

# S5 Environmental Disturbances: August '06

Robert Schofield, U of O

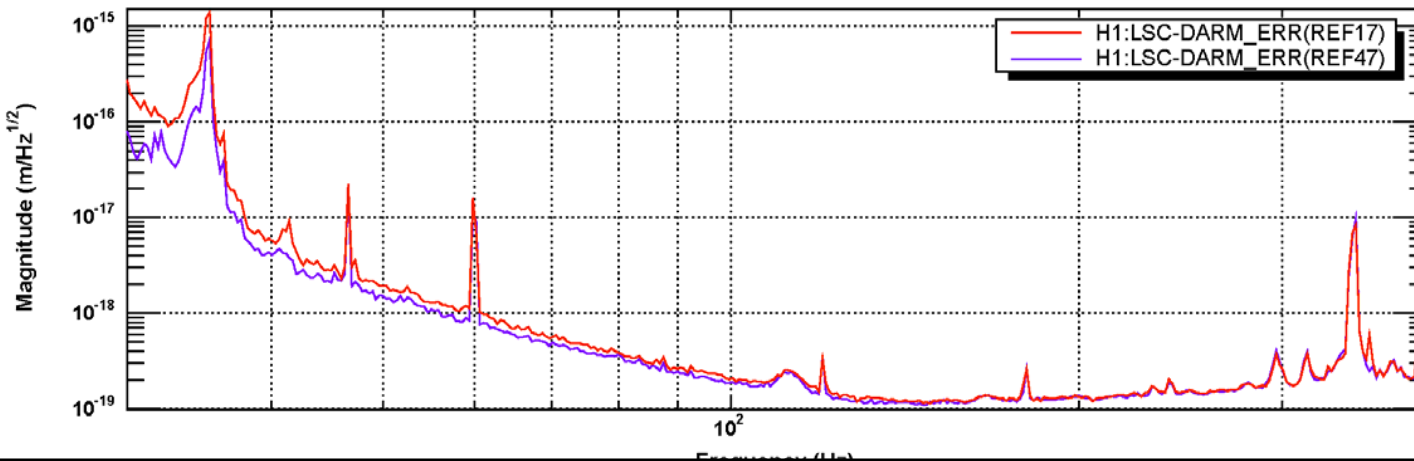
Erik Katsavounidis (MIT), Laura Cadonati (MIT), Michele Zanolin (MIT), Dennis Ugolini (Trinity), Justin Garofoli (LHO)

LIGO-G060474-00-Z

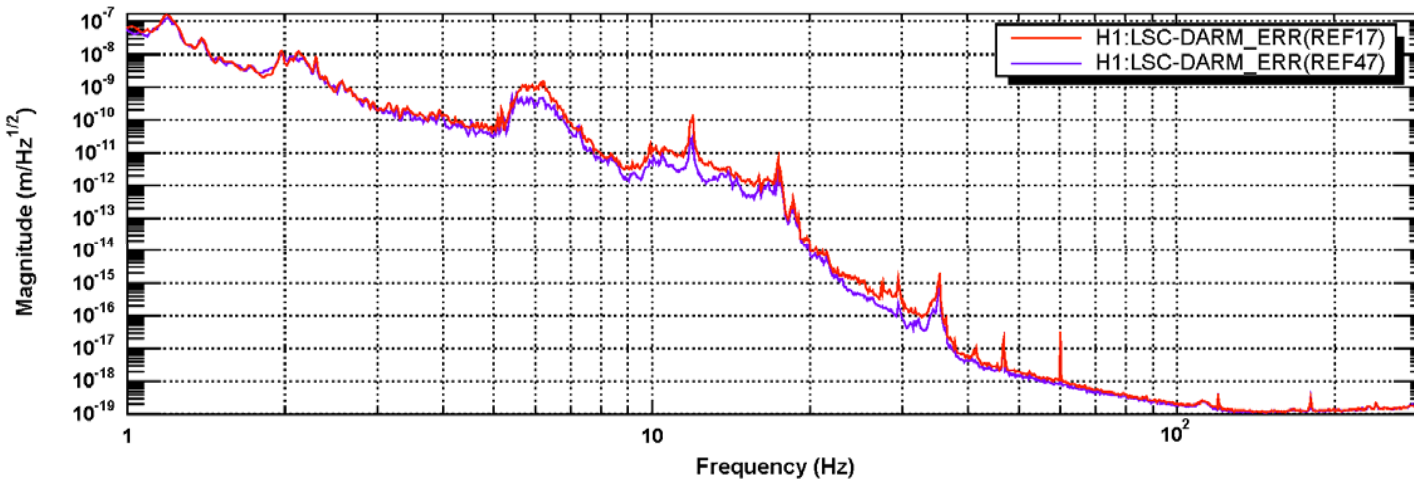
- I. HVAC effect comes from an upconversion mechanism that is not reproduced by servo injections.
- II. Coupling mechanism of glitch groups voltage/magnetomer events
- III. Does wind excite seismic motion preferentially in the wind direction?
- IV. Instrumental lines near harmonics of 1 Hz and 1/15 Hz
- V. Dam limits inspiral range

# Gravitational wave sensitivity improves when HVAC off

Power spectrum



Blue: All site turbines and chiller pad equipment off; Red: normal



\*T0=12/02/2006 17:54:39

\*Avg=1/Bin=10L

BW=0.0234367

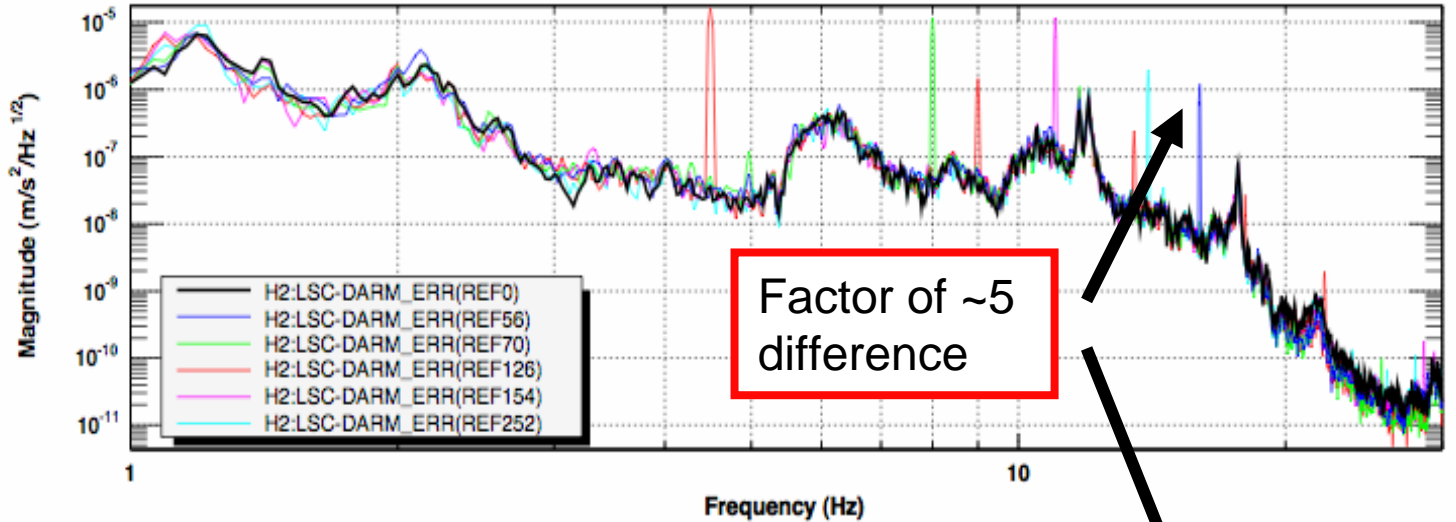
## HVAC effect on range

- *Shutting HVAC down improves H1 & H2 range about  $\frac{3}{4}$  Mpc.*
- *Influence likely seismic – air flow into LVEA/VEA not needed for range reduction.*
- *Half-flow about as good as HVAC off (seismic level 55% of full flow in 1-50 Hz band).*
- *For  $\frac{3}{4}$  LVEA flow level, seismic rms is only 61% of full flow level. This provides better temperature control and is what we are currently using.*
- *Seismic noise possibly from turbulence in supply plenum.*
- *DARM noise at 100 Hz was likely from up-conversion of lower frequency HVAC seismic signal instead of direct coupling.*

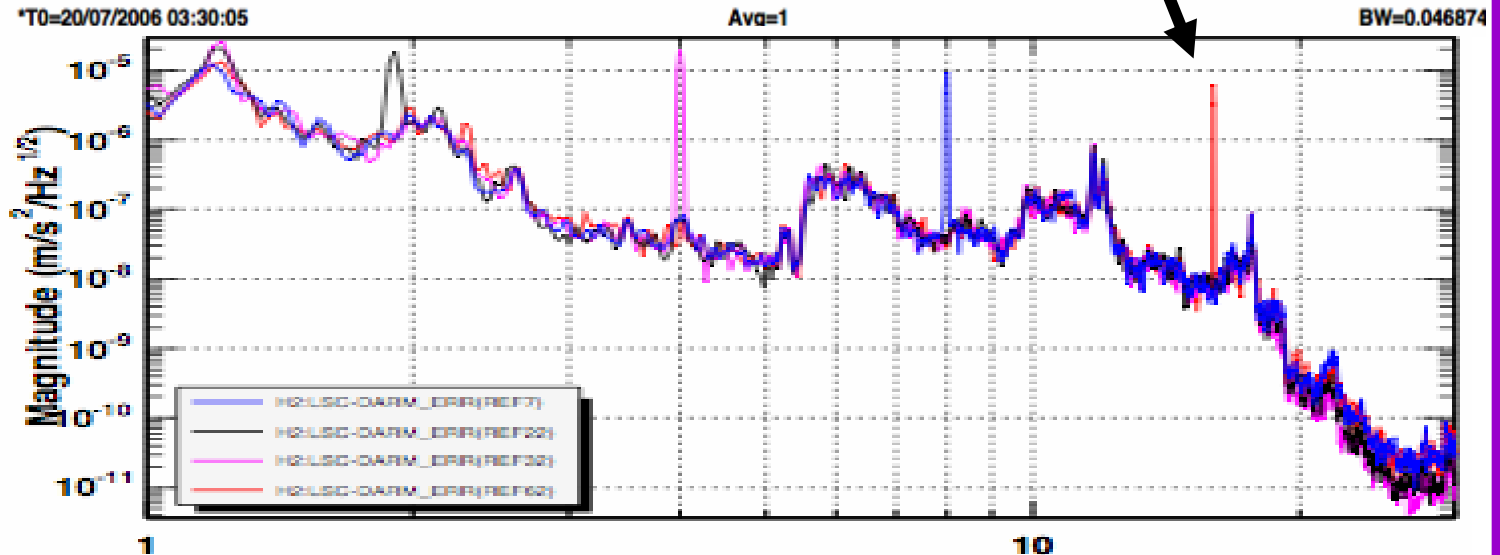
# Onset of upconversion from mechanical shaking lower than from servo injections at 16 Hz

Mechanical shaking (4.5, 8, 11, 14, 16 Hz) is adjusted in amplitude until upconversion begins

Mechanical shaking



Injection into LSC-ETMX\_EXC

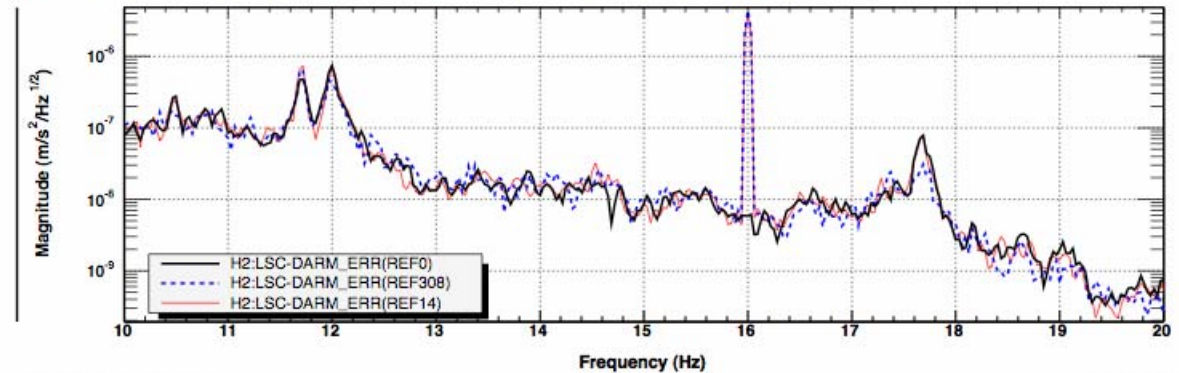


# Upconversion greater and harmonics emphasized for shaker injections

RED: shaker injection, 16 Hz;  
BLUE: servo injections to match pitch, yaw and displacement from shaker

Upconversion amplitude from shaker consistent with HVAC upconversion

RED: shaker injection, 16 Hz, BLUE: direct injection to match shaker using ETMX\_EXC, ETMX\_OLPIT\_EXC & ETMX\_OLYAW\_EXC

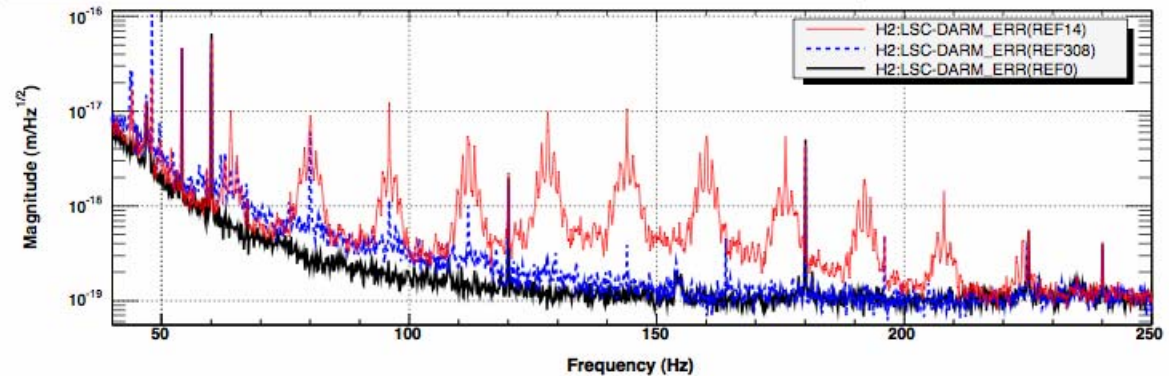


\*T0=20/07/2006 03:30:05

Avg=1

BW=0.0468742

RED: shaker injection, 16 Hz, BLUE: direct injection to match shaker using ETMX\_EXC, ETMX\_OLPIT\_EXC & ETMX\_OLYAW\_EXC



\*T0=20/07/2006 03:35:04

Avg=1/Bin=5

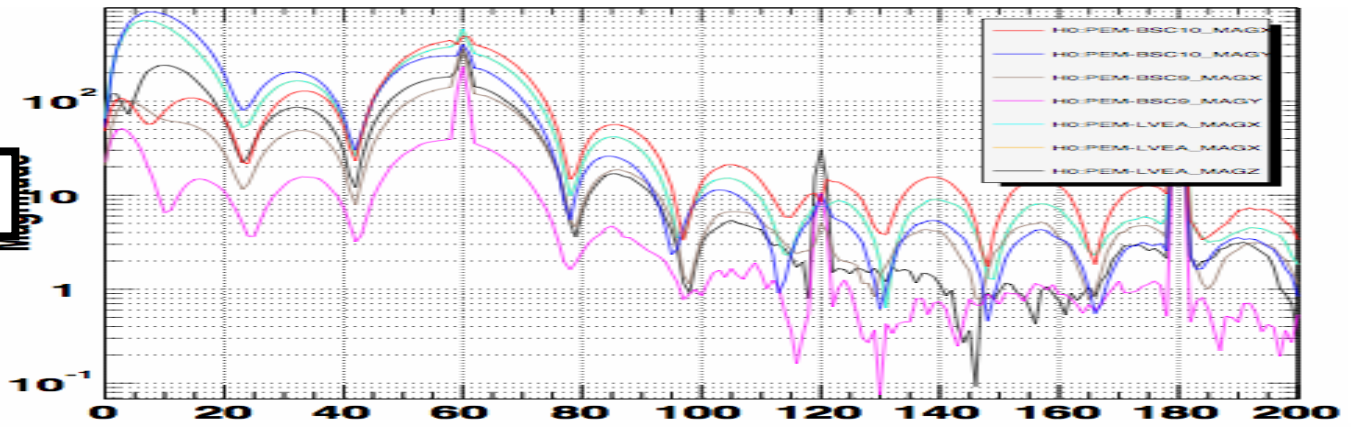
BW=0.0468742

Conclusions: HVAC effect can be explained. We may be affected by at least 2 upconversion mechanisms. In 16 Hz region we can not discount a mechanism outside the servo system.

# How do mains voltage disturbances couple into DARM ?

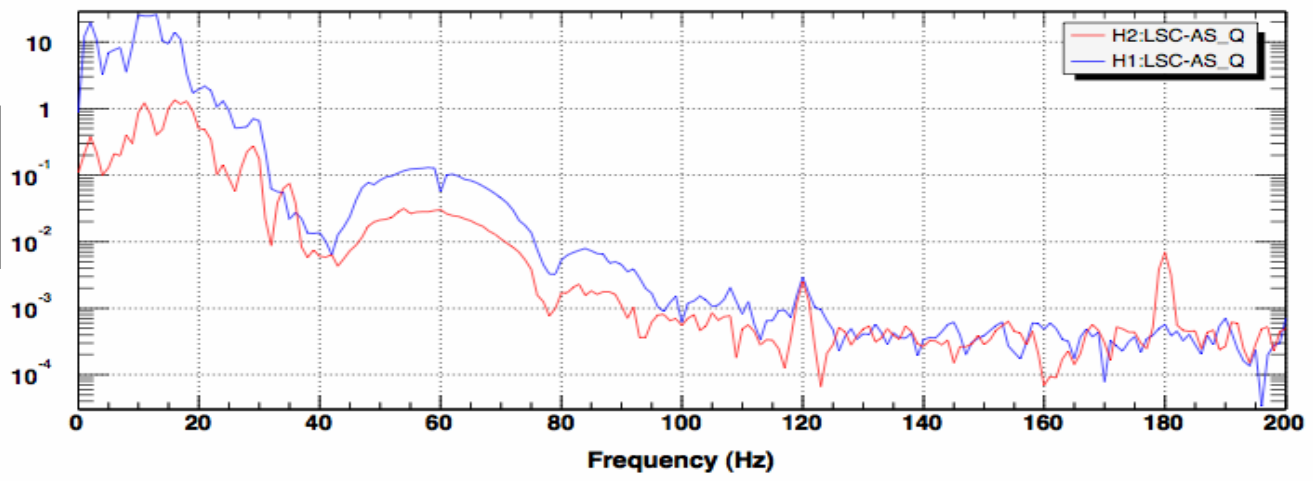
Event discovery and veto studies by Erik K. and Laura C.

Magnetometers



H1 and H2  
AS\_Q

Power spectrum



T0=22/12/2005 03:26:12

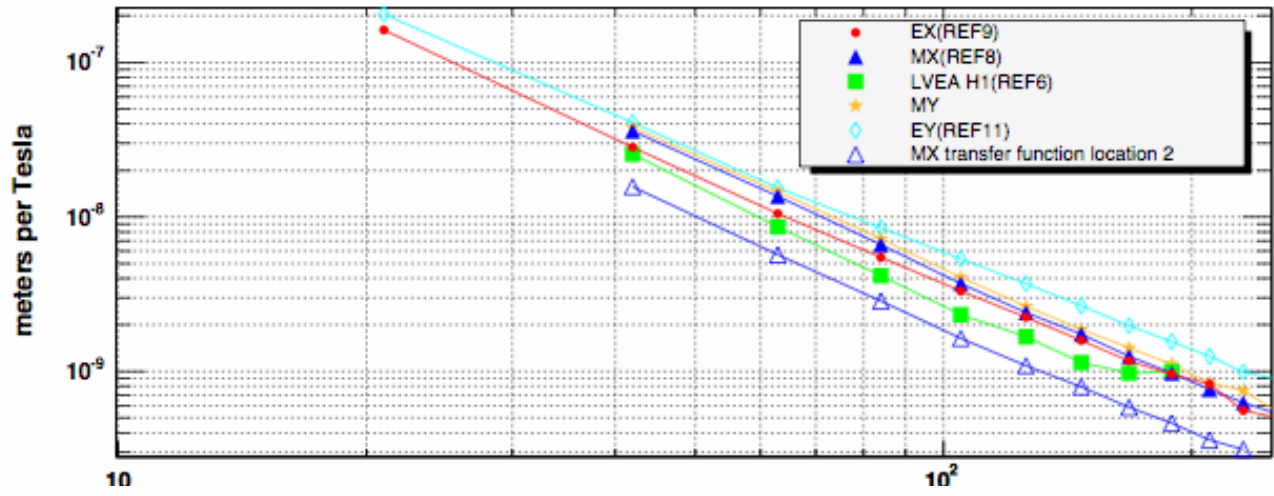
Avg=2

BW=1.5

# Magnetometer-DARM coupling factors from PEM injections

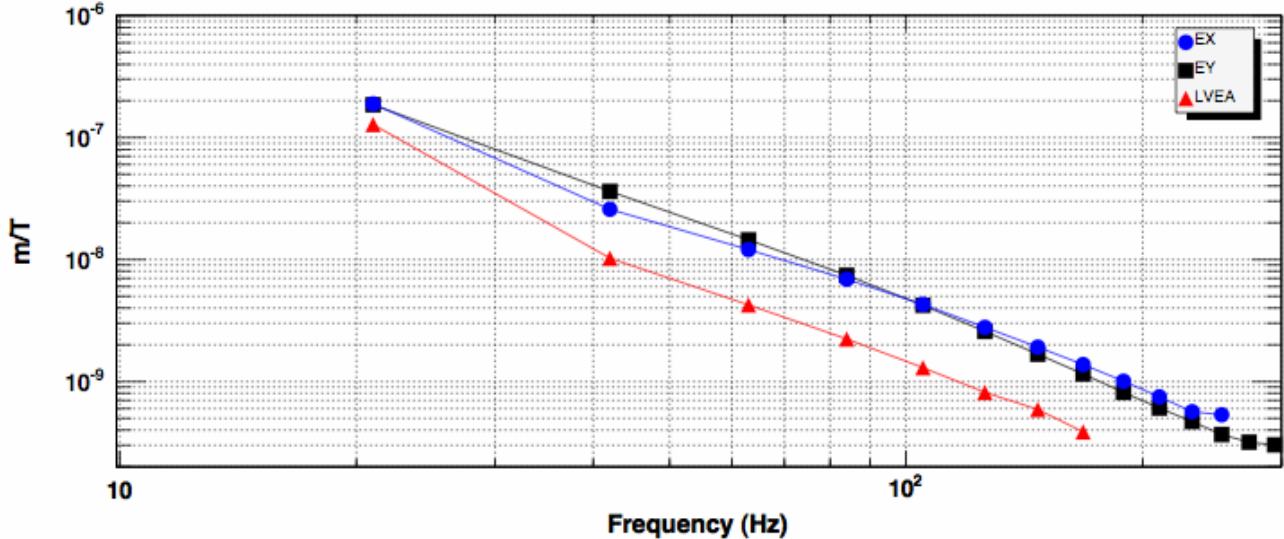
LHO

S5 APRIL magnetic field transfer functions



LLO

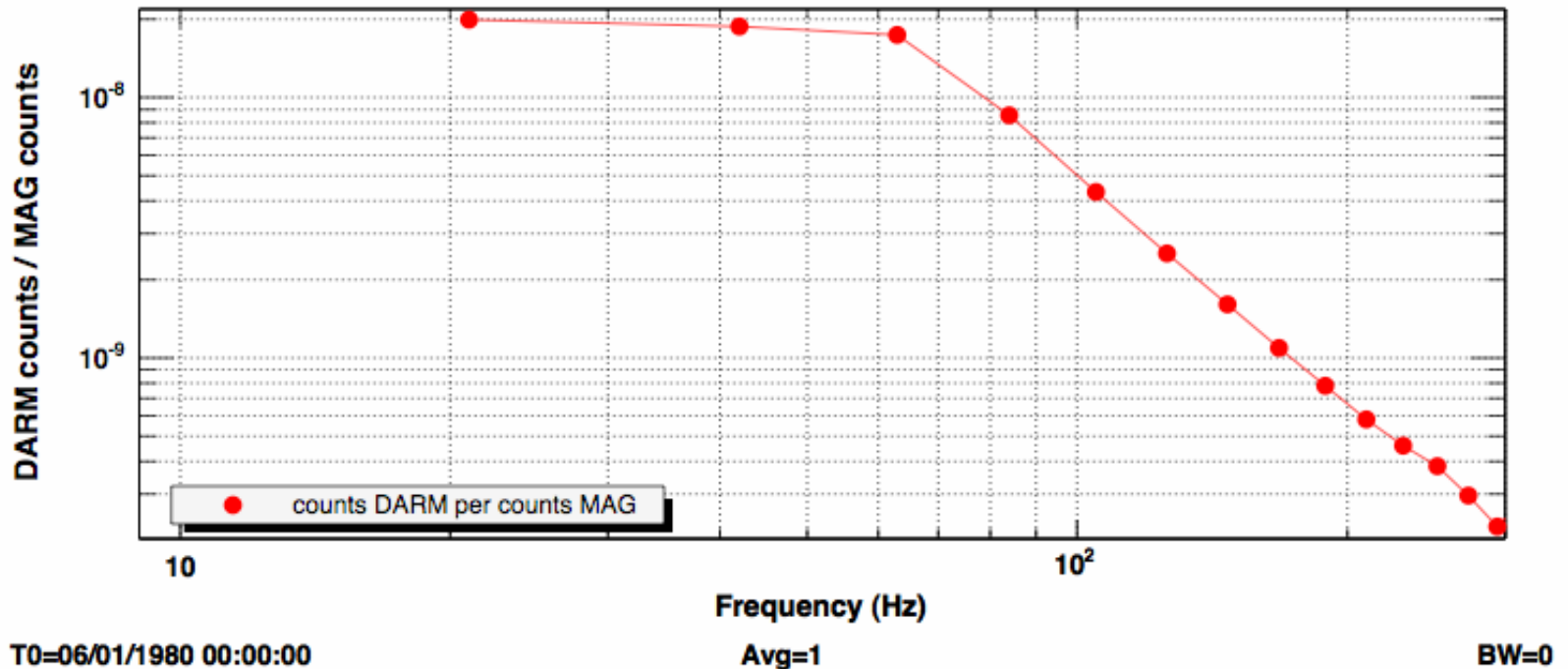
S5 LLO December 05 magnetic transfer functions



# All-station counts/count version of the H1 magnetometer-DARM transfer functions

General magnetometer (except coil) transfer function

Good to a factor of ~2





# Agreement with predictions suggests that mains voltage disturbances show up in DARM through coupling of magnetic field to test mass

MAG event	GPS time	H1 DARM event in Q-scan ?	Greatest MAG counts at 70 Hz	Predicted H1 DARM counts (MAG * 1.5 e-8)	H1 DARM counts at 70 Hz
2	<a href="#">817824113</a>	no	4	6e-8	2e-7
7	<a href="#">818507471</a>	no	4	6e-8	2e-7
9	<a href="#">818515502</a>	no	0.4	6e-9	2e-7
15	<a href="#">819257185</a>	yes	200	3e-6	4e-6
16	<a href="#">819384811</a>	yes	40	6e-7	6e-7
19	<a href="#">820394438</a>	yes	30	5e-7	3e-7
21	<a href="#">821270677</a>	yes	90	1.4e-6	2e-6
25	<a href="#">825082555</a>	no	1.5	2e-8	6e-7
28	<a href="#">827089512</a>	no	6	9e-8	2e-7
29	<a href="#">827506075</a>	no	2	3e-8	2e-7

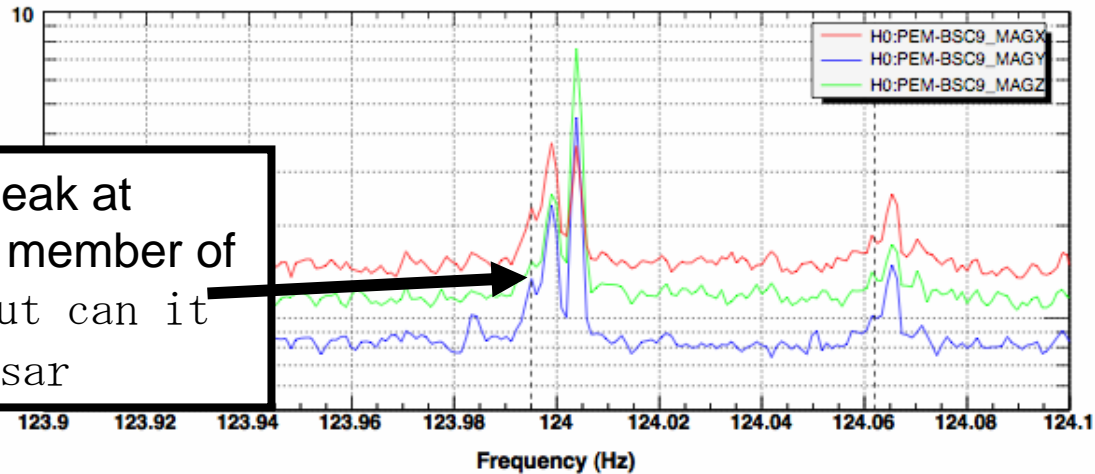
# Does wind in the Y direction mainly excite seismic motion in the Y direction?

Study by Michele Zanolin and Dennis Ugolini

- Ratio of X to Y seismic motion for wind in the Y direction varies building to building: EY and MY more Y than X, LVEA and MX have about equal motion.
- EX at LHO has more X than Y seismic motion for wind in the Y direction (axes reversed)?
- More investigations to be done by sciMon volunteers

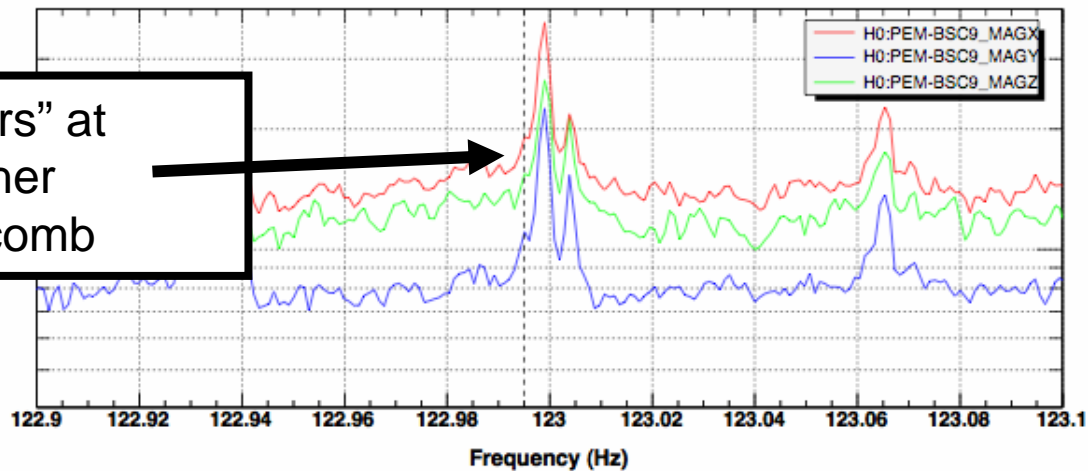
# Instrumental line at J0537-6910 frequency and suggested checks for pulsar group

Vertical cursors at 123.995 and 123.995 + 1/15th Hz



Vertical cursor at 124.995

Search for "pulsars" at frequencies of other members of the comb

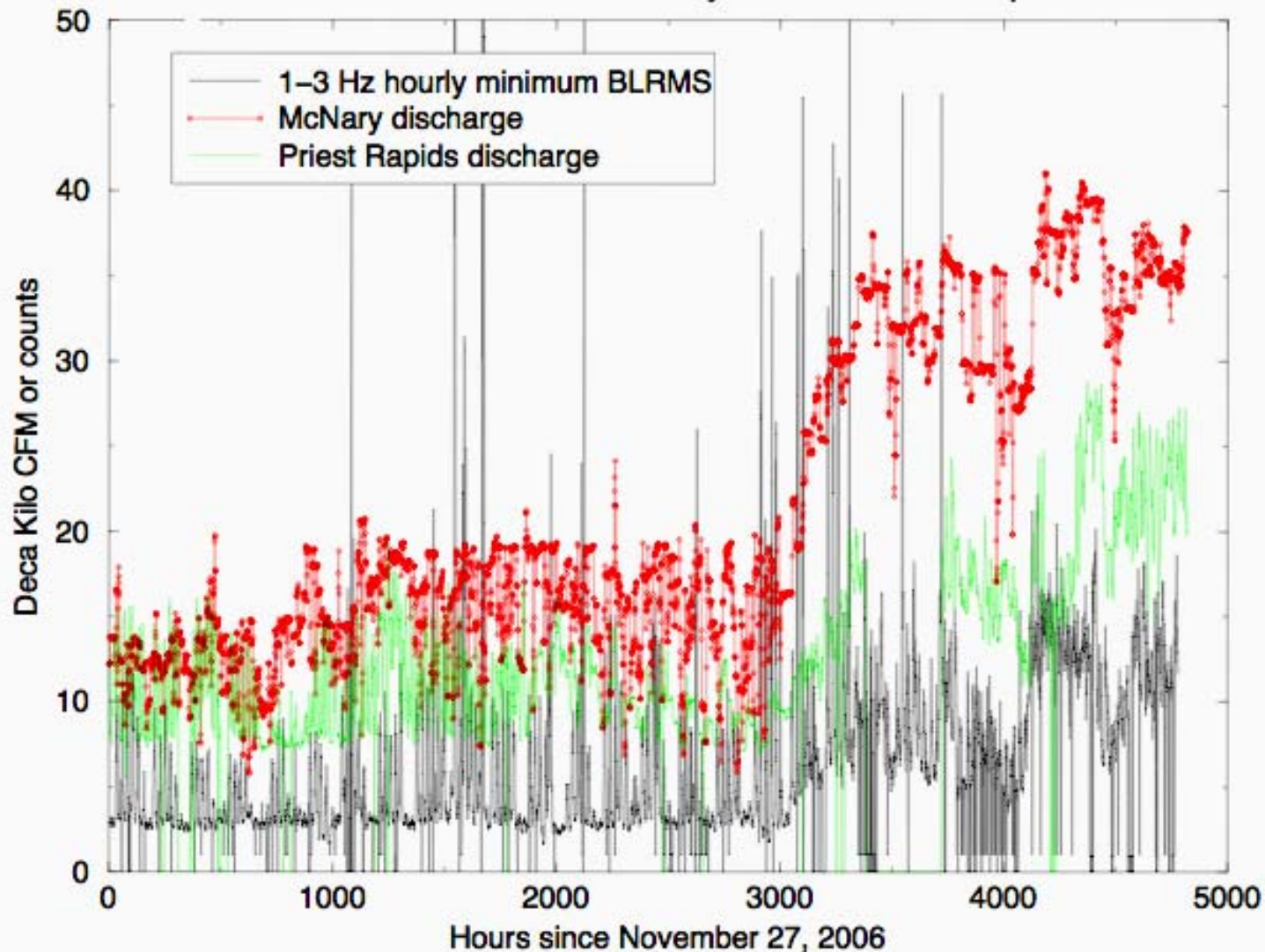


# Dam 60 km away sets maximum inspiral range

(discovered by Justin Garofoli)

## Dam Discharge and 1–3 Hz BLRMS hourly minimum

BLRMS minimum follows McNary better than Priest Rapids



**Dam affects inspiral range through upconversion of seismic signal at 1.2 Hz.**

**“Bounce” of water timed at 1 to 0.3 second.**



Large mass bouncing on the ground at our most sensitive frequency