Update from NN Working Group

JAN HARMS

WEB Array Measurement

- Array was deployed on Jan 18/19, and data were taken from Jan 25 to Feb 6
- After initial tuning phase, high-quality data were obtained covering more than a week
- Data from 38 indoor sensors can be downloaded here (public access, CSV format): http://foka.ise.pw.edu.pl/virgo/NN_Data_Reparsed/
- Data from 9 outdoor sensors can be downloaded here (password protected, SEGY format): http://gofile.me/3I0Je/88bEvHK1B
- Data format will still be unified and files copied to Virgo server

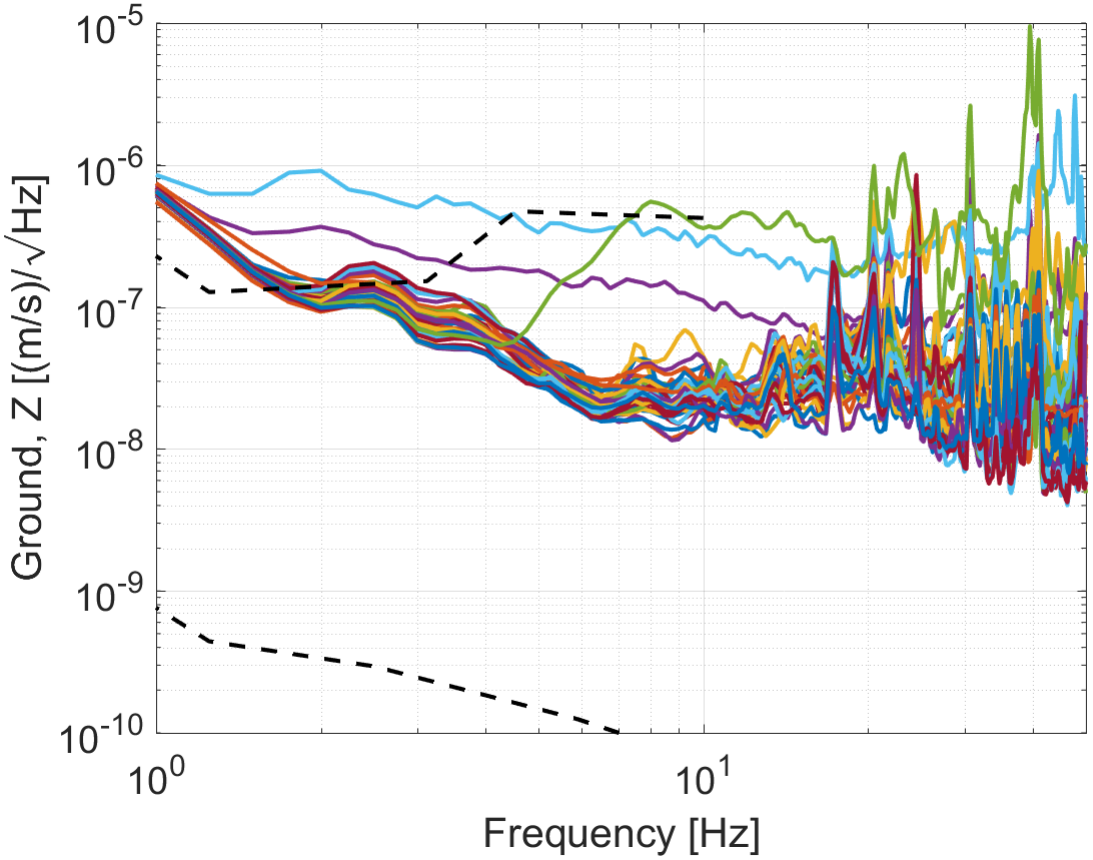
Array Components

Two sensors across interface

Central data unit

- Heavy mount plate fixed with double-sided tape to improve connection to ground
- Longer inter-sensor cabling to suppress coupling

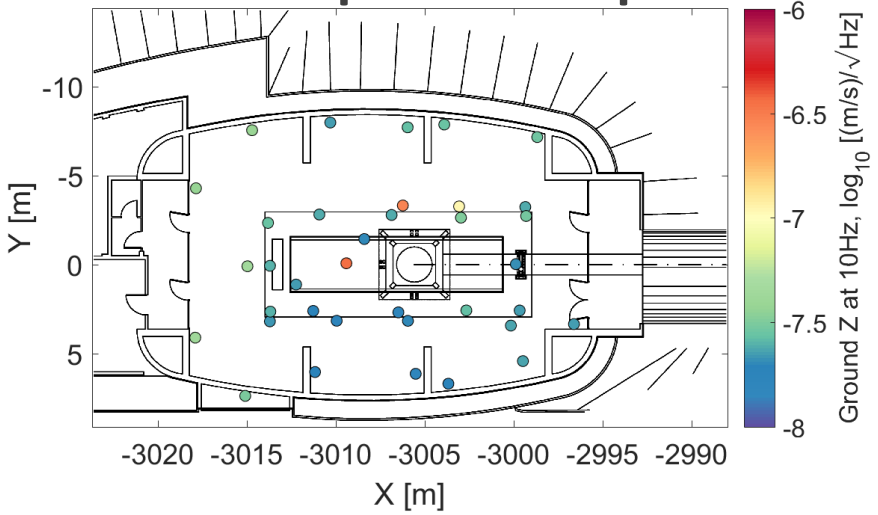
Spectra from Indoor Sensors

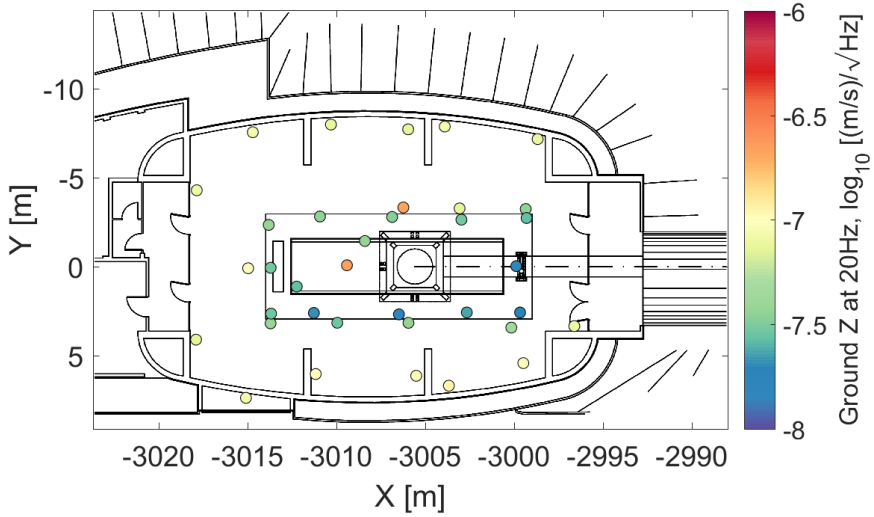


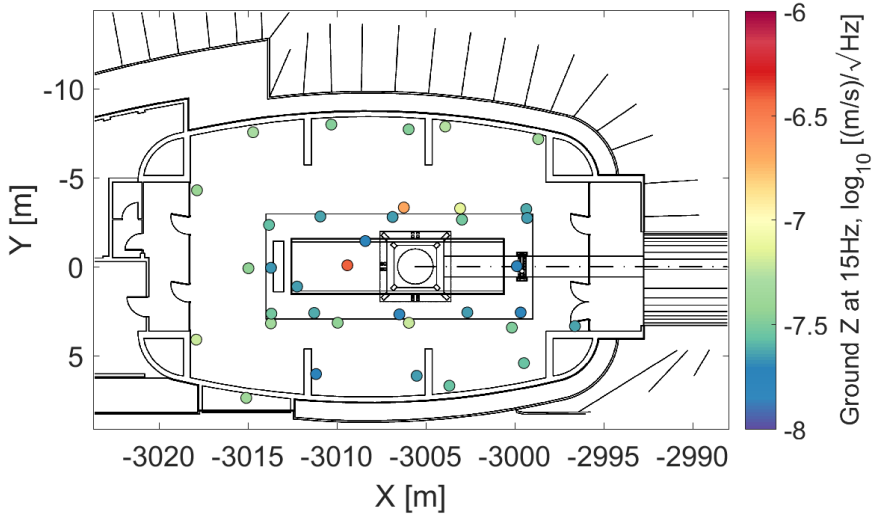
There is significant variation of seismic spectra in the NN band.

Outliers belong to sensors at specific locations, e.g., green spectrum is measured on metal sheet covering sub-level of tower platform.

Map of Spectral Densities

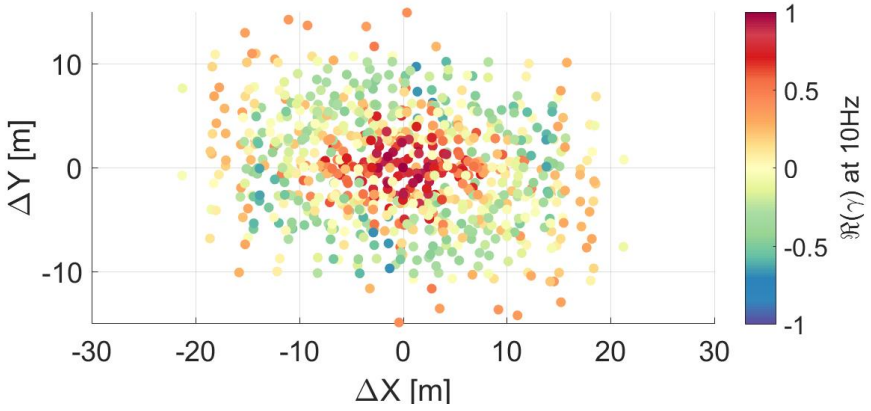


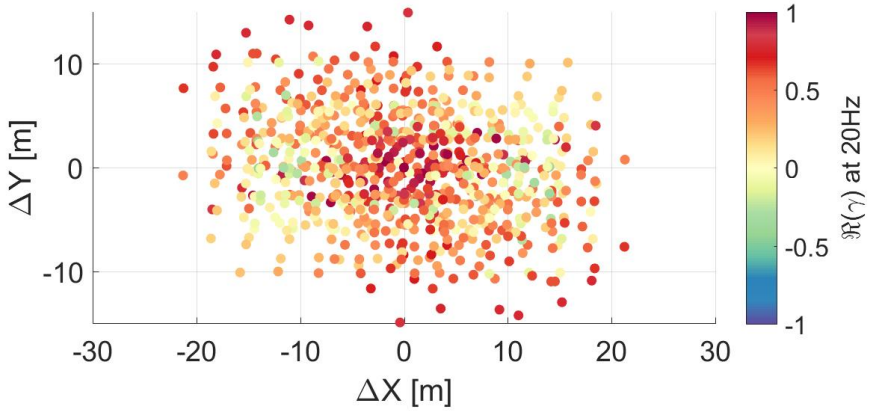


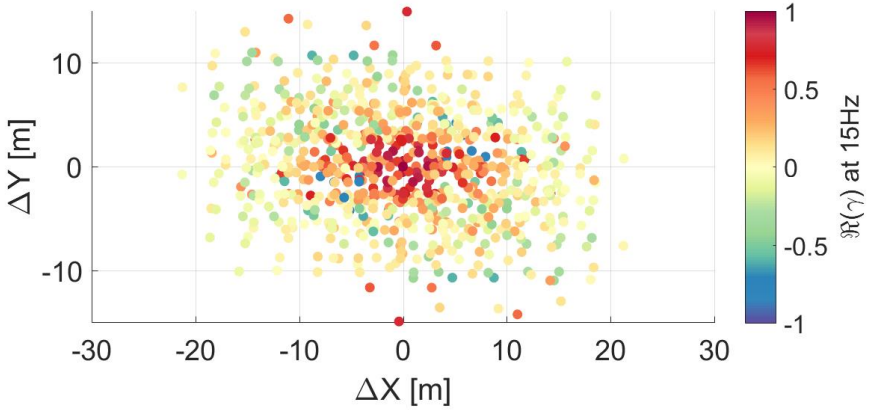


- Night-time data from Feb 1
- 10Hz: Minor discontinuities across platform interface; sources towards negative X
- 15Hz: Significantly stronger ground vibration near building walls; stronger discontinuities across interface
- 20Hz: Much stronger ground vibration near buildings walls; significant discontinuities across interface

Seismic Correlations



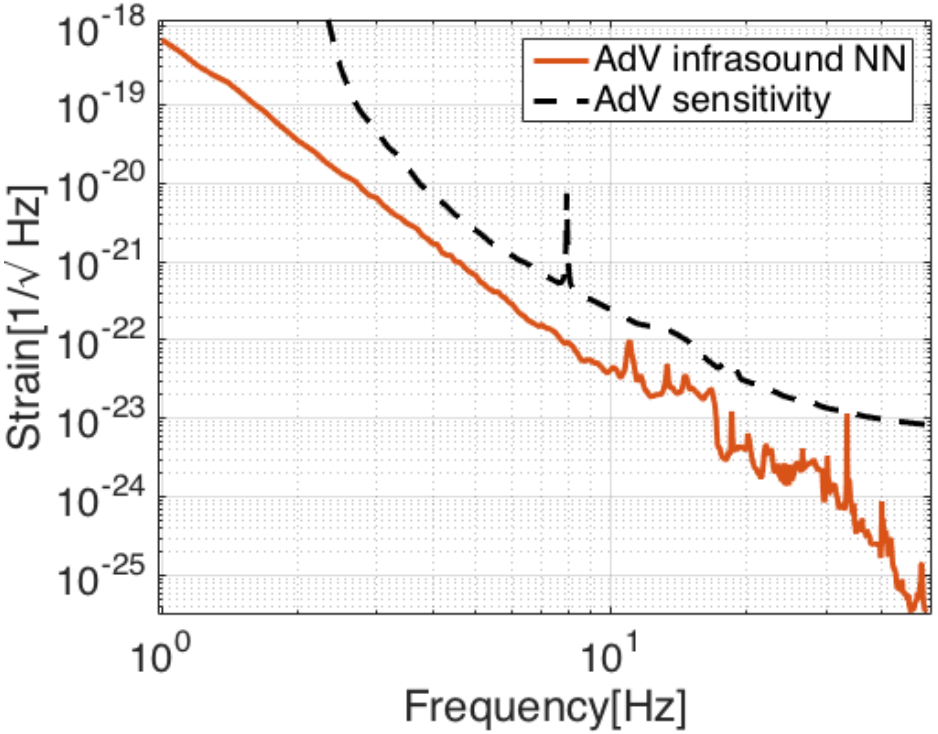


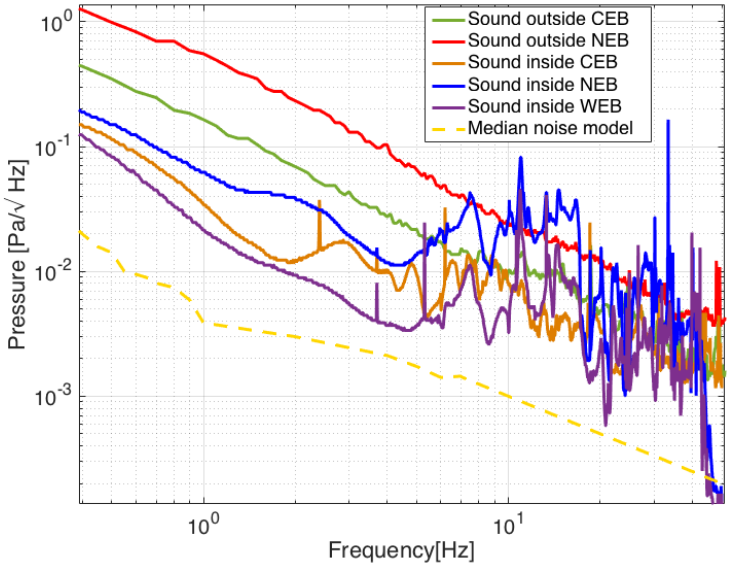


- 10Hz: higher degree of isotropy and good homogeneity; consistent with Rayleigh waves
- 15Hz: clear anisotropy due to tower platform; relatively good homogeneity; consistent with Rayleigh waves
- 20Hz: irregular correlations; correlations too high to be consistent with Rayleigh waves; Body waves? Coupling from poles?

Sound NN Model for Virgo

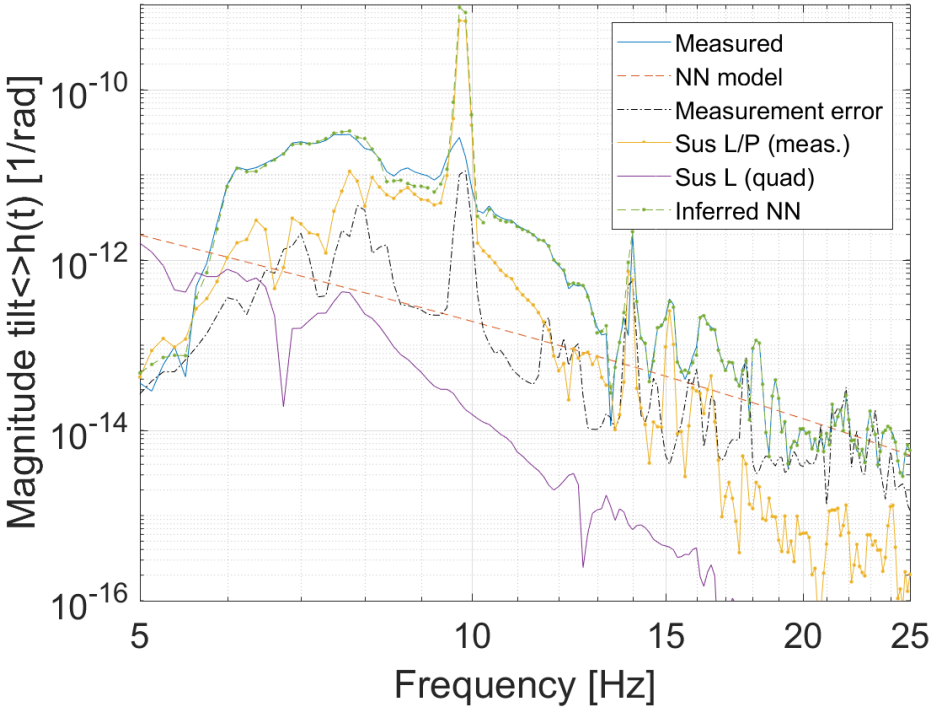
Fiorucci et al, PRD 97, 062003 (2018)





- Sound NN has a spectrum comparable to seismic NN between 10Hz and 30Hz
- Main culprit is 30x higher noise level inside NEB compared to quiet locations (and 10x higher than LIGO)
- Without any proposal for a cancellation system, we are forced to lower sound level

LIGO Measurements

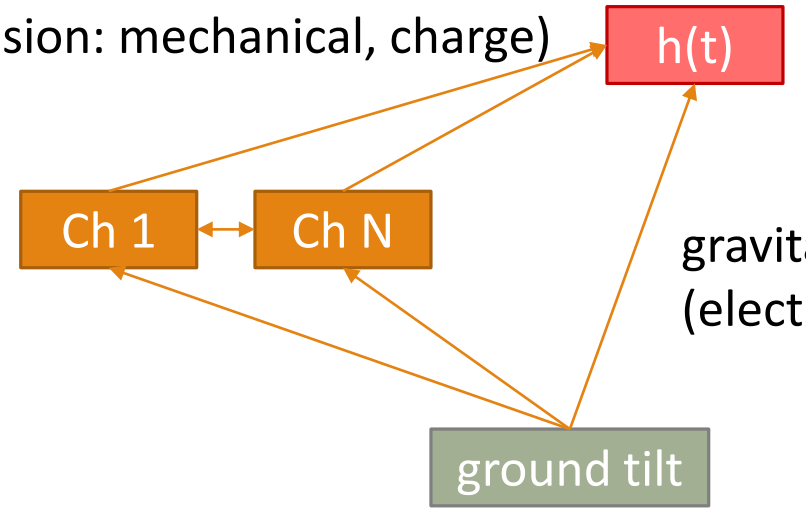


- Measurements based on 40 days of total coincident time with locked LHO interferometer during O2
- Tilt to h(t) coupling consistent with NN model above 13Hz (deviations due to anisotropy)
- No alternative model proposed that could explain this coupling
- All relevant auxiliary channels have been investigated

- Requirement in case of LHO: one month of averaging time to get good measurements up to 20Hz
- Tiltmeter (instead of array) greatly simplified the problem since tilt-to-h(t) coupling is easy to model

Non-Trivial Correlation Analysis

Separate couplings
(suspension: mechanical, charge)



Arrows indicate physical couplings, which is different from a measured transfer function

gravitational
(electrical coupling if ground charged?)

Simple example: N=1; no ground charge

$$NN_{tilt \rightarrow h(t)} = (T_{tilt \rightarrow h(t)} - T_{tilt \rightarrow Ch1}\, T_{Ch1 \rightarrow h(t)})/(1-|\gamma_{tilt \leftrightarrow Ch1}|^2)$$

Planned Work

NEB Preparations

- Modifying the central data unit for (real-time) streaming of data to Virgo server via ethernet
- NEB measurements during final weeks before the start of O3, hopefully with coincidence time with locked interferometer

WEB Analyses

- Deeper analyses of seismic correlations using WEB data
- Testing coherent noise-cancellation methods with WEB data