THUNDERSTORMS AND ELEMENTARY PARTICLE ACCELERATION

ORGANIZERS:

Cosmic Ray Division
of Yerevan Physics Institute, Armenia

Skobeltsyn Institute of Nuclear Physics
of Moscow State University, Russia

STRUCTURE OF THE SYMPOSIUM:

We anticipate the following sessions:

1. *Models of atmosphere electrification and electron acceleration; Multivariate observations of particles and fields from the Earth's surface, in atmosphere and from space (TGEs, gamma glows and TGFs);*
2. *Registration of atmospheric discharges by lightning mapping arrays and interferometers; atmosphere and from space;*
3. *Influence of the atmospheric electric field on measurements of experiments using atmosphere as a target (Surface Arrays and Cherenkov Imaging Telescopes)*
4. *Instrumentation*

We plan also discussions on the most intriguing problems of high-energy physics in the atmosphere and on possible directions for the advancement of the collaborative studies.

NOR AMBERD

International Conference Centre of the Yerevan Physics Institute, Byurakan, Aragatsotn Province, Armenia.

The new emerging field of high-energy atmospheric physics (HEAP) has been enriched recently by important observations of particle fluxes on Earth's surface, in troposphere and in space. HEAP presently includes 3 main types of measurements: Terrestrial Gamma Ray Flashes (TGFs) - brief burst of gamma radiation (sometimes also electrons and positrons) registered by orbiting gamma ray observatories in the space, Thunderstorm ground enhancements (TGEs) - prolonged electron and gamma ray fluxes (also neutrons) registered on the earth's surface, and gamma glows - gamma ray bursts observed in the thunderclouds by facilities on balloons and aircraft.
The central engine initiating the TGE is believed to be the Relativistic Runaway Electron avalanches (RREA), that accelerates seed electrons from an ambient population of cosmic rays (CR) in the large-scale thundercloud electric fields. Observation of numerous TGEs by Japanese, Russian, Armenian, Chinese, and Slovakian groups prove that RREA is a robust and realistic mechanism for electron acceleration and multiplication leaving no doubts about the correctness of the RREA model for the TGE initiation. Precisely recovered particle energy spectra gives new clues for testing models of electron acceleration in atmosphere, as well as, for scrutinizing the structure of the electric field in thunderclouds. Models using GEANT4 and CORSIKA codes support in situ measurements of electron and gamma ray energy spectra at Aragats. Numerous observations of TGEs made on Aragats during past 11 years can be063 widely used for the validation of models aimed to explain TGF phenomena.
The relationship of lightning and elementary particle fluxes in the thunderclouds was established on microsecond timescales. The particle flux data, well synchronized with the information on atmospheric discharges give valuable information on the structure of the atmospheric fields in the upper and lower parts of the thunderclouds. Many questions about thundercloud electrification and discharge mechanisms, lightning initiation, propagation and attachment processes, the global electrical circuit, and transient luminous events do not have yet a commonly accepted explanation. 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 the climate change. The influence of the electrified atmosphere on the fluxes of electrons and other charged particles can be important for experiments registering very-high energy photons (Systems of Imaging Cherenkov telescopes) and hadrons (Surface arrays registering Extensive Air Showers. The TEPA meeting is a great opportunity for the scientists to meet, discuss, invent new ideas and make new bridges for collaborative works.

INTERNATIONAL ADVISORY COMMITTEE

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- *Razmik Mirzoyan*, MPI, Munich, Germany
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- *Michail Panasyuk*, Moscow State University, Russian Federation, co-chair
- *Vladimir Rakov*, University of Florida, USA
- *David Smith*, University of California, Santa Cruz
- *Marco Tavani*, INAF and University of Rome "Tor Vergata", Italy Tatsuo Torii, Japan Atomic Energy Agency, Tsuruga, Japan Harufumi Tsuchiya, Cosmic Radiation Laboratory, Riken, Japan.
- *Lev Zeleny*, Space Research Institute, Russian Academy of Sciences, Russian Federation

A. ALIKHANYAN National Laboratory

http://www.crd.yerphi.am/TEPA_2019

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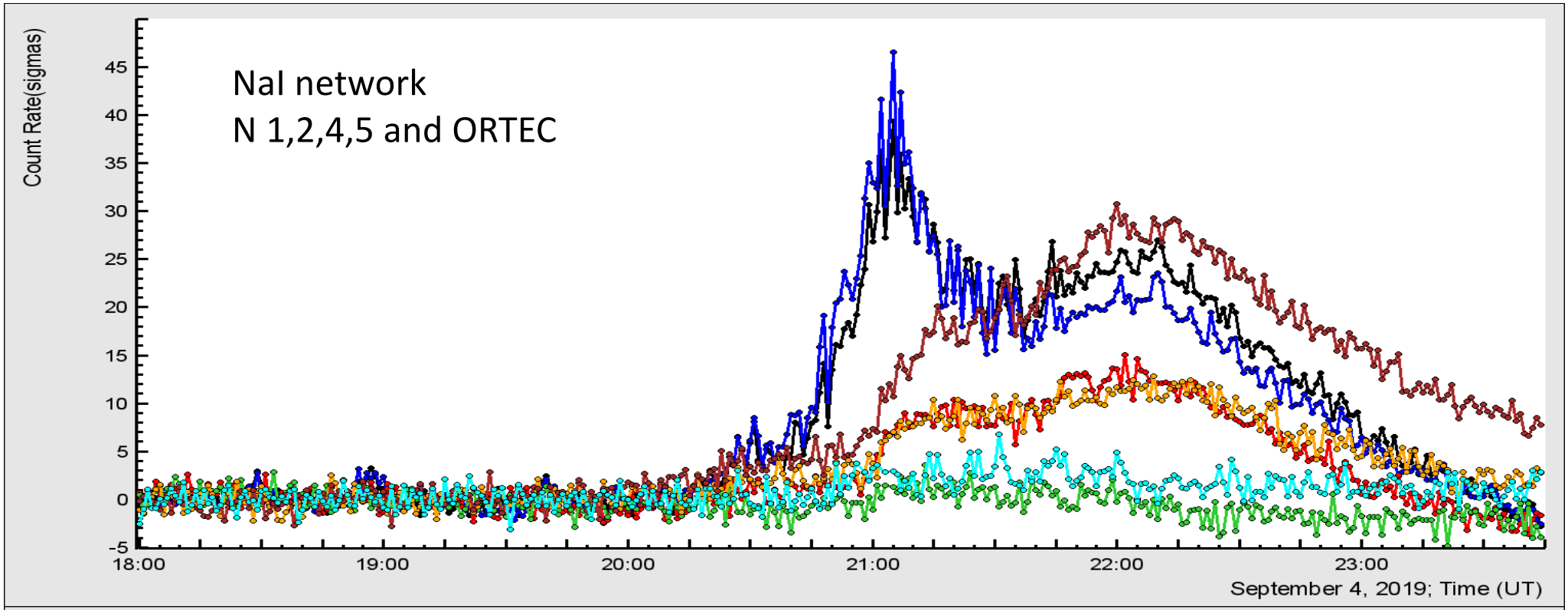
NaI network
N 1,2,4,5 and ORTEC
Count Rate(sigmas)
45
40
35
30
25
20
15
10
5
0
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18:00
19:00
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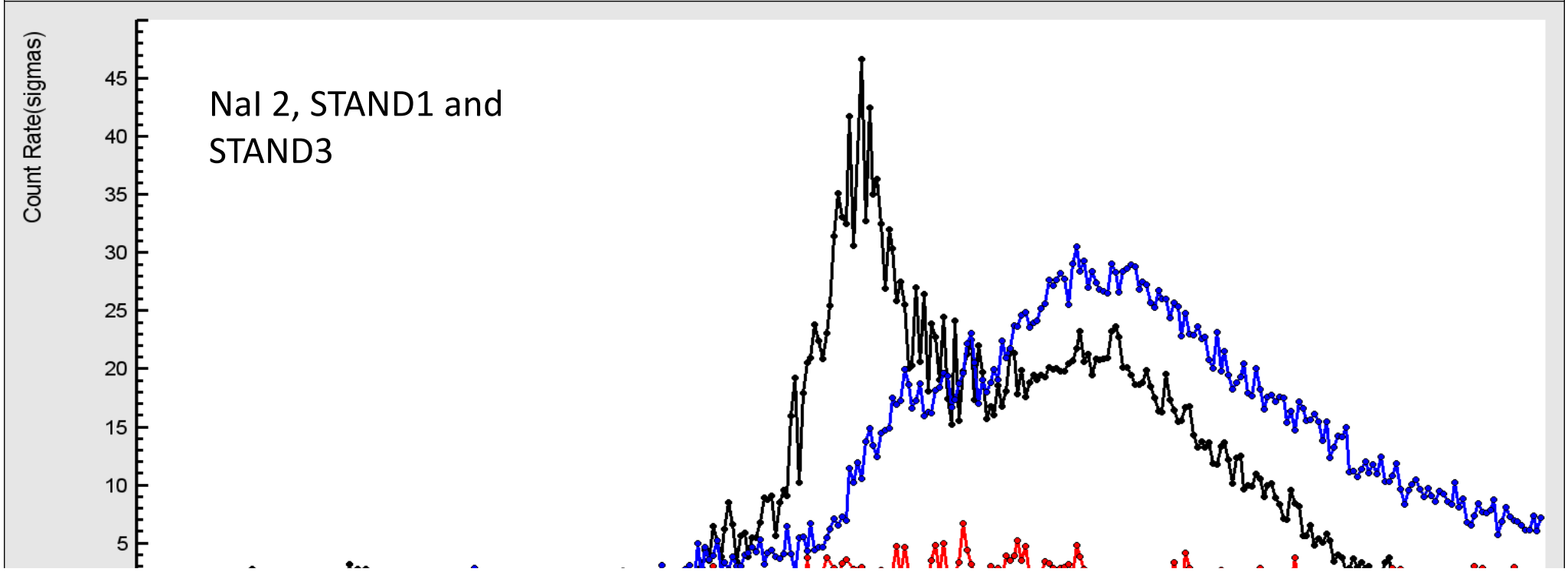
23:00
September 4, 2019; Time (UT)


NaI 2, STAND1 and
STAND3
Count Rate(sigmas)
45
40
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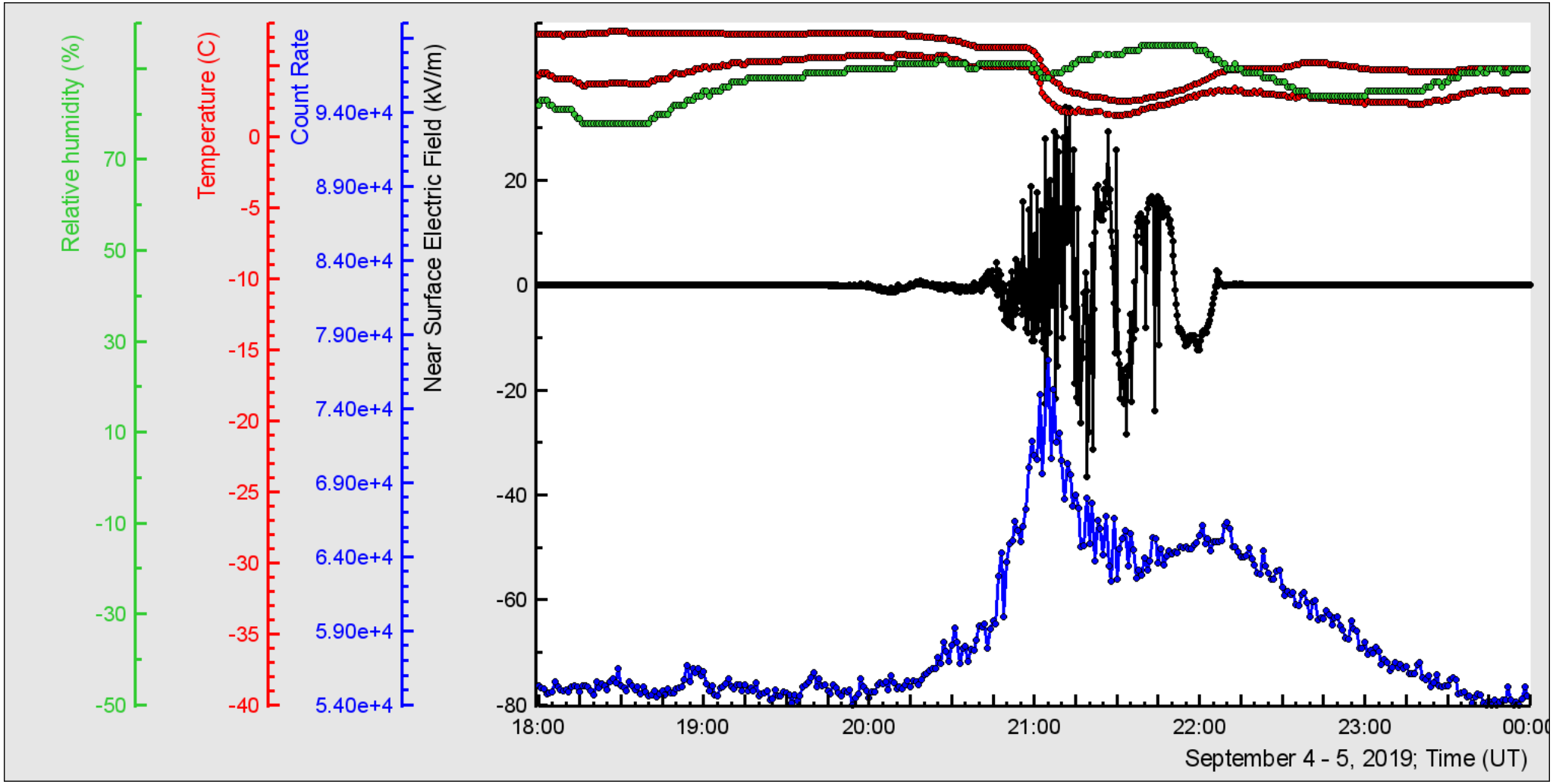
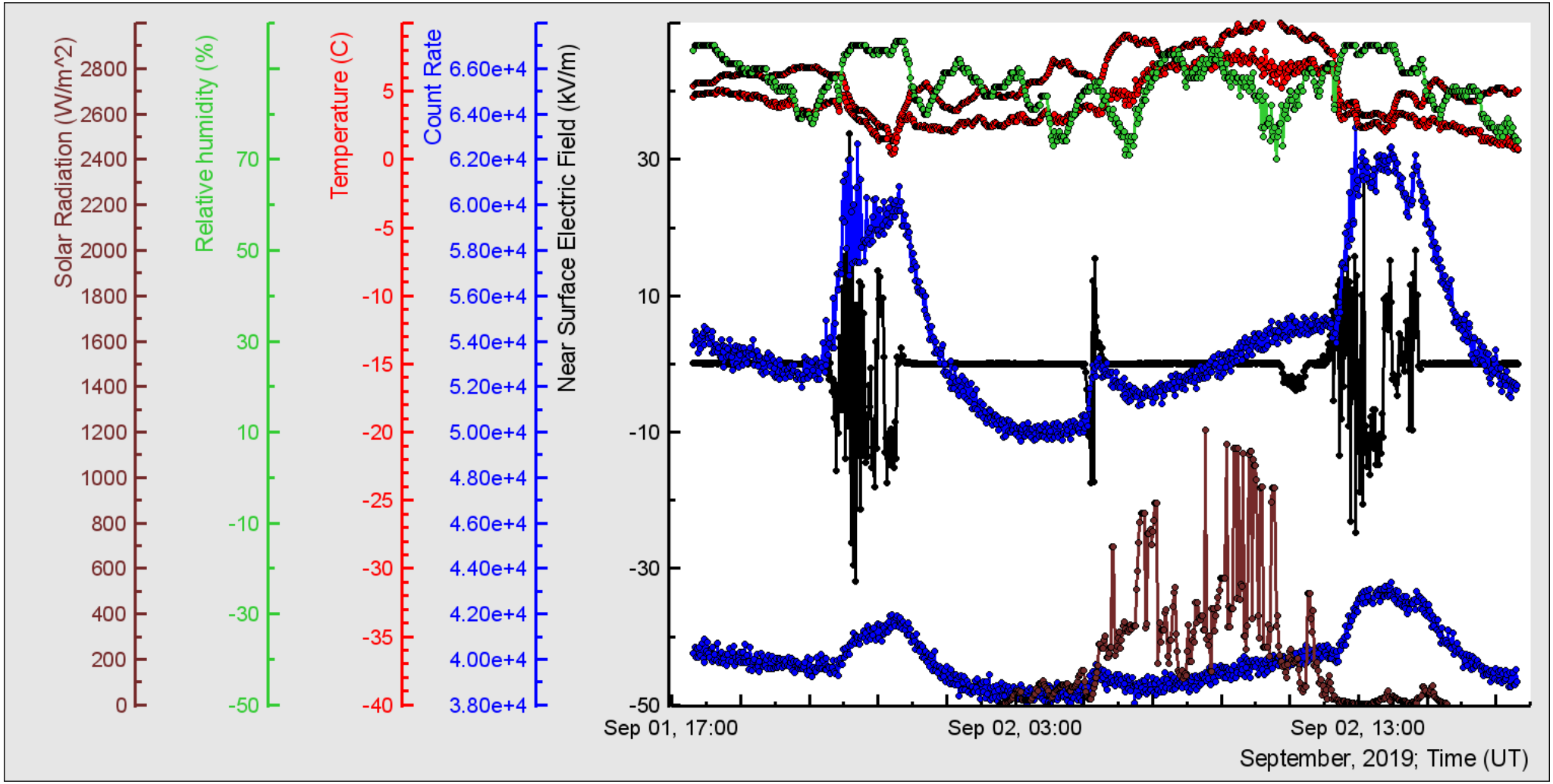
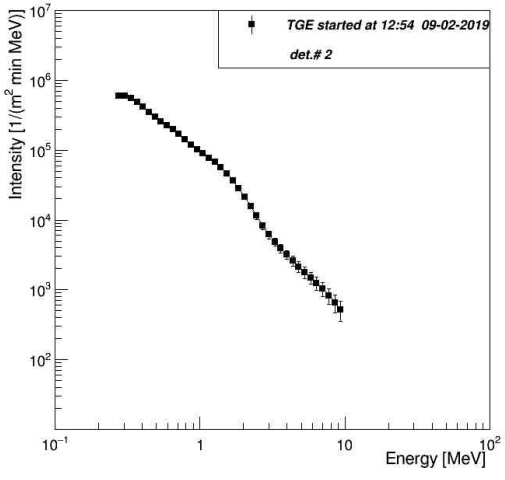
5

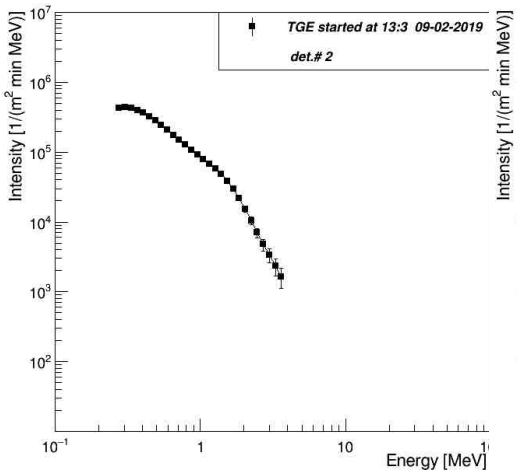
Cloud base ~100m; RH ~90%

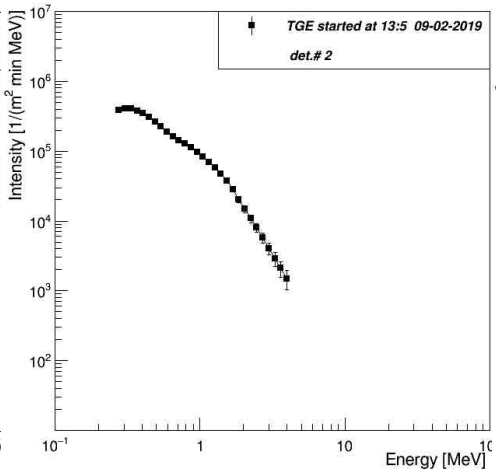


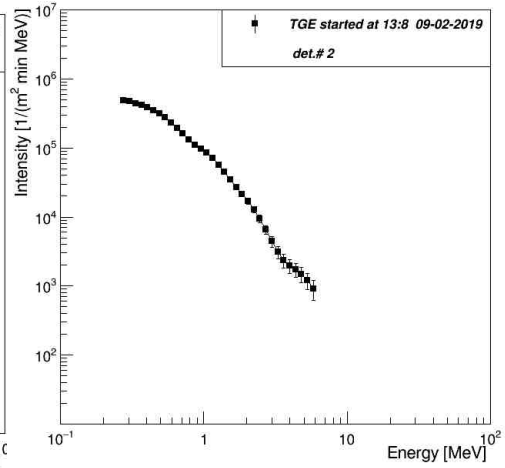
Knowledge day: 3 TGEs



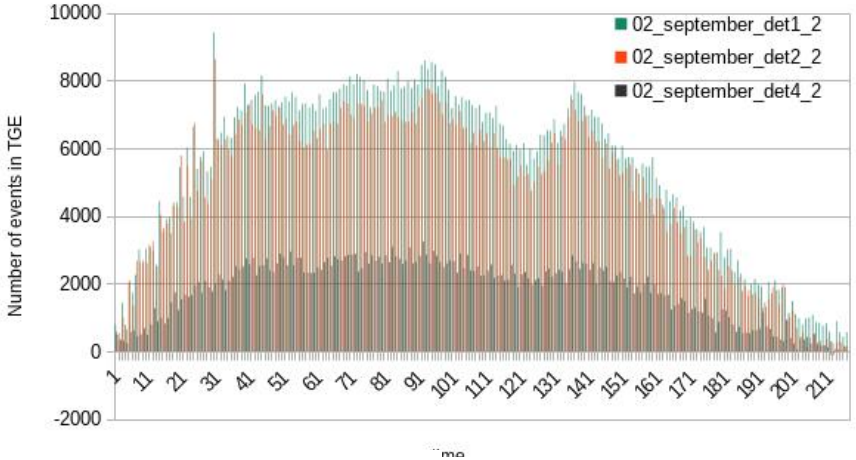




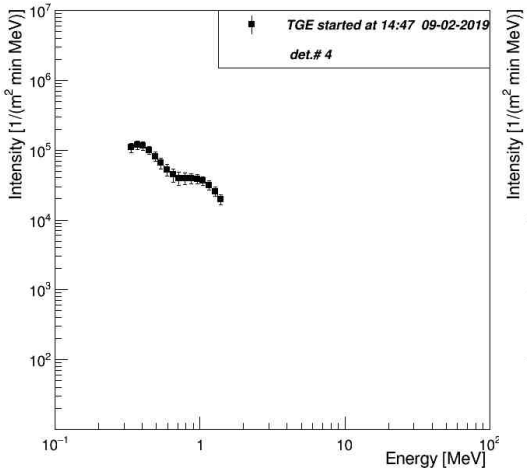


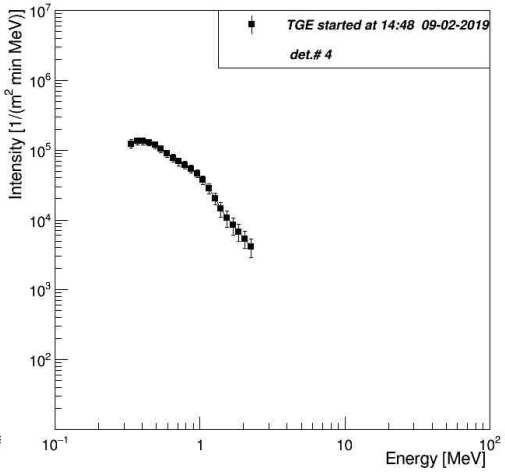


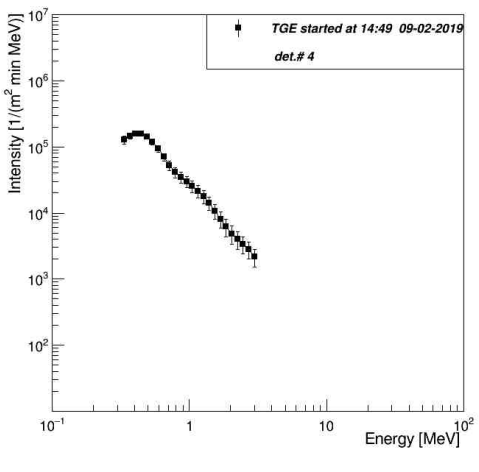
Time series of energy spectra. NaI 1,2 and 4 (lead on the top)

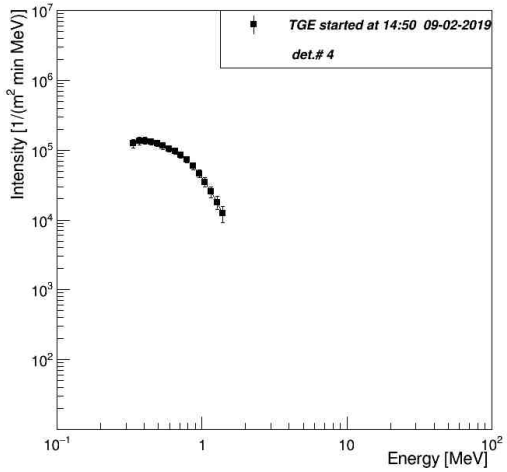


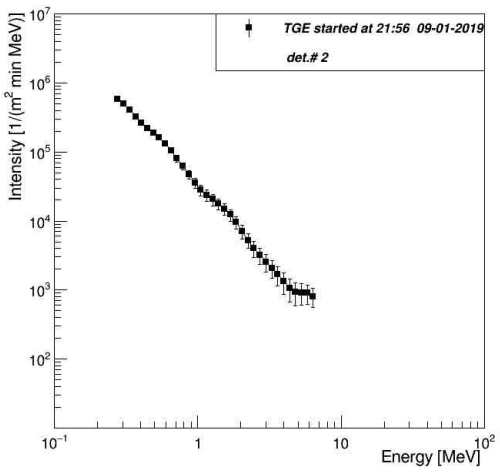
Energy spectra. NaI 2 and 4 (selected minutes)

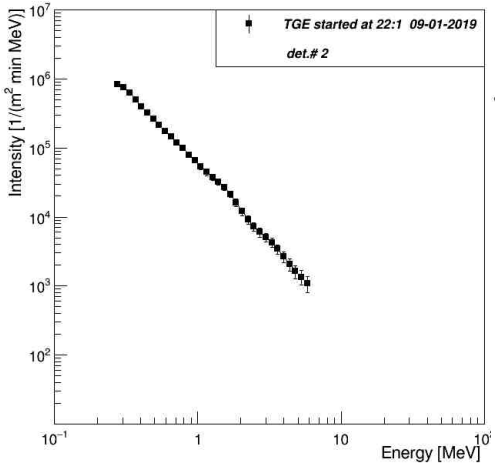


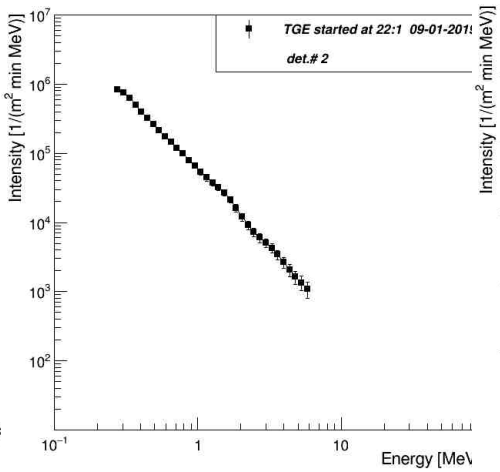


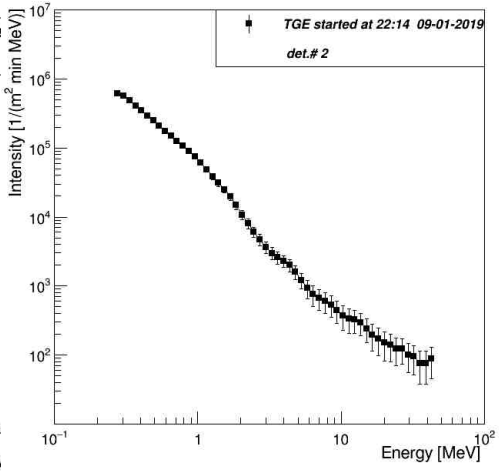




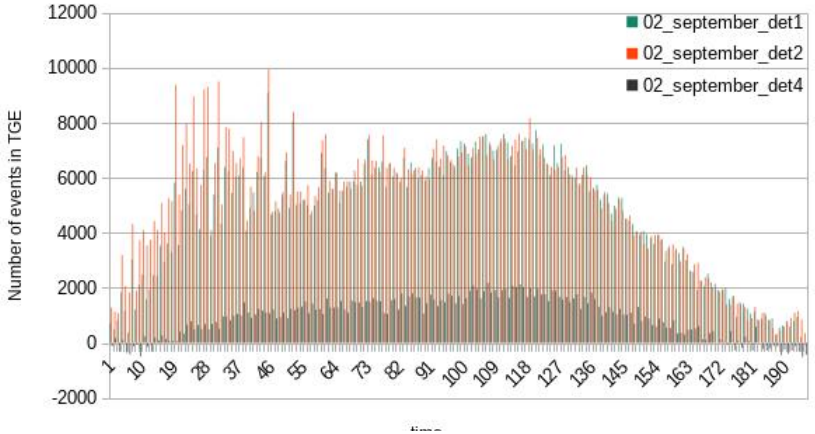




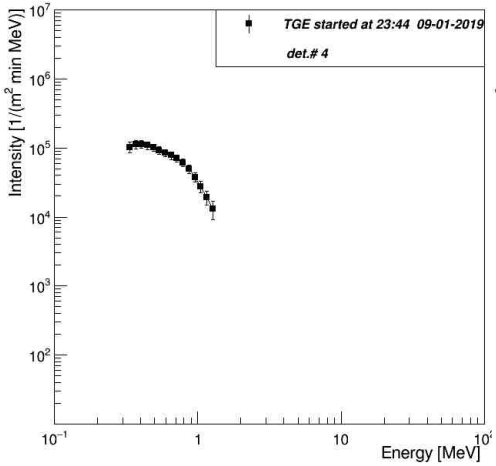


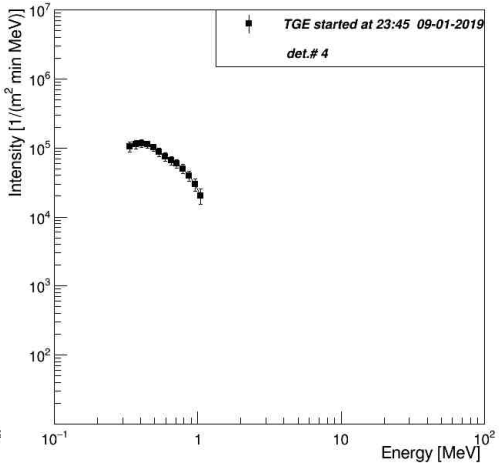


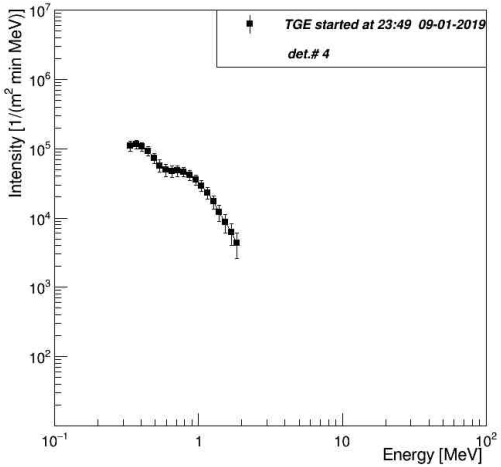
Time series of energy spectra. NaI 1,2 and 4 (lead on the top)

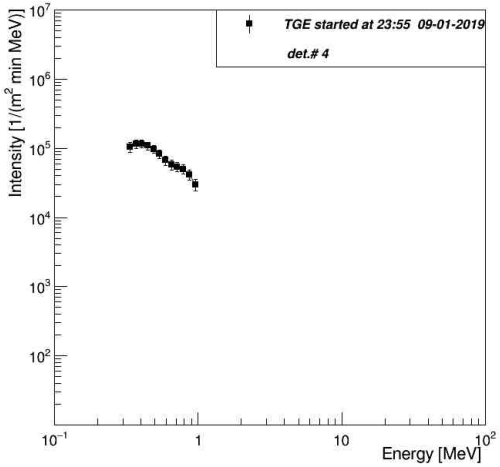


Energy spectra. NaI 2 and 4 (selected minutes)









Pb^{214} (0.3 MeV)and Bi^{214} (0.6 MeV) decay curves measured by NaI N4 (lead filters on the top – only inclined gamma rays detected). Near surface el. field measured by EFM-100 electric mill located at SKL experimental hall