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The fluctuations of EAS core at Akeno

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Abstract

Core structure of EAS has been observed at Akeno. Core detectors consist of 64 0.25m^2 scintillation ones and calorimeter with 4 layers of the concrete shield between proportional counters. The scintillation detectors are set above the calorimeter are arranged in a lattice configuration with a unit length 1m. The fluctuations of EAS core are analyzed with EAS size and muon size. These results show that the fluctuations of particle density near to EAS core seem to increase with EAS size more than the latter half of 10^6 and with muon size more than the middle of 10^5.

1. Introduction:

The highest energy obtained by accelerator is so far $\sqrt{s} = 1.8$TeV by Tevatron collider. Above this energy elementary particle interaction may not be investigated without super high energy cosmic rays. Such high energy, above 10^{16}eV, may be observed by only extensive air shower (EAS). The character of EAS may be appeared to central part of EAS in many cases. So we have observed core structure of EAS for a long time and have found that the fluctuations of EAS core seem to slightly increase as N_e. We accumulate more data of EAS core and confirm relation between the fluctuations of EAS core and N_e and also discuss relation between the fluctuations of EAS core and N_μ.

2. Experimental:

EAS core detectors consist of 64 0.25m^2 plastic (0.5m $\times$ 0.5m $\times$ 0.05m) scintillation detectors and are set up at Akeno ME4 station (ref.1). In order to observe many particles per detector, special photomultiplier tube (PMT) is used to be able to observe wide dynamic range. The name of this PMT is R1084 made by Hamamatsu photonics. The signal of PMT passes through pre and main amplifier, enters AD converter and is recorded by Automatic Digital Recorder (ADR). Relation between relative intensity and ADR of PMT, R1084 is shown in Fig.1. From this figure dynamic range is obtained of about 4.5 orders. From this result this scintillation detector can observe from 1 to 30,000 cosmic ray particles and may be applied to the observation of EAS with size (N_e) up to 10^7.

3. Results and Discussions:

In the last conference (Durban), we reported many cores of EAS, and when one scintillation detector of 64 core detectors show higher density than some other detectors near to it with the exception of main core, we called it sub peak. It is shown that fraction of events accompanied with sub peak seems to increase as N_e above $N_e=2.2\times10^6$. In this conference, we have studied relation between fraction of events accompanied with sub peak and N_μ. Now at Akeno, muon detectors consists of 8 one GeV detectors. Each muon detector has concrete shielding of thickness of 2m and it consists of an array of proportional counters of $25m^2$ (ref.2). N_μ is obtained by using Greisen's formula (ref.3). Relation between relative deviation RD and N_μ is shown in Fig.2 (ref.1). Fraction of events accompanied with sub peak is shown in Fig.3 with N_μ. The fluctuations of particle density near to the EAS core seem to increase as N_μ above the middle of $N_\mu=10^5$. Fraction of events accompanied with sub peak also increases as N_μ. Converting N_μ to primary energy E_0 is given by Akeno group (ref.4). From the fact that the fluctuations of EAS core depend on both N_e and N_μ, there may be two possibilities ; either change of nuclear interaction or primary composition above 10^{16}eV.

4. References:

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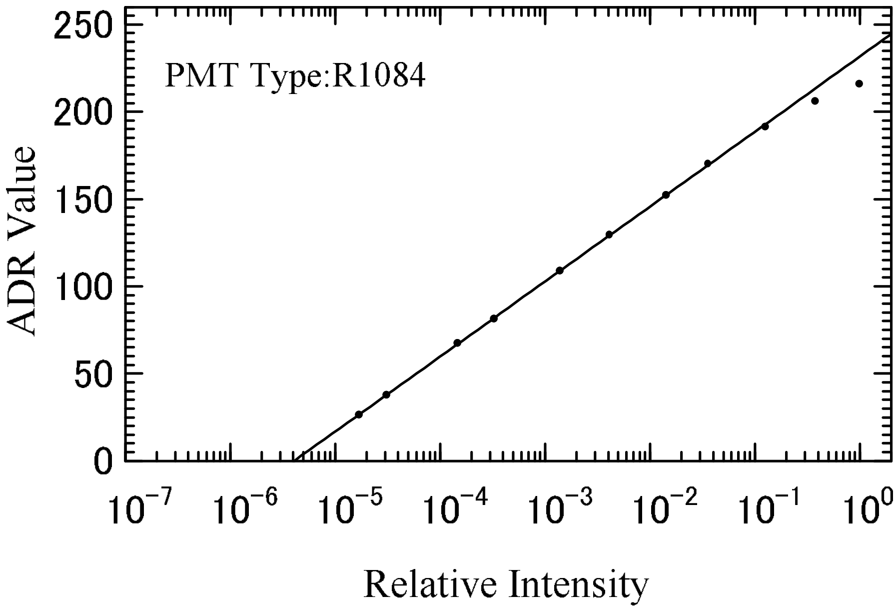

Fig.1

Relation between relative intensity and ADR of photomultiplier tube

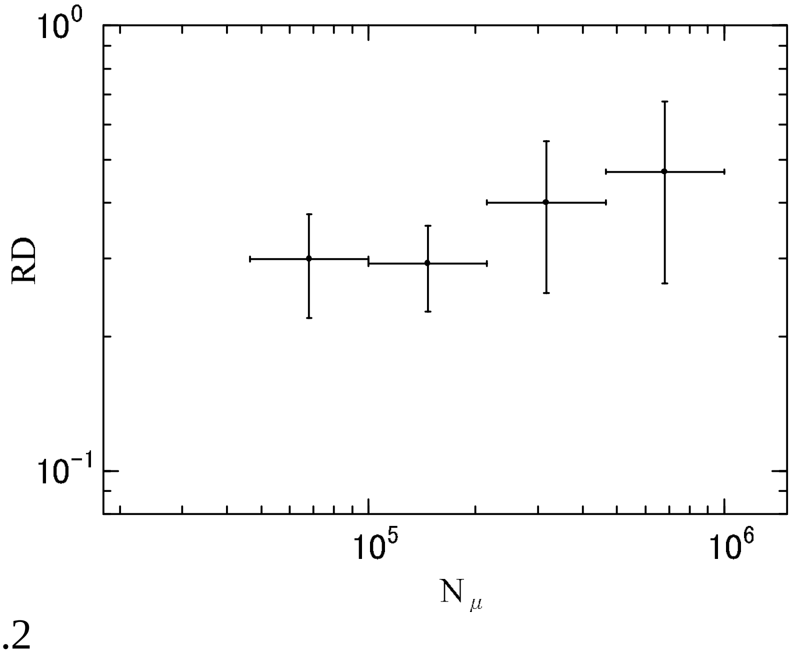

Fig.2

Relation between relative deviation RD and muon size N_{μ}

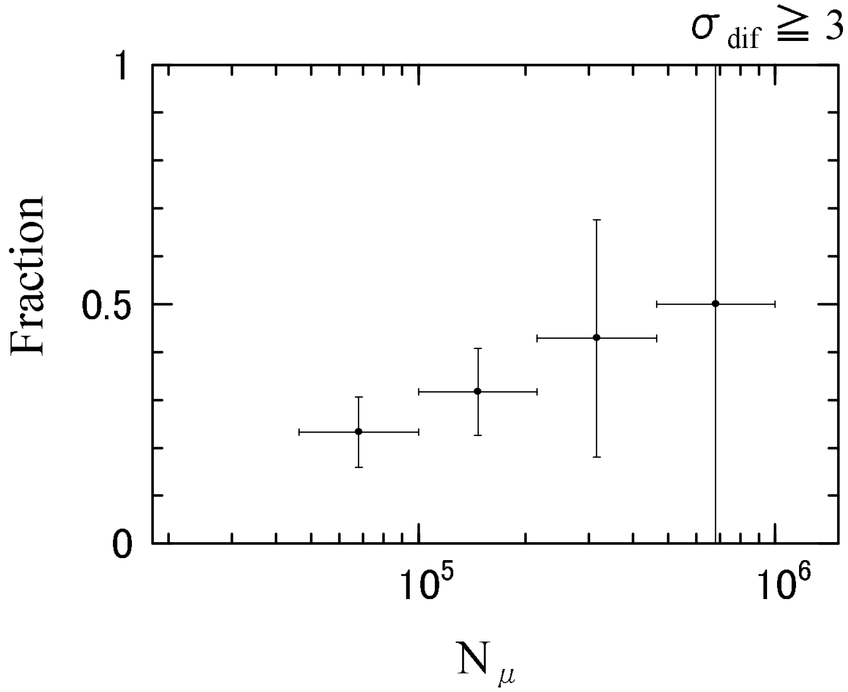

Fig.3
Fraction of events accompanied with sub peak with muon size N_μ