# The VERITAS Prototype

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## Abstract

We give an update on the status of the prototype telescope of the Very Energetic Radiation Imaging Telescope Array System (VERITAS), a next-generation atmospheric imaging Čerenkov array currently under construction in southern Arizona. VERITAS will feature significant improvements over previous instruments, including better energy resolution, lower energy threshold, improved an-

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gular resolution, and increased flux sensitivity.

## 1. Introduction

The VERITAS project is a major new ground-based astrophysical observatory for the investigation of very-high-energy (VHE) gamma rays in the energy range of 50 GeV - 50 TeV. When completed, VERITAS will comprise seven identical 12 m atmospheric Čerenkov telescopes. Each telescope will feature an imaging camera consisting of 499 pixels, with a field-of-view of 3.5°.

The initial phase of VERITAS, called VERITAS-4, is currently underway, and will involve the deployment of four detectors in a filled-triangular array [4]. As a first step, we have committed to the construction of a prototype instrument in order to verify and confirm the performance of all of the major detector subsystems. This prototype, which will be located at the Whipple Observatory, incorporates all the design elements used in VERITAS. Once tested and commissioned, the prototype instrument will become one of the VERITAS-4 detectors.

## 2. Prototype Status

The VERITAS prototype is currently well under way. All of the major electronics subsystems have been manufactured, and are currently being tested and integrated at the University of Chicago. The telescope positioner and optical support structure (OSS) have been constructed and will soon be assembled at the prototype site. Here we provide some details on the technical progress thus far achieved. A more detailed description of the VERITAS technical design can be found elsewhere [6].

### *2.1. Telescope and Optics*

The VERITAS telescopes are Davies-Cotton segmented reflectors, 12 meters in diameter, with an $f$-number of $f/1.0$. The optical support structures are made of welded tubular steel, mated to commercial positioner units. Each telescope will have 315 identical hexagonal mirror facets, for a total mirror area of $\sim$100 m$^2$. The segments, which are made of slumped and polished float glass, are aluminized and anodized at a dedicated facility located on-site.

All of the mirrors needed for the VERITAS prototype have been received and coated. Characterizations of optical quality with laser measurements indicate that the quality of the facets exceeds the original specifications. The positioner and OSS have been manufactured and will be assembled and installed in May, 2003. Installation and alignment of all the mirrors will be completed by June, 2003. Additional details on the VERITAS telescope design can be found in these proceedings [2].

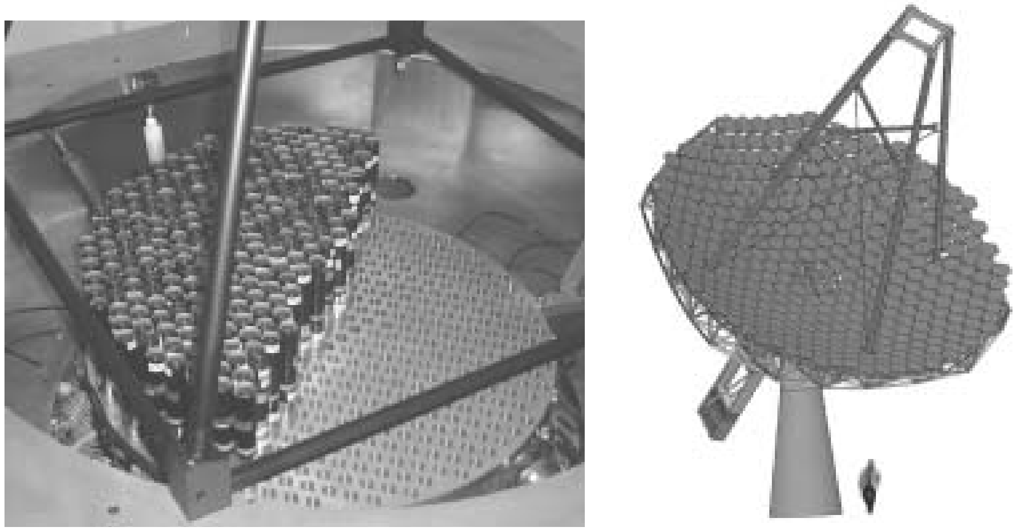

**Fig. 1.** Left Panel: The VERITAS prototype camera, during integration. The black frame is a mount for the optical calibration pulser. Right Panel: The design of the 12 m telescope and optical support structure.

### *2.2. Camera Subsystems*

Each VERITAS camera will contain 499 1 1/8-inch photomultiplier tubes (PMTs) with a 0.15° angular spacing. The high voltage (HV) for the tubes is provided by a multichannel modular commercial power supply (CAEN SY1527/A1932) which allows each tube to be controlled individually. The signals from each PMT are amplified by a high-bandwidth preamplifier integrated into the photomultiplier base. This circuit also monitors the PMT anode current and allows for the injection of calibrated charge pulses into the signal chain.

To date, all the components required for the prototype, 250 channels of signal-chain and high-voltage hardware, have been tested and installed at the Chicago integration facility. This follows an initial comprehensive 30-channel test of these subsystems, successfully completed in November of 2001.

### *2.3. Data Acquisition Systems*

The centerpiece of the data acquisition (DACQ) chain is a custom-built 500 MSPS flash-ADC system [3]. Each PMT signal is digitized by its own FADC channel with a dynamic range of 11 bits and a memory depth of $\sim 8$ $\mu$s. The FADCs for each telescope are deployed in four custom VME crates, where they are read out by local single board computers (SBCs). Buffered events from the SBCs are transferred via Scaleable Coherent Interface to an event-building computer, where they are integrated, tested, and passed on to the online analysis system.

All of the components required for the prototype DACQ system have been manufactured and are currently undergoing integration and characterization. A successful full-chain stress-test performed in April, 2003 has recently confirmed the underlying design of the entire DACQ system.

### *2.4. Trigger and Calibration Systems*

VERITAS uses a three-level triggering system. Pixel-level triggering is provided by constant-fraction discriminators (CFDs) co-located on the FADC modules [5]. The Level 2 trigger is a topological hardware trigger which can discriminate between compact, Čerenkov events, and random night-sky or afterpulse-induced events [1]. The Level 3 system receives inputs from all the telescopes and generates array-level triggers based on a geometry-adjusted multiplicity condition.

All of the trigger electronics for the VERITAS prototype have been manufactured and are currently being integrated into the telescope systems. The basic operational principles of all the components were verified in a successful end-to-end trigger test performed at Chicago in March, 2003.

The calibration systems for VERITAS include a charge injection system, (see Sec 2.2.), a nitrogen dye laser flasher, and atmospheric monitoring stations. Both the charge-injection and optical flasher systems have been installed and are presently operational. They currently comprise an important component of the overall camera testing procedures.

## 3. Schedule and Summary

VERITAS is a new, next-generation, ground-based gamma-ray observatory. The first stage of VERITAS, VERITAS-4, is currently under construction. A prototype instrument is presently approaching completion and is scheduled for deployment at the Whipple Observatory basecamp in summer, 2003. The telescope and optical support structure are currently being assembled. First light for the fully-integrated system is expected for September, 2003. First light for the completed VERITAS-4 array is targeted for 2005.

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