ABOUT INCREASE OF THE LARGE $p_\perp$ PROCESSES FRACTION IN hA INTERACTIONS AT ENERGIES $5 \cdot 10^{14}$- 10^{16} eV ACCORDING TO THE DATA ON E.A.S. HADRONS

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The lateral distributions of EAS hadrons obtained at Tien-Shan array are compared with the simulations.The simulation data have been treated by the same way as experimental data, included the recording method. The comparison shows that the experimental hadron lateral distributions are wider than simulated ones.On the base of this result the conclusion is drawn that the fraction of processes with large $p_\perp$ increases in hadron-air interactions at energies $5 \cdot 10^{14}$-10^{16} eV compared with accelerator data in p-p interactions at lower energies.

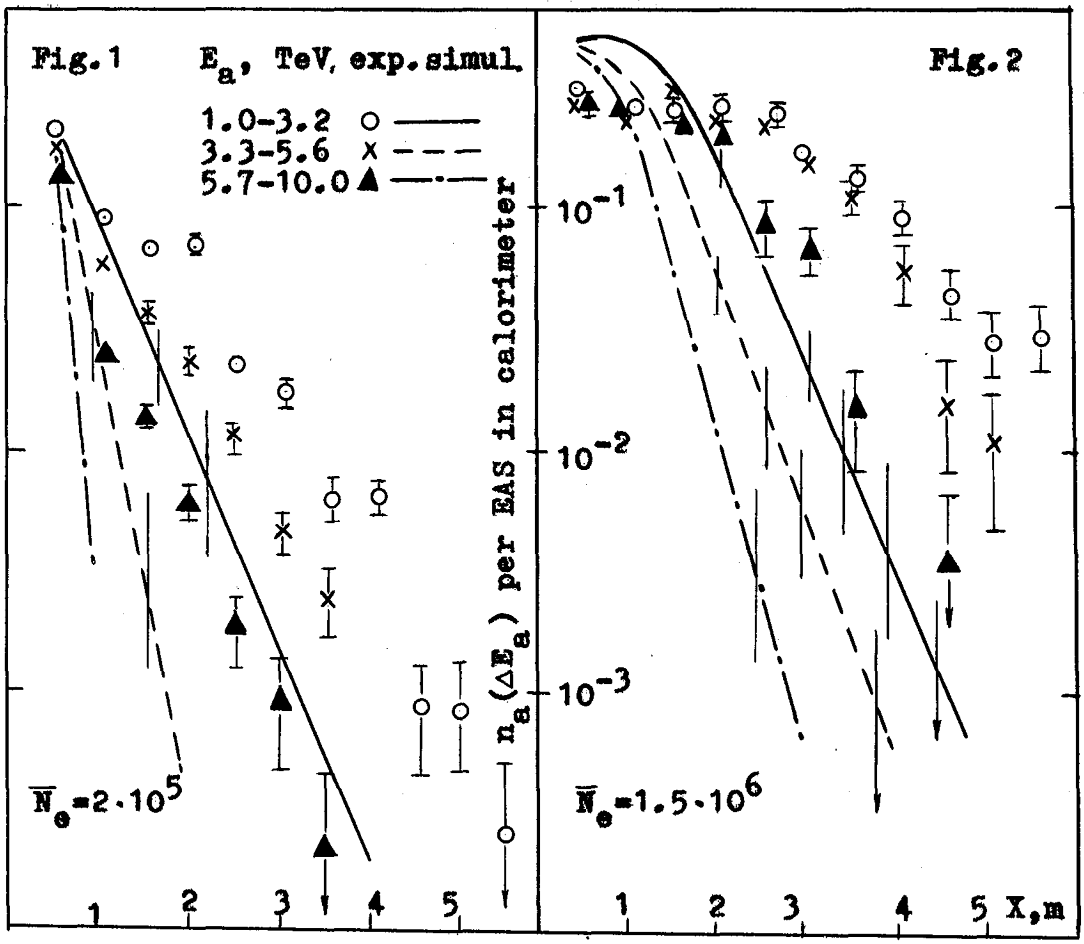
Introduction. The hadron lateral distributions of EAS detected by Tien-Shan array /I/($N_e \geqslant 1.3 \cdot 10^5$; p_o = 690 $g.cm^{-2}$) were published previously /2,3/. It was found that the experimental distributions were wider than simulated ones and the difference increased with EAS size N_e. The more rapid rise with energy of the transverse momentum in hadron-air nuclei interactions has been assumed at primary energies $E > 5 \cdot 10^{14}$ eV compared with the lower energies.

It is difficult to explain this result by variation of the primary mass composition, because calculations show a weak dependence of hadron lateral distribution at distances R=1,5-5 m from EAS axis on primary composition.

Method. EAS electron-photon component parameters (N_e-size; X_o , Y_o - axis coordinates; θ , φ -zenith and azimuth angles; S - "age" and so on) have been determined by means of the multichannel scintillation and G.M.counter system. The energy and coordinates of hadrons have been determined by means of the ionization calorimeter ($\sigma_{tot.}$ = 36 m^2). The descriptions of methods and accuracies were given in /1,2,3/.

The hadron density has been calculated as ρ_a (R) = n_a (R)/σ for various distances R; (n_a is the number of hadron cascades detected in the calorimeter; $\sigma(R, X_o, Y_o, \theta, \varphi)$ is the area within the bounds of the calorimeter). The special simulation /3/ demonstrated the correctness of n_a (R) to ρ_a (R) restoration and the small influence of coordinate location inaccuracies. It is necessary to take into account the limited lateral resolution of hadron detectors (ionization chambers). It is possible that the hadron cascades in the calorimeter could be formed by several hadrons separated by distances smaller than the chamber size (0.25 x 3) m^2.

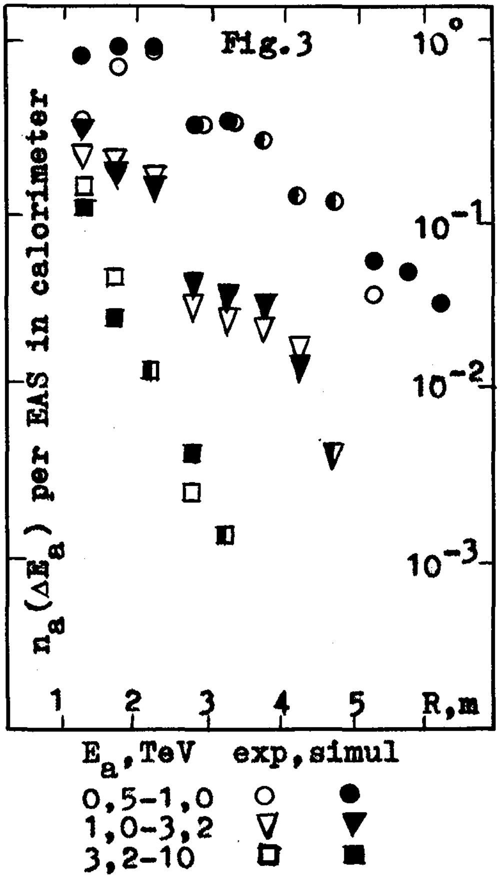
In this report Tien-Shan experimental results on lateral distributions of hadron cascades in the calorimeter: n_a (R, Δ E, N_e) are compared with the simulation data



based on atmospheric nuclear cascade model. The simulation data have been treated by the same way as experimental ones (selection, recording and processing criteria).

Experiment. On the base of ~ 5000 EAS the dependence of hadron cascade number in calorimeter on R was obtained at distances R = 1-6 m from axis in various intervals of energies E_a (ΔE_a) from 0.5 to 10 TeV and various intervals of N_e . The showers with axes passed through the upper plane of the calorimeter have been selected. EAS axis parameters (X_o , Y_o , Θ , φ) were estimated by scintillation counters for the selection and after that they were corrected with the help of lateral parameters of hadron cascade with maximum energy. The cascade energy has been measured at 150-820 g.cm^{-2} of Pb absorber in the calorimeter. The special calculation shows that this energy is equal to the energy of incident hadron on the average. The cascades which passed through the side chambers were not taken into account. The experimental results are presented in fig.1 and 2.

Simulations. The results of Monte-Carlo atmospheric nuclear cascade simulation were used to compare with the experiment. The detailed interaction characteristics at accelerator energies have been taken into consideration /4,5/. Previously the results of the calculation were checked by EAS expe-



rimental data at small N_e ($E_0 = 10^{13} - 10^{14}$ eV). The energy dependence of the transverse momentum was taken as: $p_\perp = 0.02 \lg E + 0.38$ for nucleons and $p_\perp = 0.02 \lg E + 0.295$ for pions. Two versions of secondary particles energy spectrum were examined, where the "scaling" was preserved ($\alpha = 0$) and it was violated ($\alpha = 0.25$) /6/. The "normal" mixed primary composition was considered ($\sim 40\%$ of protons). The simulation data for hadrons with the energy threshold $E_a \geqslant 0.5$ TeV were used. At first, the distortion due to the limited lateral resolution of hadron detectors was analysed. Hadrons incident on the square of (0.25×0.25) m^2 size have been combined to one cascade as in /7/. This size is equal to transverse size of ionization chambers in the experiment. The energy of the cascade was determined as the sum of energies of all hadrons in the square. The mutual perpendicular chamber disposition at adjacent rows allows to select the cascades in this square.

In fig.3 the simulation results for the number of separate hadrons are compared with the number of hadron cascade in the calorimeter. The data are presented for showers of $\bar{N}_e = 6 \cdot 10^5$, $\Theta < 45^0$ in three intervals of E_a : $\Delta E_a = (0.5-1)$; $(1-3.2)$; $(3.2-10)$ TeV. The data in fig.3 show that the number of hadron cascades on (0.25×0.25) m^2 square does not differ so much from separate hadron number at distances (1-5) m from axis.

<u>The experimental and simulation result comparison</u>. On the base of simulations one can conclude that the previous experimental data /2,3/ of hadron lateral distribution are not almost distorted by detection methods at distances R = 1-5 m from the EAS axis.

In oder to avoid the errors due to possible wrong identification of hadron cascades in two projections in the calorimeter, the new treatment of experimental and simulation data has been carried out by examination of only on X projection. In this case the total thickness of absorber above the chamber has been taken into account in the treatment of the experiment and the hadrons incident on the area (0.25×3) m^2 (the size of the ionization chamber) are combined to cascades in simulation.

In fig.1,2 the experimental data on hadron cascade number n_a (X, $\triangle E_a$, N_e) passed through the calorimeter at different X distances are compared with the simulations for the version of "scaling" model treated by the same way as experimental ones. The data for three intervals of E are presented for two intervals of N_e : N_e = (1,3-3,2).10^5; $\overline{N}_e = 2.10^5$ and N_e = (10-32).10^5; $\overline{N}_e = 1.5.10^6$. The experimental results are shown by figures, the simulated ones are by lines. It is seen from fig.1,2 the experimental distributions are wider than simulation ones. The preliminary additional calculation indicates: if hadrons with energies $E_a < 0.5$ TeV are taken into account the result changes not so much.

Conclusions. The analysis of lateral-energy EAS hadron characteristics has been carried on the base of experimental statistical material several times greater than before /2,3/. Atmospheric nuclear cascade simulations made within assumption of "normal" weak rise of $p_\perp$ (E) were carried out in the same conditions of detection and treatment as in the experiment. The comparison experimental and simulation results indicates the increase of large transverse momentum $p_\perp$ (E) processes in hadron-air nuclear interactions at energies 5.10^{14}-10^{16} eV compared with lower accelerator energies in p-p interactions. It permits one to assume that the fraction of hadron "jets" with large $p_\perp$, observed at accelerator experiments, increases with energy. This effect is predicted by QCD-theory /8/ in processes of deep inelastic scattering of partons. The special calculation is necessary to determine influence of these processes on the EAS hadron lateral distribution at $E_0 > 5.10^{14}$ eV. However, the approximate estimation has been carried out by us on the base of QCD-theory /8/ indicates to possibility to explain Tien-Shan experimental data by means of the large $p_\perp$ "jet" production.

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