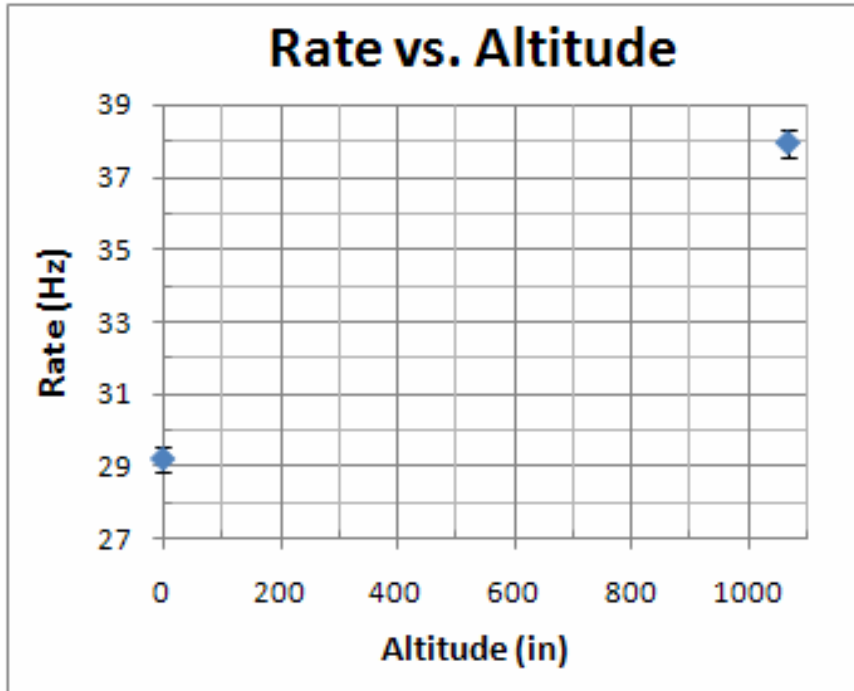


“Cosmic rays are high energy charged particles, originating in outer space, that travel at nearly the speed of light and strike the Earth from all directions. Most cosmic rays are the nuclei of atoms, ranging from the lightest to the heaviest elements in the periodic table. Cosmic rays also include high energy electrons, positrons, and other subatomic particles. The term "cosmic rays" usually refers to galactic cosmic rays, which originate in sources outside the solar system, distributed throughout our Milky Way galaxy. However, this term has also come to include other classes of energetic particles in space, including nuclei and electrons accelerated in association with energetic events on the Sun (called solar energetic particles), and particles accelerated in interplanetary space,” (R.A. Mewaldt, 1996). “Almost 90% of the cosmic rays which strike the Earth's atmosphere are protons (hydrogen nuclei) and about 9% are alpha particles. High energy collisions in the upper atmosphere produce cascades of lighter particles,” (Chaisson) Scientists have spent decades trying to find out what effects cosmic rays.

We hypothesized that altitude might be a factor that effects the rate of how many cosmic rays pass through a given surface area. We used Cosmic Chris (2 scintillation detectors), a stop watch, and a meter stick to perform this experiment. We measure the coincidence count for 240 s on levels S, P, A, B, C & D of the Physics building, keeping Cosmic Chris at the same horizontal position. We then calculated the coincidence rate and statistical error for each level.

## Results

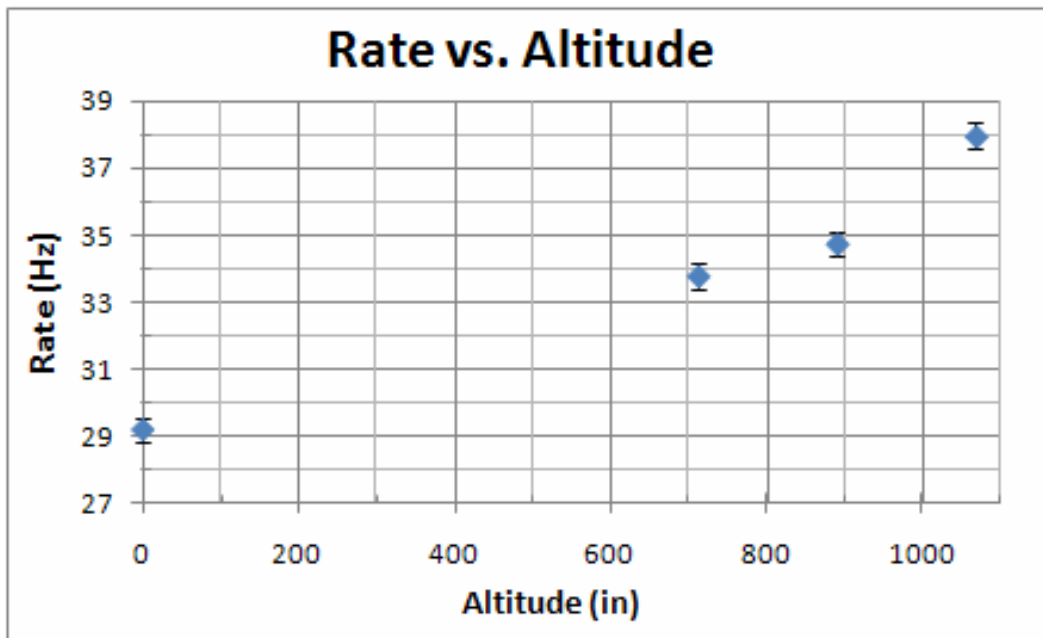
On day 1 we measured the top most point which was level D and the bottom most point which was level S.



The Coincidence rate on level D was  $1.300 \pm 0.02337$  Hz higher than on level S

### Day 2

On Day 2 we measured points on level C and B of the Physics building.

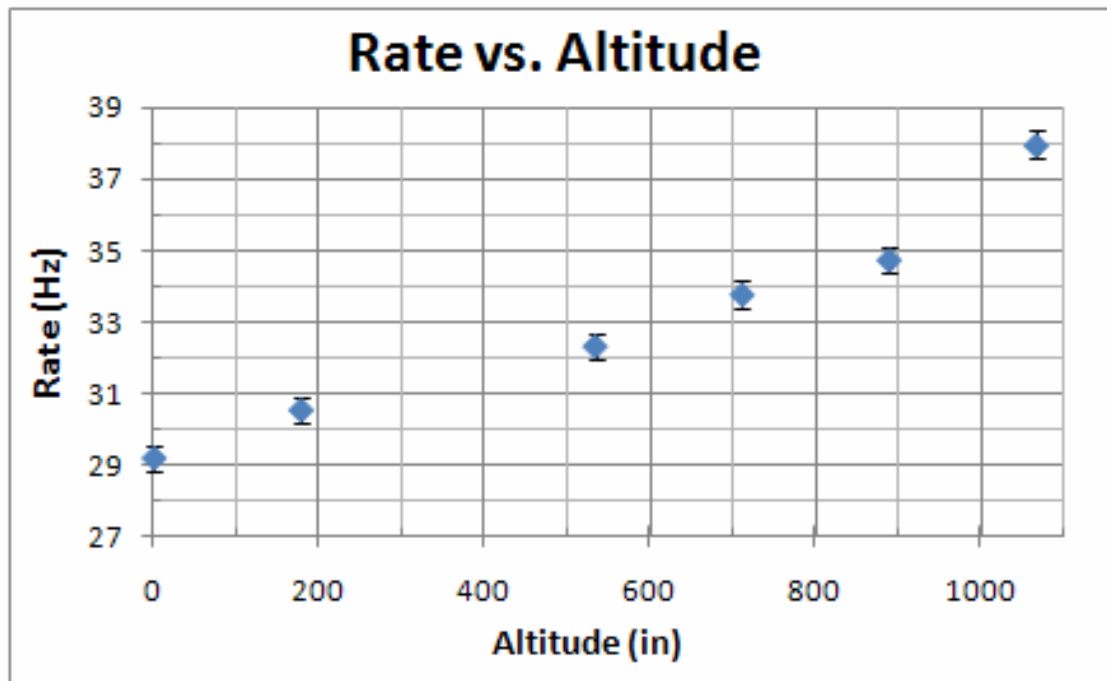


The rate increases as the altitude goes up. This we expected, but now we wanted to know why this is happening. We came to the conclusion that Cosmic rays must pass

through more material to reach the lower levels of a building thus as there is less material to pass through the top levels of the Physics building, have more cosmic rays passing through.

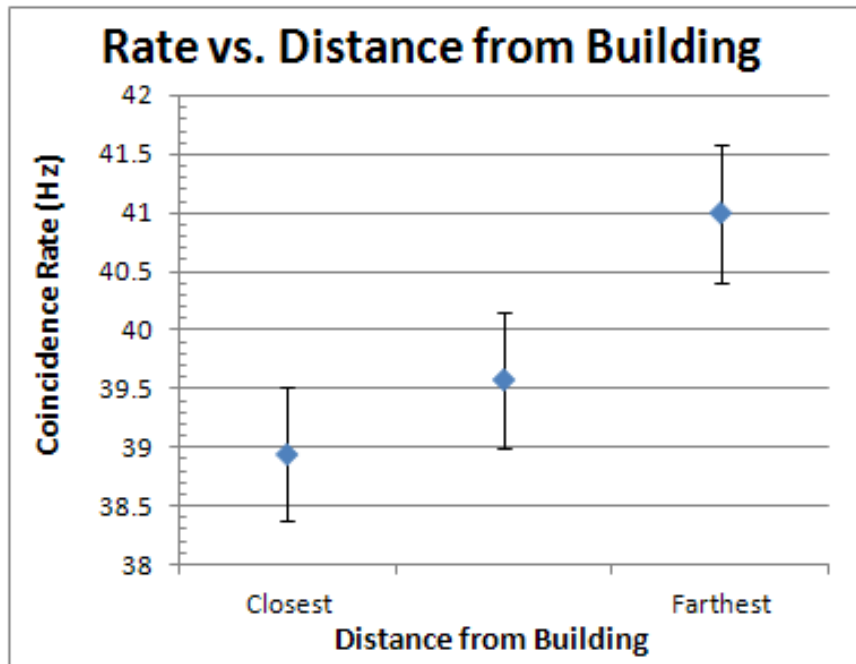
### Day 3

On Day 3 we measured points on level A and P of the Physics building.

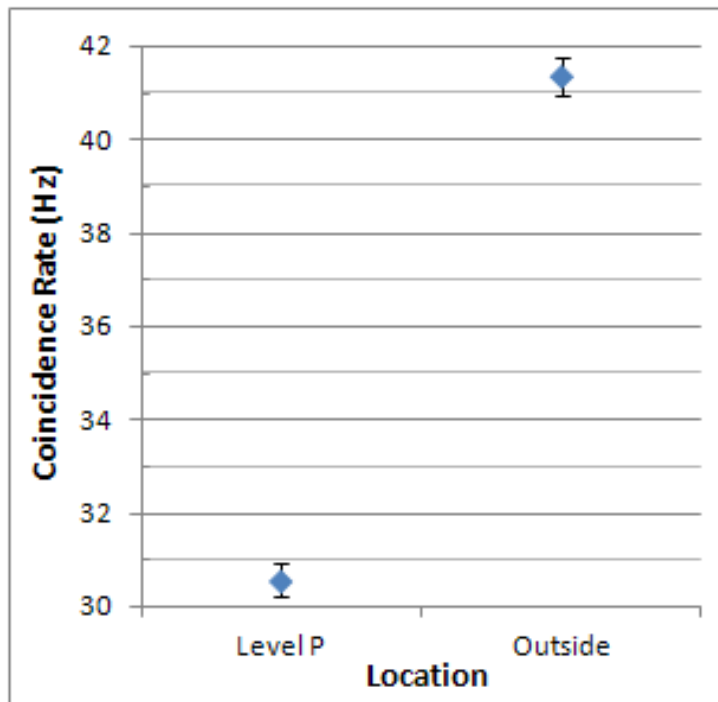


The rates of how many cosmic rays pass through a specific surface area increases as the altitude increases. So now we asked the question how the rate compares outside of the building at the same altitude.

We measured three points outside and we found out that the further away the detectors are away from the building the more rays pass through.



This could mean that materials are what causing the rate of cosmic rays to change.

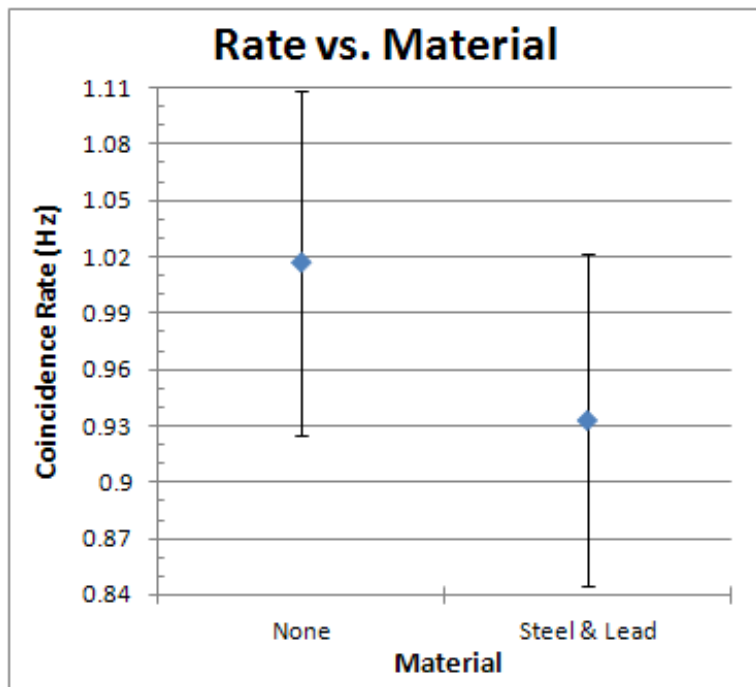


We Compared the rates on level P and outside at the same altitude. This concluded that materials are what causing the rate of cosmic rays to change. Though our hypothesis did come out to be true, it lead us to ask more questions. Like what causes the rate to change with altitude. We therefore hypothesized that building materials have an effect

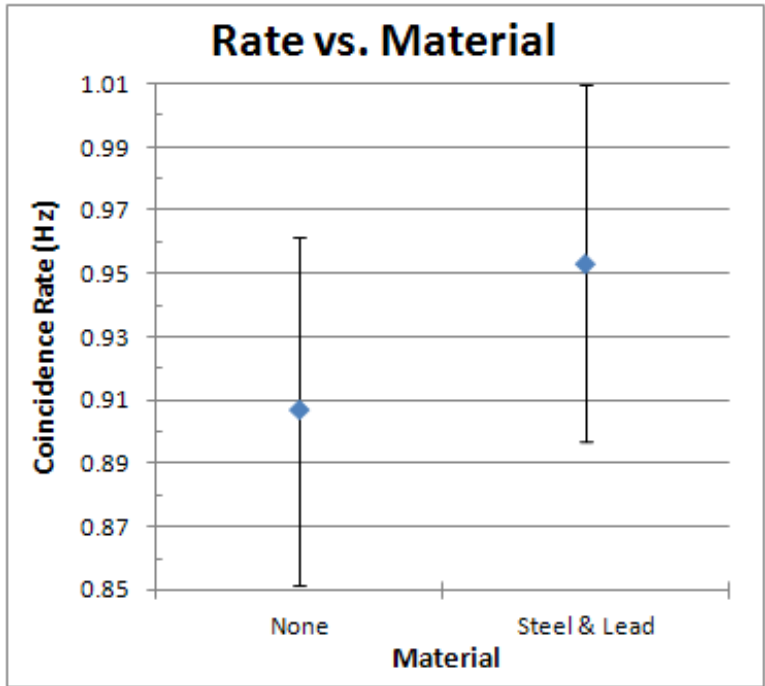
on the coincidence rate. So we designed an experiment using 2 scintillation detectors, a computer, a DAQ program, a steel board and lead blocks. We Laid detectors on top of one another at a fixed distance from each other. We then Measured the coincidence count when the Steel and lead blocks were placed between the two detectors for 120 s. We also measured the rate when no materials were present. We then calculated the rate and statistical error for each trial. To see if we got a smaller error we started measuring the rate for 300s instead.

## Results

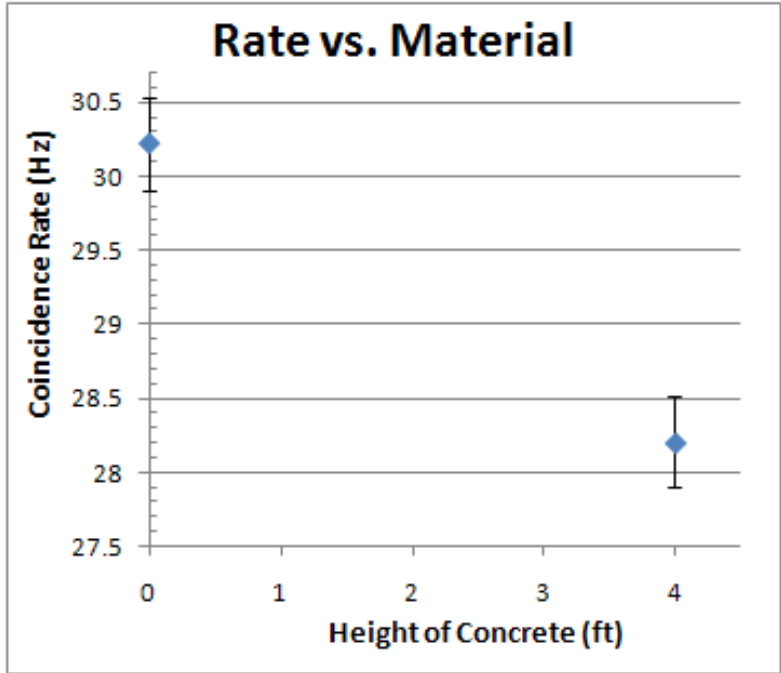
This was the result for measuring the rate for 120s



This was the result for measuring the rate for 300s



The data above is inconclusive, since the change in rate is smaller than the statistical error of each measurement. So we made improvements and decided to see if concrete is what hinders the path of cosmic rays. Hence we measured the coincidence rate under thin ceiling and compared it with measurements taken under ceiling containing 4 more ft of concrete.



We can conclude that the rate decreases as cosmic rays pass through more concrete.

## Further Study

For future studies I would like to take detectors up a hot air balloon to see how only altitude affects cosmic rays. Also it will be interesting to see how different materials like sand, glass etc, affect the rate of cosmic rays going through a particular surface area.

This course thought me a lot about thinking on my own and instead of giving me all the answers it teaches me to go and find the answers for my own questions; it is truly an amazing hands on experience. On the down side however it was short and maybe next time it could be a bit more prolonged.

## References

R. A. Mewaldt, California Institute of Technology, *Macmillan Encyclopedia of Physics in 1996*

Chaisson & McMillan, Sec 23.7, Carroll & Ostlie, Sec 30.1, <http://hyperphysics.phy-astr.gsu.edu/hbasees/Astro/cosmic.html>