

Forbush Decrease observed by nodes of SEVAN East-European particle detector network on November 2021

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A **Forbush decrease** is a rapid decrease in the observed [galactic cosmic ray](#) intensity following a [coronal mass ejection](#) (CME). It occurs due to the [magnetic field](#) of the [plasma solar wind](#) sweeping some of the galactic cosmic rays away from [Earth](#). The term *Forbush decrease* was named after the [American](#) physicist [Scott E. Forbush](#), who studied [cosmic rays](#) in the [1930s and 1940s](#).

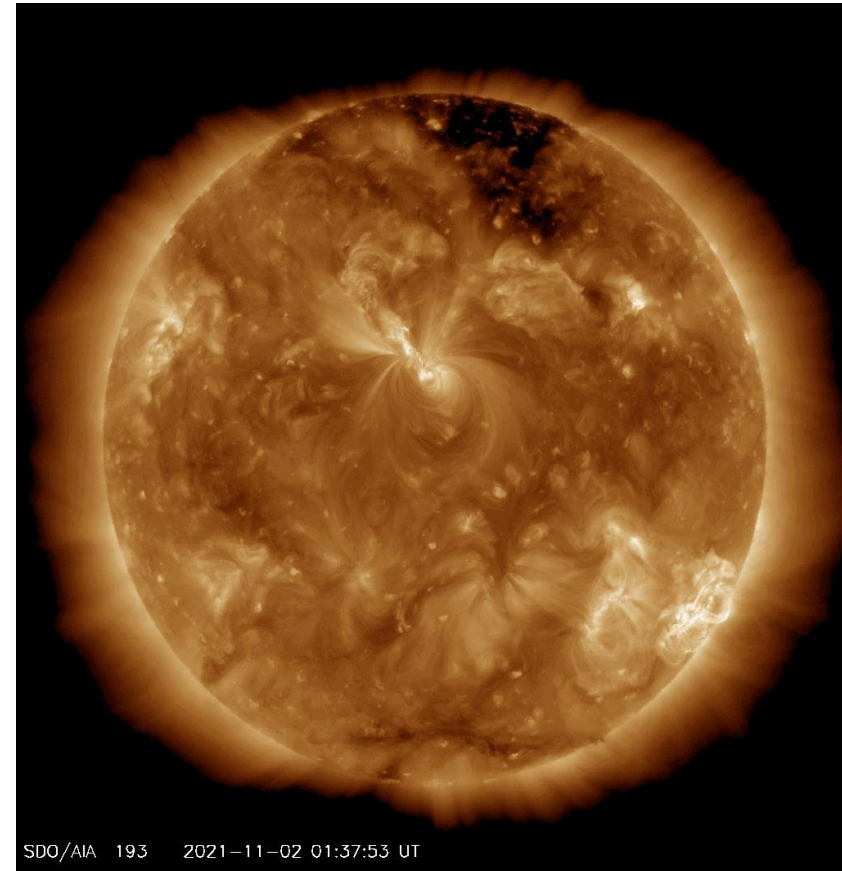
On November 3-5, 2021, CME hit the magnetosphere, sparking a strong **G3-class** geomagnetic storm and auroras as far south as California and New Mexico. European particle detector SEVAN registered Forbush decrease (Fd) coherently at all nodes. We present the results of a comparative analysis of the variations of different species of cosmic rays, and the surface electric field obtained in November 2021 at three observation sites –

Aragats (Armenia),

Lomnický štít (Slovakia)

Musala (Bulgaria) mountains.

We discuss the characteristics of the variations of the charged and neutral components of cosmic rays registered by the SEVAN particle detectors at 3 sites and the near-surface electric field (NSEF). We made a correlation analysis of the geomagnetic field and NSEF at the start and maximum of particle flux depletion.



[National Oceanic and Atmospheric Administration \(NOAA\)](#)
[U.S. Department of Commerce](#)

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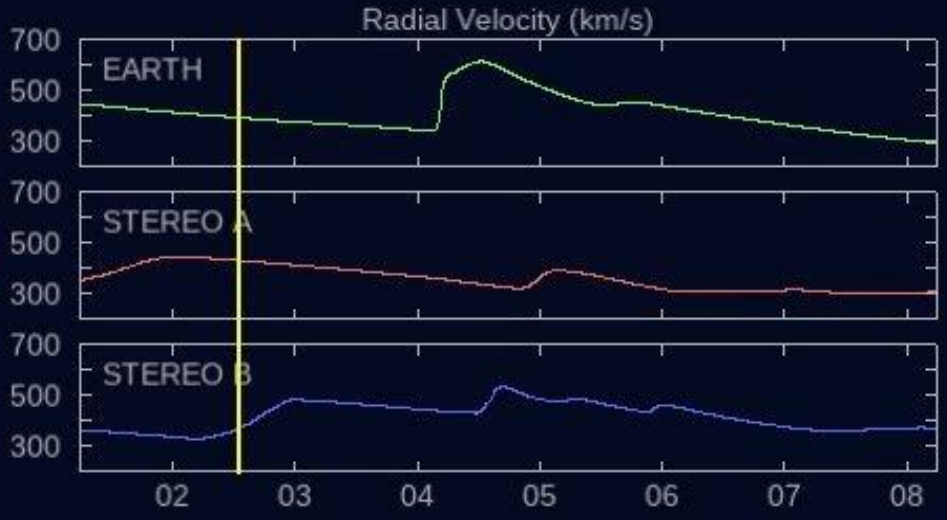
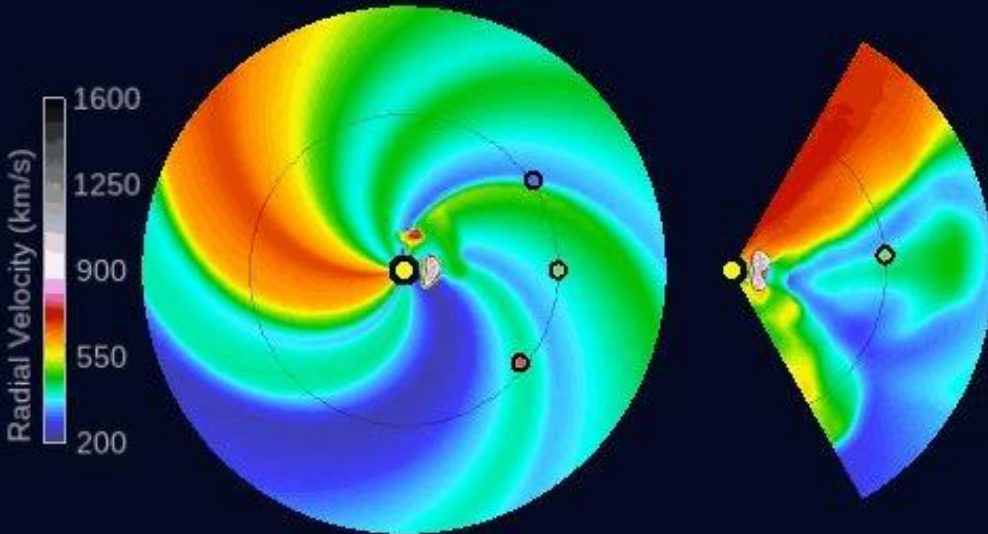
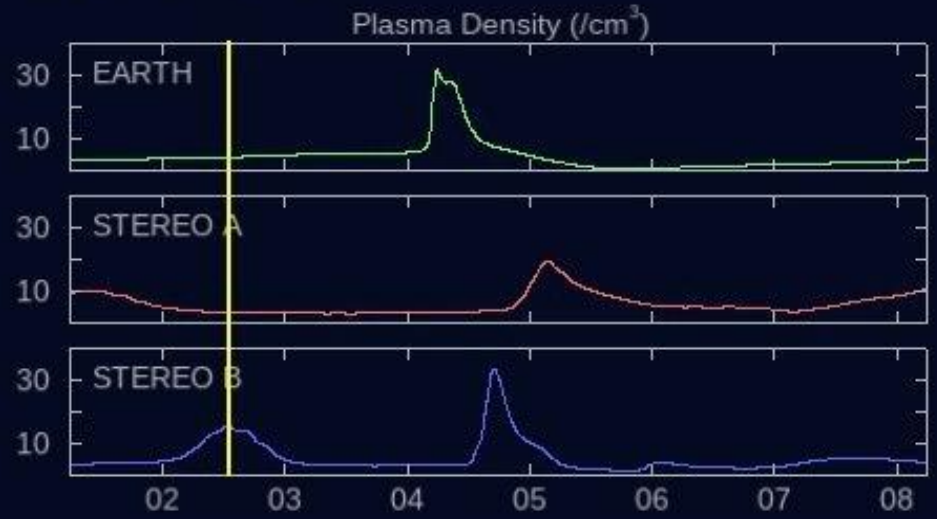
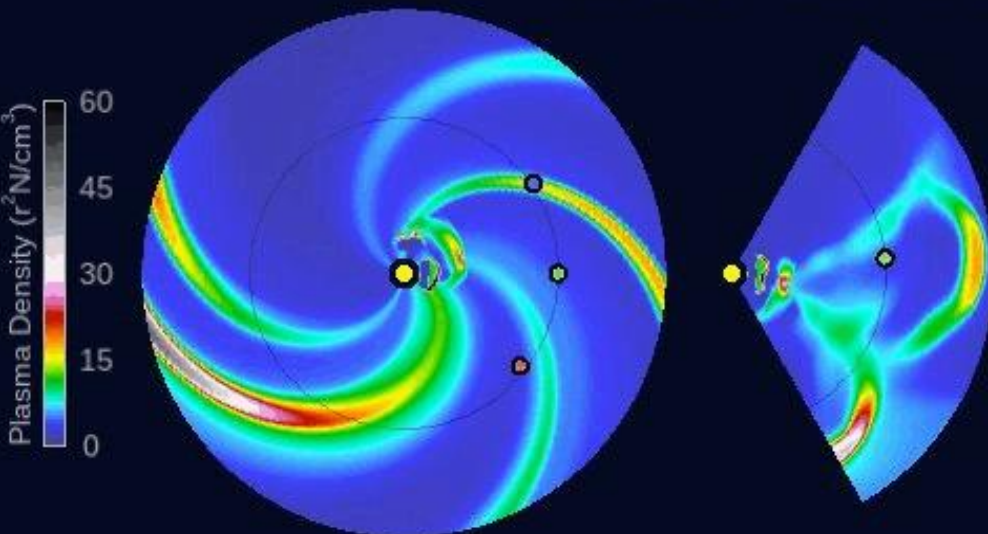


Image was taken from --- <https://www.swpc.noaa.gov/>

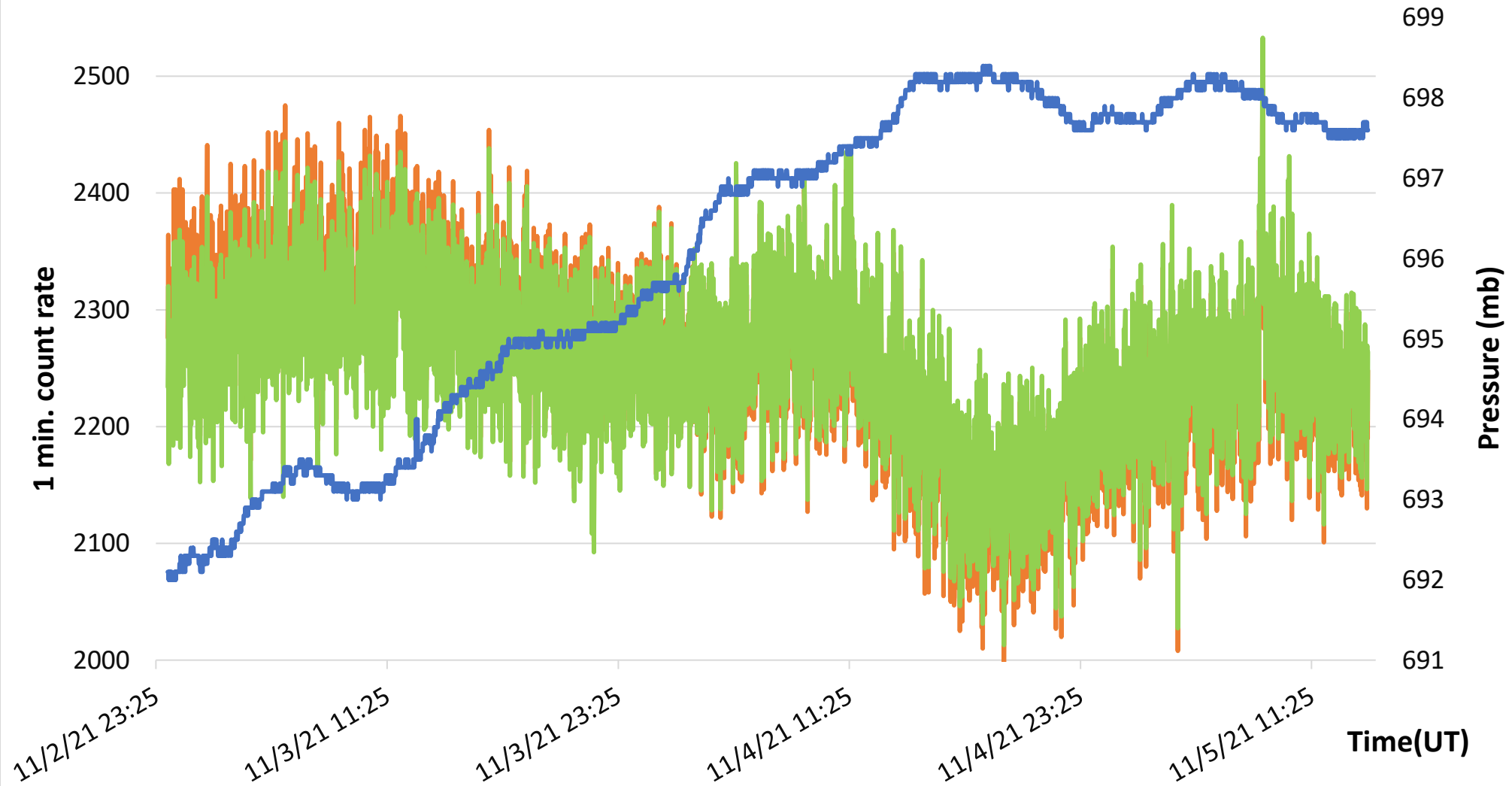
The cannibal cloud swept up one whole CME and a portion of another. If NOAA's model is correct, the combined CME will make first contact with our planet around 0600 UT on Nov. 4th. The model also predicts a +250 km/s increase in solar wind speed and a 6-fold jump in solar wind density in the CME's wake.

Barometric coefficients of SEVAN detector

Detector	Alt. (m.)	Rc (GV)	Barometric Coeff. %/mb (Oct-2018)	Correlation Coefficient	1 min. count rate [mean]	Relative Error	$\frac{1}{\sqrt{N}}$
SEVAN Aragats Coincidence 001	3200	7.1	-0.30 ± 0.02	-0.977	9144	0.010	0.010
SEVAN Aragats Coincidence 010	3200	7.1	-0.47 ± 0.04	-0.966	2297	0.020	0.020
SEVAN Aragats Coincidence 011	3200	7.1	-0.27 ± 0.01	-0.929	753	0.040	0.040
SEVAN Aragats Coincidence 100	3200	7.1	-0.38 ± 0.02	-0.984	20246	0.007	0.007
SEVAN Aragats Coincidence 101&111	3200	7.1	-0.19 ± 0.001	-0.966	7754	0.010	0.010
SEVAN Aragats Coincidence 101	3200	7.1	-0.19 ± 0.001	-0.949	4289	0.015	0.015
SEVAN Aragats Coincidence 111	3200	7.1	-0.19 ± 0.001	-0.966	3465	0.020	0.020
SEVAN Aragats Coincidence 110	3200	7.1	-0.41 ± 0.03	-0.963	1333	0.030	0.030
SEVAN Aragats Lower 5cm	3200	7.1	-0.25 ± 0.01	-0.981	17652	0.008	0.008
SEVAN Aragats Middle 20cm	3200	7.1	-0.32 ± 0.02	-0.984	7848	0.011	0.011
SEVAN Aragats Upper 5cm	3200	7.1	-0.33 ± 0.02	-0.986	29333	0.006	0.006

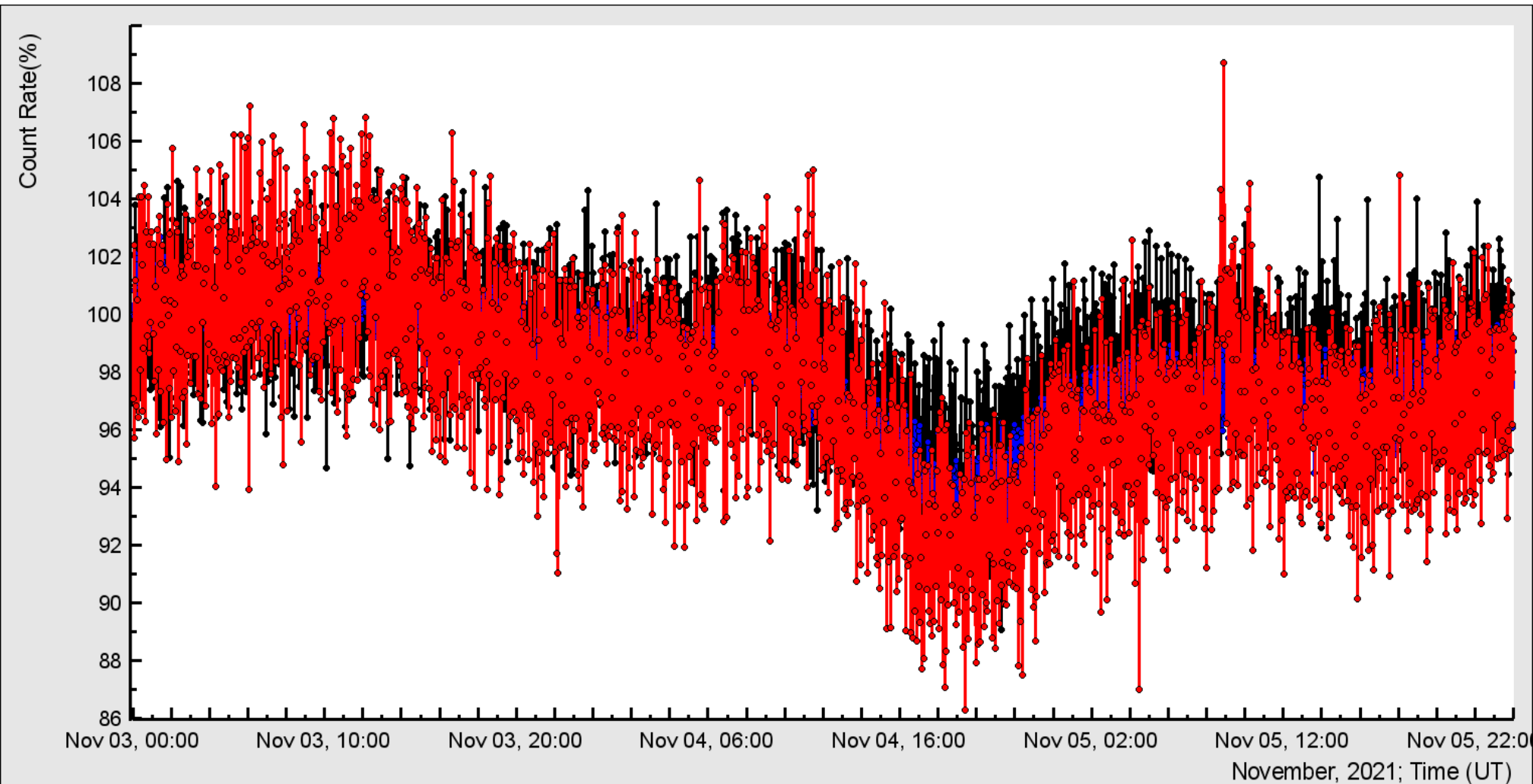
SEVAN Aragats (Coincidence 010)

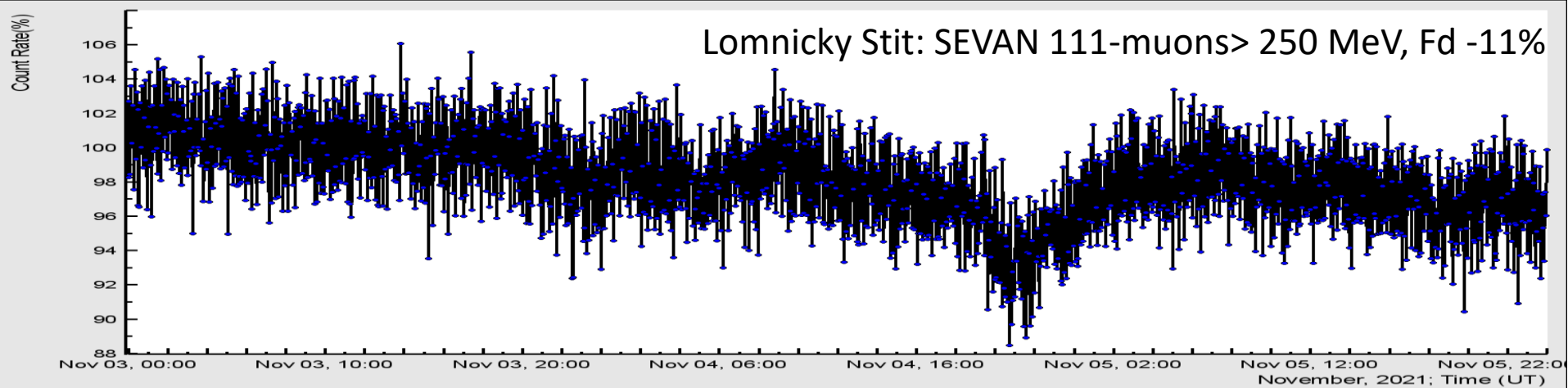
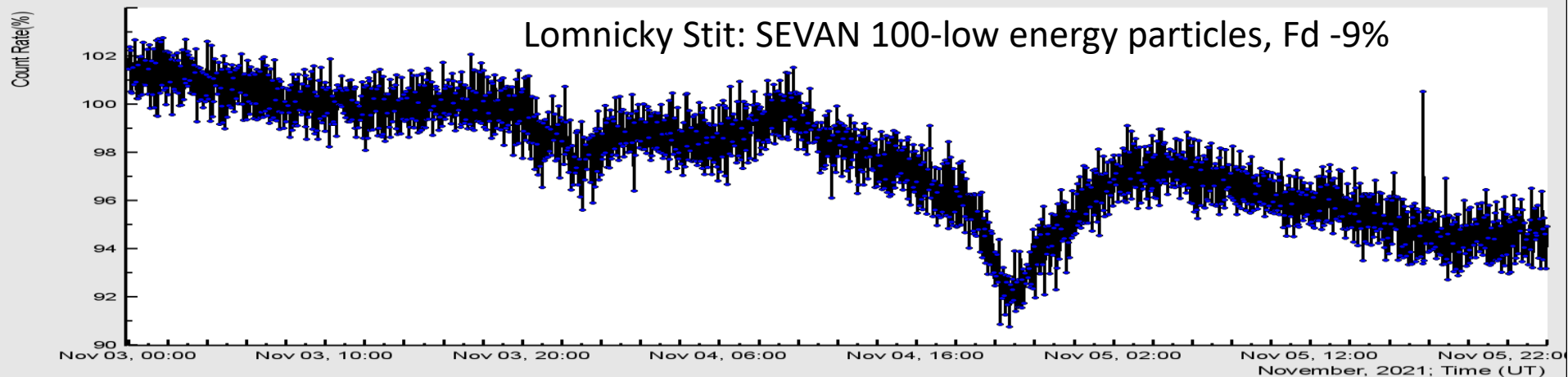
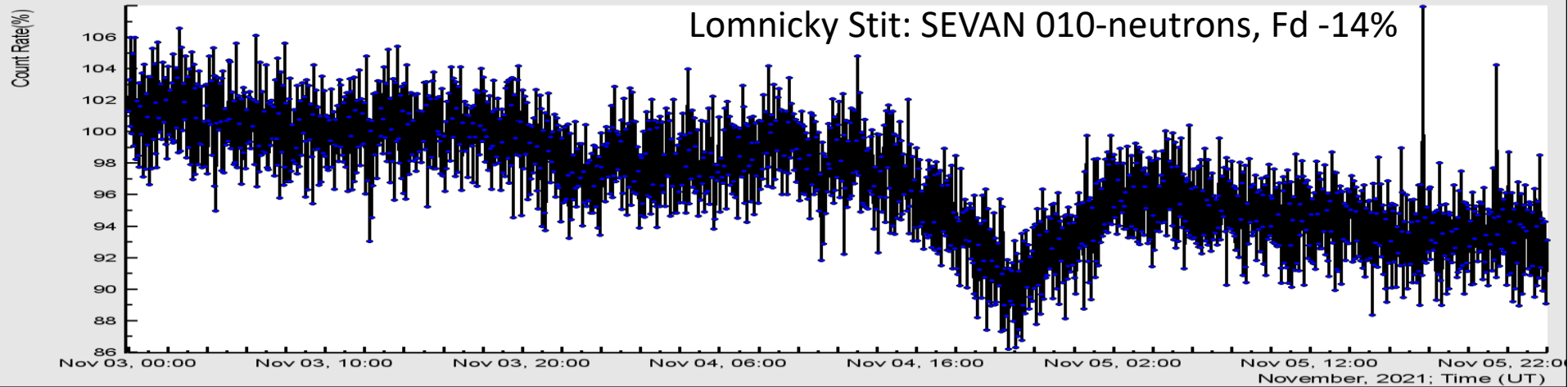
Pressure corrected and uncorrected data for 03.11.2021-05.11.2021

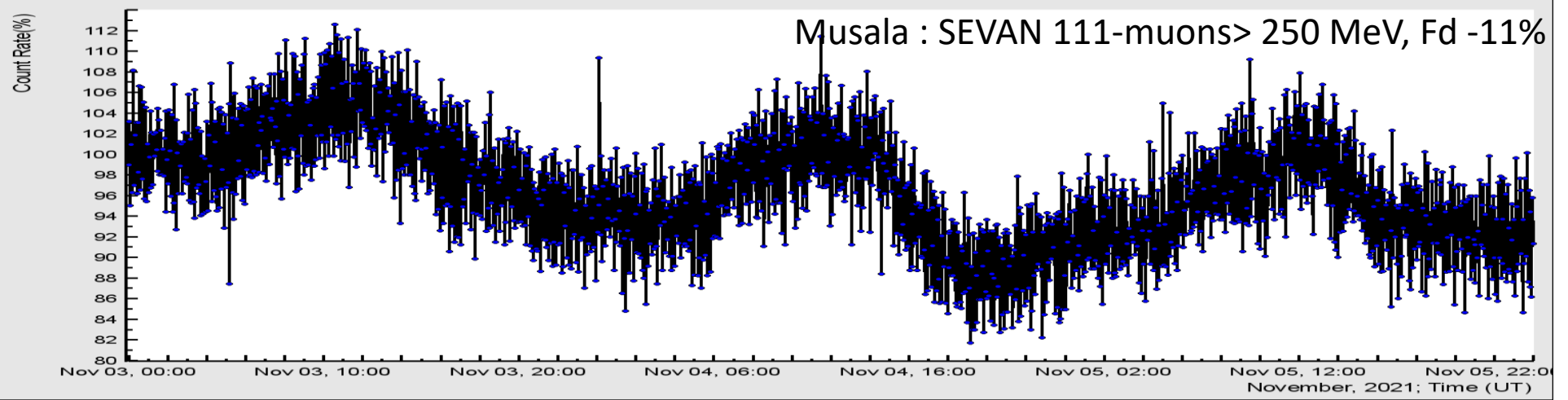
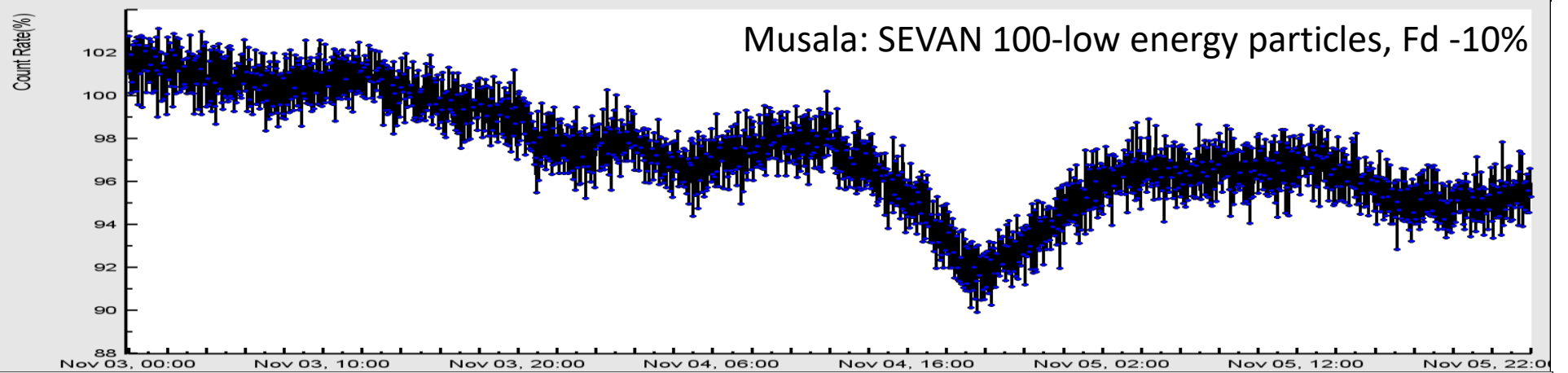
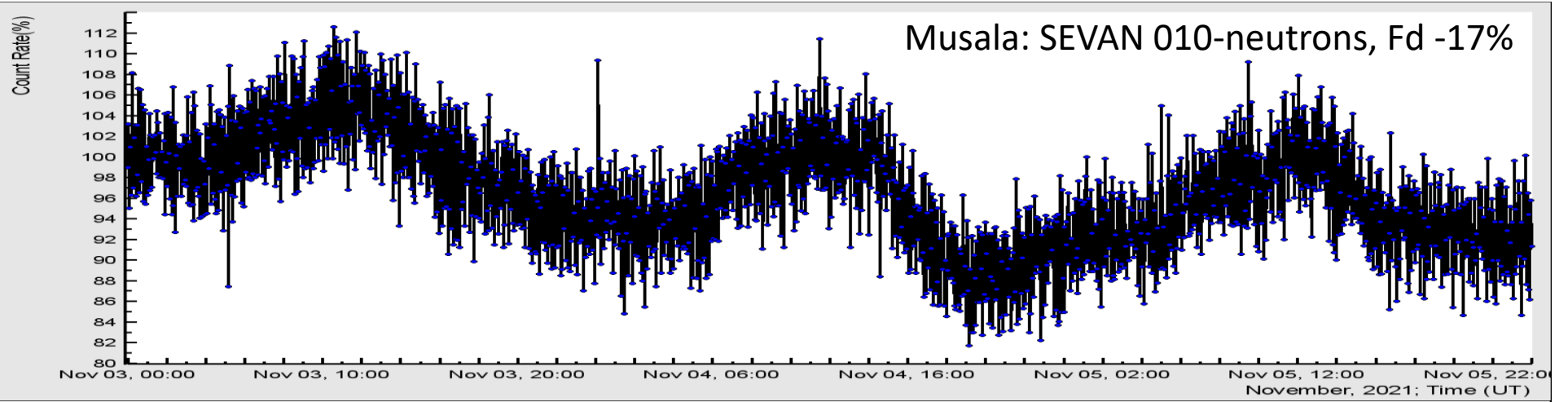


- SEVAN Aragats Coincidence 010 (1 min pressure uncorrected data)
- SEVAN Aragats Coincidence 010 (1 min pressure corrected data)
- Pressure(Weather Station)

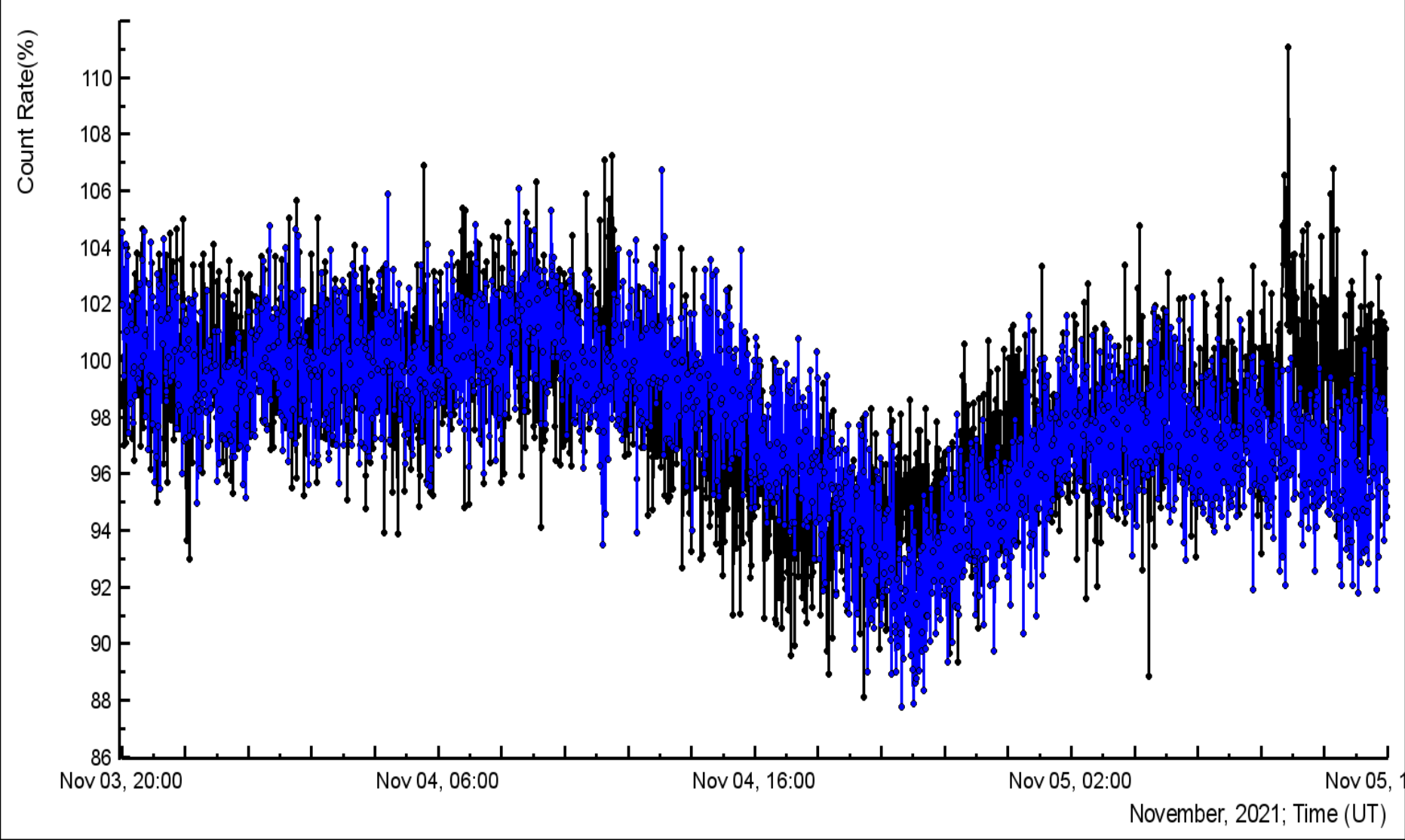
Time series of 1 minute count rates of Aragats SEVAN detector
coincidences 111 (black, muons $E_t > 250\text{MeV}$),
coincidences 100 (blue, low energy, $E_t > 7\text{MeV}$),
coincidences 010 (red, neutrons, F_d amplitude $\approx 12\%$)



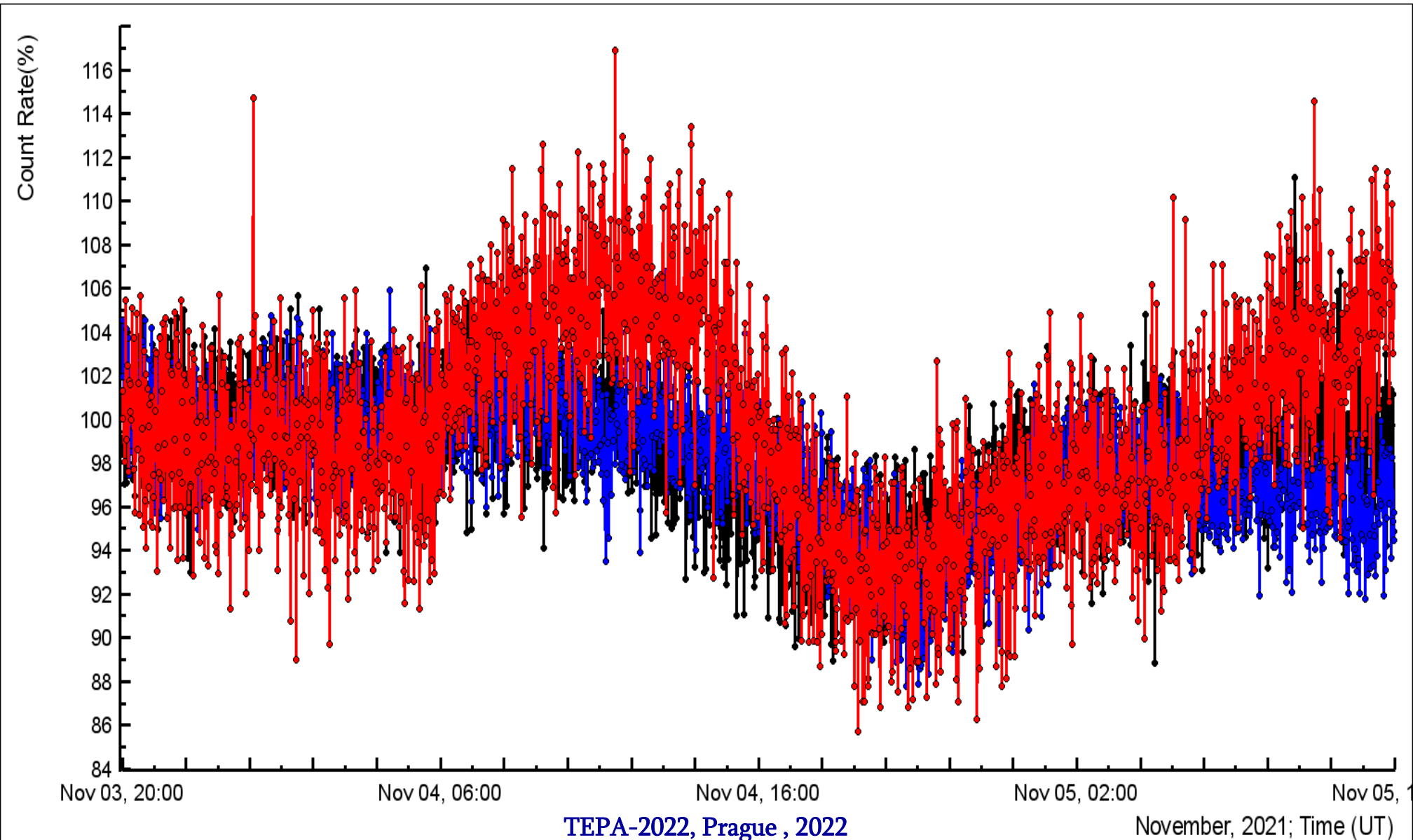




Lomnicky (blue) and Aragats SEVAN's neutrons (coincidence 010): almost complete coincidence



Lomnicky (blue), Aragats (black) and Mussala (red) SEVAN's neutrons (coincidence010)

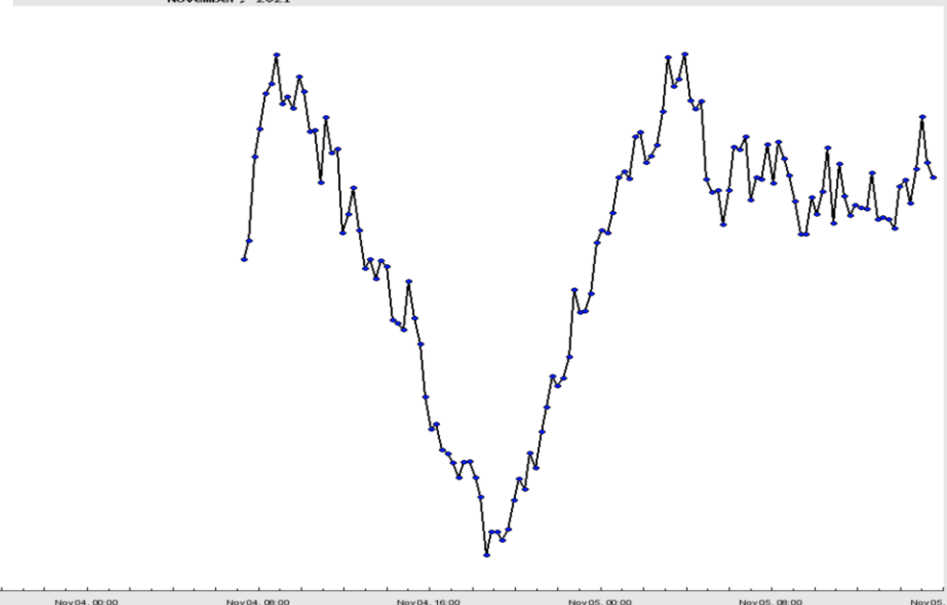
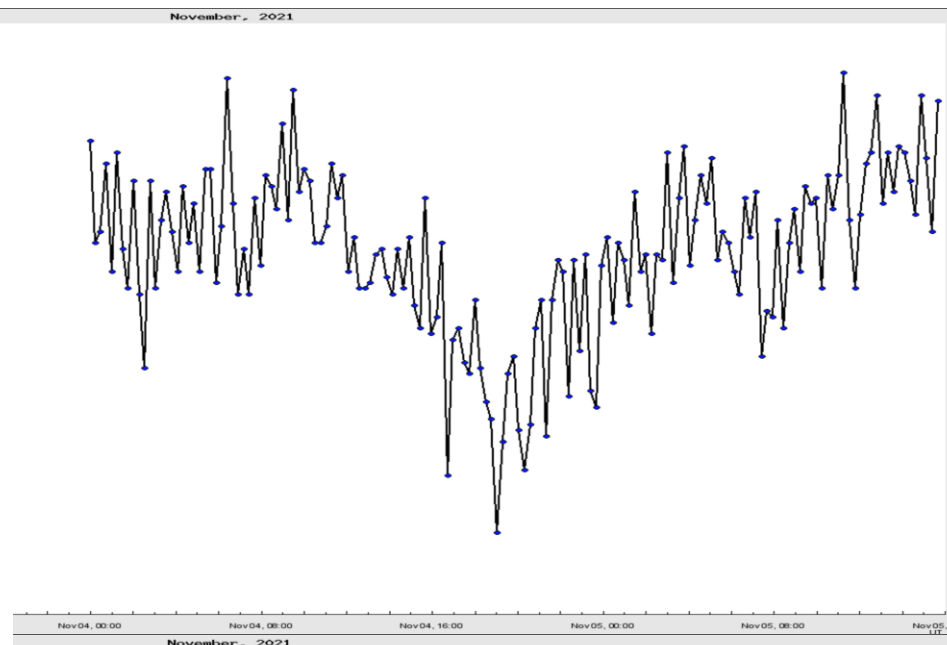
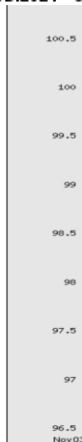
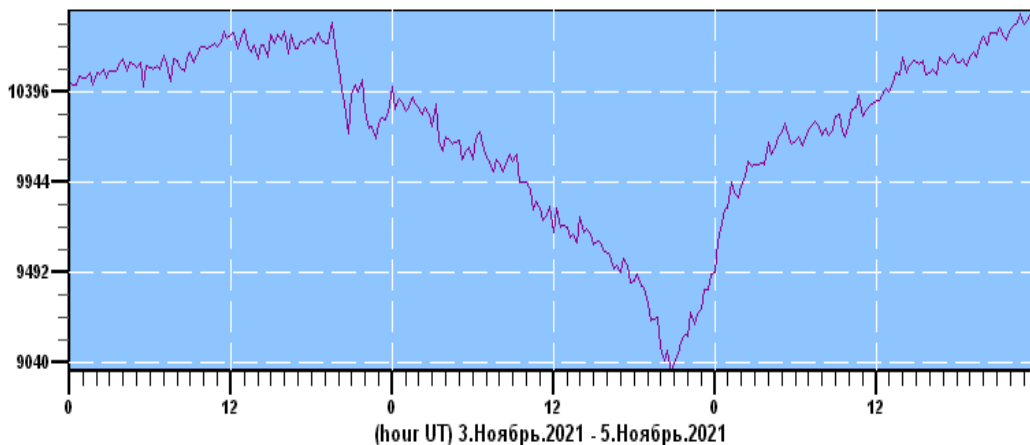


Moscow and Aragats Neutron Monitors as well as ASNT neutrons

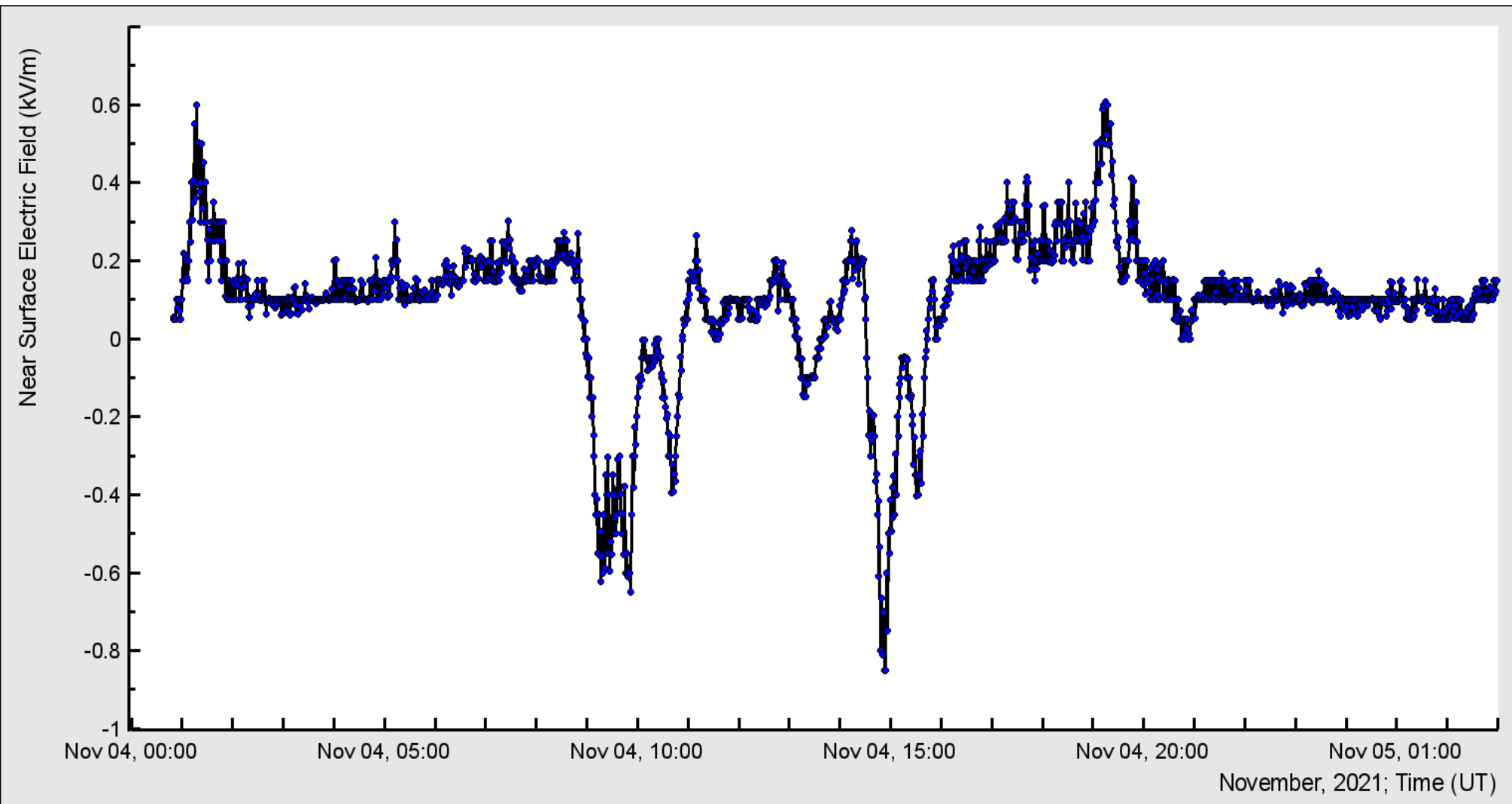
15-minute time series ≈ 3 hours diff. minimum



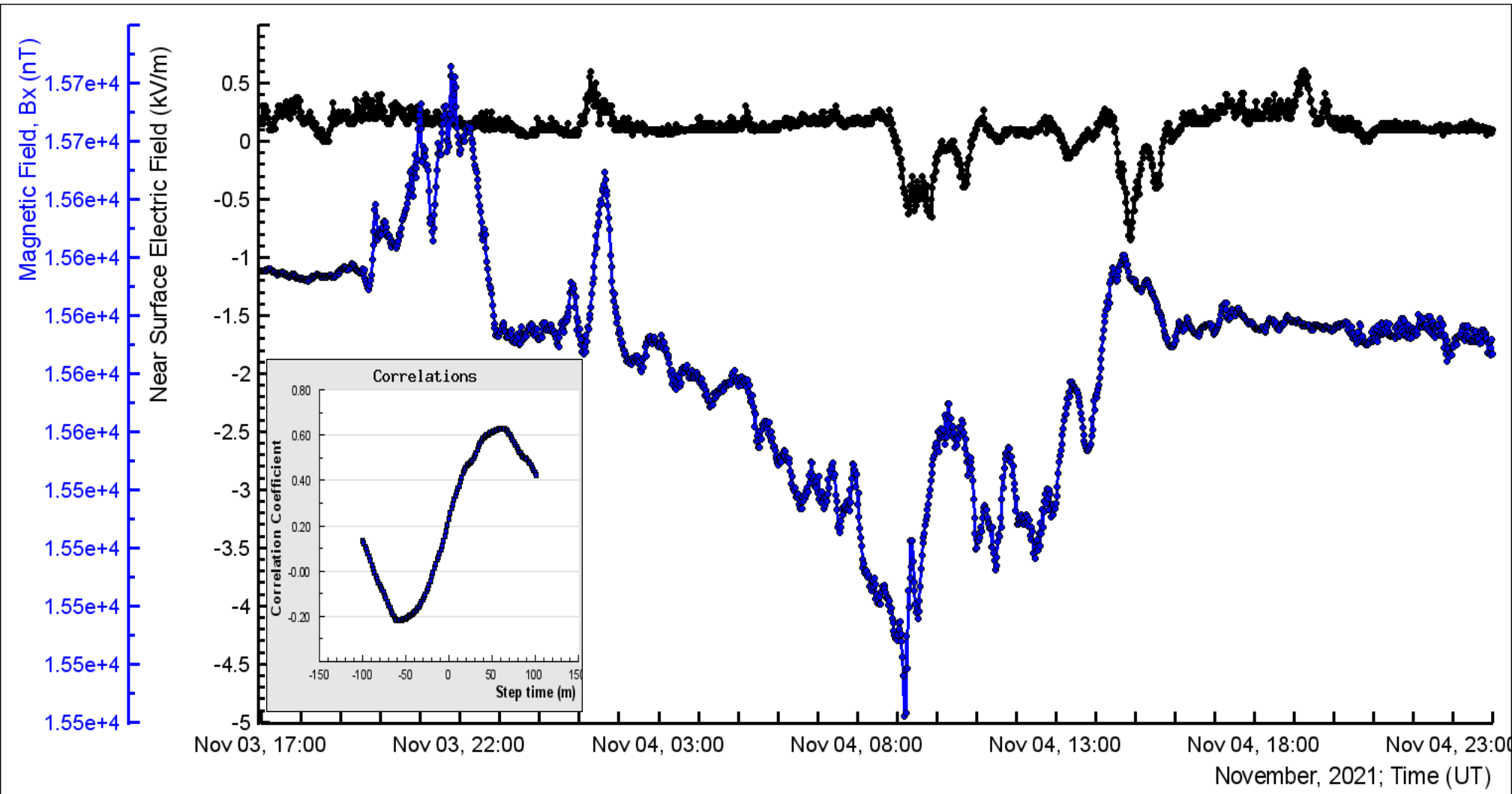
Pressure uncorrected cosmic ray intensity.



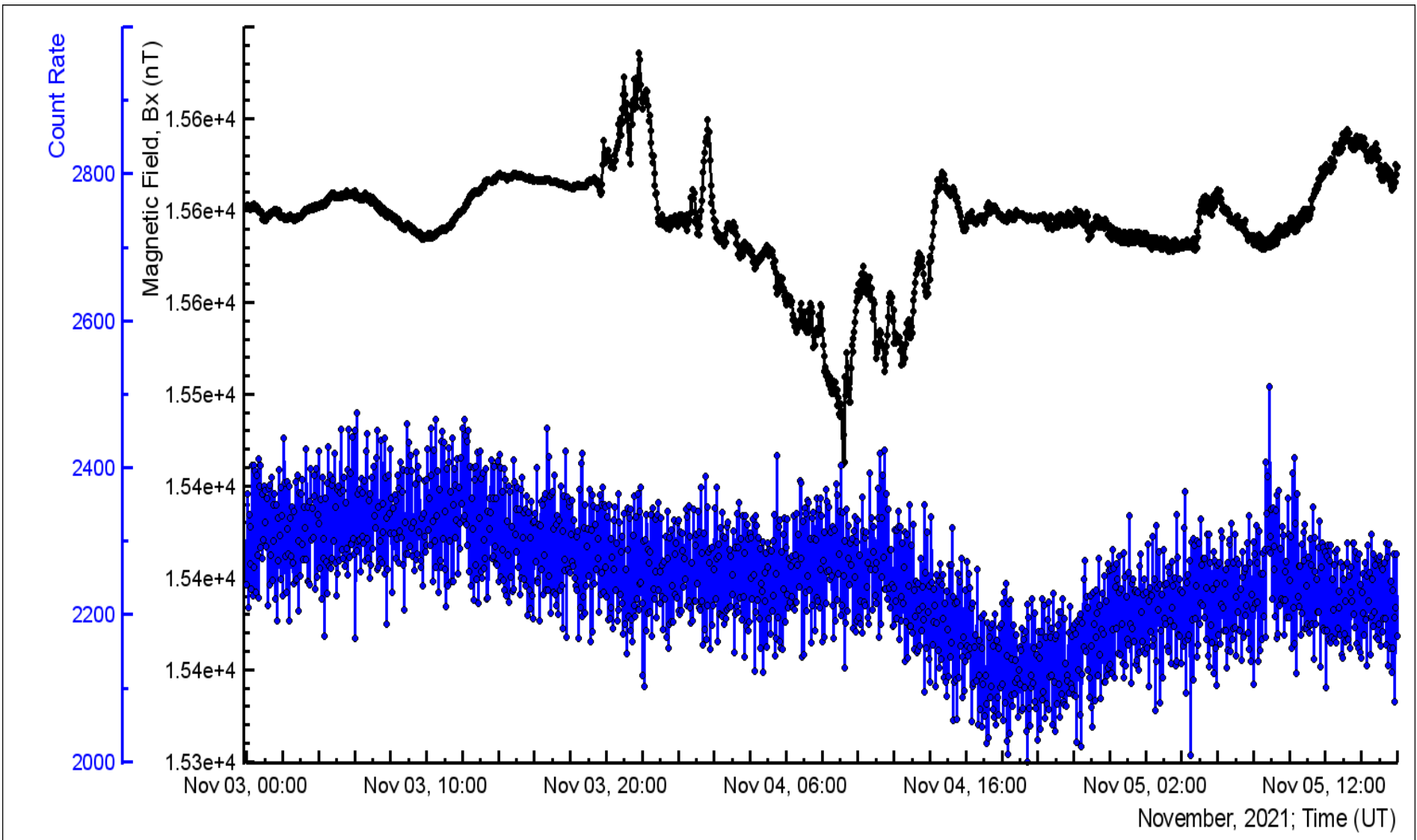
Near Surface Electric Field (measured by Boltek EFM100) disturbances during Fd



Near-surface electric field and Bx: delayed correlations ≈ 1 hour



Neutron flux measured at Aragats by SEVAN detector (coin.010) and Bx component of Geomagnetic filed by LEMI 417 magnetotelluric



Conclusions

- Deepest Fd measured for neutrons by SEVAN at:
 - Musala mtn- Fd 17%
 - Lomnicky Stit - Fd 14%
 - Aragats mtn– Fd 12%
- On Aragats was measured the disturbances of geomagnetic and electric fields simultaneously with Fd measured in almost all species of secondary cosmic rays.
- Good agreement with SEVAN units on Aragats, Musala and Lomnicky Stit mountains.

Thank you for attention

