CHICOS Detector Stations

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Abstract

The California HIgh school Cosmic ray ObServatory (CHICOS) is a large area (presently 400 square kilometers) ground array for the study of ultra high energy cosmic rays located in the Los Angeles area. Each CHICOS station employs two $1m^2$ scintillation counters from the decommissioned CYGNUS array [1] instrumented with 3" or 5" photomultiplier tubes from the decommissioned Palo Verde neutrino experiment [2]. We have developed a PC-based data acquisition system for these remote stations. Data are processed and transferred automatically over the internet once per day. At present there are 43 sites operating reliably.

1. Introduction

Ground arrays of scintillation counters have been used for many years to sample extensive air showers. This method provides reliable and stable performance and deployment is relatively straightforward. The CHICOS project utilizes the existing infrastructure in a large urban area like Los Angeles to field such an array. The L.A. school system offers internet connections, power, shelter, and enthusiastic participants. Very capable PC's, GPS receivers, and high-speed computer network connections are 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], under construction in Argentina.

We have developed an operational system for implementing this scheme, and have deployed 43 sites already. Equipment and resources presently exist for a total of 90 sites. This CHICOS-90 array will be a very capable network for the detection of ultra-high energy air showers at $E > 10^{19}$ eV.

pp. 1057–1060

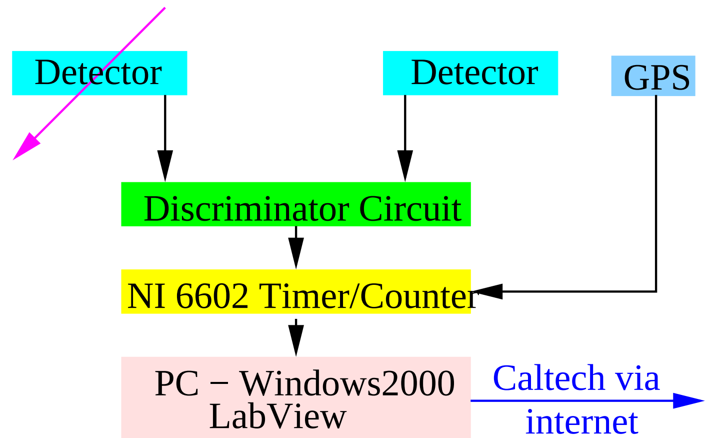

Fig. 1. Schematic diagram of a CHICOS detector station.

2. Technical Description

We employ two CYGNUS scintillator detector units (with a total area of typically 1.8 m^2) per site, usually deployed on the roof of a school. Use of 2 detectors facilitates coincident triggers that are used to identify candidate shower cores. Each station operates autonomously with GPS time stamping (accuracy < 50 nsec). Data are stored and transferred to Caltech via internet every day (during the night). A schematic diagram of the detector station is shown in Fig. 1.

We utilize two varieties of photomultipliers: 3 inch Amperex PM2312 and 5 inch Electron Tubes 9372A. The photomultipliers are powered by Brandenburg 2482-131 high voltage supplies mounted inside the detector housing, with high voltage control via a low-voltage control signal. Thus the detector units receive only low-voltage (+/-15V) power over multi-conductor cables. The detector signals are shaped by an RC shaping circuit to have a 50 nsec decay time and are transmitted to the time-over-threshold discriminator circuit by RG58 cable (typically 50 feet long).

The discriminator circuit is a two-stage fast TTL comparator (Maxim 912EPE), set to fire at typically -15mV, and is updating so that the pulse width corresponds to the time over the threshold (minimum output pulse width is 40

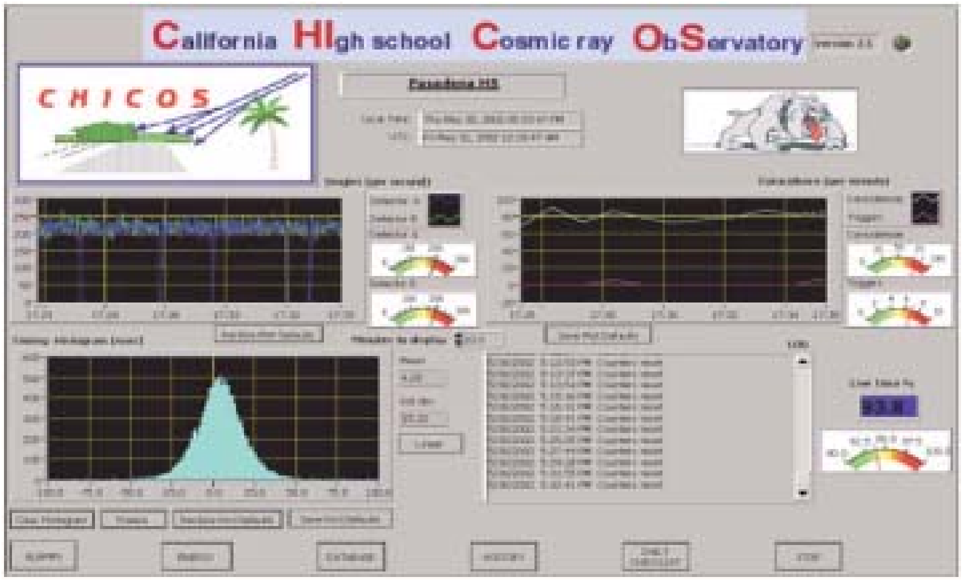

Fig. 2. CHICOS station LabView display.

nsec). The high voltage is then adjusted to provide high efficiency for single vertical cosmic rays. The dual discriminator circuit and the controls for the high voltages are contained in a "CHICOS Electronics Unit" (CEU), located in the classroom or lab of the school along with the CHICOS computer and GPS receiver. The CEU circuit is manually assembled on a printed circuit board, and can be built by high school students and teachers. Timing of the detector signals and the GPS receiver signals is facilitated by use of two National Instruments 6602 timer/counter cards, which incorporate an 80 MHz clock and are programmable for a variety of relevant timing/counting tasks. We utilize two varieties of GPS receivers: Motorola UT+ and M12. The computers are PC's utilizing the Windows 2000 Professional operating system and a LabView executable for data acquisition. The LabView software is imbedded in loops to restart the code if there are any hangups. The data transfer is implemented via scheduled FTP tasks. An example of a front panel display, available at every site, is shown in Fig. 2.

3. Commissioning, installation and operation

The station hardware is assembled and commissioned in our lab at Caltech before deployment. This facilitates calibration of timing and amplitudes of all signals and testing of all hardware, including GPS receiver, CEU, photomultipliers, HV supplies, cables, NI-6602 cards, and PC computer. Data transfer is tested and timing accuracy is checked relative to the operational Caltech site. This extensive commissioning procedure insures high reliability and accurate performance at the remote site.

Installation is performed at the remote school site with the cooperation of school maintenance personnel. Cable penetration is usually the issue that requires facilitation by school personnel. Lifting detectors, cable running, and assembly of electronics/computer equipment are responsibilities of Caltech personnel.

Operation of installed sites is very reliable. Occasional software problems are easily remedied by requesting the local teacher at the site to cycle power on the system (the software automatically restarts after reboot).

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.

4. 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. This would also involve the development of new detector hardware, electronics, and data acquisition.

5. 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.

6. References

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