CHICOS: Status and Prospects

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Abstract

The California HIgh school Cosmic ray ObServatory (CHICOS) is a large area ($\sim$ 400 km^2) ground array for the study of ultra-high energy cosmic rays in the Los Angeles area. The main scientific goals of CHICOS are to study the flux, energy spectrum, and angular direction of cosmic rays at energies $E > 10^{19}$ eV and to demonstrate a new strategy for fielding huge future arrays using urban infrastructure. At present there are 43 CHICOS sites operating; a total of 90 sites will be deployed and operational within the next year, resulting in an aperture of about 500 km^2-sr at 10^{20} eV.

1. Introduction

The study of ultra-high energy cosmic rays continues of be of great interest. The flux, composition, and origin of these particles are still quite uncertain and the subject of substantial speculation. Indeed the energy spectrum in the $10^{19} - 10^{20}$ eV region (and above) is controversial [1,2] and additional data would be extremely helpful in understanding this interesting region.

With many decades of development, ground arrays of scintillation counters have proven to provide a reliable, stable, and effective method to sample air showers. The goal of the CHICOS project is to utilize the existing infrastructure in a large urban area like Los Angeles to field such an array. In particular, the L.A. school system offers internet connections, power, shelter, and enthusiastic participants, providing an excellent opportunity to develop such a large array.

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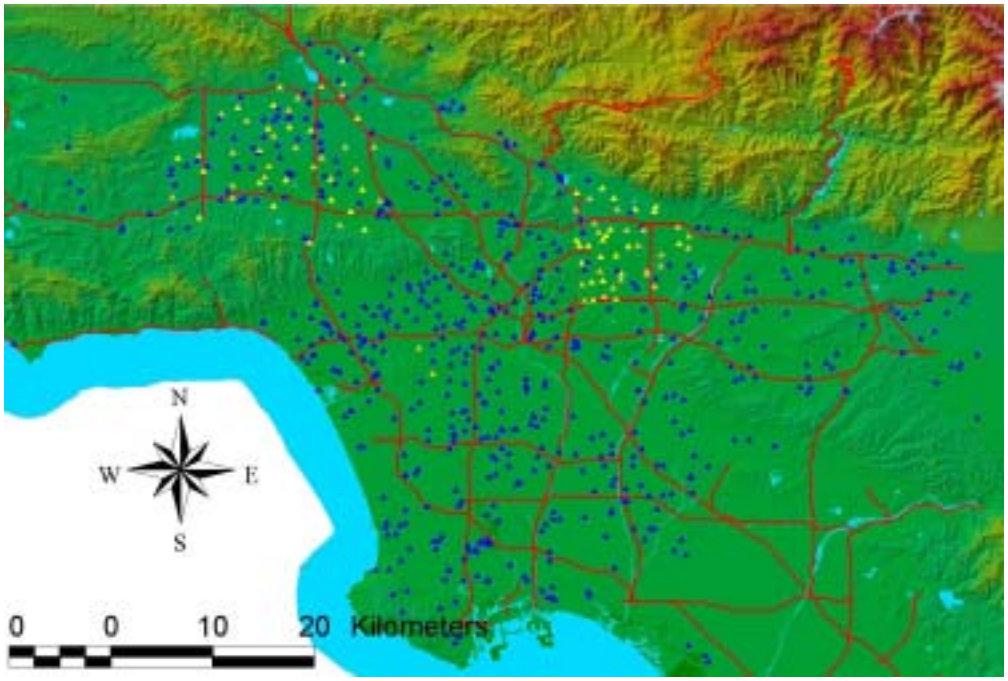

Fig. 1. Layout of the CHICOS array. Yellow triangles indicate operational sites and orange triangles are planned future deployments. These yellow and orange triangles represent the CHICOS-90 array, with the San Fernando Valley portion to the left (west) in this figure and the San Gabriel Valley portion to the right (east). The blue triangles illustrate sites identified for potential future expansion.

Very capable PC's, GPS receivers, and high-speed computer network connections are all recent technical developments that are now readily available at low cost. This cost-effective approach should provide a new method to complement the capabilities of the Pierre Auger Observatory [3].

Over the last year, we have begun fielding an array of 90 sites (referred to as CHICOS-90) using detectors from the decommissioned CYGNUS array [4]. As of mid-2003, more than 45 of these sites will be operational. The fielded sites have begun to produce interesting data on extended air showers as well as valuable operational experience.

2. CHICOS Concept

The performance of a ground array like CHICOS for the study of extended air showers depends upon basic parameters of the network, particularly the size of the detectors fielded at each site and the average areal density of the sites. In our approach, we employ two CYGNUS scintillator detector units (with a total area of typically 1.8 m^2) per site. Each site is located at a Los Angeles area school,

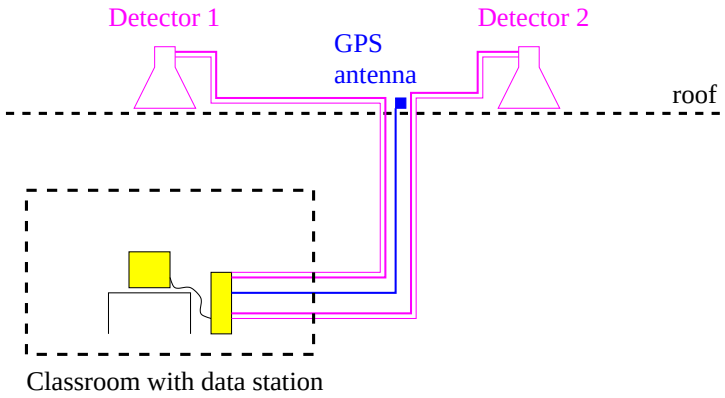

Fig. 2. Schematic diagram of typical CHICOS site hardware configuration.

usually a high school or middle (junior high) school. Fig. 1 shows the presently envisioned scope of the CHICOS project. The San Gabriel Valley area will have a higher average density of sites ($\sim 1/3\text{km}^2$), whereas the San Fernando Valley has a somewhat lower average density ($< 1/6\text{km}^2$). These 90 sites been used in simulation calculations to estimate the performance of the CHICOS-90 array.

The basic concept for the CHICOS detector site is shown in Fig. 2. Each station is configured with 2 detectors to facilitate local coincident triggers, and operates autonomously with GPS time stamping (accuracy < 50 nsec). A discriminator circuit provides a signal that indicates both the arrival time and the pulse height (through a time-over-threshold technique). Data are stored on local hard disk and automatically transferred to Caltech via internet every night by the PC computer located at each site. Local "trigger" events are defined as those where both detectors at a site detect a signal with more energy than 2 single vertical particles within 100 nsec. Each site generates typically 1500 trigger events per day. Data on these triggers and all single hits within 50 μsec of any trigger elsewhere in the array are transferred to Caltech.

Using the AGASA version of the NKG formula [5], we have simulated the performance of the CHICOS-90 array. Table 1 shows the expected rates where one trigger site and at least 4 additional sites are hit. The lower density but larger area of the San Fernando Valley part of the array is more effective at increasing the aperture for very energetic ($\sim 10^{20}$ eV) showers. Most of the rate below 10^{20} eV is due to the San Gabriel Valley sites. Our present observed rates are consistent with these expectations.

We have already observed several large showers (over $\sim 10^{19}$ eV) during the first few months of 2003 and we have a sample of over 100 lower energy events involving local coincidences of 3 or more closely spaced (< 1km) sites.

Table 1. Projected event rates.

Energy Threshold (eV)	Events/year
10^{18}	299
10^{19}	67
10^{20}	3.1

3. Future Plans

Over the next year the CHICOS-90 array will be complete, and we will then continue to operate the array. Additional deployments of sites to increase the density in the San Fernando Valley will be planned if modest equipment funds become available. In the future, we may generate a proposal for substantial expansion to several hundred sites.

4. Acknowledgements

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(see http://www.chicos.caltech.edu/collaboration/collaboration-list.html)
have been essential in the deployment and operation of the CHICOS array, and we are delighted to acknowledge their participation.

5. References

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