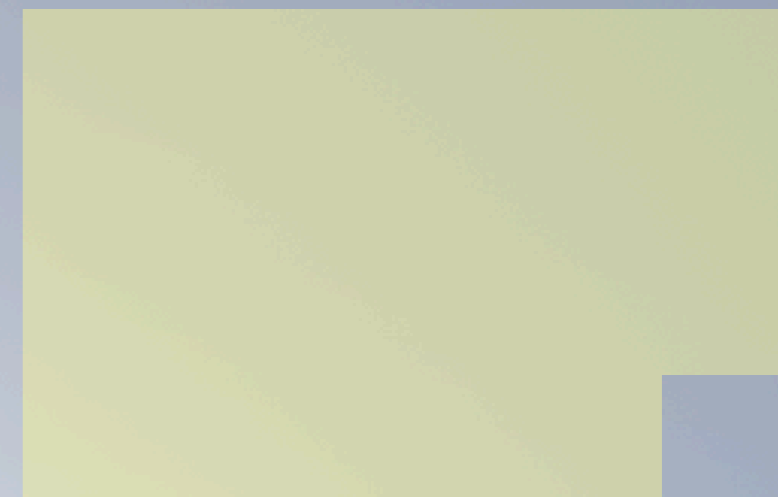
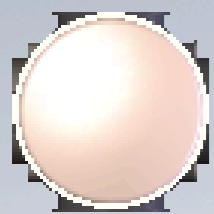
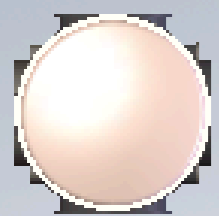
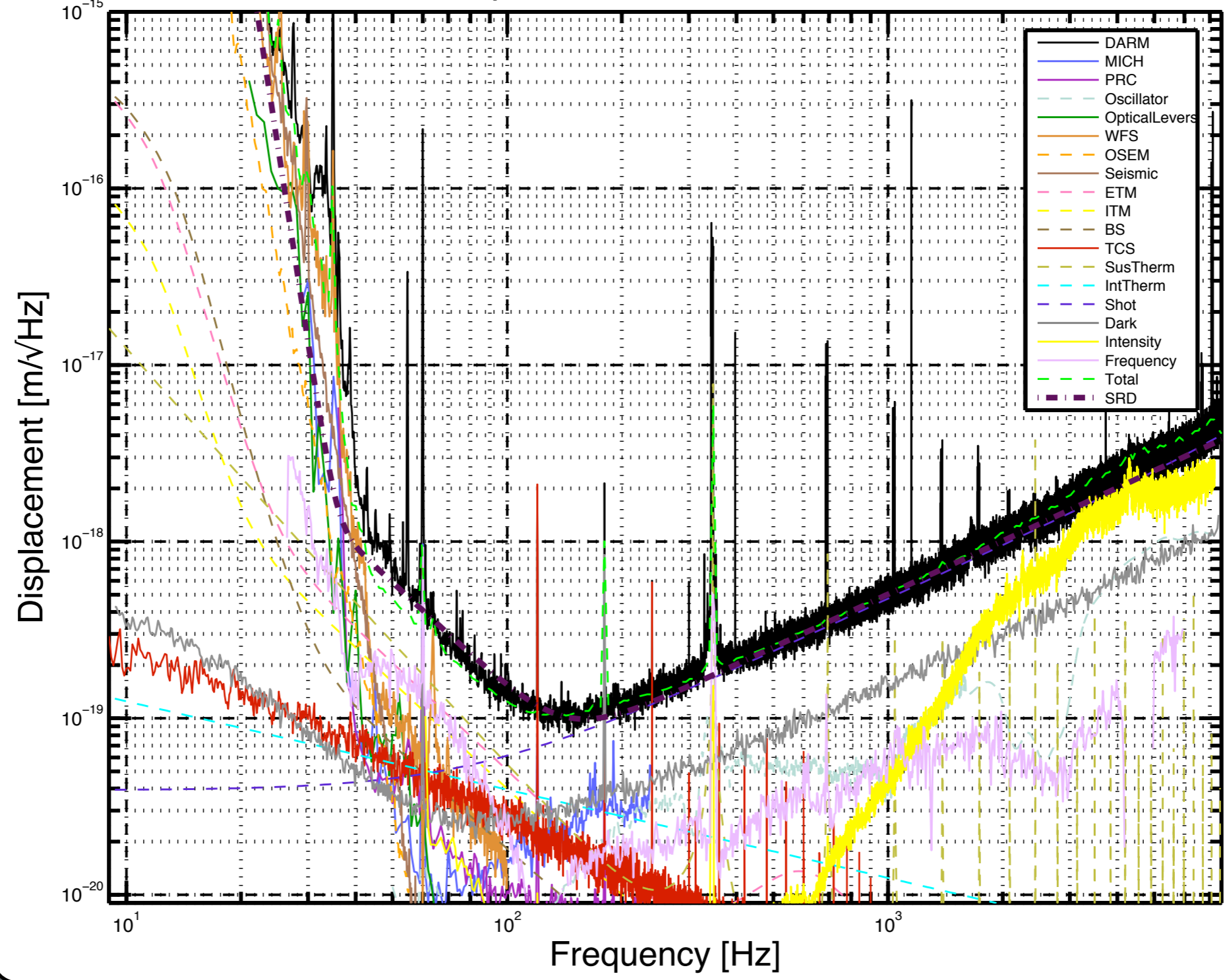


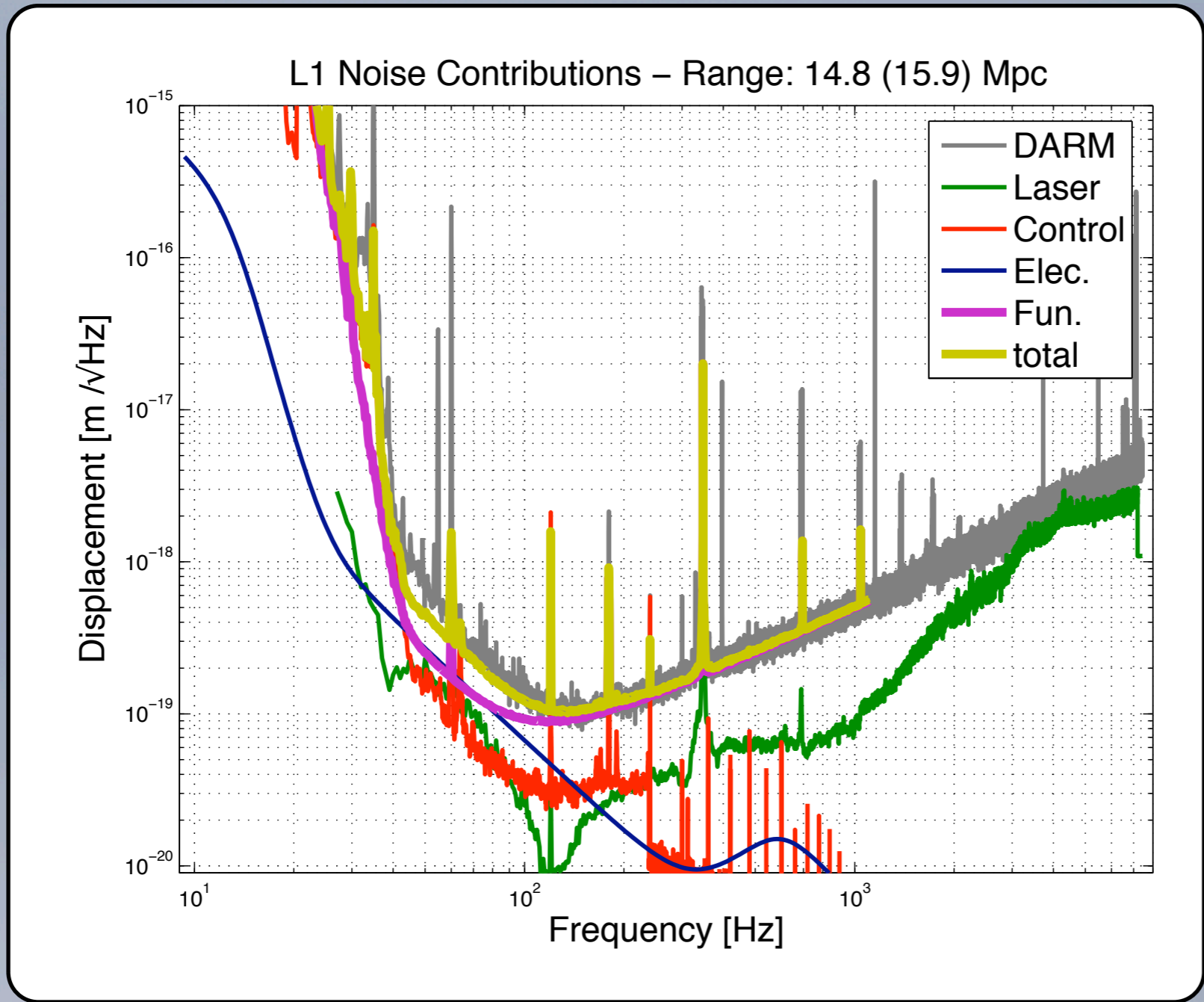
Status of Enhanced LIGO

LSC-Virgo Meeting
Baton Rouge, LA
March 2007
G070054



L1: UGF = 151 Hz, 14.8 Mpc, Predicted: 15.6, Feb 09 2007 04:28:56 UTC

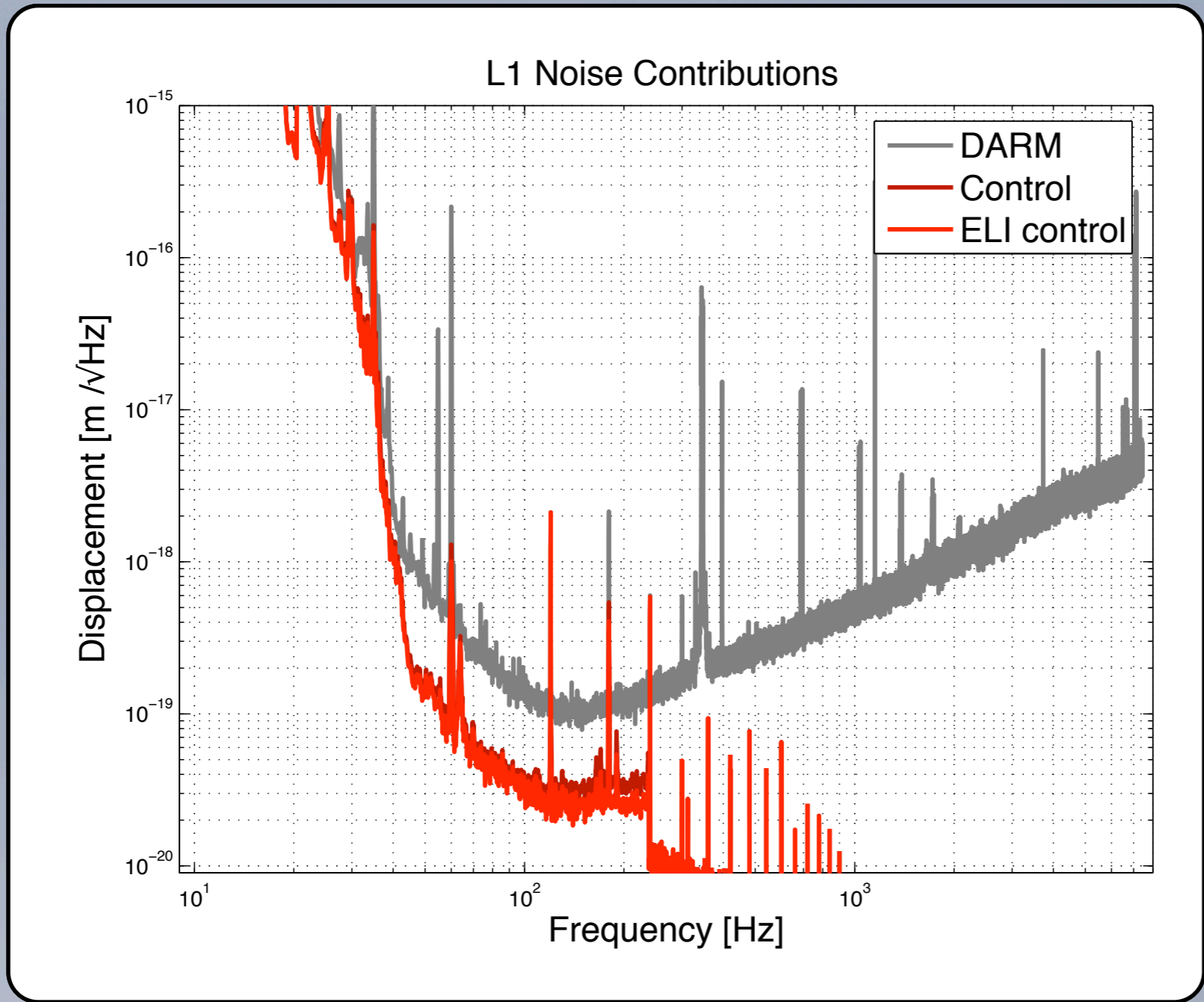
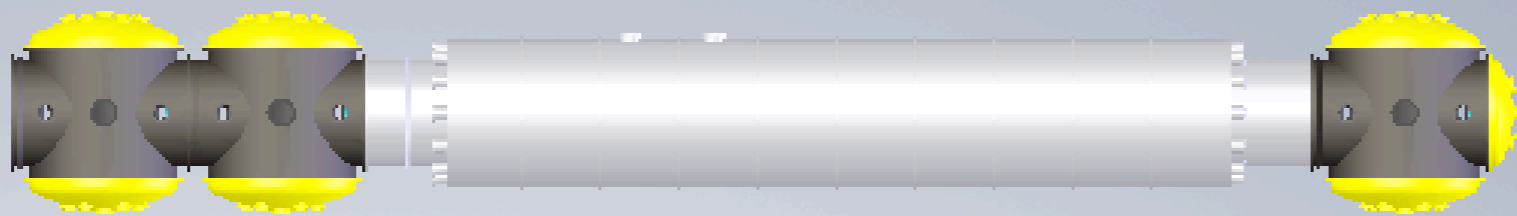
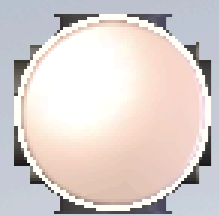




- **LASER** intensity, frequency & oscillator
- **CONTROL** MICH, PRC, WFS, OSEM, etc.
- **ELEC**tronic ETM, ITM & BS bias & coil driver
- **FUN**damental: shot, seismic, & thermal

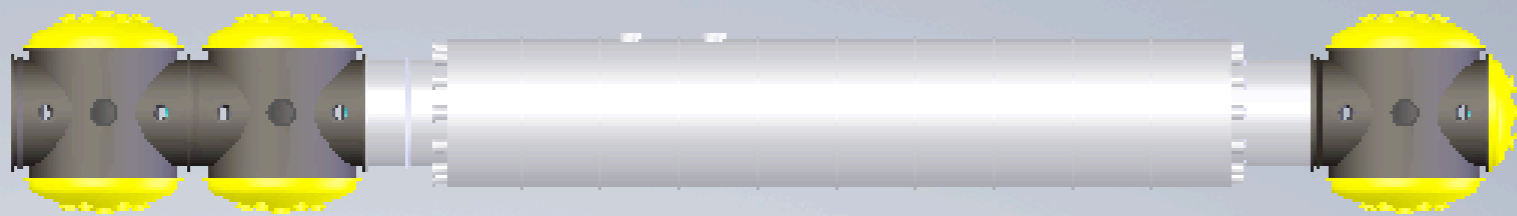
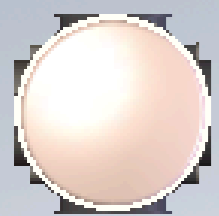
ELI Promise: RF to DC improves the noise



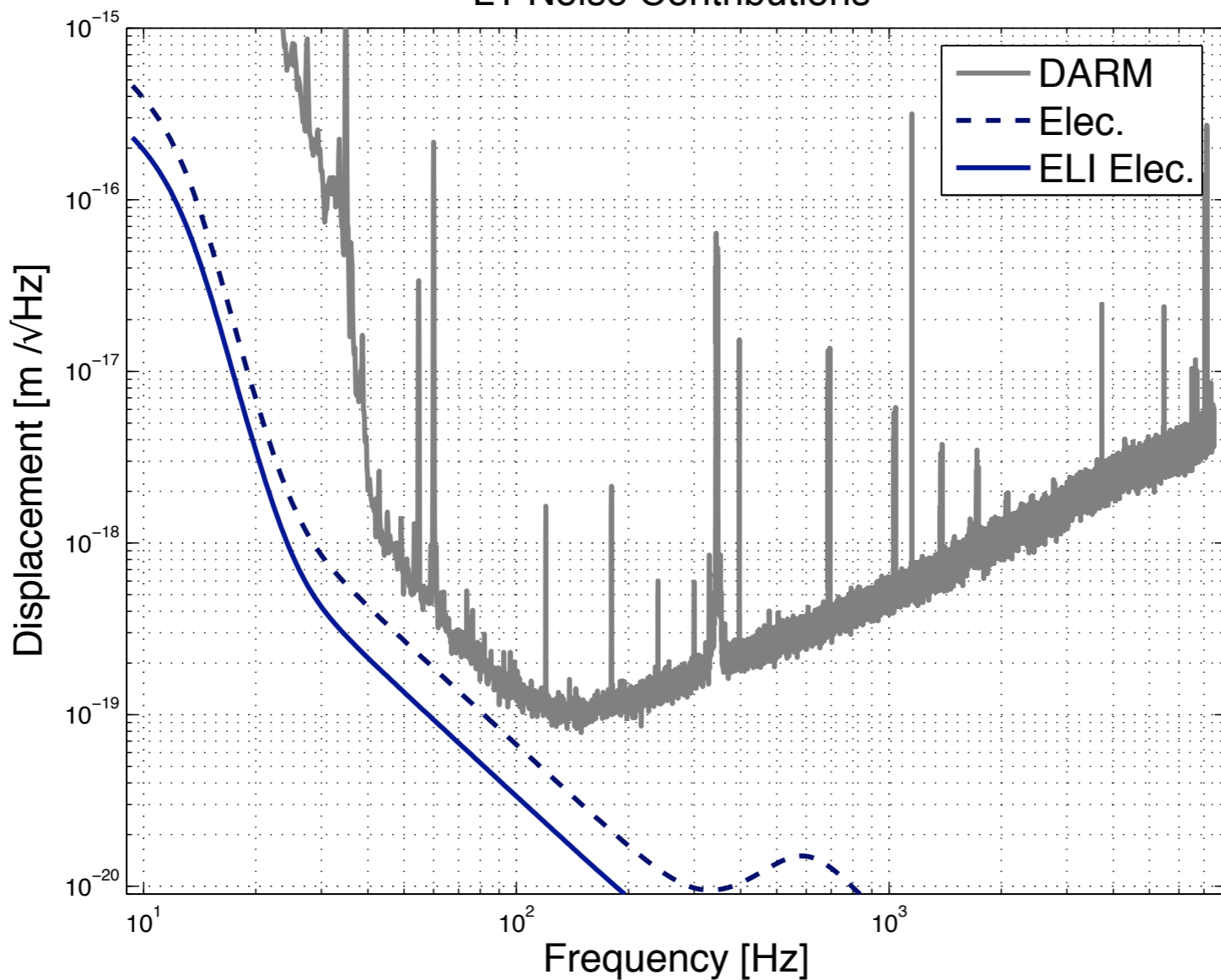


- MICHelson sensing noise improved by increasing light on detector
- PRC noise coupling reduced via frequency noise reduction



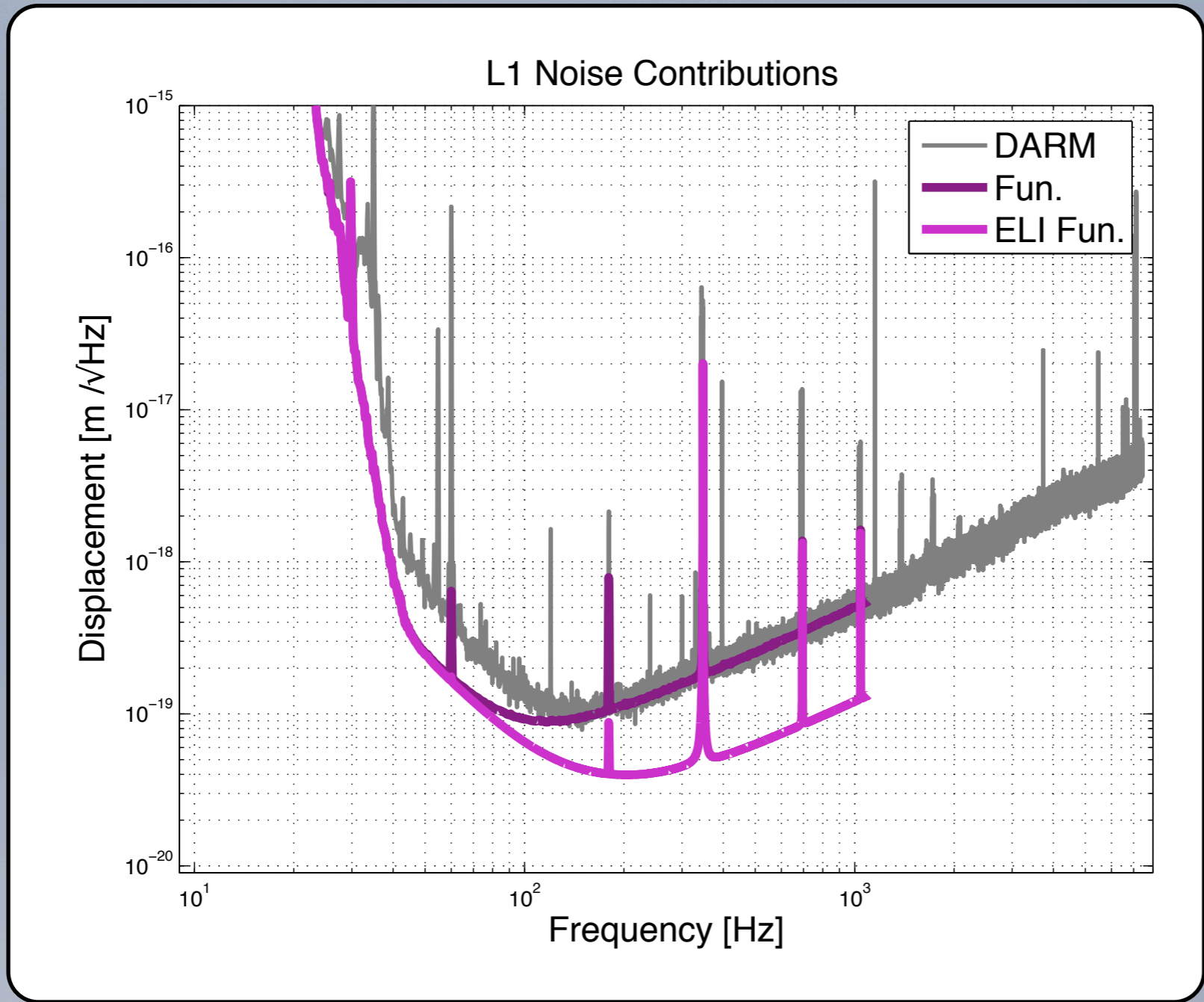
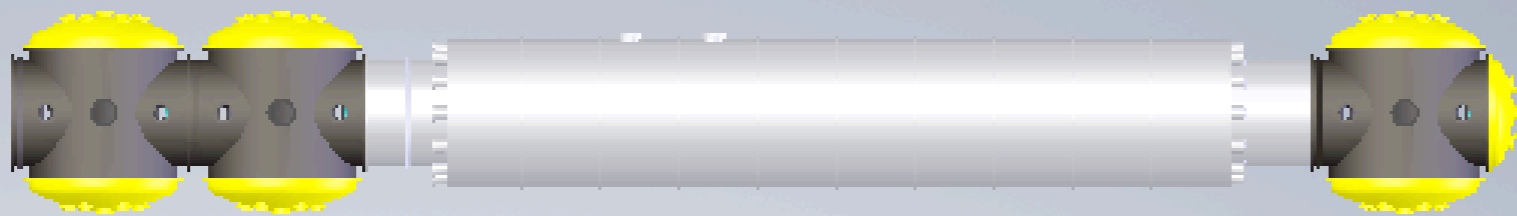
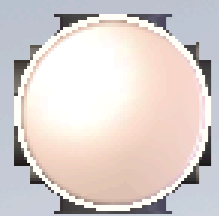


L1 Noise Contributions



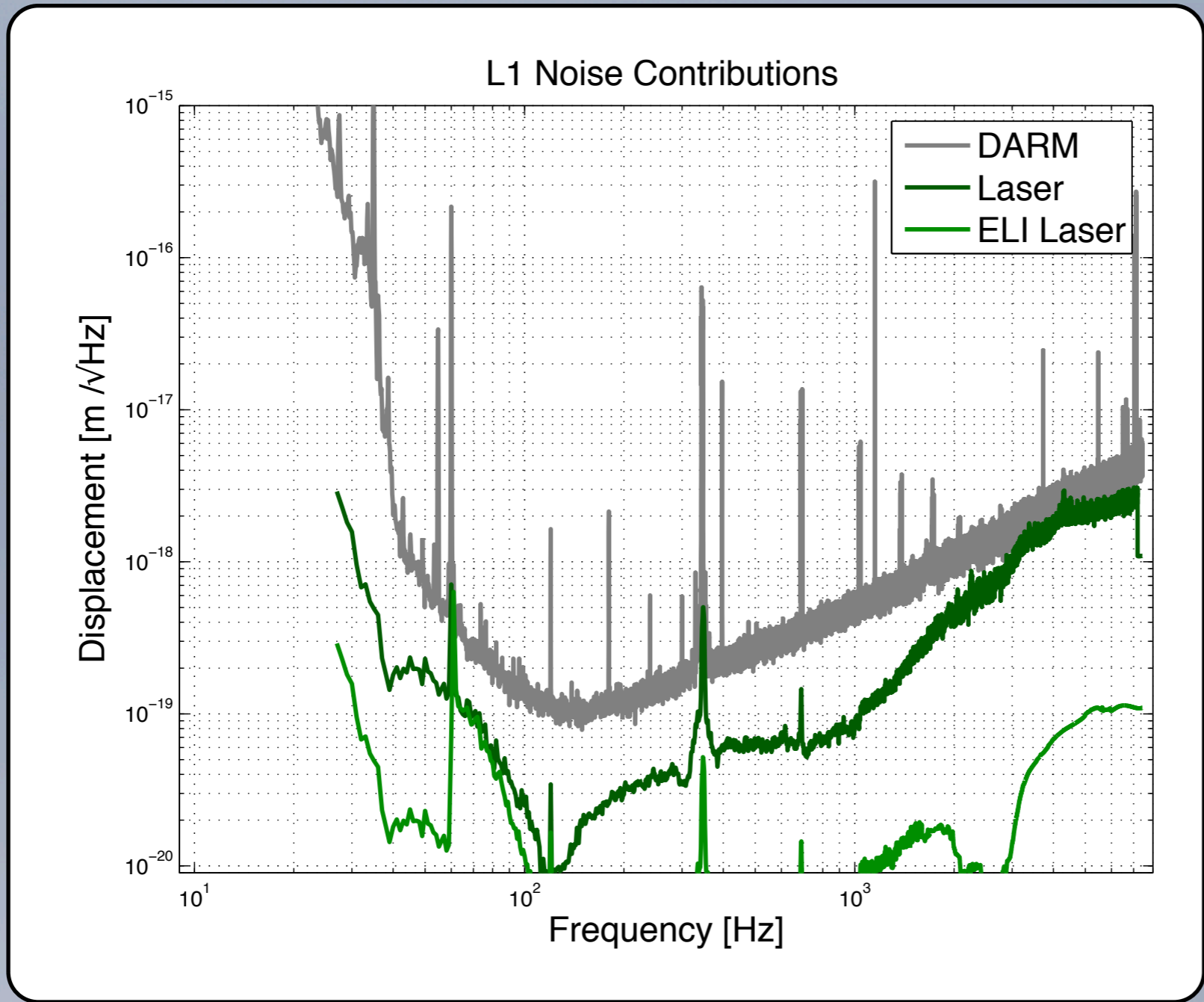
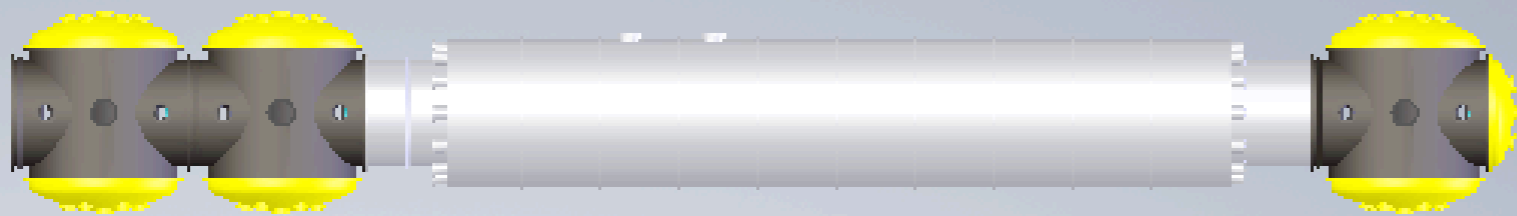
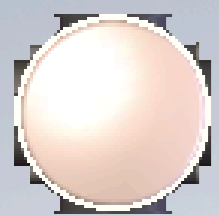
- new HV Bias modules
- Increased coil driver filtering
- *Maybe* better optic alignment with PAM magnets





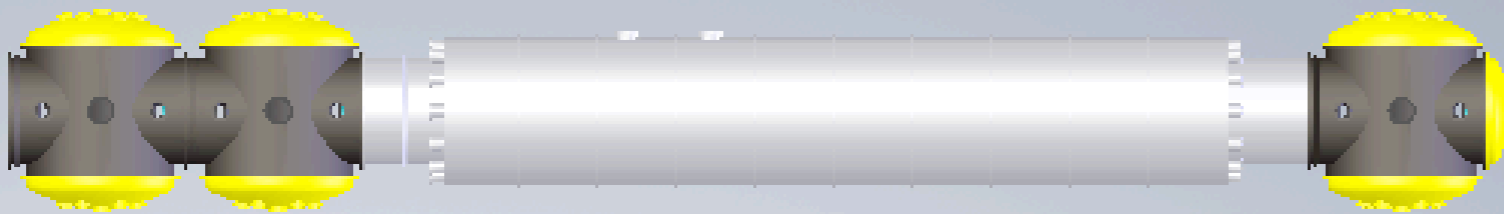
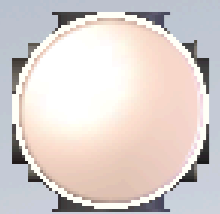
- Seismic and thermal noise remain
 - Thermal noise $\phi=1.7e-4$
- Shot noise improved
 - 2x from laser power increase
 - 2x from DC readout + OMC



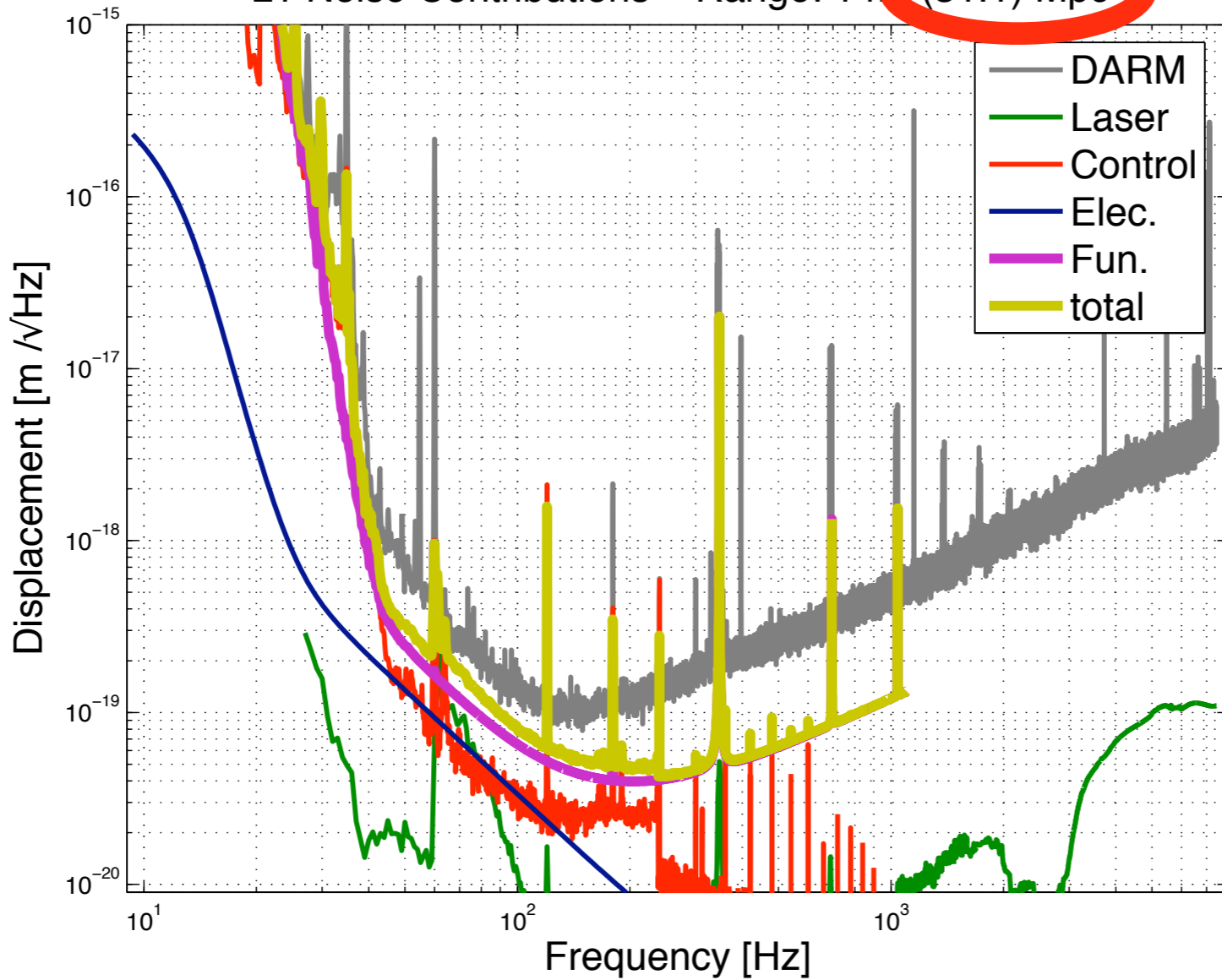


- No RF = No Oscillator noise
- Frequency noise depends on contrast defect
- Intensity noise filtered by coupled-cavity pole

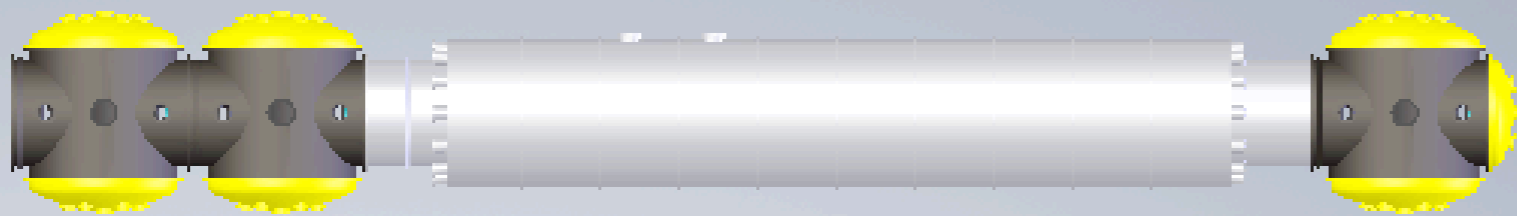
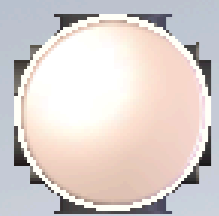




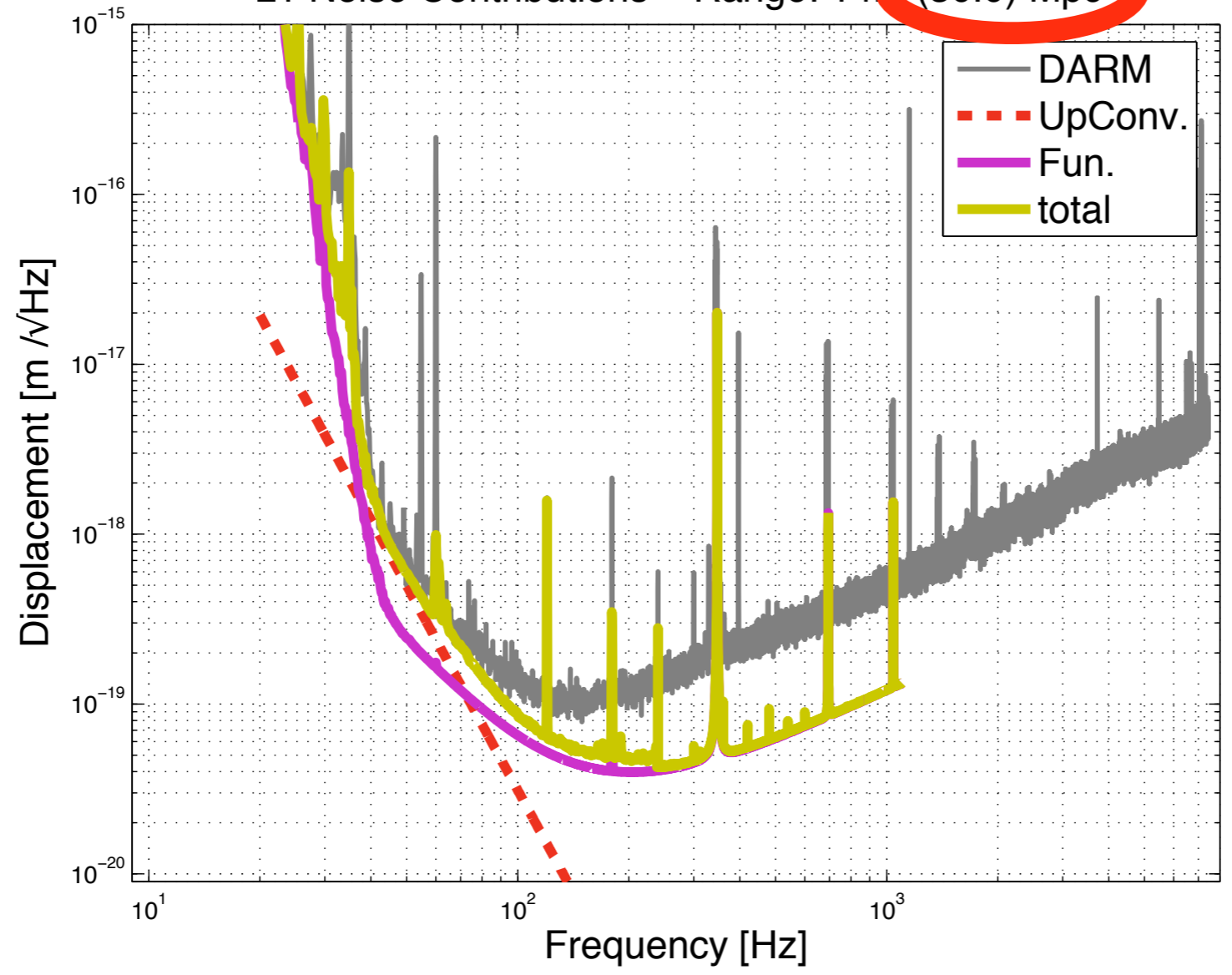
L1 Noise Contributions – Range: 14 \times (31.1) Mpc



- Enhanced LIGO noise
- Range 2x LIGO
- See R. Adhikari et al., T060156-01 for other details



L1 Noise Contributions – Range: 14 (30.0) Mpc



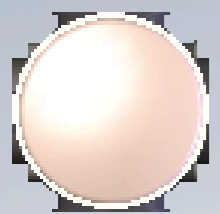
Upconversion Noise

- Assumes maximum possible $1/f^4$ noise
- Reduces range by 3%
- Several mitigation strategies possible
- As eLIGO gets better, upconversion gets worse....



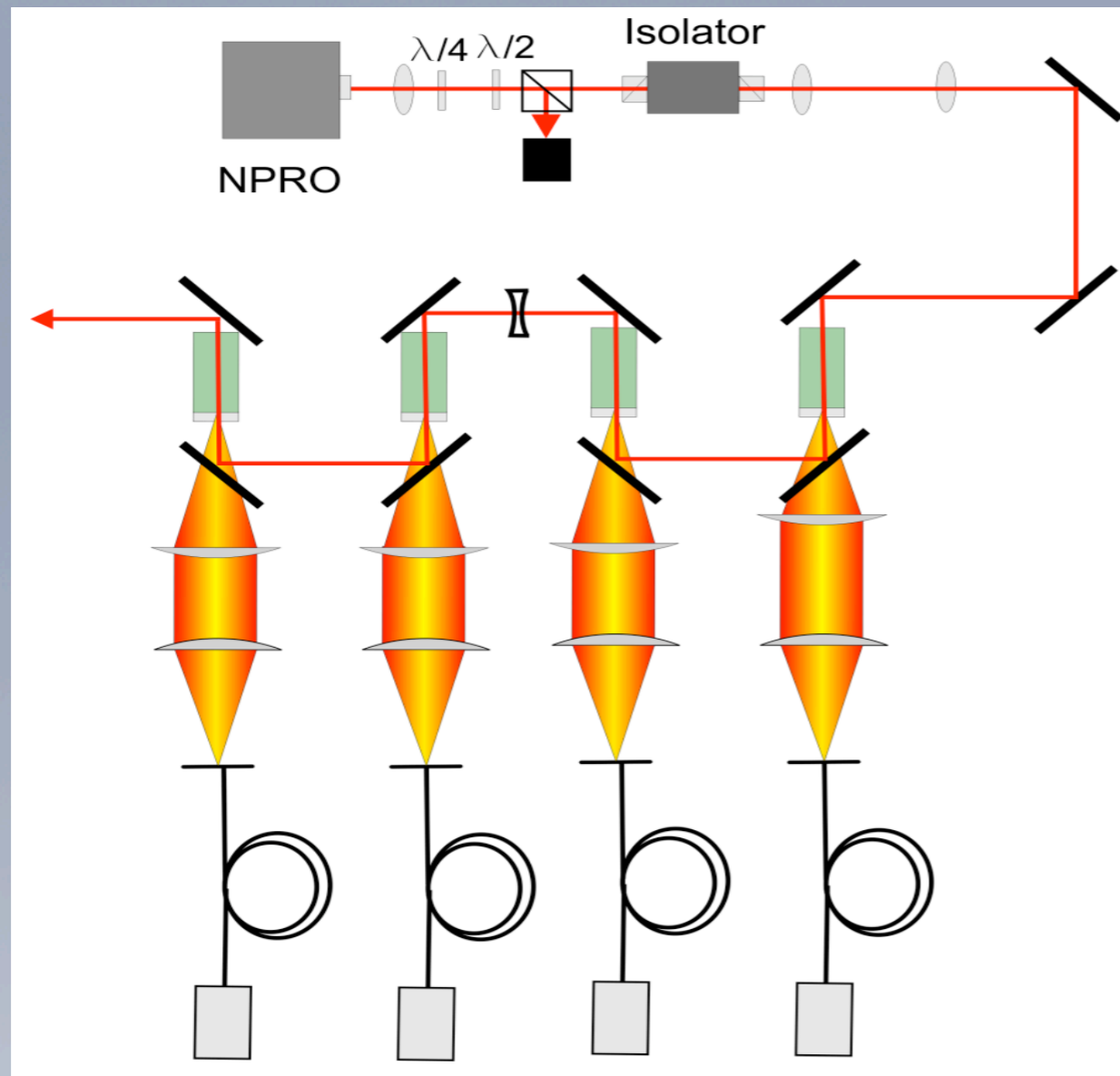
Enhanced LIGO Upgrades:

- Pre-Stabilized Laser power upgrade, table
- Input Optics re-work
- In-Vacuum modifications
- Readout changeover RF → DC
- Site Coordinators:
 - Valera Frolov @ LLO
 - Mike Landry @ LHO



Laser upgrade

Benno Wilke, Peter King, Rana Adhikari

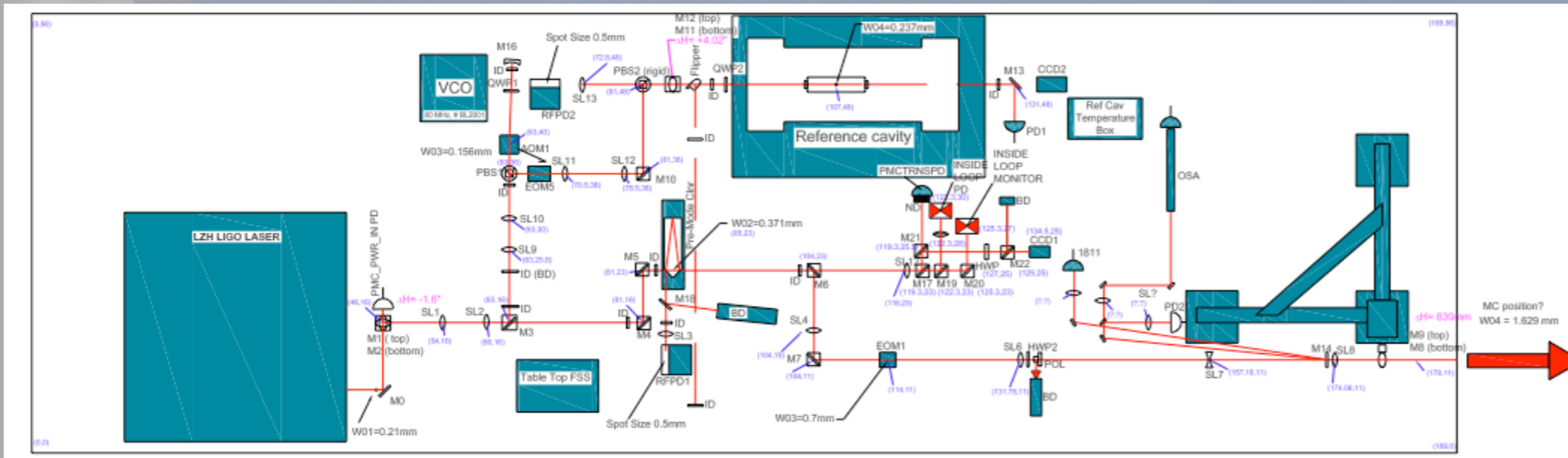


- to 35 W LZH laser (first stage of advLIGO laser)
- Same FSS, ISS, etc
- Fiber coupled pump
- Prototype to Caltech in May
- 2 lasers delivered in Fall 2008

PSL rework

Rick Savage, Anamaria Effler

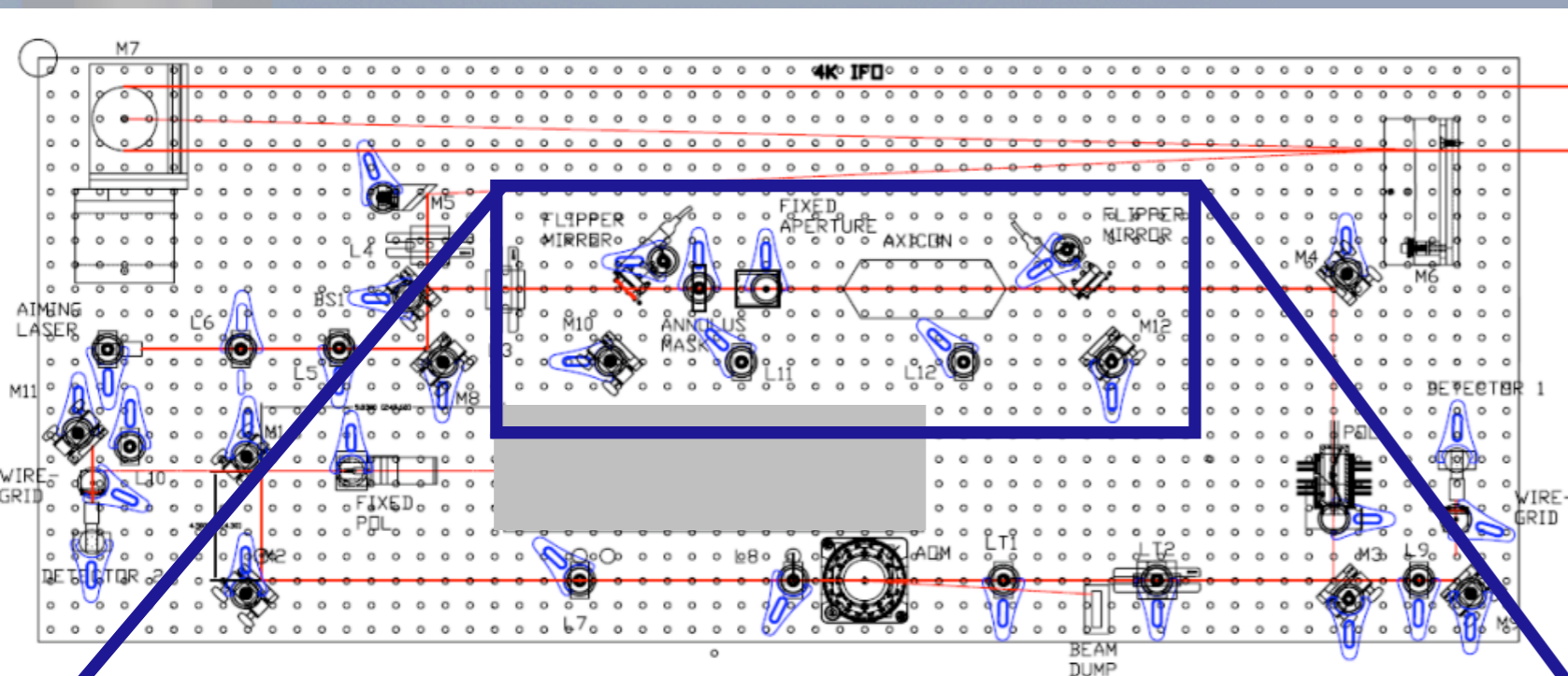
- New layout to reduce losses thru the PSL
- Super-polished optics, reduce scatter, increase transmission
- High trans. PMC
- Upgraded beam dumps



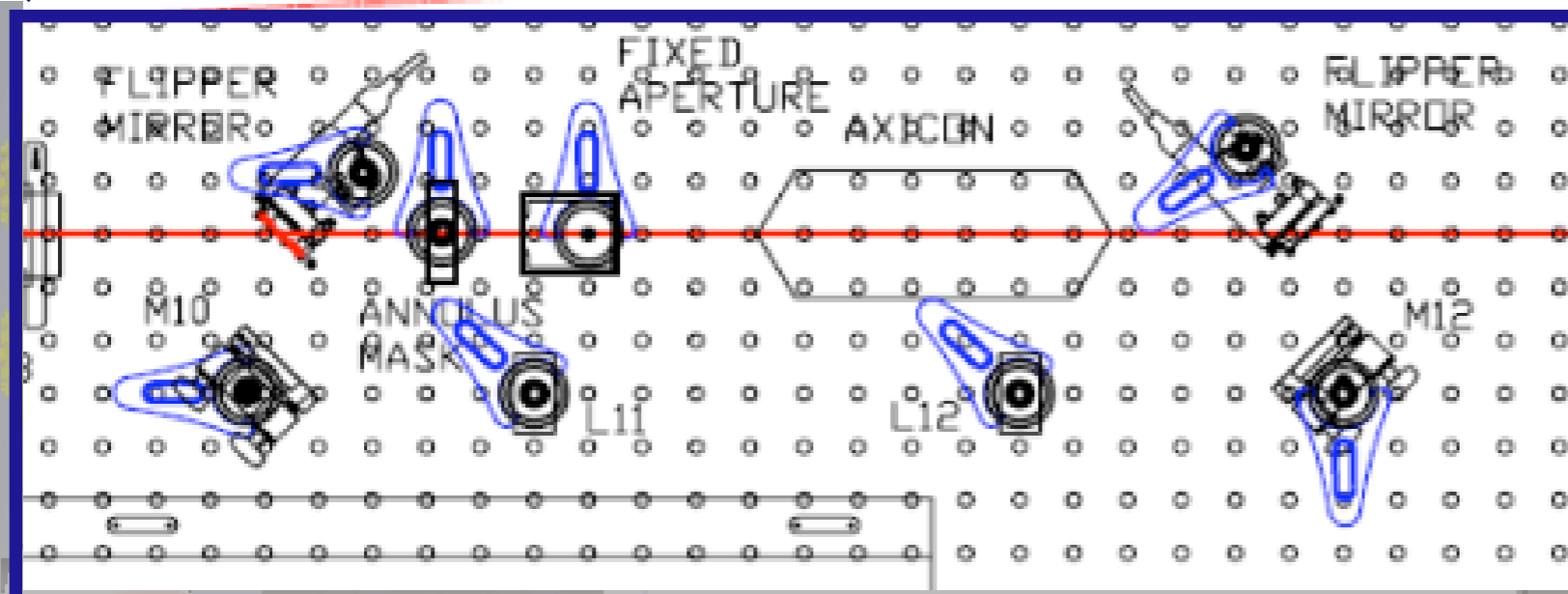
([http://ilog.ligo-wa.caltech.edu:7285/mLIGO/Pre-Stabilized Laser](http://ilog.ligo-wa.caltech.edu:7285/mLIGO/Pre-Stabilized_Laser))

TCS upgrade

Tobin Fricke, Phil Willems



- Implement TCS ISS
- Upgrade TCS optical bench
- Upgrade TCS chillers
- Increase laser power if necessary

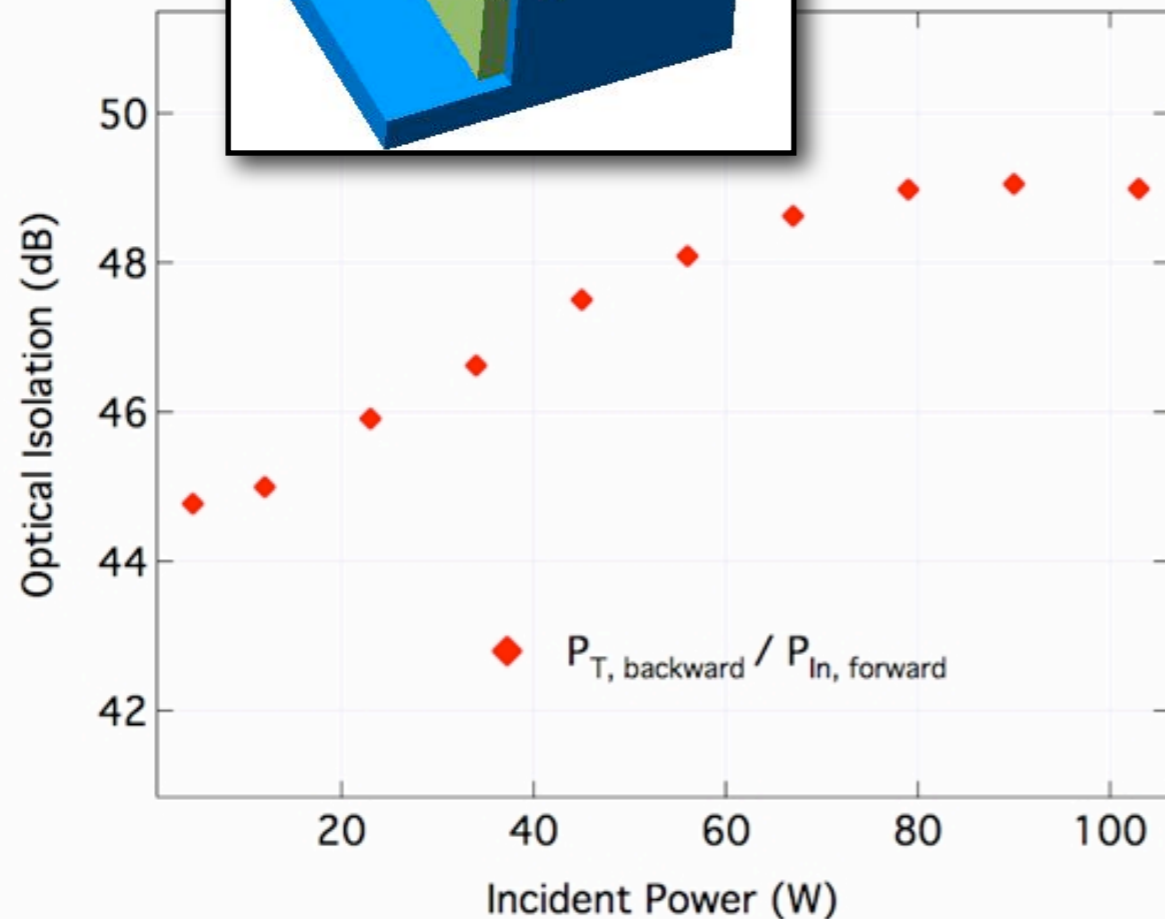
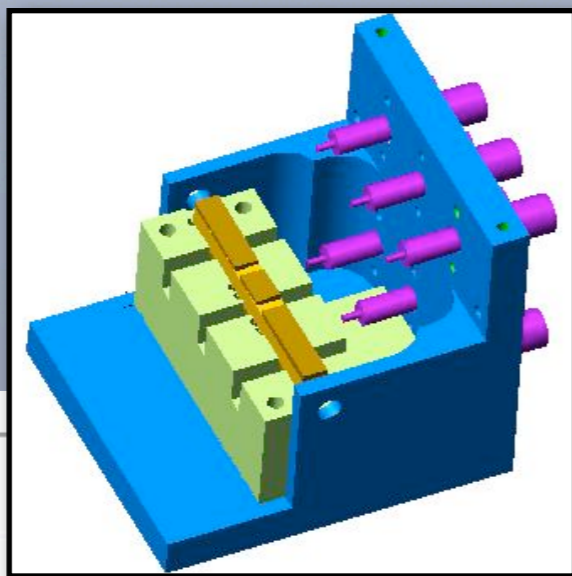


(http://ilog.ligo-wa.caltech.edu:7285/mLIGO/Thermal_Compensation_System)

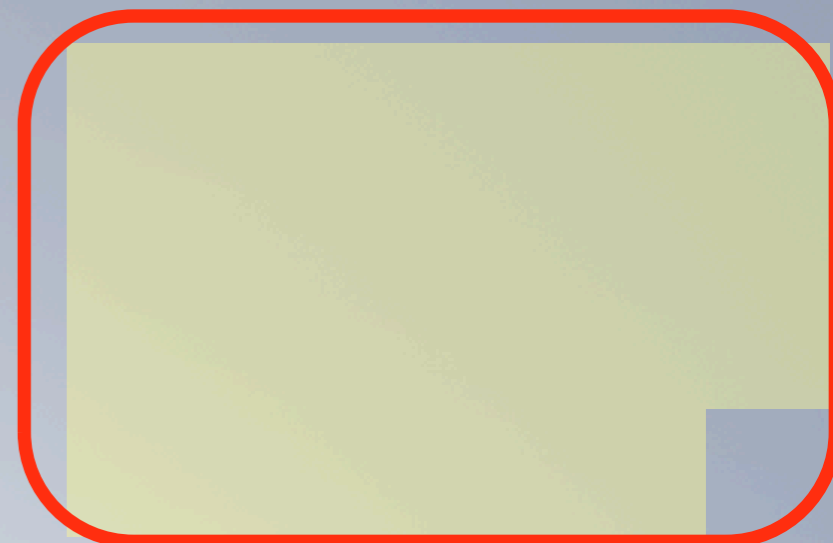
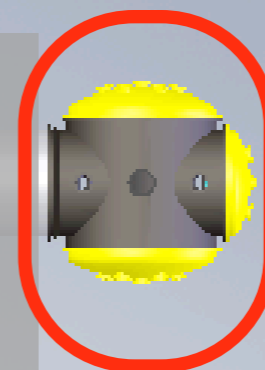
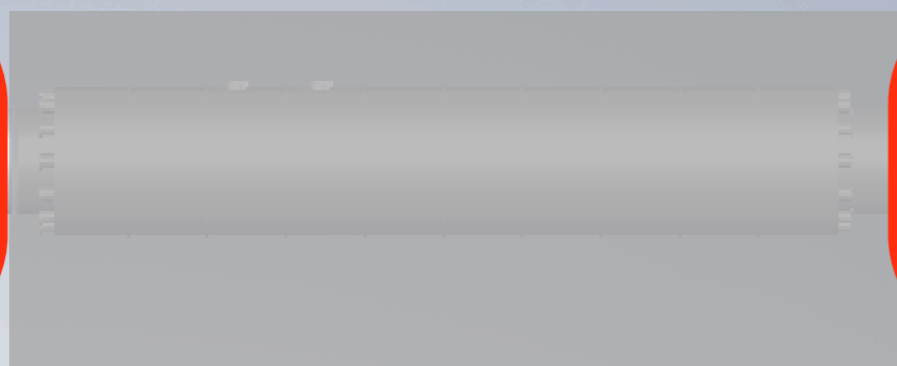
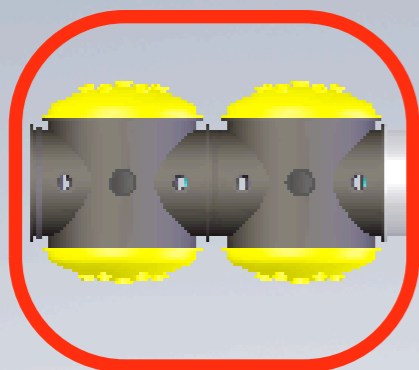
100 Upgrade

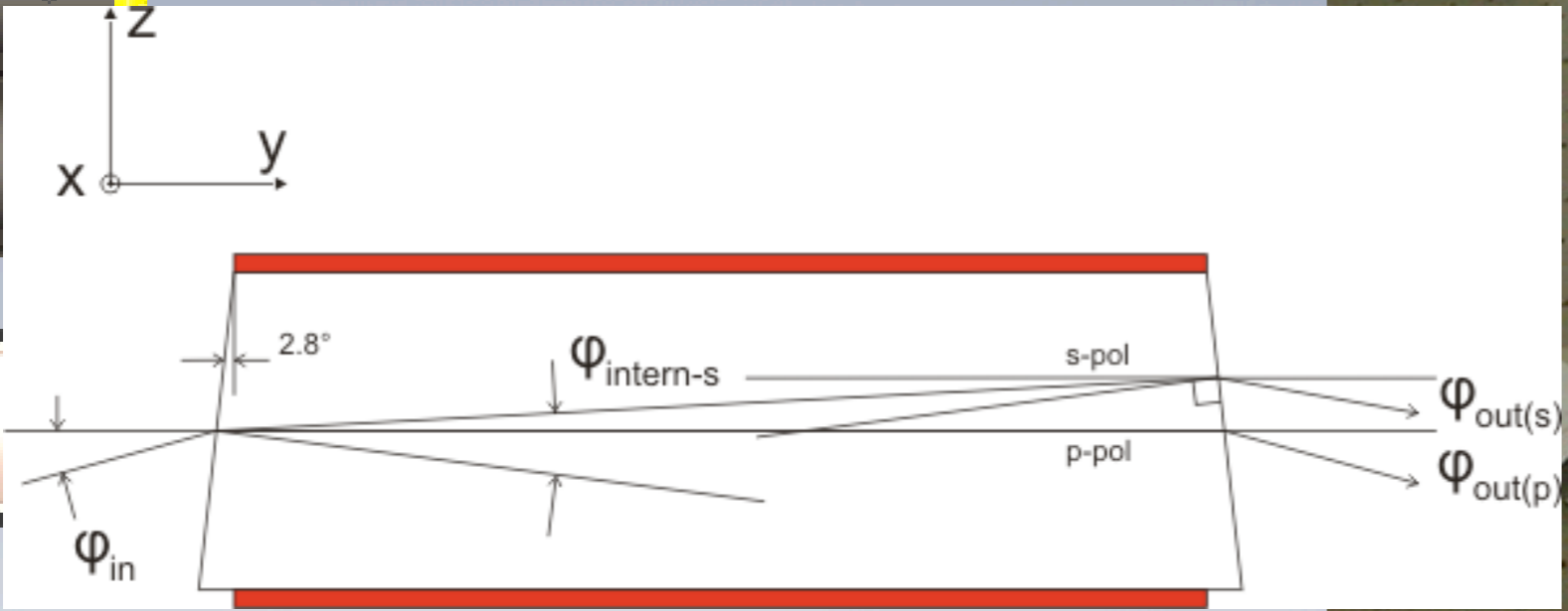
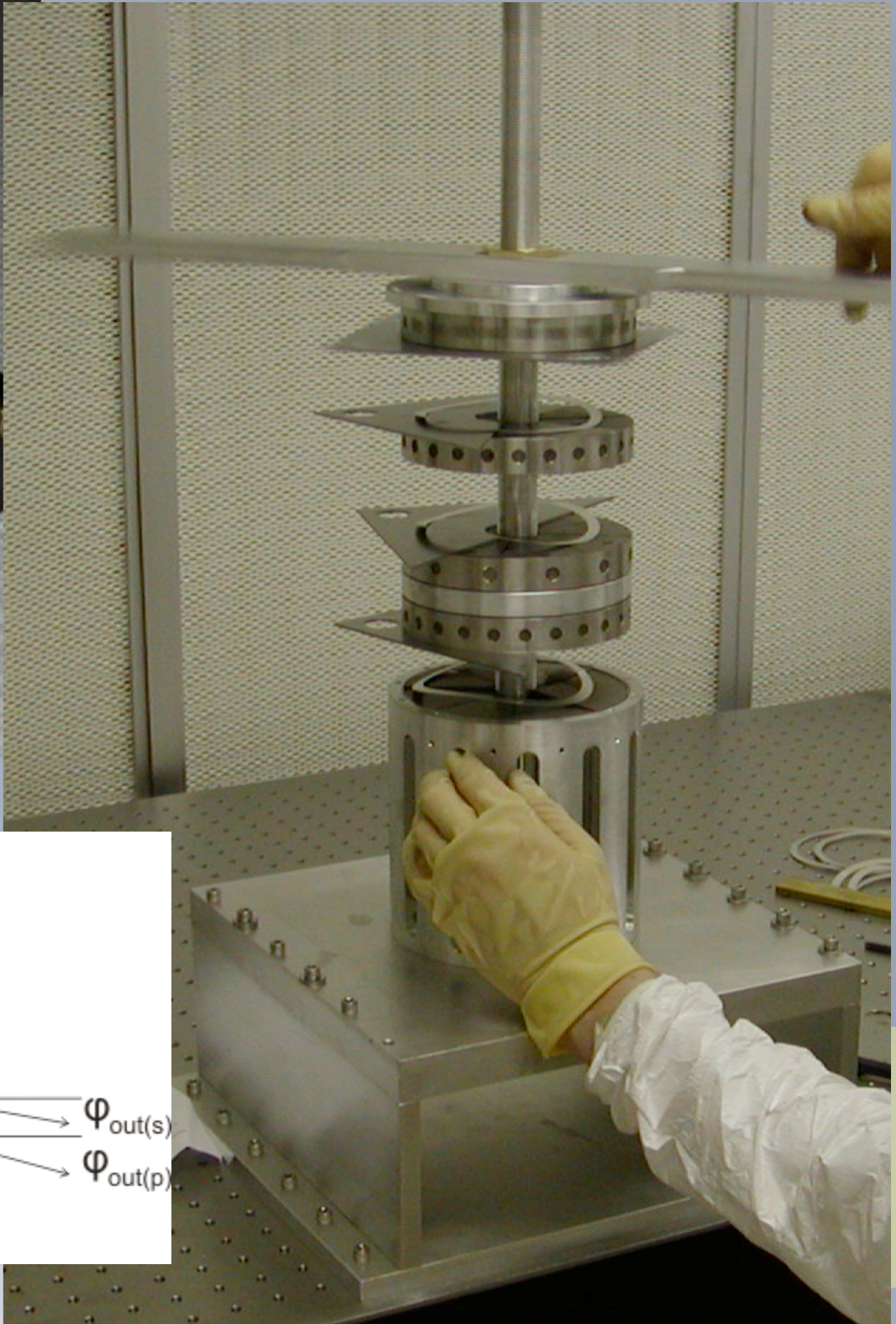
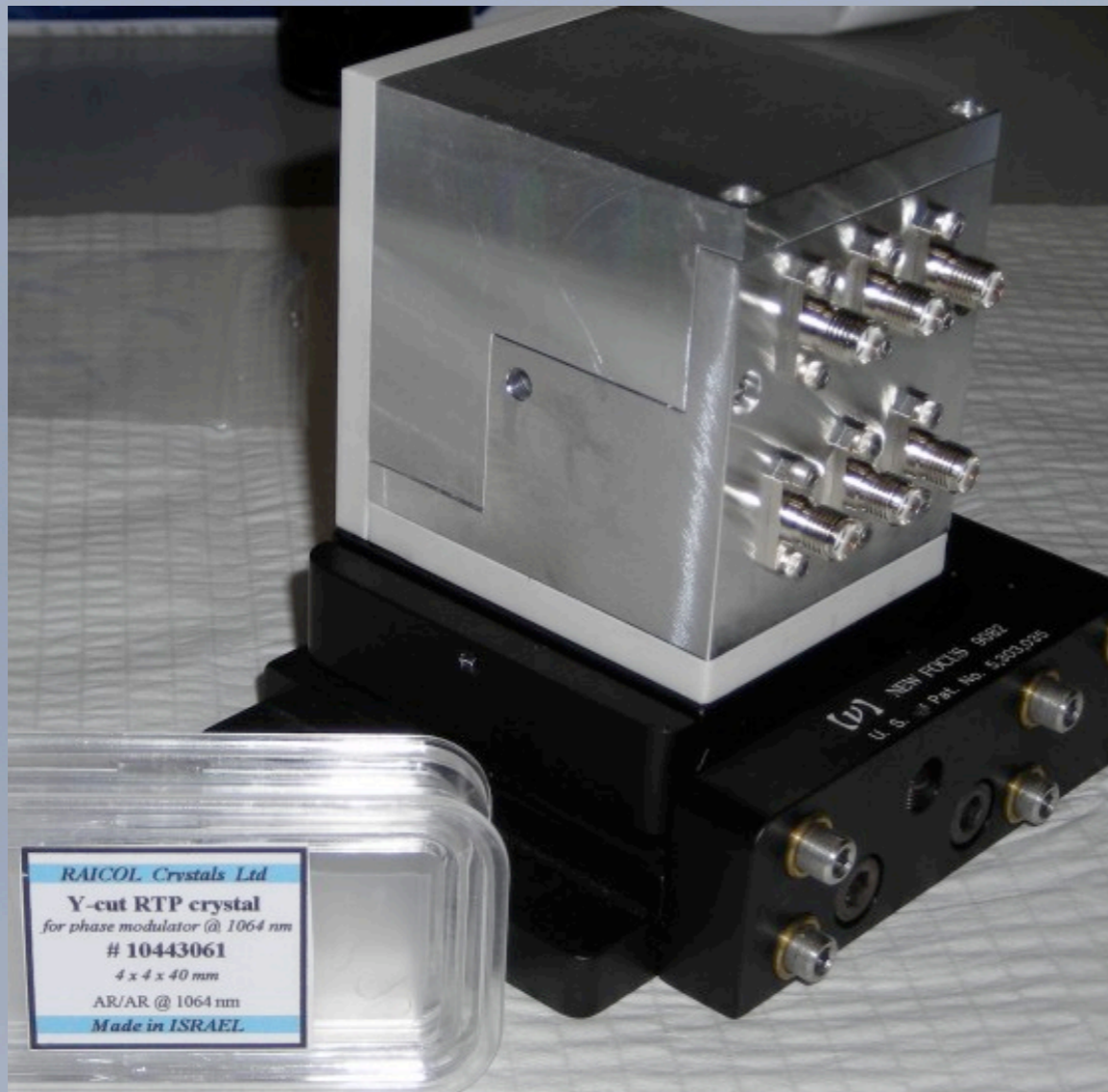
UFlorida, Dave Reitze, Volker Quetschke, et al.

- High power, large radius, wedged, 3 electrode RTP EOM
- High power, large bore Faraday Isolator
- Mode Cleaner cleaning
- Mode matching adjustment

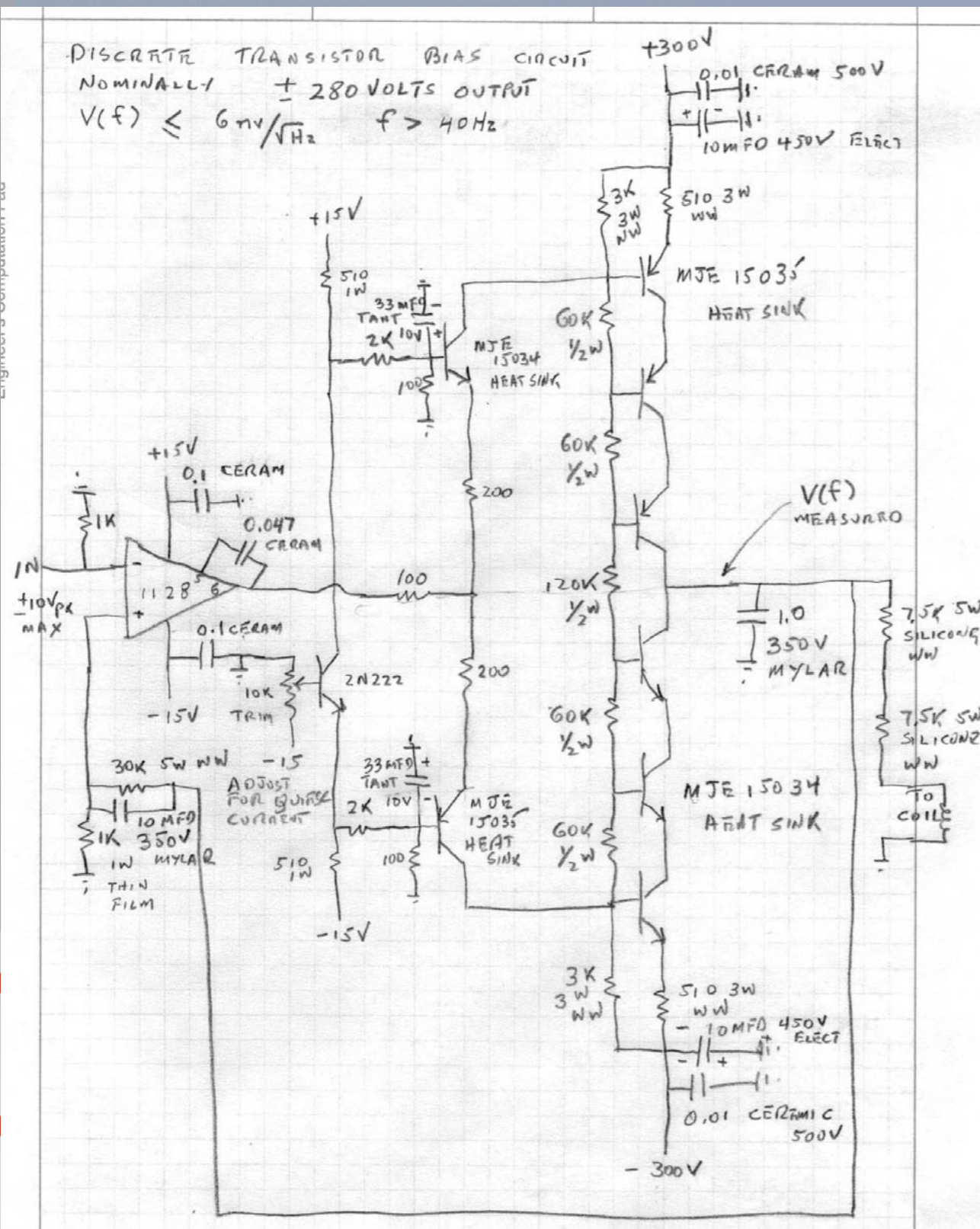


(http://ilog.ligo-wa.caltech.edu:7285/mLIGO/Input_Optics_Optics)





Bias module



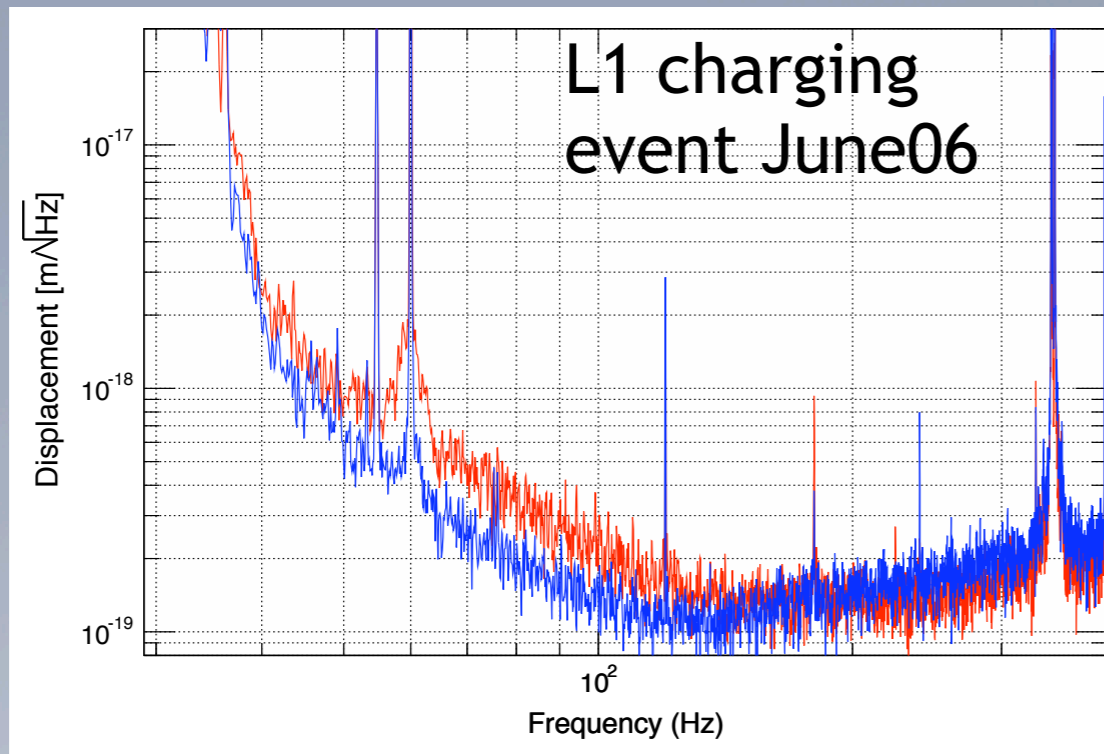
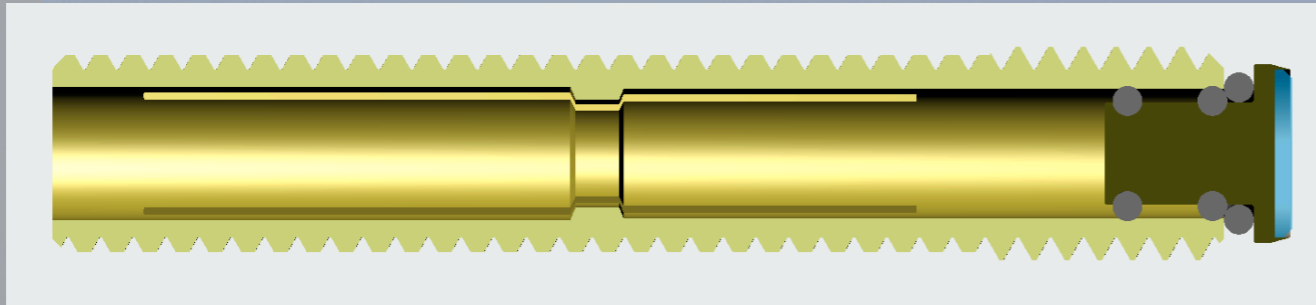
Rai Weiss, Rana Adhikari,
Wilson House

- “Discrete transistor” design prototype 2x better than spec.
- Improves on some of the PA85 shortcomings
- Safe to $\pm 325 \text{ V}_{\text{out}}$

(<http://tinyurl.com/yujp3a>)

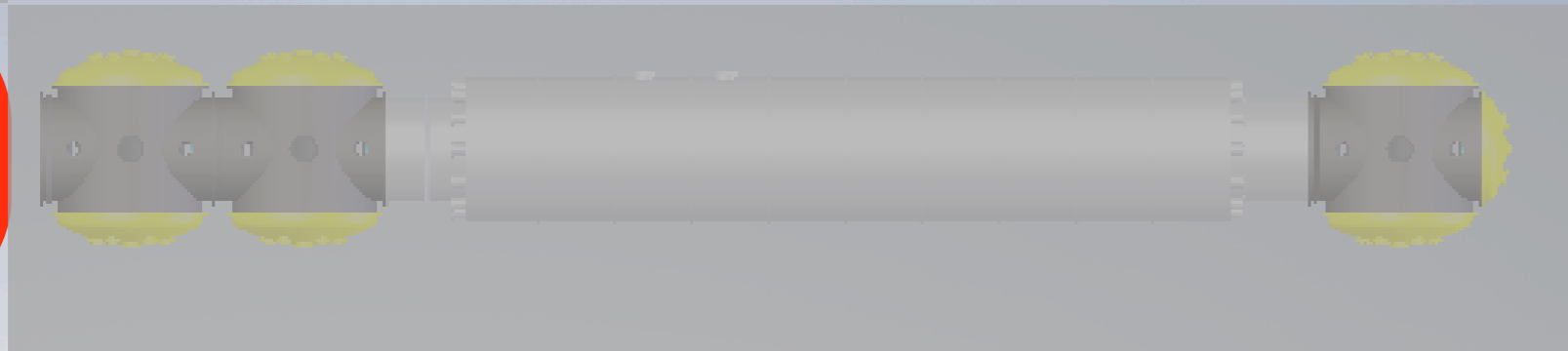
In-vacuum work

Mike Zucker, Doug Cook,
et al.



(<http://ilog.ligo-wa.caltech.edu:7285/mLIGO/Suspensions>)

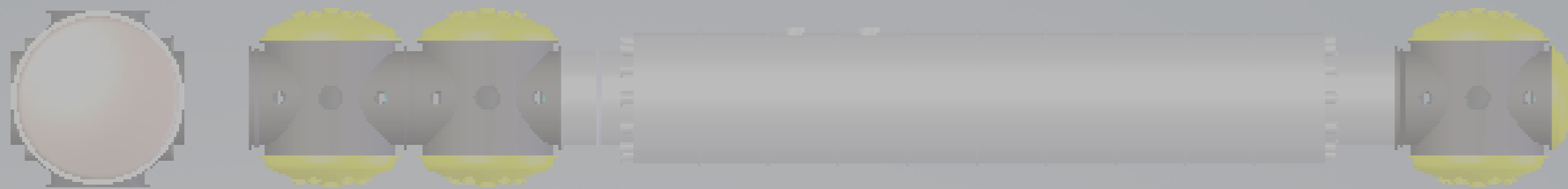
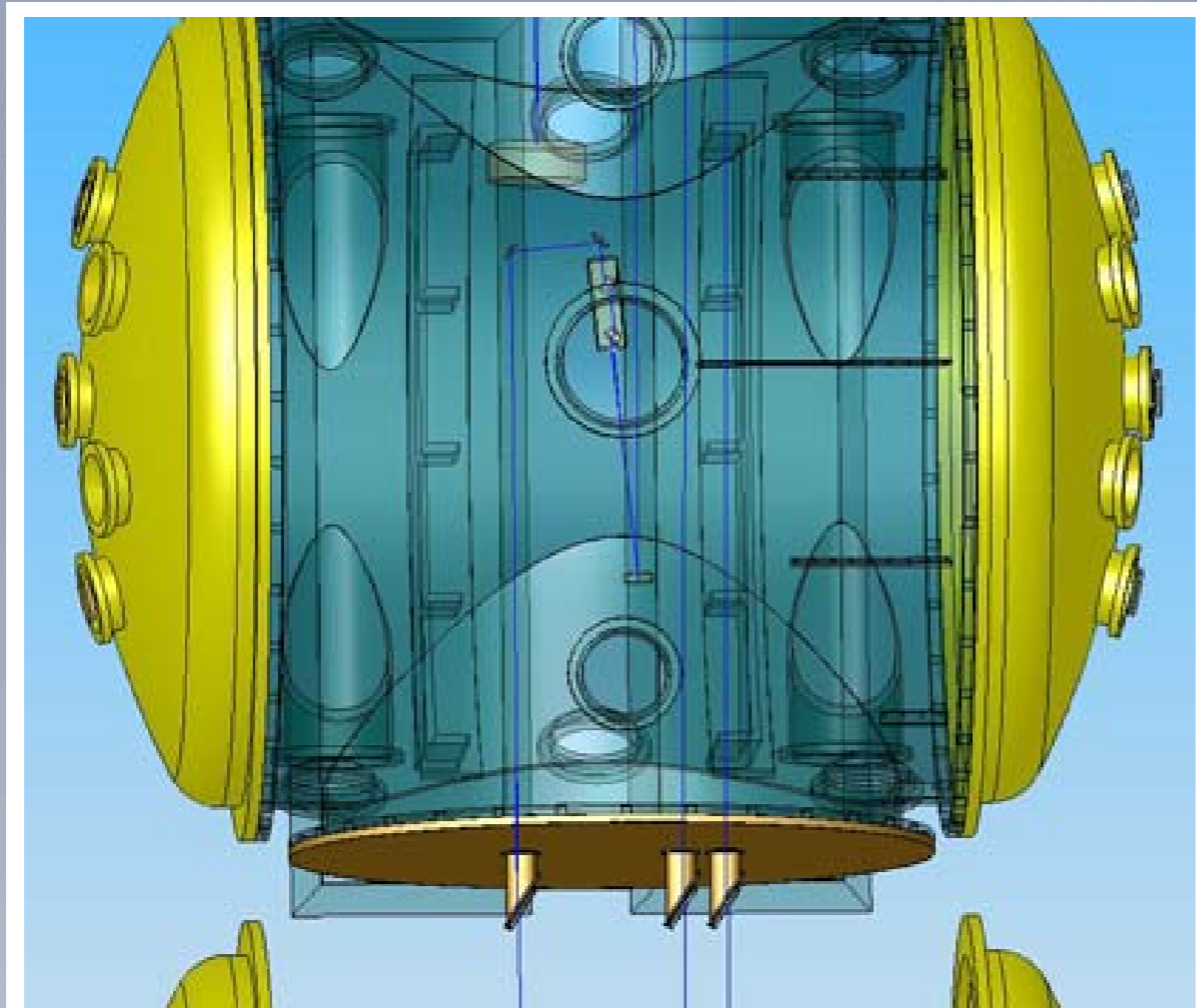
- Quartz tipped earthquake stops
- In-vacuum witness optics to measure scattering
- PAM adjustment
- In-situ cleaning

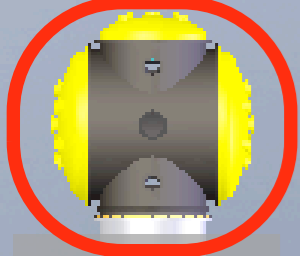


HAM6 Septum

Mike Smith, Vagesh

- Vent of HAM6 doesn't affect vertex
- Working to understand scattering, etc
- Vacuum event in HAM6 independent from test masses





HAM seismic

advLIGO seismic solution

- HAM-SAS: “soft” isolation
 - Riccardo deSalvo et al.
 - prototype assy in LASTI now
 - delivered in fall 2008
- HAM-ISI: “stiff” isolation
 - Brian Lantz et al. + HPD
 - Single stage active isolation @ 1 Hz, passive isolation above 10 Hz (baseline HAM SEI)
 - “Electronic” prototype, CAD handoff in April, build by September



- Review in early April

- Selection by end of April

HAM SAS

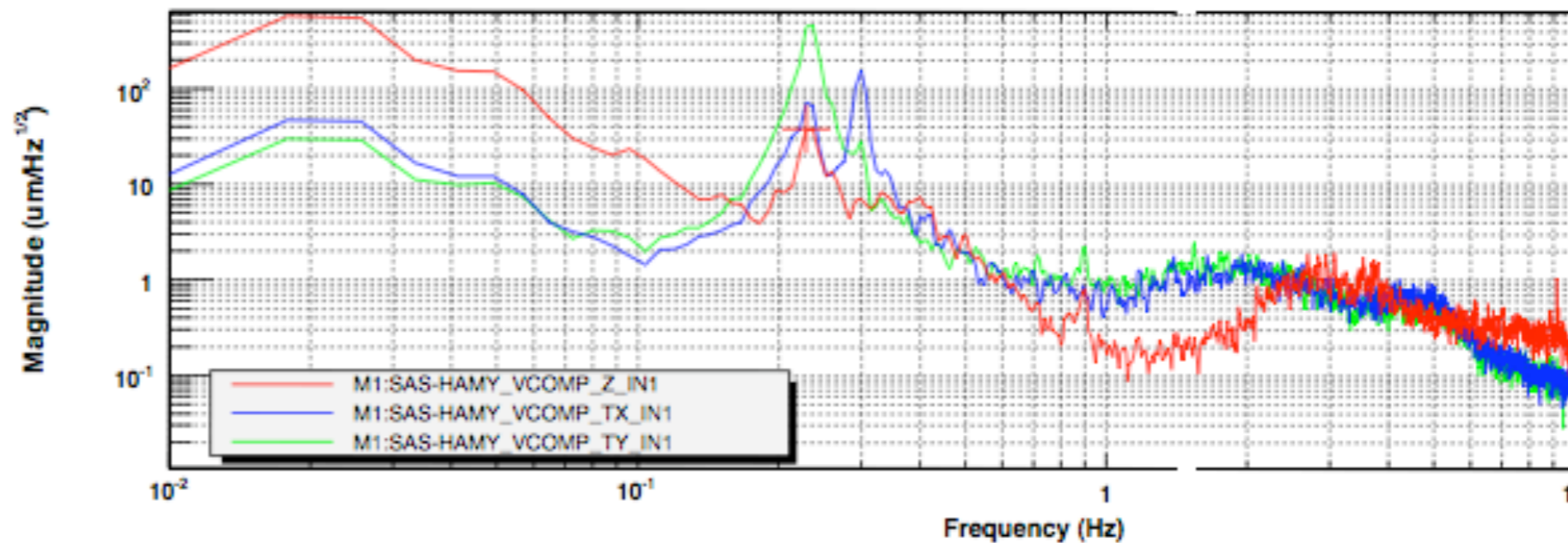
GAS table

IP table



- 70 dB attenuation at 10 Hz
- $1/f^2$ above 0.1 Hz

Power spectrum



T0=17/03/2007 01:38:47

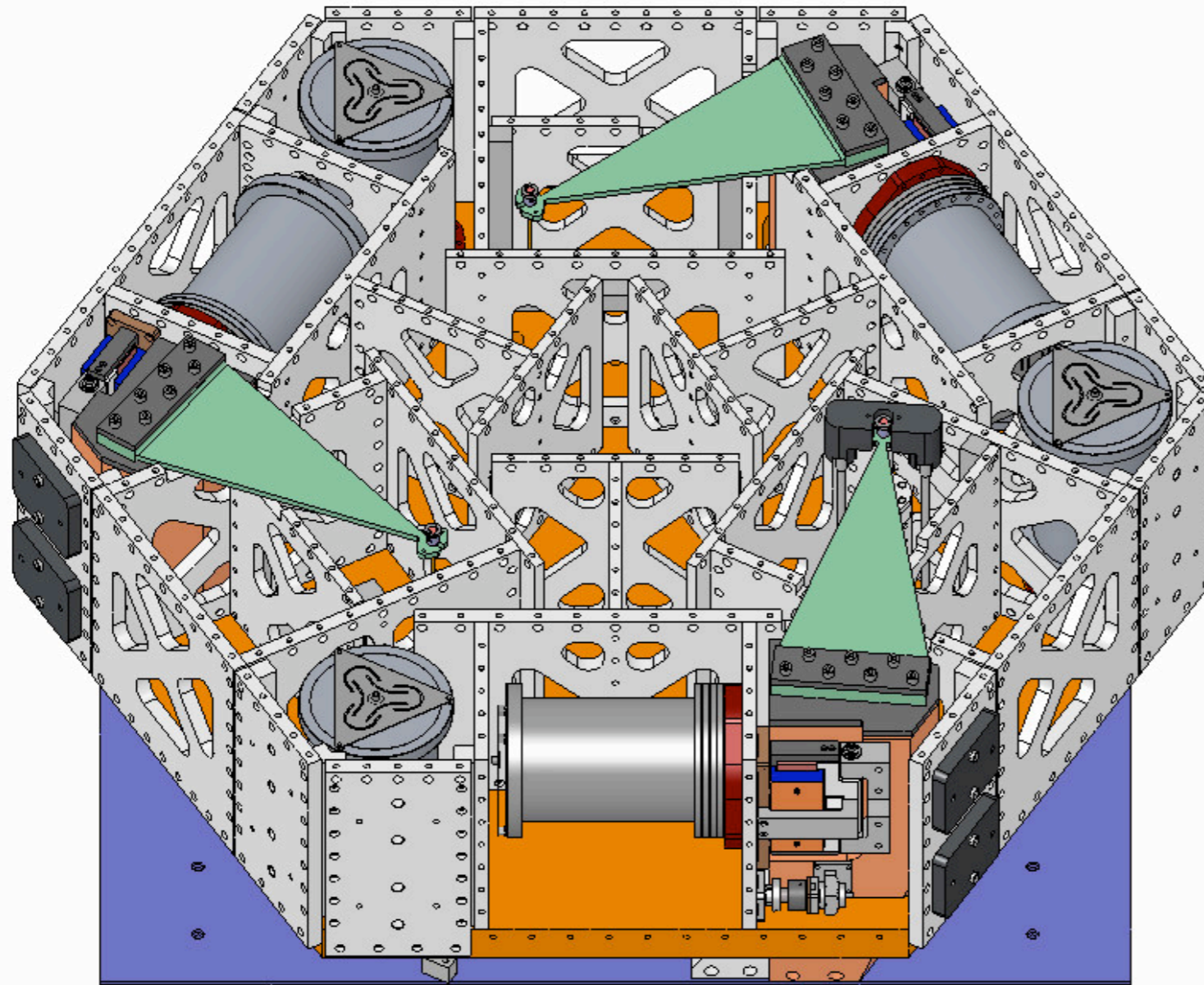
22 mHz vertical

Frequency (Hz)

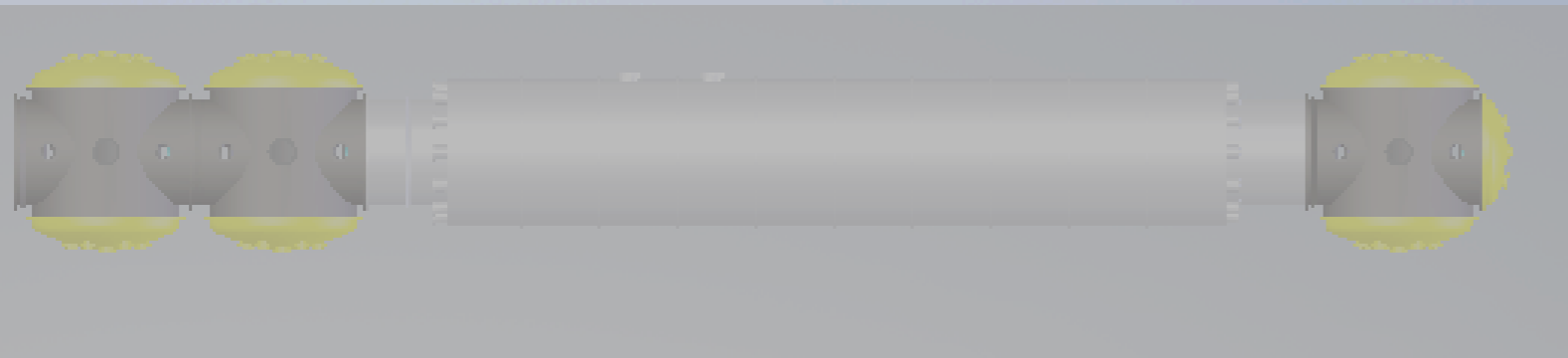
Avg=7

<http://www.ligo.caltech.edu/~citsas/HAM-SAS/Home.shtml>

HAM ISI



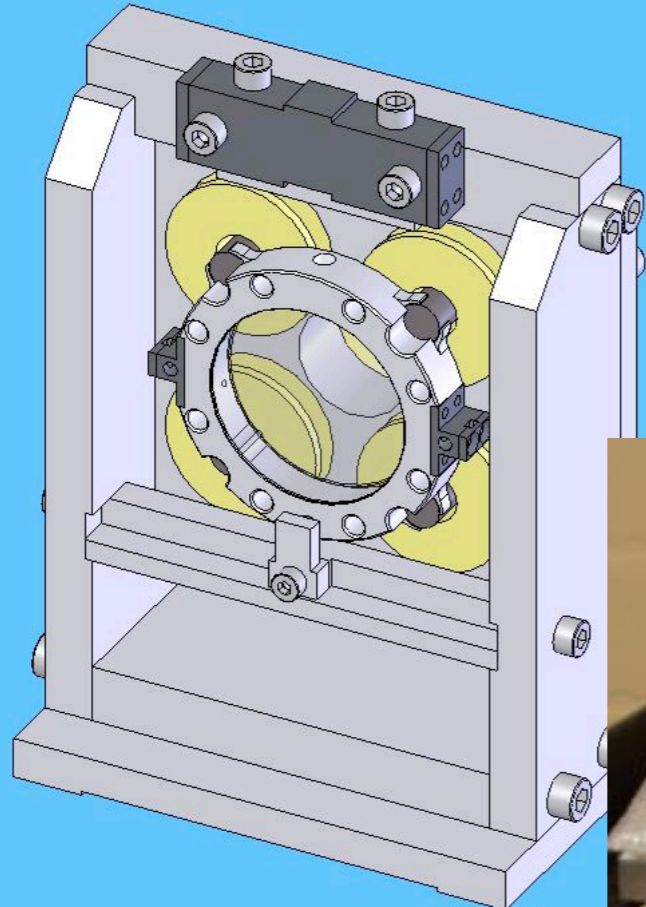
- 6 GS-13 geophone sensing, 6 actuators
- 10^{-10} m/rHz above 1 Hz, 10^{-11} m/rHz above 20 Hz



Tip Tilt Mirrors

ANU, Bram Slagmolen et al.

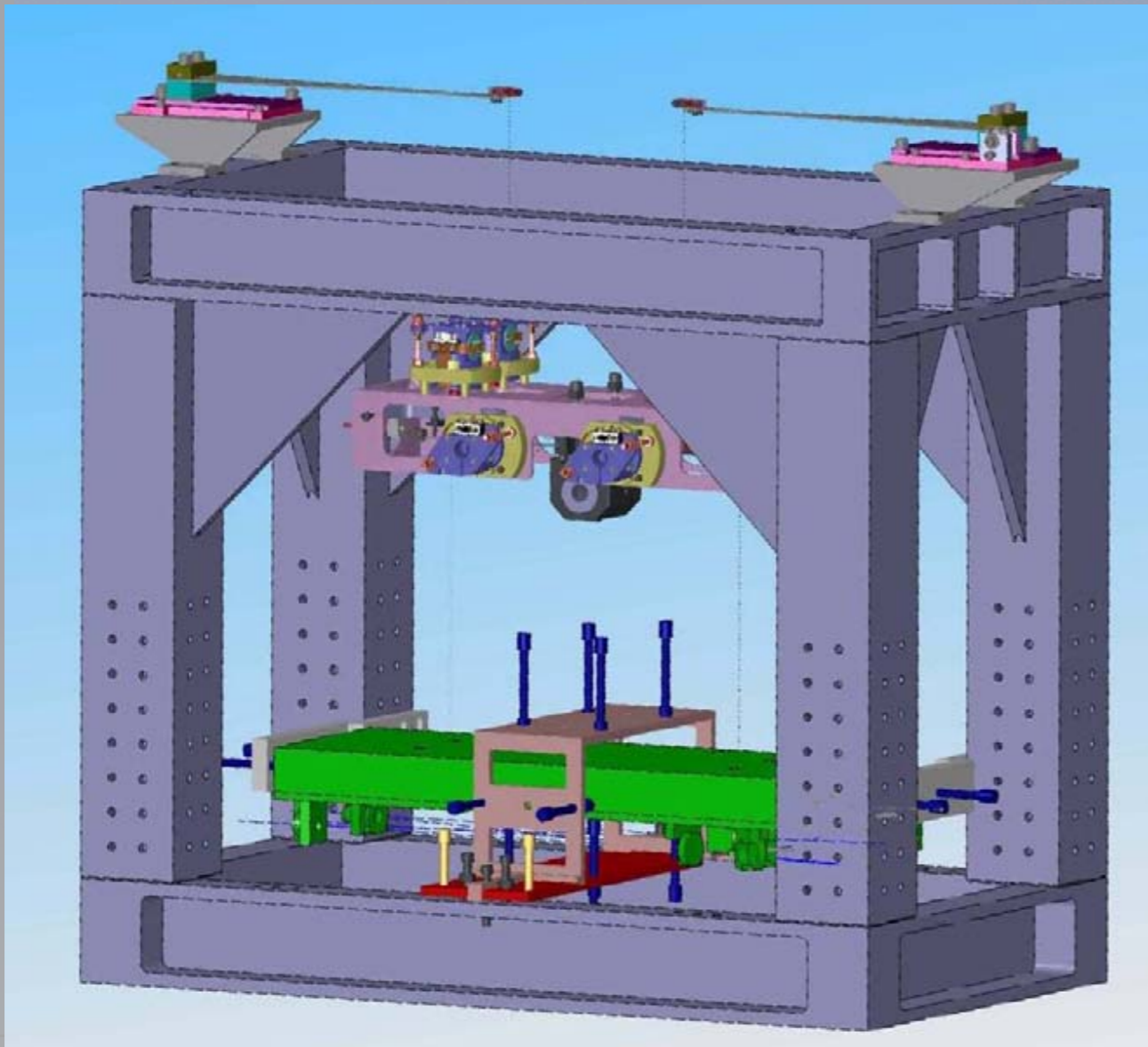
- OMC requires high bandwidth alignment stabilization
- Suspended design provides isolation
- SOS-like suspension with small footprint, advLIGO OSEMs
- ~1 KHz dither for locking
- Resonances > 2 Hz



(http://ilog.ligo-wa.caltech.edu:7285/advligo/Tip-Tilt_Stage)

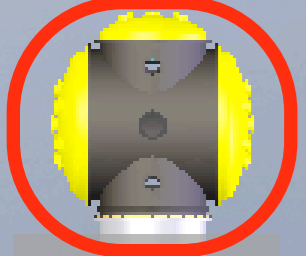
OMC suspension

Janeen Romie, Norna Robertson,
Calum Torrie, Chris Echols



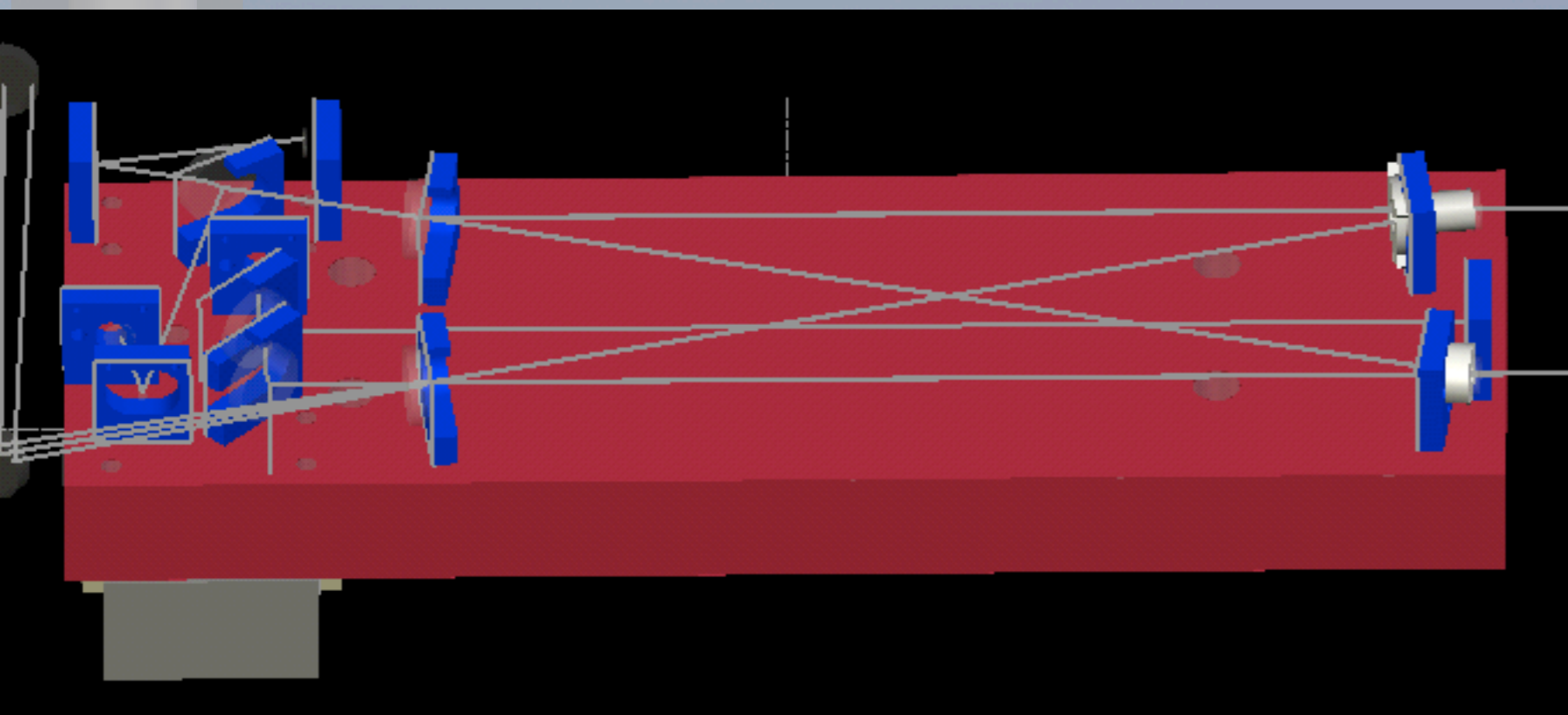
- Based on Input MC triple pendulum
- Double pendulum with dual vertical springs
- 6 DOF actuation on intermediate mass (advLIGO OSEMS)
- End of June clean OMC-SUS to LASTI

([http://ilog.ligo-wa.caltech.edu:7285/advligo/OMC Suspension](http://ilog.ligo-wa.caltech.edu:7285/advligo/OMC_Suspension))

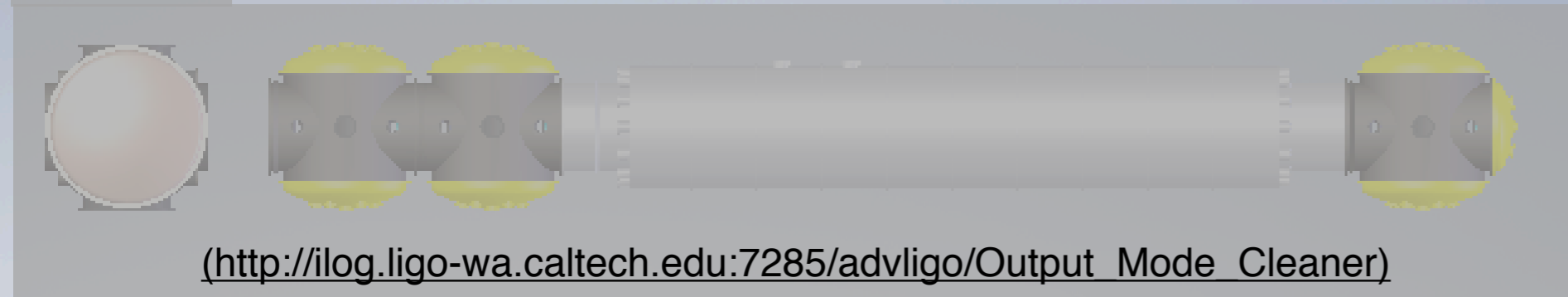
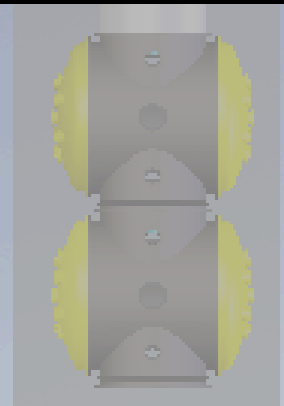


Output Mode Cleaner

Rich Abbot, Peter Fritschel, SJW



- Bonded fused silica or ULE construction (CTE, mechanical loss)
- 4 mirror, $F = 400$ bow-tie configuration
- Integrated quads, DC photodiodes and pre-amps



([http://ilog.ligo-wa.caltech.edu:7285/advligo/Output Mode Cleaner](http://ilog.ligo-wa.caltech.edu:7285/advligo/Output_Mode_Cleaner))

Enhanced LIGO is Underway

- Faraday, Input optics ready now
- Tip-Tilt & OMC-SUS prototype assemblies in April
- HAM-SAS testing/design in progress, SEI decision in April
- 35 W prototype delivery in May
- OMC assembly and testing end of June
- Possible clean testing of OMC+(OMC-SUS) at LASTI end of July

