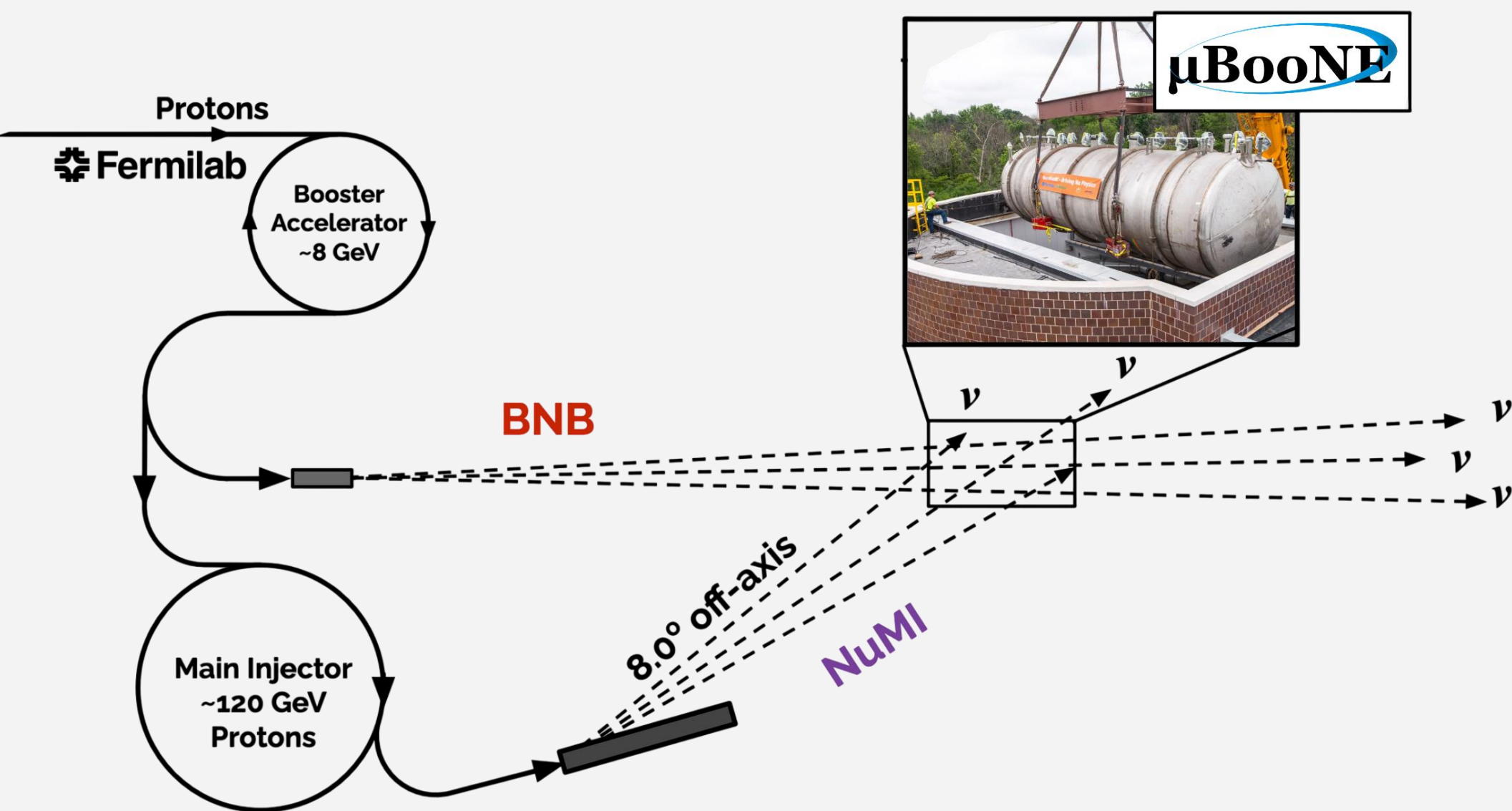


Analyzing the 3+2 model in MicroBooNE using PROfit

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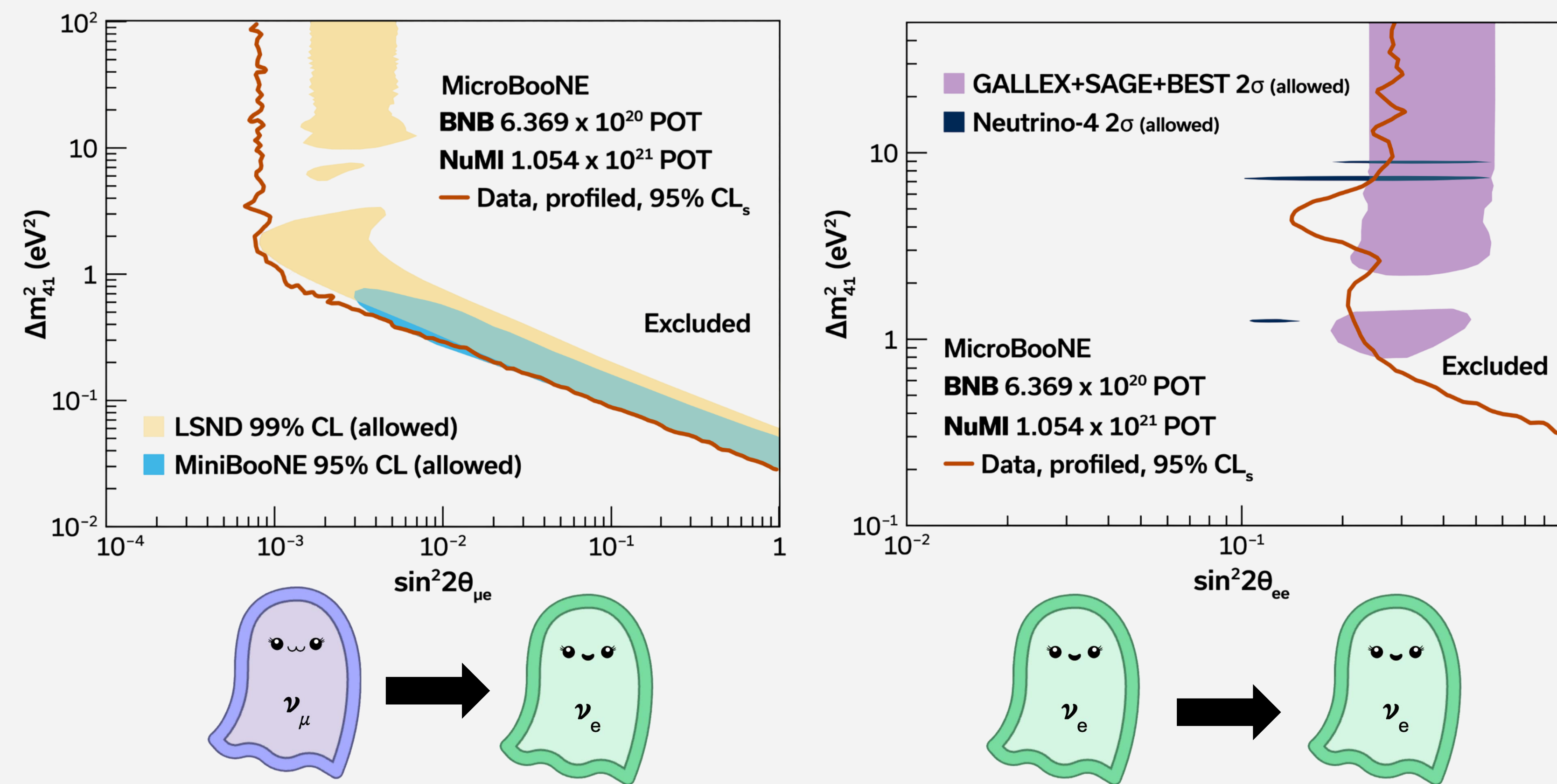
1. The MicroBooNE Detector



MicroBooNE, at Fermilab, was designed for:

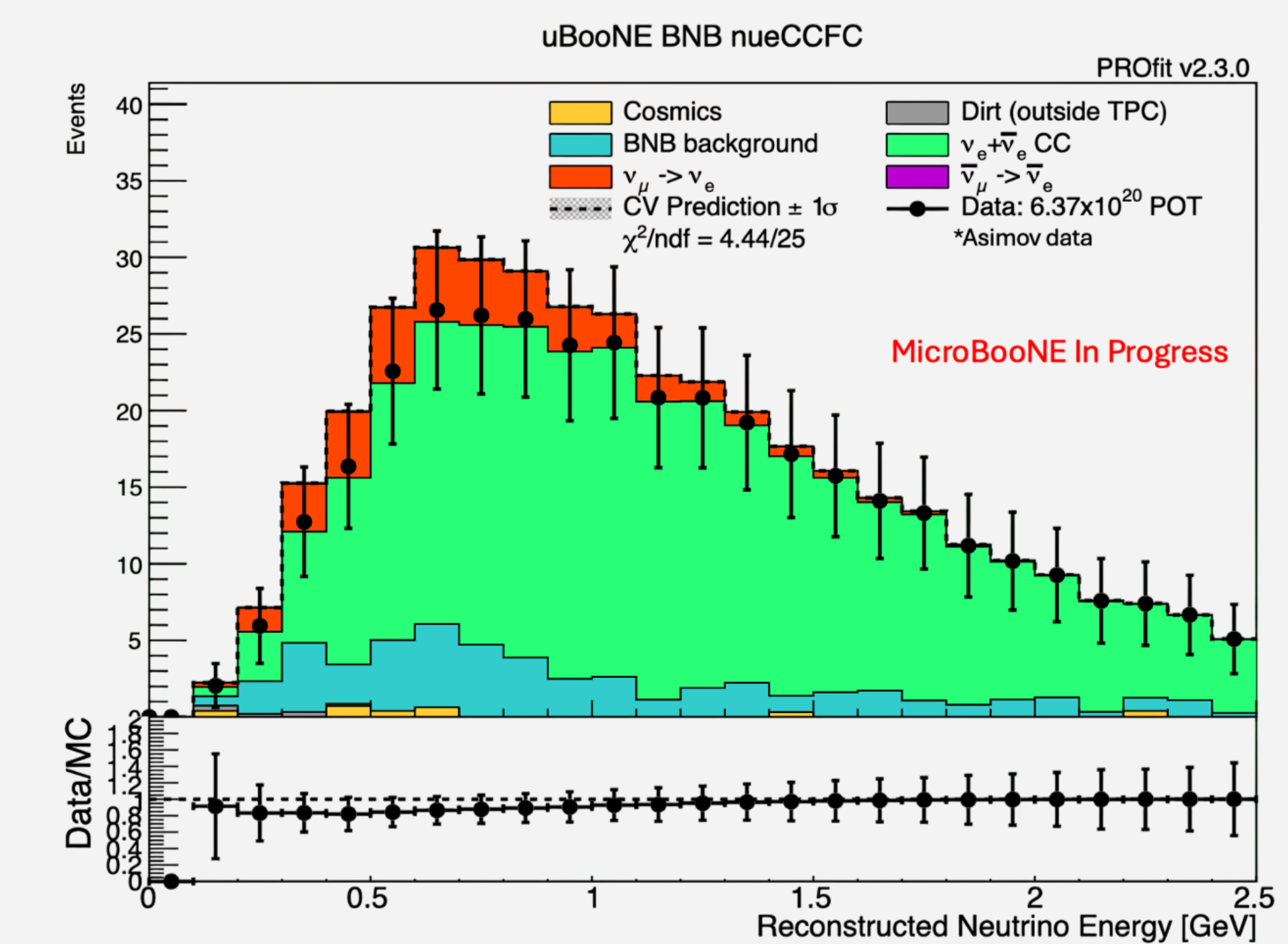
- Investigating short-baseline anomalies
- Studying neutrino interactions in Argon
- Understanding LArTPC technology

3. 3+1 BNB and NuMI Results



BNB + NuMI analysis suggests 3+1 is not a consistent explanation of these anomalies! [2]

5. 3+2 in PROfit

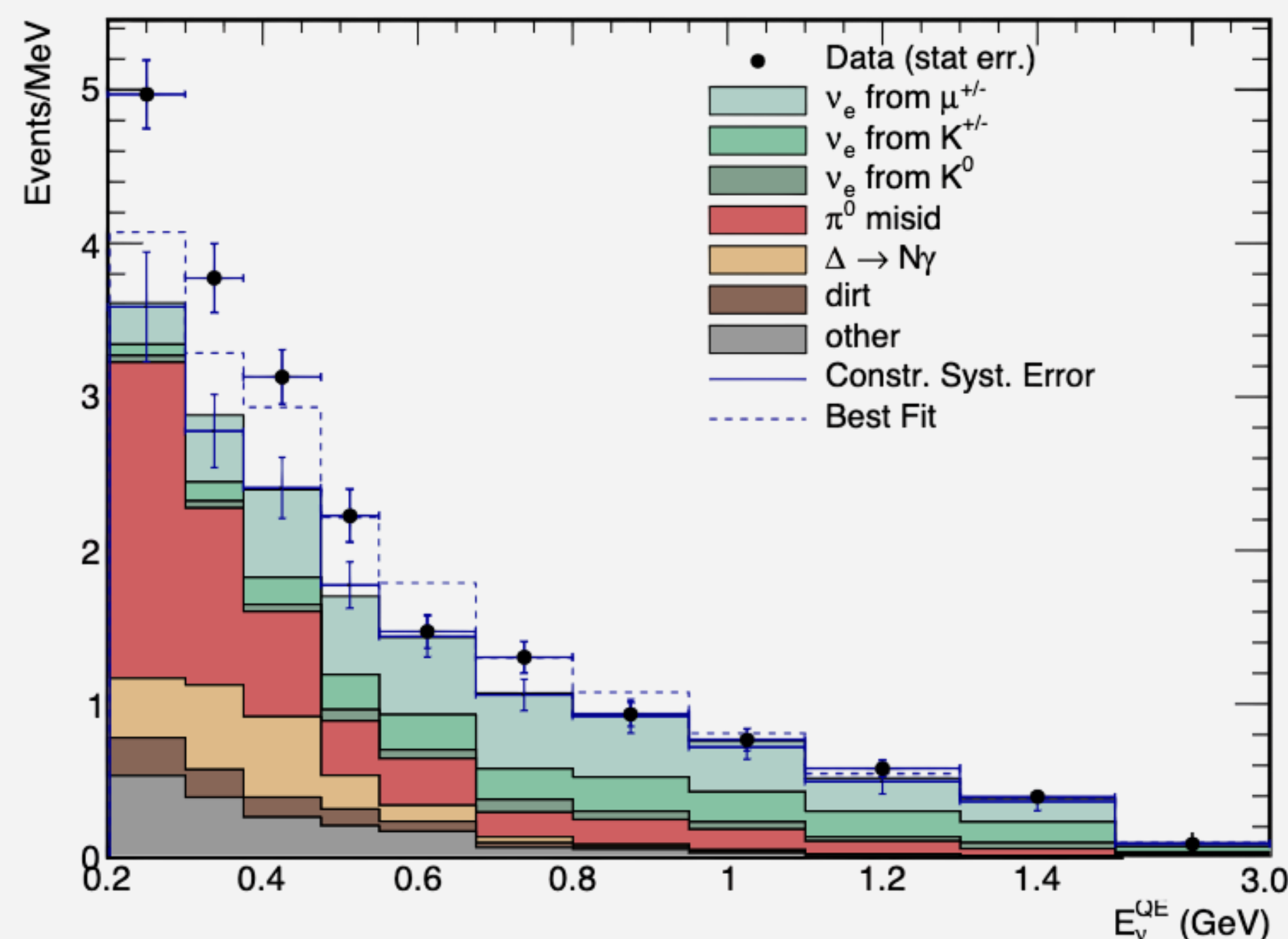


3+2 Parameters	Values
U_{e4}	0.13
$U_{\mu 4}$	0.15
Δm_{41}^2	0.46 eV ²
U_{e5}	0.14
$U_{\mu 5}$	0.13
Δm_{51}^2	0.77 eV ²
ϕ_{54}	5.56 radians

3+2 best fit parameters from D. Cianci, et al [3]

PROfit is an oscillations framework we can use to fit our data to the 3+2 model.

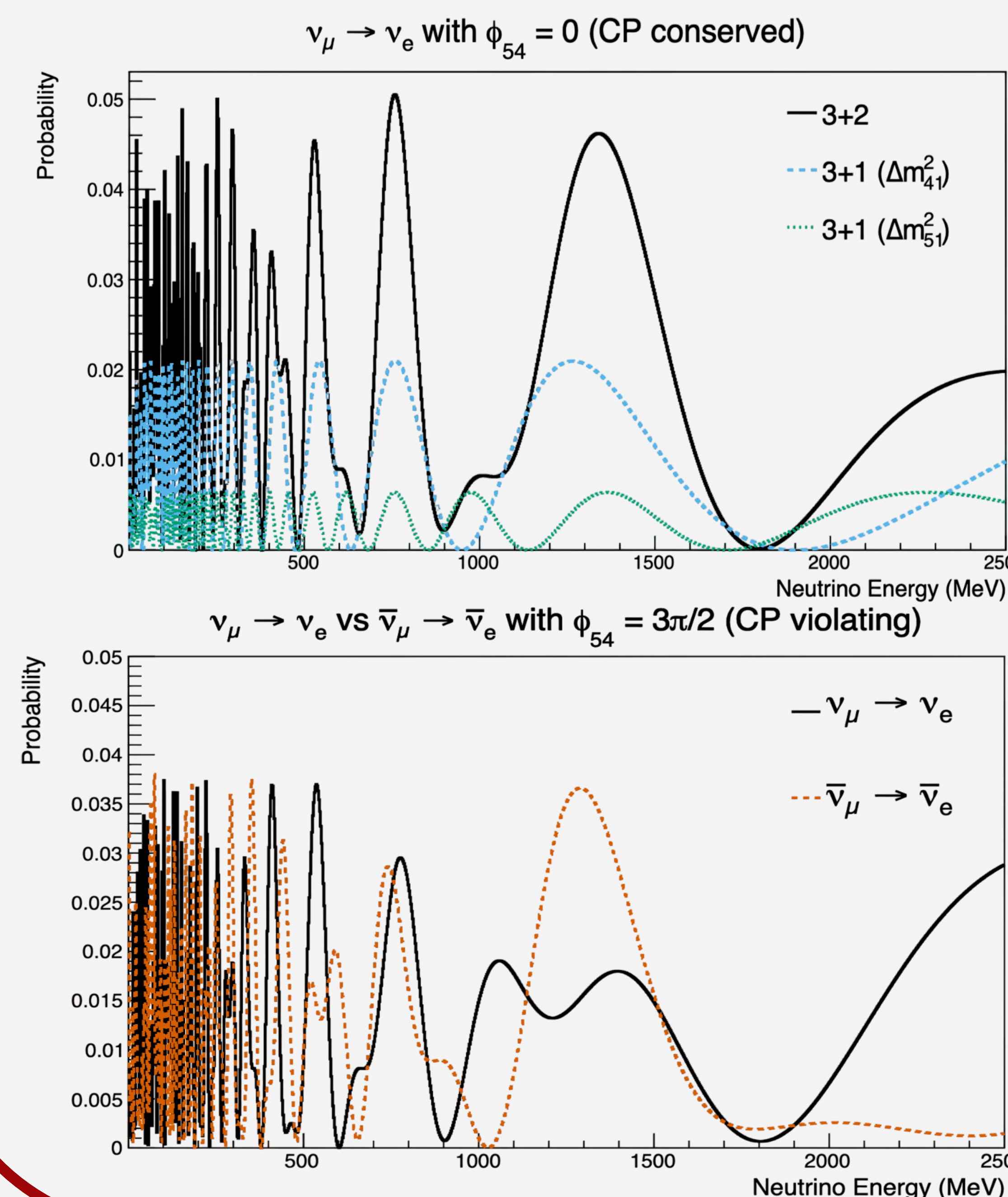
2. Short-Baseline Anomalies



MiniBooNE saw an excess of electron-like events [1].

Excess could be explained by oscillations of 3 active neutrinos and N “sterile” neutrinos in what’s called a 3+N model.

4. The 3+2 Model

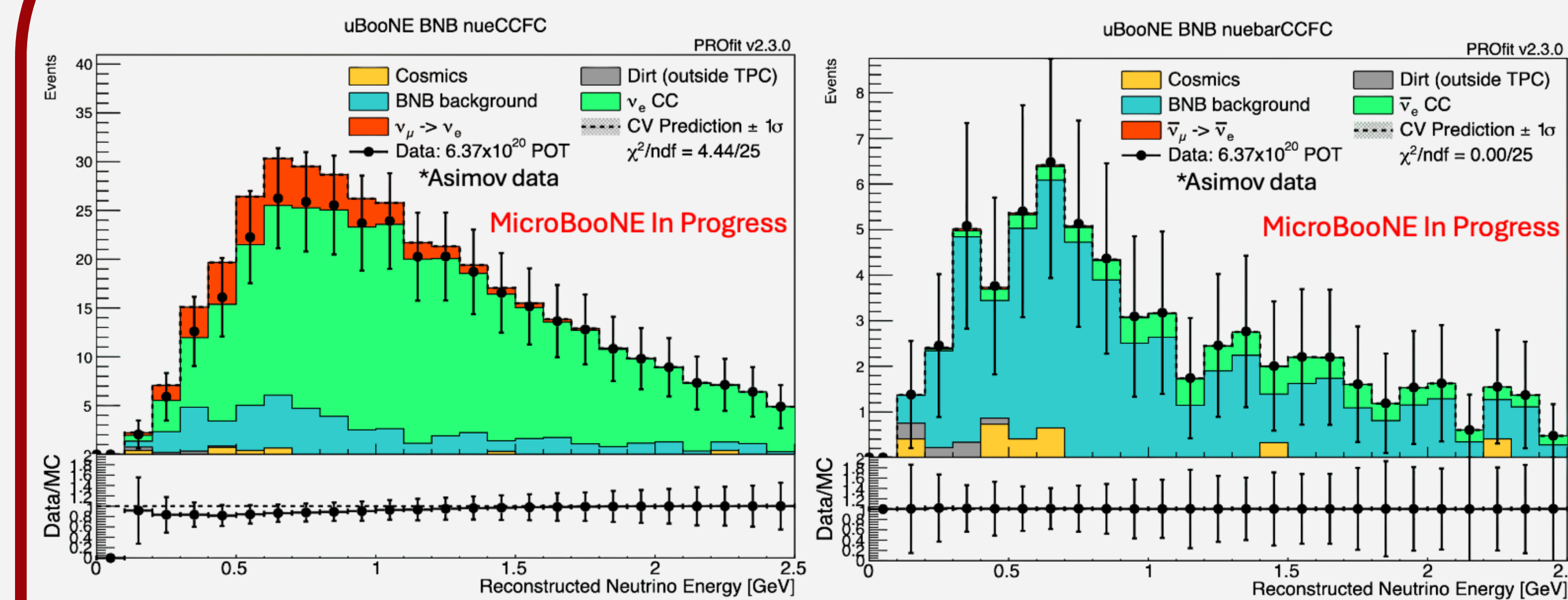


3+2 Parameters	Values
U_{e4}	0.077
$U_{\mu 4}$	0.94
Δm_{41}^2	10.02 eV ²
U_{e5}	0.4
$U_{\mu 5}$	0.1
Δm_{51}^2	18.0 eV ²

Fixed 3+2 parameters

A CP violating phase distinguishes $\nu_{\mu} \rightarrow \nu_e$ and $\bar{\nu}_{\mu} \rightarrow \bar{\nu}_e$ transitions.

6. 3+2 Separation Studies



- MicroBooNE doesn’t have separate ant-neutrino-only data.
- We can test “perfect” separation for sensitivity studies.

7. Next Steps

- Incorporate our NuMI samples for better $\nu/\bar{\nu}$ separation.
- Eventually, we will use the full dataset and use nuisance parameters from PROfit.

References

- [1] MiniBooNE Collaboration, Significant Excess of Electronlike Events in the MiniBooNE Short-Baseline Neutrino Experiment, *Phys. Rev. Lett.* 121 (2018) 22, 221801
- [2] MicroBooNE Collaboration, Search for light sterile neutrinos with two neutrino beams at MicroBooNE, *Nature* 648 (2025) 8092, 64-69
- [3] D. Cianci, A. Furmanski, G. Karagiorgi, and M. Ross-Lonegan, Prospects of Light Sterile Neutrino Oscillation and CP Violation Searches at the Fermilab Short Baseline Neutrino Facility, *Phys.Rev.D* 96 (2017) 5, 055001
- [4] https://github.com/markrosslonergan/Elephant_Vanishes/