The Status of LIGO

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CALTECH

- Facility overview
- Review of progress in last year
  - civil construction
  - vacuum system
  - detector
- Plans for coming year
- Longer term view of LIGO commissioning and operations plans

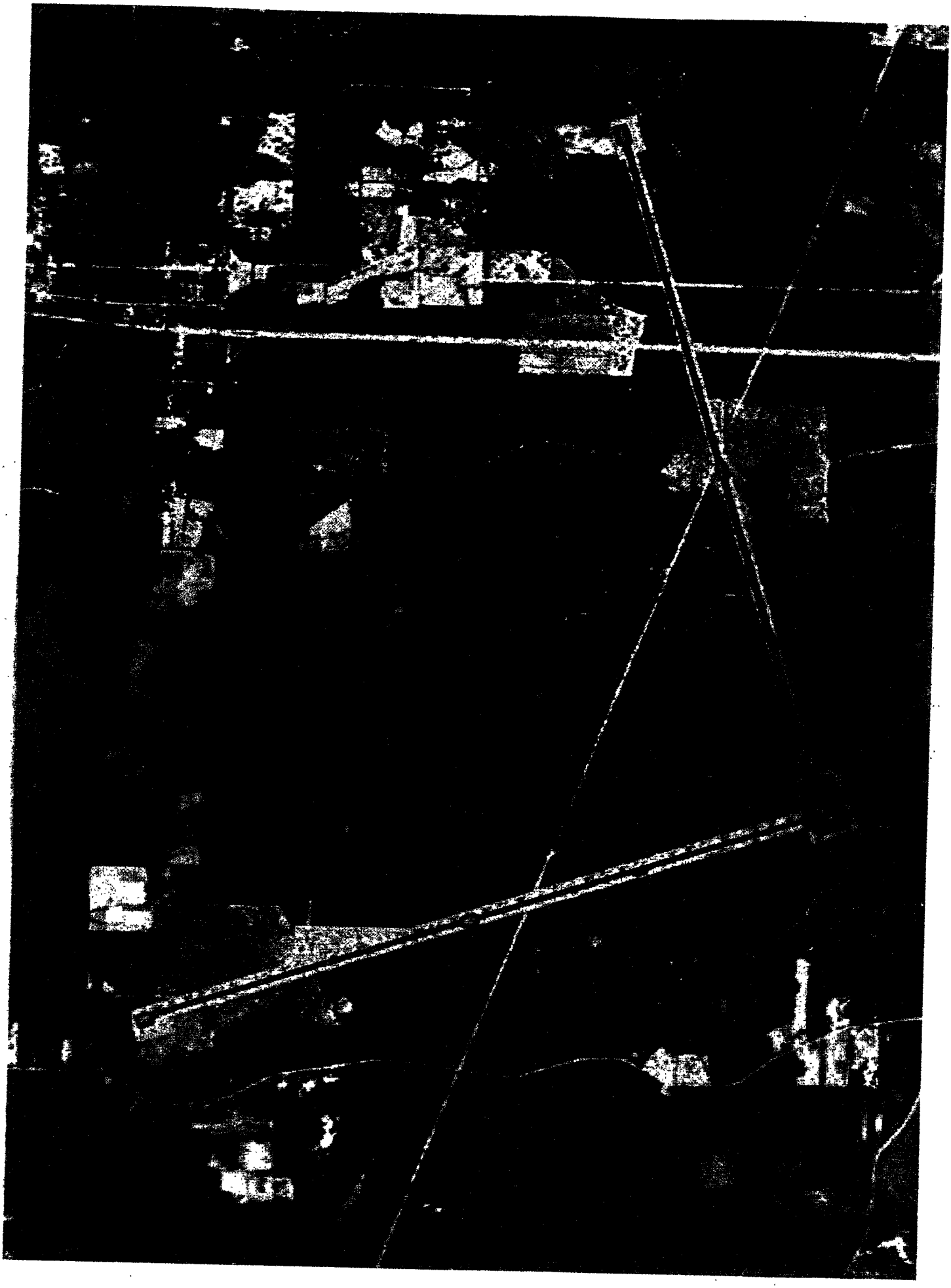
LIGO SITES

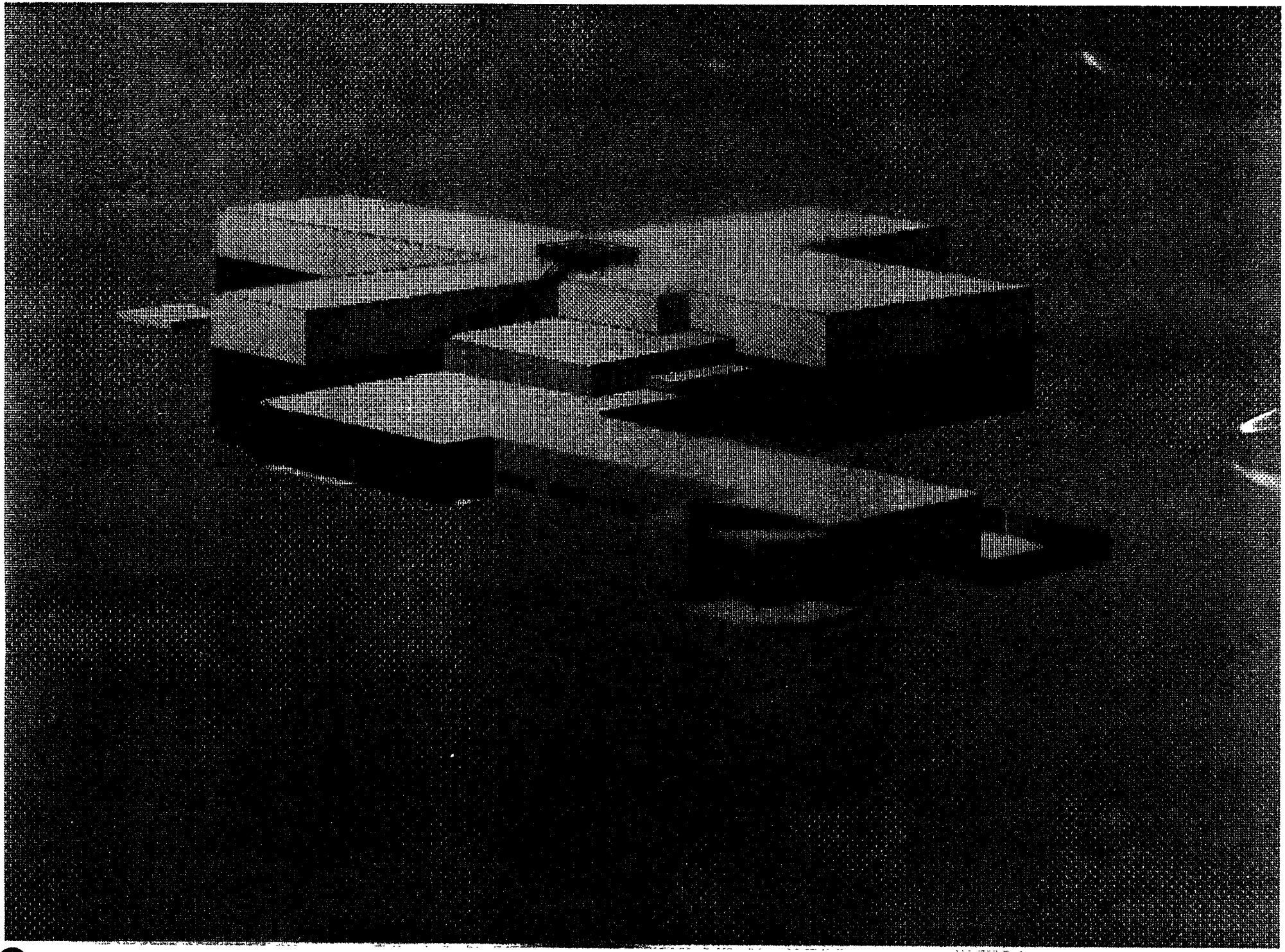
HANFORD, WASHINGTON

- LOCATED ON U.S. DOE RESERVATION
- TREELESS, SEMI-ARID HIGH DESERT
- APPROX. 25 KM FROM RICHLAND, WA (POPULATION :140,000)

LIVINGSTON, LOUISIANA

- LOCATED IN FORESTED RURAL AREA
- MIXED FOREST; LOW-LYING; POOR DRAINAGE
- APPROX. 50 KM FROM BATON ROUGE, LA (POPULATION :450,000)



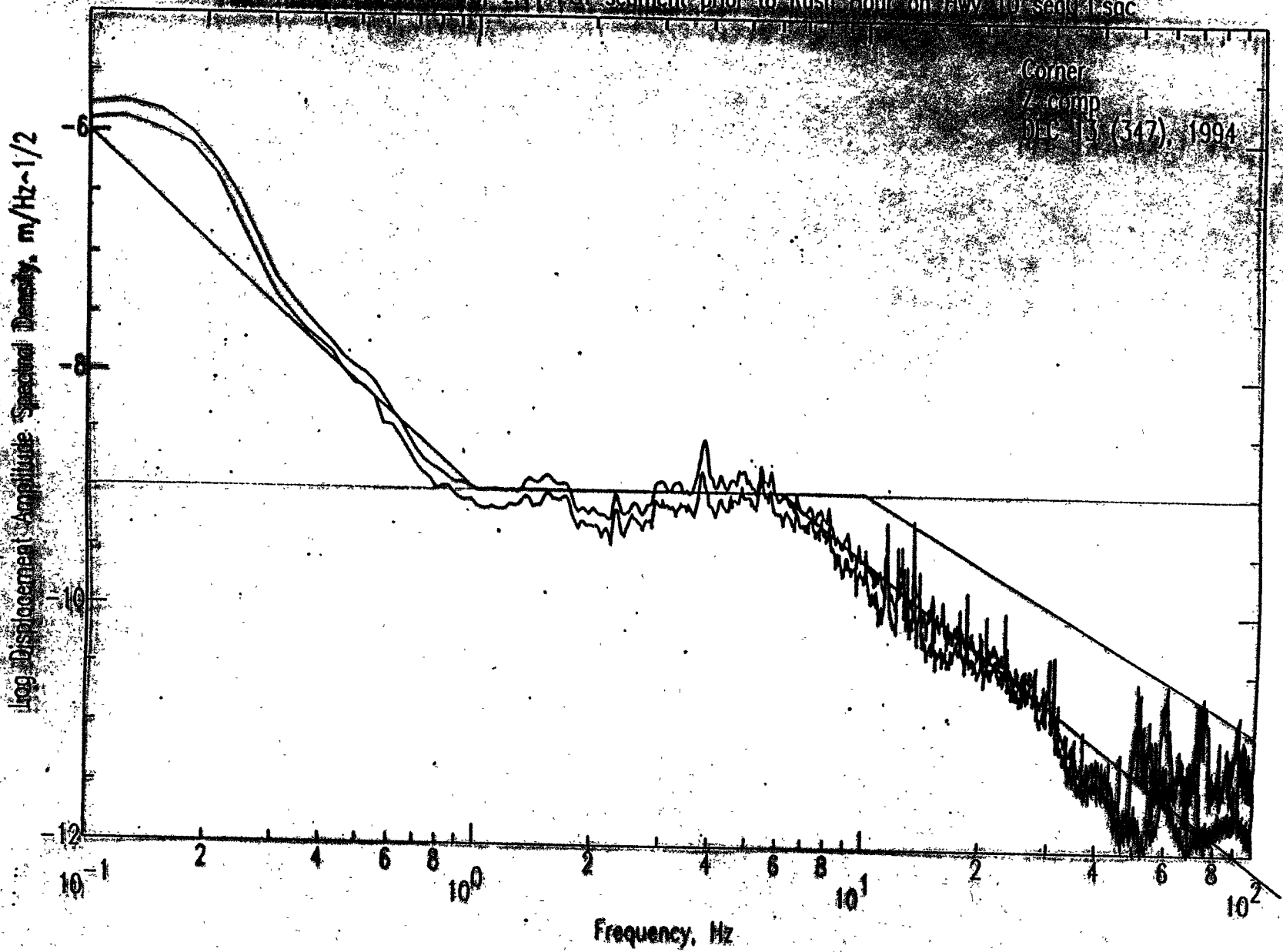


Building Features

- Laser and vacuum equipment area
  - 30 inch (75 cm) isolated slab
  - temperature stabilized +/- 2 degrees C
  - construction consistent with class 50,000 clean room
  - 26.5 ft crane hook height
- Office and lab space ~ 20,000 sq. ft (2000 sq. m)
  - office space and conference rooms for 20-30 staff
  - control room
  - computer access room for users
  - electronics shop
  - mechanical shop
  - receiving and storage area
- clean areas within OSB:
  - vacuum prep area
  - optics lab

Wind Effects on a Large Structure - Moses Lake, WA

- Japan Airlines (JAL) aircraft hangar
- Grant County Airport, Moses Lake, WA
  90 miles north of Hanford LIGO site
- 370 ft. x 268 ft. x 66 ft. high
- riveted steel truss-work
- corrugated steel siding
- 2 in. of fiber-board insulation
- 300 degrees of surrounding land is flat, level airport property
- measurements made during late night and early morning
- seismometer bandwidth: 0.1 to 50 Hz



Hanford Quiet Time

Figure 8.1-9: Vertical component amplitude spectra at the Corner on weekday afternoon prior to rush hour traffic. This time period corresponds to 680 - 1040 s on the 2 p.m. spectrogram in Figure 8.1-6.

Civil Construction Status

- Louisiana: rough grading -> July
- Washington: Concrete slab, Electrical installation, Beam tube enclosure fabrication
- Building:
  - Final design package to be completed April 12.
  - Expect to place construction package out for bid in May
  - Initiate construction ~ August.
- Preparing two separate bid packages:
  - two interferometer corner station
  - three interferometer corner station

Competitiveness of the construction industry in Washington and Louisiana will help decide capacity of initial building.

- In either case, expansion plan has been developed so that further increase in number of interferometers is not precluded.

Vacuum System Status

- Process Systems International (Westborough, Massachusetts) chosen to provide:
  - vacuum pumps
  - valves, vacuum instrumentation
  - chambers

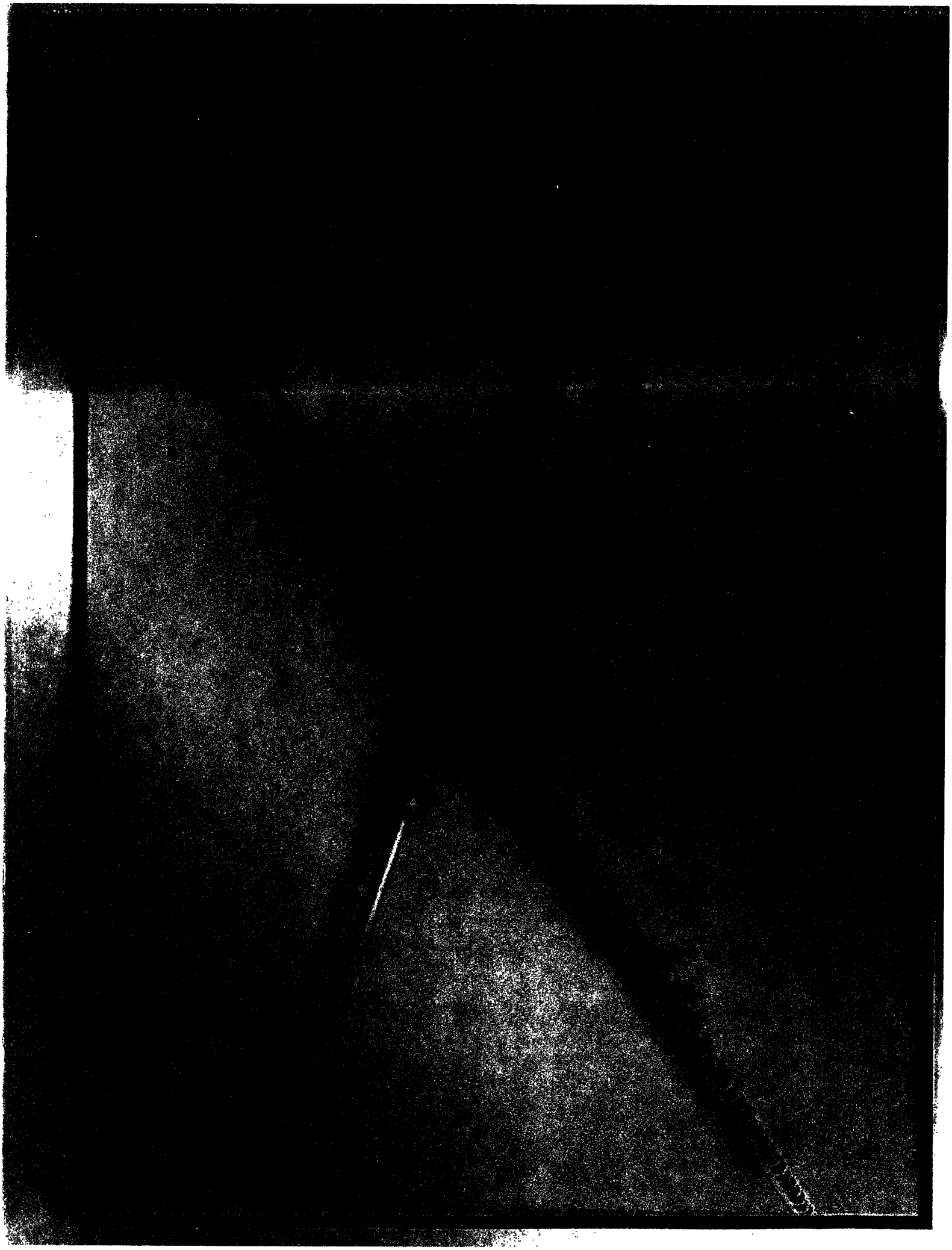
Major purchased items:

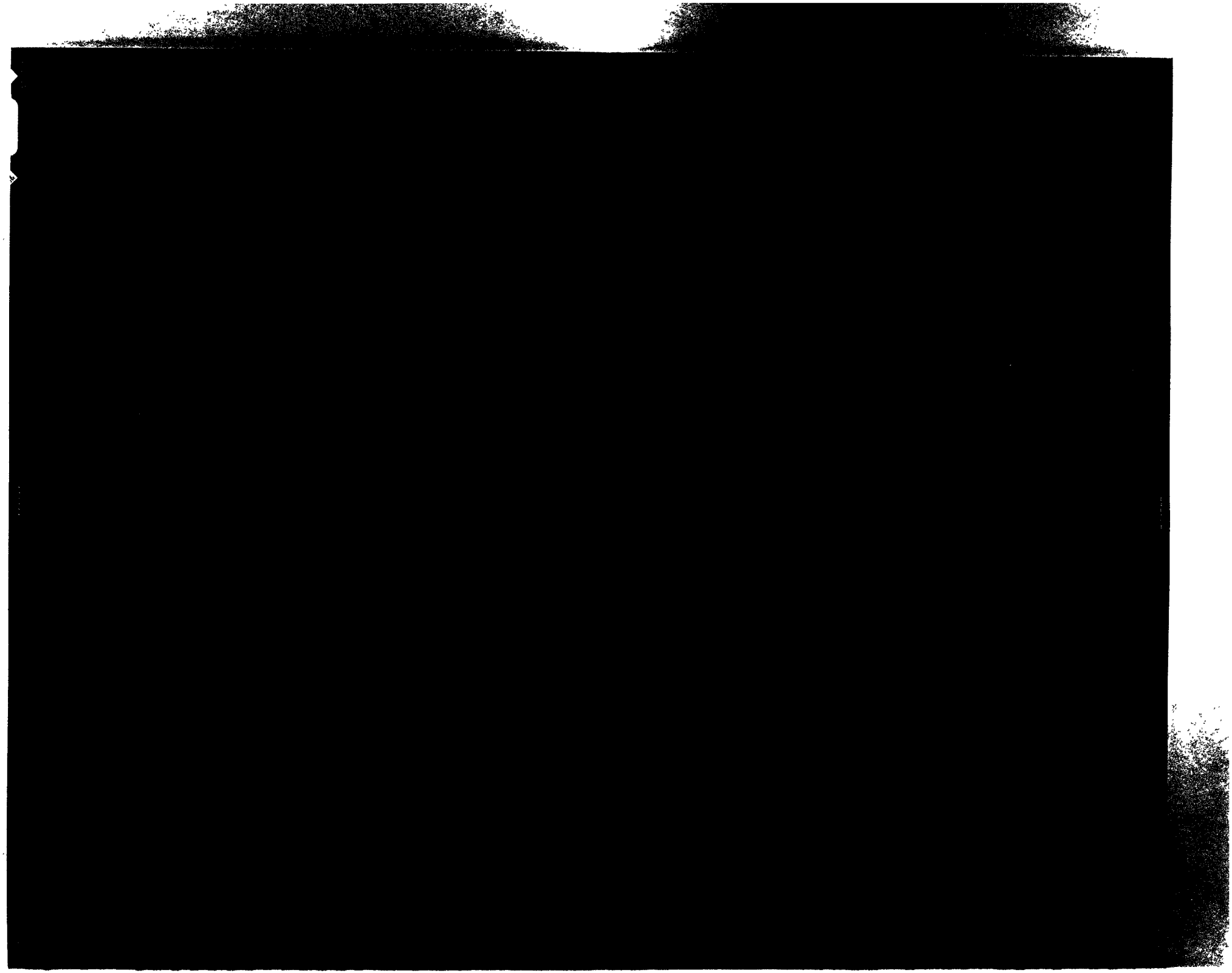
Pump type	Quantity	Vendor & model	speed
Roughing pump	4	Edwards EDP200-EH2600	1900 cu.m/hr
Backing pump	10	Edwards QDP80 (Edwards dry pump)	96 cu.m/hr
Maglev turbo pump	10	Edwards STPH2000C	2000 L/sec
Ion pump	18	Varian custom design	2500 L/sec
Other:			
large gate valves	32	GNB G44(48)P,E - 44"(48") pneumatic (electric) gate valves	

- prototype chamber now being fabricated for cleaning tests and mechanical design validation
- test results due July 1996
- fabrication of remaining chambers completes fall 1997

operational features

- Facility monitoring and control system
  - Control room monitoring of major facility eqpt (air handlers, pumps, etc.)
  - remote diagnostic information available in control room
  - remote control of temperature and humidity
  - smart circuit breakers to monitor and control lights at remote stations
  - control room monitoring of fire and intrusion alarms
  - electrical load monitoring of rotating eqpt to correlate vibrations with detector operation
- Physics related design choices
  - vibration isolation
  - control of vibration resulting from LIGO operation
  - examination of wind vibration





Physics performance considerations:

- electric gate valves near optics
- roughing pumps and ion pump transformers on separate slabs
- large capacity liquid nitrogen storage to minimize service needs (~3 months between fills)

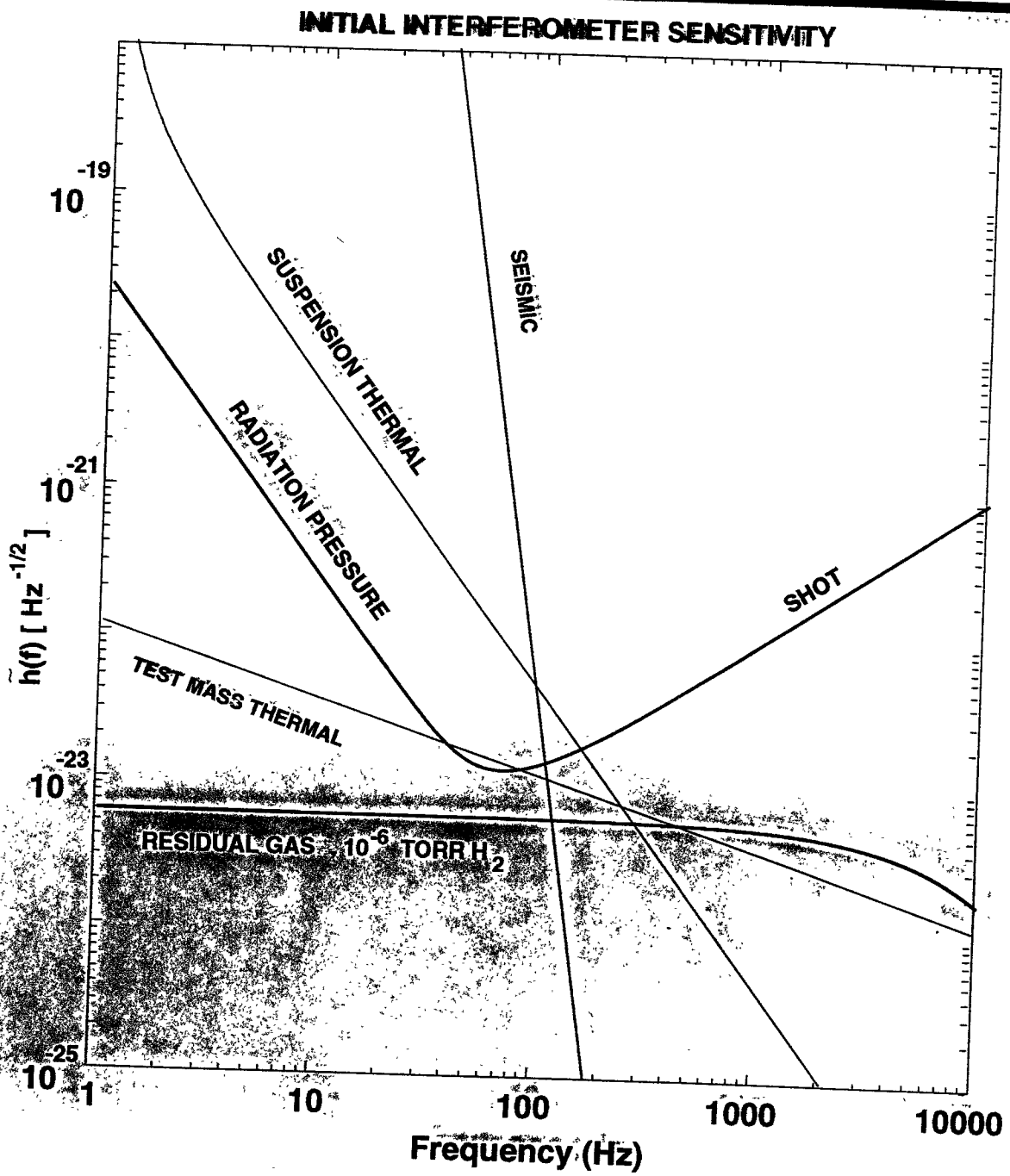
Beam tube

- Chicago Bridge and Iron Co. (Plainfield Illinois) selected as contractor
- 16 km of 1.2 m diameter tube
- 304 L stainless
- 3 mm thickness
- 24-36 inch skelp width
- expansion joints every 130 ft to accommodate 150 C bakeout
- auxiliary pumpout ports to reach 10^{-9} torr

BEAM TUBE CURRENT STATUS

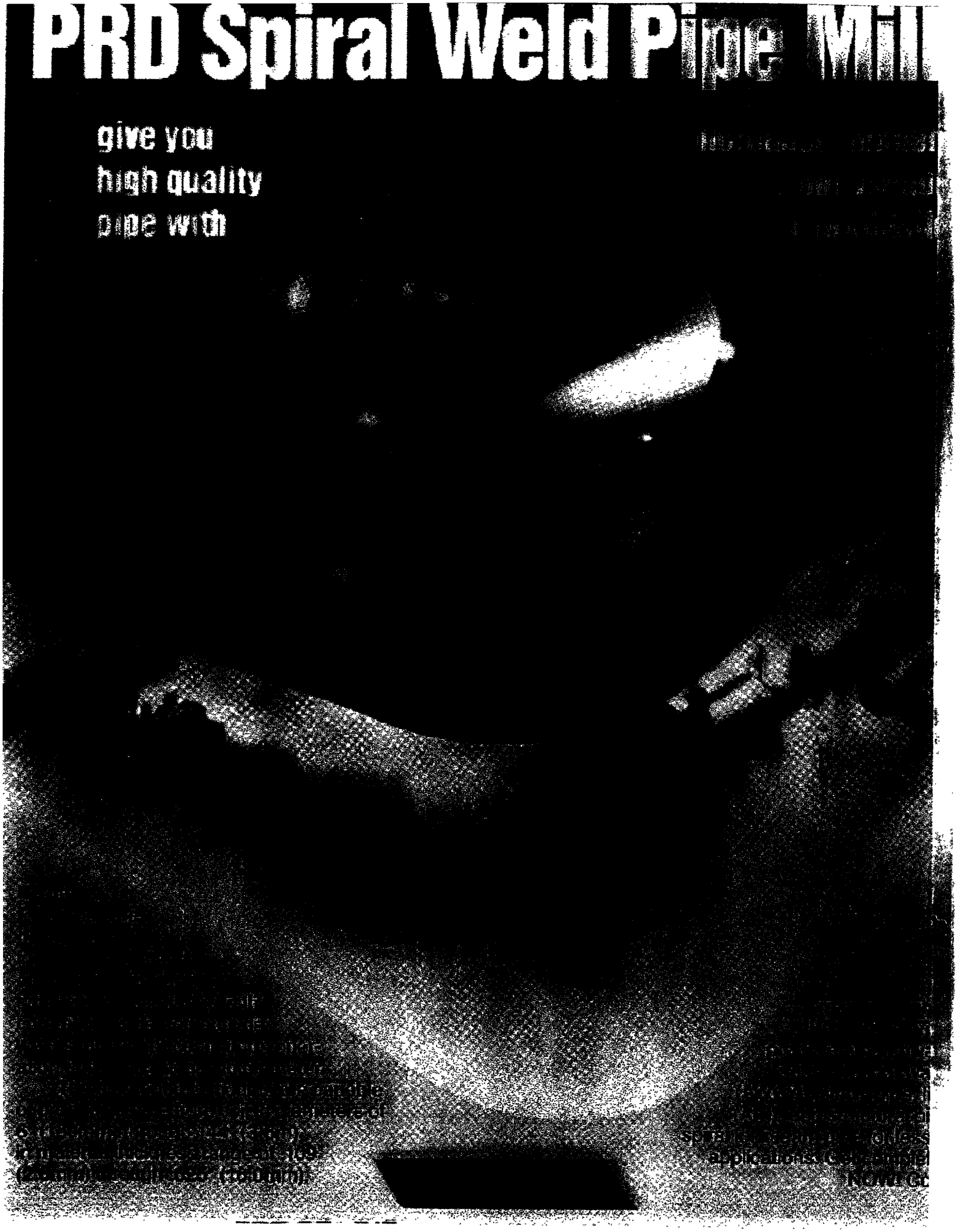
- Successfully completed Qualification Test (March, 1995)
  - ›› Demonstrated Design, Fabrication, Assembly
  - ›› Demonstrated acceptable leakage: $< 1 \times 10^{-11}$ atm cc/s
  - ›› Demonstrated acceptable outgassing: H_2, $< 1 \times 10^{-13}$ t•l/s•cm^2
    H_2O, $< 1 \times 10^{-16}$ t•l/s•cm^2
- Qualification Test Review held (April, 1995)
  - ›› Board endorsed the fact that all aspects of the test have been met
  - ›› Board concurs LIGO is ready to commence fabrication & installation of beam tubes

INITIAL DESIGN PERFORMANCE GOAL



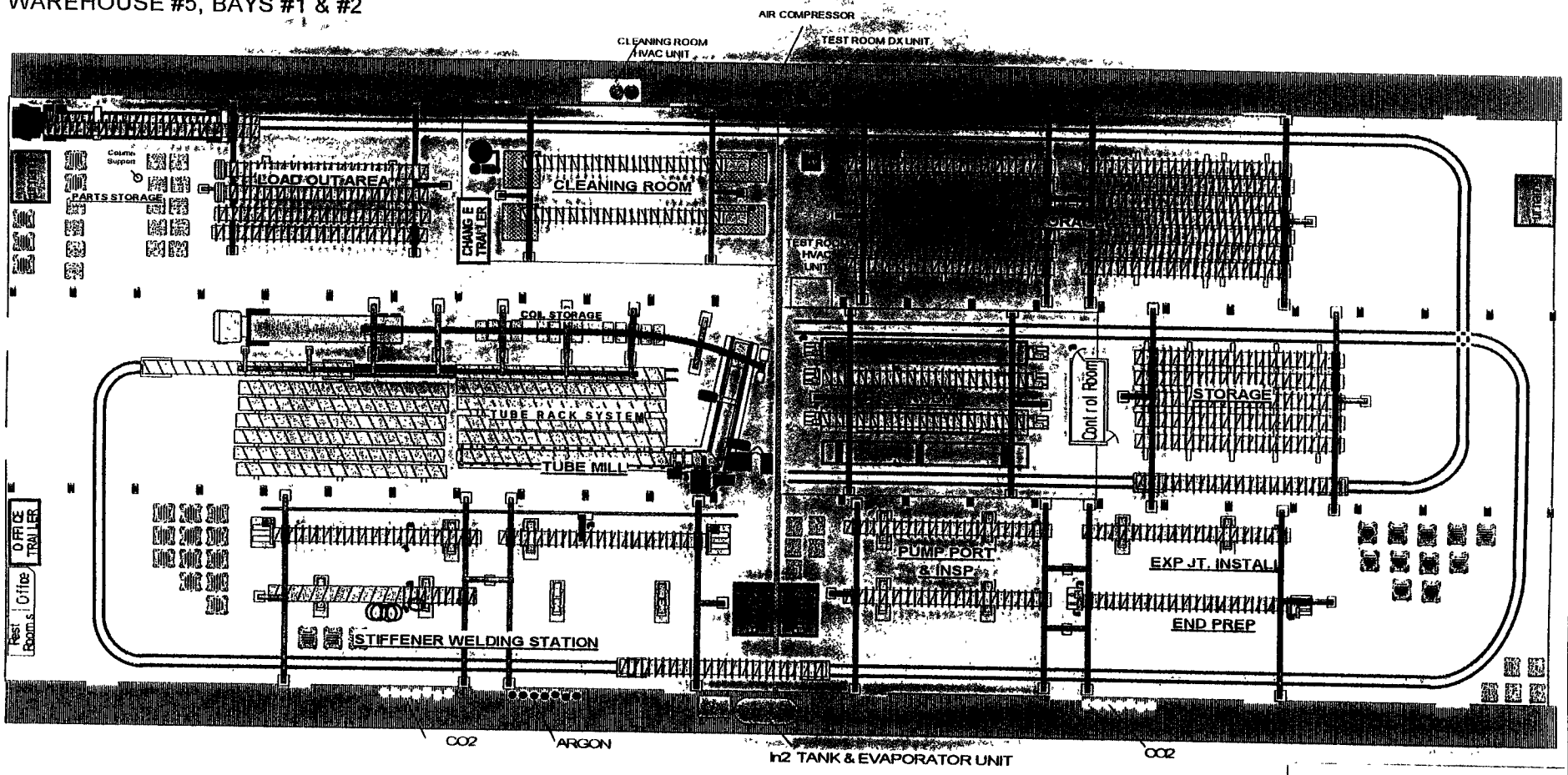
PRD Spiral Weld Pipe Mill

give you
high quality
pipe with



BIG PASCO

WAREHOUSE #5, BAYS #1 & #2



CB

LASER INTERFEROMETER GRAVITATIONAL WAVE OBSERVATORY

HANFORD LOCATION

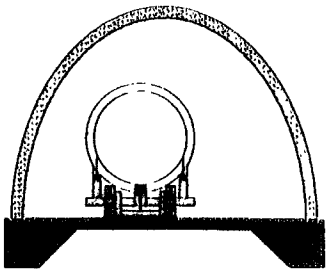
FABRICATION FACILITY

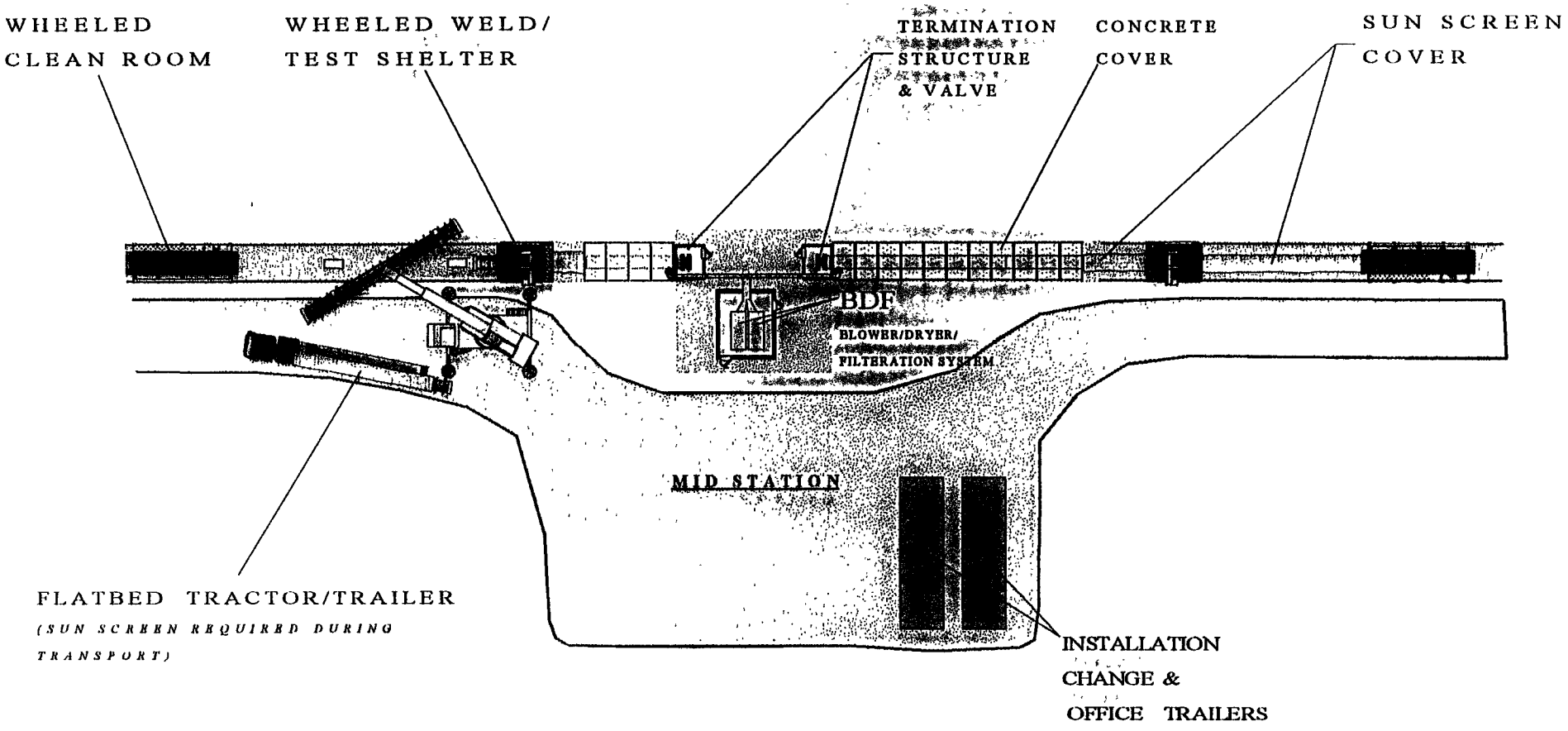
BIG PASCO WHSE #5, BAYS 1 & 2

Engineering Supervisor

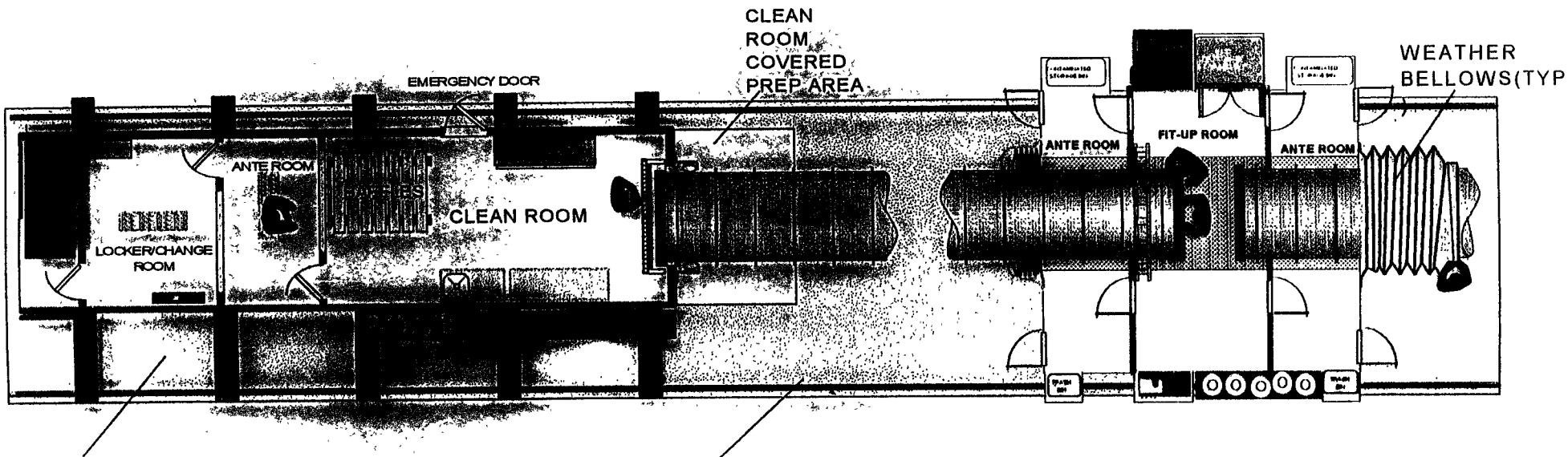
BIGPASO1.CVS

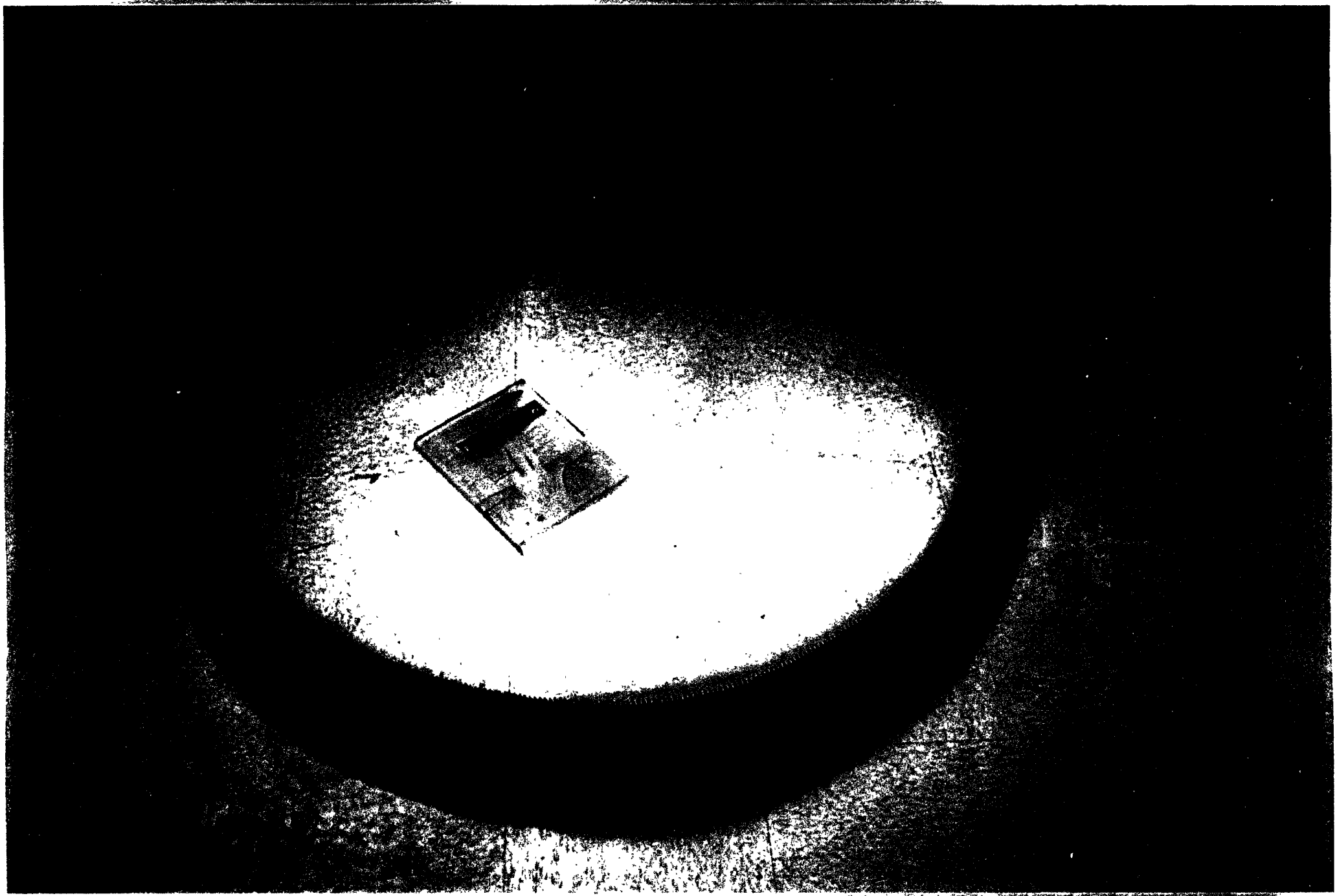
LIGO INSTALLATION PLAN





INSTALLATION PLAN



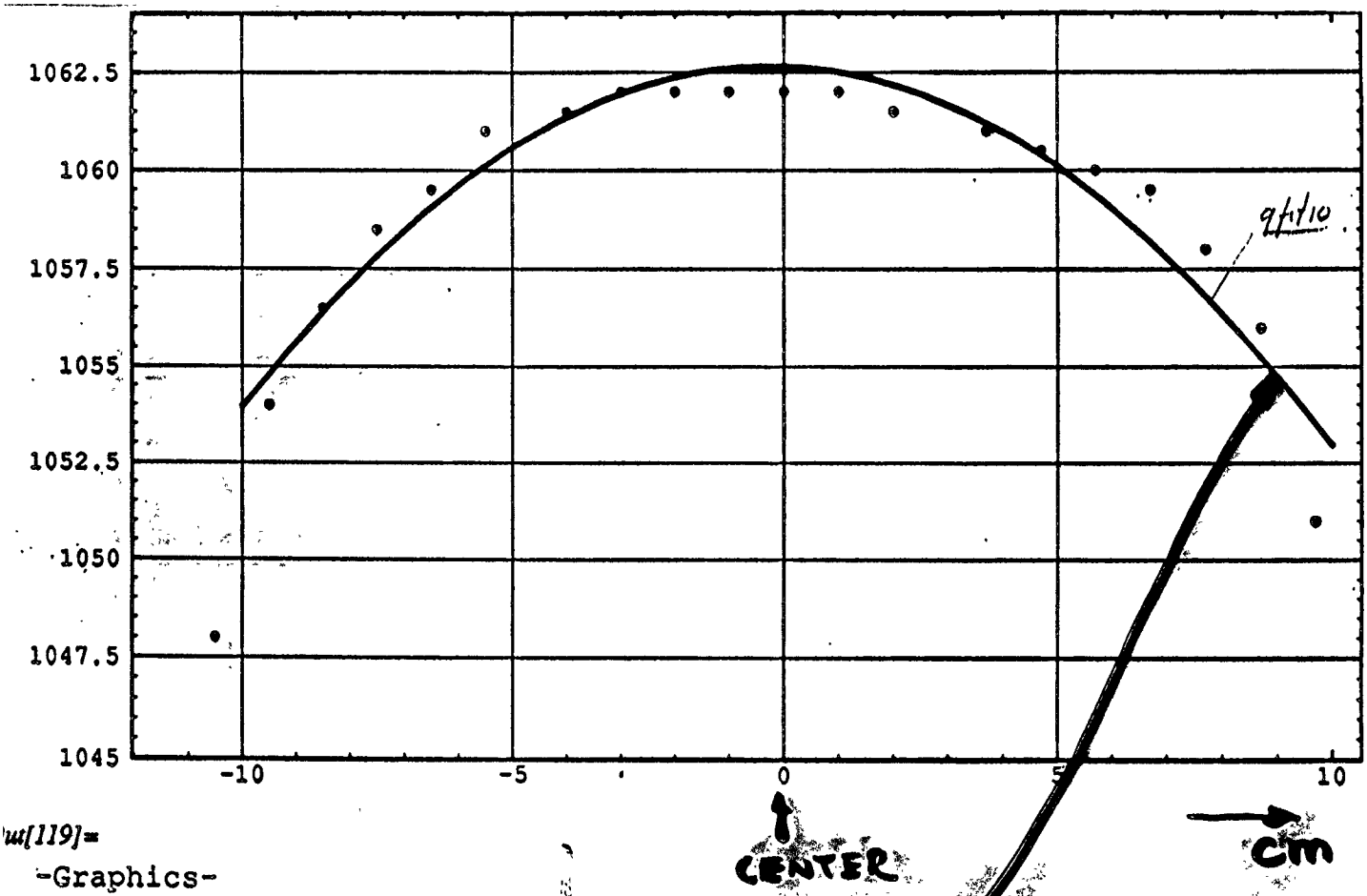


Laser

- switch to Nd:YAG - 1064 nm from argon ion
- advantages:
  - allows increase in power
  - relaxed mirror requirements
  - higher reliability
  - common with other GW efforts, industry momentum
- Contract for commercial development in early stages

Core optics

- Pathfinder program to identify polishing companies capable of meeting $\lambda/800$ smoothness.
  - CSIRO
  - HDOS
  - General Optics
  - REO
- Intial results look promising
- Looking at alternate sources to Corning for low absorption glass
- Coatings:
  - REO has made coatings meeting 2 ppm/bounce loss spec
  - Presently examining uniformity results, some improvement required
- Plan to resolve suppliers of glass, polishing, coating by end of summer



In[119]:=
-Graphics-

In[111]:=
qfit10 = Fit[smodat, {1, x, x^2}, x]

Out[111]=
1062.65 - 0.0484168 x - 0.0920605 x^2

STANDARD DEVIATION OF THIS PARABOLIC FIT FROM A B.E. DATA = 0.119%

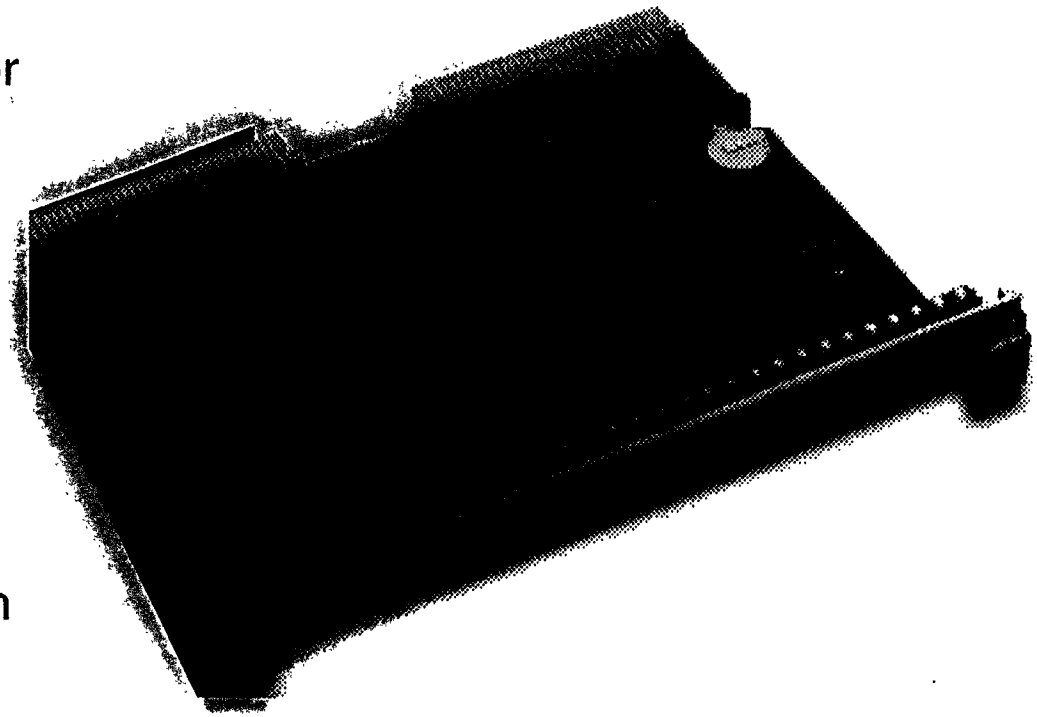
SAME "BEST PARABOLA" FIT OVER 7.5cm RADIUS: .017% STD

SAME "BEST PARABOLA" FIT OVER 4cm RADIUS: .015% STDE

(From Bill Kells)

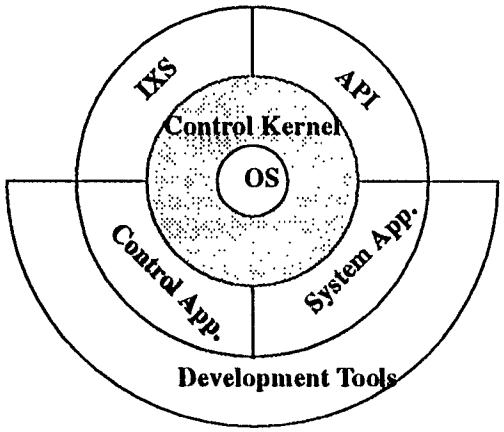
FE - VME Processor

- Heurikon baja4700
  - IDT R4700 MIPS Processor
  - 133 MHz Clock
  - 16 MBytes RAM
  - VME 64 Interface
  - 2 PCM (PCI bus) slots
  - Ethernet & Serial Ports
  - VxWorks Operating System



FE Software - Control Kernel

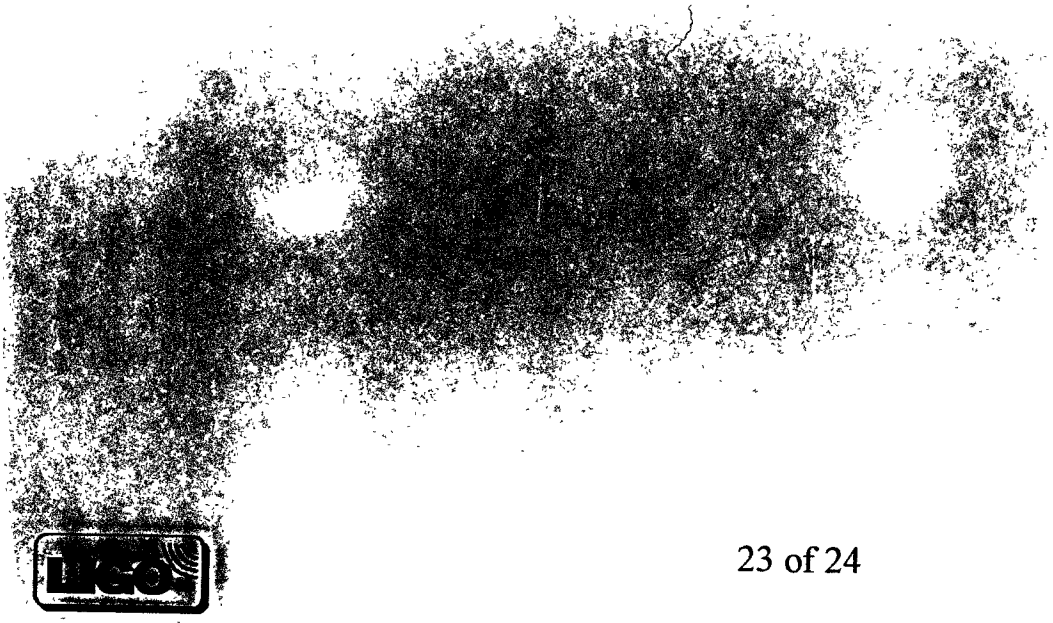
- Experimental Physics and Industrial Control System (EPICS)
  - Originated at LANL for Ground Test Accelerator
  - Collaboration include APS, CEBAF, LBL, KEK, Gemini, and others (meet every 4-6 months)
  - Kernel includes real-time database and I/O drivers for VME and industrial PLC



- EPICS will Not be used to meet all LIGO CDS requirements, but will rather provide the framework and some tools.
  - Provides, in commercial control system terms, the Supervisory Control And Data Acquisition (SCADA) functions
  - Insufficient performance for many anticipated control loops (Speed can be increased, but 10Hz type of control is typical)
  - EPICS is a set of tools, which will aid in many applications, but additional tools will be required.

Suspension

- Hi-Tech: optimizing design based on 40 meter stack, 4 layer viton/ metal
- Pursuing single loop suspension design
- have test mass same size as core optic
- Q tests in progress
- preparing single loop suspension system for test in 40 meter
- design and FEA analysis of suspension structure for LIGO in progress.



Conclusion

- Major contractors on board to provide:
  - beam tube
  - vacuum chambers, pumps, valves
  - earth work, concrete work, beam tube enclosures
  - building design
- 29 staff added to LIGO in 1995
- Future milestone dates:
  - building construction begins 6/96
  - accept buildings and vacuum equipment 3/98, 9/98
  - intitiate interferometer installation 7/98
  - begin coincidence tests 7/2000