Selection of τ Events in the LBNE FD

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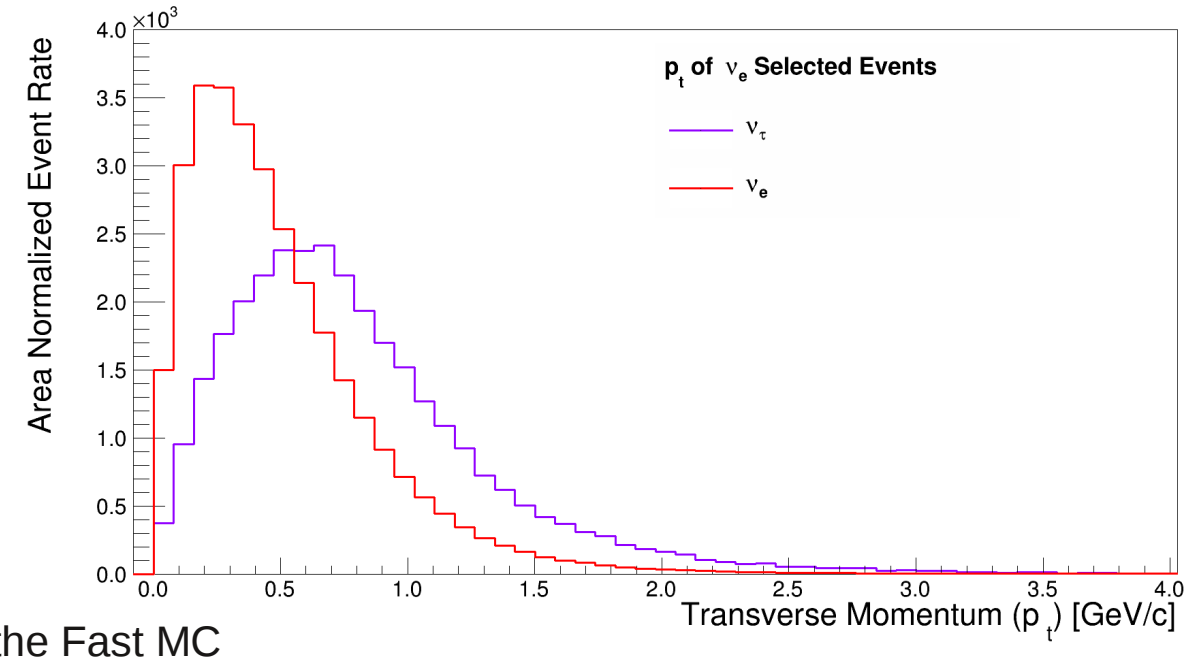
Why Do We Need a τ Selection

- Background to ν_e - appearance
  - Comprised of: $\tau \rightarrow e + \nu + \nu$
  - Branching fraction: 17%-18%
  - Large background
  - Events feed down to the signal region at lower E_ν due to missing energy
- Background to ν_μ - disappeance
  - Same as above
  - Background fraction is not as large as compared with the appearance analysis
- To make a ν_τ - appearance measurement
  - Confirm OPERA measurement
  - Over-constrain $\nu_\mu \rightarrow \nu_\tau$ / the 3-flavor oscillation model
  - NSI and other 'exotic' physics

Background Reduction (ν_e/ν_μ)

- Events with a charged lepton in the final state
- Possible selection variables
  - Total visible energy
  - Missing p_t (see plot)
  - Invariant mass of hadronic system
  - Lepton ID
  - Transverse event energy profile
  - Longitudinal event energy profile



- Top4 can easily be explored with the Fast MC
- Last two cannot currently be evaluated with the Fast MC, but some dE/dx simulation can be added
- Start with simple cuts
- Move to MVA techniques
  - KNN (<7 variables)
  - SVM (>7 variables)

Selection of a ν_τ - appearance Sample

- Leptonic decay will be hard to isolate
  - Large backgrounds from ne/nm intereactions
  - May be able to use anitselection from background reduction cuts
- Hadronic channels:
  - Identify energetic pions
    - Long MIP track with energetic shower at the end
    - QE-like: 'Dart topology'
    - DIS-like: 'Barbell topology'
  - Reconstruct ρ(770) mass from π^0 + $\pi^\pm$ (OPERA)
  - Missing p_t
- Need to study selection efficiencies/purities
- Build MVA with useful variables

Table 1: Basis modes and fit values(%) for the 2010 fit to τ branching fraction data.

$e^-\overline{\nu}_e\nu_\tau$	17.85 ± 0.05
$\mu^-\overline{\nu}_\mu\nu_\tau$	17.36 ± 0.05
$\pi^-\nu_\tau$	10.91 ± 0.07
$\pi^-\pi^0\nu_\tau$	25.51 ± 0.09
$\pi^-2\pi^0\nu_\tau$ (ex. K^0)	9.29 ± 0.11
$\pi^-3\pi^0\nu_\tau$ (ex. K^0)	1.04 ± 0.07
$h^-4\pi^0\nu_\tau$ (ex. K^0, η)	0.11 ± 0.04