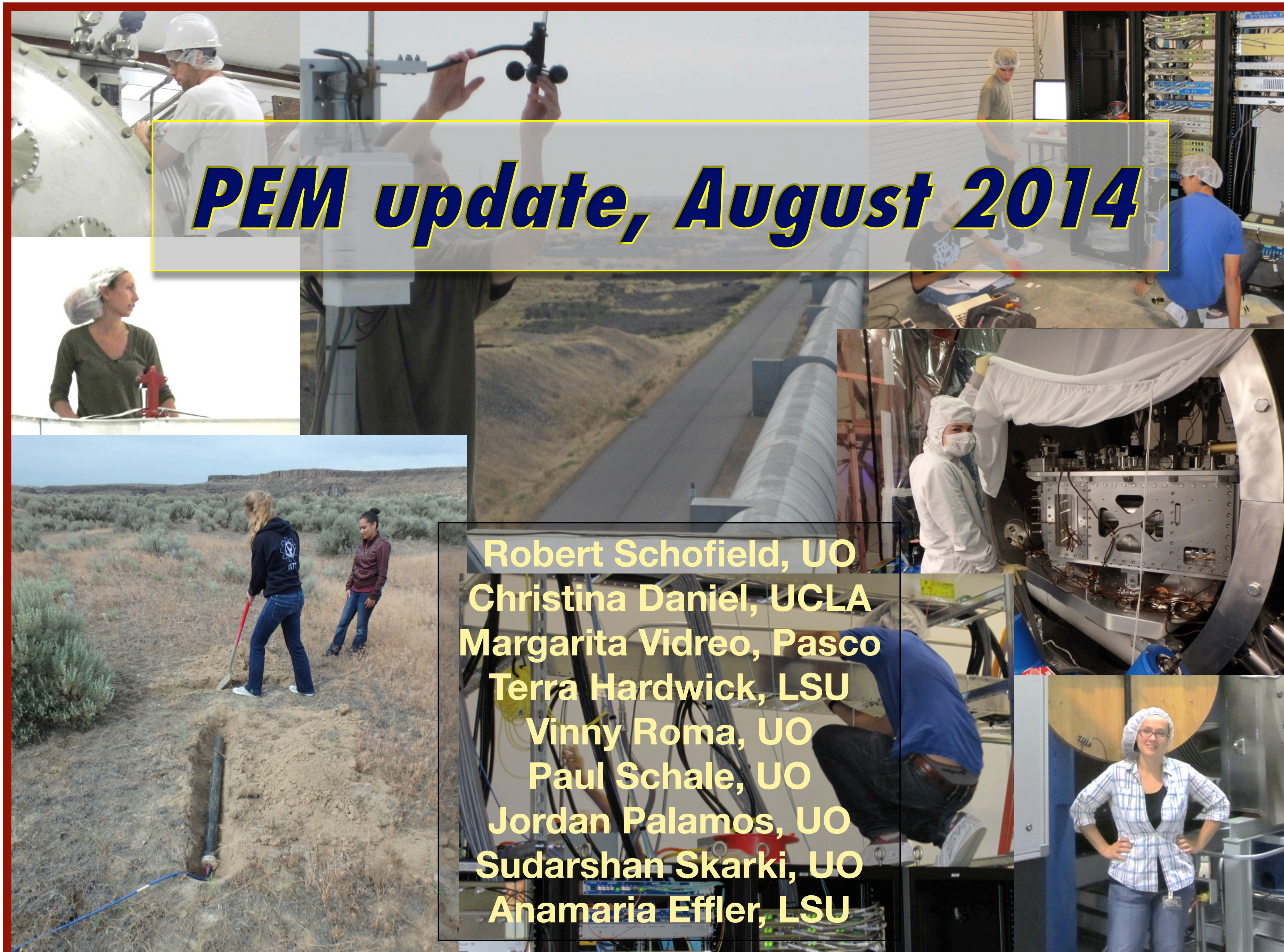
PEM update, August 2014



Robert Schofield, UO
Christina Daniel, UCLA
Margarita Vidreo, Pasco
Terra Hardwick, LSU
Vinny Roma, UO
Paul Schale, UO
Jordan Palamos, UO
Sudarshan Skarki, UO
Anamaria Effler, LSU

Installation at LHO

1) About 90% of accelerometers and microphones are installed calibrated and working, with grid positions measured, mics on temporary power supplies.

2) Magnetometers are in place, most filter boxes modified, should be calibrated and working by end of September.

3) Mains monitors, radio receivers, about half installed

4) Cross talk measured for shared chassis.

Installation at LLO

1) Most accelerometers are now working, some were missing and are being ordered.

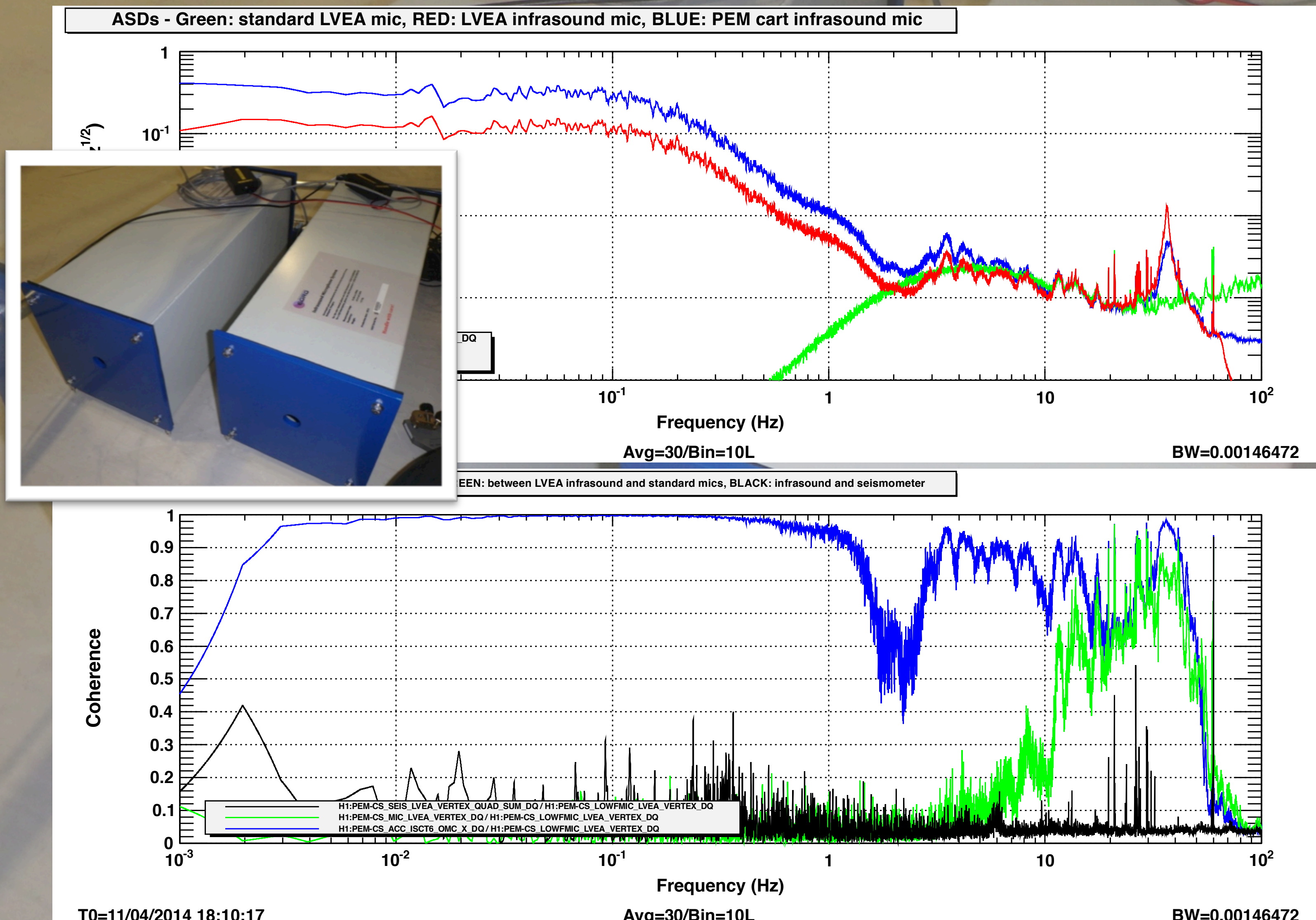
2) Magnetometers are in place but no filter boxes yet and some cable pulling remains.

3) Mics are almost done, David K.'s new power scheme will eliminate the need for temporary power.

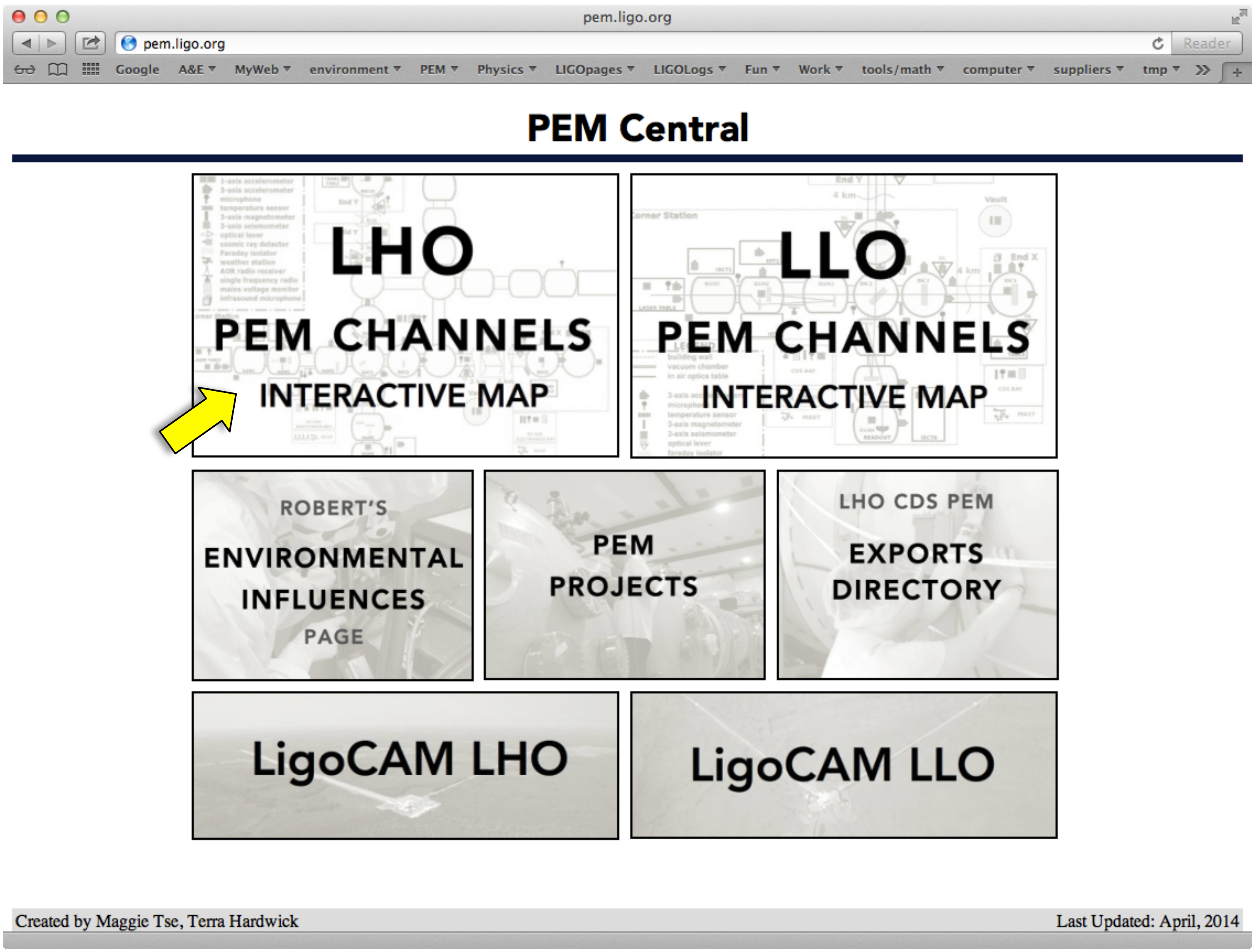
4) Reboot to make channel names uniform will happen before Sept.

Installation of Eotvos group infrasound mic

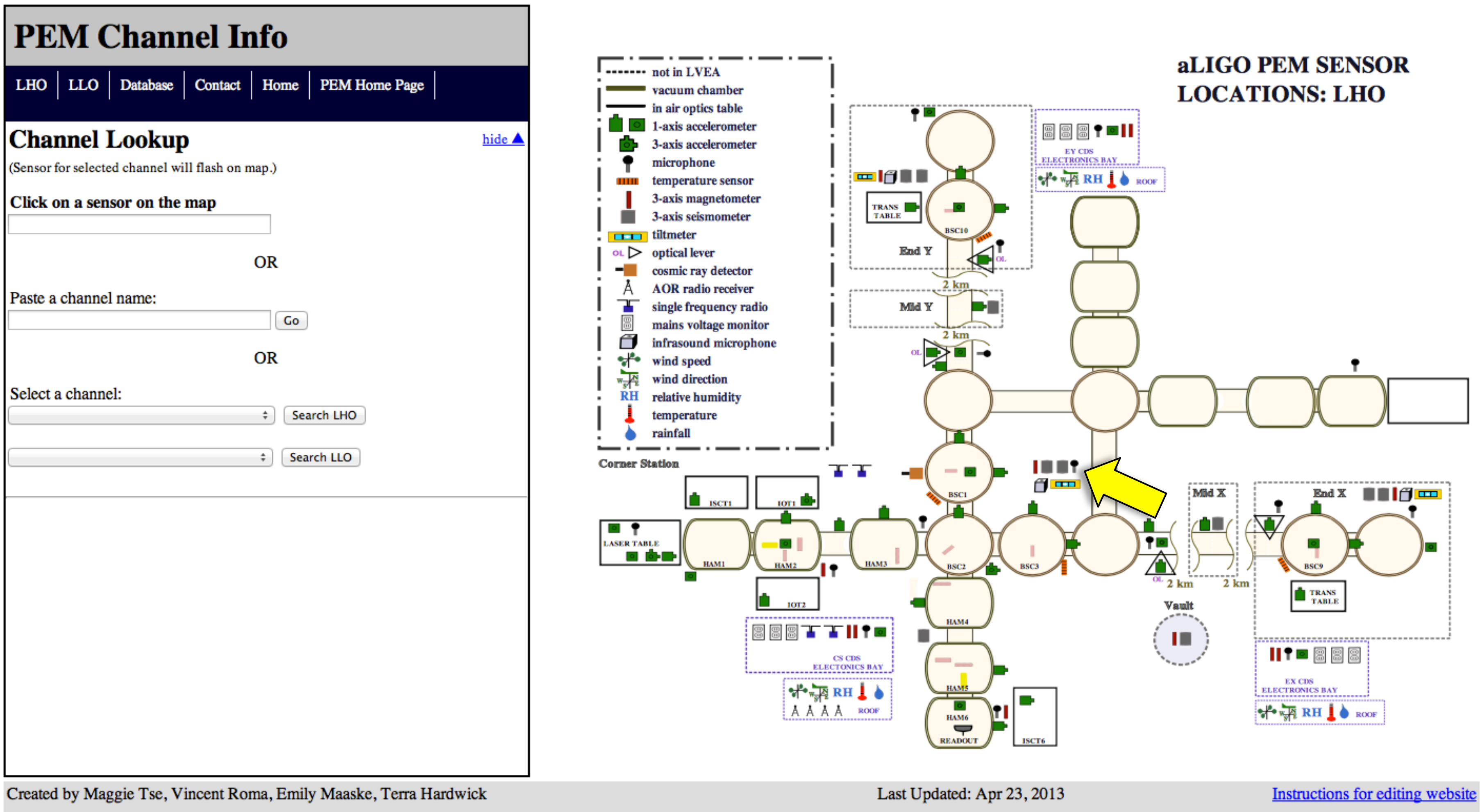
Gabor Szeifert, Péter Bojtos, Zsolt Frei



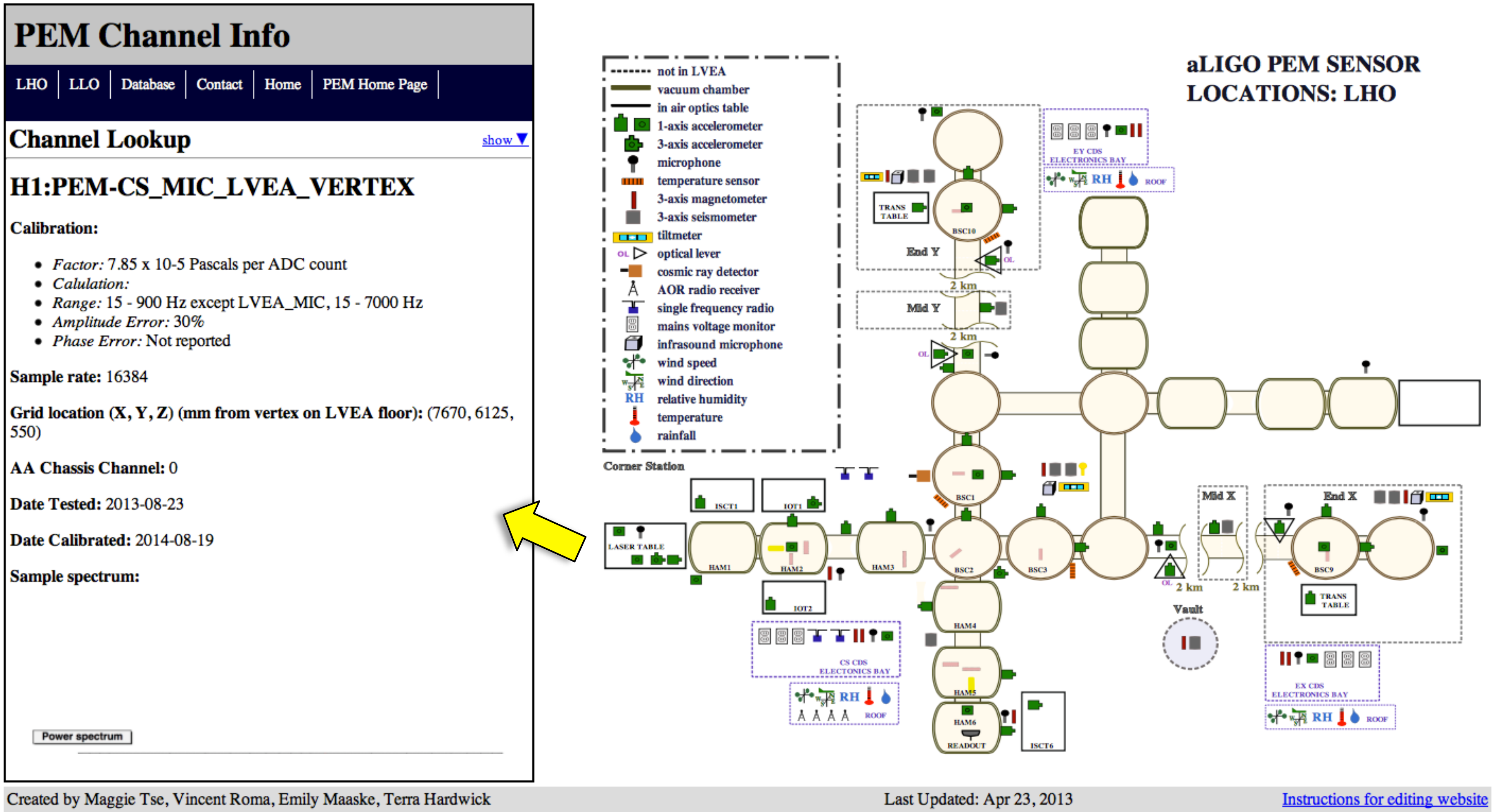
New PEM.LIGO.ORG features



New PEM.LIGO.ORG features



New PEM.LIGO.ORG features



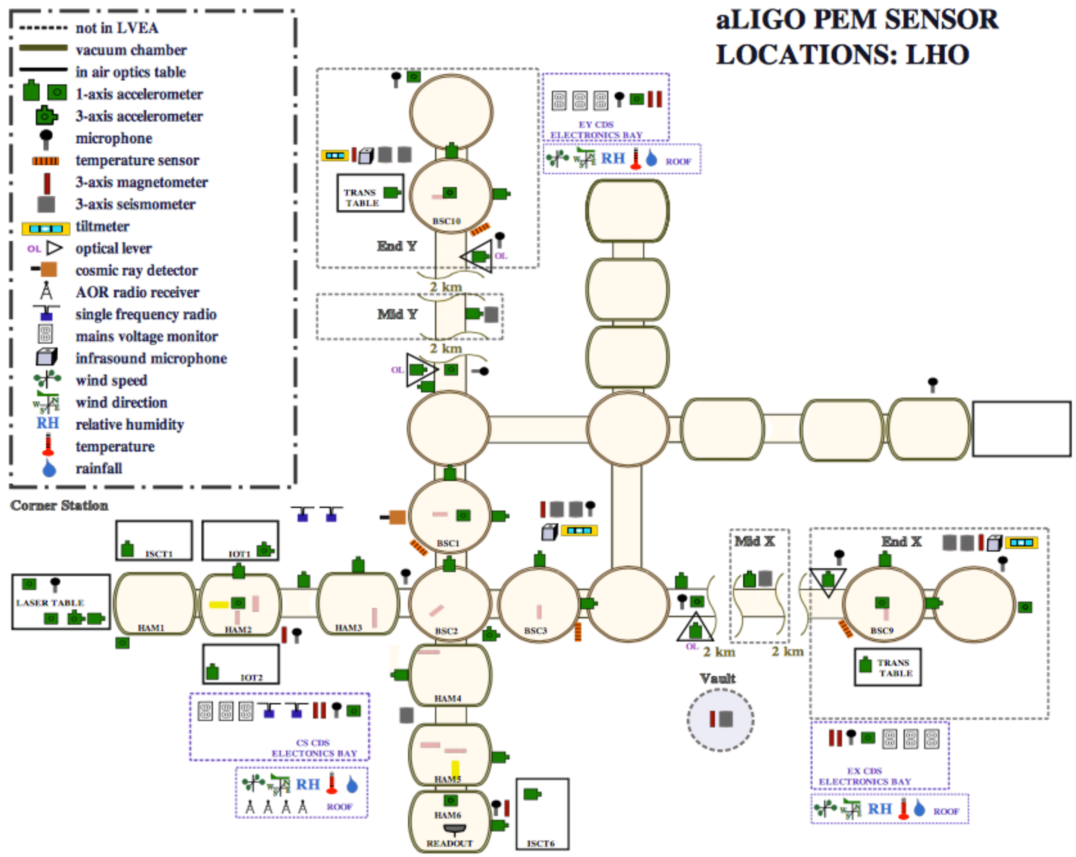
New PEM.LIGO.ORG features

PEM Channel Info

LHO | LLO | Database | Contact | Home | PEM Home Page

Channel Lookup

show ▼

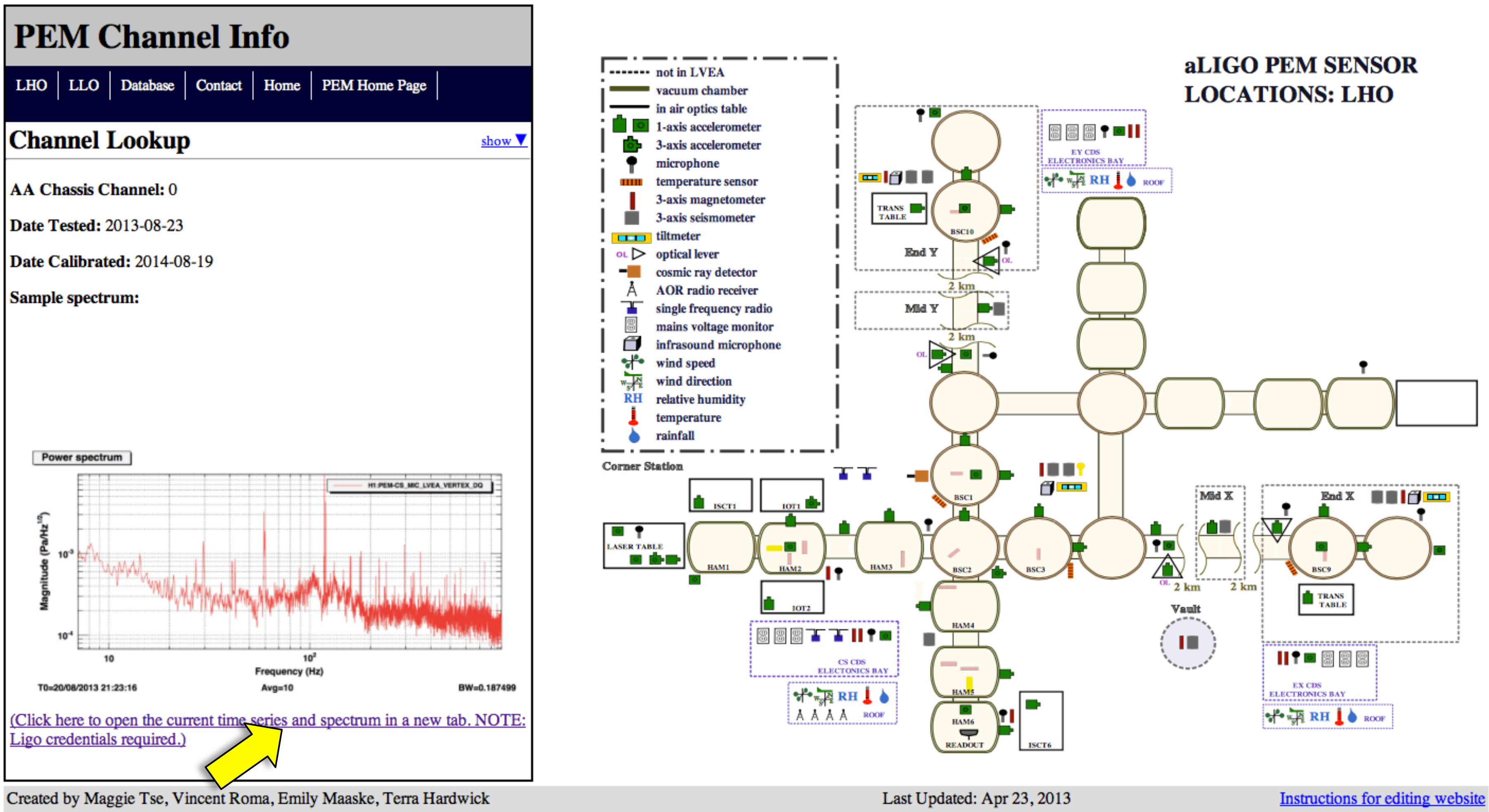


Created by Maggie Tse, Vincent Roma, Emily Maaske, Terra Hardwick

Last Updated: Apr 23, 2013

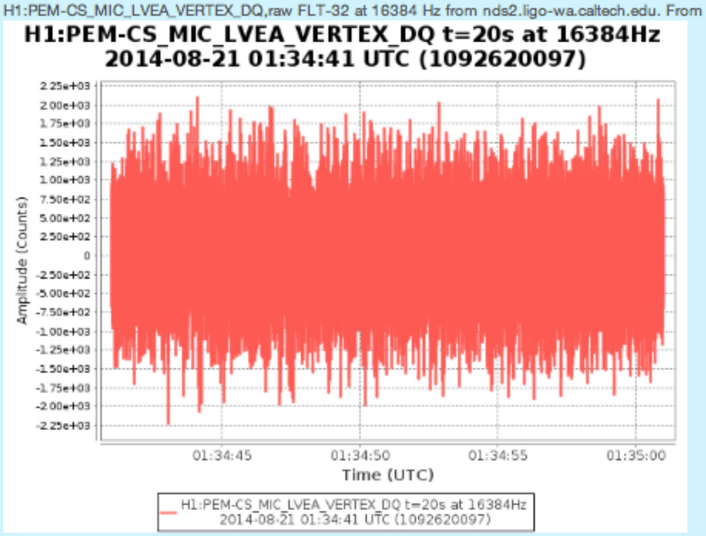
Instructions for editing website

New PEM.LIGO.ORG features



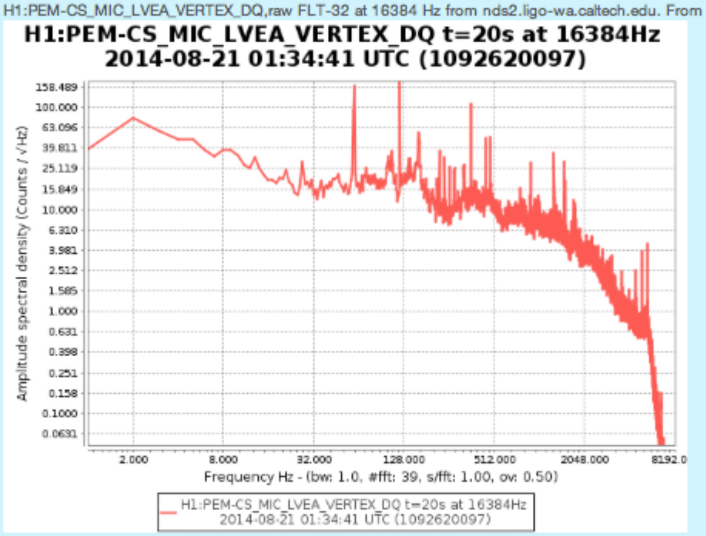
New PEM.LIGO.ORG features

H1:PEM-CS_MIC_LVEA_VERTEX_DQ,raw FLT-32 at 16384 Hz from nds2.ligo-wa.caltech.edu. From 2014-08-21 01:34:41 (1092620097) to 2014-08-21 01:35:01 (1092620117) duration 20s.

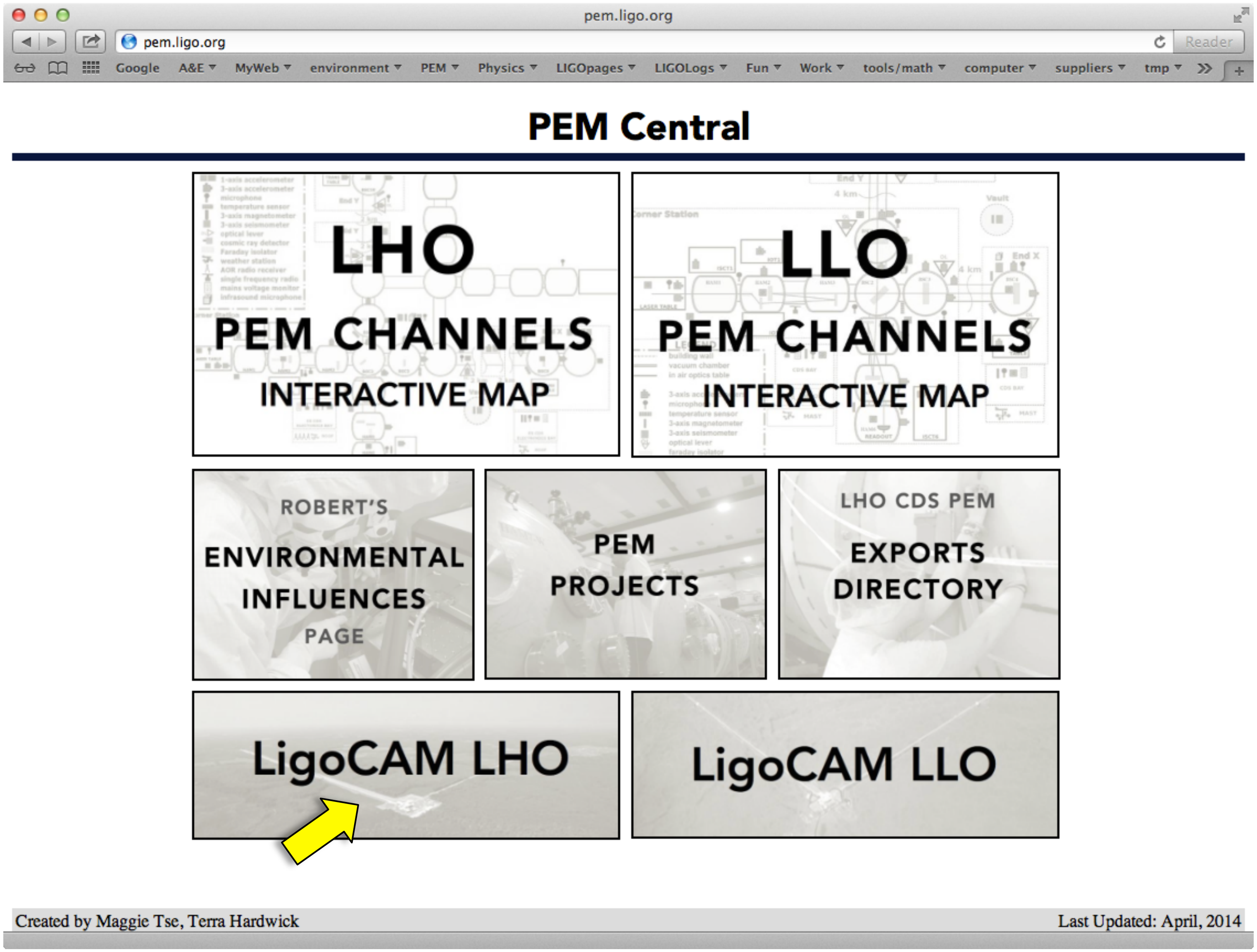


Spectrum

H1:PEM-CS_MIC_LVEA_VERTEX_DQ,raw FLT-32 at 16384 Hz from nds2.ligo-wa.caltech.edu. From 2014-08-21 01:34:41 (1092620097) to 2014-08-21 01:35:01 (1092620117) duration 20s.



LIGOCAM


pem.ligo.org
pem.ligo.org
Reader
Google A&E MyWeb environment PEM Physics LIGOpages LIGOLogs Fun Work tools/math computer suppliers tmp
PEM Central
LHO
PEM CHANNELS
INTERACTIVE MAP
LLO
PEM CHANNELS
INTERACTIVE MAP
ROBERT'S
ENVIRONMENTAL
INFLUENCES
PAGE
PEM
PROJECTS
LHO CDS PEM
EXPORTS
DIRECTORY
LigoCAM LHO
LigoCAM LLO
Created by Maggie Tse, Terra Hardwick
Last Updated: April, 2014

LIGOCAM

LigoCAM

Epoch: Aug 21 2014 02:15:03-02:31:43 UTC

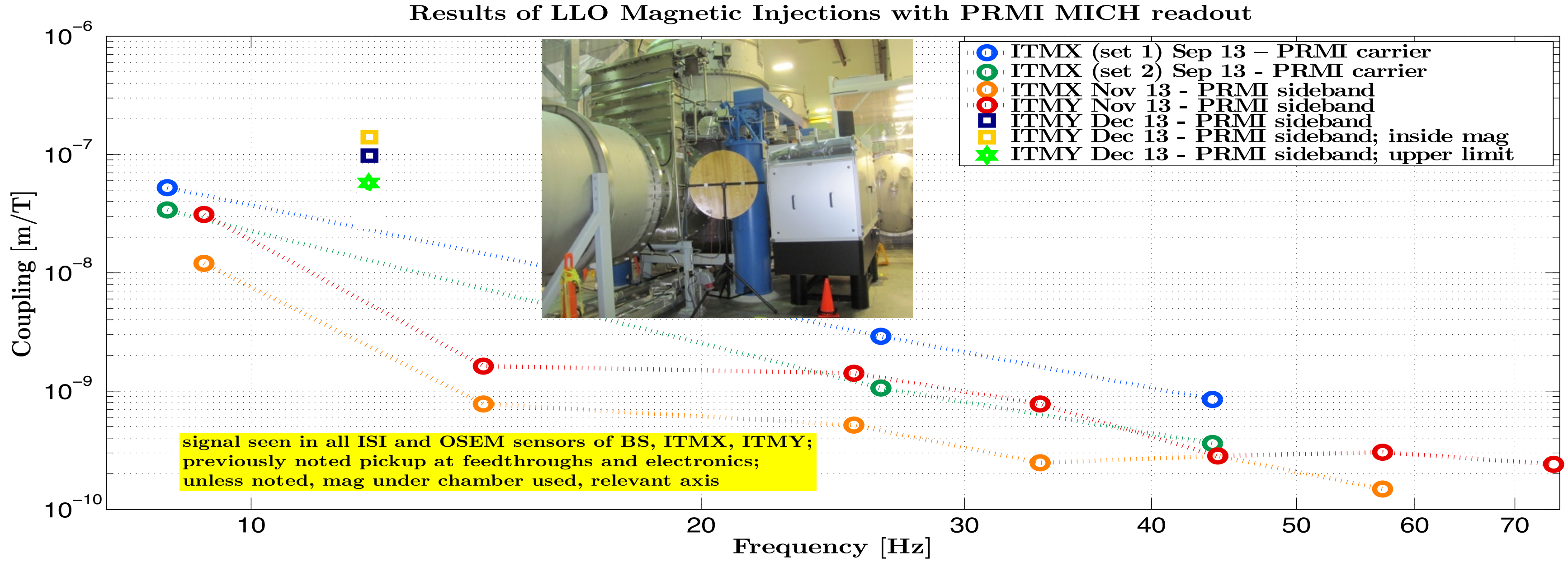
BLRMS col. = ASD_tot_cur / ASD_tot_ref; alert if > 1000 or <1/500 for 0.03-1Hz and > 50 or < 1/5 for > 1Hz; disconnect if <= 0.2 counts and DAQ failure if <= 1e-8 counts/sqrt(Hz) for 10-100Hz (exception: no alert for ACC and MIC below 10Hz and SEIS above 30Hz; SEIS disconnect and DAQ failure defined for 3-30Hz.)

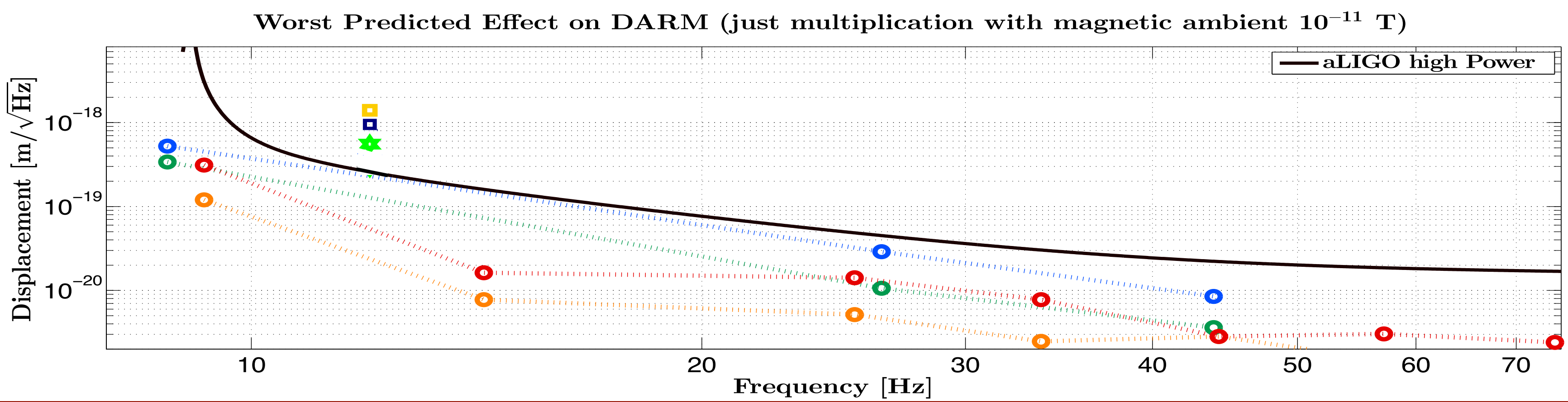
Channel name	Channel info	Image	Status	Disconnected?	DAQ failure?	BLRMS	0.03-0.1	0.1-0.3	0.3-1	1-3	3-10	10-30	30-100	100-300	300-1000	1000-3000	3000-10000
H1:PEM-CS_ACC_BEAMTUBE_XMAN_Y_DQ	link	ASD, TS	Alert	No	No	Yes	0.0151	0.0156	0.00748	0.0158	0.162	0.196	0.14	0.419	1.18	1.16	1.26
H1:PEM-CS_ACC_BSC1_ITMY_Y_DQ	link	ASD, TS	Alert	No	No	Yes	0.0247	0.0219	0.0113	0.00524	0.00237	0.0373	0.024	0.192	0.0737	0.4	0.358
H1:PEM-CS_ACC_BSC1_ITMY_Z_DQ	link	ASD, TS	Alert	No	No	Yes	0.0546	0.0542	0.0431	0.0448	0.033	0.0768	0.113	0.183	0.261	0.543	0.0964
H1:PEM-CS_ACC_BSC3_ITMX_Y_DQ	link	ASD, TS	Alert	No	No	Yes	0.00145	0.00045	0.000183	0.000321	0.000715	0.0269	0.0546	0.838	1.42	4.22	3.34
H1:PEM-CS_ACC_EBAY_FLOOR_Z_DQ	link	ASD, TS	Alert	No	No	Yes	0.000896	0.00313	0.00337	0.00556	0.0322	0.582	0.092	0.231	0.153	0.257	0.339
H1:PEM-CS_ACC_HAM5_SR1_X_DQ	link	ASD, TS	Alert	No	No	Yes	37	24.8	22.4	23.2	4.87	0.11	0.0829	0.0163	0.00875	0.00695	0.0113
H1:PEM-CS_ACC_IOT1_MC_X_DQ	link	ASD, TS	Alert	No	No	Yes	0.000288	0.000536	0.00043	0.000899	0.024	0.056	0.222	0.602	0.107	0.145	0.0473
H1:PEM-CS_ACC_IOT1_MC_Y_DQ	link	ASD, TS	Alert	No	No	Yes	0.00445	0.0117	0.0109	0.0101	0.0975	0.754	1.11	0.782	0.204	0.182	0.0771
H1:PEM-CS_ACC_IOT1_MC_Z_DQ	link	ASD, TS	Alert	No	No	Yes	0.00126	0.00215	0.00287	0.0028	0.0189	0.758	1.33	0.884	0.244	0.0851	0.0539
H1:PEM-CS_ACC_IOT2_INPUTOPTICS_Y_DQ	link	ASD, TS	Alert	No	No	Yes	0.000381	0.000752	0.00231	0.00939	0.0234	0.00648	0.504	0.591	0.29	0.286	0.0878
H1:PEM-CS_ACC_ISCT6_OMC_X_DQ	link	ASD, TS	Alert	No	No	Yes	0.000363	0.000518	0.00123	0.00551	0.0132	0.00358	0.073	0.115	0.103	0.126	0.084
H1:PEM-CS_ACC_LVEAFLOOR_BS_X_DQ	link	ASD, TS	Alert	No	No	Yes	0.308	0.292	0.191	0.0972	0.0463	0.00742	0.0154	0.0281	0.14	0.675	0.377
H1:PEM-CS_ACC_LVEAFLOOR_BS_Y_DQ	link	ASD, TS	Alert	No	No	Yes	0.063	0.0505	0.0301	0.023	0.015	0.00672	0.0173	0.0197	0.137	0.493	0.291
H1:PEM-CS_ACC_LVEAFLOOR_BS_Z_DQ	link	ASD, TS	Alert	No	No	Yes	0.126	0.406	0.637	0.558	0.336	0.0724	0.0215	0.019	0.0315	0.0767	0.153
H1:PEM-CS_ACC_OPLEV_ITMX_Y_DQ	link	ASD, TS	Alert	No	No	Yes	0.00049	0.00125	0.000867	0.00163	0.00619	0.0176	0.0331	0.16	0.338	0.319	0.176
H1:PEM-CS_ACC_OPLEV_ITMY_X_DQ	link	ASD, TS	Alert	No	No	Yes	0.00242	0.00318	0.00181	0.00413	0.0216	0.0675	0.437	0.449	0.58	0.606	0.694
H1:PEM-CS_ACC_PSL_PERISCOPE_X_DQ	link	ASD,	Alert	No	No	Yes	0.00163	0.00552	0.00734	0.00896	0.0393	0.297	0.133	0.313	0.0831	0.0441	0.00659

Dipongkar Talukder

Latest estimates of magnetic coupling

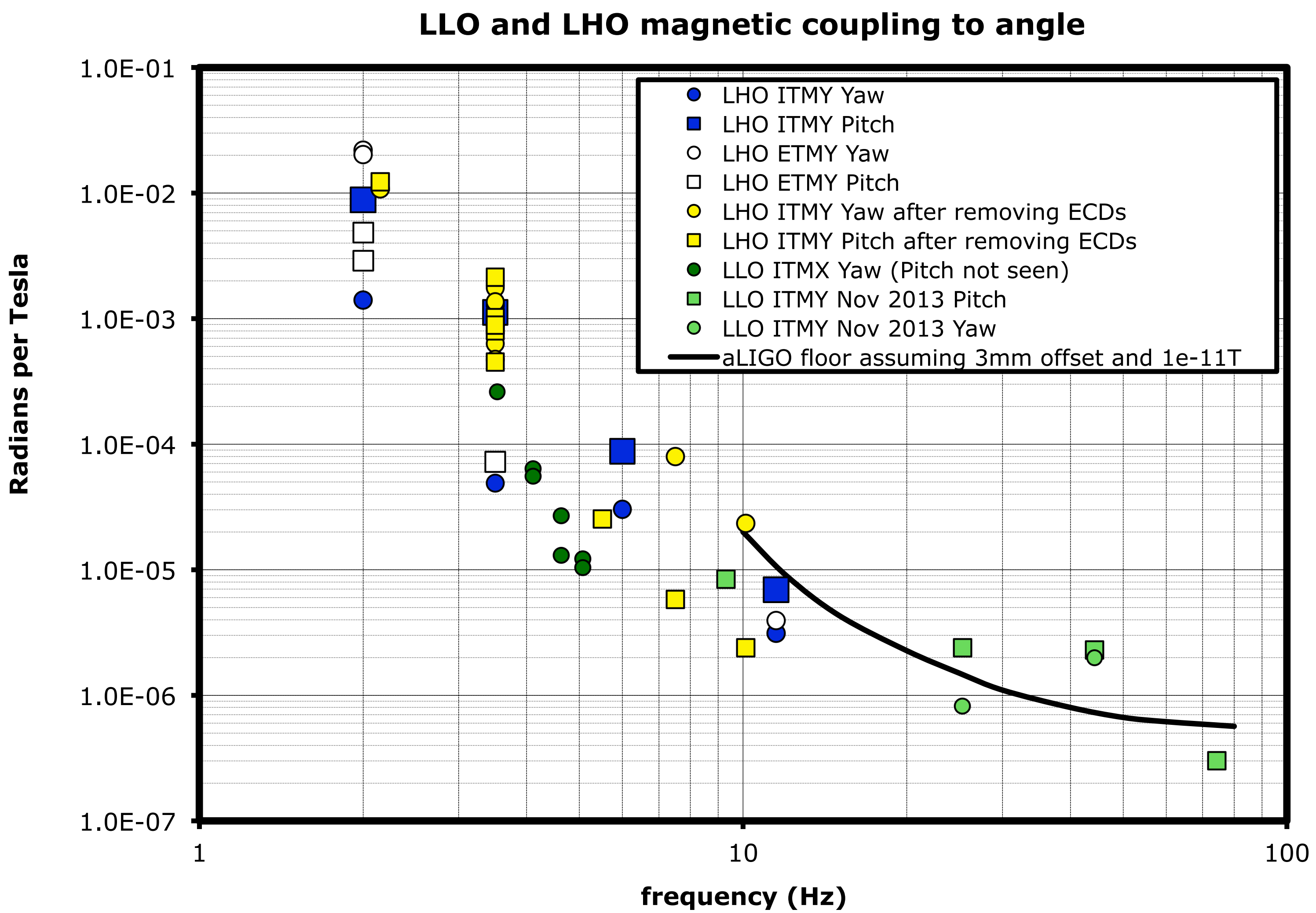
Length coupling to suspension, upper limit because cable coupling dominated





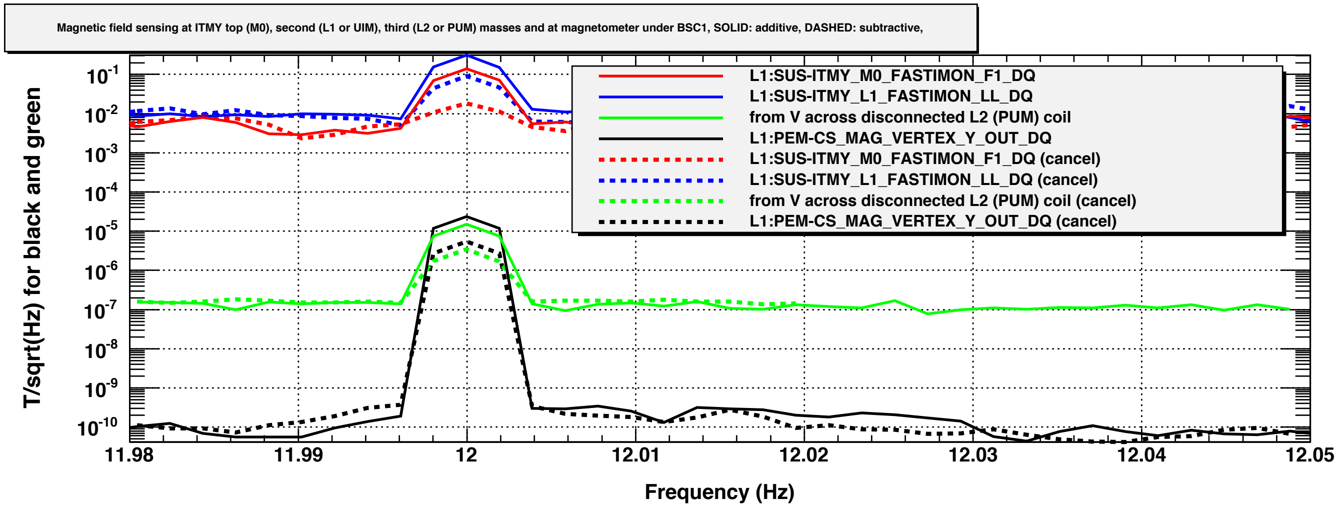
Latest estimates of magnetic coupling

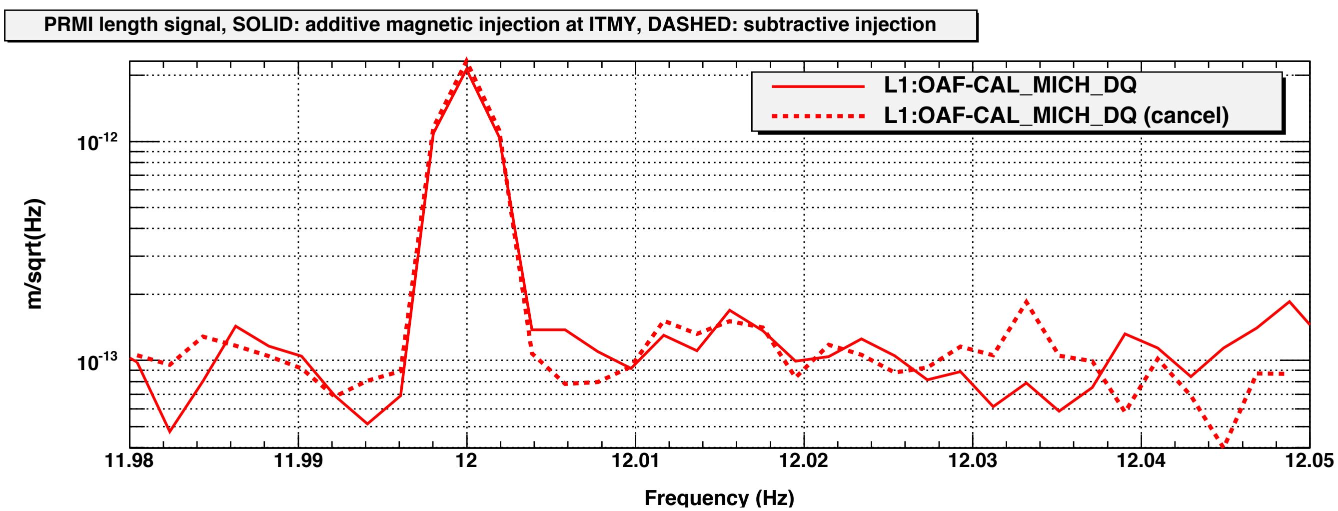
Angular coupling to suspension, not an upper limit – op lev signal changed with field at suspension, not cables



Cancelation technique

Magnetic fields are cancelled out at suspension, giving big field variation between cancel (dashed) and anti-cancel (solid). Signal in PRMI does not show similar variation

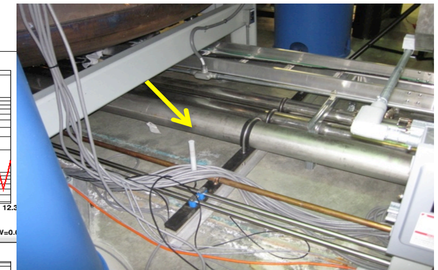


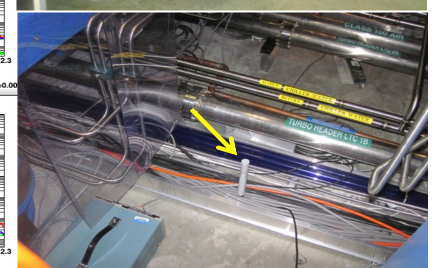


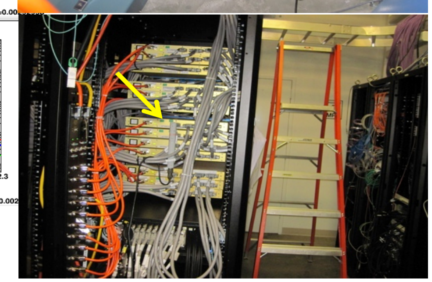
But optical lever signal did vary by 5 like field at suspension

Peak fingerprint technique

Magnetic field generators, each at a different frequency, and sensors are set up at multiple locations. The peak pattern in the IFO channel should best match the peak pattern in the magnetometer nearest the dominant coupling site.

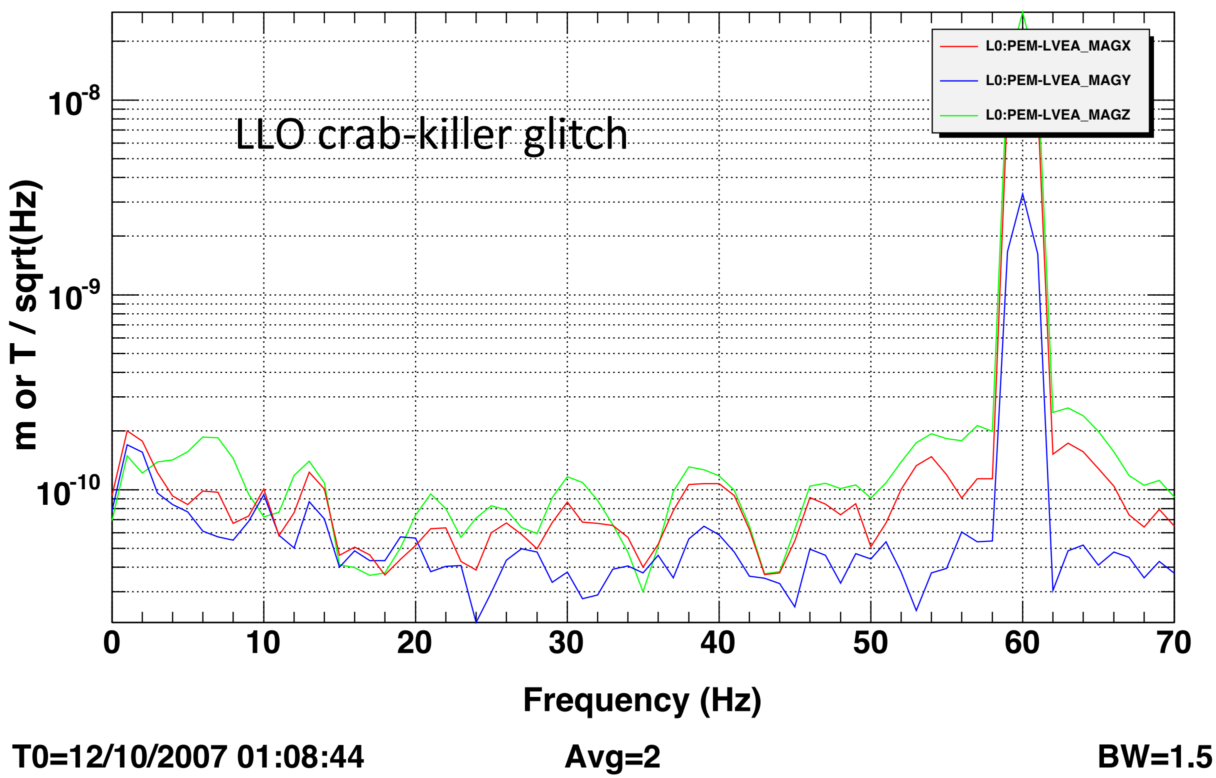






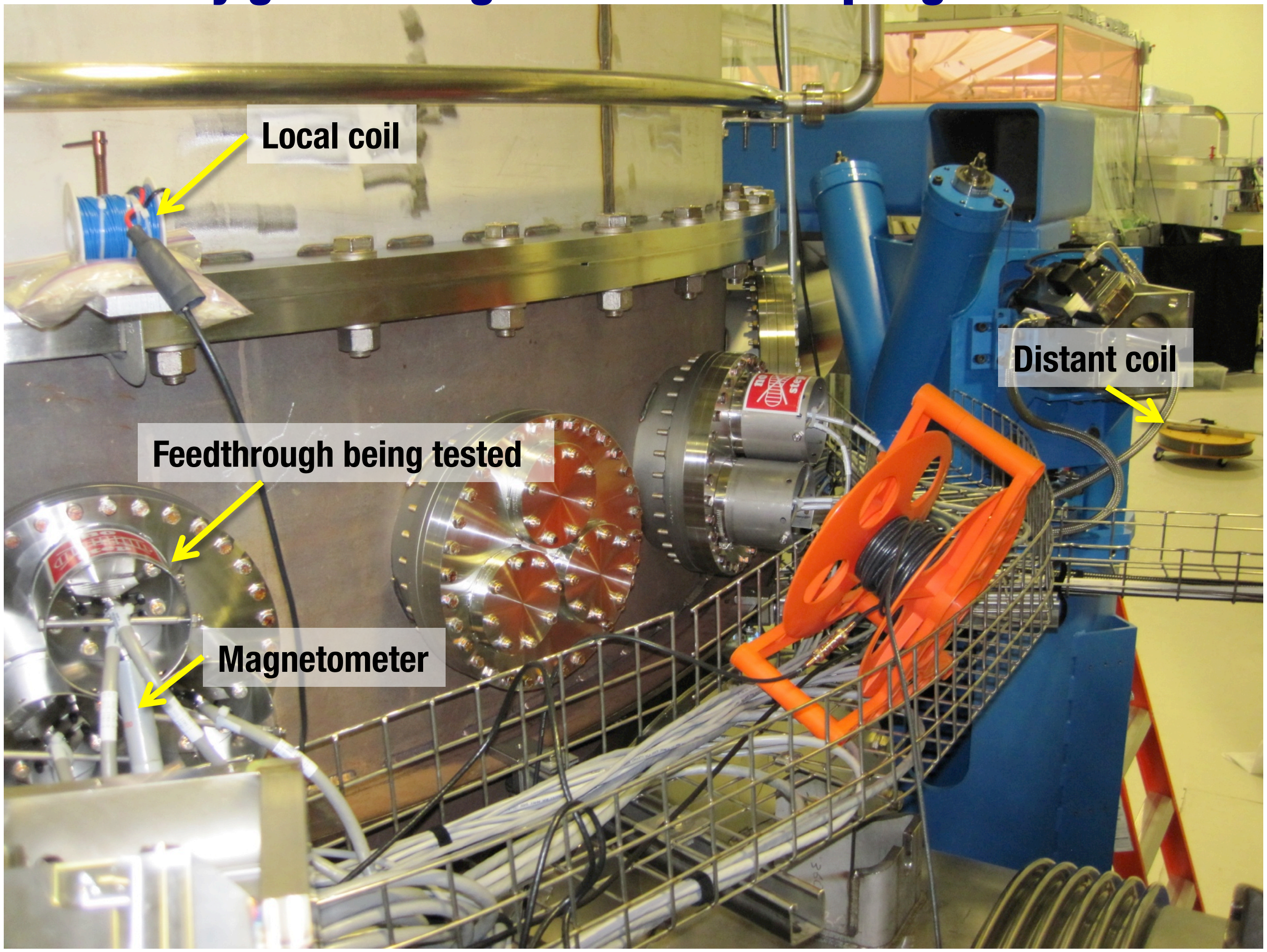
A warning about 60 Hz glitches

Displacement noise estimates were made using the average ambient level 1e-11 T/sqrt(Hz) in the tens of Hz region. But crab killer glitches at LLO increase this level by 10 and occur a couple of times a minute, 24/7



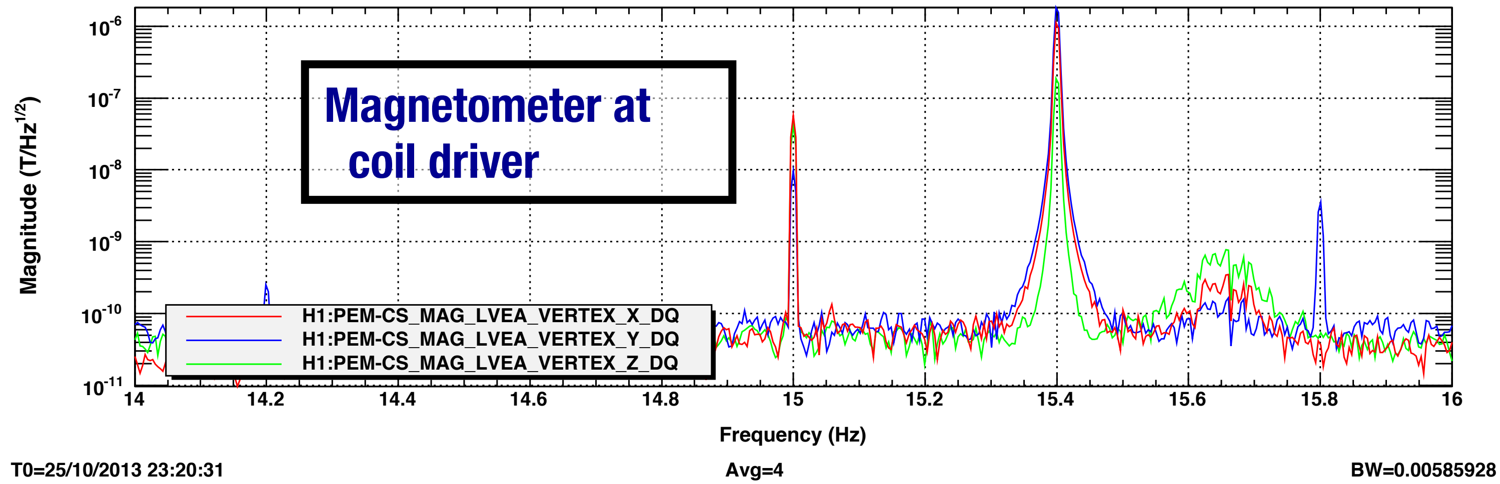
Magnetic coupling to sensors and their electronics

Are OSEM sensor feedthroughs coupling hot spots? Test by comparing coupling of distantly generated global field to coupling of local field.

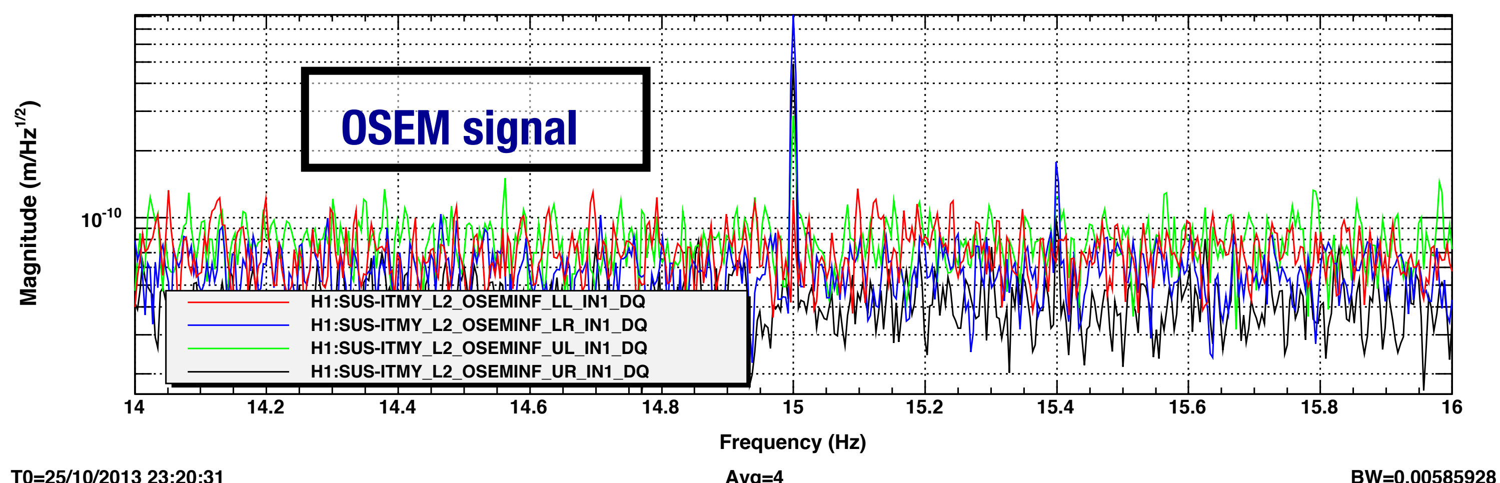


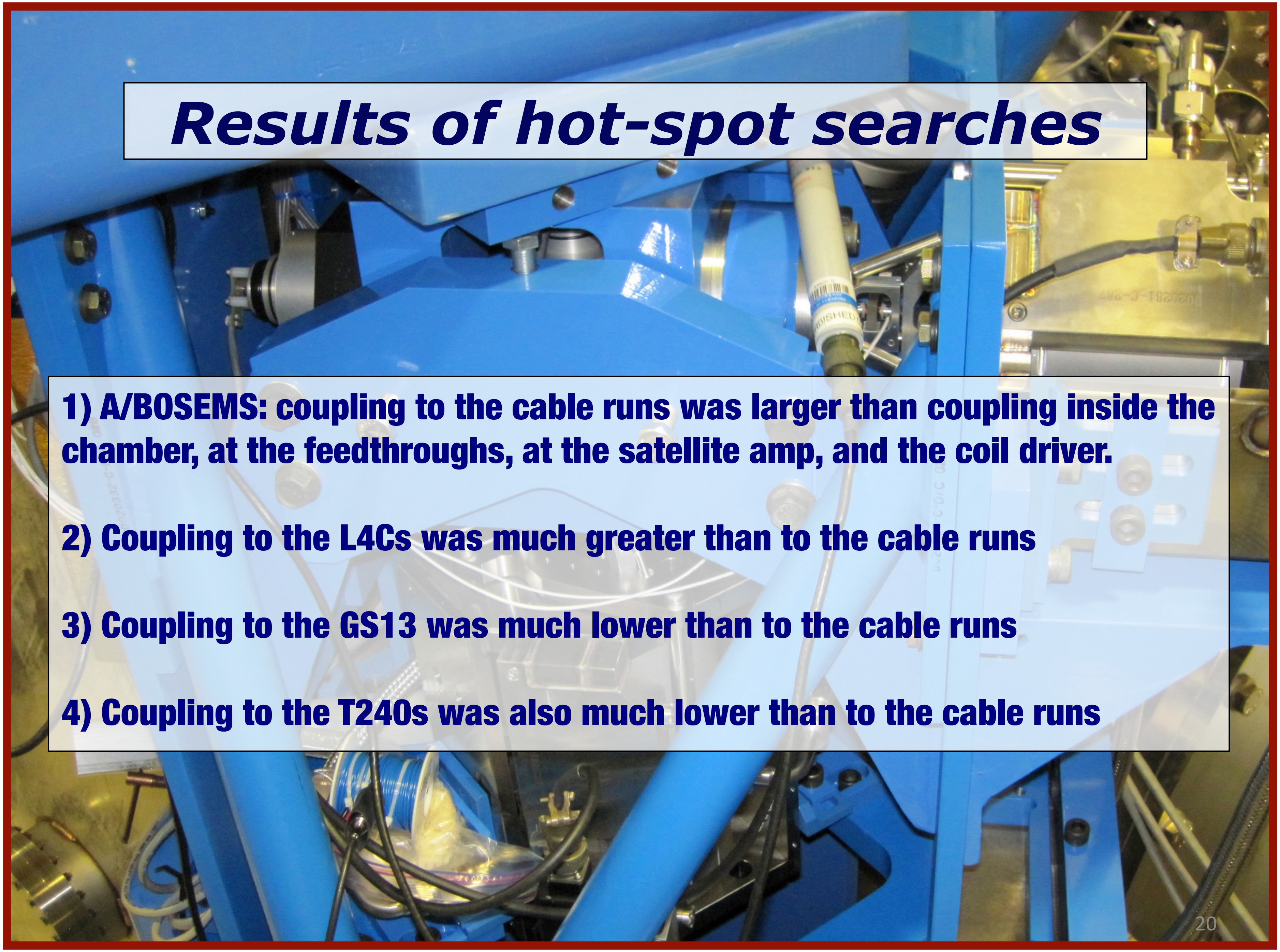
Low magnetic coupling to OSEM at coil driver

A huge field at 15.4 Hz near the coil driver produces a smaller OSEM signal than a smaller 15 Hz global field



OSEM channels showing coupling at coil drivers is relatively small





Results of hot-spot searches

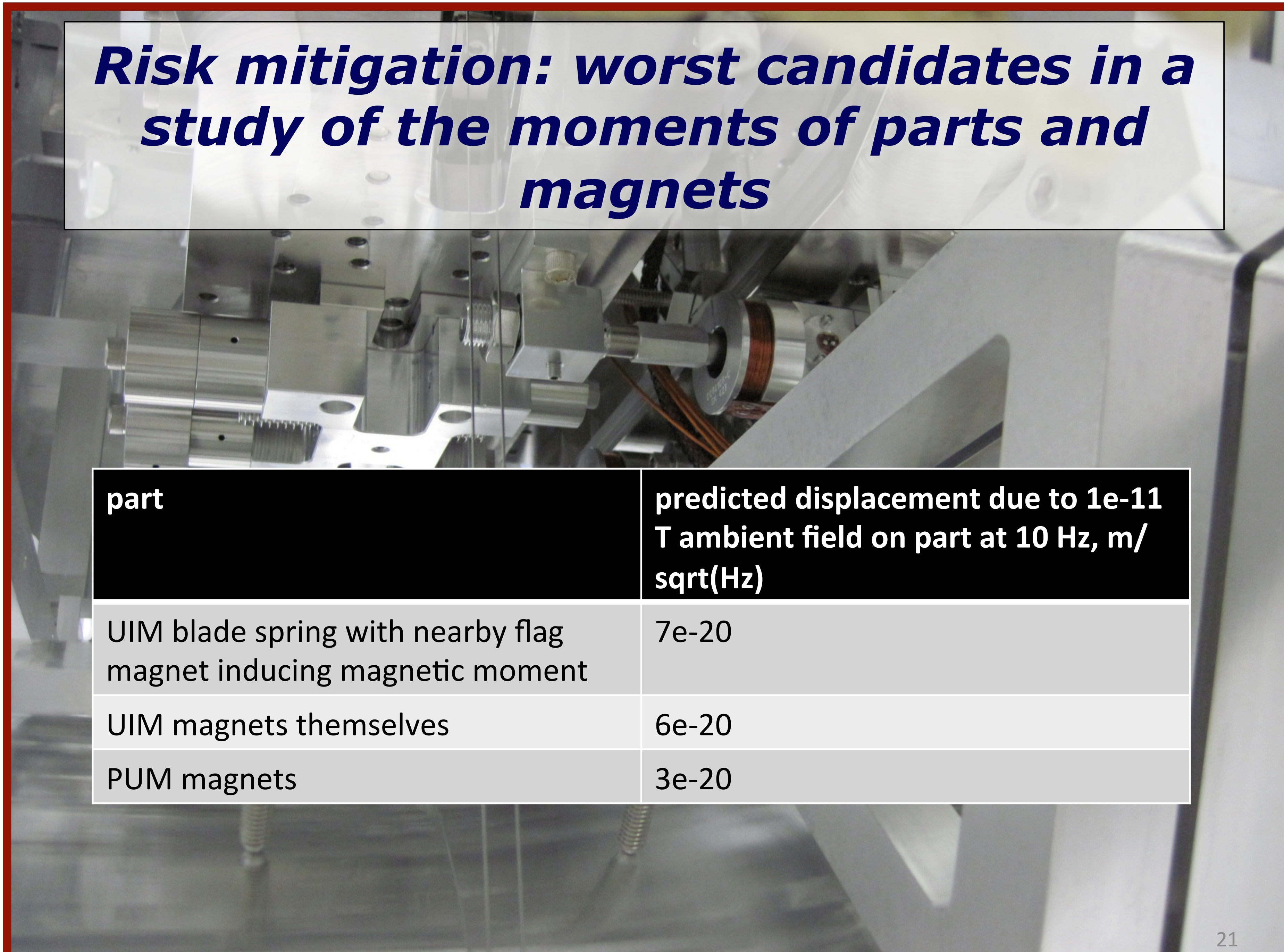
1) A/BOSEMS: coupling to the cable runs was larger than coupling inside the chamber, at the feedthroughs, at the satellite amp, and the coil driver.

2) Coupling to the L4Cs was much greater than to the cable runs

3) Coupling to the GS13 was much lower than to the cable runs

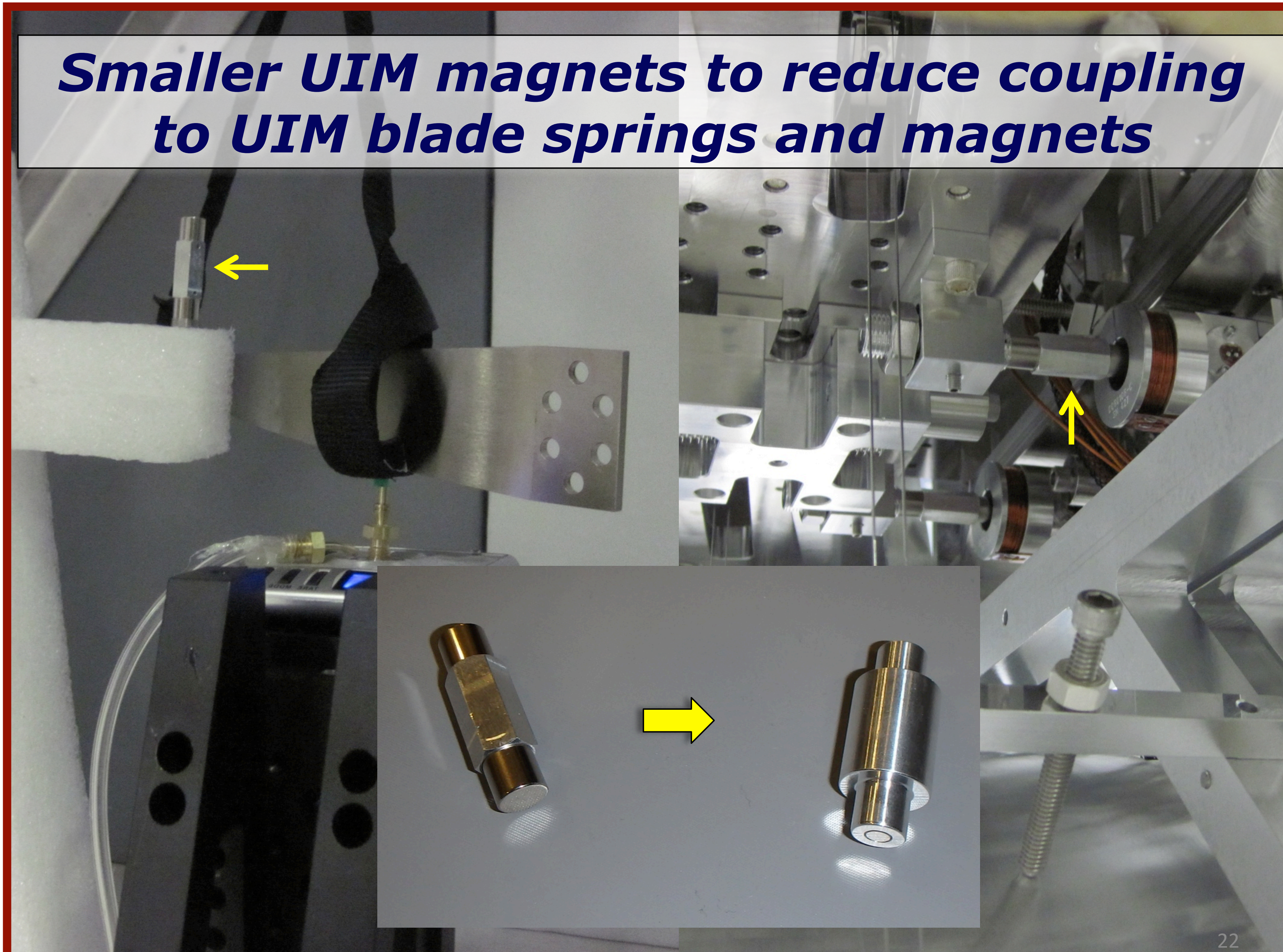
4) Coupling to the T240s was also much lower than to the cable runs

Risk mitigation: worst candidates in a study of the moments of parts and magnets



part	predicted displacement due to 1e-11 T ambient field on part at 10 Hz, m/sqrt(Hz)
UIM blade spring with nearby flag magnet inducing magnetic moment	7e-20
UIM magnets themselves	6e-20
PUM magnets	3e-20

Smaller UIM magnets to reduce coupling to UIM blade springs and magnets



Test of small-magnet flag and search for magnetized blade springs

With the 4x smaller moment magnet in the flag, the induced moment of the blade spring also dropped by ~4. Out of 7 tested blade springs, none had anomalously large moments

Part	Moment J/T	Standard Deviation	n
UIM blade springs with no magnets nearby	0.15	0.04	15
UIM blade spring with nominal flag (holding 2 10x10 magnets in cancelling configuration) at nominal relative position.	0.36	0.03	4
UIM blade spring with small-magnet flag at nominal relative position	0.20	0.10	15
6 different UIM blade springs with no magnets nearby	0.10	0.03	6
Nominal 10x10mm flag magnet (but they are used in cancelling pairs)	0.72		
Small flag magnet 10x5	0.14?		

Risk mitigation for stochastic search

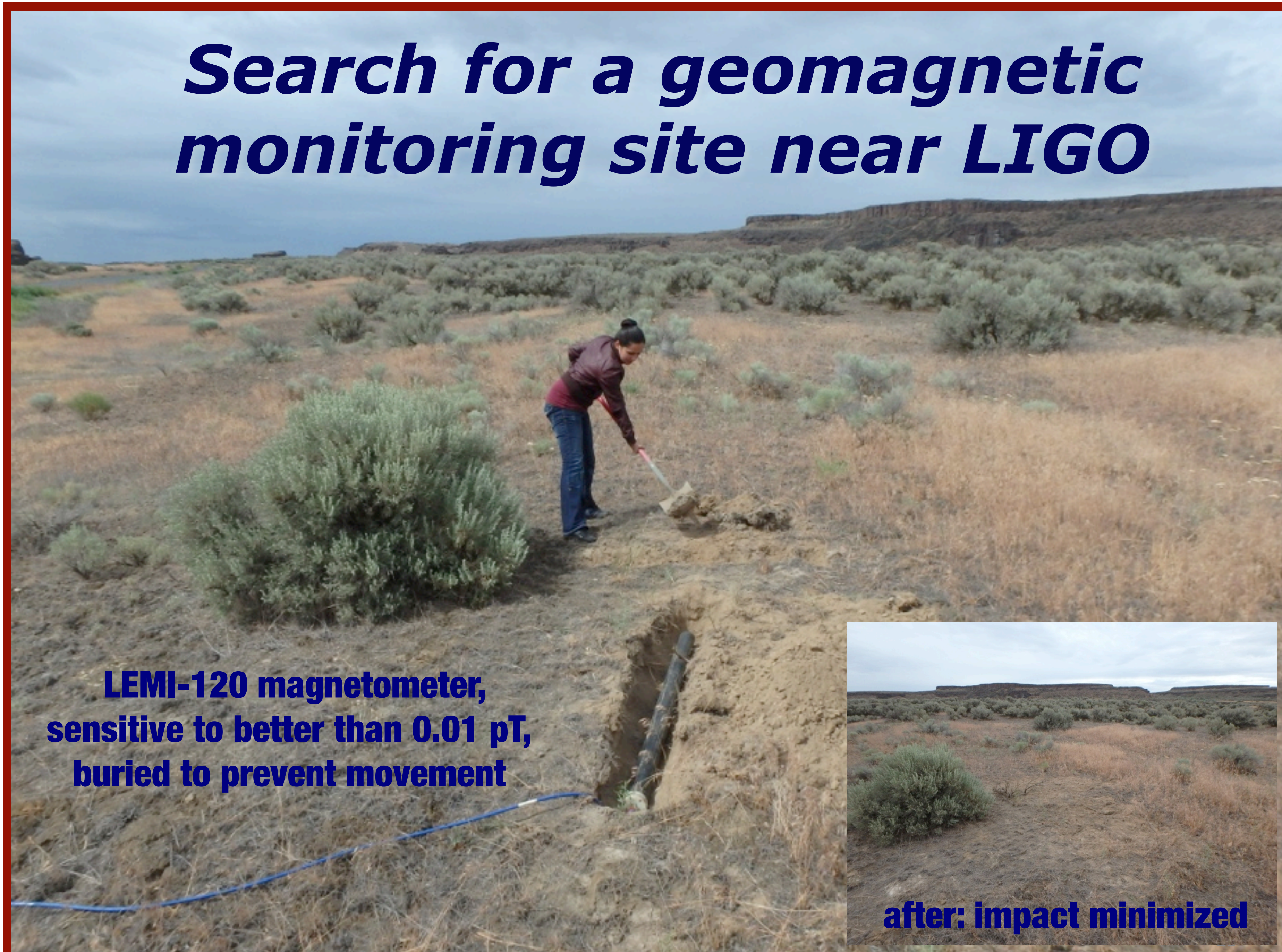
Correlated noise in networks of gravitational-wave detectors: subtraction and mitigation

E. Thrane,[1] N. Christensen,[2] R. M. S. Schofield,[3] and A. Effler[4]

[1] *LIGO Laboratory, California Institute of Technology, Pasadena, California 91125, USA*[a]
[2] *Physics and Astronomy, Carleton College, Northfield, MN 55057, USA*[b]
[3] *University of Oregon, Eugene, Oregon 97403, USA*[c]
[4] *Louisiana State University, Baton Rouge, Louisiana 70803, USA*[d]

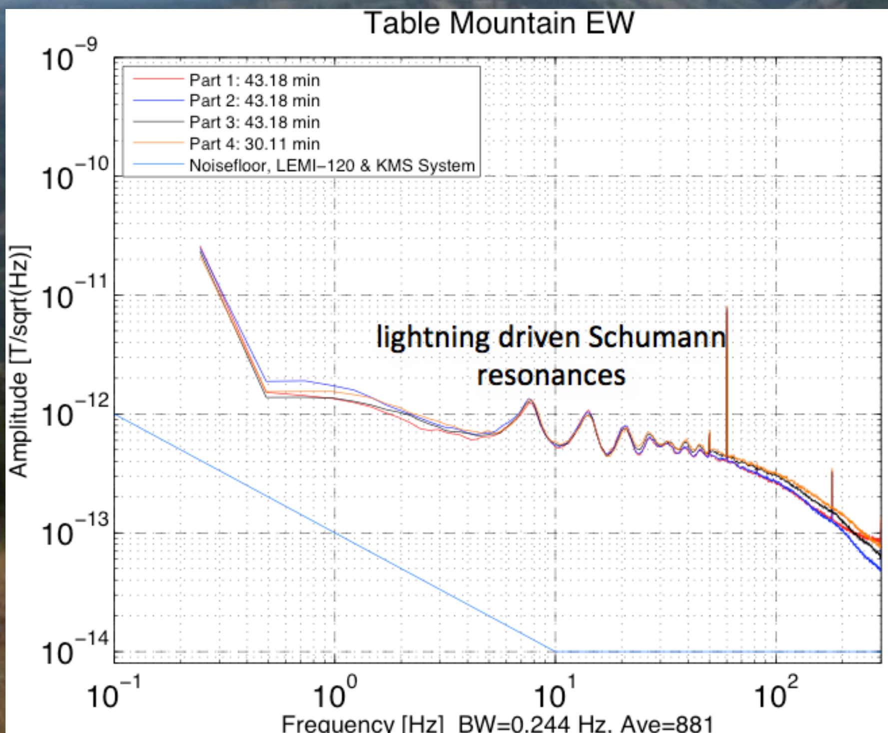
One of the key science goals of advanced gravitational-wave detectors is to observe a stochastic gravitational-wave background. However, recent work demonstrates that correlated magnetic fields from Schumann resonances can produce correlated strain noise over global distances, potentially limiting the sensitivity of stochastic background searches with advanced detectors. In this paper, we estimate the correlated noise budget for the worldwide advanced detector network and conclude that correlated noise may affect upcoming measurements. We investigate the possibility of a Wiener filtering scheme to subtract correlated noise from Advanced LIGO searches, and estimate the required specifications. We also consider the possibility that residual correlated noise remains following subtraction, and we devise an optimal strategy for measuring astronomical parameters in the presence of correlated noise. Using this new formalism, we estimate the loss of sensitivity for a broadband, isotropic stochastic background search using 1 yr of LIGO data at design sensitivity. Given our current noise budget, the uncertainty with which LIGO can estimate energy density will likely increase by a factor of $\approx$12—if it is impossible to achieve significant subtraction. Additionally, narrowband cross-correlation searches may be severely affected at low frequencies $f \lesssim 70$ Hz without effective subtraction.

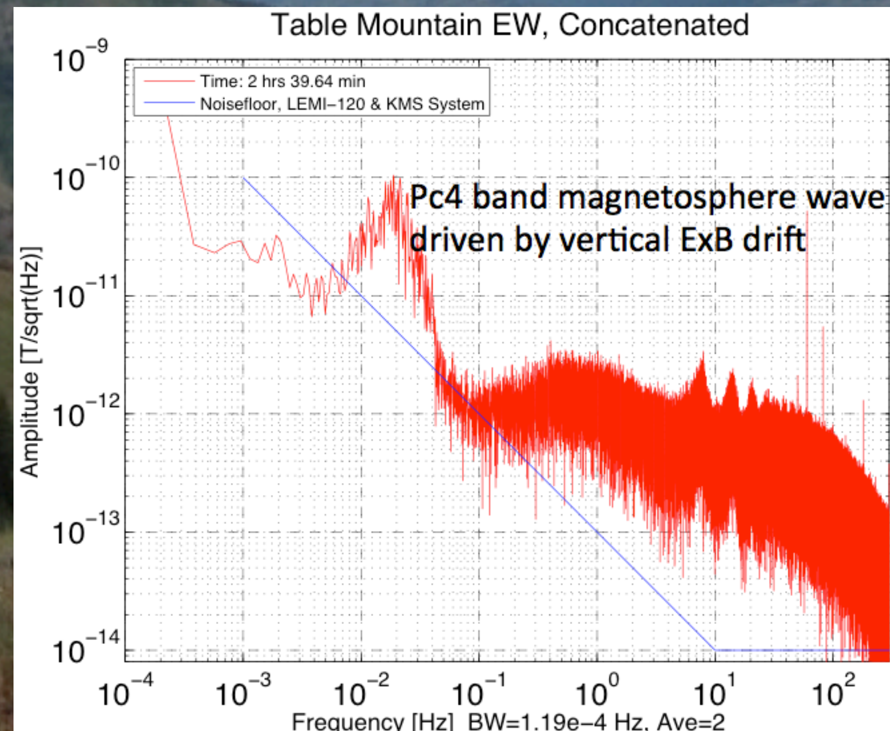
DOI: http://dx.doi.org/10.1103/PhysRevD.90.023013


Search for a geomagnetic monitoring site near LIGO
LEMI-120 magnetometer, sensitive to better than 0.01 pT, buried to prevent movement
after: impact minimized

LEMI-120 Sites

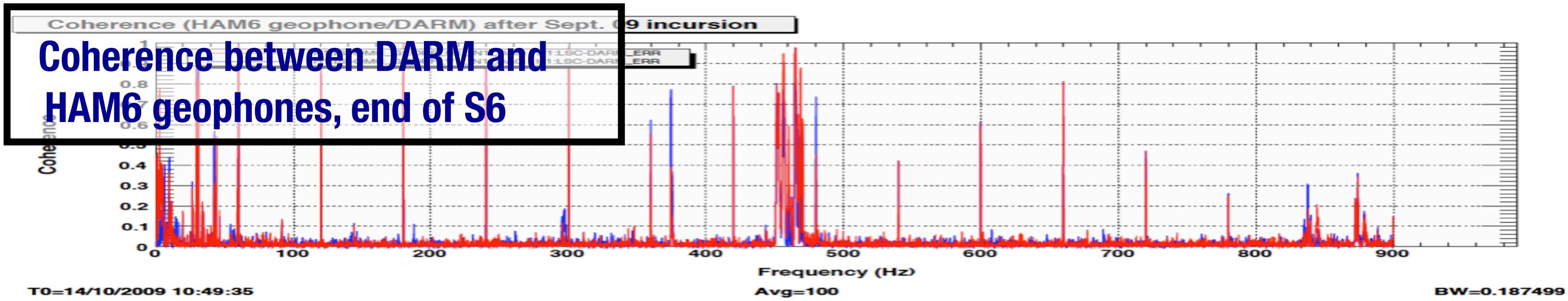
Spectra from best site

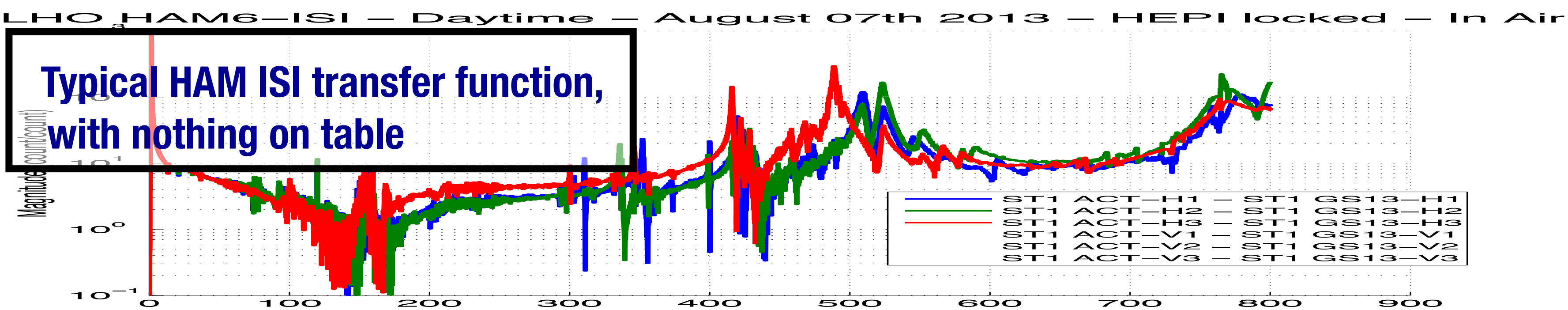


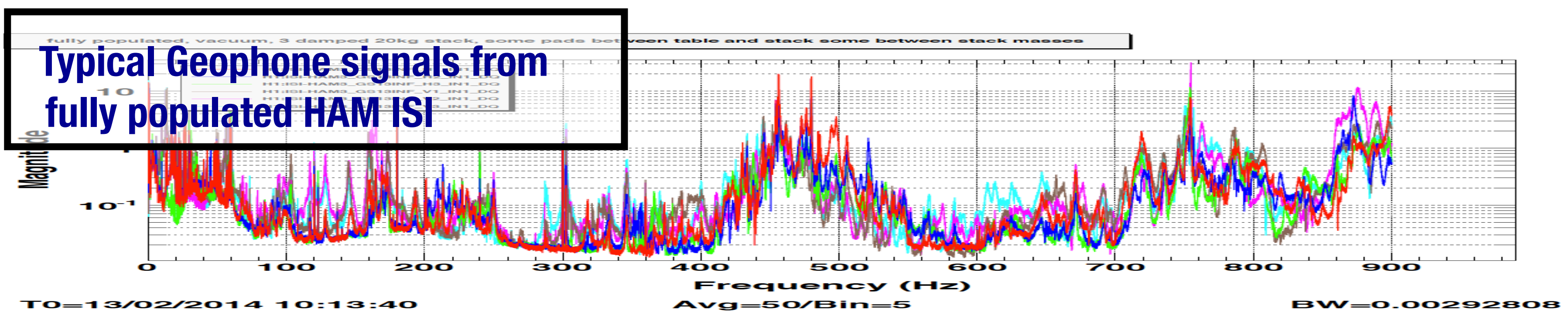


But LHO vault might work if 60 Hz glitches removed. At LLO, the only tested site that would work is off-site.

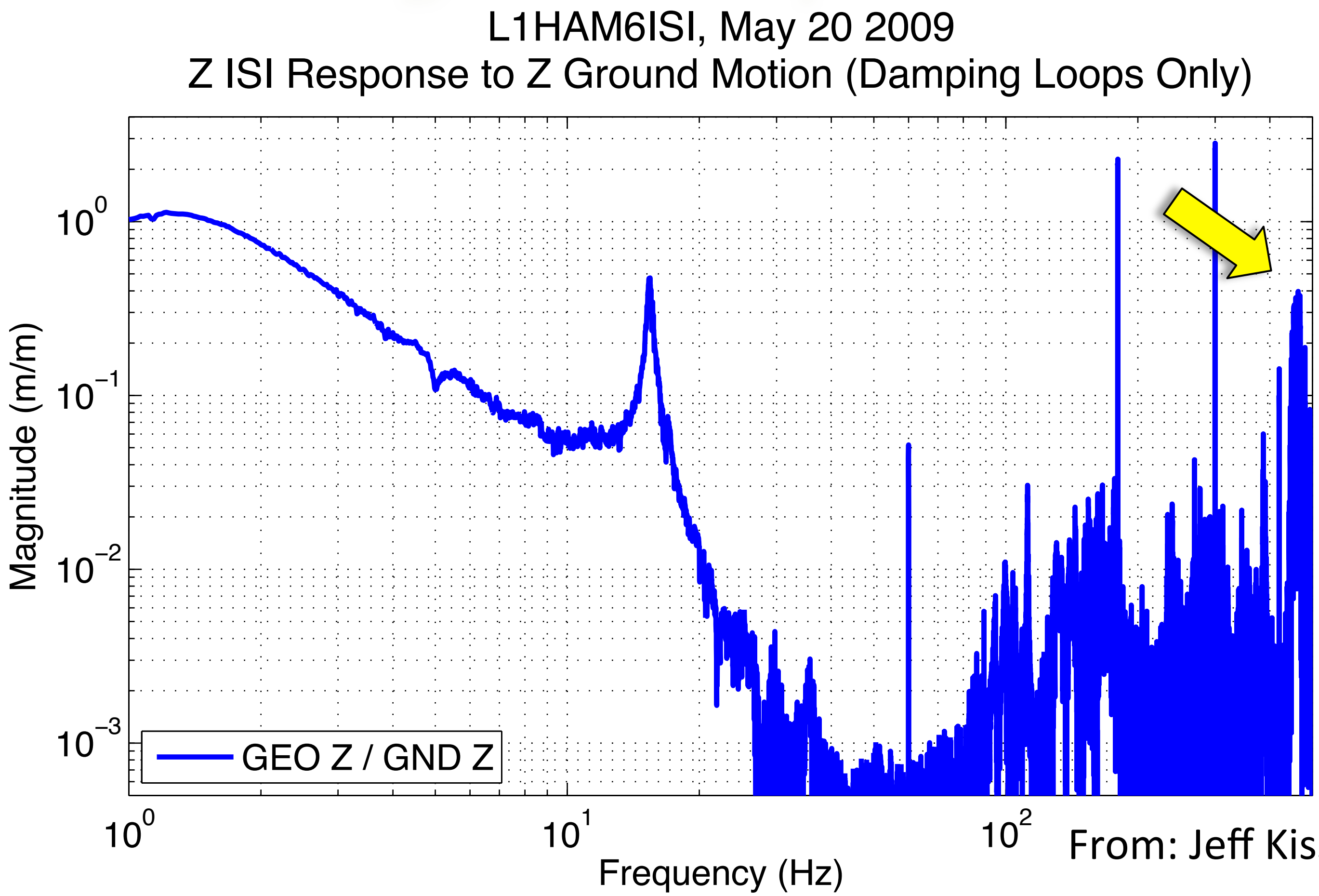
Risk mitigation: understanding acoustic coupling to vacuum tables







Attenuation can be less than 10 at higher frequencies

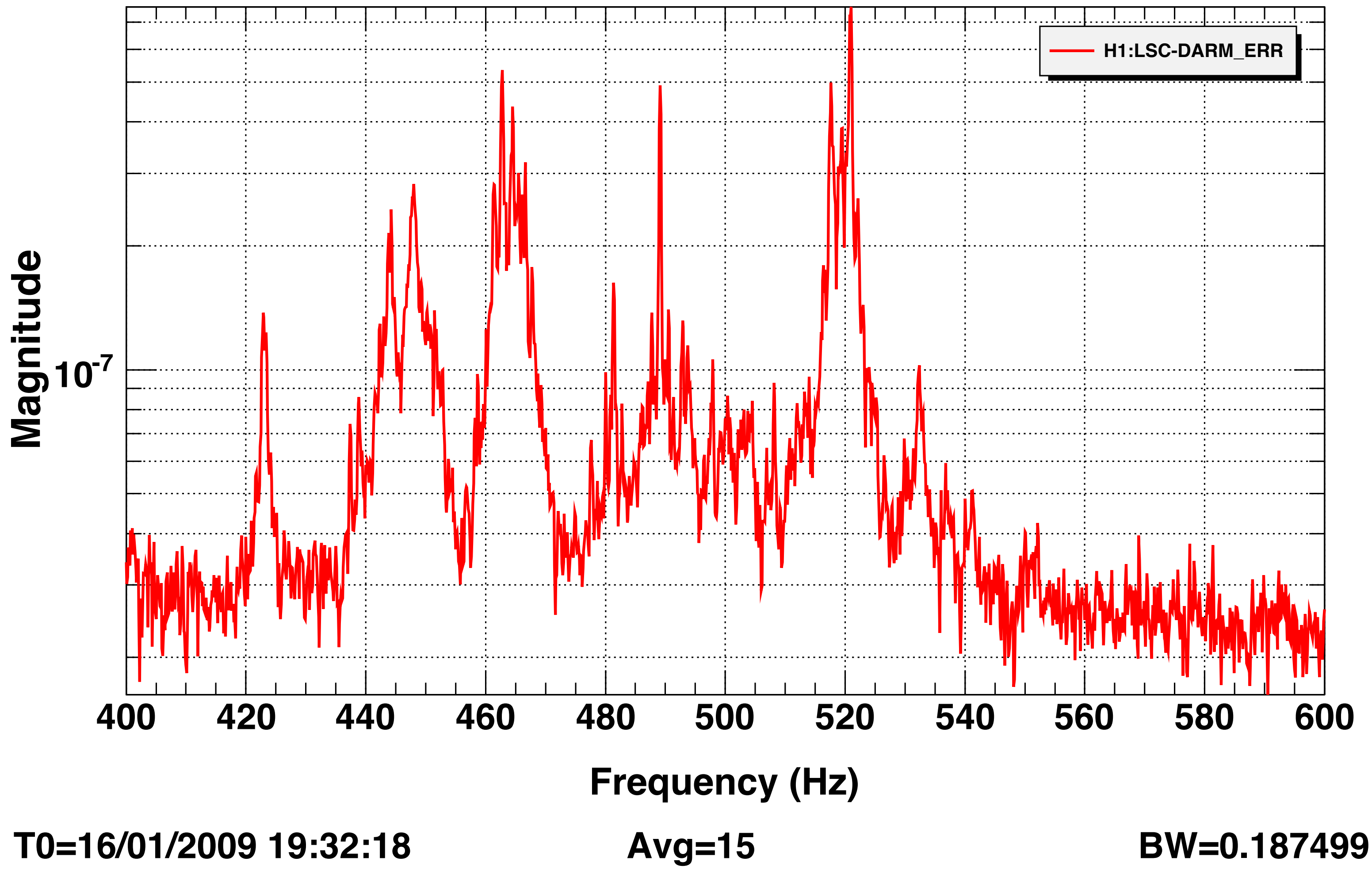


From: Jeff Kissel

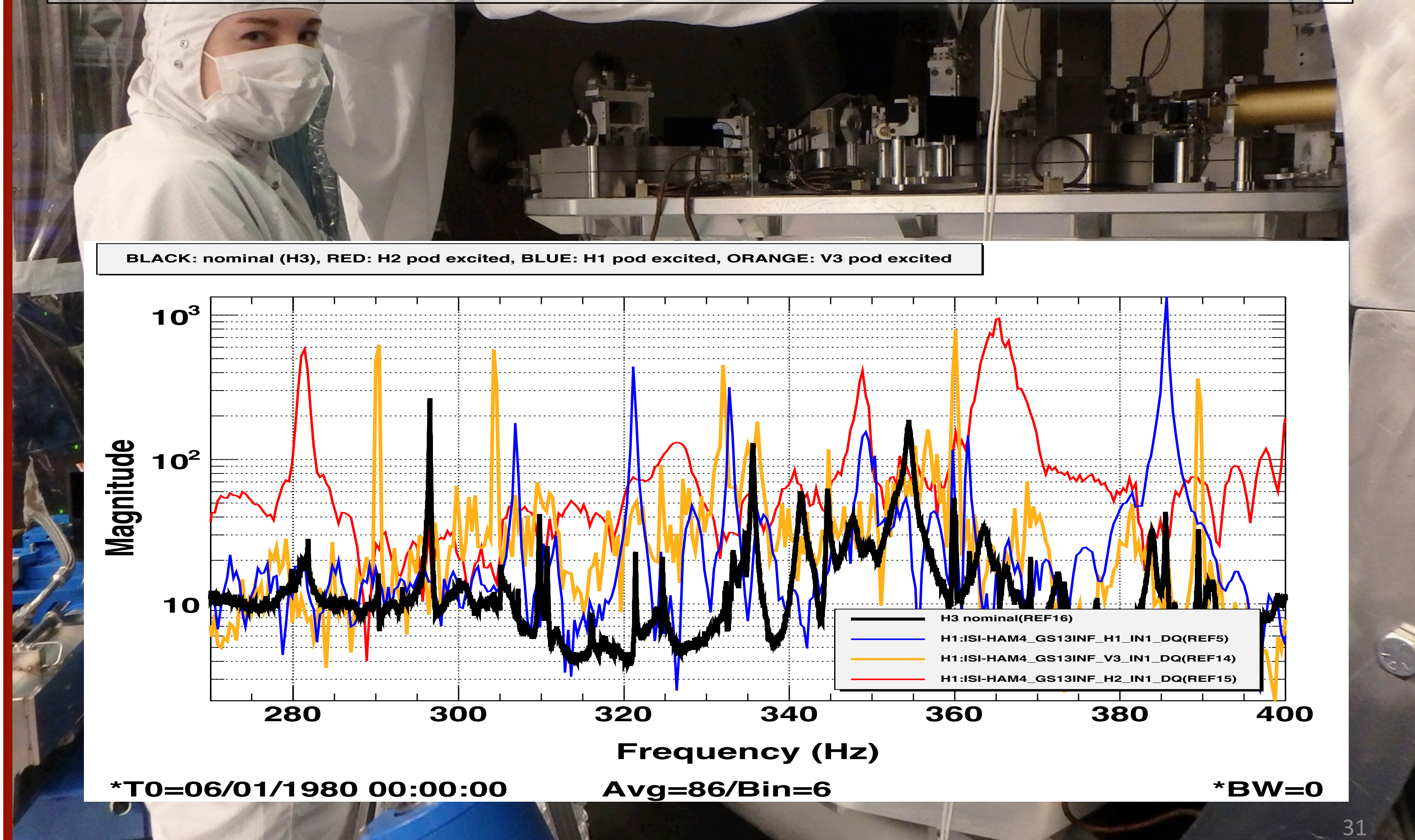
Resonance of ISI blade spring and flexure? Violin mode of support wire?

HAM6 acoustic peaks in eLIGO

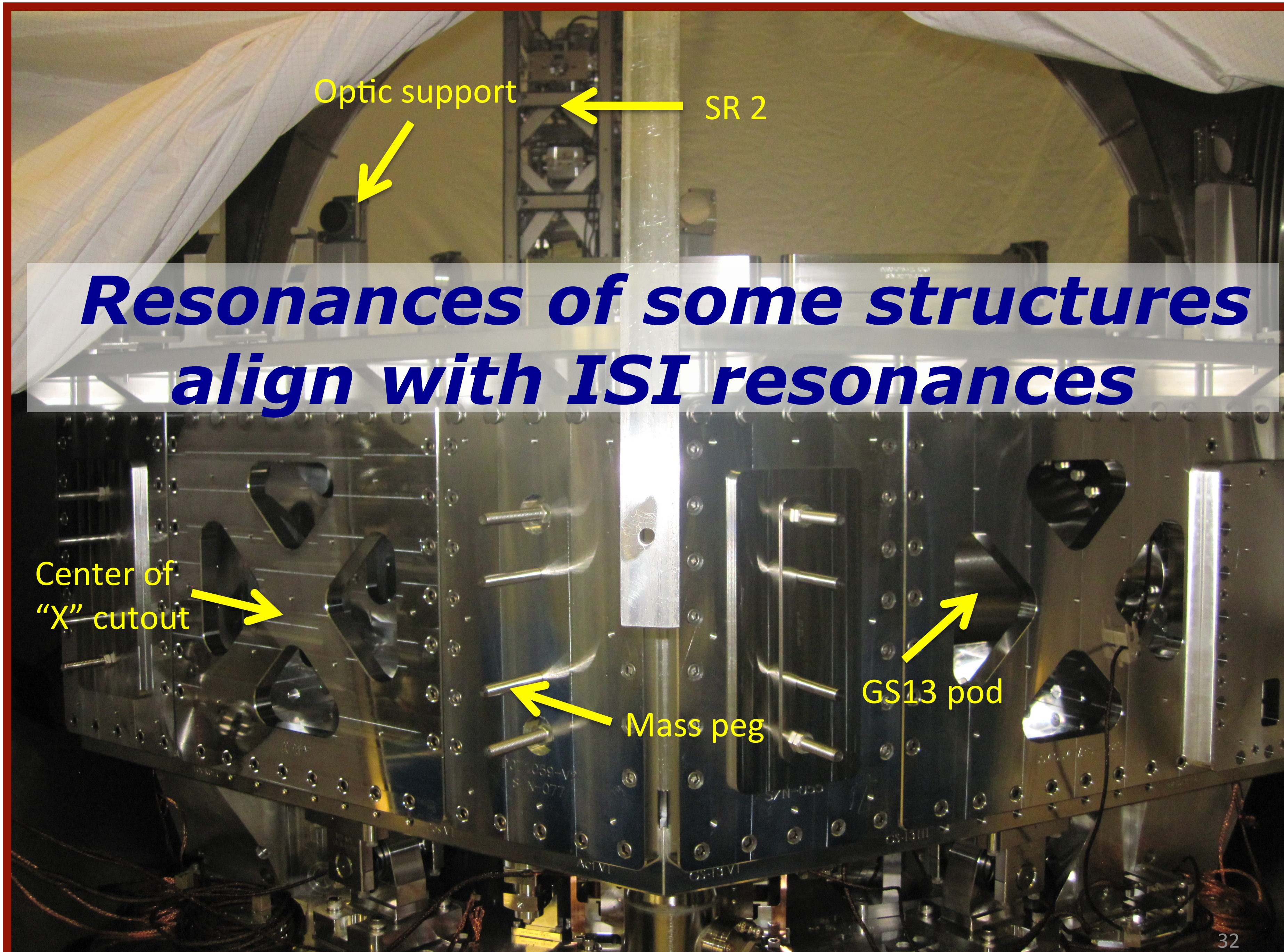
Sharp peaks (components?) riding on broader peaks (ISI resonances?)



Testing resonances for future reference

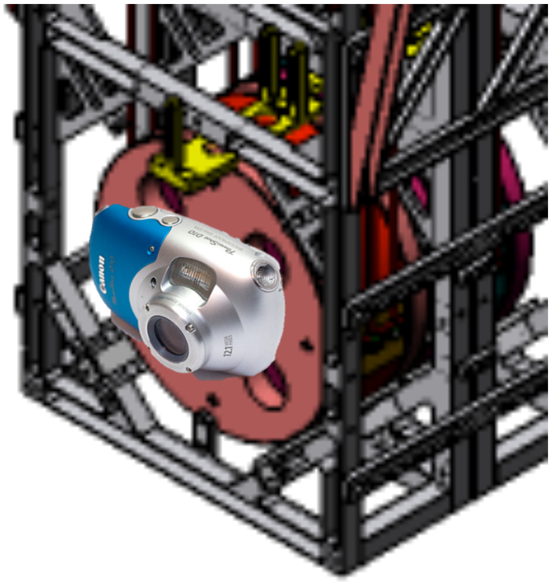


Resonances of some structures align with ISI resonances

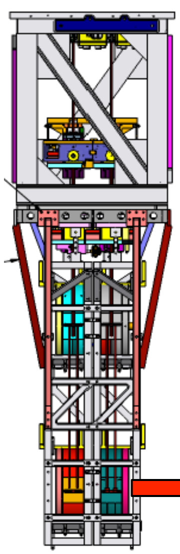


Risk mitigation for scattering sites: camera techniques for glints

Using a camera with its flash near its lens to qualitatively observe sites that back-reflect, keeping in mind that angular distribution of light from flash can be very different..

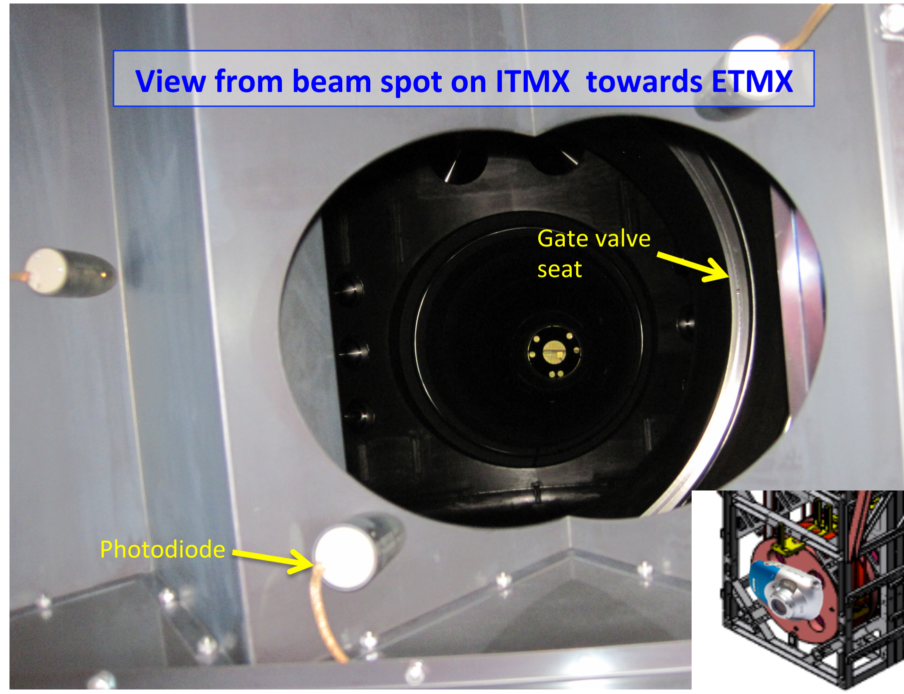


- **Beam spot view: camera place as near as possible to beam spot to observe any surfaces that retro-reflect light scattere from optic**

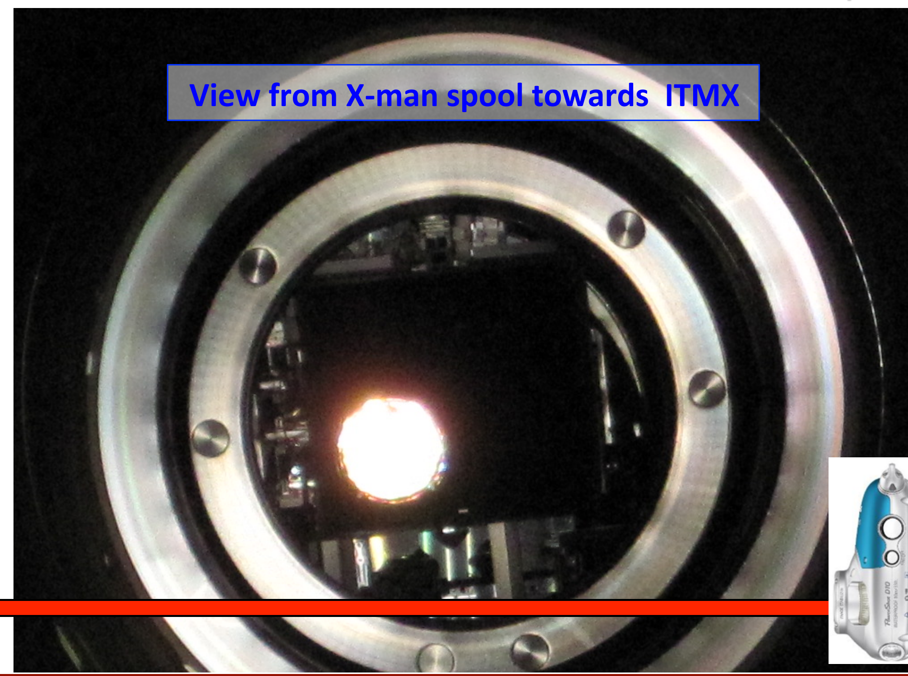


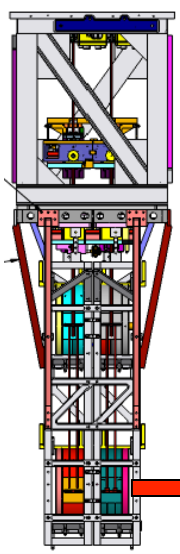
- **Distant optic view: camera placed far from optic, in beam path (flash reflects in optic), to observe glints that retro-reflect light scattered from distant optic**

Glint searches: ITMX



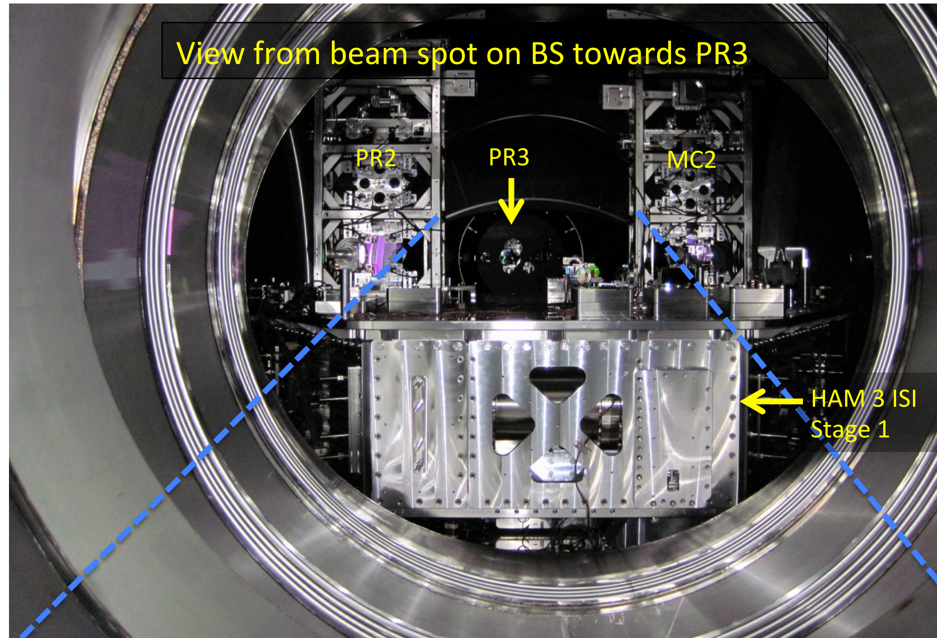
Beam spot view: possible glint from gate valve seat. First place to shake if we have a scattering problem.

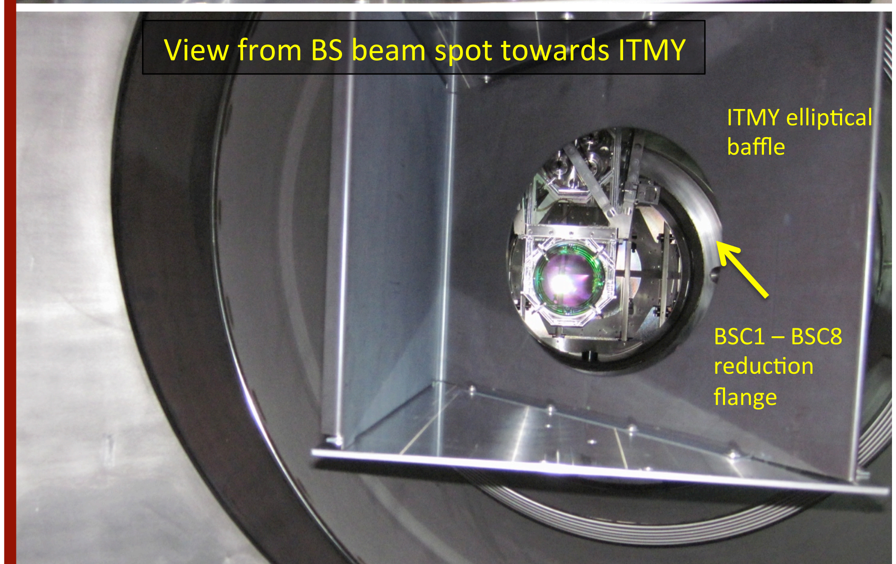


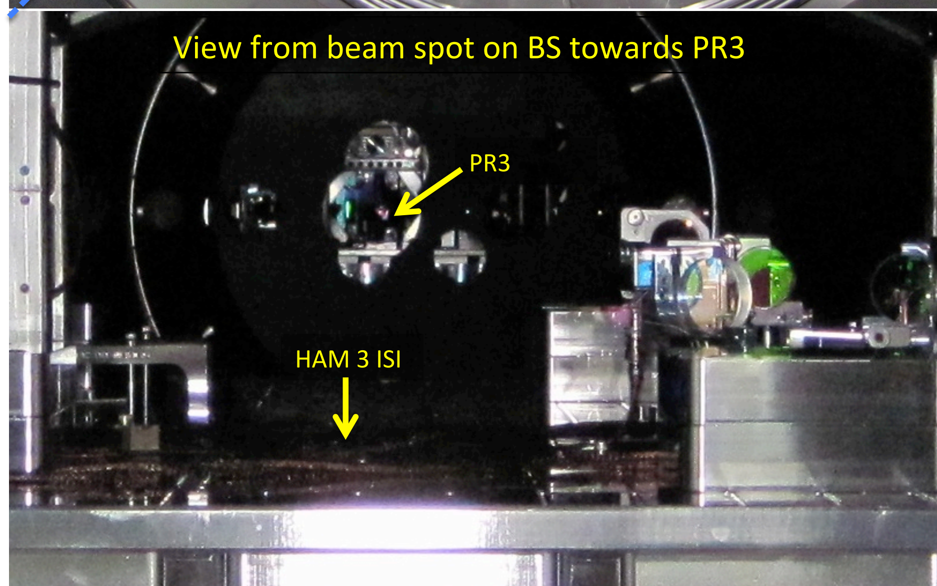


Distant optic view: looks good! No retro-reflections in clear aperture.

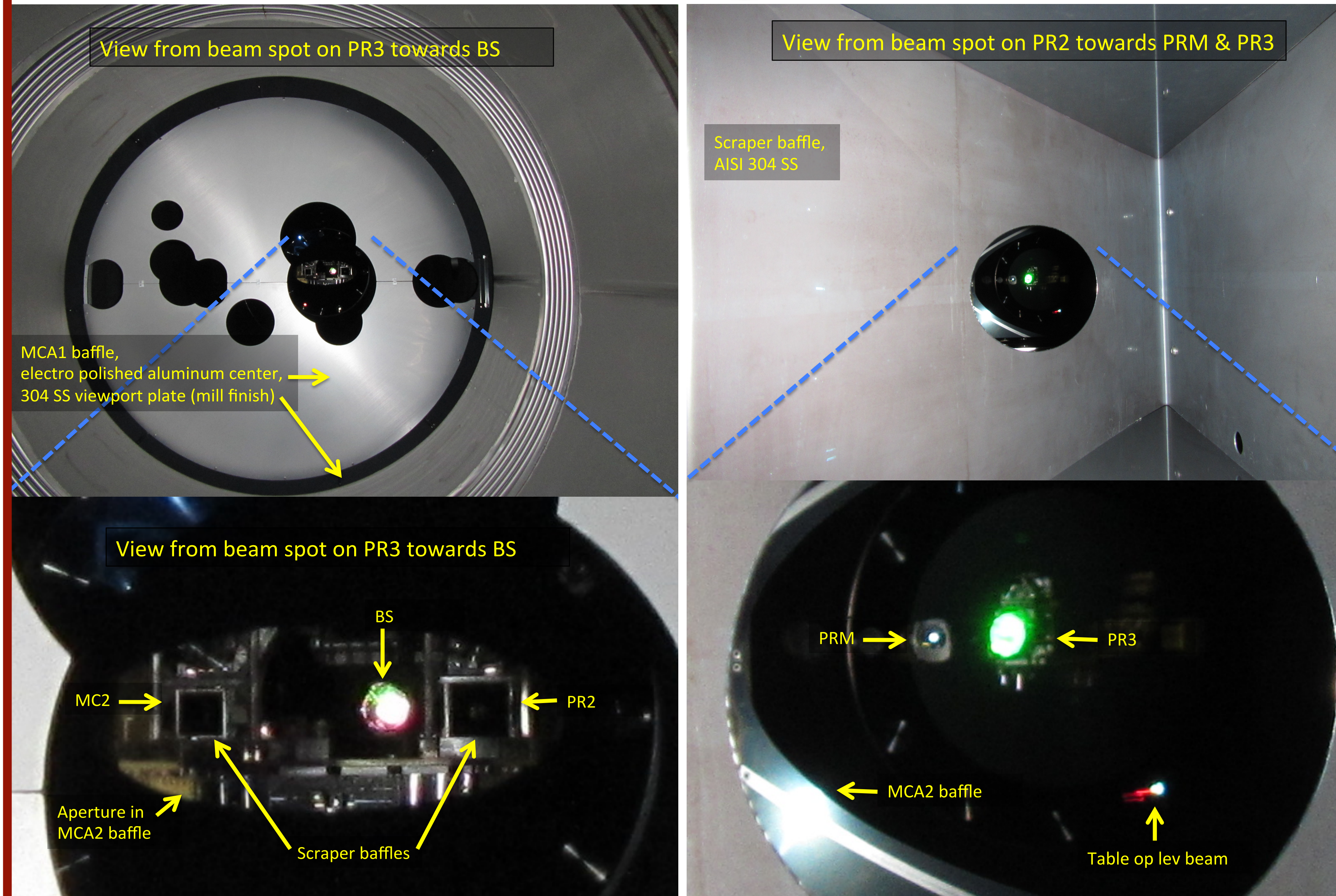
Beam splitter beam spot views



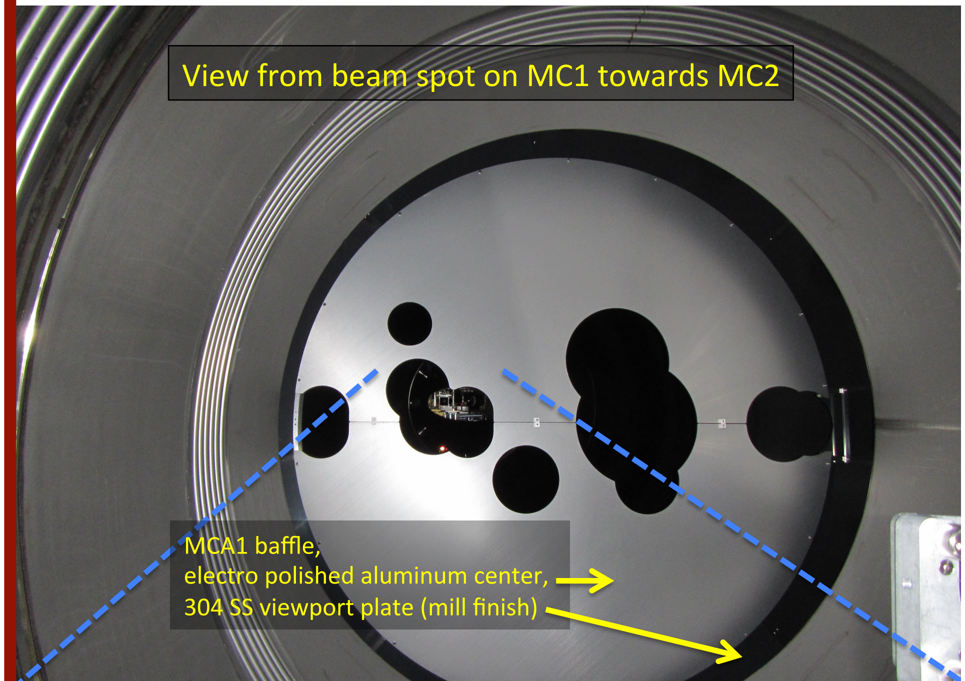


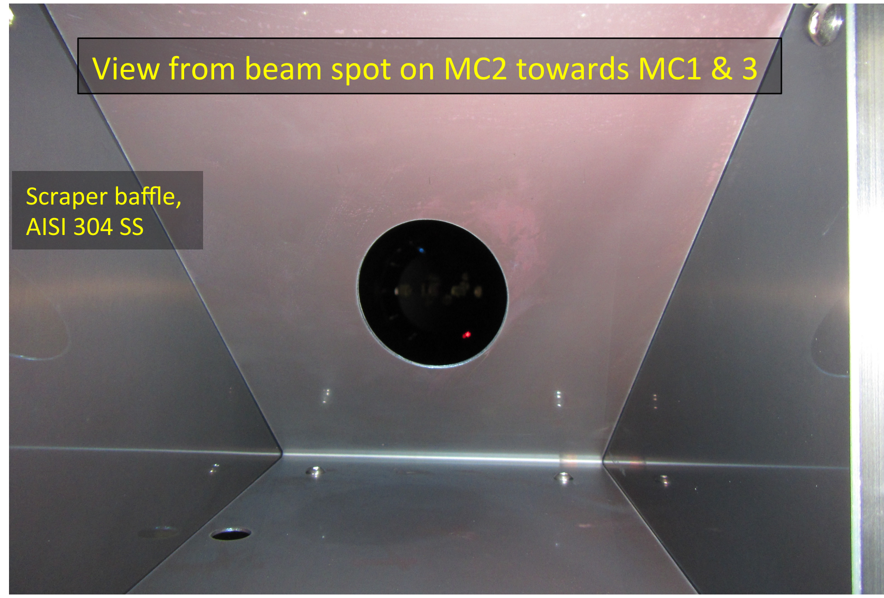


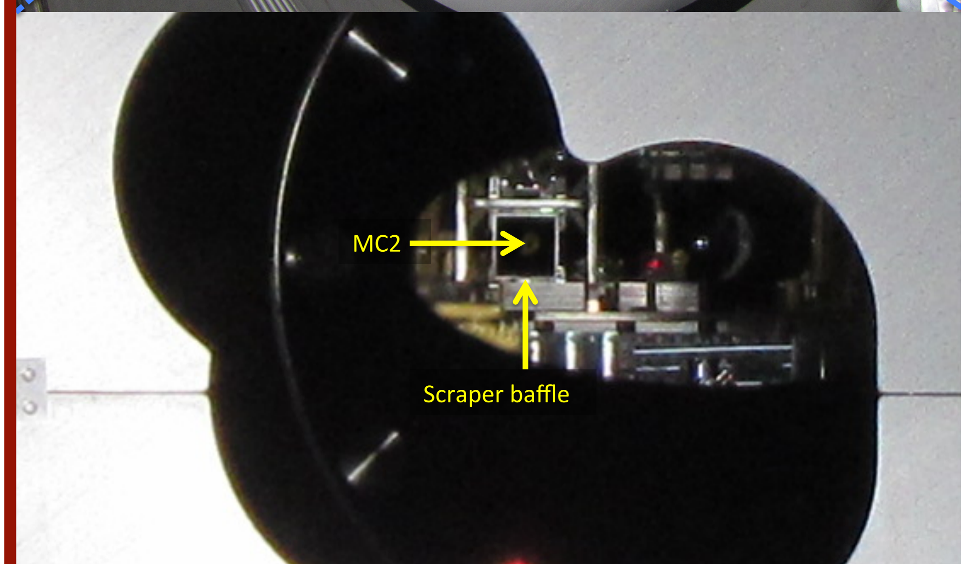
PRC beam spot views

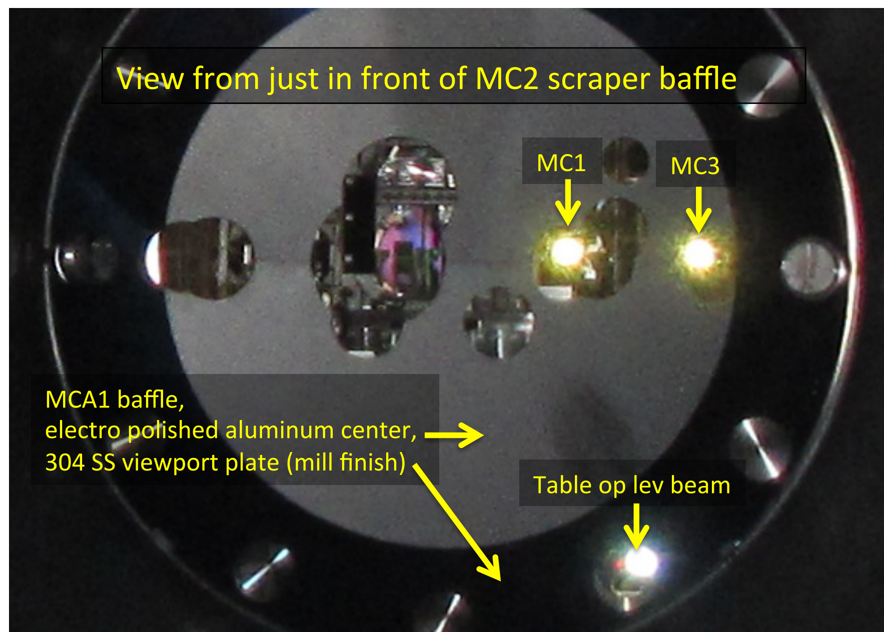


Input mode cleaner beam spot views



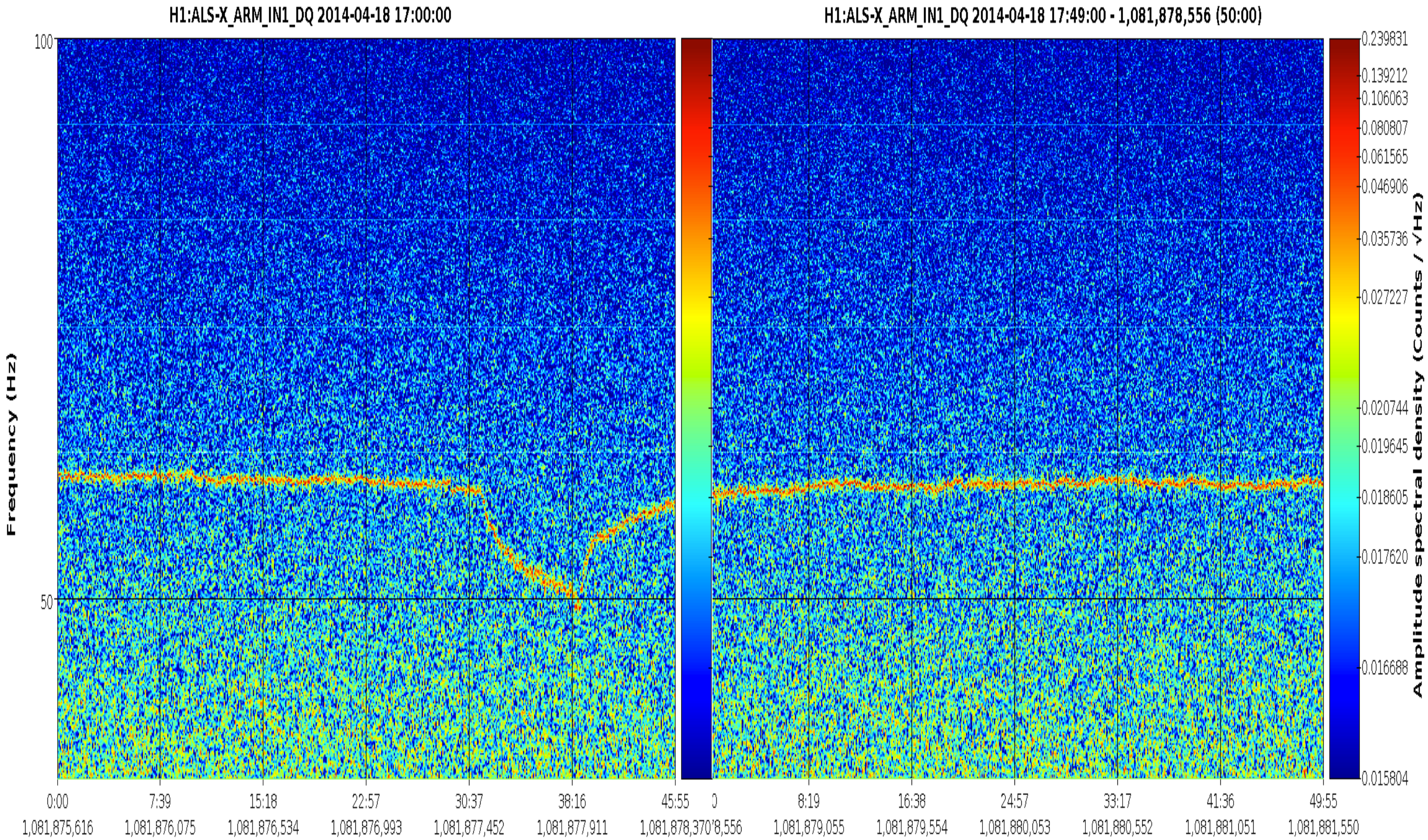






Detchar line hunters remind us that I/O box fans and switchers are contaminating channels

Line source ID: frequency drops when fan intake partially covered and returns when uncovered (gap in middle is data gap).

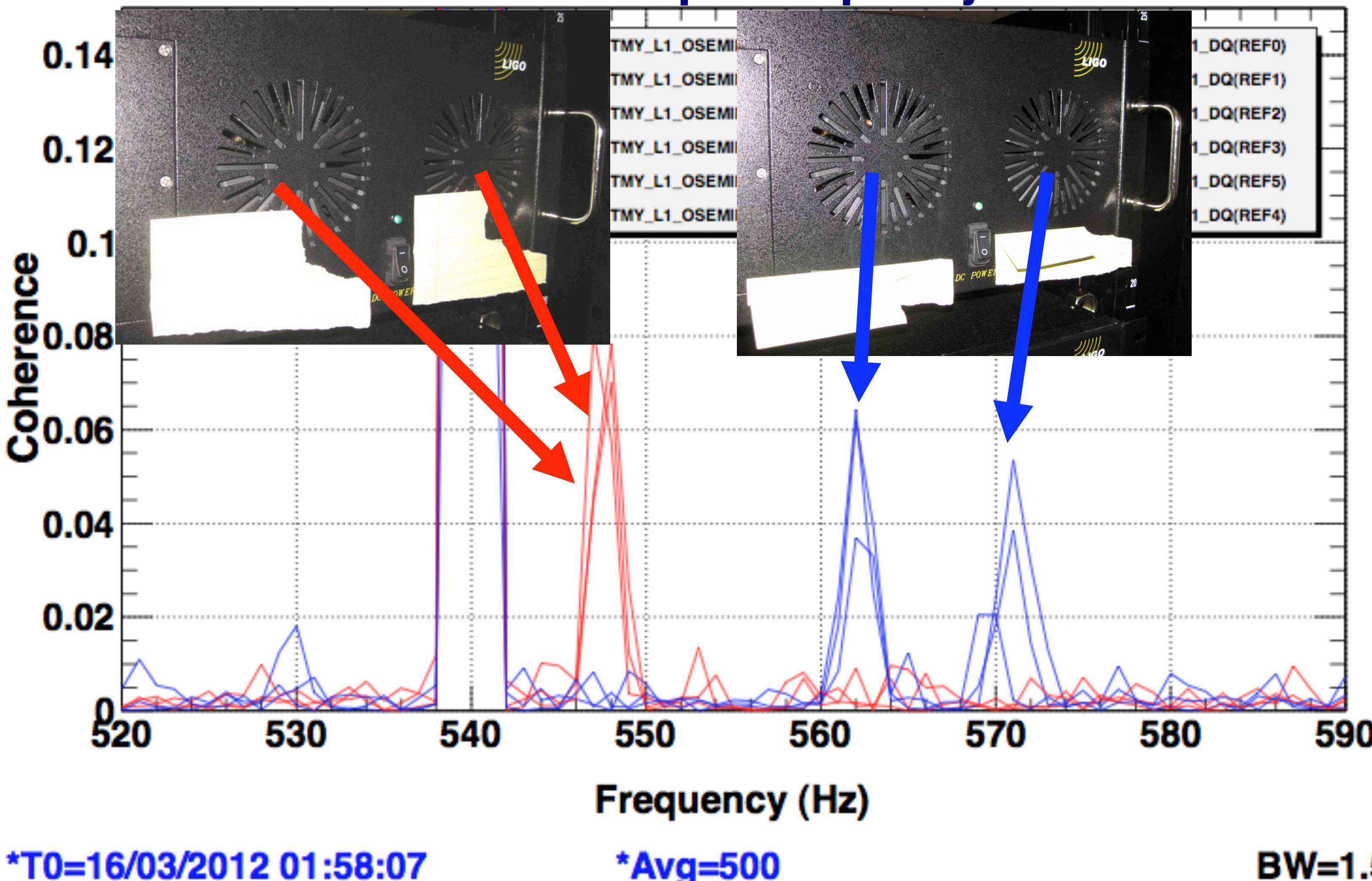


With Nelson Christensen, Jialun Luo, Patrick Meyers, Michael Coughlin, Eric Thrane, Keith Riles

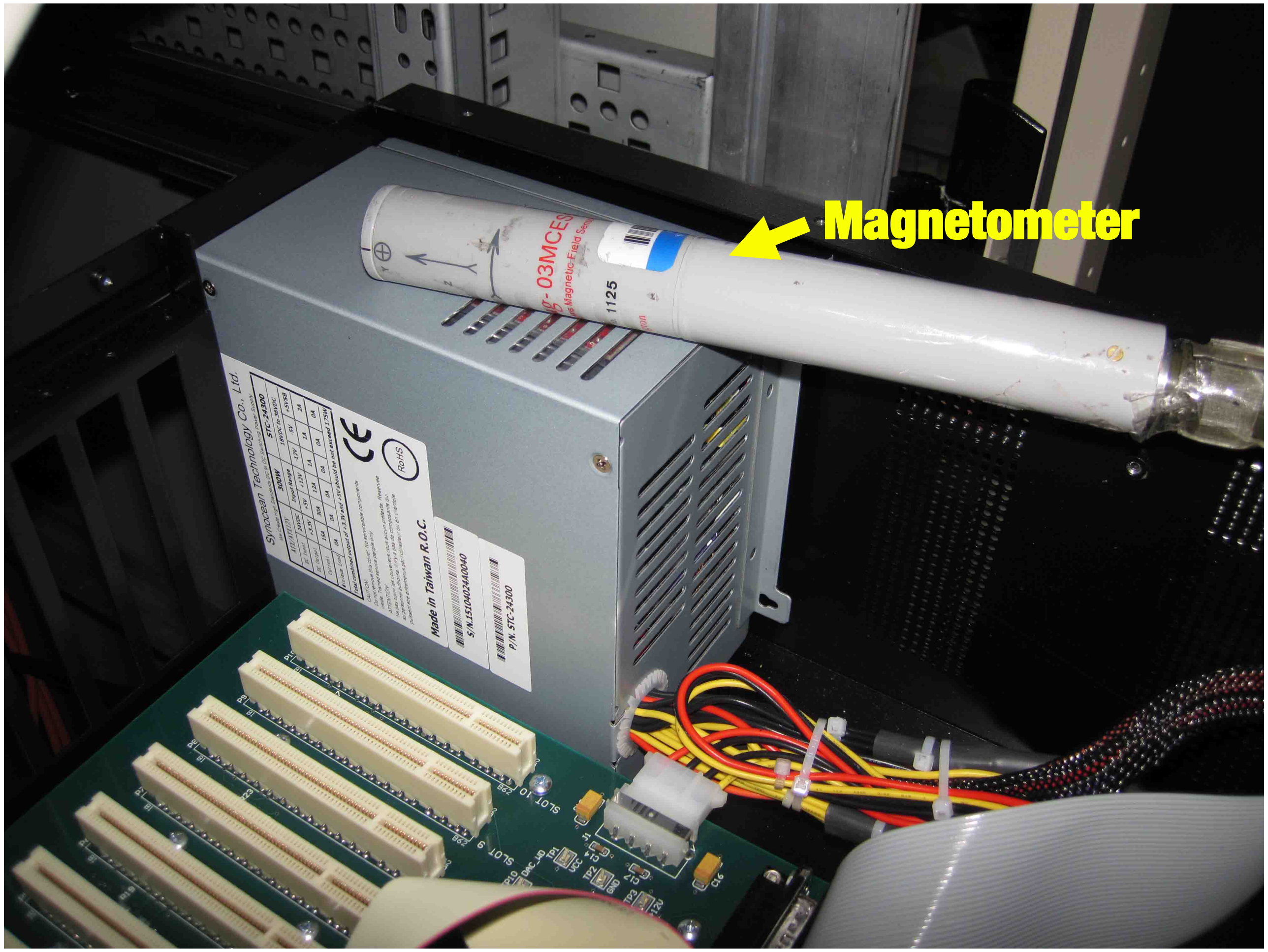
~~Recent~~ Investigations

I/O chassis (adc/dac) fans show up in channels

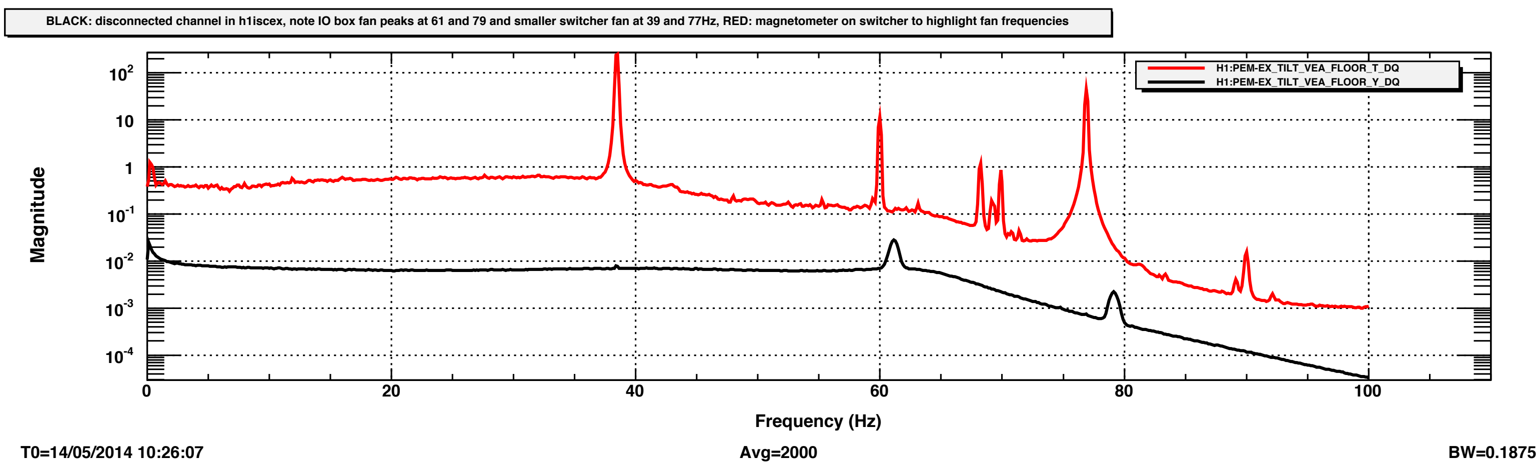
Coherence between magnetometer (signal has fan frequency) and OSEM channel in chasis. Peaks move when fan ports are partially covered.

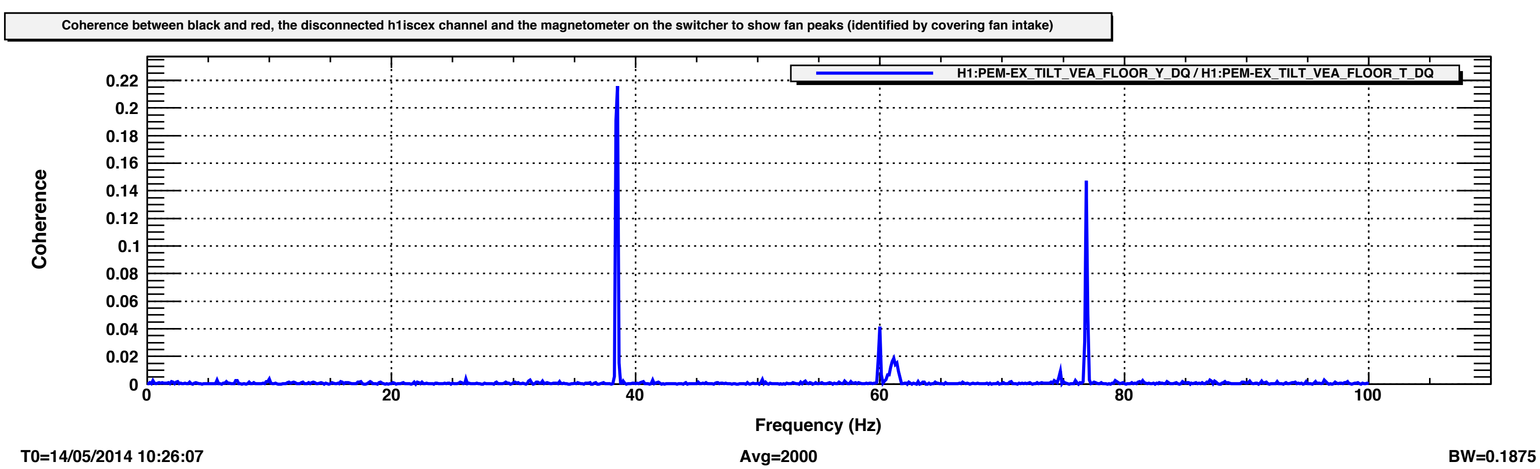


Magnetic field strongest at switching power supply for IO chasis



I/O boxes produce noise in their channels both by power supply ripple from the fans (can be fixed by using separate supply) and by magnetic coupling of fields from the switchers (probably needs different switcher).

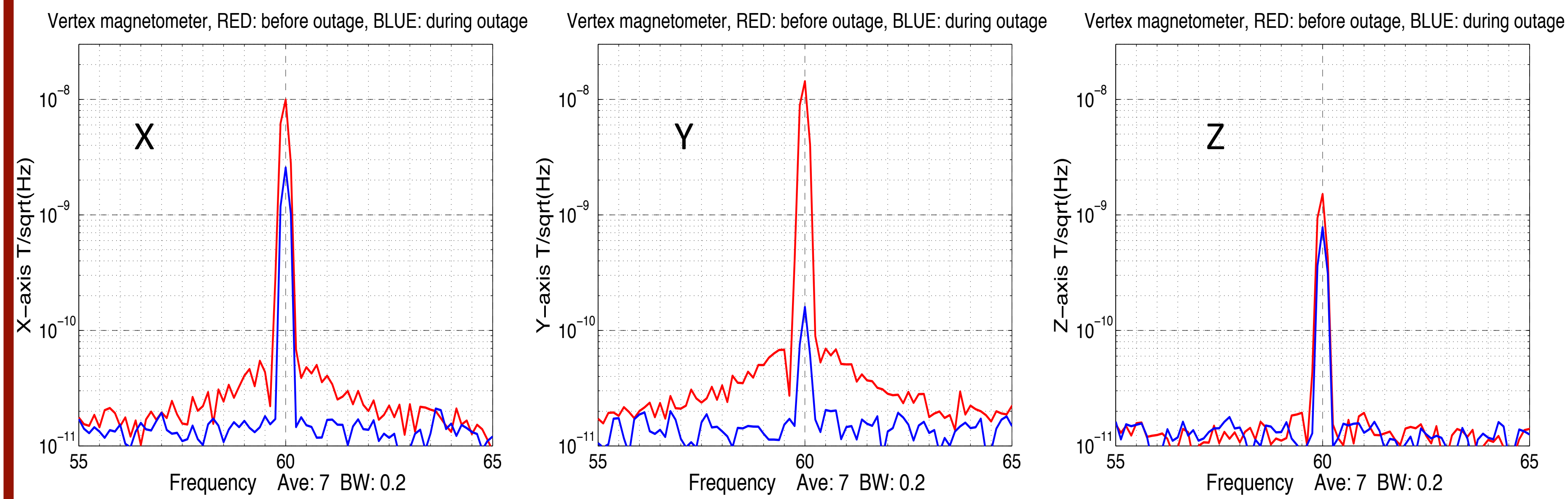




With Nelson Christensen, Jialun Luo, Patrick Meyers, Michael Coughlin, Eric Thrane, Keith Riles

Magnetometer during power outage

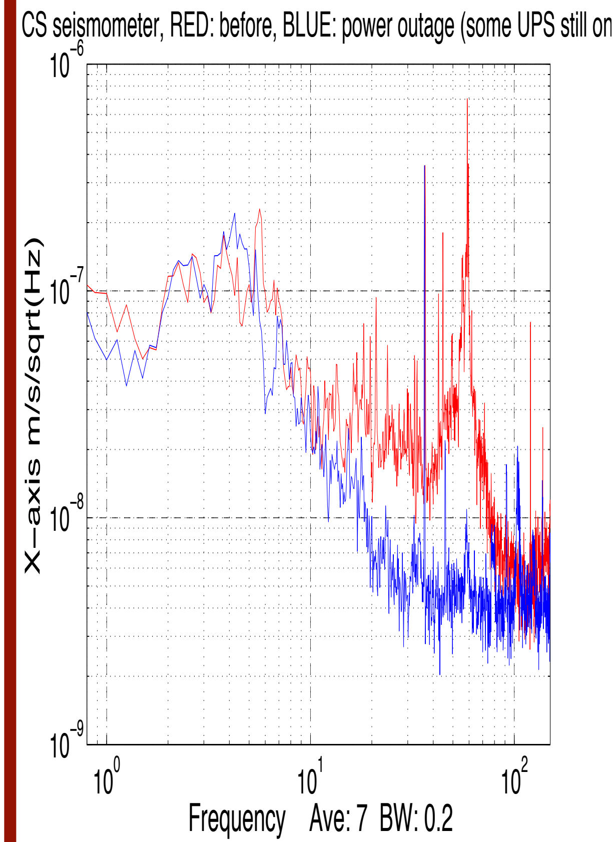
Shows what fraction of the 60 Hz magnetic peak comes from off-site, mainly the 500 kV Ashe-Slatt, Ashe-Marion transmission line

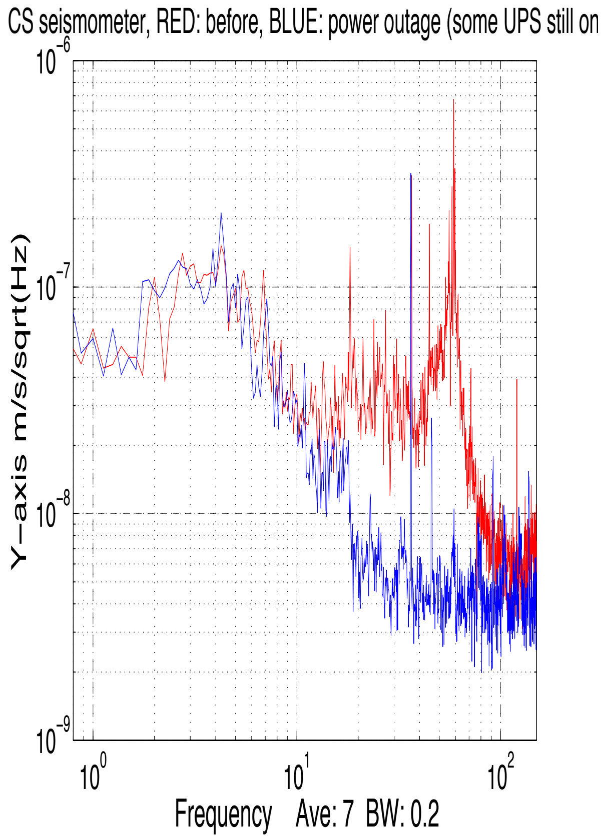


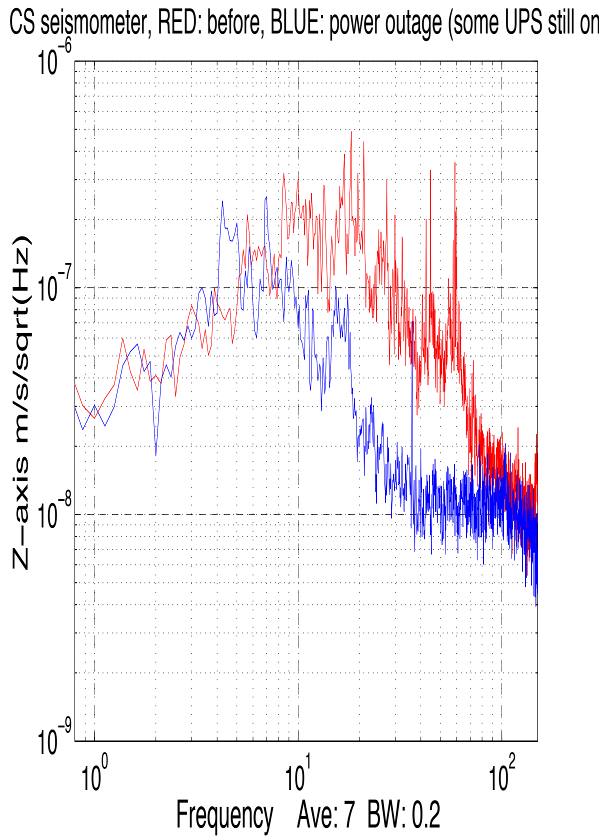
Total field now (about 3x science mode field): 7 nT, with power out, 1.1 nT

Seismometer during power outage

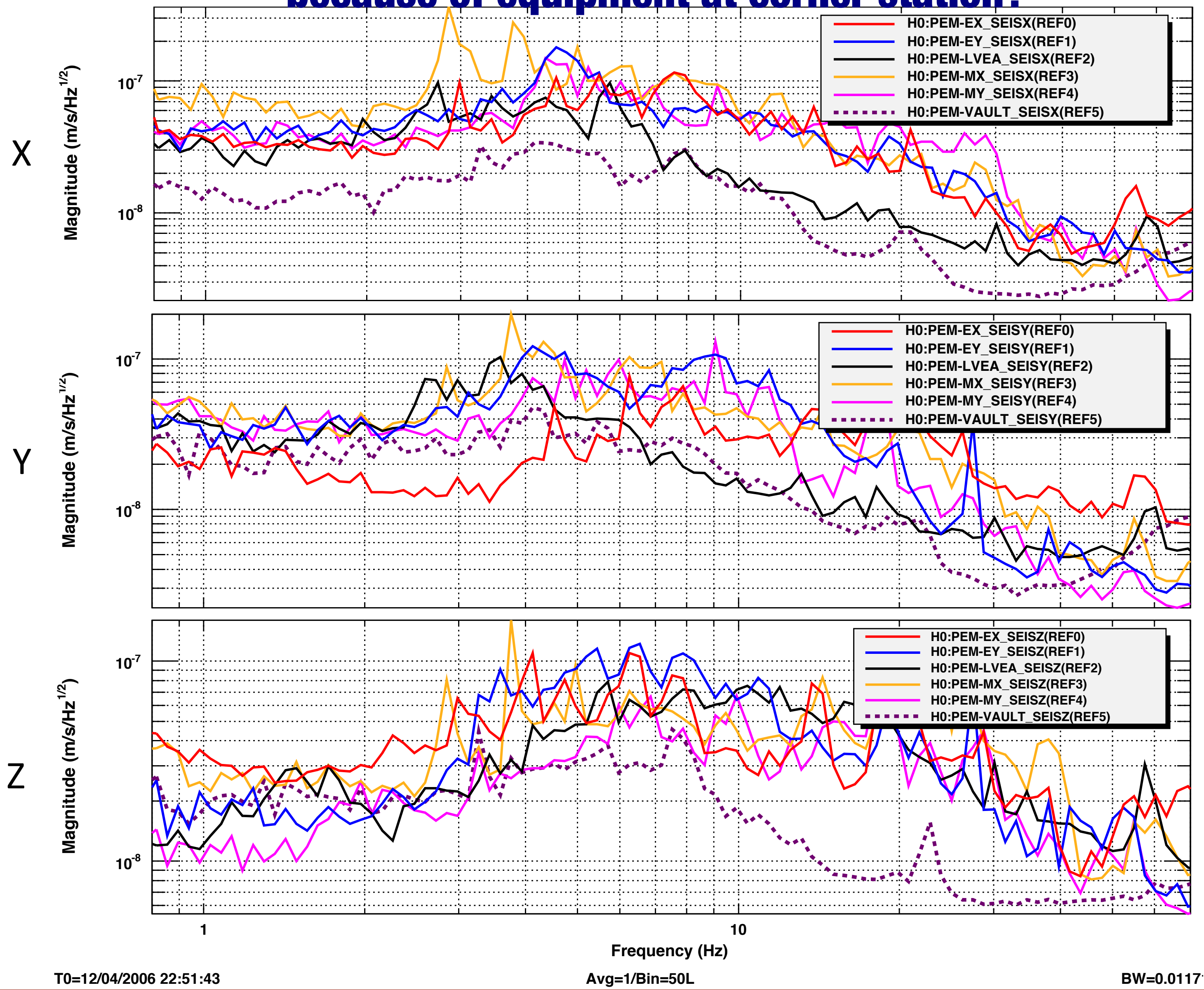
Our powered equipment increases ground motion by orders of magnitude near 60 Hz and, by ~5 down to 20 Hz for horizontal, and down to 10 Hz for vertical.





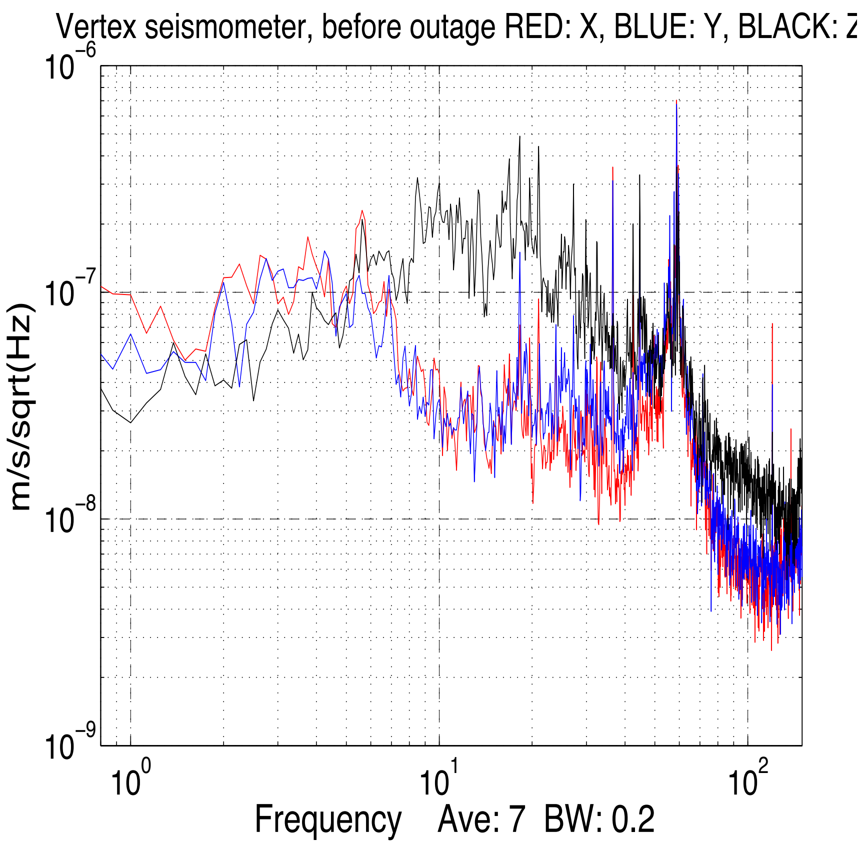


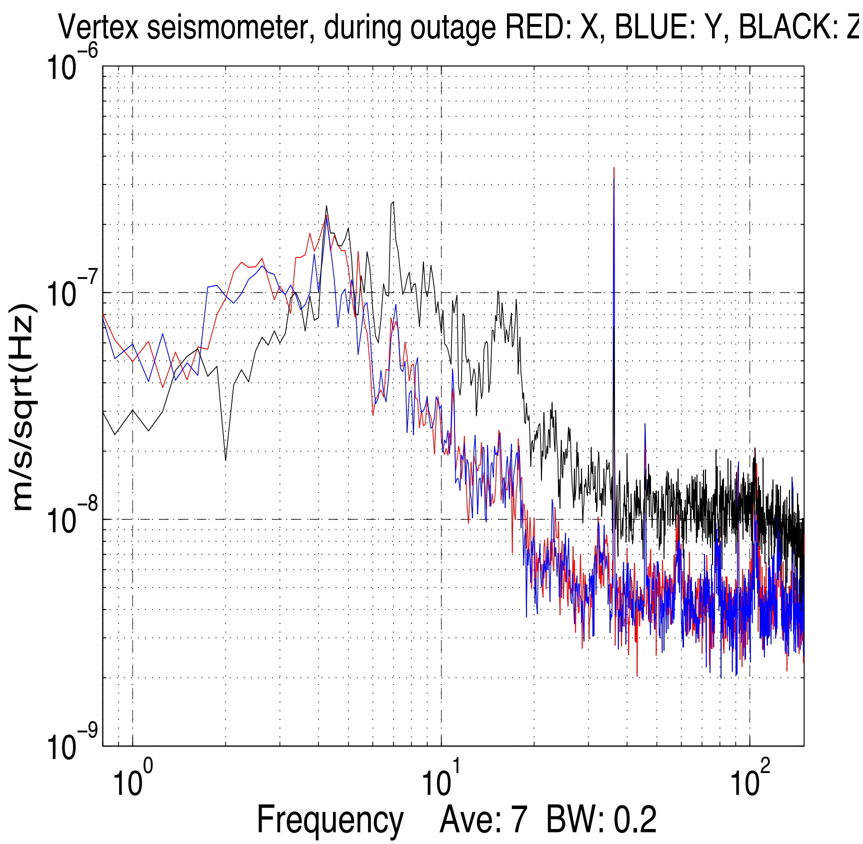
LHO corner station (black) is lower than 4 other stations in horizontal and higher in vertical. All axes are about the same at out-stations. Are these differences because of equipment at corner station?



Seismometer during power outage

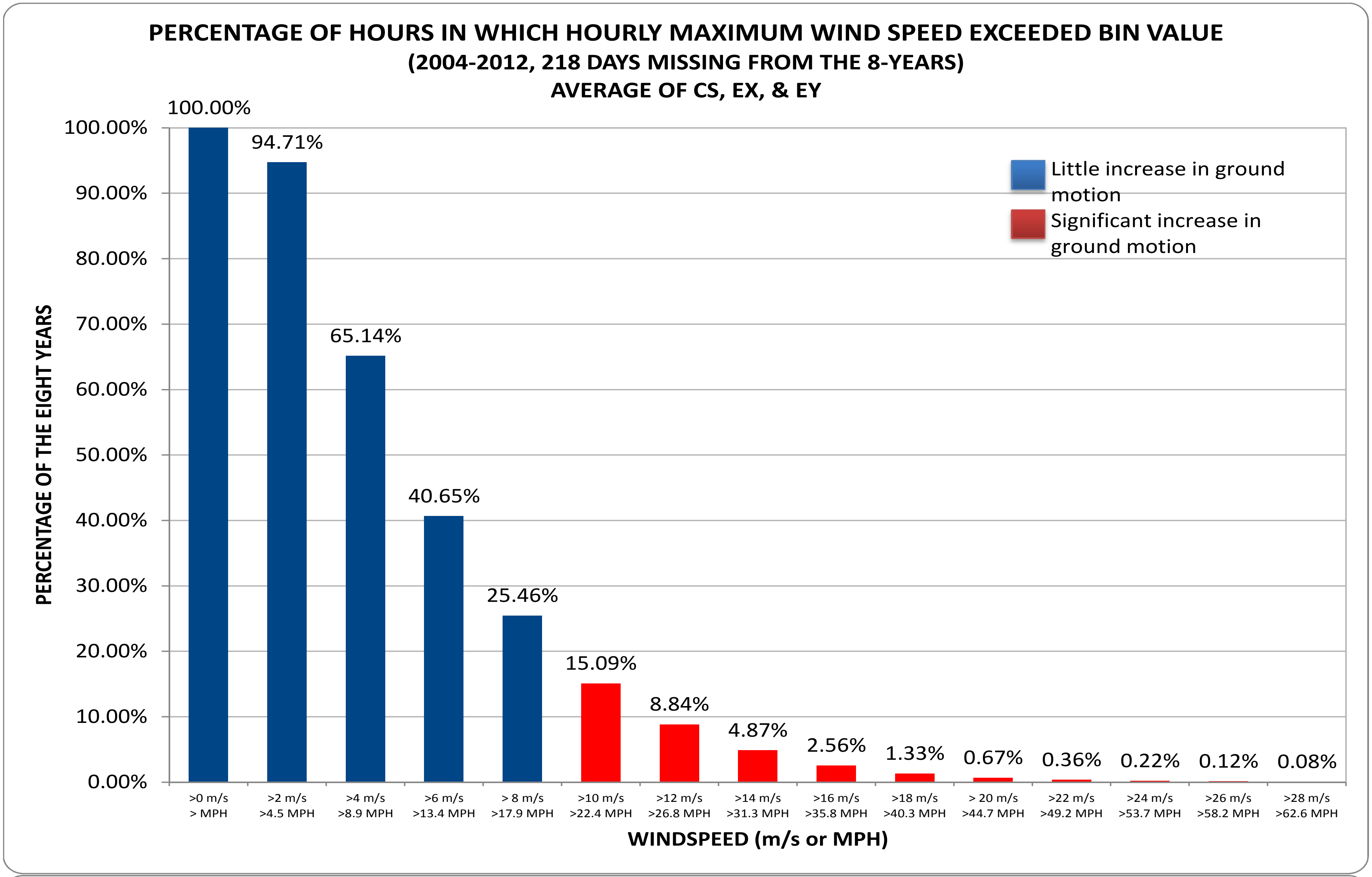
At the corner station, vertical motion is greater than horizontal, even during power outage. This suggests that slab or location is the cause (e.g. Love waves are blocked by large CS slab, and/or vertical resonance between slab and basalt layer).





8 Years of LHO wind data

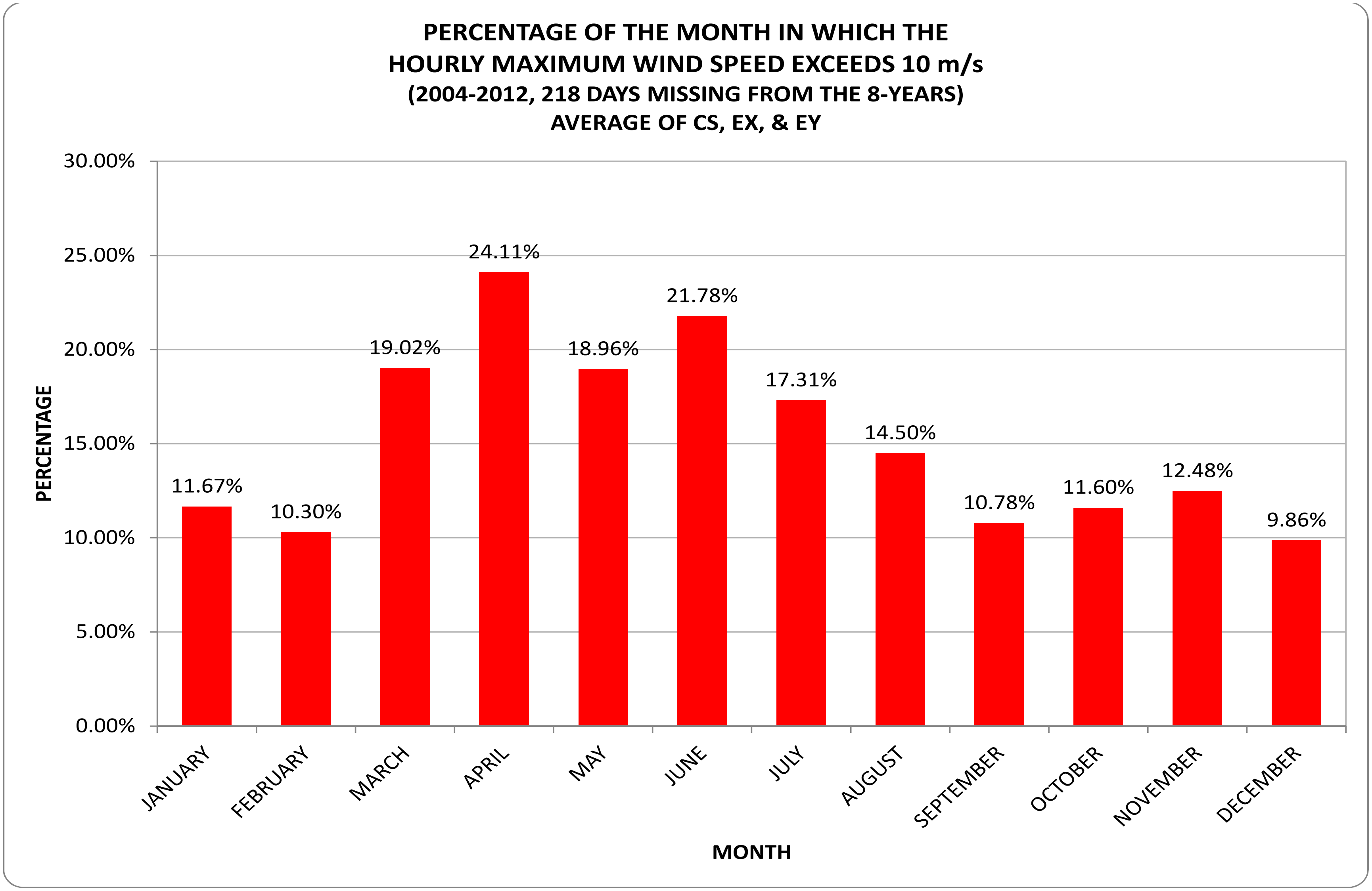
Wind increases ground motion in 15% of hours



From: Margarita Vidreo

8 Years of LHO wind data

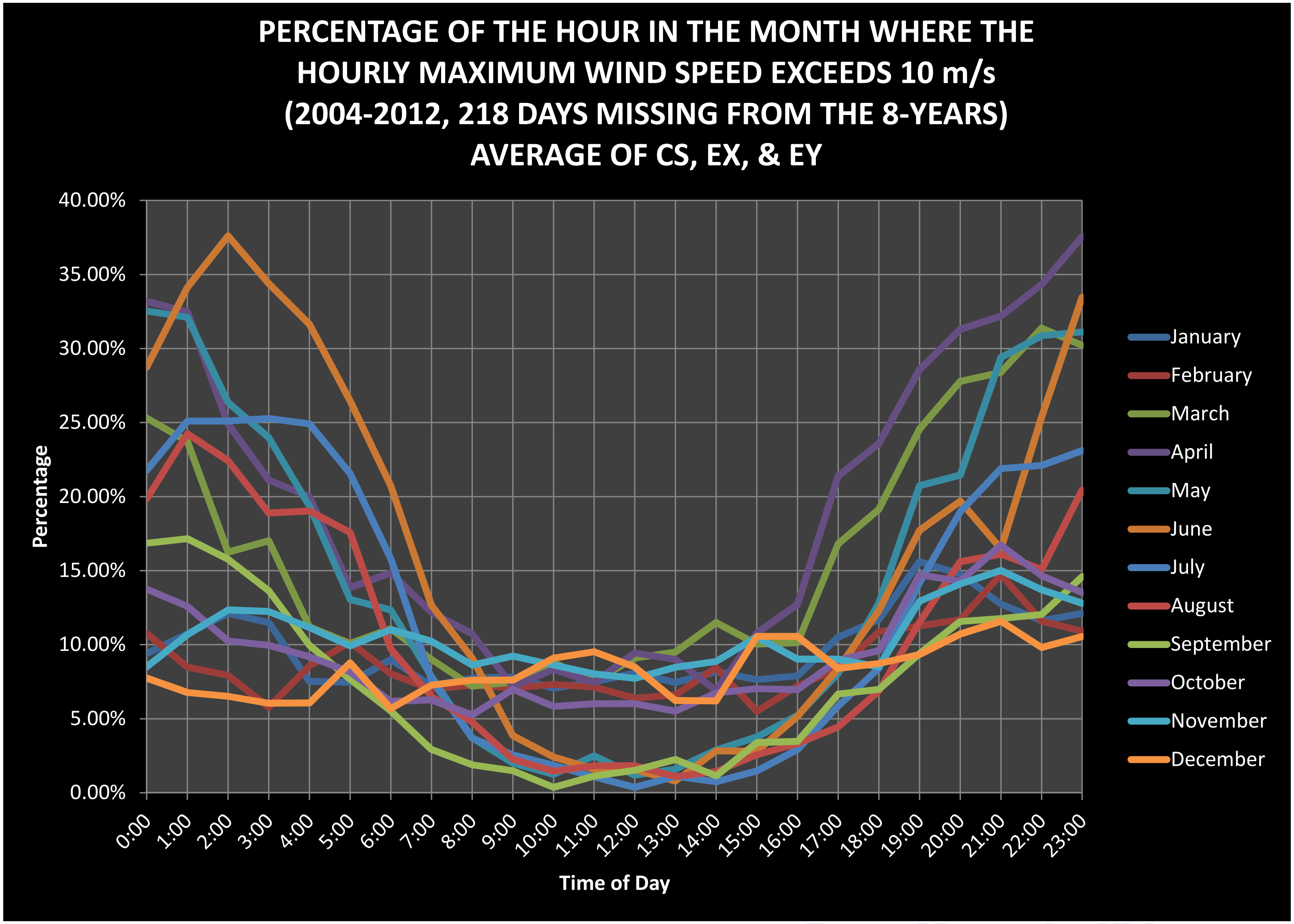
April is the worst month



From: Margarita Vidreo

8 Years of LHO wind data

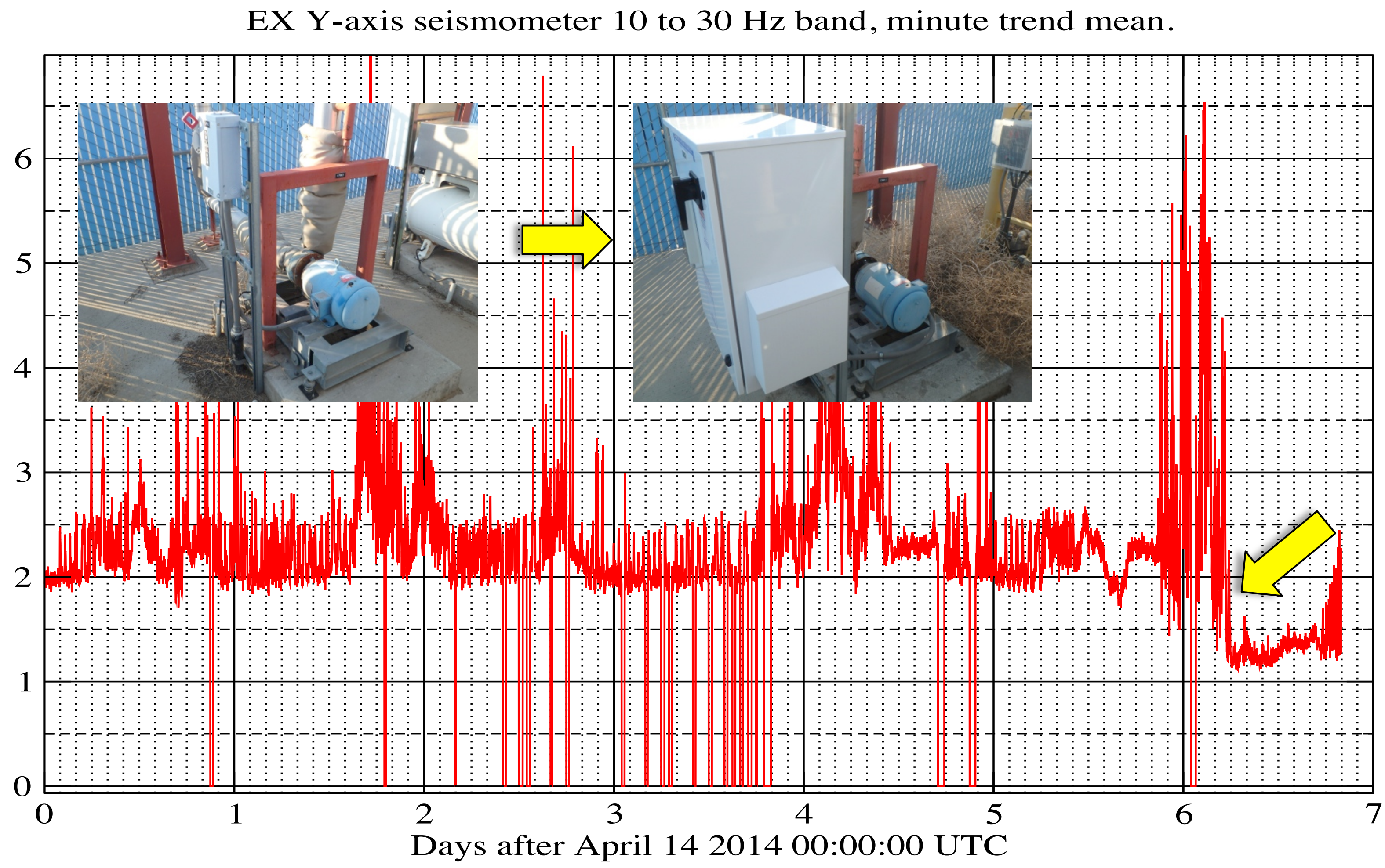
People shake the ground in the daytime, wind does at night



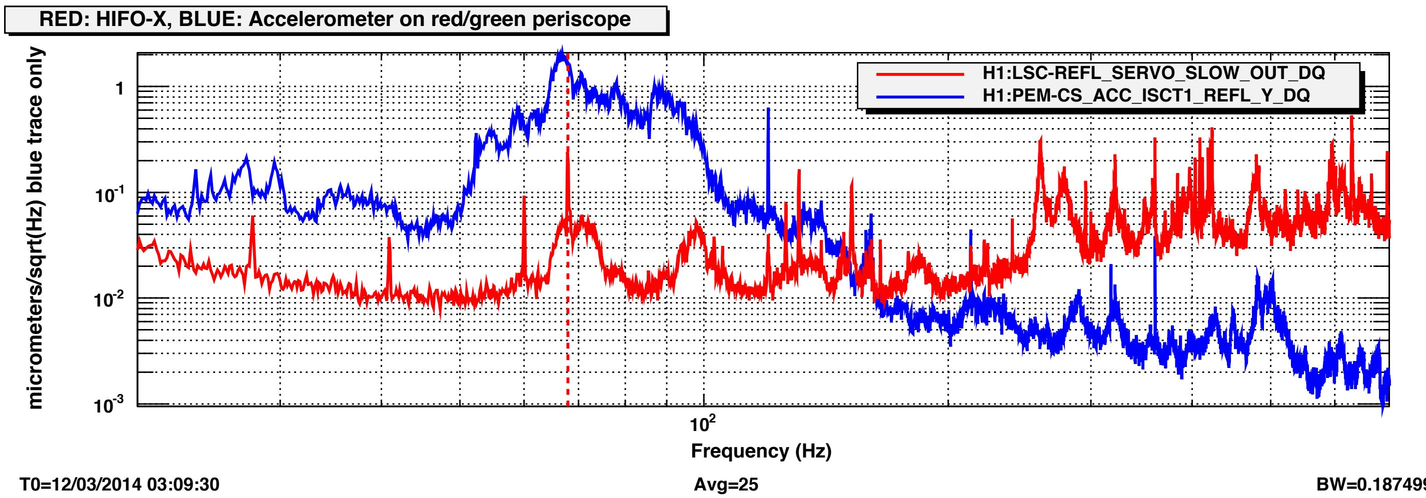
From: Margarita Vidreo

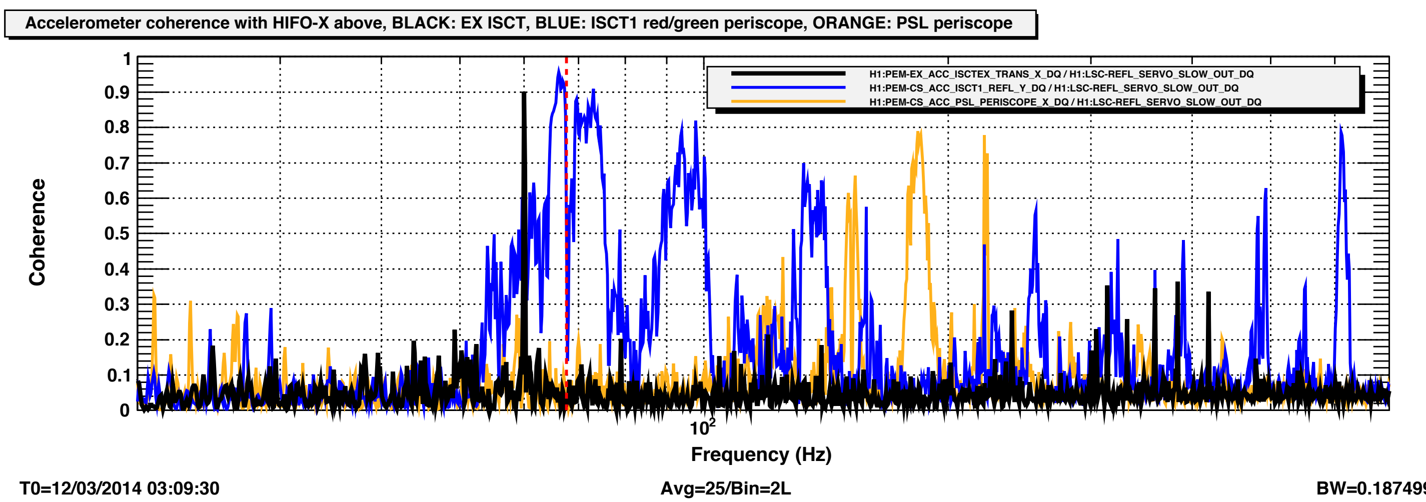
Chiller VFDs to reduce 10 Hz seismic

Turbulence in chiller lines produces broad 10 Hz peak at LHO. Test of variable frequency drive to reduce flow rate shows benefit. VFDs suggested for other chillers because turbulence is main driver of problematic SEI resonance.



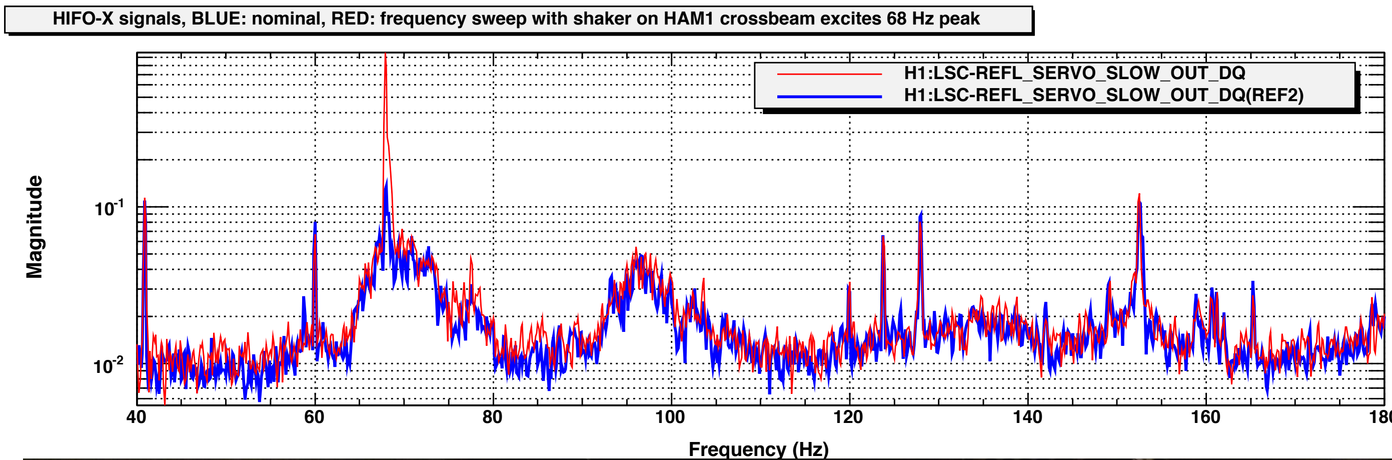
Vibrational coupling to HIFO-X ALS

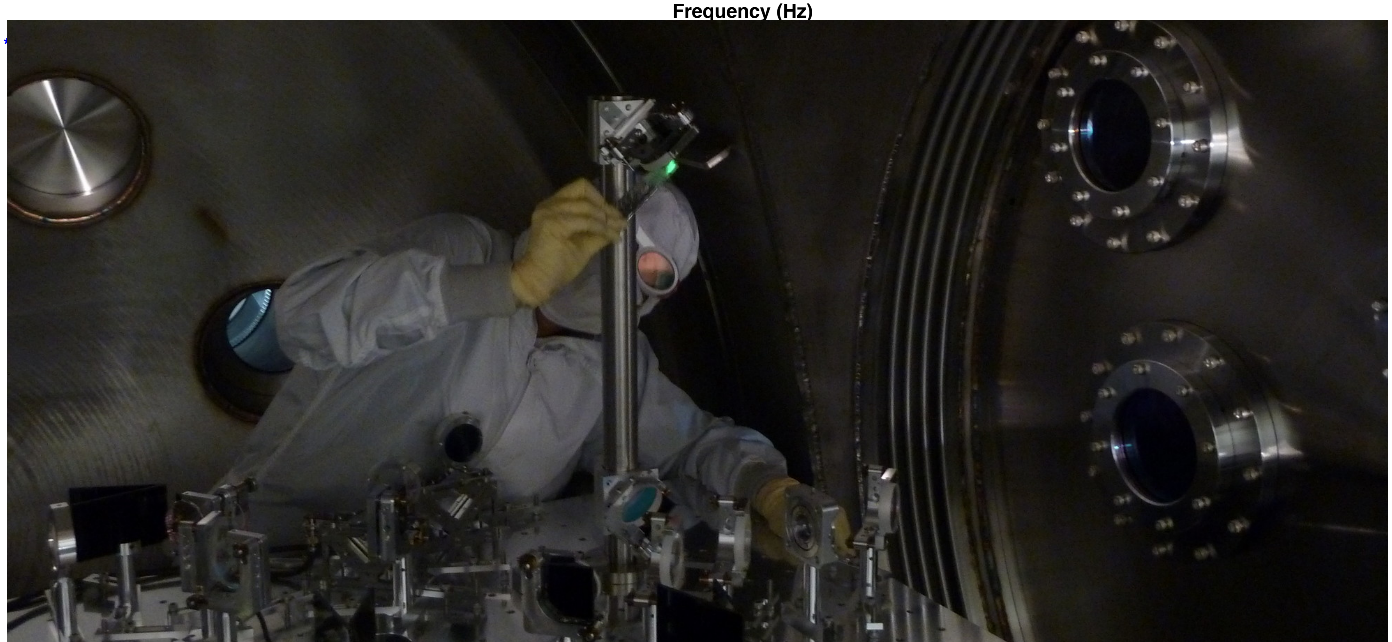




68 Hz peak

Shaking the HAM1 cross beam excites 68 Hz peak – source is inside HAM1. Very low f: likely the periscope that directs the beam out of the chamber.





PEM update, August 2014

I. PEM subsystem progress
II. Latest magnetic coupling results
III. Risk mitigation studies
  A. Magnetic coupling (smaller magnets, geomagnetism)
  B. Acoustic coupling to in-vacuum tables
  C. Scattering noise
IV. Other studies
  A. Channel contamination from I/O box
  B. Power outages studies of self-inflicted noise
  C. LHO wind statistics
  D. Reducing 10 Hz noise from water turbulence
  E. HIFO-X ALS acoustic coupling