Portable, Single-mirror, Air Fluorescence Detector

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Abstract

We have successfully designed and tested a mobile, single-mirror air flourescence detector and a mobile vertical laser system. They can both run autonomously. Both the laser and the detector have been tested at several remote locations in weather ranging from blizzard conditions to desert heat. The detector and laser were used to measure the atmospheric clarity in the Millard County area in central Utah for six months with laser-detector seperations of 12km and 36km.

1. Introduction

The fluorescence method has been used successfully for observing ultra-high energy cosmic ray showers for decades. The detectors up to this date have been, permanent, fixed facilities and historically these have been run off of grid power. These luxuries are not always required nor are they always available. If there is interest in exploring new sites for future detectors, for instance, it is desirable to measure atmospheric clarity before constructing permanent facilities.

2. Single-Mirror Detector System

The detector consists of the same mirror, cluster and electronic components used in the existing Hires-1 detector in Dugway, Utah. The mirror, cluster, electronics racks, UPS, etc. are firmly secured to the connex box. Both connex boxes are secured to trailers. The detector trailer has been implemented with a hydaulic lift so that the front of the mirror can be pointed at the desired angle. There is an acrylic window on the front of the detector to keep the inside sealed from the outside world. The detector connex has two doors to assure easy access without any need to touch the acrylic. The detector is operated from from the control center. Communication between the boxes is done with microwave to ethernet bridges. This theoretically allows the boxes to be seperated by a distance of twenty kilometers. Power is supplied by a 15kW diesel generator. Both connex boxes are constructed in such a way that they can be moved and redeployed easily. This system been has deployed in three remote locations including an eight month stay at the Black Rock Mesa site in Millard County. Utah.

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3. Vertical Laser System

The vertical laser system runs autonomously and can communicate back-and-forth with the detector operator. The laser itself is rated at 8mJ. The beam energy can be changed shot to shot. Each shot is monitored and recorded seperately. It has an integrated weather station and rain detector to prevent operation during bad weather. The laser system is secured in a refrigeration container to keep humidity and temperature levels controlled. This system has been deployed for six months in two different locations in Millard County (at 12 and 36 kilometer distances from the prototype detector). It has also been operating in Terra, Utah (in the Hires aperature) since december 2002.

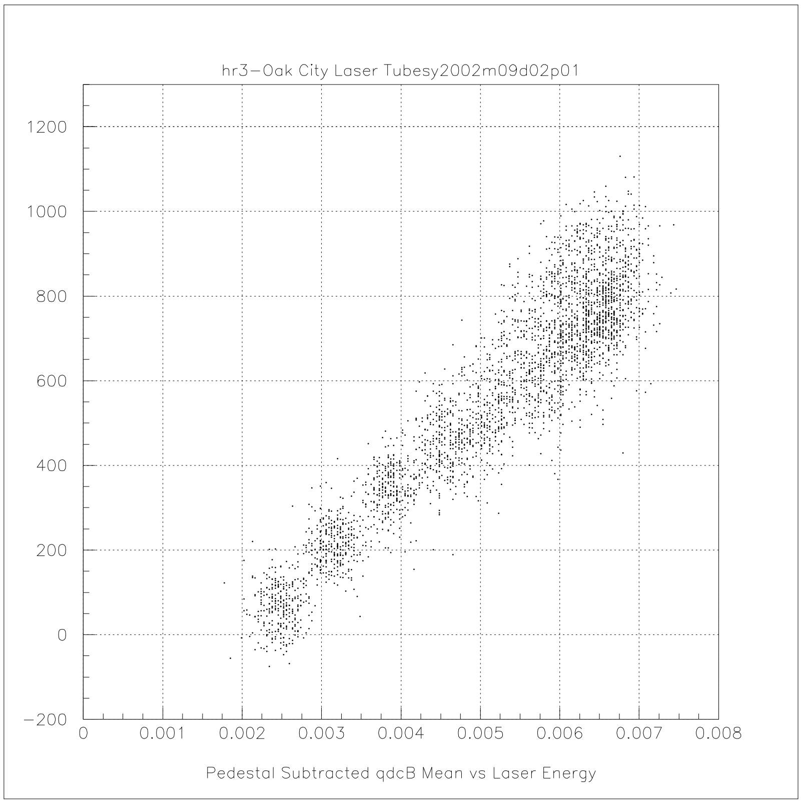

Fig. 1. A typical plot of detector ADC count vs. laser energy. This data was taken on a clear night with the laser 36 kilometers from the detector.

4. Calibration

The portable detector is calibrated twice nightly with the same xenon flasher used at Dugway (Hires). An electronic calibration is done twice nightly with a programmable pulse generator using the same procedure used at Dugway.

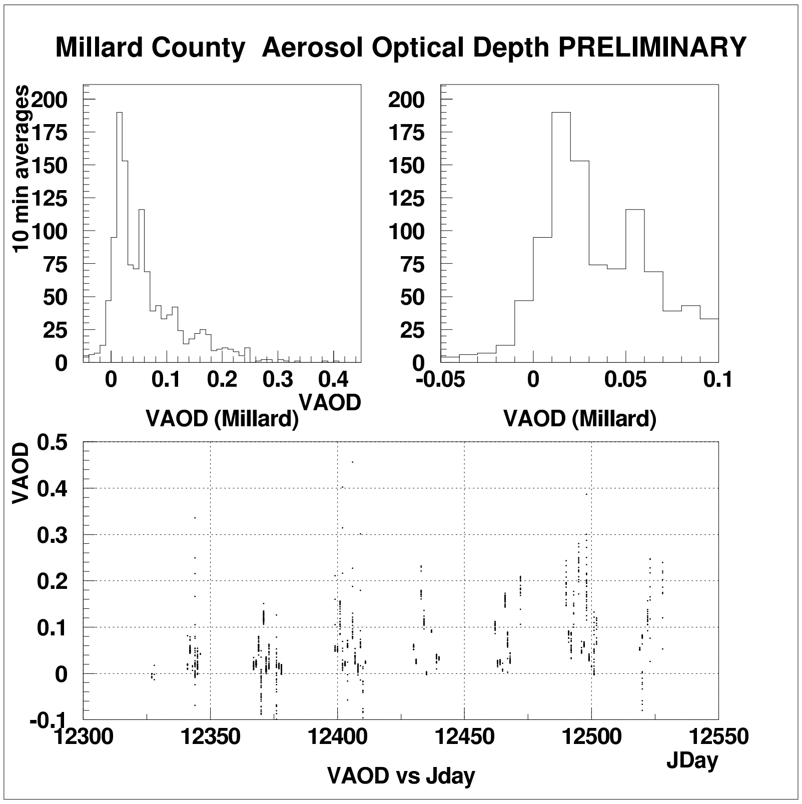

Fig. 2. A preliminary distribution of vertical aerosol optical depth measured in Millard County.

The laser was calibrated with the same radiometer and optical probe used to calibrate the lasers used at Dugway. In September and August of 2003, tests for detector linearity were added. Throughout, the August and September detector runs, the laser shot energies were ramped over ten energy settings ranging from about 2-6.5mJ (see figure 1). Each set of laser shots ranged from in energy from below the point that the detector would probably trigger to the highest energy shots that the laser would fire. In August, an ultraviolet LED was flashed at the phototube cluster every ten minutes at fifteen light intensities and a fixed pulse width similar to that of 36 kilometer laser shots. These intensities also ranged below expected thresholds and spanned the whole range of laser shot energies. Results of these tests will be presented in the form of a poster.

5. Millard County VAOD Test

From March to September 2002, the hires3 laser and detector were used to evaluate the vertical aerosol optical depth (VAOD) distribution in the Pahvant Valley region of central Utah. In march, the laser was placed 12km away from the detector in order to mimic the distance between the two Hires Fly's Eye sites. From April to September, the laser was moved to about 36 kilometers away from the detector. This longer distance had two advantages. One, the dependence on absolute calibration would be minimized due to greater atmospheric attenuation between the laser and the detector. Second, this is near the expected distance for flouorescence detectors to observe 10^{20} eV events. (see figure 2 for a preliminary results of these tests.)

6. Acknowledgements

We would like to thank Vicky Lyman (the high school science teacher in Delta, Utah) and her willing and eager students. We would also like to thank the Millard County Council.