ACOUSTIC MITIGATION
POST-S3 UPDATE

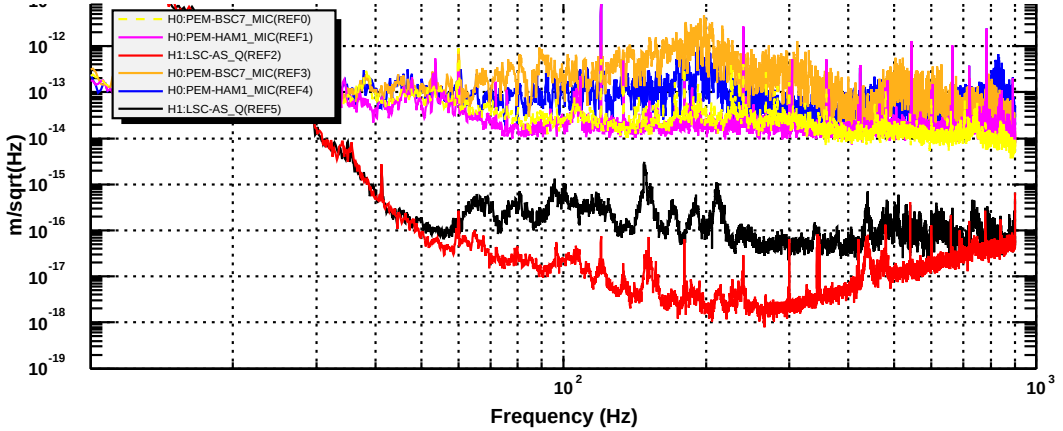
Robert Schofield, University of Oregon

AND MANY OTHERS

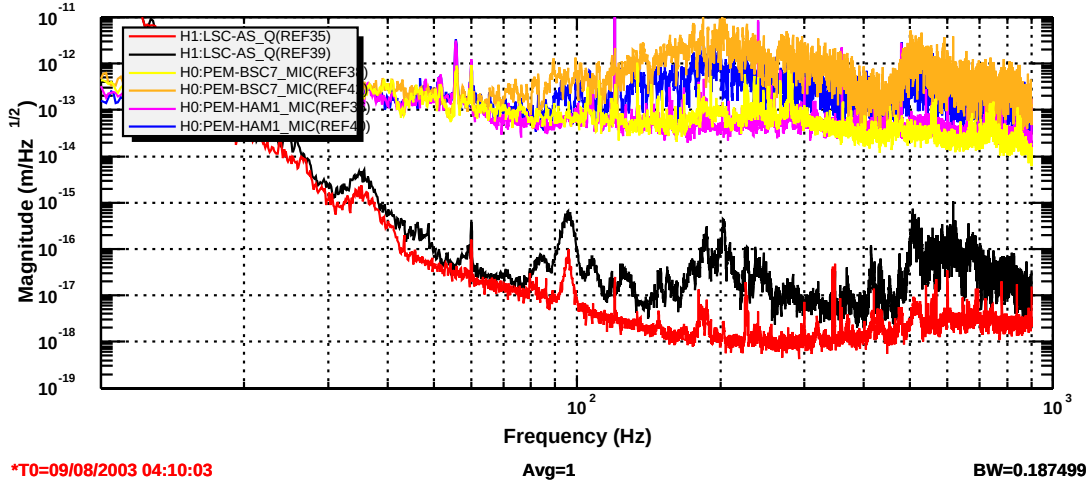
REDUCTION IN ACOUSTIC COUPLING SINCE S2

Red: AS_Q normal; Black: AS_Q with noise; Yellow & Orange: BSC7 mic

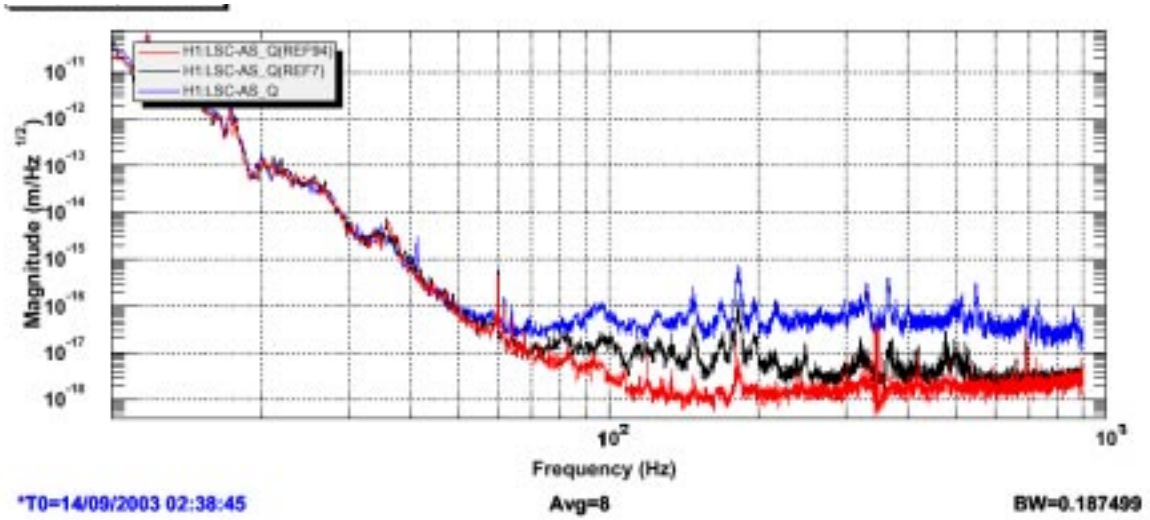
March 12: S2



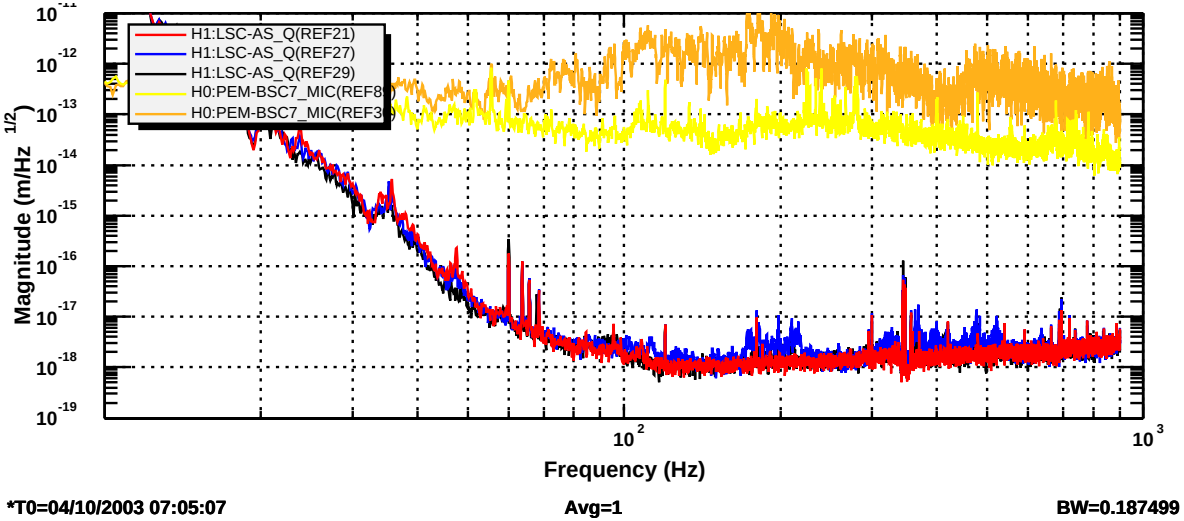
August 9: AS EO shutter out, periscope mount replaced



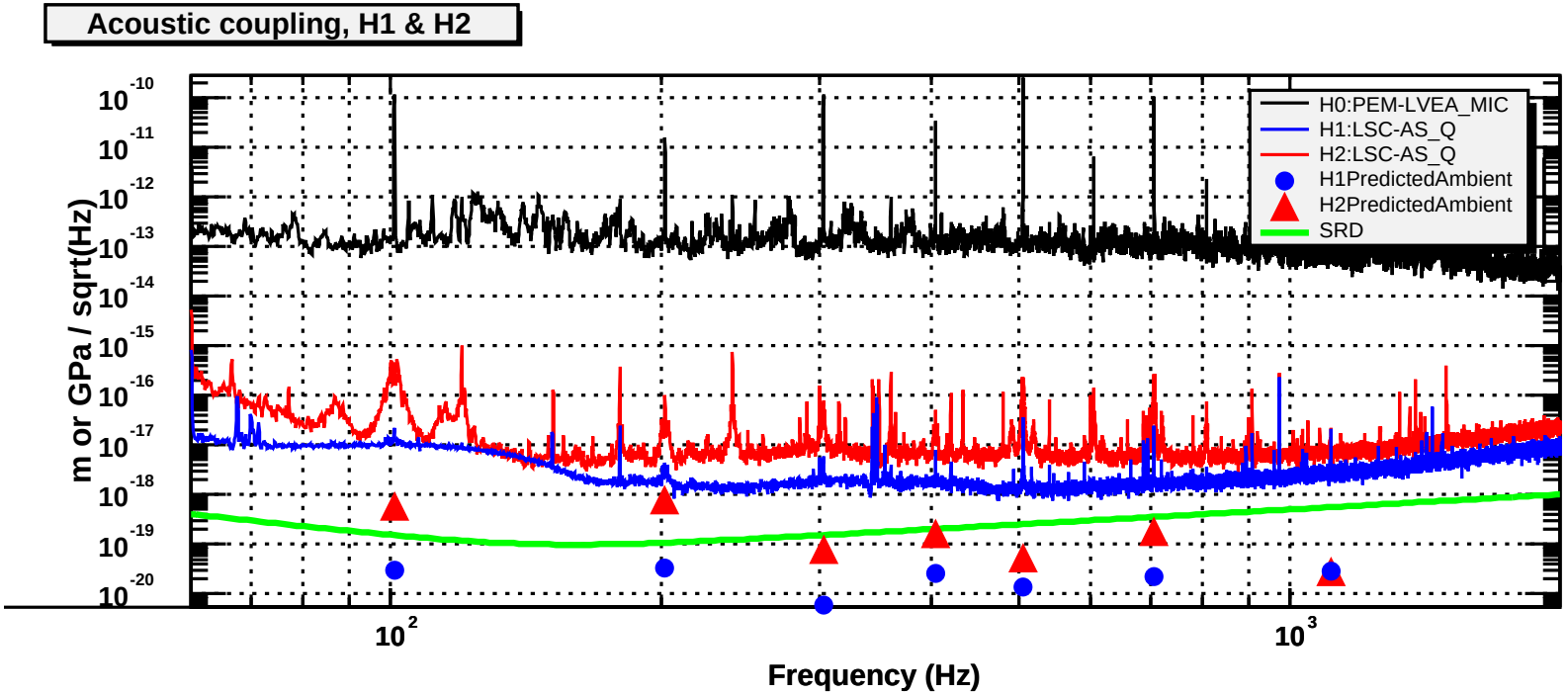
Sept. 13: after AS enclosure, 2 inch optics; Blue: injection at REFL port (now limiting)



Oct 4: after REFL port work - removal of EO shutter, 2" optics, damped periscope



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



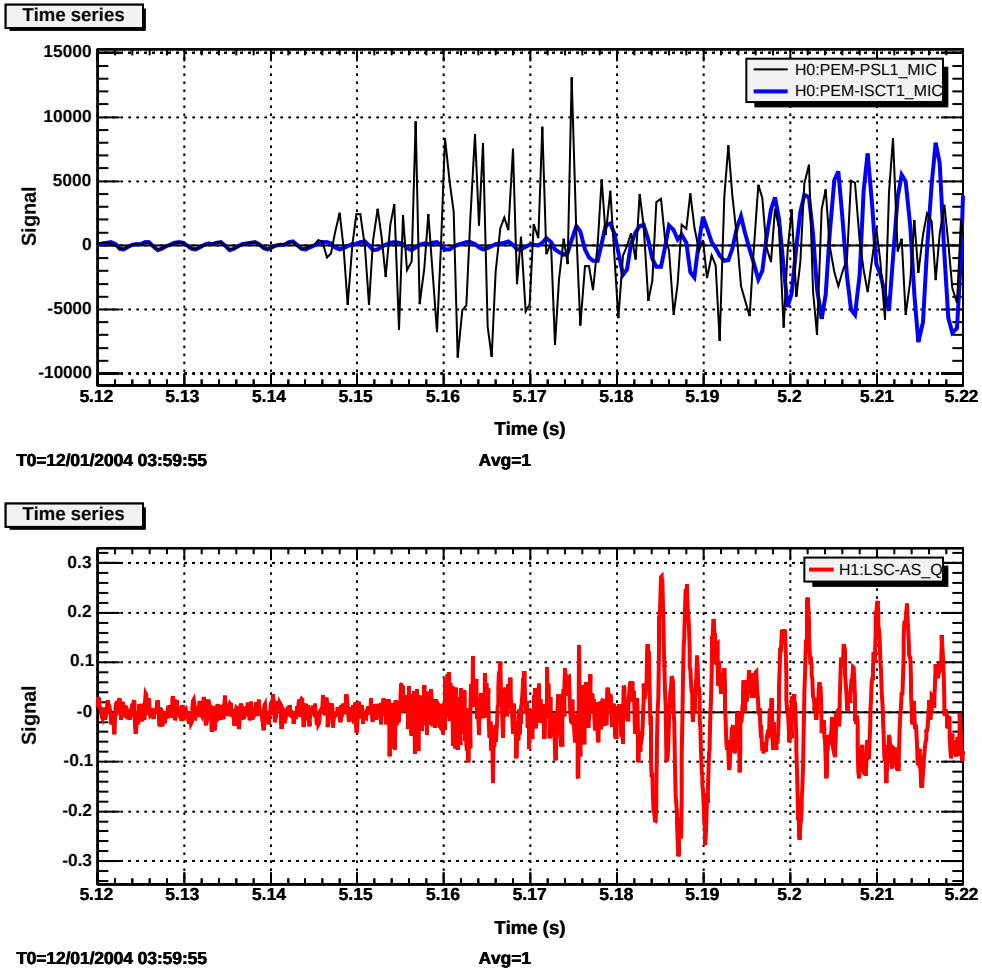
100 Hz ramped sawtooth played through speaker. Possible dust glitch at low f in H1 spectrum

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

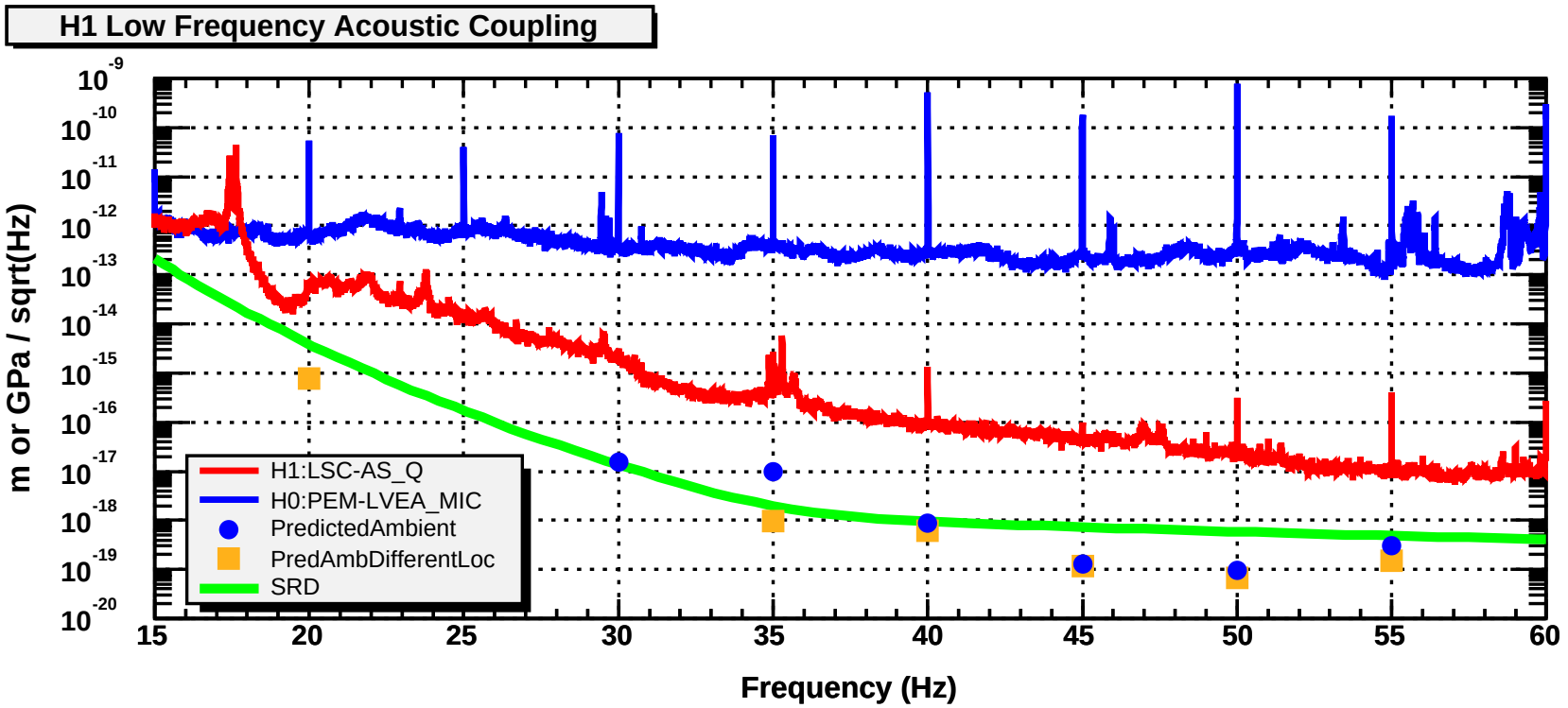
L1:
- reflected port table or input optics table (I would guess REFL)

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?

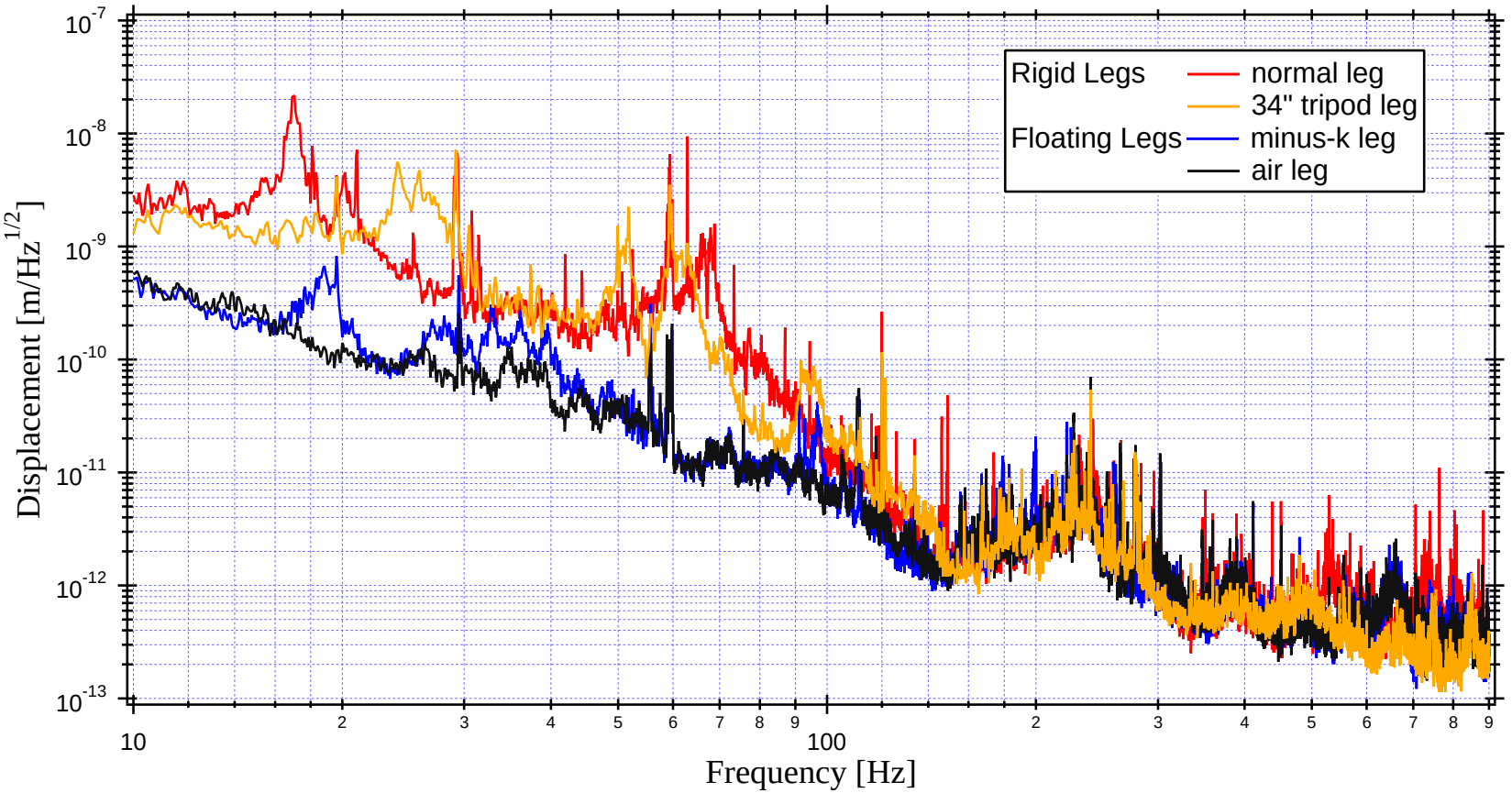
HVAC is main source, shutting it off reduces acoustic and acceleration levels by only about 5 though, and indications are that in-duct mufflers would not help - much of it comes directly through wall of mechanical room.

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

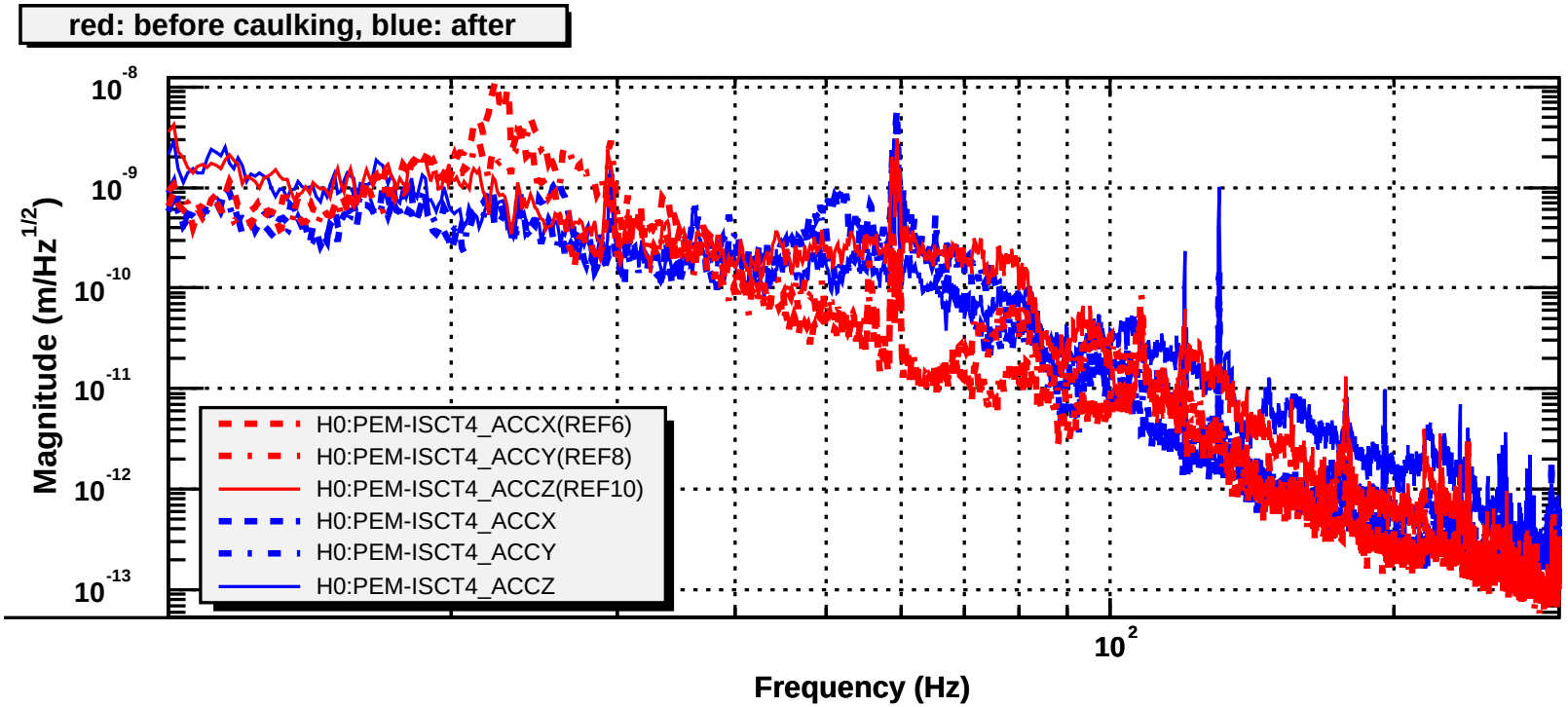
Red: current leg; Orange: tall tripod; Blue: minus-k; Black: pneumatic



Sum in quadrature of 3 accelerometer axes, converted to displacement

GROUTING OF RIGID LEGS REDUCES RMS VELOCITY BY ABOUT 5

Displacement spectra from accelerometers on ISCT4:



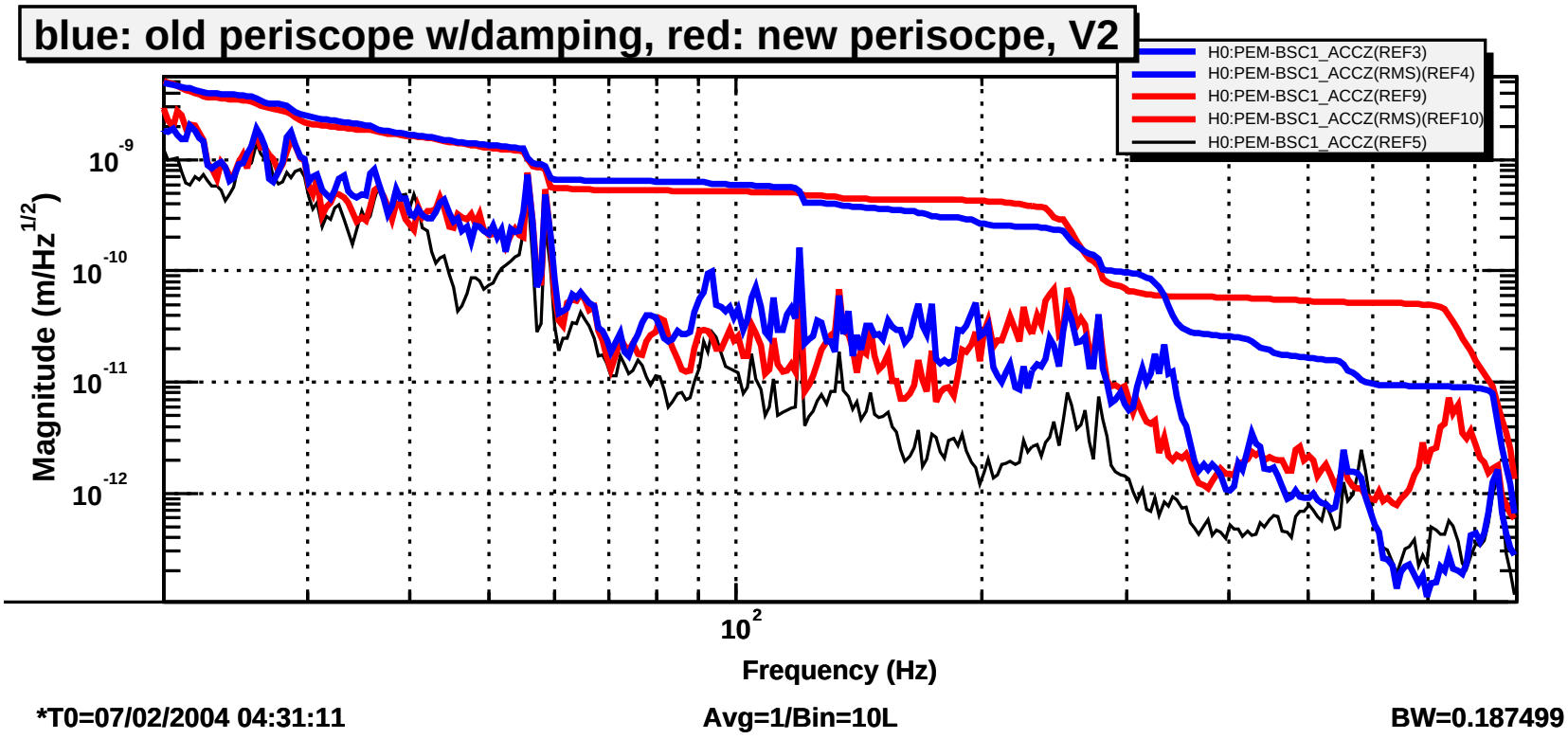
Before recommending grouted rigid legs:

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.

NEW PERISCOPE (VERSION 2) TEST RESULTS

Accelerometer attached to 2” Aluminum disk that is then placed in top mirror mount. Measured motion is normal to mirror surface.



New periscope is 2 or 3 times better in the 100 to 200 Hz region but lowest resonance (250 Hz) is still much lower than predicted. Fastener problems? Large peak in 700 Hz region. Also, reflections from inside of tube should be minimized (anodized etc.).

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.