The Capabilities of the High Resolution Fly's Eye Detector

T. Abu-Zayyad[1], M. Al-Seady[1,5], K. Belov[1], D.J. Bird[2], J. Boyer[3], G. Chen[1], R.W. Clay[2], H.Y. Dai[1], B.R. Dawson[2], Y. Ho[3], M.A. Huang[1], C.C.H. Jui[1], M. Kidd[4], D. Kieda[1], B. Knapp[3], W. Lee[3], E.C. Loh[1], E.J. Mannel[3], J.N. Matthews[1], T. O'Halloran[4], A. Salman[1], K.M. Simpson[2], J. Smith[1], P. Sokolsky[1], P. Sommers[1], S.F. Taylor[1], S.B. Thomas[1], L. Wiencke[1], C.R. Wilkinson[2]

[1]*Department of Physics and Institute for High Energy Astrophysics, University of Utah, Utah 84112, USA*
[2]*Department of Physics and Mathematical Physics, University of Adelaide S.A. 5005, AUSTRALIA*
[3]*Department of Physics, Columbia University, New York 10027, USA*
[4]*Department of Physics, University of Illinois at Urbana-Champaign, Illinois 61801, USA*
[5]*Permanent address: Physics Dept., Faculty of Science, Alexandria Univ., EGYPT*

Abstract

The HiRes Stage I Detector consists of two sites and a total of 64 mirrors elements. The detector will be in full operation by 1999. We review its aperture and its capabilities in measuring the cosmic ray spectrum, cosmic ray isotropy distribution, and resolving the primary composition. The potential for detecting EeV neutrinos is also discussed.

1. Detector configuration

The elements of the Detector are arranged to achieve the maximum aperture at the highest energy region. Twenty two elements at the HiRes-I site cover the full azimuth angle and 3 to 17 degrees elevation angle. An element or unit consists of a mirror with 256 photomultipliers and associated electronics for event formation and event data storage. Forty two elements at the HiRes-II site cover 336 degrees azimuth and 3 to 30 degrees elevation. This configuration optimizes the stereo aperture for high energy events at large distances. The aperture and resolution in the following sections are computed for stereo events.

2. Detector resolution on energy and composition

The energy resolution is studied by the detector Monte Carlo. We generate events with random geometry at different energies. The shower profile is assumed to be a Gaisser-Hillas (Gaisser & Hillas 1977) profile with proper fluctuations in the depth of shower maximum (X_{max}). The photons reach the detector are then calculated based on the shower geometry and shower profile, taking into account the atmospheric scattering and attenuation. Photon statistics is also included. Data from those tubes which triggered are written to disk and passed through our standard reconstruction procedure which reconstructs the geometry and shower profile parameters. The various resolutions are obtained by comparing the reconstructed event parameters with the input parameters.

The calculated energy resolution for events at 10^{20} eV is shown in Figure.1. The energy resolution for events between 10^{18} to 10^{20}eV are 15% in FWHM (no atmospheric variation is