

The HiRes Detector: Absolute Calibration and Alignment

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Abstract

We have studied calibration and pointing direction of the High Resolution Fly's Eye prototype detector elements. In this paper we discuss the absolute calibration of the HiRes photomultiplier tubes and different methods of determining the pointing direction of the mirror/PMT clusters. We also discuss the application of these studies to the installation and operation of the Stage-I detector system.

The High Resolution Fly's Eye detector requires accurate absolute calibration of the photomultiplier tubes and accurate survey of the detector geometry. The measurement of cosmic ray energy depends directly on the absolute calibration, while reconstruction of the shower geometry depends on an accurate survey of where the detector points in the sky.

1 Surveying

The parts of a HiRes detector station important to the survey are the mirror and the photomultiplier tube (PMT) cluster. HiRes uses 4 m² spherical mirrors made from four segments in a clover leaf like pattern. This mirror gathers light and reflects it onto a cluster of 256 hexagonal PMTs located at the focal plane. The face of the PMT cluster is set to a distance of $0.97 \times (R/2)$, where R is the radius of mirror curvature. This distance is chosen in and attempt to optimize the resolution.

When a new detector is being installed, the mirror and cluster are carefully surveyed into position and their location and pointing direction are recorded. However, in the field, instruments may shift as a function of time. The foundations of buildings may settle, equipment can be inadvertently disturbed, and so on. Changes must be identified, measured, and recorded.

To install a mirror, a reference post on the mount is aligned absolutely using a theodolite and an azimuth gyro. The azimuth gyro senses the rotation of the earth to establish true north.