Ambient signals as a tool to characterize material properties

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SPIN
MONITORING A RESTLESS EARTH

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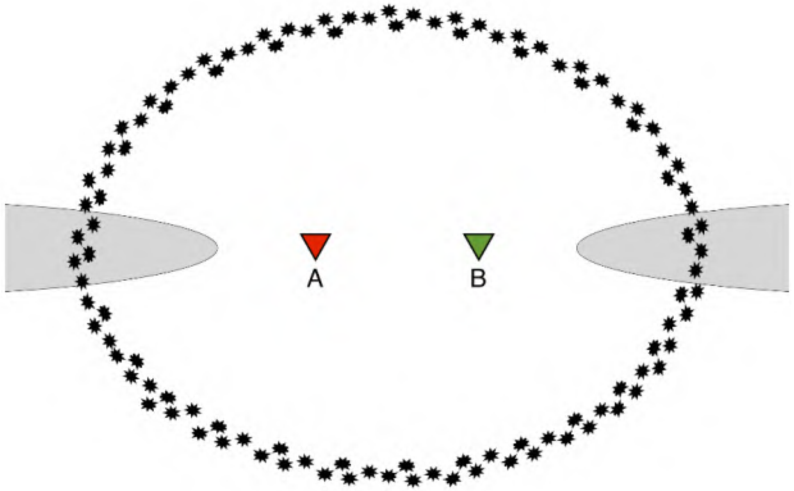
➔ Passive Seismic Interferometry:

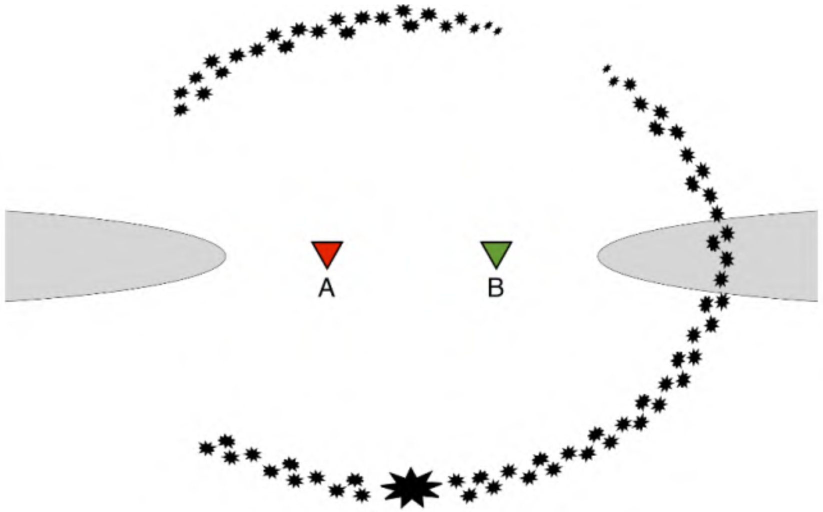
- Cross-correlation of signals from two receivers in a diffuse wavefield = Green functions of two stations

➔ Main assumption underlying PSI:

➔ Uncorrelated sources
➔ Equitation of the energy
➔ Uniform noise source distribution



➔ In the real world condition:
➔ Velocity is not uniform
➔ Sources are not isotropically distributed
➔ Modal energy is not equipartitioned



Motivation : Reducing effects of noise source distribution on ambient noise correlations

➔ Ambient seismic noise cross-correlations are now being used to detect temporal variations of seismic velocity

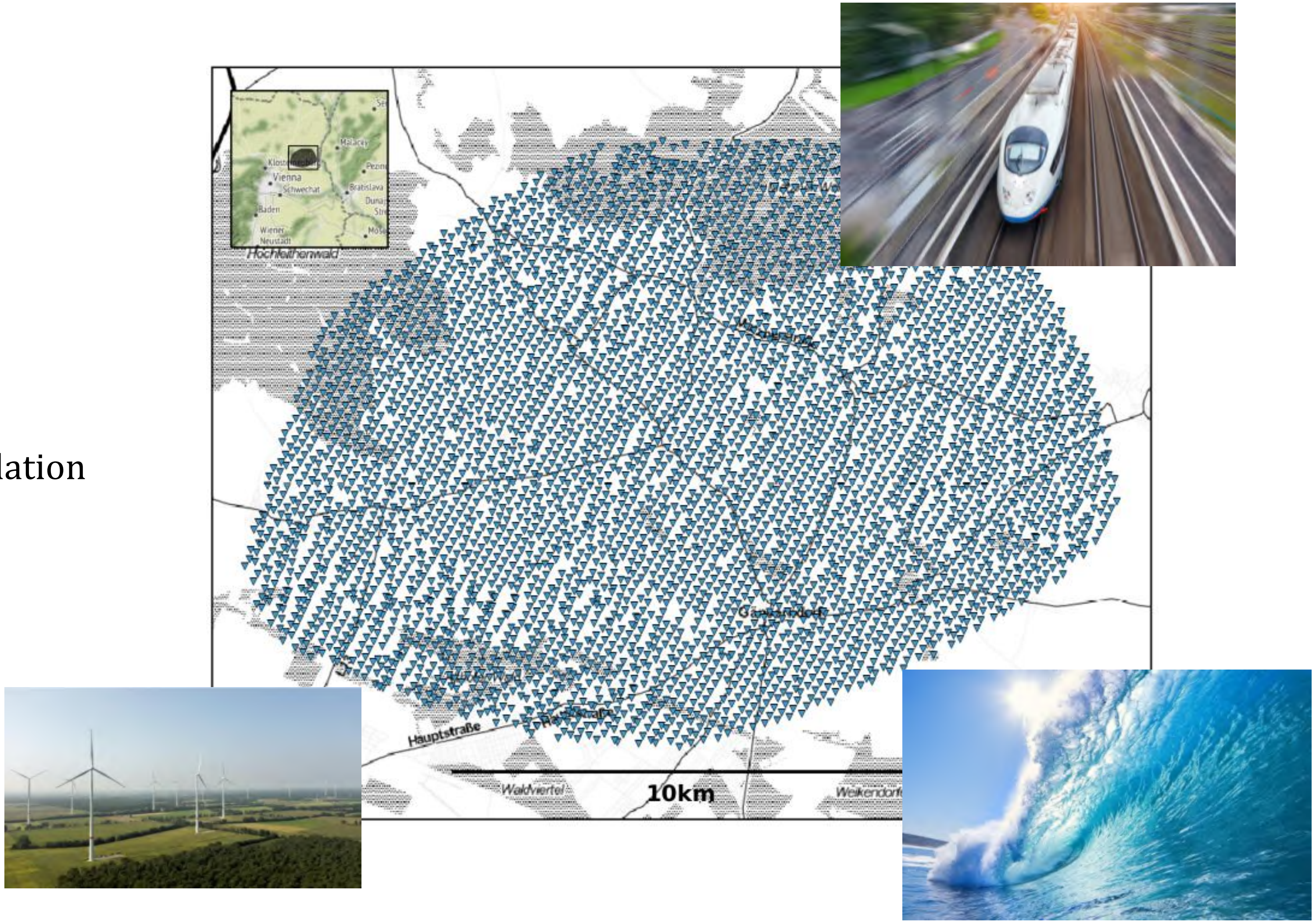
➔ Temporal variations in the properties of noise sources can cause apparent velocity changes

➔ Seasonal variation of spatial distribution and frequency content

Investigation of the effects of noise sources in cross-correlation signals

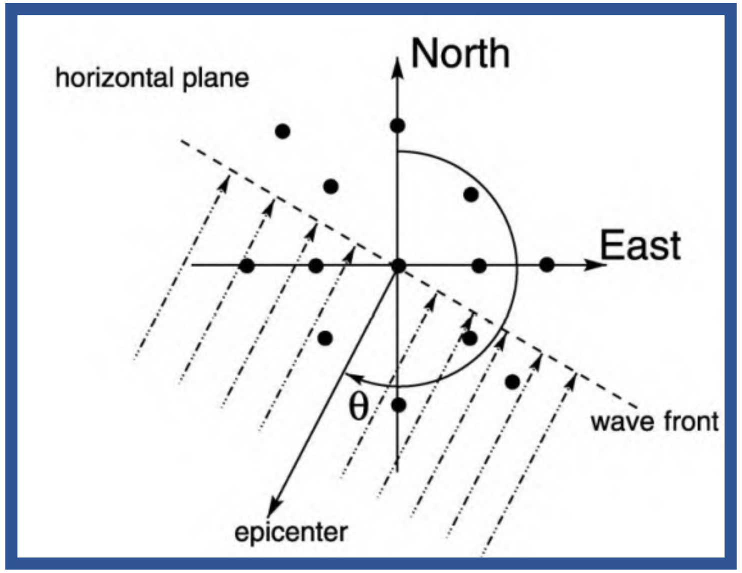
Data: Large N-array in the Vienna basin

- ➔ Extremely closely spaced (4907 stations)
- ➔ 10Hz geophones
- ➔ 80 TB of data
- ➔ On top of „Matzen“ oil & gas field
- ➔ Effects of different type of sources on Noise correlation function



Method: Beamforming

➔ First step: we are locating the different type of the noise sources in area

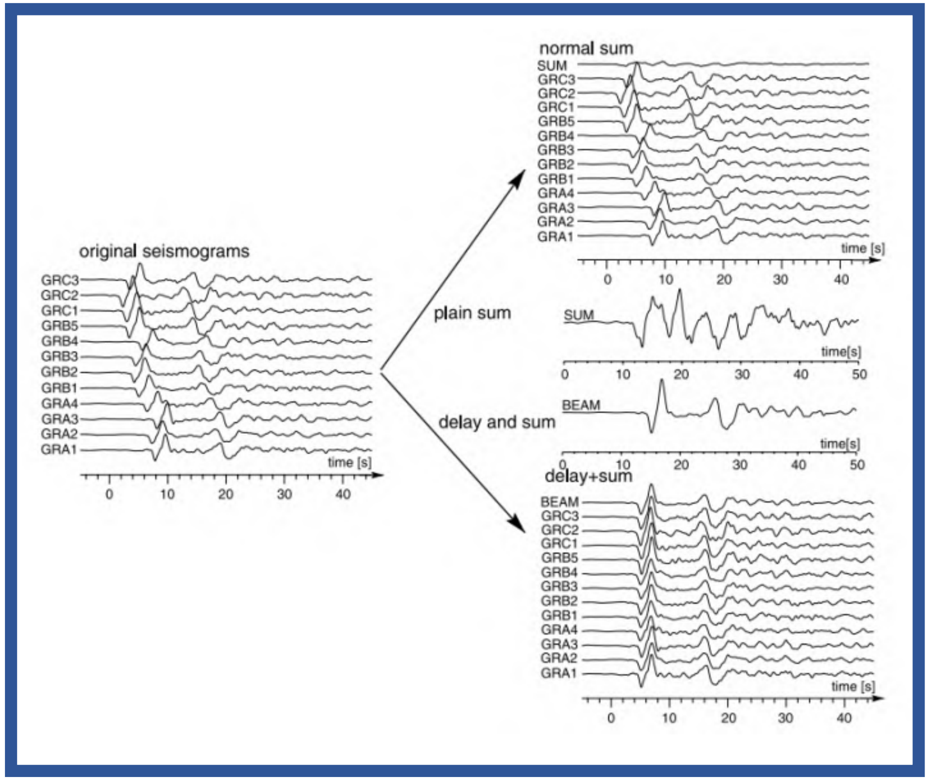


Rost &Thomas (2002)

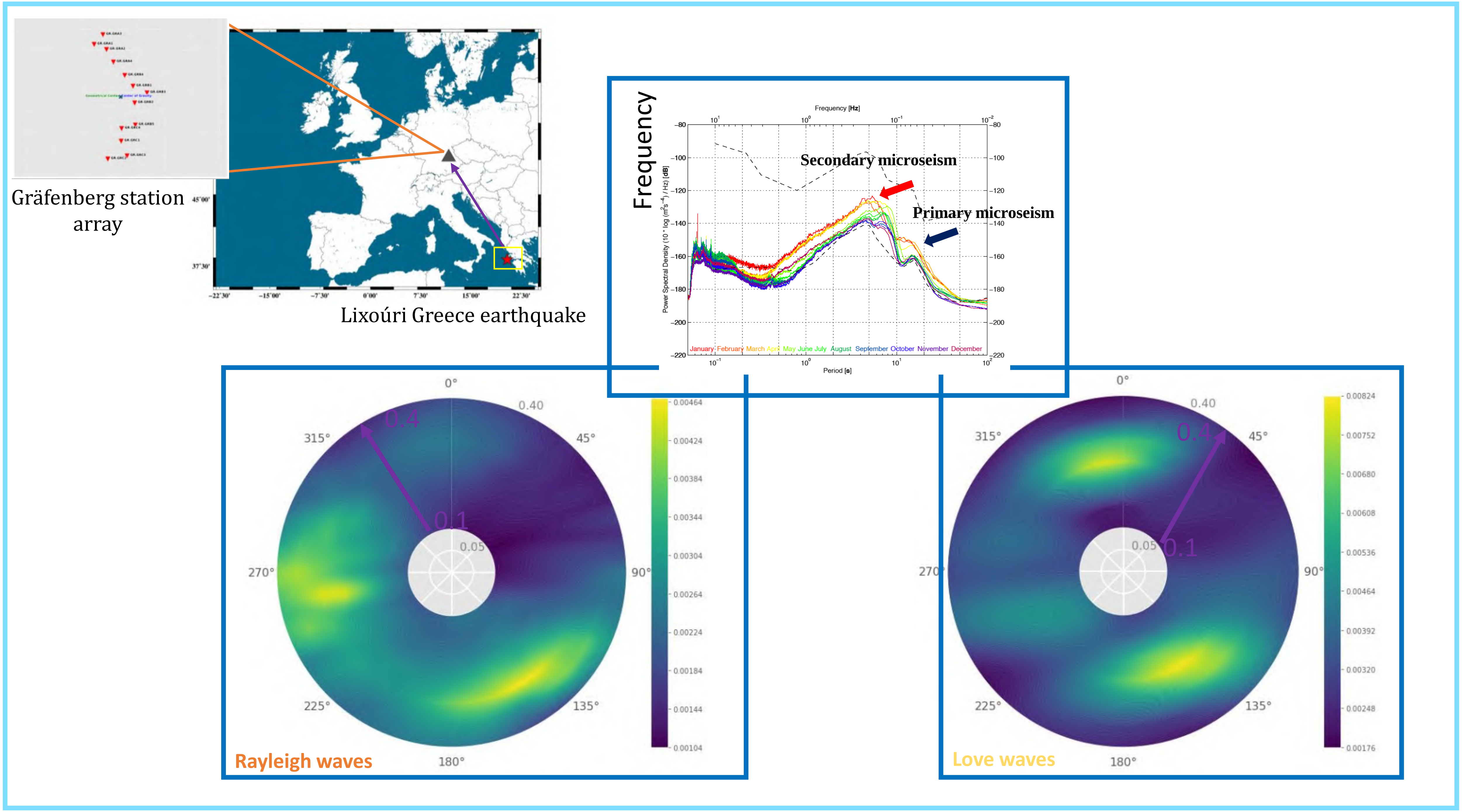
➔Differential travel times of the plane wave

➔ Specific slowness and back azimuth

Rost &Thomas (2002)



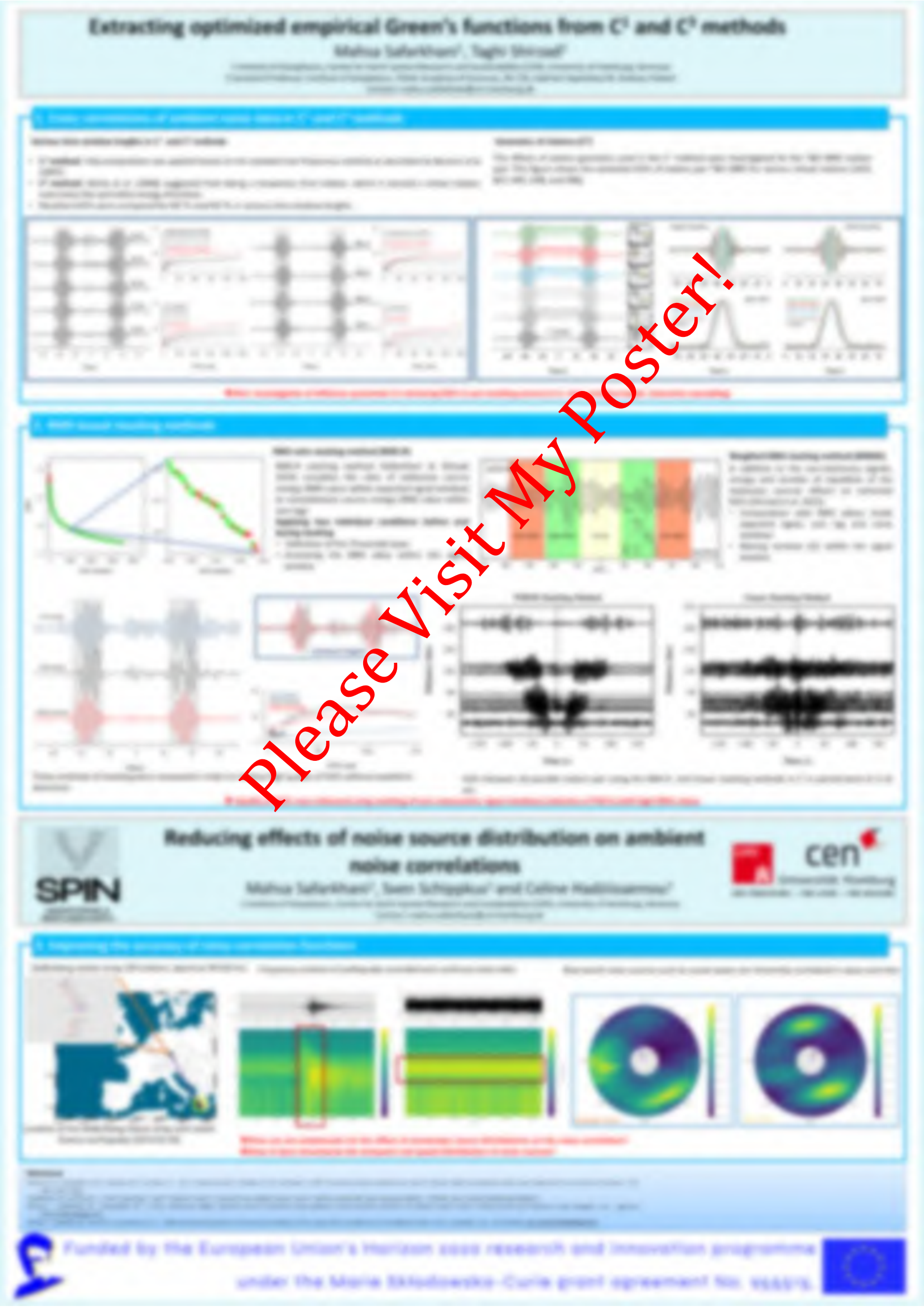
➔ All signals with the matching back azimuth and slowness will sum constructively



Gräfenberg station array
Lixoúri Greece earthquake
45°00'
37°30'
−22°30'
−15°00'
−7°30'
0°00'
7°30'
15°00'
22°30'
Frequency
Frequency [Hz]
Period [s]
Power Spectral Density (10 * log (m²s⁻⁴) / Hz) [dB]
Secondary microseism
Primary microseism
January February March April May June July August September October November December
Rayleigh waves
Love waves
0°
45°
90°
135°
180°
225°
270°
315°
0.40
0.05
0.4
0.1
0.00464
0.00424
0.00384
0.00344
0.00304
0.00264
0.00224
0.00184
0.00144
0.00104
0.00824
0.00752
0.00680
0.00608
0.00536
0.00464
0.00392
0.00320
0.00248
0.00176

Conclusion and further wok:

- Better understanding of spatiotemporal noise source properties is critical for more accurate and reliable passive monitoring.
- How we can compensate for the effect of such coherent noise sources in our ambient seismic noise field?
- Understanding of noise generation mechanisms
- Correct adverse effects (stretching method)



References:

Rost, S., and Thomas, C. (2002). Array Seismology: Methods and applications. Rev. Geophys., 40, (3), 1008, doi: 10.1029/2000RG000100