Simulation tool for MRPC telescopes of EEE experiment

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ABSTRACT

The Extreme Energy Events (EEE) experiment consists in a network of cosmic muon trackers, each made of three Multi-gap Resistive Plate Chambers (MRPC), able to precisely measure the absolute muon crossing time and the muon integrated angular flux at the ground level. To study the MRPC telescope response and assess the detector performance, a simulation tool implementing the MRPC telescope response was developed in GEMC framework. Features and main results of simulation tool are presented.

EEE Telescope

The EEE main goal is to study high-energy cosmic rays [1, 2].

- The EEE network composed of 61 muon telescope mainly installed in Italian High Schools sparse in an area of \( 3 \times 10^5 \) Km\(^2\)
- More than \( 10^{10} \) of candidate muons collected so far!
- Scientific outreach and research purposes.

EEE Telescope

Network sites

EEE telescope

SIMULATION TOOL

Detailed description of the MRPC geometry and materials was implemented in GEMC, a GEANT4 libraries based interface developed at JLAB. Dedicated single-muon event generator was implemented according to [3, 4].

Simulation validation is made by comparing data of two telescopes, TORI-03 and CERN-01 (different experimental set-up, location and working conditions), with simulated data corrected for the experimental efficiency[5]. Agreement within 5\% at small \( \theta \) and ~10\% in the whole acceptance[6].

Experimental-simulation ratio of polar angle distribution for TORI-03 (left panel) and CERN-01 (right panel) telescopes.

SIMULATION-DATA VALIDATION

DETECTOR SENSITIVITY TO WORKING ENVIRONMENT

EEE telescopes often work in different surrounding material conditions and simulation shows how this affects the counting rate:

Ratio of simulated polar angle distributions for two building structures (windows / no windows). 8\% more in counting rate for building with windows shows the sensitivity of detector to building structure. Wall thickness 30 cm concrete.

Experimental evidence of this effect was observed in real data in the telescope hosted in the University of Genoa and proved by simulation:

The asymmetry in the counting rates reflects the asymmetric structure of the building. Simulation well reproduces the effect (see details in [6]).

CONCLUSIONS AND OUTLOOK

The EEE Collaboration developed a full simulation framework, implemented in GEMC, to study the response of the cosmic muon telescopes of its network. Simulation tool was validated with experimental data.

It is a valuable tool to study the detector performance: efficiency, angular and spatial resolutions, and dependence on telescope set-up.

It can be used to compare and correct the response of different EEE telescopes for precise measurement of cosmic ray flux due to the Forbush effect.

It can be used to investigate new directions, such as the use of the cosmic muons for building tomography, extending the current scope of the EEE Collaboration.

The tool is ready to be interfaced with Corsika events generator.

REFERENCES


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