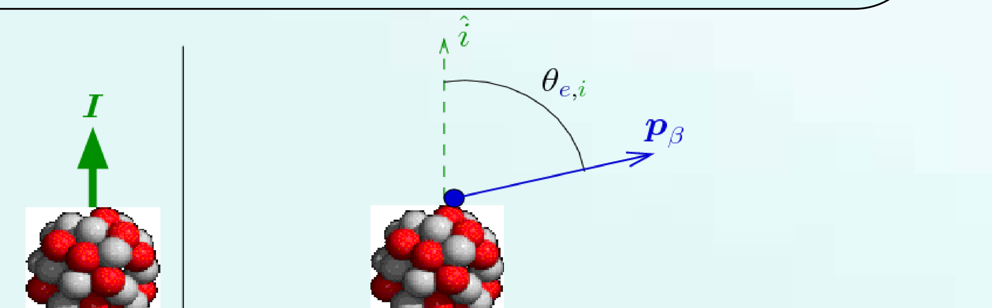
Optimization of a Scintillator for the Measurement of Positrons from Trapped, Polarized ^{37}K

2011 Cyclotron Institute REU

Erin France, Cameron University

Advisor: Dr. Dan Melconian

Introduction

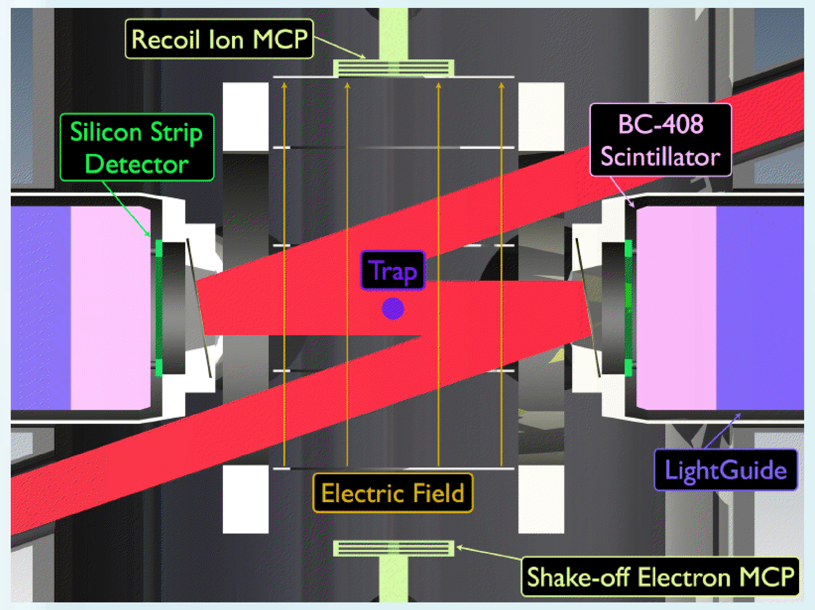


$$N(\theta_{e,i}) \sim 1 + A_\beta P_I \frac{V_e}{c} \cos\theta_{e,i}$$

^{37}K decays and emits a positron. By carefully measuring the momentum and the angle between the positron and the nuclear spin, a precise value for A_β can be found. The found A_β can then be compared to the Standard Model value. If the value is different , this would be an indication of new physics.

For the experiment, ^{37}K will be placed in a magneto-optical trap. The two beta telescopes on either side of the trap will measure the momenta of the positrons being emitted. The following equation and figure shows how the number of counts from each detector will be used to calculate A_β:

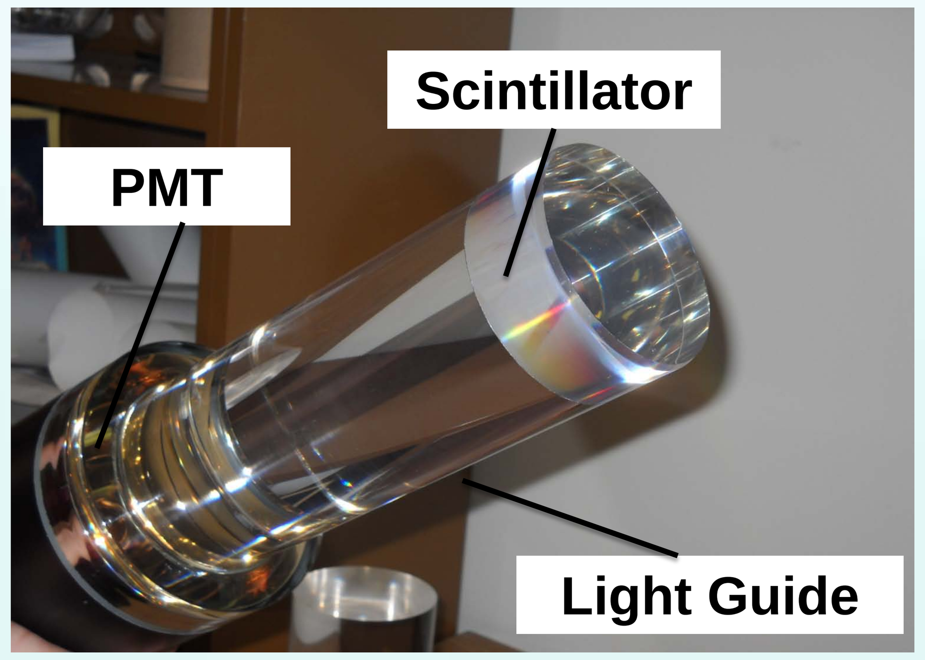
$$\frac{N_+ - N_-}{N_+ + N_-} = A_\beta P_I$$



Objectives

The goal of my research was to optimize the readout of a plastic scintillator by testing different experimental setups. These setups include wrapping the front face and sides of the scintillator and light guide with various reflective materials to find which maximized light output. It also includes testing the position dependence of the scintillator.

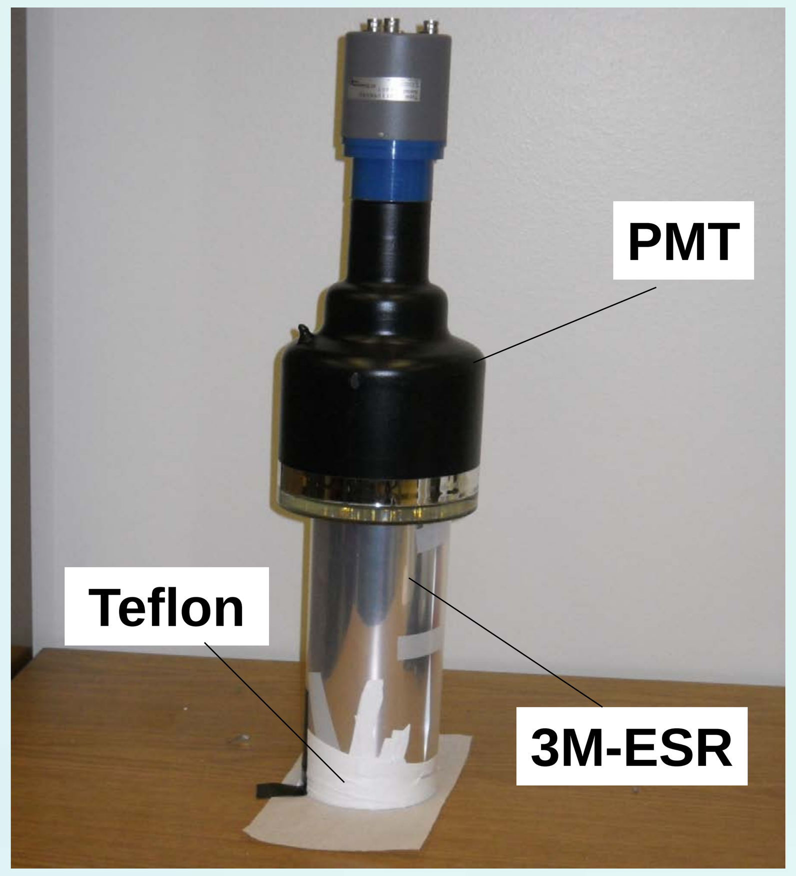
Methods



Using ^{90}Sr as our beta source, the beta particles enter the scintillator and deposit energy which gets converted to light. The scintillation light travels up the light guide, and into the PMT. The whole setup was placed inside a can for light tightness.

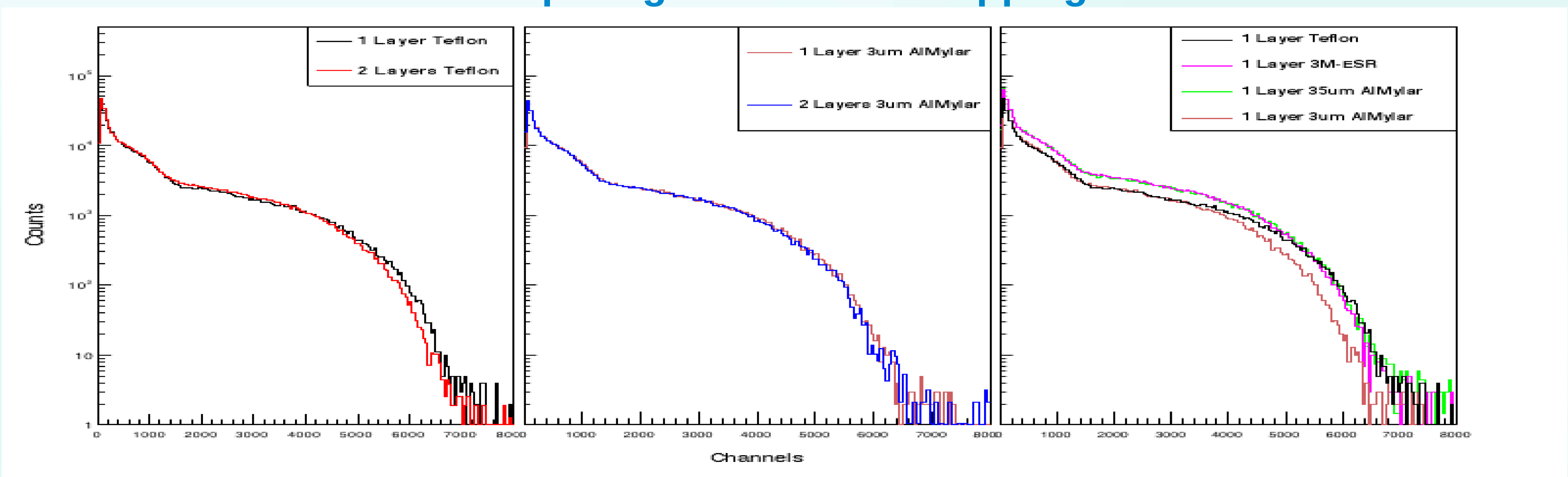
Spectra were taken for each different material wrapped around the sides and front face. The spectra that went out to the furthest channel number had the most gain in light output.

For the position dependence tests, a hole was cut near the bottom of the can, to allow a ruler to be pulled in/out. The ^{90}Sr source was placed in the center of the can on top of the ruler. Spectra were taken at a number of positions as the source was moved out to the radius of the scintillator.

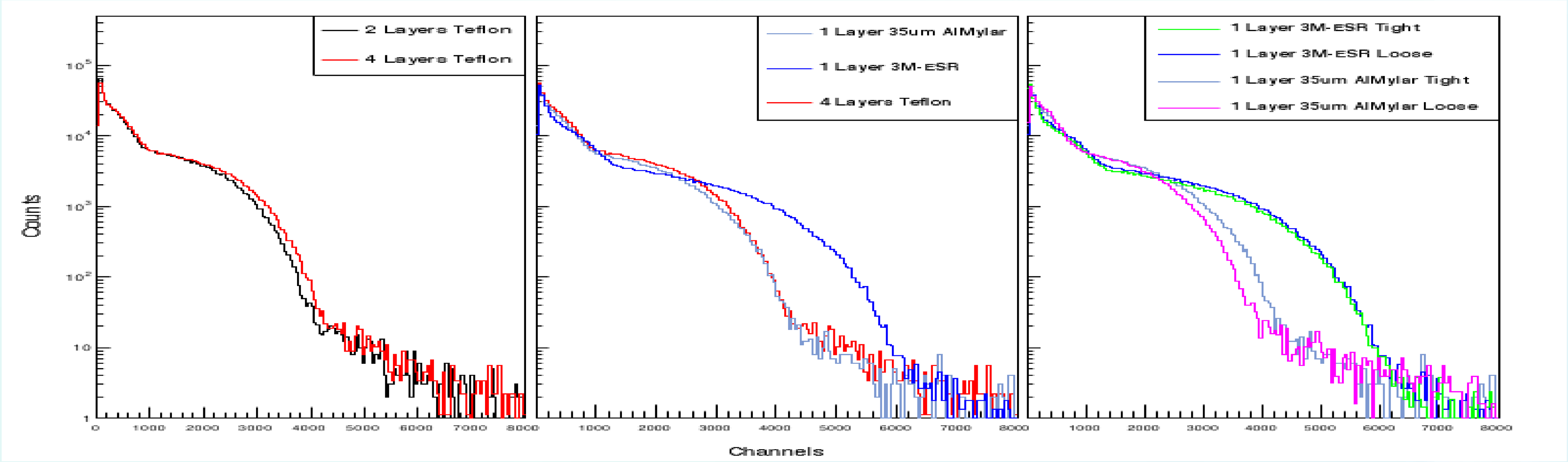


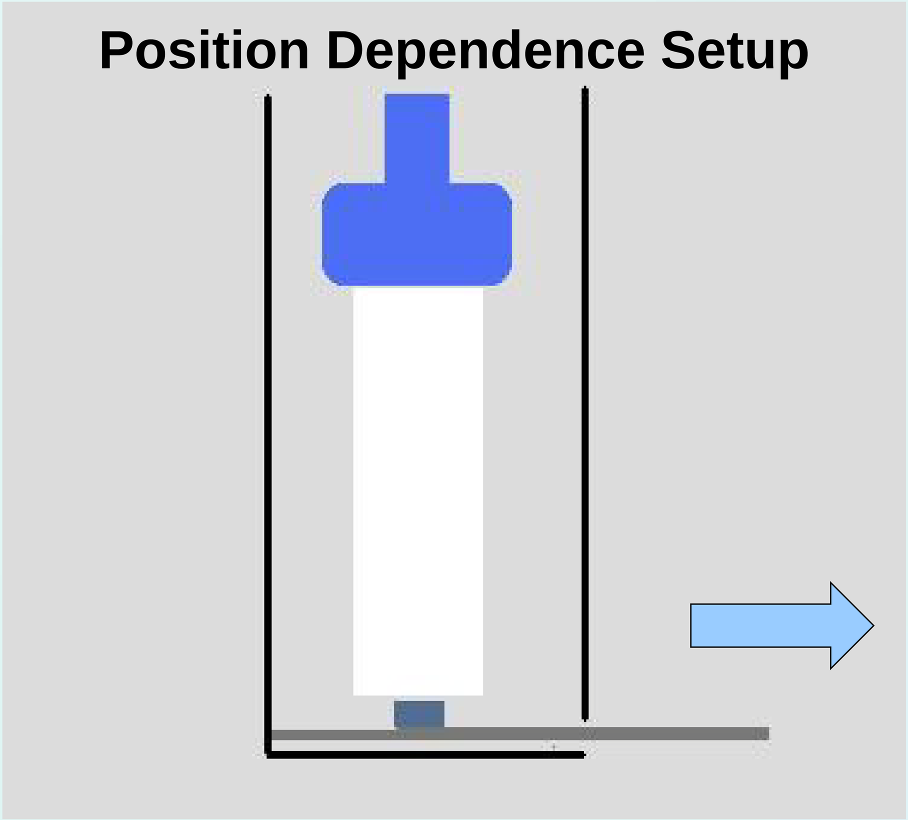
Results

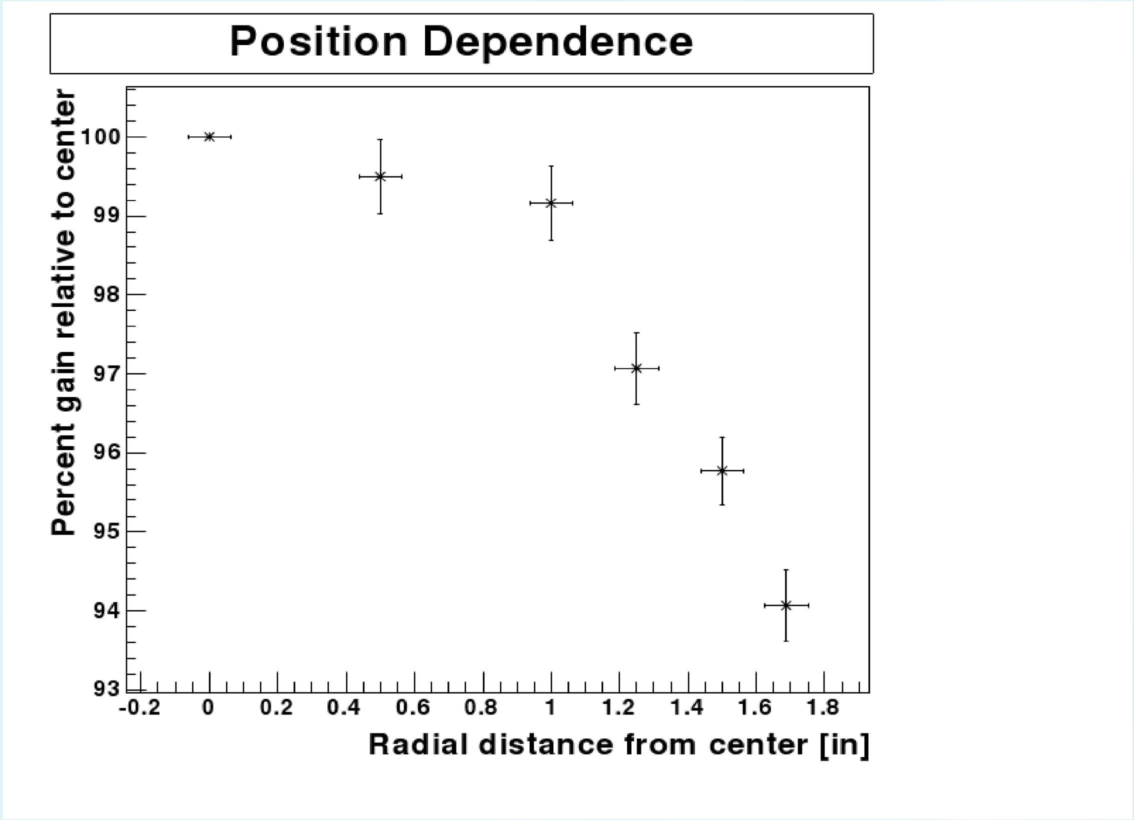
Comparing Front Face Wrappings



Comparing Side Wrappings







Conclusion

We found that one layer of Teflon tape on the front face with a loose wrapping of 3M-ESR on the sides was optimal. The position dependence showed only a (5.9 ± 0.5)% reduction in light collection at the edge compared to the center of the scintillator. The product of this work will be used in an upcoming TRINAT experiment measuring the beta asymmetry of ^{37}K.

Acknowledgements

Dr. Dan Melconian
Praveen Shidling

Benjamin Fenker
Spencer Behling

TAMU Cyclotron Institute
National Science Foundation