

The HiRes Fly's Eye Prototype Detector A Status Report

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ABSTRACT

As of late February 1993, the HiRes Fly's Eye Prototype Detector became fully operational, with 14 mirrors taking data at a real-track rate of about 0.1 Hz. Its status and some preliminary results will be discussed.

1. INTRODUCTION

The HiRes Fly's Eye Prototype Detector is located on Five Mile Hill within Dugway Proving Grounds in Utah, the site of Fly's Eye 1 (40° N, 113° W, depth 860 g cm⁻² (see Baltrusaitis, et al 1985 for details)). It has been partially operational since January 1991 (2 mirrors), and became fully operational in late February 1993 (14 mirrors), with the first full data run commencing March 11 1993.

The Prototype overlooks the CASA / MIA arrays (see Ong 1990, Sinclair 1989 for details) located 3.4 km to the northeast (centered upon Fly's Eye 2), with the intention of observing coincident extensive air showers.

The goals of the Prototype are to both evaluate the detector design for the full HiRes detector (Cooper, *et al.* 1990) and to study the primary cosmic ray flux in the 50 100 PeV energy range, based mostly upon events coincident with the CASA and MIA detectors (see Boyer, *et al.* 1993 for details).

2. THE DETECTOR

The detector is discussed in detail elsewhere in these proceedings (OG-10).

Briefly, the detector has 14 mirrors, viewing a region of the sky as indicated in Figure 1. Each small rectangle represents the aperture of a subcluster of 16 PMTs (4 x 4), and each cluster consists of 16 subclusters. Each PMT has a 1 ° aperture. Data are collected via a sample-and-hold electronics system, with a multi-level trigger arrangement (tube, subcluster, & cluster level). Each mirror is capable of independent operation with all data being sent to a central controlling computer in data packets via a thin-wire ethernet.

3. DETECTOR OPERATION

HiRes detects EAS based upon the nitrogen fluorescence principle of the Fly's Eye detectors (see Baltrusaitis, et al 1985). This requires cloudless, moonless nights, giving rise to a duty cycle of about 11 %.

The PMT gain is currently set at approximately 2×10^5 . This implies an electronic resolution of 2 photo-electrons per least count. This results in an energy threshold of

Hires Prototype Detector

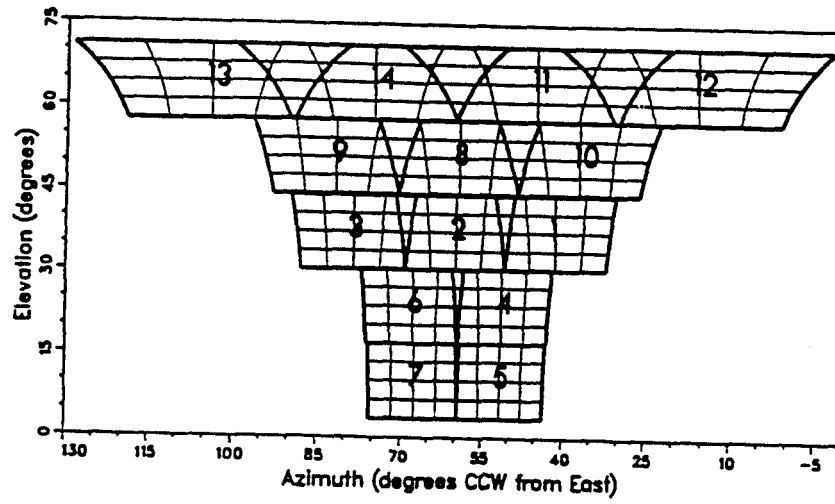


Fig 1: Sky Coverage of the Prototype

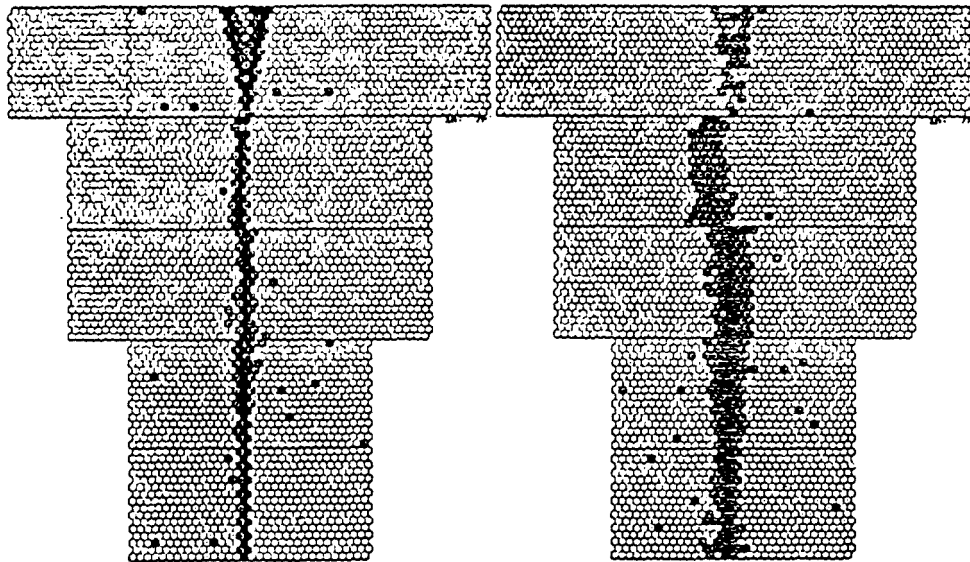


Fig 2(a): Vertical Flasher Fig 2(b): Near-Horizontal Flasher

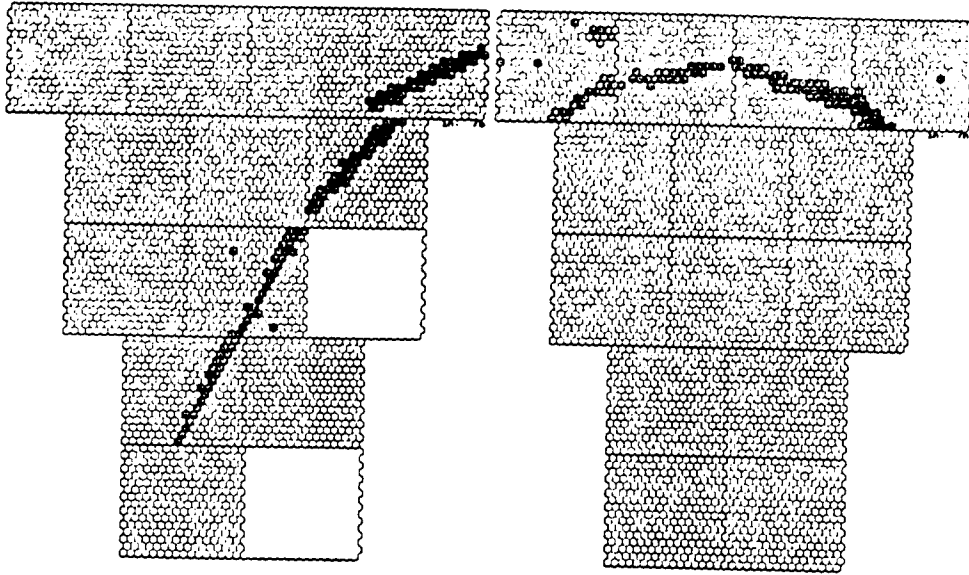


Fig 2(c) : Cerenkov Blast Fig

2(d) : Near-Vertical Cosmic Ray Track

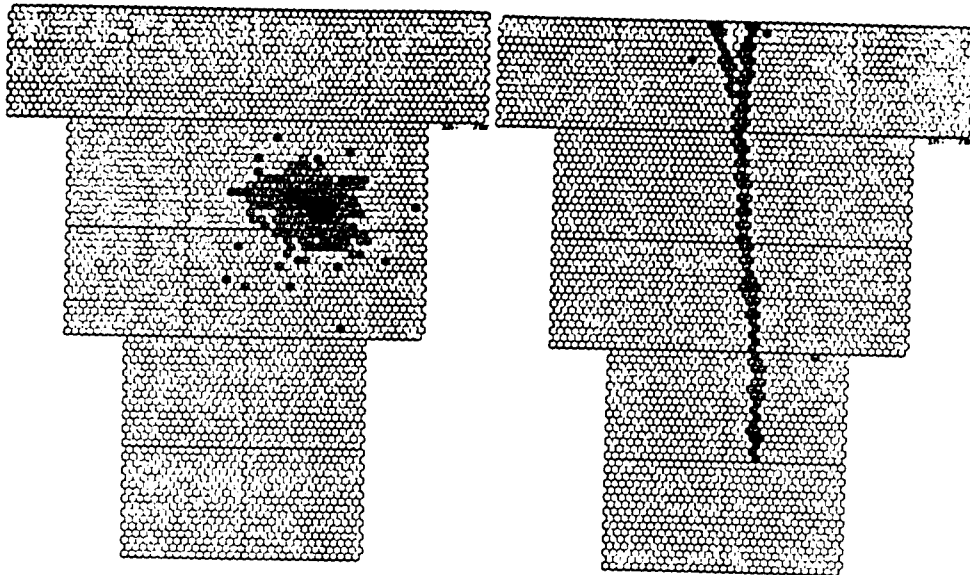


Fig 2(e) : Inclined Cosmic Ray Track

Fig 2(t) : Near-Overhead Cosmic Ray Track

about 50 PeV, which is necessary to ensure a satisfactory overlap in aperture with the CASA / MIA detectors.

Individual PMT channel thresholds are set to a singles trigger rate of 200 Hz, resulting in a mirror trigger rate of approximately 0.5 Hz, when trigger conditions of two subclusters per mirror and 3 tubes per subcluster are required.

The overall detector trigger rate is approximately 10 Hz. Of these triggers approximately 5% are 'real events', the majority of these being Cerenkov light blasts associated with lower energy (10^{13} - 10^{14} eV) primary cosmic rays (Fig 2(c)).

The detector track rate is approximately 0.1 Hz, which is over an order of magnitude greater than that of Fly's Eye 1 (Baltrusaitis, *et al.* 1985).

In addition, every mirror trigger activates an optical flasher, which is received by a PMT at Fly's Eye 2 and incorporated into the CASA / MIA data stream if a coincident CASA / MIA event has occurred within the last 50 micro-seconds. Coincident events with CASA / MIA are discussed in detail elsewhere in these proceedings (HE-3).

A number of test procedures to determine the performance of the detector, based upon the observation of collimated flashers located 2-3 km distant, and of high-energy nitrogen laser shots at distances ranging from 3 to 20 km have been carried out. In particular, the geometrical reconstruction ability has been examined in some detail and is discussed elsewhere in these proceedings (OG-10).

A LIDAR has recently been installed at Fly's Eye 2 to allow examination of the prevailing atmospheric conditions *in situ*. Work is proceeding to check Monte Carlo aperture calculations using the observation of these controlled light beams.

4. PRELIMINARY RESULTS

Fig 2(a)-(f) are examples of data taken by the Prototype. Fig 2(a) is the track of one of the vertical flashers located around Fly's Eye 1. This event demonstrates the overlap of the higher zenith angle mirrors, as indicated in Figure 1. Fig 2(b) is a near-horizontal flasher, located at Fly's Eye 2, shooting over the prototype at near grazing incidence, and gives an indication of the position of the CASA / MIA arrays. The discontinuity between mirrors is due to parallax produced by the nearness of the track to the detectors, Fig 2(c) is a typical Cerenkov blast from an EAS whose direction is collinear with the mirror axis. Fig 2(d)-(f) are examples of detected cosmic ray tracks, from vertical tracks (d) to a near-overhead track (f).

5. CONCLUSION

The HiRes prototype detector is now operating routinely and data will continue to be collected during all future construction phases of the full HiRes detector. Analysis will be carried out in detail in the next few months. Initial results will be presented at this conference.

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