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

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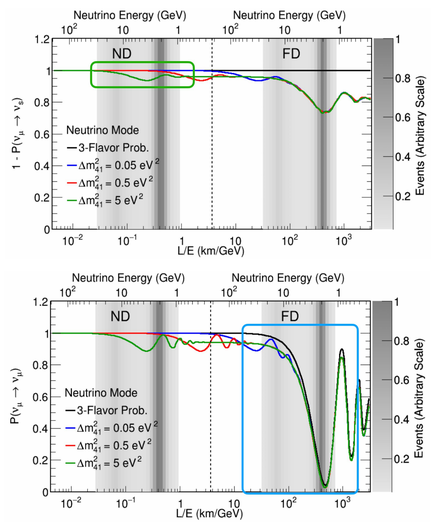
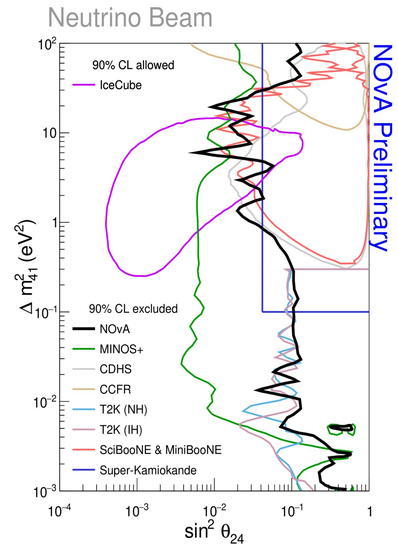
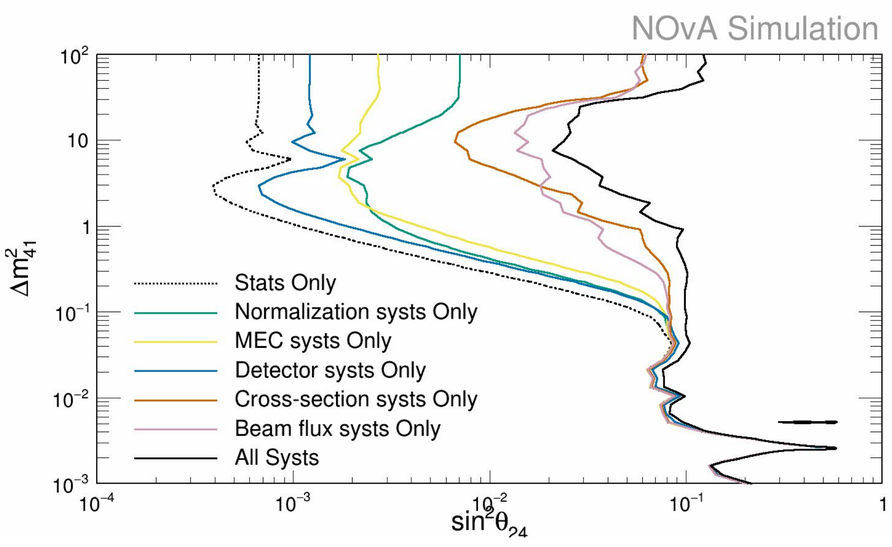
3+1 Sterile Neutrino Mixing Model

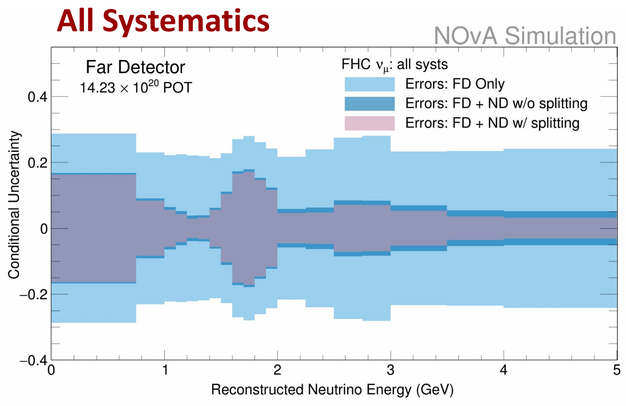
- NOvA searches for active-sterile neutrino oscillations through **Neutral Current (NC)** and ν_μ **disappearance.**
- NC interactions are flavor independent, giving clear measurement of active → sterile disappearance [1].
- NOvA 2022 sterile neutrino oscillation results show **leading limits** on $\sin^2\theta_{24}$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

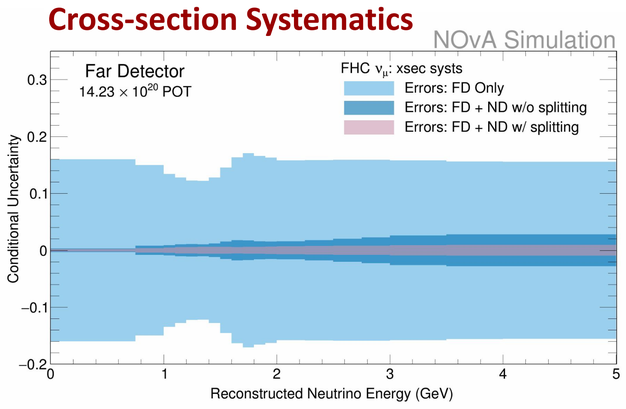


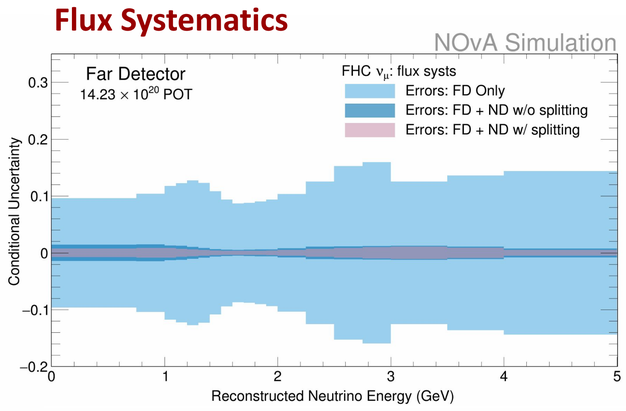


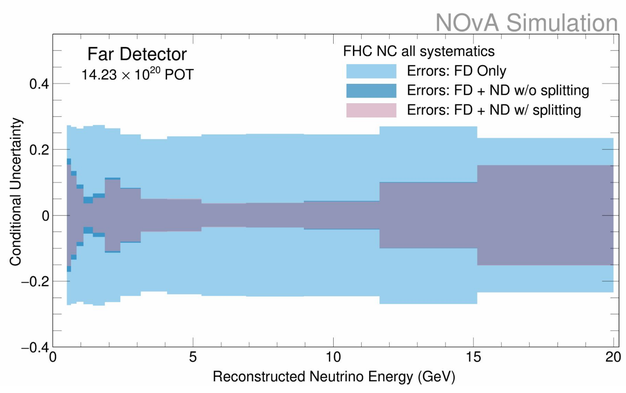


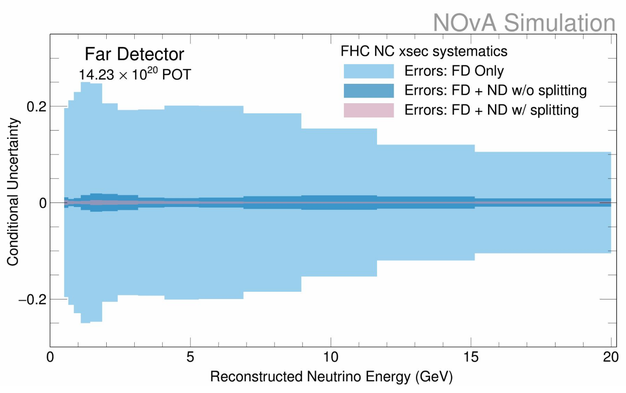
Constraining Systematics using Neutral Current Split Samples

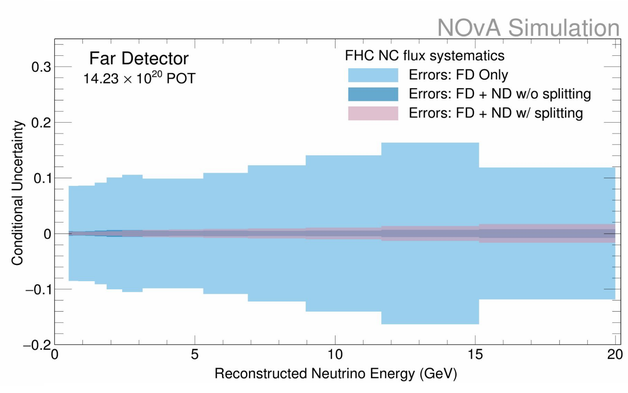








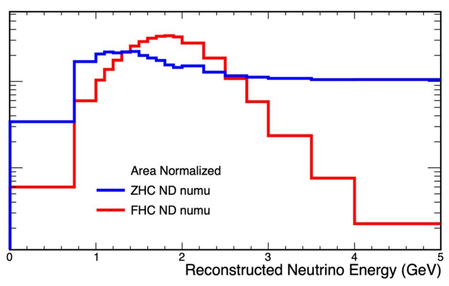


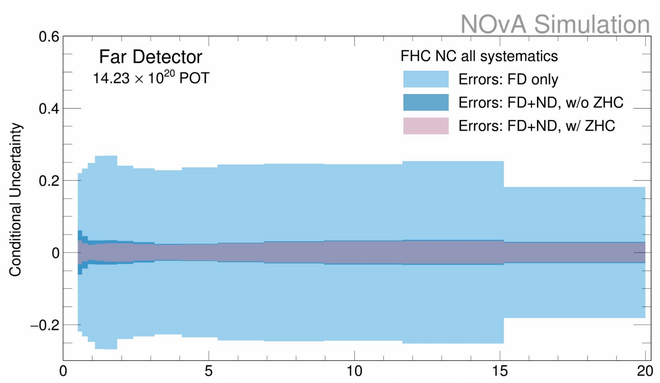


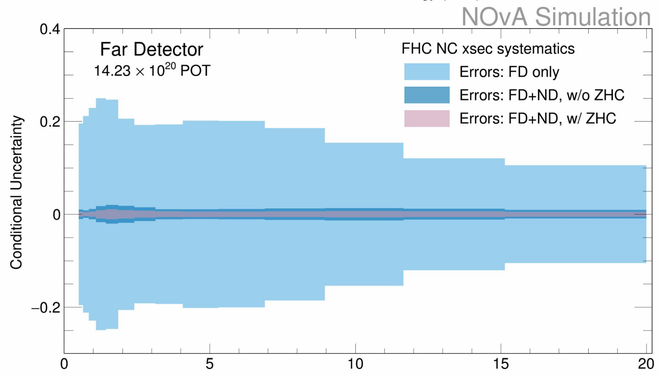
- **Advantages** of using NC split sample:
  - **Better constraint** on the systematics through splitting of samples.
  - **Split samples** based on interaction type constrains the **cross-section** systematics.
- Divide the **ND Neutral Current** sample into **4 subsamples** which are enriched in particular 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.

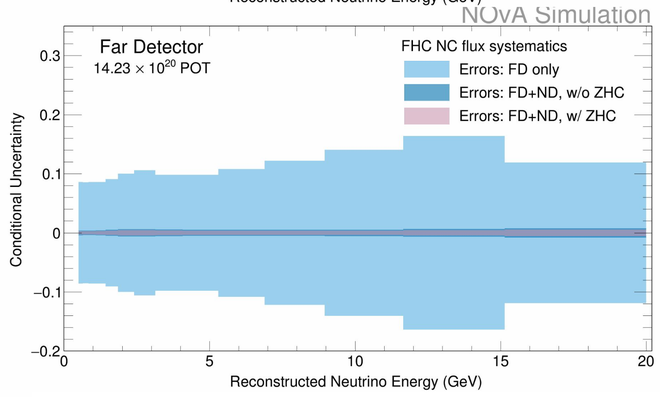
Constraining Systematics using Zero Horn Current Samples

- **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 .



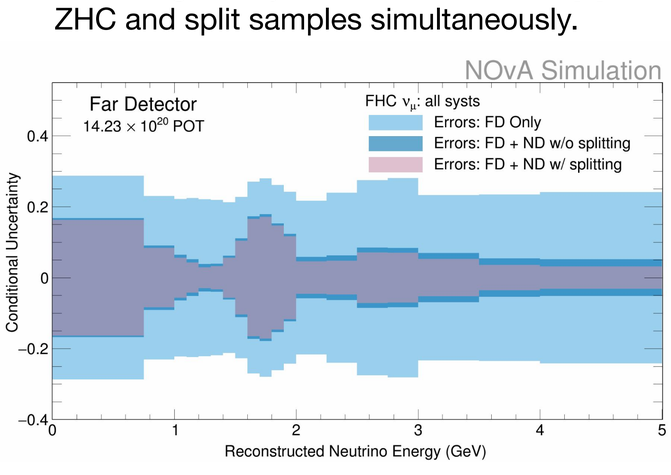


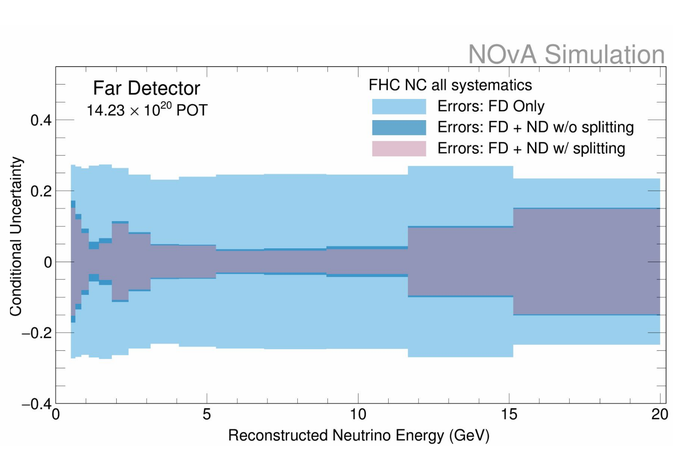




Future Work

- Constraining both cross section and beam flux systematics shows overall systematic constraint.
- Want to further constrain the systematics by using $\boldsymbol{\nu} \rightarrow$ **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"

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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.