Status of the Advanced LIGO PSL development

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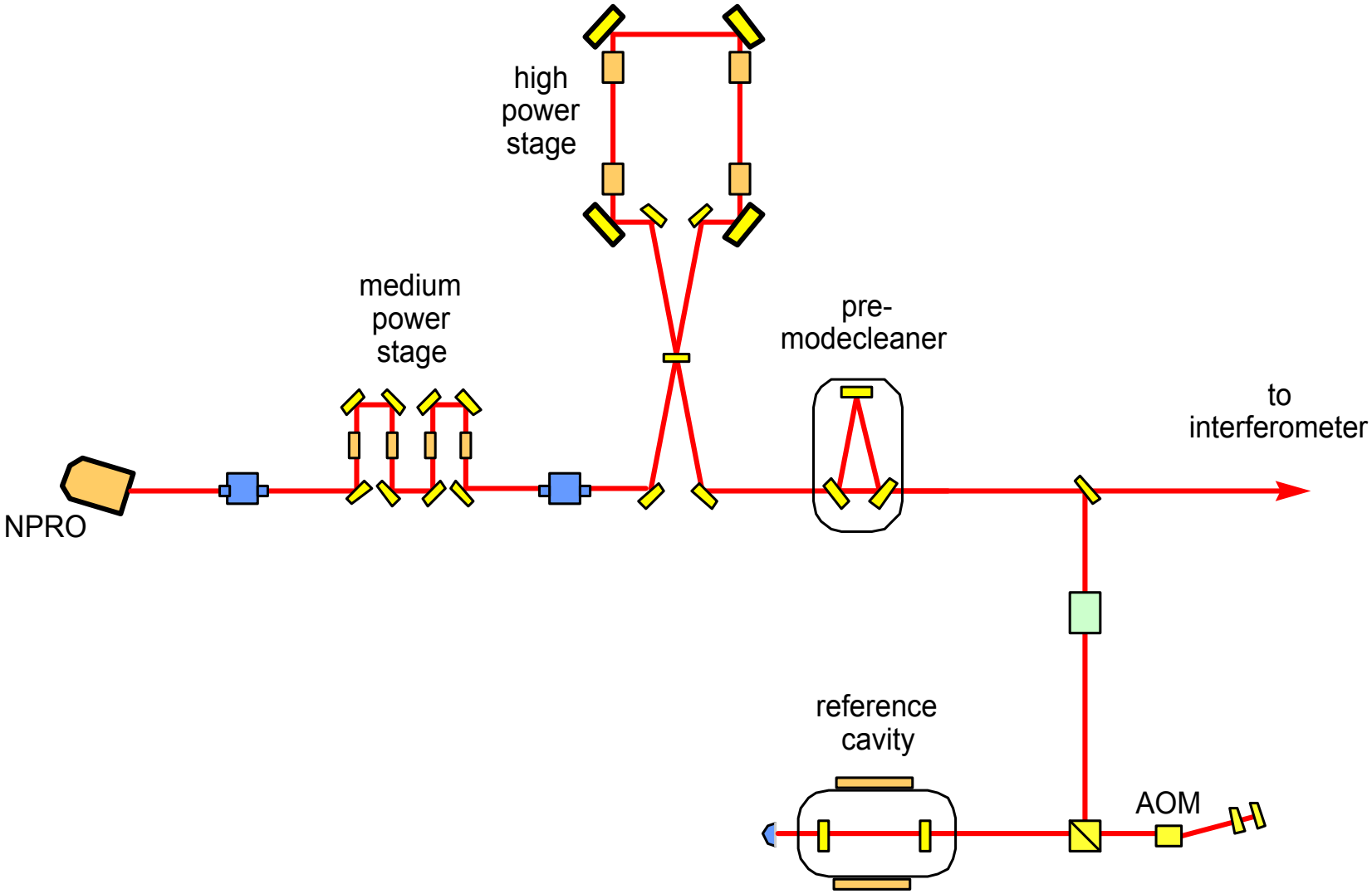
for the PSL team

LSC Virgo meeting, Caltech, March 2008

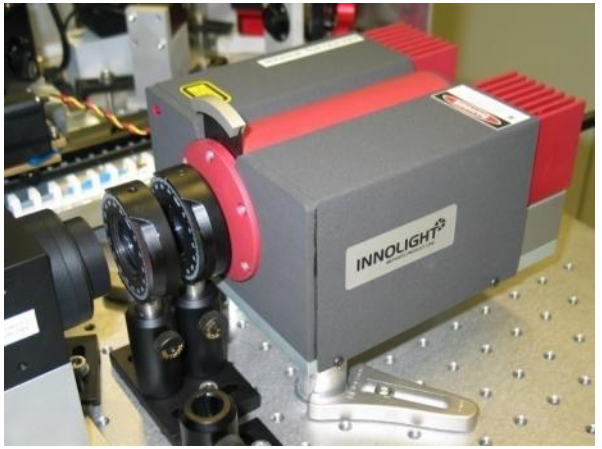
LIGO G080143-00-Z

Advanced LIGO prestabilized laser



Innolight Mephisto

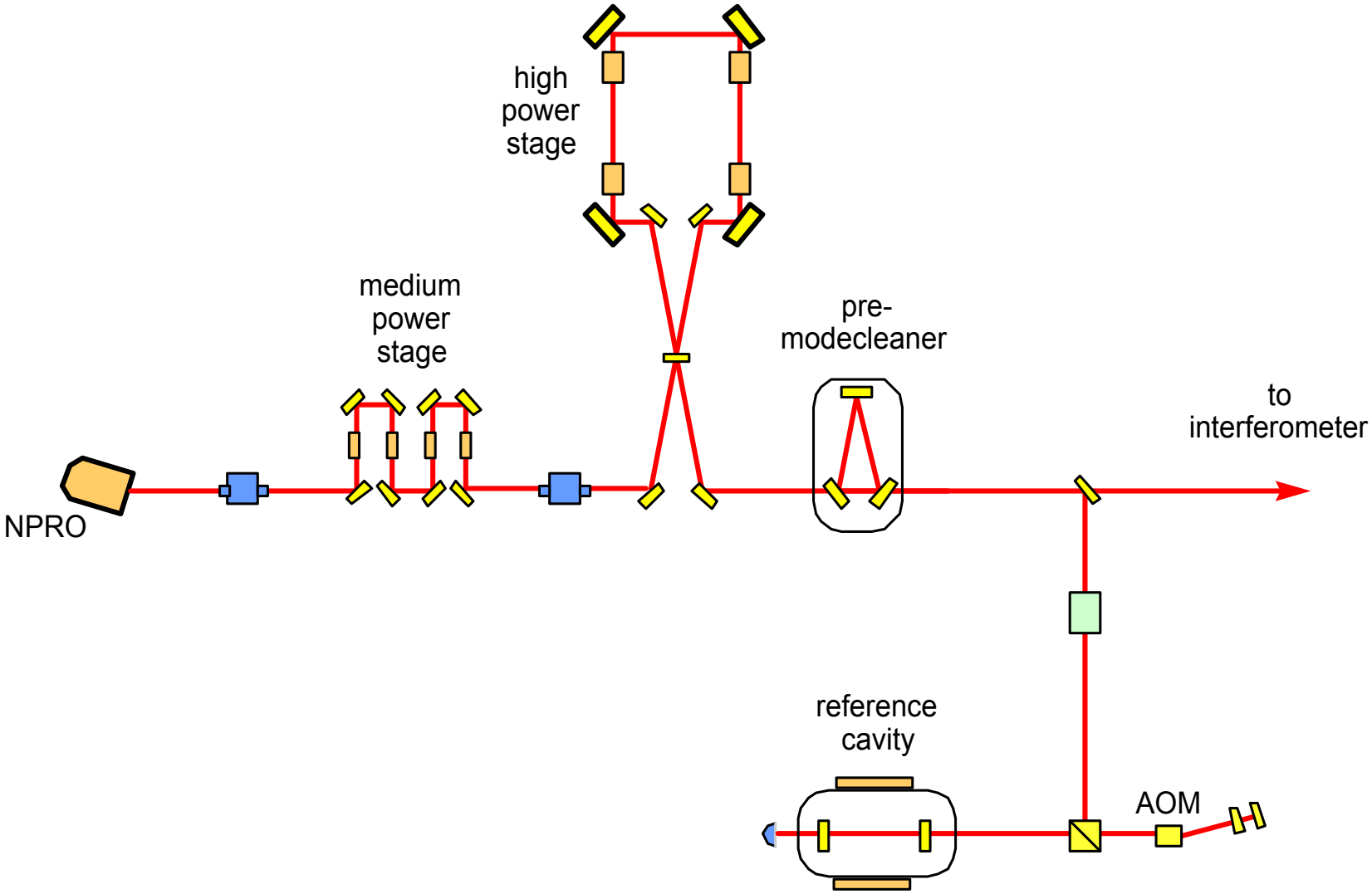
- all 8 Master lasers (2W NPROs) are delivered
- they have a special interface and specially selected LDs
- characterization program
  - power, slope, power in p-pol
  - RIN:
    - noise spectrum 1Hz – 100kHz,
    - time series (60min) rms
  - frequency noise
    - spectrum 1Hz – 100kHz
    - upper limit for drift
  - PZT and slow actuator calibration
  - beam quality
    - higher order mode content
    - beam pointing
- LDs power is de-rated by 30% to increase their lifetime and give headroom for power adjust



LD1 Power Monitor
GND
LD2 Power Monitor
GND
CTC1 Error
GND
n.c.
GND
n.c.
GND
LDTC1 Error
GND
LDTC2 Error
GND
Guard LDTC1
GND
Guard LDTC2
GND
n.c.
GND
n.c.
GND
NE Monitor
GND
Interlock

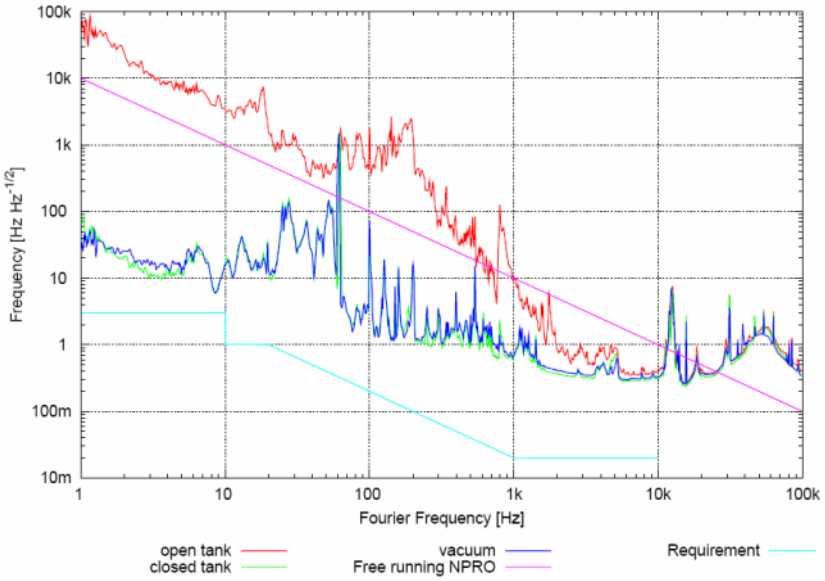
Set Temperature LD1
GND
Act. Temperature LD1
GND
Set Temperature LD2
GND
Act. Temperature LD2
GND
Set Temperature Crystal
GND
Act. Temperature Crystal
GND
Set Current
GND
Act. Current
GND
Status Laser ON
GND
n.c.
GND
Remote SW
GND
Remote SW ON
GND
Remote SW OFF

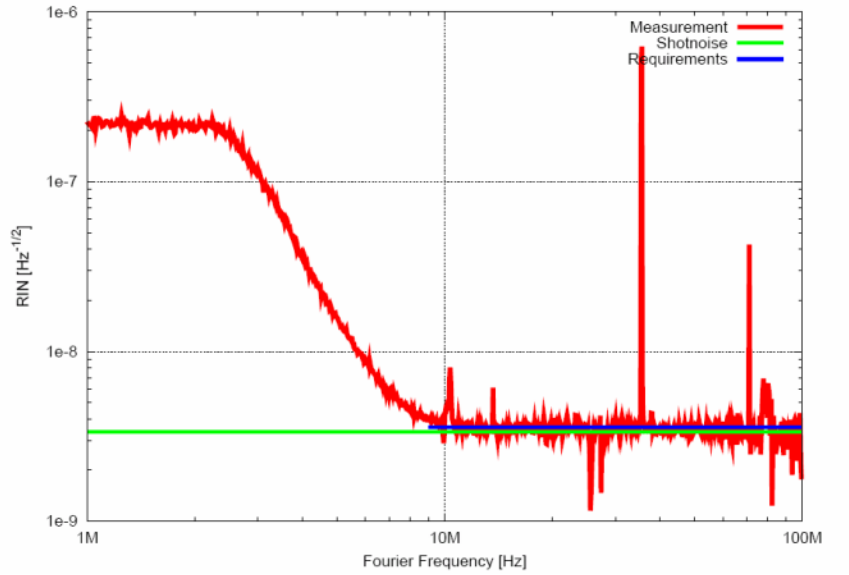
Advanced LIGO prestabilized laser



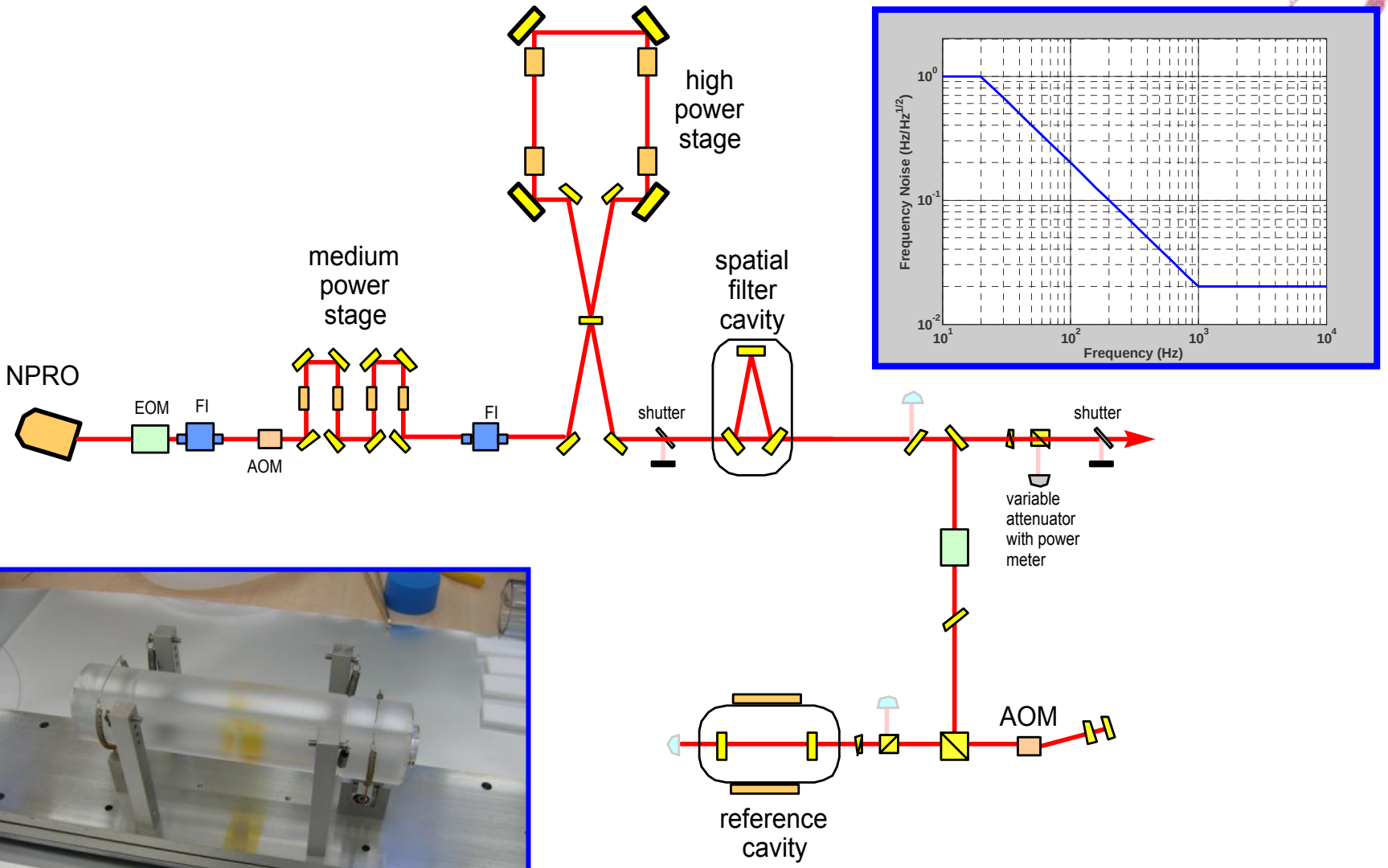
PMC design

- first prototype fabricated at AEI
  - Finesse 46 / 383
  - since Jan 2008 operated in s-pol with 35W injected (60% higher circulating power than in AdvLIGO)
  - PZT
    - FSR ↔ 140V
    - first resonance @ 10kHz
  - aluminium spacer to allow for long range thermal actuator
- in sealed housing, probably no vacuum required
- rf filtering
  - 4dB @9MHz, sufficient to meet AdvLIGO requirements

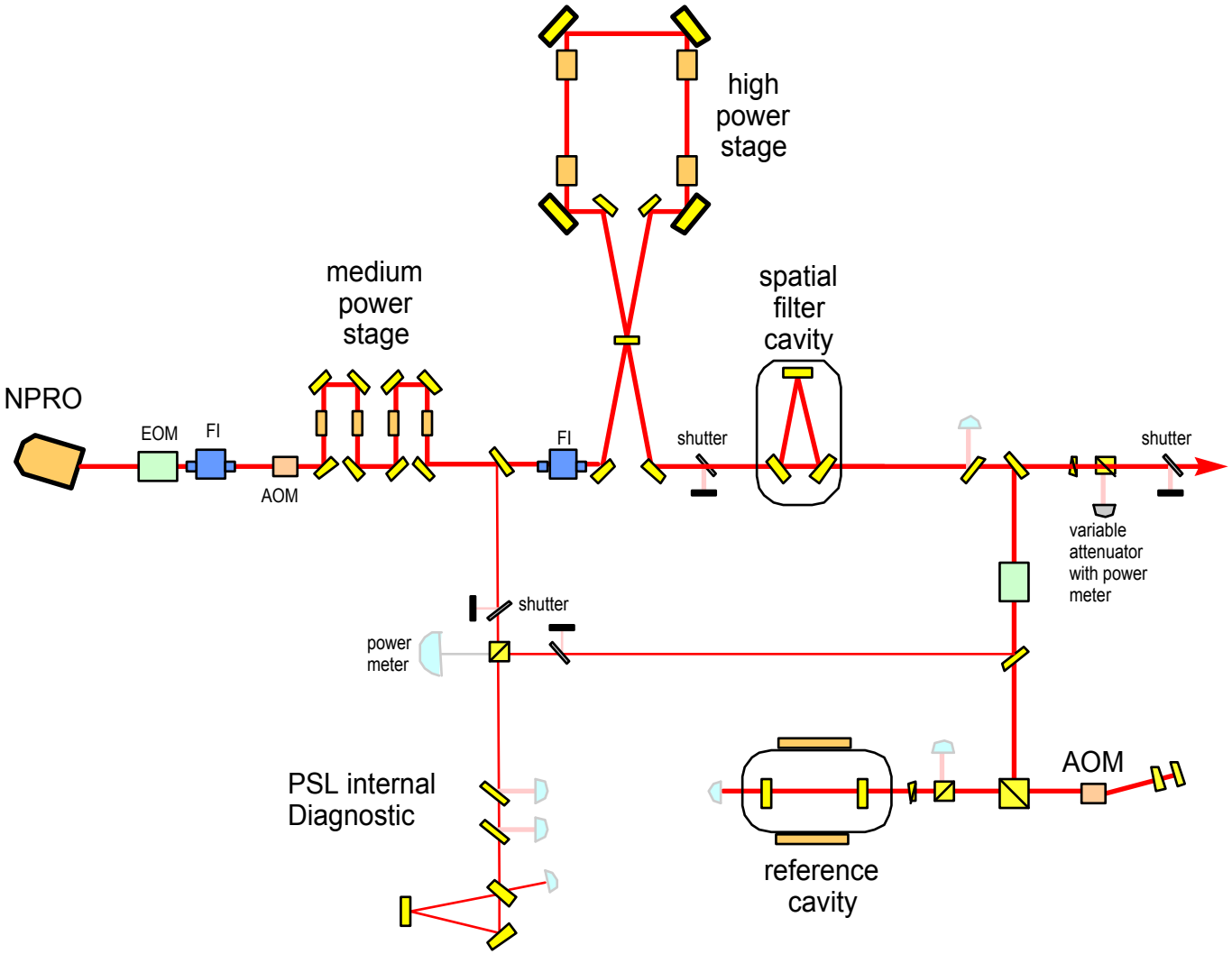




frequency stabilization

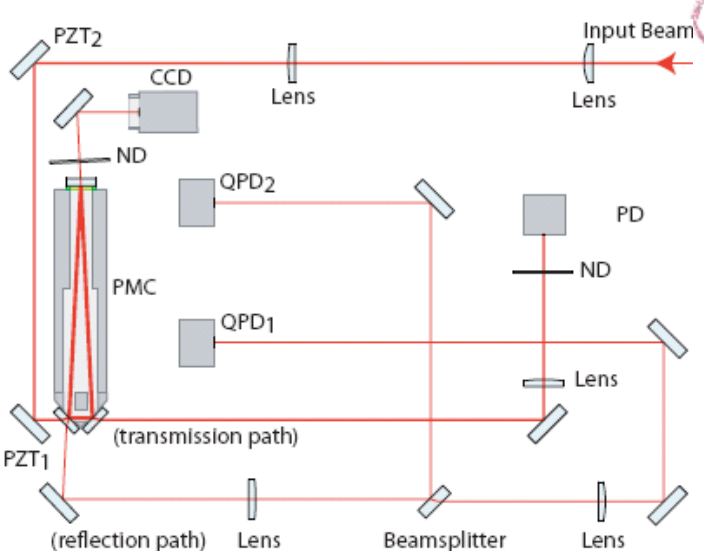


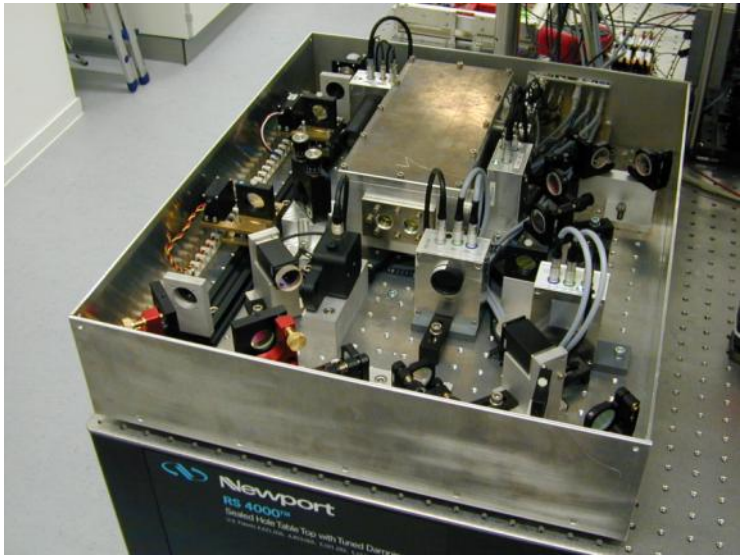
diagnostic bread board



beam diagnostic tool

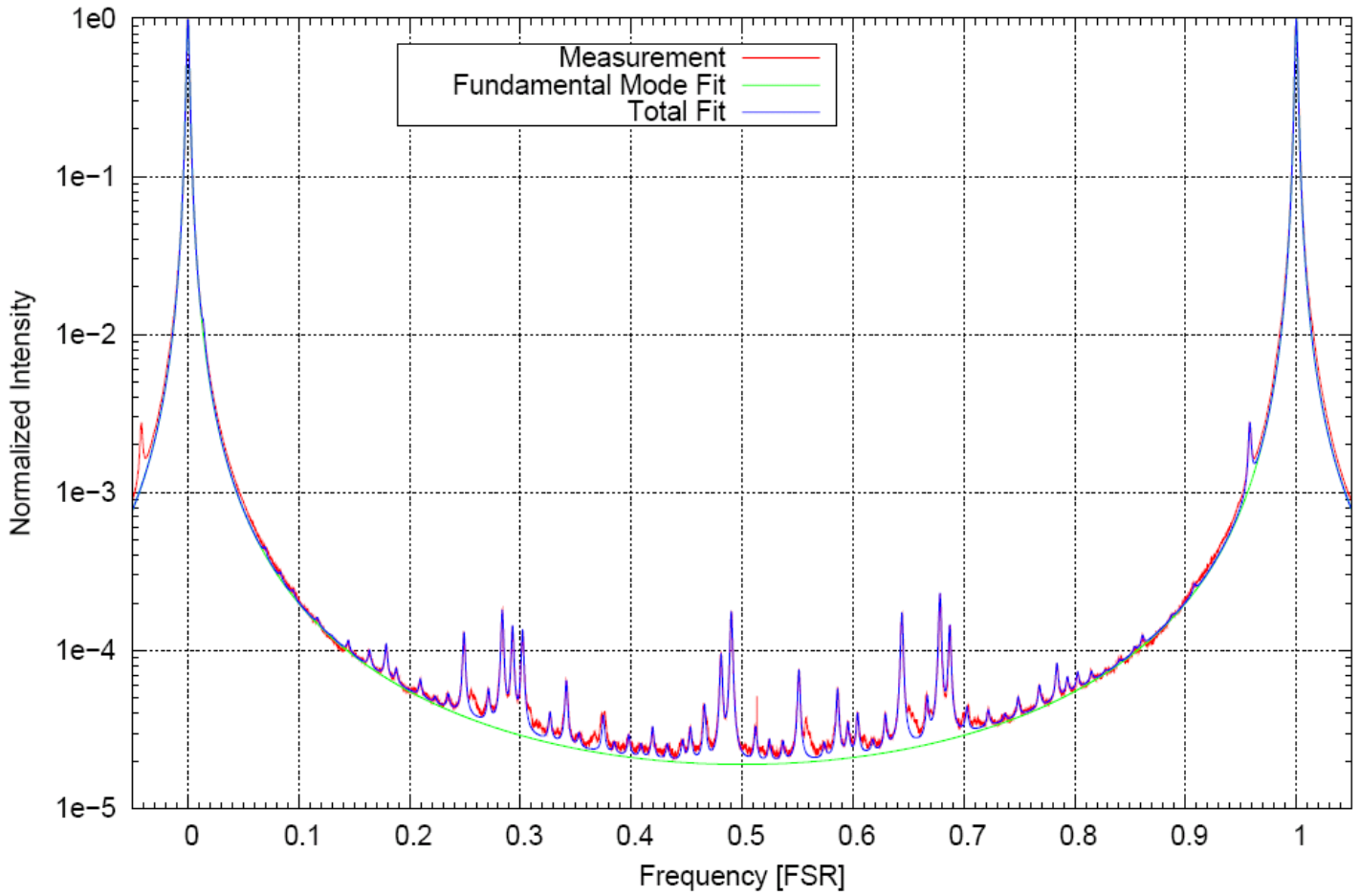
- diagnostic tool to measure
  - power noise (low f and rf)
  - frequency noise
  - higher order mode content
  - beam pointing (differential wavefront sensing)
- fully automated
  - automatic length and alignment control
  - can switch from lock to scan mode
  - performs complete beam analysis without human interaction (at night during long term test)
  - allows fast turn around between laser optimization and characterization





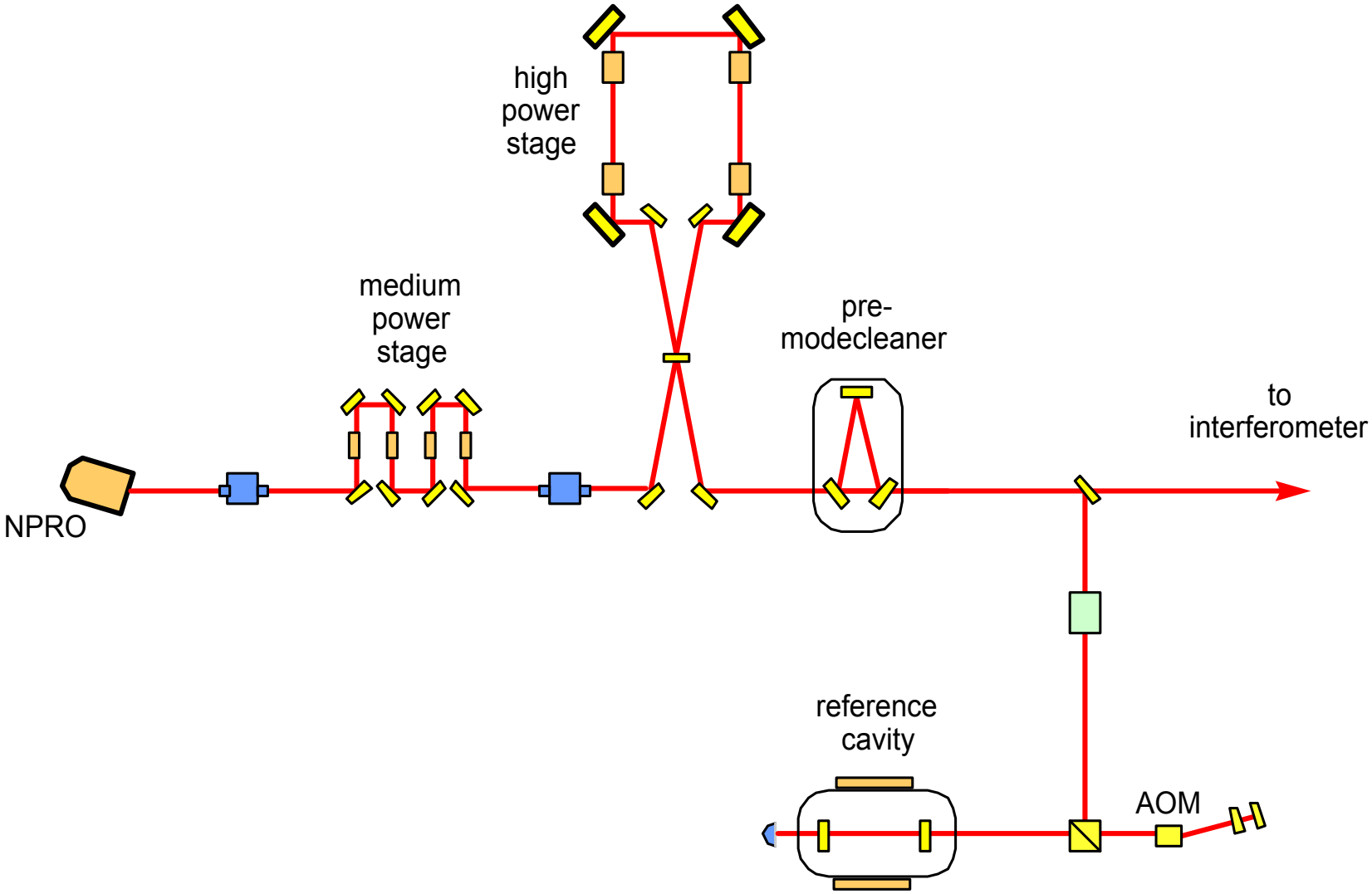
Kwee et al, Rev. Sci. Instrum. **78**, 073103 (2007)

NPRO (filtered by a fiber and PMC)

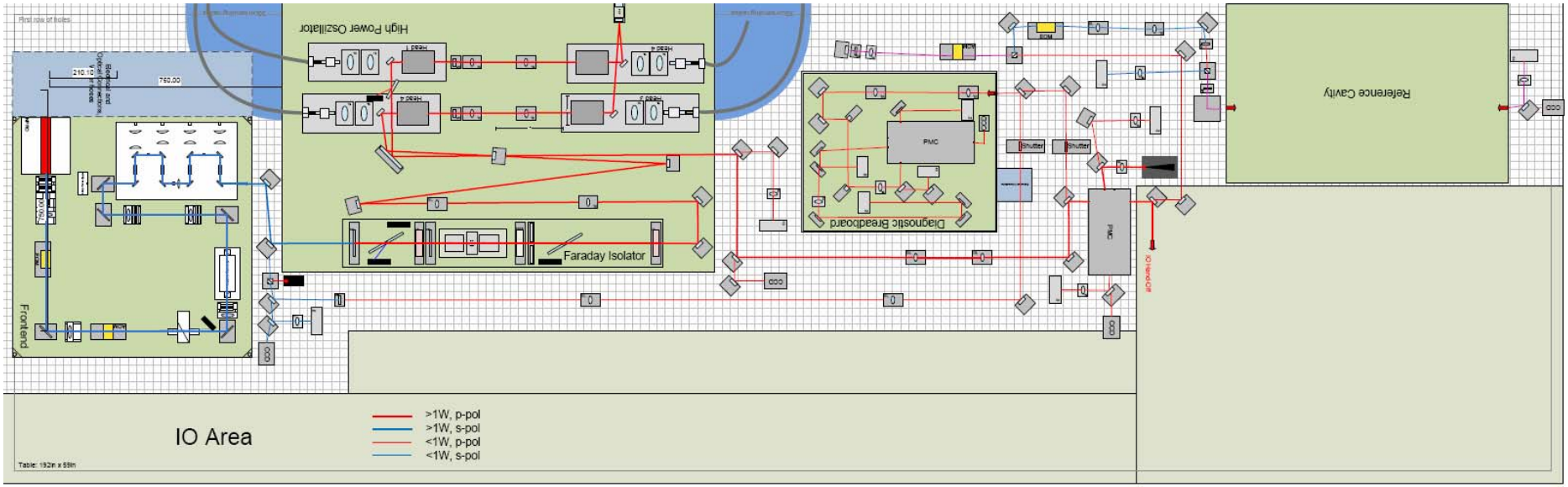


Finesse: 366 ±5
higher order mode power: 0.56% ±0.3%

Advanced LIGO prestabilized laser

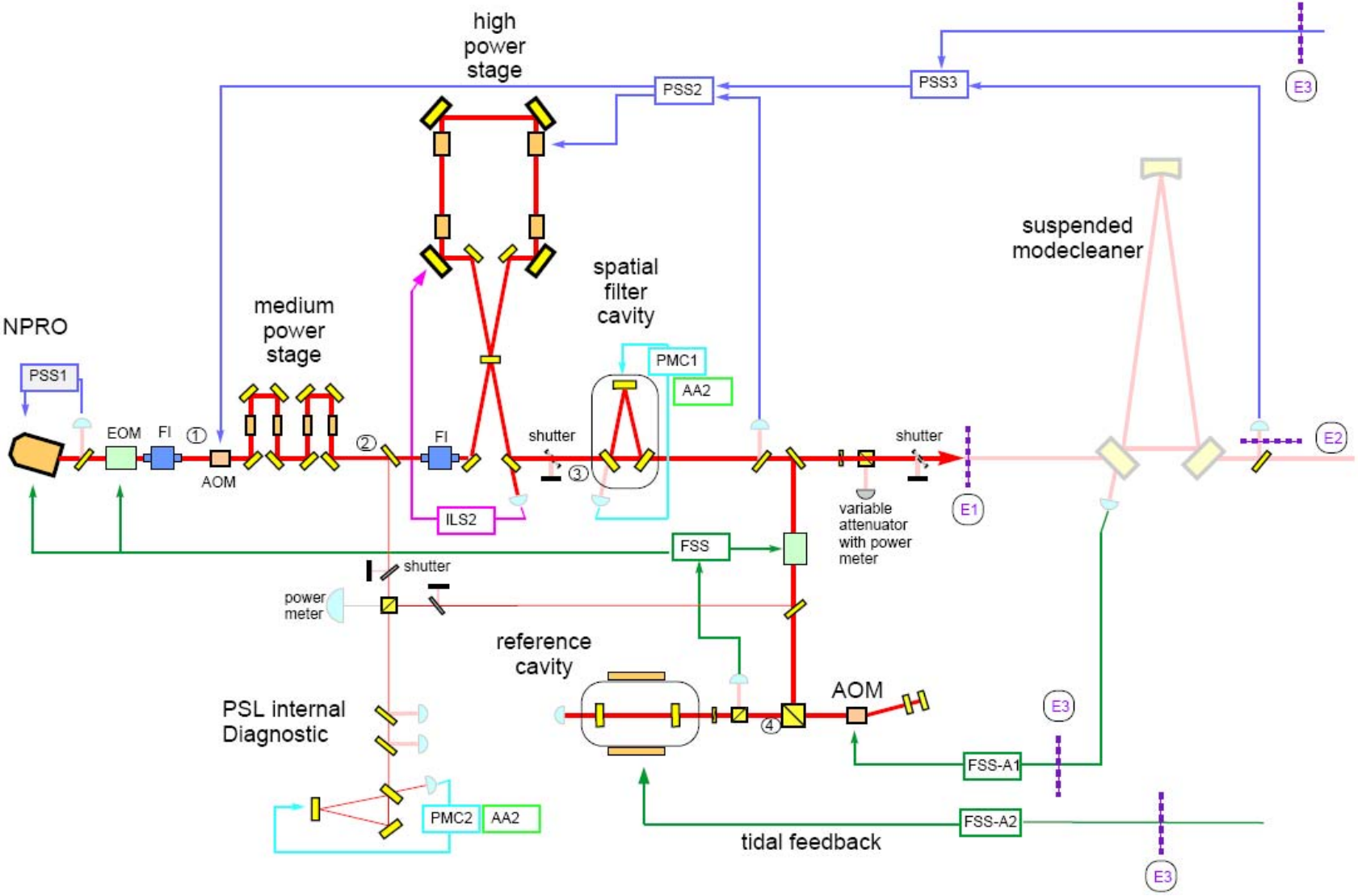


PSL / IO Table layout

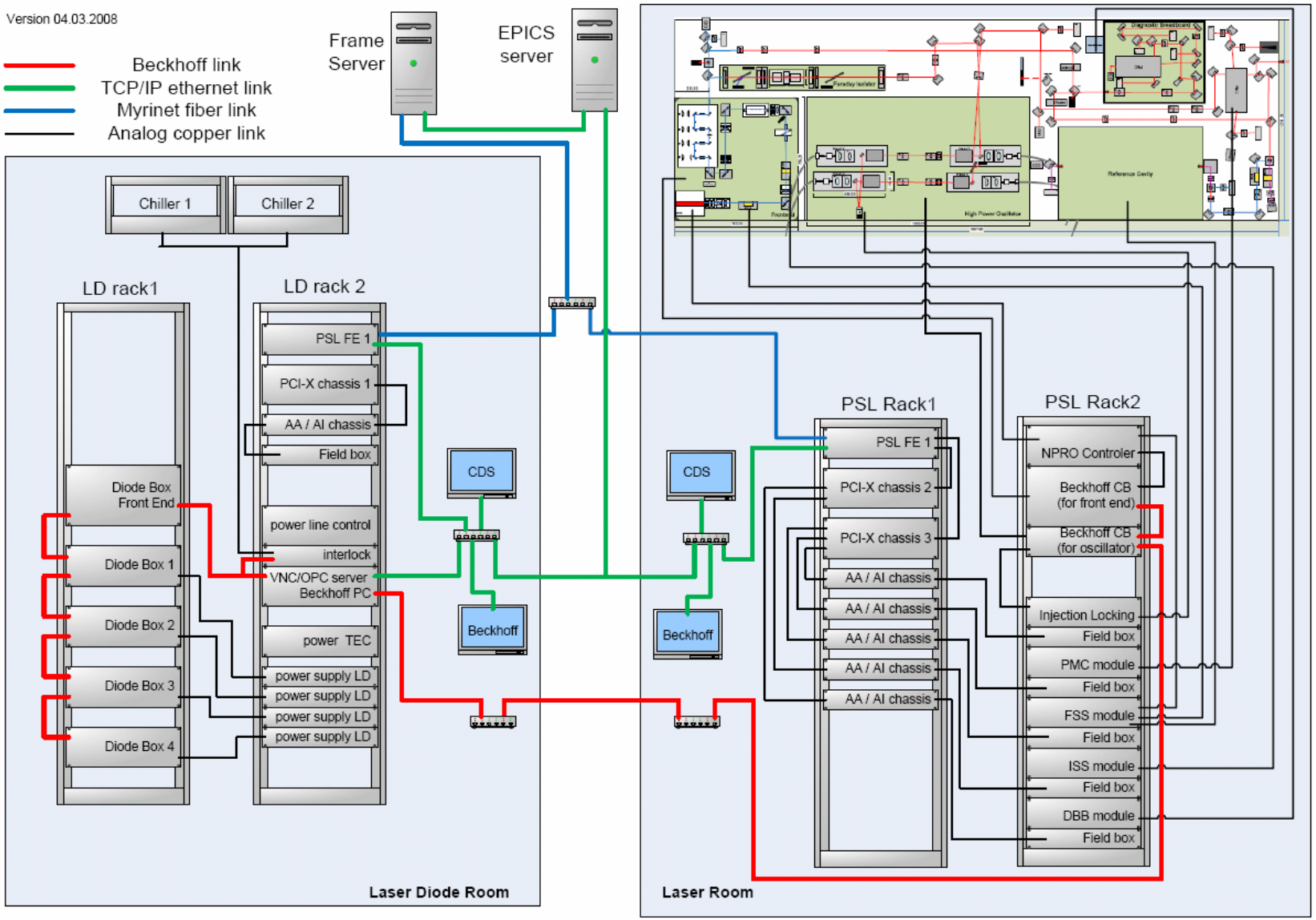


- real estate on the PSL table is currently negotiated between IO and PSL
- layout sketch above will change
- PSL table more crowded than in inital LIGO
- table size probably just big enough
- can DBB be used for IO diagnostic purposes ?
- cleanliness, easy access, small number of componets in 180W laser path

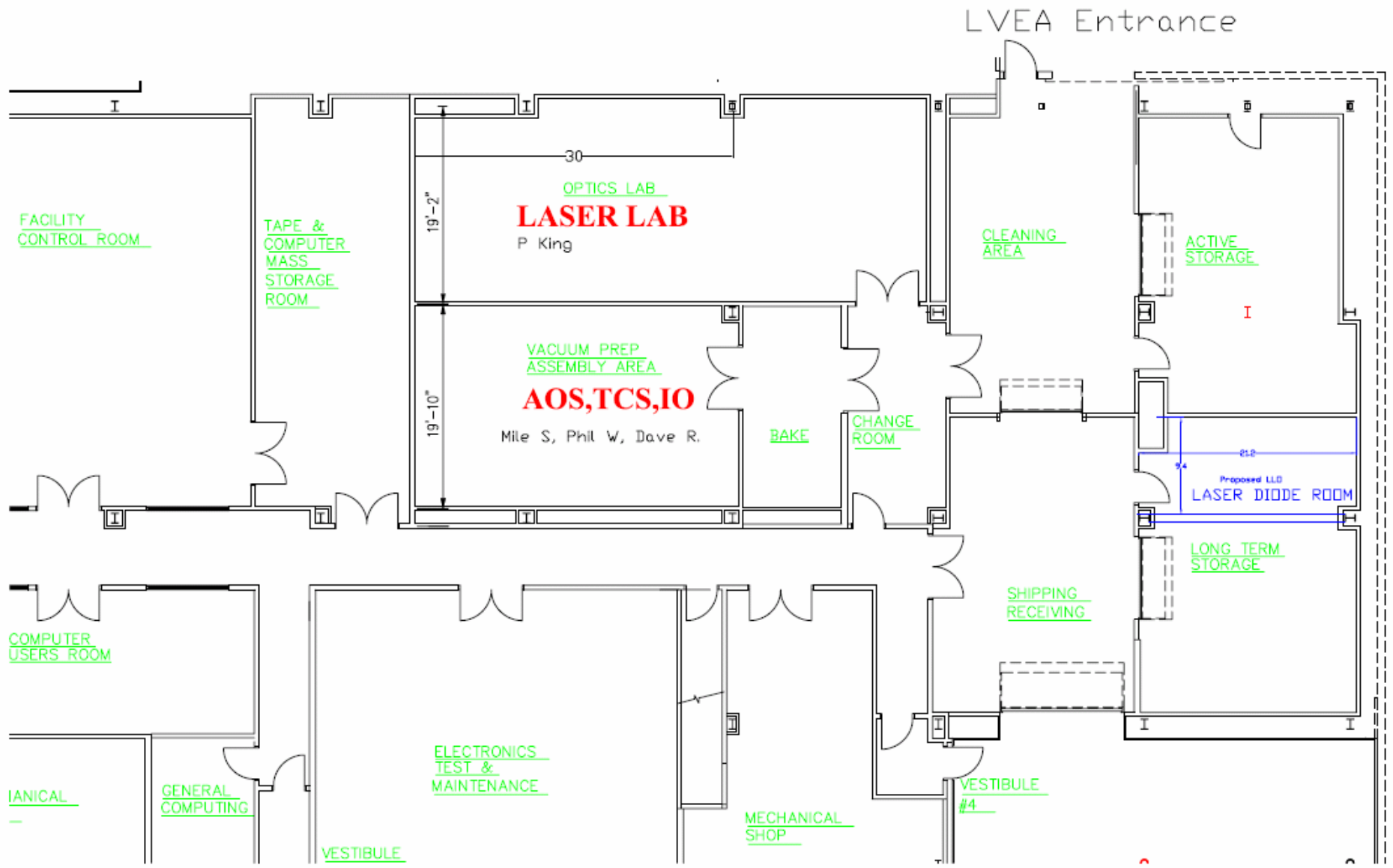
Advanced LIGO PSL setup



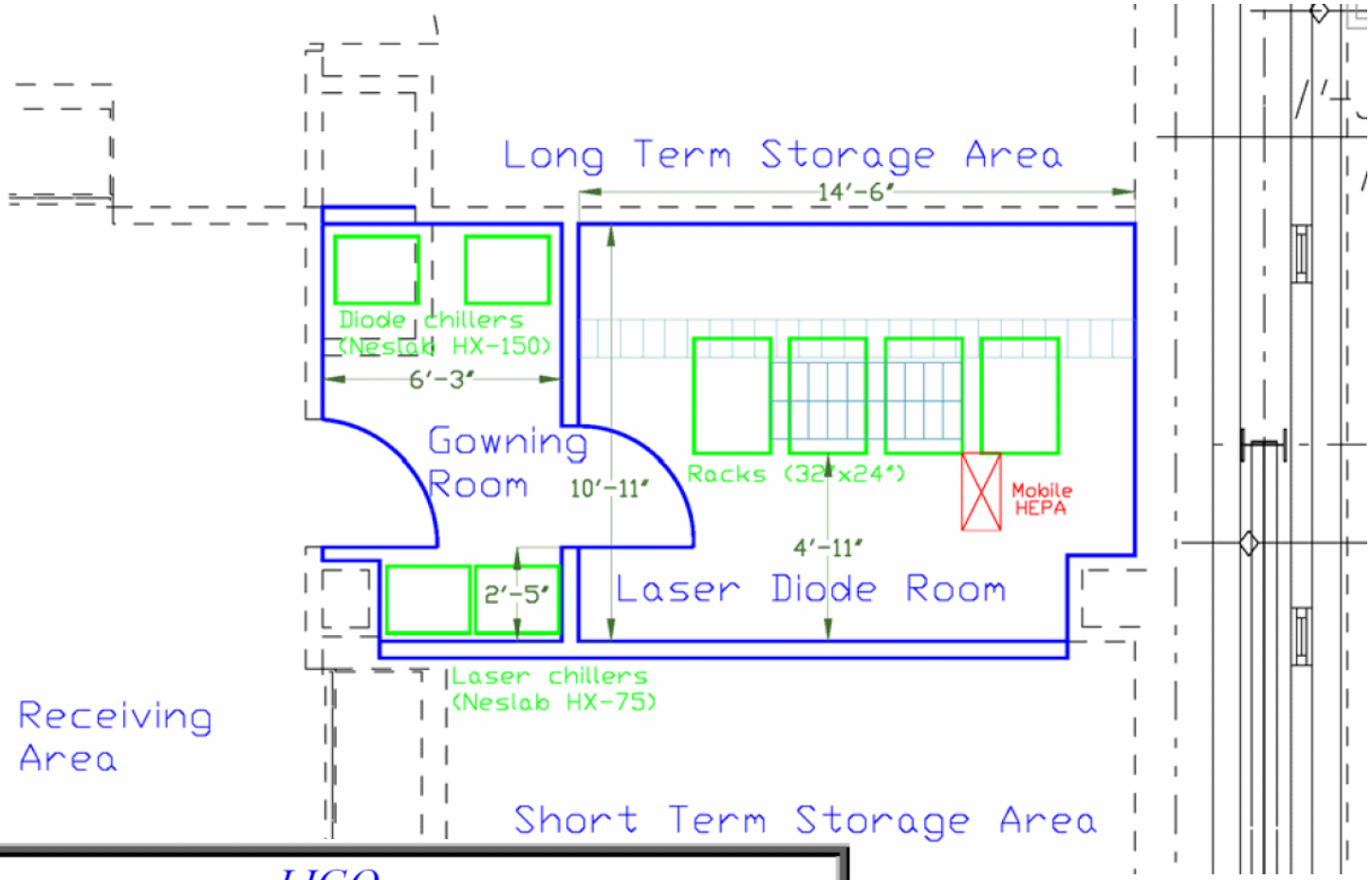
PSL control


Version 04.03.2008
Beckhoff link
TCP/IP ethernet link
Myrinet fiber link
Analog copper link
Frame Server
EPICS server
Chiller 1
Chiller 2
LD rack1
LD rack 2
PSL FE 1
PCI-X chassis 1
AA / AI chassis
Field box
power line control
interlock
VNC/OPC server
Beckhoff PC
power TEC
power supply LD
power supply LD
power supply LD
power supply LD
Diode Box Front End
Diode Box 1
Diode Box 2
Diode Box 3
Diode Box 4
CDS
Beckhoff
Laser Diode Room
PSL Rack1
PSL FE 1
PCI-X chassis 2
PCI-X chassis 3
AA / AI chassis
AA / AI chassis
AA / AI chassis
AA / AI chassis
AA / AI chassis
PSL Rack2
NPRO Controler
Beckhoff CB (for front end)
Beckhoff CB (for oscillator)
Injection Locking
Field box
PMC module
Field box
FSS module
Field box
ISS module
Field box
DBB module
Field box
CDS
Beckhoff
Laser Room

laser diode room location



laser diode room



LIGO-T070195-04-W

LIGO

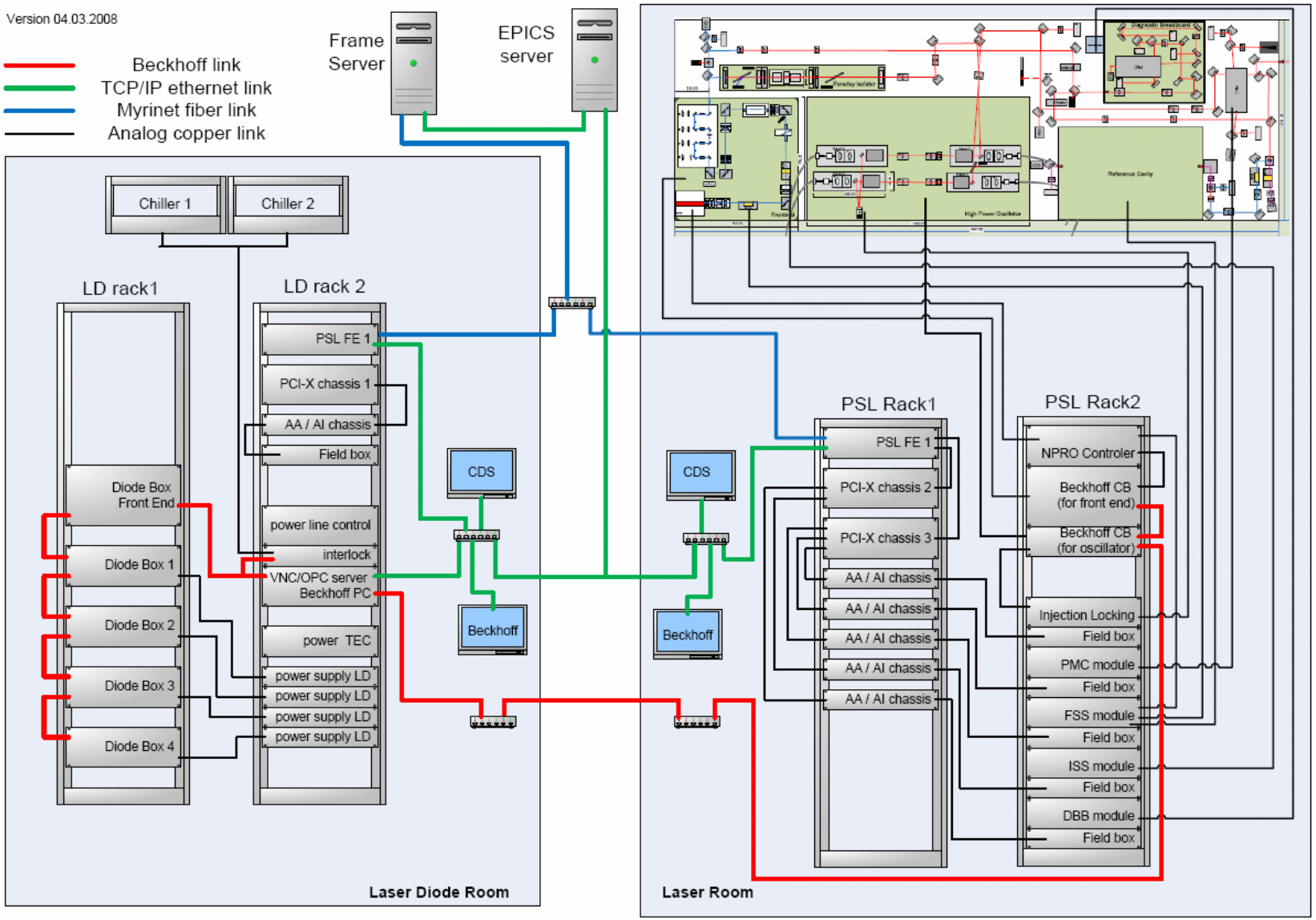
Aug. 17, 2007

Revised Sept. 5, 2007

Preliminary Design – AdvLIGO PSL Laser Diode Room

A. Effler, P. King, R. Savage, R. Wooley

PSL control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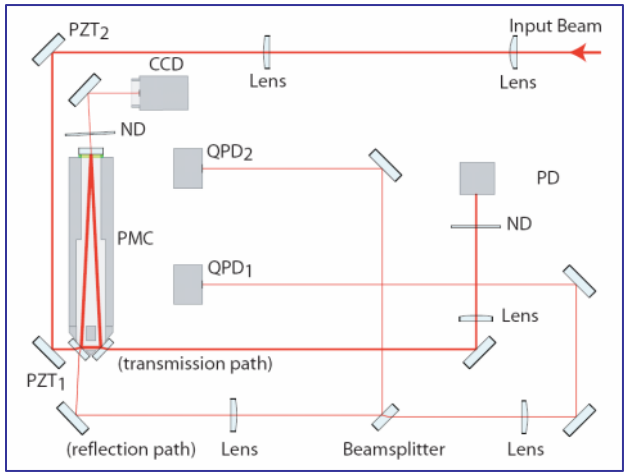
ISS module
Field box
DBB module
Field box
CDS
Beckhoff
Laser Room

DBB control with RTLinux/Epics system



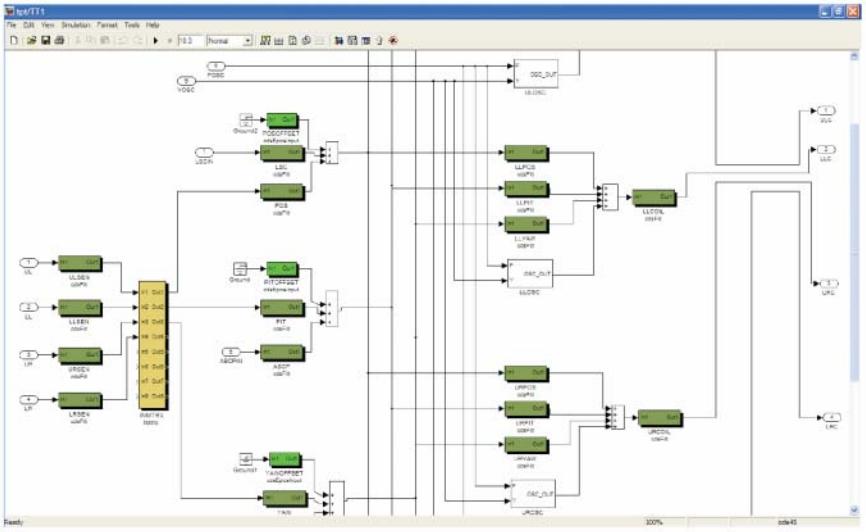
- RTLinux/Epics system was installed at AEI
- length and alignment control of ring cavity in DBB via digital control
- now used to control FSS
- next step: automate lock acqisition for ref. cavity and include PMC

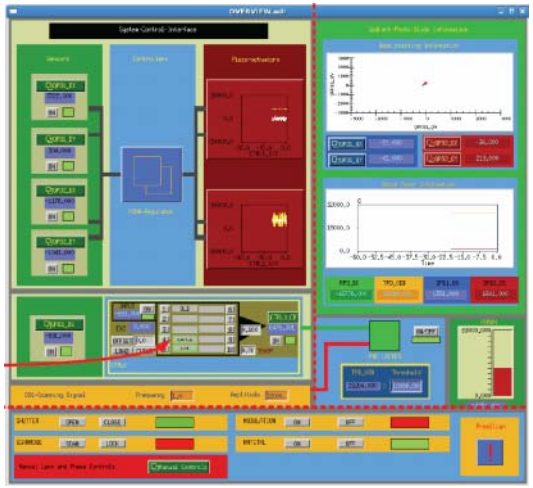
STUDIENARBEIT

Erweiterung eines CAD-Systems um die Funktionen der Modellbildung und des Reglerentwurfs

von

Anatoli Fedynitch





next steps

- finalize functional prototype of 180W laser and move to engineering prototype
- measure free running noise and actuator transferfunctions to design Pstab loop
- continue long term performance measurements and integration test at AEI
  - LIGO provides additional DAC/ADC hardware
  - implement PMC and ISS loop
  - install automation and measure cross couplings between loops
  - find phase delay in FSS and test different sensing points
- PSL preliminary design review in summer