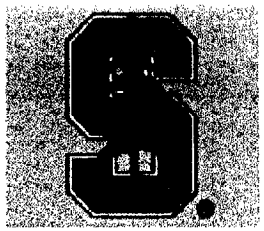
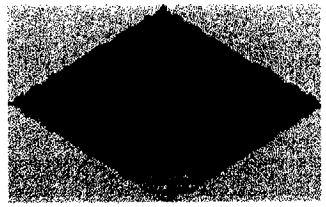




Collaboration

Intensity Noise and the pre mode cleaner

Benno Willke

thanks to German Alexander von Humboldt-Stiftung for a Feodor Lynen fellowship

LIGO-G980049-24-M

PSL Session

B. Wilke

Summary

- The PSL has been frequency stabilized to the reference cavity, with in-the-loop performance being consistent with PSL requirements.
- Intensity stabilization to levels consistent with PSL requirements has been demonstrated.
- The output power delivered after the PMC is 8.7 W, which meets PSL requirements.
- The beam delivered by the PSL is a circular TEM_{00} mode.

The Road Ahead (cont.)

- Issues for higher powers

  ›› Development of high power optical components such as Faraday isolators and EOMs.

  ›› Development of a PMC.

The Road Ahead

- Incorporation of temperature stabilization of the reference cavity to accommodate the tidal input.
- Demonstration of the viability of running the PMC in air and addressing issues concerning contamination of the mirror surfaces after prolonged exposure to high power.
- Demonstrate that the PSL can be reliably operated for long periods of time.
- Demonstration of remote operation and control via computer.
- Computer automated lock acquisition.
- Incorporation of internal and external diagnostic modes.

Other Performance Related Issues

- Beam pointing

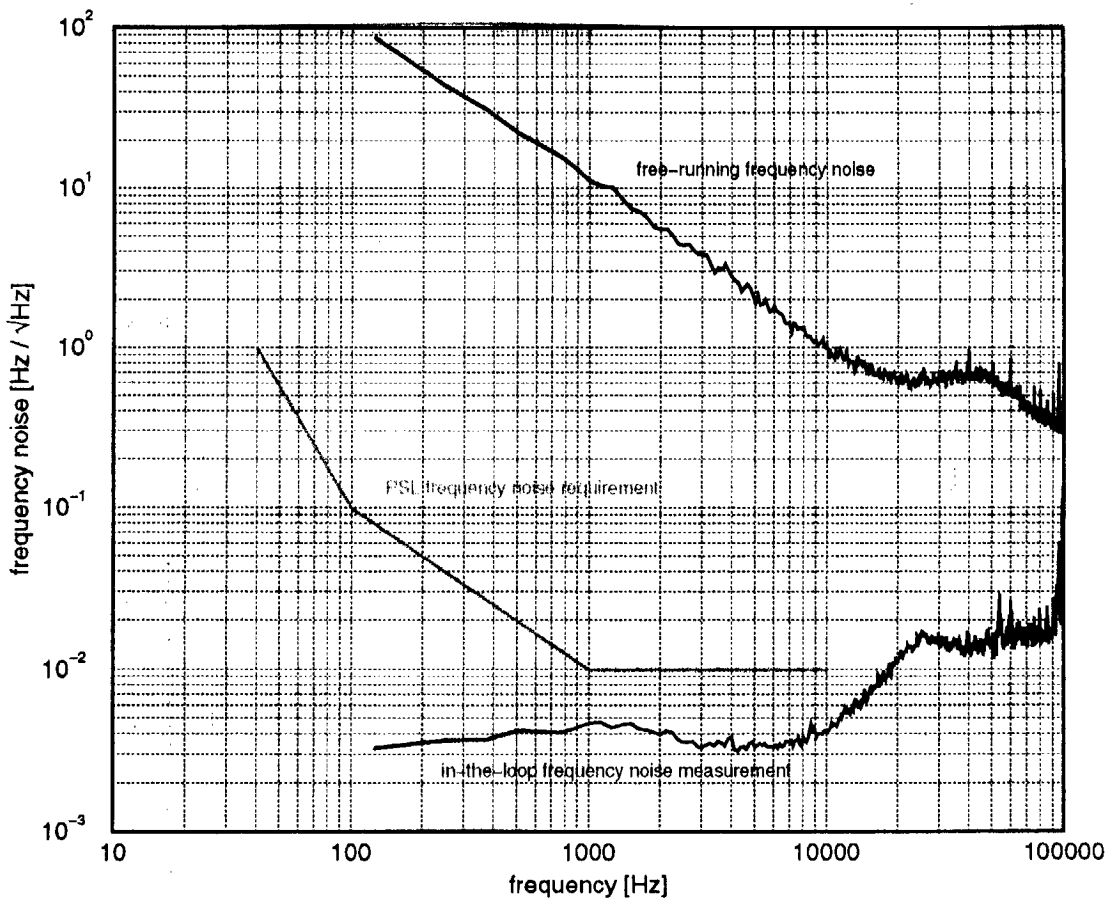
  ›› Relies on beam pointing stability of the 126 MOPA laser. Currently there is some concern about this aspect of the laser but a retrofit of the internal mirror mounts is expected to resolve this issue.

  ›› There is a beam pointing control unit before the modecleaner to control the beam into the interferometer.

- Reliability

  ›› There are problems with the reliability of the master oscillator and possibly the power amplifier pump diodes.

Frequency Stabilization (cont.)



Frequency Stabilization

- Stabilization technique.
  - ›› standard Pound-Drever-Hall (PDH) locking
  - ›› 21.5 MHz modulation sidebands
- Nested loop strategy used to reach ultimate requirement.
  - ›› wideband input from 12-m modecleaner
  - ›› tidal input from either 2-km or 4-km interferometer
- Electro-optic modulator (EOM) located between the master oscillator and the power amplifier.
- Uses a fixed spacer reference cavity and a frequency shifter.

PSL (cont.)

- Features

  ›› Frequency stabilization scheme uses a nested loop strategy based on 3, progressively more stable, reference cavities.

  — 200-mm long fixed-spacer fused silica cavity, finesse ~ 10 000, bandwidth 74 kHz

  — 12-m long modecleaner

  — 4-km long interferometer

  ›› Intensity stabilization via feedback control to the power amplifier pump diode current.

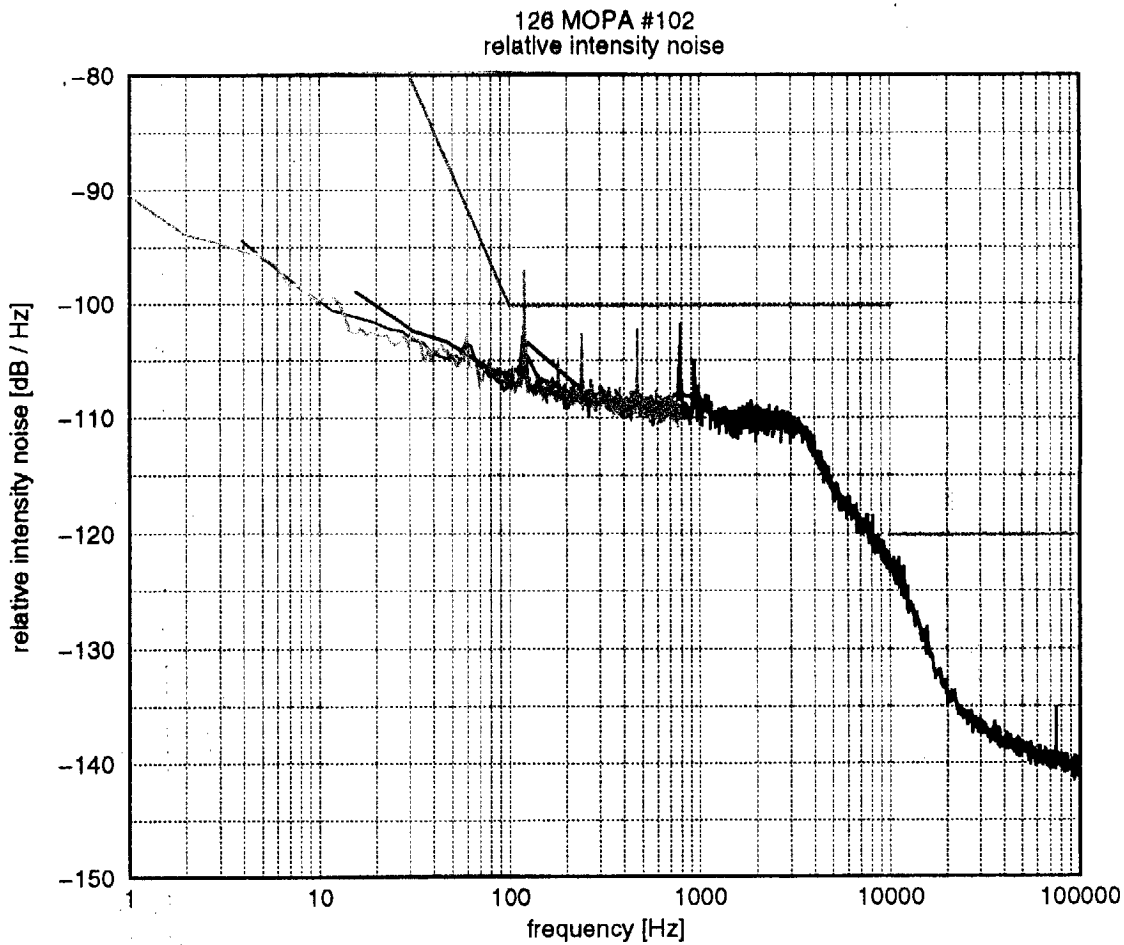
  ›› Relative power fluctuations at the interferometer modulation frequencies of 24.5 MHz and 29.5 MHz are filtered by a triangular ring cavity, the pre-modecleaner (PMC).

  ›› Computer controlled via VME interface.

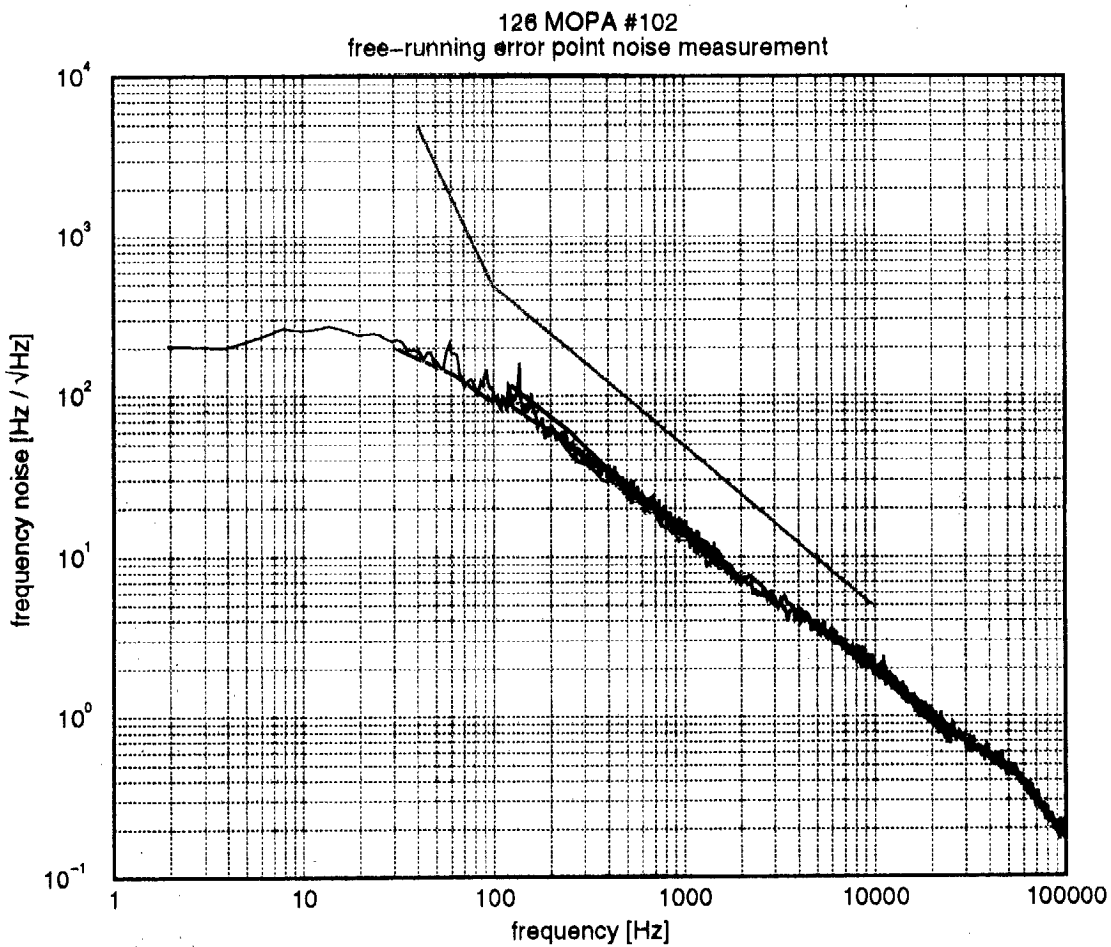
PSL

- Design Requirements
  - frequency noise
    - $< 0.1 \times (100/f)^{2.5}$ Hz / $\sqrt{\text{Hz}}$ 40 Hz $< f <$ 100 Hz
    - $< 0.1 \times (100/f)$ Hz / $\sqrt{\text{Hz}}$ 100 Hz $\leq f <$ 1 kHz
    - $< 1.0 \times 10^{-2}$ Hz / $\sqrt{\text{Hz}}$ 1 kHz $\leq f <$ 10 kHz
  - power fluctuations
    - $< 10^{-8}$ 1 / $\sqrt{\text{Hz}}$ 100 Hz $< f <$ 10 kHz
  - output power
    - The output power of the PSL is required to be at least 8.5 W in a circular TEM_{00} mode.

126 MOPA Performance (cont.)
Relative Intensity Noise



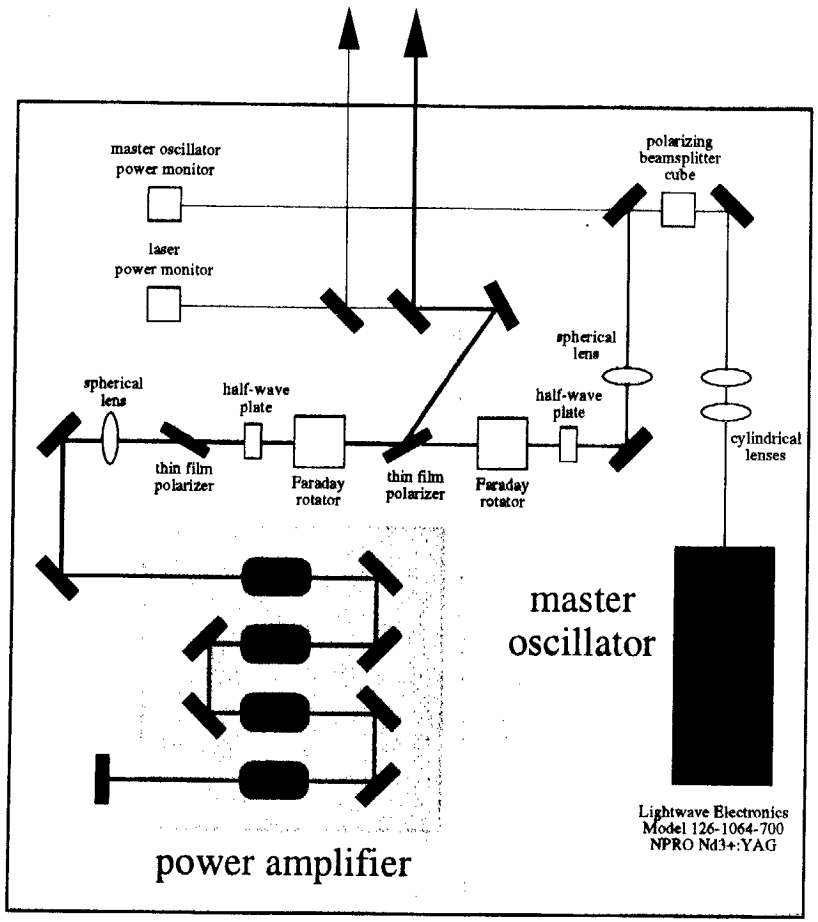
126 MOPA Performance
Frequency Noise



126 MOPA Laser Status

- Alpha-1 engineering prototype delivered October, 1997.
- First article delivered January, 1998.
- Second article expected to be delivered around April, 1998 after mirror mount retrofit.

The Lightwave Electronics 126 MOPA



- Double-passed MOPA configuration
  - master oscillator
    - Lightwave Electronics Model 126-1064-700 NPRO
  - power amplifier
    - 8×20 W diode bars pumping 4 YAG rods
- Performance
  - power in $TEM_{00} > 10$ W, cw
  - total power in non-$TEM_{00} < 1$ W

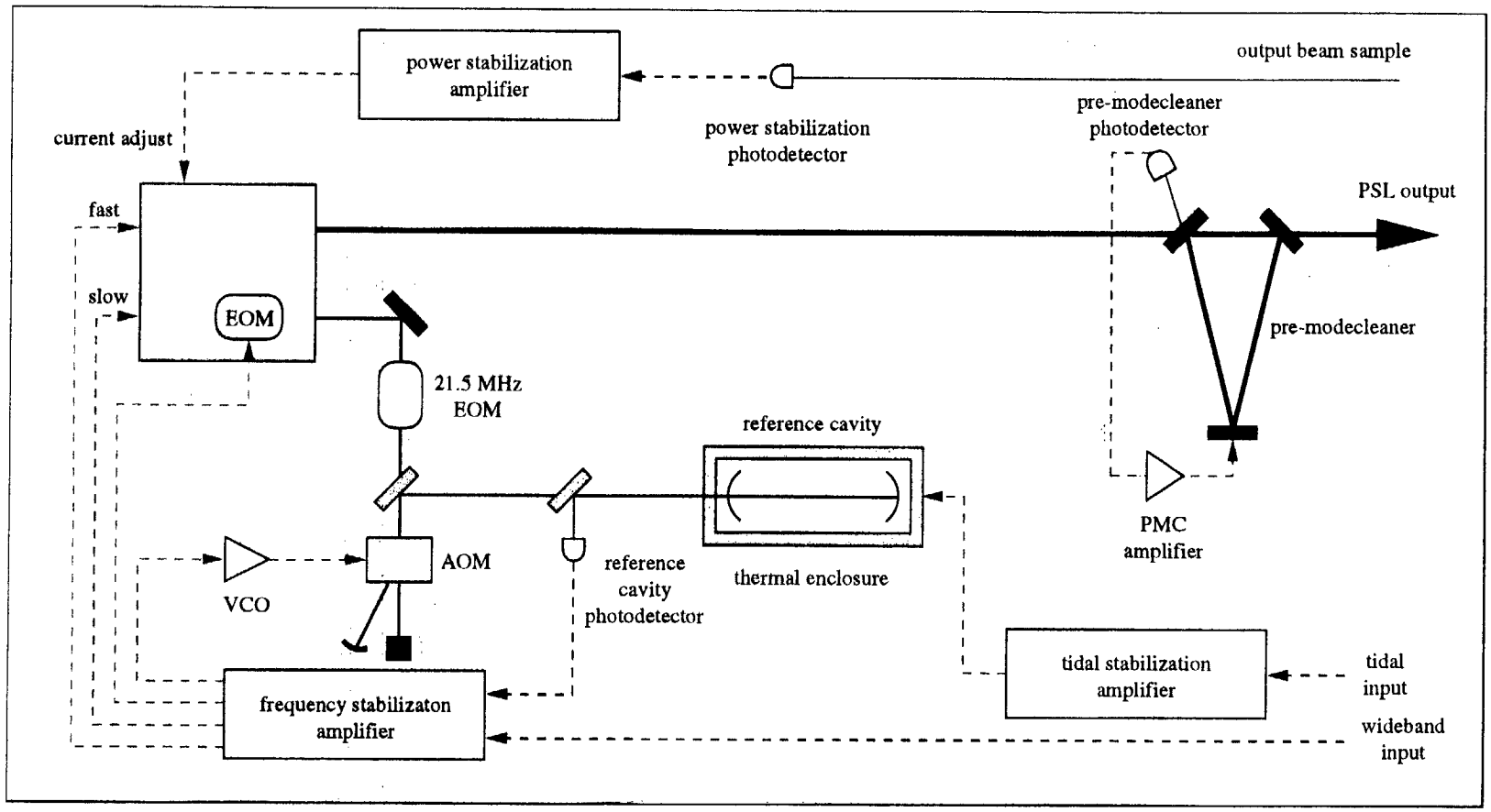
The Lightwave 10-W Laser (cont.)

- relative power fluctuations
  - < 1% peak-to-peak over 24 hours
  - < 3% peak-to-peak over 500 hours
- relative power fluctuations (cont.)
  - < 10^{-5} at 100 Hz
- beam pointing fluctuations < 10^{-5} at 100 Hz
- mean time between failures (MTBF) > 10 000 hours
- polarization extinction ratio > 300:1
- minimum time between required beam alignment adjustments > 2 500 hours

The Lightwave 10-W Laser

- Laser source developed under contract with Lightwave Electronics Inc., Mountain View, CA.
- Laser Specifications
  - wavelength 1064 nm
  - power in a circular TEM_{00} mode > 10 W
  - total power in all non-TEM_{00} modes < 1 W
  - relative spot size fluctuations < 2% peak-to-peak
  - frequency fluctuations < 500 Hz at 100 Hz.
  - frequency control via master oscillator actuators
  - power control via power amplifier current adjust actuator

PSL Optical Layout



Schedule

- Presently the PSL is in the preliminary design phase with a prototype being fabricated at Caltech.
- Prototype PSL laser scheduled to ship early April, 1998. More likely the laser will ship mid-to-late May, 1998.
- Shipment of some PSL components: optical table, optical mounting hardware ... etc. about to commence.
- Hanford 2-km interferometer installation - April, 1998.
- Hanford 4-km interferometer installation - November, 1998.
- Louisiana 4-km interferometer installation - March, 1999.

Note 1, Linda Turner, 04/21/98 08:55:37 AM
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