Recording System for Cosmic Ray Measurements at Lomnický štít

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Abstract: New system for recording information on cosmic ray intensity in multichannel measurements of cosmic rays at Lomnický štít (LS, 2634 m) is described. System allows to register data with 1 sec resolution; writing barometric pressure and other meteorological parameters. In addition to neutron monitor measurements, the system is used in testing mode also for the SEVAN installation at the site (developed by Yerevan Phys. Inst.) and in modified version is used for the thermal neutron detection (joint device with FIAN Moscow) as well as for dosimetric measurements. System under development will be useful for space weather monitoring and possible alerts, as well as for studies of relations between cosmic rays and atmospheric electricity. Current status of experiments at LS and in Košice and the perspectives are reported.

1. Introduction

Cosmic Ray Measurements in High Tatra mountains started in 1957 in connection with the IGY. Since 1982 the neutron monitor with relatively high statistical accurracy is measuring at Lomnický Štít [1]. After the first solar neutron response recorded on the ground, namely during the solar flare on June 3, 1982 at Jungfraujoch [2] and at LS [3], the time resolution was improved to 1 min. Position is suitable for study of protons accelerated to high energy in solar flares and/or due to CMEs. GLE's are summarized in [4,5].

In 2010-2013 the reconstruction of the infrastructure at the mountain allowed to enhance the measurement to higher energies by SEVAN device described in [6]. Along with that the dosimetric measurements by Liulin device [7] are available for selected intervals. Simultaneously, at lower altitude, namely in Kosice, there were done several methodological works of electronic and software/recording character leading to the increased temporal resolution (1 s) and also to measurements of thermal neutrons and of lightning. We illustrate the new development and current status of the measurements and conclude with plans for near future.

2. New infrastructure

Original container was located at Lomnický štít since December 1, 1981 until May 3, 2012
- Insufficient technical and insulation conditions
- Requirement space for SEVAN installation.

New container in order since June 30, 2012. SEVAN will be in the upper part on the left.

During the reconstruction

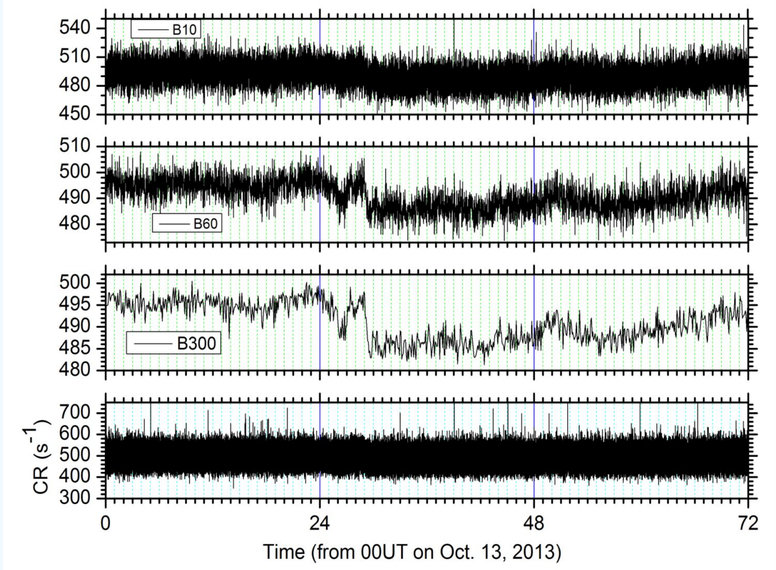
3. New system of registration

New NM registration system (Nemox) is in operation since May, 2013. Main parameters:

- 1 second and 1 minute measuring interval
- internal memory for cca 14 days 1 minute data
- ethernet interface for remote management and data handling
- very precision external barometer with indoor temperature and humidity sensor (Vaisala PTB330)
- timing GPS receiver for time base
- small size (80x54x23mm), minimum power consuption (<1W)
- complete dual redundant for error minimization (parallel operation)

4. Examples of measurements in 2012-2013

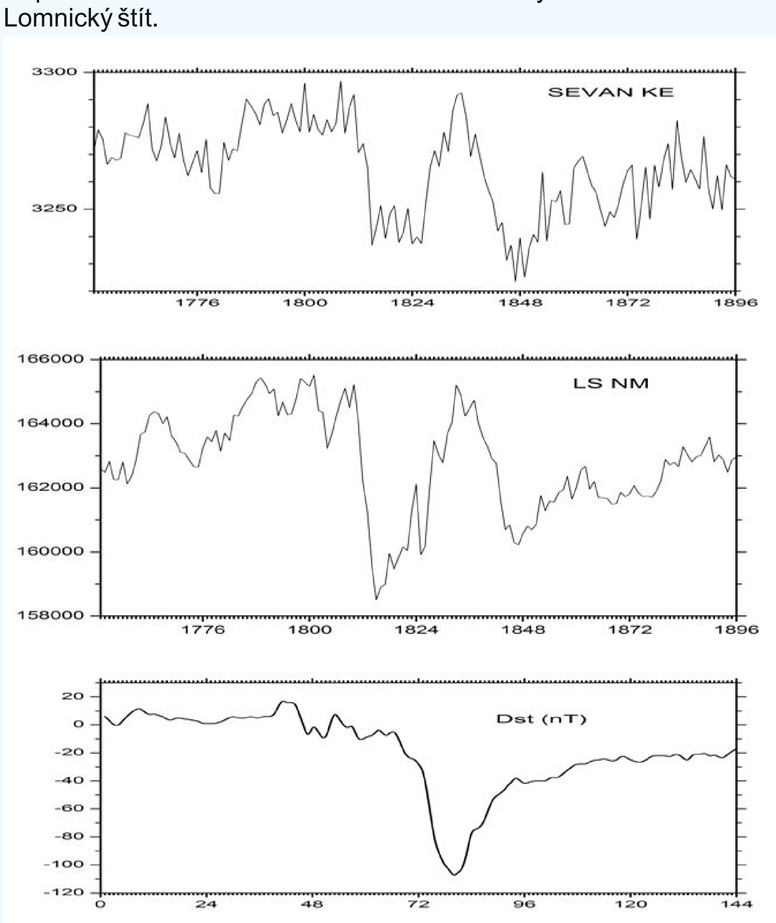
4.1. Resolution 1 sec



Example of NM LS data around the recent FD on October 13-15, 2013. From bottom to top: 1s resolution, averaging by 5 min, 1 min and 10 sec. Recordings can be used for checking possible signatures in CR fluctuations.

4.2. SEVAN – testing mode measurements in Košice

SEVAN instrument was in testing mode in Košice during the period Sep. 2012 to March 2013. After that it is currently under installation at Lomnický štít.



Detail of the SEVAN testing mode data in Košice, namely 11-16. November 2012. FD starting on Nov. 13 (LS NM, middle panel and SEVAN top panel) was evolving into CR increase with peak observed on both devices (SEVAN in Košice and NM at LS) before noon on Nov 14, 2012 when the Dst was depressed (data from Kyoto and omniweb NASA).

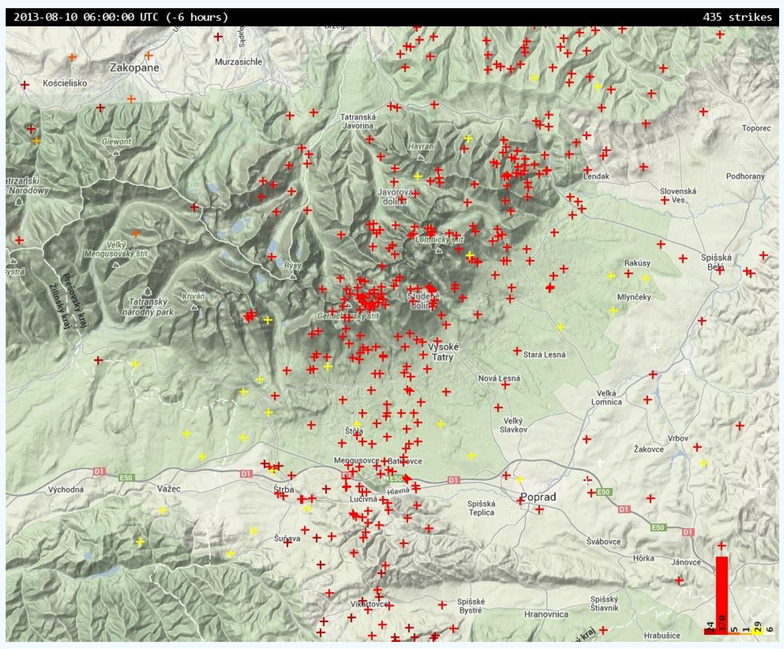
4.3. Meteo and lightning

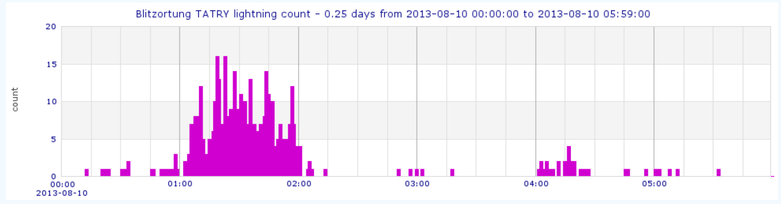
Cosmic rays play important role in atmospheric processes (e.g. [12]). Since June 15, 2012 we are a participant on the global lightning detection network Blitzortung.org. As a participant we have an access into this lightning database, what we want to improve for study the possible relations between lightnings and cosmic rays variations.

Also as a participant (since August, 2006) on the LINET - professional lightning detection network (http://www.nowcast.de) we assist in running one of LINET receiving device in Košice.

For weather monitoring we use some meteorological devices (Vaisala Weather Transmitter WXT520, Ultrasonic Wind Sensor WMT52, Digital Barometer for Professional Meteorology PTB330 etc.).

LINET sensor in Košice

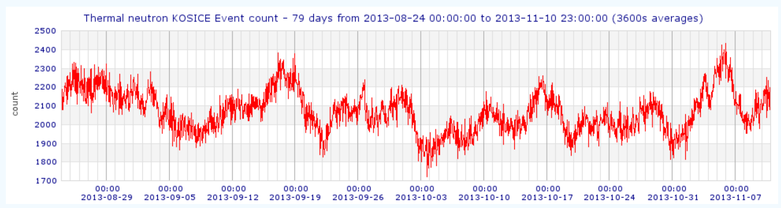




Example of lightning allocation and lightning counts in nearness our station Lomnický štít during summer storm (10 August, 2013)

4.4. Thermal neutron data

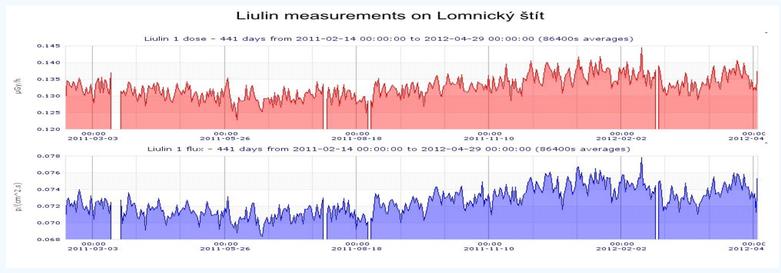
Thermal neutron detectors have been shown recently to observe variations connected with Forbush decrease [8]. Helium-3 tubes CHM-18 were produced in Russia. Although 5 detectors we started to measure with (jointly with FIAN Moscow) in Košice have rather small geometrical factor, it may be of interest to measure the flux at Lomnický štít and at different low altitude places simultaneously. Time of each pulse is recorded with accuracy 100 nanoseconds synchronized to timing GPS receiver.



The hourly sums of counts of thermal neutrons for period August 24 – November 7, 2013.

4.5. Dosimetric measurements.

Similarly to other mountain investigations (e.g. [7]) the measurements by Liulin device at Lomnický štít are available for selected time intervals.



Dose and flux at LS for period 14 Feb, 2011 to 29 Apr, 2012

5. Current status, plans for future

- Comparison of data from BF3 tubes (the same type as used e.g. at Alcala NM [9]) with older ones installed at LS presently
- Implementing SEVAN in full mode at LS
- Checking system of each pulse time recording (thermal neutrons, NM) and possible coincidences with lightning observations (using eventually e.g. system [10]
- Multiplicity in NM will be recorded. Fast recording system will be used for possible alerts of dangerous solar particle events [11]; distribution of time differences between pulses will be used for testing relations to atmospheric processes.
- Simultaneous thermal neutrons measurements at LS and at low altitude(s)
- Continuation of dosimetric measurements at LS (Liulin, Spectroscopic Radiation Detector PM1704GN, Timepix)

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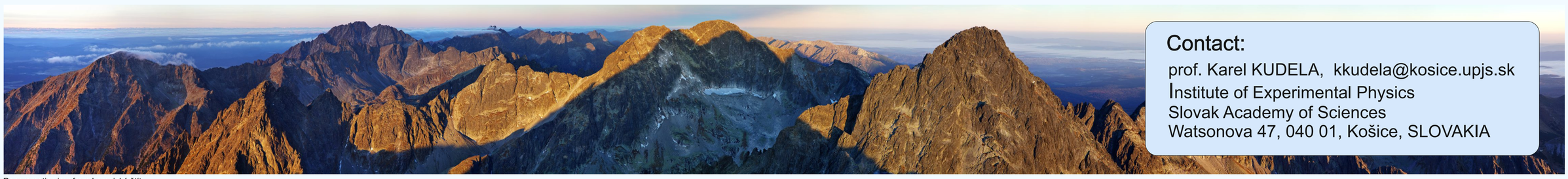
[1] Kudela, K. and R. Langer, Adv. Space Res., 44, 10, 1166-1172, 2009
[2] Debrunner, H., Flückiger, E., Chupp, E. L., Forrest, D.J. Proc. 18th ICRC Bangalore, vol. 4, p. 75-78, 1983
[3] Efimov, Yu. E.; Kocharov, G. E.; Kudela, K., Proc. 18th ICRC Bangalore, vol. 10, p. 276 – 278, 1983
[4] Kudela, K., M.A. Shea, D.F. Smart and L.C. Gentile, Proc. 23rd ICRC Calgary, 3, 71-74, 1993
[5] Kudela, K. and R. Langer, Proc. 30th ICRC Merida, 1, 205-208, 2008
[6] Chilingarian, A., Hovsepyan, G., Arakelyan, K. et al, Central European Astrophysical Bulletin, 31, 1, 259-272, 2007
[7] Mishev, A and E. Hristova, ArXiv: 1104.2685v.1 physics 14 April 2011
[8] Alekseenko, V. et al., J. Phys. Conf. Ser. 409, 012190, 2013
[9] Medina, J., Blanco, J.J., García, O. et al., Nucl. Instrum. Meth. A, 727, 97-103, 2013
[10] Betz,H.D., K. Schmidt, W. P. Oettinger, and B. Montag, Adv. Geosci., 17, 55-61, 2008
[11] Dorman, L.I. et al., Proc. 28th ICRC, Tsukuba, Japan, 8366, 2003
[12] Stozhkov, Y.I. J. Phys. G: Nucl. Part. Phys. 29, 913, 2003



Panoramatic view from Lomnický štít

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