



June 22nd, 2026

First Physics Results from the Short-Baseline Near Detector

Linyan Wan (Fermilab) on behalf of the SBND Collaboration
NEUTRINO '26: International Conference on Neutrino Physics and Astrophysics



U.S. DEPARTMENT
of **ENERGY**

Fermi National Accelerator Laboratory is managed by
FermiForward for the U.S. Department of Energy Office of Science

Booster
Neutrino
Beamline

BNB
target

Short-
Baseline
Near
Detector

SBND
Active mass: 112 t
Distance: 110 m
Operation: 2024-

MicroBooNE

MiniBooNE

ICARUS

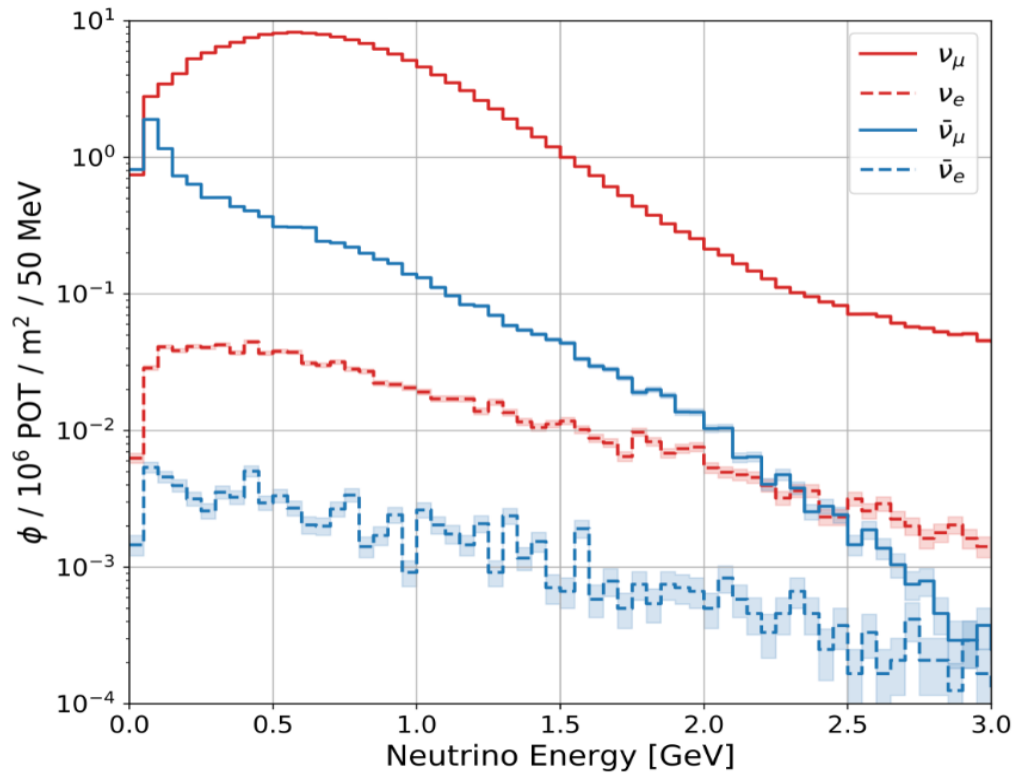


The **S**hort **B**aseline **N**eutrino program consists of two **L**iquid **A**rgon **T**ime **P**rojection **C**hambers, **SBND** and **ICARUS**

BNB Neutrinos at SBND

Beam composition:

ν_μ (93.6%) $\bar{\nu}_\mu$ (5.9%) $\nu_e + \bar{\nu}_e$ (0.5%)



Detected mean ν_μ energy: ~ 0.8 GeV

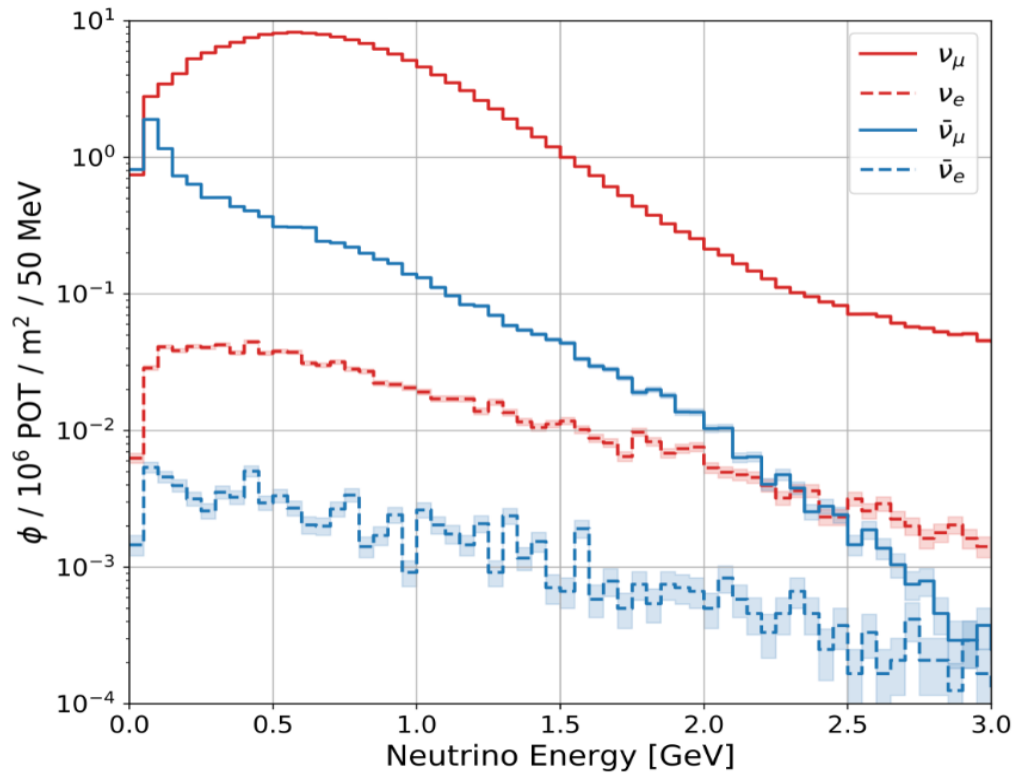
ν interactions per day: 12,000

BNB Neutrinos at SBND

PRISM

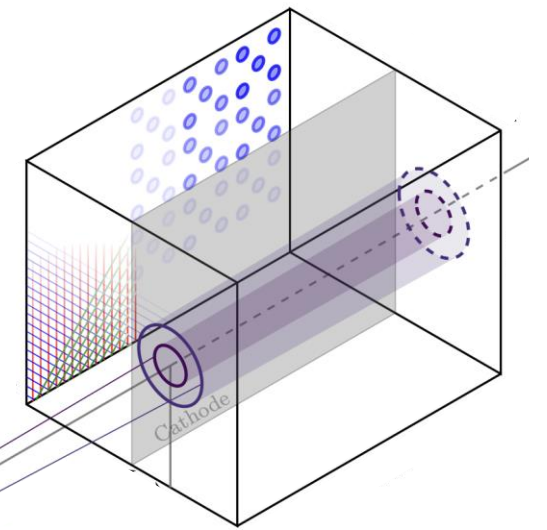
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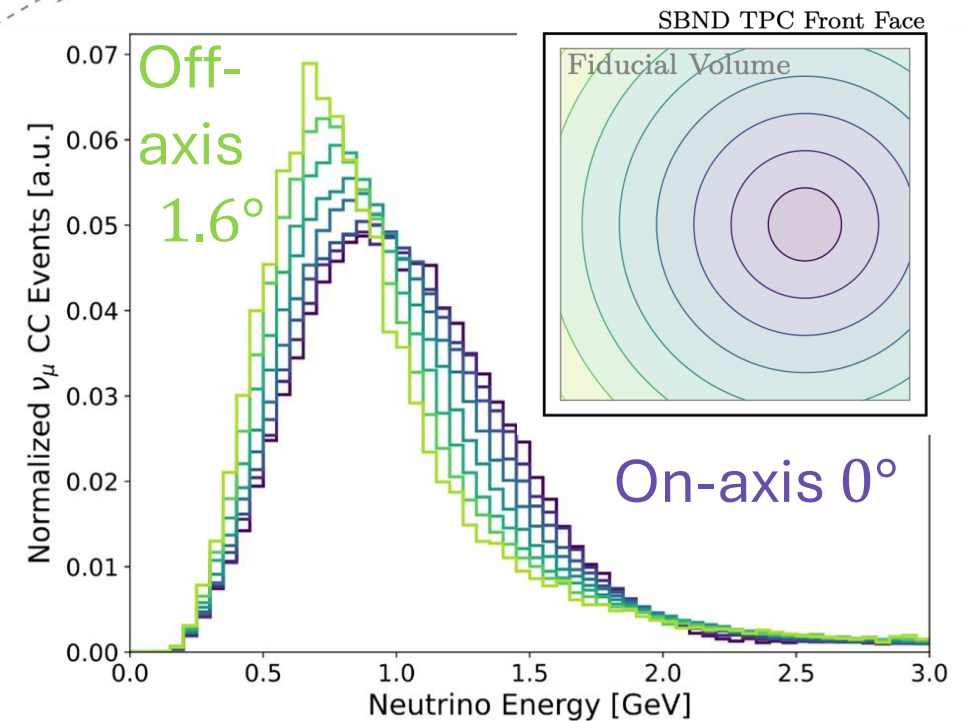


Detected mean ν_μ energy: $\sim 0.8 \text{ GeV}$
 ν interactions per day: 12,000

SBND's proximity to beam target provides a high neutrino flux and a range of flux angles to sample from.



Beam direction

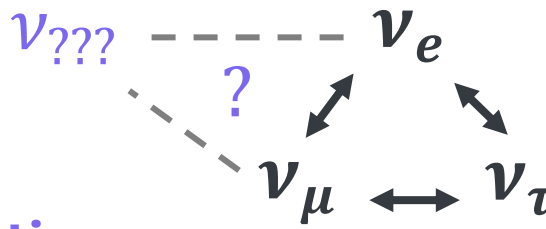


SBND PRISM
Phys.Rev.D 113 (2026)
7, 072007

SBND Physics

- Short-baseline neutrino oscillations:
- Neutrino-nucleus interaction physics:
- Beyond Standard Model physics:

SBND Physics



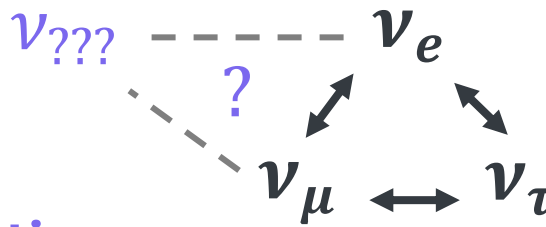
- Short-baseline neutrino oscillations:

- Test baseline-dependent new physics in ν_μ and ν_e with two-detector setup, beyond single-detector sensitivity.

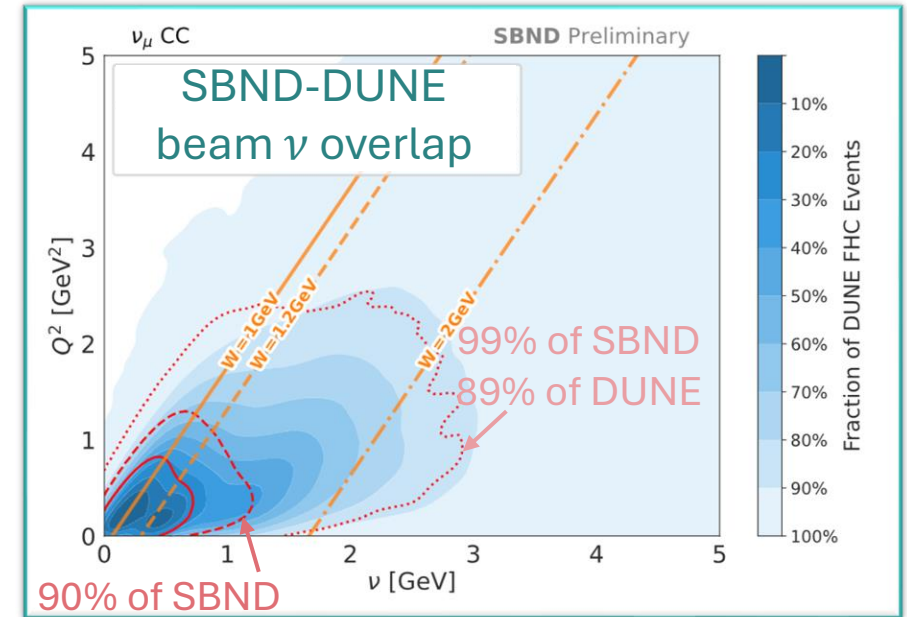
- Neutrino-nucleus interaction physics:

- Beyond Standard Model physics:

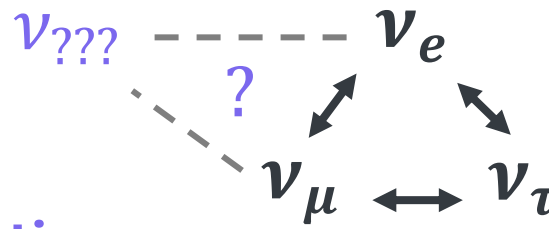
SBND Physics



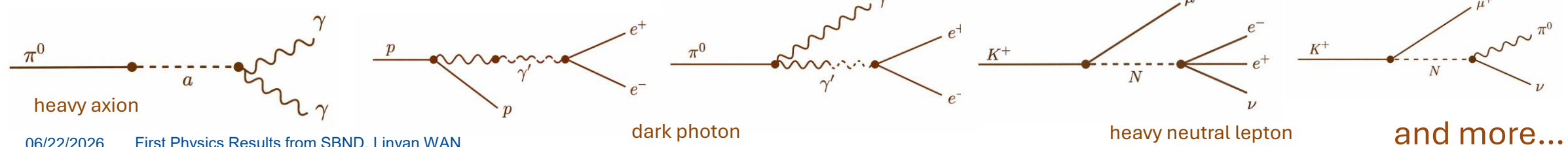
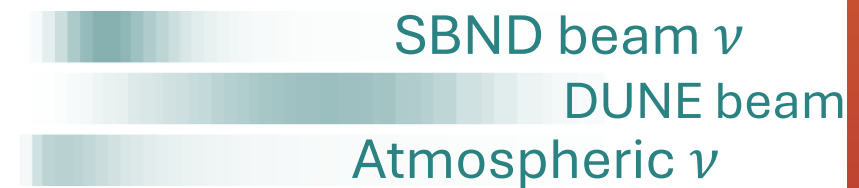
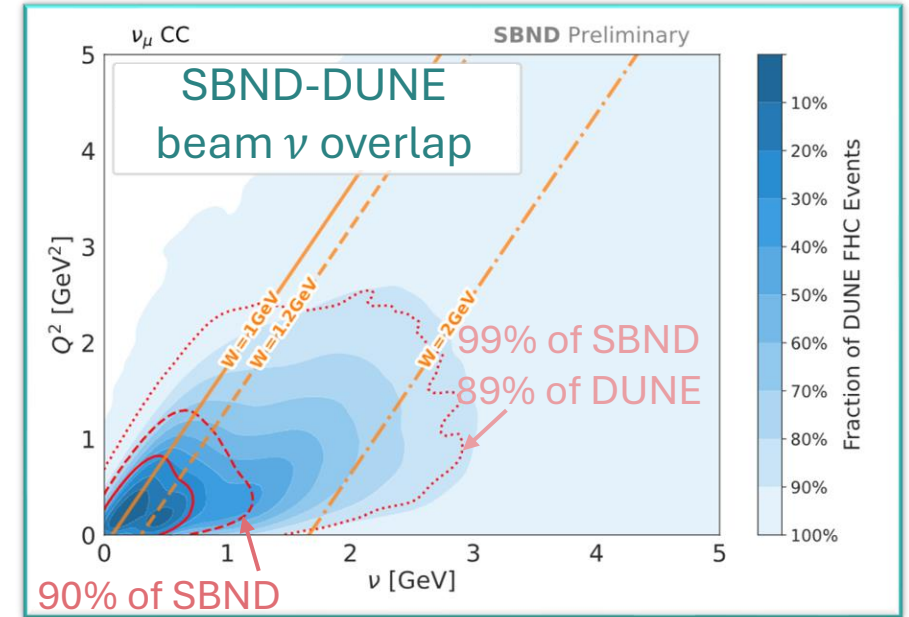
- **Short-baseline neutrino oscillations:**
 - Test baseline-dependent new physics in ν_μ and ν_e with two-detector setup, beyond single-detector sensitivity.
- **Neutrino-nucleus interaction physics:**
 - Probe complicated GeV particle and nuclear physics
 - Improve ν -Ar interaction modeling
 - Provide critical ingredients to ν oscillation, particularly for DUNE with strong phase-space overlap
- **Beyond Standard Model physics:**



SBND Physics

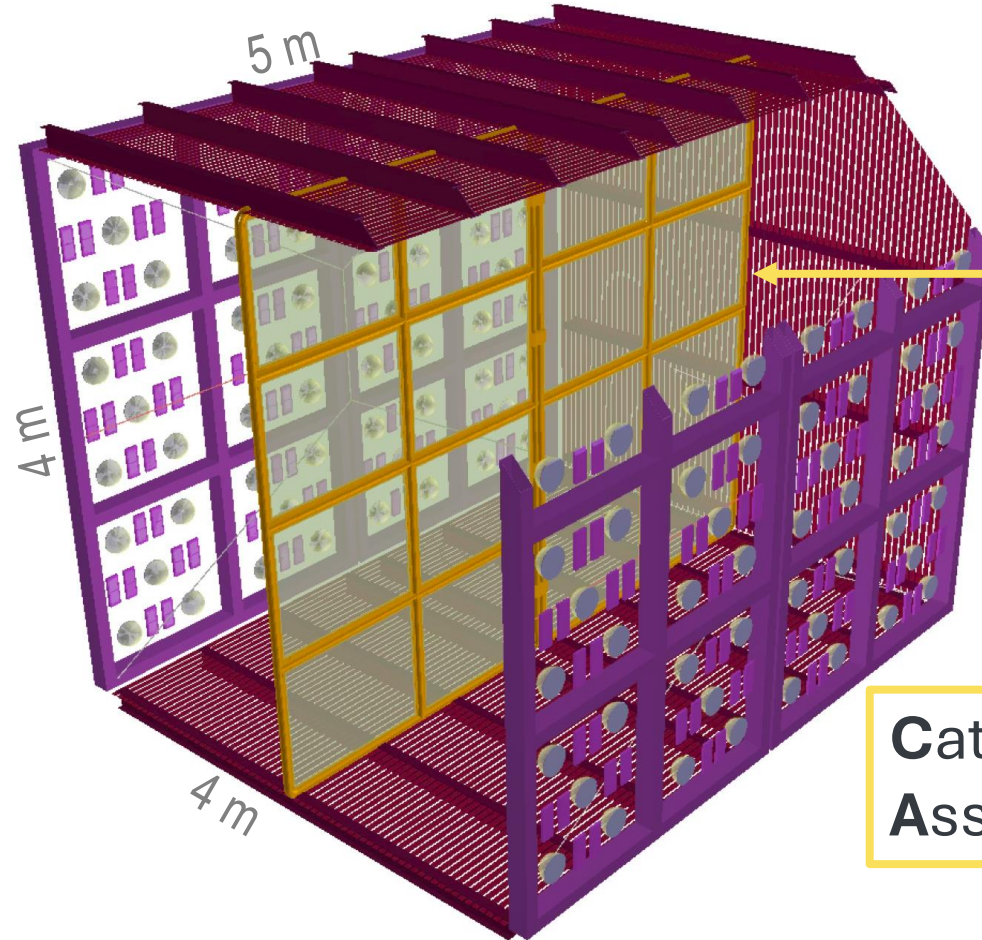


- **Short-baseline neutrino oscillations:**
 - Test baseline-dependent new physics in ν_{μ} and ν_e with two-detector setup, beyond single-detector sensitivity.
- **Neutrino-nucleus interaction physics:**
 - Probe complicated GeV particle and nuclear physics
 - Improve ν -Ar interaction modeling
 - Provide critical ingredients to ν oscillation, particularly for DUNE with strong phase-space overlap
- **Beyond Standard Model physics:**
 - Test many dark sector models and alternative explanations of short-baseline anomalies.



The SBND Detector

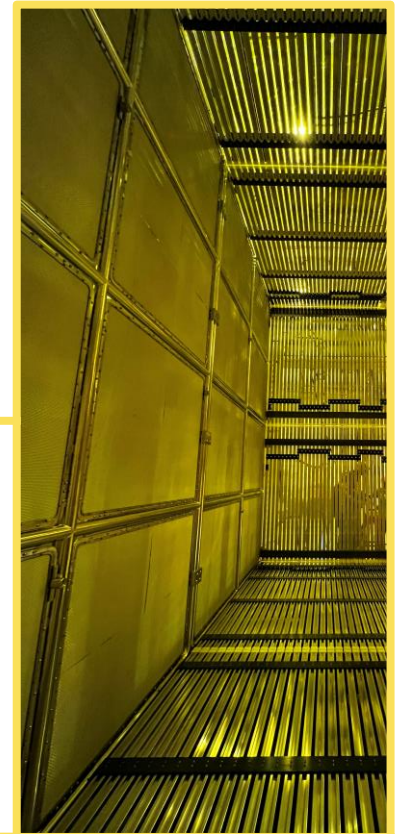
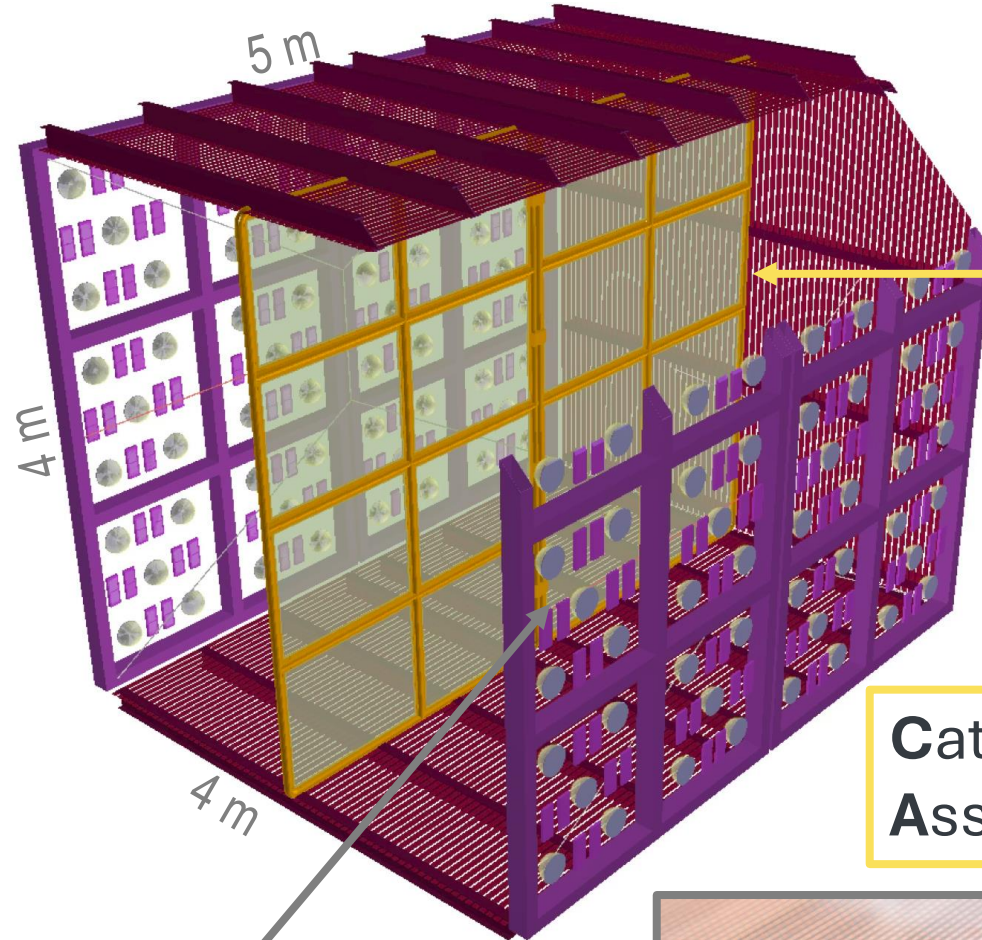
Time Projection Chamber



**Cathode Plane
Assembly at -100 kV**

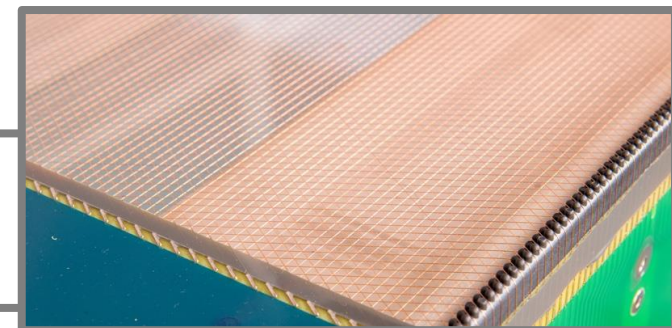
The SBND Detector

Time Projection Chamber



Cathode Plane Assembly at **-100 kV**

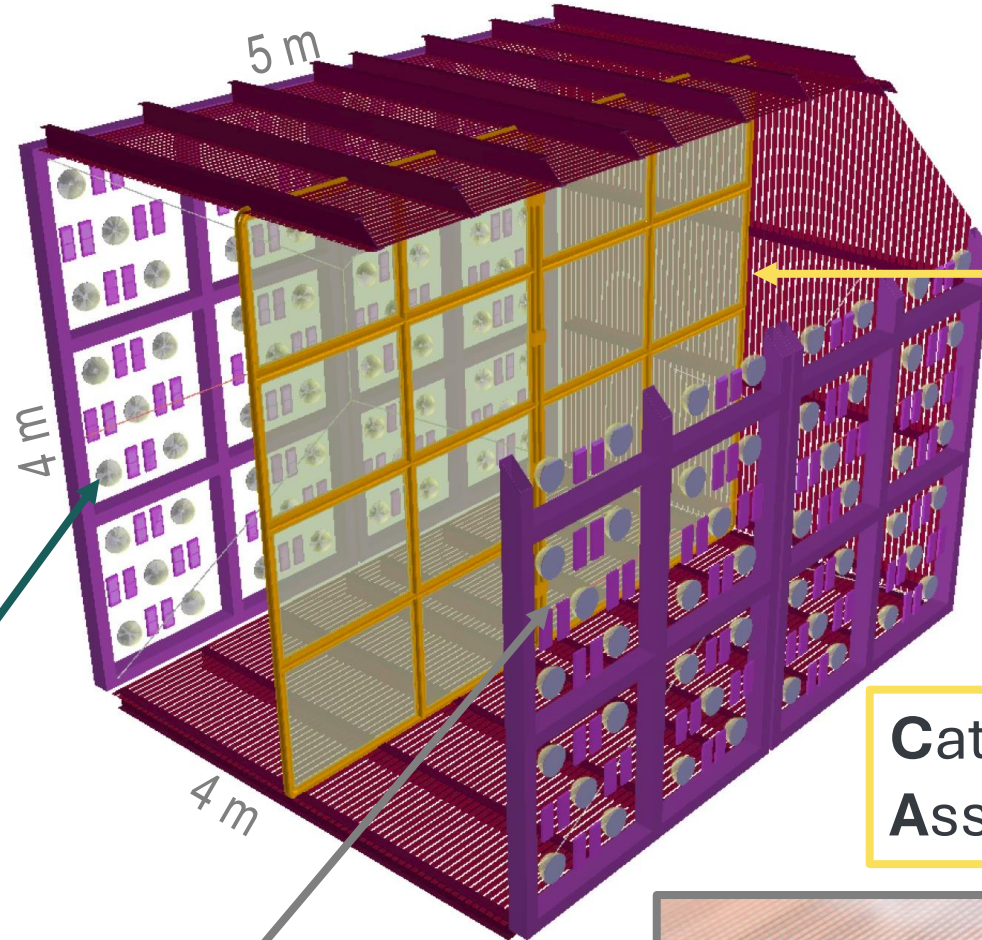
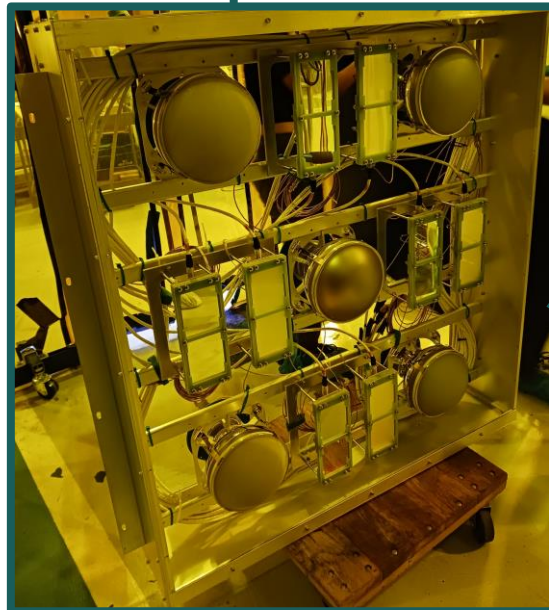
Anode Plane Assemblies connected to **cold electronics**



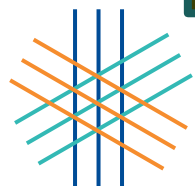
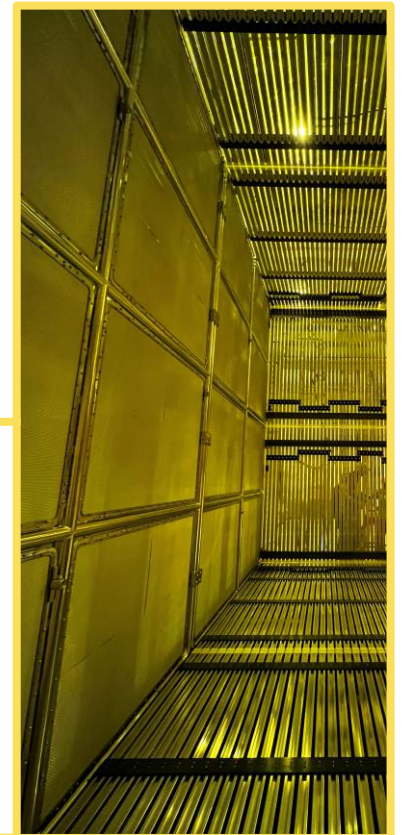
The SBND Detector

Time Projection Chamber

Photon
Detection
System

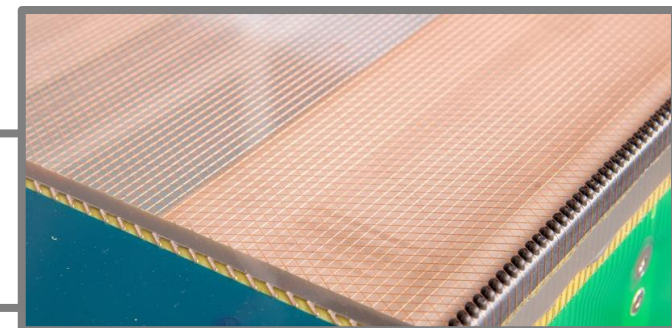


Cathode Plane
Assembly at **-100 kV**



Inductions
Collection

Anode Plane Assemblies
connected to **cold electronics**

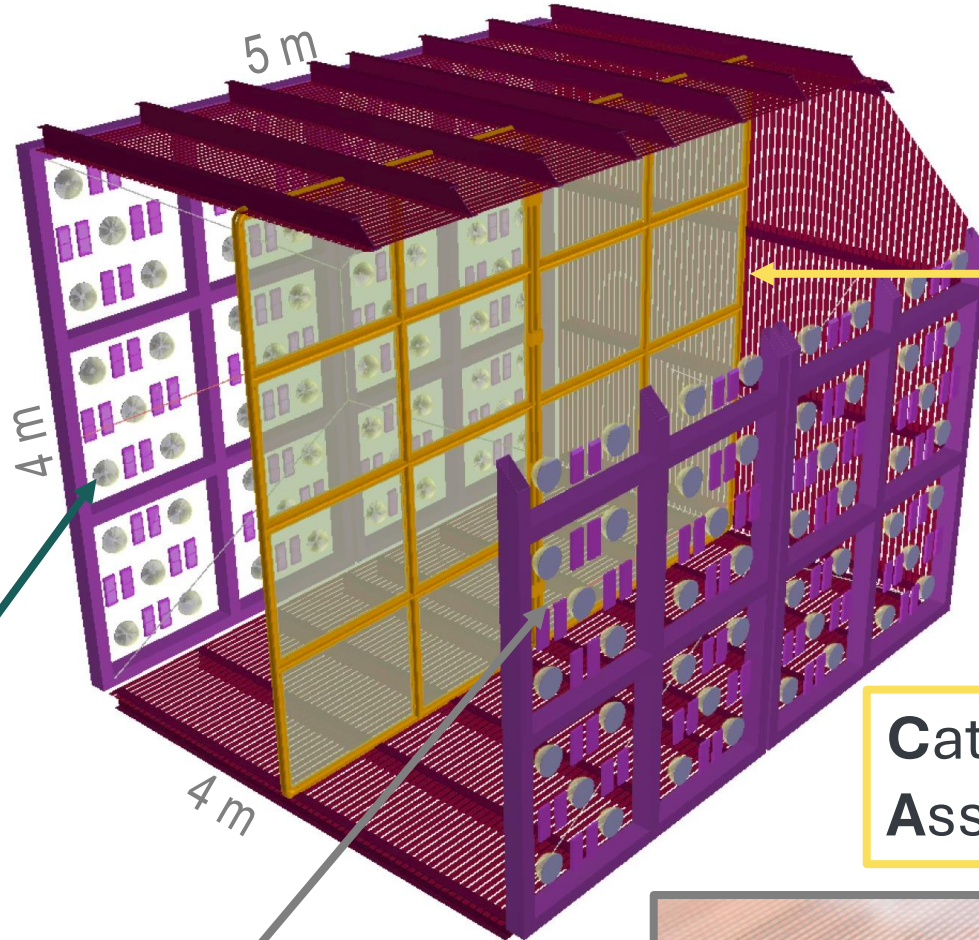


The SBND Detector

Time Projection Chamber

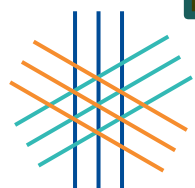
Photon
Detection
System

Cosmic
Ray
Tagger

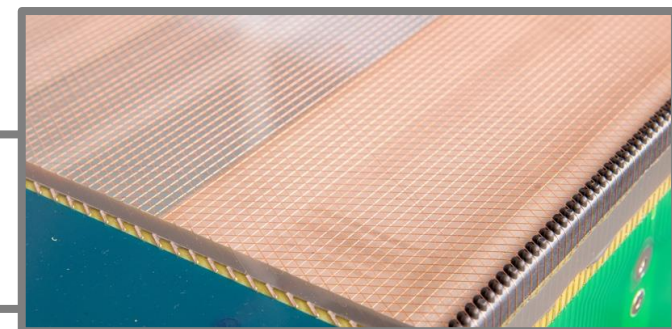
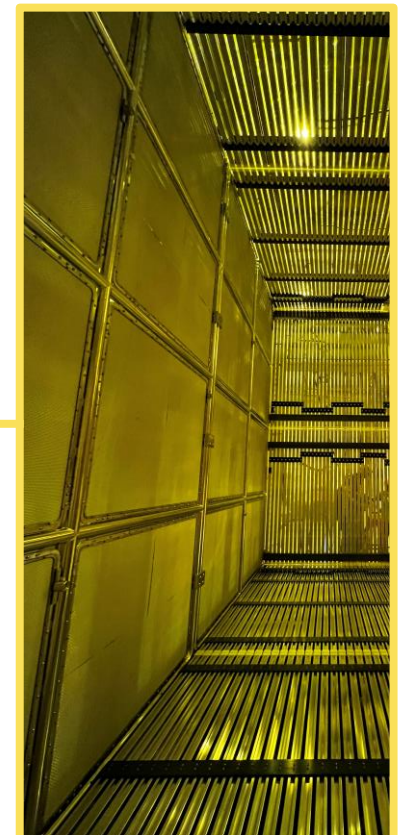


Cathode Plane
Assembly at **-100 kV**

Anode Plane Assemblies
connected to **cold electronics**



Inductions
Collection



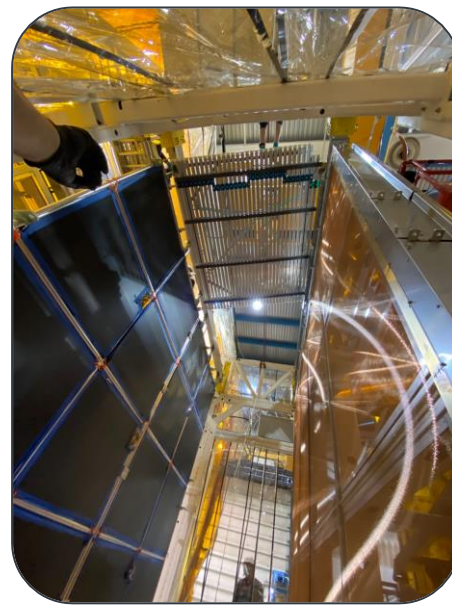
SBND Construction



2015
proposal



Wire plane construction



LArTPC assembly

2022 Dec.
Detector transportation



2015

2018

2020

2022



2016-2018: Site construction



Meeting during COVID



Cryostat installation

Installation & Commissioning

2024 July: high voltage ramp up



PDS installation



High-voltage installation

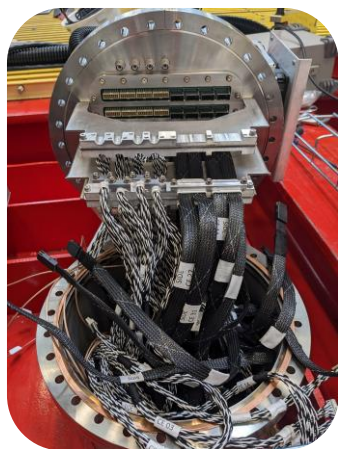


2023

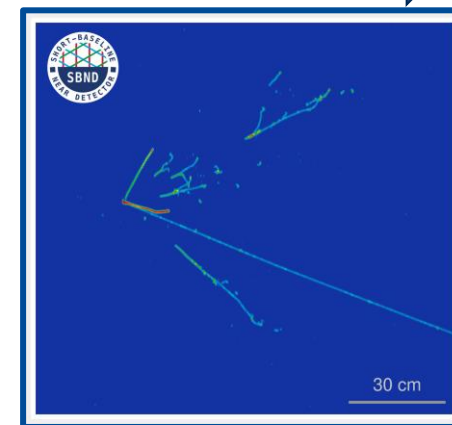
2024



Detector Installation



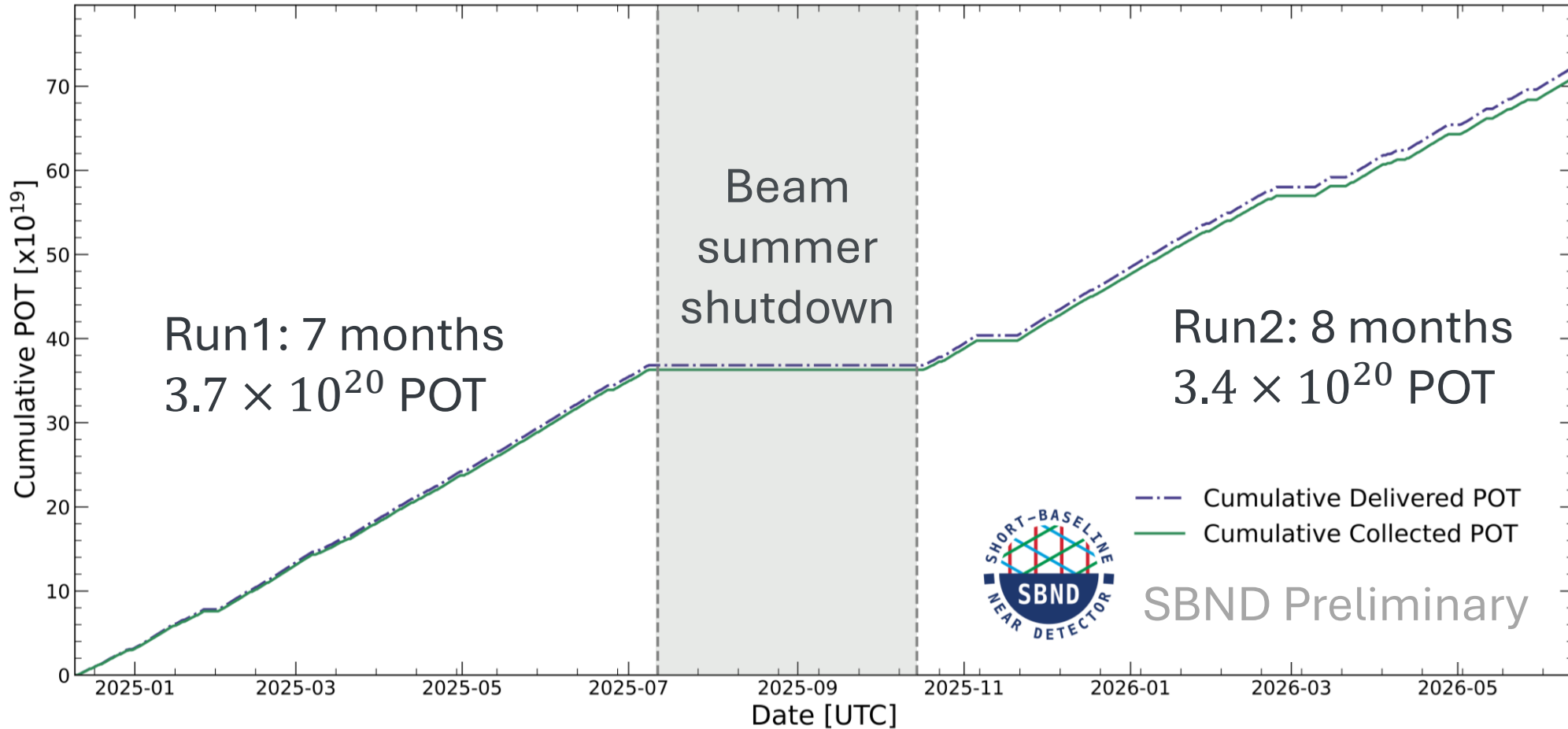
Liquid argon filling



Neutrino data-taking!

SBND Physics Data Taking

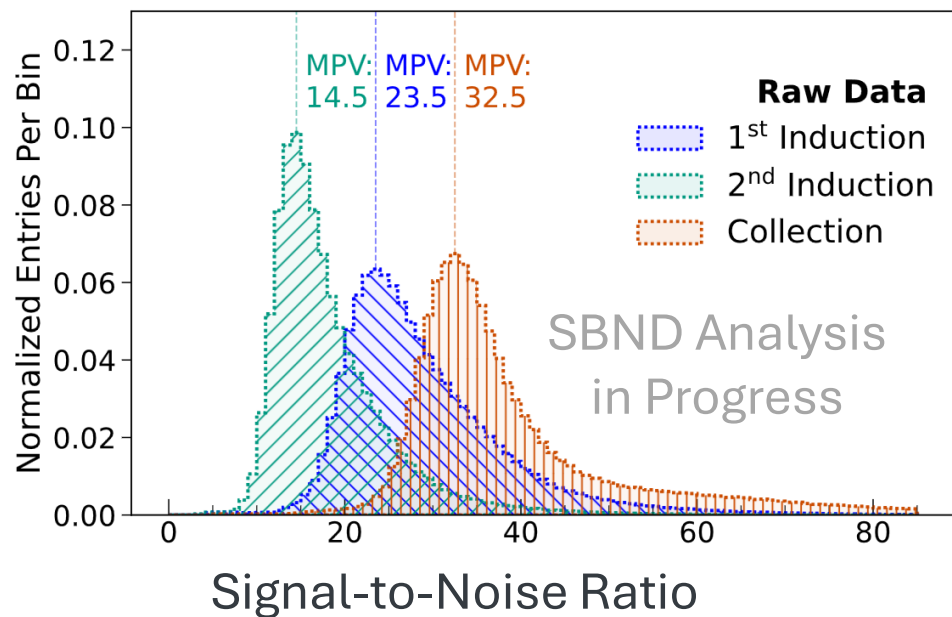
Proton On Target



6 million neutrino interactions (4 million charged-current) collected, largest ν -Ar dataset ever!

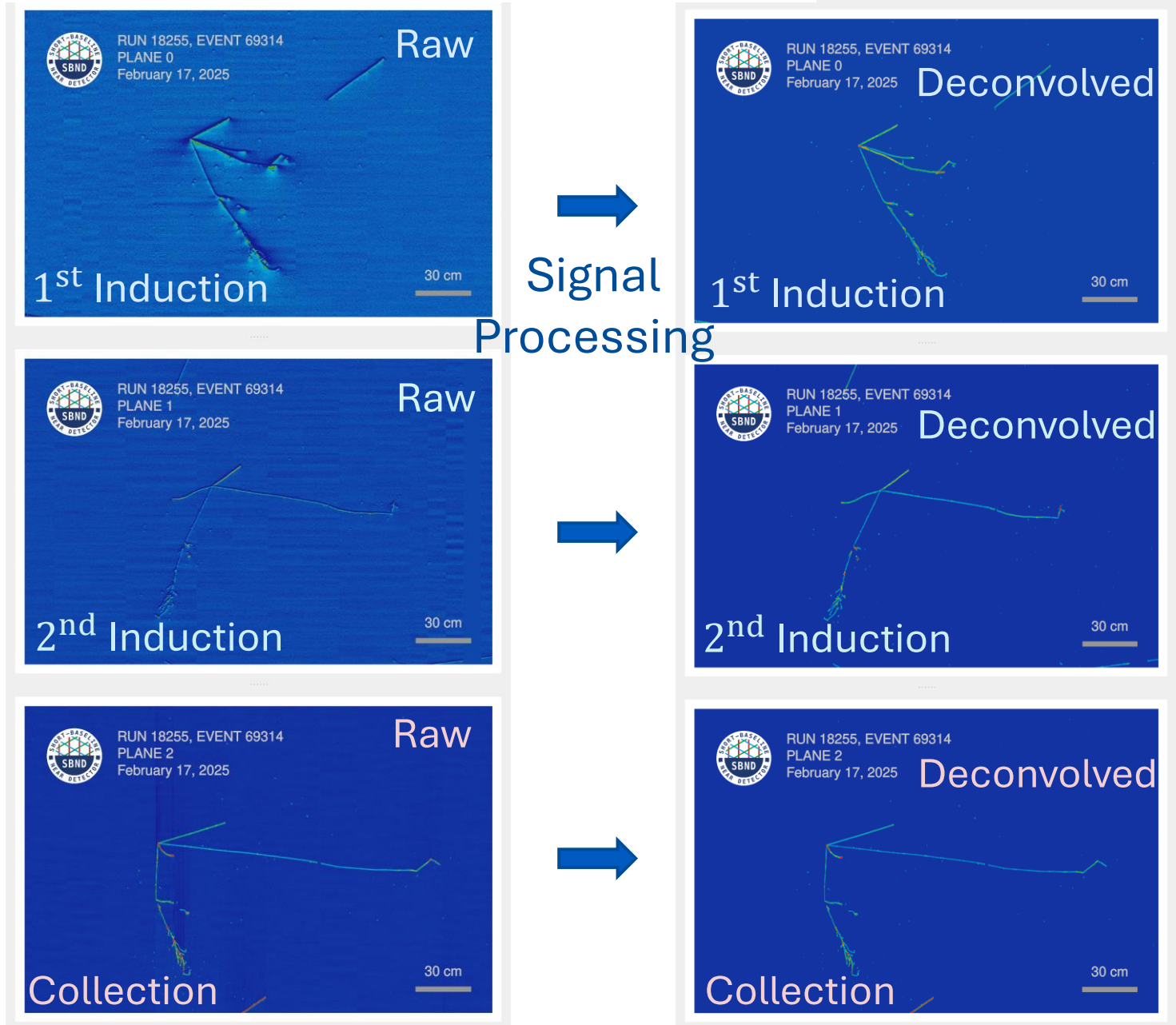
Time Projection Chamber Performance

TPC cold electronics achieves excellent signal-to-noise ratios.



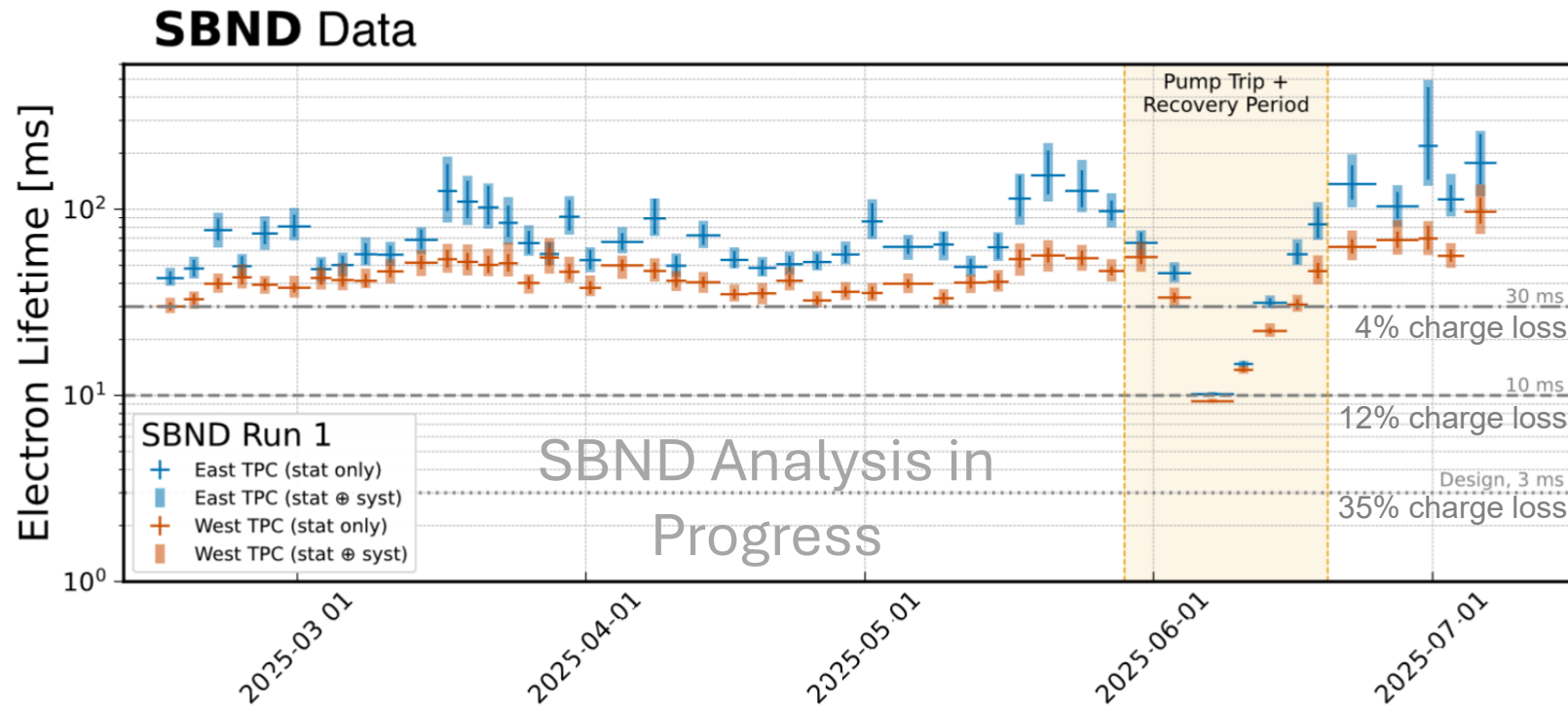
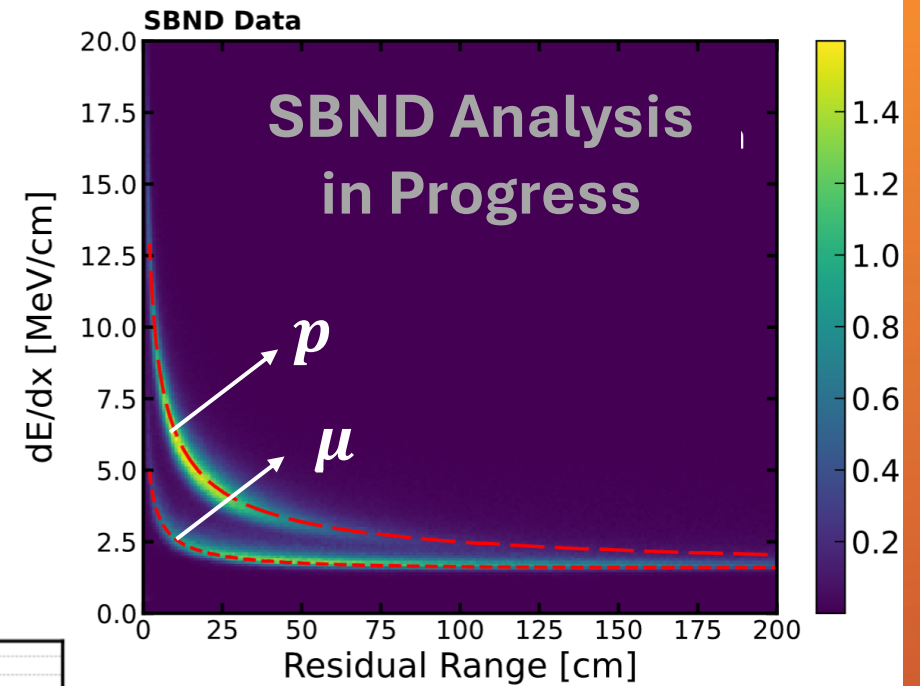
Poster #436 (Tue.)
Signal Processing

DNN ROI arXiv: 2605.18861



Time Projection Chamber Calibration

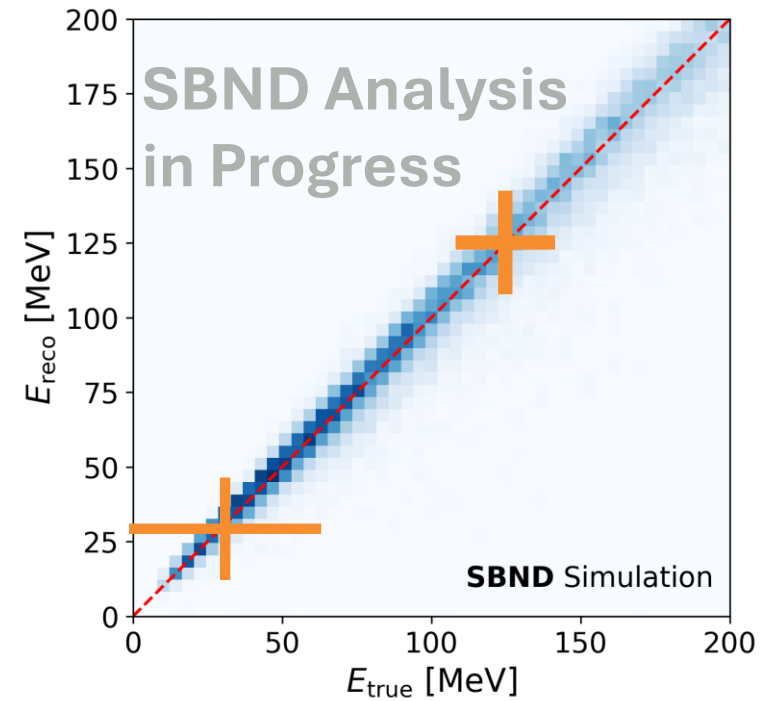
$\tau_e \geq 30$ ms \rightarrow less than 4% charge loss
indicating high purity and uniformity in TPC



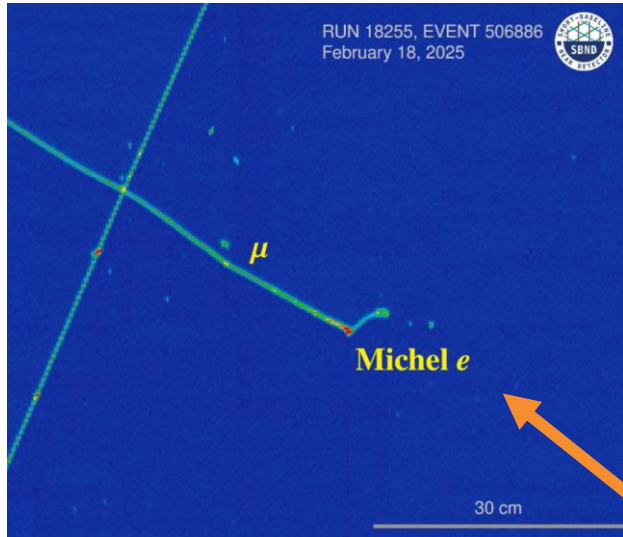
Excellent calorimetry
and data/MC
agreement in particle
identification

Electron/Photon Performance

Michel-e and π^0 mass peak serves as control samples for shower calibration.

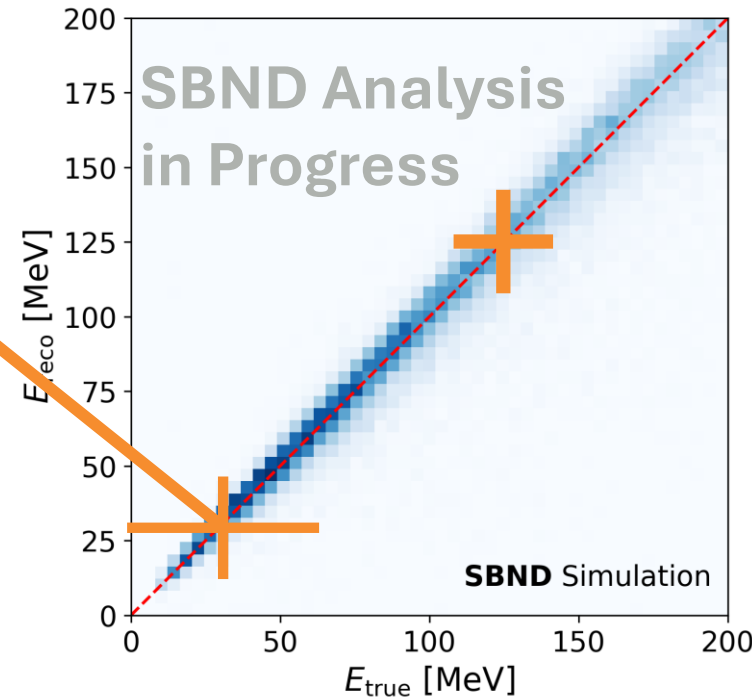
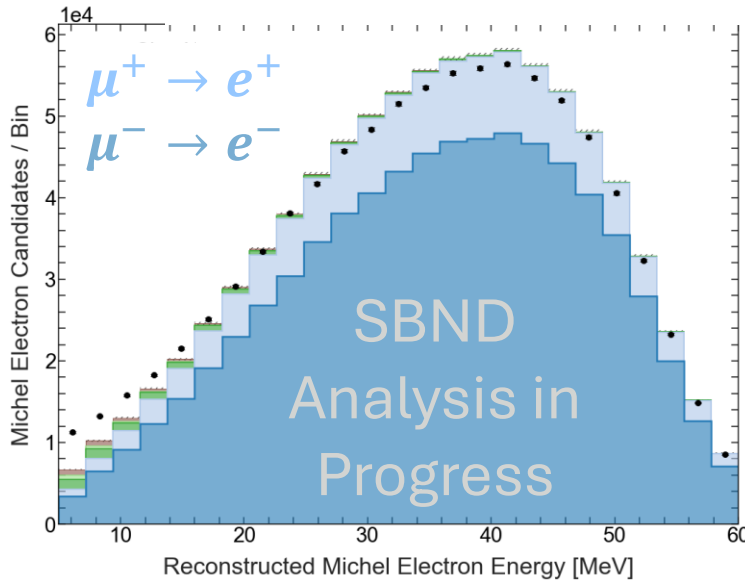


Electron/Photon Performance



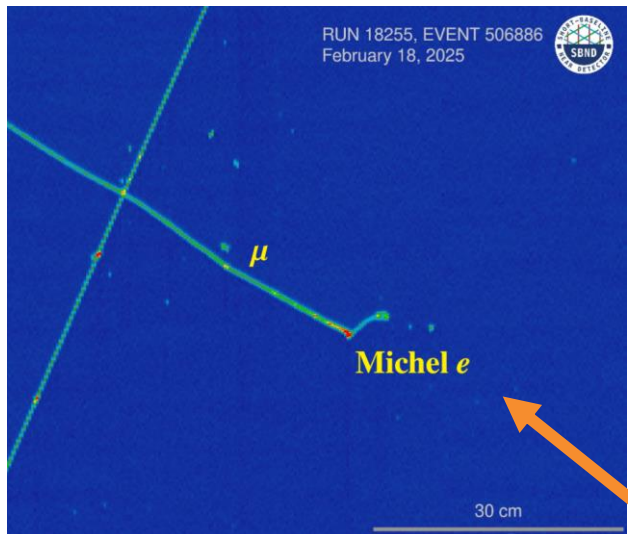
Michel- e and π^0 mass peak serves as control samples for shower calibration.

Michel electron



Michel- e
 efficiency: 85%
 Purity: 98%

Electron/Photon Performance

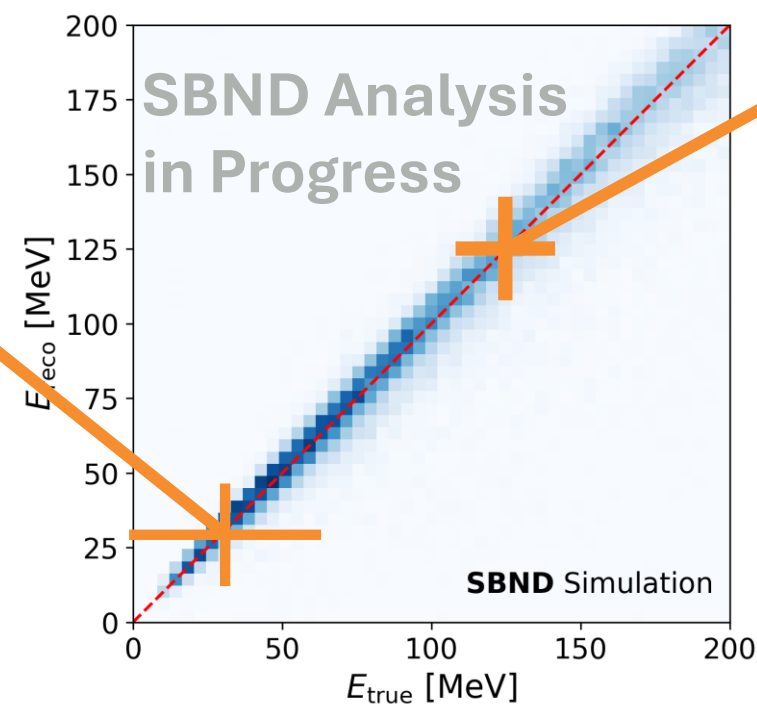
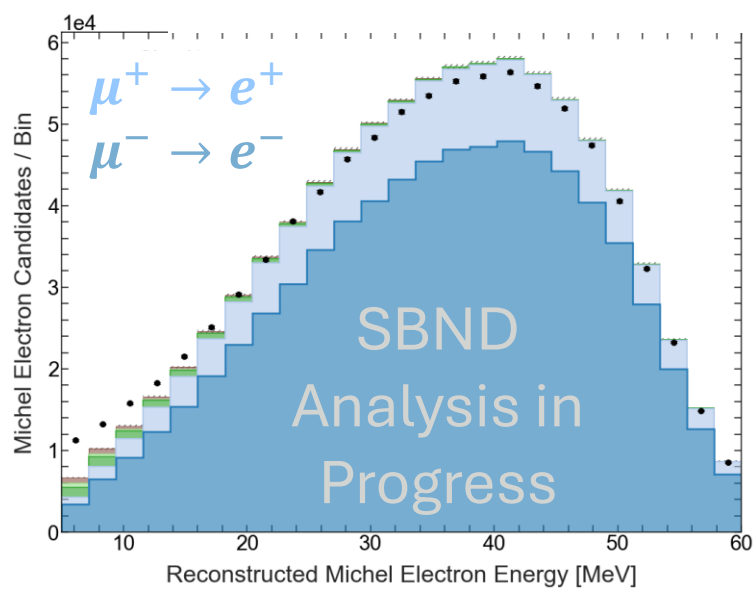


Michel electron

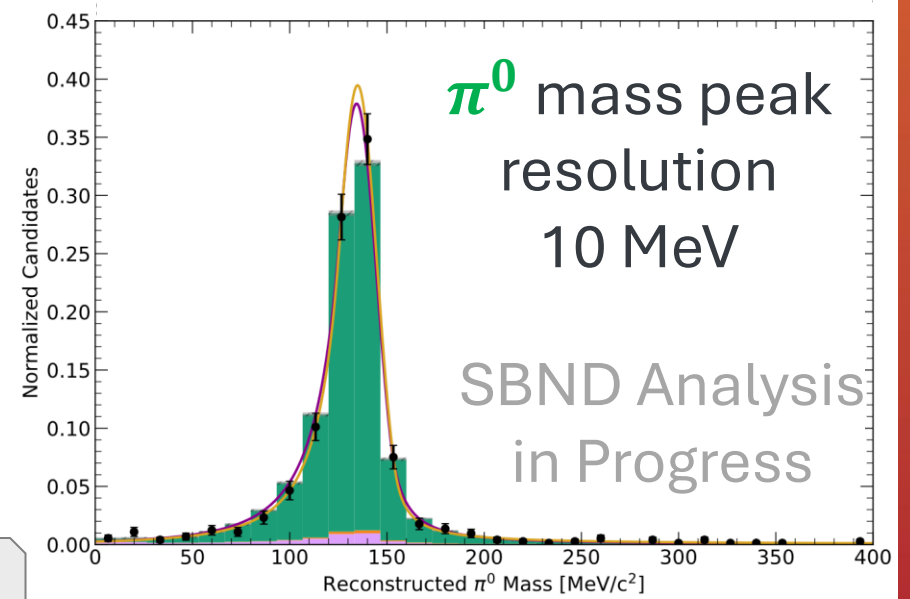
Michel-e and π^0 mass peak serves as control samples for shower calibration.



Charged Current $1\pi^0$



Michel-e
efficiency: 85%
Purity: 98%

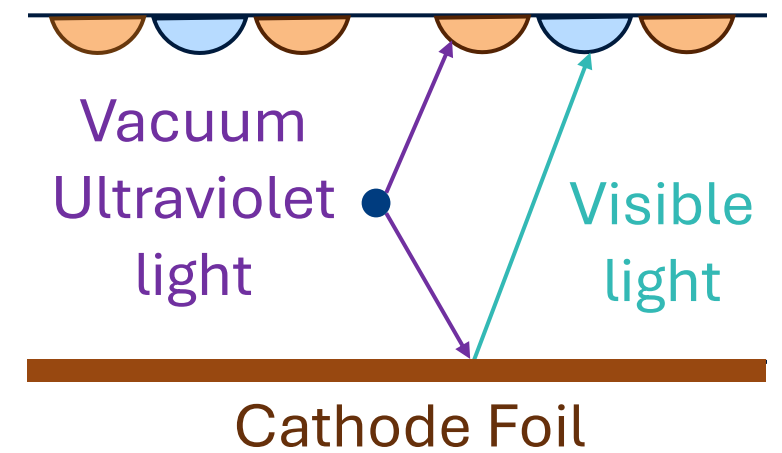


Poster #214 (Thu.)

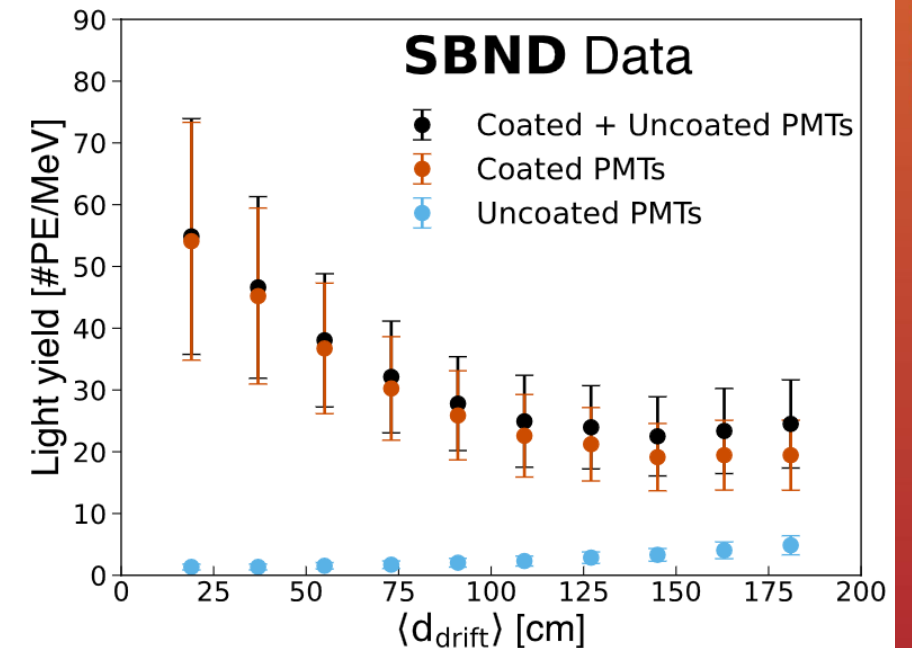
Photon Detection System

With wavelength-shifting foil on cathode, coated and uncoated PMTs, SBND PDS is capable of independent 3D spatial reconstruction

Coated PMT & uncoated PMT

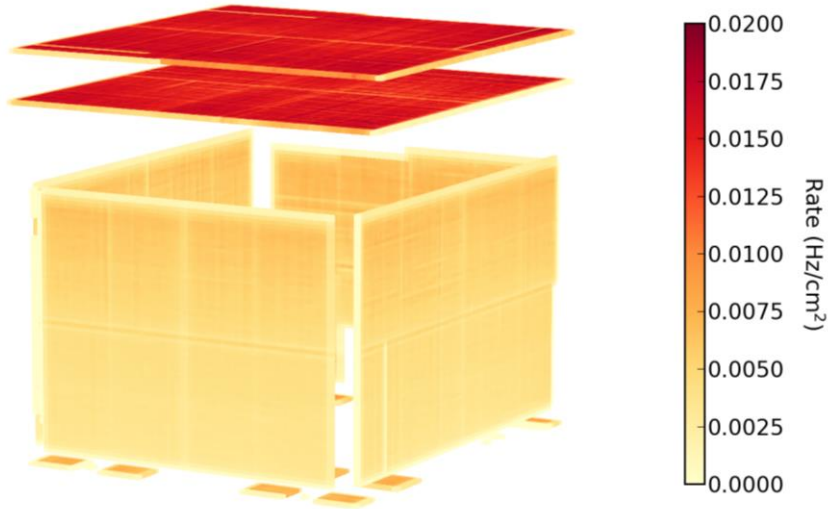


SBND Analysis in Progress



Photon Detection System

Cosmic-Ray Tagger



CRT measures cosmic muons and tags timing information to geometrically matched tracks.

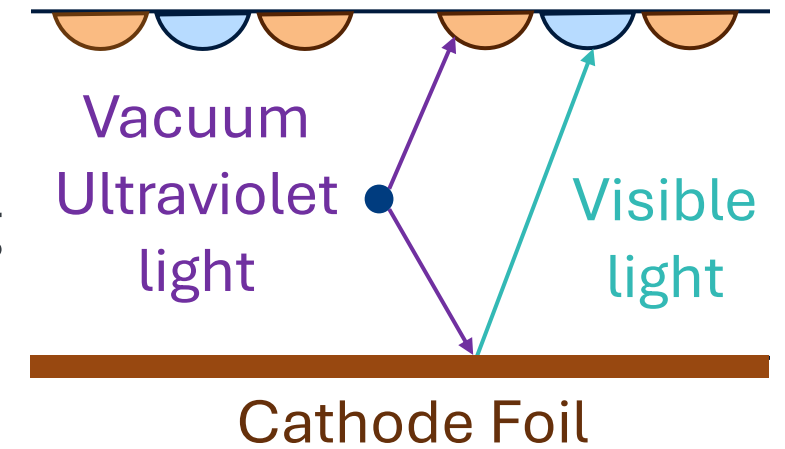
With wavelength-shifting foil on cathode, coated and uncoated PMTs, SBND PDS is capable of independent 3D spatial reconstruction

Achieved beam timing resolution:

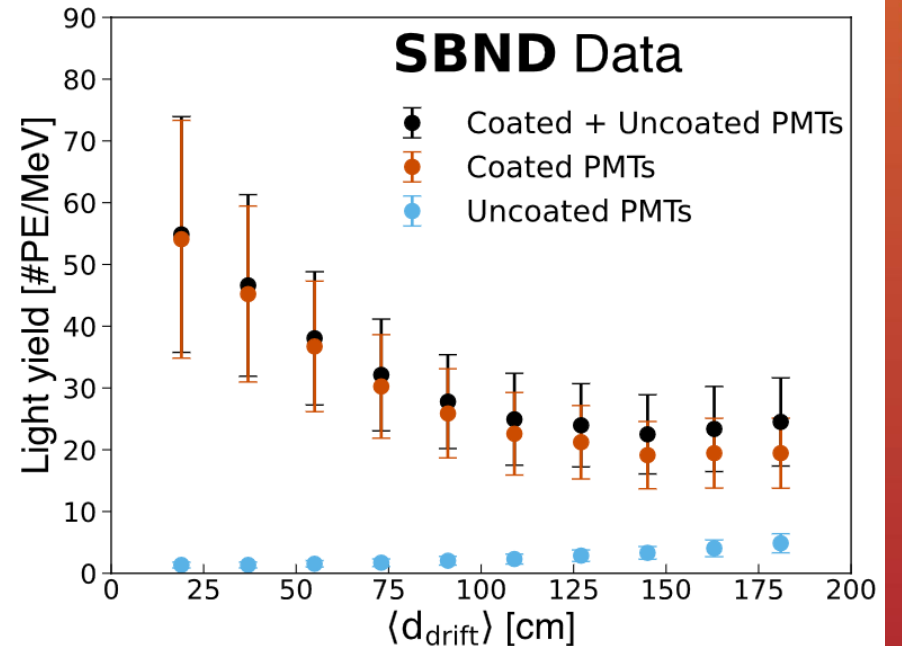
$$\sigma < 1.3 \text{ ns}$$

Poster #186 (Tue.)
Timing Reconstruction

Coated PMT & uncoated PMT

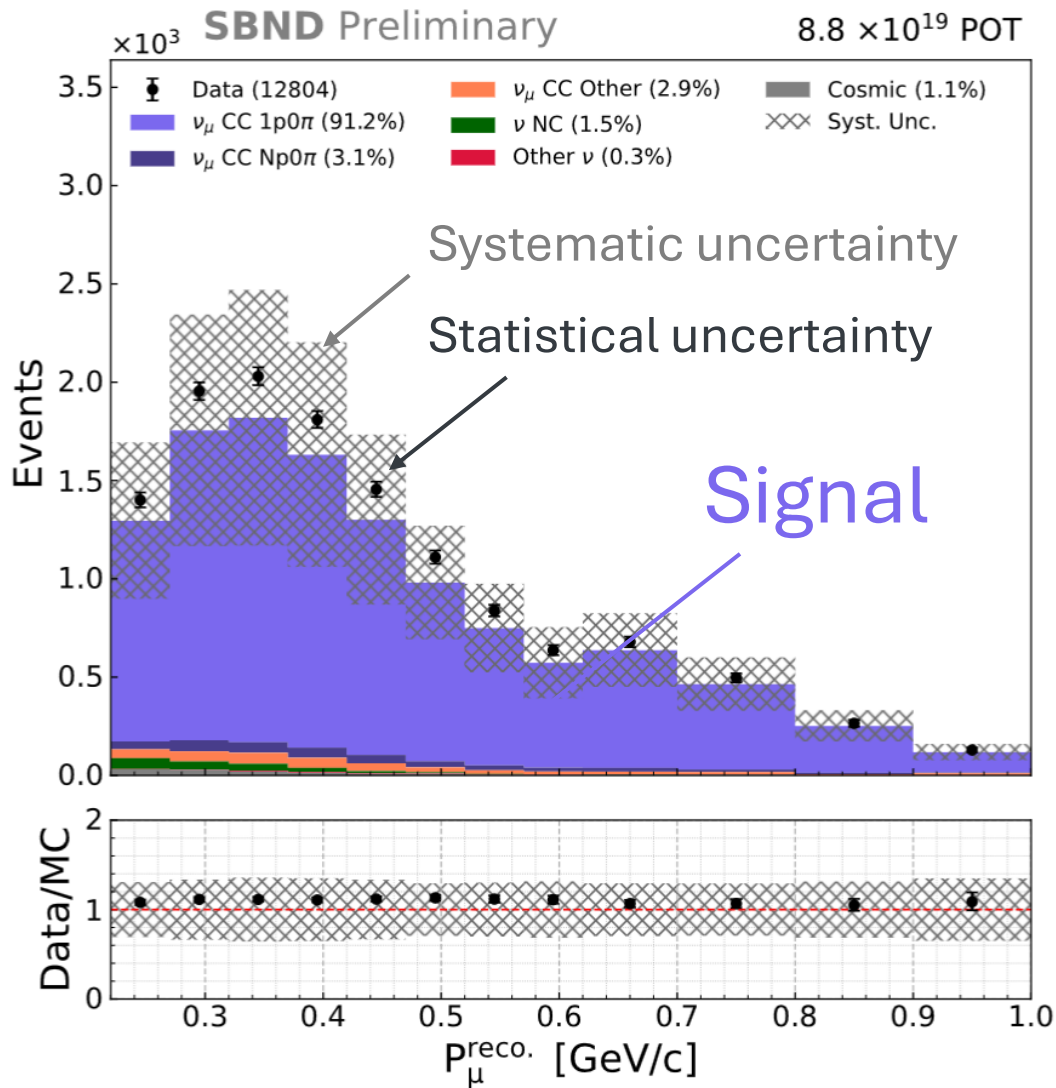


SBND Analysis in Progress



First Physics Results:

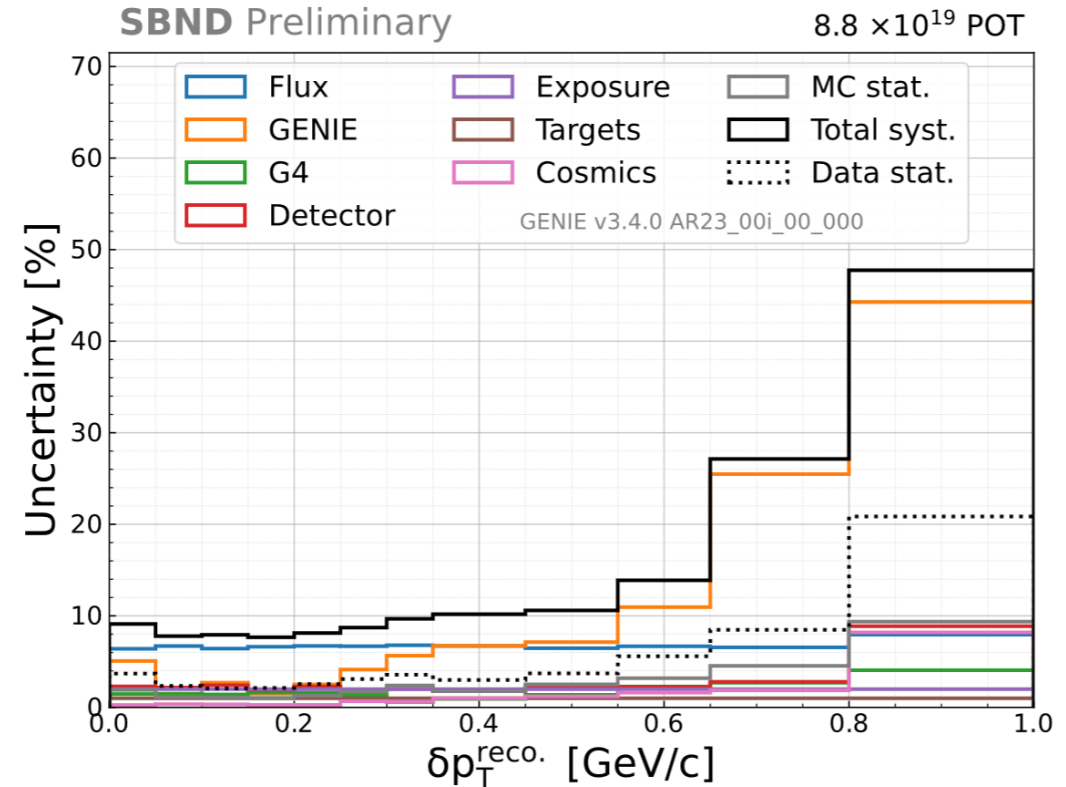
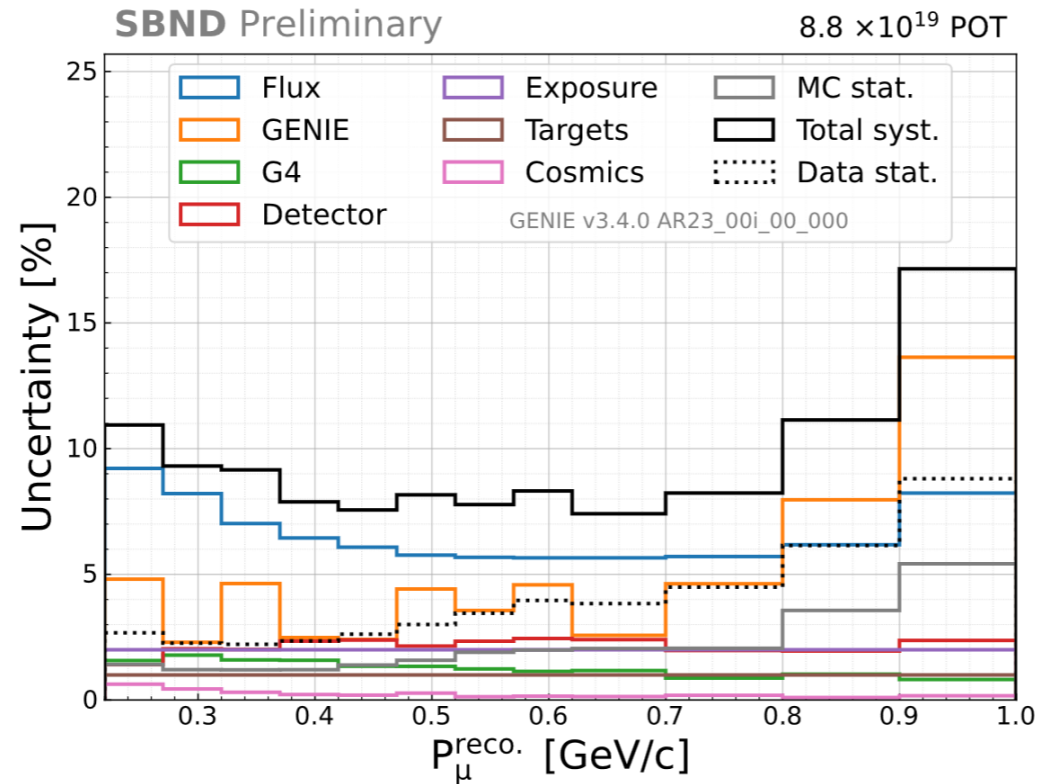
First Physics Results: ν_μ Charged Current $1\mu 1p$



- Sample purity: 91%
- Selection efficiency: 38%
- 12k selected events collected in 2 months (15% of data collected so far)



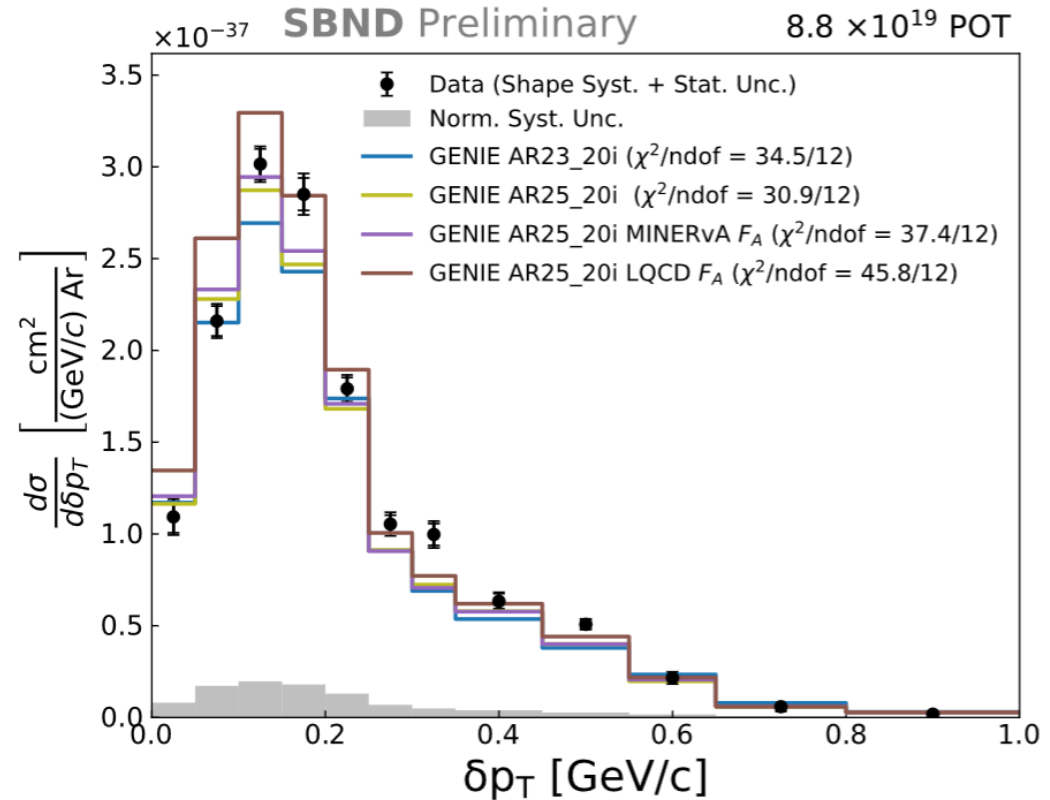
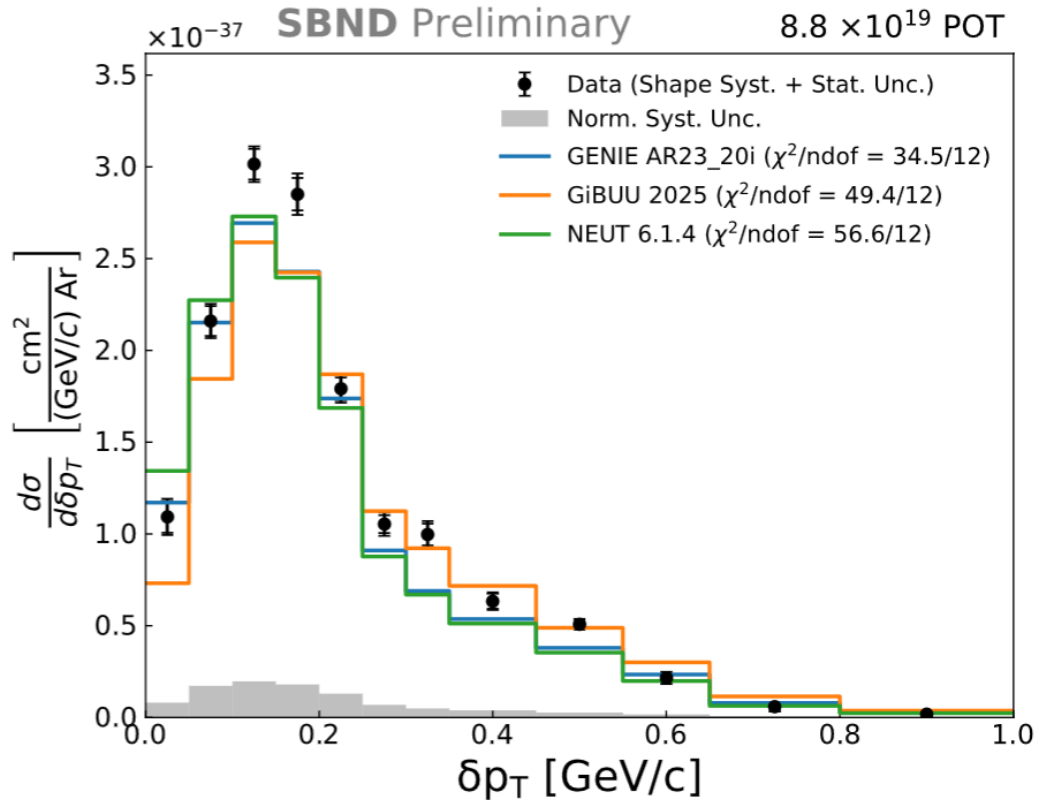
First Physics Results: ν_{μ} CC $1\mu 1p$ Systematics



- Systematic budget is dominated by **flux** & **background channel cross-section** uncertainty, both smaller than previous measurements
- Small **detector modeling systematics** indicate good TPC modeling

Poster #444 (Tue.)
Detector Systematics

First Physics Results: $\nu_{\mu}\text{CC } 1\mu 1p$ Cross-Section



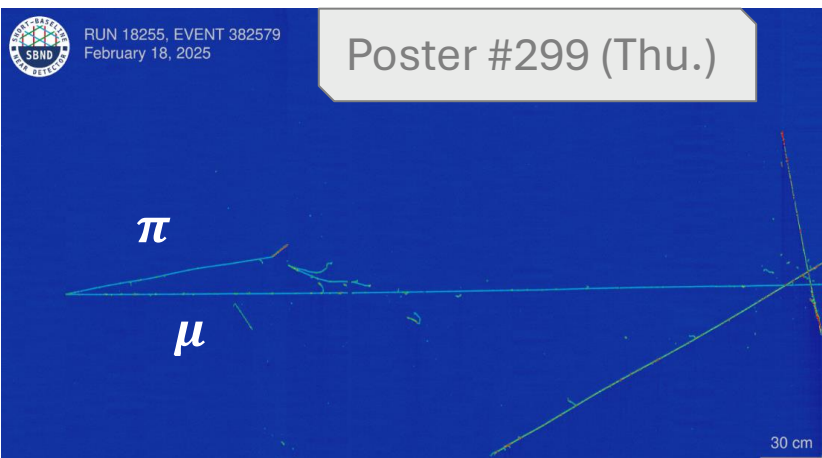
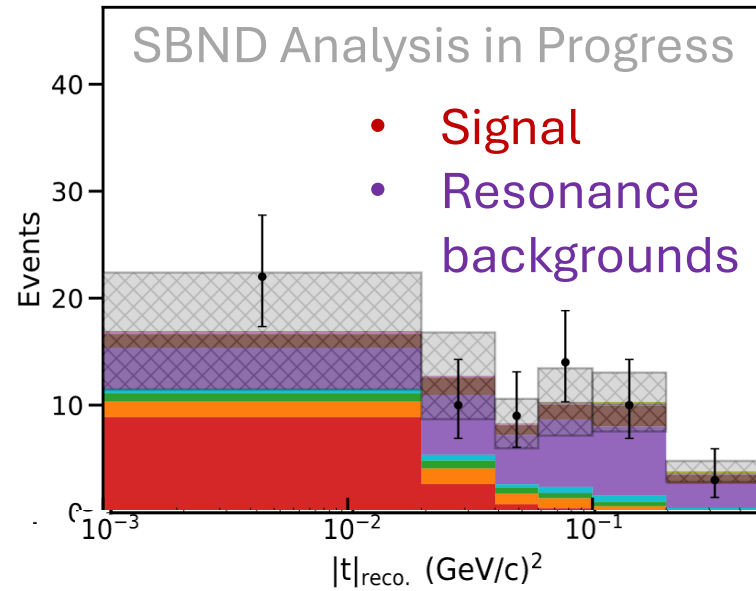
- First physics result within 1.5 years of physics data-taking
- Unprecedented precision on $\nu_{\mu}\text{CC } 1\mu 1p$ cross-section!
- With unique capability to scrutinize interaction models

More Exclusive Channels

Analyses in progress with only **2 days** of SBND data!

4.6×10^{18}
POT

ν_μ CC coherent π

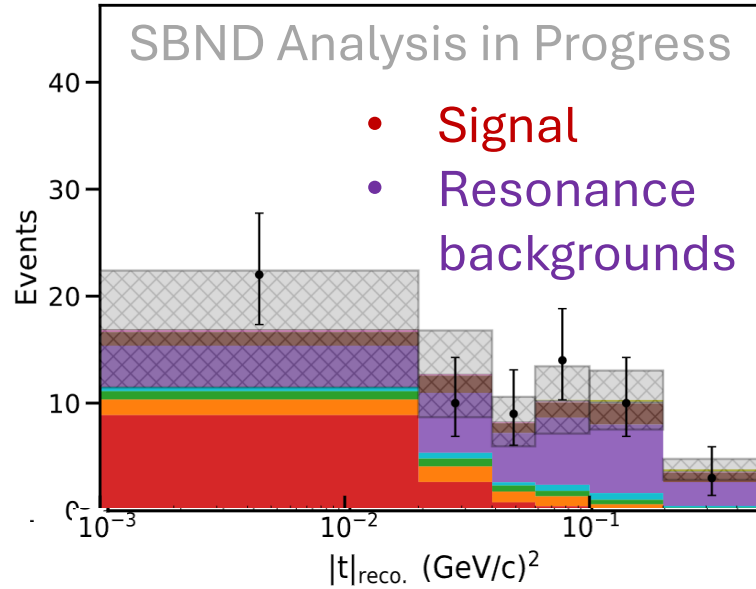


More Exclusive Channels

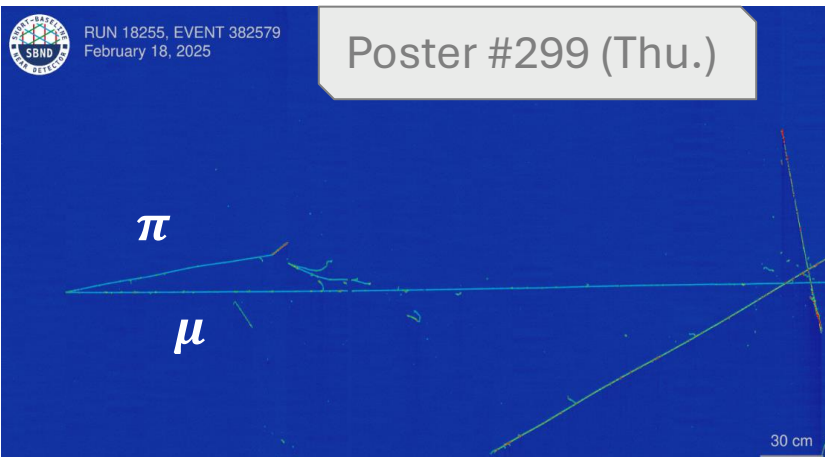
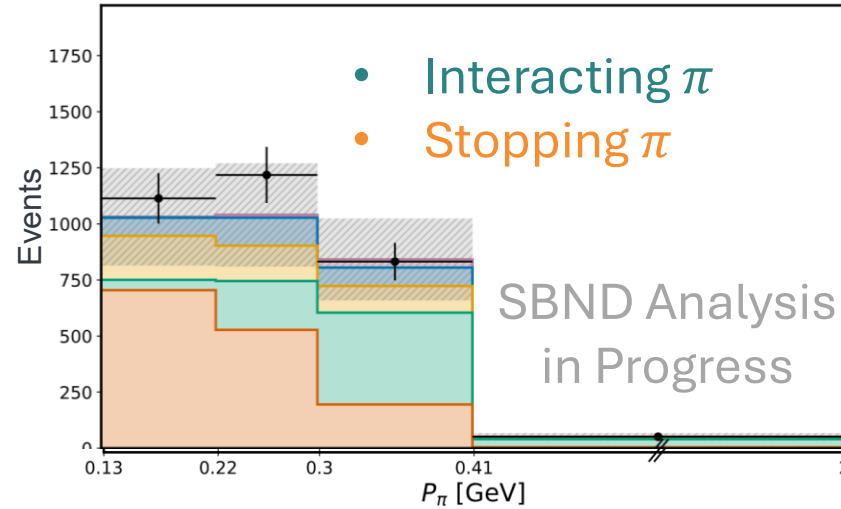
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4.6×10^{18}
POT

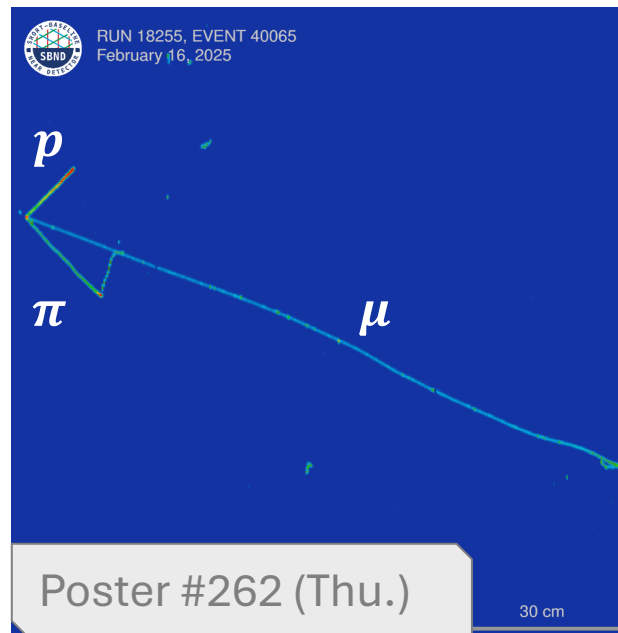
ν_μ CC coherent π



ν_μ CC1 π



06/22/2026 First Physics Results from SBND, Linyan WAN

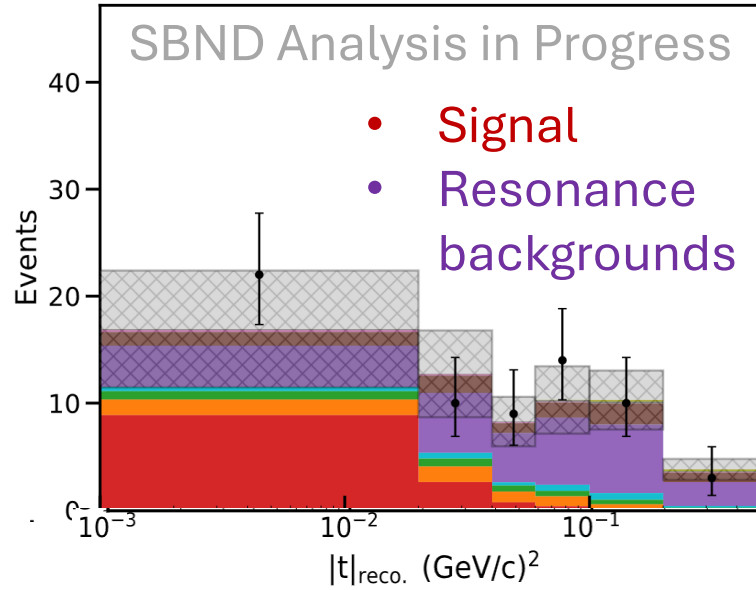


More Exclusive Channels

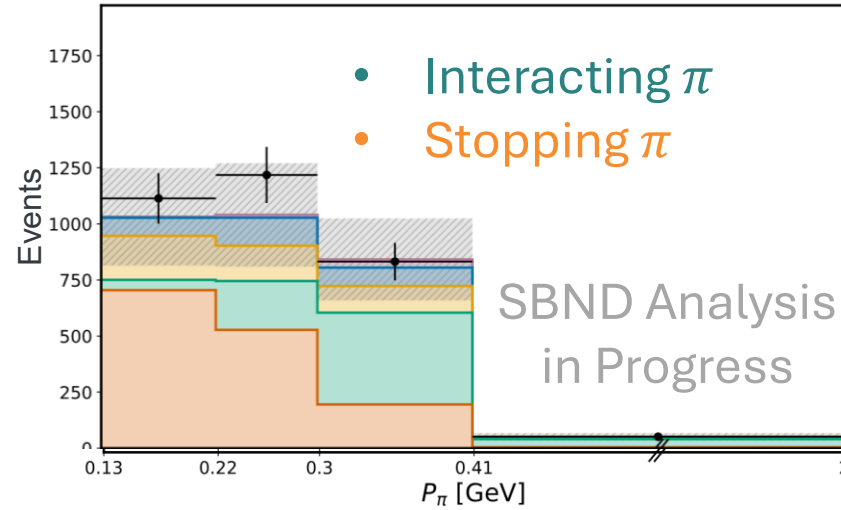
Analyses in progress with only **2 days** of SBND data!

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POT

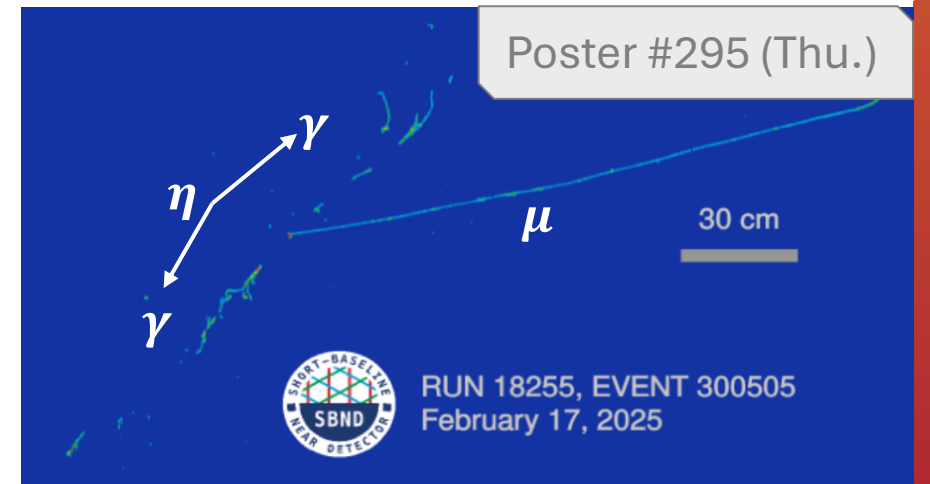
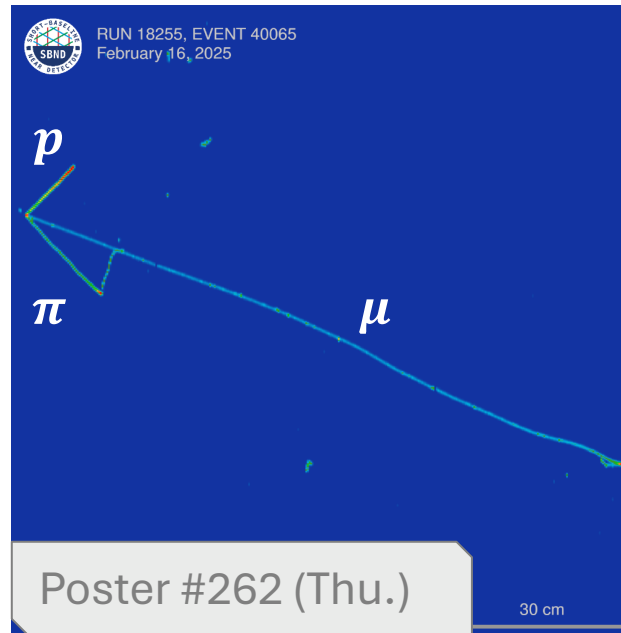
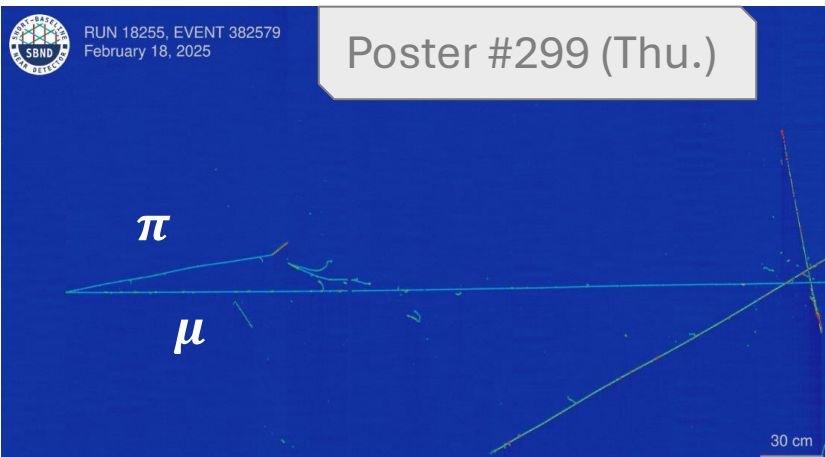
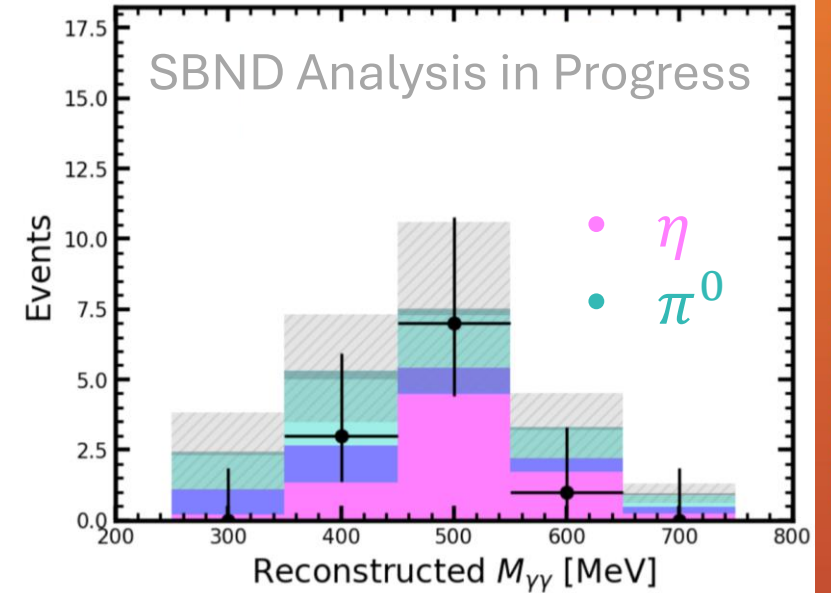
ν_μ CC coherent π



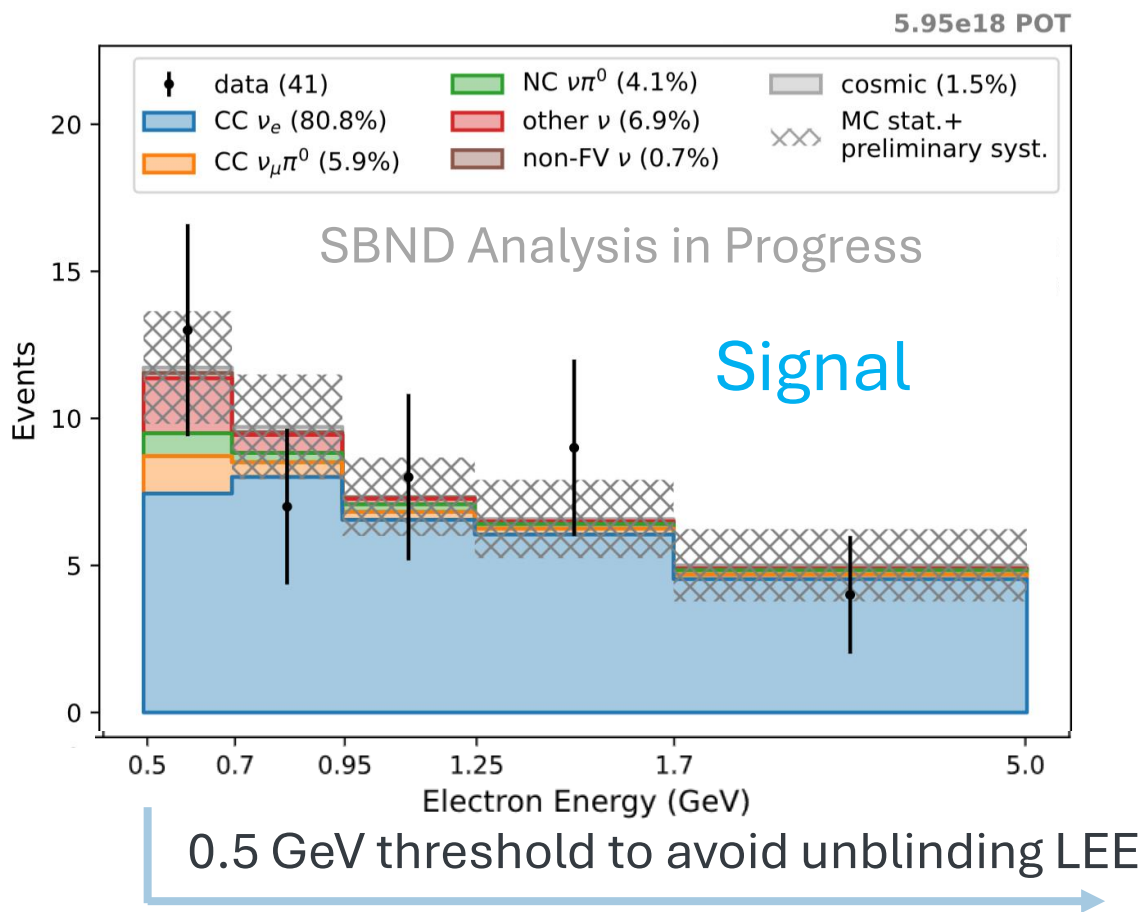
ν_μ CC 1π



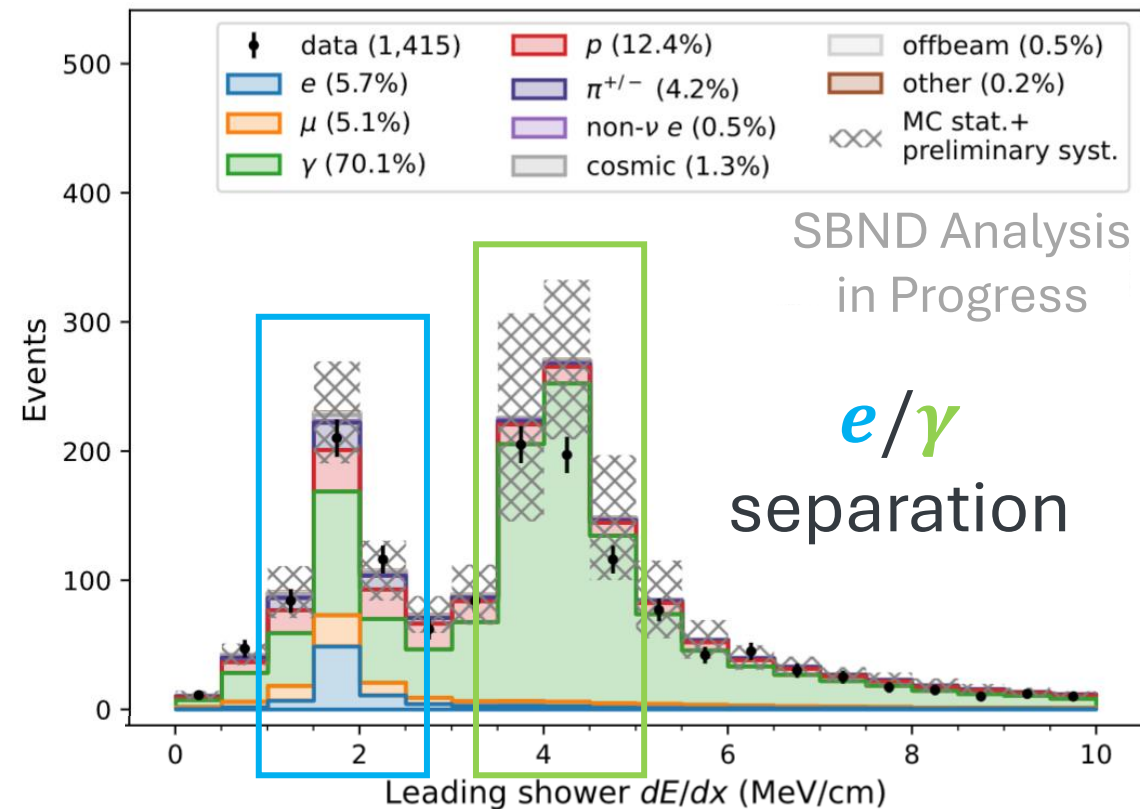
ν_μ CC η



ν_e CC Inclusive Selection



- Integrated purity: 81%
- Integrated efficiency: 26%
- Expect >10k events in 3-year SBND data



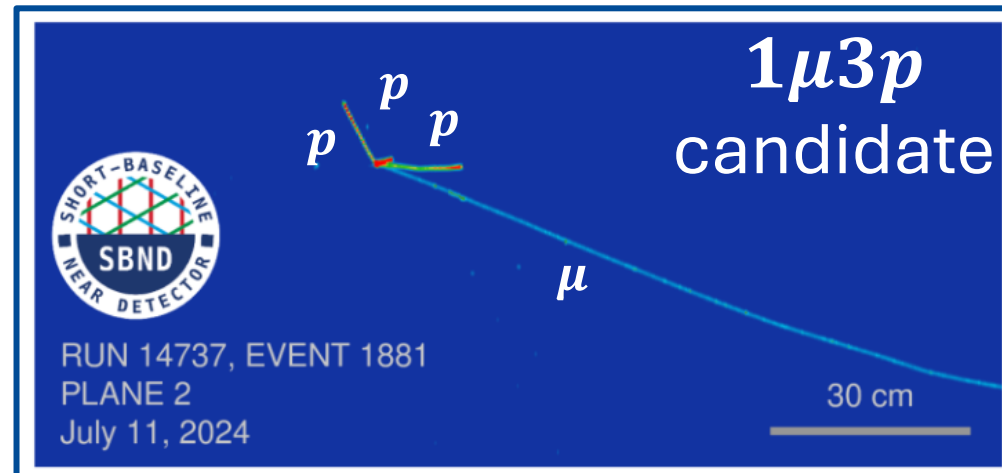
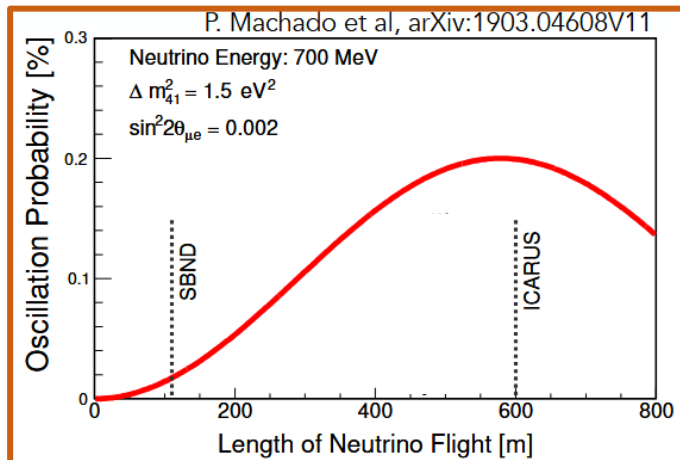
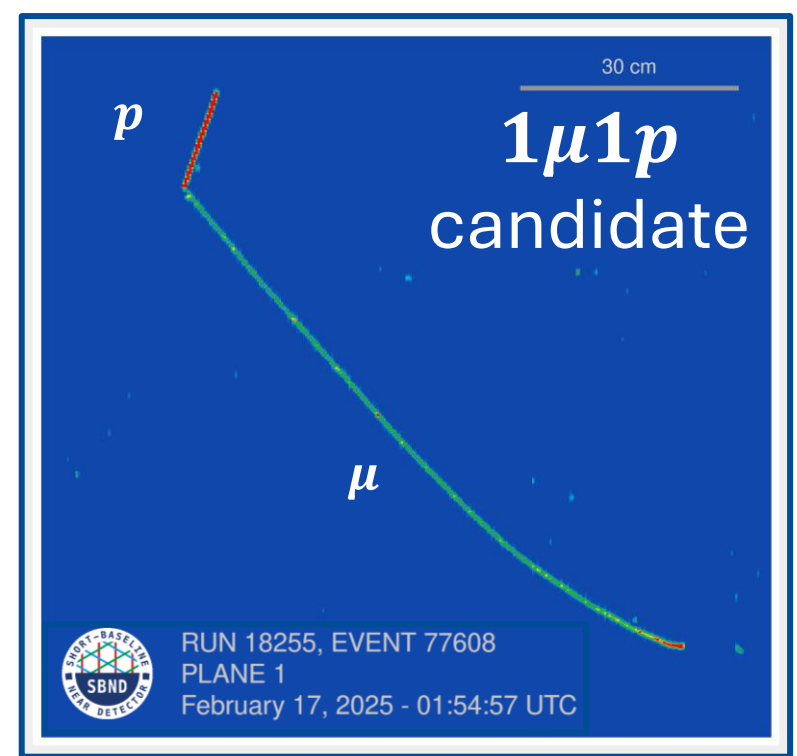
RUN 14729, EVENT 41
PLANE 2
July 11, 2024

30 cm

Poster #479 (Thu.)

Sterile Neutrino Oscillation

- SBN can probe the short-baseline anomaly on ν_μ , ν_e , and neutral-current channels independently, each with high sensitivity, using various topologies and reconstruction techniques
- Two-detector setup enables us to probe the short-baseline neutrino anomalies model-independently.



ν_μ

Poster #287 (Tue.)
Poster #375 (Tue.)
Poster #382 (Tue.)
Poster #465 (Tue.)

ν_e

Poster #298 (Tue.)

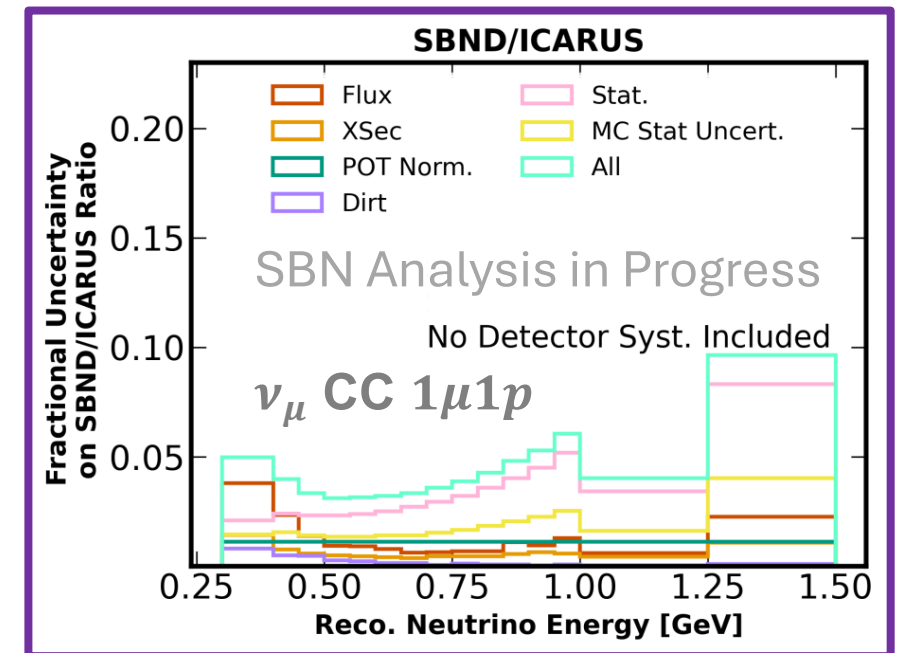
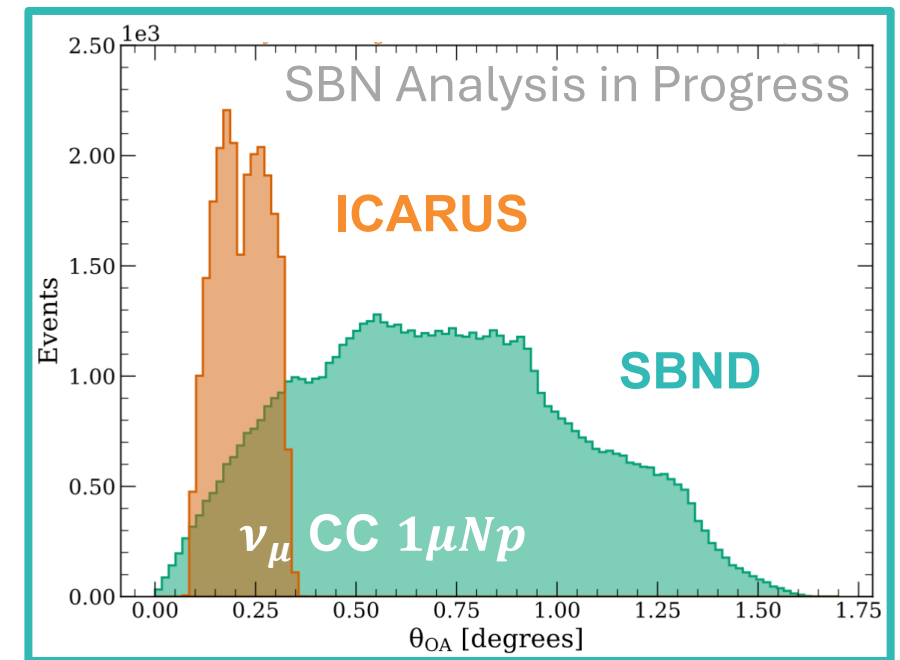
NC

Poster #300 (Tue.)

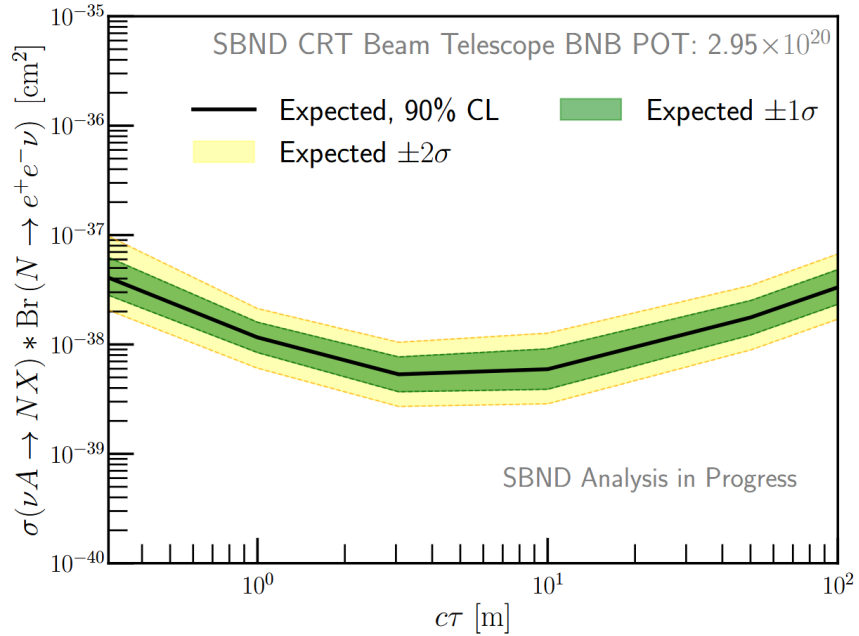
Sterile Neutrino Oscillation

- SBND deepens the SBN sensitivity by more than an order of magnitude by constraining the event rate close to the source.
- The high statistics and unique features like SBND-PRISM allows binning the data to provide powerful handles on flux and cross-section.
- Using the same detector technology, target nucleus, and beamline, SBN can constrain systematic uncertainties to percent-level.

Poster #297 (Thu.)
Cross-section modeling



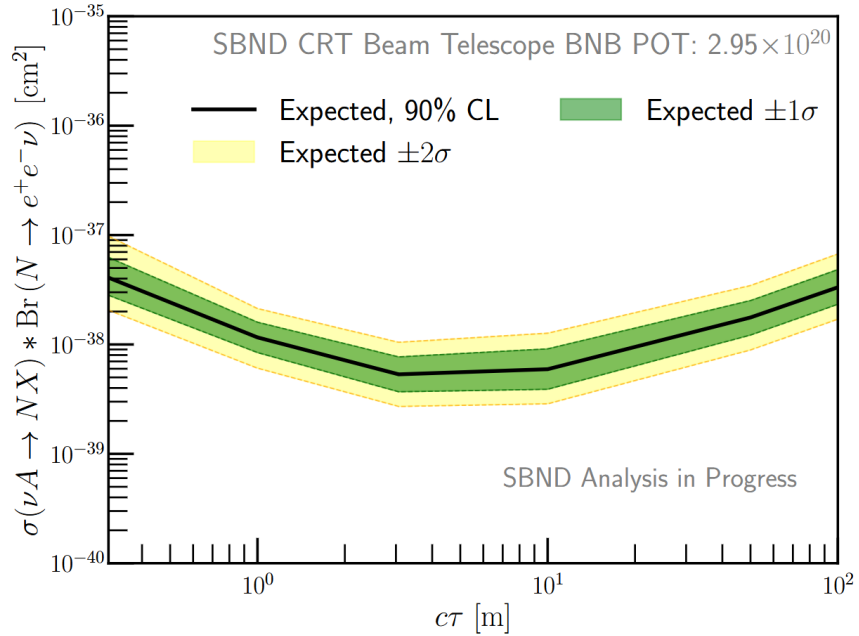
Searching for New Physics



Prior to SBND data-taking, we conducted a search for **Long-Lived Particles** using SBND CRT with high sensitivities.

Data result coming soon!

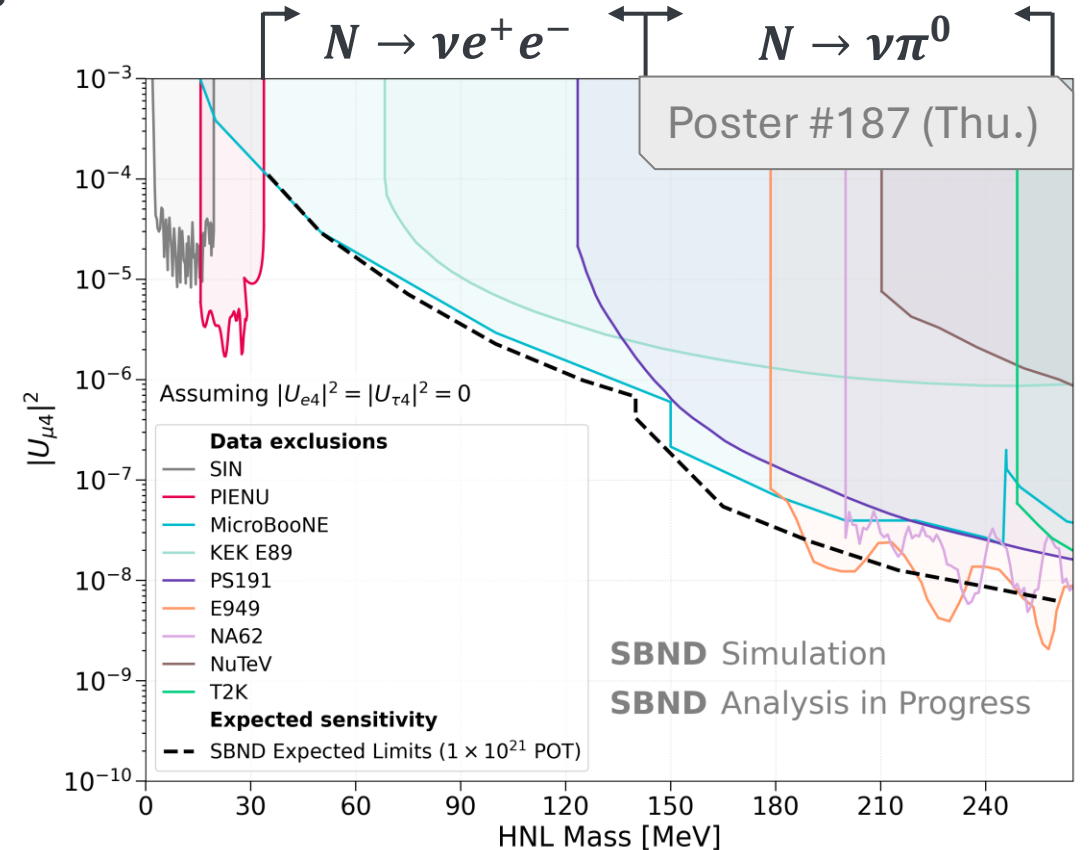
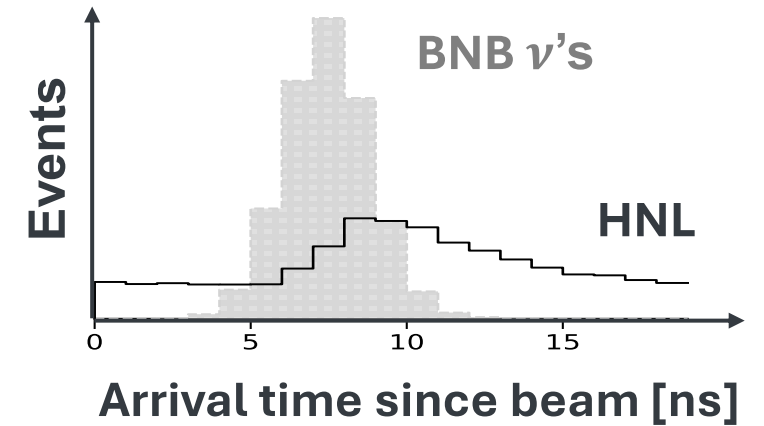
Searching for New Physics



Prior to SBND data-taking, we conducted a search for **Long-Lived Particles** using SBND CRT with high sensitivities. Data result coming soon!

MeVPrtl
BSM
generator
arXiv:
2605.11321

SBND is sensitive to BSM physics such as **Heavy Neutral Lepton** with the high-precision timing and high flux.



Looking Ahead

First physics NOW:

- Exclusive and inclusive cross-section channels
- Short-baseline anomaly with various topologies
- Novel physics searches with timing information

Looking Ahead

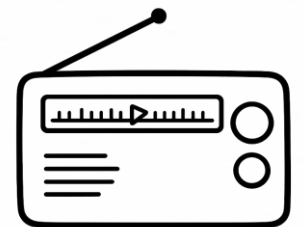
First physics NOW:

- Exclusive and inclusive cross-section channels
- Short-baseline anomaly with various topologies
- Novel physics searches with timing information

Much more to COME:

- $\sim 10 \times 10^{20}$ POT and 9 million events in the planned 3-year running.
- Holistically probe and constrain ν interaction in the 0.2-3 GeV range
- Conclusively address the sterile neutrino solution to the short baseline anomaly
- Expand novel physics searches to unexplored phase space and signatures
- ...

stay tuned!



Take-Away Messages

- **SBND is here!**
 - SBND has been stably taking physics data since 2025, has accumulated the largest ν -Ar dataset, and shows amazing detector performance.
- **We released the first physics results!**
 - On ν_{μ} CC $1\mu 1p$ cross-section with a high precision capable of scrutinizing models
 - Also, a lot more analyses in-progress!
- **Expect a flood of physics results coming!**
 - Covering cross-section, short baseline anomaly, and new physics searches!



Check Our Posters!

Thursday:

Cross-section and BSM Physics

Tuesday

Detector Performance

#436 signal processing
#123 MeV reconstruction
#186 timing reconstruction
#444 detector systematics
#478 X-ARAPUCA at SBND

Tuesday

Oscillation Physics

#287 $1\mu 1p$ channel
#375 $1\mu Np$ traditional reconstruction
#465 $1\mu Np$ ML reconstruction
#382 multi-topology ν_μ channel
#298 ν_e channel
#300 neutral current channel

#299 ν_μ CC coherent π
#262 ν_μ CC 1π
#295 η production
#479 ν_e CC inclusive
#214 showers and photons
#297 cross-section modeling
#187 heavy neutral lepton





Fermilab

Fermi *FORWARD*



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of ENERGY