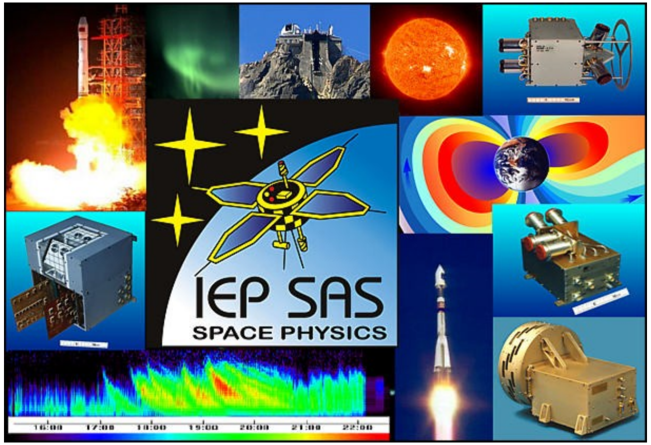
# Research of Cosmic Rays at the Lomnický štít observatory

**Baláž Ján, Bobík Pavol, Kubančák Ján, Langer Ronald, Mackovjak Šimon, Pastirčák Blahoslav, Strhársky Igor a ďalší**

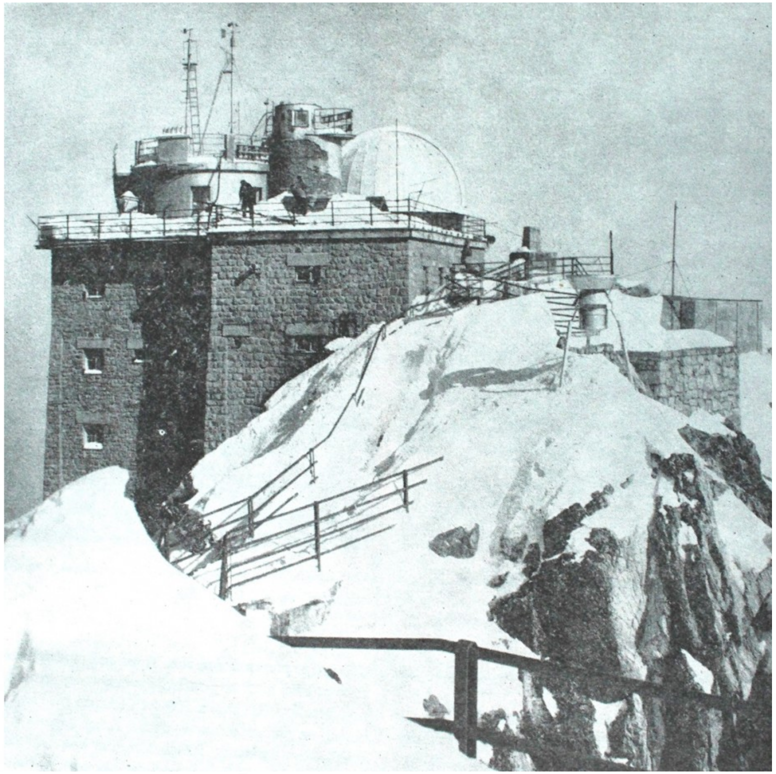
# Beginning of cosmic rays research in Slovakia (Czechoslovakia)

- research of cosmic rays in Slovakia dates back into after WWII period and is closely related to the Lomnicky stit observatory
- in 1958, Lomnicky stit observatory joined the cosmic rays research groups within the international geophysical year, the new academic building (attached to the old one)
- nowadays, research continues in Slovakia with IEP SAS as the operator of the neutron monitor and SEVAN instruments at the Lomnicky stit





# Beginning of cosmic rays research in Slovakia (Czechoslovakia)



# First important international article

**Nature 168, 1004 (08 December 1951)**

Determination of the Mean Life-time of μ-Mesons

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***doi:10.1038/1681004a0***



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## Determination of the Mean Life-time of μ-Mesons

THE photographic emulsion method has been applied to the determination of the mean life-time of μ-mesons from their anomalous absorption. Ilford C 2 plates with emulsion thicknesses 140 μ, 150 μ and 185 μ were exposed to cosmic radiation under controlled conditions for 42 days during the winter of 1950 in the High Tatra Mountains. One batch of plates was exposed without any absorber at Skalnaté Pleso (1,780 m.) and another one was placed on the top of Lomnický Štít (2,640 m.) under 12 cm. of lead absorber, corresponding in stopping power to the layer of air, 85 gm./cm.², between the two stations. The plates were developed by the freezing method of C. C. Dilworth[1].

The mean life-time $\tau_0$ of μ-mesons was calculated from the formula

$$\tau_0 = \frac{m_0}{p} L, \qquad (1)$$

where $m_0$ is the rest mass of the μ-meson, $p$ is the effective momentum and $L$ is the mean range before decay. The rest mass of mesons was determined by grain counting and Coulomb scattering methods, giving the result $m_0 = 110$ MeV./$c^2$. The effective momentum $p$ was calculated by numerical integration of the Bethe–Bloch formula and corrected according to B. Rossi and D. B. Hall[2]. The mean range before decay was calculated from the formula:

$$L = -(H_1 - H_2)\left(\log \frac{N_2}{N_1}\right)^{-1}, \qquad (2)$$

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where $H_1$ is the height of Lomnický Štít, $H_2$ is the height of Skalnaté Pleso, $N_1$ is the number of mesons in a given volume of the emulsion from the higher station under lead, $N_2$ is the number of mesons in the same volume of the emulsion exposed at the lower station.

Substituting the measured and calculated values of $m_0$, $p$, and $L$ in formula (1), we obtained for the mean life-time of the μ-meson, $\tau_0 = (2\cdot3 \pm 0\cdot3) \times 10^{-6}$ sec., in good agreement with the value $\tau_0 = (2\cdot15 \pm 0\cdot1) \times 10^{-6}$ sec. from direct measurements.

This method makes it possible to work with mesons in the low-energy region where the absorption anomaly[2] is more pronounced and where the polarization of the medium[3] is negligible. Since it is possible to measure the mass $m_0$ of mesons from the tracks observed, we were able to determine the value of $\tau_0$ directly, whereas using Geiger–Müller counters it is possible to obtain from the anomalous absorption the value of the ratio $\tau_0/m_0$ only. In this way, our measurements show that ρ-mesons are almost exclusively μ-mesons.

A detailed account of this work will be published in the *Bulletin international de l'Académie tchèque des Sciences*. I am indebted to Prof. V. Petržílka for helpful discussions during the course of this work.

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July 25.

# First time series of cosmic rays measurements

THREE VARIATIONS IN THE INTENSITY OF COSMIC RADIATION IN THE FIRST HALF OF 1958

J. Hladký, P. Chaloupka, V. Kadečka, T. Kowalski,* P. Mokrý
*Institute of Physics, Czechosl. Acad. Sci., Prague*

*The time courses are given of three variations in the intensity of cosmic radiation, which occurred in the first half of 1958. The measuring apparatus is described and the energies of the particles recorded a reestimated. The paper is the partial result of systematic measurements of the intensity of cosmic radiation carried out in Czechoslovakia in the International Geophysical Year.*

**Czechosl. Journ. Phys. 6 (1956) 2**

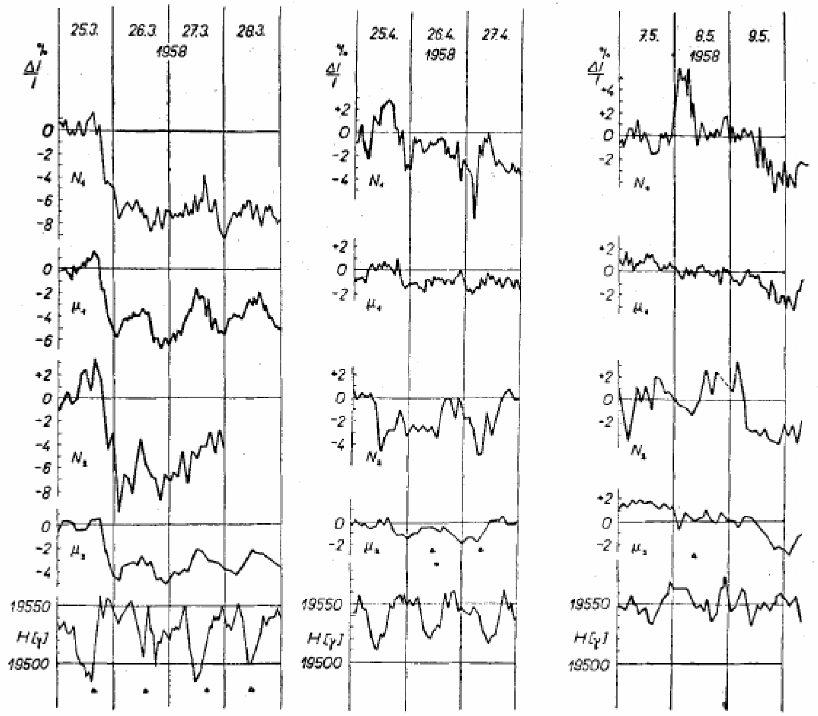



Fig. 3. Fig. 4. Fig. 5.

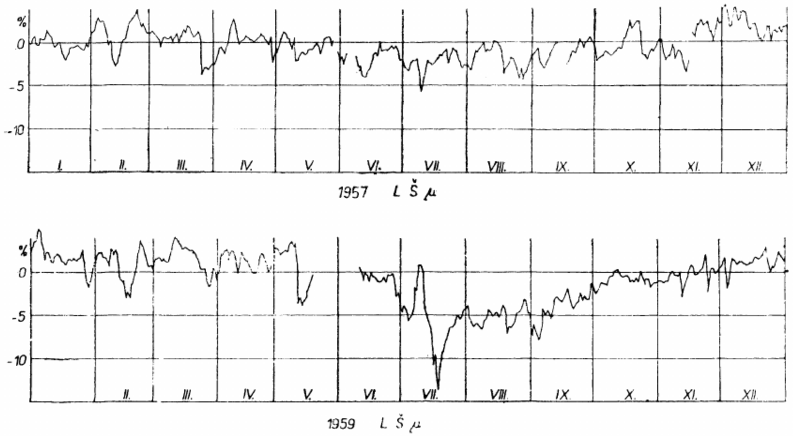
Fig. 3—5. Course of variation in intensity of penetrating and neutron components of cosmic radiation and horizontal component of intensity of Earth's magnetic field. $N_1$ neutron monitor Lomnický Štít, $\mu_1$ cubic telescope Lomnický Štít, $N_2$ neutron monitor Prague, $\mu_2$ cubic telescope Prague, $H$ horizontal component of intensity of Earth's magnetic field. ○ beginning of magnetic storm, △ Dellinger effect.

# First time series of cosmic rays measurements

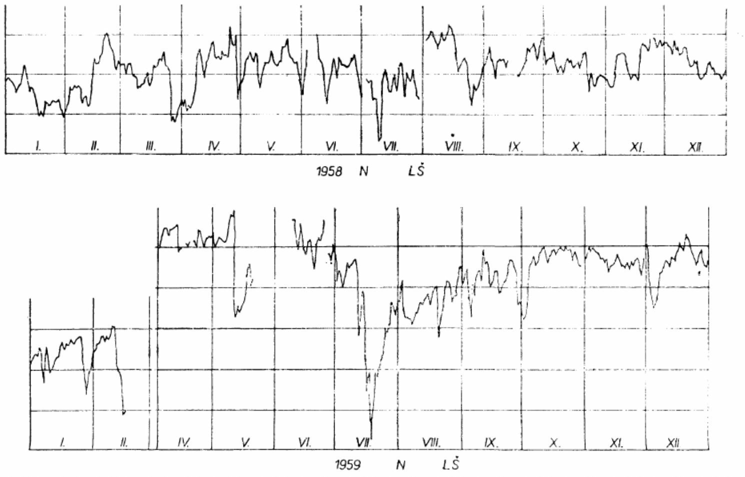
MATEMATICKO-FYZIKÁLNY ČASOPIS SAV, X, 4-1960

## PRIEBEH INTENZITY KOZMICKÉHO ŽIARENIA V ROKOCH 1958—1959

JURAJ DUBINSKÝ, PAVEL CHALOUPKA, TADEUSZ KOWALSKI

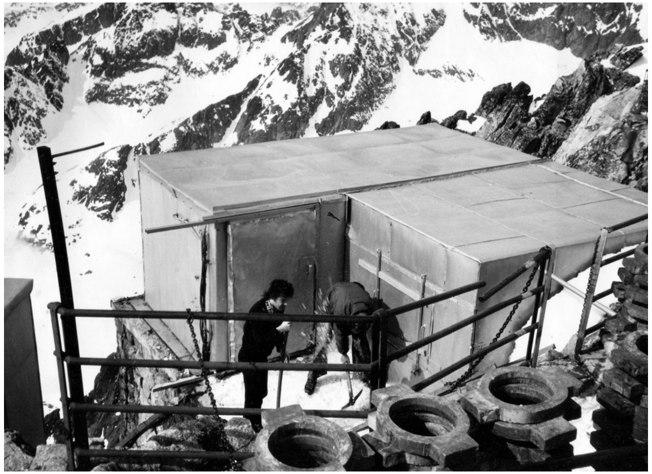



Obraz 1. Priebeh intenzity mezónovej zložky v r. 1958 a 1959 na Lomnickom štíte (2634 m).




Obraz 2. Priebeh intenzity neutrónovej zložky na Lomnickom štíte (2634 m), od 1. I. 1958 do 17. II. 1959 a od 2. IV. 1959 do 31. XII. 1959 (od 18. II. 1959 do 1. IV. 1959 bolo meranie na monitore prerušené pre úpravu terénu v súvislosti so stavbou laboratória na Lomnickom štíte.)

# Cosmic rays measurements at the Lomnický štít



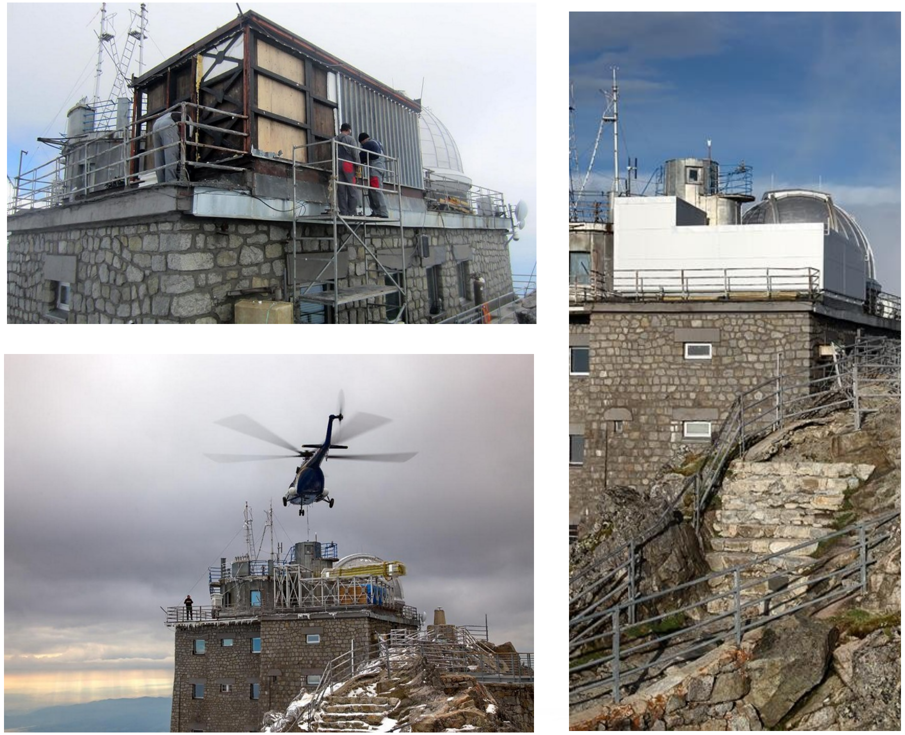
**First neutron monitor**
*4NM64 operated from 1970 – 1981.*

**Place after removal of first neutron monitor**


**Skywalk**

# Cosmic rays measurements at the Lomnický štít

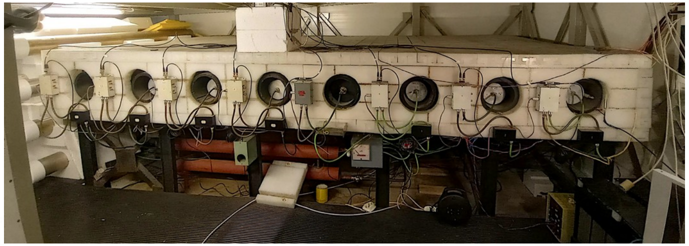
- **Neutrónové monitory na Lomnickom štíte**
  - 1970-1981 - operation of a neutron monitor located outside the main building, which proved to be an inappropriate location; 4 NM tubes in operation
  - since December 1981 - measurement of secondary cosmic rays using the 8NM64 detector located in the measurement house on the roof of the building
  - continuous measurement to this day, first with a resolution of 1 hour and 5 minutes, later 1 minute and today 1 second
  - May 2012 - general reconstruction of the measuring house



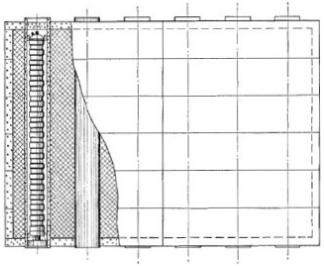
Reconstruction of the measuring house on Lomnický Štít, May 2012

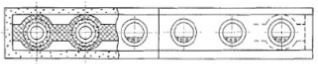
# Cosmic rays measurements at the Lomnický štít

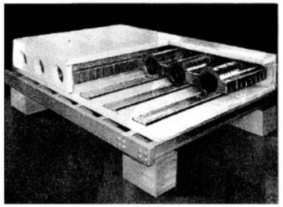
- **Current state of the measurements**
  - 8NM64, counter tubes SNM-15 ($^{10}BF_3$) continuous operation since 12 / 1981
  - SNM-15 are going to be replaced with LND tubes
  - mass of the lead: ~ 11 000 kg
  - mass of the polyethylene: ~ 1 800 kg reflector & ~ 240 kg moderator

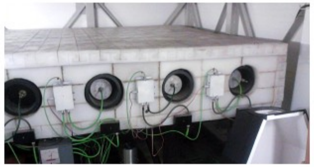


8NM64 neutron monitor at the Lomnický štít





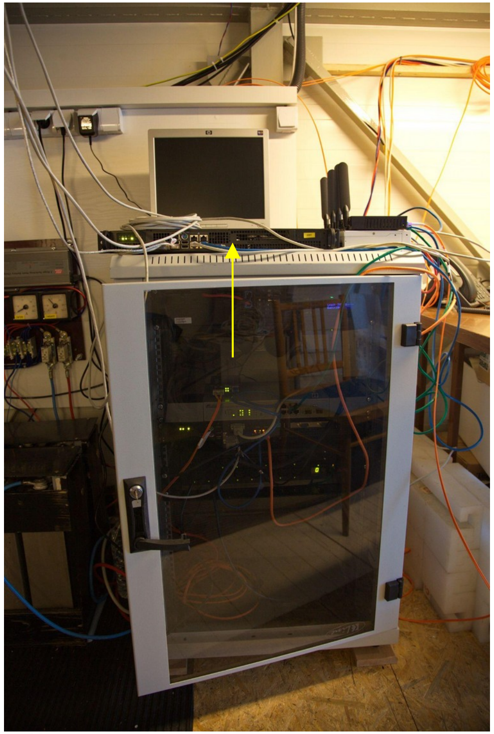




# Cosmic rays measurements at the Lomnický štít

- **Outputs and further processing**
  - NEMO-X
  - NMDB.EU
  - DAPRES


**NEMO-X –** Miniaturized read-out module NEMO-X

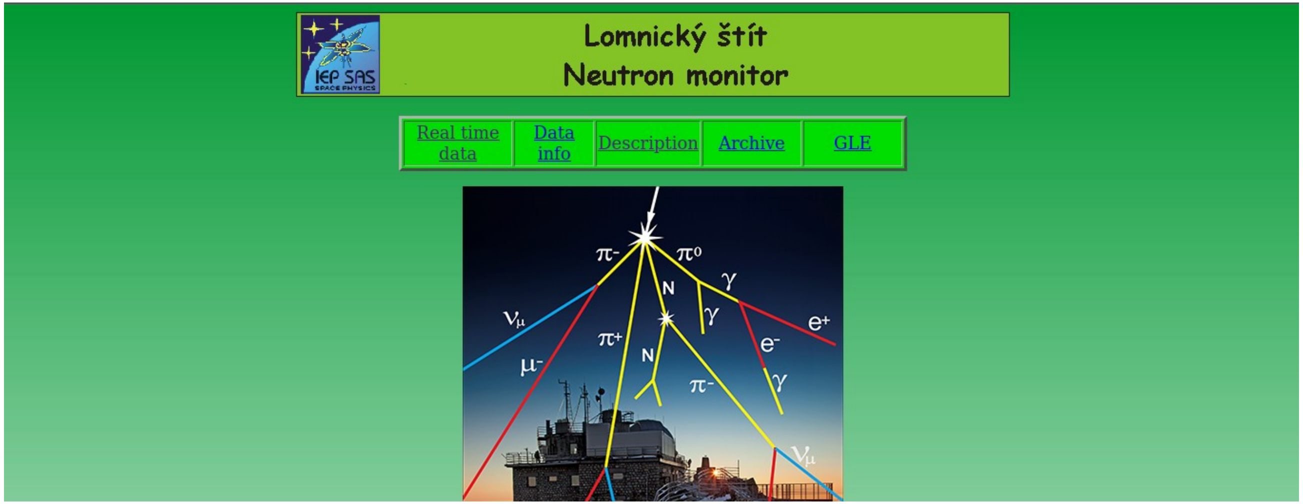


Highest located server in Slovakia

# Cosmic rays measurements at the Lomnický štít

**WARNING: NEW DOMAIN NAME FOR OUR OLD WEB SITE: http://neutronmonitor.ta3.sk**

## http://neutronmonitor.saske.sk



# Cosmic rays measurements at the Lomnický štít

**Space physics database centre**

Devices Status Logs Admin

Logged in as admin [admin] (Log out)

Status

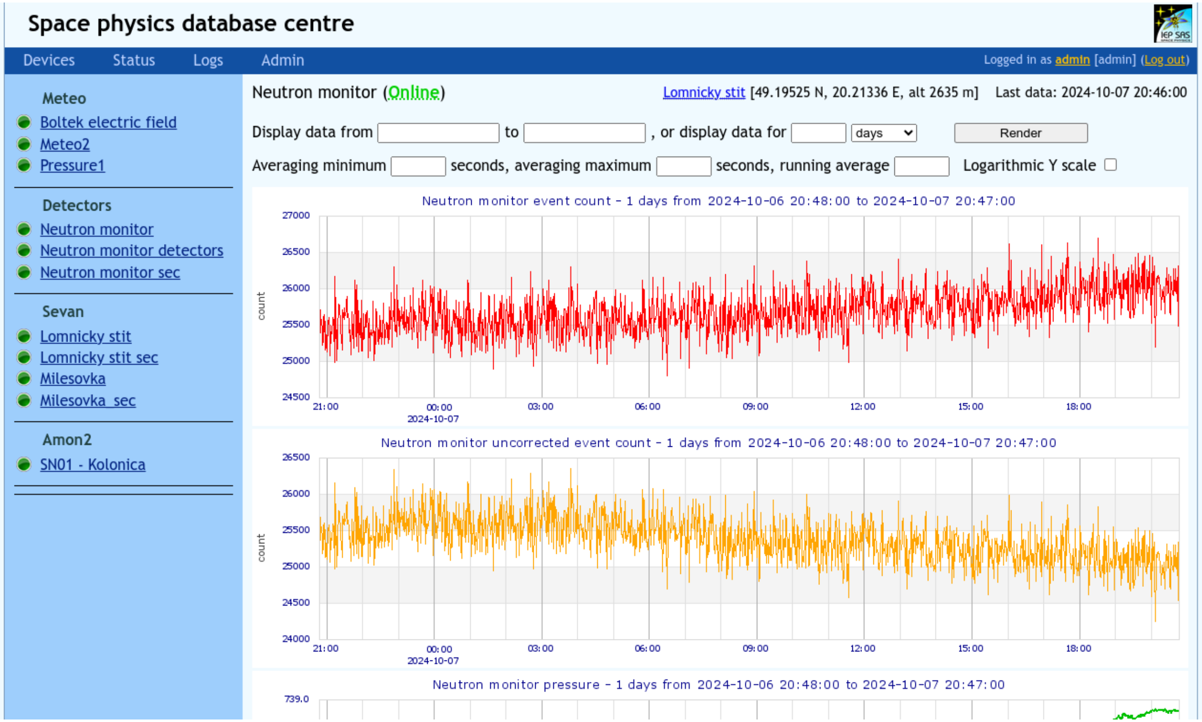
Status

| Device name | Status | Last timestamp |
|---|---|---|
| Meteo | | |
| Boltek electric field | Online | 2024-10-07 20:36:33 |
| Meteo2 | Online | 2024-10-07 20:35:00 |
| Pressure1 | Online | 2024-10-07 20:35:00 |
| Detectors | | |
| Neutron monitor | Online | 2024-10-07 20:35:00 |
| Neutron monitor detectors | Online | 2024-10-07 20:35:00 |
| Neutron monitor sec | Online | 2024-10-07 20:36:33 |
| Sevan | | |
| Lomnicky stit | Online | 2024-10-07 20:36:00 |
| Lomnicky stit sec | Online | 2024-10-07 20:36:34 |
| Milesovka | Online | 2024-10-07 20:35:00 |
| Milesovka_sec | Online | 2024-10-07 20:35:59 |
| Amon2 | | |
| SN01 - Kolonica | Online | 2024-10-07 20:36:33 |



**http://data.space.saske.sk/**

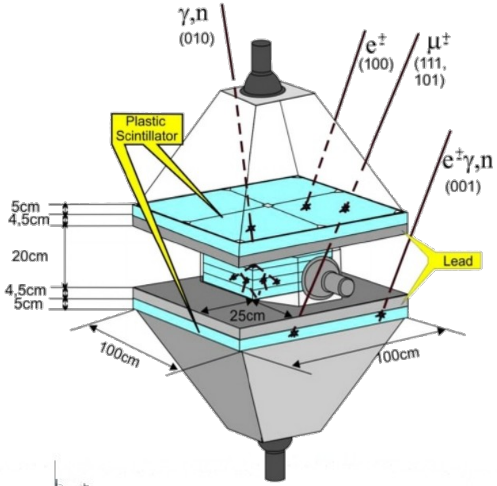
# Cosmic rays measurements at the Lomnický štít




http://data.space.saske.sk/

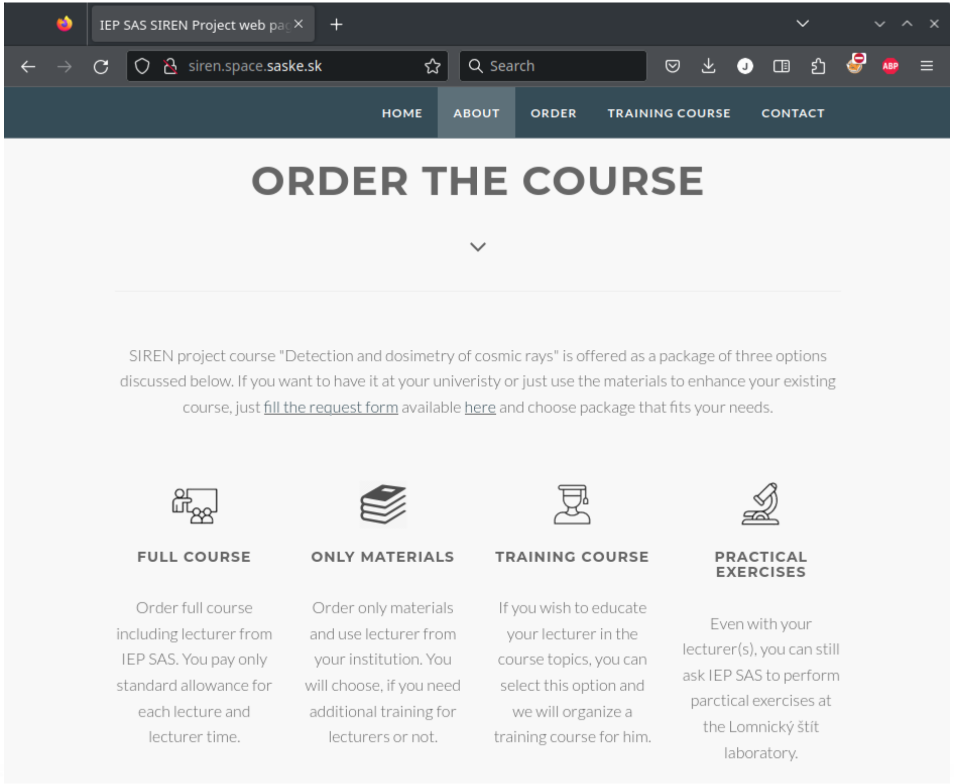
# Cosmic rays measurements at the Lomnický štít

- **SEVAN na Lomnickom štíte**
  - in continuous operation since 2014




# Educational activities

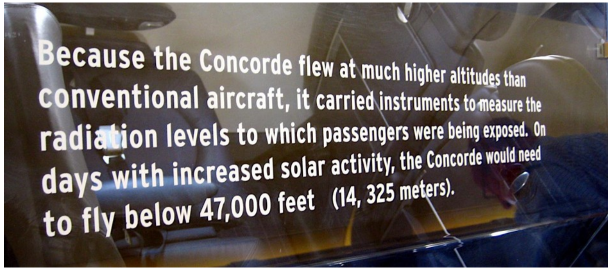
- **educational activities**
  - interdisciplinary course focused on detection and dosimetry of cosmic rays
  - **SIREN - S**pace **I**onizing **R**adiation **E**xperts **N**ursery (2020 - 2021)
  - project supported by the European Space Agency
  - **COURSE MATERIALS AVAILABLE FOR FREE** (after filing request form)
  - electronic study book and electronic lectures
  - web-site: http://siren.space.saske.sk/



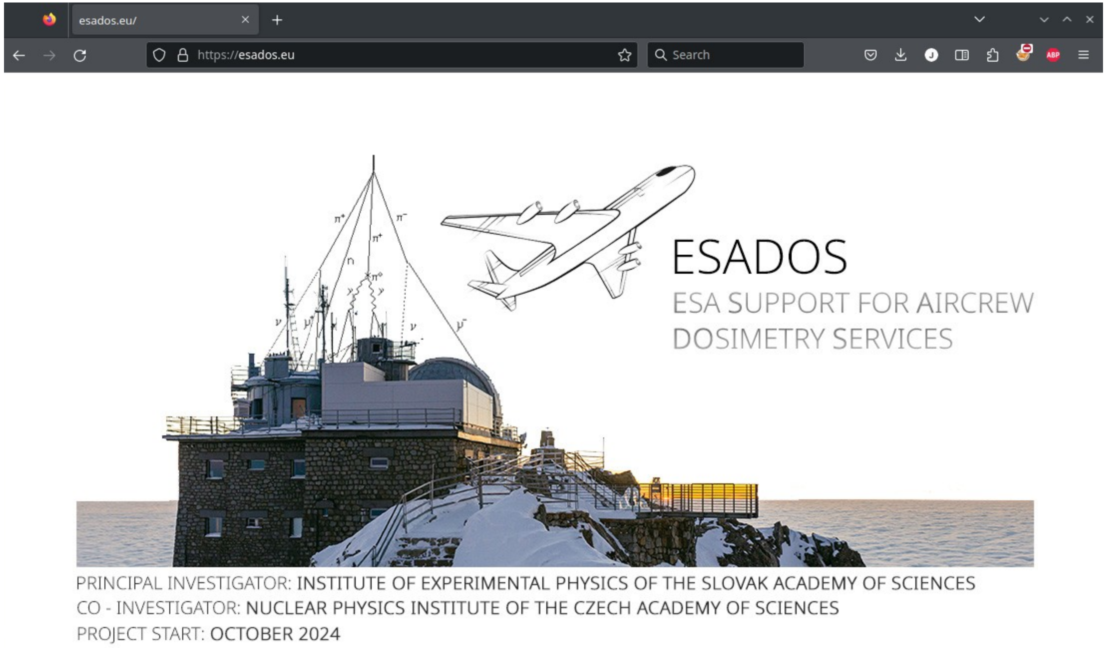

**SIREN.SPACE.SASKE.SK –**Official project website

# Plans for future

- **project ESADOS**
  - **E**SA **S**upport for **A**ircrew **DO**simetry **S**ervices
  - start IV/2025




**CONCORDE –** Radiation warning. Intrepid museum, NYC

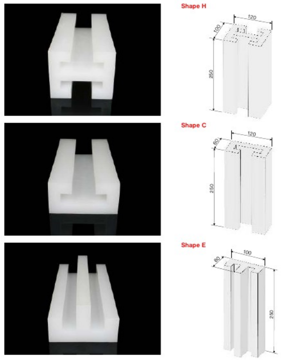


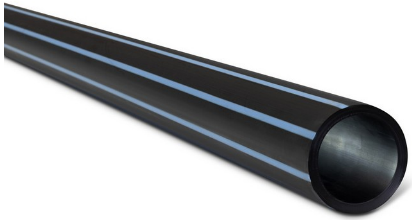

**ESADOS.EU –** Official website

# Plans for future

- **common neutron monitor operated in Poland**
  - Polish Air-Force University & IEP SAS & …. you all are welcome
  - currently in stadium of search for full funding

- **example of problems we encounter**
  - NM64 requires inner moderator diameter of 107 mm and outer diameter o 127 mm, wall thickness of 20mm
  - standard available pipeline tube (DN125 SDR11 PE100 ) offer outer diameter of 125 mm, wall thickness of 22,7 mm resulting inner diameter of 102,7 mm
  - difference is only 4,3 mm but is acceptable?

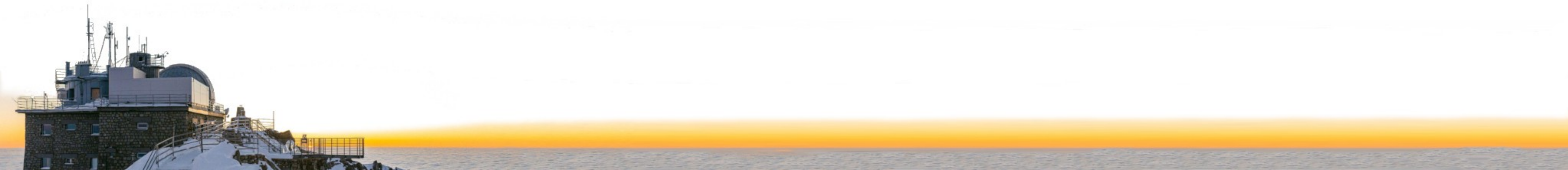



| Date | EUR/USD | USD/Ton | EUR/Ton | EUR/USD Performance(%) | | USD/Ton Performance(%) | | EUR/Ton Performance(%) | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | 1 day | 90 days | 1 day | 90 days | 1 day | 90 days |
| 01-08-2024 | 1.0793 | $ 2047 | € 1897 | -0.32 ▼ | 0.44 ▲ | 1.14 ▲ | -5.06 ▼ | 1.46 ▲ | -5.47 ▼ |
| 02-08-2024 | 1.0830 | $ 2000 | € 1847 | 0.34 ▲ | 0.78 ▲ | -2.30 ▼ | -7.24 ▼ | -2.63 ▼ | -7.96 ▼ |
| 05-08-2024 | 1.0959 | $ 1917 | € 1750 | 1.19 ▲ | 1.79 ▲ | -4.15 ▼ | -12.74 ▼ | -5.28 ▼ | -14.28 ▼ |
| 06-08-2024 | 1.0915 | $ 1905 | € 1746 | -0.40 ▼ | 1.58 ▲ | -0.63 ▼ | -12.89 ▼ | -0.23 ▼ | -14.25 ▼ |

# Please could you help us?

- what is the proper way to determine the heliocentric potential from the neutron monitor response
- is it common / how to correct response of NM tube for decreasing level of $^{3}H$ / $^{10}B$ in working gas
- NM64 NM are standardized models of detectors, how is it with electronics, data output?
- materials available today: PP, PE, LDPE, HDPE, which one to use?
- standard dimensions pipeline tube or custom-tailored moderator tube?
- is there any universal guide for construction, operation and maintenance of standard NM64 type neutron monitors?




*The laboratory at the Lomnicky stit was scientifically and organizationally led for a long time by Prof. Ing. Karel Kudel, DrSc. (5. 9. 1946 Ostrava – 20. 1. 2019 Košice).*

*Thanks to his enthusiasm, scientific work, expertise and personal contacts, an active international collaboration was launched, which continues to this day and yields valuable scientific results.*

*Without him, we would not be here in Athens now.*

*For all of this, we owe him our sincere thanks.*

Thank you for your attention.