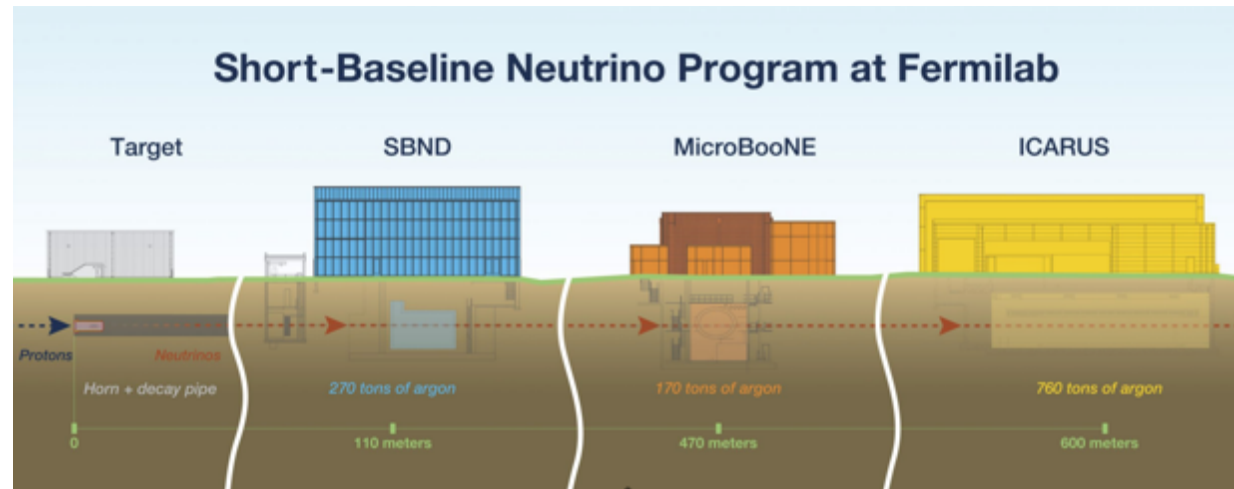


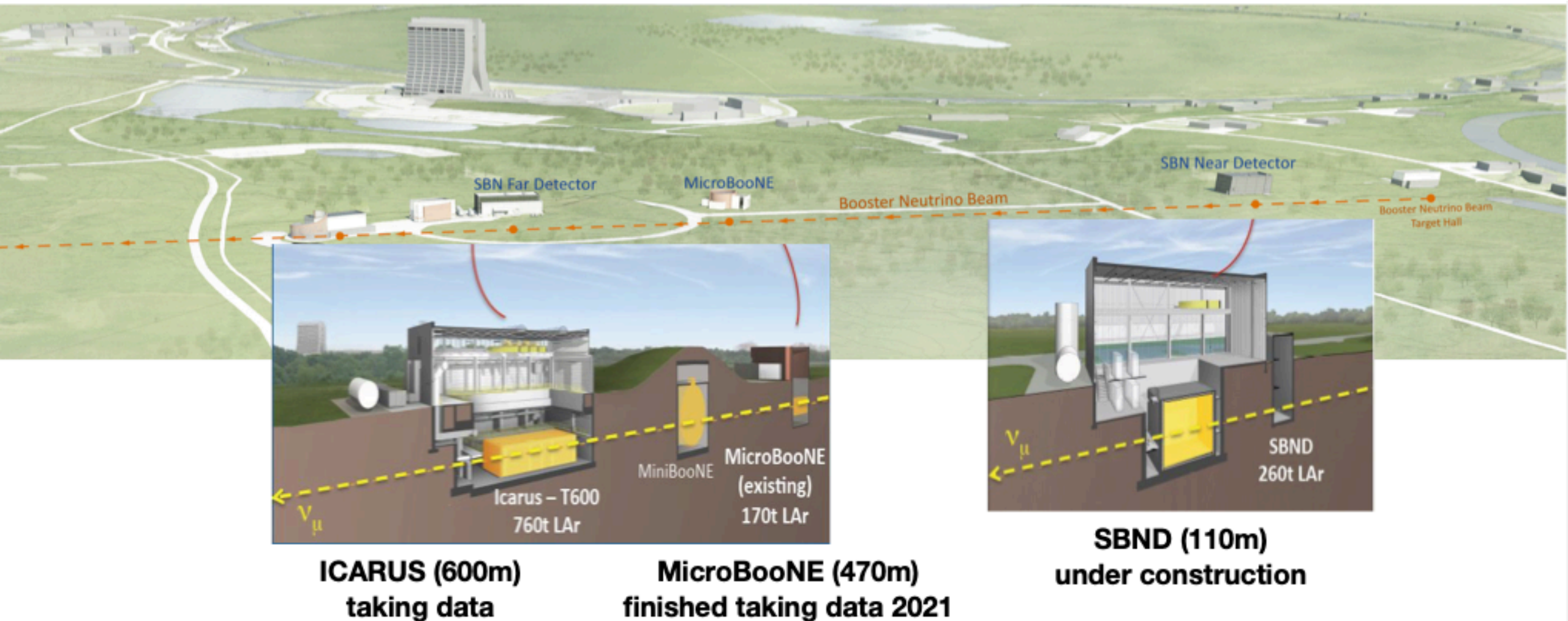
MicroBooBE operation and SBND construction and commissioning

INTENSE MidTerm Review

M. Weber, WP1

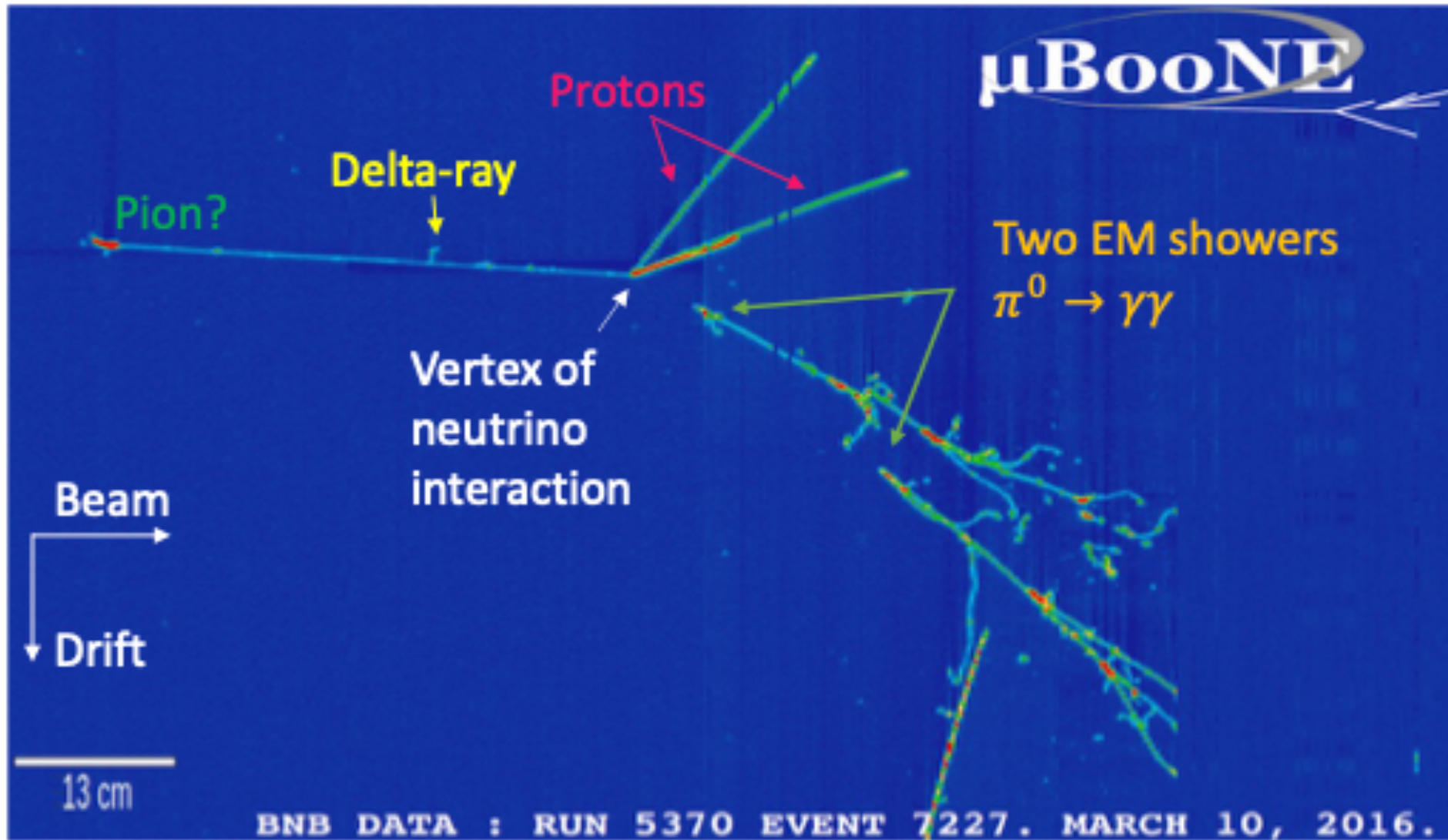


Status

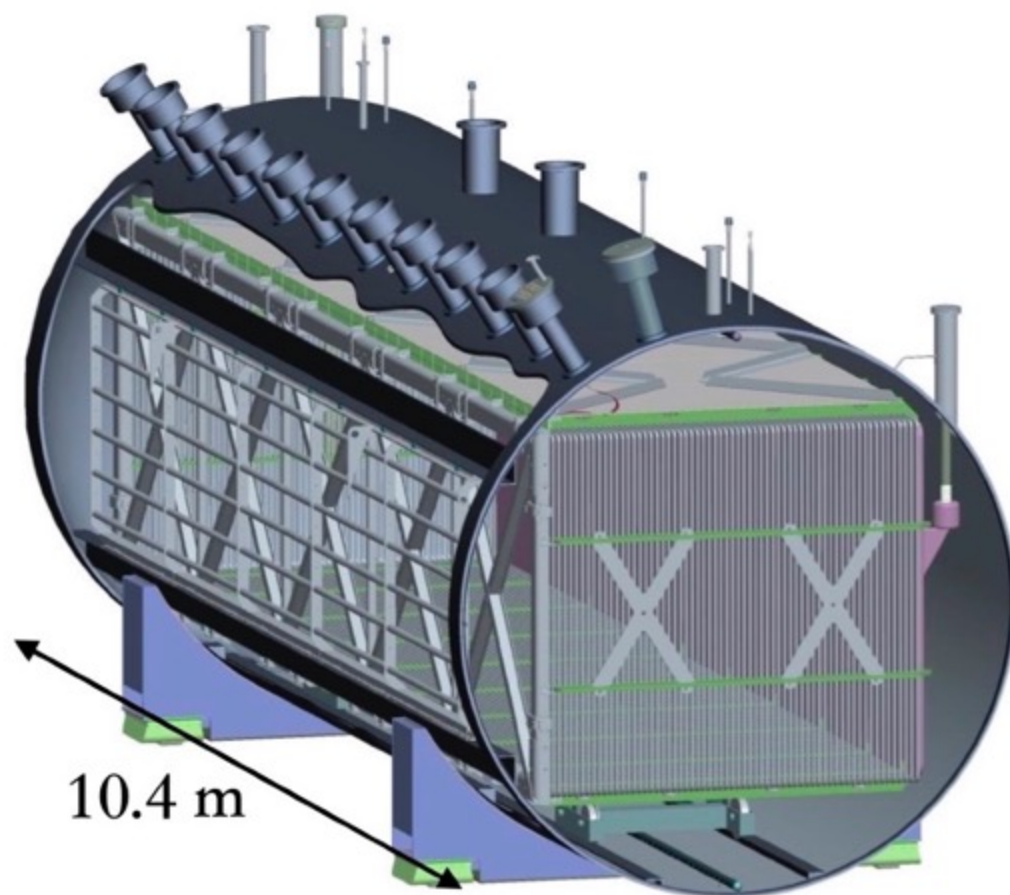


Alberto Guglielmi

LArTPC: fully active calorimeter + high-resolution tracking

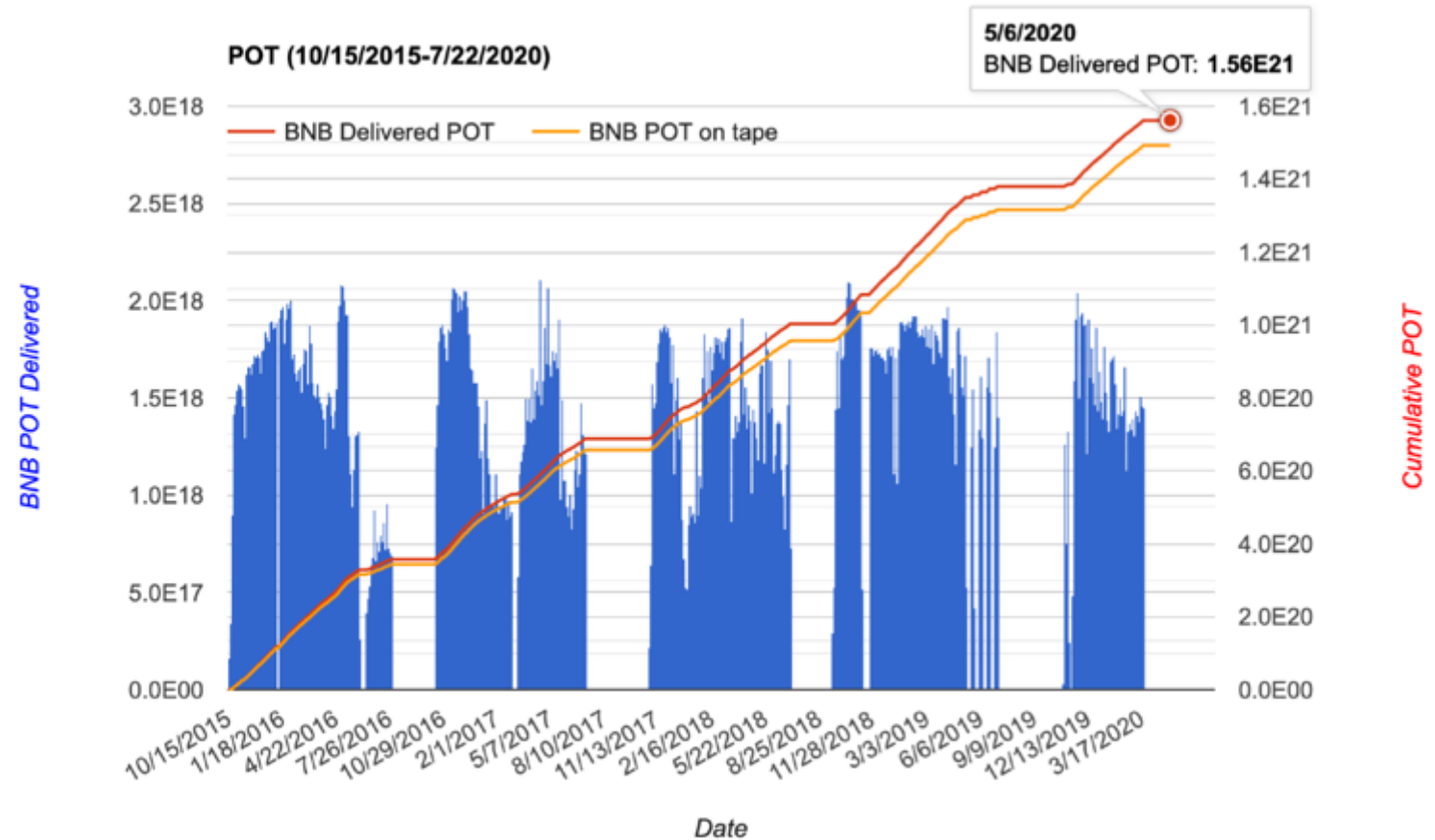


MicroBooNE

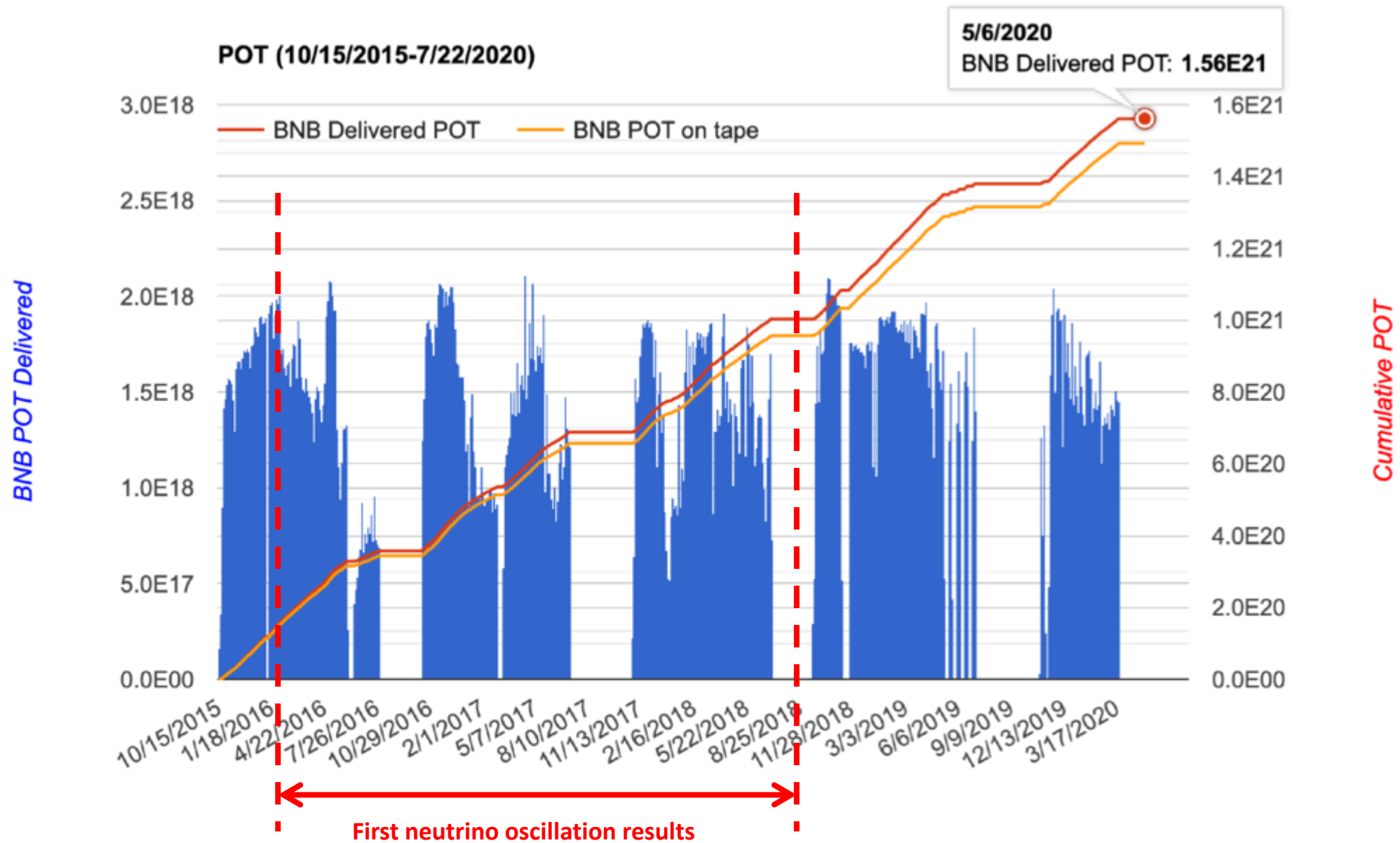


MicroBooNE operation

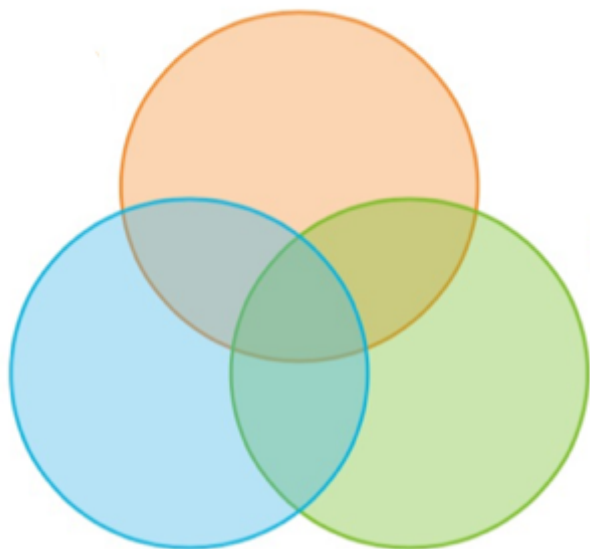
- Longest operated LArTPC to date
- 24/7/365 operation
- 1-2 people on shift on-site, later also remote-only shifts
- 10-15 on-call experts on-site and off-site
- Overall very stable
- Recoverable issues with wire-charge-readout, noise, degrading light detection, lower high-voltage (detailed studies with significant exchange of expertise world-wide)







Understand MiniBooNE LEE & other New Physics Searches



2017 2018 2019 2020 2021 2022

Observation of radon mitigation in MicroBooNE by a liquid argon filtration system
Cosmic ray muon clustering for the MicroBooNE liquid argon time projection chamber using sMask-RCNN
Nivel approach for evaluating detector-related uncertainties in a LArTPC using MicroBooNE data
First measurement of energy-dependent inclusive muon neutrino charged-current cross sections on argon with the MicroBooNE detector
Search for an anomalous excess of inclusive charged-current ν_e interactions without pions in the final state with the MicroBooNE experiment
Search for an anomalous excess of charged-current quasi-elastic ν_e interactions with the MicroBooNE experiment using deep-learning-based reconstruction
New theory-driven GENIE tune for MicroBooNE
Search for an anomalous excess of inclusive charged-current ν_e interactions in the MicroBooNE experiment using Wire-Cell reconstruction
Search for an excess of electron neutrino interactions in MicroBooNE using multiple final state topologies
Wire-Cell 3D pattern recognition techniques for neutrino event reconstruction in large LArTPCs
Electromagnetic shower reconstruction and energy validation with Michel electrons and π^0 samples for the deep-learning-based analyses in MicroBooNE
Search for neutrino-induced NC & radiative decay in MicroBooNE and a first test of the MiniBooNE low-energy excess under a single-photon hypothesis
First measurement of inclusive electron-neutrino and antineutrino charged current differential cross sections in charged lepton energy on argon in MicroBooNE
Calorimetric classification of track-like signatures in liquid argon TPCs using MicroBooNE data
Search for a Higgs Portal Scalar Decaying to Electron-Positron Pairs in the MicroBooNE Detector
Measurement of the Longitudinal Diffusion of Ionization Electrons in the Detector
Cosmic Ray Background Rejection with Wire-Cell LAr TPC Event Reconstruction in the MicroBooNE Detector
Measurement of the Flux-Averaged Inclusive Charged Current Electron Neutrino and Antineutrino Cross Section on Argon using the NuMI Beam in MicroBooNE
Measurement of the Atmospheric Muon Rate with the MicroBooNE Liquid Argon TPC
Semantic Segmentation with a Sparse Convolutional Neural Network for Event Reconstruction in MicroBooNE
High-performance Generic Neutrino Detection in a LAr TPC near the Earth's Surface with the MicroBooNE Detector
Neutrino Event Selection in the MicroBooNE LAr TPC using Wire-Cell 3D Imaging, Clustering, and Charge-Light Matching
A Convolutional Neural Network for Multiple Particle Identification in the MicroBooNE Liquid Argon Time Projection Chamber
Vertex-Finding and Reconstruction of Contained Two-track Neutrino Events in the MicroBooNE Detector
The Continuous Readout Stream of the MicroBooNE Liquid Argon Time Projection Chamber for Detection of Supernova Burst Neutrinos
Measurement of Differential Cross Sections for Muon Neutrino ν_e Interactions on Argon with Protons and No Pions in the Final State
Measurement of Space Charge Effects in the MicroBooNE LAr TPC Using Cosmic Muons
First Measurement of Differential Charged Current Quasi-Elastic-Like Muon Neutrino Argon Scattering Cross Sections with the MicroBooNE Detector
Search for heavy neutral leptons decaying into muon-pion pairs in the MicroBooNE detector
Reconstruction and Measurement of $O(100)$ MeV Electromagnetic Activity from Neutral Pion to Gamma Gamma Decays in the MicroBooNE LArTPC
A Method to Determine the Electric Field of Liquid Argon Time Projection Chambers Using a UV Laser System and its Application in MicroBooNE
Calibration of the Charge and Energy Response of the MicroBooNE Liquid Argon Time Projection Chamber Using Muons and Protons
First Measurement of Inclusive Muon Neutrino Charged Current Differential Cross Sections on Argon at E_{nu} ~0.8 GeV with the MicroBooNE Detector
Design and Construction of the MicroBooNE Cosmic Ray Tagger System
Rejecting Cosmic Background for Exclusive Neutrino Interaction Studies with Liquid Argon TPCs: A Case Study with the MicroBooNE Detector
First Measurement of Muon Neutrino Charged Current Neutral Pion Production on Argon with the MicroBooNE detector
A Deep Neural Network for Pixel-Level Electromagnetic Particle Identification in the MicroBooNE Liquid Argon Time Projection Chamber
Comparison of Muon-Neutrino-Argon Multiplicity Distributions Observed by MicroBooNE to GENIE Model Predictions
Ionization Electron Signal Processing in Single Phase LArTPCs II: Data/Simulation Comparison and Performance in MicroBooNE
Ionization Electron Signal Processing in Single Phase LArTPCs I: Algorithm Description and Quantitative Evaluation with MicroBooNE Simulation
The Pandora Multi-Algorithm Approach to Automated Pattern Recognition of Cosmic Ray Muon and Neutrino Events in the MicroBooNE Detector
Measurement of Cosmic Ray Reconstruction Efficiencies in the MicroBooNE LAr TPC Using a Small External Cosmic Ray Counter
Noise Characterization and Filtering in the MicroBooNE Liquid Argon TPC
Michel Electron Reconstruction Using Cosmic Ray Data from the MicroBooNE LAr TPC
Determination of Muon Momentum in the MicroBooNE LAr TPC Using an Improved Model of Multiple Coulomb Scattering
Convolutional Neural Networks Applied to Neutrino Events in a Liquid Argon Time Projection Chamber
Design and Construction of the MicroBooNE Detector

**Precision
measurements of
 ν – Ar cross-
sections**

**Pioneering R&D
of LArTPC
detector
technology**

- More than 45 publications in the past 5 years
<https://microboone.fnal.gov/documents-publications/>
- More than 75 public notes sharing progress with community as we go <https://microboone.fnal.gov/public-notes/>

Detector studies “space charge effects”

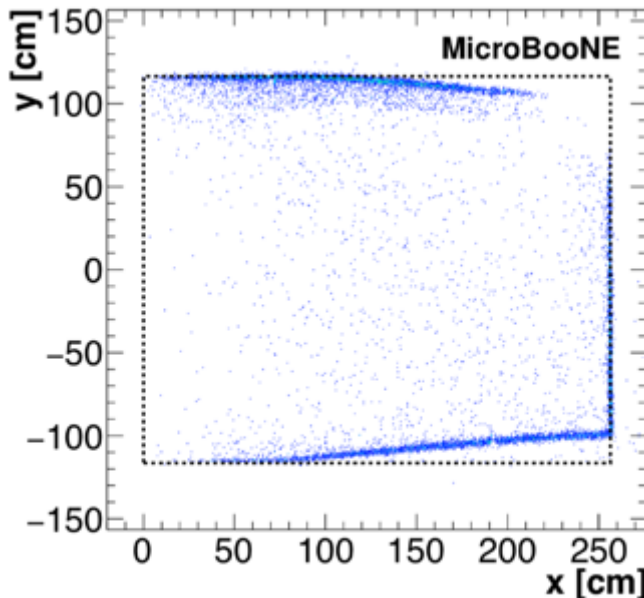
MicroBooNE is at earth' surface: large Cosmic Ray flux

Space charge leads to distortion of electron drifts

=> tracks/showers appear “bent”

Pioneering data-driven SCE/E-field measurement & calibration

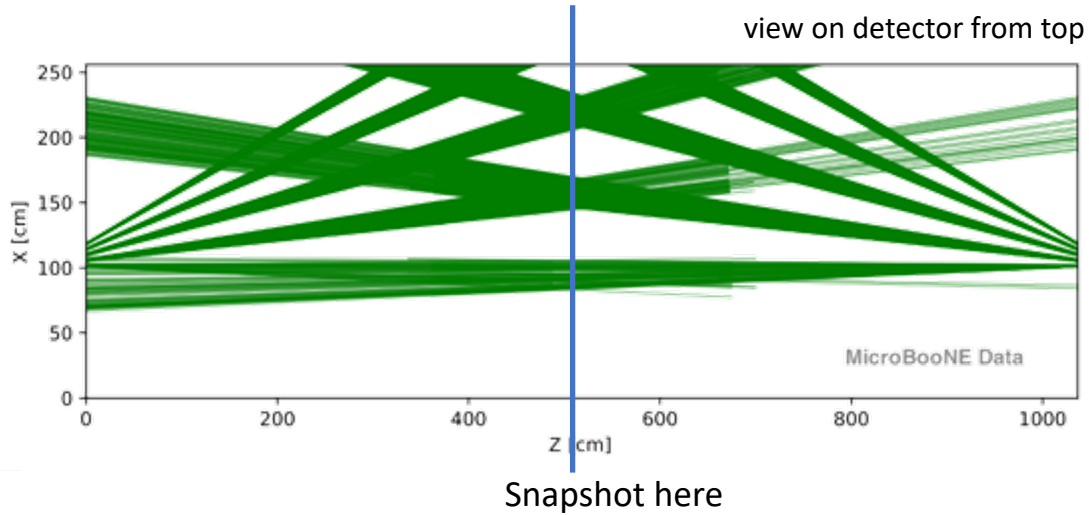
Laser UV system operated with support of INTENSE: JINST 15, P07010 (2020)



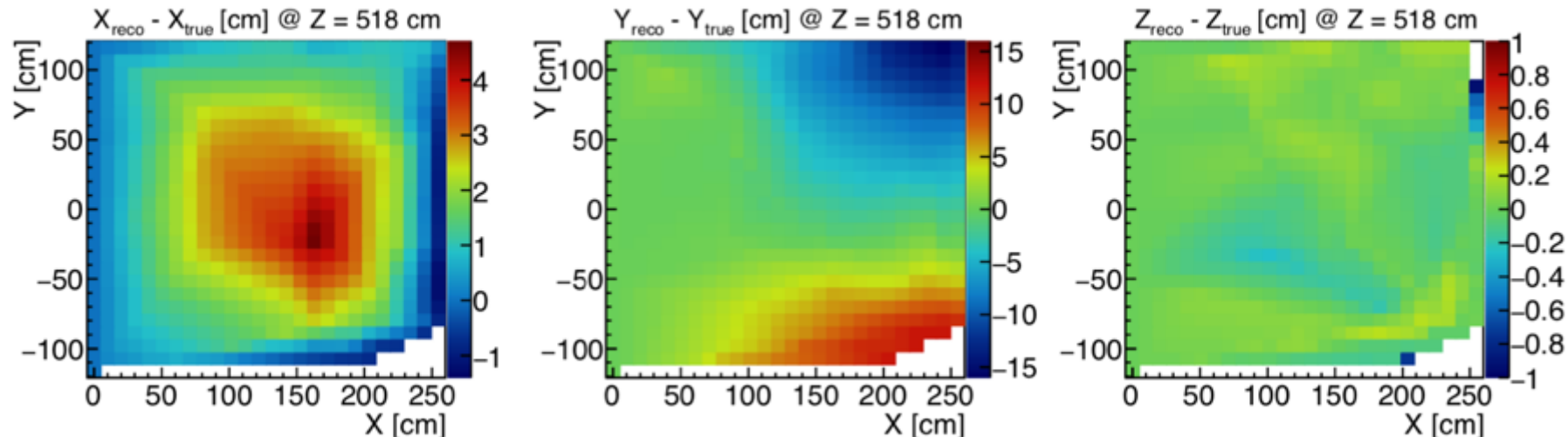
Muon track reconstructed
entry/exit points Near cathode
points deviate from TPC boundary
(dashed line) due to SCE

UV-laser operation

Laser tracks shot
into MicroBooNE
Laser light induces
straight tracks



MicroBooNE Laser Data

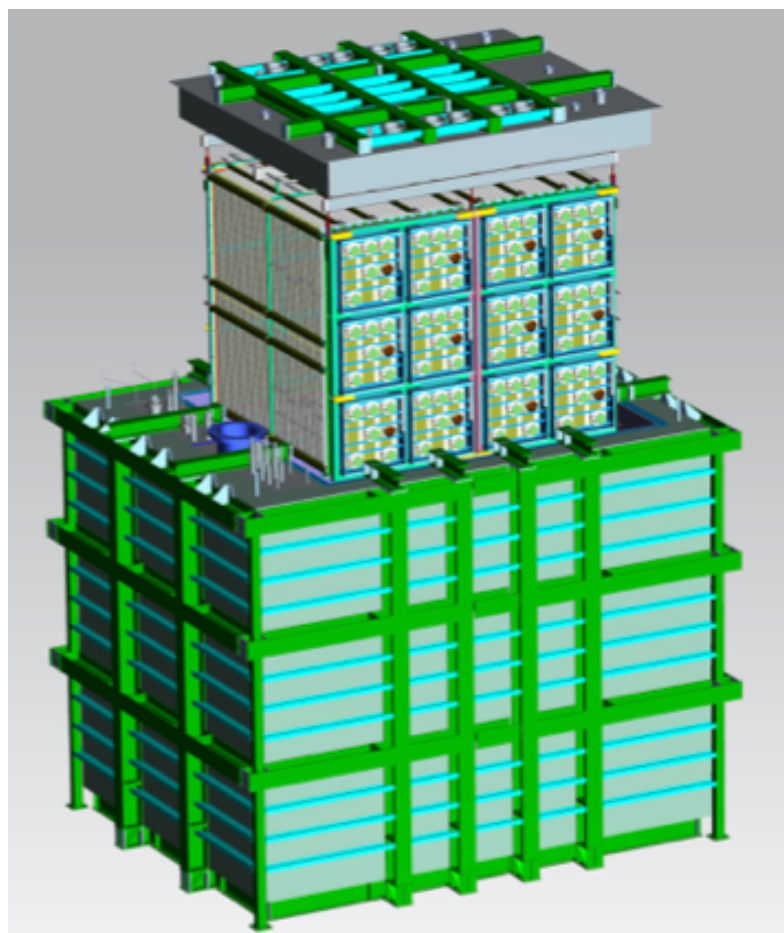


vertical

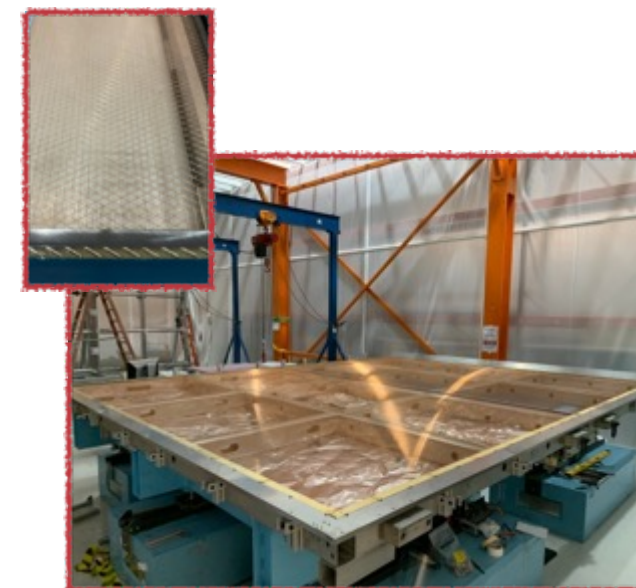
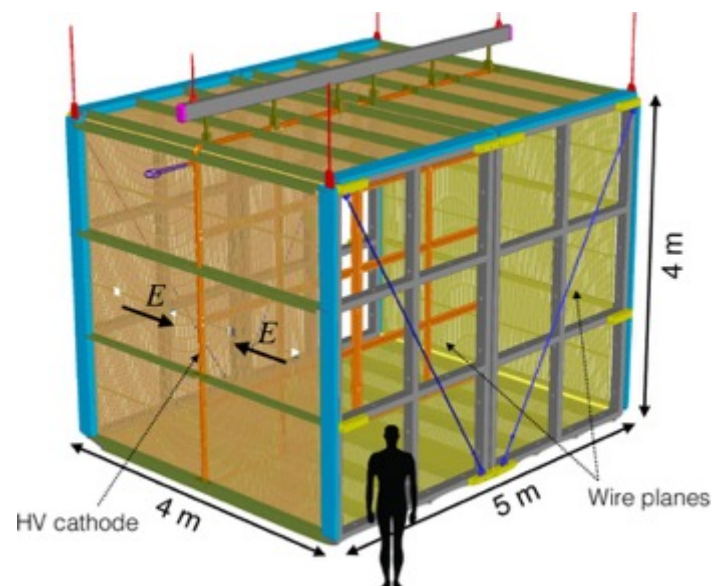
Measured Electric field



SBND



Short-Baseline Near Detector (SBND) is located 110 meters from the Booster Neutrino Beam target, and has 112 tons of liquid argon within the active





SBND TPC assembly



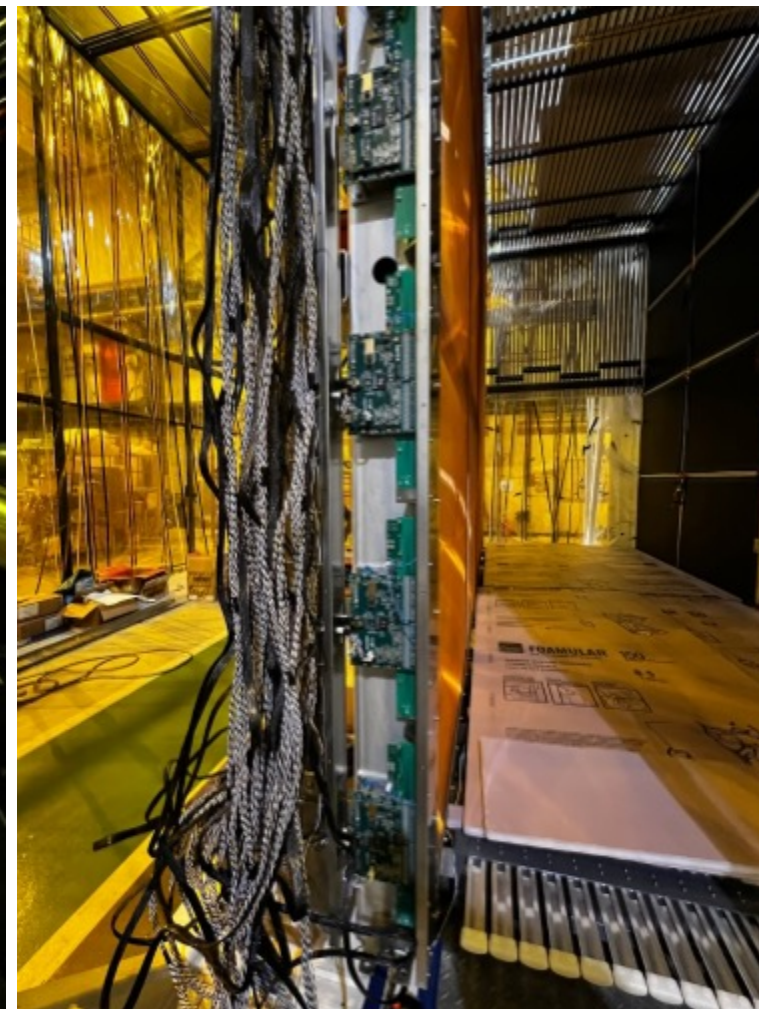
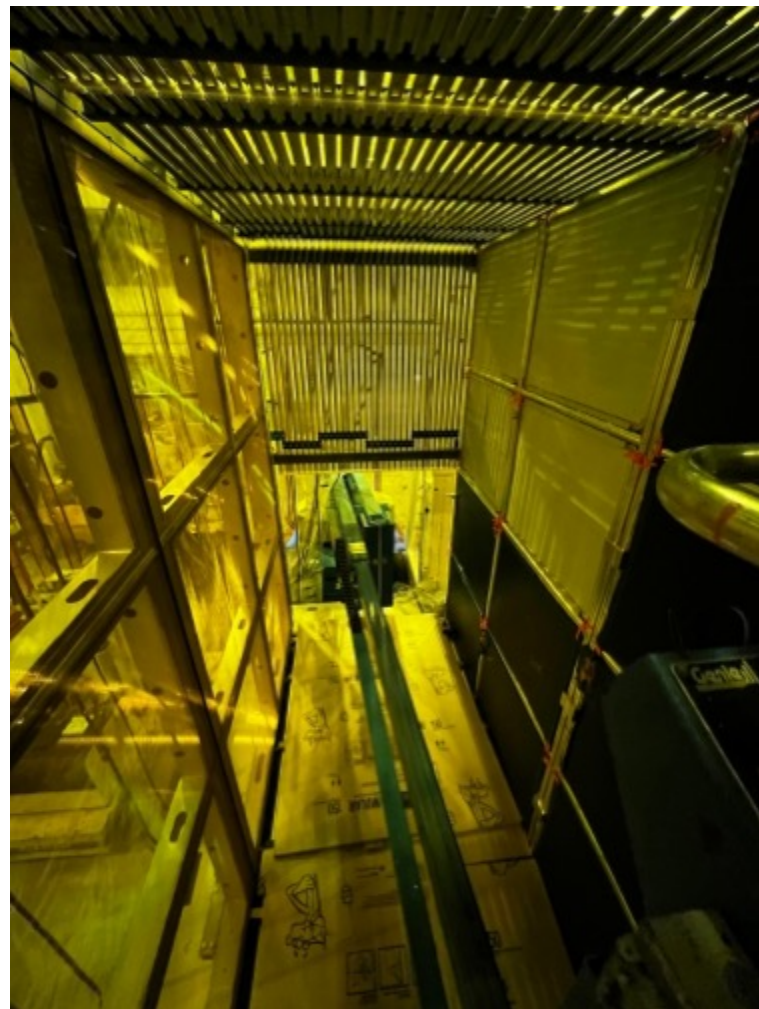
Cathode assembly in place



Anode plane (charge readout) installation



Field cage assembly



Cold electronics installation

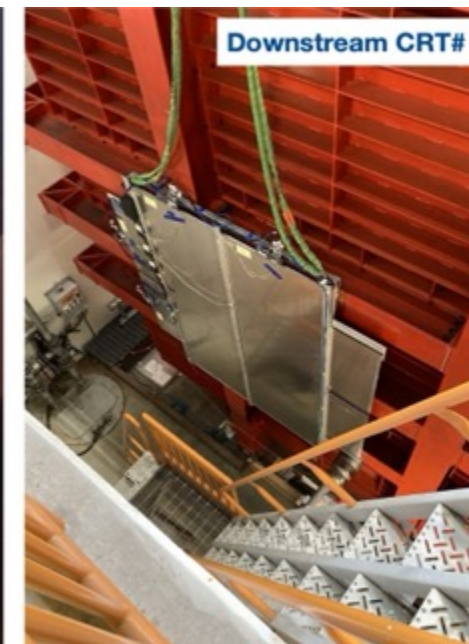
SBND Photon detection system

8" PMTs (120 total) and X-ARAPUCAS (192 total)

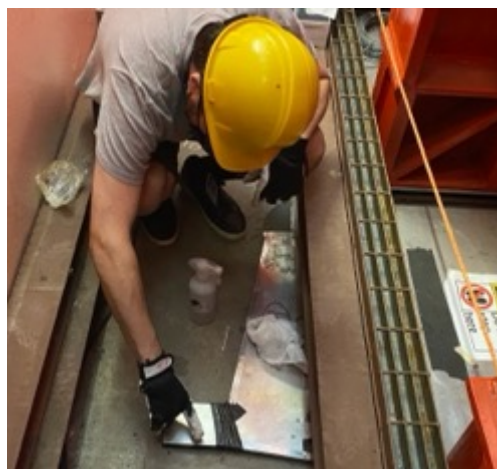
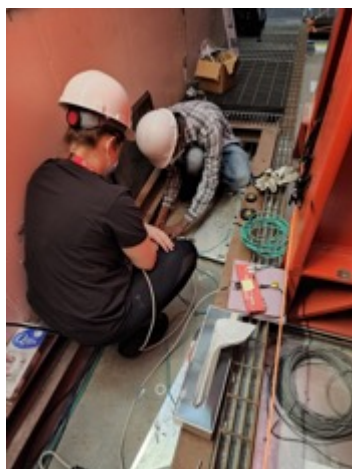


SBND Cosmic Ray Tagger

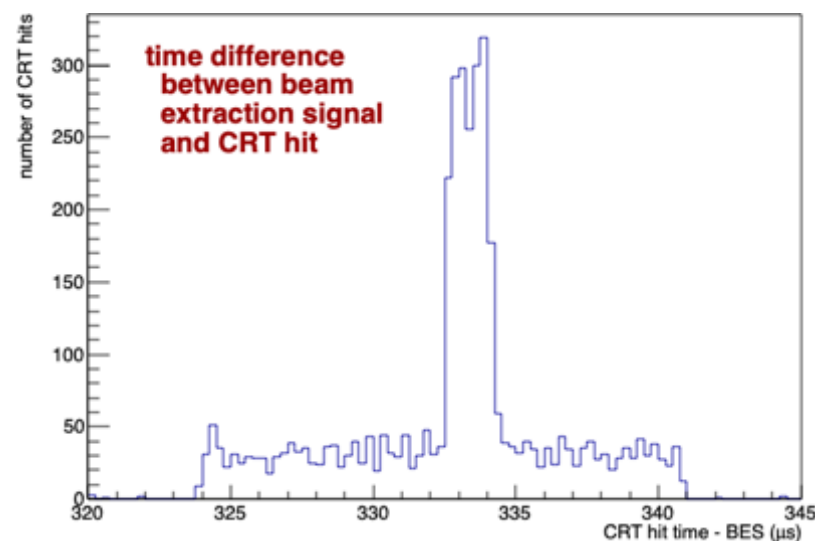
- System delivered from UBERN
- Temporary beam muon telescope installed on the upstream and downstream walls of the SBND cryostat.
- This CRT enabled pre-LAr commissioning of the DAQ, CRT, Beam, Trigger and PMT electronics.
- Bottom modules installed before cryostat placed on top



First “SBND data” before full detector installation

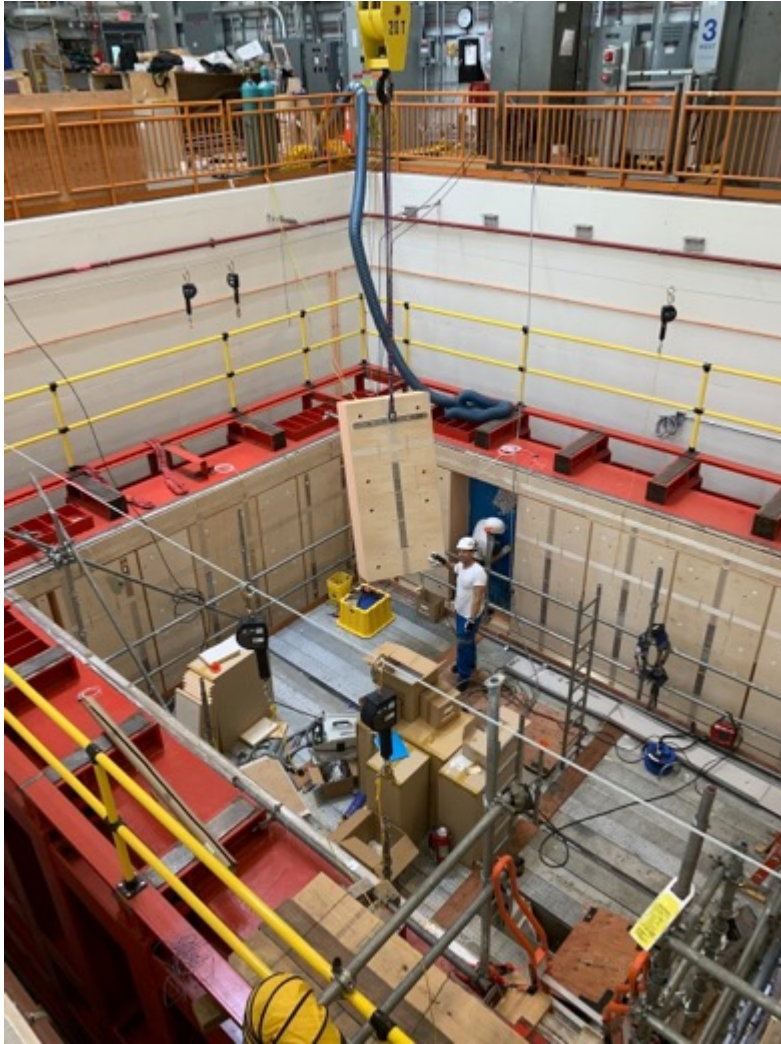


Bottom CRT installation



Beam spill duration is 1.6 μs
CRT timing resolution is 1-2 ns

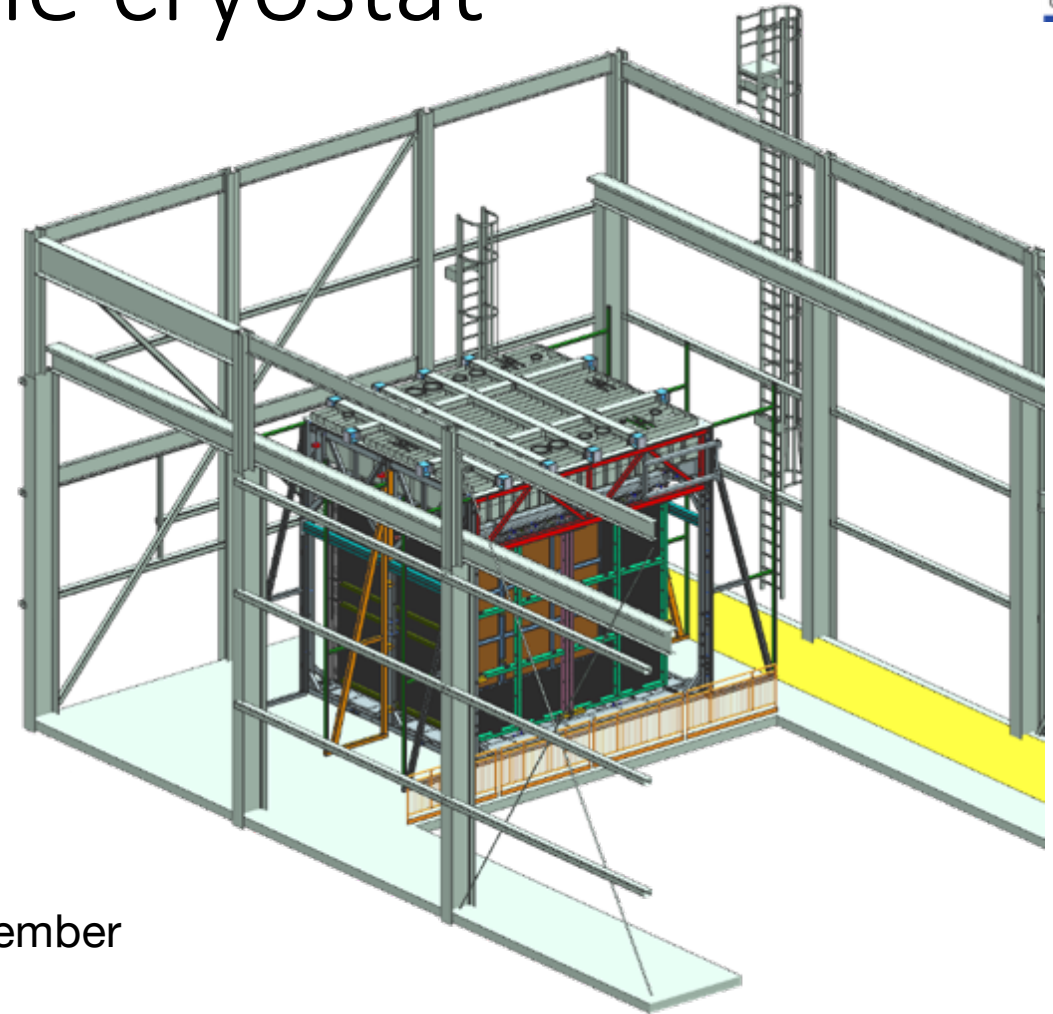
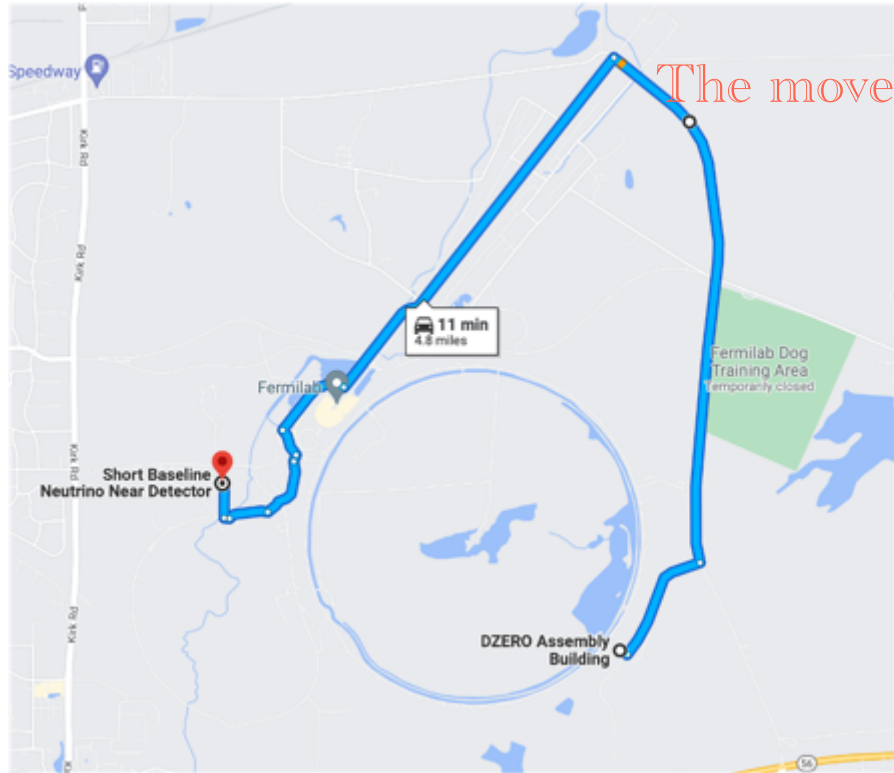
SBND cryostat assembly



- The SBND cryostat is a membrane type, the same as planned for the future DUNE far detectors.
- 9.3m x 7.5m x 7.6m H SS outer cryostat.
- 2 layers of 40 cm insulation blocks with a secondary membrane in between. A corrugated stainless steel innermost layer as primary membrane.
- Finished in October 2022



Putting the detector into the cryostat



- Assembled Detector will be moved to the ND building in November
- Detector insertion inside the cryostat is expected to take place in spring
- Expected to be ready for cryogenic operations at the beginning of next summer

Summary

- 6 successful years of operation of MicroBooNE
- >50 publications, about $\frac{1}{2}$ from detector physics and studies
- Close to start operation of SBND in 2023



MicroBooNE control room at Fermilab



SBND building in June 2022