



# The LIGO I Pre-stabilized Laser

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LIGO II Meeting with LZH

November 15th, 2000

Peter King



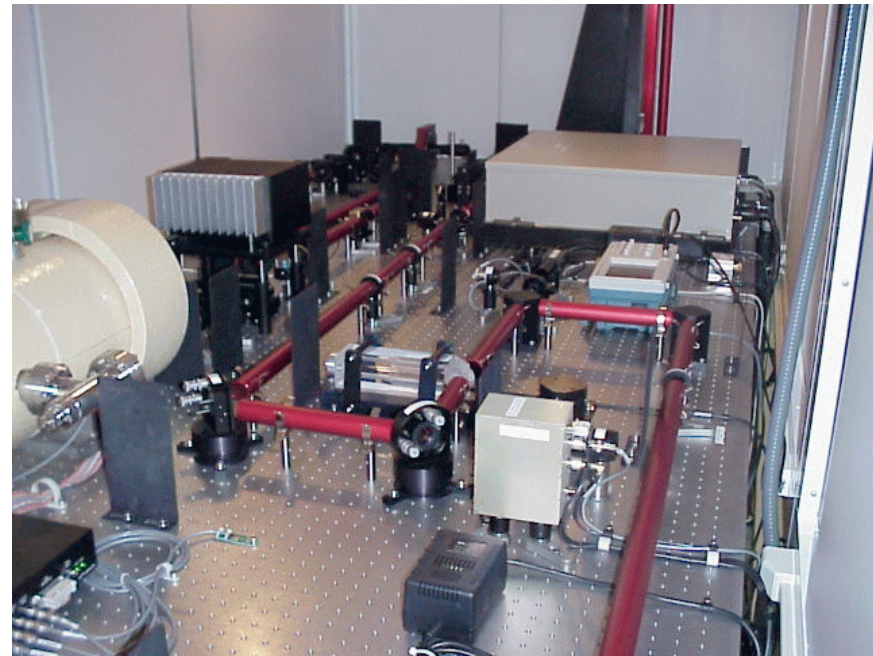
# Contents

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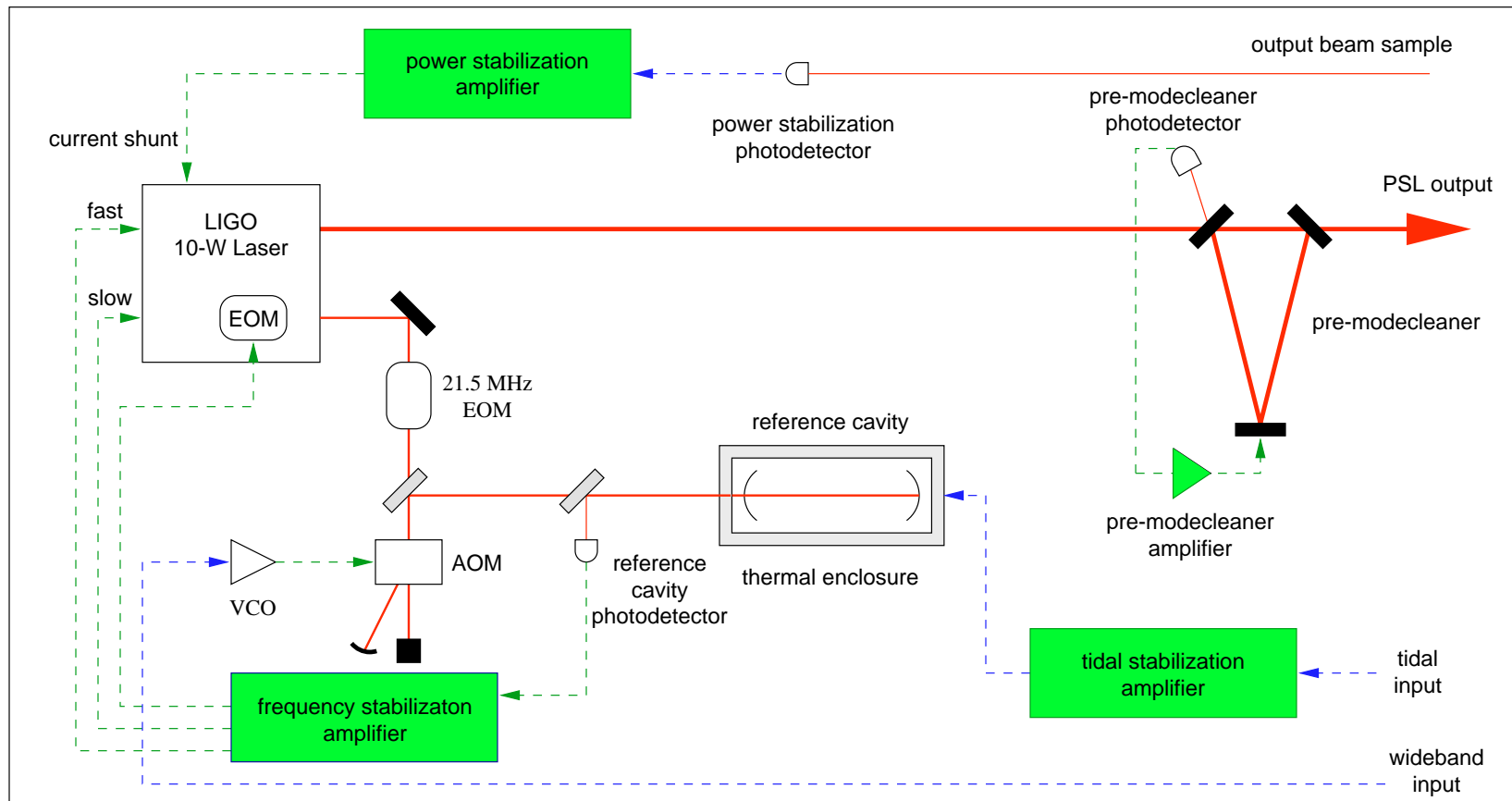
- The PSL
- PSL Anatomy
- LIGO 10-W Laser
- Frequency Stabilization
- Pre-modecleaner
- Intensity Stabilization
- Computer Interface
- User Interface
- Reliability
- Logistics
- Installation
- System Integration
- User Support

# The PSL

- light source for LIGO interferometer
  - » interfaces with IO, LSC and CDS
- frequency stabilized
- intensity stabilized
- diffraction-limited output
- computer controlled

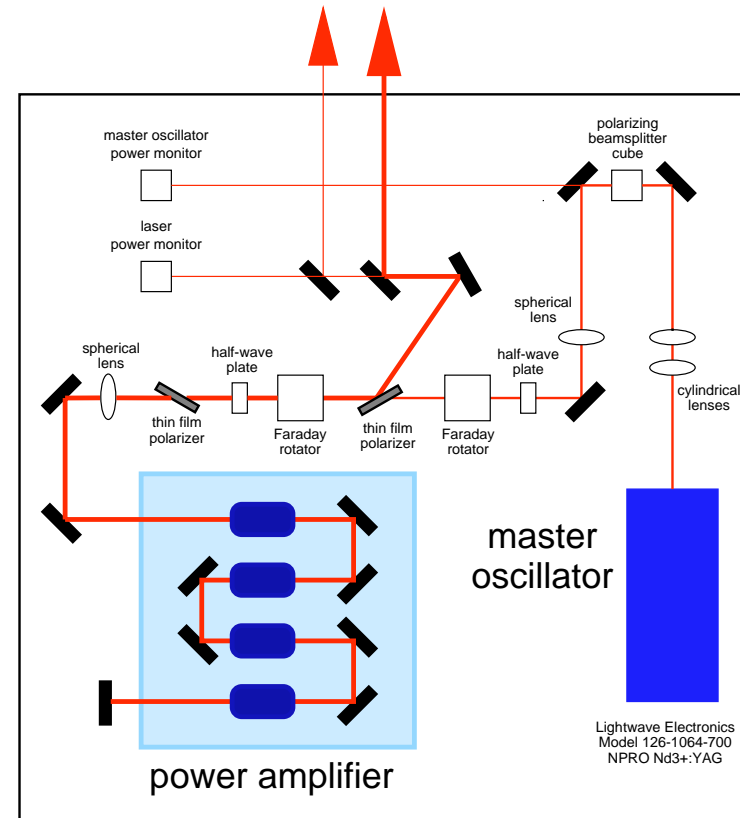


# PSL Anatomy



# LIGO 10-W Laser

- developed under contract with Lightwave Electronics
- NPRO-based MOPA
  - » frequency actuators
    - SLOW
    - FAST
  - » intensity actuators
    - POWER
    - AC CURRENT ADJUST





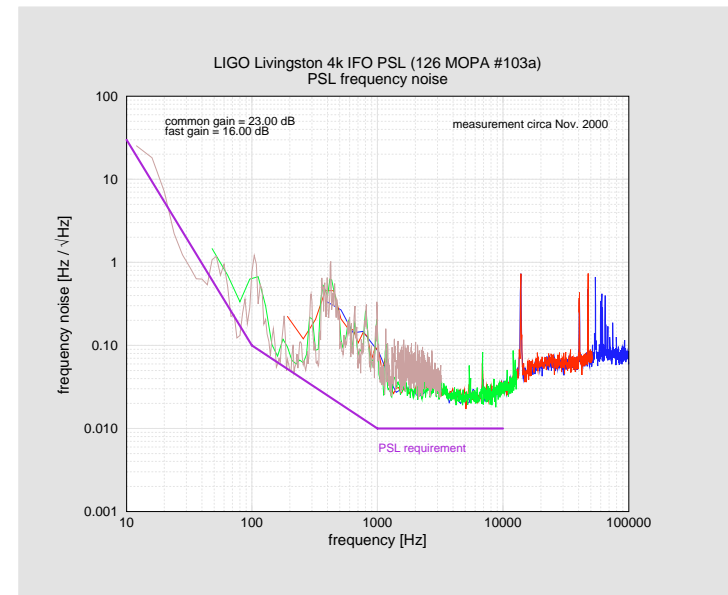
# Frequency Stabilization

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- robust performance
  - » operational for over ~18 months with a high degree of availability
  - » various servo gain settings have not changed significantly from their installed values
- automated lock acquisition demonstrated but not fully debugged
- off-site testing is limited to in-the-loop measurements
- full testing requires a fully operational modecleaner

# Frequency Stabilization (cont.)

- performance
  - » recent measurement from LLO
    - modecleaner not fully debugged
- external noise sources
  - » mechanical resonances
  - » acoustic noise



# Pre-modecleaner

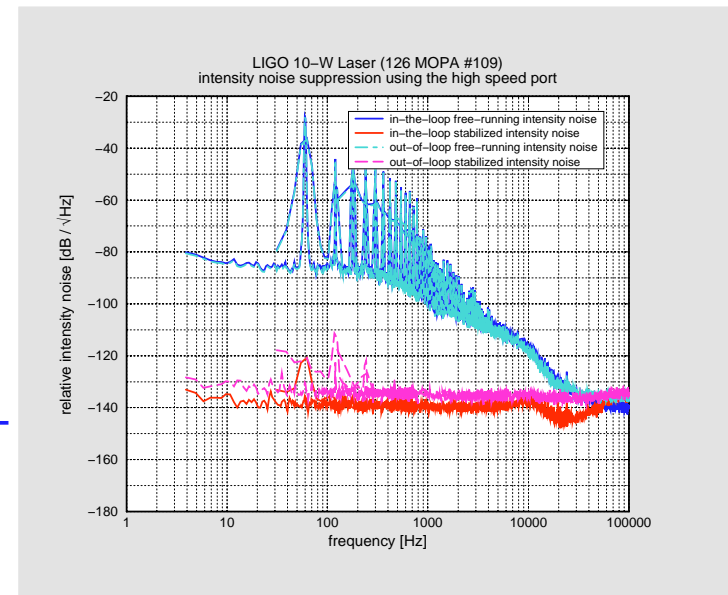
- dual role
  - » spatial filter
  - » intensity noise suppression at 25 MHz
- majority of goals met with current design
- various enhancements in progress
  - » constructed using optical cement
  - » sealed construction
  - » kinematic mounting





# Intensity Stabilization

- actuators tried
  - » NPRO POWER actuator
  - » AC CURRENT ADJUST actuator
  - » ACOUSTO-OPTIC MODULATOR
  - » INTEGRATED CURRENT SHUNT
- intensity stabilization will be based on the integrated current shunt
- intensity stabilization servo currently in design stage





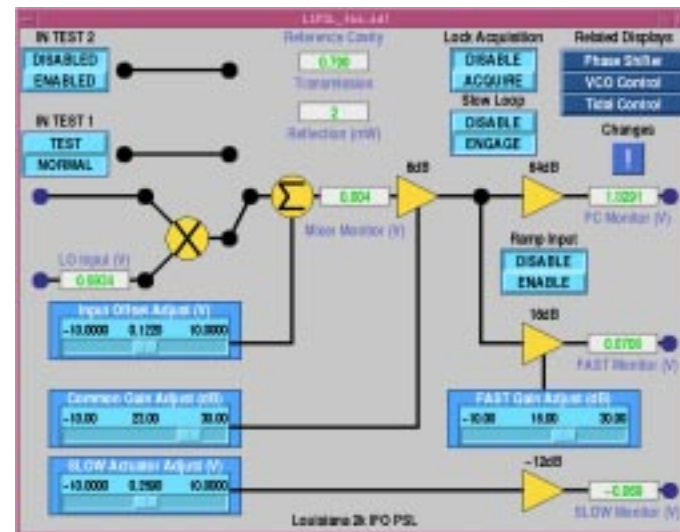
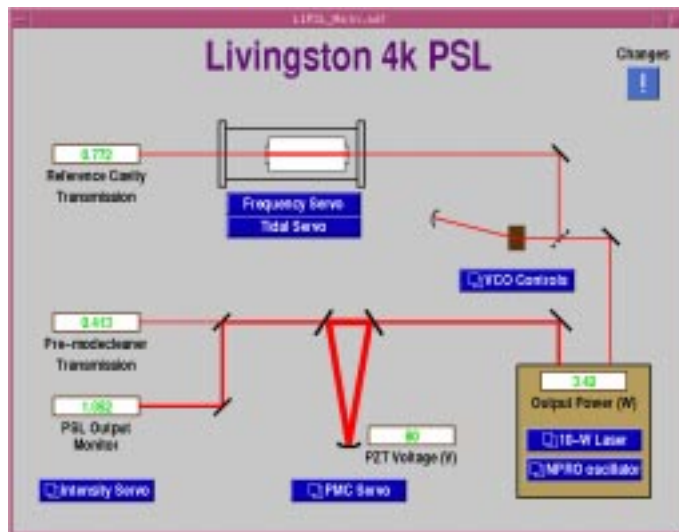
# Computer Interface

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- EPICS-based controls
  - » MIPS-based CPU running VxWorks
    - signals database, channel access
- event-based sequencers written in C or state notation language
  - » software under cvs revision control

# User Interface

- operator screens generated with MEDM or DM
  - » Motif Editor Display Manager





# Reliability

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- laser reliability
  - » mean time between failures > 10000 hours
  - » mean time between adjustments > 2500 hours
    - LHO 2k > 17000 hours
    - LLO 4k > 8500 hours
- PSL required to operate without loss of lock for 40 hours during normal seismic conditions
  - » demonstrated and exceeded for both LHO 2k and LLO 4k
- stability of servo settings



# Logistics

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- shipping and receiving procedures
  - » temporary storage of equipment on site during installation
- customs declarations
- equipment tracking
- test equipment
- labor personnel



# Installation

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- LHO 2k started September 98, completed December 98
  - » crew of 3 used during installation for 23 man-weeks
    - installation of laser and opto-mechanical components
    - installation of field wiring and servos
    - testing of servos, user interfaces and lock acquisition codes
    - acceptance testing of PSL, integration with suspended modecleaner
  - » still reliant on some site infrastructure and labor
- LLO 4k started March 99, completed July 99
  - » similar level of effort as LHO 2k installation



# System Integration

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- optical interface with IO
  - » beam waist size and location
  - » size and power of beam sample after modecleaner used for intensity stabilization
- electrical interfaces with IO and LSC
  - » wideband actuator (VCO drive)
  - » tidal actuator
- integration and interfacing with DAQ
- computer interface to network



# User Support

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- provide operational information to observatory staff
  - » hands on demonstrations
  - » operator notes
- automate as many functions as possible
  - » backup and restore servo settings via BURT
  - » automated lock acquisition sequencers
- alarm handler to alert operator to changes in PSL status
  - » servo status and condition
  - » laser condition and operational status





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