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Research and Development Facility at Black Rock Hills Utah for a next Generation Air Fluorescence Detector

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Abstract

Research and development for a next generation air fluorescence detector will be conducted at a facility planned for Black Rock Hills in Juab county Utah about 35 km from the existing High Resolution Fly's Eye observatory. This R&D effort will investigate techniques for measuring air showers over distances of 30-40 km which is the distance between stations in an array of 10 air fluorescence detectors proposed for western Utah. We report on the status of the Black Rock Hills facility and discuss the planned R&D.

1 Introduction:

The first generation Fly's Eye experiment[1] used two detector stations separated by 3.4 km and measured the cosmic ray spectrum in between 10^{17} and approximately 10^{19} eV [2], and recorded one event above the GKZ cutoff[3]. The second generation detector, the High Resolution Fly's Eye[4], has two stations separated by 12.6 km and will extend the spectrum measurement recording perhaps tens of events above the GKZ cutoff. To study this interesting region in greater detail, a proposed next generation detector features an array of 11 stations with a nearest neighbor separation of 30-40 km. This ambitious goal will require an R&D facility to extend many aspects of the earlier generation experiments to this longer baseline.

2. The Black Rock Hills Site

The Black Rock Hill (BRH) site is a remote flat hill top located on arid public land 38.5 km southwest of the HiRes2 site (Fig 1). Several factors were considered in selecting this site. It is in the proximity of two operational air fluorescence detectors with a total 63 mirrors and 16,000 photomultiplier tubes. BRH and the HiRes2 sites also form the beginning of the Telescope Array. Their 38 km separation is typical for the proposed array. The site is at nearly the same elevation as the HiRes sites, both in absolute elevation and in relative height above the surrounding desert floor (Table 1). The site features a flat table top and a slightly lower bench area that will be convenient for construction (Fig. 2). A short access road will be required to access the site from a maintained unpaved road running 2km north of the sites. 13 km to the west, the US department of Fish and Wildlife operates the Fish Springs Wildlife refuge operated year round where limited facilities can be made available. The site can be reached directly from Dugway Proving Grounds, or via a longer route on public roads. People of any nationality can access the site at any time.

Application for a temporary right of access permit is at the final review stage with the Bureau of Land Management (BLM). All environmental reviews have been completed. We plan to construction the access road, and central structure this year.

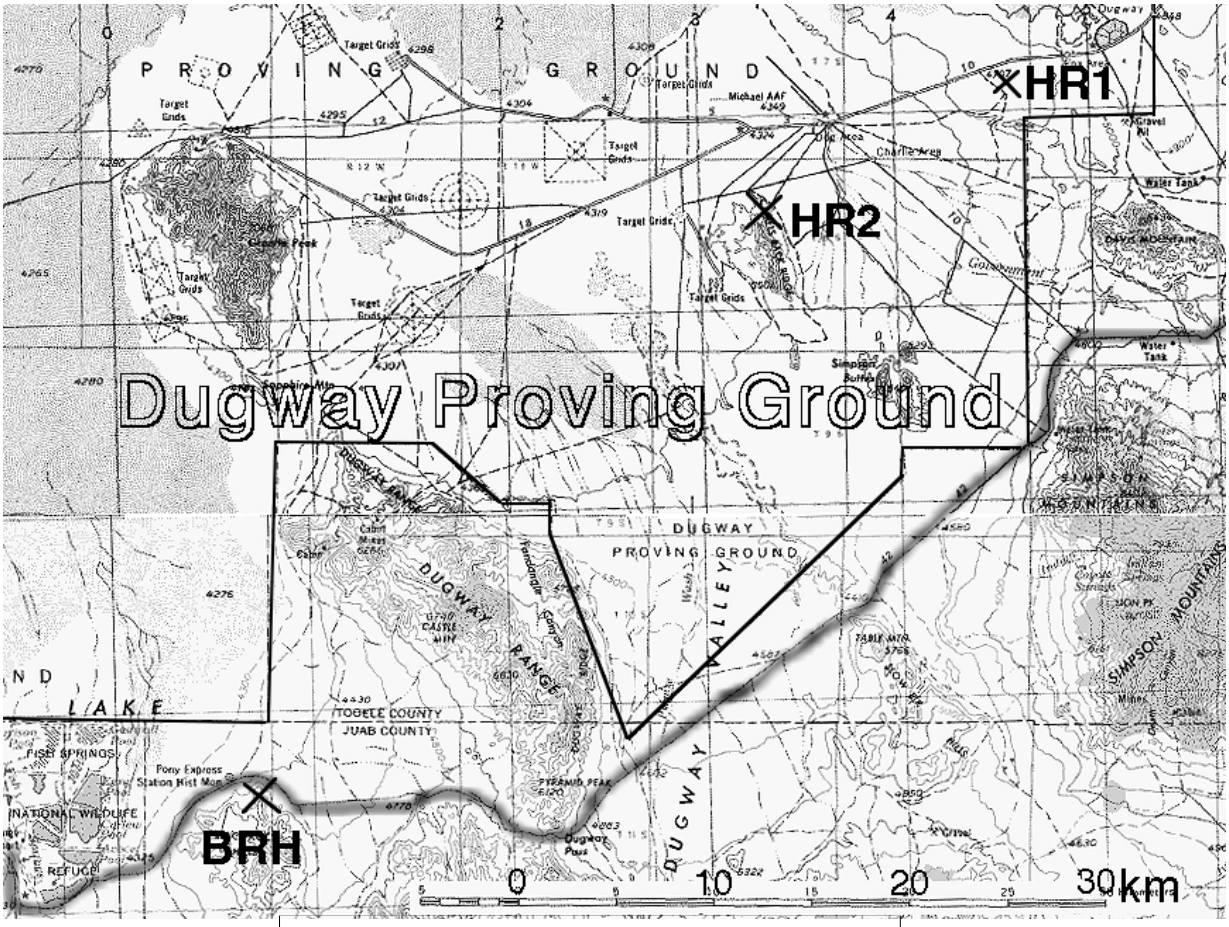

Fig. 1. Location of Black Rock and the two Hires.

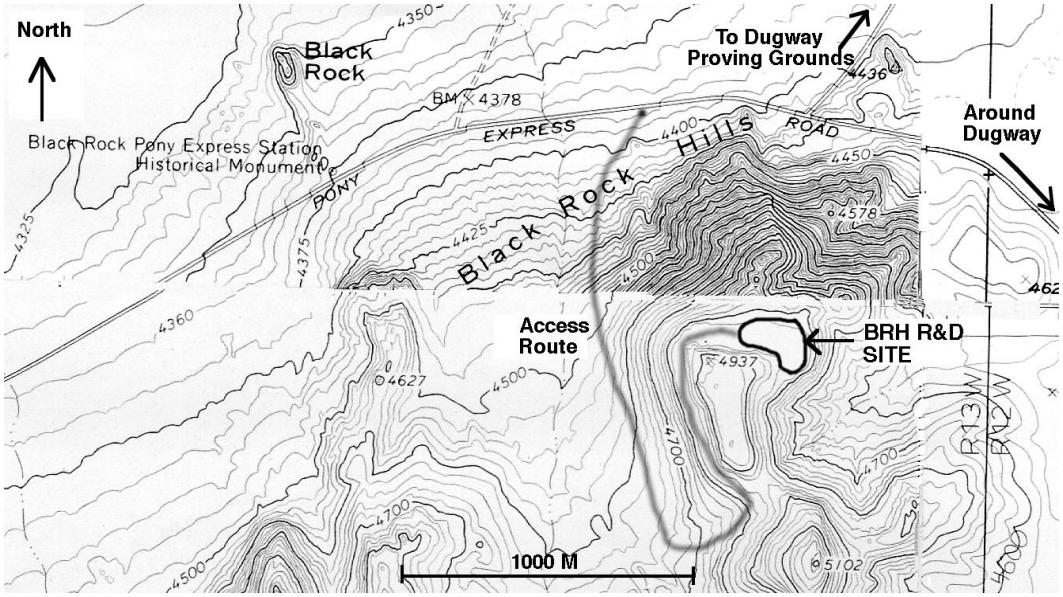

Fig 2. Black Rock Hills and the location of the planned R&D facility.

Site	Longitude	Latitude	Elv. (m) absolute	Elv. (m) above desert floor	X (km)	Y (km)	Distance to BRH
BRH	-113.2580 W	39.8725 N	1496	~140	-36.0	-35.85	0
HR2	-112.9590 W	40.1321 N	1552	~140	-10.503	-7.010	38.5
HR1	-112.8358 W	40.1952 N	1596	~130	0	0	50.9

Table 1. Locations of Black Rock Hills Site and HiRes 1&2 sites.

3. Testing at Black Rock Hills

Use of this facility as a test bed can be divided into three general areas: remote infrastructure, atmospheric monitoring, and observation of extensive air showers.

3.1 Remote Infrastructure

Each of the sites of the Telescope Array will require an access road, power, voice and data communications, housing for the detectors and control, calibration and monitoring systems. Because of the remoteness of the area, extending the nearest power and telephone lines to most of the sites under consideration would be too costly. These sites including BRH will need to be self contained. A promising solution for power generation is a micro turbine generator[5] (ref) developed for used in remote oil fields. Several global satellite based telephone systems are expected to come on-line over the next few years. We will use an Irridium service telephone at BRH to provide a voice communications for logistics and as a safety measure. We are investigating microwave spread spectrum systems to provide link for data transfer and remote operation. At BRH we intend to install a link to the Fish Springs Ranger station and connect it to a second microwave link that is operated between there and Dugway.

The design of structures to house equipment are constrained by the environmental considerations and local topology. We are considering structures supported by concrete pilings rather then by poured concrete slab foundations. At BRH we will evaluate several different types of structures.

Reliability is of paramount concern. Because telescope array sites are expected to be run remotely, the communications, power and doors must operate reliably. If there is a power or communication failure, each site affected must automatically go to a safe state with all doors closed and detector power off. When power and communications are restored, it must be possible to bring the site back on-line without sending someone there. BRH will be a test of this important requirement.

3.2 Atmospheric Monitoring

Although the array is located in the dry desert area where the atmosphere is generally clear, the proposed sites are on small hills above ground level aerosols, and much of the aperture observed is at a height greater than typical aerosol scale heights, atmospheric monitoring will be an extremely important part of the Telescope array. To evaluate techniques for atmospheric monitoring over a 40 km baseline, we propose to install and operate a steerable laser system at BRH and observe the light scattered out of the beam by the HiRes2 and HiRes1 detectors. Since the minimum distance the light will travel from the laser to the nearest detector is several atmospheric extinction lengths, this arrangement will be a sensitive probe of this quantity. Measurements by HiRes1 of a light from laser at HiRes2 indicate that a 50 mJ 355mJ YAG laser will have sufficient energy for this study.

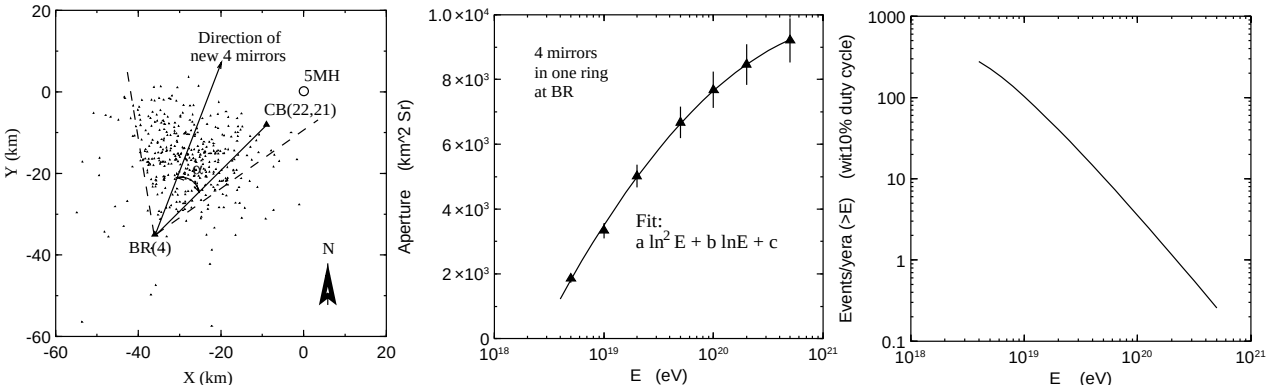

Fig 3. Montecarlo simulation of showers observed by the HiRes2 detector and a 4 mirror detector at Black Rock Hills. Left Panel: core locations of triggered showers. Middle Panel: Aperture, Right Panel:

3.3 Observation of Extensive Air Showers

A test of air shower observation and reconstruction over a 30-40 km baseline could be performed by several mirrors at BRH. A Monte Carlo study was made of the expected aperture and expected event rate for showers observed in coincidence between HiRes2 and BRH. This simulation used the $3.5M^2$ mirror and 256 1 degree PMT configuration of the HiRes detectors. Four mirrors were considered viewing a region of sky 12 degrees in elevation by 64 degrees in azimuth and centered at 10 degrees above the horizon and 22 degrees to one side of the direction towards HiRes2. The last figure was determined by optimizing the aperture. Showers were generated with an energy spectrum as measured by the Fly's Eye and extrapolated to 10^{21} eV. Core locations of the showers that triggered at least 6 PMT's at each site are shown in Fig 4. The aperture reaches 800 km^2 Sr at 10^{20} eV. The expected event rate above 10^{19} eV would be 100 events per year. A detector of this configuration could be expected to observe approximately 10 events per month in coincidence with HiRes2.

Conclusion

A facility located at Black Rock Hill will provide a test bed for techniques for a next generation air fluorescence experiment. In particular, it will allow tests that make use of the two existing HiRes detectors. Construction is planned for summer of 1999.

References

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