

LIGO I PSL Status

R. Savage* 3/17/00

LSC Meeting

* for Peter King

WA 2K PSL

- Installation complete 12/98
- Commissioning underway

LA 4K PSL

- Installation complete 3/00
- Commissioning underway

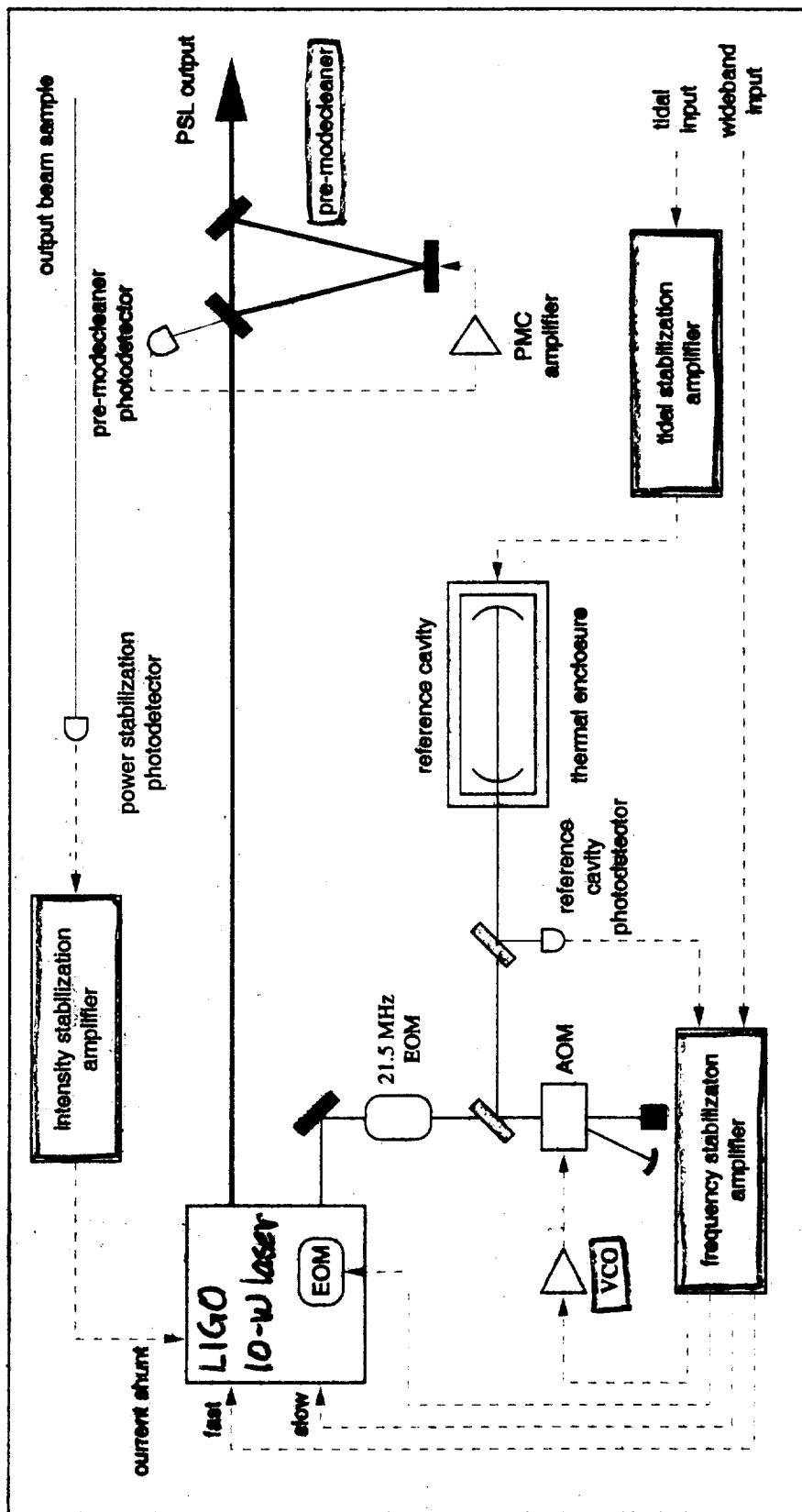
WA 4K PSL

- Installation to begin 4/00

LIGO 10-W Laser (Lightwave Electronics)

- continuous operation for > 10,000 hrs (WA2K)
- Power ~ 30% below spec. (~7W)
- beam quality: non-TEM₀₀ ~ 3x spec. (~3W)

PSL Anatomy

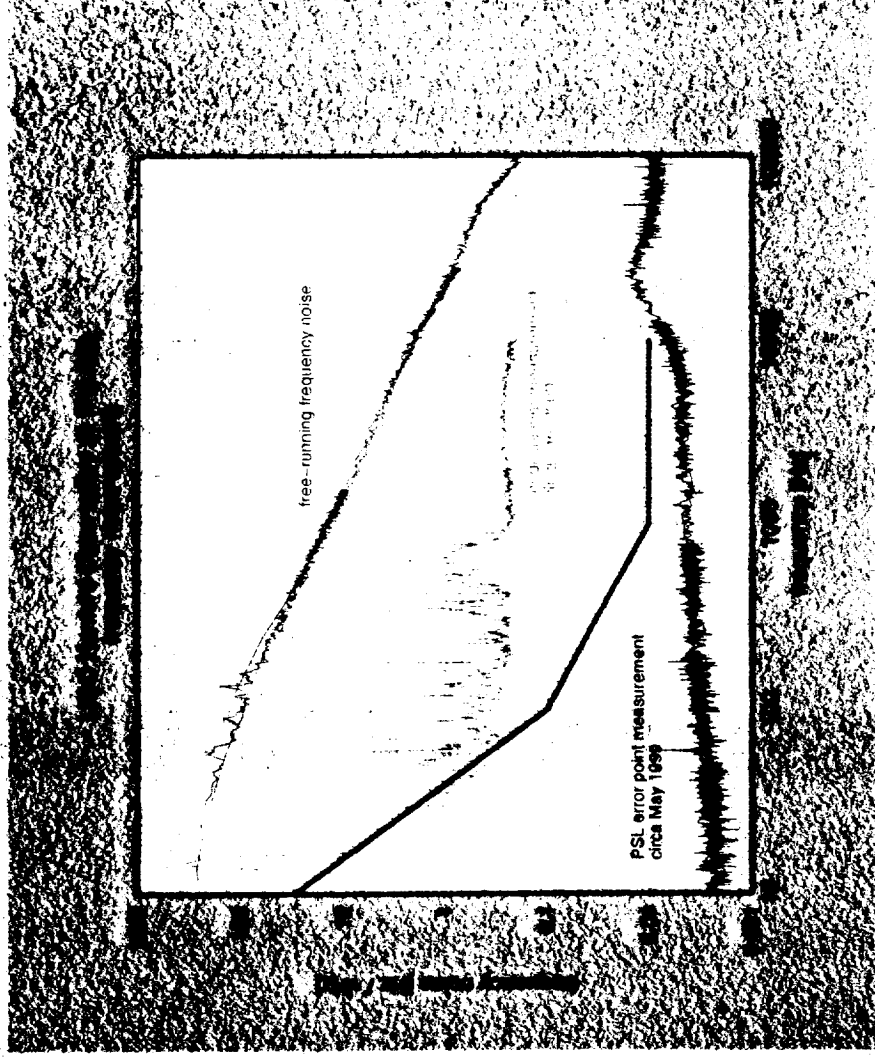


Frequency Stabilization Servo

- very robust - locked for one year
- frequency noise $\sim 10 \times$ spec. (measured with 15m mode cleaner)
- investigating freq. noise caused by optical component vibrations - Landry, Ottaway, Shoemaker
- investigating freq. noise due to reference cavity motion Cella, Yamamoto
- tidal servo not yet tested - ref. cavity temp. stabilization implemented to enable long lock periods for long arm test.
- upgraded ref. cav. vacuum chamber, servo electronics, tidal actuator hardware to be installed next month.
- sample ref. cav. beam after PMC for improved beam quality?
- move phase-correcting EOM outside laser head?

Frequency Stabilization Servo (cont.)

- comparison of in-the-loop frequency noise and frequency noise as measured with the suspended modecleaner



Pre-Mode Cleaner

Piezo length control is on far side; cavity is open to atmosphere.



Pre-mode cleaner Servo

- pressure-induced optical path length changes cause loss of lock \sim once per day
 - require $> 4.5 \mu\text{m}$ range for PZT
 - install inside sealed chamber?
- known problems with servo electronics
 - upgrade planned
 - loop offsets and spacer vibrations cause intensity noise
- relative intensity noise at 600mW at 24.5 MHz not yet measured.
 - preliminary measurements indicate that higher finesse will be required

PMC - Piezo Range Needed to Hold Lock For Historical Barometric Pressure Fluctuations at Hanford

Index of refraction changes with barometric pressure cause a strain in optical path length of about 2.7×10^{-9} per Pascal. The optical path length of the pre-mode cleaner is about 0.4 m.

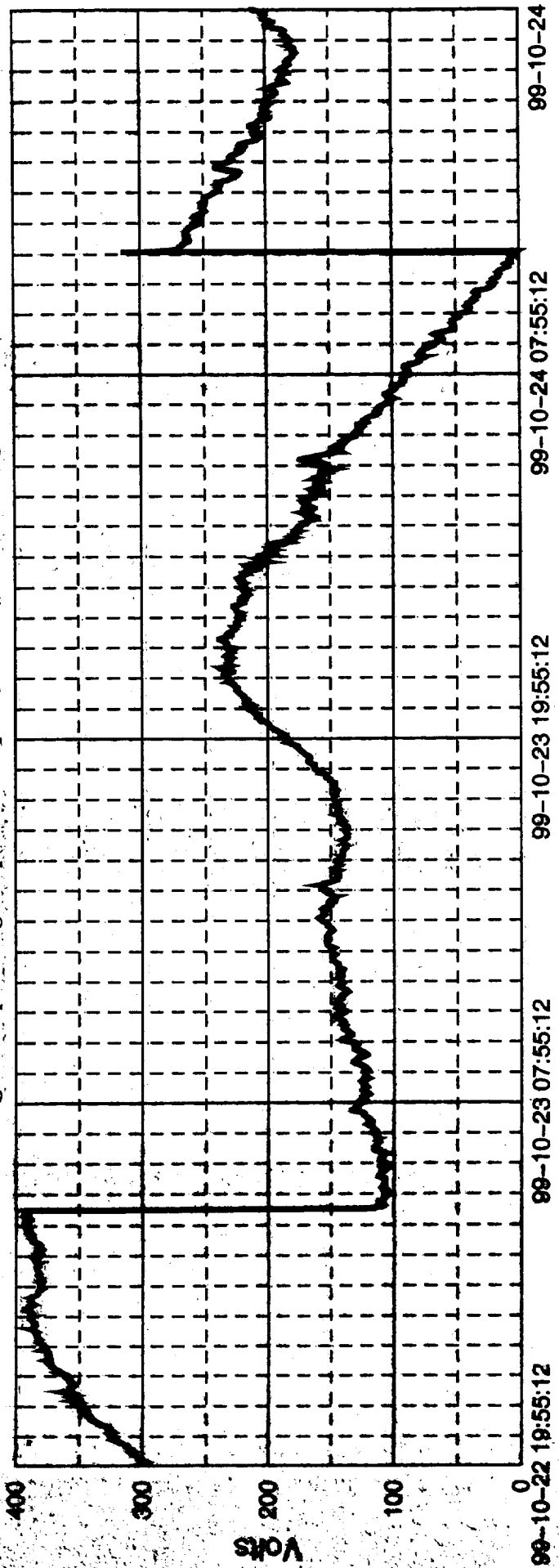
Time Span	Maximum Pressure (Pascals)	Minimum Pressure (Pascals)	Minimum Piezo Range (μm)
1998 - 1999	102,122	96,806	2.7
1955 - 1999	103,442	95,993	3.8

In order to acquire lock at any pressure, an extra free spectral range ($0.5 \mu\text{m}$) is needed. Also, when lock is acquired, the piezo setting must be coordinated with pressure, or else the range must be further increased.

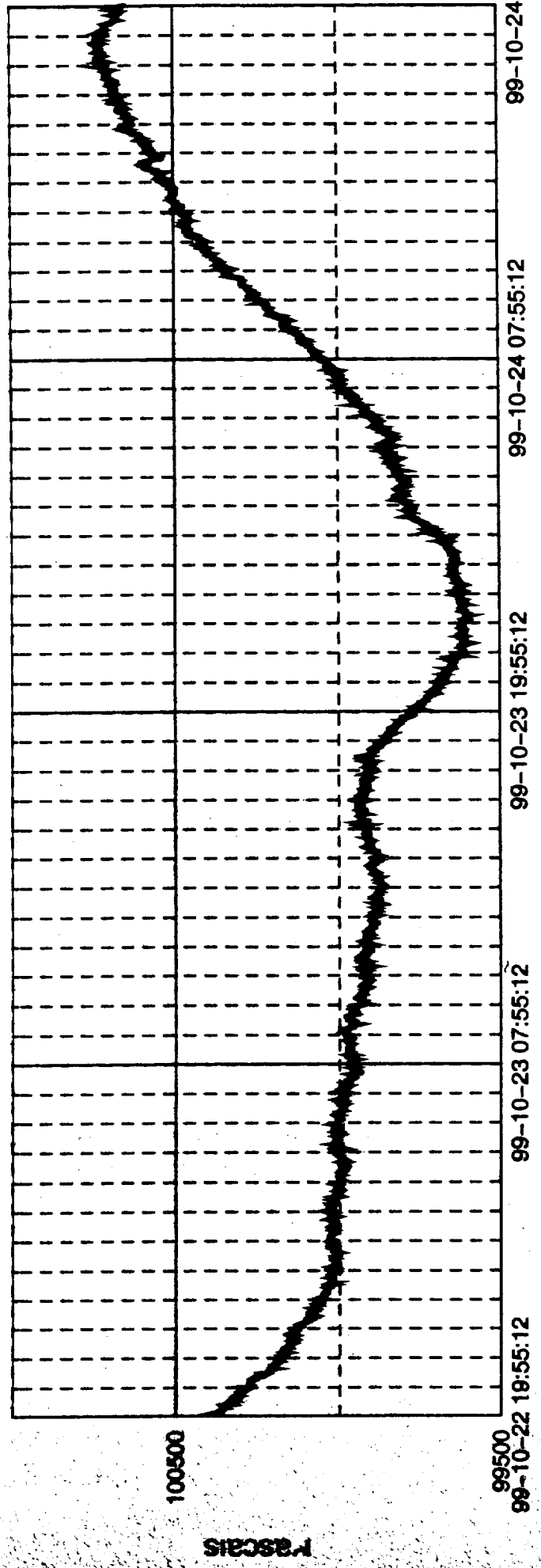
Piezo range $> 4.3 \mu\text{m}$ (a factor of 6.4 over present range of $0.67 \mu\text{m}$) or air-tight PMC.

LOSS OF FIRE-MODE CLEANER LOCK DUE TO CHANGES IN ATMOSPHERIC PRESSURE

Voltage on the piezo ring that positions the pre-mode cleaner mirror (range: 0 - 400 V)



Atmospheric pressure in the mass storage room



Intensity Stabilization Servo.

- AC current adjust actuator abandoned due to unfavorable frequency response
- Acoustic-optic modulator abandoned due to beam distortions
- current shunt actuator implemented by Lightwave
 - preliminary tests promising
 - servo amplifier not yet designed
- stabilization after long mode cleaner not yet tested
 - high-power, low-noise photodetector not yet designed

Integrated PSL subsystem testing with locked mode cleaner (VCO input enabled) yet to be performed.

- frequency noise known to be too high
- RIN at GW modulation freq. expected to be too high.

Note 1, Linda Turner, 05/17/00 10:35:28 AM
LIGO-G000144-00-D