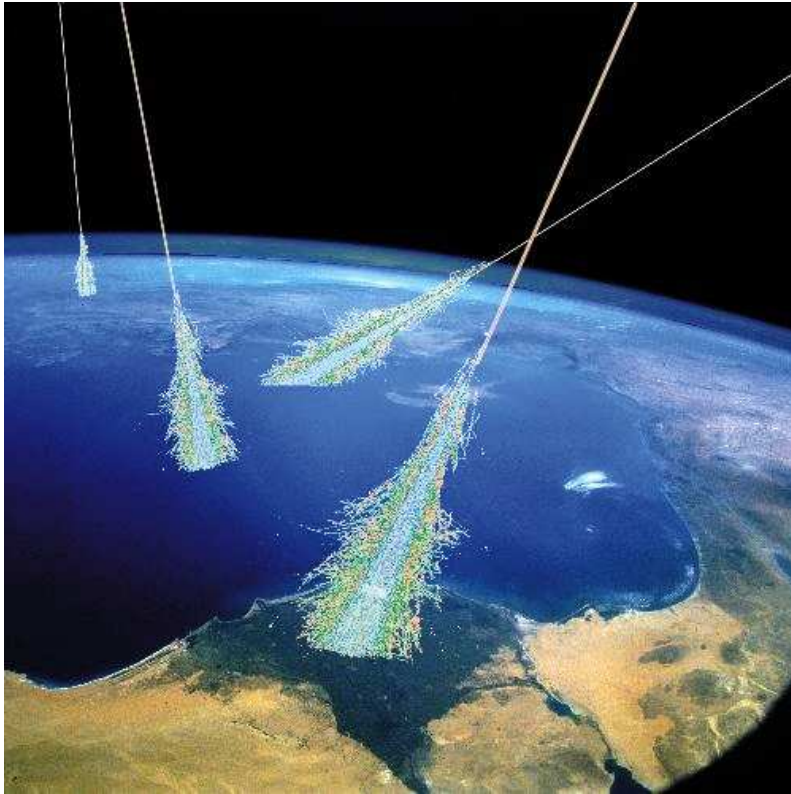


# Muon Absorption



In the following document you will view the procedure on how to set up and analyze a  
Muon absorption experiment.

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**Objective:** The objective of this project is to successfully count the percentage of Muons absorbed by a given substance using the Quarknet System.

- Build detector structure
- Setup HyperTerminal
- Take Data
- Analyze Data

The following bullets are the steps in conducting a Muon absorption experiment.

**What is absorption?** Absorption is the phenomenon in which particles are slowed down in a given material.

**Building Detector Structure:** In order to successfully complete the experiment we had to construct a stand that could carry a heavy load of material(mostly metal).



We built this structure by using a support brace kit that was easy to assemble. This kit was designed to hold approximately 300 pounds. The key thing to remember when designing a structure like this is to make sure the scintillator panel does not bare any weight because these scintillators are very fragile.

### **Setting up HyperTerminal:**

1. Make sure you are connected to the Qnet board
2. Open HyperTerminal
3. Type "RE" then hit enter
4. Type "CD" then hit enter
5. Type "WT 00 00" then hit enter
6. Type "WT 00 02" then hit enter
7. Type "WC 00 13" then hit enter

8. Type "WC 00 1F" then hit enter
9. Type "SA 1" then hit enter
10. Type "CE" then hit enter
11. Now HyperTerminal is taking data. When you want to start your experiment and take data type in:  
"RB" then hit enter  
"CE" then hit enter
12. This is now taking data until you tell it to stop by typing in:  
"CD" then hit enter
13. To display the counts received from the time you entered in "CE" type in:  
"DS" this will display the scalars in hexadecimal  
The first group of Hex is scintillator 1 singles  
The second group of Hex is scintillator 2 singles  
The last group of Hex is coincidence counts

**Converting from Hexadecimal to Decimal:** this link is an online program that will convert the HEX for you.

<http://www.parkenet.com/apl/HexDecConverter.html>

**Types of Data to Take:** In a shielding project you want to take different types of data with different materials being used to shield. But first you want to take data with no materials in between to see what the coincidence rate is without any shielding. Taking data for 30 minutes segments is a reasonable amount of time for more accuracy.

After you have taken data with all the materials you need to analyze the data.

**Analyzing:** So now you should have multiple sets of numbers from the scalars in HyperTerminal. The best way to analyze this data is in Microsoft Excel. Type the three numbers for each run in. The coincidence data is the most important because it shows the change in the counts due to the shielding. So if you graph all of the coincidence numbers you see a change in the amount of coincidences from each type of shielding.

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The experiment for the 2007 internship at Santa Cruz Institute for Particle Physics was to test the amount of charged particles absorbed by different materials.

The tests were performed under semi-controlled conditions with approximately 50 cm. of concrete above test site.

Materials Tested:

2" Pb + .5" Al

.5" Pb

.2" Al

The experimental structure for supporting materials and scintillators consist of heavy gauge steel frame with an area to support the materials to be tested.

The support structure can cause erroneous readings due to several factors such as inconsistent distances between scintillator panels, possible irradiated shielding materials, noise coincidences in the photomultiplier tubes or inaccurate calibration of testing devices.

Results demonstrated a high discrepancy between predicted shielding rates and measured rates. Shielding was predicted to be 21% of muons blocked by two inches of lead, however the measured rate was approximately 73% blocked by the same.

Sources of error for this obvious discrepancy could be:

- 1: Inconsistent spacing of scintillator panels
- 2: Inconsistent environment (Tests were performed in an environment with possible beta radiation)
- 3: Erroneous plateauing
- 4: Inaccurate DAQ card
- 5: Incorrect predicted absorption

Source # 1 is fairly innocuous as the variation was less than 10 cm, and the vast majority of charged particles enter from directly above. Source # 2 is possible, yet unlikely as the Beta sources are fairly low energy/Source # 3 is unlikely as the two scintillators with most similar plateaus were used.

Source # 4 is extremely unlikely as the DAQ board has enjoyed high accuracy. Ultimately the source of this variation is unknown.

Research also shown that a mere half inch of aluminum has a shielding potential of approximately 41%. Similarly a half an inch of lead has near the same absorption potential (68% as opposed to 73%) as the whole two inches of lead in concert with the half inch of aluminum.

Further experimentation would be required to establish absolute source of error. With current data, only assumptions can be made.