

Model Sensitivity and Variables for HPTPC

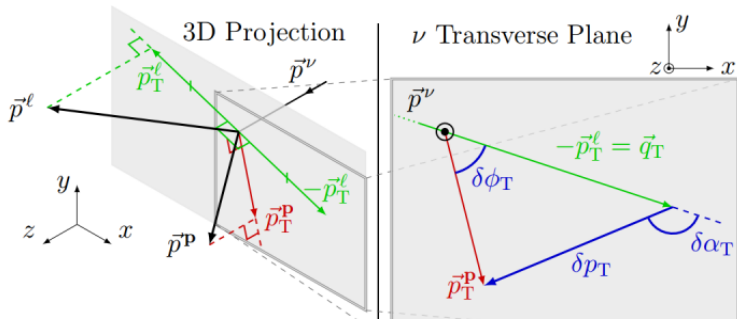
Patrick Dunne - Imperial College London

Overview

- ▶ Will present a preliminary study on 2p2h model sensitivity of the HPTPC
 - Previous presentation on Single Transverse Variables (STV)
- ▶ Will show more information on hadron kinematics and new transverse variables

Single Transverse Variables - Reminder and Naming

- ▶ Use hadronic information to estimate nuclear effects
- ▶ Variables are all used frequently at hadron colliders
 - Naming that is emerging in neutrino physics is different
 - In hadron colliders: $\delta p_T = p_T^{\text{miss}}$, $\delta\phi_T = \pi - \Delta\phi(\text{lep}, \text{had})$, $\delta\alpha_T = \pi - \Delta\phi(\text{lep}, p_T^{\text{miss}})$
- ▶ Personally find hadron collider naming more intuitive

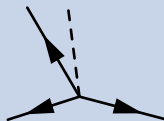


Other Transverse Variables - Reminder

- ▶ Particularly for p_T^{miss} context is important



VS



- ▶ Both events have the same $p_T^{miss} \delta p_T$ but on the right this is clearly more significant compared to uncertainties on visible object momenta

HPTPC Study - Reminder

- ▶ HPTPC-like and ND280-like momentum thresholds (below) and efficiencies (see Mark's talk 10th October) were applied to ND280 MC truth
 - Same as shown previously
- ▶ Then calculated transverse variables
 - Only make sense in samples with a proton or a pion

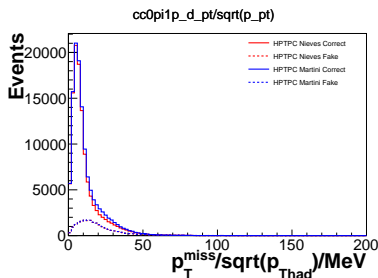
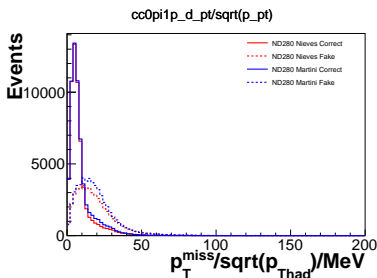
Particle	ND280 Threshold/MeV	HPTPC Threshold/MeV
μ	100	15
π	120	16
p	450	60
e	100	1

HPTPC Study

- ▶ Truth information is used to determine which events truly belong in the sample (“correct”), and which are “fakes”
 - Distributions of transverse variables are shown for both
- ▶ Have seen previously that transverse variables look similar in ND280 and HPTPC
- ▶ Will show today effect of 2p2h model on variable shapes in ND280 and HPTPC
 - 2p2h Describes interactions between neutrino and 2 nucleons
 - MC is generated with Nieves model
 - Use reweighting to study Martini model

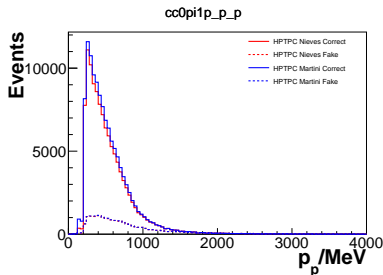
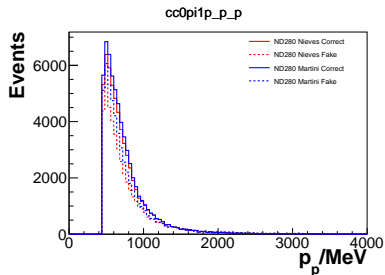
CC0 π 1p

- ▶ Look at sample with 1 proton and no pions
- ▶ Compare detectors (N events is arbitrary)



CC0 π 1p

- Look at sample with 1 proton and no pions

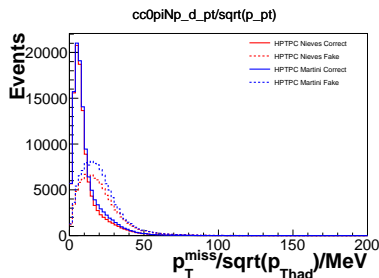
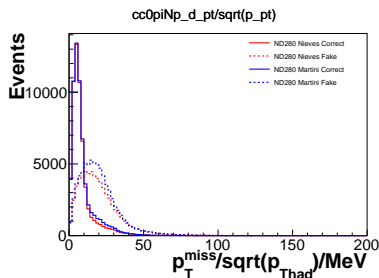


Discussion of 2p2h

- ▶ Results from $\text{CC}0\pi 1p$ don't show much discriminating power from HPTPC
- ▶ Expect there may be more power in $\text{CC}0\pi Np$ because Martini and Nieves predict different proton multiplicities
 - Caveat, reweighting is only done as a function of E_ν so may not accurately describe hadron kinematics

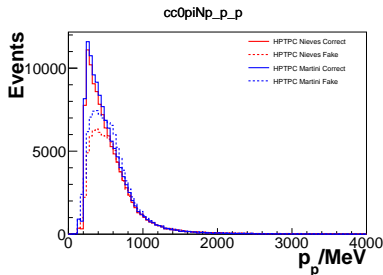
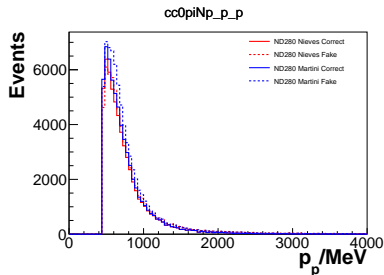
CC0 π Np

- ▶ Look at sample with ≥ 1 proton and no pions
- ▶ Compare detectors (N events is arbitrary)



CC0 π Np

- Look at sample with ≥ 1 proton and no pions



- ▶ HPTPC may have some sensitivity to interaction model
 - Slightly better than ND280 for the chosen parameters in terms of difference in rate
 - Need to choose the right sample
- ▶ Caveat: Reweighting that was done is only a function of E_ν , so may not accurately describe hadron kinematics
- ▶ Next step is to look at fake data studies for more models and see if 2p2h reweighting can be improved