Inside MicroBooNE's Sterile Neutrino Search: Two Beams, Three Channels, One Detector

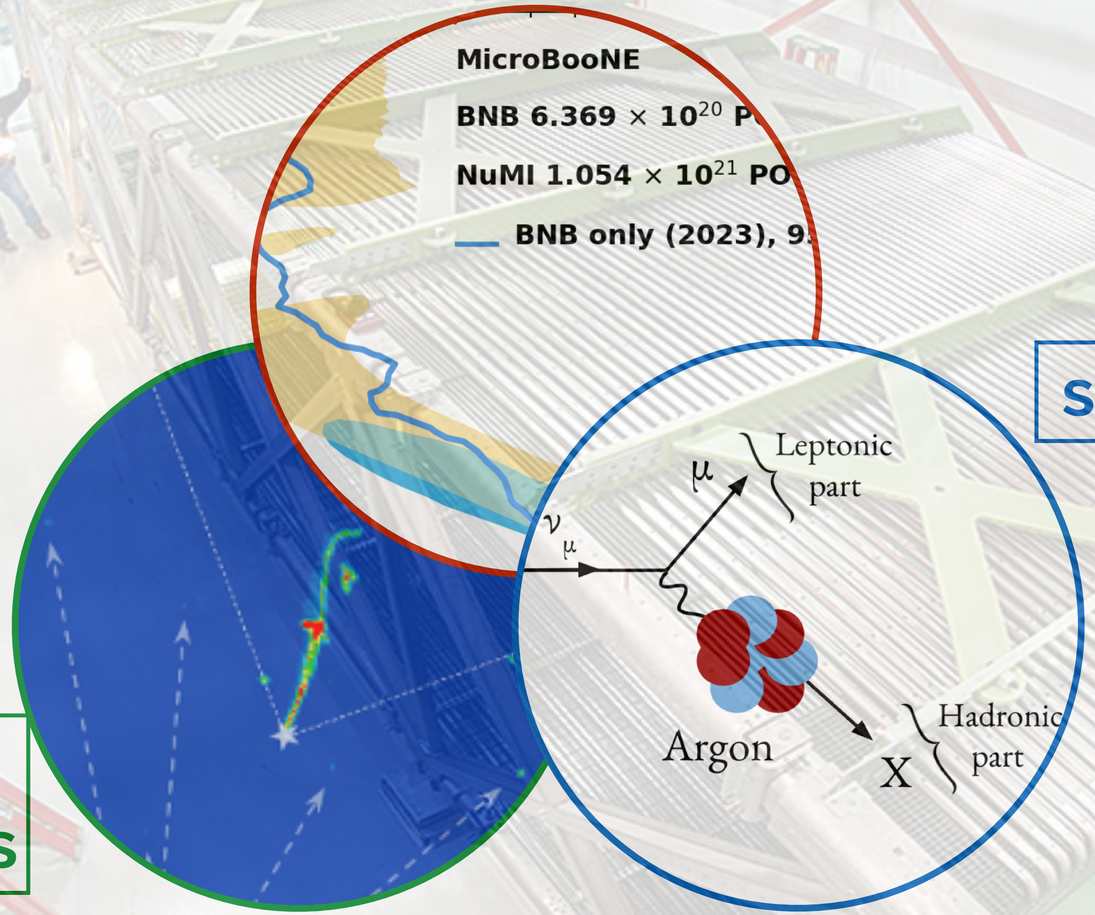
Jay Hyun Jo
Brookhaven National Laboratory

CPNR Workshop 2026
October 26, 2026

Brookhaven National Laboratory

MicroBooNE Physics Program

neutrino oscillation & beyond the standard model physics searches

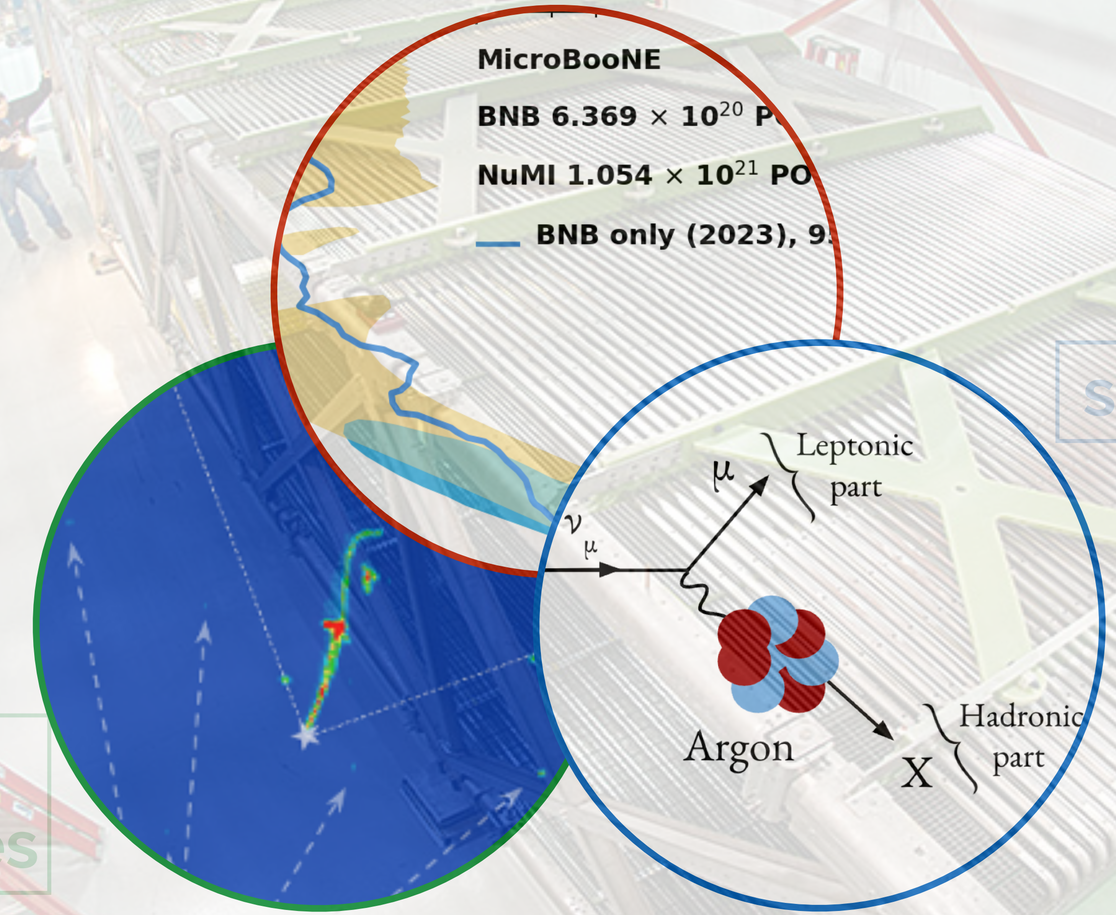


study ν-Ar interactions

advancing LArTPC technology capabilities

MicroBooNE Physics Program

neutrino oscillation & beyond the standard model physics searches



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Outline

1 **short-baseline anomalies**

appearance and disappearance hints at L/E ~ 1 m/MeV

2 **MicroBooNE's 3+1 search**

the LArTPC, two beams to break the degeneracy, and all three oscillation channels in one detector

3 **beyond 3+1**

if not sterile neutrinos, then what? the low-energy excess and BSM searches

4 **outlook**

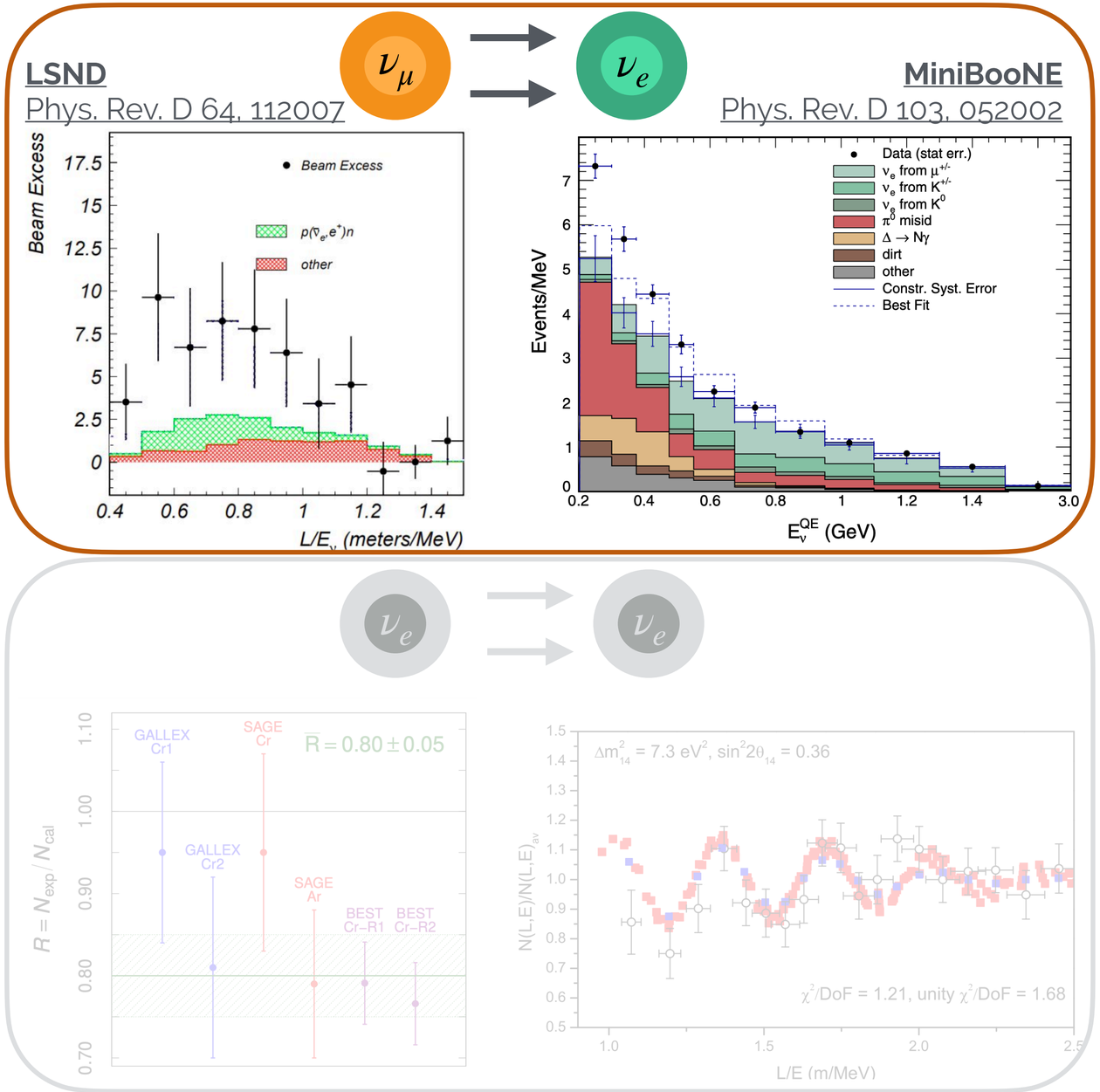
what comes next for MicroBooNE and the field

Short Baseline Neutrino Anomalies

- LSND and MiniBooNE observed an **excess of ν_e**, which can be interpreted as **appearance of ν_e from ν_μ**

- radiochemical gallium detectors and a reactor neutrino experiment observed a **deficit of ν_e**, which can be interpreted as **disappearance of ν_e from ν_e source**

- all these anomalies happen at L/E of $\mathcal{O}(1)$ m/MeV with large Δm^2: **hinting towards a sterile neutrino**

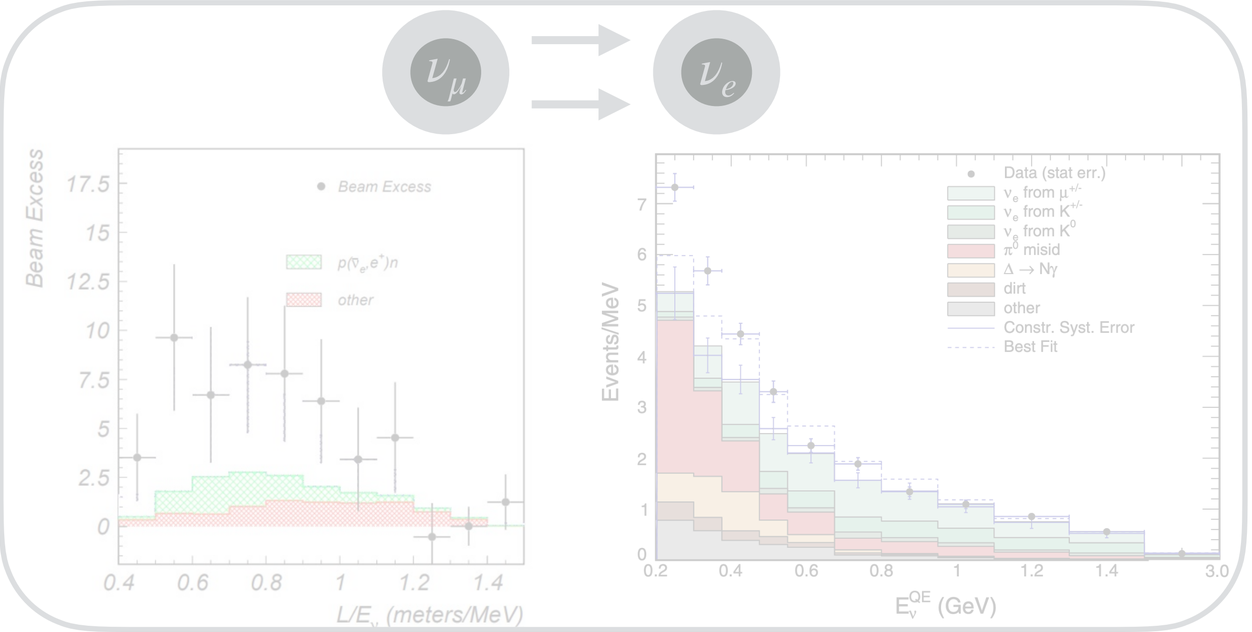


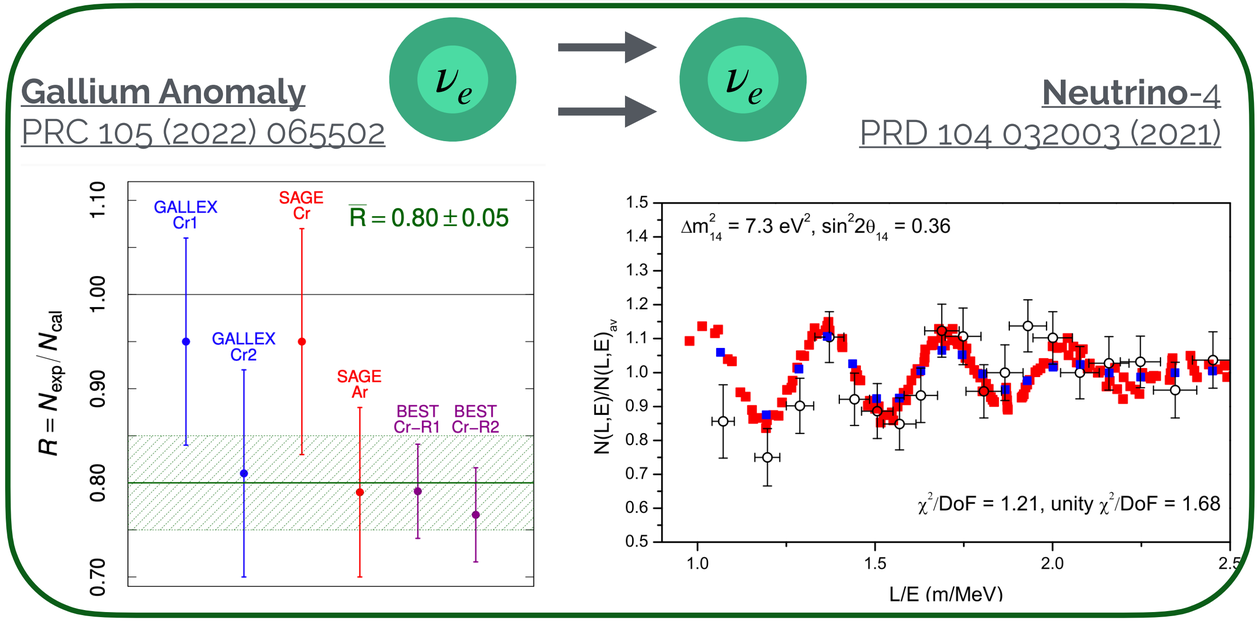
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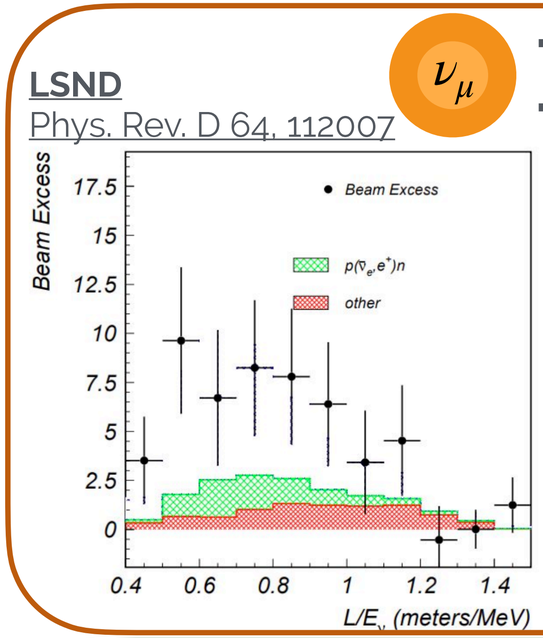




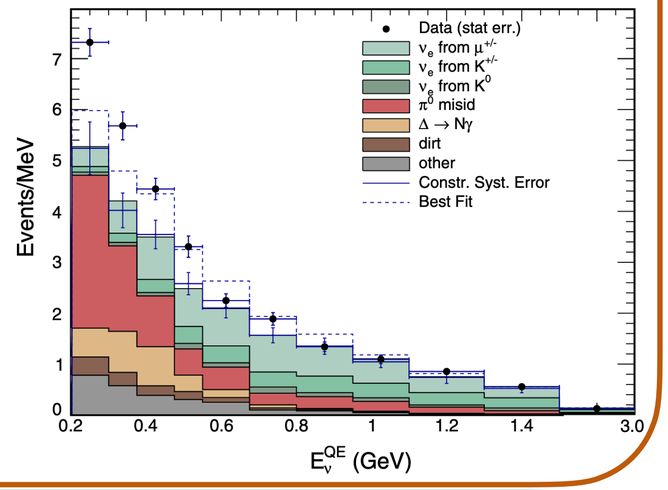
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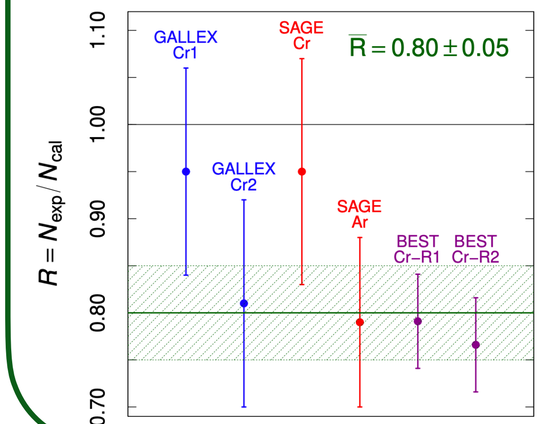
LSND
Phys. Rev. D 64, 112007



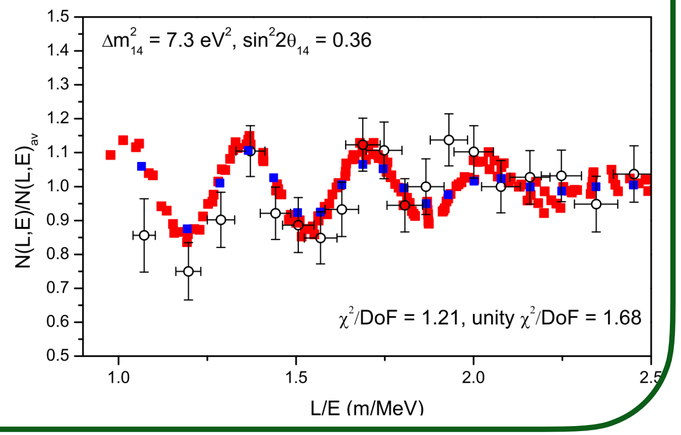
MiniBooNE
Phys. Rev. D 103, 052002



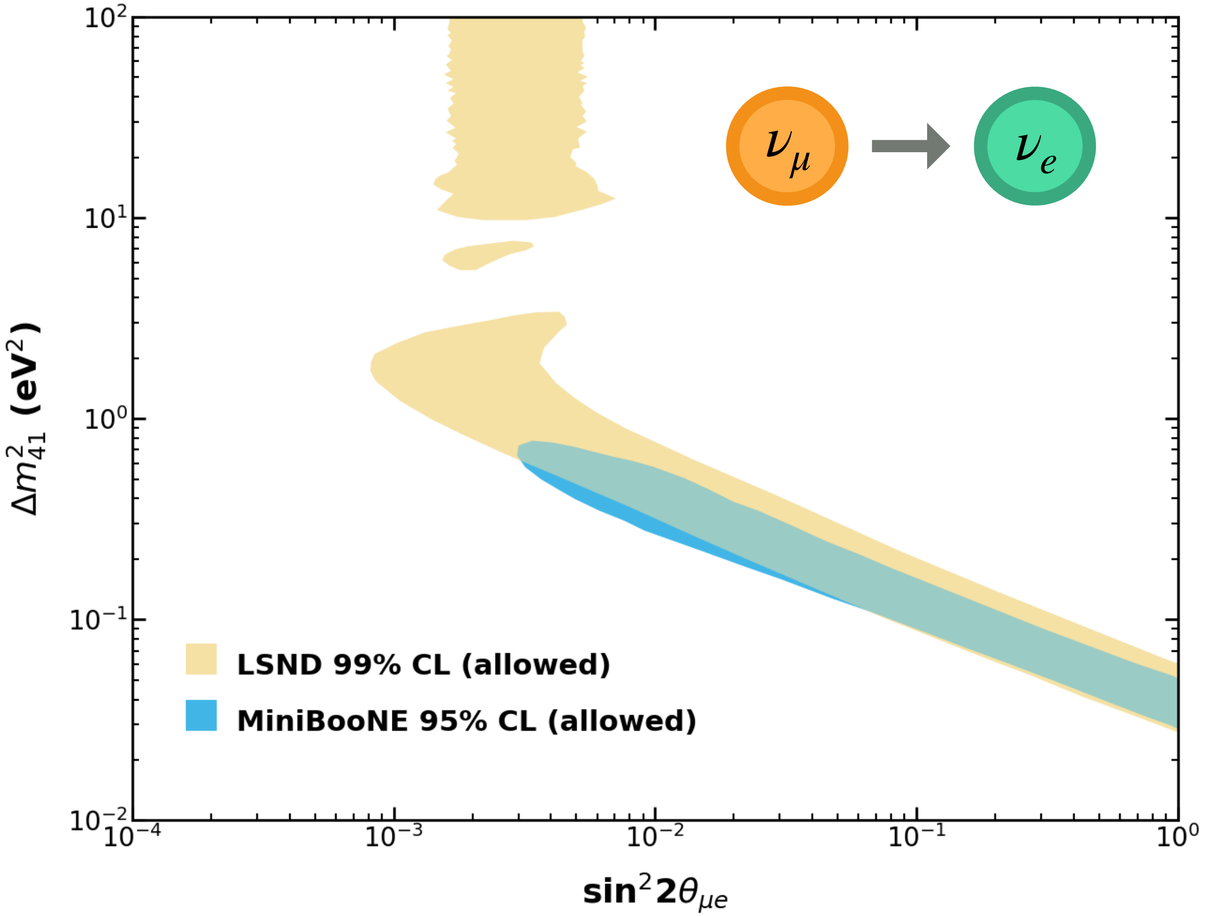
Gallium Anomaly
PRC 105 (2022) 065502

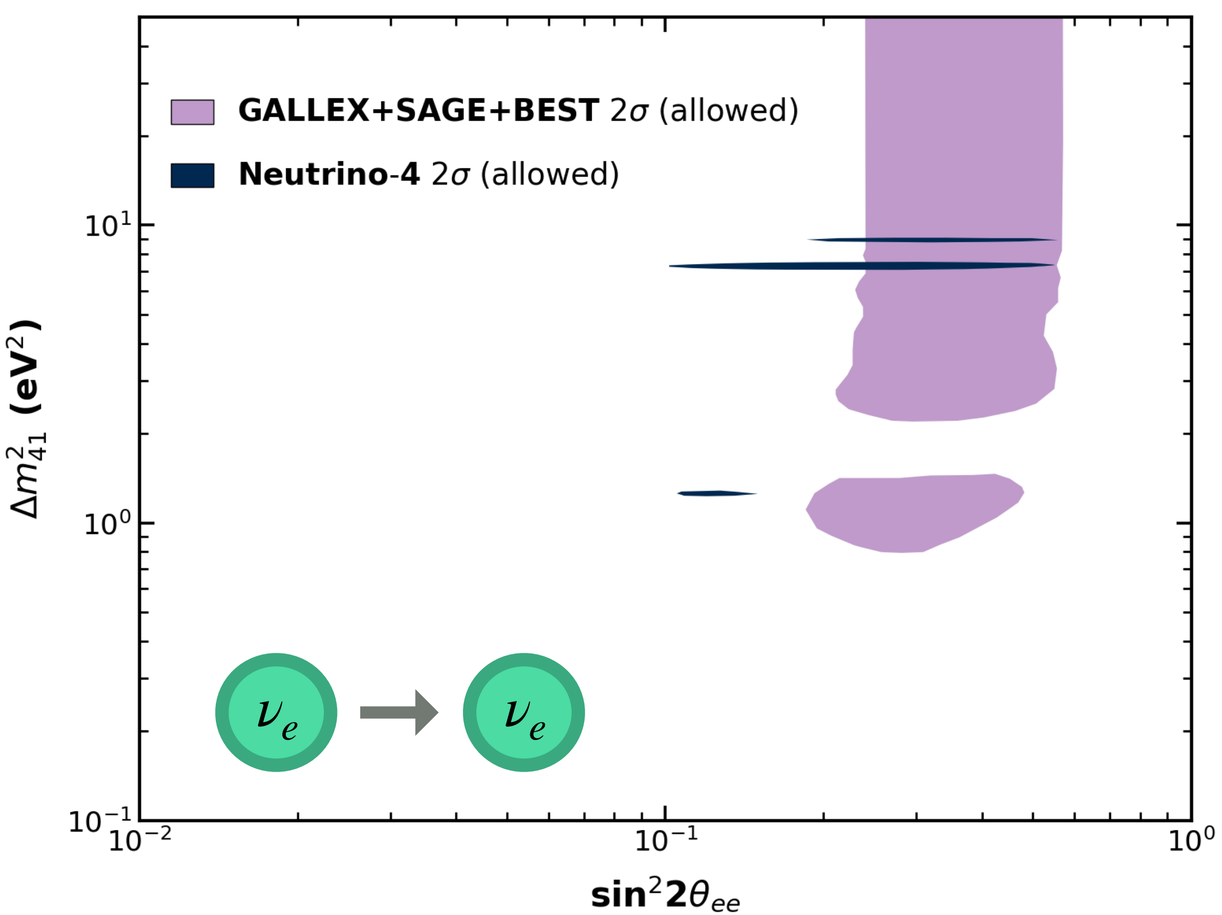


Neutrino-4
PRD 104 032003 (2021)



Short Baseline Neutrino Anomalies: Allowed Regions

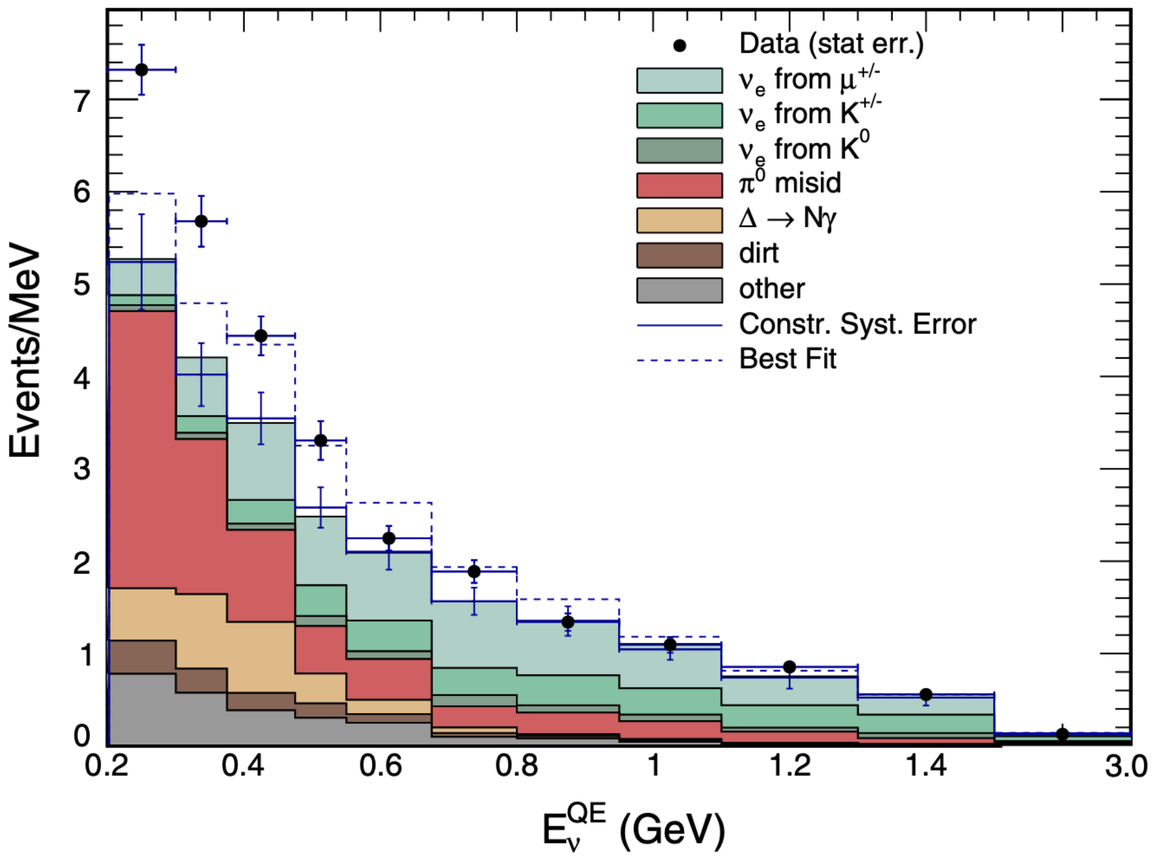




these ν_e appearance and disappearance anomalies point to a **similar Δm^2 scale**, and the oscillation hypothesis provides a plausible explanation for all of them

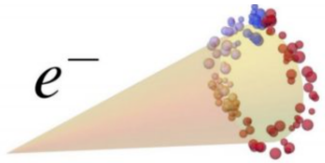
Why LArTPC? Electron or Photon?

MiniBooNE, PRD 103, 052002 (2021)



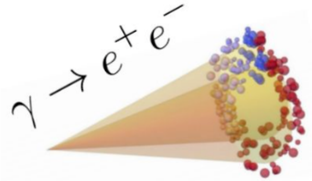
in a Cherenkov detector, an electron and a photon both leave a single fuzzy ring: the MiniBooNE excess could be either

electron?



→ ν_e appearance, the 3+1 oscillation picture

single photon?

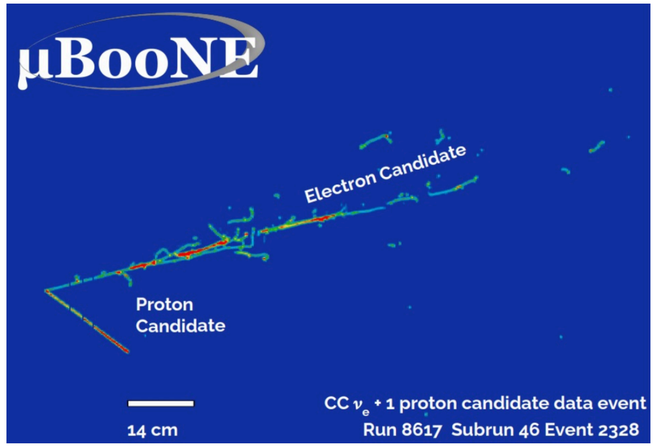


→ mis-modeled background (e.g. Δ → Nγ), or new physics (e.g. dark-sector e^+e^- pairs)

a LArTPC images each event in 3D and can tell electrons from photons: **one detector can address both questions**

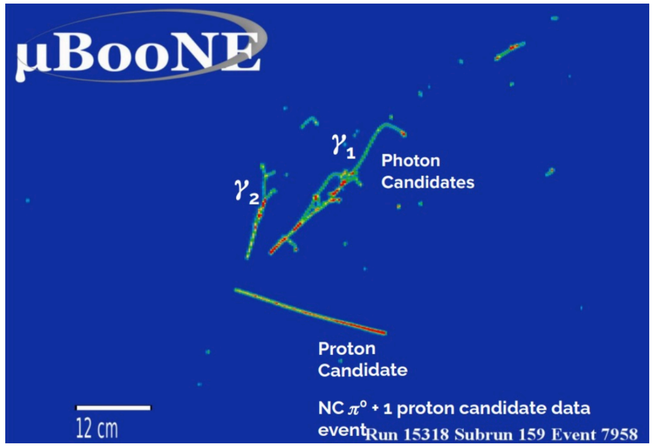
Telling Electrons from Photons

electron (ν_e CC)

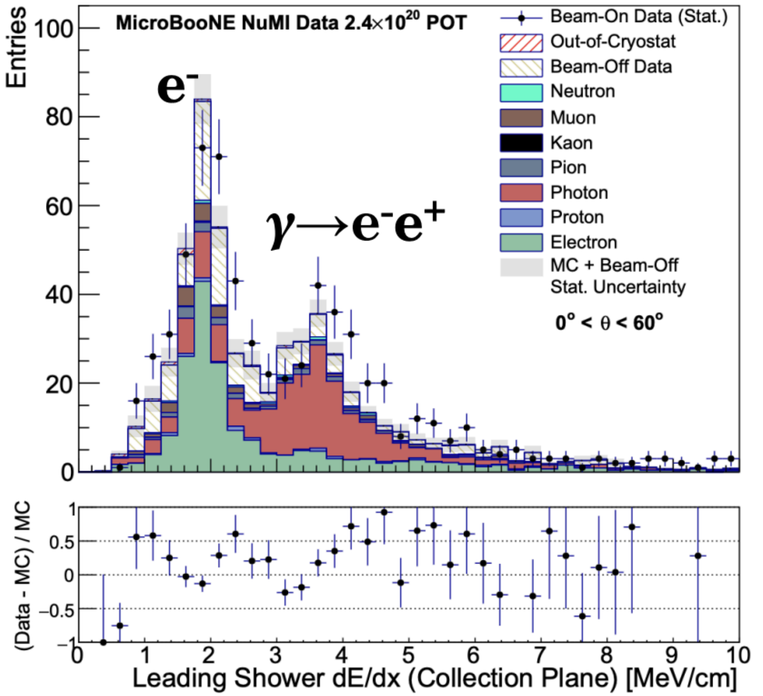


dE/dx at shower start ≈ 2 MeV/cm (**1 MIP**)

photon (e.g. $\pi^0 \rightarrow \gamma\gamma$)



dE/dx at shower start ≈ 4 MeV/cm (**2 MIP**)

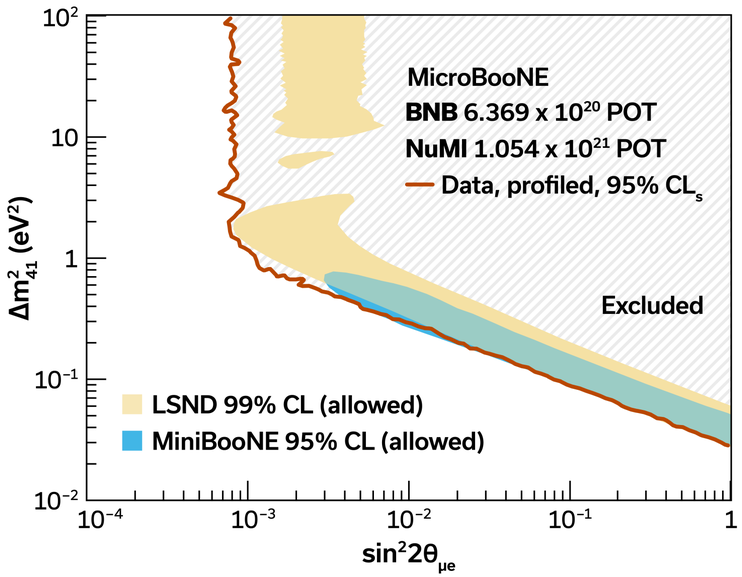


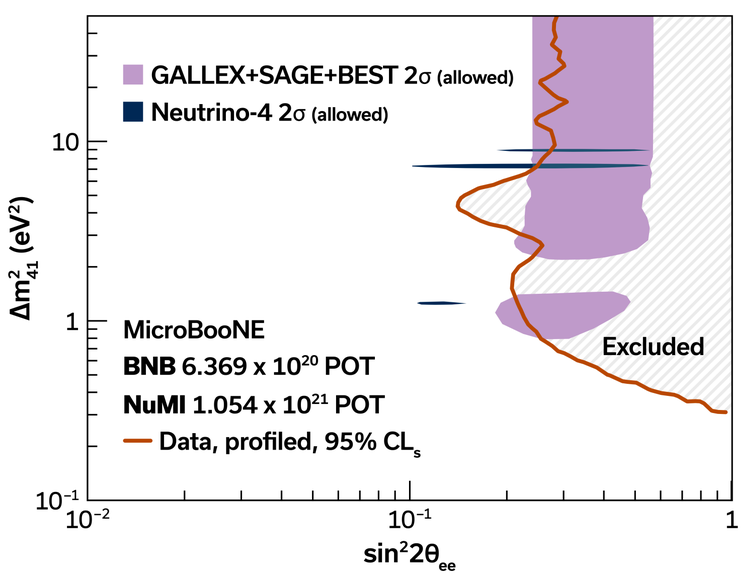
- **energy at the shower start**: one electron vs an e^+e^- pair
- **gap** between vertex and shower: a photon travels ~18 cm on average in LAr before converting

together with the full 3D topology, this lets MicroBooNE **select ν_e** and **test photon hypotheses** separately

MicroBooNE's new sterile neutrino search result

Nature 648 64-69 (2025)





- MicroBooNE's recent search for sterile neutrino is much improved from our previous 2023 result
- *how have we achieved such improvements?*

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Search for light sterile neutrinos with two neutrino beams at MicroBooNE

The MicroBooNE Collaboration

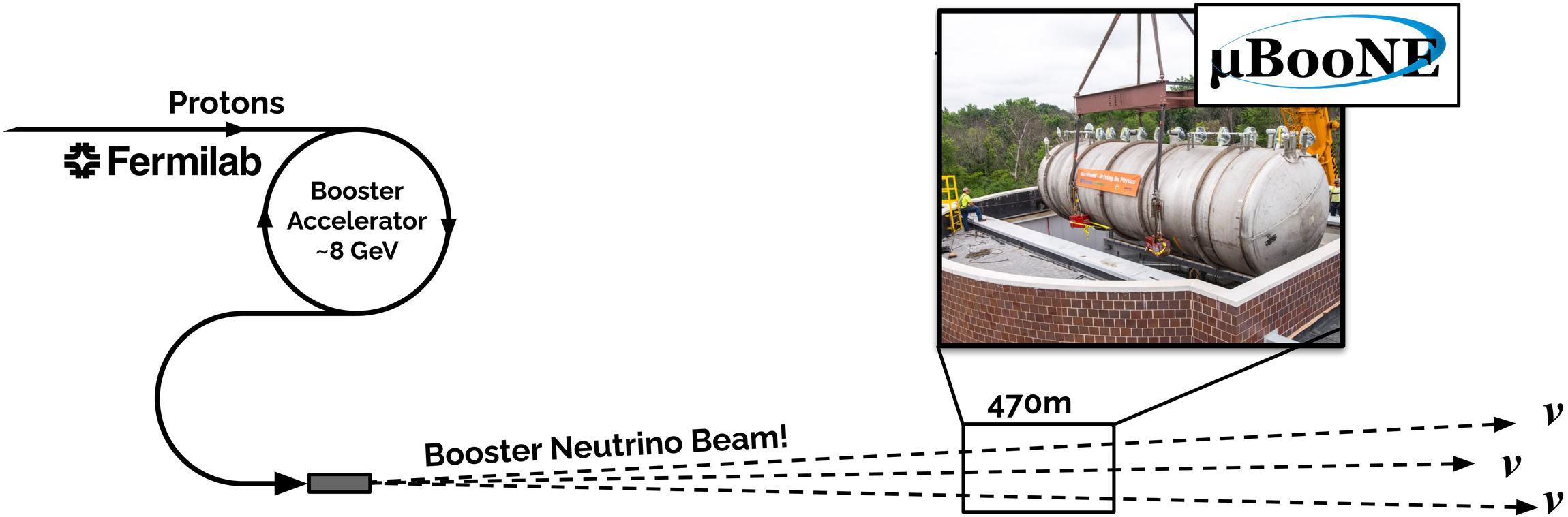
Nature **648**, 64–69 (2025) | Cite this article

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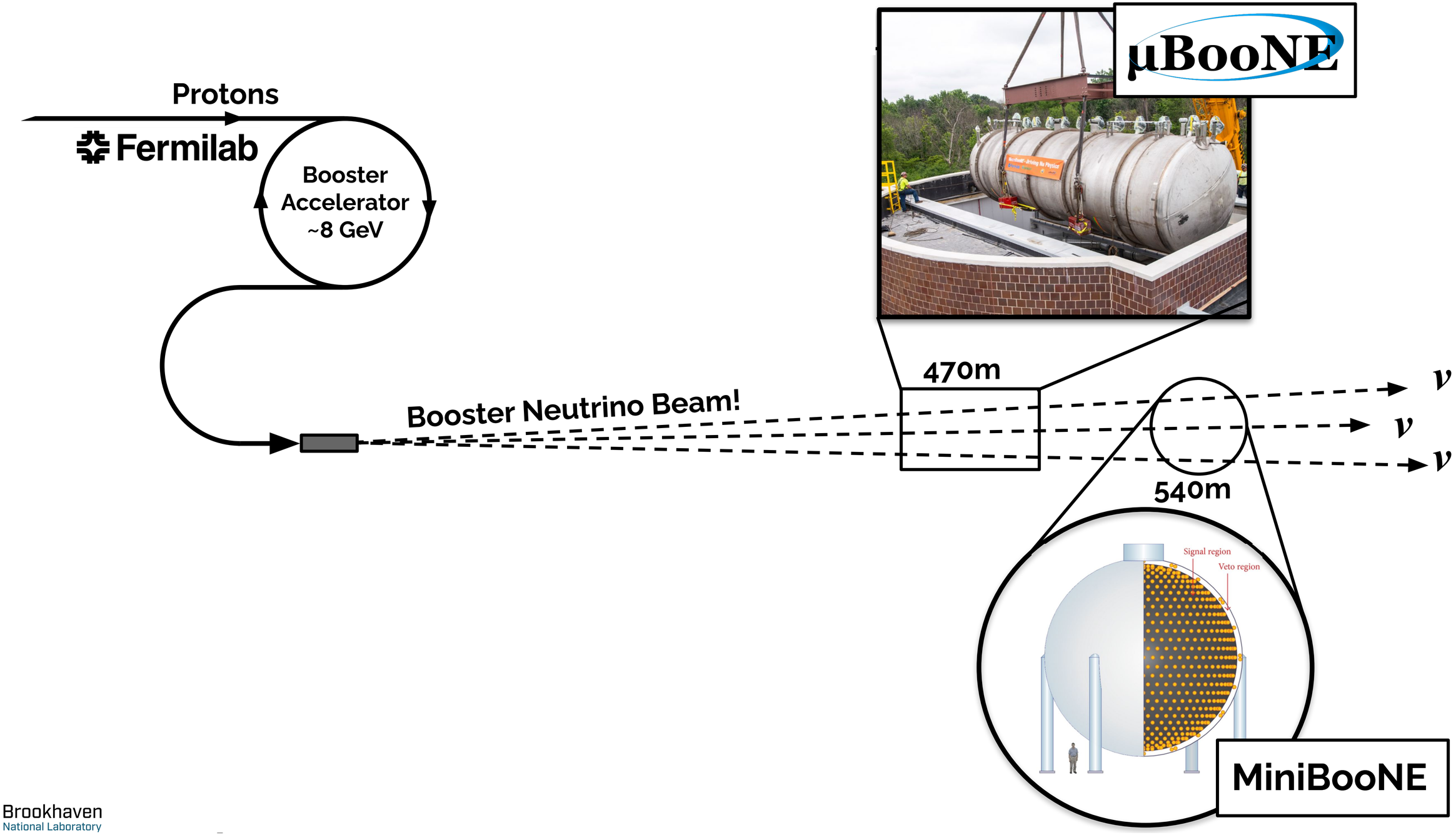
Abstract

The existence of three distinct neutrino flavours, ν_e, ν_μ and ν_τ, is a central tenet of the Standard Model of particle physics[1,2]. Quantum-mechanical interference can allow a neutrino of one initial flavour to be detected sometime later as a different flavour, a process called neutrino oscillation. Several anomalous observations inconsistent with this three-flavour picture have motivated the hypothesis that an additional neutrino state exists, which does not interact directly with matter, termed as 'sterile' neutrino, ν_s (refs. [3,4,5,6,7,8,9]). This includes anomalous observations from the Liquid Scintillator Neutrino Detector (LSND)[3] experiment and Mini-Booster Neutrino Experiment (MiniBooNE)[4,5], consistent with $\nu_\mu \rightarrow \nu_e$ transitions at a distance inconsistent with the three-neutrino picture. Here we use data obtained from the MicroBooNE liquid-argon time projection chamber[10] in two accelerator neutrino beams to exclude the single light sterile neutrino interpretation of the LSND and MiniBooNE anomalies at the 95% confidence level (CL). Moreover, we rule out a notable portion of the parameter space that could explain the gallium anomaly[6,7,8]. This is one of the first measurements to use two accelerator neutrino beams to break a degeneracy between ν_e appearance and disappearance, which would otherwise weaken the sensitivity to the sterile neutrino hypothesis. We find no evidence for either $\nu_\mu \rightarrow \nu_e$ flavour transitions or ν_e disappearance that would indicate non-standard flavour oscillations. Our results indicate that previous anomalous observations consistent with $\nu_\mu \rightarrow \nu_e$ transitions cannot be explained by introducing a single sterile neutrino state.

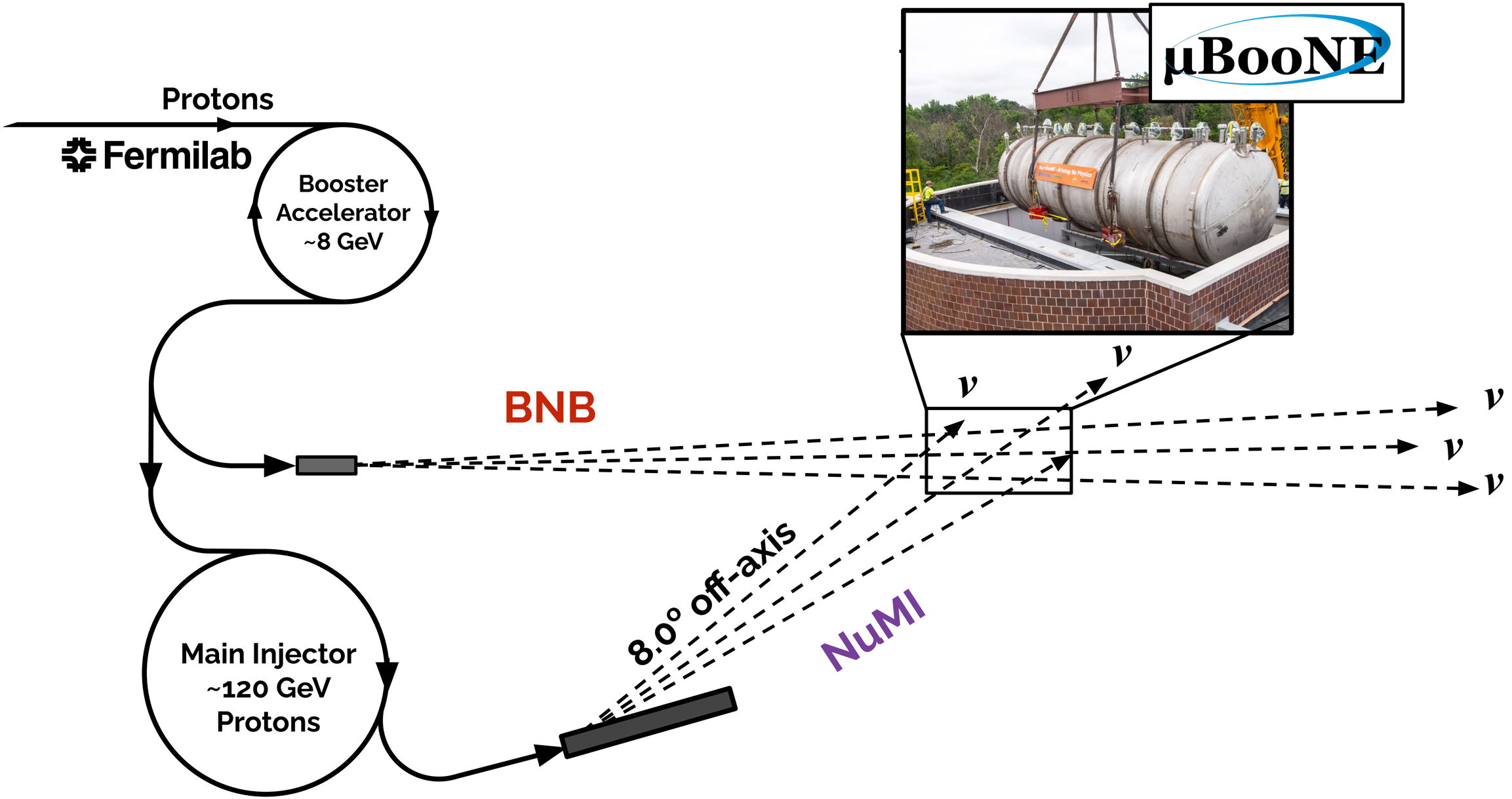
3+1 Sterile Neutrino Search: Two beam lines



3+1 Sterile Neutrino Search: Two beam lines

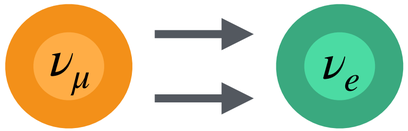


3+1 Sterile Neutrino Search: Two beam lines



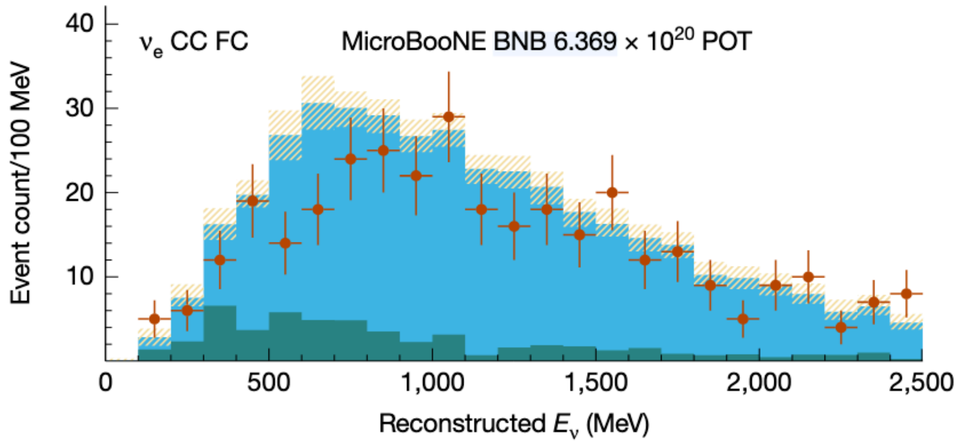
3+1 Sterile Neutrino Search: ν_e appearance search

Nature 648 64-69 (2025)

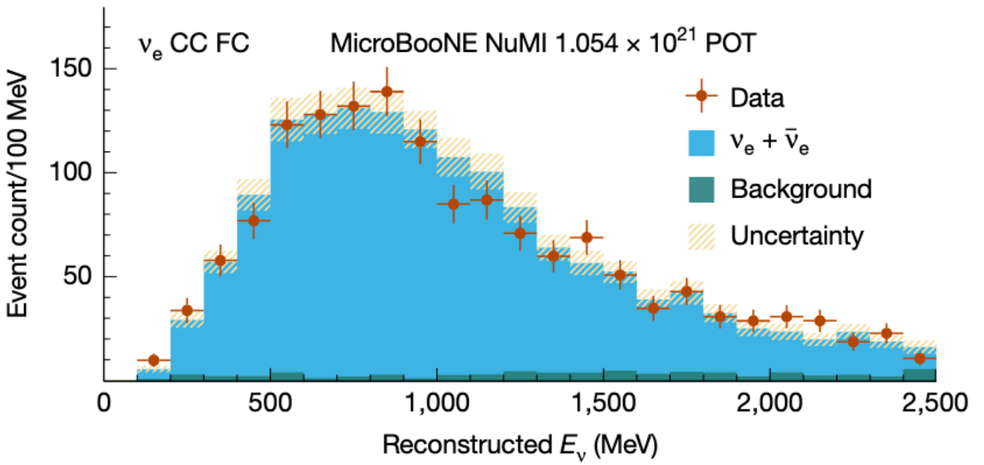


- after updating our information using larger statistic sideband data (ν_μ and π^0) to reduce uncertainties, **we look for an excess in the ν_e**
- no excess observed over the expected background, both in BNB and NuMI
- *but why do we need both beams?*

BNB CC ν_e



NuMI CC ν_e



3+1 Sterile Neutrino Search: degeneracy

- we consider three main oscillation channels

beam detector



$\nu_\mu \rightarrow \nu_e$ appearance

$\nu_e \rightarrow \nu_e$ disappearance

$\nu_\mu \rightarrow \nu_\mu$ disappearance

} …and these two effects can *cancel each other* at certain oscillation parameters

- BNB and NuMI have different amount of intrinsic ν_e: BNB with **0.6%** and NuMI with **4%**

- **using both beams simultaneously breaks this degeneracy!**

3+1 Sterile Neutrino Search: degeneracy

Nature 648 64-69 (2025)

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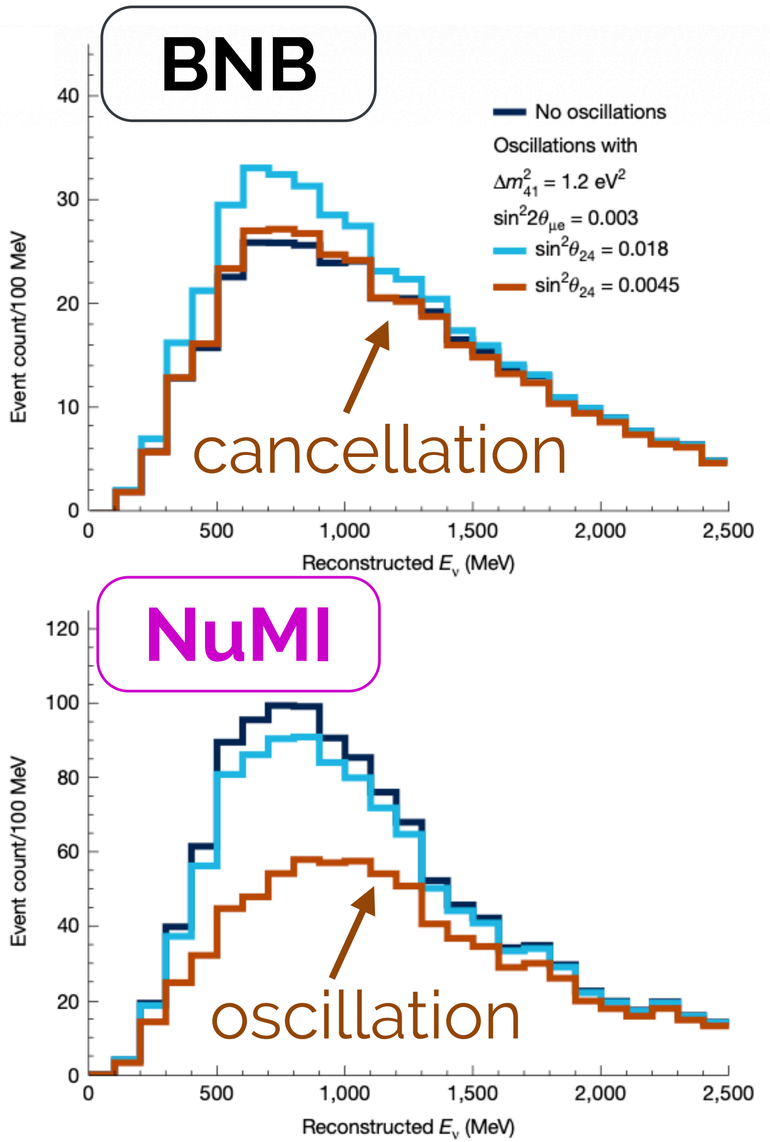
$\nu_\mu \rightarrow \nu_e$ appearance

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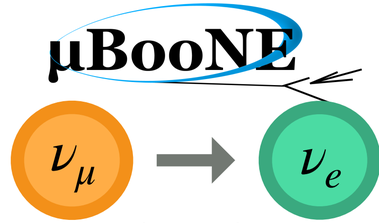
$\nu_\mu \rightarrow \nu_\mu$ disappearance

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3+1 Sterile Neutrino Search: BNB-only result (2023)

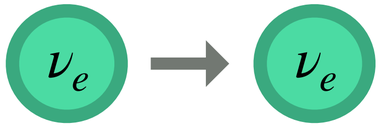


PRL 130 011801 (2023)

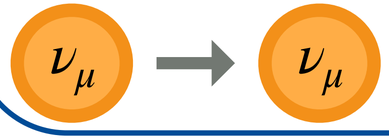
BNB-only Result (2023)



appearance

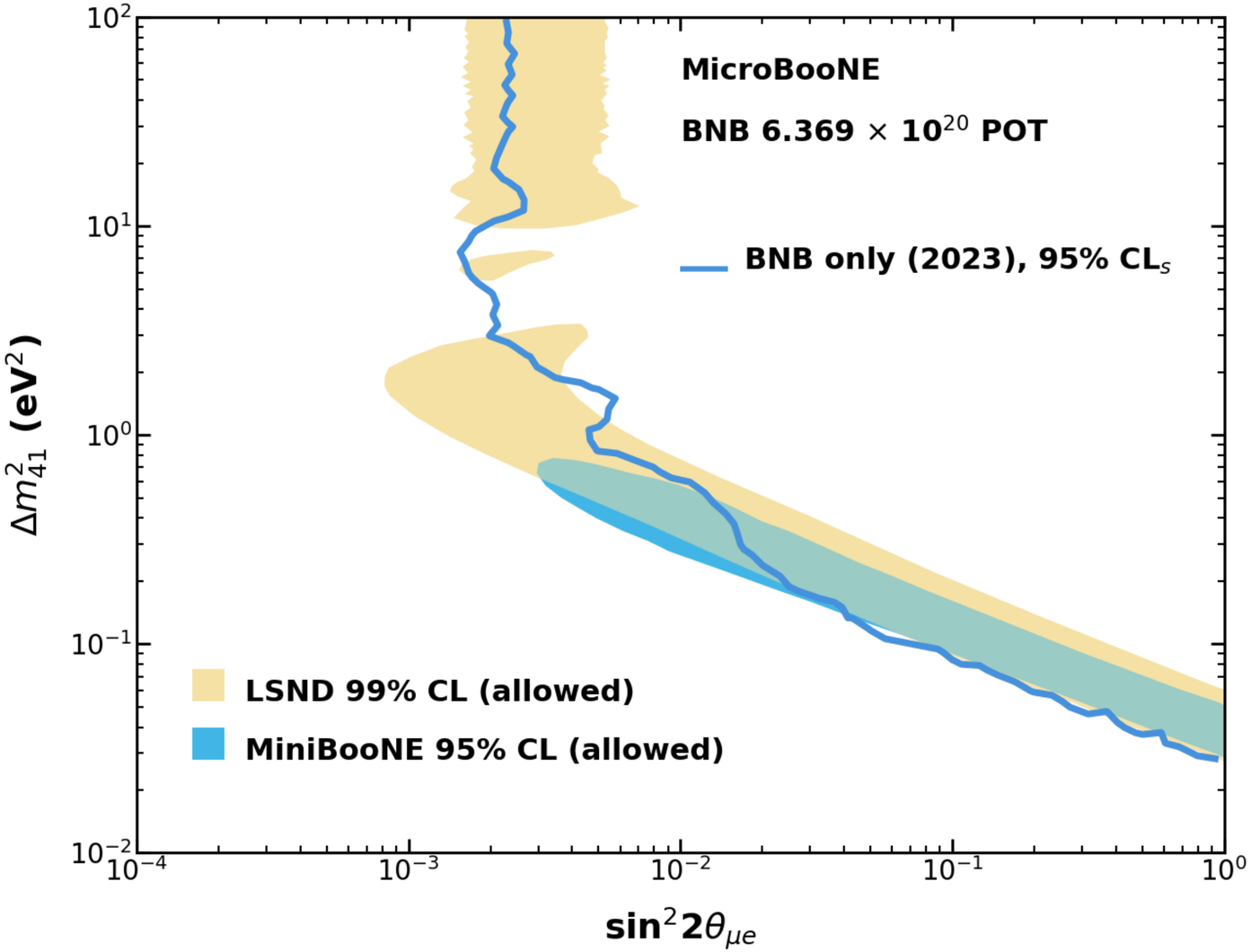


disappearance



disappearance

2023 result is not strong enough to exclude the allowed regions *due to the degeneracy*



3+1 Sterile Neutrino Search: with BNB, revisited

Unphysical

BNB-only Result (2023)

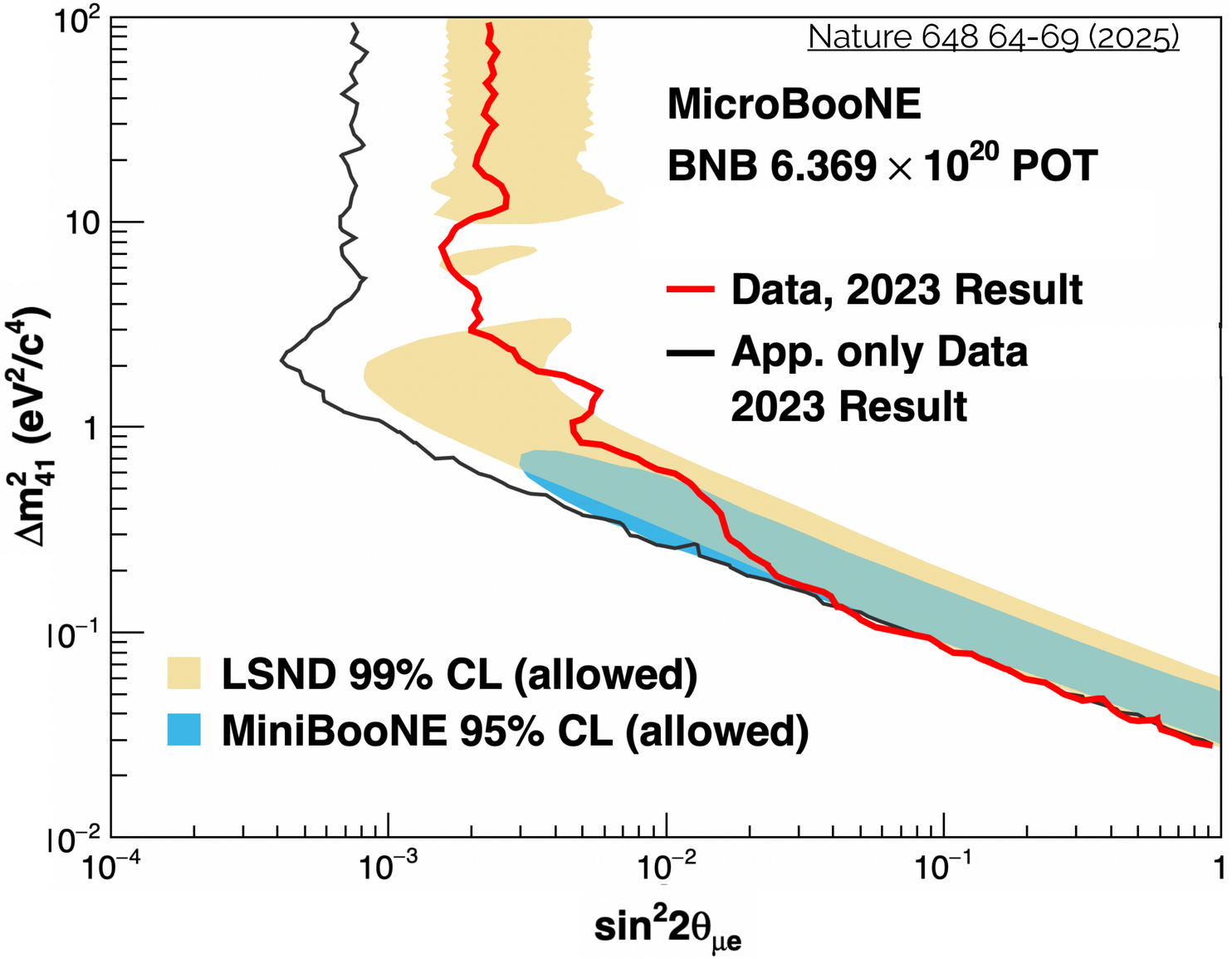
$\nu_\mu \rightarrow \nu_e$ appearance

$\nu_e \rightarrow \nu_e$ disappearance

$\nu_\mu \rightarrow \nu_\mu$ disappearance

Full BNB-only result weaker than Appearance only result

→ due to degeneracy of oscillation parameters



3+1 Sterile Neutrino Search: BNB+NuMI result

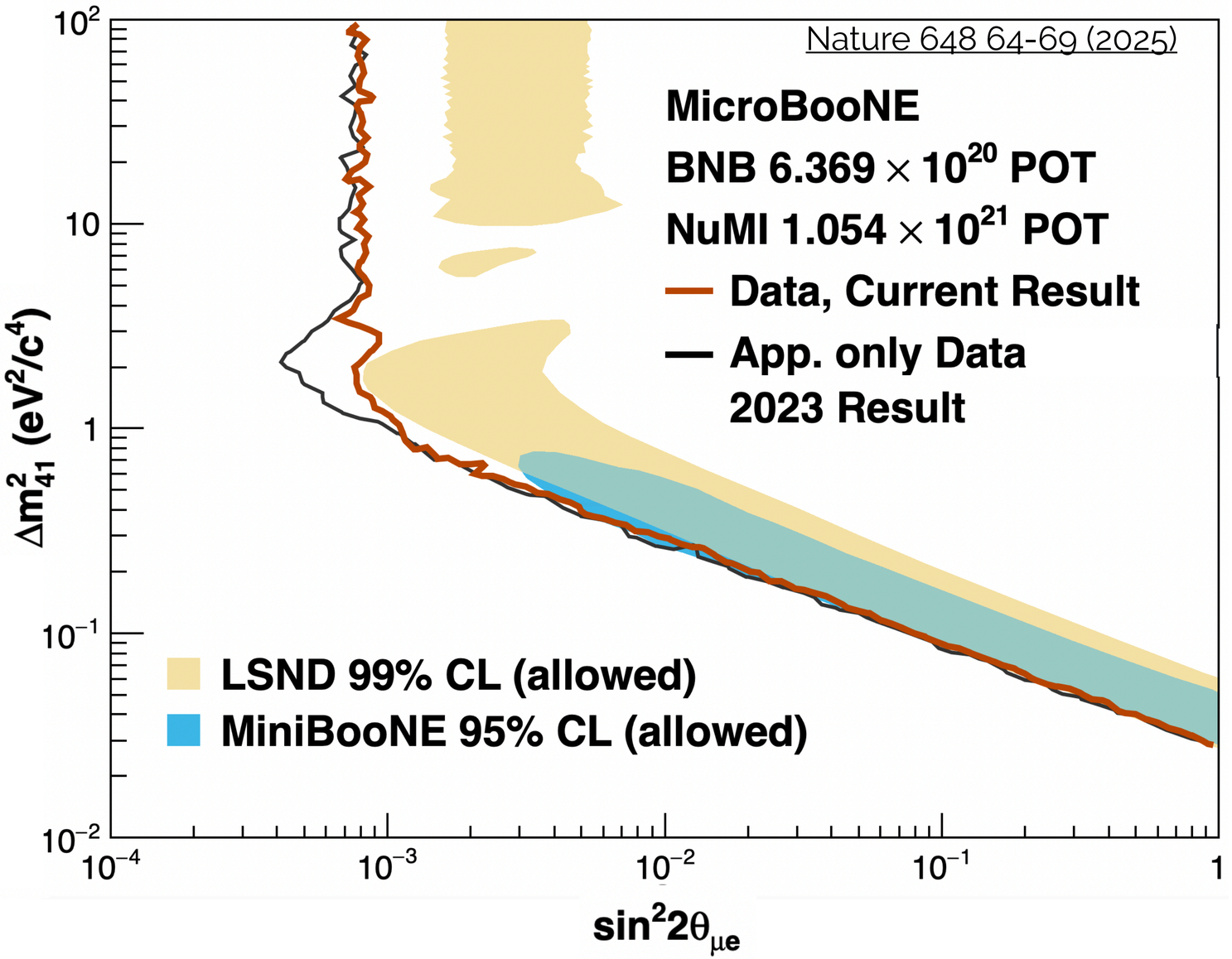
BNB+NuMI Result

$\nu_\mu \rightarrow \nu_e$ appearance

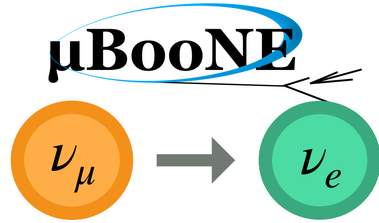
$\nu_e \rightarrow \nu_e$ disappearance

$\nu_\mu \rightarrow \nu_\mu$ disappearance

addition of NuMI data unlocks full potential of the BNB to constrain ν_e appearance



3+1 Sterile Neutrino Search: BNB+NuMI result

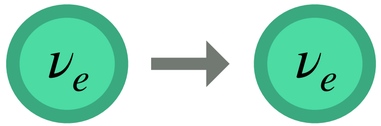


Nature 648 64-69 (2025)

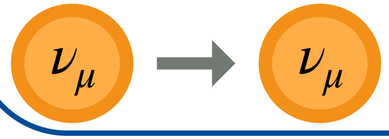
BNB+NuMI Result



appearance

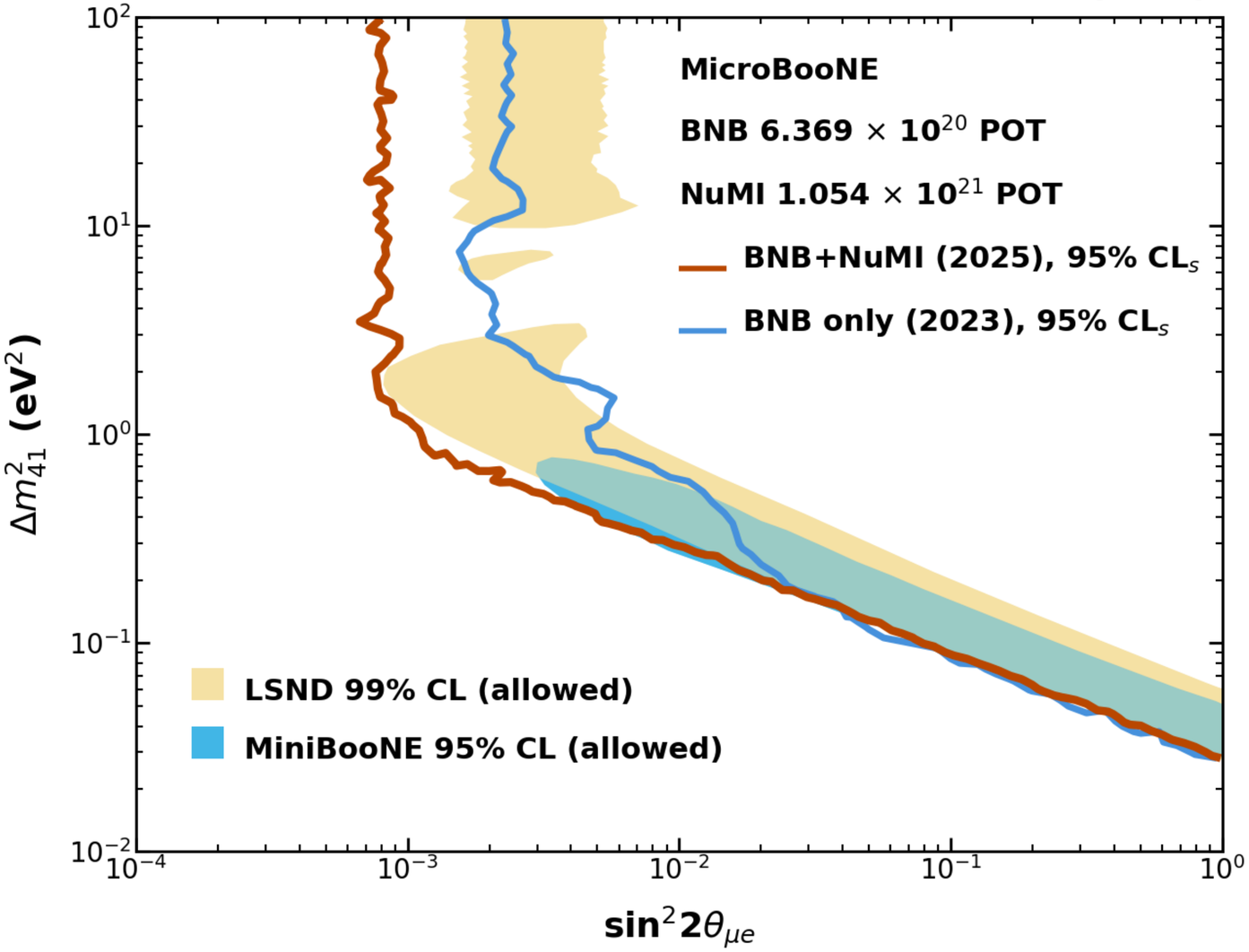


disappearance

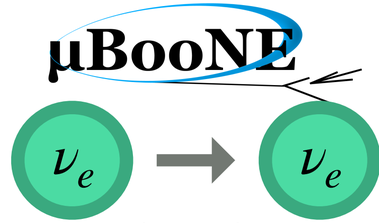


disappearance

in ν_e appearance channel, MicroBooNE excludes LSND and MiniBooNE allowed region at the 95% CL by mitigating degeneracy



3+1 Sterile Neutrino Search: BNB-only result (2023)

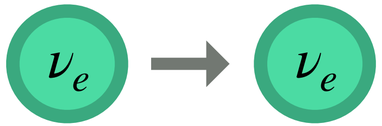


PRL 130 011801 (2023)

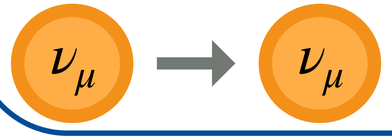
BNB-only Result (2023)



appearance

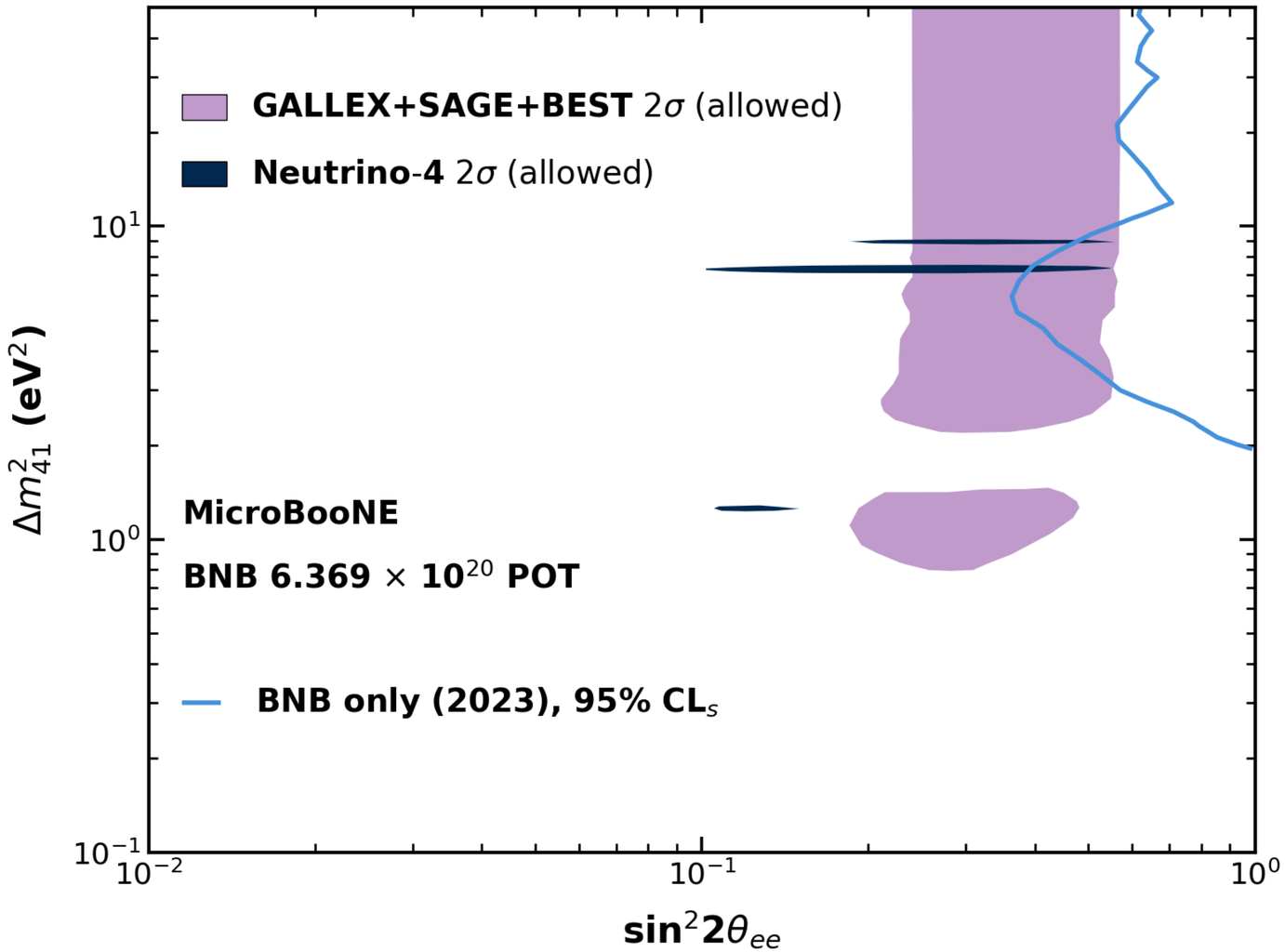


disappearance



disappearance

2023 result is not strong enough to exclude the allowed regions *due to the degeneracy*



3+1 Sterile Neutrino Search: BNB+NuMI result

μBooNE

$\nu_e \rightarrow \nu_e$

Nature 648 64-69 (2025)

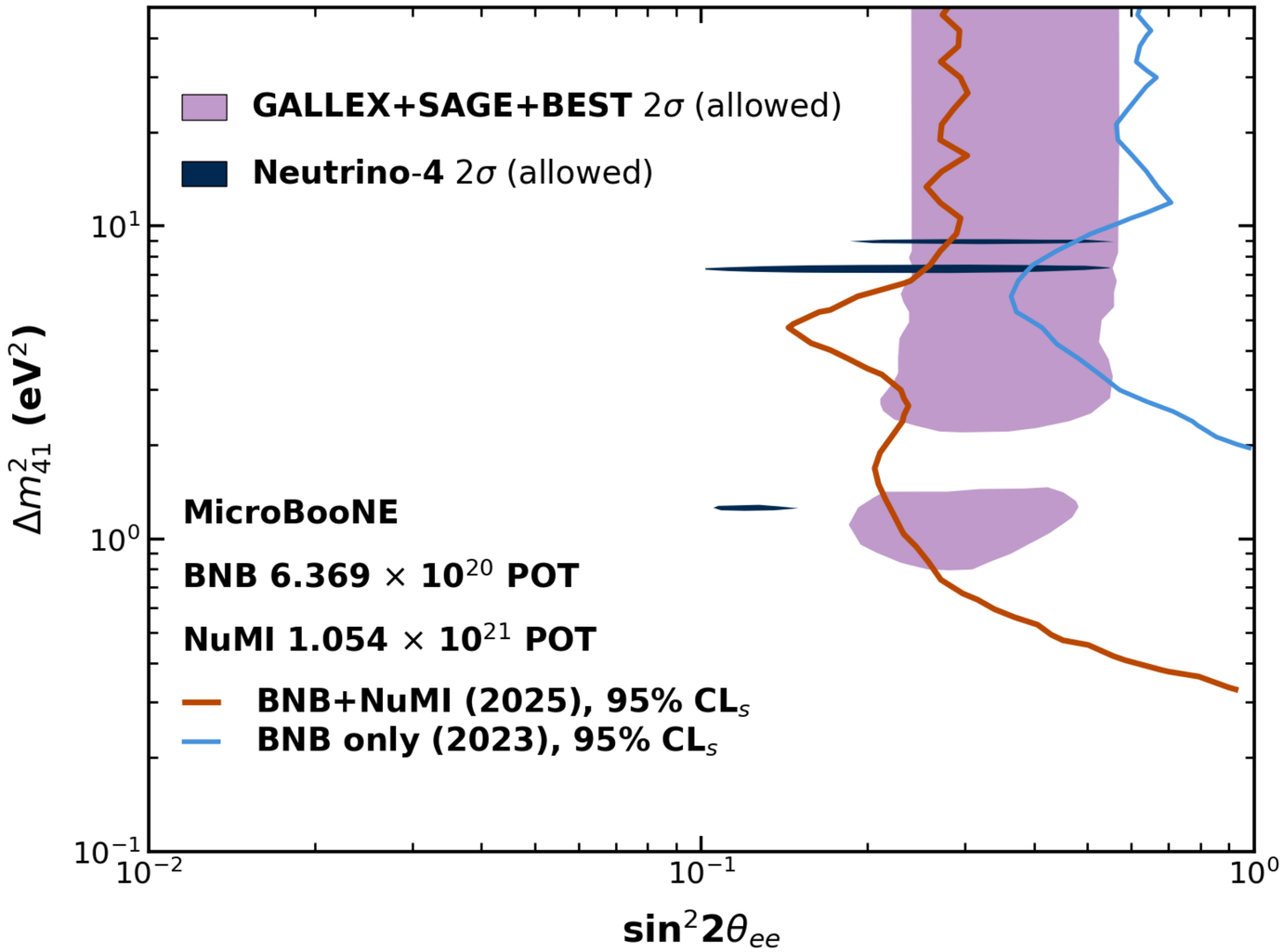
BNB+NuMI Result

$\nu_\mu \rightarrow \nu_e$ appearance

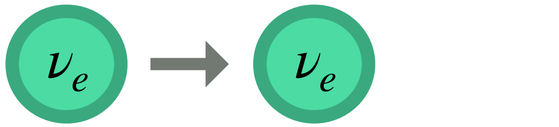
$\nu_e \rightarrow \nu_e$ **disappearance**

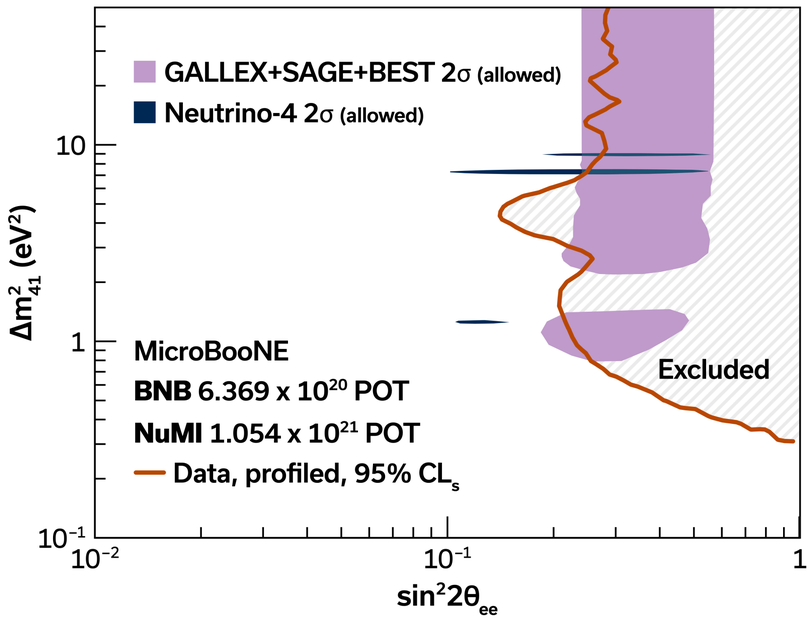
$\nu_\mu \rightarrow \nu_\mu$ disappearance

in ν_e disappearance channel, MicroBooNE excludes most of Gallium allowed region and part of Neutrino-4 allowed region

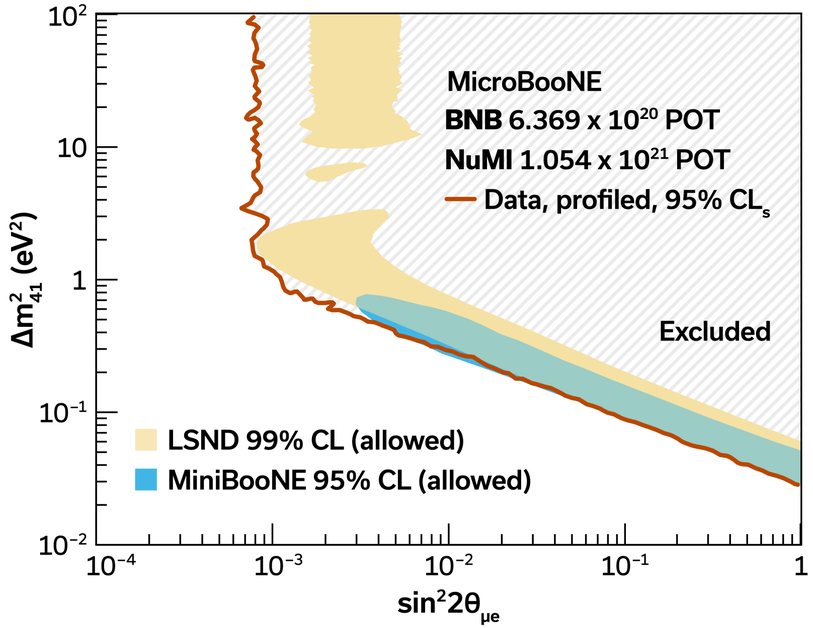


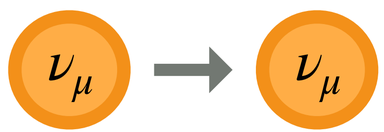
3+1 Sterile Neutrino Search: What about ν_μ disappearance?

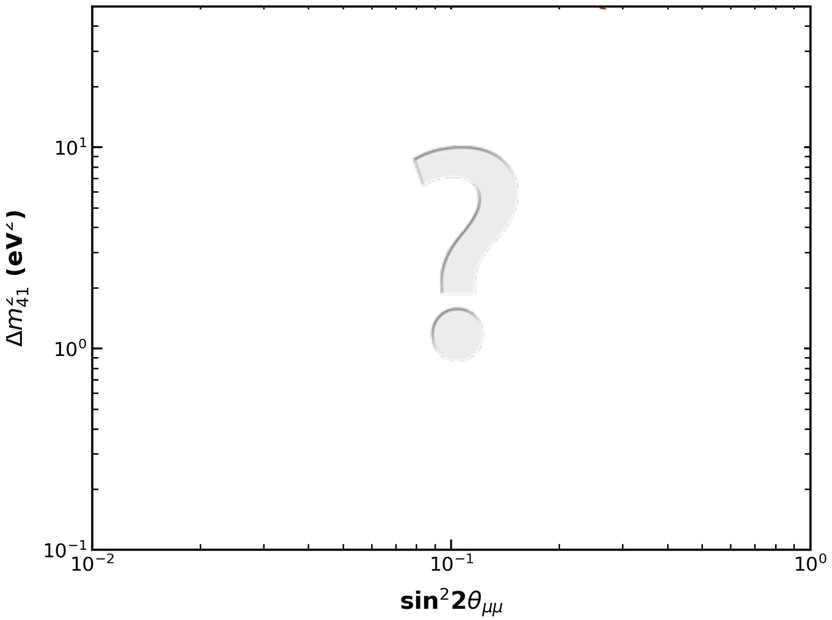






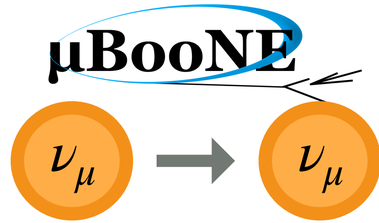






- MicroBooNE detects three main oscillation channels, but only showed two so far: ν_e appearance and ν_e disappearance
- these results rely on powerful ν_μ constraints to reduce systematic uncertainty of ν_e measurements ; whereas systematic uncertainty on the absolute CC ν_μ rate and shape is large and unconstrained

3+1 Sterile Neutrino Search: BNB+NuMI result



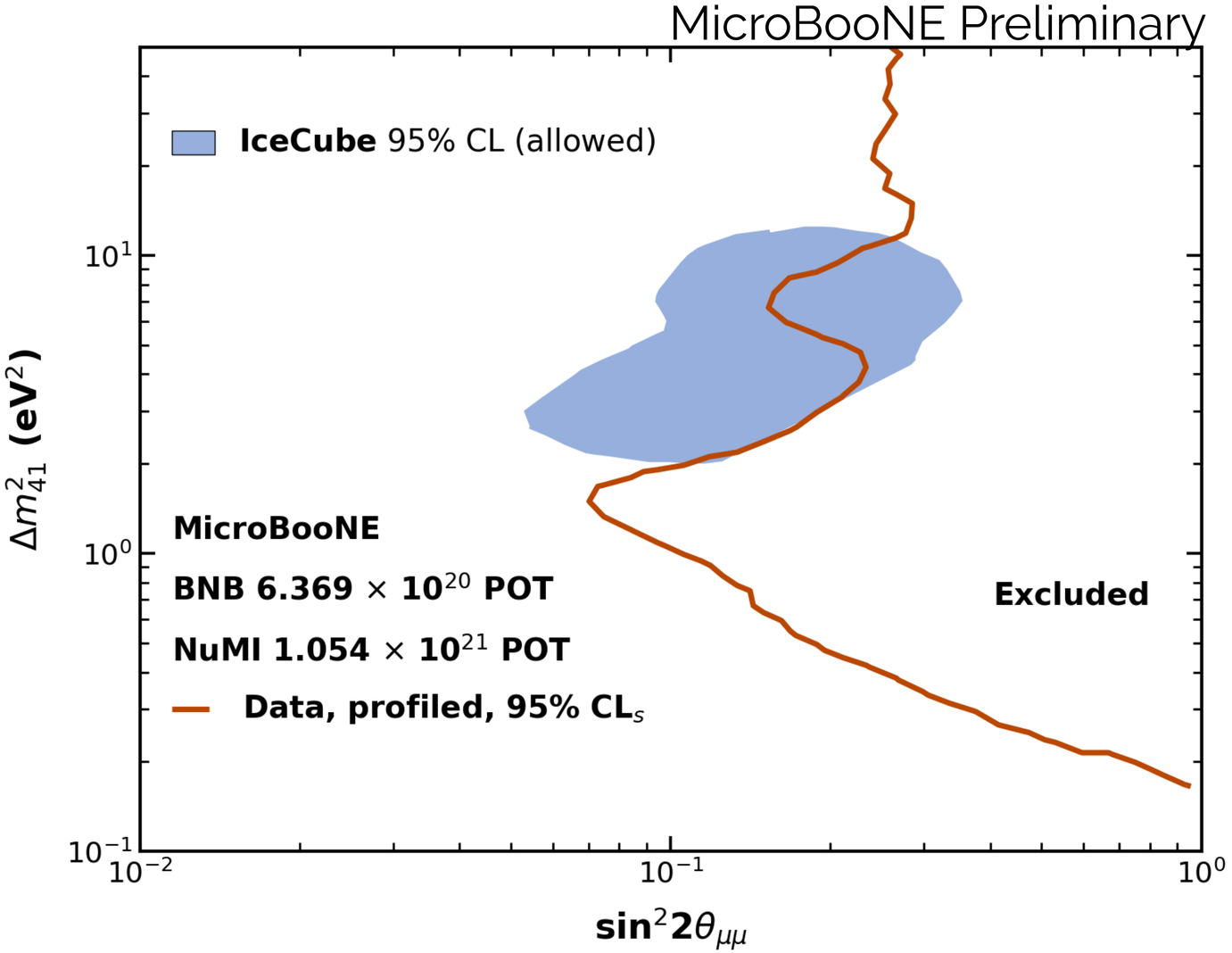
BNB+NuMI Result

$\nu_\mu \rightarrow \nu_e$ appearance

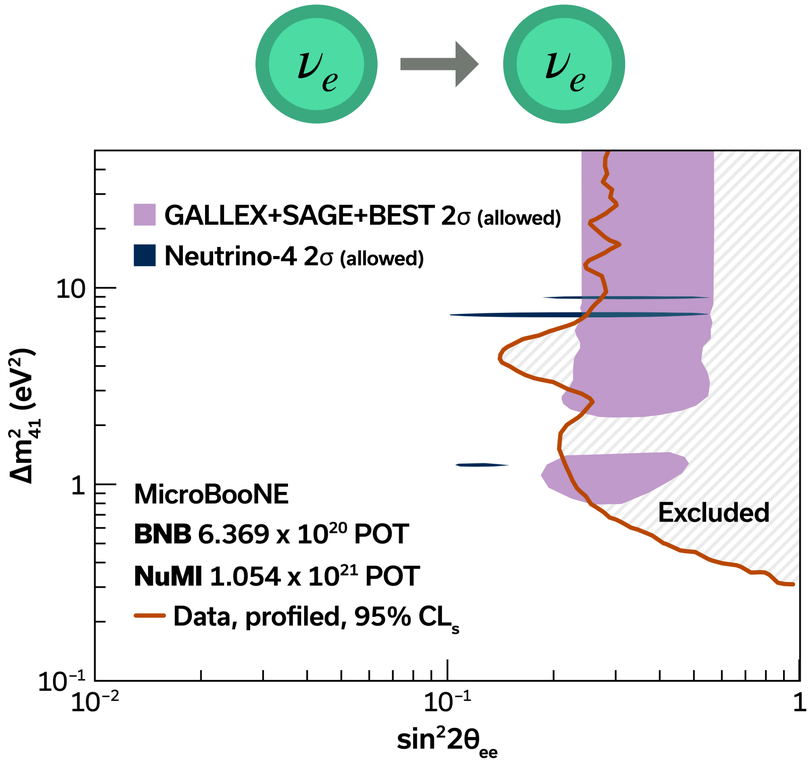
$\nu_e \rightarrow \nu_e$ disappearance

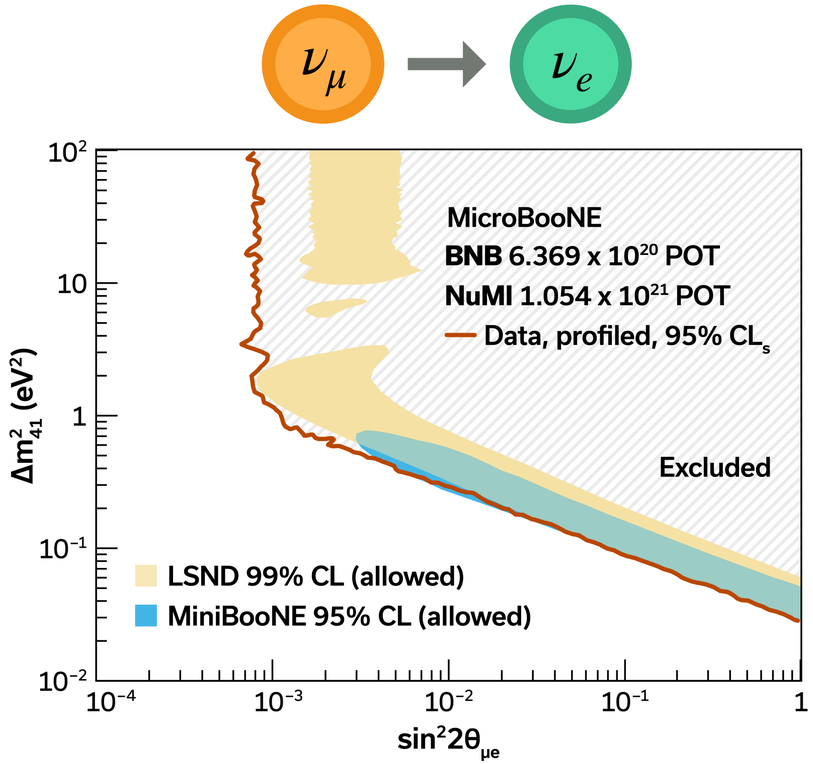
$\nu_\mu \rightarrow \nu_\mu$ **disappearance**

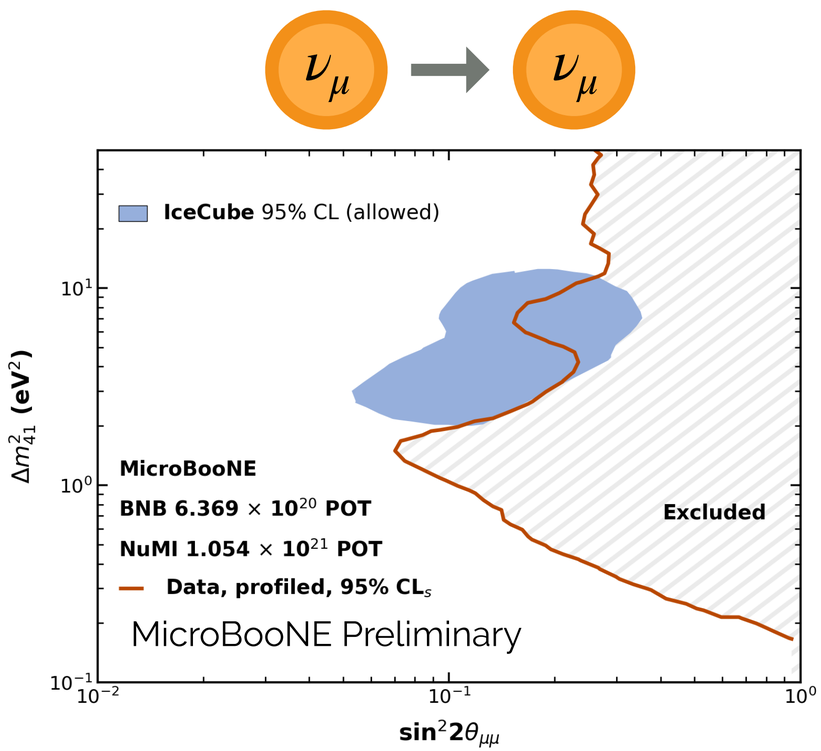
MicroBooNE excludes part of IceCube allowed region



3+1 Sterile Neutrino Search: BNB+NuMI result



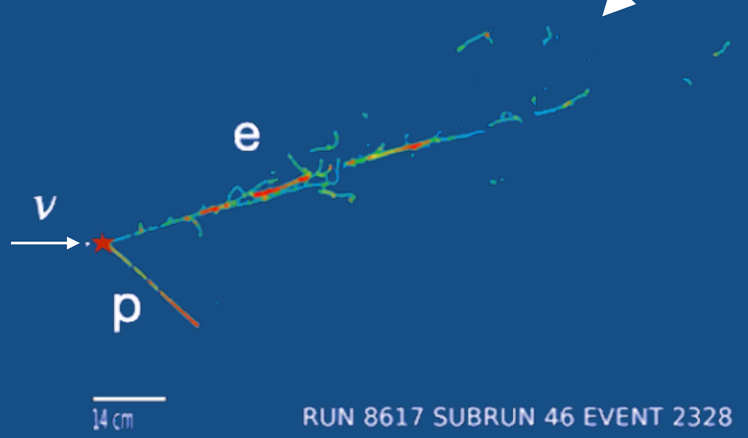




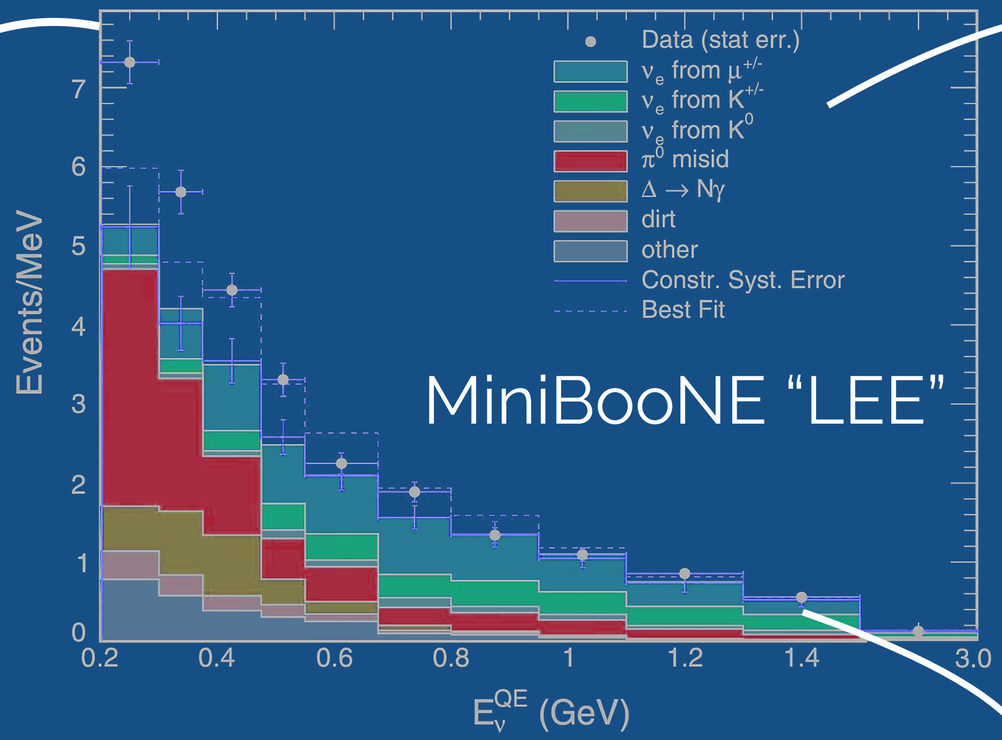
- MicroBooNE has now completed the full 3+1 program, all three oscillation channels measured in one detector
- all consistent with no sterile neutrino, with limited sensitivity in certain channels
- but the question still remains: *then what were the anomalies?*

MicroBooNE's "Low Energy Excess" Search

electron?

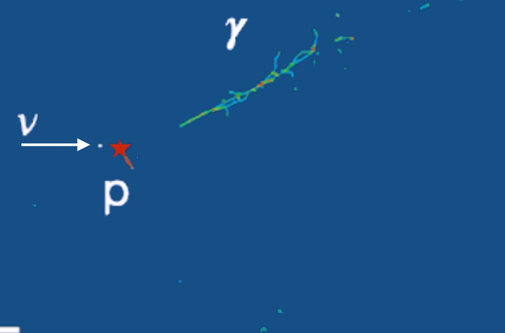


RUN 8617 SUBRUN 46 EVENT 2328



MiniBooNE "LEE"

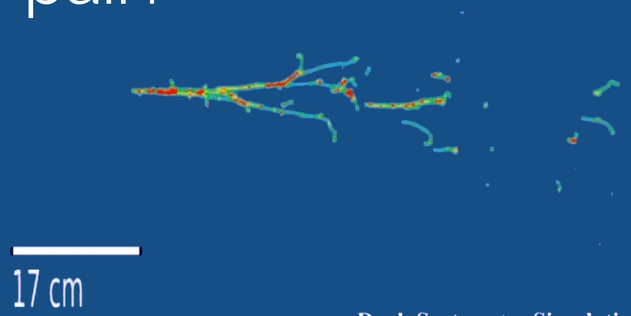
single photon?



MicroBooNE Data, Run 5462 Subrun 14 Event 732

e^+e^- opening angle 5.6°
e^+e^- energy 617 MeV

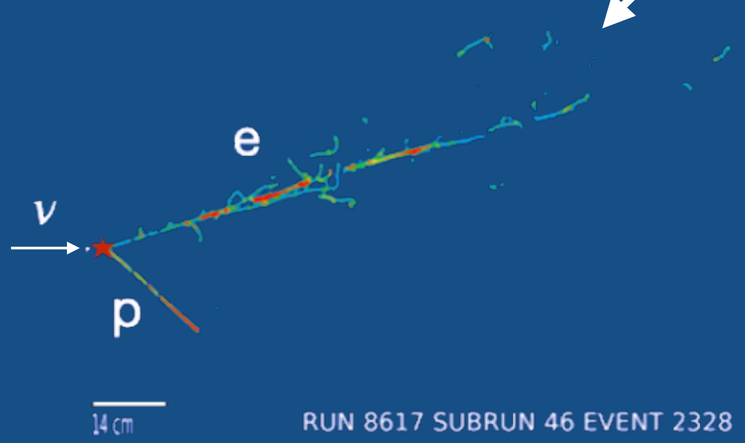
e^+e^- pair?



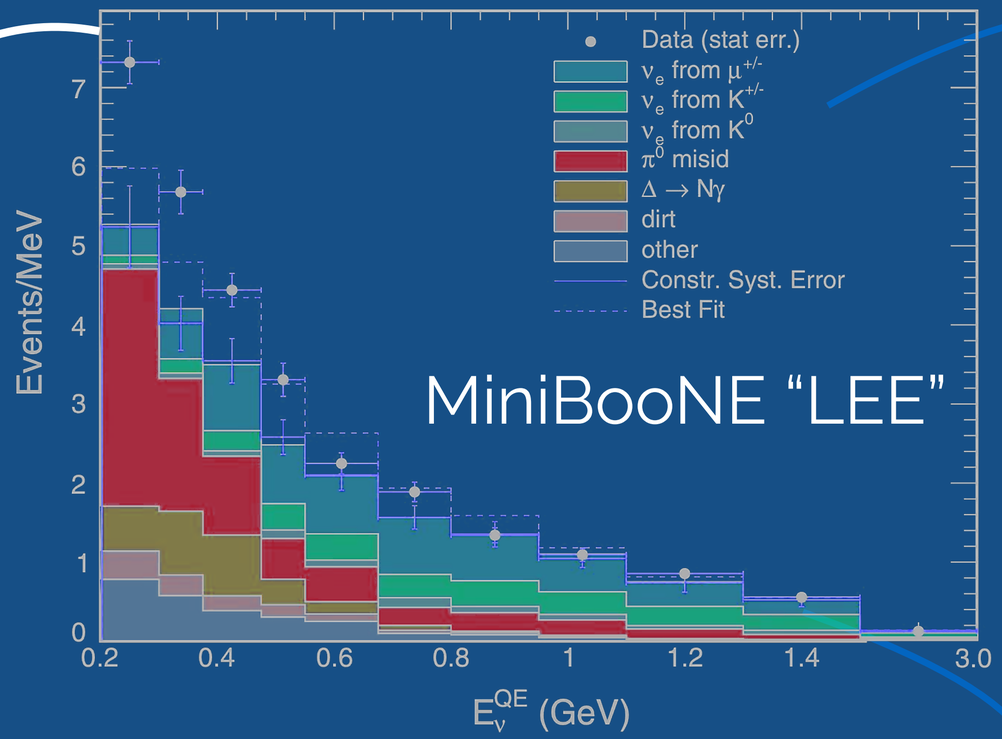
Dark Sector e^+e^- Simulation

MicroBooNE's "Low Energy Excess" Search

electron?



RUN 8617 SUBRUN 46 EVENT 2328



single photon?



disfavored!

[PRD 105 112003 (2022)](#)
[PRD 105 112004 (2022)](#)
[PRD 105 112005 (2022)](#)
[PRL 128 241801 (2022)](#)
[PRL 135 081802 (2025)](#)

[PRL 130 011801 (2023)](#)
[Nature 648 64-69 (2025)](#)

e^+e^- pair?



MicroBooNE's "Low Energy Excess" Search

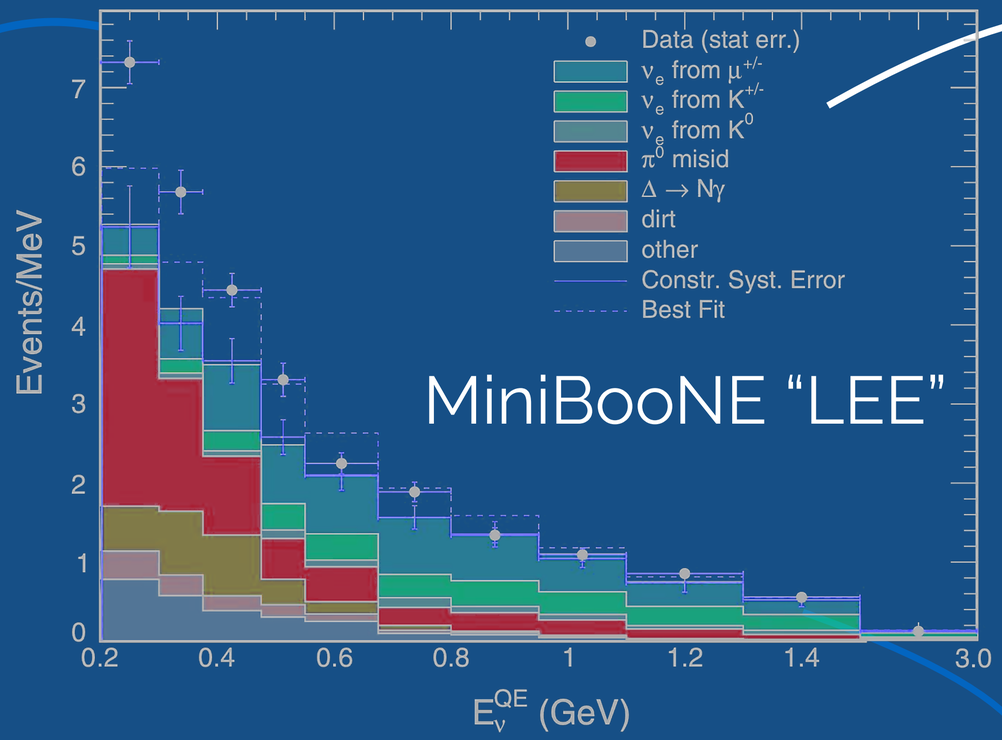
electron?



RUN 8617 SUBRUN 46 EVENT 2328

14 cm

disfavored!



e^+e^- opening angle 5.6°
e^+e^- energy 617 MeV

e^+e^- pair?



17 cm

Dark Sector e^+e^- Simulation

single photon?



25 cm

MicroBooNE Data, Run 5462 Subrun 14 Event 732

disfavored most popular SM process explanations:

NC Δ → 1γ

PRL 128 111801 (2022)

NC coherent 1γ

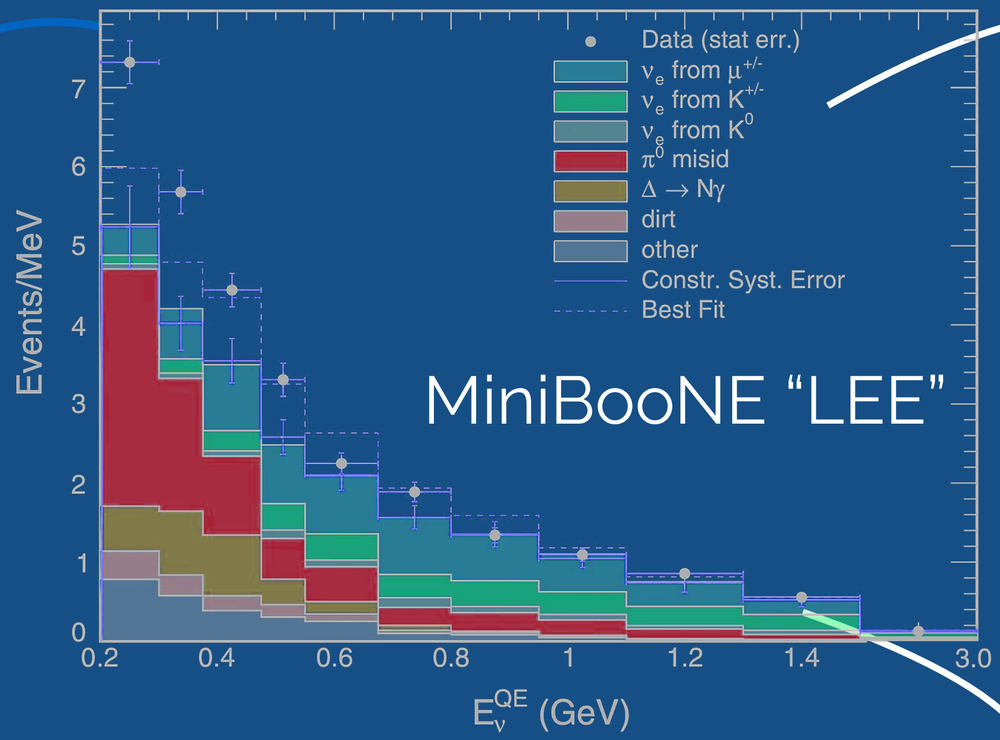
arXiv:2502.06091

MicroBooNE's "Low Energy Excess" Search

electron?



disfavored!



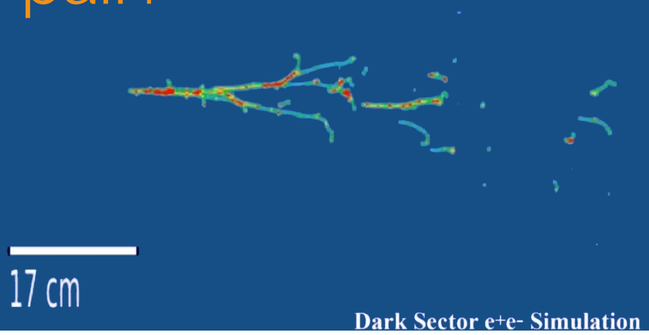
e^+e^- opening angle 5.6°
e^+e^- energy 617 MeV

single photon?



disfavored most popular SM process explanations

e^+e^- pair?

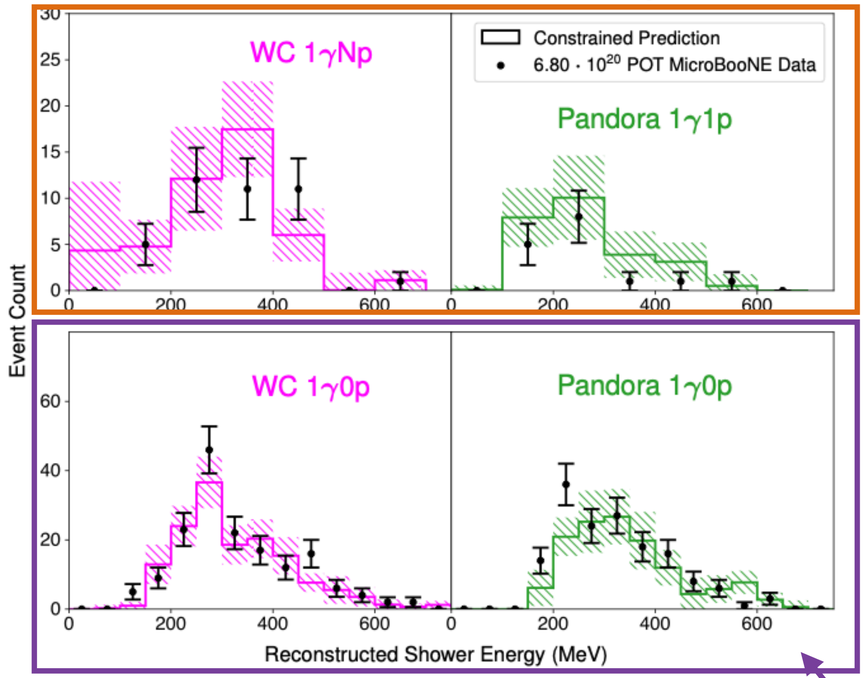


remaining signatures to probe: other **single photon** processes, or ***e+e-* pair** production with new physics

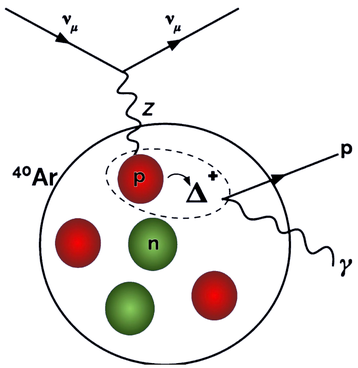
MicroBooNE's "Low Energy Excess" Search: Single Photons

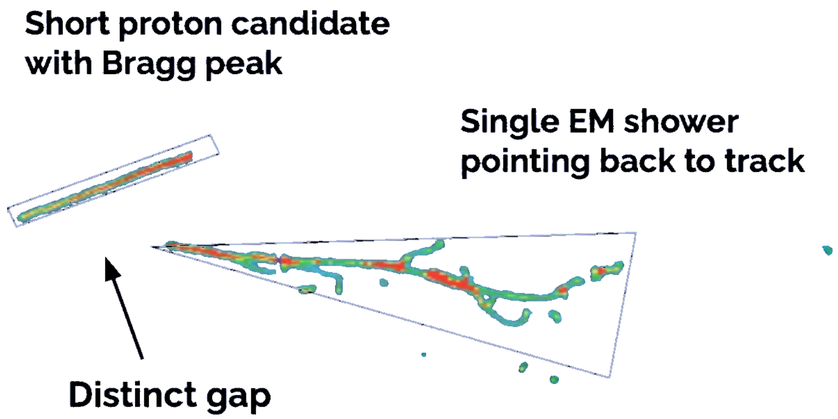
PRD 112 L091101 (2025)

- improved from our 2021 result, NC $\Delta \rightarrow 1\gamma$ SM background search by doubling selection efficiency and enabling much enhanced sensitivity for $1\gamma 0p$ topology
- data are found to be consistent with the nominal prediction

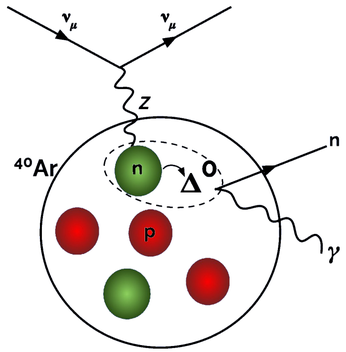


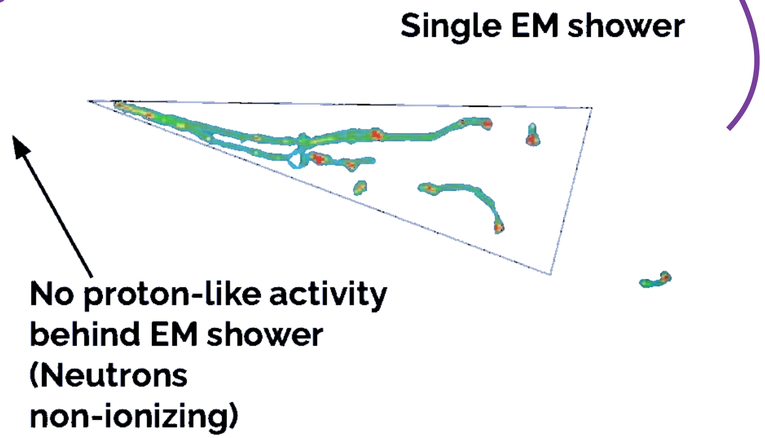
$1\gamma Np$ topology



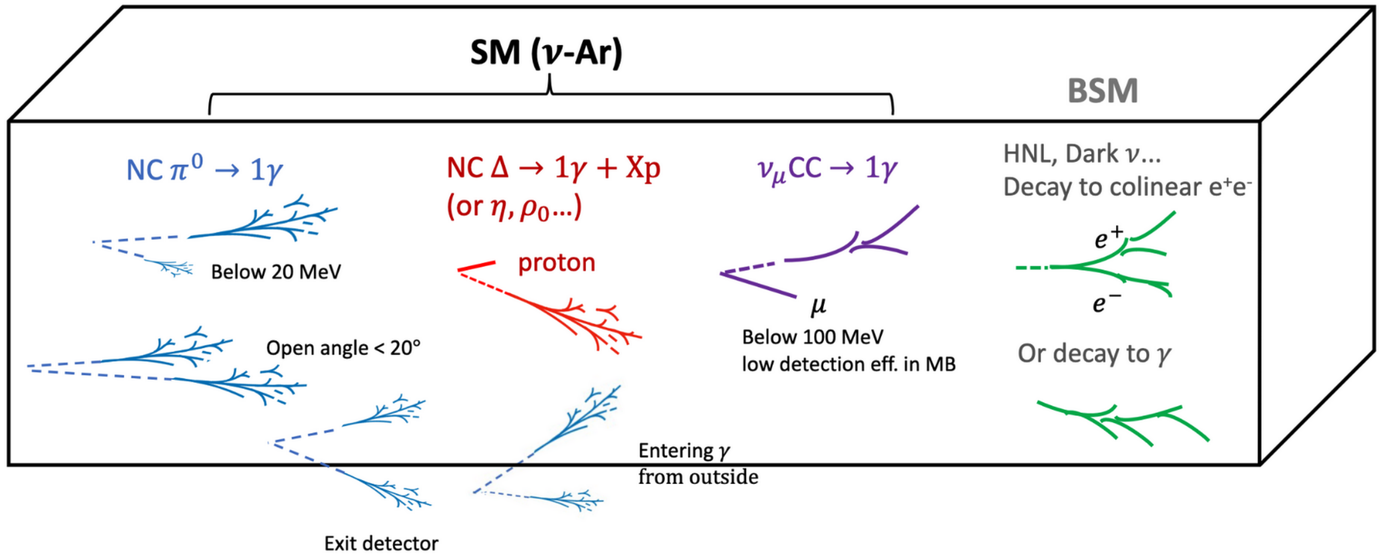


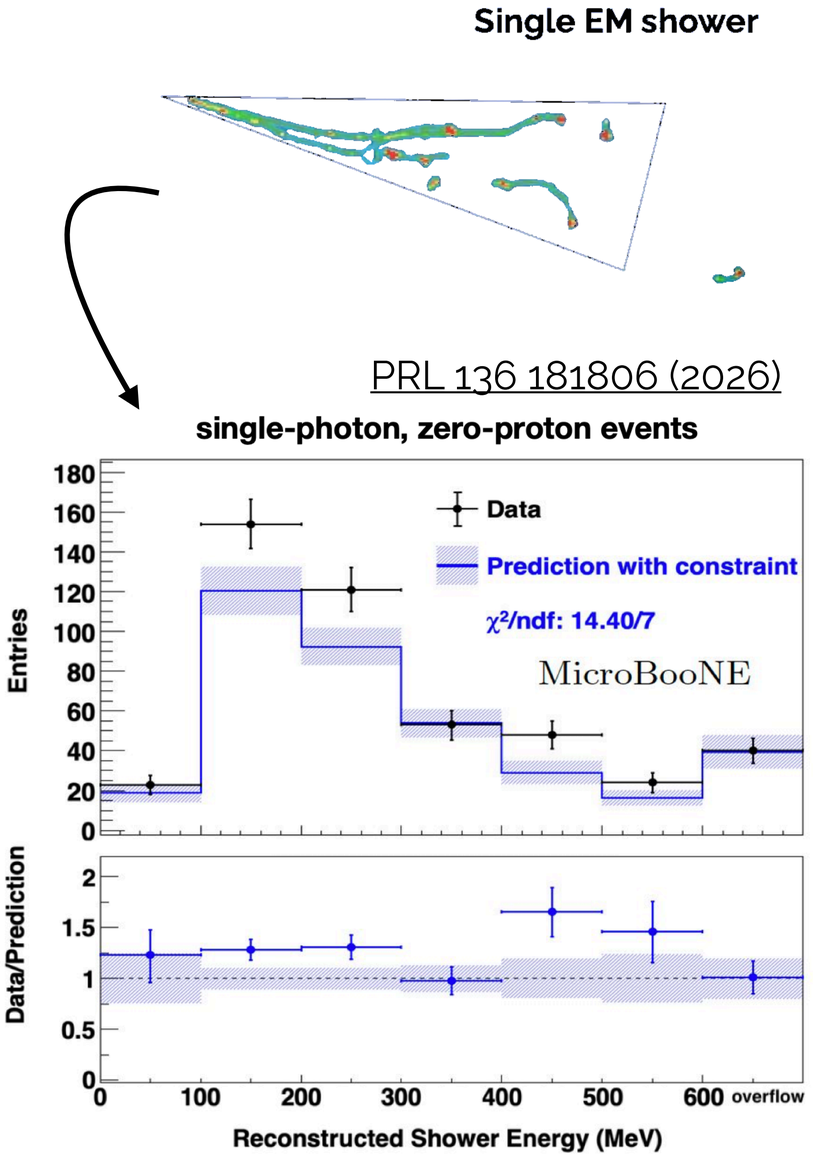
$1\gamma 0p$ topology





MicroBooNE's "Low Energy Excess" Search: Single Photons

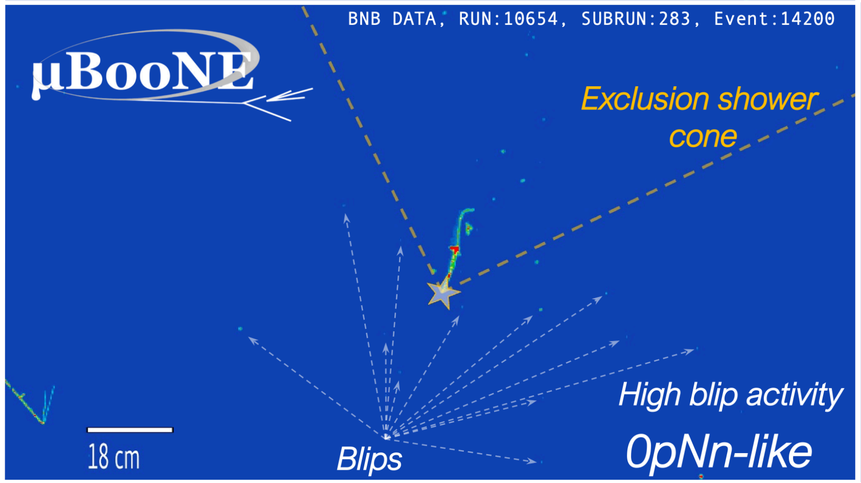


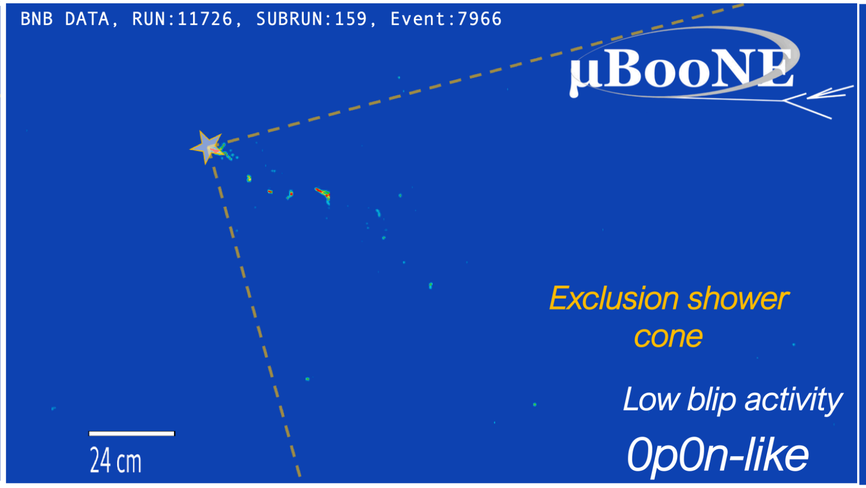


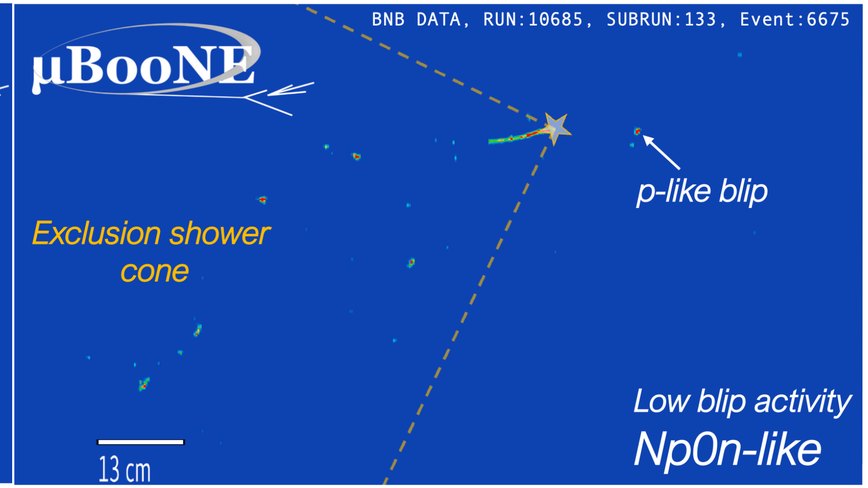
- instead of searching for specific process, also casted a wide net on single photon channel *no matter the origin:* **inclusive** single photon search

  - low energy zero-proton subsample shows an excess with **2σ local significance**, motivating more detailed investigations

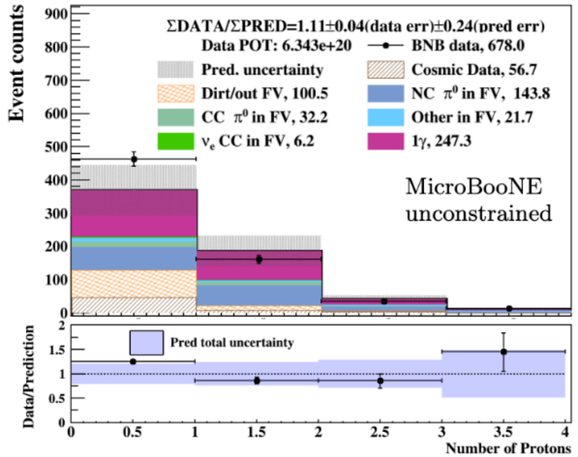
MicroBooNE's "Low Energy Excess" Search: Single Photons



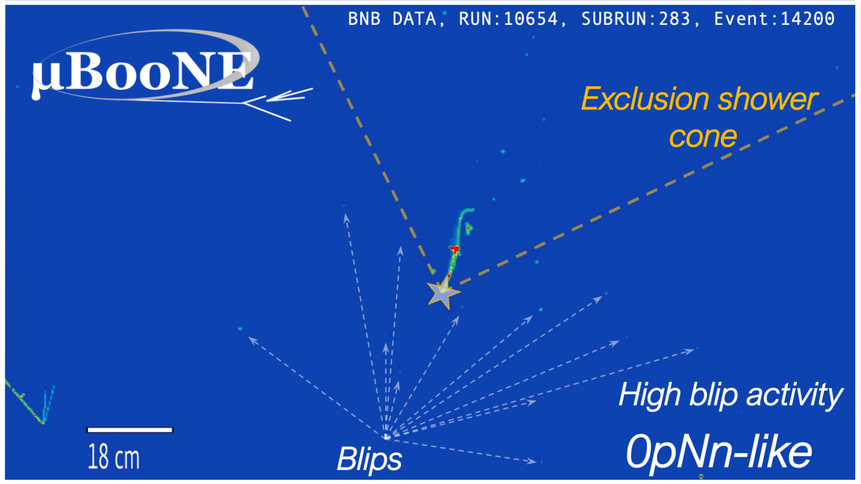


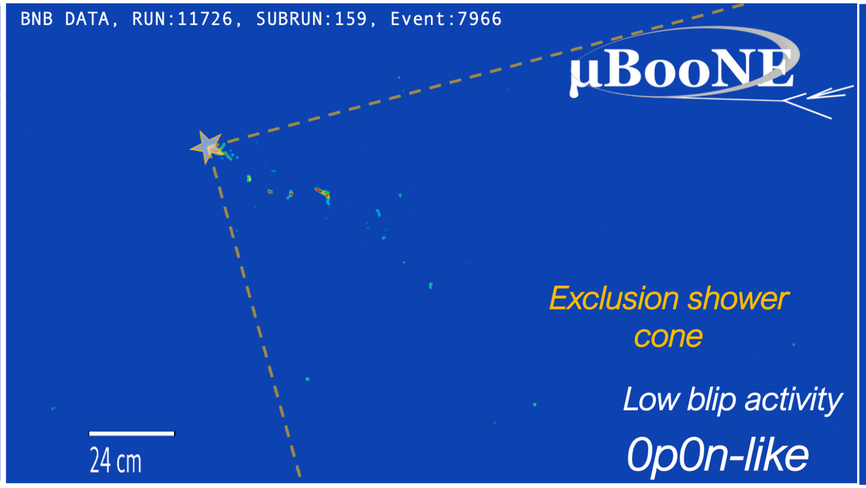


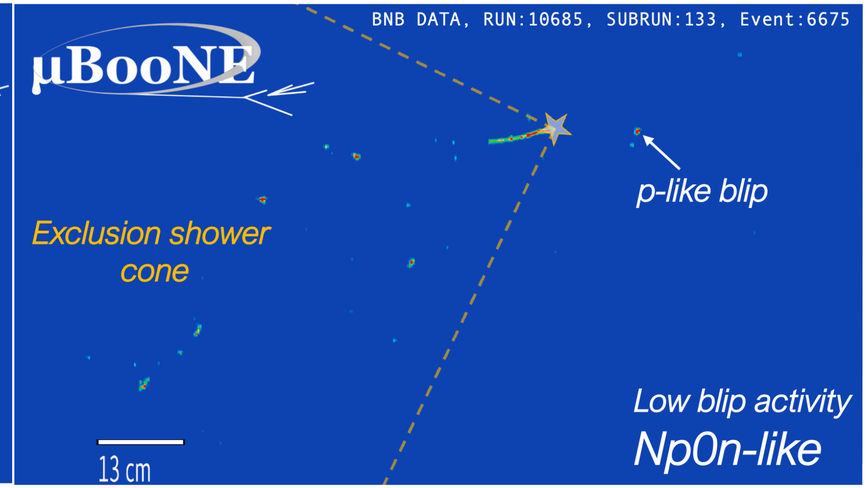
- reconstruction of MeV-scale features in LArTPC (**blips**) can reveal formerly unidentified final-state particles near isolated single showers
  - diffuse low-energy (0-3 MeV) blips: inelastic scattering of final state neutrons
  - higher-energy blips upstream of the isolated shower: final state protons
- this new technique can provide accurate understanding of the features observed in the inclusive single photon analysis



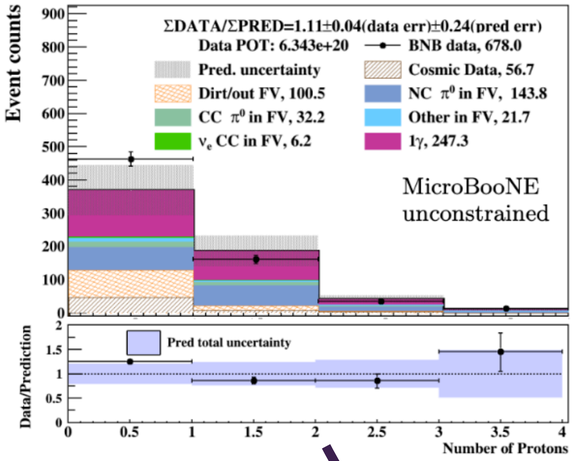
MicroBooNE's "Low Energy Excess" Search: Single Photons



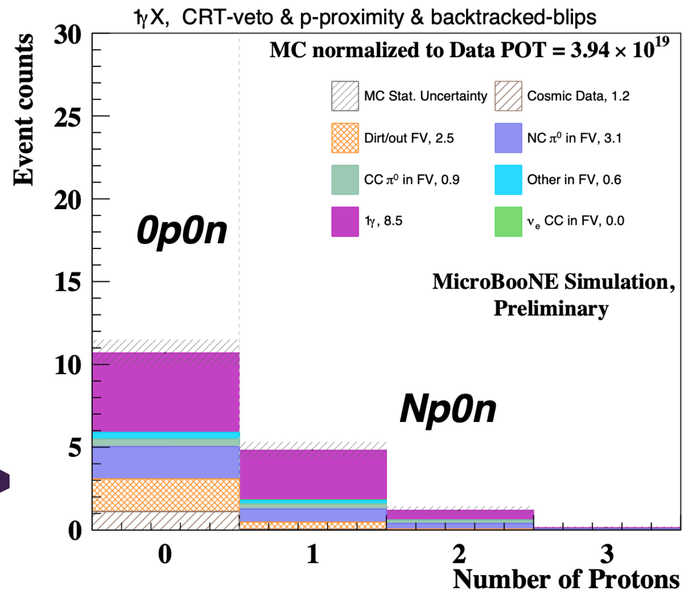




- reconstruction of MeV-scale features in LArTPC (**blips**) can reveal formerly unidentified final-state particles near isolated single showers
  - diffuse low-energy (0-3 MeV) blips: inelastic scattering of final state neutrons
  - higher-energy blips upstream of the isolated shower: final state protons
- this new technique can provide accurate understanding of the features observed in the inclusive single photon analysis

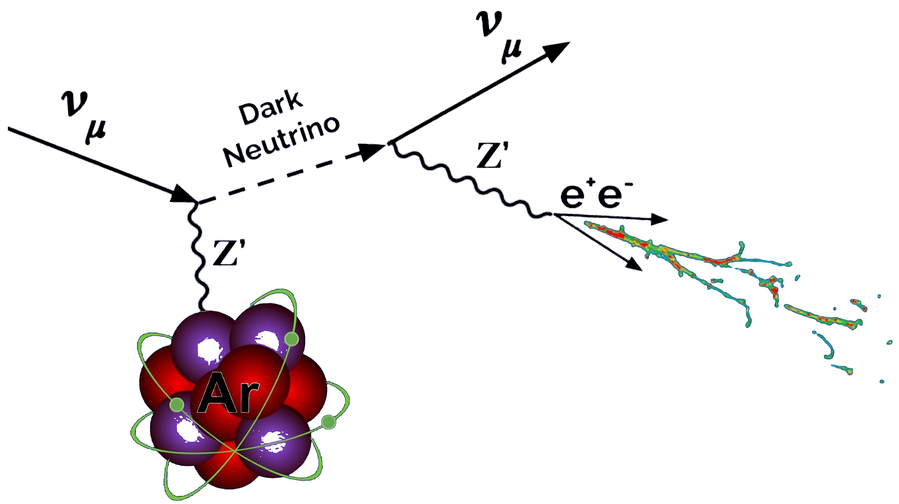


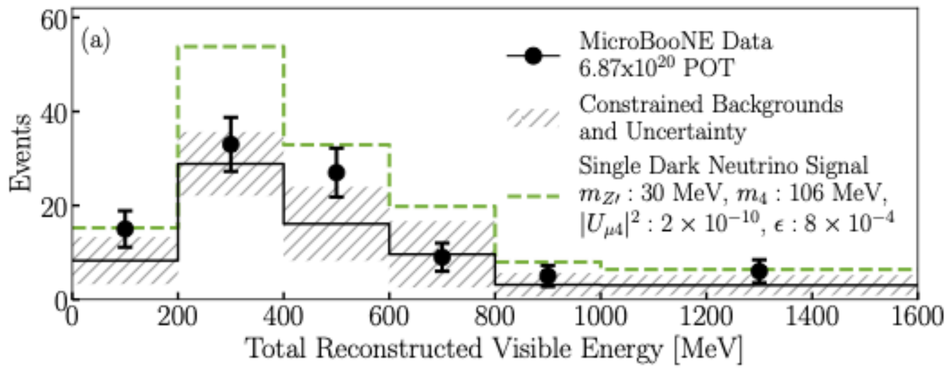
MicroBooNE Public Note 1134

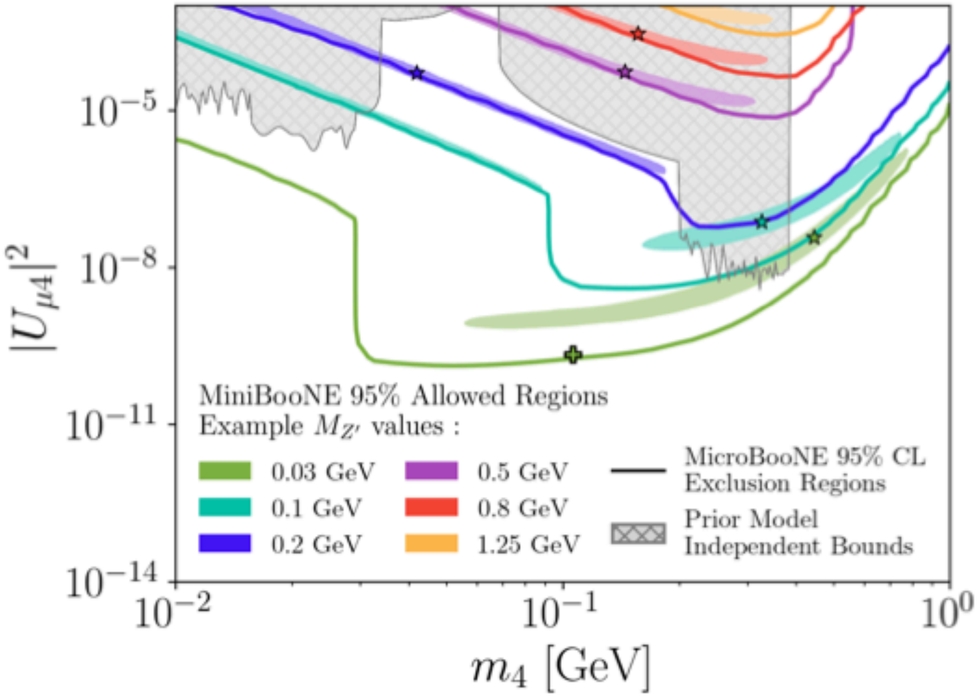


MicroBooNE's "Low Energy Excess" Search: BSM *e+e-*

PRL 136 121804 (2026)



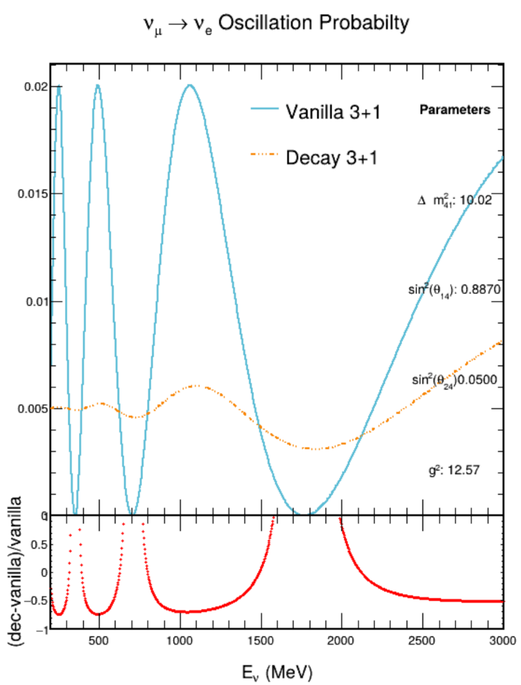




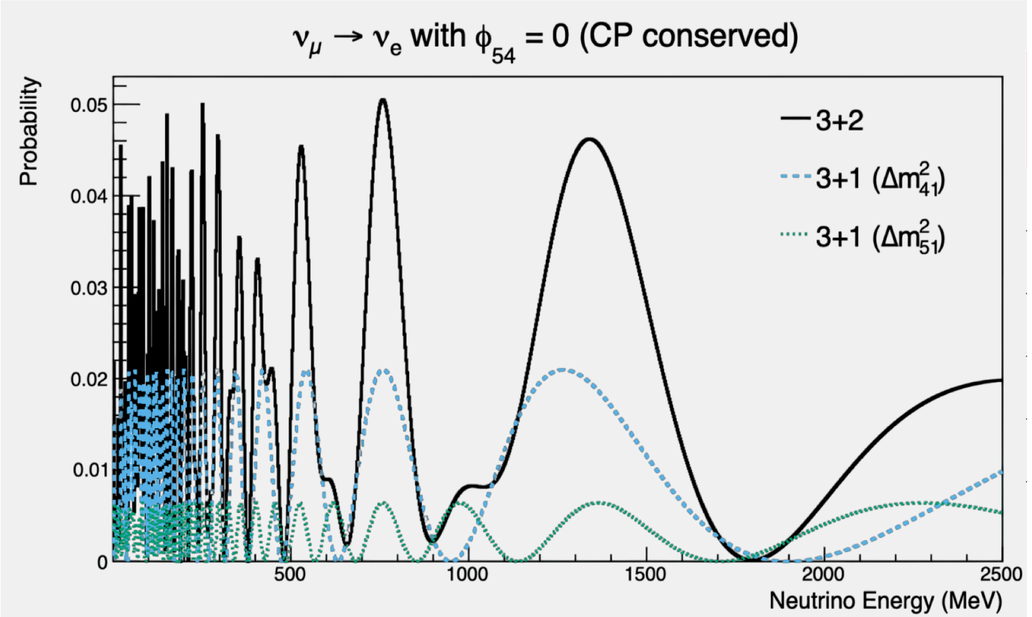
- search for forward going *e+e-* pairs from unstable dark neutrino decay
- sensitive to MiniBooNE allowed region for these models at >95% CL
- MicroBooNE places world leading exclusion limits, ruling out this interpretation of the MiniBooNE anomaly

Expanded Sterile Neutrino Search

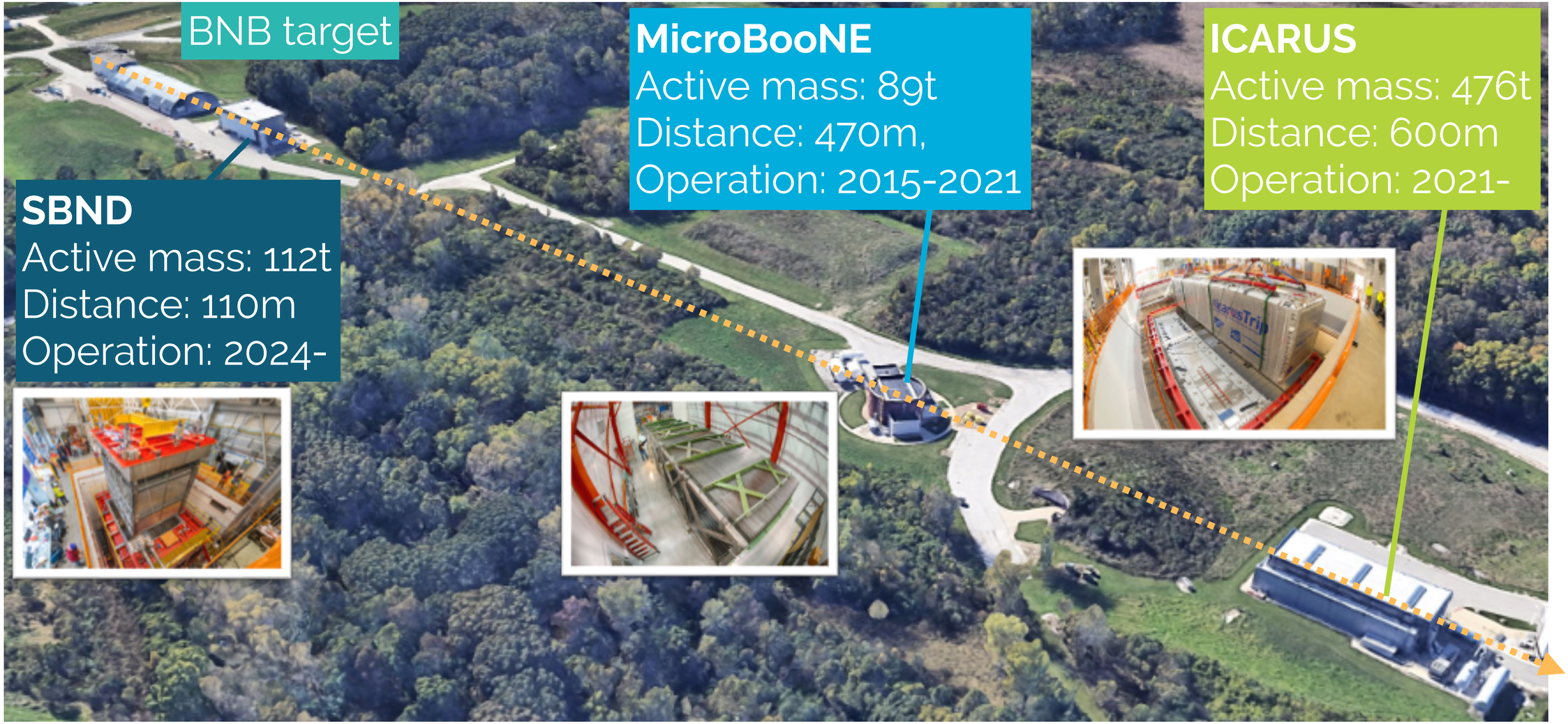
- **full-dataset 3+1 analysis**
  - almost double data in both BNB & NuMI
  - addition of external datasets (Prospect/KATRIN/ICARUS)
  - thorough investigation of 3D 3+1
- **additional models beyond vanilla 3+1**
  - 3+1+decay (invisible and visible)
  - 3+2 (includes CP violation)
- **expanding framework** to allow full Feldman-Cousins analysis and pull-term/nuisance systematics



MicroBooNE Work In Progress



How can we do even better: SBN Program at Fermilab



- SBN program with two additional near & far LArTPC detectors, will provide a more comprehensive and sensitive exploration of sterile neutrino and other BSM physics

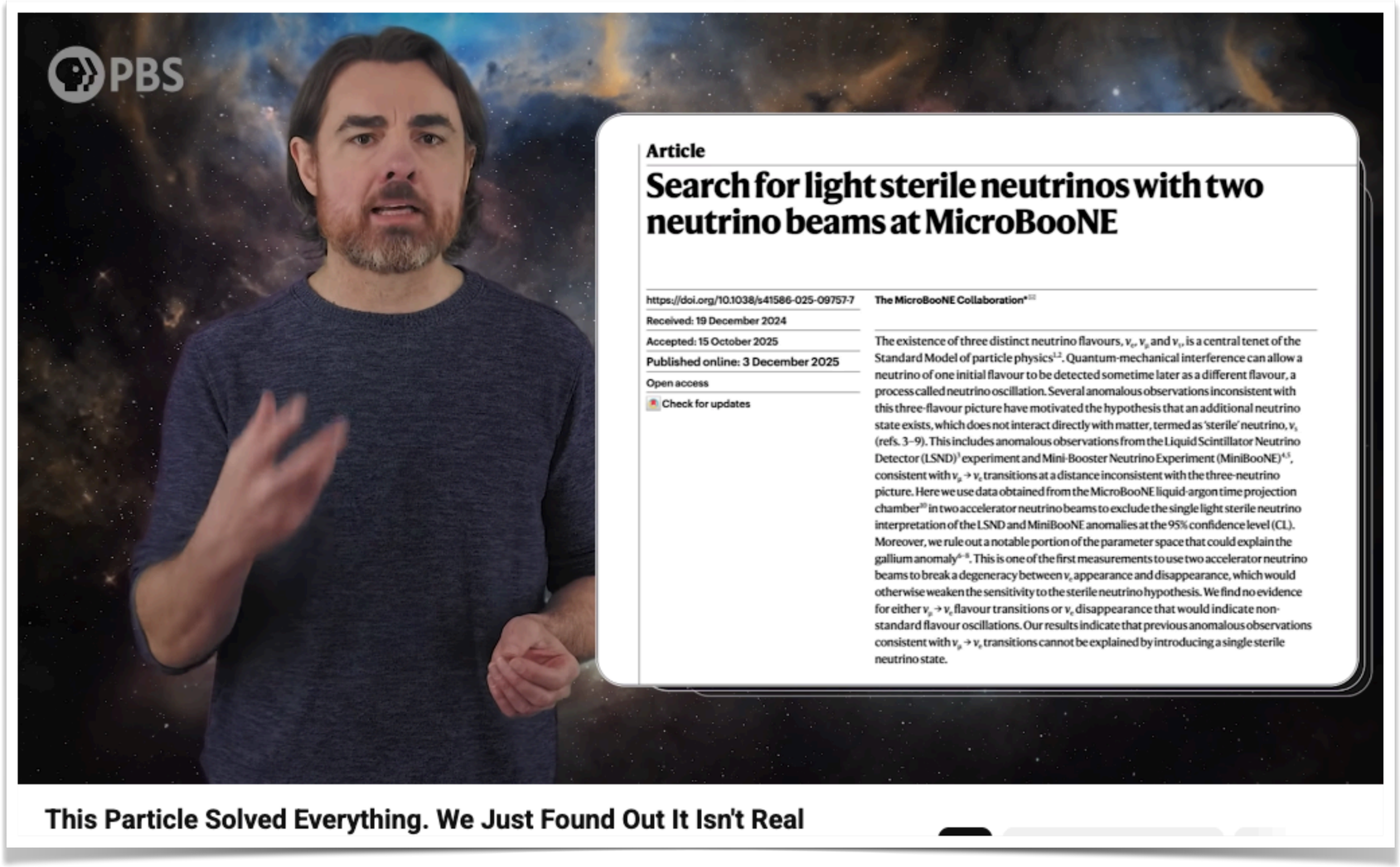
Summary

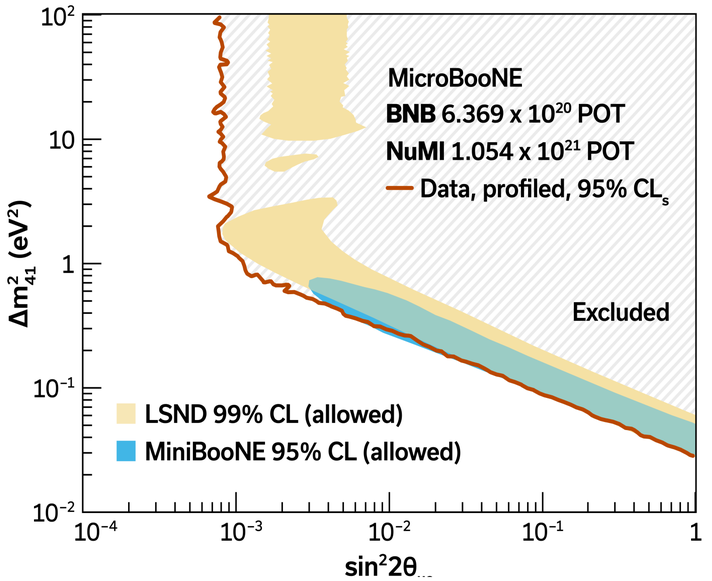
- appearance (LSND, MiniBooNE) and disappearance (gallium, reactor) **anomalies** all point to $\Delta m^2 \sim 1\ eV^2$
- MicroBooNE's **two beams in one detector** break the appearance/disappearance degeneracy
  - ν_e appearance excludes the LSND and MiniBooNE regions at 95% CL
  - ν_e disappearance excludes most of the gallium region
  - ν_μ disappearance (preliminary) excludes part of the IceCube region
- **beyond 3+1**: $\Delta \rightarrow N\gamma$ and dark-neutrino e^+e^- explanations of the MiniBooNE excess are disfavored
- **ahead**: MicroBooNE's full-dataset analysis and extended models (3+2, 3+1+decay)
- **the wider program**: JSNS^2 tests LSND directly in the antineutrino channel, and SBN will provide the near/far two-detector test

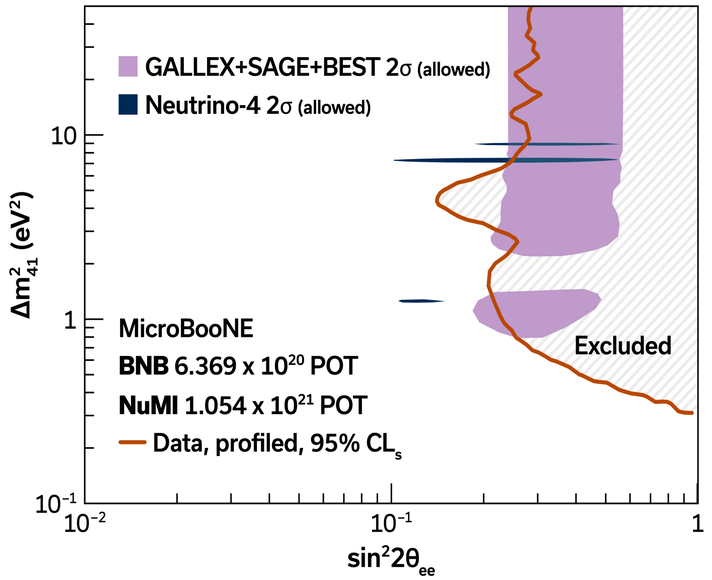
the anomalies remain unexplained, and the coming results will test them from several independent directions

“This Particle Solved Everything. We Just Found Out It Isn’t Real”

PBS Space Time Youtube Channel

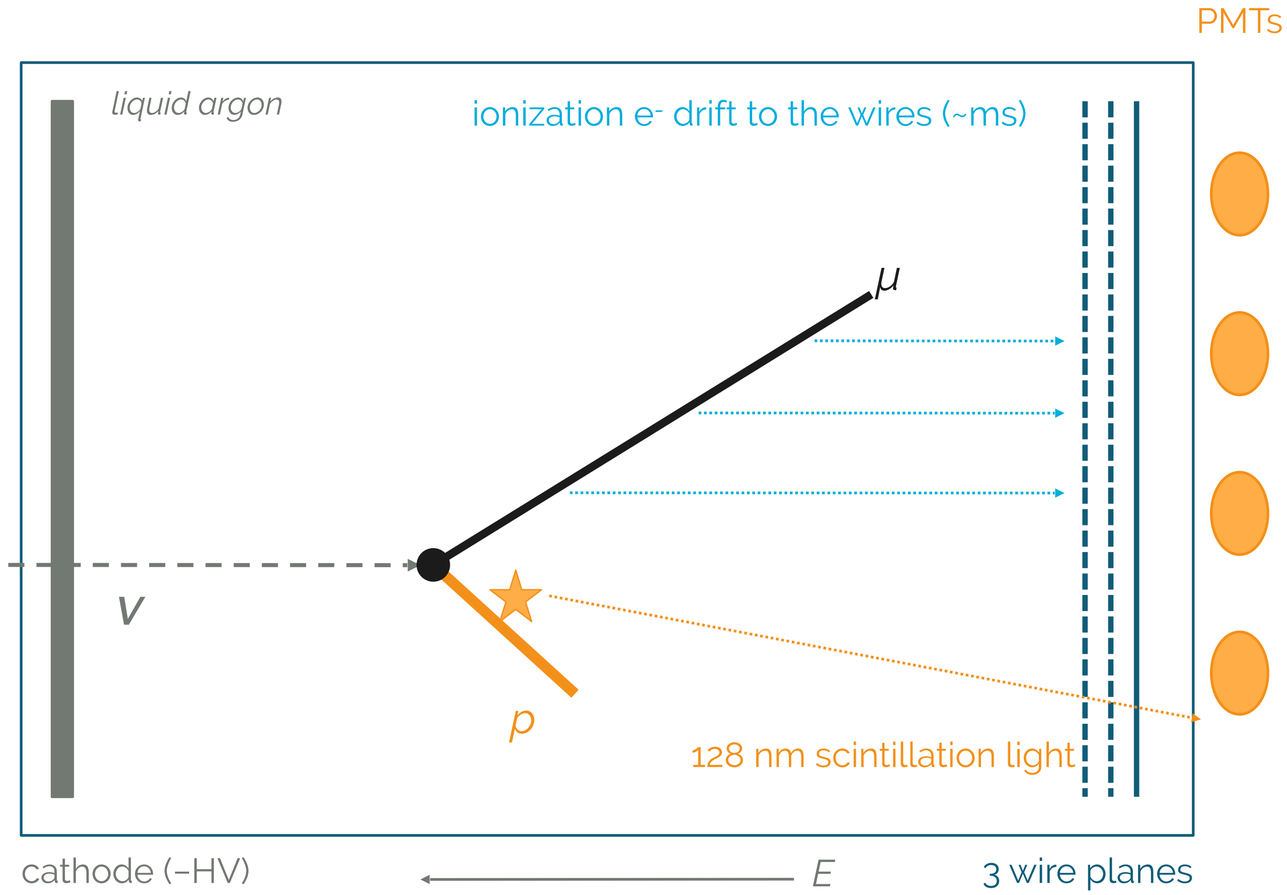






Backup slides

How a Liquid Argon TPC Works

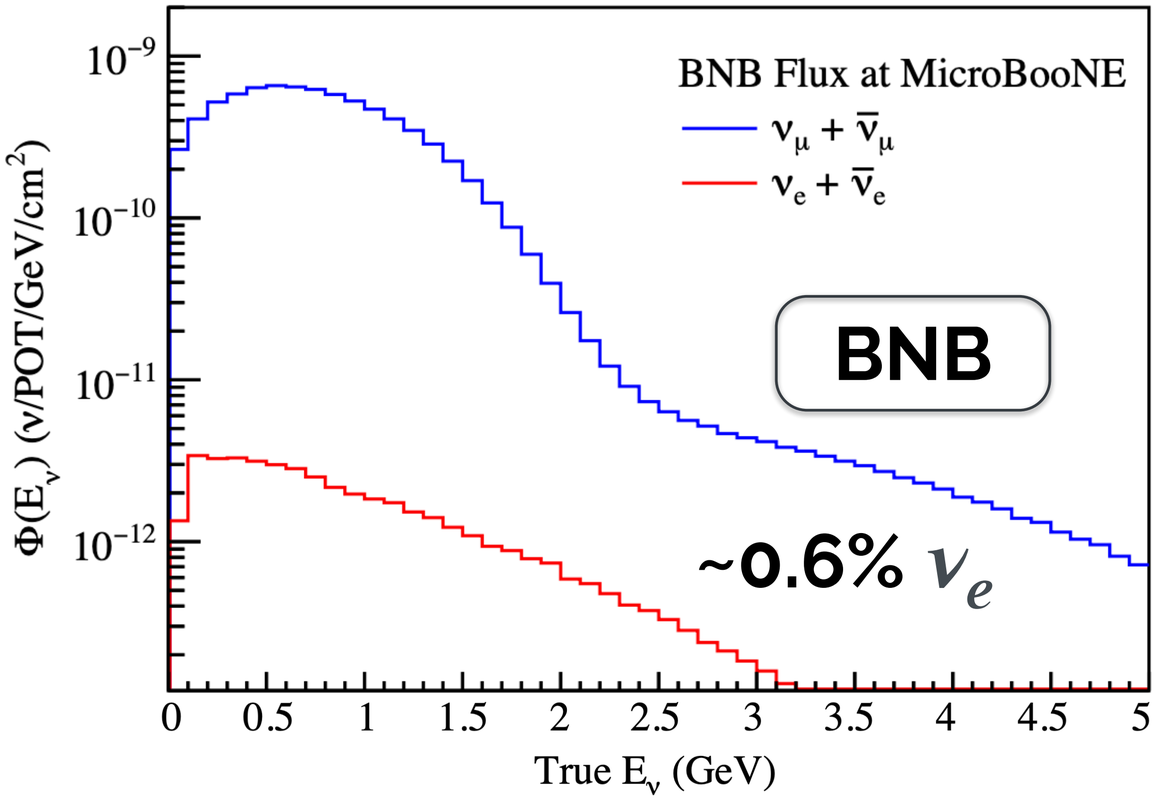


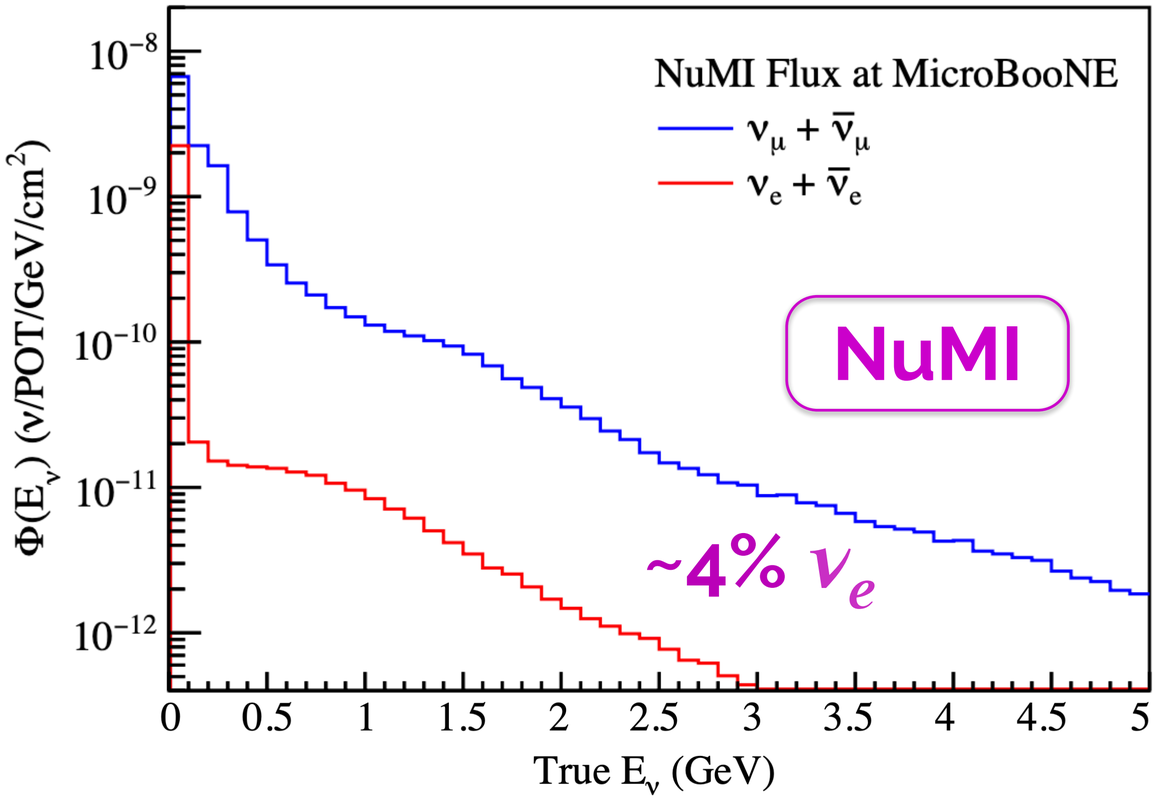
- charged particles **ionize** the argon and produce **scintillation light**
- ionization electrons **drift** in a uniform field to the anode wire planes
- three planes give three 2D views, combined into a **mm-scale 3D image**
- the light flash gives the **event time** (t_0) and the trigger

MicroBooNE

- 89 t active LAr, 470 m from the BNB target
- 2.56 m drift, 3 planes with 3 mm pitch (8,256 wires)
- 32 PMTs + cosmic ray tagger
- sees both BNB (on-axis) and NuMI (off-axis) beams

3+1 Sterile Neutrino Search: adding NuMI





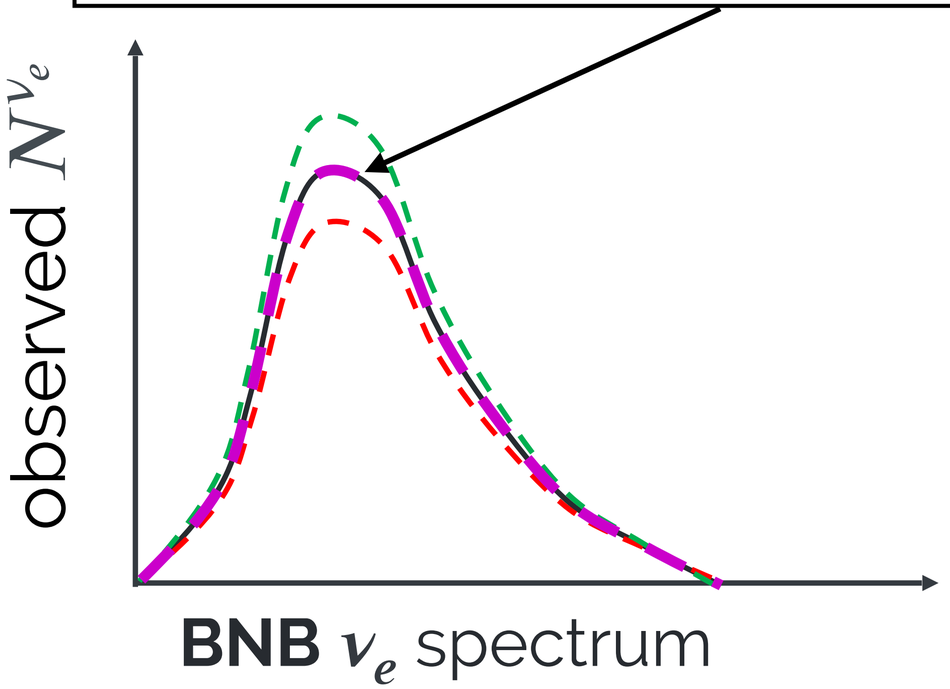
beam ν_μ-to-ν_e ratios: BNB~200 vs NuMI~25

they have quite different degeneracy points!

so we have two "handles" to lift the appearance-disappearance degeneracy

3+1 Sterile Neutrino Search: degeneracy

Cancellation of ν_e appearance and disappearance



No oscillation: N^{ν_e}

Disapp effect: $N^{\nu_e} \times P_{ee}$

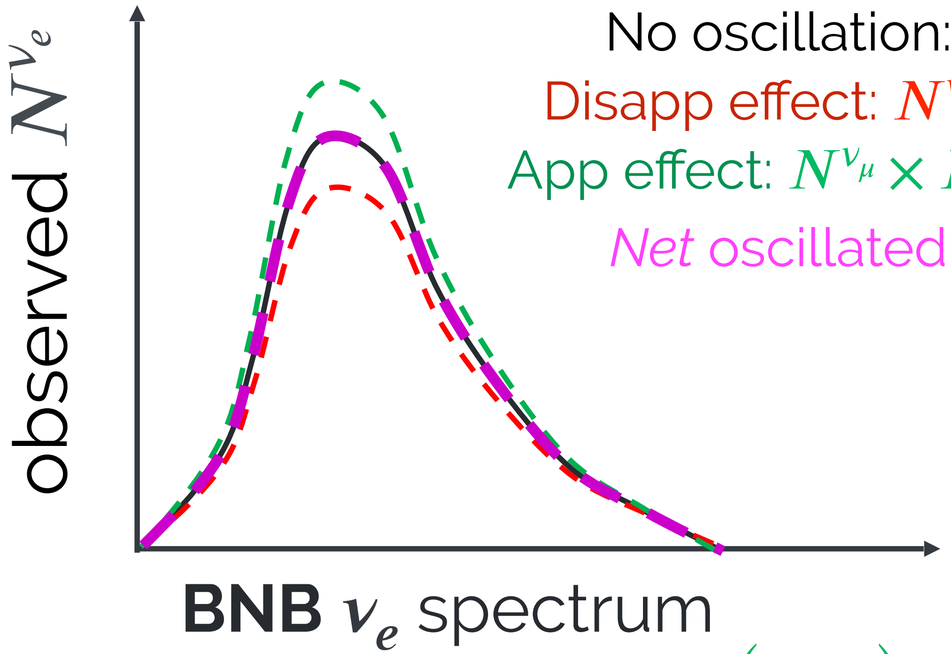
App effect: $N^{\nu_\mu} \times P_{\mu e} + N^{\nu_e}$

Net oscillated N^{ν_e}

degeneracy "point": $\frac{P_{\mu e}}{P_{ee}} = \frac{\sin^2\left(2\theta_{\mu e}\right)}{\sin^2\left(2\theta_{ee}\right)} = \frac{N^{\nu_e}}{N^{\nu_\mu}}$, fixed value for a given beam

3+1 Sterile Neutrino Search: adding NuMI

Cancellation of ν_e appearance and disappearance



No oscillation: N^{ν_e}

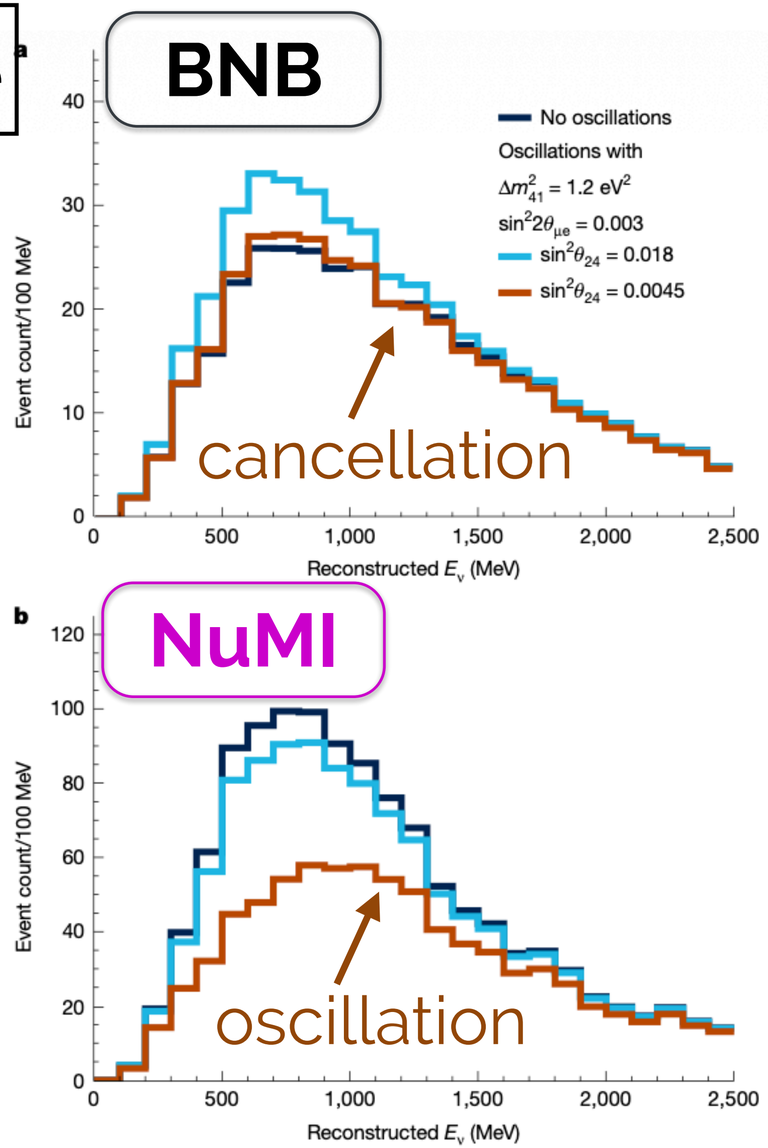
Disapp effect: $N^{\nu_e} \times P_{ee}$

App effect: $N^{\nu_\mu} \times P_{\mu e} + N^{\nu_e}$

Net oscillated N^{ν_e}

now with different $\frac{P_{\mu e}}{P_{ee}} = \frac{\sin^2(2\theta_{\mu e})}{\sin^2(2\theta_{ee})} = \frac{N^{\nu_e}}{N^{\nu_\mu}}$ for BNB and NuMI,

even BNB (NuMI) has cancellation, NuMI (BNB) at the same oscillation parameters still show oscillation!

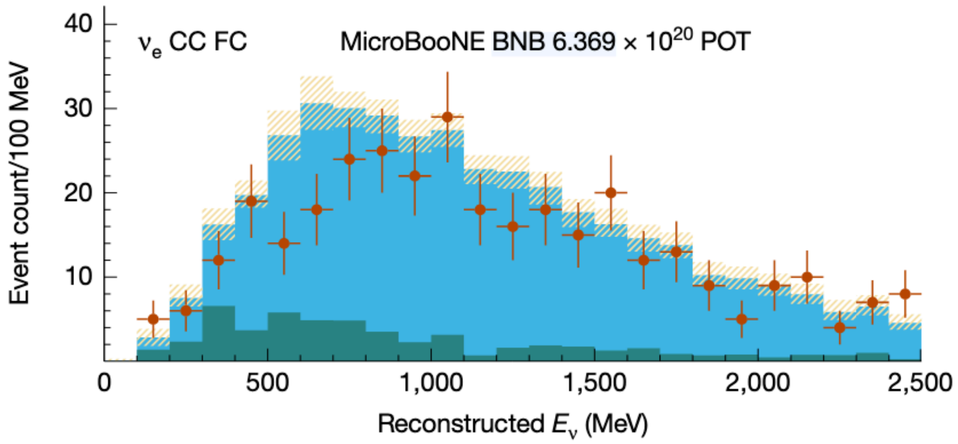


3+1 Sterile Neutrino Search: BNB+NuMI result

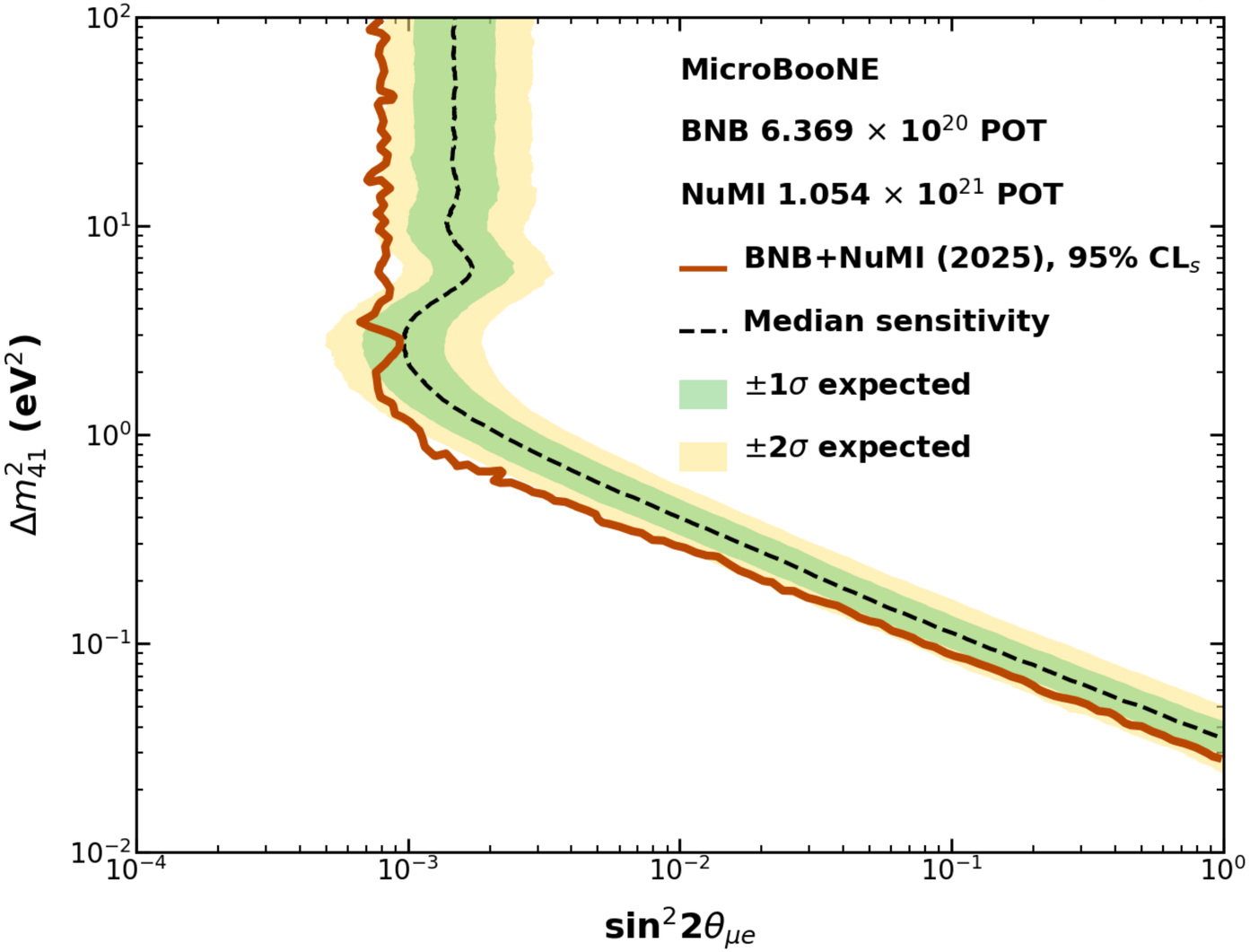


Nature 648 64-69 (2025)

BNB CC ν_e



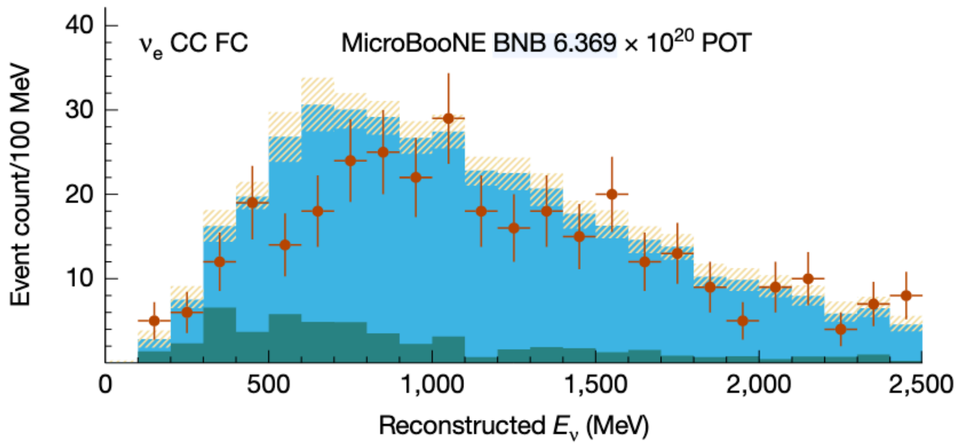
data exclusion is stronger than median sensitivity: driven by deficit in BNB ν_e sample



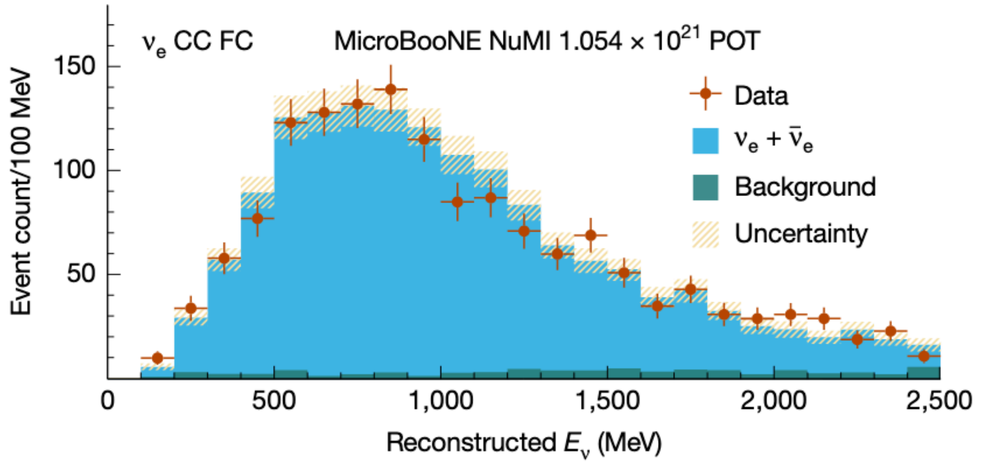
Strength of Result driven by BNB ν_e

Nature 648 64-69 (2025)

BNB CC ν_e



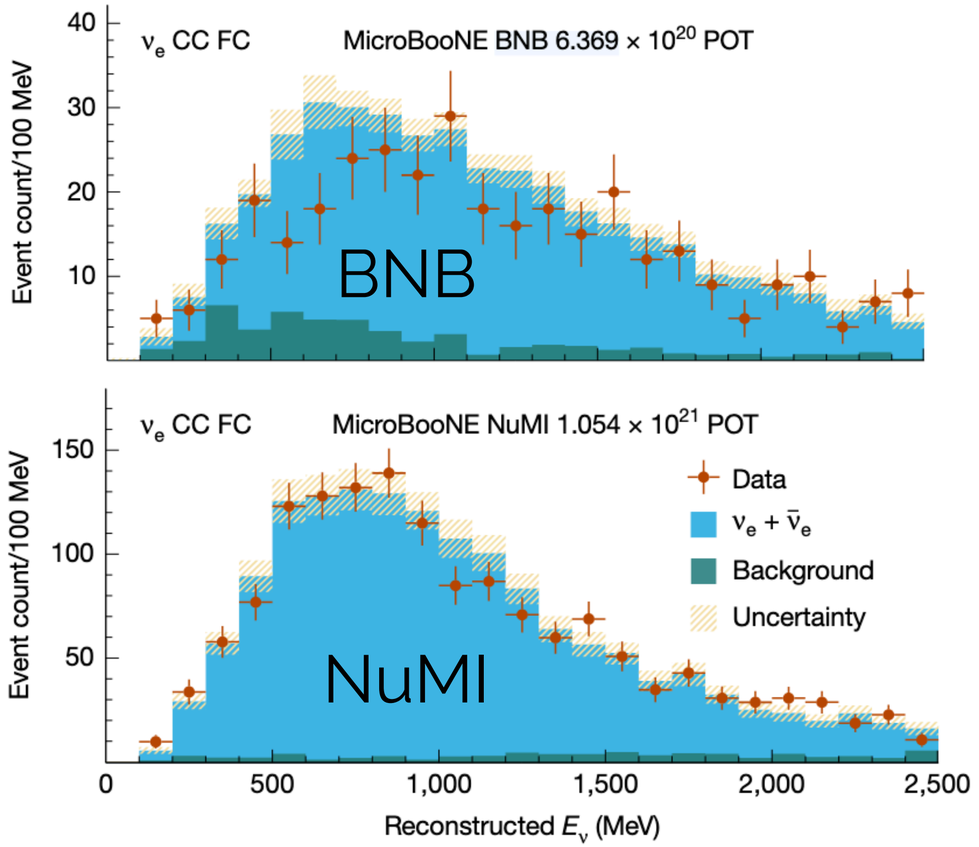
NuMI CC ν_e



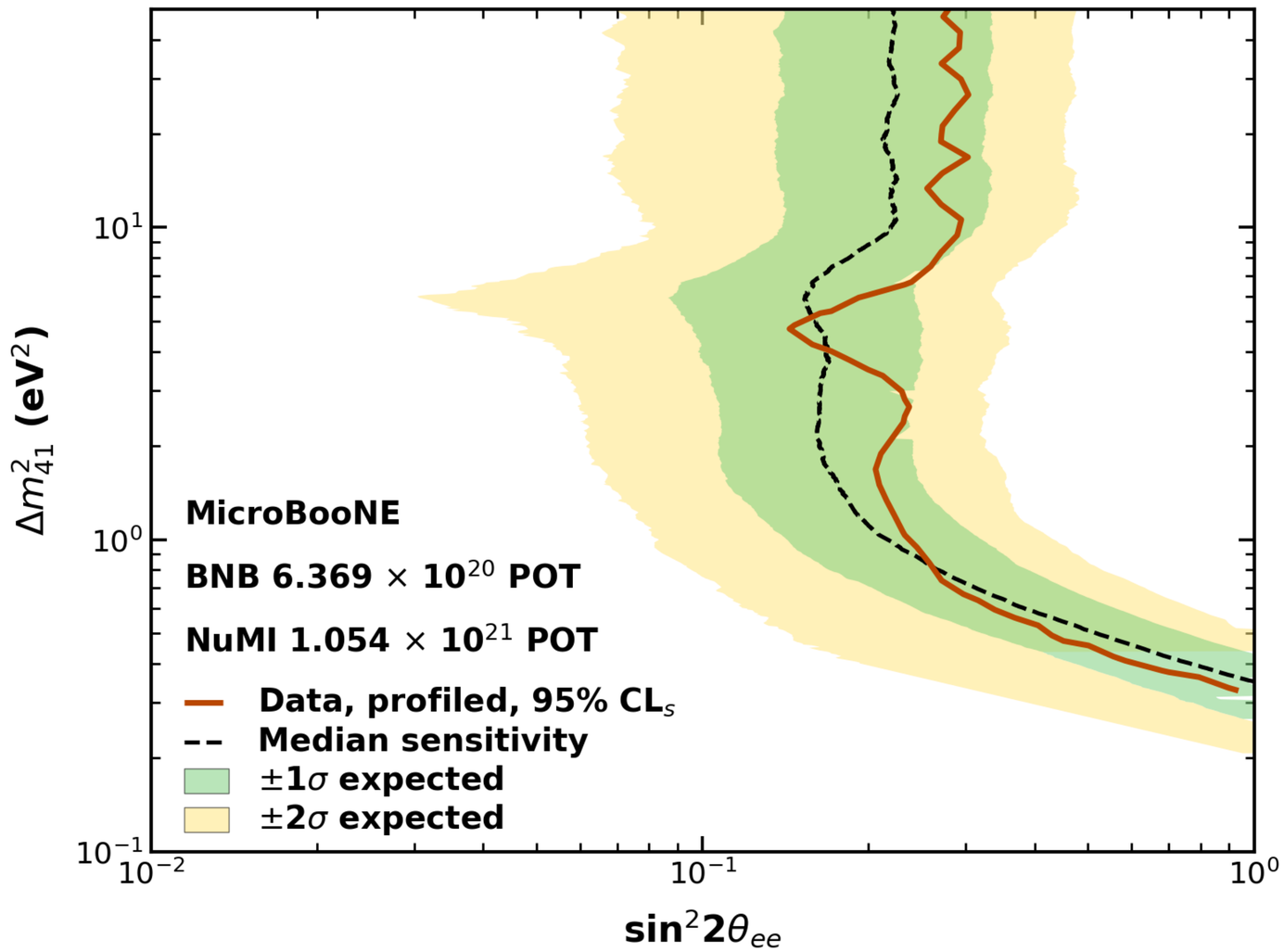
- ~2.1σ local deficit observed in BNB CC ν_e
- results in stronger (weaker) data exclusion in ν_e appearance (disappearance) channel
- BNB plays more significant role in ν_e appearance, so the impact of the data deficit is stronger in the appearance channel

- excellent agreement in NuMI CC ν_e

3+1 Sterile Neutrino Search: BNB+NuMI result

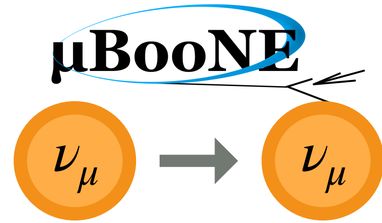


data exclusion is slightly weaker than median sensitivity: driven by deficit in BNB ν_e sample

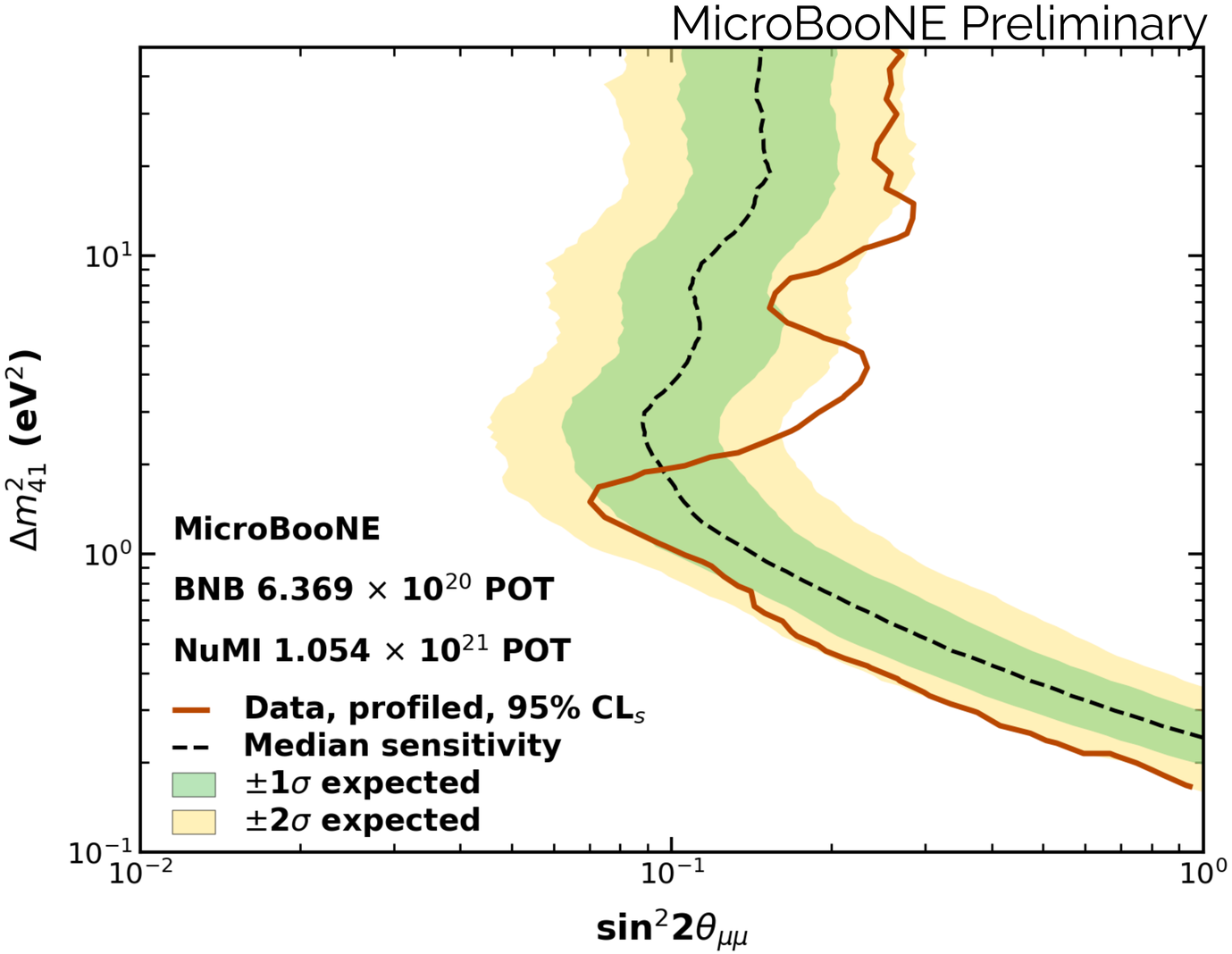


Nature 648 64-69 (2025)

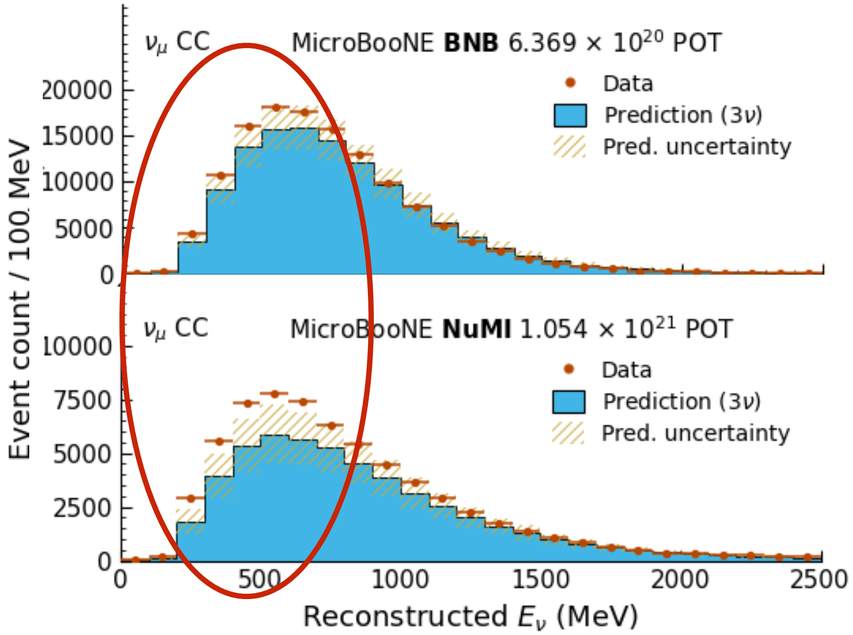
3+1 Sterile Neutrino Search: BNB+NuMI result



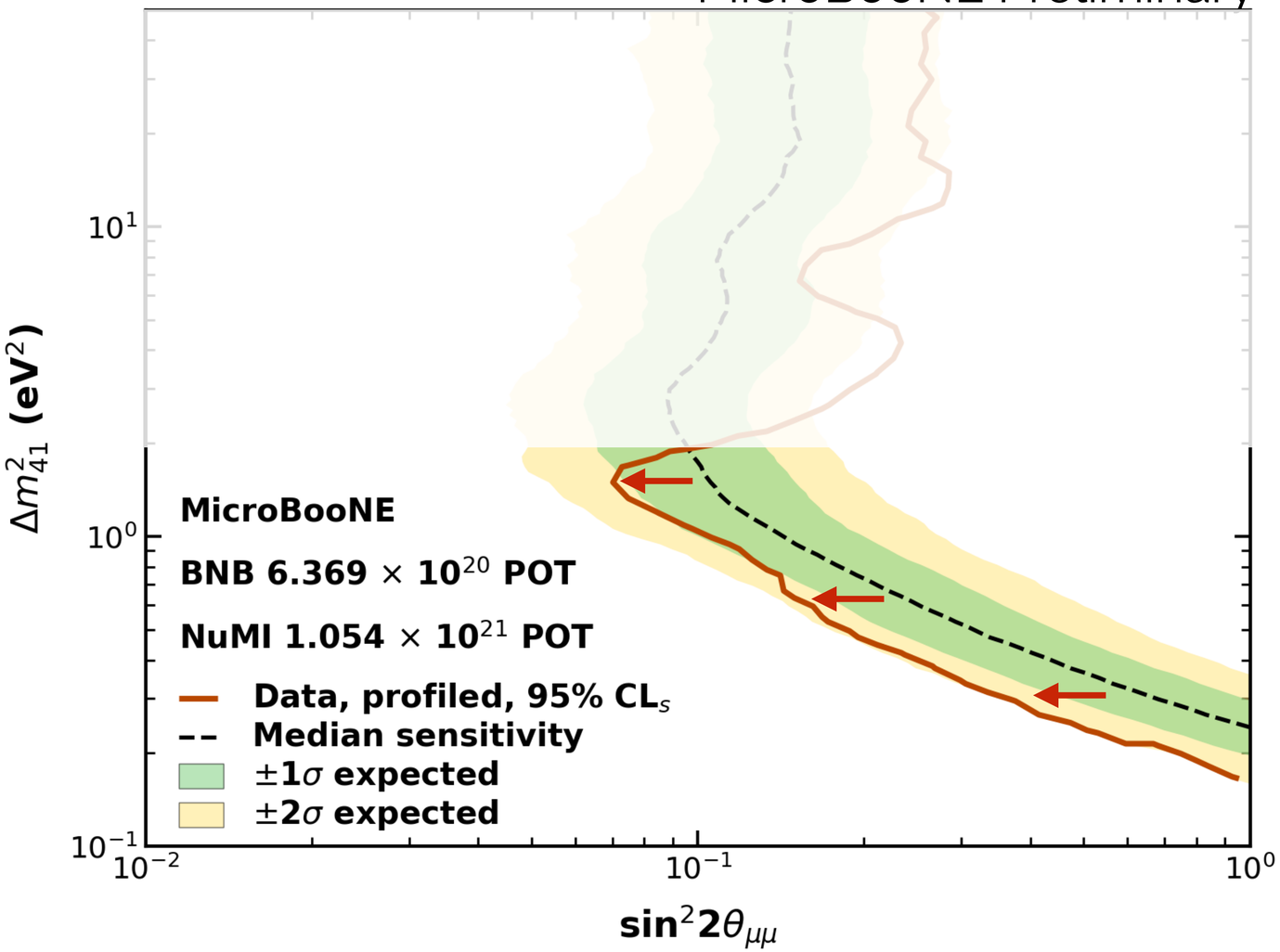
data exclusion is weaker than median sensitivity in high Δm^2 region, and slightly stronger in low Δm^2 region



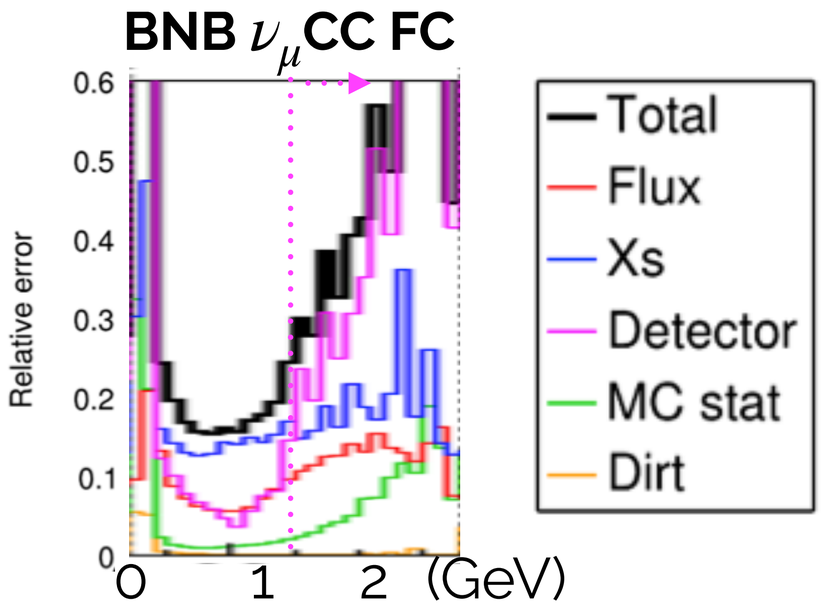
3+1 Sterile Neutrino Search: BNB+NuMI result



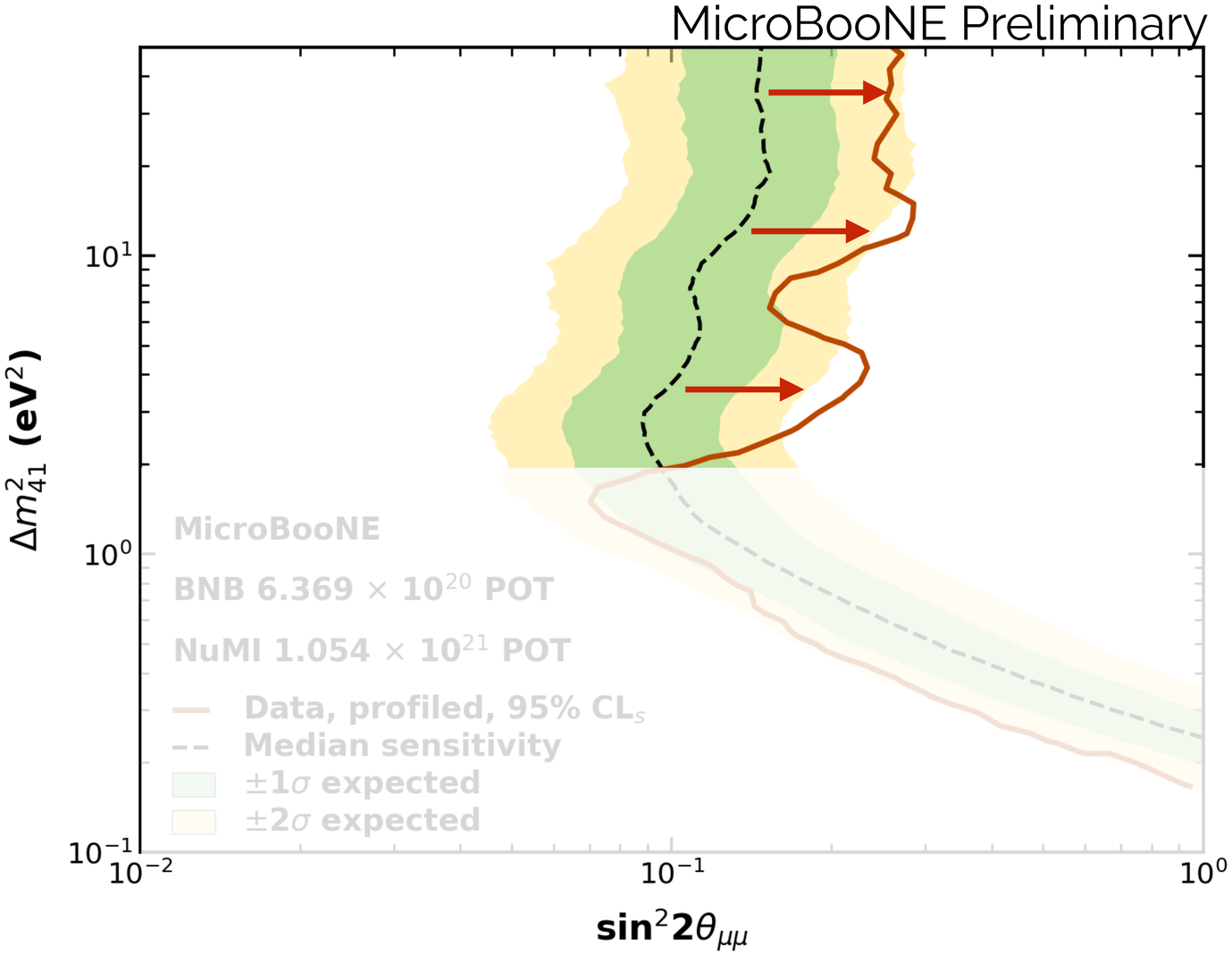
low Δm^2 region (<~1 eV²) is where the oscillation maximum sits at lower energy portion of the ν_μ spectrum, where we have the data excess → stronger limit



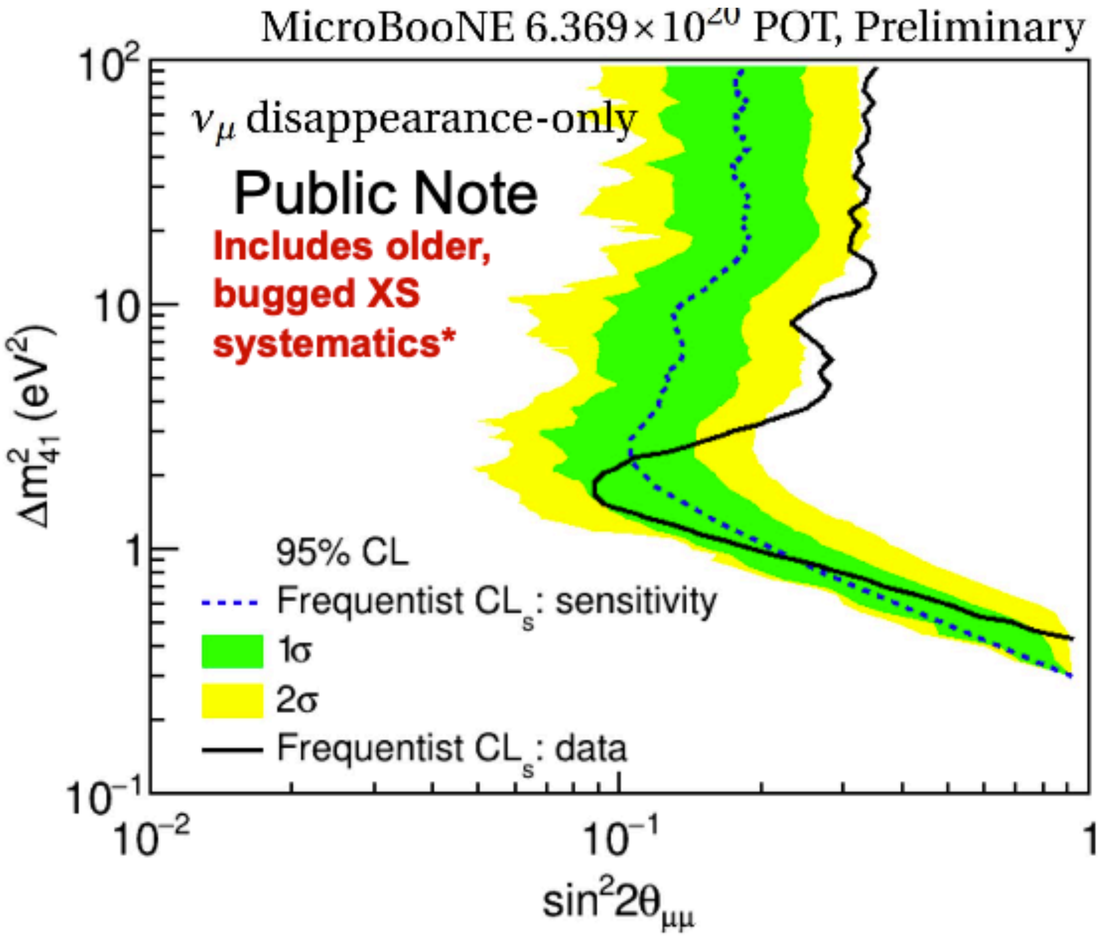
3+1 Sterile Neutrino Search: BNB+NuMI result

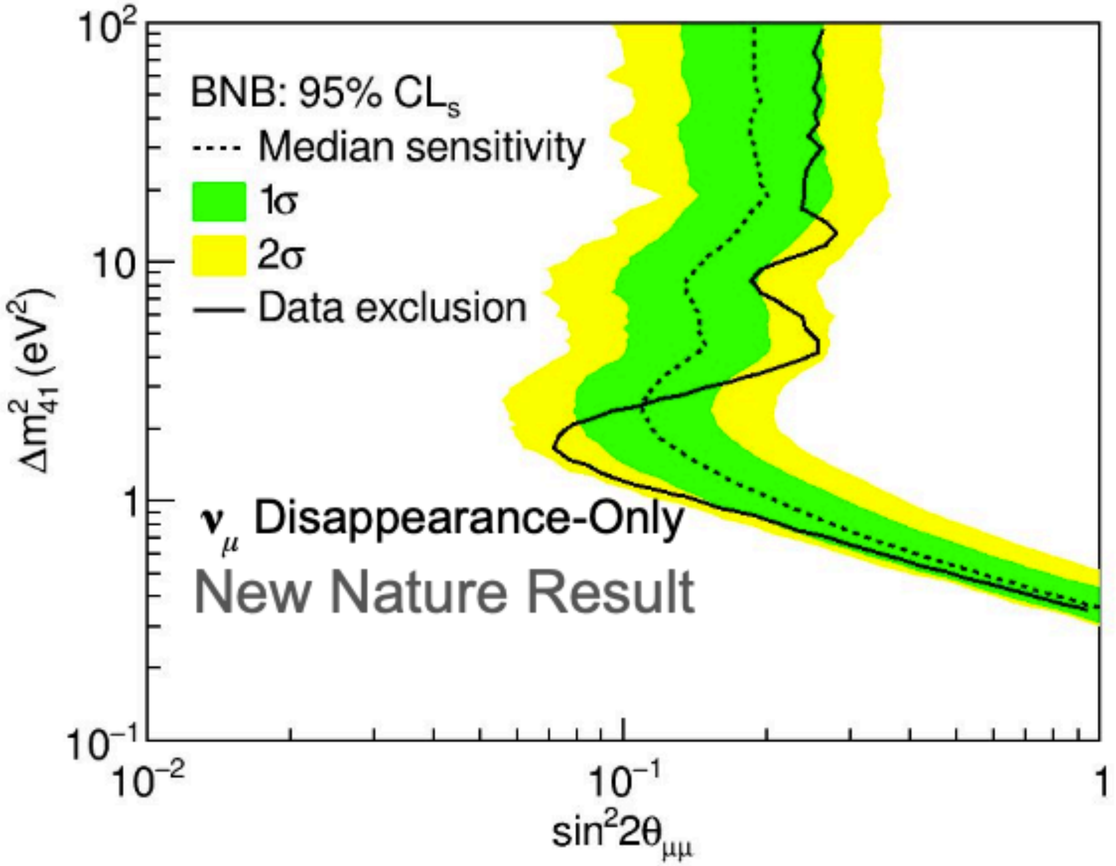


high Δm^2 region (>~1 eV²) is where oscillations reach higher energies and eventually average out as a pure rate effect, and our conservative detector systematics over-cover the data fluctuation



Comparison to Public Note: ν_μ disappearance-only result





The FSI bug fix is the main change

*Note these bugs were fixed long before our Nature result, but we never back ported to our Public Note until now

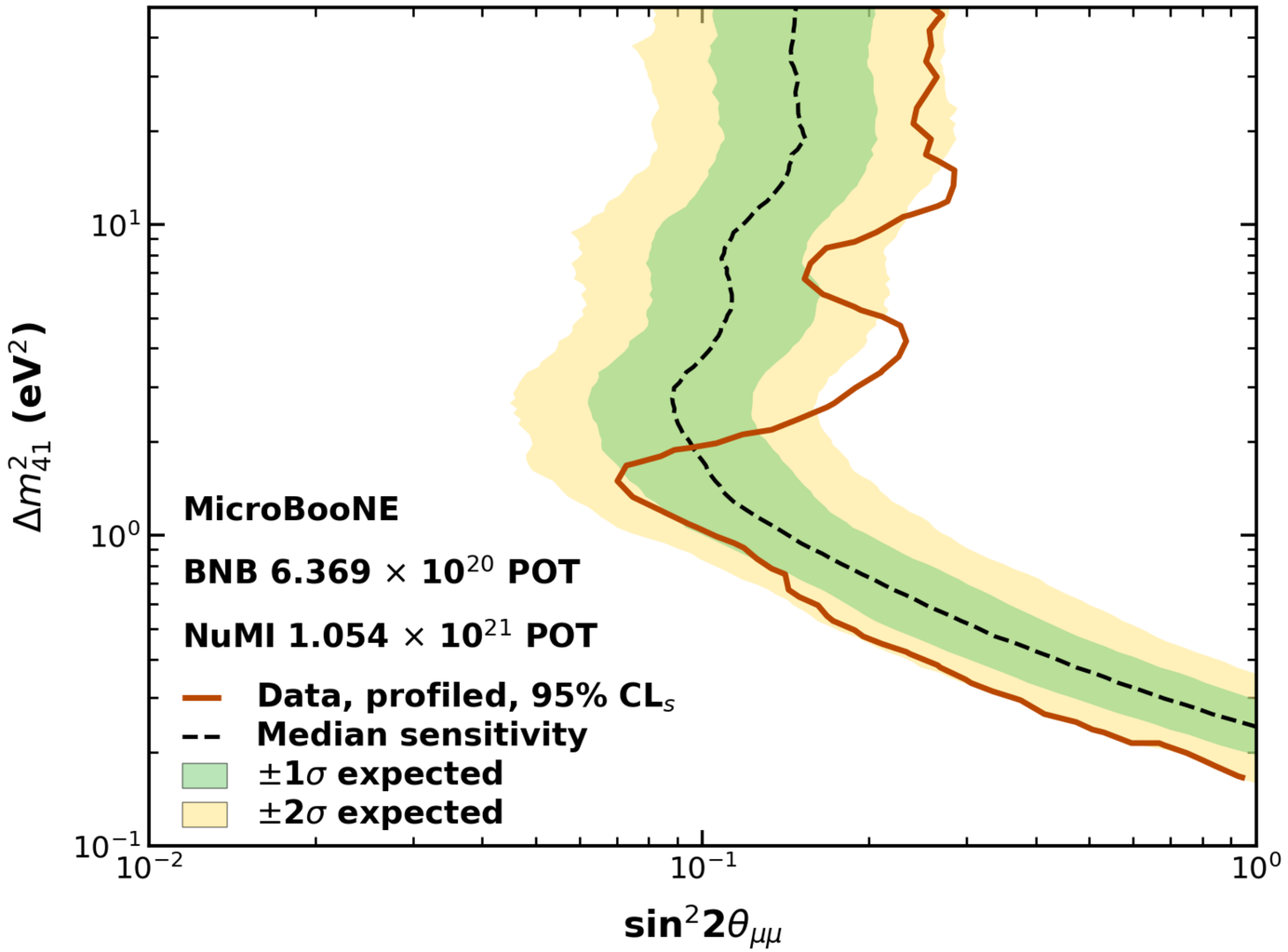
ν_μ disappearance result

- why would large (detector) systematics be responsible for weaker data exclusion limit? wouldn't such systematics shift median sensitivity similarly to the data?

- over-coverage of the detector systematics is the main reason, where we do not see the same fluctuation in data

- this means our data is very similar to our nominal prediction than our conservative covariance expects

MicroBooNE Preliminary

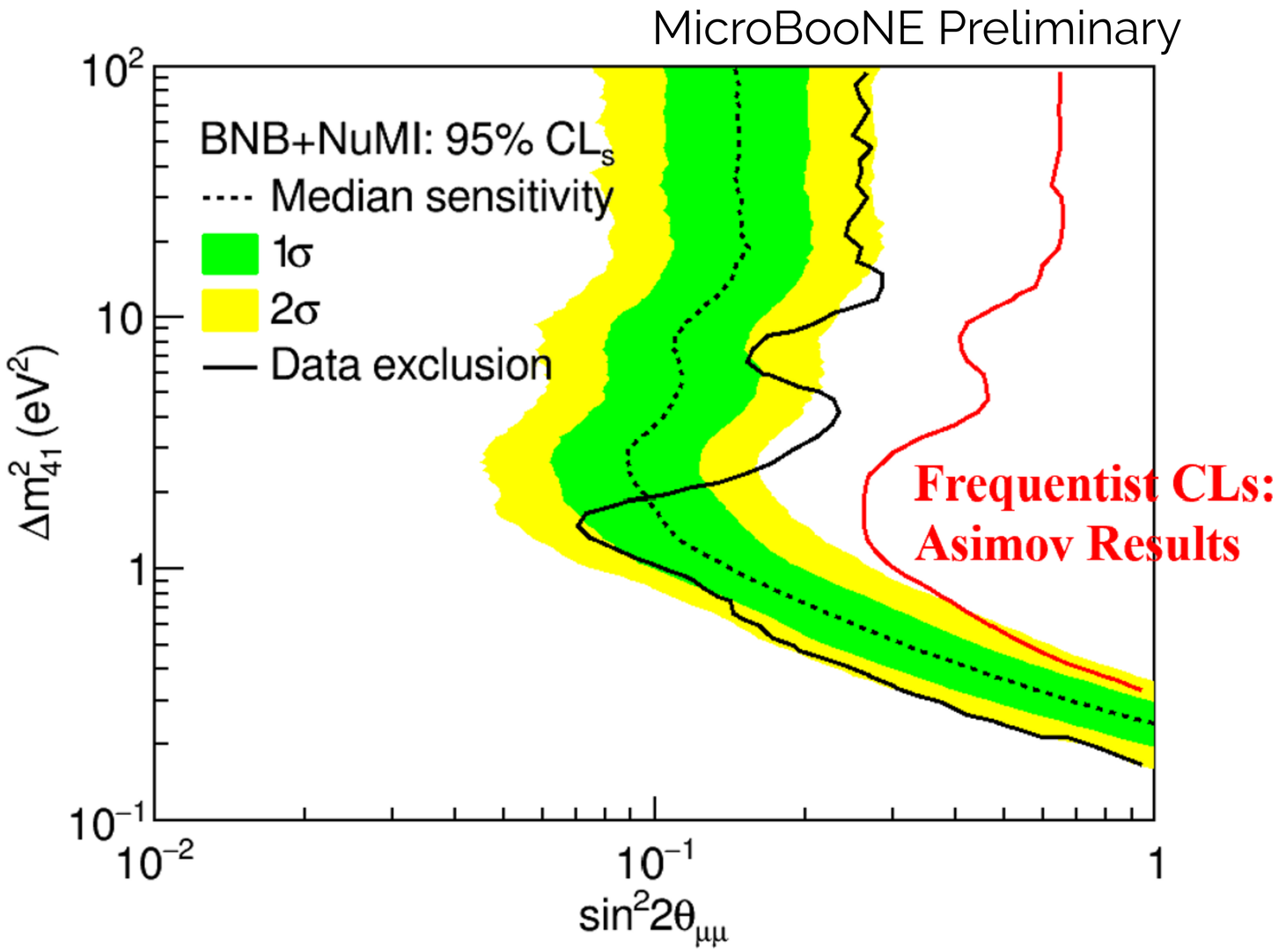


ν_μ disappearance result

- why would large (detector) systematics be responsible for weaker data exclusion limit? wouldn't such systematics shift median sensitivity similarly to the data?

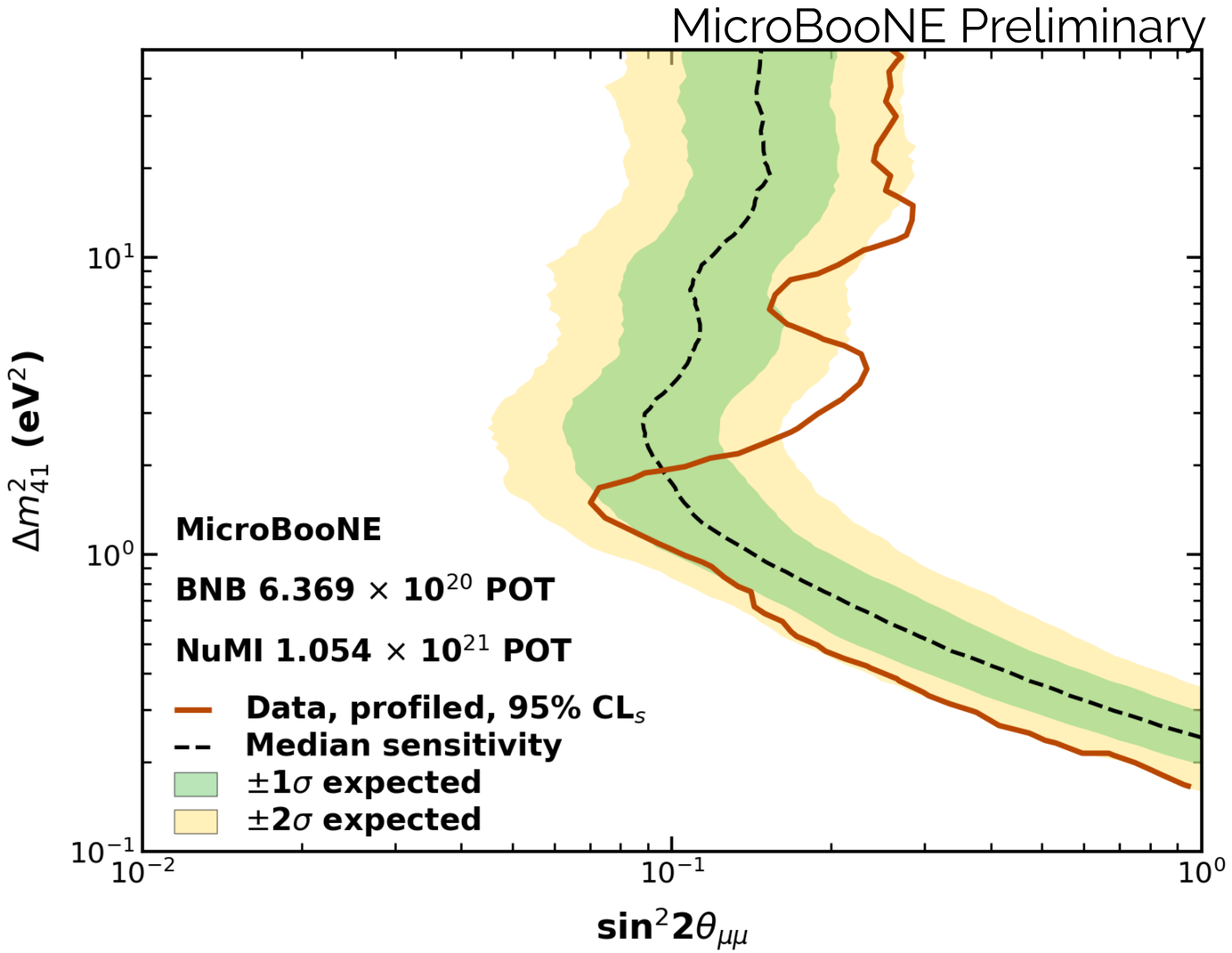
- over-coverage of the detector systematics is the main reason, where we do not see the same fluctuation in data

- less fluctuation in data than the covariance assumes → data exclusion is weaker than it would be otherwise (Asimov, with zero fluctuation, is the limiting case)



ν_μ disappearance result

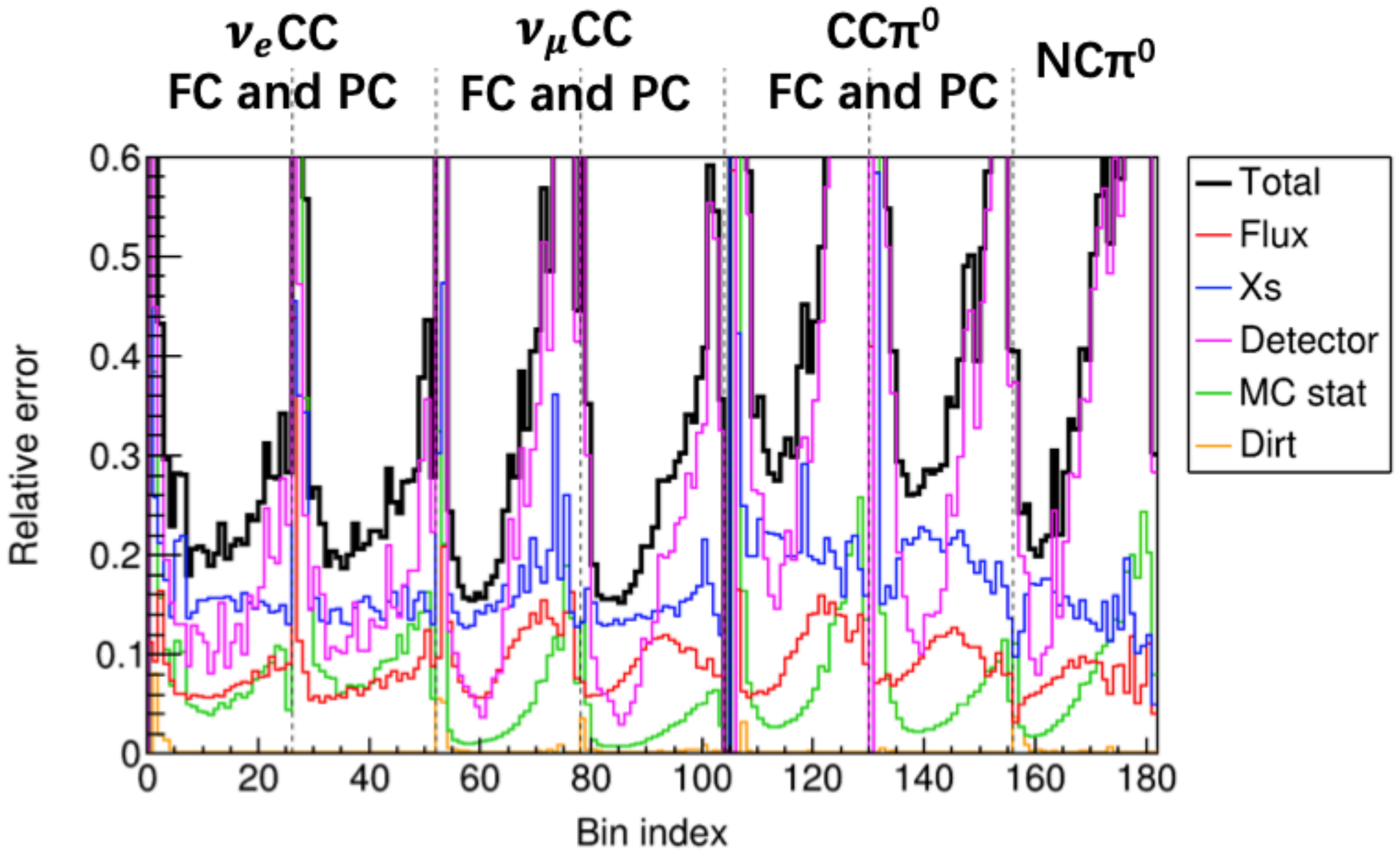
- why do the large systematics affect this channel more than ν_e app/disapp channels?
- the large detector systematics are inflated by low statistics MC for ν_μ
- for ν_e channels, we have separate intrinsic ν_e MC samples with much higher statistics



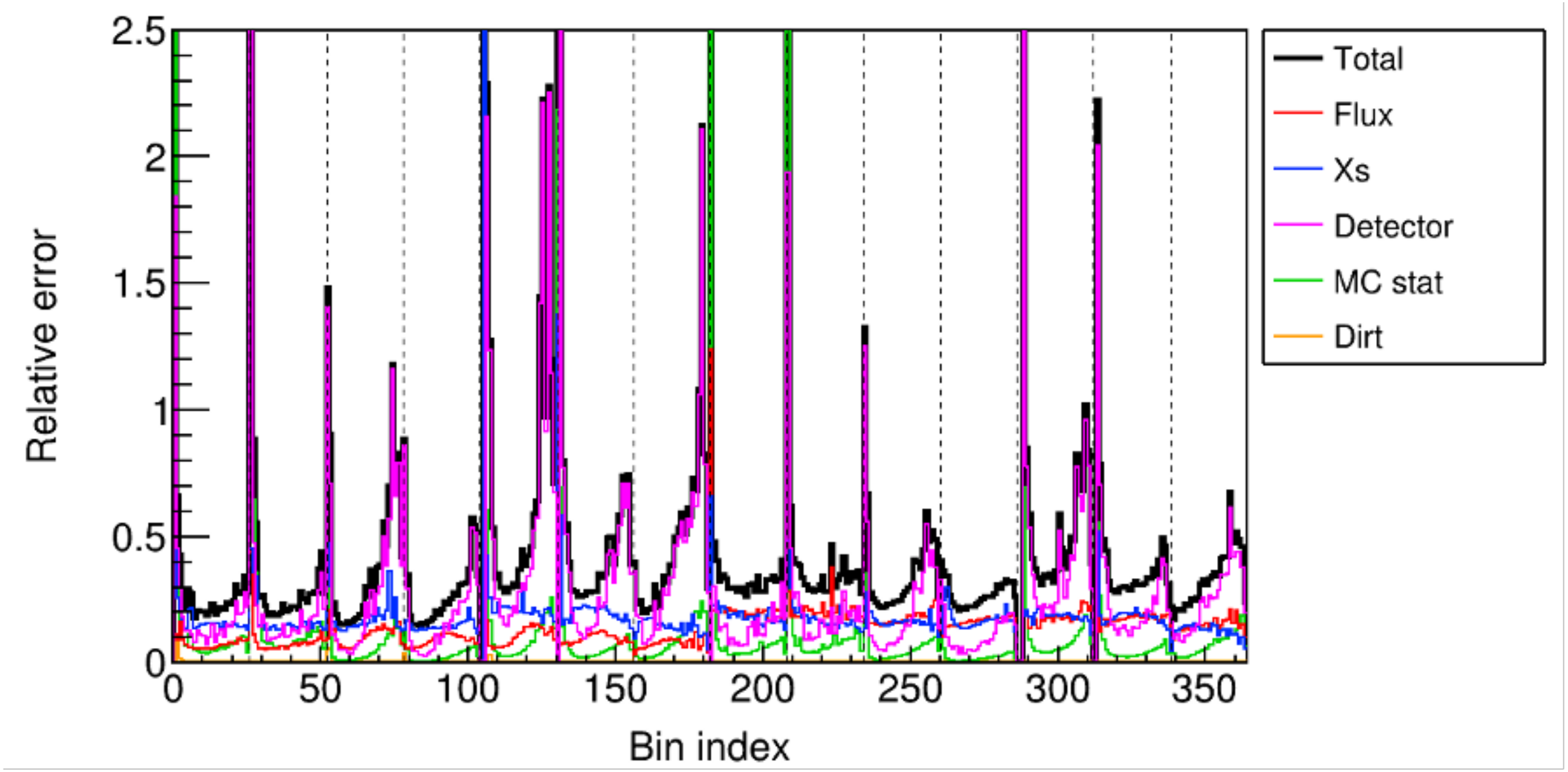
Data

Channel/Data	BNB	NuMI		NuMI/BNB
nueCC FC	338	1490		4.41
nueCC PC	219	824		3.76
numuCC FC	41290	16471		0.40
numuCC PC	88371	47480		0.54
CCpi0 FC	2885	1440		0.50
CCpi0 PC	5174	4846		0.94
NCpi0	6102	4962		0.81
BNB: numu/nue FC	122.16		NuMI: numu/nue FC	11.05
BNB: numu/nue PC	403.52		NuMI: numu/nue PC	57.62
BNB: numu/nue	232.78		NuMI: numu/nue	27.64
NuMI/BNB: nue	4.15			
NuMI/BNB: numu	0.49			

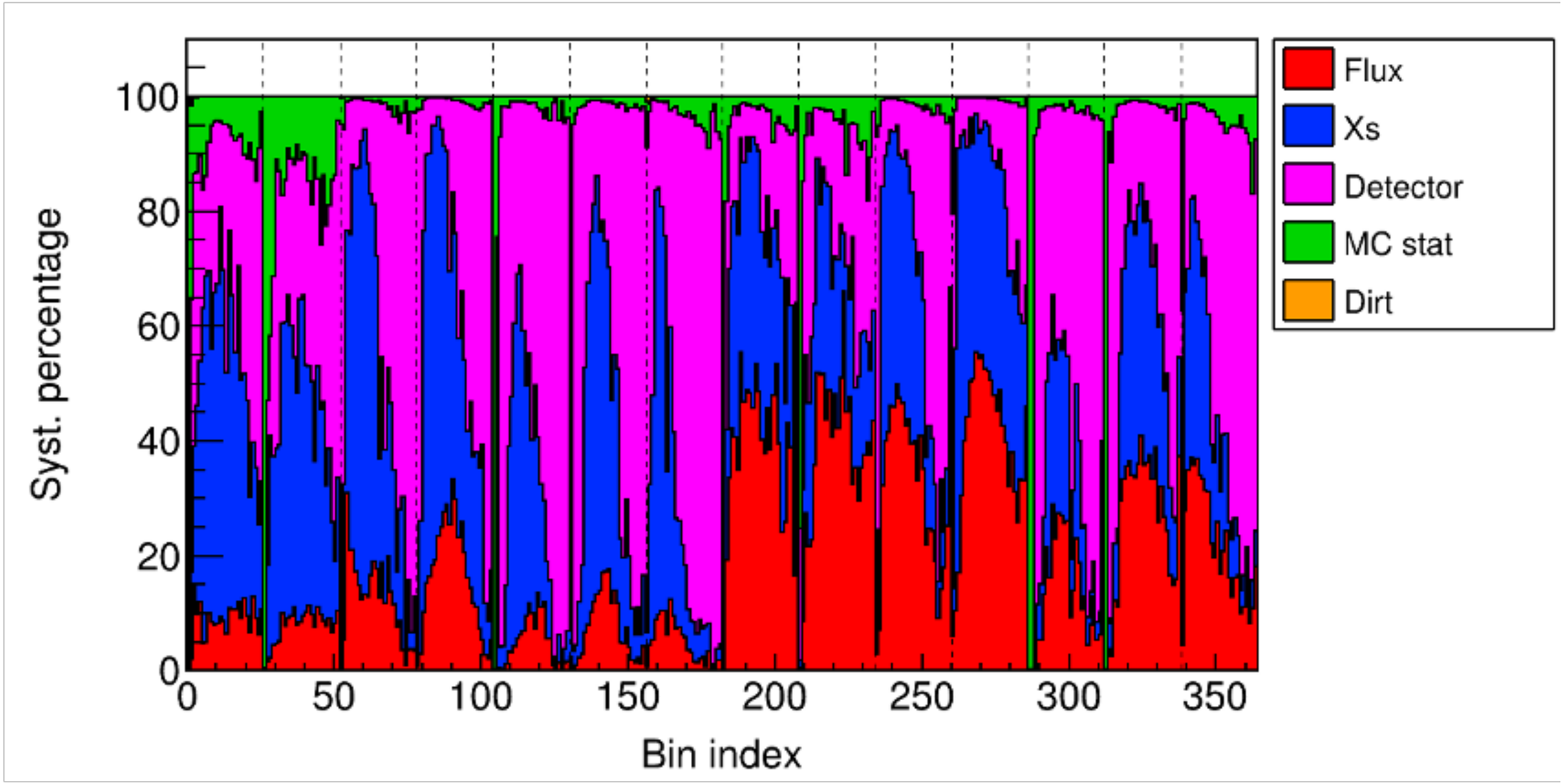
Systematics (BNB)



Systematics (BNB+NuMI)

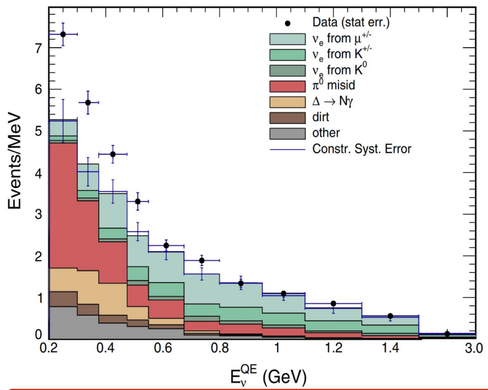


Error budget for BNB and NuMI



MicroBooNE “Low Energy Excess” Search

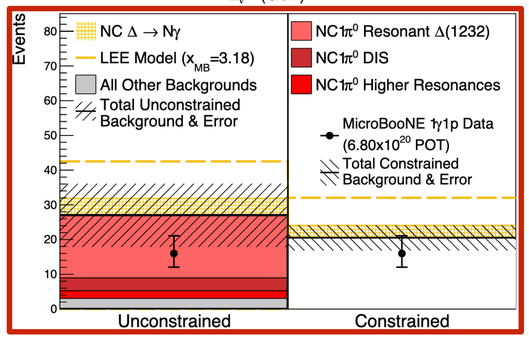
- MicroBooNE has been extensively exploring potential source of MiniBooNE low energy excess
- 2021: ν_e and single photon from delta radiative decay search
- 2024: expanded ν_e search with full dataset and 2D LEE model
- 2024~present: BSM *e+e-* search, inclusive & extended NC **Δ** radiative single photon searches, and improved low energy proton ID

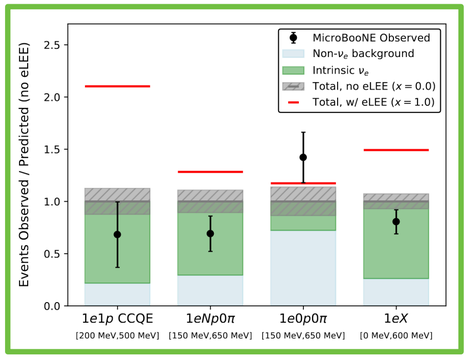


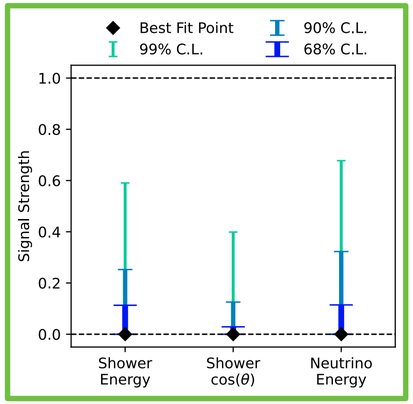
ν_e ?

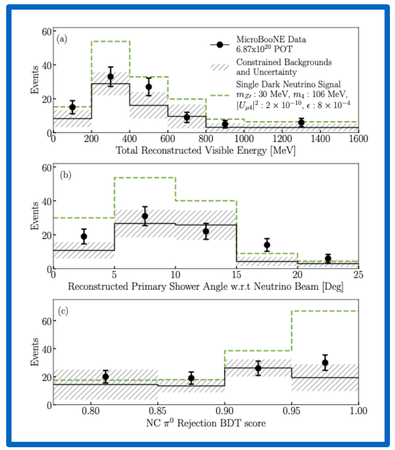
e^+e^- ?

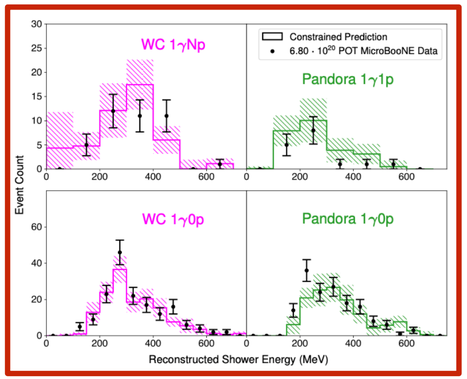
single-γ ?

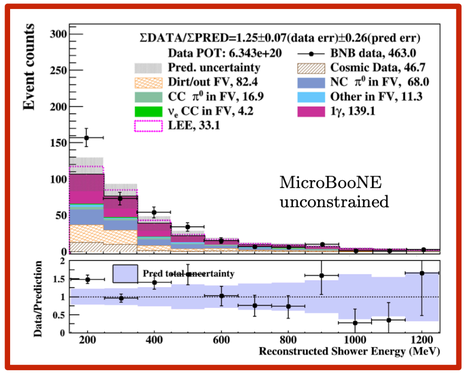






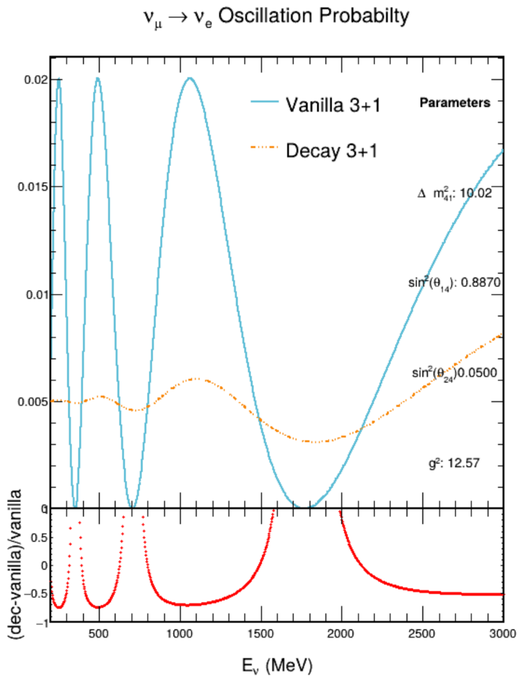




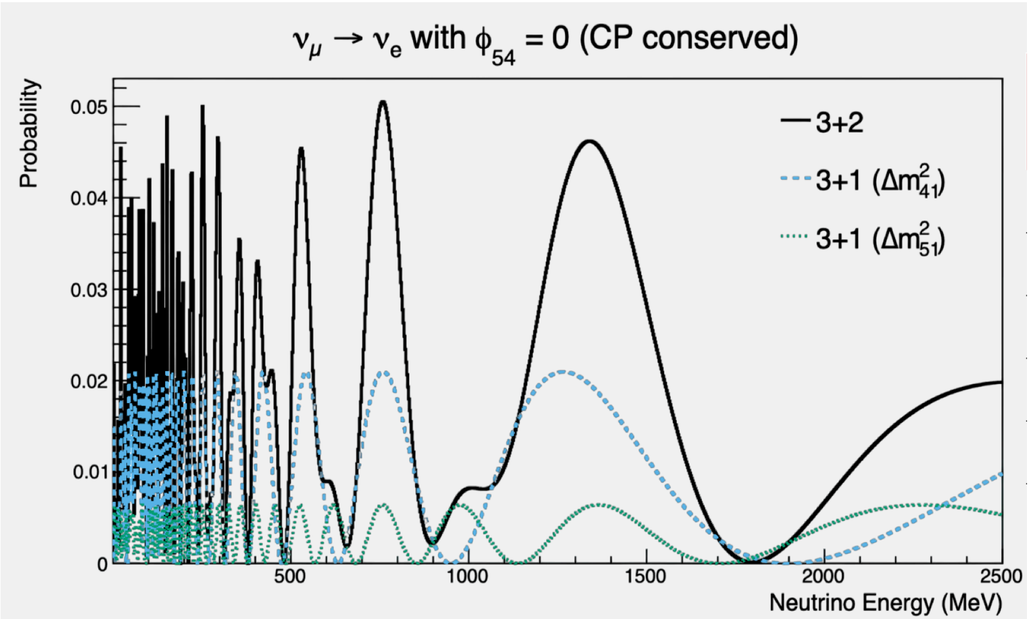


Expanded Sterile Neutrino Search

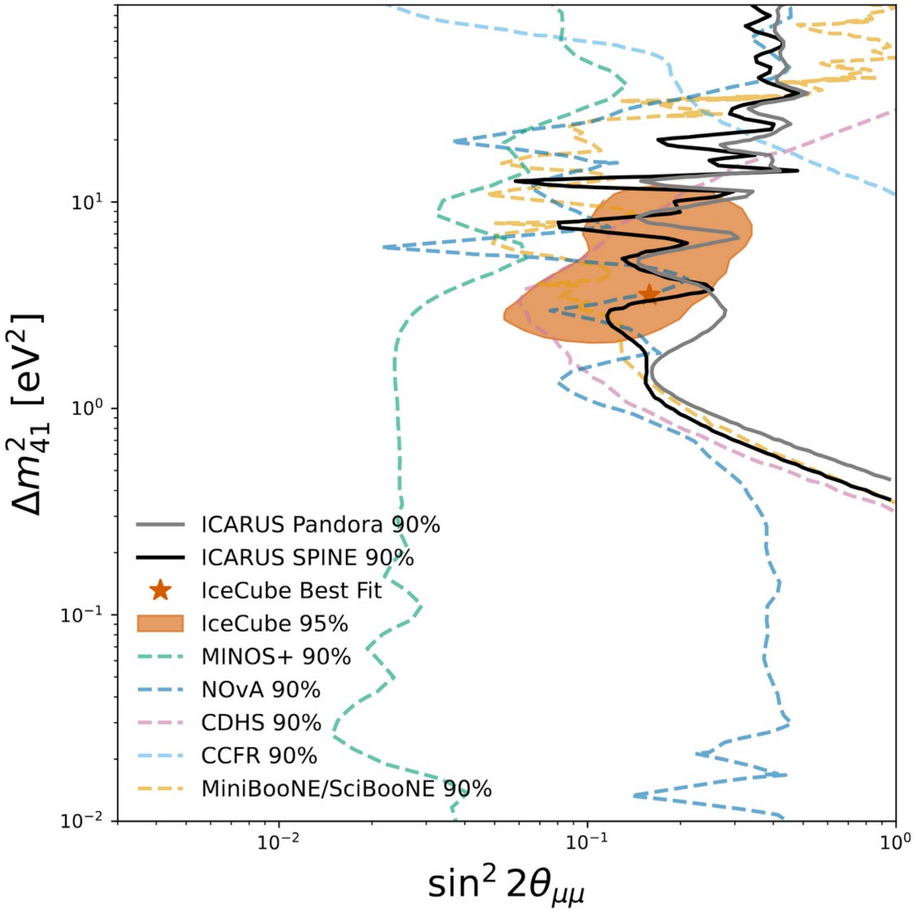
- **full-dataset 3+1 analysis**
  - almost double data in both BNB & NuMI
  - addition of external datasets (Prospect/ KATRIN/ICARUS)
  - thorough investigation of 3D 3+1
- **additional models beyond vanilla 3+1**
  - 3+1+decay (invisible and visible)
  - 3+2 (includes CP violation)
- **expanding framework** to allow full Feldman-Cousins analysis and pull-term/ nuisance systematics



MicroBooNE Work In Progress



SBN Program: Toward a Two-Detector Test



ICARUS, arXiv:2603.22557; M. Mooney, Neutrino 2026

- **ICARUS** (far, 600 m): first single-detector ν_μ disappearance search, with no significant oscillation and a result limited by systematics
- **SBND** (near, 110 m): running since 2024, collecting the largest ν–Ar dataset to date
- near/far comparison **cancels most flux and cross-section uncertainties** by design

past		*present*		*future*
ICARUS ν_μ disappearance	→	SBN ν_μ disappearance (+ SBND)	→	**SBN ν_μ disapp. + ν_e app./disapp.**

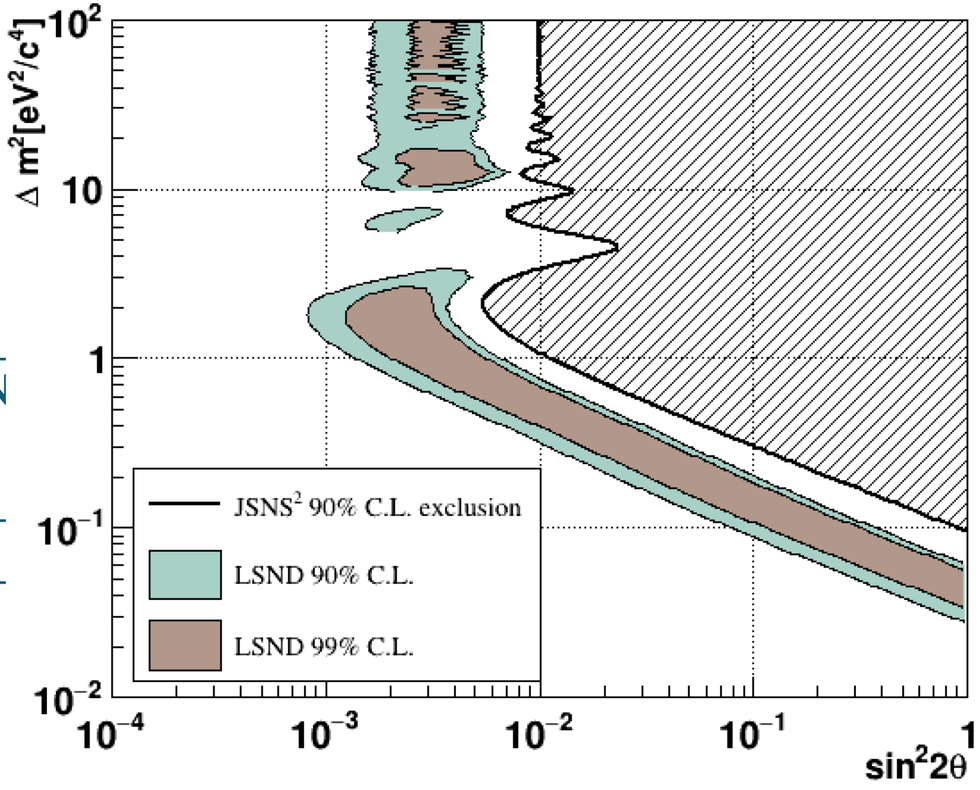
JSNS^2: a Direct Test of LSND at J-PARC

- **same** source (μ^+ decay at rest), target (H) and detection (IBD) as LSND
- 24 m baseline, 3 GeV pulsed proton beam, Gd-loaded liquid scintillator

2022 + 2024 runs (1.95×10^{22} POT), JSNS^2 Preliminary

observed	background	bkg + LSN
8	6.1 ± 1.0	8.9

- consistent with **both** background-only and the LSND expectation, so far
- ahead: **~6×** this dataset in Phase 1, and a **far detector at 48 m** (JSNS^2-II, commissioning since Nov 2025)



D. Lee, Neutrino 2026 (JSNS^2 Preliminary)