

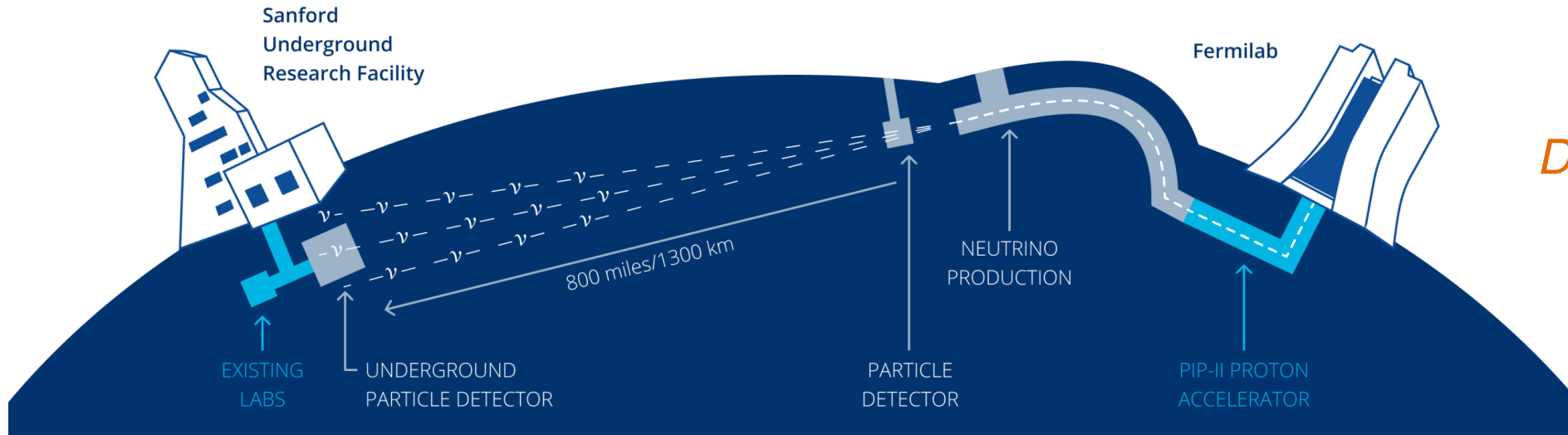
# DUNE: Status & Plans



*Sowjanya Gollapinni, LANL  
(For the DUNE Collaboration)*

*Neutrino 2026  
UC Irvine  
June 23, 2026*

# DUNE in a Nutshell



*DUNE has entered the installation phase!*

*LBNF: Long Baseline Neutrino Facility*

## The Science (DUNE)

- CPV in neutrinos
- neutrino mass ordering
- Test 3-flavor paradigm
- New Physics
- Astrophysics

## The Technology (DUNE)

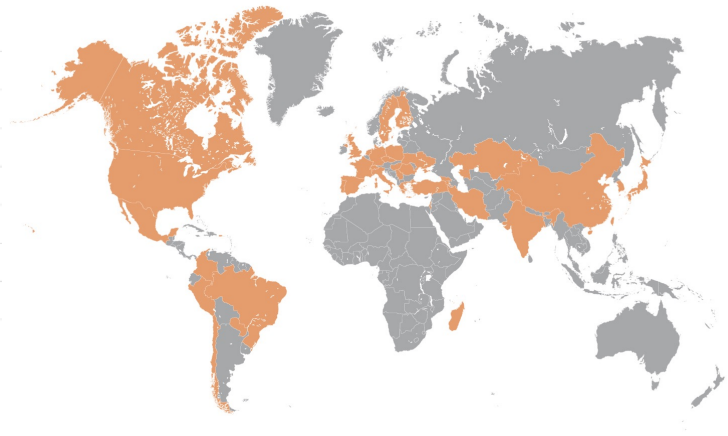
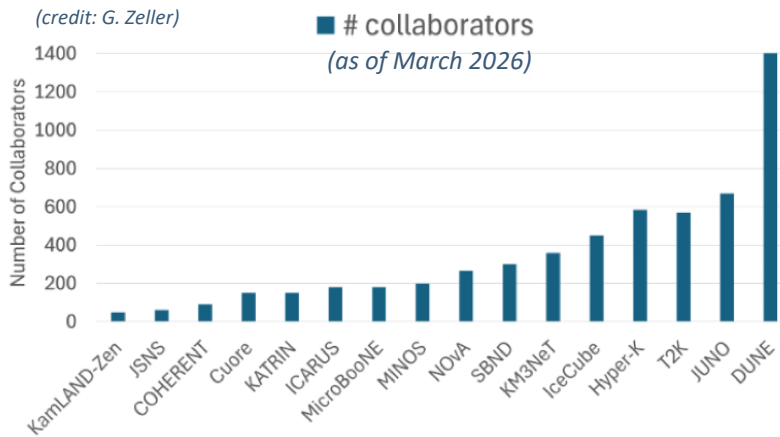
- Four 17 kiloton LAr detectors – largest of its kind!
- A movable near detector

***DUNE will be built in two phases***

## The Facility (LBNF)

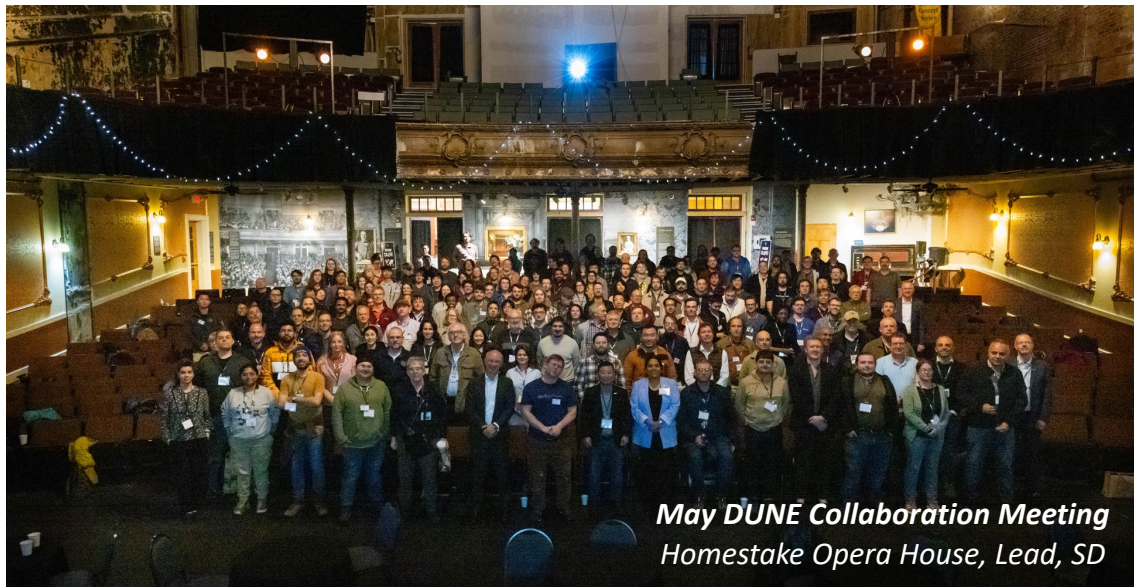
- Colossal caverns at 1.5 km underground
- World's most intense neutrino beam (> 2 MW) and wide-band
- longest distance accelerator neutrinos ever traveled

# DUNE is the Largest Neutrino Collaboration in History



Sowjanya Gollapinni

David Newbold

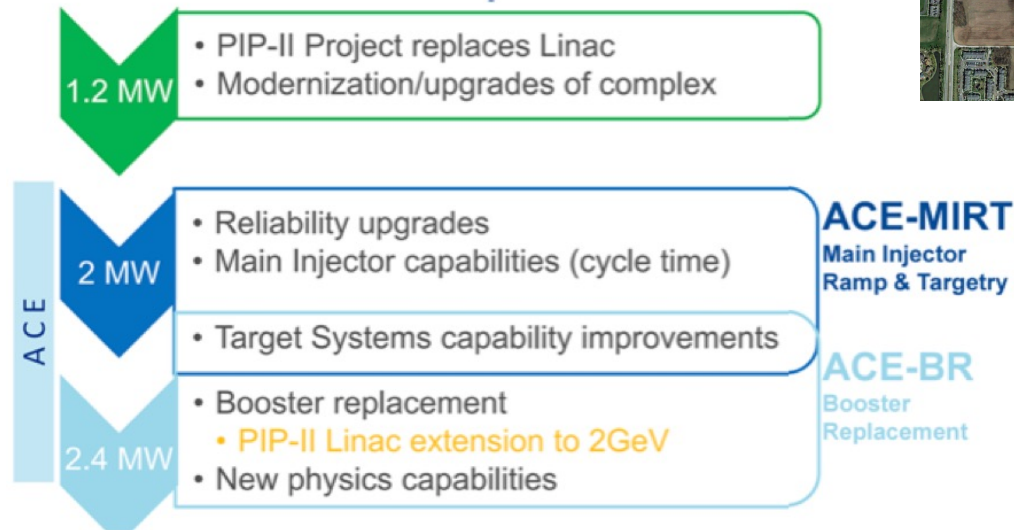
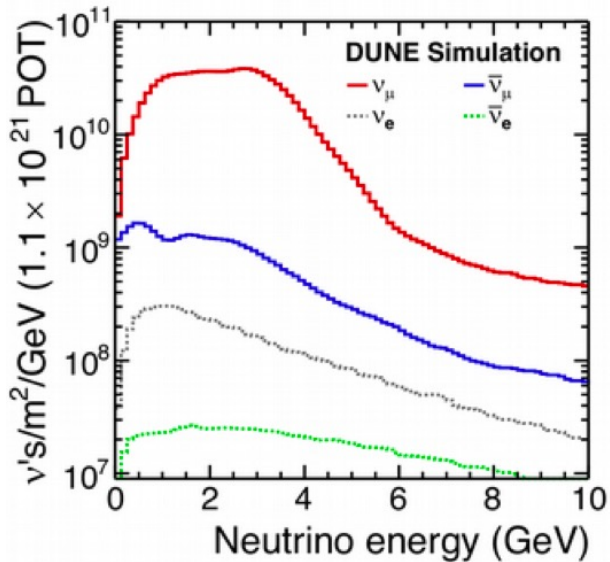
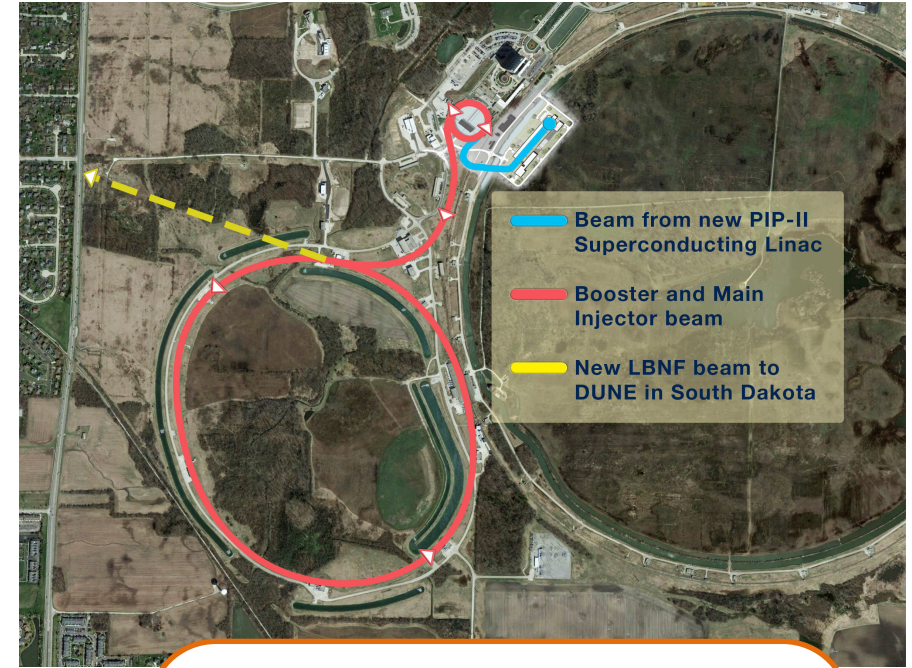


**More than 1500 collaborators from  
220+ institutes in 38 countries  
including CERN**

**Roughly half of the collaboration is  
students/postdocs**

# Beamline

- New PIP-II linac to increase energy from 400 to 800 MeV. Proton flux at 8 GeV increases 2 times resulting in beam power from Main Injector up to 1.2 MW
- Accelerator Complex Evolution (ACE) is planned upgrades to reach > 2 MW intensity



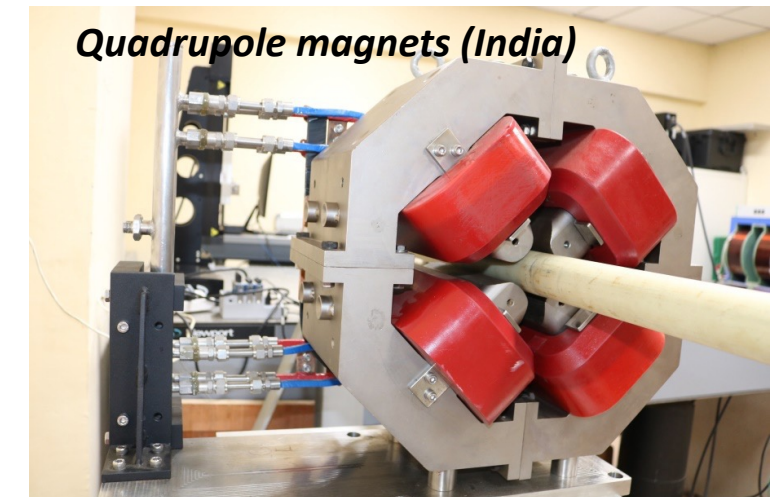
## PIP-II planned upgrades

- 800 MeV LINAC
- LINAC to Booster Transfer line
- Upgraded Booster
- Upgraded Recycler and Main Injector
- Conventional Facilities

**PIP-II creates a platform for next-generation upgrades**

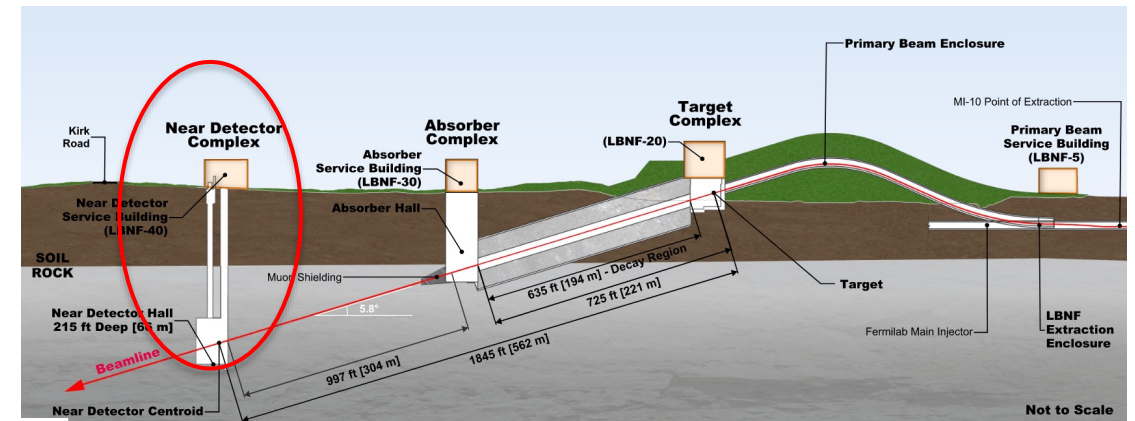
# Beamline Status

- PIP-II making steady technical progress – *project is on track to reach completion in early 2030*
- Target production in UK progressing well

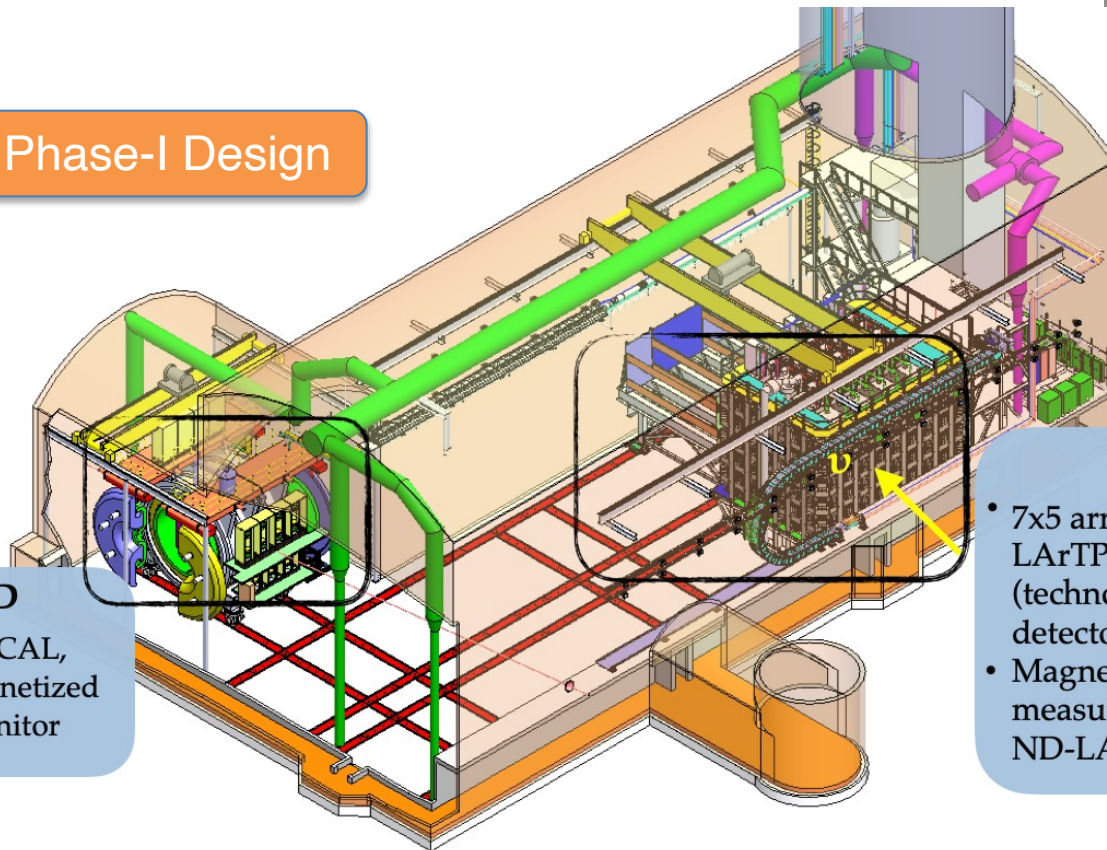


# DUNE Near Detector

- Located 60 m underground at Fermilab
- 574 m from neutrino beam target
- Comprised of two major components



## Phase-I Design



**SAND**  
Tracker, ECAL,  
On axis magnetized  
beam monitor

## ND-LAr + TMS

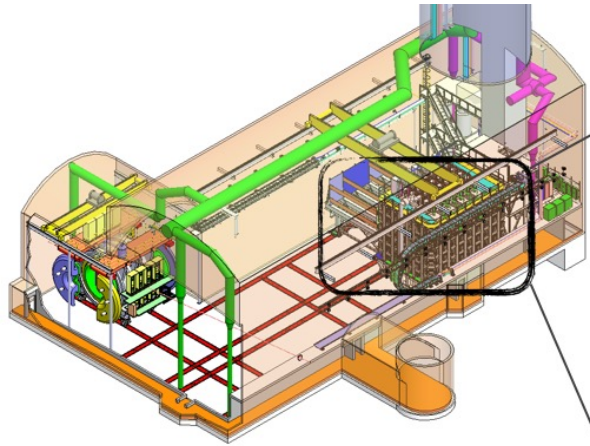
- 7x5 array of modular 1x1x3 m<sup>3</sup> LArTPCs with pixel readout (technology closest to far detector)
- Magnetized steel range stack for measuring muons that exit ND-LAr

## Primary Goals

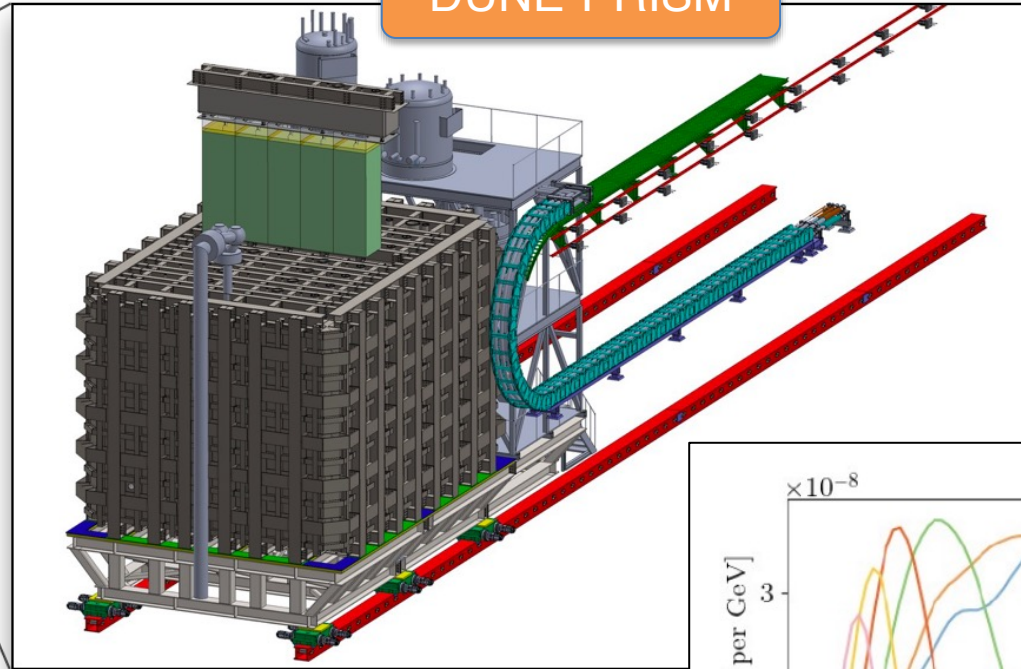
- Characterize neutrino beam
- Constrain neutrino cross sections on argon for precision oscillation physics
- Perform in a high-rate environment

*ND will see about ~50  
neutrino interactions  
per spill!*

# DUNE-PRISM

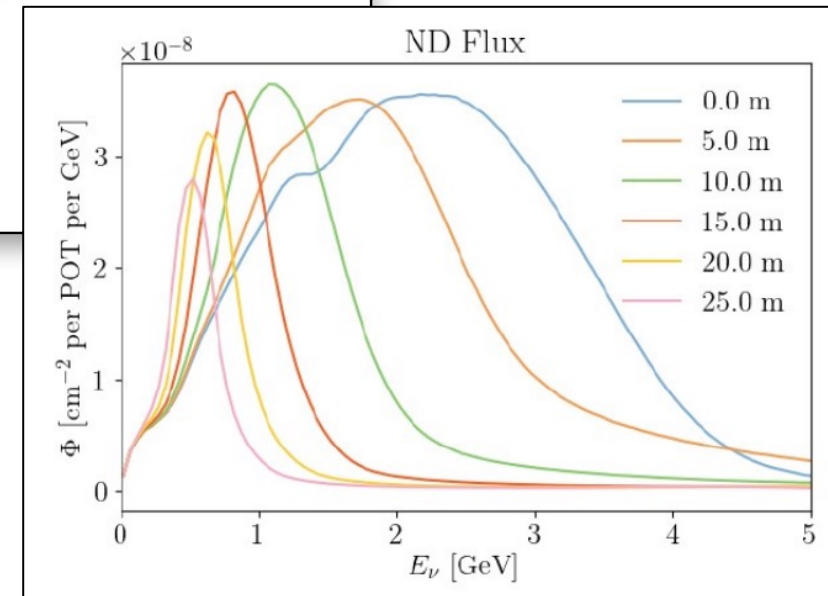


DUNE-PRISM

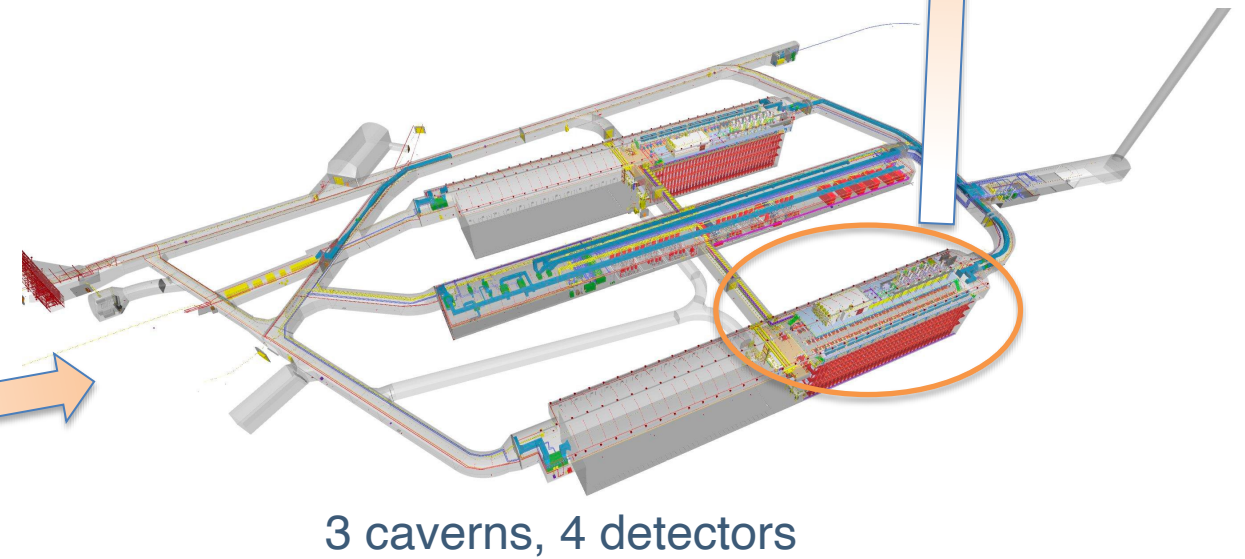
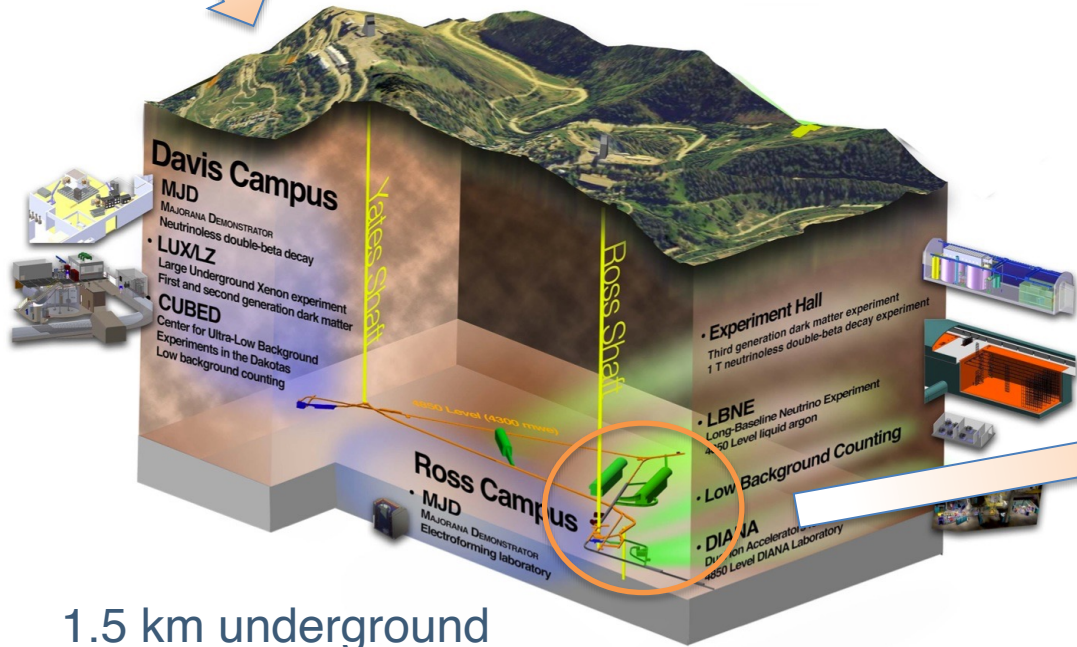
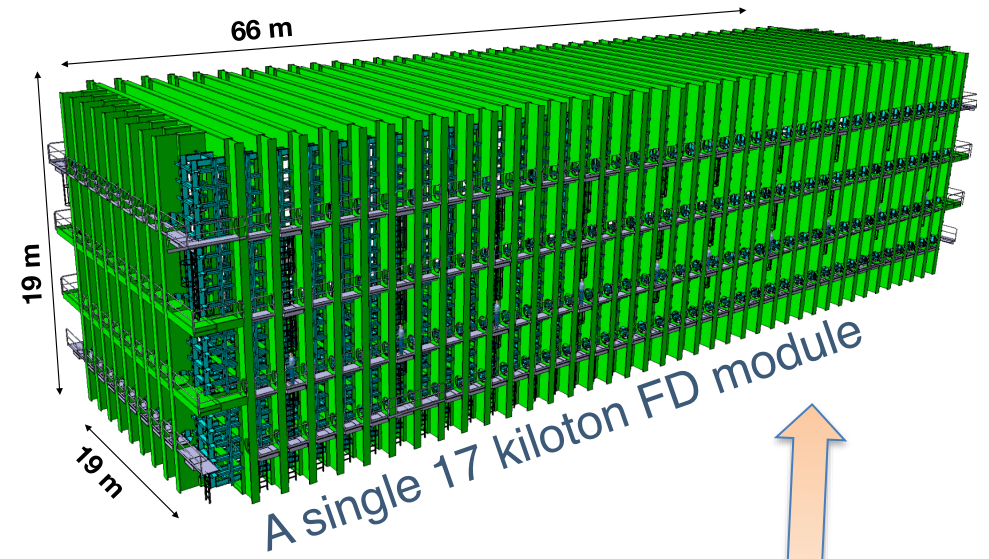
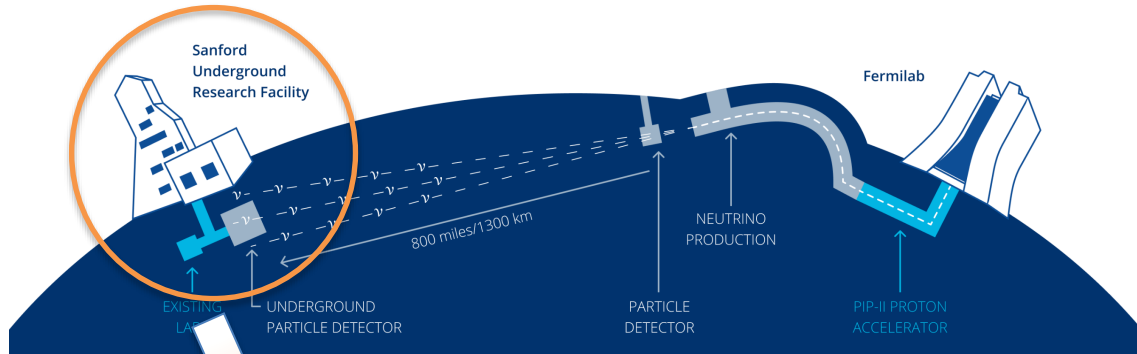


*ND-LAr and TMS systems can move off-axis up to 28.5 m to observe varied beam spectra*

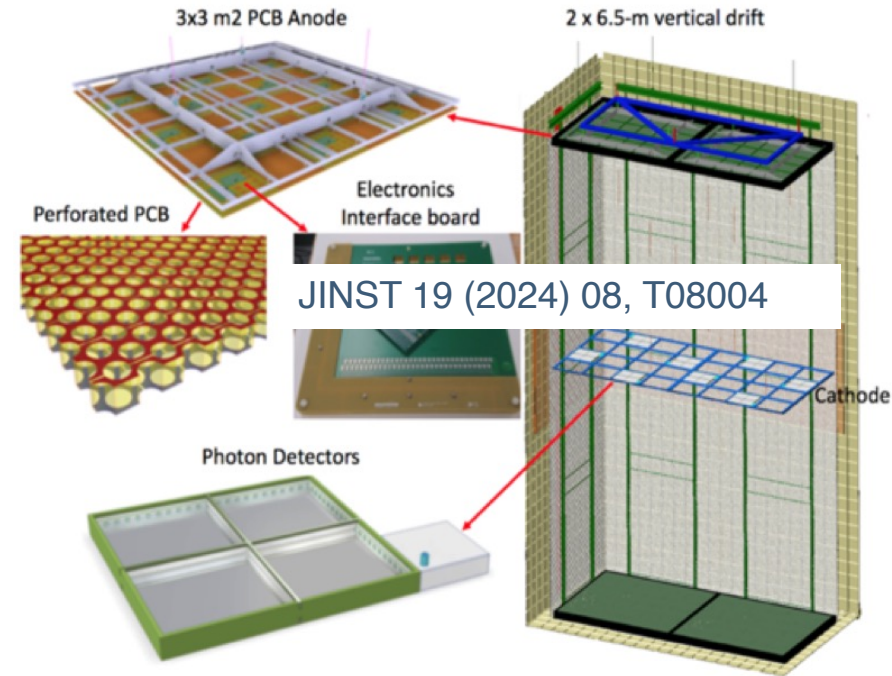
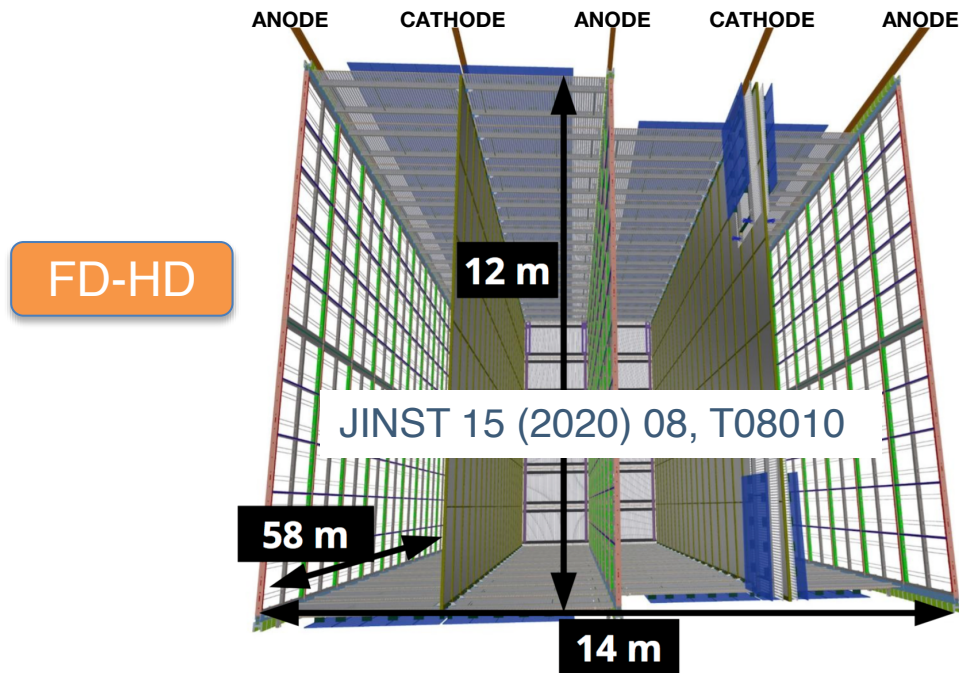
- ND flux changes with angle due to pion decay kinematics
- constrains energy dependence of neutrino cross sections; build oscillation analysis with minimal interaction modeling



# DUNE Far Site



# DUNE Far Detectors

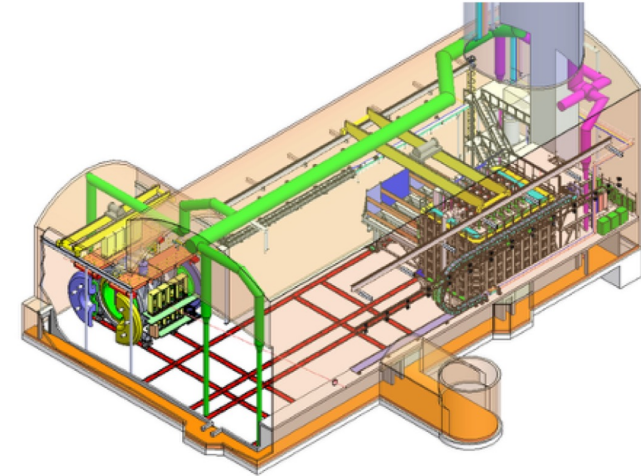
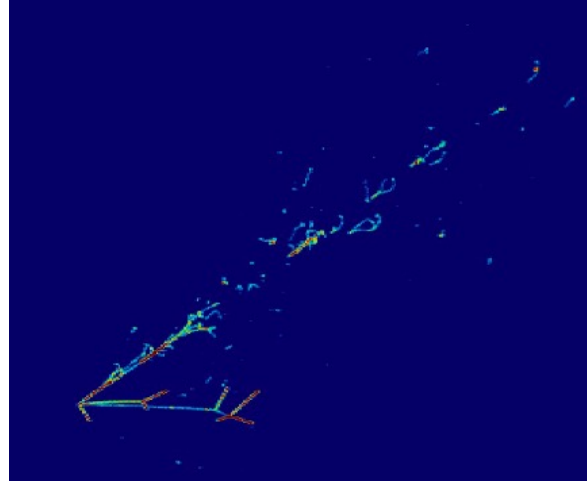
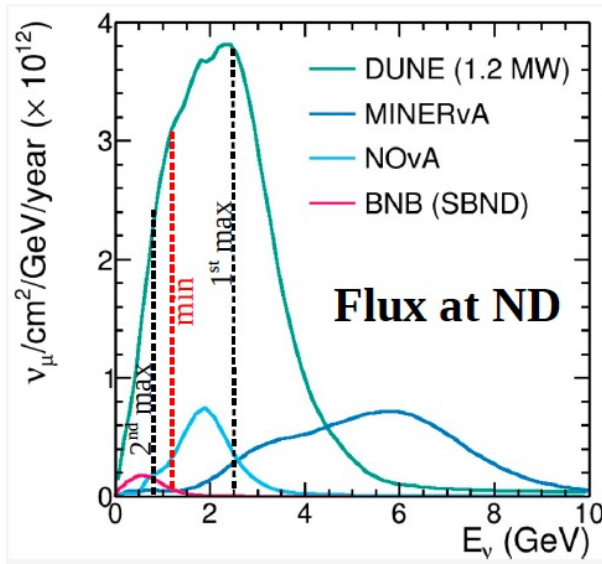


FD-VD

Two LArTPC technologies,

- **Horizontal-Drift (HD):** shorter drift; more segmented; wire readout
- **Vertical-Drift (VD):** longer drift; less segmentation; strip readout

# DUNE's Unique Physics Program is Enabled by 4 Key Ingredients

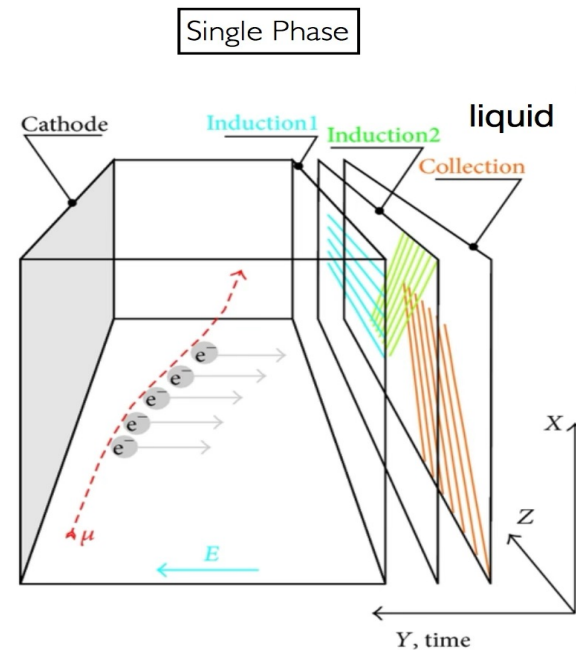


1. **Wide-band neutrino beam** → *measure all parameters at once and enable a rich physics program*
2. **Very long-baseline** → *break degeneracies between CPV and matter effect*
3. **Liquid argon technology** → *measure neutrino interactions with unprecedented detail*
4. **Movable, high-performance Near Detector** → *unprecedented control of systematics*

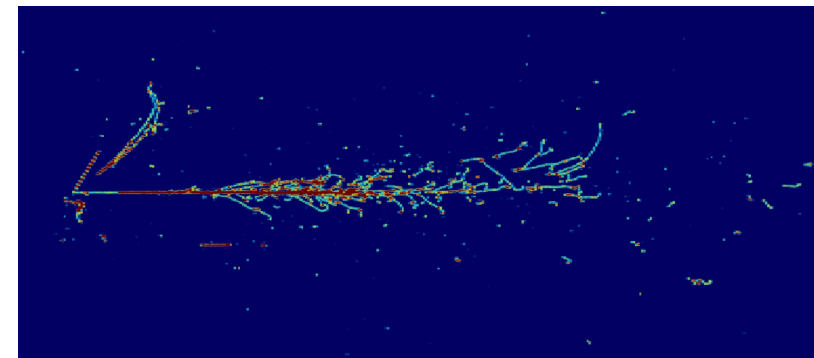
***Strongly complimentary to other experiments***

# The Technology Choice: LArTPC

- DUNE is the only experiment of this kind using the LAr technology
- Scalable in size
  - Technology scalability demonstrated at overwhelming levels (*ProtoDUNE*s, *ND-LAr "2x2"*, *MicroBooNE*, *SBND*, *ICARUS*, *LArIAT*, *ArgoNeuT* etc.)
- Ideal technology for  $\nu_e$  measurements
  - Excellent signal (charged-current  $\nu_e$ ) efficiency and background (Neutral Current  $\pi^0$ ) rejection compared to traditional technologies
- More than 60% of DUNE interactions have final state pions – *LArTPCs enable precise hadron reconstruction*
- Needed for wide band beam to accurately reconstruct neutrino energies

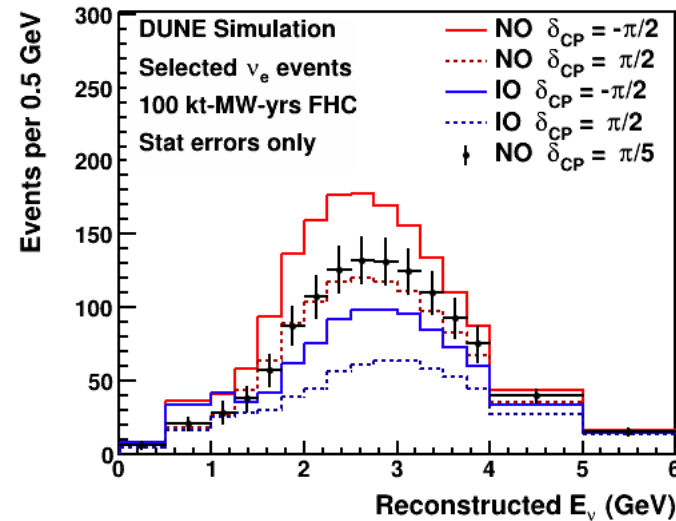
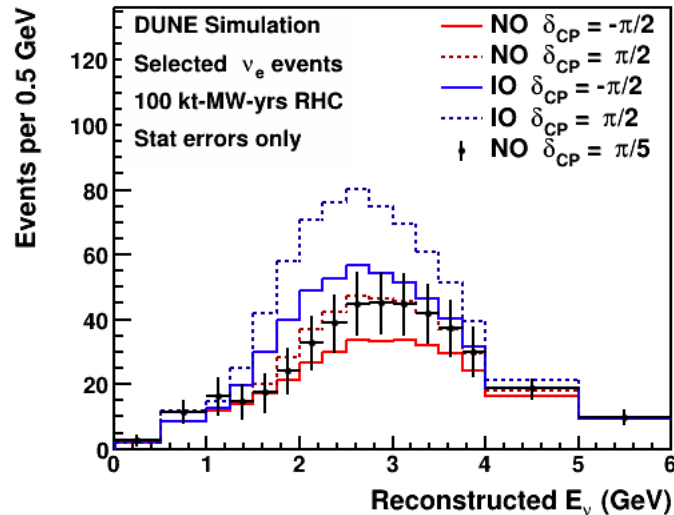


Ar	
Boiling Point [K] @ 1atm	87.3
Density [g/cm <sup>3</sup> ]	1.4
Radiation Length [cm]	14.0
dE/dx [MeV/cm]	2.1
Scintillation [γ/MeV]	40,000
Scintillation λ [nm]	128



*A simulated 4 GeV  $\nu_e$  from a resonant interaction in DUNE Horizontal Drift Far Detector*

# Neutrino Energy Spectra at the Far Detector

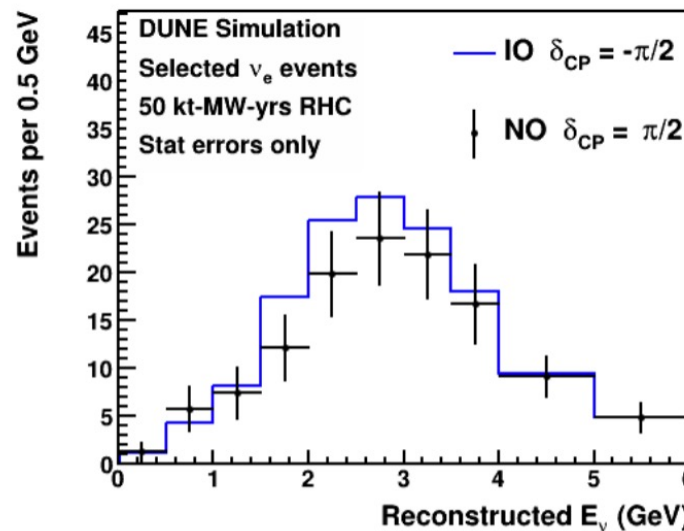
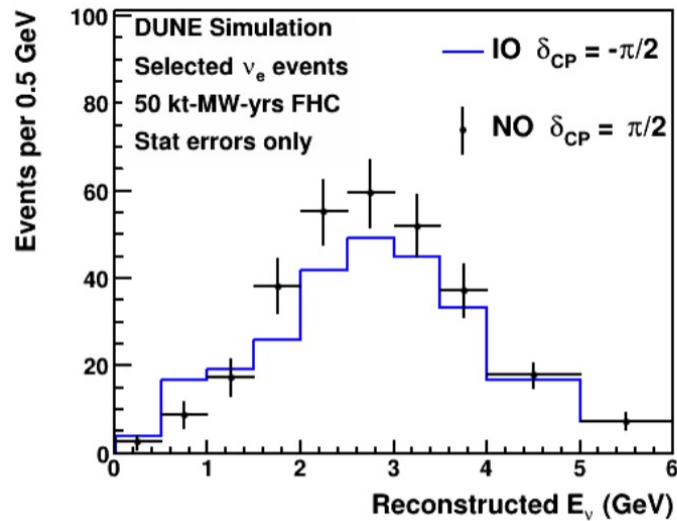


*DUNE has rate and shape sensitivity*

- DUNE will measure oscillations over  $>1$  full period, long baseline  $\rightarrow$  *parameters are not degenerate, measure everything in one experiment*
- DUNE can measure oscillation parameters at each bin of  $L/E$   $\rightarrow$  *broad  $L/E$  range is essential to resolving all parameters at once*
- It is likely that new physics would distort the result as a function of  $L/E$   $\rightarrow$  *DUNE has unique sensitivity to new physics*

# DUNE Oscillation Physics

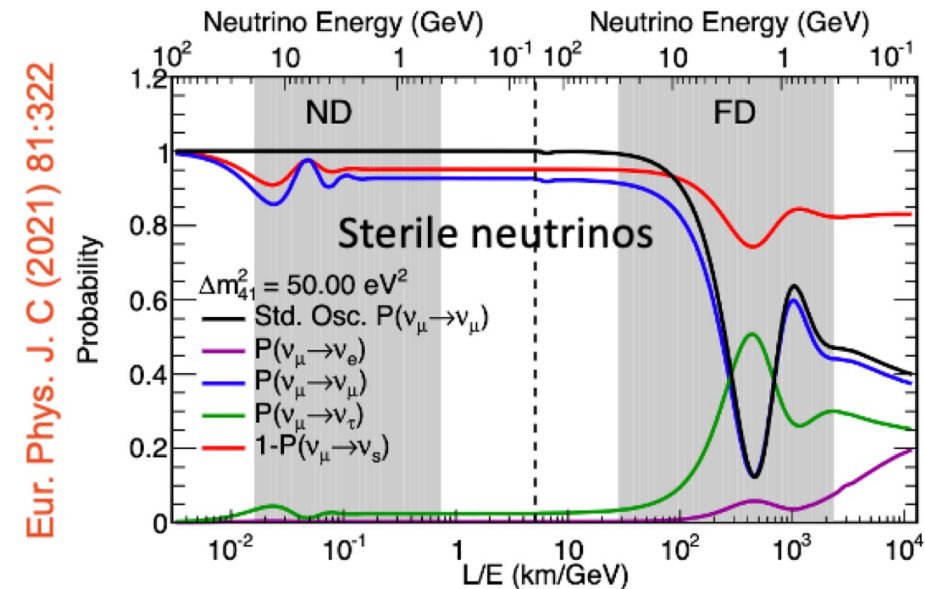
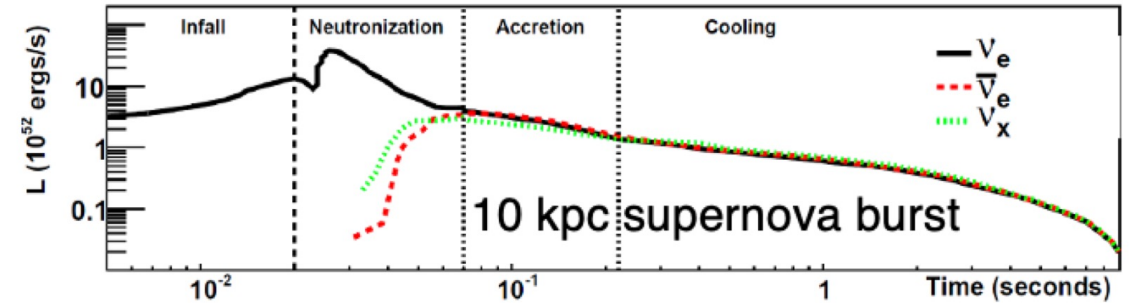
- DUNE infers MO in a different way than other experiments
- DUNE is the only experiment that measures the MO by separately measuring  $\nu_\mu \rightarrow \nu_e$  and anti- $\nu_\mu \rightarrow$  anti- $\nu_e$  oscillations
- Shown here is the worst-case scenario where CPV and matter effect go in opposite directions – *spectral information is paramount*
- DUNE resolves MO at  $> 5\sigma$  in any scenario



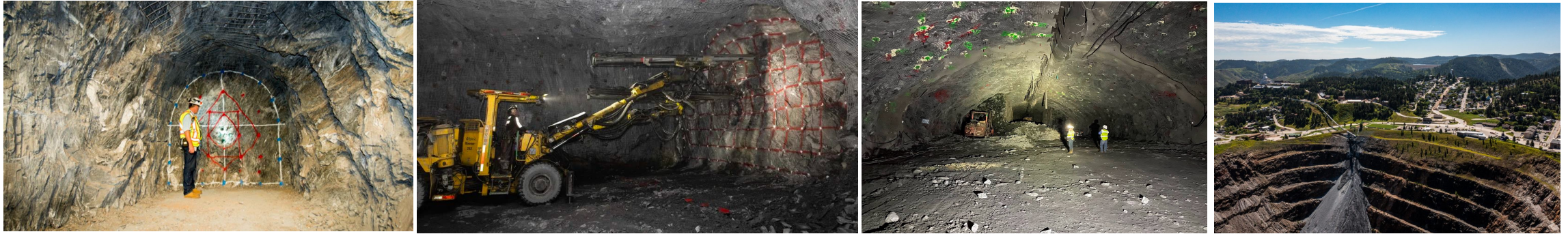
*Sensitivity plots in backup  
(unchanged from Neutrino 2024)*

# Beyond Oscillation Physics: Supernova, Solar and New Physics

- Supernova flux includes  $\nu_e$ , anti- $\nu_e$ , and other flavors ( $\nu_x$ ), DUNE is uniquely sensitive to  $\nu_e$  due to Argon target and reach extends beyond the Milky Way with additional modules
- DUNE has broad BSM program with ND and FD with New physics in oscillations (e.g., sterile neutrinos, CPT violation) and other areas (e.g., Dark matter, nucleon decay, heavy neutral leptons, neutrino tridents)
- DUNE astro, atmospheric, and BSM program starts the moment the first far detector turns on



# Far Site Status – Caverns Excavated at SURF



800,000 tons  
of rock  
crushed and  
removed!



# LBNF/DUNE Wins the Project of the Year Award!

EVENTS NEWS SUBSCRIBE WORK WITH US LOG IN SEARCH



ABOUT VISITOR CENTER RESEARCH EDUCATION SUPPORT SURF



Photo by Matthew Kapust

[Home](#) | [News](#) | Largest Neutrino Experiment In The U...

## Largest neutrino experiment in the U.S. wins Project of the Year Award

The largest neutrino experiment in the U.S. was named the Project of the Year by the Underground Construction Association for completing a significant and challenging underground construction project with little or no issues.

APRIL 13, 2026

by Tracy Marc

NEUTRINOS

Stay up-to-date on our latest news and upcoming events.

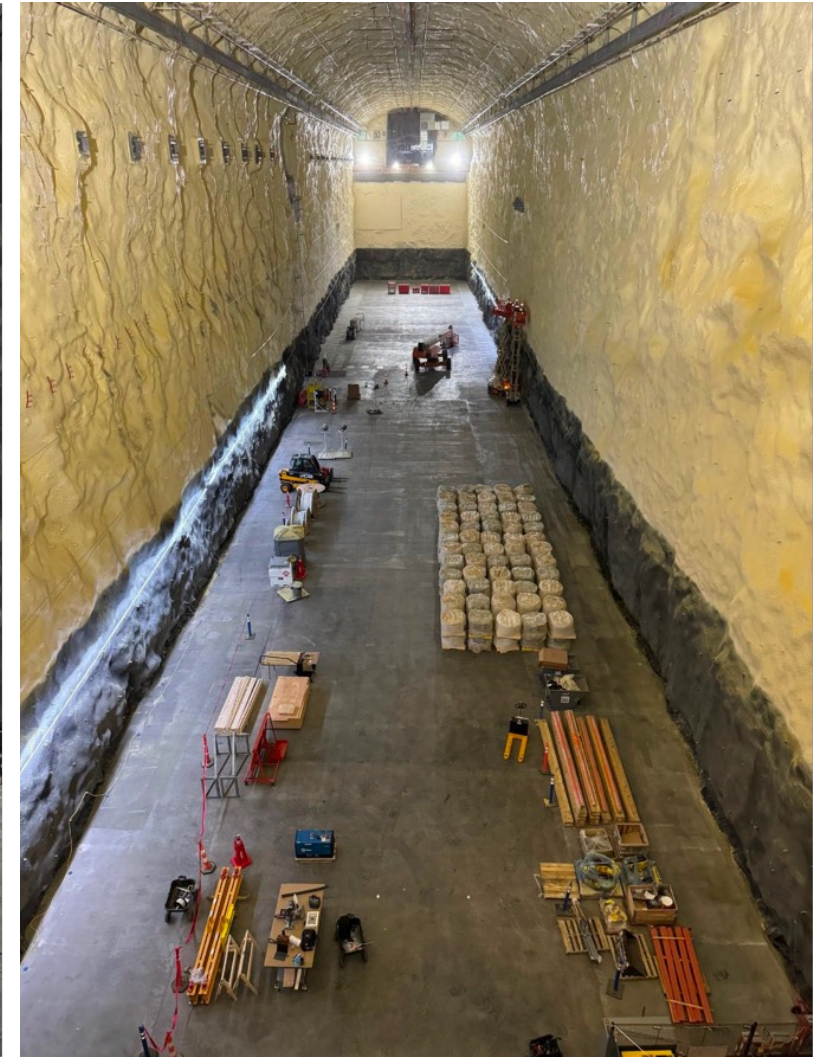
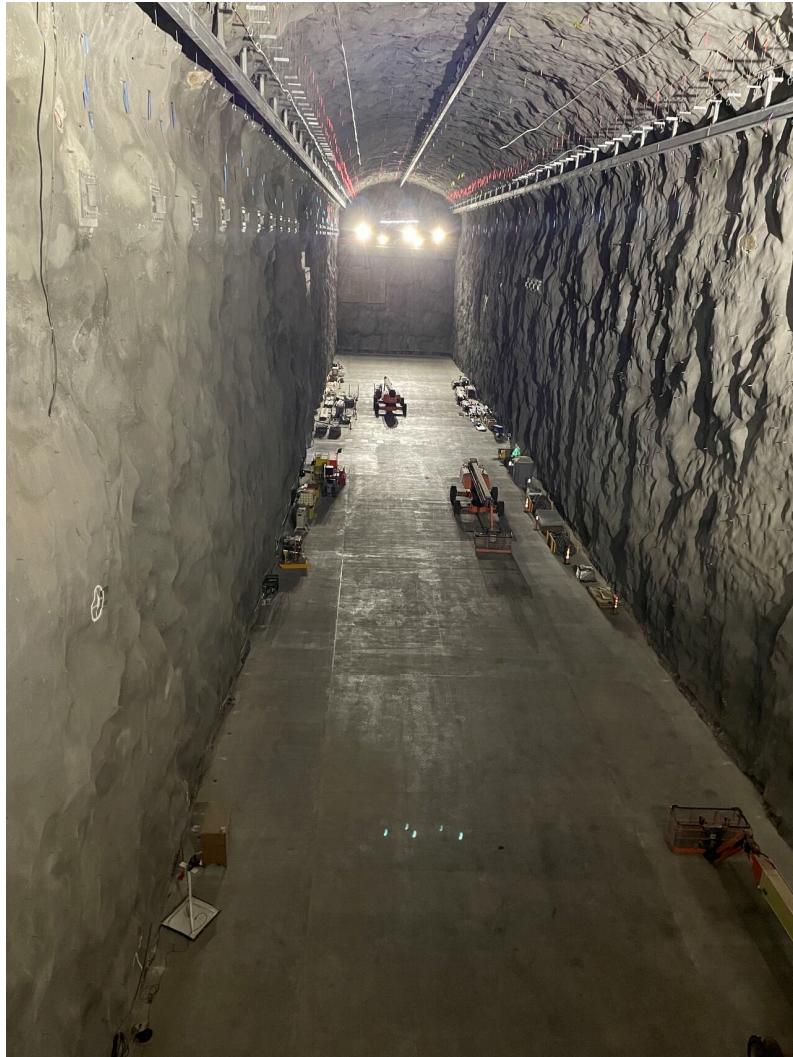
[SUBSCRIBE TO DEEP THOUGHTS](#) →

<https://sanfordlab.org/news/largest-neutrino-experiment-us-wins-project-year-award>

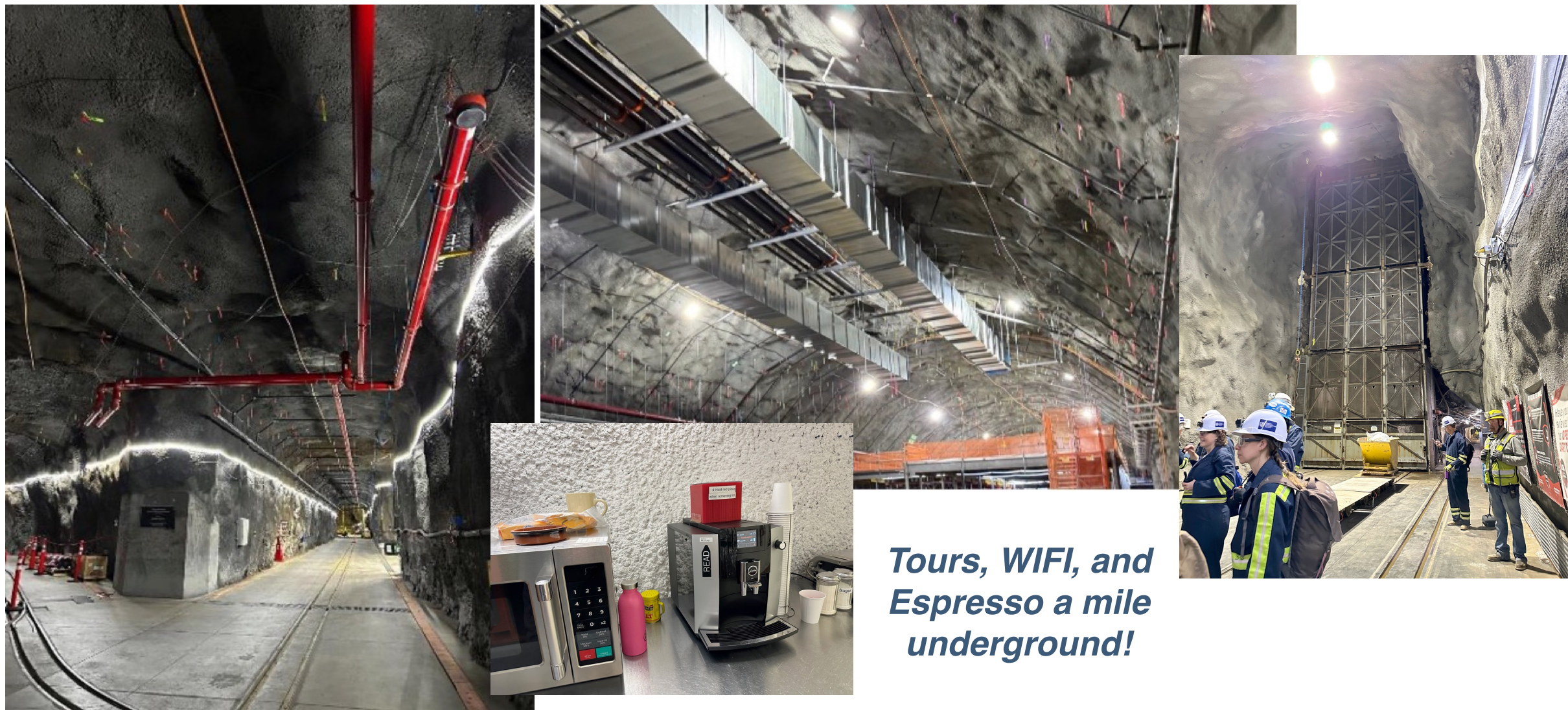
(by the Underground Construction Association)

April 2026

# The Caverns are Functional Labs Today

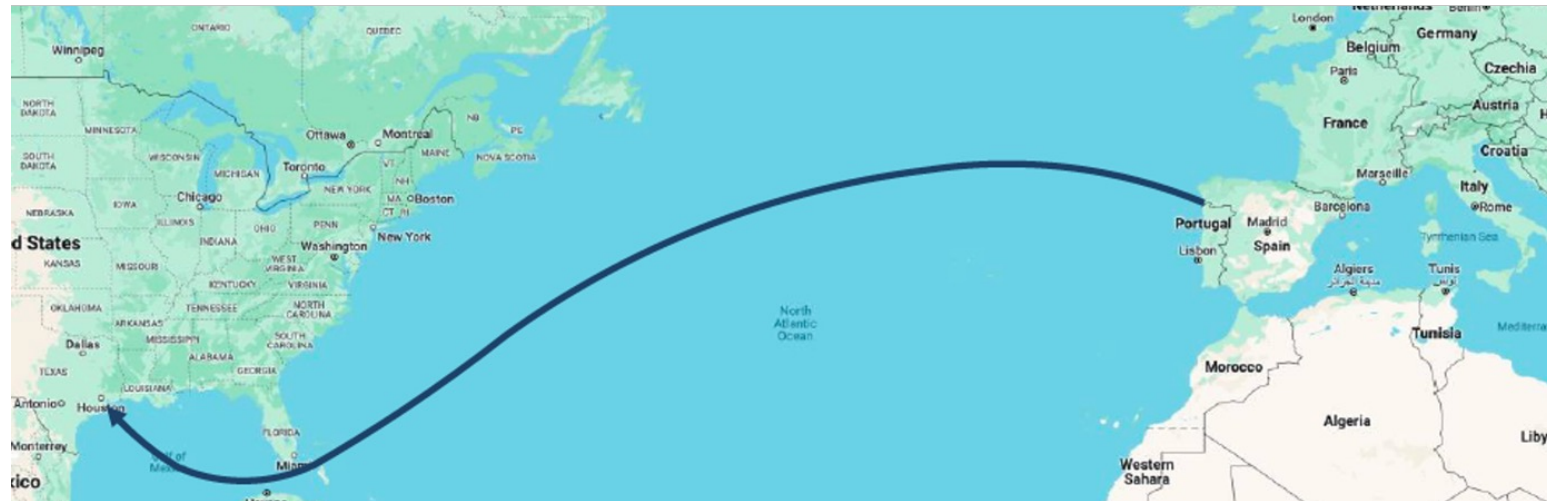


# Cavern Outfitting Complete



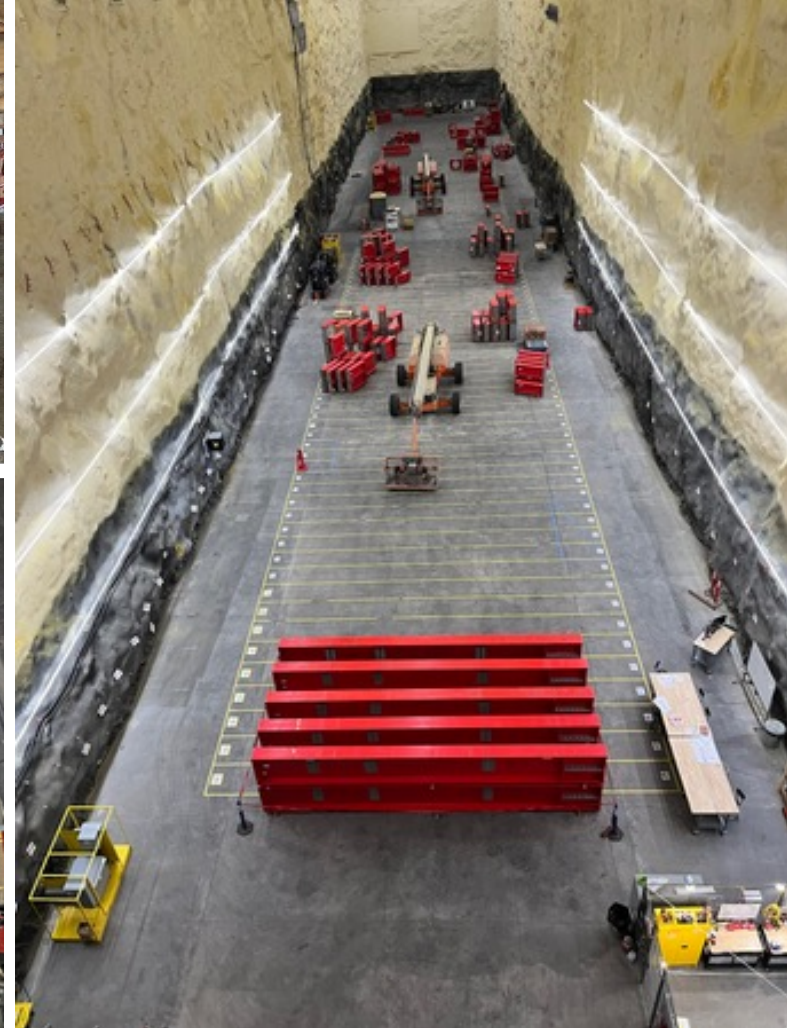
*Tours, WiFi, and Espresso a mile underground!*

# All Cryostat Material Arrived in South Dakota



# Cryostat Material Transported Underground

*We are the cusp of starting cryostat assembly*

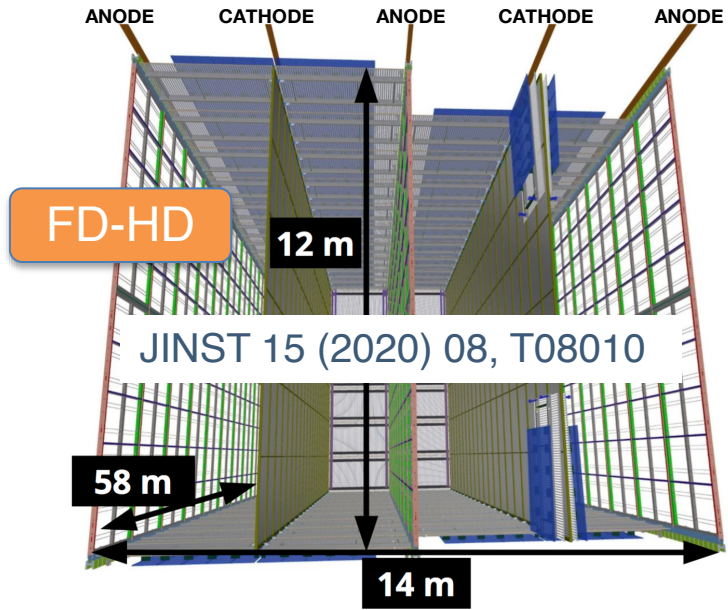


# A Cryostat Beam Signing Event

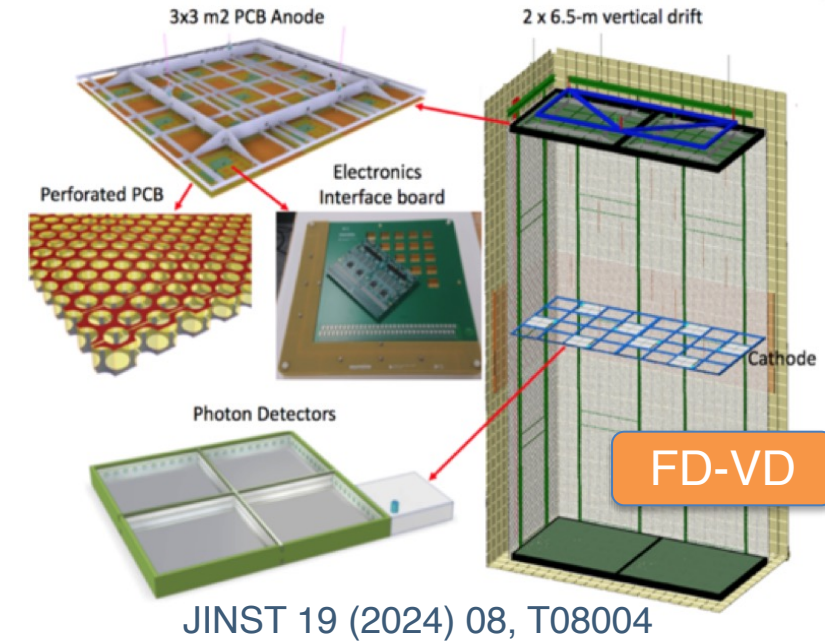
*to mark the start of installation phase*



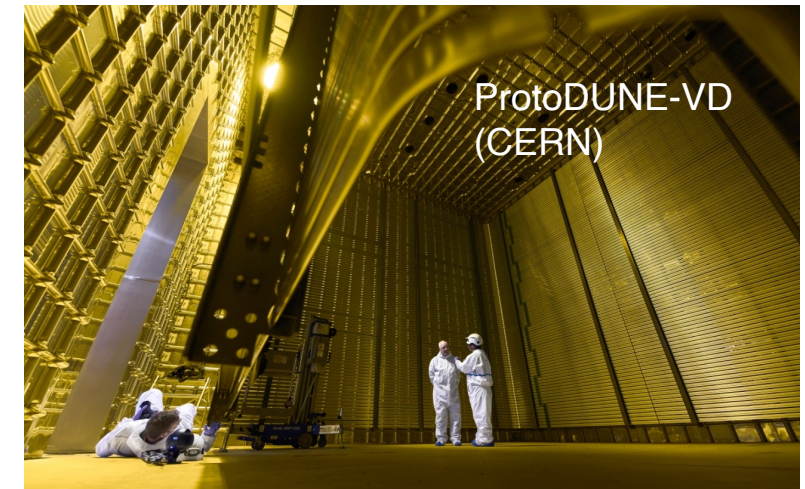
# DUNE Far Detectors



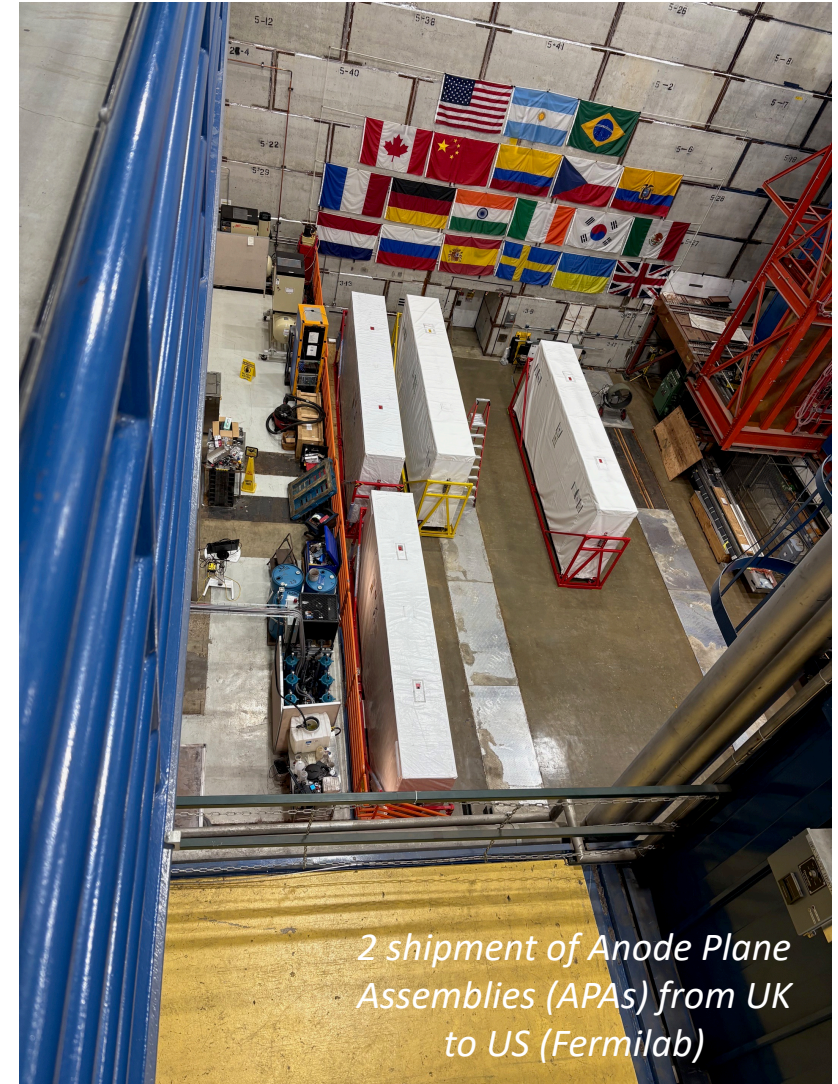
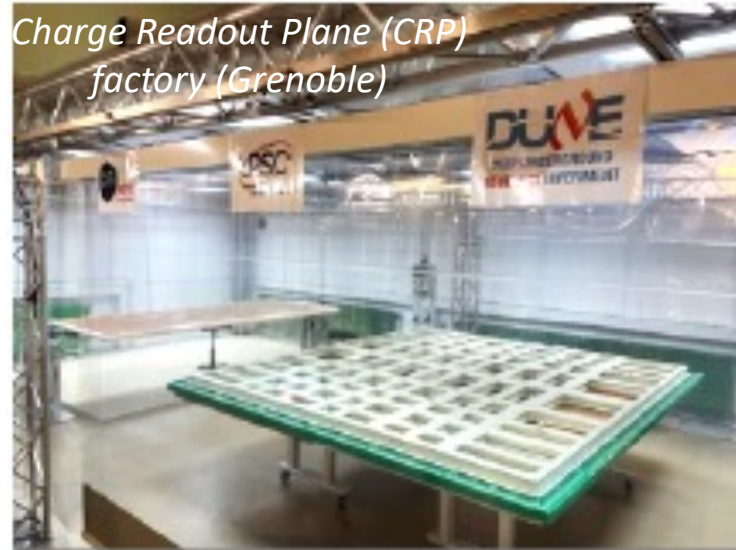
- Both technologies successfully demonstrated at scale in ProtoDUNE (770-tons) along with physics performance resulting in 13 papers!



- All far detector components in production
- Installation of far detectors to start next year once cryostat assembly concludes

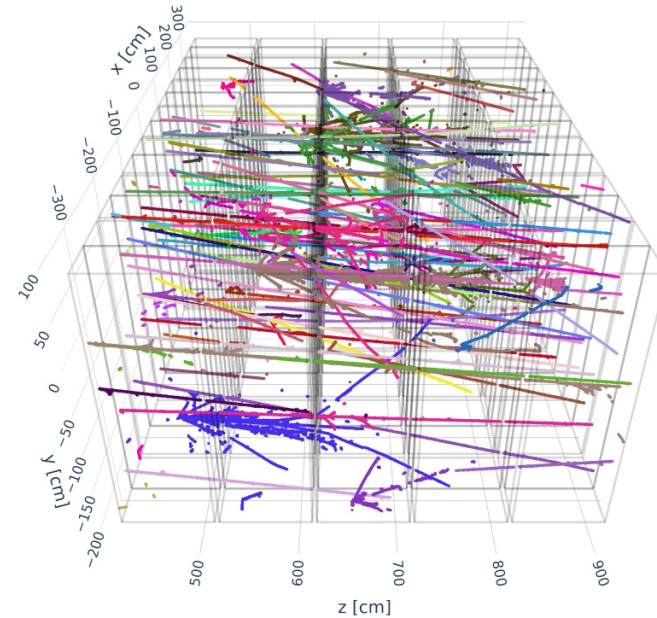


# DUNE Far Detectors Making Rapid Progress

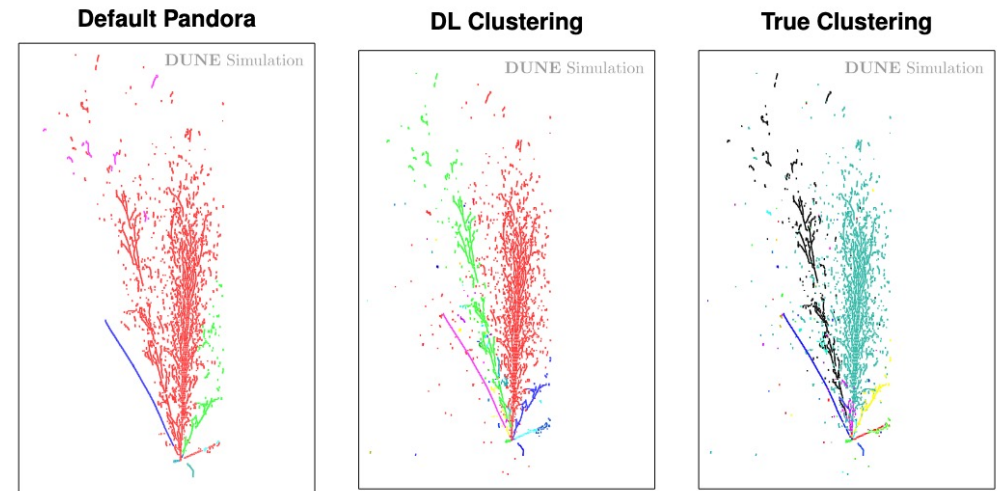


# Readiness for First Data

- **Advancing Simulation/Reconstruction:** moving to FD simulations with full geometries and including trigger; simulation and validation of full-spill ND samples
- **Assessing calibration sources:** laser and neutrons source in ProtoDUNEs; Source injections in ND-LAr “2x2”
- **DUNE non-beam sensitivities at FD using full simulation/reconstruction:** solar boosted dark matter, solar neutrino hep flux; low-energy reconstruction
- **Advancing First DUNE neutrino data analyses:** NuMI neutrinos in ND-LAr “2x2”, CERN SPS neutrinos in ProtoDUNEs
- DUNE presents a unique environment for machine learning and is leveraging AI/ML across its entire workflow including hardware and monitoring aspects

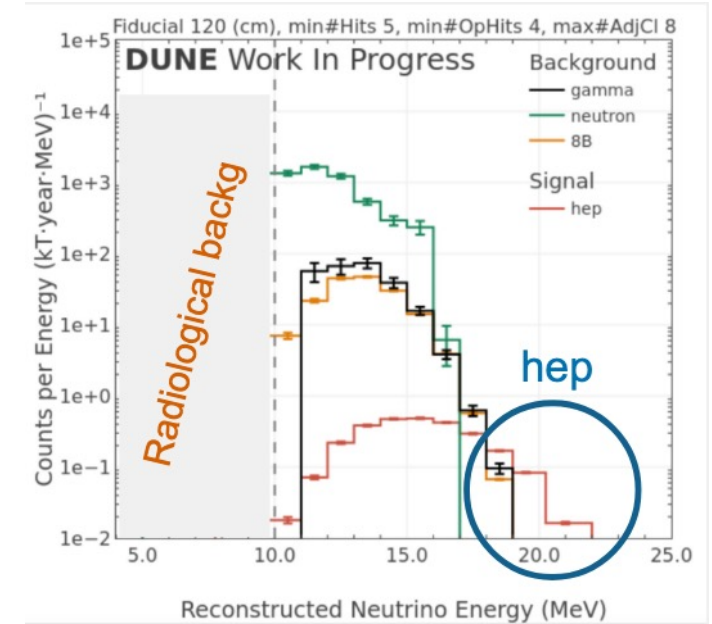
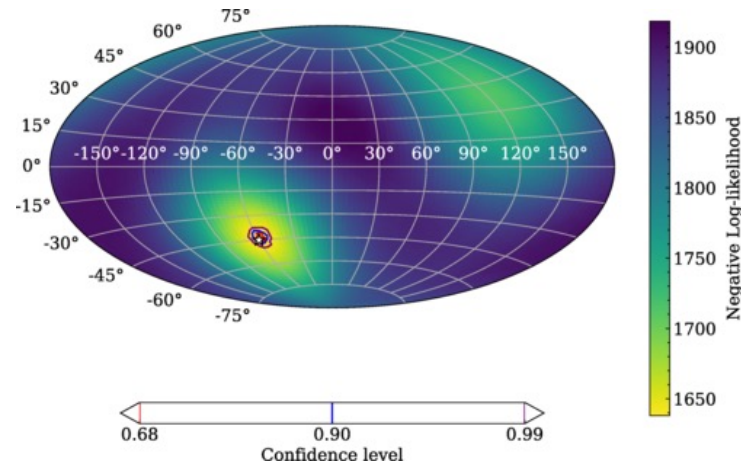
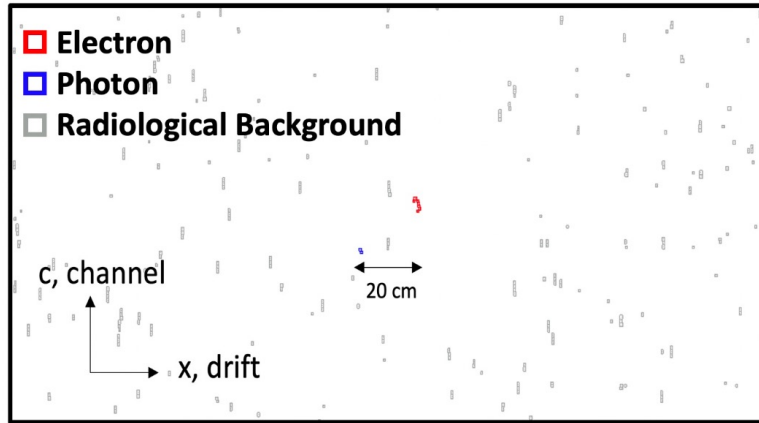


*Simulation & Reconstruction demonstration of pile up in ND-LAr*



*Pandora shower reconstruction with Deep Learning*

# Low-energy & Astrophysical Neutrinos in DUNE



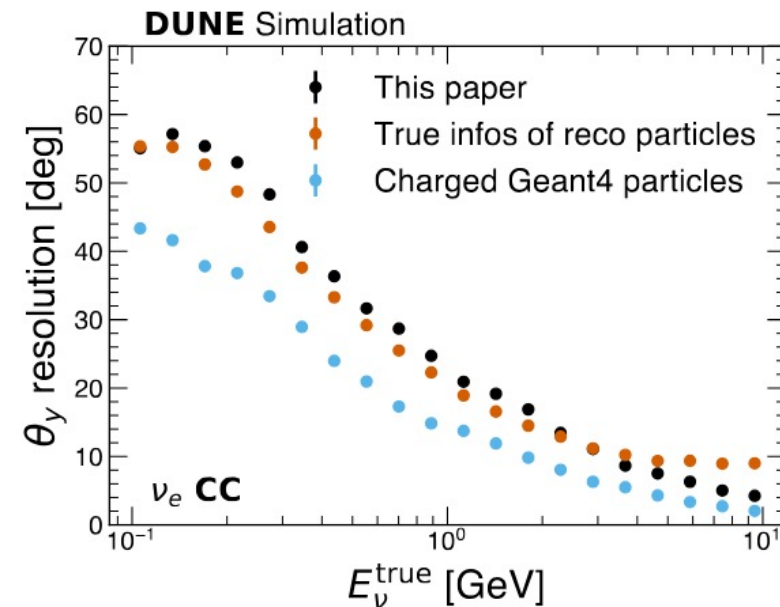
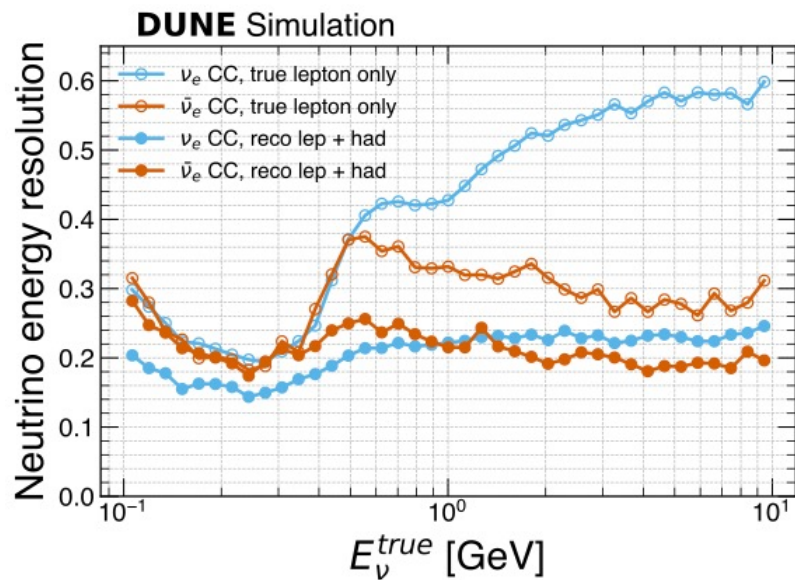
**First end-to-end low energy reconstruction workflows demonstrated for HD and VD far detectors for 4-70 MeV**  
*(paper in review)*

**Supernova pointing**  
 ES channel  $\sim 5^\circ$  pointing resolution (40 kt, 10 kpc)  
*PRD 111 (2025) 9, 092006*

**Solar Neutrinos**  
 Excellent sensitivity to 8B solar neutrinos above  $\sim 10$  MeV, and discovery sensitivity to the hep solar flux  
*(paper in preparation)*

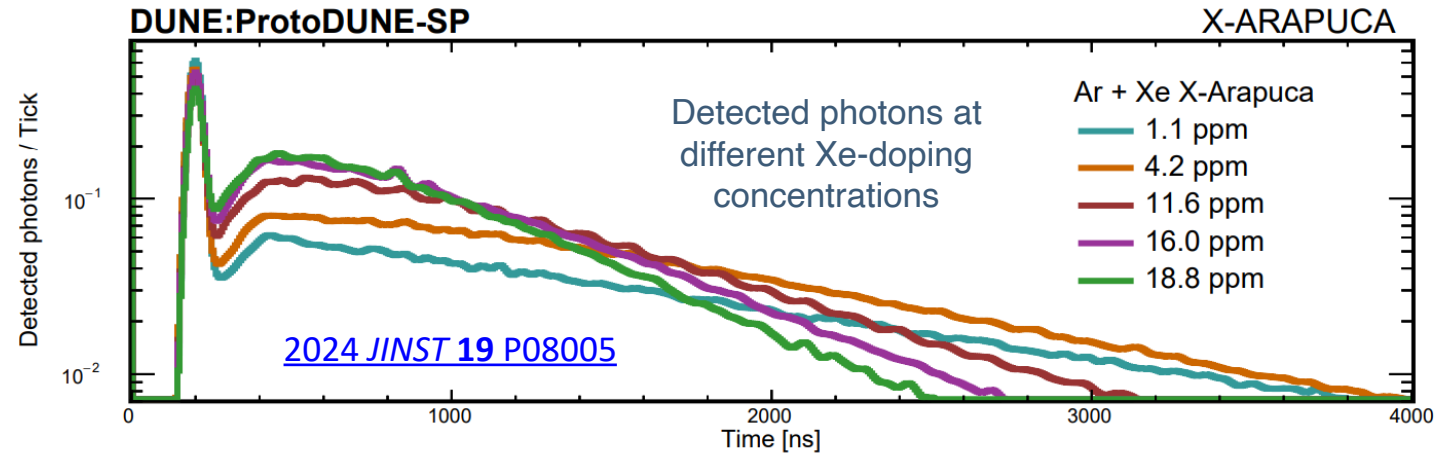
# Atmospherics in DUNE

- Atmospheric neutrino reconstruction paper for Horizontal Drift FD accepted by EPJC (<https://arxiv.org/pdf/2601.05697>)
- Full reconstruction and simulation chain between 0.1 and 10 GeV has been demonstrated. Next step is implementing the first atmospheric neutrino oscillation analysis

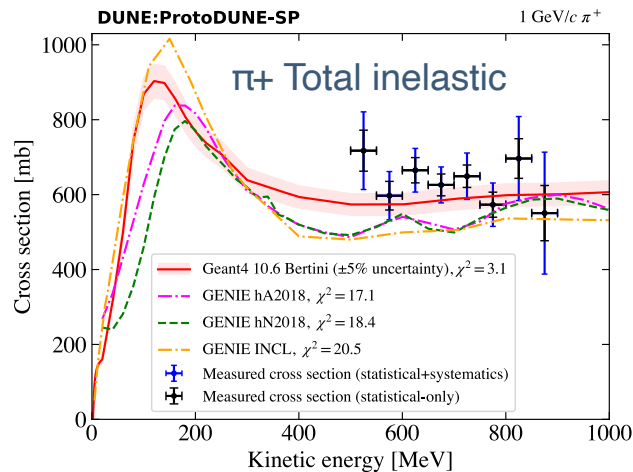


# ProtoDUNE Phase-I Results

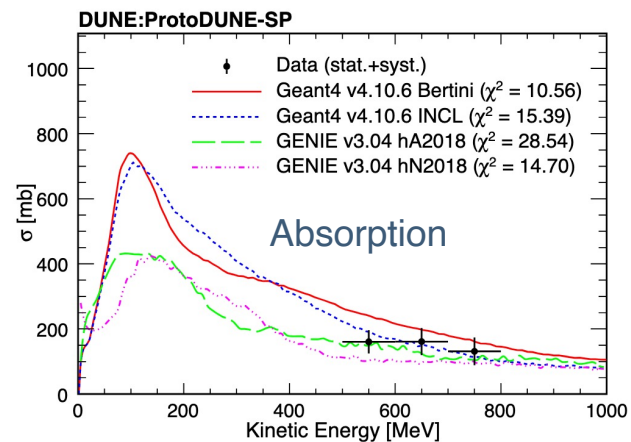
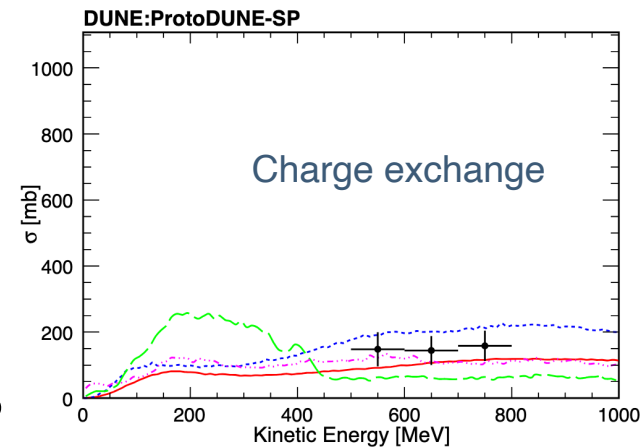
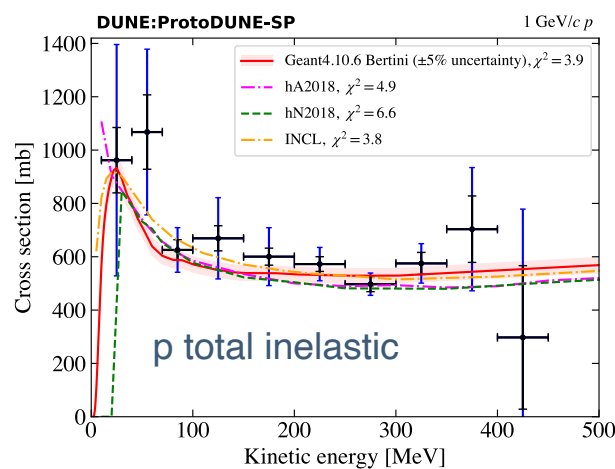
- 13 papers and counting! (technical, detector performance, cross section papers etc.)
- Data has provided an important test of Geant4 and GENIE Argon scattering models



<https://arxiv.org/abs/2511.11925>

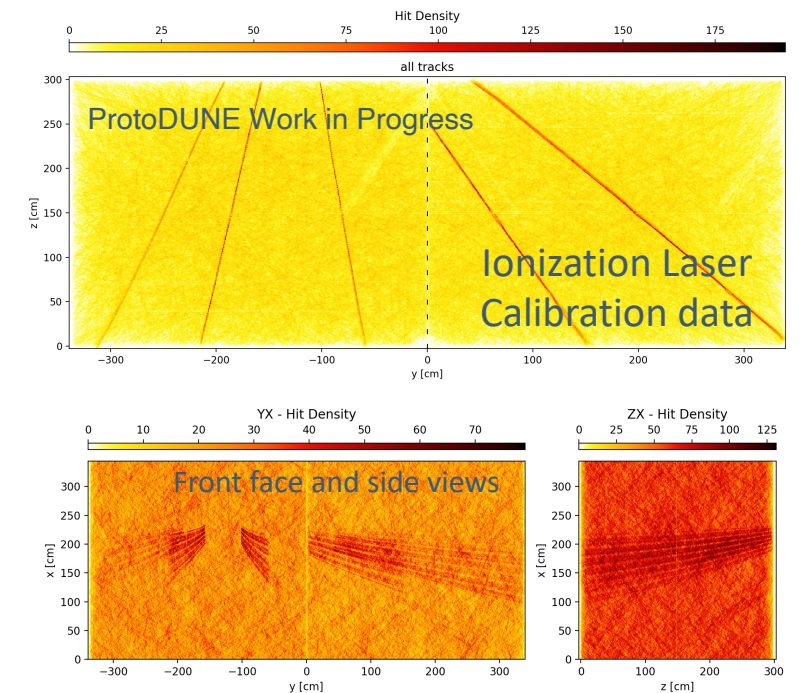
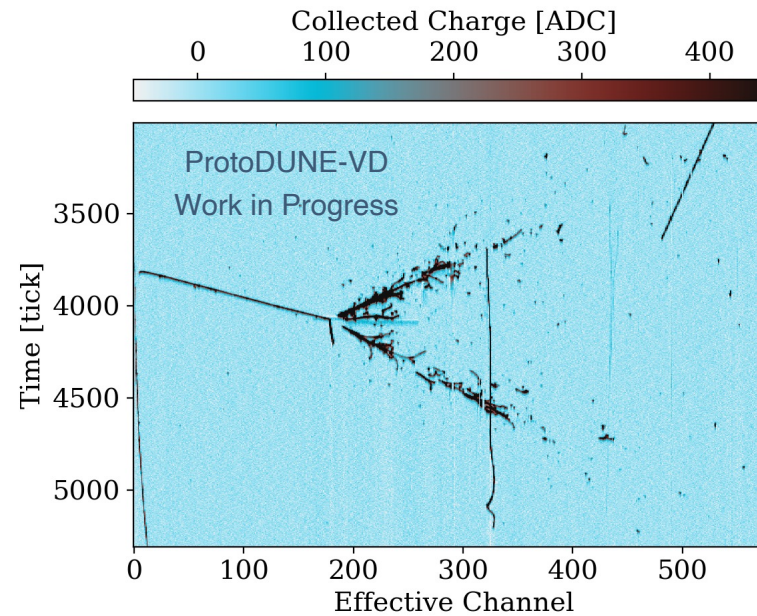
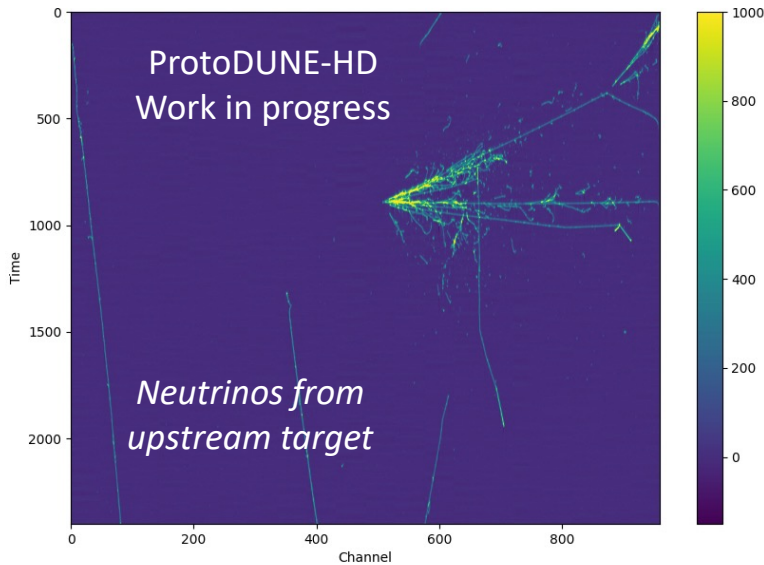
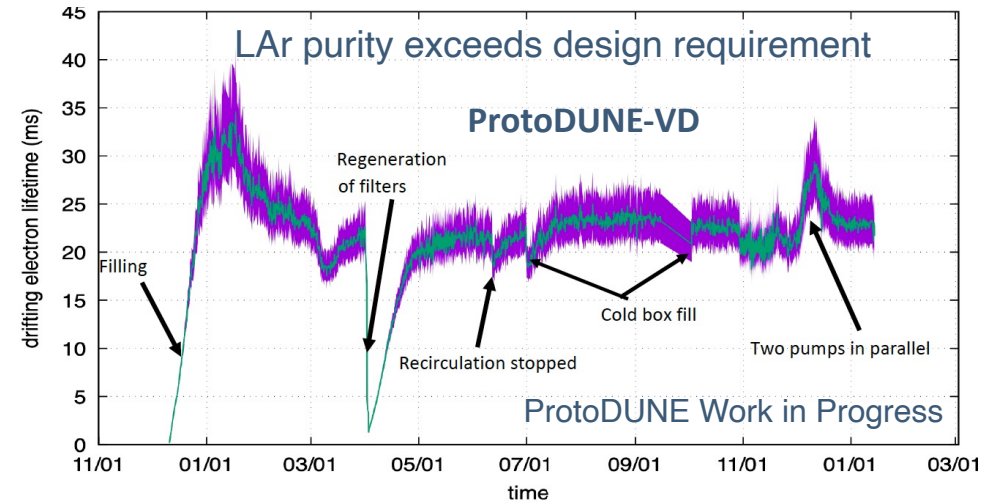


<https://arxiv.org/abs/2511.13462> (Pion Exclusive)



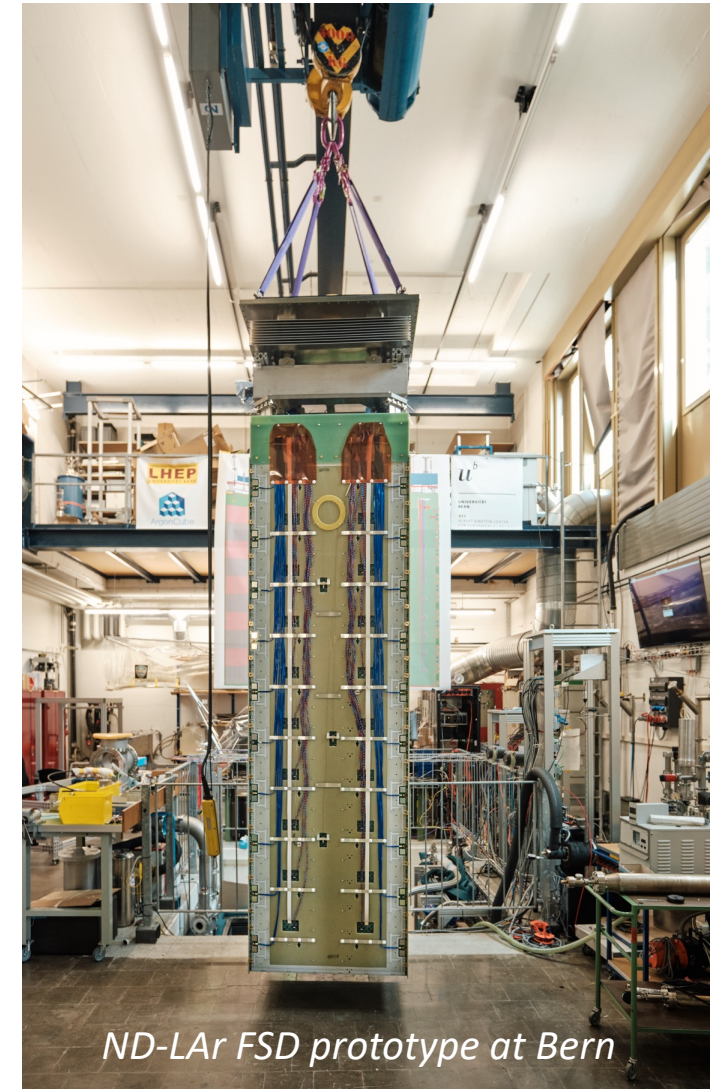
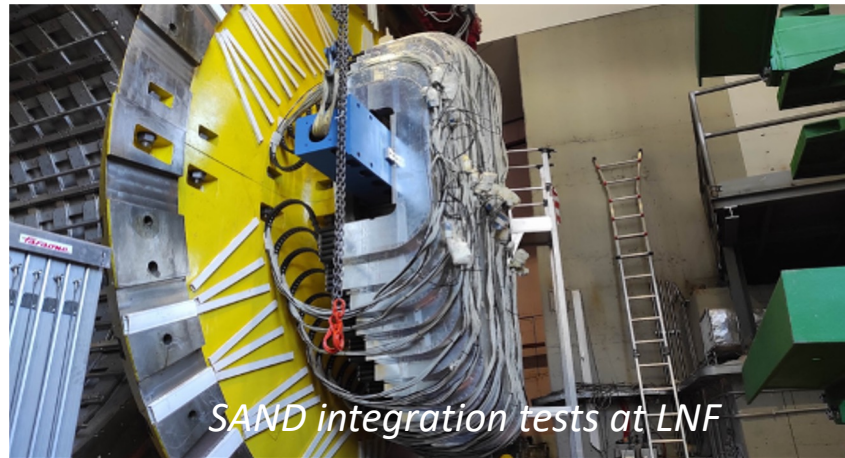
# ProtoDUNE Phase-II Highlights

- ProtoDUNE-HD: 23M events (2024)
- ProtoDUNE-VD:
  - > 4M events (July-Sept 2025)
  - Post-beam operations ongoing: High Voltage stress tests, Xe doping, neutron source calibration etc.
- Excellent overall performance; data analyses ongoing



# Near Detector Status

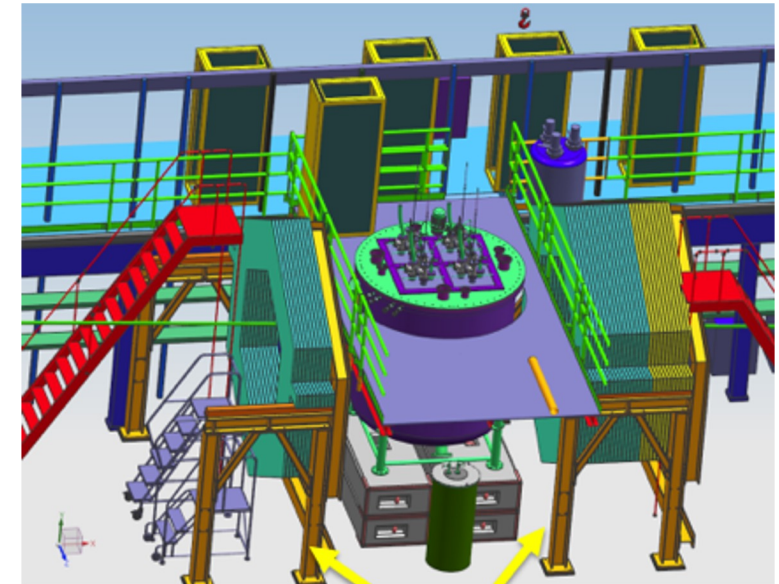
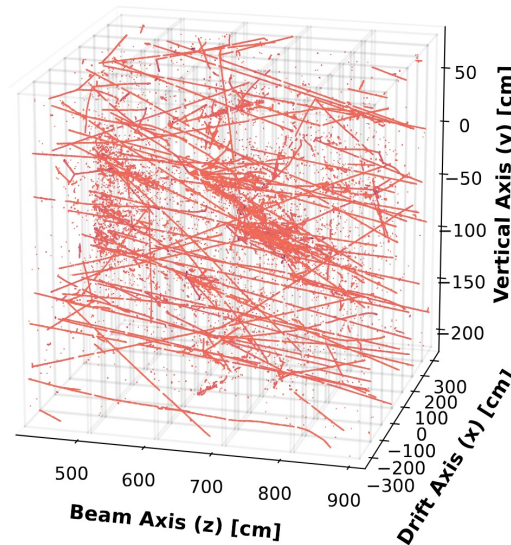
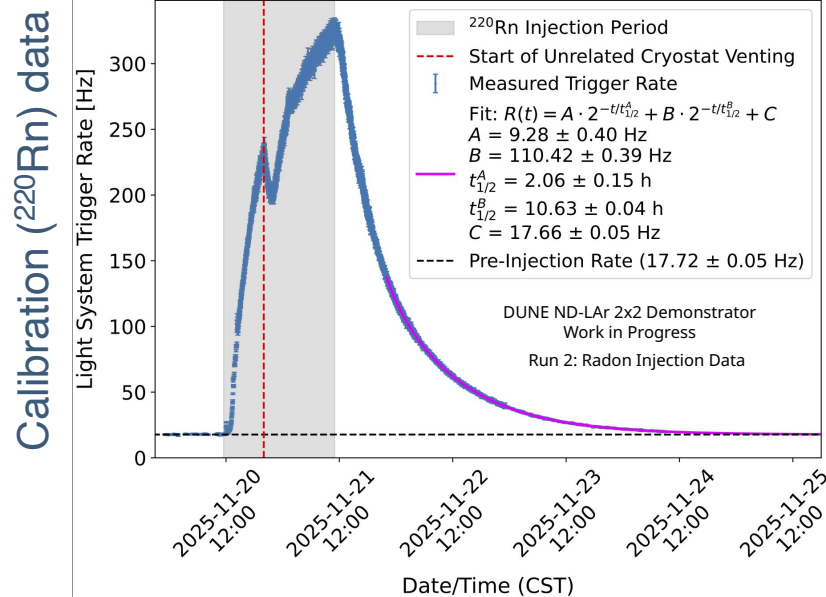
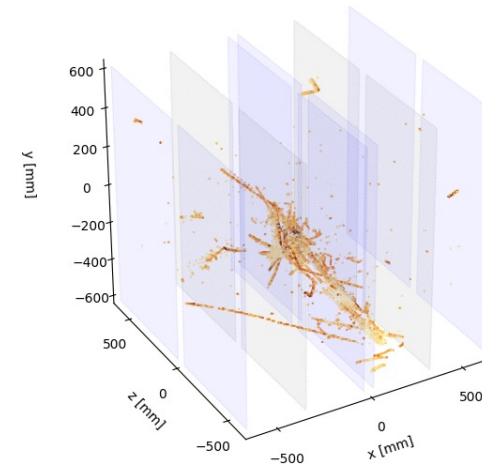
- A Near Detector is critical to starting oscillation physics in DUNE
- DUNE Near Detector steadily moving towards final designs and a Technical Design Report (TDR) is in preparation
- DUNE Cold lab (aka Material Assembly Test Facility or MATF) at Fermilab progressing well and received the first test equipment



# ND-LAr “2x2” Demonstrator at Fermilab

- **Run 1:** 4.5 days of NuMI data in 2024
  - Submitted operations paper to JINST <https://arxiv.org/abs/2509.07012>
- **Run 2:** non-beam run Oct. – Dec. 2025. 3 types of source calibrations deployed along with other improvements (e.g., cryogenics)
- **Run 3:** Preparing for a NuMI neutrino beam run in fall 2026 (*anticipating ~20 weeks of beam time*)

Event 20, ID 20 - 2024-07-08 00:20:14 UTC



# DUNE Publications

- DUNE is actively publishing on physics, software and technical topics, both collaboration-wide papers and small-author technical papers
- About 150 conference proceedings by DUNE so far

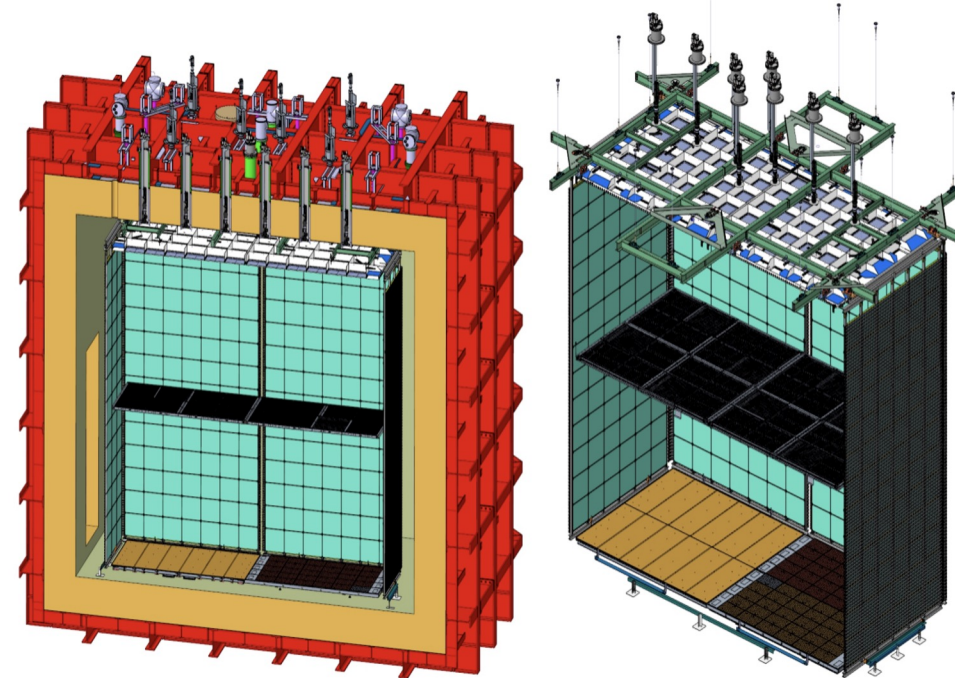
Topic	Published	Under Review
Physics	12	4
Detector	9	2
Simulation & Reconstruction	8	3
Design reports & White Papers	14	-
Other	1	-
<b>FULL-AUTHOR PAPERS</b>	<b>44</b>	<b>9</b>
Small-author technical papers	53	-

***About 100 papers  
published and 9  
in review!***

# Charting a Path for Phase-II

(See backup for more details)

- Considering several technologies that meet DUNE's core physics goals while expanding physics reach
  - Argon gas near detector (ND-GAr)
  - Optimized Light/Charge Readout for FD
  - Non-Argon FD Option (THEIA)
  - Improved Background Mitigation
- Active R&D and prototyping underway  
(*global collaborations including ECFA DRDs and APS CPAD RDCs*)
- An ProtoDUNE-III proposal has been submitted to CERN to test a subset of these technologies – currently under review by CERN



DUNE Phase-II White Paper  
[JINST 19 P12005 \(2024\)](#)

Neutron Antineutron Transition Search at DUNE	Kaiwen Yu
Photon Detection System Calibration for DUNE	Denis Torres
Preparing for the DUNE Far Detector activities with ProtoDUNE at CERN	Dario Pullia
Data-Driven Precision Charge–Light Matching	Yuxuan (Billy) Wang
Probing BSM Oscillatory Signals with the DUNE Detectors and the LBNF Neutrino Beam: NSI and Sterile Neutrino Sensitivities	Luiz Ricardo Prais
MIP dQ/dx Calibration in DUNE ND-LAr Prototypes with Pixelated Charge Readout	Luis Zazueta
Data-Driven Correlated Noise Simulation for the ICEBERG LArTPC	Avik Ghosh
Charge Readout Planes for the First DUNE Far Detector	Tyler D. Stokes
AskDUNE: Connecting Documentation, Automation, and HPC Workflows for DUNE	Aleena Rafique
NDLAr-2x2 Antineutrino studies with Charged Hadrons in Final States	Muhammad Bilal Azam
Run2 Results from DUNE ND-LAr 2x2 Demonstrator	Luis Mora-Lepin
Event Selections at the DUNE Near Detector Complex	Eva Sabater
R&D of Power Over Fiber in harsh environments and its novel application for the DUNE Photon Detection System	David Martinez
Using Stopping Cosmic Muons for Calibrations at DUNE	Alexandra Moor
Studying MeV Scale Neutron Interactions in DUNE 2x2	Edgar (Enda) Mao
GPU-Accelerated Forward Simulation and Signal Unfolding for DUNE ND-LAr	Yousen Zhang
Improved Supernova Pointing for DUNE	Geting Qin
ProtoDUNE-VD for BSM Searches: First Studies and Future Prospects	Biao Wang
AI/ML-based Real-time Anomaly Detection in DUNE for Supernova Burst Neutrinos	Sunny Seo
Advancing Detector R&D for High-Pressure Gaseous Argon TPCs in Precision Neutrino Physics	Brenna McConnell
Electric Field Non-Uniformity Mapping for DUNE ND-LAr 2x2 Demonstrator and Full Scale Demonstrator	AJ Nielsen
A Detector Systematics Model for Atmospheric Neutrino Analysis in DUNE	Claire Dalmazzone
Improving ProtoDUNE pion cross-section measurements with NuGraph Michel-electron tagging	Soamasina Herilala Razafinime
Track Matching using Graph Neural Networks Across DUNE's Near Detectors	Jessie Micallef
Liquid Argon Purity Monitoring for DUNE	Alejandro Yankelevich
The cathode system performance of the DUNE VD PDS System	Mariya Mollova
Induced Magnetic Fields in LBNF Horns and DUNE-PRISM Predictions	Yuri Bae
Design of a Shielding Plane for LArPix	Jiangmei Yang
Production Strategy for Cryogenic Readout Electronics in the Deep Underground Neutrino Experiment	lingyun ke
DetSuM: an uncertainty-aware surrogate model to reduce computing load	Linyan Wan
Robotic Testing System Automation for DUNE Cold-Electronics ASIC Quality Control	Natalie Tianai Ma
Astrophysical neutrino searches with the DUNE experiment	Amanda Weinstein
Scalable Low-Energy Event Reconstruction in DUNE Using NuGraph and Inference-as-a-Service	Meghna Bhattacharya
A Transformer-Based Convolutional Visual Network for Neutrino Event and Final-State Particle Identification in DUNE	Zhengyang Chen
A Magnetised High-Pressure Gaseous Argon TPC for the DUNE Near Detector	Francisco Martinez Lopez
A straw tube tracker for the DUNE ND	Nibir Talukdar

# DUNE @ This Meeting

- In addition to this talk, DUNE will be a key topic in several overview talks (e.g., Neutrino interactions, AI/ML, BSM physics, Future outlook etc.)
- A total of **38 dedicated DUNE posters** – *a poster on almost every topic!*

# Closing Remarks

- DUNE is making steady progress across all fronts
- Far detector technologies successfully validated by ProtoDUNEs at CERN
- Assembly of the first far detector cryostat at SURF to begin soon
- First data at the Far site in early 2030
- ND is moving rapidly towards final design with the start of pre-production in 2027
- Goal of first MW-scale beam to DUNE in 2031
- Active R&D ongoing globally for Phase-II – a ProtoDUNE-III run planned at CERN

***With the launch of installation at the Far Site, DUNE have officially transitioned from planning to execution!***

*DUNE Collaboration Meeting, Rapid City, SD  
May 18-21, 2026*



# Thank you!

# EXTRAS

# DUNE Remains a Priority in ESPPU 2026 Update

The 2026 ESPPU report was released earlier this year and emphasized the importance of Neutrino Physics to maintain a broader and diverse research portfolio. The report called out that LBNF/DUNE remains a priority for CERN.

*"The global neutrino programme has made significant advances towards the determination of neutrino masses and leptonic mixing, and the construction of the next generation of accelerator-based neutrino experiments is progressing rapidly. The CERN Neutrino Platform is a focal point of European participation in the global long-baseline neutrino programme. **In particular, the current commitments to the LBNF/DUNE project have been decisive and remain a priority for CERN.**"*

<https://cds.cern.ch/record/2950671/files/CERN-ESU-2025-002.pdf>



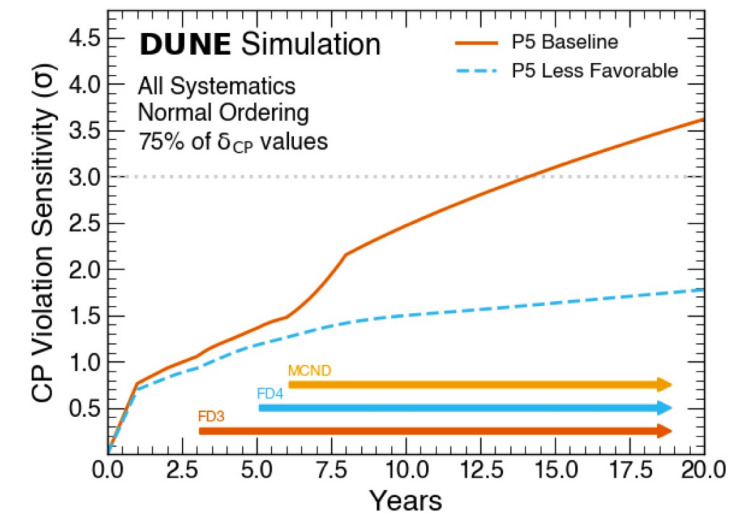
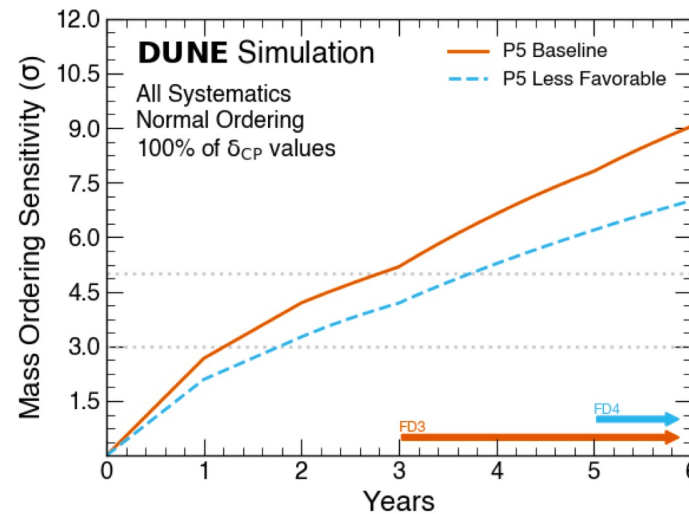
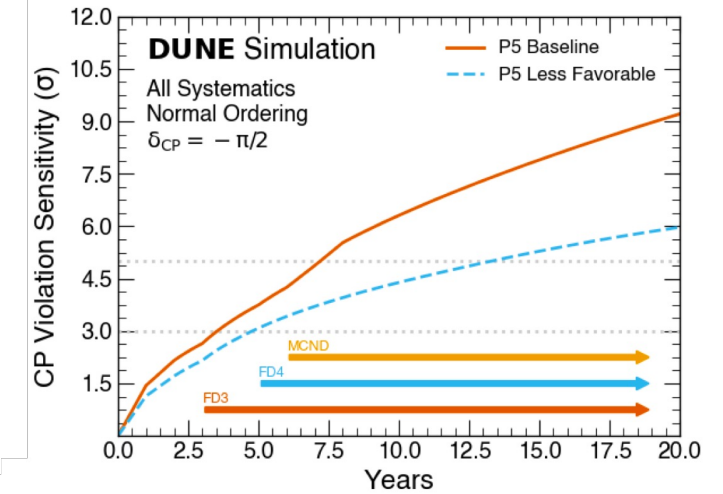
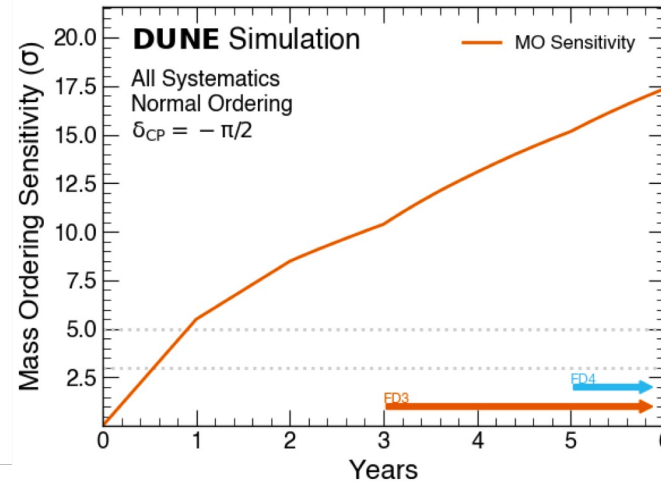
# DUNE Oscillation Sensitivities

For *best-case* oscillation scenarios,

- DUNE has  $>5\sigma$  MO sensitivity in 1 year
- $>3\sigma$  CPV sensitivity in 3.5 years

For *worst-case* oscillation scenarios,

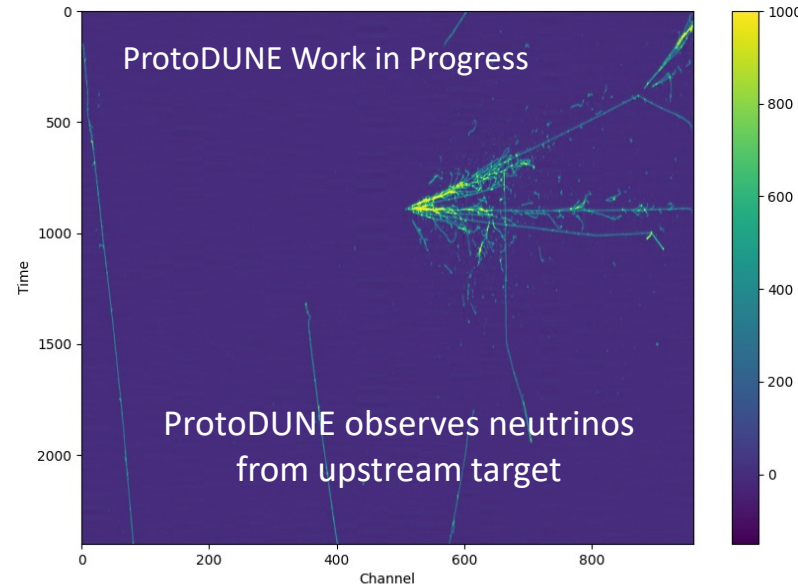
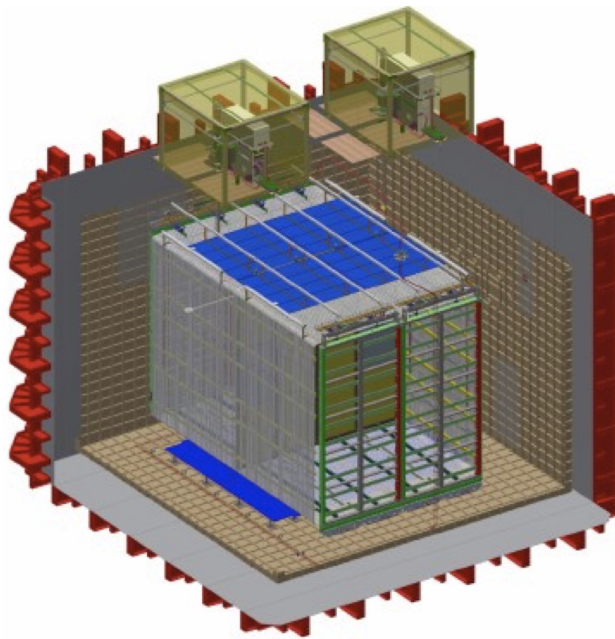
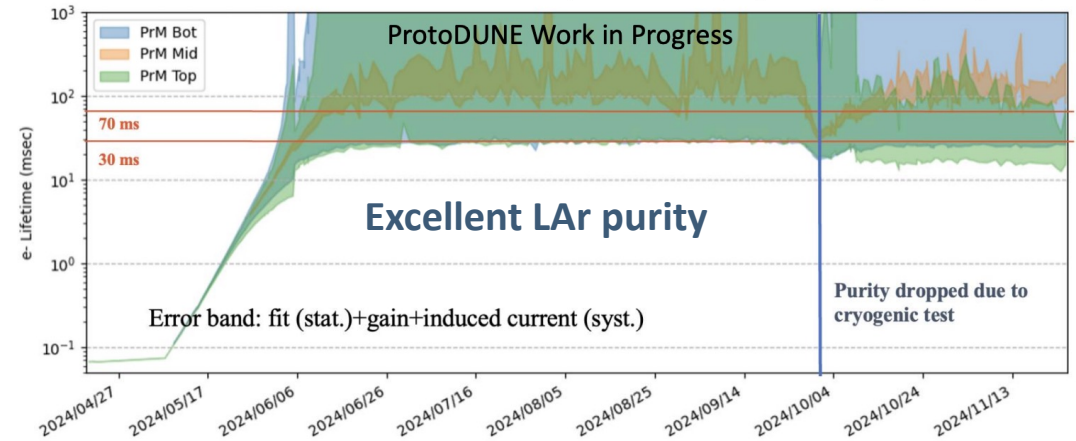
- DUNE has  $>5\sigma$  MO sensitivity in 3 years
- In long term, DUNE can establish CPV over 75% of  $\delta_{CP}$  values at  $>3\sigma$



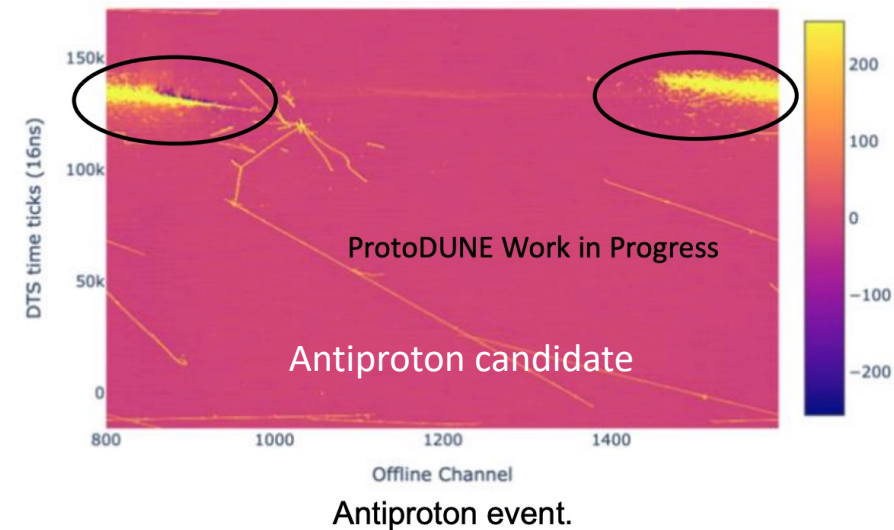
Eur. Phys. J. C 80, 978 (2020)

# ProtoDUNE-HD Highlights

- ProtoDUNE-HD (Phase-II) tested FD-HD final designs and new calibration systems, took data in 2024 (23M triggers collected) – **excellent overall performance**
- Several papers in preparation: detector performance papers, reconstruction, calibration, observation of neutrino events from upstream target etc.

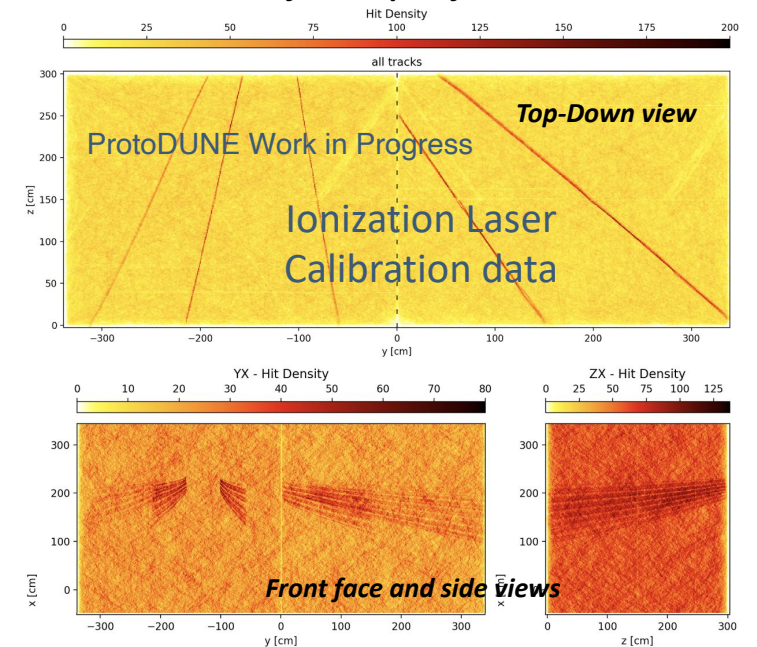
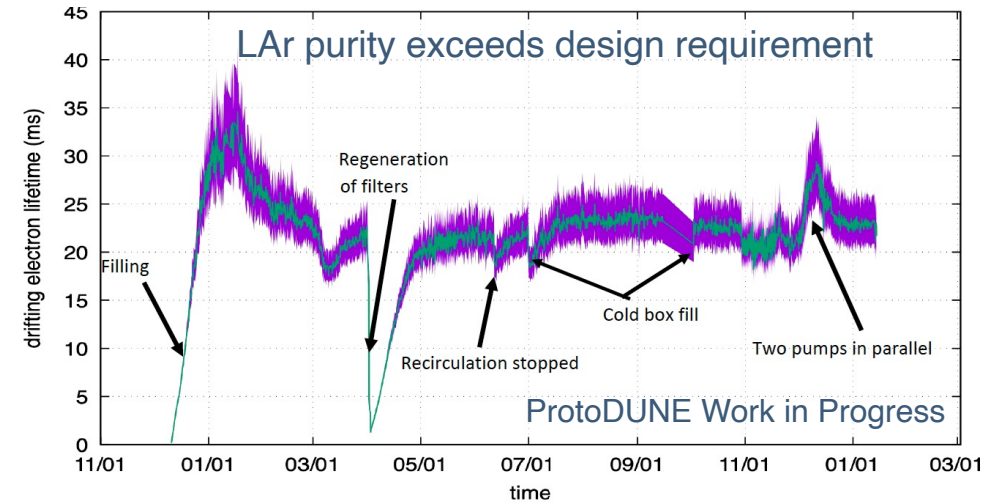
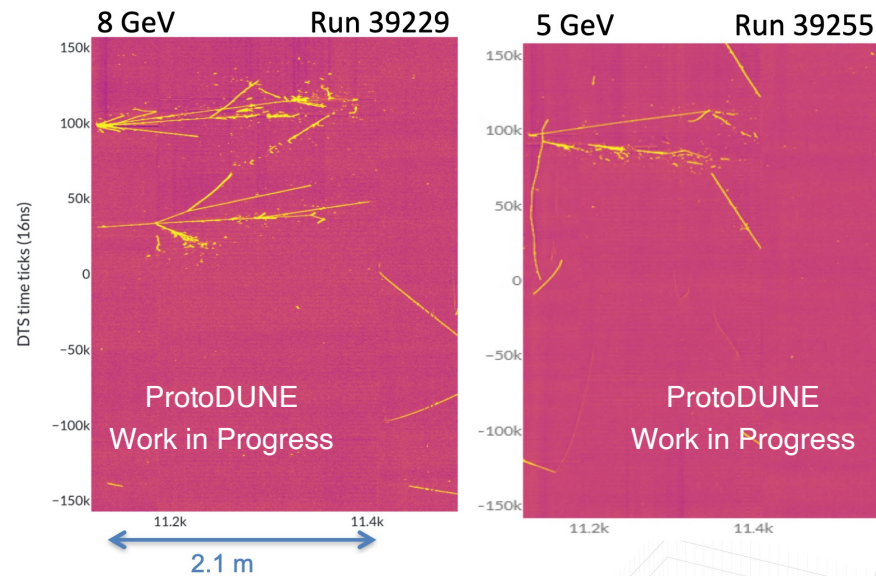
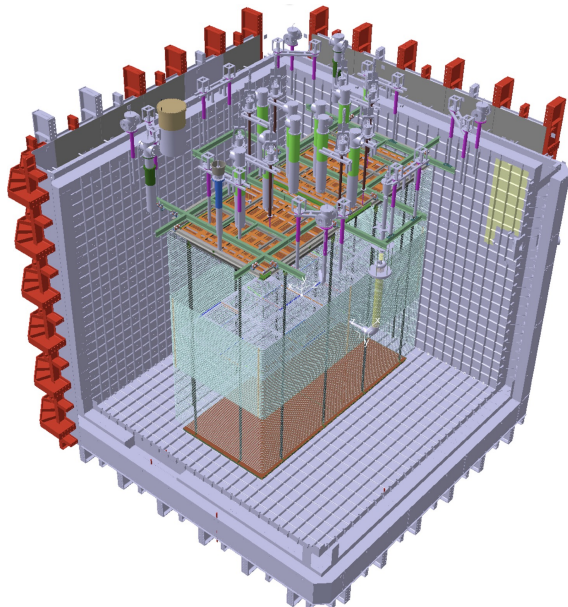


Run 28836, Trigger 50648, APA1 Plane 1  
Trigger Type (CTBBBeamChkvHxLx), 2024-08-22 08:24:33+02:00 (CERN)

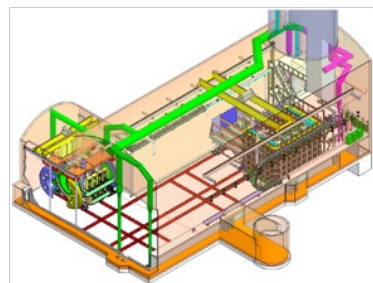


# ProtoDUNE-VD Highlights

- **Beam run: 5 weeks (July-Sept 2025)** with > 4M events recorded at different energies
- **Post-beam operations ongoing:** High Voltage stress tests, Xe doping, neutron source calibration etc. Will continue into summer
- Data analyses ongoing

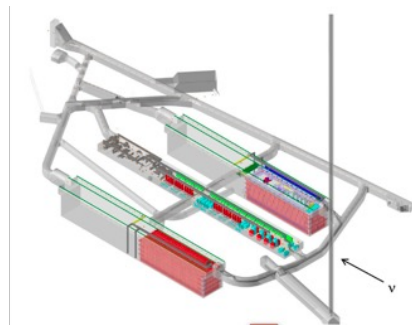


# DUNE will be Built in Two Phases

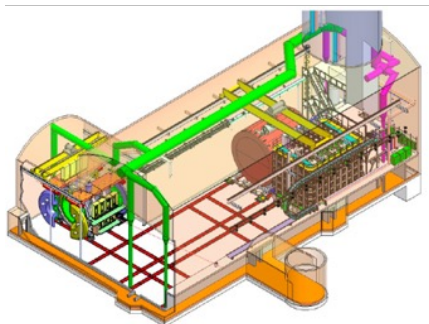


Phase-I

- **FD:** 2 x 17 kt LArTPCs
- **ND:** LArTPC + Muon Spectrometer (with PRISM) + On-axis Beam Monitor
- **Beam:** 1.2 MW (PIP-II)

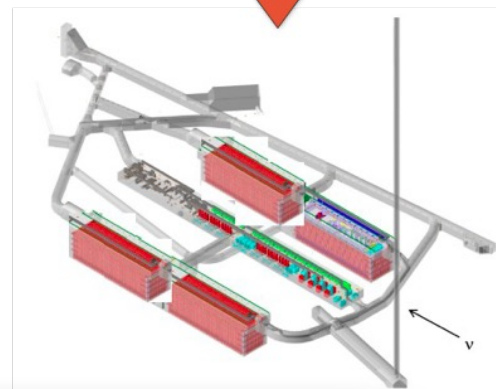


The dual facilities built by LBNF support both Phase-I and Phase-II scope



Phase-II

- **FD:** 2 additional modules (total = 4 x 17 kt LArTPCs)
- **ND:** LArTPC + GArTPC (with PRISM) + On-axis Beam Monitor
- **Beam:** > 2MW beam



*We are well on our way to executing Phase-I!*

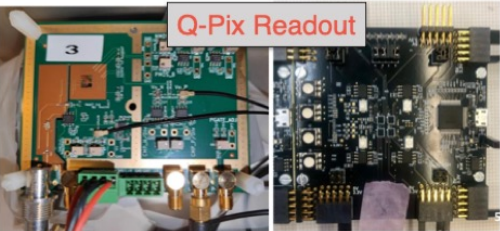
Parameter	Phase I	Phase II	Impact
FD mass	2 FD modules (20 kt fiducial)	4 FD modules (40 kt fiducial LAr equivalent)	FD statistics
Beam power	1.2 MW	Up to 2.3 MW	FD statistics
ND configuration	ND-LAr+TMS, SAND	ND-LAr, ND-GAr, SAND	Systematics

# Charting a Path for Phase-II

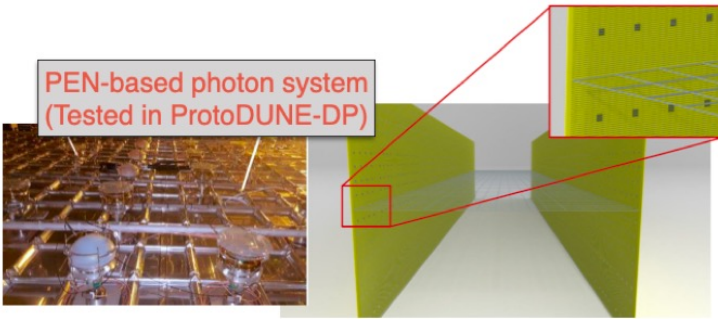
- Active prototyping for Phase-II technologies (ton-scale and above) underway around the world (e.g., US, Europe, Brazil, CERN etc.)
- The R&D underpinning the Phase-II concepts is done as part of a global program which includes the *European Committee for Future Accelerators (ECFA)* and the *Coordinating Panel for Advanced Detectors (CPAD)* in the United States



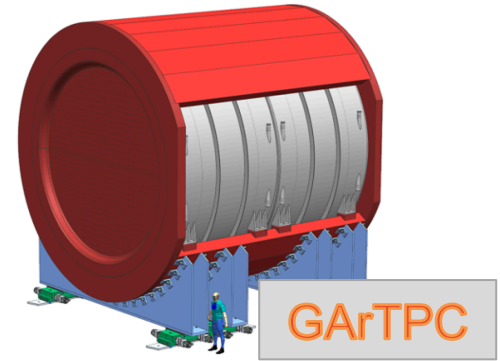
ARIADNE 1-ton Test @Liverpool



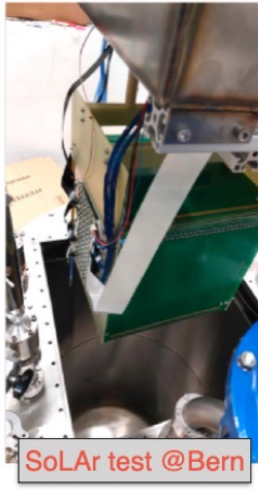
Q-Pix Readout



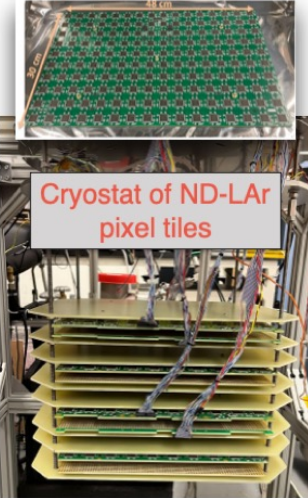
PEN-based photon system (Tested in ProtoDUNE-DP)



GArTPC



SoLAr test @Bern



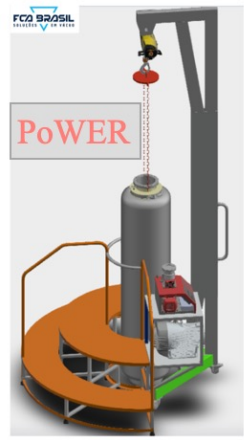
Cryostat of ND-LAr pixel tiles



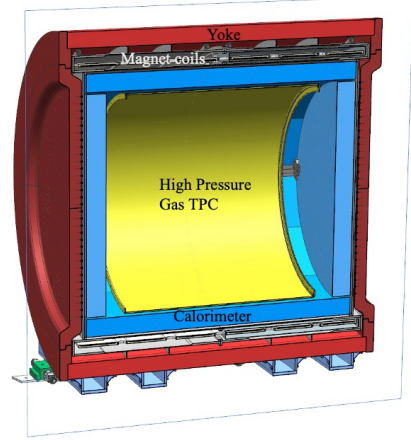
THEIA Demonstrator (EOS)



APEX 2-ton prototyping



PoWER



Yoke  
Magnet-coils  
High Pressure Gas TPC  
Calorimeter