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WALTA progress report

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Abstract. WALTA (WAshington Large-area Time-coincidence Array) aims to study ultra-high energy ($> 10^{19}$ eV) cosmic rays (UHECR) by placing detector elements in Seattle area secondary schools, and linking their data acquisition systems to the University of Washington via a computer network. The goal of WALTA is to have teachers and students be active participants in forefront scientific project, while building a long term partnership between the schools and the university-based physics research community. During a recent meeting in Seattle, WALTA joined other similar projects in the USA and Canada to form NALTA, a North American consortium of school-based cosmic ray detector network projects. In addition to the usual motivations for studying UHECRs, such as the puzzles of their origin, acceleration, and apparent abundance beyond the GZK cutoff, the NALTA consortium will allow us for the first time to search for coincident parallel showers, or even single ultra-giant showers, covering distance scales of 100s to 1000s of km at the earth's surface.

1 Introduction

Ultra-high energy cosmic ray particles with energies greater than about 5×10^{19} eV cannot traverse great distances through the cosmos without losing energy to pion photoproduction in collisions with the cosmic microwave background. Such a particle will lose energy until it is below threshold for this reaction. This process, referred to as the GZK cutoff (Greisen, 1996; Zatespin and Kuzmin, 1966), happens in about 50–100 Mpc (Cronin, 1992; Aharonian and Cronin, 1994). Hence for a 10^{20} eV particle to arrive at Earth, it must originate in the local neighborhood. The observed arrival direction of events with energies greater than 5×10^{19} eV provide no compelling evidence for a nearby source. However there is a possible indication of correlations in event arrival direction (Cronin, 1999). Further, there are no known nearby astrophysical objects which are likely to accelerate particles to these energies (Hillas, 1984; Biermann, 1997). This paradox is one of the major current mysteries in astrophysics.

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WALTA (Washington Large-area Time-coincidence Array) is a project to study these ultra-high energy cosmic rays through a network of detectors that will be placed in high schools in the Seattle-metro area. The project will be a direct physical science outreach program between the University of Washington and the Seattle area schools. Students and teachers will be co-investigators, contributing to the project in a number of ways, including instrument deployment, data acquisition and data analysis.

In September 2000, the WALTA group hosted a workshop entitled "Cosmic Ray Physics with School-Based Detector Networks" (see http://phys.washington.edu/∼walta). During the workshop, the North American Large-scale Time-coincidence Arrays (NALTA) consortium was formed. Through the NALTA consortium (see http://csr.phys.alberta.ca/nalta), we will have the opportunity to look for coincident showers between the various sites. We will also be able to detect ultra-giant showers, if such an event were to occur.

2 WALTA stations and the Seattle array

Individual school detector stations will consist of a low-cost desktop computer with an Internet connection, interfaced to custom electronics for the cosmic ray detector modules. Students and teachers will also use the computer to monitor hardware status and data flow, and participate in data analysis. Figure 1 shows a block diagram of the system. Each site will have three or four scintillation counters separated by distances on the order of 10 m. The DAQ electronics will form local coincidences and digitized pulse heights and arrival times. A GPS clock system will provide timestamps with 10 nsec precision. By using custom designed DAQ boards, the cost per site will be kept low. Data will be buffered and forwarded to a computer cluster at the University of Wash-

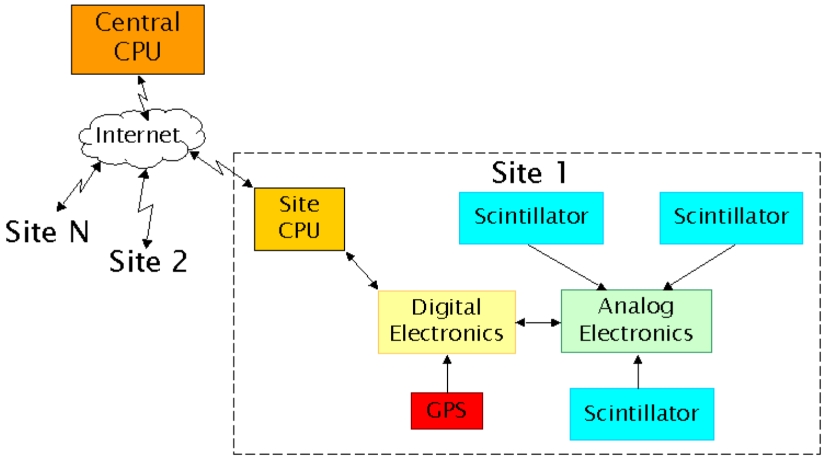

Fig. 1. Block diagram of the proposed WALTA system

ington for analysis.

To determine the trigger efficiency of the Seattle-area array, we have run simulations using the CORSIKA code (Heck, 1998). We will be extending the array to include suburbs in the north, south and east. In addition to analyzing the response of the full array, we have performed simulations on the detector layout of individual school sites. Ideally, we would like to use the school sites to look at the cosmic ray spectrum around the knee, $E \sim 10^{15}$ eV. With this in mind, we are working to determine the optimum spacing and number of detectors to use at each site. Simulations indicate that using 4 detectors with a spacing of between 10 and 15 meters is the most appropriate. Obviously the more detectors there are, the better the array will perform.. However, the cost of the detectors and the logistics of having detectors placed on a school rooftop are an important factor in the analysis. Four detectors performs significantly better than three. Our preliminary results indicate that to get a good measurement at knee energies, we will want to set up a few sites with a larger number of detectors. We will continue simulations to determine what the layout of these larger sites should be.

Approximately 140 scintillators (61 cm $\times$ 61 cm $\times$ 1.3 cm), 140 photomultiplier tubes, and 60 low to high voltage converters were retrieved from Dugway, Utah. This equipment was used in the Chicago Air Shower Array (CASA) (Glasmacher, 1999), an experiment to study cosmic rays that was in operation from 1990 through 1998. These scintillators, PMTs and power converters will constitute the initial detectors used in the WALTA array. Research has been conducted on the efficiency of the CASA detectors and on ways to improve this efficiency. We adapted a charge-to-time (QTC) converter from the Super Kamiokande experiment to study the CASA hardware (Kearns, 2000). This test station is also being used to help determine the optimum design for the custom data acquisition board we are developing. Data acquisition software was developed to accompany the QTC electronics board.

3 WALTA outreach efforts

As a continuation of the NALTA collaboration, we are working with CROP (Cosmic Ray Observatory Project) from the University of Nebraska to run an outreach program at the Snowmass 2001 Summer Study on the Future of Particle Physics. We will conduct a one week workshop for 5 high school teacher/student teams. Each team will consist of a teacher and 2-3 students. The workshop is an abbreviated verson of a three week long workshop CROP ran last summer. Through a combination of lecture style discussions and laboratory activities, the students and teachers will learn about cosmic rays. At the end of the week, each team will return to their high schools with 4 detectors and various electronics to be used in coincidence measurements.

After the workshop at Snowmass, we will run a similar workshop in Seattle entitled "Summer 2001 WALTA/Quarknet Workshop for Teachers." This week long workshop for Seattle area teachers is being funded by Quarknet, an outreach program through the Fermi National Accelerator Laboratory. Upon completion of the workshop, we will equip two Seattle high schools with 4 detectors and electronics modules.

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