Students' Placement Office, IIT Kanpur

Title of the Project	Radio Detection of Pev Cosmic Rays
Commencement Date	11-05-2023
Completion Date	12-07-2023
Project Supervisor	Prof. Pankaj Jain
Organization/Institution where the Project was accomplished	Indian Institute of Technology, Kanpur

Project Description (You can use extra A4 sheets in case you run out of space however the extra sheets should also have the seal & signature of the Project Supervisor or the relevant authority)

The (primary) cosmic rays, while propagating through Earth's atmosphere, in a series of interactions with the nuclei of atmospheric constituents result in a cascade of new secondary particles, also referred to as extensive air shower (EAS). This includes gamma rays, electrons, and positrons (electromagnetic shower), muons and hadrons (hadronic shower) which move relativistically. Among these secondaries, electrons, and positrons, in the Geomagnetic field, emit coherent radio waves".

By characterizing this radio emission, the properties of the parent primary cosmic rays can be determined, this is referred to as "radio detection of cosmic rays"". The GRAPES-3 (Gamma Ray Astronomy at Pev EnergieS phase-3) experiment at Ooty, India detects primary cosmic rays (PCRs) in an energy range of few Tev to 10 PeV, including the proton knee. The knee for heavier nuclei are supposed to follow at higher energies. This motivates to increase the upper threshold of the GRAPES-3 experiment. An extension of the upper threshold of the GRAPES-3 experiment to 100 Pev can be achieved by deploying the radio antennas along with the existing scintillator detectors.

Studied basics of Extensive Air Shower (EAS) and its properties and laws governing its formation like NKG theory and Heitler model.

200 plus Simulations were done for proton and helium for 2 different hexagonal patterns of radio arrays (7 antennas array and 19 antennas array) and we will be using this to compare them to figure out if one of them turns out to be better than the other in reconstructing the shower parameters. Then, we exported these data as hdf5.py file, added noise to the signal and ran simulation (each takes 2-3 hours) on them using RIT_subhadip_14.py file to get data in .dat file. Data files consist of values for 20 different heights each having 2200 voltage values. We plotted graphs for noise plus signal. We have written python code to plot histograms of max_SNR of each file and calculated Mean and deviation of max_SNR of all files.

Project Verification Form

By appending your signatures to this form you acknowledge and agree that:

- This form along with the certificate would serve as the official document between the project supervisor and Students Placement Office, IIT Kanpur regarding verification of the student's project work
- The student will provide additional information and documentation relevant to his/her project upon request by the Students' Placement Office
- The student has clearly defined his/her individual role in projects done in cooperation with other students, faculty, groups or company personnel.
- Incorrectly over-stating the reach, impact and/or quantitative/qualitative results of a project is unethical.
- In case of violation of any of the above rules, Students' Placement Office, IIT Kanpur reserves the right to take necessary action including de-registering the student from the placement season and reporting the misconduct to the Institute Authorities.

Submitted by:-	**Project Supervisor Details:-**
Name: Rohan Kumar	Name: Prof. Pankaj Jain
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Signature:	Signature:
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