SPECTRA OF THE THUNDERSTORM CORRELATED ELECTRON AND GAMMA-RAY MEASURED AT ARAGATS ON 19 SEPTEMBER 2009

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ABSTRACT

For the first time we present the electron and gamma ray energy spectra produced in the avalanche processes in the atmosphere during thunderstorms and detected by surface particle monitors. The huge flux of thunderstorm correlated particles was detected by the experimental facilities of Aragats Space environmental Center (ASEC) on 19 September 2009. Using ASEC detectors with various energy thresholds, spectrum of thunderstorm correlated electrons was obtained. GEANT4 based detector response calculation of the Aragats Solar Neutron Telescope (ASNT) allows us to reconstruct gamma ray spectrum from the energy release spectra measured by ASNT each minute. We have also compared the September 19, 2009 event with smaller event on July 9, 2009.

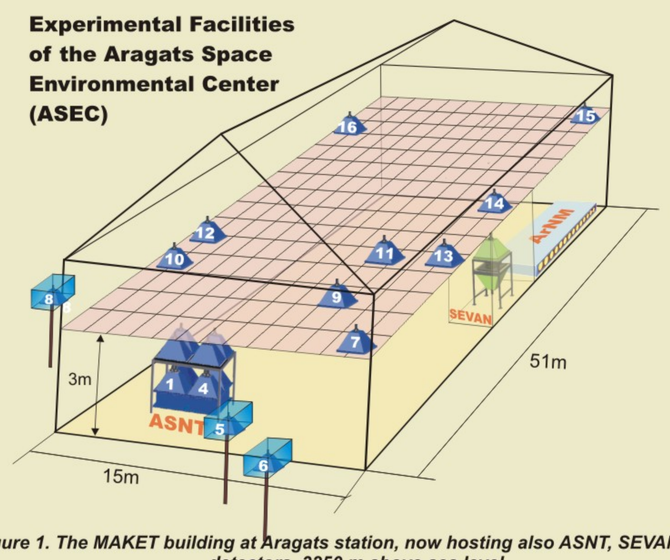

Figure 1. The MAKET building at Aragats station, now hosting also ASNT, SEVAN, ArNM detectors, 3250 m above sea level

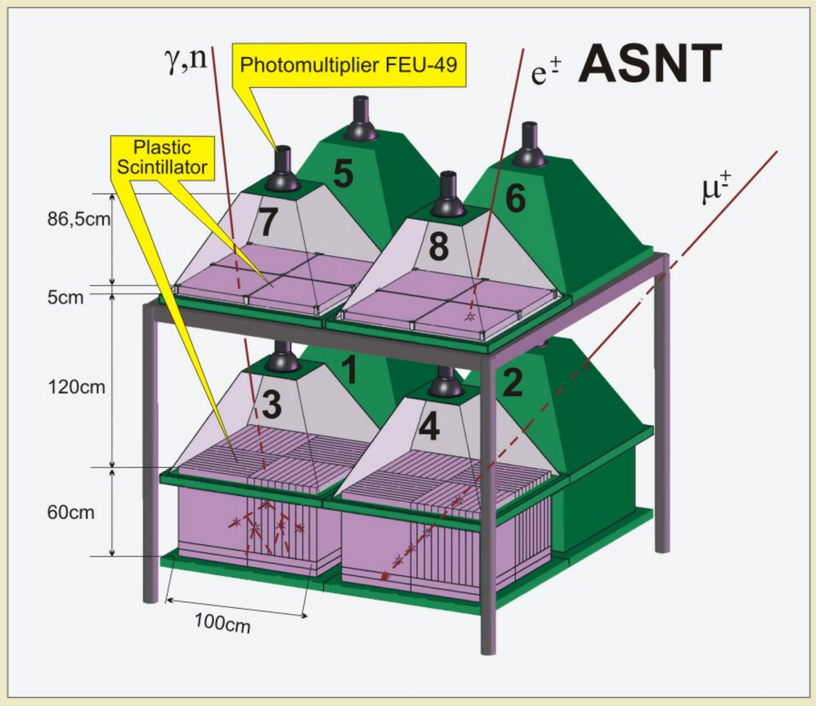

Figure 2. Aragats Solar Neutron Telescope (ASNT)

The unfolding of the gamma ray spectrum above the roof of the MAKET building at altitude of 3250 m was made in the following way:

- A power spectrum with initial parameters randomly chosen from predetermined interval is generated;
- This spectrum is used to simulate traversal of gamma rays via roof and ASNT detector components to finally obtain simulated energy release spectrum;
- The obtained simulated spectrum is compared with experimental one; the discrepancy quality function and initial spectrum parameters are stored;
- If number of iterations is not fulfilled go to step 1.

CONCLUSION

For the first time we present the energy spectra of RREA electrons and gamma rays, using the variety of ASEC detectors including the enhanced possibilities of ASNT to measure energy releases in the thick scintillator. The obtained energy spectra confirm the RREA multiplication/acceleration of the seed electrons provided by the secondary cosmic rays.

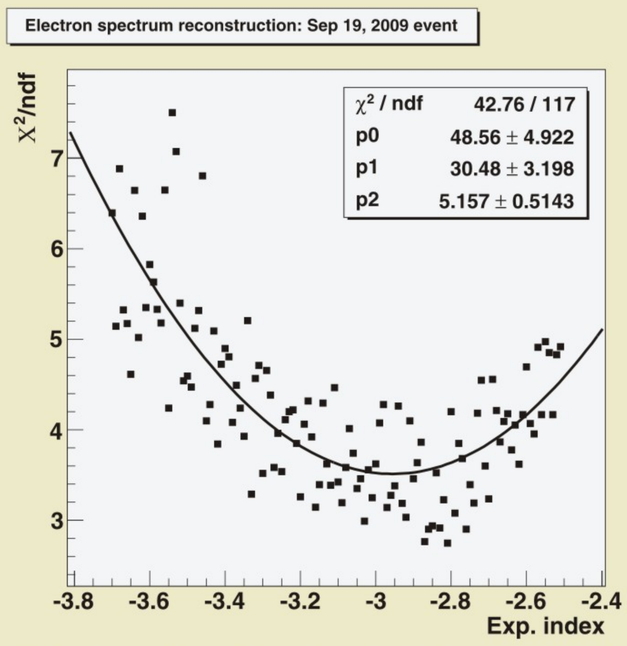

Figure 3. Dependence of the quality function on incident gamma-ray spectral index

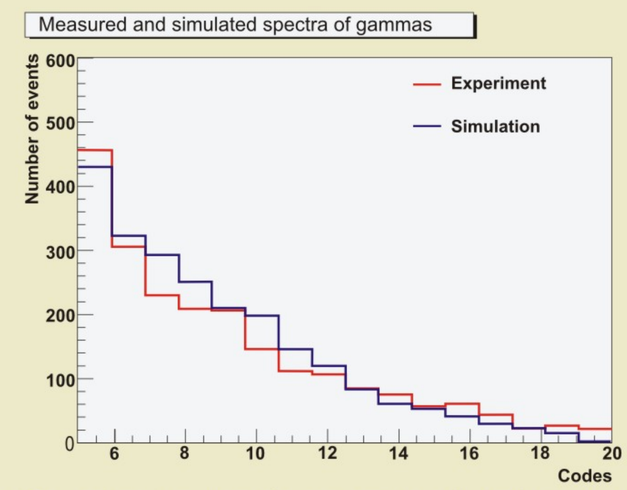

Figure 4. Energy deposit spectrum of gamma-rays, according to the experiment and simulation; number of events vs. ADC codes

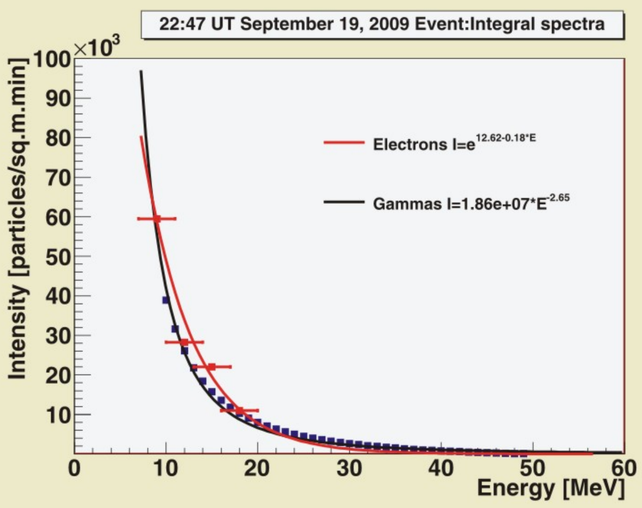

Figure 5. Unfolded electron and gamma ray spectra fitted by exponential and power functions respectively

	a	b	Chi-square/ndf
Electron e^{a-b*E}	12.62±0.784	-0.18±0.056	0.34
Gamma $a*E^{-b}$	1.86e+07±81853	-2.65±0.018	3.07

Table 1. Parameters of the fit for September 19 event

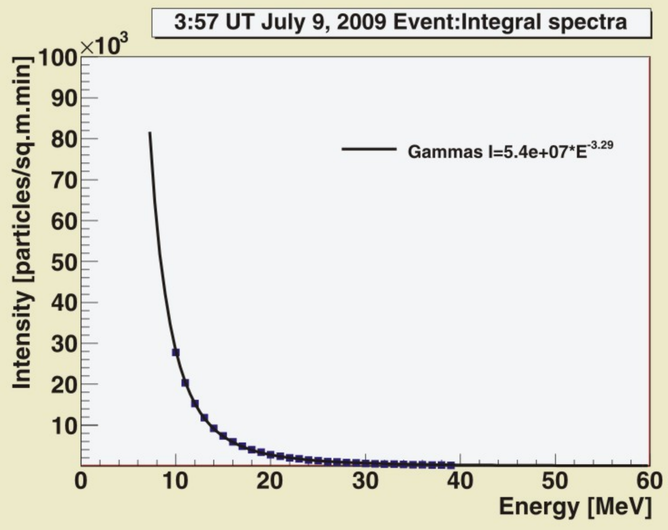

Figure 6. Unfolded gamma ray spectrum of July 9, 2009 event fitted by power function

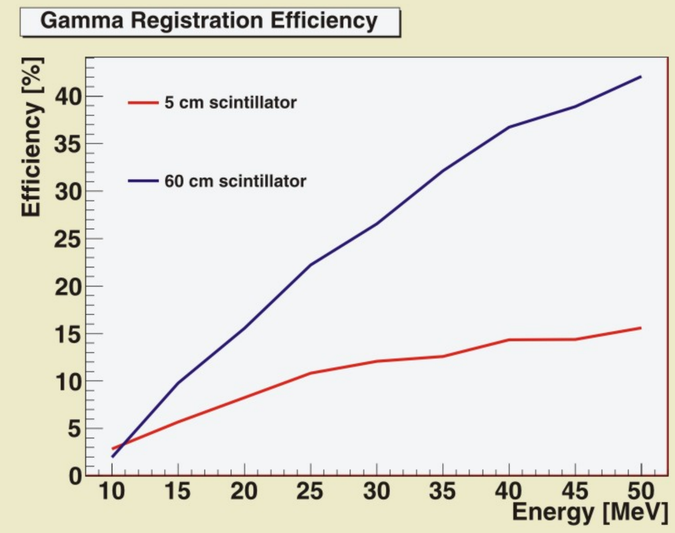

Figure 7. Gamma ray registration efficiencies of the ASNT 5cm and 60cm scintillators

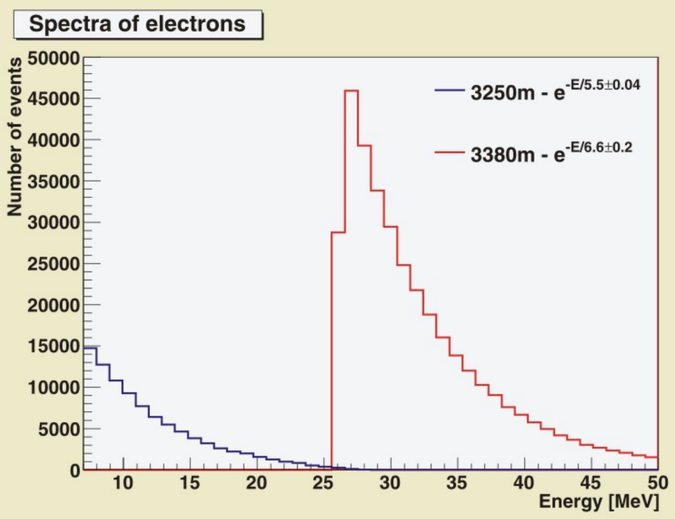

Figure 8. Electron spectra at 3250 and 3380m (only high energy portion of spectra to reach 3250 m)

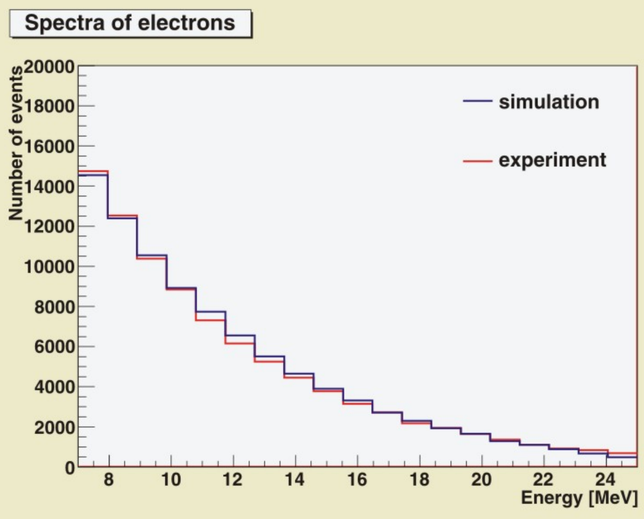

Figure 9. Comparison of the simulated and experimental electron spectra at 3250 m

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