The Lifetime of the Muon

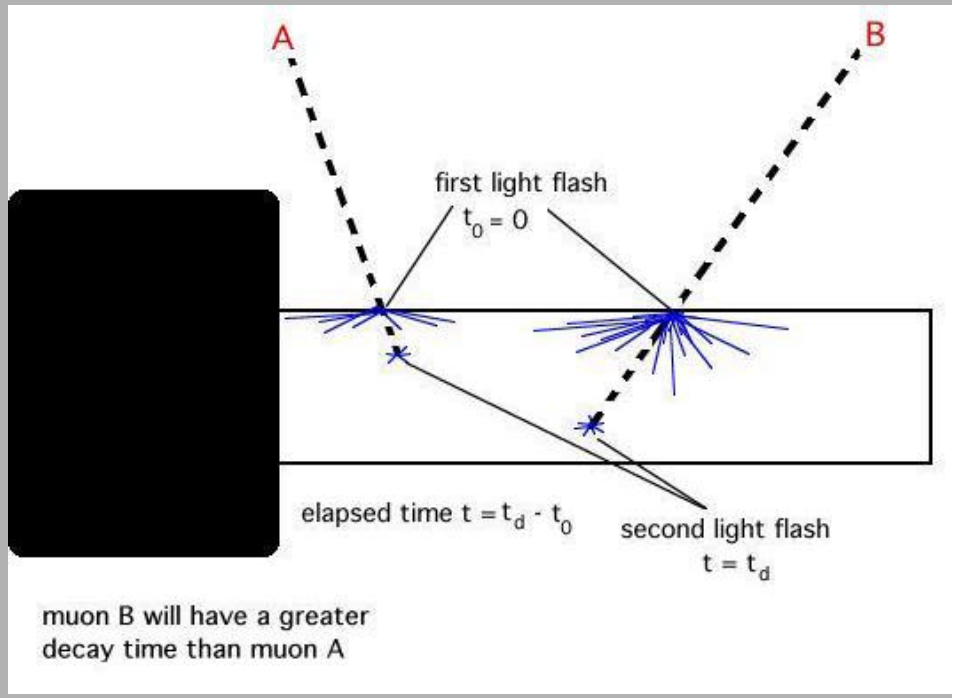
Pittsford Sutherland Physics Department

Objectives of the Experiment

- To gather data from the muon telescope and use it to determine the lifetime of the muon
- To compare the results of the experiment conducted at Sutherland High School to the known value of the lifetime of the muon

Basic Operation of the Muon Telescope

- The muon telescope used in the experiment consisted of three detectors
- Most muons detected hit the detectors once and continue on through the telescope
- A small percentage of the muons decay in the detectors, causing a double hit



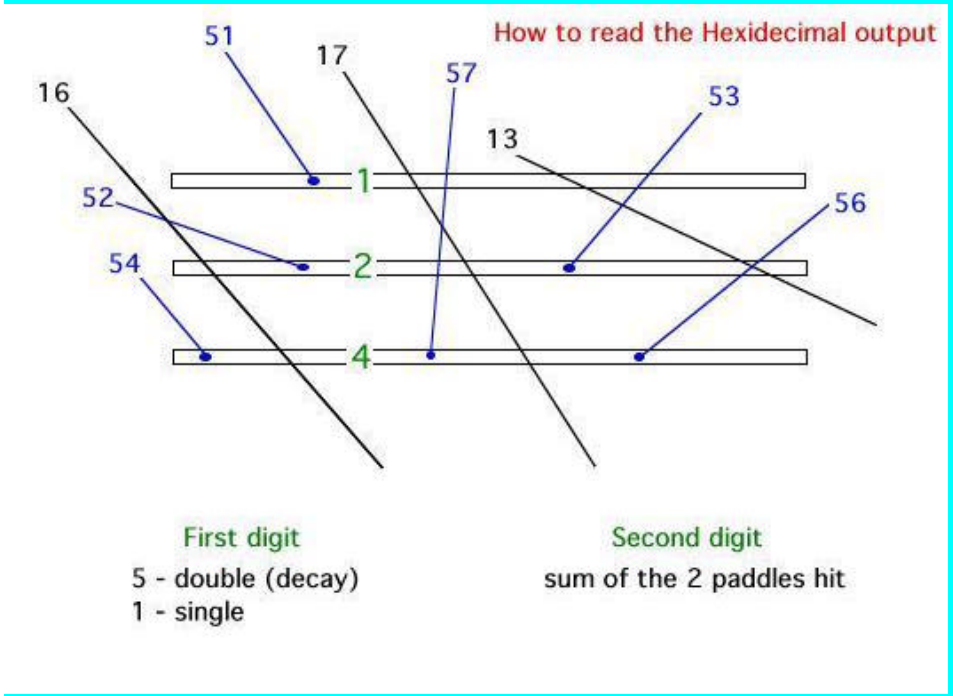
Interpretation of a Double Hit

- As stated before, the muon telescope used in the experiment consisted of three detector paddles
- The top, middle, and bottom paddles are assigned the hexadecimal integers 1, 2, and 4, respectively
- The sum of any combination of the integers may only be obtained with that specific combination (i.e. the hexadecimal sum of 3 may only be obtained with the combination of paddles 1 and 2)

Interpretation of the Double Hit (continued)

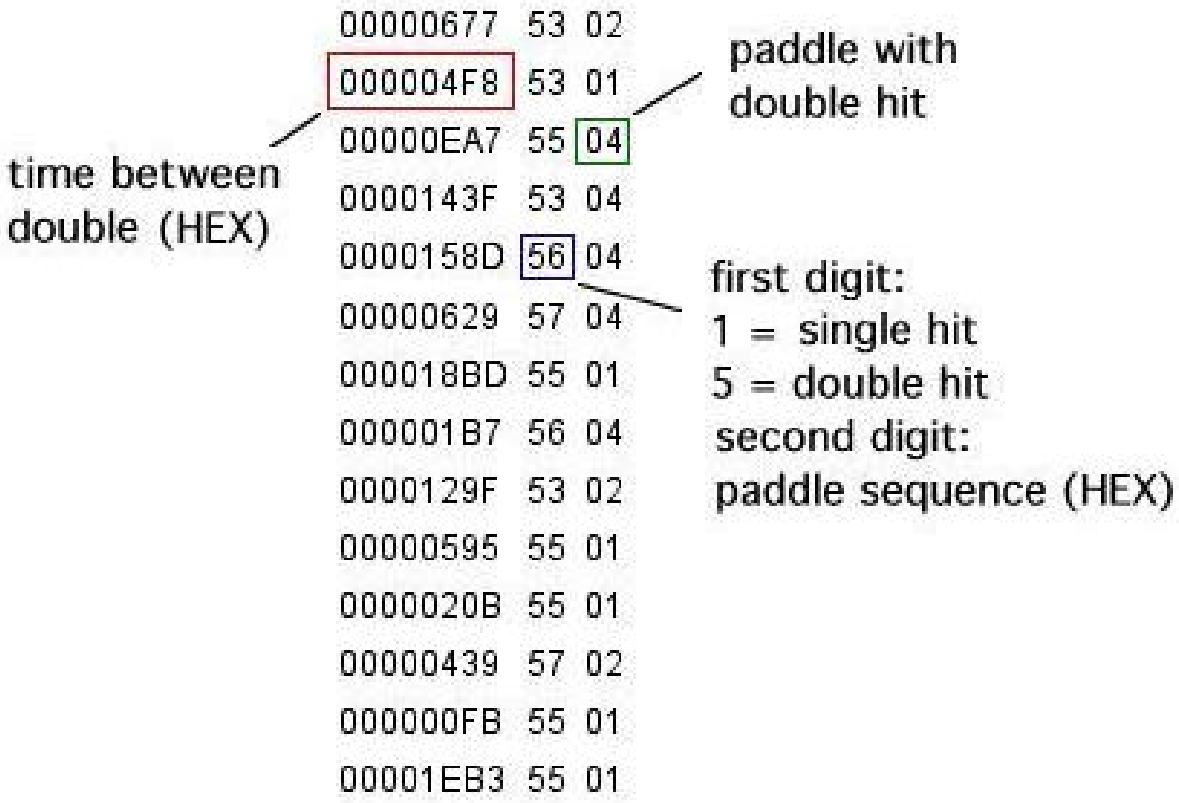
- When a double hit occurs, the computer program will use the hexadecimal integer 5 to notate this occurrence
- A single hit is notated with the HEX integer of 1, and the DAQ has eliminated these hits from our data
- A two digit HEX integer combination then denotes whether the hit was single or double and in which paddles the muon hit (i.e. 5 6 would indicate the muon was a double hit and contacted paddles 2 and 4)

Interpretation of the Double Hit (continued)

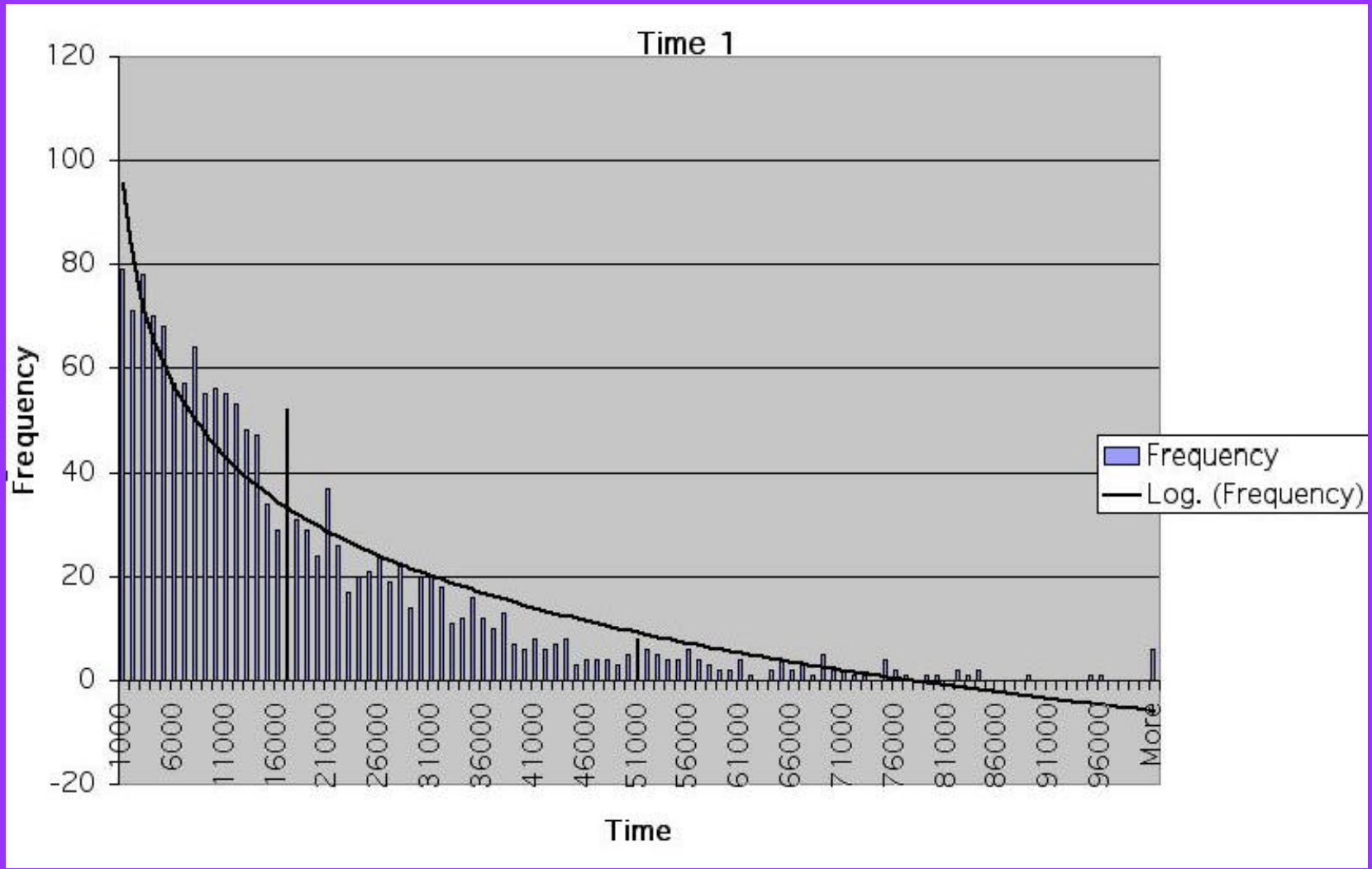


- The diagram demonstrates the various hits that can take place
- With a third HEX integer, we are able to determine the paddle in which the double hit (decay) occurred

Sample Data File



Results


Time 1
120
100
80
60
40
20
0
-20
Frequency
1000
6000
11000
16000
21000
26000
31000
36000
41000
46000
51000
56000
61000
66000
71000
76000
81000
86000
91000
96000
More
Time
Frequency
Log. (Frequency)

Calculations

Equation for Exponential Decay

$$N = N_0 e^{-t/t}$$

The slope of a natural log graph equals

$$-1/t$$

Our slope: 638.6 ???

Theoretical: 2.2×10^{-6} sec.

What’s Next?

- Determine the time units from the board
- Run more in-depth statistical analysis
- Collect more data

Project Participants

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