Lunar/Solar effects on Cosmic Rays

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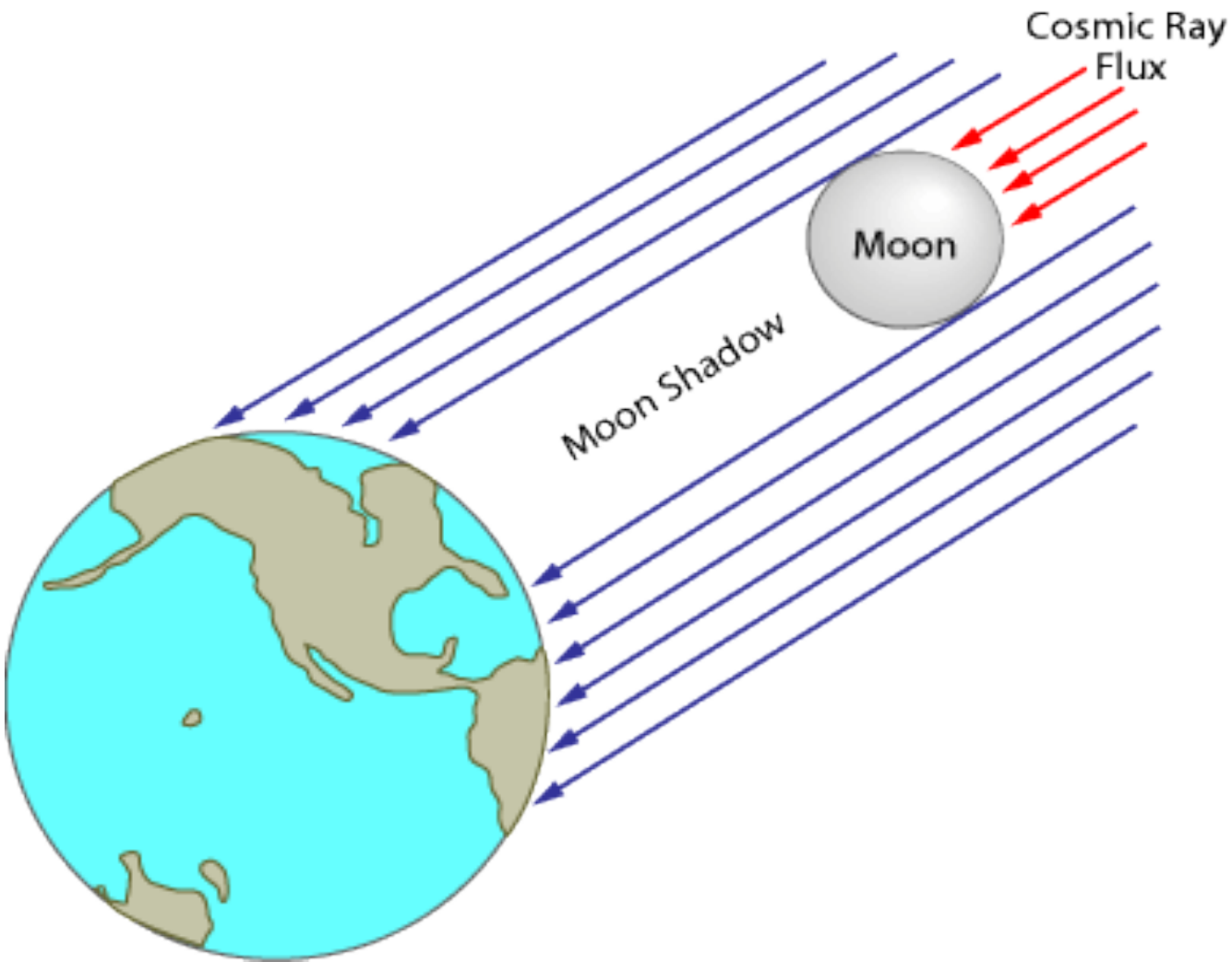
Introduction

- When cosmic rays travel through the moon they will decay because of the mass of the moon. Therefore there should be less cosmic rays coming into the earth's atmosphere from the direction of the moon.

- We were interested in if the moon has an effect on the number of cosmic rays, and therefore muons that make it to the earth’s surface.

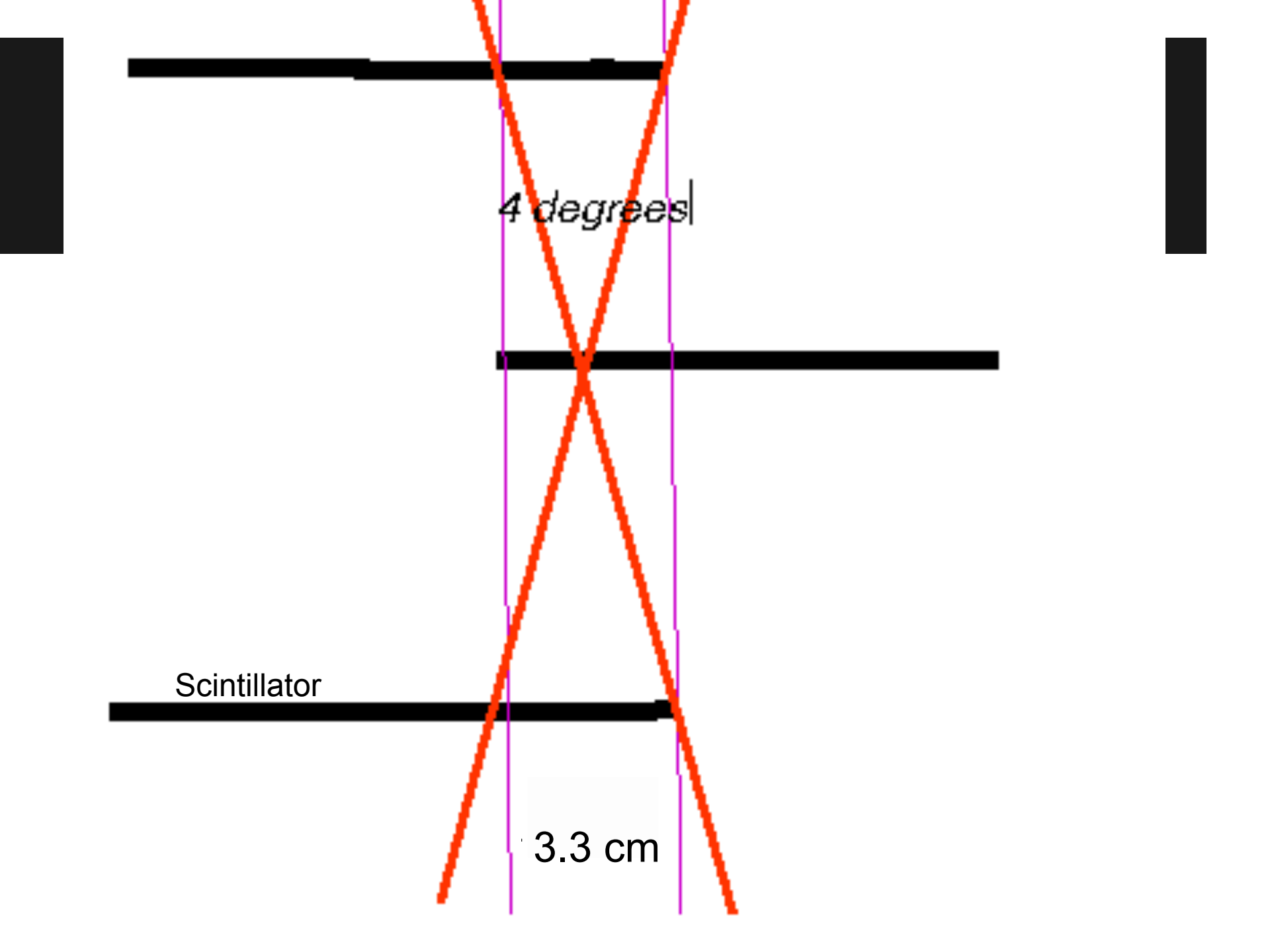
Hypothesis

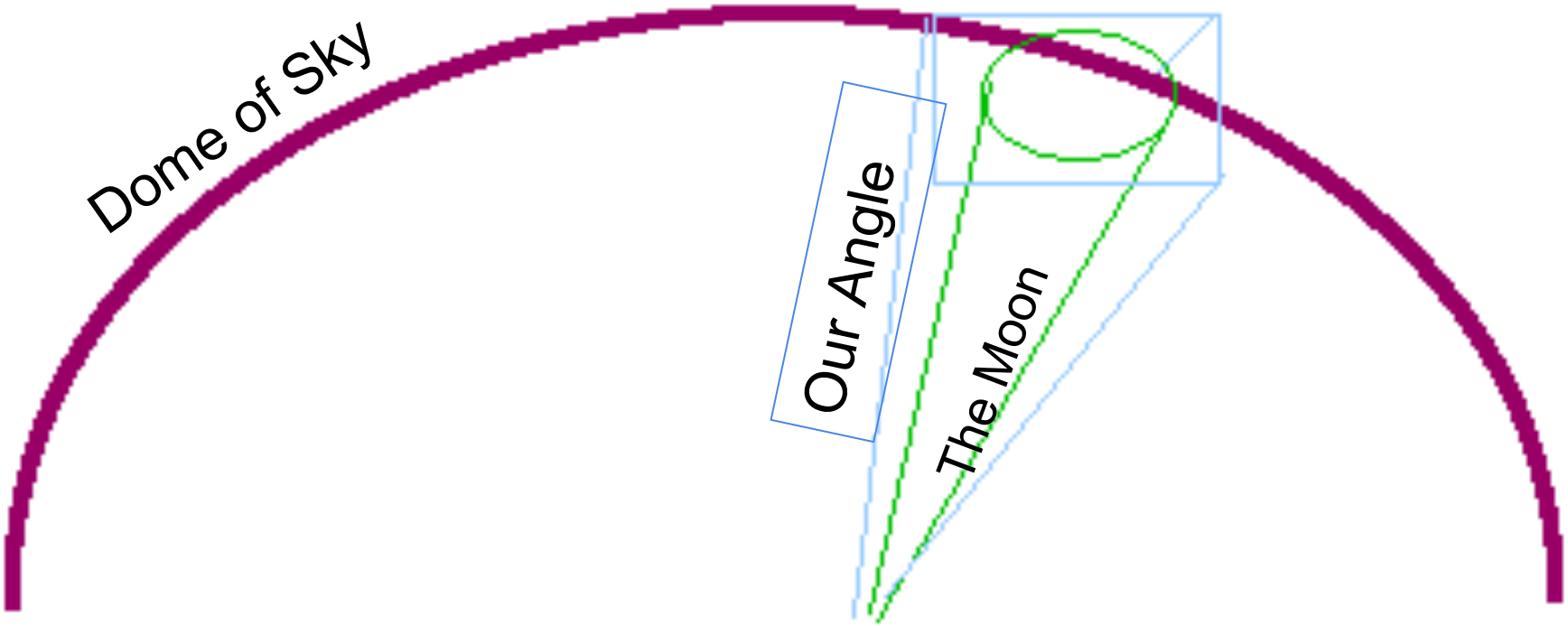
We believe that the moon creates a cosmic ray shadow. With less cosmic rays coming from the direction of the moon, this shadow should decrease the number of muons that make it to our detector.



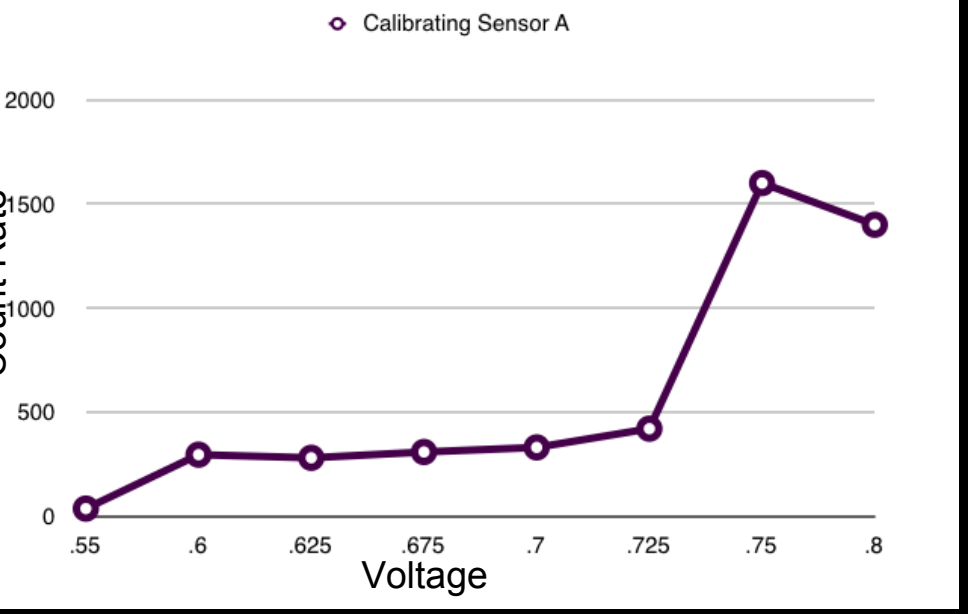
Procedure/ Set Up

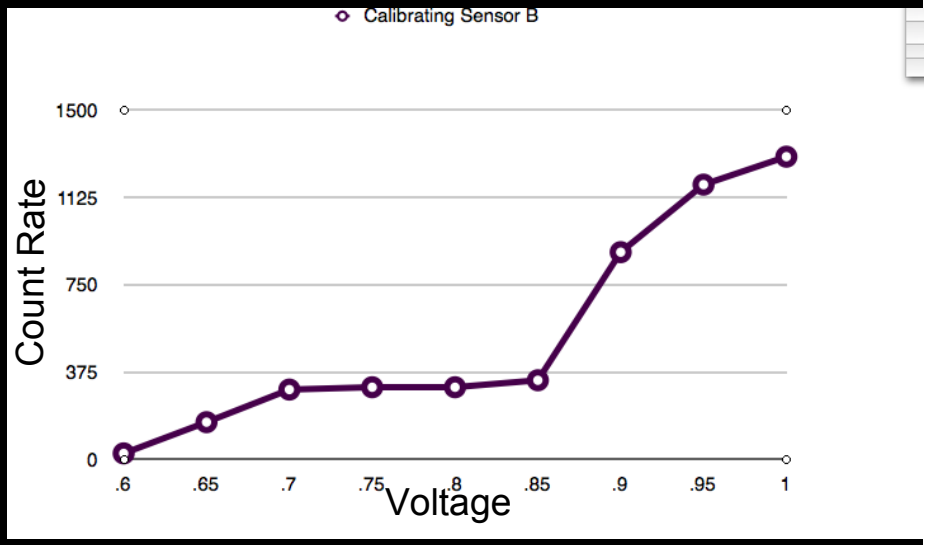
- The moon only takes up a one half degree of the sky, so our first task was to overlap the scintillators so that they formed the smallest acceptance angle possible.
- After doing the math, we discovered that the most reasonable angle was about four degrees when the top and bottom scintillators were placed six feet apart.
- We then set our monitor to a 3-fold coincidence so that only the muons that made it through all three scintillators were counted. The moon moves approximately 1.5 degrees every ten minutes, so we had to adjust our structure accordingly. We also took data when our board was pointed at the sun in order to compare those results with that of the moon's count.

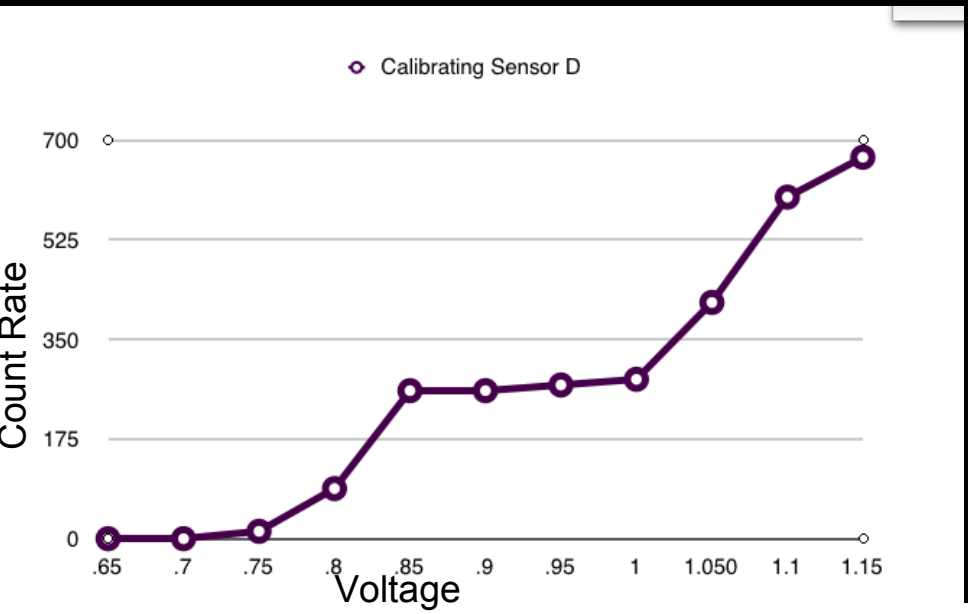

4 degrees
Scintillator
3.3 cm


Dome of Sky
Our Angle
The Moon

Calibrations







Data

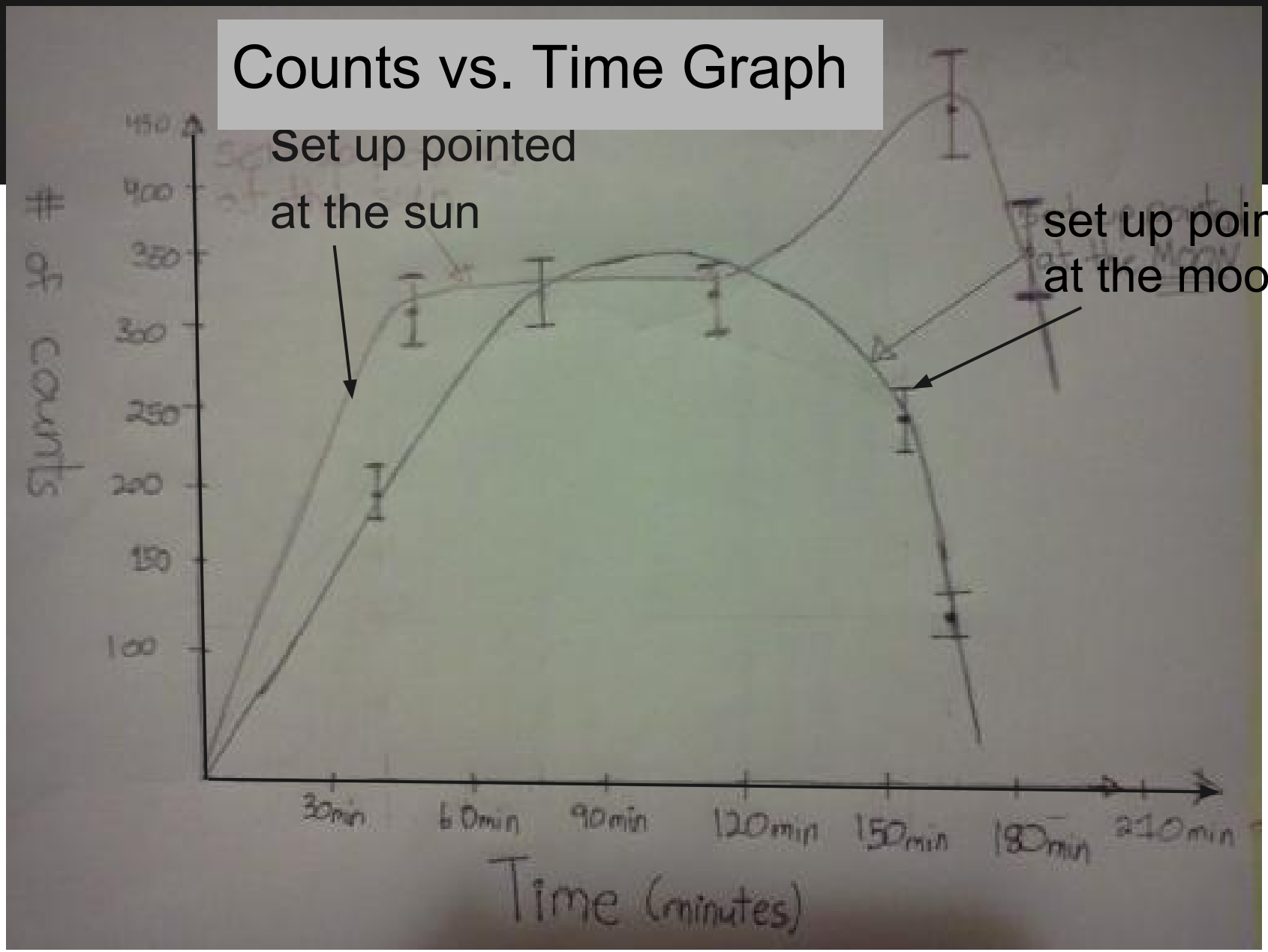
Pointed at the Moon

Date:	# of counts:	Time:
7/25/12	112	2hr 42min 8sec
7/26/12	318	1hr 15min 26sec
7/27/12	243	2hr 26min 12sec
7/25/12	178	42min 48 sec

Pointed at the Sun

Date:	# of counts:	Time:
7/27/12	294	1hr 57min 9sec
7/26/12	302	1hr 18min 52sec
7/30/12	442	2hr 40min 34sec
7/31/12	341	2hr 54min 12sec

Counts vs. Time Graph



In Theory....

$$\%\ \text{of the sky taken up by our angle of acceptance} = \frac{\text{area subtended by solid angle}}{\text{area of sky}} = \frac{R^2\Theta^2}{2\pi R^2}$$

Therefore, our angle takes up .08% of the sky. We should see a count of about one muon every 2 minutes assuming a muon flux of 10Hz arrives from all directions.

The moon takes up about 1% of our detector, so we should expect to see 0.0001% difference in muon flux within our scintillators assuming there is a moon shadow.

Results

- We were unable to determine the moon’s effect on cosmic rays because muons come in at every angle and will usually fill in any noticeable gaps.

- This means that the deficit in counts due to the moon is so small that we would need millions of counts to be able to identify a “moon shadow.”

- Also we learned that the "moon shadow" would not be directly in the direction of the moon because the earth's magnetic field pulls cosmic rays because they have a low energy.

Ways to improve

- If we had a longer time to observe the moon, we could get more counts (closer to 100.000,000) so that we could see if our data showed conclusively that the moon did or did not have an effect on the amount of muons making it to the earth's surface.
- Also, we could have made a larger structure, so that the acceptance angle was half of a degree in the sky, only covering the area of the moon.
- An apparatus could also be made that continually shifts the altitude and azimuth of the structure, so that it is constantly exactly following the path of the moon.
- Using smaller scintillators could make data more accurate because different parts of our large scintillators may be more or less sensitive to accepting muon counts.

Works Cited

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