# MUO - Muon Lifetime

## Signature Sheet

Student's Name _____ Partner's Name _____

**Pre-Lab Discussion Questions**

Please sign up for a time slot with a partner to meet an instructor and discuss the pre-lab. Be prepared to answer the questions below.

1. What is a muon?
2. How and where are the muons in this experiment produced?
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 $\times$ 30 cm $\times$ 240 cm high, calculate the number of cosmic rays per minute that enter the detector.
6. The fact that Figure 6 of Rossi Ref. 4 is relatively flat from zero to several hundred g/cm$^2$, 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 (integrate $\cos\theta$ 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/cm$^3$.
7. How do you determine the background events from the data?
8. How do you distinguish the counts from the positive muons and the negative muons? (Hint: read page 11 of reference 5 in the MUO manual)

**Mid-Lab Discussion Questions**

You should have successfully acquired a muon spectrum with a calibrated time scale. Show your spectrum to an instructor and discuss your analysis procedure.

1. Explain why it is necessary to use **semilog plots** to analyse the data.
2. Explain how you determine the background.
3. Explain how you decide what the time interval you plan to use to extract the lifetime.
4. Make a crude measurement of the lifetime of the muon.