

**PROJECT TECHNICAL, SCOPE
AND SCHEDULE OVERVIEW**

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LIGO CONCEPT

LIGO GOALS

Long Term: Gravitational Wave Observatory Operation
Initial: Autonomous facility for detection of gravitational waves and Source Survey

LIGO SENSORS

Free mass, broad band, laser interferometric

$$h = \frac{\Delta L}{L}$$

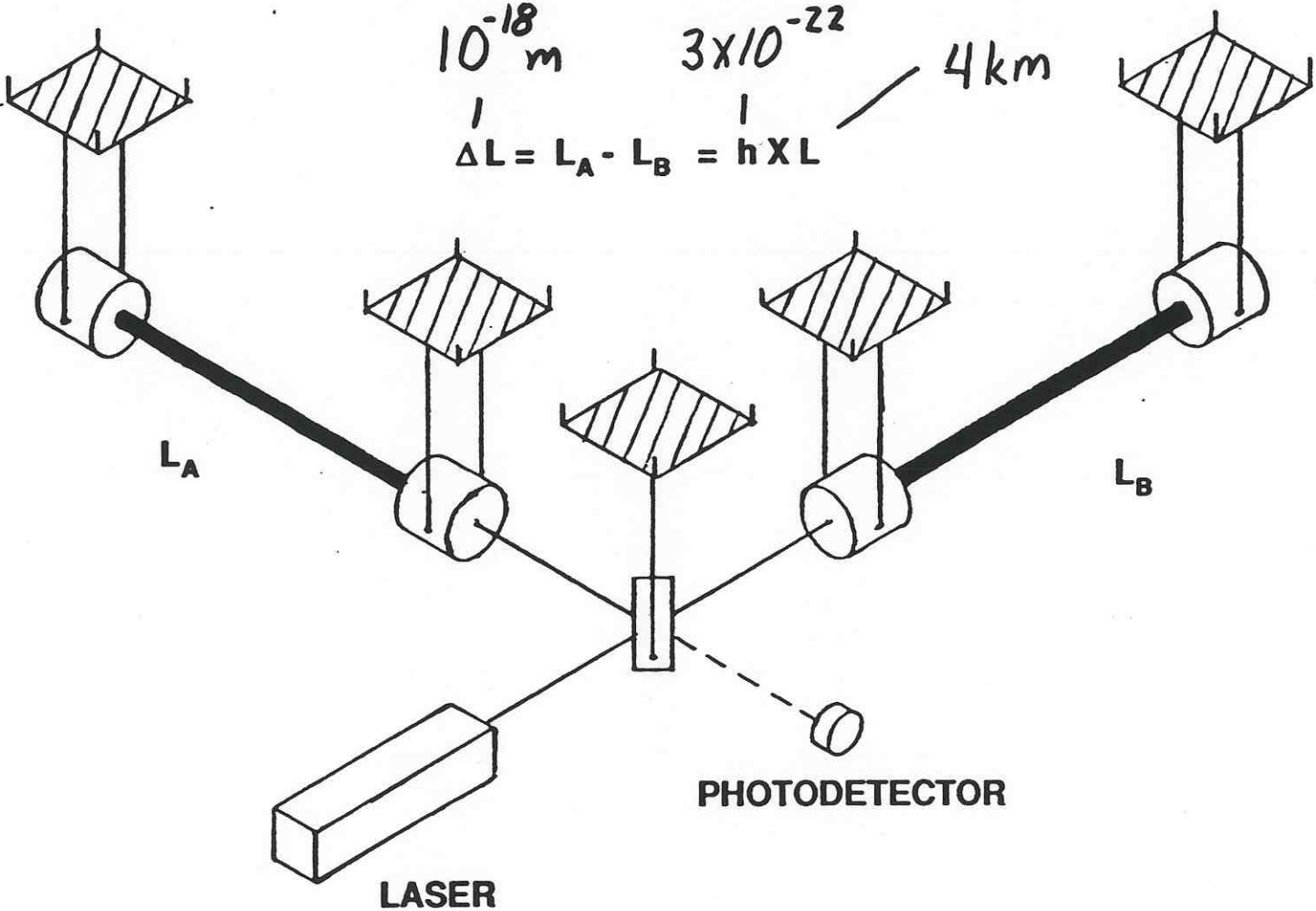
h = gravitational wave strain

ΔL = net displacement of test masses

L = separation of test masses
(interferometer arm length)

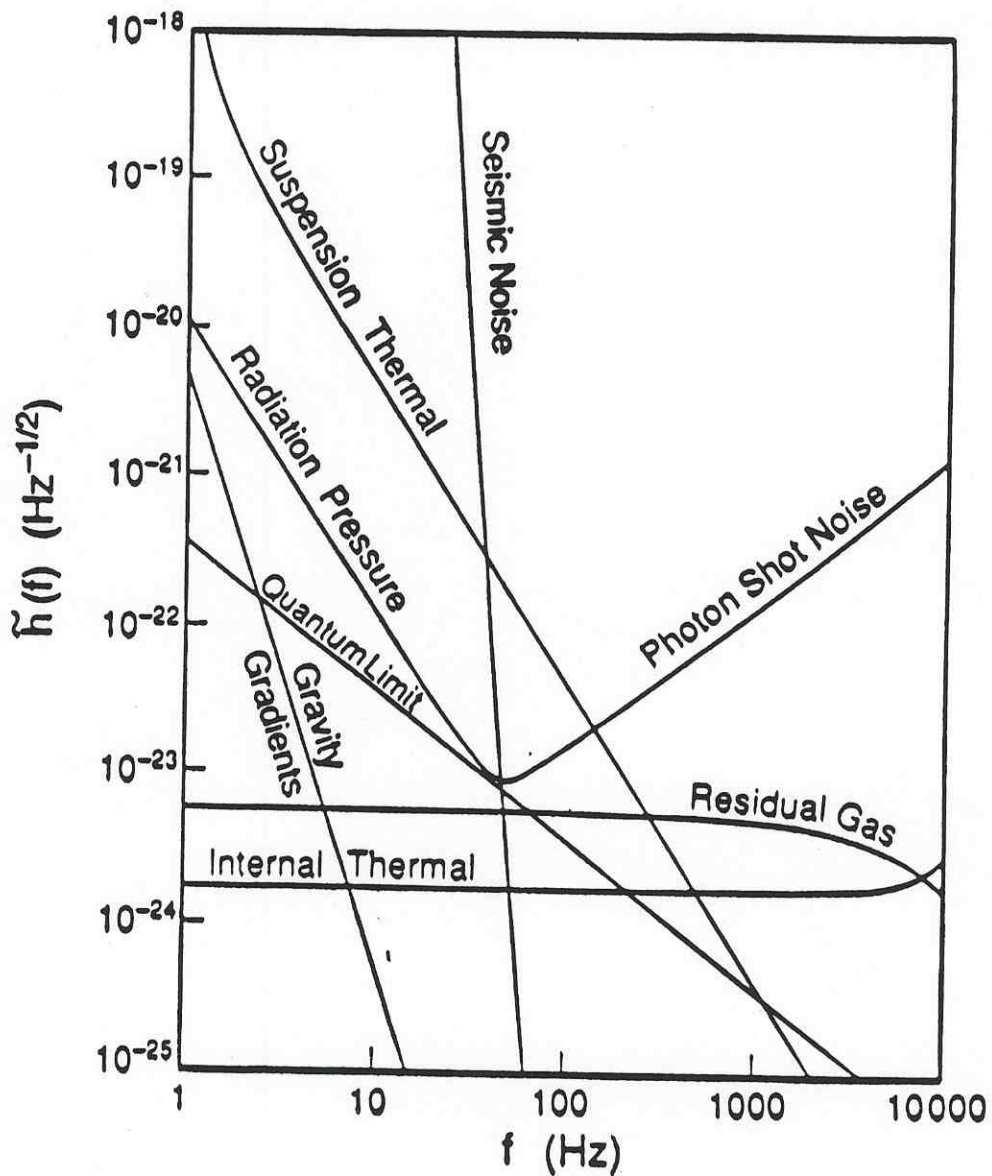
- Ultimate operation as part of global observatory
- Initial objectives can be achieved by LIGO alone

SCHEMATIC INTERFEROMETRIC DETECTOR



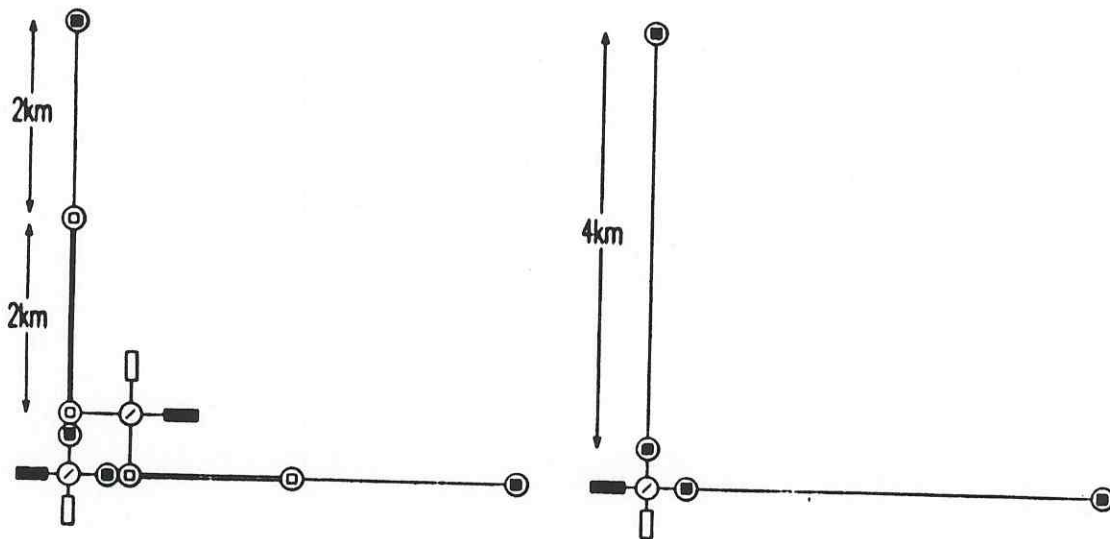
Noise Budget For First LIGO Detectors

- 5 Watt Laser
- Mirror Losses 50 ppm
- Recycling Factor of 30
- 10 kg Test Masses
- Suspension $Q=10^7$



Laser Interferometer Gravitational-Wave Observatory (LIGO)

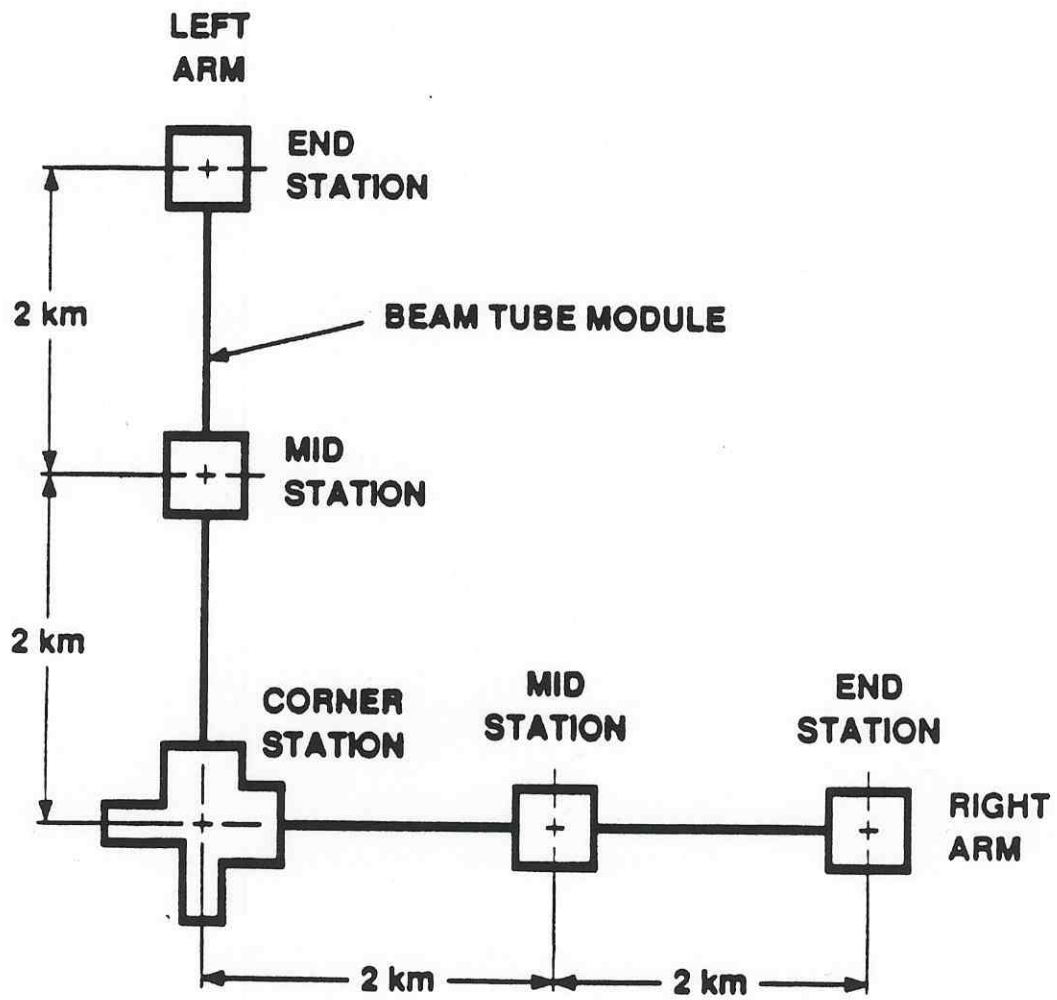
- Two Sites, Widely Separated, Operating as a Single Observatory
- Each Site Has 4 km Long L-Shaped Vacuum System Housing a Full-Length Interferometer
- One Site has Mid-Stations For Half-Length Interferometer
- Can Be Upgraded to Support Subsequent Generations of More Sensitive Detectors

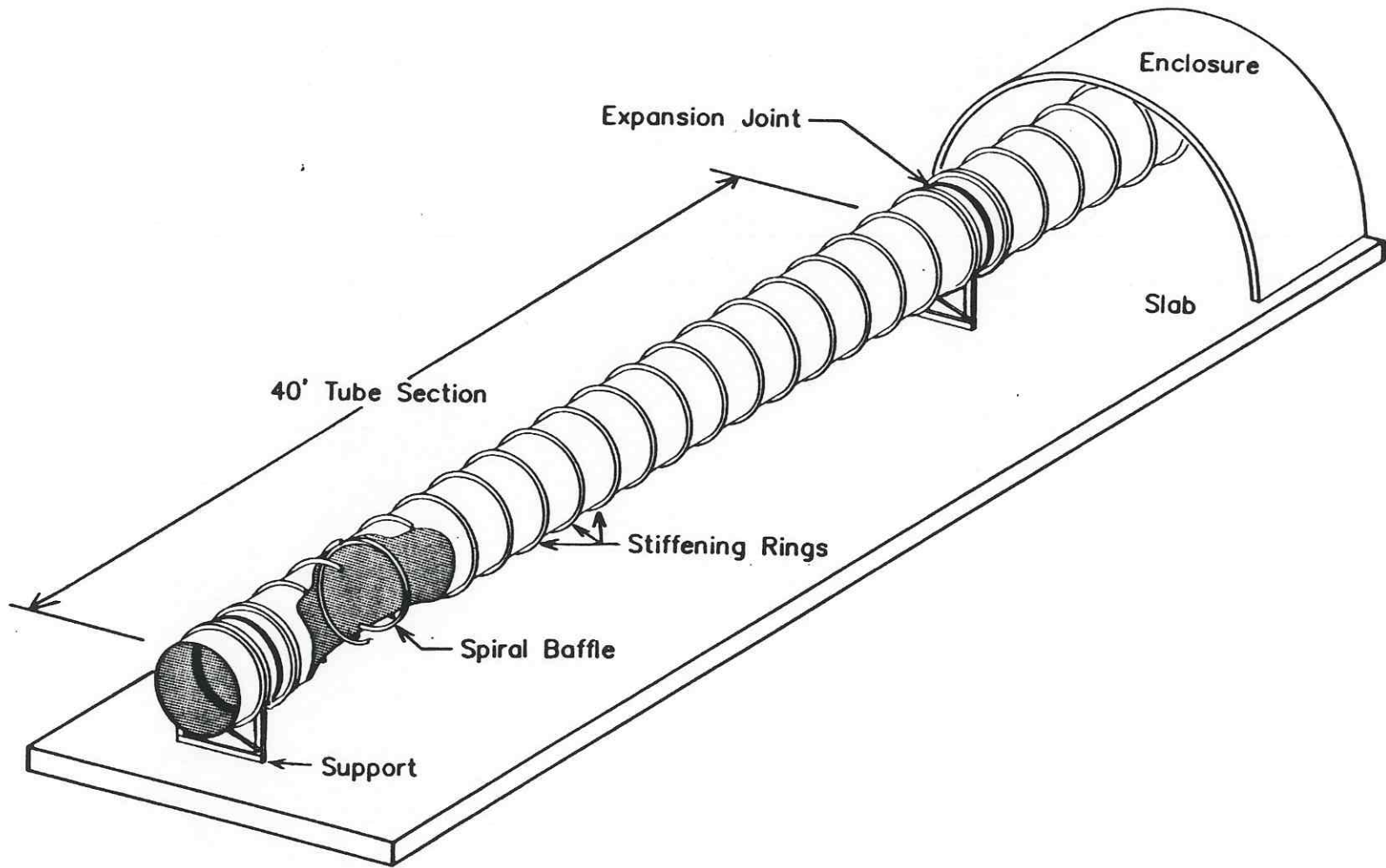


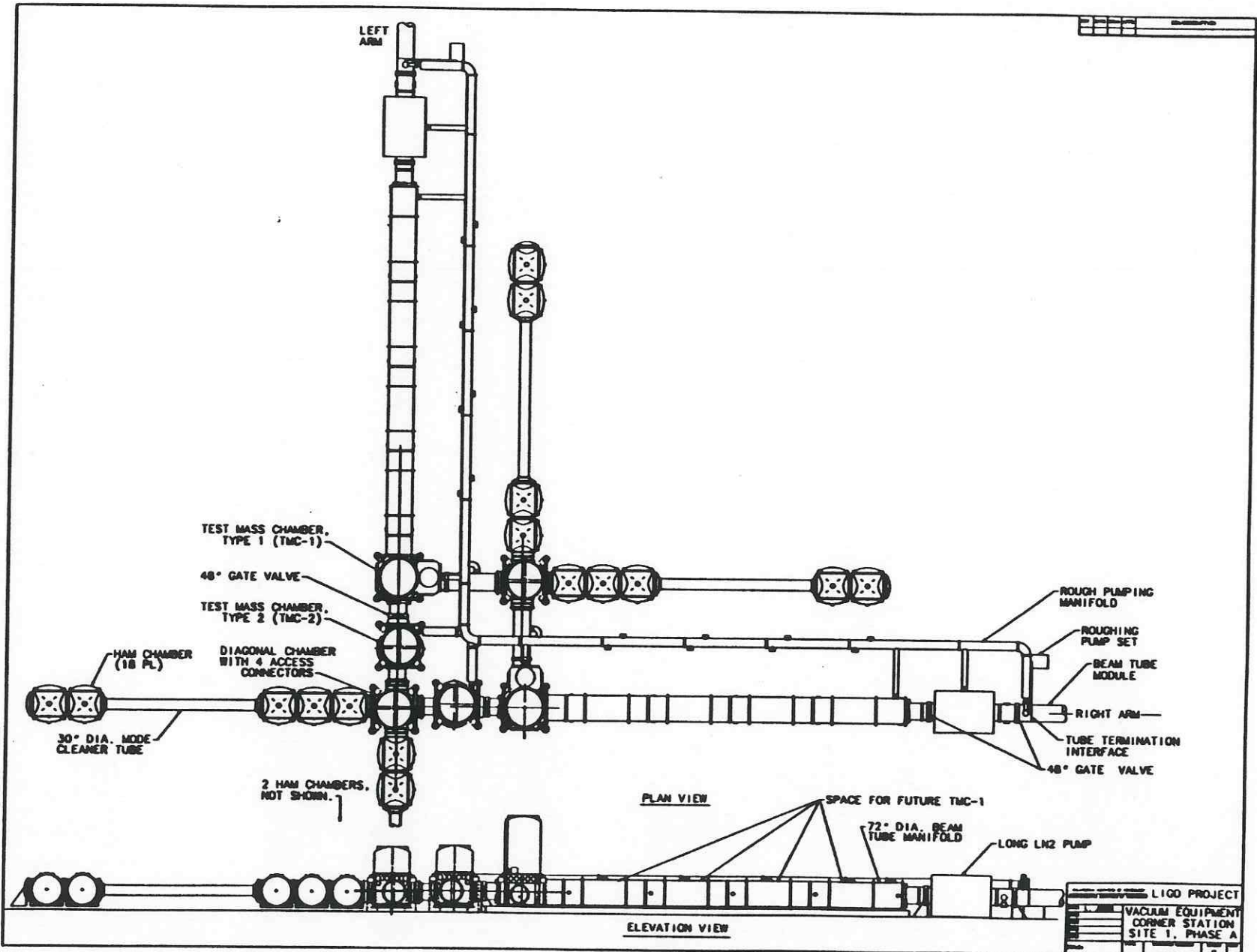
LIGO Site Pair

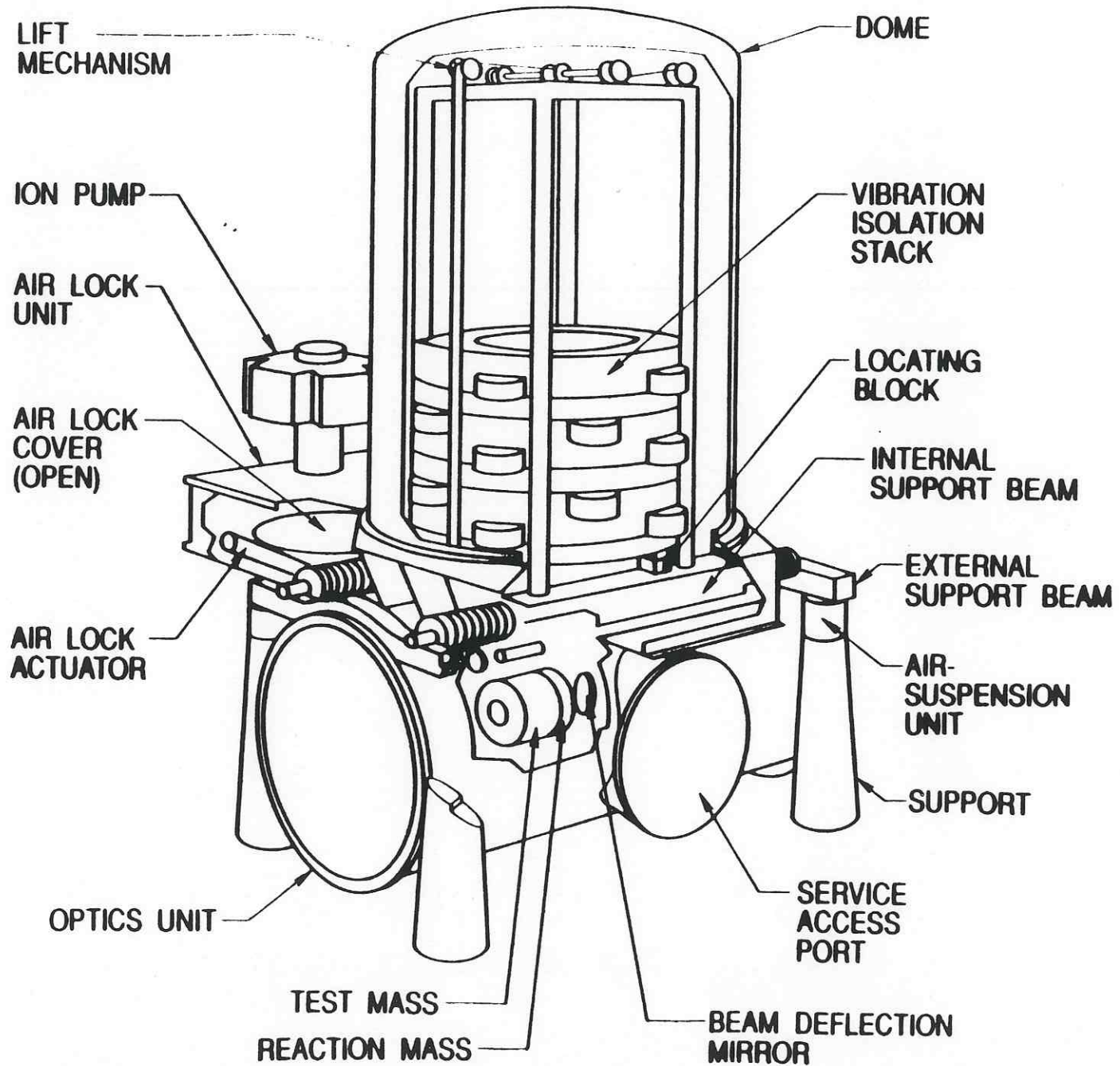


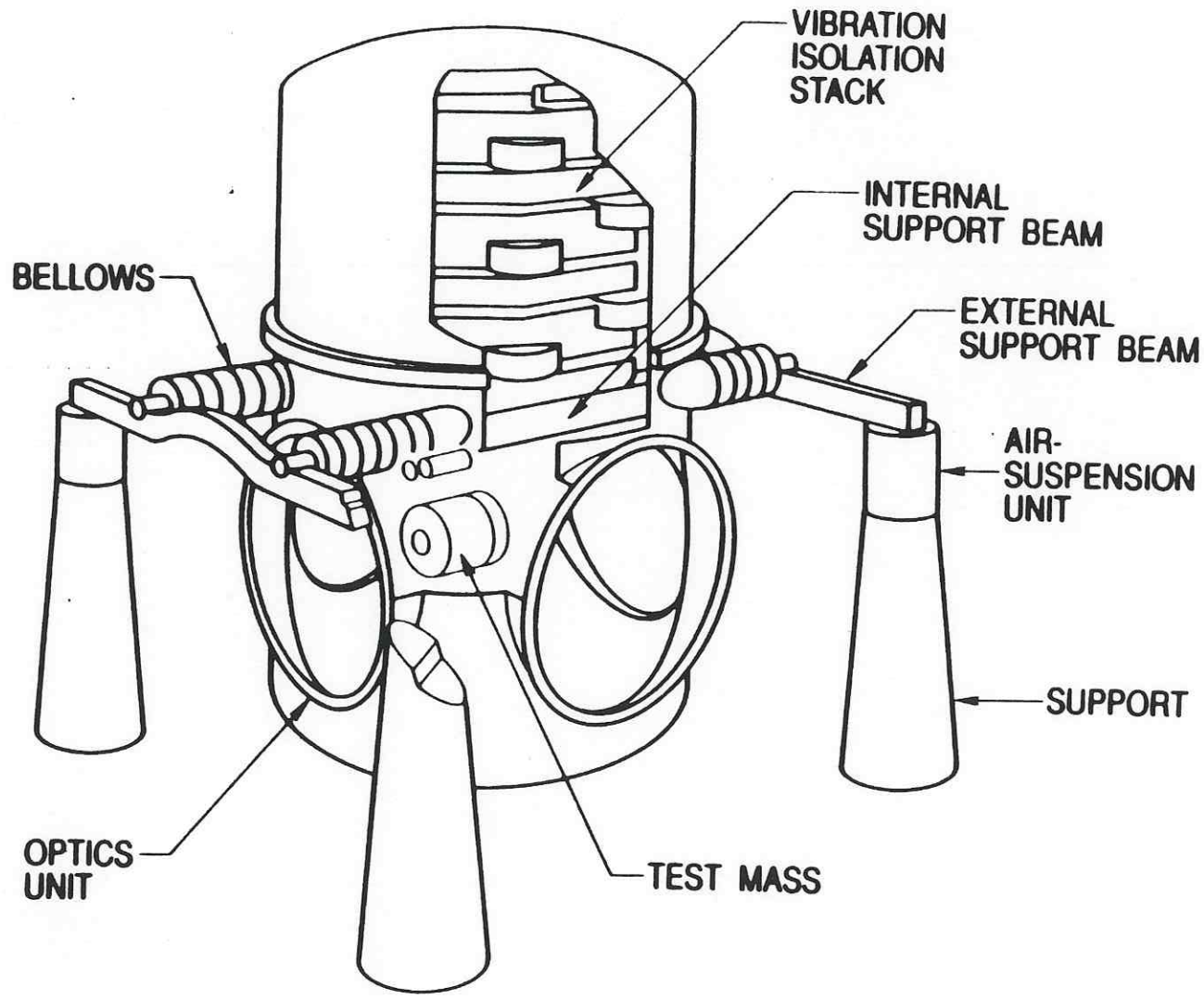
- **Hanford, Washington**
 - Located on U.S. Dept. of Energy Reservation
 - Treeless, Semi-arid Desert
 - Approx. 25 km from Richland (Metropolitan Pop. 140,000)
- **Livingston, Louisiana**
 - Located in Forested Rural Area
 - Approx. 50 km from Baton Rouge (Pop. 450,000)











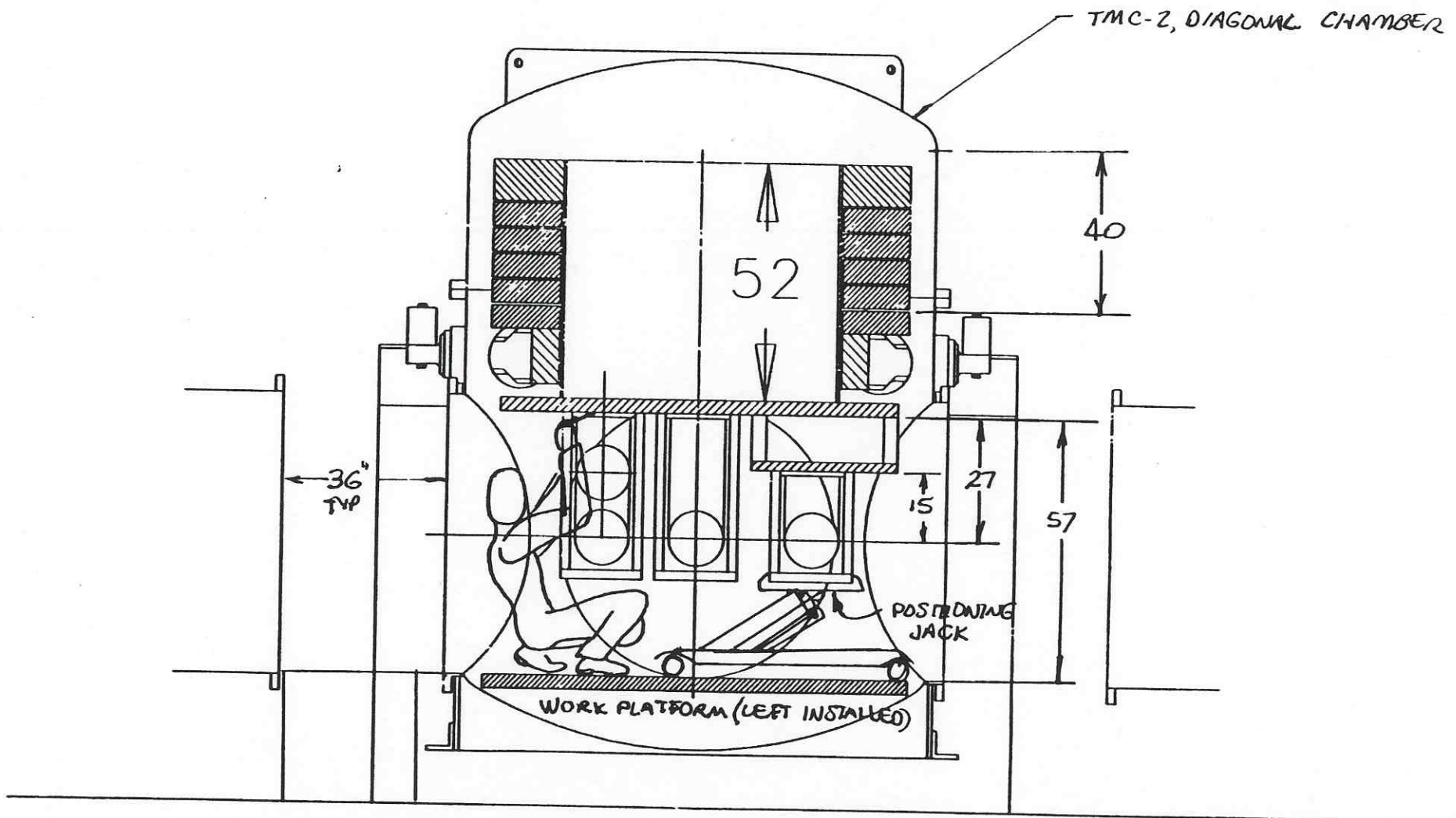
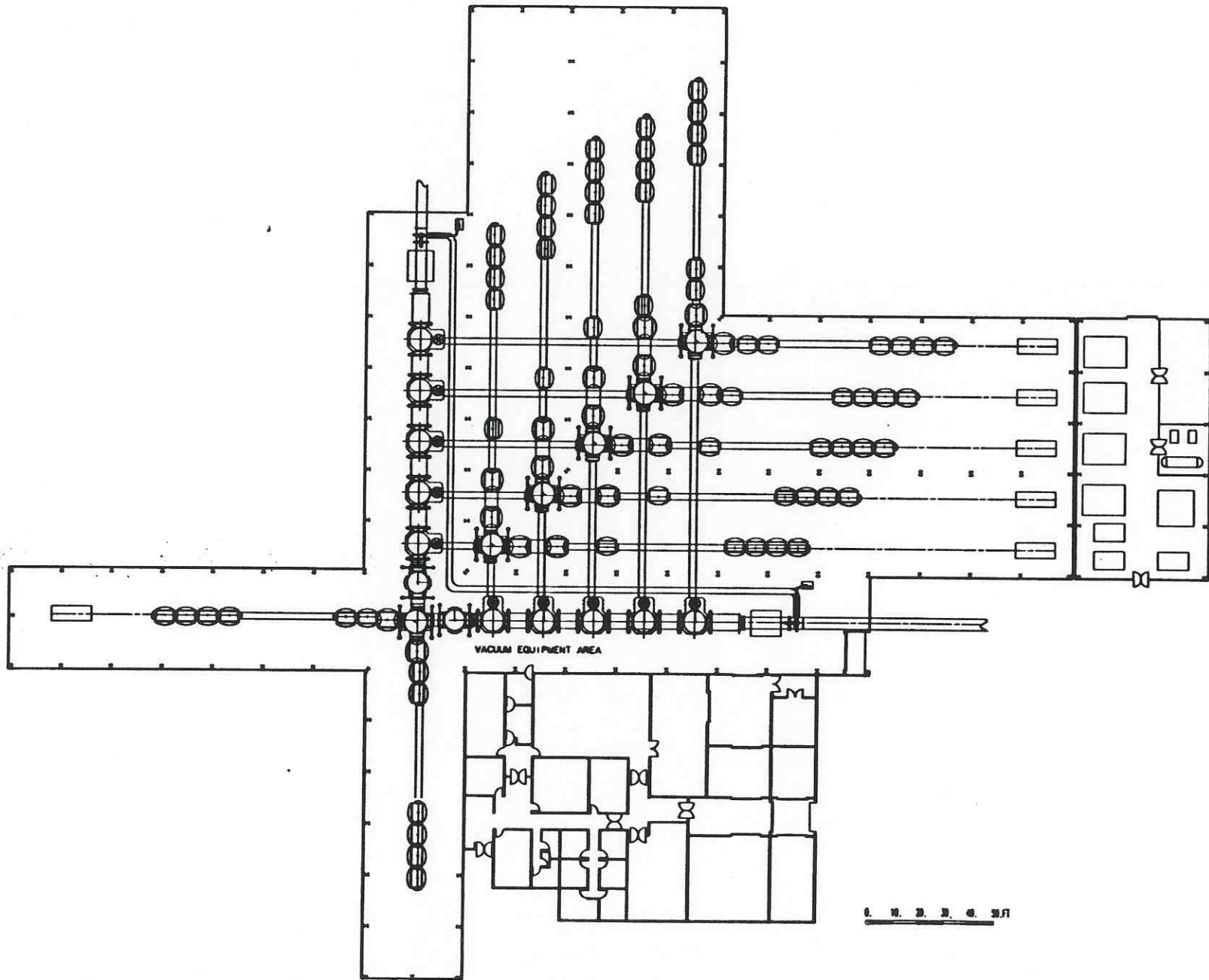


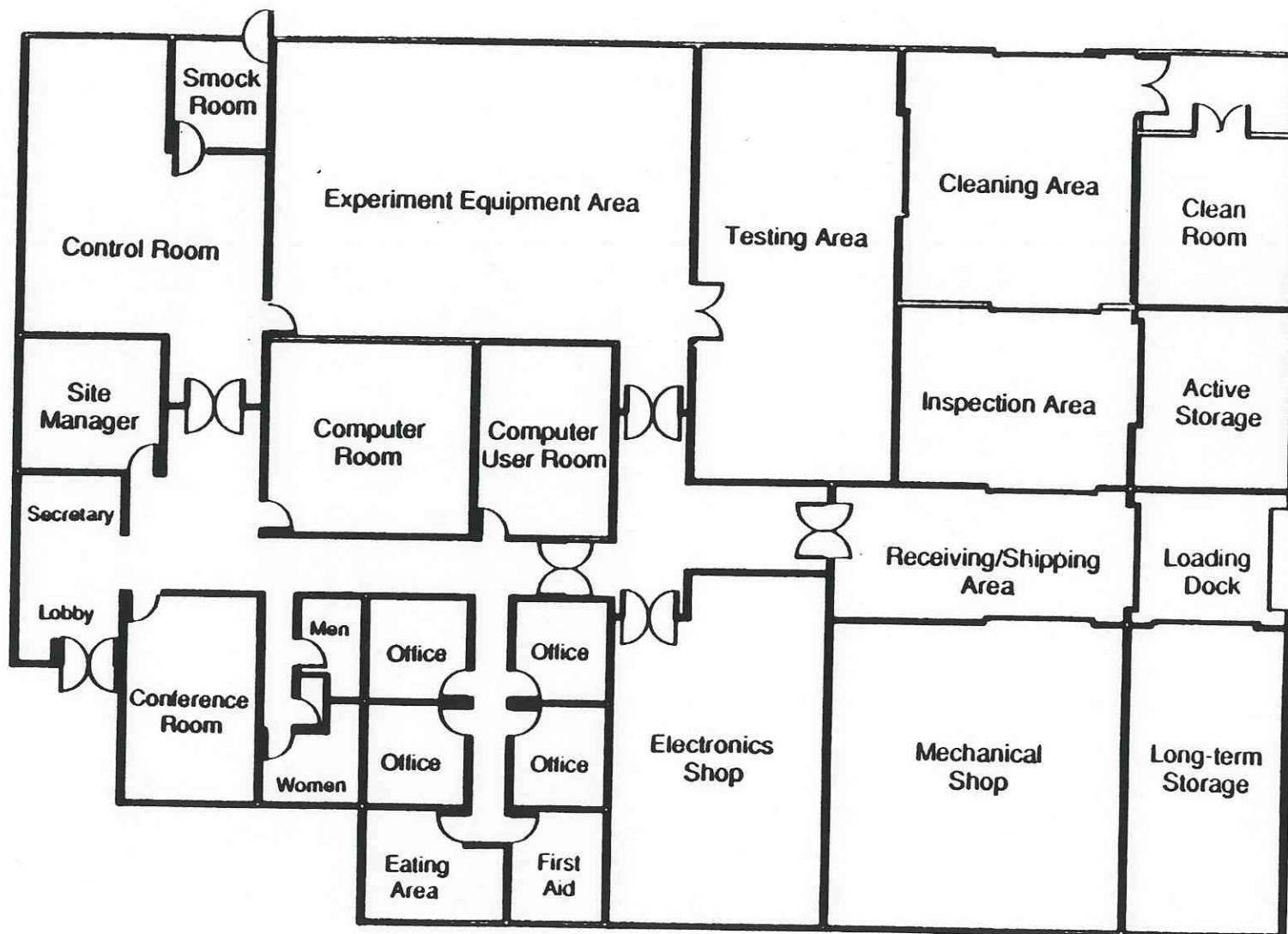
FIG. 3 INTERNAL ACCESS

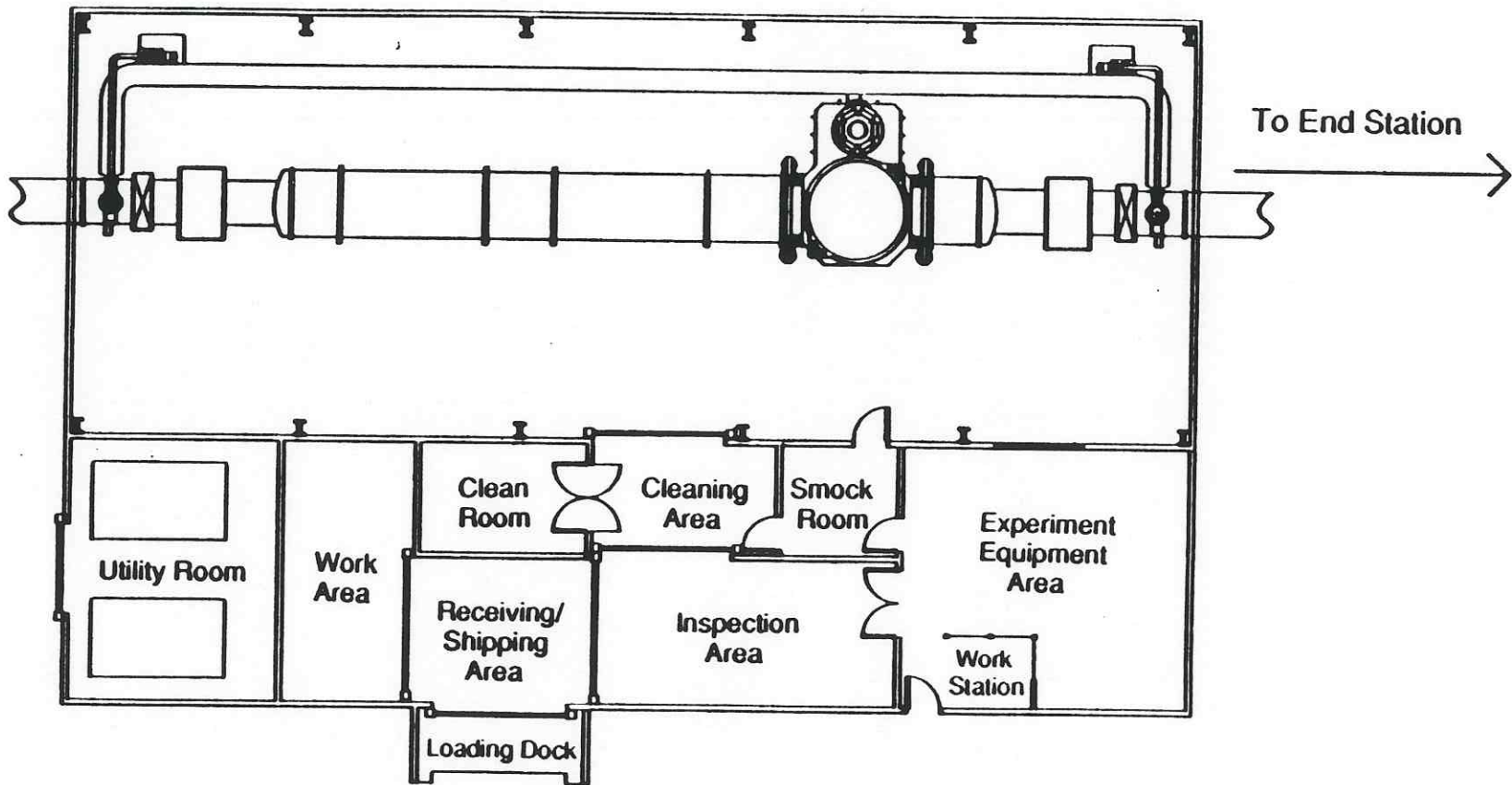
SD
9-2-92



VACUUM EQUIPMENT AREA

0 10 20 30 40 50 FT





PROGRAMMATIC STATUS

- **LIGO Construction Proposal Submitted Dec 1989**
- **Funding Approved for FY 92**
- **Cooperative Agreement Signed May 1992**
- **Funding to Date**
 - **FY92 \$15.9M**
 - **FY93 \$24M**
 - **FY94 \$39M**
- **Program Review November 1992**
E. Temple, Chair
- **In-Depth Technical Review June 1993**
A. Sessler, Chair
- **Management Plan**
 - Initial Submission Sept 1993**
 - Revised Submission Feb 1994**

CONSTRUCTION STATUS

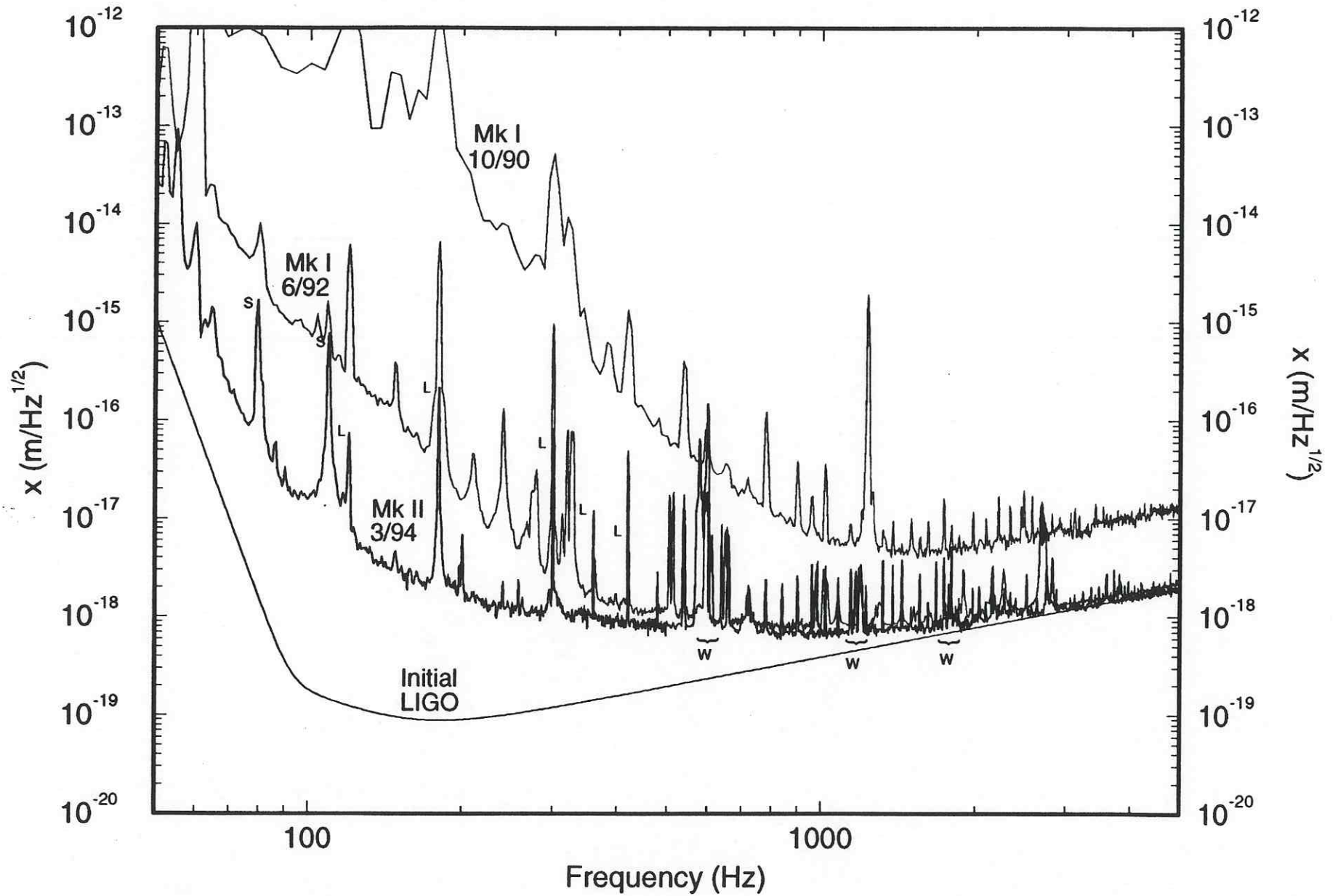
- **Sites**
 - **Hanford, WA**
 - Use Permit and MOU with DOE Signed Sept 1993**
 - Environmental Assessment and FONSI Completed Dec 1993**
 - Rough Grading to Level Foundation Plane Started Mar 1994**
 - **Livingston Parish, LA**
 - LSU Purchasing Land for Site on Behalf of State**
 - Draft EA submitted to NSF for Comment Mar 1994**
 - Several Site Issues Remain**
- **Beam Tube**
 - **Contract for Design and Qualification Test Signed Aug 1993**
 - **Preliminary Design Review Held Nov 1993**
 - **Final Design Review Scheduled April 1994**
 - **Qualification Test to Begin After FDR**
- **Preparations for Getting A-E Subcontractor for Building Design Underway**
- **Specification for Vacuum Equipment Has Been Delayed, but Expect to Restart Soon**

R&D STATUS

Substantial Progress in Most Areas

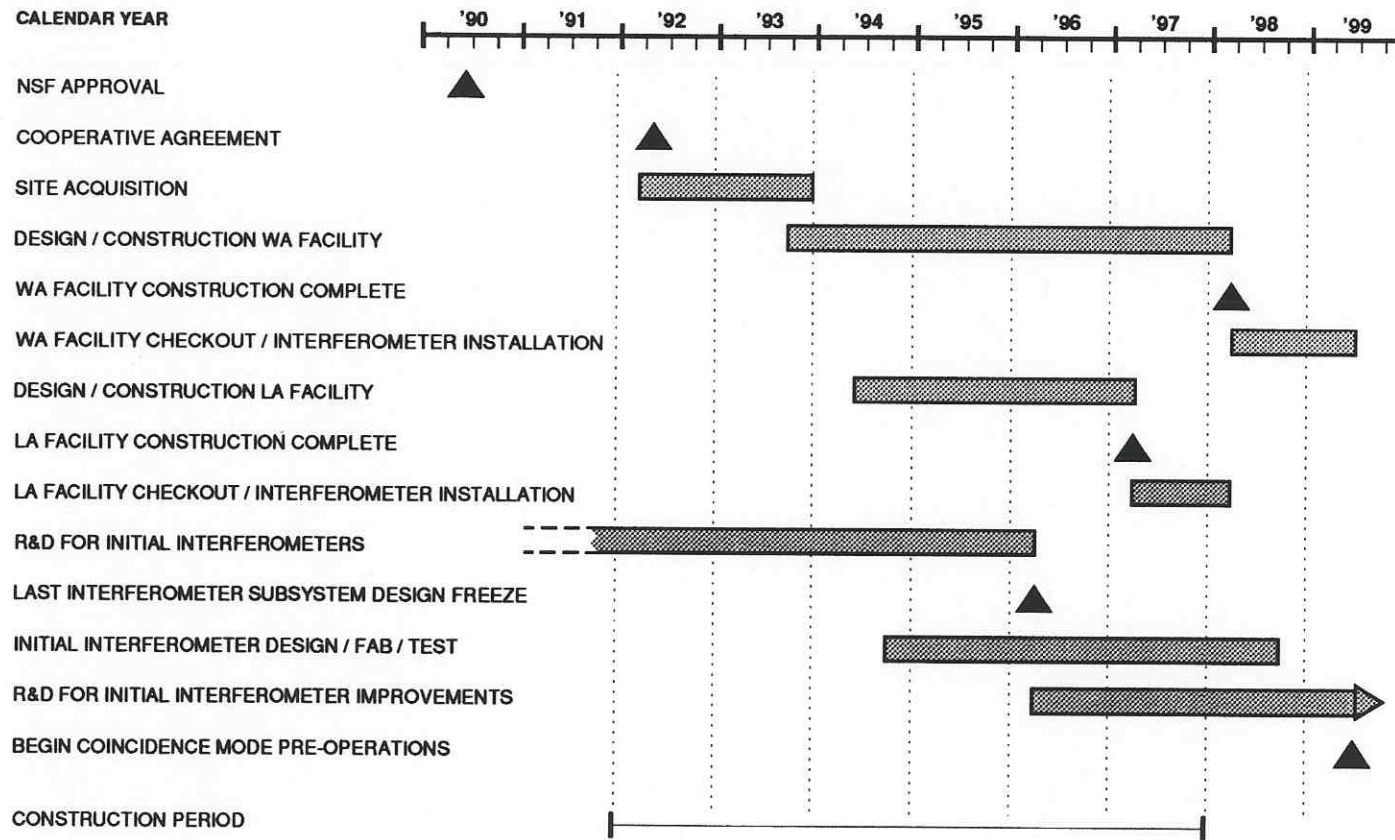
- **Interferometer R&D**
 - **Completion of Mark II 40 m Interferometer Construction**
 - All Systems Operational**
 - Improved Noise Performance at Low Frequencies Due to New Seismic Isolation Stacks**
 - Immediate Plans Include Installation of Monolithic Test Masses to Reduce Thermal Noise.**
 - **Wrap-up of Interferometer Topology Investigations Using Fixed Mass Interferometers**
 - Selection of Optical Topology for Initial LIGO Interferometers**
- **Development and Testing of “LIGO-Scale” Subsystems**
 - **Prestabilized Laser Operating**
 - **Mode-Cleaner Under Initial test**
 - **Seismic Isolation Stacks Under Test in 40 m Interferometer**
 - **Suspension System, Alignment System, Length Sensing Servosystem in Planning Stage**
- **Continuing Development of Large Optical Components**
 - **Detailed Optical Modeling to Develop Specification for Surface Figure**
 - **Preparing to Fabricate Full Scale Test Pieces**
 - **Collaboration with VIRGO Project**
- **Control and Data System**
 - **Hiring of Core Group Now Complete**
 - **Initial Top-level Design in Progress**

Displacement Sensitivity of Caltech 40 m Interferometer



LIGO PROJECT SCHEDULE

9/93



SIGNIFICANT MILESTONES

CONSTRUCTION ← → PRE-OPERATIONS

MILESTONE	1992	1993	1994	1995	1996	1997	1998	1999
<u>PROGRAMMATIC</u> Start LIGO Construction Phase Start LIGO Pre-Operations Phase	△						△	
<u>CIVIL CONSTRUCTION</u> Initiate Site Development Tube Slab Accepted Tube Cover Accepted Select Building Design Contractor Building Designs Completed (FDR) Buildings Completed/Accepted		△ △	△ △ △	△		△ △ △		
<u>VACUUM SYSTEM</u> Beam Tube FDR Beam Tube Qualification Test Review Beam Tube Installed/Accepted Release Vacuum Equipment RFP Vacuum Equipment FDR Vacuum Equip. Installed and Accepted Facility Ready/Accepted		△ △	△	△ △	△	△ △	△ △	△
<u>INTERFEROMETER</u> Select Interferometer Optical Topology Freeze Subsystem Requirements Select CDS Architecture Validate Test Mass Susp. Capability Validate Optics Capability Validate Phase Noise Capability Demonstrate Laser/CDS Interface Freeze Length Sensing Servo Design Select Data Analysis Algorithm Initiate Interferometer Integration Interferometer Installation Complete		△	△ △ △ △	△ △ △	△	△	△	△

W = Washington, Hanford Site
 L = Louisiana, Livingston Site