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EFFECTS OF MUON RESOLUTION ON SIGNAL TO BACKGROUND IN E161

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Abstract

The suggestion to increase the radiation lengths of the the absorber in E161 will degrade the resolution due to multiple scattering. This in turn will effect the signal to background in E161 since the dominant background of muons from pi and K decay has a different P_T dependence than the muons from charm decay. I find that the signal to background gets worse as the resolution gets worse.

METHOD

The counting rates shown in Figure 10 of the E161 proposal for K=40 and $5 < P < 10$ GeV were used as input (target) cross sections. This is not entirely correct, since they are actually already multiple scattered and pass thru the acceptance. The counting rate for charm decay is

$$P_T \times exp(-3.2 * P_T^2). \tag{1}$$

The counting rate for the background is

$$80(1 - exp(-10|P_T|))exp(-9.4|P_T|). \tag{2}$$

The first exponential brings the counting rate to zero at $P_T = 0$ and produces a maximum at about $P_T = 0.075$ somewhere near half the pion mass. These are shown in Figure 1, with some points taken directly from the proposal.

These counting rates are then smeared with a Gaussian resolution function in $P - T$ with a sigma ranging from .8 to 1.6 GeV. This straddles the P_T resolution in Table 4 of the E161 proposal. For each measured P_T, a convolution of "target" counting rate from the parameterizations and a Gaussian was integrated numerically. The resolution degraded spectrum is the "Measured" distribution.

RESULTS

The ratio of the measured to target counting rate as a function of P_T is shown in Fig. 2. for both the charm (solid) and background (dashed)muons and for various values of the resolution smearing. Note that the background target distribution is an exponential and the smeared background is also an exponential for $P_T > .6$ but with a larger number of counts which increases with poorer resolution. For $P_T < .6$ the resolution corrections are less important. For charm decay, the resolution causes a change in shape of the counts as a function of t P_T. Below about $P_T = 0.7$, the number of counts decreases due to resolution smearing out, while for $P_T > 0.7$, there is an increase in the measured counts compared to target counts.

I calculated the ratio of charm to background (c/b) for both the target distribution $(c/b)_t$ and measured distribution $(c/b)_m$. The double ratio:

$$(c/b)_m/(c/b)_t = (c_m/c_t)/(b_m/c_m) \tag{3}$$

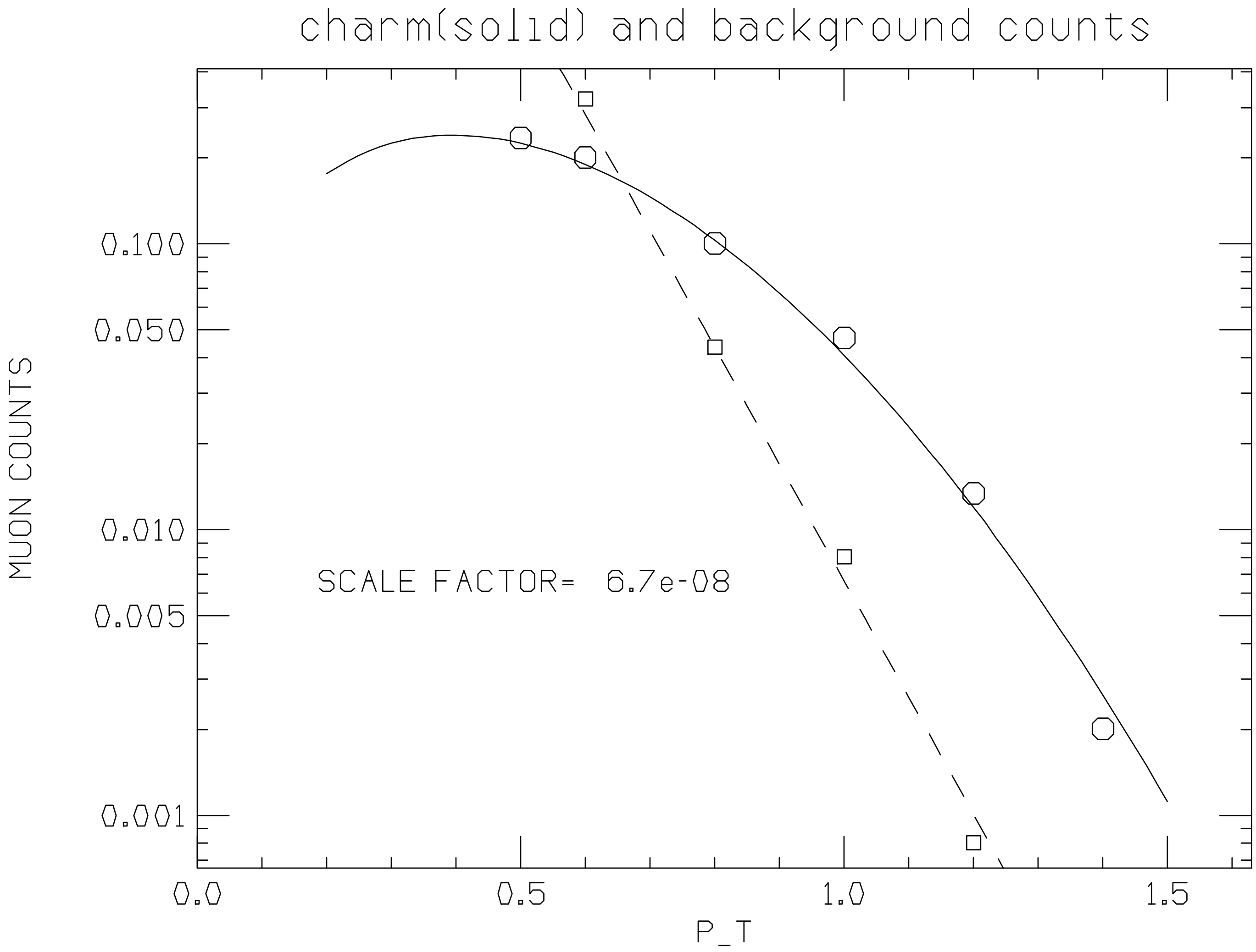

Figure 1: Counting rates for muons from the formulas in text designed to mimic the rates in Figure 10 of the E161 proposal for K=40 and low P. The solid line is muons from charm while the dotted line is muons from π and K decay. The points are taken from Figure 10. There is a scale factor of 6.7E-8 compared to the proposal.

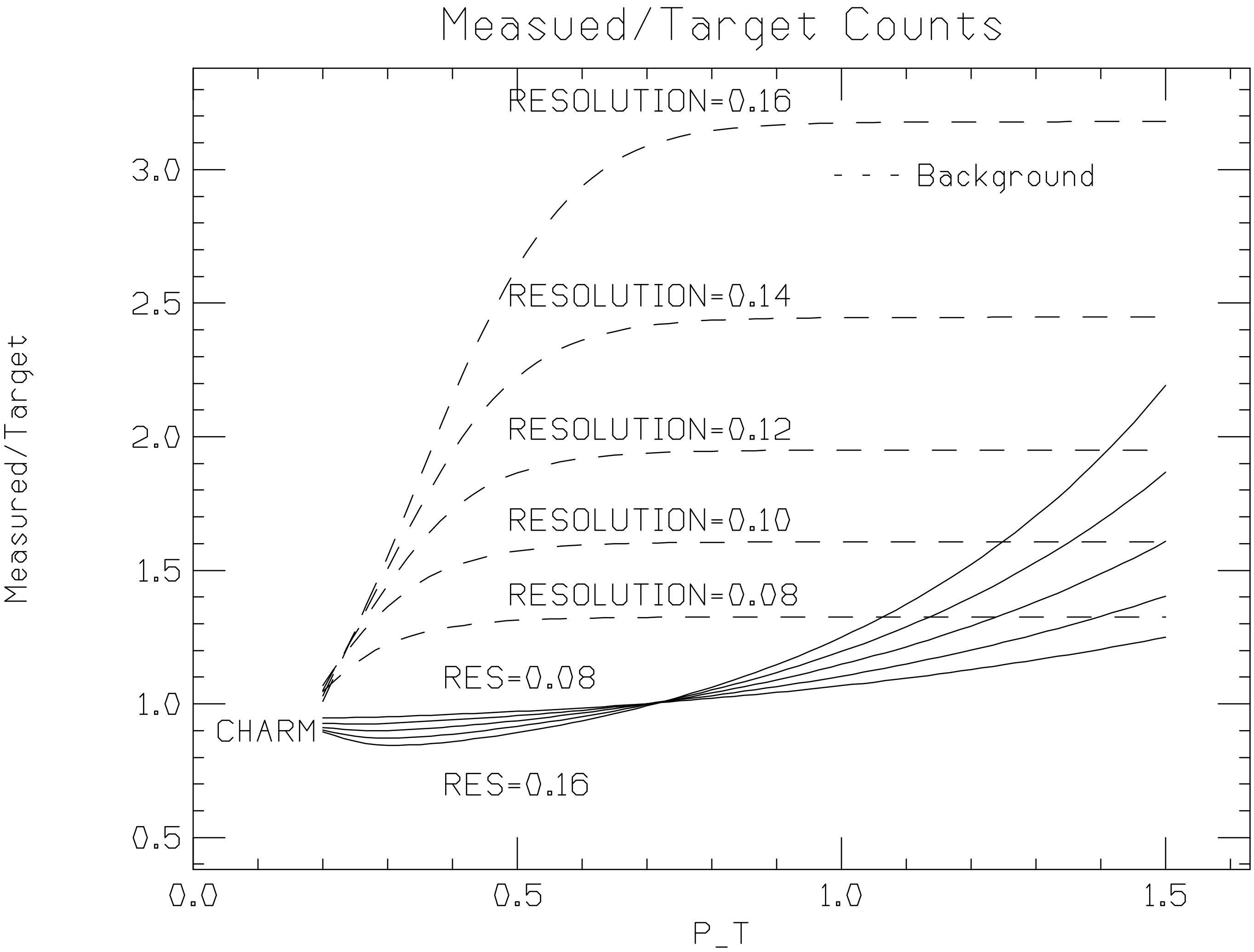

Figure 2: Ratio of measured to target counts as a function of P_T for various values of the resolution. The solid curve is for charm decay and the dashed for the background.

gives the change in the charm to background with various amounts of resolution smearing. Fig. 3 has this double ratio as a function of the sigma of the resolution for various values of P_T. The curves are normalized to unity at a resolution of 0.12 GeV, the average resolution of the E161 proposal. As the resolution gets worse, the charm/background decreases. With a resolution in P_T of .16 GeV charm/background decreases to about 70% of its value compared to a resolution of 0.12 GeV. This corresponds to increasing the radiation length by a factor of about 1.8. A doubling of the radiation length would cause a decrease in c/b to about 65% of its nominal value. Unfortunately, as seen in Fig. 3 the loss in charm/background is worst at low P_T where the charm/background is already marginal.

CONCLUSIONS

There are significant disadvantages in loss of charm signal compared to background from increasing the radiation length of the absorber. There are very large smearing effects seen in the magnitude of the background due to smearing. This will make us very sensitive to the changes in the absorber configuration used to measure the background.

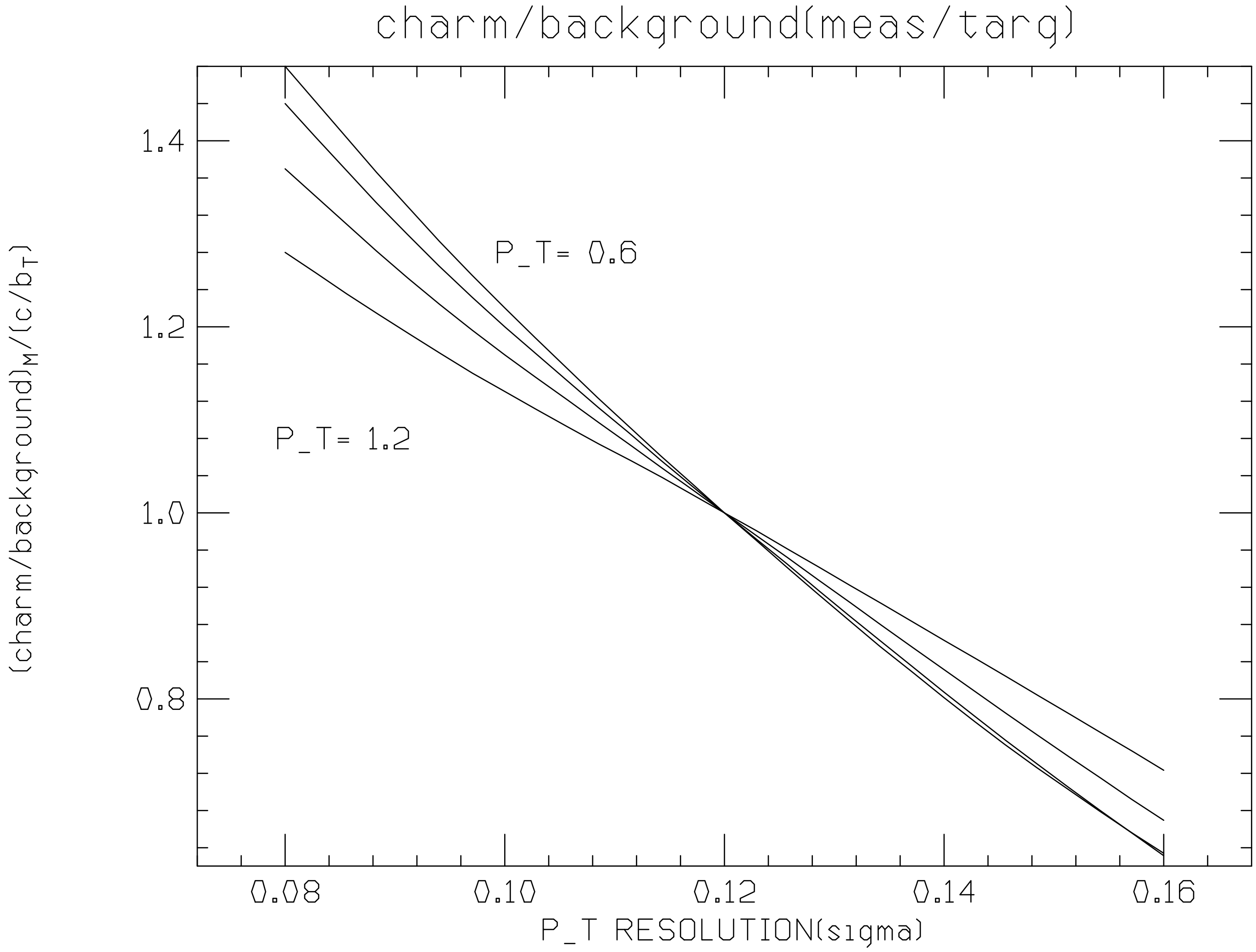

Figure 3: Effects of resolution smearing on ratio of charm counts to background counts as a function of the P_T resolution. The double ratio $(c/b)_m/(c/b)_t$ of charm/background for measured and target spectrum. Different curves are for different values of P_T. All curves are normalized to unity at the nominal E161 resolution of sigma=0.12 GeV.