ET Candidate Sites: Introduction to Seismic and Newtonian Noise Qualification

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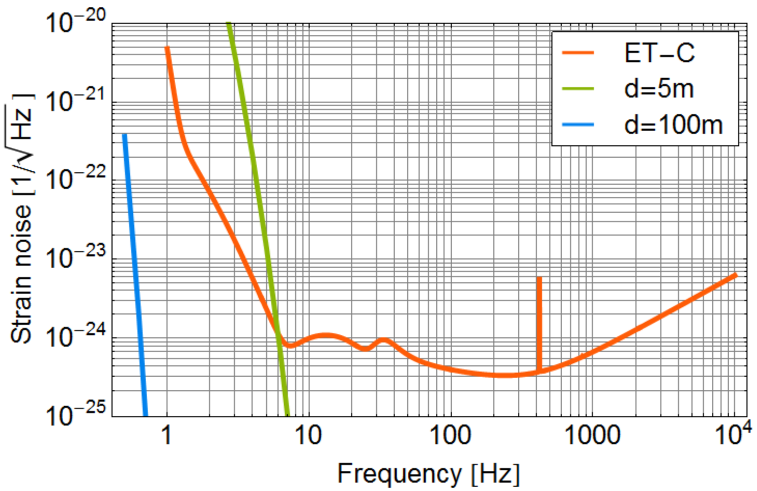
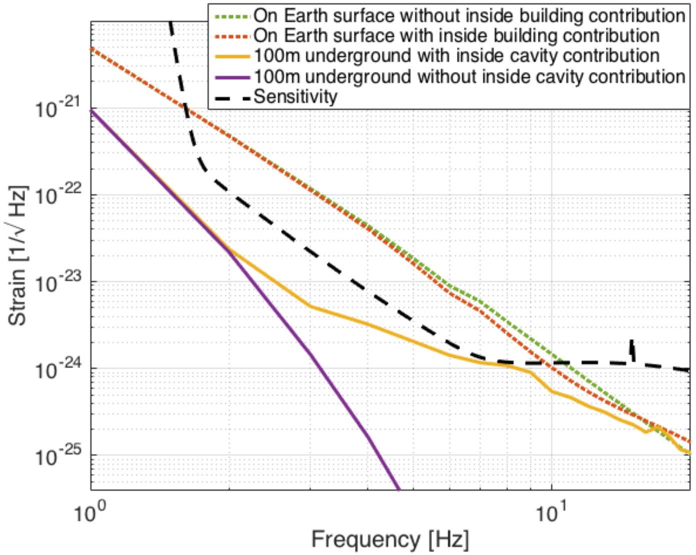
Perugia, 16/02/2019

ATMOSPHERIC NN PREDICTION FOR ET

Temperature NN
Uniform air flow, v=20m/s

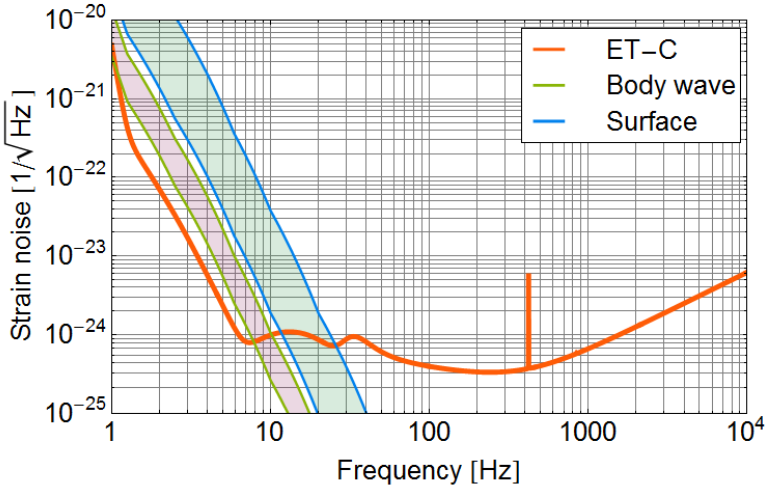


Infrasound NN

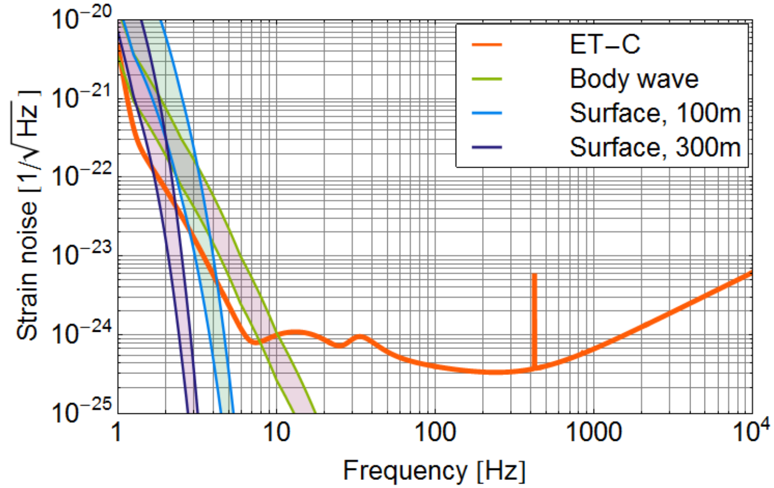


SEISMIC NN PREDICTION FOR ET

Surface Detector



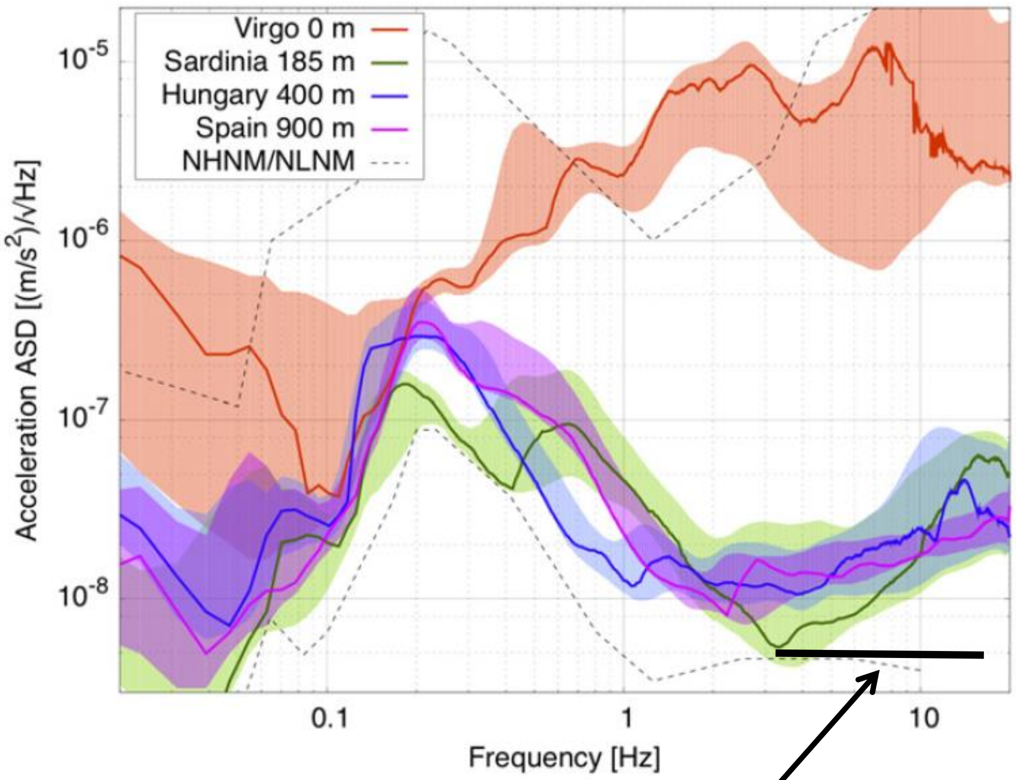
Underground Detector



- Seismic models: Body wave: 3x – 12x LNM, Surface: 50x – 1000x LNM
- Rayleigh dispersion model: 1.5km/s @ 1Hz to 300m/s @ 10Hz

UNDERGROUND SEISMIC SPECTRA

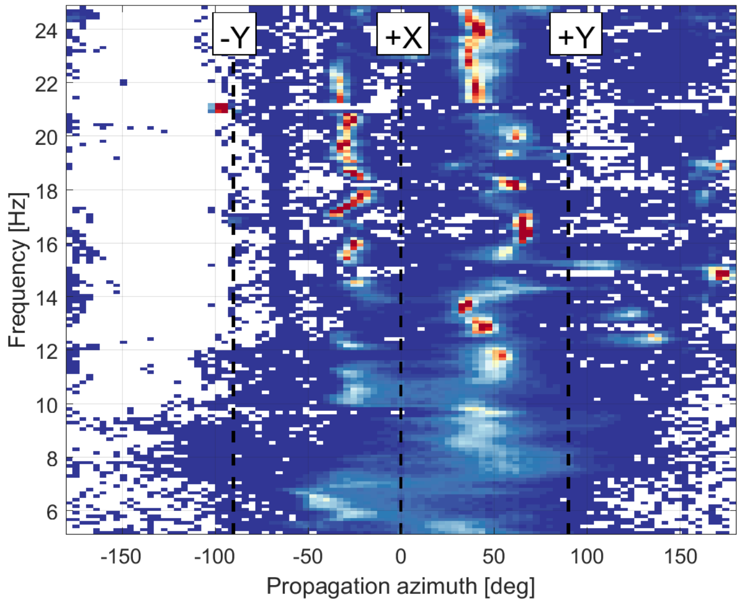
Beker et al, 2012

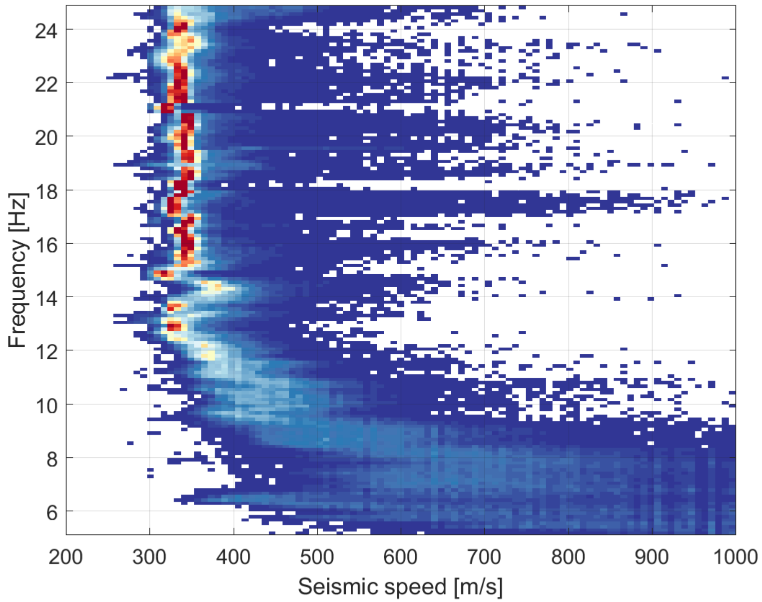


Requirement ET
(conservative: underground displacement dominated by compressional waves)

ANISOTROPY AND DISPERSION AT LIGO HANFORD

These results require arrays with several tens of seismometers



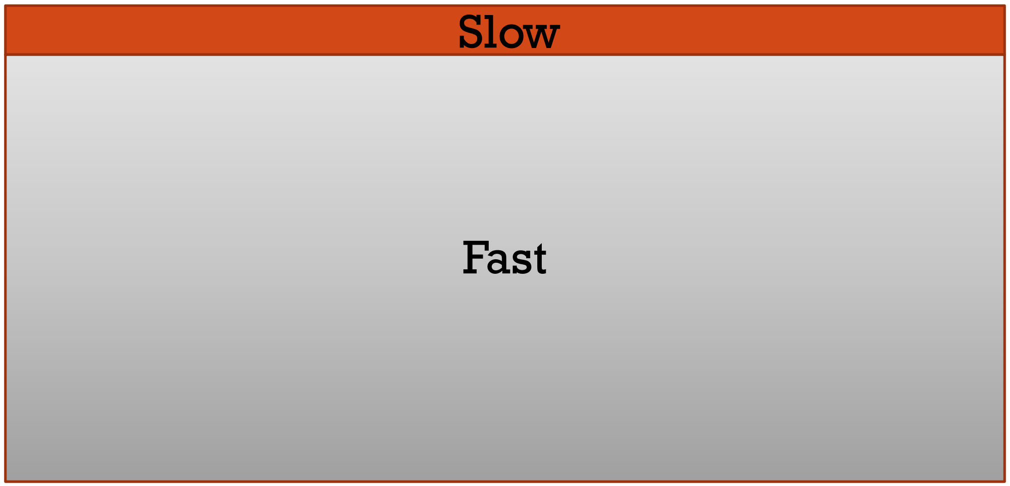


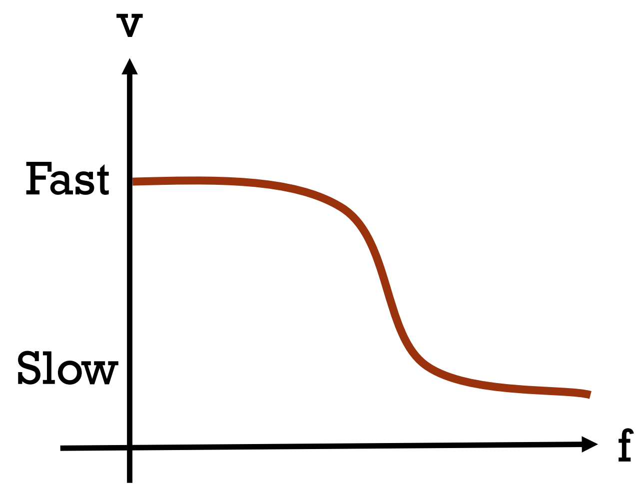
NN EVALUATION

Scenario 1:
Complete data (i.e., underground and surface arrays at each future test-mass location with array diameter of a few 100m and a few tens of sensors), which means model-independent prediction of NN and calculation of optimal arrays for NN cancellation.

Scenario 2:
Incomplete data, which means that NN prediction and design of cancellation system are partially based on models.

STRATIGRAPHY AND NN





- Dispersion curves are required for Rayleigh NN calculations in underground detectors.
- Dispersion curves can be measured with surface arrays (no borehole information needed)
- Seismic waves produced by point-like sources at the surface are trapped in surface layer (point-like means much smaller than thickness of surface layer)

SOURCES OF NN-PRODUCING SEISMIC WAVES

- Traffic
- Buildings
- Machines

- Trees
- Turbulent wind flow
- Sound
- Precipitation
- Rivers

Coupling of some of these sources to ground can be complicated (e.g., piers, foundations, roots, long coherence lengths)

INSTRUMENTATION

Seismic and NN characterization for ET requires high quality sensors

STS2/T240/GS13

Infrasound microphones

THE BARE NECESSITIES

1. Seismic surface measurements over the course of a full year above all future test-mass locations.
2. One (months-long) underground measurement at the foreseen detector depth somewhere at the detector site.

BARE NECESSITIES: MOTIVATION

1. Assumption is that ET will not be deep enough to avoid seismic surface NN
2. There can be significant variation of seismic surface seismicity over 10km distance
3. You cannot predict underground seismicity from surface measurements
4. There is much smaller variation of underground seismicity over (horizontal) distances of 10km

Achieving «within factor 5» NN prediction.

GOOD SITE SURVEY

1. Bare necessities
2. Weeks-long correlation measurement between two seismometers
   a) at foreseen detector depth, separated horizontally
   b) at the surface, above all future test-mass locations
3. Year-long wind and sound measurements above all future test-mass locations

GOOD SURVEY: MOTIVATION

1. If ET less than 300m deep underground, then I would not exclude atmospheric NN to be relevant
2. You need correlation measurements to have some idea about polarization and anisotropy

Achieving «within factor of 3» NN predictions and some idea about array configuration for seismic NN cancellation.

ACTIVITIES IN THE ET COLLABORATION

Site-study teams (Sardinia and 3-border sites)
Carrying out the site studies

Site-evaluation parameters (SEP) team
WG1: Data storage and sharing; code and information sharing
WG2: Practical guide for setting up environmental observations
WG3: Geology and infrastructure
WG4: Site-data analysis; ET noise modeling

GOALS OF SEP TEAM

1. Make sure that data analyses and ET noise modeling are done in the same way by both site-study teams (implying that you agree on NN models)
2. Avoid missing any important evaluation parameters or site data
3. Avoid recording low-quality site data
4. Facilitate an open exchange of data and information between site teams, and with the ET collaboration and the public