LONG TERM MEASUREMENTS IN THE MATRA MOUNTAIN RANGE

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MGGL Collaboration

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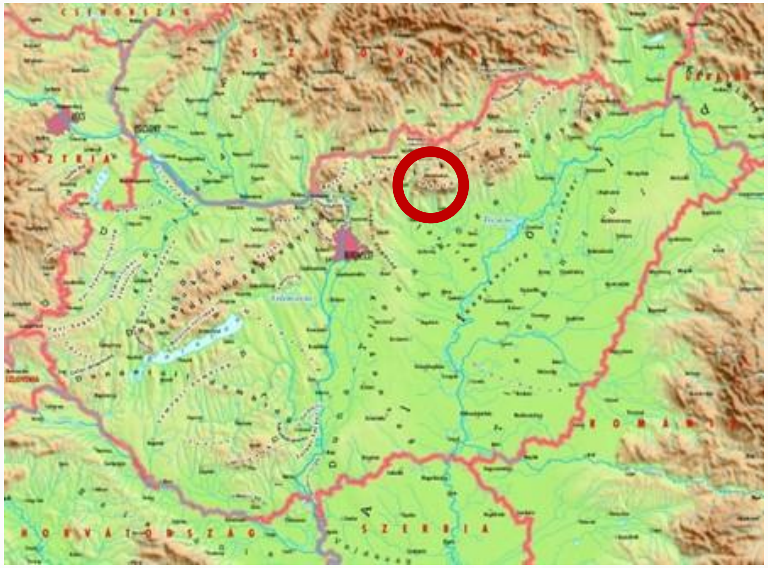
Introduction

- Matra mountains
  - 1 h drive from Budapest
  - Nearest town: Gyöngyös
  - Seismic station (5 km): Piszkéstető
- Gyöngyösoroszi mine
  - old ore mine, out of operation
  - high humidity, oozing acid water
  - recultivation activity
- MGGL Laboratory

  devices, measurements
- Noise studies

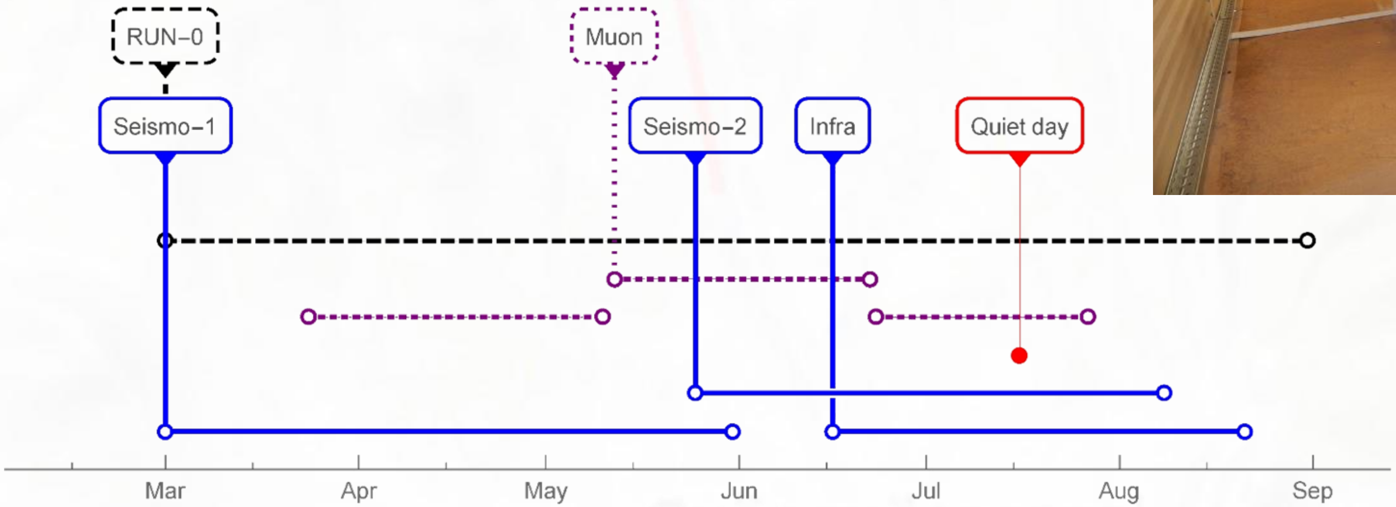
  local and environmental effects



Gyöngyösoroszi mine

Matra Gravitational and Geophysical Laboratory

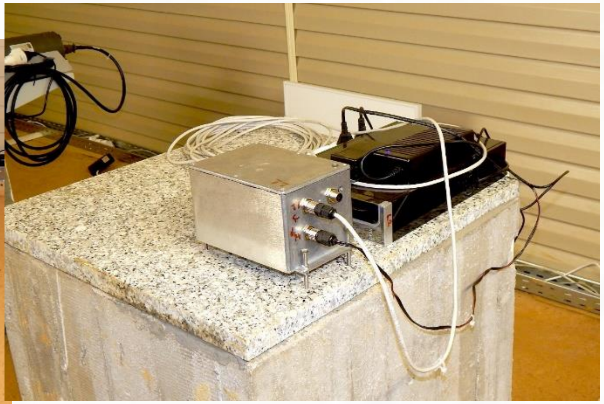
- Construction finished in February 2016
  - old instruction office repaired
  - 1.3 km from entrance, 88 m below surface
  - 3 measurement platforms
  - optical data connection to the surface
  - data collection from March 2016

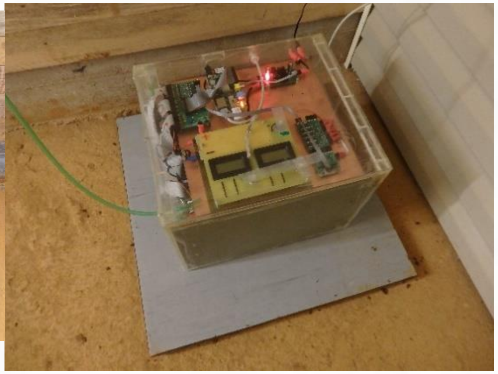


Matra Gravitational and Geophysical Laboratory

- Installed devices
  - Guralp CMG-3T seismometer
  - Seismic sensor of Warsaw Univ.
  - Infrasound monitoring system (developed by EGRG)
  - Lemi-120 magnetometers
  - portable muon detector





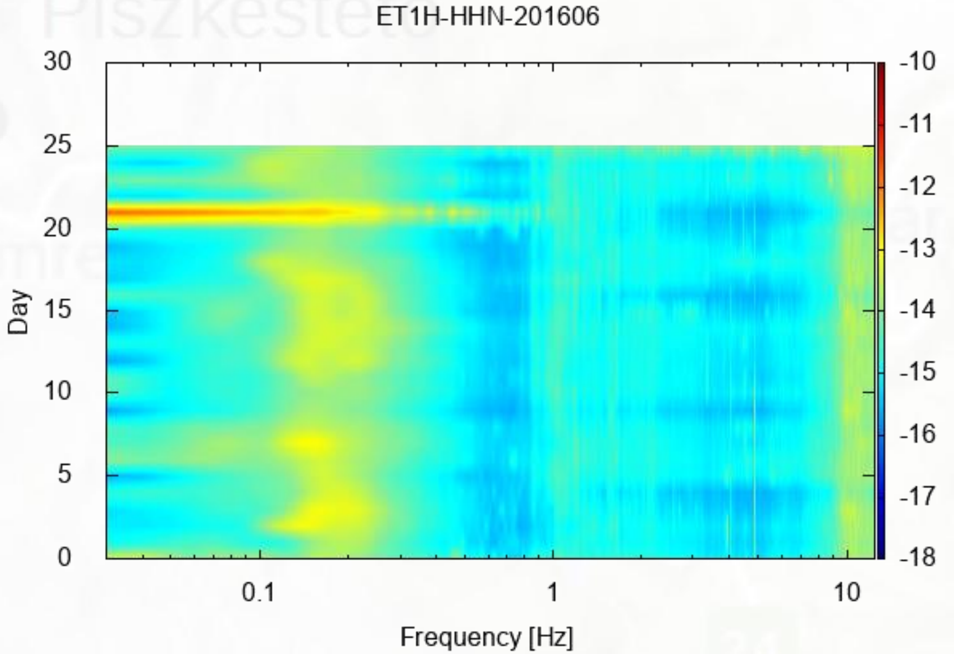


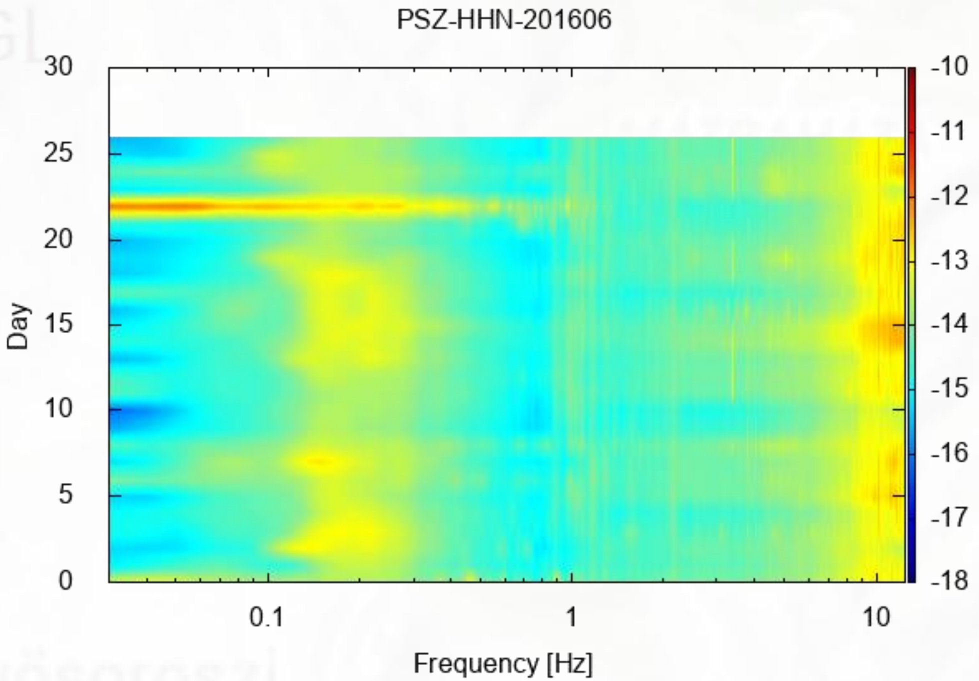
Seismological noise

- Monthly variation of noise
  in the mine and on the surface

- Weekdays / weekends

- Cultural noise above ~5 Hz

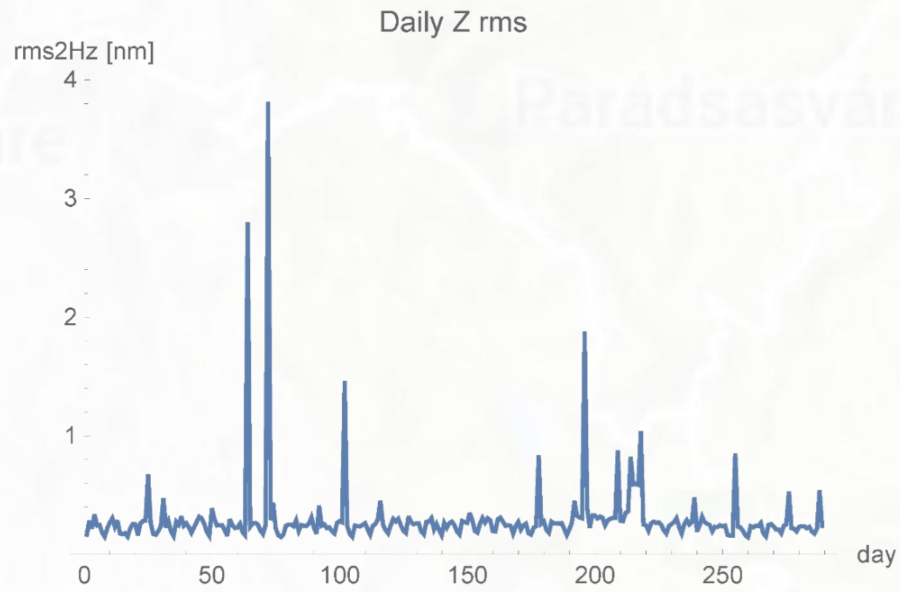


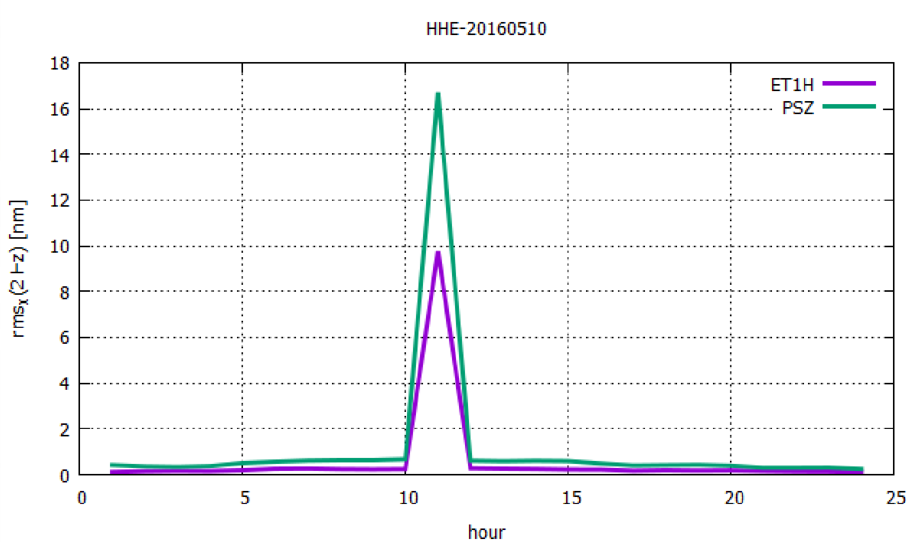


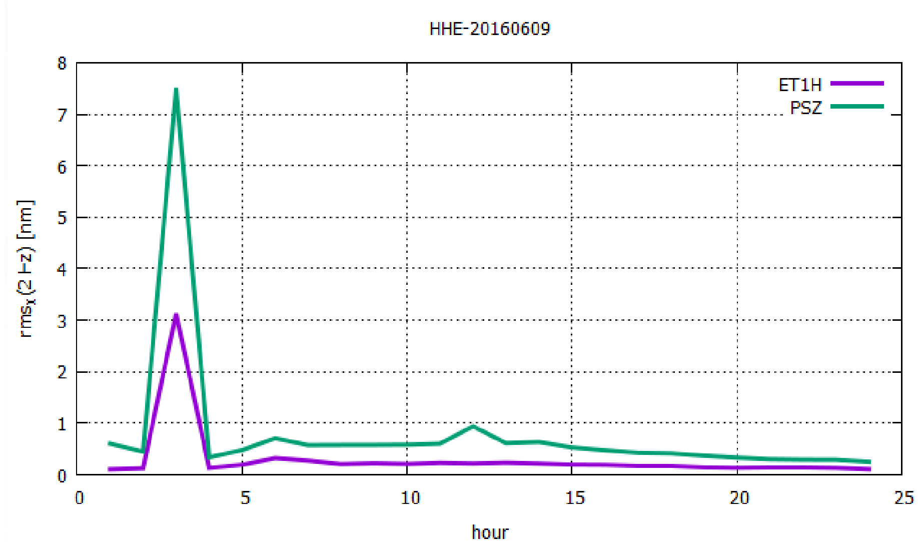
Noise level

$$\mathrm{rms}_l^{(x)} = \sqrt{\frac{1}{T}\sum_{k=l}^{N/2+1} P_k^{(x)}}$$

- ET optimal RMS value at 2 Hz is 0.1 nm (Beker 2013)
- High RMS values are correlated between the mine and the surface

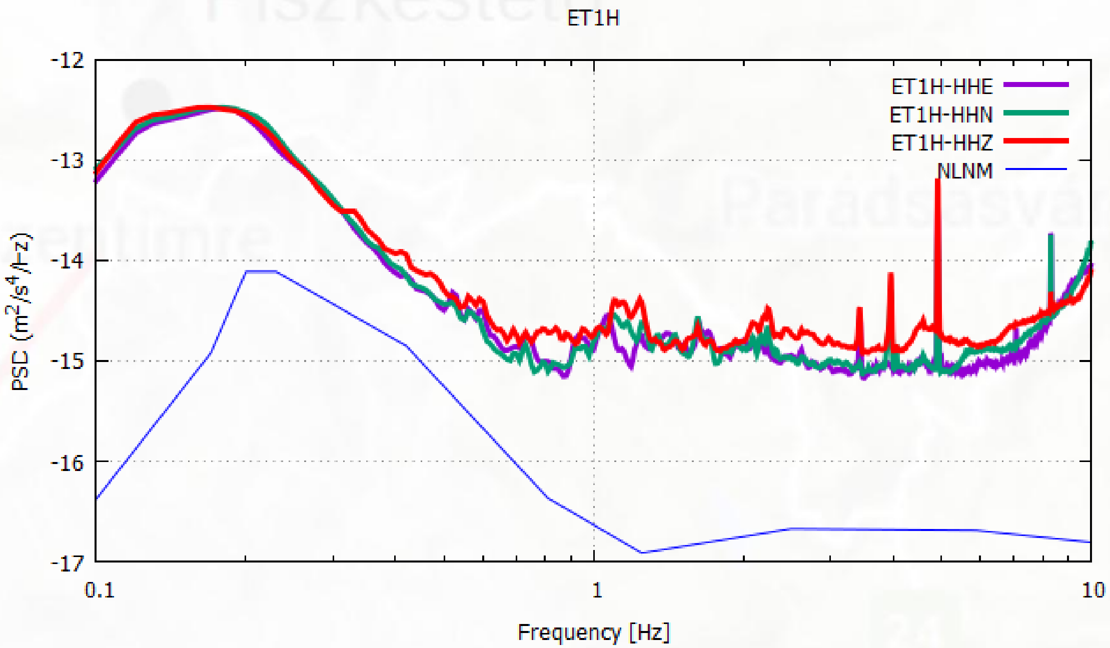


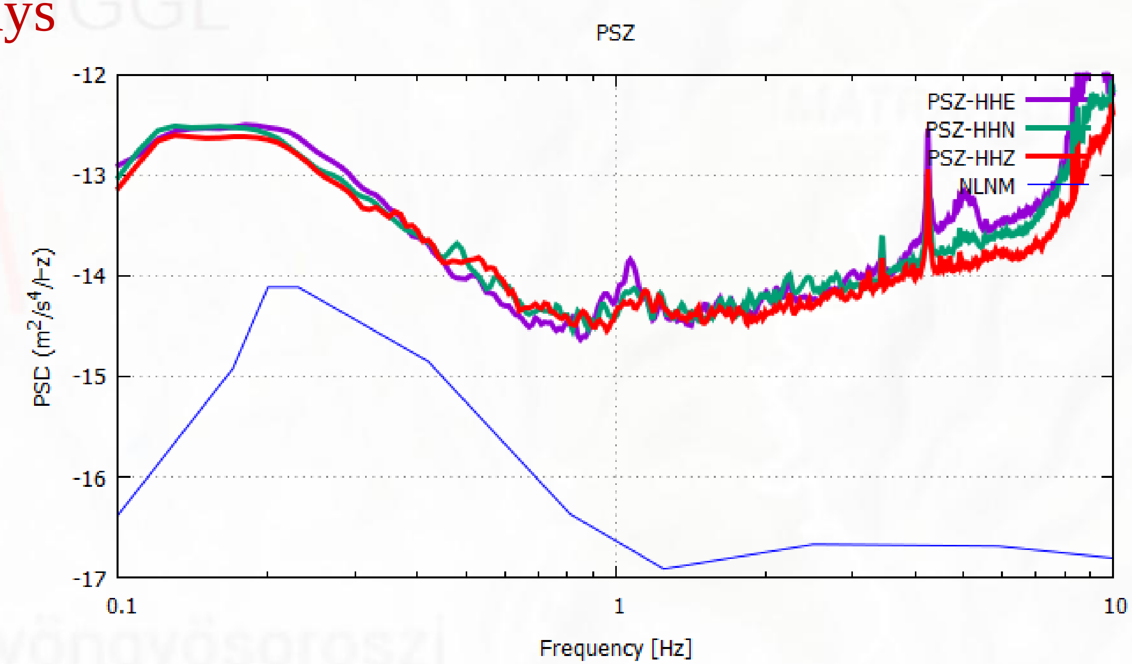




Noise level

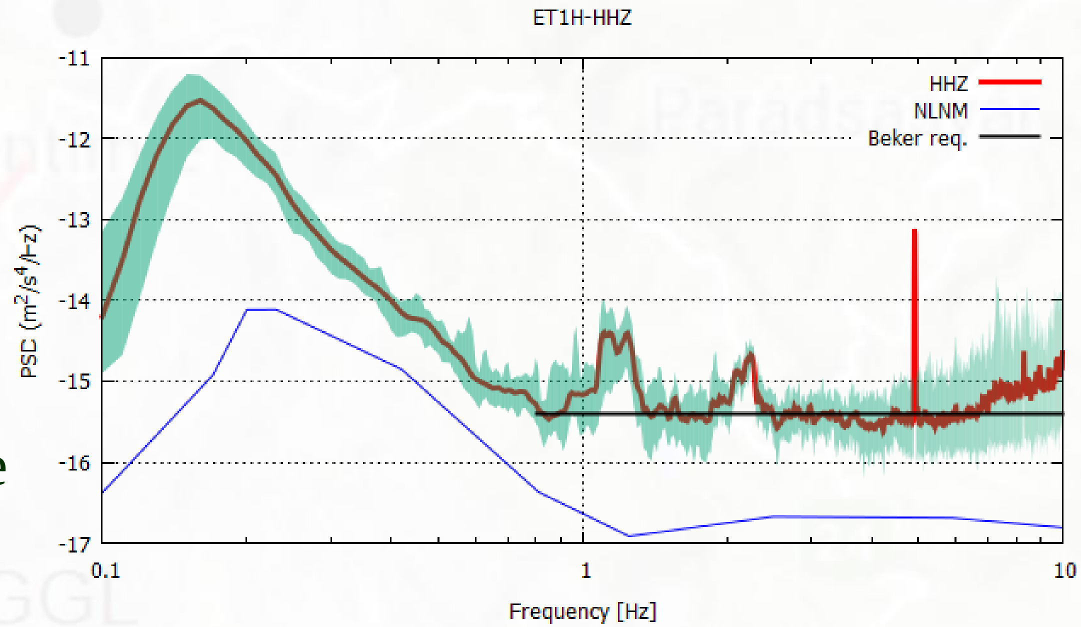
- Averaged PSD for the observation period ~ 280 days
- No data for 16 days
- Correlated high level and filtered noise: 20 days
- Averaged RMS (nm) at 2 Hz:
  MGGL - E: 0.19
  PSZ - E: 0.89

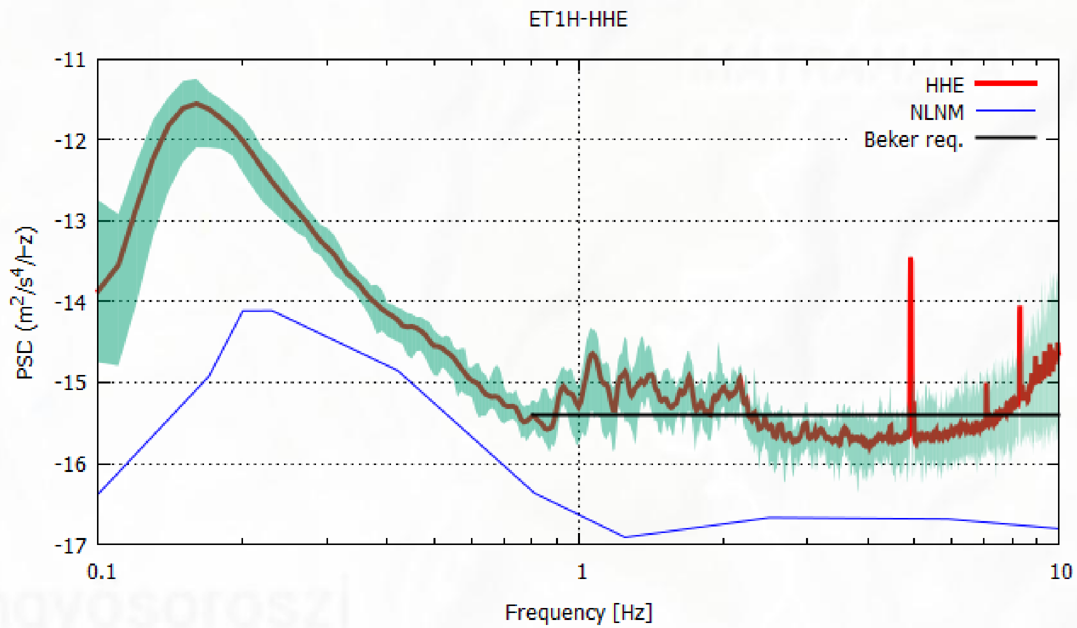




Averaged PSD – quiet day

- 01.01.2017
- Average value (red) and envelope
- aPSD level below black line (Beker 2013)
- Averaged RMS (nm) at 2 Hz:
  MGGL - E: 0.11

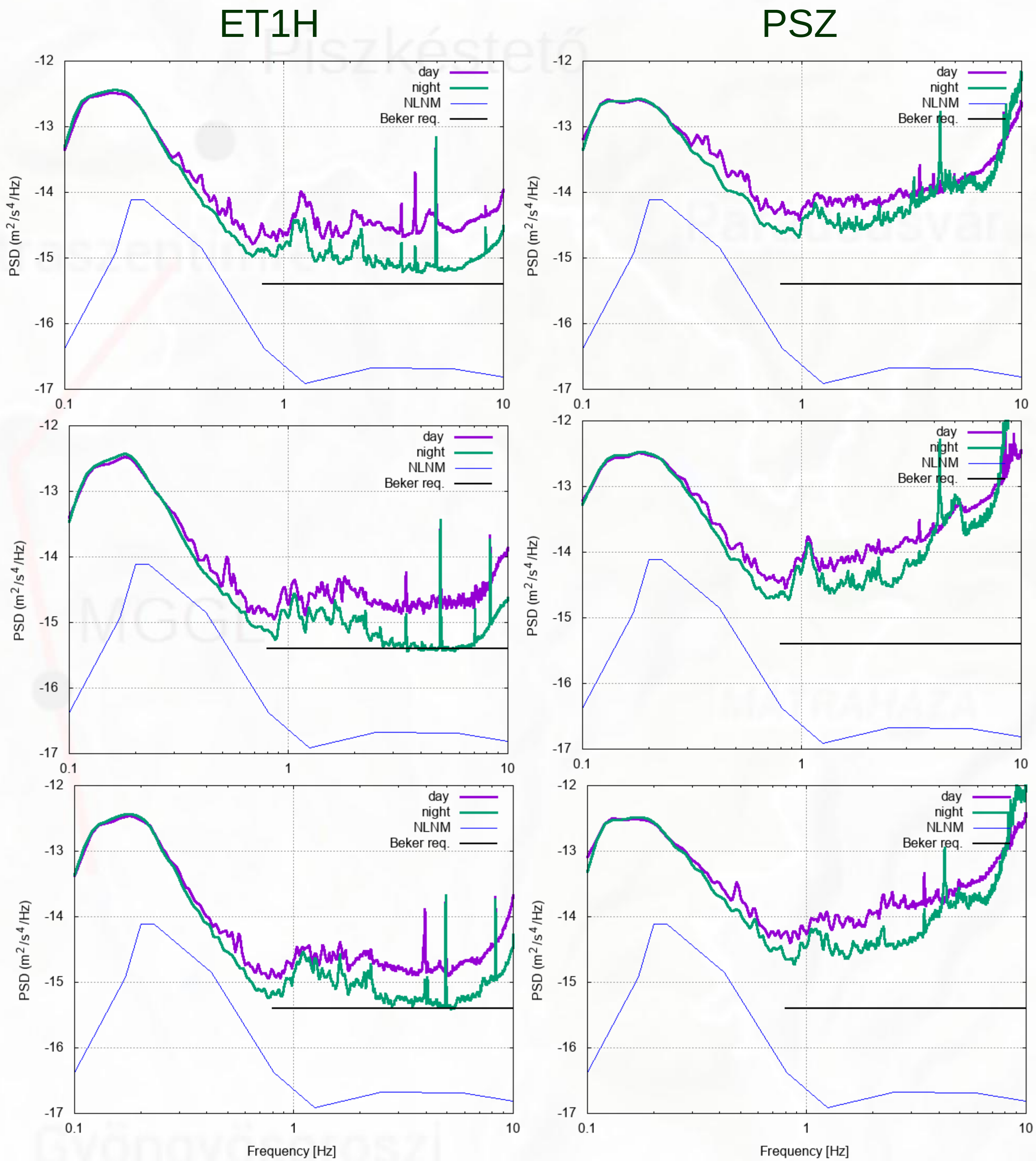




Noise variation

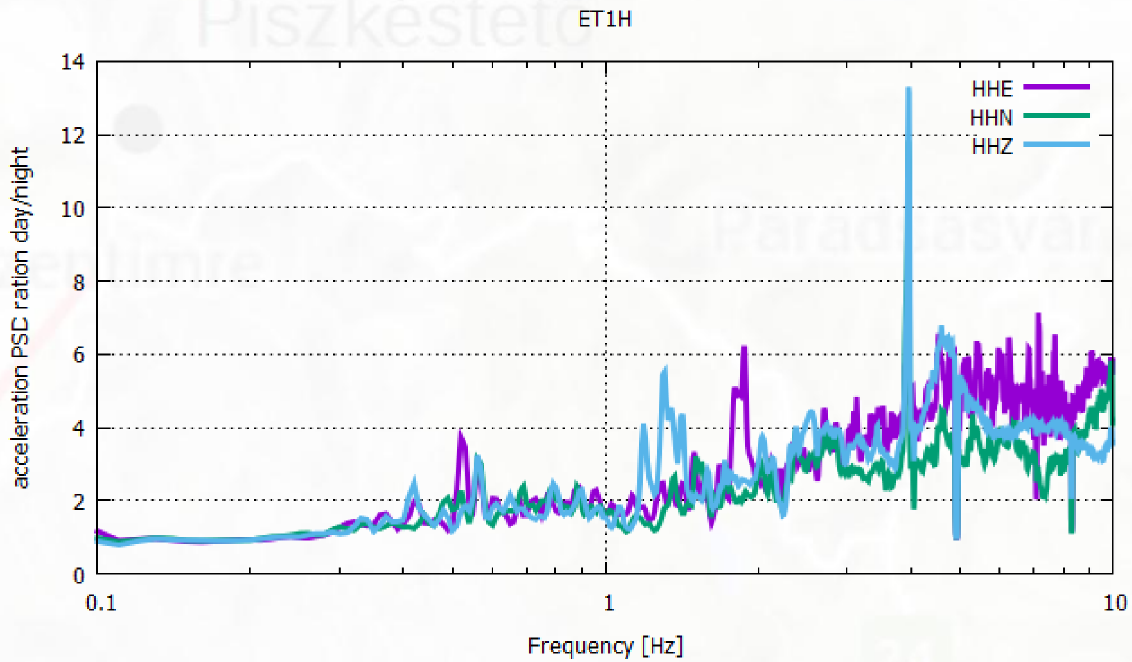
- day / night
  acceleration PSDs
  for Z, E, and N comp.
  ~280 days

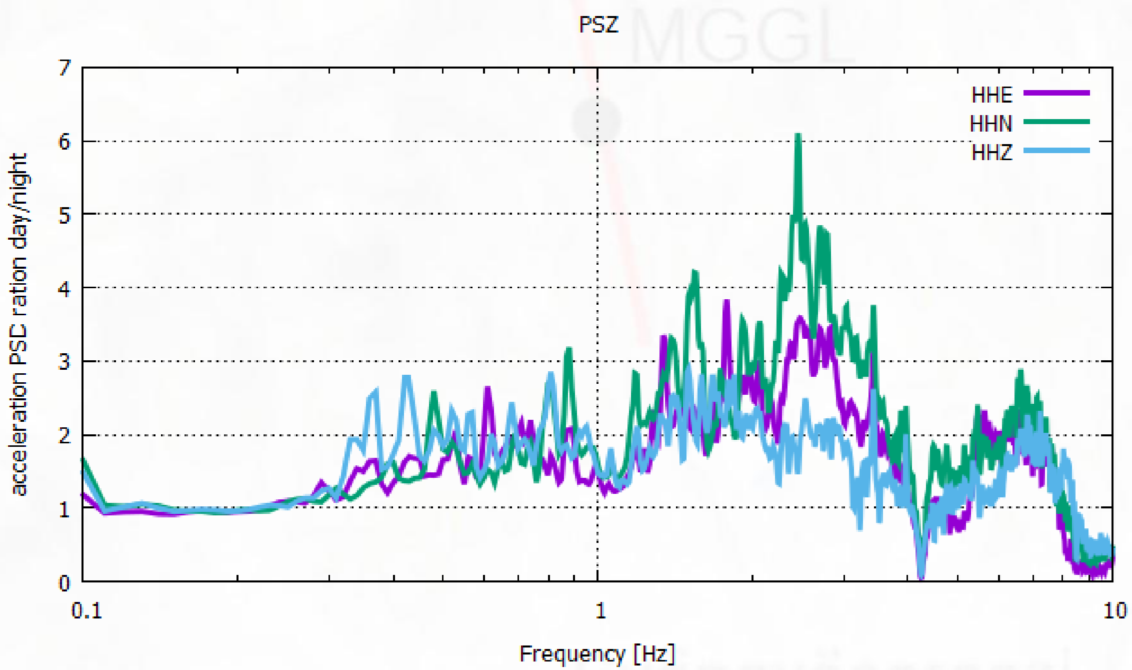
- night conditions during
  usual mine operation
  are close to required
  level



Day / night ratio

- Ratio between 2 – 6
- Cultural noise is present above a few Hz

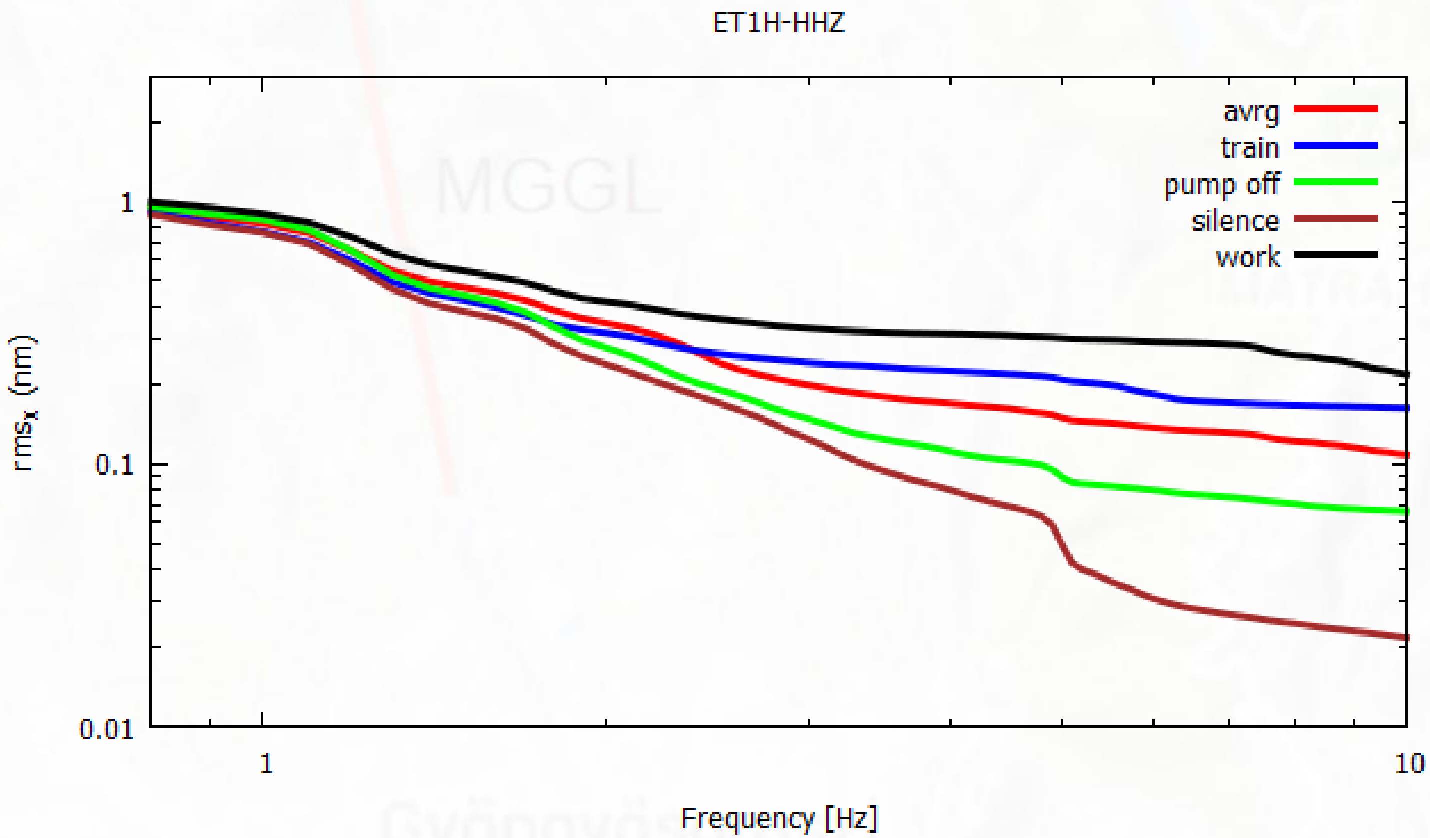




Internal noise sources

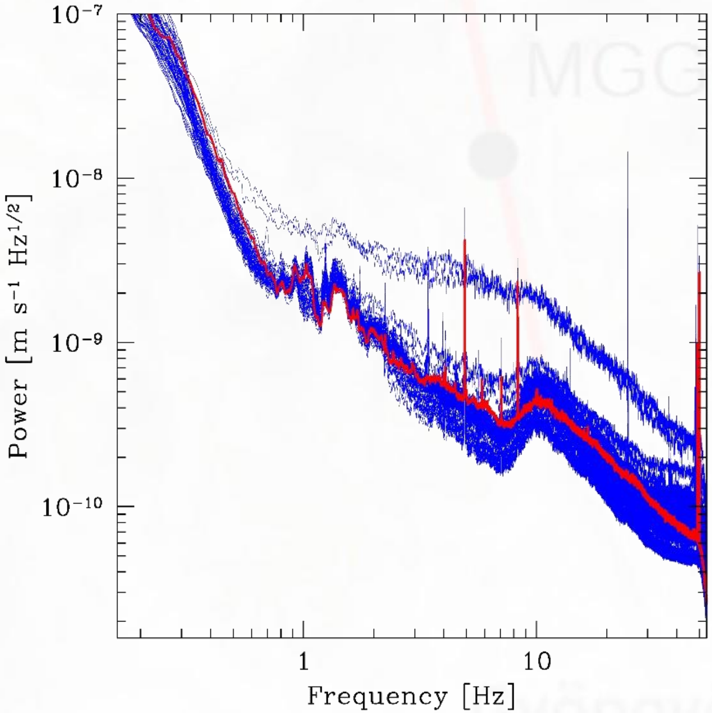
- RMS values (nm) at 2 Hz
- Quiet day, 15.12.2016, MGGL controlled mine operation

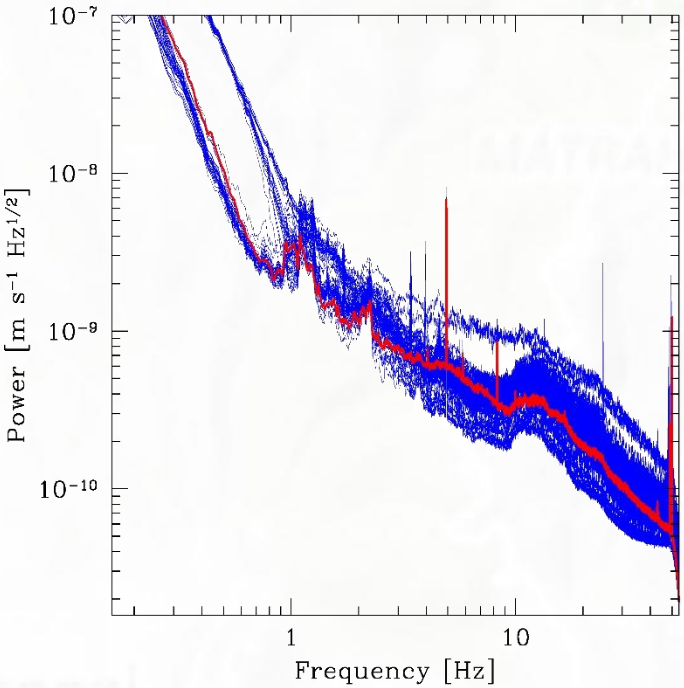
station	channel	train	pump off	silence	work	average
ET1H	HHZ	0.316	0.278	0.240	0.416	0.344
ET1H	HHN	0.232	0.229	0.212	0.362	0.249
ET1H	HHE	0.218	0.222	0.213	0.371	0.252



Seismic sensor

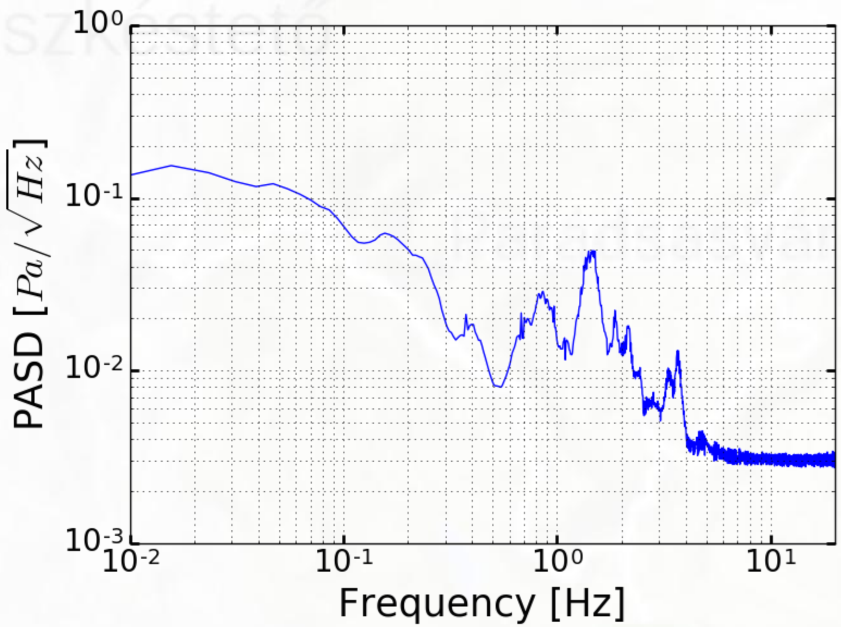
- Developed by Polish colleagues
- Daily amplitude spectra of velocities, RUN-0
  - Horizontal and vertical components
  - First quiet day (16.07.2016, Sa): red

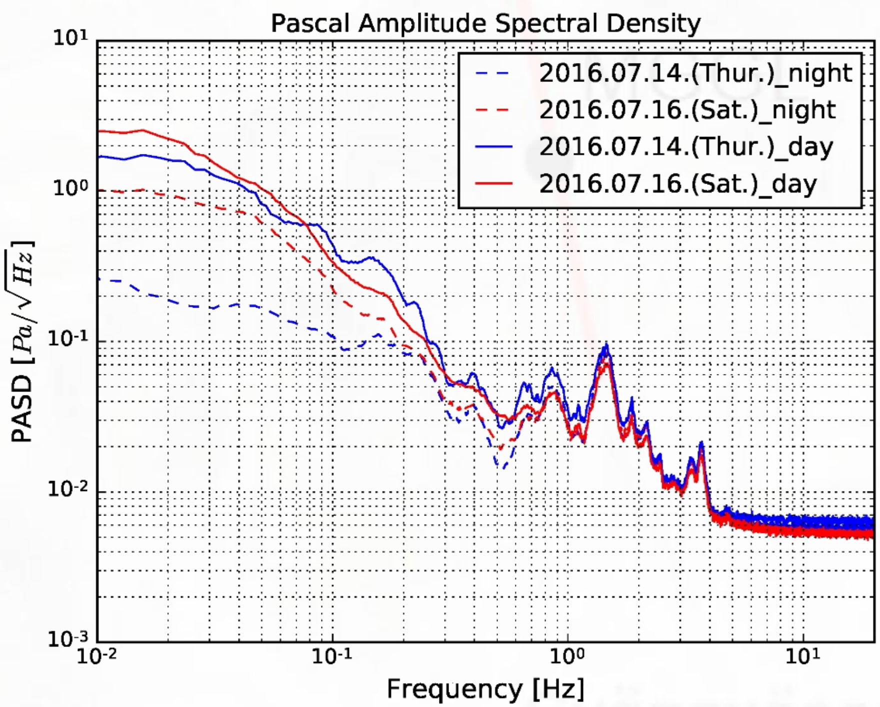


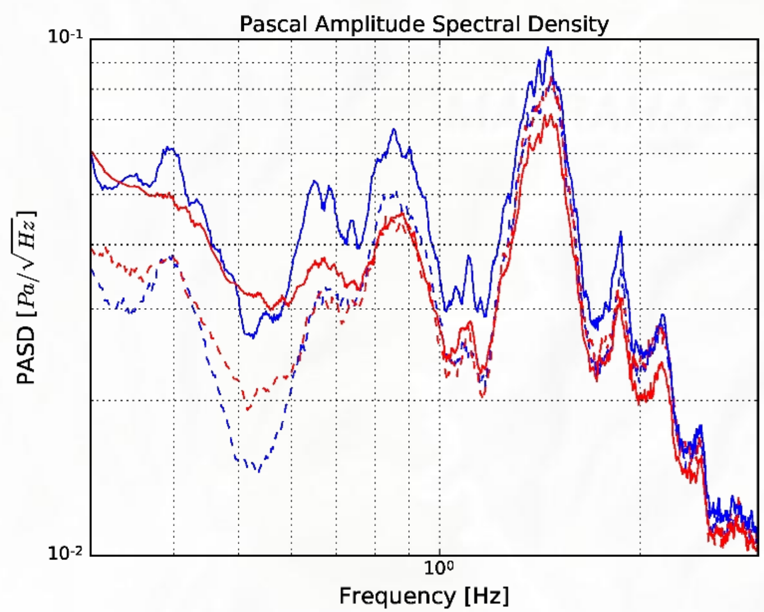


Infrasound detector

- Variation of the pressure
  - Representative pressure amplitude spectral densities, 2 month
  - Daily averaged RMS at 2 Hz: 0.165 (Thur.) and 0.167 (Sat.)

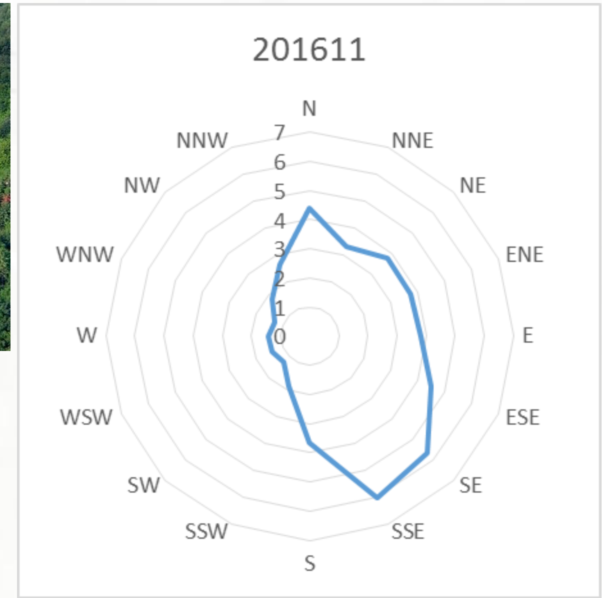


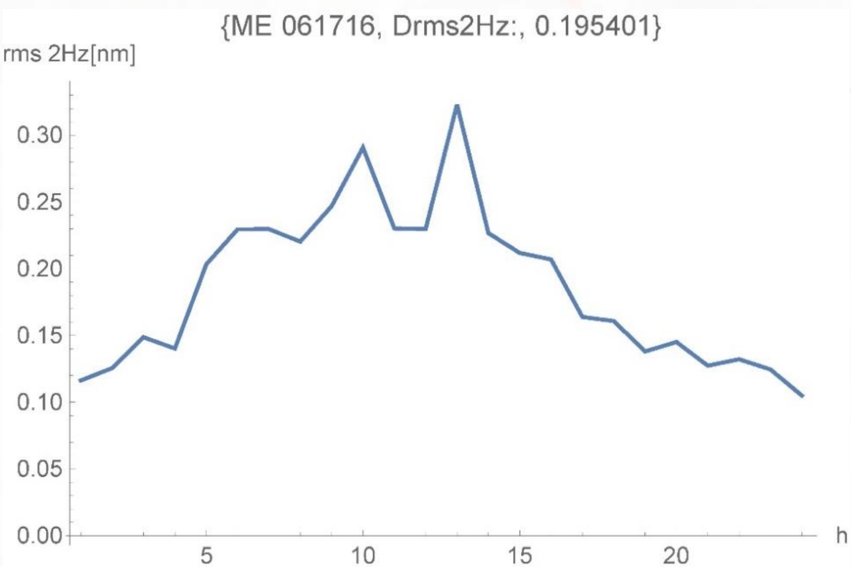


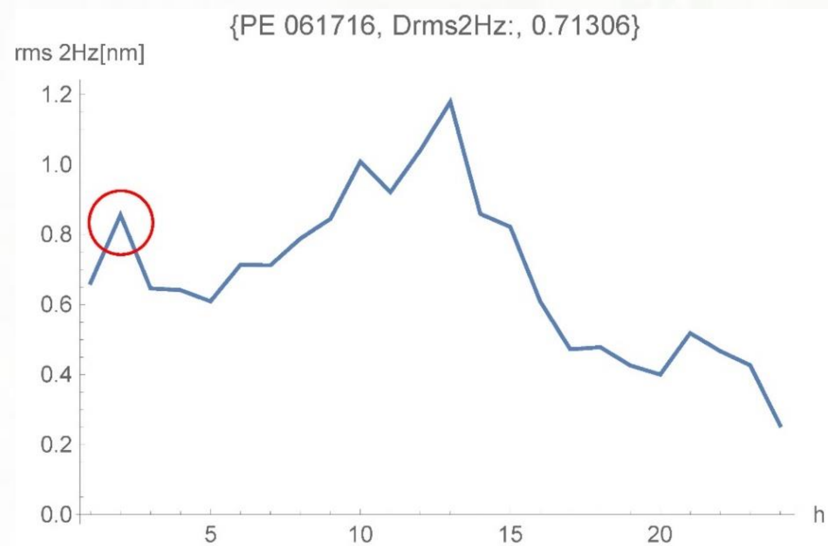


Effect of wind

- No significant effect
  - Location of weather station
  - No effect below 100 m for 8 m/s and lower wind (Young etal. 1996)







MGGL Collaboration

- Collaboration (31 participants) with many Institutions
  - Wigner FK
  - MTA CSFK GGKI
  - Atomki
  - Univ. of Miskolc
  - BME
  - ELTE
  - Univ. of Warsav
  - Univ. Of Zielona Góra
- Report of the first data collection period, arXiv:1610.07630

FIRST REPORT OF LONG TERM UNDERGROUND SEISMIC, INFRASOUND, ELECTROMAGNETIC AND MUON RADIATION MEASUREMENTS IN THE MÁTRA MOUNTAIN RANGE

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ABSTRACT. Matra Gravitational and Geophysical Laboratory (MGGL) has been established near Gyöngyösoroszi, in 2015 in an unused ore mine. The laboratory is 88m underground, therefore the collected data could provide information on noise reduction capabilities for third generation gravitational wave detectors. Specialized instruments have been installed to measure seismic, infrasound and electromagnetic noise. Furthermore, shielding of the cosmic muon radiation was investigated, too. In the test period, 2016 March–August (RUN-0), data collection has been accomplished. In this paper we describe the research potential of the Laboratory, list the installed equipments and summarize first experimental results. A theoretical background of noise damping in rock masses is summarized as well. However, we emphasise the preliminary nature of these data, the recent activity prepares the next period of systematic data collection (RUN-1).

1. INTRODUCTION

The recent discovery of gravitational waves by the LIGO/VIRGO Collaboration [25] generated a focused interest on the further improvements of the detection capability of these ground based facilities, reducing the surrounding environmental noise. A conceptual design study into the feasibility of a third-generation gravitational wave observatory, called the Einstein Telescope (ET), has been completed [1]. The undergound facility of KAGRA in the Okuhida mountains in Japan is close performing test run [2]. As part of the Einstein Telescope design phase, a ground motion study was performed to determine the seismic noise characteristics at various sites across the globe [3]. Such investigation has been performed in Hungary in 2010 at Gyöngyösoroszi in the Mátra mountain range (Fig. 1/a), indicating excellent parameters in noise reduction.

In 2015 the Matra Gravitational and Geophysical Laboratory (MGGL) of MTA Wigner Research Centre of Physics has been established in the Gyöngyösoroszi ore mine, which is out of operation in these days. The Laboratory is located in the coordinates (399 mBf, 711232.27, 281949.94 EOV), along the horizontal tunnel of the mine, 1280 m from the entrance, 88 m deep, in the former instruction office near to the first shaft. It is near to one of the sites of the above mentioned short term measurements [1, 3, 4]. In the MGGL several measurement tables were constructed

Date: October 12, 2016.

1

Summary

- Several month of data collected
- Internal water flow has no effect
  1000 – 5000 m^3/d
- No effect of rain and wind
- Measurements at 400 m below surface
  under preparation
- Averaged RMS - E: 0.19 at 88 m below surface
  in mine cultural noise: ~30 %
  external cultural noise: ~30 % - these can be reduced

Thank you for your attention!