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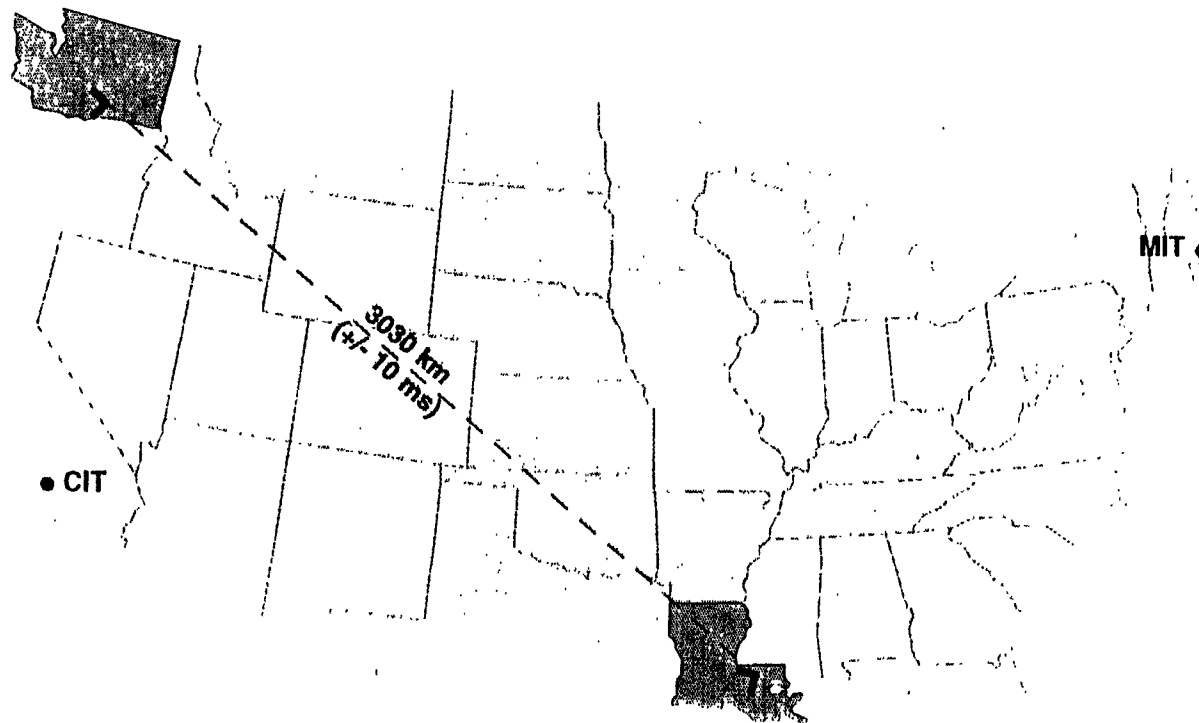
LIGO Status

Barry Barish

PAC Meeting

November 6th - 7th, 1997

Two LIGO Observatory Sites

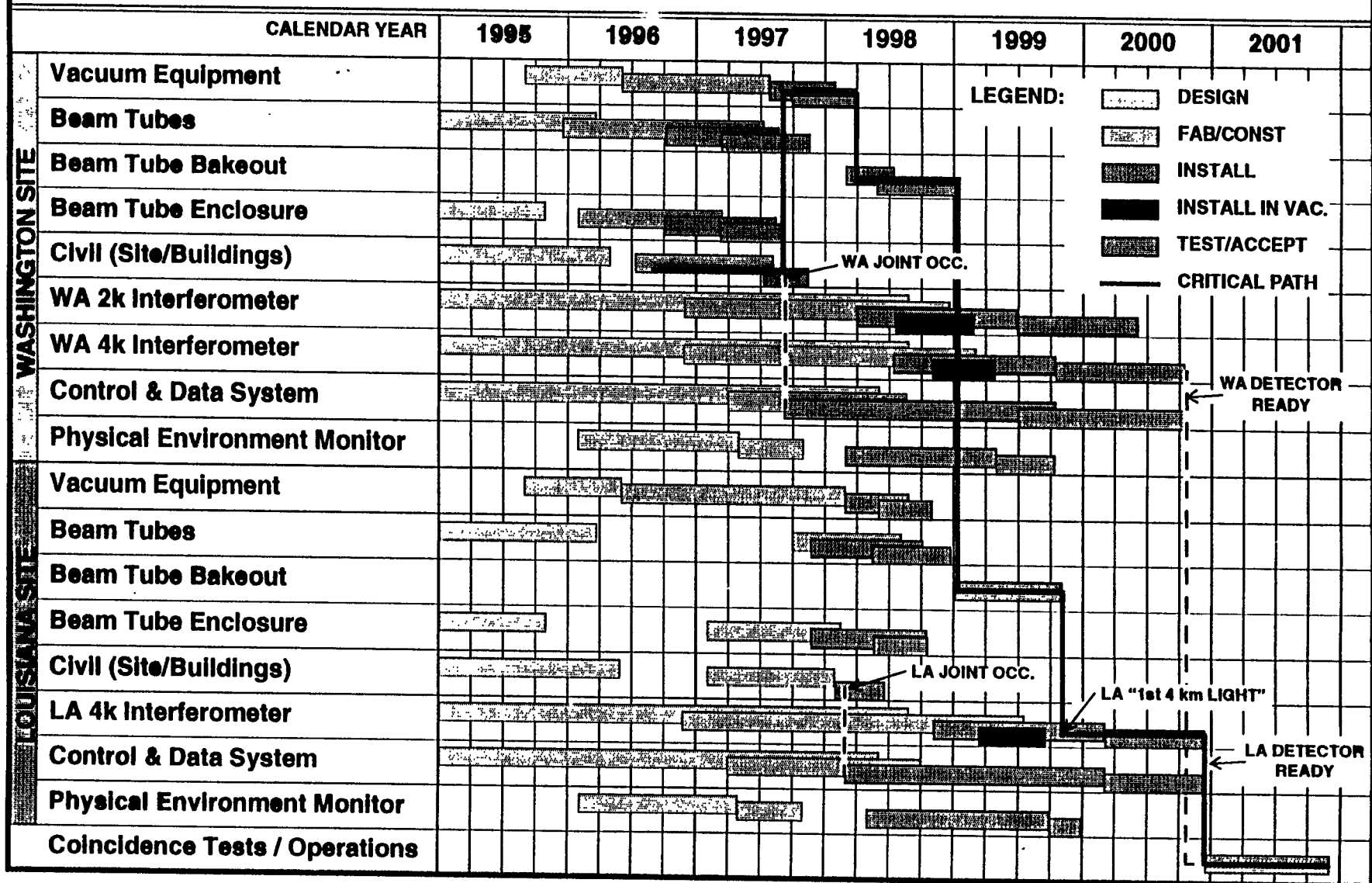


LIGO

the facility

- National Science Foundation
- Construction Project (1995-1999)
 - » Facilities and Initial Detector
- Commission Facility (1999-2001)
 - » Implement Initial Detectors
 - $h \sim 10^{-20}$ - Coincidence (Hanford/Livingston)
 - Engineering run (end of 2000)
 - $h \sim 10^{-21}$ - Initial Design Sensitivity (end 2001)
- Full Operations (2002 + ...)
 - » Data Taking/Analysis
 - LIGO I (2 year run @ $h \sim 10^{-21}$)
 - » Enhance Initial Detector
 - improved subsystems (lasers, test masses, etc)
 - » Advanced Detectors
 - new interferometer configurations

SUMMARY INTEGRATED SCHEDULE



LIGO Plans

schedule

- Main Activity

- | | |
|------|-------------------------------|
| 1996 | Construction Underway |
| | -mostly civil |
| 1997 | Facility Construction |
| | -vacuum system |
| 1998 | Interferometer Construction |
| | -complete facilities |
| 1999 | Construction Complete |
| | -interferometers in vacuum |
| 2000 | Commission Detectors |
| | -first light; testing |
| 2001 | Engineering Tests |
| | -sensitivity; engineering run |
| 2002 | Initial LIGO Detector Run |
| | - $h \sim 10^{-21}$ |



Technical Highlights - Hanford Civil Construction

- Hanford beam tube enclosures construction complete
- Hanford site buildings are complete, testing is underway
- Hanford buildings are all in joint occupancy or beneficial occupancy.
- Followon contractors now working in buildings
 - ›› Beam tube bakeout insulation contractor working in enclosure for module X1 - kickoff last week
 - ›› Vacuum equipment installation contractor is working in LVEA and several other buildings
 - ›› Office Support Building (OSB) furniture is inside and offices are being occupied
 - ›› Computer network is being brought online

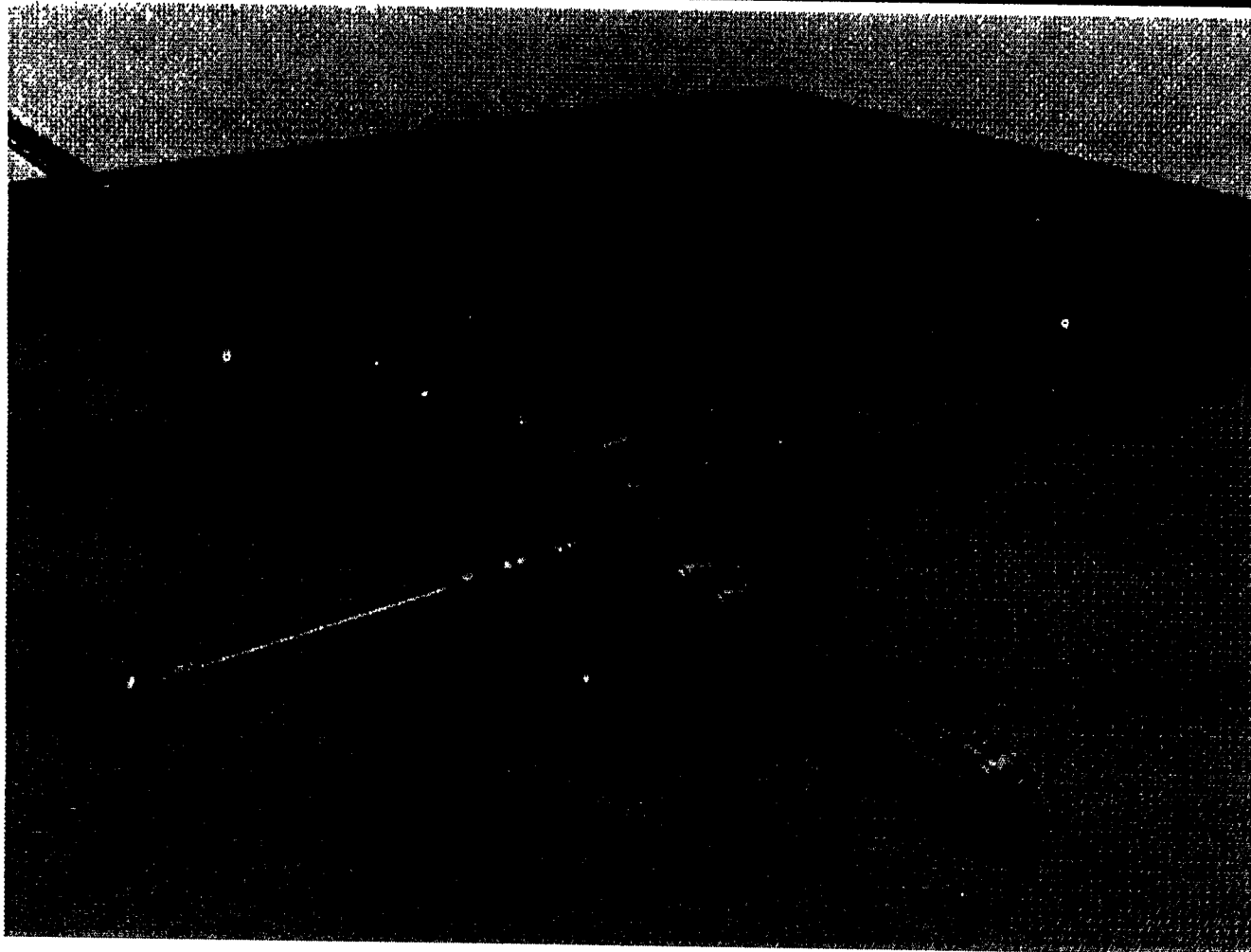
Technical Highlights - Livingston Construction

- First arm slab is complete
- Second arm slab is under construction
- Livingston buildings are in advanced stages of construction and are ahead of schedule
- Site access road problems have been successfully managed
- Site schedule coordination has dealt with several schedule disconnects and conflicts, preserving schedule

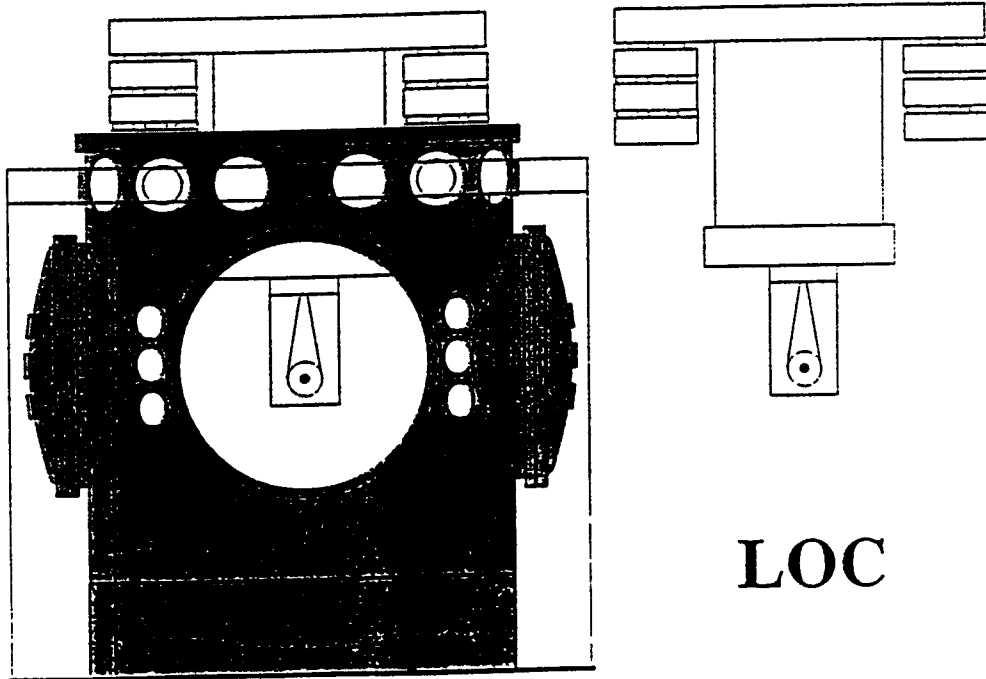
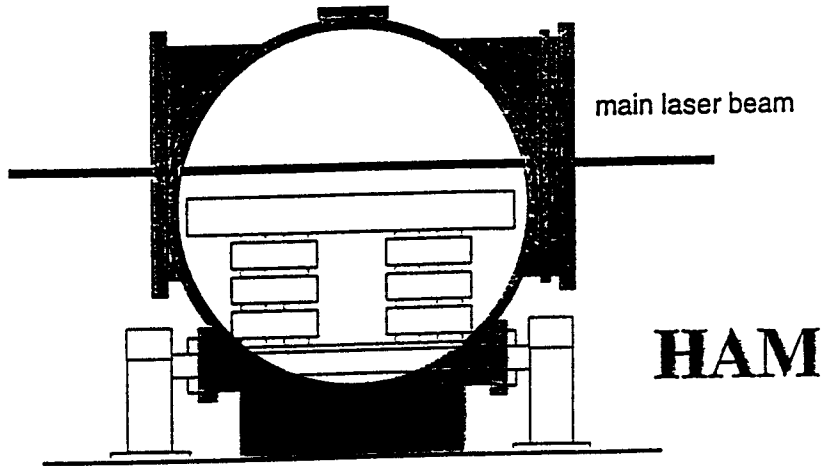
Technical Highlights - Vacuum Equipment

- Vacuum Chambers
 - ›› Hanford vacuum equipment complete and being installed on site
 - ›› Livingston vacuum equipment complete early in 1998
- Gate Valves
 - ›› Hanford valves installed
 - ›› First Livingston valves installed
 - others awaiting shipment when buildings are ready
- Pump sets in use to pump beam tube acceptance tests

Vacuum Equipment System Cartoon



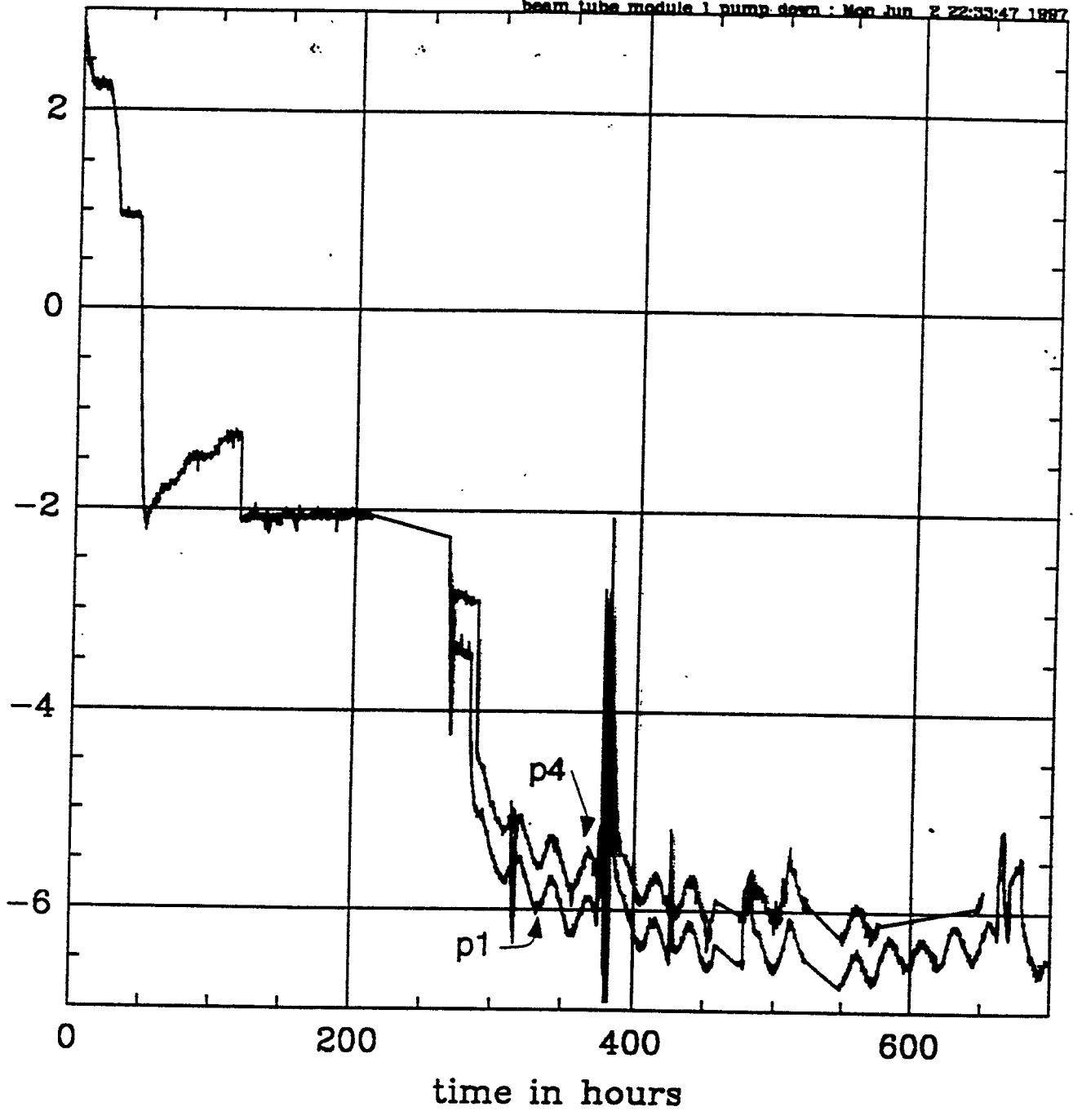
SEI Configuration



Technical Highlights - Beam Tube

- Hanford Beam Tube Complete
 - ›› X arm 2 km modules passed prebake outgassing and alignment
 - Viton outgassing appears to provide limit to leak detection sensitivity, but well below our requirements
 - ›› Y arm acceptance test underway
- All baffles installed at Hanford after resolving glass coating and weld cracking problems
- Livingston beam tube fabrication underway
- Livingston Installation is ready to proceed
 - ›› Installation Readiness Review successfully completed last week

log10(pressure in torr)



Outgassing Result From First 2 km Module

Table 1: Prebake Outgassing Rates (torr liters/sec cm²)

gas	measured at 1100 hrs	assumed 1/t	comments
H ₂	$< 7.4 \times 10^{-14}$		larger than QT by 2 max correction for ordinary 304 SS $2.7 \times 10^5 \text{ cm}^2$ at $J(\text{H}_2) = 1 \times 10^{-11}$ $J_{\text{equiv}}(\text{H}_2) < 3.5 \times 10^{-14}$
CO	6.9×10^{-15}	$7.6 \times 10^{-12} / \text{t}(\text{hr})$	smaller than QT by 10
CO ₂	1.9×10^{-14}	$2.1 \times 10^{-11} / \text{t}(\text{hr})$	smaller than QT by 2
CH ₄	5.2×10^{-16}	$5.6 \times 10^{-13} / \text{t}(\text{hr})$	larger than QT by 4
H ₂ O		$8.0 \times 10^{-9} / \text{t}(\text{hr})$	<i>see table 7 and 8</i> smaller than QT by 2
Hydrocarbons $\sum_{41, 43, 55, 57}$		$8 \times 10^{-3} * J(\text{H}_2\text{O})$	larger than QT by 2

Technical Highlights - R&D

- MIT Phase Noise Interferometer

- ›› Demonstration of phase sensitivity $\sim 2 \times 10^{-10} \text{ rad}/\text{Hz}$, with 150 W circulating 1064 nm light power

- CIT 40 Meter Interferometer

- ›› Power recycled Michelson is running with recycling gain ~ 4

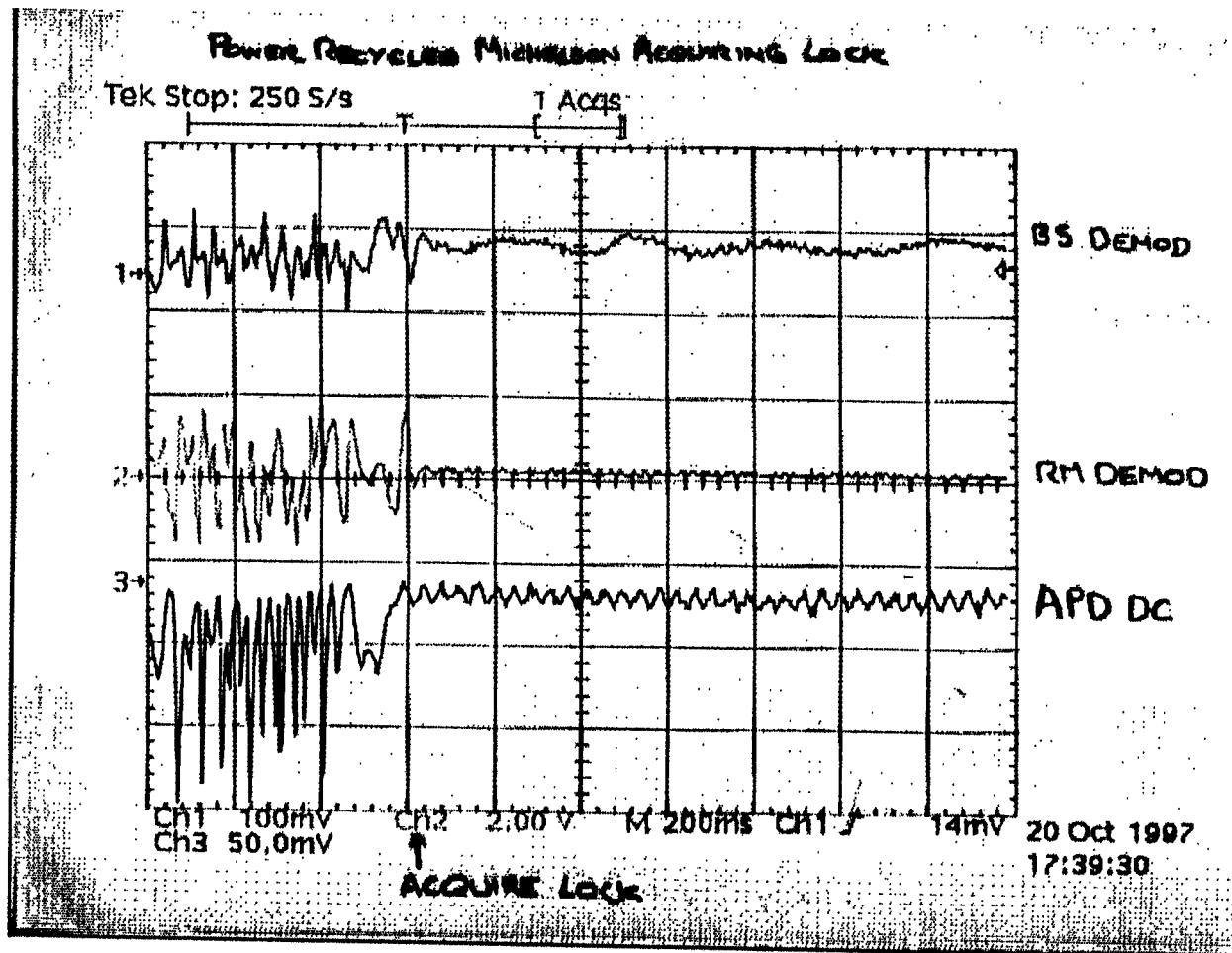
- Lock acquisition guided by LIGO modeling

- Fabry Perot cavities to be added next

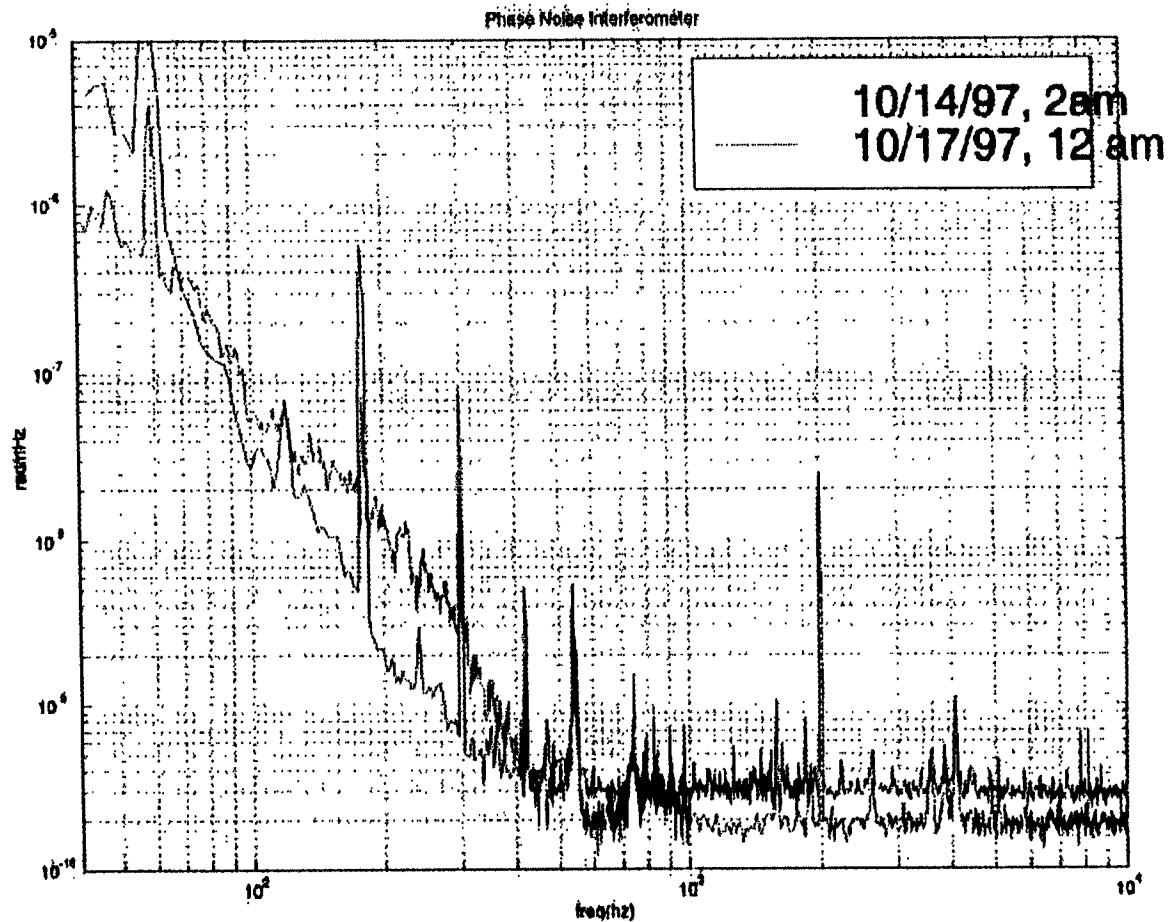
- ›› LIGO end-to-end model has successfully reproduced single cavity response

- more modeling tests planned

Power Recycled Michelson Acquiring Lock



Phase Noise Sensitivity From MIT Interferometer



Technical Highlights - Detector

- 10 W laser delivered by Lightwave Electronics; meets our power and noise requirements
- Most Corning and Heraeus glass for core optics is delivered
 - ›› absorption requirements met
- Polishing and coating underway
- Seismic isolation fabrication contracts are being initiated
 - ›› “creak” testing of springs carried out with encouraging results
 - ›› “First Article” fabrication initiated

Technical Highlights - Detector

- Final designs for Length and Alignment Sensing and Control Systems underway
- Small Optics Suspension fabrication initiated
- Large Optics Suspension ready to bid mechanical fabrication
- Final design of Control and Data System global architecture nearing completion
- Vacuum Control and Monitoring System complete and being readied for use in Hanford

Summary of Technical Status

- › Facilities - Buildings and Vacuum Systems nearly complete in Hanford and well along in Livingston
- › Detector - Design nearing completion; detector construction beginning