decay time of the signals from the PMTs. These two tanks, as well as a third, a test tank situated at the central campus, which is fitted with a re-used liner, have shown a faster decay time than observed in any of the other tanks. The present variability of the water resistivity allows study of the signal dependence on liner and water properties. The observed variation of signal shape and amplitude with water quality will provide a valuable diagnostic at later stages.

Water from some selected detectors is monitored periodically. The filling of detectors is not a sterile procedure and a very definite kind of bacteria was found in many of the detectors. Bacteriological analysis showed a number of colony-forming units of Serratia (an aerobial mesophyl). However, in all of the sampled detectors, the number of bacteria remained stable (below 2000 colonies ml^{-1}) or decreased, over a period of more than 2 years. This is interpreted as indicating that the tanks do not provide an environment for bacterial growth.

3.4. Electronics

Except for the PMTs and their bases, all of the electronics is contained in a plastic waterproof box situated next to the antenna mast or below the solar panels. A schematic of the various boards used in the EA is shown in Fig. 3, along with a typical pulse from low-energy shower, as recorded at the end of the complete local acquisition chain.

3.5. PMTs

Three different types of PMTs were used in the EA: Hamamatsu R5912 (8 in. diameter), ETL 9353 (8 in. diameter) and Photonis XP1802 (9 in. diameter) as part of an evaluation procedure. Details of other tests have been given elsewhere [13]. Some tanks were equipped with three identical PMTs, while others had one of each type. The PMTs are optically coupled to the windows of the liner with GE or Wacker RTV silicone, encased in a black fez for light and humidity isolation, and connected to the junction box above the larger hatch cover. A control cable brings the necessary voltages to the base of the PMTs. The high voltage supply is located directly on the base, and controlled by a low voltage from the slow control board (see Section 3.7). Signals are extracted from the last dynode and from the anode. An amplification of $\times 32$ is applied on the dynode signal to match the dynamic range. The anode signal will be used for large signals, typically those seen by tanks relatively close to

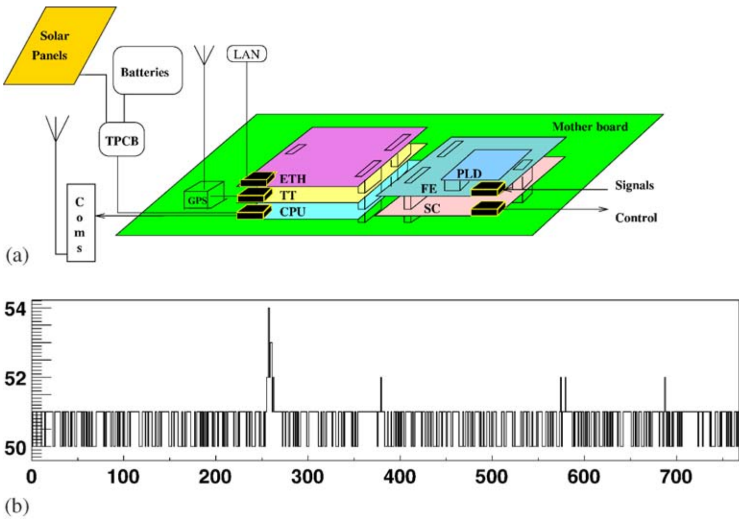

Fig. 3. (a) Schematic diagram of the electronics of the EA; (b) A typical signal from an FADC channel. Each time bin corresponds to one 40 MHz clock tick, or 25 ns.

the core. The cross-over point corresponds roughly to the signal from a vertical event of 10^{19} eV within 700 m of the core. Half of this amplification is done at the PMT base, with the other part being carried out at the front-end electronics (see 3.6).

Analysis of the data from the first 6 months of the operation of the EA (from July 2001) was used to determine which phototube would be used in the whole array.

3.6. Front-end electronics and first level trigger

The readout of the six signals from each tank (the signals from the anode and the amplified dynode of each of three PMT) is accomplished using front-end electronics having six 10 bit Fast Analog to Digital Converters (FADCs) running at 40 MHz. The digitised signals are sent to a daughter PLD (programmable logic device) board, which is used to implement the various triggering decisions.

Two different trigger modes are currently implemented in the EA for the first level (T1) trigger. The first uses a 'single threshold'. In this mode, one looks for a coincidence of some PMTs above a threshold. The second mode uses the 'time over threshold' in which a specified number of 25 ns bins are each above a threshold value within a pre-determined time window. A further trigger mode, based on the sum of the signals, can be programmed, but has so far not been used.

The majority of data from the EA has been taken using the 'single threshold' trigger set at a 3-fold coincidence of 1.75 Vertical Equivalent Muons, (VEM, see Section 3.9) on each PMT, and with the 'time over threshold' requiring a 2-fold coincidence of 12 bins at 0.2 VEM within a 3 μs window. For this trigger, 12 of the 120 bins (a 3 μs window) must be above 0.2 VEM for two PMTs at the same time. Any of these parameters may be changed using the slow control system (Section 3.7).

Whenever a trigger is generated, a time block of 19.2 μs (768 bins) from the FADC is copied to a buffer, which can be accessed by the station controller. There are 256 pre-trigger and 512 post-trigger bins. This first level trigger can operate at a maximum rate of $\sim$200 Hz but has been running routinely at around 110 Hz.

3.7. Station Controller

The local electronics is controlled by a CPU board that hosts a Power PC 403GCX at 40 MHz running under the OS9 operating system. The station controller is used to select from the T1 trigger signals, arriving at $\sim$110 Hz, the ones likely to have come from EAS. Such events are forwarded to the CDAS system at the Central Station. For the EA, all 'time over threshold' triggers are designated as second level triggers (T2), as are any single threshold triggers above 3.2 VEM. These trigger choices mean that the efficiency of the array is greater than 90% above 10^{19} eV. The rate of T2 triggers is around 20 Hz. A slow control board (SC) is used as the interface to the PLD trigger, so that thresholds and PMT voltages can be set, and a wide range of monitoring information can be read. The monitoring information is collected from a range of sensors that provide the temperatures of the electronic box and PMT bases, and from the motherboard voltages.

The time at which a local station triggers is crucial for determining the shower direction. It is measured at each local station using a commercial Motorola GPS board (OnCore UT). The signal is processed by the CPU board and a time tagging board which provides the event time with a precision of $\sim$8 ns. To achieve this time resolution, precise knowledge of the position of each station must be provided to the CPU board. This position will be obtained routinely during the surveying procedures carried out as part of tank deployment. Most of the data from the EA has been taken without these coordinates being fixed, degrading the resolution to around 14 ns. This timing precision, measured in the laboratory with respect to an atomic clock, has been replicated in the field.

3.8. Power supply

The electronics at each station is designed to have a power consumption lower than 10 W as