# Some characteristics of extensive air showers at Chacaltaya observation level

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## Abstract

One of the principle problems in high energy astrophysics are the investigations of cosmic rays, precisely their spectrum and mass composition. In this paper in attempt to facilitate future experiments based on different technics and registration of different components of extensive air showers some characteristics are simulated using CORSIKA code. In the very interesting energy range $10^{12} - 10^{16}$ eV for primary proton and gamma quanta and $10^{12} - 10^{16} eV$ for primary iron and helium the lateral distributions of Cerenkov light, electron, muons and hadrons are obtained for Chacaltaya observation level ($536 g/cm^2$).

## 1. Introduction

Cosmic rays are the most energetic particles ever measured. The precise determination of their spectrum in the range above of $10^{14}$ eV is very important in aim to obtain some information of their origin and acceleration mechanisms. Other important problem is the mass composition of primary cosmic ray flux. It is clear that in the very interesting region of high and ultra high energies the only possible way of cosmic rays registration is indirect from extensive air showers produced in atmosphere. The reconstruction of the energy and the mass composition from ground observation alone is very difficult but possible from measuring one or few components of an extensive air shower. Most of the well known operational experiments use coincidence technique. One experiment in preparation is HECRE [1]. This is a complex one at Chacaltaya cosmic station. According the proposal one has detectors for muon registration, electromagnetic component registration and finally detectors similar to AEROBICC [2] for Cerenkov light registration. In attempt to simulate precisely the configuration and detector response some characteristics of extensive air showers are simulated using CORSIKA [3] code using VENUS [4] and GHEISHA [5] like hadronic models.

pp. 247–250 

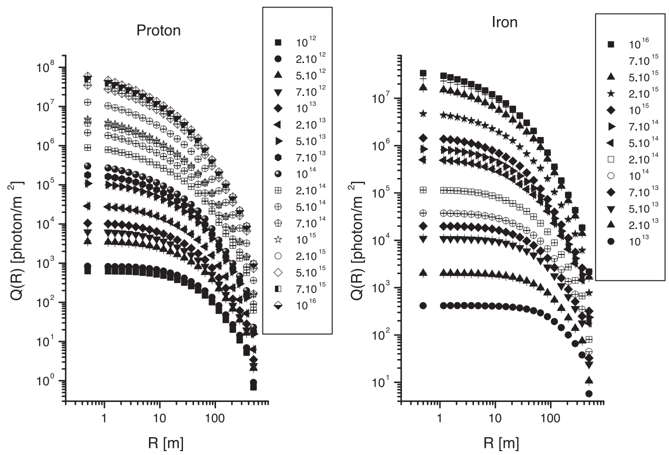


**Fig. 1.** Lateral distributions of Cerenkov light for proton and iron.

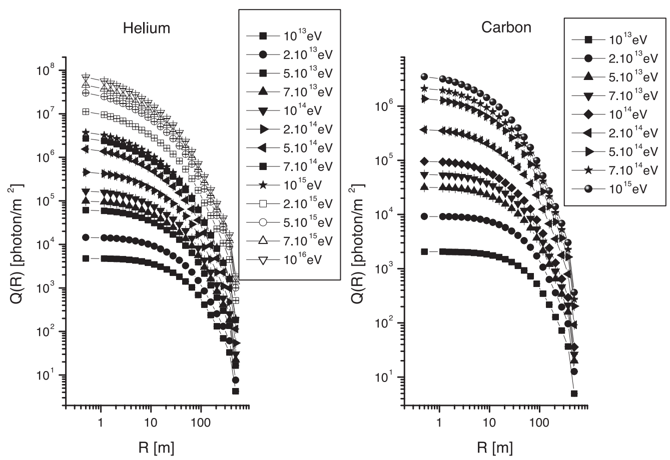


**Fig. 2.** Lateral distributions of Cerenkov light for Helium and Carbon.

## 2. Simulations

Then lateral distributions of Cerenkov light, electrons, muons and hadrons in EAS at Chacaltaya observation level ($536g/cm^2$)in the energy range $10^{12} - 10^{16}$ eV are obtained with help of CORSIKA [3] code using VENUS [4] and GHEISHA [5] like hadronic models for primary proton, iron helium and carbon nuclei and primary gamma quanta. One large detector 800x800m is used in attempt to reduce the statistical fluctuations. The lateral distributions of Cerenkov light for primary protons and iron is shown in fig.1 and for helium and carbon at fig.2.

The obtained lateral distributions for electrons are presented in (fig.3 and 4) and muonic lateral distributions (fig. 5 and fig.6). Using previously defined selection parameter [6] and the relative fluctuations of $N_e$ and $N_\mu$ is possible to obtain sone information about the mass composition of primary cosmic radiation.

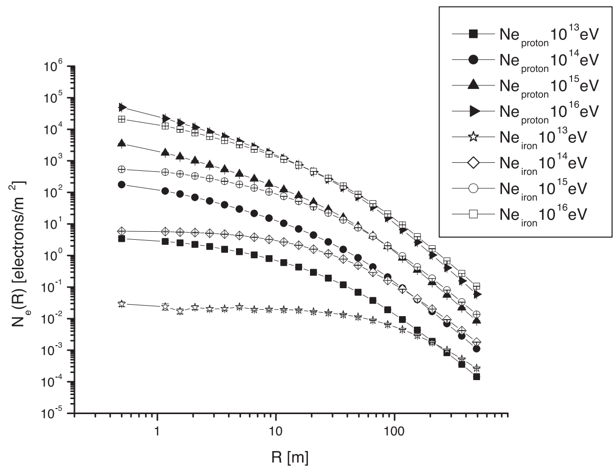


**Fig. 3.** Lateral distribution of electrons for primary proton and iron.

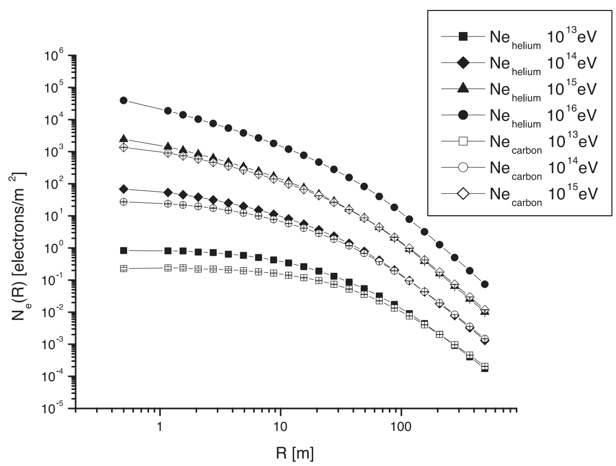


**Fig. 4.** Lateral distribution of electrons for primary helium and carbon.

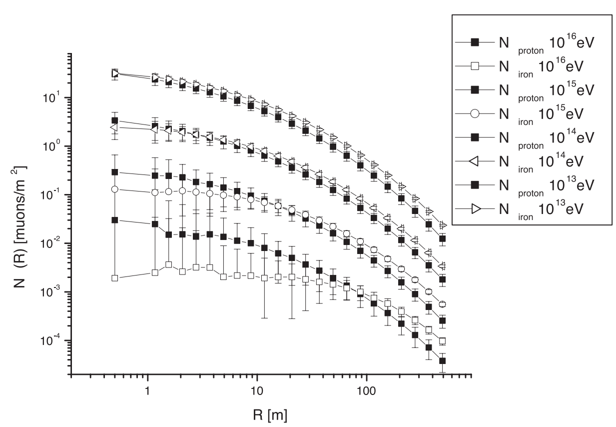


**Fig. 5.** Lateral distribution of muons for primary proton and iron..

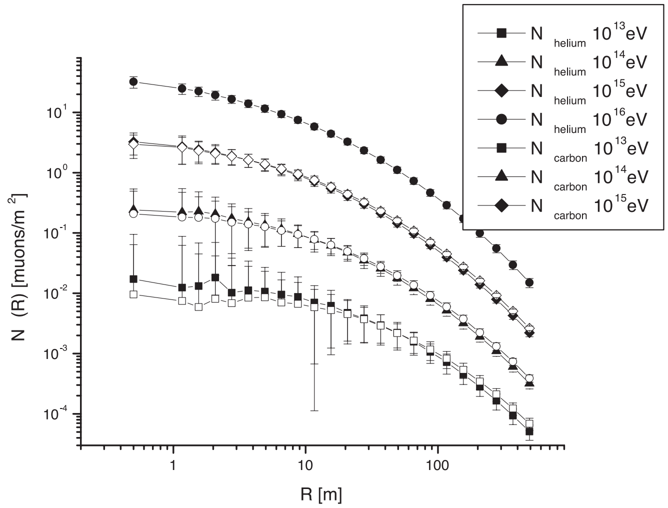


**Fig. 6.** Lateral distribution of muons for primary helium and carbon.

Analogical simulations are made for primary Helium and Carbon and primary gamma quanta shown in fig.2. The simulated data are the basis on a new methodology for energy estimation and mass composition studies of primary cosmic ray using only the atmospheric Cerenkov light densities measurements (see the paper presented in this conference and [7]). Moreover an analytical approximation for Cerenkov light distribution is proposed.

## 3. Discussion

Many cararteristics as Cerenkov light, electronic muonic and hadronic components of EAS at Chacaltaya observation level are obtained using CORSIKA code. One can see the different behavior of lateral distributions especially Cerenkov light for the different primaries and as was pointed out this is the basis for new methods for cosmic ray spectrum and mass composition studies also for the development of new technics.

## 4. References

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