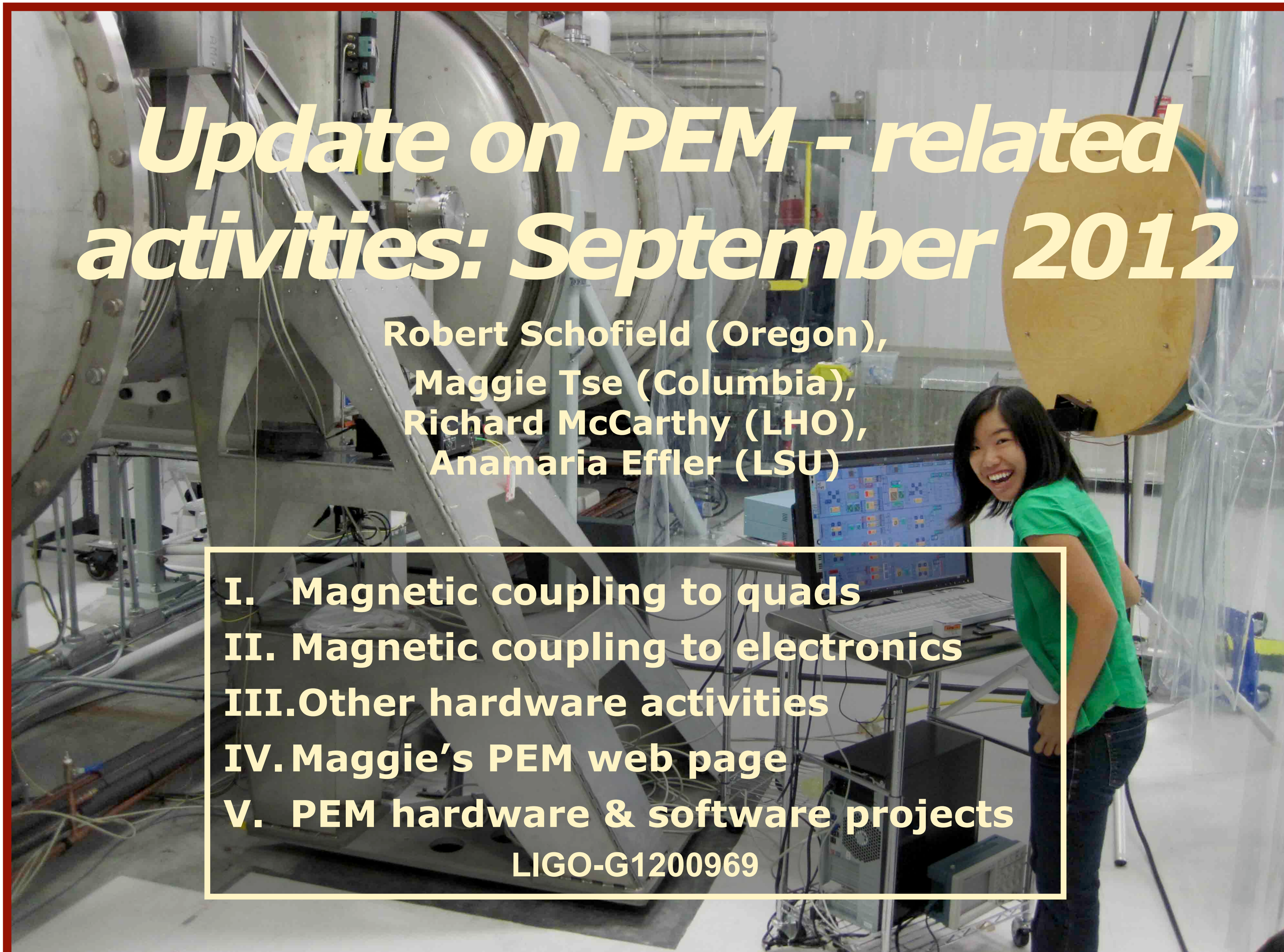


Update on PEM - related activities: September 2012

Robert Schofield (Oregon),
Maggie Tse (Columbia),
Richard McCarthy (LHO),
Anamaria Effler (LSU)

I. Magnetic coupling to quads
II. Magnetic coupling to electronics
III. Other hardware activities
IV. Maggie's PEM web page
V. PEM hardware & software projects

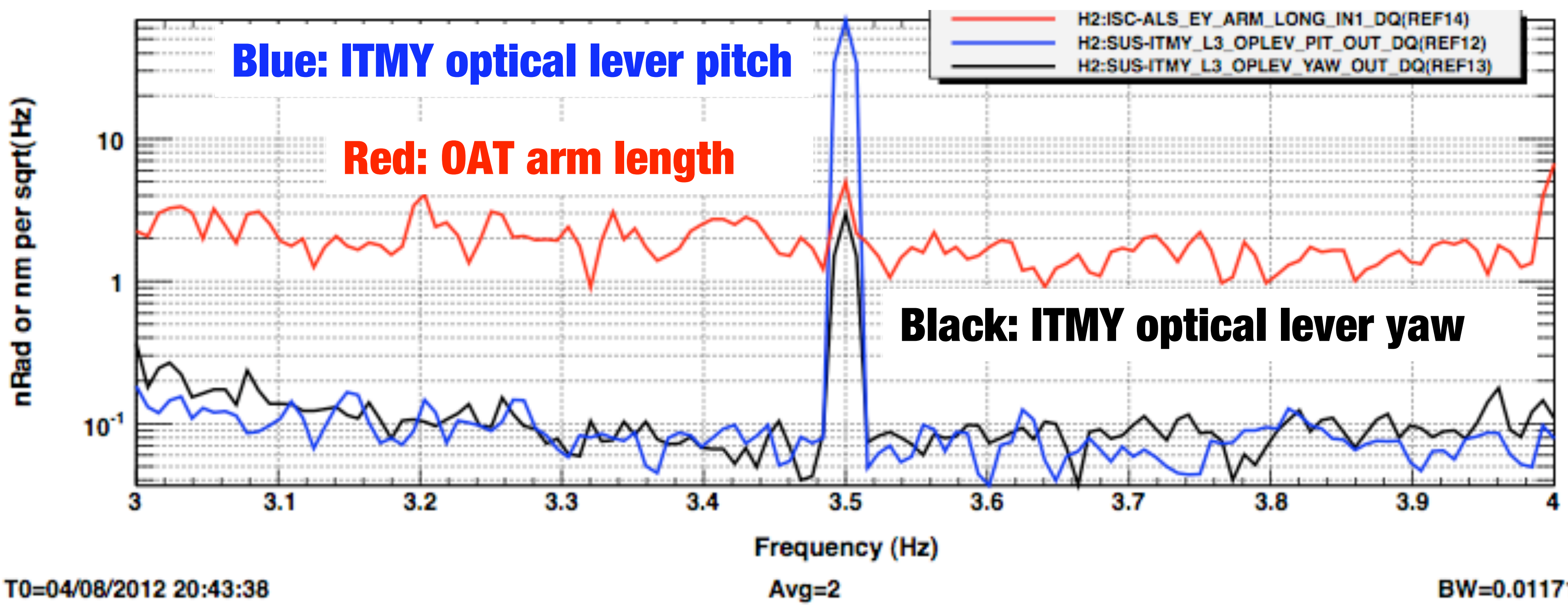
LIGO-G1200969

Study of magnetic coupling to quad

Injection coils at ITMY in pseudo-Helmholtz configuration

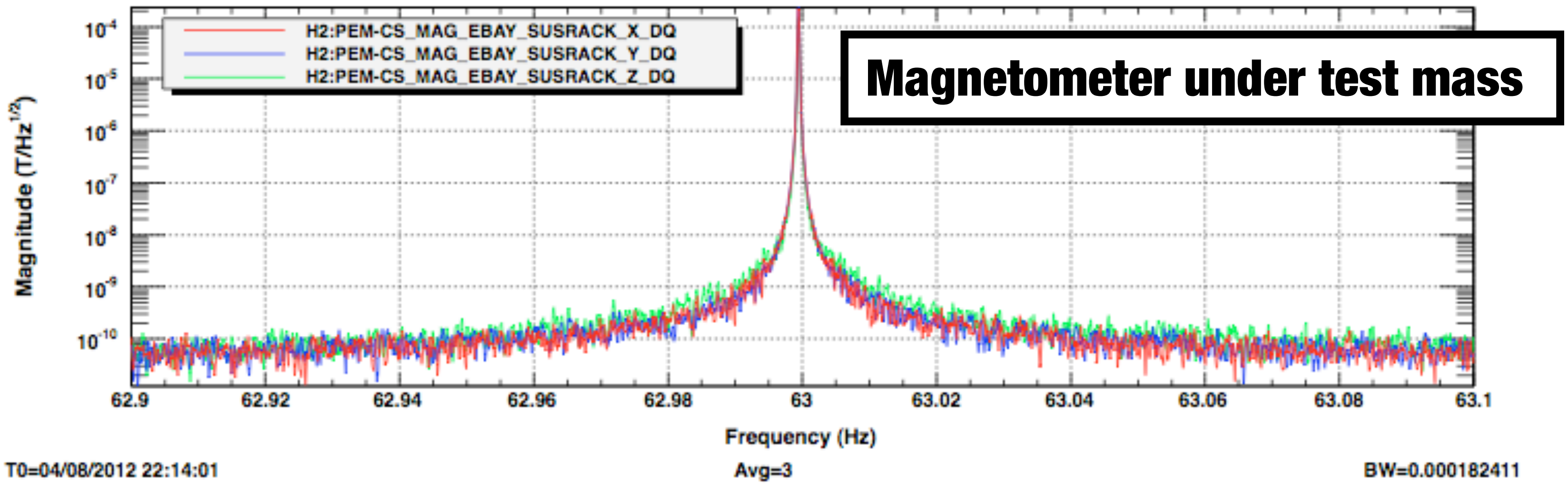
3.5 Hz Injection

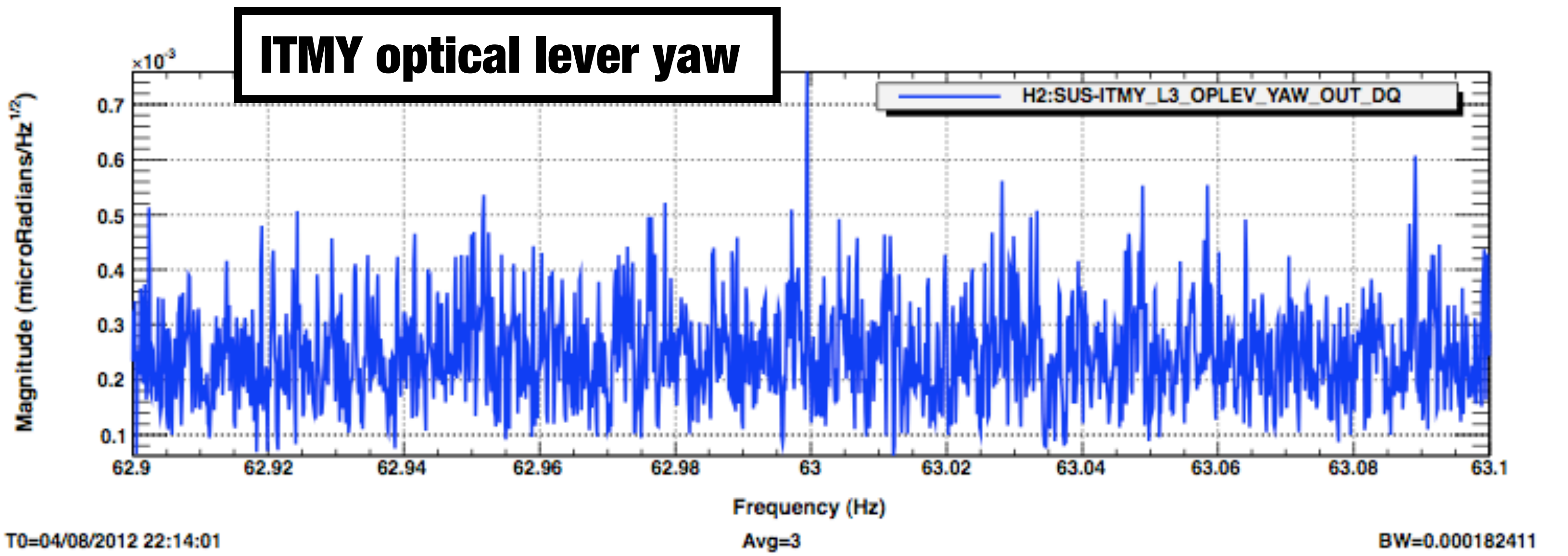
Evident in one arm test arm length and optical lever



63 Hz injection

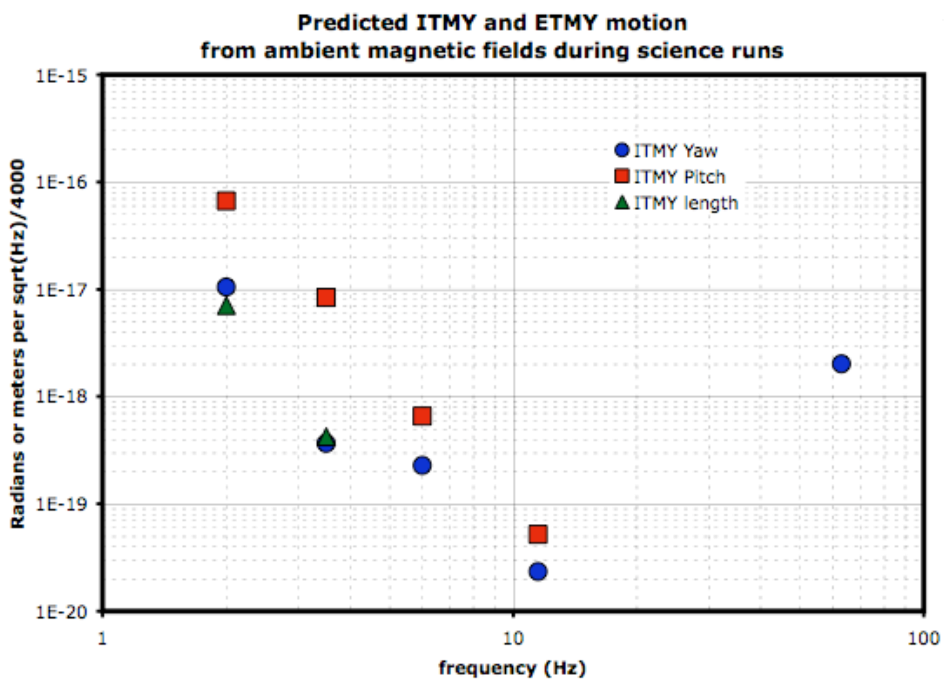
Evident on optical lever

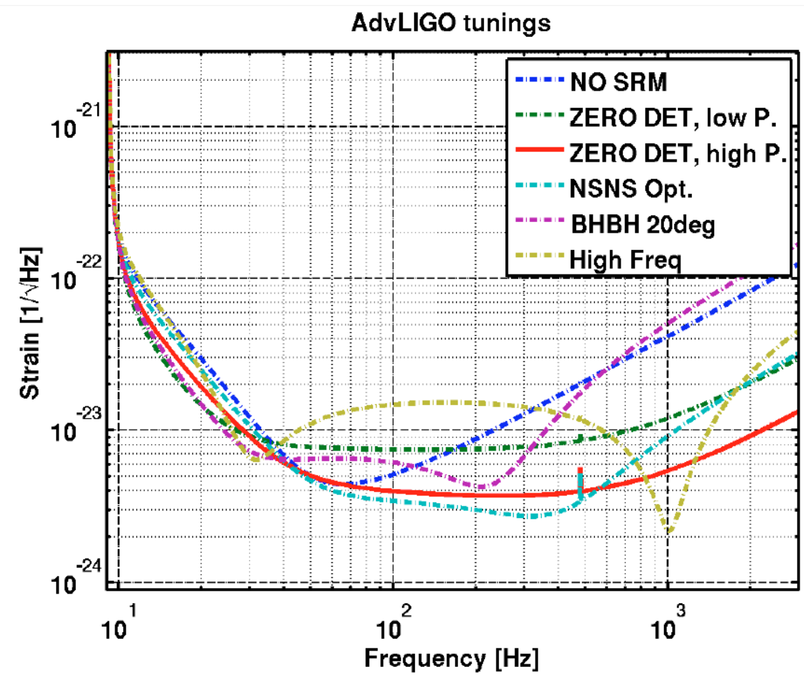




Predicted motion

Assumes linear coupling (motion/field = constant), predicts motion from ambient magnetic fields measured in S6

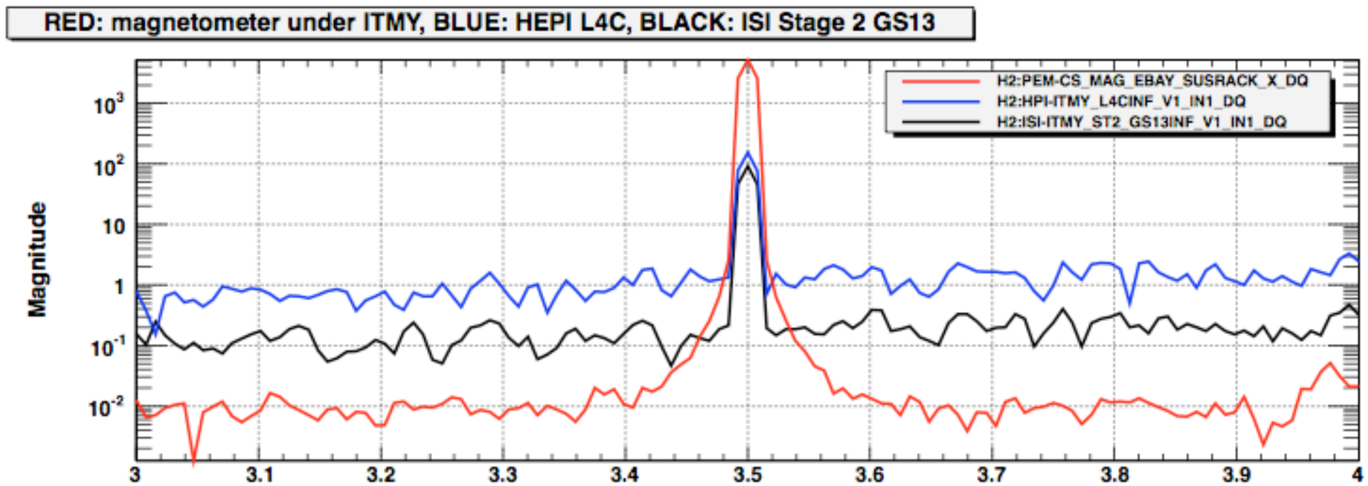


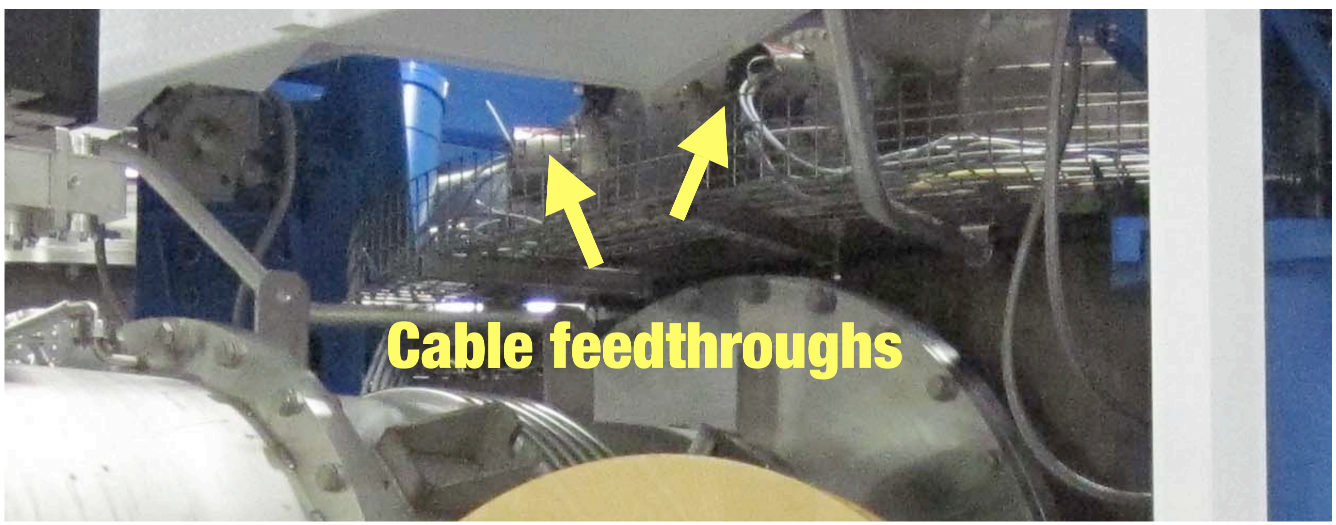


Exceeds aLIGO curve at 11.5 Hz by about 3 orders of magnitude and 60 Hz peak would be 5 orders of magnitude tall

Coupling at HEPI, ISI, SUS cables?

Injection shows up on HEPI & ISI as well as SUS channels

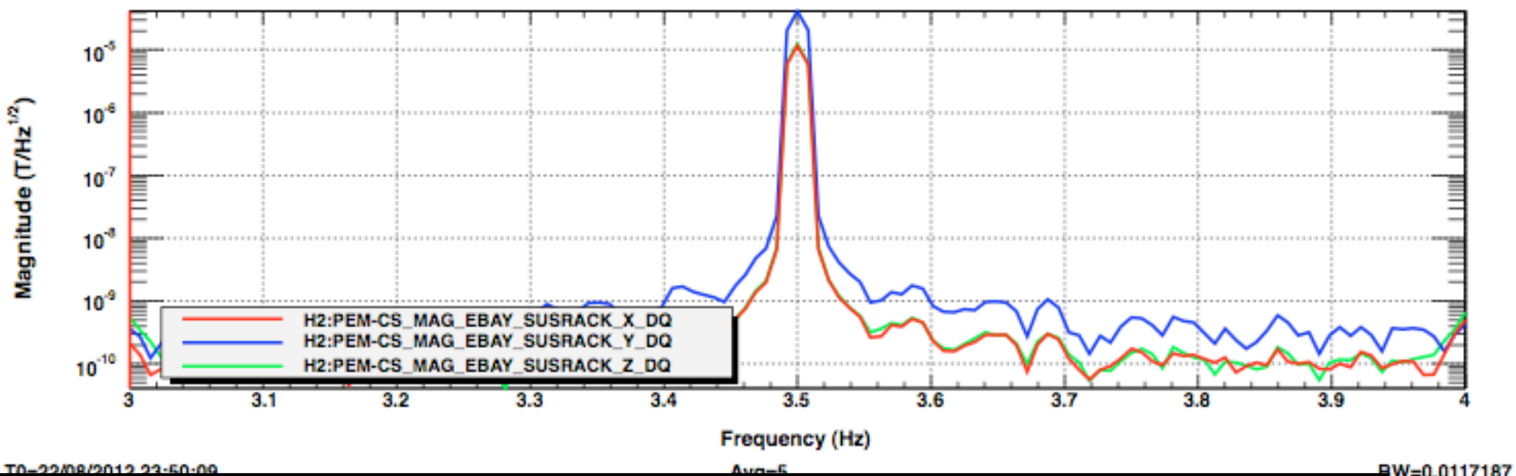




Coupling is not to coil circuits

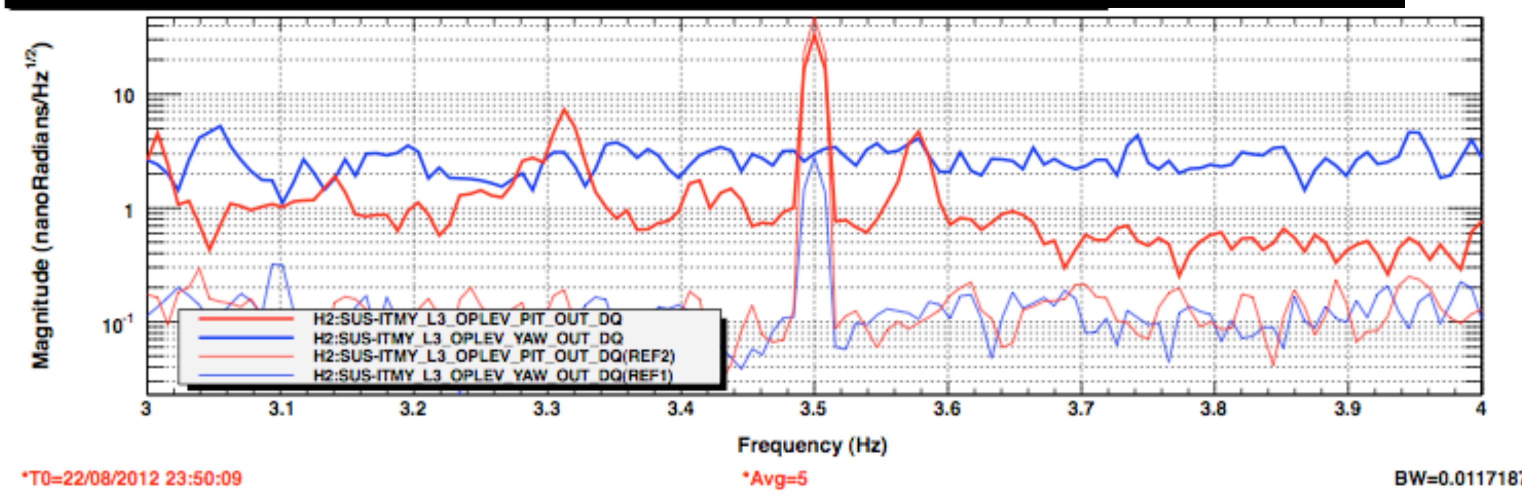
Disconnected SUS at satellite amp, ISI at coil drive, HEPI off

Magnetic field near ITMY



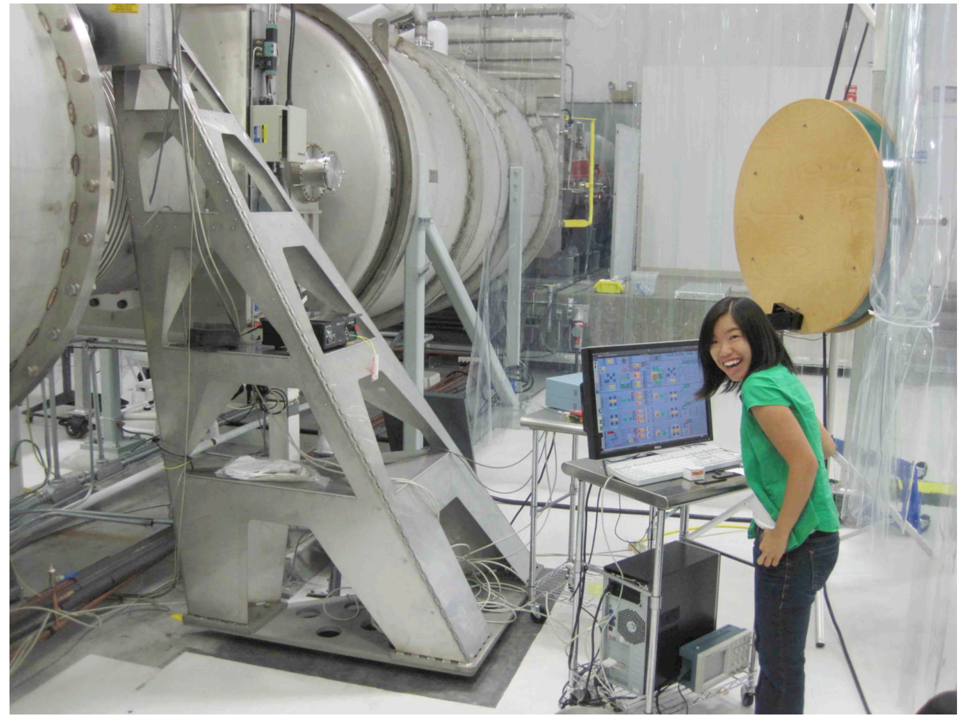
Red: pitch, Blue: yaw, Thick: disconnected, Thin: connected

Optical lever



Checks

1) Coupling to optical lever? Much higher fields at optical lever and its electronics produced smaller peak in optical lever channel.



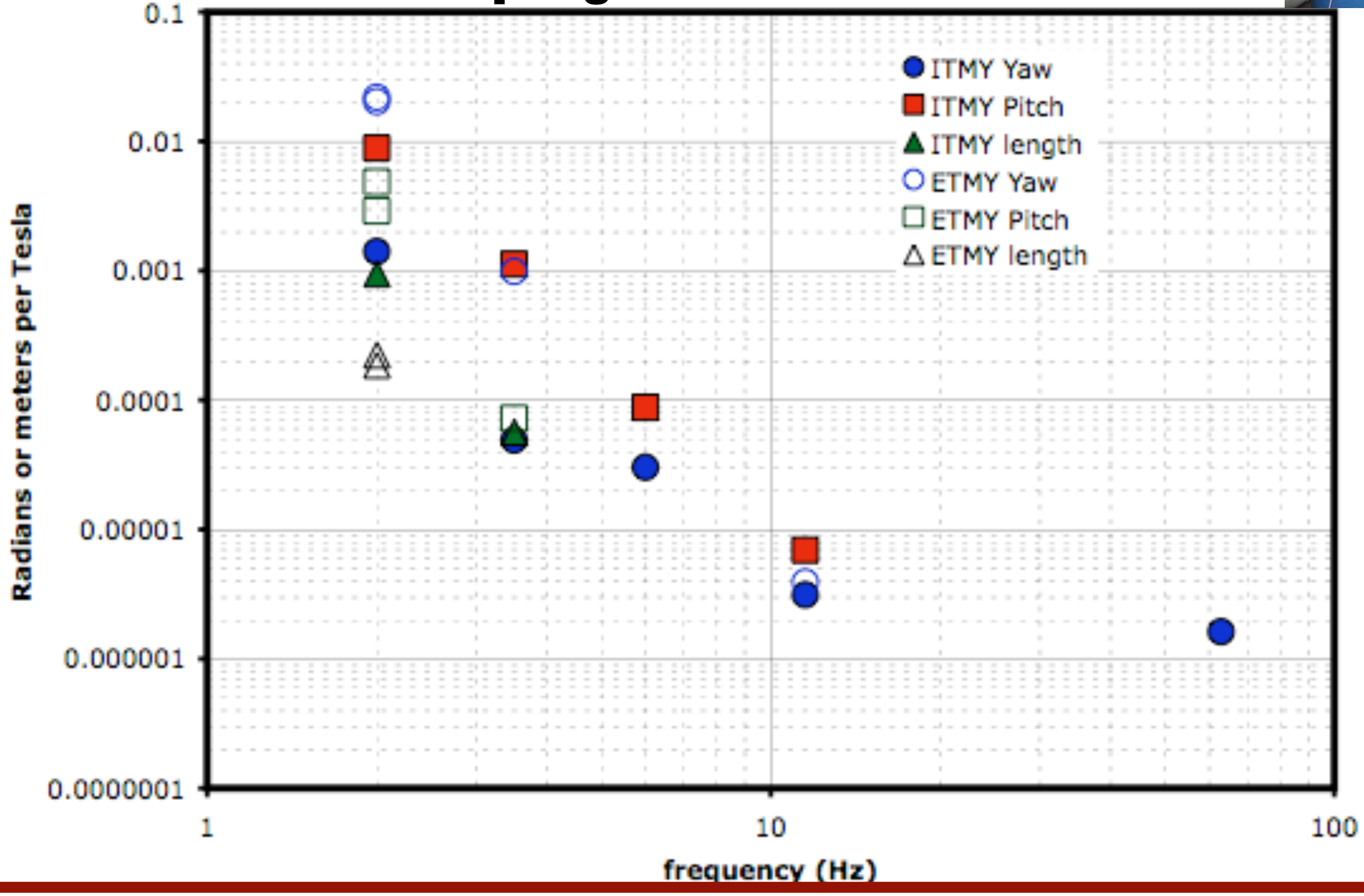
2) Linear coupling? Increased field by 2.98 increased motion by 3.00 (uncertainty a couple of percent).

3) Calibration? In-situ magnetometer calibration

Injections at ETMY

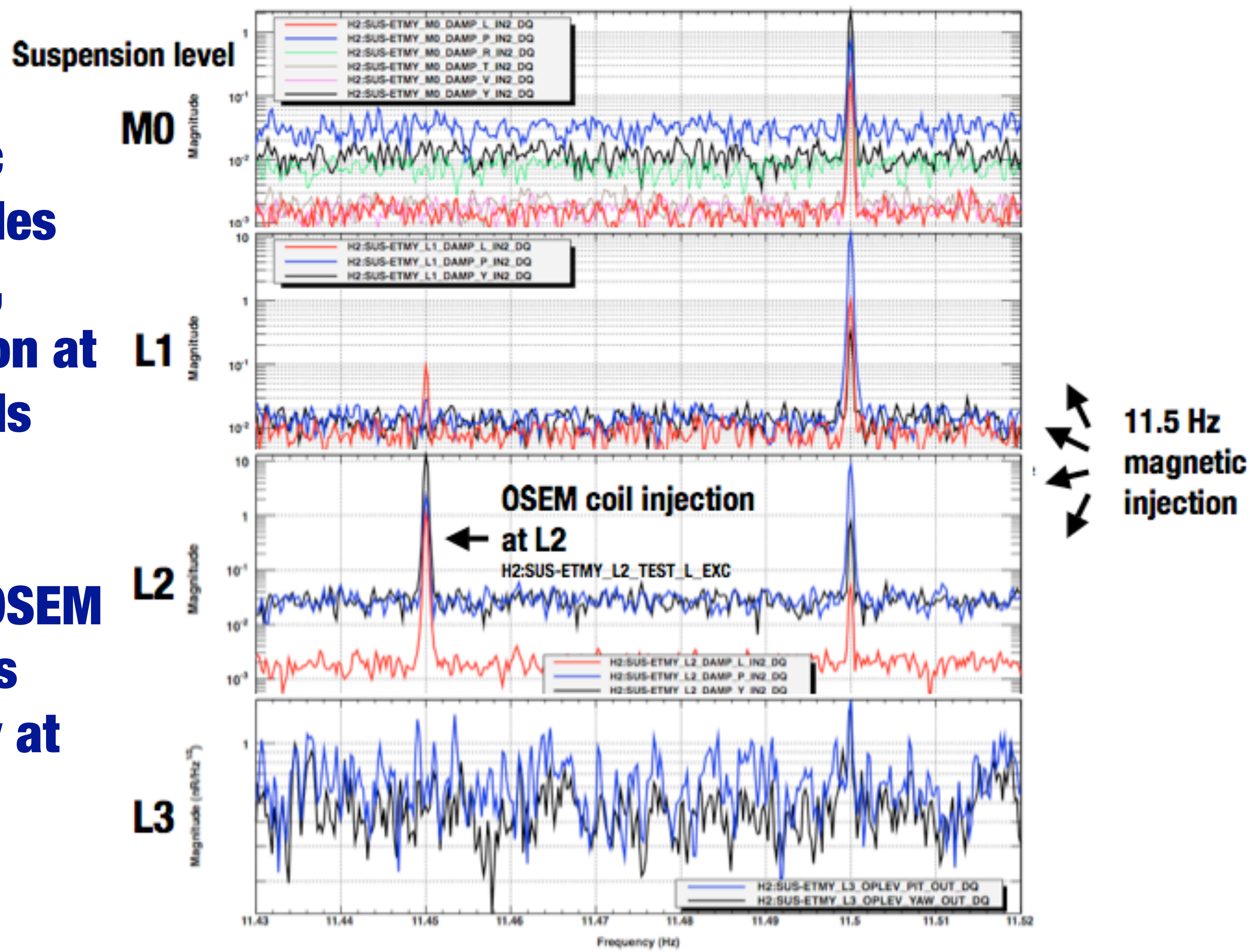
Found coupling similar to coupling at ITMY

Coupling functions m/T or R/T



Field couples at multiple levels

If magnetic field couples only at L2, then motion at other levels should be similar to when an OSEM injection is made only at L2.



Caveats

1) The cable coupling test was at ITMY, coupling to multiple SUS levels seen at ETMY: could ETMY coupling be to cables? But similar coupling levels at ETMY and ITMY…

2) Linearity was only studied at ITMY at 3.5 Hz, and may not apply to the coupling mechanism at 63 Hz or ETMY at 11.5 Hz.

My suggestions

1) More tests at higher sensitivity.

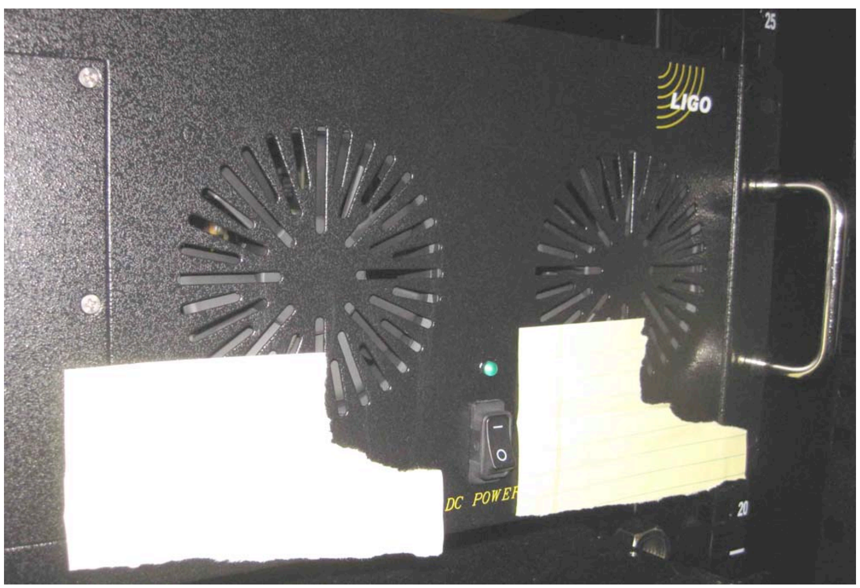
2) ETMY and ITMY both have eddy current damping magnets. Investigate first damping magnet-free suspensions.

3) Off line investigations (e.g. at LASTI)? Remove magnets one by one and monitoring coupling with optical lever.

4) Mechanism that might increase coupling - eddy currents can turn low gradient fields into high gradients near metal surfaces.

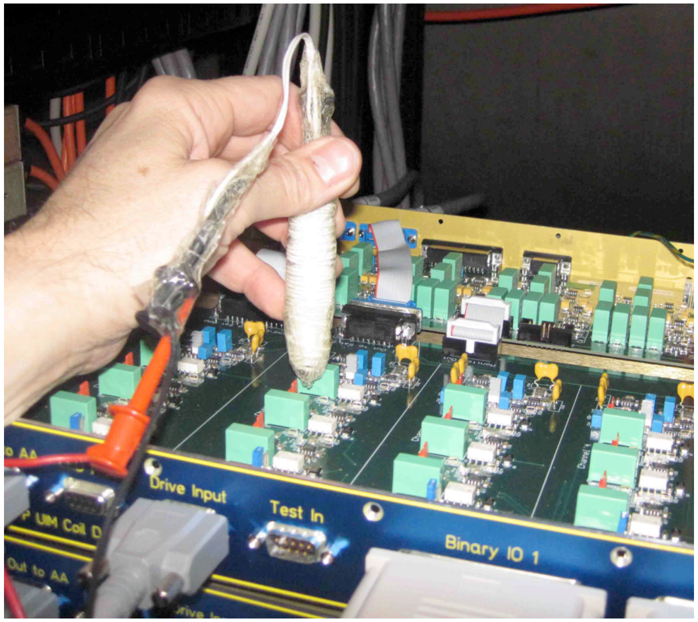
Magnetic coupling to electronics

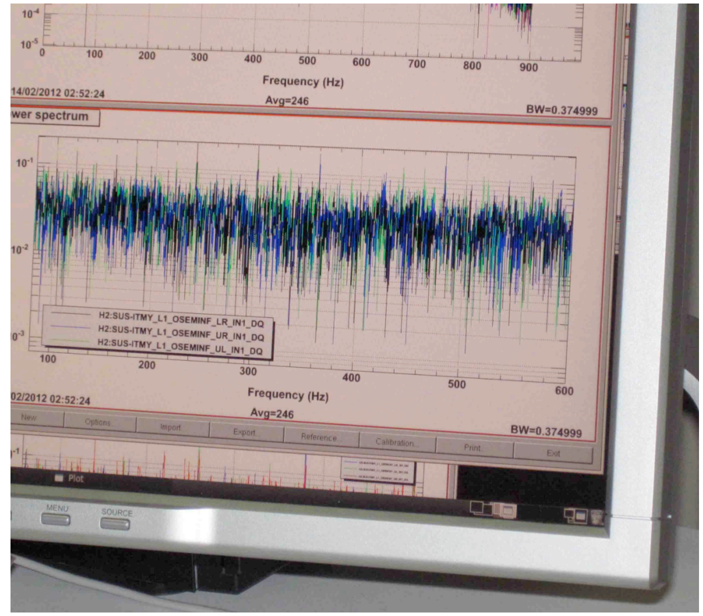
Magnetically loud I/O chasis power supply produced signals that nearly showed up in channels. **Where is field coupling?**

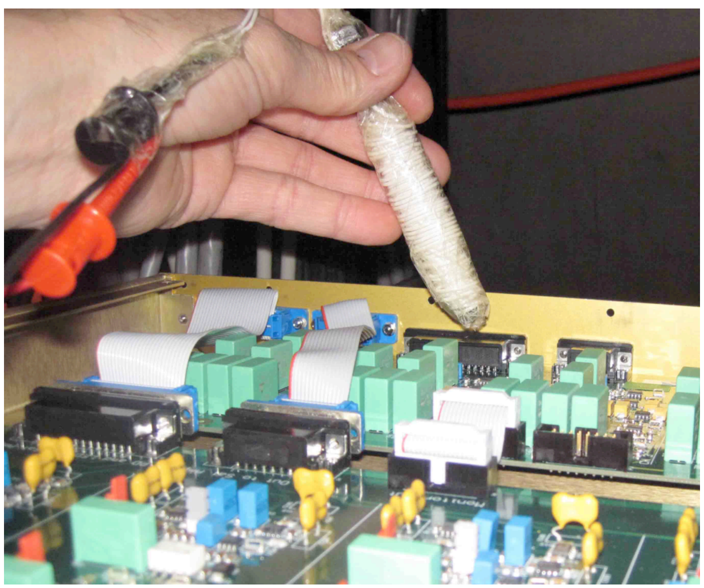


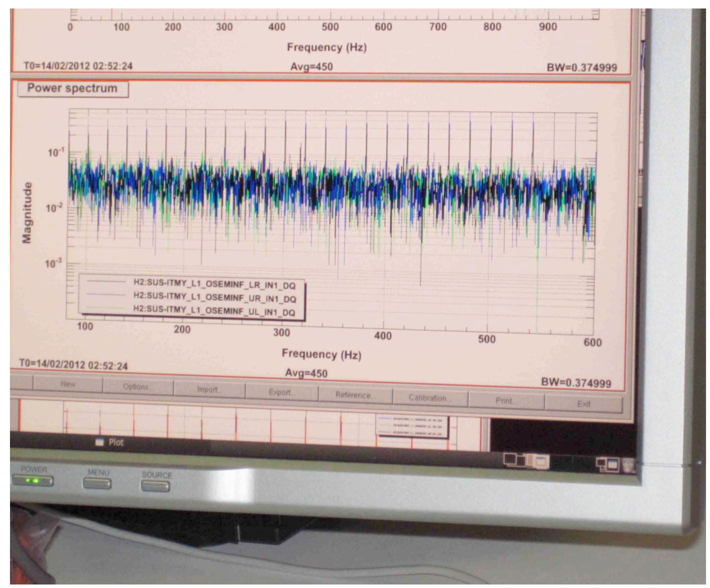
I/O chasis fans showed up in channels, less when separate fan power supply. **How much less?**

Coupling at connectors









Summary of magnetic coupling to electronics investigation

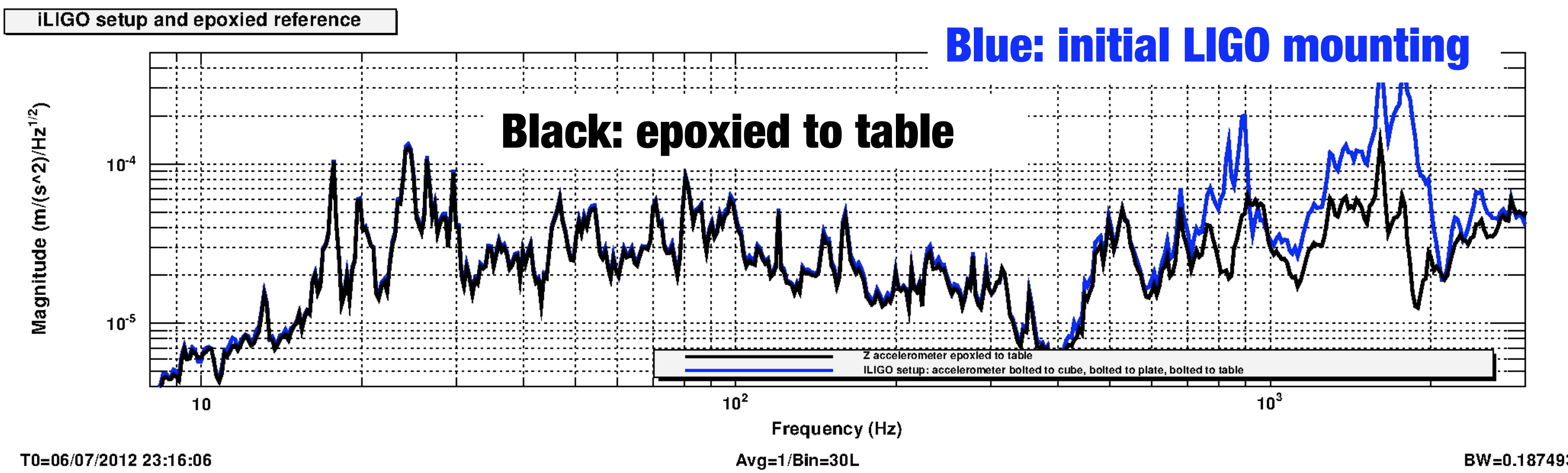
1) I/O chasis power supply magnetically very noisy - could show up on channels - CDS is replacing

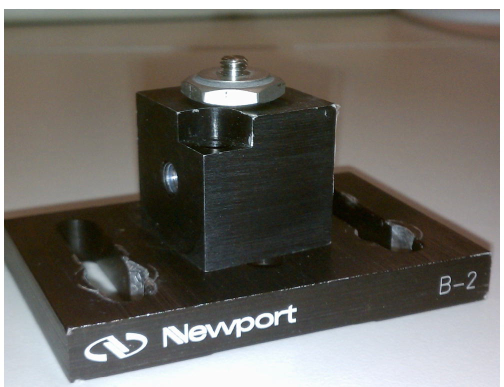
2) Magnetic coupling mainly at cable connections, not components

3) Running I/O chasis fans on a separate power supply reduces fan peaks by more than 10

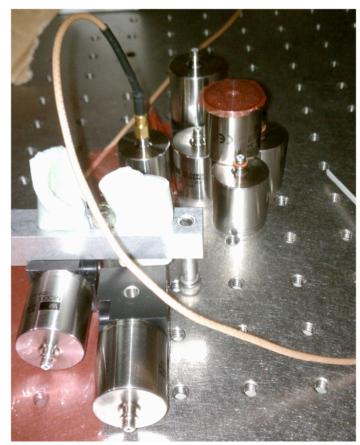
4) Keep cables from running near power supplies (power supply to nearby cable was dominant power supply coupling mechanism)

Accelerometer mounting





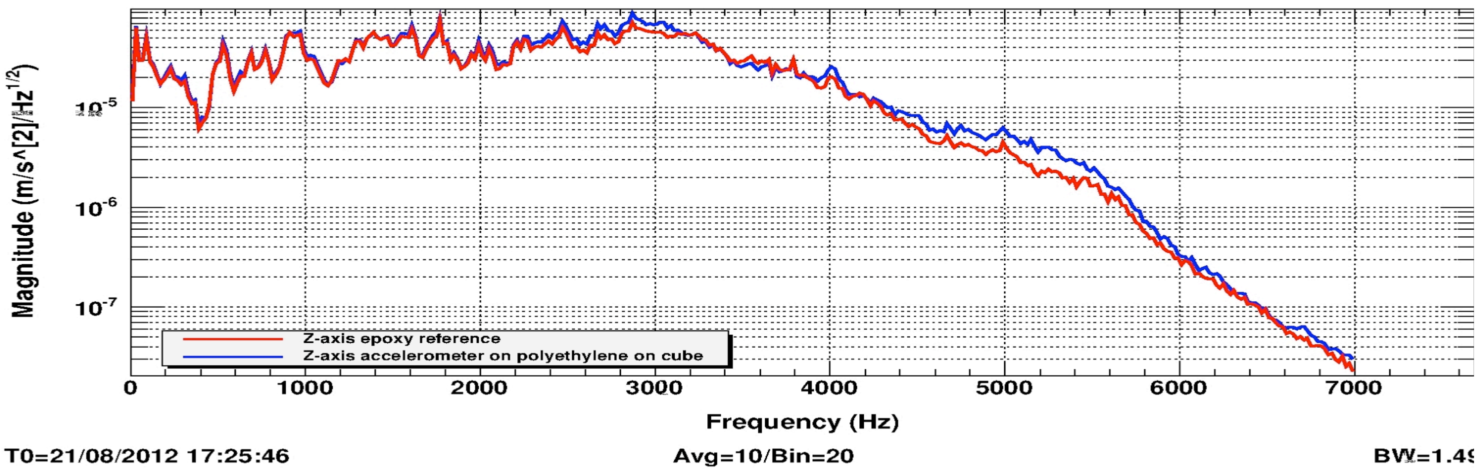
iLIGO mount adds noise at 750 and above



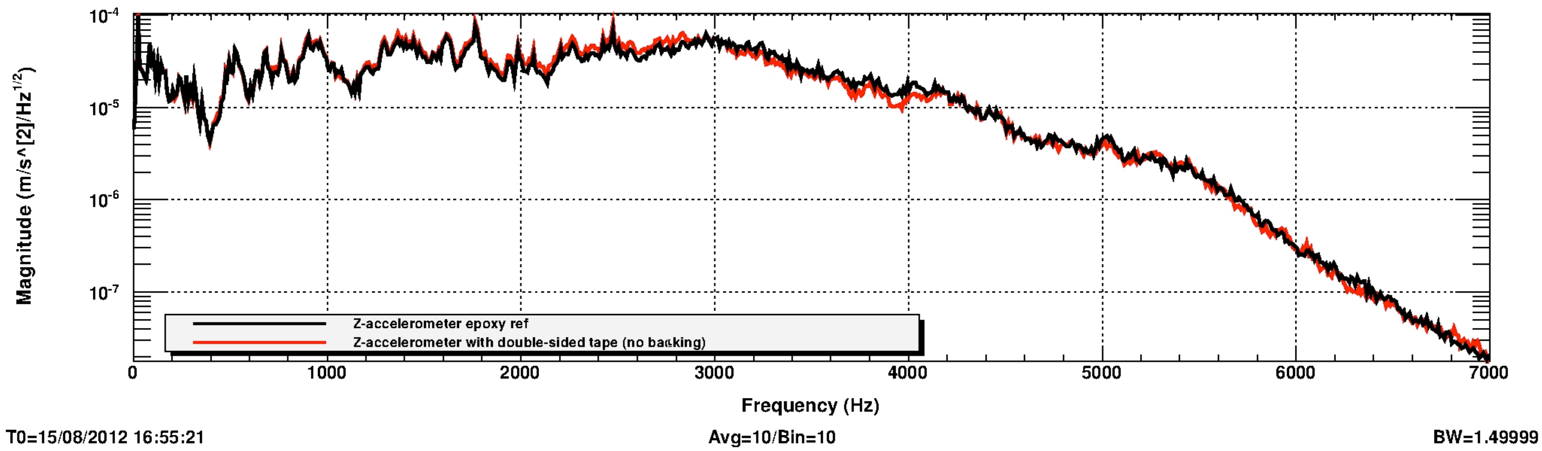
Maggie's accelerometer testing huddle

aLIGO schemes

Acc. epoxied to cube with plastic film between, then to table



Accelerometer attached with double sided clean room tape



Other PEM activites

1) Sensors installed for one arm test

2) Several peaks in one arm test identified and mitigated

3) Sensors installed at LLO PSL

4) Magnetic fields from PSL chillers are OK

5) PSL table vibrations from cooling circuit reduced somewhat (bubbles?)

6) Maggie's PEM website.........

PEM.LIGO.ORG website

PEM Channel Info

LHO | LLO | Channel Naming | Sensor Info | Database

LHO PEM Lookup

show ▼

H1:PEM-CS_ACC_FLOOR_YCRYO_Z

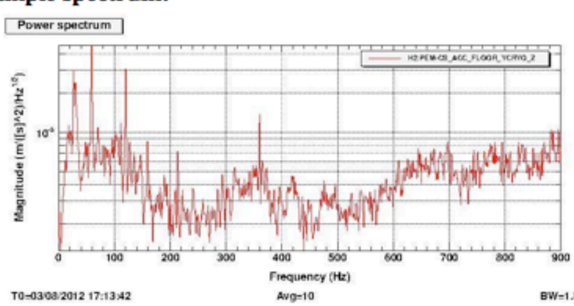
Calibration:

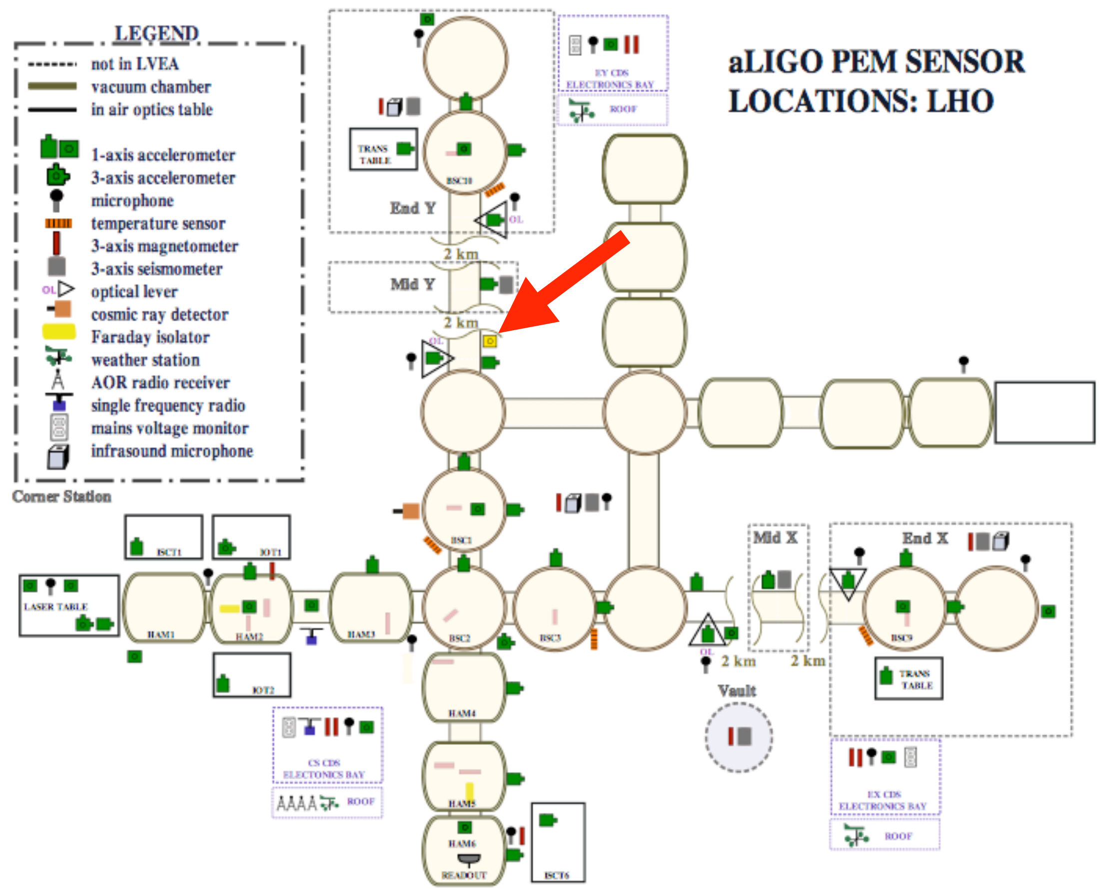
- *Factor:* 6.1 um/s2 per ADC count
- *Calulation:* ((10 m/s2) / 100 V) * (4 V / 65536 counts)
- *Range:* 1 - 900 Hz
- *Amplitude Error*:* 35%
- *Phase Error:*

Sample rate: 8192

Grid location:** -77.4, 41704.2, 0

Sample spectrum:

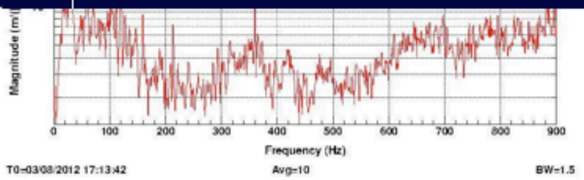




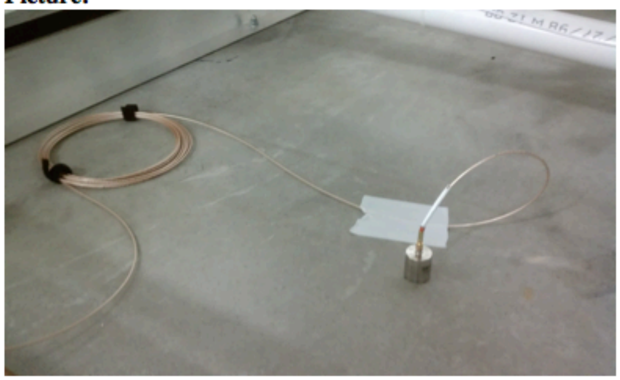
Paste in channel name, and sensor will light up on map; calibration, grid location, sample spectrum, photo displayed

PEM Channel Info

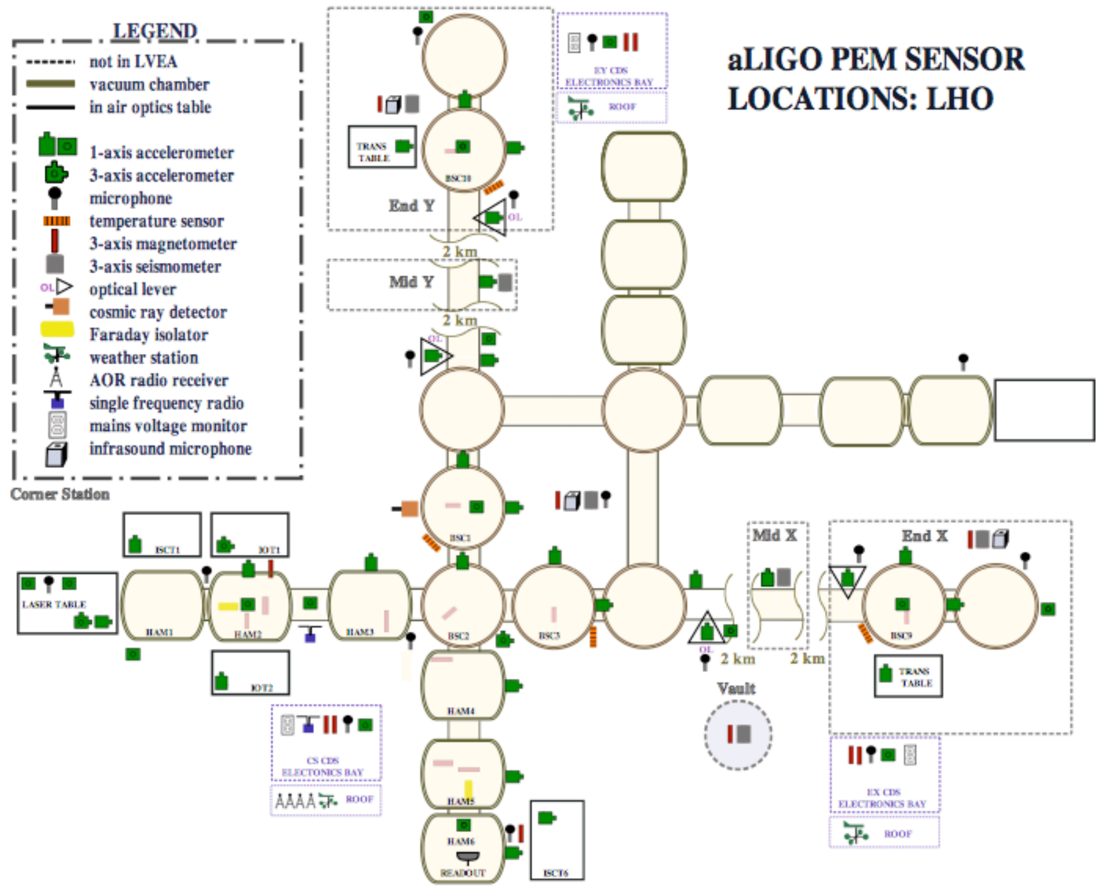
LHO | LLO | Channel Naming | Sensor Info | Database



Picture:



*15% uncertainty range for adc's (variation obtained from a couple of actual calibrations) + maximum variation of instrument calibration (e.g. the most extreme factory calibration for an individual seismometer axis is 816 instead of 800 giving 2% for a total uncertainty of 17%). When the calibration is through the entire DAQ system, the 15% is, of course, not included. To this number, I have added a percentage to account for amplitude response variation over the given frequency range.
**(x,y,z) values in mm, using LIGO global coordinates. Errors are within 10cm.

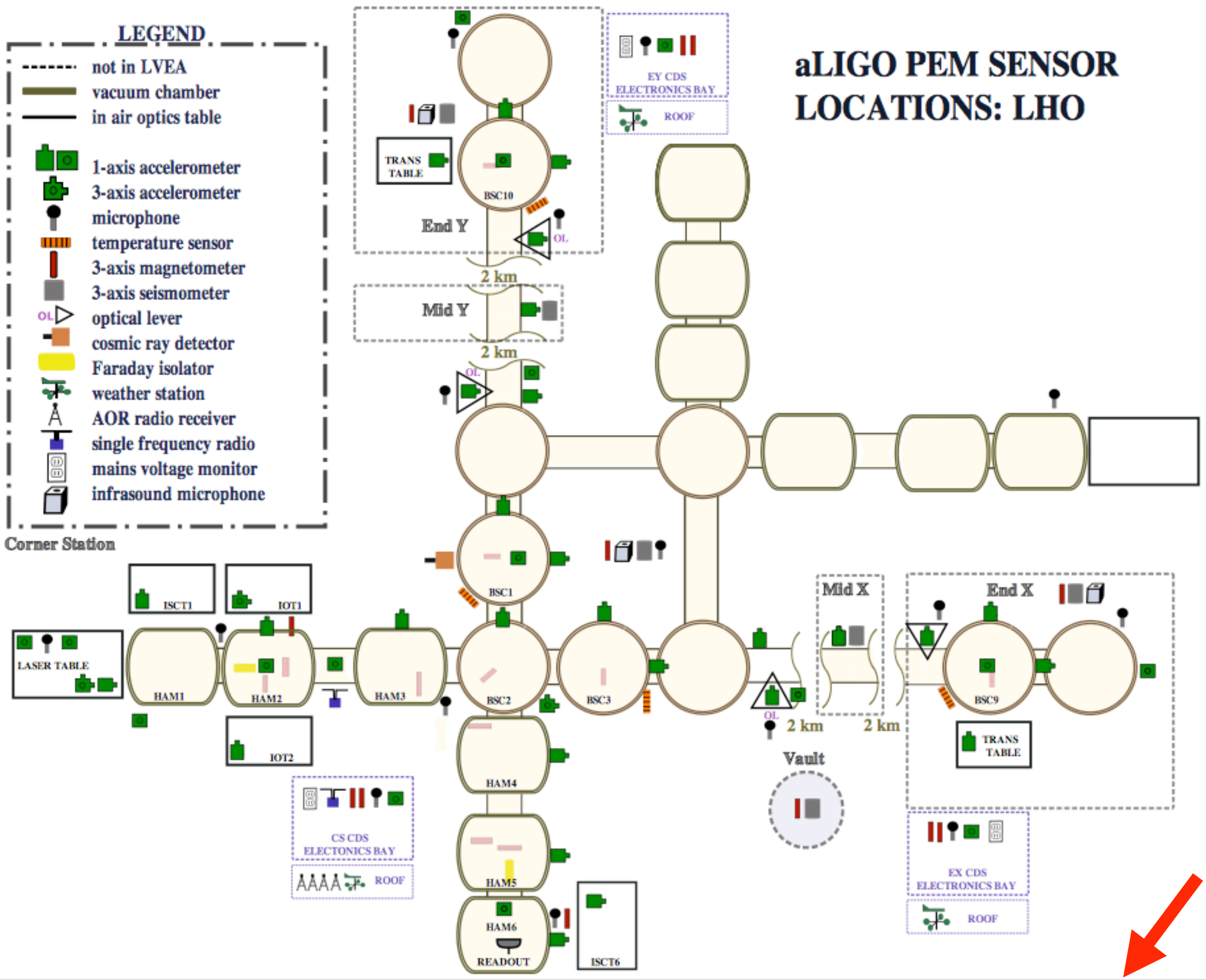


Created by Maggie Tse

Last Updated: 8/16/2012, [Instructions on adding sensors and editing website]

Created by Maggie Tse, Columbia

aLIGO PEM SENSOR LOCATIONS: LHO



Last Updated: 8/16/2012, Instructions on adding sensors and editing website

3. Sensors and Channels: Database

[Prev] [Index] [Next]

The database is handled by mySQL, and the web interface for editing the database is handled by a PHP extension for n the "Database" link in the navigation bar from the main webpage. Login using your ligo.org credentials.

The table "calibration" contains information on how to calculate the calibration factors for each type of sensor, as well a these factors. It also contains the frequency range of each type of sensor. This information is taken from Robert Schofie

The table "channels" has an entry for each PEM channel, and provides calibration factors, sample rates, and grid locatic

Editing the Database

MySQL » localhost » pem » Select: channels

Select: channels

Select data Show structure Alter table New item

Select | Search | Sort | Limit: 30 | Action: Select

```
>> SELECT * FROM `channels` LIMIT 30 Edit
```

	id ↓	calibration ↓	sample_rate ↓	grid_location_x
edit	H1:PEM-CS_ACC_EBAY_FLOOR_Z	6.1 um/s2 per ADC count	8192	NULL
edit	H1:PEM-CS_MIC_EBAY_RACKS	3.16 x 10-5 Pascals per ADC count	16384	NULL
edit	H1:PEM-CS_MAG_EBAY_SUSRACK_X	6.10 pT per ADC count above 10 Hz, 6100 pT per ADC	2048	NULL
edit	H1:PEM-CS_MAG_EBAY_SEIRACK_Y	6.10 pT per ADC count above 10 Hz, 6100 pT per ADC	2048	NULL
edit	H1:PEM-CS_MAG_EBAY_SEIRACK_X	6.10 pT per ADC count above 10 Hz, 6100 pT per ADC	2048	NULL
edit	H1:PEM-EY_ACC_EBAY_FLOOR_Z	6.1 um/s2 per ADC count	8192	NULL
edit	H1:PEM-EY_MIC_EBAY_RACKS	3.16 x 10-5 Pascals per ADC count	16384	NULL
edit	H1:PEM-EY_MIC_VEA_PLUSY	3.16 x 10-5 Pascals per ADC count	16384	-1082

3. Sensors and Channels: SVG Maps

[Prev] [Index]

JavaScript Functions

There are three JavaScript functions that are built ino the SVG maps:

writeText(txt)

This is the function set to the "onmouseover" attribute of sensors on the map. When the user points the mouse at a sensor, this function will writ corresponding channel name to a text box in the search section of the page.

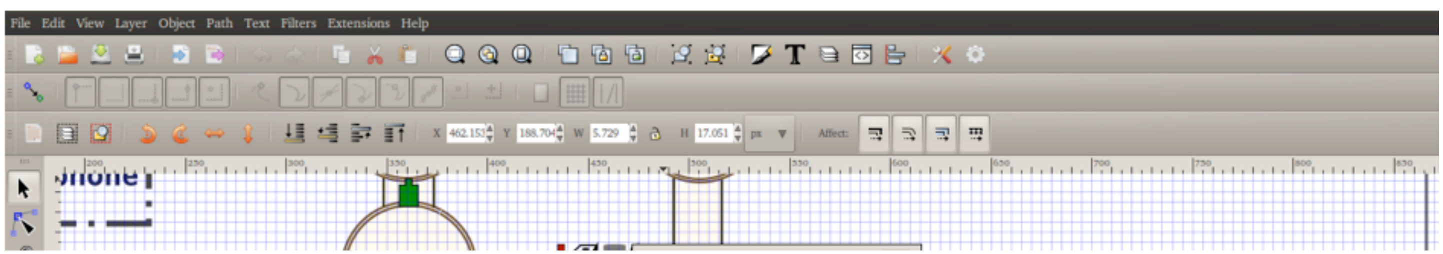
writeDefault()

This function is set to the "onmouseout" attribute of sensors on the map. It clears the text box mentioned above once the mouse stops pointing a sensor.

lookupChannel(id)

This function is set to the "onmousedown" attribute of sensors on the map. When the user clicks a sensor, this function sends the channel name sensor to the function map_to_channel(selection) located in script.js, which sends the channel name to the PHP form that looks up the channel i database.

Adding Sensors to Map



2. Website Structure: JavaScript Functions

[Prev] [Index] [Next]

Aside from interactions with the database, all other interactivity on the website is controlled with JavaScript functions. These are the three functions found at the top of the .svg maps control interactions with the map, and the rest of the functions that control tl script.js. Below are descriptions of their properties and purposes:

map_to_channel(selection)

This function gets called by lookupChannel(id), a function defined in the .svg maps. lookupChannel(id) passes the name (map_to_channel(selection), which then posts the channel name in the search form on the webpage and submits the search database, and returns information about the selected channel.

highlight(selection)

This function gets called in index.php every time the search form is submitted (i.e. when the user clicks one of the "Go" b map). It searches the svg document for an object whose "id" matches the selected channel, then identifies all the path elen color(newElements) on those path elements every 600ms to achieve the flashing effect.

color(newElements)

This function first stores the original colors of the path elements of a sensor, then colors them all yellow. It calls uncolor(n that the sensor flashes yellow at 300ms intervals.

uncolor(newElements)

This function restores the original colors of a sensor. It is called 300ms after color(newElements) is called.

toggle()

This function toggles between hiding and showing the search section of the webpage. By default the search section is sho is submitted, this function is called, which hides the search section and makes room for displaying the channel informatior whenever the hide/show button in the top right corner of the search section is pressed.

loadPage(page)

PEM Hardware Projects

RF

1) **Power meters for roof radio monitors.** Monitor RF in modulation frequency bands (e.g. 9MHz 45MHz) etc. A unit would monitor 6 frequencies at once and output 6 analog signals proportional to the power in the band.

✔ 2) **RF monitors at the main modulation frequencies for inside the LVEA (Richard @ LHO).** These would use signals from the RF distribution system as the local oscillators. They would be attached to lamda/2 antennas in the LVEA.

✔ 3) **An RF spectrum monitoring system that sweeps from a few KHz to a couple of GHz (U of O).** It would monitor the RF environment and output spectrograms using a spectrum analyzer and a laptop. The motivation for this is that coupling can occur at frequencies outside our 100kHz bands (e.g. 10 MHz).

4) **An audio frequency RF system (1 Hz to 10,000 Hz).** Would use a Marconi antenna and audio amp into the DAQ system.

PEM Hardware Projects

Non-RF

1) 6 more coil magnetometers. One in each building, would reproduce design of vault coil magnetometers.

✔ 2) Eotvos infrasound microphones.

✔ 3) A temporary monitor for electrostatic fields inside the BSCs (U of O). Would be connected to a dead-end wire that goes into the BSC.

✔ 4) Develop mounting system for chamber accelerometers.

PEM Software Projects

✔ 1) Dead channel monitor and more sophisticated band change monitor / coherence monitor (Dipongkar Talukder, U of O)

✔ 2) Channel snapshots (Thomas Abbott started)

✔ 3) Modify DAQ system to produce channels containing the sum in quadrature for all 3-axis sensors. The quadrature channels would each replace 3 single-axis channels in the RDS.

4) Channel directory entries. Take responsibility for describing channels in channel directory.

✔ 5) Channel location documentation web page. Enter channel name to light up sensor location on sensor map, also shows photos of sensor in its location.

✔ 6) Channel calibration documentation (Columbia?)

7) Direction to source finder. Uses propagation delays to point in source direction.

PEM Software Projects

With emphasis on stochastic and CW searches

9) Search for pulsars in selected auxiliary channels with modified all-sky and/or specific pulsar search code.

✔ 10) Modify stochastic code to search for signal between aux channels (Violet Poole, WSU). Compare empty channels between sites, coil magnetometer channels, and other aux channels.

✔ 11) Add significance FOM to Carleton DARM-aux coherence line monitor (Greg Mendell, LHO).

✔ 12) Modify coherence code to look between auxiliary channels instead of just DARM-aux (U of O).

✔ 13) 1Hz (and other) comb monitor (Carl Brannen, WSU, Greg Mendell, LHO). Searches for combs in DARM and auxiliary channels and monitors f-dependent amplitude.

PEM naming scheme

site:system-building_sensor_location_descriptor(_axis, units)

Examples:

H1:PEM-CS_ACC_HAM2_PRM1_X

H1:PEM-CS_ACC_HAM2_PRM1_Y

H1:PEM-CS_ACC_HAM2_PRM1_Z

H1:PEM-CS_ACC_LVEA_FLOORHAM1_Z

H1:PEM-CS_ACC_PSL_PERISCOPE_X

H1:PEM-CS_ACC_PSL_TABLE1_Z

H1:PEM-CS_MIC_PSL_CENTER

H1:PEM-CS_RELHUM_BAKE1_DUSTMON

H1:PEM-EX_SEIS_VEA_FLOOR_X

L1:PEM-CS_MAG_EBAY_LSCRACK_Z

L1:PEM-CS_RADIO_ROOF_45MHZ