Commissioning Progress and Plans Livingston Observatory

LSC Meeting, March 21, 2005

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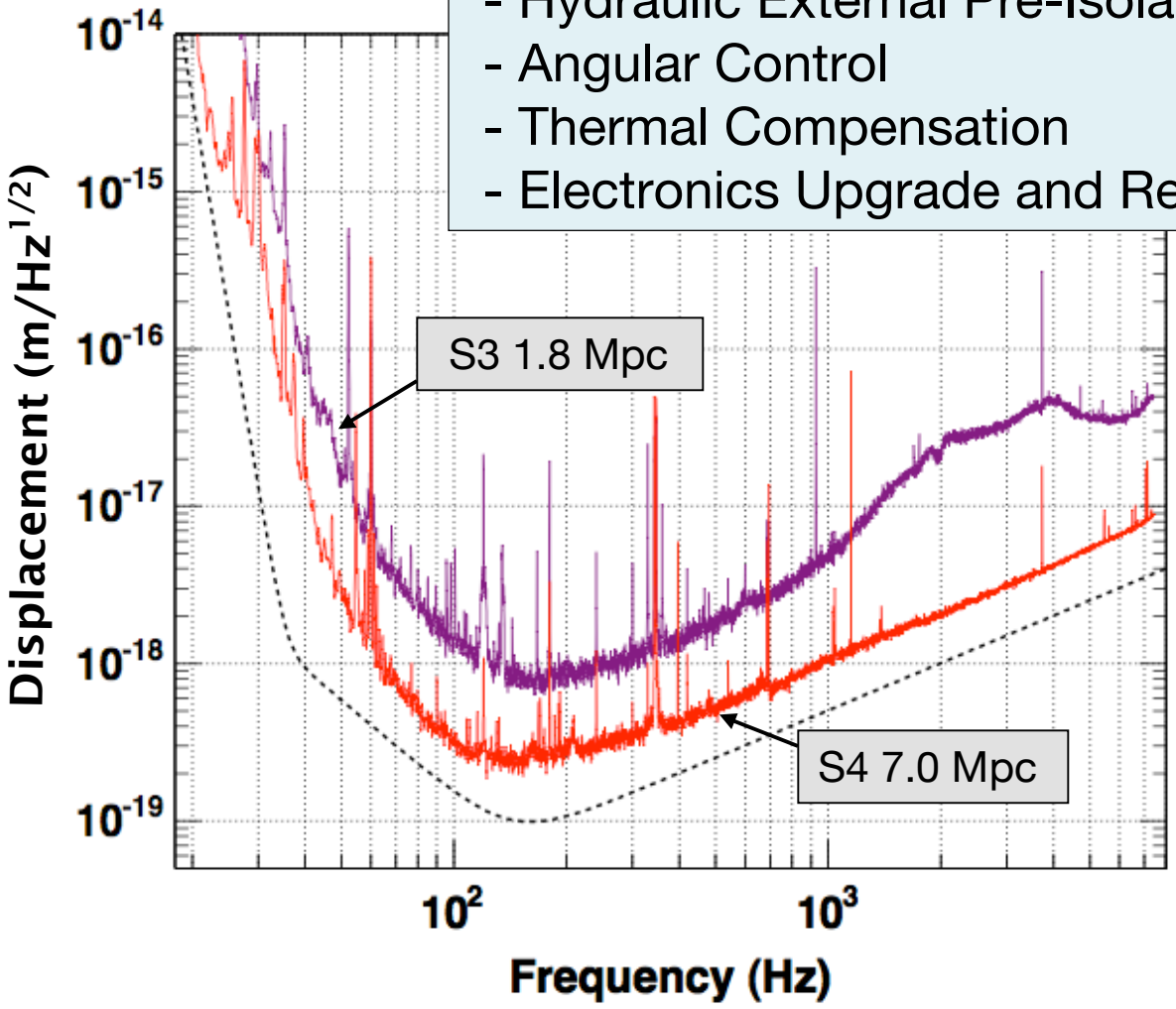
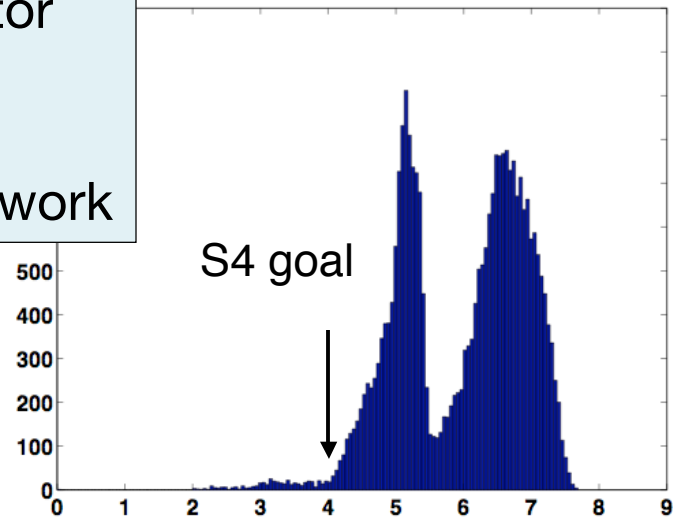
G050106-00-D

LLO Commissioning Highlights

Main Efforts Since S3:
- Hydraulic External Pre-Isolator
- Angular Control
- Thermal Compensation
- Electronics Upgrade and Rework





S4 Inspiral range (Mpc)

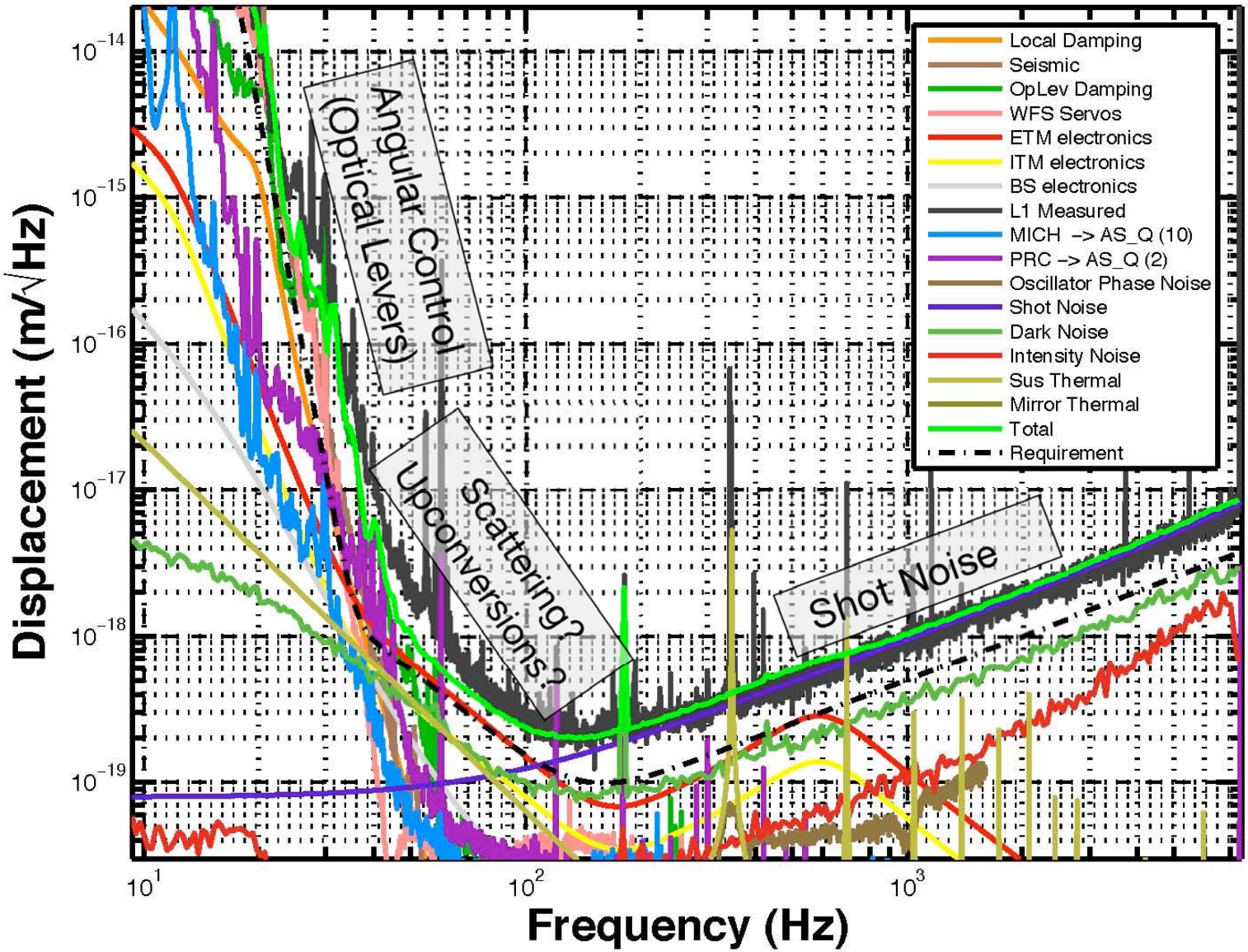
	Duty cycle
S3	22%
S4	72%
S4 goal	70%

Duty Cycle and Stability

- **HEPI saved the day**
  - LLO duty cycle is no longer limited by daytime seismic noise from the human activity 1-3 Hz in surrounding area
  - Sensitivity to the microseism 0.1-0.3 Hz is greatly reduced
  - Increased sensitivity to the ground motion and tilt in 0.05-0.1 Hz range. The tidal servo bandwidth was extended to 0.1 Hz.
  - Sometimes can stay locked during the train
  - For more information see HEPI talk
- All degrees of freedom Angular Control is functional
  - Calibration lines are stable within a few percent during multi hour locks
  - Don't have enough gain at the 1-2 Hz stack modes to disable the optical lever damping
  - Made initial ifo alignment more robust

Sensitivity: Noise Budget

L1 Noise, Mar 12 2005 05:00:26 UTC



Sensitivity: Optical Gain

- Thermal Compensation System
  - No evidence of ITMs thermal lensing at the current power levels
  - Central heating applied: 25 mW ITMX, 45 mW ITMY
  - Increased sideband recycling G_{sb} by a factor of 2
  - AS_Q optical gain improved as $(G_{sb})^{0.80\text{-}0.85}$. In agreement with FFT calculations. Expect $(G_{sb})^{0.5}$ from SB power increase and the rest comes from the improved spatial overlap between the carrier and sidebands.
  - PO_I/Q optical gains improved by a factor of $(G_{sb})^2$
  - Reduced the AS_I signal by a factor of 2-3
  - Reduced coupling to the laser amplitude noise and oscillator phase noise by an order of magnitude
  - Running open loop - no feedback to the CO_2 heaters

Sensitivity: Light Detection

- Switched to the ITMX pick-off beam. Reduced noise in auxiliary degrees of freedom l_+ and l_- by using five times more light (also more optical gain from the TCS).
- Larger optics on AS port optical table
- Test masses are seismically isolated but optical tables are not. Noise from scattered light.
- Mitigated scattering: uncoated lenses on the arm transmitted beam tables, improper beam dump on the reflected port, normal incidence beams on some photo detectors

Sensitivity: Electronics

- Relocated electronics racks from LVEA to reduce the acoustic noise and RF pickup
- Switched to AC balanced power. Reduced power line harmonics at 120 and 180 Hz by an order of magnitude.
- Installed low noise crystal oscillator from Wenzel and low noise RF distribution system. Eliminated the phase noise bump above 1kHz.
- Installed new table top FSS and ISS
- Modified LSC photo detectors to notch out the second harmonic of the RF sideband. Increased number of PDs from 2 to 4. New AS_I servo electronics.

Sensitivity: Electronics(2)

- Actuation electronics upgrade: DAC, Anti-imaging, De-whitening, Coil driver, Suspension bias
- Collecting data around 1-FSR using 100kHz ADC
- Added the second ETM photo detector for lock acquisition
- Reworked the WFS photo detectors to get rid of RF oscillations

LLO Main Tasks After S4

- Increase laser power into the MC from 2W to the design value of 8W (6W into RM).
  Not as straightforward as it may seem:
  - AS_I and REFL_Q signals make too much RF current in PD
  - AS_I servo electronics dominates the dark noise
  - Laser lifetime?
- Possible solutions:
  - More AS port photo detectors or increase the AS_I range - 2 per PD
  - Increase the angular control bandwidth, HEPI resonant gain
  - Reduce optical AS_I using ifo alignment, TCS, OMC
  - Lower the modulation depth. Limited by the carrier contrast defect and the dark noise.
  - Use non-resonant sideband on the REFL port
  - Understand the implication of the input beam mode mismatch, SB frequency/MC length effect on the oscillator phase noise coupling

LLO Main Tasks After S4(2)

- Electronics:
  - Finish RFI/EMC retrofit. Different RF feed through.
  - Install new MC/CM boards
  - Finish coil driver modification
- Mitigate the remaining scattering on the optical tables
- Look for transient noise sources both external and internal to the interferometer