MC Charm Production - 1

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Abstract : The production of charm from the LUND Monte Carlo generator is examined. The production rate is about 30% too high and the E_ν dependence is peculiar.

MC Sample

For this study the LUND package LEPTO is used to generate a sample of nm interactions with the "standard" energy spectrum, without any geometrical cuts on the location of the interaction. This gives a sample of unbiased events that can be compared to the production of single charm in models and published experiments. The total charm in the MC sample is defined to be the events which have a D^0, D^+ or D_s or the charge conjugate state. The GEANT simulation was not enabled for this study since only the primary particles of the interaction are relevant.

Two results are reported here. First, the dependence of the charm yield as a function of "m_c" as defined by `PMAS(4,1)` in the common `/LUDAT2/`. The second result is the dependence the charm yield on the input neutrino energy, E_ν.

Charm Yield vs "m_c"

The parameter `PMAS` was varied from 1.35 GeV/c² to 1.50 GeV/c² and the corresponding charm yield was measured as the ratio of the event weights: $\Sigma(w_{\text{charm}})/\Sigma(w_{\text{any}})$. The sample size was about 7400 events for each mass value.

`PMAS(4,1)` GeV/c²	Relative charm yield
1.35	0.064
1.40	0.068
1.45	0.072
1.50	0.081

Table 1. The number of nm CC interactions containing charm relative to the total number of interactions.

The expected behavior is that the total cross section containing charm would *decrease* as a function of increasing m_c . One can conclude that either this parameter is not used in calculating the kinematics of the interaction in LEPTO, or that the kinematics are simply not calculated properly in LEPTO (or both).

Energy Dependence

The energy dependence of the neutrino cross section is linear with E_n , of course, the part of the cross section in which charm is present is expected to have a behavior similar to the ν_τ cross section due to the threshold effect of producing a heavy fermion. This function is determined in the Monte Carlo by plotting the ratio of the charm yield to the total, in bins of E_ν. The total number of ν_μ CC interactions for this sample was 4×10^4 .

The results are shown in the two plots. Figure 1 shows the neutrino energy spectrum for all interactions and for interactions containing charm. As expected, the charm sample has a larger average energy. Remember that there are no geometrical cuts in this data, and the event is *not* re-

quired to be in the targets. Figure 2 shows the ratio of the two spectra in Figure 1. The value for the "mass", PMAS, is set to 1.30 GeV/c^2. The dots shown are model calculations fit to available data [1] using m_c =1.5 GeV/c^2 and $|V_{cd}|^2$ = 0.049. The MC ratio is too large for all bins but the first. The ratio of charm to total interactions for this set is 0.064±0.002, but on the basis of the calculation one would expect about 0.04. Although the behavior is qualitatively correct, it is surprising that the kinematics of the event do not appear to be correct. The statistical error per bin is <20% for E_n < 60 GeV.

References

1. Appendix B in the P803 Proposal, October 1993 (and references therein)

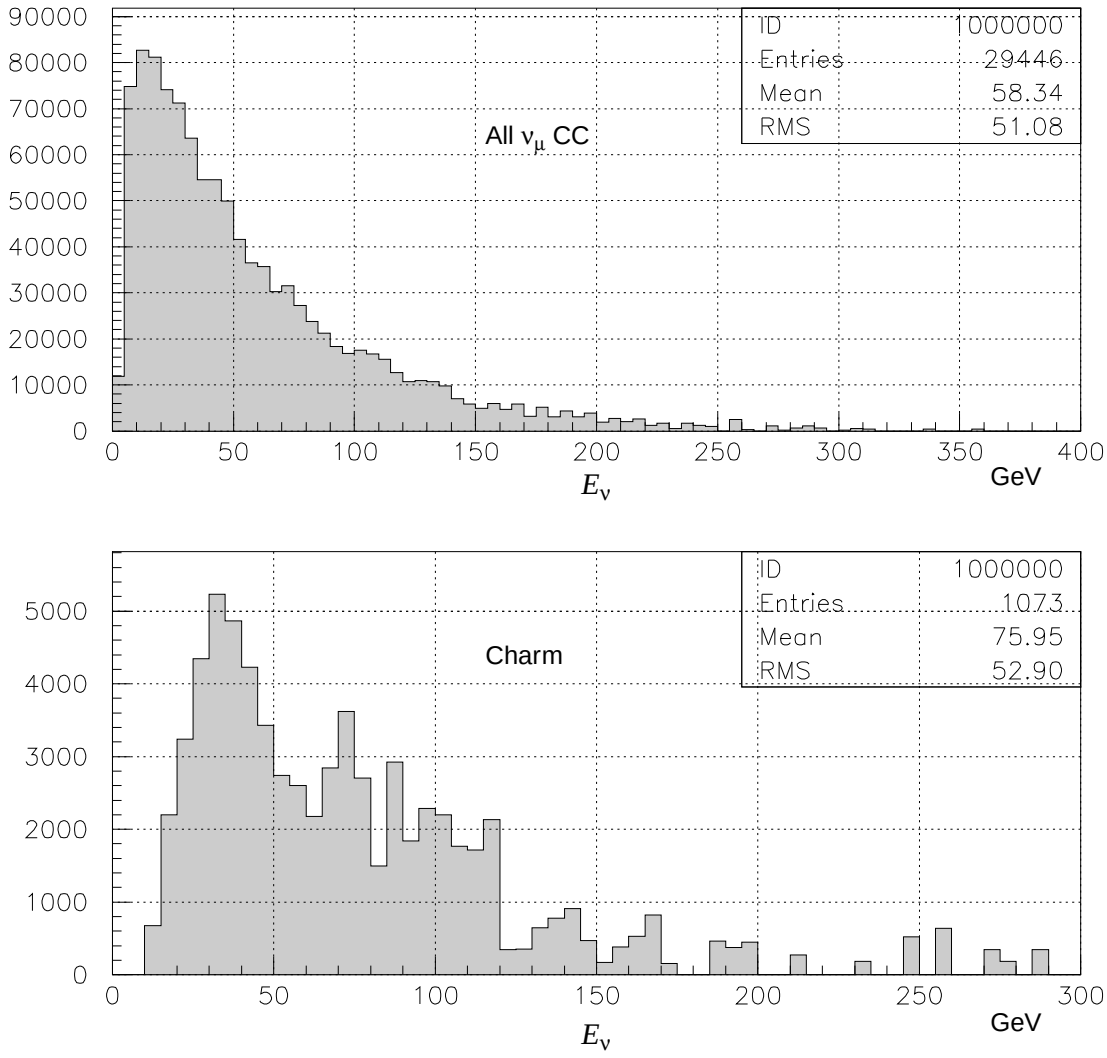

Figure 1. The energy spectra of the incident neutrino for : (*top*) all events in the sample, and (*bottom*) for events with a charm meson produced in the interaction.

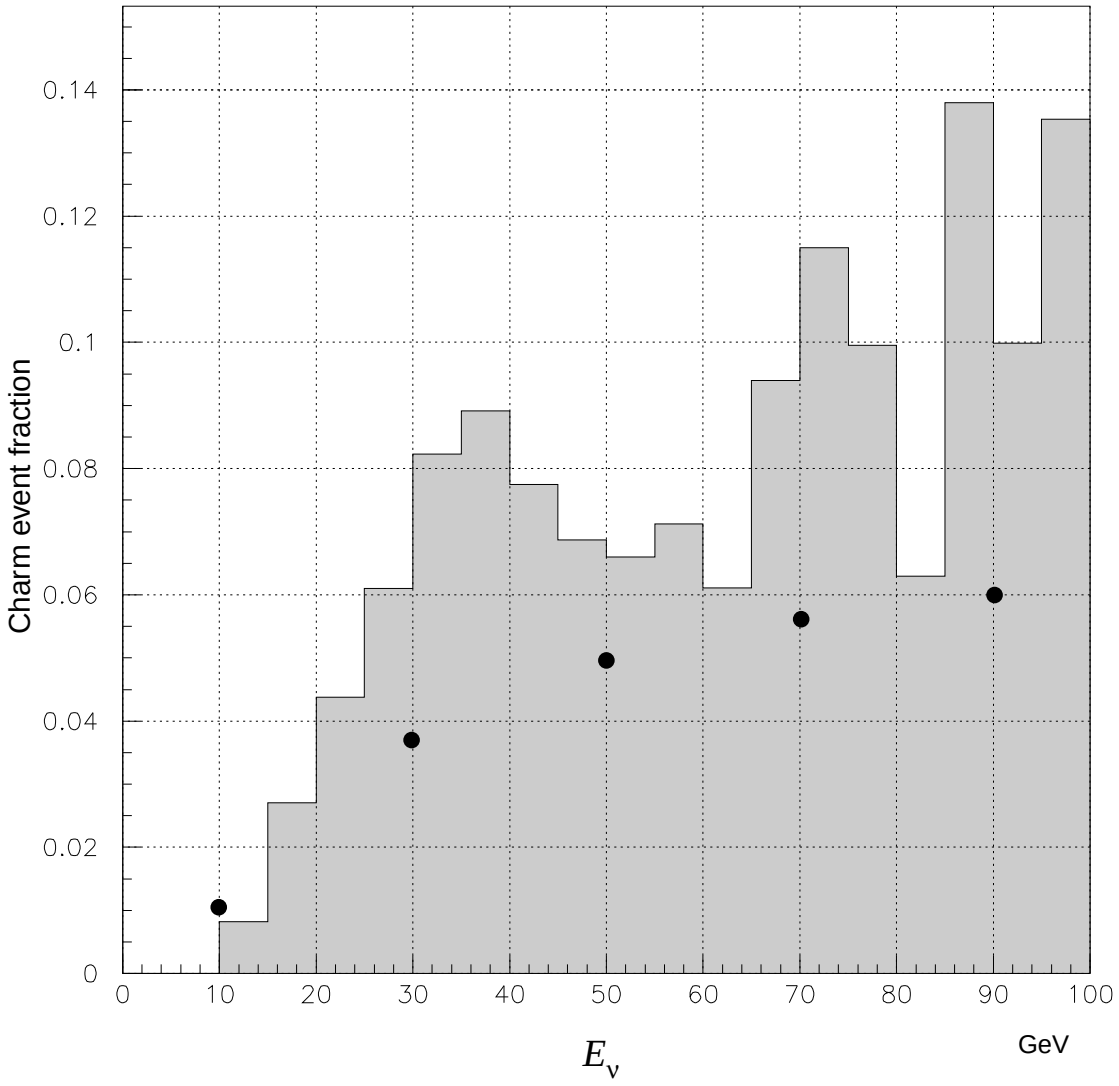

Figure 2. The ratio of charm events to the total as a function of the neutrino energy, E_ν. The filled circles are calculations using structure functions and parameters given in Ref 1.