



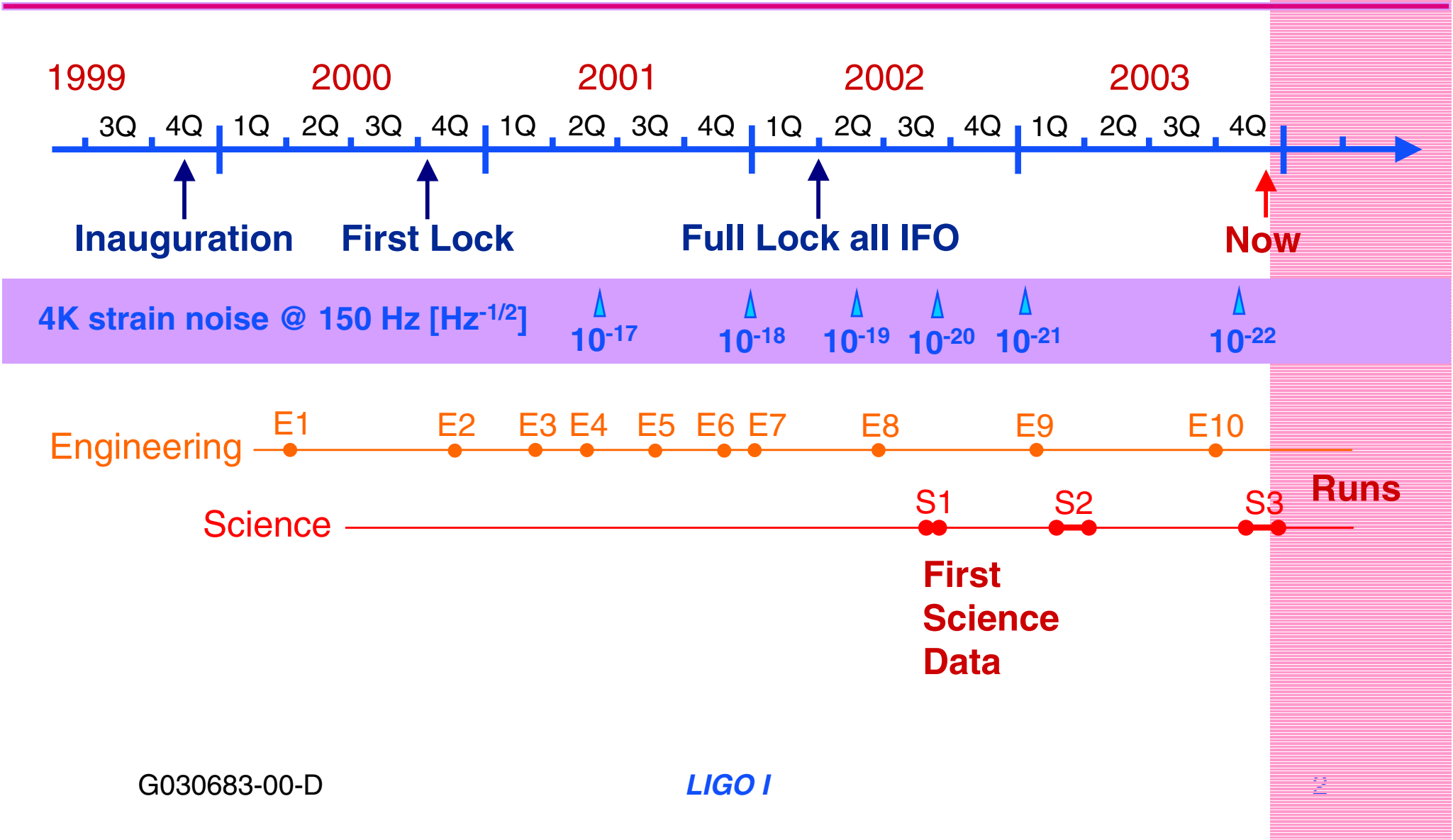
Commissioning Update

PAC 15, Dec. 11, 2003

Daniel Sigg



Time Line

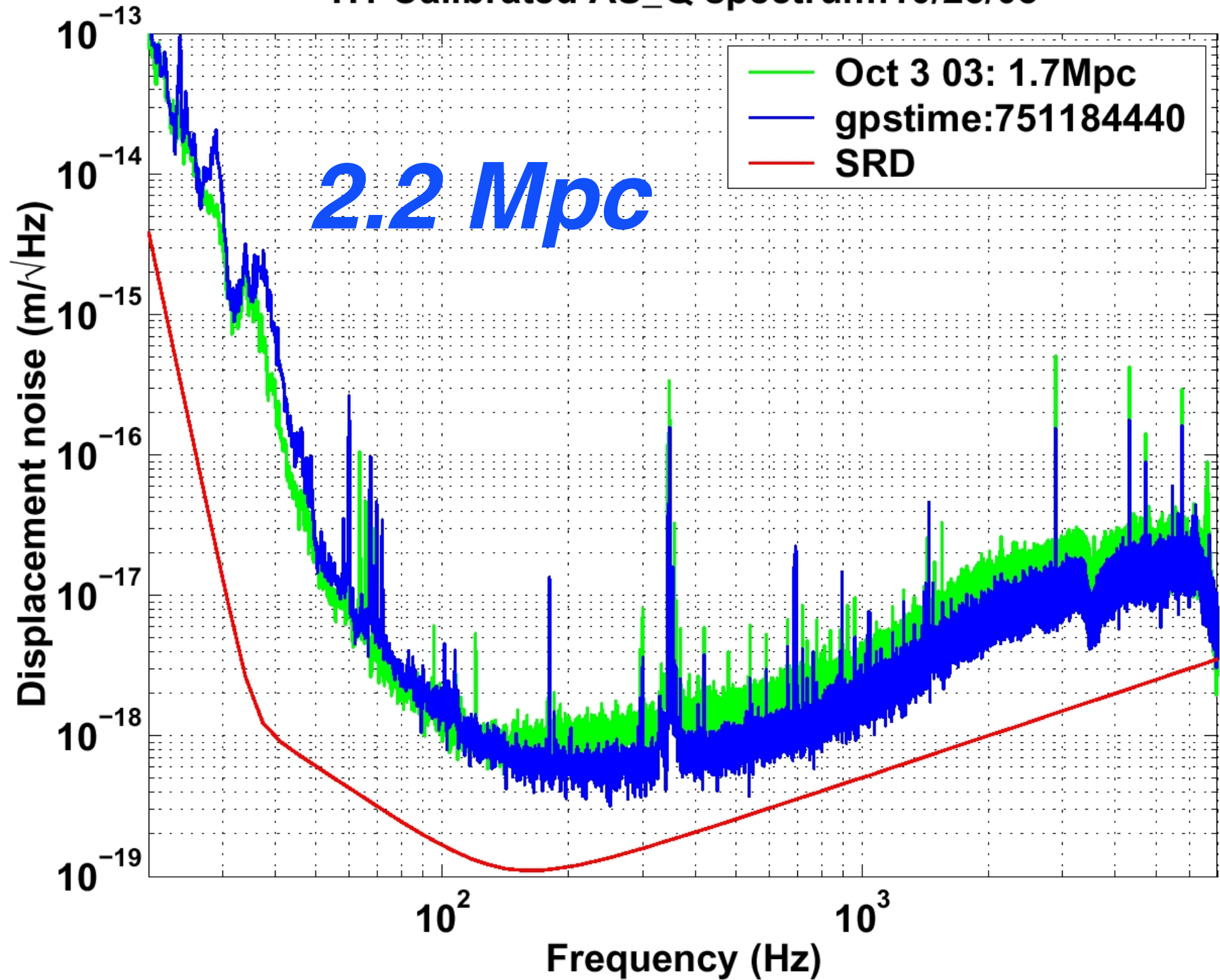




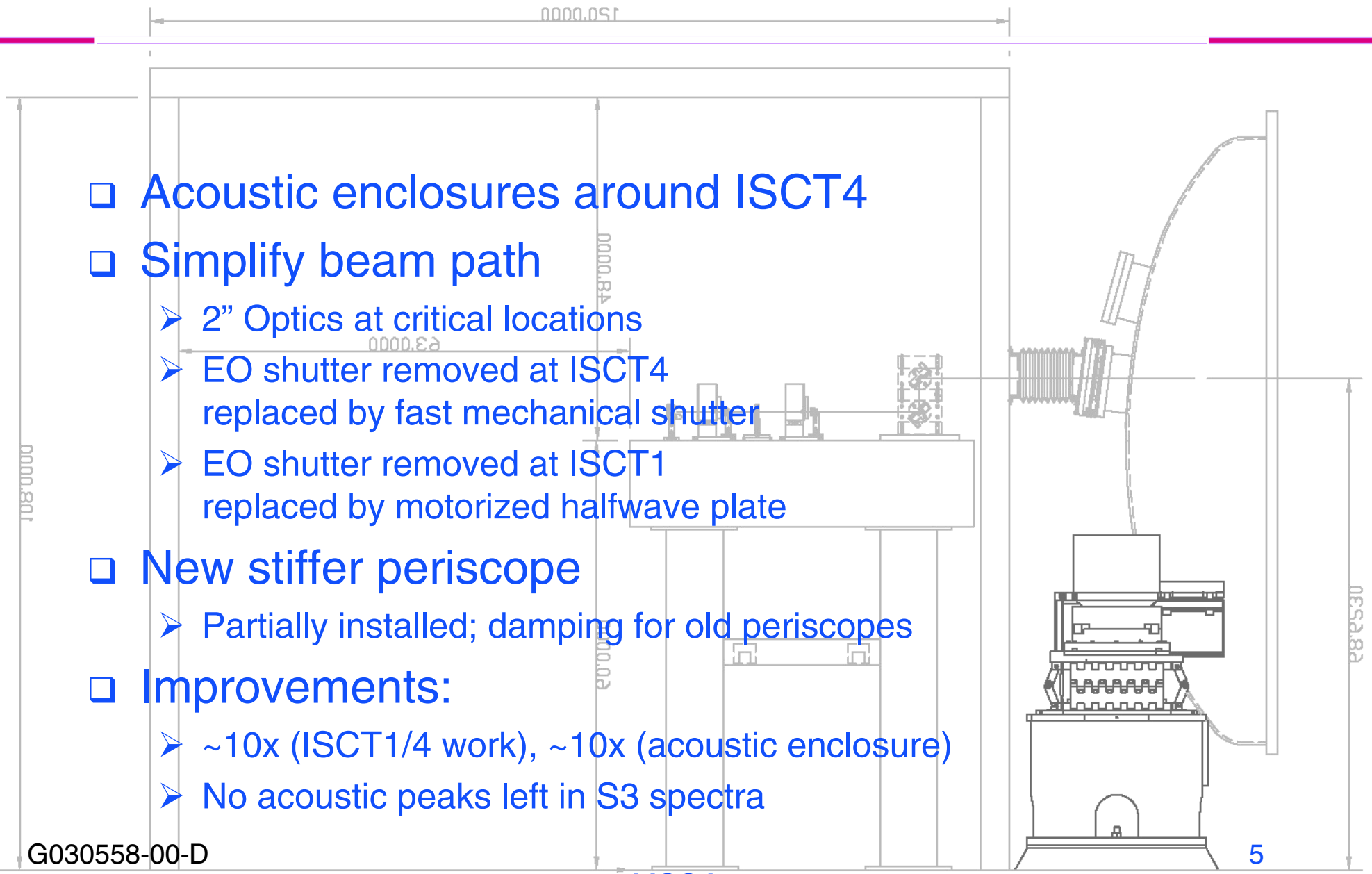
Major Achievements Since S2

- ❑ Inspiral sensitivity up to 4Mpc (H1)
- ❑ Acoustic mitigation
- ❑ Auto-alignment system on all angular dofs
- ❑ High(er) power operations

H1 Calibrated AS_Q spectrum:10/25/03



- ❑ Acoustic enclosures around ISCT4
- ❑ Simplify beam path
 - 2" Optics at critical locations
 - EO shutter removed at ISCT4 replaced by fast mechanical shutter
 - EO shutter removed at ISCT1 replaced by motorized halfwave plate
- ❑ New stiffer periscope
 - Partially installed; damping for old periscopes
- ❑ Improvements:
 - ~10x (ISCT1/4 work), ~10x (acoustic enclosure)
 - No acoustic peaks left in S3 spectra

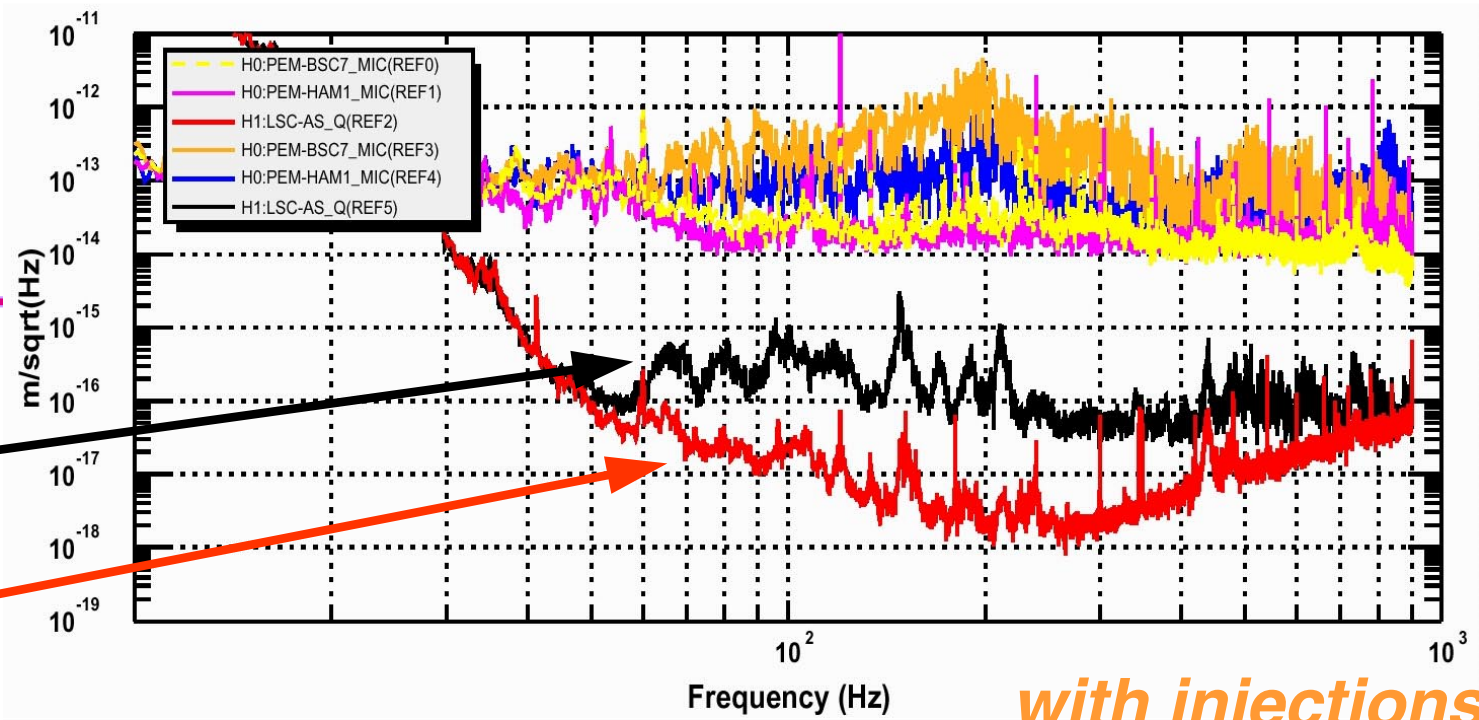


G030558-00-D



with acoustic injections at ISCT4

S2

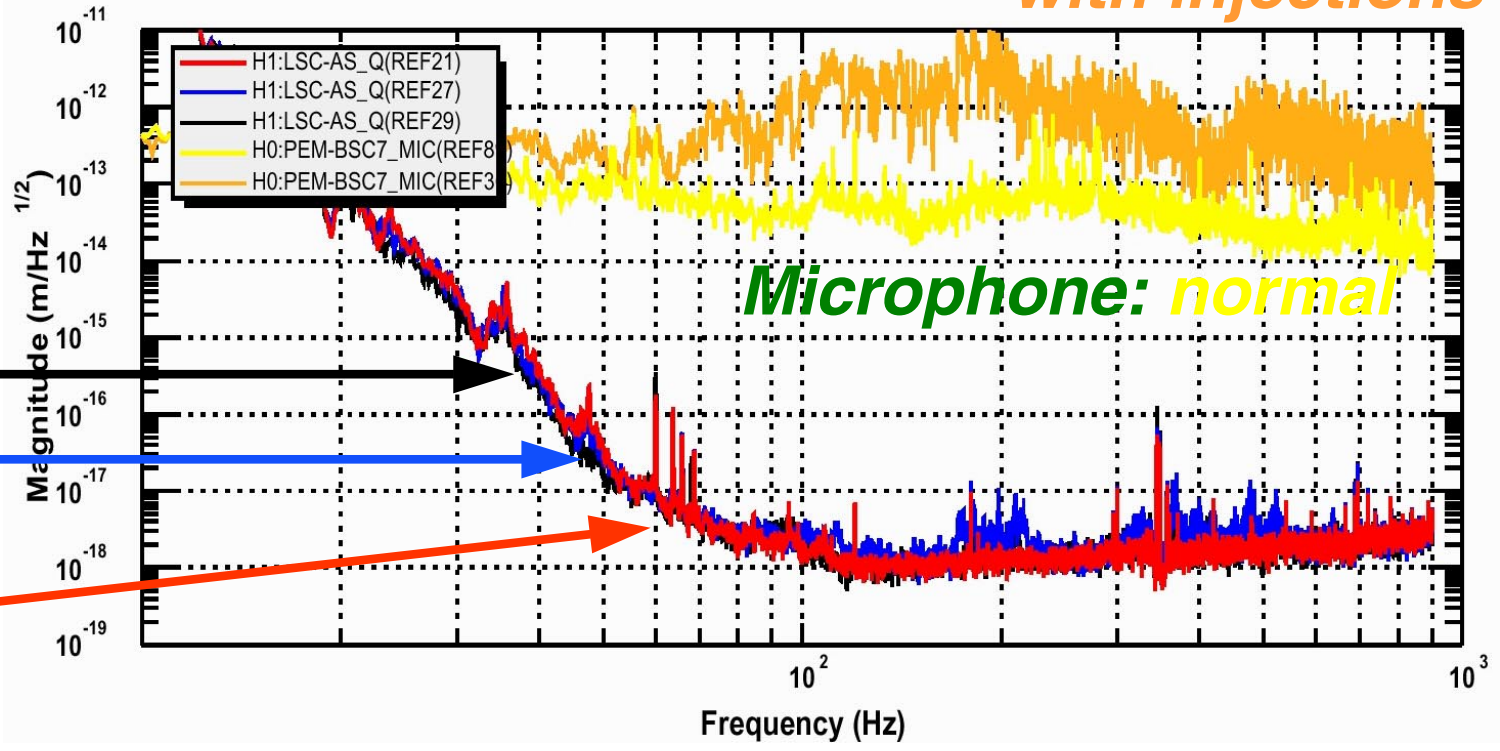


Displacement Spectra

with acoustic injections at ISCT4 and ISCT1

ISCT1

S3



with injections

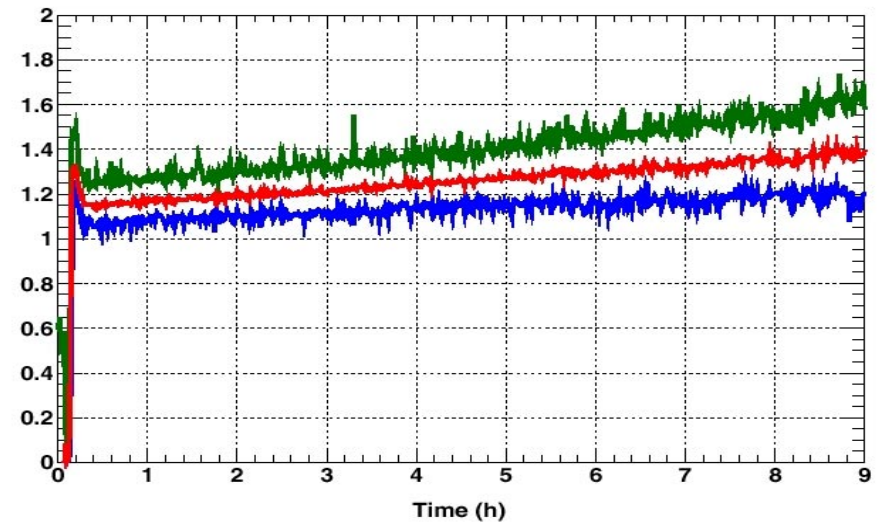
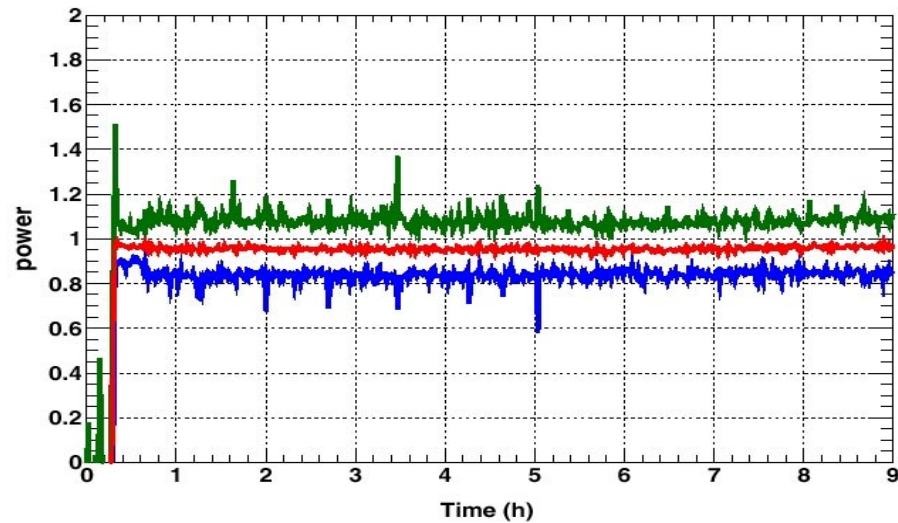
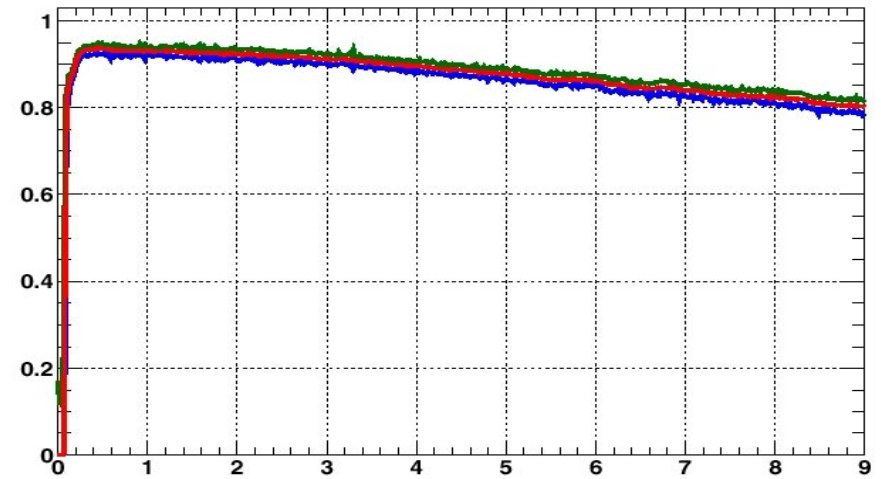
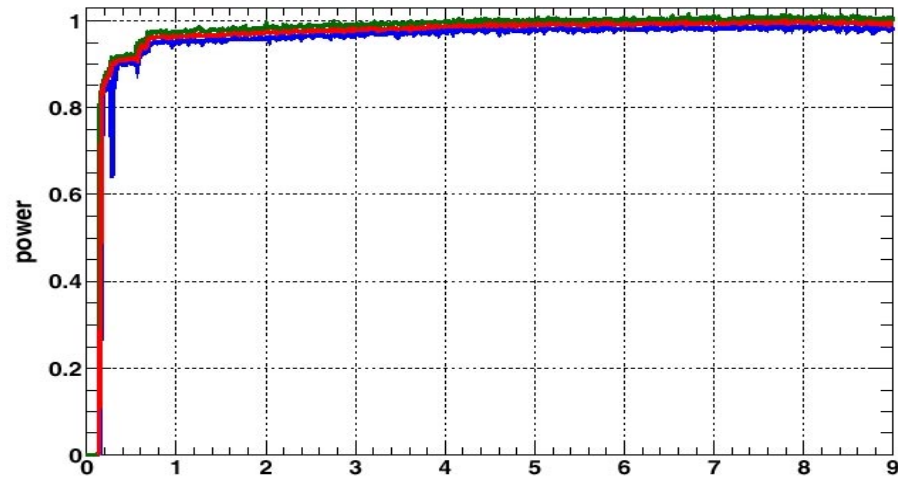
Microphone: normal



Auto-Alignment System

WFS ON

WFS OFF

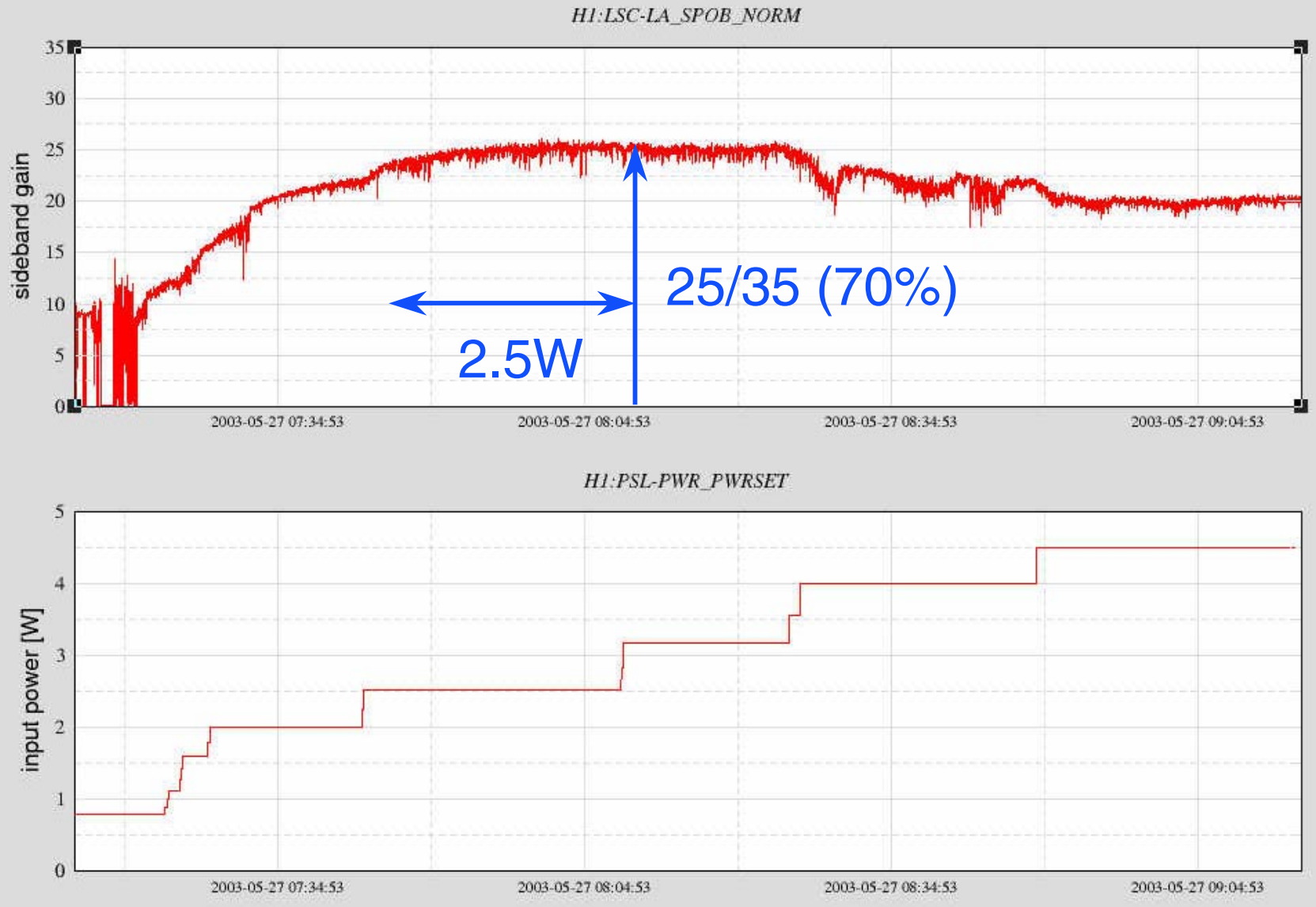




High Power Operations

H1 Thermal Heating: 03-5-27-7-15-0 to 03-5-27-9-14-59

Thermal
Lensing





Major Goals and Tasks After S3

□ Sensitivity

- Operate at high power
 - ❖ Laser: factor 2 short; IO transmission efficiency not great either
 - ❖ Thermal compensation system (TCS)
 - ❖ Output mode cleaner (OMC)
 - ❖ Design of sensing chain
- Manage auxiliary degrees-of-freedom (e.g., POB light level)
- Finish acoustic mitigation
- Clean up electronics: RFI mitigation

□ Reliability & Stability

- Seismic retrofit at LLO
- Auto-alignment system at full bandwidth

Thermal Compensation System

- ❑ Add missing heat with a CO₂ laser
 - See G030167-01
- ❑ Build a prototype to fully equip a single ifo
- ❑ Testing on H1 is highest priority task at LHO
- ❑ Install phase cameras
- ❑ RF sideband measurement setup(?)
- ❑ Requires a quick vent to install ZnSe windows
- ❑ Aim to have hardware ready at end of S3
- ❑ Modeling of asymmetric heating

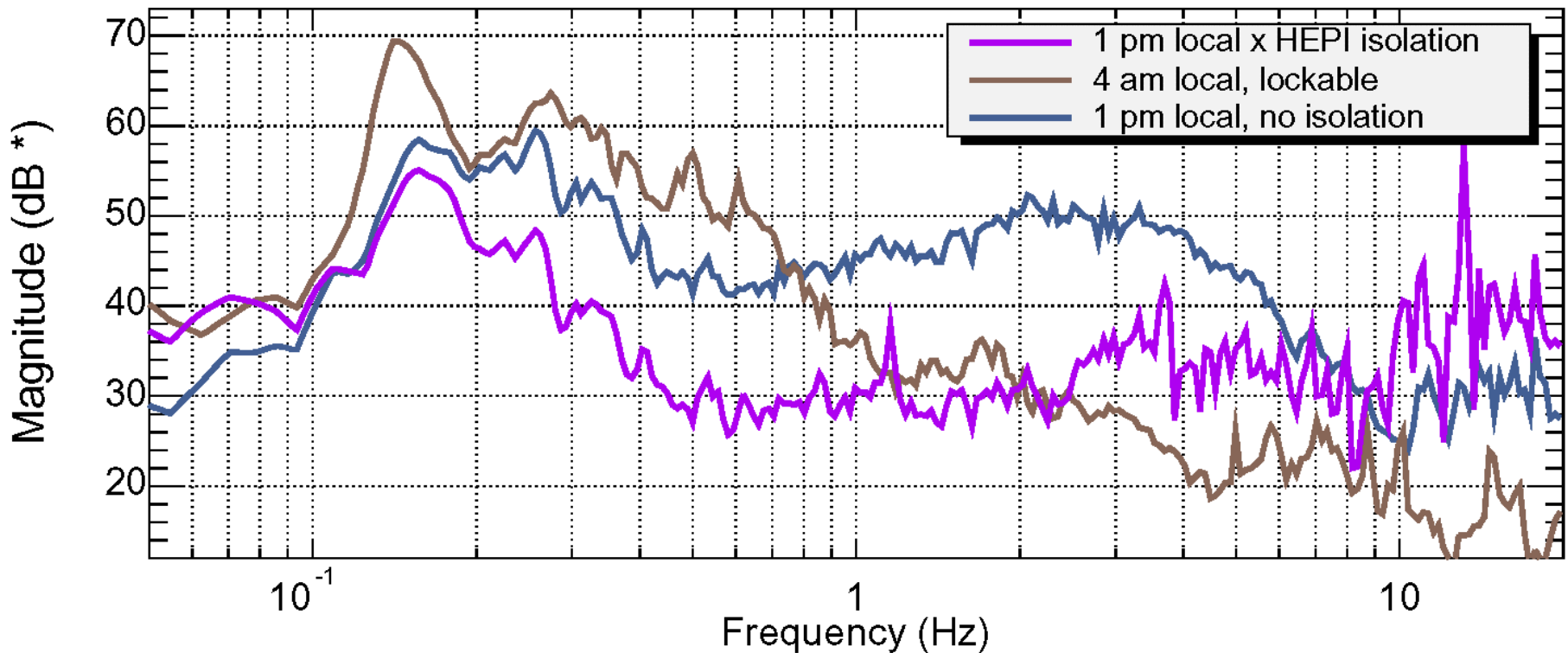
Output Mode Cleaner

- Study feasibility of OMC
 - Fixed spacer triangular Fabry-Perot cavity
 - In vacuum design?
 - Seismic isolation required?
 - Length sensing & control system: RF + thermal? PZT + dither?
- Model of sideband asymmetry
- OMC prototype & in-air test at LHO
 - Effect on contrast defect
 - Effect on ASI
 - Effect on 2Ω problem
 - Effect on fringe offset
 - Effect on noise

Seismic Retrofit at LLO

Example effect of HEPI isolation on daytime ground noise:

LLO Y End Ground Noise, various conditions



*T0=03/10/2003 18:20:50

G030683-00-D

Avg=10/Bin=7L

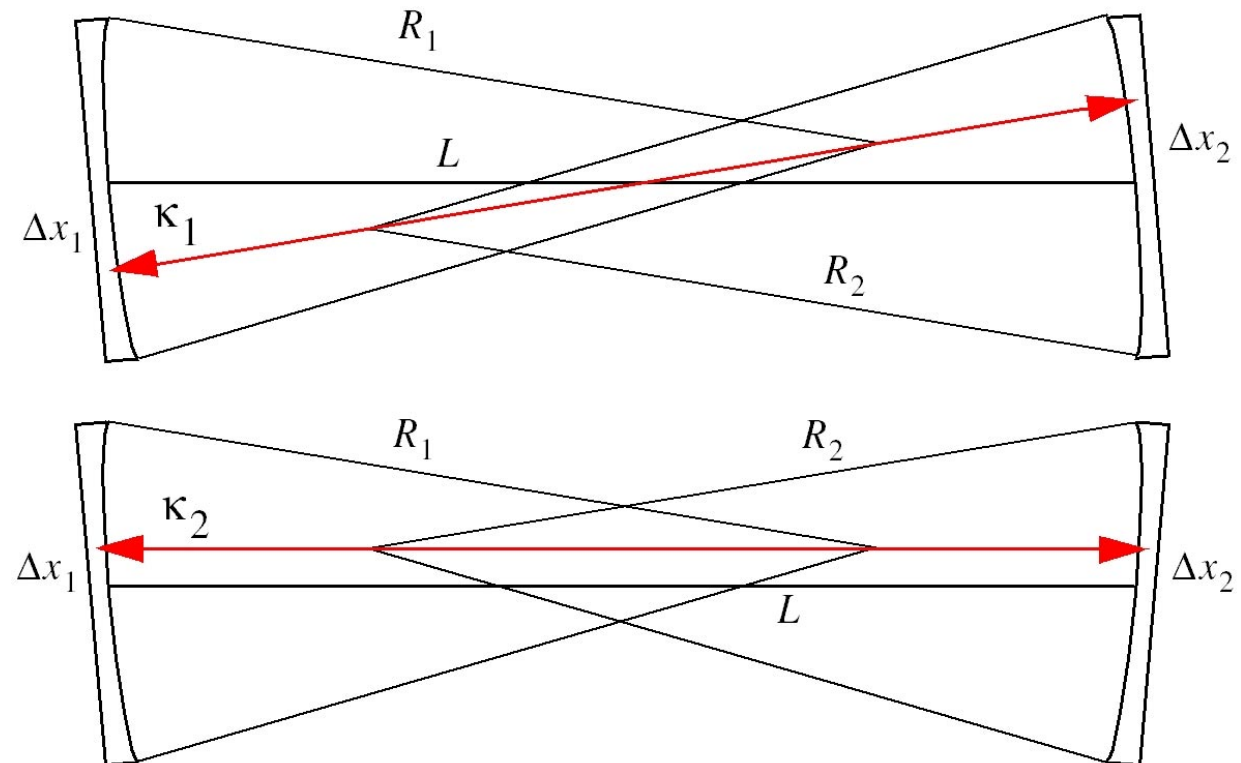
LIGO I

BW=0.0117187

12

Wavefront Sensing

- ❑ High bandwidth
- ❑ Noise investigations
- ❑ Study and minimize cross-couplings
- ❑ New software
 - Radiation pressure compensation
 - Input matrix
 - Adaptive control: power levels, SPOB & intermodulation
- ❑ Initial Alignment
 - WFS5 / Dither



Finish Acoustic Mitigation



- ❑ ISCT1/ISCT7 acoustic mitigation
 - acoustic enclosure? Not necessary.
 - REFL PD2, fast shutter & analog switching for CM
- ❑ IOT1/IOT7(?)
- ❑ Implement new periscope design
- ❑ Source isolation
- ❑ Move racks

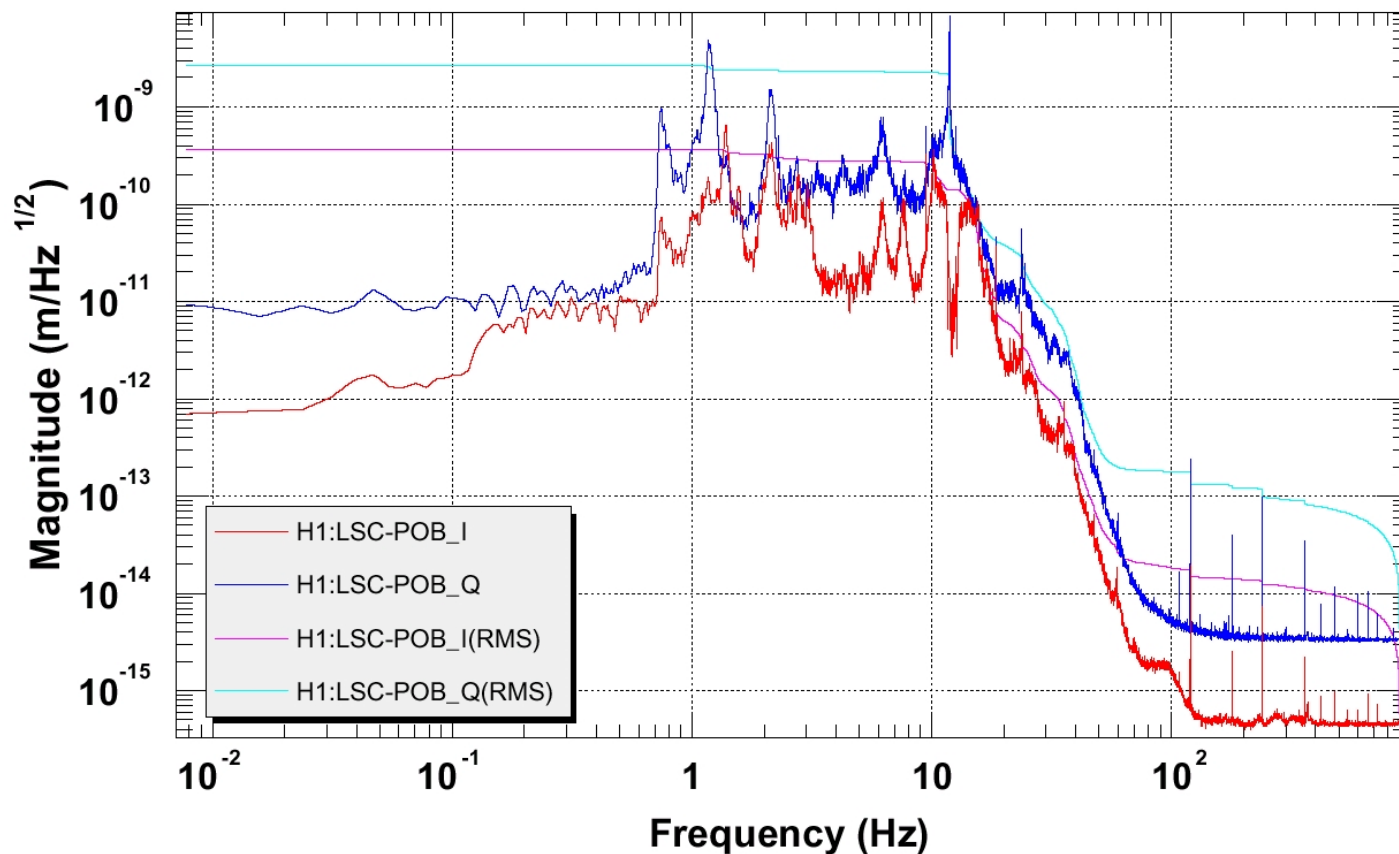
Auxiliary Degrees-of-Freedom

- More light power for POB

- Install POB2 on POX or POY

- ~~New ITM with reduced AR coating efficiency??~~

- Bounce mode damping(?)



Beam Centering

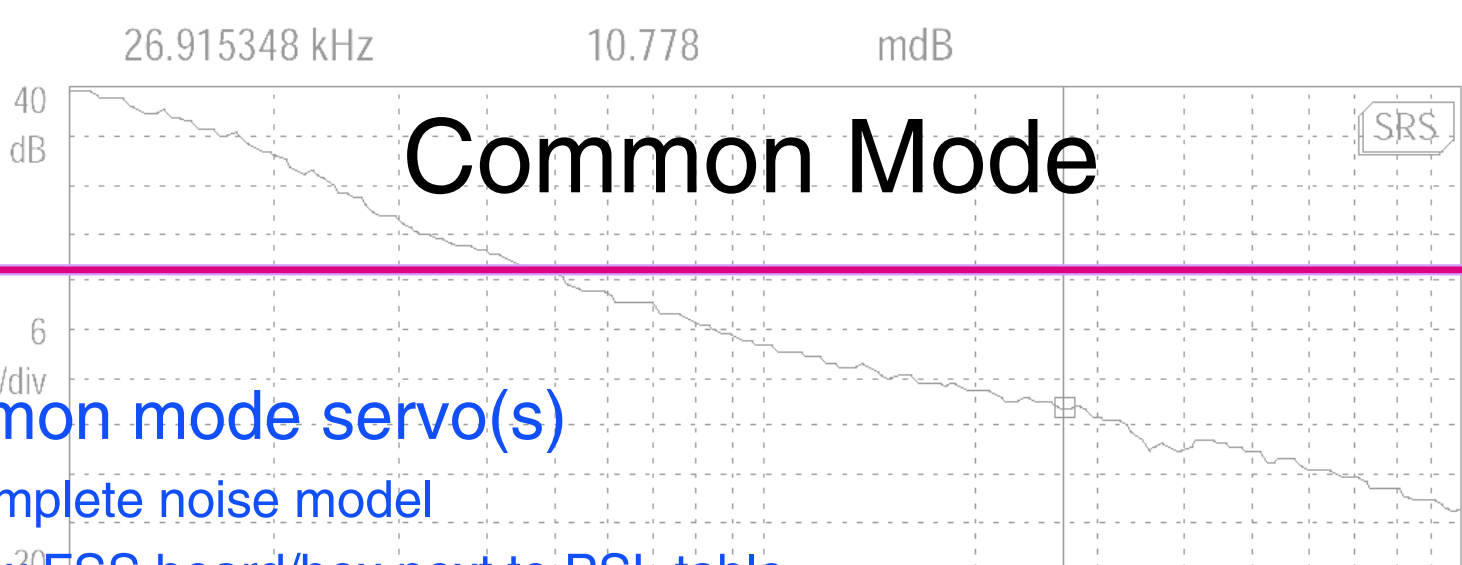
- Center beams on mirrors to within 1mm

- 300mm zoom lenses for ITMs w/ remote controlled iris
- Determine center of rotation with radiation pressure shifts?
- Fast image processing for MMT1 servo?

- Automatic beam centering on ISCTs

- Fast steering mirrors & quad detectors on every ISC/IOO table
- Feedback using digital or analog controllers(?)
- Automatic turn on and turn off

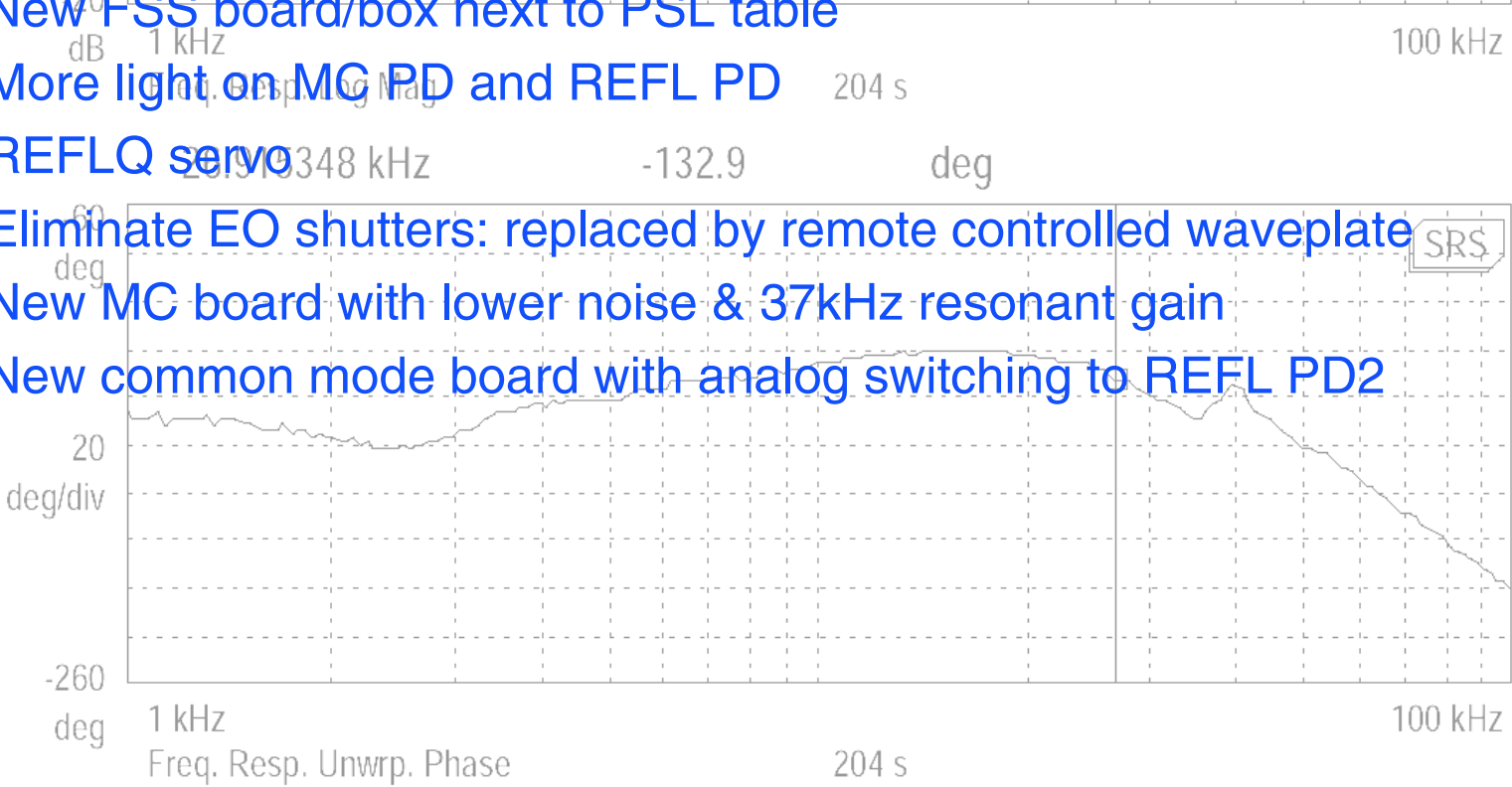




□ Common mode servo(s)

- Complete noise model
- New FSS board/box next to PSL table
- More light on MC PD and REFL PD
- REFLQ servo
- Eliminate EO shutters: replaced by remote controlled waveplate
- New MC board with lower noise & 37kHz resonant gain
- New common mode board with analog switching to REFL PD2

B Done

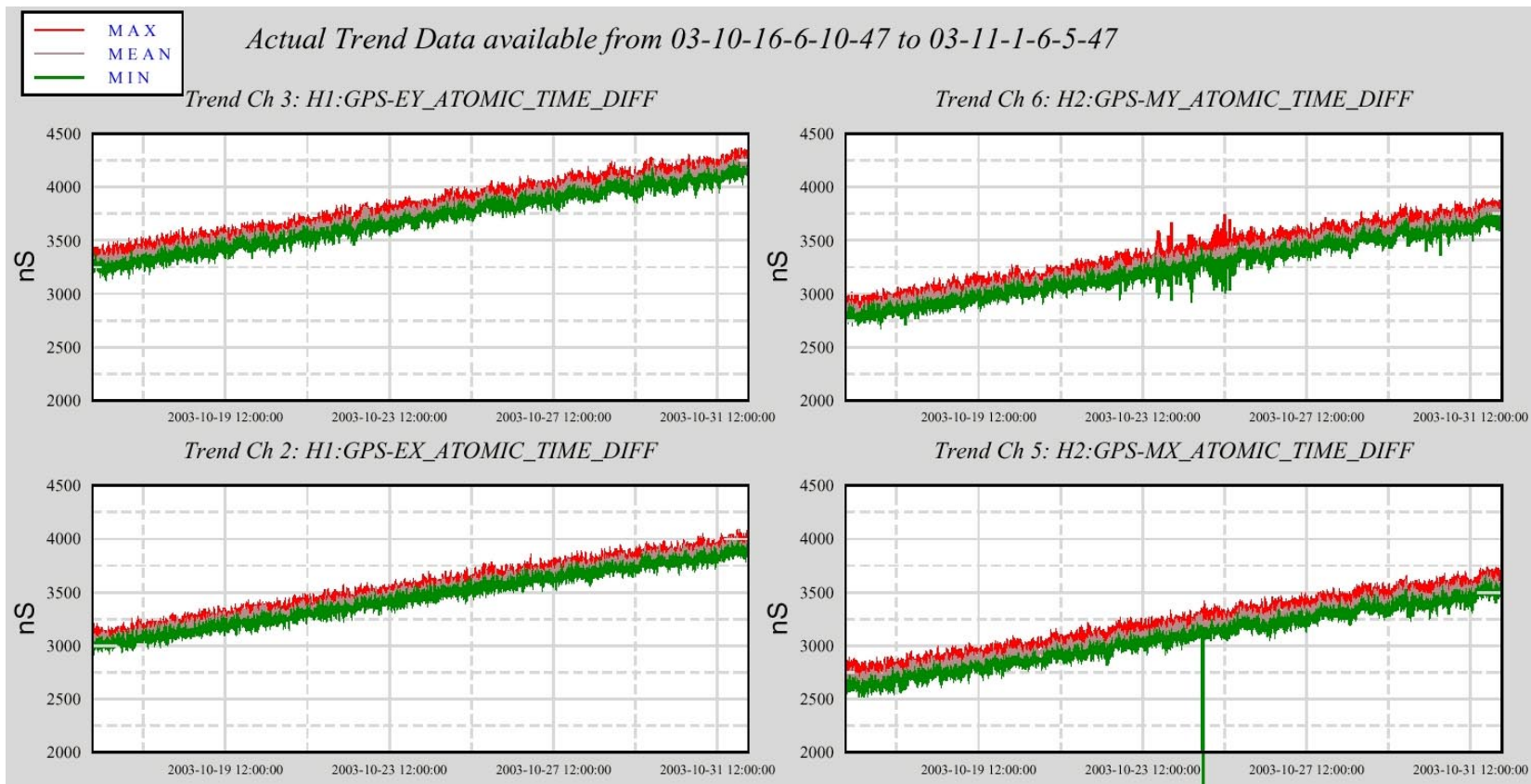


Atomic Clock

□ New timing diagnostics

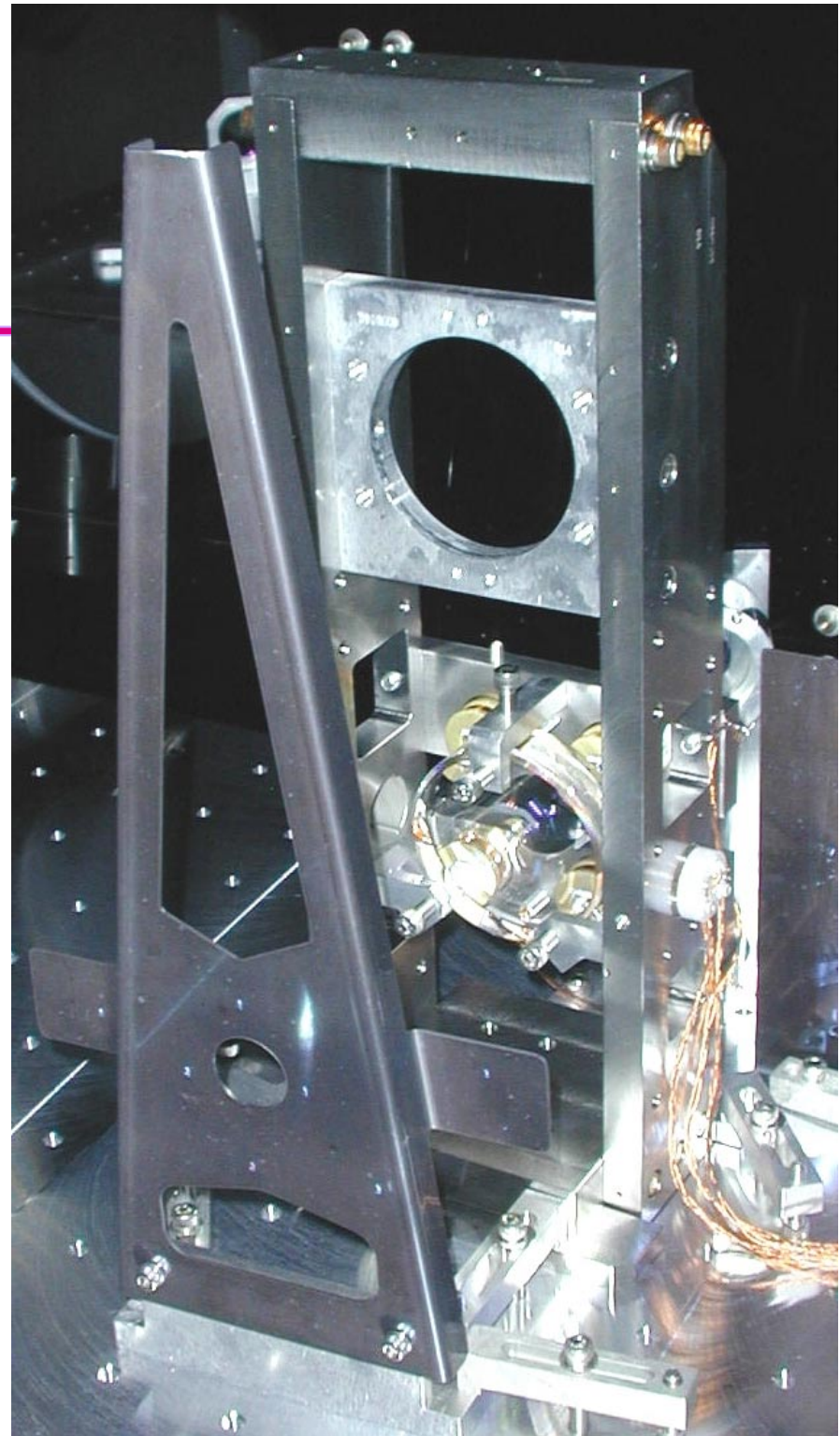
- Implement and test new timing distribution system
- Implement and calibrate new atomic clocks
- Implement photon calibrators

Drift: 50ns/day



IOO Improvements

- IOO baffle retrofit at LHO
 - Target of opportunity or disaster?
- IOO Faraday
 - New larger aperture model(?)
 - Study thermal effects –
UFI AdLIGO compensated design(?)
- Digital IOO WFS
 - Feedback to MC mirrors
 - Better filtering
 - Radiation pressure compensation



Miscellaneous (1)

- LSC photodetector redesign
 - ASI input
 - New 100Hz-10kHz output
- ISS
- Finish ASI servo design and fabrication
 - Anit-image & dewhitening
 - Modulator: $>1/4W$ output power(?), phase adjust
- New low-noise DACs from FDI (40 dB lower noise)
- Dewhitening/whitening switching
 - New boards with stages or parallel paths
 - Need an intermediate stage to avoid switching in one big step

Miscellaneous (2)

- Dual ETM transmission photodetectors
 - Single element, high-gain PD for acquisition
 - Current QPD for detection
 - Lower offsets & less drift
- Servo to track modulation frequency to MC length(?)
- RFI cleanup
 - Rack re-allocation
 - New EMI shielded racks
 - Redo cabling and connectors.
 - Redesign of critical electronics for low noise

Summary: Post-S3 Steps

First ~6 months after S3

L1

- ▶ Seismic upgrade: HEPI installation & commissioning
- ▶ Electronics rack relocation

- ▶ New DACs (old DACs to HEPI)
 - ▶ Thermal compensation trial
 - ▶ New ASC code

H1

- ▶ Wideband WFS control
 - ▶ Laser power increase
 - ▶ Output mode cleaner?
 - ▶ Duty cycle

H2

- ▶ Power increase (thermal lens) testing