

Status of the European SEVAN network and planned modernizations

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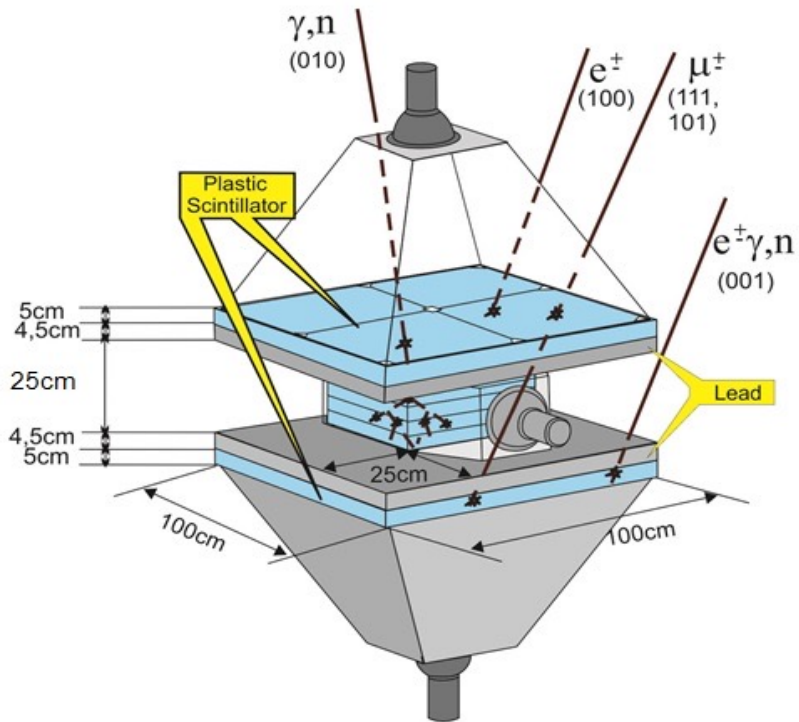
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Design of the SEVAN basic unit (Space Environment Viewing and Analysis Network)



15 years of IHY.



A network of middle to low latitude particle detectors called SEVAN (Space Environmental Viewing and Analysis Network) is planned in the framework of the International Heliophysical Year (IHY), to improve fundamental research of the Solar accelerators and Space Weather conditions. The program of TGE detection with SEVAN network started in 2016.

SEVAN detector simultaneously measures fluxes of secondary cosmic rays (electrons, photons, muons and neutrons) from solar modulation and particle acceleration in a thunderstorm atmosphere.

- 100 – traversal of the low energy charged particle ($5\text{MeV} < E < 100\text{MeV}$);
- 010 – traversal of the neutral particle;
- 111, 101 – traversal of the high energy muon ($>250\text{ MeV}$, $>200\text{ MeV}$);

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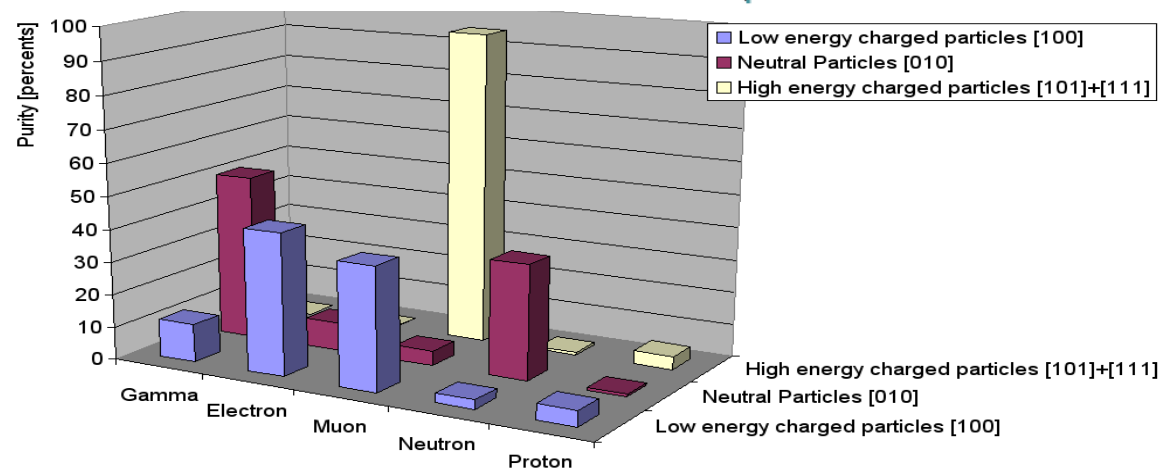
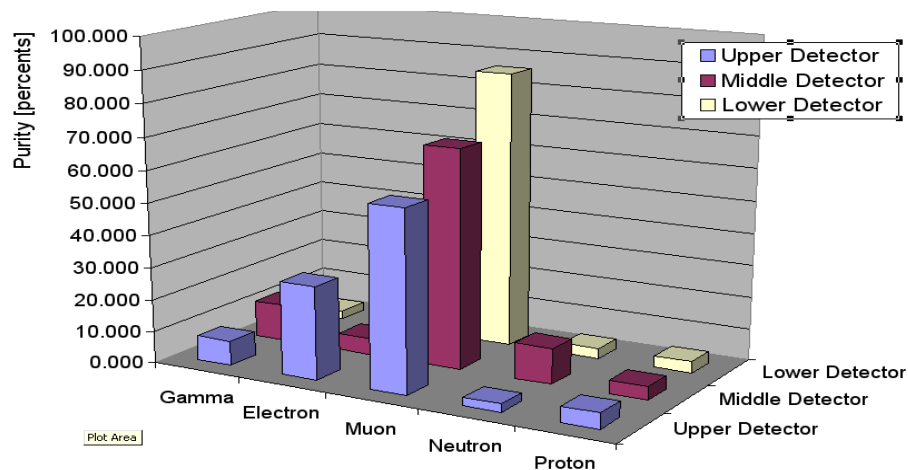
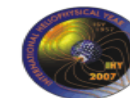
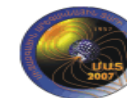


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Selection of Secondary Cosmic Rays



	Gamma ray	Electron	Muon	Neutron	Proton
Registered particles Purity by detecting coincidences					
Low energy charged particles [100]	11.605	43.300	37.380	2.838	4.804
Neutral Particles [010]	50.612	8.837	4.494	35.071	0.972
High energy charged particles [101]+[111]	0.002	0.106	94.904	0.808	4.077
Registered particles Purity by count rate of the 3 scintillators					
Upper Detector	7.616	28.952	56.080	2.448	4.814
Middle Detector	11.550	5.223	67.913	11.038	4.167
Lower Detector	2.696	4.438	85.873	3.267	3.634

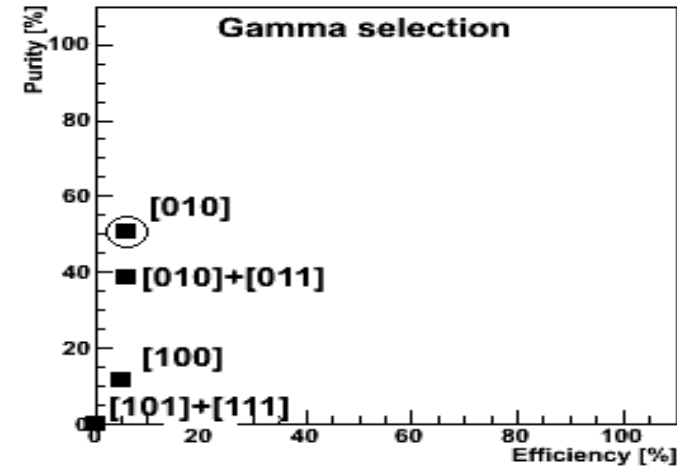
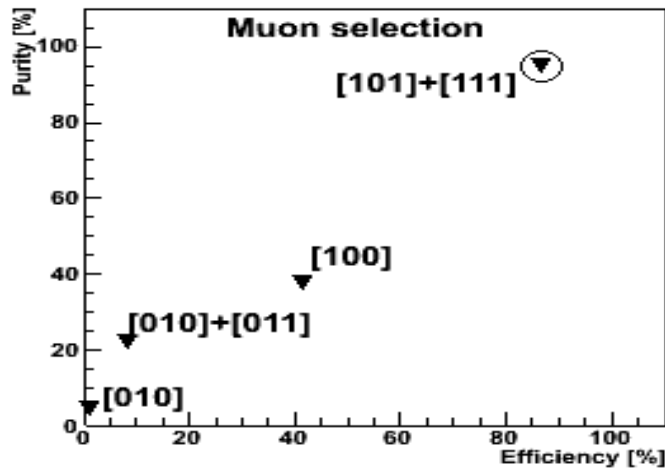
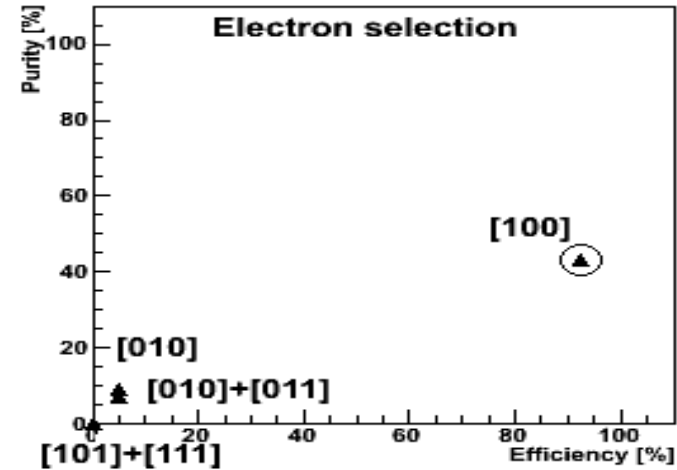
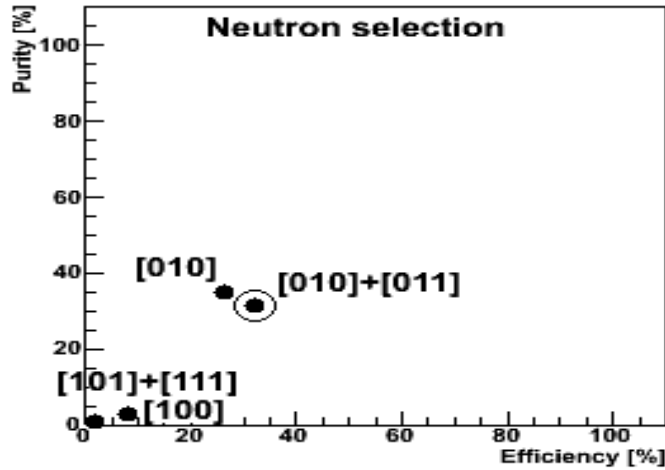
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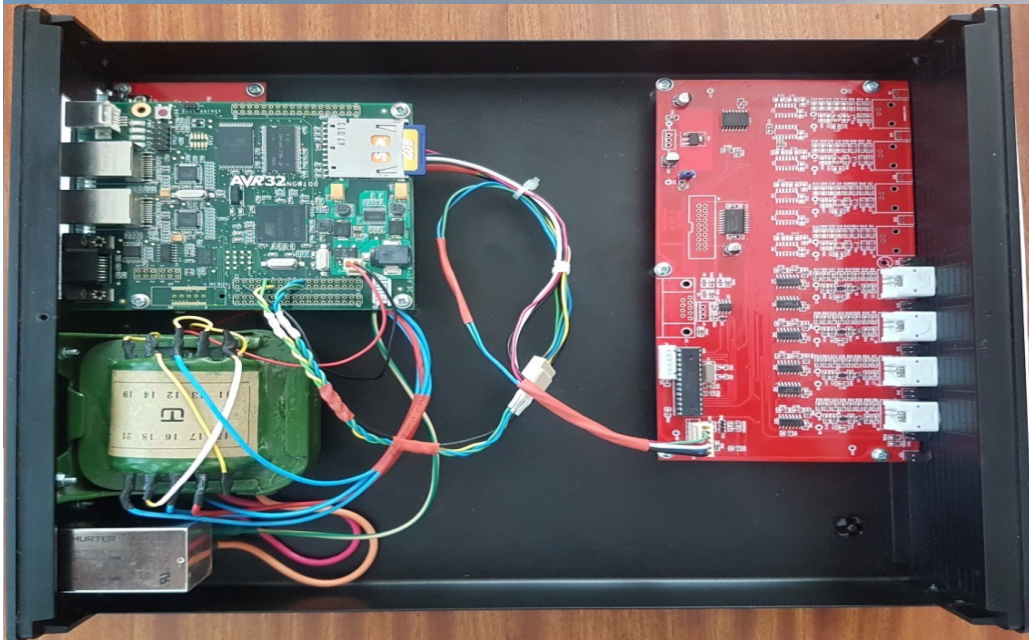
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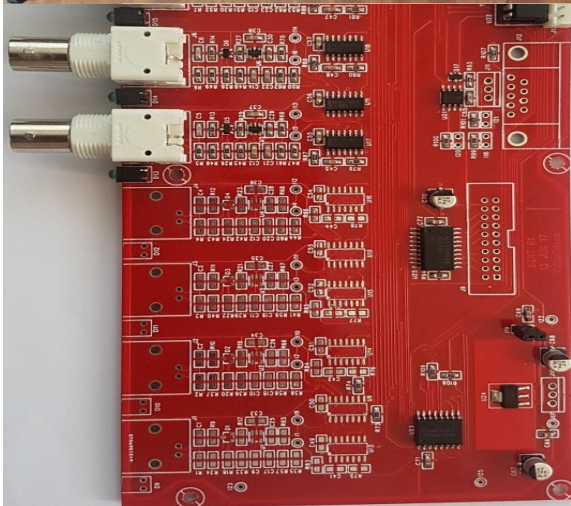
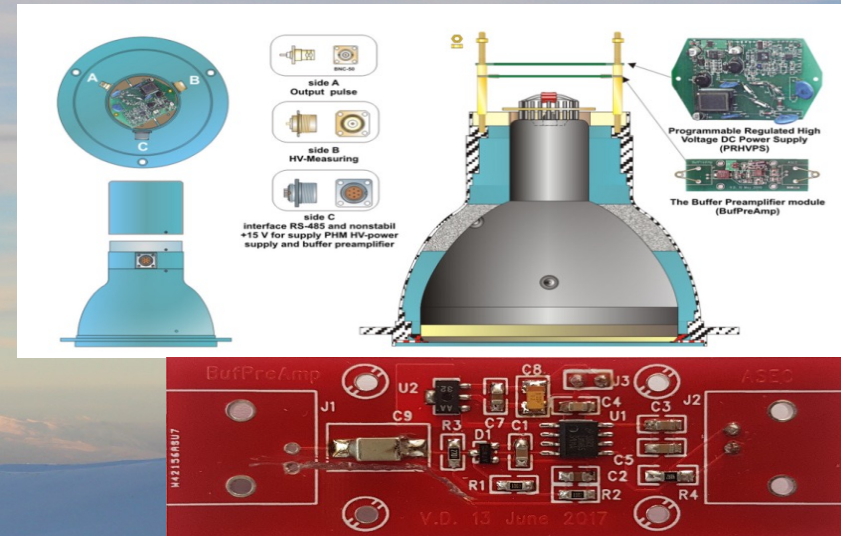
Purity-Efficiency Diagram



All electronic parts and software have been designed and manufactured in Cosmic Ray Division



ripple



- Time delay, depending on
- Threshold programming
- RS-485 interface with DSU
- Internal +3.3V regulator,
- Power supply voltage – un
- Supply Current $\leq 200\text{mA}$
- Maximal counting frequen
- LEDs to indicate the input
- module power and program
- 8 input BNC connectors,
- 20-pin connector for digital
- 6-pin connector to the Mu

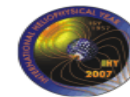
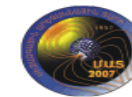
The module counter and interf

microcontroller.





SEVAN monitors in Armenia are located in three places



Yerevan

Latitude: 40° 21' 00" N
Longitude: 44° 16' 12" E
Altitude: 1571m a.s.l
R_c: 7.1 GV



Nor Amberd

Latitude: 40° 22' 30.27" N
Longitude: 44° 15' 51.82" E
Altitude: 2000m a.s.l
R_c: 7.1 GV



Aragats

Latitude: 40° 28' 17.93" N
Longitude: 44° 10' 51.49" E
Altitude: 3200m a.s.l
R_c: 7.1 GV

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www.aragats.am

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SEVAN detectors in Croatia, Slovakia, Bulgaria, Czech Republic, Germany and in India



SEVAN Detector in Zagreb Observatory, Croatia;
 Latitude: 45° 49'08.2"N;
 Longitude: 15° 58'29.7"E;
 Altitude: 227m. a.s.l.
 Rc : 4.89 GV



SEVAN Detector in Lomnický štít, Slovakia;
 Latitude: 49° 11' 42.53" N
 Longitude: 20° 12' 47.43" E
 Altitude: 2633 m. a.s.l.
 Rc : 3.88 GV



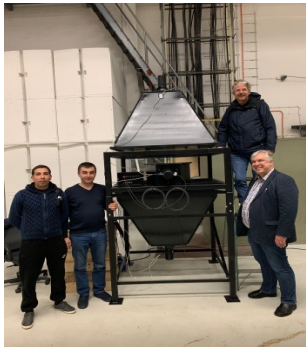
SEVAN Detector in mountain Mussala, research station of institute for Nuclear Research and Nuclear Energy; Bulgaria
 Latitude: 42° 10' 45.07" N
 Longitude: 23° 35' 6.96" E
 Altitude: 2926 m. a.s.l.
 Rc : 6.19 GV



SEVAN Detector in Mílesovka hill. Department of Radiation Dosimetry Nuclear Physics Institute of Czech Academy of Sciences; Czech Republic
 Latitude: 50° 33' 41.9" N
 Longitude: 13° 55' 51.82 E
 Altitude: 863 m. a.s.l.
 Rc : 14.14 GV



SEVAN Detector in India, Jawaharlal Nehru University;
 Latitude: 28°61' N
 Longitude: 77°23' E
 Altitude: 239 m. a.s.l.
 Rc : 14.14 GV



SEVAN Detector in Hamburg, Germany
 Latitude: 53°34' 28.254" N
 Longitude: 9°52' 47.258" E
 Altitude: 8 m. a.s.l.
 Rc : 2.25 GV



SEVAN Detector in Zeuthen, Germany
 Latitude: 52°20' 42.216" N
 Longitude: 13°38' 0.802" E
 Altitude: 34 m. a.s.l.
 Rc : 2.25 GV



SEVAN home page:
http://crd.yerphi.am/SEVAN_Data
<http://crd.yerphi.am/ADEI>



File Edit View History Bookmarks Tools Help

SEVAN OnLine Data - Cosmic R. X

crd.yerphi.am/SEVAN_Data

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RSF Project Important Lectures and Papers CRD production

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SEVAN PROJECTS

SEVAN OnLine Data

- Space Environmental Viewing and Analysis Network
 - Network Detectors
 - Official Documents
 - Electronics
 - Mechanical Charts
- SEVAN OnLine Data
 - Aragats
 - Nor-Amberd
 - Yerevan
 - Moussala
 - Zagreb
 - JNU
 - Lomnicky stit
- + How To
 - Papers & Presentations
 - ADEI of ASEC
 - Projects Archive
 - Thunderstorms
 - Current scientific reaserch
- + Fluxes measured at Aragats
 - GLEs at 22 and 23 Solar Cycle
- + ASEC Monitors
 - ASEC Data Description
- + Analysis and Nonparametric Inference (ANI)
 - 2017 CRD Grants/Projects

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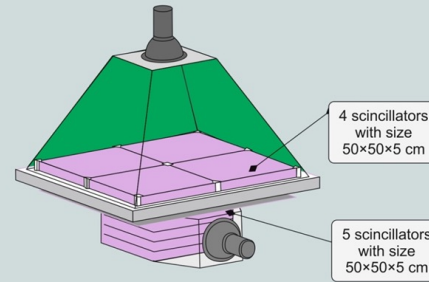
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Zugspitze altitude 2962 m a.s.l.

SEVAN_Light detector
will be located at altitude 2650 m a.s.l

SEVAN
Space Environmental Viewing
and Analysis Network

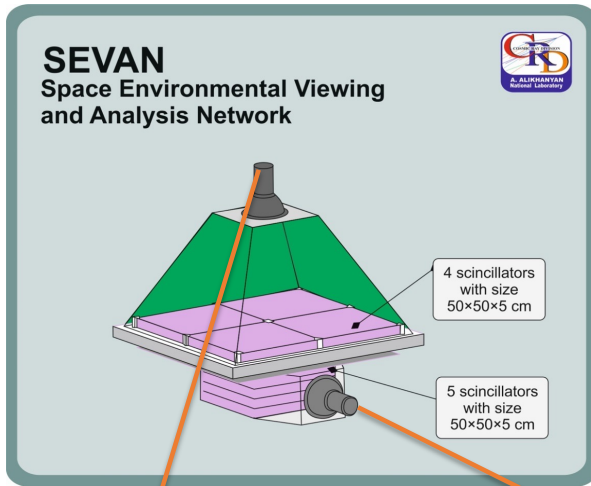


In the framework of the collaboration with DESY to fully exploit the scientific potential of the SEVAN detectors already installed in Zeuthen, German group plan to move the detector to the Umwelt-Forschungs-Station(UFS, Schneefernerhaus, 2650 m asl,) near the top of the Zugspitze (2962 m).

Armenian and German groups plans to modify the detector to become more compact (due to constrained location at Zugspitze, SEVAN-light).

The weight will be less than 120 kg (without frame) and height less than 120 cm. This option will be fully operational for the high-energy atmospheric physics research. Additionally, by new electronics which will be attached to SEVAN_Light will be measured energy spectrum of TGE particles.

SEVAN - light unit



The weight will be less than 120 kg (without frame).

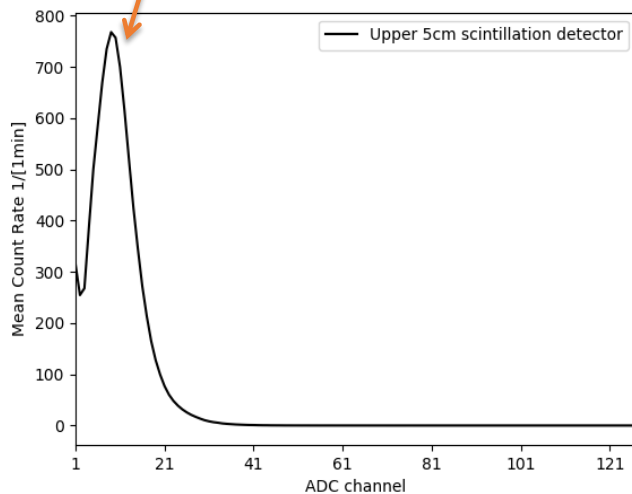
The height less than 120 cm.

This option will be fully operational for the high-energy atmospheric physics research. Additionally, will be measured energy spectrum of TGE particles. New electronics also will give possibility to use as a separate additional detector the bottom top of SEVAN.

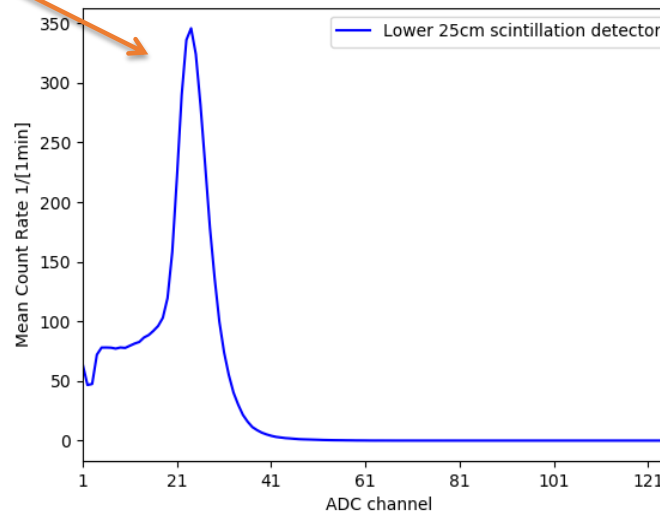
The list of available information from modernized SEVAN-light is as follows:

- 1 minute count rates (easily can be changed to another time span) of 2 channels of SEVAN.
- 1 minute count rates of the special coincidences between 2-layers (**coincidence 10, coincidence 11 and coincidence 01**).
- Histograms of energy releases in all 2 channels of SEVAN.
- Histograms of energy releases of all special coincidences of SEVAN.

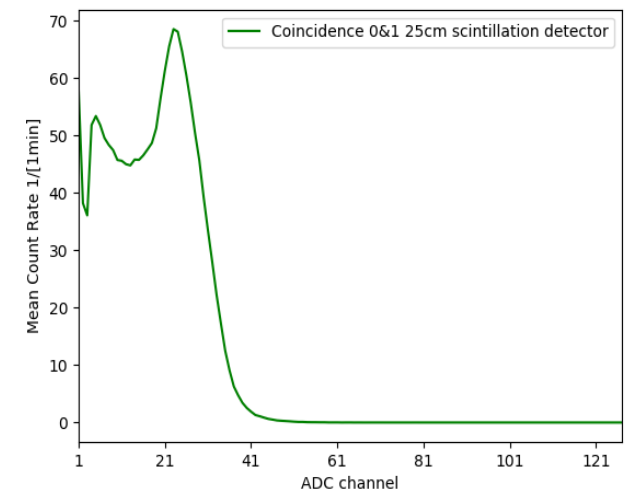
Histogram of energy release in the upper 5cm thick scintillator



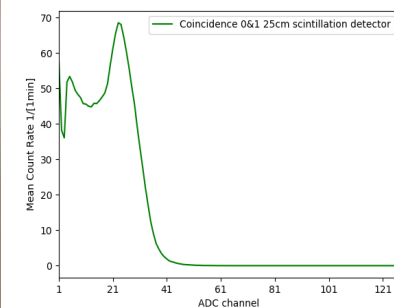
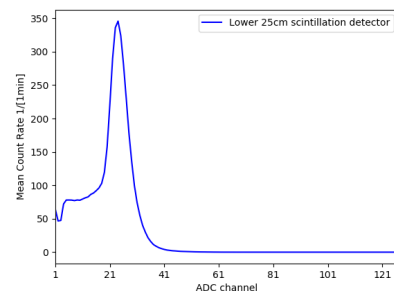
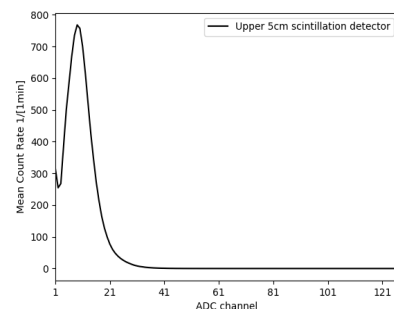
Histogram of energy release in the lower 25 cm thick scintillator



Histogram of the energy releases selected by coincidence "01"



New hardware and software for the SEVAN module to be installed on Zugspitze (2650m a.s.l) in Germany, Repair, re-calibrate, cross-calibrate SEVAN detectors of European network. Visit to Zeuthen



New DAQ system applied to 3-layered “standard” SEVAN unit will give the following additional possibilities to the SEVAN physics, measuring energy releases (to be recovered to energy spectra) of the SEVAN coincidences:

“100” – energy spectrum of low energy electrons with sizable contamination of gamma rays, possibly subtracted after recovering the gamma ray spectra from ASNT or NaI network;

“010” – gamma rays with possible contamination of neutrons, possibly subtracted from ArNM measurements.

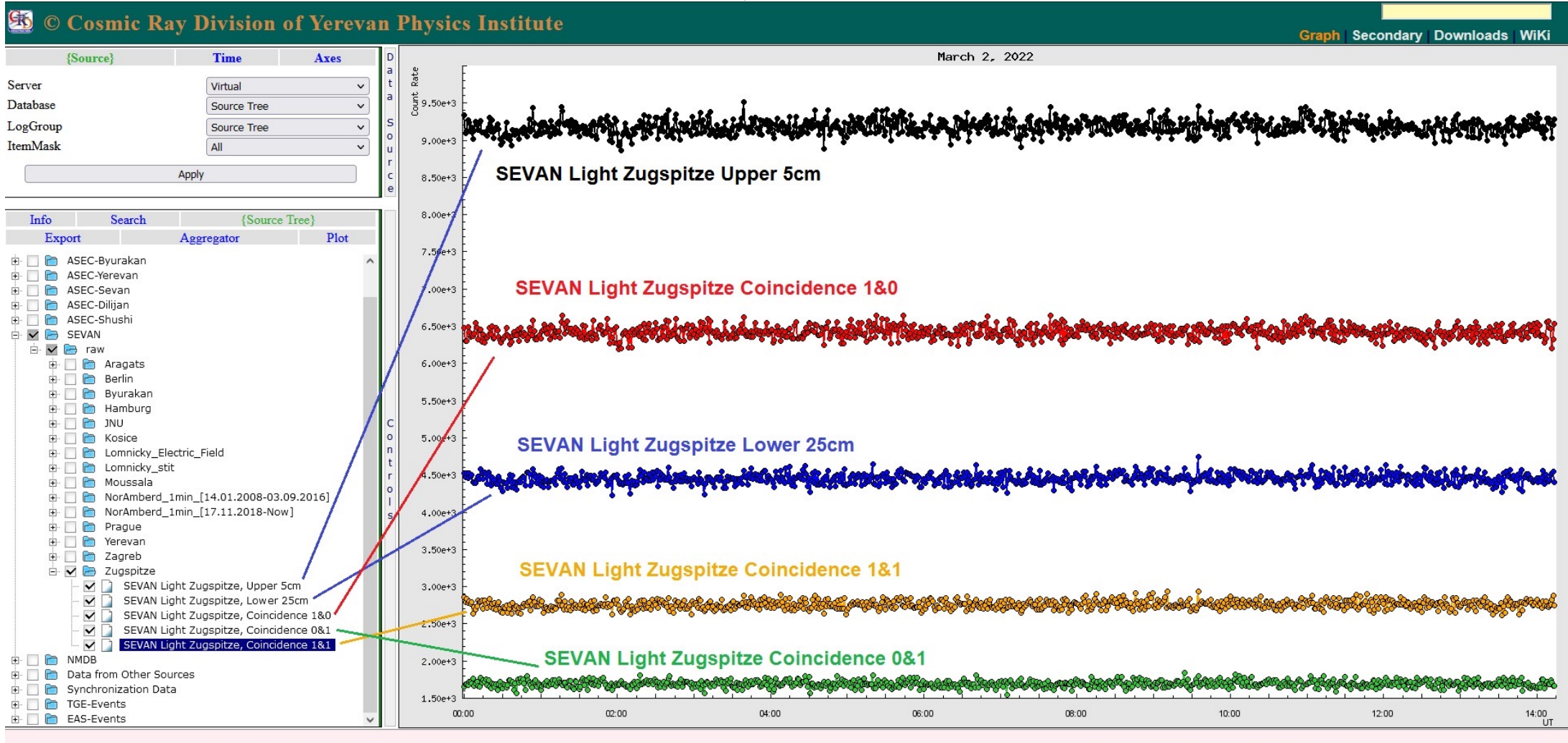
“111” – energy spectra of high-energy (above 30 MeV) muons;

“011” - energy spectra of the “stopping” muons, when above detectors there is the strong positive electric field, the muon flux will be depressed due to deceleration of positive muons.

The list of available information from modernized SEVAN is as follows:

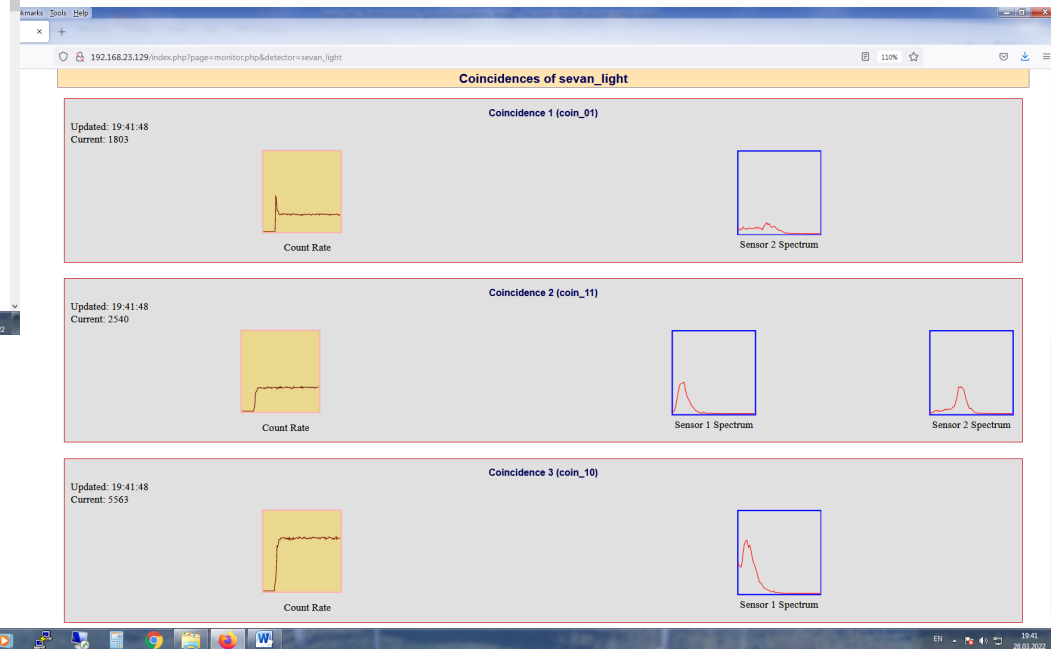
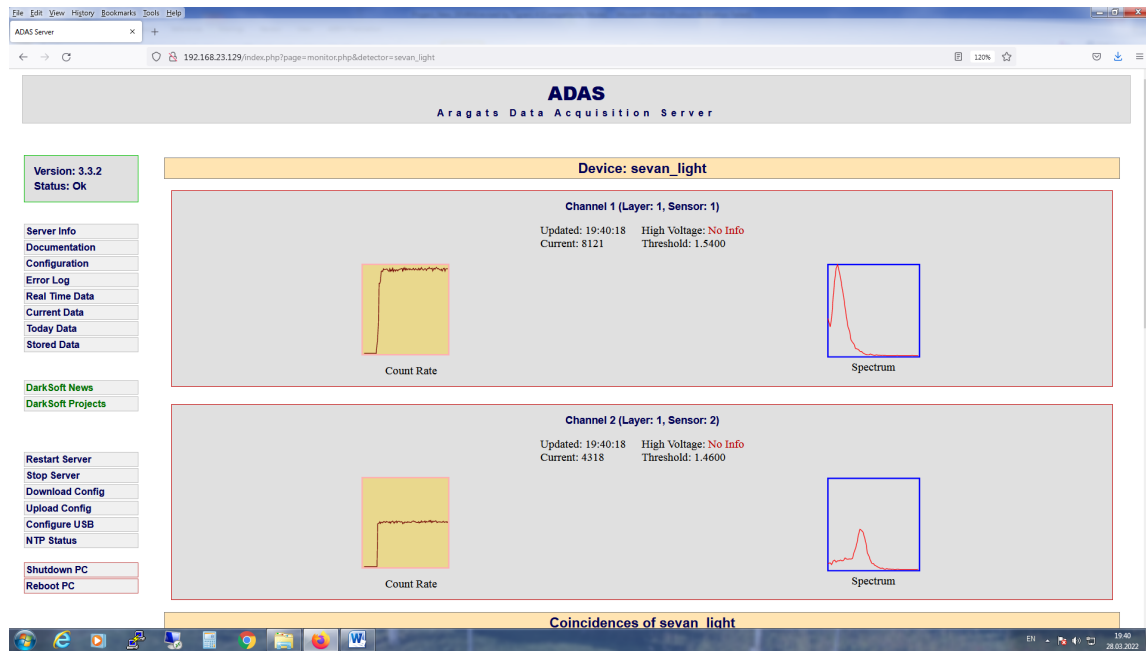
- **1 minute count rates (easily can be changed to another time span) of all 3 channels of SEVAN.**
- **1 minute count rates of the special coincidences between 3-layers.**
- **Histograms of energy releases in all 3 channels of SEVAN.**
- **Histograms of energy releases of all special coincidences of SEVAN.**

Web page of Advanced Data Extraction Infrastructure (ADEI) <http://crd.yerphi.am/adei>



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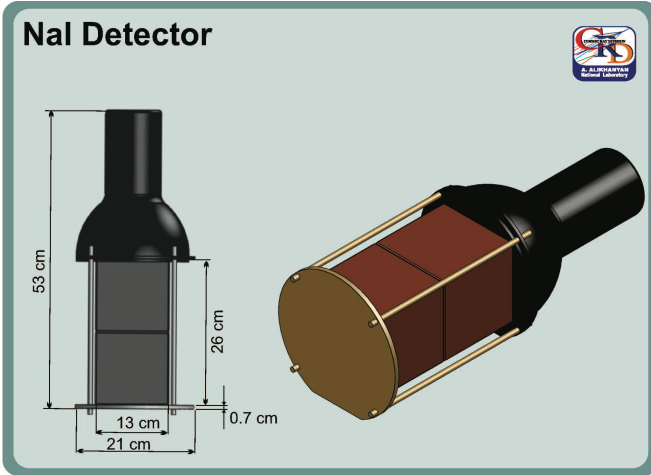
On the main page of ADAS by choosing the menu under name of “Monitor” one can see the energy releases histograms of particles in Upper 5cm, Lower 25cm scintillators and for coincidence 01, coincidence 11 and for coincidence 10.



Status of 9 SEVAN detectors and characteristics of their operations on 16.10.2022

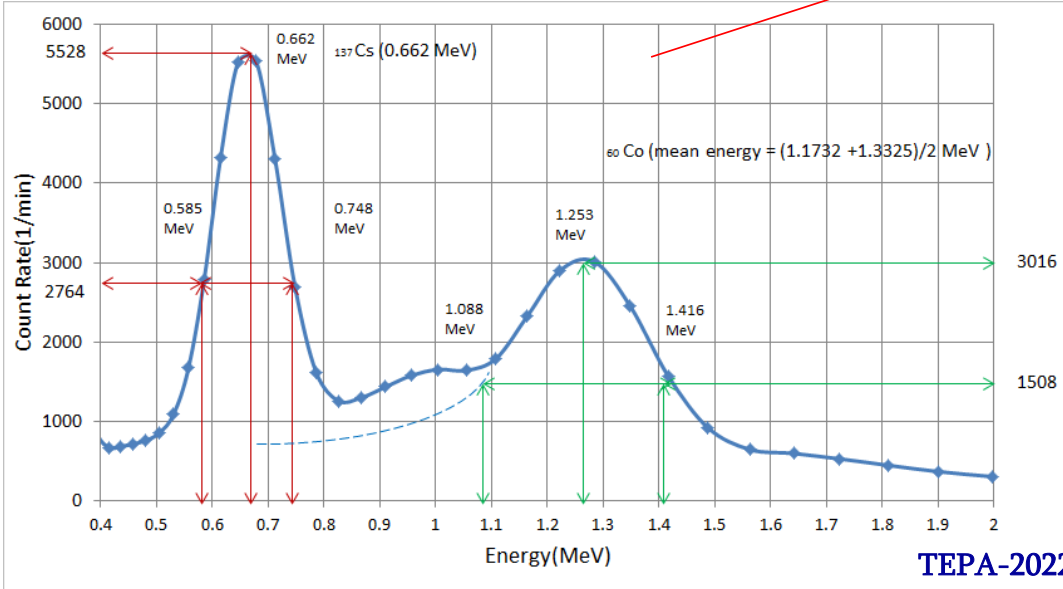
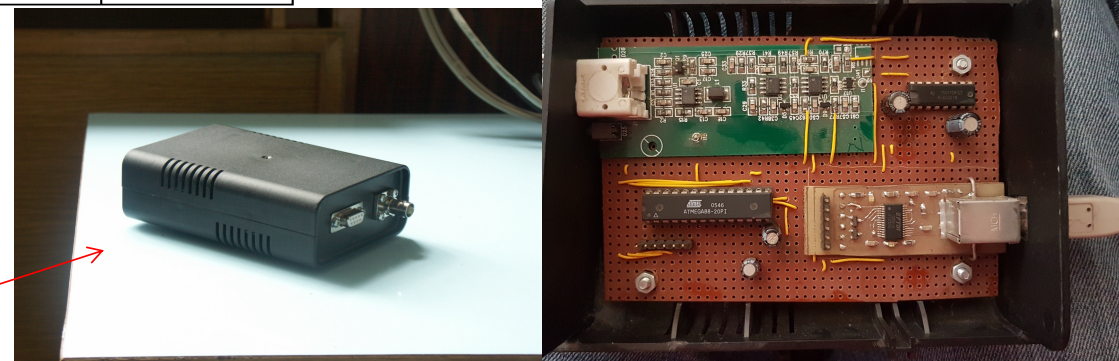
SEVAN detector	Status	Altitude (m)	1 min. mean count rate	Standart deviation (σ)	Relative Error	1/sqrt(N)
Aragats (Armenia) Upper 5cm channel	Is operating	3200	28155	236.27	0.008	0.006
Aragats (Armenia) Middle 25cm channel			7395	98.75	0.013	0.012
Aragats (Armenia) Lower 5cm channel			16735	151.28	0.009	0.008
Nor Amberd (Armenia) Upper 5cm channel	Is operating	2000	11827	121.08	0.010	0.009
Nor Amberd (Armenia) Middle 25cm channel			4547	68.12	0.015	0.015
Nor Amberd (Armenia) Lower 5cm channel			7258	85.38	0.012	0.012
Byurakan (Armenia) Upper 5cm channel	Is operating	1571	15078	139.37	0.009	0.008
Byurakan (Armenia) Middle 25cm channel			4151	76.61	0.018	0.016
Byurakan (Armenia) Lower 5cm channel			8630	160.08	0.019	0.011
Mileshovka (Czech Republic) Upper 5cm channel	Is operating	863	12849	170.07	0.013	0.009
Mileshovka (Czech Republic) Lower 25cm channel			3190	62.73	0.020	0.018
Mileshovka (Czech Republic) Lower 5cm channel			5755	93.83	0.016	0.013
Lomnický Stit (Slovakia) Upper 5cm channel	Is operating	2633	26741	163.54	0.006	0.006
Lomnický Stit (Slovakia) Middle 25cm channel			8007	89.26	0.011	0.011
Lomnický Stit (Slovakia) Lower 5cm channel			14937	115.43	0.008	0.008
Hamburg (Germany) Upper 5cm channel	Is operating Lower channel count rate is higher than Upper channel	8	5493	74.43	0.014	0.014
Hamburg (Germany) Middle 25cm channel			2917	54.01	0.019	0.019
Hamburg (Germany) Lower 5cm channel			6219	80.77	0.013	0.013
Zeuthen (Germany) Upper 5cm channel	Under reconstruction	34	-	-	-	-
Zeuthen (Germany) Middle 25cm channel			-	-	-	-
Zeuthen (Germany) Lower 5cm channel			-	-	-	-
Moussala (Bulgaria) Upper 5cm channel	Isn't operating from 30.09.22	2926	-	-	-	-
Moussala (Bulgaria) Middle 25cm channel			-	-	-	-
Moussala (Bulgaria) Lower 5cm channel			-	-	-	-
Zagreb (Croatia) Upper 5cm channel	Isn't operating from 08.02.21	227	-	-	-	-
Zagreb (Croatia) Middle 25cm channel			-	-	-	-
Zagreb (Croatia) Lower 5cm channel			-	-	-	-

New autonomous NaI(Tl) spectrometers (300 KeV-50 MeV, 5RL) by new LogADC and DAQ system



Material	Radiation length		Density
	g/cm ²	cm	g/cm ³
Polystyr. scint.	43.72	42.4	1.032
Cesium iodide (CzI)	8.39	1.85	4.53
Sodium iodide (NaI)	9.49	2.59	3.67

LogADC 1st version



Energy resolution of 1st version LogADC attached to 2x2 inch NaI(Tl) crystal

24.6% for Cs137 (0.662MeV)

26.2% for Co60 (1.253MeV)

Energy resolution of 2nd version LogADC attached to 2x2 inch NaI(Tl) crystal is about

17% for Cs137 (0.662MeV)



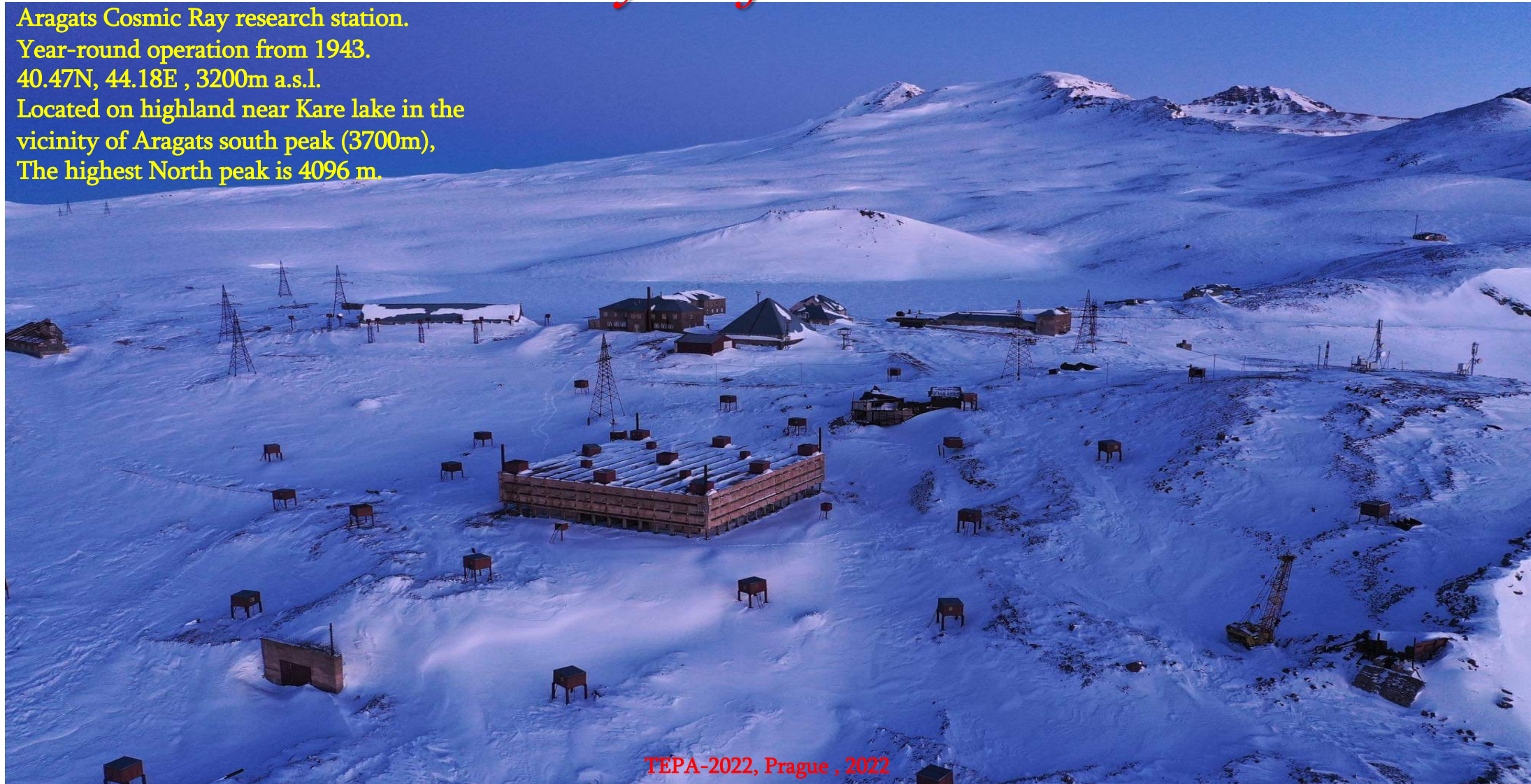
Conclusion

The network of hybrid particle detectors, measuring neutral and charged fluxes provide the following advantages over existing detector networks measuring single species of secondary cosmic rays (Neutron Monitors and Muon detectors):

- ✓ Measure count rates of 3 species of the secondary cosmic rays: charged particles with energy threshold > 5 MeV, neutral particles (gamma rays and neutrons) and high-energy muons (above 250 MeV);
- ✓ Probe different populations of primary cosmic rays with rigidities up to GV;
- ✓ Record Ground Level Enhancements (GLEs) initiated by solar protons and neutrons;
- ✓ Show energy dependences of the barometric coefficients and diurnal waves;
- ✓ Enlarge the reliability of Space Weather alerts due to simultaneous detection of fluxes of different particles;
- ✓ Detect Thunderstorm Ground Enhancements (TGEs) in gamma ray and charged particle fluxes;
- ✓ Address one of the most important problems of the atmospheric physics – cloud electrification by measuring surge and deficit of detected particle fluxes;
- ✓ Record runaway electron acceleration during thunderstorms and lightning initiation;
- ✓ Data Acquisition (DAQ) is Microcontroller-based provides registration and storage of all logical combinations of the detector signals and the remote control of the PMT high Voltage and other important parameters of the detector;
- ✓ New DAQ system applied to 3-layered “standard” SEVAN unit will give additional possibilities to the SEVAN physics, measuring energy releases (to be recovered to energy spectra) of the SEVAN for the all 3 channels separately and also for the all possible coincidences between them;
- ✓ The modernized DAQ system will turn the SEVAN module to a powerful spectrometer, measuring different species of secondary cosmic rays from galactic and atmospheric accelerators;
- ✓ SEVAN modules comprised from plastic scintillators are relatively cheap compared with ones using more expensive sensors, for instance ^3He counters;

Thank you for attention

Aragats Cosmic Ray research station.
Year-round operation from 1943.
40.47N, 44.18E , 3200m a.s.l.
Located on highland near Kare lake in the
vicinity of Aragats south peak (3700m),
The highest North peak is 4096 m.



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