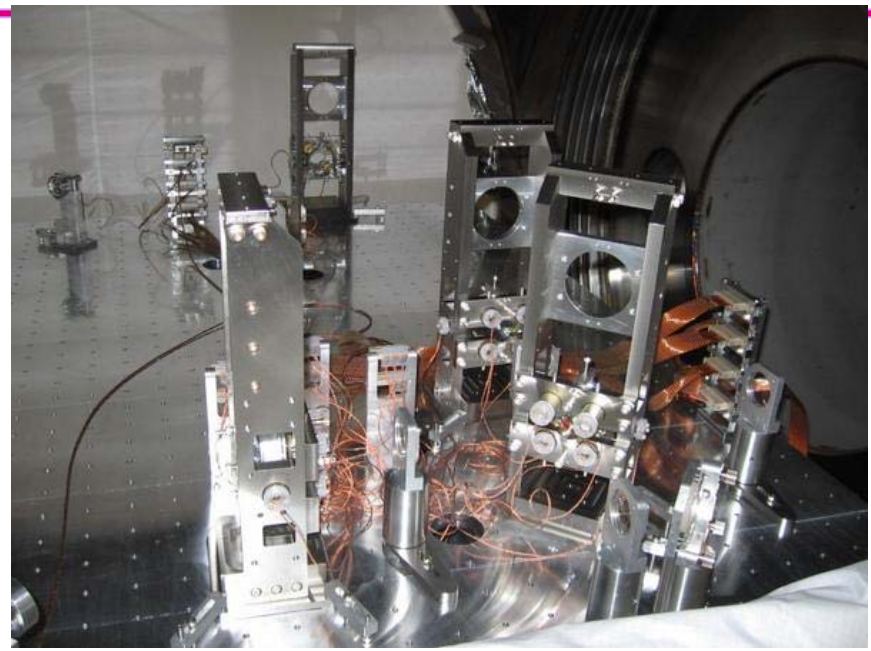
Ponderomotive Squeezing

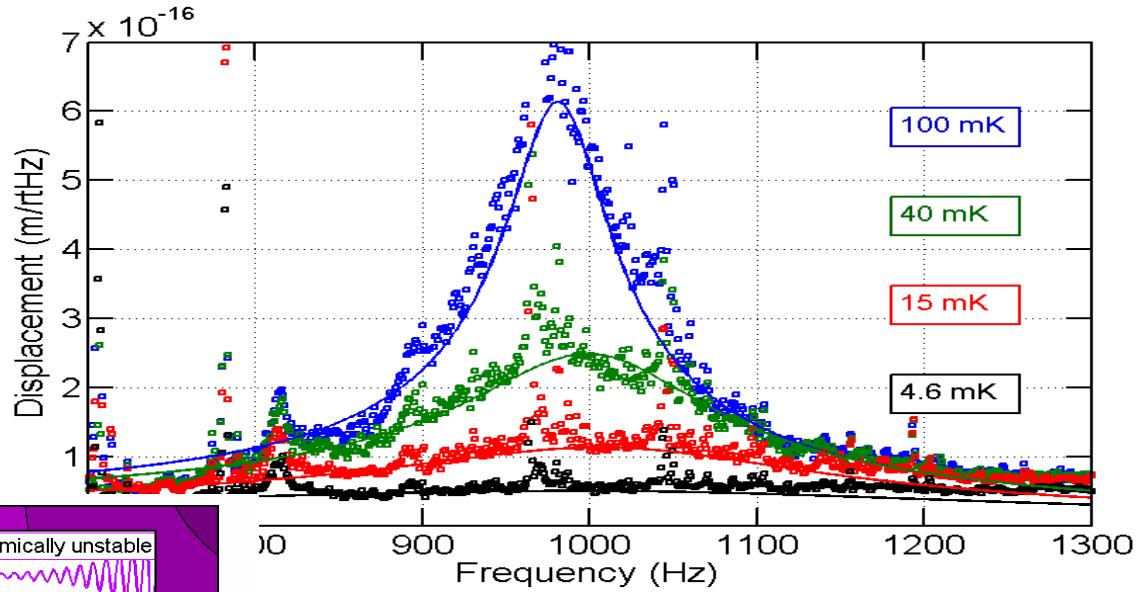


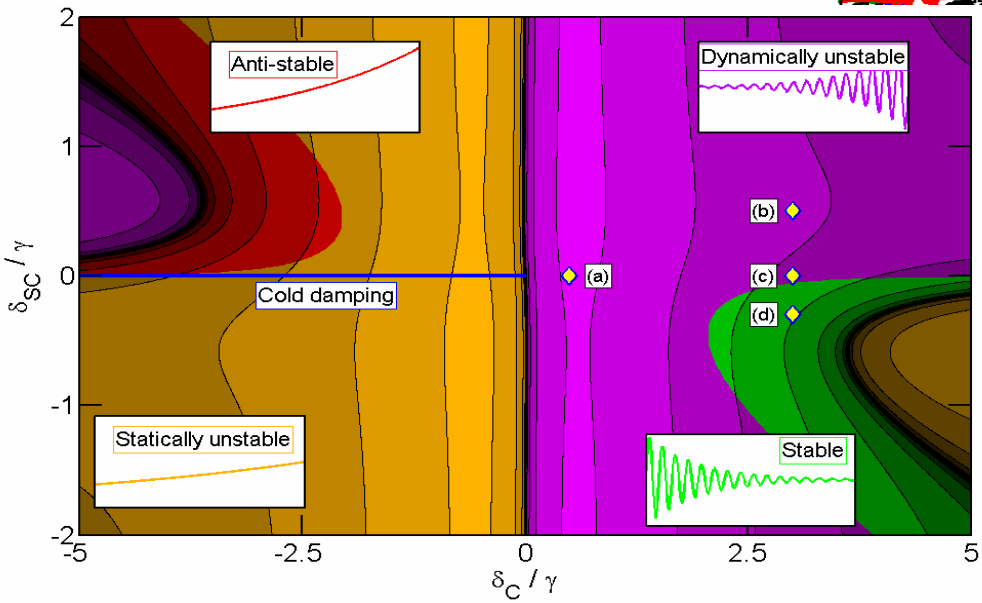


- Demonstrated optical trapping using double optical spring
- Demonstrated 5 mK cooling
- Installed new Michelson Interferometer with Fabry-Perot arms and 1g suspended end mirrors

Neat Results

Cooling vs Power





Trapping Phase space Diagram

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Short Term Plans

- Quad Triple Cavity
  - » All in-vacuum components installed
  - » Matched Cavity with 99% reflectivity mirrors
  - » Cavity Length = 16m Quad Mirror flat, Triple Mirror ROC = 20m
  - » Planned to test non-linear quad lock acquisition and ESD strength
- ISI
  - » Currently being de-assembled for cleaning
  - » Clean assembly to start in 8 weeks
- Noise Prototype
  - » Parts begin arriving at the end of April
  - » Attached to the ISI in late summer – Full system integration begins
  - » Metal wires used first with monolithic suspension built up in parallel

LASTI Old Plan

- Develop & test EPI for LLO seismic remediation (Completed)
- Qualification test of early pre-prototype triple pendulum (Completed)
- Integrate/test active HAM SEI pathfinder (Delayed)
- Integrate/test active BSC SEI pathfinder (Underway)
- Integrate/test Quad and Triple suspensions (Due to start)
- ~~Integrate/test sapphire & fused silica core optics (Sapphire deleted)~~
- ~~Qualify for low displacement noise with sensitive interferometer system~~
- Integrate and test full scale adaptive thermal compensation
- ~~Integrate/test AdLIGO 180 Watt PSL & Mode Cleaner~~

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Planned New Program for LASTI

- Complete characterization of noise prototype TM mechanical modes
- Testing of damping of mechanical modes using ES drive and others
- Testing of active violin mode active damping strategies
- Non –Gaussian noise in violin mode studies – bond studies
- Complete end to end test of Adv LIGO TCS system including SEI/SUS thermal interactions
- Installation and Test of a HAM Single Stage Seismic Isolation Platform
- Installation and Test of a Recycling Mirror Triple Suspension
- More rigorous quad lock acquisitions studies
- BSC ISI Loading Experiments
- Beta Testing of CDS Advanced LIGO Controls Infrastructure

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Effects on Subsystems

Sub System	Effect	Comment
SEI	Positive	More time to fully characterize the seismic platform without artificially loading it
SUS	Neutral Positive	Will not test the mode cleaner noise prototype but will test the recycling mirror prototype
AOS	Extremely Positive	Full end to end test of the TCS system
PSL	Negative	Test of 180 Watt laser will not occur at LASTI. The one benefit is that the 180 Watt laser will spend more time at Caltech where the US head of PSL (Peter King) resides
IO	Negative	Full test of modecleaner removed from scope plus test of mode cleaner noise prototype suspension delayed until 2009
CDS	Positive	A greater range of CDS deliverables are tested
COC	Neutral	Different COC optics are tested
SYS	Positive	More time dedicated to lock acquisition studies and parametric instability mitigation.

Conclusions
Where we are now

- 3 New Experimental Systems have been installed
  - HAM SAS
  - Ponderomotive IFO
  - Quad Triple Cavity Test Bed
- The Internal Seismic Isolation (ISI) “dirty” assembly tests have been completed
- Quad Noise Prototype assembly due to start at the end of April
- A new plan for the next 2 years has been presented