Perspectives of the ATHLET Installation at the Tien Shan

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Abstract

A new complex installation *ATHLET* is now being build at the Tien Shan near Almaty. Some problems of the planned cosmic ray studies are discussed.

1. Introduction.

In the framework of joint scientific investigations of Russia and Kazakhstan Republic a new experimental complex *ATHLET* is being created in the vicinity of Almaty city. The complex includes three cosmic ray installations of similar type placed at heights of 3340, 1750, and 850 m a.s.l. The main part of the *ATHLET* is the *HADRON-M* installation at the Tien Shan mountain station (3340 m a.s.l.) [1]. The field of experiments being planned is very wide and includes many directions: physics of cosmic rays and their interactions with the atmosphere; physics of the Sun and solar-terrestrial relations; the mechanism of the generation of atmospheric discharge (lightning); ecological environment monitoring. The *ATHLET* complex joins not only the material and financial resources of Russia and Kazakhstan but also the experience of many research groups. This paper enlightens only a few part of the problems connected with

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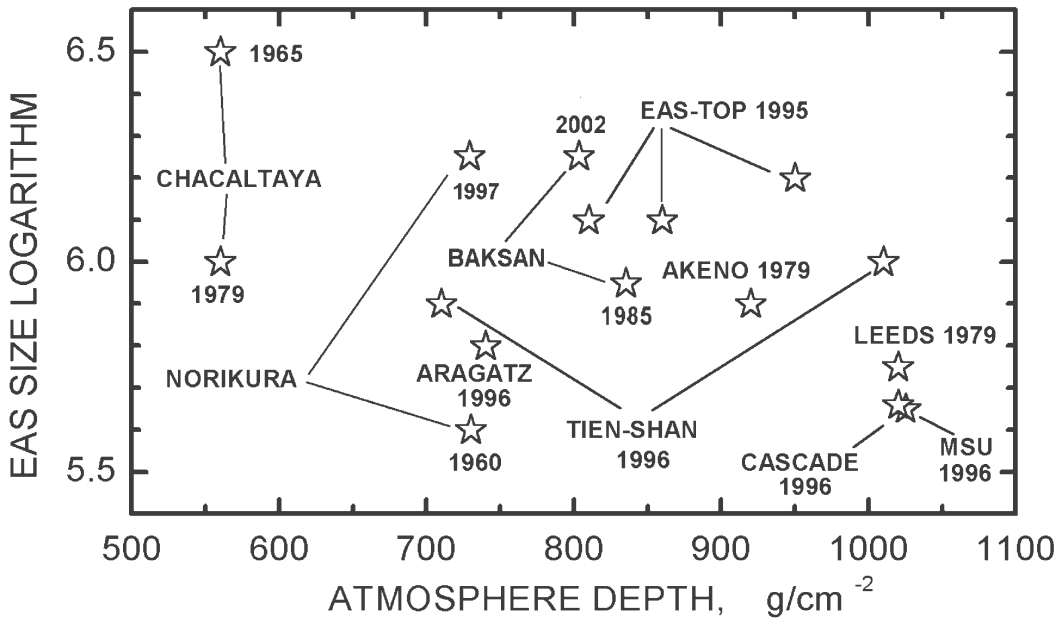

Fig. 1. Position of the primary spectrum "knee" according to different experiments.

cosmic ray physics which are meant to be solved at the complex newly build.

2. The problem of primary cosmic ray spectrum in the "knee" range

At present time our understanding of the nature of the famous "knee" around $3 \cdot 10^{15}$ in the primary cosmic ray spectrum is quite unsatisfactory. The last measurements at the *CASCADE* installation have still more confused this problem instead of making it clear. According to the analysis of the EAS's muon and hadron components, the primary composition seems to be heavy, but the data concerning electron-photon component indicates that the protons do prevail among cosmic particles [2].

The main EAS component used for the determination of the "knee" position is the number of charged particles, N_e. Fig.1 shows the correlation between the shower size and atmosphere depth observed with the used of various EAS arrays [3]. One can see a very large data scattering on the plot even in the framework of one experiment. It is very important that it is impossible to find a depth dependence of the "knee" position. This ambiguous situation permit to draw various and contrary conclusions on origin of the kink in the N_e spectrum, beginning from the traditional diffusion model up to the violation of the hadron interaction properties [3].

The kink position in N_e spectrum at various depths is related to the shower absorption with depth. In the framework of QGS-based models, the attenuation

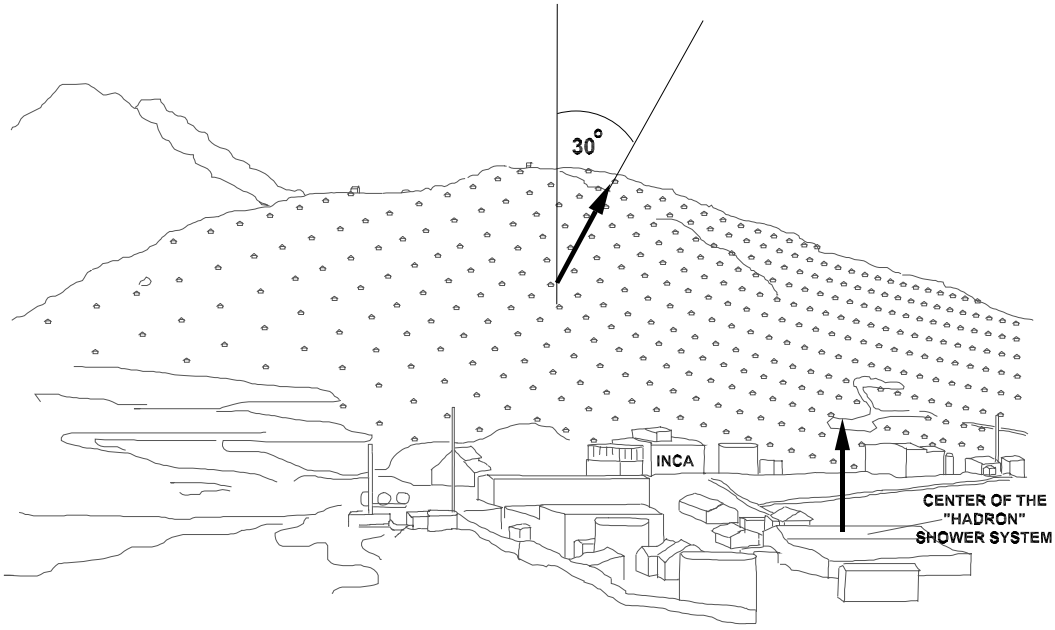

Fig. 2. Layout of the *ATHLET* installation in the plane of Tien Shan station. Small triangles indicate the position of detectors of the new planned tilted shower system.

length, λ_{att}, varies at mountain altitudes from $160 - 180$ g/cm^2 for vertical showers to ≈ 80 g/cm^2 at zenith angles $\theta \sim 45^\circ$ [4]. Thus, the dependence of the kink position in N_e spectrum on atmospheric depth must be essentially more strong for measurements carried out at one point under various angles than for measurements carried out for vertical EAS's at different depths. In this connection it is very strange that Tien Shan and EAS-TOP experiments do not observe any shift of the kink position in N_e spectrum although the EAS intensity decreases with depth by $40 - 50$ times. If this phenomenon cannot be explained by methodical reasons, it is necessary to use rather unconventional physical models of EAS development in the atmosphere. In this connection we would like to remind that a series of unusual phenomena and events are observed in various cosmic ray experiments just in the same energy range [5-7].

The primary goal of the *ATHLET* complex is the solution of this problem, i.e., the determination of the kink position in N_e spectrum from measurements of both the EAS's angular distribution as well as the vertical EAS intensity at different altitudes (3340, 1750, and 850 m a.s.l). To solve this problem, the horizontal part of the *HADRON-M* installation is supplemented with an inclined EAS array (Fig.2) that will permit to measure N_e spectra at different angles, in part, at $\theta = 0^\circ$ and 60° under the similar conditions of the detector position with respect to the EAS direction.

To study anomalous phenomena in EAS cores, the second ionization-

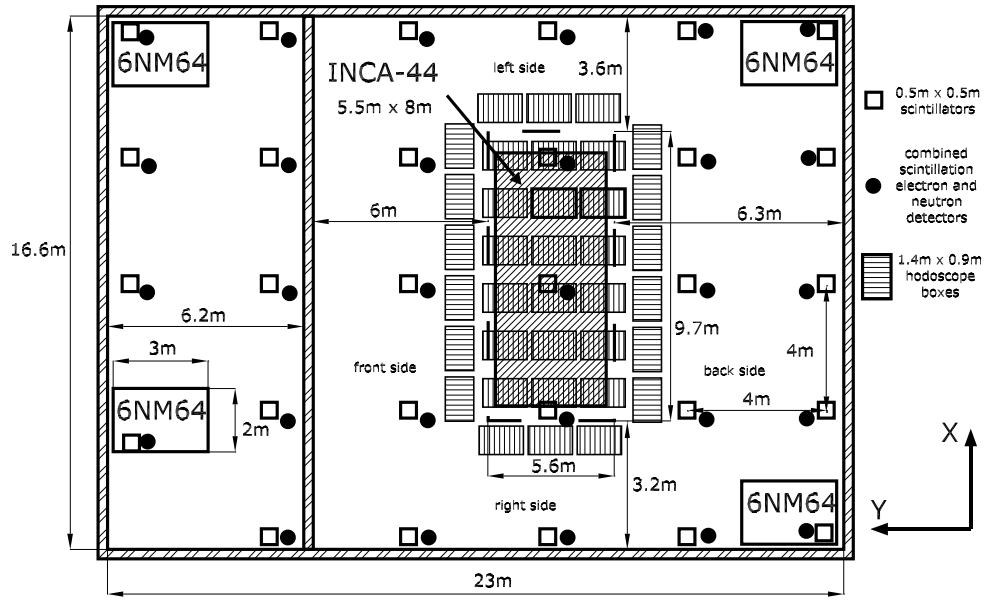

Fig. 3. The plan of the second center of the *ATHLET* complex.

neutron calorimeter (INCA-44, 44 m^2) is constructed in addition to the *HADRON-M*'s INCA (160 m^2). Both the calorimeters are planned to be used together with X-ray emulsion chambers similar to those applied by PAMIR Collaboration. A series of different detectors (20-m^2 central hodoscope, four NM-64 neutron monitors, and an array of 30 scintillation detectors) are positioned above and around INCA-44 (Fig.3) that will permit to study lateral and temporal distributions of various components in the vicinity of the EAS axis.

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3. References

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