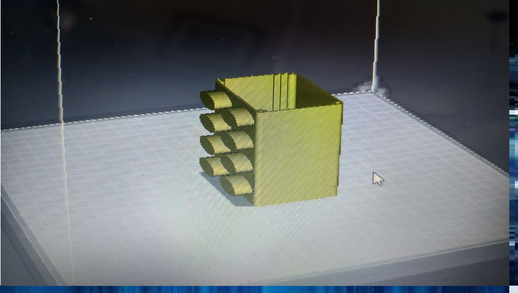

Cosmic Watch Muon Detector Case Builds and Radiation Event Counts

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Abstract

In this experiment, as a student in an advanced lab at Weber State University an opportunity was given to verify whether making cases of different materials in a 3D printer will have the same amount of muon counts as an Aluminum case. The material used in the 3D printer consists of a non-glow in the dark material and a glow in the dark material. These cases were made in a Lego brick shape and are a little bigger than a typical Aluminum muon detector case. The experiment is also taken with one muon detector board for each separate event experiment. The radiation sources Ra D/E (Beta), Co-60 (Gamma), and Th-230 (Alpha) were used in this experiment to determine the effects as they are each placed on top of each separate case. The 3D non glow in the dark print case had more events than that of a typical Aluminum or 3D Glow in the dark casing except for in the Co-60 (Gamma) radiation experiment as the Aluminum case had more events. This experiment also showed how the glow in the dark case had less counts all together in every experiment.

INTRODUCTION / PURPOSE

Muons are one of the most fundamental subatomic particles and is one of the most basic building blocks of the universe. Muons are similar to electrons in many ways but are heavier by 207 times that of an electron. Muons are a part of the lepton group.

Moving at nearly the speed of light, muons hit earth as a result of particles colliding with cosmic rays' high energy photons and atomic nuclei. Muons exist for a relativistic speed of 2.2 μs before they start decaying into an electron and two kinds of neutrinos. Considering time dilation, we can then see that muons will reach earth before they start to decay.

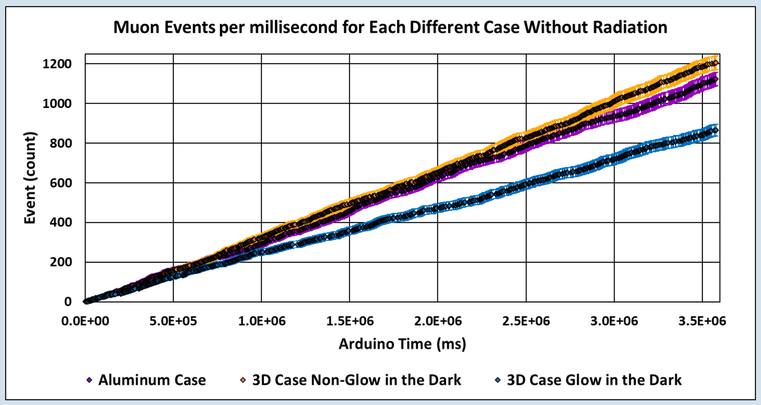
Muons are known to constantly hit each inch of the earth's surface as they pass through most of every substance on earth. They continue to travel until they penetrate at some length far below the earth's surface. [3][4]

Experiment Set Up

Using a 3D printer, Blender was used to build the muon detector case. The muon detector was built using cosmic watch and a Lego brick build found online was used to create the muon detector case[1][2]. There were many trials of making the detector using different techniques to get the print to stay on the platform for the 3.5-hour build duration to make the design. The ends for the 3D Cases were also made separately after making the main build using just glue as the base. An aluminum case was also tested.

After making the 3D cases, one-hour long counts starting with the Aluminum case were taken. The ADC threshold was set to a high of 50 and low of 25. In this experiment 15 min long counts were also taken of each separate Ra D/E (Beta), Co-60 (Gamma), Th-230 (Alpha) radiation pieces placed on top of each separate muon detector case to test how detector cases impact the detector performance.

Data was taken in TY105 and in TY125. Each data set was taken right after the other and was taken on sunny with little to no cloud coverage days. The elevation of the building is 1437 m up above sea level. The time of year this data was taken is March of 2023.



3D Print Case Non-Glow in the Dark

The second case is made from Poly Lactic Acid (PLA). This material is commonly known for being very safe and durable. It's also a biodegradable plastic made from renewables such as cornstarch. Its low melting point makes it easy to use at home. It's also known as Lego plastic. Taking one-hour long data collection of events per millisecond we see that in the data there is an average rate of 0.0003 counts/ms.

3D Print Case Glow in the Dark

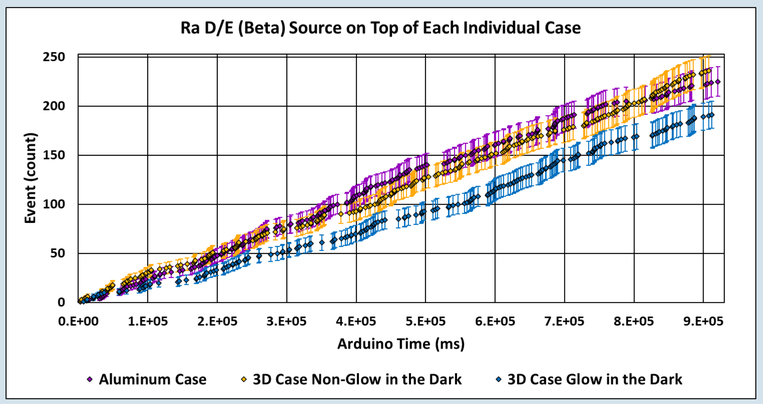
The third case is made from Poly Lactic Acid (PLA) and phosphorescent materials. This material is known to absorb energy directly from visible light sources. It glows once charged up for a relatively short amount of time. Taking one-hour long data collection of events per millisecond we see that in the data there is an average rate of 0.0002 counts/ms.

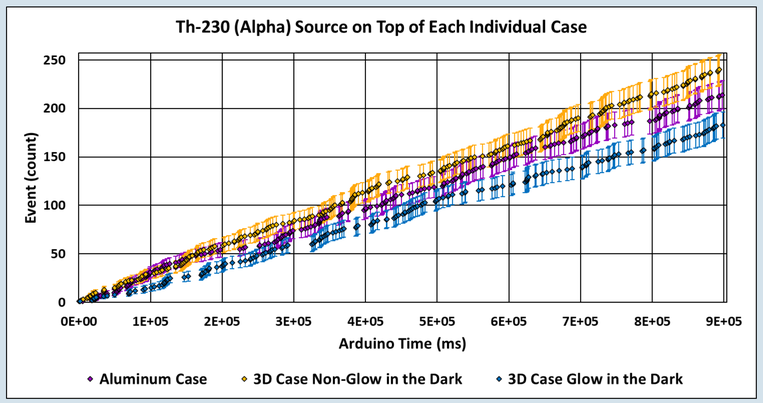
Aluminum Casing

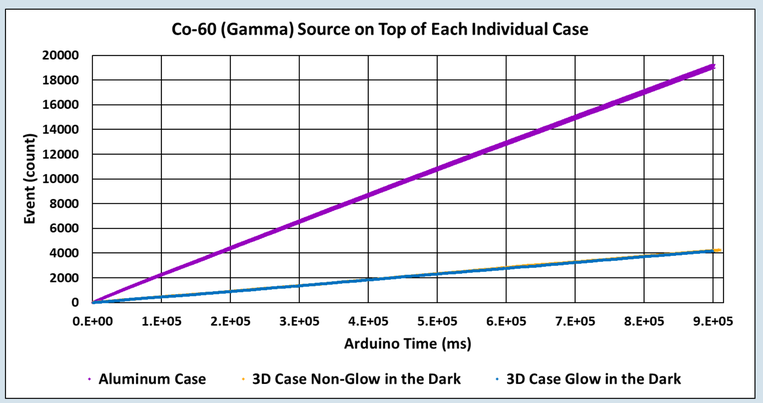
The first case is made from an Aluminum material with two plastic ends on the sides. Taking one-hour long data collection of events per millisecond we see that in the data there is an average rate of 0.0003 counts/ms.

Ra D/E(Beta), Co-60 (Gamma), Th-230 (Alpha) Radiation on Cases

The radiation sources Ra D/E (Beta), Co-60 (Gamma), and Th-230 (Alpha) are placed on each case with a 15-minute-long data collection. Each case was taken in one room for all 3 data collections for each separate case.







Conclusion

This shows that overall, the aluminum case had many more counts than the PLA csases with the Co-60 (Gamma) radiation with an overwhelming total count of a little under twenty thousand. This also showed that the 3D printed glow in the dark case had the lowest number of counts overall with each instance of each type of radiation and in general without radiation.

References

[1] *Spenceraxani. (n.d.). GitHub - spenceraxani/CosmicWatch-Desktop-Muon-Detector-v2: The CosmicWatch Desktop Muon Detector supplementary material. GitHub. https://github.com/spenceraxani/CosmicWatch-Desktop-Muon-Detector-v2*

[2] *Brick 2 x 4 Lego compatible brick. (n.d.). PrintableBricks.com. https://printablebricks.com/bricks/Brick_2_x_4*

[3] *DOE Explains. . .Muons.* (n.d.). Energy.gov. https://www.energy.gov/science/doe-explainsmuons#:~:text=The%20muon%20is%20one%20of,a%20type%20of%20fundamental%20particle.

[4] Gesualdi, F., & Supanitsky, A. (2022). Estimation of the number of counts on a particle counter detector with full time resolution. *European Physical Journal C, 82*(10). https://doi.org/10.1140/epjc/s10052-022-10895-9

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