H/V spectral ratios at the InSight landing site using ambient noise and Marsquake records

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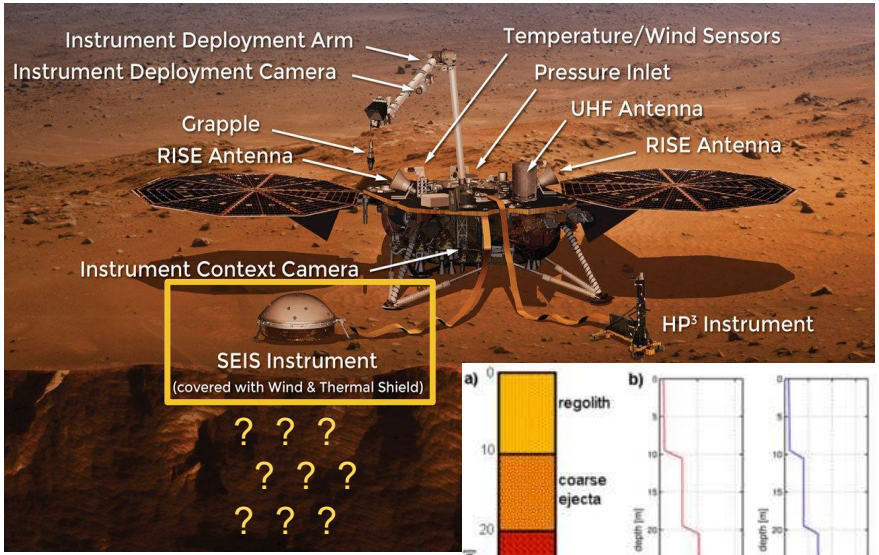
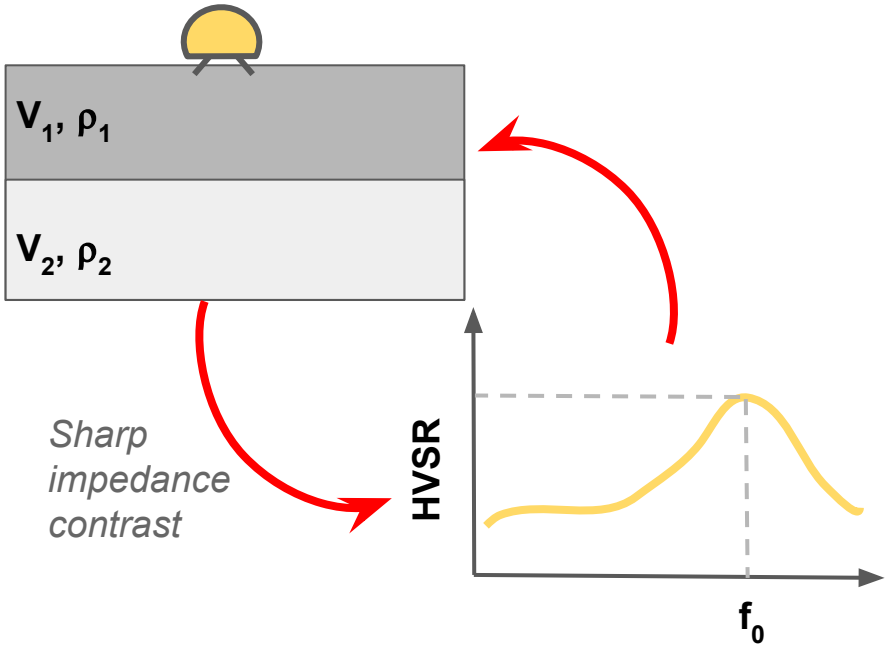
Motivation and H/V spectral ratios

What do we have beneath InSight?



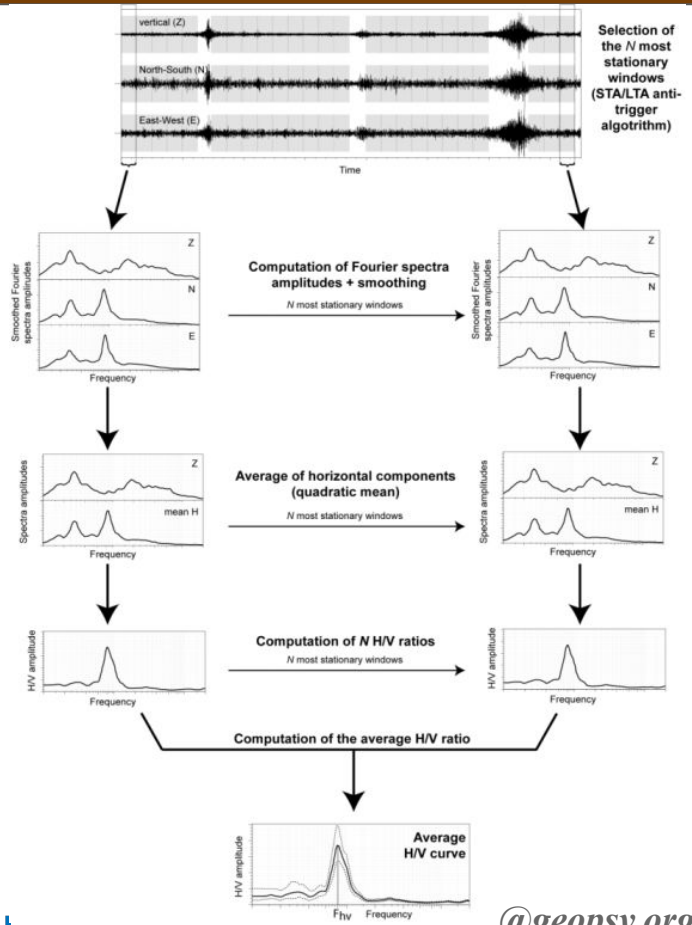
Proposed pre-landing model based on orbital images, lab experiments and numerical modeling (Knapmeyer-Endrun et al., 2017)

The H/V spectral ratios (HVSR): a consolidated tool for imaging the subsurface structure.



f_0 *is the characteristic resonant frequency of the shallow subsurface structure.*

Methods and data



- Classical Fourier spectra approach focused in the range 1-20 Hz.
- Similar procedure applied to the **seismic noise** and the **seismic events** recorded by SEIS with the *Very Broadband (VBB)* and *Short Period (SP)* seismometers.
- The preferred HVSR curve will be inverted using the Neighbourhood Algorithm (NA), assuming fundamental mode of the Rayleigh wave.
- Forward modeling using the full Diffuse Field Approach (DFA) to evaluate whether the features can be related to body, surface waves or the full wavefield.

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Data: the seismic events (a.k.a. Marsquakes)

Higher Frequency excitation

	A	B	C	D	Total
Low Frequency (LF)	2	7	12	13	**34**
Broadband (BB)	1	4	9	2	**16**
2.4 Hz	0	38	141	183	**362**
High Frequency (HF)	0	33	18	6	**57**
Very High Freq (VF)	0	14	17	6	**37**
Total	**3**	**96**	**197**	**210**	**506**

Q A, B → **99 events**

Q A, B, C → **296 events**

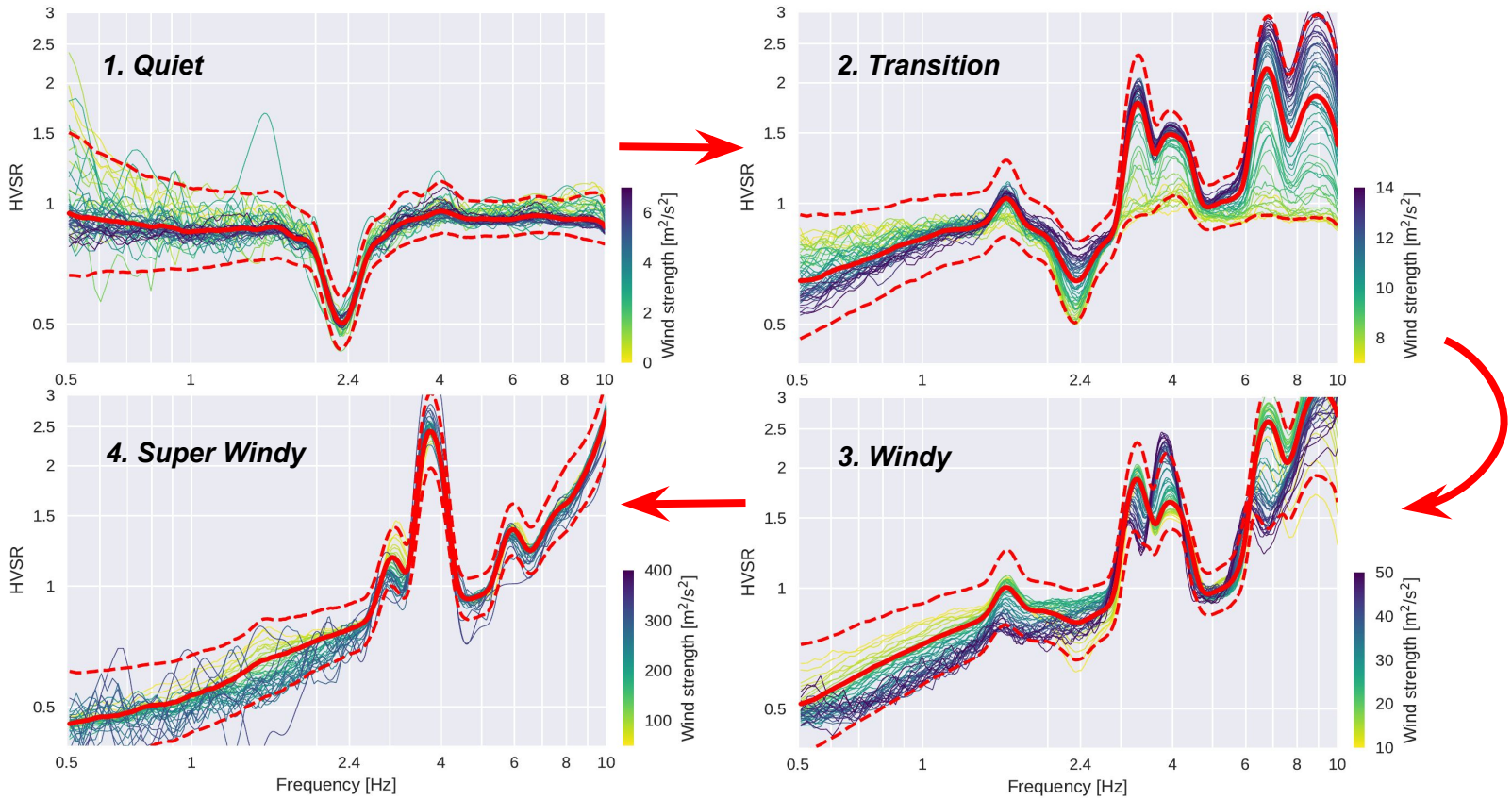
* Catalogue obtained on March 16th, 2021

HVSR from noise: the wind effect

VBB@20sps

50 s window

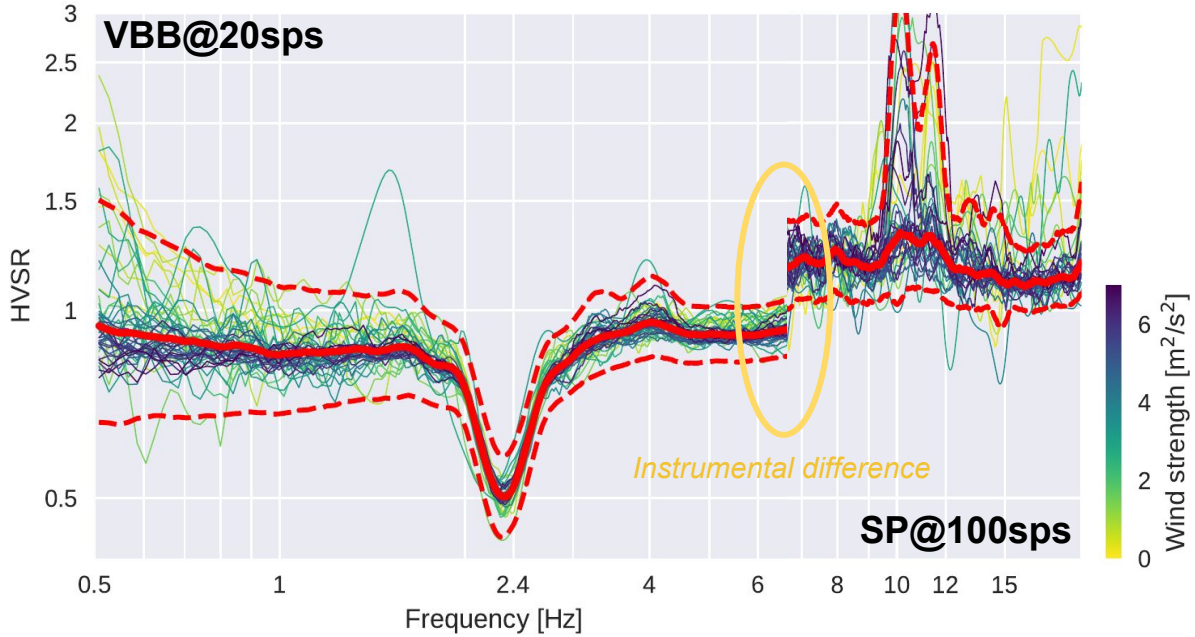
Different wind levels



HVSR from noise

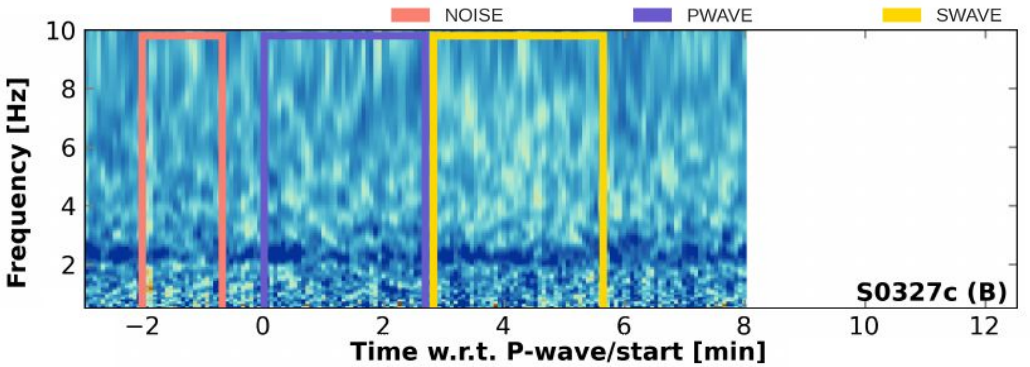
Only one trough at 2.4 Hz is observed.

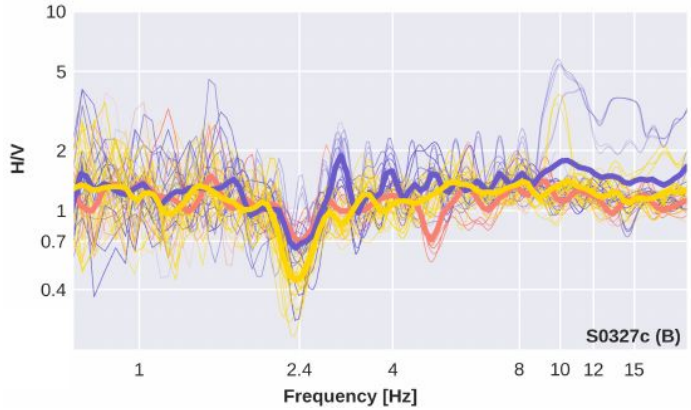
Slight peak at ~11 Hz related to instrument.



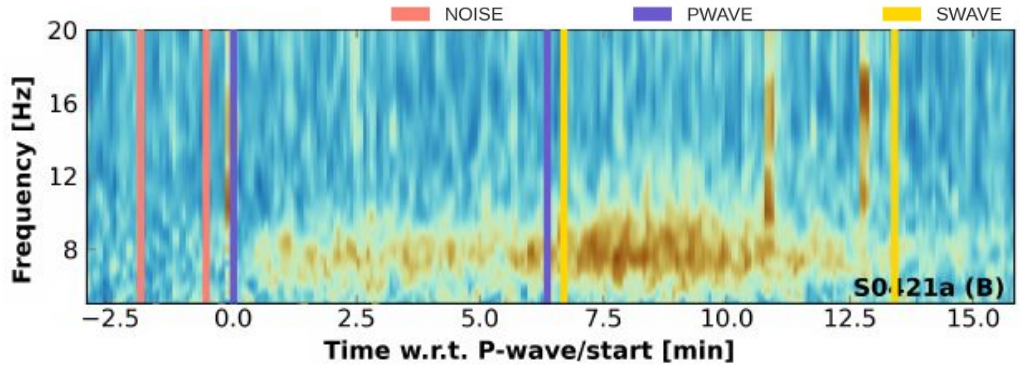
HVSR from events

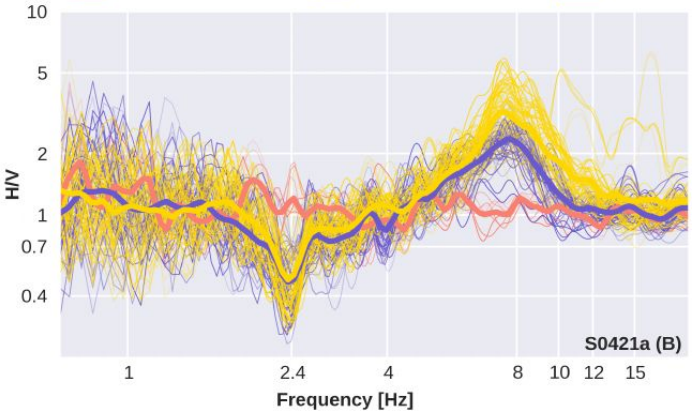
HF event





VF event

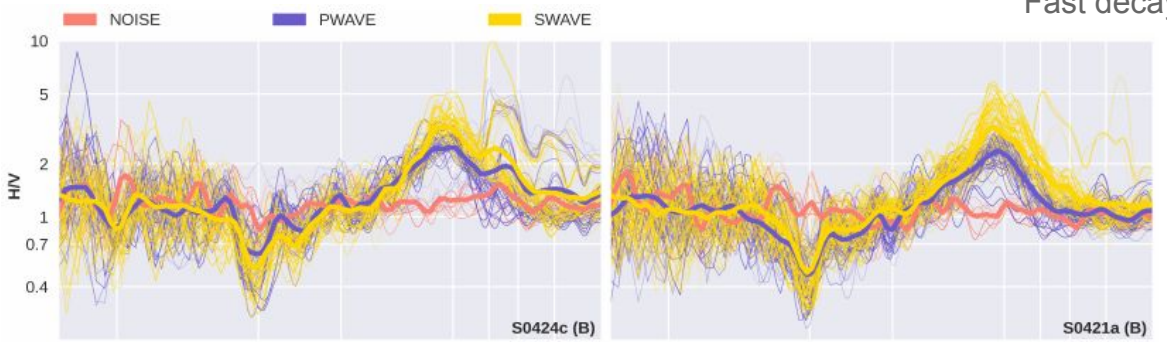




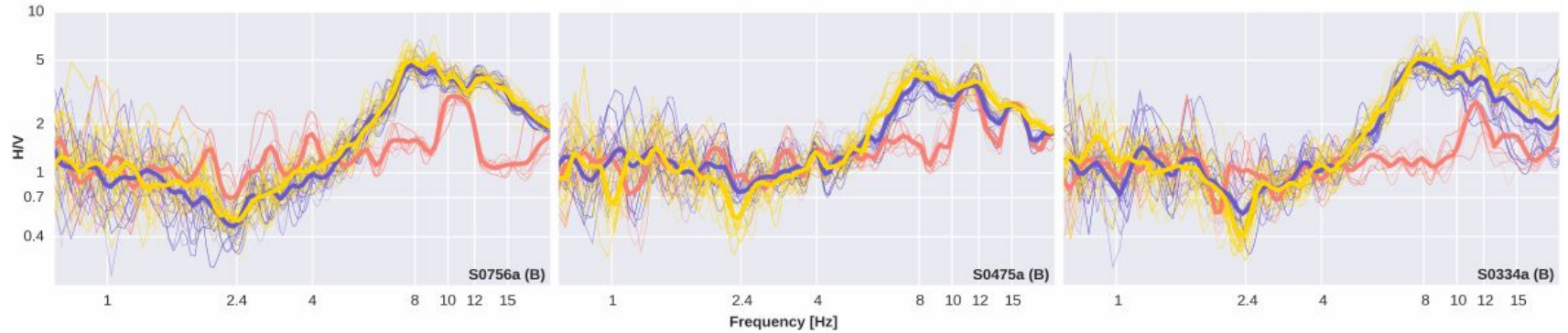
HVSR from events

Right flank decay during VF events

No previous excitation of instrument resonance,
Fast decay



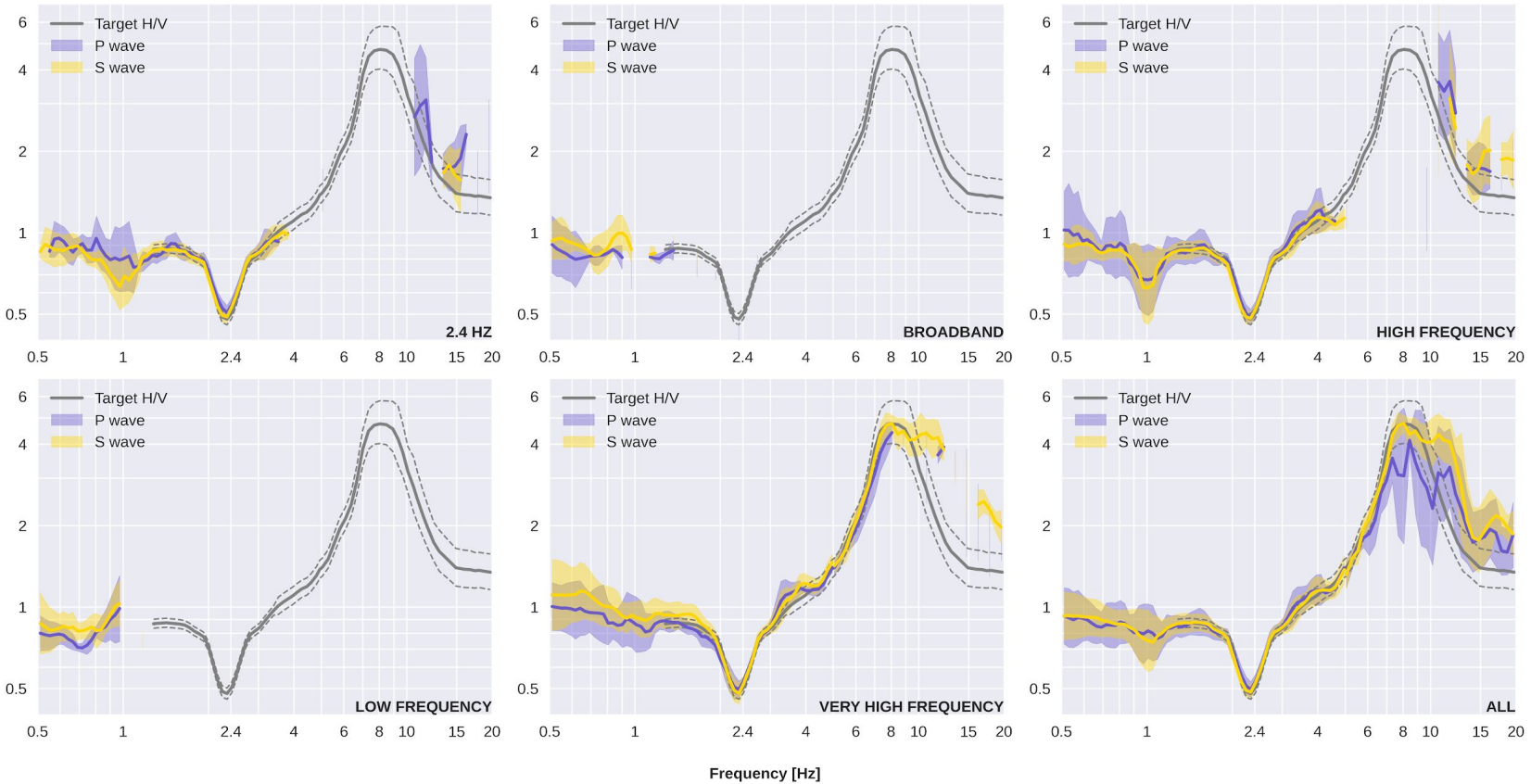
Previous excitation of instrument resonance,
Slow decay



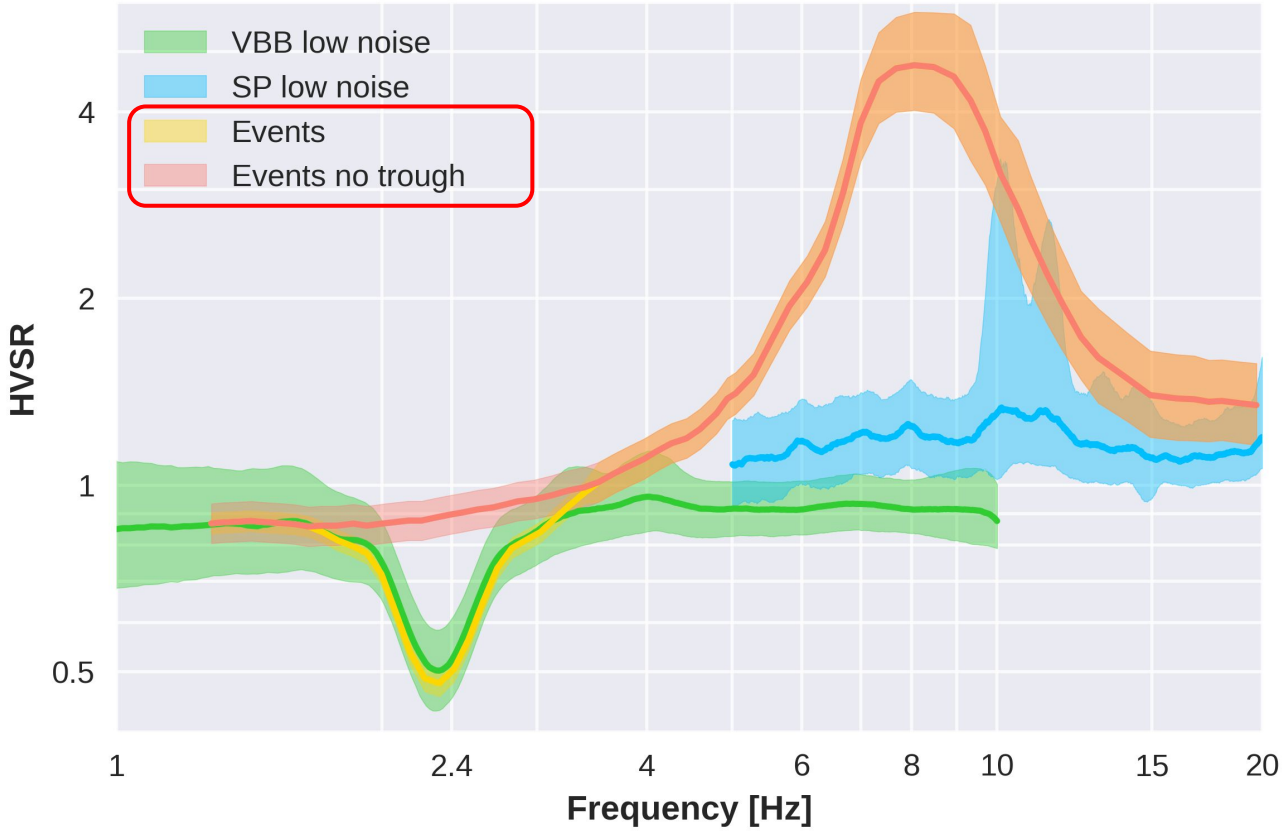
HVSR from events

Q A, B events

SNR_V > 5 dB

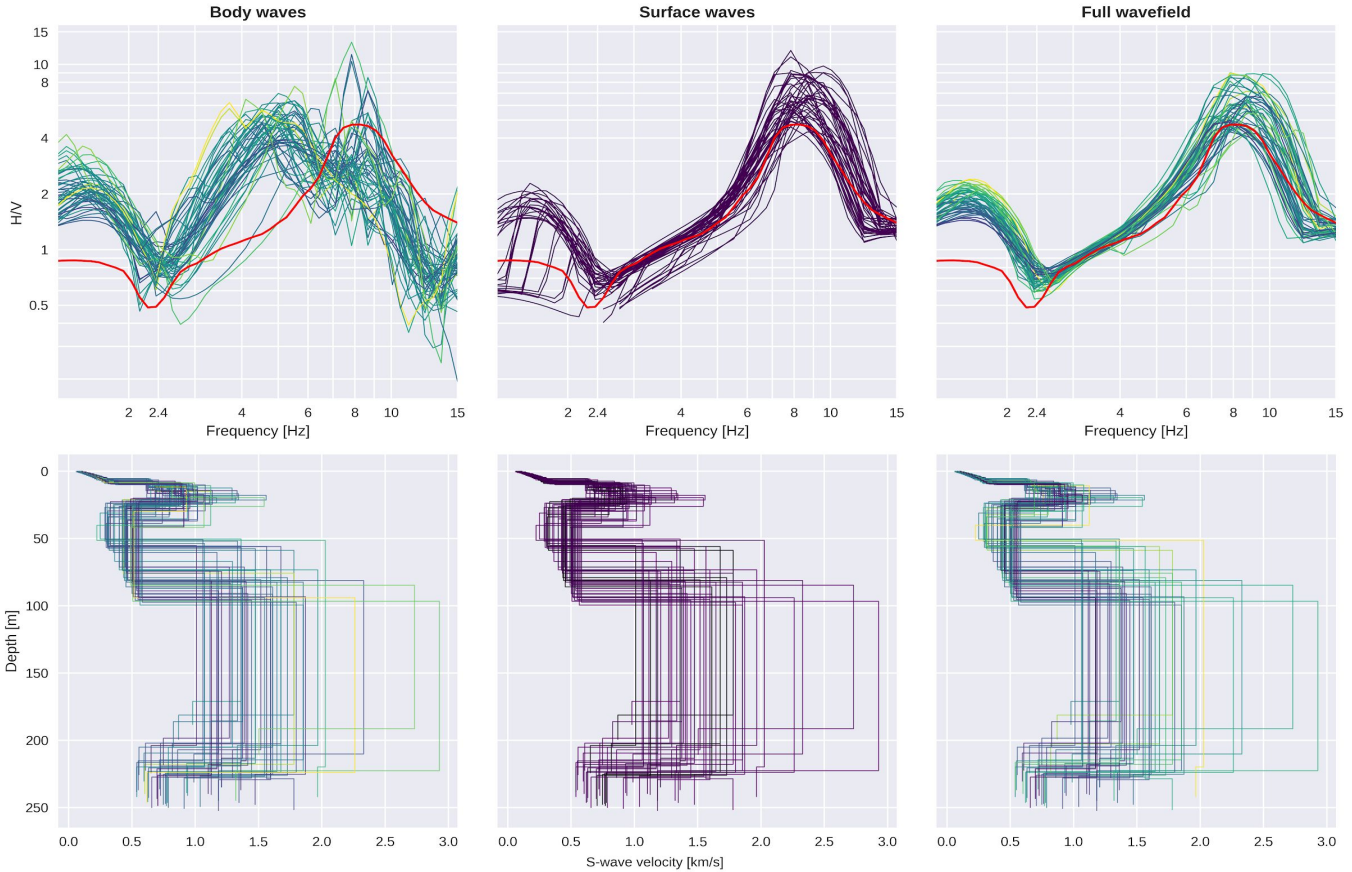


HVSR: seismic noise vs events



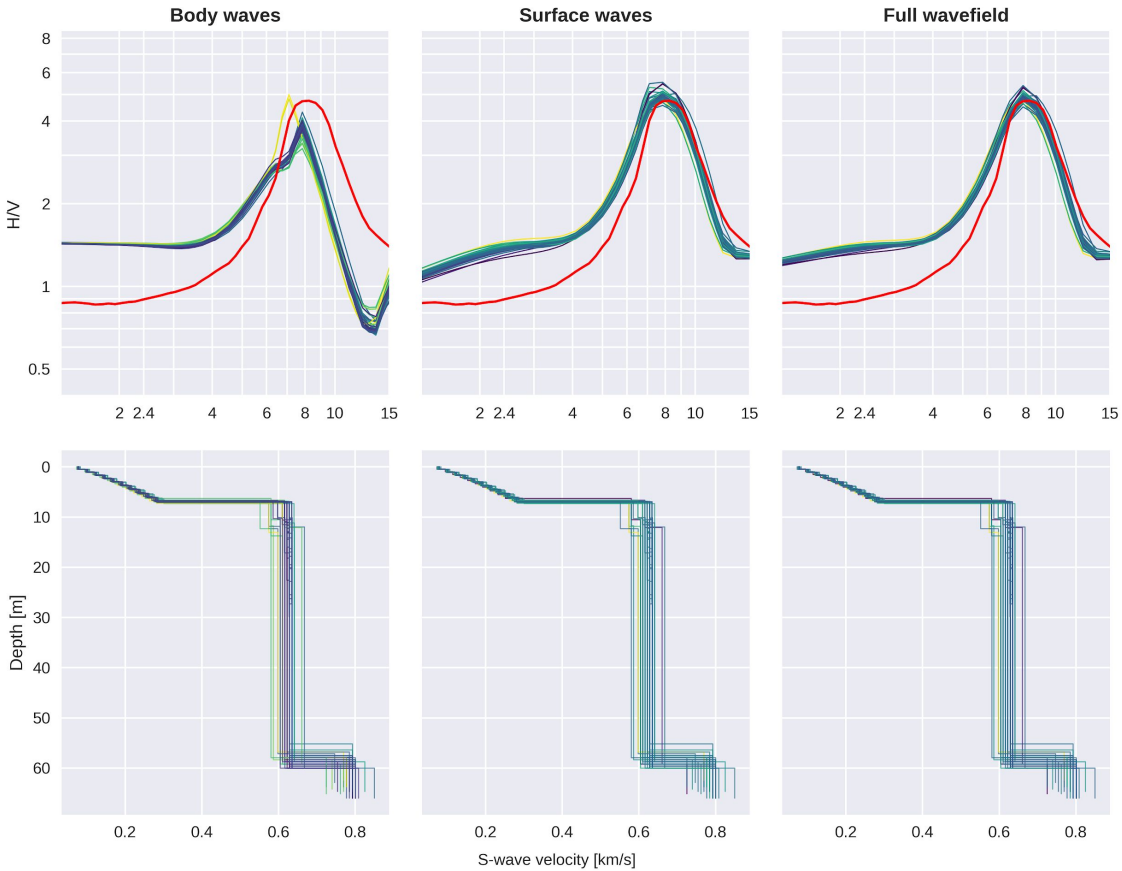
Inversions

- 2.4 Hz trough and 8 Hz peak **<u>are both</u>** related to the subsurface structure.
- Very shallow subsurface is constrained by results from HP3 experiment and ground compliance.
- Based on parameterization studied by Schmelzbach et al. (2021), allowing an intermediate Low Velocity Layer (LVL).



Inversions

- 2.4 Hz trough **is not** but 8 Hz peak **is** related to the subsurface structure.
- Simple parametrization (3 layers over a halfspace).
- Single peak around 8 Hz from shallow discontinuity.



Summary

1. The H/V spectral ratios (HVSR) from the seismic noise are different from the seismic events.

2. A strong peak at 8 Hz in the HVSR curve is observed from the events only. It is mainly related to the Very High Frequency events as they contain enough energy in this frequency band.

3. We propose the 8 Hz resonance is related to the discontinuity between the regolith and the coarse ejecta layer.

4. This peak is not excited by the environmental seismic noise because there is no enough seismic energy in this frequency range but it is rather excited by VF events.

Still open questions

1. Is there any azimuthal/2D effects? (No azimuths available for VF events).
2. Which is the right mechanism to explain the VF events? Similar to SOFAR channel and T-phases?