Results from the NOvA-T2K Joint Analysis

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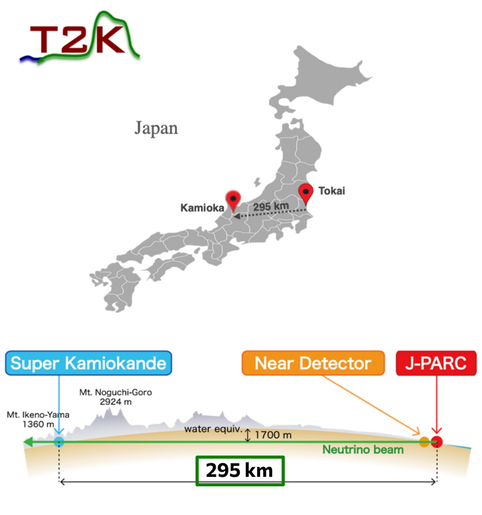
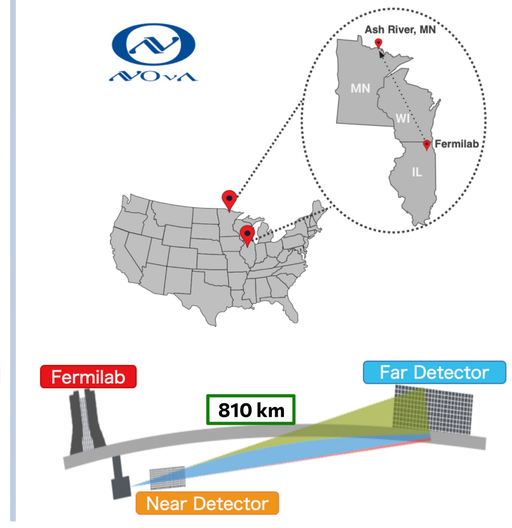
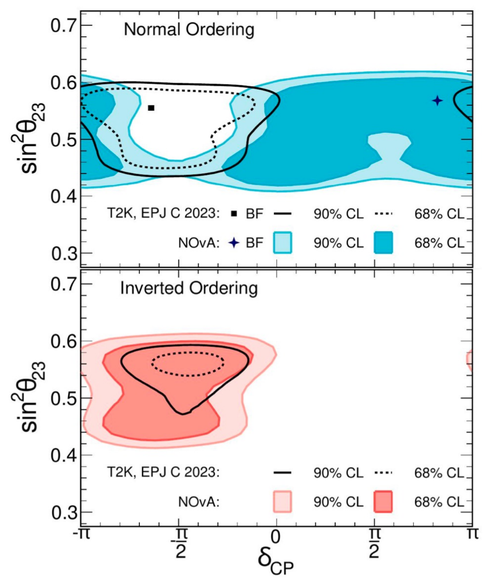
XXXI International Conference on Neutrino Physics and Astrophysics, Milan, Italy

NOvA and T2K

- Two current-generation long baseline neutrino oscillation experiments.
- **Joint analysis combines 2020 datasets[1][2][3] in a unified framework** with detailed likelihoods and consistent statistical treatment.

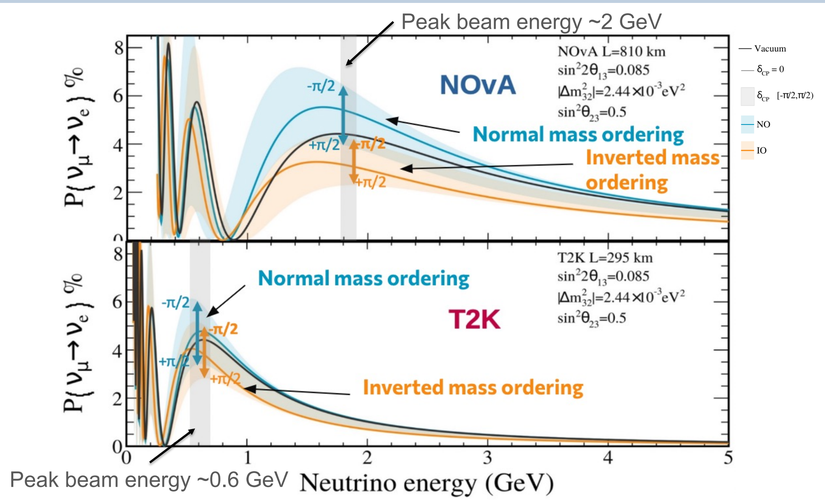






- Individual results with 2020 datasets show different best fit points in normal mass ordering, good agreement in inverted.

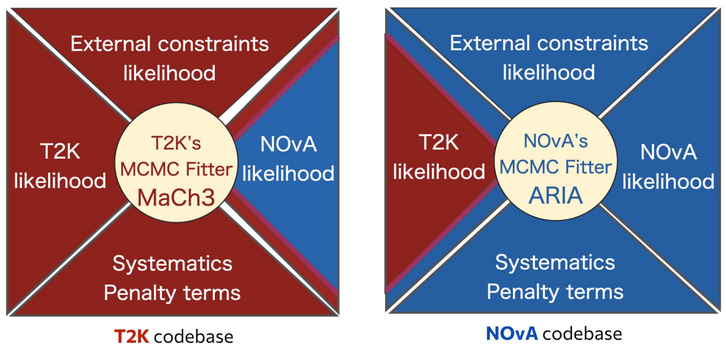
Motivation



- NOvA and T2K have **different sensitivities to the mass ordering and δ_{CP}** that are driven by the differences in baseline.
- **A joint result has the potential to lift the degeneracies** and demonstrate compatibility.

Constructing the Fit

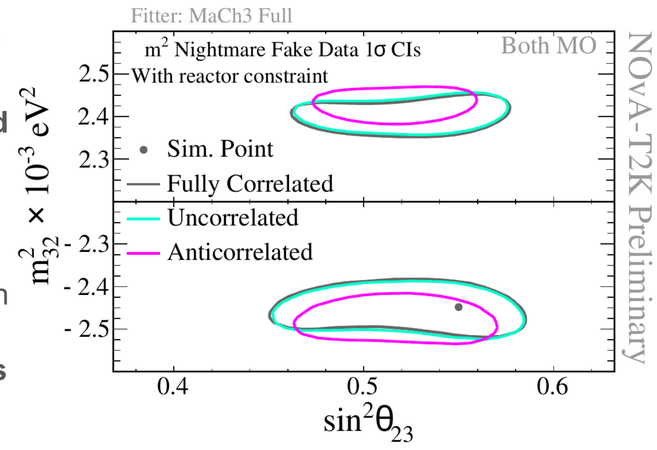
- Shared full access to Monte-Carlo simulation and data, **shared likelihoods via a containerized environment.**



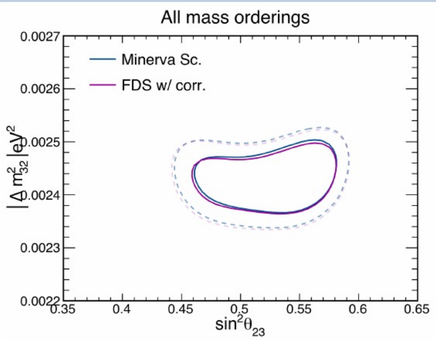
- Both T2K and NOvA used their own Bayesian **Markov Chain Monte Carlo (MCMC) fitters.** Comparisons provided rigorous validation.

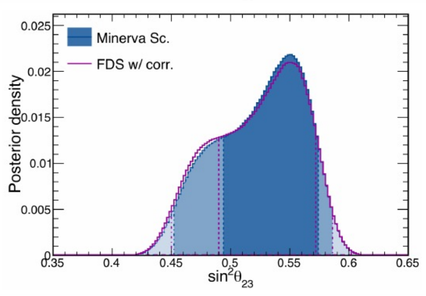
Investigating Correlations

- Conducted thorough review of input models, systematic uncertainties and possible correlations
- **No significant flux or detector correlations identified**
- The underlying physics of neutrino interactions is the same - tests done to assess role of model and correlation choices
- Example: Fabricated parameters that bias the oscillation dip in $\upsilon_\mu / \bar{\upsilon}_\mu$ appearance and are fully correlated across both experiments; **incorrectly correlating systematics shows a bias**

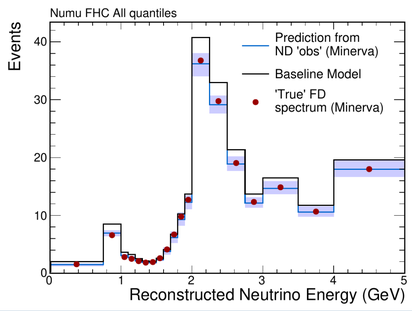


Out-of-Model Tests

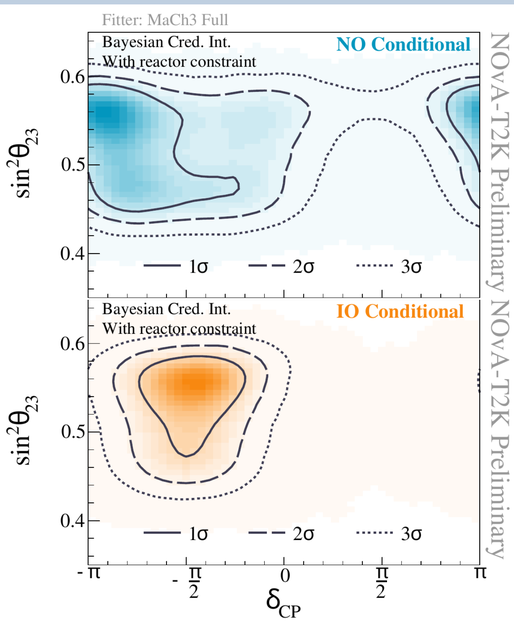




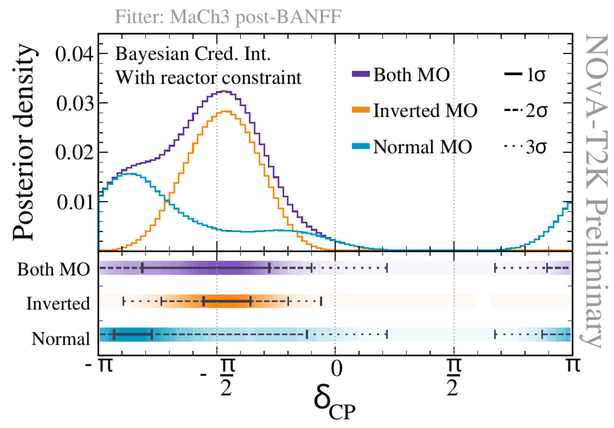
- Tested the robustness of the joint fit against alternate, data-driven neutrino interaction models
- Example: suppression of single pions in the final state based on MINERvA data[4]
- **No alternate model tests failed the preset threshold bias criteria**



Results

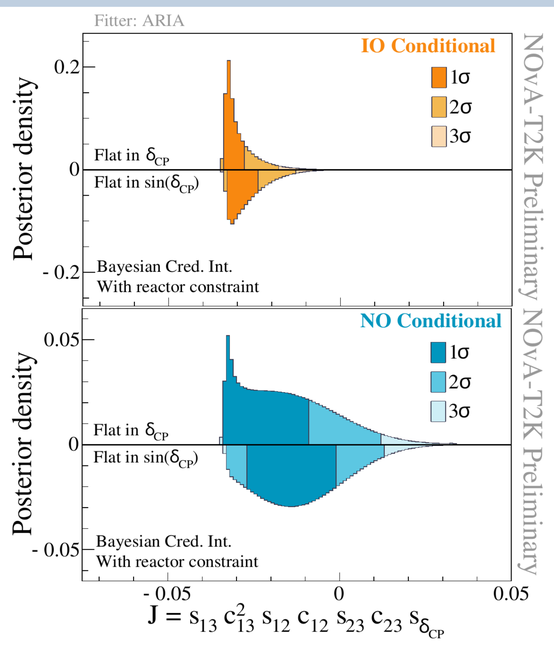


- **CP conservation excluded at 3σ in inverted ordering**, preference for $\delta_{CP} = -\frac{\pi}{2}$.
- Wide range of allowed δ_{CP} values in normal ordering, preference for $\delta_{CP} = \pm\pi$

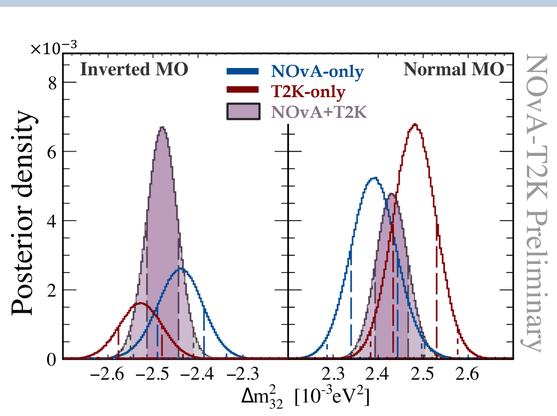


Statements about δ_{CP} dependent on mass hierarchy determination

Results Cont.



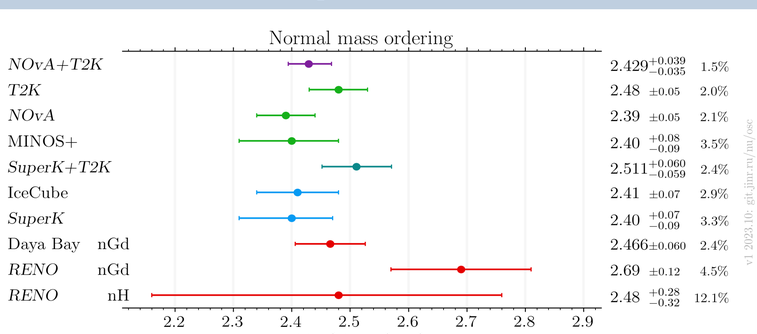
- Jarlskog invariant: parameterization independent way[5] to measure CP violation.
- J=0: CP-conservation
- J ≠ 0: CP-violation
- **In inverted ordering see J=0 outside 3σ credible interval**



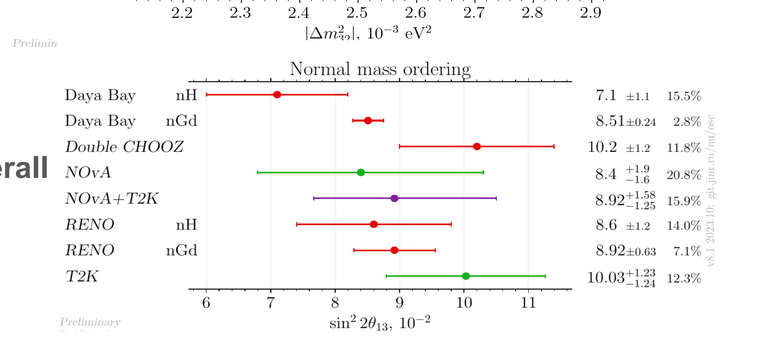
- **Best fit in the inverted ordering** for joint fit with reactor constraint but no significant preference (58% posterior)
- Individual experiments prefer normal mass ordering.

Global Comparisons

Smallest uncertainty on $|\Delta m^2_{32}|$ in both normal and inverted mass orderings.



$sin^2 2\theta_{13}$ is consistent overall with reactor experiments.



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References:
[1] Eur. Phys. J. C 83: 782 (2023)
[2] Phys. Rev D 106, 032004 (2022)
[3] arXiv:2311.07835 (2023)
[4] Phys. Rev. D 100, 072005 (2019)
[5] Phys. Rev. D 100, 053004 (2019)
[6] Phys. Rev. Lett. 130, 161802 (2023)

Joint analysis workshops were facilitated by DOE US-Japan & UKRI funds

NEUTRINO 2024
XXXI International Conference on Neutrino Physics and Astrophysics
Milano (Italy) - June 16-22, 2024