

Arrival time distribution of EAS using Cherenkov detectors at Taro

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Abstract

EAS has been observed since 1995 at Taro. The EAS arrays consist of 5 1m^2 , 191 0.25m^2 scintillation detectors, 8 fast timing counters of 0.25m^2 and 4 ultra fast Cherenkov detectors of 0.25m^2 . 169 0.25m^2 scintillation counters are arranged in a lattice configuration with a unit distance of 1.5m. Cherenkov detectors are connected with the 400MHz-storage oscilloscope by using a 10D coaxial cable. Rise time and FWHM by these detectors have been analyzed with distance from EAS core ($r=0\sim 20\text{m}$). Rise time and FWHM seem to be almost independent of r .

1. Introduction:

Arrival time distribution of EAS near to the EAS core at Taro (200m above sea level, $206.7\text{g}/\text{cm}^2$) since 1995 (ref.1). By using ultra fast Cherenkov detector, time structure of arrival time distribution is investigated in comparison with scintillation detector in more detail. Thickness and time structure of shower disk, and mean delay time from shower front have been studied precisely. The system response of this fast Cherenkov detector is highly precise in comparison with the system response of scintillation detector. A new information of time structure of shower disk may be obtained by using this precise scale of Cherenkov detector.

2. Experimental arrangement:

The EAS experiment has been carried out at Taro. 169 0.25m^2 scintillation detectors are core detectors of EAS and have been arranged in a lattice configuration (13×13) with a unit length of 1.5m. Conventional EAS arrays of 22 0.25m^2 and 5 1m^2 detectors have also

been arranged up to 100m from the center of the lattice array. In order to observe the arrival time distribution of EAS particles, ultra fast Cherenkov detectors have been used. Up to October 1997 3 0.25m² Cherenkov detectors have been used and after that one more Cherenkov detector is added. The system response of these detectors is shown in Table 1 and also results of other group by using scintillation detector is shown. Our Cherenkov detectors are characteristic of fast photomultiplier (R1828-01, R4004), acrylic plate BC800 (BICRON), thick coaxial cable (10D-2FA) and 400MHz storage oscilloscope (TS-8422).

3. Results and Discussions:

The EAS array was triggered by three fold coincidence of three Cherenkov detectors and four fold coincidence of four scintillation detectors placed at the central part of the lattice array. EASs whose cores were inside the central 13 × 13 scintillation detectors array were adopted for the analysis. In an operating time of 4901 hours, about 34,000 showers have been recorded, when Cherenkov pulse wave with more than 6 particles per one Cherenkov detector was observed, the shower event was adopted. Relation between rise time (T_r) and distance from the core axis (r), and also between a full width at half maximum (FWHM) and r is shown in Fig.1. Relation between age parameter (S) and T_r , and also relation between S and FWHM are shown in Fig.2. Thickness of shower disk seems to be independent of r , but there are some events have more than two standard deviations (σ). No such events have found by the observation of scintillation detector. T_r and FWHM show a tendency to increase slightly as N_e increases.

4. References:

1. H. Sakuyama et al., Proc. 25th ICRC Durban, 7, 241 (1997).
2. H. Sasaki et al., ICRR report, 47-85-1, 105 (1985).
3. Y. Toyoda et al., ICRR report, 38-83-1, 95 (1983).

Table 1 System response

	Meisei Univ.			Koti Univ.		Kobe Univ.	
	Cherenkov Number	PT-Pulse	Single Muon	PT-Pulse	Single Muon	PT-Pulse	Single Muon
rise time (ns) [10~90%]	C1	1.43	1.5	2.51	3.45	2.5	4.6
	C2	1.56	1.5				
	C3	1.44	1.4				
	C4	1.45	1.4				
FWHM (ns)	C1	2.44	2.2	4.37	6.44	5.5	8.5
	C2	2.34	2.2				
	C3	2.23	2.1				
	C4	2.35	2.2				

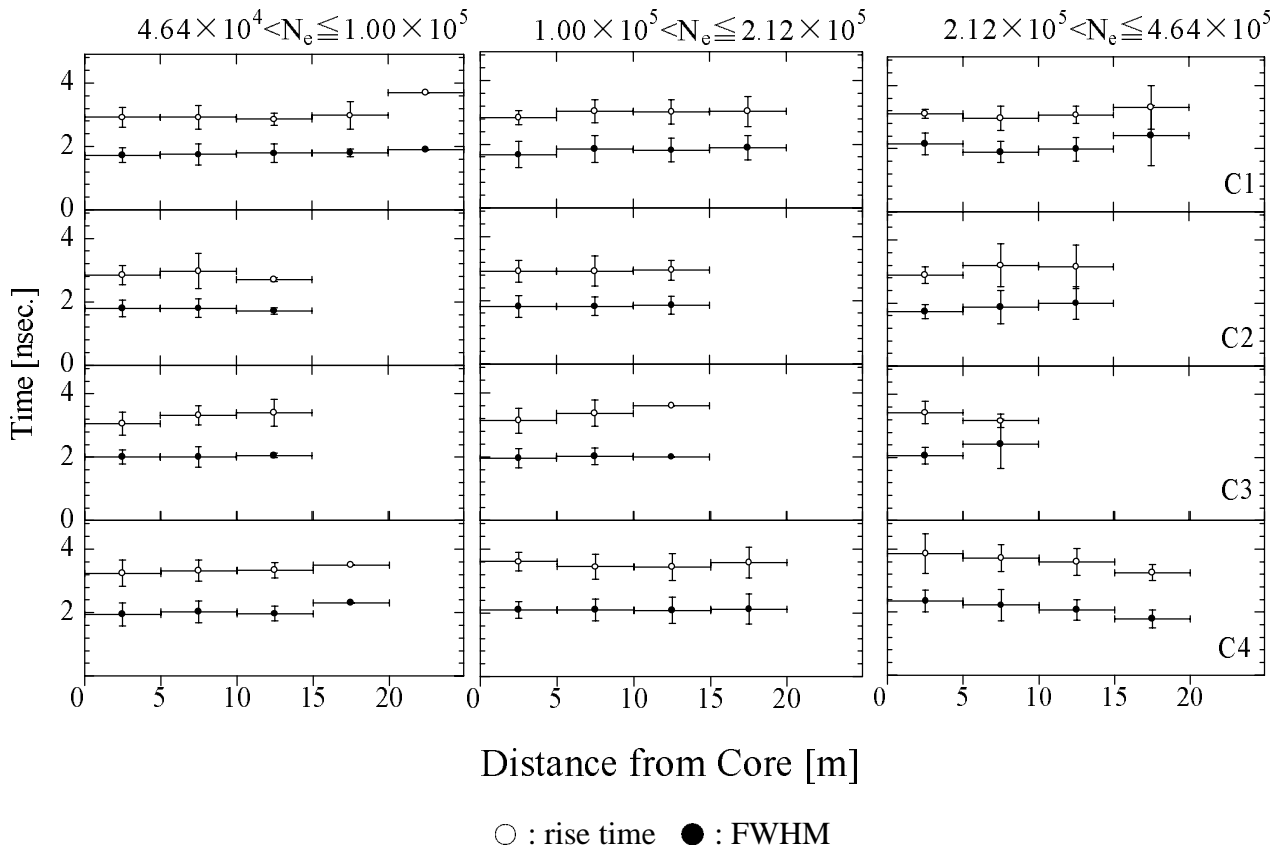


Fig.1
Relation between distance from core (r) and rise time,
and also relation between r and FWHM

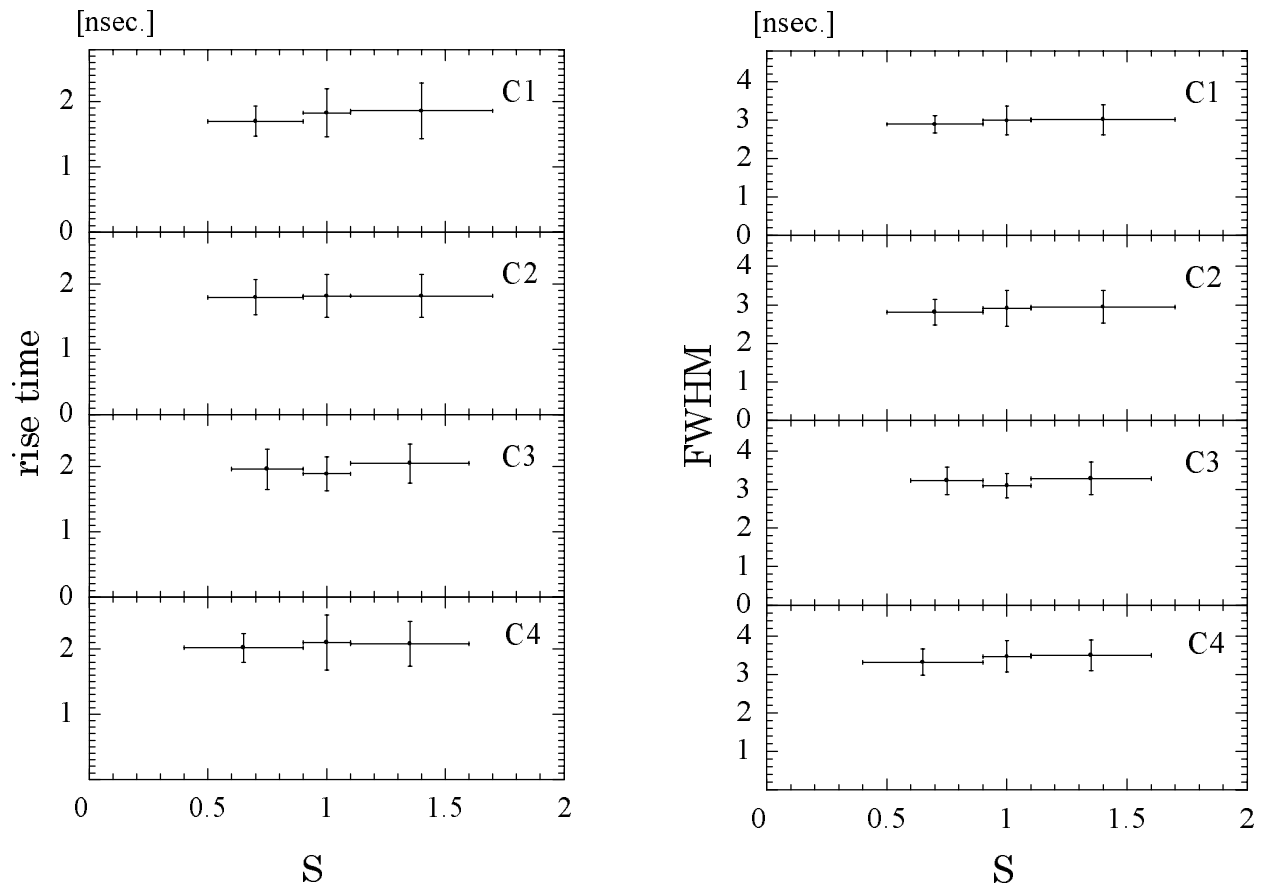


Fig.2
Relation between shower disk and age parameter (S)