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Constraining Cross Section and Beam Systematics for Future NOvA Sterile Neutrino Search

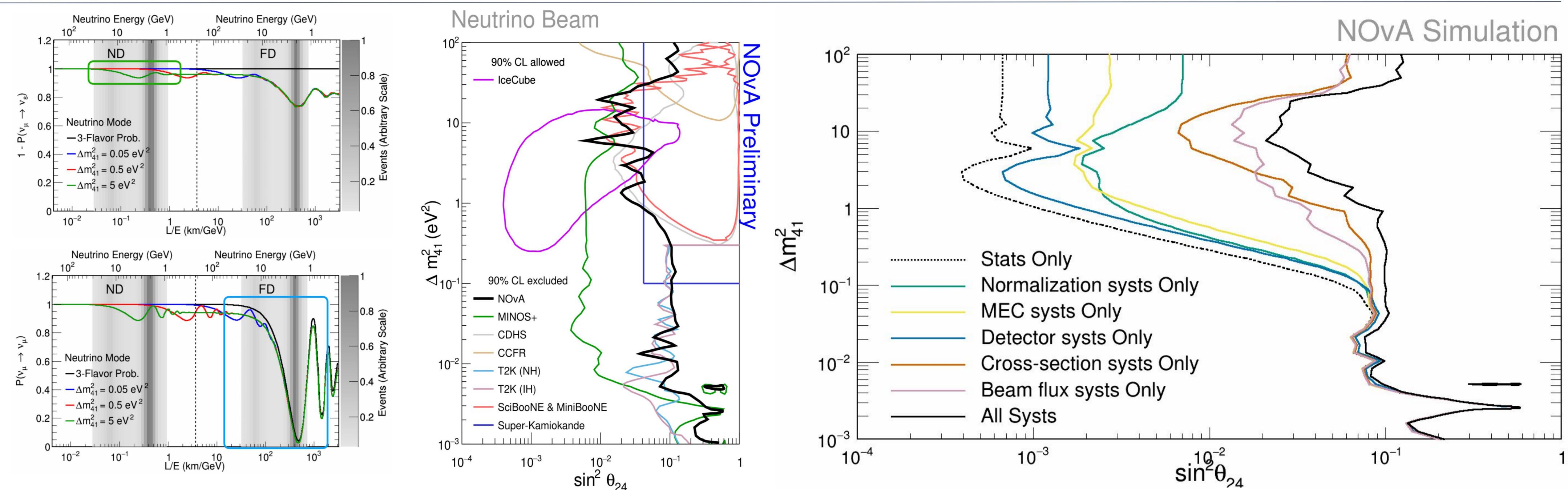
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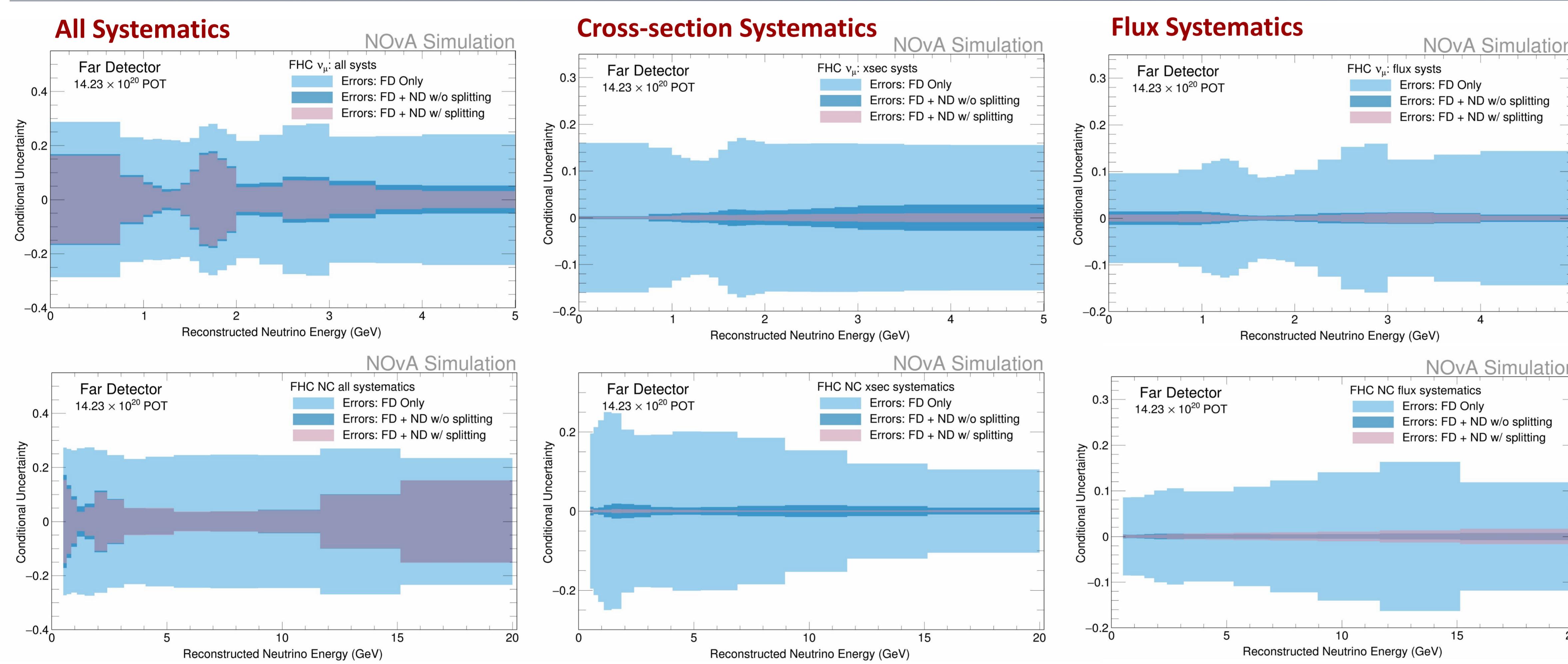


3+1 Sterile Neutrino Mixing Model

- NOvA searches for active-sterile neutrino oscillations through **Neutral Current (NC)** and ν_μ **disappearance**.
- NC interactions are flavor independent, giving clear measurement of active \rightarrow sterile disappearance [1].
- NOvA 2022 sterile neutrino oscillation results show **leading limits** on $\sin^2\theta_{24}$ in high regions of Δm_{41}^2 .
- Sensitivity contour of $\sin^2\theta_{24}$ vs. Δm_{41}^2 split into individual systematic groups show that **cross section and beam flux** have the largest effect.



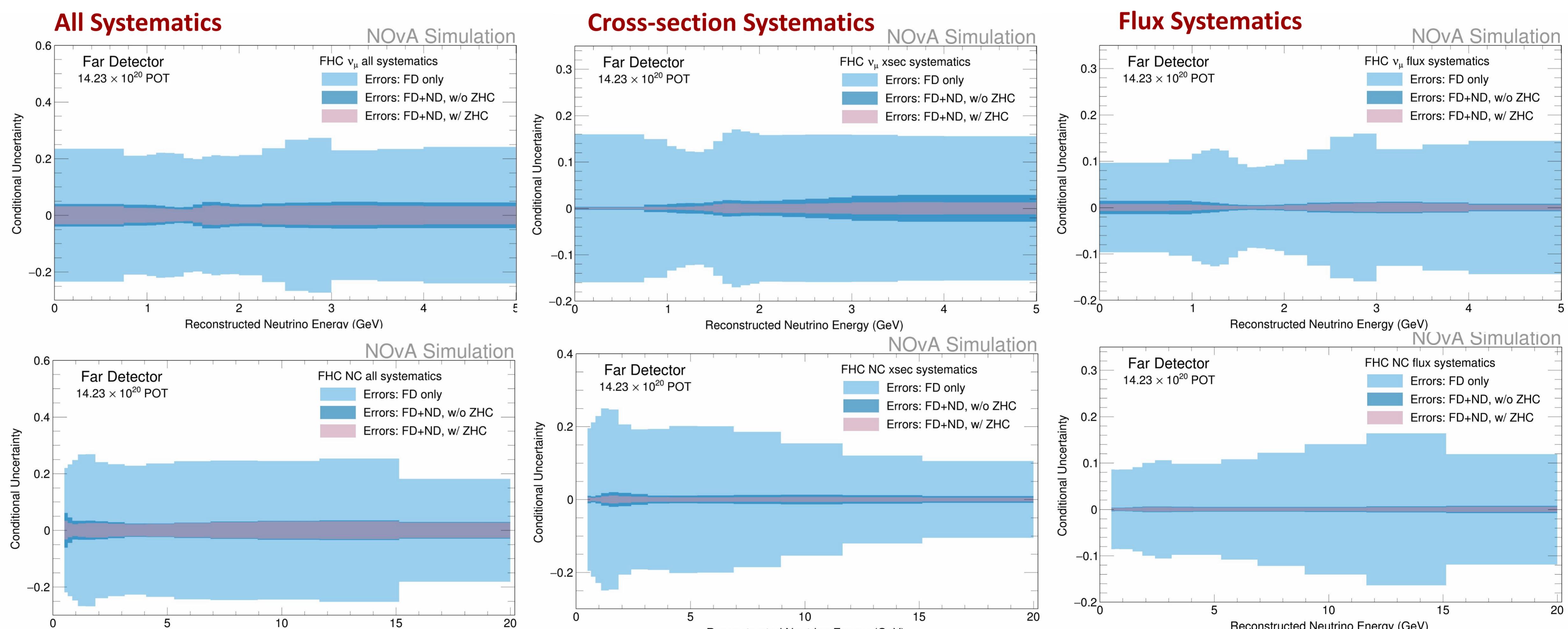
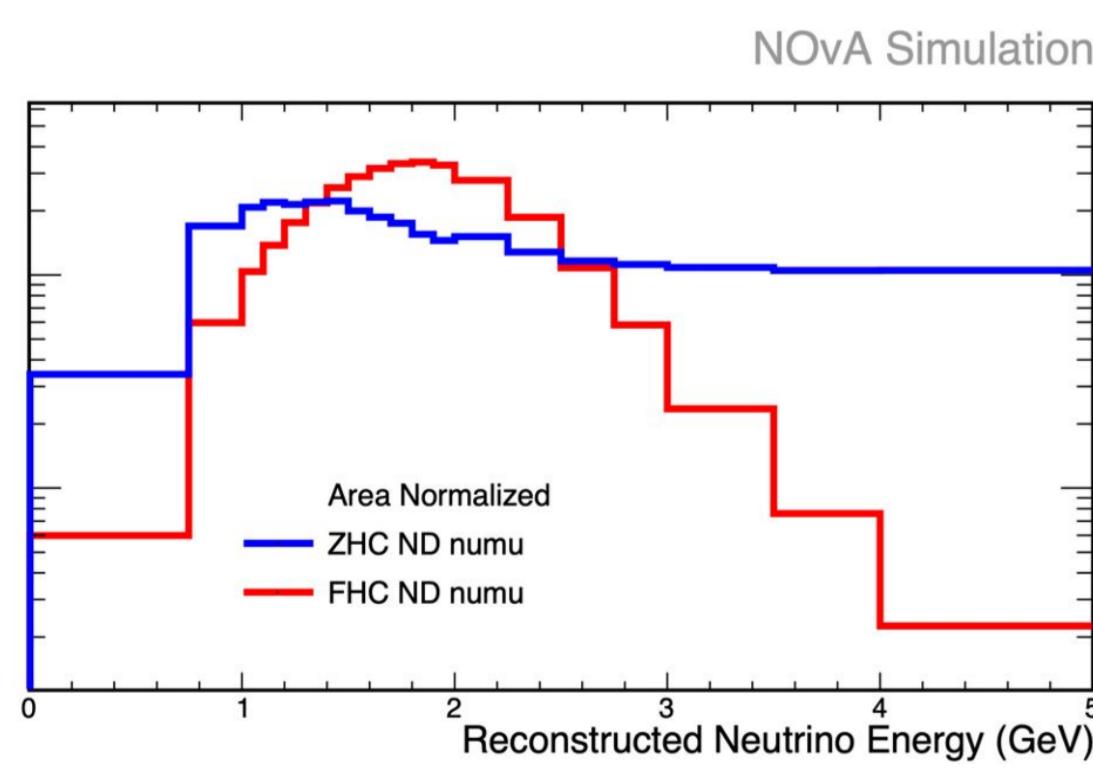
Constraining Systematics using Neutral Current Split Samples



- Advantages** of using NC split sample:
 - Better constraint** on the systematics through splitting of samples.
 - Split samples** based on interaction type constrains the **cross-section** systematics.
- Divide the ND Neutral Current sample into **4 subsamples** which are enriched in particular interaction types based on the number of prongs as a distinguishing feature.
- Using a **conditional multivariate** technique, the light blue FD error bands are conditioned by the observations at the ND.

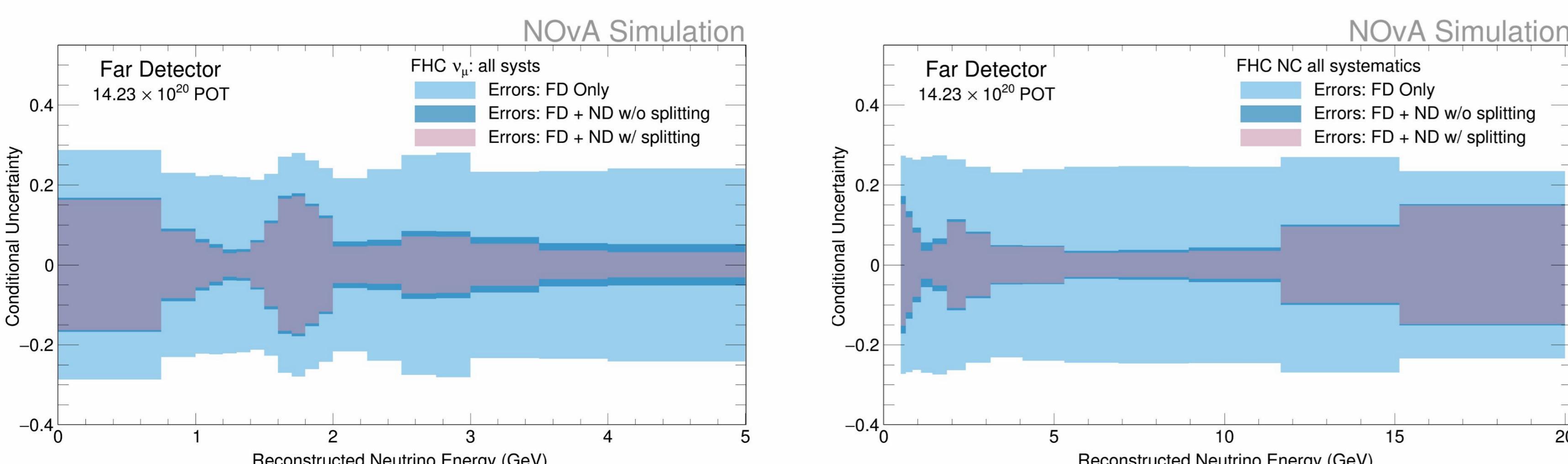
Constraining Systematics using Zero Horn Current Samples

- Advantages** of ZHC sample:
 - NuMI focusing horn current is **turned off**.
 - No focusing uncertainties** prior to meson decay.
 - Sample with only hadron production uncertainties.
- Below compares reconstructed energy distribution between ND FHC ν_μ and ND ZHC ν_μ .



Future Work

- Constraining both cross section and beam flux systematics shows overall systematic constraint.
- Want to further constrain the systematics by using $\nu \rightarrow e$ scattering sample as seen in MINERvA [2].
- Assuming flux systematics are halved [2], the plots show **potential improvements** with implementing ZHC and split samples simultaneously.

Also See [poster #271](#) by Adam Lister ["Improving NOvA's Sterile Neutrino Search with the Booster Neutrino Beam"](#)

Acknowledgement

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Literature Cited

- [1] M. Acero et al., *Phys. Rev. D*, vol. 96, no. 7, p. 072006, 2017.
- [2] E. Valencia et al., *Phys. Rev. D*, vol. 100, no. 14, p. 092001, 2019.