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Thoughts on Hanford wind

Brian Lantz, Nov 11, 2015

Observations, Speculations, and Suggestions based on data from Krishna's Beam Rotation sensor and Robert's outdoor STS-2

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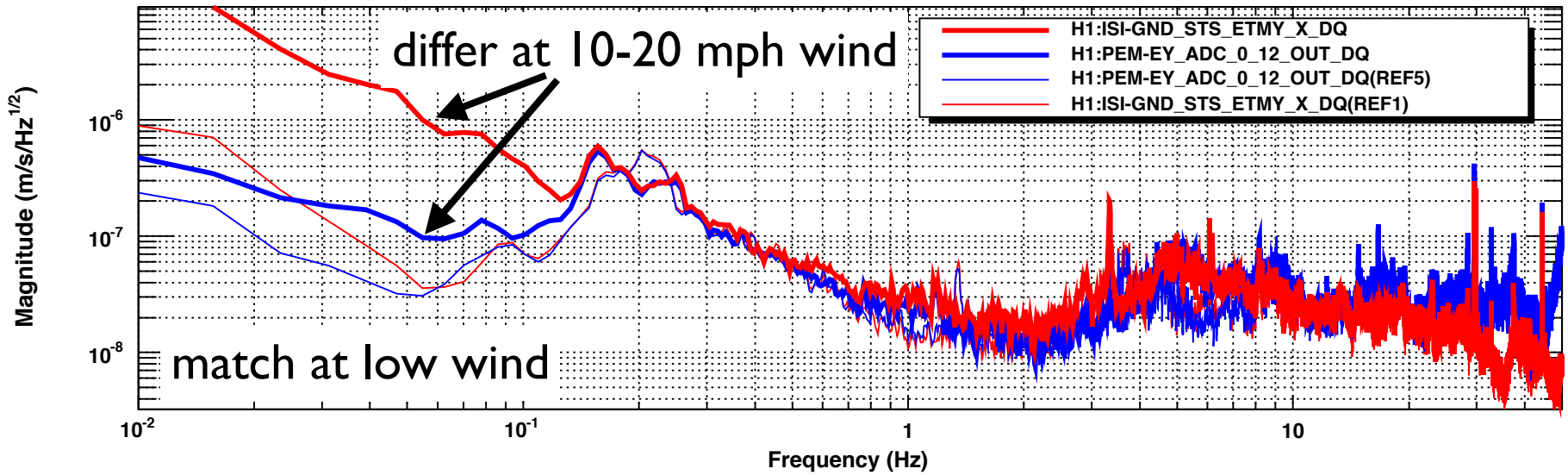
Observations on wind-driven building motion

- wind driven motion is local to the building. (Robert's data)
- tilt spectra on the slab is smooth, amplitude varies with wind speed.
- wind seems to rock the building:
  - STS-2 response < 0.1 Hz is from tilt of the slab. (Krishna's data)
  - STS-2 response > 0.3 Hz is from slab translation. (i.e. rocking about a point below the slab surface) - Krishna tilt-sensor data.
- amplitude varies faster than speed^1. Consistent with speed^2.

Robert's outdoor STS-2

X-axis, RED: SEI seismometer, BLUE: 40m from building, THIN: 0-2 MPH, THICK 10-20 MPH

X

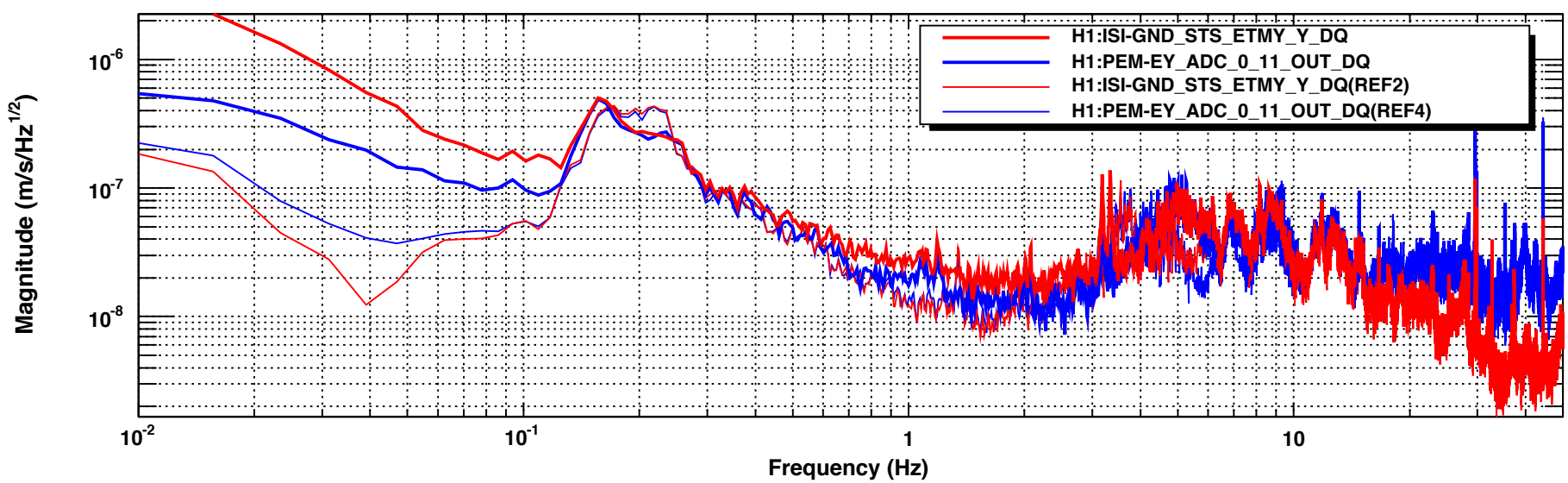


*T0=13/06/2015 06:36:00 *Avg=25 BW=0.0117187

red on slab, blue outside

Y-axis, RED: SEI seismometer, BLUE: 40m from building, THIN: 0-2 MPH, THICK 10-20 MPH

Y

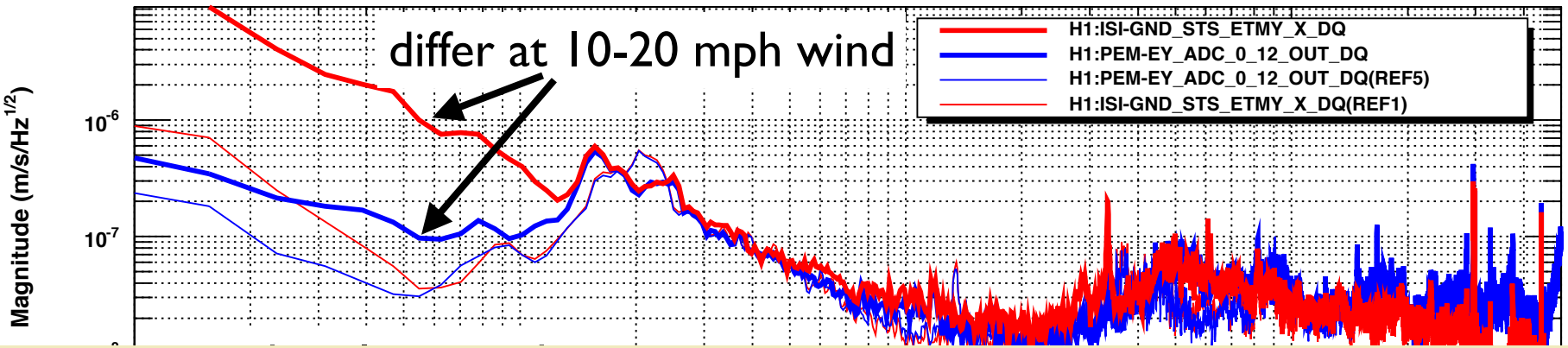


LHO log 19210, June 17, 2015. STS-2 in a 1 m deep hole 40 m from EY

Robert's outdoor STS-2

X-axis, RED: SEI seismometer, BLUE: 40m from building, THIN: 0-2 MPH, THICK 10-20 MPH

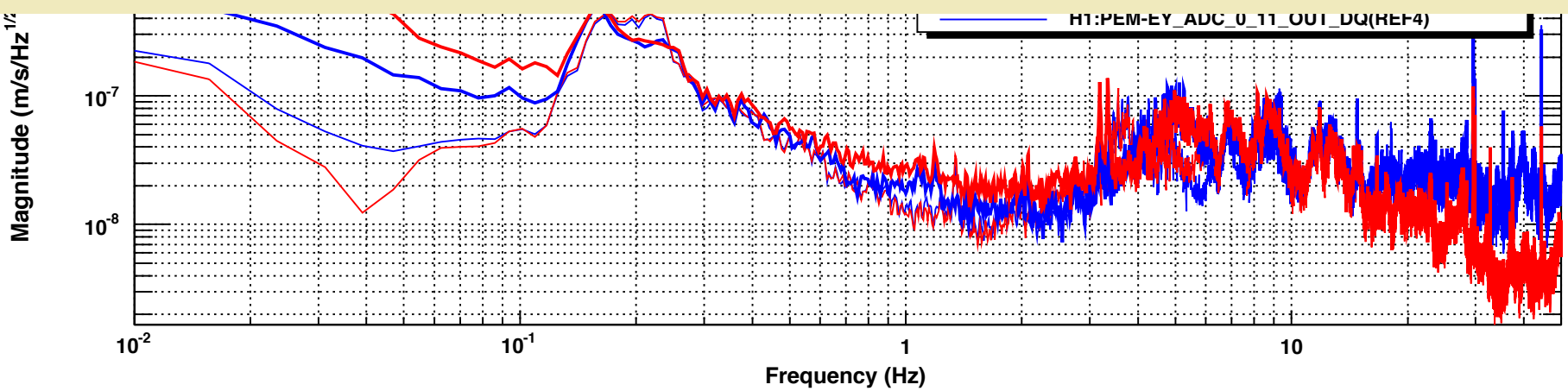
X



1. data taken 24 hours apart so 50 mHz motion is likely different
2. 50 mHz motion 2-10 x better than slab, but might be contaminated
3. X difference > Y difference. Beam in Y direction.
4. data match at microseism
5. data do not match at 1 Hz.
6. Could be useful to use outdoor STS-2, but not a cure-all, still need indoor sensor

de

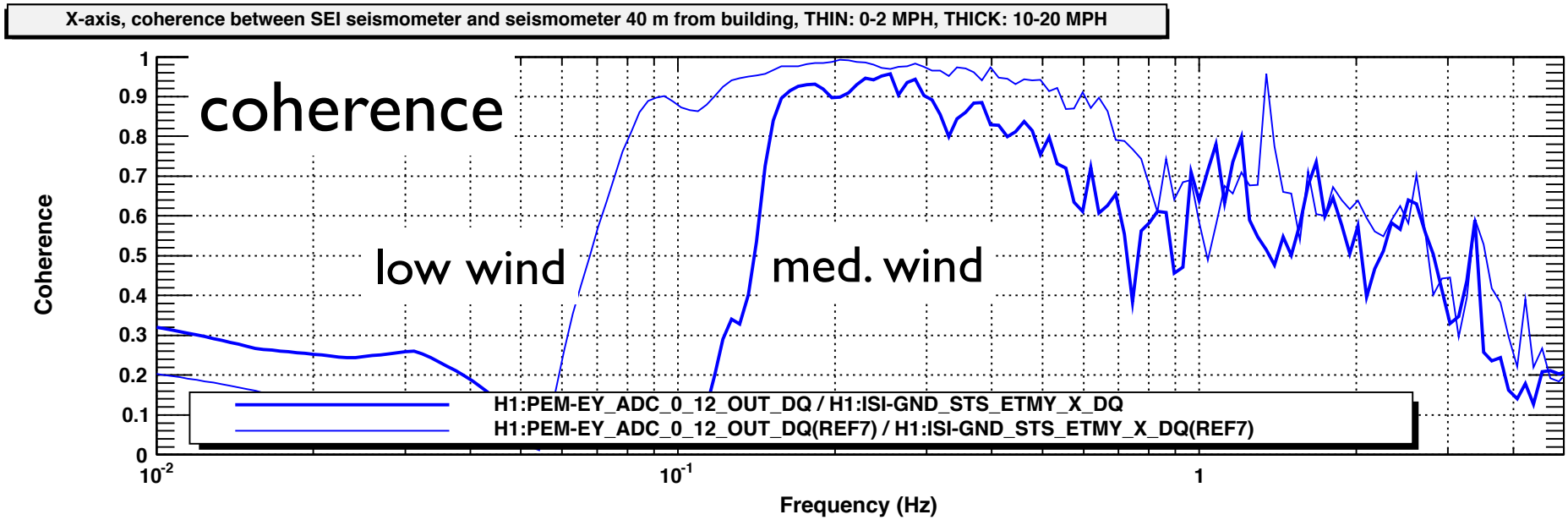
Y



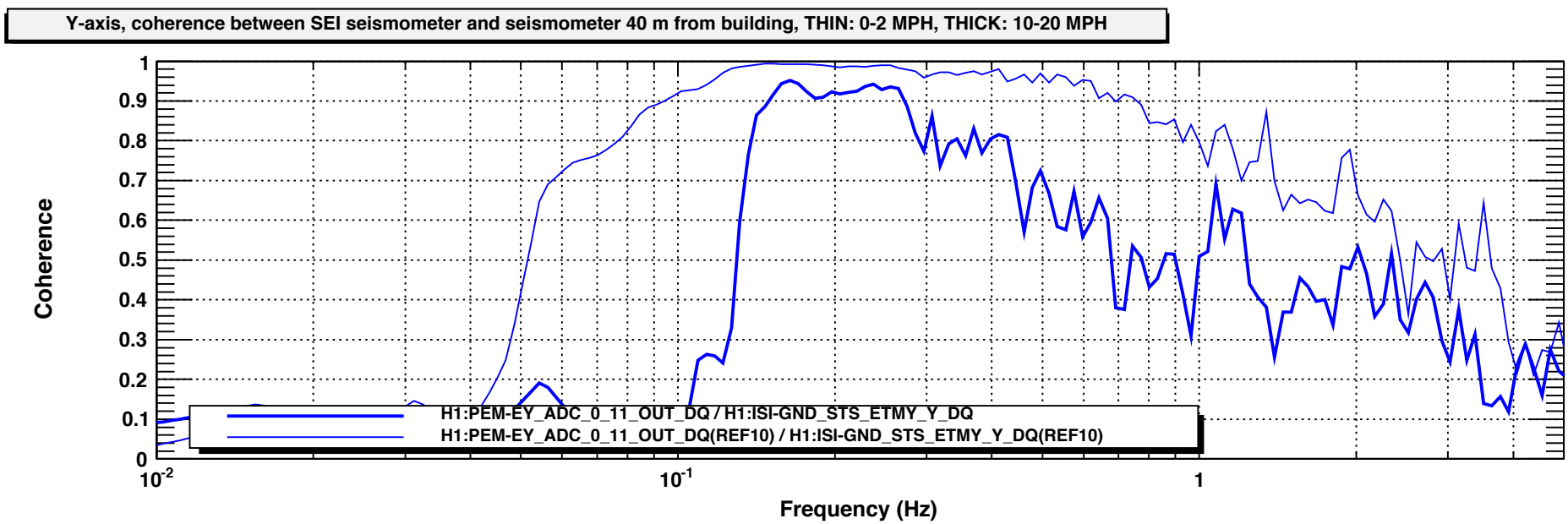
LHO log 19210, June 17, 2015. STS-2 in a 1 m deep hole 40 m from EY

Robert's outdoor STS-2

X

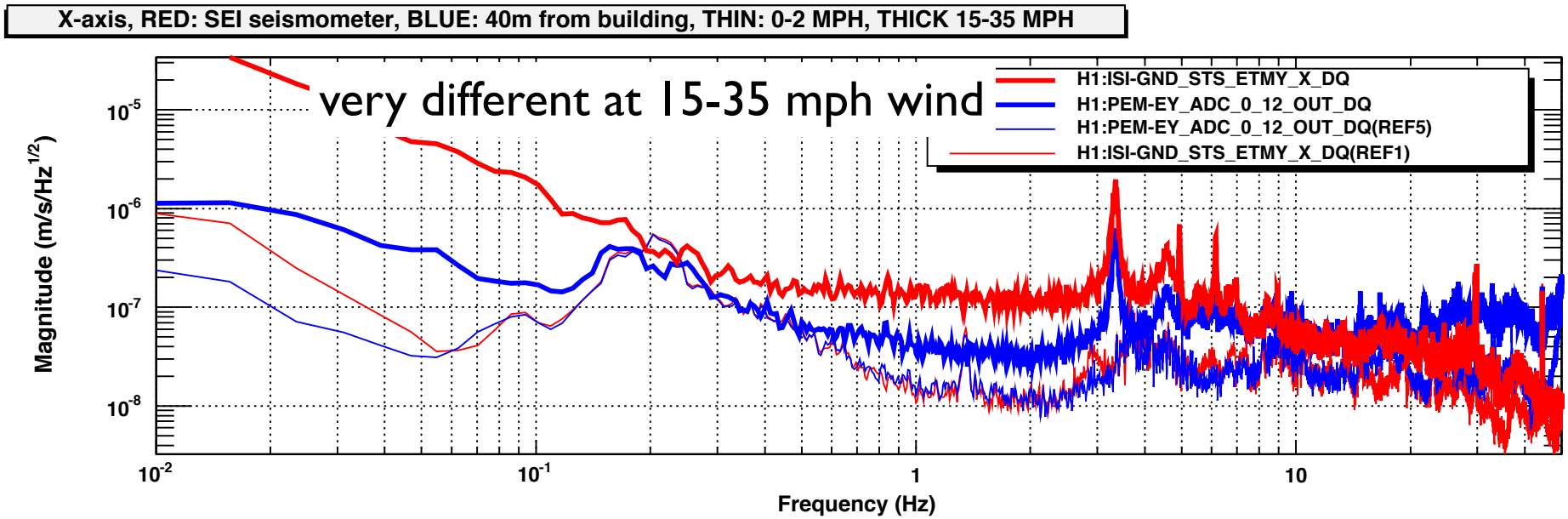


Y



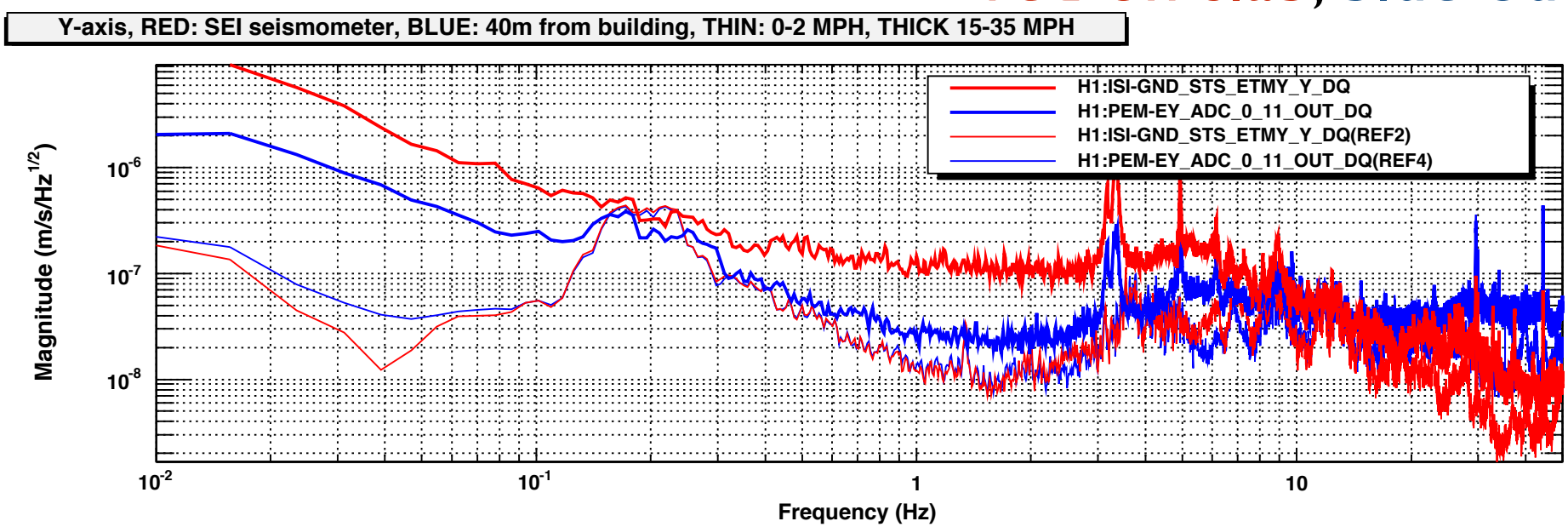
Robert's outdoor STS-2

X



red on slab, blue outside

Y



LHO log 19210, June 17, 2015. STS-2 in a 1 m deep hole 40 m from EY

Krishna data

- Beam Rotation Sensor at End X next to the STS-2.
- Brian took a chuck of data with high wind and medium wind and did some analysis.
- Used mccs2.m (MultiChannel Coherent Subtraction) tool to optimally remove tilt data from STS-2 data to see what we could learn.

SEI log 602, Oct. 30, 2014. BTL on Krishna's BRS data from EndX

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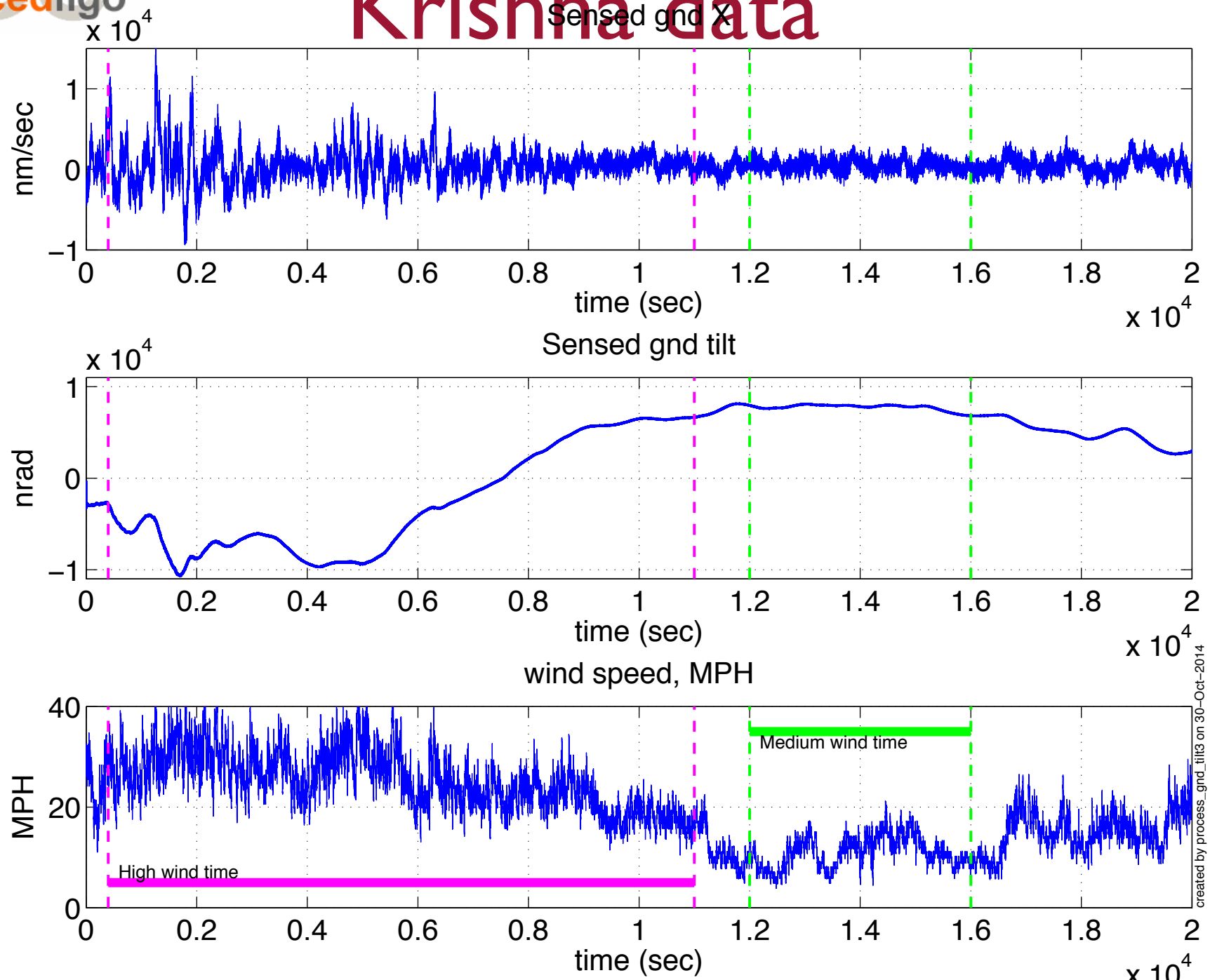
Krishna data



SEI log 602, Oct. 30, 2014. BTL on Krishna's BRS data from EndX

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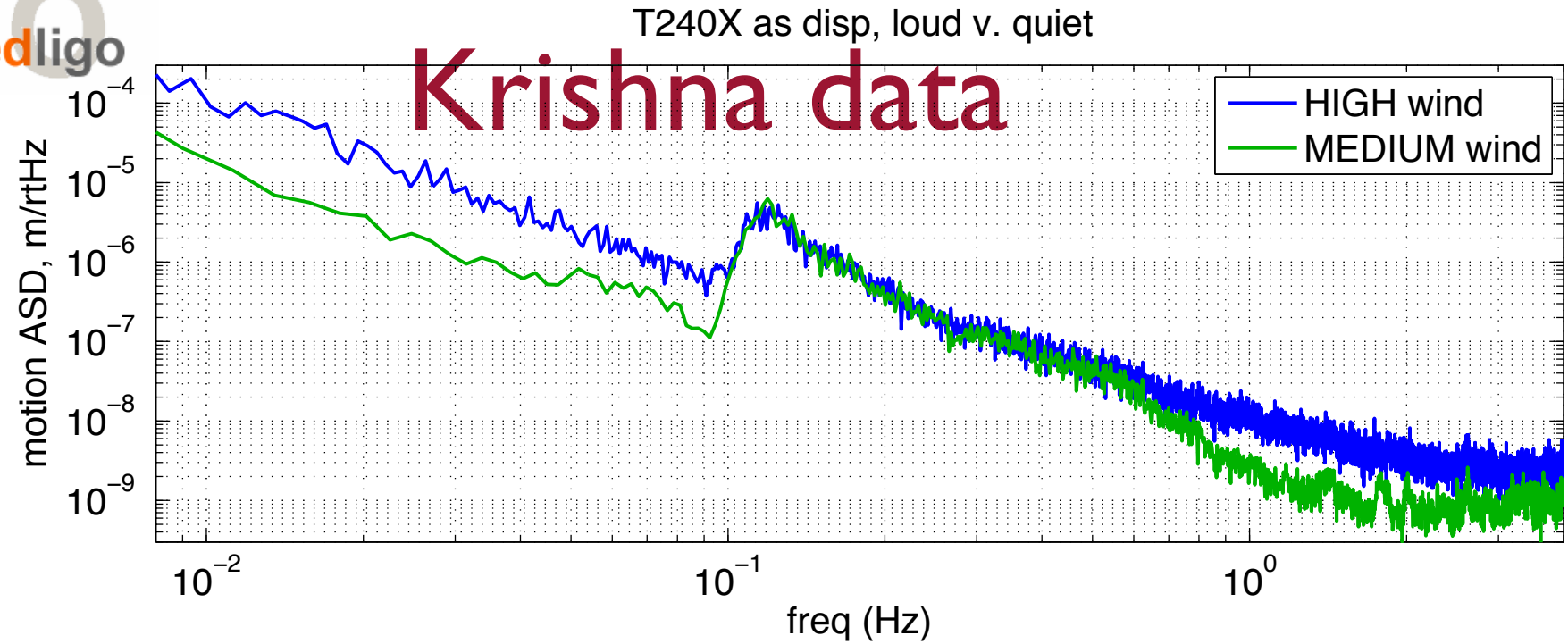
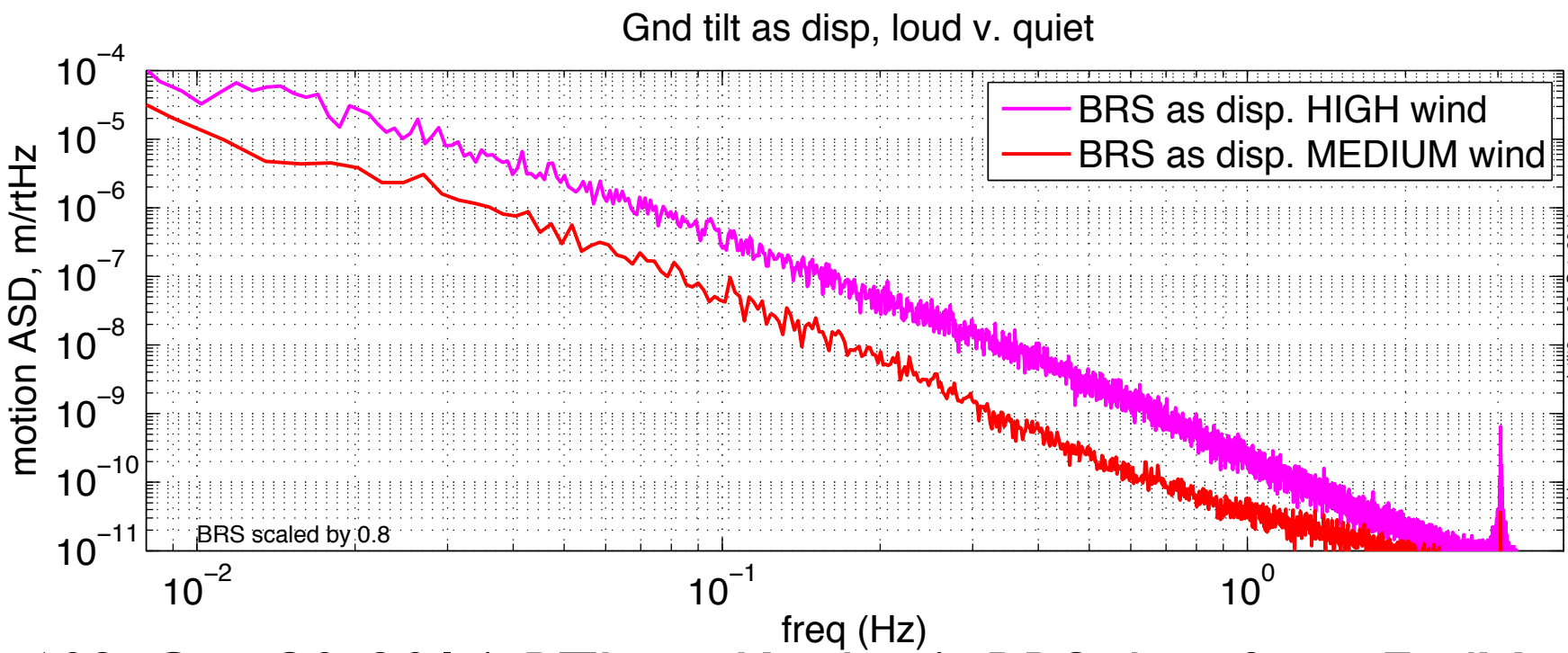
Krishna data





SEI log 602, Oct. 30, 2014. BTL on Krishna's BRS data from EndX

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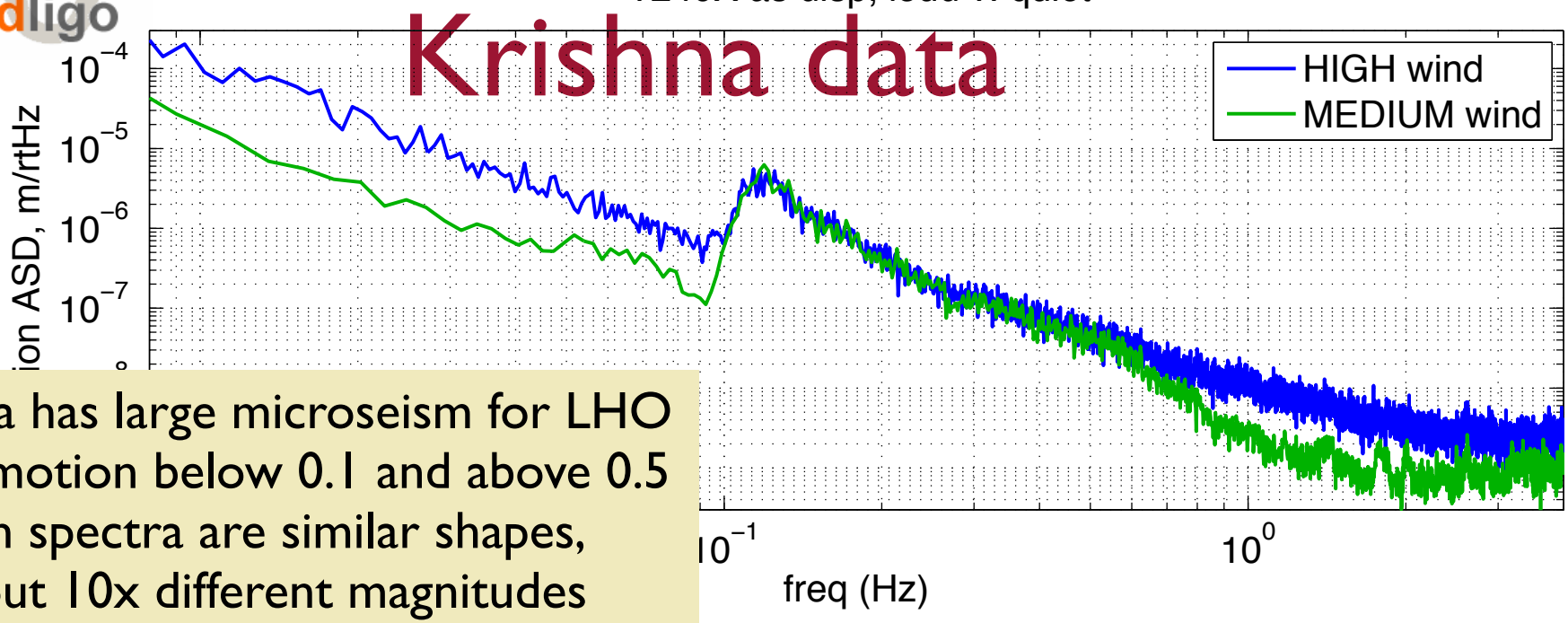
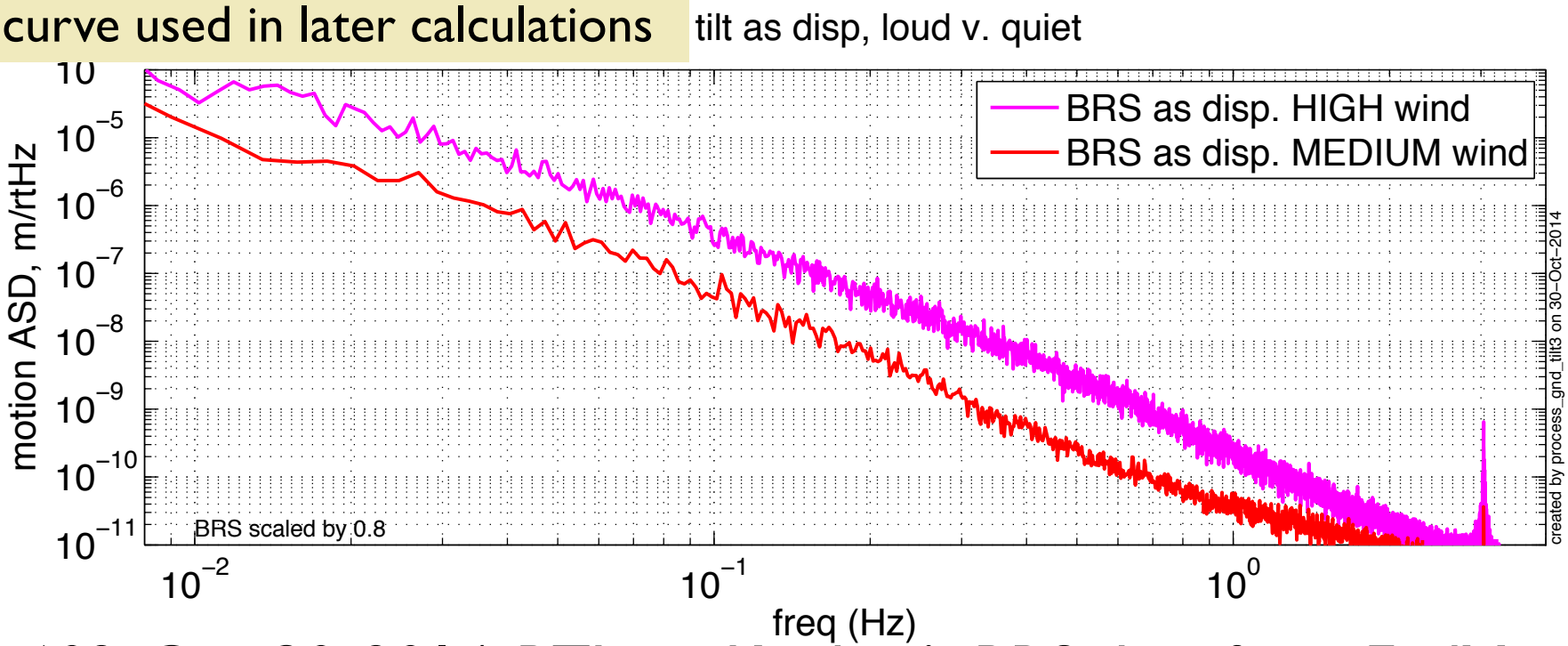
Krishna data



1. This data has large microseism for LHO
2. Excess motion below 0.1 and above 0.5
3. Rotation spectra are similar shapes, but about 10x different magnitudes
4. Pink tilt curve used in later calculations



SEI log 602, Oct. 30, 2014. BTL on Krishna's BRS data from EndX

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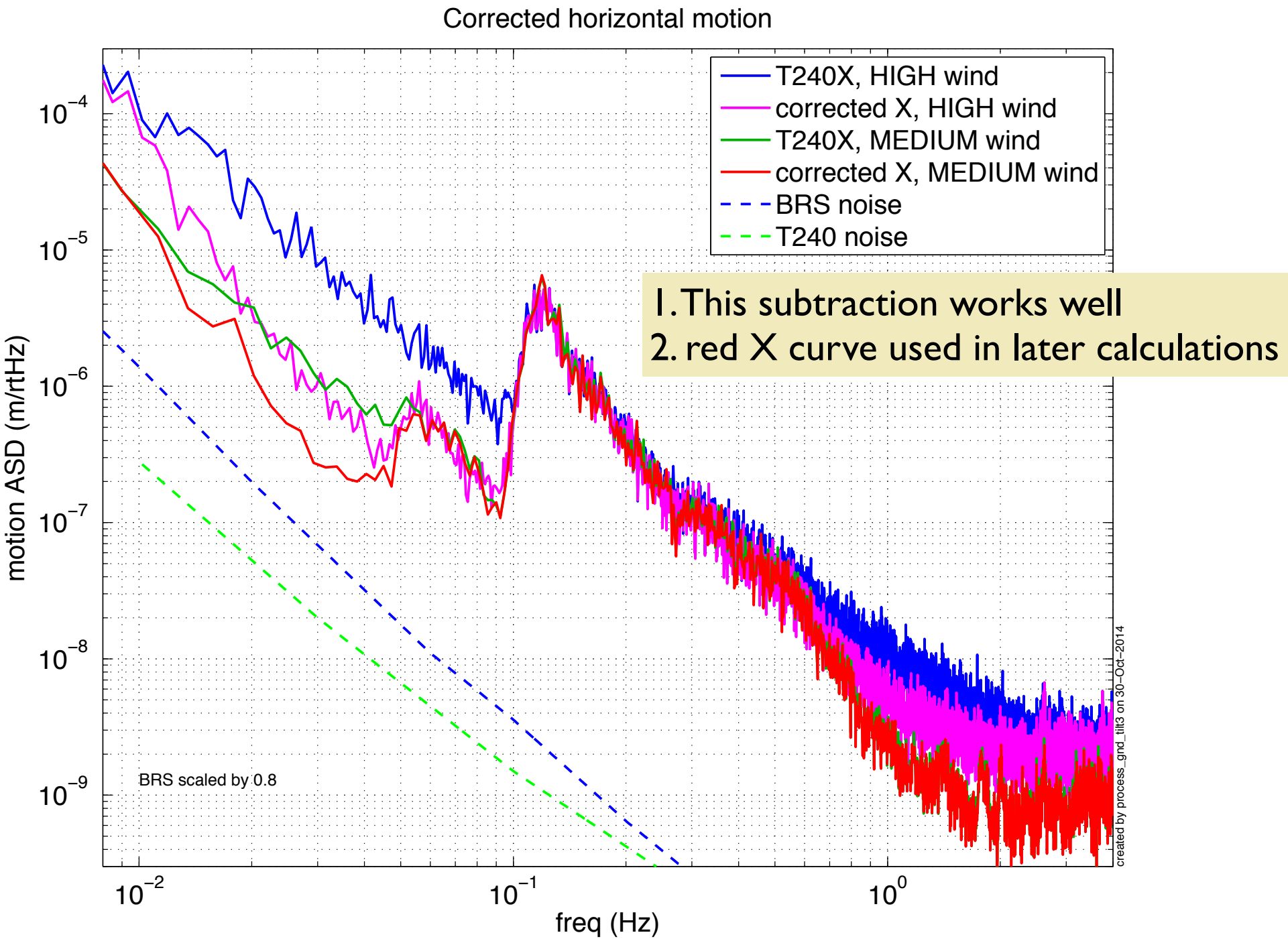
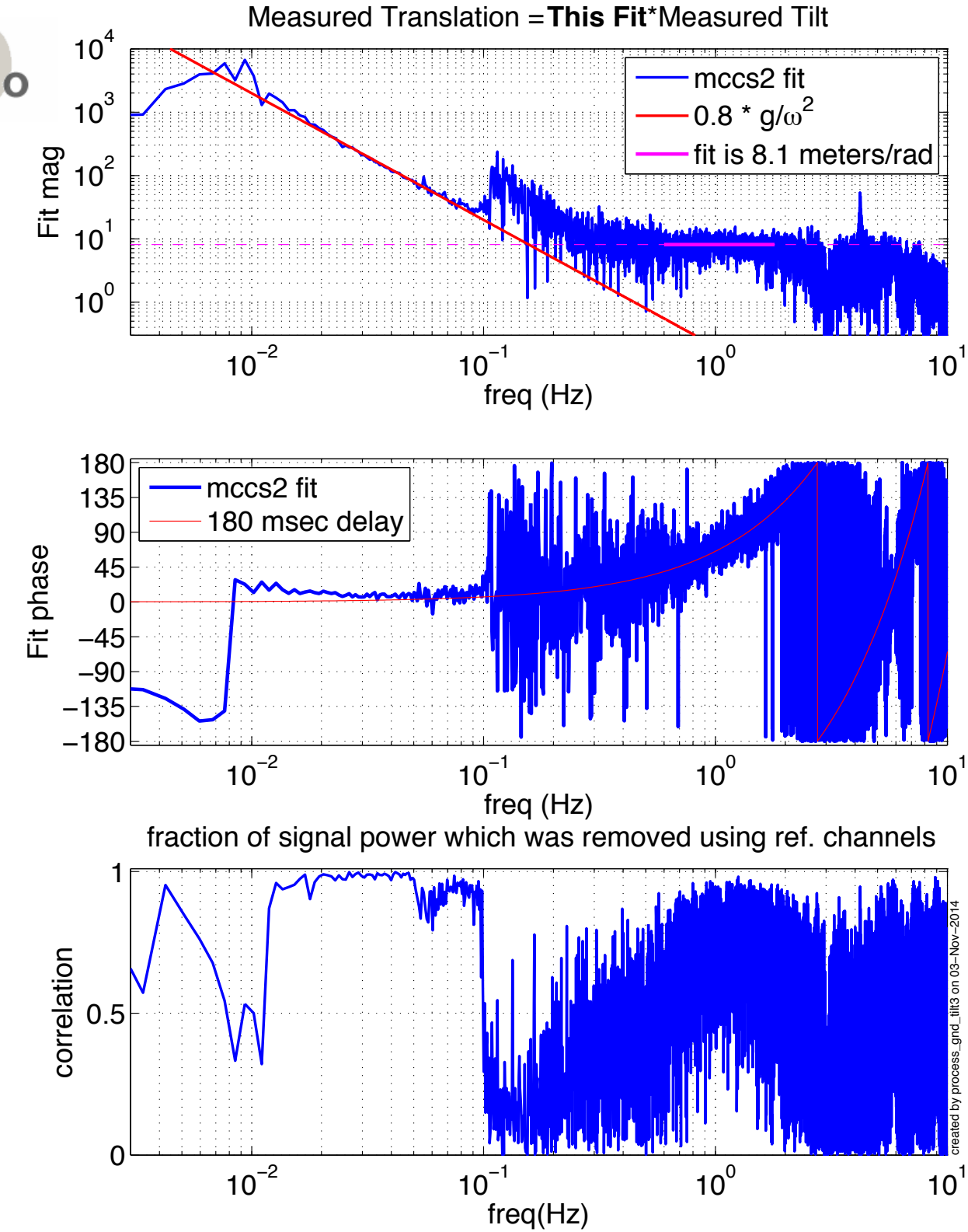
Corrected motion w/ BRS



1. This subtraction works well
2. red X curve used in later calculations


Measured Translation = **This Fit***Measured Tilt
mccs2 fit
0.8 * g/ω²
fit is 8.1 meters/rad
Fit mag
freq (Hz)
mccs2 fit
180 msec delay
Fit phase
freq (Hz)
fraction of signal power which was removed using ref. channels
correlation
freq(Hz)
created by process_gnd_tilt3 on 03−Nov−2014

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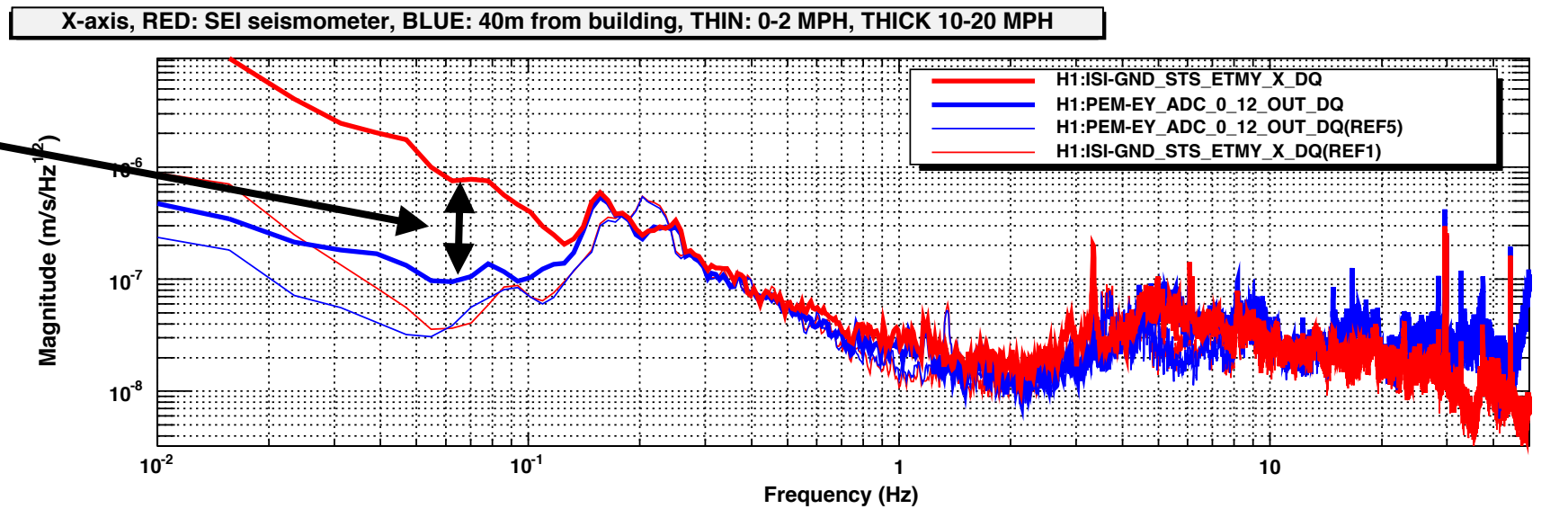
Speculations
Can we exploit this?

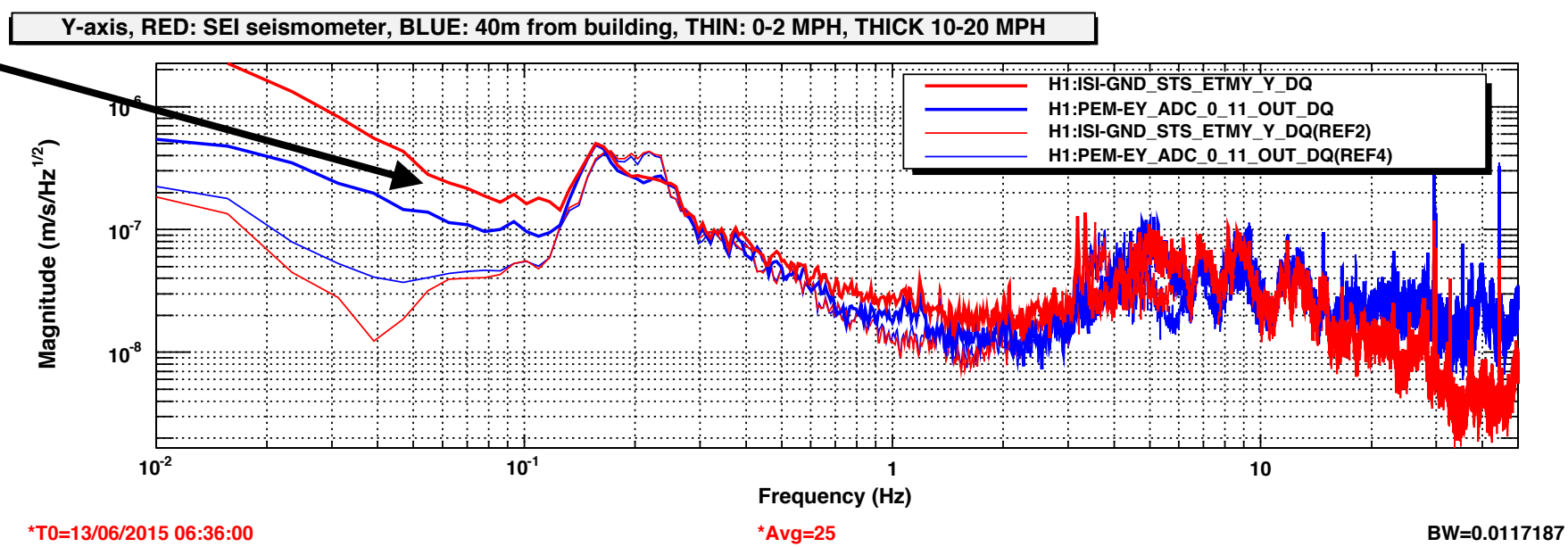
- we can probably benefit by using Robert's outdoor STS-2 at microseism and below + slab STS-2 at microseism and above.
- assume -
  - STS-2 outside sees ground translation.
    (we know this is optimistic)
  - STS-2 on slab sees ground translation
    + real slab translation (above microseism)
    + bad tilt (below microseism)
- desire ground translation + real slab trans.
- apply existing Sensor Correct using new blended STS-2 pair.

Recall Robert Data

This is compelling

This is the beam direction





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Recall Robert Data

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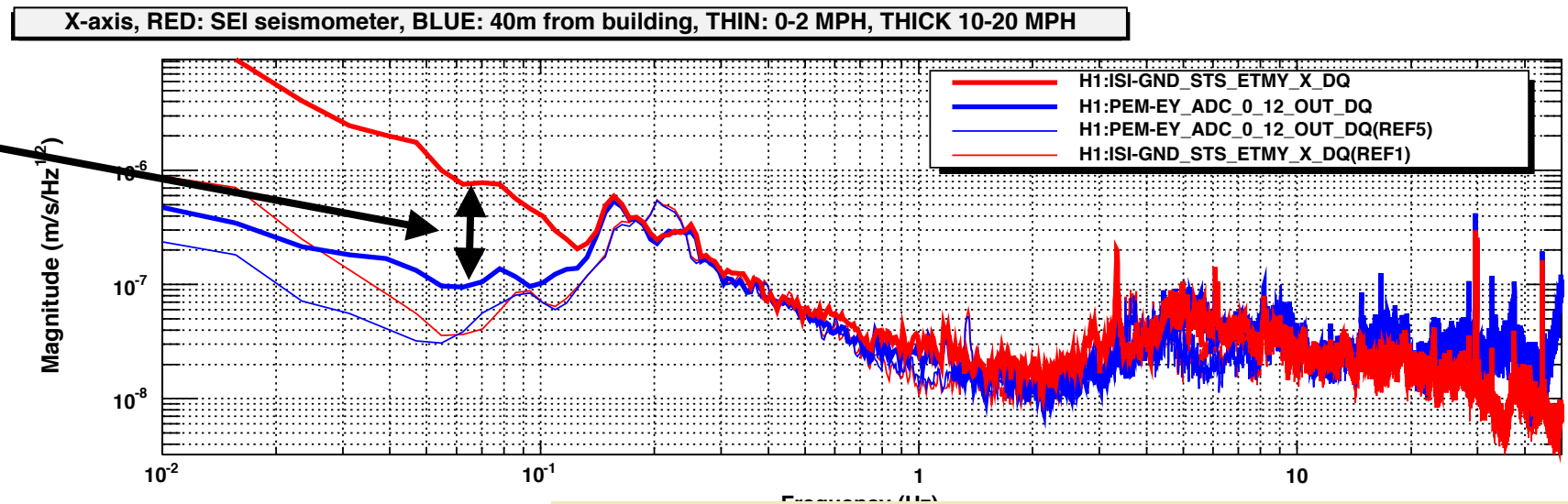

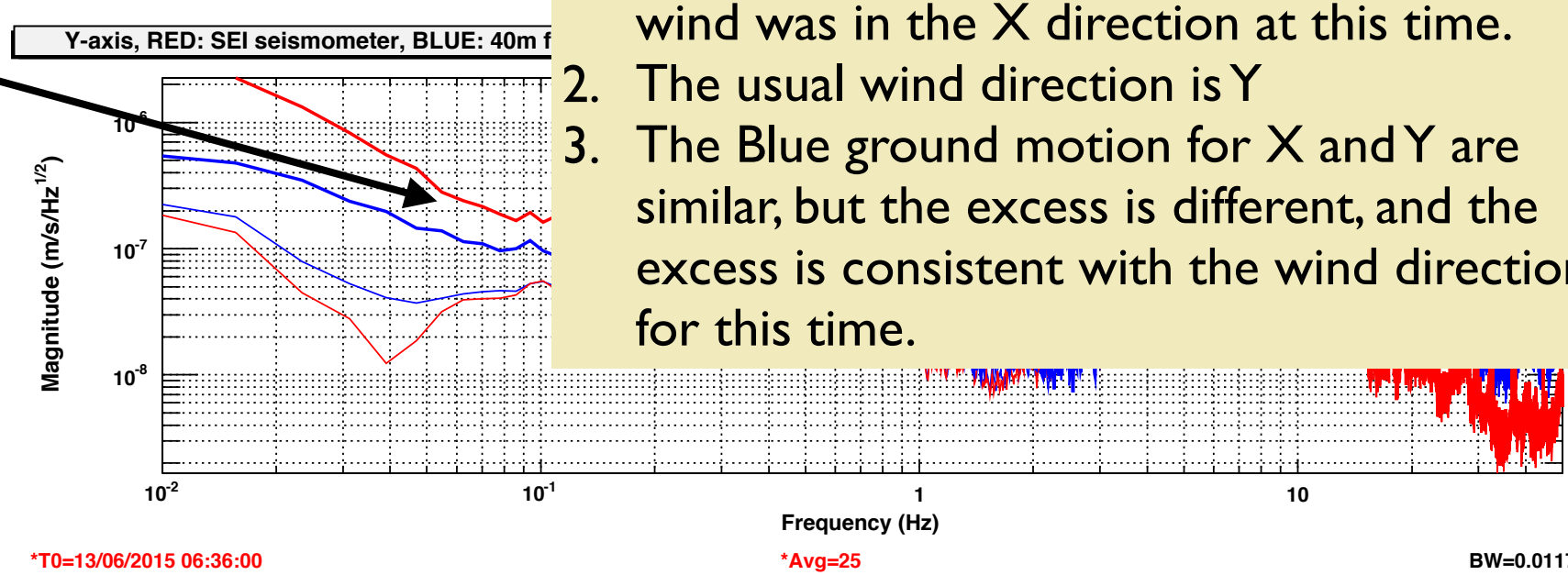

1. During the talk, Robert S reminded us that wind was in the X direction at this time.
2. The usual wind direction is Y
3. The Blue ground motion for X and Y are similar, but the excess is different, and the excess is consistent with the wind direction for this time.

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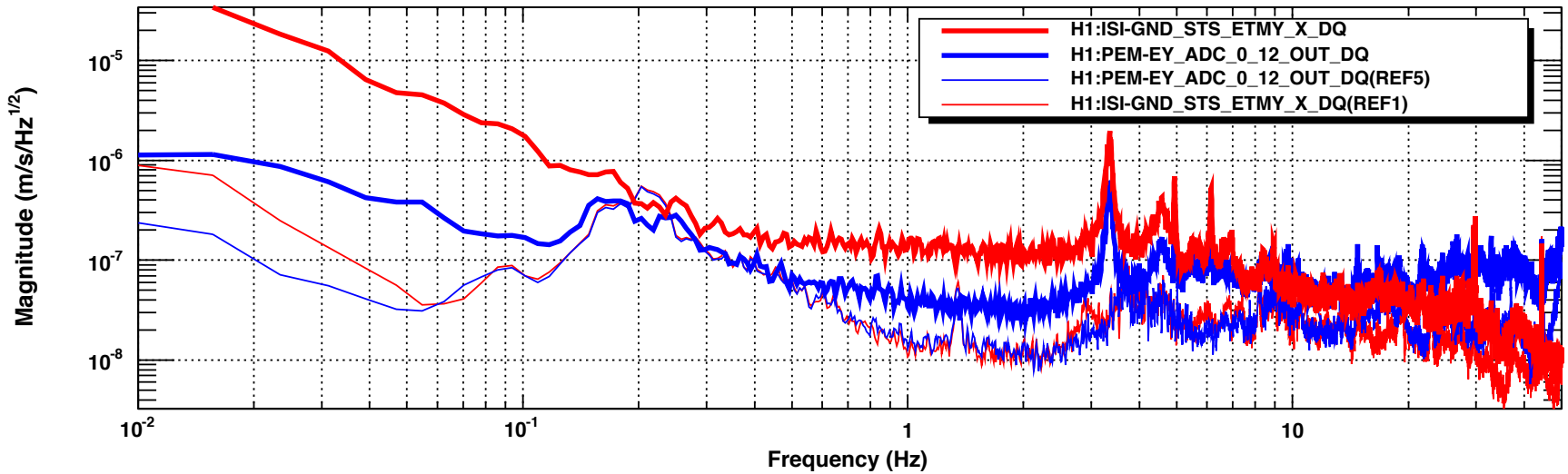
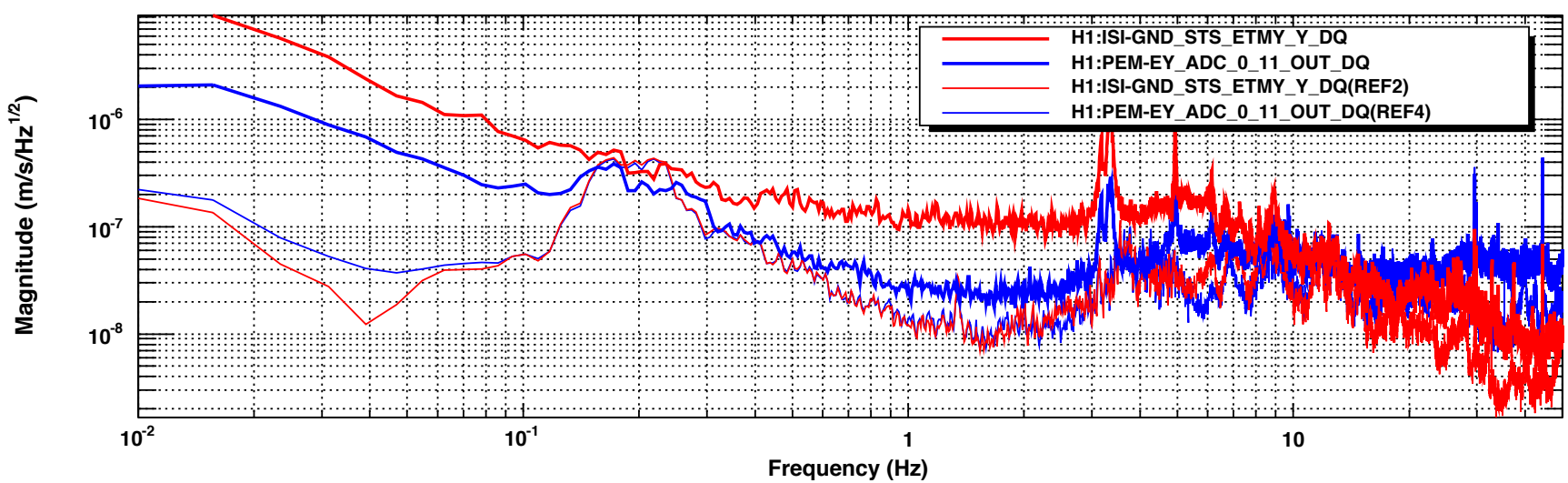
High wind version

X-axis, RED: SEI seismometer, BLUE: 40m from building, THIN: 0-2 MPH, THICK 15-35 MPH



*T0=13/06/2015 02:20:00 *Avg=25 BW=0.0117187

Y-axis, RED: SEI seismometer, BLUE: 40m from building, THIN: 0-2 MPH, THICK 15-35 MPH



*T0=13/06/2015 02:20:00 *Avg=25 BW=0.0117187

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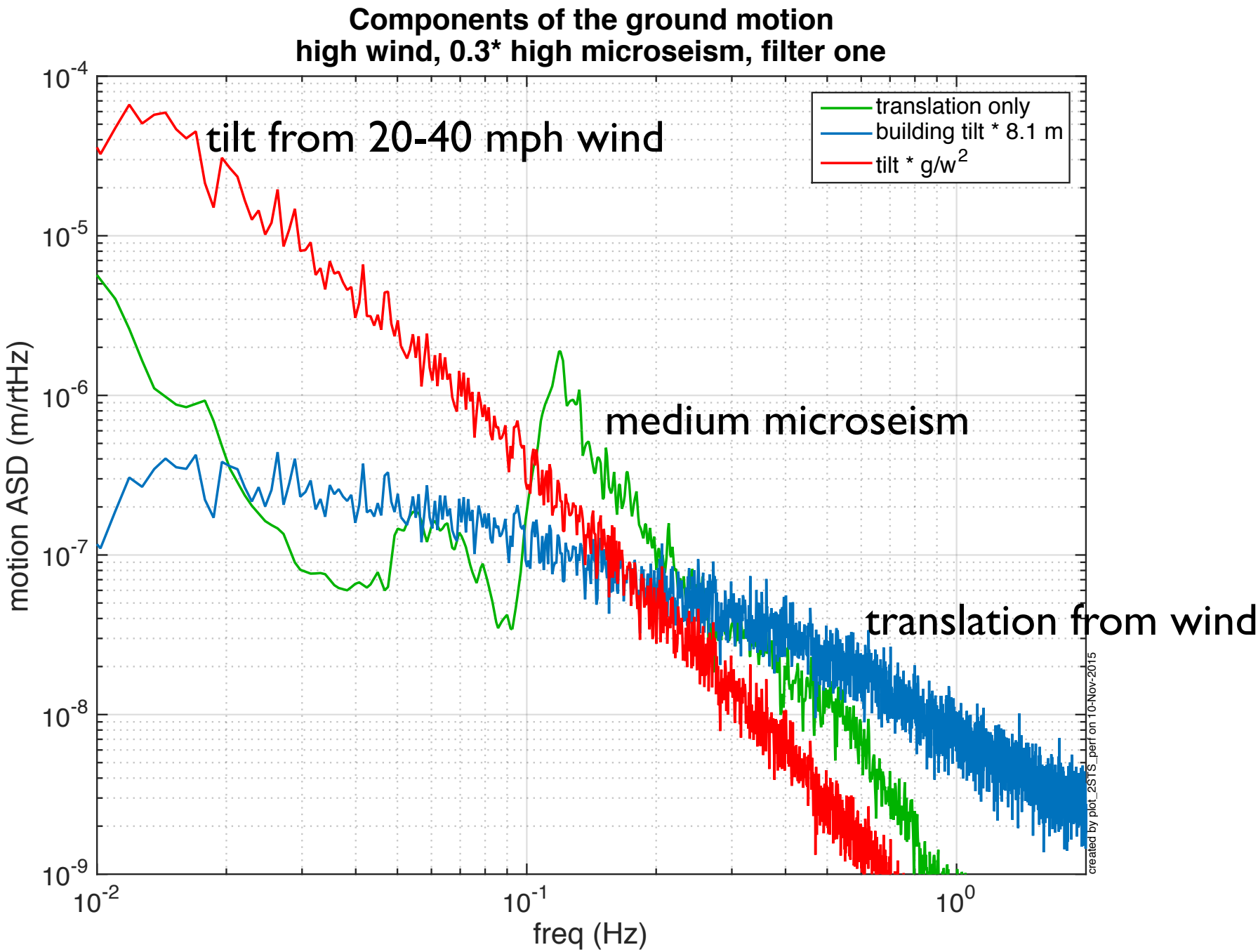
Best Case for Dual STS-2s



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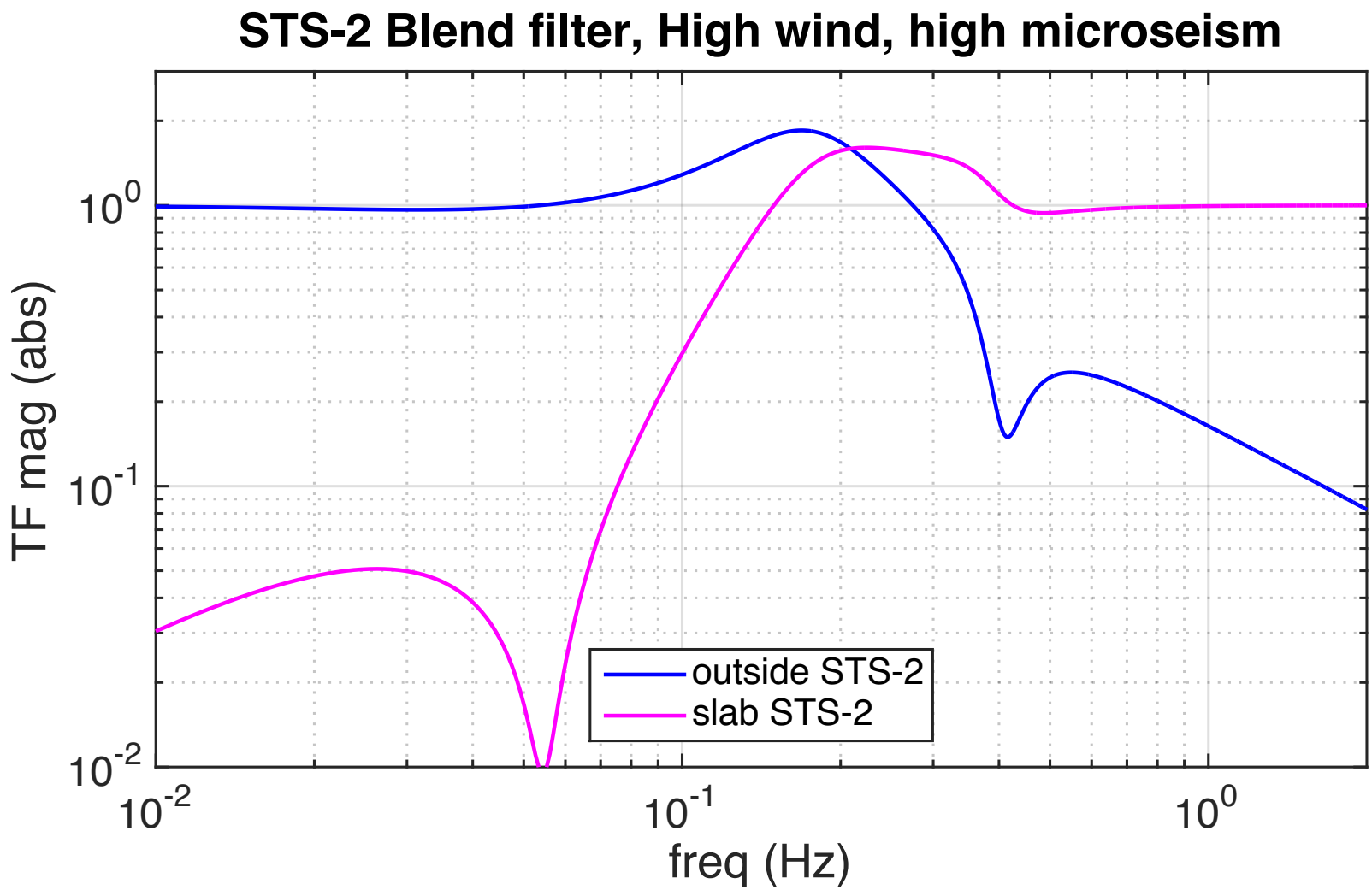
Filter for blending



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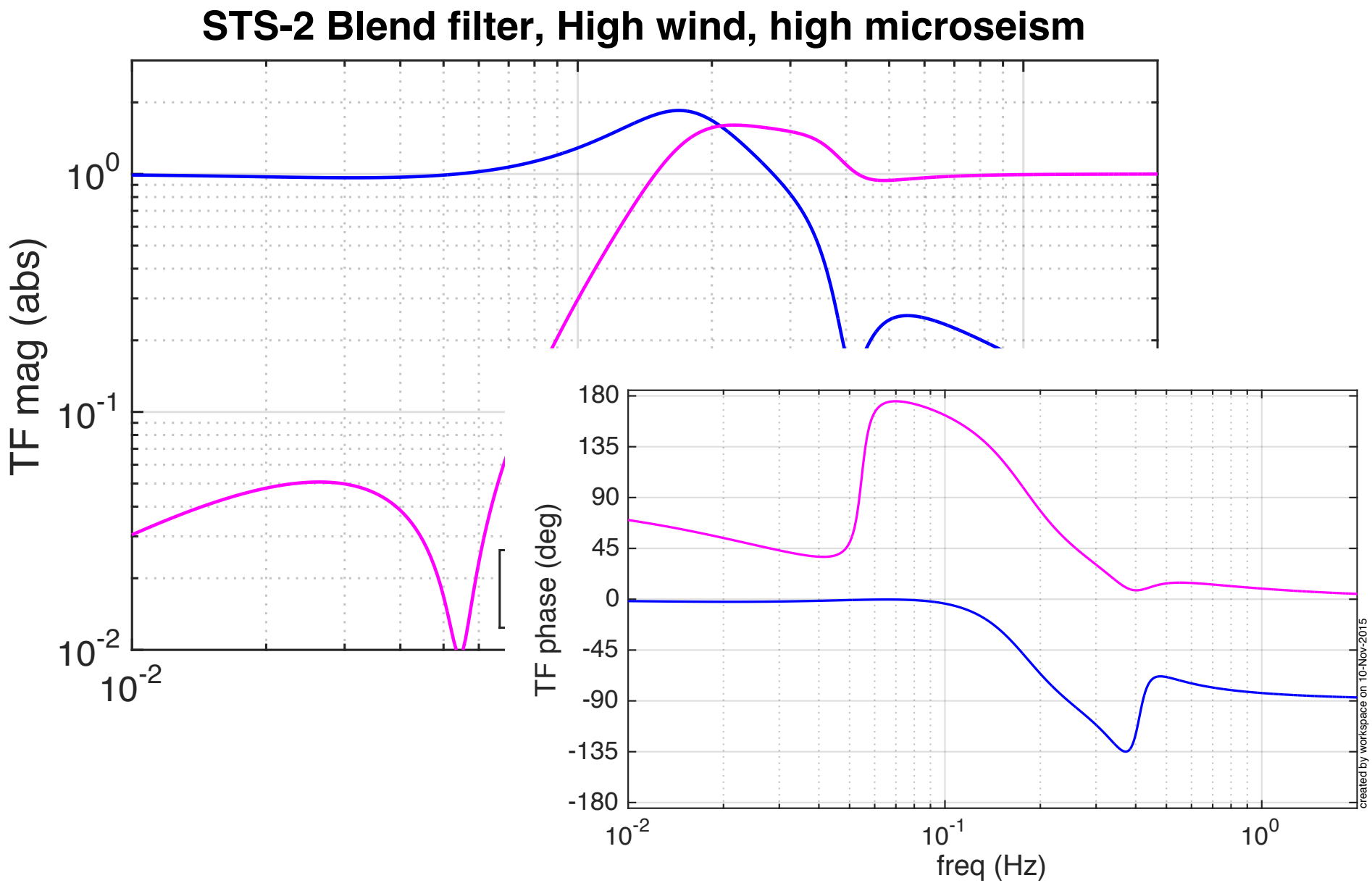

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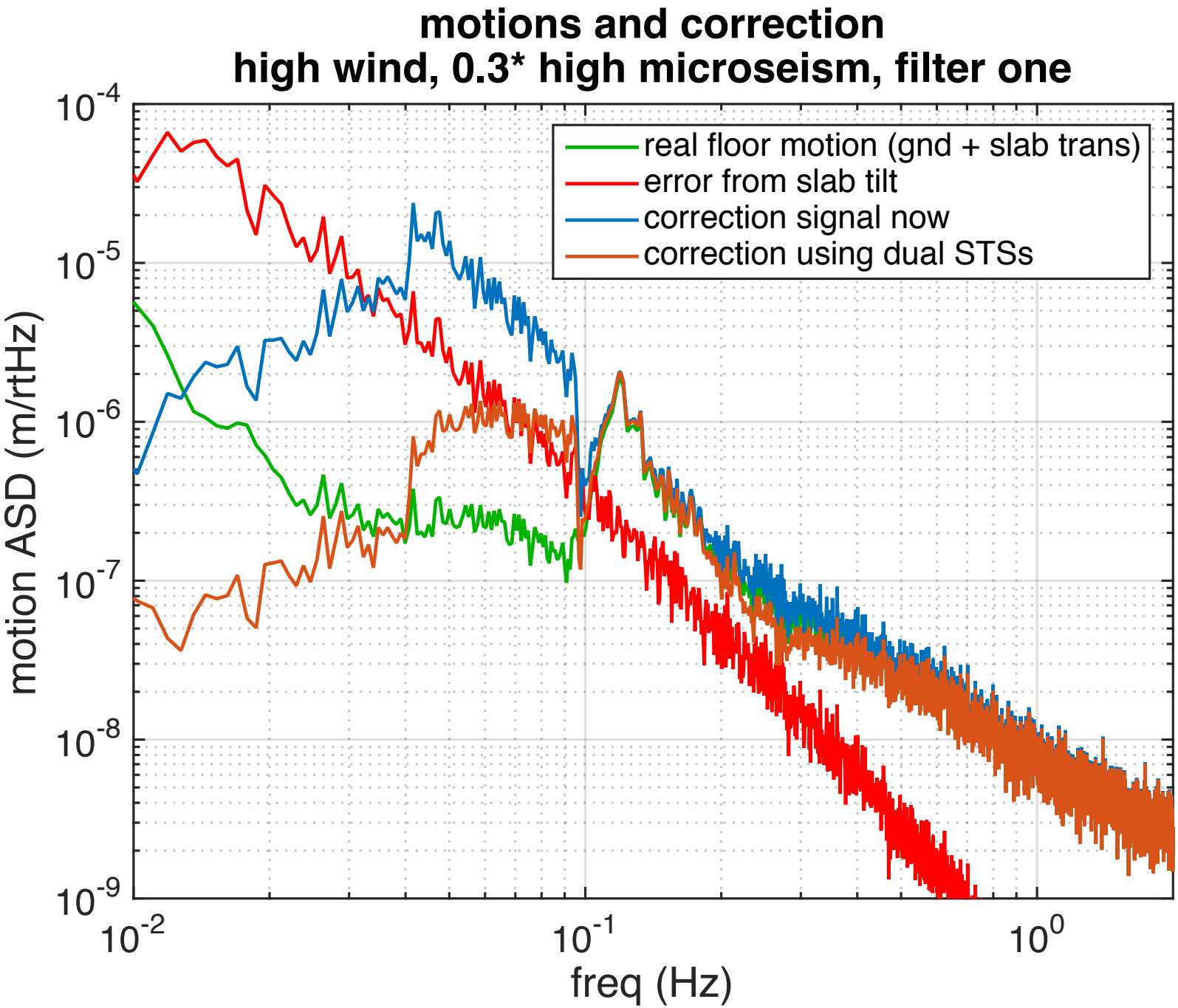
Best Case for Dual STS-2s



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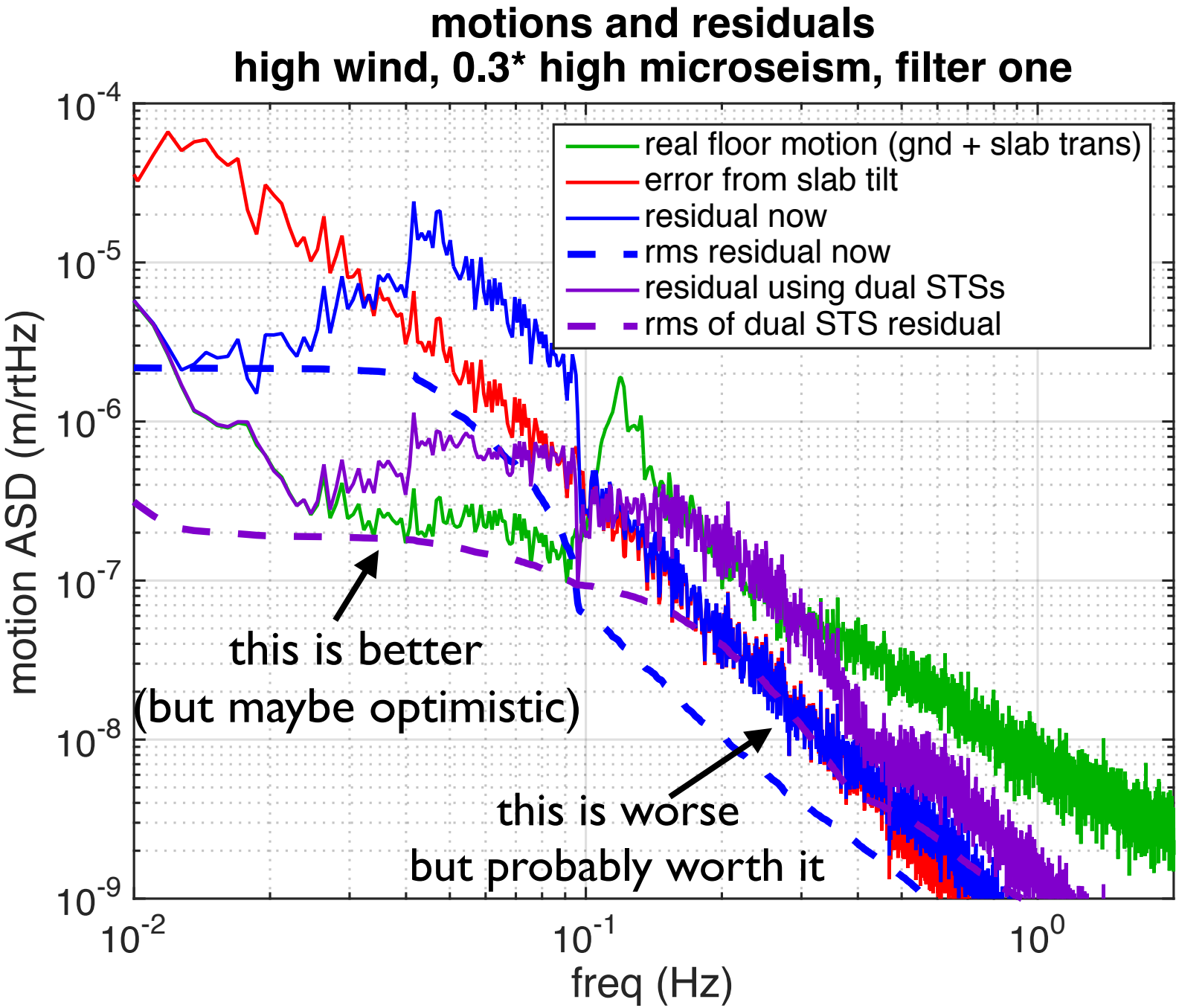
Best Case performance



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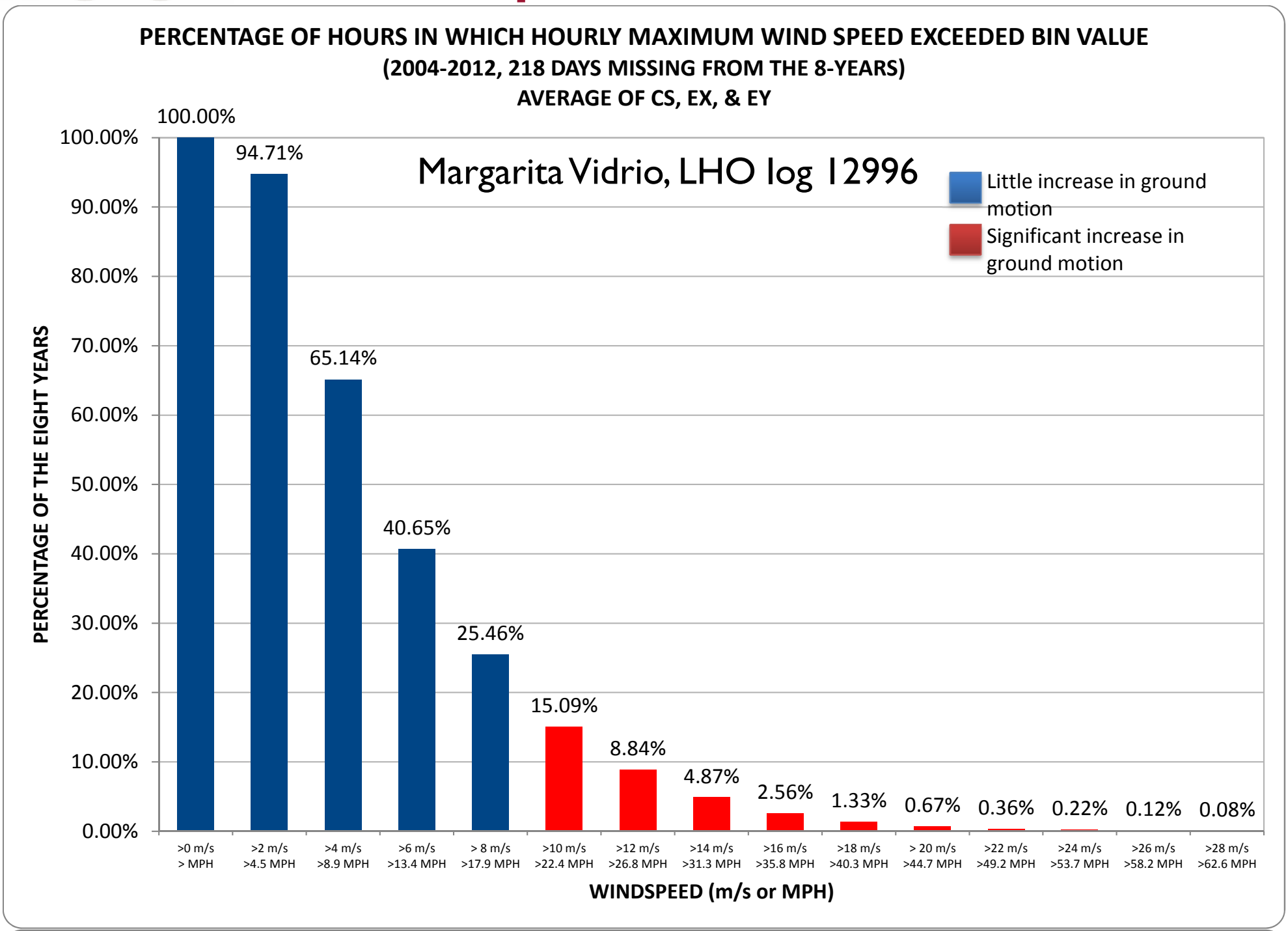
Suggestions

1. Figure out how to get the 'good direction performance' from the outside STS-2s in both X & Y, or at least along beam direction.
2. Move 2 of the 3 STS-2s from the LVEA to outside the ends.
3. (keep working on the BRS)
4. Study non-linear pain vs. windspeed observation. (Jordan Palamos)
5. Evaluate ways to cut the wind impact on the slab.

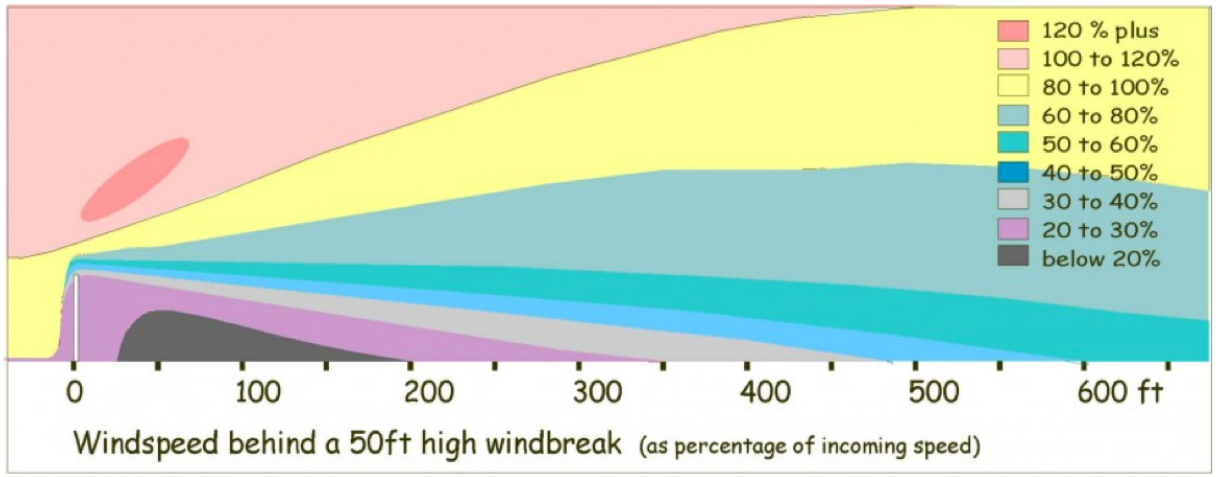
Wind speed distribution



windfence picture and plot from WeatherSolve.com

Wind Fences

Windbreaks control the amount of “crashing down and in” by letting a little wind flow through. The wind flowing through holds the faster (deflected) wind away for a few hundred feet. This lets the winds merge together again more gently with less turbulence.
The effects are shown in the drawing which shows a side view of a well-designed windbreak and the windspeeds around it.



PNW0005

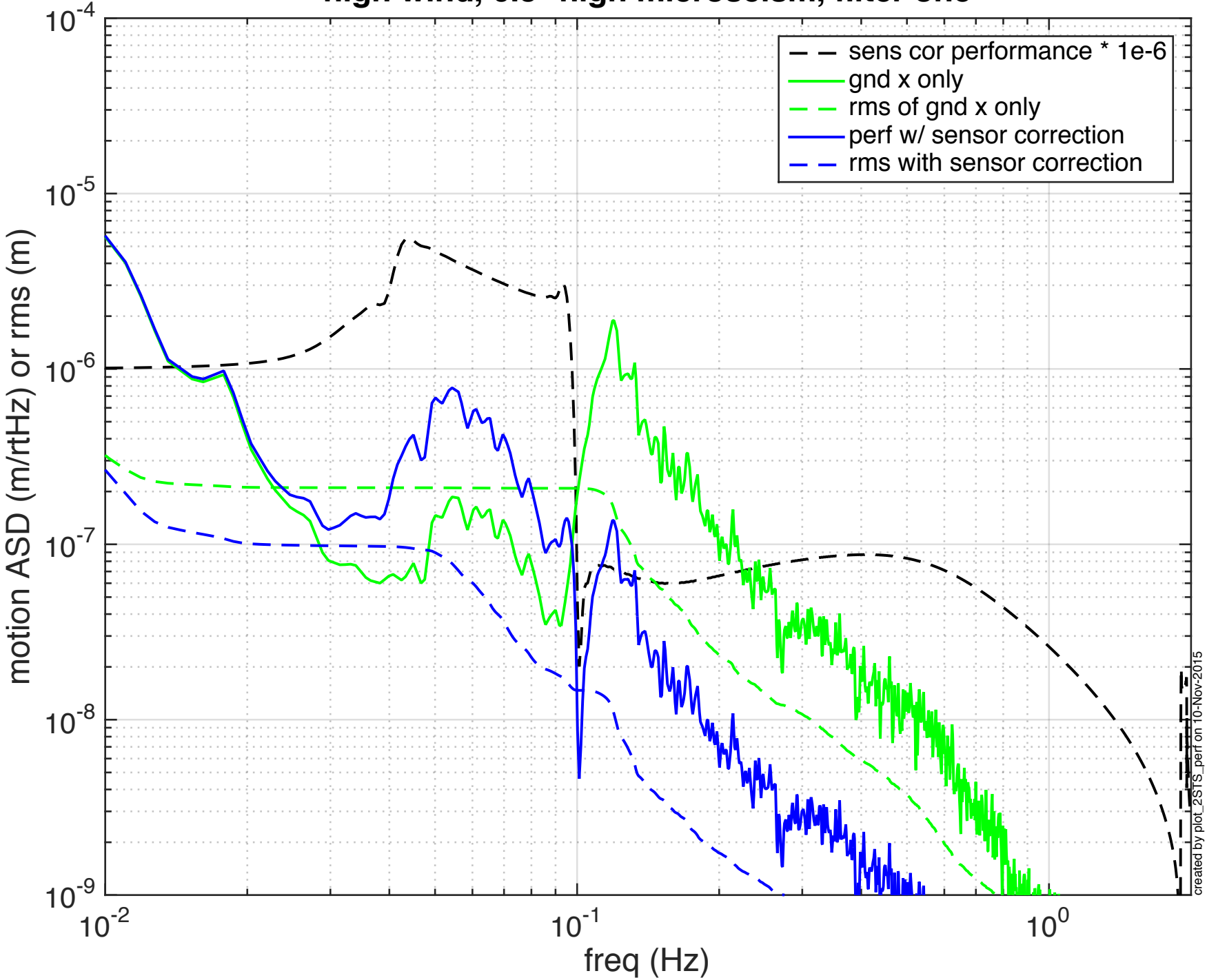
Trees against the Wind

array of solar powered, self-assembling nano-structured macroscopic bio-engineered aerodynamic damping structures

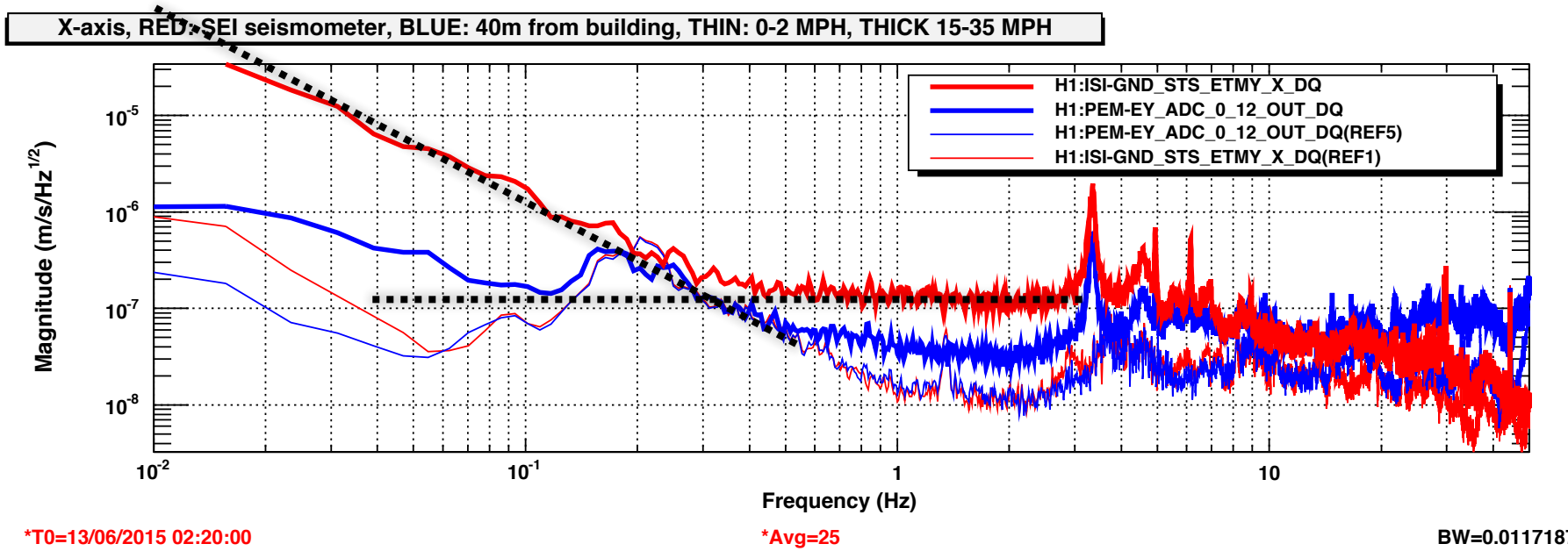
A Pacific Northwest Extension Publication

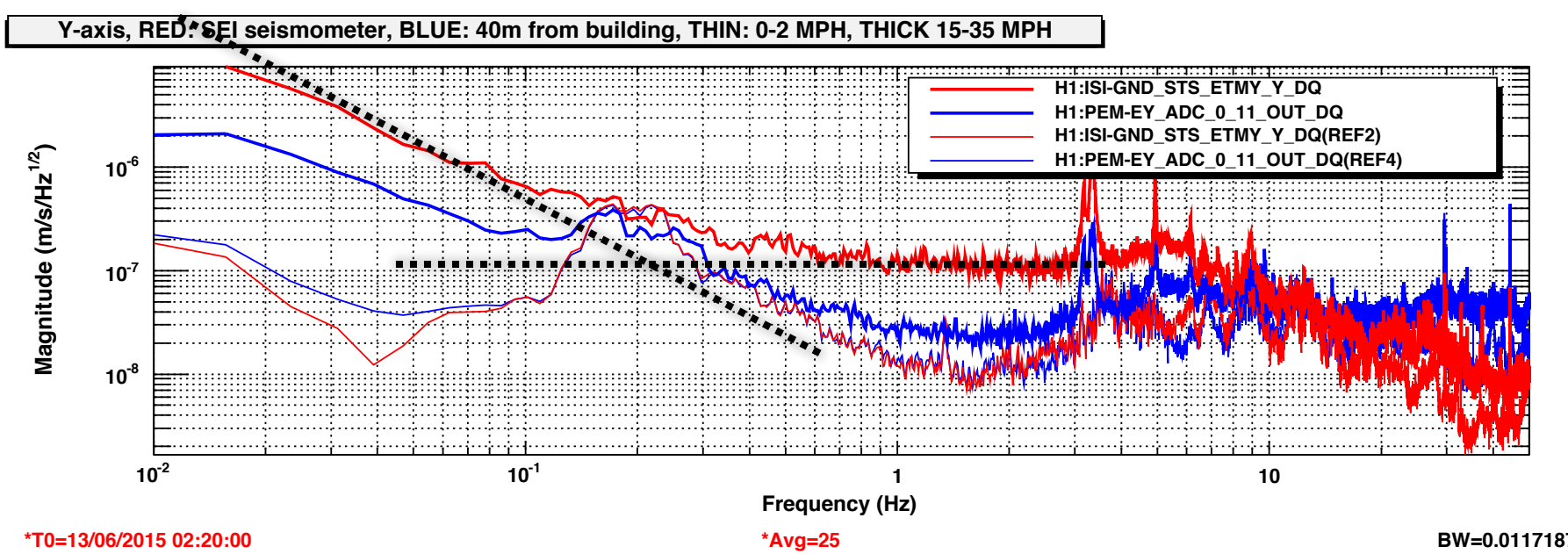
Washington State University • University of Idaho • Oregon State University

Model performance with NO TILT (for reference)
high wind, 0.3* high microseism, filter one



- data lives at /Users/BTL/Brians_files/SeismicSVN/seismic/BSC-ISI/Stanford/Transfer/RobertSchofield_June2015_buried_seis_data
- https://alog.ligo-wa.caltech.edu/aLOG/index.php?callRep=19210





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