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Tunka-Grande array for high-energy gamma-ray astronomy and cosmic-ray physics: preliminary results.

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The Tunka-Grande scintillation array is a part of the TAIGA experimental complex designed for high-energy gamma-ray astronomy and cosmic-ray physics.

In this work methods of reconstruction of primary particles parameters are presented, as well as the accuracy of reconstruction of the EAS core position, energy, and arrival direction, obtained by comparing the reconstruction results with the data of the Tunka-133 and TAIGA-HiSCORE Cherenkov arrays.

The EAS parameters are reconstructed using a curved shower front.

As a measure of energy, we use the charged particle density at a core distance of 200 meters. Correlation ro200 with the primary energy is determined using the experimental results of the TAIGA-HiSCORE Cherenkov array.

To determine the Tunka-Grande accuracy of the EAS parameters reconstruction, the Tunka-133 and TAIGA-HiSCORE experimental data are used.

The Tunka-Grande angular resolution is about 1.5 degrees. The standard deviation of the ratio between shower core coordinates, reconstructed from the data of the Tunka-Grande and Cherenkov arrays, is about 22 meters.

The Tunka-Grande energy resolution is about 18% for events with 3 and more Tunka-Grande triggered stations and 12% for joint events with 6 and more Tunka-Grande triggered stations.

The primary cosmic-ray energy spectrum based on 3 Tunka-Grande operation seasons was reconstructed. To plot the energy spectrum, events with zenith angles less than 45 degrees and axial positions in a circle with a radius of about 400 meters were selected for energies less than 100 PeV and in a circle with a radius of about 600 meters for showers with energies more than 100 PeV.The spectrum in the energy range of 2×10^{16}–10^{18} does not obey the unified power law but has a number of characteristic features: at the energy range 2×10^{16} - 3×10^{17} eV, the value of the power spectrum index is $\gamma = 2.99 \pm 0.01$. At higher energies, the spectral index rises sharply to $\gamma = 3.33 \pm 0.09$ (the second knee). In the energy range of 10^{16}–10^{17} eV, the agreement is observed between the results of this work and the spectra obtained by the KASCADE-Grande [1], TALE [2] and Ice TOP [3] arrays.

References

[1] W. D. Apel et al., *The spectrum of high-energy cosmic rays measured with KASCADE-Grande*, Astropart. Phys. **36** (2012), 183.

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[3] K. Rawlins [IceCube Collaboration], *Cosmic ray spectrum and composition from three years of IceTop and IceCube*, J. Phys. Conf. Ser. **718,** (2016), no. 5, 052033.