CALIFORNIA SCIENCE & ENGINEERING FAIR
2019 PROJECT SUMMARY

Name(s)

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Project Number

S1702

Project Title

Changing the Rate of Electronically Detected Muon Occurrences by Modifying External Variables

Abstract

Objectives

The purpose of this study is to determine how different variables effect the rate of muons passing through a specific space.

Methods

Built two electronic muon detectors using free online instructions (cosmicwatch.lns.mit.edu), sourced all components necessary including the Arduino Nano, scintillator, and photomultiplier. Used open source code by "Spencer Axani." Once two detecters entered coincidence mode, multiple trials were conducted in different environments, and the data was compared.

Results

After conducting trials by using concrete, steel, and metal foam screening, testing different altitudes, changing the angle of the detectors, and looking at heat, humidity, pressure, visible climate conditions (rain, overcast, clear), and time of day, it was discovered that many specific variables can mildly impact the rate of incoming muons. Data showed that higher elevations, warmer temperatures, and a horizontal detecting direction showed an increase in events, while humidity, pressure, visible climate conditions, and time of day showed no obvious trends. Shielding showed a slight reduction in occurrences from the average number of events.

Conclusions

As variables such as elevation and temperature increase, so does the number of muon occurrences. Based on data from different angular measurements, most muons at sea level are traveling in near vertical direction because the farther the detectors were rotated from horizontal, the lower the count rate became. Concrete is more efficient as a shield to muon radiation than metal foam, but metal foam is a greater screen than 11 gauge steel. Humidity, pressure, visible climate, and time of day, had little to no impact or obvious trends.

Summary Statement

Using a scintillator coupled to a photomultiplier, I determined that variables like elevation, temperature, specific shielding, and detecting direction impact the rate of muons traveling through a specific area.

Help Received

Through email, I received help from Spencer Axani, who is a PHD student at MIT, who was able to help me identify physical problems in my detectors through photos while building them.