

Sosenattos infrasound data analysis

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The infrasound installation in Sardinia

- characterization of the infrasound field in the mine, a place similar to the destination site for the telescope
- multipoint infrasound measurements
- infrasound are one of the components of the Newtonian noise
- more than 3 months of data (since 21st November 2022)
- data stored at etrepo.df.unipi.it and info. also on wiki.et-gw.eu

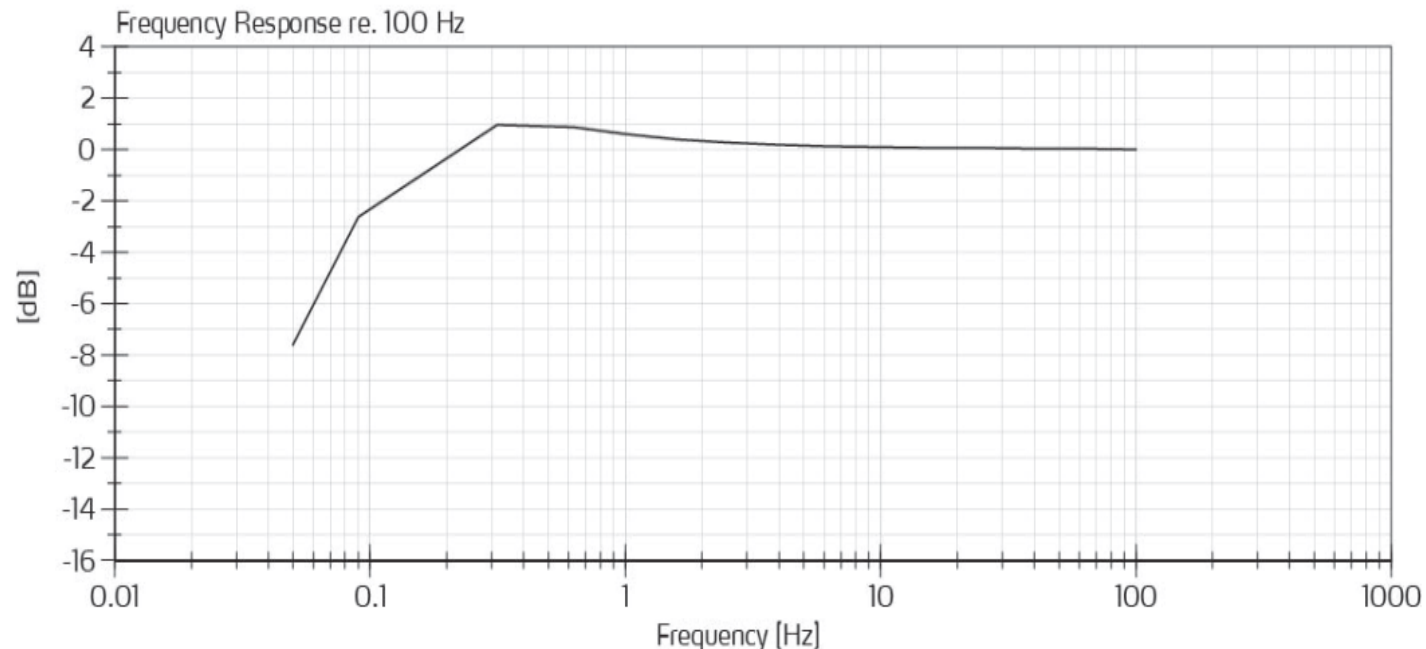
Two types of infrasound sensors (infrasound microphones):

- GRAS 47AC 1/2"
- Astrocent microphones

GRAS 47AC 1/2" CCP Infra-Sound Microphone Set

Condenser microphone set for infra-sound measurements in open acoustic fields

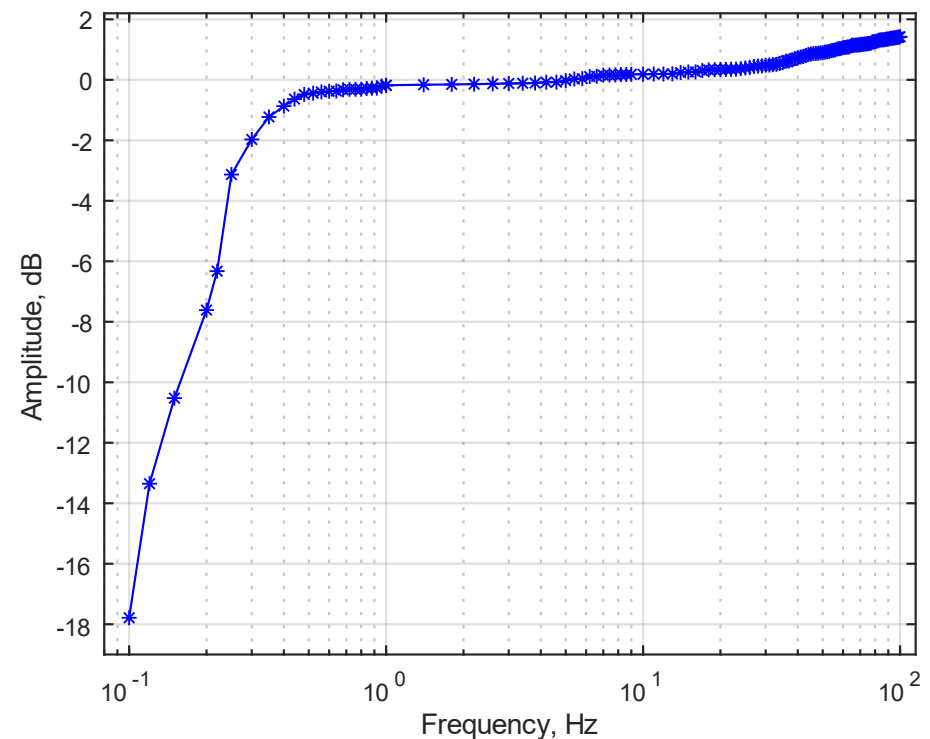
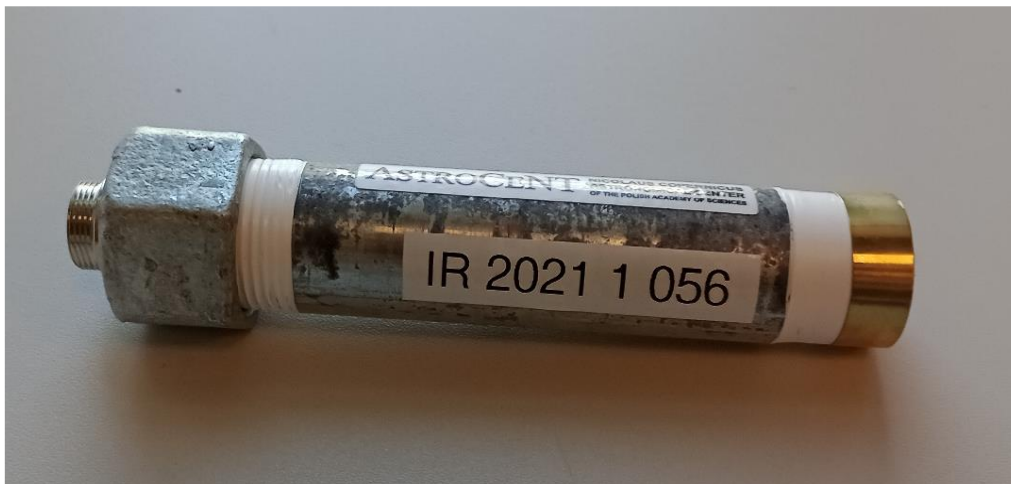
- frequency range: **0.09 Hz** to 10 kHz
- dynamic range: 20 dB(A) to 148 dB
- sensitivity: **8 mV/Pa**



<https://www.grasacoustics.com/products/special-microphone/infra-sound-microphones/product/712-47ac>

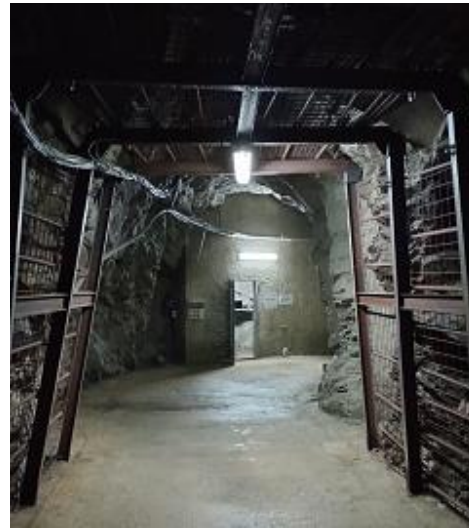
Infrasound microphones - Astrocent

- developed by the Astrocent team
- low-cost infrasound microphone ~100 EU
- frequency range from **0.1 Hz** to 120 Hz (AC47 Gras from 0.09 Hz to 20 kHz)
- sensitivity: **2.5 mV/Pa**
- distortion max. 1.5 dB



Sos Enattos mine

The mine consists of tunnels with caverns



Caverns:



ST0 - Surface Station

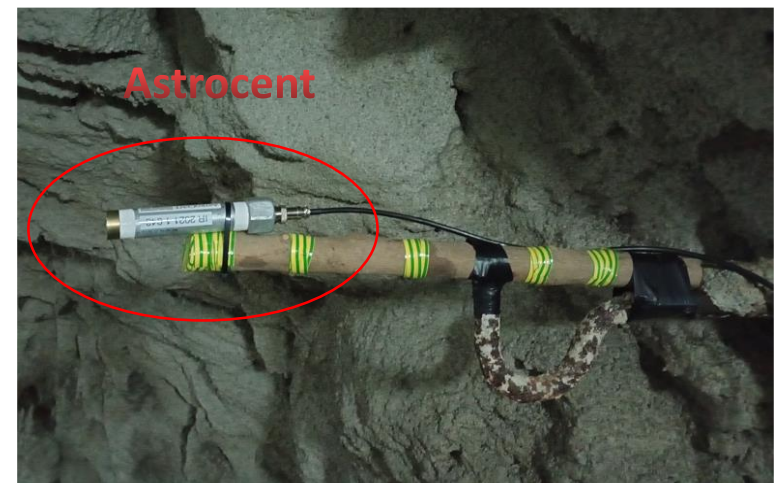
- power supply from solar panels
- 1x GRAS 47AC 1/2", 1x microphone developed by Astrocent
- data synchronized by GPS, 1 pps signal (1 Hz)



Stations

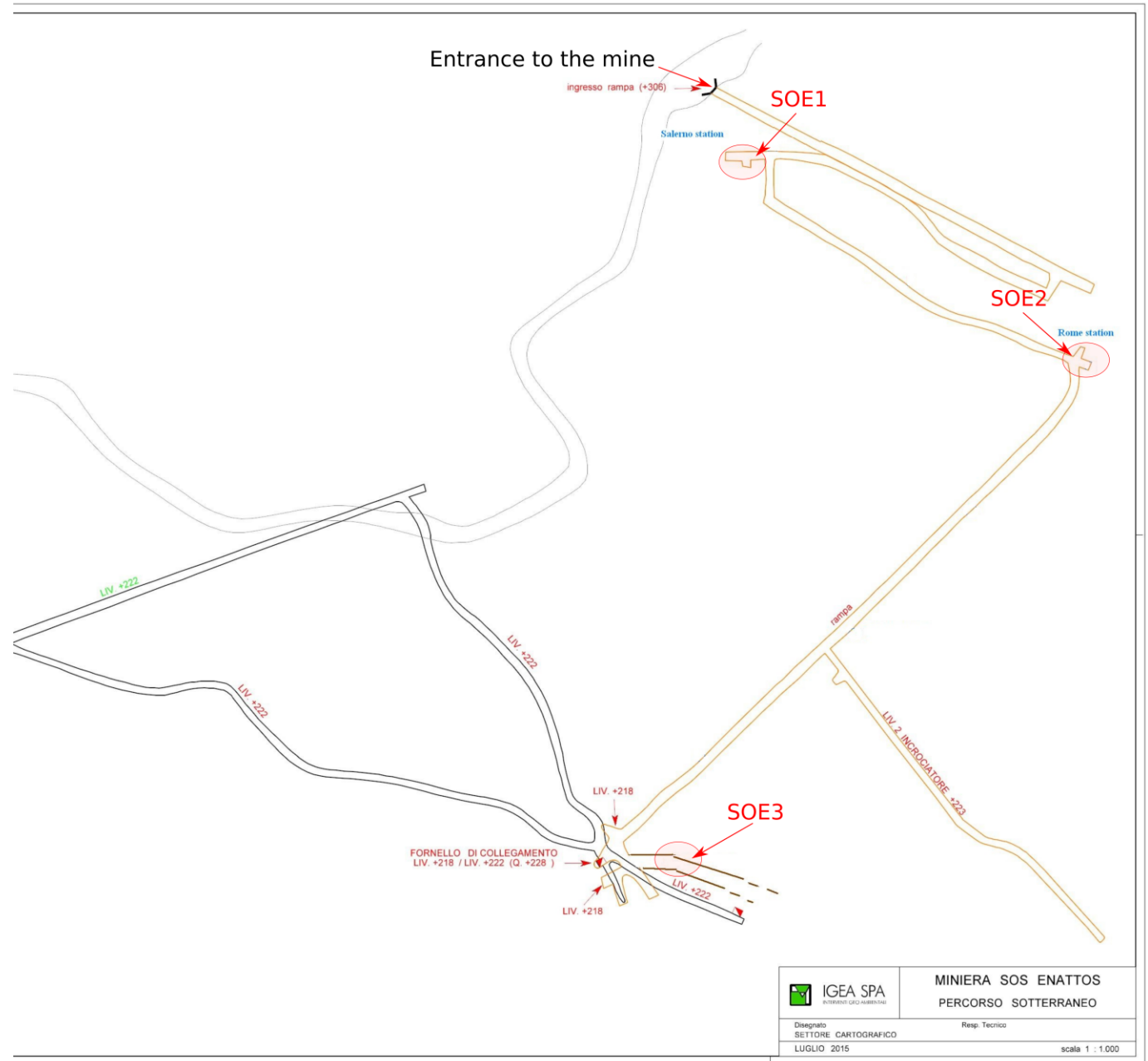
ST1, ST3 - in every station 3x infrasound microphones

- data synchronized by NTP server via Internet
- 1x Gras + 1x Astrocent microphone (inside the cavern)
- 1x Astrocent (outside the cavern)



Sardinia - Sos Enattos Mine

SOE1-3



Sardinia - Sos Enattos Mine SOE3

Inside the cavity

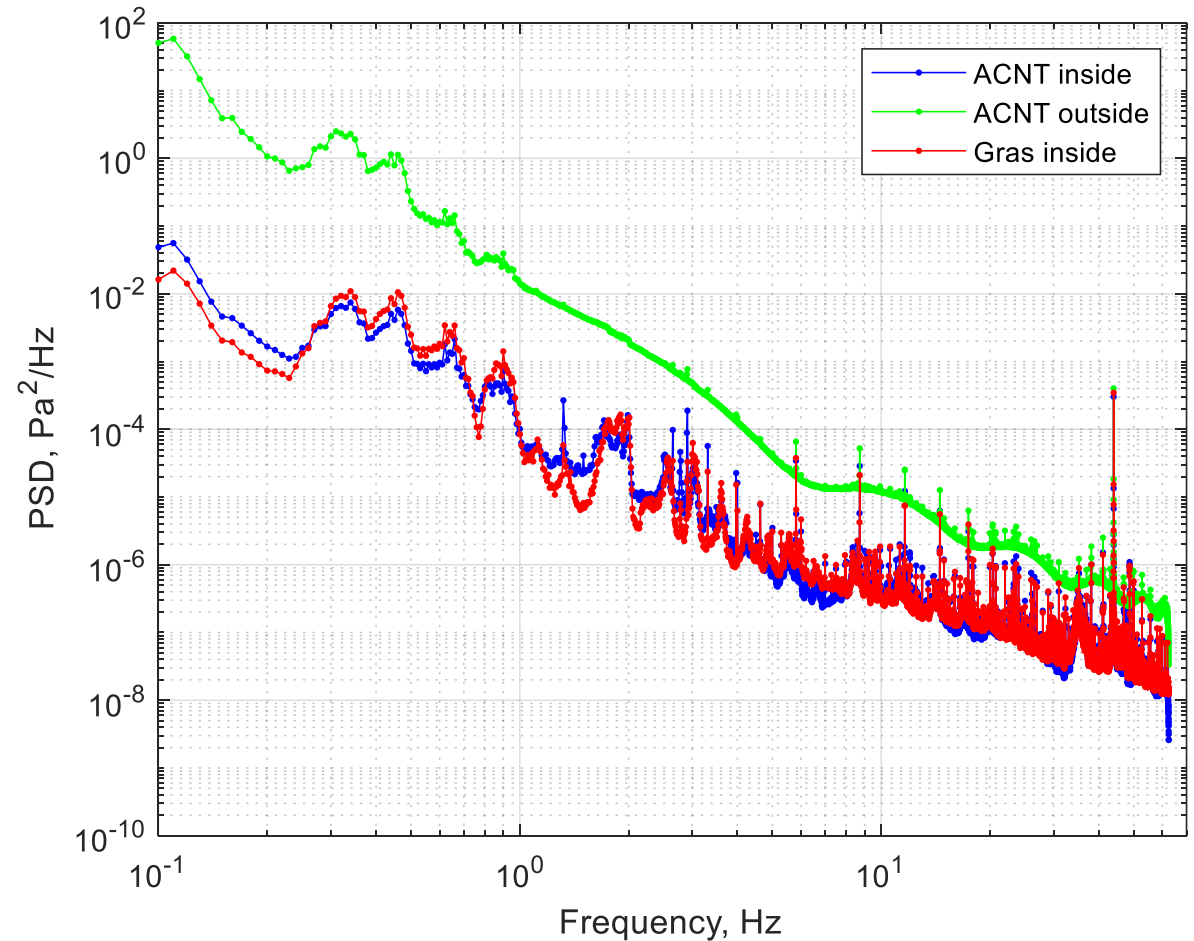
1x Gras - red

1x Astrocent - blue

Outside the cavity

1x Astrocent - green

10th December

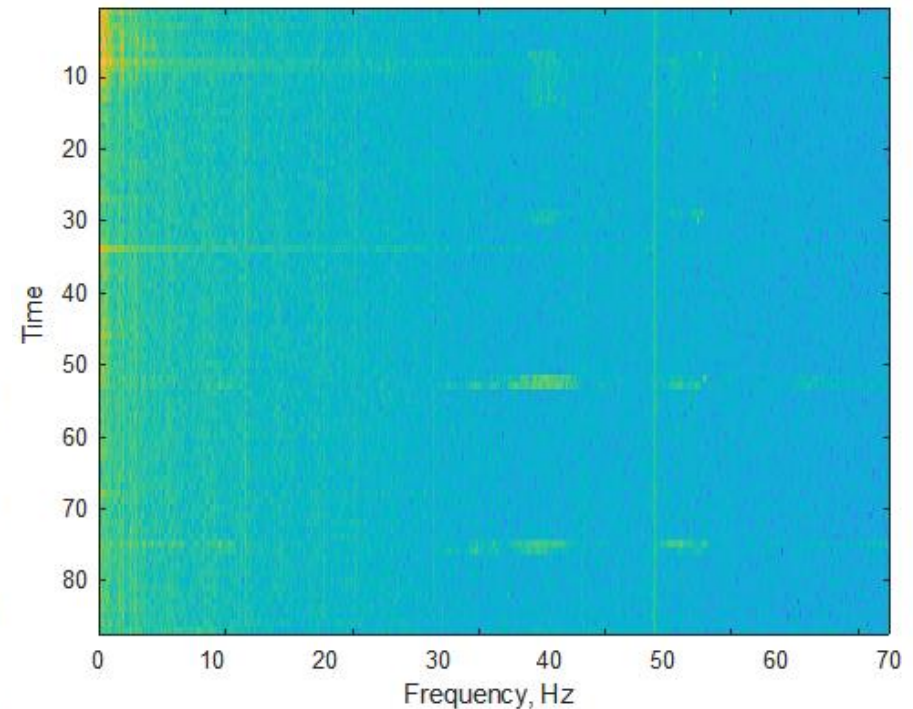
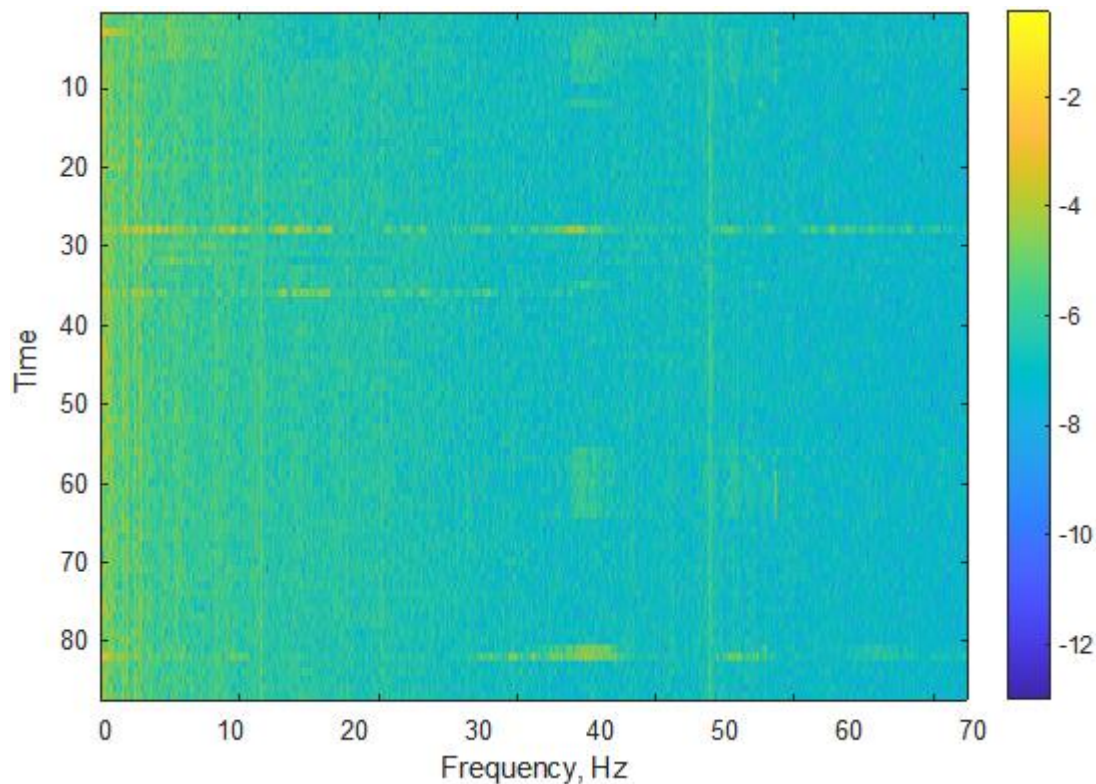


Sardinia - Sos Enattos Mine SOE3

10th and 11th of December - all day as a function of time (Gras microphone)

10th December

11th December



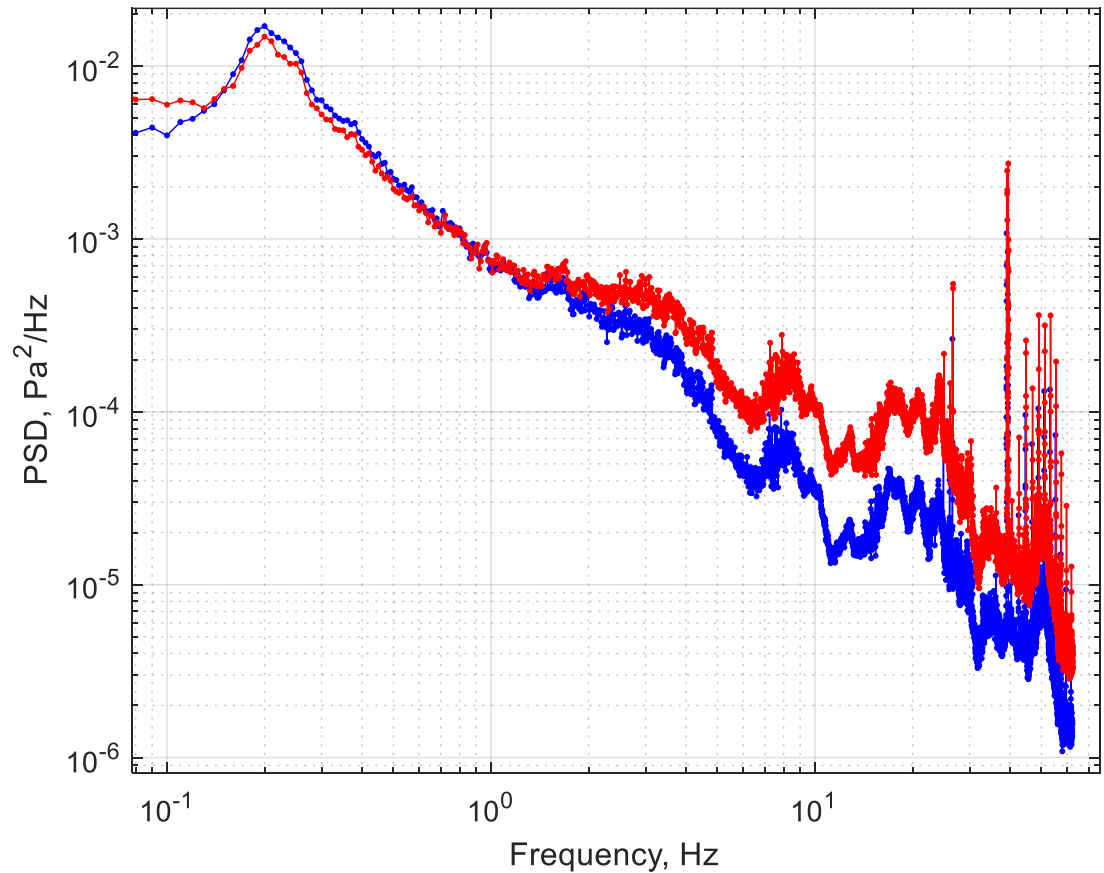
Sardinia - Sos Enattos surface SOE0

January

microphones:

1x Gras - red

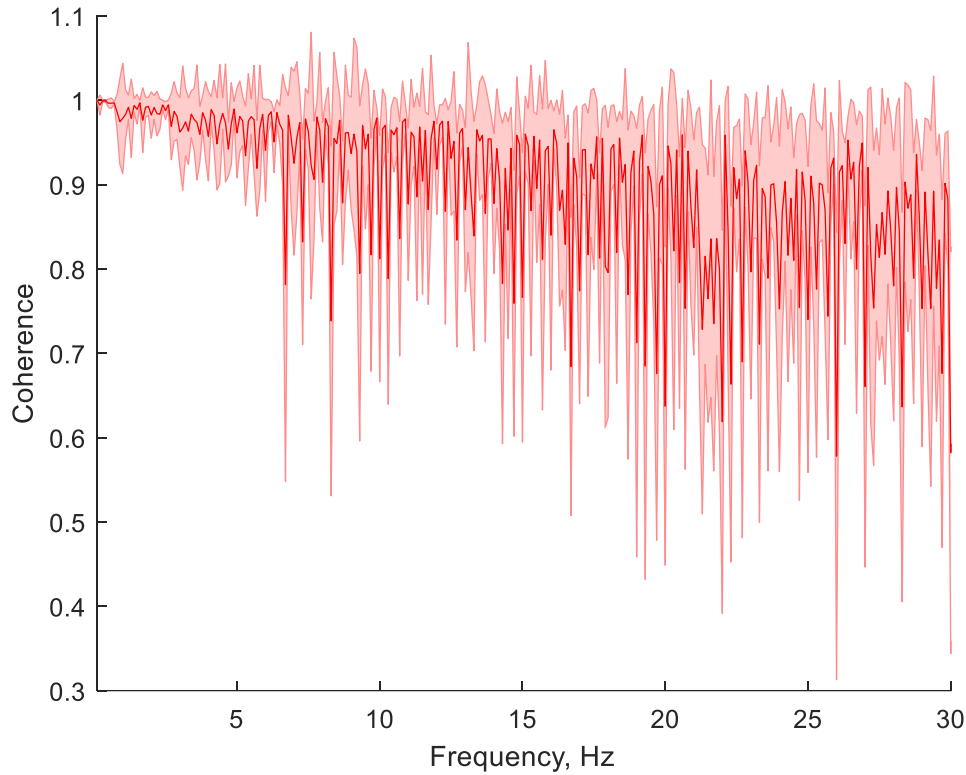
1x Astrocent - blue



Coherence ST3

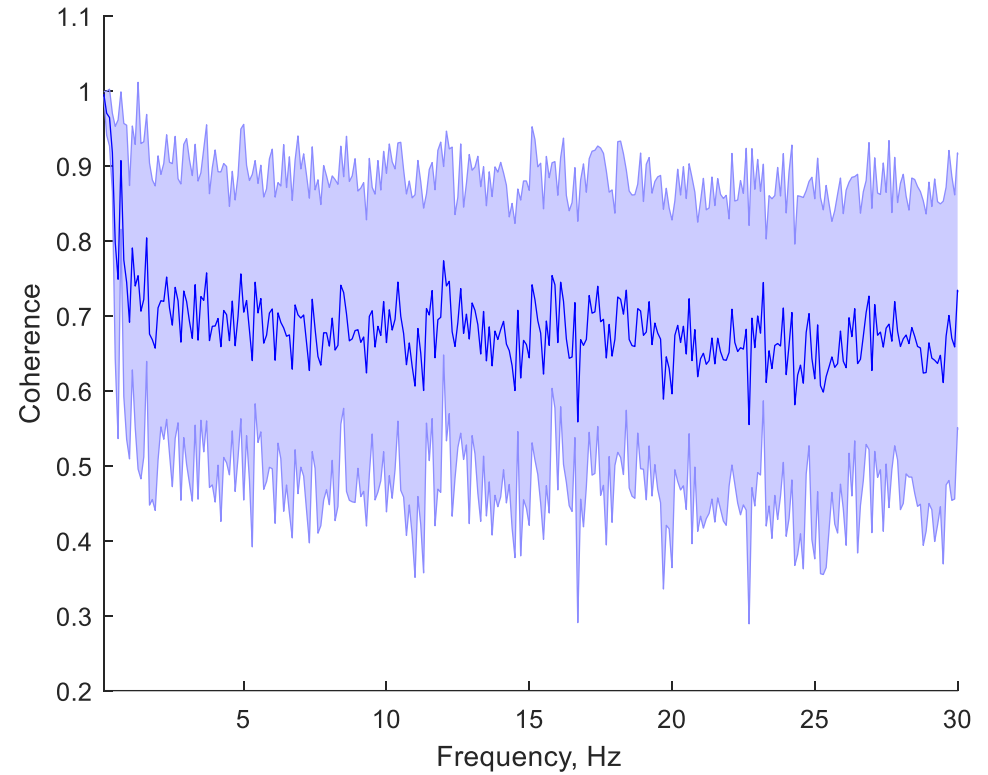
Inside cavity microphones

Gras-Astrocent



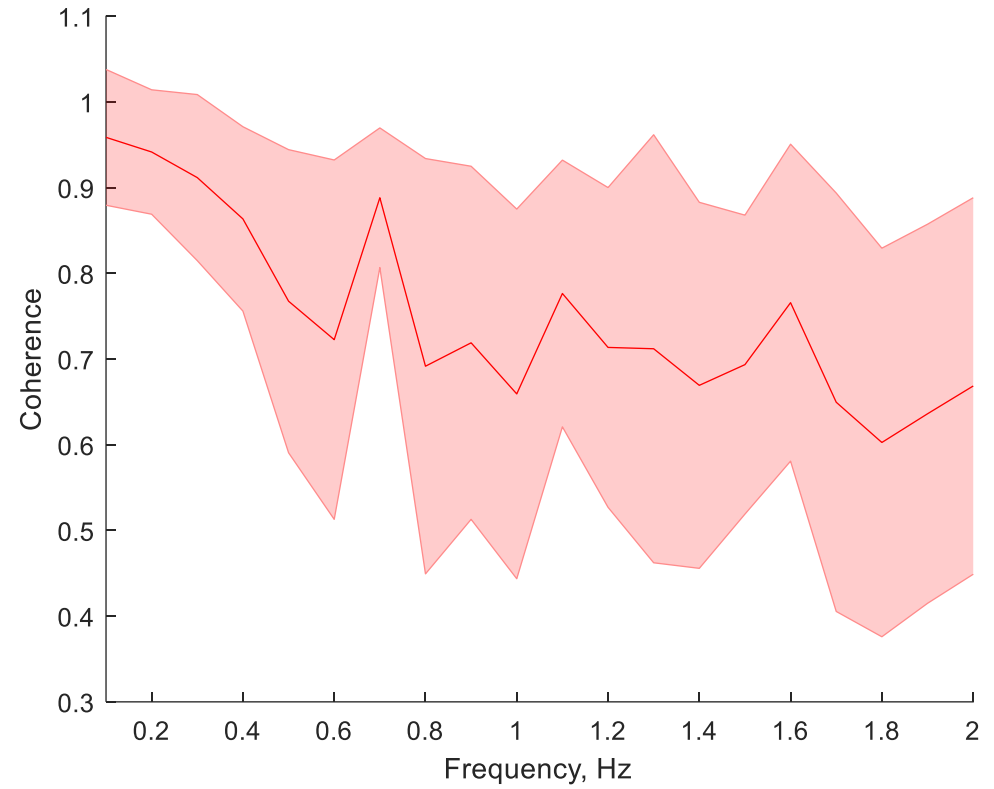
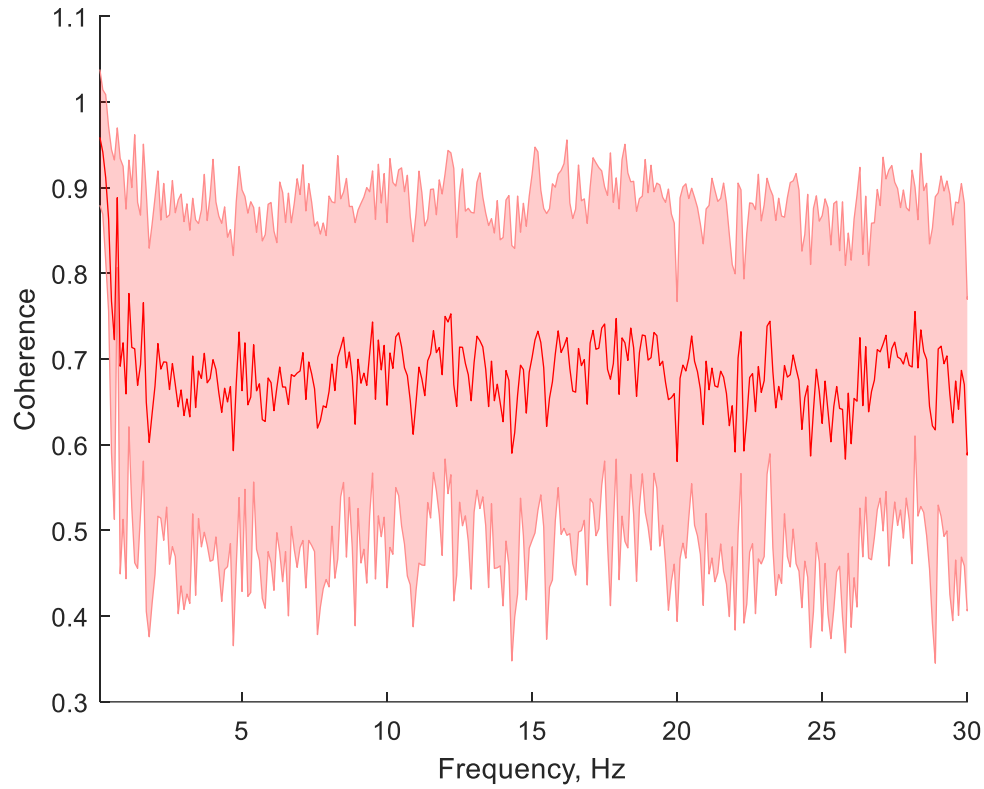
Inside and outside cavity

Astrocent-Astrocent



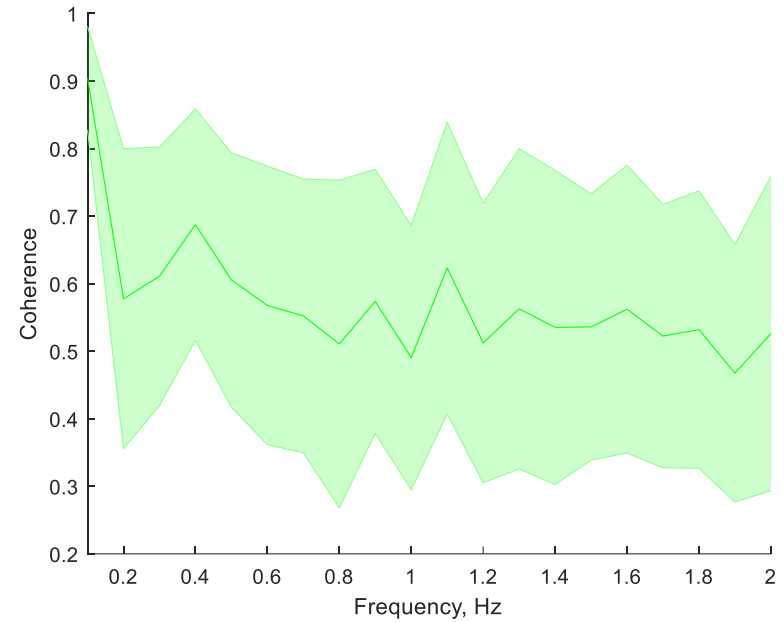
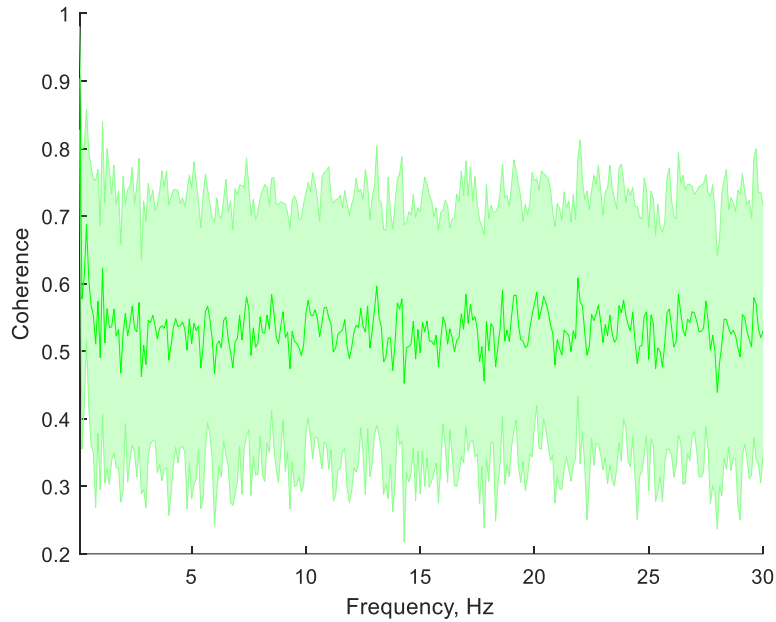
Coherence ST1 (inside) & ST3 (inside)

ST1 & ST3 Gras

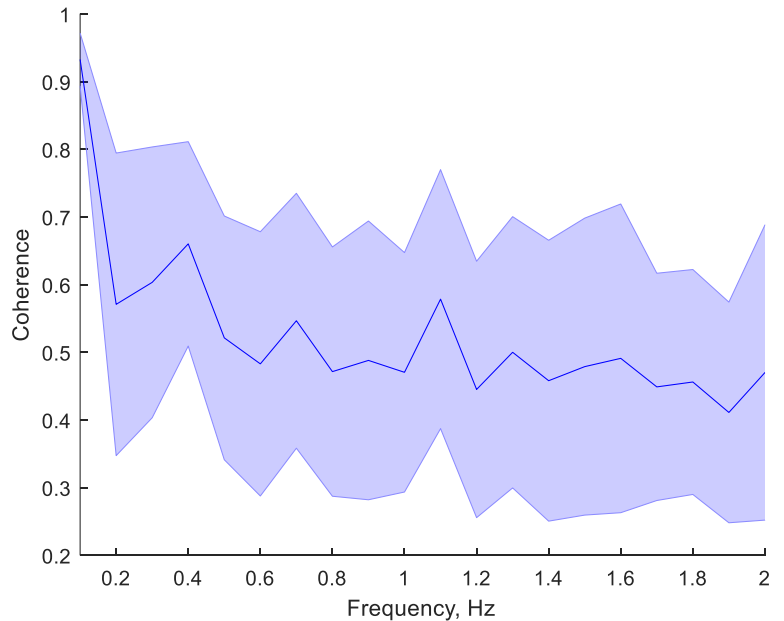
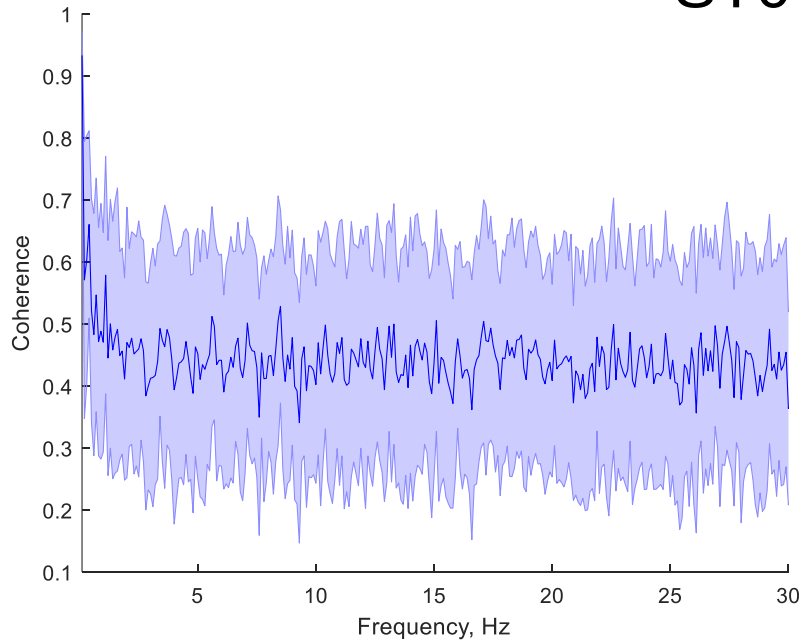


Coherence ST0 (surface) & ST1/3 (inside)

ST0 & ST1 Gras



ST0 & ST3 Gras



Conclusions

- Sosenattos 6x infrasound microphones inside the mine, 2 outside (installation since 21st November 2022)
- distributed infrasound measurements
- ST1, ST3 - 3x infrasound microphones 1x Gras + 1x Astrocent microphone (inside the cavern) + 1x Astrocent (outside the cavern)
- damping of the wall between the tunnel and the cavern about factor 10x (amplitude, 100x PSD)
- very high coherence between microphones below 0.6 Hz

Thank you for your attention
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Power spectrum & coherence

Power spectrum

$$S_{xx,f} = \frac{2dt^2}{T} X_f X_f^*$$

$$S_{xy,f} = \frac{2dt^2}{T} X_f Y_f^*$$

X, Y - spectrum of signal

T - total time of recording

dt - samplig time

Coherence

$$K_{xy,f} = \frac{|\langle S_{xy,f} \rangle|}{\sqrt{\langle S_{xx,f} \rangle \langle S_{yy,f} \rangle}}$$

Improved Infrasound microphones - Astrocent

- developed by Astrocent team
- low-cost infrasound microphone ~100 EU
- frequency range from 0.04 Hz to 120 Hz (AC47 Gras from 0.09Hz to 20 kHz)
- sensitivity: 46 mV/Pa
- distortion max. 1 dB

