

# ET Acoustic Newtonian noise based on LNGS case

T Bulik, M Suchenek + LNGS team  
University of Warsaw  
Astrocent, CAMK, Warsaw, Poland



# The idea

Campaign to measure seismic and acoustic noise at DarkSide

Existing working underground infrastructure

What would be the NN if ET built Gran Sasso?

# DarkSide campaign

Measure the seismic and infrasound noise at the DarkSide location

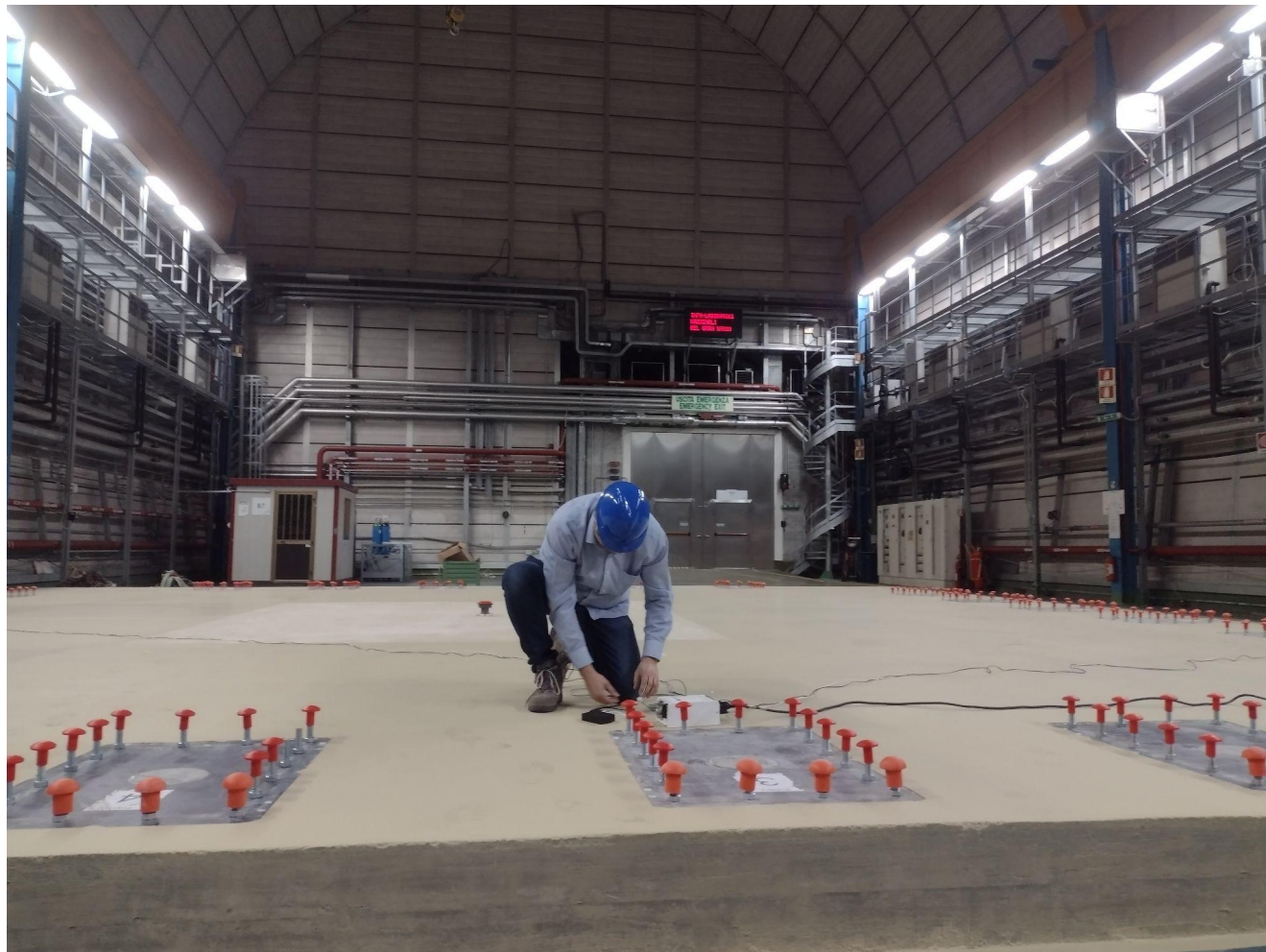
3 week campaign

2 microphones

Hall 1 with existing experiments

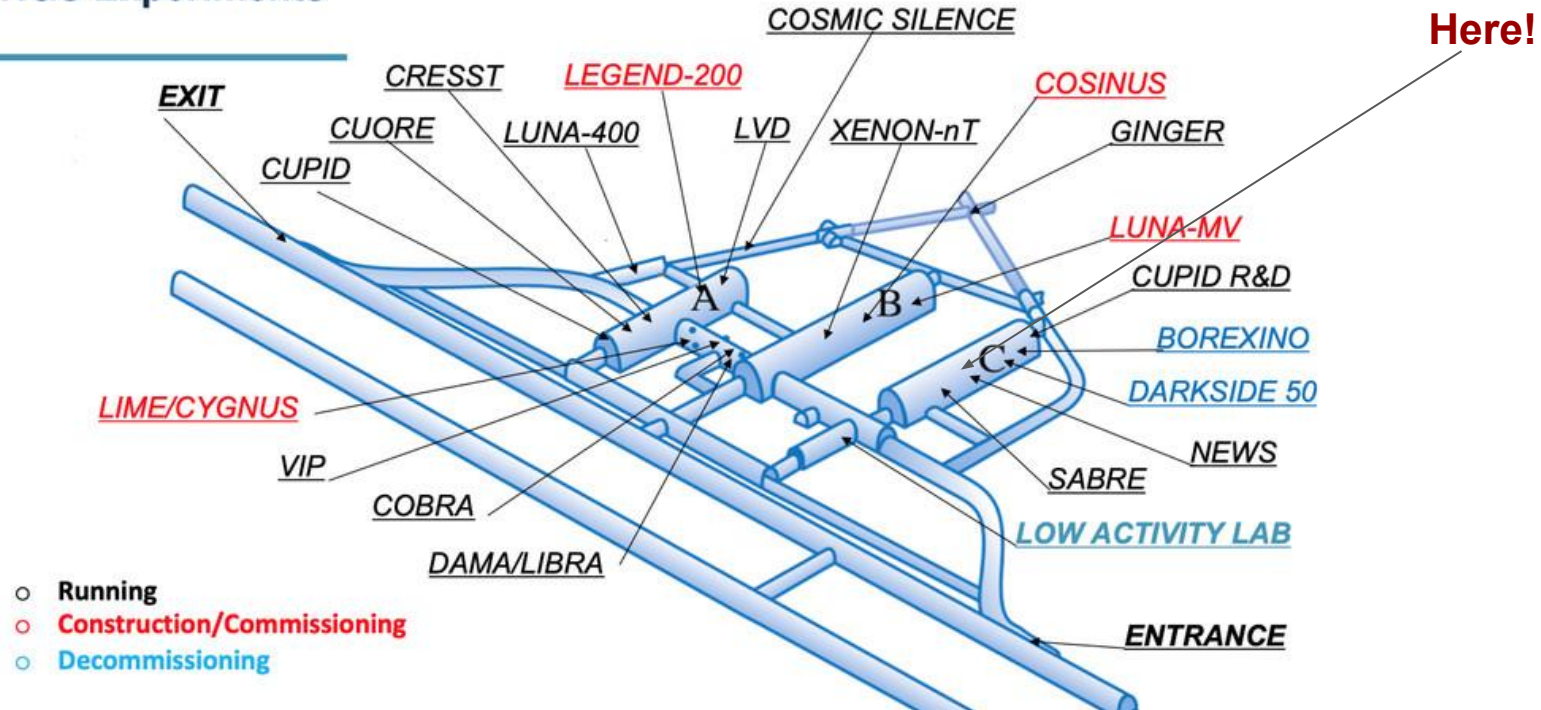


# The hall



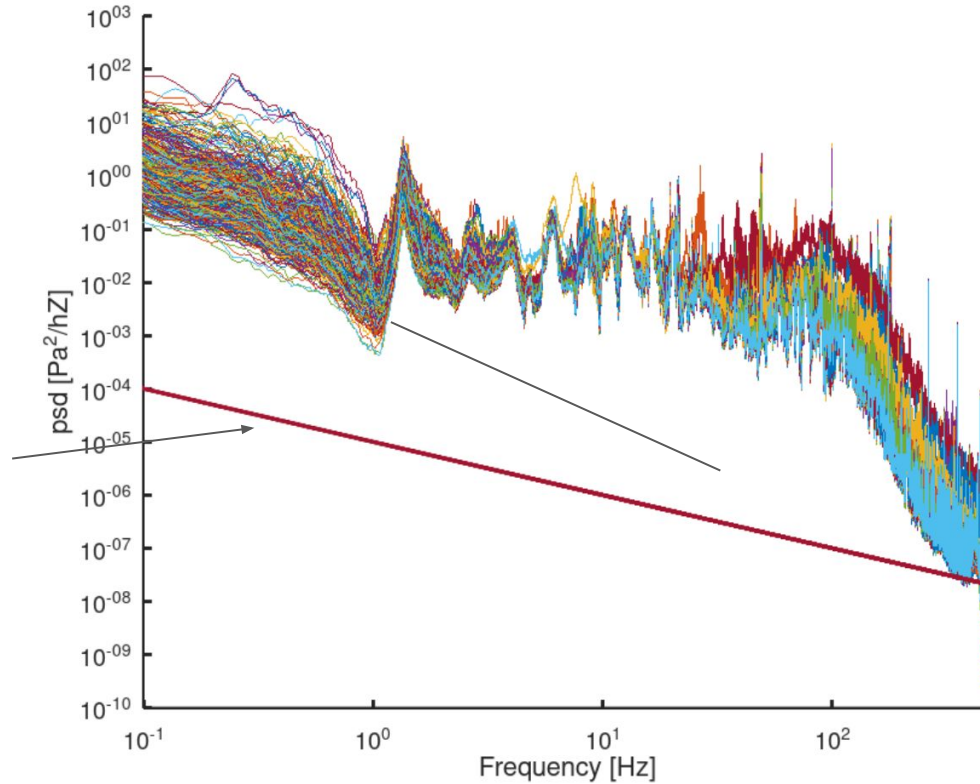
# Where were the measurements taken?

## LNGS Experiments



# Sound spectra

Ambient noise model  
Bowman et al. 2005



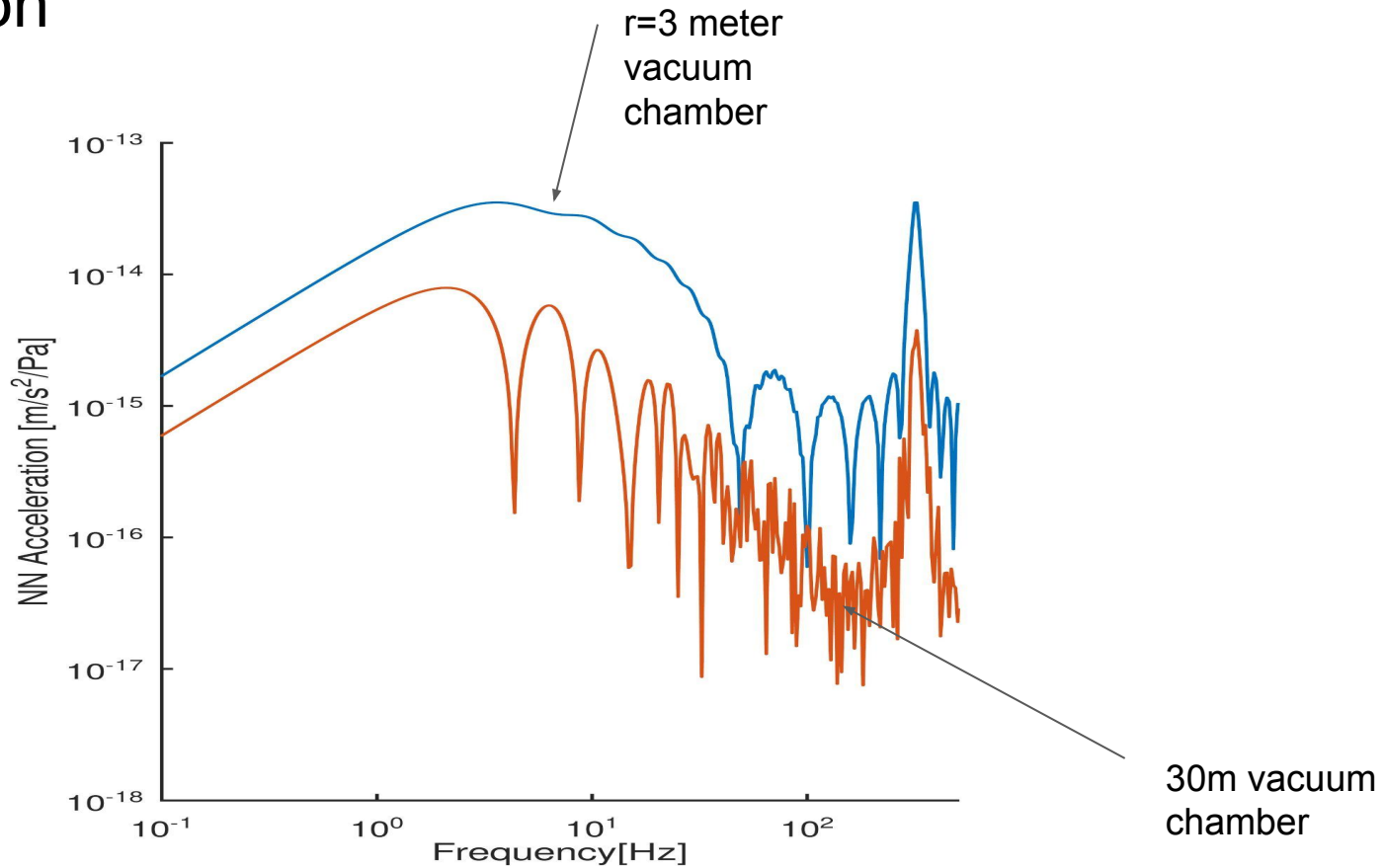
# Calculating the Newtonian noise

1. Assume a geometry of detector: hall 100m x 20m x 25 m
2. Assume position of test mass in the center 3 m above the ground
3. Calculate NN acceleration per unit pressure fluctuation as function of frequency - straightforward numerical calculation
4. Assume four test masses have similar uncorrelated noise
5. Follow the calculations in Fiorucci et al. 2018

$$S_{\text{tot}}(\vec{r}_0, \omega) = S_{\text{int}}(\vec{r}_0, \omega) + S_{\text{ext}}(\vec{r}_0, \omega) =$$
$$\frac{1}{(L\omega^2)^2} S_{\delta p}^{\text{int}}(\omega) \langle |a_{\text{int}}(z_0, \theta, \phi, \omega)|^2 \rangle +$$
$$\frac{1}{(L\omega^2)^2} S_{\delta p}^{\text{ext}}(\omega) \langle |a_{\text{ext}}(z_0, \theta, \phi, \omega)|^2 \rangle, \quad (15)$$

$$S_{\text{tot}}^{\text{Adv}}(\omega) = 2 \times S_{\text{tot,CEB}}(\omega) +$$
$$S_{\text{tot,NEB}}(\omega) + S_{\text{tot,WEB}}(\omega)$$

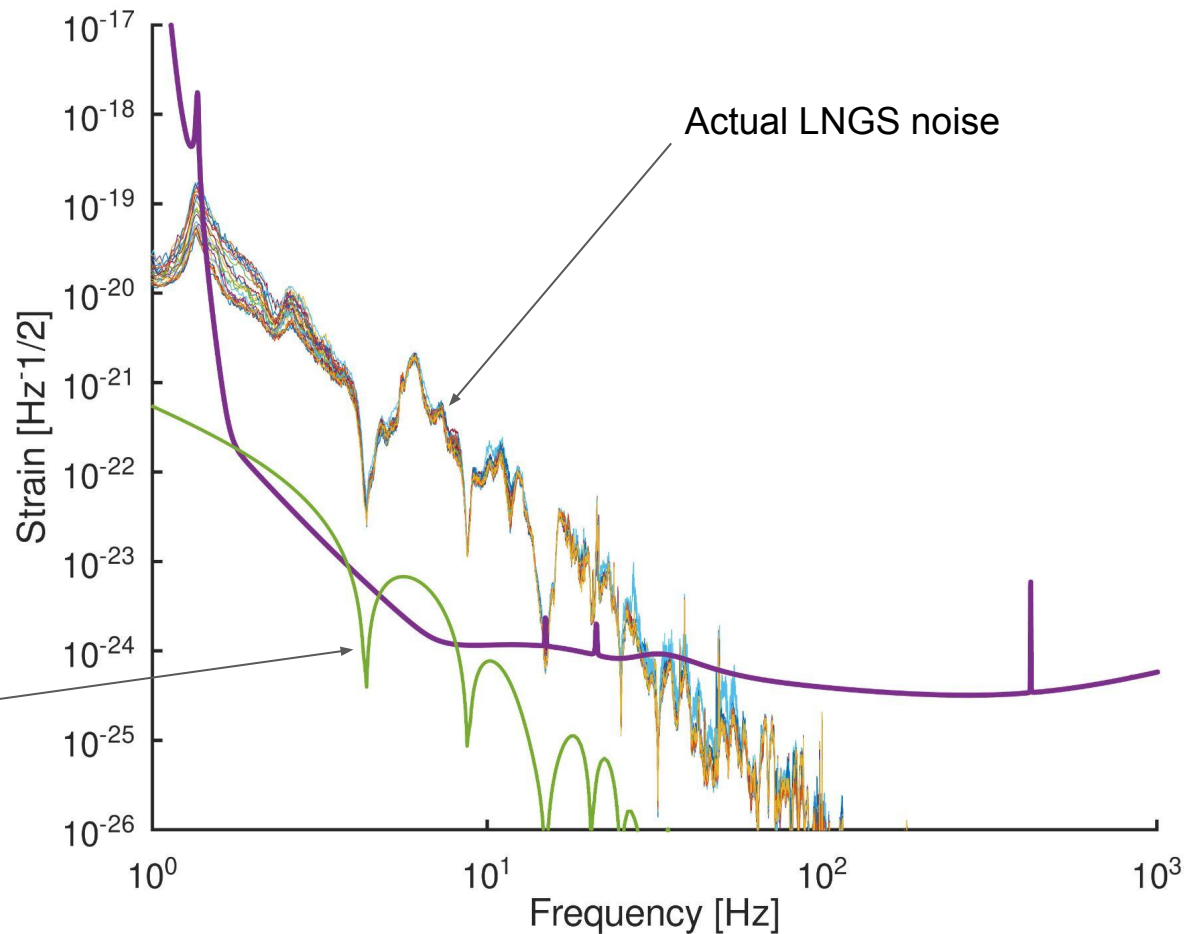
# NN acceleration



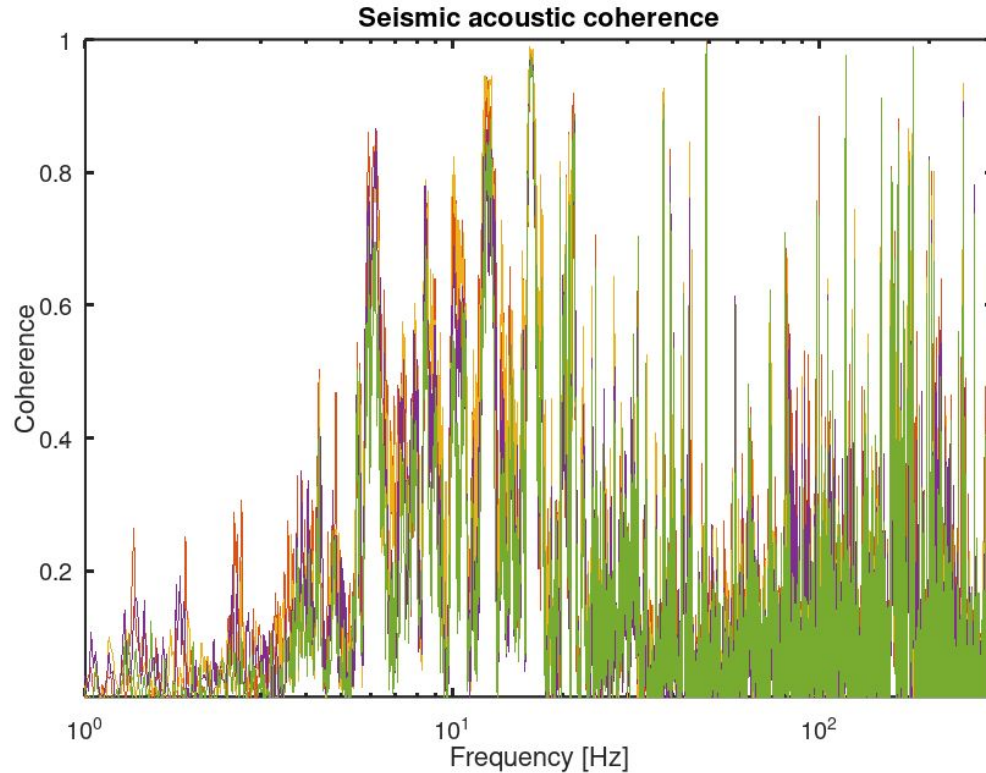


# Estimate of the noise

Ambient noise model



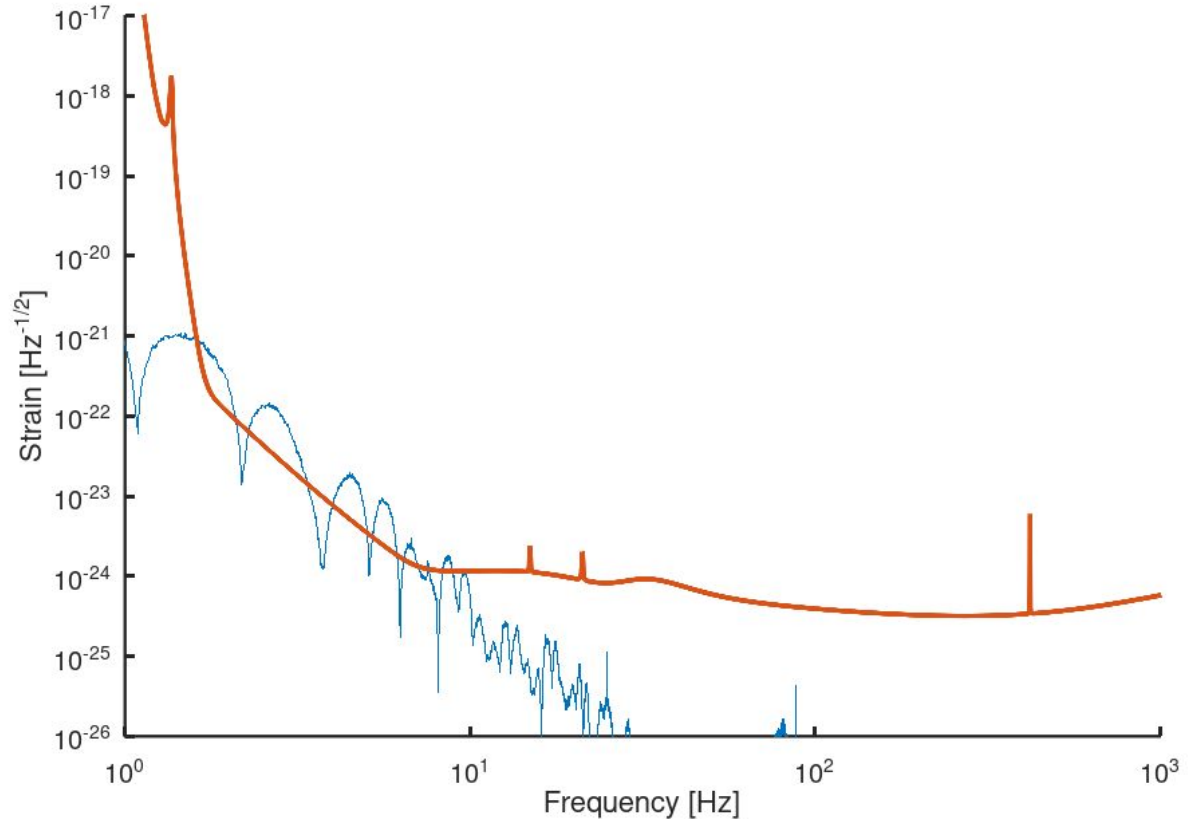
# What drives the acoustic oscillations?



# Sos Ennatos

Noise in Sos Ennatos tunnels - it is really quiet....

But acoustic NN noise above expected ET sensitivity



# What to make of it?

Acoustic NN is not negligible

LNGS measurement can be considered as upper limit

Current noise level in tunnels is too high

Lower limit - from ambient noise can also affect ET sensitivity.

We need to take actions to lower this noise:

- silence all equipment?
- decrease pressure?
- build ET in several smaller halls?

This needs to be investigated now to prepare for the construction and noise mitigation.