Preliminary Vibration Budget For SuperB

XIV Super-B General Meeting
Frascati, Italy
29 Sept 2010

Kirk Bertsche

Vibration Issues

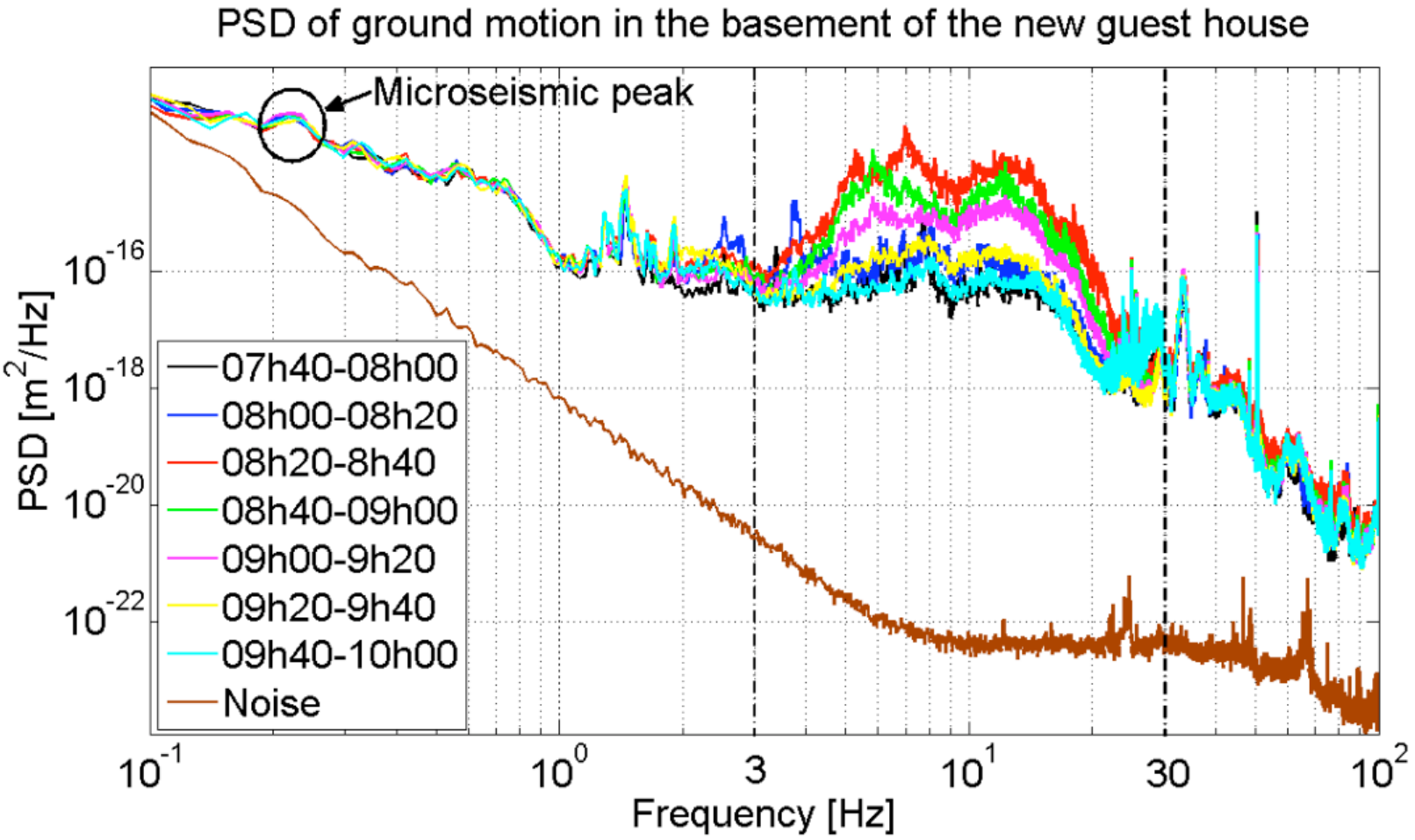
- Allowed beam displacement at IP
  - from IX SuperB General Meeting (June 2009, Perugia)
- Expected ground motion
  - from XI SuperB General Meeting (Dec 2009, Frascati)
- Effect of cantilevered cryostat
  - new
- Effects of quad motion on beam
  - from IX SuperB General Meeting (June 2009, Perugia)
- Requirements on beam feedback
  - partly from VII SuperB General Meeting (Feb 2009, Paris)
- Overall beam displacement
  - new

Allowed Displacement at IP

- Y position has very tight tolerance:
  - 8 nm relative beam displacement at IP reduces luminosity by 1%
- Other dimensions much looser:
  - Y angle: 200 urad relative displacement at IP reduces luminosity by 1%
  - X position: 2 um relative displacement at IP reduces luminosity by 1%

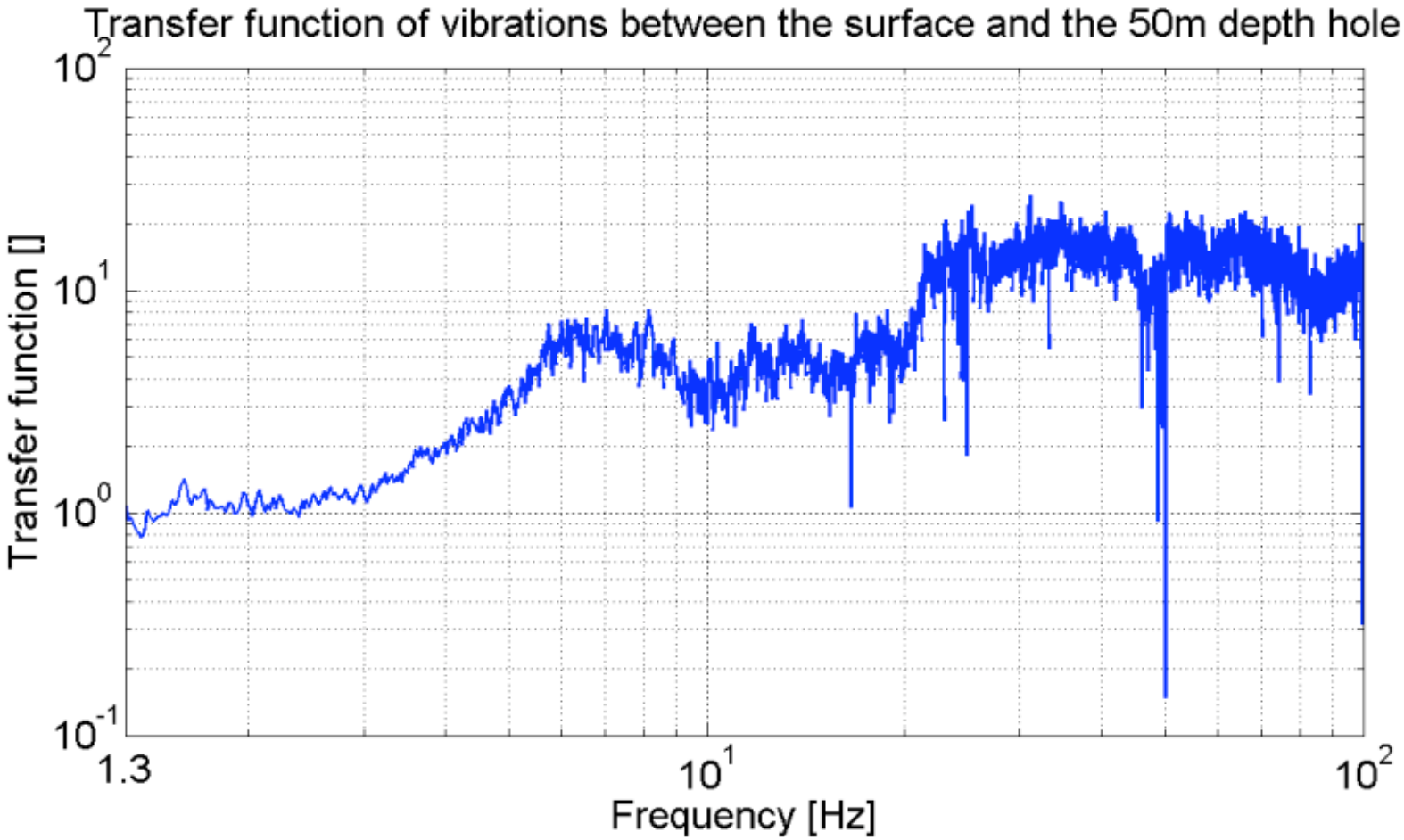
From Bertsche, IX SuperB General Meeting (June 2009, Perugia)

Ground Motion at LNF



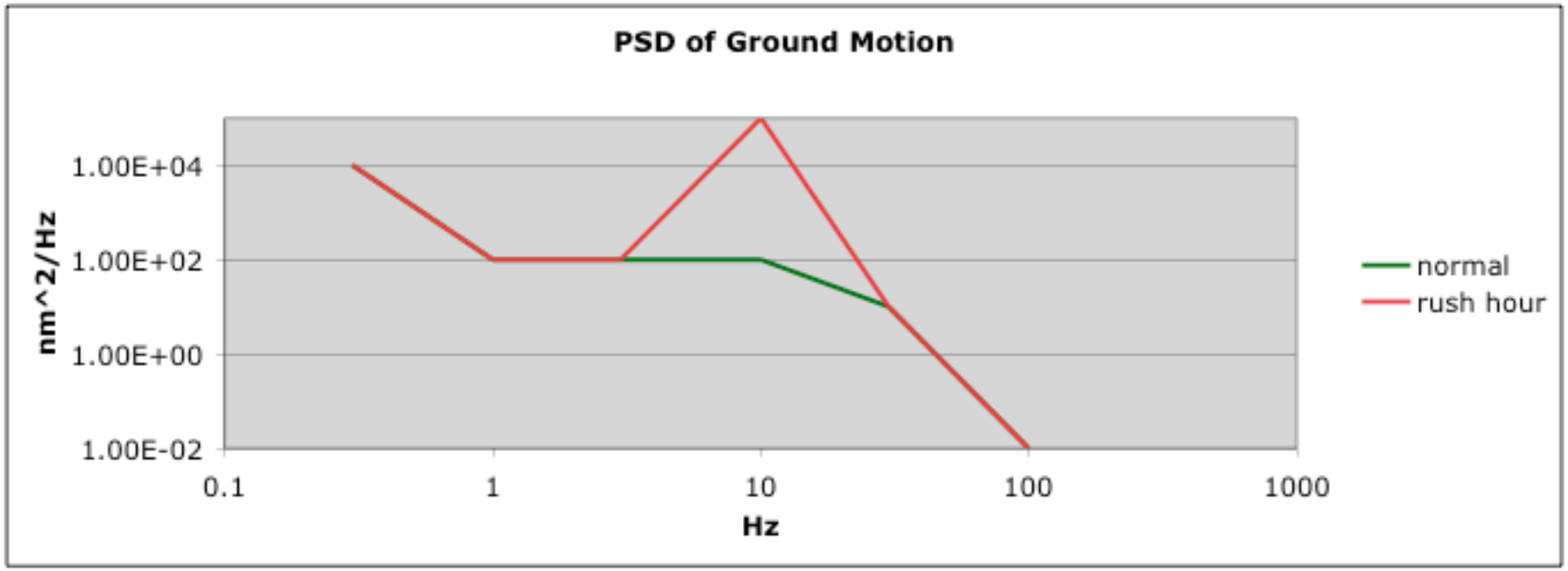
From Bolzon et al, XI SuperB General Meeting (Dec 2009, Frascati) and IPAC10 (Kyoto, Japan)

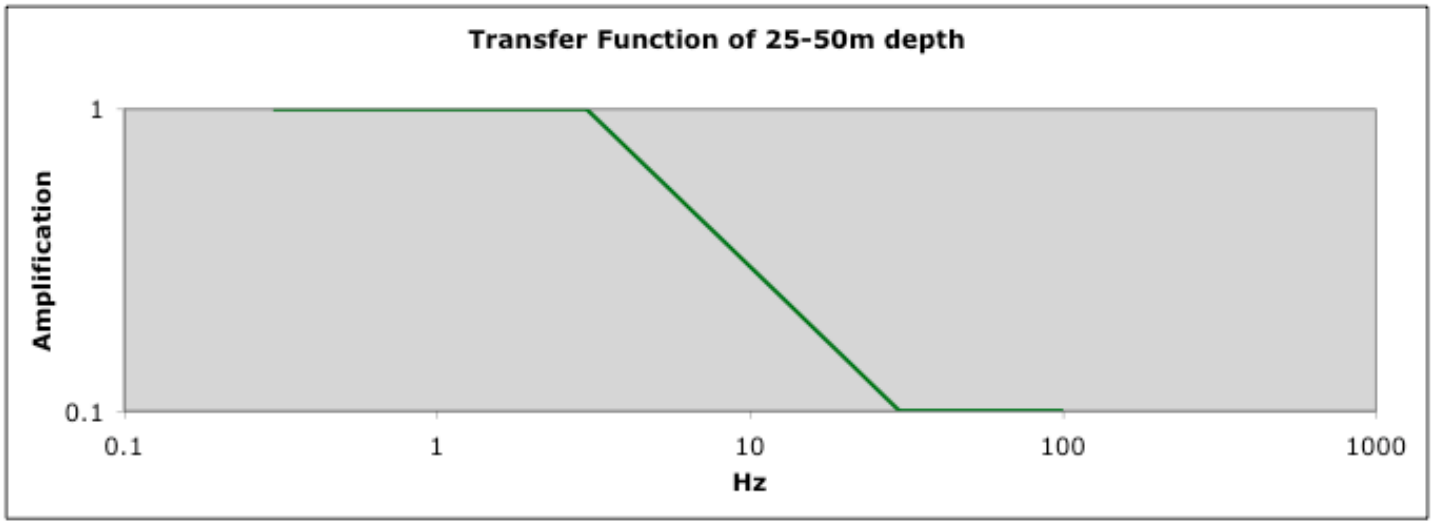
Vibration Transfer Function with Depth



From Bolzon et al, XI SuperB General Meeting (Dec 2009, Frascati) and IPAC10 (Kyoto, Japan)

Idealizations For Error Budget





Quadrupole to IP Transfer Function

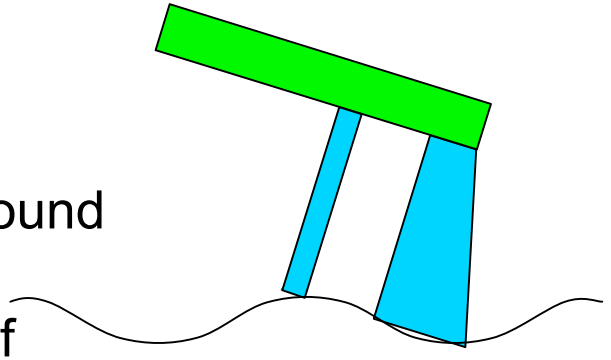
Quadrupole motion in Y	Vibration transfer fn
QD0 (total)	~ 0.7
QF1	~ -0.15
Arc QDs (RMS sum)	< 0.05

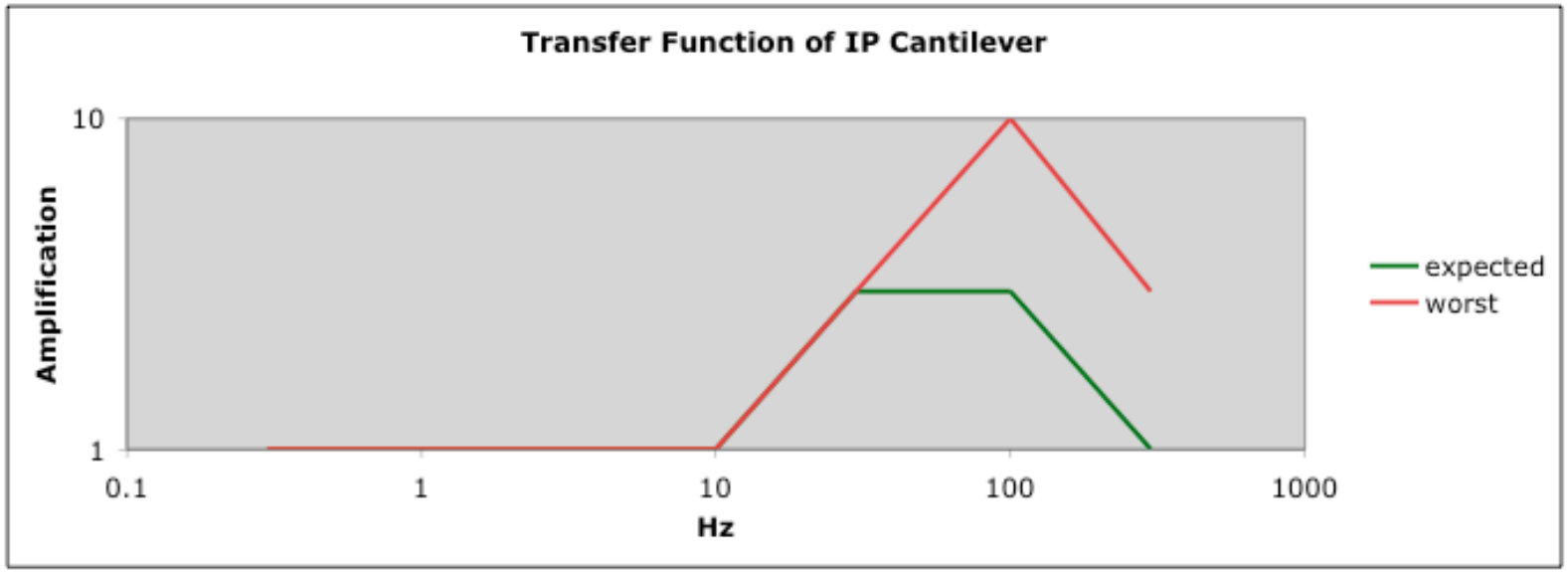
- Collisions very sensitive to QD0 vertical motion (cryostat)
  - ~ 5x less sensitive to QF1 motion (and opposite sign)
  - Y angle and X position: >100x less sensitive than Y position
  - HER and LER very similar; relative motion will be 1.4x larger
- Values assume closed orbit, with tune near ½ integer
- We will consider only QD0 (RMS sum of everything should be less)
  - 8 nm motion of both QD0s gives 8nm relative beam displacement, or 1% lumi reduction

From Bertsche, IX SuperB General Meeting (June 2009, Perugia)

Vibration Amplification of IR

- Cantilevered cryostat can amplify ground vibrations, even if a rigid body
  - Increases with frequency due to y-angle of ground motion
  - Decreases when wavelength shrinks to size of base

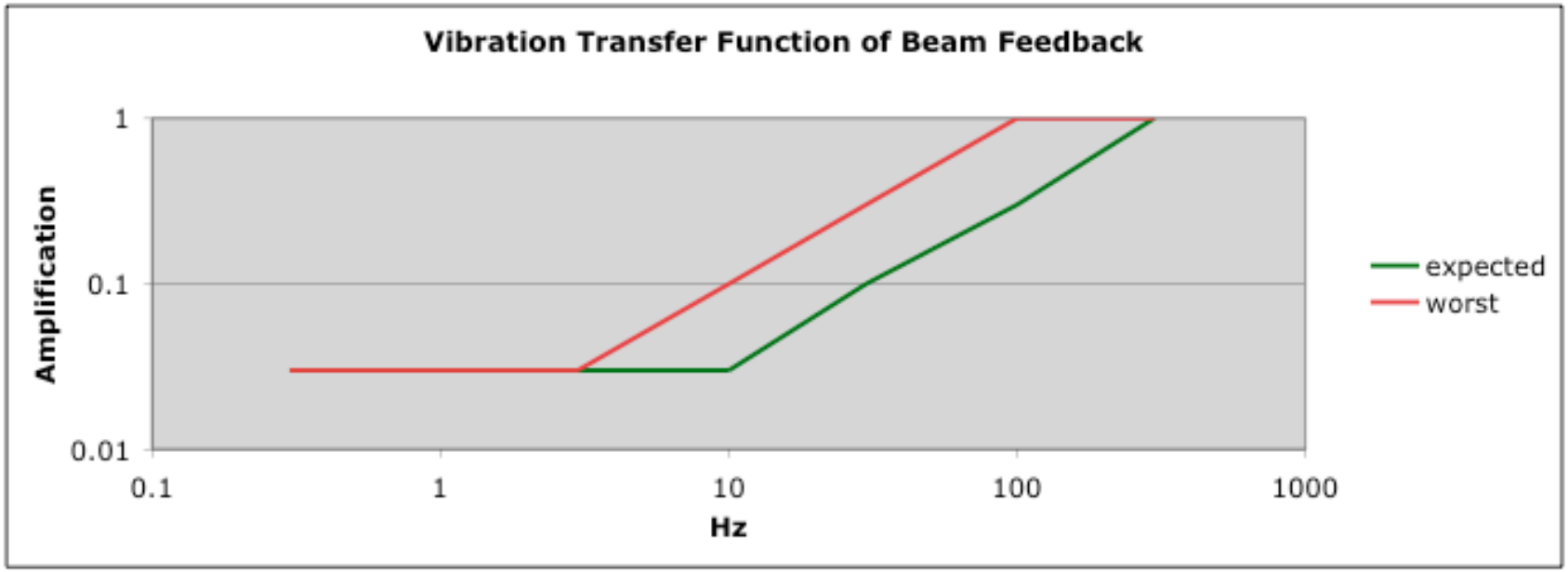




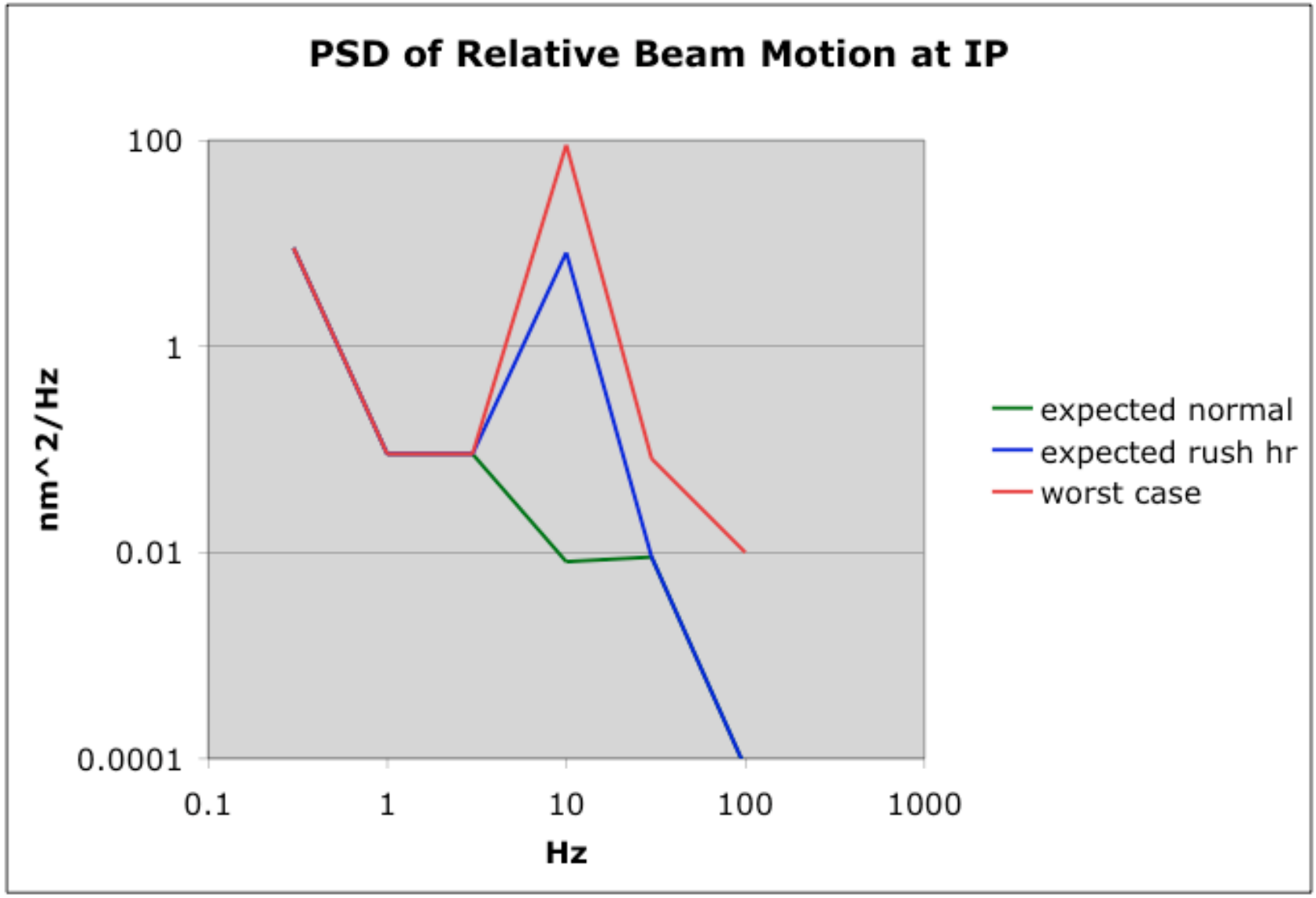
- Assumes:
  - Ground vibration wave velocity 100-200m/s
  - Cantilever ~ 2m
  - Base 1-2m

Active Beam Feedback

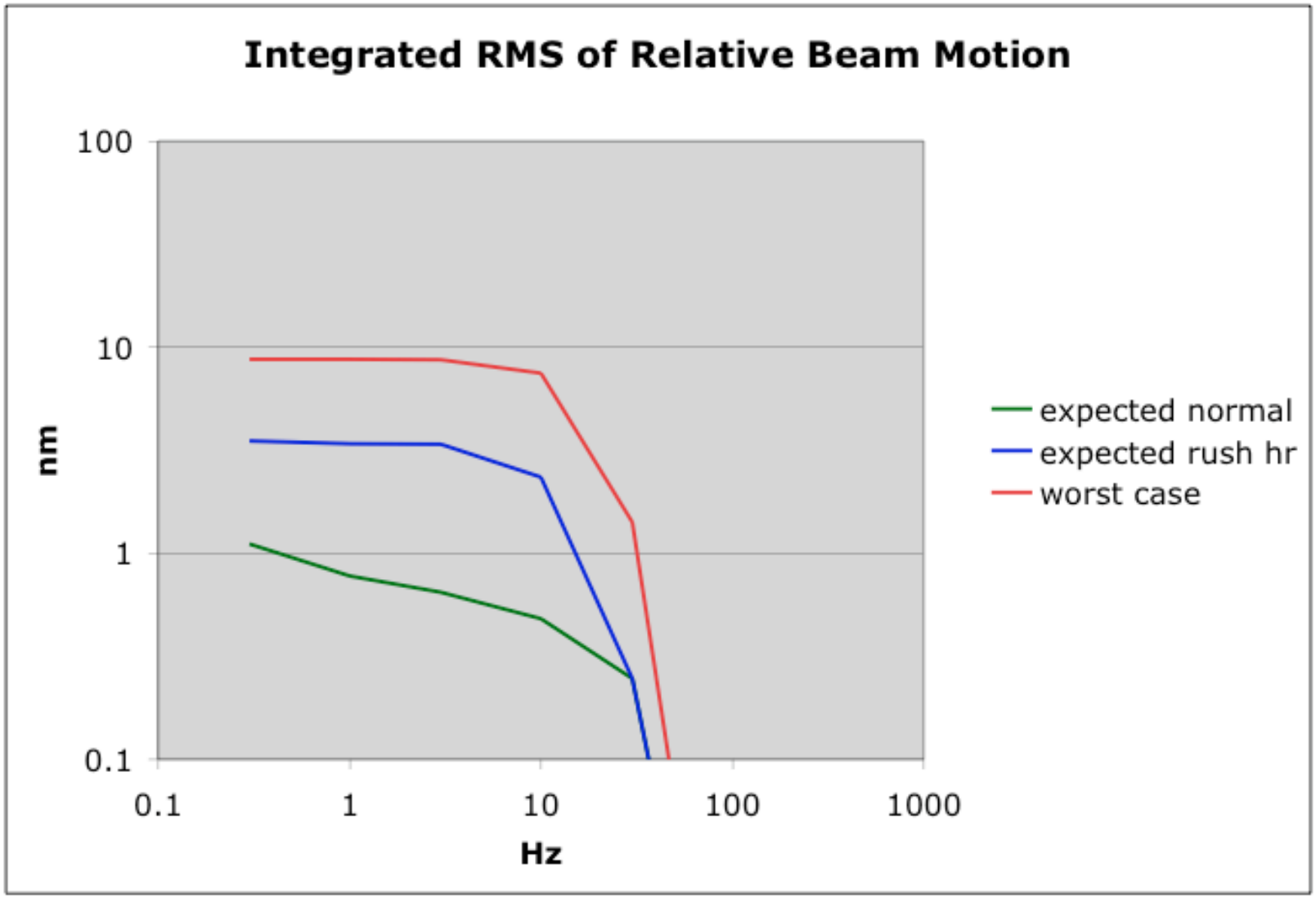
- Fast dither system
  - Presented by Bertsche at VIII SuperB General Meeting (Feb 2009, Orsay), PAC09 (May 2009, Vancouver)
- Fast IP feedback system
  - Presented by Drago at VIII SuperB General Meeting (Feb 2009, Orsay)
- Need 100 Hz bandwidth, ~30x vibration reduction at LF



Resultant Beam Motion



Resultant Beam Motion



Worst case: 1% loss of luminosity

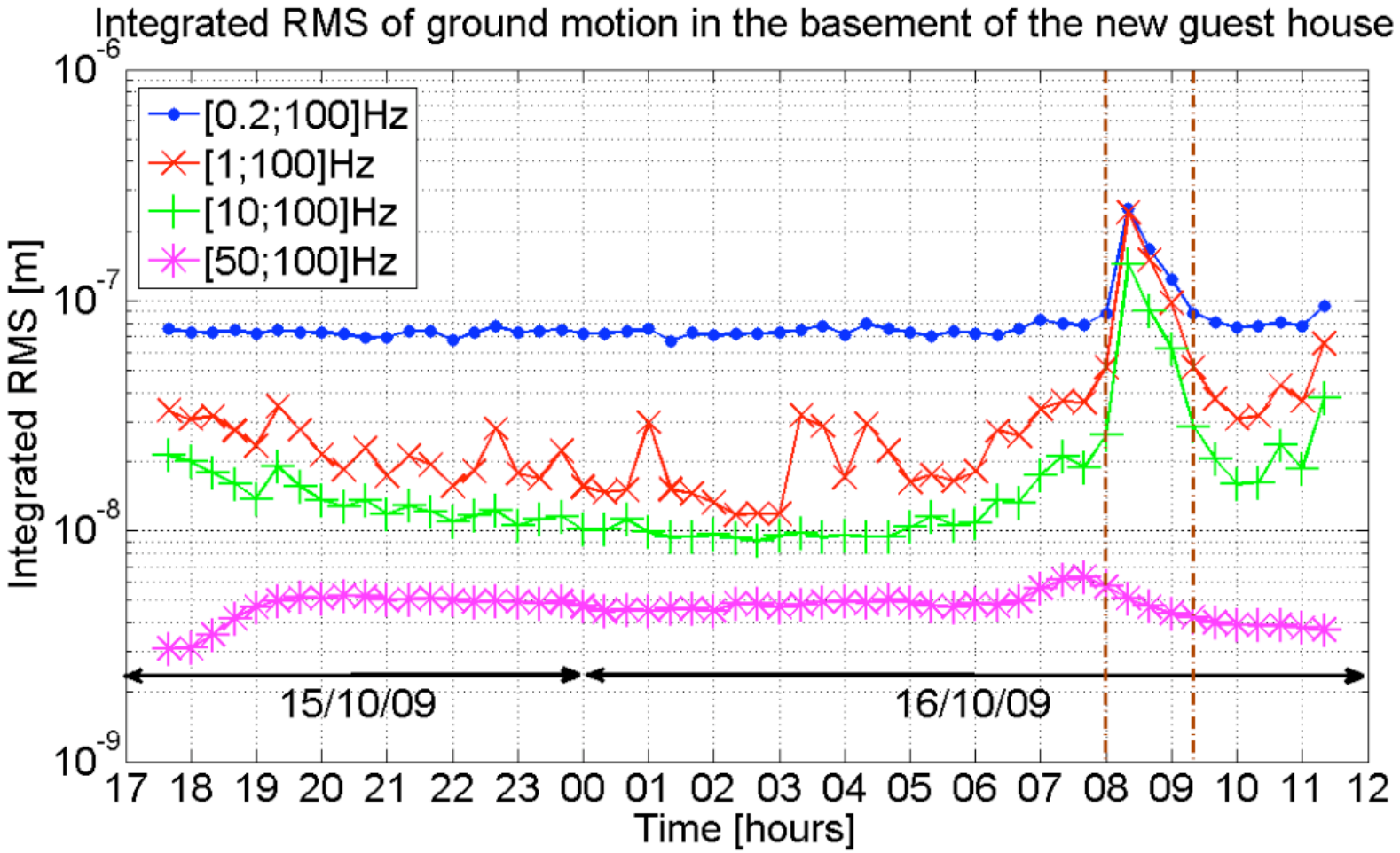
Summary

- Cantilevered cryostat should be rigid
  - Damp resonances and push > 10 Hz
  - Support on both sides of detector door
- Beam feedback should extend to 100Hz, provide ~30x vibration reduction at LF
- LNF site
  - Active mechanical feedback not needed (unless cryostat or beam feedback requirements not met)
- Surface site
  - Limit cultural noise (roads, trains)
  - May need active mechanical feedback?


SLAC
NATIONAL ACCELERATOR LABORATORY

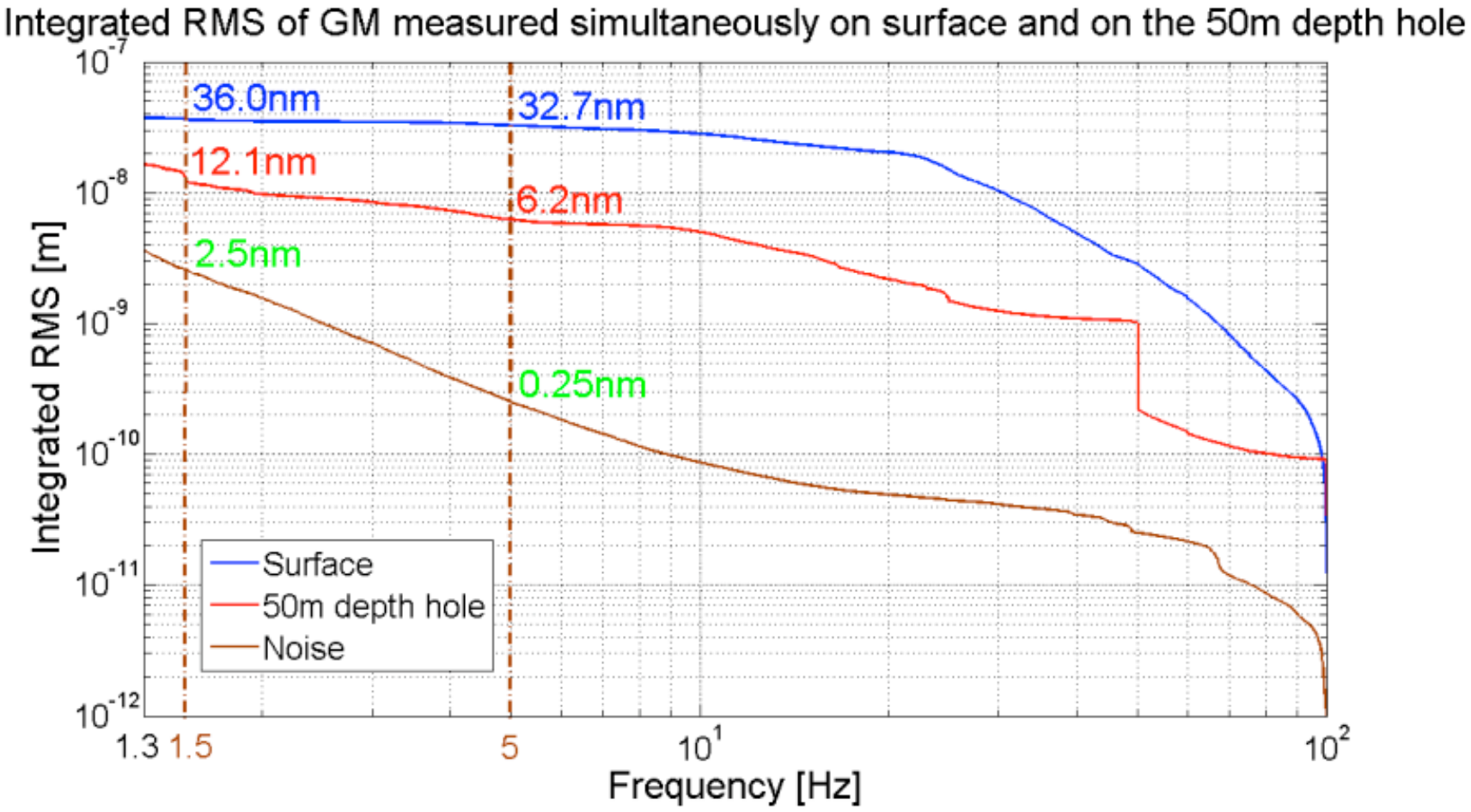

SuperB

Ground Motion Data



From Bolzon et al, XI SuperB General Meeting (Dec 2009, Frascati) and IPAC10 (Kyoto, Japan)

Vibration Variation with Depth



From Bolzon et al, XI SuperB General Meeting (Dec 2009, Frascati) and IPAC10 (Kyoto, Japan)