MuCap Memo on muSR Oscillations in Silver and Plastic Target Materials

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1 Introduction

Due to recent MuCap and MuLan concerns about muon spin depolarization in different target materials, I conducted an analysis of mucap02c runs containing silver (runs 605−618) and plastic (runs 509−521) muon targets. In particular, I attempted to isolate the muSR oscillations in MuCap gondolas which lie in the muon spin plane; unfortunately there is no pair which exactly lies in the rotation plane, so either gondolas 4 & 12, or 5 & 13 serve as approximate opposing spin−plane pairs (the applied magnetic field was vertically directed). The analysis which follows will focus exclusively on the 4&12 gondola pair for simplicity.

2 The Analysis

Using the merlin computing cluster at PSI, I ran the **mu** analysis program on the silver and plastic runs in turn, with a version of **mu_hist.f** which generated the muon lifetime histograms for gondolas 4,5,12, and 13 (the histograms required a 4−fold coincidence for a given gondola). I then merged the silver and plastic hbook files into respective compilation files for fitting and further manipulation in Berkeley.

Figure 1 exhibits two different methods of isolating muSR oscillations in the silver target. The inferior method is to calculate the "asymmetry", which is the ratio of the scaled difference of gondolas 4 and 12, divided by the scaled sum of gondolas 4 and 12. This leads to a specious "depolarization" away from t=0, since the backgound in the denominator becomes increasingly significant and the uncancelled exponential in the numerator continues to degrade the signal. A better procedure is to divide the scaled difference (4−12) by 2 times the lifetime exponential. It is readily apparent that when the mathematics is done correctly, there is negligible depolarization in the silver target.

Figure 2 is the same as Figure 1, but for the plastic target.

Figure 3 exhibits the muSR oscillations for both silver and plastic (calculated in a *slightly* different manner than those mentioned above). There is a factor of 5 difference between the initial polarization amplitudes for the two targets, but there is little subsequent depolarization in either after t=0.

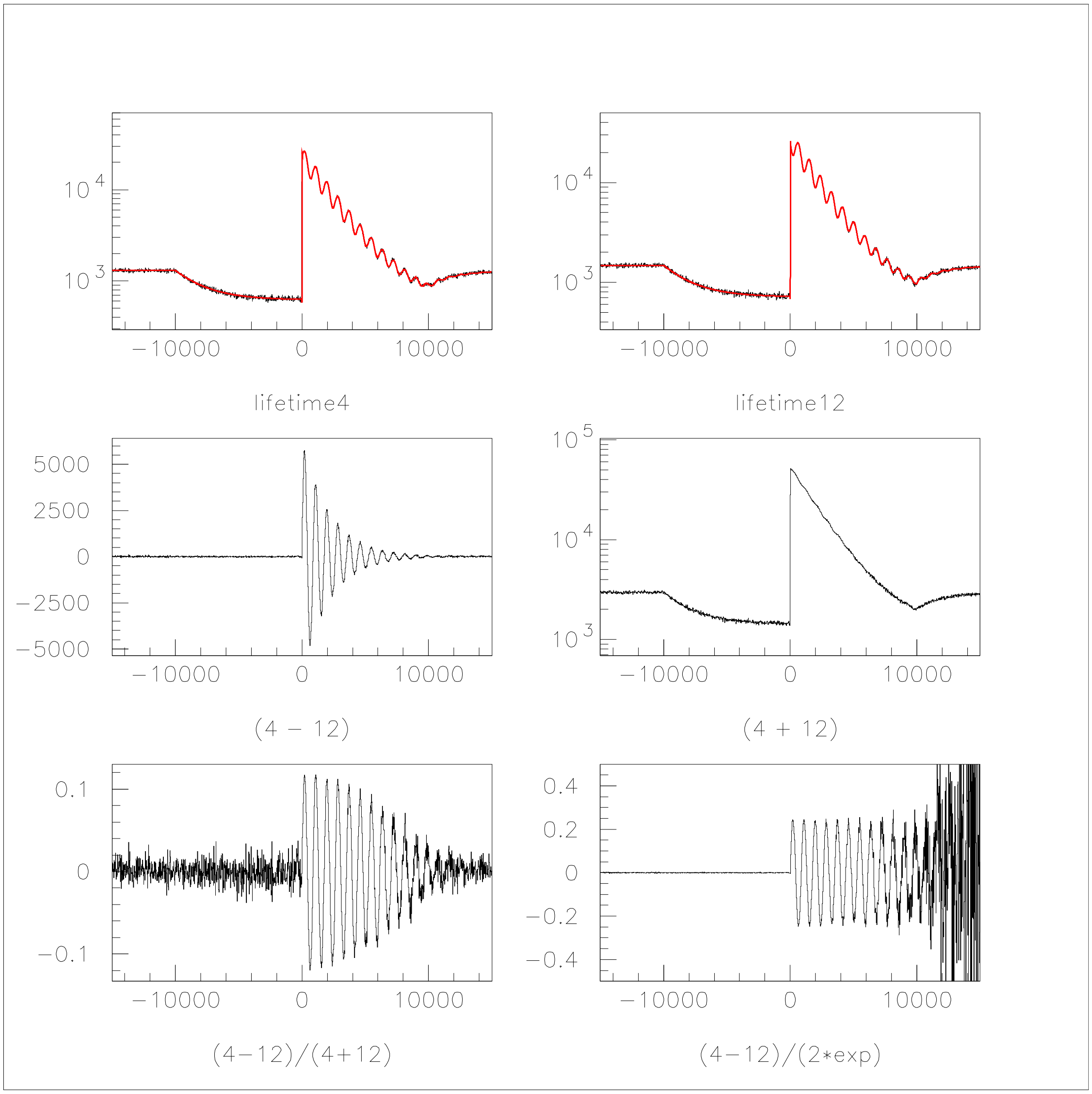

Figure 1 –Silver Target Histograms

The histograms above are a compilation of runs mucap02c.605 through mucap02c.618.

<u>Top Left</u>: Pileup–protected gondola 4 lifetime
<u>Top Right</u>: Pileup–protected gondola 12 lifetime
<u>Middle Left</u>: Scaled gond.4 – gond.12 subtraction
<u>Middle Right</u>: Scaled gond.4 + gond.12 addition
<u>Bottom Left</u>: "Asymmetry" = (4–12)/(4+12)
<u>Bottom Right</u>: Properly isolated muSR wiggles

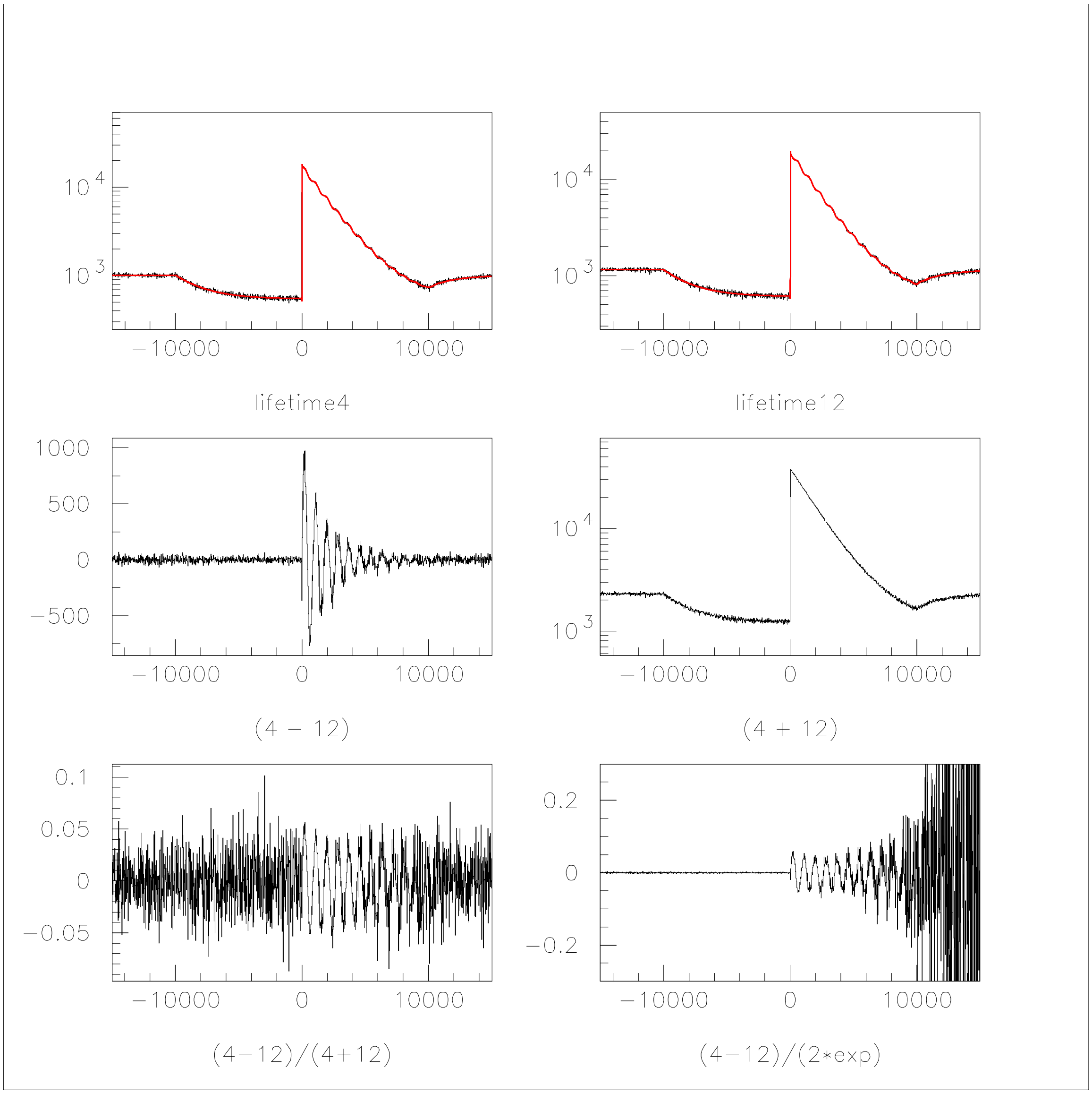

Figure 2 −Plastic Target Histograms

The histograms above are a compilation of runs mucap02c.509 through mucap02c.521.

<u>Top Left</u>: Pileup−protected gondola 4 lifetime
<u>Top Right</u>: Pileup−protected gondola 12 lifetime
<u>Middle Left</u>: Scaled gond.4 − gond.12 subtraction
<u>Middle Right</u>: Scaled gond.4 + gond.12 addition
<u>Bottom Left</u>: "Asymmetry" = (4−12)/(4+12)
<u>Bottom Right</u>: Properly isolated muSR wiggles

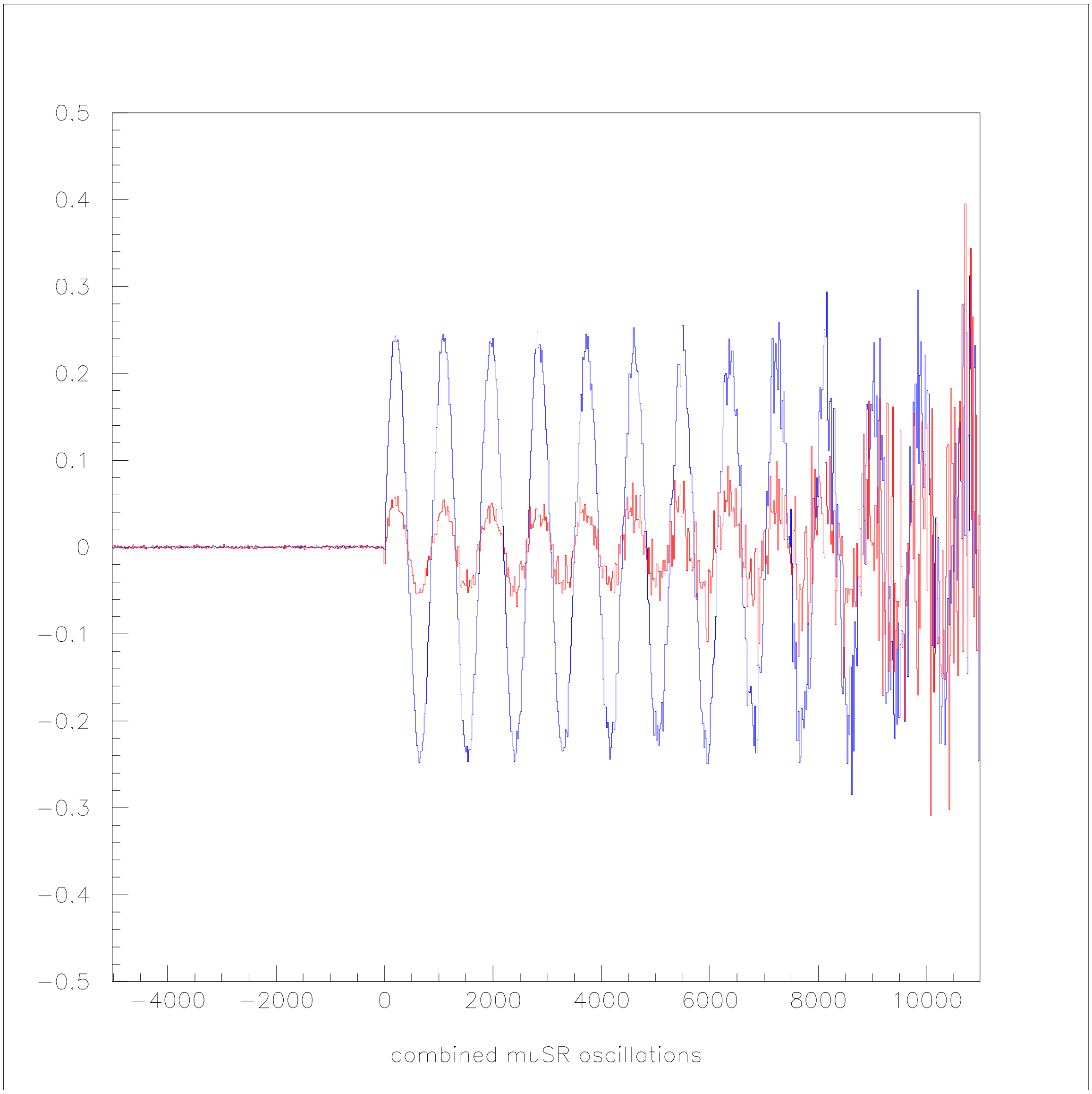

Figure 3 – Combined silver/plastic muSR histogram

Blue: Silver target muSR oscillations, gondola 4 – gondola 12
Red: Plastic target muSR oscillations, gondola 4 – gondola 12