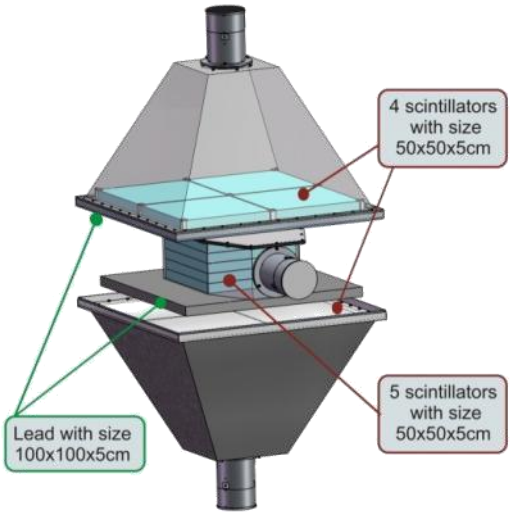
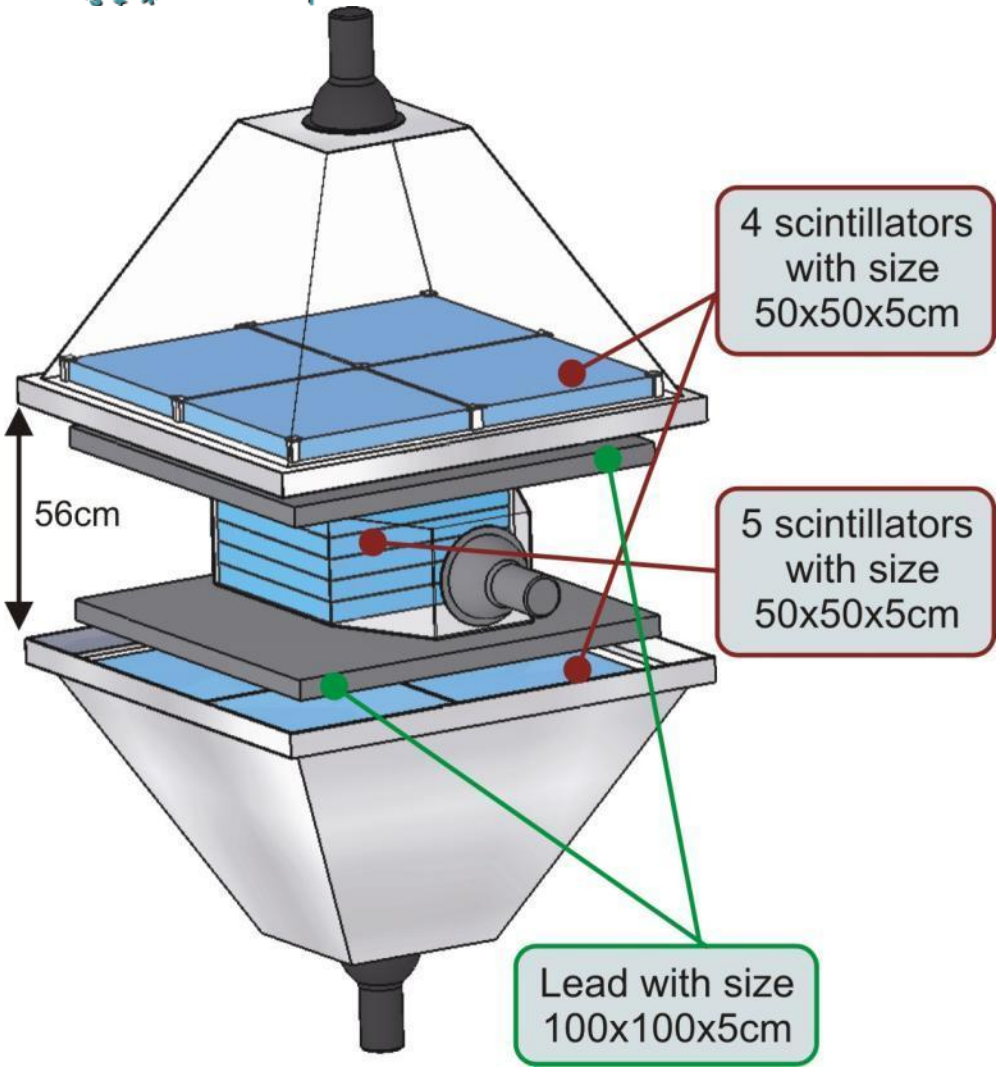
Space Environmental Viewing and Analysis Network (SEVAN)

Chilingarian[1], Ch.Angelov[2], K. Arakelyan[1], T.Arsov[2], Avakyan[1], S. Chilingaryan[1,4], K. A.Hovhanissyan[1], G. Hovsepyan[1], D. Hržina[3], T.Hovhannisyan[1], D. Maričić[3], A.Nishev[2] ,D.Roša[3], J.Stamenov[2], S. Tserunyan, A. Tchorbadjieff[2], I.Kalapov[2], T.Karapetyan[1], L.Kozliner[1], B.Mailyan[1], A. Reymers, I. Romštajn[3]

[1]*Alikhanyan Physics Institute, Yerevan, Armenia, Alikhanyan Brothers 2, Yerevan 375036, Armenia,*
[2]*Nuclear Physics Institute of the Bulgarian Academy of Science, 72 Tzarigradsko chaussee Blvd. 1784 Sofia, Bulgaria*
[3]*Zagreb Astronomical Observatory, Opatička 22, 10000 Zagreb, Croatia*
[4]*Institut fuer Prozessdatenverarbeitung und Elektronik, Forschungszentrum Karlsruhe, Hermann-von-Helmholtz-Platz 1, 76344 Eggenstein-Leopoldshafen, Germany*



Construction of the SEVAN basic unit



100 – traversal of the low energy charged particle (~<200MeV);

010 – traversal of the neutral particle;

111 & 101 – traversal of the high energy muon (~>250MeV);

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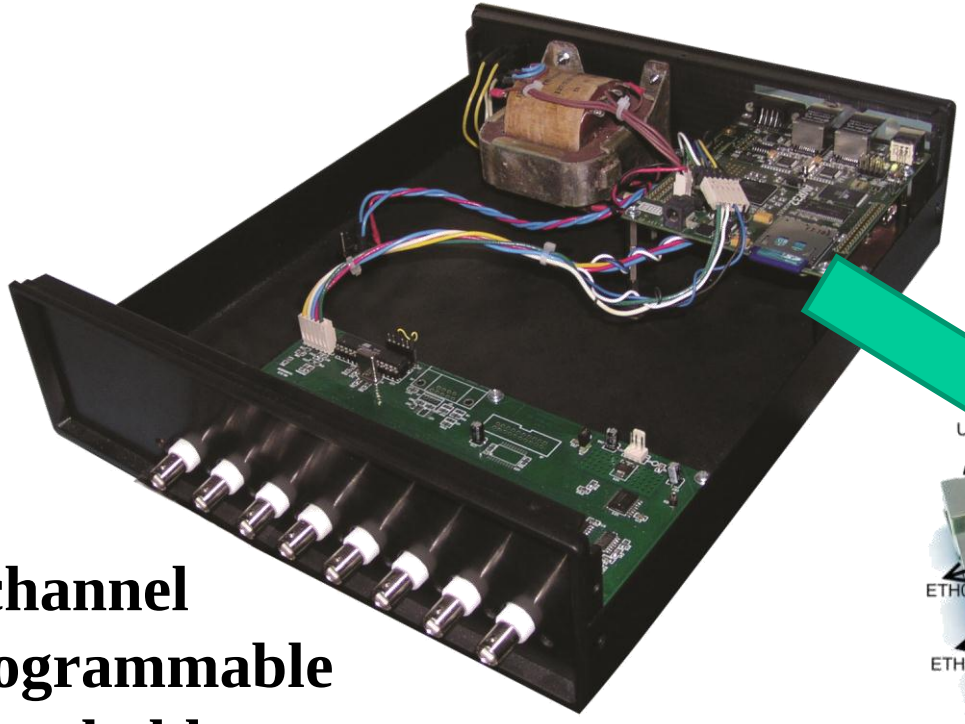
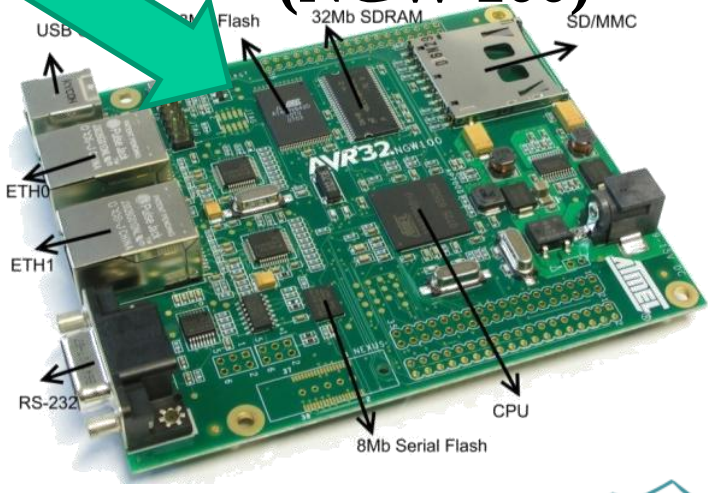
Electronics for the SEVAN



8-channel Programmable Threshold Comparator and Counter

Atmel Tiny Little AVR32 Board (NGW 100)



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SEVAN home page: http://crd.yerphi.am/sevan

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Space Environmental Viewing and Analysis Network(SEVAN)

SEVAN Posters
SEVAN Detectors
SEVAN Official letters
SEVAN MOU Examples
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Space Weather Definitions Approved by All Members of COST action N 724

SW definition: 28 Languages
SW definition English
SW definition Russian
SW definition Armenian

About SEVAN Project

SEVAN (Space Environmental Viewing and Analysis Network) is a network of middle to low latitude particle detectors which aims to improve fundamental research of space weather conditions and to provide short and long-term forecasts of dangerous consequences of space storms.

The network will detect changing fluxes of different species of secondary cosmic rays at different altitudes and latitudes, thus turning into a powerful integrated device used to explore solar modulation effects.

To facilitate SEVAN network creation, CRD will design and develop the basic hybrid SEVAN particle detector module and assume responsibility for all electronics and advanced data acquisition system (ADAS). CRD will also fabricate and test the SEVAN prototype module, as well as provide free scintillator slabs and photomultipliers to be installed at the host institutions

International Heliophysical Year(IHY)

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Starting of SEVANs in Bulgaria and Croatia

Figure 3 SEVAN detector at Zagreb observatory, Croatia

Figure 2 SEVAN detector at Mussala mountain research station of Nuclear Physics Institute of Bulgarian Academy of Science

Figure 4 Armenian and Croatian Physicists at Zagreb observatory; from left to right: Armenian and Croatian Physicists at Zagreb observatory: from left to right Darije Maricic, Dragan Rosa, Karen Arakelyan, Gagik Hovsepyan and Ivan Romstajn

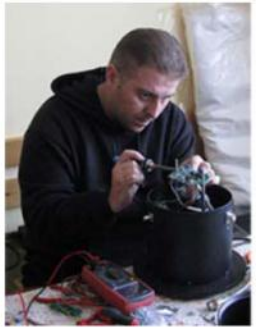
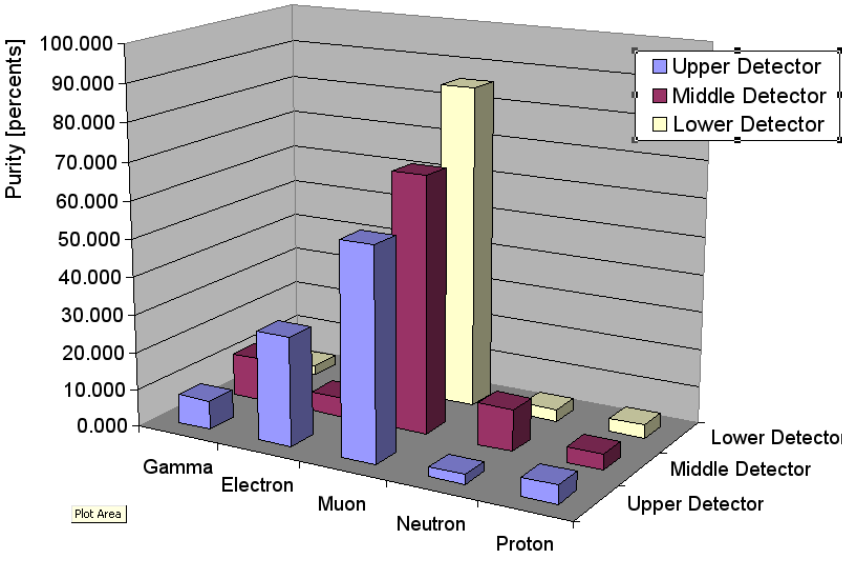
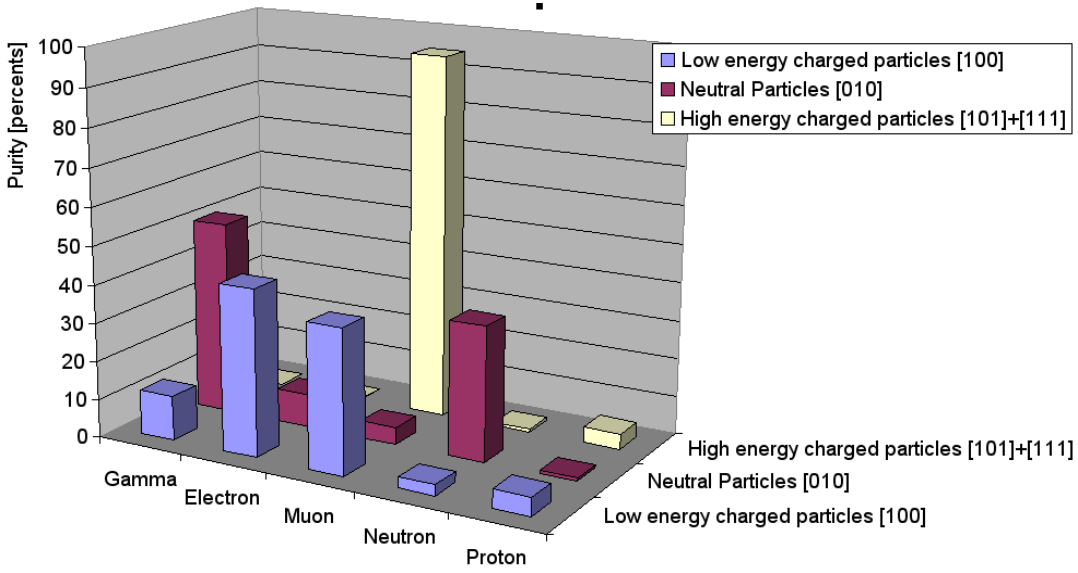


Figure 5 Karen Arakelyan assembling high voltage power supply of Photomultiplier

Figure 6 Gagik Hovsepyan checking the gap in the SEVAN detector

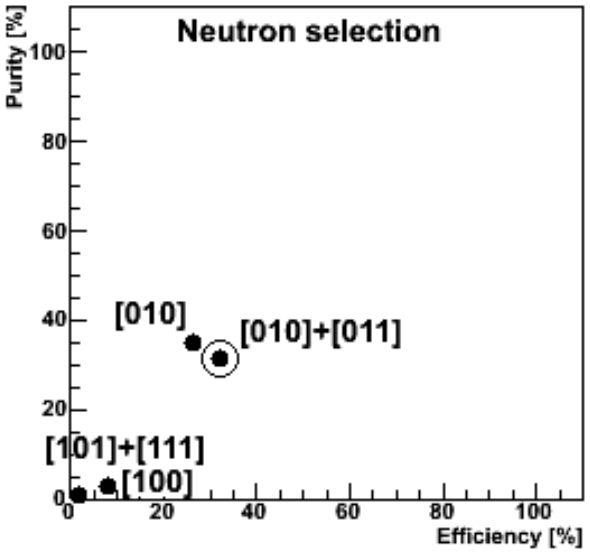
Selection of Secondary Cosmic Rays

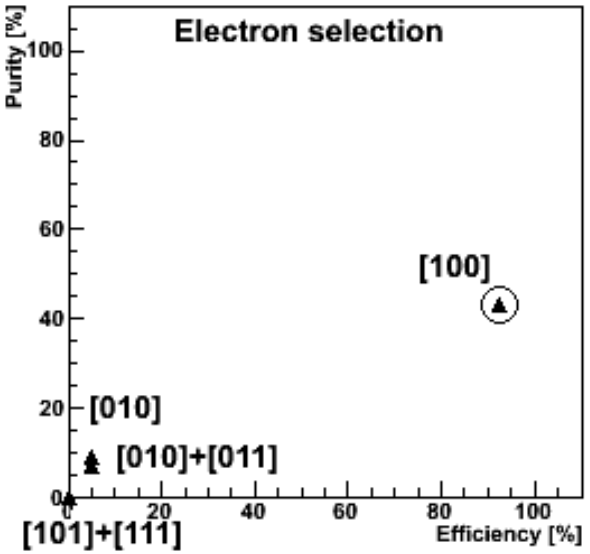


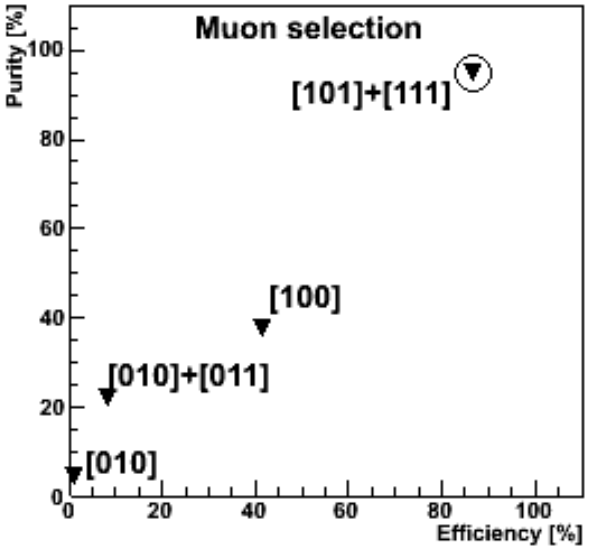


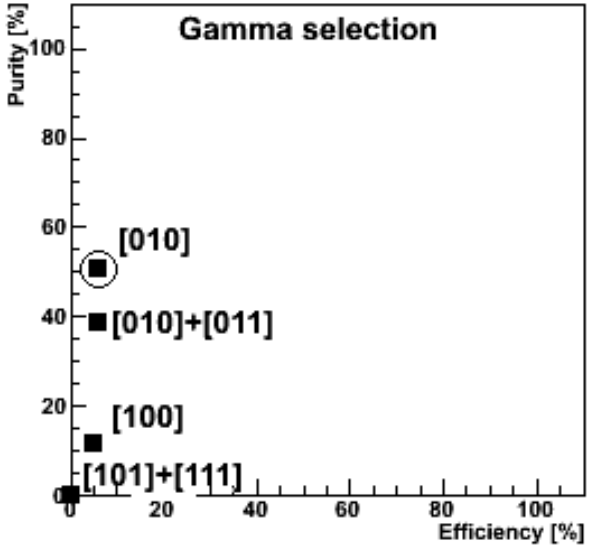
	Gamma	Electron	Muon	Neutron	Proton
Registered particles Purity by special combination					
Low energy charged particles [100]	11.605	43.300	37.380	2.838	4.804
Neutral Particles [010]	50.612	8.837	4.494	35.071	0.972
High energy charged particles [101]+ [111]	0.002	0.106	94.904	0.808	4.077
Registered particles Purity by count rate of the detectors					
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

Purity-Efficiency Diagram

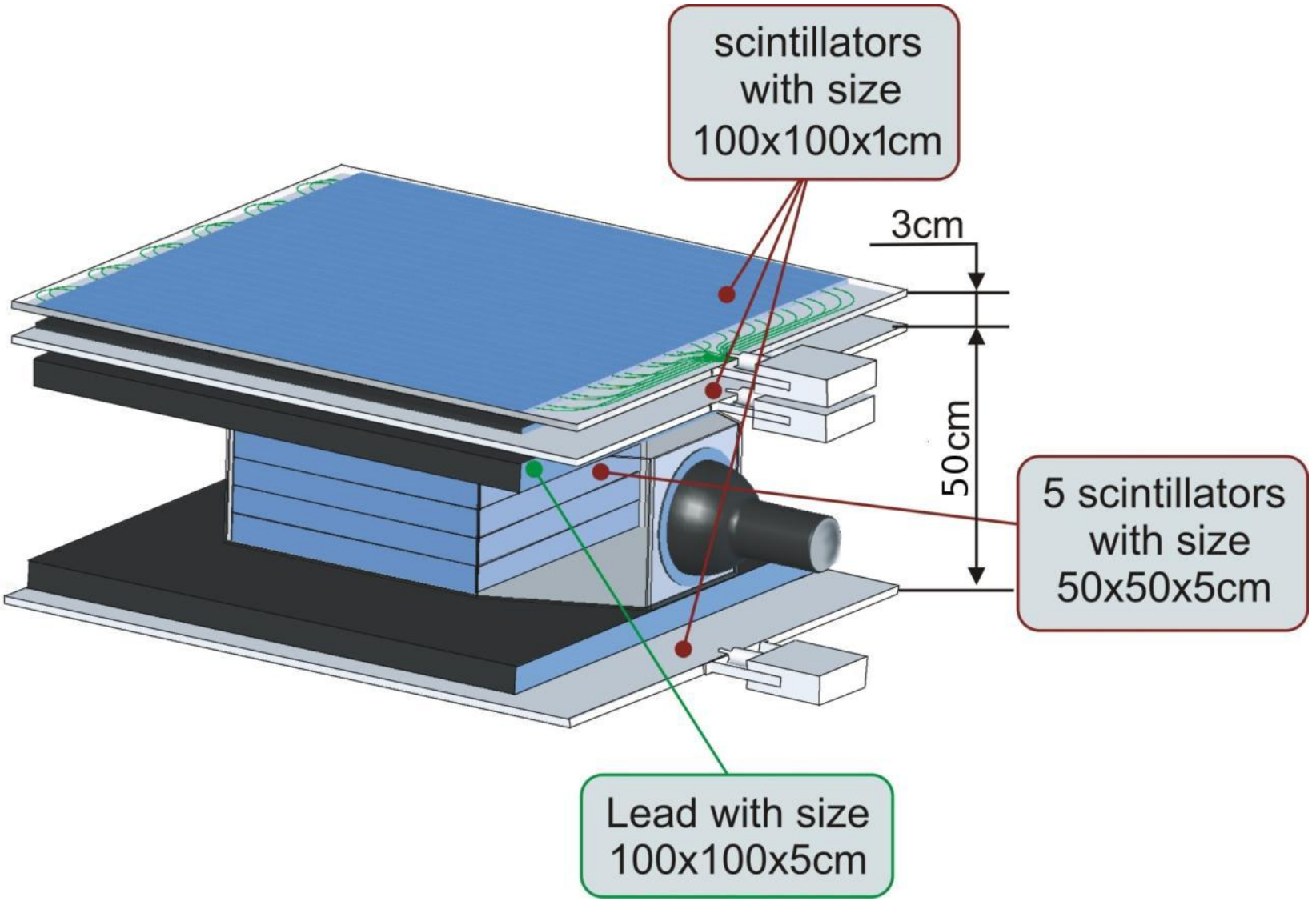








4-layered SEVAN module



SEVAN Count Rates

Aragats 3200 a.s.l.	ArNM 18NM64 0.4ms	SEVAN [100]	SEVAN [010]	SEVAN [111]
Relative Error	0.0068	0.0081	0.0218	0.0192
1/sqrt(N)	0.0049	0.0078	0.0223	0.0194

	YerPhI (1000m)		NorAmberd (2000m)		Aragats (3200m)		Zagreb, Croatia (130m)	Moussala, Bulgaria, (2925 m)
Type of secondary particle	**Measured count rate**	**Simulated count rate**	**Measured count rate**	**Simulated count rate**	**Measured count rate**	**Simulated count rate**	**Measured Count rate**	**Measured count rate**
Low energy charged particles (100)	**8862±108**	**7202**	**11593±161**	**10220**	**16581±130**	**17202**	**6415±84**	**17479±136**
Neutral particles (010)	**363±19**	**359**	**690±27**	**795**	**2011±46**	**1584**	**316±18**	**1115±38**
High energy muon (111 & 101)	**4337±67**	**5477**	**4473±99**	**5548**	**5534±64**	**8051**	**3824±64**	**6315±78**

Barometric coefficients, count rates and relative errors of SEVAN monitors

Monitor	Altitude (m)	Rc (Gv)	Barometric Coeff. %/mb	Correlation Coefficient	Count rate [min]	Relative error	$\frac{1}{\sqrt{N}}$
Aragats SEVAN Low energy charged particles (Coincidence 100)	3200	7.1	-0.5±0.018	0.995	15389	0.007	0.0080
Aragats SEVAN High energy muons (Coincidence 111+ Coincidence 101)	3200	7.1	-0.351±0.038	0.96	3868	0.014	0.0161
Aragats SEVAN neutrons (Coincidence 010)	3200	7.1	-0.511±0.018	0.995	1959	0.019	0.0225
Nor Amberd SEVAN Low energy charged particles (Coincidence 100)	2000	7.1	-0.281±0.022	0.957	5941	0.013	0.0129
Nor Amberd SEVAN High energy muons (Coincidence 111+ Coincidence 101)	2000	7.1	-0.242±0.022	0.952	1988	0.026	0.0224
Nor Amberd SEVAN neutrons (Coincidence 010)	2000	7.1	-0.54±0.070	0.899	674	0.037	0.0385
Yerevan SEVAN Low energy charged particles (Coincidence 100)	1000	7.1	-0.3±0.014	0.987	9446	0.010	0.0102
SEVAN High energy muons (Coincidence 111+ Coincidence 101)	1000	7.1	-0.149±0.035	0.765	4714	0.015	0.0145
Yerevan SEVAN neutrons (Coincidence 010)	1000	7.1	-0.4±0.039	0.943	425	0.048	0.0485

Simulated enhancements detected by the SEVAN basic unit

5min simulated enhancements in the Upper and Middle layers of the SEVAN basic unit.

Detector Layer	Solar Protons	Solar Neutrons
Upper 5cm scintillator	4.8σ	2.6σ
Middle 25 cm scintillator	1.7σ	6.4σ

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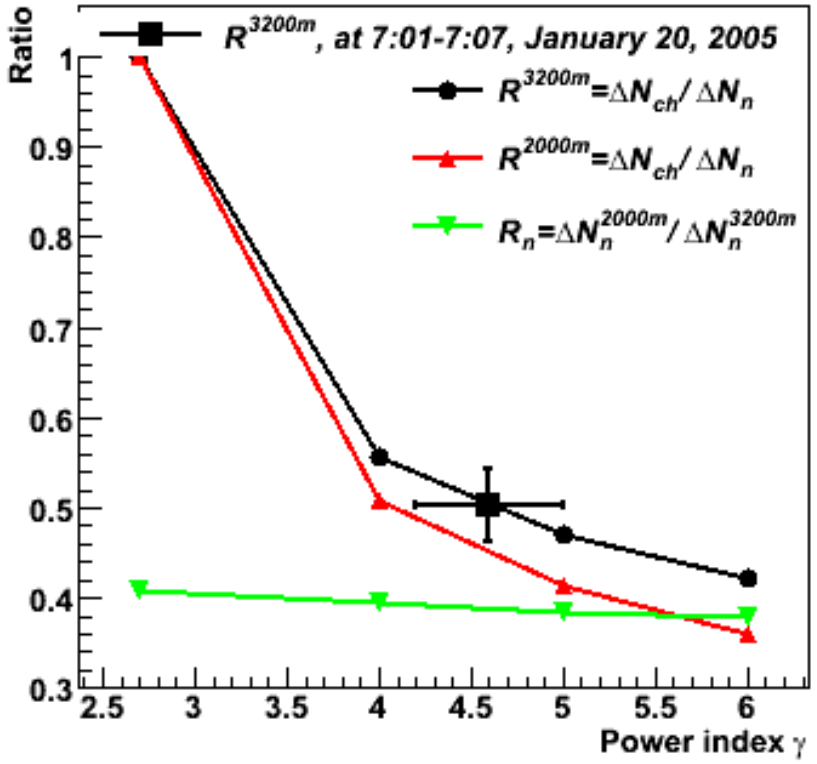
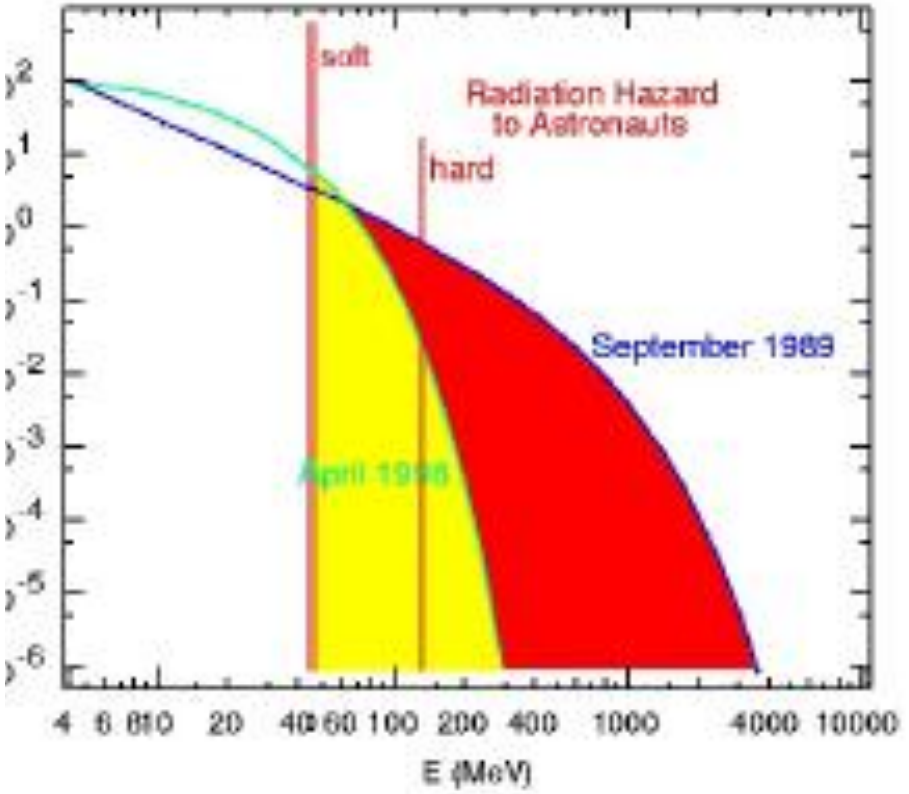
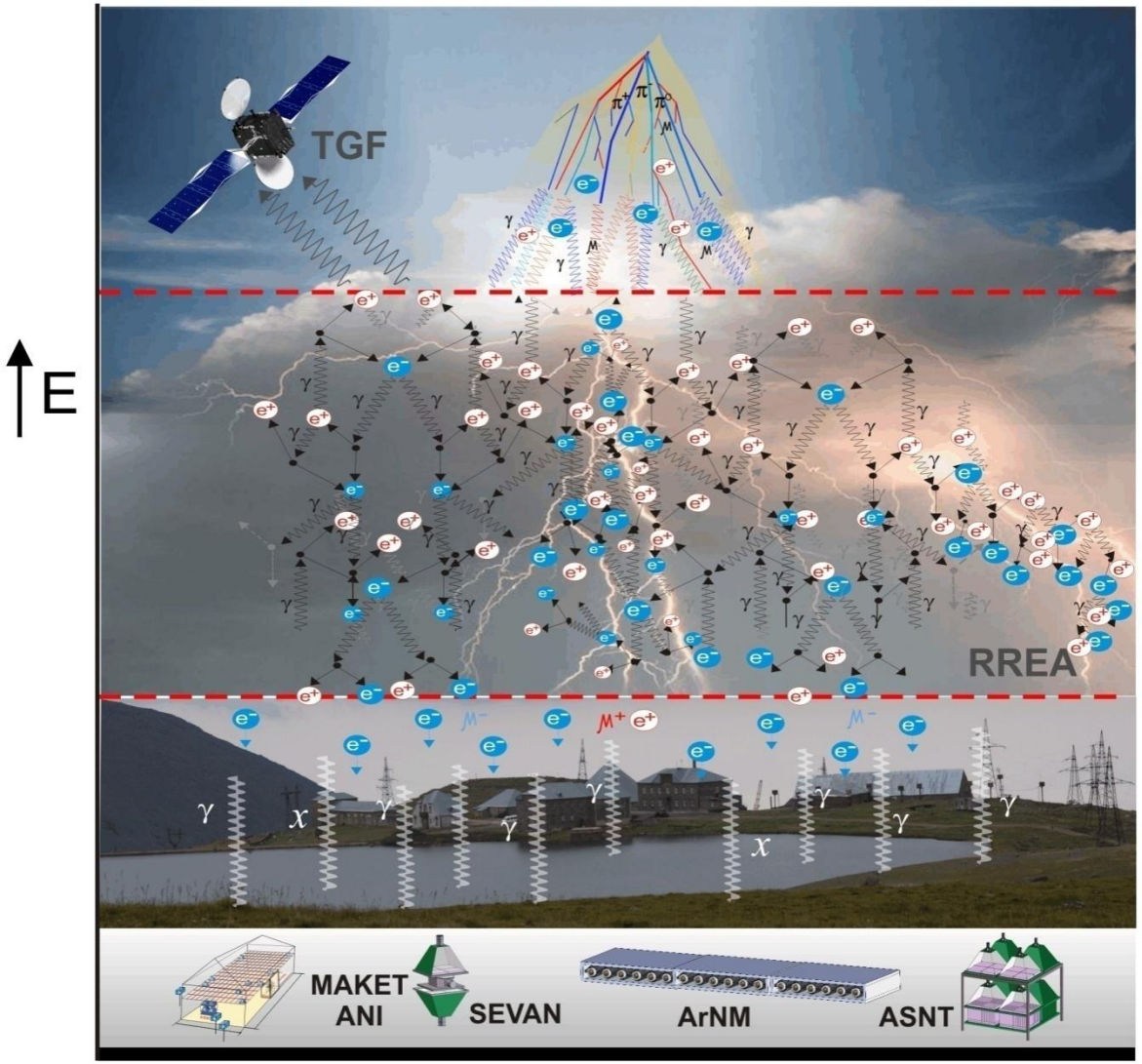
Spectral “knees” of SCR

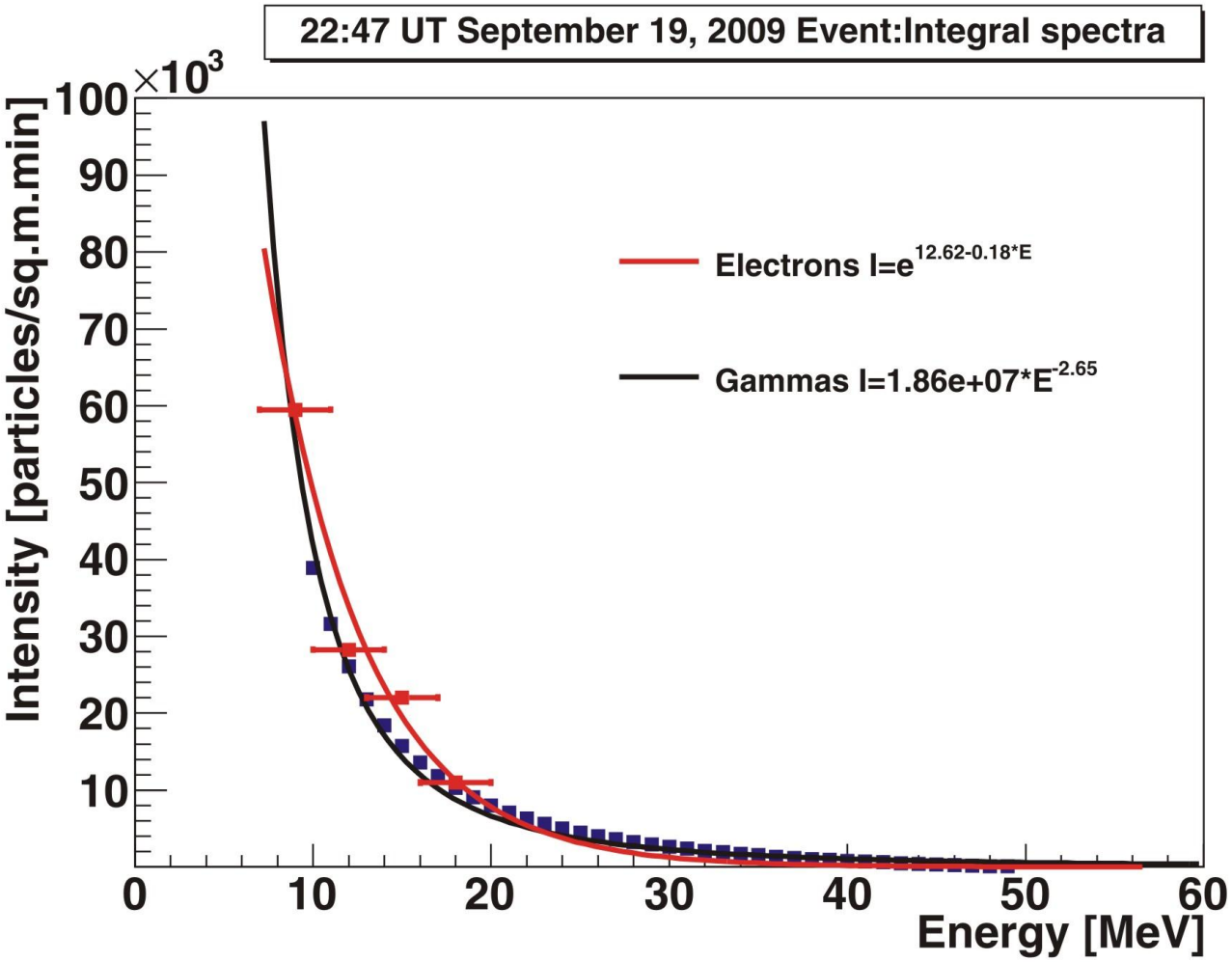




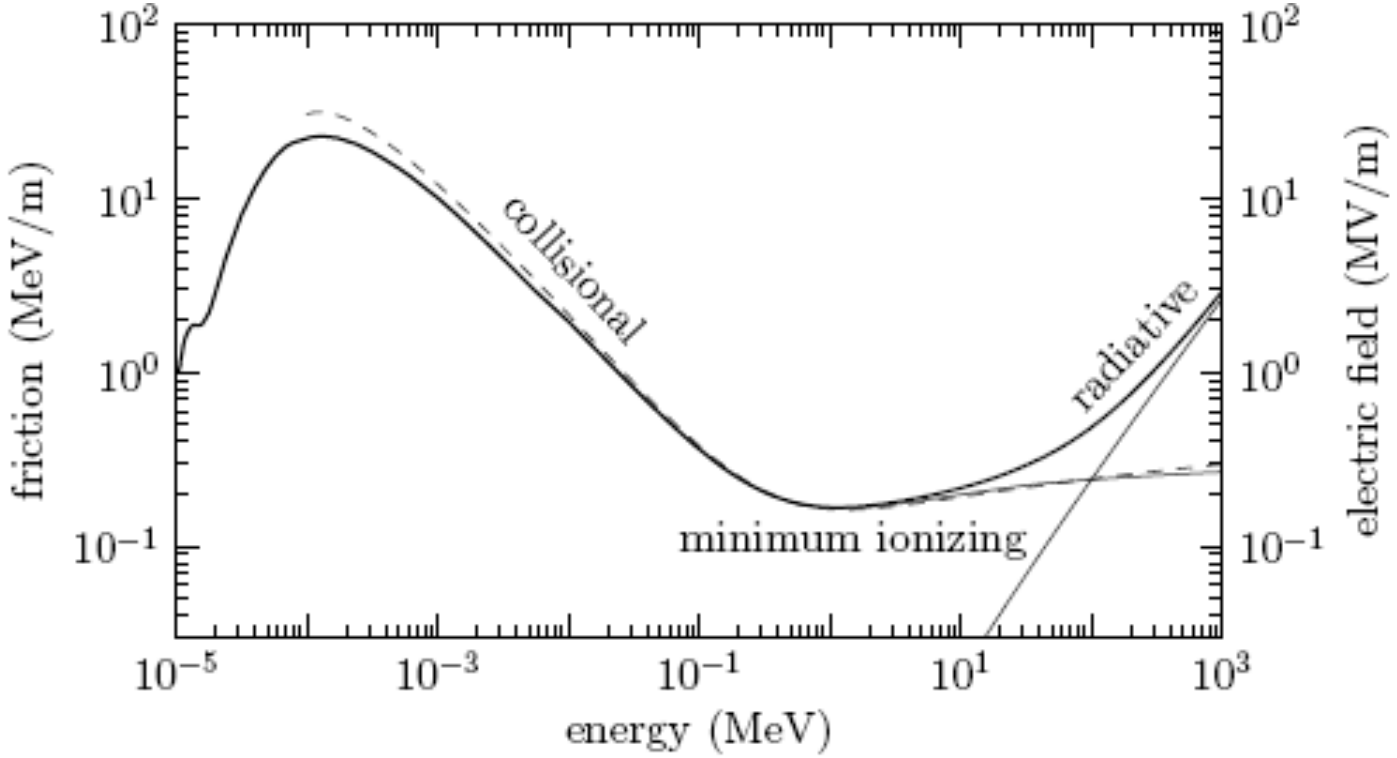
Relativistic Runaway Electron Avalanches in thunderstorm atmosphere



Energy Spectra of RREA Electrons and Gamma - rays



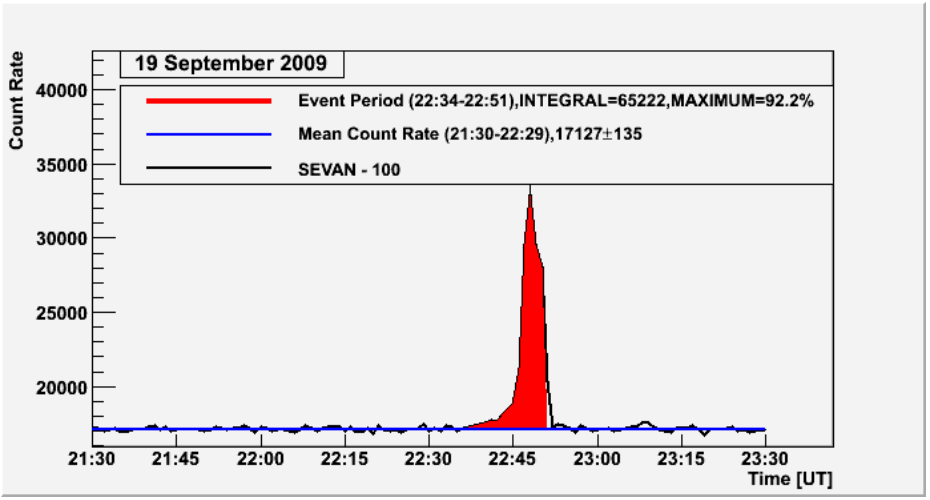
How electrons can “runaway”?

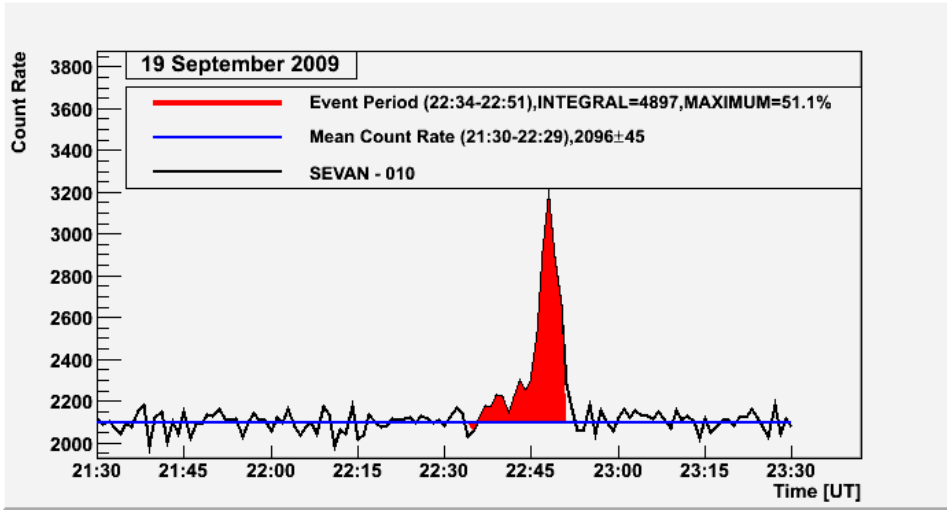


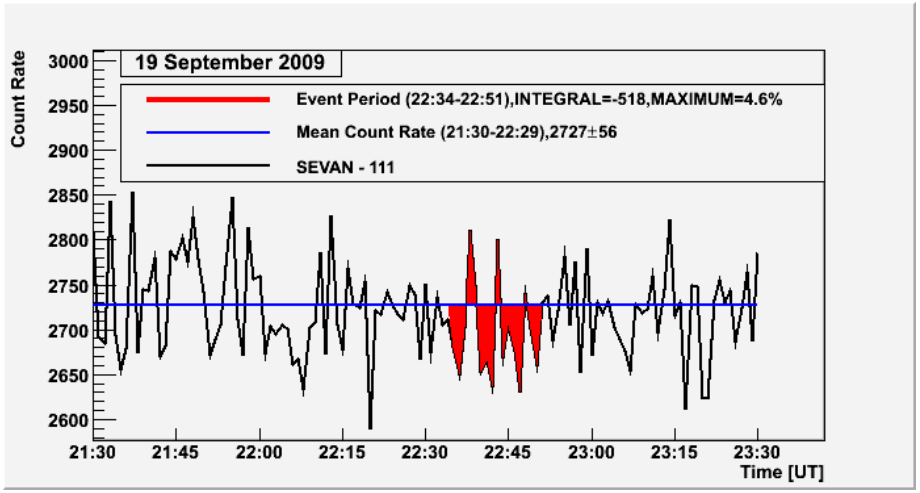
Friction on electrons in air at sea level. Shown as a function of electron energy. “Collisional" and “radiative" labels indicate dominant process for energy range in question. The dashed curve is the Bethe-Bloch equation. The axis on the right indicates the electric field strength required to produce a force on an electron equal to the frictional force.

Brant Carlson’s PhD thesis

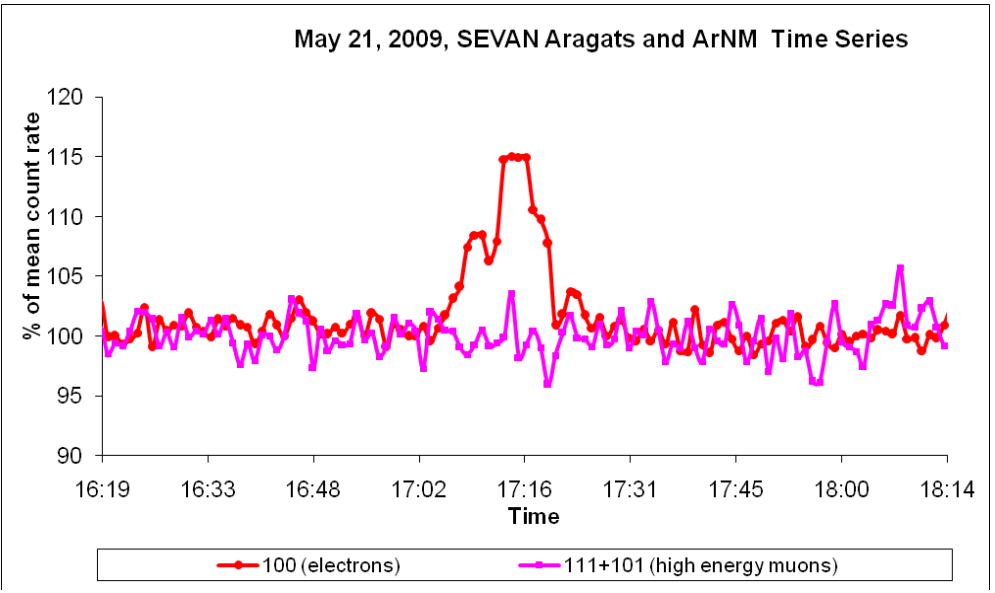
SEVAN response to electron and gamma fluxes at 19 September 2009

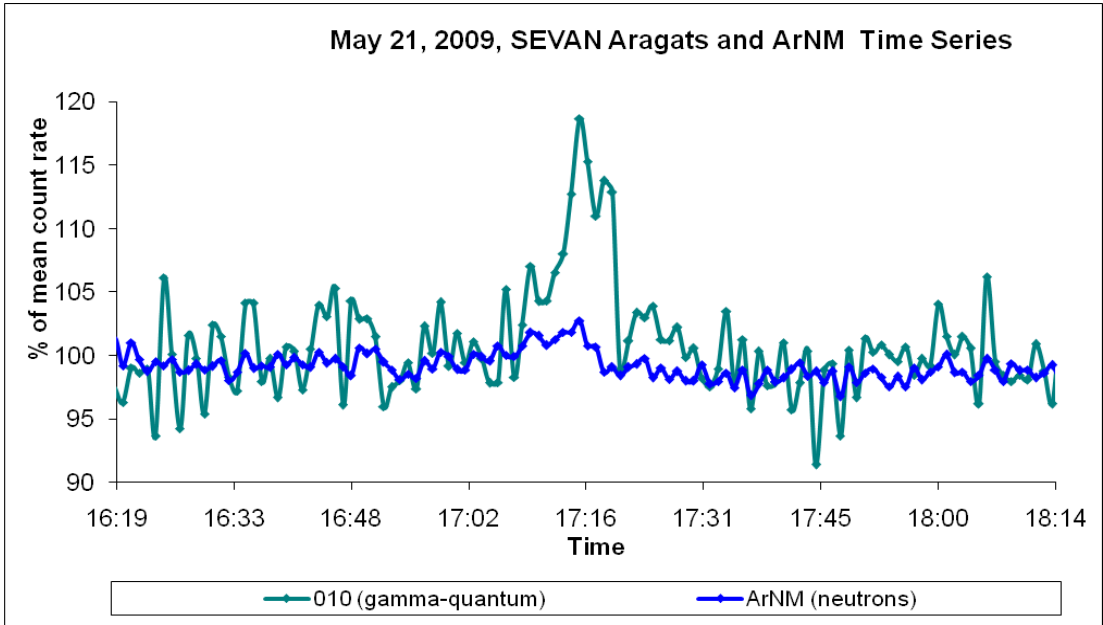




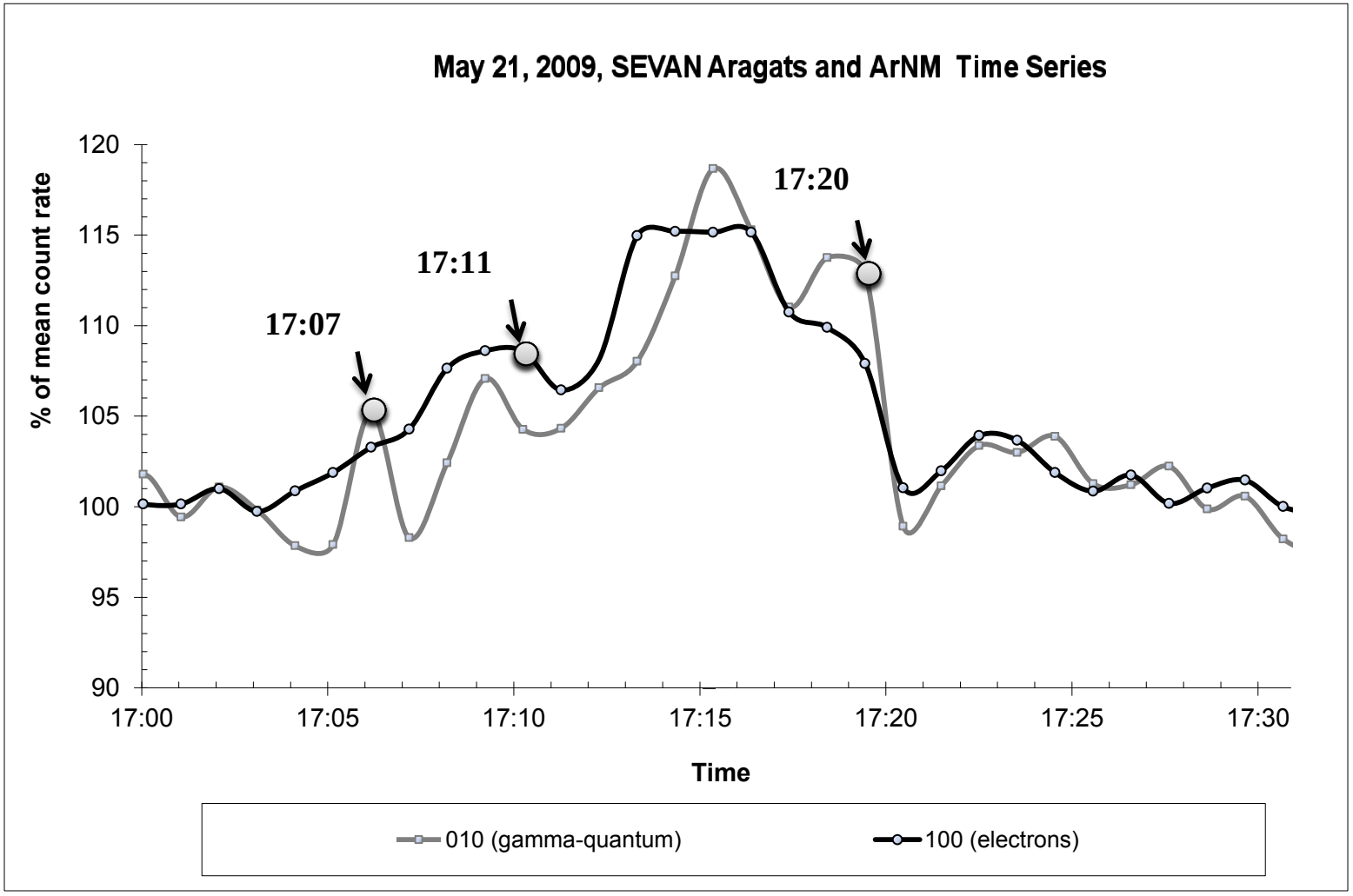


RBF Gammas and Electrons detected by SEVAN





Electron-photon cascade and lightings



SEVAN Advantages

The hybrid particle detectors, measuring neutral and charged fluxes provide following advantages upon existing detector networks measuring single species of secondary CR:

- **Enlarged statistical accuracy of measurements;**
- **Probe different populations of primary cosmic rays with rigidities from 7 GV up to 20-30 GV;**
- **Reconstruct SCR spectra and determine position of the spectral "knees";**
- **Classify GLEs in "neutron" or "proton" initiated events;**
- **Estimate and analyze correlation matrices among different fluxes;**
- **Significantly enlarge the reliability of Space Weather alerts due to detection of 3 particle fluxes instead of only one in existing neutron monitor and muon telescope world-wide networks.**
- **Detection of electrons and gamma-quanta from showers generated by powerful natural accelerators operating during thunderstorms – research of RREA process**

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