

AUGER PRIME: SURFACE DETECTOR ELECTRONICS

The hybrid detector that constitutes the Pierre Auger Observatory consists of both surface detectors (SD) and fluorescence detectors (FD), and these detectors require electronic systems for their operation. In this text, we will focus on the electronics of the SDs.

Each surface detector records signals that are essential for the study of ultra-high-energy cosmic rays. These signals originate from the water-Cherenkov detector based on an ultrapure water tank (WCD), the surface scintillation detector (SSD), the radio detector (RD) (Fig. 1), and the underground muon detector (UMD).

The first link in the processing chain is an electronic system called the UUB (Fig. 2), an acronym for Upgraded Unified Board. It serves as the electronic core of the surface detector and plays an essential role in signal acquisition and system control.

Once the analog signals are acquired, they are transferred to a chain of integrated circuits that performs processing, digitization, storage, control, management, and communication with the outside world.

Signal acquisition is achieved using five dual analog-to-digital converters (ADCs) operating at a sampling frequency of 120 MHz, with a resolution of 12 bits. These signals are processed by an integrated circuit that combines digital logic and a microprocessor (SoC Zynq-7020) capable of running an operating system.

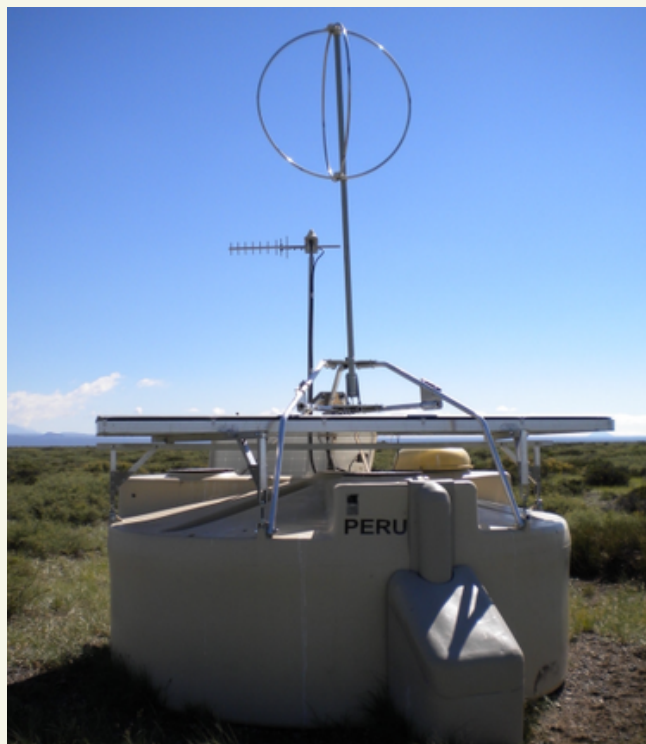


Figure 1: AugerPrime detector- Surface systems

The UUB is not limited to signal acquisition; it also controls various detector subsystems. Among other functions, it controls the operation of the photomultiplier tubes (PMTs), synchronizes the system using a GPS receiver (with a precision better than 10 nanoseconds), monitors the photovoltaic system that supplies power to the detector, and measures electrical parameters that are essential for monitoring the overall status of the detector.

In addition, the UUB must communicate with the Central Data Acquisition System, known as CDAS. For this purpose, a radio system specially designed for the Observatory is used to transfer the acquired information and enable remote control of the UUB.

The design and manufacture of the UUB were made possible through the collaborative work of different members of the Collaboration, including engineers, physicists, programmers, specialized technicians, and other professionals. The result was a robust and reliable electronic system, with nearly 1,700 units installed in the field and exposed to varying weather conditions. These units are expected to contribute to the operation of the Observatory at least until 2035. The UUB is the successor to the UB, the electronics system that operated at the Observatory for two decades. This new version of the UB, or UUB, introduced improvements in sampling rate, resolution, and data-processing capabilities.

Currently, the Observatory has laboratories equipped with electrostatic protection and instrumentation suitable for the repairs required by such complex electronics. Specialized personnel work on repairing problems that arise during operation.

In conclusion, the UUB is responsible for acquiring the data generated by the surface detector and transmitting it so that it can be stored and subsequently analyzed by the scientists of the Collaboration. Its maintenance and proper operation ensure data integrity and, consequently, the quality of the scientific results obtained.

More info: <https://iopscience.iop.org/article/10.1088/1748-0221/18/10/P10016/pdf>



Figure 2: Assembled UUB unit, equipped with front panel, GPS receiver, cables, and shielding covers.