Arrival Time Distribution by the New Observation System at Taro

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Abstract

The arrival time distribution of EAS has been observed by using Ultra Fast Cherenkov detector (UFC) and oscilloscope at Taro observatory since 1995 (sea level 200m). The EAS array is arranged 169 sets of 0.25m^2 scintillation detectors in the shape of a lattice at intervals of 1.5m and about 40 scintillation detectors which consists of 1m^2 and 0.25m^2 is arranged in the peripheral part. Then, it consists of 8 fast timing detectors. The UFC detector is installed in the palce of about 20m from the trigger center.
The observation system of a UFC detector was changed from the autumn of 2000. The outline of a new observation system and EAS arrival time distribution are reported.

1. Introduction

It is important to observe the detailed time structure of EAS in order to know composition of the primary cosmic ray and an interaction. Then, the arrival time of EAS has been observed using the UFC detector of high time resolution at Taro since 1995.[2)] This EAS information records the analog signal output from the UFC detector using high speed A/D conversion function of the oscilloscope as waveform data of digital signal. Then, it is possible to analyze waveform data directly. Therefore, various information of EAS is obtained. UFC detector is installed in palce about 20m from center of the trigger, and it can observe time structure within 50m from the core of EAS.[3)]
Initial waveform data had combined the signal from two detectors by the adder. However, we could use all signals from each detector by using Digital Phosphor Oscilloscopes (Tektronix TDS303) and LabVIEW made by NATIONAL INSTRUMENTS in autumn, 2000 (Fig.1). This change could get start time from each detector. Therefore, arrival direction of EAS and precision of arrival time improved. This time, arraival time distribution of EAS got from UFC detector is reported

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using waveform parameter FWHM, Rise Time and Area.
Waveform is X-axis Time, Y-axis Voltage. Therefore, we think that Area of waveform is synthetic information with number of particles and time structure.

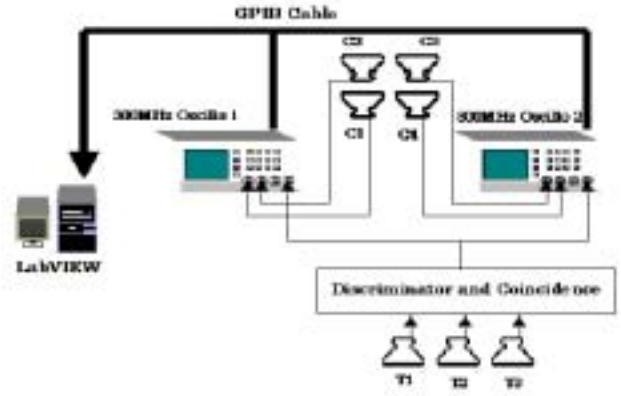

Fig. 1. UFC Observation System.

2. Observation Device

In order to observe near EAS core, 169 0.25m^2 scintillation detectors are arranged shape of a lattice (13×13) at intervals of 1.5m in center of array (TASC-1).[4] And scintillation detector of 0.25m^2 and 1m^2 of about 40 is arranged around TASC-1. All detection area are about 15400m^2. 8 fast timing detectors and 3 trigger detectors are installed on the TASC-1. Fast timing detector has the angular resolution of 1 degree. Trigger method uses 3-hold coincidence Fast Trigger System. 4 UFC detectors are installed about 20m from trigger center. The signal from UFC detector is taken in Digital Phoshor Oscilloscopes. Oscilloscope control software is constructed using graphical programming language LabVIEW.

3. Analysis

Observation period for analysis is shown in the following.
The event was selected under following conditions.

Observation periods	November 22, 2000 - January 29, 2003
Observation Times	19200 hours
Trigger Events	324409 events
Trigger Rate	16.90 events/h

1. The signal has entered in UFC detectors over 3.
2. Pulse Height of UFC detector is over 0.2V (40 particles).
3. Waveform has not been over flow on oscilloscope.
4. There is EAS core on TASC-1.
5. Zenith angle of EAS is sec$\theta \leq 1.1$.

Number of data is shown.
Cherenkov Events 18 events
• The condition of Area[ns×V] is waveform area in the region which exceed Pulse Height 10%.
•R[m] is distance from EAS core.

4. Results and discussion

FWHM, Tr, Area, relation between EAS Size (Ne) are shown Fig.2, Fig.3, Fig.4. It tended not to be able to observe the change near the EAS core by Size increase. Although we were thought that Size dependence was reflected, Area could not observe the correlation with Size. Therefore, when it thinks about relevance with Size, Area can be thought to have weight to time structure more than number of particles. Then, from these results, we think there is not large change to the time structure of near the EAS core by Size. However, Although it is some from after Size 3e+6, FWHM and rise time is observed with big value data. The waveform of this data is shown Fig.5. Such waveform is the 0.1% rare event. And because system response of our UFC detector was very much excellent, the event which had such complex time structure could be caught.
We think that fact such waveform generates is very interesting. Therefore, detailed analysis of event which this waveform generates will be carried out.

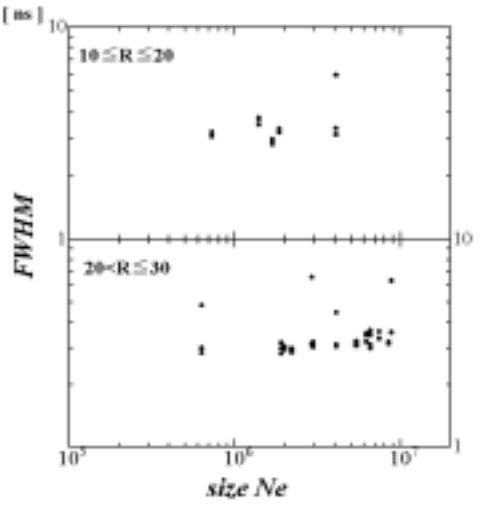

Fig. 2. The correlation of Size Ne and FWHM in R.

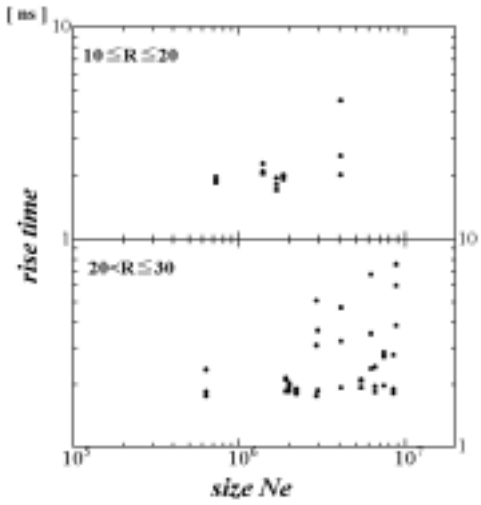

Fig. 3. The correlation of Size Ne and Rise Time in R.

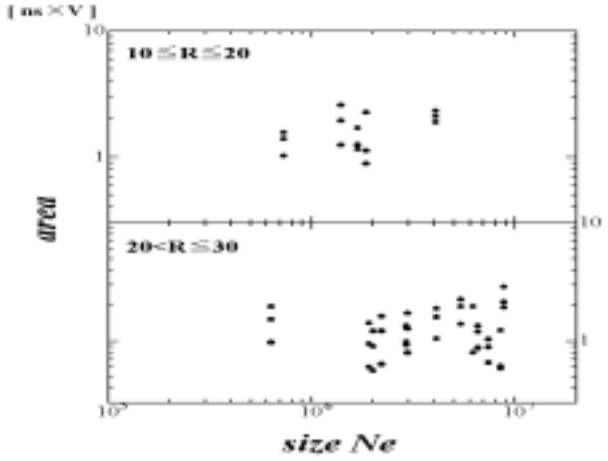

Fig. 4. The correlation of Size Ne and Area in R.

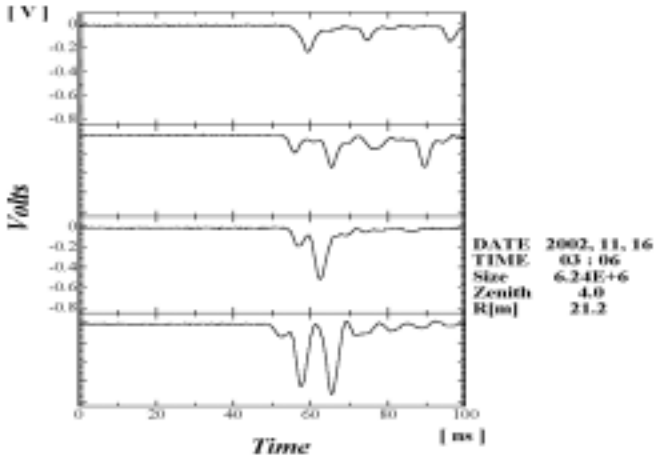

Fig. 5. The special waveform.

5. References

1. H. Sakuyama and N. Suzuki., Proc. 17^{th} ICRC 11, 309 (1981)
2. H. Sakuyama et al., Proc. 26^{th} Int. Cosmic Ray Conf. HE2.2.28 (1999)
3. T. Maeda et al., Proc. 27^{th} Int. Cosmic Ray Conf. HE1.2.4 (2001)
4. H. Kuramochi et al., Proc. 28^{th} Int. Cosmic Ray Conf. (2003)