A SEARCH FOR SOURCES OF ULTRA HIGH ENERGY GAMMA RAYS AT AIR SHOWER ENERGIES WITH OOTY EAS ARRAY

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ABSTRACT

A 24 detector extensive air shower array is being operated at Ootacamund (2200 m altitude, 11.4° N latitude) in southern India to search for sources of Cosmic gamma rays of energies greater than 5×10^{13} eV. The angular resolution of the array has been experimentally estimated to be better than about 2°. Since June '84, nearly 2.5 million showers have been collected and their arrival directions determined. These showers are being studied to search for very high energy gamma ray emission from interesting astrophysical objects such as Cygnus X-3, Crab pulsar and Geminga. Detailed results will be presented at the Conference.

1. INTRODUCTION

Studies of very high energy Cosmic gamma rays can reveal the sources of high energy cosmic rays and provide interesting information on the highest energy processes occurring in astrophysical objects. Many sources of gamma rays have been detected at energies less than 1 GeV through observations with detectors aboard SAS-II and COS-B satellites. Atmospheric Cerenkov radiation techniques have also indicated the possible existence of few sources at energies $\sim 10^{12} - 10^{13}$ eV which need to be confirmed with better statistics and consistent observations. Cosmic gamma ray sources at energies greater than 10^{14} eV have been searched for using extensive air shower arrays sine the late 1950's but the first positive result has been reported by the Kiel group[1] only two years ago with the possible detection of Cygnus X-3 at energies above 2×10^{15} eV. Since then there have been few more reports of possible detection of signals from Cygnus X-3 and some other objects. Unfortuna--tely many of these results have low statistical significance and suffer from inconsistency among themselves, for example, in the phase of the emission for pulsating objects[2].

All the results reported till recently for Cosmic sources at energies above 10^{14} eV have come from observations with extensive air shower arrays which have not been optimised for better determination of arrival directions and therefore have poor angular resolution. We report here the observations from the EAS array at Ootacamund which was modified last year to improve the angular resolution for studies of Cosmic sources at these very high energies. A specific aim for this study has been the observation of showers of energies $\sim 10^{14}$ eV, to fill the

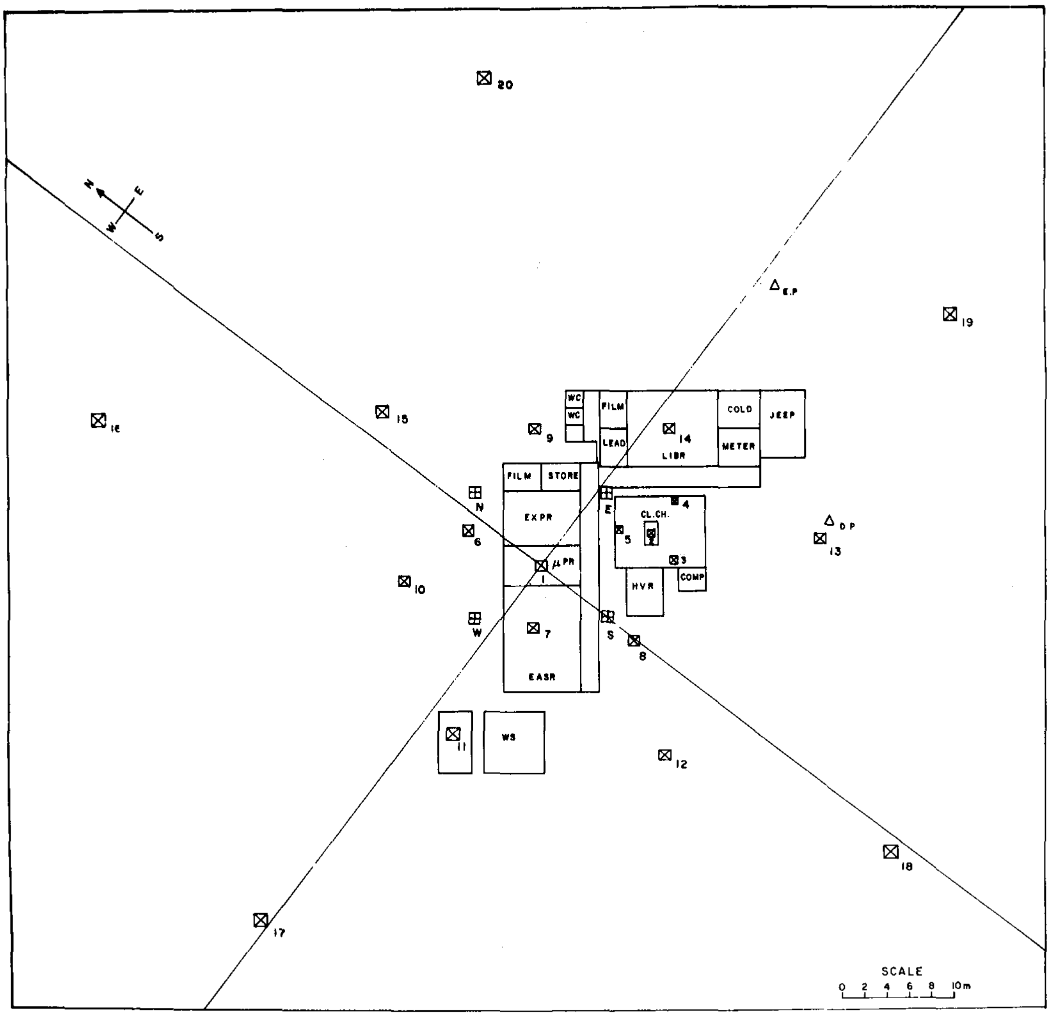

Figure : Schematic diagram of Ooty EAS array

important gap between energies of less than 10^{13} eV where results have come from experiments using atmospheric Cerenkov radiation telescopes and energies larger than 10^{15} eV where most of the recent results from EAS studies have been reported.

2. EXPERIMENTAL SYSTEM

The EAS array operating at Ootacamund (Ooty for short, 2200 m altitude, 11.4° N latitude) in southern India, consists of 24 scintillation detectors of various sizes spread over an area of radius of about 40 meters, as shown in the figure above. Detectors numbered 1 to 20 are plastic scintillation detectors, each 5 cm thick. Detectors labelled N,E,W, and S are liquid scintillators using 10 cm thick column of mineral oil. All the scintillators are viewed by 5 cm diameter fast photomultip--liers (RCA 8575) placed some distance above the scintillator. Signals from all the 24 detectors are digitized for total charge as well as the arrival time relative to the trigger for each recorded shower using fast ADC's and TDC's.

Showers were selected with a 4-fold coincidence of 100 ns wide pulses obtained from discriminators for detectors N,E,W, and S, with selection threshold of one particle in each detector. In addition at least one of the four detectors is required to have a signal larger than 3 particles. Observed shower rate with this selection criterion is about 7 per minute.

Data from all the TDC's and ADC's and the real time from a clock run on temperature stabilized crystal (accuracy of 1 part in 10^9) are recorded onto magnetic tape through a memory buffer. The shower recording time is only 1.25 ms enabling observation of showers very closely spaced in time, if there are any. Some more details about the experimental system are given in an accompanying paper (OG 9.5-8) in the Conference.

3. OBSERVATIONS

Datataking was started in June '84 and nearly 2.5 million showers have been collected over the last one year. As discussed above, the shower trigger has been optimised for selection of low energy showers to observe sources at energies $\sim 10^{14}$ eV. It is, however, necessary that a large number of detectors are triggered for each shower to provide timing information on the shower front to enable an accurate determination of the arrival direction of shower. As discussed in detail in paper OG9.5-8 in this Conference, Ooty array gives an angular resolution of better than 2° for showers which trigger at least 15 of the 20 detectors ignoring the four selection detectors. It has been seen that nealy 80% of the showers recorded satisfy this criterion giving a sample of nearly 2 million showers for study of Cosmic gamma ray sources.

4. RESULTS

Right ascension and declination coordinates have been computed for all showers recorded during the past year. Based on the estimated 2° angular resolution, showers are being grouped in angular regions of 4° x 4°, centered on the suspected source directions. Nearby regions of same angular area provide the study of background under identical conditions. For pulsating sources, the phase analysis is being carried out both on the source region showers as well as the background region showers. Analysis is in progress and results will be presented at the Conference.

REFERENCES

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