Environmental Disturbances: Early S5 and S4

LIGO-G060152-00-Z

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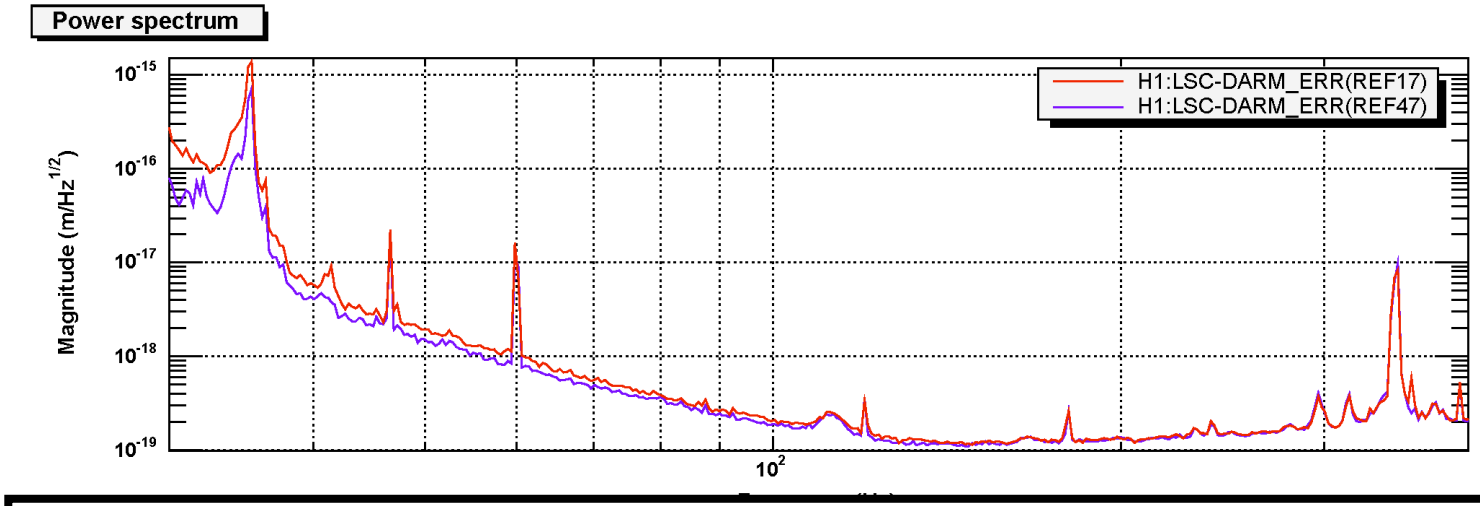
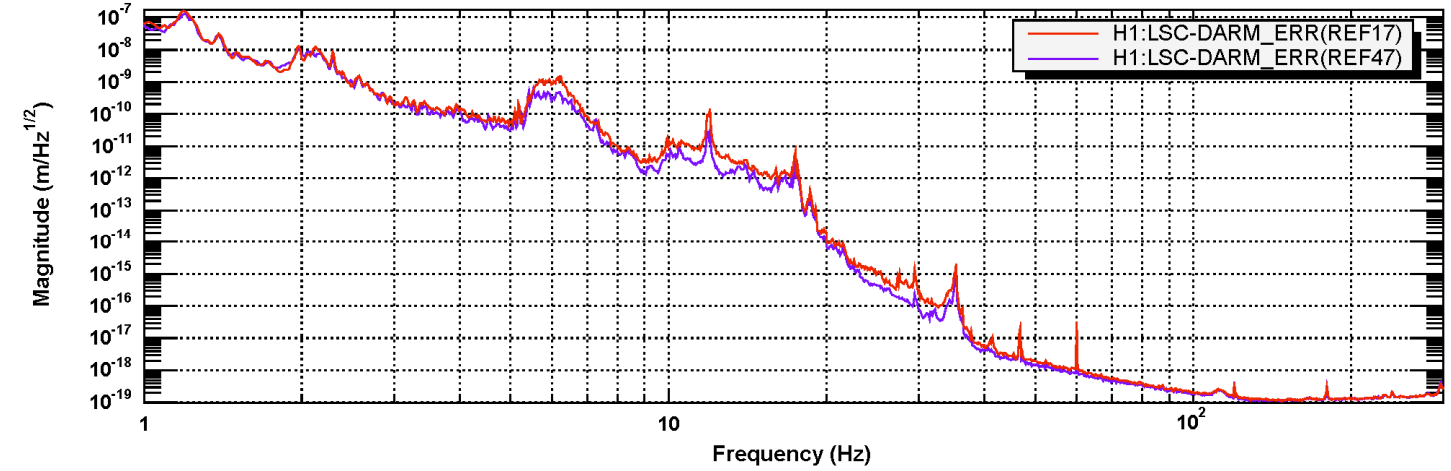
I. HVAC flow rate reduction improves sensitivity
II. Seismic up-conversion experiments
III. S4 H1-H2 coincident events from site activity
IV. PEM injections
V. Electronics rack diagnostic magnetometer
VI. Crab protection

Gravitational wave sensitivity improves when HVAC off



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

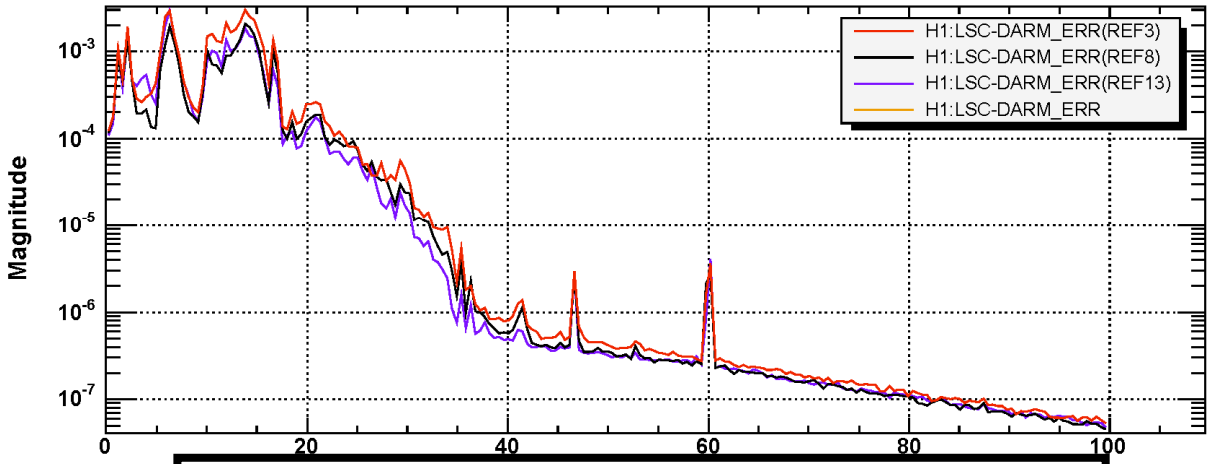


*T0=12/02/2006 17:54:39 *Avg=1/Bin=10L BW=0.0234367

Half-normal flow rate about as good as fans off

Red: pre-Feb. 15 flow rate, Black: all off, Blue: half flow rate

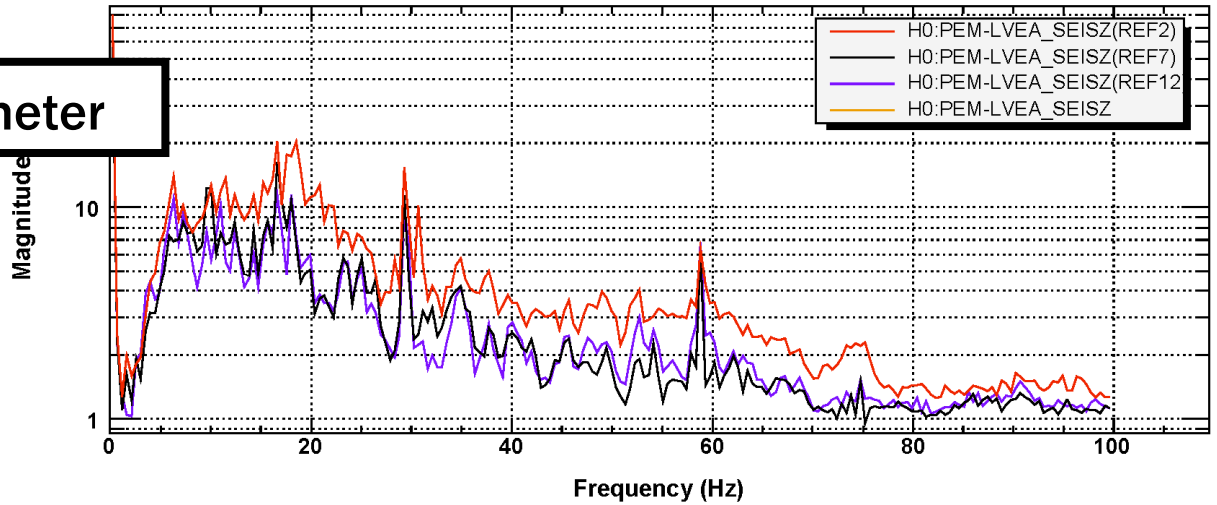
DARM



Black: off; Blue: ½ flow; Red: full flow

Power spectr

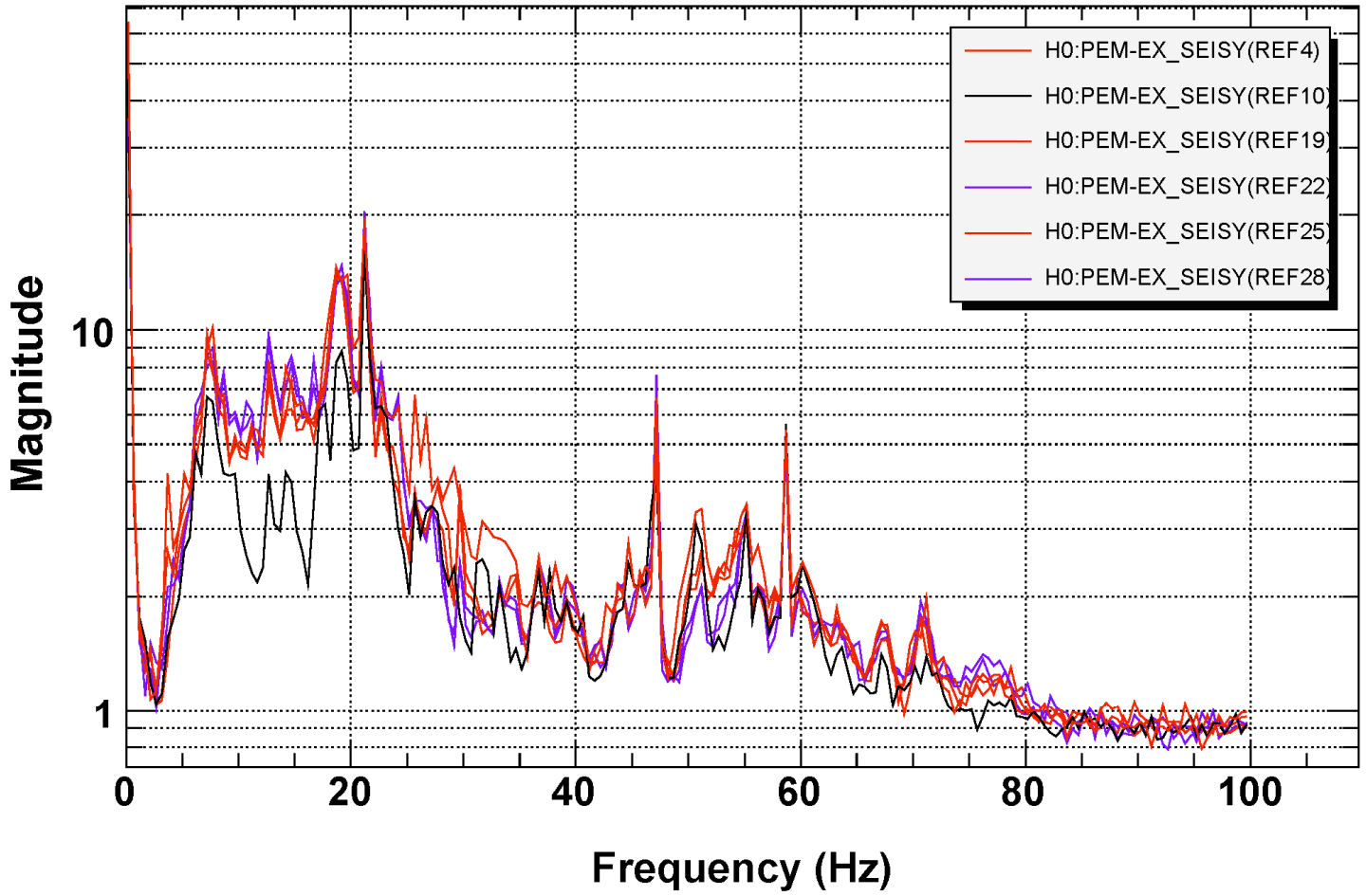
seismometer



*T0=15/02/2006 06:35:00 Avg=9/Bin=30 BW=0.0234374

Seismic noise likely from fan and plenum, not ducts (at X-end)

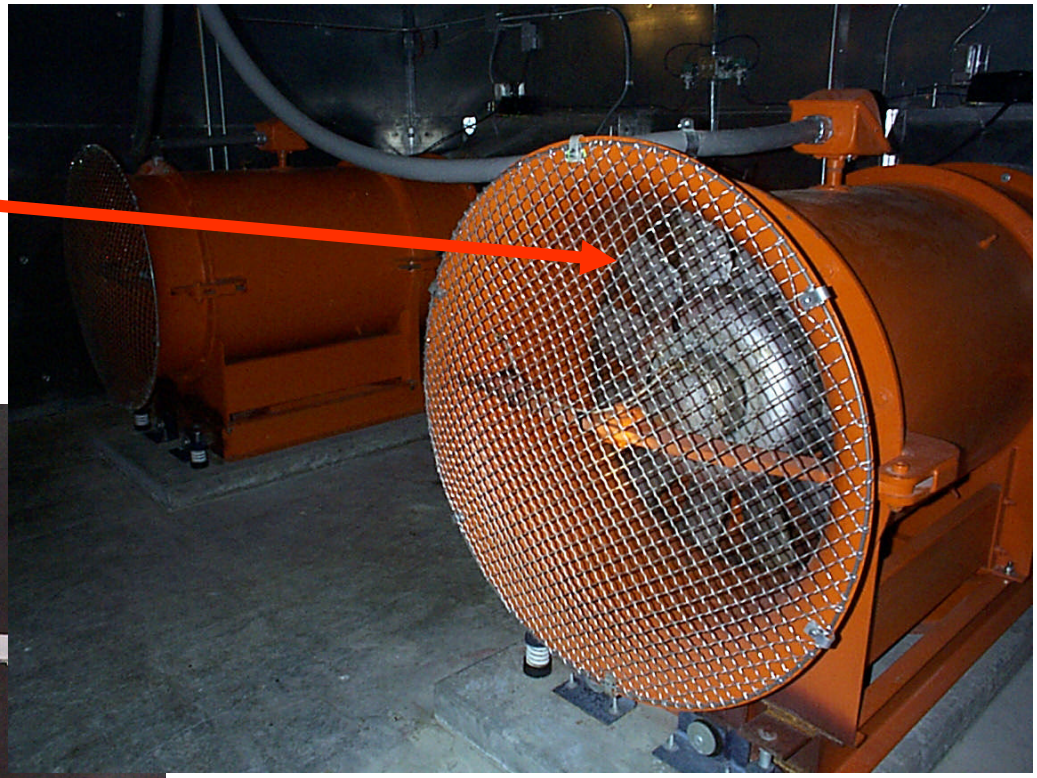
Black: off; **Red: normal flow**; **Blue: like red but ducts closed off at plenum**

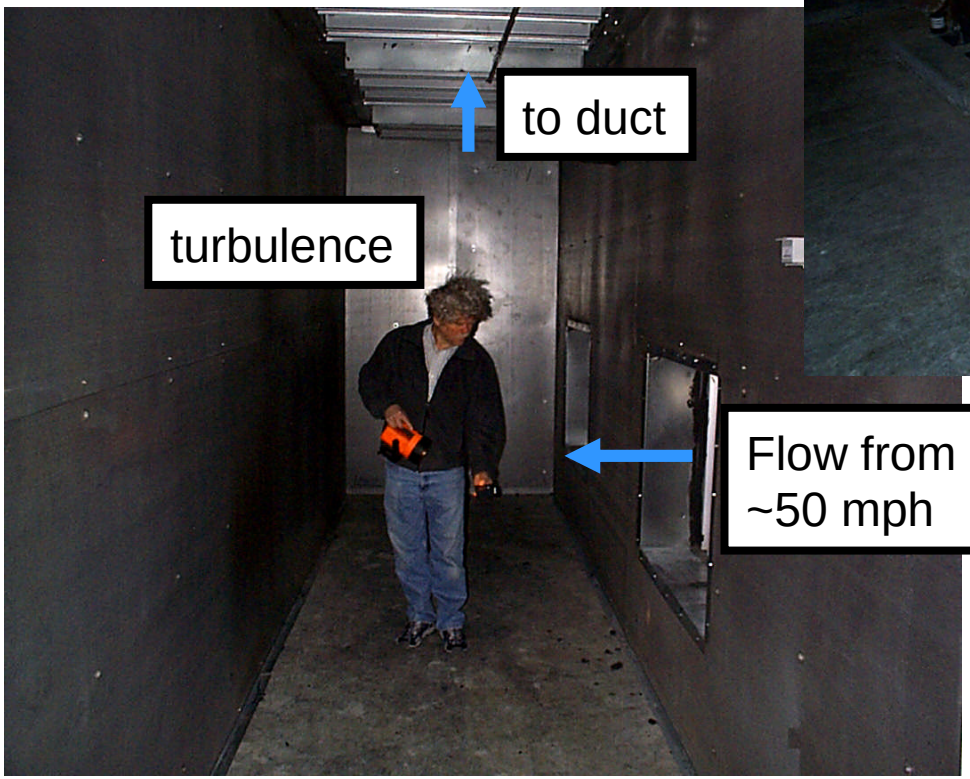


*T0=17/02/2006 03:07:00 *Avg=30/Bin=4 BW=0.1875

Broad-band seismic signal from HVAC possibly produced by plenum turbulence

Pitch of blades controls flow rate through turbine

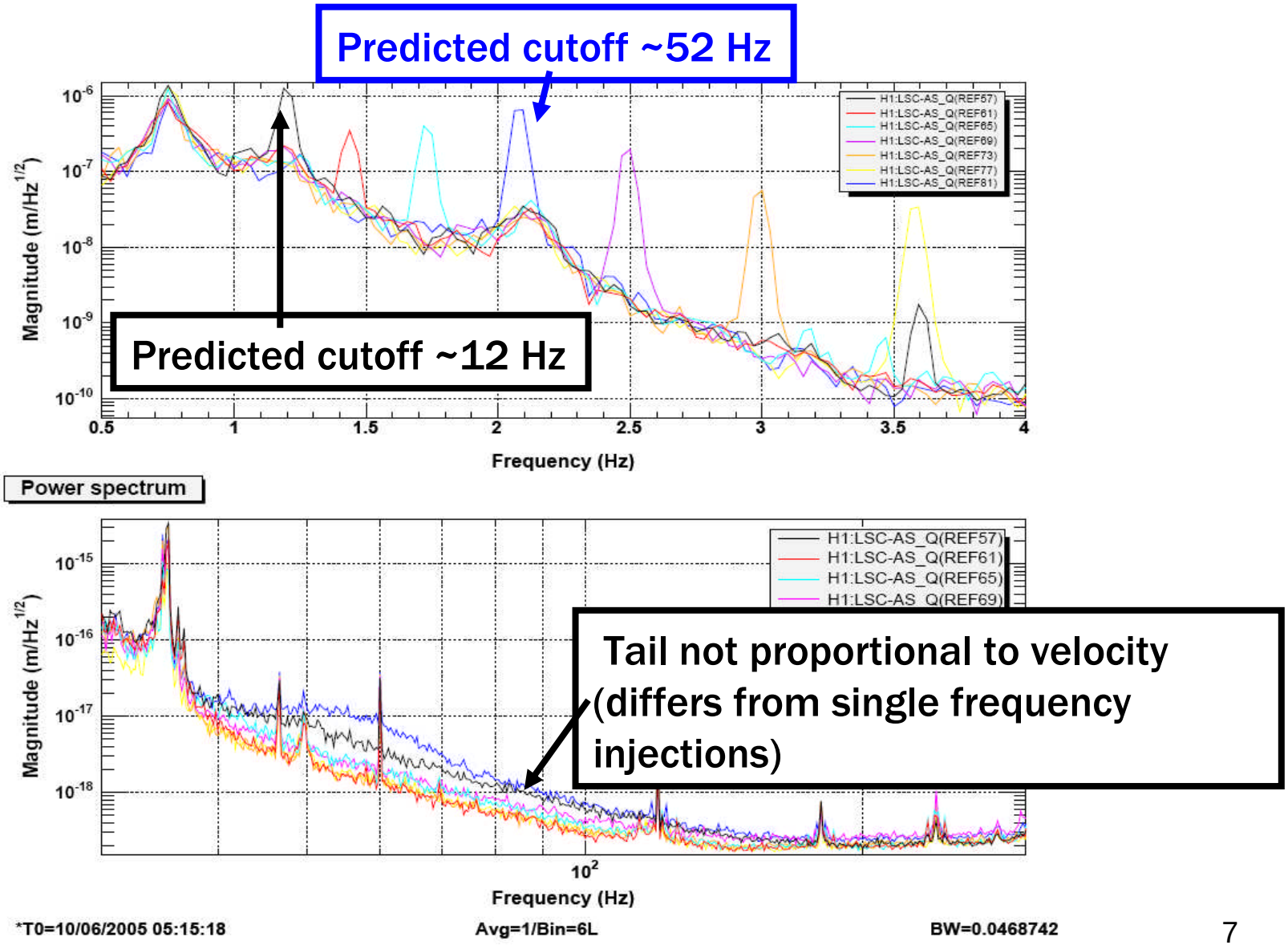




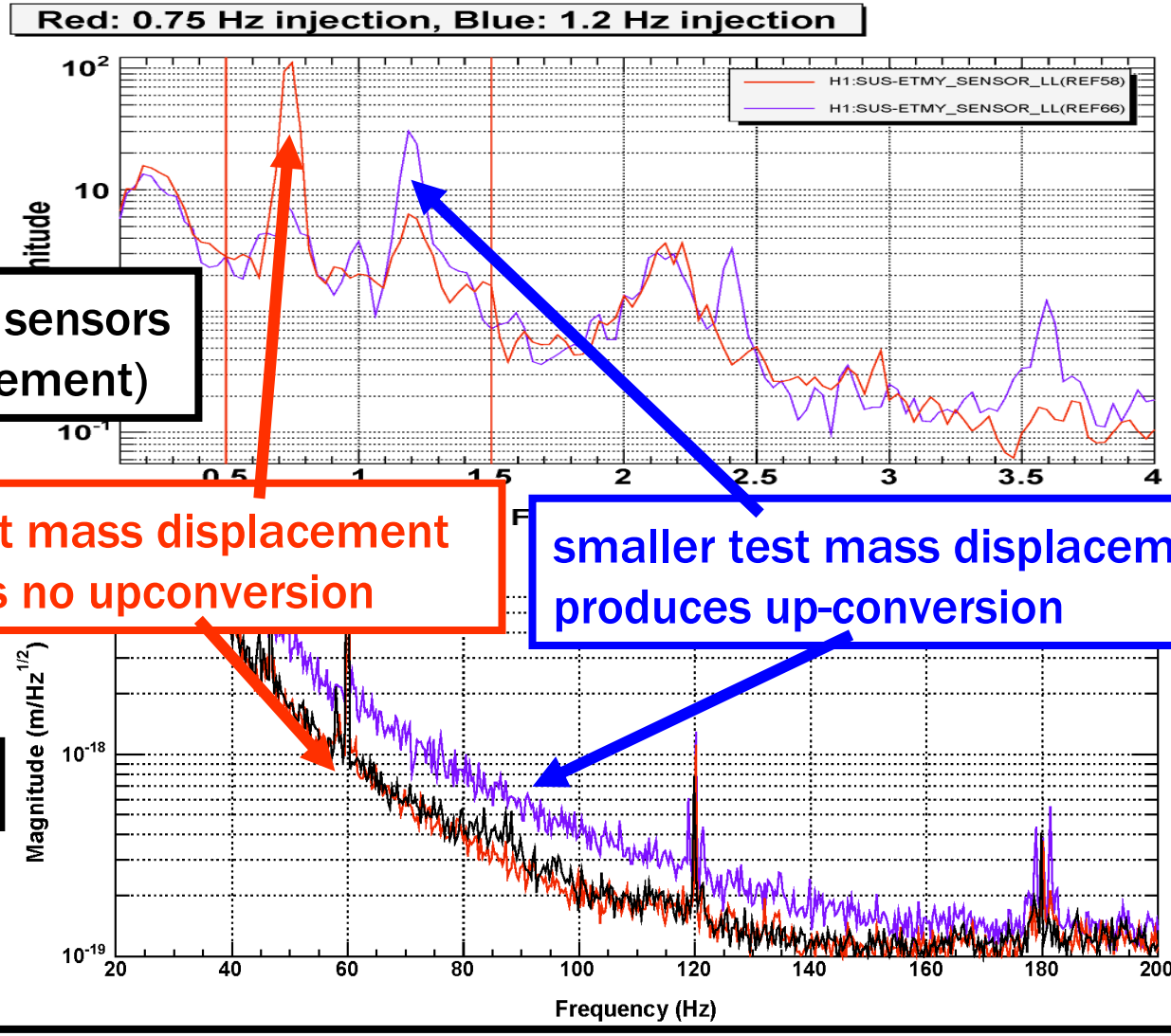
Summary: HVAC effect on range

- *Shutting HVAC down improves H1 & H2 range about ¾ 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 ¾ 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.*

Simple back-scattering model doesn't explain tail



Up-conversion not from “squeaky” optic suspension point

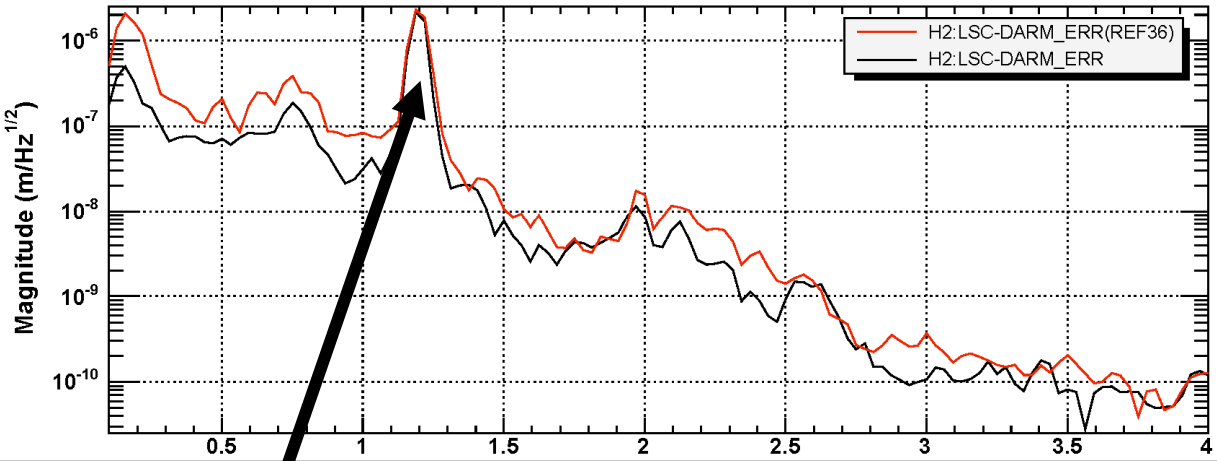


Blue peak is smaller than red in displacement and velocity but not in acceleration.

Ground or isolation system motion not needed to produce up-conversion

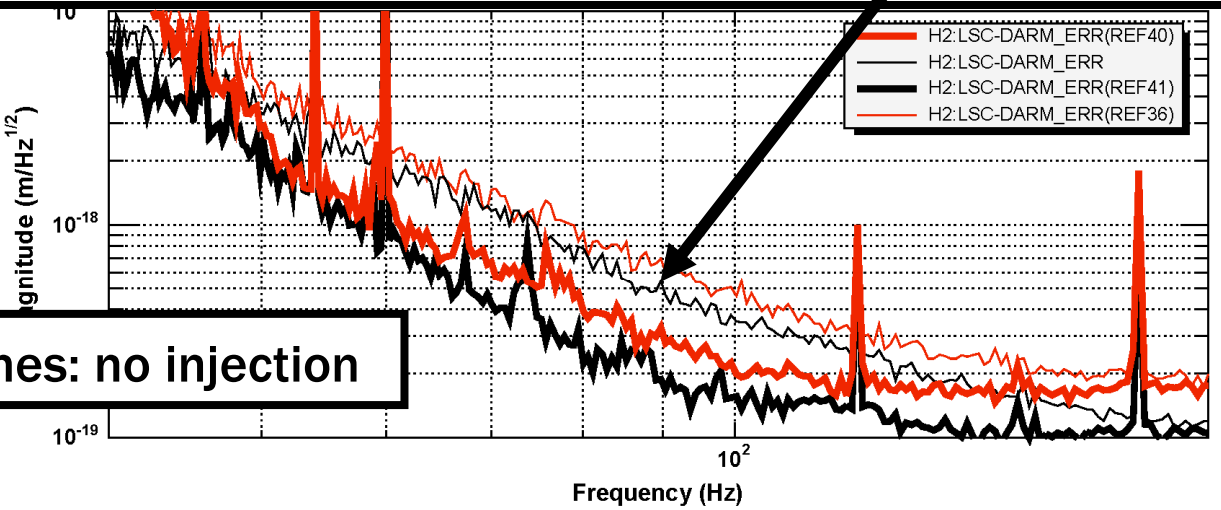
Black: ETMY coil injection; Red: ground shaking at ETMY

DARM low f



matched ground and coil injections produce similar upconversion

DARM high f

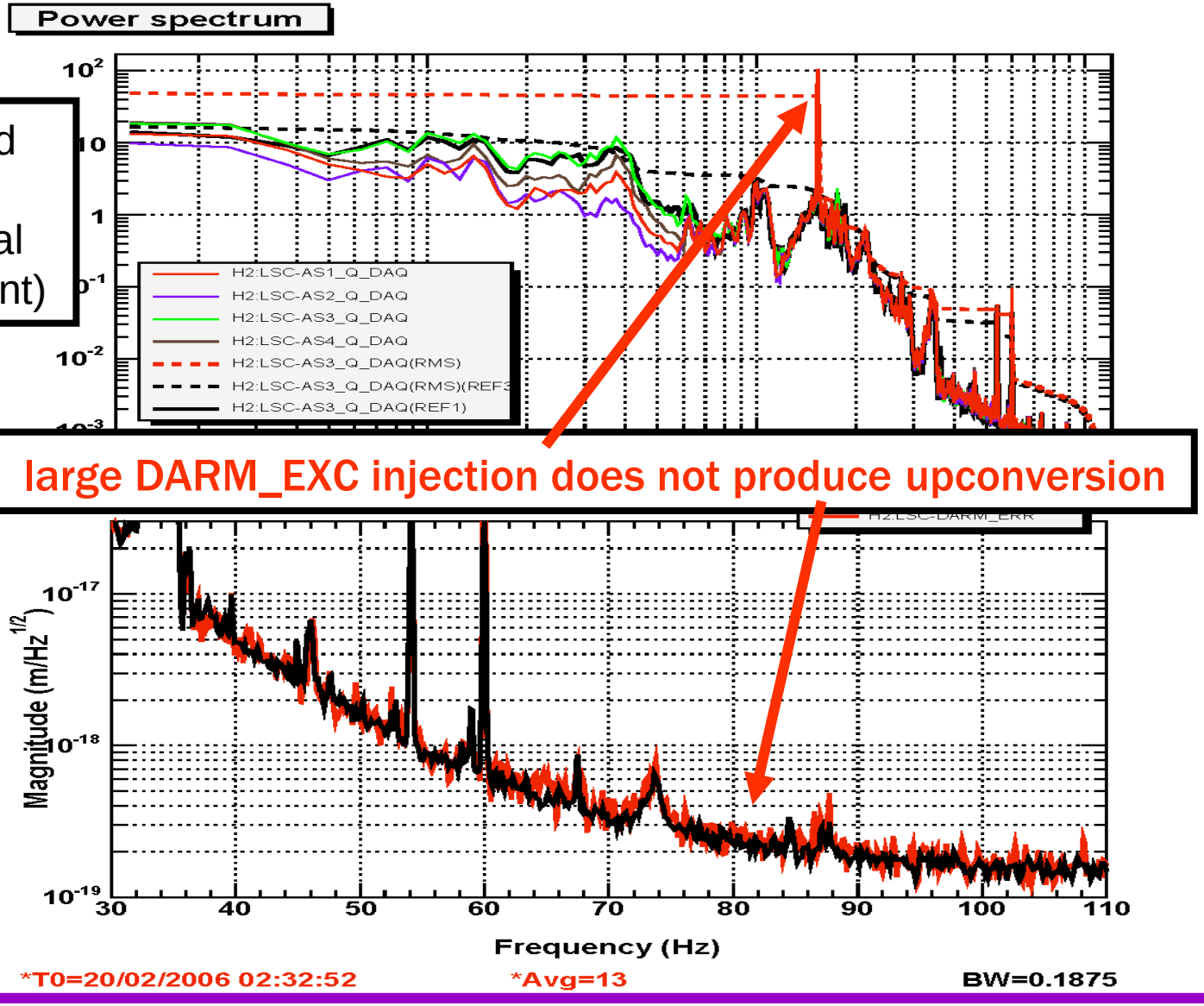


thick lines: no injection

*T0=04/11/2005 13:06:33 *Avg=5/Bin=7L BW=0.0468662

Up-conversion not from RF saturation

uncalibrated DARM (proportional to RF current)

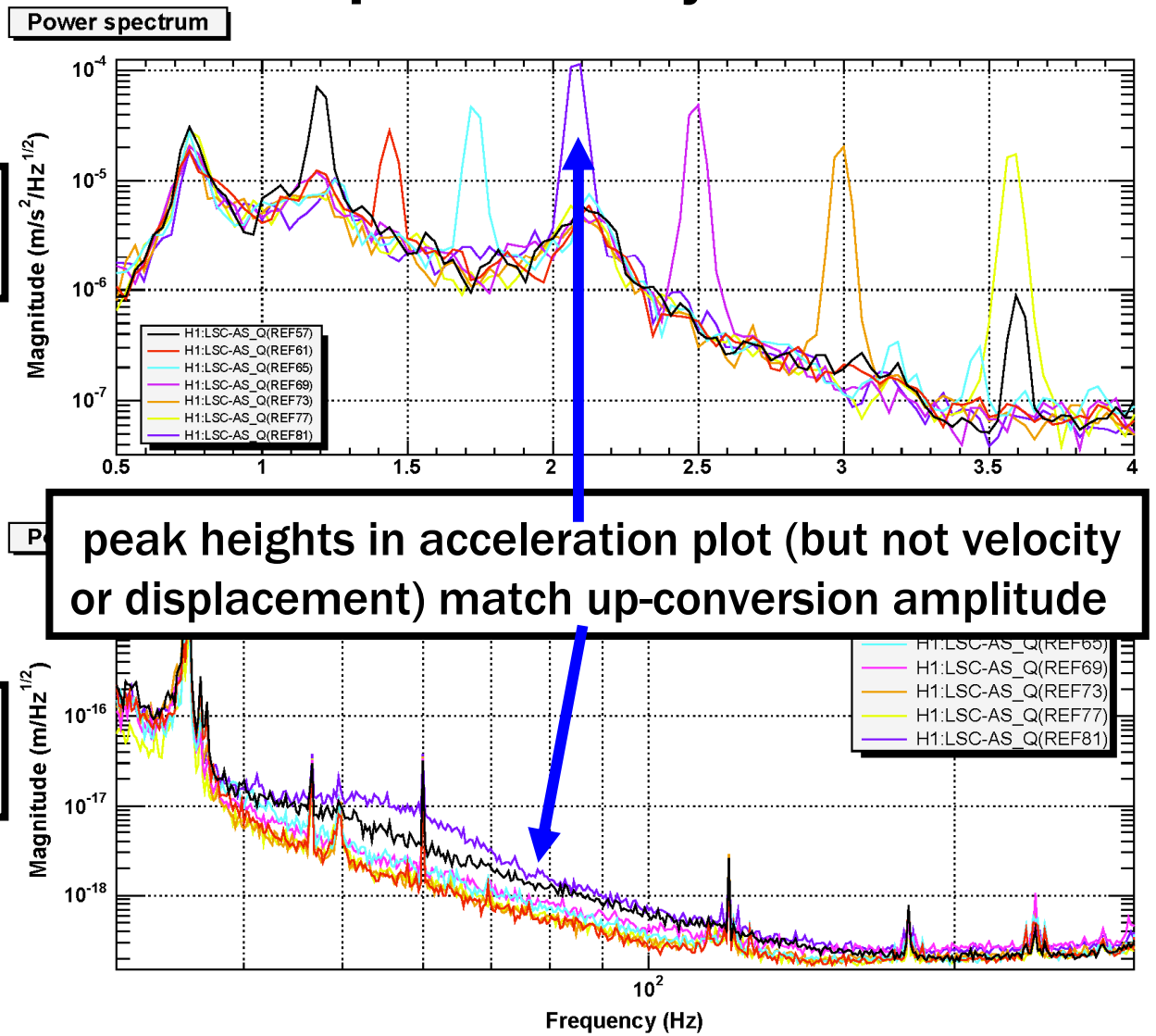


DARM

Up-conversion best predicted by acceleration of optic

DARM: acceleration

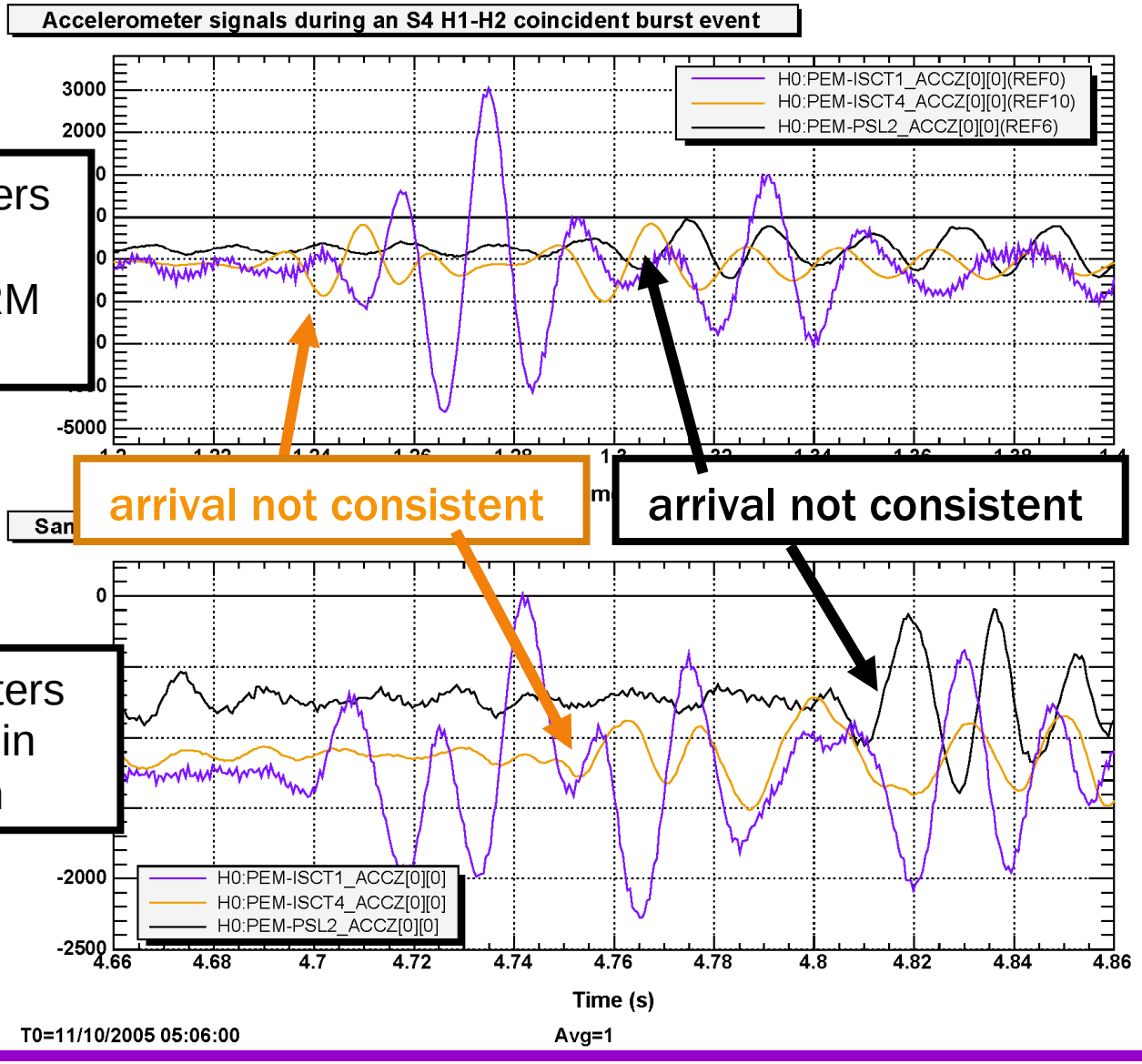
DARM: displacement



Up-conversion summary

- *At low seismic amplitudes, not consistent with back-scattering*
- *Not suspension point mechanical up-conversion*
- *Ground or stack motion does not appear to be necessary (is produced by direct ETMY coil injection)*
- *Acceleration of test mass predicts up-conversion better than velocity or displacement.*
- *Not RF saturation*
- *Up-conversion in actuation system?*
- *Magnetic domain-flipping (Barkhausen) noise?*

What produced coincident H1 H2 bursts during S4?

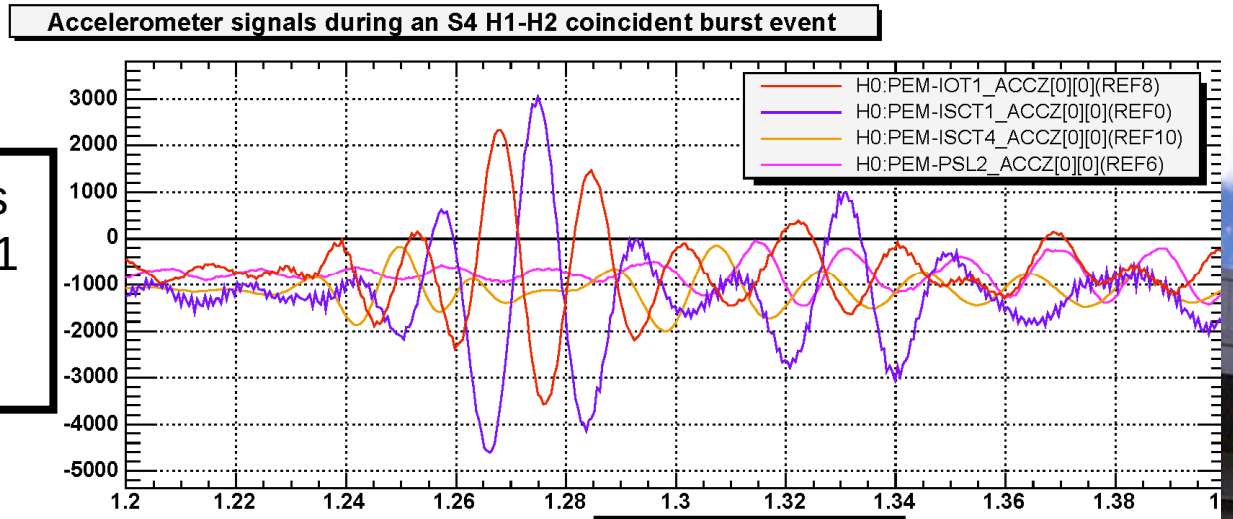


Accelerometers at time of S4 H1& H2 DARM burst

Accelerometers during jump in control room

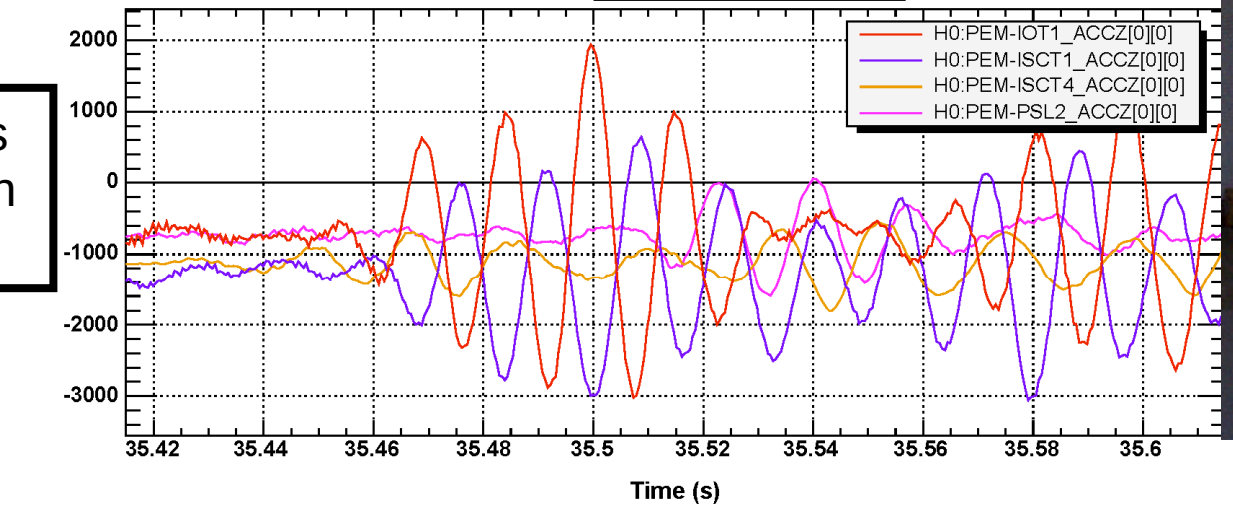
Door slams and water bottle drop also not consistent (delay, amplitude, f), but fork lift set-down at shipping is.

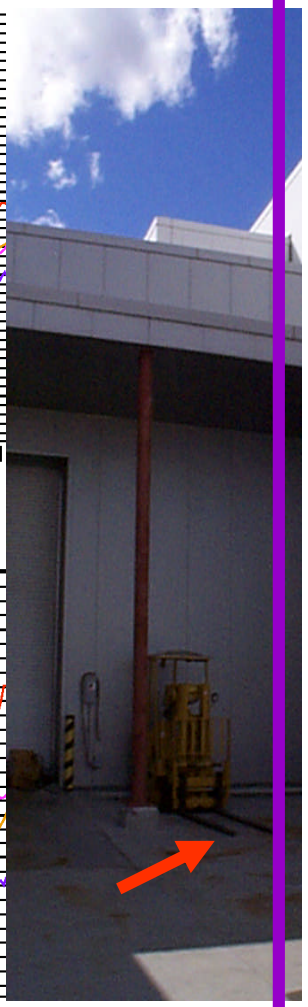
Accelerometers at time of S4 H1 & H2 DARM burst



Agreement

Accelerometers during set-down of fork lift forks

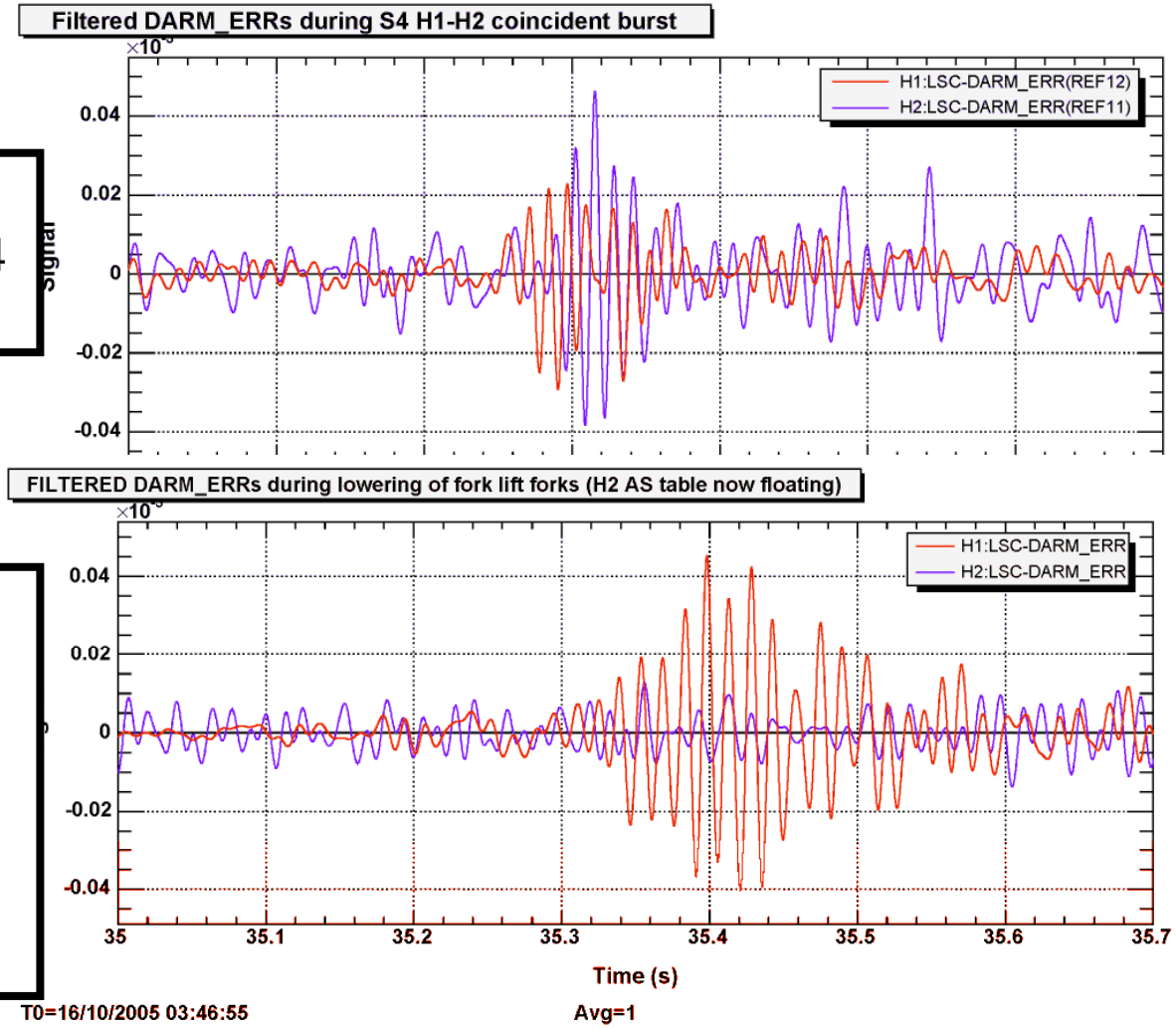




“Floating” H2 dark port should reduce H1-H2 coincidences

H1 DARM, H2 DARM during S4 event

H1 DARM, H2 DARM during forklift event: with floating H2 dark port, very little signal is seen on H2



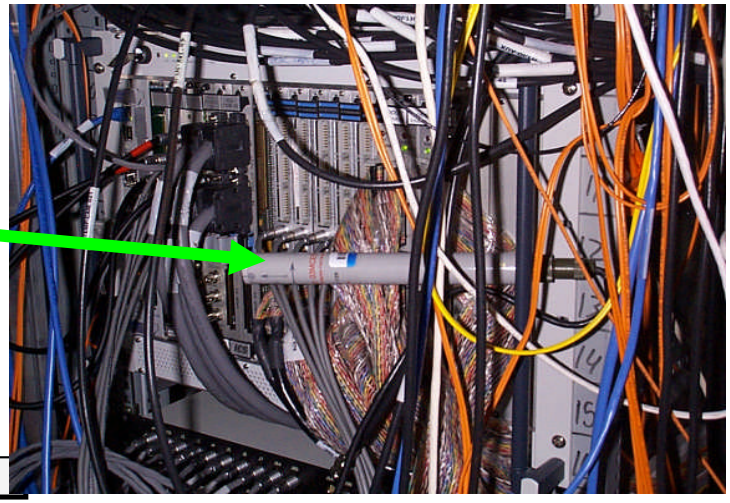
S5 PEM Injections

- **LLO: Dec 10 2005 elog has burst injection times and transfer functions. Summary:**
- ACOUSTIC/SEISMIC - coupling lower than S4; no coupling found in electronics bays.
- MAGNETIC - coupling about the same as S4; we can not reduce DARM 60 Hz substatially without reducing 60 Hz ambient magnetic field; LVEA pulsed heating should be turned off.
- RF - external sources loud enough to occasionally show up in DARM - radio channels areimportant veto channels

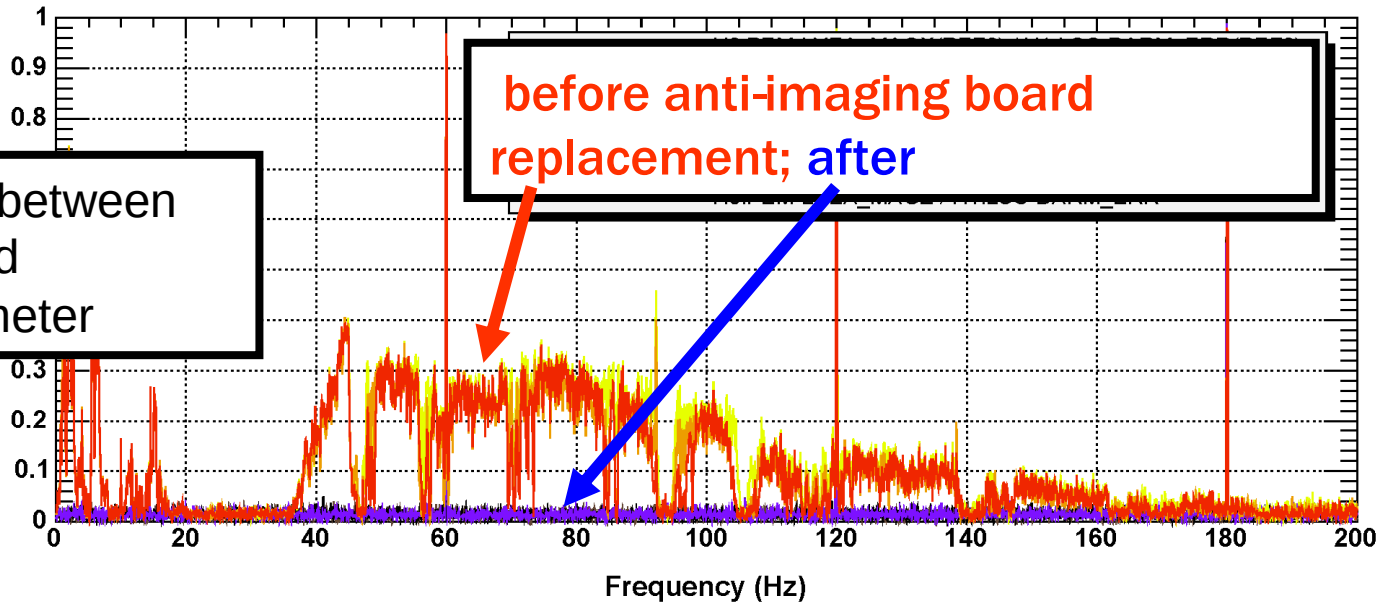
- **LHO: Jan 8 2006 elog has burst injection times, transfer functions. Summary:**
- ACOUSTIC/SEISMIC-coupling 5x lower than S4; possible backscattering problem from end-station transmitted ports.
- SEISMIC UPCONVERSION-same for all H1 and H2 out-stations, would be seen daily in H2 except for mystery noise.
- RF-about the same as S4: signal on RADIO_LVEA about 100x SNR of DARM.
- MAGNETIC-about the same as S4: a substantial or dominant contributor to DARM 60 Hz, 3 Hz sidebands need fixing...

Electronics racks magnetometer diagnostic

Magnetometer near electronics racks previously used to identify peaks in DARM from sources in electronics racks. During S5 break, broad band coherence between magnetometer and DARM led to discovery of bad board (which put ripple on power supply).



cohernce between DARM and magnetometer



Crab protection

Kyle Ryan improves the seismic isolation of the office area air handler, which has been running recently at 59.6 Hz

LVEA HVAC experiments

CONFIGURATION	TOTAL LVEA FLOW (CFM)	SEIS_Z BAND (counts) 33-50 Hz	1-27 Hz
A) Original flow	40,000	15.7	52
B) 2 LVEA fans and labs at 50% flow	20,000	8.6	29
C) Full LVEA flow with 2 fans. Labs at 50%	40,000	12.3	40
D)Full LVEA flow with 3 fans. LABs at 50%	40,000	9.2	37
E) 75% LVEA flow with 3 fans. LABS at 50%	30,000	9.2	32
F) 2 LVEA fans at 75% 2 LAB fans at 50%	30,000	9.5	34
G) 2 LVEA fans at 50% 2 LAB fans at 75%	20,000	9.8	35