S3 ENVIRONMENTAL DISTURBANCES

Acoustic Mitigation Update,
Gravel Truck Bursts,
Dust Bursts, and
Pulsed Heaters

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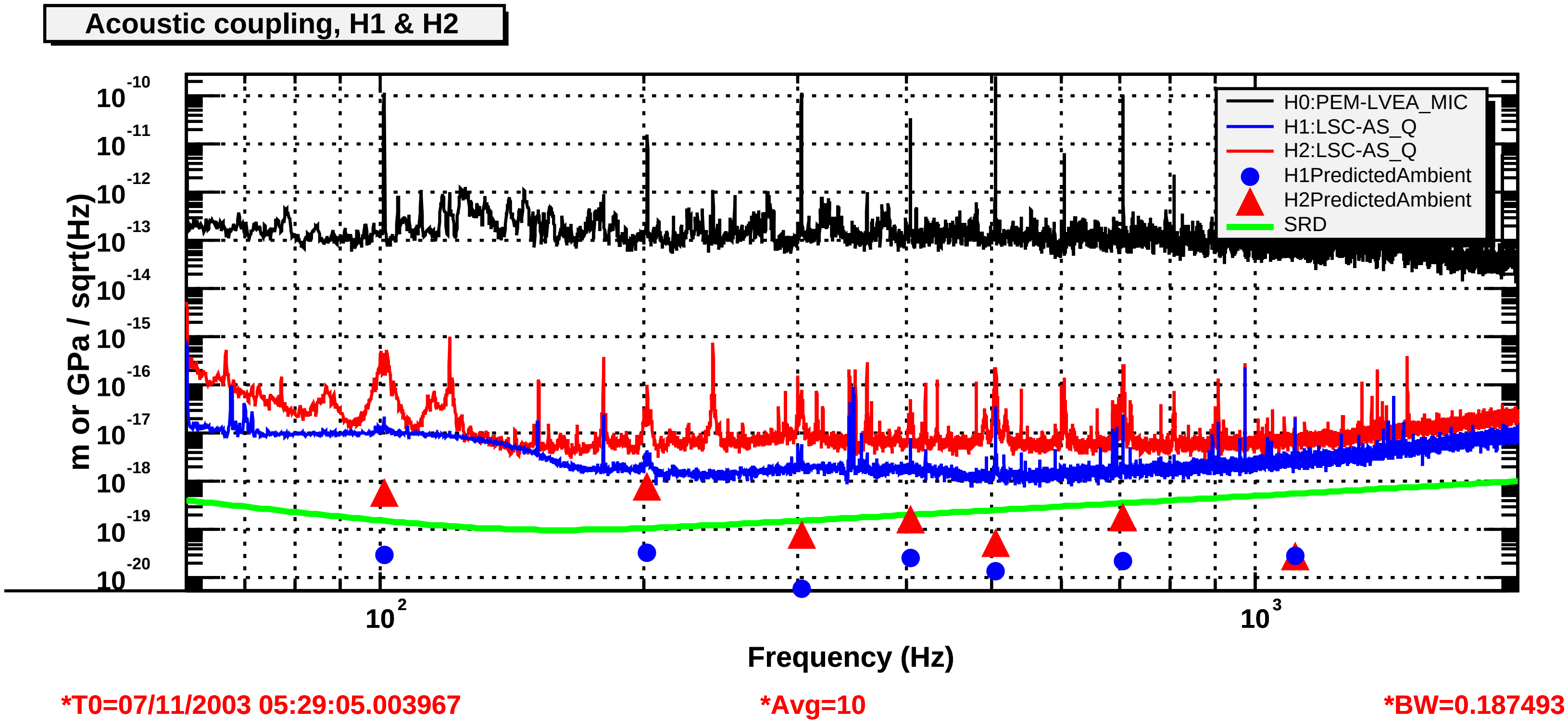
AND MANY OTHERS

LIGO-G040159-00-Z

During S3 PEM injections (with predicted displacement noise from ambient sound)



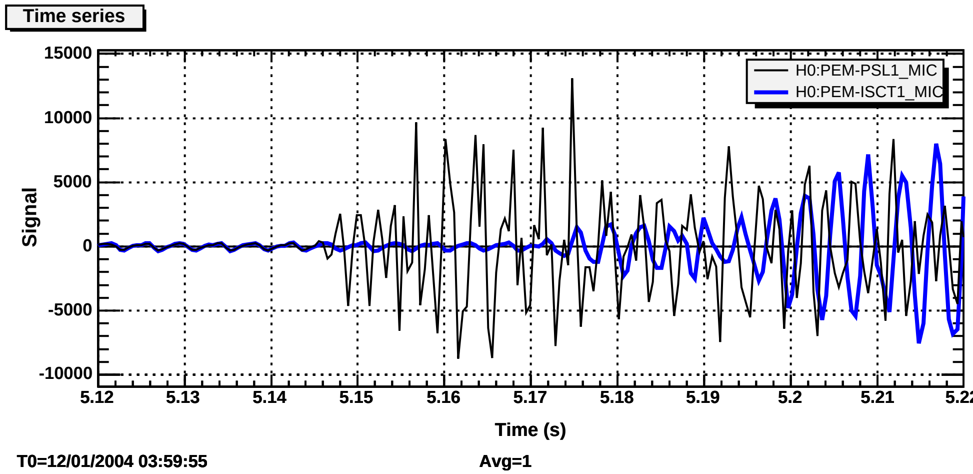
100 Hz ramped sawtooth played through speaker. Possible dust glitch at low f in H1 spectrum

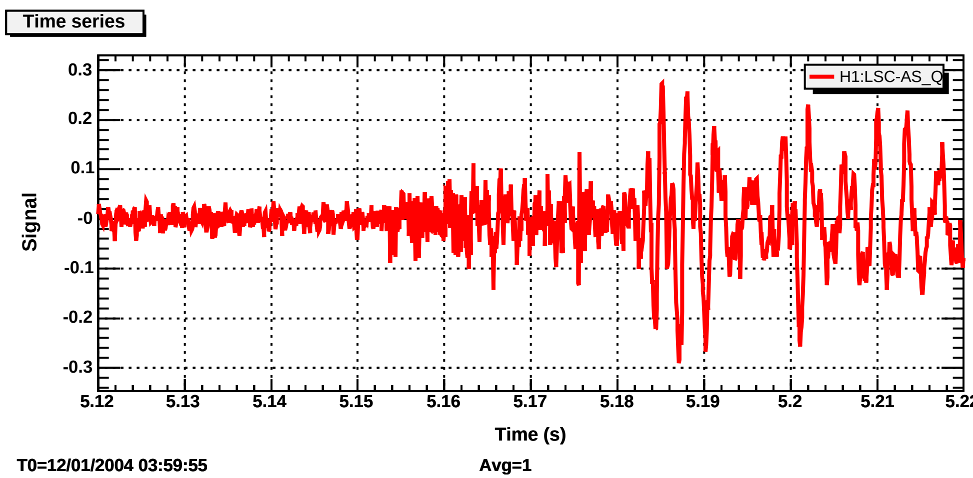
L1 coupling levels were about as bad as H2 around 100 Hz, but as good as H1 at higher frequencies

For H1, we have reached our goal (a factor of 1000 improvement), but bar has been raised for H1 & H2 to improve stochastic b.g. upper limits.

CURRENT COUPLING LOCATIONS AND SEVERITY FROM PROPAGATION DELAYS

Acoustic burst near H1 PSL:





S3 coupling sites ranked by severity, strongest coupling first

H1:
- reflected port table
- PSL table

H2:
- dark port
- reflected port table

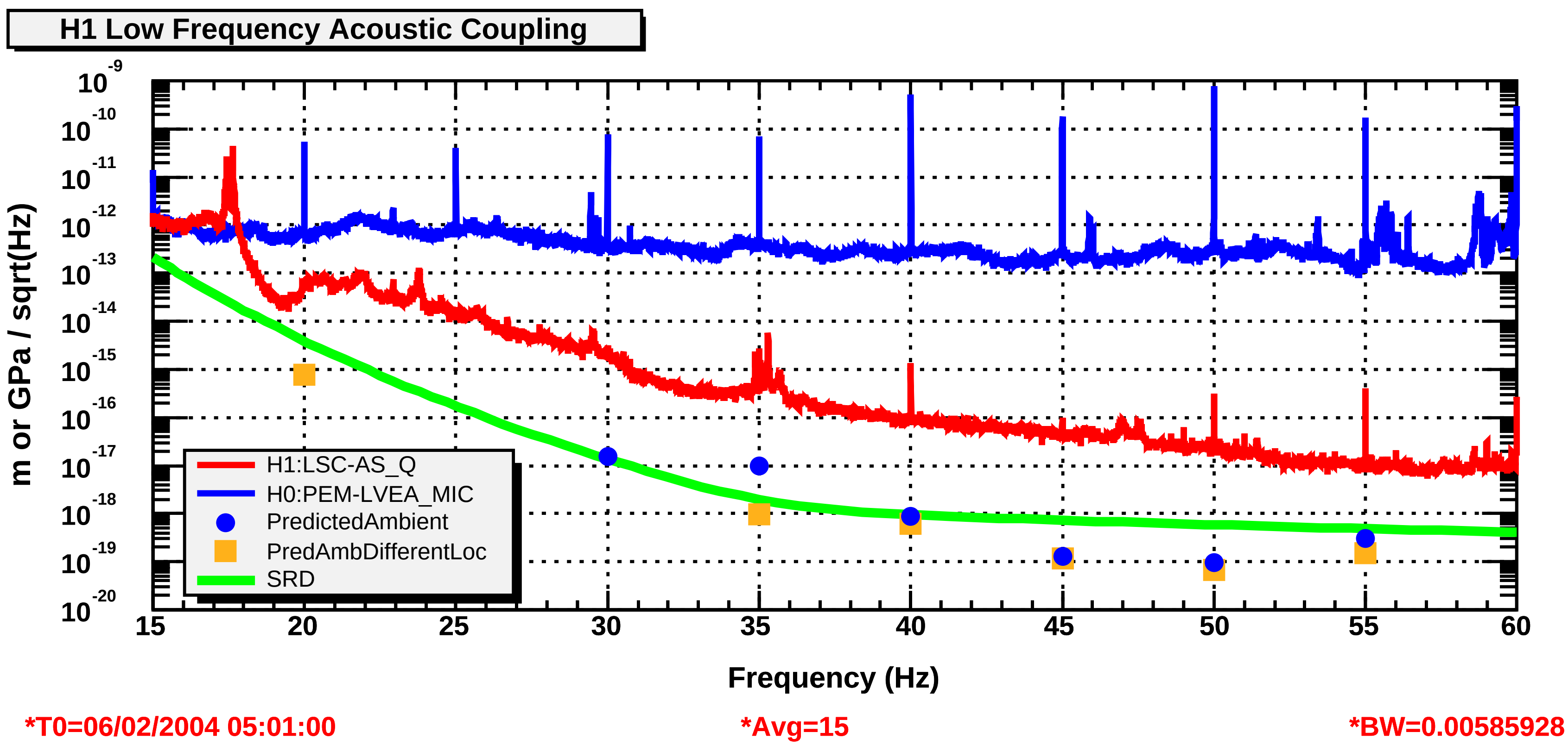
L1:
- reflected port table or input optics table (I would guess REFL)

Recent investigations of H1 reflected port table and PSL table suggest that, in both cases, injections near the periscope produce the strongest AS_Q signal.

LOW FREQUENCY COUPLING,

and predicted displacement noise from ambient sound levels.

5 Hz ramped sawtooth played through large “woofer” 10m from ISCT4:



What can be done to reduce acoustic contribution to noise at low frequency?

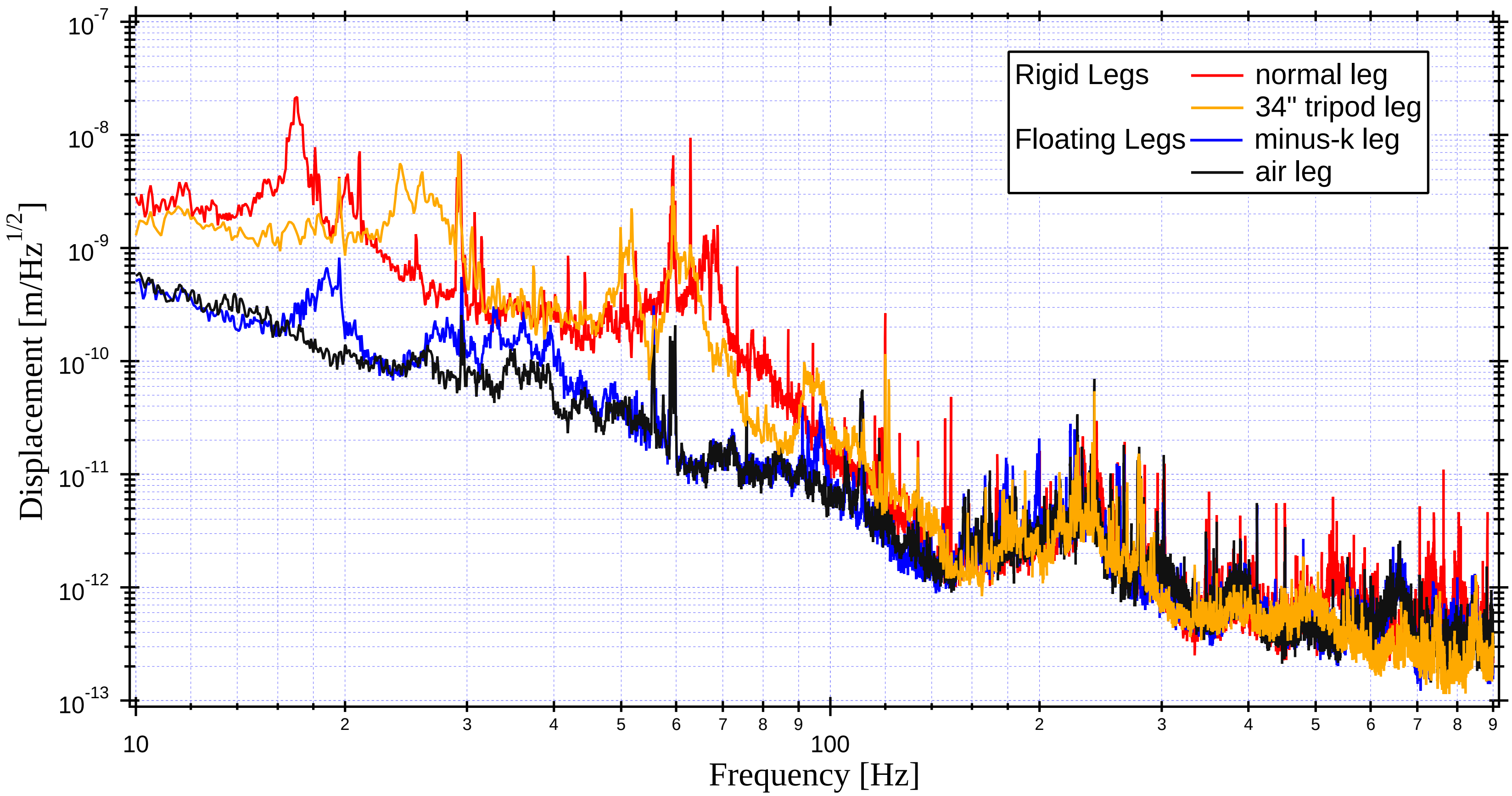
HVAC is main source, shutting it off reduces acoustic and acceleration levels by only about 5 though, and indications are that in-duct mufflers would not help - much of it comes directly through wall of mechanical room.

Enclosures don't help much at these low frequencies; ours reduce the sound level by about 3, but the accelerations on the table by less than that.

"Floating" legs may be best hope for reducing low f acoustic-seismic coupling.

COMPARISON OF RIGID AND “FLOATING” TABLE LEGS ON ISCT3

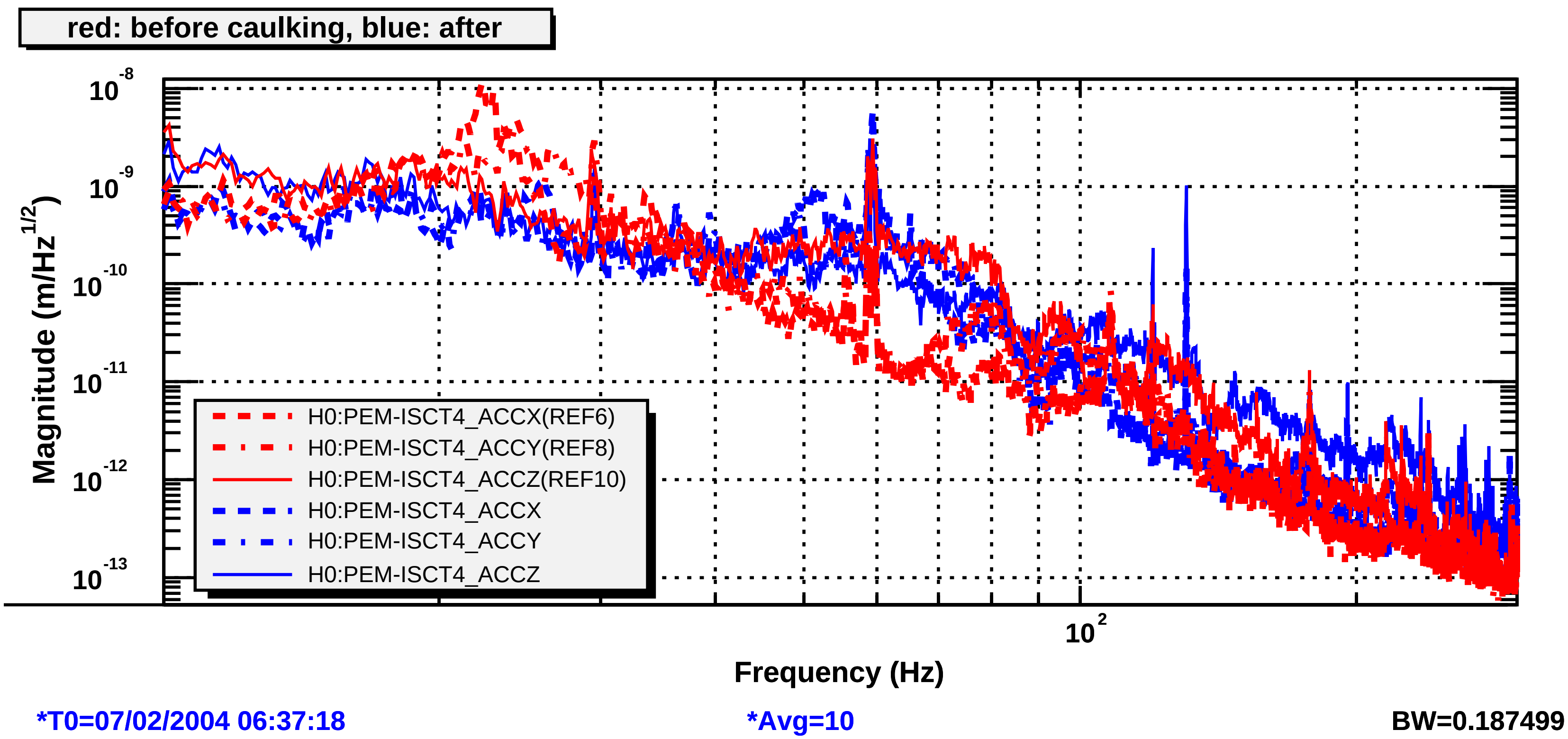
Red: current leg; Orange: tall tripod; Blue: minus-k; Black: pneumatic



Sum in quadrature of 3 accelerometer axes, converted to displacement **9**

GROUTING OF RIGID LEGS REDUCES RMS VELOCITY BY ABOUT 5

Displacement spectra from accelerometers on ISCT4:



Before recommending grouted rigid legs:

1) decide if the displacement spectra are better, or at least as good as, for current legs,
2) try grouting current legs?

"Floating" legs best in velocity and amplitude by about 10; ready to be tested on ISCT3.

RECOMMENDATIONS

I. REDUCE CONTINUOUS SOURCES (factor of 3 to 5)

A. Continue with plans to acoustically house or remove electronics cabinets

B. Insulate pipe-feed through from mechanical room

C. Insulate PSL chillers

II. REDUCE COUPLING (factor of 5 for H1 & L1, less for H2)

A. Clipping

1) Replace AS and REFL periscopes with V3 of new design
2) Enlarge or remove 1/2 lambda plate and polarizer in REFL path
3) Damp PSL periscopes
4) Damp mounts and dumps etc.
5) Continue testing floating legs for low f

B. Backscattering from table (out of prudence - we haven't seen coupling)

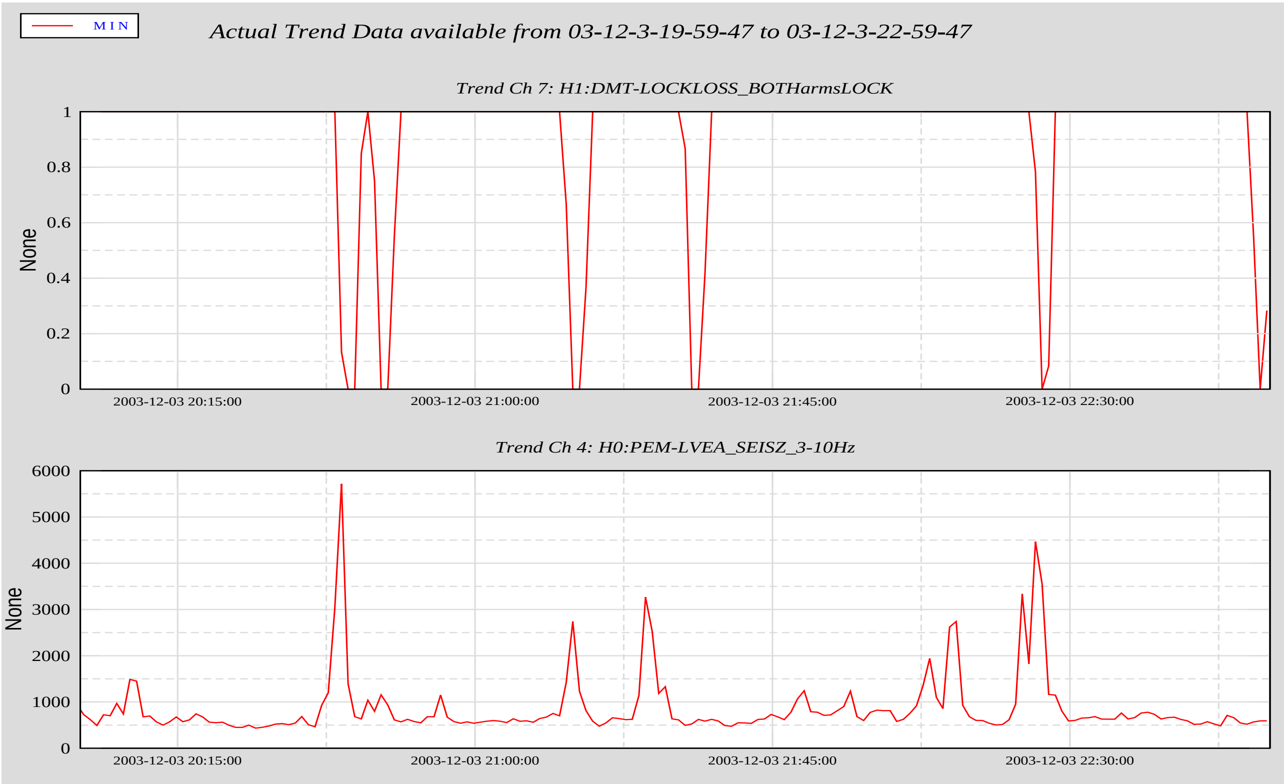
1) Grouted damped rigid legs, unless interferes with clipping reduction above

III. ACOUSTICALLY ISOLATE WORST COUPLING SITES

A. REFL port enclosures with internal absorption kits? Reevaluate after above REFL work.

DURING S3, GRAVEL TRUCKS CAUSED IN-BAND AS_Q GLITCHES AND LOCK-LOSSES

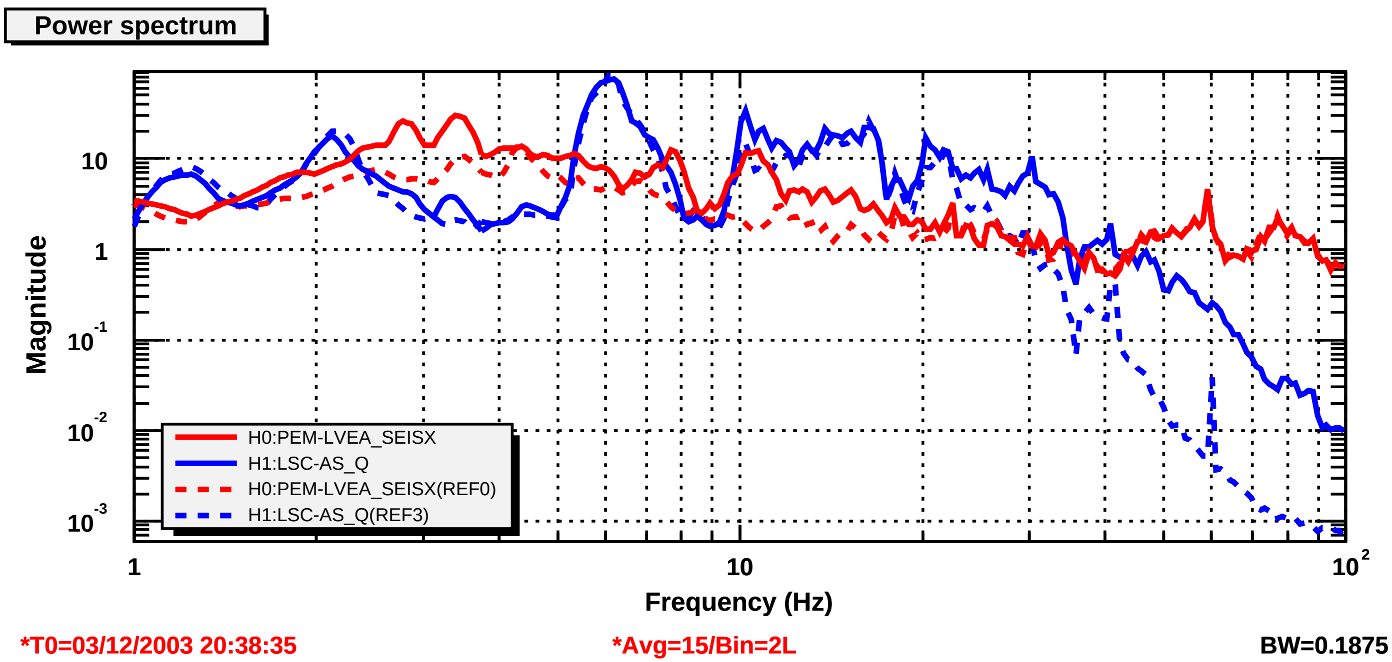
3 Lock losses correlated with minute scale spikes in 3-10 Hz band



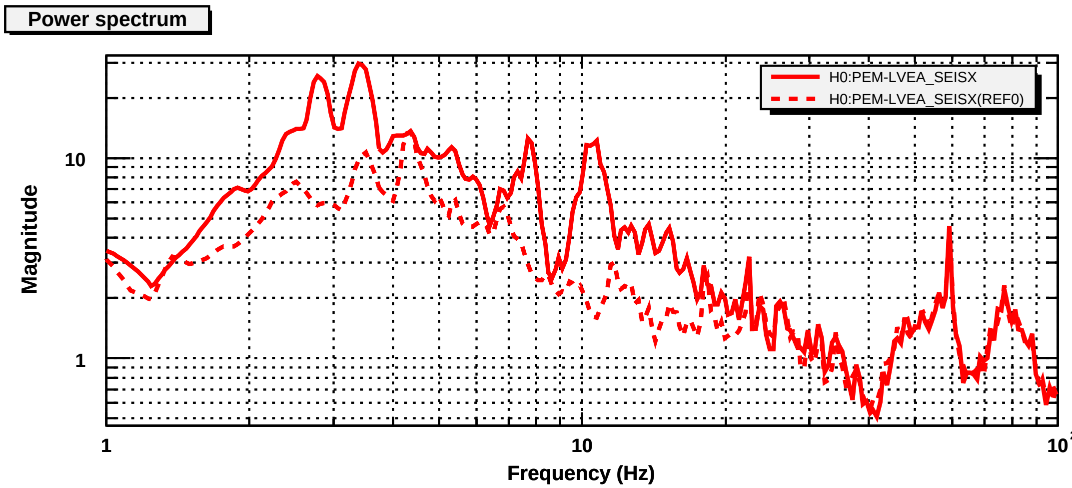
Culprits determined by training video camera on SR10; largest events were gravel trucks

Trucks also produce in-band noise by upconversion

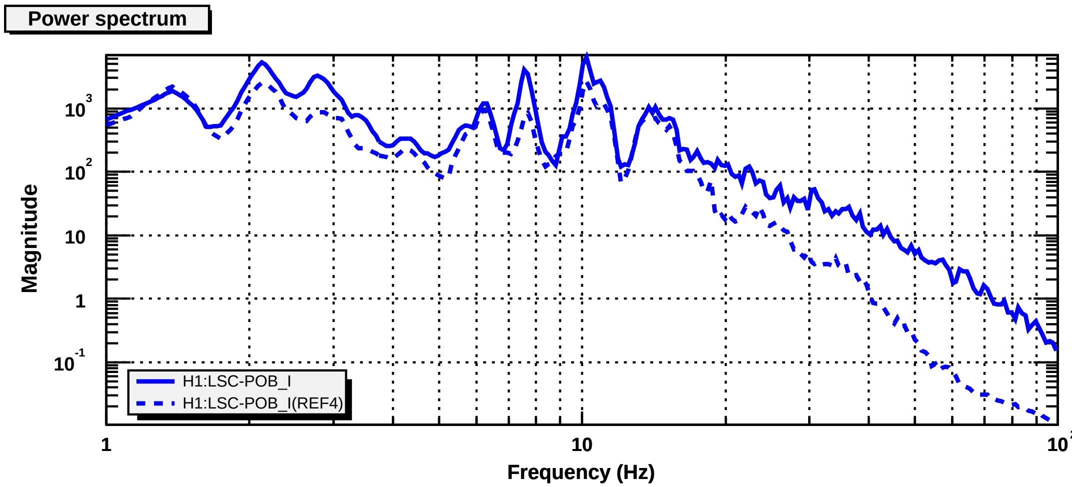
64 second spectra; RED: seismometer; BLUE: AS_Q; SOLID: truck; DASHED: no truck



Suggestion: veto periods when 3-10 Hz band of H0:PEM-LVEA_SEISZ exceeds 1000



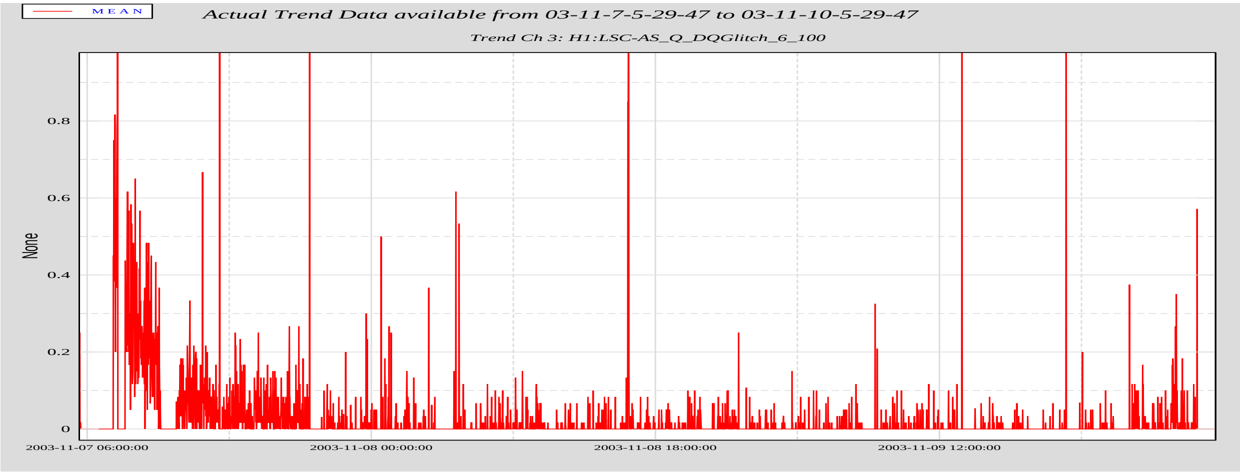
*T0=03/12/2003 20:38:35 *Avg=15/Bin=2L BW=0.1875



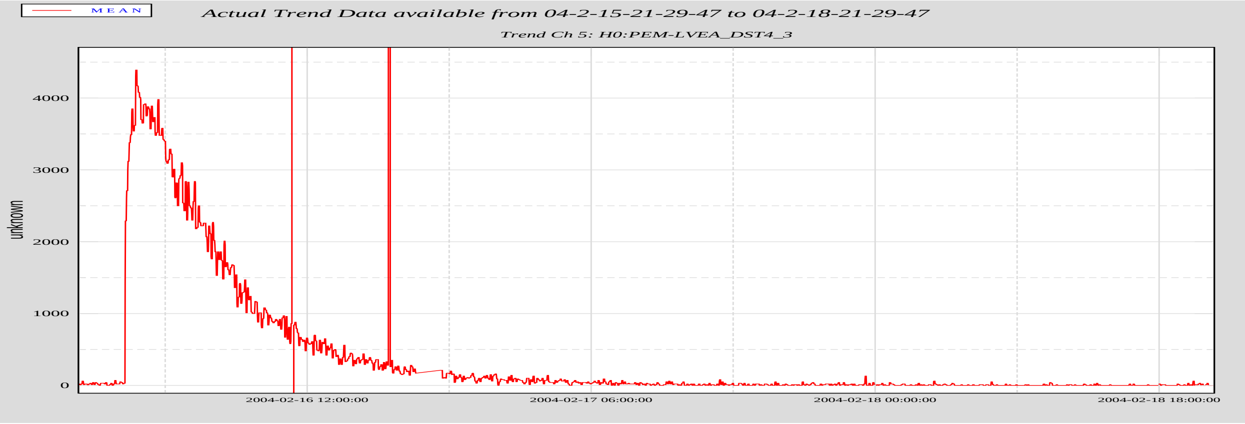
*T0=03/12/2003 20:38:35 *Avg=15/Bin=2L BW=0.1875

DUST CAUSES BURSTS IN AS_Q

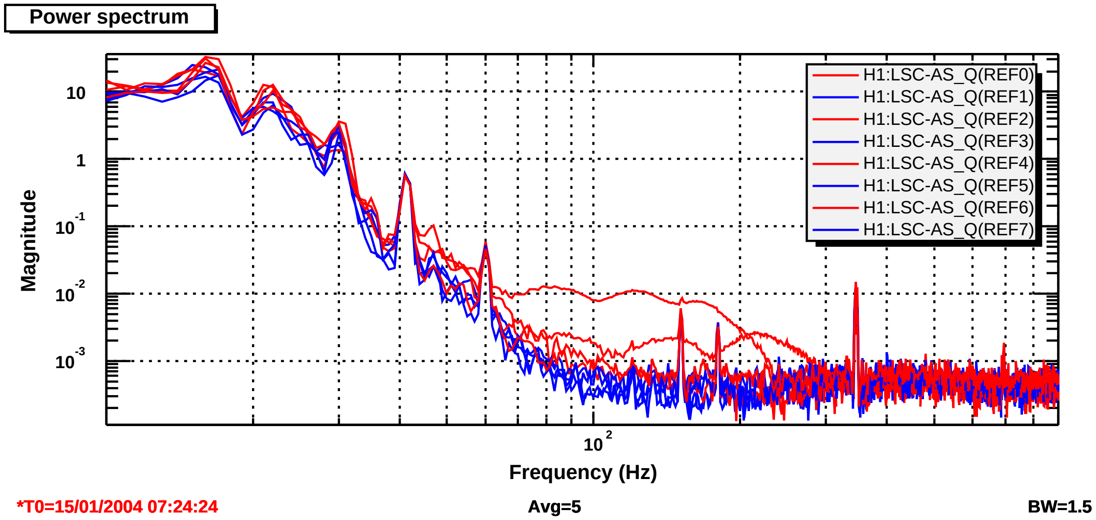
H1 AS_Q 6 sigma glitch rate after ISCT4 entry during S3 (3 day trend):

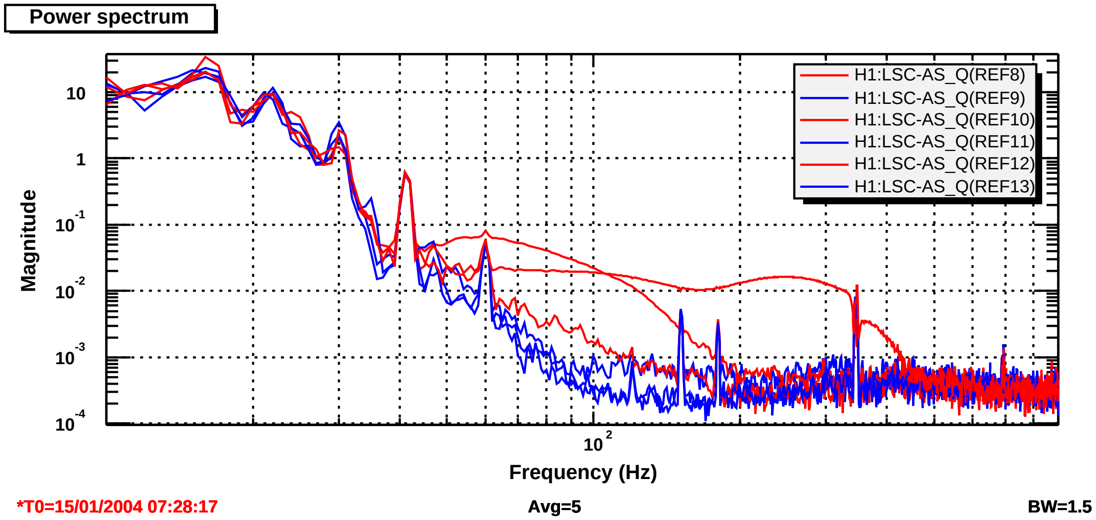


Dust monitor was installed after S3; dust count after ISCT4 entry (3 day trend):



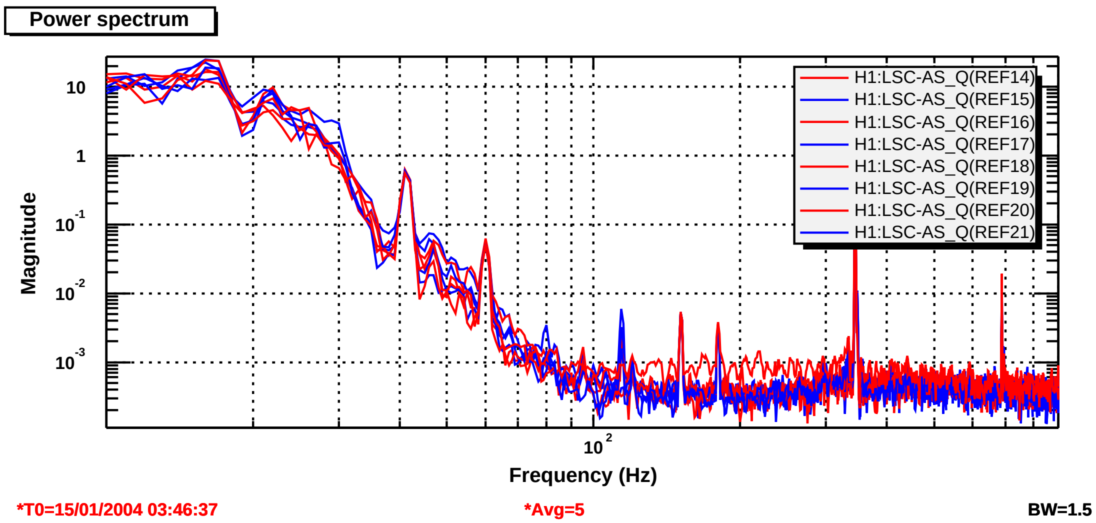
RED: spectra for dust flash times on video tape of AS_Q photodiode region;
BLUE: spectra OFFSET +/- 10 s from dust flash on video tape





Near periscope where beam is much larger

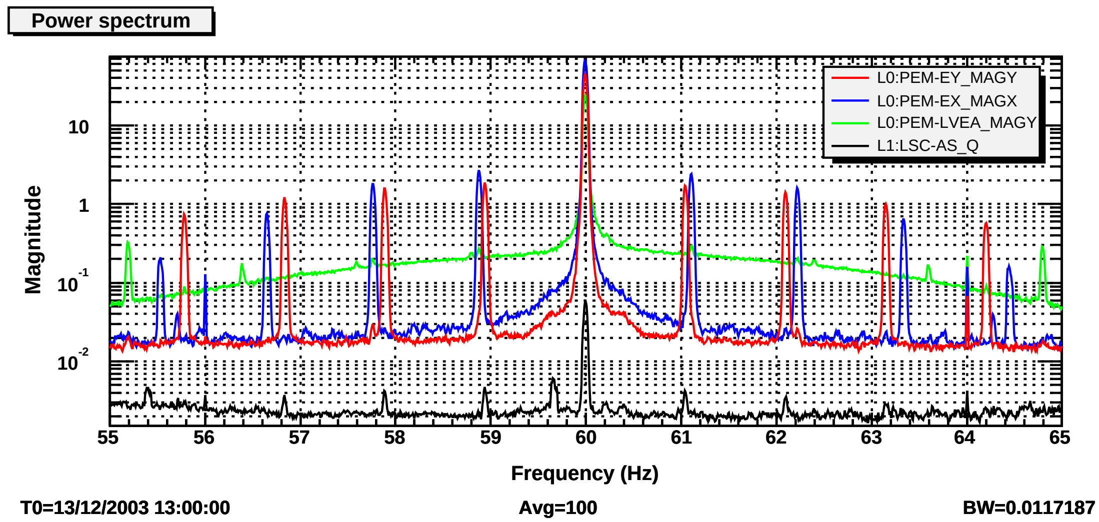
Red: dust flash; Blue: offset from flash

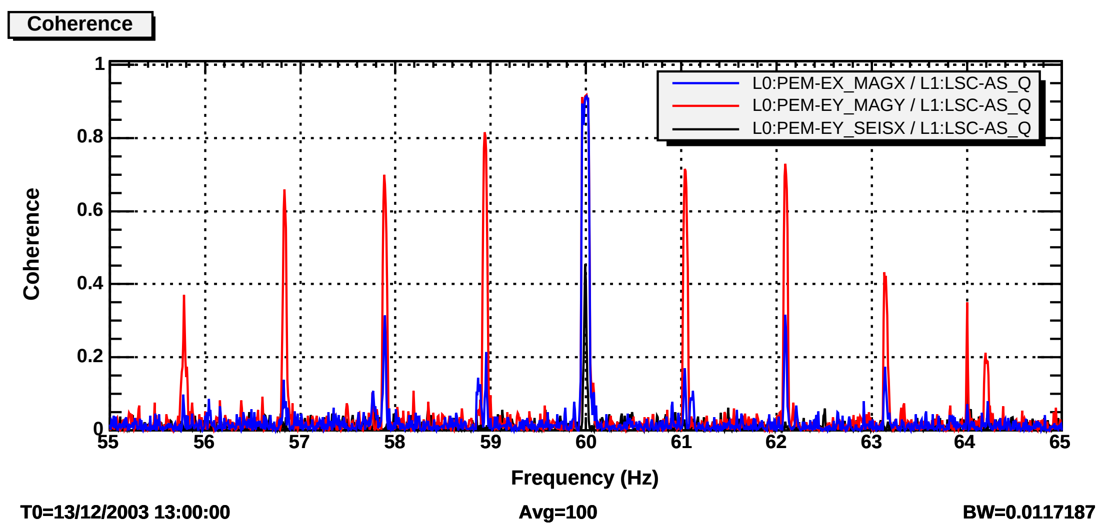


So dust produces large glitches when it passes through small beams.

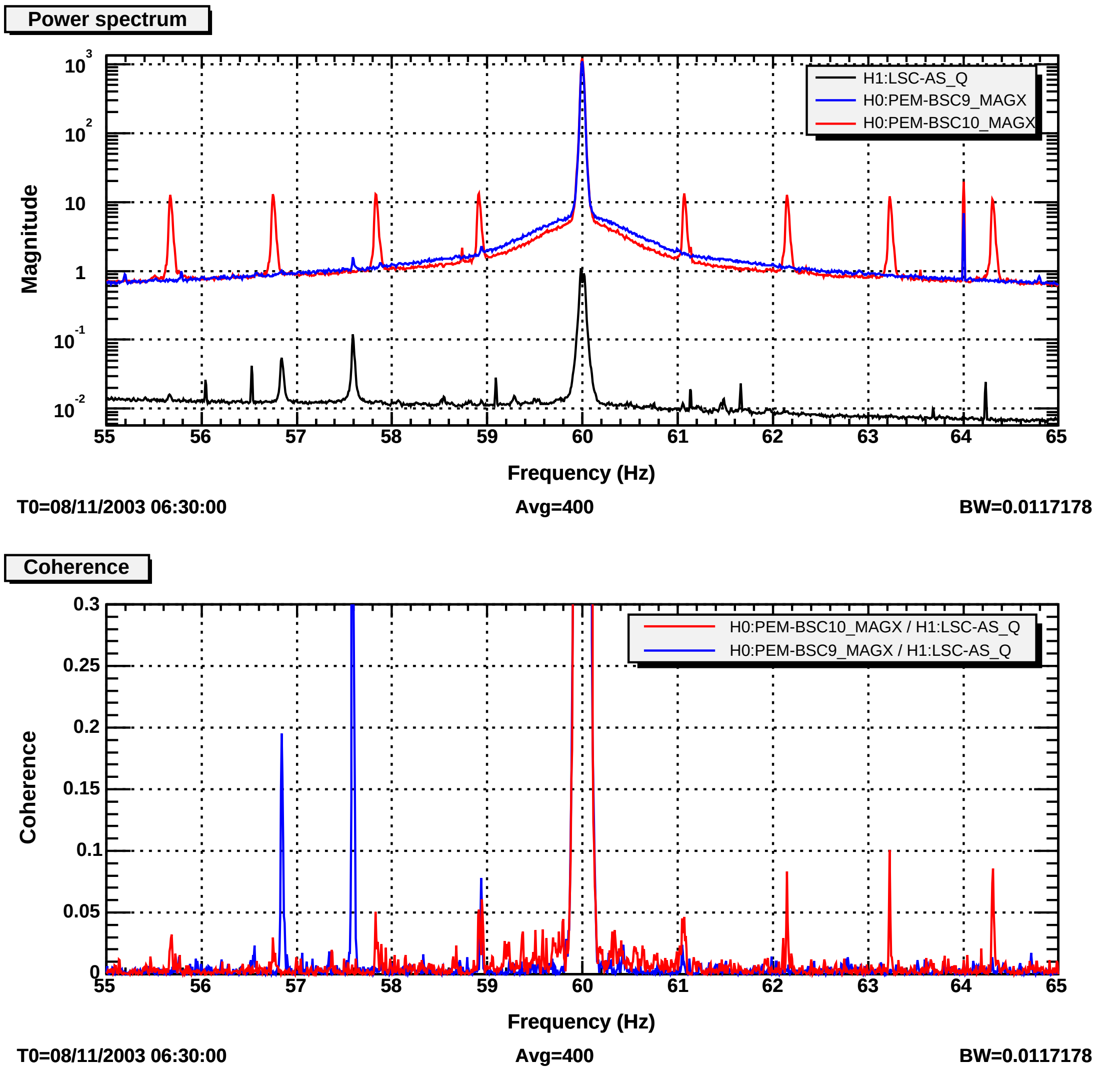
DURING S3, 1 HZ SPACED SIDE BANDS AROUND 60 Hz STARTED TO APPEAR IN AS_Q

LLO:





LHO:



Power spectrum
Magnitude
H1:LSC-AS_Q
H0:PEM-BSC9_MAGX
H0:PEM-BSC10_MAGX
Frequency (Hz)
T0=08/11/2003 06:30:00
Avg=400
BW=0.0117178
Coherence
Coherence
H0:PEM-BSC10_MAGX / H1:LSC-AS_Q
H0:PEM-BSC9_MAGX / H1:LSC-AS_Q
Frequency (Hz)
T0=08/11/2003 06:30:00
Avg=400
BW=0.0117178

Level in AS_Q consistent with magnetic field coupling from PEM injections

Traced to pulsed in-duct LVEA and VEA heating:

Red: pulsed and staged heating on; Black: staged heating only