Shower rates measured at DEASA, Agra

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Introduction

The aim of DEASA is to explore how cosmic rays can be measured to study Earth and space weather at Agra [1] [2]. The Dayalbagh Educational Air Shower Array (DEASA) has been established at the Dayalbagh Educational Institute in Agra. This ground-based array aims to provide insights into how cosmic ray fluxes are influenced by geomagnetic latitude, longitude and altitude. DEASA is one of the air shower arrays in northern India, alongside other high-caliber arrays. The array's construction, experimental setup, and initial results are detailed in [3]. Shower rate measurements over 118 days using Nuclear Instrumentation Modules (NIM) has been presented with comparison of similar area arrays in India.The detector efficiency of each of the eight detectors is also shown for performance.

Description of Air Shower Array

The Dayalbagh Educational Air Shower Array, at Dayalbagh Educational Institute, Agra (27.22° N, 78° E, 170 m above sea level), features eight plastic scintillator detectors (100 cm x 100 cm x 2 cm) spaced 8 meters apart, covering 260 m^2. Based on the Particle Data Group, the expected muon flux is 10,000 particles per minute, with an additional 3,500 electrons per minute, totaling an ideal count of 13,500 particles per minute.
The array detectors have been studied through two sections: Block A (Detectors D1 to D4) and Block B (Detectors D5 to D8) (Fig. 1(a)). Each detector's analog signals are processed by an eight-channel leading-edge discriminator with a -30 mV threshold, converting them to logic signal pulse of time width 50 ns. These pulses are sent to a Quad Four-Fold Logic Unit (Phillips Scientific, Mod. 756) with a 150 ns coincidence window, using AND logic to count the coincidences. Block A and B shower rate is recorded for every 5 minutes. This is measured from channels 1 and 2 using a scaler (CAEN, Mod. N1145). The eight-fold coincidence rate per minute is determined by combining outputs from both blocks with AND logic, and the final count is recorded from the scaler's third channel (Fig. 1(b)).

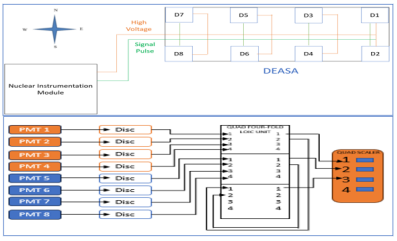

FIG. 1: (a) DEASA Layout (b) Schematic Diagram of NIM crate

Results and Discussion

Preliminary results show that all eight detectors, arranged at the same horizontal level into Blocks A and B, exhibit varying performance. The efficiency of each detector in Block B is relatively greater than responses of detectors in Block A, as shown in figure 2. The range of the efficiency of the detector varies for each detector D1, D2, D3, D4, D5, D6, D7, and D8 are 0.85, 0.78, 0.65, 0.76, 0.84, 0.89, 0.95, and 0.75 respectively.

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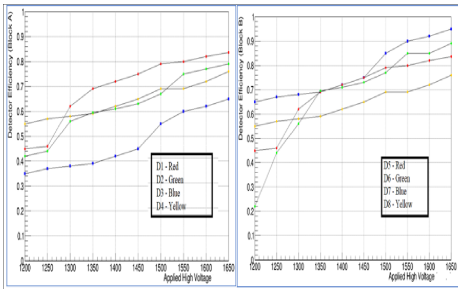

FIG. 2: Efficiency plots as a function of Applied High Voltage (in mV) (a.) For Block A, (b.) For Block B.

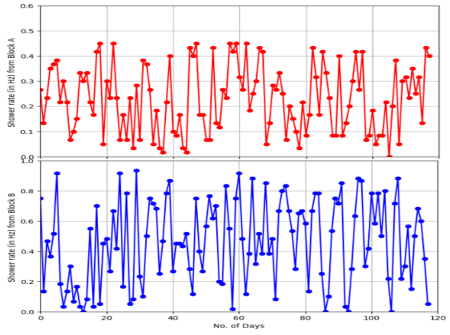

FIG. 3: Plot of Shower rate (in Hz) as a function of number of Days (a.) For Block A (b.) For Block B.

The data collected over five months, manually from 10 A.M. to 5 P.M., shows higher shower rates between 12 P.M. and 3 P.M., possibly due to photomultiplier tubes(PMT) noise. Presently the data is being observed for the entire day to get a better picture of the periodicity in the data. The data acquisition is being updated with help of micro-controller and sensors to study the pressure,temperature and relative humidity. The variations in the air showers shall be studied with these parameters in the hope to study space physics and extreme events.

The average shower rate is 0.22 Hz for Block A with standard deviation of 0.24 and 0.46 Hz with standard deviation of 0.28 for Block B, with an overall average of combined data of Block A and Block B is 0.35 Hz with standard deviation of 0.02. This data is compared to results from similar arrays in Darjeeling (27.3° N, 88.16° E) at 2200 m altitude and the GRAPES-3 experiment in Ooty (11.4° N, 76.7° E) at 2200 m altitude. Darjeeling array is at the same latitude (almost) as Agra but the altitude is very different.

Summary

The similar studies conducted in mountainous regions, one in Darjeeling (Geomagnetic Latitude 18.5 N , 2200 m a.s.l.) by a mini array consisting seven plastic scintillation detectors and another one is GRAPES -3 experiment (Geomag. Lat. 3.18 N, 2200 m a.s.l.) measured shower rate 1.8 Hz and 1.05 Hz respectively have been shown in Table 1 below. On other hand DEASA (Geomag. lat. 18.82 N, 170 m), located at a northern plateau is at 170 m above sea level. From the table given below, it seems that moving from equator to pole, the shower rate increases even at the same altitude. The shower rate decreases with altitude. This may explain DEASA shower rates in comparison to both of them and we need to observe more data to form a statement.

S. N.	Geomag. Lat.	Alt. (a.s.l)	Rigidity	Cover / Eff. Area	Shower Rate
1	18.82	170 m	14.35 GV	260 m^2/ 8 m^2	0.46 Hz [3]
2	18.5	2200 m	15 GV	168 m^2/ 8 m^2	1.8 Hz [2]
3	3.18	2200 m	17 GV	25,000 m^2, 400 m^2	1.05 Hz [1]

TABLE I: Comparison of shower rate at different locations, cutoff rigidity .

Acknowledgments

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