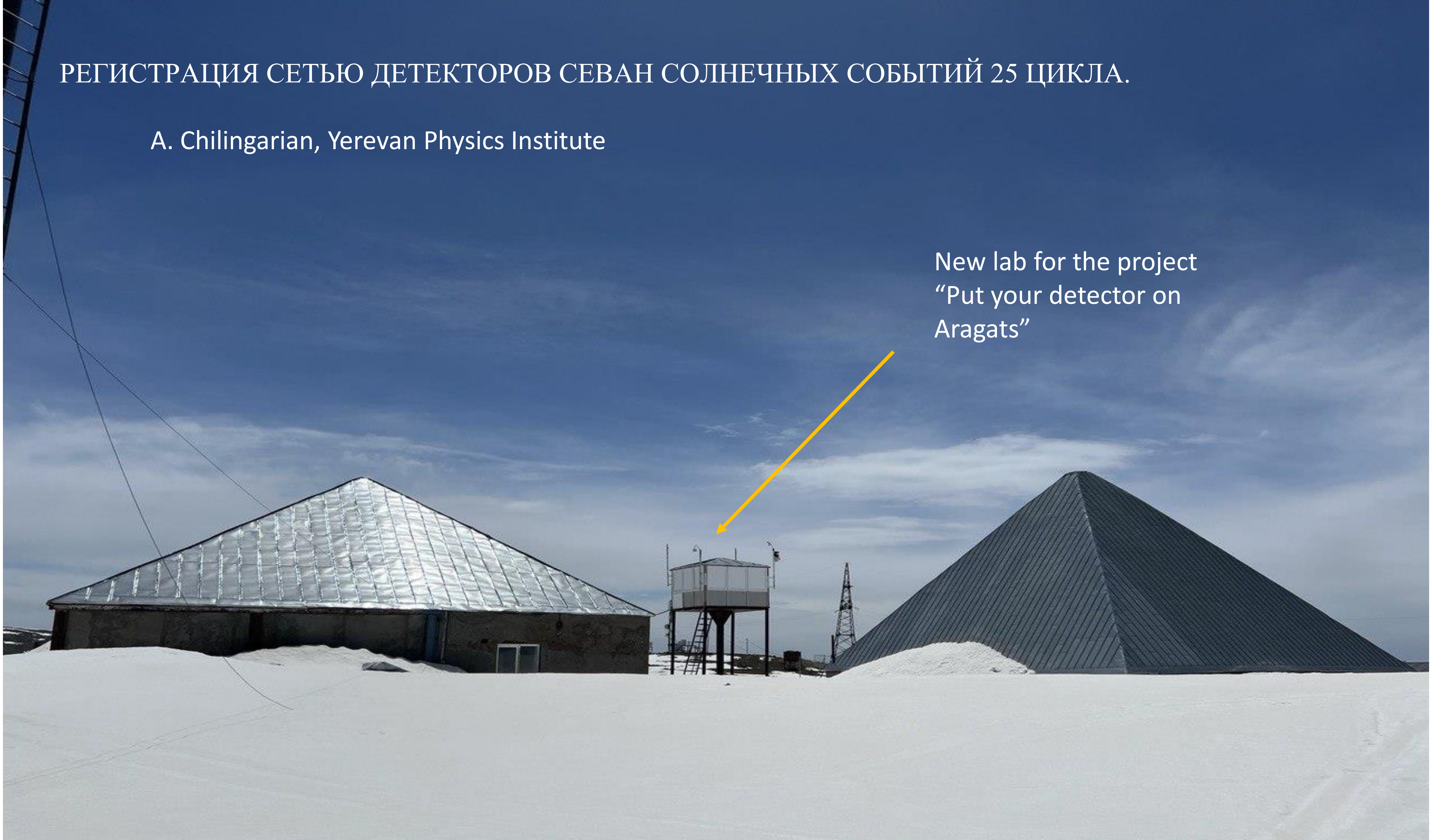
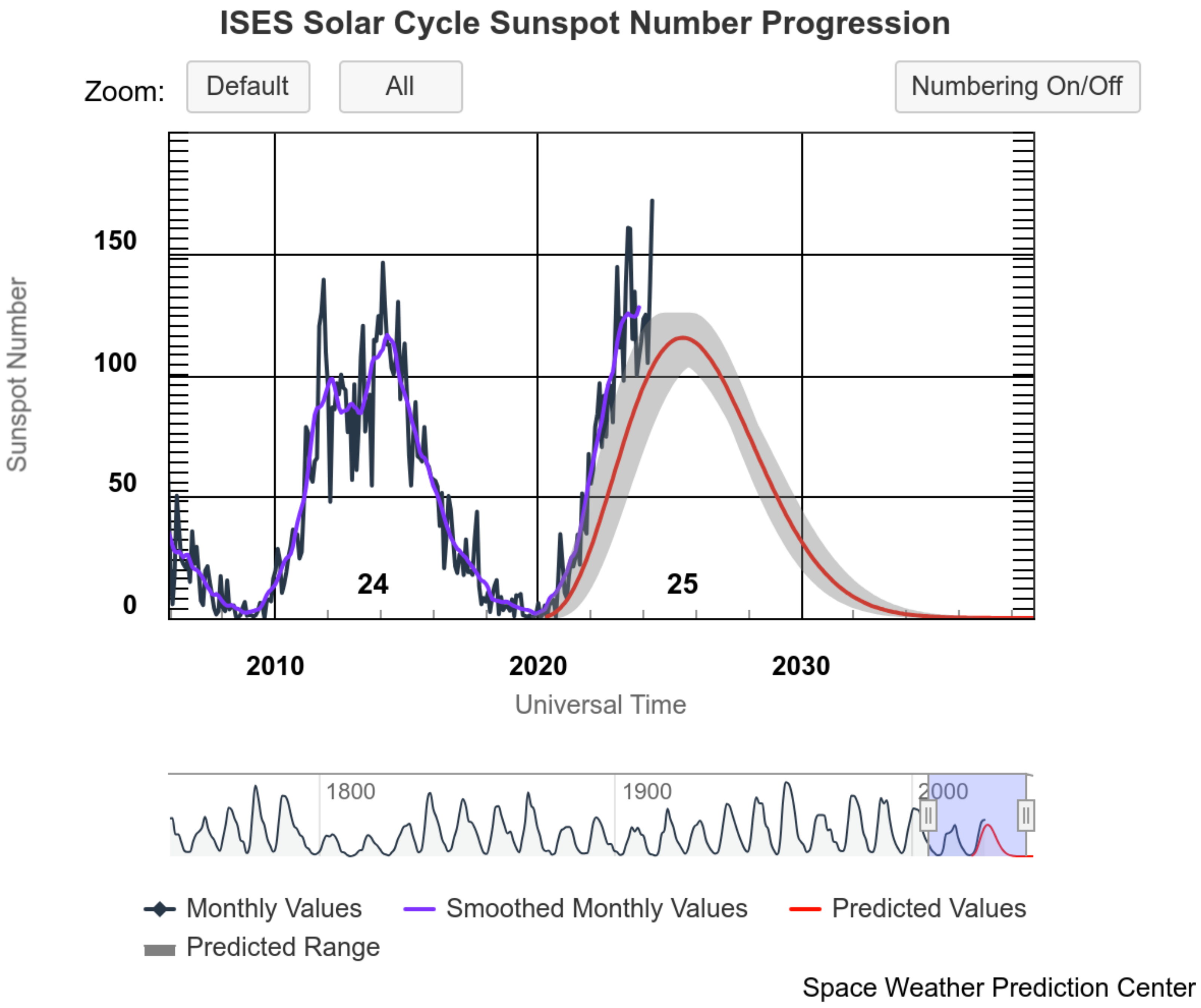
РЕГИСТРАЦИЯ СЕТЬЮ ДЕТЕКТОРОВ СЕВАН СОЛНЕЧНЫХ СОБЫТИЙ 25 ЦИКЛА.

A. Chilingarian, Yerevan Physics Institute





ISES Solar Cycle Sunspot Number Progression
Zoom:
Default
All
Numbering On/Off
Sunspot Number
150
100
50
0
24
25
2010
2020
2030
Universal Time
1800
1900
2000
Monthly Values
Smoothed Monthly Values
Predicted Values
Predicted Range
Space Weather Prediction Center

Historical Comparison of May 2024 Solar Storms

WHAT: How did the G5 Geomagnetic Storm Compare to Other Major Events?

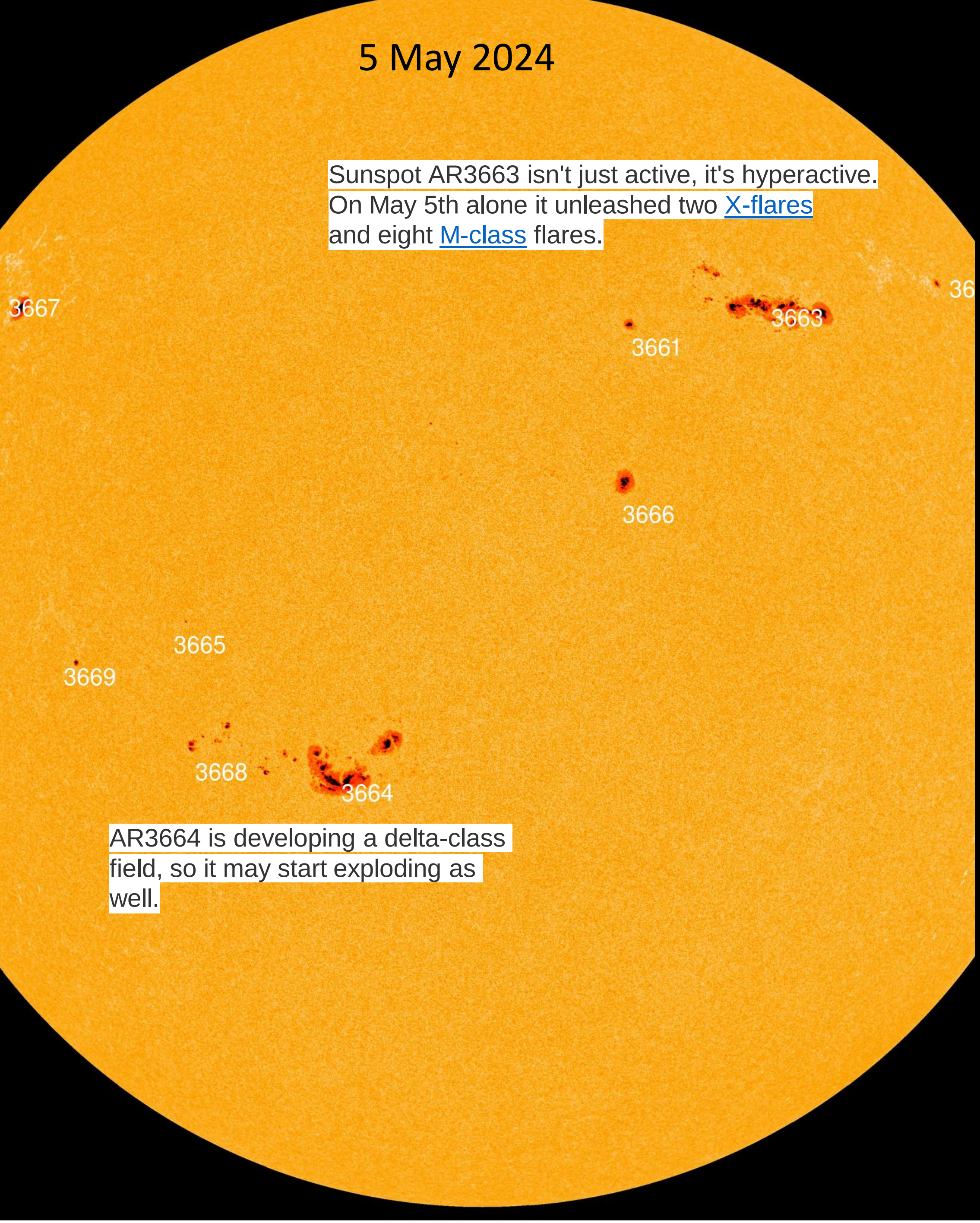
Index	MAY 2024	OCT 2003	MAR 1989	MAY 1921	SEP 1859
Disturbance Storm Index (nT)	-412	-383	-589	~ -907	~-1200
A_p-Index	271	204	246	NA	NA

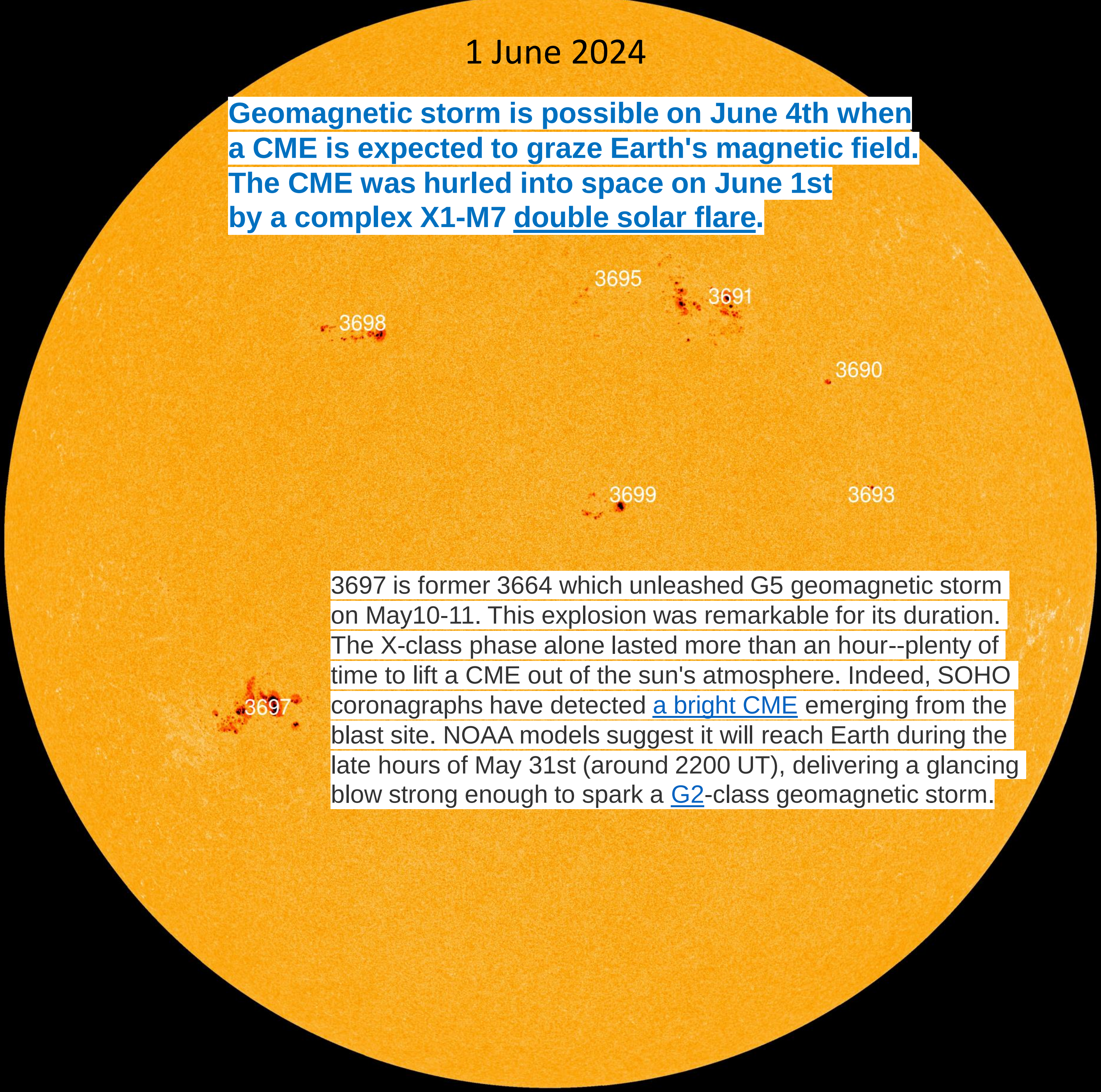
Disturbance Storm Index (Dst): An index of magnetic activity derived from a network of near-equatorial geomagnetic observatories that measures the intensity in space of the ring of westward current around Earth (higher negative values generally correlate with stronger storms)

A_p-Index: The average from eight daily values gives the A_p-index of a certain day (every 3-hour K-value - or measure of geomagnetic activity - is converted into a linear scale). Days with higher geomagnetic activity have a higher daily A_p-value.

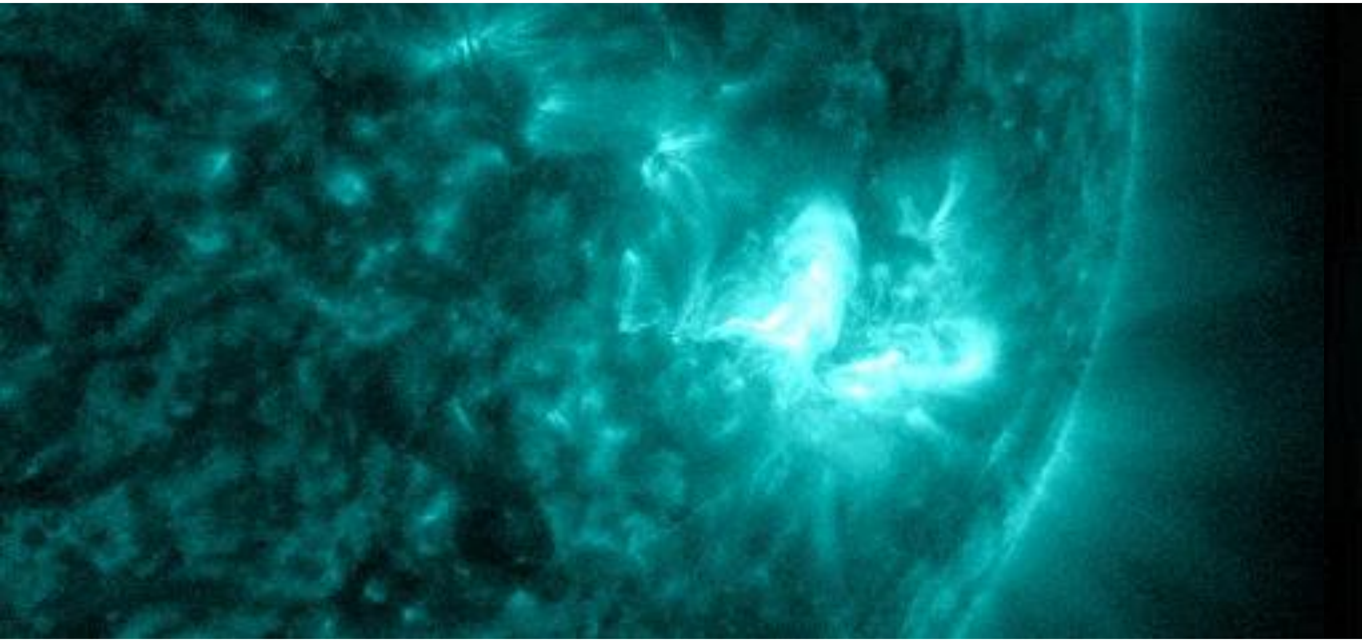
Loveland Pass, Colorado, 5/10/24. Credit: Dan McManus, SWPC.

Boulder, Colorado, 5/10/24. Credit: Jon Lash, SWPC.

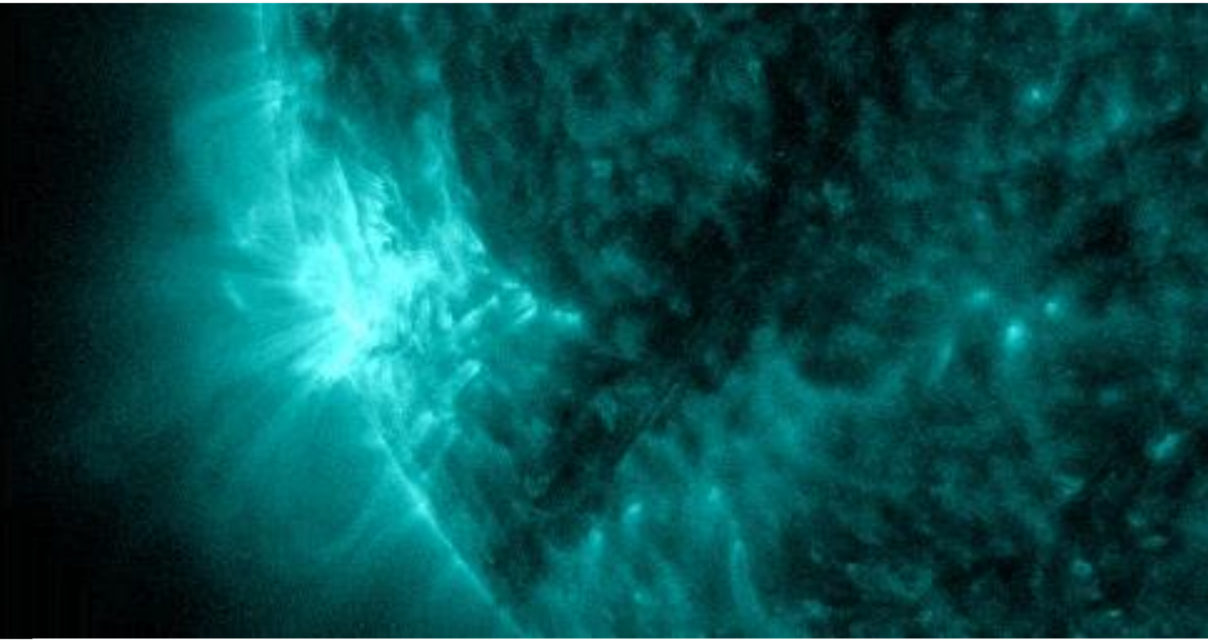

5 May 2024
Sunspot AR3663 isn't just active, it's hyperactive. On May 5th alone it unleashed two X-flares and eight M-class flares.
3667
36
3663
3661
3666
3665
3669
3668
3664
AR3664 is developing a delta-class field, so it may start exploding as well.


1 June 2024
Geomagnetic storm is possible on June 4th when a CME is expected to graze Earth's magnetic field. The CME was hurled into space on June 1st by a complex X1-M7 double solar flare.
3695
3691
3698
3690
3699
3693
3697
3697 is former 3664 which unleashed G5 geomagnetic storm on May10-11. This explosion was remarkable for its duration. The X-class phase alone lasted more than an hour--plenty of time to lift a CME out of the sun's atmosphere. Indeed, SOHO coronagraphs have detected a bright CME emerging from the blast site. NOAA models suggest it will reach Earth during the late hours of May 31st (around 2200 UT), delivering a glancing blow strong enough to spark a G2-class geomagnetic storm.

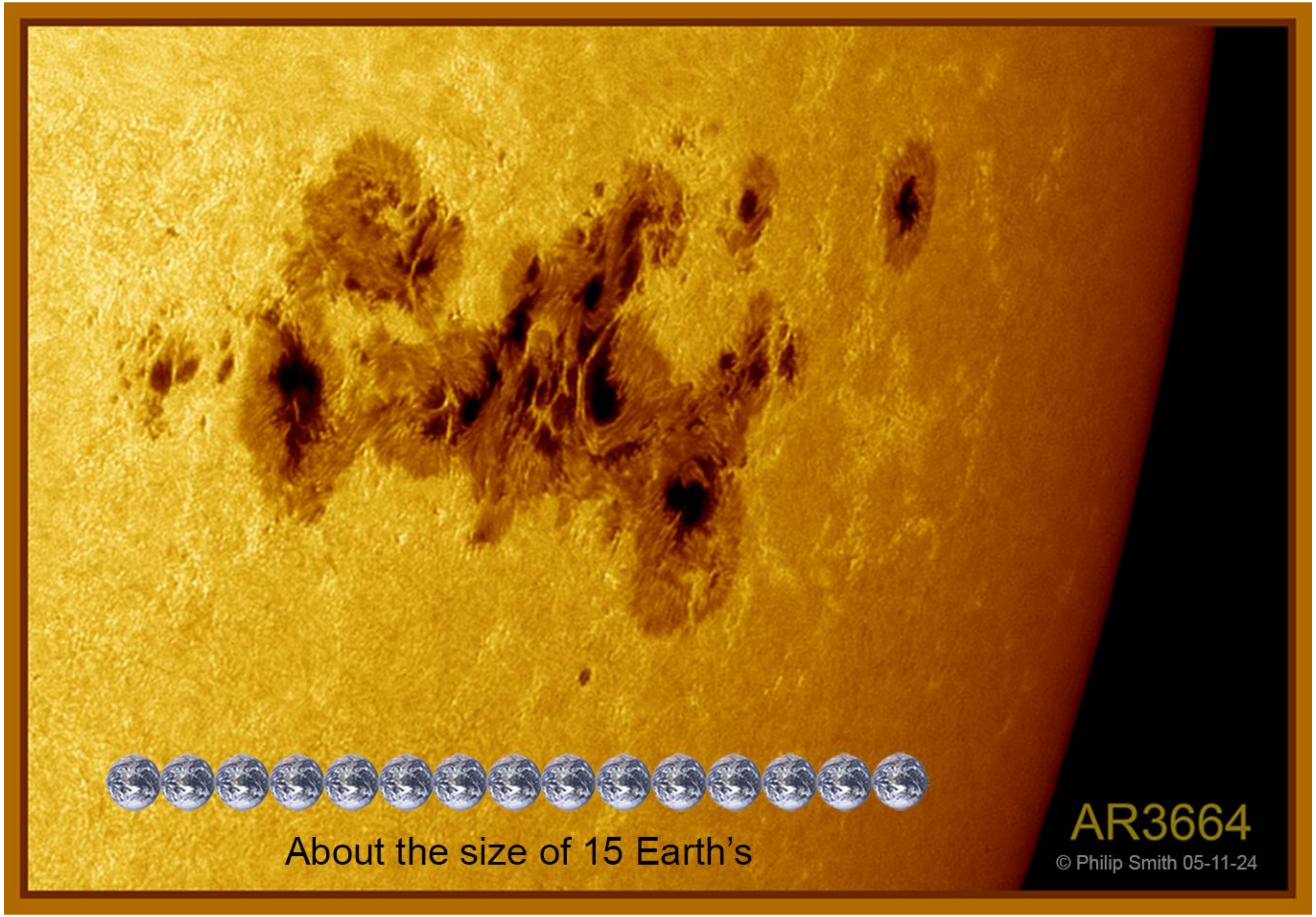
THE STRONGEST X-FLARE YET: the first from a series that accelerates protons!



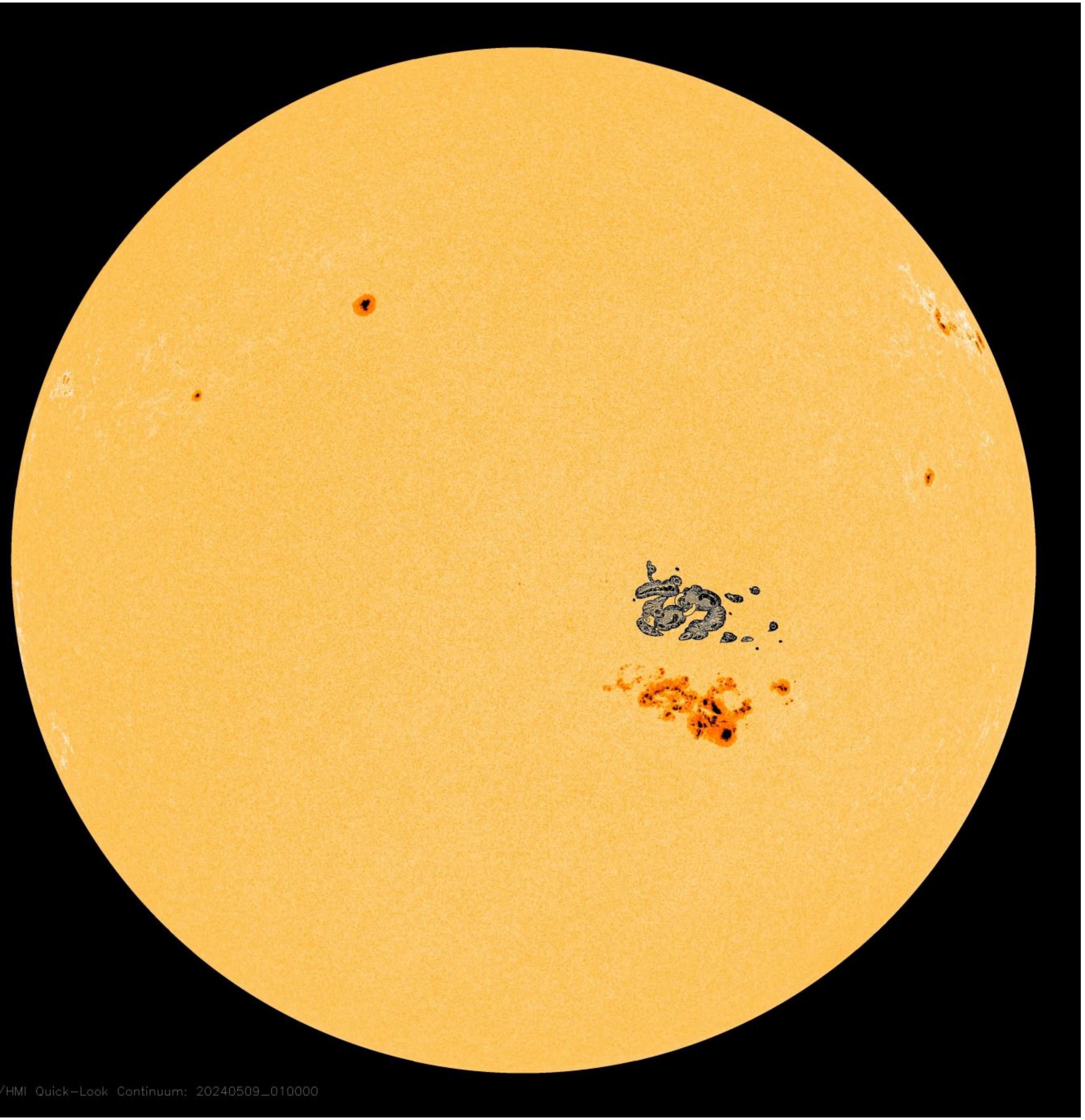
Giant sunspot AR3664 unleashed another X-flare today on west May 11th @ 0139 UT)--its strongest yet. NASA's Solar Dynamics Observatory captured a bright ultraviolet flash from the category X5.8 explosion:



Sunspot AR3664 (a.k.a. AR3697 appears on the from the east) has decayed, but it is still potent. On May 31 it emitted another X-flare (X1.1), the third this week. NASA's Solar Dynamics Observatory captured the extreme ultraviolet flash:



About the size of 15 Earth's
AR3664
© Philip Smith 05-11-24

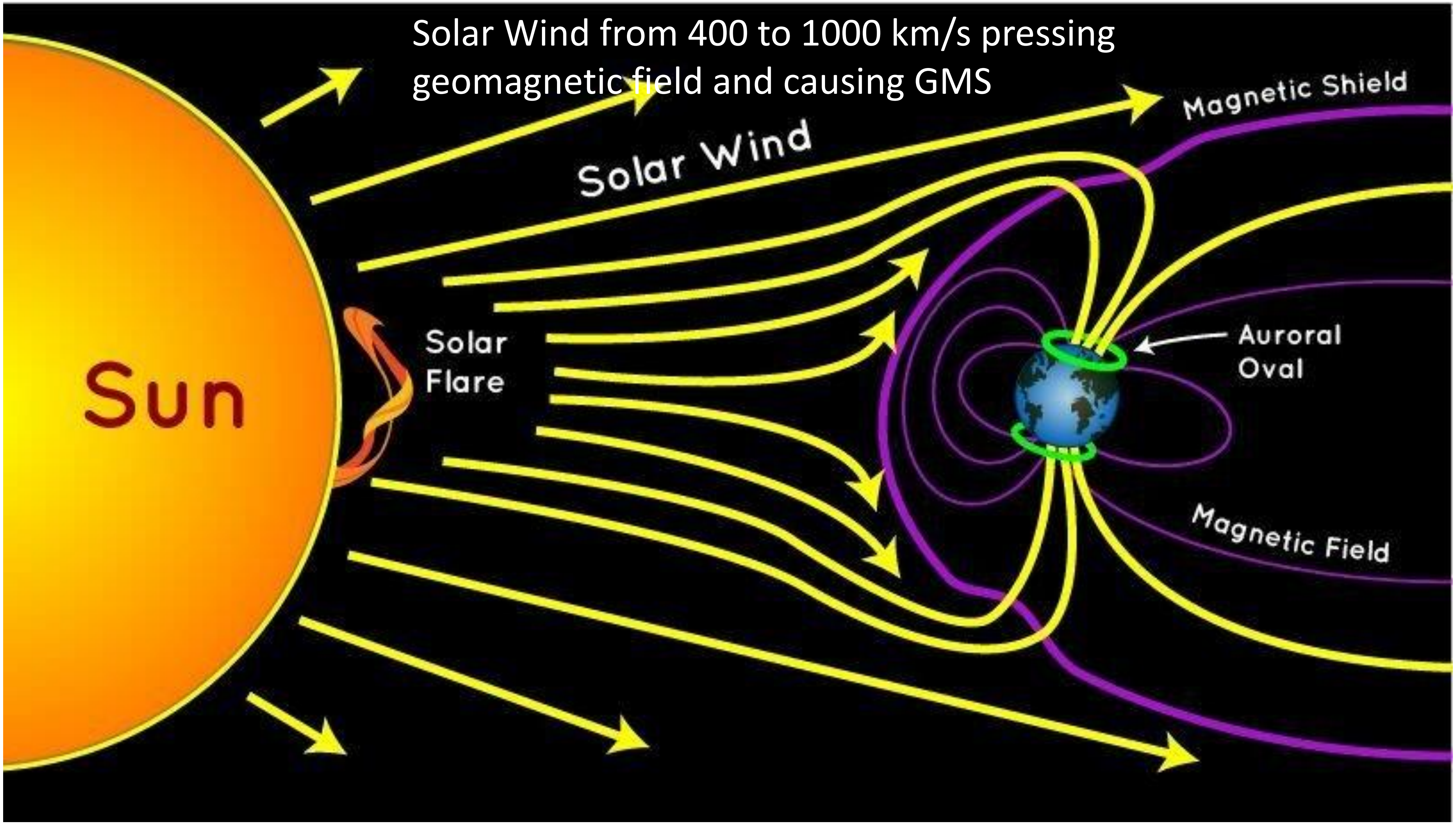


A CARRINGTON-CLASS SUNSPOT: Sunspot AR3664 has grown so large it now rivals the great Carrington sunspot of 1859. To illustrate their similarity, we've added Carrington's famous sketch (to scale) to a NASA photo of today's sun. Sprawling almost 200,000 km from end to end, AR3664 is 15 times wider than Earth. You can see it through ordinary eclipse glasses with no magnification at all. Moreover, it is easy to project an image of this sunspot onto the sidewalk or a white screen, just as Carrington did in the 19th century. Carrington's sunspot is famous because in August and Sept. 1859, it emitted a series of intense solar flares and CMEs. The resulting geomagnetic storms set fire to telegraph offices and sparked auroras from Cuba to Hawaii. The "Carrington Event" has since become a touchstone of space weather in pop culture, with recent headlines stoking fears of an "internet apocalypse" if it repeats.

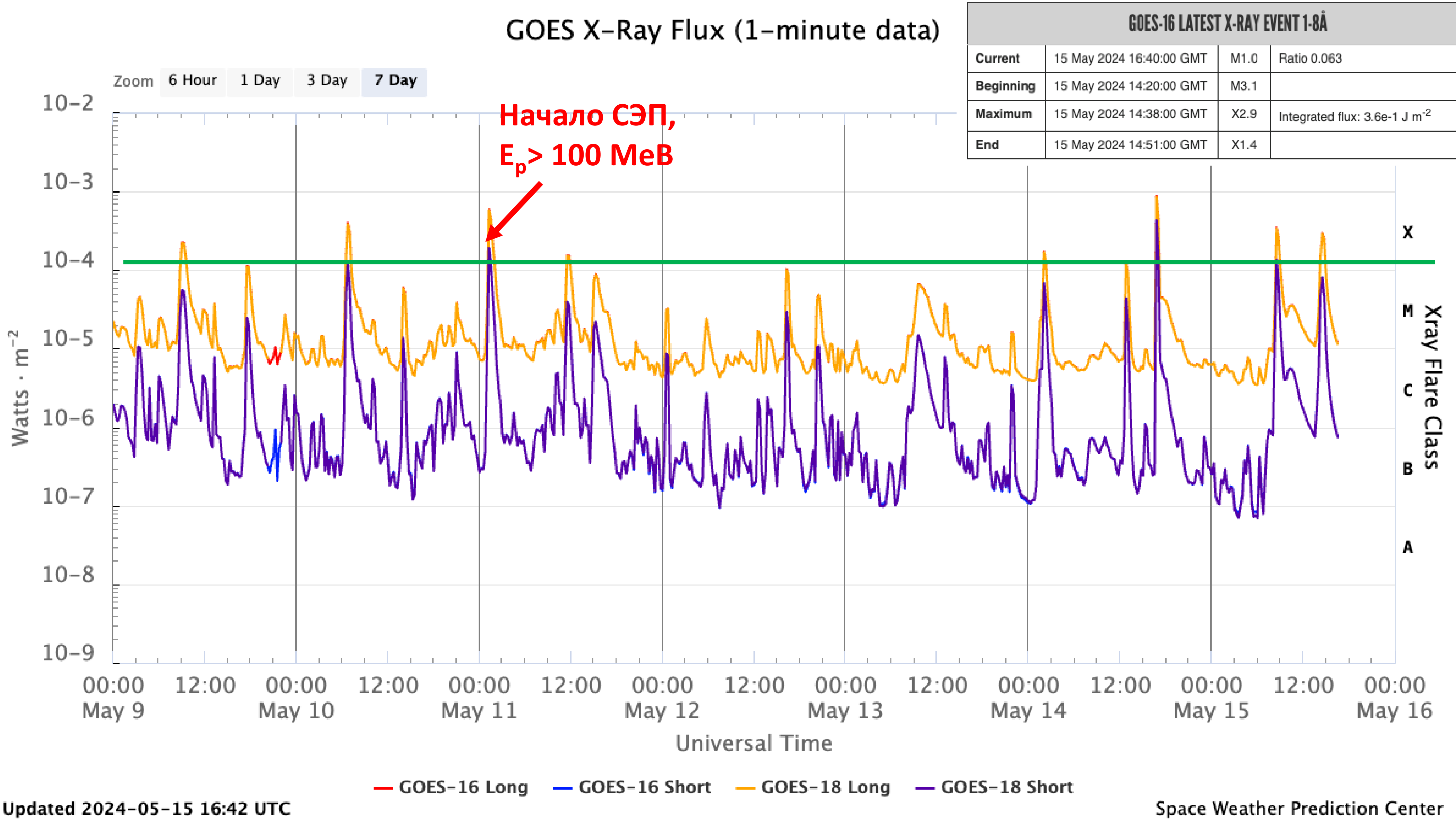
Indeed, it could repeat. Studies suggest that Carrington-class storms occur once every 40 to 60 years, so we're overdue. Don't worry, though. The four CMEs currently en route to Earth--even combined--are probably no match for the monster CME of 1859. The Carrington Event won't happen again this weekend. Nevertheless, keeping an eye on this growing active region while Earth is in its strike zone would be wise.


Approaching
“cannibal” ICME

Solar Wind from 400 to 1000 km/s pressing geomagnetic field and causing GMS



X class flares from AR 3664 on 9-15 May 2024

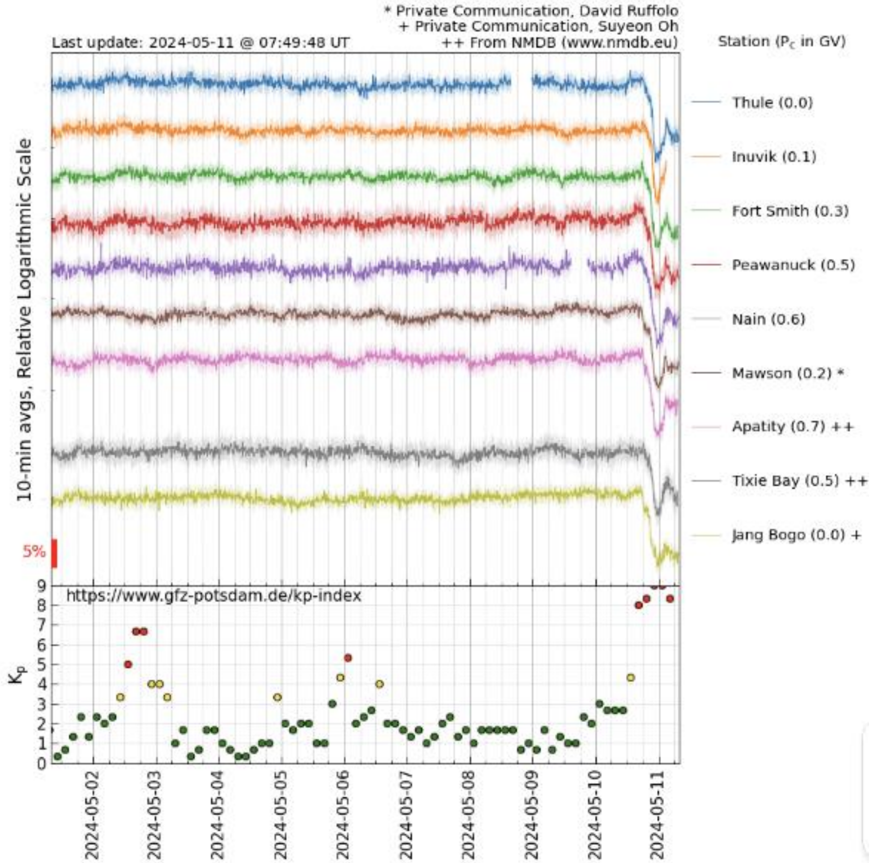


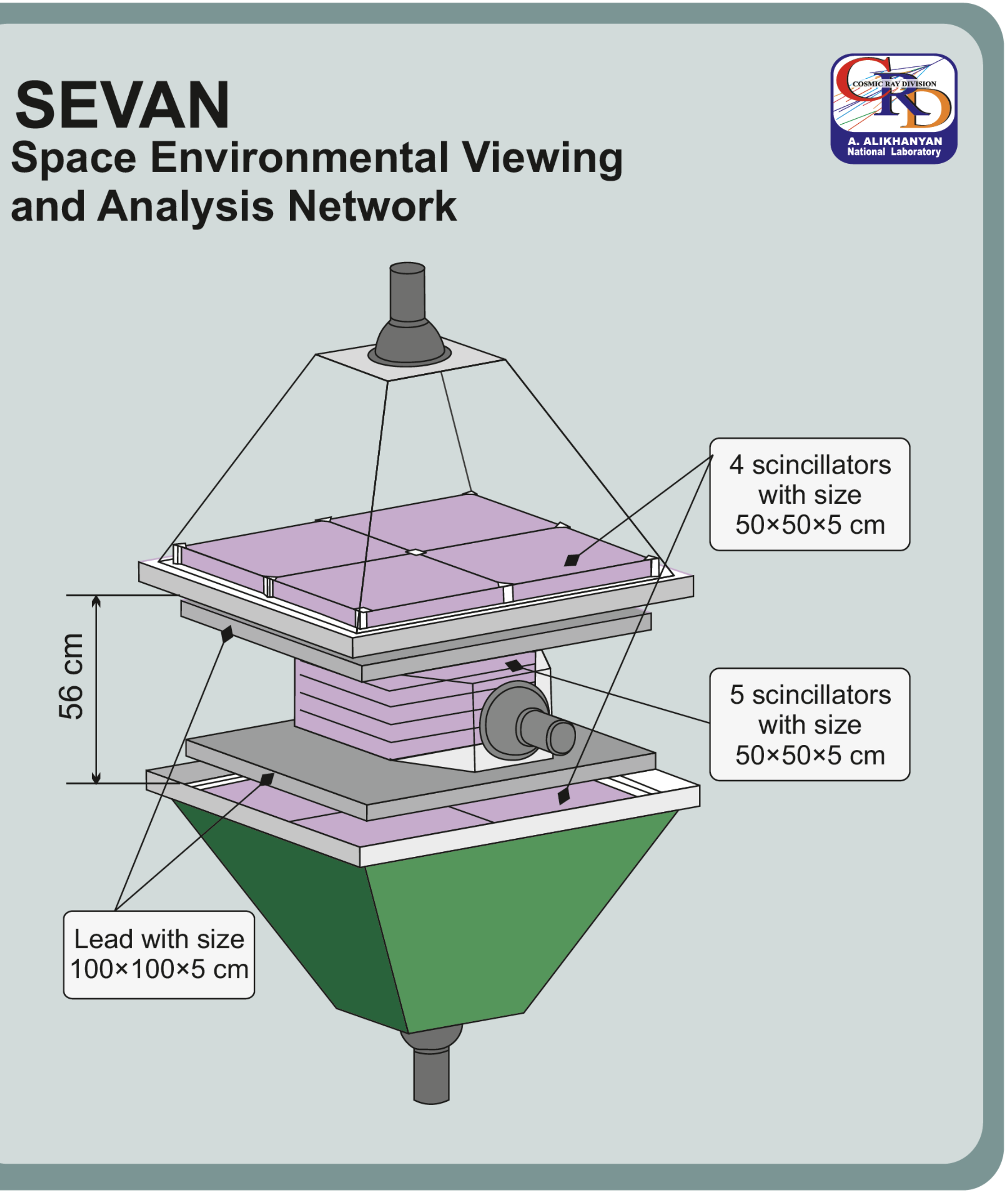
GOES-16 LATEST X-RAY EVENT 1-8Å			
Current	15 May 2024 16:40:00 GMT	M1.0	Ratio 0.063
Beginning	15 May 2024 14:20:00 GMT	M3.1	
Maximum	15 May 2024 14:38:00 GMT	X2.9	Integrated flux: 3.6e-1 J m^{-2}
End	15 May 2024 14:51:00 GMT	X1.4	

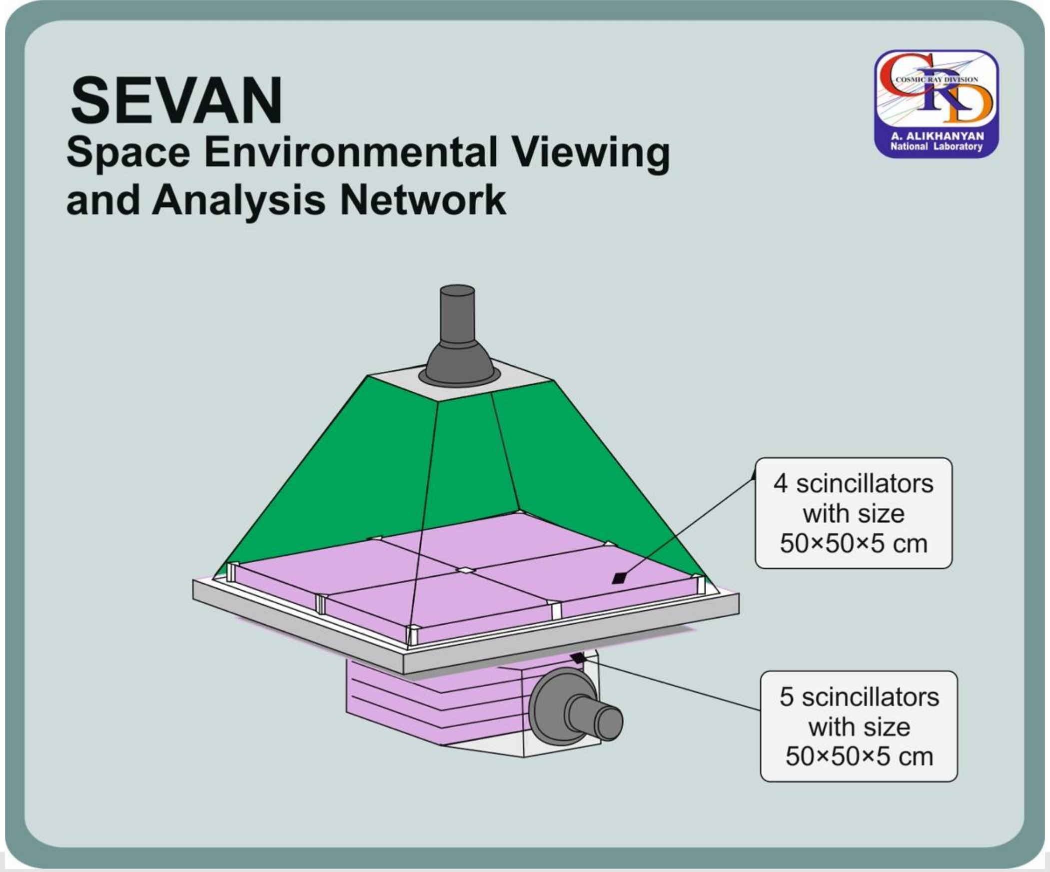
Солнечные События

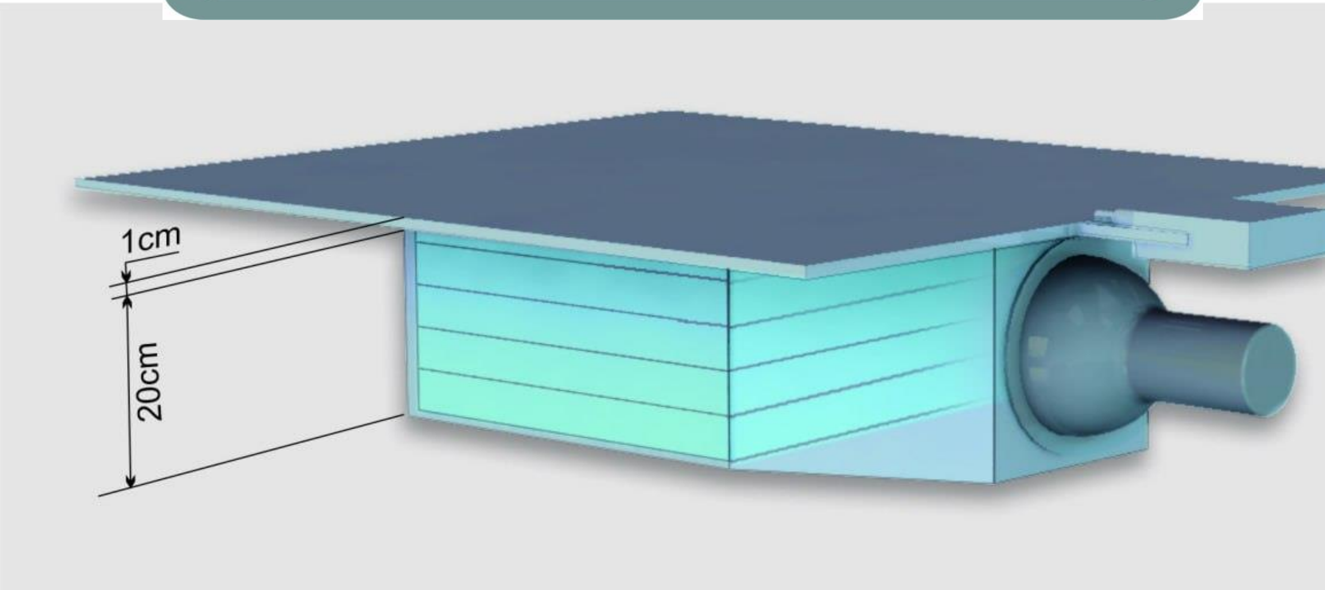
- GLE - солнечные ГэВые протоны от СЭП, попадая в земную атмосферу, создают вторичные нейтроны и мюоны, которые достигая поверхности Земли создают импульсные усиления с амплитудой, зависящей от геомагнитной жесткости жесткости и высоты. Последний крупный GLE был обнаружен на Арагаце 20 января 2005 года и 11 мая 2024 года (небольшой и нетипичный). Не зависит от взаимодействия магнитных полей
- ФУ - при взаимодействии облка плазмы с «замороженным» магнитным полем и геомагнитного поля возникают ловушки, препятствующие проникновению в атмосферу галактических протонов с энергией выше геомагнитной жесткости, и поток вторичных частиц, регистрируемых поверхностными детекторам, уменьшается до 20% (на Арагаце). Зависит степени возмущения геомагнитного поля и, следовательно от B.
- Магнитосферный эффект (МЭ) : южная компонента «замороженного» магнитного поля Bz позволяет солнечным протонам с энергией ниже геомагнитной жесткости жесткости войти в атмосферу и создать дополнительные вторичные частицы регистрируемым поверхностными детекторами.

Network of Neutron Monitors 50 detectors from Antarctic to Arctic




SEVAN
Space Environmental Viewing
and Analysis Network
COSMIC RAY DIVISION
A. ALIKHANYAN
National Laboratory
4 scincillators
with size
50×50×5 cm
5 scincillators
with size
50×50×5 cm
56 cm
Lead with size
100×100×5 cm


SEVAN
Space Environmental Viewing
and Analysis Network
COSMIC RAY DIVISION
A. ALIKHANYAN
National Laboratory
4 scincillators
with size
50×50×5 cm
5 scincillators
with size
50×50×5 cm


1cm
20cm

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

http://crd.yerphi.am/ADEI

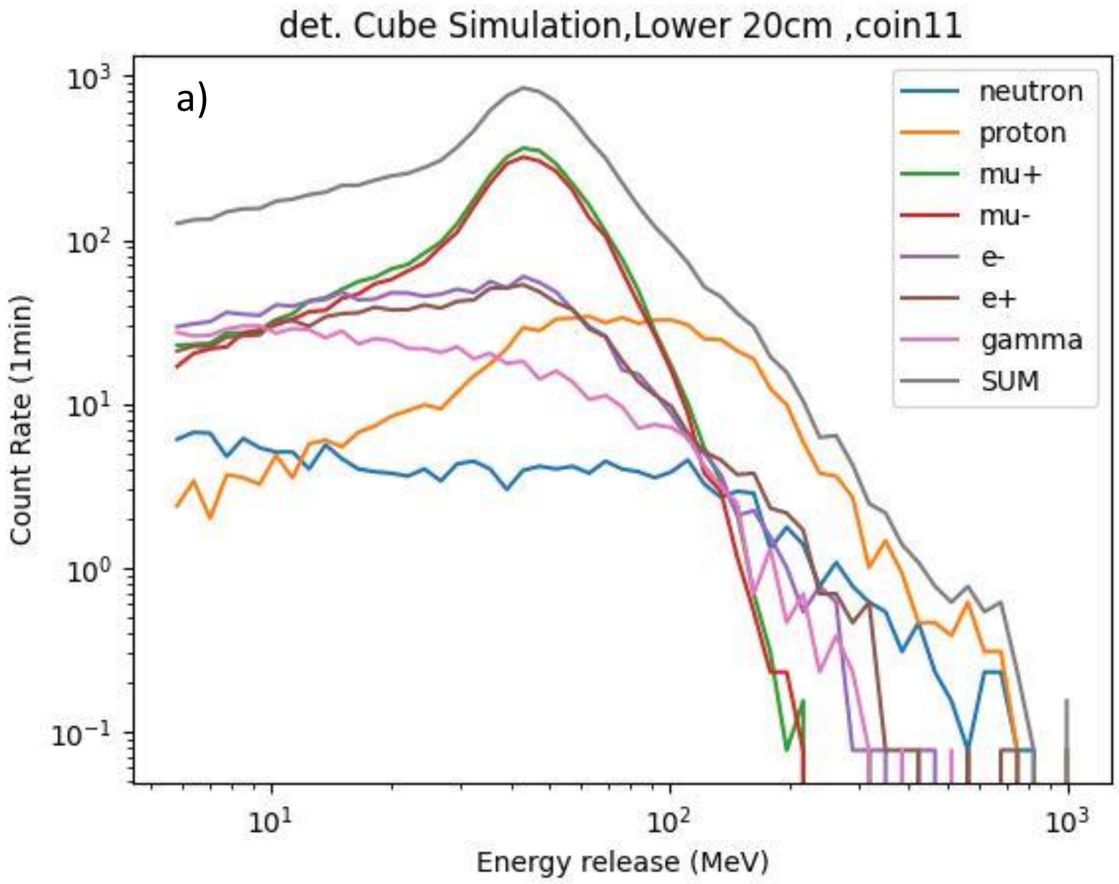
EGU 2023

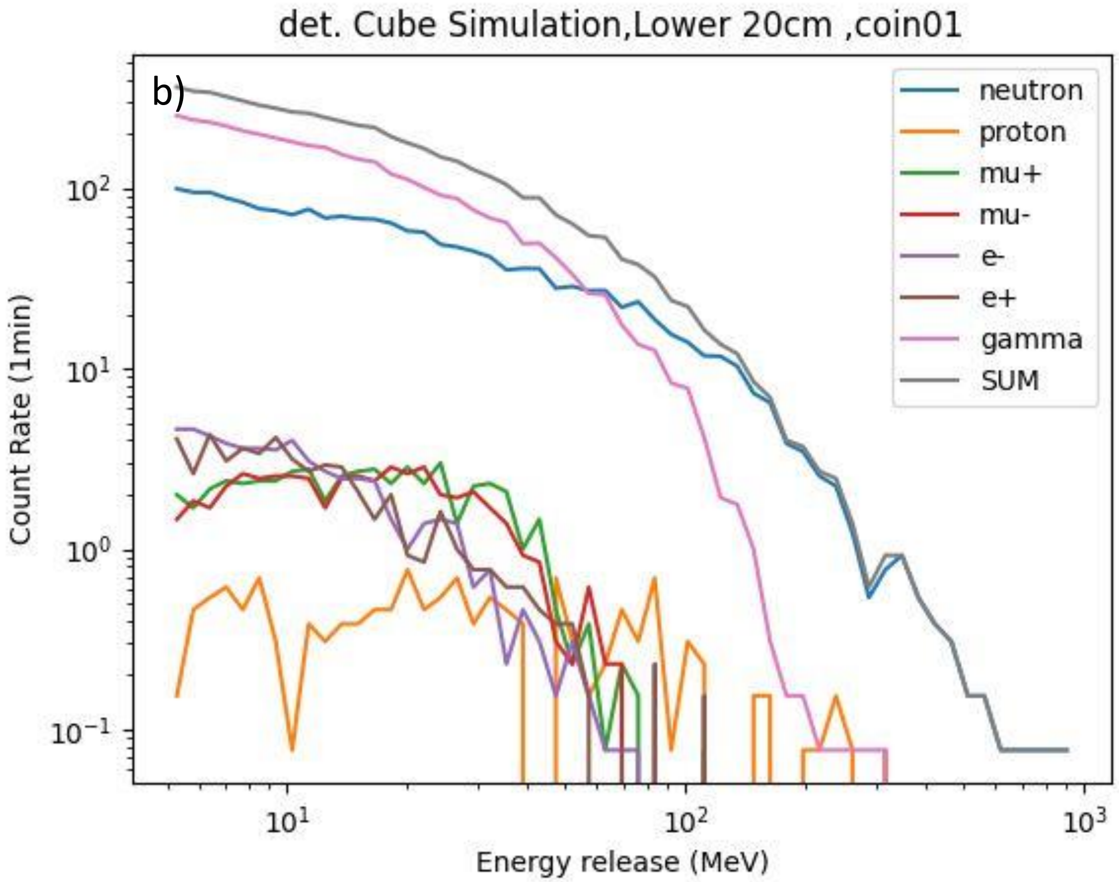
COSMIC RAY DIVISION
Alikhanyan Physics Institute,
Alikhanyan Brothers 2,
Yerevan 375036, Armenia

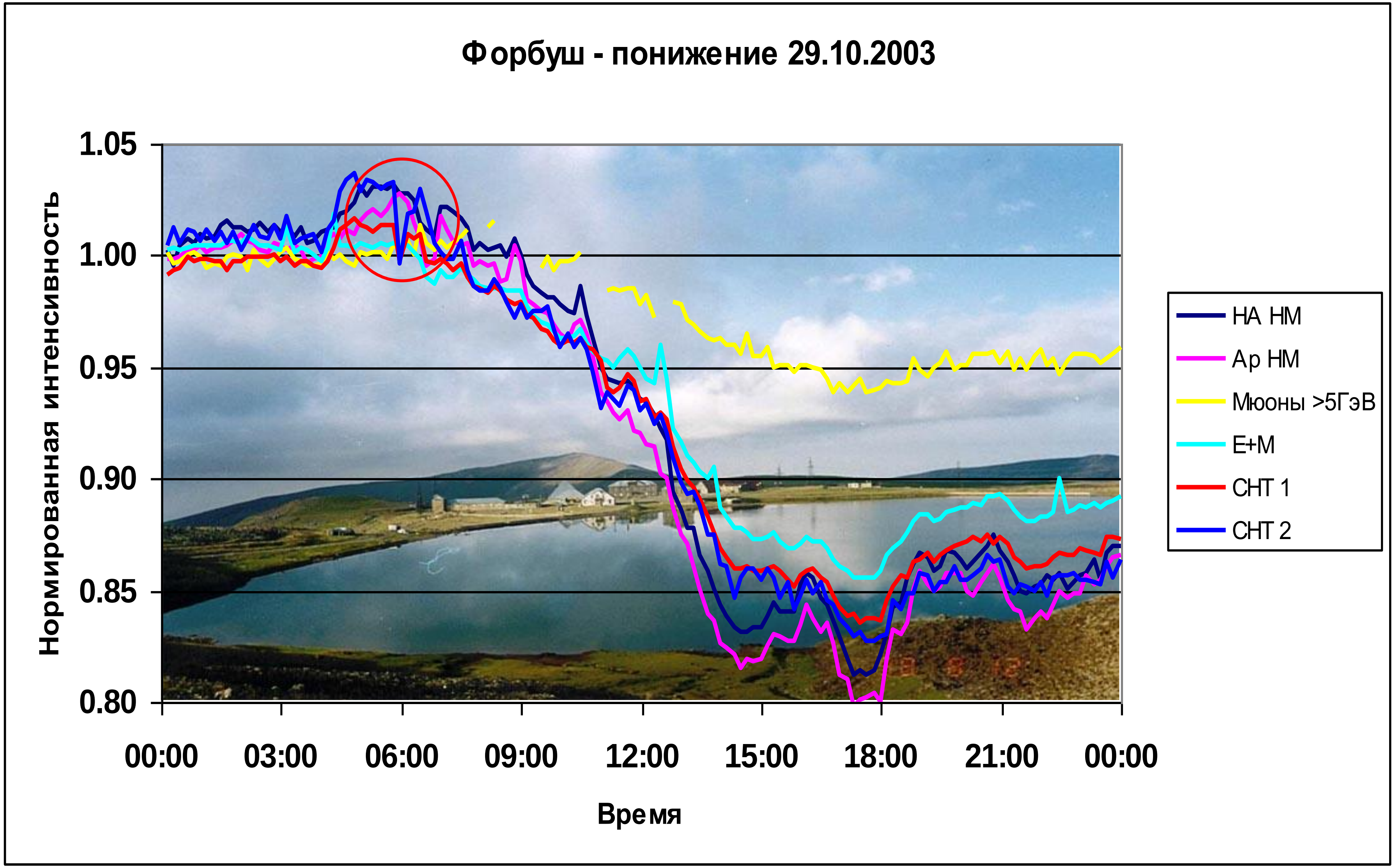
arbra Armenia Brandenburg WORKSHOP

NMDB neutron monitor database | ASEC | A1554 | INTAS 8777 | FA8655 | COSPAR

Purity of CUBE coincidences: 11 – muons, 01 neutrons and gamma rays

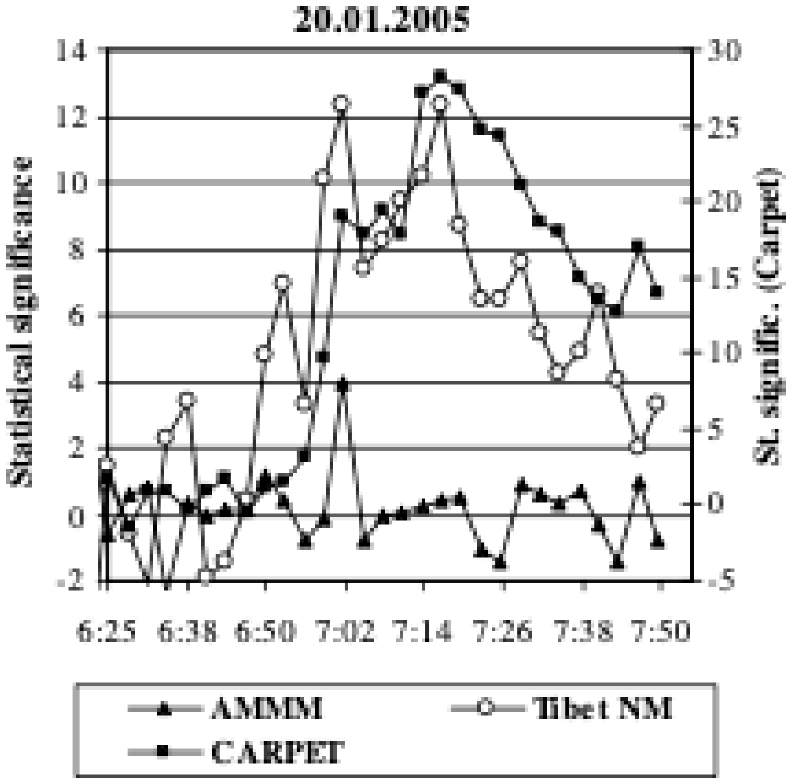






Форбуш - понижение 29.10.2003
Нормированная интенсивность
1.05
1.00
0.95
0.90
0.85
0.80
00:00
03:00
06:00
09:00
12:00
15:00
18:00
21:00
00:00
Время
НА НМ
Ар НМ
Мюоны >5ГэВ
Е+М
СНТ 1
СНТ 2

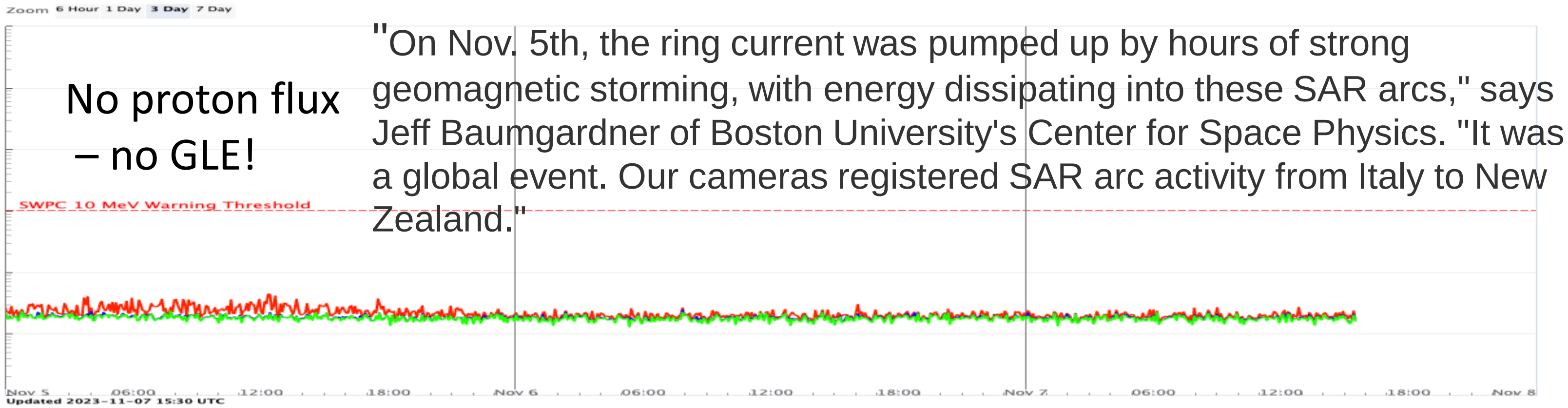
Rigidity dependence of the amplitude for the 20 January 2005 GLE. Carpet (R>6 GeV) – 28%, AMMM (R>20 GeV) – 4%)



Comparison of the time series of the particle detector sensitive to the highest energies of solar particles: CARPET (energy range >6 GeV), Tibet NM (>13 GeV) and AMMM (>20 GeV).

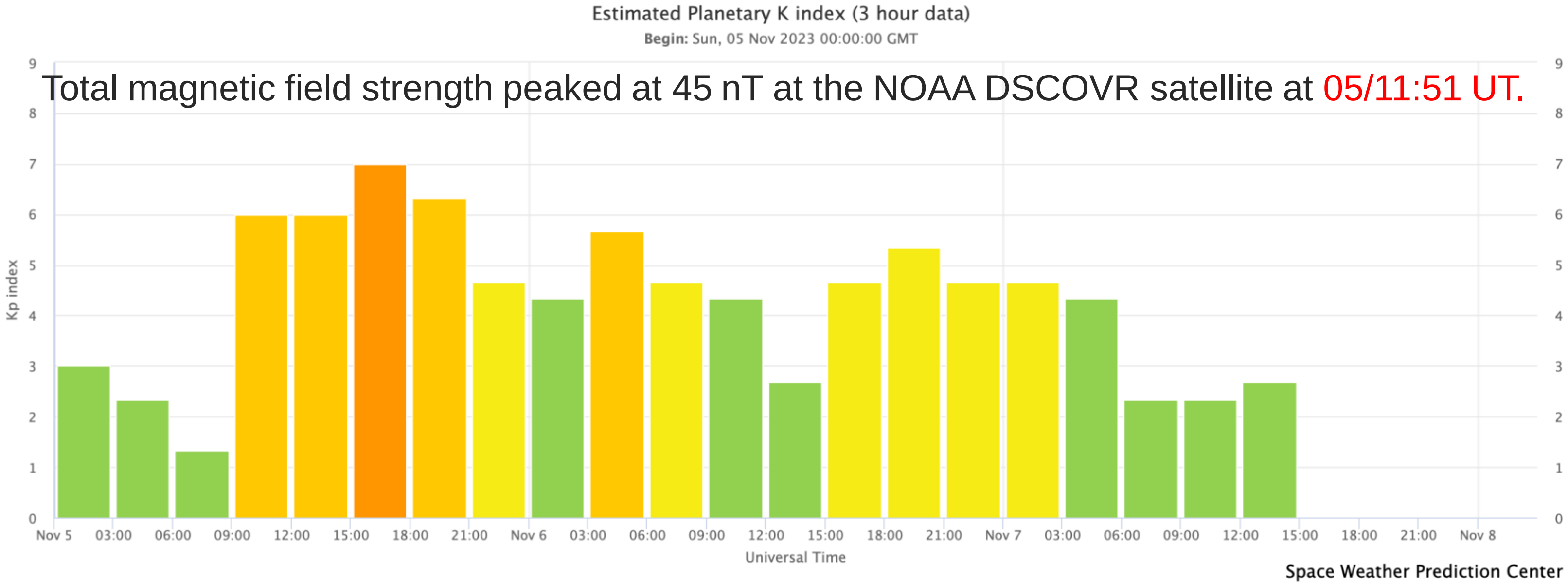
Credit: N.Kh. Bostanjyan et. al.,
On the production of the highest energy solar protons on 20 January 2005, Advances in Space Research 39 (2007) 1454–1457

The magnetospheric effect observed at 10:20 – 13:40 on 5/11, 2023



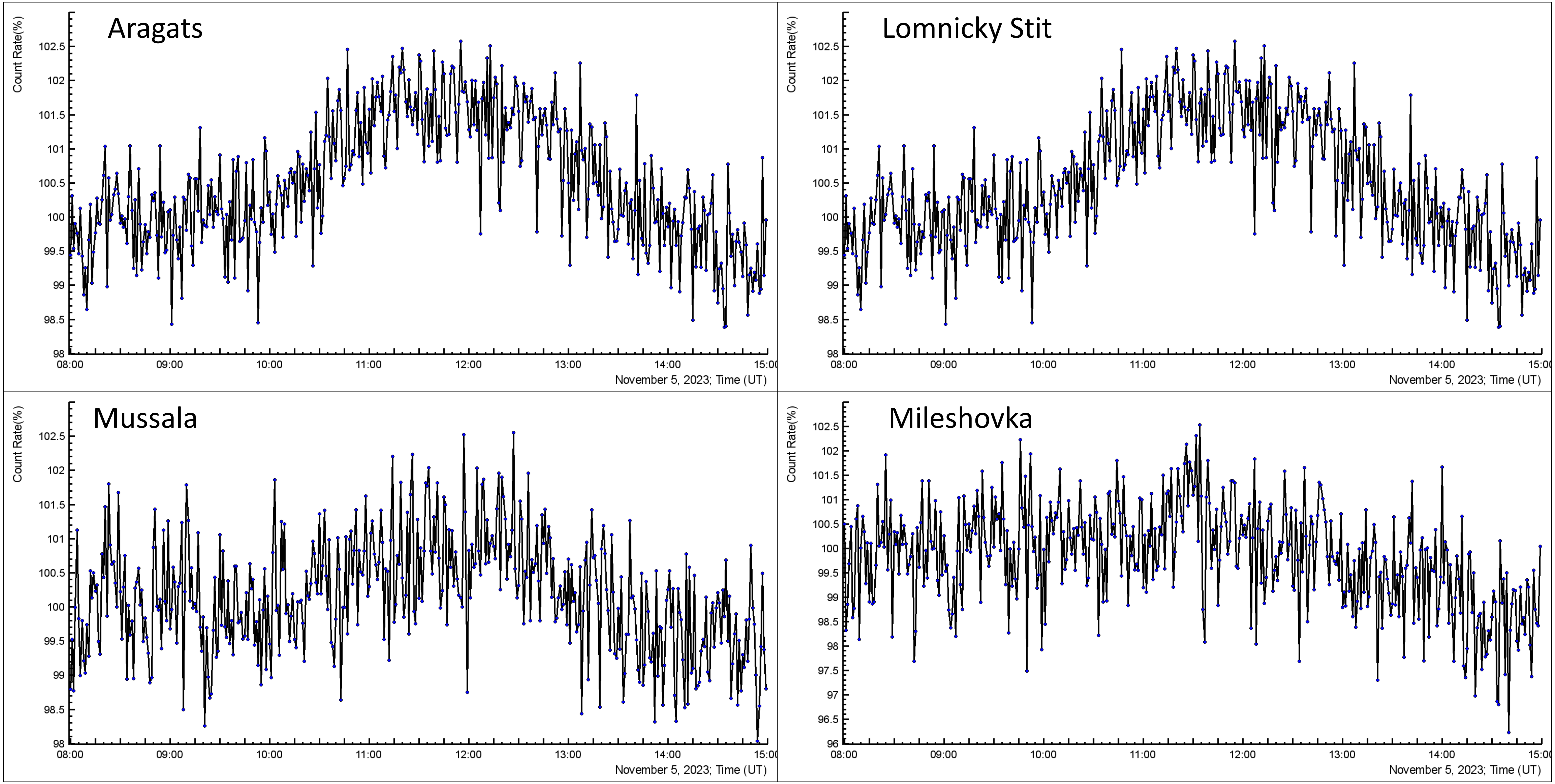
No proton flux – no GLE!

"On Nov. 5th, the ring current was pumped up by hours of strong geomagnetic storming, with energy dissipating into these SAR arcs," says Jeff Baumgardner of Boston University's Center for Space Physics. "It was a global event. Our cameras registered SAR arc activity from Italy to New Zealand."

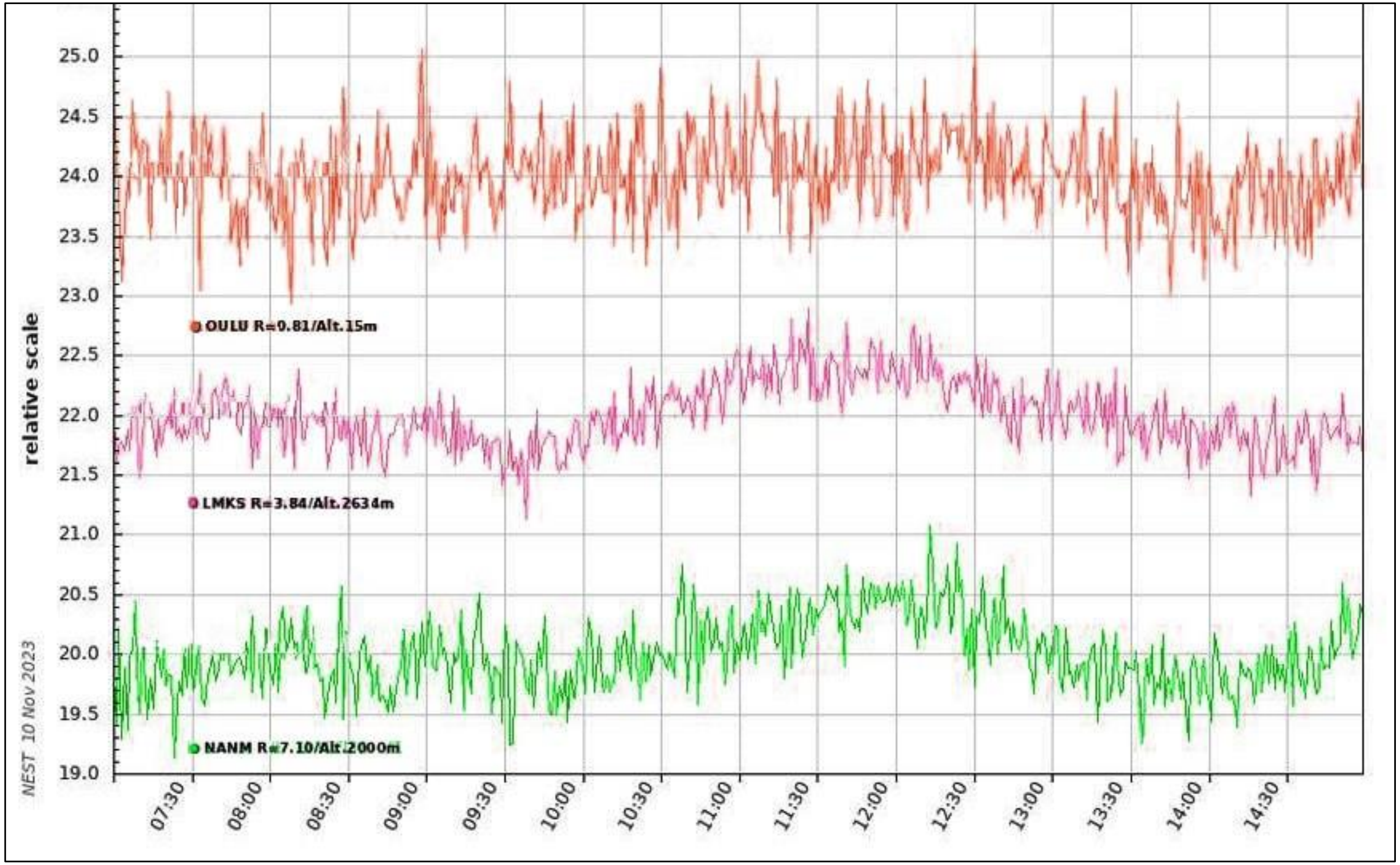


Total magnetic field strength peaked at 45 nT at the NOAA DSCOVR satellite at 05/11:51 UT.

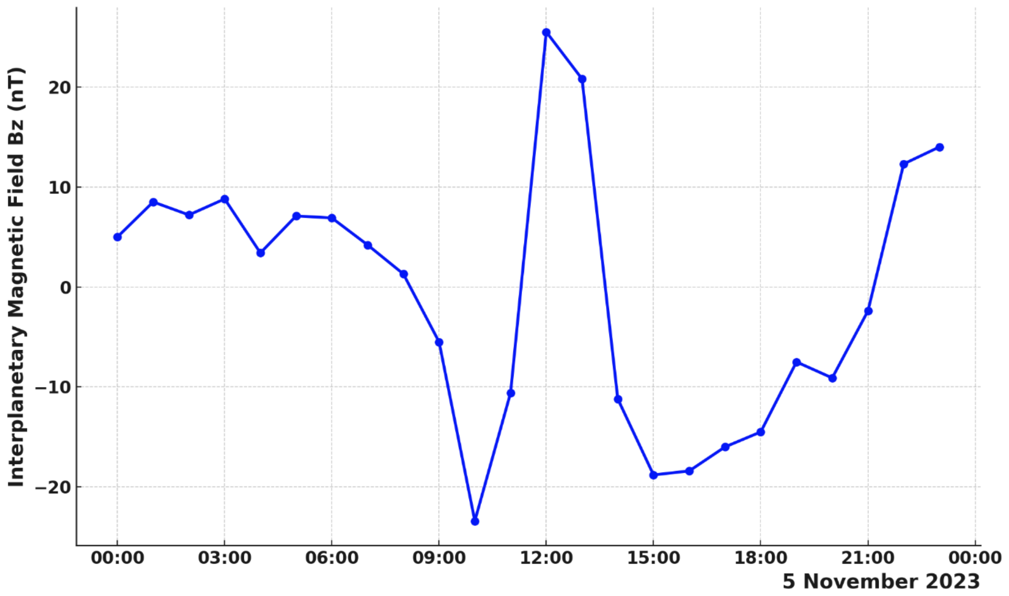
SEVAN network detection of the ME on 5/11, 2023. Upper 5 cm. thick scintillatoror

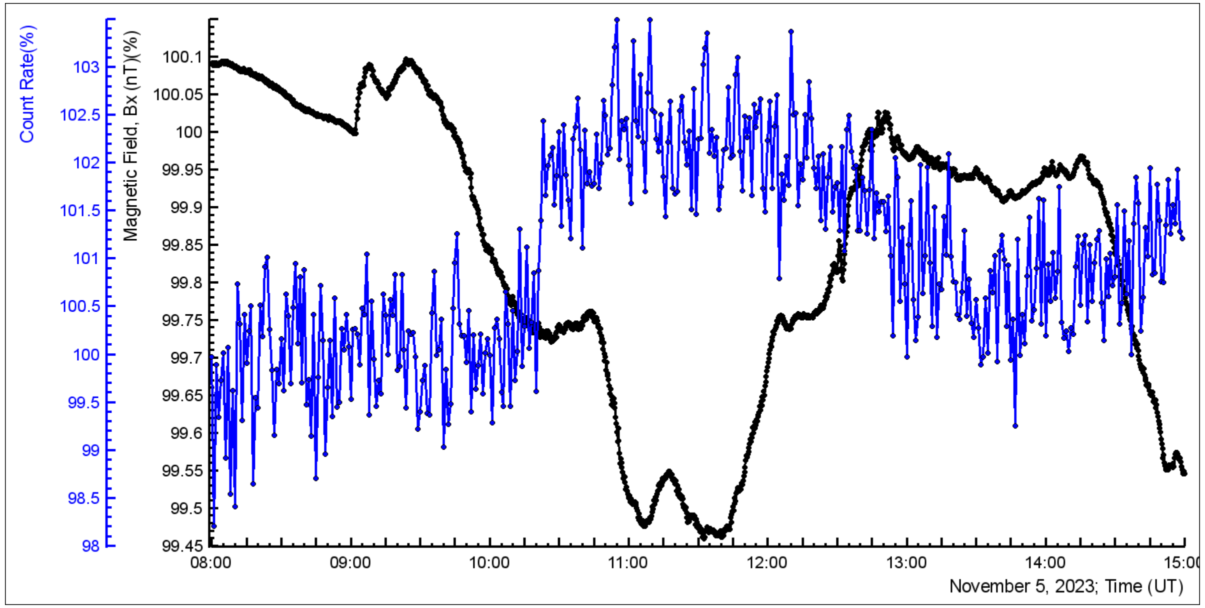


High-altitude stations show count rate enhancement, low-altitude (Ouly) – not!



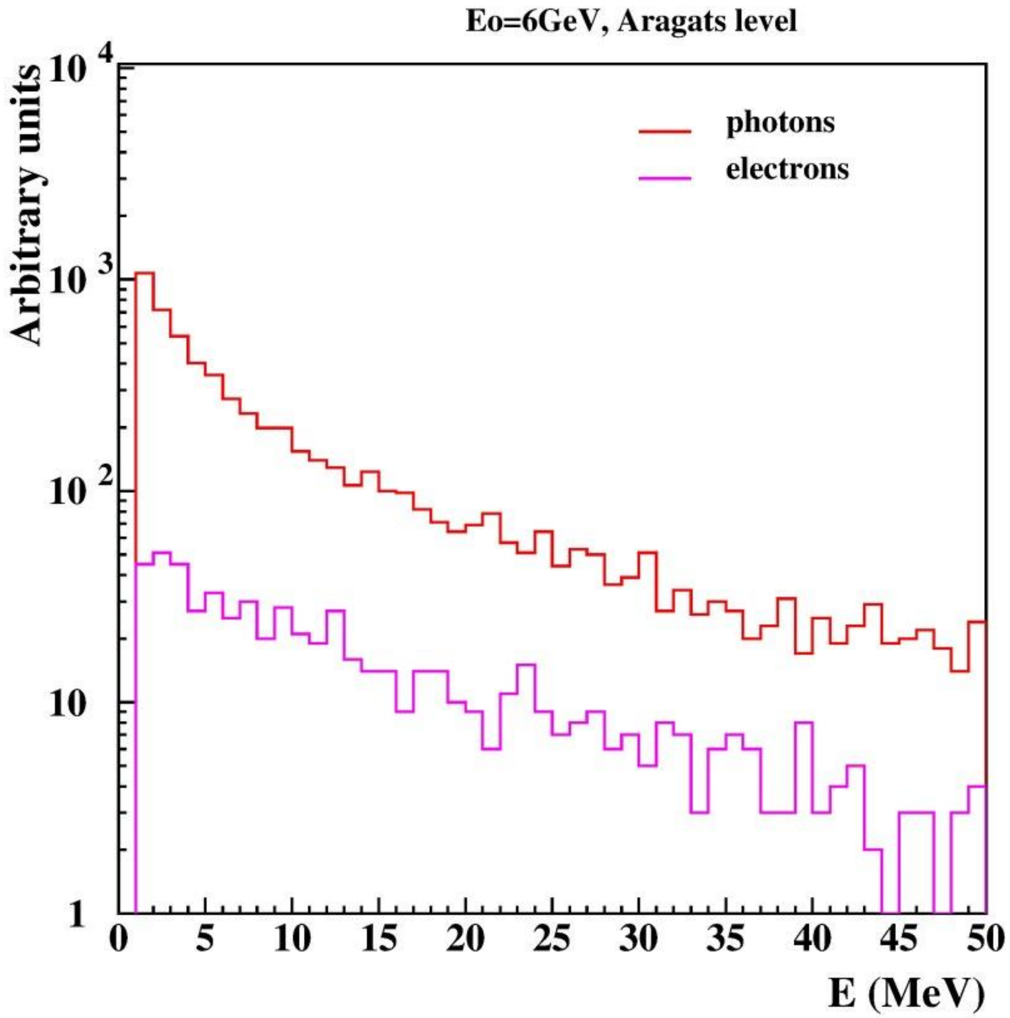
The interplanetary magnetic field peaked southward (Bz ≈ 27nT), coinciding with the reduction of the **horizontal component of Earth's magnetic field** (Bx ≈-0.5%). Thus making ideal conditions of magnetic reconnections and the entrance of solar protons with energies below cutoff rigidity into the terrestrial atmosphere (see the peak in the count rate of electron/muon detectors)

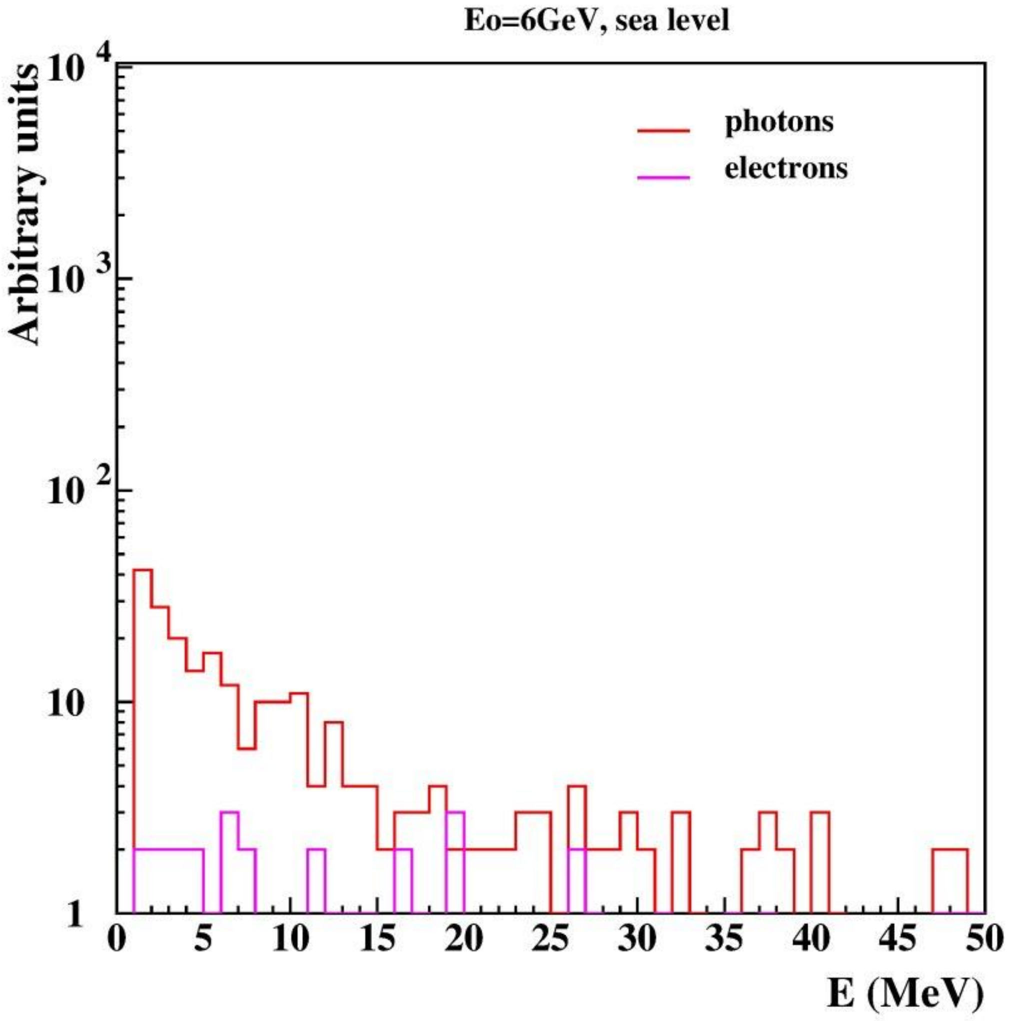




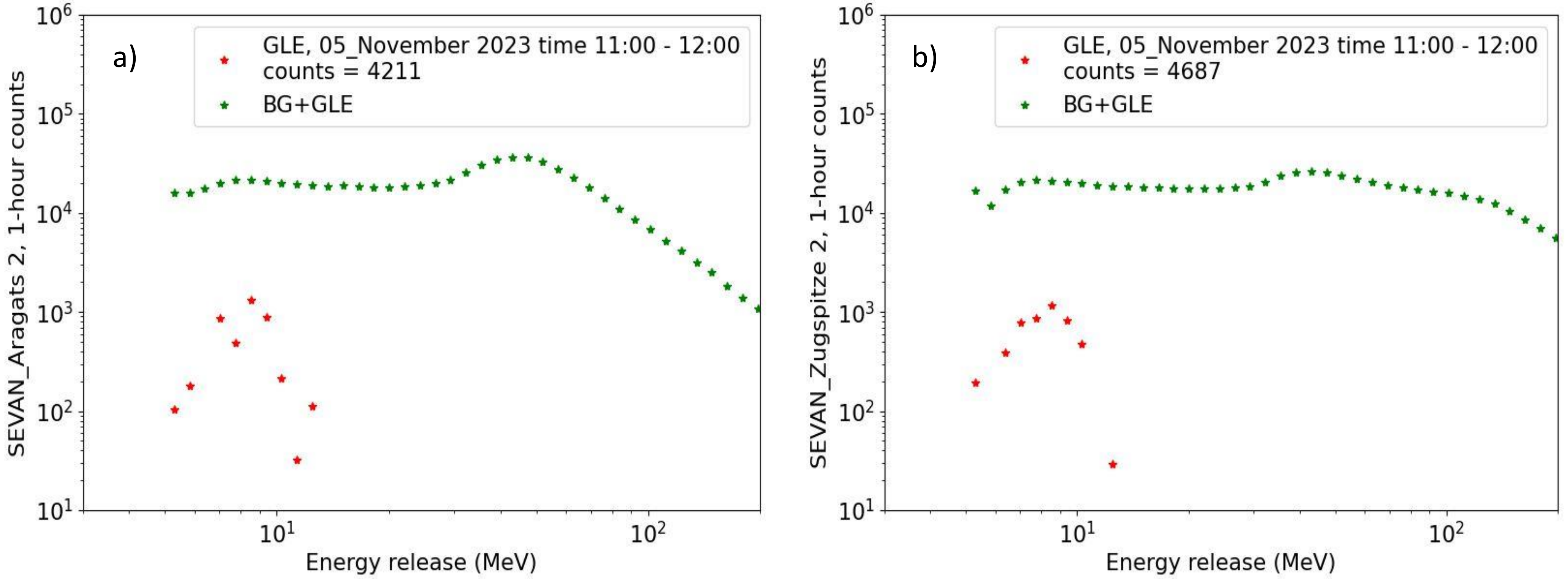
Chilingarian A., Karapetyan T., Sargsyan B., Knapp J., Walter M., Rehm T. (2024) Increas count rates of ground-based cosmic-ray detectors caused by the heliomagnetic disturban November 2023, EPL, doi 10.1209/0295-5075/ad329c.

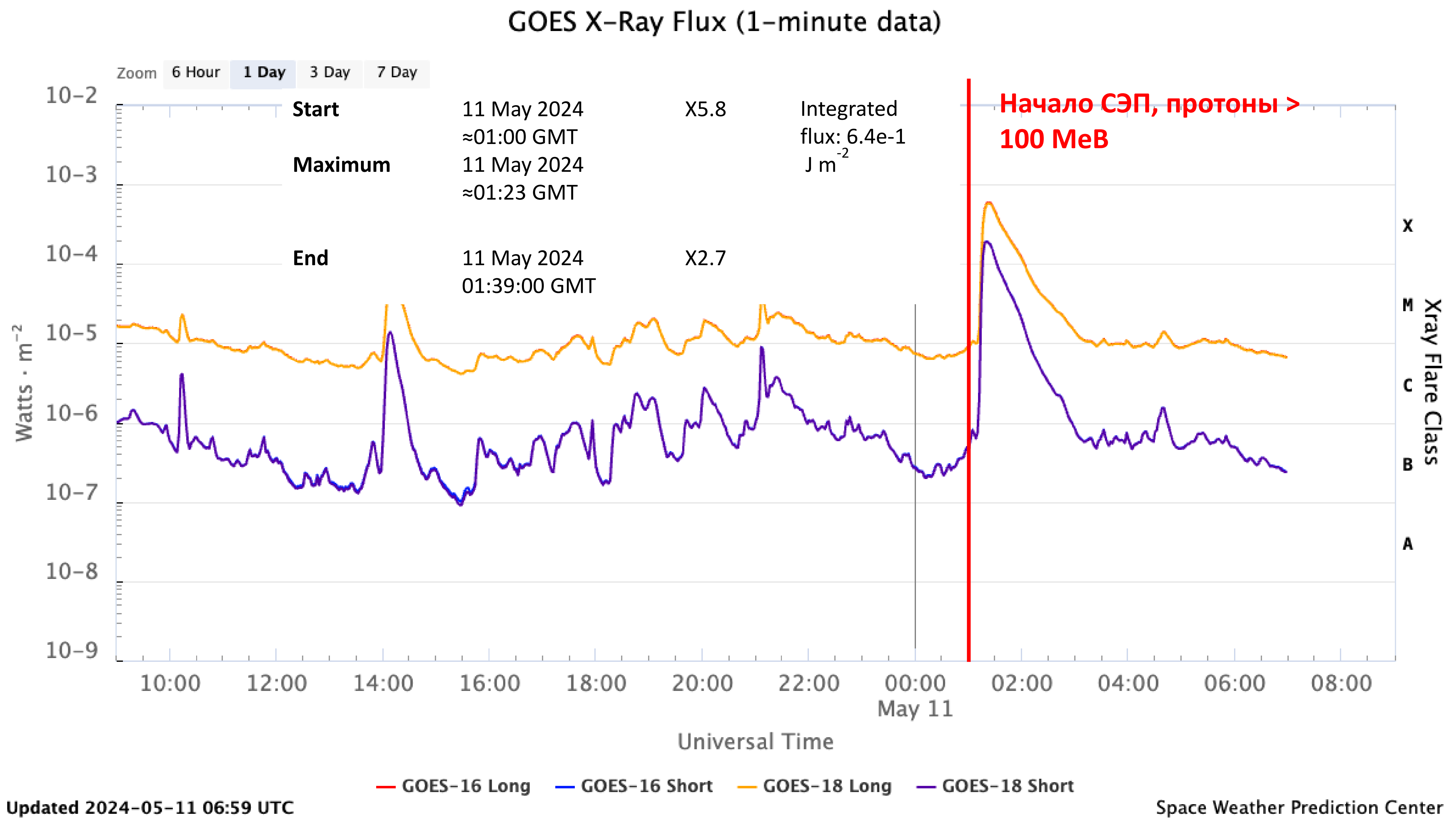
Corsika Simulations Primary particle – Proton with energy 6 GeV at Aragats and sea level

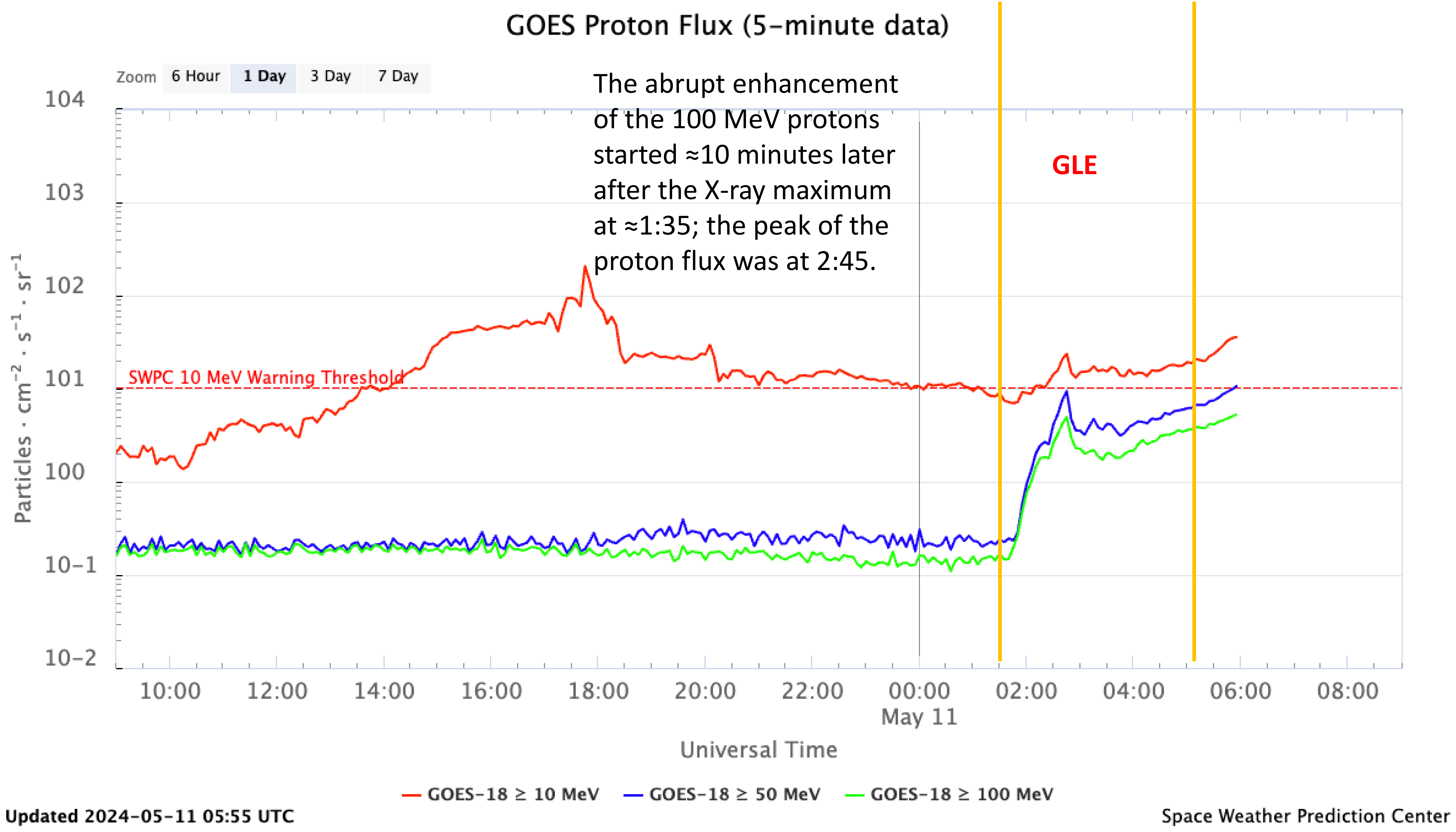




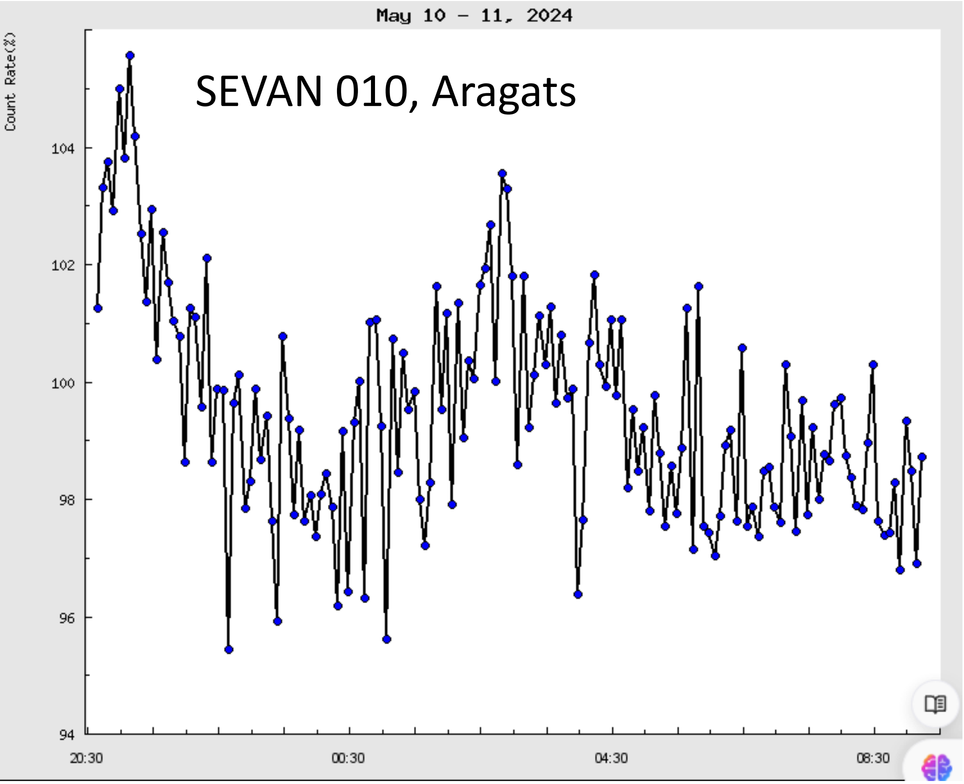
ME: Low-energy primary protons induce low-energy muons+neutrons

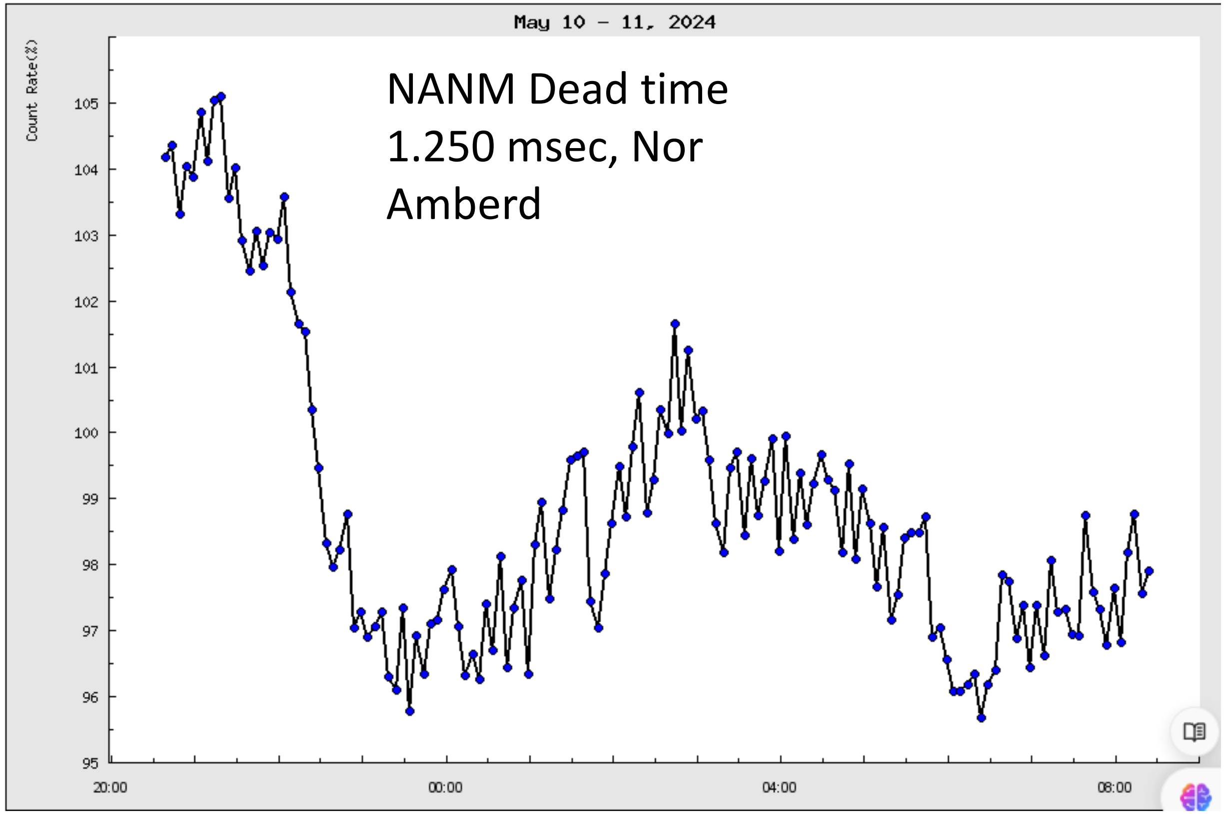


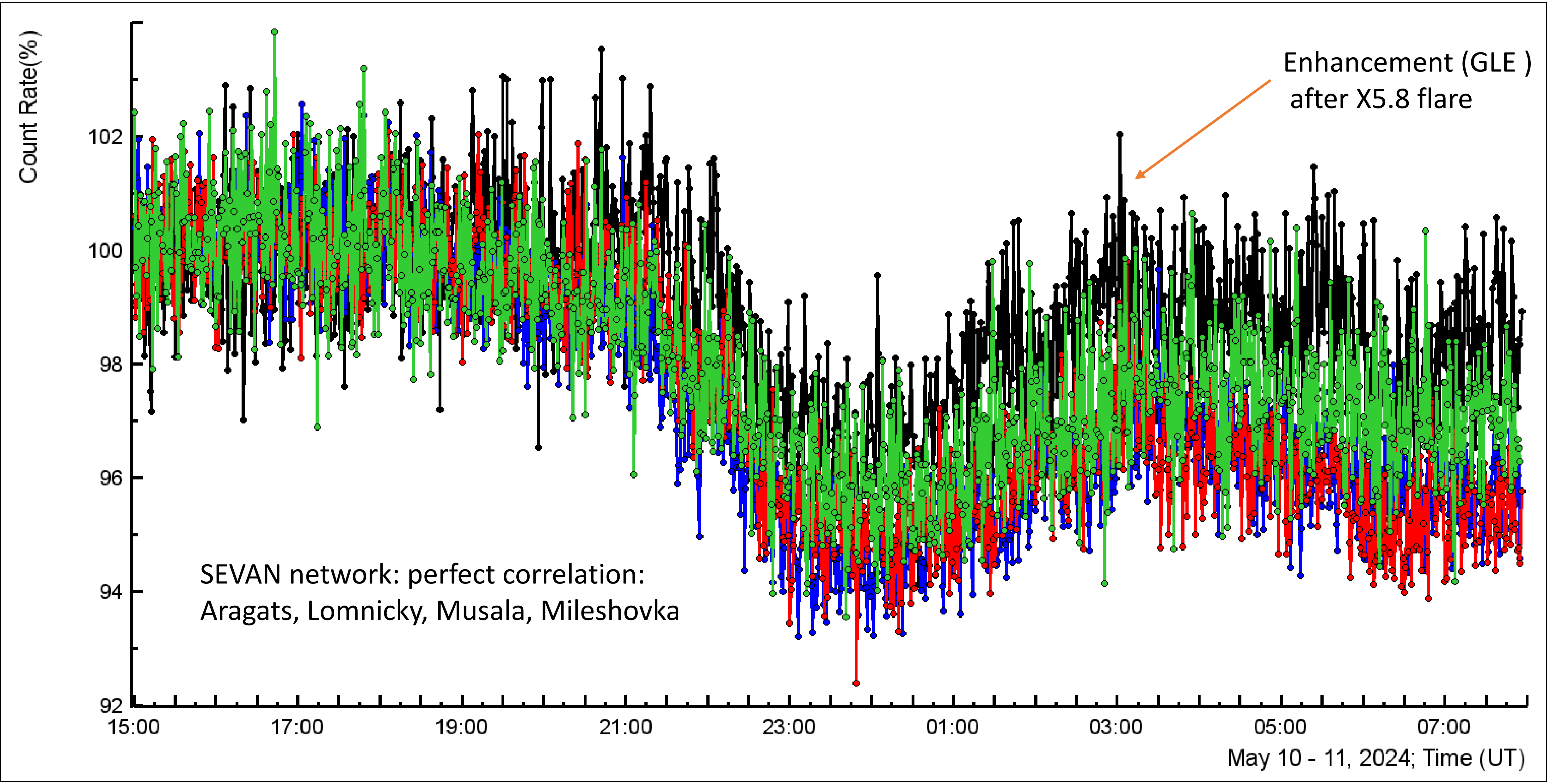

GOES X-Ray Flux (1-minute data)
Zoom 6 Hour 1 Day 3 Day 7 Day
Start 11 May 2024 ≈01:00 GMT X5.8 Integrated flux: 6.4e-1 J m-2
Maximum 11 May 2024 ≈01:23 GMT
End 11 May 2024 01:39:00 GMT X2.7
Начало СЭП, протоны > 100 МеВ
Watts · m-2
10-2
10-3
10-4
10-5
10-6
10-7
10-8
10-9
X
M
C
B
A
Xray Flare Class
10:00 12:00 14:00 16:00 18:00 20:00 22:00 00:00 May 11 02:00 04:00 06:00 08:00
Universal Time
GOES-16 Long GOES-16 Short GOES-18 Long GOES-18 Short
Updated 2024-05-11 06:59 UTC
Space Weather Prediction Center

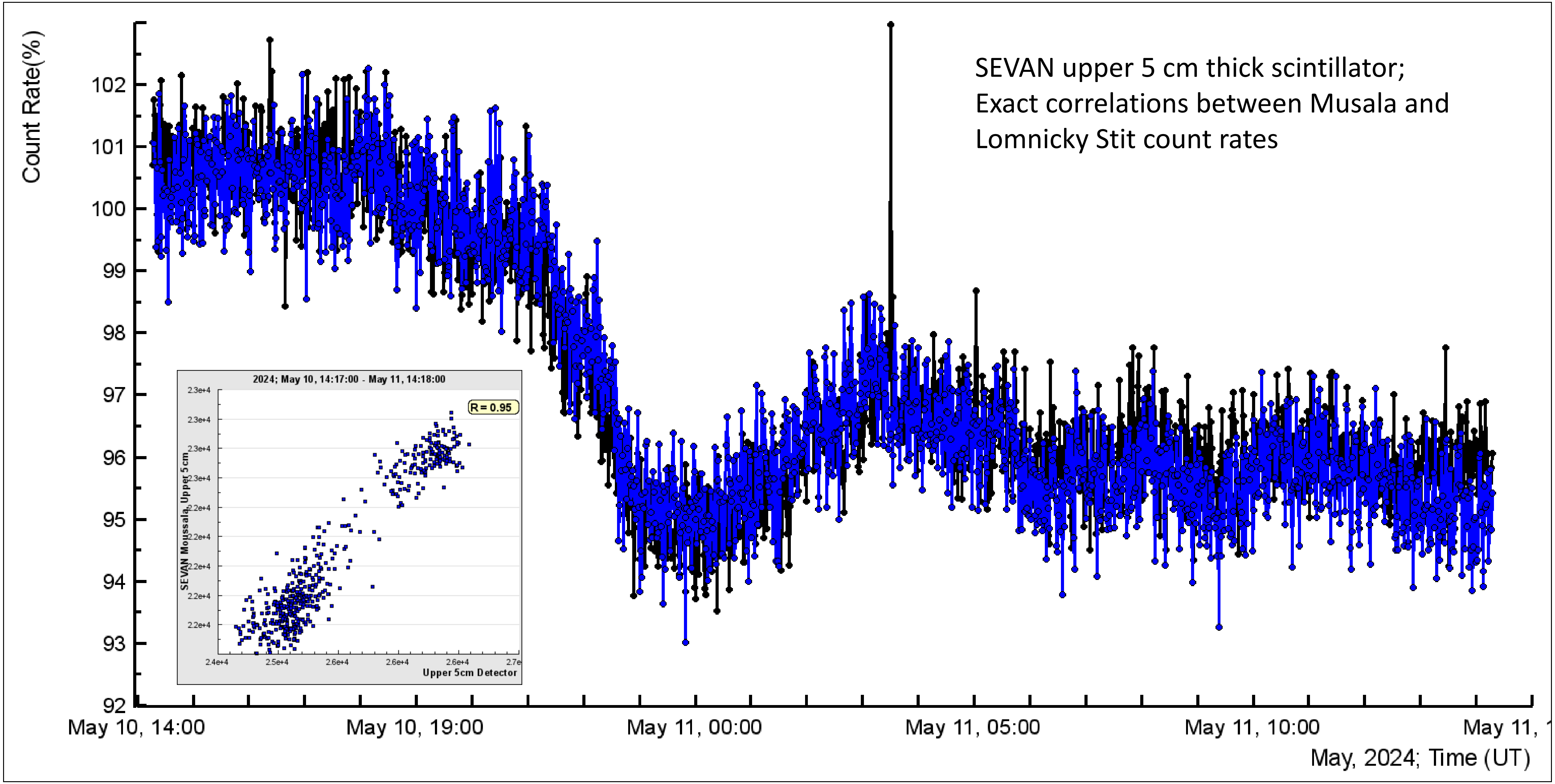

GOES Proton Flux (5-minute data)
Zoom 6 Hour 1 Day 3 Day 7 Day
The abrupt enhancement of the 100 MeV protons started ≈10 minutes later after the X-ray maximum at ≈1:35; the peak of the proton flux was at 2:45.
GLE
SWPC 10 MeV Warning Threshold
10^4
10^3
10^2
10^1
10^0
10^{-1}
10^{-2}
Particles · cm^{-2} · s^{-1} · sr^{-1}
10:00
12:00
14:00
16:00
18:00
20:00
22:00
00:00
May 11
02:00
04:00
06:00
08:00
Universal Time
GOES-18 ≥ 10 MeV
GOES-18 ≥ 50 MeV
GOES-18 ≥ 100 MeV
Updated 2024-05-11 05:55 UTC
Space Weather Prediction Center

SEVAN 010: five-minute time-series

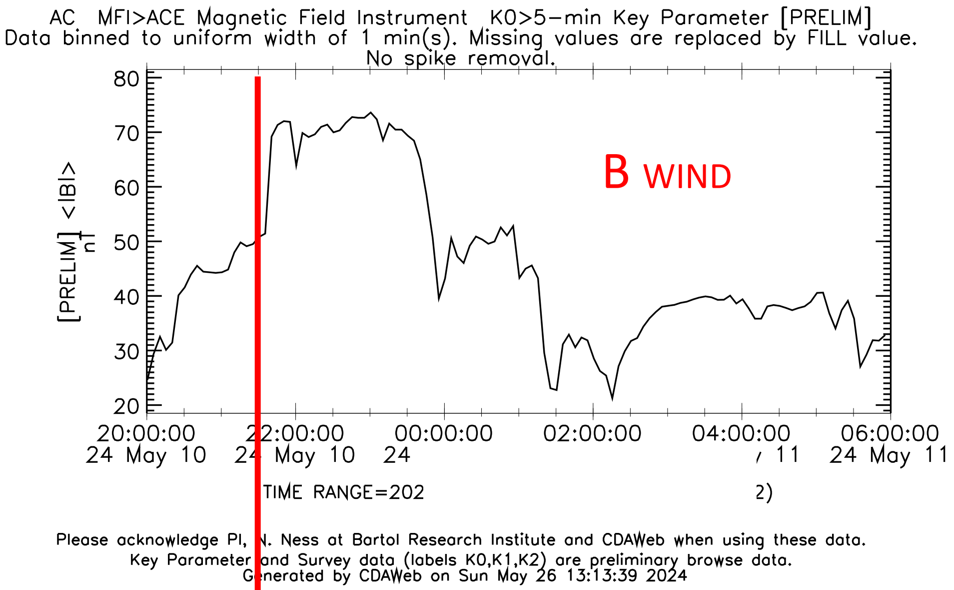


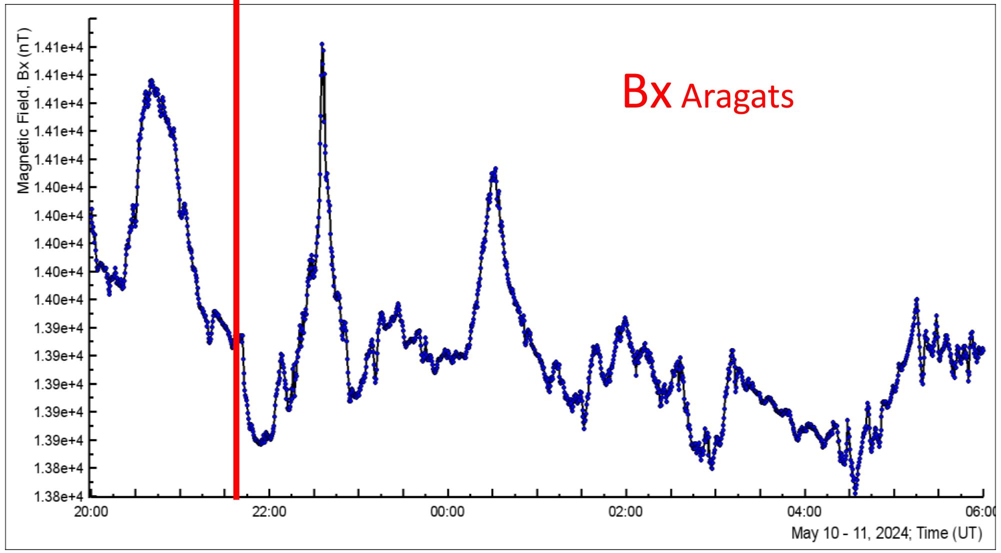



Count Rate(%)
102
100
98
96
94
92
15:00
17:00
19:00
21:00
23:00
01:00
03:00
05:00
07:00
May 10 - 11, 2024; Time (UT)
Enhancement (GLE)
after X5.8 flare
SEVAN network: perfect correlation:
Aragats, Lomnicky, Musala, Mileshovka

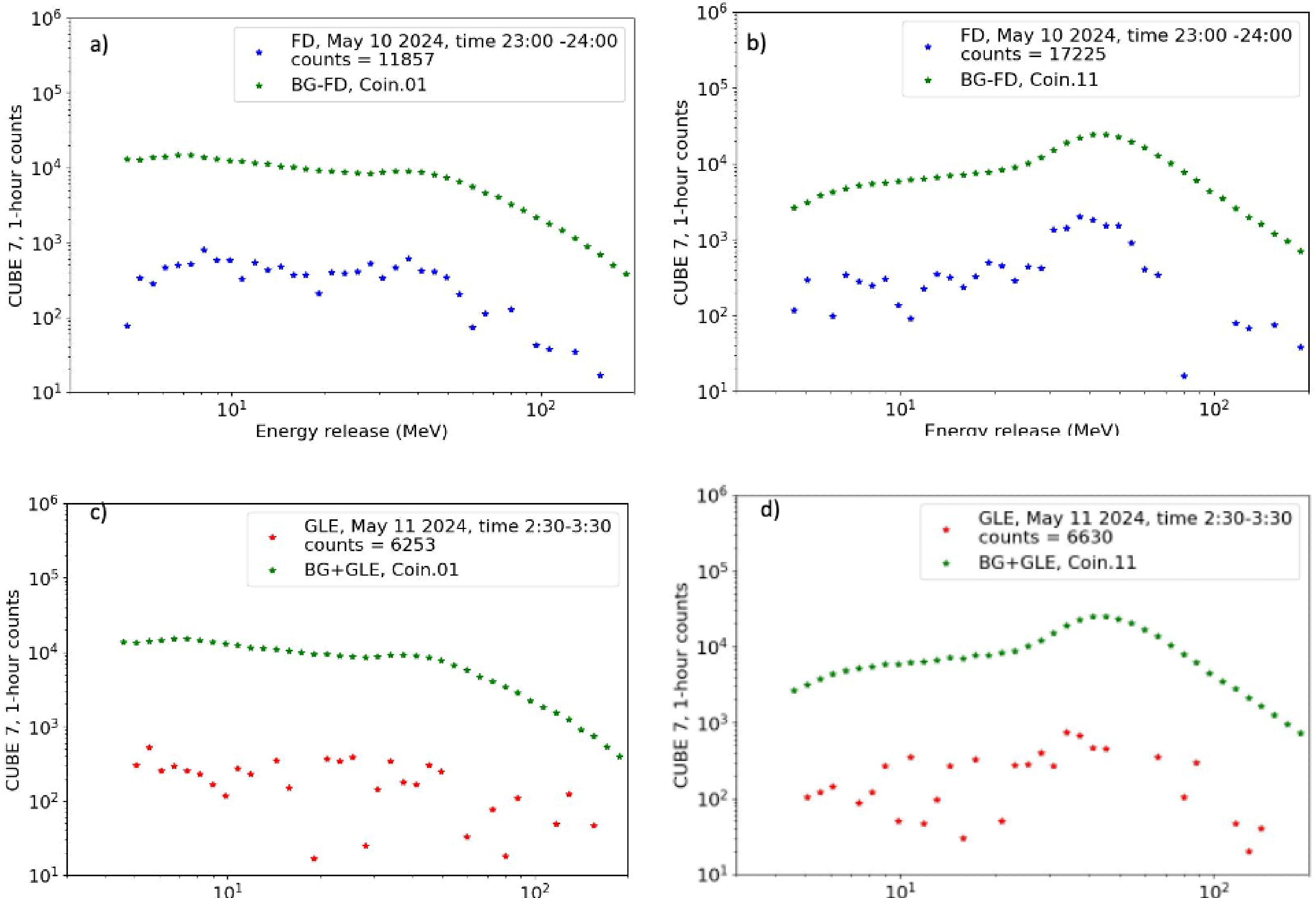

SEVAN upper 5 cm thick scintillator;
Exact correlations between Musala and
Lomnicky Stit count rates
Count Rate(%)
102
101
100
99
98
97
96
95
94
93
92
May 10, 14:00
May 10, 19:00
May 11, 00:00
May 11, 05:00
May 11, 10:00
May, 2024; Time (UT)
2024; May 10, 14:17:00 - May 11, 14:18:00
R = 0.95
SEVAN Moussala, Upper 5cm
Upper 5cm Detector
2.3e+4
2.2e+4
2.4e+4
2.5e+4
2.6e+4

ФУ началось при усилении B и ослаблении Bx





Energy release spectra measured by SEVAN light detector



Приближаясь к максимуму 25-го цикла солнечной активности: что могут дать сети детекторов частиц.

- GLE эффективно регистрируется в потоке мюонов и нейтронов Восточно Европейской сетью СЕВАН
- Взаимодействие "замороженного" магнитного поля с геомагнитным полем способствует проникновению частиц солнечного ветра в магнитосферу. Потоки частиц, регистрируемые наземными детекторами, усиливаются за счет уменьшения геомагнитной жесткости отсечки (магнитосферный эффект, МЭ). Выражен на средних широтах и больших высотах. Bz-компонента отрицательна.
- Ориентация Bz-компоненты менее важна для Форбуш-уменьшения (ФУ); преобладает преобладает влияние скалярного магнитного поля (B), причем Bz-компонента, направленная на север, также может вызвать значительное ФУ.
- Данные, полученные с помощью магнитометра WIND и спектрометров Aragats, подчеркивают прямую связь между магнитными конфигурациями ICME и вариациями потоков частиц на земле.
- Энергетические спектры дополнительных частиц во время МЭ ограничены 10 МэВ из-за низкой энергии солнечных протонов, генерирующих вторичные частицы в земной атмосфере. Напротив, энергетические спектры "недостающих" частиц FD могут простираться до 100 МэВ, демонстрируя, что магнитные ловушки, образующиеся при взаимодействии магнитных полей, могут отклонять и высокоэнергетические солнечные протоны.

Ever first Aurora Boreal in Armenia 10/11 May 2024