



THUNDERSTORMS & ELEMENTARY PARTICLE ACCELERATION



ÚSTAV JADERNÉ FYZIKY AV ČR
veřejná výzkumná instituce

**TEPA-2023
SYMPOSIUM
PROGRAMME**
October 2-5,
Conference Hall of the
Czech Academy of
Sciences,
Narodni 3, Prague,
Czechia

http://crd.yerphi.am/TEPA_2023

**THUNDERSTORMS & ELEMENTARY PARTICLE
ACCELERATION**



GENERAL INFORMATION:

TIME FRAME: October 2-5, 2023

VENUE: Conference Hall of the Czech Academy of Sciences,

Národní 3, Prague, Czechia

SYMPOSIUM WEBSITE:

http://crd.yerphi.am/TEPA_2023

ORGANIZERS:

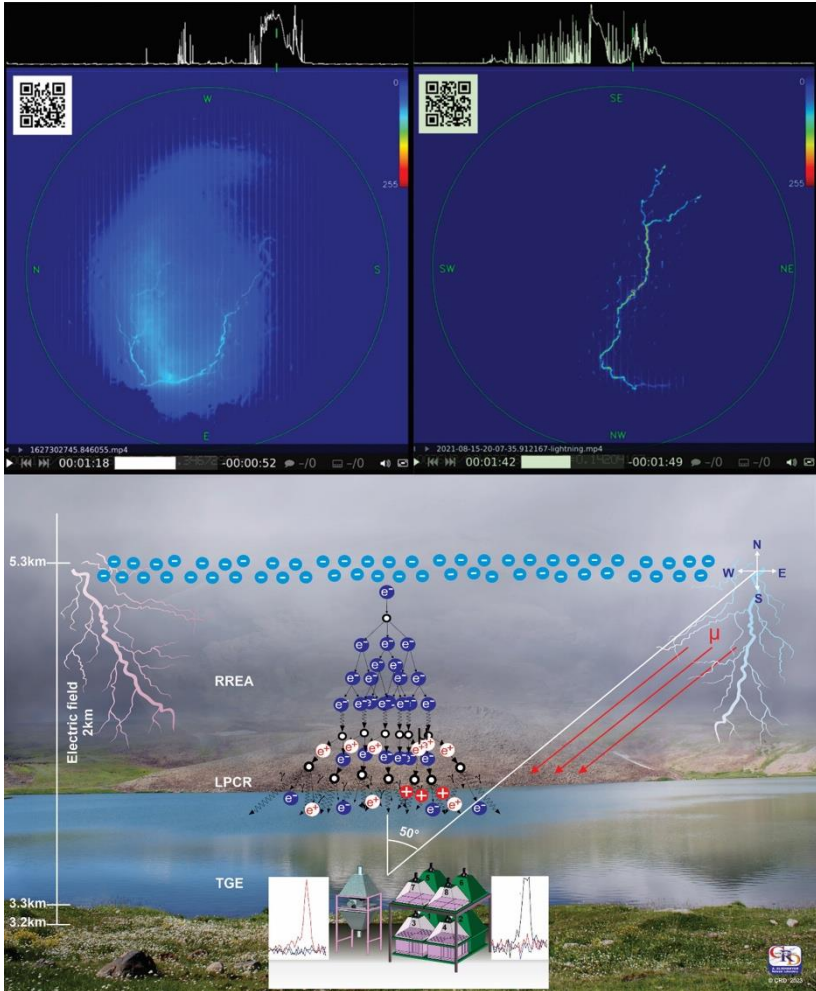
Cosmic Ray Division
of Yerevan Physics Institute, Armenia

**Research Centre of Cosmic Rays and Radiation Events in Atmosphere
(CRREAT)**

Nuclear Physics Institute of the CAS, Czechia



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Strong atmospheric fields originate both lightning flashes and TGEs. Measured modulation of the cosmic ray fluxes by the atmospheric electric fields allows the recovery of the structure of charge distribution in the thunderclouds.

INTERNATIONAL ADVISORY COMMITTEE:

Ashot Chilingarian, Yerevan Physics Institute, Armenia, chair

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Harufumi Tsuchiya, Cosmic Radiation Laboratory, Riken, Japan

BACKGROUND:

High-energy physics in the atmosphere (HEPA) has undergone an intense reformation in the last decade. Correlated measurements of particle fluxes modulated by strong atmospheric electric fields, simultaneous measurements of the disturbances of the near-surface electric fields and lightning location, and registration of various meteorological parameters on the Earth have led to a better understanding of the complex processes in the terrestrial atmosphere. In May 2023, large TGEs were detected at Lomnický štít and Aragats, which demonstrated the success of the first TGE research campaign on the mountaintops in Eastern Europe and Armenia. These extreme events shed light on the entire HEPA scientific field and indicate that TGE is a universal physical phenomenon that originates in the thunderous atmosphere, caused by the strongest natural electron accelerator. The cooperation of cosmic rays and atmospheric physics has led to the development of models for the origin of particle bursts recorded on the Earth's surface, estimation of vertical and horizontal profiles of electric fields in the lower atmosphere, recovery of electron and gamma-ray energy spectra, the muon deceleration effect, etc. Visualization and statistical analysis of particle data from hundreds of measurement channels disclosed the structure and strength of the atmospheric electric fields and explained observed particle bursts. More and more groups worldwide are monitoring particle fluxes around the clock using synchronized networks of advanced sensors that record and store multidimensional data.

Various particle accelerators operate in the cosmic plasma, filling the galaxy with high-energy particles. Reaching the Earth's atmosphere, these particles cause extensive air showers (EASs) consisting of millions of elementary particles (secondary cosmic rays), covering several km² on the ground. During thunderstorms, strong electric fields modulate the energy spectra of secondary particles and cause short and long particle bursts. Large amplifications of particle fluxes (the so-called thunderstorm ground enhancements TGEs) manifest themselves as prominent peaks in the time series of count rates of particle detectors, coinciding with a strong atmospheric electric field accelerating and multiplying the free electrons of cosmic rays. Free electrons, abundant at any altitude in the atmosphere from the small to large EASs, serve as seeds for atmospheric electron

accelerators, an analog of “electron guns” in artificial accelerators. EAS cores randomly hitting arrays of particle detectors generate short bursts of relativistic particles with a duration of less than 1 μ s. We plan to discuss the origin of the particle bursts recently reported as inverse TGFs, disclosing their relation to lightning flashes and/or the EAS cores.

Violent solar bursts fill the interplanetary space with immense magnetized plasma structures, moving up to 3000 km/s (the so-called interplanetary coronal mass ejection ICME) and perturbing the interplanetary magnetic field (IMF) and the magnetosphere. These disturbances could lead to major geomagnetic storms damaging multi-billion-dollar assets in space and on Earth. Monitoring the high-energy particles can provide highly cost-effective information for predicting geomagnetic storms. For fundamental research in solar physics, solar–terrestrial relations, and space weather, as well as for forecasting the dangerous consequences of space storms, networks of particle detectors located in different geographical coordinates and measuring various types of secondary cosmic rays are vital. Geophysical research is becoming increasingly important with rising natural disasters in the coming decades. Solar, astrophysical, and atmospheric physics are synergistically linked and must be integrated to reveal the consequences of violent solar flares and extreme atmospheric electric fields. The synergy of high-energy space and atmospheric physics will open up new research areas for a better understanding and development of geospace physics. The new view of thunderclouds as media full of radiation can help to establish a comprehensive theory of cloud electrification and estimate the possible role of cloud radiation on climate change. The influence of the electrifying atmosphere on the fluxes of electrons and other charged particles can be significant for experiments registering very-high-energy photons (Atmospheric Cherenkov telescopes) or electrons and hadrons (Surface arrays registering Extensive Air Showers). The TEPA meeting allows scientists to discuss the current ideas and exploit synergies between Atmospheric and Cosmic ray physics.

PROGRAMME OF TEPA-2023

Monday, October 2nd, Academy of Sciences, Národní 3, Prague

9:30 – 10:00 *Registration* Czech Academy of Sciences, Národní 3, Prague, Czechia

10:00 – 10:20 *Welcome, Opening ceremony, Organizational issues*

Scientific Session 1:

Multivariate observations of particles and fields (TGE physics)

Chairperson – Martin Kákona

10:20 – 11:00 **Ashot Chilingarian, Yerevan Physics Institute, Armenia (YerPhi)**, Enormous enhancement of the Natural Gamma Radiation during Thunderstorm Ground Enhancements on May 23,

11:00 – 11:30 **Coffee/Tea Break**

11:30 – 12:00 **Ondřej Ploc, Nuclear Physics Institute CAS (NPI)**
The Continued Journey of the CRREAT Project

12:00 – 12:30 **Iva Ambrožová, NPI**
Metrology for Earth Biosphere: Cosmic Rays, Ultraviolet Radiation and Fragility of Ozone Shield

12:30 – 13:30 **Lunch**

13:30 – 14:00 **Jakub Šlegl, NPI**
Second strongest TGE ever detected on Lomnický štít

14:00 – 14:30 **Tigran Karapetyan, YerPhi**
Energy spectra of the first TGE observed on Zugspitze by the SEVAN-light detector

14:30 – 15:00 **Martin Kákona, NPI**
Observations of Ambiguous Events at Lomnický štít Observatory by SEVAN

15:00 – 15:30 **Coffee/Tea Break**

15:30 – 16:00 **Gauri Datar Indian Institute of Geomagnetism, Navi Mumbai**
Correlated measurements of lightning flashes and gamma-ray flux observed from near sea-level location in India

16:00 – 16:30 **Excursion to the Library of the Czech Academy of Sciences**

Tuesday, October 3rd, Academy of Sciences, Národní 3, Prague

Scientific Session 2:

Instrumentation

Chairperson – Jakub Šlegl

- 9:30 – 10:00** **Marek Sommer, NPI**
Feasibility of using weather balloons and high-altitude pseudo satellites for research of terrestrial gamma-ray flashes
- 10:00 - 10:30** **Toma Oregel-Chaumont, EMC Laboratory, EPFL, Switzerland,**
Multi-band measurements of an upward negative flash at SántisTower
- 10:30 - 11:00** **Yuliia Ruban, NPI**
Simulation of thunderstorm radiation effect on the soil using the Monte Carlo transport code PHITS
- 11:00 - 11:30** **Coffee/Tea Break**
- 11:30 – 12:00** **Martin Kákona, NPI**
Quantitative Assessment of Hydrometeors Charge During Thunderstorm Ground Enhancements
- 12:00 – 12:30** **Suren Chilingaryan, Institute for Data Processing And Electronics, KIT**
Leveraging scientific notebooks and LLM agents to perform analysis of SEVAN data
- 12:30 – 12:50** **Martina Lužová, NPI**
Angular measurements with MOSAIC detector at Lomnický štít
- 12:50 – 13:50** **Lunch**
- 13:50 – 14:20** **Roman Dvořák, NPI**
DOSPORTAL: Tool for dosimetry and spectroscopy data management
- 14:20 – 14:50** **Bernd Heber, Institut für Experimentelle und Angewandte Physik, Christian-Albrechts Universität zu Kiel**
Mini neutron monitor measurements at the Neumayer III station and on the German research vessel Polarstern

Scientific Session 1 (continuation):

Multivariate observations of particles and fields (TGE physics),

Chairperson – Tigran Karapetyan

- 14:50 -15:10** **Olena Velychko, NPI**
Catalog of High-Energy Events (TGE) recorded by the GASTRON network
- 15:10 – 15:30** **Balabek Sargsyan, YerPhI**
Atmospheric positron flux modulation during thunderstorms
- 15:30 – 15:50** **Balabek Sargsyan, YerPhI**
Natural Gamma Radiation (NGR) measured on Aragats mountain in Armenia
- 16:50 – 16:20** **Coffee/Tea Break**
- 16:20 – 18:00** **City walk**
- 18:00 - ...** **Conference dinner: <https://www.restauracevltava.cz/>**

Wednesday, October 4th

Department of Radiation Dosimetry NPI, Na Truhlářce 39, Prague

Scientific Session 3: Particle bursts registered on the Earth's surface

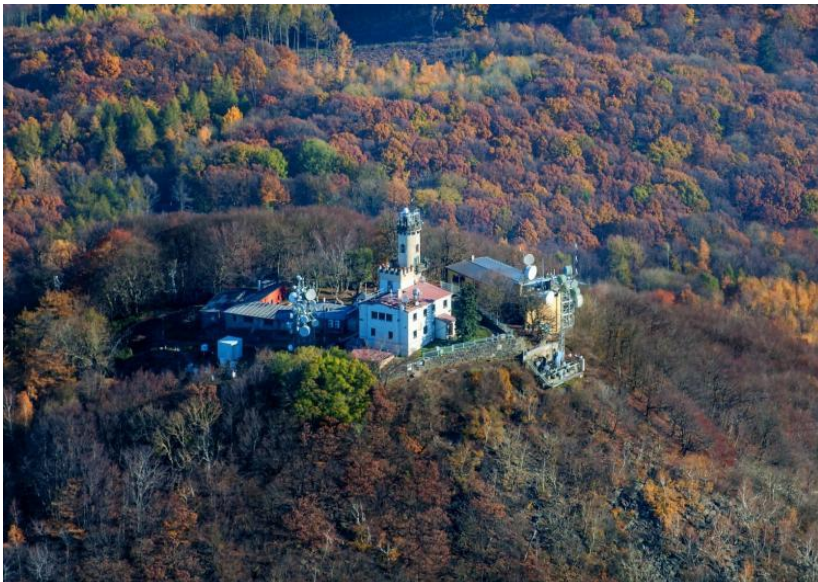
Chairperson - Marek Sommer

- 9:30 – 10:00** **Ashot Chilingarian, YerPhI**
Particle bursts observed on the Earth's surface: TGEs, EAS cores, or "inverse" TGFs
- 10:00 – 10:30** **Jakub Šlegl, NPI**
Downward terrestrial gamma-ray flashes detected on Mílesovka hill in central Europe
- 10:30 – 11:00** **Yuuki Wada, Osaka University, Japan**
High-energy atmospheric physics in Japan: what we learned and will learn from winter thunderstorms
- 11:00 – 11:30** **Coffee/Tea Break**
- 11:30 - 12:30** **Discussion: Lightning flashes and particle fluxes, Experiment, Closing ceremony**
- 12:30 – 14:00** **Lunch**
- 14:00 – 15:00** **Excursion to the spark generator at Faculty of electro engineering, Czech Technical University**

Thursday, October 5th

Conference excursion to the Milešovka observatory

- 09:30 – 10:30** Transport by minibus from Department of Radiation Dosimetry NPI /hotel Castle Residence to Milesovka
- 10:30 – 12:00** Walk from Bilka to Milesovka observatory including coffee break (distance 3 km, elevation 350 m)
- 12:00 – 12:30** ***Roberta Colalillo, Università degli Studi di Napoli Federico II***
Study of downward Terrestrial Gamma-ray Flashes with the surface detector of the Pierre Auger Observatory
- 12:30 – 13:30** ***Lunch***
- 13:30 – 14:00** ***Excursion to measurement facilities on top of Milesovka***
- 14:00 – 15:00** *Walk from Milesovka observatory to Bilka*
- 15:00 – 16:00** Transport by minibus from Bilka to Department of Radiation Dosimetry NPI /hotel Castle Residence



For a virtual visit of Milesovka, use the link here:
<https://prohlidky.virtualvisit.cz/milesovka/>

List of Participants

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