

LIGO ADVANCED SYSTEMS TEST INTERFEROMETER (LASTI)

Program Update:

LSC Meeting, LLO

Dave Ottaway for the LASTI team

March 2006

LIGO-G060183-00-Z

Talk Overview

1. Review of LASTI goals
2. Progress since March 05
3. Proposed Experiments for the next year
4. Conclusions

LASTI Mission

- Test LIGO components & systems at **full mechanical scale**
- Practice installation & commissioning
- Minimize delays & downtime for advanced LIGO upgrades
- Qualify design modifications & retrofits for initial *LIGO*

Specific Advanced LIGO Program Tasks ('05 - '09+):

- Qualify advanced isolation & suspension systems and associated controls at full scale
- Develop detailed SEI/SUS installation & commissioning handbook
- Look for unforeseen interactions & excess displacement noise
- Test PSL and Input Mode Cleaner together at full power

LASTI People

Resident MIT Staff

- **Students** - Laurent Ruet (PhD student at INSA), Thomas Corbitt, Brett Shapiro
- **Engineering** - Myron MacInnis, Ken Mason
- **Scientists** - Gregg Harry, Rich Mittleman, Dave Ottaway, David Shoemaker, Pradeep Sarin, Mike Zucker (Advice), Fabrice Matichard (Visiting Postdoc from INSA)
- **Computers** – Keith Bayer

Laboratory and LSC Visitors (Recent and Immediate Future)

- **PSL Upgrades** – David Hosken, Rupal Amin, Joe Giamme

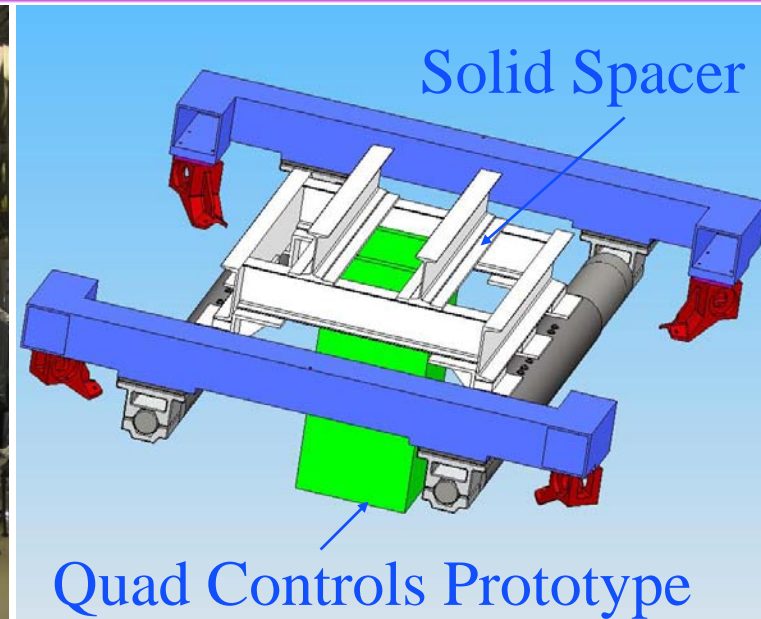
Laboratory and LSC Visitors (cont.)

- **Advanced SEI** - Joe Giaime, Brian Lantz, Brian O'Reilly, Riccardo Desalvo
- **Advanced SUS** - Norna Robertson, Calum Torrie, Janeen Romie, Phil Willems, Justin Greenhalgh, Ken Strain, Caroline Cantley, Mark Barton...
- **CDS/DAQ** - Jay Heefner, Rich Abbott, Rolf Bork and Mohanna

Since the Last Review

- Infrastructure (MacInnes, Mason)
 - » Test stand with new cleanroom installed
 - » Granite Table Installed
- Double Triple Experiment Started (Ruet, MacInnes, Mittlemann , Ottaway and the SUS Group)
- Radiation Pressure Investigations (Corbitt, Ottaway, Mavalvala, Innerhoffer)
- PSL Power Scaling Experiments Started (Hosken, Ottaway, Giaime, Amin)
- Controls Prototype Installed (MacInnes, Mason Mittlemann, Shapiro, SUS Group)
- Advanced LIGO Seismic Assembly Started (Mason, MacInnes, SEI Group)
- Ongoing Seismic Characterization and novel control (Mittlemann, Shapiro and Ruet)

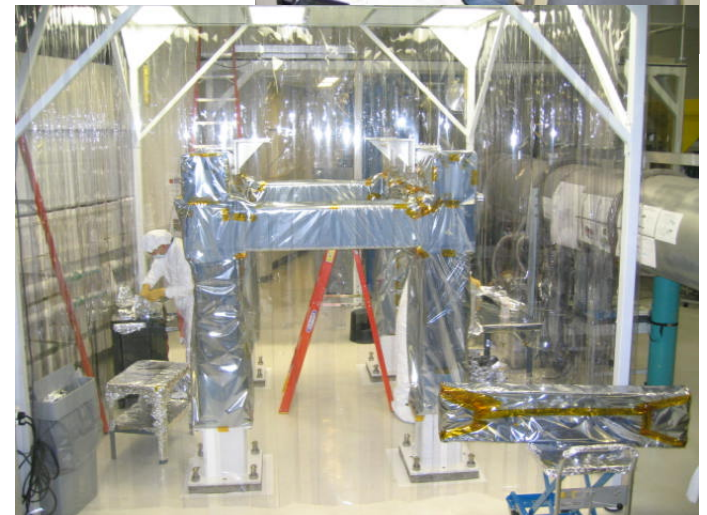
Quad Suspensions Controls Prototype



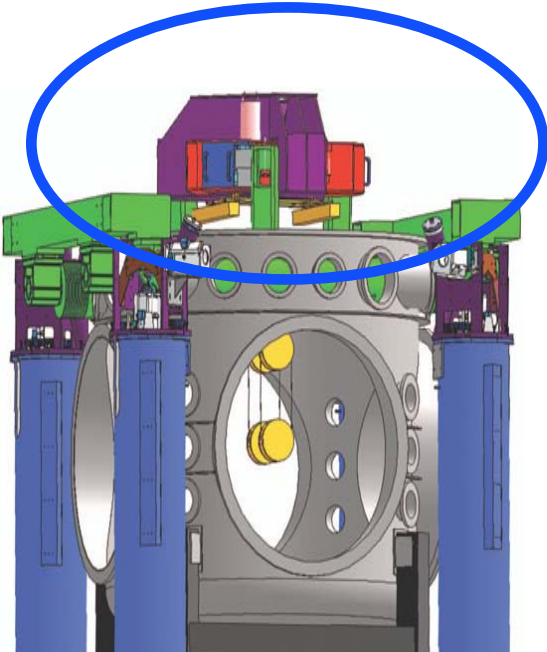
- Quad Controls Prototype Mounted on Test Stand
- Initial Characterization Underway
 - TS much stiffer than Caltech Platform
 - Currently working on local damping
- Installation in BSC Chamber by April 2nd

LASTI Infrastructure

- New Cleanroom installed for Quad and Seismic Isolation system assembly
- Test Stand Installed and very well leveled to Seismic requirements
- Plagued by temperature control problems in high bay
 - » Causing problems with Controls Quad and PSL systems
- CDS infrastructure being developed
 - » New racks hardwired into the facility
 - » Plans for PCI based control being developed (Jay, Rolf, Rich A and Mohanna)
- Granite table installed for Seismic Assembly



BSC Seismic Isolation System

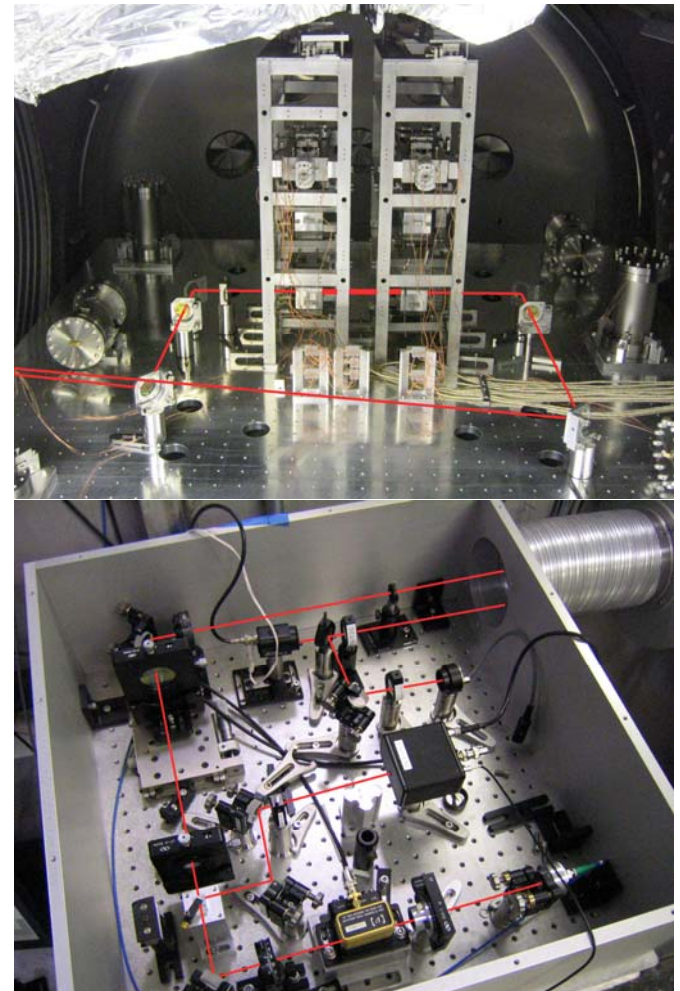


- All parts have been ordered
- Significant number of parts are starting to arrive
- Initial Installation on granite slab
- Significant driver for the speedy installation of the Quad into the LASTI Vacuum System (Need test stand for combined assembly)

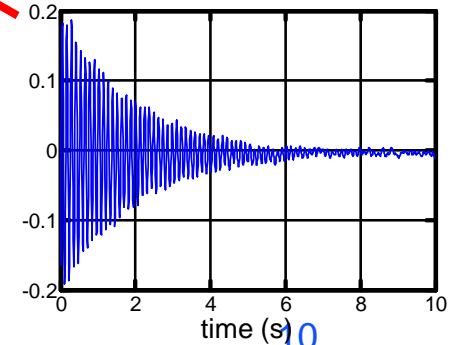
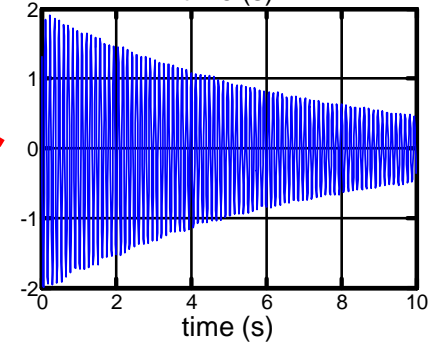
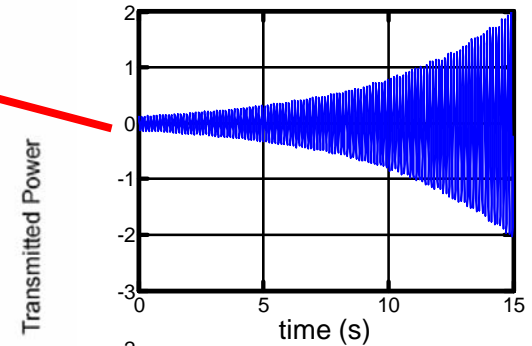
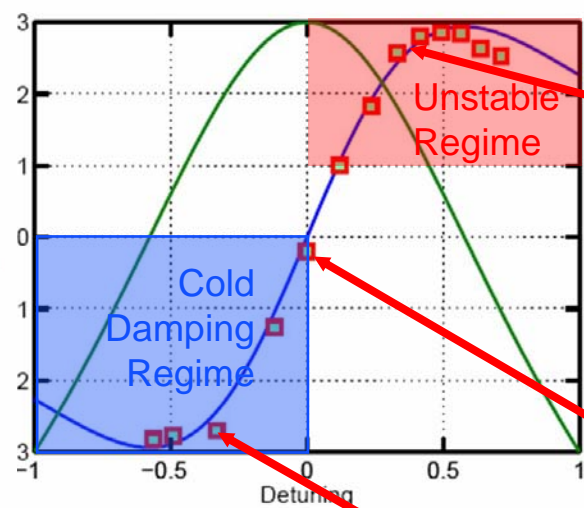
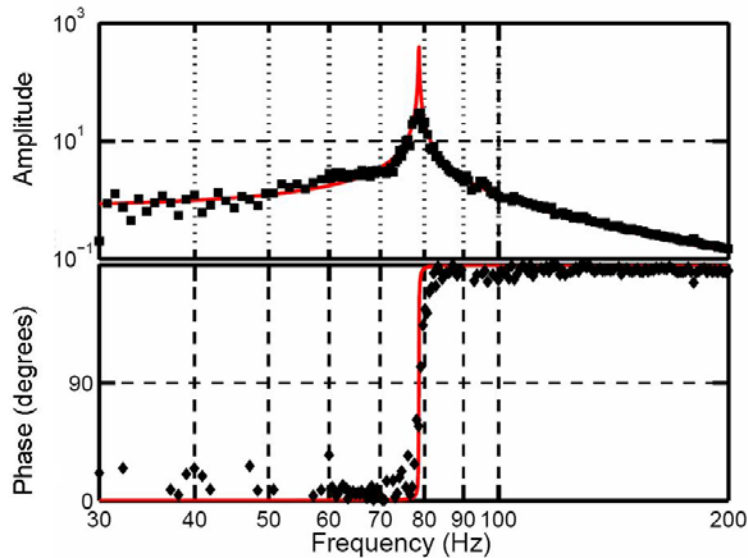


Double Triple Experiment

- Aims:
 - » Test sensor noise immunity of predictive modal methods
 - » Test viability of fiber coupled PSL source
- Status
 - » Fiber installed
 - » Pier top table installed
 - » Second triple installed
 - » Cavity between test masses locked
- Result
 - » Noise hunt underway



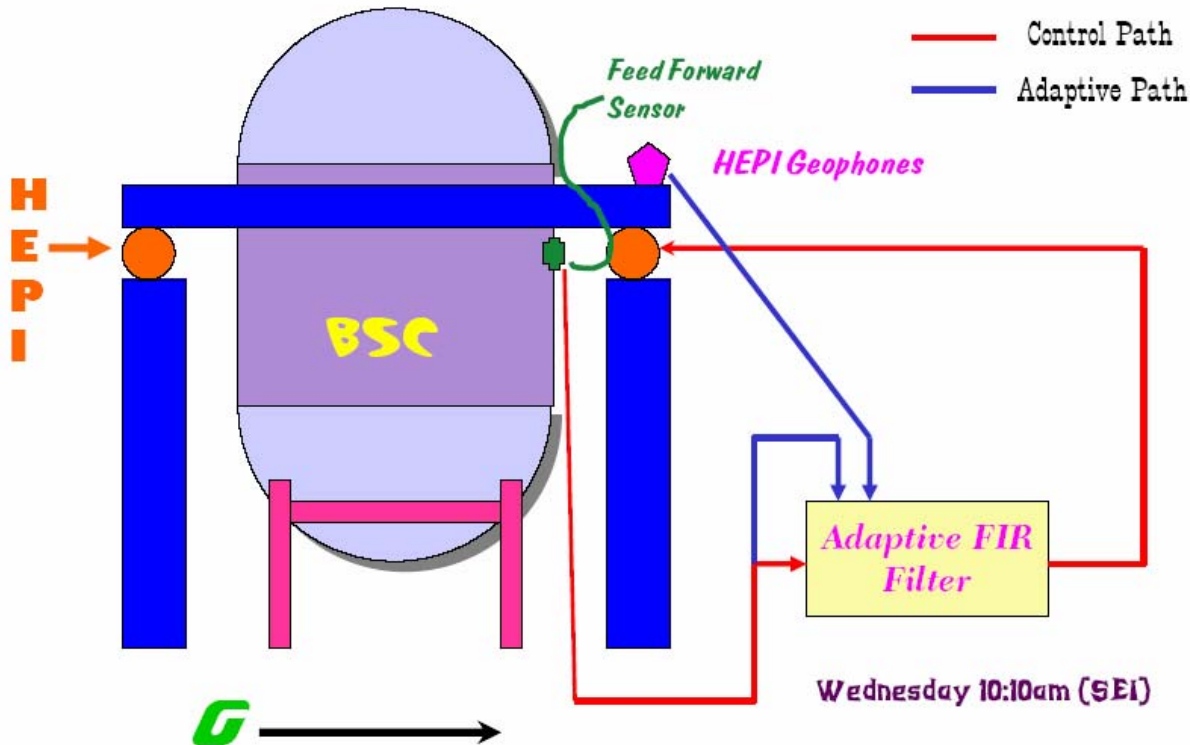
Radiation Pressure Experiments



- Utilized existing LASTI test cavity in Mid Y HAM
- Demonstrated Parametric Instability and the Unstable nature of the Optical Spring
- Experiments performed by members of the MIT Quantum Measurement group using LASTI Infrastructure
- New experiment using 1 g mirror installed

Seismic Characterization and Control

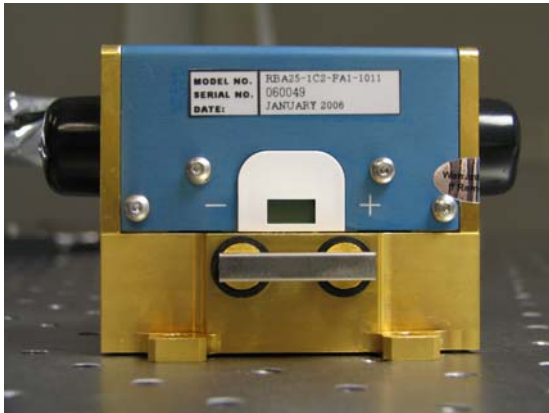
ADAPTIVE FIR FILTERS (GRADIENT MINIMIZATION)



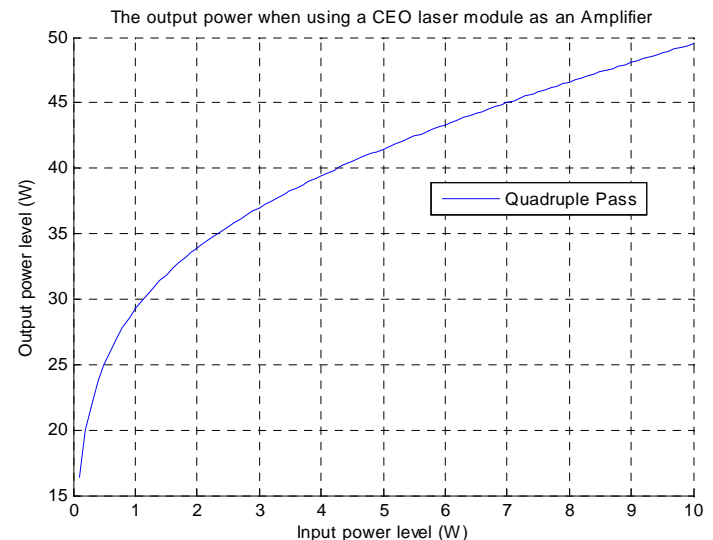
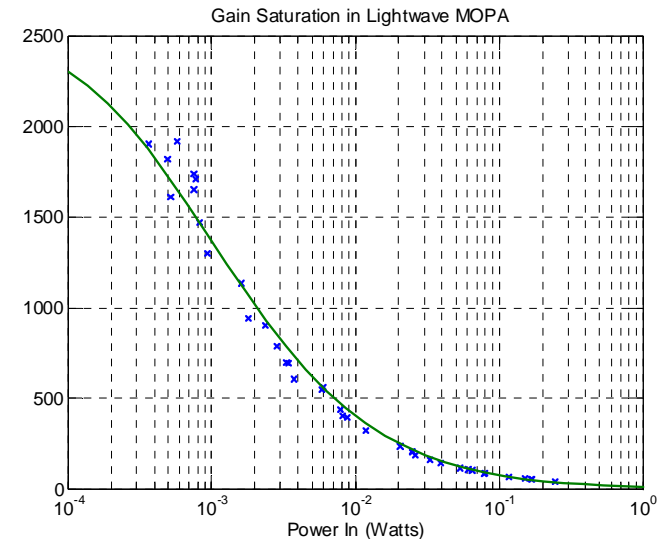
- Identified the cause of noise amplification at the top of pier
- Identified an adaptive feedforward approach to reduce the noise impact
- Work done by Rich M, Laurent and Brett S
- See talk by Rich M

PSL Power Upgrade Test

- Aim: Investigate the feasibility of increasing the power of Lightwave 10 Watt PSL Using commercially available optical amplifiers
- Status
 - » Predictive code upgrade by David Hosken
 - » Parts have been ordered, (Funded by Joe Giaime and LSU)
 - » Rupal Amin to visit MIT
 - » Assembly beginning early March

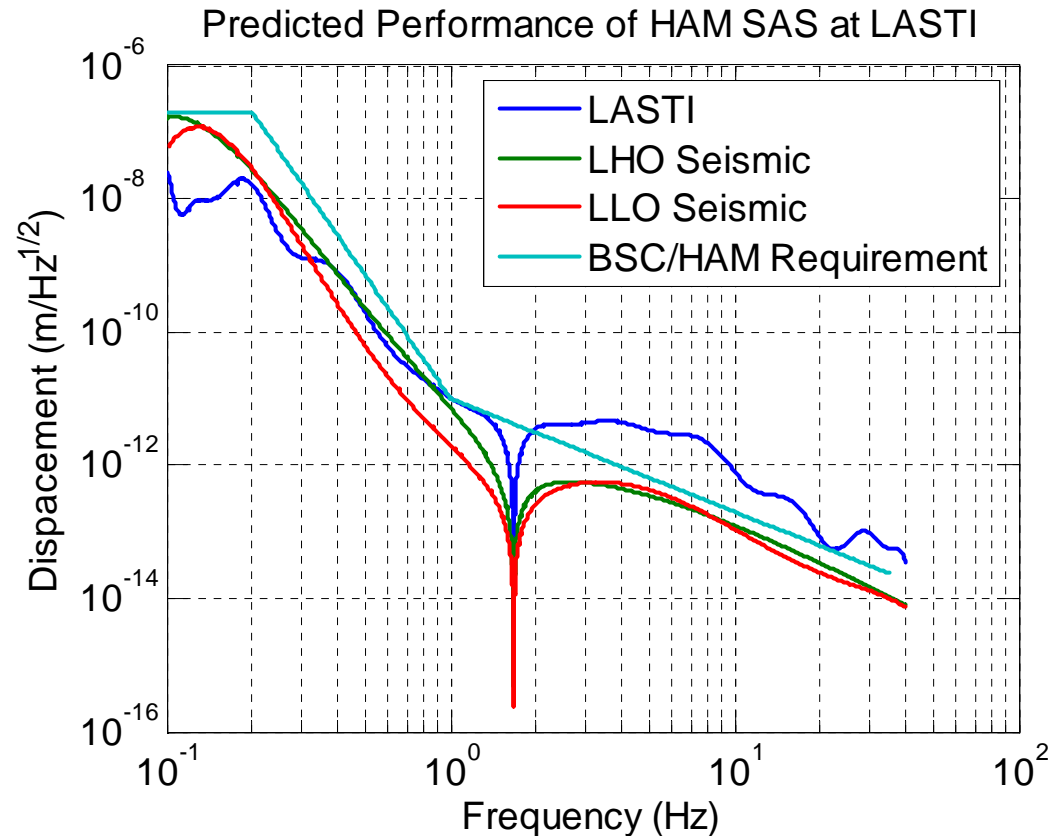


LSC Meeting March '05



HAM SAS

- Will be installed in the Yend HAM – Late Summer 2006
- Currently does not have a HEPI unit on this HAM
- Will use excess scissor tables from LLO
- Will need another cleanroom in LASTI
- Important to minimize required vent time to not impact rest of LASTI Schedule



LASTI Schedule for Advanced LIGO SUS/SEI

Controls Prototype

- Jan '05 Design and fabricate Solid Spacer for BSC
- Jun '05, Feb '06 Assembled Quad arrives and external shakedown begins
- Jul '05, Apr '06 Cartridge installed into vacuum
- Apr '06, Sept '06 Stand alone testing
- Oct '05, Oct '06 Preliminary locking tests begin ???
- Jan '06, Sept '06 Removed from vacuum

BSC Seismic Development

- Mar – Aug '05, Feb '06 Procure parts
- Oct '05, Apr '06 Dirty assembly
- Nov '05, May '06 Modal testing
- Nov '05, June '06 Disassemble
- Dec '05, Aug '06 Clean parts
- Jan '06, Aug '06 Clean assembly
- Mar '06, Sept '06 Pre- installation test
- May '06, Oct '06 Vacuum installation
- Jun '06, Dec '06 Removal from vacuum

Schedule Code
From Mar '05
Current Estimate
Done

Feb '06, Feb '07

Combine Quad and
BSC Extra-Vacuum

Jul '06, Mar '07

Cartridge Install

Other Key Dates:

April '06 Double Triple Experiments Conclude

Aug '06 HAM SAS Installation Begin

May '06 PSL Power Scaling Conclude

Conclusions

- Many projects are successfully being worked in parallel
- Significant progress has been made
- The next six months to year promises a wide array of results for a variety of Enhanced LIGO and Advanced LIGO sub-systems.

LASTI Detailed Optical Layout

Yend HAM – Currently Empty, Oct '06
HAM SAS

Y Mid HAM – Currently used by Quantum
Optics, Oct '06 Quantum Optics Experiments

BSC – Currently Empty (Bare Seismic
Tests), Oct '06 Controls Prototype
Standalone Tests

Xend HAM – Currently Double Triple
Experiment, Oct '06 Single triple for
Quad/Triple cavity experiments

