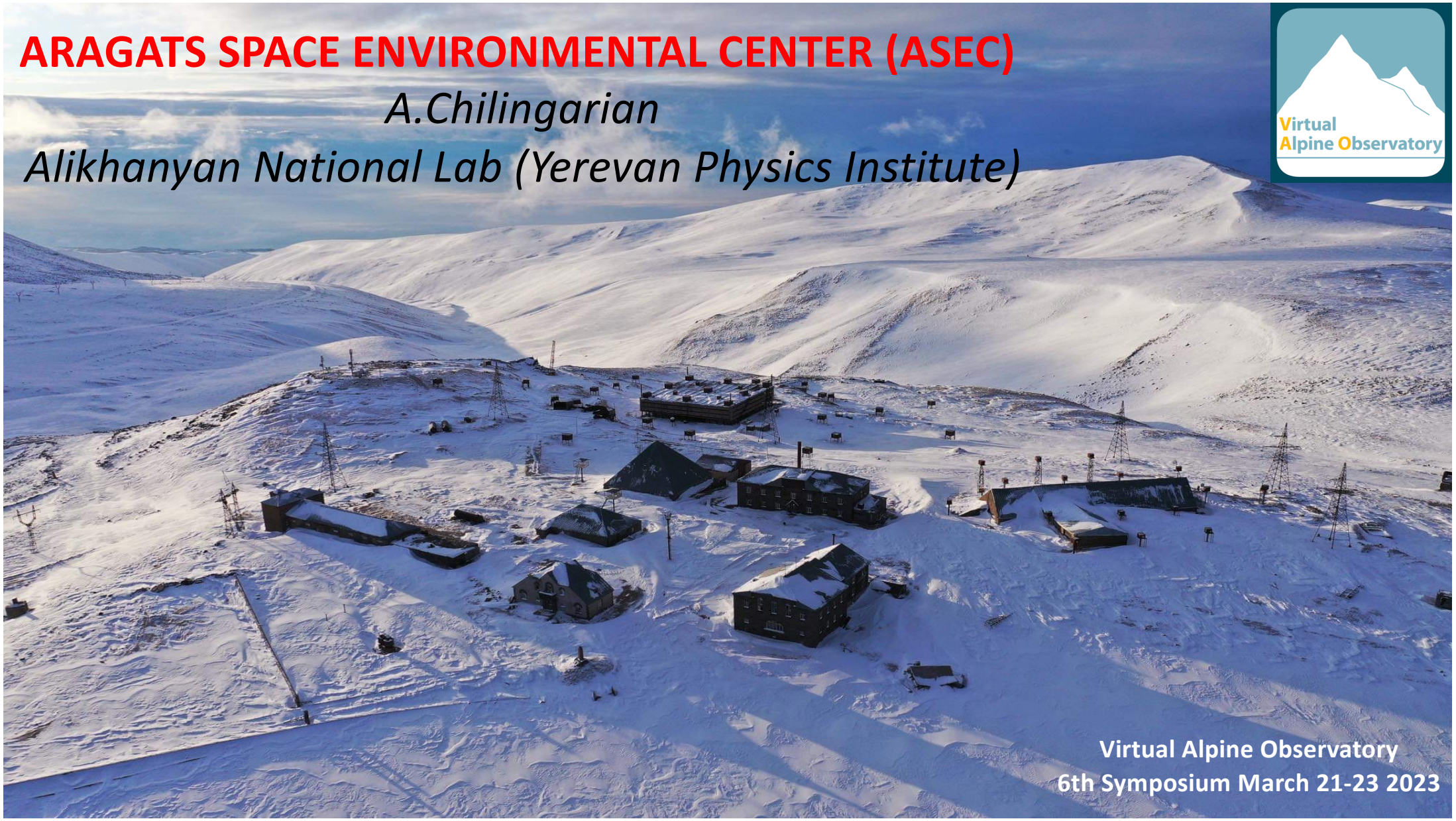
ARAGATS SPACE ENVIRONMENTAL CENTER (ASEC)

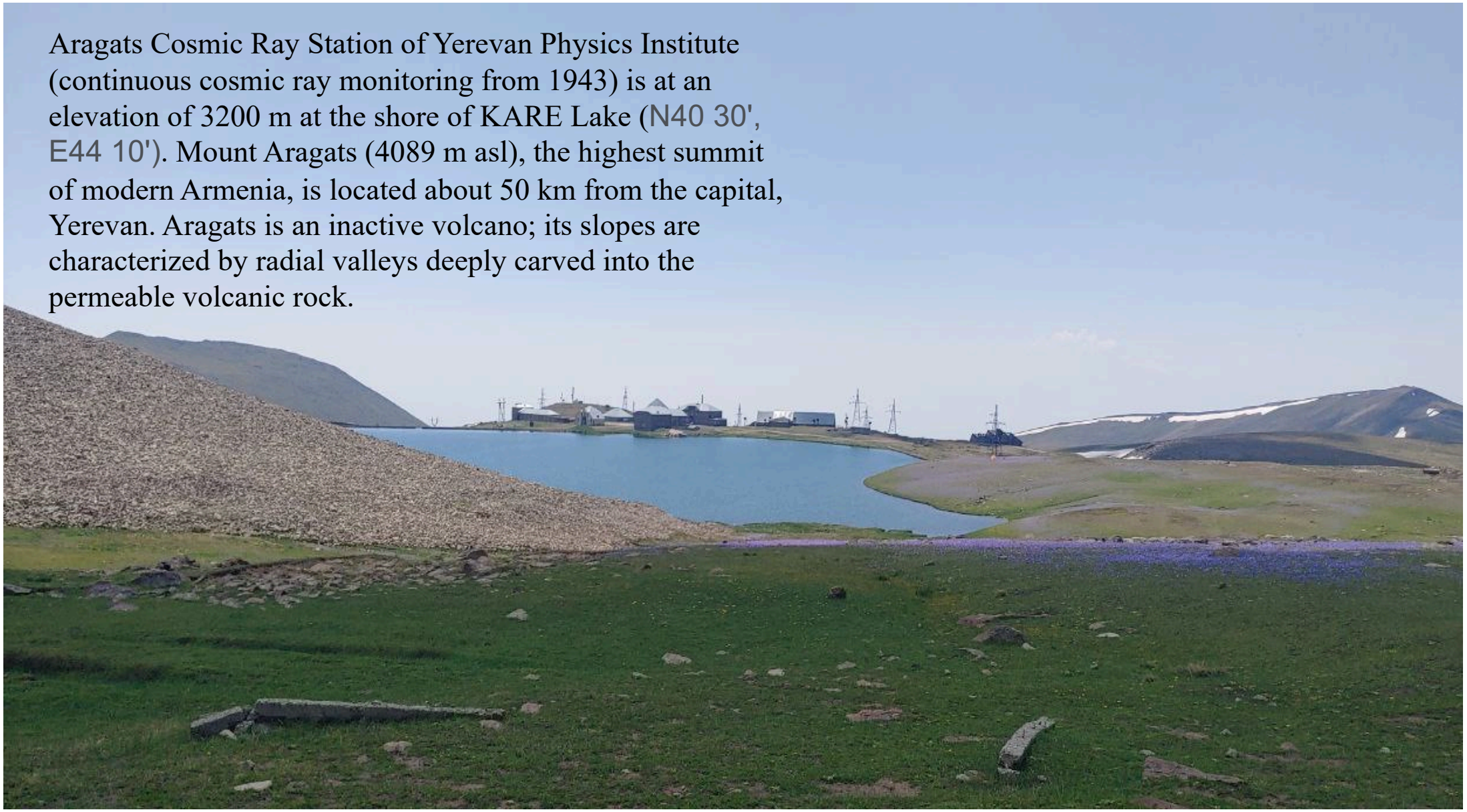
A.Chilingarian

Alikhanyan National Lab (Yerevan Physics Institute)



Virtual Alpine Observatory

6th Symposium March 21-23 2023



Aragats Cosmic Ray Station of Yerevan Physics Institute (continuous cosmic ray monitoring from 1943) is at an elevation of 3200 m at the shore of KARE Lake (N40 30', E44 10'). Mount Aragats (4089 m asl), the highest summit of modern Armenia, is located about 50 km from the capital, Yerevan. Aragats is an inactive volcano; its slopes are characterized by radial valleys deeply carved into the permeable volcanic rock.


Ararat mountain (100 km from Aragats) dominated over Armenia’s capital Yerevan;
The height of Masis is 5137 and of Sis 3896 m.

Road to Aragats is opened in May via snow tunnels of 5 meters in height

Experimental hall MAKET under the snow, only lightning detector is seen

12.8 km between Nor Amberd and Aragats;
39.1 km between Yerphi and Aragats;
26.5 km between Yerphi and Nor Amberd;
4 km between Byurakan and Nor Amberd.

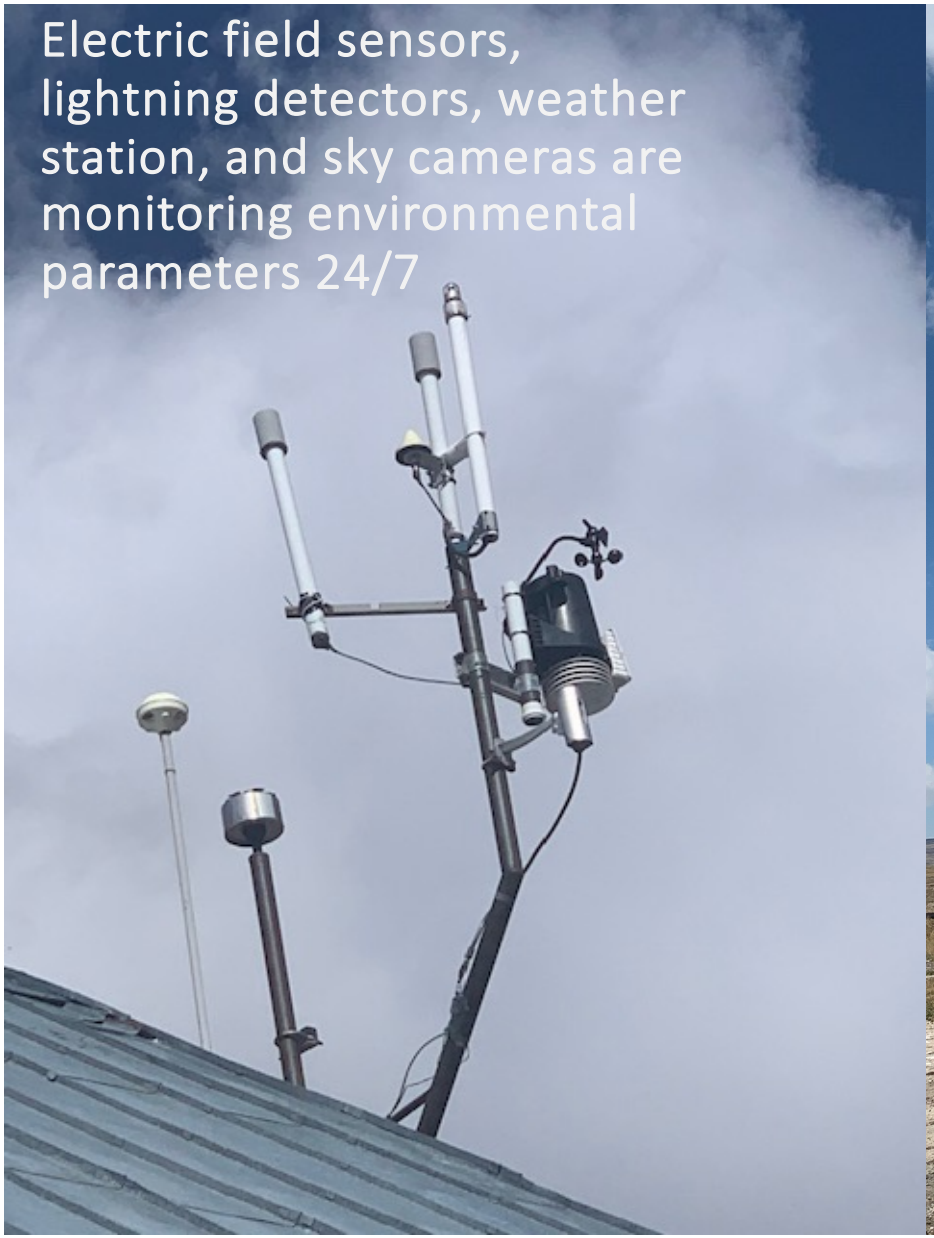
1.Byurakan
Latitude= 40.3400° N,
Longitude =44.2703° E
2.Nor Amberd
Latitude= 40.3750,
Longitude =44.2640
3. Aragats
Latitude= 40.4713,
Longitude =44.1819
4.Yerevan Physics Institute
Latitude= 40.2067 ,
Longitude =44.4857


Nor Amberd station
Scout Camp
Distance 1470m
Scout Camp
Amberd hotel
Distance 2800 m
Byurakan house
Radio Optical
Observatory ROT-54
Antarut
Amberd

Beline and Vivacell operators provide mobile connections for data flow from Aragats detectors (100 Gb per day)

Reserve radio-modem connections 2.4 and 5.2 GHz

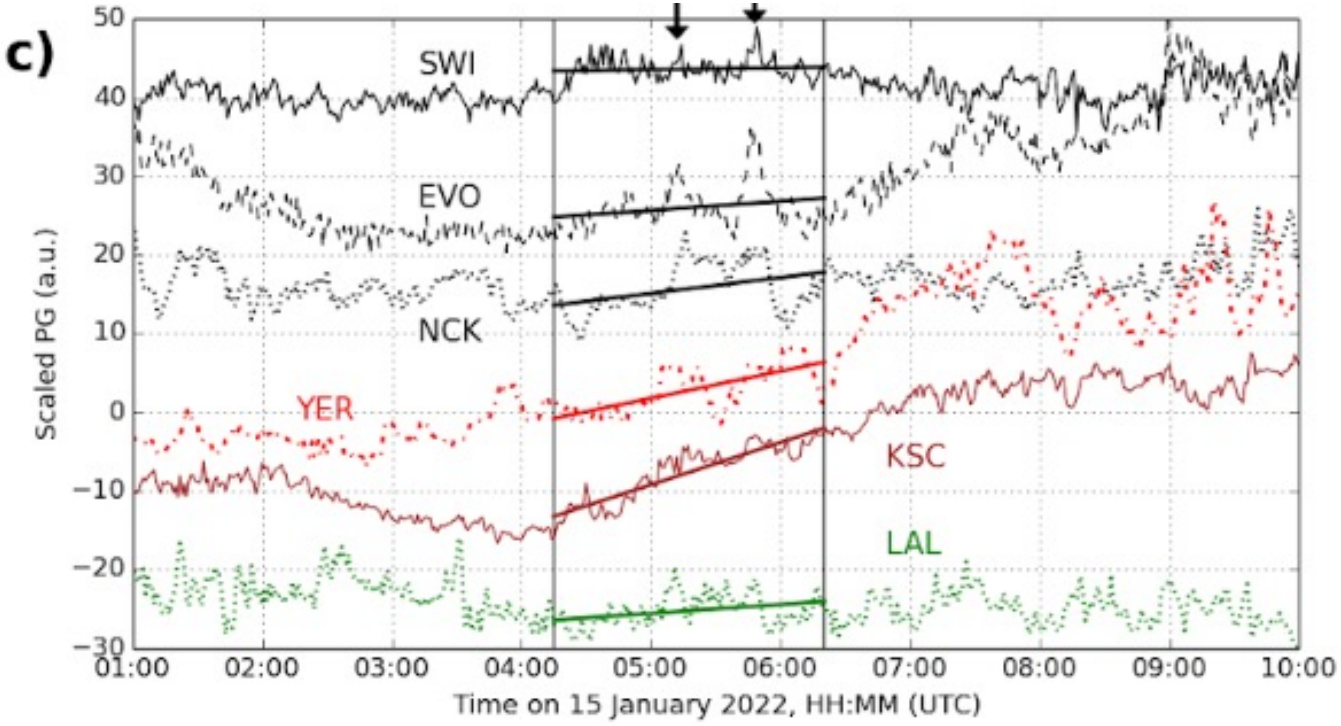
Electric field sensors, lightning detectors, weather station, and sky cameras are monitoring environmental parameters 24/7



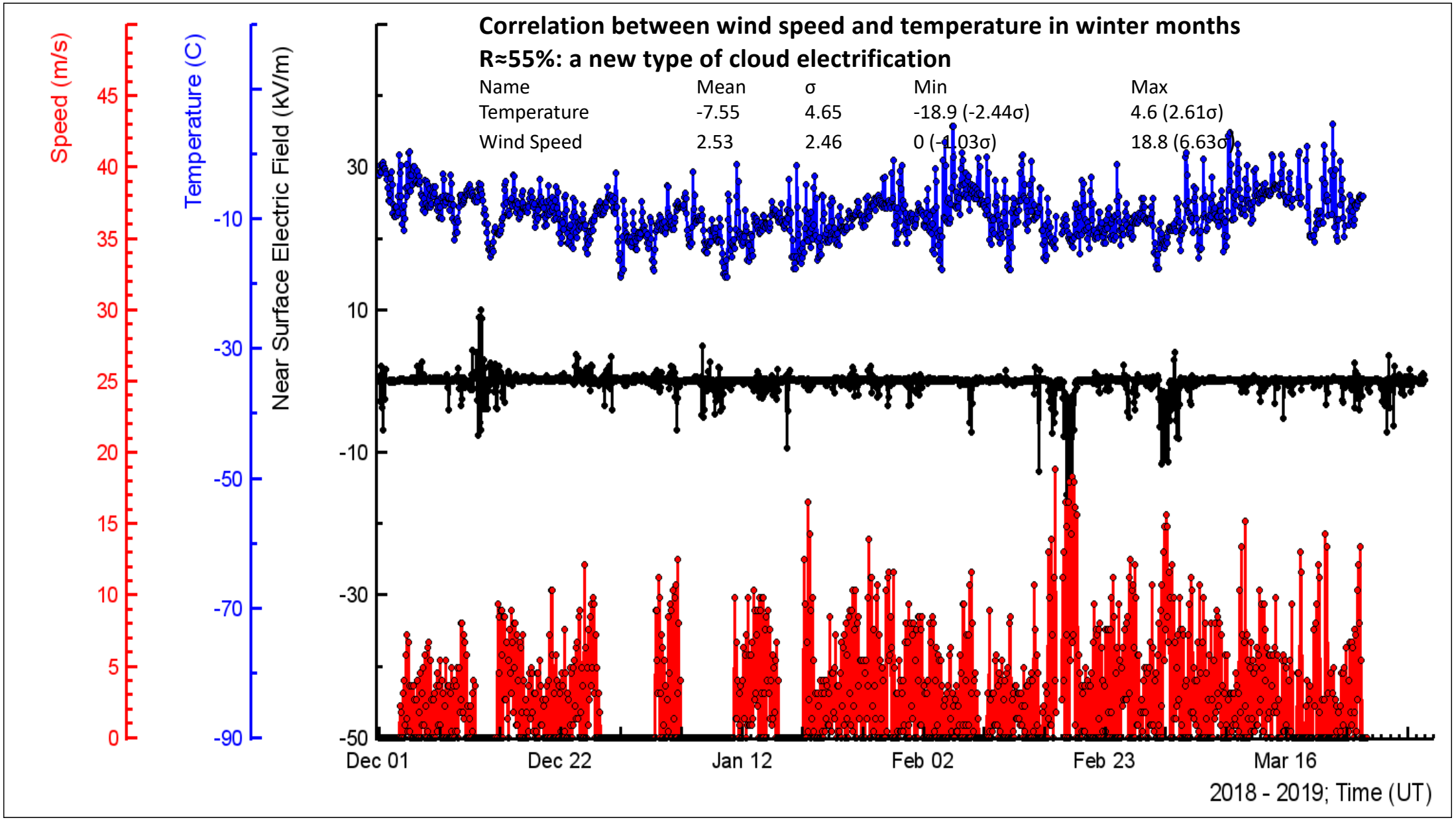
From the ASEC databases are available ≈ 40 environmental parameters, fields, and fluxes of cosmic rays for the correlation analysis with world data

	Mean temperature C°	Variance	Minimal temperature	Maximal temperature	Mean wind speed m/sec	Variance	Maximal wind speed
2011	-9.2	5.59	-23.5	4.9	3.03	2.5	16.5
2012	-7.8	4.8	-24.1	6.6	2.97	2.58	21.5
2013	-6.72	4.87	-21.5	4.6	2.58	2.39	19.7
2014	-6.94	5.32	-28.3	8.1	3.31	2.46	20.6
2015	-6.9	5.49	-28.3	8.1	3.25	2.47	16.1
2016	-9.01	5.84	-25.5	3.7	2.43	2.11	18.8
2017	-5.78	4.23	-18.2	4.3	0.45	1.22	14.8
2018	-7.55	4.65	-18.9	4.6	2.53	2.46	18.8
2019	-6.09	5.09	-27.8	7.2	1.98	2.05	21.9
2020	-6.62	4.77	-21.9	3.9	2.04	2.09	20.1
2021	-7.63	5.81	-24.7	6.8	2.35	2.33	23.2
2022	-7.6	5.66	-23.0	4.8	1.72	1.73	16.5

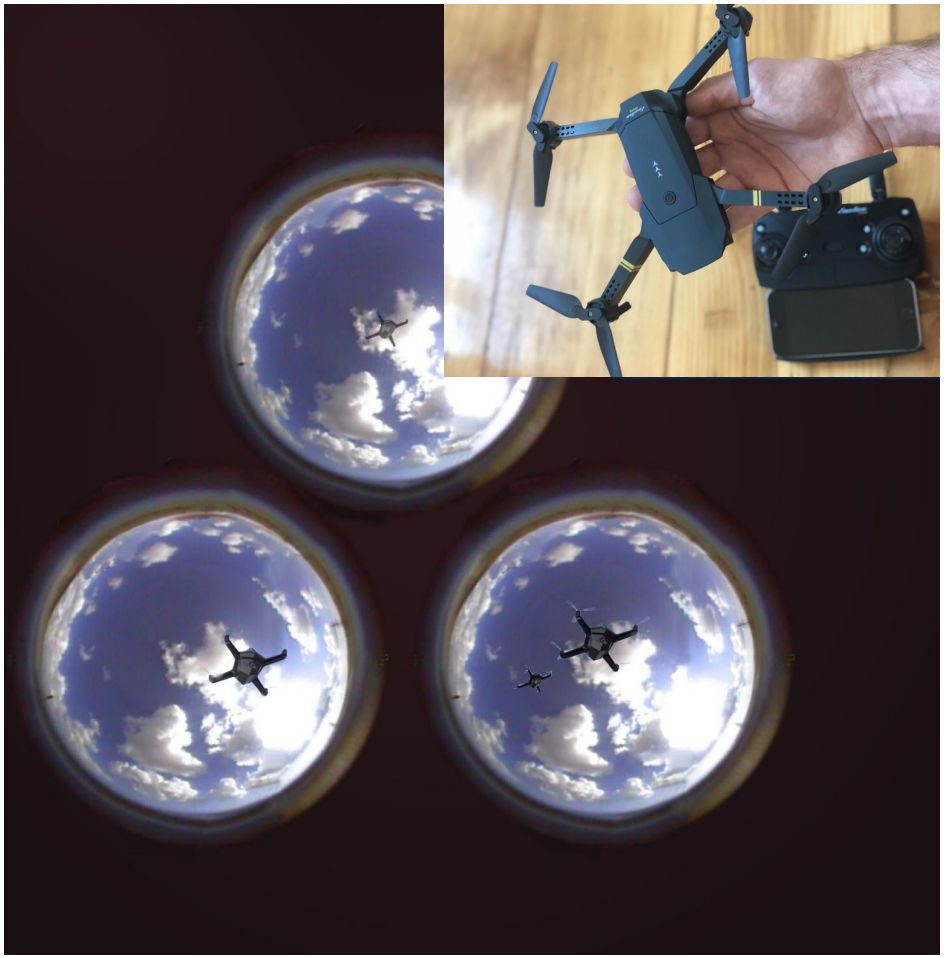
Responses of the AC/DC Global Electric Circuit to Volcanic Electrical Activity in Tonga - Hunga Eruption on 15 January 2022, J.Bor et al., submitted to JGR



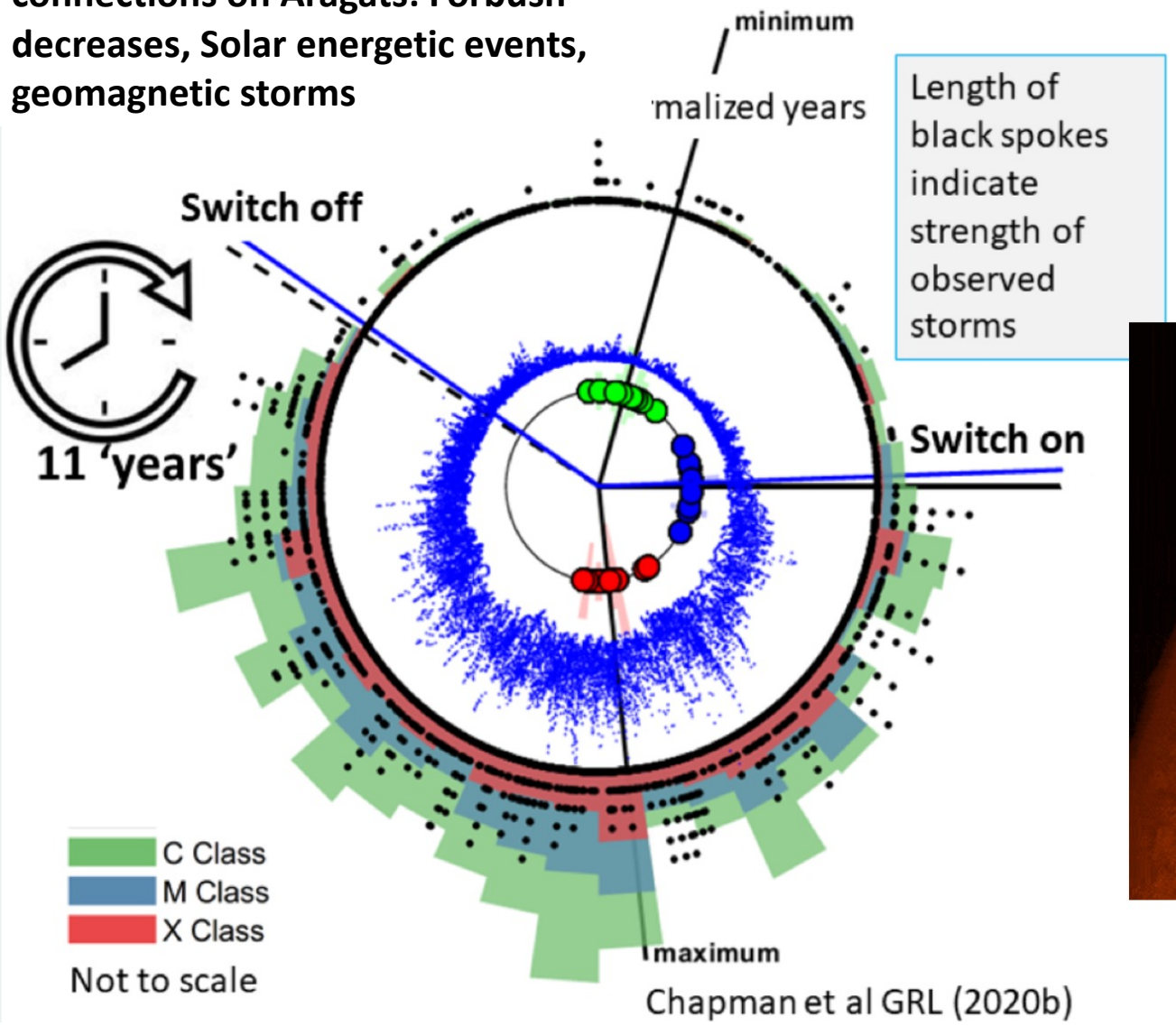
Due to a huge lightning current (50-60% of total global lightning activity) that influences the Carnegie curve (short-term correlation). “If the peaks corresponded to global PG enhancements, this would be a unique, globally detectable coherent excitation of the DC GEC from a single known source, and the observed delay of 7-8 minutes of the PG peaks from the peaks of negative lightning episodes in the eruption could be taken as a direct measure of the time constant of the near-surface atmospheric electric field changes.” The Earth’s surface is a very good conductor, so the change in its total surface charge density is expected to occur practically simultaneously everywhere. The time constant of 7-8 minutes is the response time of the electric field as measured within the atmosphere to the immediate change in the charging of the Earth.


Correlation between wind speed and temperature in winter months
R≈55%: a new type of cloud electrification
Name Mean σ Min Max
Temperature -7.55 4.65 -18.9 (-2.44σ) 4.6 (2.61σ)
Wind Speed 2.53 2.46 0 (-1.03σ) 18.8 (6.63σ)
Speed (m/s)
Temperature (C)
Near Surface Electric Field (kV/m)
45
40
35
30
25
20
15
10
5
0
-10
-30
-50
-70
-90
30
10
-10
-30
-50
Dec 01
Dec 22
Jan 12
Feb 02
Feb 23
Mar 16
2018 - 2019; Time (UT)

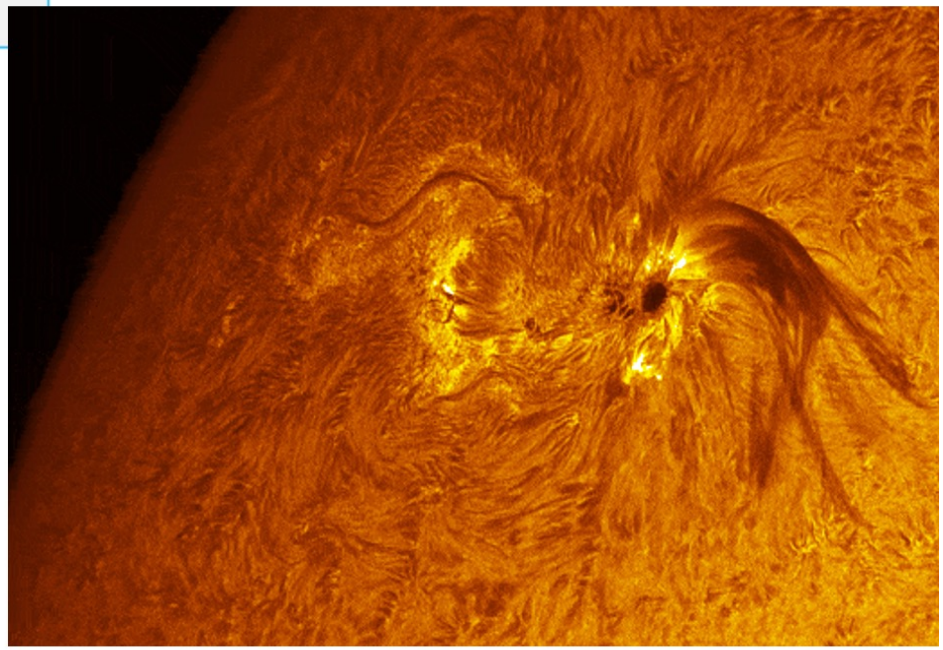
Sky monitoring above Aragats with 3 all-sky cameras (30 Hz)



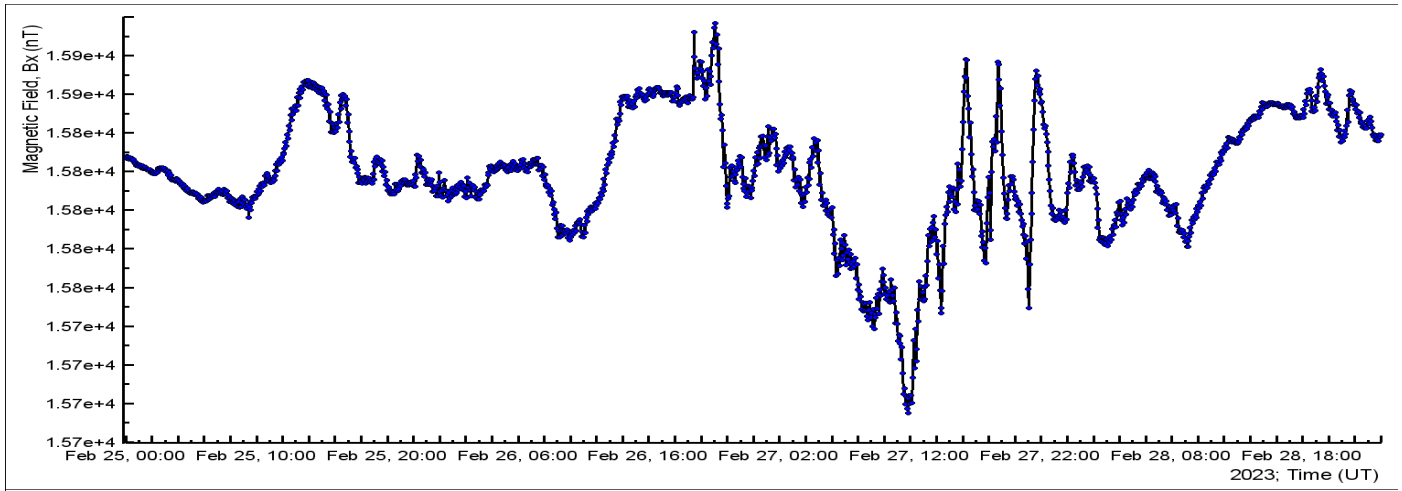
Monitoring of Solar-terrestrial connections on Aragats: Forbush decreases, Solar energetic events, geomagnetic storms

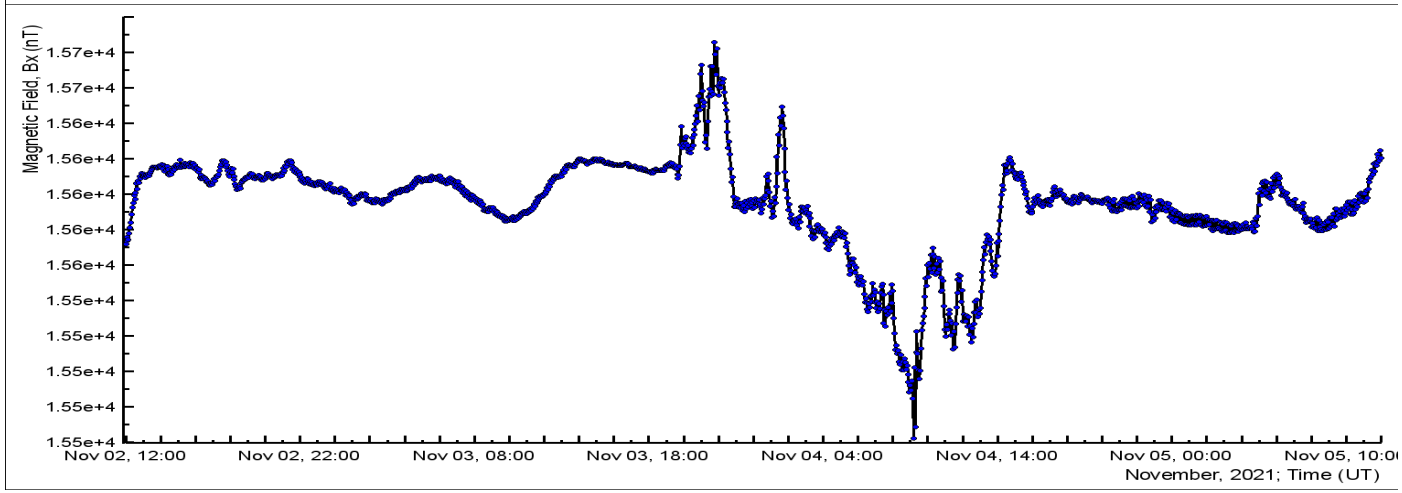


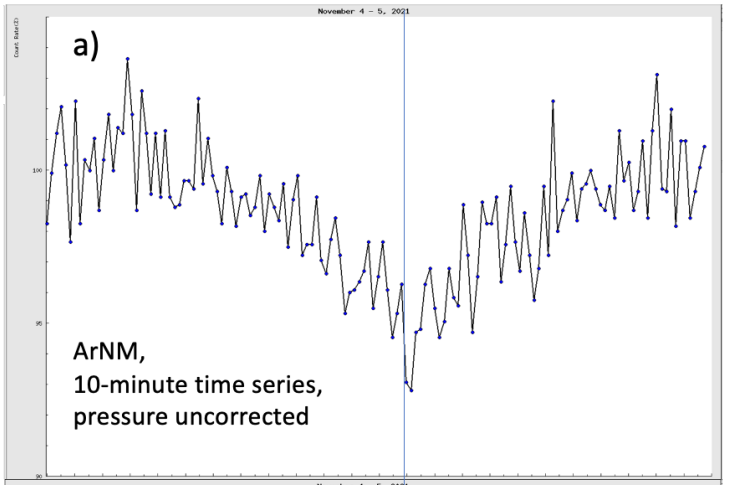
The violent Sun is back;
Solar spots are in exploding!

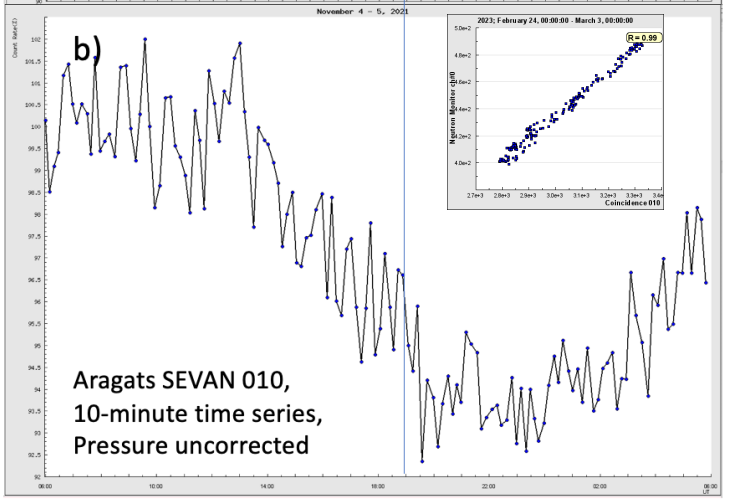


Disturbances of the geomagnetic field at the arrival of CME at major Solar activity in November 2021 and February 2023 and FD registered by Aragats neutron detectors in November 2021

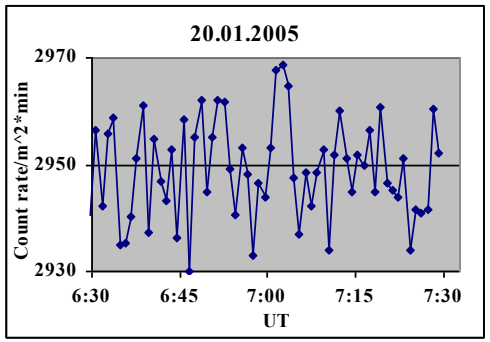


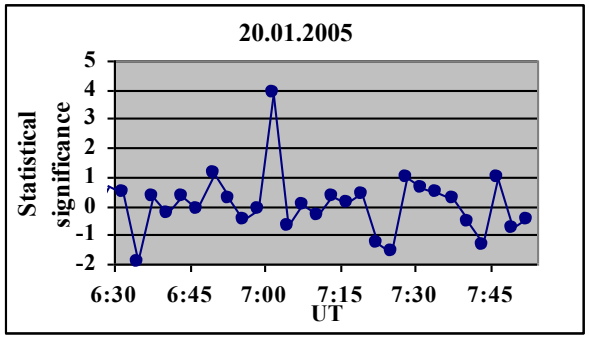




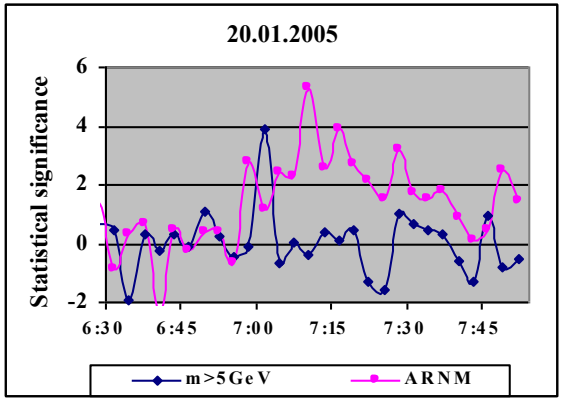


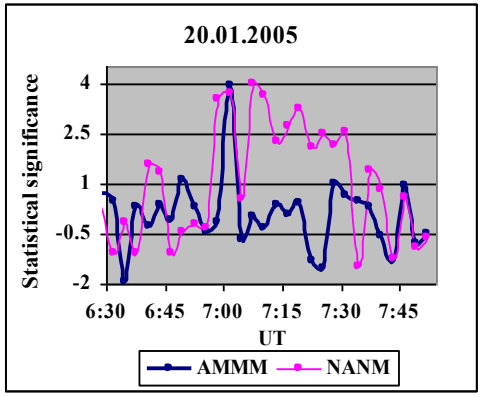
The maximum energy of solar proton accelerators: detection of GLE 20 January 2005 by ASEC monitors

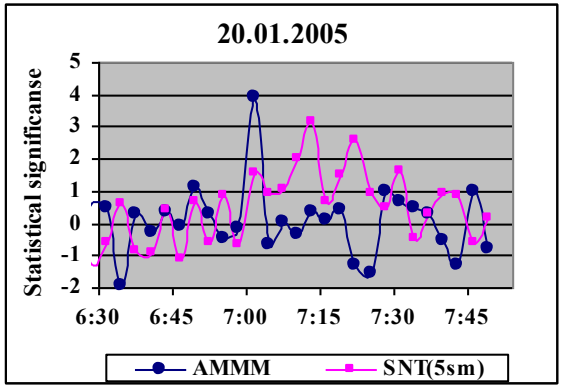




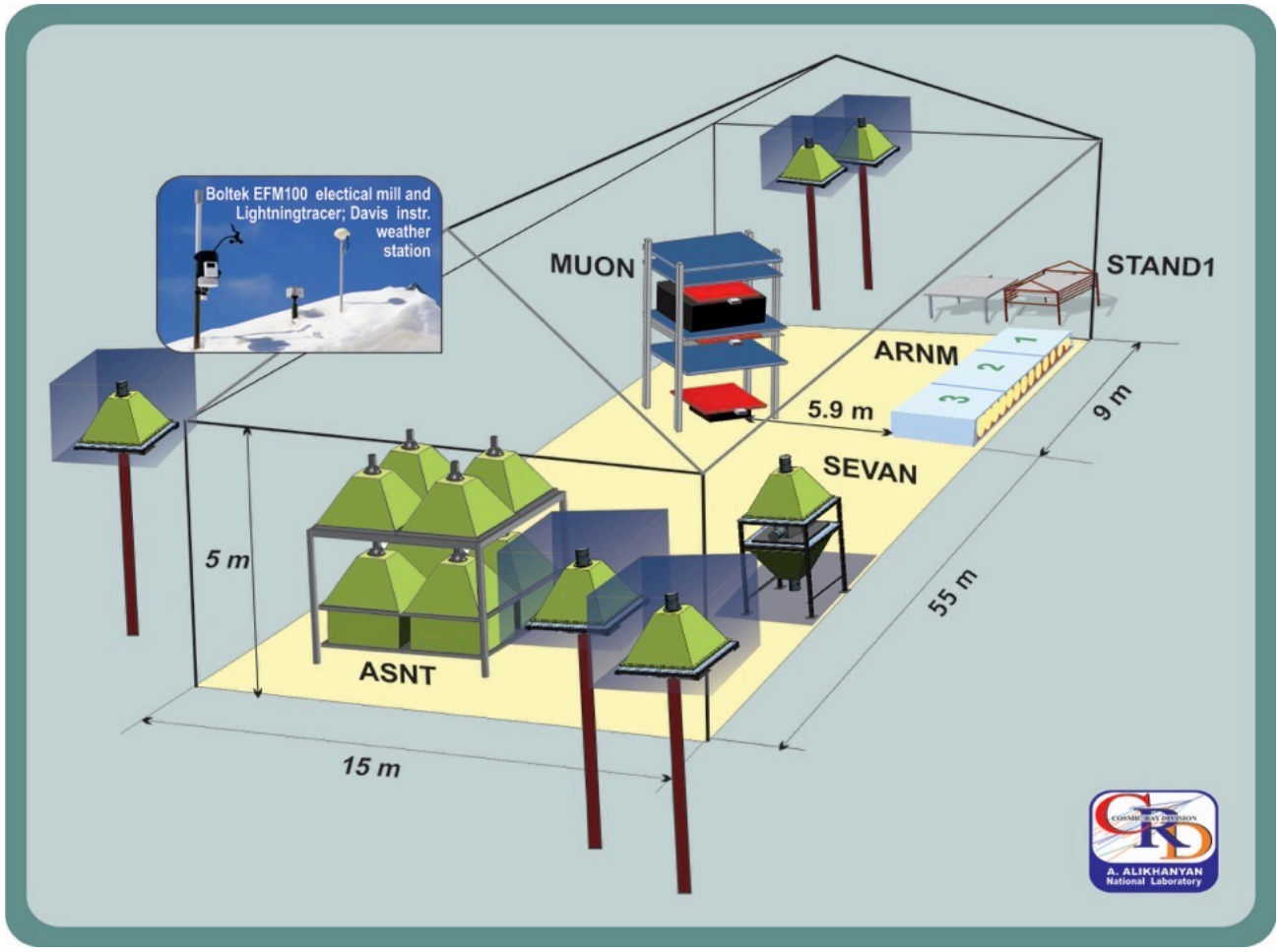
The additional signal at 7:02-7:04 UT equals 2354 (0.644%) significance = 3.93σ

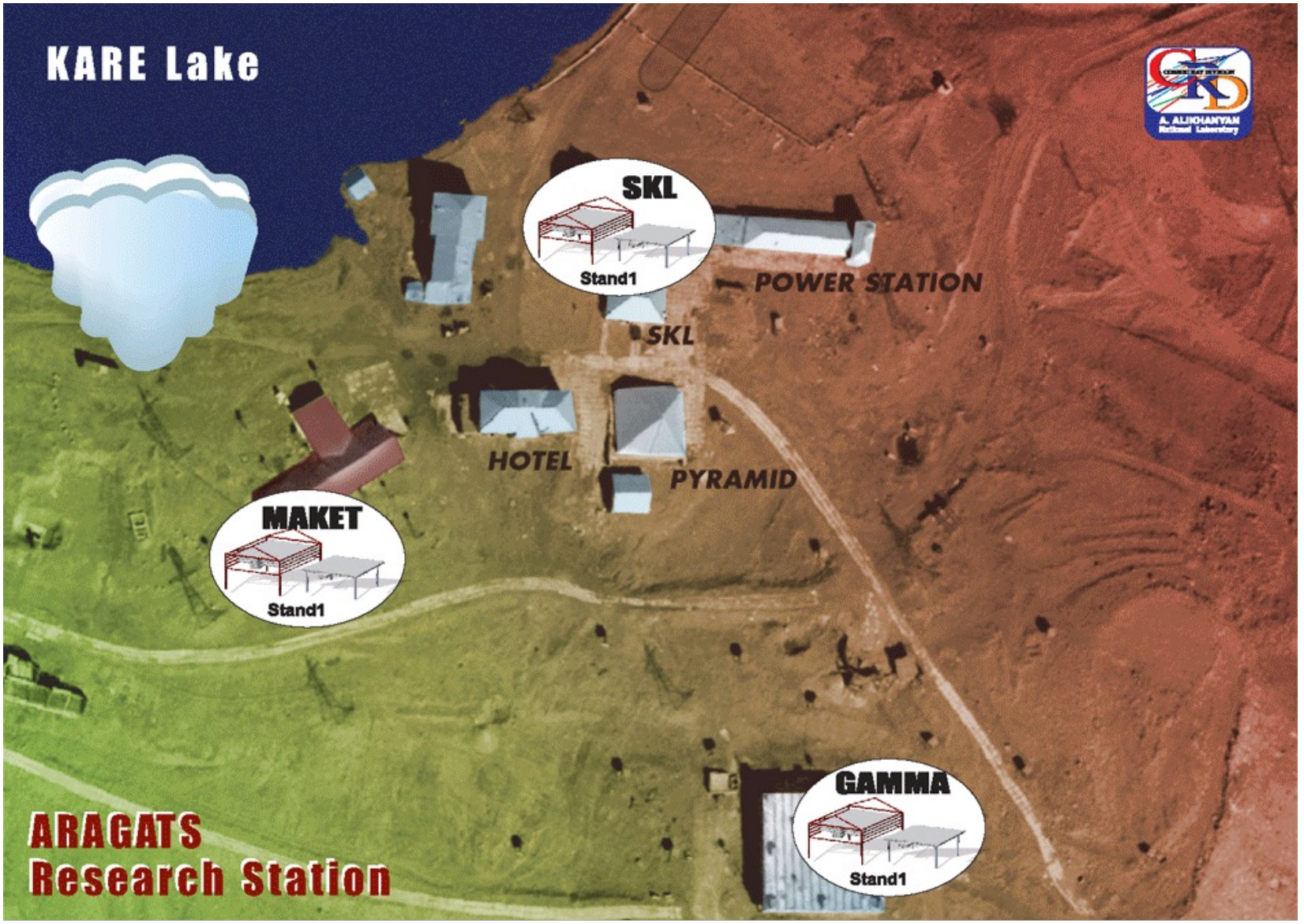


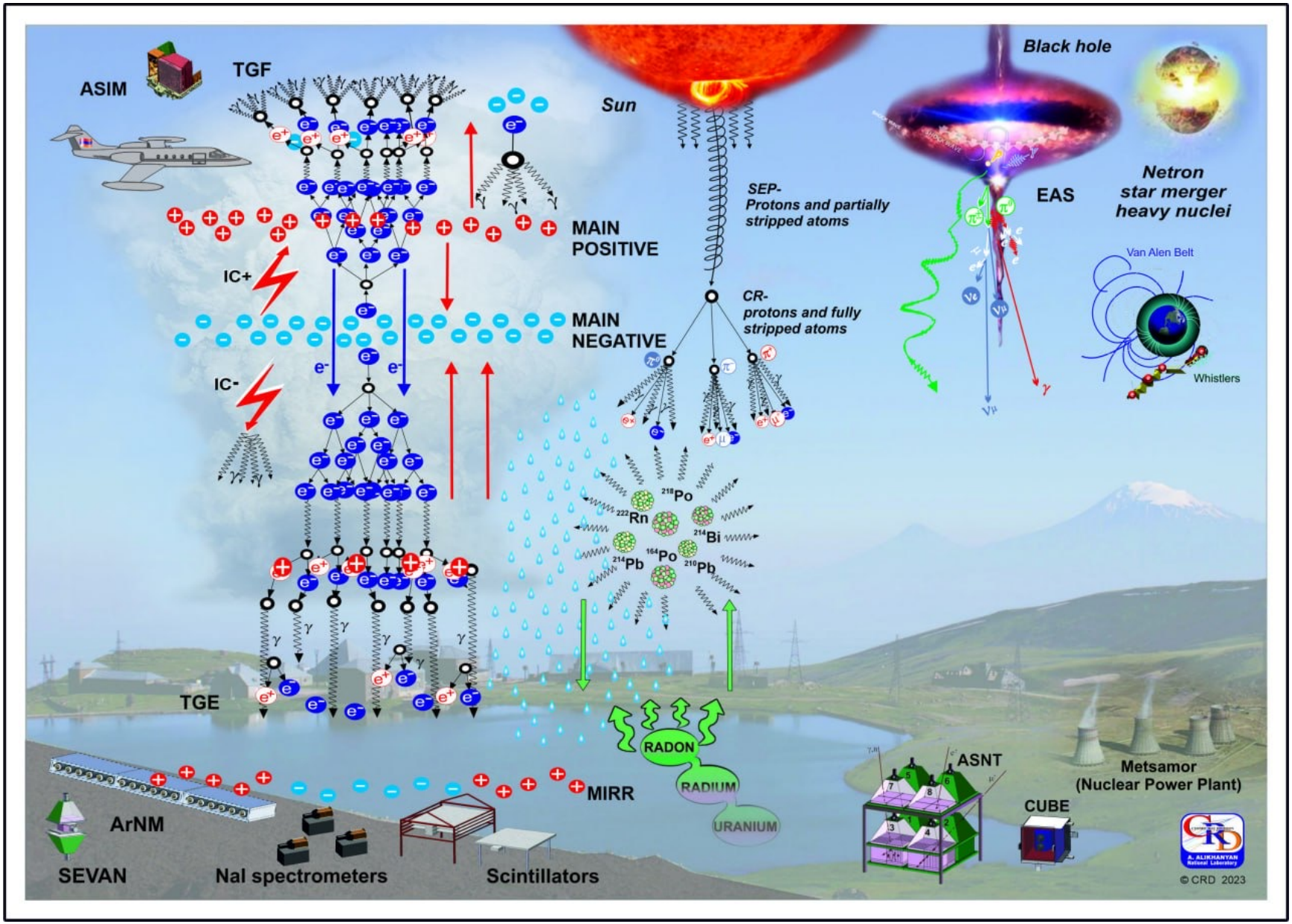




High-Energy Atmospheric Physics (HEPA)Particle detectors located in MAKET experimental hall: Electron accelerators in thunderclouds




KARE Lake
SKL
Stand1
POWER STATION
SKL
HOTEL
PYRAMID
MAKET
Stand1
GAMMA
Stand1
ARAGATS
Research Station


ASIM
TGF
Sun
Black hole
Netron
star merger
heavy nuclei
EAS
SEP-
Protons and partially
stripped atoms
MAIN
POSITIVE
IC+
MAIN
NEGATIVE
IC-
CR-
protons and fully
stripped atoms
Van Alen Belt
Whistlers
TGE
RADON
RADIUM
URANIUM
MIRR
ArNM
SEVAN
NaI spectrometers
Scintillators
ASNT
CUBE
Metsamor
(Nuclear Power Plant)
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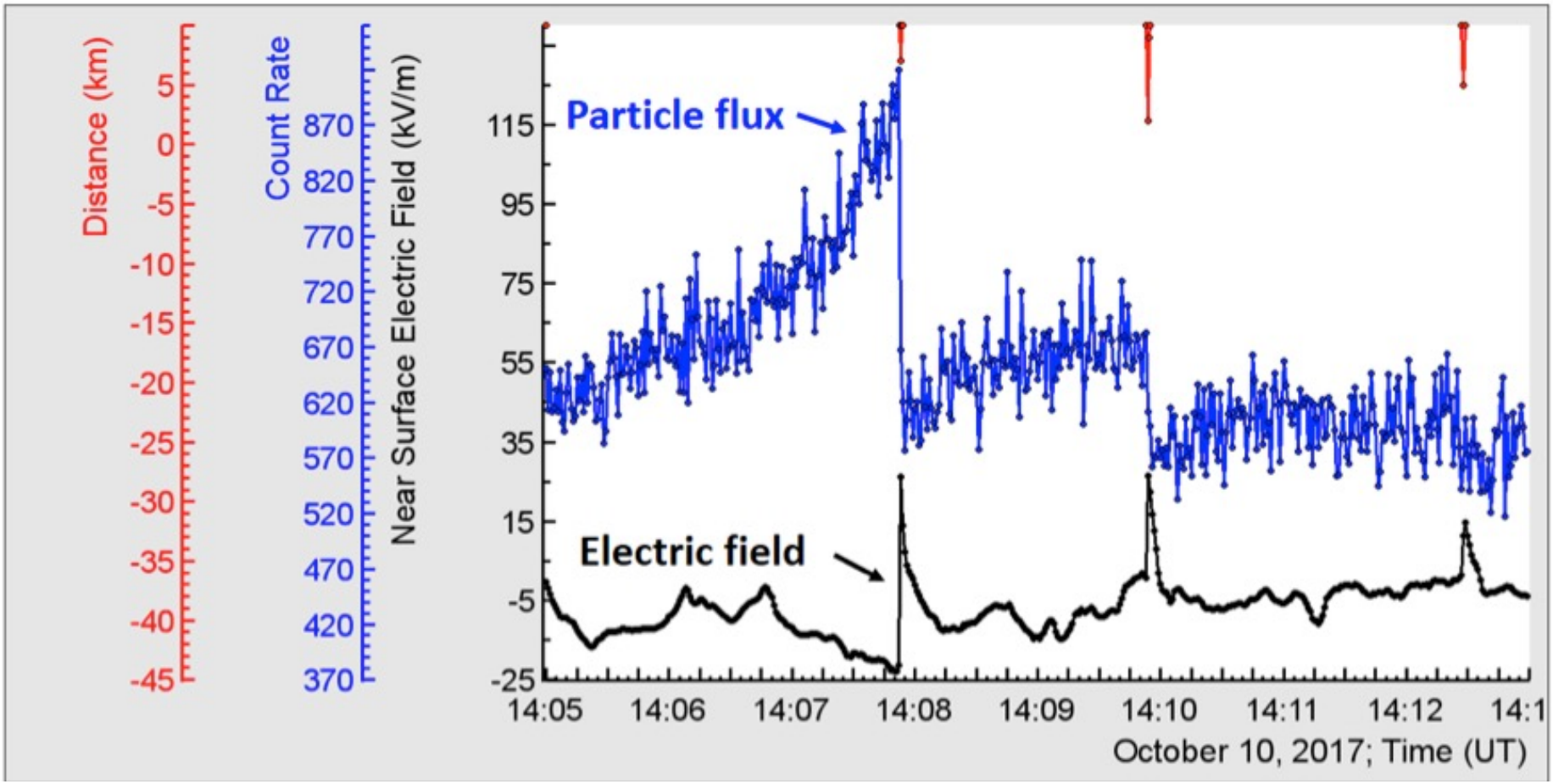
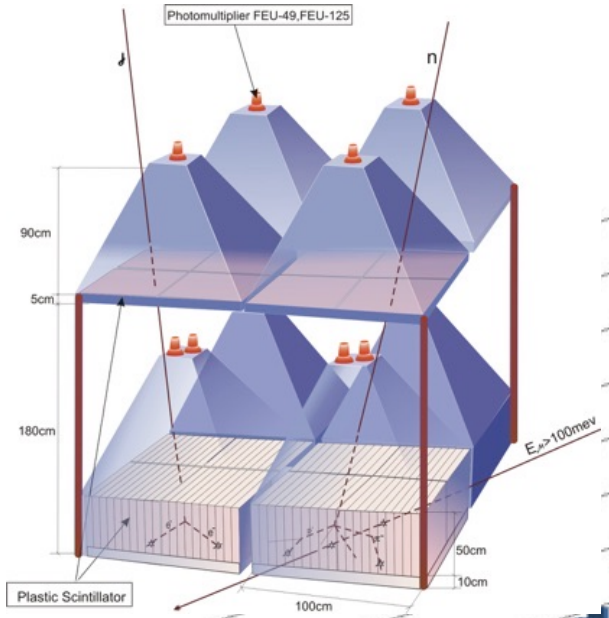
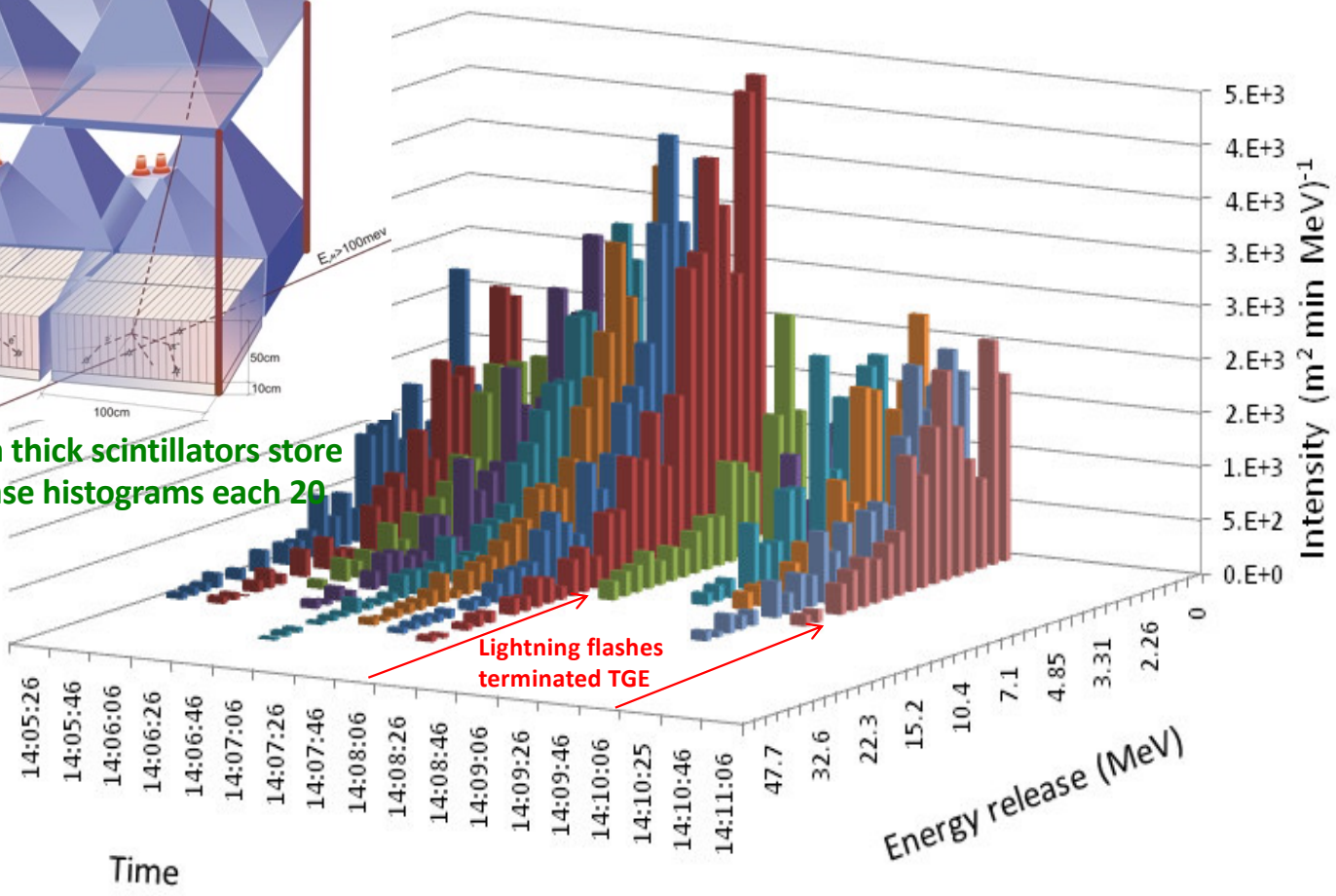
One-second time series of the Thunderstorm ground enhancement (TGE) abruptly terminated by the lightning flashes: TGEs are precursors of the lightning!



10-sec histograms of energy releases in 60 thick scintillator. Normal polarity intracloud flashes terminate TGE 2 times

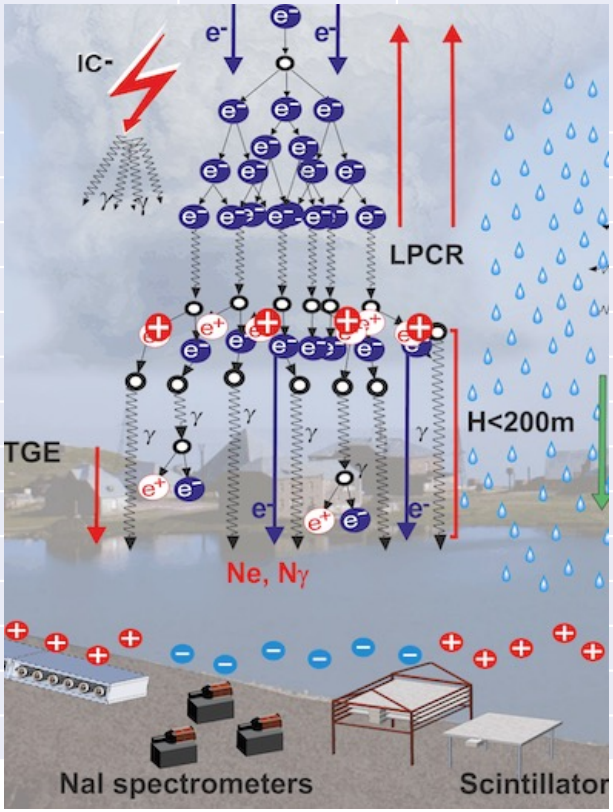


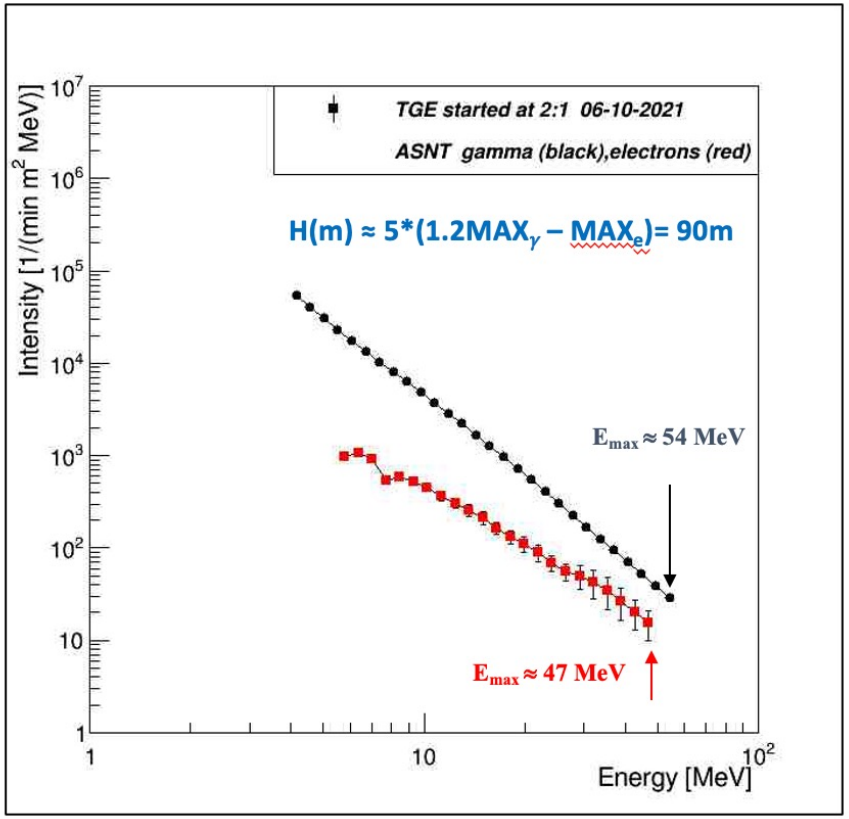
ASNT: 60 cm thick scintillators store energy release histograms each 20 seconds



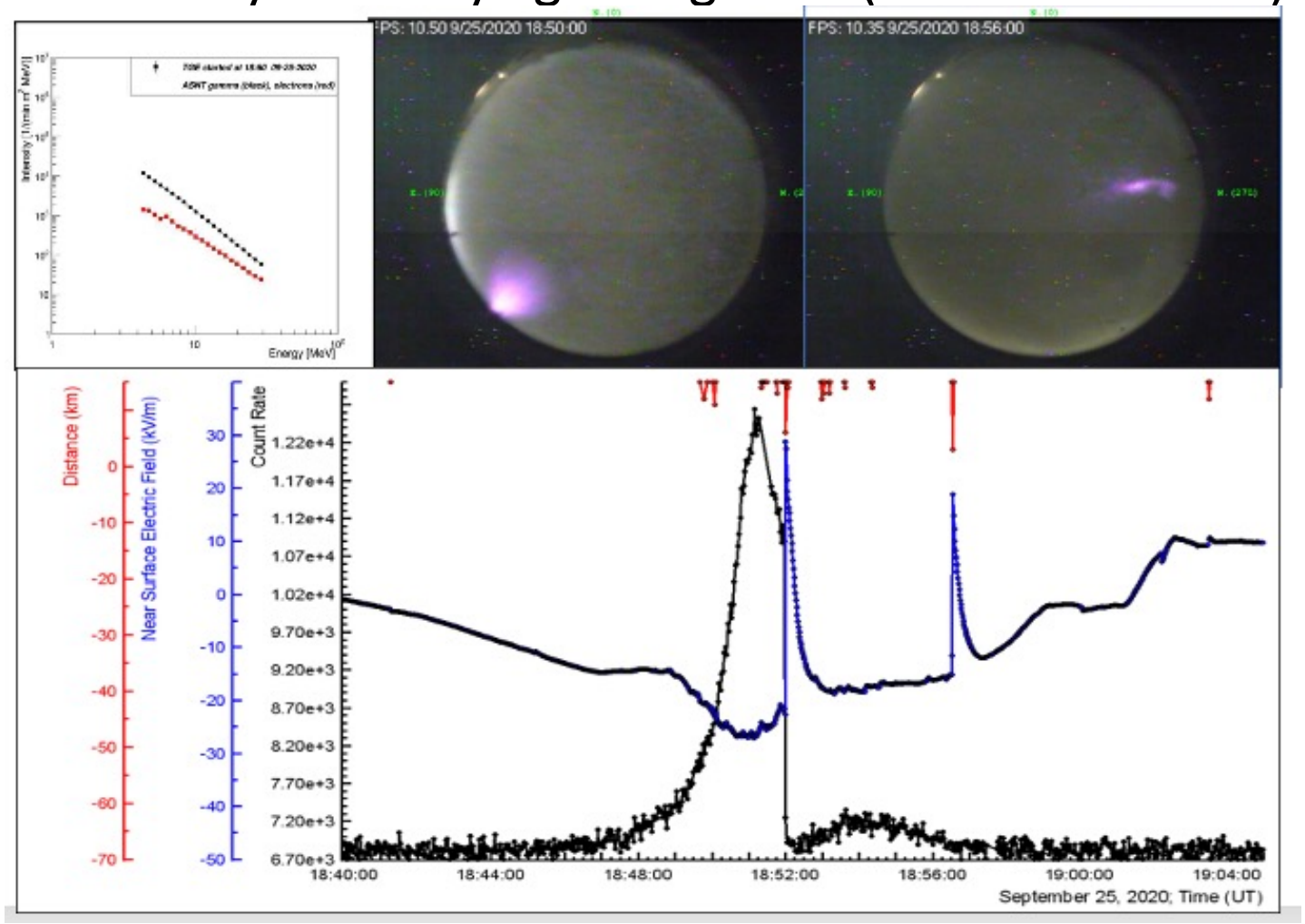
The difference in attenuation of gamma ray and electron fluxes allows estimation of the height where both fluxes leave the electron acceleration region: a strong accelerating field (≈2.1 kV/cm) can be 50-100 m above the earth's surface!

Distance from detector to the bottom edge of the field (m)	Expected gamma absorption (%) and electron ionization losses (MeV)
50	8.67
100	16.6
200	30.44
300	41.98
400	51.62
1000	83.7
10000	99.99999
50	8
100	16.1
200	32.1
300	48.23
400	64.3

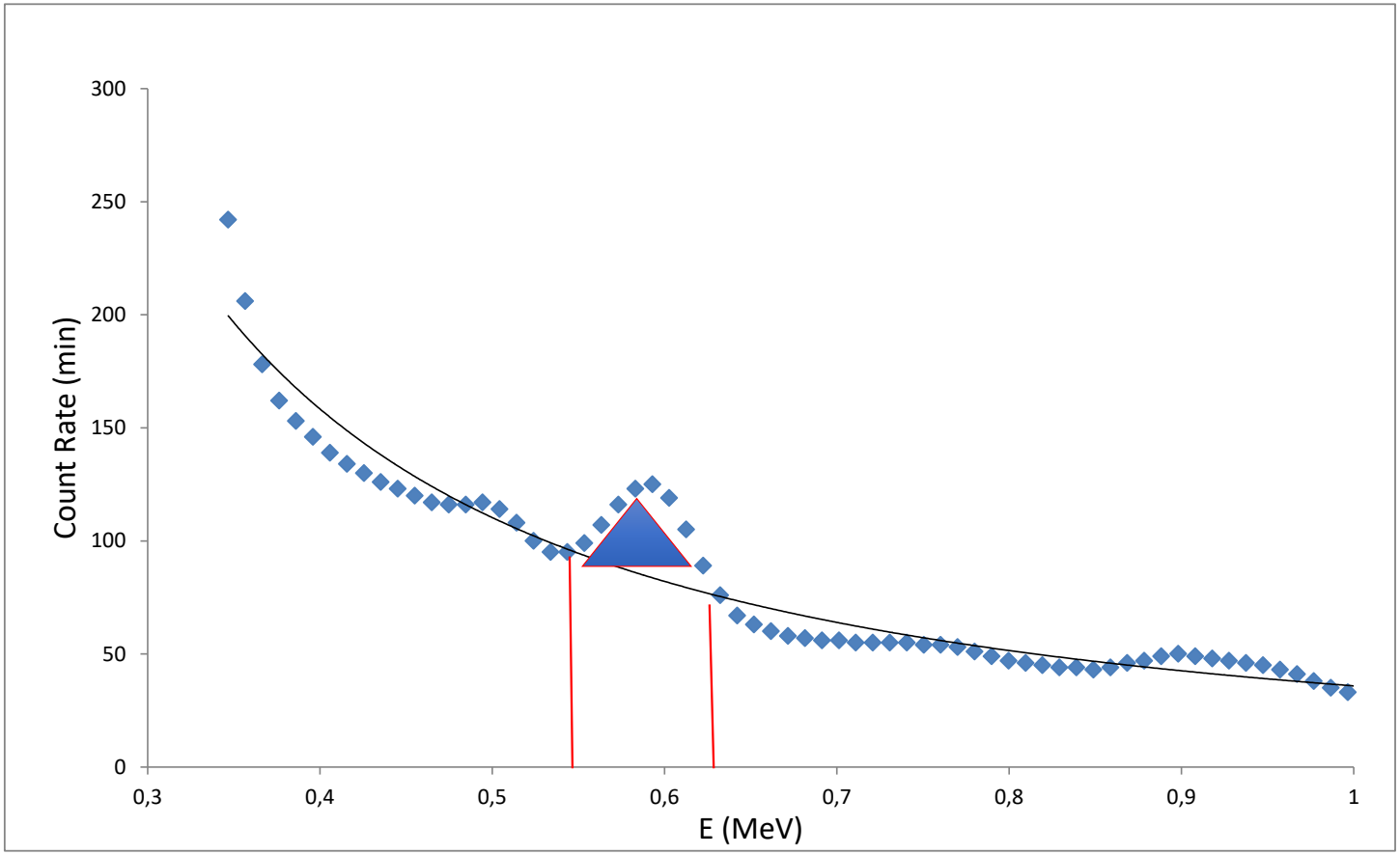




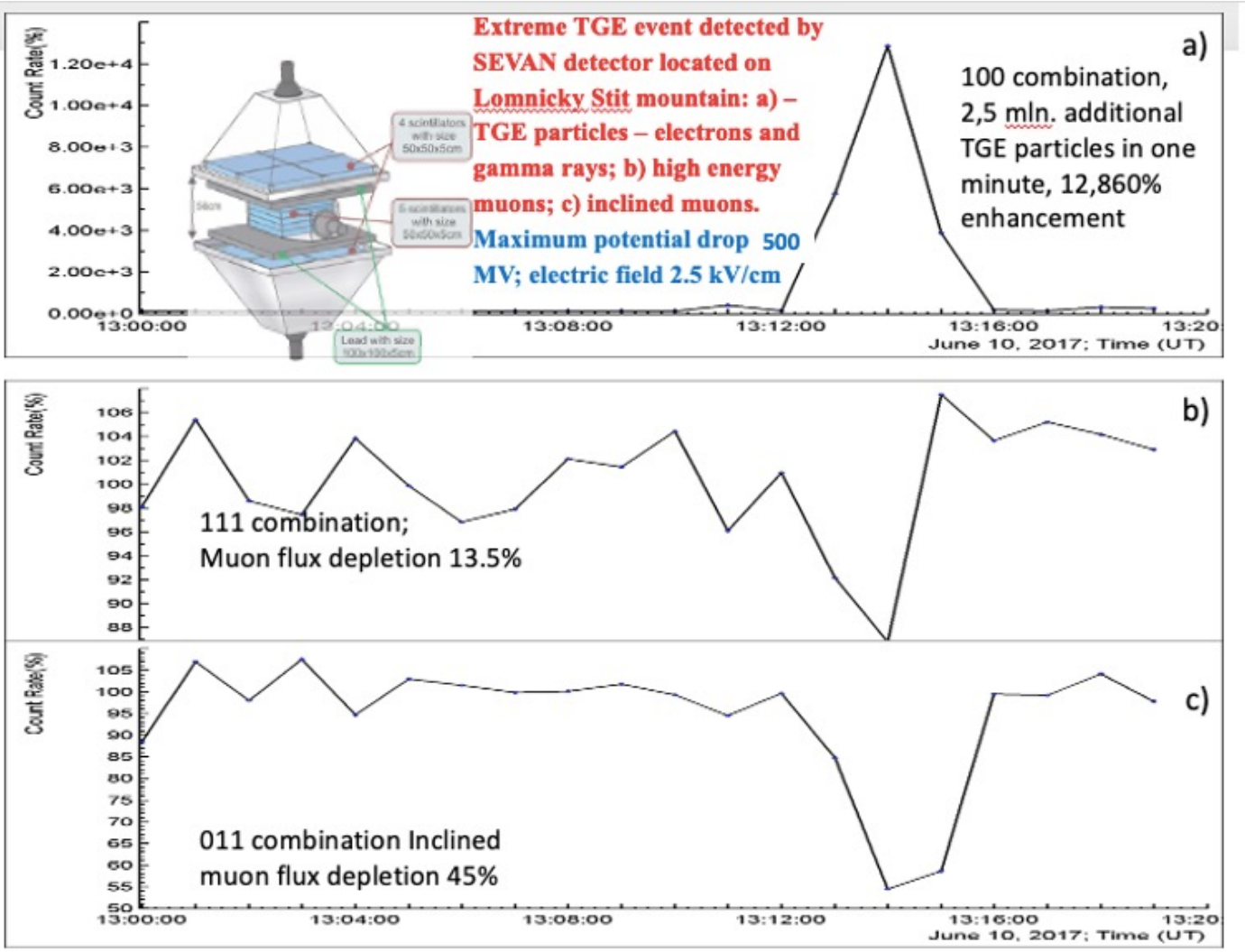
Lights registered by the panoramic camera below the thunderclouds during a 5-minute TGE occurred during a negative NSEF terminated by a nearby lightning flash (distance 5.4 km).



0.609 MeV ^{124}Bi spectral line enhancement: Radon circulation effect



Maximum electric field strength at Lomnicky Stit and Aragats



Chum, J., Langer, R., Baše, J., Kollárik, M., Strhárský, I., Diendor- fer, G., and Rusz, J.: Significant enhancements

TEPA -2019 (Thunderstorms and elementary particle acceleration)
conference participants on Aragats near Dragon stone


“Alpian carpets” on Aragats
3200 asl, July-August

There are more than 30 types of flowers on Aragats summits; some of them are endemic.


Amberd a 10th-century fortress located 2,300 meters,
on the slopes of Aragats at the confluence of the
Arkashen and Amberd rivers


Berghotel Hammersbach Kreuzeckweg 2–6, Grainau

Conclusions

- Enormous particle fluxes (10^{18} particles per minute per square meter with energies above 100 KeV) from the atmospheric electron accelerators must enter the digital models of the Earth.
- ASEC adopted open access policy (no registration of users); 20 years of data from Armenia's research stations and from abroad. Almost all particle fluxes, energy spectra, electric and geomagnetic fields, lightning locations, weather parameters, and skies photos are available for users via interactive multivariate visualization and statistical analysis platforms.
- We are ready to cooperate with VAO and EU organizations in nowcasting and forecasting violent space and terrestrial storms.