

Jánossy Underground Research Laboratory

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Underground Physics

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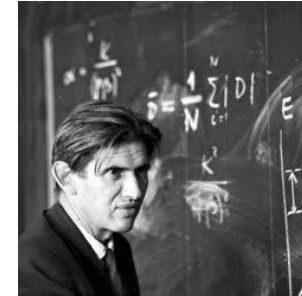
Lajos Jánossy (1912-1978)

Beginning of his career:

- Germany, England, Ireland
- experiment and theory
- cosmic rays, Geiger's coincidence

Later:

- application of probability and calculus to experimental results in nuclear physics and particle physics
- Jánossy densities



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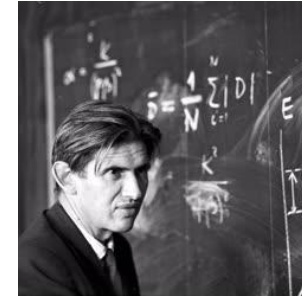
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- theory of relativity
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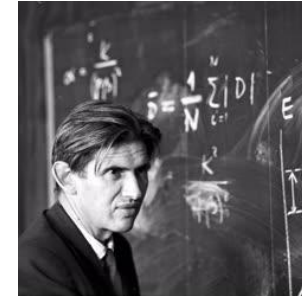
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Last one and a half decades of his theoretical activity:

- hydrodynamic model of quantum mechanics and the interpretation problems of the theory of relativity
- education and promotion of physics, organization of public science



Introduction

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- 1951: the laboratory was ready for experiments
- 1951-1952: early years
 - Geiger-Müller tubes and a Wilson cloud chamber were built
 - reproduction of the results of foreign experiments (e. g. measuring the lifetime of μ -mesons produced in the upper atmosphere)
 - investigations of large-scale cosmic showers
 - examination of cosmic background radiation was the only method to get new results at experimental high energy particle physics
- 1990-2010: the laboratory was abandoned
- 2010: renovations: renewing the building and upgrading the infrastructure
 - Muon tomography measurements were started



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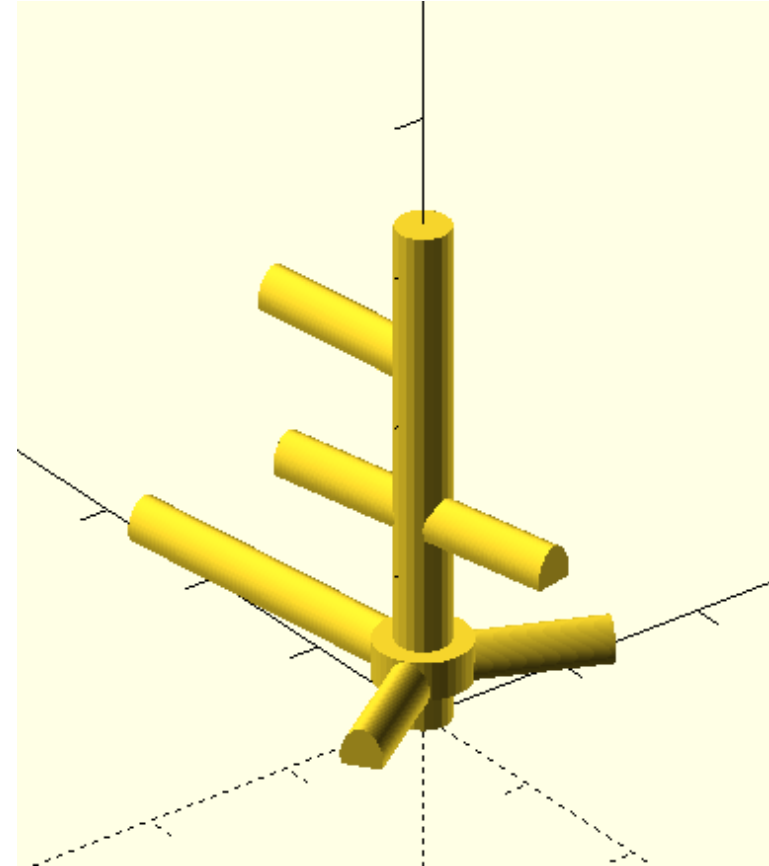
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Structure and Infrastructure

- 30m below the ground in Dachstein-type limestone
- The useful area of the lab is 150 sqm on 3 levels
 - 20 sqm at level -1,
 - 2x20 sqm at level -2
 - 2x20 sqm + 50sqm at level -3.
- 40 cm thick walls made from concrete for nuclear reactors
- air conditioning, uninterruptible power supply, internet and service/rescue telephone availability
- the site ideal for measurements that need low cosmic background
- also appropriate for other measurements that require stable temperature and low environmental- and seismic noise level
- physical environment is monitored by temperature-, pressure- and humidity sensors together with a seismometer and an infrasound microphone.
- full CAD model & density map is available

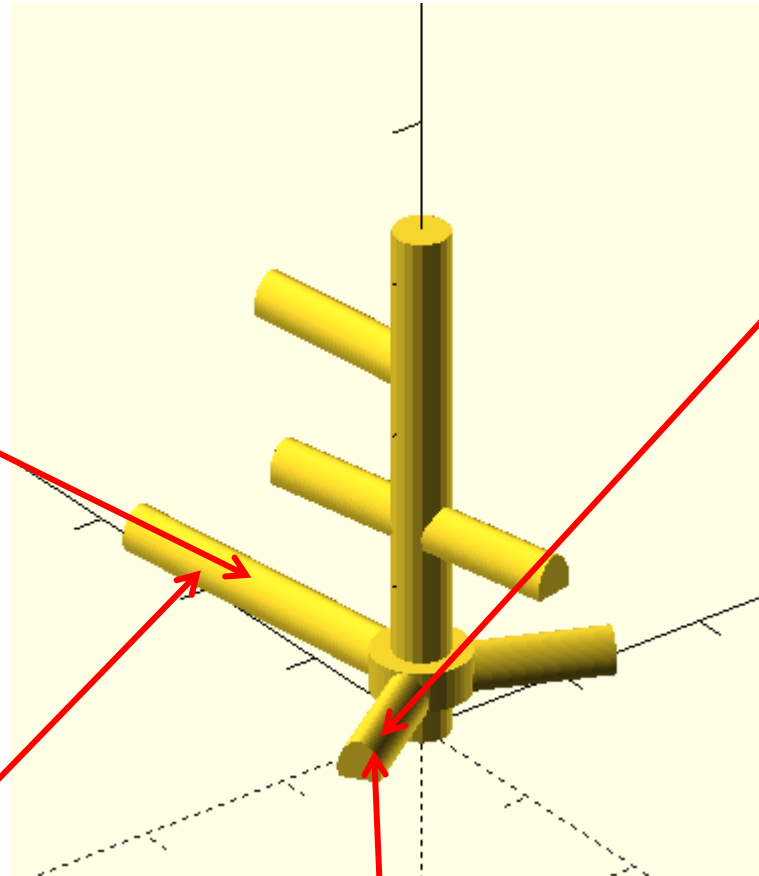


Ongoing Experiments



Re-measurement of the Eötvös Experiment

Infrasound and seismology



Radon detection



High Purity Germanium (HPGe) Radiation Detector

Muon tomography



Re-measurement of the Eötvös Experiment

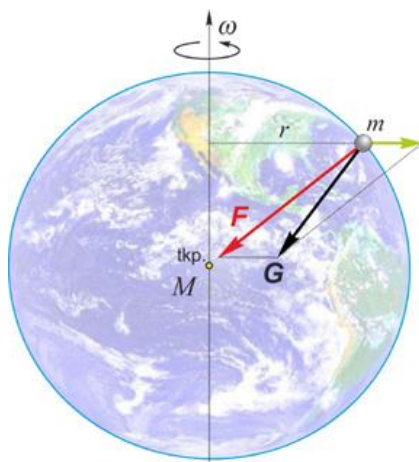
- weak equivalence principle
- gravito-gradiometers
- gradient effect

Fifth force mystery:

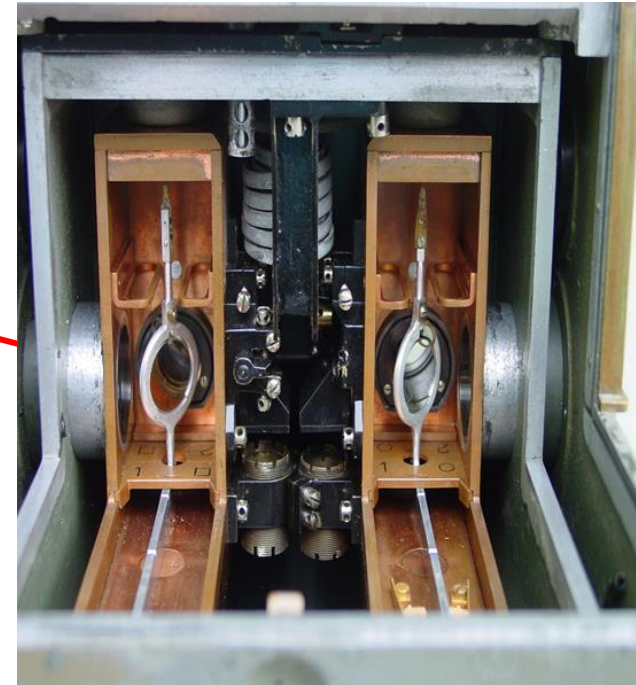
$$V(x) = -\frac{Gm_1m_2}{x} + FB_1B_2e^{-x/x_0}/x$$

$$V(x) = -\frac{Gm_1m_2}{x} \quad \text{if } x \gg x_0$$

$$V(x) = -\frac{G_{eff}m_1m_2}{x} \quad \text{if } x \ll x_0$$

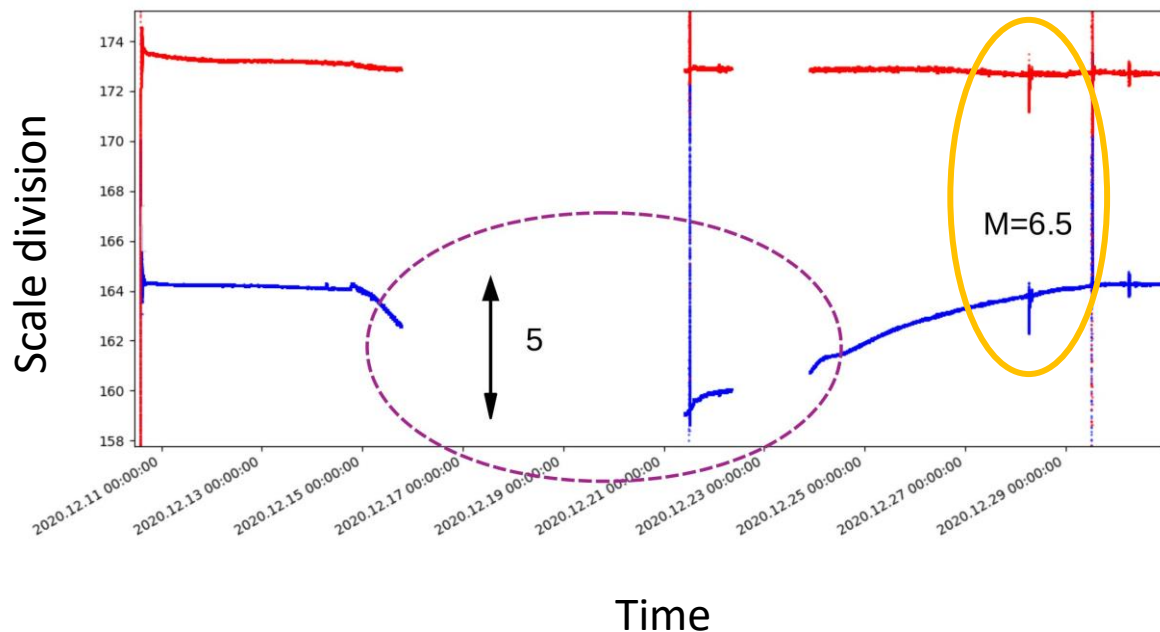


Re-measurement of the Eötvös Experiment

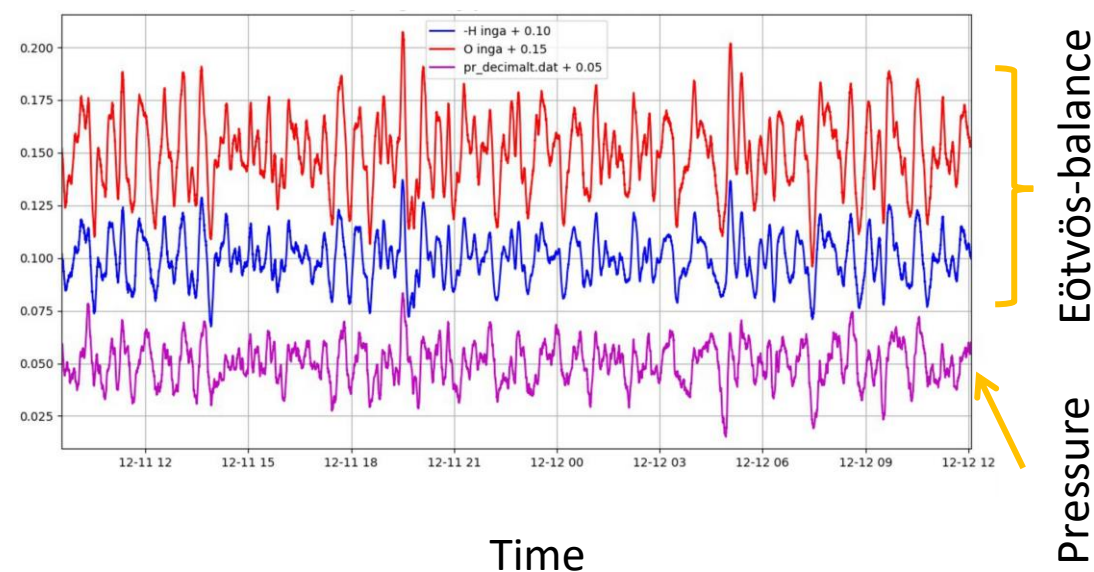


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Earthquake detection



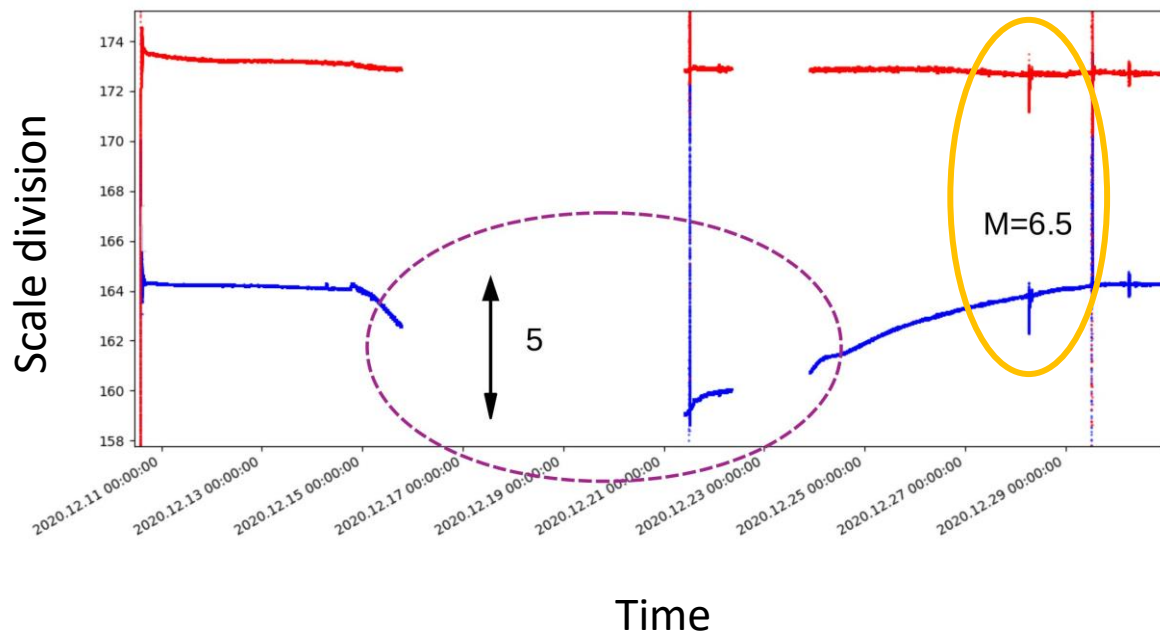
Pressure sensitivity



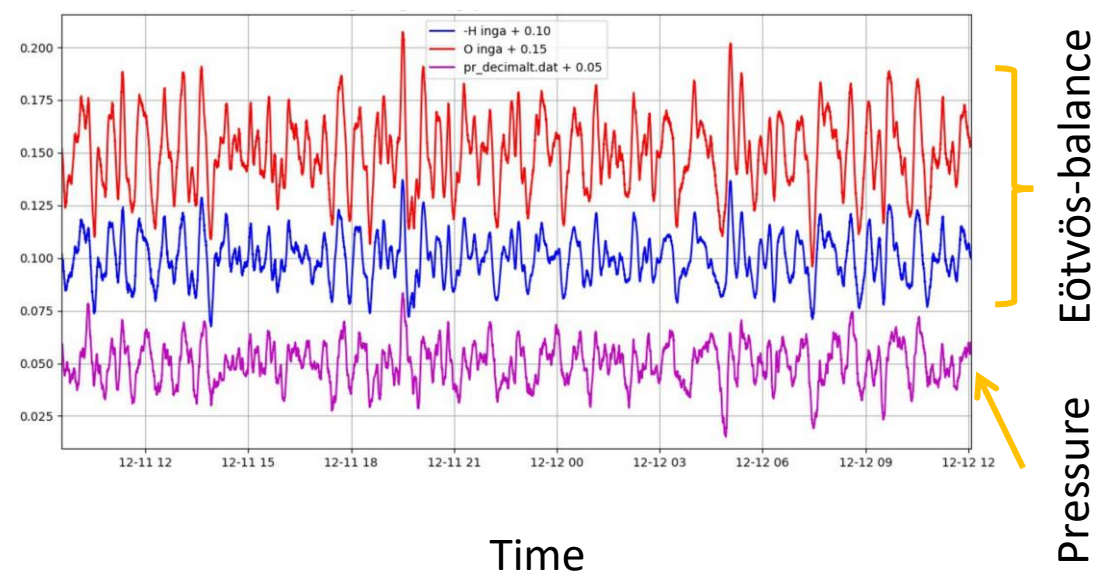
Eötvös-balance
Pressure

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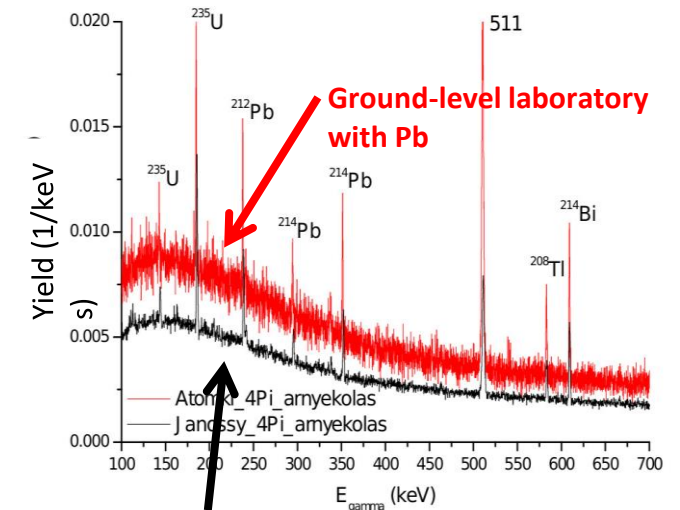


Eötvös-balance
Pressure

Low-background Radiation Measurements

High-purity Germanium (HPGe) detector:

- Nucleon synthesis measurements in weak decay channels with low radiation background
- Measurement of radiation decay anomaly
- Radon measurements with stable and variable environmental conditions
- Remote-controlled, automatized long-range measurements (Canberra + Lynx DSP)



Jánossy Underground
with Pb

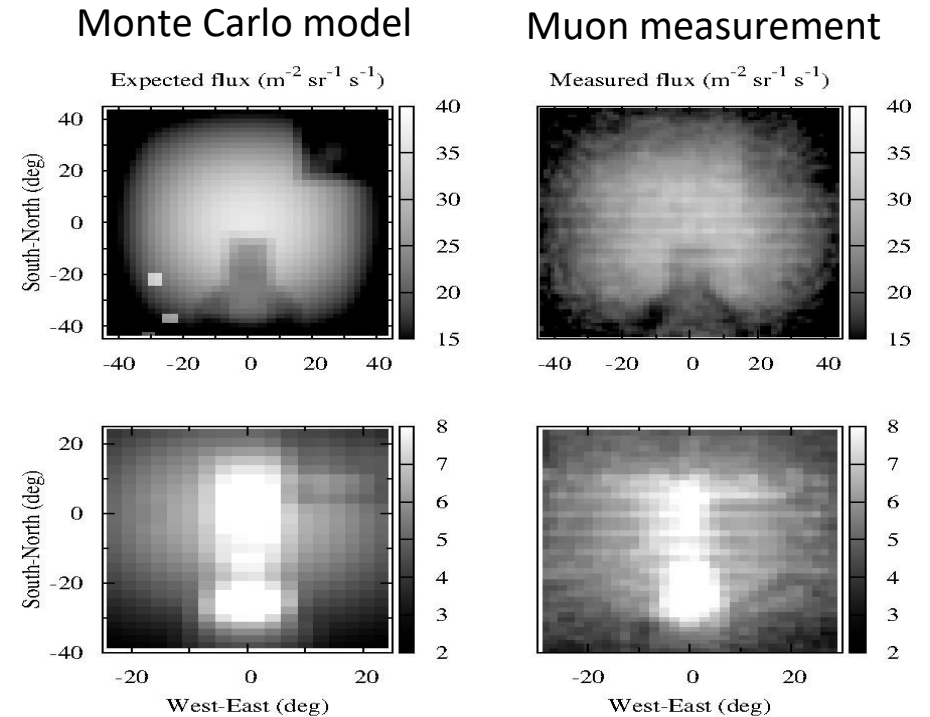
Refs: Activation thick target yield measurement of $^{100}\text{Mo}(\alpha, n)^{103}\text{Ru}$ for studying the weak r-process nucleosynthesis (accepted in PLB)

Muon tomography developments

Cosmic muon radiography & tomography:

- Developments and test of the ReGaRD's innovative portable muontomograph
- Environmental applications: unknown cave searches, online vulcanic activity monitoring
- Industrial application: building & civil engineering structurala measuremetns by cosmic muons

Refs: *Adv.High Energy Phys.* 2013 (2013) 560192, *PoS NICXIII* (2015) 129; *Nucl.Instrum.Meth.A* 689 (2012) 60-69
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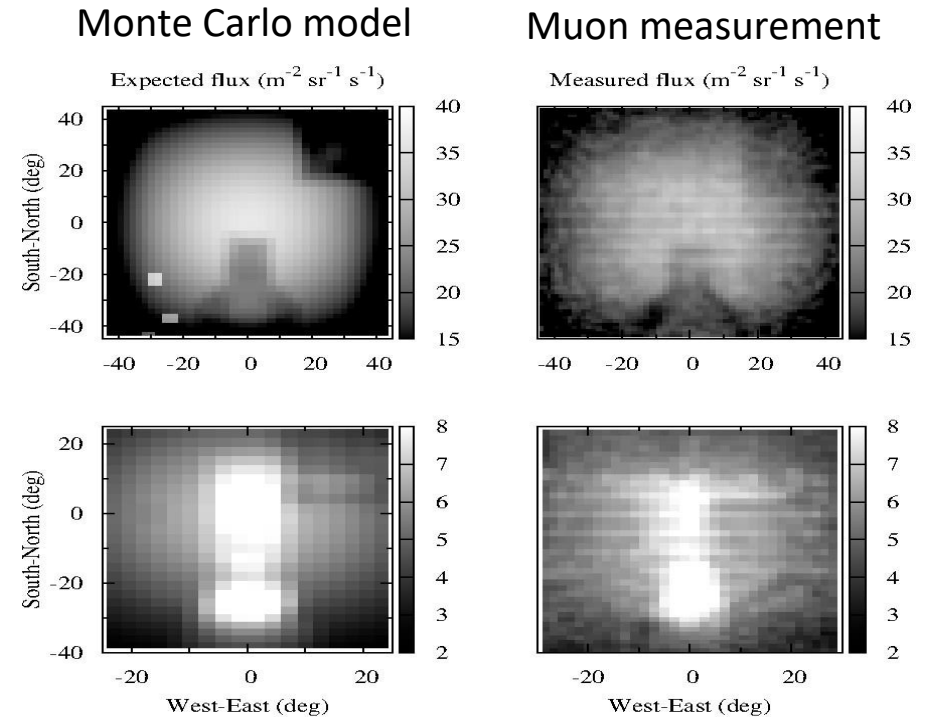


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Infrasound and seismology

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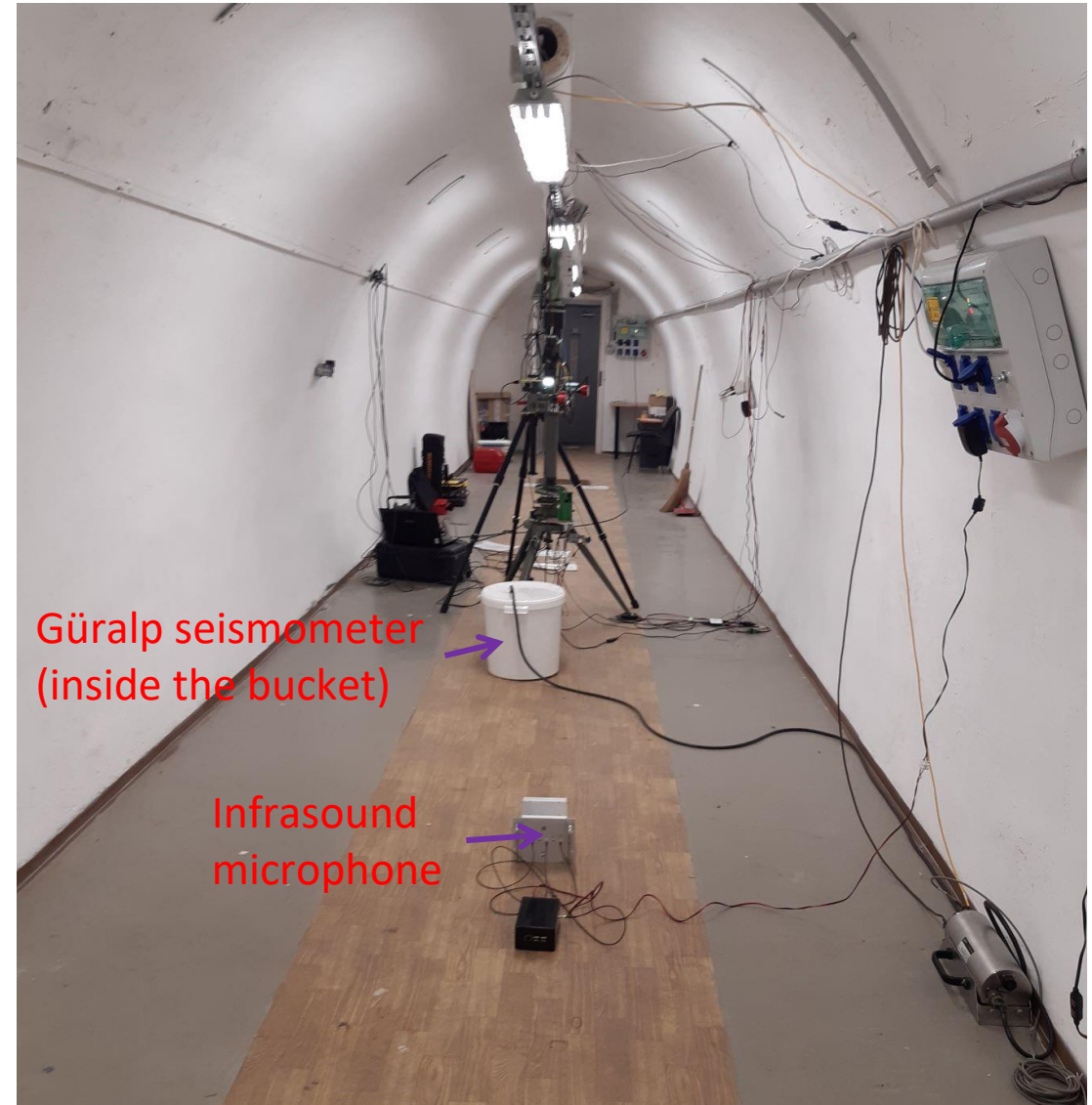
- To explore the origin of noises of different measurements
- To study the behaviour of infrasound and seismic background noise 30 m below the ground.
- To see the attenuation of the noises at different depths



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Summary & Contacts

Jánosy Underground Research Laboratory:

- Open national infrastructure
- Remote control
- Automatized measurements
- Minimized human activity
- Controlled environmental parameters in laboratory

Contact:

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