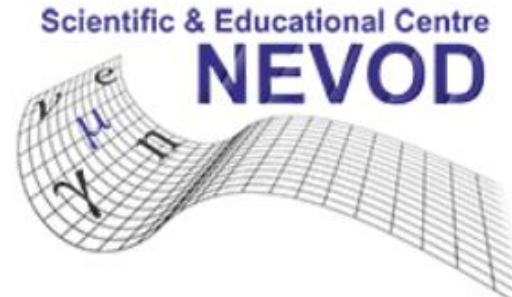

The 5th international conference on particle physics and astrophysics



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Simulation of the response of the URAN and PRISMA-32 facilities to the passage of the EAS

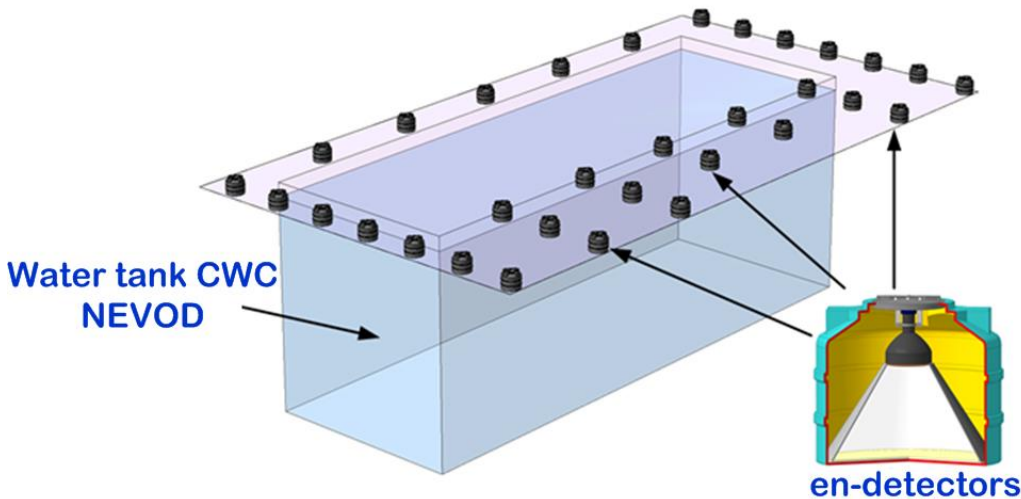
Z.T. Izhbulyakova, D.M. Gromushkin, A.G. Bogdanov, F.A. Bogdanov

*National Research Nuclear University MEPhI,
Scientific & Educational Centre NEVOD*

Moscow, October 9th 2020

PRISMA-32 and URAN

The PRISMA-32 Array



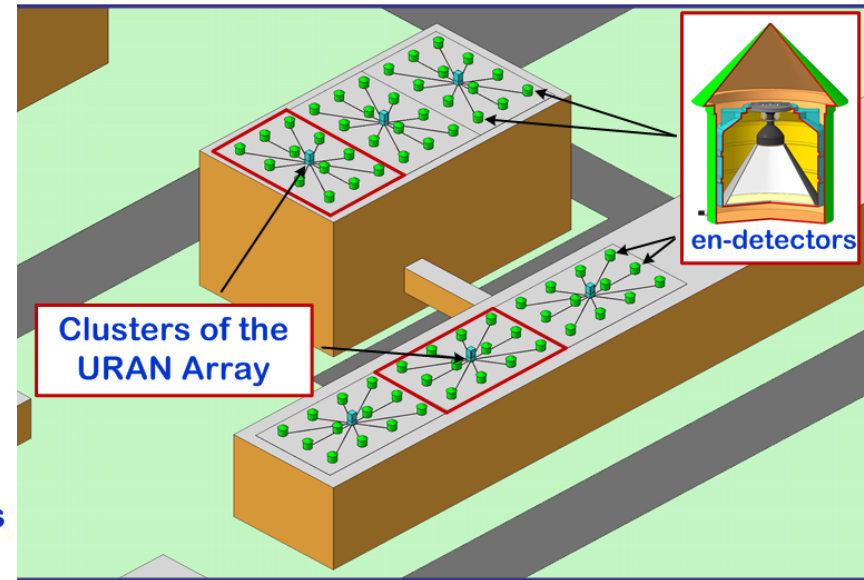
32 (en)-detectors

2 clusters

location: the 4th floor of the
NEVOD building

the scintillator: $\text{ZnS}(\text{Ag})+\text{LiF}$

The URAN Array



72 (en)-detectors

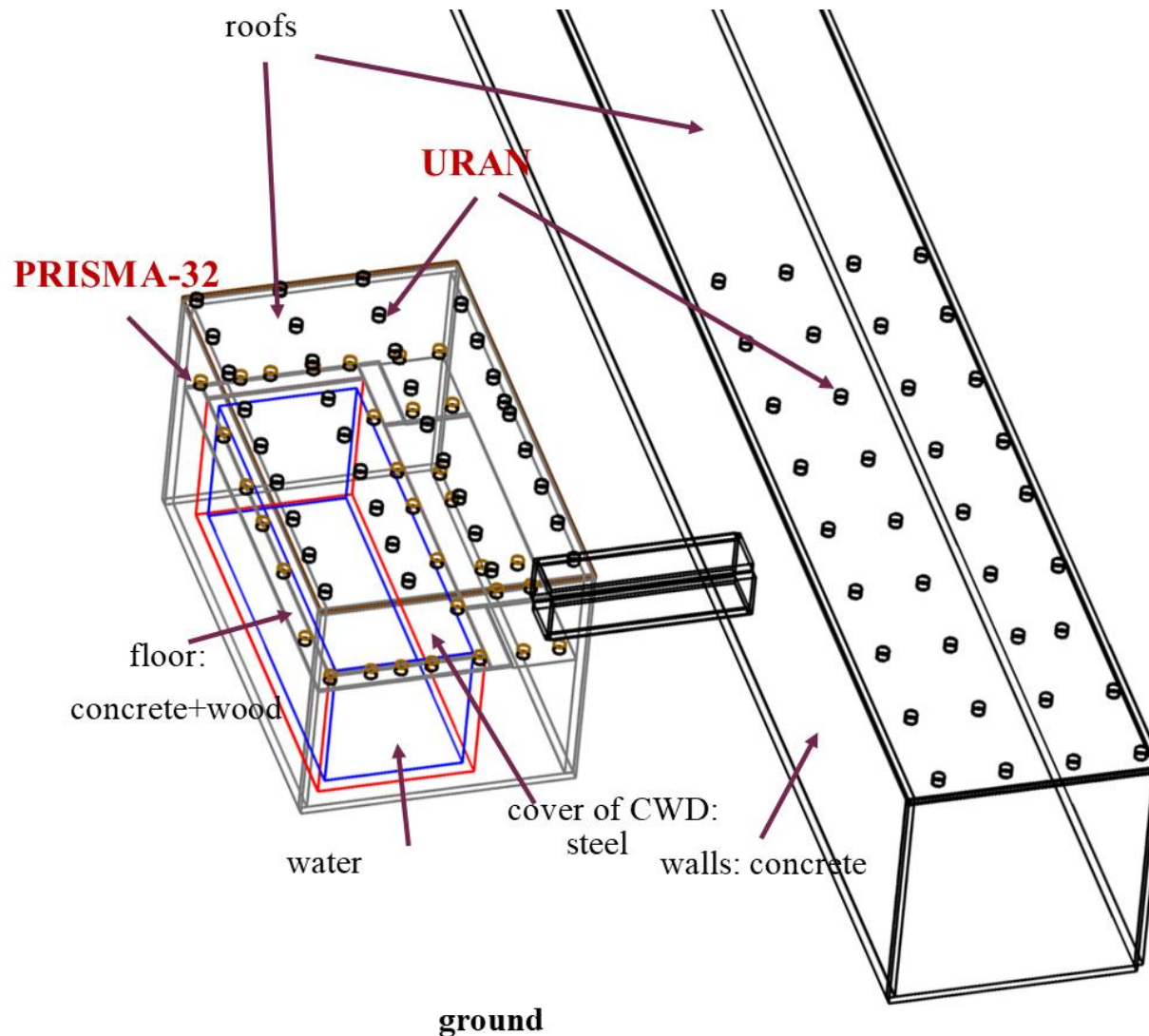
6 clusters

location: the roofs of the
NEVOD building

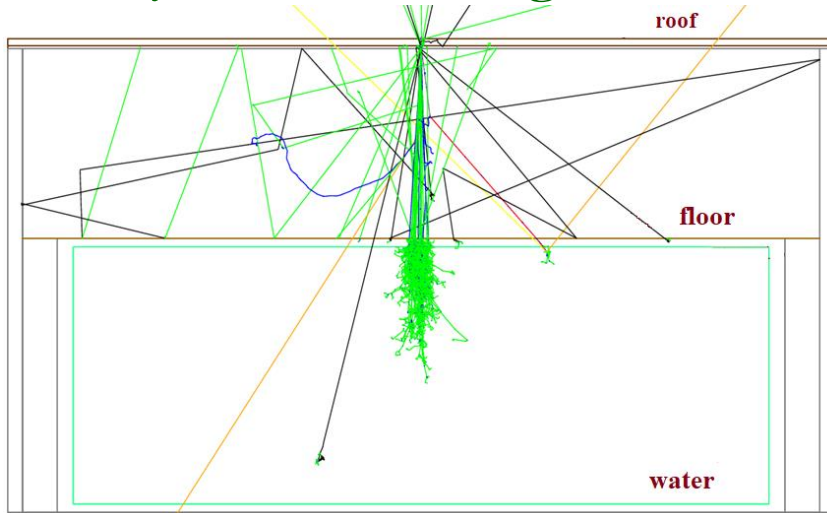
the scintillator: $\text{ZnS}(\text{Ag})+\text{B}_2\text{O}_3$

Models of PRISMA-32 and URAN arrays

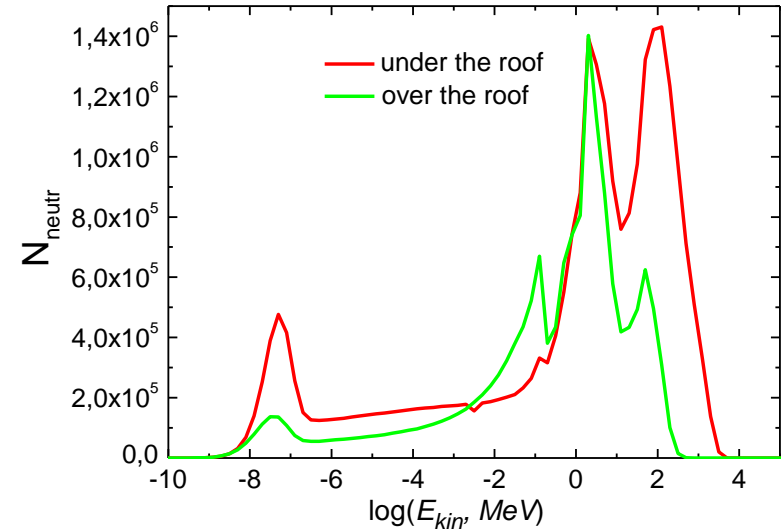
A mathematical model of the PRISMA-32 and URAN facilities has been developed. Geant4.10.5 software package was used to simulate the arrays' response.



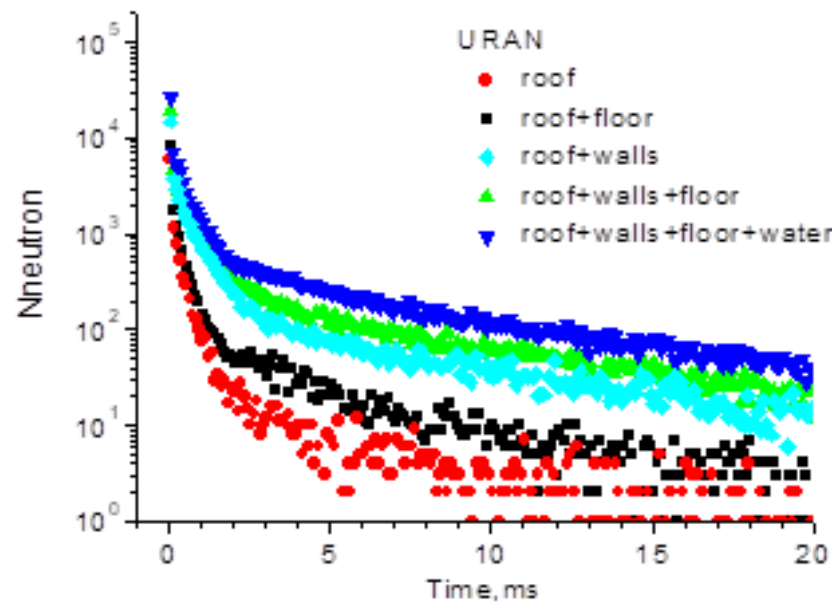
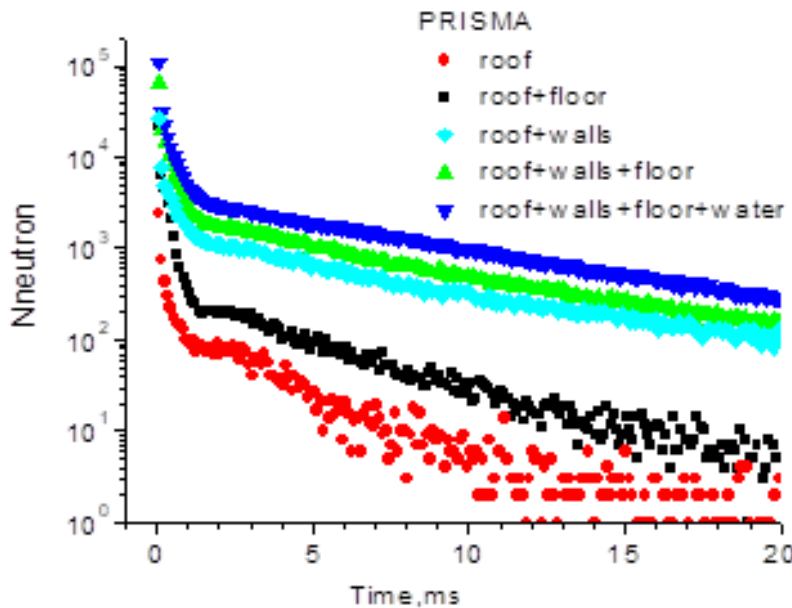
Study of neutron generation in a building



Geant4 visualization of the interaction of a hadron with the roof of a building (neutron trajectory– gray, γ – green, e – blue, μ – red)



Distributions of the kinetic energies of neutrons

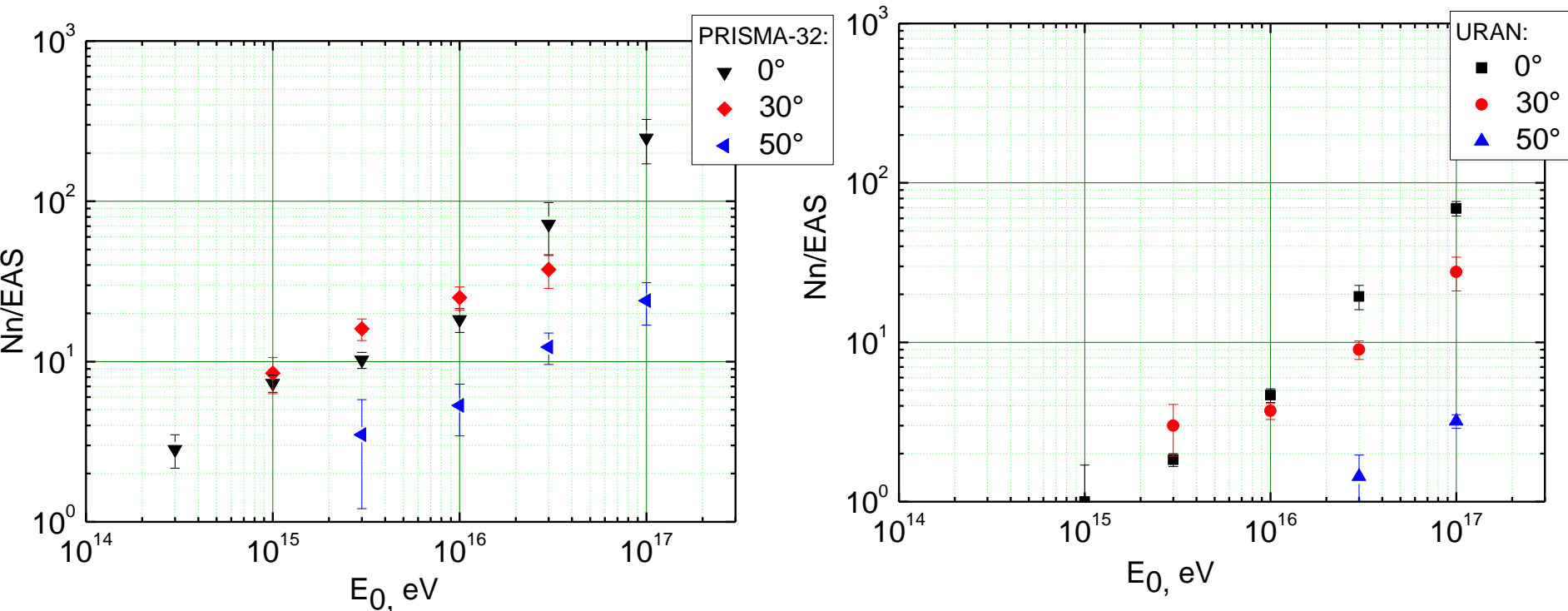


Temporal distribution of neutrons generated in various parts of the building registered by PRISMA-32 and URAN arrays

The dependence of the number of registered neutrons on primary particle energy

Simulation of the EAS was carried out using the CORSIKA7.6900 program.

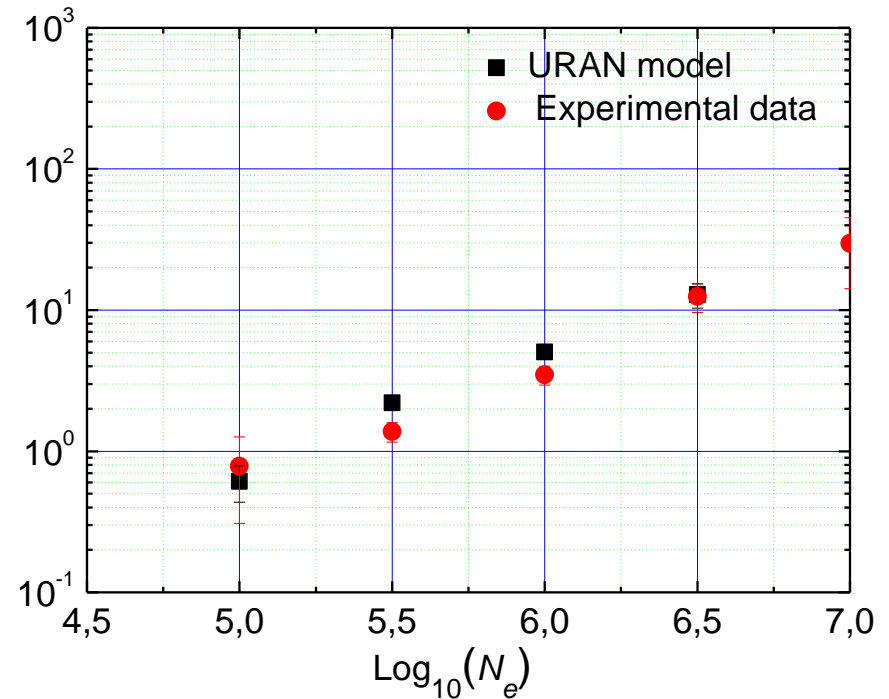
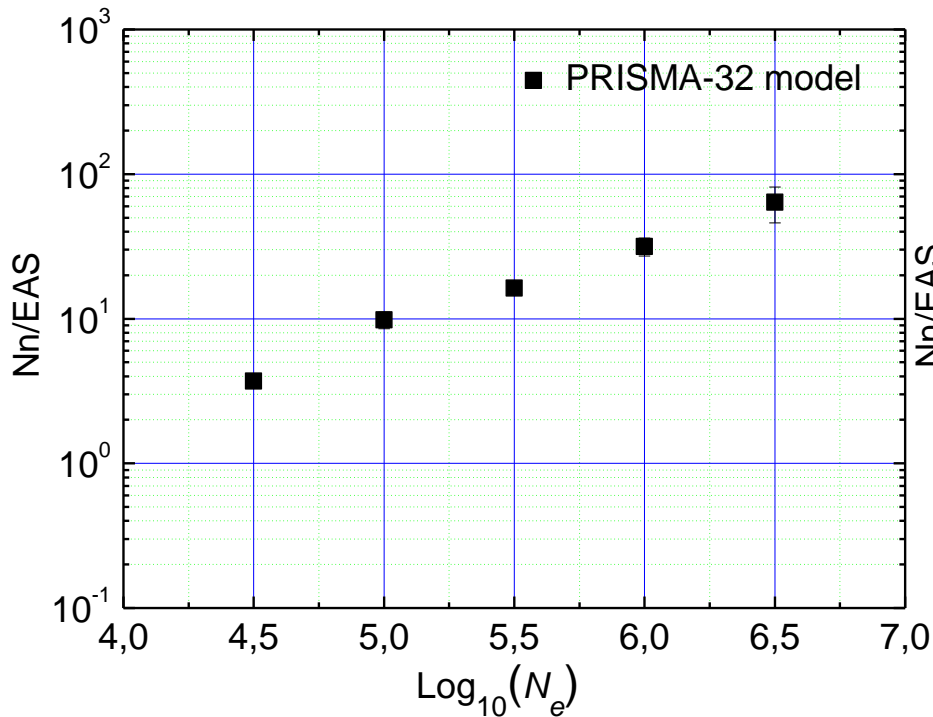
Primary cosmic ray particle: p with $E_0 = 10^{14} \div 10^{17}$ eV



The dependence of the average number of neutrons registered by PRISMA-32 and URAN models on primary particle energy (black: the zenith angle is 0°, red: 30°, blue: 50°)

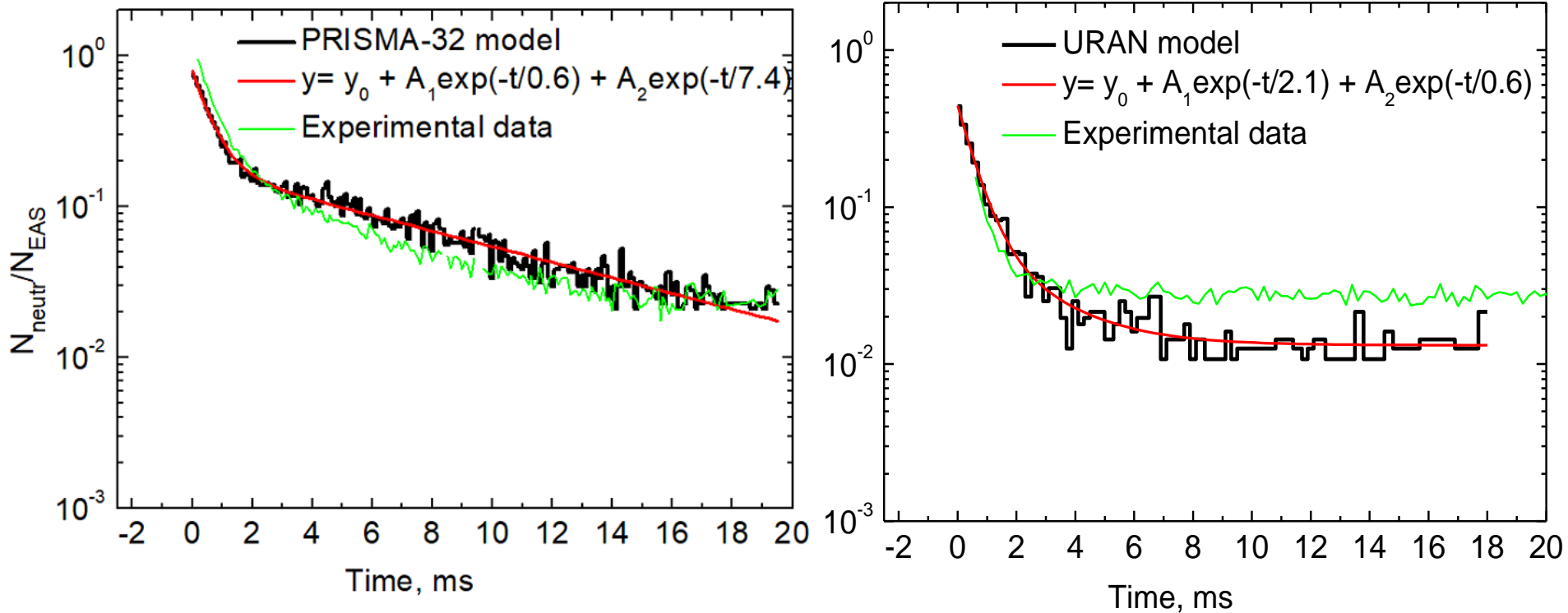
The dependence of the number of registered neutrons on the shower size

Primary cosmic ray particle: p , energy of particles correspond to the spectrum
 $dN/dE \sim E^{-2.7}$, energy range is $E = 10^{15} \div 10^{17}$ eV (~ 5000 events)



The dependence of the average number of neutrons registered by PRISMA-32 and URAN models on the shower size

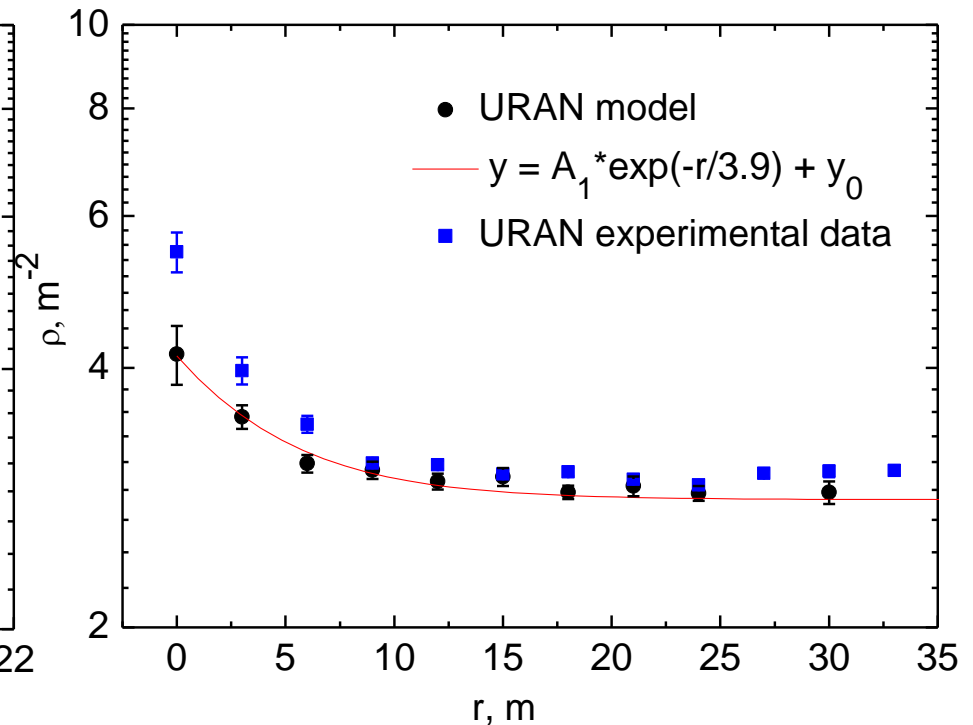
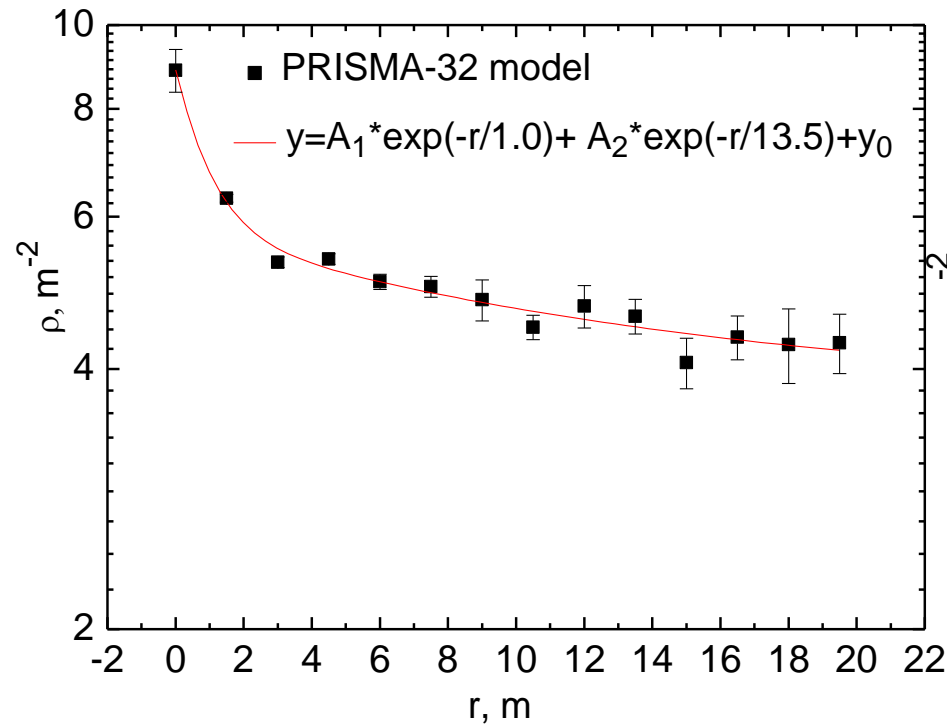
Temporal distribution of neutrons



Temporal distribution of thermal neutrons registered by PRISMA-32 and URAN arrays

PRISMA-32	t_1 , mc	t_2 , mc	URAN	t_1 , mc	t_2 , mc
Simulation	0.60 ± 0.02	7.40 ± 0.97	Simulation	2.11 ± 0.71	0.58 ± 0.04
Experiment	0.6	4.6	Experiment	2.72 ± 0.93	0.43 ± 0.03

Lateral distribution function of neutron component

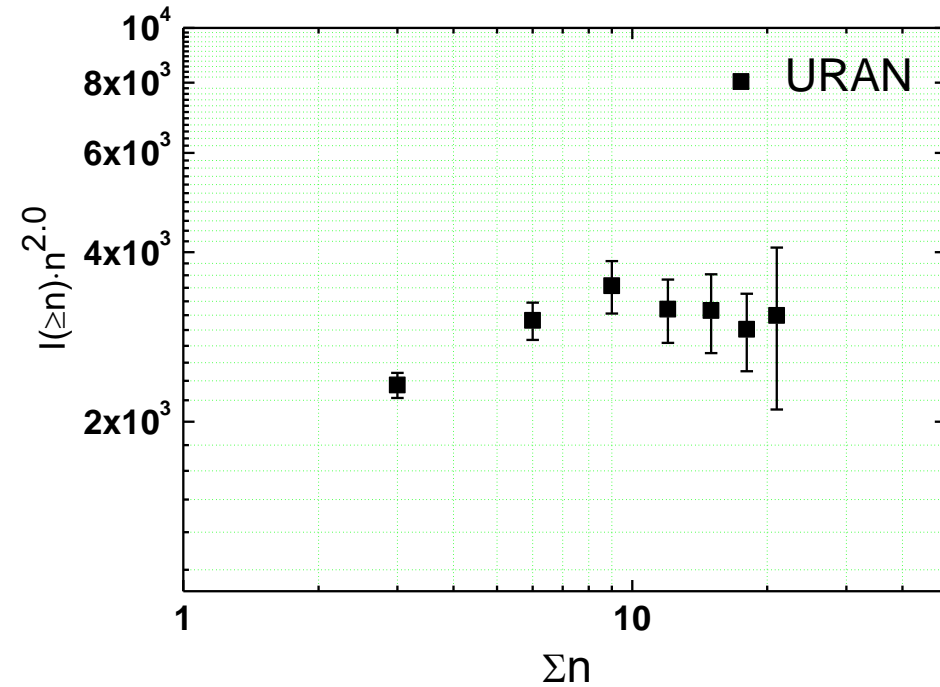
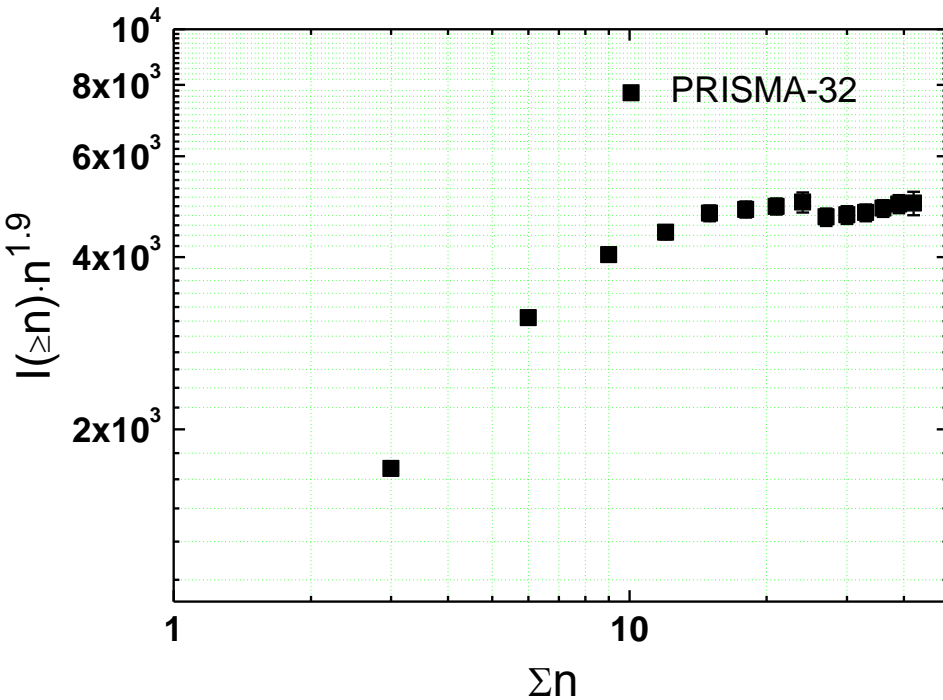


LDF of EAS neutron component registered by PRISMA-32 and URAN array

PRISMA-32	r_1, m	r_2, m	URAN	r_1, m
Simulation	0.98 ± 0.34	13.46 ± 5.31	Simulation	3.94 ± 0.89
Experiment	1.2	10.5	Experiment	3.25 ± 0.26

The integral distribution of EAS neutrons

The integral distribution of EAS neutrons is described in a power function with an index of 1.9 for PRISMA-32 and 2.0 for URAN array .



Distribution of registered showers in the number of neutrons for PRISMA-32 and URAN arrays

Conclusion

A mathematical model of facilities for registration of the neutron component of EAS on large areas (PRISMA-32 and URAN) has been developed. The generation of neutrons in various parts of the NEVOD building has been studied.

The analysis of the model response to EAS was conducted, which resulted in:

- the dependence of the registered neutrons from primary particle energy and shower size;
- LDF of neutron component;
- the time distribution of EAS neutrons;
- the integral distribution of EAS neutrons;

The simulation results are consistent with experimental data. These mathematical models will be used as part of a software package for simulating the process of multicomponent EAS registration with the other NEVOD facilities and detectors.

Thank you for your time!