

# **S5 Environmental Disturbances: March to July 07**

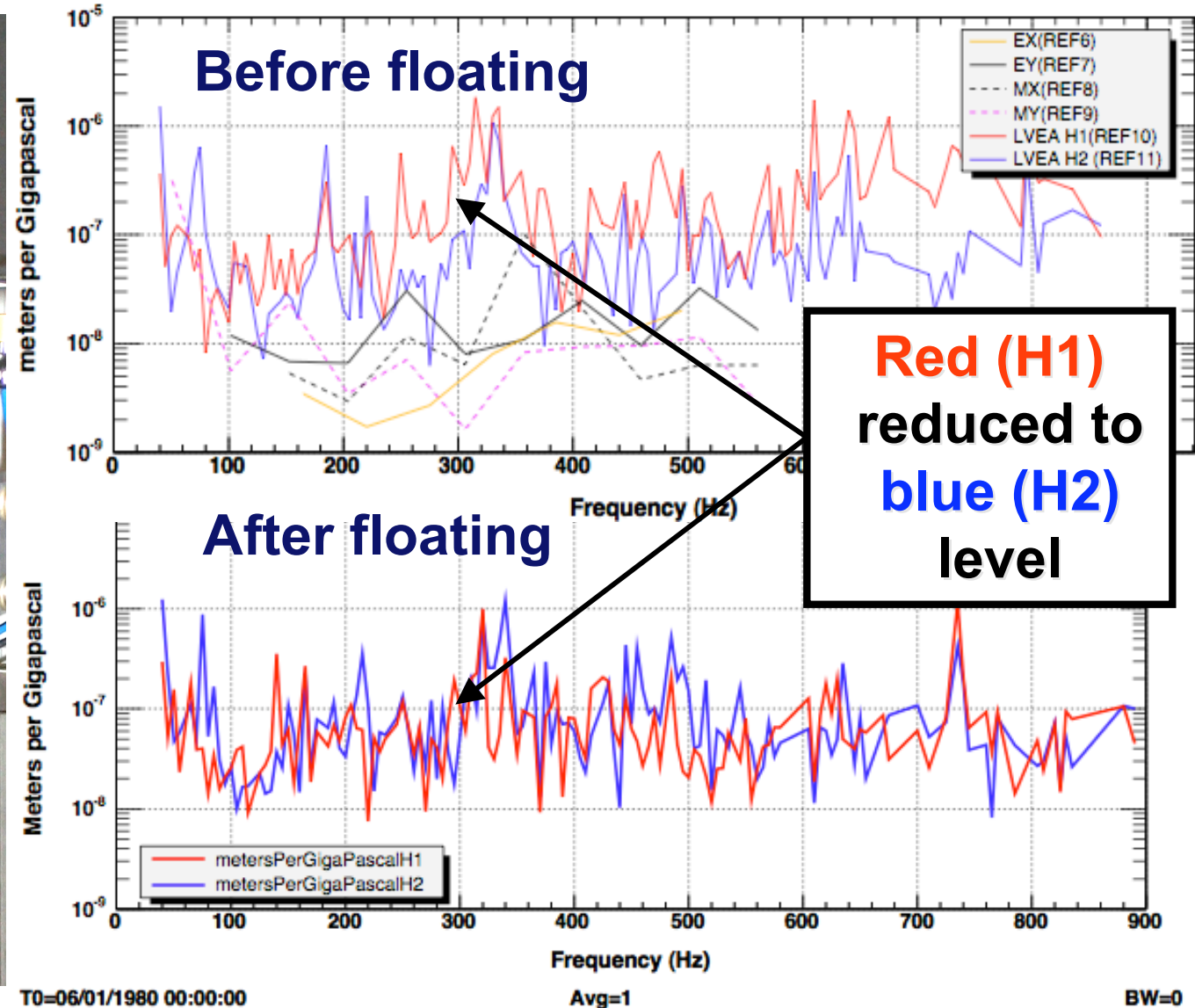
Robert Schofield,

Jim Brau (U of O), John Worden, Doug Cook (LHO), Vuk Mandic,  
Stefan Balmer, Rana Adhikari (CIT), Brian O'Reilly, Dan Hoak, Chris  
Rinaldi, Valery Frolov (LLO), Rai Weiss (MIT), David Luneke  
(Northwest Wind Partners)

- I. Acoustic coupling reduction with floating of LHO 4k dark port**
- II. Staging building HVAC source of “thirty minute glitches”**
- III. Update on studies for potential wind farm**
- IV. Largest S5 solar storms not seen on interferometers**
- V. Back-scattering studies**

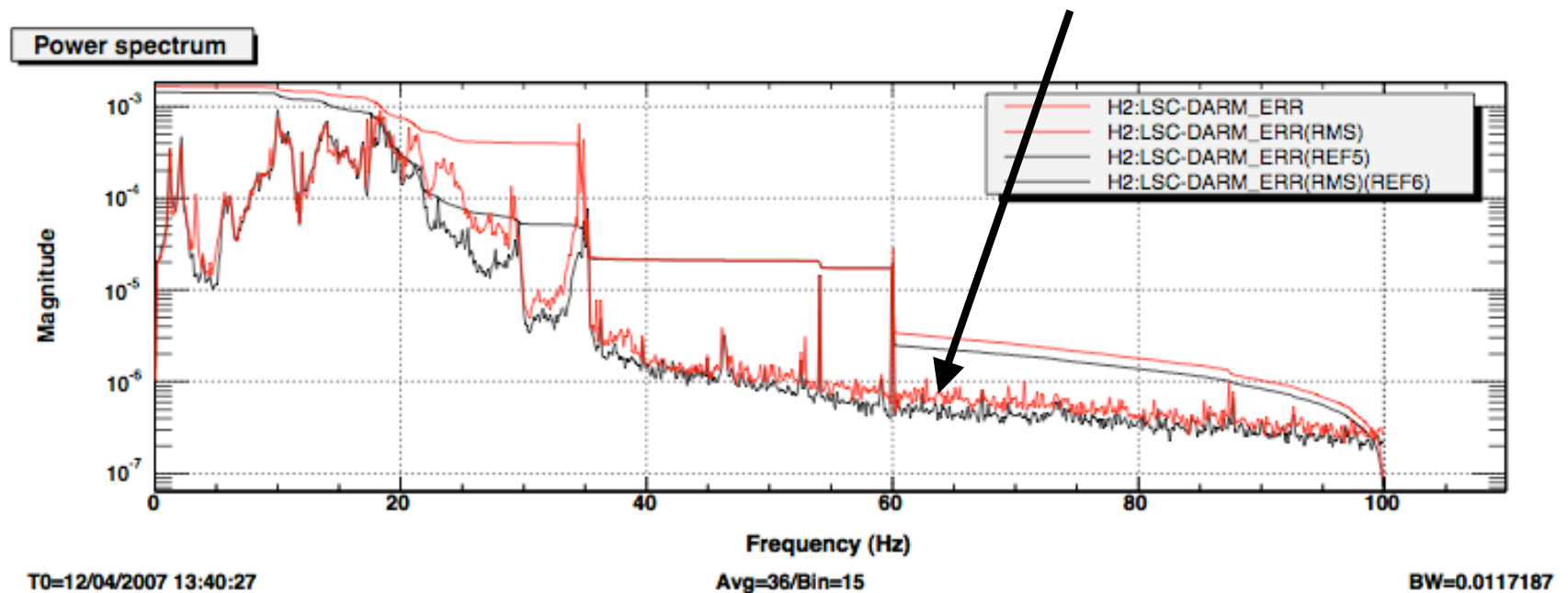
Image: SOHO

# H1 acoustic coupling reduced by several after seismic isolation (“floating”) of dark port

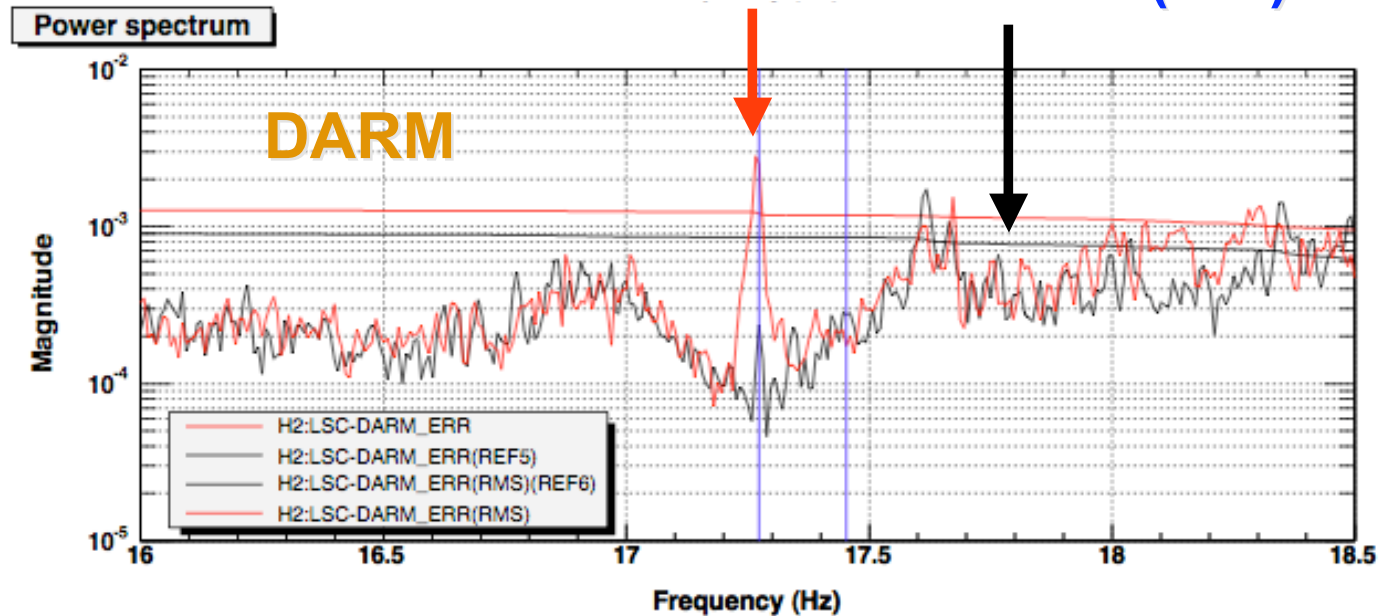
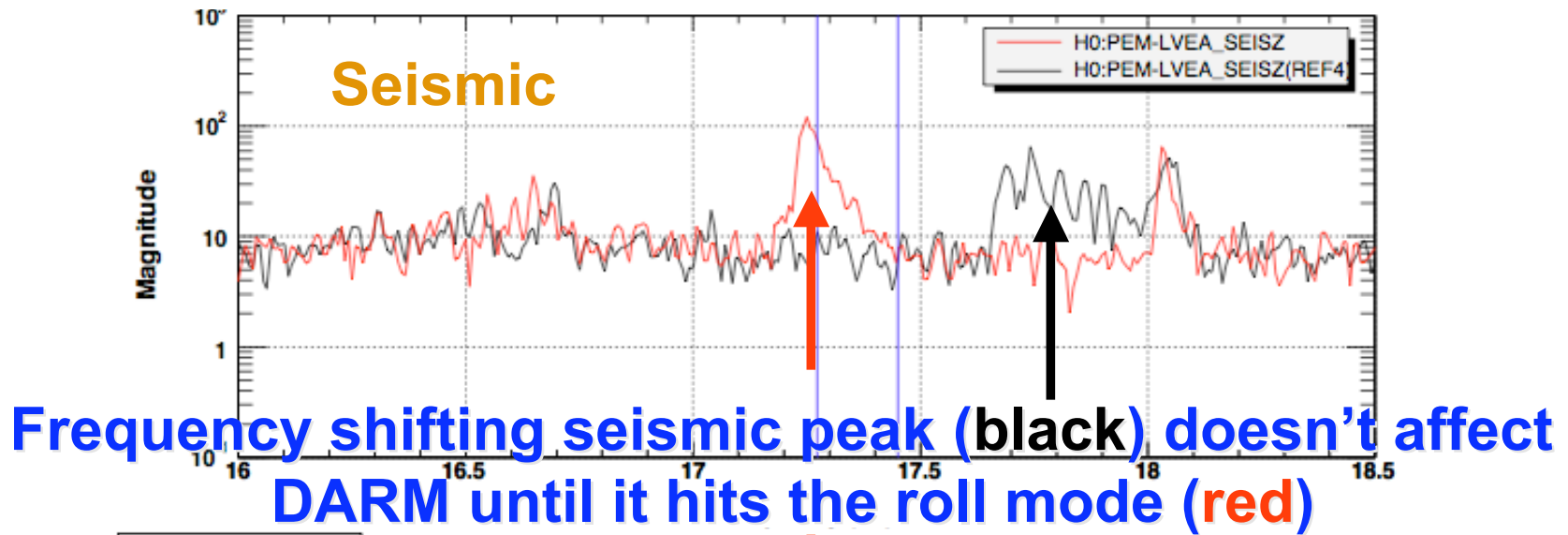


# Source of “thirty minute glitches”

**Problem: every thirty minutes the DARM spectrum was jumping up to the red level.**



Why? Test mass roll mode excited every 30 minutes.



T0=12/04/2007 13:40:27

Avg=36

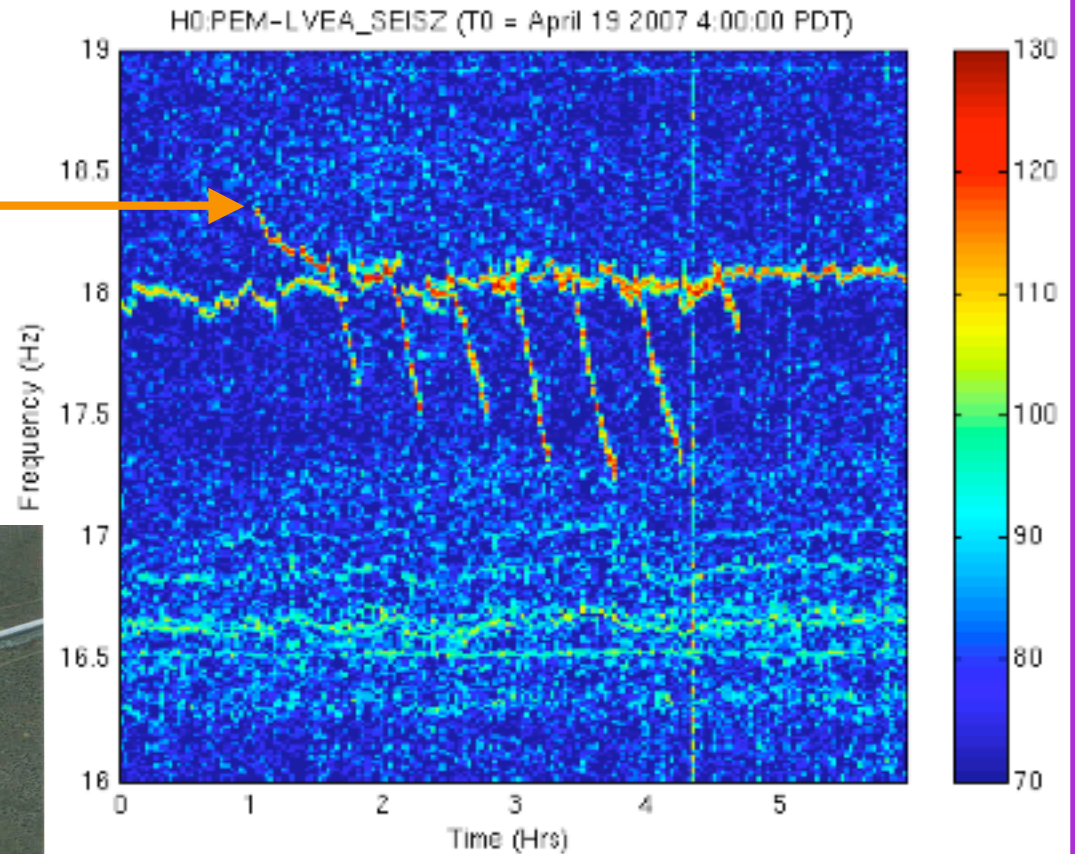
BW=0.0117187



# Experiment shows that the source is staging building HVAC

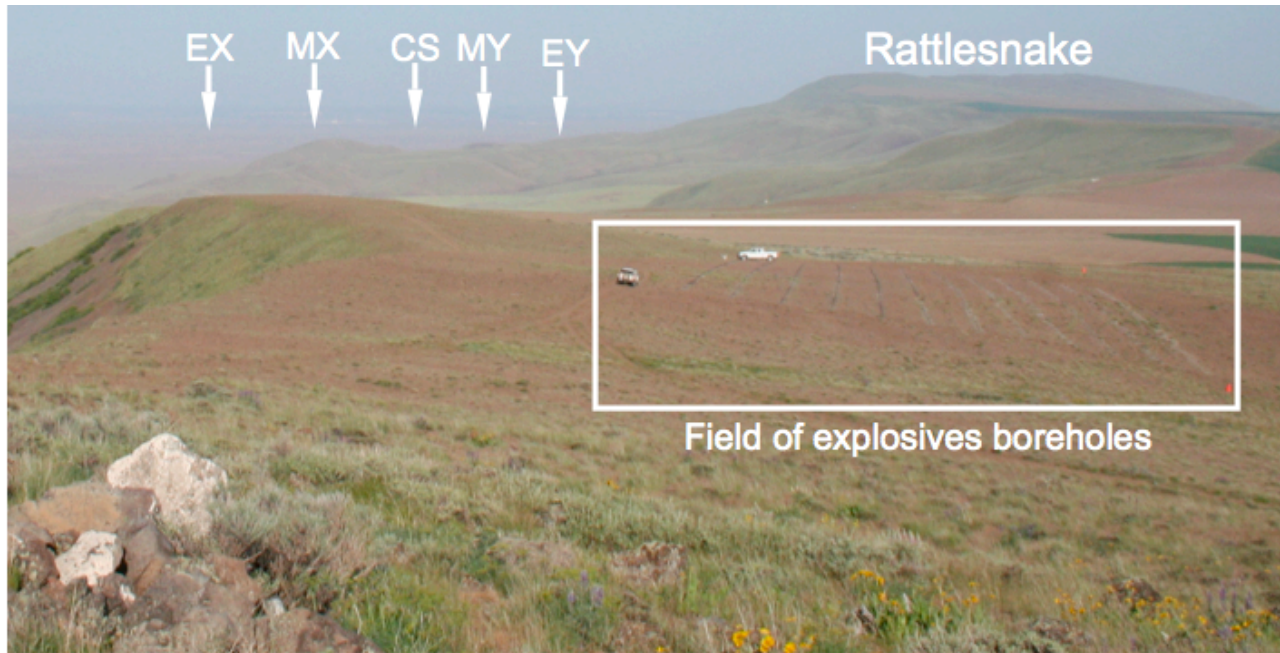
HVAC turned on

Staging building



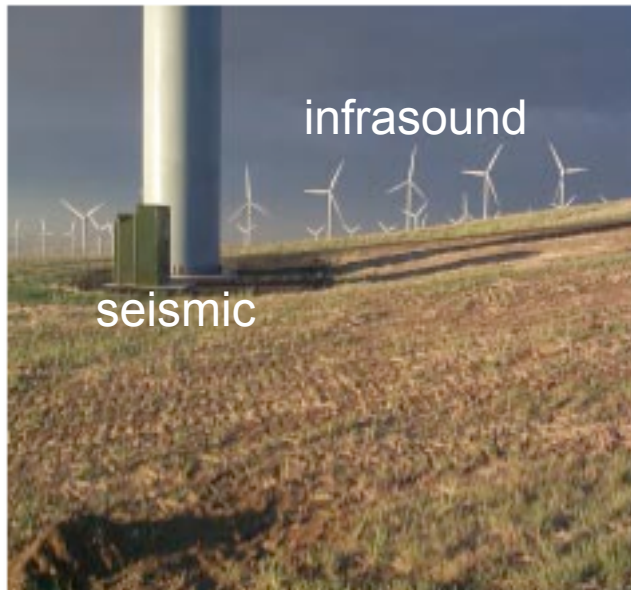
Similar to E12 problem but more regular.

# Updates on tests for effects of proposed wind farm





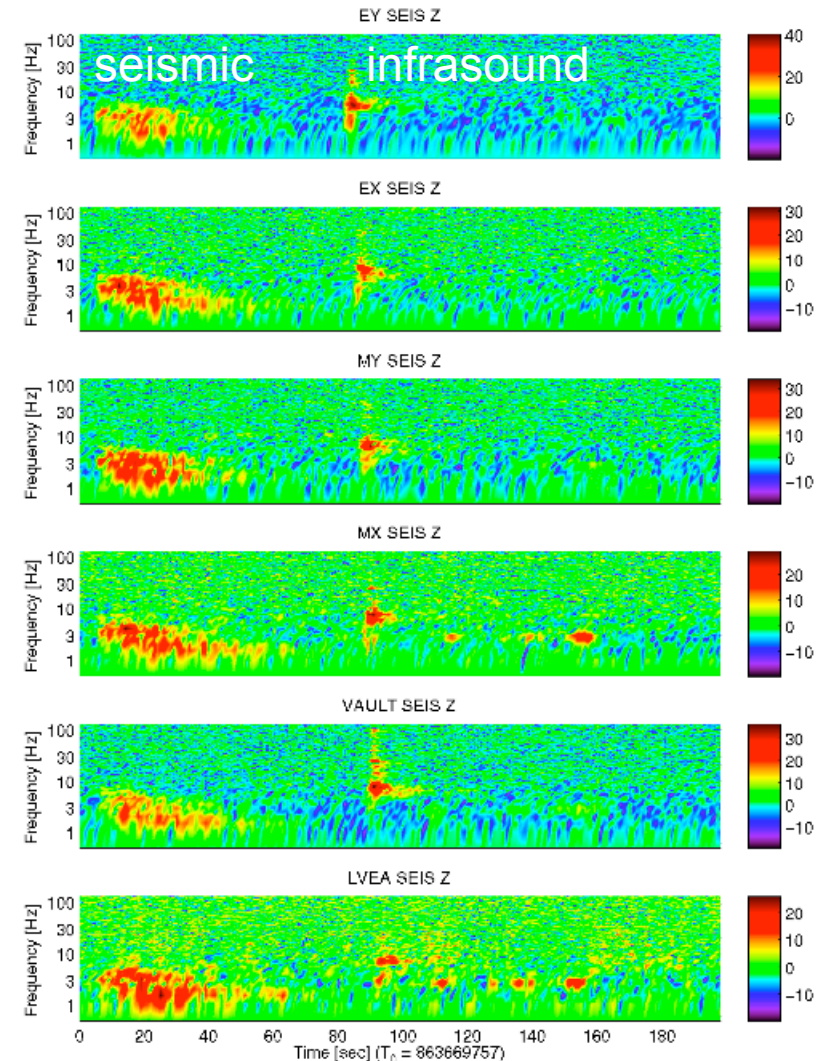
# Concerns: direct seismic and infrasound



## Importance of infrasound

demonstrated by the pounds of ANFO needed to knock H1 out of lock: above ground <50, below ground >3000

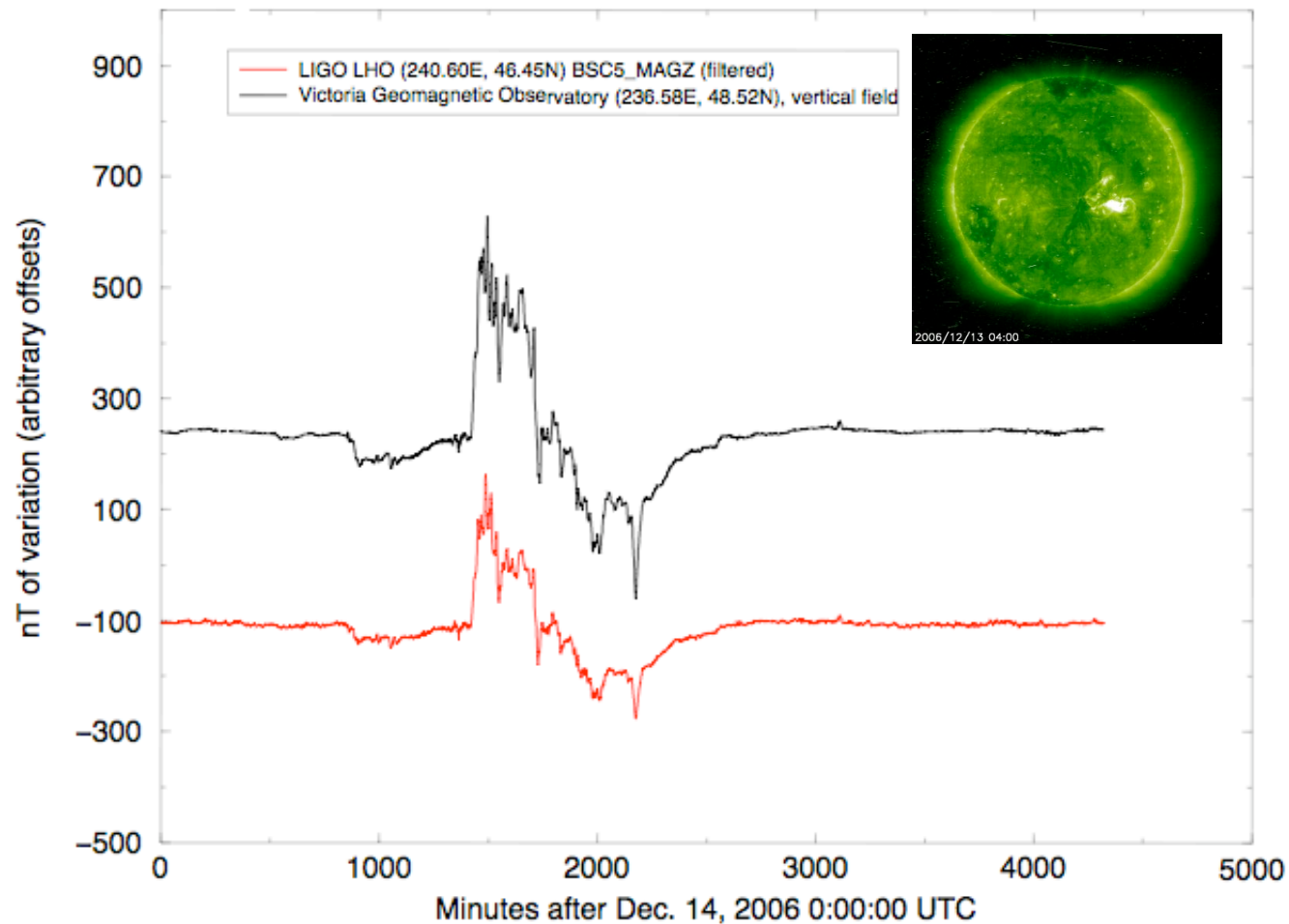
## Explosion signals arriving at LHO



# Do solar RF and magnetic storms affect LIGO data?

## Largest solar magnetic storm during S5

On geomagnetic observatory and LIGO LHO magnetometers

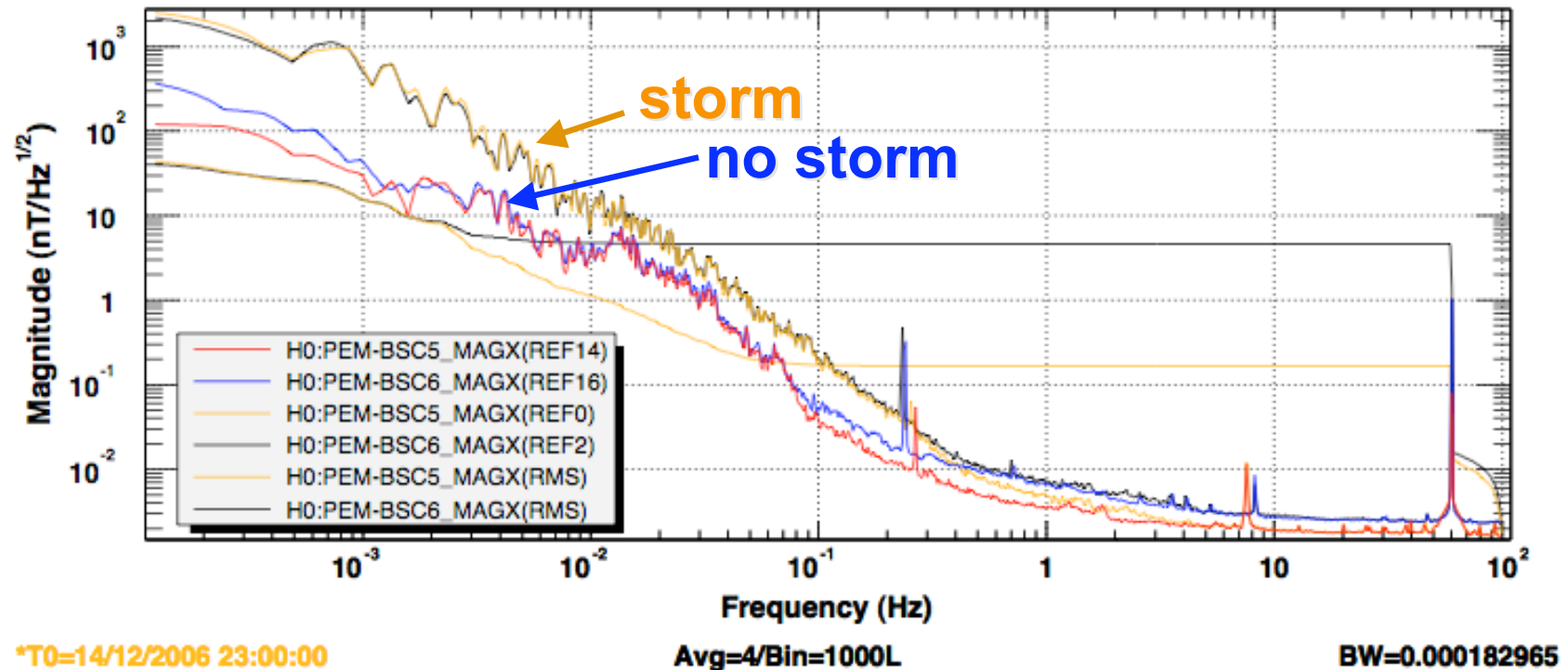


**Magnetic storm seen on building magnetometers**



# Magnetic storm signal up to 1 Hz

Magnetic storm: Orange and Black (Mid-X,Y), No storm: Red and Blue (Mid-X,Y)

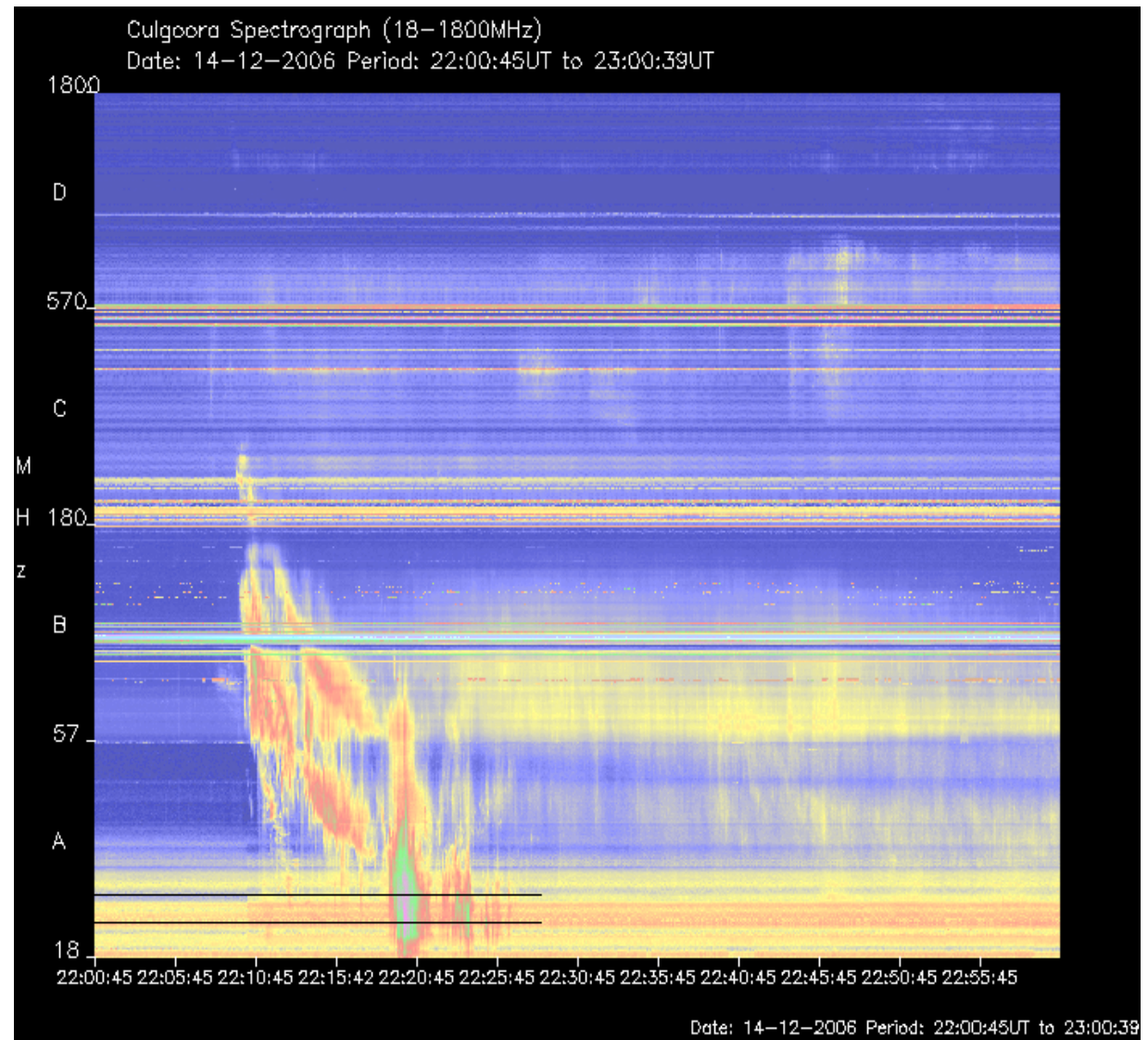


Estimate of displacement noise (from extrapolated spectrum and magnetic PEM injections) at 100 Hz:  $3e-25$  m/sqrt(Hz)

# RF from coronal mass ejection

Radio observatory spectrogram of one of the largest S5 events (Dec. 14, 2006 22:00:45 to 23:00:45). Type II event: plasma frequency drops as mass moves away from sun.

29.5 MHz →  
24.5 MHz →

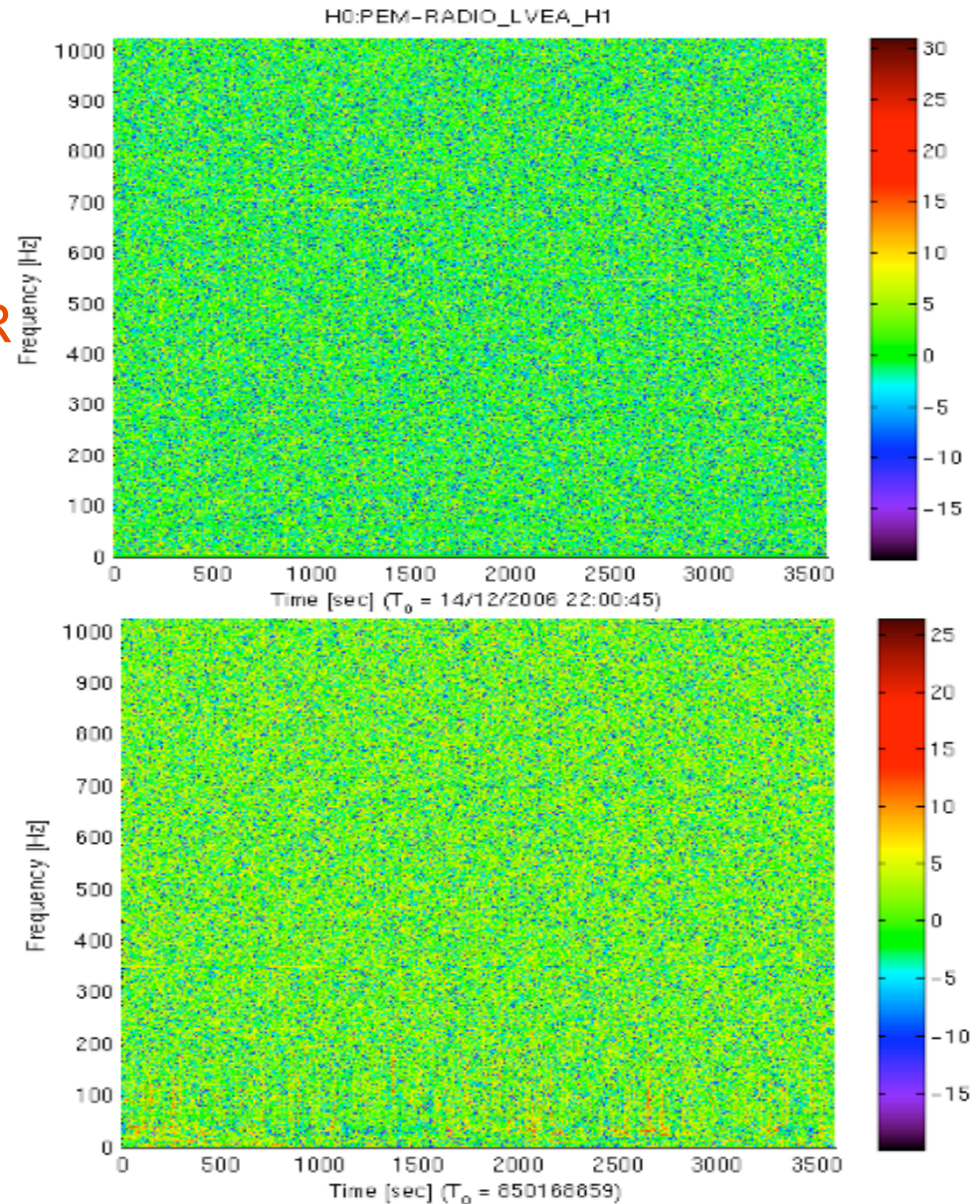


# RF event not evident in radio or DARM channels

Radio LVEA\_H1 for same period:  
 $\lambda/2$  antenna mixed with H1  
modulation frequency (24.5 MHz).

RF injections show that the SNR  
of the radio channel must reach  
 $\sim 100$  before the event shows in  
DARM.

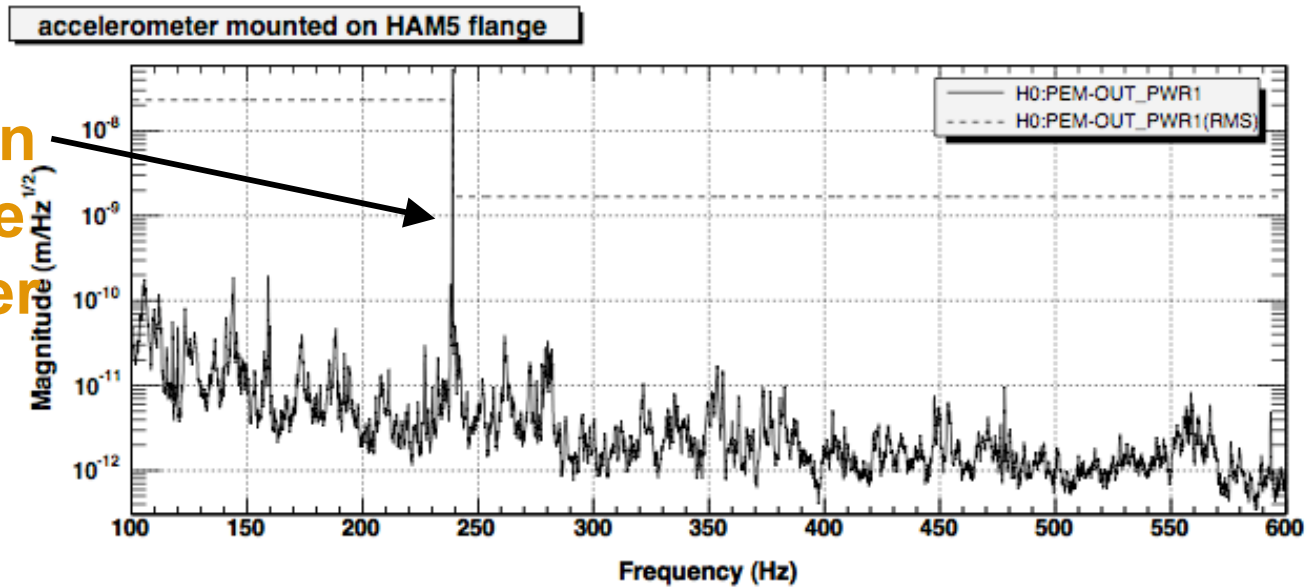
H1 DARM\_ERR  
for same period



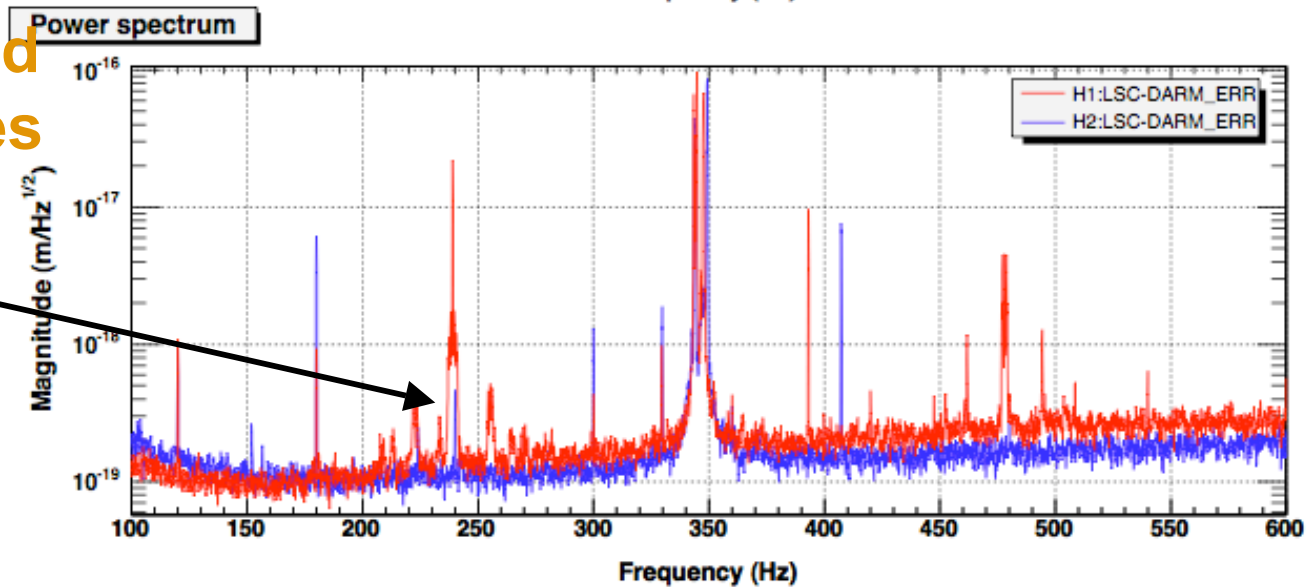


# Study of back-scattering from vacuum enclosure

Shaker peak in  
HAM 5 flange  
accelerometer  
spectrum



Back-scattered  
light produces  
H1 and H2  
peaks



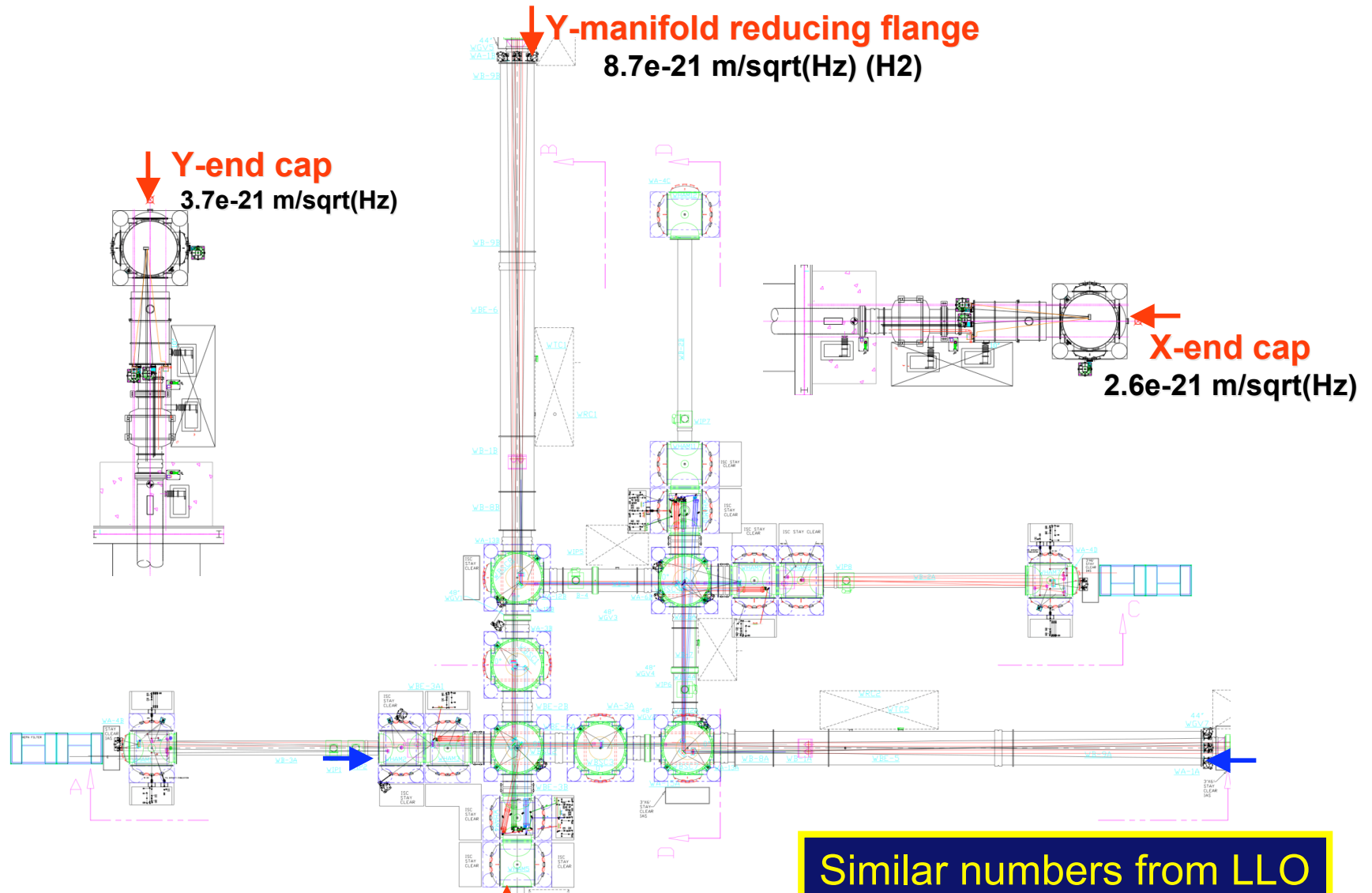
T0=09/06/2007 01:35:30

Avg=15

BW=0.187499



# Worst\* scattering sites (↓); proposed S6 baffles (↓, ↓)

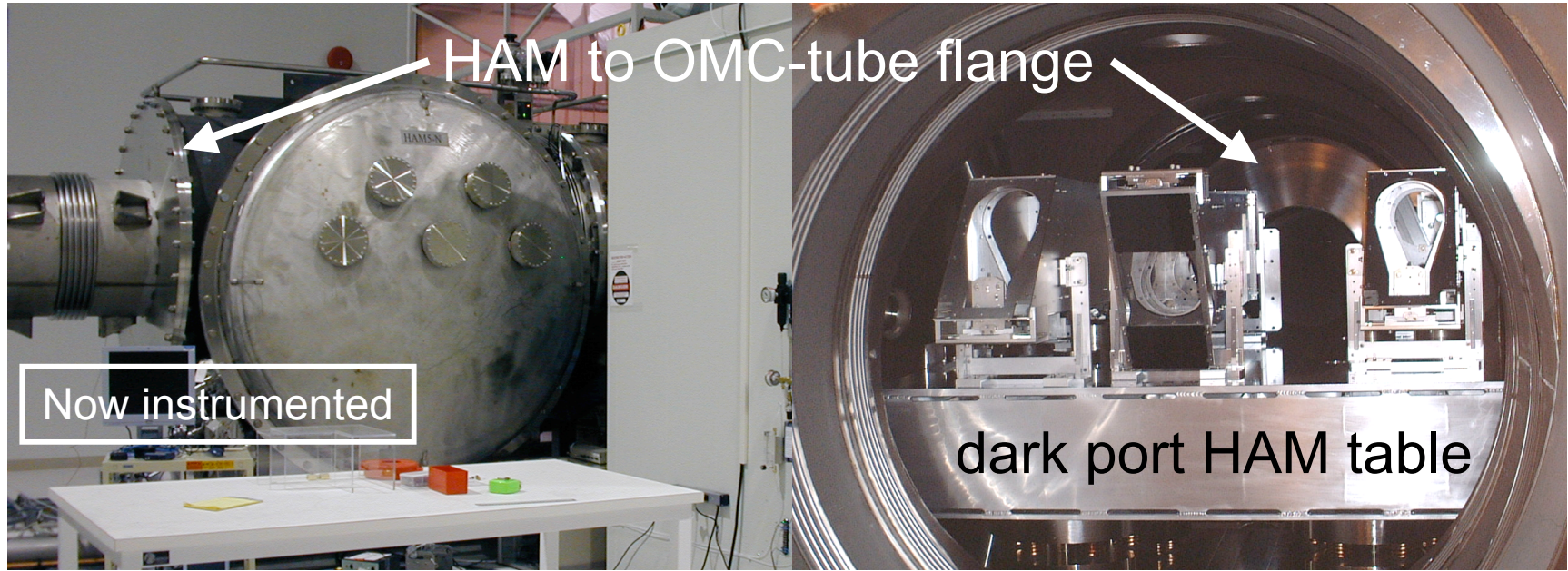


\* Predicted noise > 1e-21 m/sqrt (Hz)

↑ HAM 5 flange  
4e-20 m/sqrt(Hz)

Similar numbers from LLO

# Worst back-scattering sites



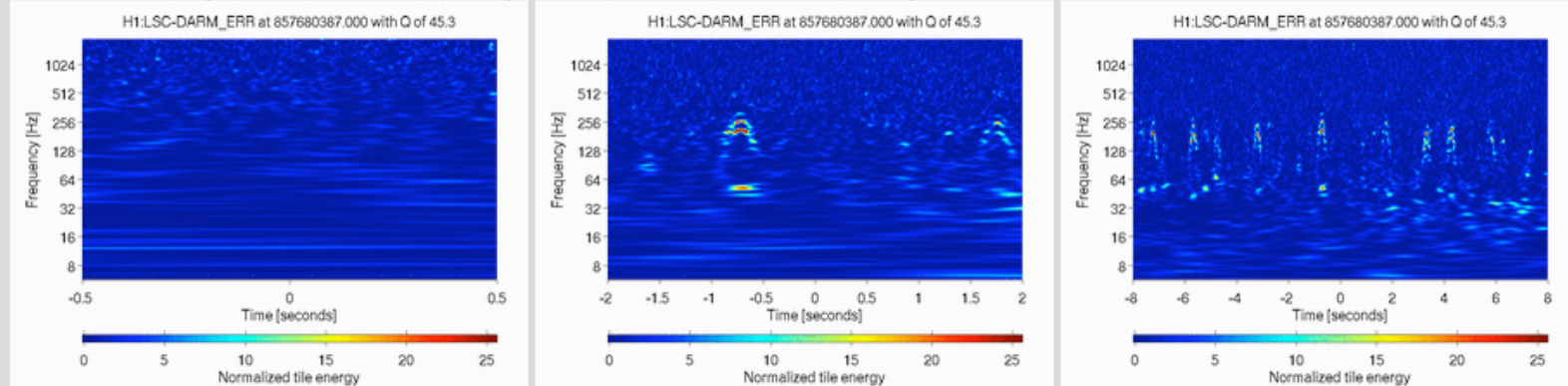


# Can back-scattering produce H1-H2 events that are not present in auxiliary channels?

✓ **H1:LSC-DARM\_ERR** ( $t = 857680387.078$  s,  $f = 1.9 \times 10^3$  Hz,  $Q = 4.5 \times 10^1$ ,  $Z = 7.7 \times 10^0$ ,  $X = 3.0 \times 10^{-8}$  Hz $^{-1/2}$ )

time series: raw, high passed, whitened | spectrogram: raw, whitened, autoscaled | eventgram: raw, whitened, autoscaled

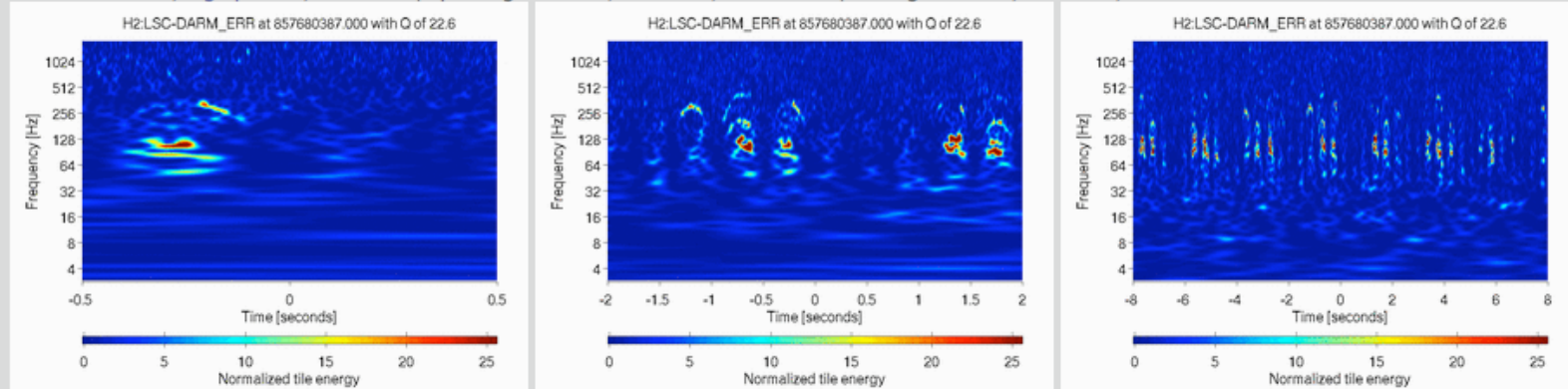
## H1



✓ **H2:LSC-DARM\_ERR** ( $t = 857680386.750$  s,  $f = 1.1 \times 10^2$  Hz,  $Q = 2.3 \times 10^1$ ,  $Z = 3.2 \times 10^1$ ,  $X = 4.8 \times 10^{-6}$  Hz $^{-1/2}$ )

time series: raw, high passed, whitened | spectrogram: raw, whitened, autoscaled | eventgram: raw, whitened, autoscaled

## H2

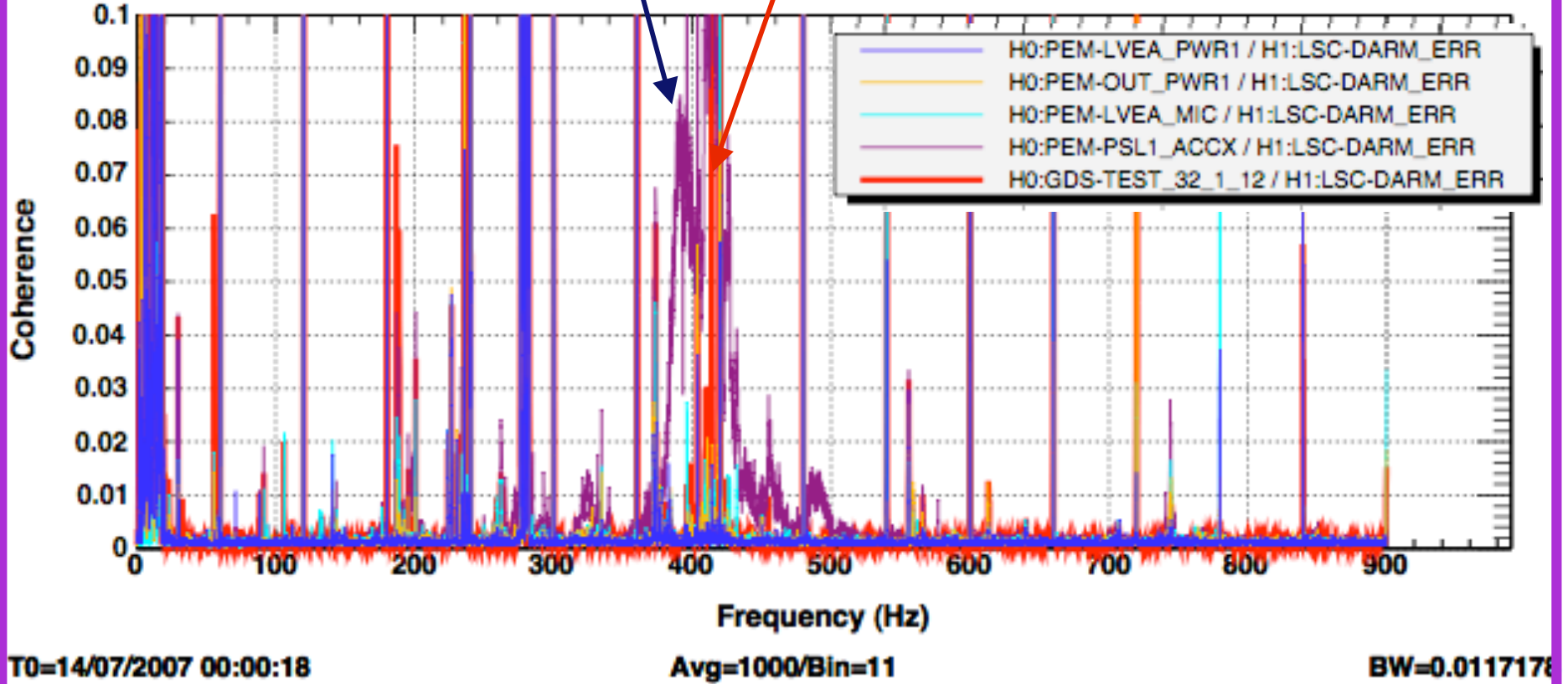


These events during H2 malfunction (in science mode), but show that multi-bounce back-scattering paths exist between H1 and H2 15

# No evidence that HAM5 flange supplants 4k PSL as worst H1 acoustic coupling site

4k PSL accelerometer -  
H1 DARM coherence

HAM5 accelerometer -  
H1 DARM coherence





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