MWPC Gas Gain and Drift Time Studies

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Outline

Gas Gain Studies

- Ar:CO_2 80:20 Iron-55 Studies (In Progress)
- Ar:CO_2 80:20 Cosmic Ray Studies (Upcoming)

Monte Carlo for Muon Path length through cell

Gas Gain Studies

In order to calibrate the prototype detector we are performing gas gain studies. We want to figure out how much charge arrives at one wire cell for a given ionizing when the detector is at a certain voltage.

Two different gas mixtures will be tested. Ar:CO_2 in an 80:20 ratio, and Ar:CO_2:CF_4 in a 88:2:10 ratio. Two ionizing sources will be looked at for these tests: an Iron 55 radioactive source and cosmic rays.

Ar:CO_2 80:20 Iron-55 Studies (In Progress)

- Iron-55 source with detector
- MWPC is read out on oscilloscope
- Data from the oscilloscope is captured using a program developed in-lab called ScopeOut.
- ScopeOut performs various functions, among them integrating signals from the oscilloscope and putting those values in a histogram.
- A voltage sweep is applied to the detector and histograms are made for each voltage level.

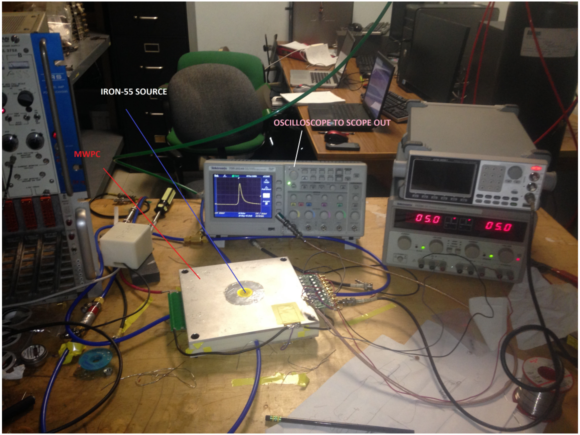

Figure 1: A picture of our setup

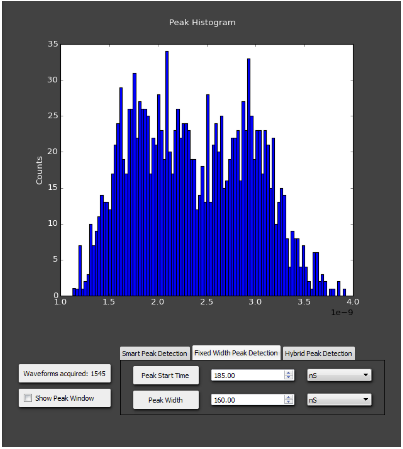

Figure 2: Histogram of Peak Integrals from ScopeOut

The charge on the sense wire can be determined from the integrated scope peak. From Ohm's Law

$$\begin{aligned} Q &= \int I dt \\ &= \int V dt/R \end{aligned} \tag{1}$$

For an iron-55 source, x-rays of energy 5.9 keV are produced. The average ionization energy of argon is 26eV. For an x-ray which loses all its energy to the detector, $5900/26 = 227$ electrons are produced.

This gives a gain of $Q/(227 * 1.6 * 10^{-19} C$

Ar:CO_2 80:20 Cosmic Ray Studies (Upcoming)

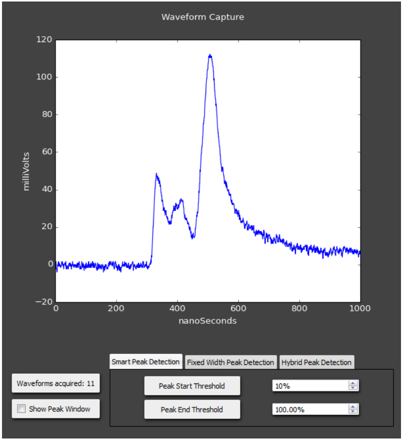

Figure 3: Sample Cosmic Ray Waveform Capture

Monte Carlo for Muon Path length through cell

$$\frac{dP}{d\Omega} = k\cos^2\theta \tag{2}$$

Normalizing sets $k = \frac{3}{2\pi}$.

$$\begin{aligned}\frac{dP}{d\theta} &= \frac{3}{2\pi}2\pi\sin\theta\cos^2\theta \\ &= 3\sin\theta\cos^2\theta\end{aligned} \tag{3}$$

Define the integrated probability

$$\begin{aligned} G(\theta) &= \int_0^\theta \frac{dP}{d\theta} d\theta \\ &= 1 - \cos^3\theta \end{aligned} \tag{4}$$

Let $x = G(\theta)$ be a uniformly randomly distributed variable (UDRV), $0 \leq x \leq 1$. Solving for θ gives

$$\theta = \cos^{-1}((1-x)^{\frac{1}{3}}) \tag{5}$$

This will give a distribution of θ which fits $\frac{dP}{d\theta}$.

Similarly, for a UDRV y, ϕ can be generated as

$$\phi = 2\pi y \tag{6}$$

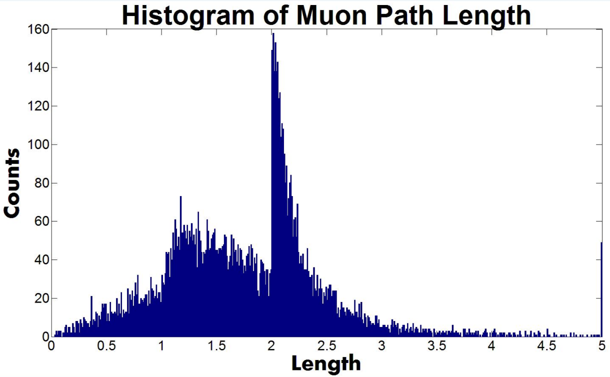

Figure 4: Muon Path Length