Single Transverse Variables in MicroBooNE

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INTRODUCTION

This poster presents the results of Monte Carlo simulations examining the current capability of MicroBooNE to reconstruct Single Transverse Variables (STVs) in neutrino-argon interactions. The STVs form a set of observables that characterize the kinematic imbalance between particles in the final state. Some potential for discrimination between two competing theoretical predictions for the STVs is seen, but some improvements to the analysis are needed to enable a full cross section measurement.

BACKGROUND

1. Cross-section Measurement

- High accuracy in cross-section measurement- → better understanding of neutrino- nucleus interaction
- CC0πNp: 1 muon, 0 pions, at least 1 proton
- MicroBooNE : pursuing cross-section measurements of neutrino-nucleus interactions with high statistics.

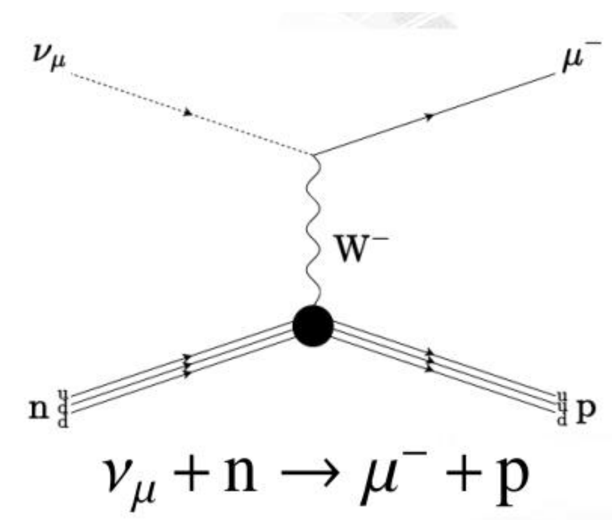
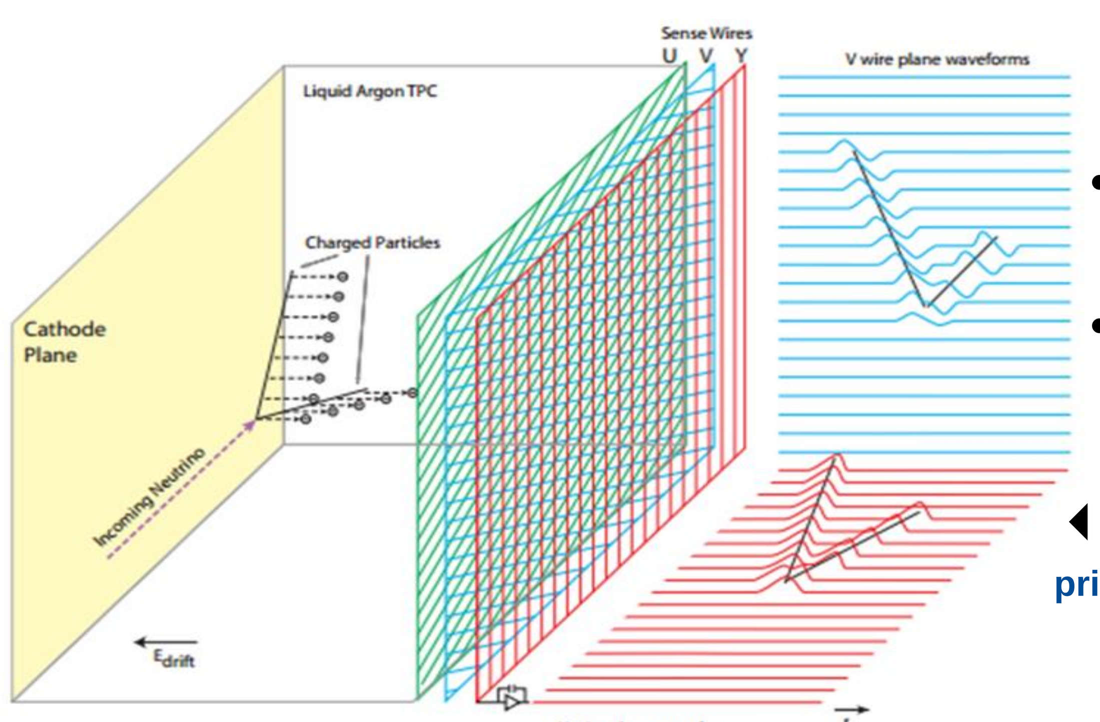


Fig.1 Feynman's Diagram of CCQE



- TPC offers detailed 3D reconstruction capabilities
- 170-ton LArTPC that operates in Fermilab Booster Neutrino Beam

Fig.2.Operational principle of LArTPC.

4. Single Transverse Variables (STVs)

- 3 observables: quantify the momentum imbalance between the final muon & leading proton.
- Defined on the transverse plane
- δp_T → magnitude, $\delta\phi_T$ and $\delta\alpha_T$ → direction

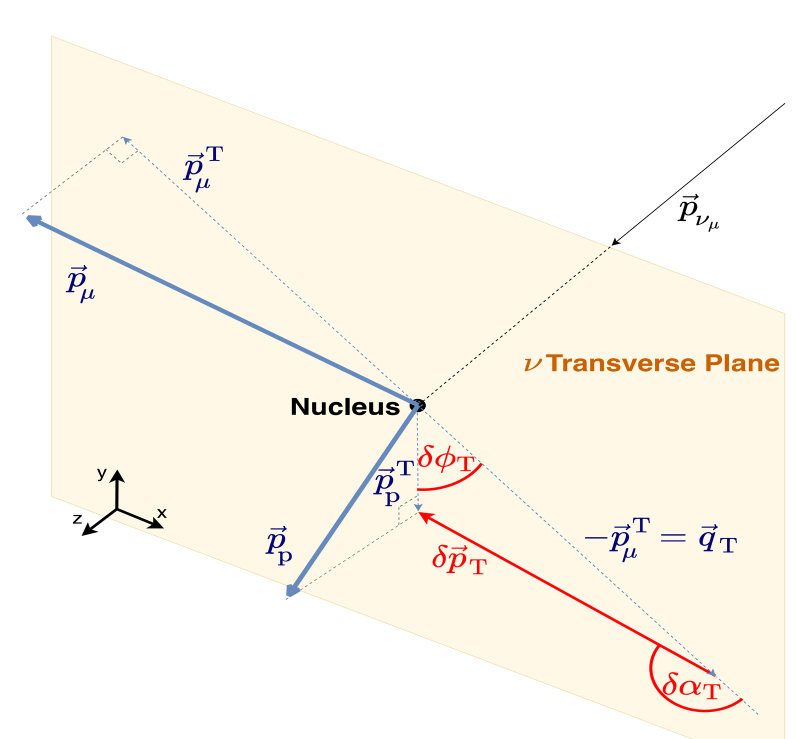


Fig.3 Schematic presentation of STV.

METHOD

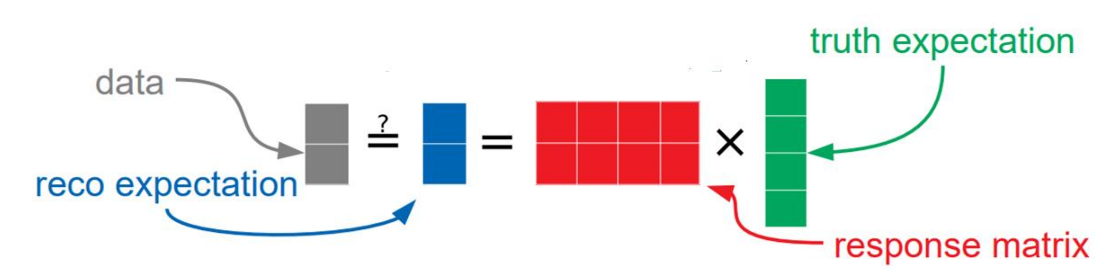
GENIE v3.0.6 : theory events

1. Tune G18_10a_02_11a: default model
2. Tune G00_00b_00_000: alternate model

Uboonecode v8 : reconstructed events

1. Reconstructed events for default model
2. Reconstructed events for alternate model

Smearing matrix



- Smearing matrix: represents average detector effect.

Cross-section extraction:

$$\left(\frac{d\sigma}{dx}\right)_i = \frac{N_i - B_i}{\tilde{\epsilon} \cdot N_{target} \cdot \Phi_{\nu_\mu} \cdot (\Delta x)_i}$$

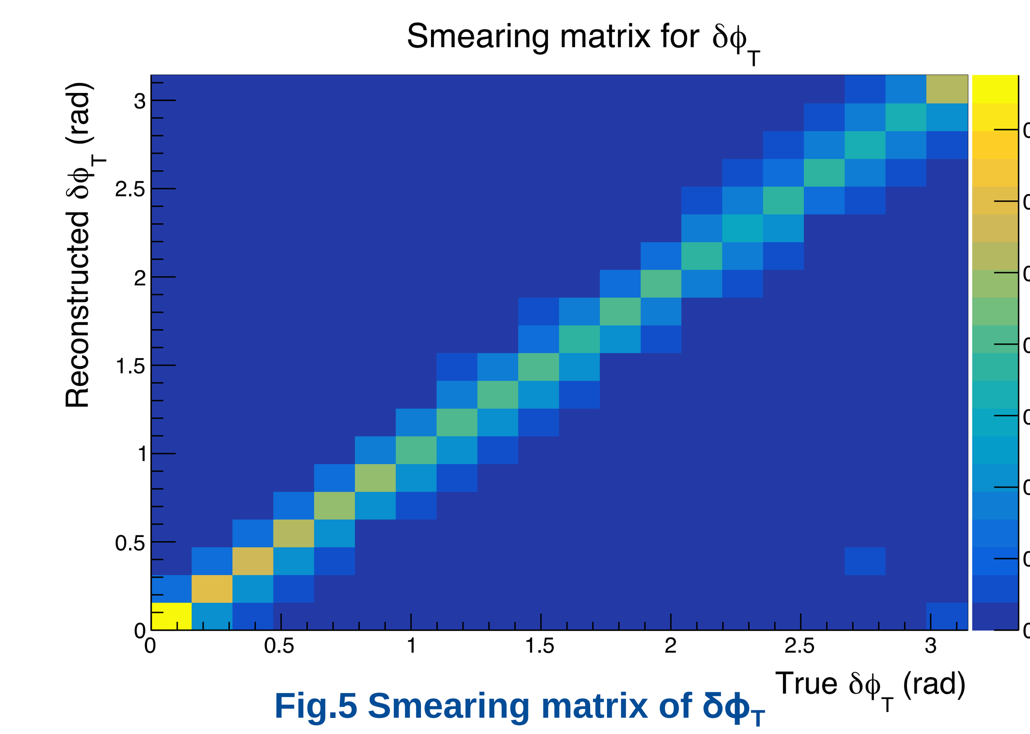


Fig.5 Smearing matrix of $\delta\phi_T$

RESULTS

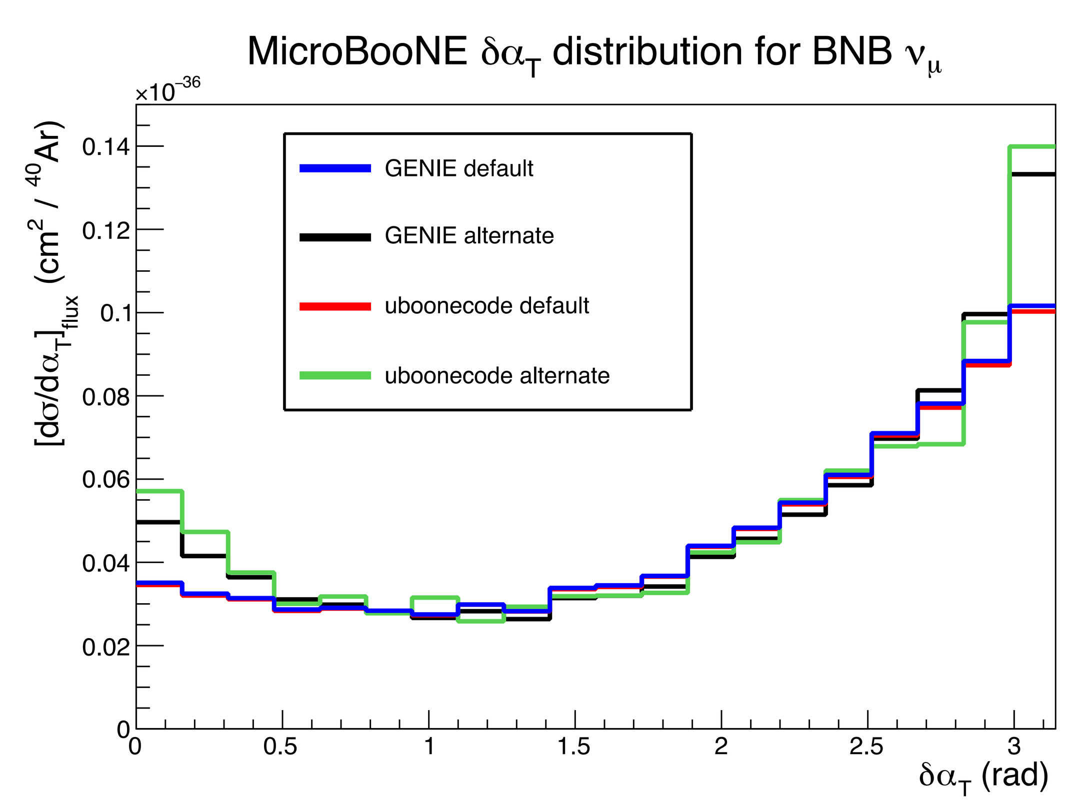


Fig.6 Differential cross section as a function of $\delta\alpha_T$

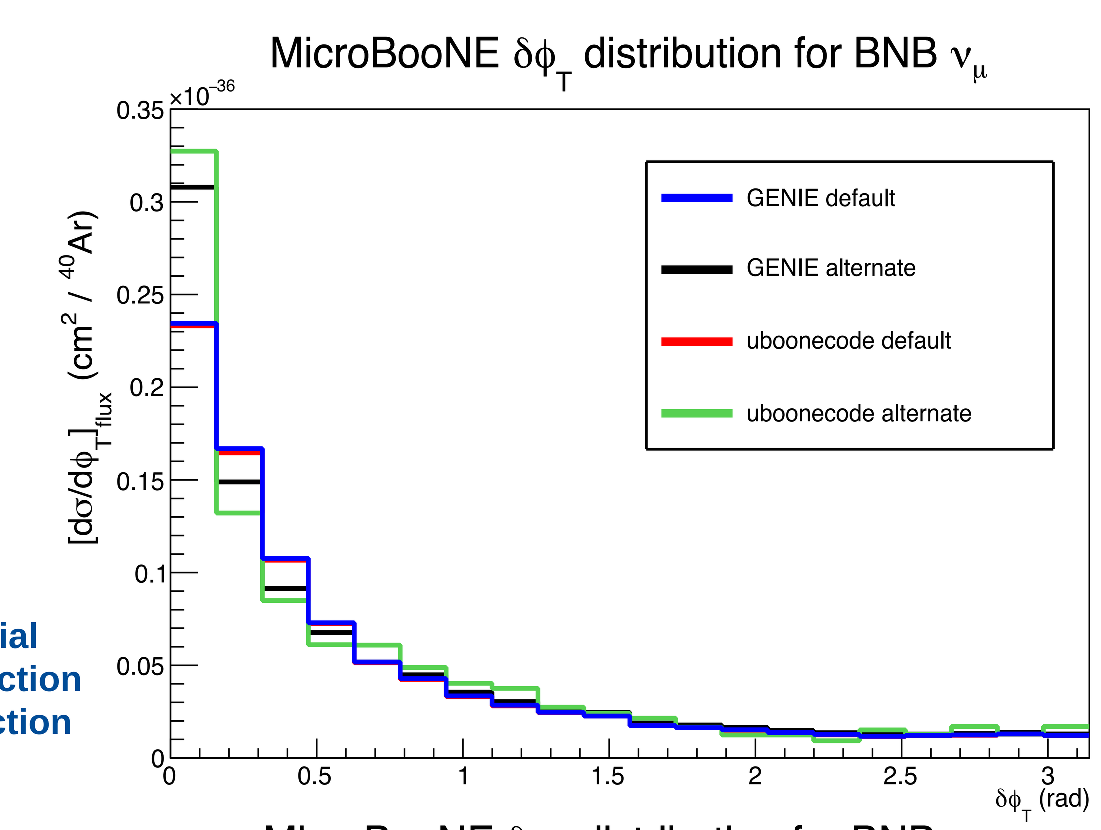


Fig.7 Differential cross section as a function of $\delta\phi_T$

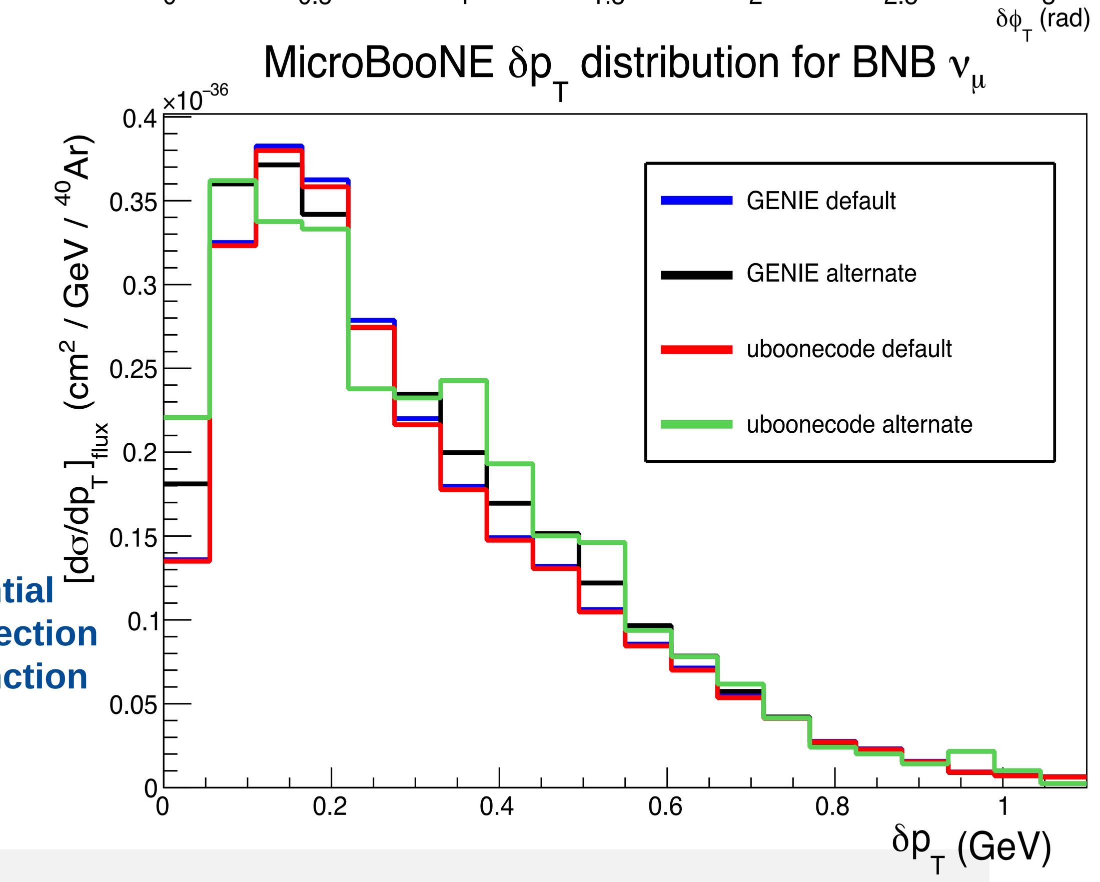


Fig.8. Differential cross section as a function of δp_T

- The angular STVs show opportunities for model discrimination in the tails of the distribution, but some model-dependence exists in the current smearing matrix.
- The δp_T reconstruction has the most trouble: the discrepancy between the smeared and reconstructed results for the alternate model is comparable to the difference between the physics model predictions.