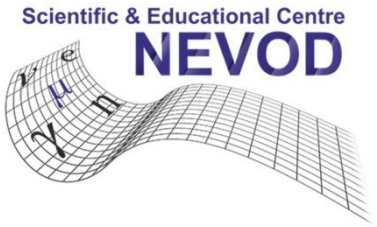
The 4th International Conference on Particle Physics and Astrophysics (ICPPA-2018)



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The results of the first experimental series carried out at the NEVOD-EAS shower array

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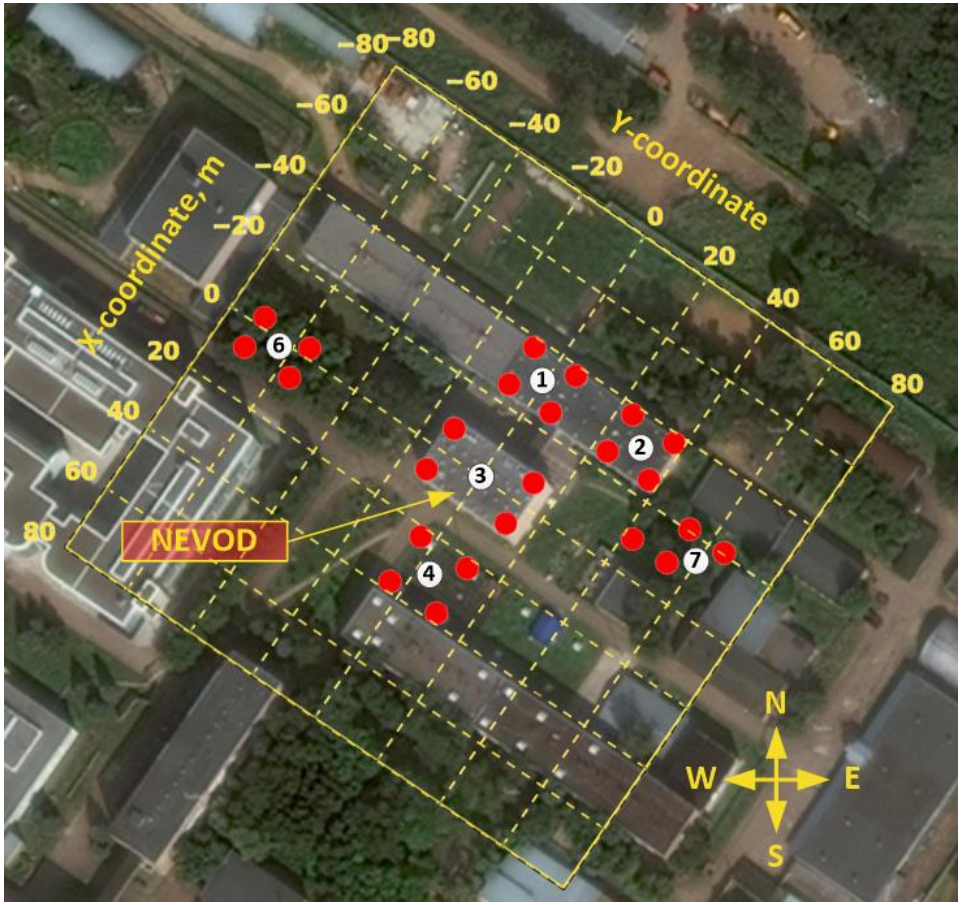
Layout of the NEVOD-EAS array



96 counters

24 detector stations

6 clusters

typical cluster size:
15 × 15 m^2

array area:
10^4 m^2

energy range:
from 10^{15} to 10^{17} eV

Tasks of the first experimental series:

- analysis of EAS angular distributions and counting rate, as well as of the array response during registration of EAS of different energies to verify the correctness of the calibration procedures;
- determination of conditions to search joint events in NEVOD-EAS and EC NEVOD detectors;
- comparison of the results of reconstruction of responses of the NEVOD-EAS array and other detectors of the EC NEVOD;
- estimation of the NEVOD-EAS angular resolution.

Experimental series at the array

Experimental series is a sequence of **RUNs** with a duration of **24 hours**.

RUN includes **6 intervals** consisting of **“exposition”** and **“monitoring”**.

Exposition:

- **EAS detection;**
- duration **3 hours 50 minutes**;
- multiplicity of triggered DS – **2**;
- registration threshold – **0.75 MIP**.

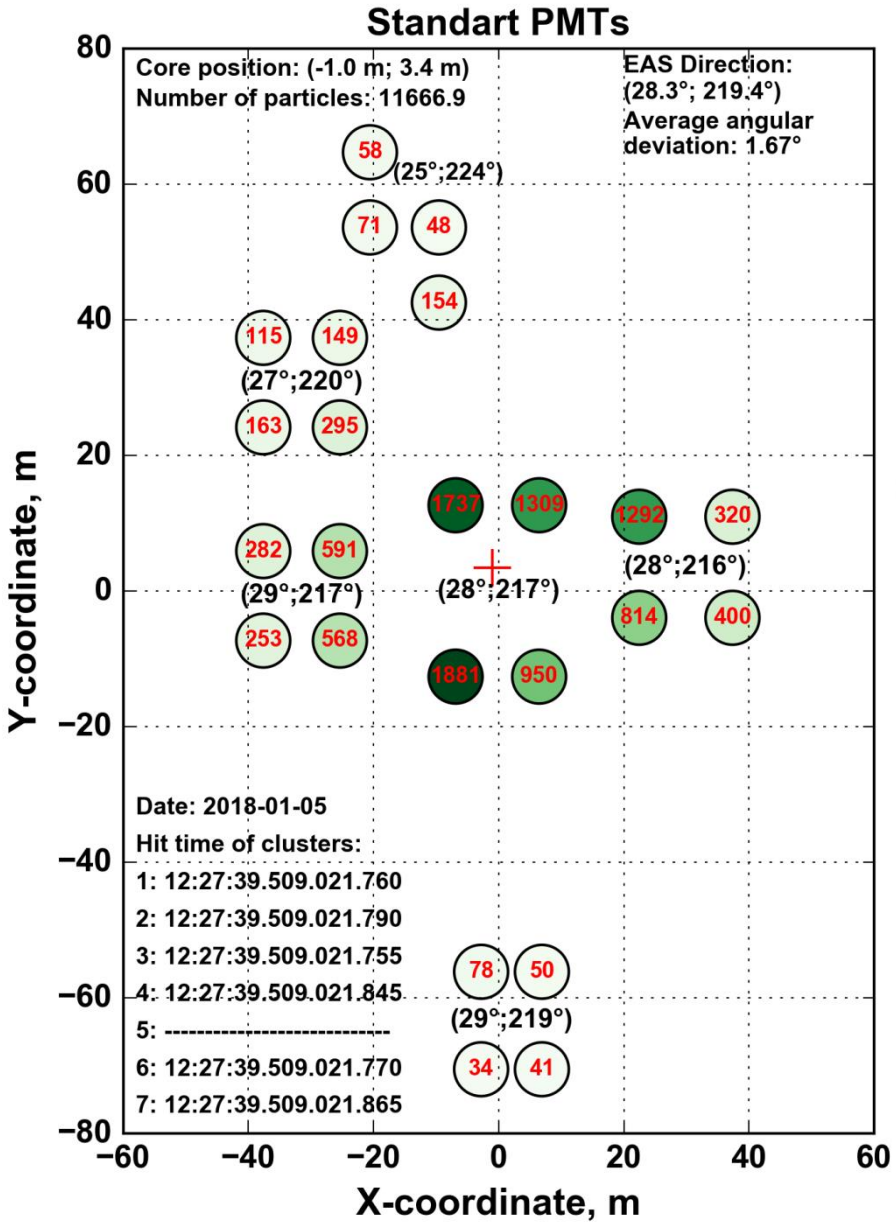
Monitoring:

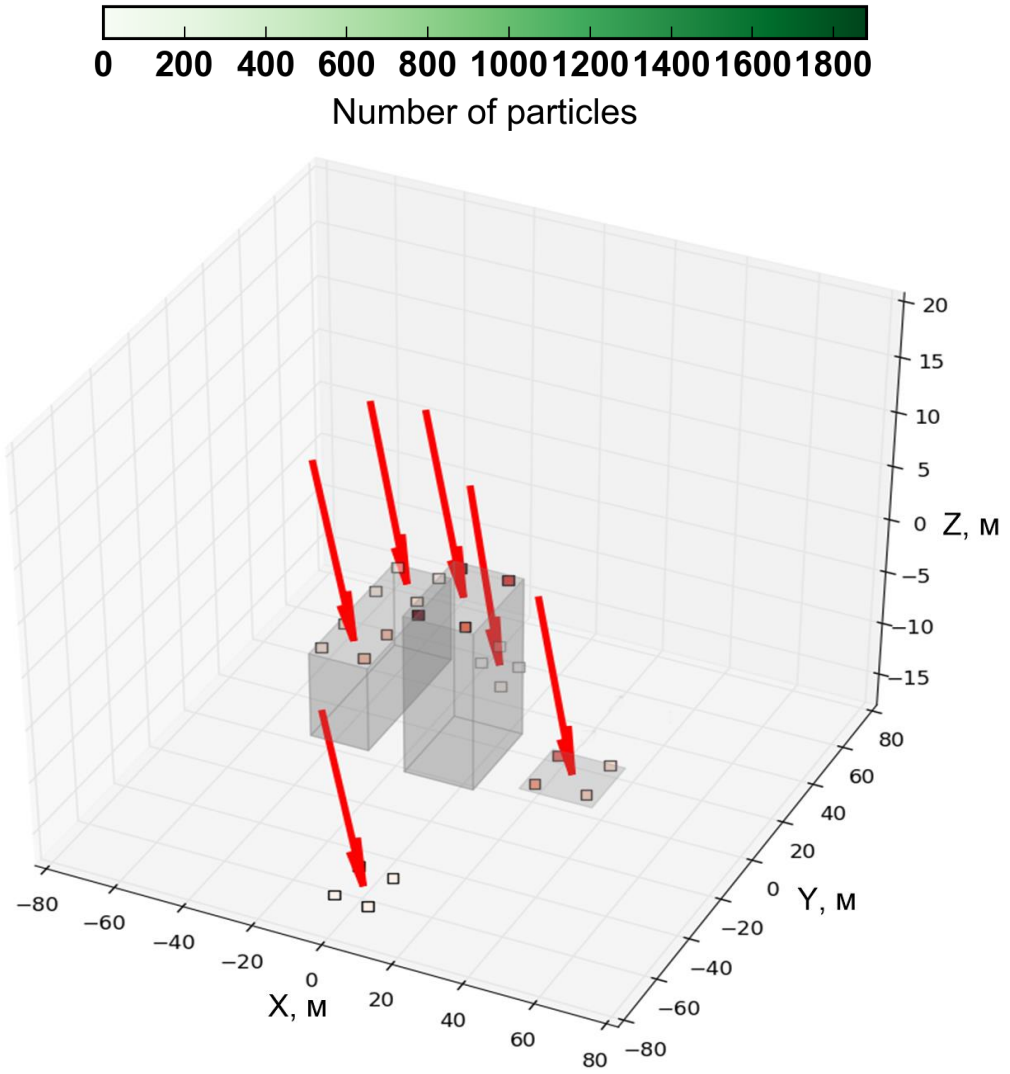
- **measurement of DS responses to the passage of single muon;**
- duration **10 minutes**;
- multiplicity of triggered DS – **1**;
- registration threshold – **0.5 MIP**.

Using the data of RUN the following parameters are determined for every cluster:

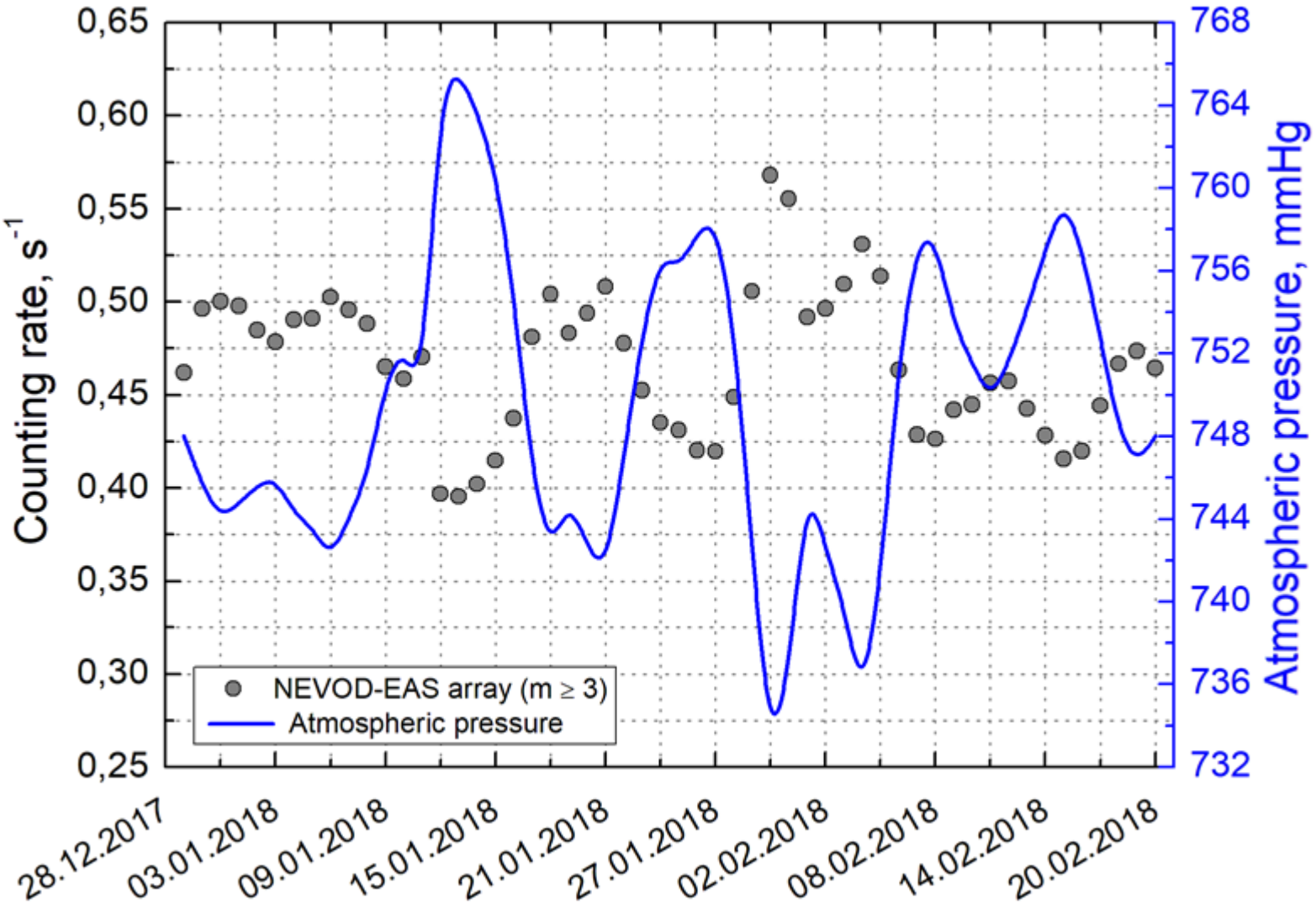
- counting rate of cluster and its DS;
- mean and r.m.s. values of the ADC base lines;
- triggering delays of DS;
- responses of DS to the passage of single muon;
- calibration coefficient for the responses of DS additional photomultipliers;
- arrival direction of all detected EAS;
- number of particles registered by DS in every event.

NEVOD-EAS event example





Counting rate of extensive air showers

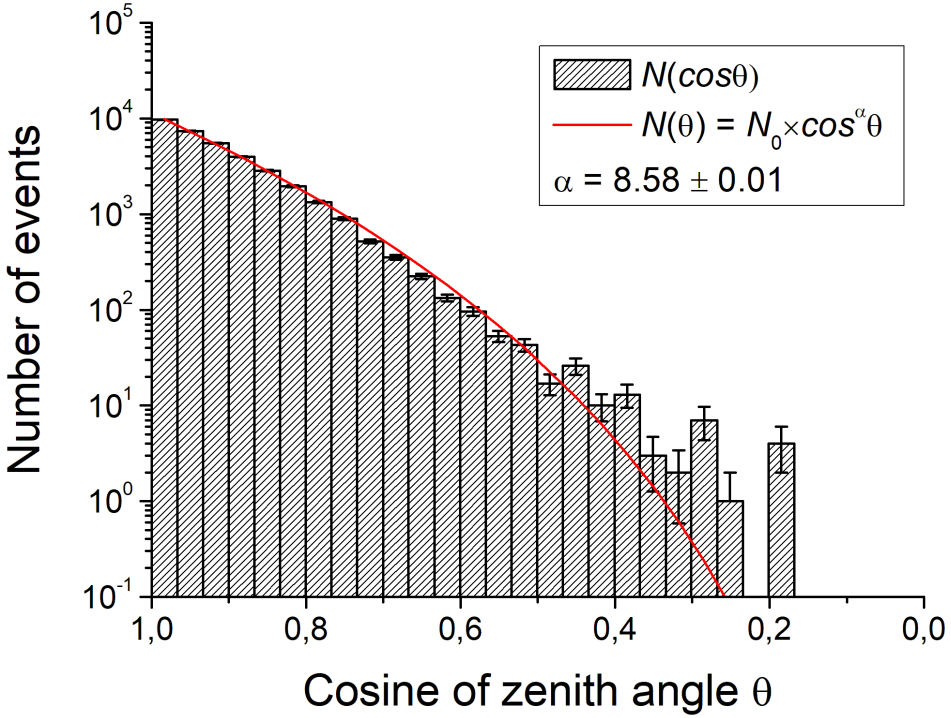


Average counting rate of events with at least **3** triggered clusters is ~ **0.47 s^{-1}**.

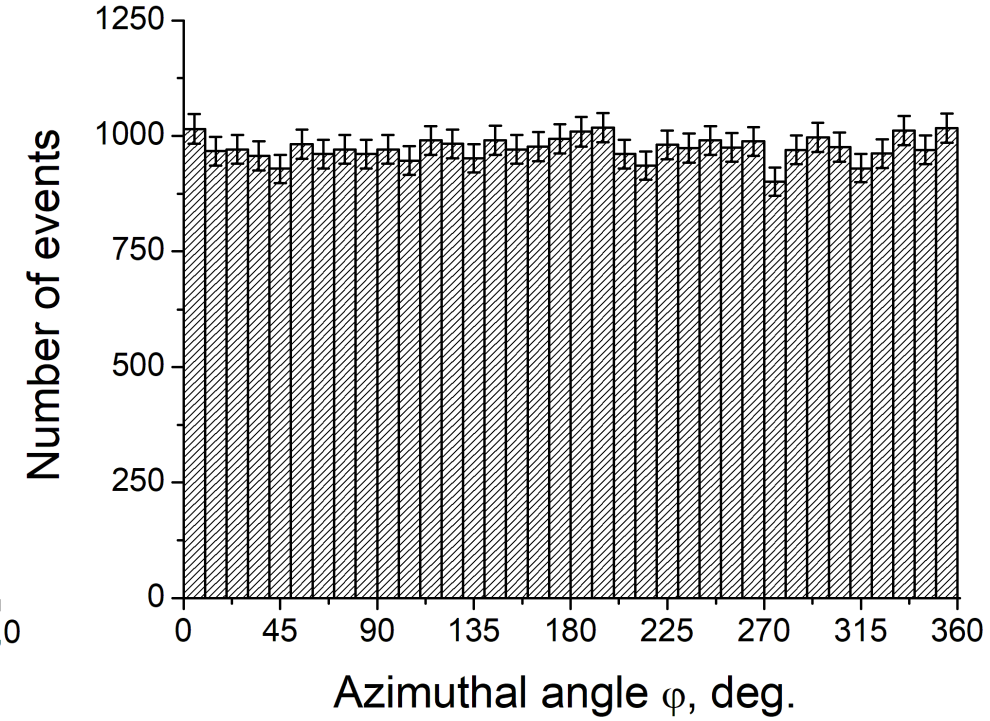
Barometric coefficient : -1.08 %/mmHg

Reconstruction of the arrival direction of extensive air showers

Distribution of events on cosine of zenith angle of EAS arrival direction



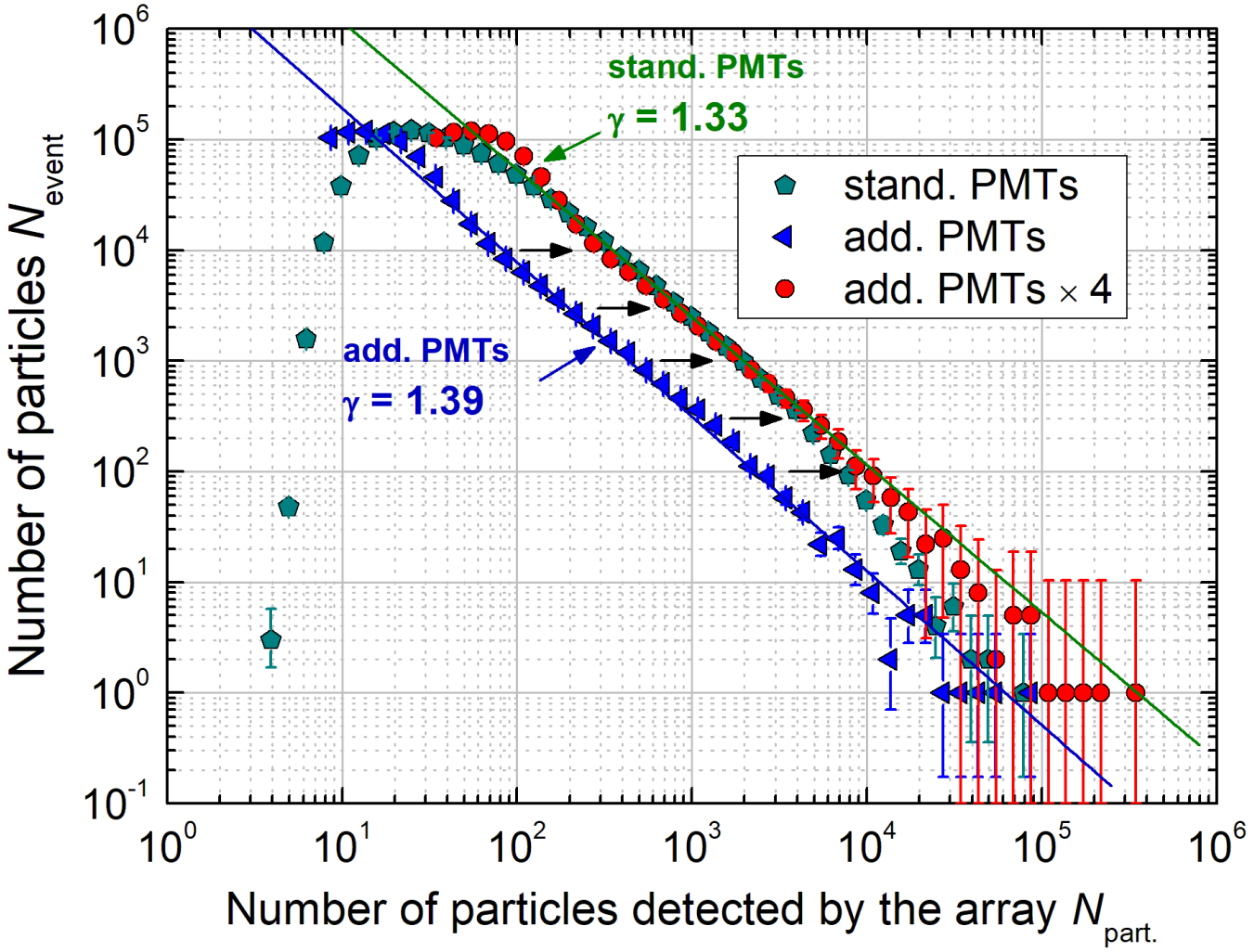
Distribution of events on azimuthal angle of EAS arrival direction



Response of the array during detection of EAS of different energies

Distribution of events on the measured size of extensive air showers
(1136751 events, multiplicity of triggered clusters ≥ 3):

- according to the data of **standard PMTs** of array detector stations (DS);
- according to the data of **additional PMTs** of array DS;
- according to the responses of additional PMTs reduced to the DS area.



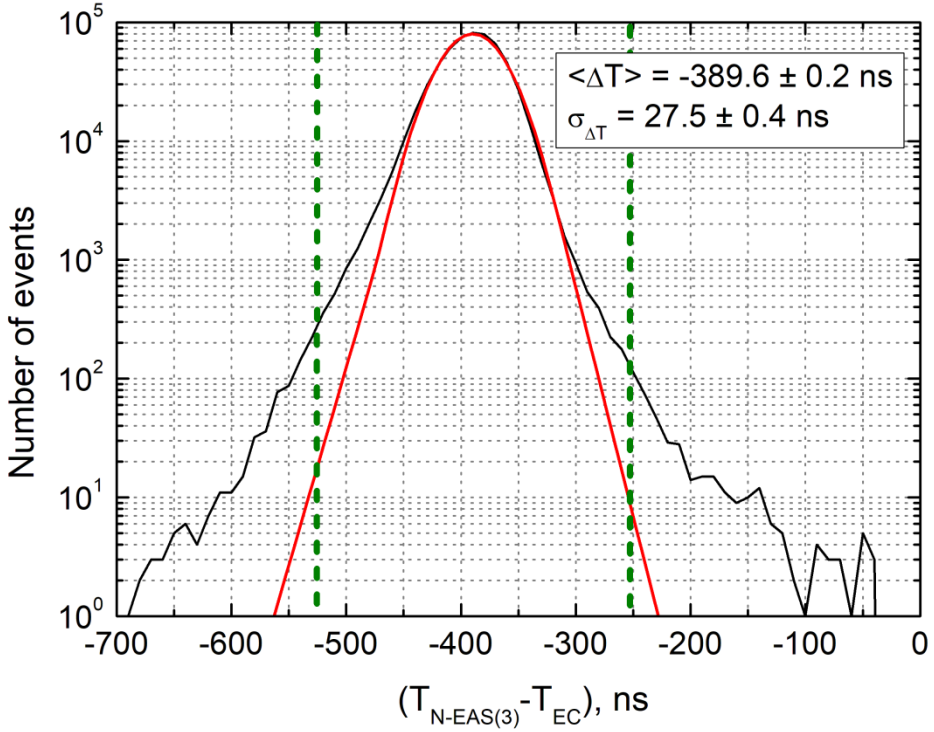
Selection of joint events

The following types of events were selected: **576084 events**

NEVOD-EAS – events with at least 3-fold coincidence of clusters (cluster No. 3 deployed on the roof of the EC NEVOD building must be triggered)

EC NEVOD – all events by any type of trigger that fall inside the time gate with a duration of 700 ns starting from the hit time of the 3rd cluster of the NEVOD-EAS array.

The distribution of the time difference between the triggers in cluster No. 3 of the NEVOD-EAS array and in the EC NEVOD



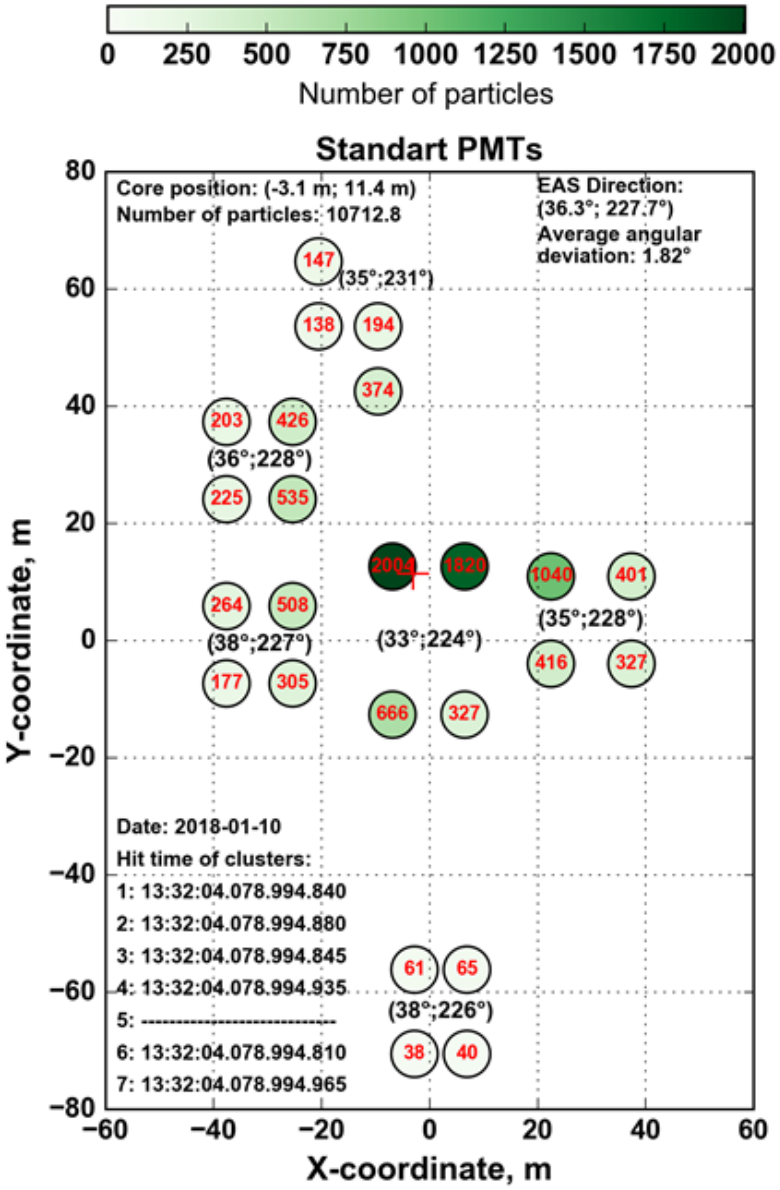
Time gate for joint event selection: 275 ns

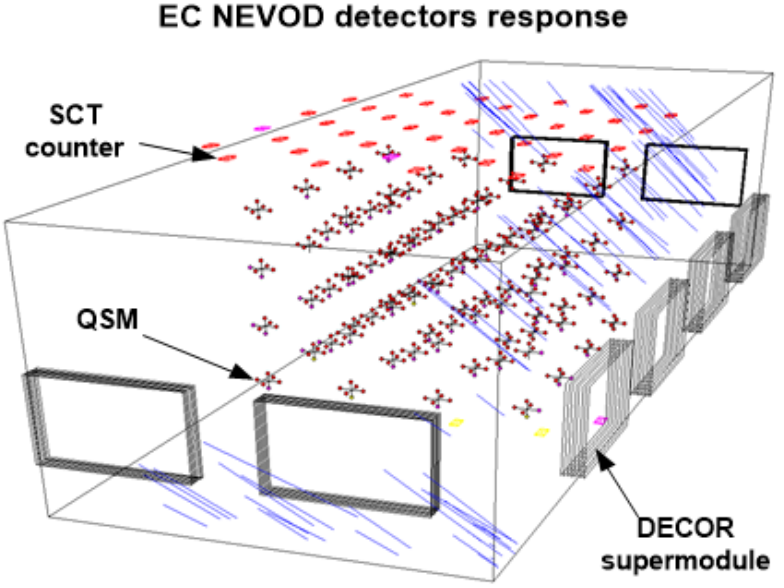
Average time between events:

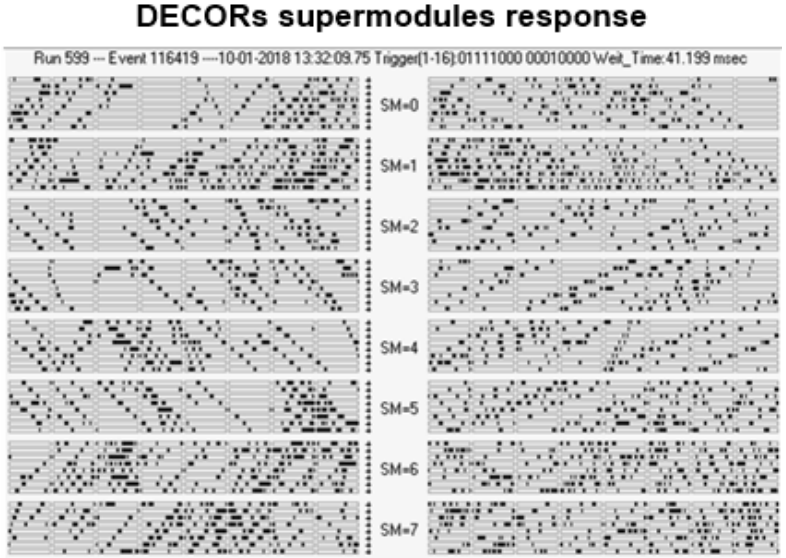
NEVOD-EAS	2.1 s
EC NEVOD	50 ms

Probability of wrong selection of joint events: $< 5.5 \times 10^{-3}$

Joint event example







NEVOD-DECOR-SCT: θ = 37.1°, ϕ = 227.4°, 86 reconstructed tracks

NEVOD-EAS: θ = 36.3°, ϕ = 227.7°

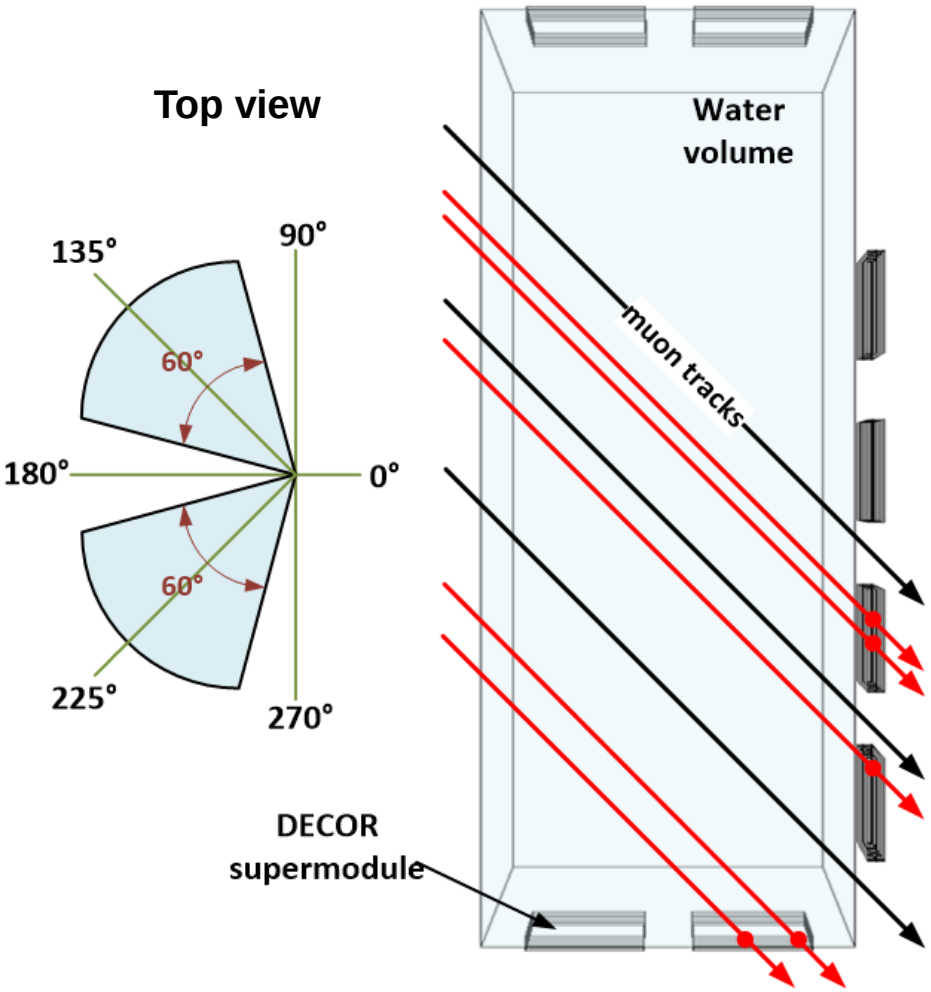
NEVOD-EAS angular resolution

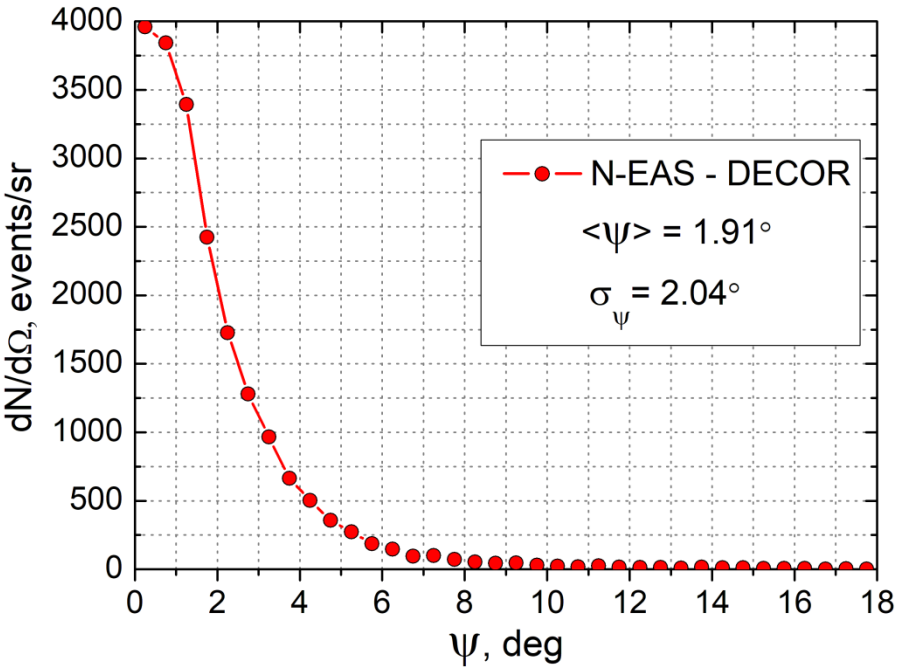
Minimum 3 parallel (within ~ 5°) muon tracks with azimuthal angles of arrival in intervals (105°; 165°) and (195°; 255°) in at least three shielded supermodules of DECOR.

6465 events

The distribution of the number of events in the unit of solid angle (event density) by the intervals of angular deviation **ψ** of the direction in NEVOD-EAS from the muon bundle direction in EC NEVOD

$$\frac{dN}{d\Omega}(\psi) = \frac{1}{2\pi \cdot \sin\psi} \cdot \frac{dN}{d\psi}(\psi)$$





In 90% of events angular deviation is less than **3.75°**
Angular resolution of the array ~ **2°**

Conclusion

The first results obtained at the NEVOD-EAS array shows that the EAS **counting rate**, **reconstructed arrival direction** and **spectrum of measured size** are **in good accordance with the expected dependences and distributions** which means that **all calibration procedures works correctly**.

According to the information on EAS registered during the experimental series, joint with the detectors of the EC NEVOD, the following results were obtained:

- the search conditions for joint events in the NEVOD-EAS and other detectors of the EC NEVOD were determined;
- good accordance of EAS event topologies and characteristics reconstructed by different detectors was shown;
- the angular resolution of the array was estimated (~ 2°).

Thank you for attention!