



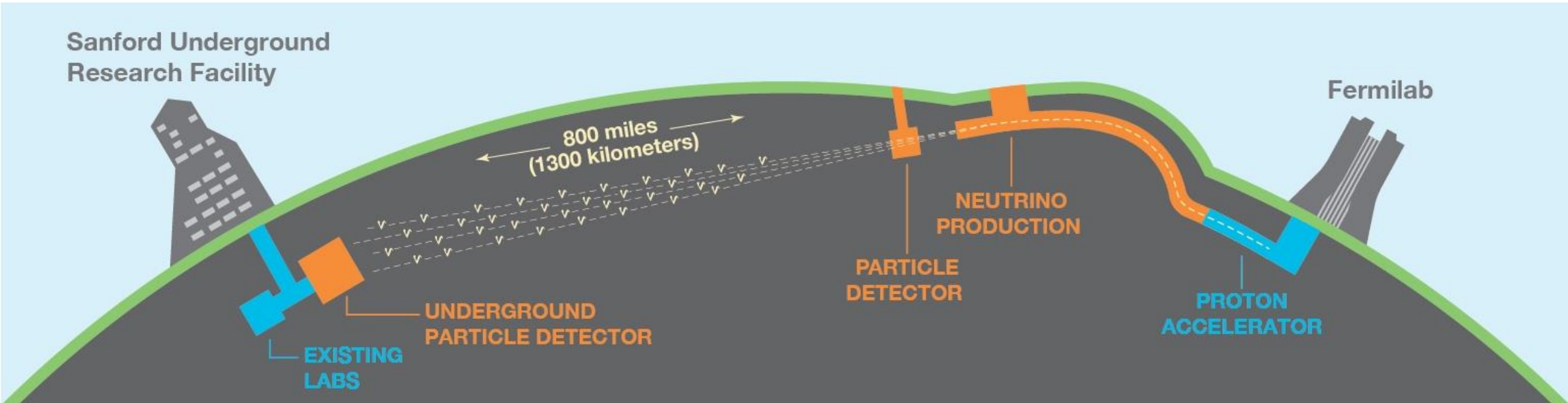
DUNE at Liverpool

Liverpool Particle Physics Annual Meeting

Christos Touramanis

21 May 2026

DUNE in one slide



Phase I

Physics Goals

- Measure CP violation in the neutrino sector
- Determine the neutrino mass ordering
- **Stress-test the 3-flavor paradigm**
- Search for BSM physics
- Measure astrophysical neutrinos

- **FD:** 2 x 17 kt LArTPC modules
- **ND:** ND-LAr+TMS (w/PRISM) + SAND
- **Beam:** 1.2 MW beam line (PIP-II)

Phase II

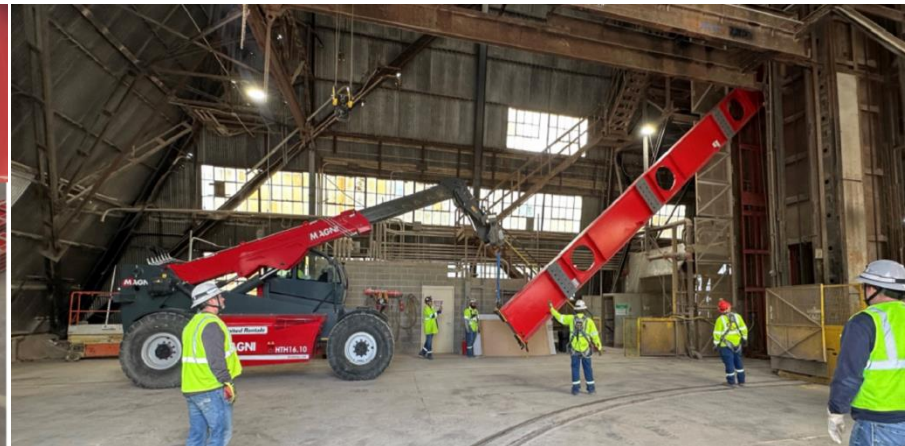
- **FD:** 2 additional modules
- **MCND:** Replace TMS by ND-GAr
- **Beam:** 2+ MW proton beam

Far Detector update

- Far Site construction completed.
- Caverns covered with Thin Sprayed-on Layer (TSL)
- BSI nearing completion for first FD cavern.
- CD-2/3 DOE IPR passed in March.
- All materials for 2 cryostats at SURF (CERN contribution).
- Cryostat construction starting soon.
- All components for FD-VD and FD-HD in construction / procurement.



Cryostat warm structure steel



Schedule update

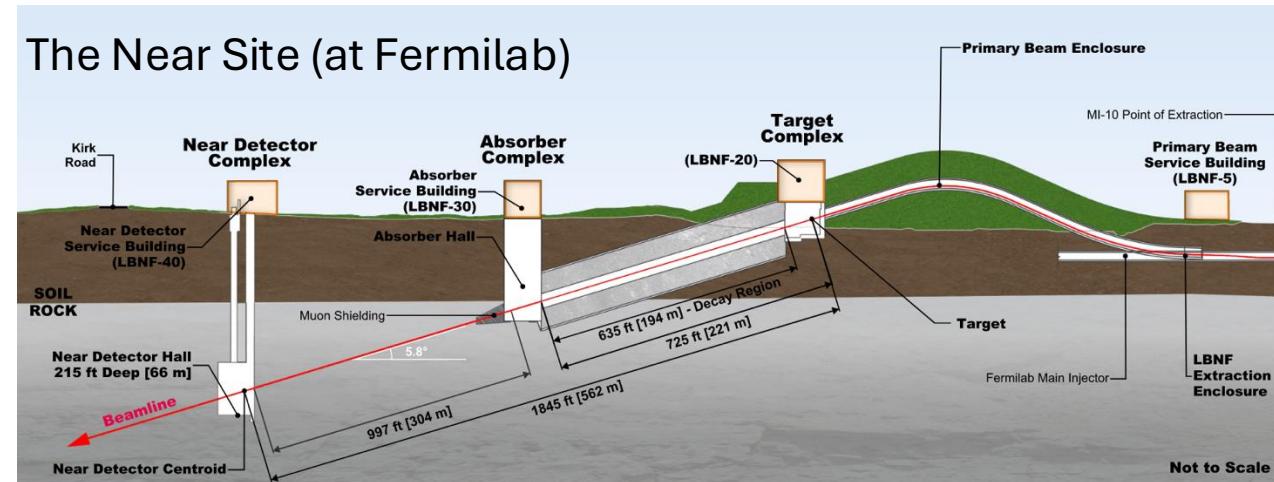
- New Fermilab director defined “beam to DUNE in 2031” as the lab’s primary aim.
- 2030: “Start of Science” with first FD (Vertical Drift)
- 2032: “Start of beam-based Science” with 2 FDs, ND, 1.2 MW proton beam

DUNE Phase I

The PIP-II buildings



The Near Site (at Fermilab)



Liverpool in DUNE

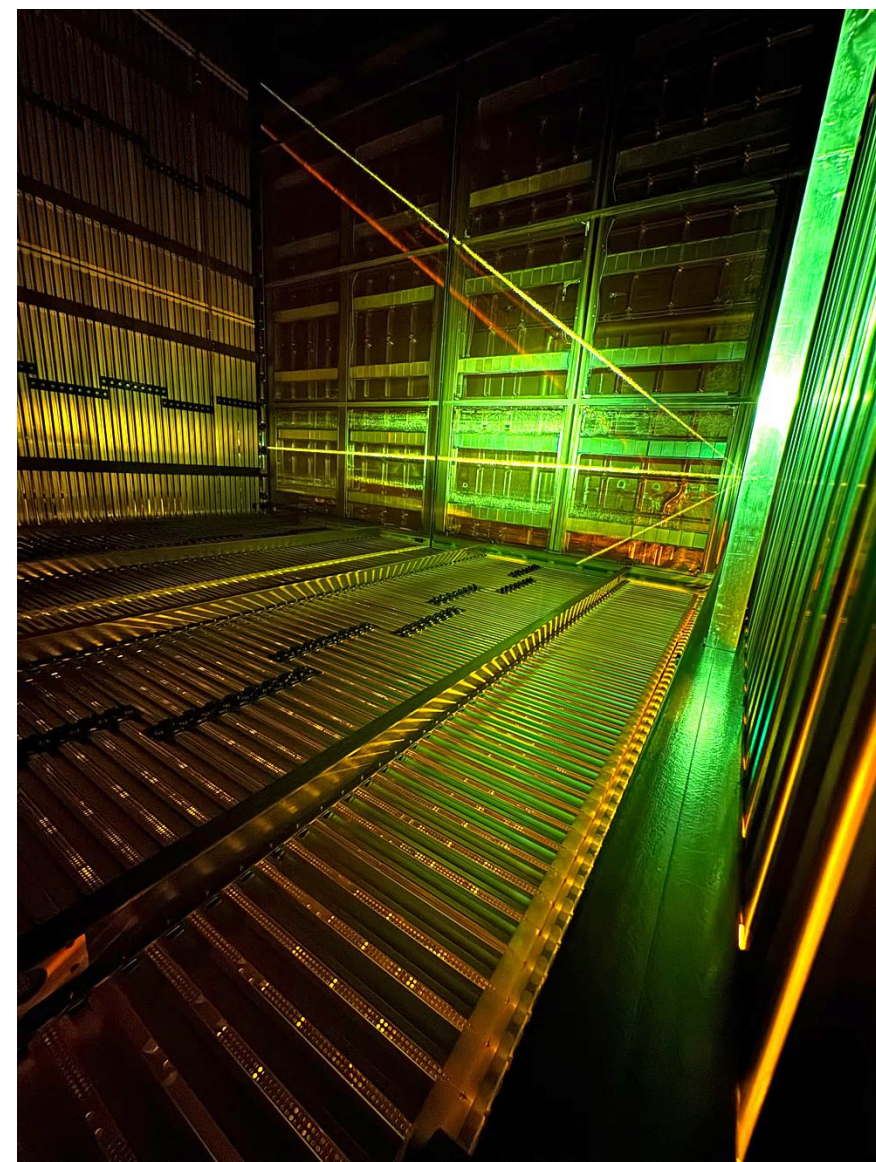
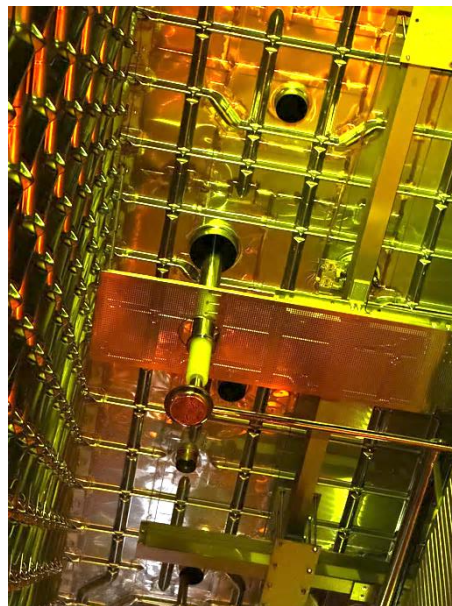
- **Christos Touramanis:** ProtoDUNE-HD coordinator; CERN Neutrino Platform Deputy Technical Coordinator; DUNE Exec Board member.
- **Kostas Mavrokoridis:** TPC Optical Charge Readout development for DUNE Far Detectors 3,4; he initiated the ProtoDUNE III plan which was submitted by DUNE as LOI to CERN SPSC.
- **Krish Majumdar:** APA Factory computing manager & developer; APA database developer. The only university physicist working at the factory.
- **Marco Roda:** DUNE DAQ CCM coordinator; ProtoDUNE DAQ coordinator 2025.

APA production and testing



ProtoDUNEs at the CERN Neutrino Platform

- ProtoDUNE-HD (NP04) took beam data in 2024.
- In 2025 we entered the cryostat, un-installed half of the TPC and did a detailed inspection of all components.
- We now consider NP04 completed. All scope has been successfully delivered. Performance surpassed all DUNE FD requirements and targets (HV, electron lifetime, spatial and energy resolution).
- We are now writing the detector papers and preparing the data for analyses.
- ProtoDUNE-VD (NP02) took beam data in 2025: first kton-scale demonstration of the Vertical Drift design. Also very successful!



NP04 publications

Black: instrumentation
Green: reco/analysis
Red: physics (non-instrumentation)

Since our 2025 annual meeting



1. B.Abi et al. [DUNE], **First results on ProtoDUNE-SP liquid argon time projection chamber performance from a beam test at the CERN Neutrino Platform**, JINST 15 (2020) no.12, P12004
2. B.Abi et al. [DUNE], **Design, construction and operation of the ProtoDUNE-SP Liquid Argon TPC**, JINST 17 (2022) no.01, P01005
3. A.Abed Abud et al. [DUNE], **Separation of track- and shower-like energy deposits in ProtoDUNE-SP using a convolutional neural network**, Eur. Phys. J. C 82 (2022) no.10, 903
4. A.Abed Abud et al. [DUNE], **Reconstruction of interactions in the ProtoDUNE-SP detector with Pandora**, Eur. Phys. J. C 83 (2023) no.7, 618
5. A.Abed Abud et al. [DUNE], **Identification and reconstruction of low-energy electrons in the ProtoDUNE-SP detector**, Phys. Rev. D 107 (2023) no.9, 092012
6. A.Abed Abud et al. [DUNE], **Doping liquid argon with xenon in ProtoDUNE Single-Phase: effects on scintillation light**, JINST 19 (2024) no.08, P08005
7. A.Abed Abud et al. [DUNE], **First measurement of the total inelastic cross section of positively charged kaons on argon at energies between 5.0 and 7.5 GeV**, Phys. Rev. D 110 (2024) no.9, 092011
8. A.Abed Abud et al. [DUNE], **The track-length extension fitting algorithm for energy measurement of interacting particles in liquid argon TPCs and its performance with ProtoDUNE-SP data**, JINST 20 (2025) no.02, P02021

9. S.Abbaslu et al. [DUNE], **Spatial and temporal evaluations of the liquid argon purity in ProtoDUNE-SP**, JINST 20 (2025) no.09, P09008
10. S.Abbaslu et al. [DUNE], **Identification of low-energy kaons in the ProtoDUNE-SP detector**, Phys. Rev. D 113 (2026) no.5, 052004

Submitted / to be submitted

11. S.Abbaslu et al. [DUNE], **First Measurement of π^+ -Ar and p-Ar Total Inelastic Cross Sections in the Sub-GeV Energy Regime with ProtoDUNE-SP Data**, arXiv:2511.11925, (submitted to PRL)
12. S.Abbaslu et al. [DUNE], **Measurement of Exclusive n^+ -argon Interactions Using ProtoDUNE-SP**, arXiv:2511.13462, (PRD)
13. S.Abbaslu et al. [DUNE], **Design of the DUNE horizontal drift far detector charge readout electronics and performance in ProtoDUNE-HD**, arXiv:2604.23966, (JINST)

In collaboration-wide review:

S.Abbaslu et al. [DUNE], **Cosmic ray muon seasonal variations with the ProtoDUNE-SP Detector**

DAQ CCM

Control – starts, controls and stops DAQ applications

Configuration – provide tools to define and describe DAQ sessions

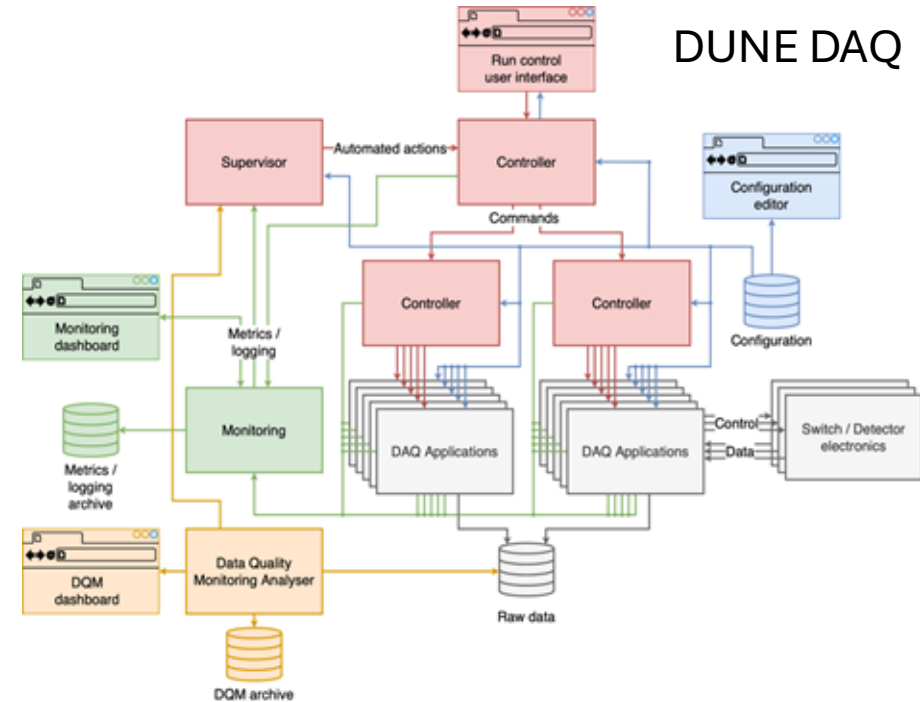
Monitoring - monitors applications and overall system and flags errors etc.

Mix of custom and industry (micro) services, databases and applications.

Group is ultimately responsible for the high uptime of the experiment.

It is the largest WG in DUNE DAQ.

- Uptime: Each FD module shall have an uptime of at least 95%, and the FD as a whole shall have an uptime of at least 98%, during which at least one module is operational. Since a few days per year of downtime for infrastructure maintenance cannot be avoided, and individual hardware failures (electronics, servers, disks, ...) may occur, this translates into a very strong requirement for the TDAQ. The TDAQ shall operate continuously, dynamically adjust to changing conditions, tolerate faults, and recover from errors autonomously.



Thank you