SBND In 10 Minutes

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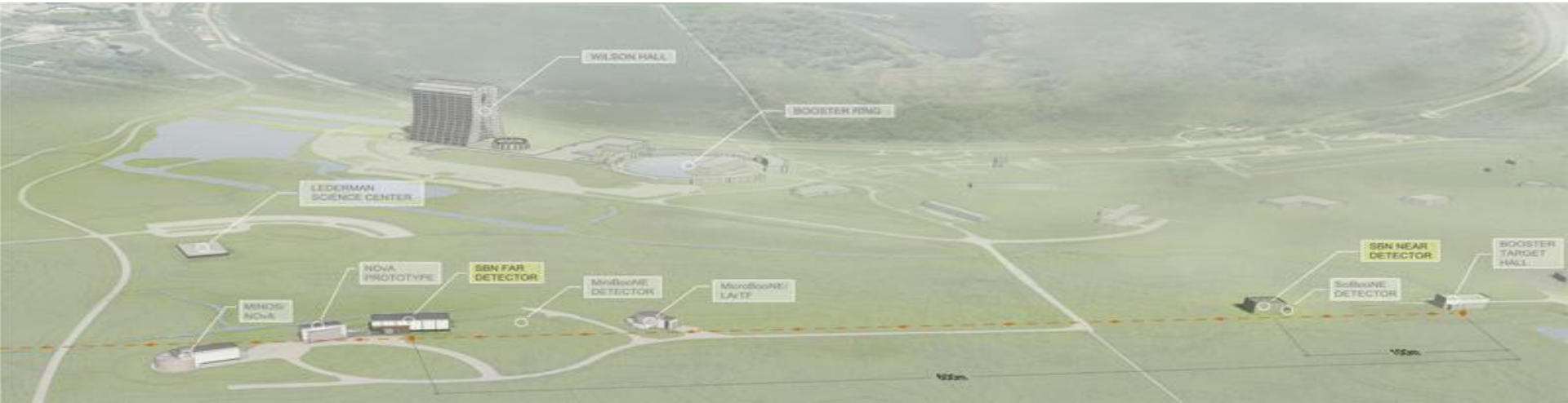
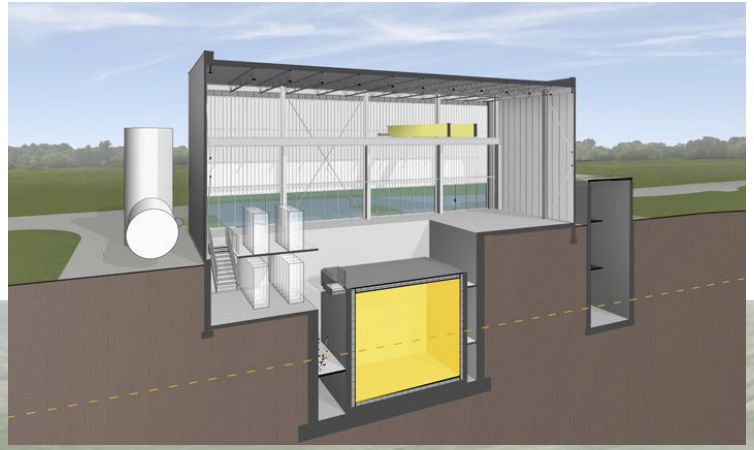
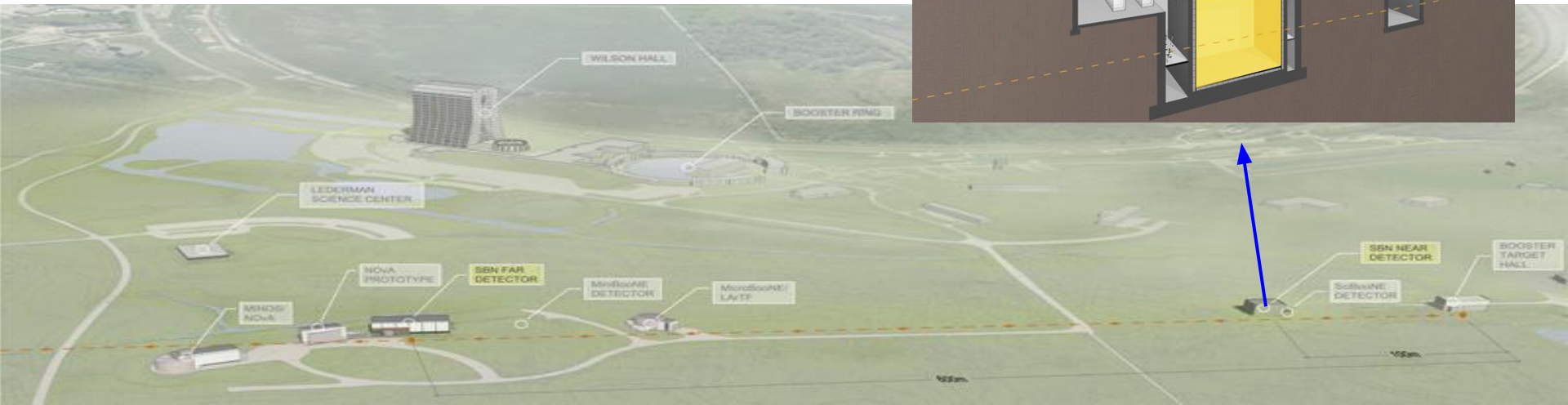


Where and What is the Short-Baseline Near Detector?

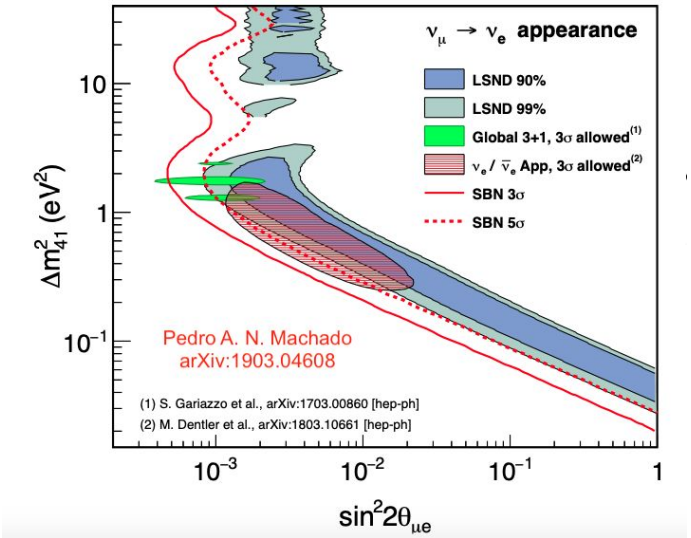
- SBND is the near detector of the SBN Programme.
- The other SBN detectors are MicroBooNE (470 m) and ICARUS (600 m).
- 110 m from the BNB target.
- LArTPC technology.
- 112 tons of LAr.

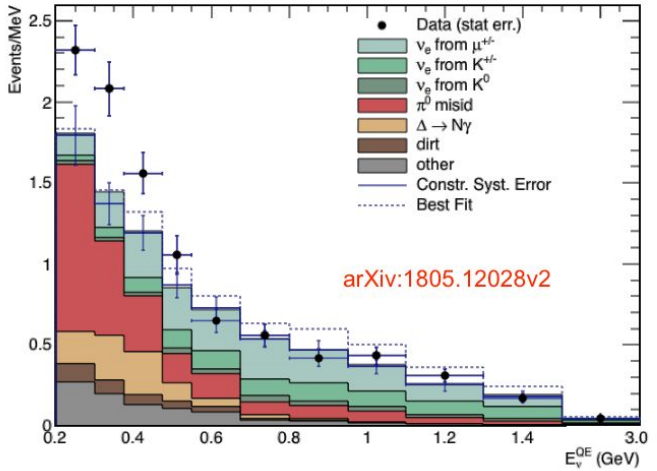




What Will SBND Do? Sterile Neutrinos

- Past experiments have identified anomalies in neutrino spectra rates assuming 3 neutrino oscillations.
- One possible explanation for these discrepancies are sterile neutrinos.

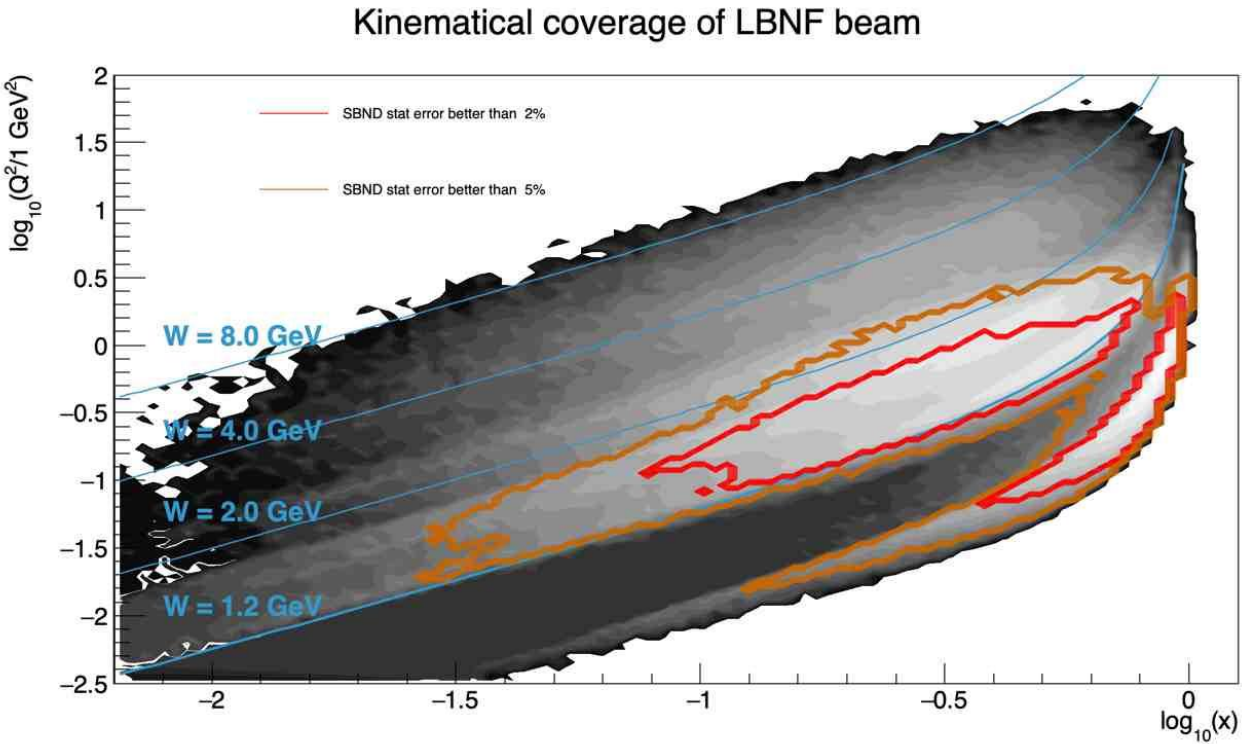




- A goal of SBN is to search for muon neutrino disappearance and electron neutrino appearance.
- SBND provides information to constraint the BNB flux. This is what makes the SBN sterile searches so powerful.
- See Justin Mueller talk coming up.

What Will SBND Do? Cross-sections

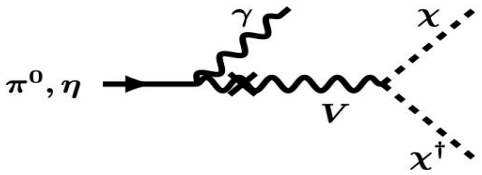
- Millions of Neutrino Interactions.
- Unprecedented cross-section measurement upon liquid argon.
- Ability to perform exclusive cross-section measurements.
- Useful for our analyses as well as future experiments such as DUNE.



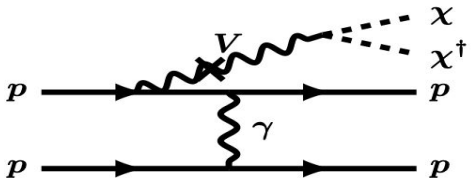
What Will SBND Do? BSM

- SBND has a host of potential BSM searches possible.
- See arXiv:1903.04608v1 for more detail.

- Electronvolt scale sterile
- Large extra dimensions
- Violation of Lorentz and CPT symmetry
- Heavy sterile neutrinos
- Neutrino tridents
- Light dark matter ....



(a) Meson Decay

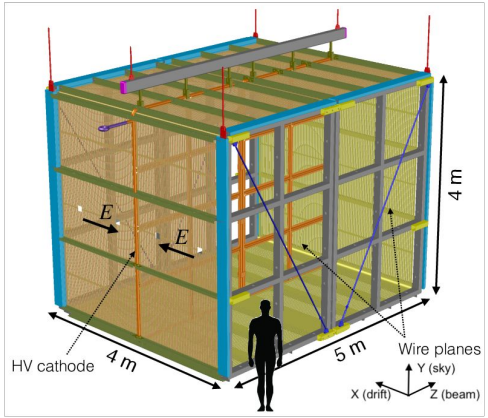


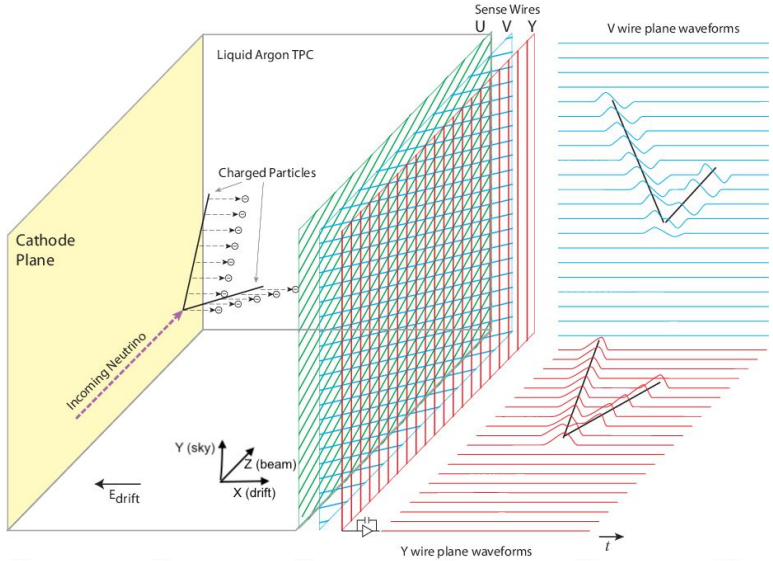
(b) Proton Bremsstrahlung + Vector-Mixing

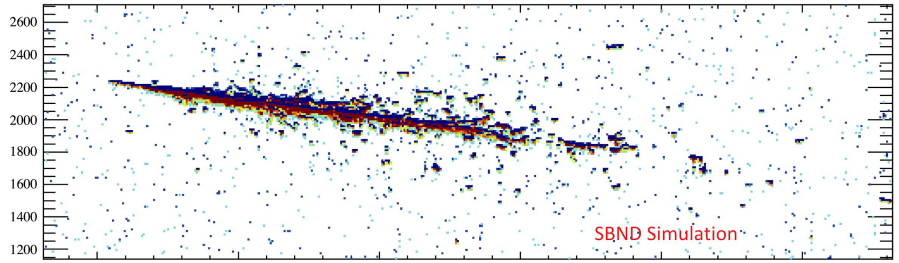
arXiv:1807.06137v2

SBND TPC Design

- Two TPCs in the LAr. The cathode is in the center of the liquid argon.
- Three Planes: Collection plane (Y) in the vertical, two induction planes +/- 60 degrees (U,V).
- Wire vs time for each plane provides 2D reconstruction.
- Combining planes produces 3D reconstruction with precise calorimetry.
- SBND is a prototype for DUNE in a neutrino beam.



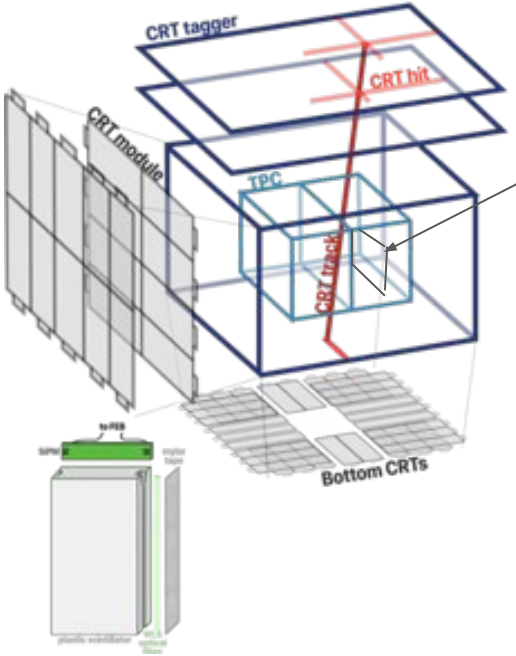


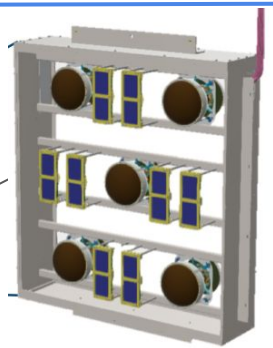


SBND Subdector Design

Cosmic Ray Tagging System

- Made of several scintillator modules.
- Two layers of modules for 2D reconstruction.
- Almost full coverage of the detector.
- Drastically reduces cosmic background.





Photon Detection System

- 120 8” Hamamatsu PMTs
- 192 Light trap ARAPUCAs
- Mixture of ARAPUCA + X-ARAPUCAs (introduction of acrylic bar + more)
- R&D for DUNE
- TBP reflector foils behind the cathode to boost light collection.

SBND Installation Status

TPC

- All components constructed.
- Currently undergoing assembly.
- Warm crates installed at SBND building.
- Electronics tested and ready for installation.

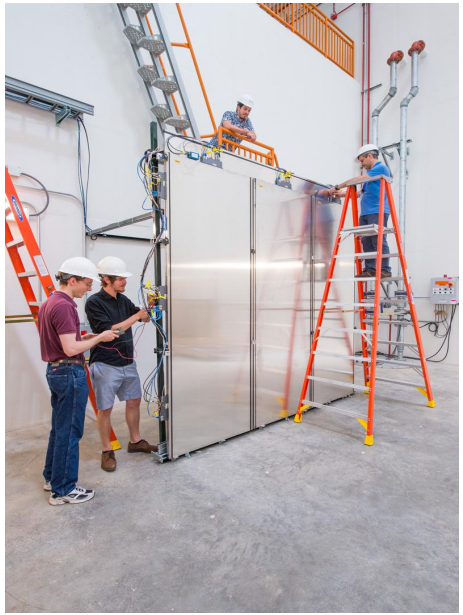
SBND APA

Coherent Captain Mills

Light Detection

- ARAPUCA assembly ongoing.
- PMTs are being tested at Los Alamos in the Coherent Captain Mills Experiment.
- Reflector foils ready for placement in the cathode.

SBND Installation Status



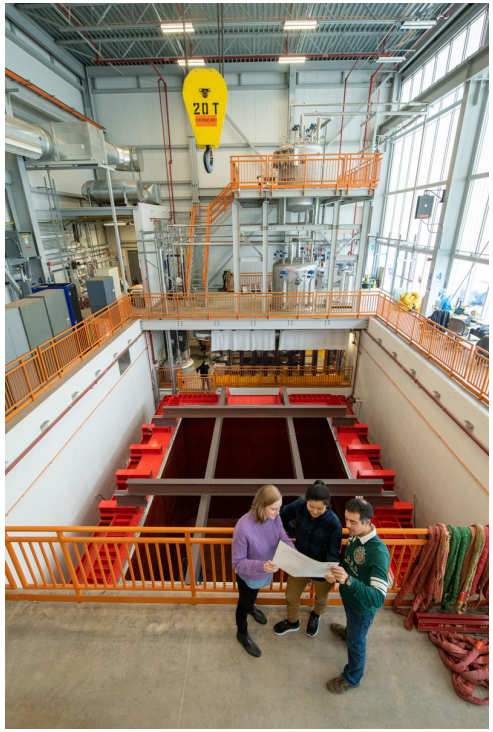
Side CRT panels

Cryostat

- Warm outer vessel installed.
- Fabrication of membrane currently ongoing by CERN

CRT System

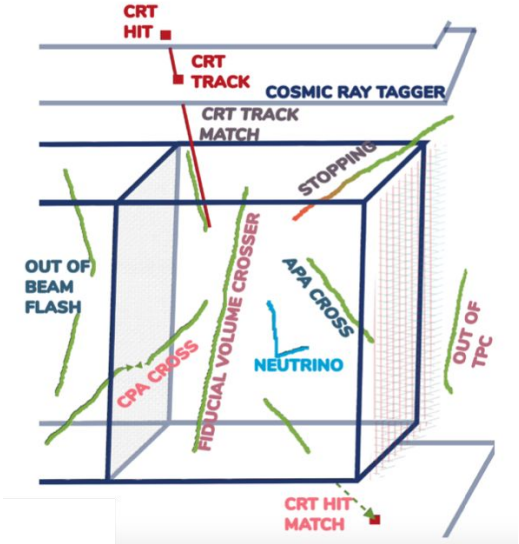
- Panels are constructed
- Bottom panels installed
- Beam measurements undertaken in the SBND pit.

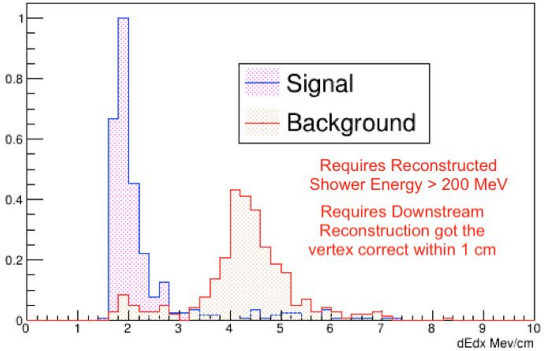


SBND pit with cryostat vessel

SBND Software Status

- Continuously updating simulation, reconstruction and preparing for analysis.
- Heavily incorporating the work of pioneering experiments through LArSoft.
- See Ed Tyley's talk in a couple of weeks for more detail.



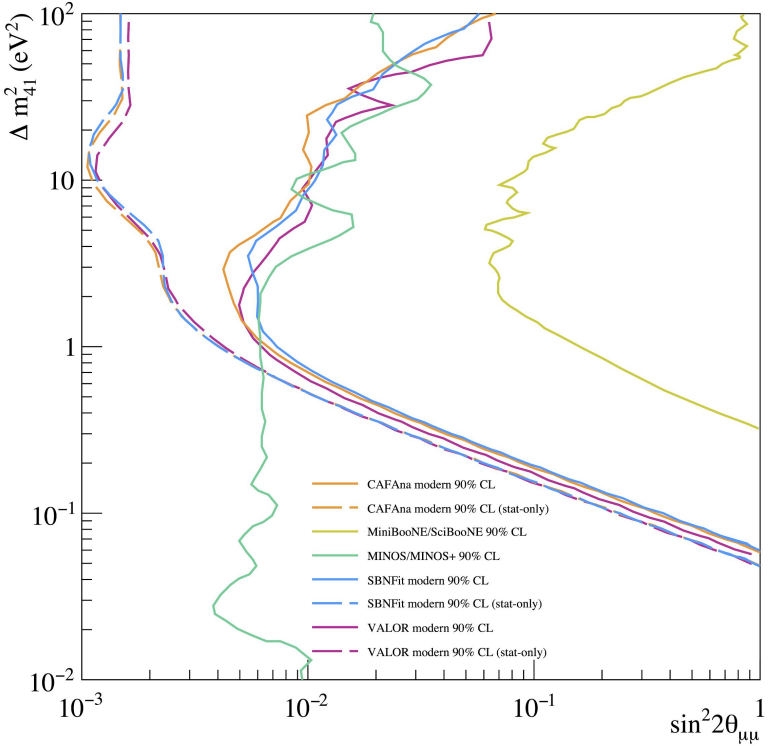


- Reconstruction follows the Pandora multi-pattern recognition approach.
- Introduced machine learning to improve reconstruction.
- Developing new shower characterisation.
- Improvements in the light simulation.
- Incorporated flash matching reconstruction.
- Developed CRT reconstruction.
- Included and corrected for space charge
- Updating the noise simulation.

SBN Software Status

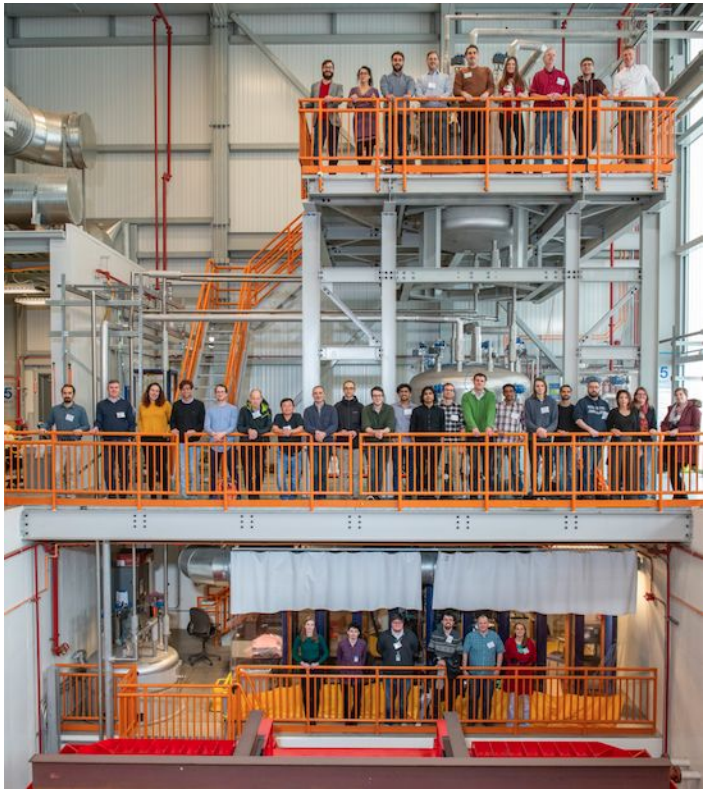
- Working closely with the other experiments in the SBN programme.
- Sharing and incorporating developed software between collaborations.
- SBN software infrastructure development ongoing.
- Three fitting frameworks perform the analysis: VALOR CAFAna and SBNFit.

Muon neutrino disappearance sensitivity



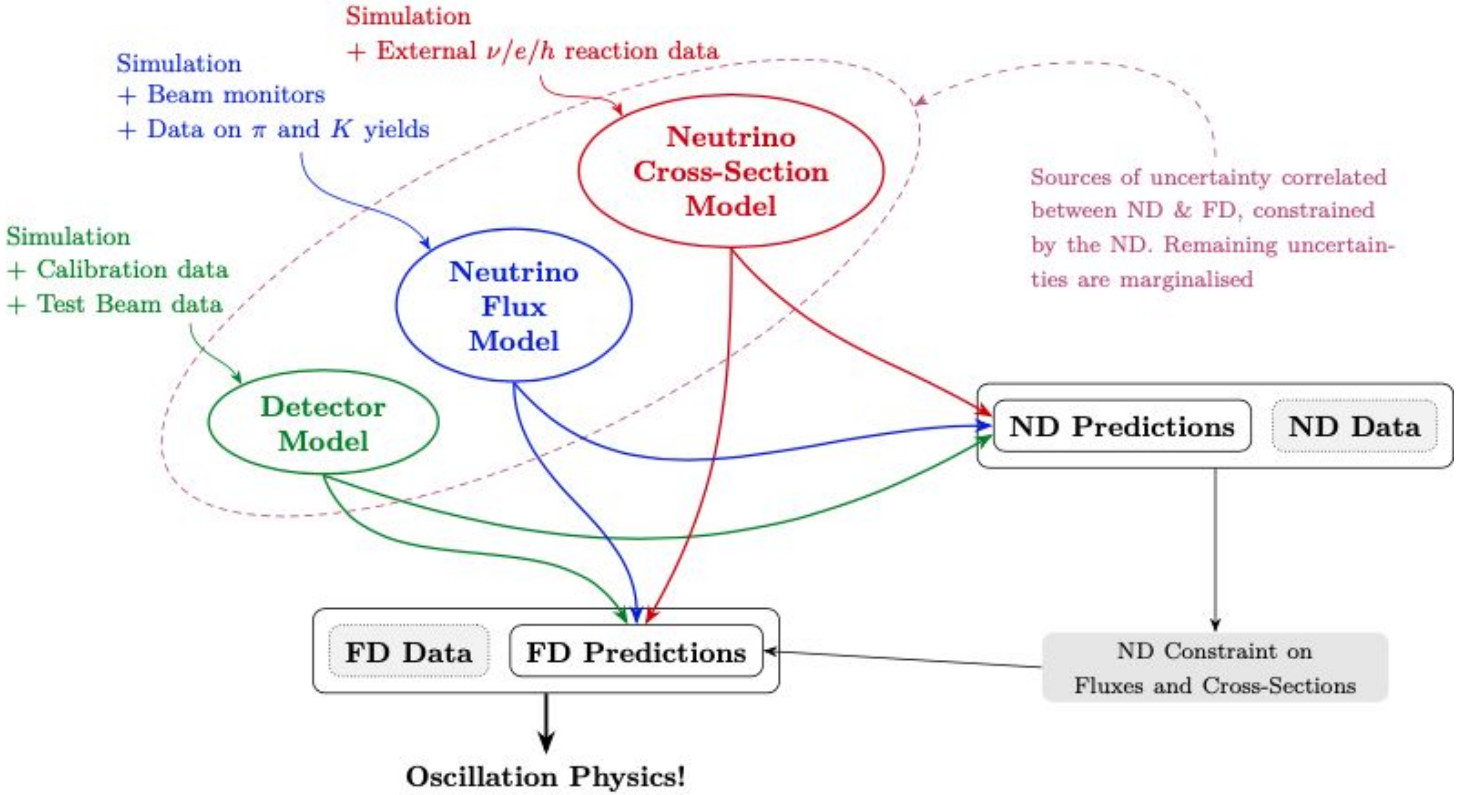
Summary

- SBND has a large physics programme with high statistics.
- Majority of detector components are at Fermilab.
- Detector assembly is currently underway.
- Advancements in software are continuing to improve the simulation and reconstruction.
- Efforts are ongoing to establish a SBN framework for sophisticated analyses.

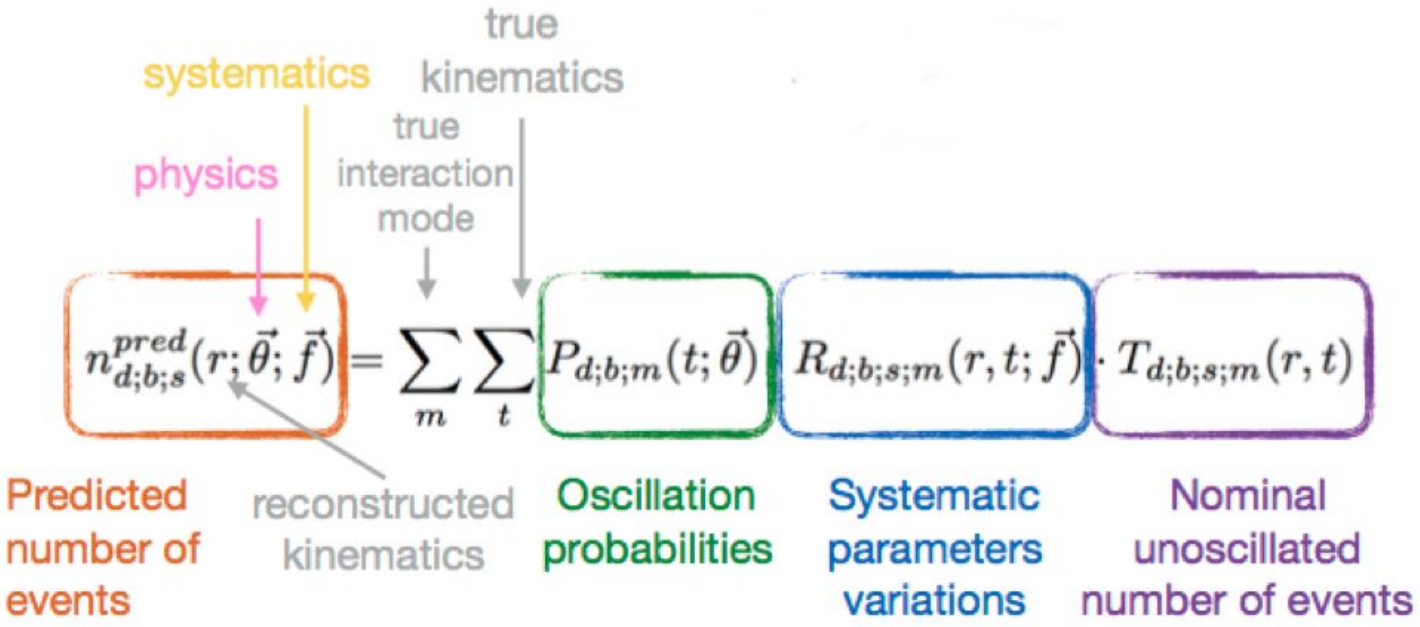


Backups

SBN Fitting with VALOR



SBN Fitting with VALOR



3+1 Sterile Model

- Assume short-baseline approximation so no standard oscillations.

$$P^{3+1}_{\nu_\mu \to \nu_e} = \sin^2 2\theta_{\mu e} \sin^2 \left(\frac{\Delta m^2 L}{4E_\nu} \right)$$

$$P^{3+1}_{\nu_\mu \to \nu_\mu} = 1 - \sin^2 2\theta_{\mu\mu} \sin^2 \left(\frac{\Delta m^2 L}{4E_\nu} \right)$$

The SBND Collaboration

246 Total Collaborators

200 Scientific Collaborators (faculty/scientists, postdocs, PhD students)

39 Institutions

23 US Institutions

- 4 DOE national laboratories
- 19 US universities

16 International Institutions

- 5 Brazilian universities
- 1 Paraguayan university
- 1 Spanish university, 1 national lab
- 1 Swiss university
- 6 UK universities
- CERN