The Washington Large Area Time Coincidence Array

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Abstract

WALTA (WAshington Large-area Time-coincidence Array) aims to study ultra-high energy ($> 10^{18}$ 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 become active participants in forefront scientific project, while building a long term partnership between the schools and the university-based physics research community. Considerable progress has been made in recruiting and training teachers and equipping school sites since the last ICRC, including development of a low-cost data acquisition card in collaboration with Fermilab and the University of Nebraska.

1. Introduction

The number and density of secondary schools in the Seattle area is a good match for the detector module spacing needed to efficiently observe ultra-high energy ($> 10^{18}$ eV) EAS[1,2]. A network of school-based detector modules can provide a valuable supplement to planned large-scale dedicated arrays like Auger, at very modest cost per station. WALTA (WAshington Large-area Time-coincidence Array) includes teachers and students as collaborators, and provides them an opportunity to become active participants in forefront research. University faculty and graduate students are regular visitors at participating schools.

We are developing a distributed detector for UHE air showers, using existing school infrastructure to provide sites and Internet connections. Individual detector stations, each consisting of several independent scintillation counter modules, DAQ electronics, and a GPS time logger, buffer and forward time-stamped counter data from local coincidences to a central site at the University of Washington, where multi-site coincidences can be analyzed. Considerable progress has been made since our reports[2] at previous ICRCs.

WALTA is part of a consortium of similar projects (NALTA, North American Large-area Time-coincidence Arrays) which will link regional networks thousands of miles apart, making it possible for the first time to look for correlated

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cosmic ray showers on a scale of thousands of km, across the USA and Canada.

2. Progress

Week-long workshops were held during the summers of 2001 and 2002, where a total of 22 local teachers refurbished salvaged CASA counters and learned how to use oscilloscopes and NIM electronics (borrowed from Fermilab) to evaluate their counters, build a simple muon telescope, and other activities they can bring into their classrooms. Summer workshops were followed up by 1-day weekend meetings held 3 times in each academic year. Teachers and students from participating schools were able to contact and network with peers, describe their own efforts, and extend their understanding of cosmic ray astrophysics and experimental techniques. Undergraduate assistants visited schools regularly to assist with detector preparation and testing.

Figure-1 shows a map of the Seattle area, with stars marking participating schools. Current participants are widely distributed, but we expect to add more inner-city schools soon.

Each school has been initially supplied with modular fast electronics (a NIM crate, discriminator, coincidence and scalar modules loaned by Fermilab), and 4 plastic scintillator counters, along with necessary cables and HV supplies. The NIM electronics will be swapped this summer for custom-designed front-end boards, costing less than US$500 each for parts, which were designed and developed by a collaboration including Fermilab, UNL and UW and at time of writing are under construction at Fermilab[3]. The Quarknet Data Acquisition (DAQ) board forms local coincidences, digitizes pulse arrival times with sub-nanosec resolution, and records times-over-threshold (TOT), providing an estimate of pulse area. An integrated GPS clock system, adapted from a system used in particle physics experiments[4], provides timestamps with $\sim$ 100 nsec accuracy for synchronization between sites. Schools supply a desktop PC with Internet connection, and an oscilloscope, although in many cases the latter is simply borrowed from UW when needed.

Each counter consists of a 50x50x1-cm^3 plastic scintillator with a vertically-mounted 5-cm PMT and associated HV supplies, salvaged from the CASA detector in cooperation with members of the CROP project at U. of Nebraska. Students and teachers are expected to repair and upgrade the counters, remount and plateau the PMTs, and design and construct weatherproof housings for the counters. Once the custom DAQ boards are in place, data consisting of time-stamped 2-fold or greater local coincidences will be buffered and forwarded to a server at the University of Washington for analysis.

To allow secondary school students easier access to their local station's data via a commonly available software tool, we have developed a graphical user interface (GUI) to the custom DAQ board using LabVIEW, a data acquisition

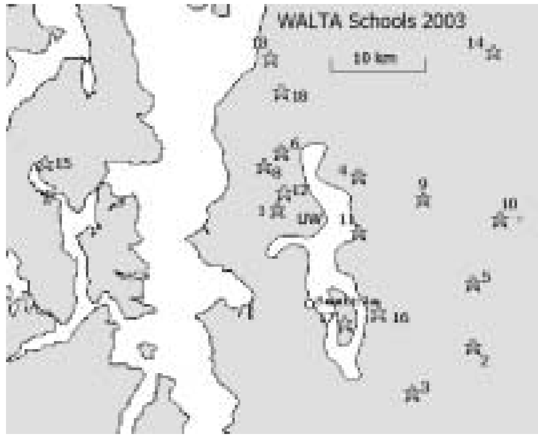

Fig. 1. Locations of secondary schools participating in WALTA.

and manipulation system from National Instruments Corp., which is widely distributed and used in schools, universities and industry. An educational version of LabVIEW is available to schools free or at nominal cost. Skills acquired in the use of this application for WALTA data analysis may later be of value to students elsewhere; for example at UW, undergraduate physics laboratory classes use the same system. Students may take our prototype interface as a model for development of their own general or specialized GUIs.

A prototype array has been set up on the UW campus, providing a test stand for development of hardware and software required for the project, and a model for school sites. Figure-2 shows a block diagram of the test array and DAQ card. Figure-3 shows the arrival time distribution for the closest-spaced pairs of pulses in three-fold coincidences at this single site. The detectors were arranged in a straight line, spaced $\sim$ 6m (center to center) apart and run for 8 days in April 2003 in this configuration.

3. Future Plans

We expect to have custom DAQ cards operating in several schools by autumn, 2003, and thus for the first time can begin taking time-synchronized data from widely-distributed sites. This will mark the true beginning of WALTA as a working array. For further details and updated progress reports, please see `http://www.phys.washington.edu/~walta/`.

4. Acknowledgements

We are grateful to the Quarknet program for funding outreach activities in Seattle, and especially to Mr. Tom Jordan at Fermilab for his essential support, both material and spiritual. One of us (MB) thanks the Murdock Foundation for

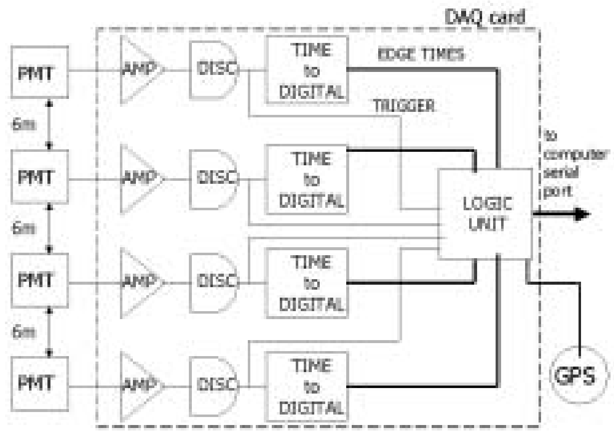

Fig. 2. Layout of prototype array and block diagram of DAQ card.

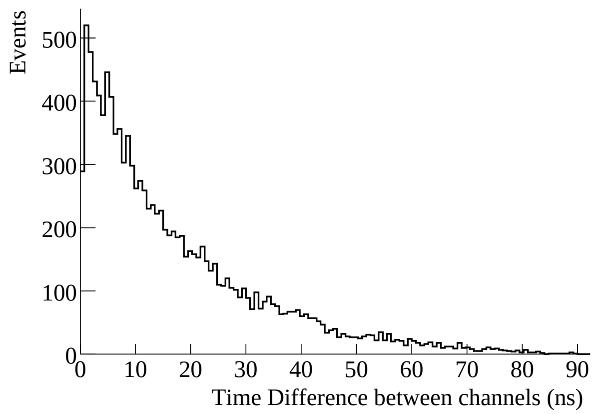

Fig. 3. Shortest time difference between two channels in three-fold coincidences for rooftop array data.

summer support via its Partners in Science program. We are also grateful to Prof. Greg Snow and colleagues at UNL for collaboration and help recovering CASA hardware.

5. References

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