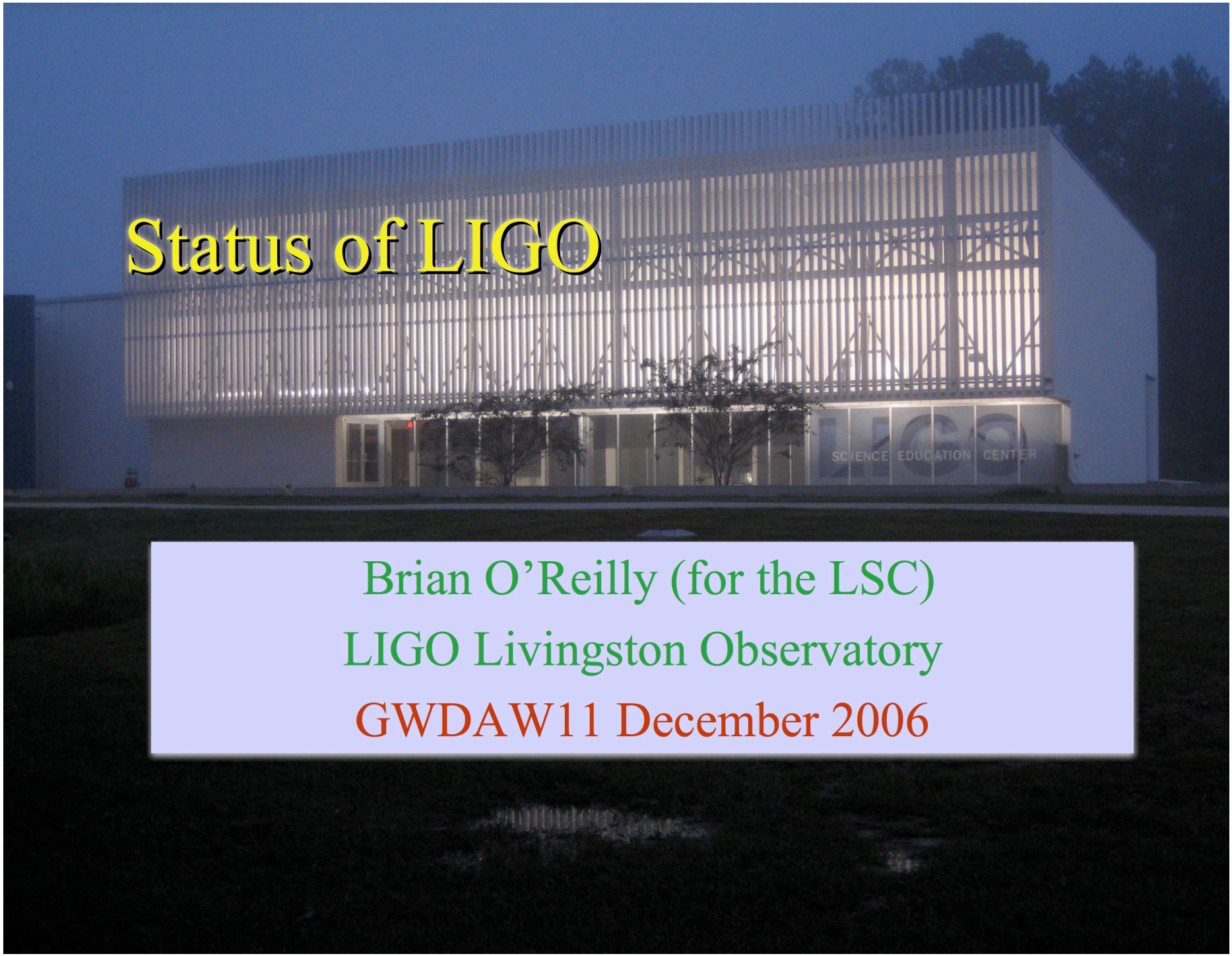


Status of LIGO

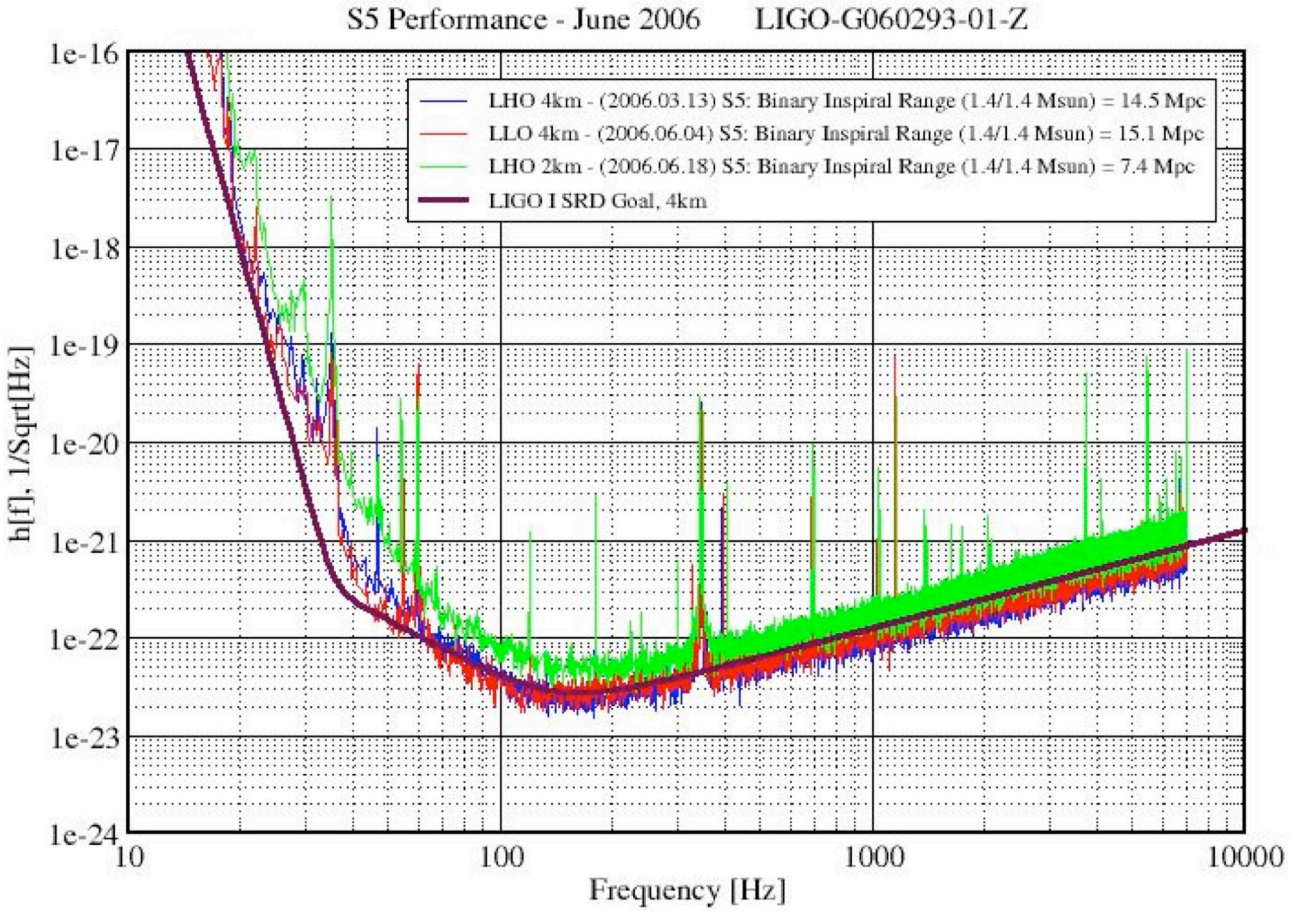
Brian O'Reilly (for the LSC)
LIGO Livingston Observatory

GWDAW11 December 2006

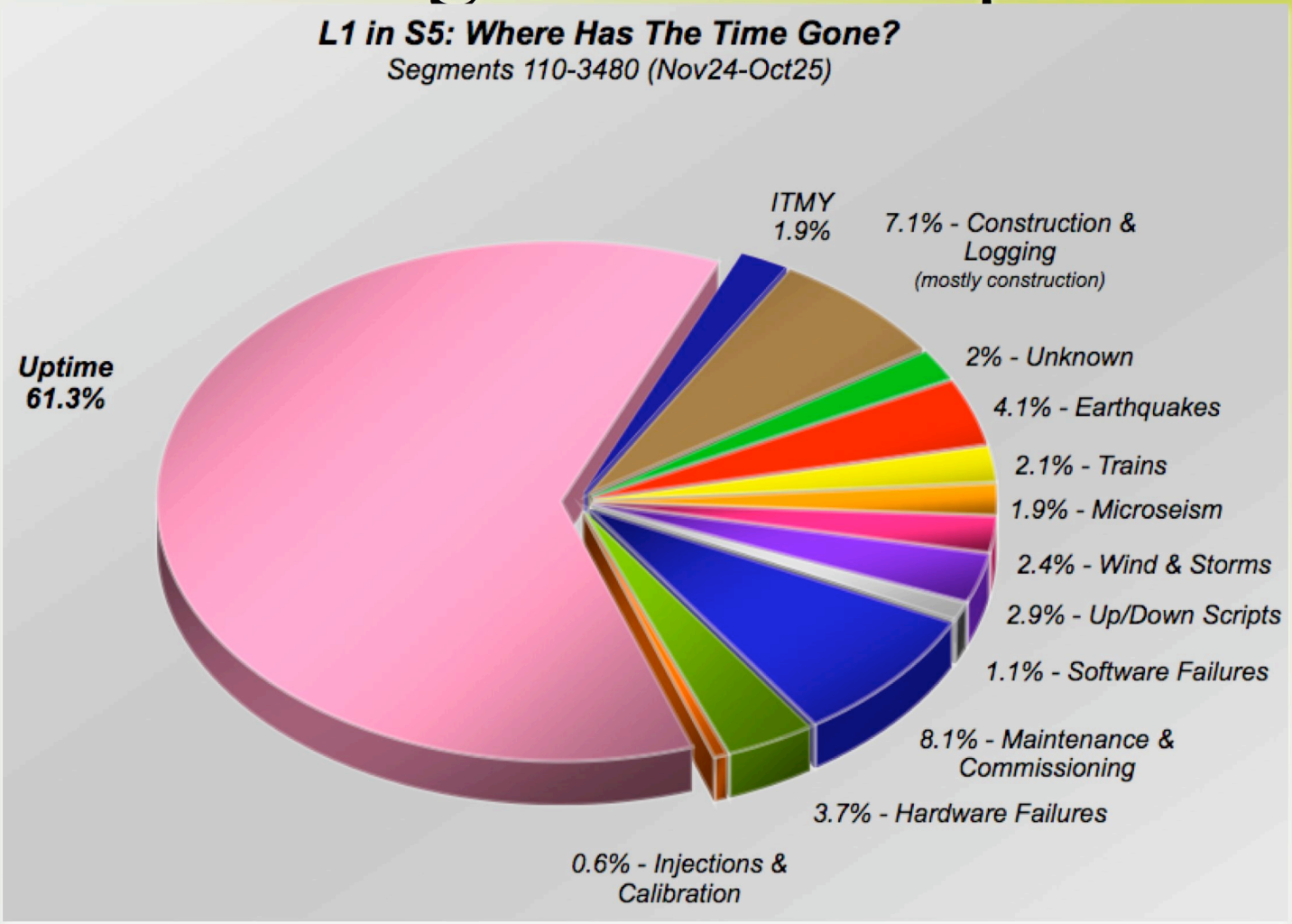
Duty Factor Comparison

Run	*S2*	*S3*	*S4*	*S5 to 12/13/06*
Livingston 4km	37%	22%	75%	61%
Hanford 4km	74%	69%	81%	73%
Hanford 2km	58%	63%	81%	77%
Triple	22%	16%	57%	47%

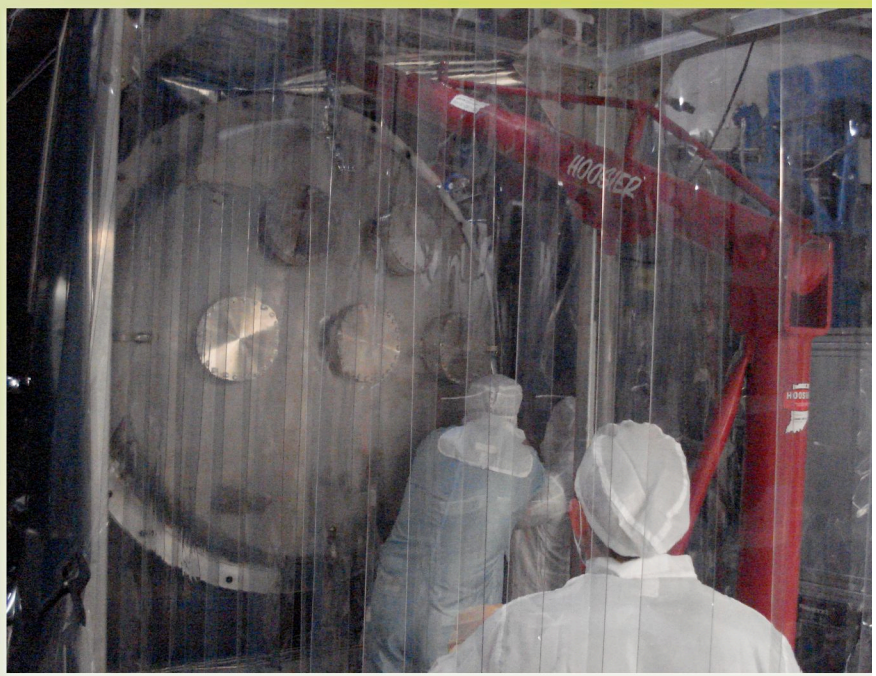
Sensitivity



S5 Livingston 4km Uptime



ITMY gets Jammed

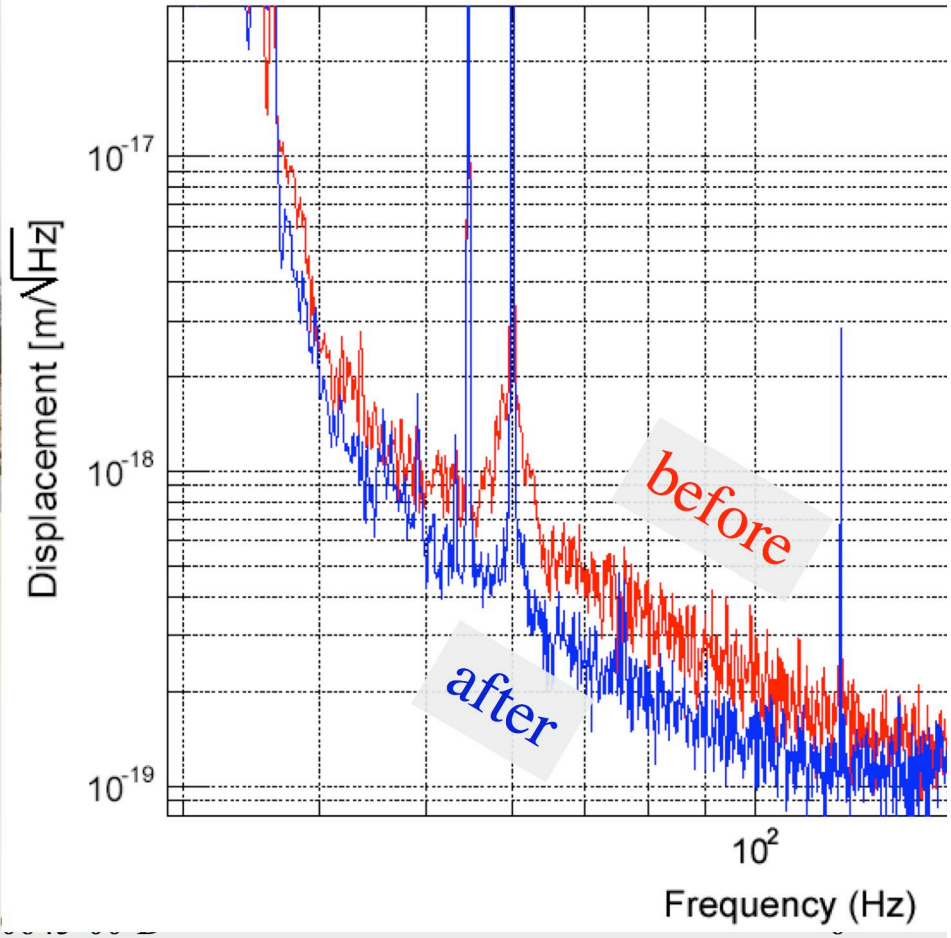


- Caused by construction activity.
- But after freeing the optic the range improved.
- Extra 2 Mpc of Inspiral Range!

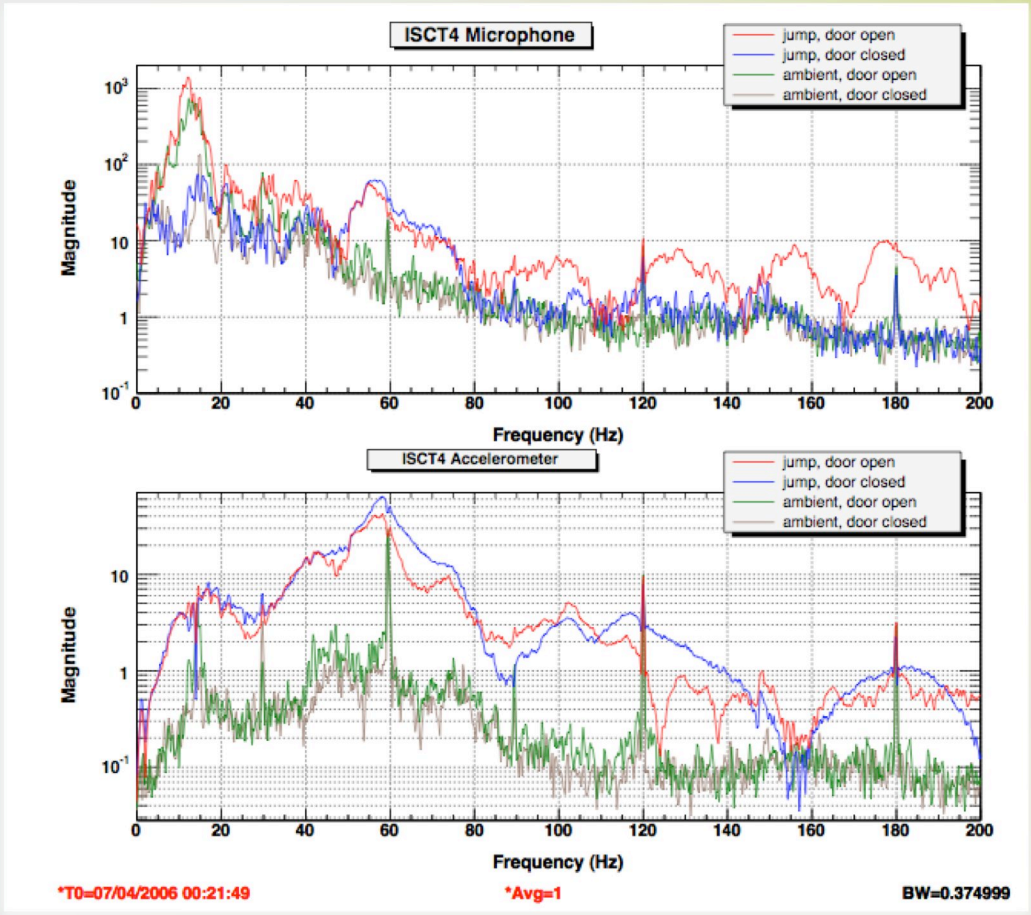
Getting Lucky

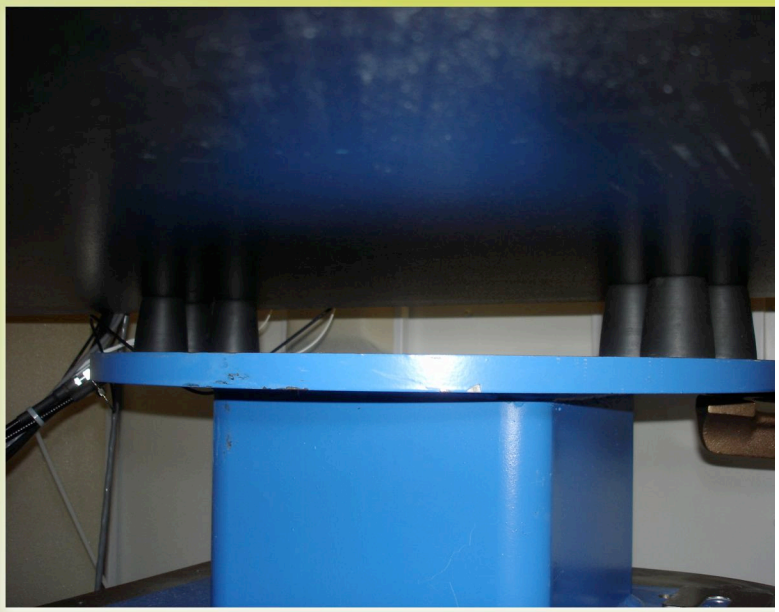
Extra 2 Mpc of range!

Probably due to dissipation of static charge.



Isolation of Livingston Dark-Port Table



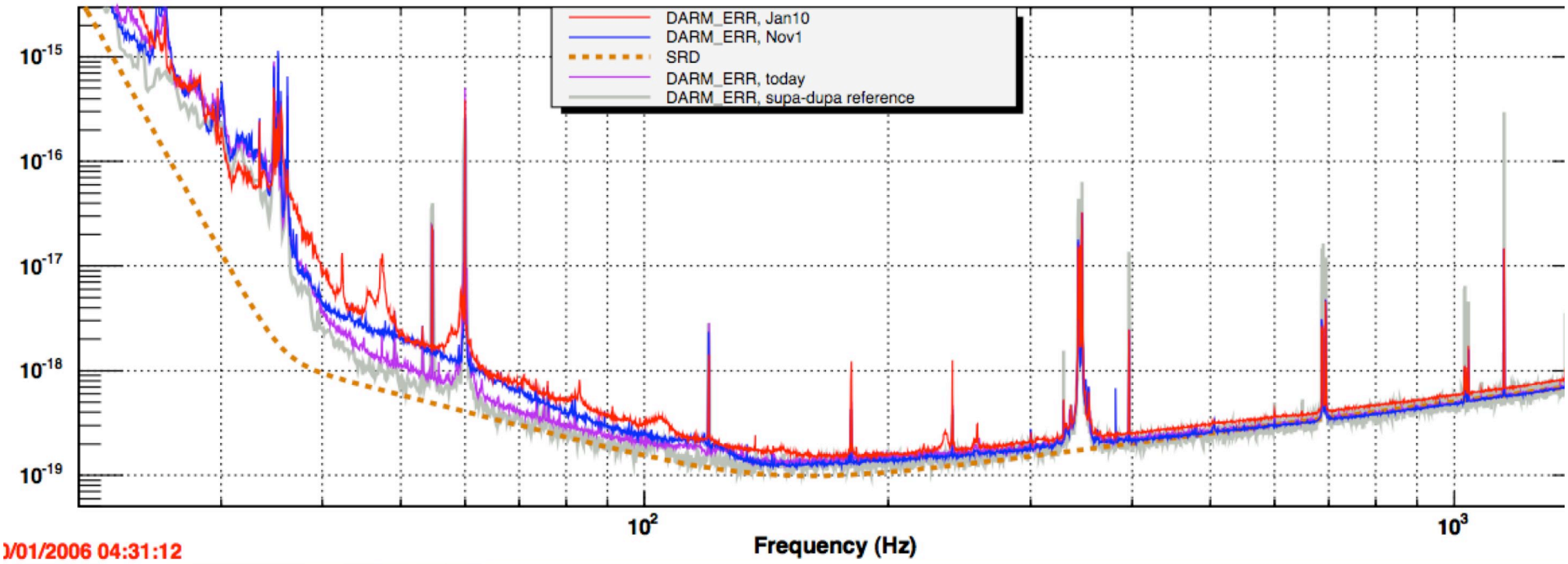


Floated on Viton stoppers.

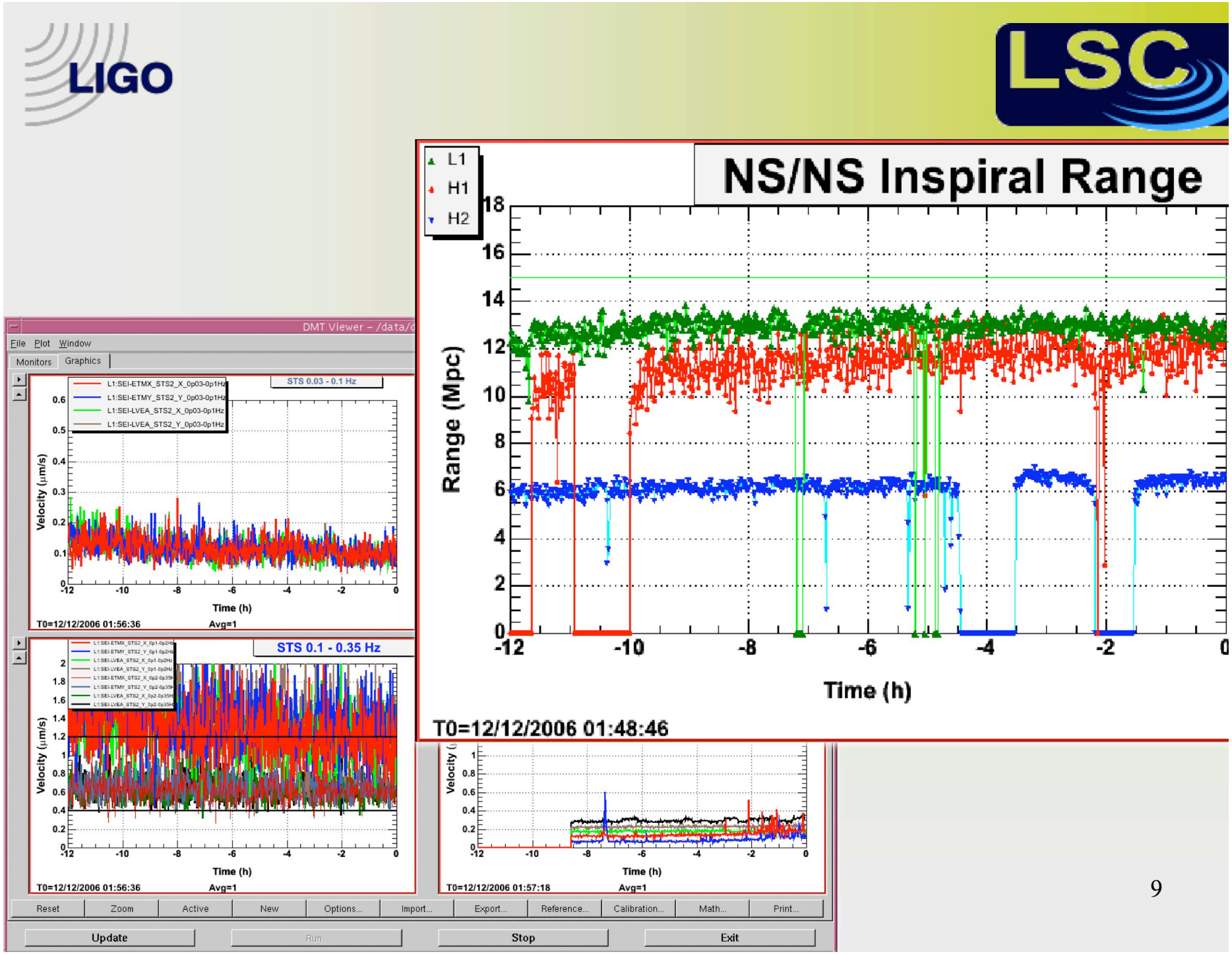
Increased bandwidth on angular control sub-system

➔ More stability

More Tidal Gain

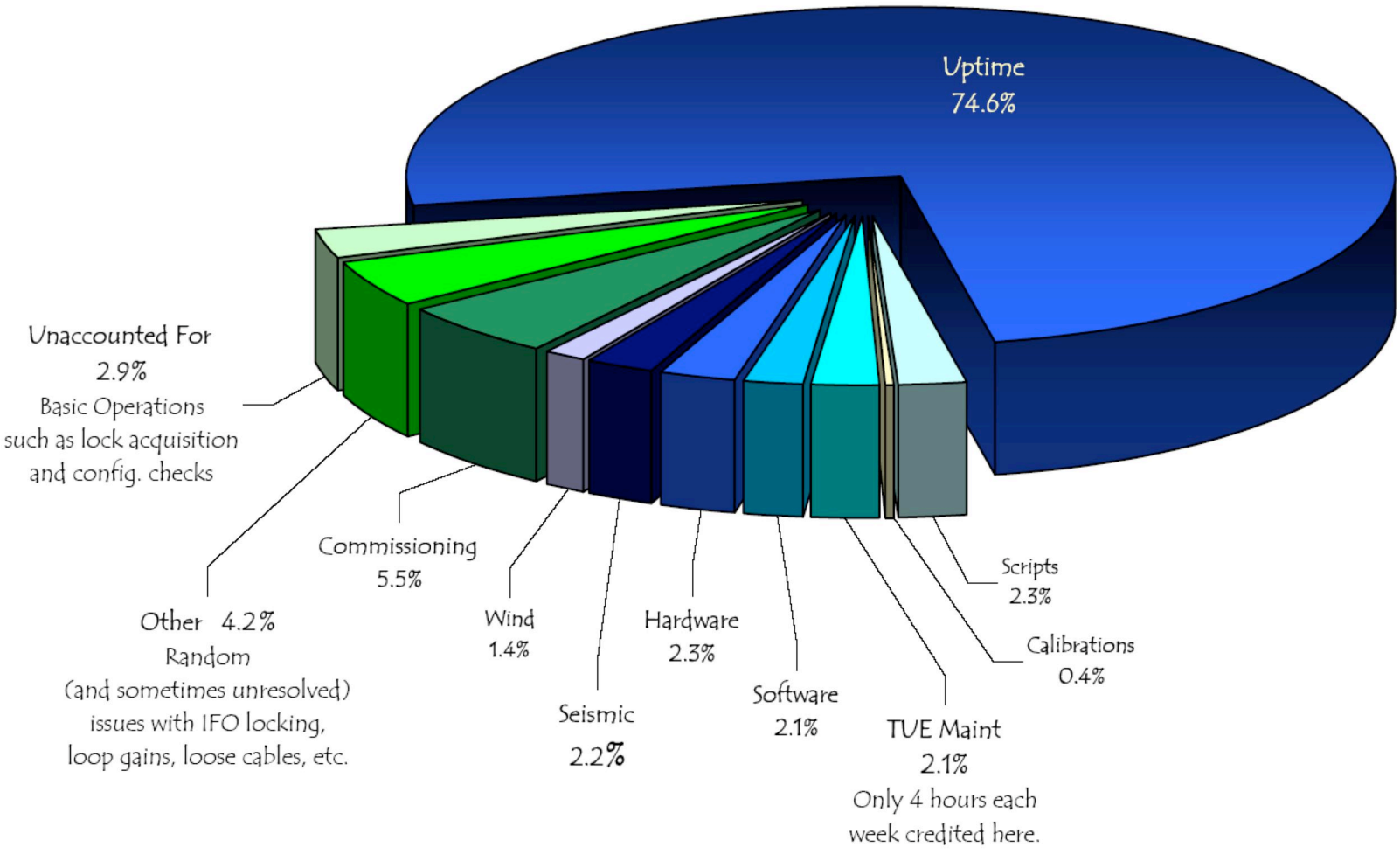


- Optic motion at low frequencies is offloaded to the Hydraulic External Pre-Isolation system.
- Better job of filtering, (stack inversion) ➔ more loop gain.
- Improved suppression of microseism leads to improved range.
- Preliminary indications are that duty factor also improves.

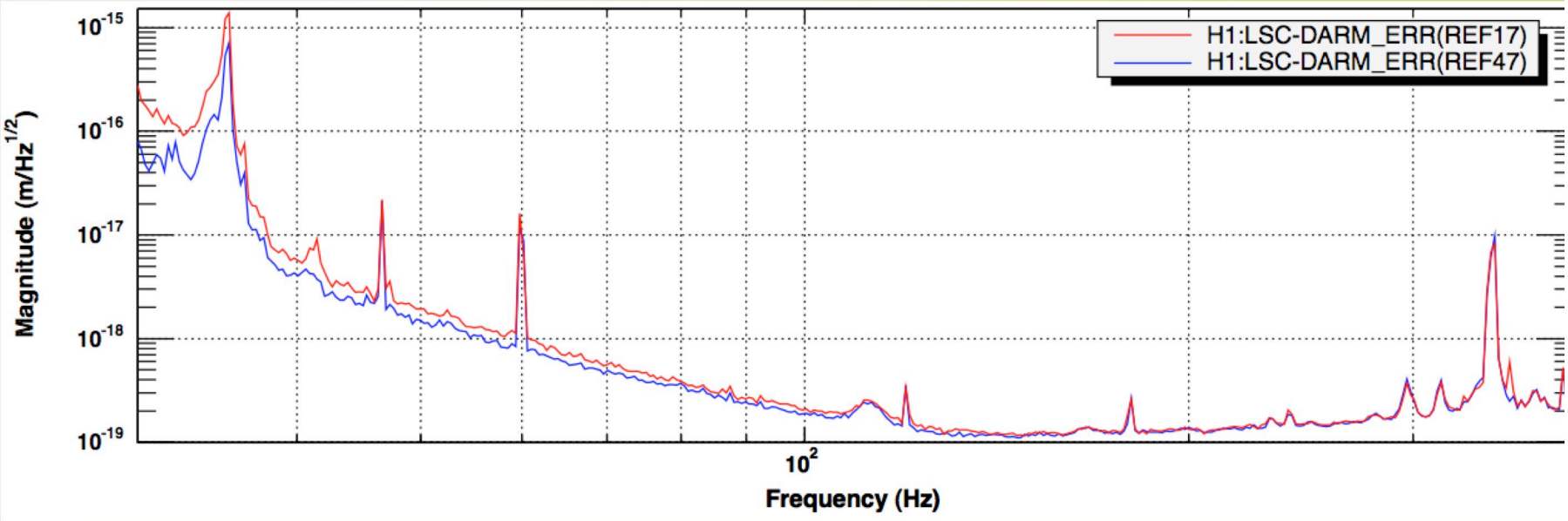

LIGO
LSC
NS/NS Inspiral Range
L1
H1
H2
Range (Mpc)
Time (h)
T0=12/12/2006 01:48:46
DMT Viewer – /data/c
File Plot Window
Monitors Graphics
STS 0.03 - 0.1 Hz
L1:SEI-ETMX_STS2_X_0p03-0p1Hz
L1:SEI-ETMY_STS2_Y_0p03-0p1Hz
L1:SEI-LVEA_STS2_X_0p03-0p1Hz
L1:SEI-LVEA_STS2_Y_0p03-0p1Hz
Velocity (μm/s)
Time (h)
T0=12/12/2006 01:56:36
Avg=1
STS 0.1 - 0.35 Hz
T0=12/12/2006 01:57:18
Reset
Zoom
Active
New
Options...
Import...
Export...
Reference...
Calibration...
Math...
Print...
Update
Run
Stop
Exit

S5 Hanford 4km Uptime

Data taken from elog and conlog and covers H1-35-2388, includes 3 commisioning periods.
Covers Nov 14, 2005 thru Oct 28, 06



Hanford Facility Noise

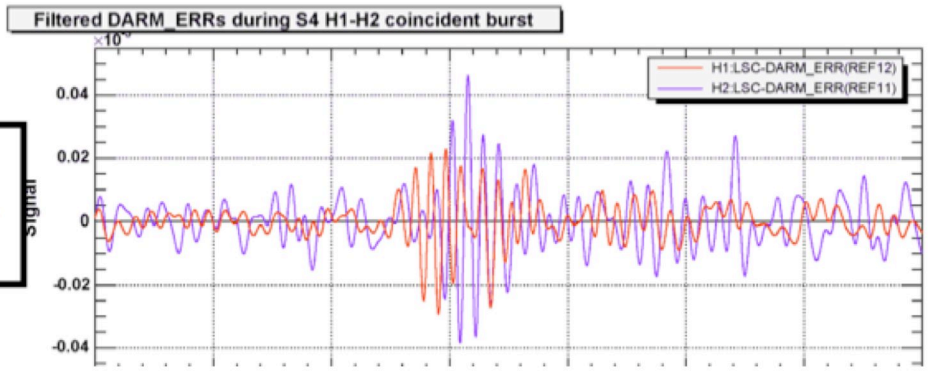


- Dramatic improvement in noise seen from turning off facility equipment.
- Changed HVAC flow rates at LHO to half previous values.
- Culprit believed to be turbulent air flow in ducts.

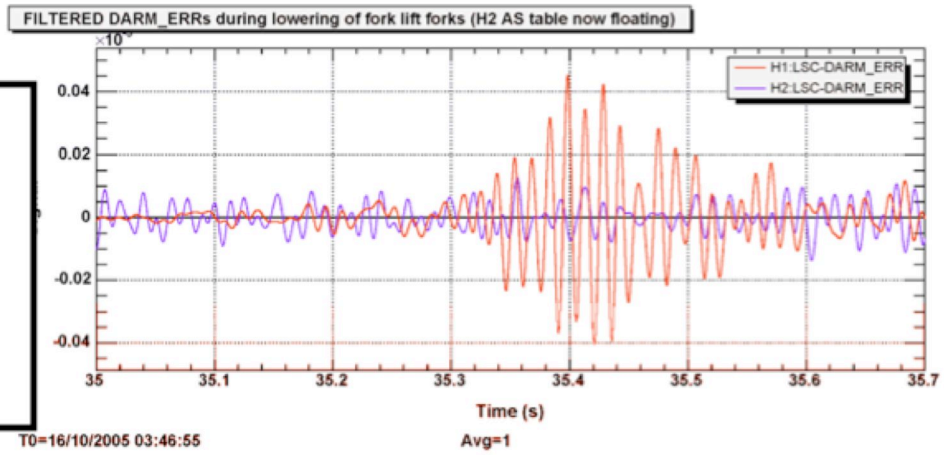
Coherence Between Hanford Detectors

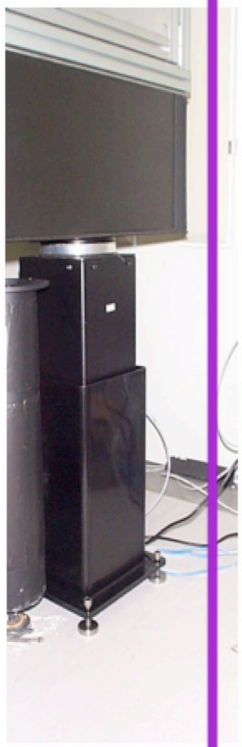
"Floating" H2 dark port should reduce H1-H2 coincidences

H1 DARM, H2 DARM during S4 event

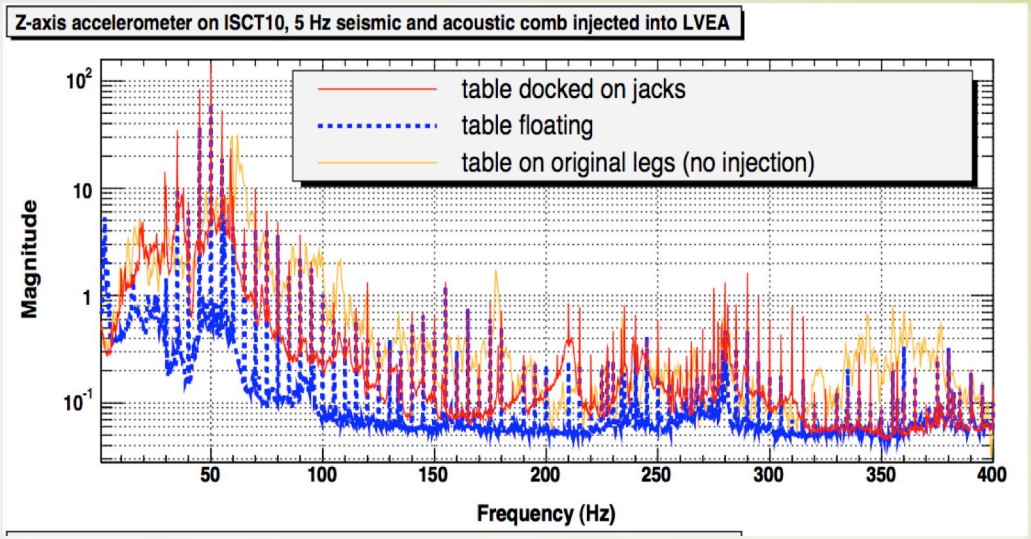


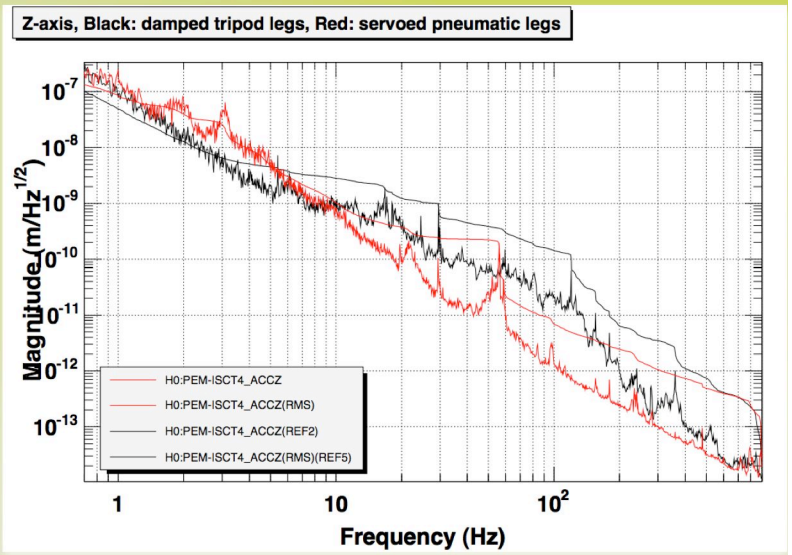
H1 DARM, H2 DARM during forklift event: with floating H2 dark port, very little signal is seen on H2





Isolation of Hanford Dark-Port Tables

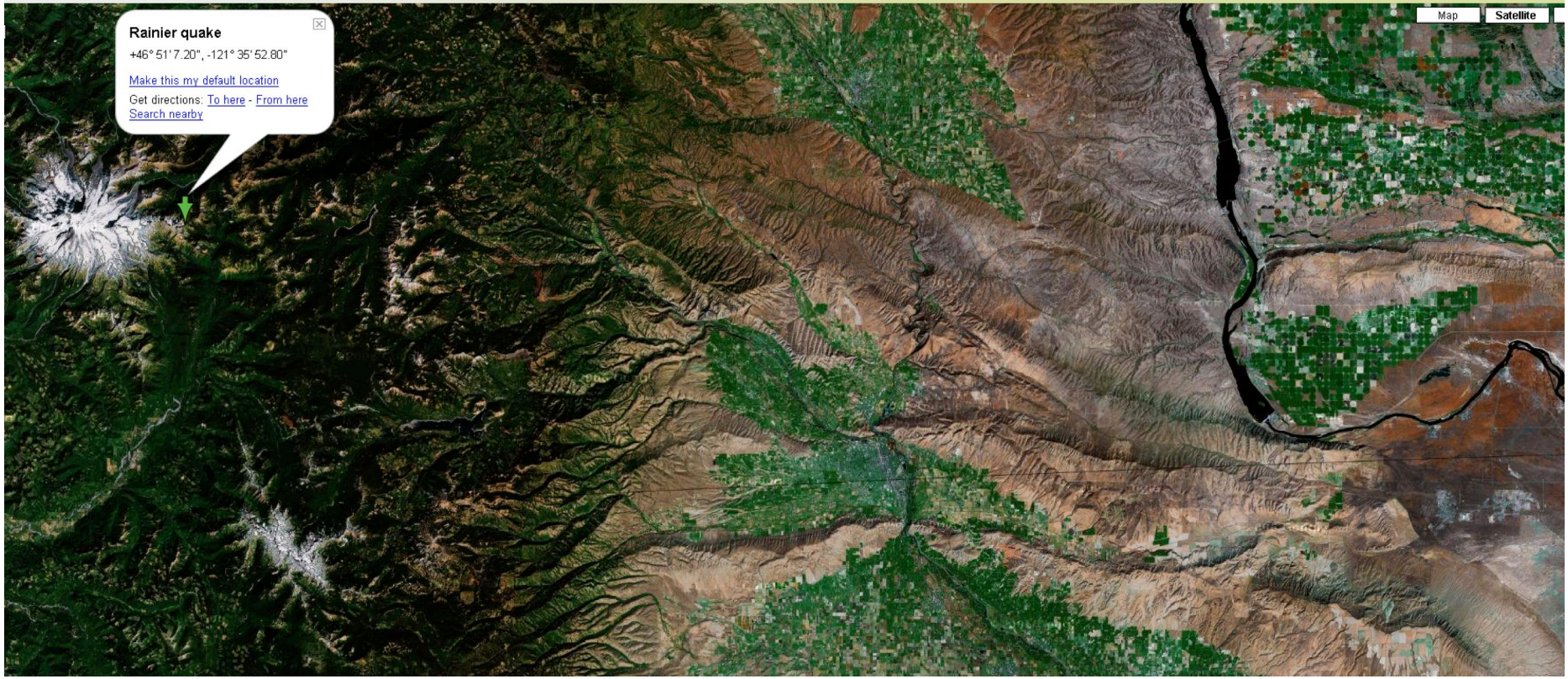




- Tables floated using servoed pneumatic legs.
- 2km was floated before S5, 4km was floated recently, but had been on damped tripod legs.
- Isolation reduces coherence between 2km detector and 4km detector arising from environmental effects.

Problems at Hanford

- Magnitude 4.5, E of Mt Rainier, WA
- Saturday October 7, 2006 at 07:48:26.57 PM (PDT)
- Depth : 4km



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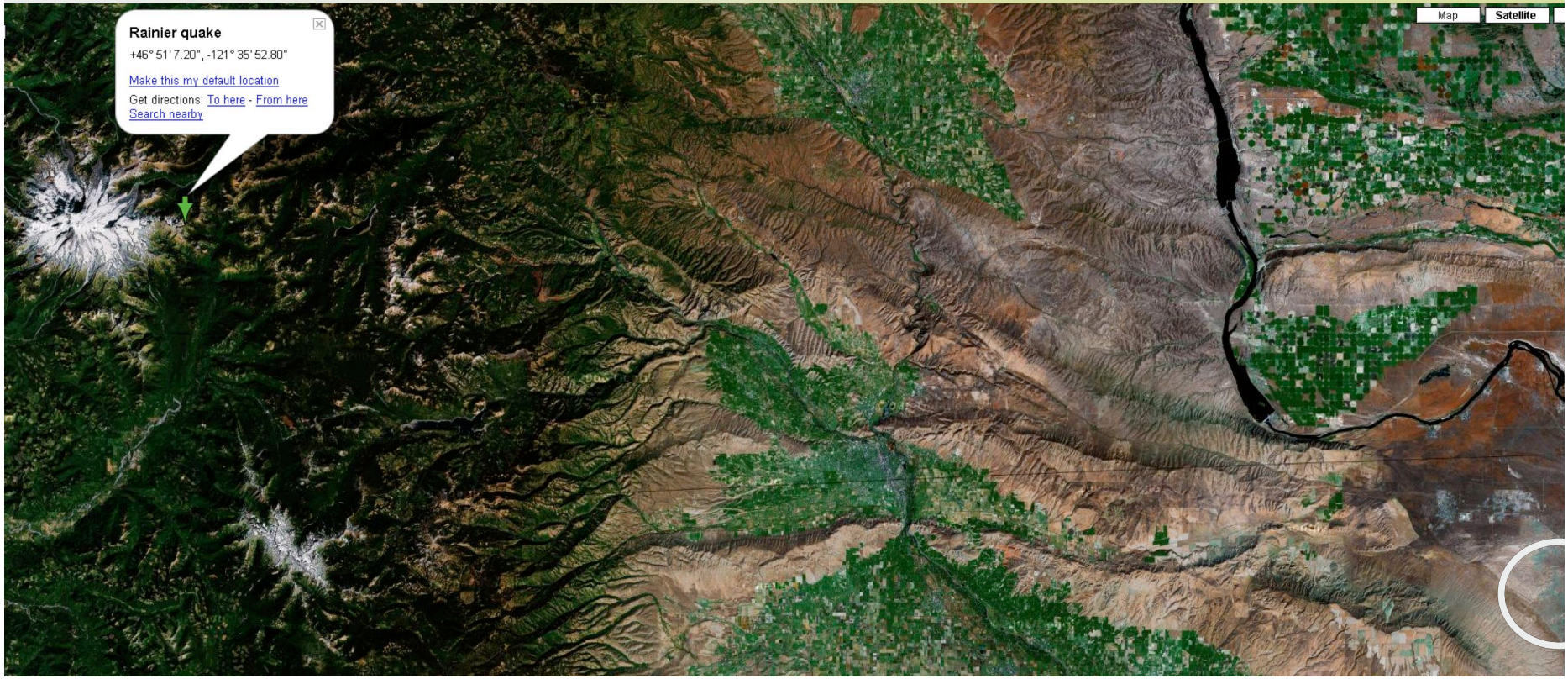

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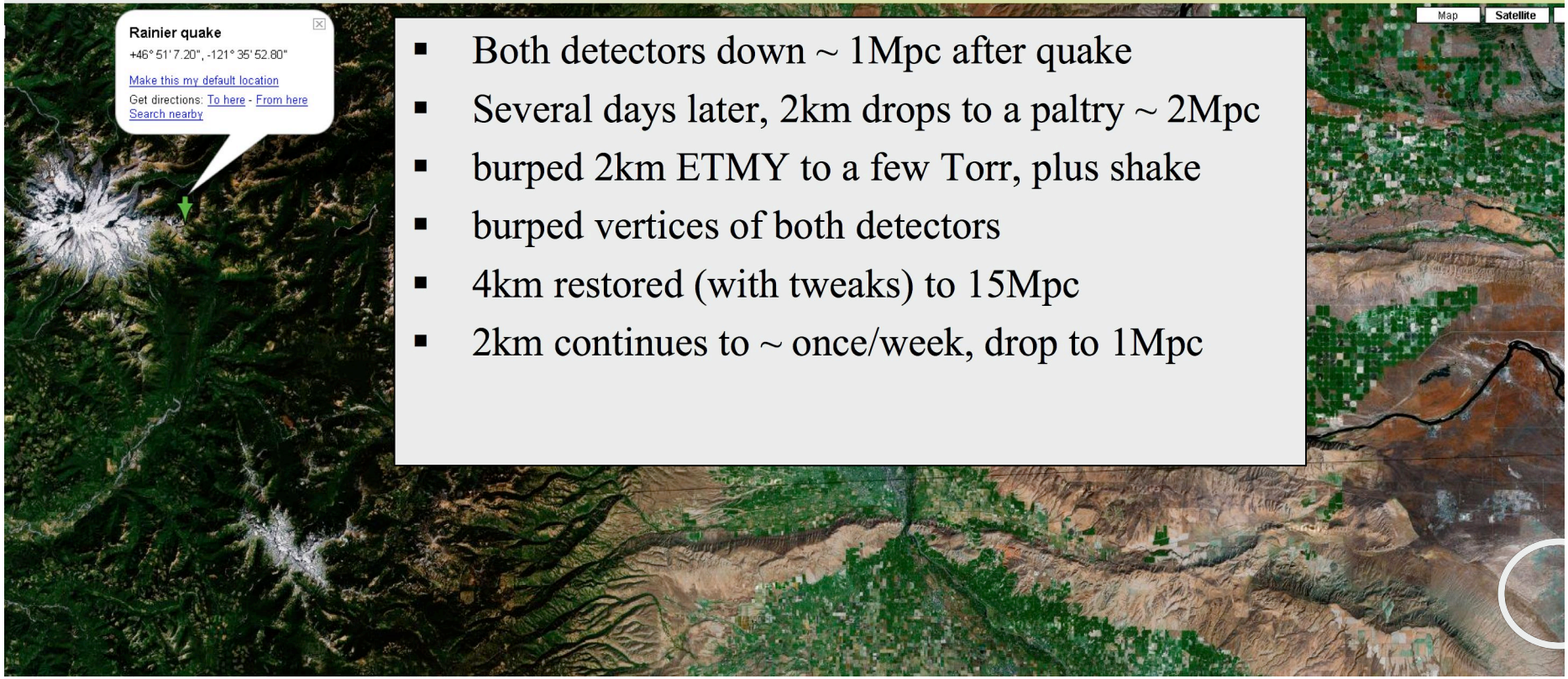
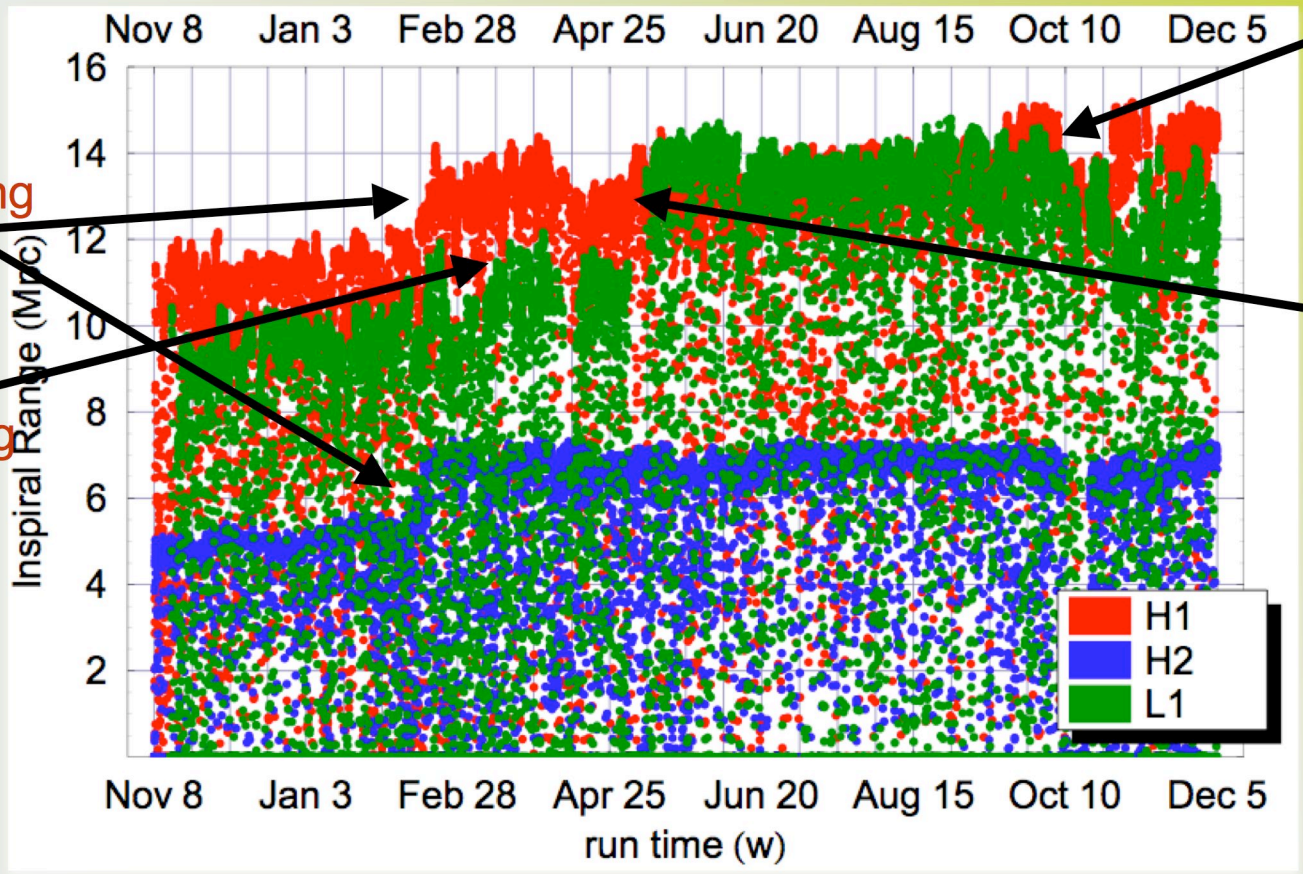


- Both detectors down ~ 1Mpc after quake
- Several days later, 2km drops to a paltry ~ 2Mpc
- burped 2km ETMY to a few Torr, plus shake
- burped vertices of both detectors
- 4km restored (with tweaks) to 15Mpc
- 2km continues to ~ once/week, drop to 1Mpc

Sensitivity



LHO Commissioning

LLO Commissioning

Mt. Rainier Quake

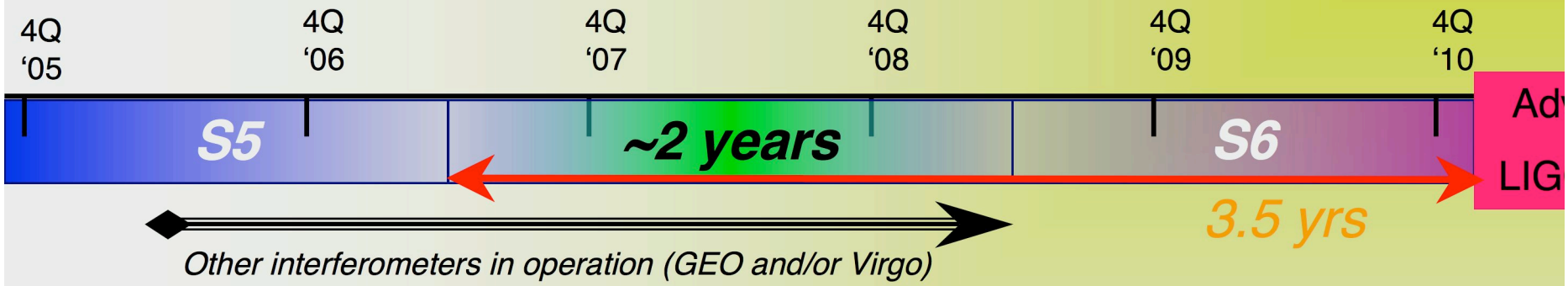
LLO Vent

More information on detector noise performance in talks by Cadonati, Katsavounidis, Sung and Mukherjee in the detector characterization session

Commissioning

- Other Improvements:
  - New Pre-Mode Cleaners installed on both 4km detectors
    - ➔ more power.
  - Thermal Compensation System tuning for higher power.
  - More bandwidth on angular controls.
  - Improved OSEM filters on H1
  - New Optical Lever Lasers
  - Stabilization of the reflected beam.
- Future Plans/Studies:
  - Feed-forward system at Hanford to mitigate seismic and wind noise.
  - Up-conversion studies will continue.
  - ~25 hours/month continues to be devoted to interferometer studies.

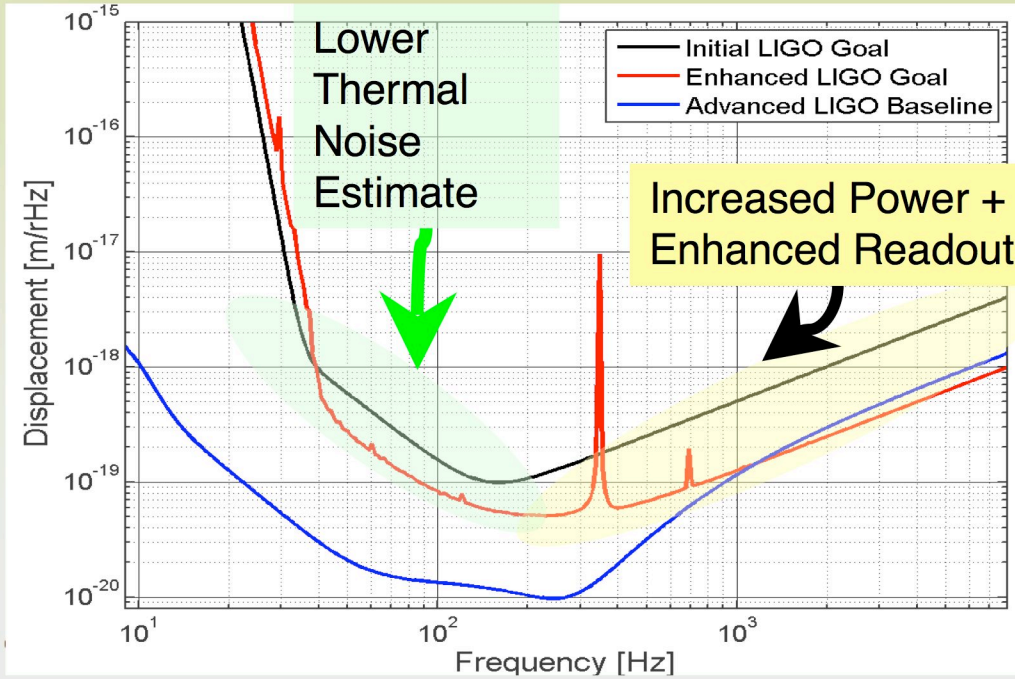
Enhanced LIGO for S6



Motivation:

Factor of ~2 in noise improvement above 100 Hz
Factor ~6.5 in inspiral binary neutron star event rate

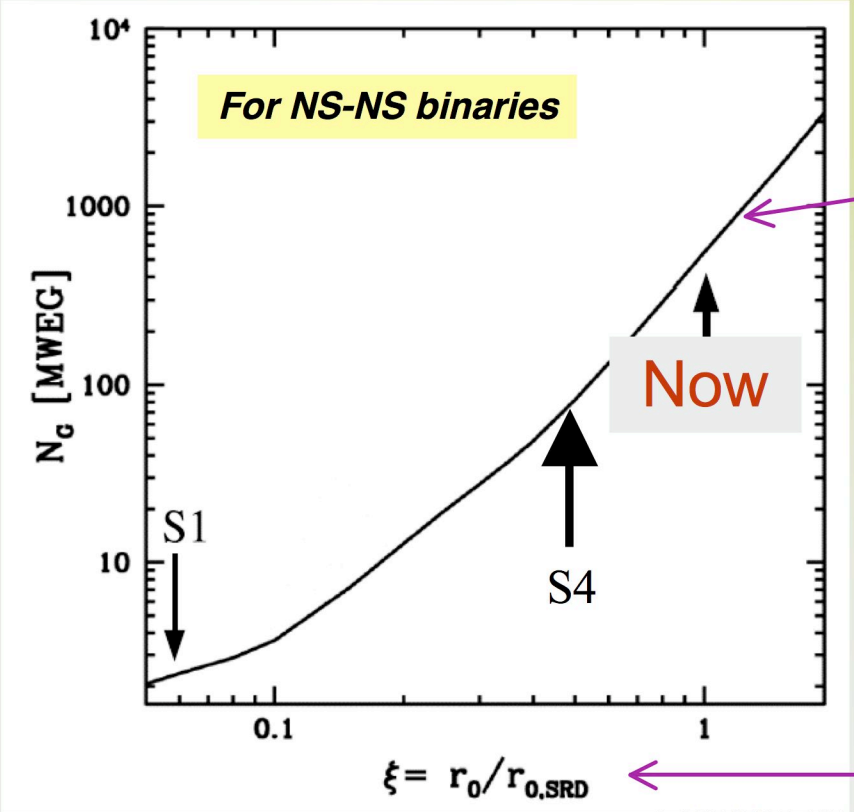
Debug new Advanced LIGO technology in actual low noise interferometers
Reduce the Advanced LIGO commissioning time



Astrophysics

How does the number of surveyed galaxies increase as the sensitivity is improved?

From astro-ph/0402091, Nutzman et al.



Power law: 2.7

Factor of 2 reduction in strain noise,

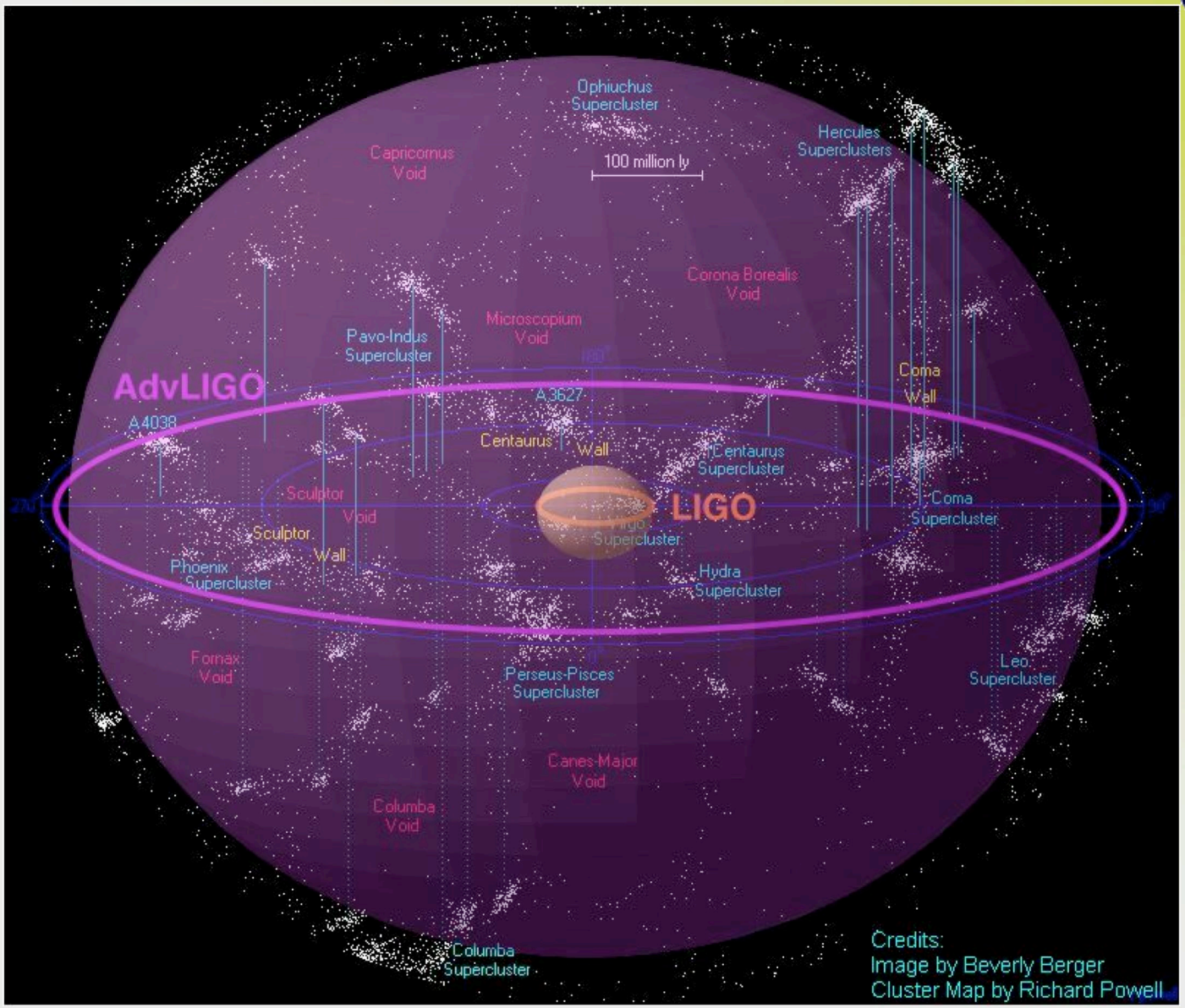
⇨factor of 6.5 increase in MWEG

Prop. to inspiral range

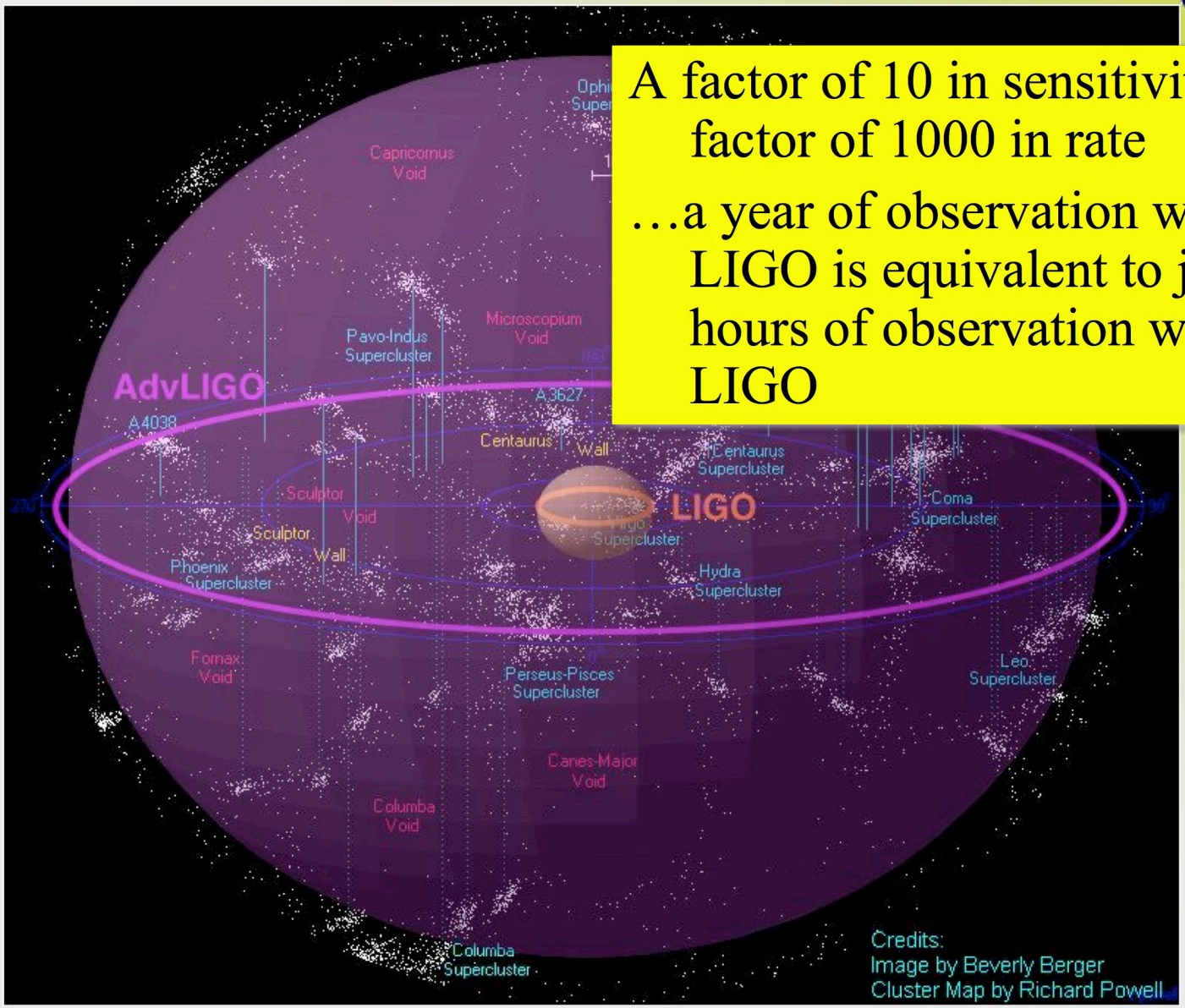
Advanced LIGO

- Advanced LIGO R&D well advanced, heading toward Final Design phases for each subsystem
- Initial LIGO S5 run to reach goal of one year of integrated data in Fall 2007
- Advanced LIGO funding at start of FY2008; fabrication, assembly, and stand-alone testing of detector components
- Advanced LIGO R&D ramps down end FY2008
- Initial LIGO Enhancements to be installed, commissioned progressively at Livingston, Hanford
- Science runs with Enhancements starting in early 2009, running to early 2011
- Advanced LIGO starts decommissioning initial LIGO instruments in early 2011, installing new detector components from stockpile
- First Advanced LIGO interferometer accepted in early 2013, second and third in mid-2014. Project completes!
- Commissioning of instruments, engineering runs starting in 2014

Advanced LIGO



Advanced LIGO



A factor of 10 in sensitivity, thus a factor of 1000 in rate

…a year of observation with initial LIGO is equivalent to just several hours of observation with Advanced LIGO

LIGO at Design