

GASTRON

Gamma Spectrometry of Thunderstorm Radiation
Observatory Network

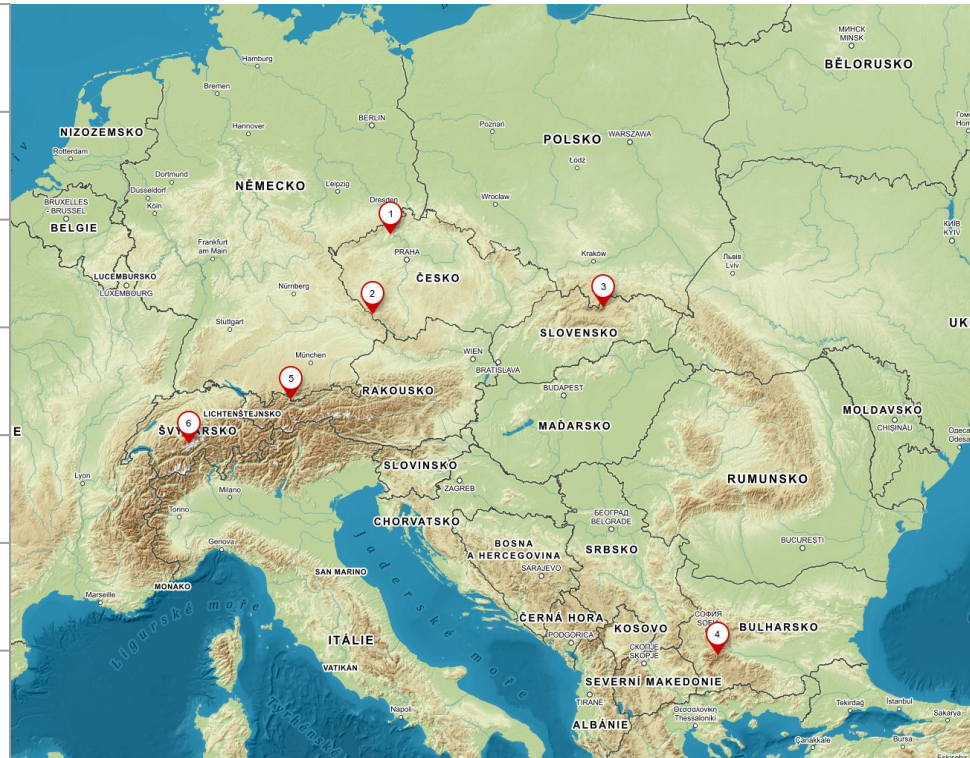
Long-term burst events at high mountain
observatories Lomnický štít and Milešovka

Jakub Šlegl, CRREAT

GASTRON

Gamma Spectrometry of Thunderstorm Radiation Observatory Network

Milešovka	CZ	837 m	RT-56
Poledník	CZ	1,315 m	RT-56
Lomnický štít	SK	2,634 m	RT-56
Musala	BG	2,925 m	GROWTH
Zugspitze	DE	2,962 m	GROWTH
Jungfrauoch	CH	3,454 m	GROWTH
Säntis (planned)	CH	2,502 m	RT-56



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Alexander von Humboldt claimed the view to be the third nicest view in the world.

TGE - Thunderstorm Ground Enhancement

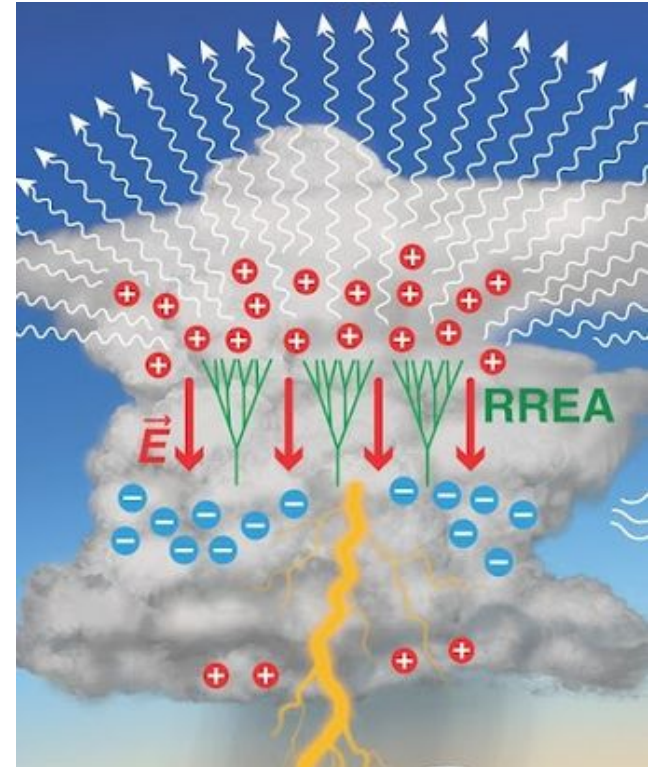
TGE - enhancement of ionizing radiation measured on ground during thunderstorm.
Duration: tens of seconds up to a lower tens of minutes.
Sometimes stopped by discharge.
Energies up to tens of MeV.

- photons
- electrons
- positrons
- neutrons
- decrease of muons

Complicating phenomenon - radon progeny washout.

TGF - Terrestrial gamma ray flash

Short time - up to a millisecond, possibly related to lightning discharge, Energy up to tens of MeV



Zugspitze

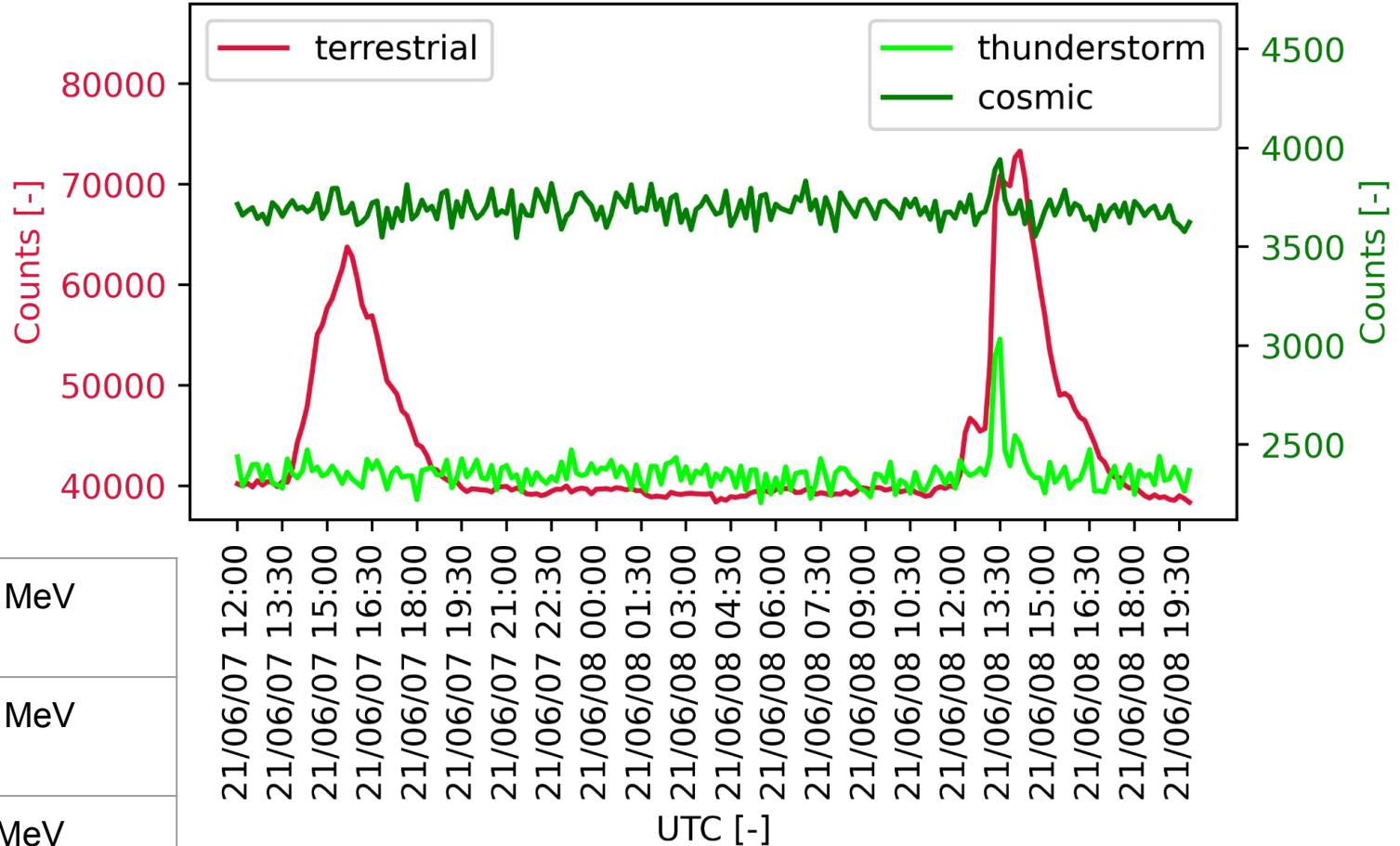
June 2021

GROWTH

NaI(Tl)

3" x 5"

Pulse height - 10min integration time

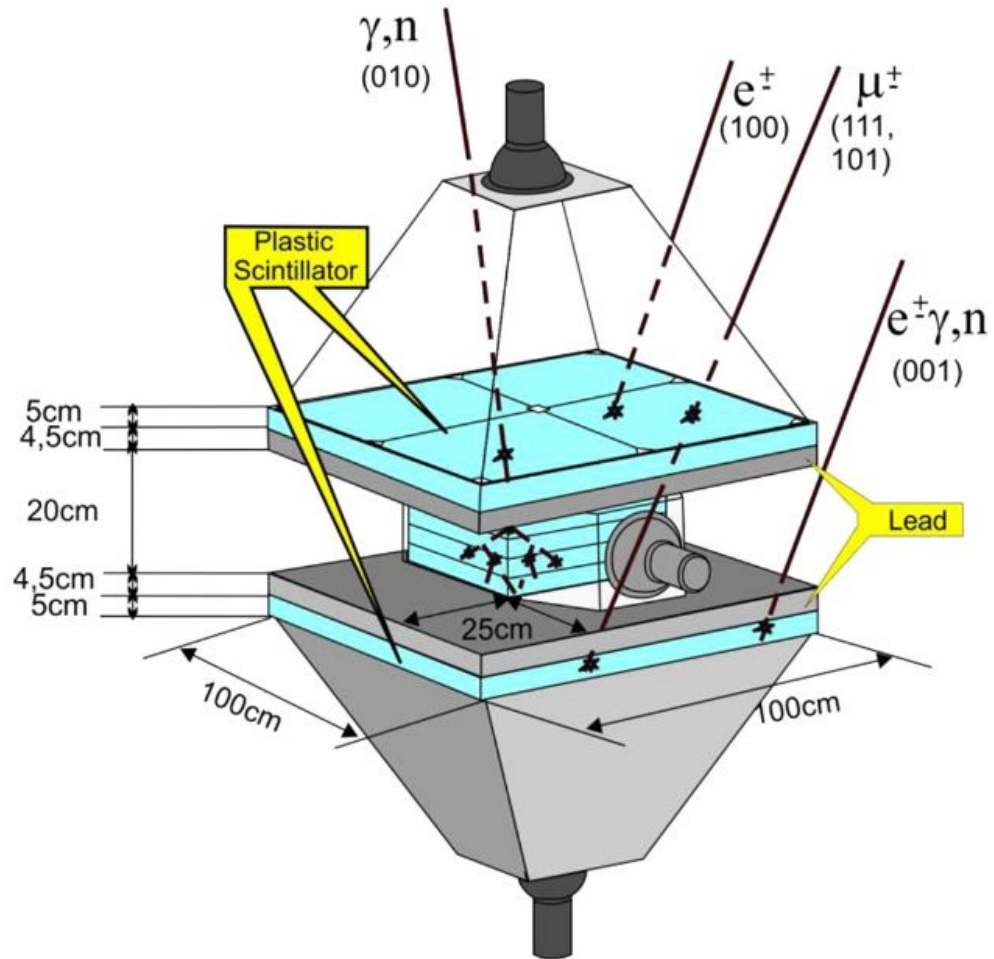
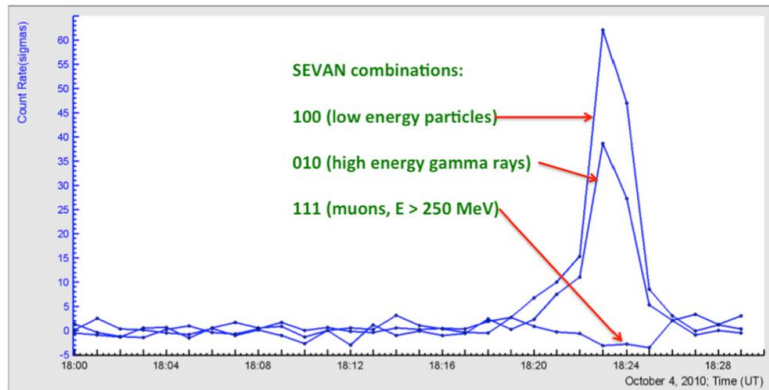


terrestrial	0-3 MeV
thunderstorm	3-9 MeV
cosmic	>9 MeV

SEVAN



Příklad naměřeného TGE zařízením SEVAN - Musala



RT-56 gamma spectrometer

Georadis s.r.o.



1024 channels of **primary spectrum**

256 channels of **secondary spectrum**

- either around 511 keV or cosmic mode

GPS timestamping of every event

batteries for one day operation

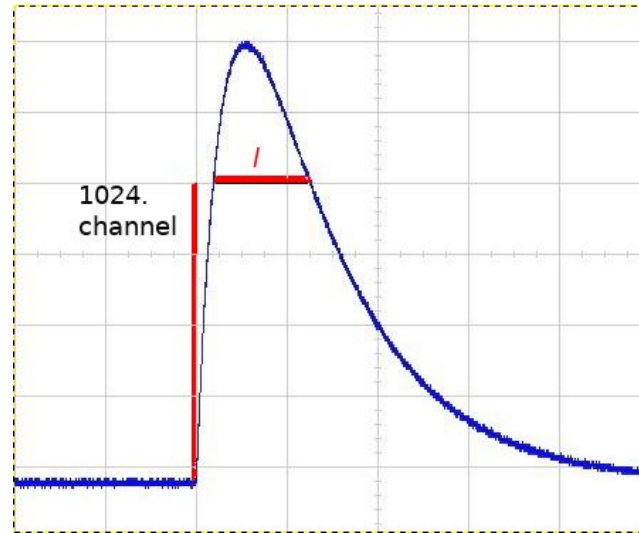
calibration from natural isotopes

1x BGO 3" x 3"

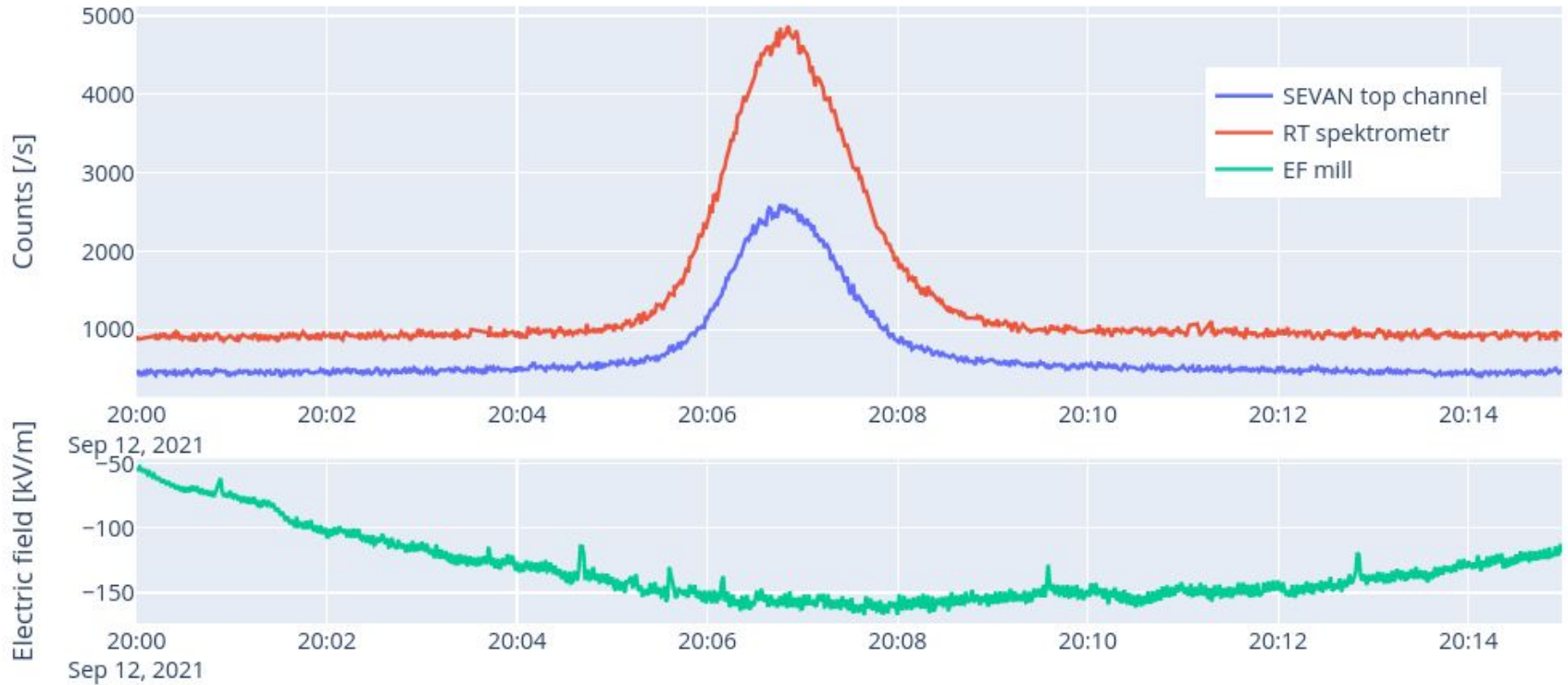
2x NaI(Tl) 3" x 3"

2x NaI(Tl) 3" x 5"

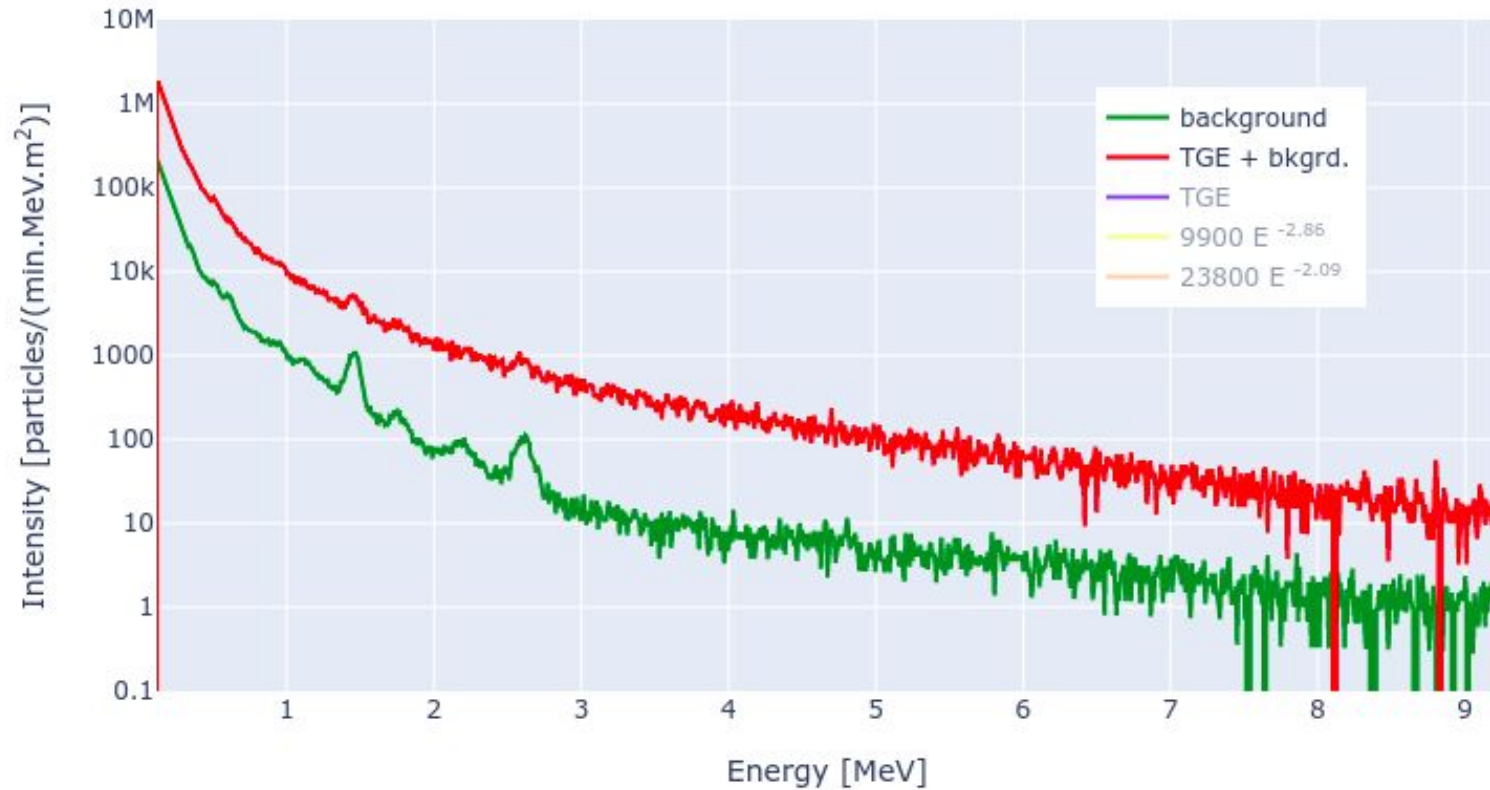
1x NaI(Tl) 4" x 4" x 16"



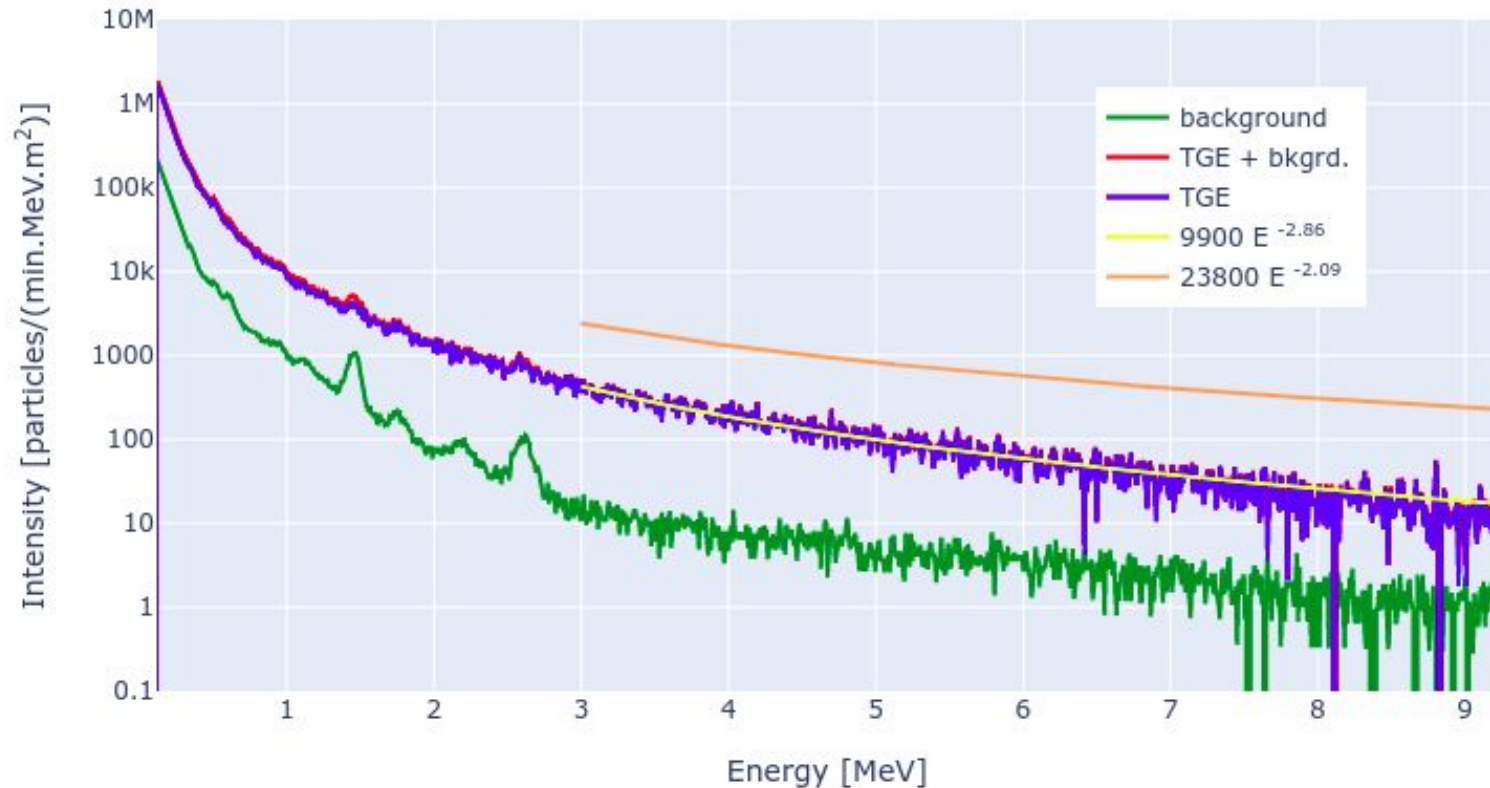
TGE - 2021-08-12 - 1 second data



RT-56 TGE spectrum - measured



RT-56 TGE - estimation of spectrum irradiating the detector



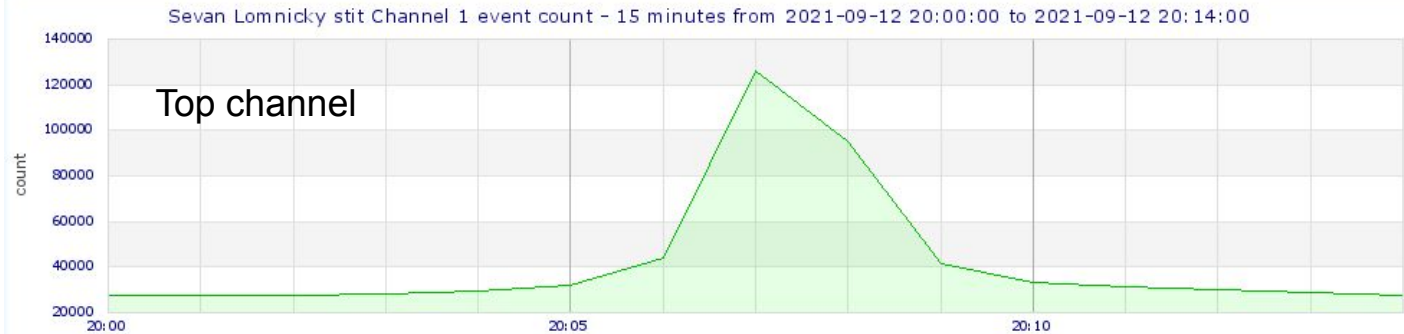
$$\text{Intensity}(\text{Energy}) = 23800 \cdot \text{Energy}^{-2.09} \text{ [particles/(min.MeV.m}^2\text{)]}$$

SEVAN

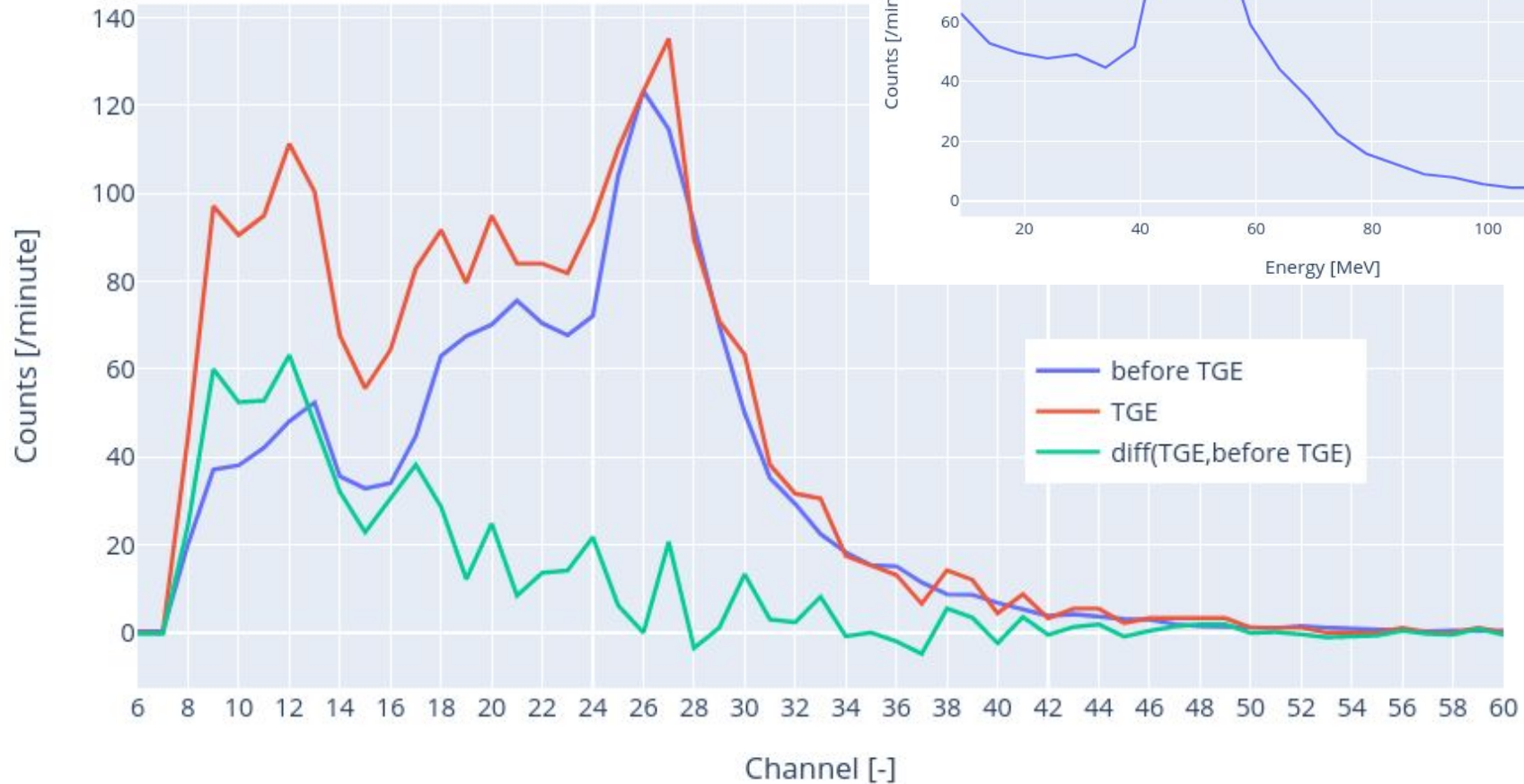
1 minute data

Coincidence without any significant peaks

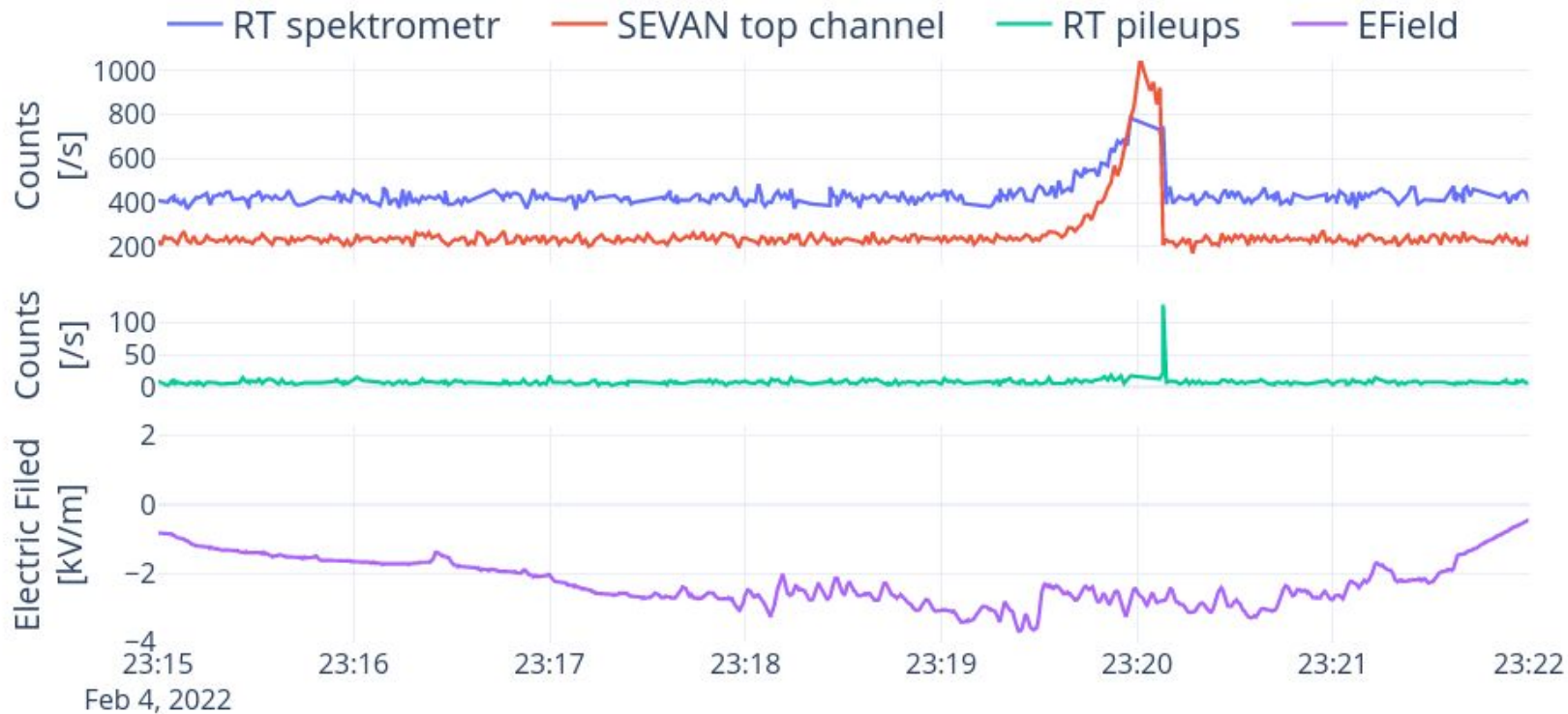
channel	Measured rise [/min]
H	99300
P	2300
D	650



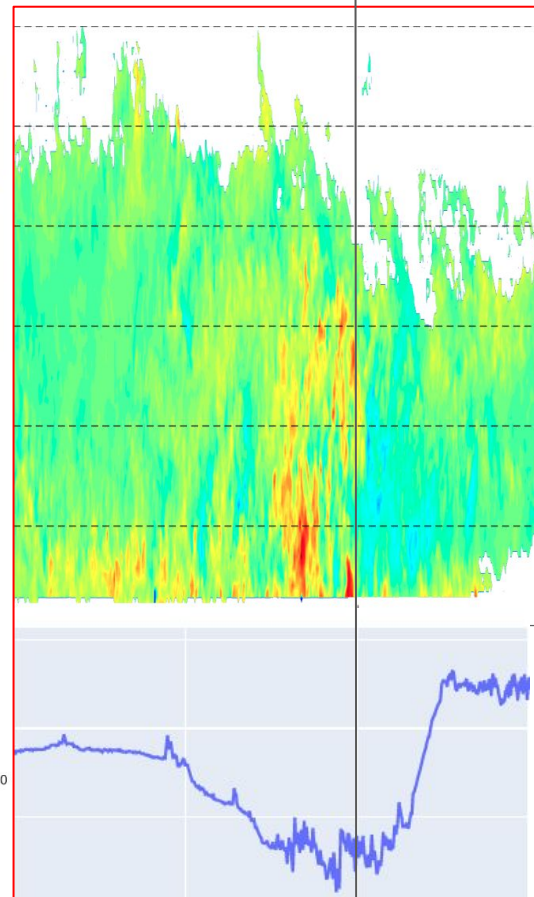
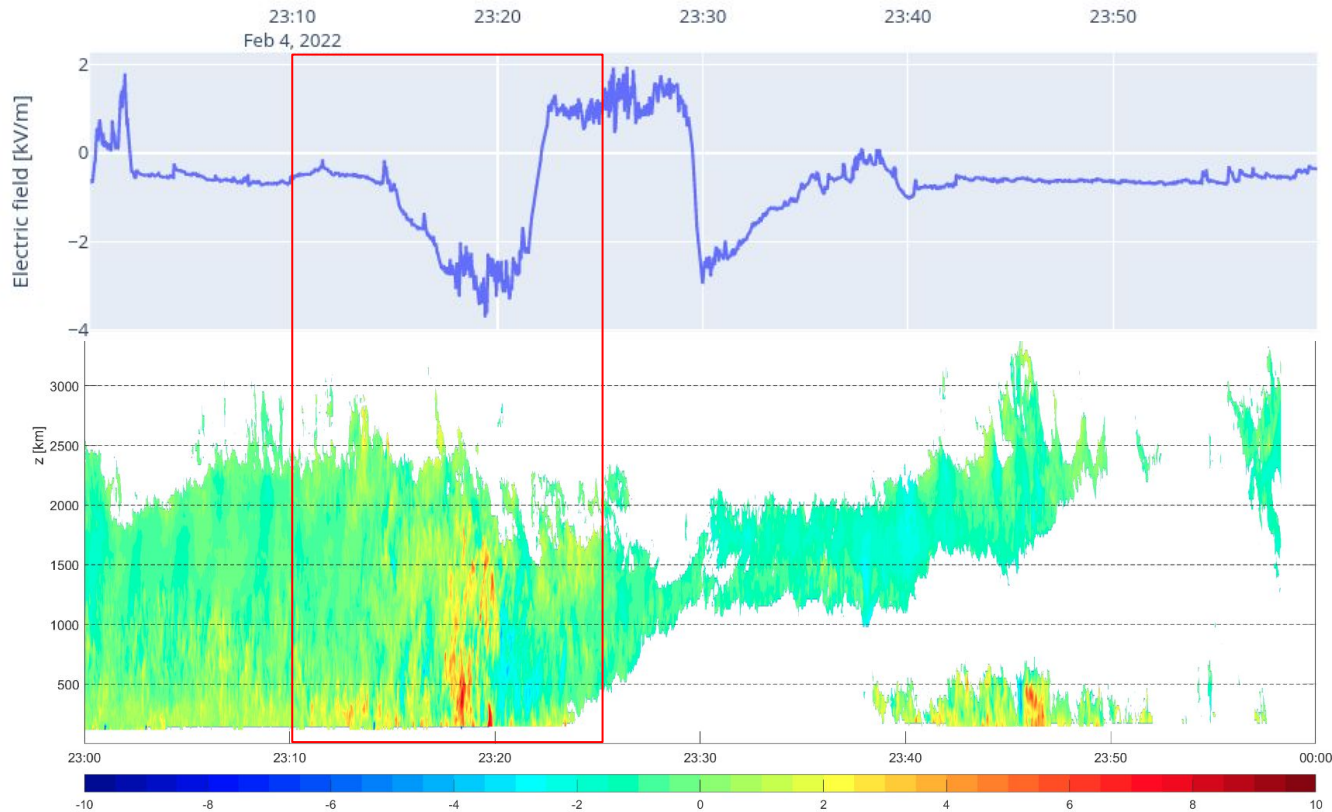
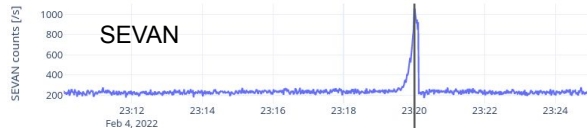
RT-56 Cosmic spectrum



Milešovka event 2022-02-04

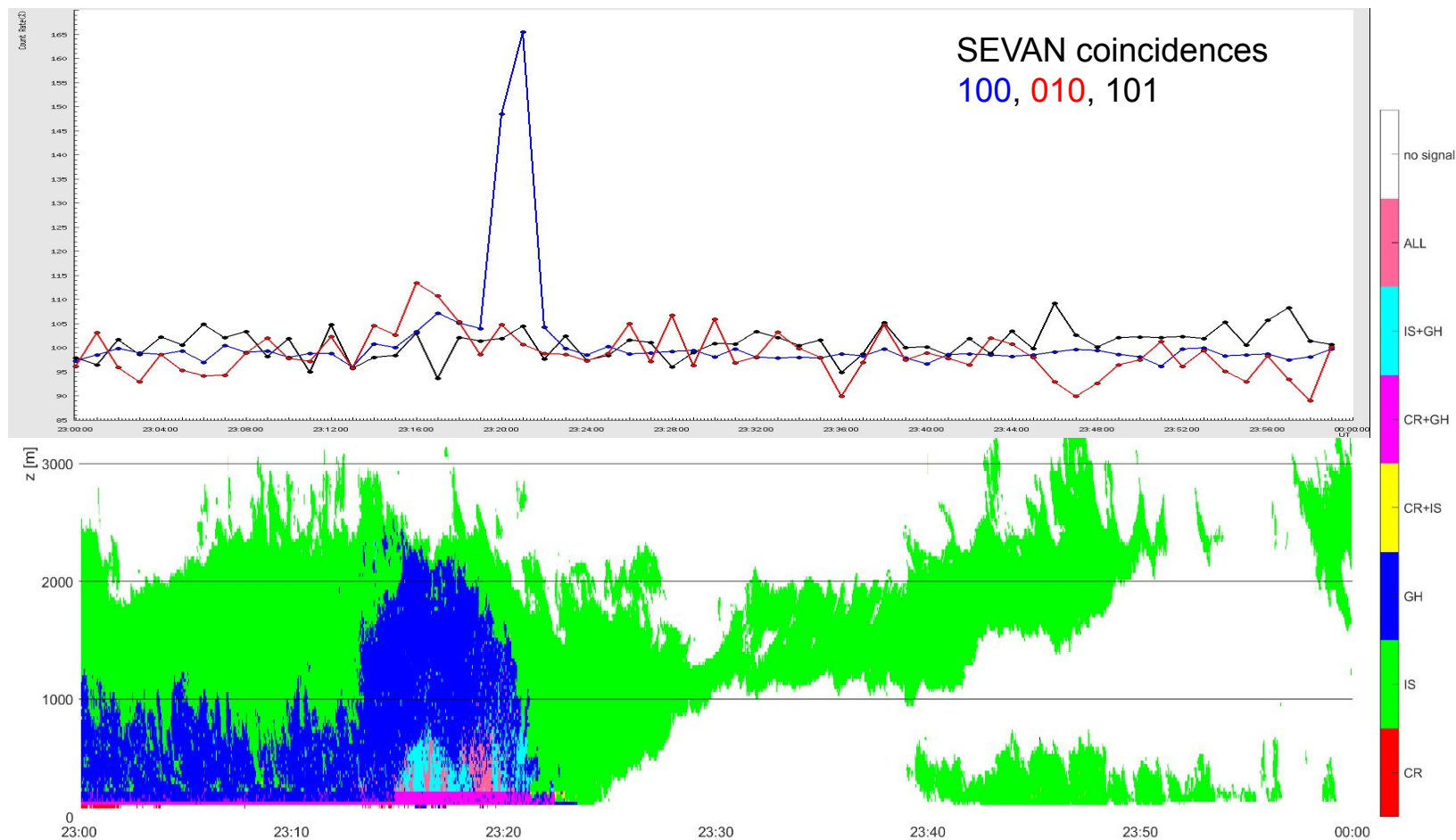


Milešovka event 2022-02-04



vertical velocities of air, red is upward direction, time resolution 2s

Milešovka event 2022-02-04, hydrometeor classification



Plans for future

- Calibration of cosmic spectrum.
- New GASTRON stations.
- Looking for short term events.
- Add other detectors.

