Event Selection and Systematic Uncertainties for the NOvA Sterile Neutrino Search

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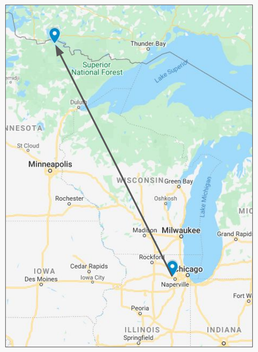
THE NOvA EXPERIMENT

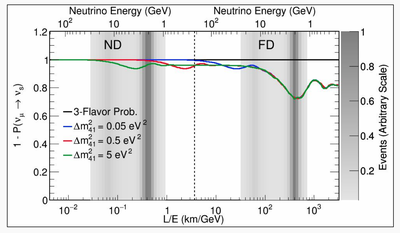
The NOvA Experiment is a long-baseline neutrino oscillation experiment.

- Primarily probing mixing parameters of the three-flavor neutrino paradigm (θ_{23}, Δm^2_{32}, δ_{CP})
- NOvA is also able to look for evidence of more exotic phenomena such as **sterile neutrinos**, which do not interact via the weak force

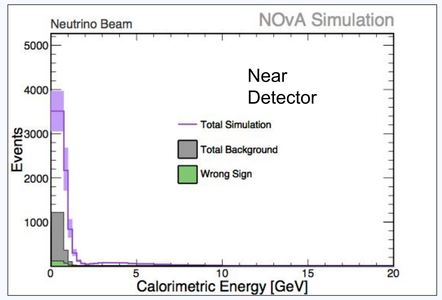


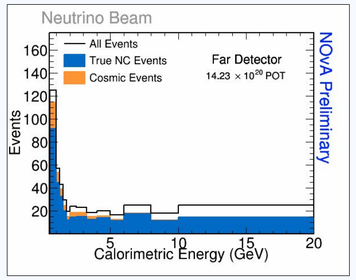
STERILES AT NOvA

- Active-to-sterile oscillations could manifest as **deficit of NC events**[1]
- **Two detector fit** will expand available phase space

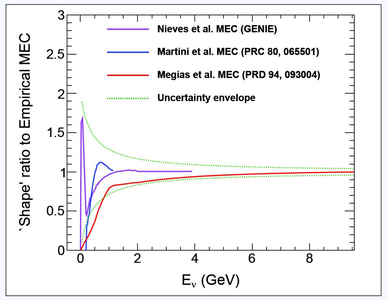


SYSTEMATIC UNCERTAINTIES





- In the NOvA 3-flavor oscillation analyses, the Near Detector data is used to constrain the cross section uncertainties , but this is not viable as there could be oscillations in the near detector.
- Instead we use *a priori* cross section uncertainties from GENIE v3_00_06, and rely on the Valencia model[3] for our MEC events, with an uncertainty based on a model spread uncertainty from the Martini MEC[4] and SuSA MEC[5] models.



SELECTION OF NC EVENTS

STRATEGY

QUALITY

- Must have reconstructed vertex
- ≥ 1 reconstructed particle (prong)
- Must have extent > 2 planes
- Must not be ν_μ or ν_e candidate

FIDUCIAL

- Vertex must be in fiducial volume
- Distance from prong extrema to detector edge must be large

CVN & BDT

- A Convolutional Visual Network[2] is used to distinguish between NC and CC interactions
- A Boosted Decision Tree is used for cosmic rejection at the far detector

FIGURE OF MERIT

CVN and BDT cut values tuned jointly using a bin-wise figure of merit

$$FOM = \frac{1}{N}\sum_{i}^{N}\frac{S_i}{\sqrt{S_i + B_i + \sigma_i^2}}$$

- S_i is the number of signal events in bin *i*
- B_i is the number of background events in bin *i*
- σ_i is the systematic uncertainty in bin *i*

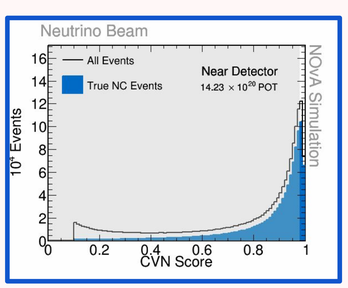
FOM prefers tight CVN cut in ND, loose cut in FD

PREDICTED EVENTS

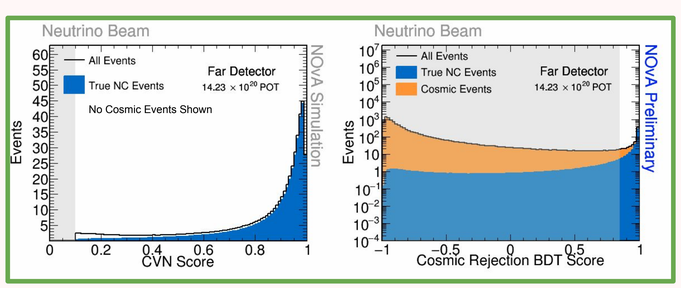
	NEAR DET	FAR DET
TRUE NC	380663	328.9
MC BG	150609	91.5
COSMIC	-	99.7
TOTAL	531272	520.1

At **14.23 x 10^{20} POT**, **328.9 signal events** are expected in the far detector

NEAR DETECTOR



FAR DETECTOR



MOVING FORWARD

The NOvA collaboration is pursuing a two-detector, covariance matrix-based fit to expand the available phase space of a sterile neutrino search. The selection and systematic uncertainties outlined in this poster represent a first step towards that search.

NOvA STERILE NEUTRINOS IN THIS SESSION

- **J. Hewes** - *Poisson Likelihood Covariance Technique for 3+1 Sterile Neutrino Searches in NOvA*
- **M. Wallbank** - *Sterile Neutrino Search via Neutral-Current Disappearance with Antineutrinos in NOvA*

REFERENCES

[1] NOvA Collaboration, **DOI 10.1103/PhysRevD.96.072006** (2017)
[2] NOvA Collaboration, **DOI 10.1103/PhysRevD.100.073005** (2019)
[3] R. Gran, J. Nieves, F. Sanchez, and M. J. Vicente Vacas, **Phys. Rev. D88, 113007** (2013)
[4] M. Martini and M. Ericson, **Phys. Rev. C87, 065501** (2013)
[5] G. Megias, J. Amaro, M. Barbaro, J. Caballero, T. Donnelly, and I. Ruiz Simo, **Phys. Rev. D94, 093004** (2016)

http://novaexperiment.fnal.gov

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