

**Project:
Detection of Cosmic-Ray Ensembles**

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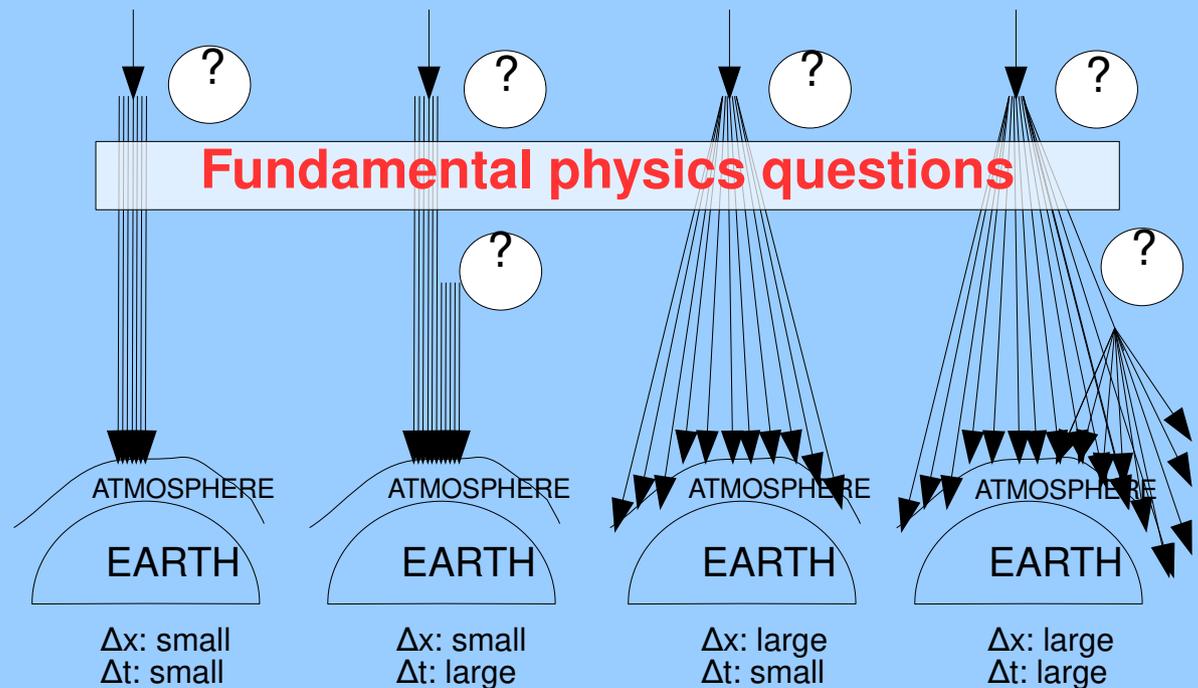
Cosmic Ray Super Pre-Showers

In some astrophysical scenarios, ultra high energy cosmic-ray particle (for example a photon) may interact far from the Earth producing a Super Pre-Shower
Several classes of SPS are possible

SPS were not observed yet, mostly because currently working cosmic-ray observatories are optimized to register only single cosmic-ray showers of very high energy.

Classes of super-preshowers (SPS)

A: γ_{UHE} (e.g. 10^{20}eV) **B:** γ_{UHE} (e.g. 10^{20}eV) **C:** γ_{UHE} (e.g. 10^{20}eV) **D:** γ_{UHE} (e.g. 10^{20}eV)

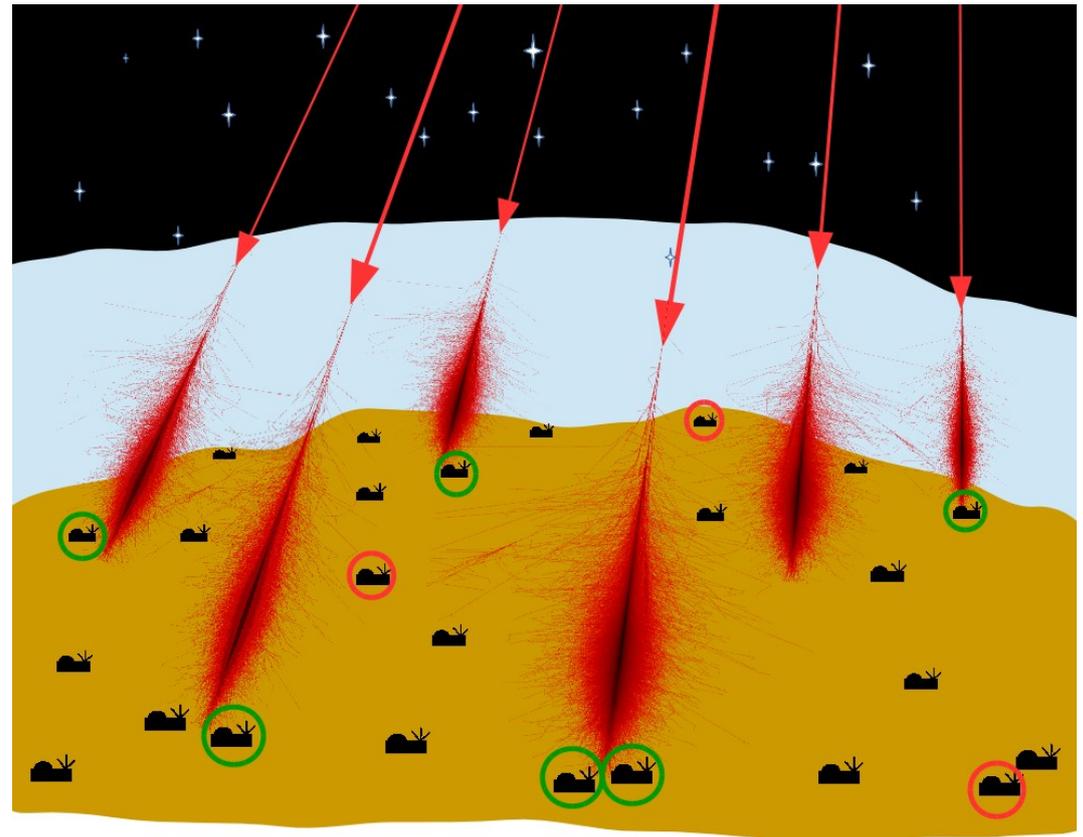


Cosmic-Ray Extremely Distributed Observatory

Cosmic-Ray Extremely Distributed Observatory is a project intended to search for SPS using detectors spread over large area.

Detection of many signals of cosmic-ray showers correlated in time would be a sign of a SPS

Any detectors, even very simple, may contribute to such a study.



-  detector with signal from a Cosmic Ray Ensemble
-  detector with signal from background
-  detector without signal

Cosmic-Ray Extremely Distributed Observatory

Cosmic rays may be detected even using a smartphone with the CREDO application. Data collected this way are stored in a central computer server for further analysis.



In this PPSS project simulations of cosmic-ray showers at different energies will be analyzed in order to determine the particle density on the ground. This information is crucial for calculation of efficiency of cosmic-ray shower detection using small and simple detectors.

CORSIKA

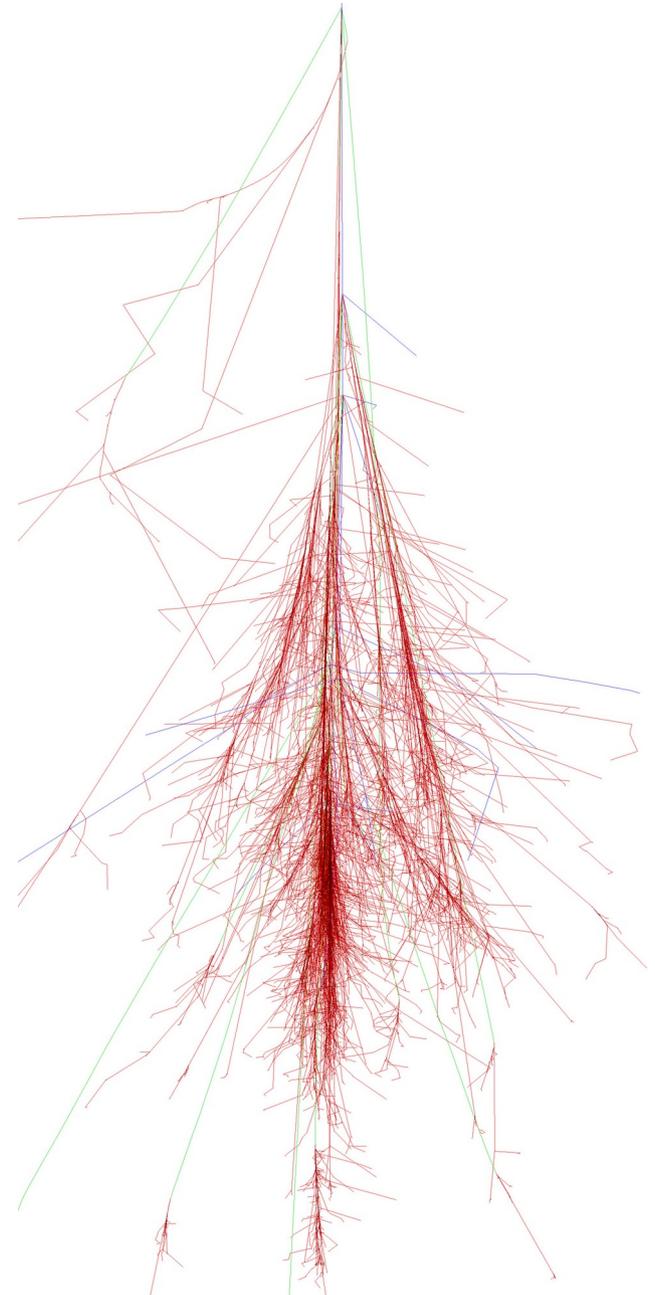
Simulations of showers generated by cosmic-ray particles are performed using CORSIKA program
(**CO**smic **R**ay **SI**mula tions for **KA**scade)
<https://www.ikp.kit.edu/corsika/>

Results of simulations can be stored in ROOT format and then analyzed using this standard in particle physics tool.

The work during PPSS will include:

- instalation of CORSIKA
- running example simulations *
- analysis of properties of generated showers

* in case of problems with instalation files with simulated cascades will be provided



Analysis

In previous years:

- reconstruction of cascade direction
- radial shape of the particle density on the ground
- dependence on the altitude of the observatory

All these was studied for vertical cascades, now it's time to analyse the properties of cascades coming at various zenith angles.

