The Air Shower Array in Beijing

Y.H. Tan, Y.J. Dong, P. Yuan, H. Wang, H.M. Zhang,
T.H. Wang, L. Meng, X.X Sun, Z. Chao, H.Y. Dai, J. Li
Institute of High Energy Physics, Academia Sinica
BEIJING.

Abstract

A small EAS array had been built in Huairou near Beijing in March of 1988 and now is in data collecting. Its area is 110mx100m, consists of 53 plastic scintillation detectors (each 1/4 ml) with corresponding electronics and an online computer. Its composition and performance are reported here.

1. Array

A EAS array consists of 53 scintillation detectors has built up in Huairou county of Beijing and has operated for EAS study since March 1988. The array site is about 70 km north-east from Beijing, with longitude 116° 41' E and latitude 40° 25', near sea level.

53 detectors are deployed over an area of about 10500 m^2 in a flat land (see Fig.1). In each detector, a 0.25 m^2 plastic scintillator (ST-401) with thickness of 5cm is housed in a pyramidal enclosure and viewed from below by a 44 mm photomultiplier (GDB44F)(PMT) from a distance of 50 cm. The surfaces of plastic scintillator except the side facing to the PMT and the inner sides of enclosure are painted with high reflection efficiency material composited by TiO_2. Among them, 9 detectors are equiped with fast time PMT (GDB50L) also for the determination of EAS arrival direction. And GDB44F is for measurement of local density of EAS particle.

The diagram of array electronics is shown in Fig. 2. The EAS data from fast time channels and particle density channels (8 bits each) together with some service data are recorded on floppy disk by a micro-computer (IBMPC/XT) data taking system automatically. The trigger detectors and trigger condition can be selected freely. The original data in floppy disk is copied to magnetic tape for EAS parameter calculations.

2. Main performance

2.1 Dynamic range of detector. By calibration process, we know the maximum measurable particle number of most density channels is a little larger than 10^4. The density determination using calibration parameters was checked in < 80ptls / m^2 region by comparing the density with those pulse height measured directly at detector's output by a storage oscilloscope for individual showers. Linearity is good enough for EAS observation. 2.2 Uniformity of detector response. The position dependence of pulse height of a typical detector was measured with an arrangement include a narrow angle telescope to select hard muons coming from near vertical direction and locate their-impact points. The different incident positions on the scintillator is
shown in Fig. 3 and the result is tabled as following

position	M/C	P/C	N/C
uniformity (%)	96.7 $^{+3.1}_{-3.0}$	92.9 $^{+3.3}_{-3.2}$	90.2 $^{+3.1}_{-3.0}$

2.3 Relative deviation of density measurement. The fluctuation of response of detectors was examined by using the real AS events. More than one thousand showers were analyzed . Detectors were divided into groups of different core distances, and the mean density ρ and standard deviation ó of each group were calculated. The result is shown in Fig. 4. It shows that ó / ρ trend be constant when ρ >200 / m^2, and not larger than those given by Akeno group (Hatano 1979).

2.4 Time resolution of FT channel. Time resolution was estimated by measuring the dispersion of time difference of the FT channels y fired at same time with an arrangement as shown in Fig. 5. When using light pulse or cosmic ray as signal source, we get typical FT channel's time resolution ó$_t$ without / (and with) including the fluctuation process within the scintillator as ó$_t$ = 0.99 ns and 1.67 ns respectively.

For AS observation, the contribution of particle distribution in-AS disc should be included in the consideration. By calculating the arrival time difference between any FT detector and the front plane of AS particles determined by others, we get the resolution time of our FT system ó$_t$. The recorded AS data in term from March of 1988 to June of 1989 shows, ó$_t$ 3.7 ns for showers with size surrounding $1.6x10^5$ and core failed in the inner region of array. Assuming a normal distribution with ó = 3.7 ns of time fluctuation of each FT channel, to add a fluctuation to the original data of each FT channel for real As event using monte carlo method and recalculate the direction of AS axis, the angle resolution is estimated from 20000 AS events as ó$_θ$ = 2°, ó$_ρ$ = 5° for showers with size > $1.5x10^5$. Simulation also shows the accuracy of age parameter and core position are ± 0.1 and ± 2m.

3. Operation check.

We did density spectra with two typical detectors separately. They can be well expressed as I (> ρ) æ ρ$^{-á}$, á = 1.30 ± 0.20 (detector 1) and 1.35 ± 0.20 (detector 2) for density ρ < 600 / m^2, coincidence with each other. It also coincide with the measurement of Limiting Current Spark Chamber (Porter et al 1981).

In Fig. 6, NKG function are compared with average experimental lateral distribution (normalized to size 10^6). Experimental distribution can be well fitted by NKG function in the core distance of 2 to 90 m.

Measure the Intensity of UHE cosmic rays may be the best test and calibration for a new array. The preliminary result (OG6.2-16) of Beijing array gives resonable integral intensity and other statistic characters, shown that the array can be used for AS observation reliably.

References

Y. Hatano et al (1979) Proc. 16th ICRC, 11, 161
M.R.Porter et al (1981) Proc. 18th ICRC, 6, 308

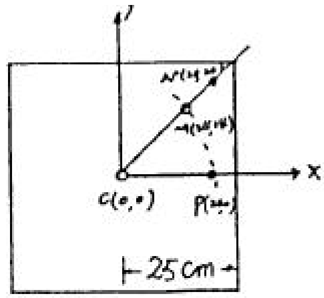
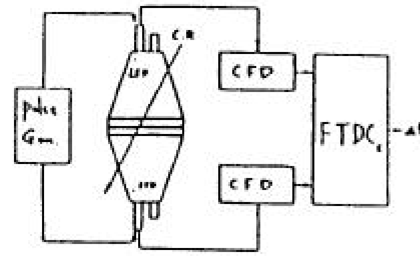


Fig. 3. The incident positions of muons on scintillator for uniformity measurement.



Fib. 5. The arrangement of time resolution. Measurement of FT channel.

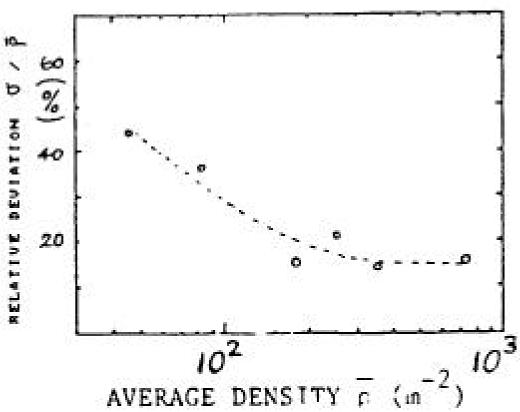


Fig. 4. Relative deviation of detector response vs particle density.

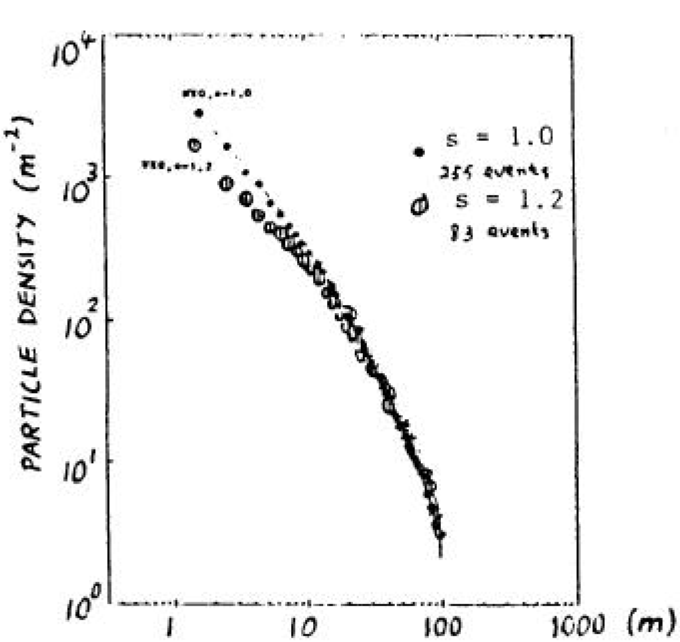


Fig. 6. An average lateral distribution of a shower normalised to size $N=10^6$.

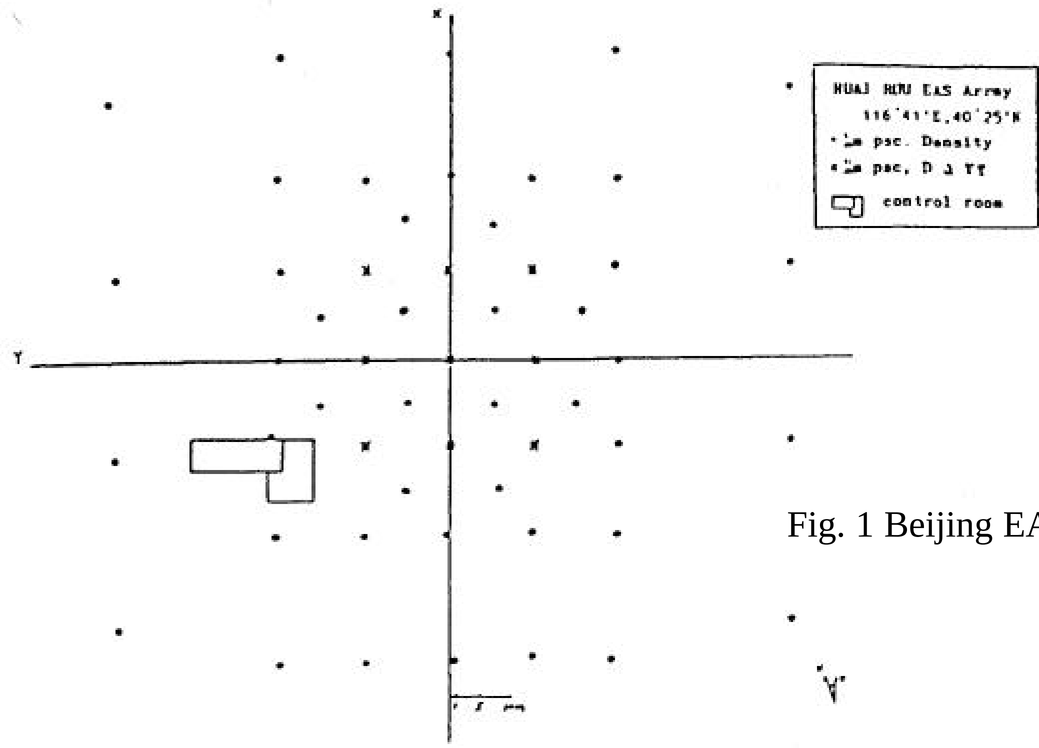


Fig. 1 Beijing EAS Array

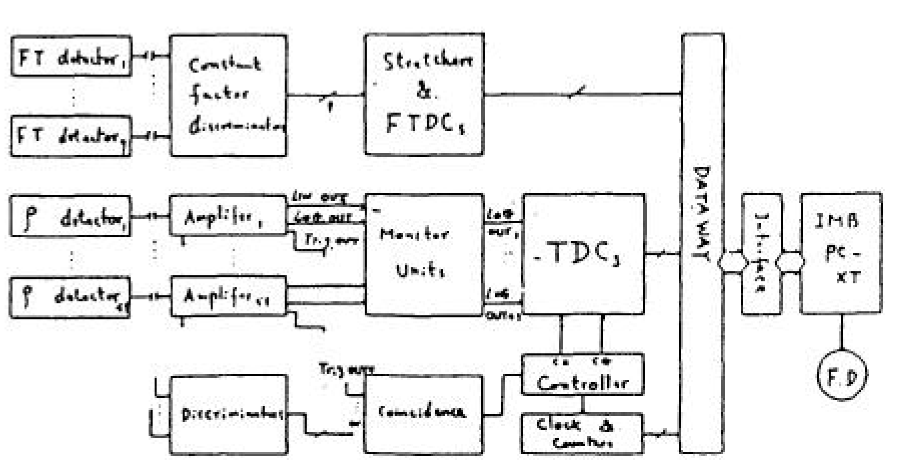


Fig.2 Electronics diagram of Beijing Array