



Neutrino Interaction Measurement Capabilities of the Short Baseline Near Detector

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1. The Short Baseline Near Detector

Key Milestones:

1. **TPC completion**
Oct. 2022
2. **Detector moved**
Dec. 2022
3. **TPC into cryostat**
April 2023
4. **First CRT installed**
May 2023
5. **Argon fill**
Feb. 2024
6. **Commissioning**
July 2024
7. **Data-taking NOW**

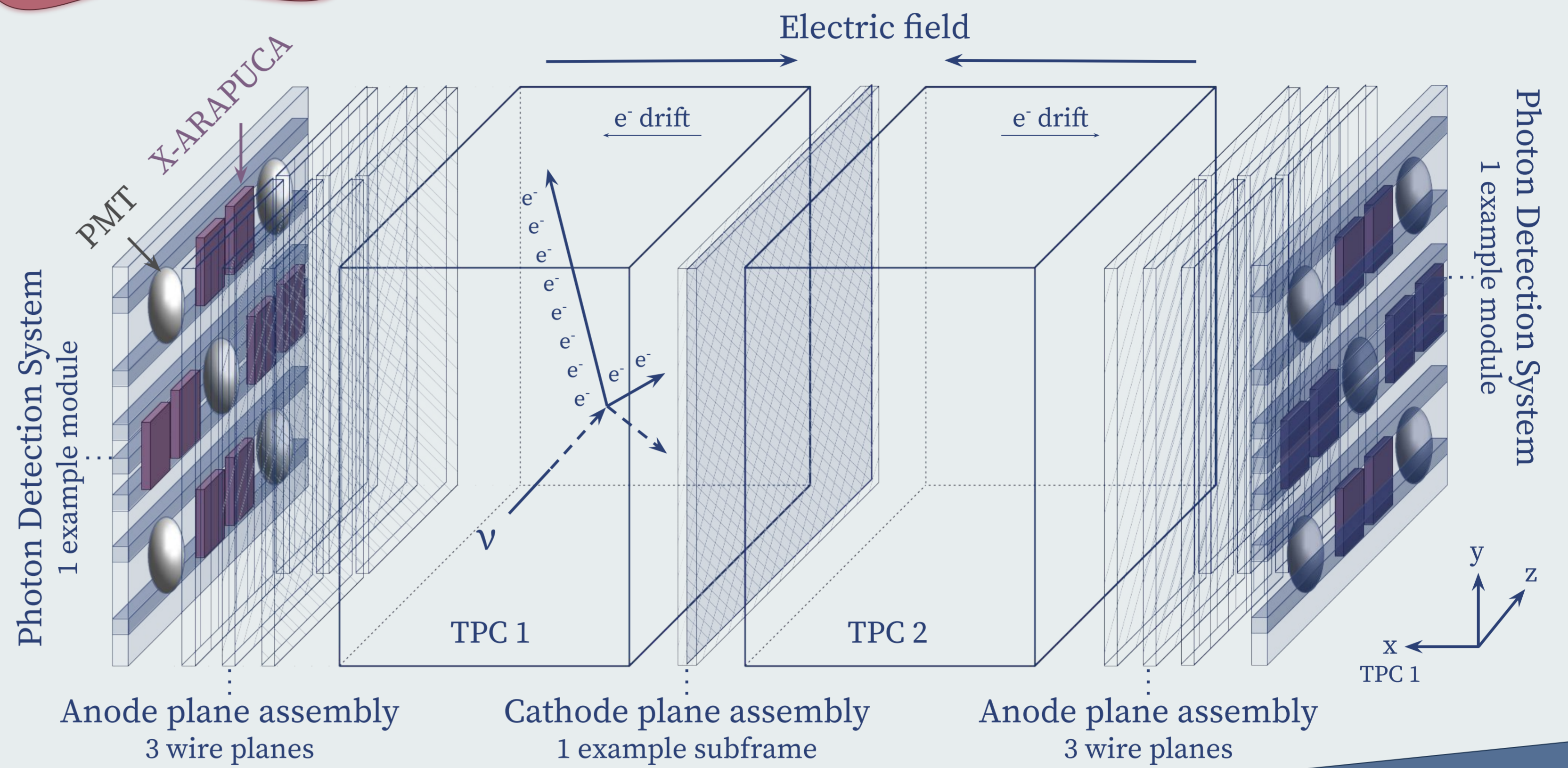


TPC installation, April 2023

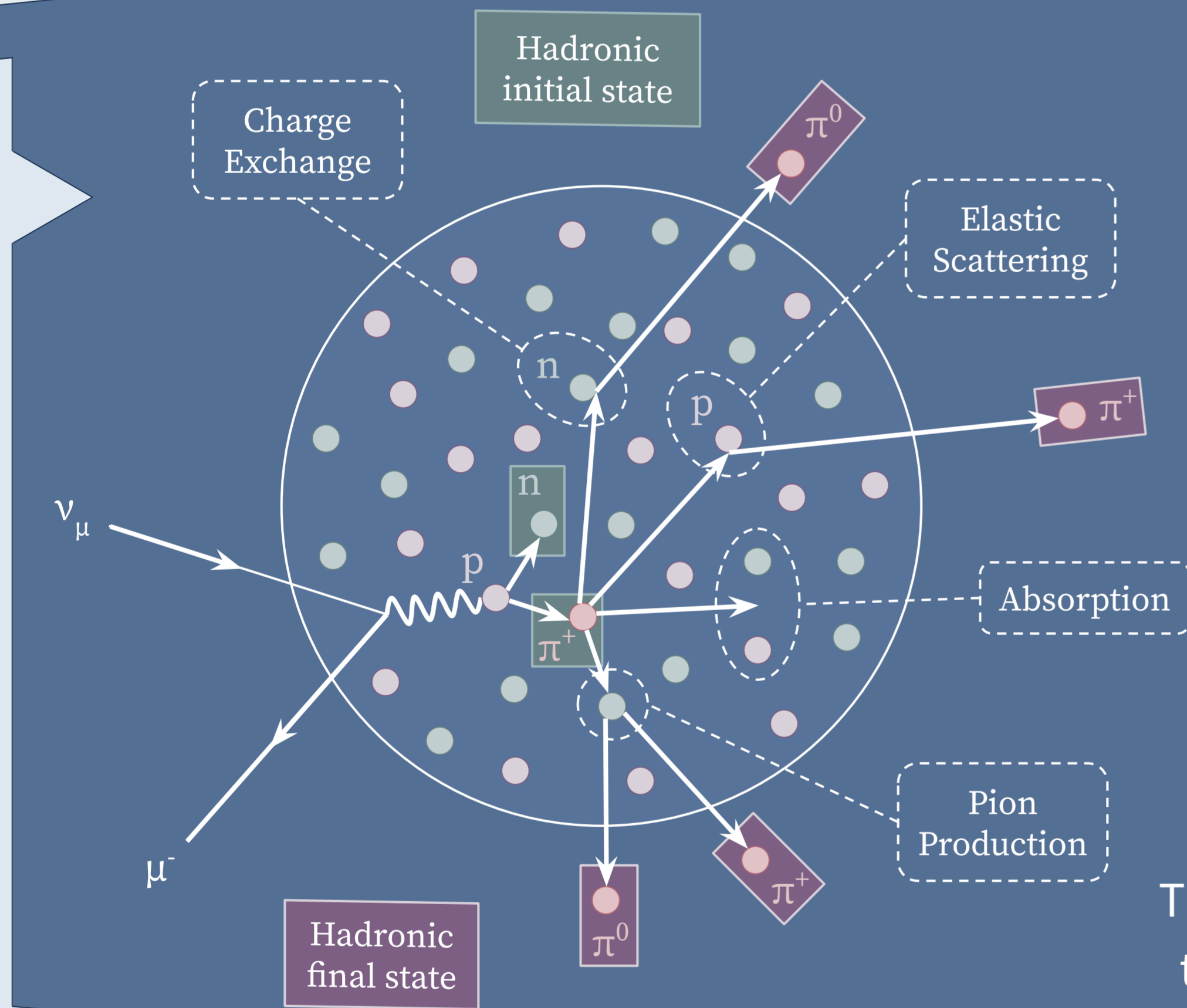
SBND will record **~2 million** neutrino interactions per year.

LArTPCs are imaging detectors with **mm-scale** resolution.

SBND is a liquid argon time projection chamber (**LArTPC**) neutrino experiment located in the Booster Neutrino Beam (**BNB**) as part of the Short Baseline Neutrino (**SBND**) programme at Fermilab [1][2].



2. ν -Ar interactions



Argon is a **high-Z** nuclear target.

- The nuclear model is crucial
- The initial interaction is impacted by multi-body correlations
- Intranuclear final state interactions occur

ν -Ar interactions must be well understood and modelled to make precision physics measurements. Excellent opportunity with **SBND's** substantial dataset.

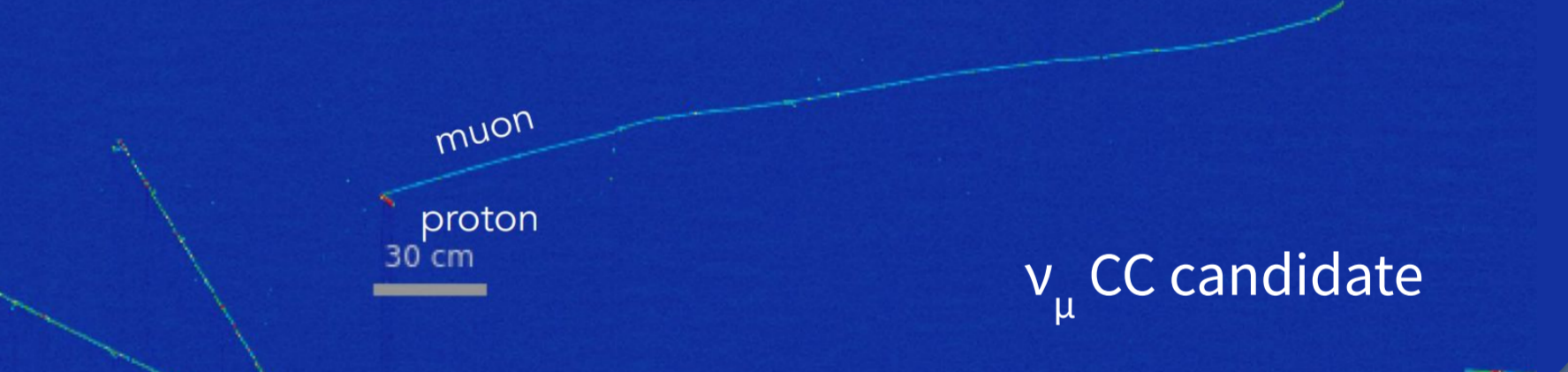
The **GENIE** neutrino interaction generator [3] and the **GiBUU** transport-theory based model [4] are used to generate SBND event rate predictions.

LArTPC final states are **complex** but **clear**.



RUN 14480, EVENT 567
July 05, 2024 - 13:28:18 UTC

SBND Data

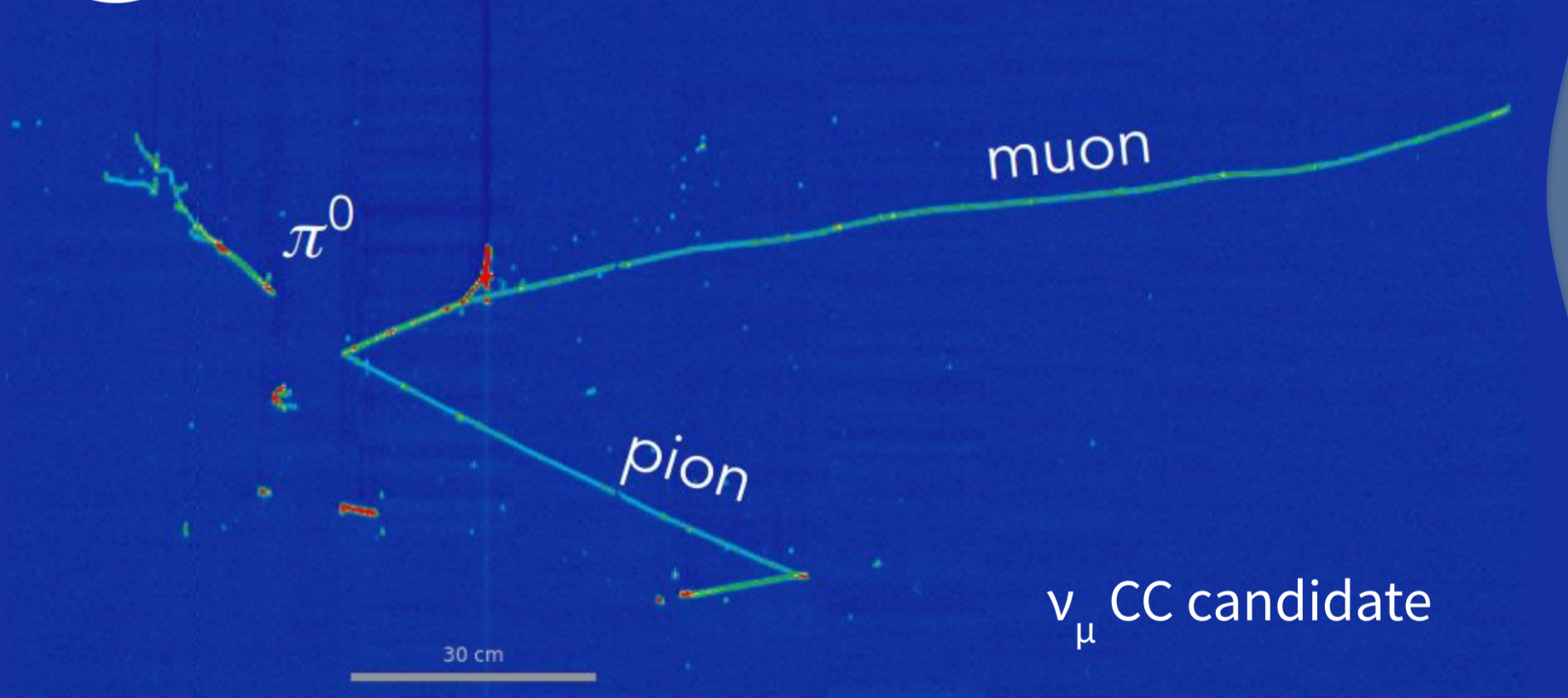


ν_μ CC candidate



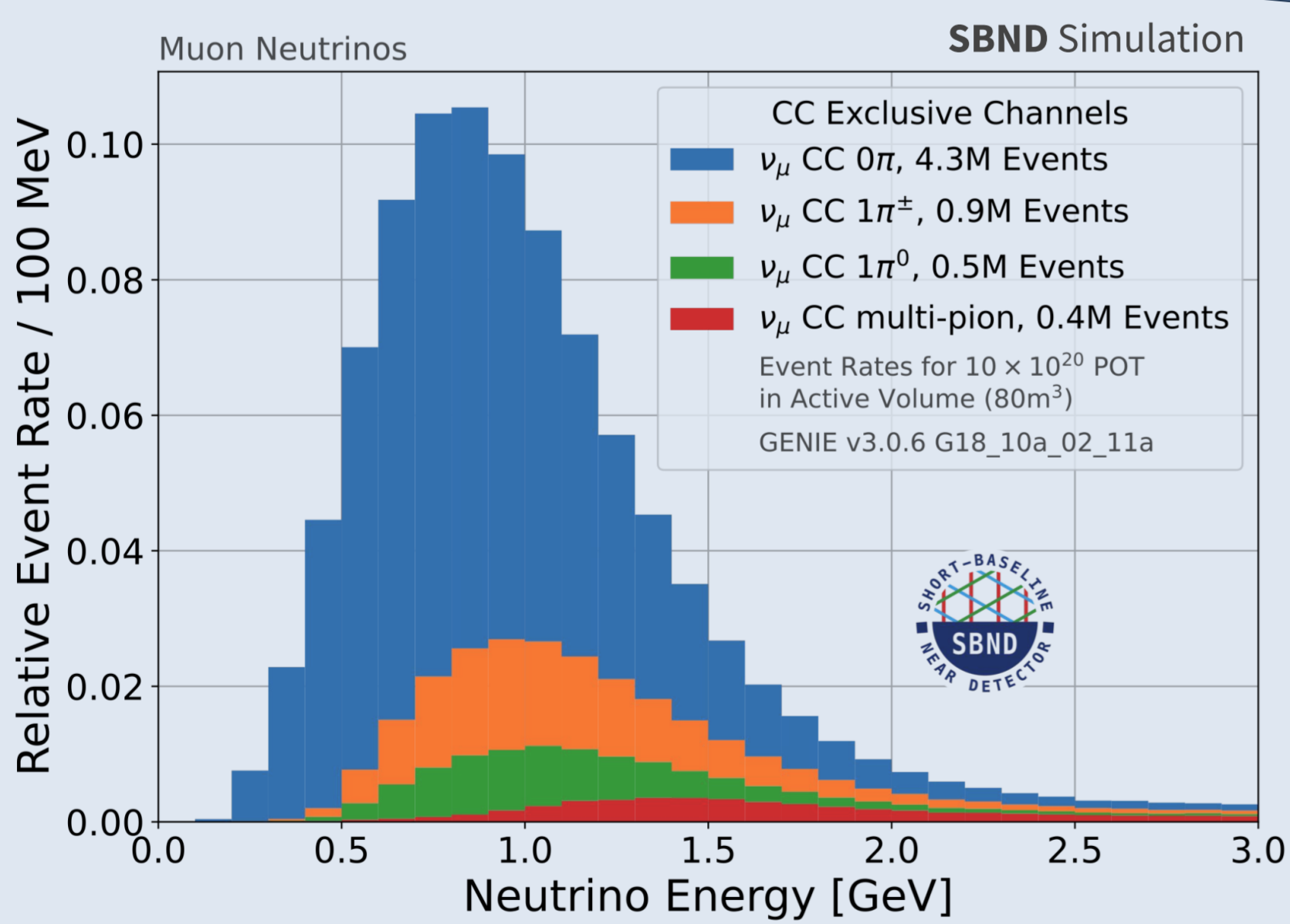
RUN 14445, EVENT 7379
July 04, 2024 - 21:11:00 UTC

SBND Data

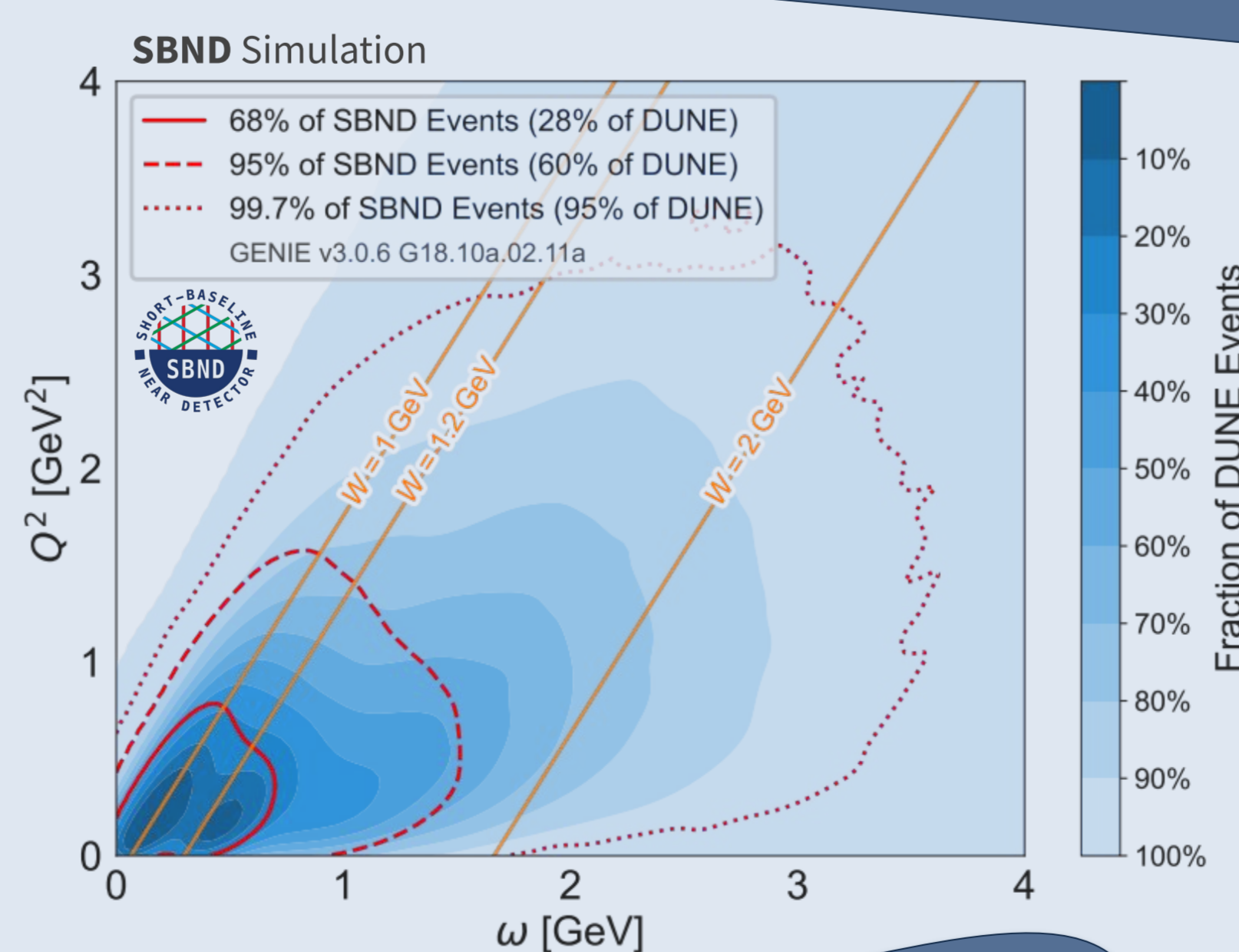


ν_μ CC candidate

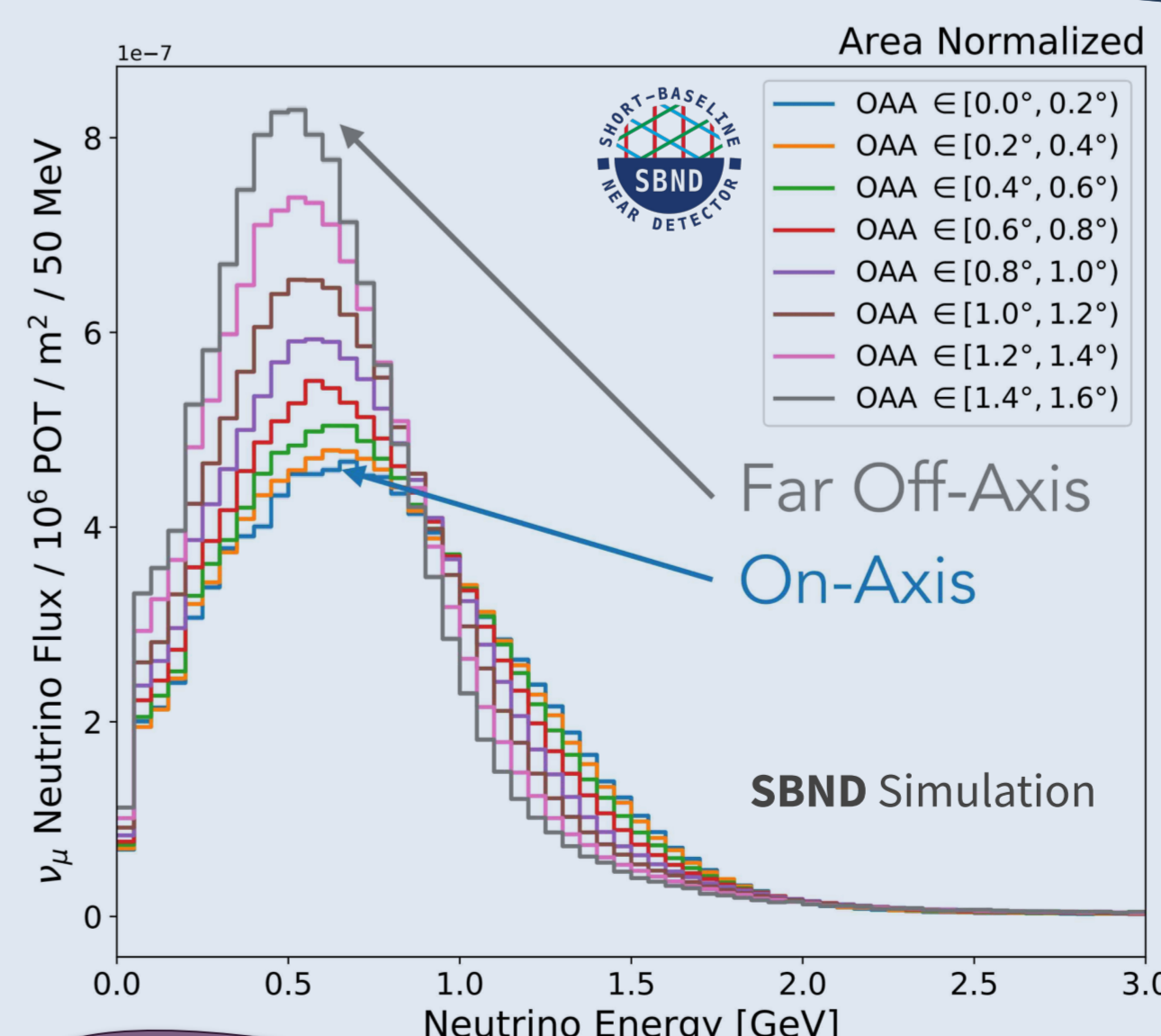
High-purity, efficient particle identification & low reconstruction thresholds.



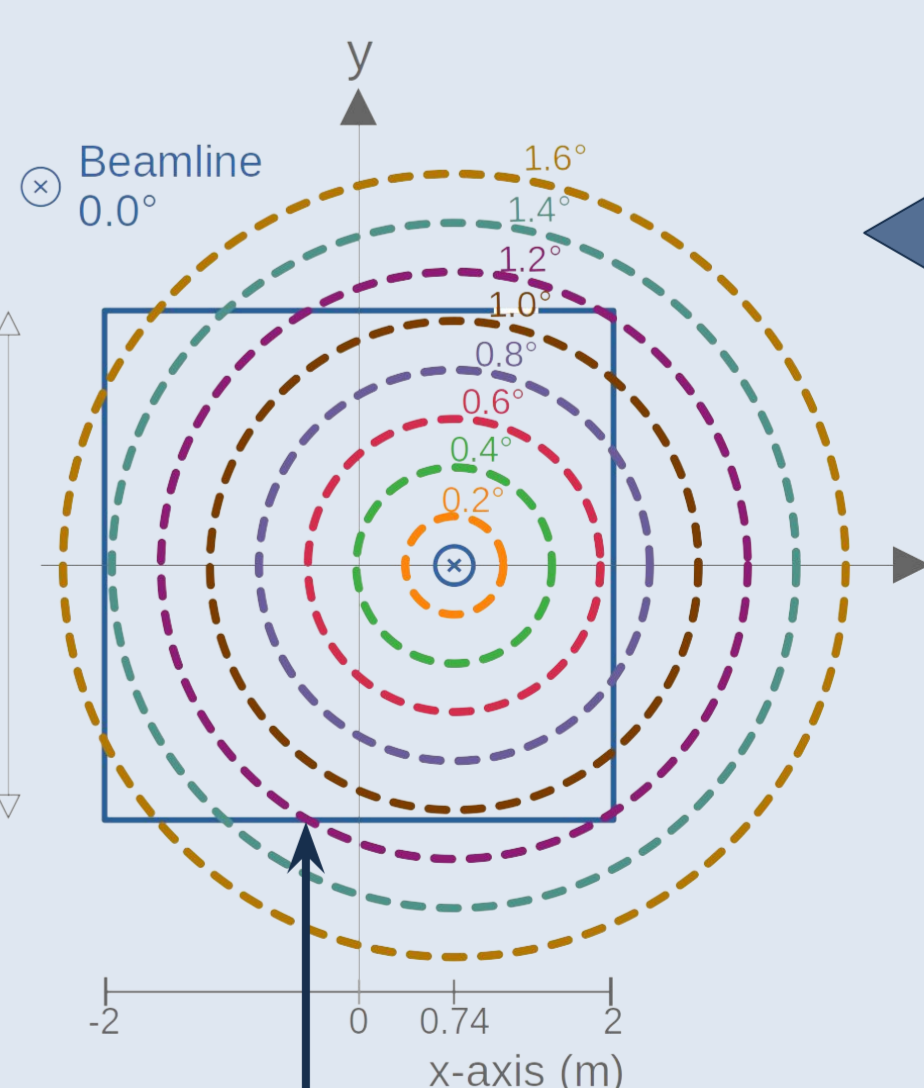
Neutrino interactions separable into **many exclusive final state topologies** with **huge statistics & high purity**. **Large & broad** cross-section physics programme in SBND.



SBND phase space has substantial overlap with that of **DUNE**, including the first and second **DUNE oscillation maxima**. SBND cross-section measurements will be used to optimise DUNE simulations.



SBND PRISM
High statistics in off-axis (0° - 1.6°) angular subsets of the full phase space facilitates **model & energy-dependent** measurements.



SBND detector boundaries.

3. SBND measurements

References

- [1] R. Acciarri et al., The SBND Collaboration, JINST 15 P06033 (2020).
- [2] P. A. Machado, O. Palamara, and D. W. Schmitz, Ann. Rev. Nucl. Part. Sci 69 (2019).
- [3] C. Andreopoulos et al., Nucl. Instrum. Meth A614, 87 (2010).
- [4] K. Gallmeister, U. Mosel, and J. Weil, Phys. Rev. C 94, 035502 (2016).