The 2x2 DUNE Near Detector Demonstrator

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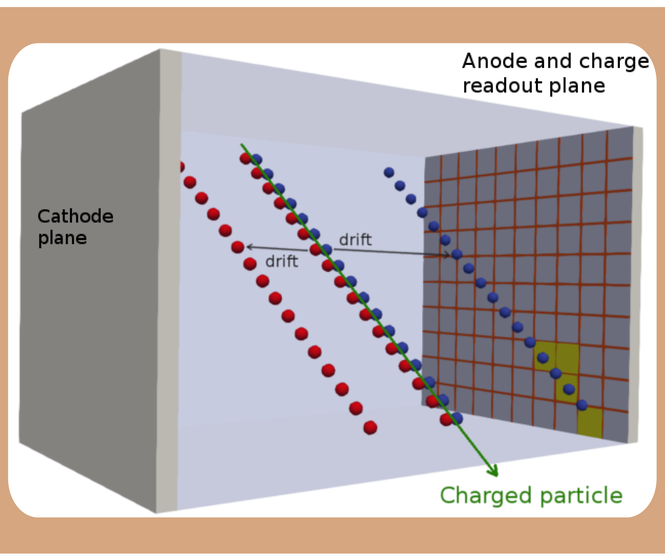
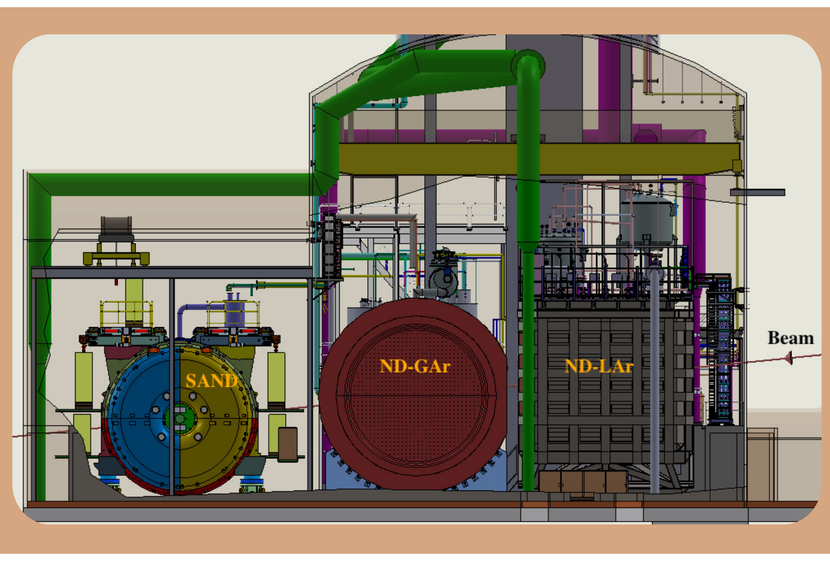
What is DUNE?

- DUNE (**D**eep **U**nderground **N**eutrino **E**xperiment) is a next-gen **L**iquid **Ar**gon **T**ime-**P**rojection **C**hamber (LArTPC) based long-baseline project.
- It has a **N**ear **D**etector (ND) complex at Fermilab and a 70kt **F**ar **D**etector (FD) at SURF, 1300km away.
- DUNE's rich science program includes precisely measuring the neutrino oscillation parameters and the CP-violating phase, determining the neutrino mass hierarchy and BSM searches such as proton decay (+ more!)



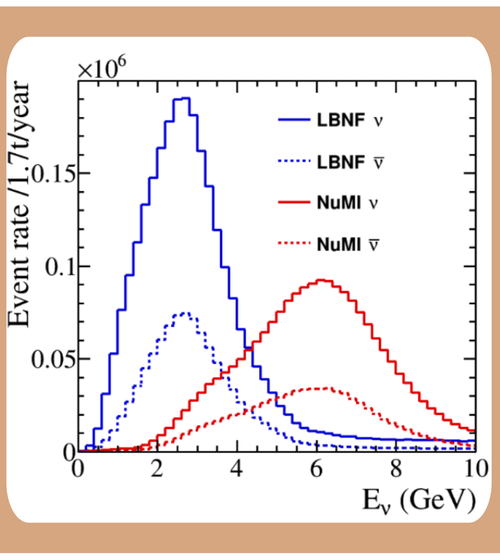
DUNE ND

- The ND is vital for constraining uncertainties in beam flux and neutrino-nucleus interactions.
- The ND will consist of complimentary sub-detectors including ND-LAr, a first-of-its-kind 35t modular, pixelated LArTPC, made of 35 1m×1m×3m modules, each made of 2 optically isolated pixelated TPCs with high-performance light readout. [3][4]
- It will be ~574m from the world's most intense neutrino beam at LBNF [2]



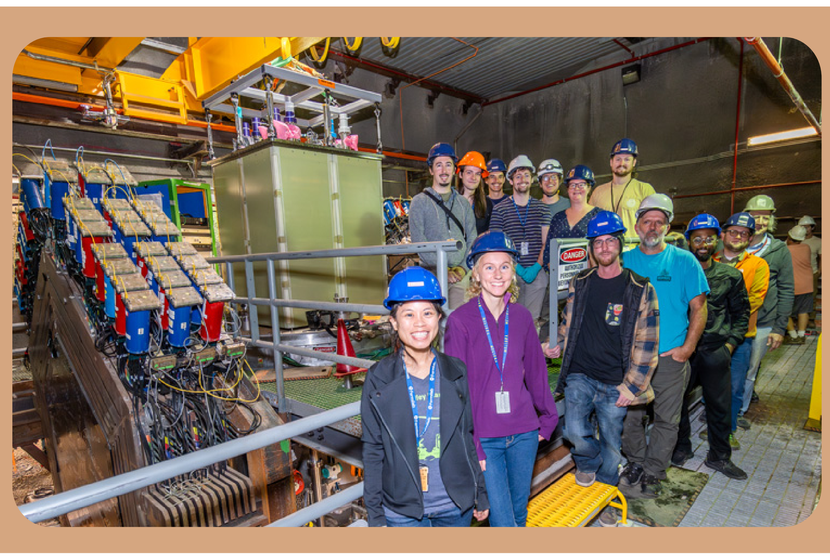
The "2x2"

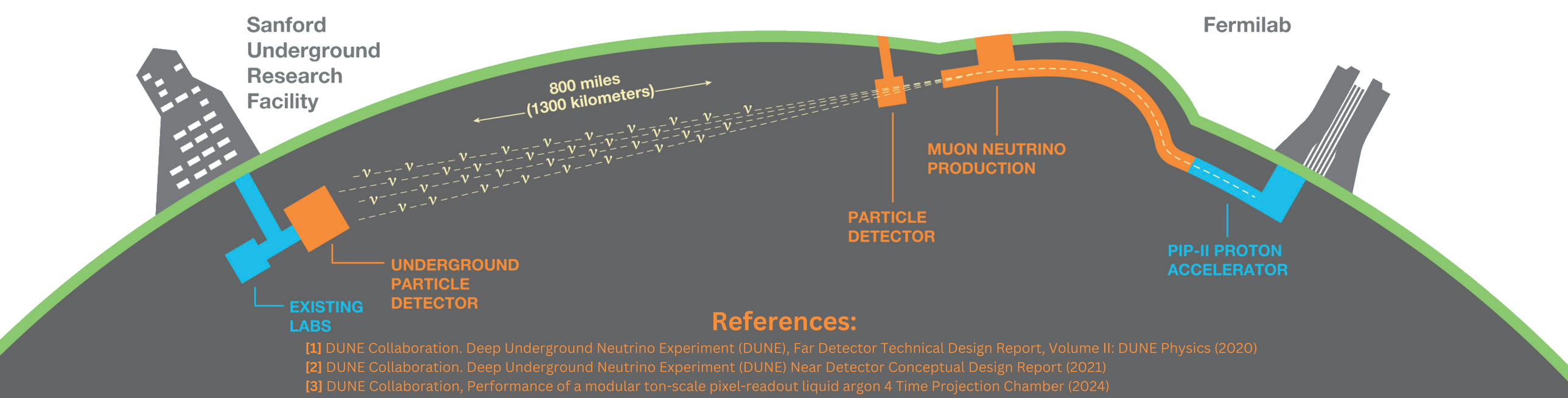
- The 2x2 is a prototype for ND-LAr, made of 4 0.7m×0.7m×1.4m modules (2.4t active mass) similar in design and operation to the ND-LAr modules.
- Positioned along the NuMI neutrino beam, 2x2 will see events and conditions comparable to ND-LAr.
- It also utilises hardware from MINERvA, a well-established scintillator neutrino experiment for tracking, tagging & calorimetry. [2]
- The 2x2 will demonstrate key innovations: pixelated charge readout, high-performance light readout and modularity. [3]



Current status & future plans

- The 2x2 is currently being commissioned and is set to begin data-taking in the coming weeks.
- It will be DUNE's 1st neutrino beam data & the 1st modular, pixelated LArTPC in a high-intensity neutrino beam.
- Lessons from 2x2 will inform ND-LAr's final design and plan.
- 2x2 will also perform physics analyses in its own right, including measuring cross sections on Liquid Argon.





References:

[1] DUNE Collaboration. Deep Underground Neutrino Experiment (DUNE), Far Detector Technical Design Report, Volume II: DUNE Physics (2020)
[2] DUNE Collaboration. Deep Underground Neutrino Experiment (DUNE) Near Detector Conceptual Design Report (2021)
[3] DUNE Collaboration, Performance of a modular ton-scale pixel-readout liquid argon 4 Time Projection Chamber (2024)
[4] A Gaseous Argon-Based Near Detector to Enhance the Physics Capabilities of DUNE (2022)