G4 Beam MC Upgrades and Implications

Three upgrades were done (post-WIN03 fluxes and post-Tech Note # 103):

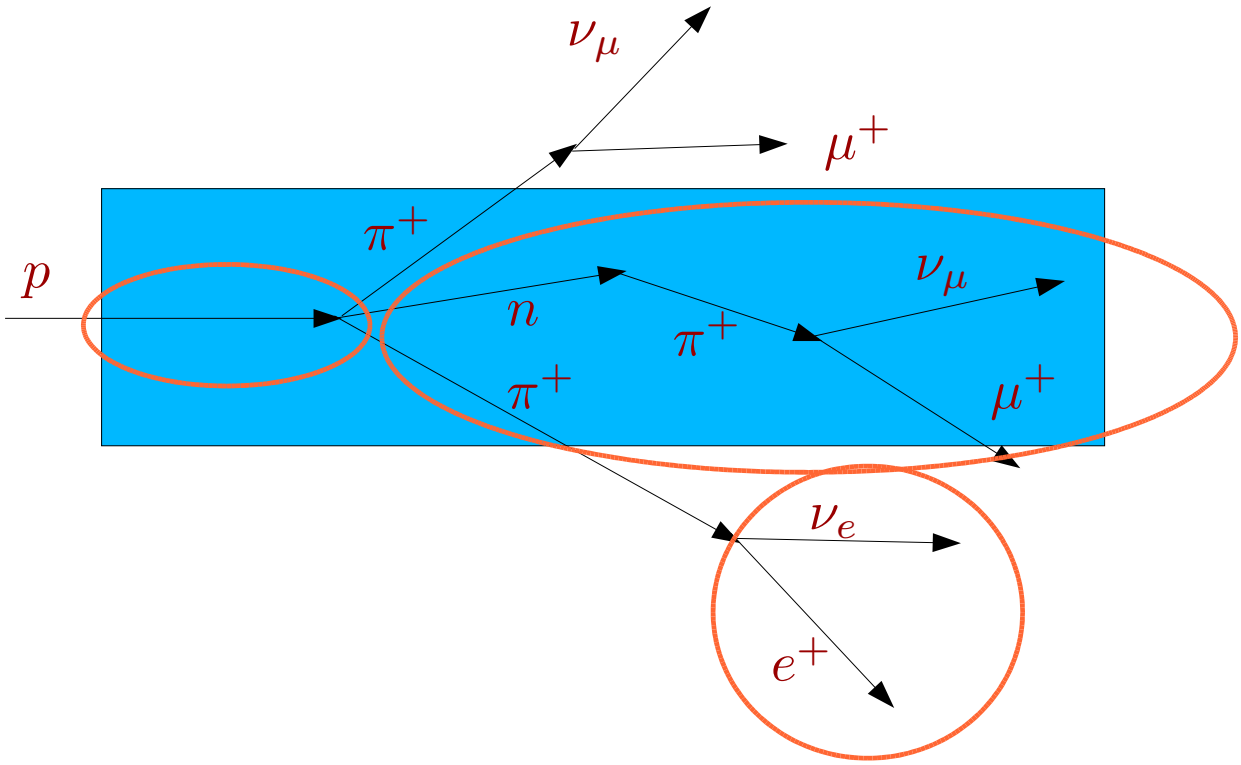
1. **freedom to choose the inelastic interaction length in p-Be interactions**
   The p-Be inelastic cross-section value specified in the user interface is now used not only to compute the multiplicity of final state particles, but also to determine where the interactions occur in the target. Before: G4 default cross-section used;

2. **added $\pi \to e\nu_e$ decay mode**
   BR=$1.23 \cdot 10^{-4}$. Can increase intrinsic ν_e background, since $1.23 \cdot 10^{-4}$ is not entirely negligible compared to ν_e/ν_μ ratio in the beam. Before: $\pi \to \mu\nu_\mu$ only;

3. **added neutron production and fast neutron tracking**
   By default, use MARS neutron production in p-Be interactions. Neutrons with > 10 MeV kinetic energy are tracked, can inelastically produce $\pi^{\pm}$'s, which in turn produce neutrinos. Before: no neutrino contribution from neutron production and tracking.

Interactions in the target

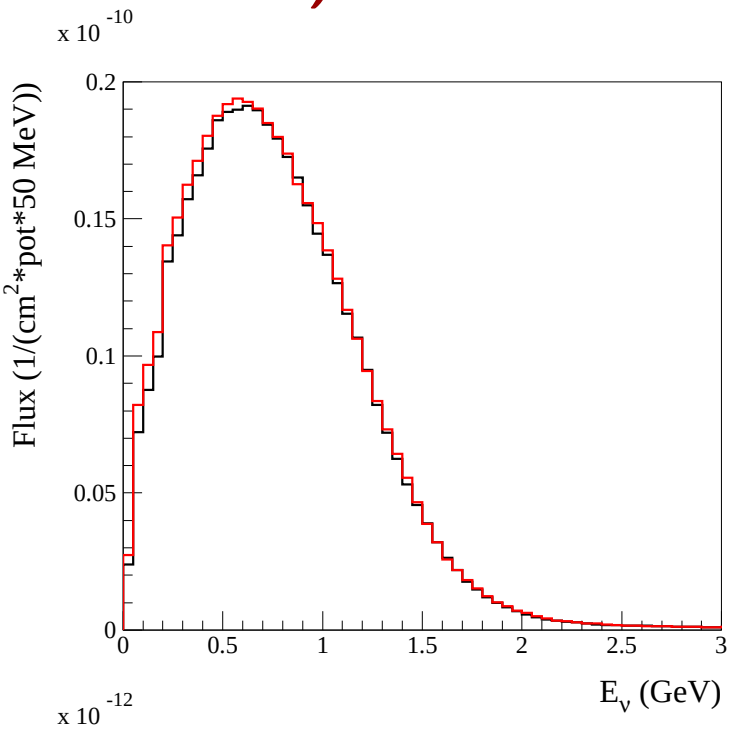
The three changes made are schematically shown below:



Results (JAM model)

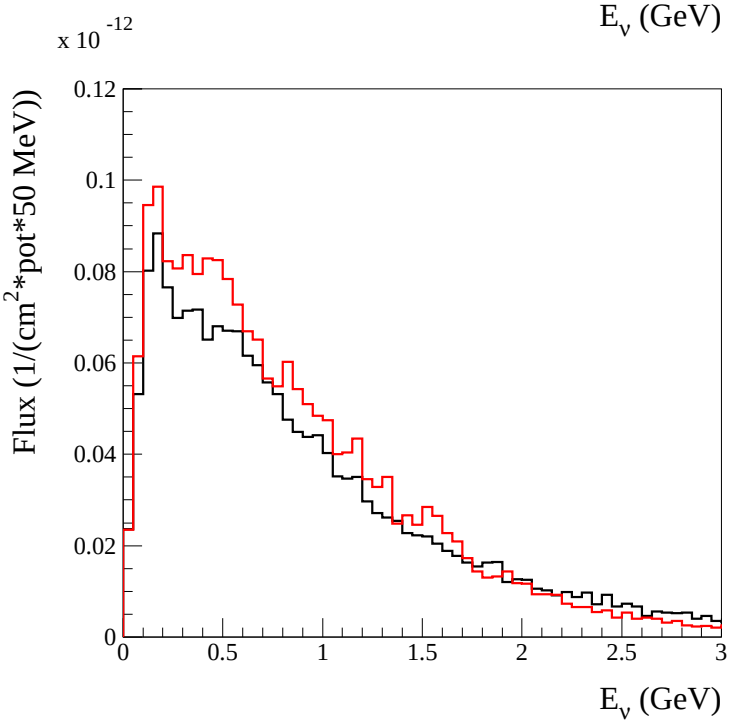
ν_μ fluxes:

JAM Model	ϕ $((pot \cdot cm^2)^{-1})$	$\langle E_\nu \rangle_\phi$ (GeV)
Aug03	$4.16 \cdot 10^{-10}$	0.784
Nov03	$4.25 \cdot 10^{-10}$	0.779



ν_e fluxes:

JAM Model	ϕ $((pot \cdot cm^2)^{-1})$	$\langle E_\nu \rangle_\phi$ (GeV)
Aug03	$1.88 \cdot 10^{-12}$	0.935
Nov03	$2.05 \cdot 10^{-12}$	0.855



- minor differences
- ν_e/ν_μ ratio: 0.45% $\longrightarrow$ 0.48%
- $\nu_e(\pi)/\nu_e(\text{all})$=2.3% only