

DEVELOPING NEW BEAM CONSTRAINTS TO IMPROVE STERILE NEUTRINO SEARCHES IN NOvA



IMPROVING OUR LIMITS

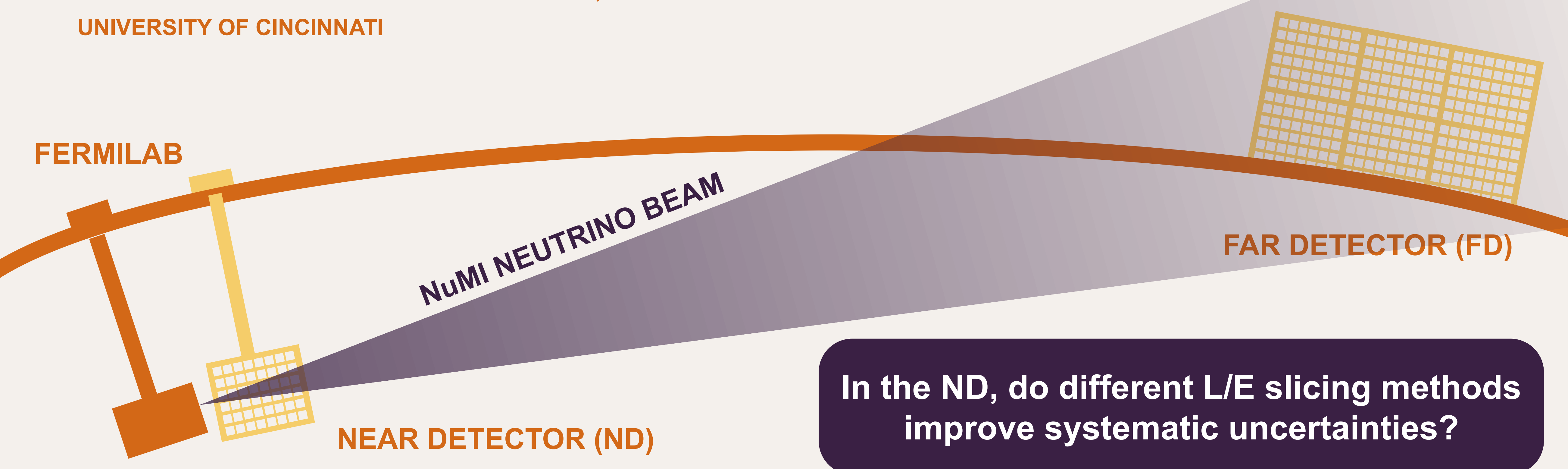
Improving our L/E Resolution
This poster!

Including ν_e appearance channel
See Bishnu's poster (#21)

Additional samples for disambiguating oscillations and systematic effects
See Adam's poster (#194)

Current Limits
See Shivam's Poster (#195)

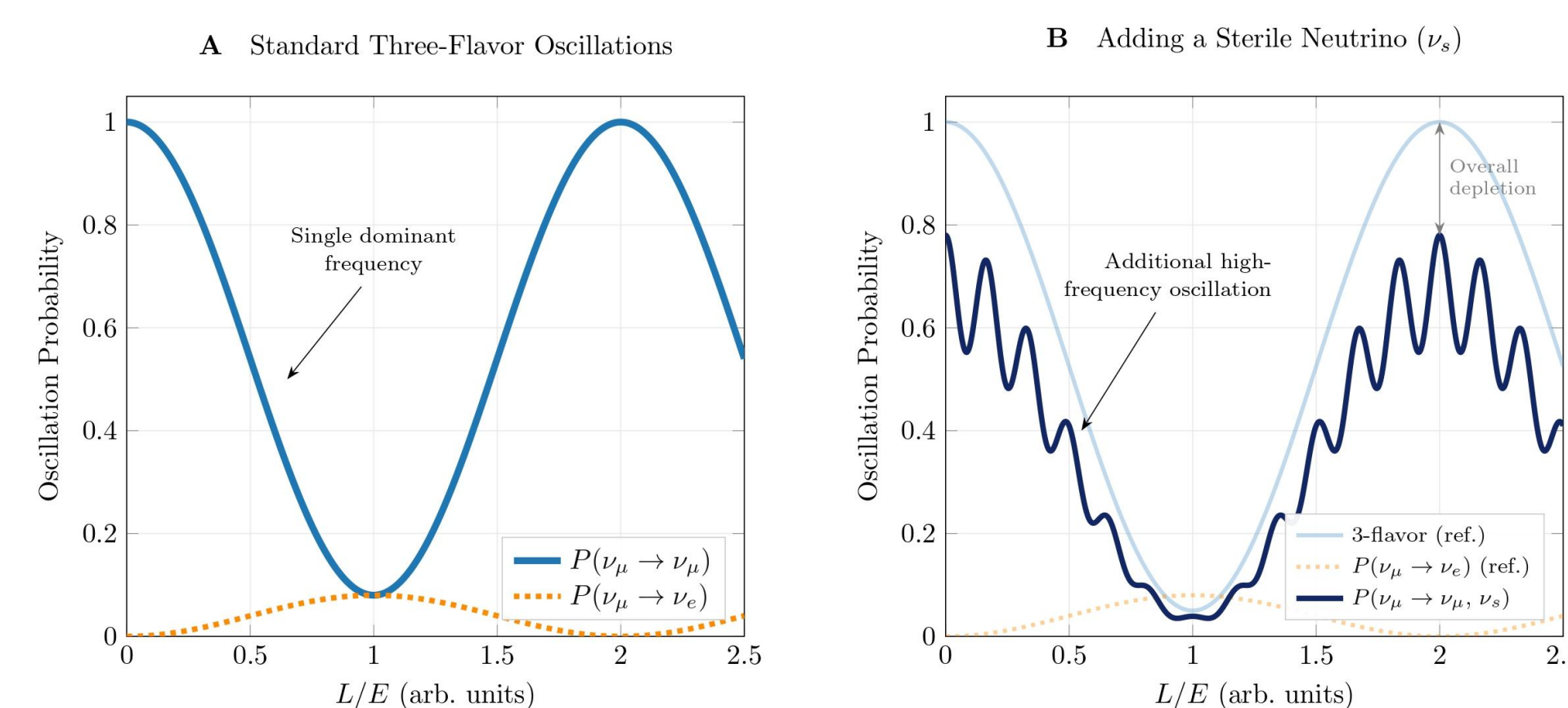
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UNIVERSITY OF CINCINNATI



In the ND, do different L/E slicing methods improve systematic uncertainties?

INTRODUCTION

- NOvA's sterile neutrino search in the NuMI beam uses ν_μ disappearance and NC disappearance at its Near Detector (ND, $L \sim 1$ km) and Far Detector (FD, $L \sim 810$ km)
- In oscillation calculations, **steriles would introduce new mixing angles and a new mass splitting Δm_{41}^2**



- A combined ND+FD analysis can probe sterile oscillation parameters, but presents systematic uncertainties that inhibit the sterile neutrino search

CHALLENGES

BASELINE SMEARING

The pion decay point is unobserved, smearing L across 275–1000 m event-by-event. This baseline smearing washes out oscillation structure at the ND, obscuring the sterile signal

BEAM FLUX

Errors in modeling pion and kaon production and beamline hadron focusing

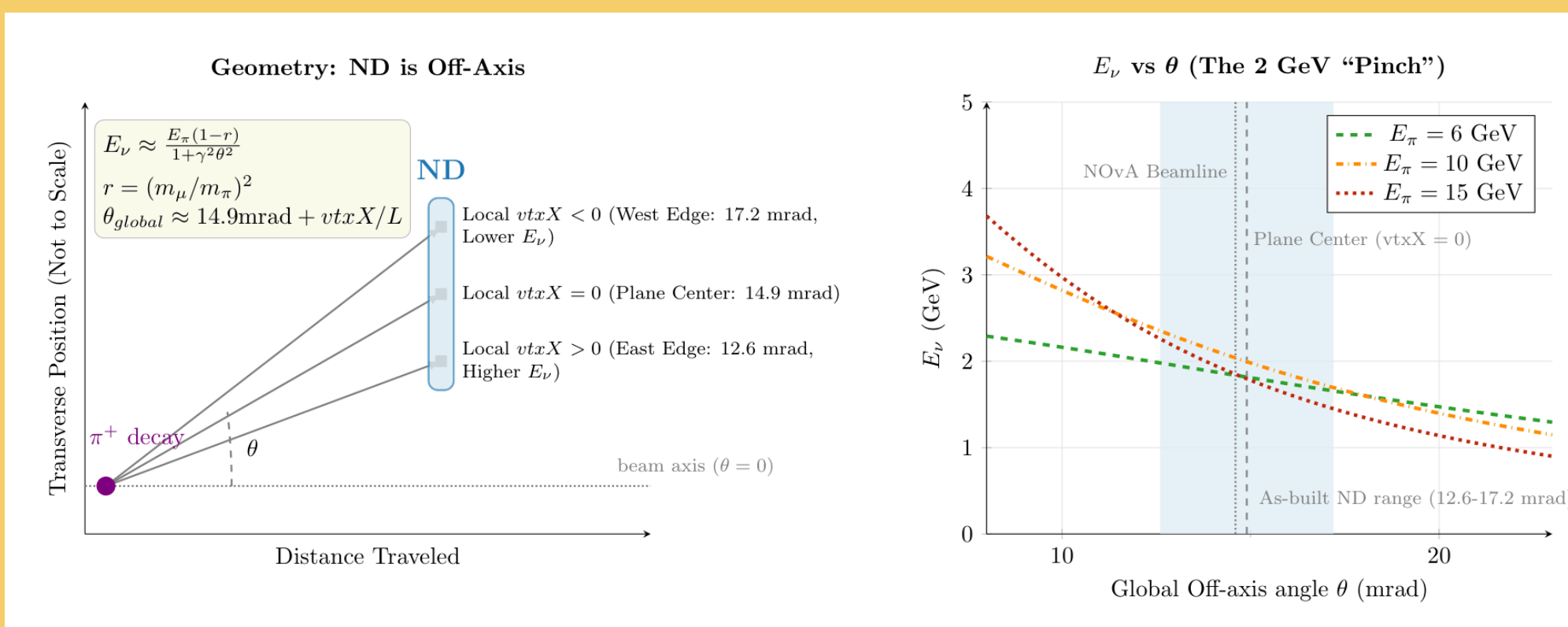
CALIBRATION

Uncertainties in detector energy calibration affect the reconstructed neutrino energy scale

METHOD

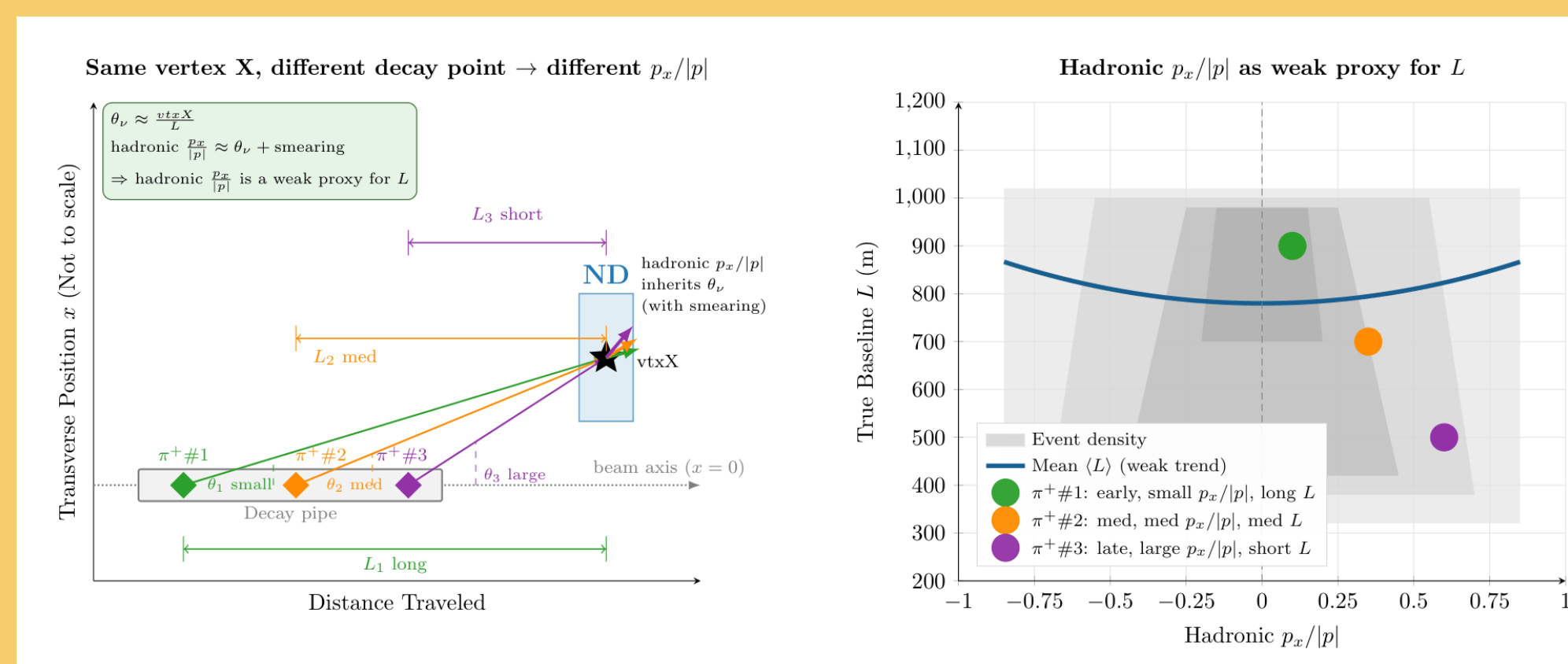
- Mean E_ν varies strongly with vertex X , weakly with $\frac{p_x}{|p|}$
- Mean L varies somewhat with $\frac{p_x}{|p|}$, weakly with vertex X

VERTEX POSITION AS AN ENERGY PROXY



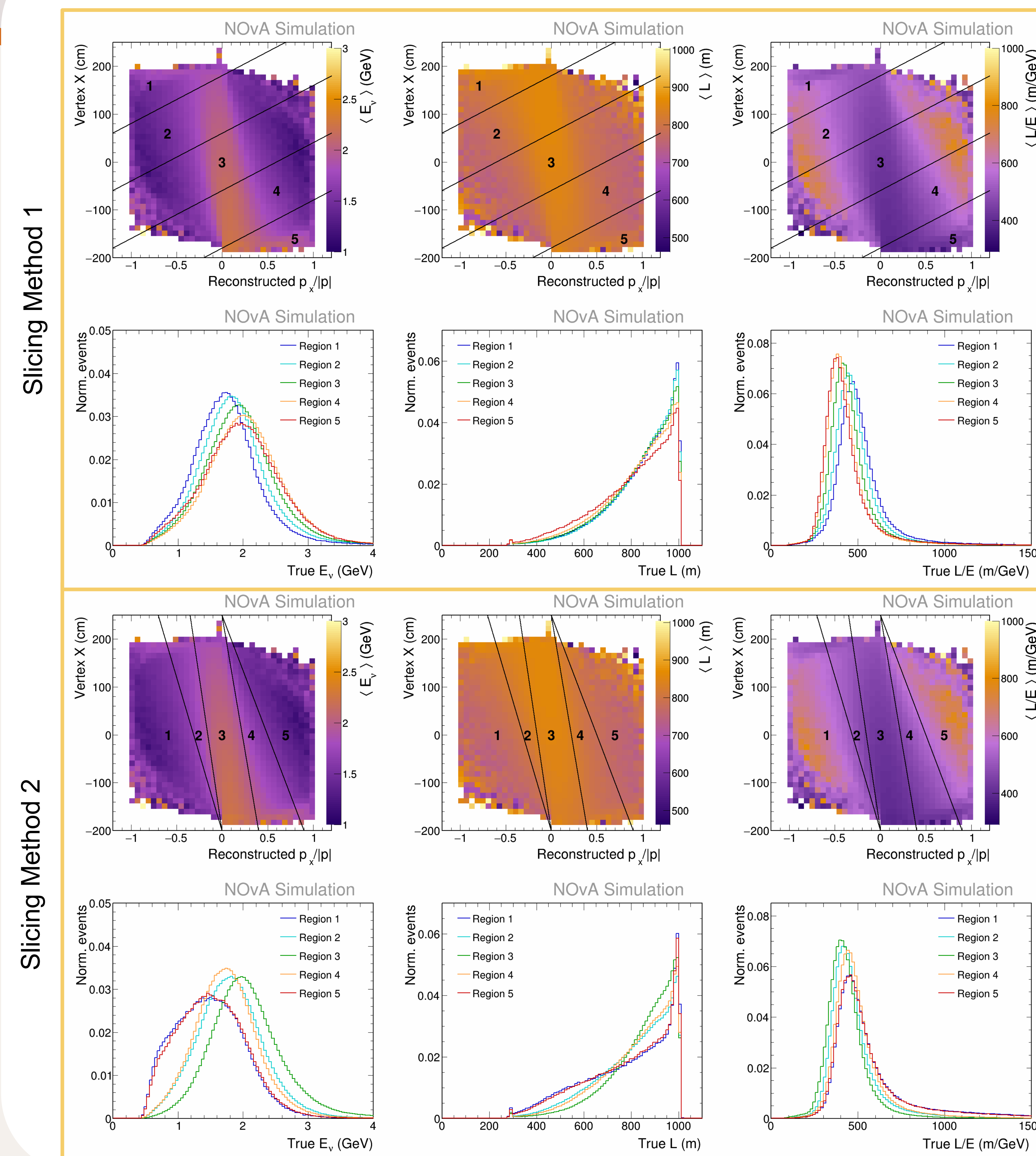
Vertex transverse position maps to off-axis angle, selecting specific energy flux

RECONSTRUCTED EVENT MOMENTUM ($\frac{p_x}{|p|}$) AS A BASELINE PROXY



Reco event momentum direction indicates neutrino path length, distinguishing long from short baselines

RESULTS



Slicing the $(\frac{p_x}{|p|}, \text{vtX})$ phase space selects regions with distinct true L/E distributions, directly isolating the oscillation signal.

Each variable provides an independent handle on systematic uncertainties: Vertex X selects narrow-band subsets of the beam, while $\frac{p_x}{|p|}$ picks out different neutrino energy ranges and interaction topologies.

Together, they offer complementary constraints on flux normalization and detector calibration uncertainties, though the precise mapping is still under investigation.