Observation of EAS Core with the Small Scintillation Detector at Taro

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Abstract

We have observed the core structure of extensive air showers(EAS) that primary energy above 10^{16}eV. To measure the more detail and the correct density of the incident particles near EAS core, we installed 100 small scintillation detectors (using plastic scintillator : 15cm × 15cm × 2.5cm) that are placed on a lattice 10 × 10, and 40cm separation, at Taro Cosmic Ray Laboratory, at autumn 2002. We report the detail of the small detector, and preliminary results.

1. Introduction

Measurement of the particle number correctly near EAS core with 0.25m^2 scintillation detector that we used past, is difficult when shower size is larger, because it cannot observe the particle number in the range of the linearity of PMT. Especially when shower size is greater than 10^7, the number of incident particle within the detector exceed the dynamic range of PMT. So we used the small scintillator and PMT with the small diameter of photocathode, for down to the sufficient particle number to observe EAS core, and possible to measure in the range of good linearity of PMT. From the observation of EAS core that primary energy is very high, we will discuss the primary composition and the high energy particle interacion.

2. Methods

We installed 169 0.25m^2 scintillation detectors (2.5cm thickness) arranged in a lattice 13 × 13 with 1.5m separation at the center of Taro Cosmic Ray Laboratory [1] that is located at Taro Iwate, Japan (39.8°N, 141.9°E, 200m a.s.l.), and we call this array TASC-1 (T*aro* A*ir* S*hower* C*ore detector*-1) that shown in Fig. 1. Detection area of TASC-1 is about 324m^2 and it possible to detect more EAS core. 100 0.0225m^2 scintillation detectors (15cm × 15cm × 2.5cm)

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have been set at center of TASC-1 and arranged in a lattice 10 x 10 with 40cm separation at Oct. 2002 (TASC-2) (Fig. 1). These scintillation detectors used in TASC-2 are movable, and it able to set closely, but this time, arranged to be a maximum detection area (about $13m^2$). PMT used in TASC-2 is R580 (Hamamatsu Hotonics) with 1.5” diameter of photocathode, and the characteristics of linearity is excellent. Fig. 2 shows a sample of the linearity of PMT using the Blue LED. Dynamic range of this PMT is about 5. The slope of the integral frequency of the particle number by the AS trigger was -1.526(Fig. 3).

3. Analysis

We used the data obtained from observation period : 2002.11 - 2003.04, and event was selected as following condition, 1. zenith angle $\theta \leq 25.0°$, 2. the detector recorded maximum density is within a lattice 7×7 of the central part of TASC-1, 3. average density of 4 detectors around the maximum density is more than 100 particles per detector. Selected events as 1-3 were scanned by eye in order to search the core hit in TASC-2. Finally, 335 events were selected and examined about a fluctuation of the number of partilces of EAS core.

4. Results and Discussion

Relation between the maximum density per detector each of TASC-1 and TASC-2 is shown in Fig. 4. The solid line in Fig. 4 indicates simply ratio of the detectors’ area. This distribution will depend on a spread of the high density region in the core, and on detection area of each detector, and on spacing. It shows that measurement of the number of particles was correctly both of TASC-1 and TASC-2 in this range. Relation between RD and shower size is shown in Fig. 5. Shower size smaller than 10^6, this result is consistent with the previously experiment. When shower size is greater than 10^6, the tendency seems to be different. This tendency was seen at the results of Akeno[2,3]. By calculation using CORSIKA[4], core structure seems to depend on the distribution of high energy electron and muon[5].

5. References

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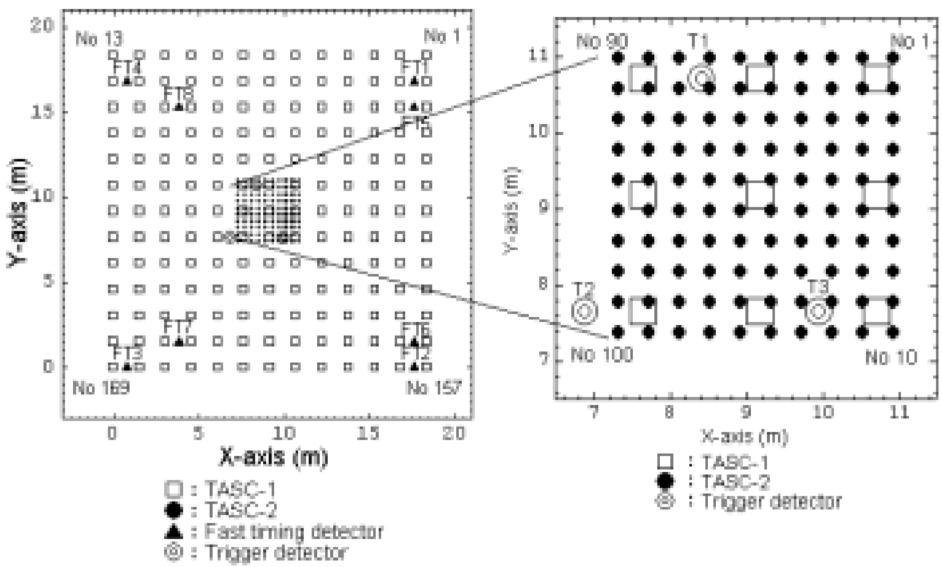

Fig. 1. TASC-1, TASC-2 Array

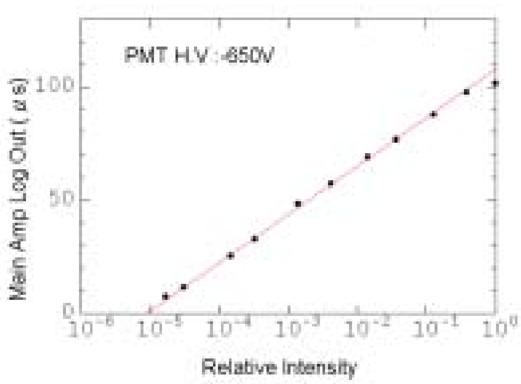

Fig. 2. A sample of the charactaristics of linearity(R-580)

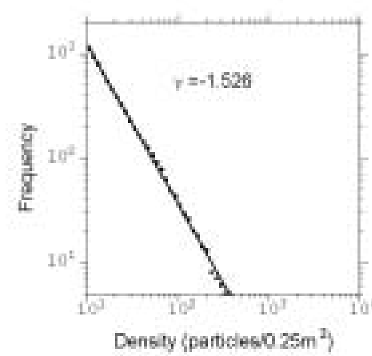

Fig. 3. A sample of integral density frequency

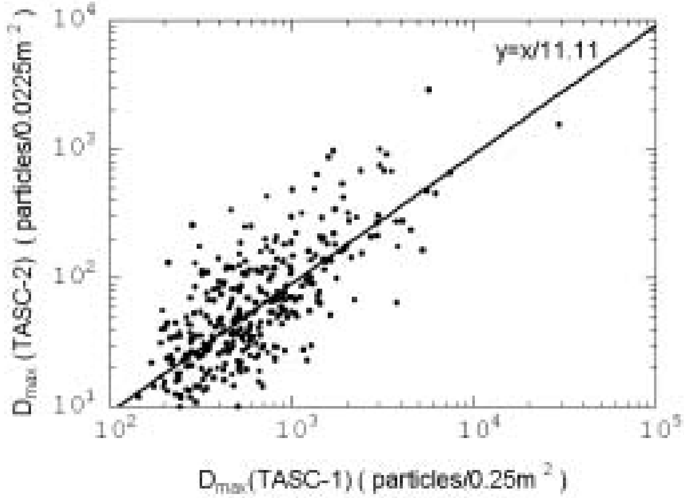

Fig. 4. Relation of D_{max} between TASC-1 and TASC-2

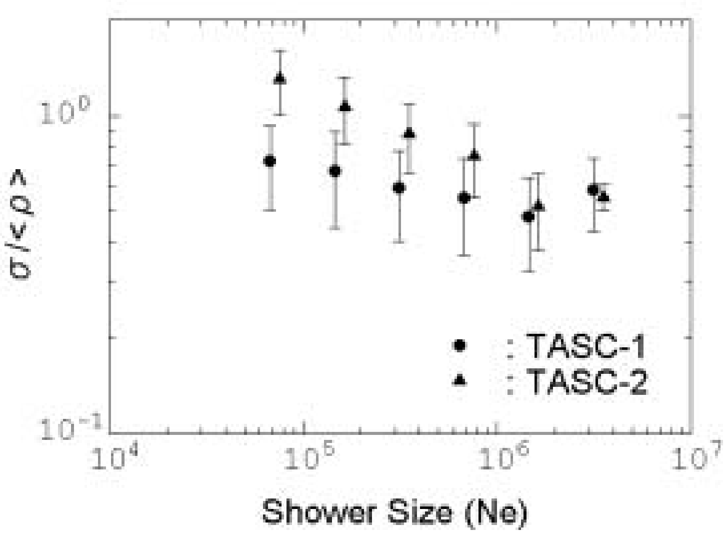

Fig. 5. Relation between RD and shower size