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The System of DAQ for TA Surface Array

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The installation of The Telescope Array experiment started in earnest. Since observation by combine two different type air shower detector, we aim to search super GZK cosmic ray and determine accurately the energy of these CRs. In past, extensive air shower observations using scintillation detector array give many good results Utilize these experience, we combine scintillator array and fluorescence detectors for determination for EAS energy scale, core position and incoming direction. In this paper, we introduce the electronics and data acquisition system for our scintillator array; call Surface Detector (SD). The engineering array that constituted 18 scintillation detectors was installed on December 2004. We have tested our electronics and DAQ on this small array. Complete SD will have 576 detectors, around 900 km^2. This will be about 9 times larger than AGASA.

1. Introduction

The new DAQ system of TA SD is used Wireless LAN for data acquisition because our observation site in Utah, USA is vast. Since wireless, the direction of observed shower event cannot determine by recent wired Fast Timing method. Then, we install a GPS receiver module on each detector, and record the event timing using accurate clock of GPS. This GPS unit has accuracy around 10ns since our test. In this way, we will be able to determine the direction of EHE Cosmic rays in accuracy of around 1 degree.

Similarly, so that the power supply system should also independently operate each detector, we use solar panels and batteries and we developed the system of low power consumption. Our electronics system need only 10W or less. To construct an independent system of such low power consumption, we select the combination of SH4 CPU and TRON OS, the architecture of hi-voltage supply to PMT is active divider, etc. In Decenver 2004, we install "the engineering array". This array has 18 scintillation detectors and they are controlled "the DAQ center". Detectors parted around 10km from this center.

2. Electronics' feature

We installed the prototype electronics to engineering array. This electronics is made up 3 units –Main board, slow control board and charge control unit. In these units, Charge control units change another units developed by us for be able to control more intelligent. Figure. 1 shows the system block diagram for engineering array.

Main board
Main board has two Flash ADCs for signal detection, CPU, wireless LAN module and GPS module. The CPU is SH4 (Renesas, 266MHz, 1.2GFlops) controlled by TRON OS. This CPU controls all of electronics. We can change almost the configuration of systems on CPU by using wireless LAN communication.
Wireless LAN module is ADLINK540 (ADTEC) that is based on IEEE 802.11b with directional antenna. Only the control station have co-liner antenna, can sense all direction from detectors. In spec of itself, the rate of communication speed is 11MB/s.

GPS module is Motorola M12+ timing receiver. This has around 10ns accuracy for 1 par a second. We use this GPS for event timing measurement and position monitor. The result that GPS 1 pps compare with UTC

1pps is shown in Figure.2.

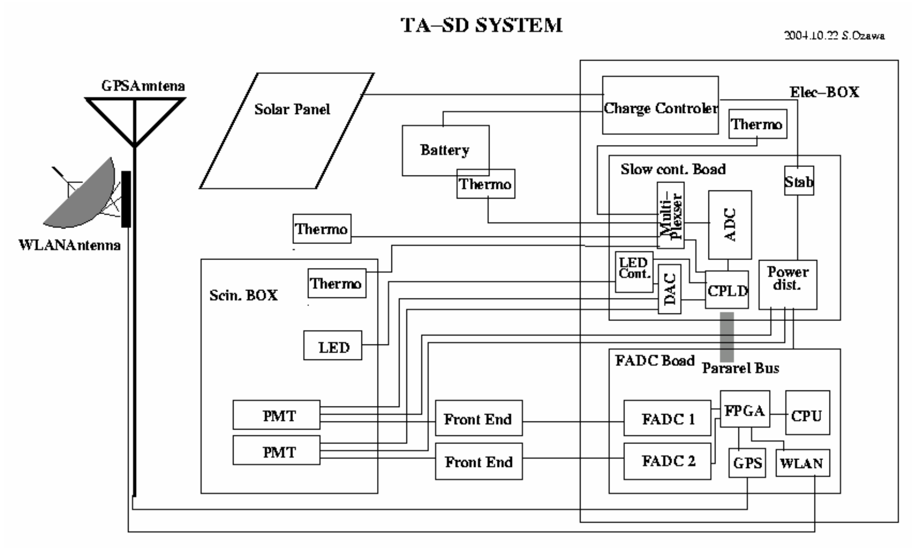

Figure 1 The block diagram of DAQ system for TA engineering array. The character of scintillation detector is presented elsewhere in this conference.

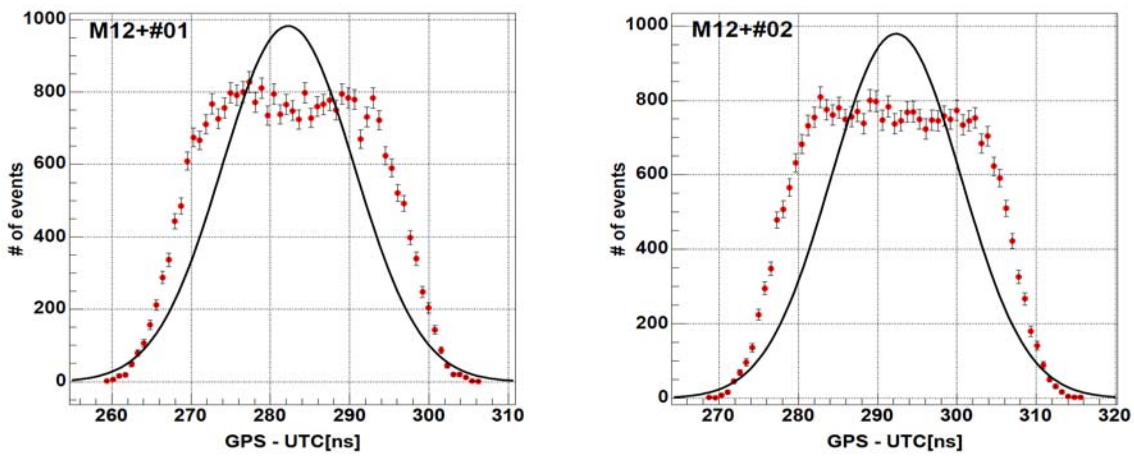

Figure 2 Measurement of 1 pulse par second accuracy of GPS. The 1pps compare with 1pps of UTC. These distributions are not fit to Gaussian. We tested two GPS units. The mean values of each measurement are 282.3ns(left) and 292.4ns(right). The standard deviations are around 10ns both of them. These offsets will be calibrated before installation.

FADCs are driven with 50MHz clock. There are two channel for signal, these can be controlled thesethresh-old and which is trigger channel in independent. These front ends of signal have the signal waveform

shaping circuit. Since this circuit, the pulse shapes of detected events drag out about ten times. Figure. 2 shows an example for event signal. This is expected single muon event. The pulse shape can be observed clearly.

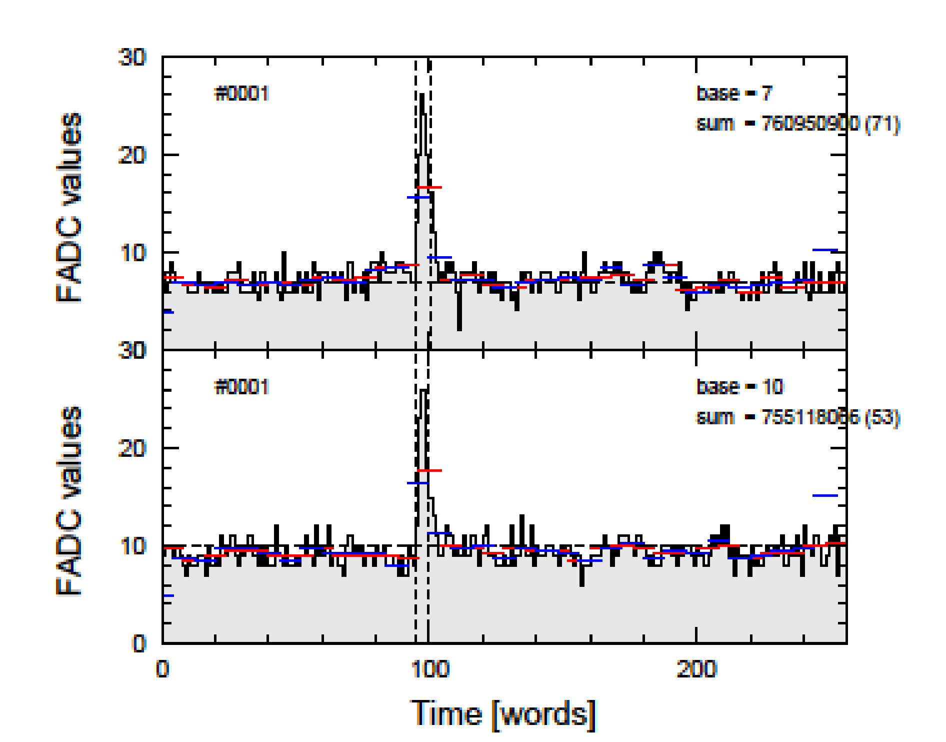

Figure 3 The pulse shape of PMTs read by FADC. The signal from PMT is stretched by shaping circuit. 1 tick of time is 20ns. The dynamic range of FADC is 0 to 1V and resolution is 12 bits. The Dynamic range of FADC will be expanded to 2V.

Slow control board

Slow control board administrates controlling high voltage for PMTs, logging environmental data, LED flasher for calibration of PMTs. We use the power supply for PMT type of charge pumping active divider. Since this, we may use low voltage and save power economical. The control voltage is given in 1/1000 of to want to supply for PMT, the 12 bits DAC can control each 0.001V.

These functions that slow control board has will unify main board at next revision.

3. The system of DAQ

Since each detector have no cables out of itself, the data is taken by wireless LAN. Communication method is HDLC not TCP/IP. The merit of this method is that the size of data packet less than by TCP/IP.

If FADC read data match the condition set us from PMTs, it store these data in memories included itself and

send trigger information to the control center. This information includes arrival time of detection and number of particles. Since the arrival time of trigger information is not just a serial about time, when control center receive trigger signal, it store data and search coincidence event using arrival time information.
If it find out efficient coincident, control center send command to each detector that send information in a period of appointed time.

This method is developed and tested in our engineering array. The shower event have not detected in our regret, we have effort to develop the fast and accurate data taking system.

4. Conclusion

Now, we just started R&D in our field by using engineering array. The communication by wireless LAN is satisfactory from temporally communication tower shown in Figure 4. We can get PMT signals and environmental data on all of 18 detectors. We are planning deploying 150 detectors on this December. If we will have no trouble, we will start observation in early 2006 while increase directional area.

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Figure 4. The communication tower. This is the tower setting temporally. We will construct communication towers fixed ground. These are 15m heights and have the lift of directional antennas. Communication towers will set 5 places and they will be able to communicate each other.