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# LIGO Status

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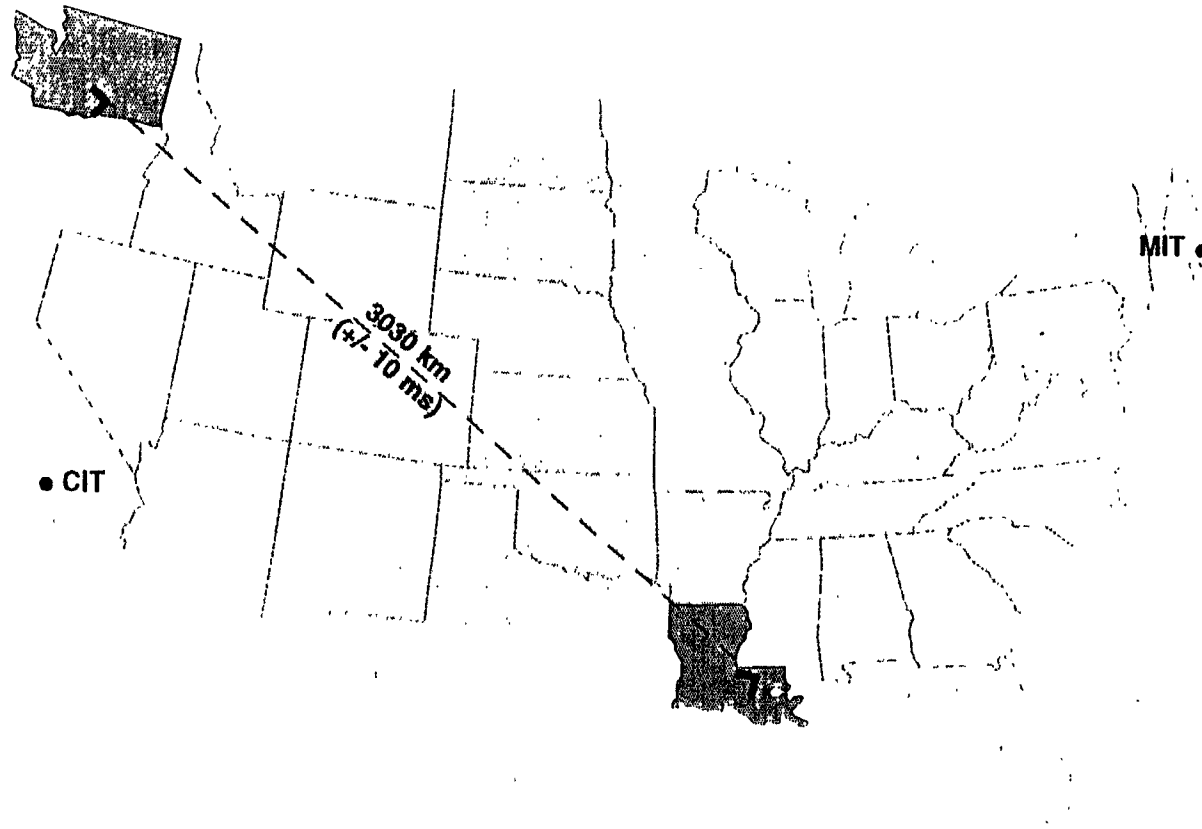
Barry Barish

GWDAW-2

November 11<sup>th</sup> - 12<sup>th</sup>, 1997

# Two LIGO Observatory Sites

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# LIGO

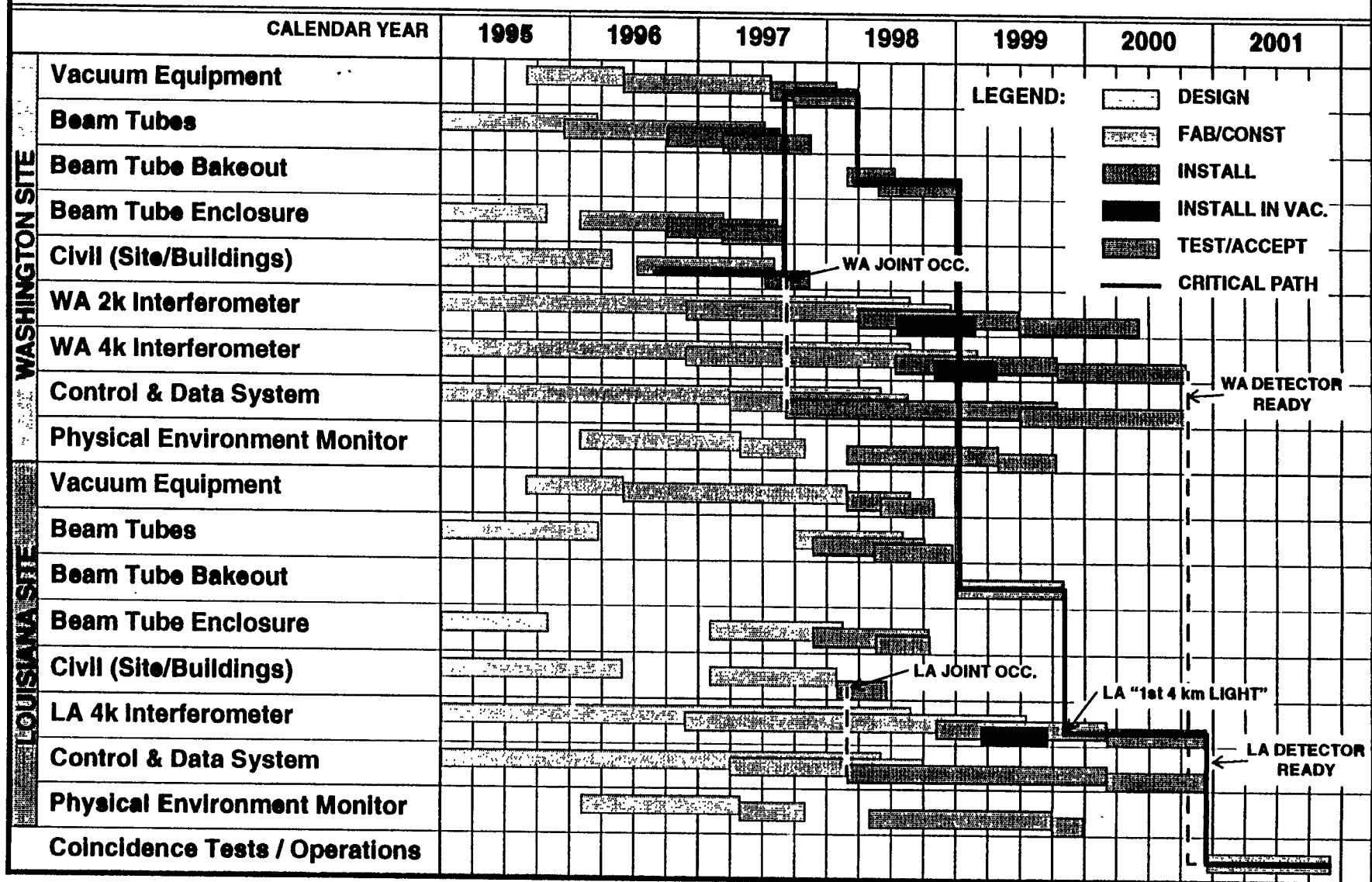
## *the facility*

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- 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*

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- 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

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- 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

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- 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

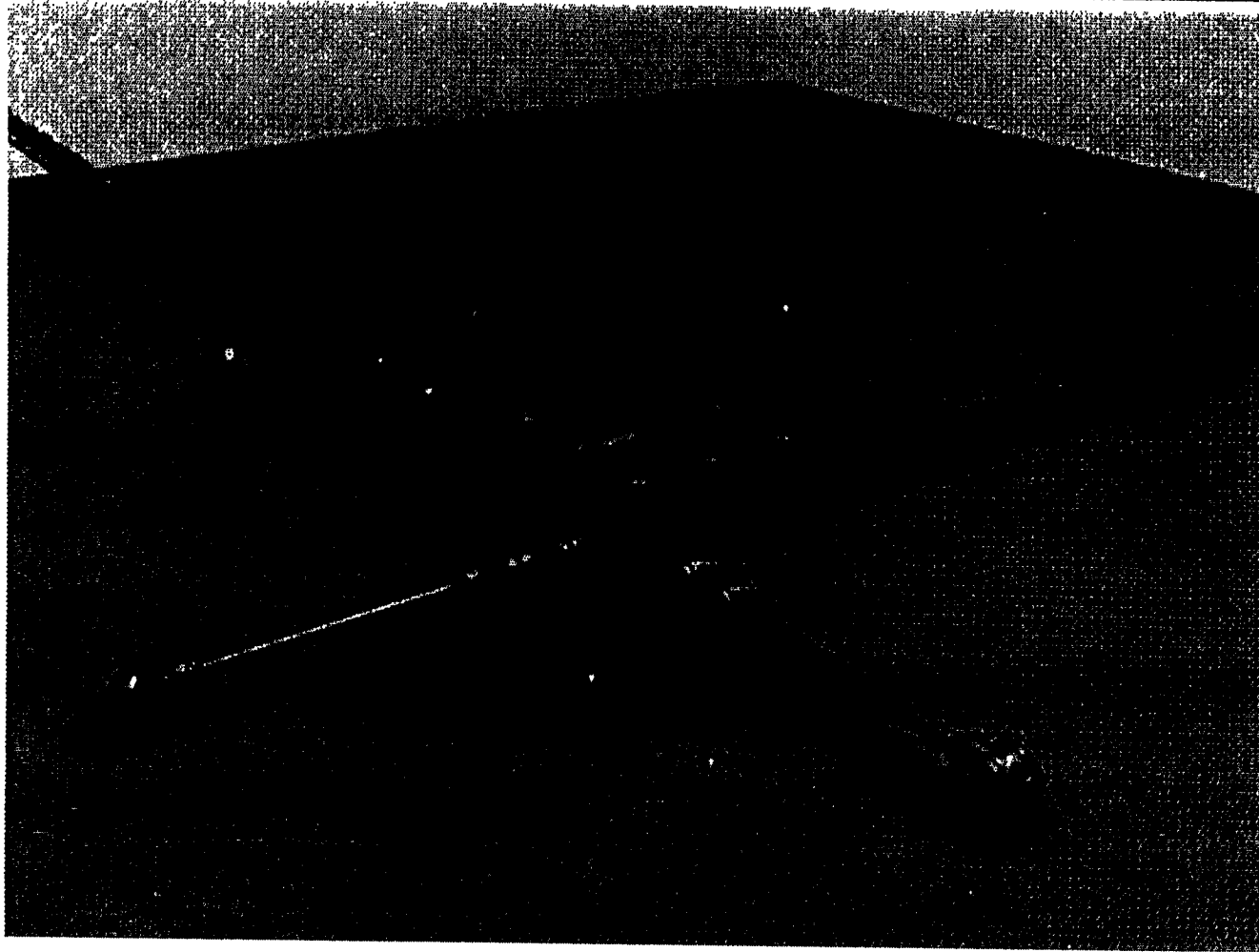
# Technical Highlights - Vacuum Equipment

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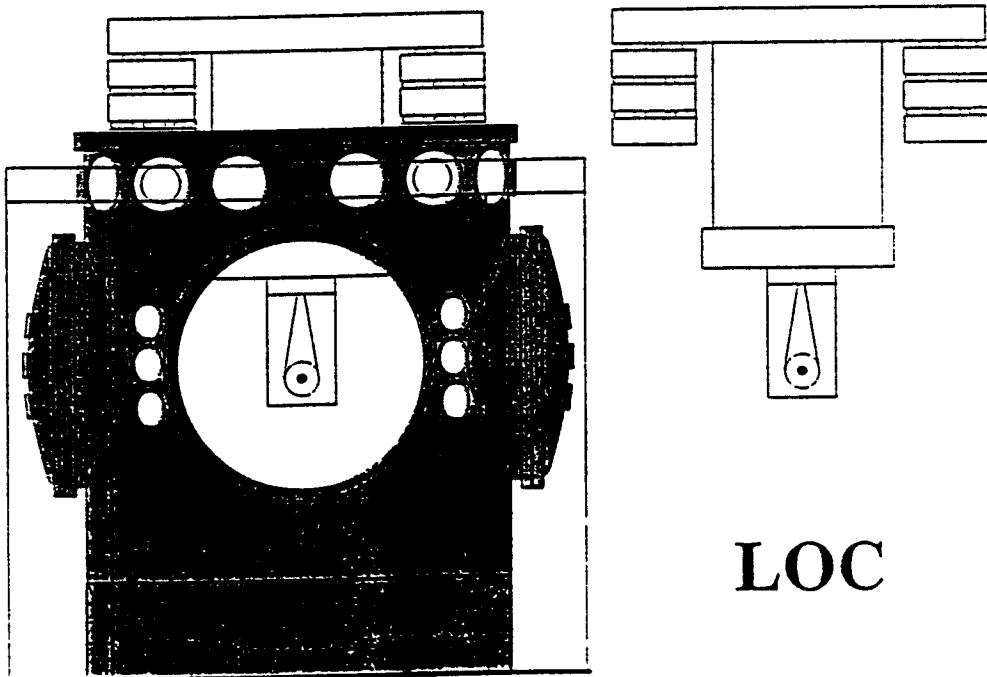
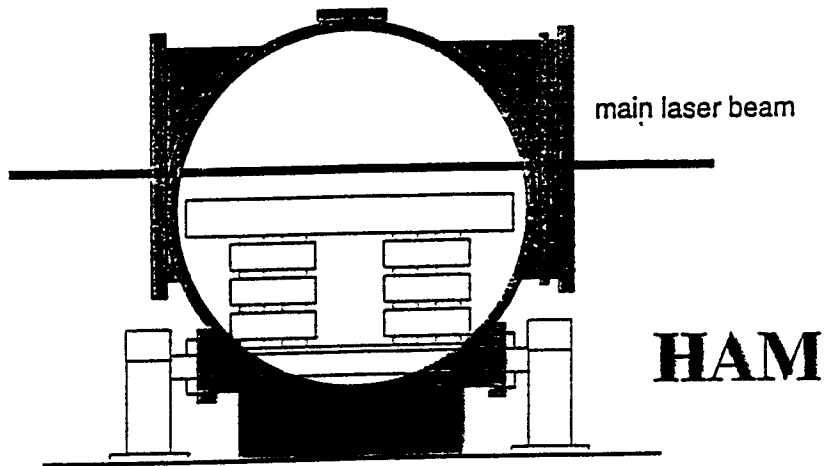
- Vacuum Chambers
  - ›› Hanford vacuum equipment complete and being installed on site
  - ›› Livingston vacuum equipment complete early in 1998
- Gate Valves
  - ›› Hanford valves installed
  - ›› First Livingston valves installed
    - others awaiting shipment when buildings are ready
- Pump sets in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



# Vacuum Equipment System Cartoon



# SEI Configuration



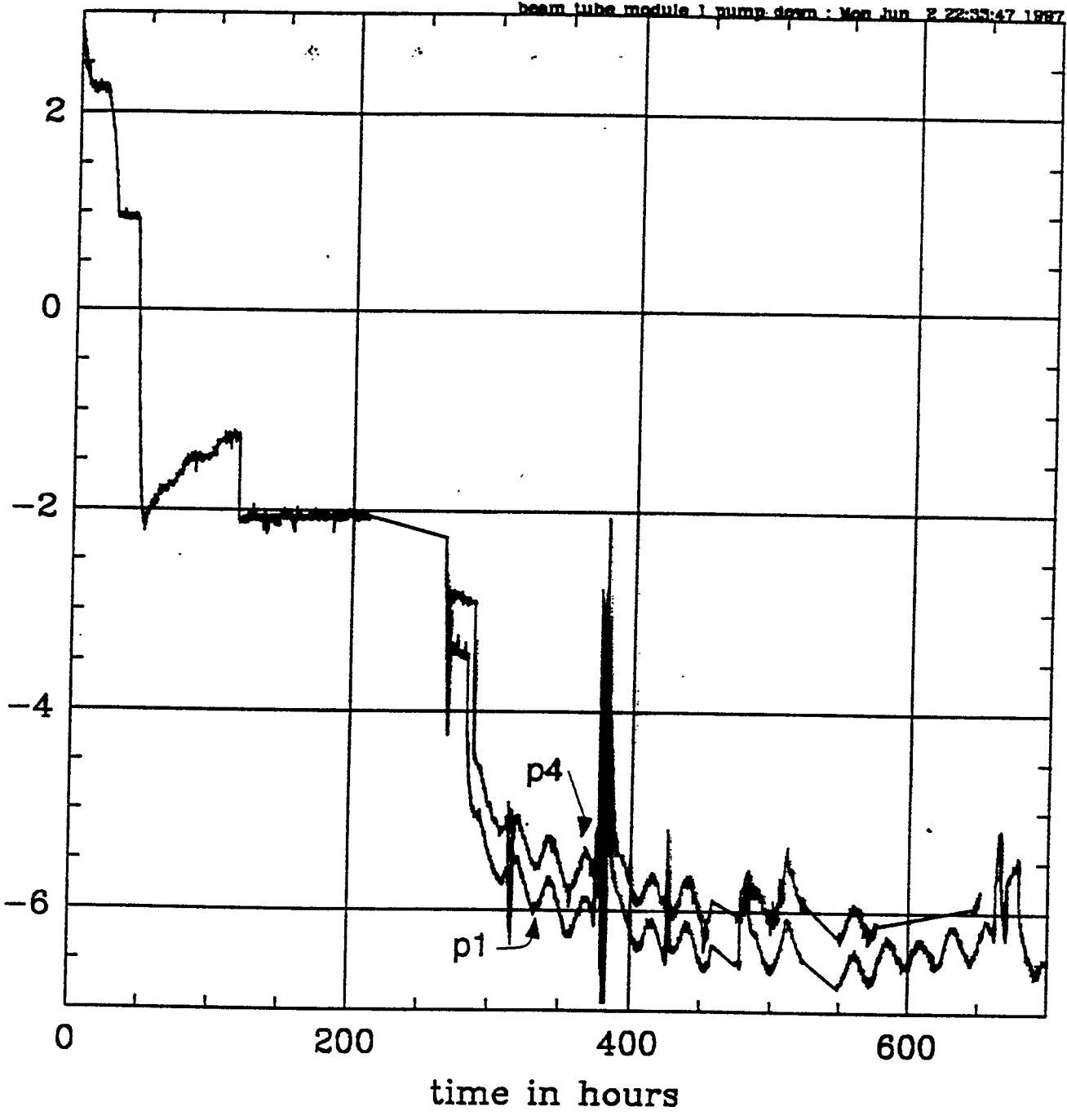
# Technical Highlights - Beam Tube

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- 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

beam tube module 1 pump down : Mon Jun 2 22:35:47 1987

log10(pressure in torr)



# Outgassing Result From First 2 km Module

Table 1: Prebake Outgassing Rates (torr liters/sec cm<sup>2</sup>)

gas	measured at 11.00 hrs	assumed 1/t	comments
H <sub>2</sub>	$< 7.4 \times 10^{-14}$		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	$6.9 \times 10^{-15}$	$7.6 \times 10^{-12} / \text{t}(\text{hr})$	smaller than QT by 10
CO <sub>2</sub>	$1.9 \times 10^{-14}$	$2.1 \times 10^{-11} / \text{t}(\text{hr})$	smaller than QT by 2
CH <sub>4</sub>	$5.2 \times 10^{-16}$	$5.6 \times 10^{-13} / \text{t}(\text{hr})$	larger than QT by 4
H <sub>2</sub> O		$8.0 \times 10^{-9} / \text{t}(\text{hr})$	see table 7 and 8 smaller than QT by 2
Hydrocarbons $\Sigma_{41, 43, 55, 57}$		$8 \times 10^{-3} * J(\text{H}_2\text{O})$	larger than QT by 2

# Technical Highlights - R&D

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- MIT Phase Noise Interferometer

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

- CIT 40 Meter Interferometer

- ›› Power recycled Michelson is running with recycling gain  $\sim 4$

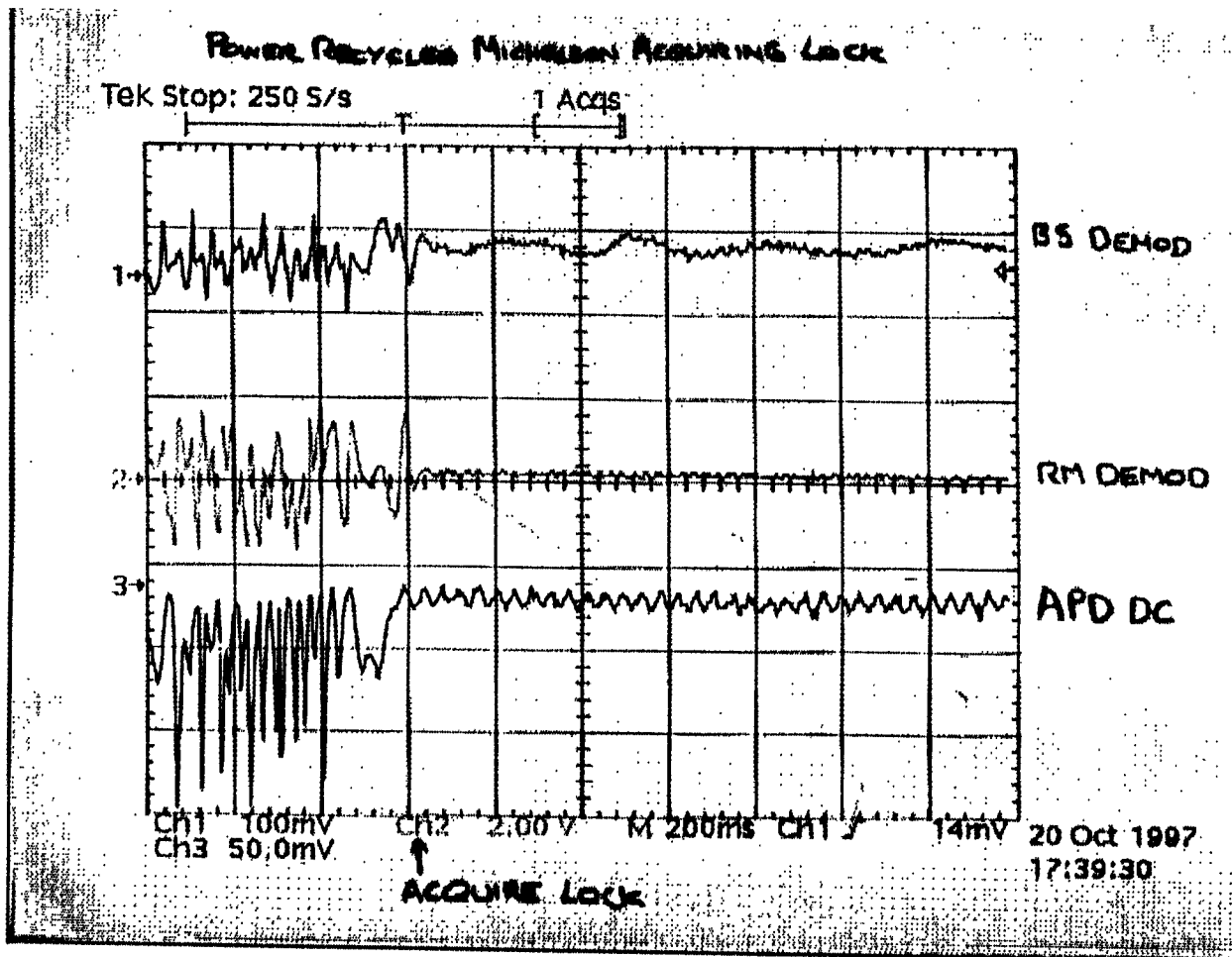
- Lock acquisition guided by LIGO modeling

- Fabry Perot cavities to be added next

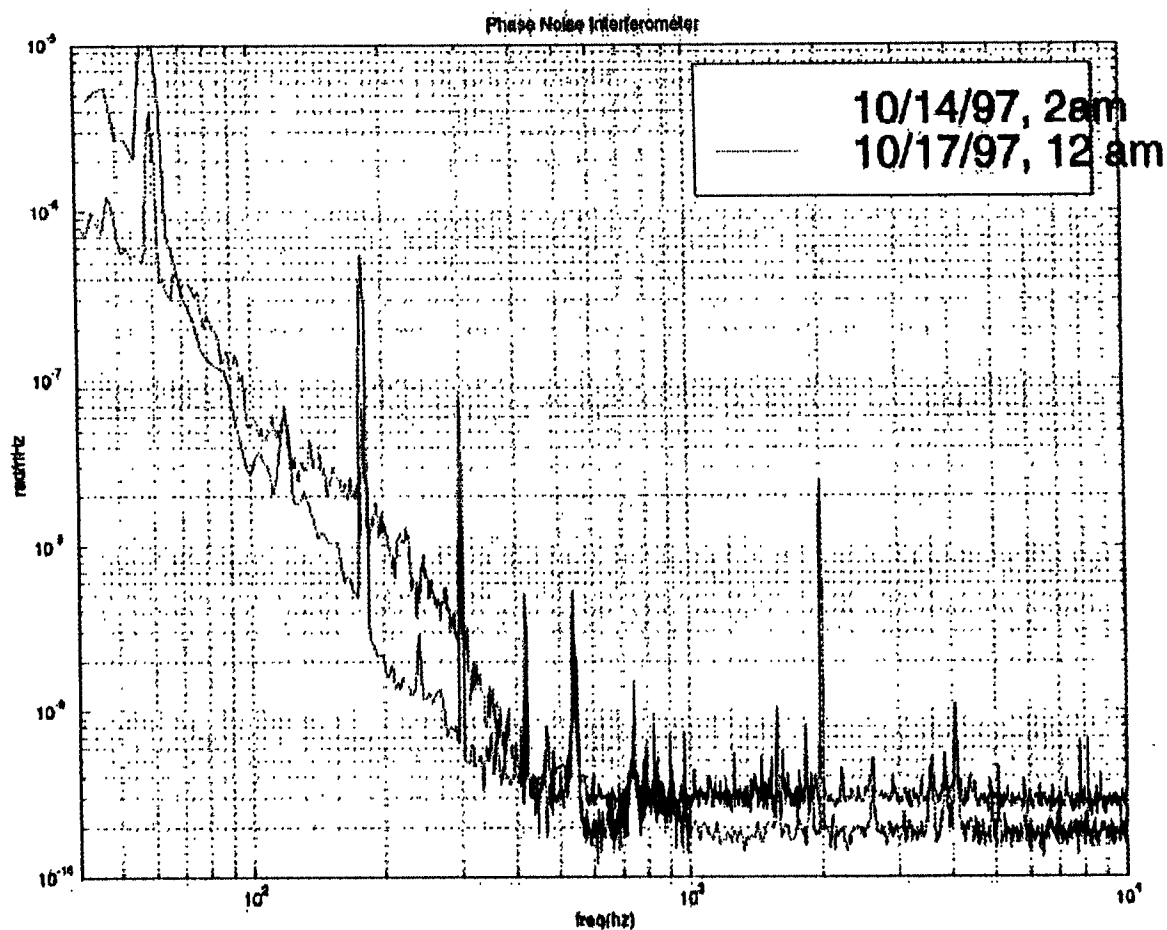
- ›› LIGO end-to-end model has successfully reproduced single cavity response

- more modeling tests planned

# Power Recycled Michelson Acquiring Lock



# Phase Noise Sensitivity From MIT Interferometer





# Technical Highlights - Detector

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- 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

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- 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

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