TRIUMF Experiment E614
Technical Note #75

Monte Carlo study of tracks rescattered from E614 magnet yoke.

M.A.Vasiliev
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Tracks coming back to E614 detector sensitive area from magnet yoke were investigated. Monte Carlo simulations were done using E614 GEANT [1] **devel** version. A beam of polarized muons (with positron admixture) has 29.79 MeV/c momentum, momentum spread $\Delta P/P = 0.7\%$ and spot in focus x=1mm, y=1mm. Beam was simulated using **PGUN** E614 GEANT card. Explicit delta ray production with reduced Landau fluctuations for energy loss was used in these simulations. 2×10^6 triggers were generated. Approximately 65% of the events was muons stopped in target. All together 1,297,776 muon stops in target was observed.

Rescattered tracks in E614 detector.

While it is easy to estimate, that fraction of tracks which comes back to sensitive area of the E614 setup from magnet yoke should be rather small, the question about possible impact of such tracks on the measured Michel spectrum must be investigated. Even small admixture of "bad" events can be potentially dangerous for achieving high resolution in Michel parameters measurements. For instance, such tracks can give troubles in case they originate only from some, limited part of Michel spectrum, other words, if momentum spectrum of positrons with such tracks do not follow Michel spectrum shape itself. In order to learn it, the detailed Monte Carlo simulation of events with tracks coming back from magnet yoke to sensitive part of E614 detector was performed.

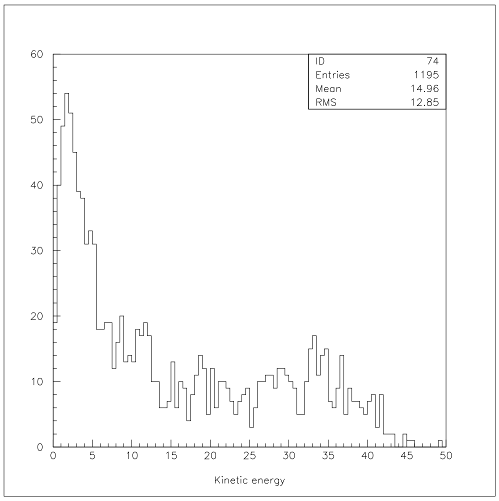

Figure 1: Kinetic energy of particles coming back to E614 detector sensitive area from magnet yoke.For 1.3M μ stoped in target.

Monte Carlo Study

Particles, which came to magnet yoke was marked, but contrary to normal E614 GEANT version, not stopped, and their later history was considered.In magnet yoke all usual physics processes was taken into account, but absence of magnetic field in yoke was supposed in that study. Particles coming back to sensitive area, which was defined as cylinder around the target with radius $r < 16.9$ cm and length along the beam $z < 74.0$ cm, appeared in histograms. Study show that all together we have 0.092% of such events (normalized on the amount of muons stoped in target).

93.5% of such particles are positrons, while others are electrons.

Kinetic energy spectrum of these particles shown in Fig 1.

Main part of them (62%) have kinetic energy below 15.85 MeV, which is supposed to be E614 lower limit (x=0.3) for measured Michel spectrum. That reduce amount of potentially dangerous events to 0.035%.

Space origin of particles, coming back from yoke to sensitive area are shown in Fig 2.

Approximately 60% coming from target region. While other 40% tracks can be rejected by reconstruction of their vertexes, tracks coming from target region probably can not and because of that require detailed consideration.

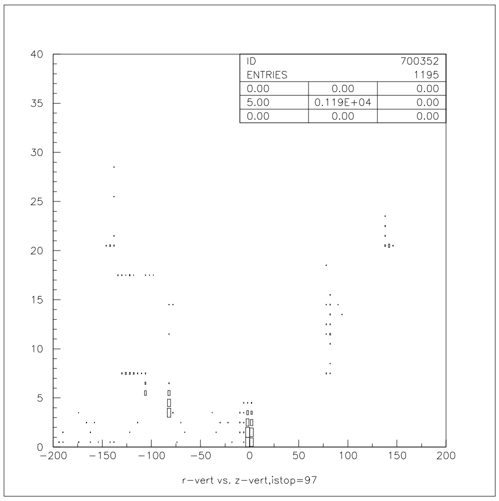

Figure 2: Radius vs z of coming back tracks at their original vertex. For 1.3M μ stoped in target.

Original momentum spectrum of all rescattered by yoke tracks have Michel shape, except for it's lower momentum part. That part correspond to tracks originated not from the target region - Fig 3. After rejection of such tracks one can see (also at Fig. 3) that the original momentum distribution favors higher momentum decays compared to an unbiased Michel shape. Therefore, if we reconstruct the events that contain these backscattered particles in the Monte Carlo (because the tracking terminated prior to the backscatter occurring) and fail to reconstruct them in the data, we will end up with a smaller value of ρ than we should by up to ~ 5 parts in 10^4 [2].

On Fig 4 angular distribution in original vertex of rescattered tracks are presented. Strong forward-backward asymmetry are seen, while shapes for forward only or backward only tracks are consistent with flat angular distributions. To understand that effect additional beam pipe after target was introduced. With such additional beam pipe it is much more symmetric situation in detector geometry then the real one has. 779,939 muon stops in target for such geometry was generated. 456 tracks came back to detector sensitive area. It corresponds to 0.058% from all stoped in target muons. Simulations performed with such artificially symmetric geometry show (Fig 5) nearly symmetric original angular distribution for rescattered from yoke tracks. It means that observed suppression in backward direction

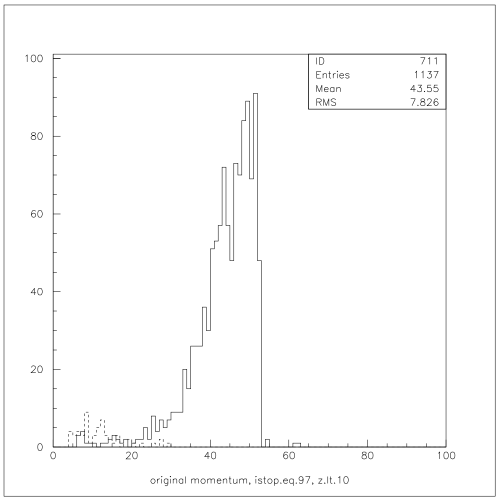

Figure 3: Original momentum for particles coming back from yoke, which vertex has $z < 10$. Dashed line - particles with vertex $z > 10$. For 1.3M μ stoped in target.

in angular distribution is due to presence of beam pipe upstream of target mainly, which introduce some asymmetry in detector setup. Corresponding distribution for original momentum can be seen on Fig 6. It has an even larger bias for high momentum decays than was present in Fig 3.

Conclusion

Performed Monte Carlo study showed that rescattered from magnet yoke decay positrons come preferably from high momentum part of Michel spectrum. It is approximately 0.092% of such events, or less. They mainly rescattered from downstream part of the yoke due to some asymmetry in detector geometry, caused by presence of beam pipe before target. If we will not take into account these events we can end up with a smaller value of ρ than we should.

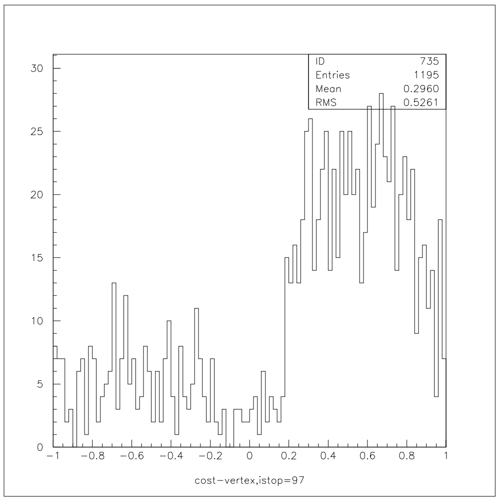

Figure 4: Original angular distribution at vertex for particles coming back from yoke. For 1.3M μ stoped in target.

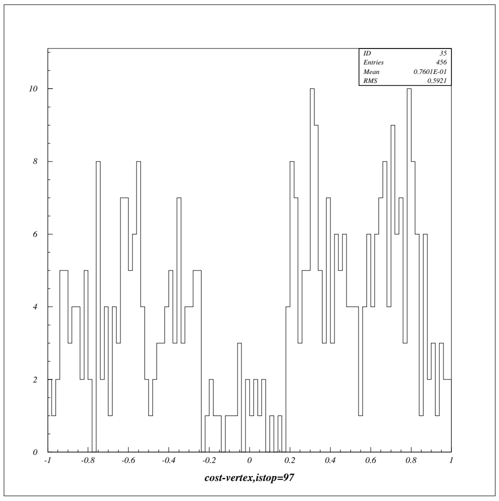

Figure 5: Original angular distribution at vertex of particles coming back from yoke for detector geometry with additional beam pipe behind the target. For 780K μ stoped in target.

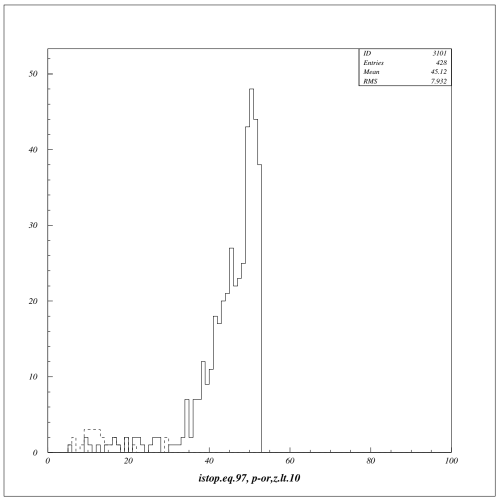

Figure 6: Original momentum for particles coming back from yoke, which vertex has $z < 10$, for detector geometry with additional beam pipe behind the target. Dashed line - particles with vertex $z > 10$. For 780K μ stoped in target.

References

[1] D.H. Wright, A Users Guide to E614 GEANT, E614 TN-29, 30 March 1999.

[2] C. Gagliardi, Private communication, 2003