

*R. Vogt Presentation
to Advisory Committee
for Physics & ACAST*

GOALS AND POSSIBLE PAYOFFS Oct. 1988

I. Physics

- Verification of existence of gravitational waves
- Measurement of rest mass ($m = 0?$) and spin ($S = 2?$) of graviton
- Verification of existence and dynamics of black holes; first test of general relativity in domain of highly non-linear, dynamic gravity

II. Astronomy & Astrophysics

- Open new (non-electromagnetic) window onto universe
- Physics of neutron stars
- Binary coalescences = "standard candles" for determination of Hubble constant
- Primordial (10^{-43} sec) gravitational waves



CALTECH/MIT LIGO HISTORY

- 1971: • R. Weiss (MIT) completes feasibility study for interferometric gravity wave detector (Michelson/delay-line type)
- 1976: • R. Drever (Glasgow) invents Fabry-Perot type gravity wave interferometer
- 1979: • R. Drever moves from Glasgow to Caltech
 - Deslattes Comm. (NSF) endorses interferometers
 - Caltech and MIT funded by NSF for interferometer R&D
- '81-'83: • MIT/Stone & Webster/A. D. Little design and cost study of multi-km baseline interferometer
- 12/83: • Drever-Thorne-Weiss (DTW) presentation to NSF Physics Advisory Comm.
 - DTW presentation to Wilkinson subpanel of Physics Survey Comm.
- 3/84: • DTW presentation to NSB
- '84-'87: • Caltech/MIT/JPL design study for LIGO
- 7/84: • DTW presentation to President's Science Advisor
- 11/84: • Caltech/MIT MOU
 - DTW presentation to NSB and OMB
- 11/86: • NSF Cambridge Review Comm. report

LIGO: Supporting Studies

- “A Study of a Long Baseline Gravitational Wave Antenna System” (MIT, Oct. 1983)

Industrial Consultants:

Arthur D. Little Corp.

Stone & Webster Engineering Corp.

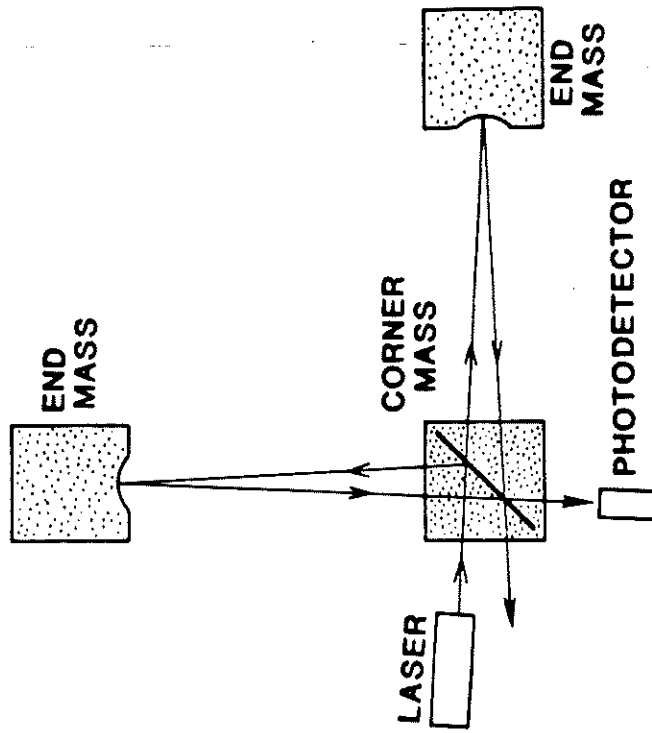
- “LIGO Study: JPL Summary Report” (Caltech/MIT, Jan. 1988, initiated Apr. 1984)

Outside Consultants:

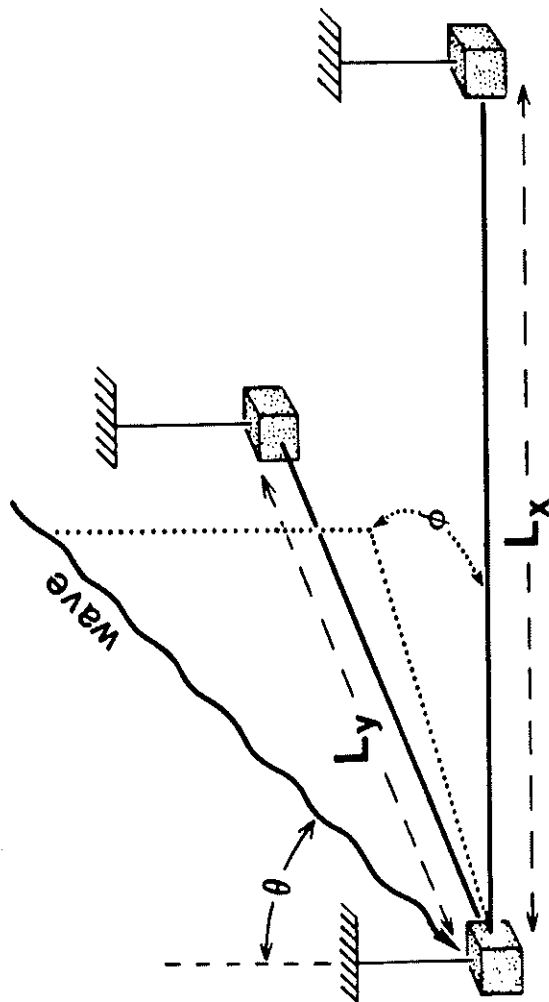
Jet Propulsion Laboratory (JPL), Caltech

1984 CAL TECH/MIT MOU

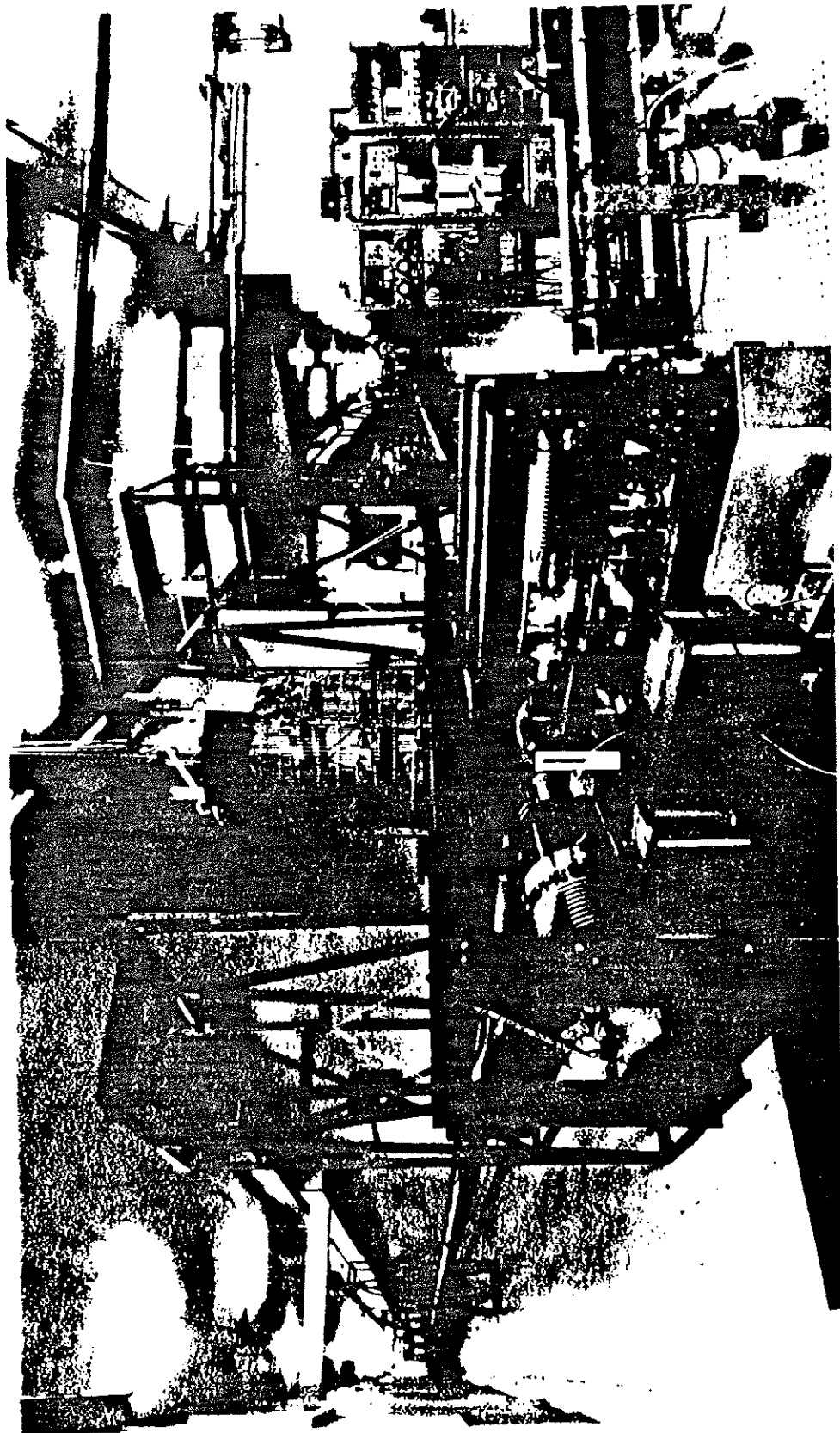
- **JOINT DESIGN, CONSTRUCTION, AND OPERATION OF FACILITIES FOR LASER INTERFEROMETERS, DETECTORS.**
- **JOINT DESIGN, CONSTRUCTION, AND OPERATION OF FIRST DETECTORS IN FACILITIES.**
- **ACCESSIBILITY OF FACILITIES FOR INTERFEROMETERS FROM OTHER SCIENCE TEAMS (AFTER COMPLETION OF FIRST JOINT GRAVITY-WAVE SEARCHES).**

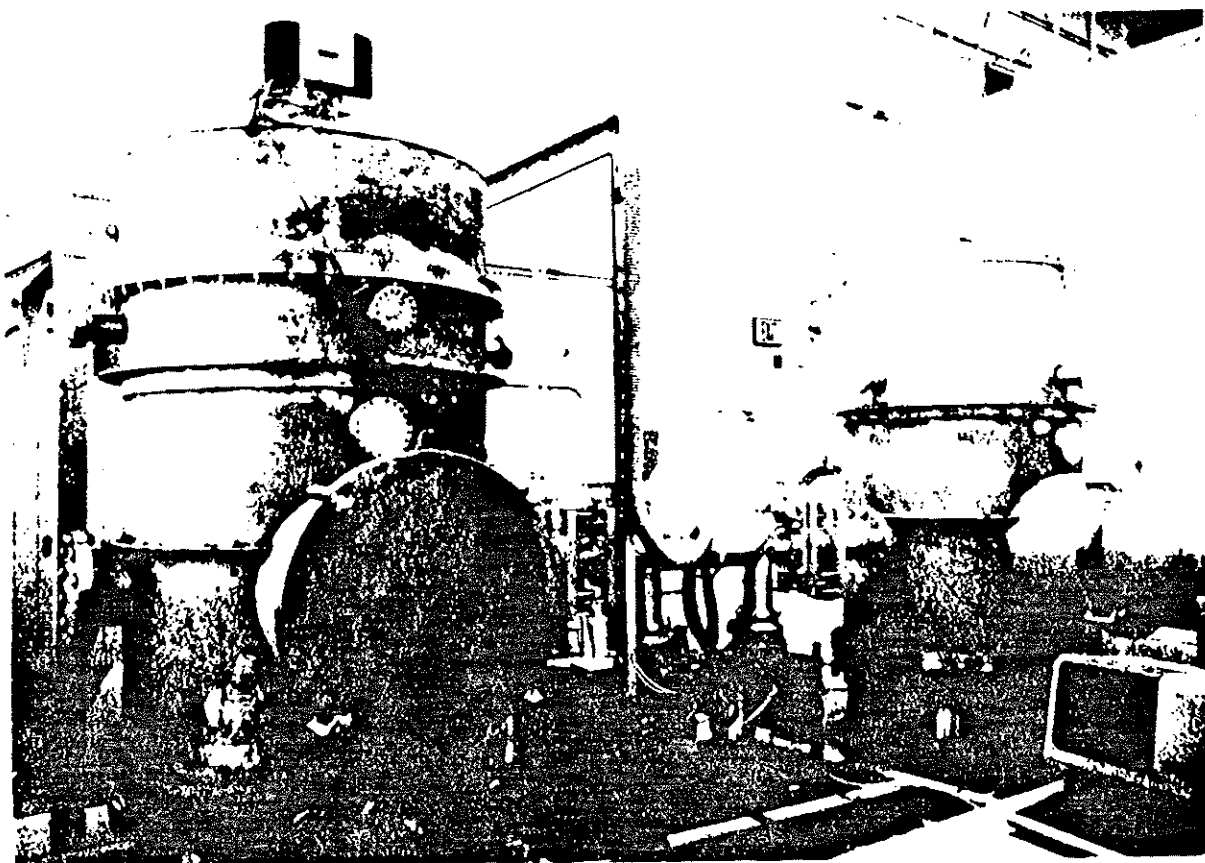
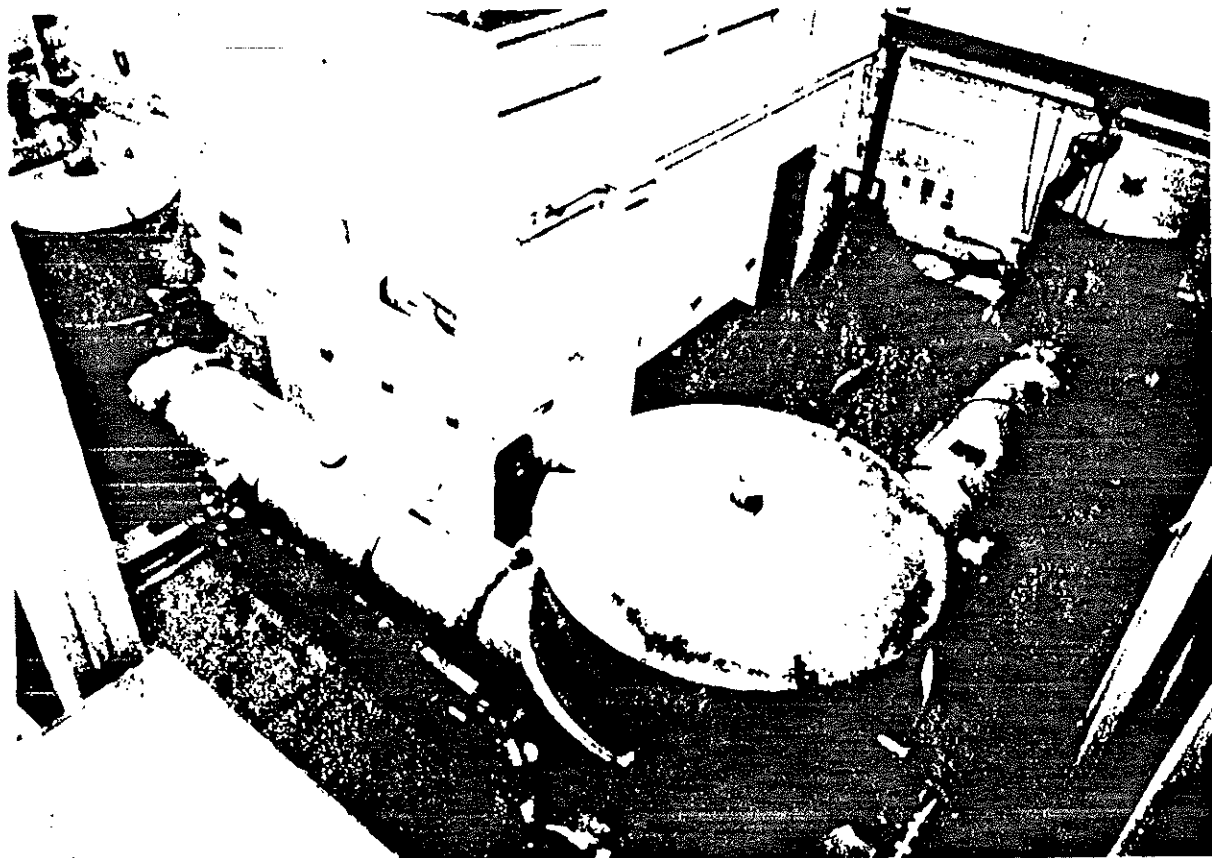


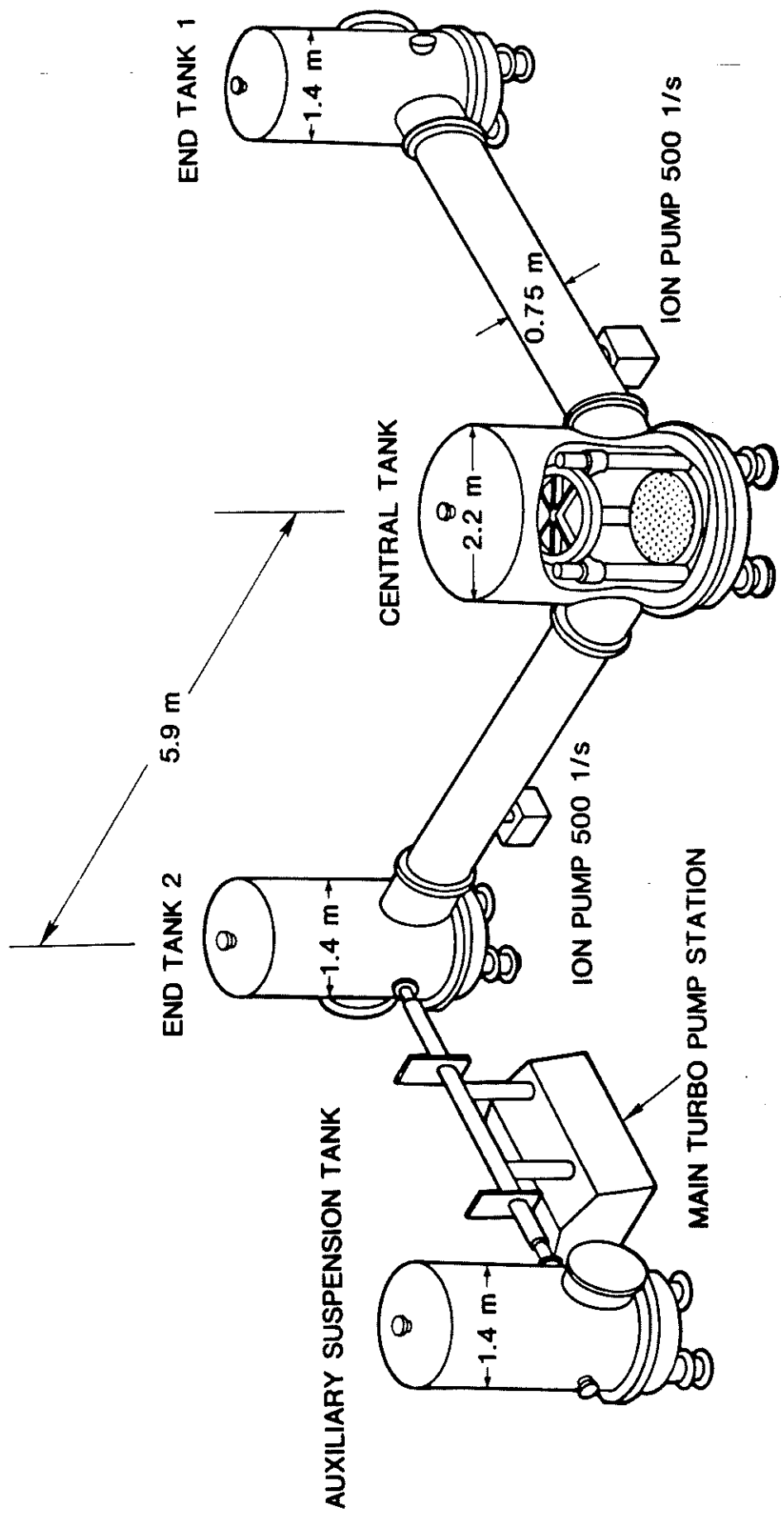
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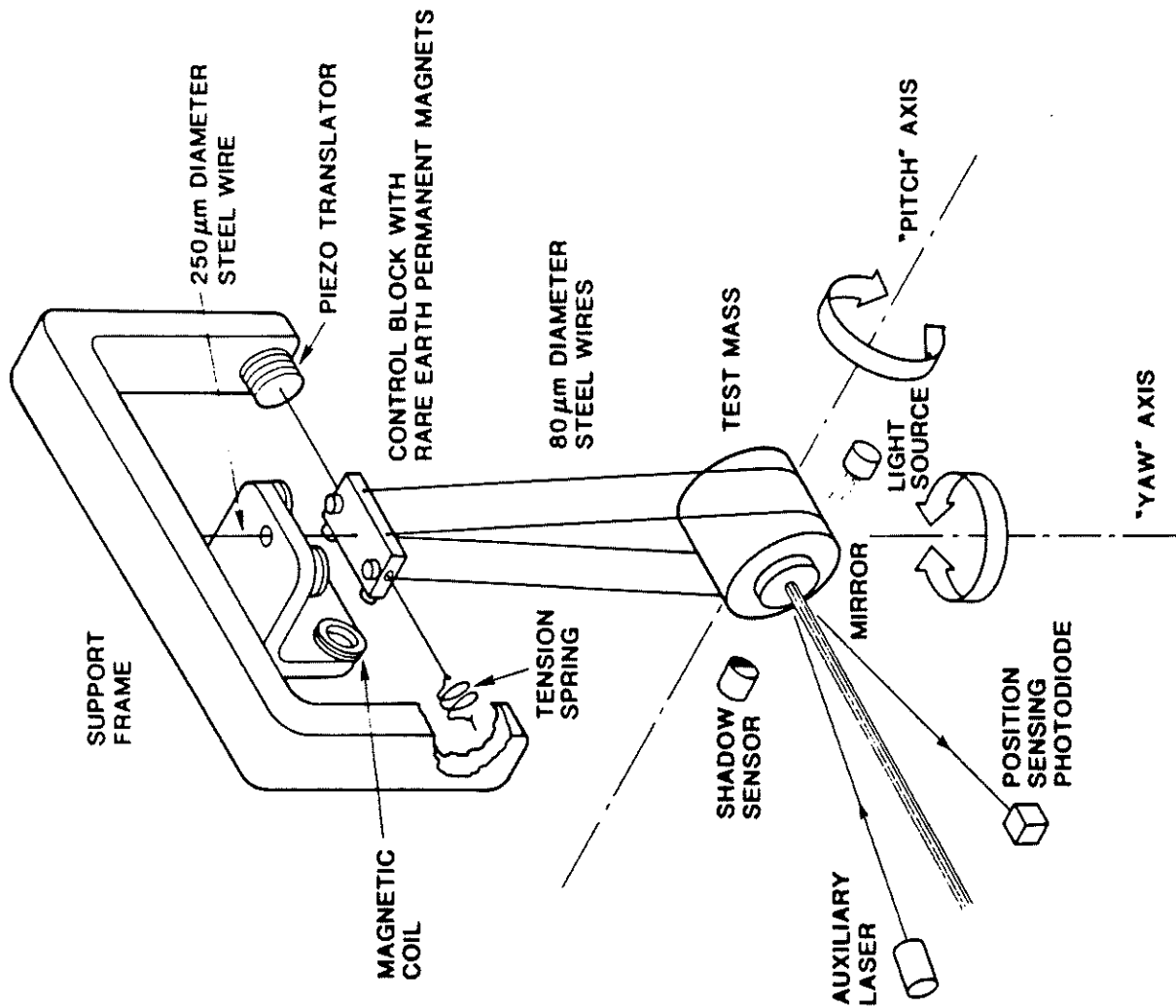


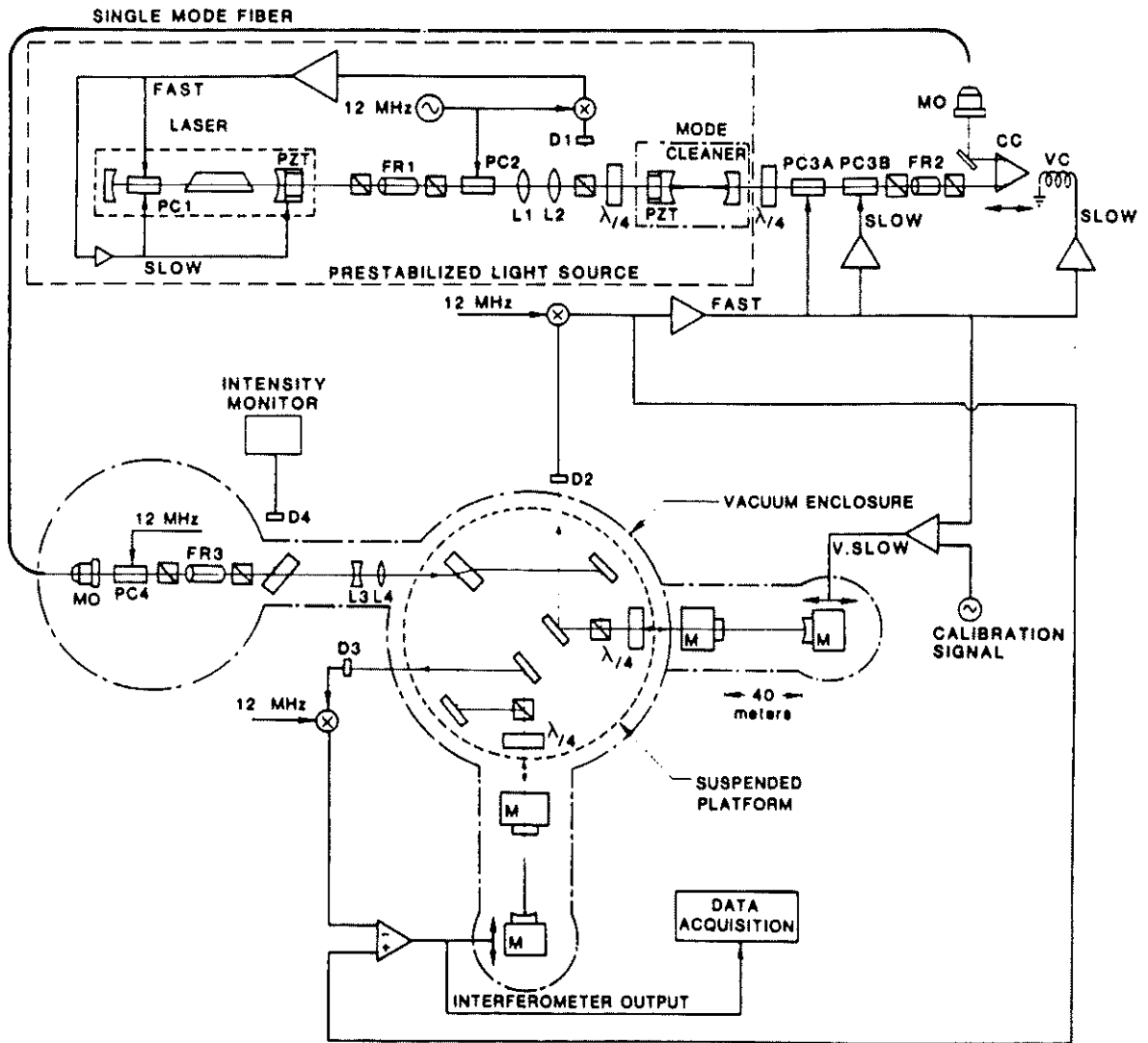
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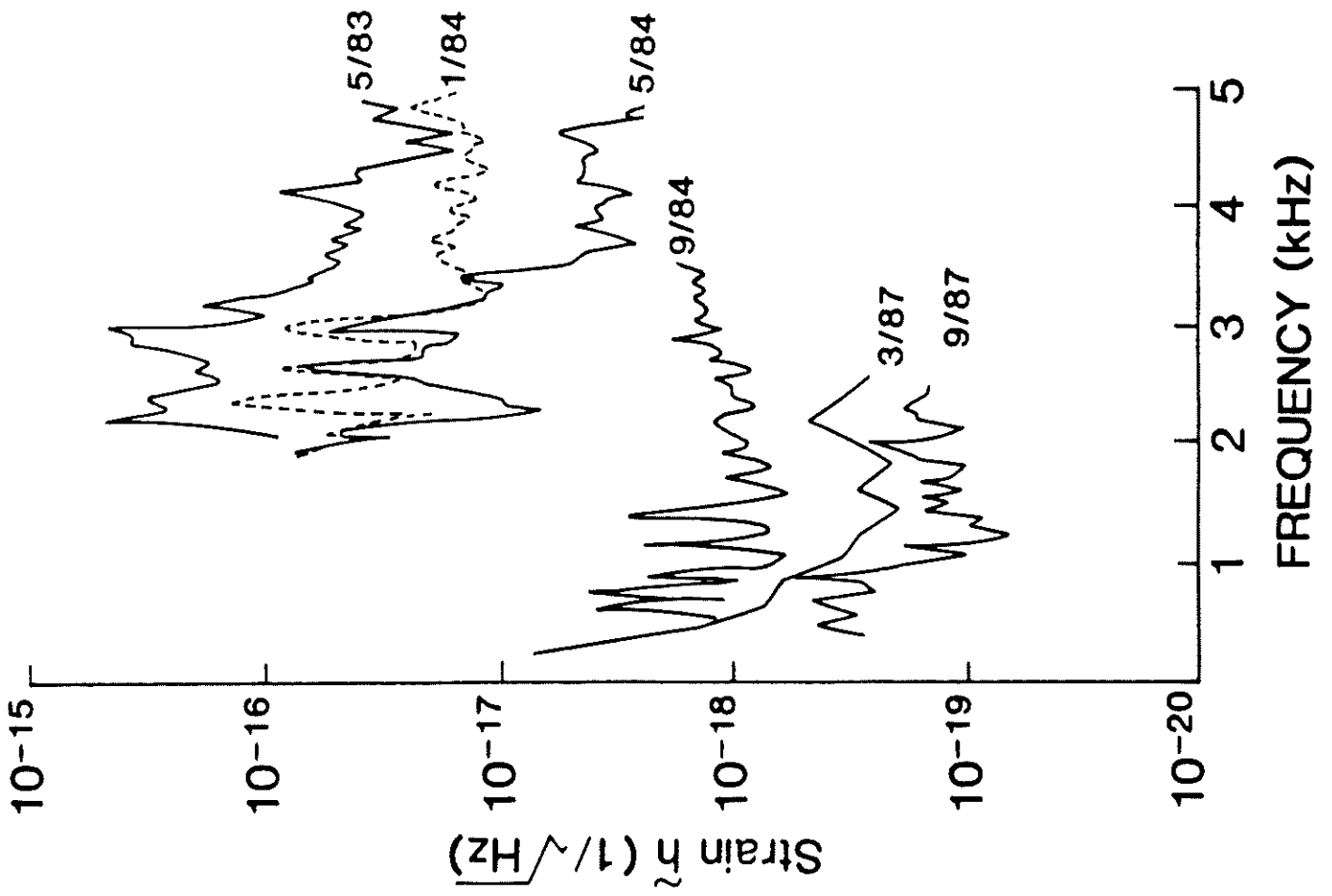






KEY TO SYMBOLS:

- | | | |
|--|---|--|
|  Beam-splitting Polarizer |  Piezo-electric transducer |  rf demodulator (mixer) |
|  Pockelscell |  Quarter-wave plate |  Sine-wave generator |
|  Test Mass with mirror |  Faraday rotator |  Amplifier |
|  Mode-matching lenses
L1 - 4 |  Moving
Corner cube |  Photodiode/amplifier |
| | |  MO Microscope objective |
| | |  VC Voice Coil |



GRAVITY WAVE SIGNALS

$$h(t) \equiv \frac{\Delta L}{L}$$

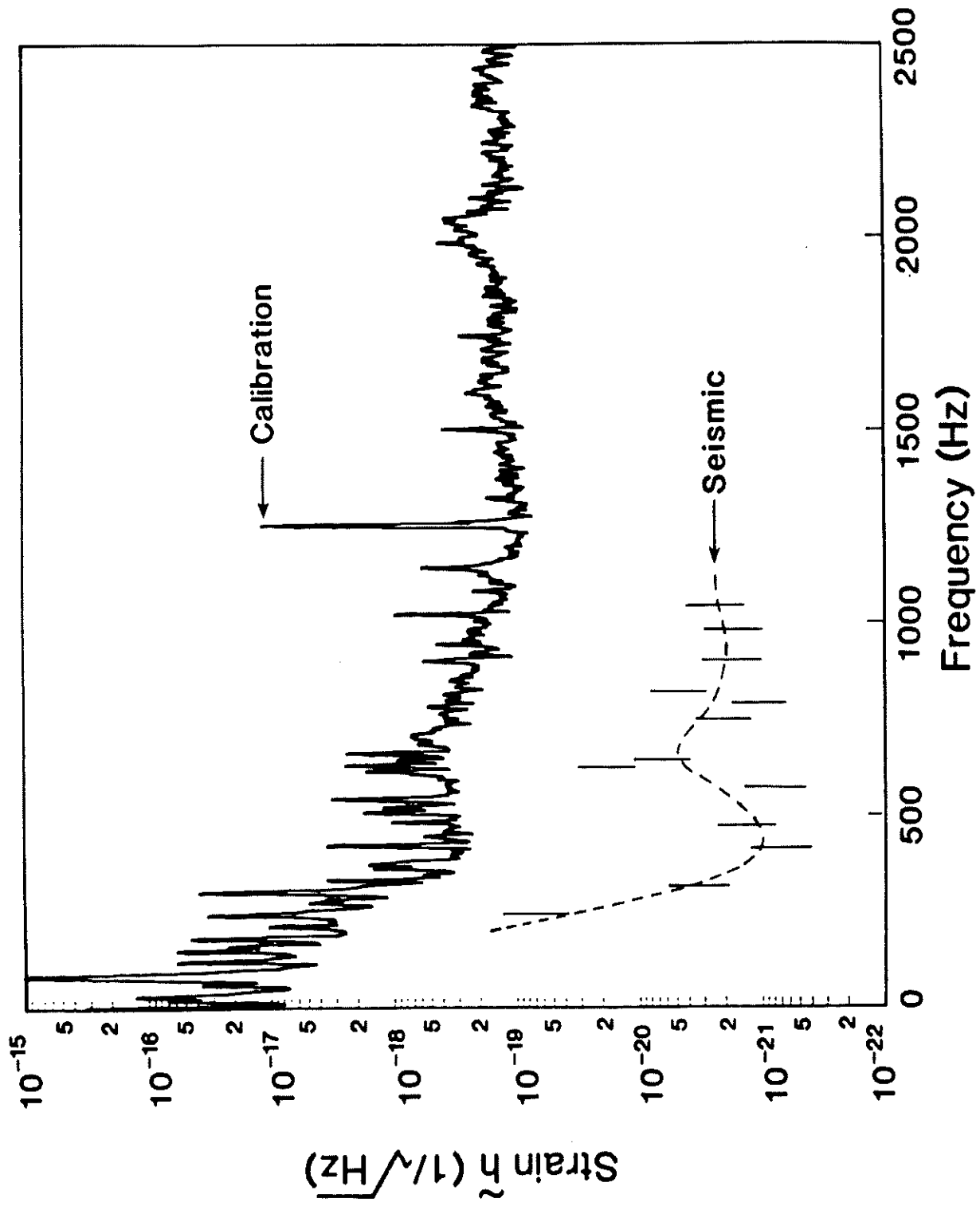
$$\tilde{h} \equiv \sqrt{S_h(f)}$$

$S_h(f)$ = spectral density of h

$$h = \tilde{h} \sqrt{\Delta f}$$

bursts: $\Delta f \approx f$

periodic: $\Delta f \approx 1/\tau$



SITE CANDIDATES

Group I

- Edwards Air Force Base (EAFB), California

Idaho National Engineering Laboratory (INEL), Idaho

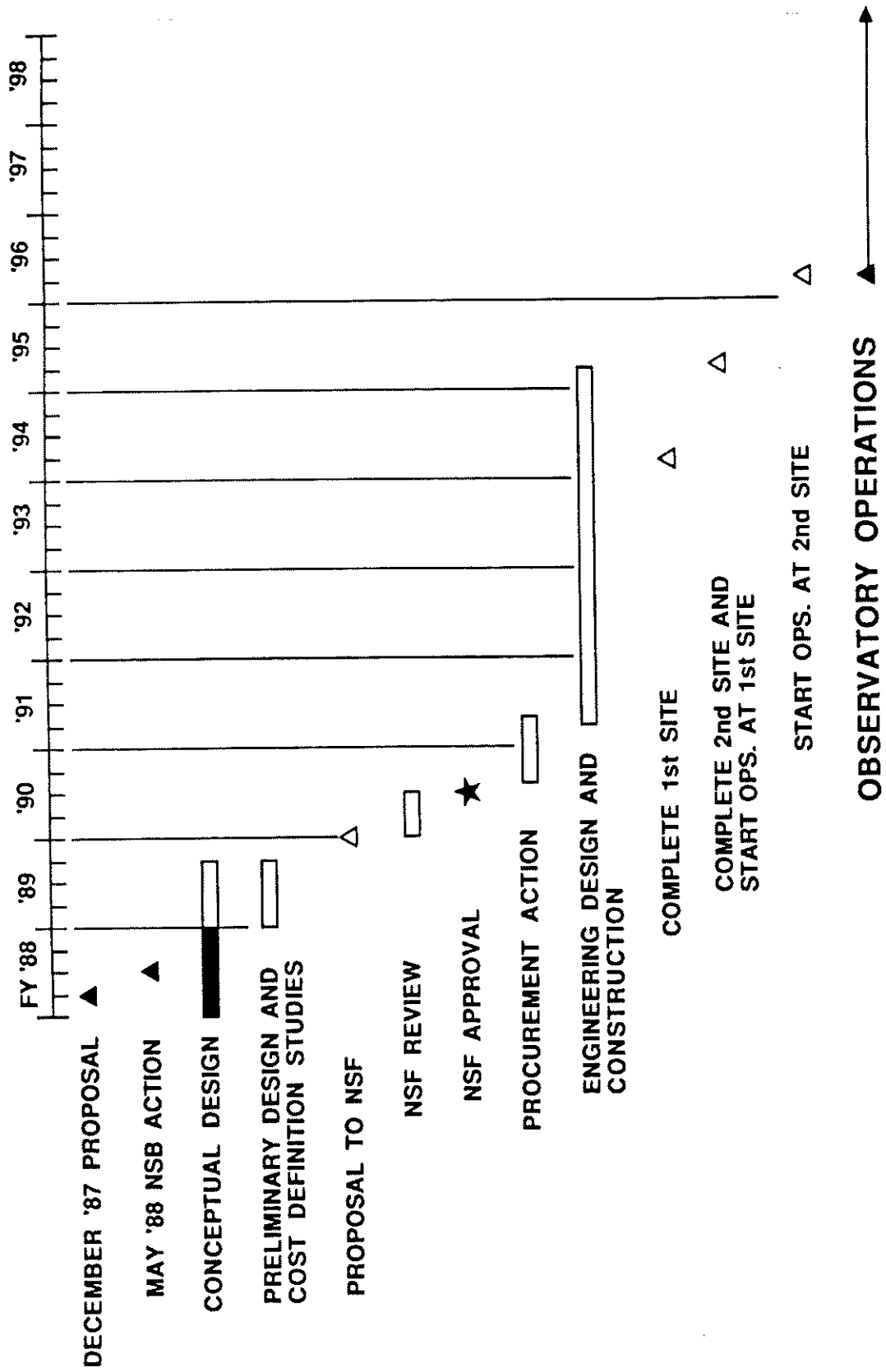
Skull Valley, Utah

Group II

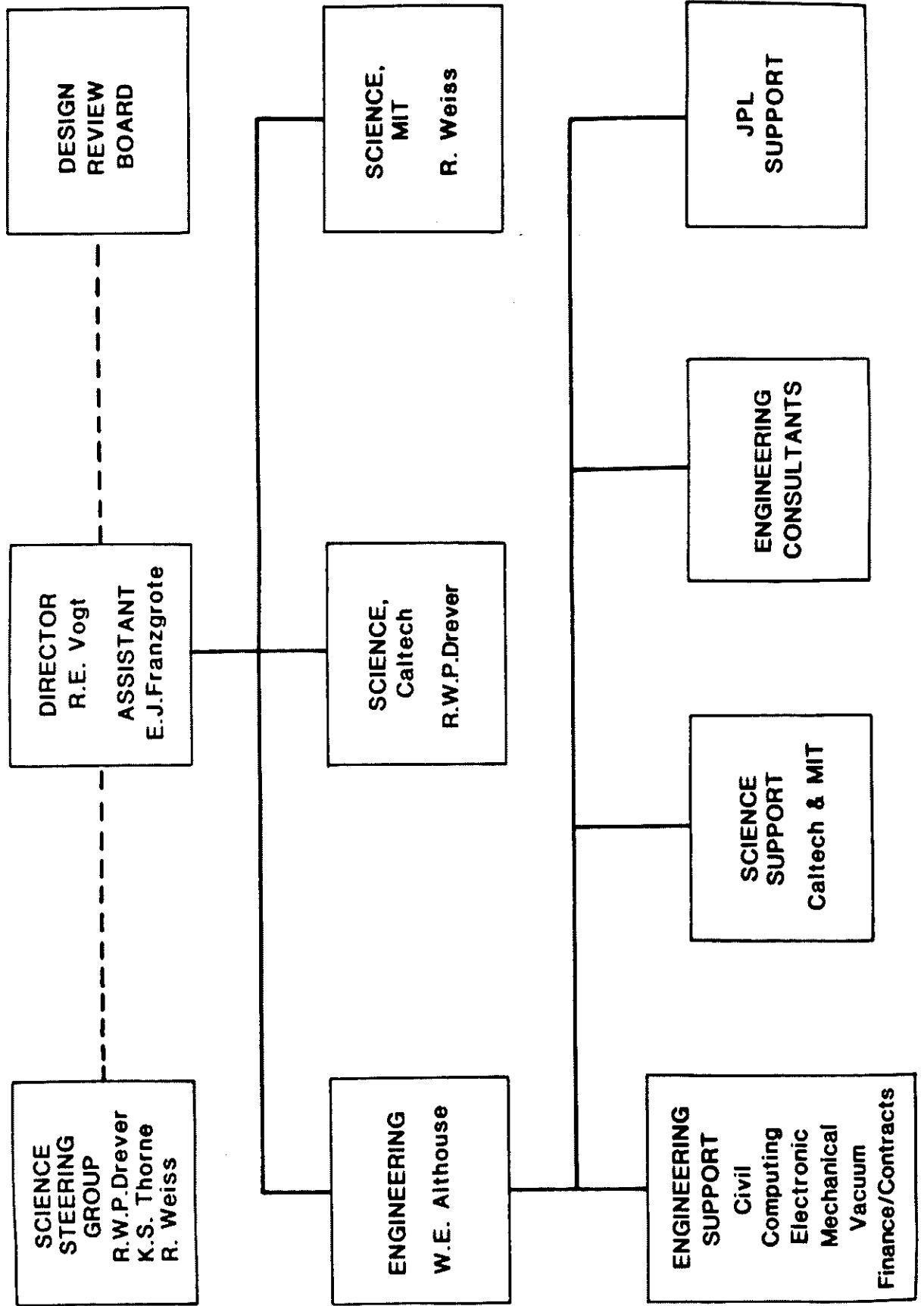
Columbia, Maine

Livingston Parish, Louisiana

LIGO PROJECT SCHEDULE



LASER INTERFEROMETER GRAVITATIONAL WAVE PROJECT (LIGO)



CALTECH/MIT LIGO: DESIGN FEATURES

1. OBSERVATORY:
 - ONE L-SHAPED DETECTOR FACILITY AT EACH OF TWO WIDELY SEPARATED SITES UNDER COMMON MANAGEMENT.

2. DETECTOR FACILITY
 - a) INTERFEROMETERS
 - TUBE ARM LENGTH, ≈ 4 KM
 - TUBE DIAMETER, ≈ 1.2 M
 - VACUUM CAPABILITY, $\approx 10^{-8}$ TORR
 - b) VACUUM FACILITY
 - CAPABILITY FOR INTERFEROMETERS OF TWO DIFFERENT ARM LENGTHS
 - CAPABILITY FOR SIMULTANEOUS OPERATION OF SEVERAL INTERFEROMETERS

3. MINIMUM LIFETIME
 - 20 YEARS

