Real Photon Collaboration Technical Note RPC-XXX
15 July 02

E161 MUONS FROM π and K DECAY
Tex file in ∼ser/EXPERIMENTS_realphoton_tech_notes/mu_from_kpi.tex

Abstract

I have studied the number of muons coming from π and K decay for E161. π and K were generated using the Wiser fit and HERWIG 6.4. HERWIG 6.4 is very unreliable in this energy range and disagrees completely with the Wiser Fit. The number of muons produced does not agree very well with the numbers in the proposal.

1 METHOD

1.1 HADRON CROSS SECTION

1.1.1 Wiser Fit

The Wiser fit comes from David Wiser's thesis (1977,Wisconsin) on SLAC data taken with a Brem beam, proton target and the 8 GeV spectrometer. π, K and p were identified. The cross section for the Brem beam is parameterized in the thesis. This fit was put into the program ser/fits/wiser_all_fit.f some time ago and updated recently. The fit agrees with the data for a primary electron beam of 19 GeV. See Figures 1-4. The fit also agrees with the E154 data as shown in Fig 12 of the E161 proposal.

1.1.2 Herwig 6.4

Herwig 6.4 Monte Carlo has been used to generate c -$\bar{c}$ thru photon-gluon fusion. It seems to work reasonably for heavy quarks. However, for light quarks, at our energies the results are very unstable. Bryan Weber, one of the authors of Herwig, indicates that it should not be used for $P_T < 1$. I find that for lower P_T the results depend strongly on the P_T chosen. Figure **??** shows the comparison between the Wiser fit and Herwig 6.4.

1.2 HADRON DECAY

The hadrons decay isotropically into μ, ν with 100% probability for π and 66% for K. I assume that the hadrons can only decay in the first two interaction lengths of material. After that they have been completely absorbed. I assume a Copper absorber starting right at the target. Cu has an interaction length for protons of 135 grms. For π and K the interaction lengths are estimated to be approximately twice as long in our energy range from various cross section curves in the Particle Data Book.

```
Title: Two interaction lengths for the hadrons in units of grams of Cu.
pi+   540 grms Cu    60  cm
pi-   540
K+    563
K-    482
```

For π decay the μ gets most of the longitudinal momentum because of the π and μ masses are similar. For K decay, the momentum is more equally shared.

2 RESULTS

2.1 EXPERIMENTAL CONDITIONS

The rates were calculated with the following experimental conditions.

```
INCIDENT BREMSTRULUNG BEAM;
Electron Energy = 48.300
LOWER LIMIT OF BREM BEAM;  K_LO=42.000
COHERENT PEAK FROM:48.30<K<42.00  ENHANCED BY FACTOR OF  2.00
DIAMOND RAD LENGETH=  1.50\%
EQUIVILENT QUANTA=  7.50E+08
BEAM ELECTRON/SPILL=  5.0E+10
TARGET DENSITY(gms/cm2)=1.600
```

Thus this is equivilent to a Bremstulung subtraction with the first data at 48 GeV and the second data at 42 GeV. The Number of photons in this region is enhanced by a factor of 2 because of the diamond.

2.2 RATES

Figure **??** shows the muons/spill into bins of $\Delta P_T = 0.05$ and $\Delta P = 0.5$ as a function of P_T for various values of P (2.25(top), 3.25, 4.25) . They fall off exponentially above about P_T =0.5 and are parametrerized by $C_1 * (1 + \frac{C_2}{(P_T+.5)})e^{C_3 * P_T}$ Where for $P < 10$, $C_2 \sim -0.64$ and $C_3 \sim -6.5$, but vary somewhat as a function of P. (see file ~ser/EXPERIMENTS_realphoton/e161/kpi/FIT_PT_COEF_K_LO42.0.OUT). The normalization coeficient C_1 depends on P_T.

2.3 COMPARISON WITH PROPOSAL

Figure **??** compares the results of this calculation with the proposal. At $P_T > 0.7$ this calculation has a higher rate of muons than the proposal, increasing to almost an order of magnitude at $P_T = 1.25$. For low P_T, the proposal rate is higher, perhaps due to the smearing. The total rate for $P_T > 0.5$, $5 < P < 10$ is:

```
This calculation Brem Subtracted   6.42/$mu$/spill
This calculation, Full Brem       28
Proposal                           9.2
```

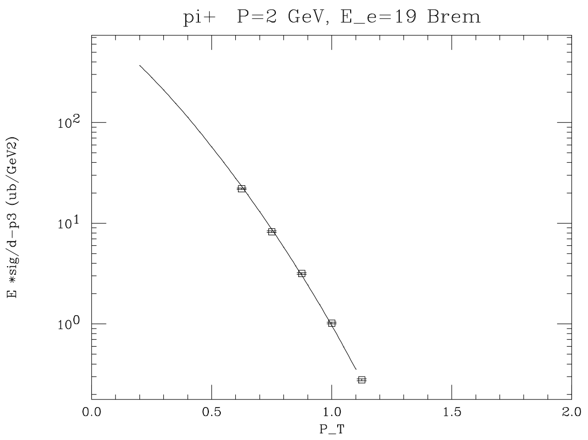

Figure 1: Wiser Fit for E electron = 19 GeV, π^+, P_π=2 compared to Wiser data.

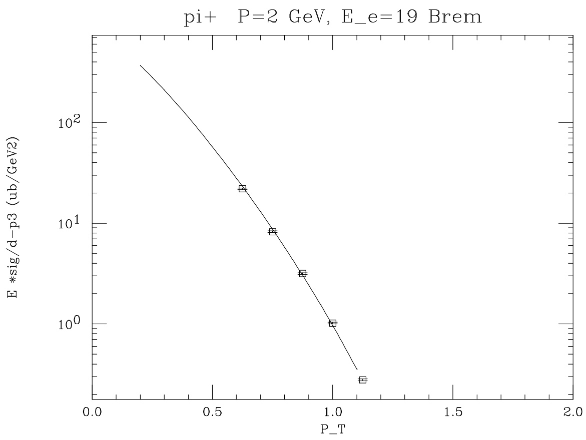

Figure 2: Wiser Fit for E electron = 19 GeV, π^+, P_π=3 compared to Wiser data.

Thus with the full Bremstulung beam, the muon singles rates will be about 30/spill, which is much higher than the μ from charm decay (1.3/spill). Thre random rates from these background muons would swamp any signal.

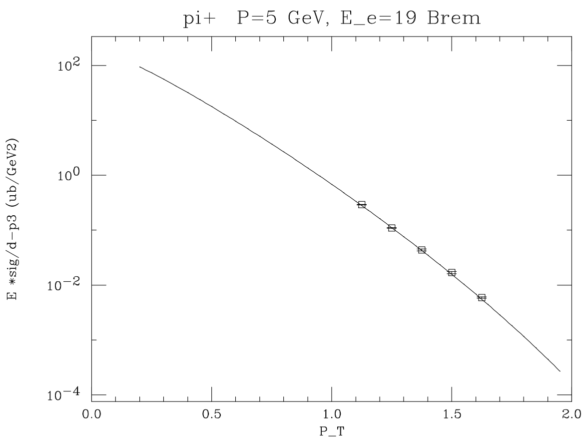

Figure 3: Wiser Fit for E electron = 19 GeV, π^+, P_π=5 compared to Wiser data.

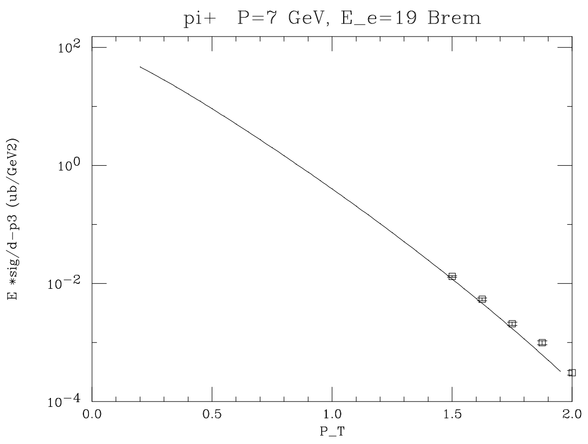

Figure 4: Wiser Fit for E electron = 19 GeV, π^+, P_π=7 compared to Wiser data.

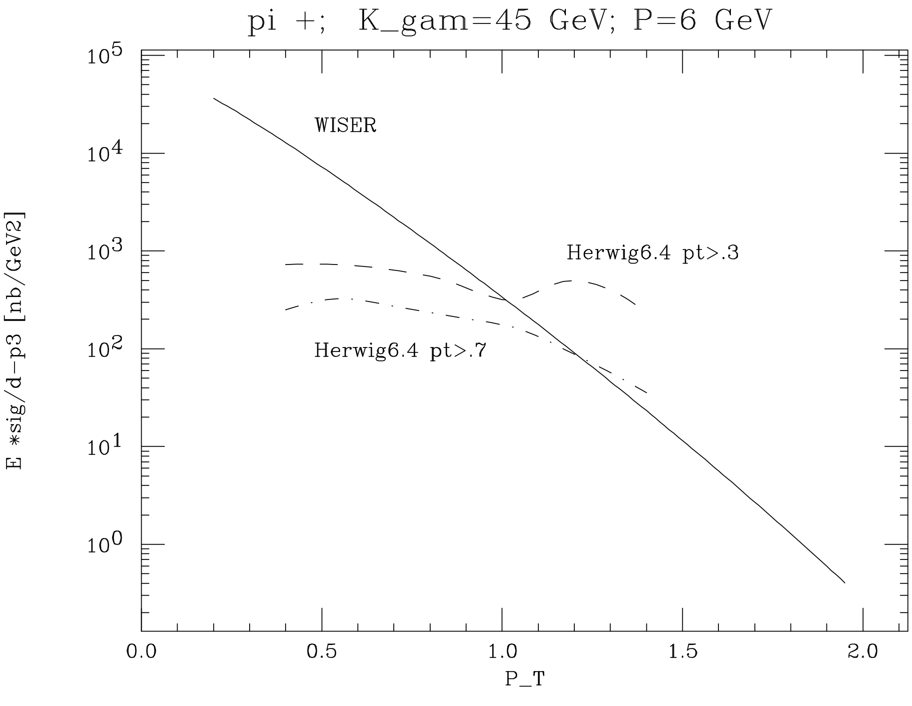

Figure 5: Wiser Fit for E electron =48 GeV integrated for $42 < K_\gamma < 48$ compared with HERWIG 6.4 with parameter PTMIN=.3 and PTMIN=.7

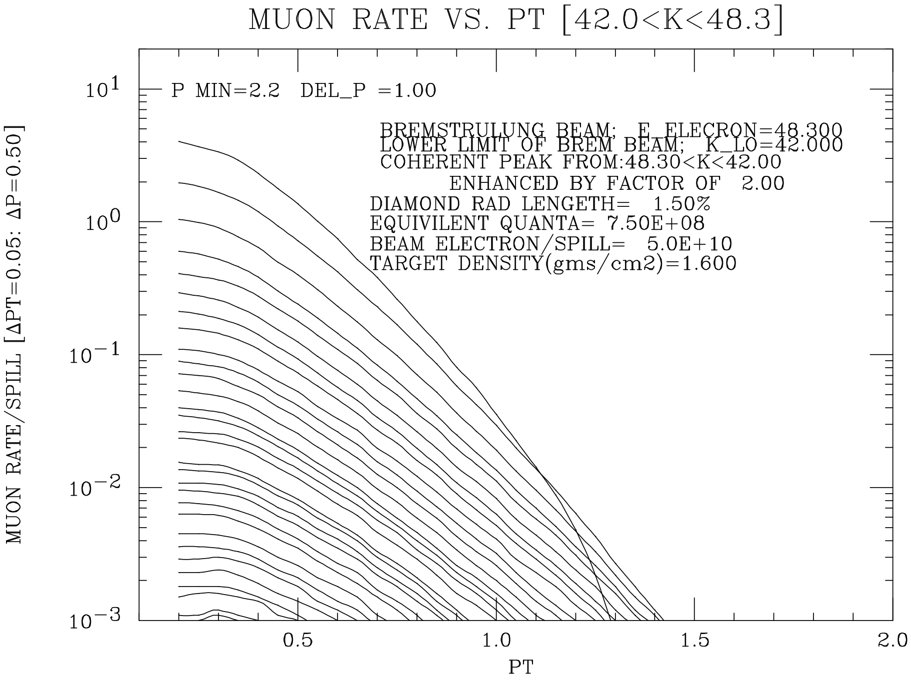

Figure 6: Rate of μ/spill into bins of $\Delta P_T = 0.05$ and $\Delta P = 0.5$ as a funtion of P_T. The lines are constant P starting at the top at P MIN, and going down in intervals of ΔP shown. Hadrons from Wiser Fit for E electron =48 GeV integrated for $42 < K_\gamma < 48$ for the beam and target shown on the plot.

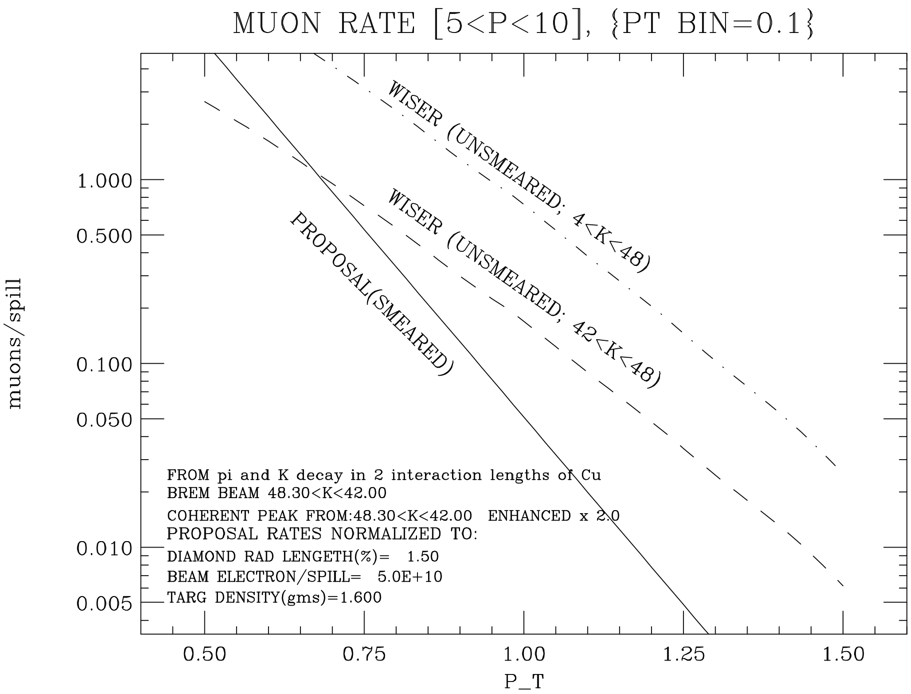

Figure 7: μ/spill/ΔP_T = 0.1 for $5 < P < 10$ from the proposal Fig. 10, K=45, compared with this calculation from the Wiser fit. This calculation is down with both Brem Subtracted (average γ energy about 45) and unsubtracted. It has not been resolution smeared and 100% acceptance is assumed.