



Estimation of depth of maximum by relative muon content in air showers with energy greater than 5 EeV measured by the Yakutsk array

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In this work, an estimate of the depth of the maximum development was made, independent of the model of hadron interactions, by the parameter $\rho_\mu(600) / \rho_{\mu+e}(600)$ in showers with energies above 5 EeV. The average values of $\langle X_{\max} \rangle$ and their dependence on energy were found from the data in a wide range of energies.

Based on these data, an estimate of the CR MC was made above 5 EeV, which indicates a change in MC. This follows from a comparison of the experimental data X_{\max} , $\sigma(X_{\max})$ and calculations using different models of hadronic interactions shown in Fig. 1 and Fig. 2.

Using results of this work and results of other experiments it can be concluded that CR MC consists of mix of light nuclei in energy interval 5-10 EeV (Fig. 2, Fig. 3). It also indicated by fast displacement rate of X_{\max} to sea level $ER = (63 \pm 5) \text{ g/cm}^2$ (Fig. 1), which is distinctive for mix of light nuclei --- protons and helium nuclei.

For energies greater than 30 EeV, as can be seen from Fig. 4, CR MS starts to change to heavier elements --- CNO and iron nuclei.

The independent MC results obtained by measuring air shower radio signals at the Yakutsk facility and the LOFAR do not contradict these conclusions. It should be noted that the results obtained for MC are preliminary, because the models used do not fully reflect the real development of air shower, for example, in terms of muons. Discussions are currently underway on this issue.

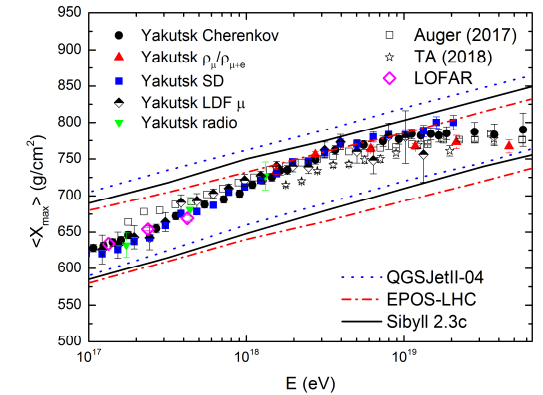


Fig. 1

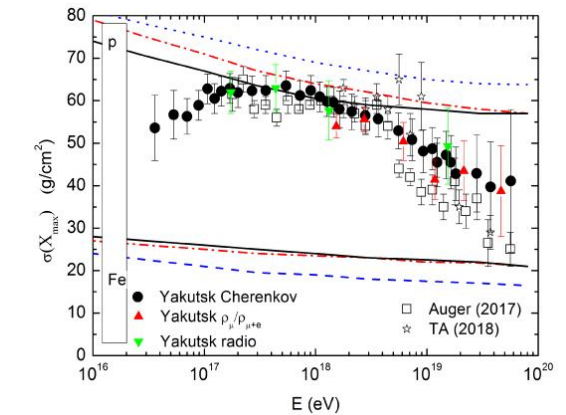


Fig. 2

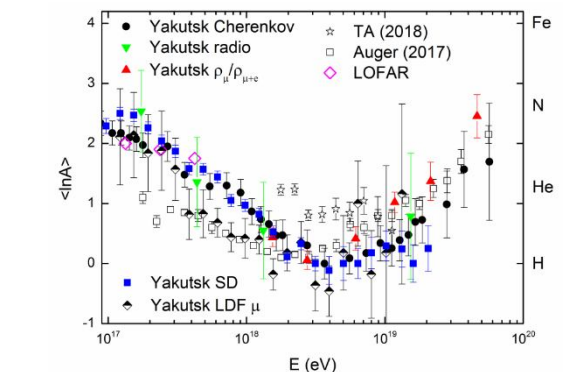


Fig. 3