DUNE: Status, Plans & Prospects



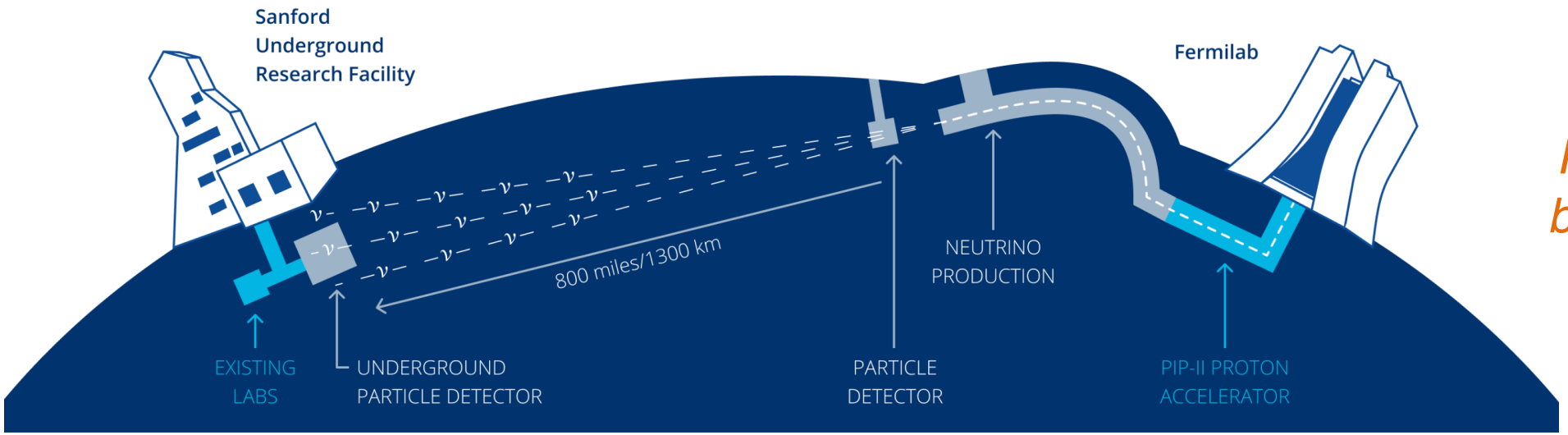
Sowjanya Gollapinni
DUNE Co-Spokesperson
(For the DUNE Collaboration)
Los Alamos National Laboratory

DUNE Focus Session
KPS 2026 Fall Meeting
Jeju Island, South Korea
October 23, 2026

Los Alamos NATIONAL LABORATORY

DUNE

DUNE in a Nutshell



Installation has begun at the far site!

LBNF: Long Baseline Neutrino Facility

The Science (DUNE)

- Charge-Parity Violation 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

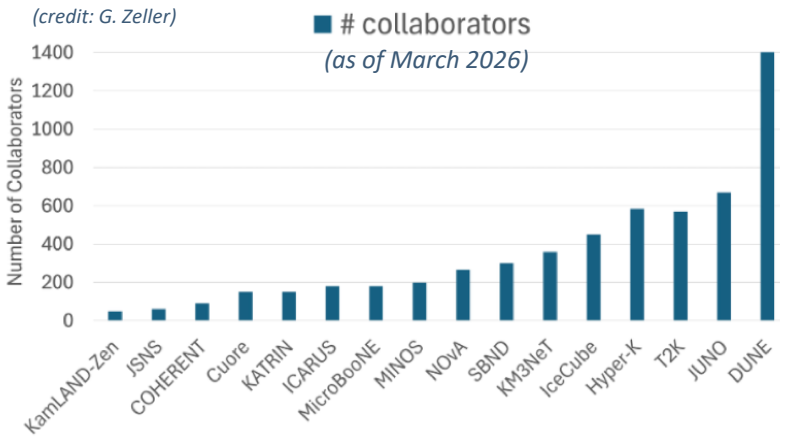
DUNE will be built in two phases (DUNE Phase-I and Phase-II)

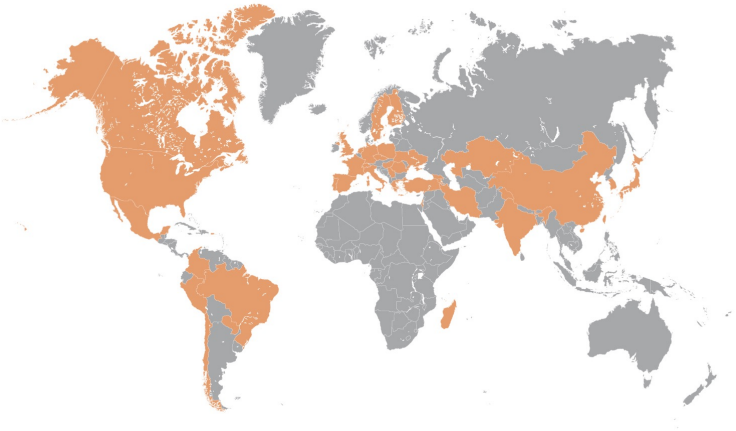
The Facility (LBNF)

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

Los Alamos NATIONAL LABORATORY DUNE

DUNE is the Largest Neutrino Collaboration in History







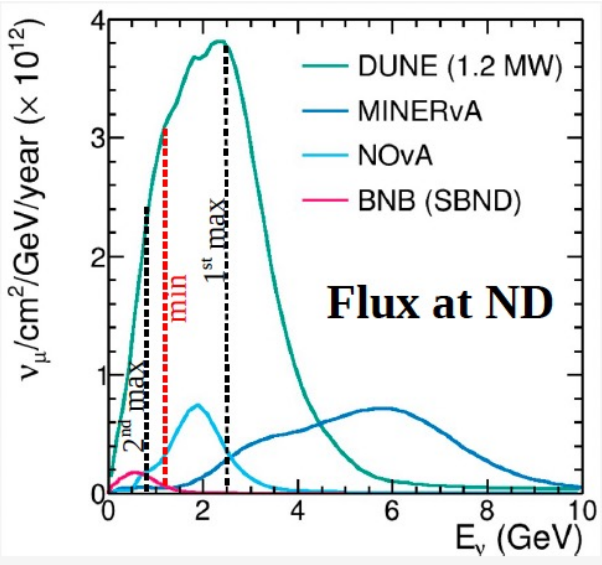
Sowjanya Gollapinni David Newbold

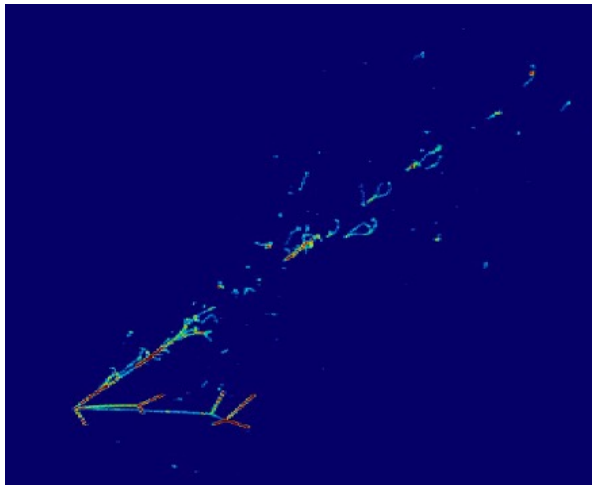


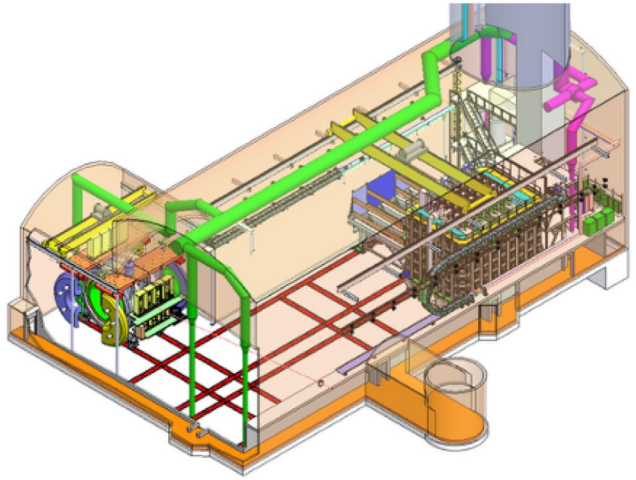
*More than **1500 collaborators** from **220+ institutes** in **37 countries** and CERN*

Roughly half of the collaboration is students/postdocs

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





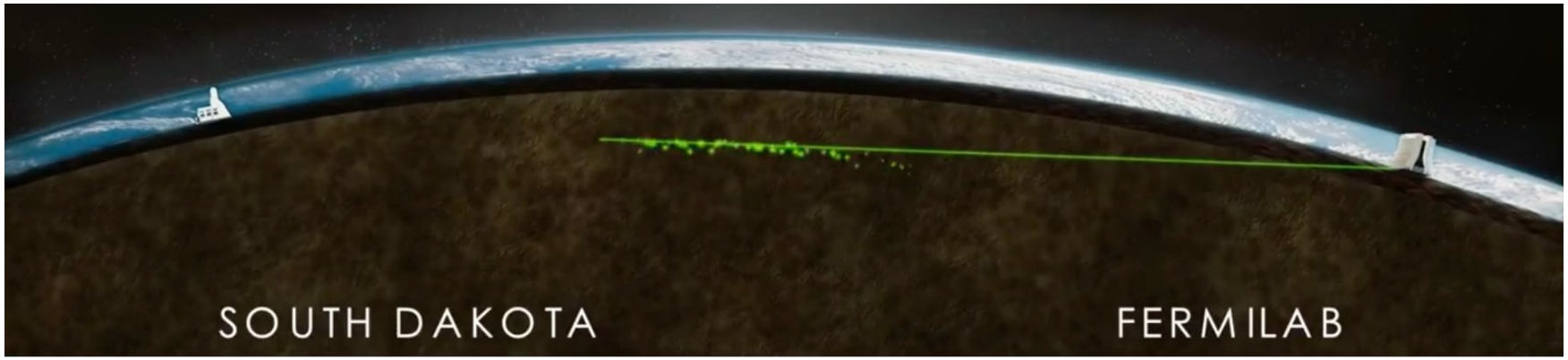


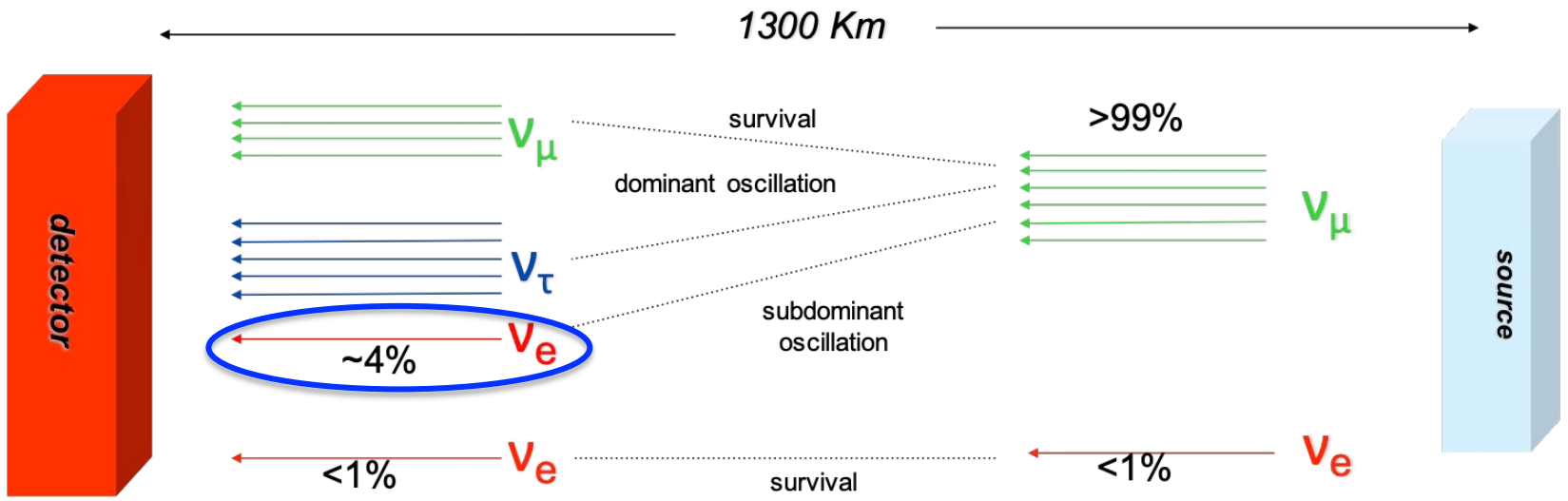
Strongly complimentary to other experiments

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

For most recent results on DUNE, see the DUNE plenary talk at Neutrino 2026 conference:
https://indico.global/event/15740/contributions/155589/attachments/72630/140788/Neutrino2026-DUNE-June2026-v2.pdf

DUNE Oscillations



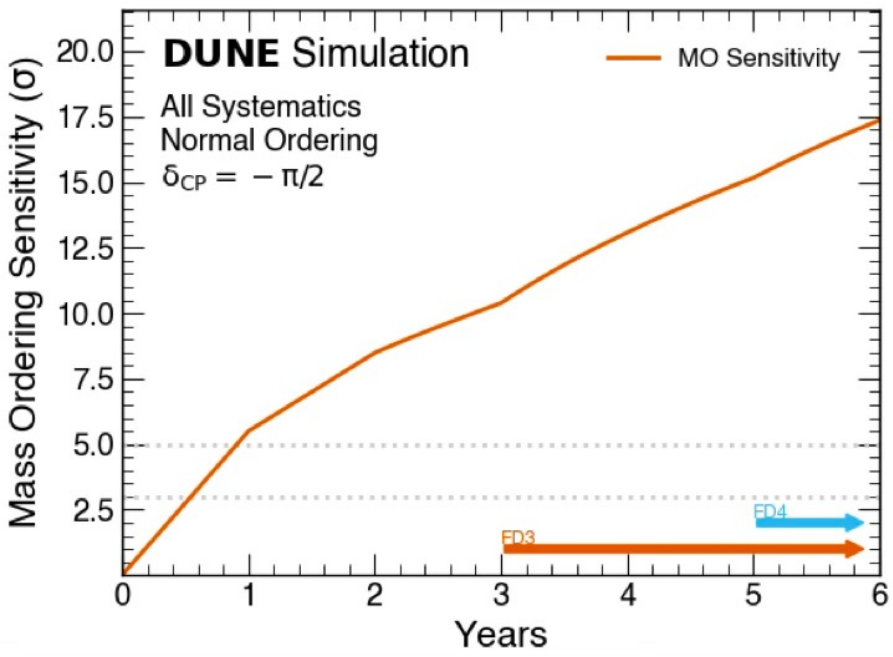


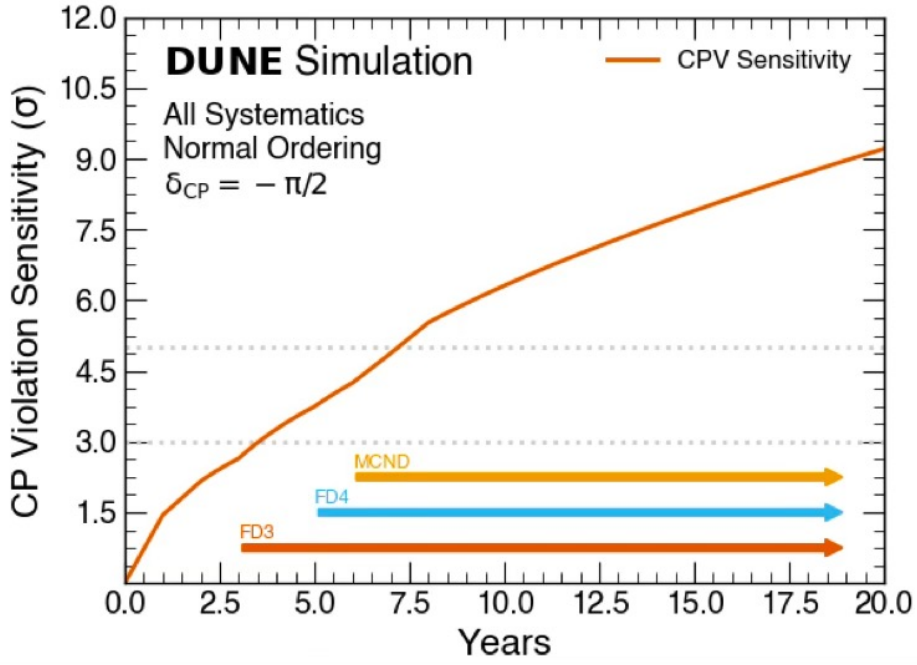
Mass Ordering & CP Violation Sensitivity *(if Nature is Kind)*

For *best-case* oscillation scenarios, DUNE reaches

- >5σ MO sensitivity in 1 year
- >3σ CPV sensitivity in 3.5 years

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



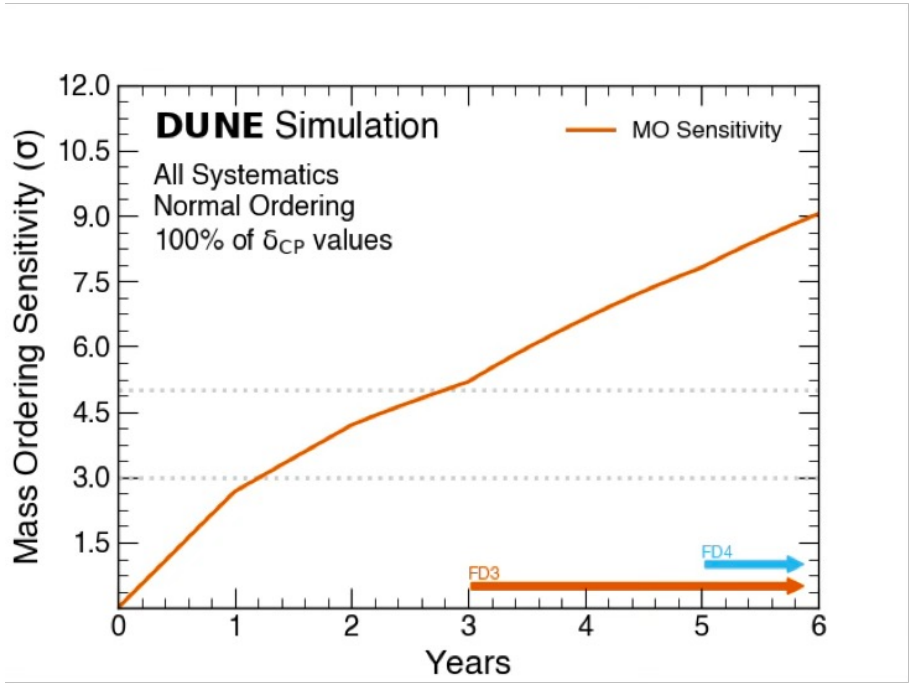


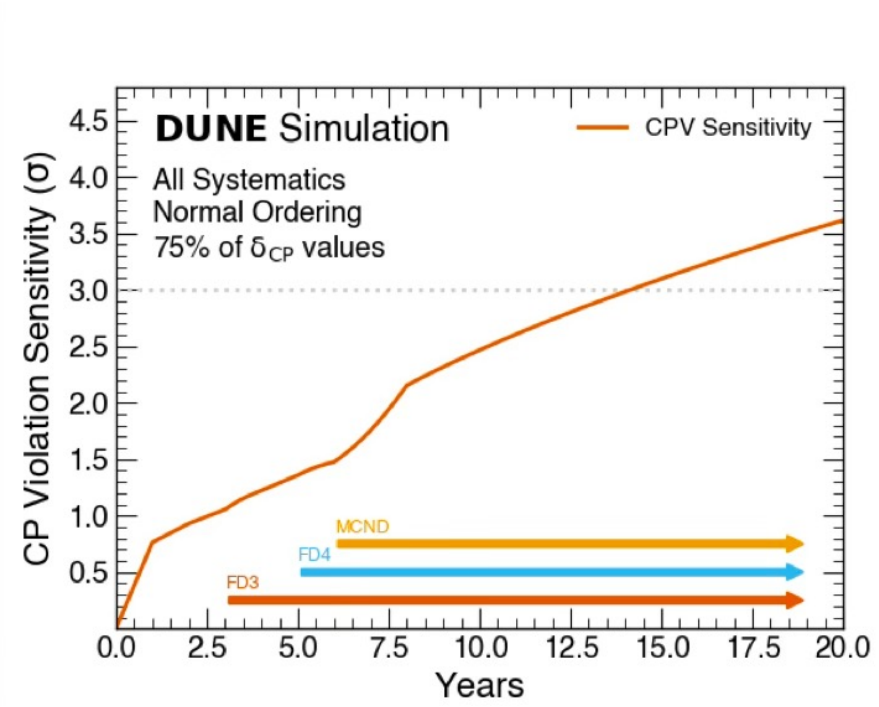
Mass Ordering & CP Violation Sensitivity *(if Nature is Unkind)*

For *worst-case* oscillation scenarios, DUNE reaches

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

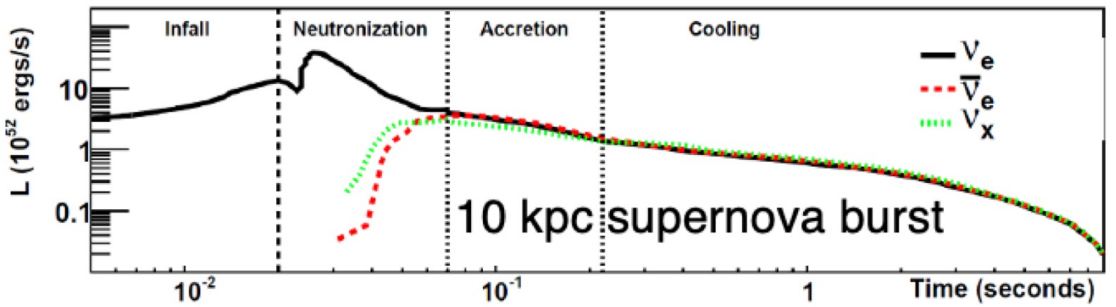
Eur. Phys. J. C 80, 978 (2020)

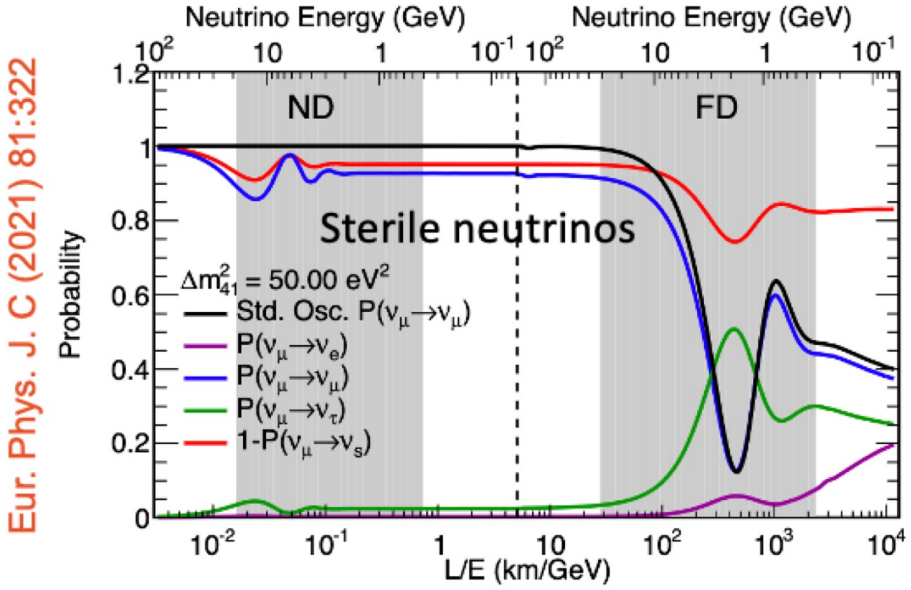




Beyond Oscillation Physics: Supernova, Solar and New Physics

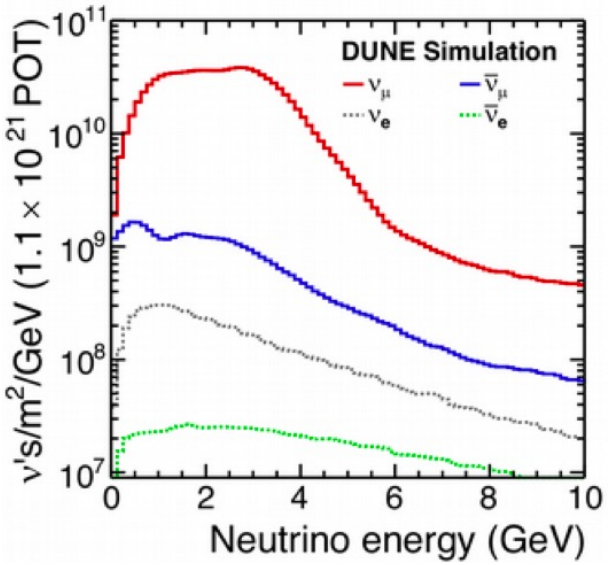
- Supernova flux includes ν_e, anti-ν_e, and other flavors (ν_x), DUNE is uniquely sensitive to ν_e due to Argon target and reach extends beyond the Milky Way with additional modules
- DUNE has broad BSM program with ND and FD with New physics in oscillations (e.g., sterile neutrinos, CPT violation) 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 in 2030

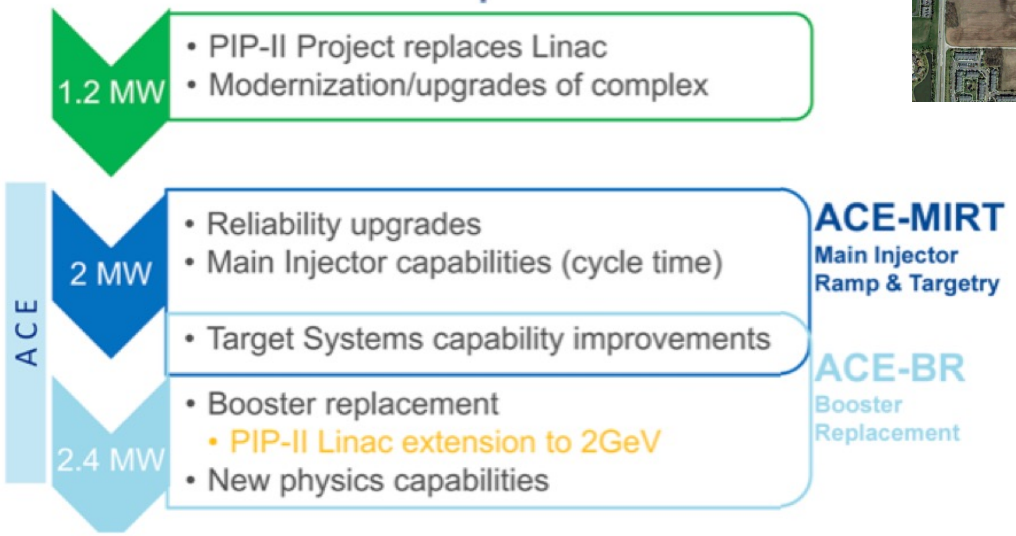


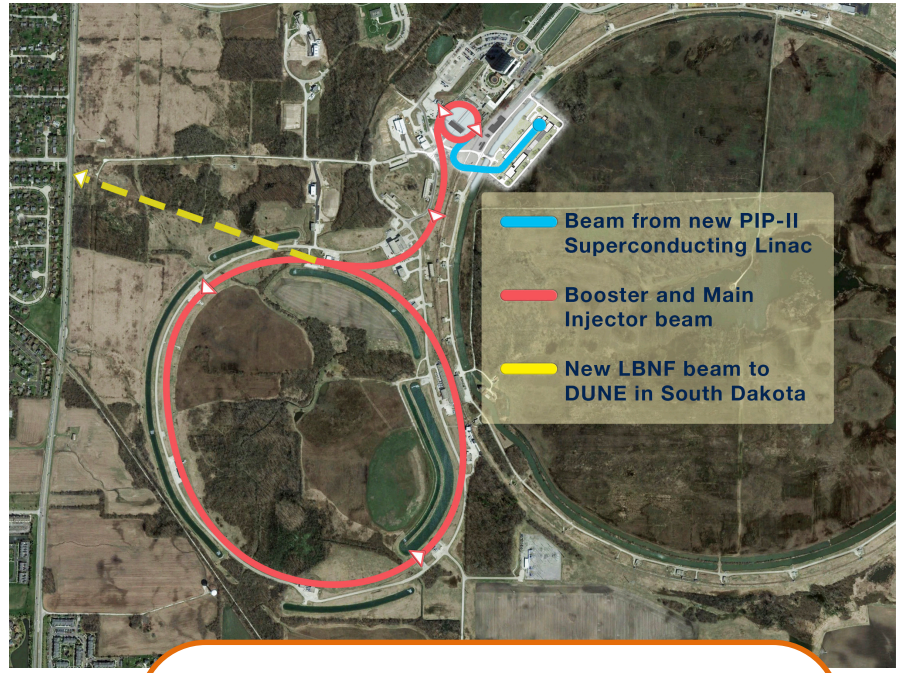


Beamline

- 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

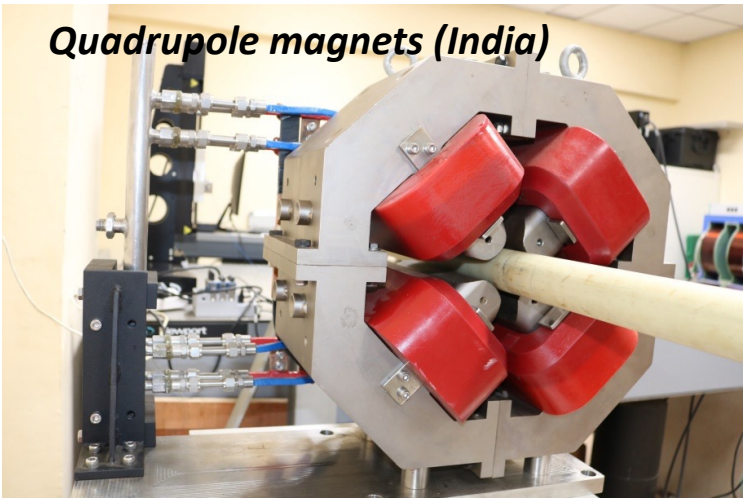
Beamline Status

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



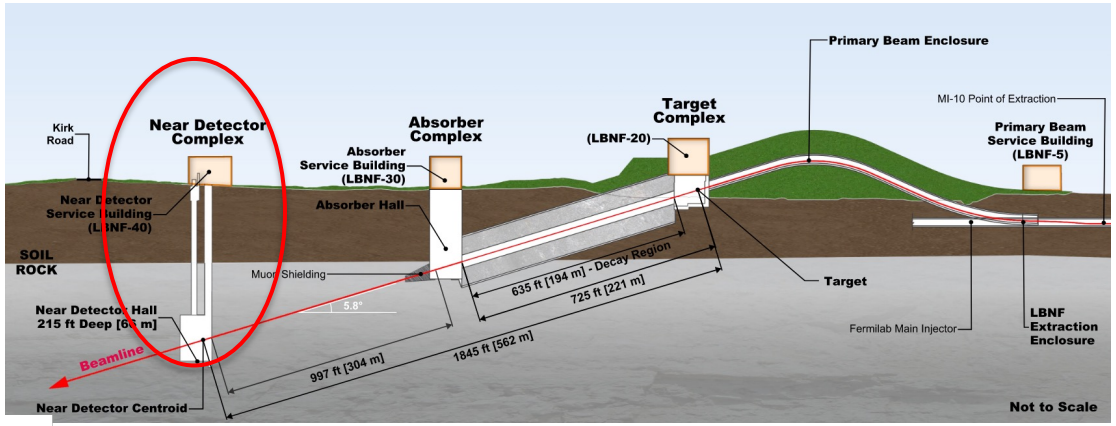




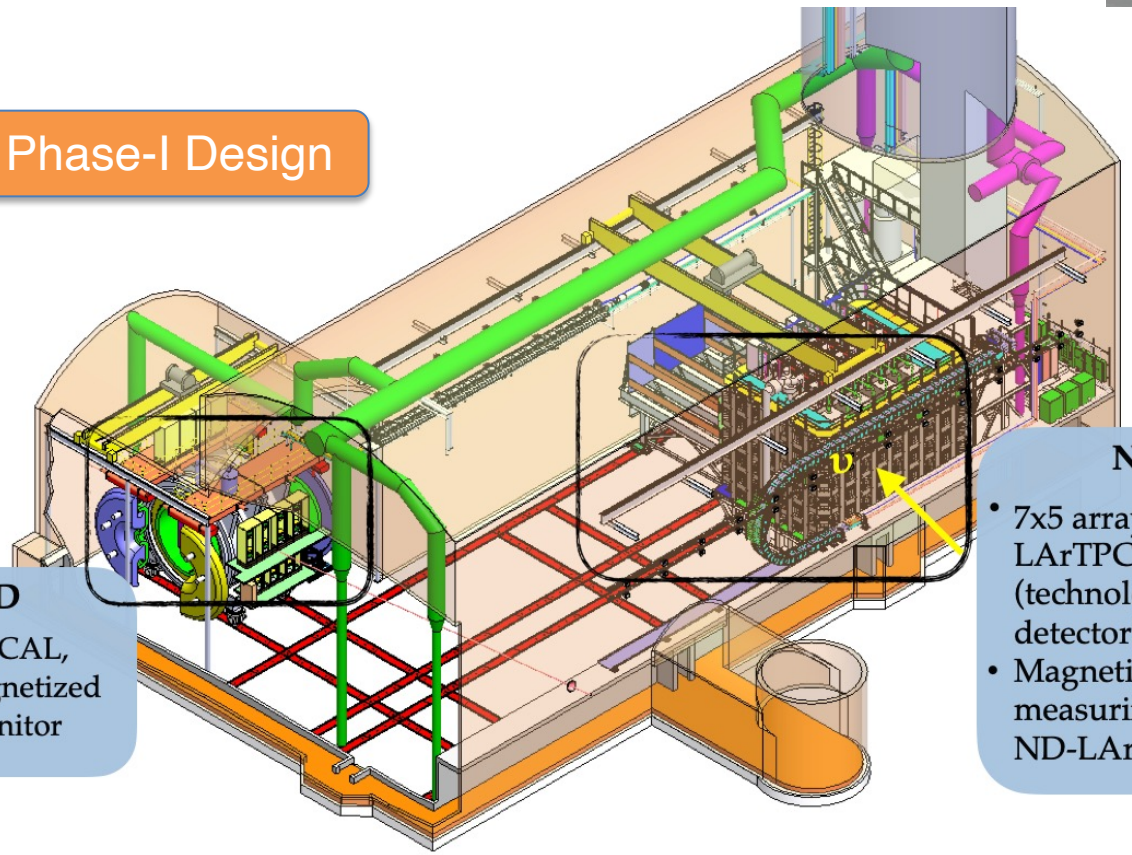


DUNE Near Detector

- 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

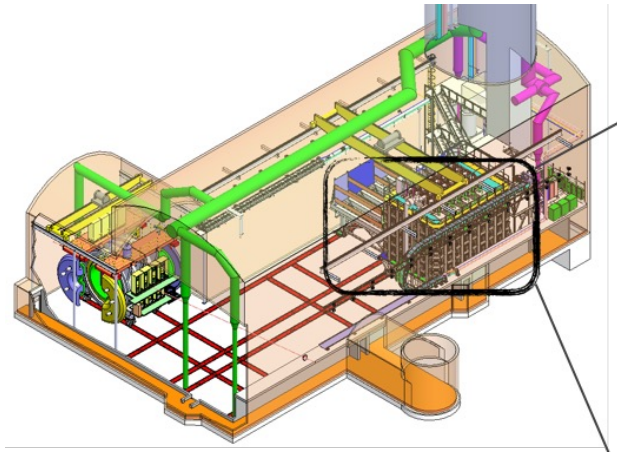
- 7x5 array of modular 1x1x3 m^3 LArTPCs with pixel readout (technology closest to far detector)
- Magnetized steel range stack for measuring muons that exit ND-LAr

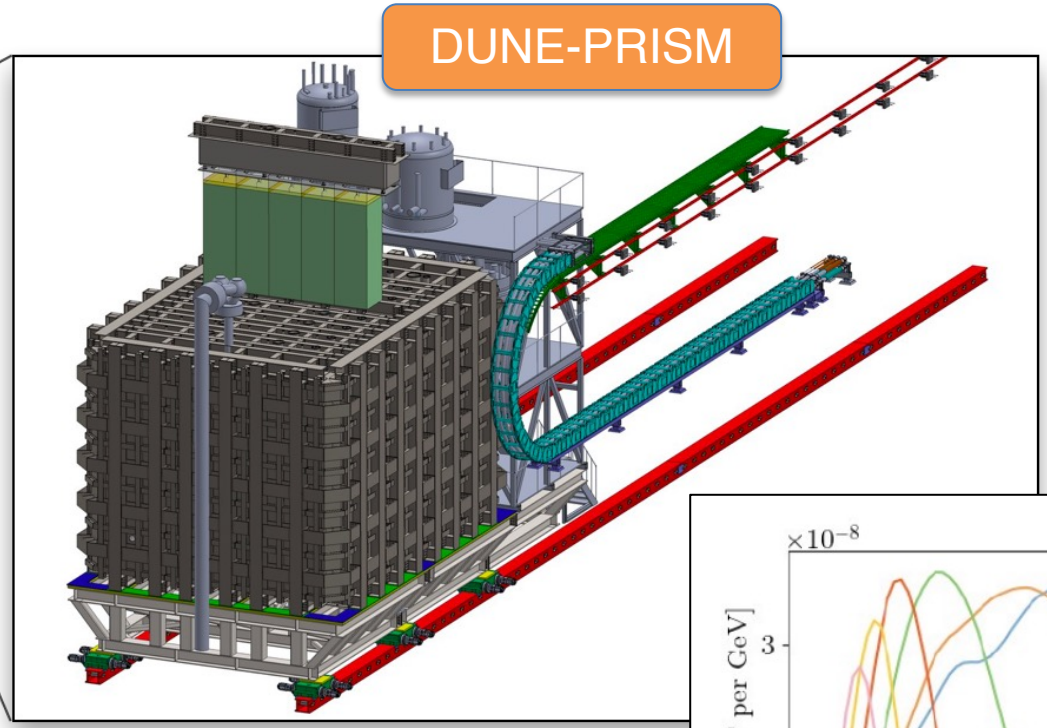
Primary Goals

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

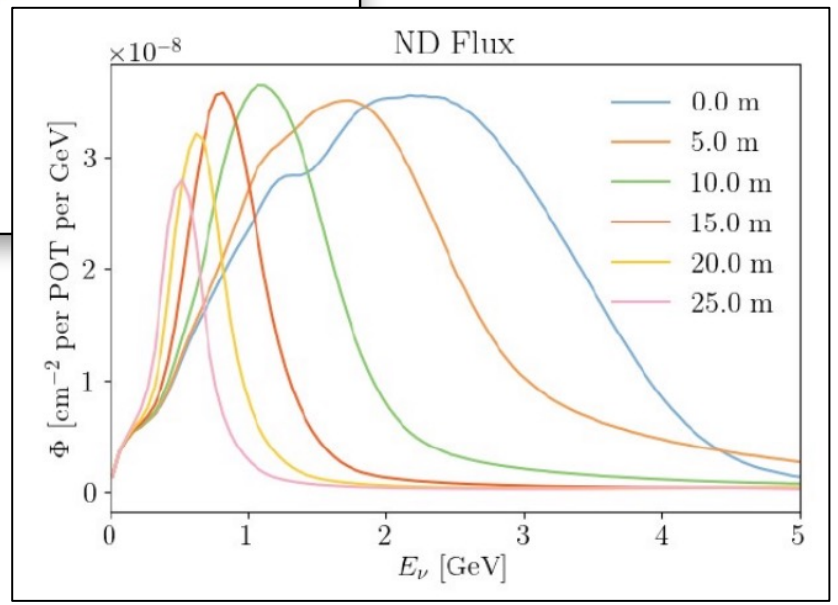
Near Detector will see about ~50 neutrino interactions per spill!

DUNE-PRISM





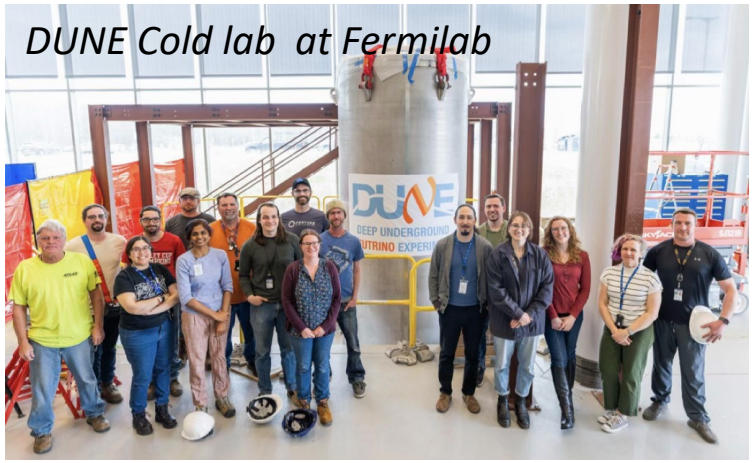
ND-LAr and TMS systems can move off-axis up to 28.5 m to observe varied beam spectra



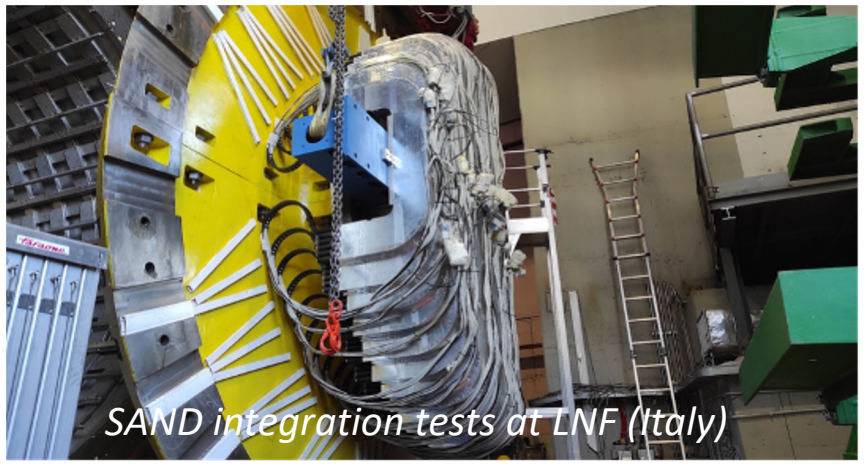
- ND flux changes with angle due to pion decay kinematics
- constrains energy dependence of neutrino cross sections; build oscillation analysis with minimal interaction modeling

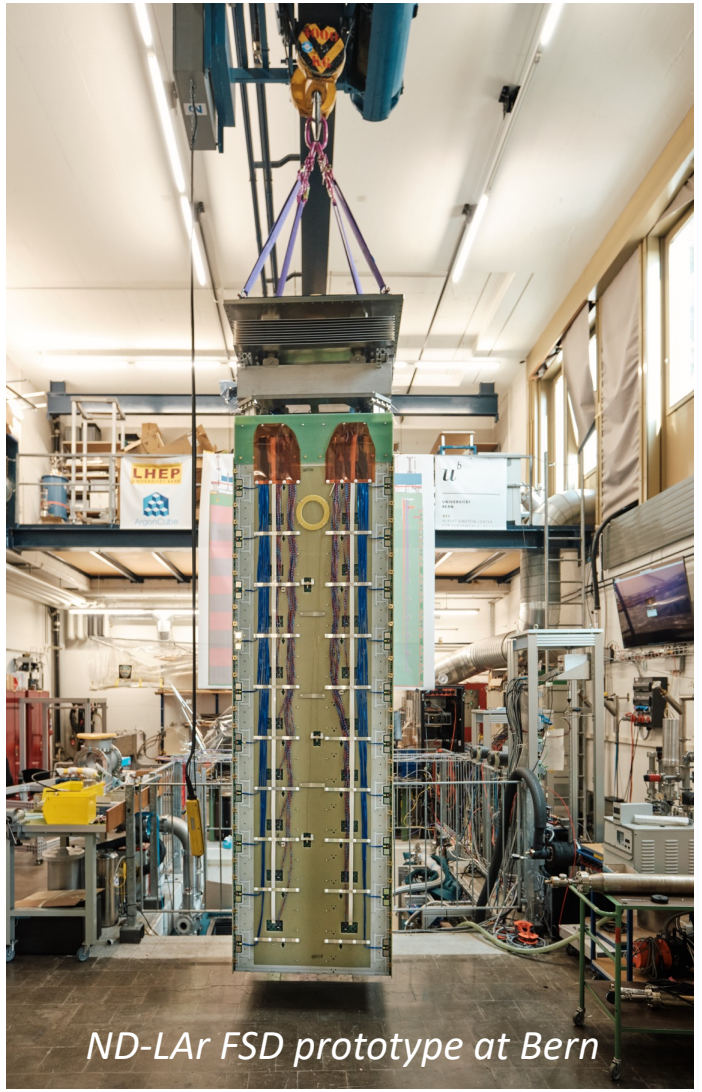
Near Detector Status

- 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



DUNE Cold lab at Fermilab

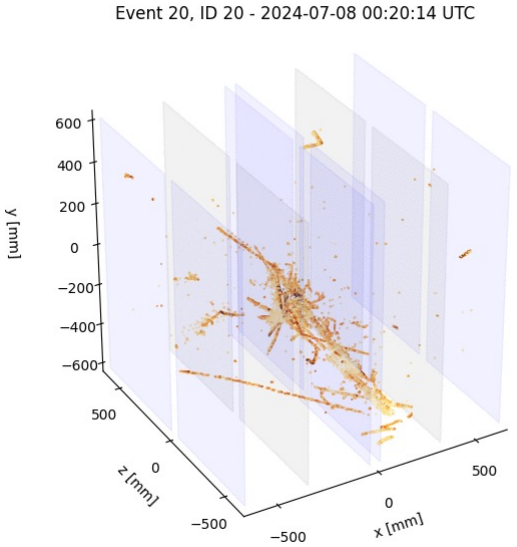

SAND integration tests at LNF (Italy)



ND-LAr FSD prototype at Bern

ND-LAr “2x2” Demonstrator at Fermilab

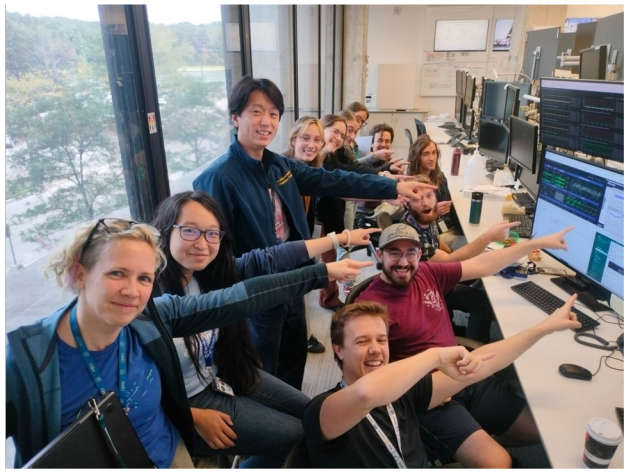
Instruments 8 (2024) 3, 41
(Neutrino events)

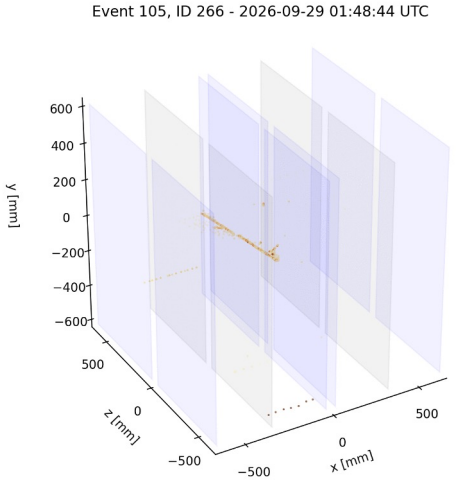


- **Run 1:** 4.5 days of NuMI data in 2024
  - Submitted operations paper to JINST https://arxiv.org/abs/2509.07012
- **Run 2:** cosmic runs, Oct. – Dec. 2025. 3 types of source calibrations deployed along with other improvements (e.g., cryogenics)
- **Run 3:** Preparations complete for the NuMI neutrino beam run starting this month *(~12 weeks of beam time and possibly more)*



ND-LAr “2x2” prototype

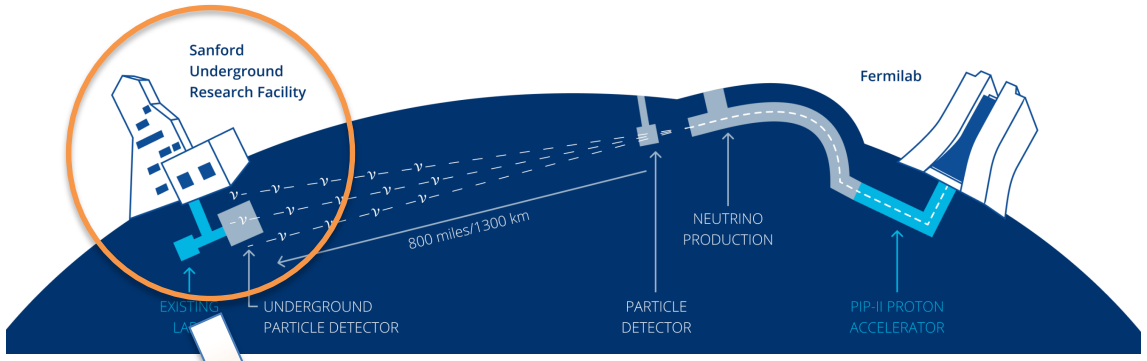


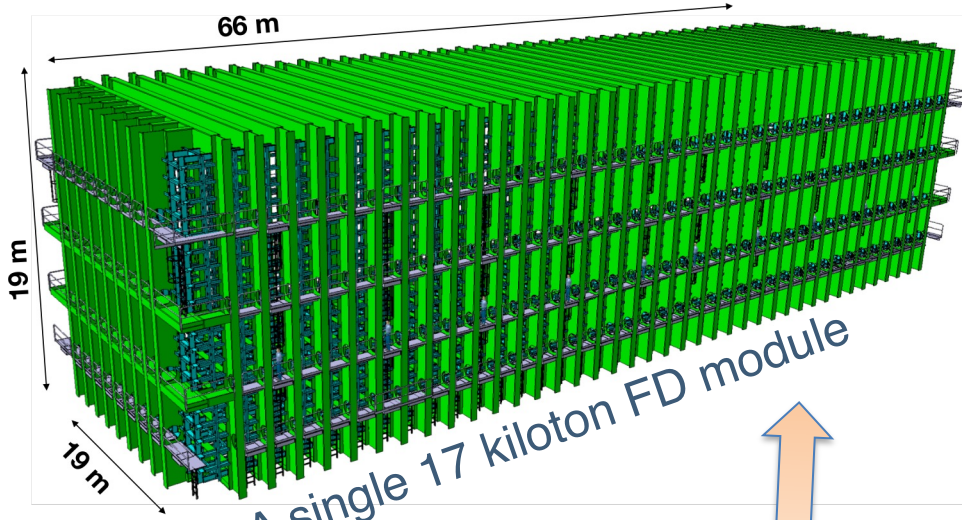


Cosmic events in 2026



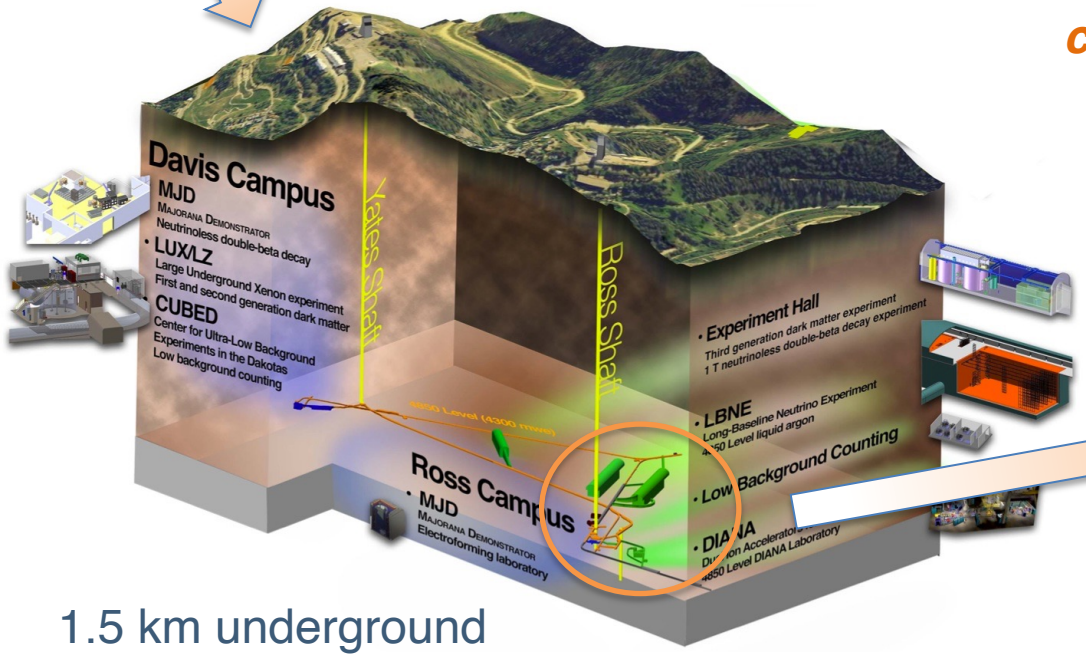
DUNE Far Site



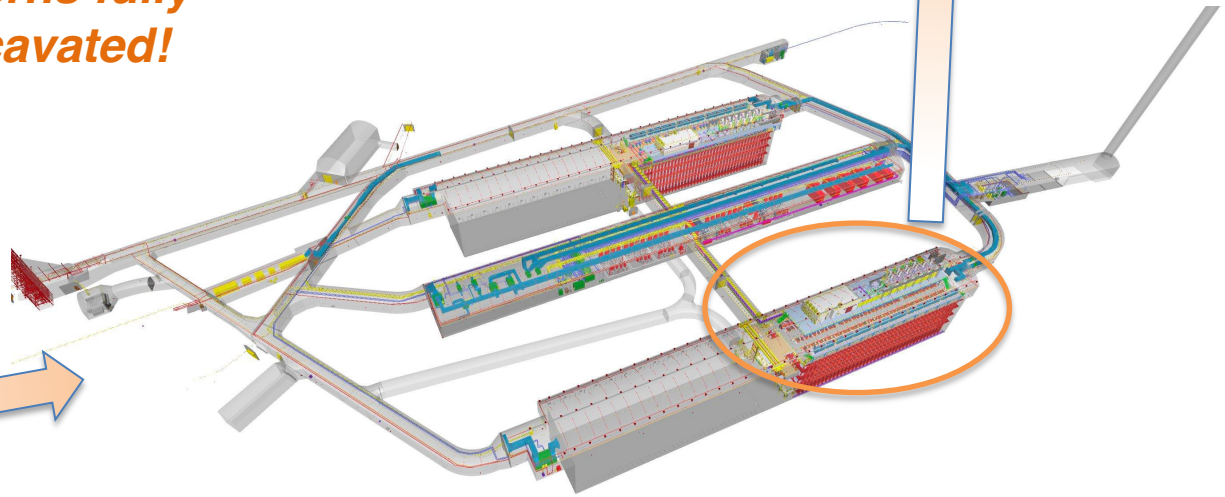


A single 17 kiloton FD module

Far Site caverns fully excavated!



1.5 km underground



3 caverns, 4 detectors

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DUNE

A Time Lapse: Empty Caverns to Fully Functional Labs



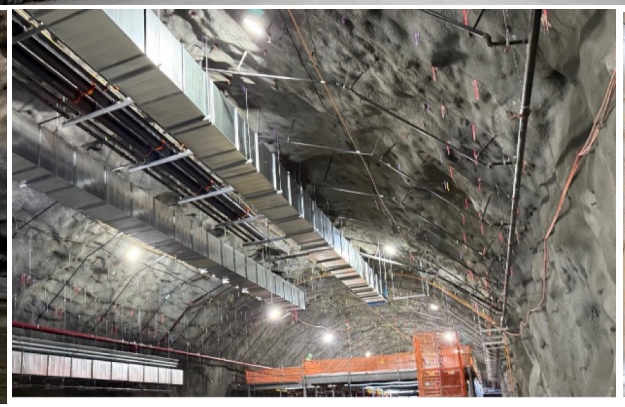






800,000 tons of rock crushed and removed!






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DUNE

Cavern Outfitting Complete







Tours, WIFI, and Espresso a mile underground!

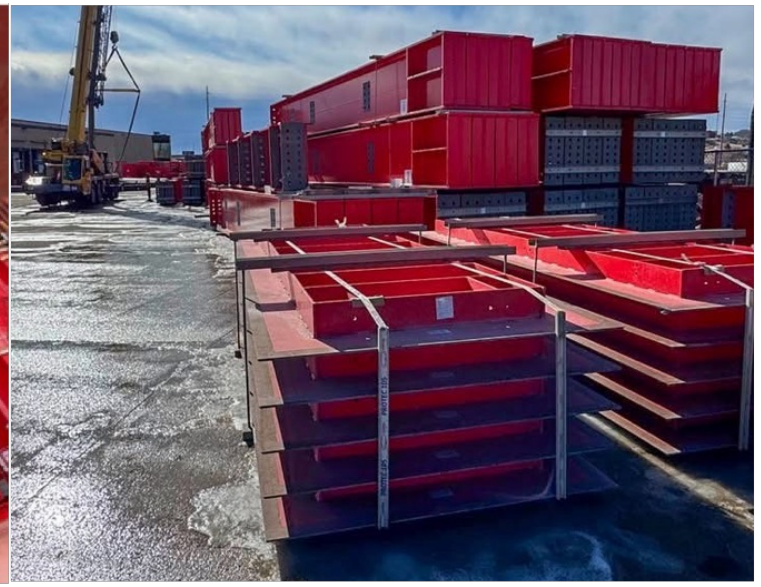


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DUNE

All Cryostat Material Arrived in South Dakota





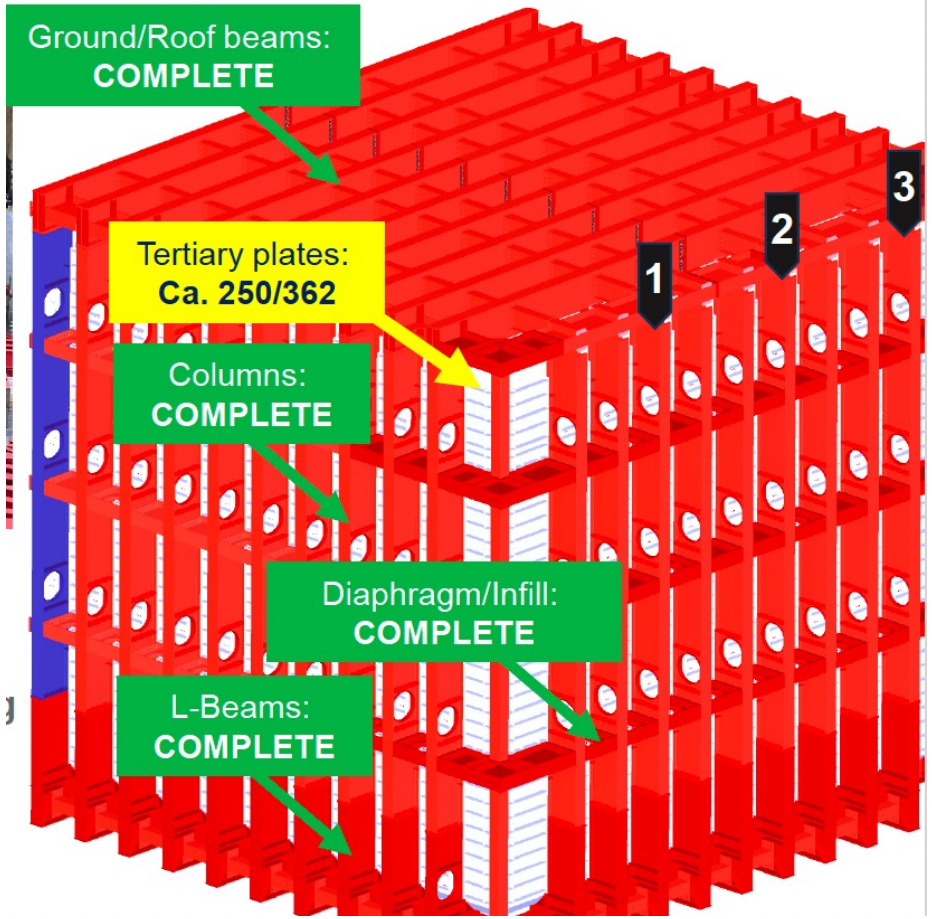




We are at the Cusp of Starting Cryostat Assembly

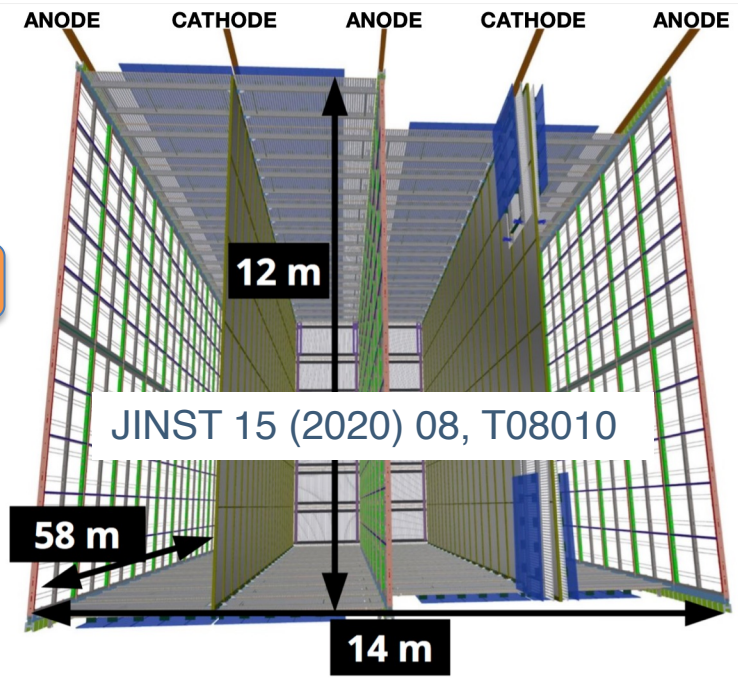
Caverns are full of cryostat steel beams



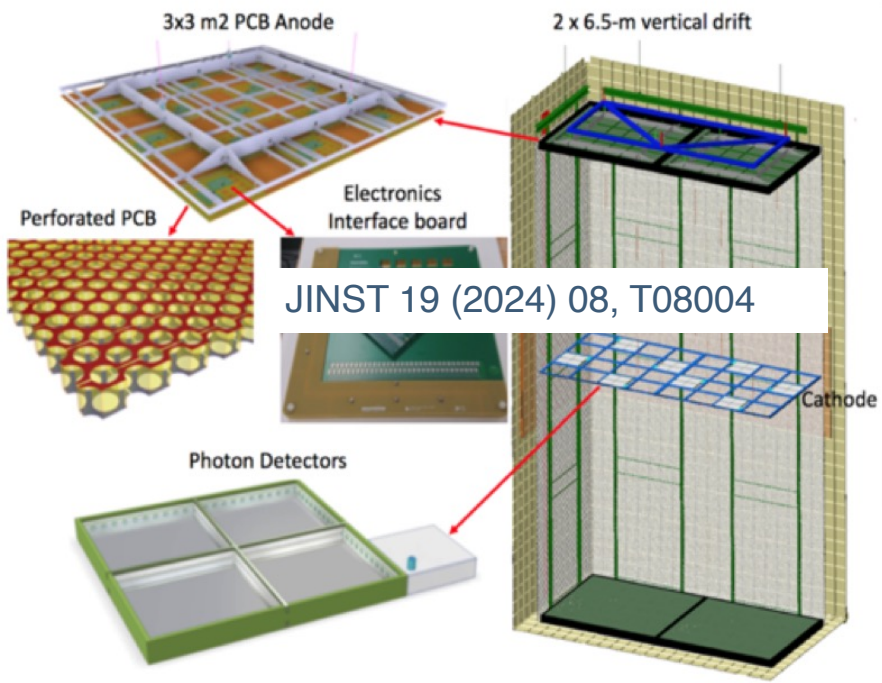


DUNE Far Detectors

FD-HD



JINST 15 (2020) 08, T08010



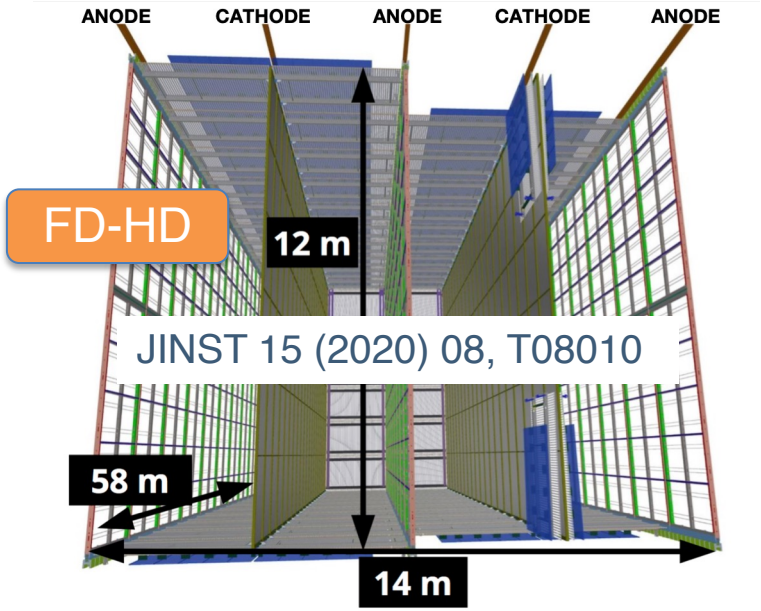
JINST 19 (2024) 08, T08004

FD-VD

Two LArTPC technologies,

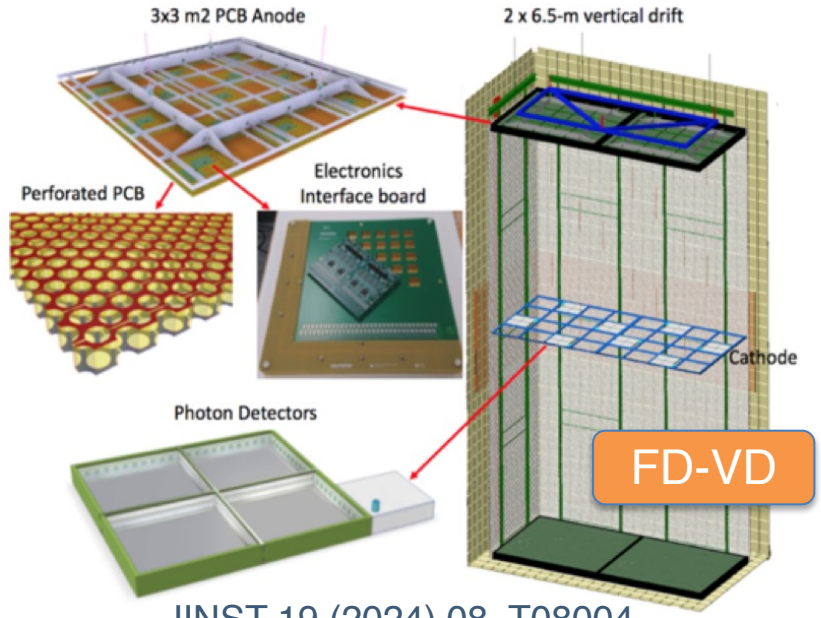
- **Horizontal-Drift (HD):** shorter drift; more segmented; wire readout
- **Vertical-Drift (VD):** longer drift; less segmentation; strip readout

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



JINST 19 (2024) 08, T08004



DUNE Far Detectors Making Rapid Progress



FD-VD installation testing platform at CERN



Charge Readout Plane (CRP) factory (Grenoble)



Photon System Production (Brazil)



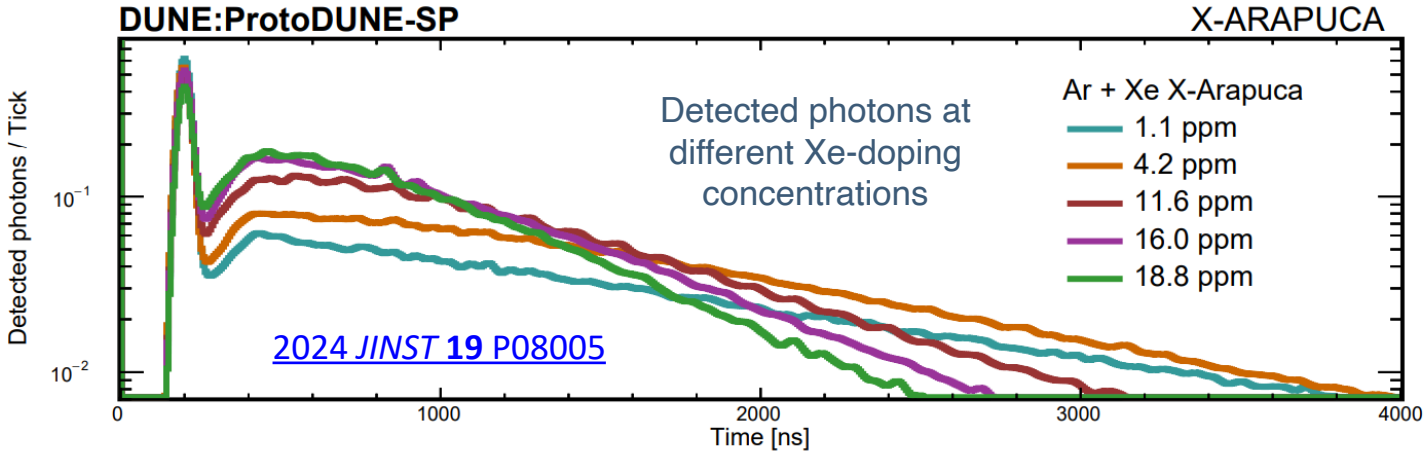
2 shipment of Anode Plane Assemblies (APAs) from UK to US (Fermilab)

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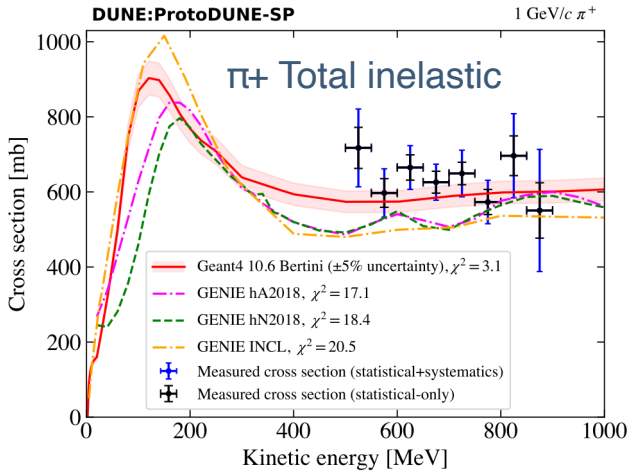
DUNE

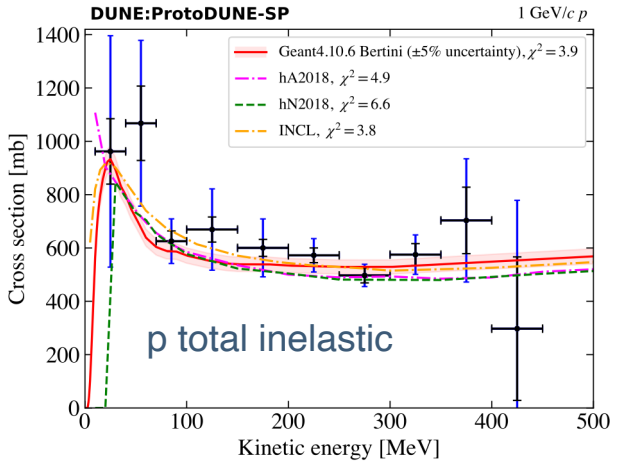
ProtoDUNE Phase-I Results

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

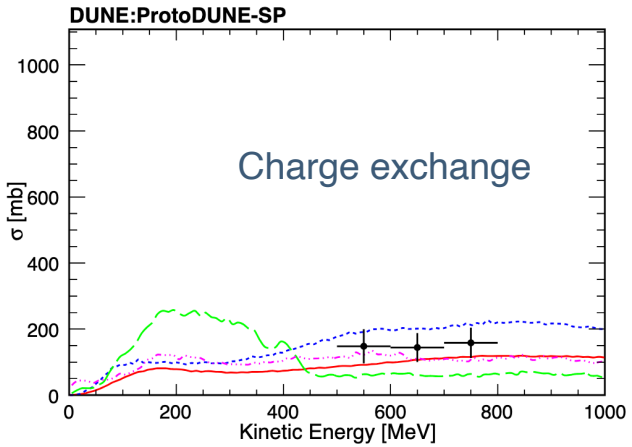


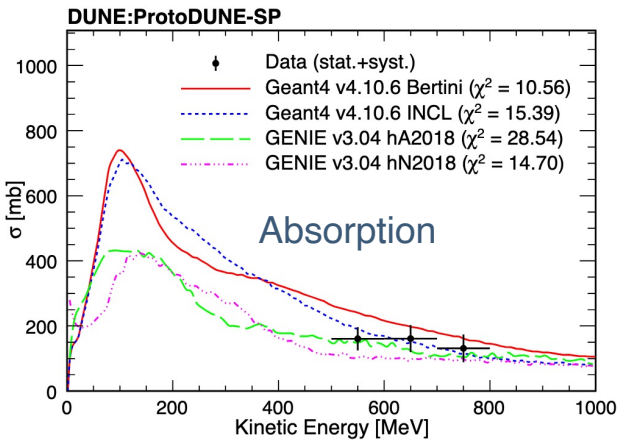
https://arxiv.org/abs/2511.11925





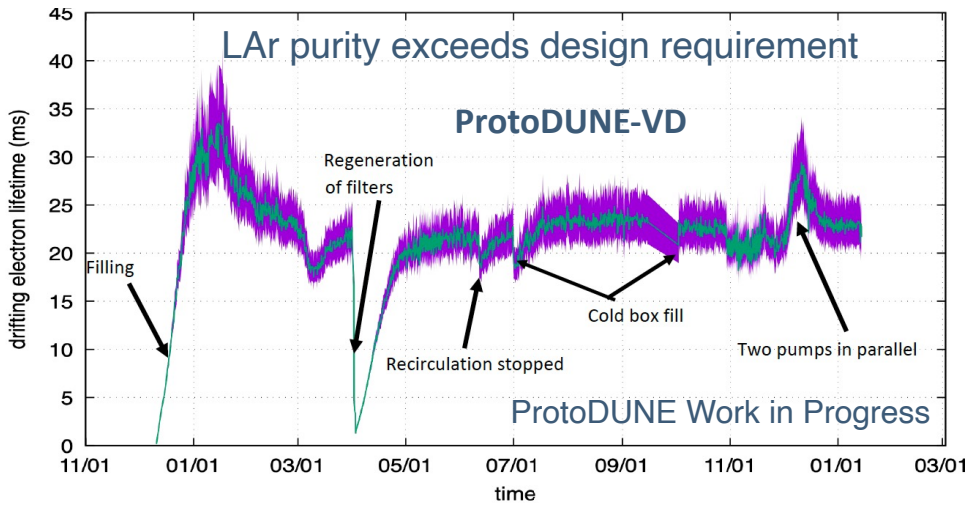
https://arxiv.org/abs/2511.13462 **(Pion Exclusive)**

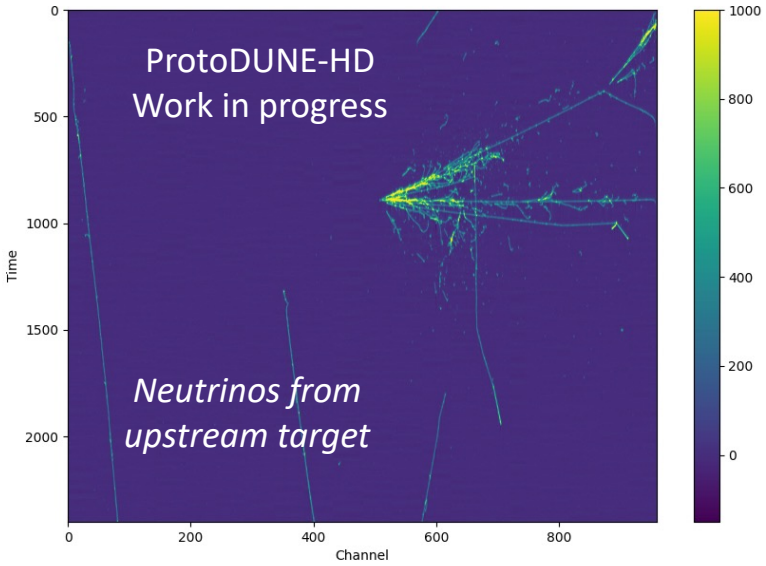


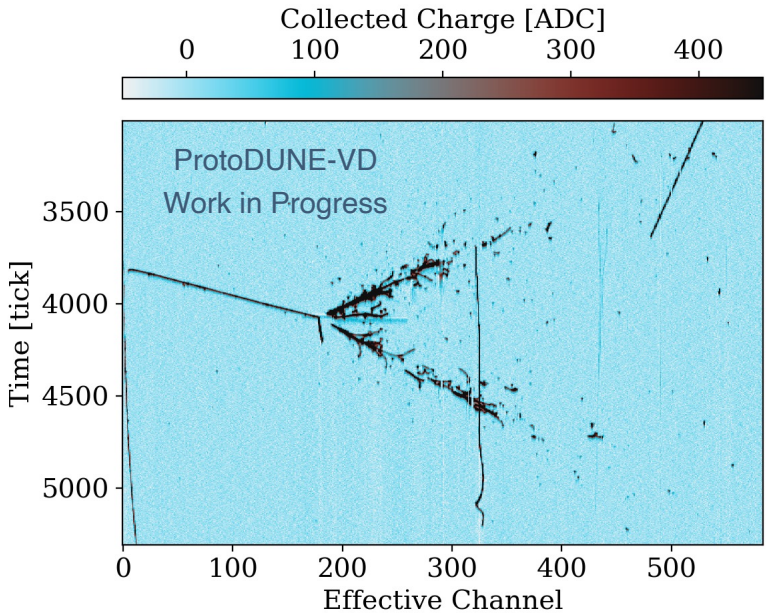


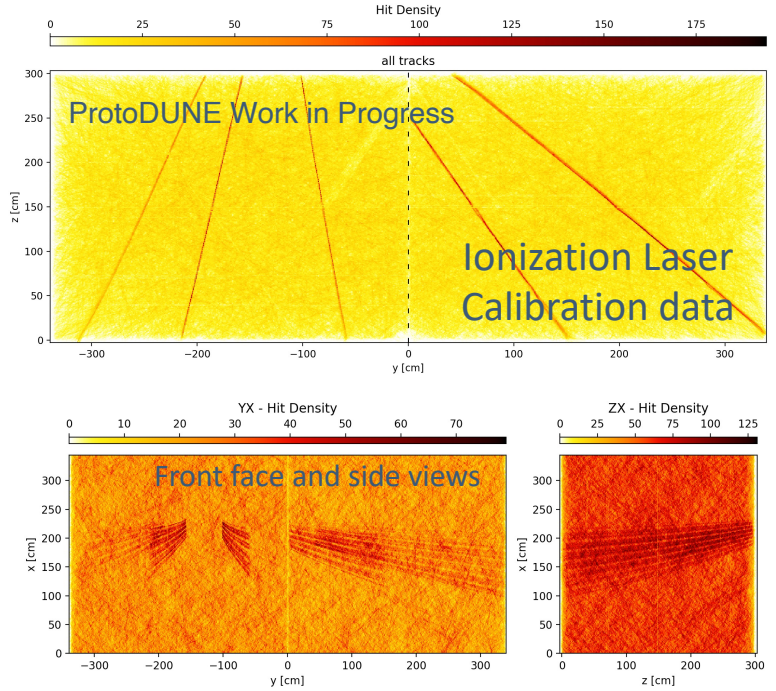
ProtoDUNE Phase-II Highlights

- **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









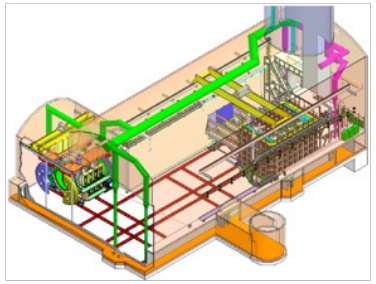
DUNE Publication Highlights

- DUNE is actively publishing on physics, software and technical topics, both collaboration-wide papers and small-author technical papers
- About 165 conference proceedings by DUNE so far

Topic	Published	Under Review
Physics	13	4
Detector	10	1
Simulation & Reconstruction	8	2
Design reports & White Papers	14	-
Other	1	1
FULL-AUTHOR PAPERS	46	8
Small-author technical papers	53	1

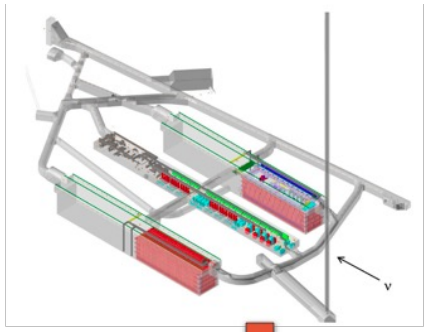
About 100 papers published and 9 in review!

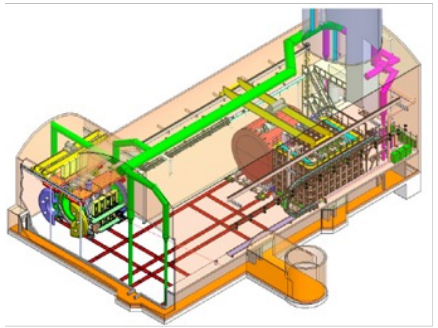
DUNE will be Built in Two Phases



Phase-I

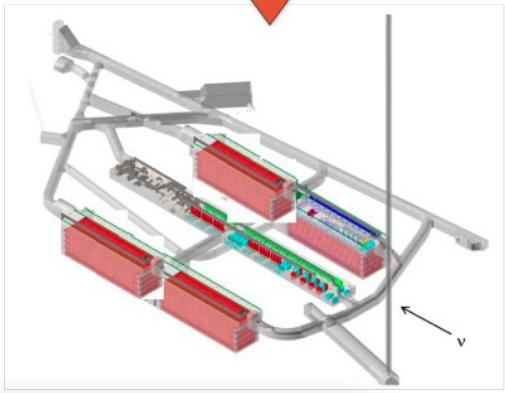
- **FD:** 2 x 17 kt LArTPCs
- **ND:** LArTPC + Muon Spectrometer (with PRISM) + On-axis Beam Monitor
- **Beam:** 1.2 MW (PIP-II)





Phase-II

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



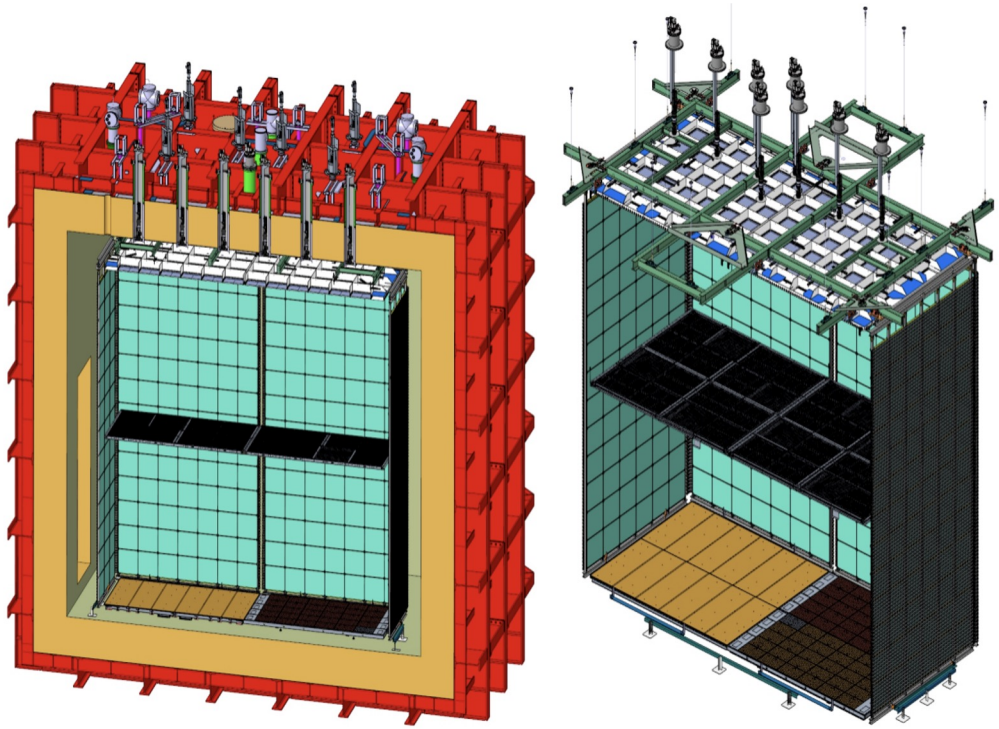
The dual facilities built by LBNF support both Phase-I and Phase-II scope

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

- 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
- An ProtoDUNE-III proposal has been submitted to CERN to test a subset of these technologies – *currently under review by CERN*
- ProtoDUNE-III is expected to start installation in 2029

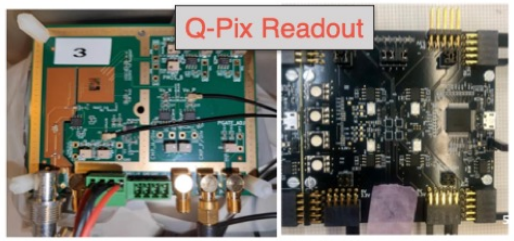


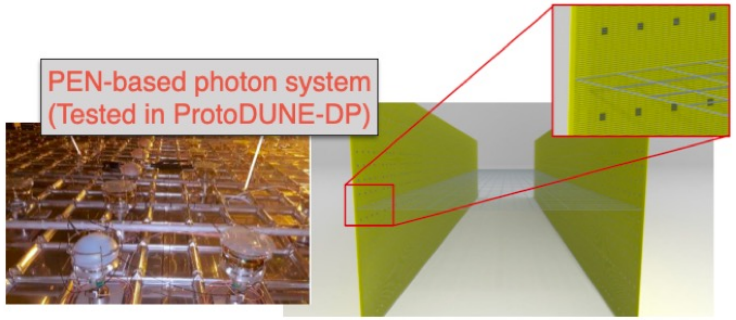
DUNE Phase-II White Paper
JINST 19 P12005 (2024)

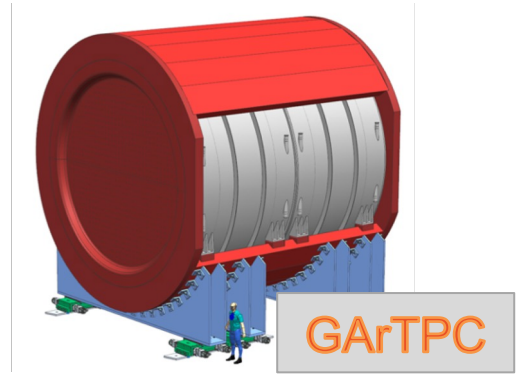
Active Prototyping Underway for Phase-II

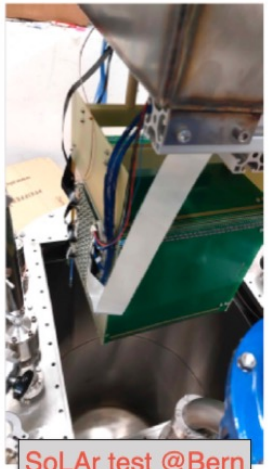
- Active prototyping for Phase-II technologies (ton-scale and above) underway around the world (e.g., US, Europe, Brazil, CERN etc.)
- The R&D underpinning the Phase-II concepts is done as part of a global program which includes the ***European Committee for Future Accelerators (ECFA)*** and the ***Coordinating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

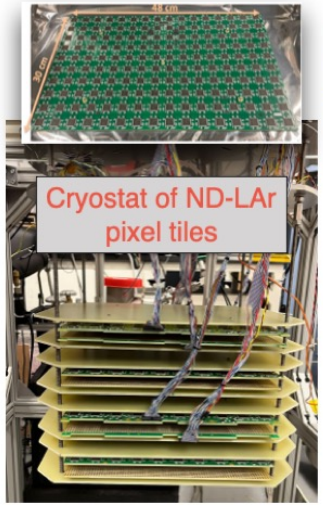






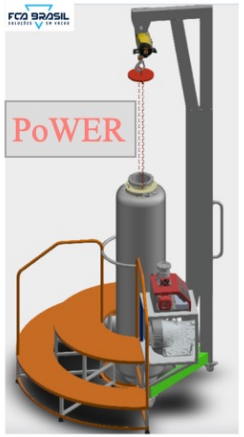


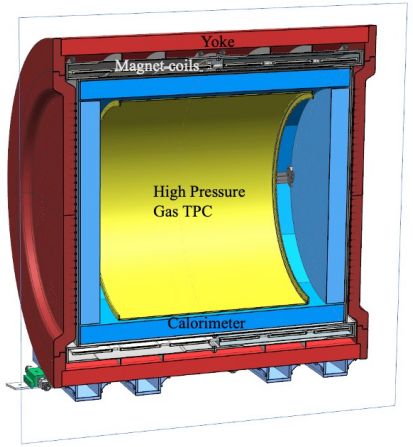










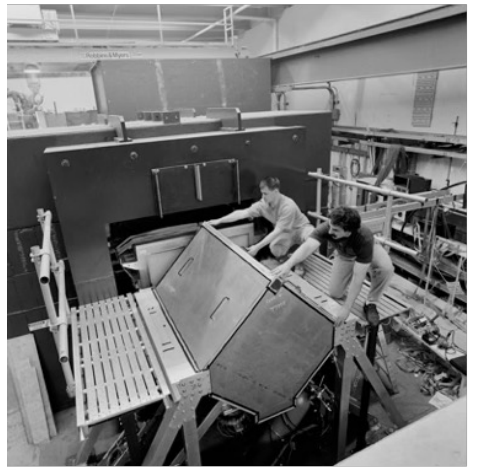


South Korea & Global Particle Physics

Korea made vital contributions to global particle physics

- Discovery of the θ_{13} mixing angle by the RENO experiment is a key result of the field and directly informs DUNE's physics program
- Experiments like AMoRE demonstrate Korea's broad leadership in the search for fundamental neutrino properties
- Long history of successful collaboration at Fermilab with critical contributions to the discoveries of the top quark (1995) and the tau neutrino (2000)
- Strong collaboration at CERN on LHC experiments bringing strong leadership and synergistic expertise from collider physics
- **Korea is making important contributions to DUNE**
  - 5 institutes in DUNE: *Chung Ang, HanYang, Jeju National, Jeonbuk, Seoul tech*
  - *Contributions span multiple fronts (see next set of talks)*









Los Alamos NATIONAL LABORATORY DUNE

Growing Interest from South Korea in DUNE

- Strong interest to expand South Korea footprint in DUNE and grow to become a major partner
- Active interactions at US-Korea Conferences (2026 & 2027) with Science Ministry & Korean university leadership teams







Formal invitation extended to Ministry of Science and ICT to expand South Korea's role in DUNE



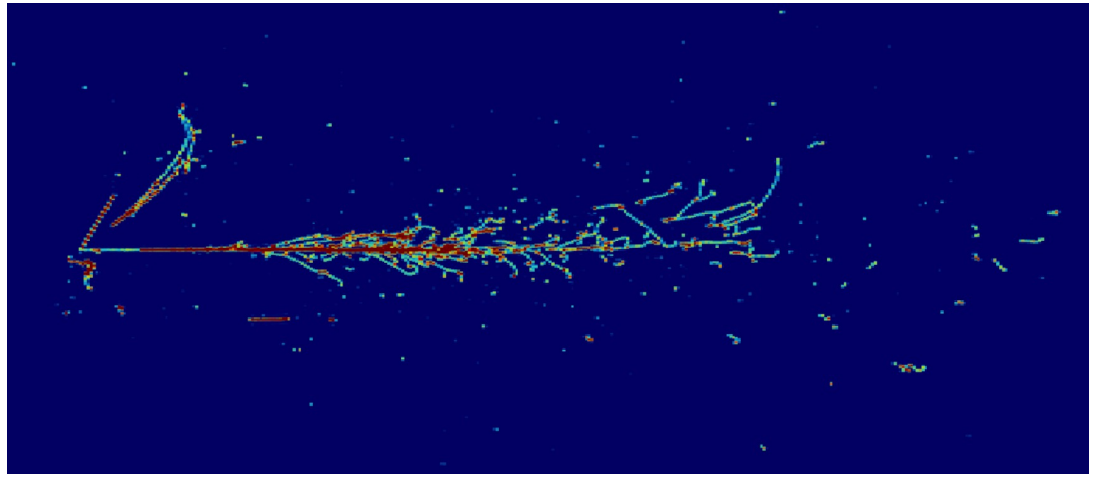


UKC 2026 Science Policy & Diplomacy Forum

Los Alamos NATIONAL LABORATORY

DUNE

DUNE Offers an Ideal Platform for AI/ML Development

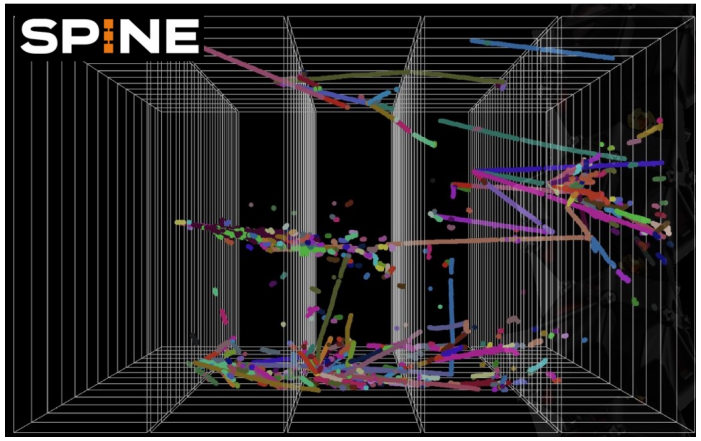


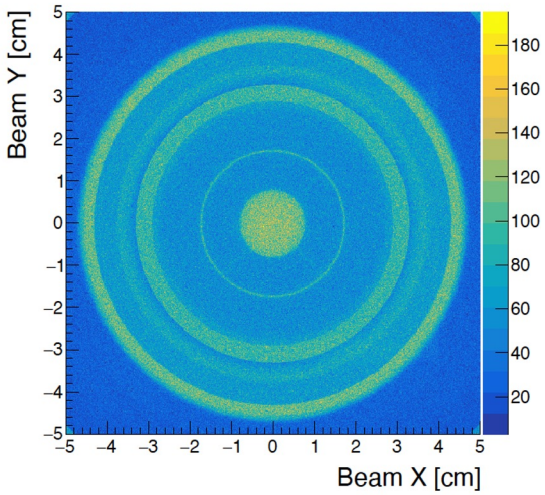
Detector scale unprecedented

generating tens of PB of data

DUNE is applying state-of-the-art AI models (e.g., LLMs, Foundation models, Agentic AI) and leverages AI infrastructure at labs

- Simulation/Reconstruction/Analyses
- Trigger & Data Acquisition
- Beam design and monitoring
- Computing workflow
- Documentation search pipeline
- Quality Control & Assurance





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DUNE

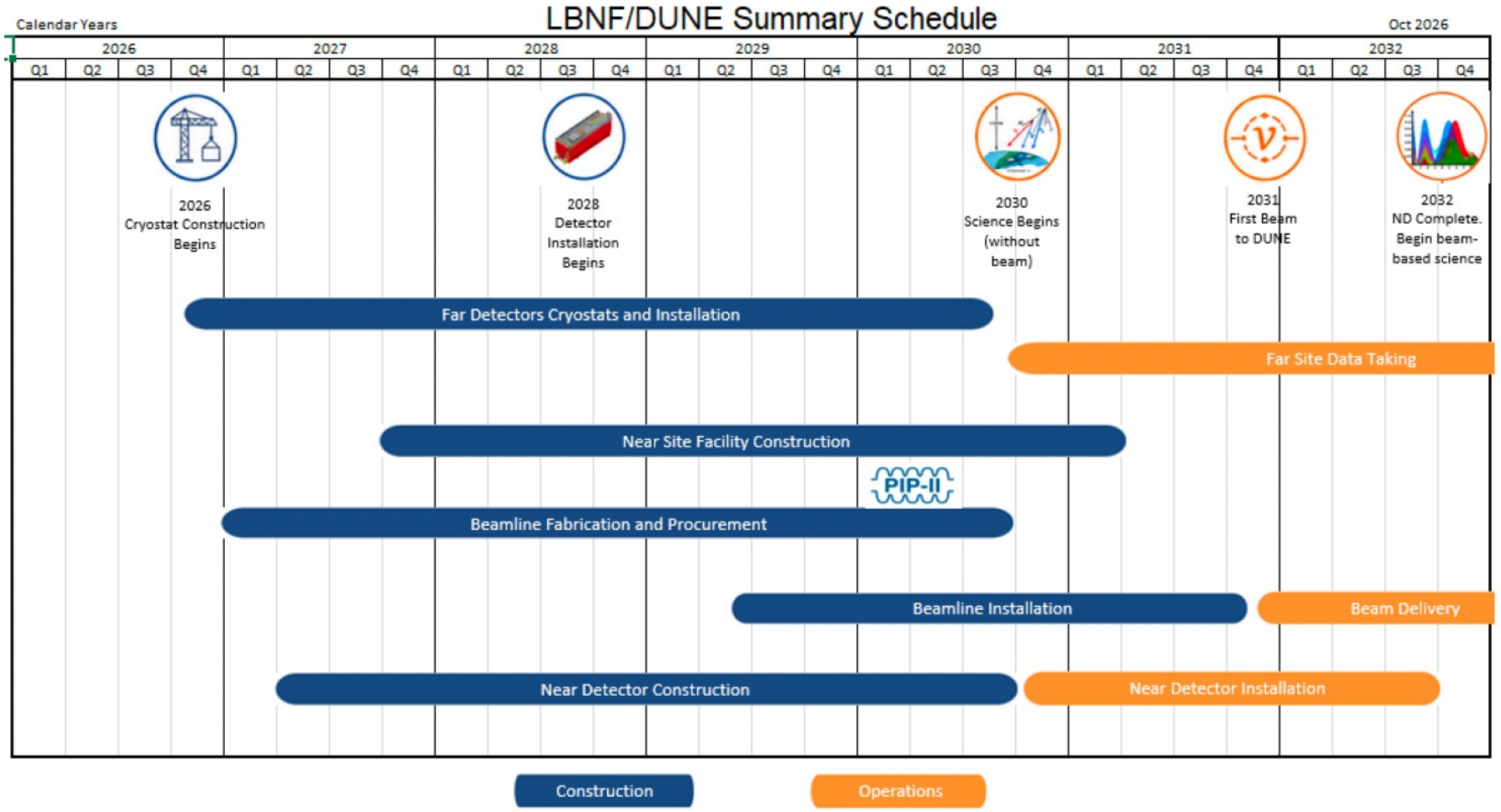
Ample Opportunities for South Korea to Expand on DUNE
(for both Phase-I and Phase-II)

- Physics/Simulation/Reconstruction
  - Increased effort is needed across the board
  - AI/ML developments (Korea's 2026 program for exploratory cooperation with U.S. Genesis Mission being exercised)
- Far Detectors
  - Already solid contributions to cold electronics (Phase-I)
  - Slow Controls, Data Quality Monitoring, photon detector system potential areas (Phase-I)
  - Supporting and taking key roles on Installation, commissioning and data taking at far site (Phase-I)
  - R&D and prototyping for far detectors FD3 and FD4 (Phase-II); ProtoDUNE-III at CERN
- Near detector
  - DAQ, Slow controls (Phase-I)
  - Supporting production, testing and installation activities at Fermilab (Phase-I)
  - Gaseous Argon Detector development (Phase-II)
- Core Software & Computing
  - A number of areas including computing sites

*A **Korea-DUNE Workshop** at Chung Ang on **Oct. 30** to discuss these opportunities in more detail*



DUNE Top-Level Schedule



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 in a few days (Nov. 2nd, 2026)
- First data at the Far site in 2030
- 1.2 MW neutrino beam to DUNE in 2031
- Active R&D ongoing globally for Phase-II – a ProtoDUNE-III run planned at CERN
- **Several opportunities exist in Phase-I and II for Korea to strengthen its current role and expand efforts in a significant way**
- **Positive interactions with Korean Ministry. The collaboration welcomes and exceptionally supports Korea's plan to further expand their role in DUNE**

Thank you!





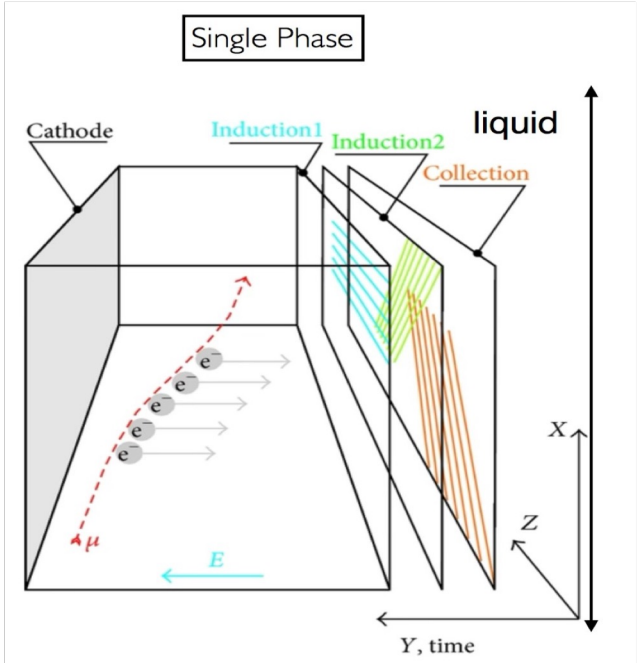
A Cryostat Beam Signing Event *to mark the start of installation phase*

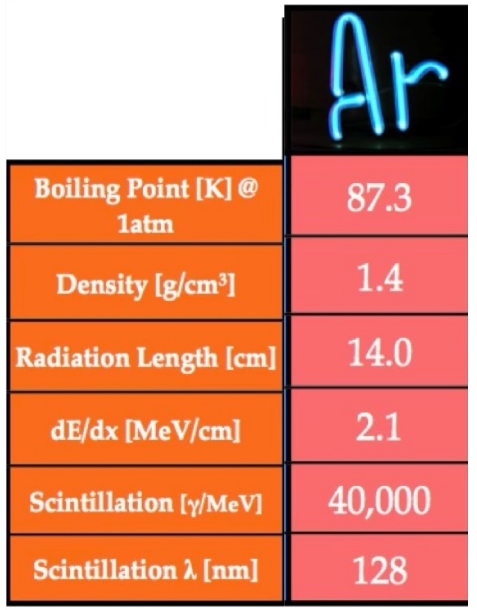
DUNE Collaboration Meeting @SURF (May 22, 2026)

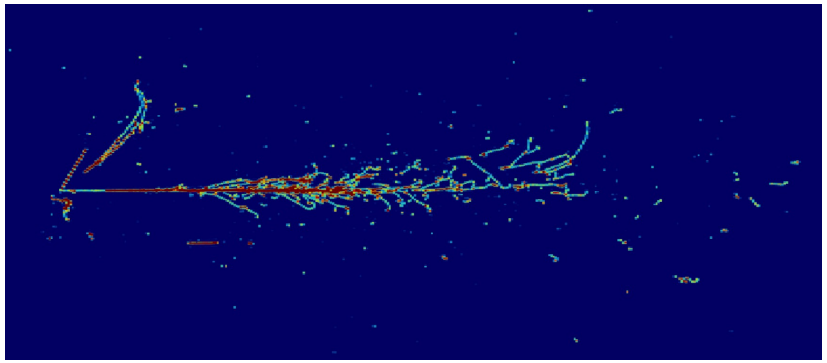
EXTRAS

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 *(ProtoDUNEs, ND-LAr "2x2", MicroBooNE, SBND, ICARUS, LArIAT, ArgoNeuT etc.)*
- Ideal technology for ν_e measurements
  - Excellent signal (charged-current ν_e) efficiency and background (Neutral Current π^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

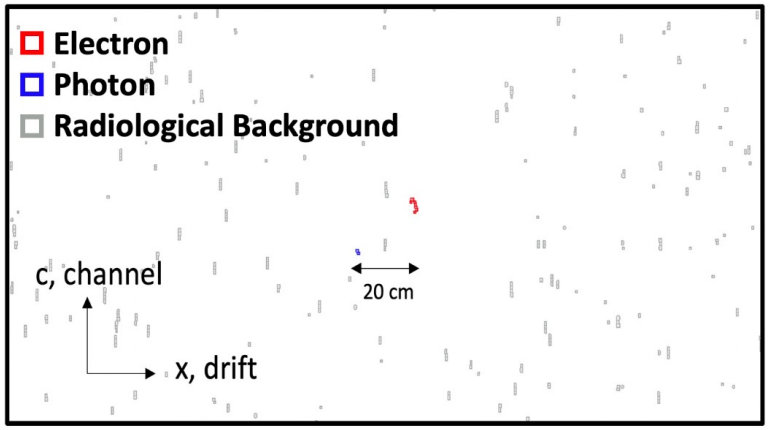


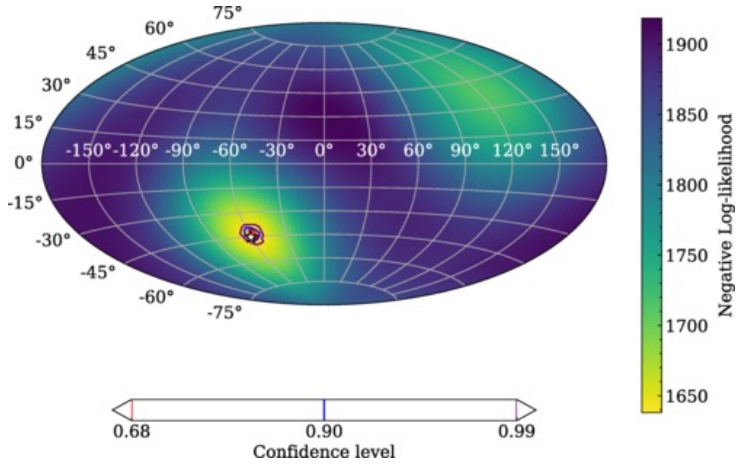


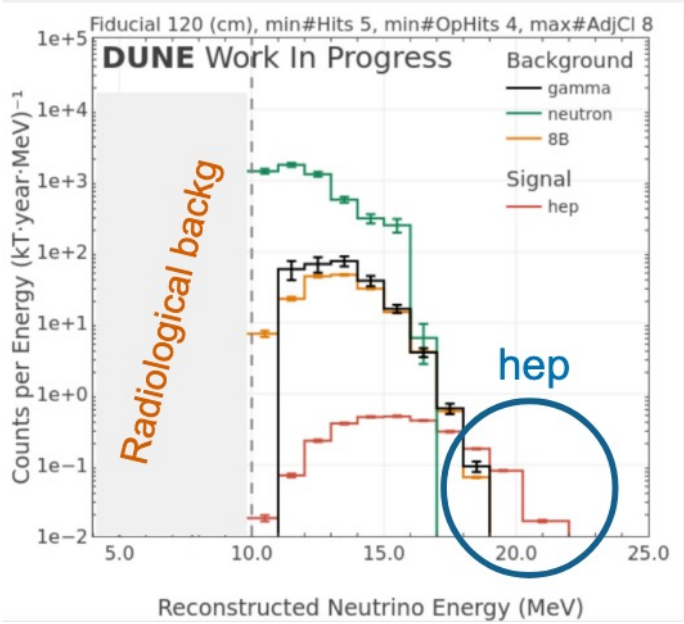


A simulated 4 GeV ν_e from a resonant interaction in DUNE Horizontal Drift Far Detector

Low-energy & Astrophysical Neutrinos in DUNE







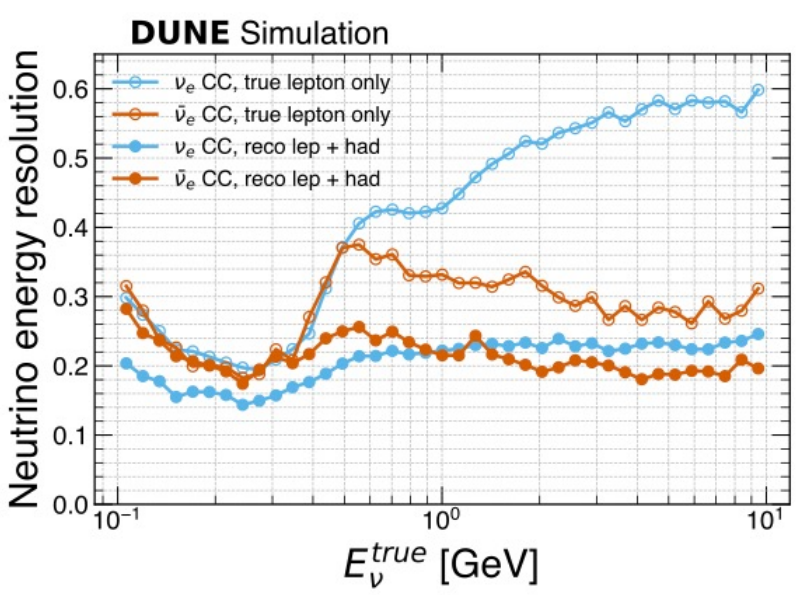
First end-to-end low energy reconstruction workflows demonstrated for HD and VD far detectors for 4-70 MeV *(paper in review)*

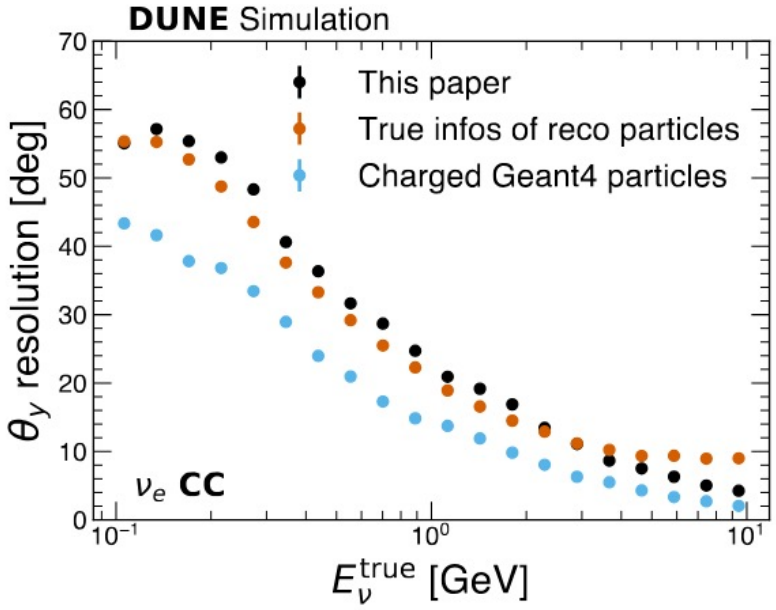
Supernova pointing ES channel ~5° pointing resolution (40 kt, 10 kpc) *PRD 111 (2025) 9, 092006*

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

Atmospherics in DUNE

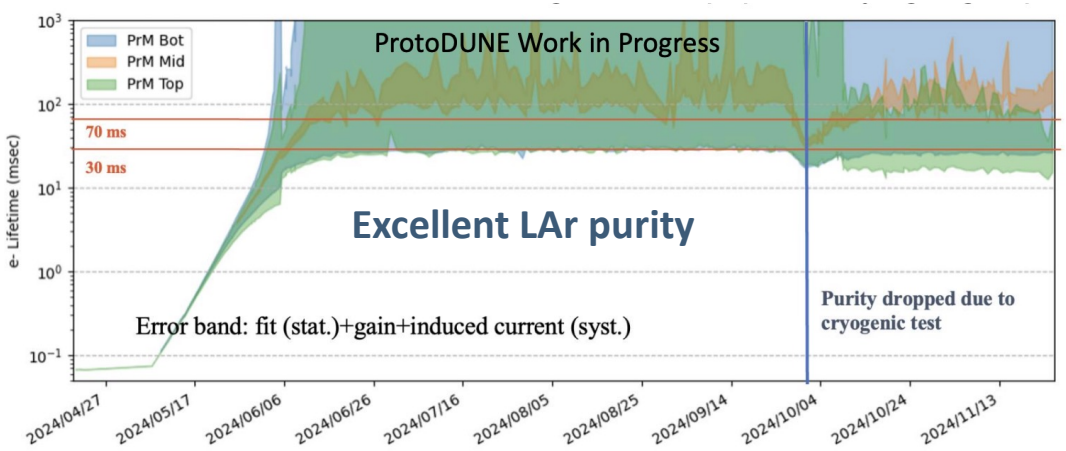
- Atmospheric neutrino reconstruction paper for Horizontal Drift FD accepted by EPJC (https://arxiv.org/pdf/2601.05697)
- Full reconstruction and simulation chain between 0.1 and 10 GeV has been demonstrated. Next step is implementing the first atmospheric neutrino oscillation analysis

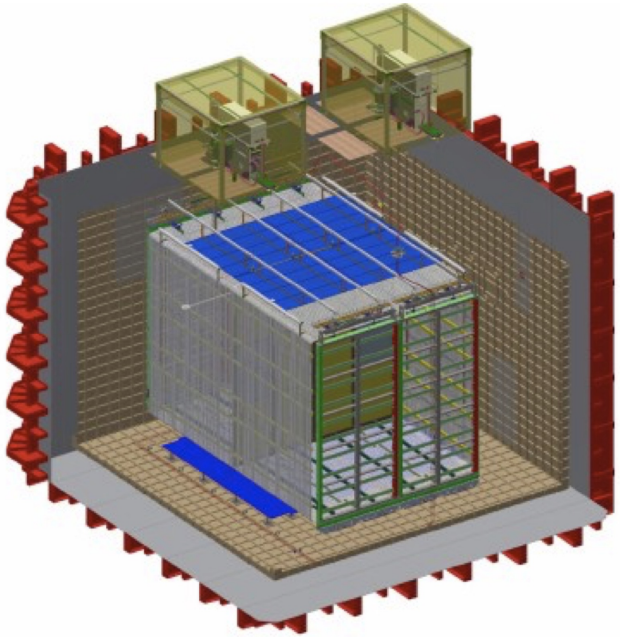


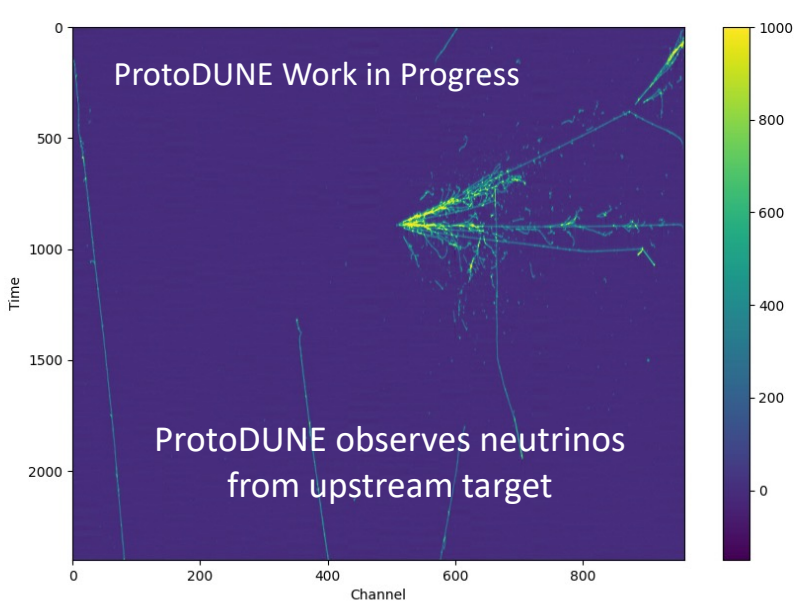


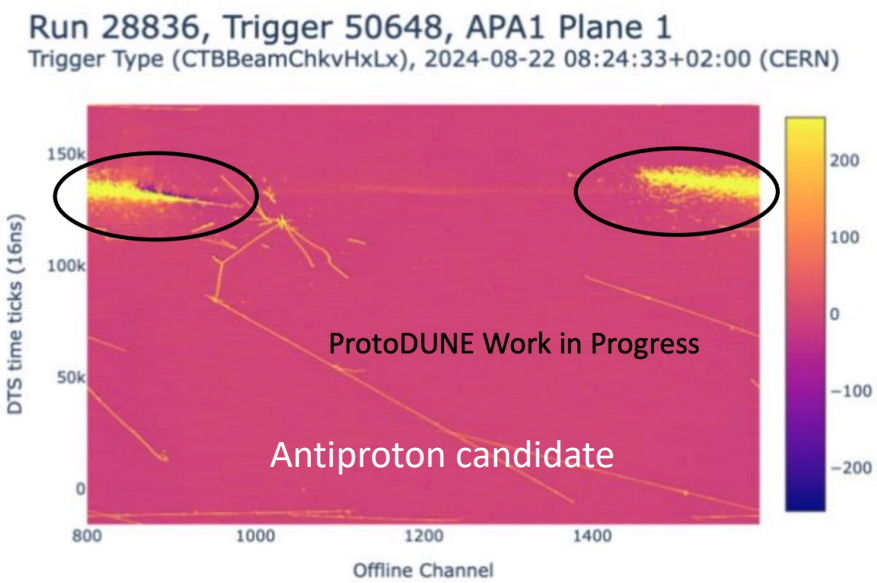
ProtoDUNE-HD Highlights

- 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.









Antiproton event.

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

