Tunka-Grande scintillation array: resent results.

A. Ivanova[1,2], TAIGA Collaboration (1-Irkutsk State University, 664003, Irkutsk, Russia; 2-Novosibirsk State University, 630090, Novosibirsk, Russia)

Description

The number of the objectives of the TAIGA Astrophysical complex includes the study of the flux of charged cosmic rays and diffuse gamma rays with energies above 100 TeV. This complex is located in the Tunka Valley, about 50 km from Lake Baikal at the site of the Tunka-133 Cherenkov facility. TAIGA includes the TAIGA-HiSCORE wide-angle Cherenkov array, the network of Imaging Atmospheric Cherenkov Telescopes (TAIGA-IACT), the Tunka-Grande and TAIGA-Muon scintillation arrays.

The results of an analysis of the joint events of the Tunka-Grande scintillation array and TAIGA-HiSCORE and Tunka -133 Cherenkov facilities are presented. Joint events comparison results verify scintillation experiment sufficient accuracy for the joint study of mass composition of cosmic rays and gamma-hadron separation.

Tunka-Grande Scintillation array:

19 **Scintillation Stations** on area ≈ 0,5 km^2.

Scintillation Station = Surface detector + Underground detector ;

Surface detector =12 scintillation counters;

Underground detector = 8 scintillation counters.

- Scintillation counter area – 0.64 m^2.
- Surface detector area ~ 8 m^2.
- Underground detector area ~ 5 m^2.
- Distance between stations ~ 175 m.
- Altitude of 669 m a.s.l.

TAIGA-HiSCORE Cherenkov array:

120 wide-angle Optical Stations on area ≈ 1 km^2.

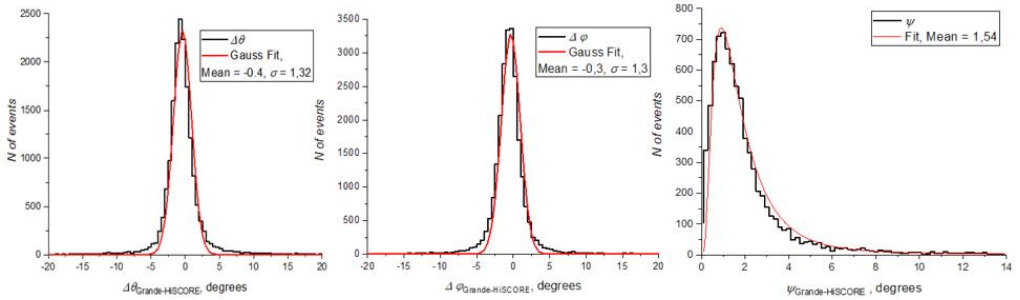
- Optical Station includes four PMTs, with a total entrance of about 0.5 m^2.
- Each PMT is equipped with a Winston cone.
- All stations were inclined in the south direction through an angle of 25◦.
- Field of view - 0.6 sr.
- Distance between Stations ~ 106 m.
- Altitude of 669 m a.s.l.

Tunka-133 Cherenkov array:

25 **Clusters** on area ≈ 3 km^2.

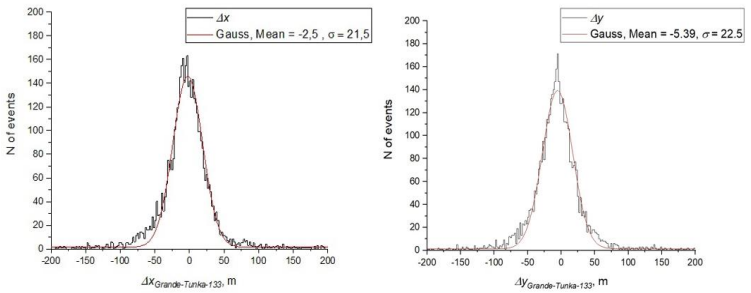
- **Cluster** = 7 wide-angle Cherenkov detectors;
- In each cluster, one detector is in the center, and six are located symmetrically relative to the center at the vertices of a regular hexagon with a side of 85 m.
- Altitude of 669 m a.s.l.

Estimating the accuracy of the main EAS parameters experimentally



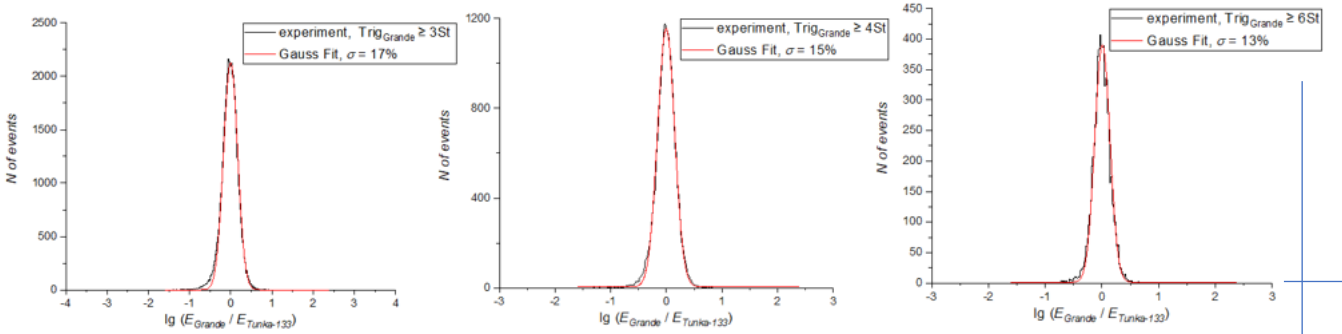
The accuracy of the arrival direction reconstruction by the Tunka-Grande array in comparison with data of TAIGA-HiSCORE array.

≈ 240 hours, 17300 joint events with 3 and more Tunka-Grande triggered stations

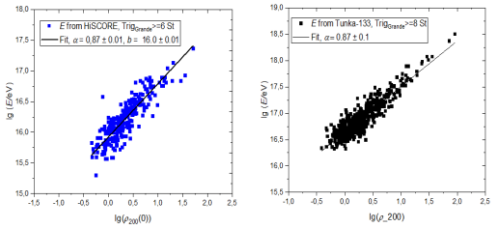


The accuracy of the EAS core position reconstruction by the Tunka-Grande array in comparison with data of Tunka-133 array.

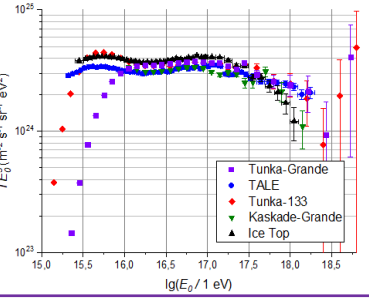
≈ 439 hours, 4500 joint events with 6 and more Tunka-Grande triggered stations



The standard deviation of the ratio between the shower energies, reconstructed from the data of the Tunka-Grande and Tunka-133 arrays, is 17% for joint events with 3 and more Tunka-Grande triggered stations, 15% for joint events with 4 and more Tunka-Grande triggered stations and 13% for joint events with 6 and more Tunka-Grande triggered stations.



Correlation $\rho_{200}(0)$ with the primary energy from the Cherenkov arrays experimental data



The spectrum of this work in the range of 20 PeV–1EeV coincides with those collected by the Tunka-133, KASCADE-Grande [1], TALE [2] and IceTop [3] facilities.

References: [1] W. D. Apel et al., Astropart. Phys. **36** (2012) 183; [2] R.U. Abbasi et al, https://arxiv.org/pdf/1803.01288.pdf
[3] K. Rawlins [IceCube Collaboration], J. Phys. Conf. Ser. **718,** (2016), no. 5, 052033