STUDY OF EXTENSIVE AIR SHOWERS (EAS) DETECTED WITH THE FLY'S EYE AND THE UMC AIR SHOWER ARRAY

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Abstract

The Fly's Eye and the Utah-Michigan-Chicago (UMC) air shower array simultaneously detect Extensive air Showers (EAS) from Ultra High Energy ($E > 5 \times 10^{17}$ eV) cosmic rays. EAS parameters are compared from the coincident events detected during 1990.

I. Introduction

The Fly's Eve (FE)[1] at Dugway. Utah detects the longitudinal profile of EAS via the atmospheric fluorescence technique. The UMC Array[2]-[4] consists of a large surface array (CASA) and underground array which measures muons. It detects the EAS total particle lateral distribution and muon content at a vertical depth of 870 gm cm^{-2}. It is located 3.4 km from FEI and centered around FE2. The 2 systems operate in coincidence detecting EAS from primaries with $E > 5 \times 10^{17}$eV landing near the ground arrays.

Results on the Muon lateral distribution have been presented previously.[5],[6] The muon content is consistent with that measured by the Yakutsk group[7] in the core distance range of 300 - 1000 m when their parameterization is adjusted to the Dugway altitude.

From March to November, 1990, there were 340 hrs of coincident operating time between FE and the UMC array. During that time 80 events were detected by both experiments with > 50 CASA stations and 8 were well enough contained for geometry to be determined entirely by the CASA event reconstruction. We present results from the 8 events.

II. Comparison of Geometry

CASA event reconstruction is described in other papers at this conference.[3],[8] For the largest showers detected by CASA, the arrival direction is known to better than 0.5°. Shower cores which are contained inside the array have an error of < 10 m which gives a FE impact parameter error of äR_p < 15 m. The directional uncertainty for events reconstructed by FE data alone are 2° x 9° for the shower plane direction and shower angle in the plane respectively (ö), and äR_p / R_p < 0.2.

Since the EAS direction lies in the FE shower plane, we can test the FE plane reconstruction by measuring the angle between the CASA determined direction and the FE event plane. For the 8 contained events, the average angular difference is 1.8° which is consistent with FE resolution. The average absolute difference in plane angle ö differs by 12.1° and average absolute relative difference in R_p is 10.7%. These values are also within the FE resolution.

III. Comparison of Shower Size

Figure 1 shows a plot of a CASA determined total particle lateral distribution for one of the coincident events, and Figure 2 shove's the FE longitudinal profile and the surface determined N_{total} for the same event. For comparison with the Fly's Eve, the CASA size is reduced by 31% to remove the detected low energy ã-rays.[9] We compare the CASA determined shower size with the extrapolated FE longitudinal profile to CASA depths in Table 1.

Table 1. Parameters of the 8 contained coincident events measured by the Fly's Eye and CASA. äR_p / R_p = (| R_p (FE) – R_p (CASA) |) / R_p (CASA)

Day UT	R_p	äR_p / R_p	Iog$_{10}$$N_{CASA}$	log$_{10}$$N_{FE}$	log$_{10}$((N_{FE}(proj))/N_{CASA})
81 04:53:24.408	3.48	.14	7.56	8.41	.85
81 10:51:12.376	3.45	.06	7.45	8.35	.90
85 08:54:07.400	3.26	.18	7.63	7.82	.19
140 05:50:10.102	3.14	.04	7.21	7.28	.07
170 08:49:31.866	2.50	.15	7.05	6.79	-.26
205 09:24:29.308	3.51	.15	7.83	8.21	.38
314 07:15:09.198	2.90	.04	7.57	-	-
318 07:47:16.876	3.03	.09	7.41	6.62	-.79

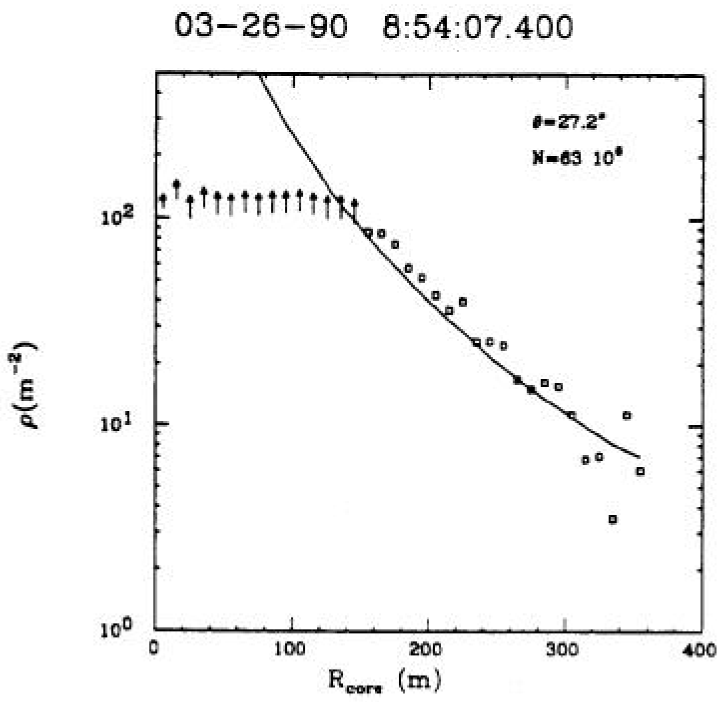

Figure 1. CASA measured lateral distribution of one coincident event. The solid line is an NKG function with S = 1.3. Because of detector saturation, only lower limits (represented by the arrows) of the particle density are possible near the shower core.

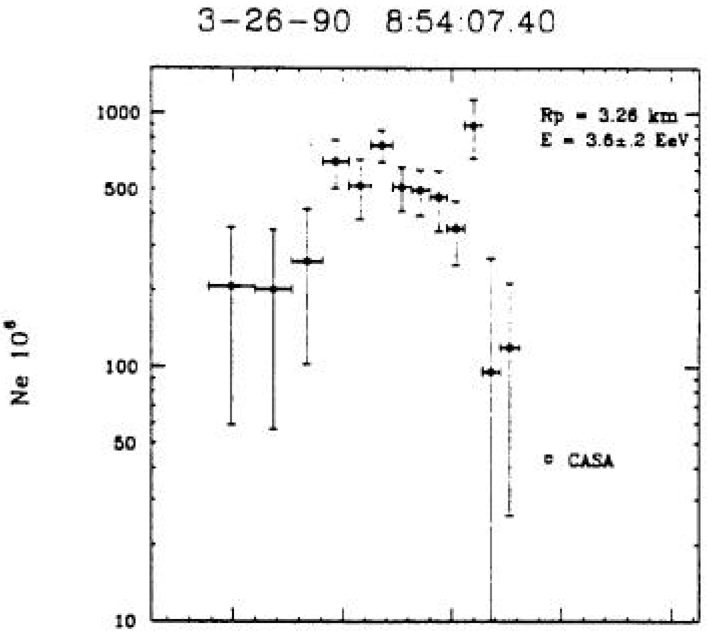

Figure 2. Shower profile measured by the Fly's Eye for the same event shown in Figure 1.

IV. Conclusions

As can bee seen from Table 1, the shower geometry and electron sizes measured by CASA and the Fly's Eye are in reasonable agreement.

Future capabilities are excellent. CASA has been expanded to 1089 stations, and the Michigan Muon array to 1024 counters for a total of 2500m^2 active area. The full detector will cover 500m. on each side for a total of .25km^2 of area. The HiRes FE prototype is currently being constructed near the FEl site.[10] Thus, the average lateral distribution and its fluctuations will be accurately measured as a function of Energy. This unique setup of this detector will provide a direct test of the Hillas hypothesis of the relationship of total shower Energy to ρ(600), the density of particles at 600m from the shower core for showers[11]-[13] above Primary Energies of 0.1 EeV.

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