MUO - Muon Lifetime

Signature Sheet

Student's Name _____ Partner's Name _____

Suggested reading to start with (see the end of the manual for more):

1. 111B MUO manual
2. Tektronix, "**How to use an Oscilloscope**"

Pre-Lab Discussion Questions

It is your responsibility to discuss this lab with an instructor before your first day of your scheduled lab period. This signed sheet must be included as the first page of your report. Without it you will lose grade points. You should be prepared to discuss at least the following before you come to lab:

1. What is a muon? How and where are the muons in this experiment produced? Introduce different types of muon decay.
2. How to capture a muon and convert the decay process into electric signal so that we can do statistics?
3. In deriving the muon lifetime from the measured data, does any correction need be made for the time that the muon travels before it reaches the tank?
4. The cosmic ray flux at sea level, integrated over all angles is approximately one particle per square centimeter per minute on any horizontal surface. The flux passing in both directions through a vertical surface is one-half as much. Use the zenith angle dependence of muon intensity to prove this result. Muons come only from the upper hemisphere (above the horizon). Based on this result, do you think the geometry of the detector matters.
5. Given the geometry of the detector, 60 cm x 30 cm x 240 cm high, calculate the number of cosmic rays per minute which enter the detector.
6. The fact that Figure 6 of Rossi (Ref. 2) is relatively flat from zero to several hundred g/cm2, means that the number of muons which stop in a fairly shallow detector depends only on the mass of the detector. It does not depend on the shape of the detector, nor on the direction of incidence of the muons. For solid angle use $2\pi/3$ steradians ($\cos 2\theta$ integrated over the upper hemisphere), calculate the number of muons that will stop in the detector. Assume the density of the mineral oil is 0.8 g/cm3.
7. Think how you will analyze the data. 1) Data selection. If two muons enter the detector nearly at the same time, how does this "double-pulse" (pileup) affect the lifetime measurement, and how can we identify and remove these events? Also, if there is a roughly constant background noise rate, how will it bias the fitted lifetime, and what is the proper way to correct for it? 2) The late-time tail often has low statistics and can be background-dominated. How should we choose a reasonable fitting range, and how do we decide where to stop (cut) the data used in the fit? 3) Does the muon capture process affect the measured lifetime, how you correct that?

Staff Signature _____ Date _____

Completed before the first day of lab? (Circle one) Yes / No

Mid-Lab Discussion Questions

On day 3 of this lab, you should have successfully acquired an over-night muon spectrum with a calibrated time scale. Make a crude measurement of the lifetime. Show your spectrum to a GSI and ask for a signature.

Staff Signature _____ Date _____

Completed by day 3 of lab? (Circle one) Yes / No

Checkpoint Signatures

1. Apparatus in the other room

   Staff Signature _____

2. Oscilloscope (MSO-2024)

   Staff Signature _____

3. Trigger Rate

   Staff Signature _____

4. Initial Test Run

   Staff Signature _____

5. Time Difference Data

   Staff Signature _____