CHAPTER 4

SUMMARY , DISCUSSION AND CONCLUSIONS

In the present study , the electrons and muons in Extensive Air Showers have been detected by the NBU air shower array operating near sea-level.Radial electron density distribution is determined by using 19 scintillation detectors located at various points (Fig.1.1) covering an area of ~ 1200 m^2 and the momenta of muons have been measured by two shielded magnet spectrographs separated from each other at a distance of 4m . The muons having momenta in the range 2.5 GeV/c - 100 GeV/c have been taken for analysis in the present study . Results obtained from the analysis of the measured data are compared with the experimental results of other EAS experiments as well as Monte Carlo simulation results based on different high energy interaction models to draw conclusion about the primary mass composition.

The first chapter of the thesis presents an introduction to EAS phenomena with special emphasis on the discussion on detection of EAS muons to extract information about the Primary Cosmic Ray mass composition . A brief review of the previous works particularly concerned with the composition of primary mass is also given in this chapter.

The details of the present experiment for detection of EAS electrons and muons of various energies are discussed in the second chapter . Analysis of EAS data for the estimation of air shower parameters and errors in the estimated shower parameters are also included in this chapter . The chapter includes the description of the operation of the whole data acquisition system consisting of shower selection system , timing data handling system , density data handling system and muon data handling system . The χ^2 - minimisation procedure for the estimation of air shower parameters and the artificial shower analysis for the measurement of errors on the estimated shower parameters have been given . The sensitivity of the EAS array of detecting showers at different N_e and s have also been discussed in terms of the computed detection efficiency and triggering probability in the same chapter.

Experimental results are presented , discussed and compared with the experimental results of other EAS groups in the third chapter

Various Monte Carlo simulation results based on different high energy interaction models are also presented to compare with the present experimental results in this chapter. The main results of the present study with conclusions as presented in the third chapter are the following

(1) The mean energy of the Primary Cosmic Ray particle (protons) is obtained from the energy scale established on the basis of hybrid Monte Carlo model (Trzupek et al , as referred to in the third chapter) at sea-level.

Similar such relation between the primary energy and shower size was obtained from the calculated results of Wrotniak and Yodh (as referred to in the third chapter) using Monte Carlo simulation results has also been given.

(2) The measured radial distribution of electrons in EAS of various shower sizes in the radial range 0-40m have been presented and compared with the distributions obtained from Hillas (as referred to in the third chapter) structure function . It has been observed that the Hillas function represents a good fit to the observed density distribution in 0-40m radial range.

(3) A comparison of the measured radial muon density distribution has been made with the experimental results of Khrenov (1961), Khrenov (1966) , Earnshaw et at , Rada et al , Atrashkevich et al and Vashkevich et al.(all are referred to in the third chapter) It is seen that the measured muon density distribution agrees well with those of Khrenov (1961) and Earnshaw et al for $E_\mu \geqslant 10$ GeV and with the results of Atrashkevich et al but for $E_\mu \geqslant 50$ GeV. Again for $E_\mu \geqslant 100$ GeV the measured radial muon density distribution agrees with those reported by Vashkevich et al.

Measured radial density distribution of muons have also been compared with the calculated results using Greisen distribution function and Khrenov and Linsley distribution function .It is seen that the radial muon density distribution agrees well with the distribution of Khrenov and Linsley but deviates from the Greisen's predictions.

(4) Results on the energy spectra of EAS muons at different shower sizes and radial distances have been presented.

(5) Comparison of the observed variation of muon density to electron density ratio as a function of radial distance with the Monte Carlo simulation results calculated by S.Mikocki et al (as referred to in the third chapter) has been made.

(6) The observed variation of the total number of muons (N_μ) with shower size (N_e) for $E_\mu \geqslant 2.5$ GeV has been compared with the Monte Carlo simulation results calculated by Wrotniak and Yodh (as referred to in the third chapter)on the basis of nuclear interaction model MF01 for proton primary and RM-F00 for iron primary for $E_\mu \geqslant 2$ GeV . For $E_\mu \geqslant 10$GeV, the observed N_μ-N_e variation has been compared with the calculated results of Hillas (as referred to in the third chapter) based on Feynman-Yan scaling model.Comparison has also been made of the observed N_μ-N_e variation for $E_\mu \geqslant 10$ GeV with the Monte Carlo simulation of Bourdeau et al.

All these comparisons show that the observed N_μ-N_e variations are close to the simulated results for mixed composition of the Primary Cosmic Ray.

(7) The variation of muon density with shower size at fixed radial distances and at various muon threshold energies has been studied and it is seen that the radial muon density distribution at low and high muon energies does not change with the primary energy.

(8) Finally, the variation of muon density with radial distance in showers of various sizes has been investigated . These variations show that the radial muon density distribution steepens in the primary energy range 4.3×10^{14}-4.6×10^{15} eV indicating that the effective primary mass decreases between 4.3×10^{14} and 4.6×10^{15} eV.

All these results discussed above seem to indicate that the primary mass composition is mixed in the primary energy range 2.48×10^{14} - 8.34×10^{15} eV (shower size range 3.15×10^{4} - 1.79×10^{6} particles) and the effective primary mass decreases with the primary energy in the energy range 4.3×10^{14} - 4.6×10^{15} eV.