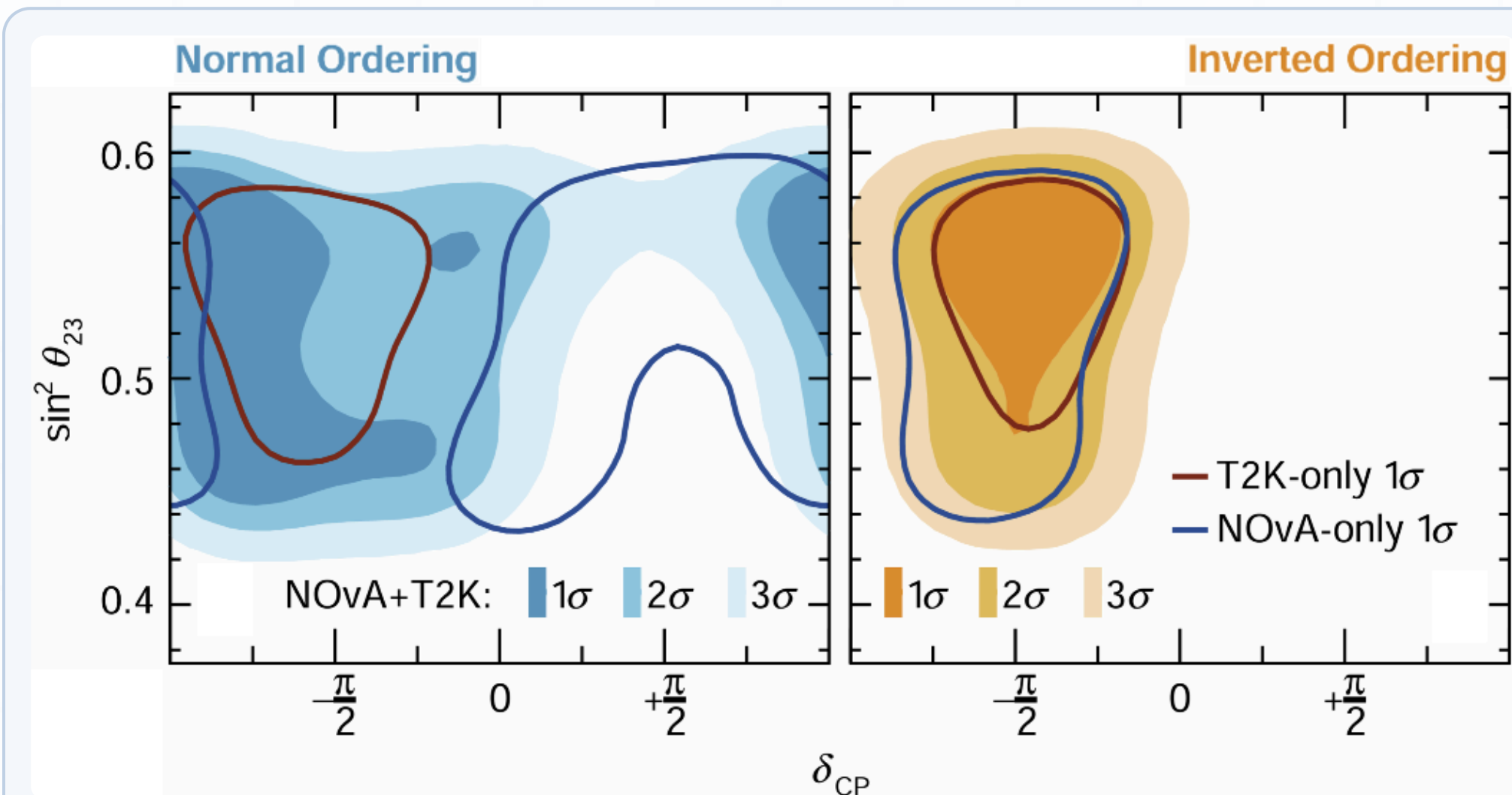


Prior Joint-Analysis Context



Nature 2025[‡]: First joint T2K-NOvA analysis set world leading 3-flavor oscillation constraints.

- Different baselines and energies provide complementary sensitivity to BSM matter effects.[†]
- Neutral Current Non-Standard Interaction (NC-NSI) framework provides a well-motivated model to explore these deviations.

NC-NSI Propagation Model

NC-NSI modifies the effective Hamiltonian in matter, deforming PMNS oscillation patterns:

Σ Matter-Modified Hamiltonian

The total effective Hamiltonian in flavor space:

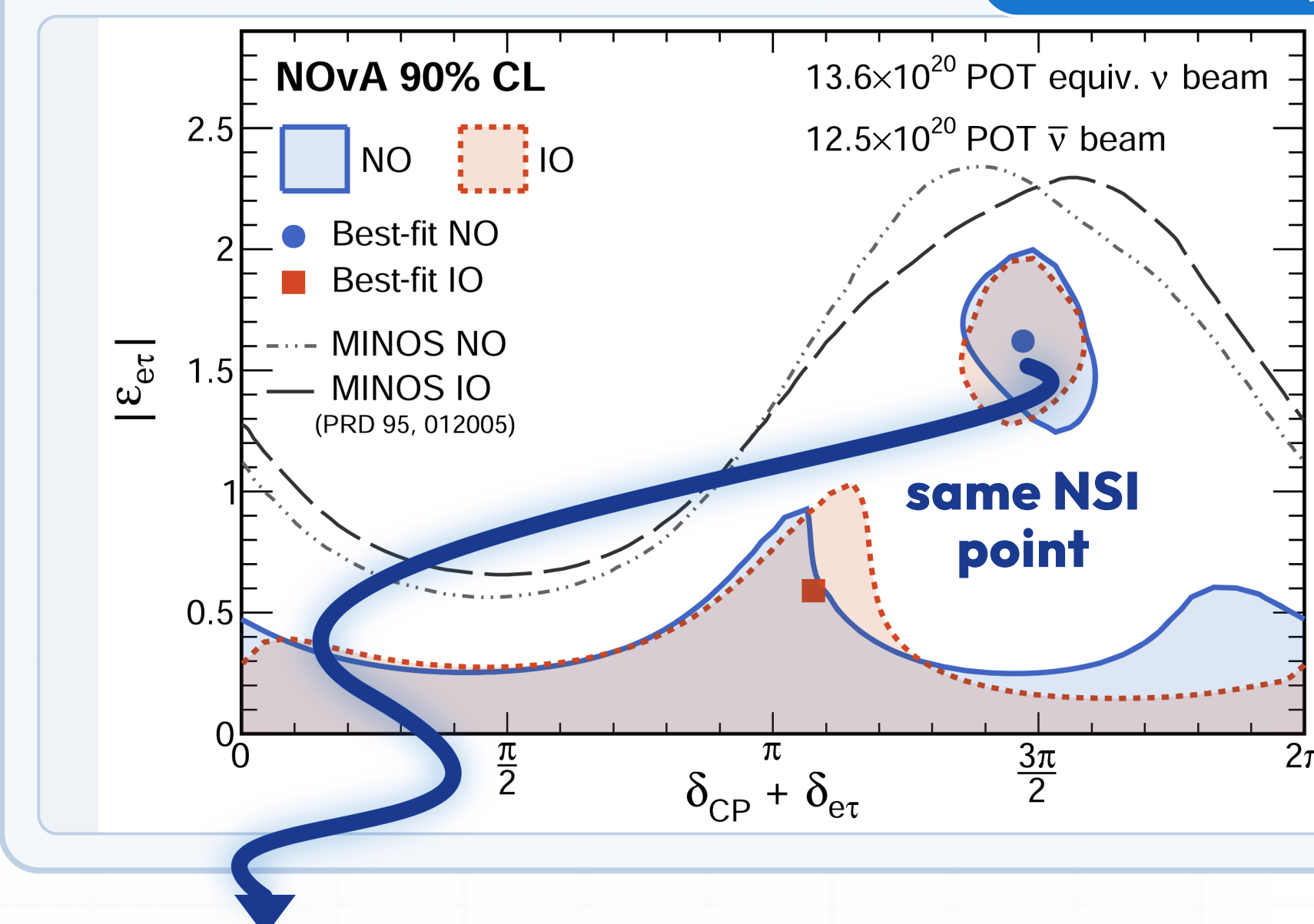
$$H = \frac{1}{2E_\nu} U \begin{pmatrix} 0 & 0 & 0 \\ 0 & \Delta m_{21}^2 & 0 \\ 0 & 0 & \Delta m_{31}^2 \end{pmatrix} U^\dagger + V_{CC} \begin{pmatrix} 1 + \epsilon_{ee} & \epsilon_{e\mu} & \epsilon_{e\tau} \\ \epsilon_{e\mu}^* & \epsilon_{\mu\mu} & \epsilon_{\mu\tau} \\ \epsilon_{e\tau}^* & \epsilon_{\mu\tau}^* & \epsilon_{\tau\tau} \end{pmatrix}$$

- V_{CC} CC matter potential*: $\sqrt{2}G_F N_e$
- $\epsilon_{\alpha\beta}$ Complex NSI strength relative to CC
- $\epsilon_{e\tau}$ Focus parameter; complex phase $\delta_{e\tau}$

Example Combination Degeneracy Breaking

Different baseline and energy lever arms causes NSI to shift NOvA and T2K spectra differently; combining them is powerful for breaking degeneracies.

NOvA-only NSI Contour # best-fit input

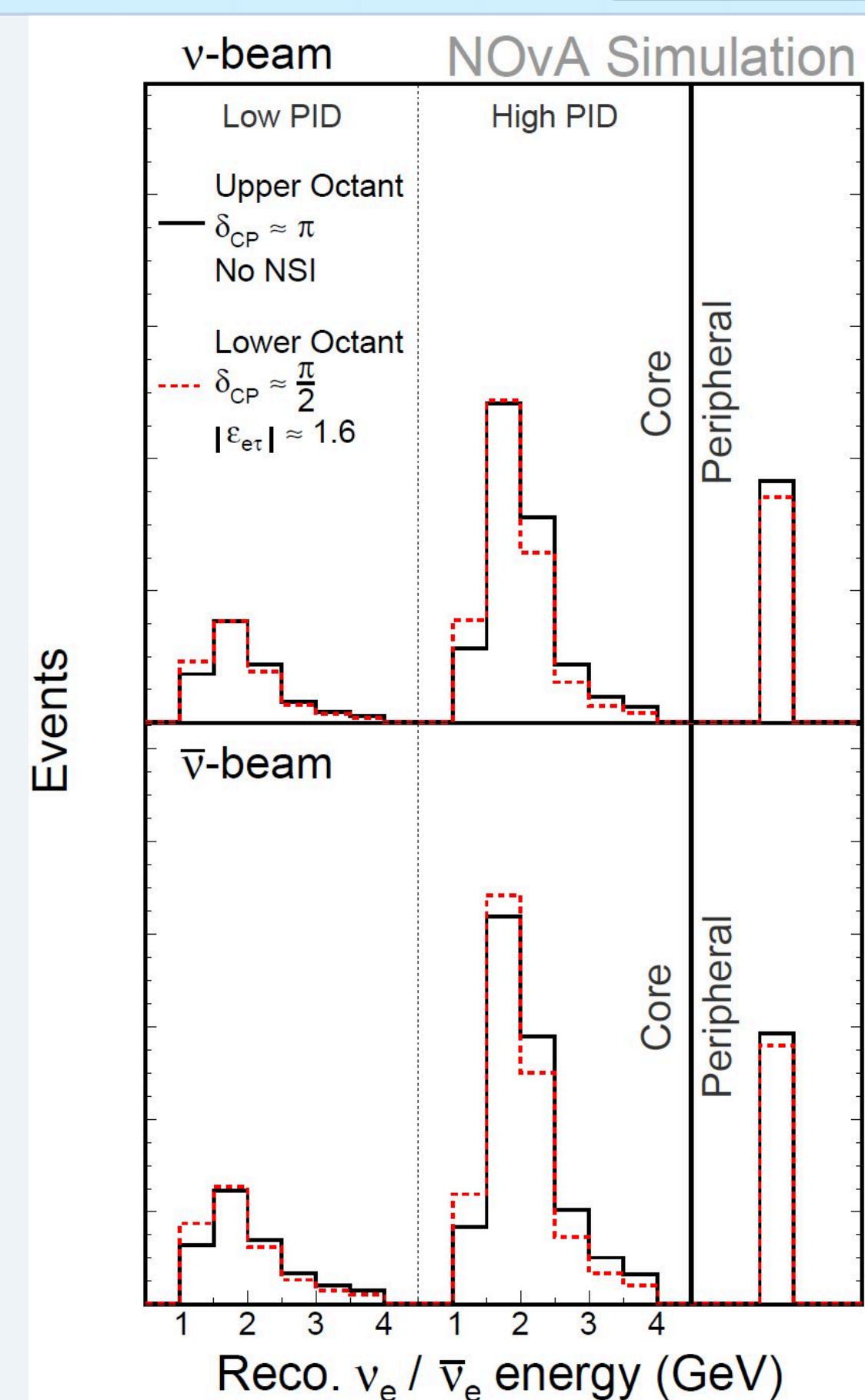


NSI Constraints & Degeneracy

NOvA places good constraints on the NSI parameter space.

However, certain NSI parameter combinations can mimic standard oscillations, creating degenerate parameter solutions.

NOvA Spectra DEGENERACY



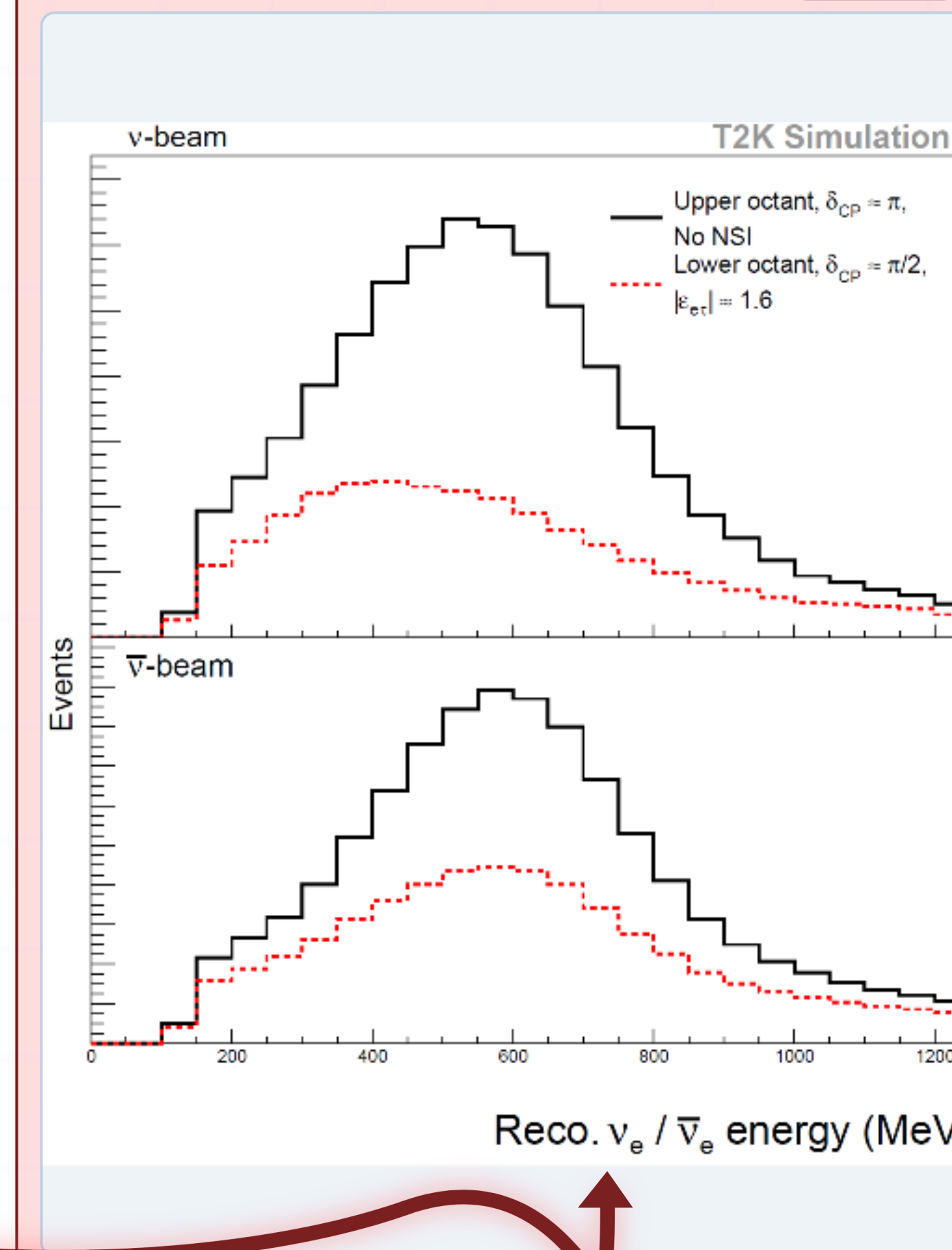
Limited Sensitivity

At the NOvA best-fit NSI point, ν and $\bar{\nu}$ spectra mimic standard oscillations.

Degeneracy Broken

At the same NSI point, degeneracy is broken with a T2K and NOvA combination.

T2K Spectra BREAK!

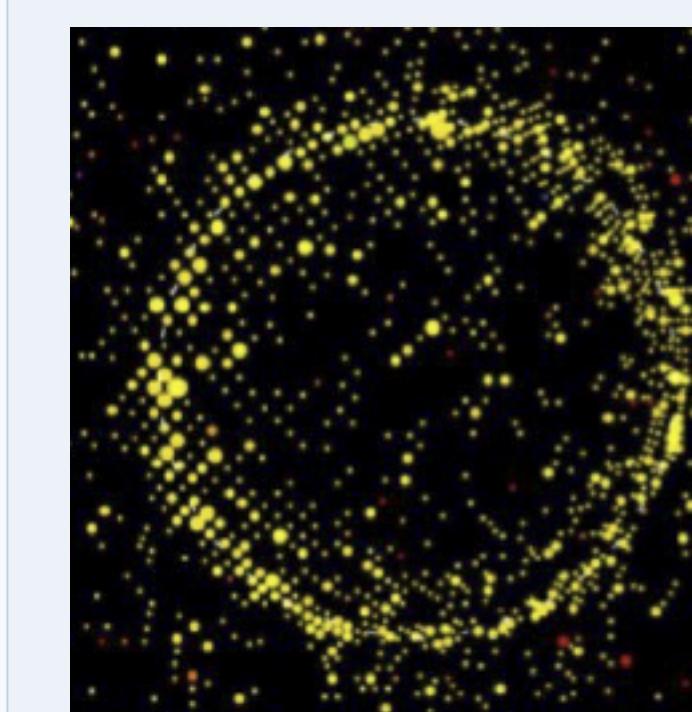


T2K vs. NOvA: By the Numbers

| | | |
|-------------|---------|-------------|
| 295 km | L | 810 km |
| ~0.6 GeV | E | ~2.0 GeV |
| ~490 km/GeV | L/E | ~405 km/GeV |
| 50 kt | FD MASS | 14 kt |

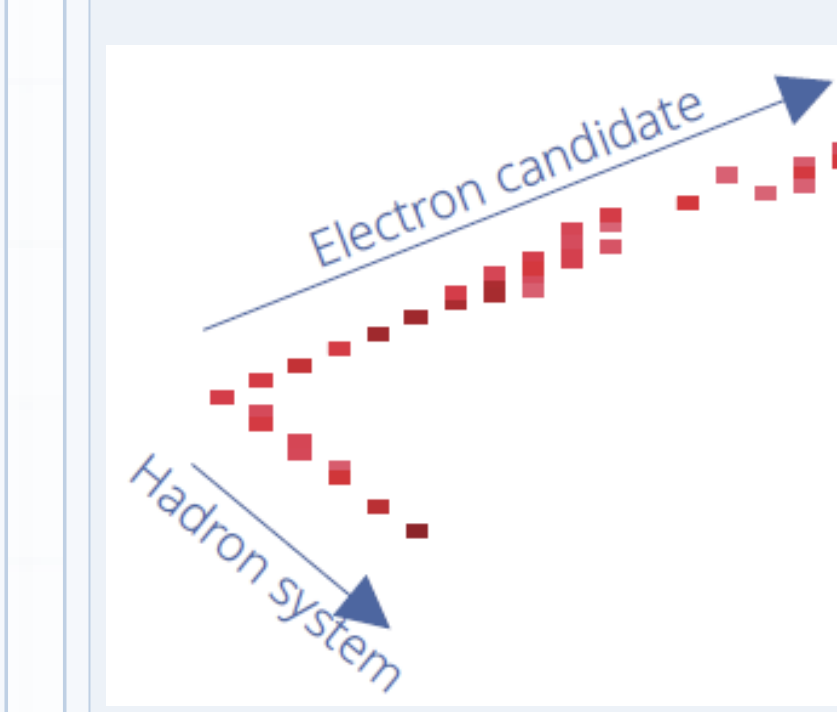
Detector Event Reconstruction

T2K ν_e Candidate



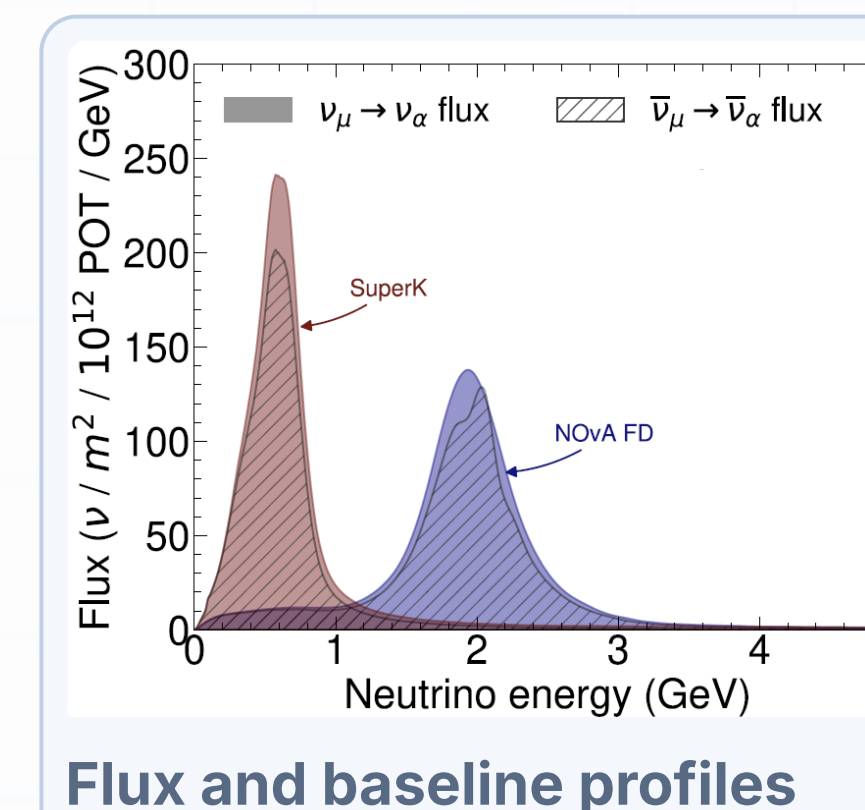
Super-Kamiokande:
EM showers produce fuzzy Cherenkov rings on PMTs.

NOvA ν_e Candidate

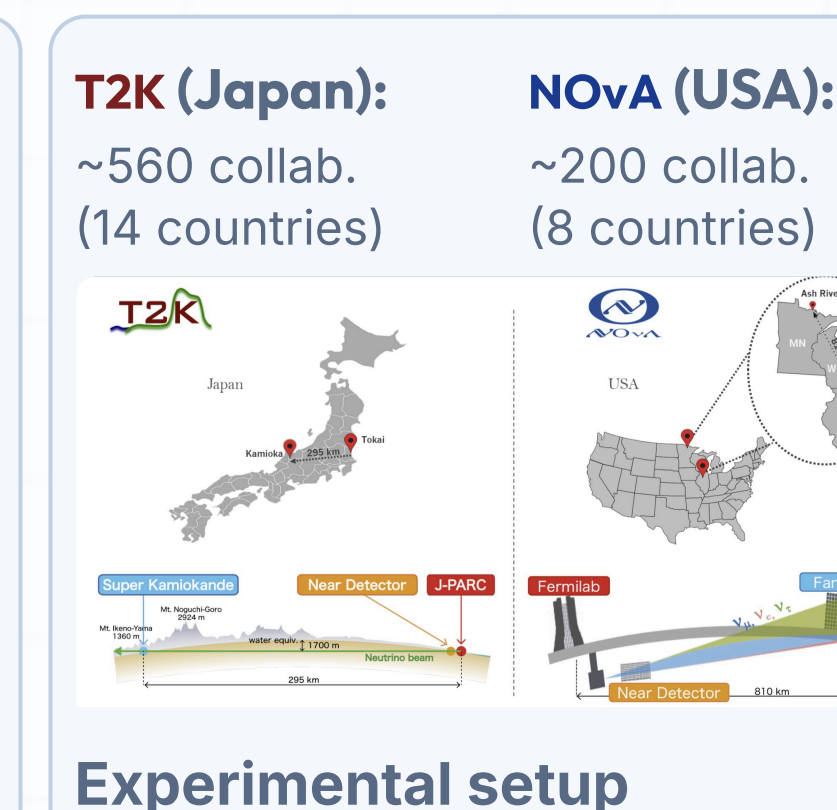


NOvA calorimeter:
Liquid scintillator cells record EM shower topology.

Beam and Experimental Setup



Flux and baseline profiles



Experimental setup

SEE ALSO AT NEUTRINO 2026

No. 309 Probing NSI in NOvA with Bayesian MCMC methods

No. 27 Expanding NSI searches at NOvA

No. 499 Developments in joint neutrino oscillations analysis of NOvA and T2K