

# **40m TAC Meeting**

## **July 15, 2010**

LIGO-G1000699-v1

# People

## Faculty/Staff

Rana Adhikari

Koji Arai

Steve Vass

## Postdoc

Joe Betzwieser

## Graduate

Alberto Stochino

Kiwamu Izumi

Jenne Driggers

## Undergrad. (SURF)

Kevin Kuns (Pre/Post LHO SURF) - IOO

Nancy Aggarwal - MC WFS work

Gopal Nataraj - MC WFS work

Katharine Larson - Magnetic levitation

Sharmila Dhevi - Magnetic levitation

Razib Obaid - Phase camera

## ex grad

Rob Ward (1/2004-3/2010)  
gone to Paris - APC/Barsuglia

[Link to Rob's Thesis](#)



# ***Agenda***

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- **Purpose of the upgrade**
- **Current status of the upgrade**
- **Upgrade Plans**

# *40m upgrade*

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- **Purpose of the upgrade**
- **Testbed for the AdvLIGO interferometer technologies**
  - Length sensing & control
  - IFO responses
  - Noise couplings
- **Development of advanced interferometer techniques**
  - Adaptive noise cancellation

# 40m upgrade

- **More relevance of the new 40m to aLIGO**
- **Length Sensing & Control: more resemblance to aLIGO**
  - Two PM sidebands (11MHz/55MHz)
    - 9MHz/45MHz for aLIGO
  - Small asymmetry ( $\sim 3\text{cm}$ ):
    - small leakage of SB1 to SRC
    - large leakage of SB2 to SRC by resonance in SRC
  - Use of 3f demodulation
    - base line design in aLIGO
  - Arm finesse:  $\sim 450$ 
    - same as that in aLIGO
- **Comprehensive tests of the aLIGO technologies**
  - Green laser injection for arm length stabilization
  - aLIGO CDS with RFM/PCIe network topologies

# *40m upgrade*

- **Major difference of the new 40m to aLIGO**
- **Arm storage time difference (1/30)**
  - Arm storage time will be insignificant  
as arm locking is to be achieved in the deterministic way  
(green locking)
- **Arm power difference (3kW/850kW)**
- **lighter mass (0.25kg/40kg)**
  - => in total, similar DC radiation pressure effect
- **No alignment sensing & control for the IFO**

# ***IFO Status***

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- **Installation just on the way**
- **MZ removed**
- **First stage vent Mar-Jun**
- **IOO realignment**
  - **Input MC refinement**
  - **New MMT installed**
- **Green Locking**
  - **Green beams at the PSL table and one of the ends**
  - **The green beam was PDH-locked to the arm fringe**
- **Coming works**
  - **Green beam steering (for PLL)**
  - **Installation of PRC/SRC (SOSs and TTs)**
  - **Oplev and aux optics**

# 40m upgrade items

- **Mechanics**

- ✓ **SOS towers**

- ITMs / RMs done

- ETM SOSs: exists, ready to be cleaned / reassembled

- ✓ **Passive TT suspensions built**

- vertical blades + compliant eddy current damping

- main modes nicely damped

- ( $Q_{\text{pit}}$ ,  $Q_{\text{yaw}}$ ,  $Q_{\text{pos}} < \sim 3$ )

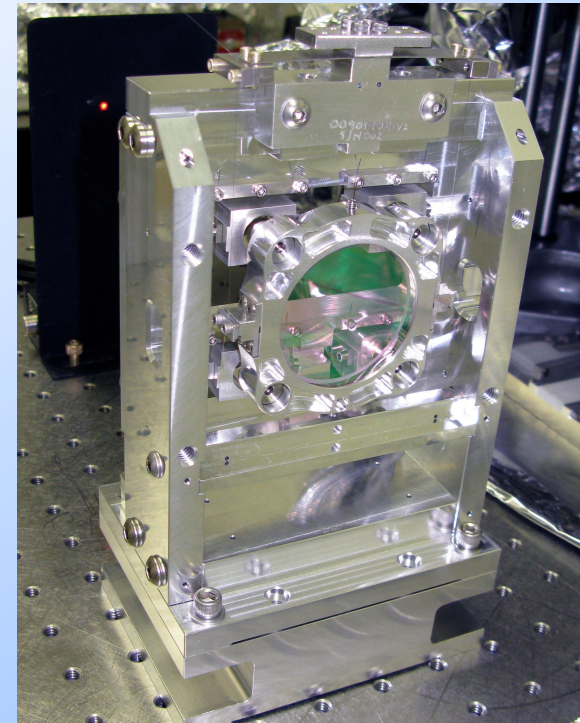
- ✓ **in-vac mounts for green beams**

- **Some more TTs**

- to be suspended

- **ETM SOS towers**

- exists & to be cleaned / reassembled

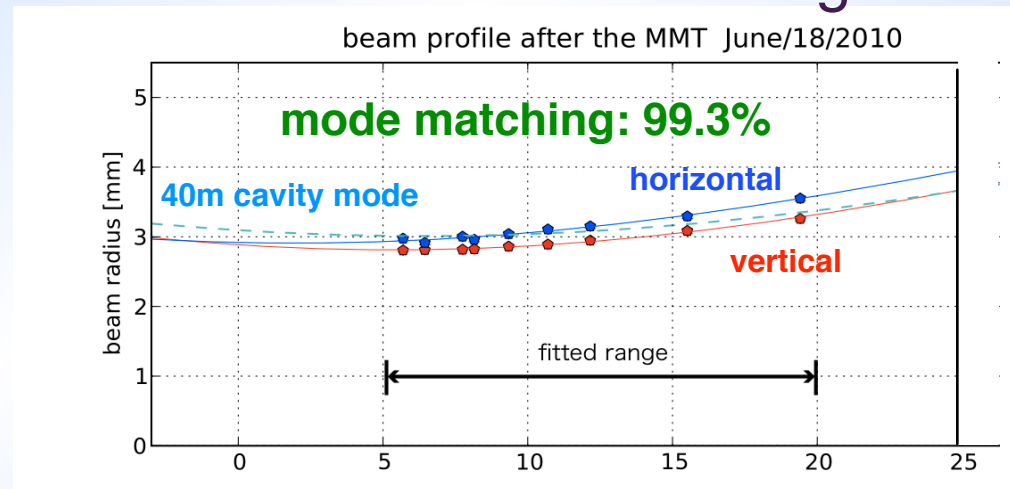




# 40m upgrade items

## • Optics

- ✓ **ITMs (dichroic):** suspended and installed
- ✓ **SRMs (T=10%):** suspended and waiting for the installation
- ✓ **Decided final PRM T to be 5.5%-6% :**  
conservative value against (previous) round-trip loss of 130ppm
- ✓ **2-m mode-matching telescope:**  
Installed & measured the mode matching of 99.3%



- ✓ **Small aux optics and green mirrors all in hand**
  - **ETMs are being polished / coated.**  
Delivery estimated to be July - October

# 40m upgrade items

- **Electronics**

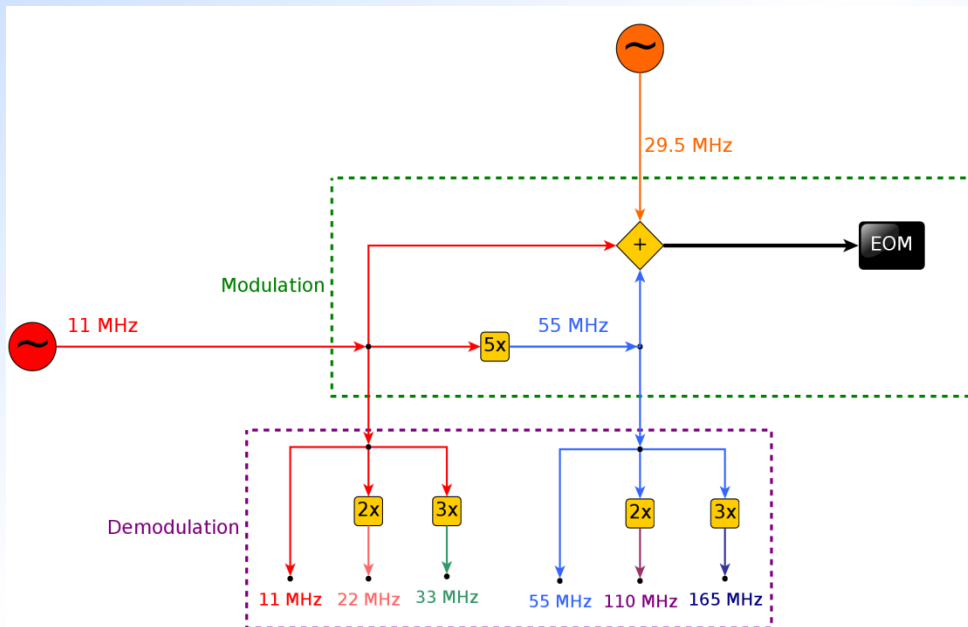
- ✓ Designed and fabricated 75% of the multi-freq RF box

- ✓ Built Triple-Resonant EOM (11/29.5/55MHz)

New Focus KTP + ext. circuit

- Complete the RF box (3weeks)

- Freq distribution and demodulation box (3 weeks)

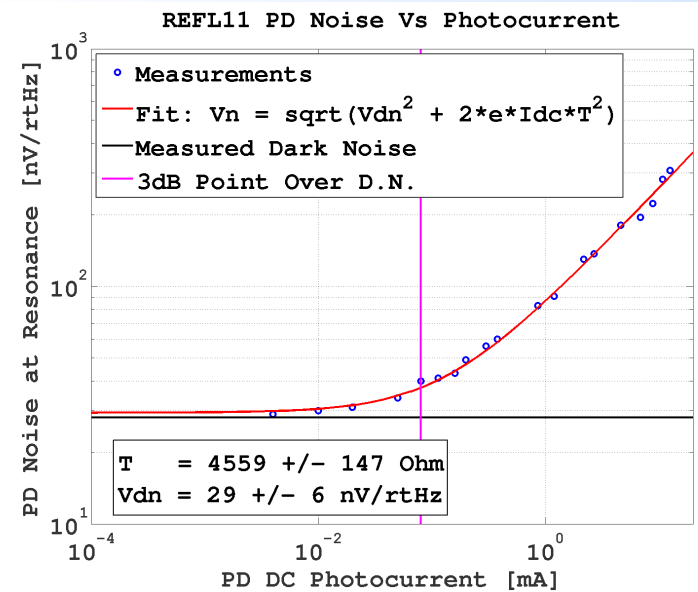
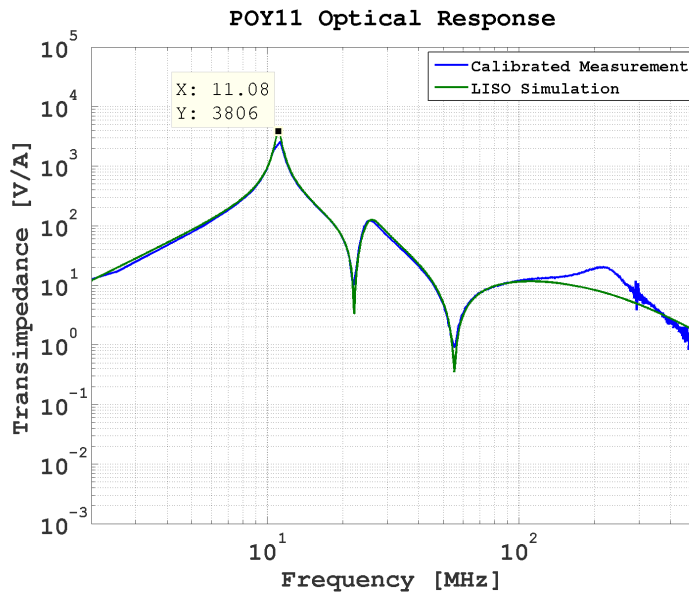


# 40m upgrade items

## • Electronics

✓ 5 of 10 PDs, replaced diodes to 2mm, re-tuned, and characterized the noise current (typically  $\sim 0.1$  mA)

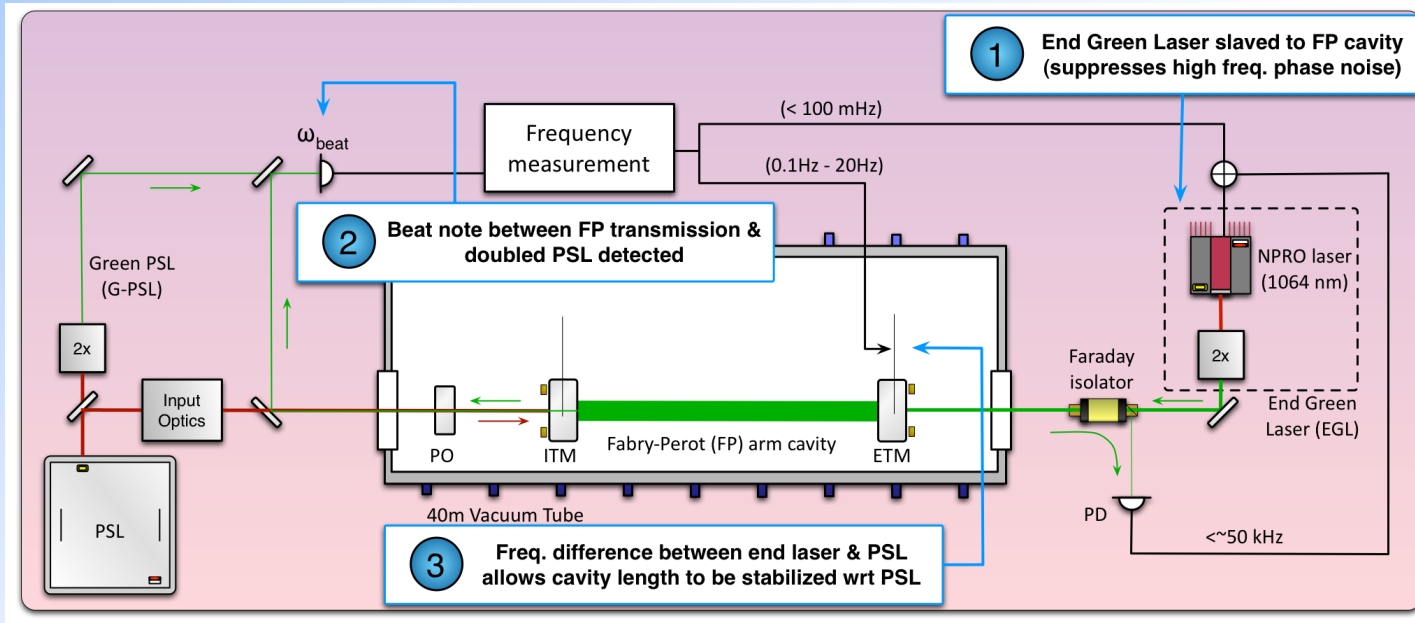
PD
REFL11
REFL55
AS55
POX11
POY11
POP11
POP55
SPOB22/SPOB110
REFL33 (lower priority)
REFL165 (lower priority)



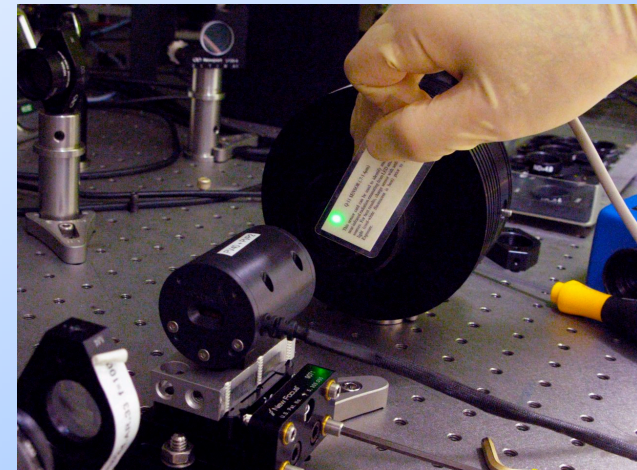
- Finish the remaining 5 PDs
- Installation of the PDs on the optical tables

# 40m upgrade items

- Green locking ~ assists arm locking by green beam

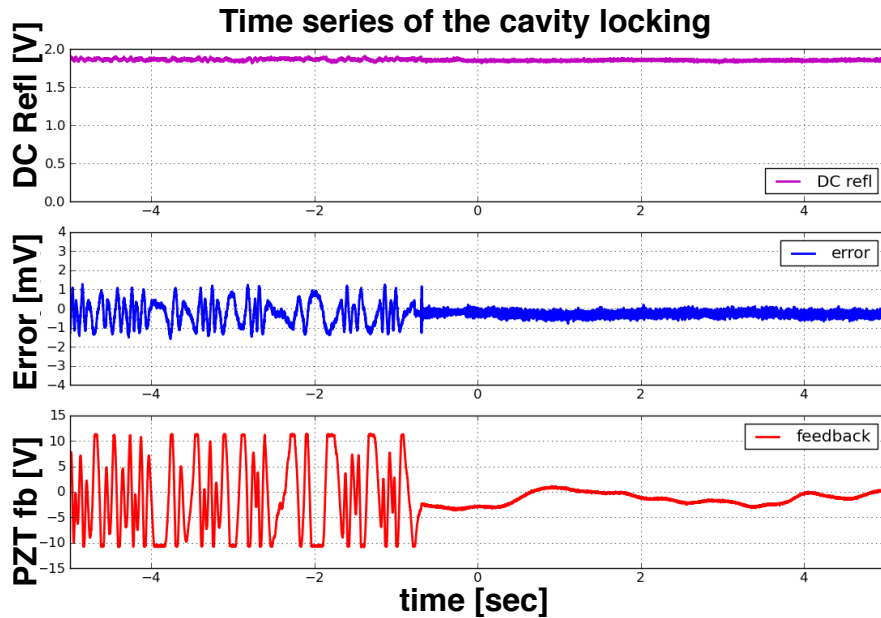
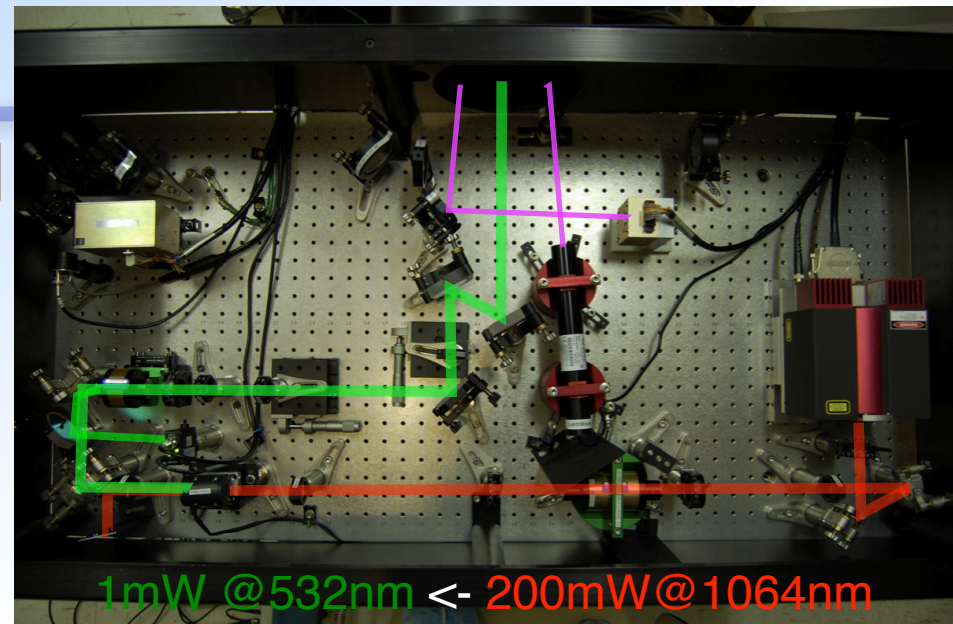
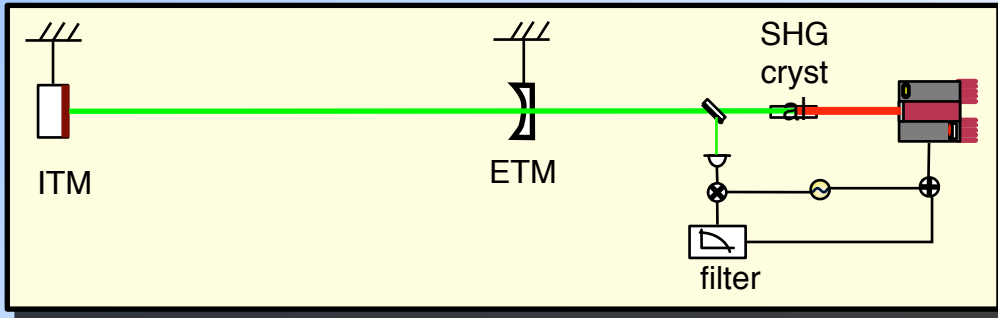


- ✓ PPKTPs and ovens in hand
- ✓ All green optics except for ETMs in hand
- ✓ One end table constructed
- ✓ Green beams generated  
at the PSL table and the end table
- ✓ Arm fringe of the green locked by PDH  
Arm finesse still  $< 1$



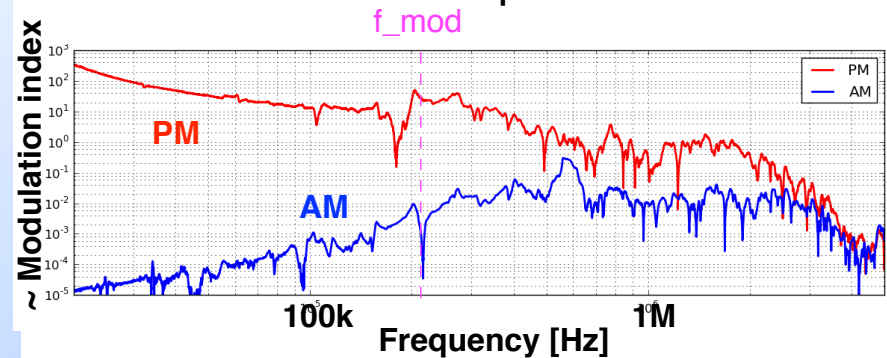
# Green locking

- Arm fringe lock achieved



## PDH locking with PZT FM@200kHz

NPRO PZT response



# 40m upgrade items

- **Digital control**

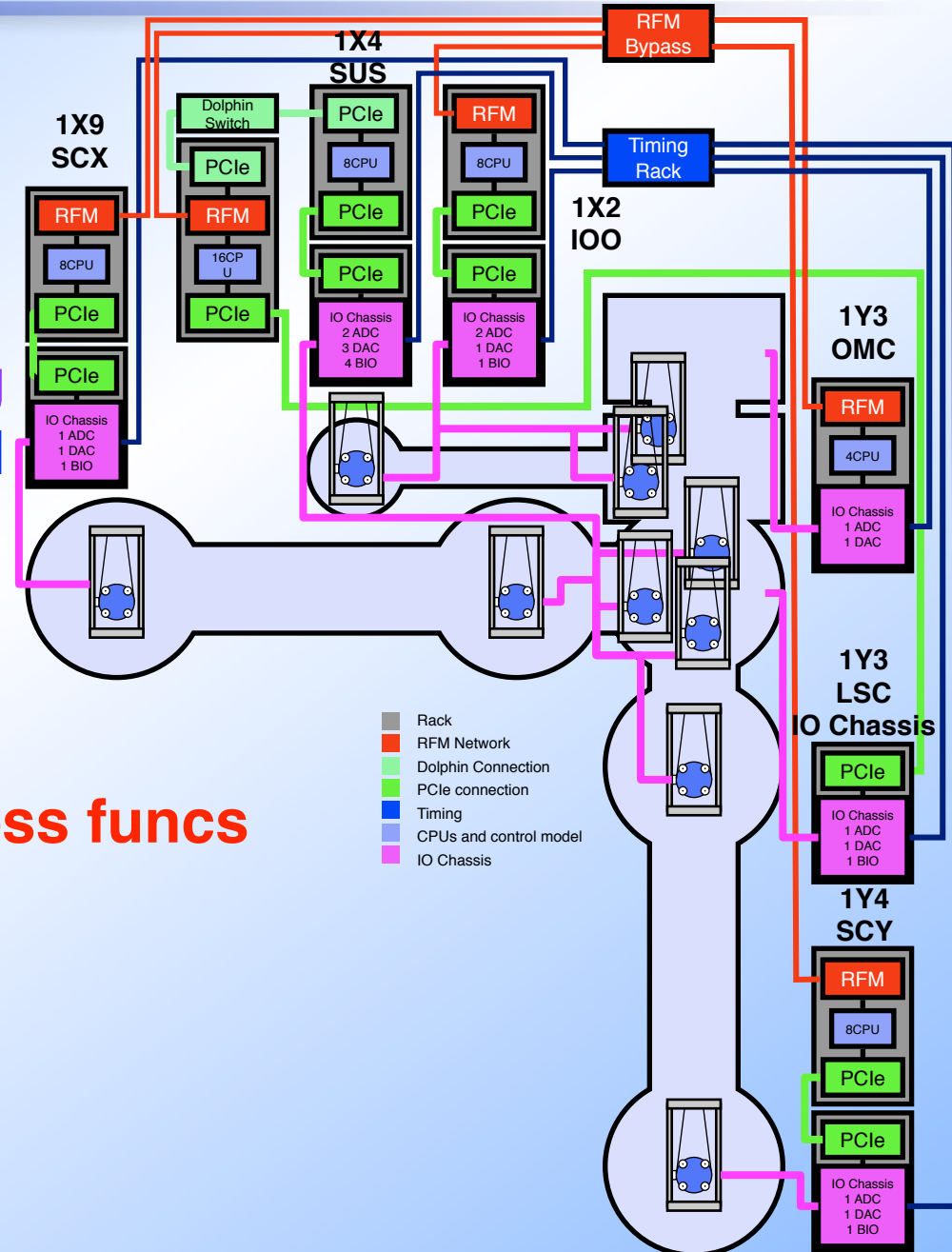
- ✓ **CDS plan updated**  
to fit to the aLIGO topology
- ✓ **Successful test of ETMY**  
Local damping / arm locking
- ✓ **90% of the HW transported to the 40m**

- **Local control test**

Local damping / arm locking

- **Coding of the for interprocess funcs**  
(i.e. LSC/ASC/Green etc)

- **Simulated Plant**

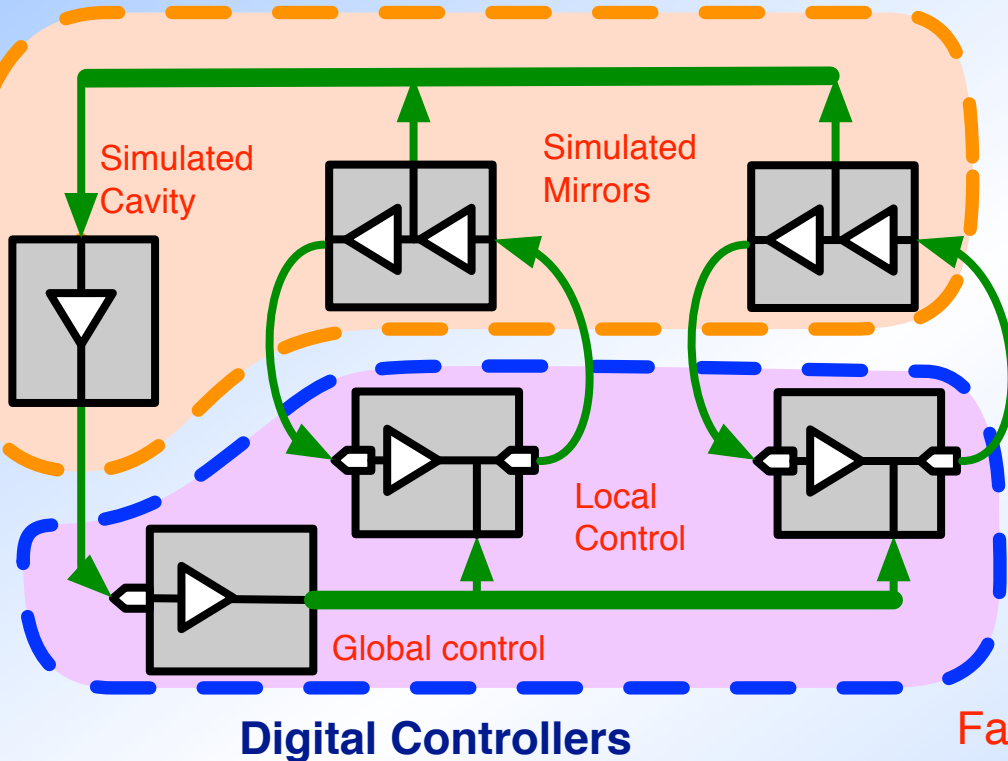


# Simulated Plant

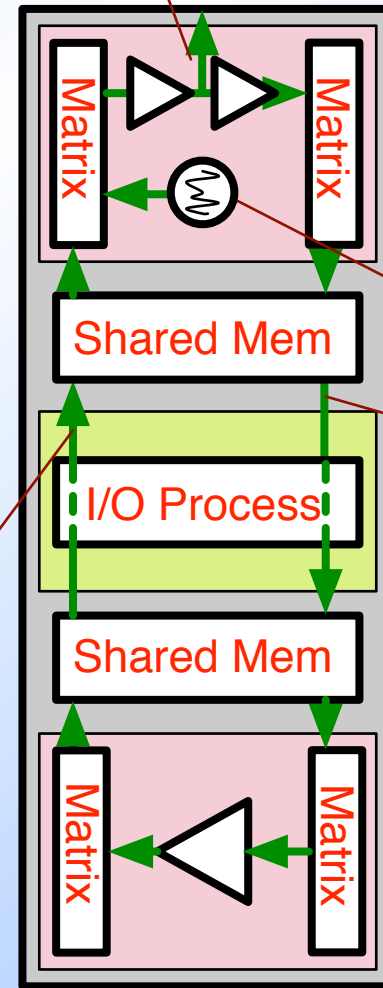
Replace H/W responses with digital filters  
Enables to run IFOs only with the SW

Suspension  
Controller / Plant

Simulated Plants



Fake Mass Position



Simulated  
Suspension  
Plant

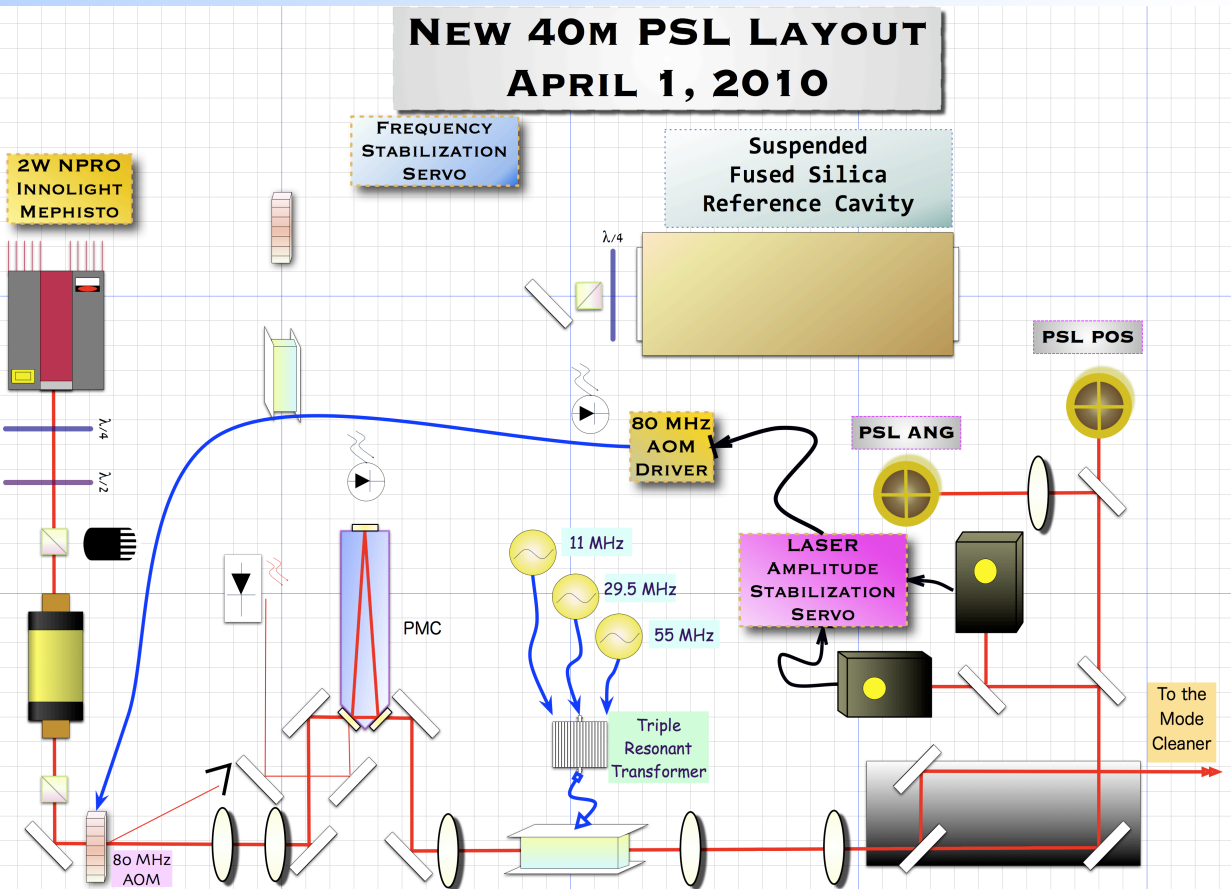
Fake  
seismic

Fake  
sensor  
signal

Servo Filter Controller

# Laser replacement

- 10W PSL slowly dying -> Replace to 2W NPRO (in hand)
- Use an AOM for ISS (in hand)
- Raise the PSL table height by TMC tripods





# Upgrade schedule

**IFO / Sus / Optics**

**RF**

**CDS**

**2010/7**

Vent / Optics installation (II)

**2010/8**

Green locking test

RF upgrade prep

Stand alone tests

**2010/9**

PSL upgrade

SRC TT prep  
ETM SOS prep

RF system upgrade

Integration tests  
(Simulated Plant)

**2010/10**

Vent / Optics installation (III)

**2010/11**

Initial optics adj.

**CDS Swap**

Optical table work

**2010/12**

**Partial locking**

**Full locking**