

DUNE Overview

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Expertise Sharing Workshop

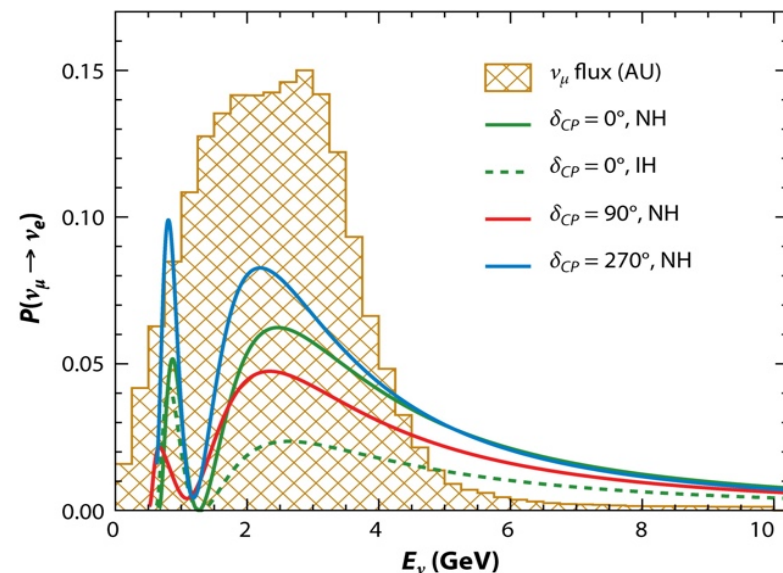
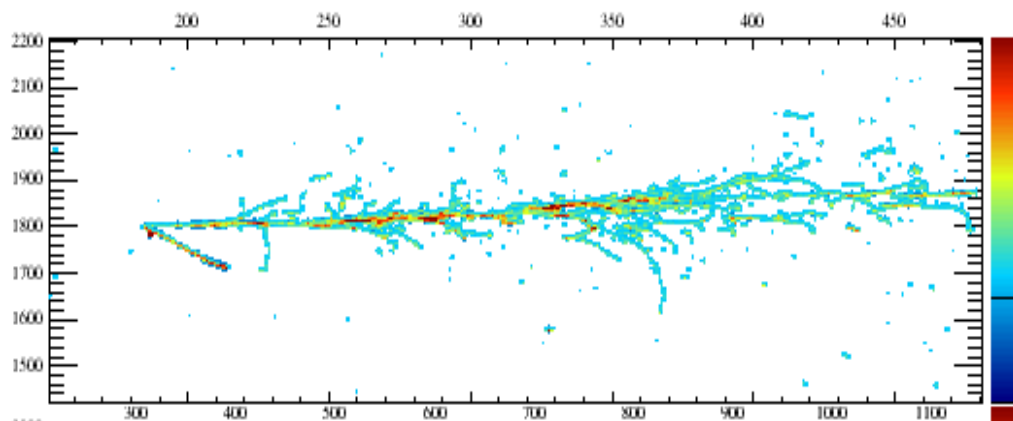
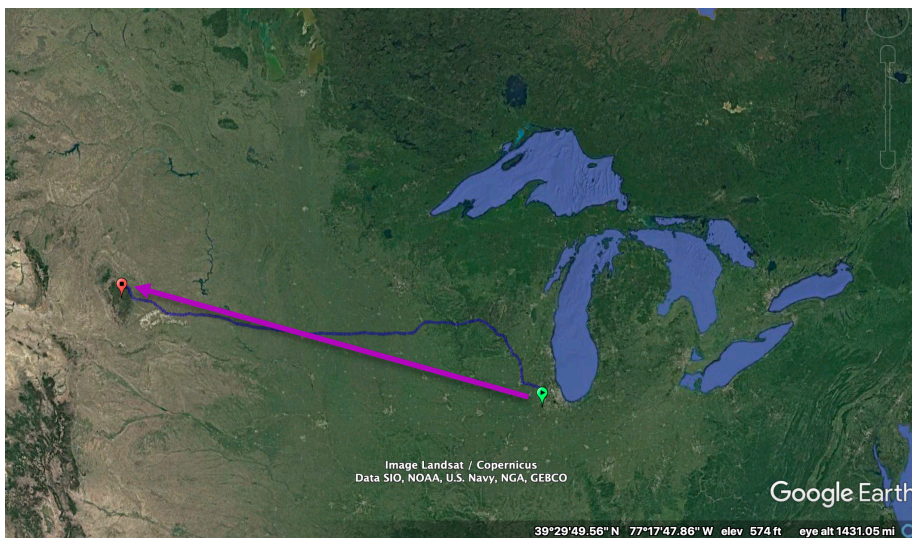
November 25, 2020

Welcome!

- Information Transfer Goals of this workshop:
 - Current DUNE Status
 - Activities on DUNE already taking place in Canada
 - Areas of mutual interest on DUNE
- Format for each section after the overview:
 - Introduction to challenges from DUNE perspective
 - Information about Canadian Expertise and introduction
- Lots of time for discussion on Monday at end of workshop

DUNE

- Long baseline neutrino experiment: 1300km distance of accelerator-based neutrino travel
- Broad Band experiment: 1-6 GeV neutrinos
- Physics Goals: Neutrino Mass Ordering and search for CP violation
- Liquid Argon Detector (very fine granularity)



AR Diwan MV, et al. 2016.
Annu. Rev. Nucl. Part. Sci. 66:47–71

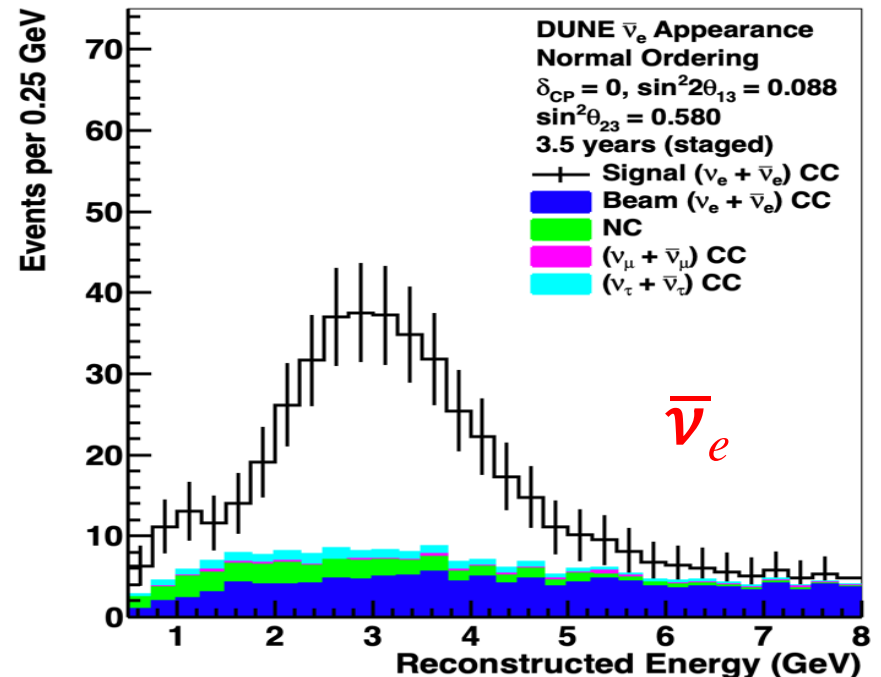
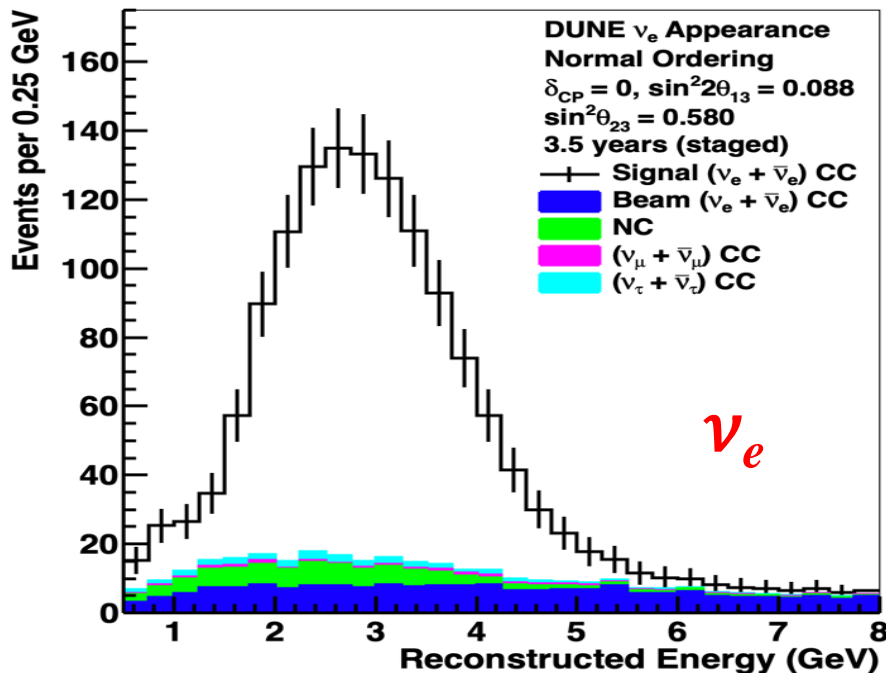
Next: ν_e Spectra, not just events

Real test of the framework,

see ν_e appearance versus neutrino energy

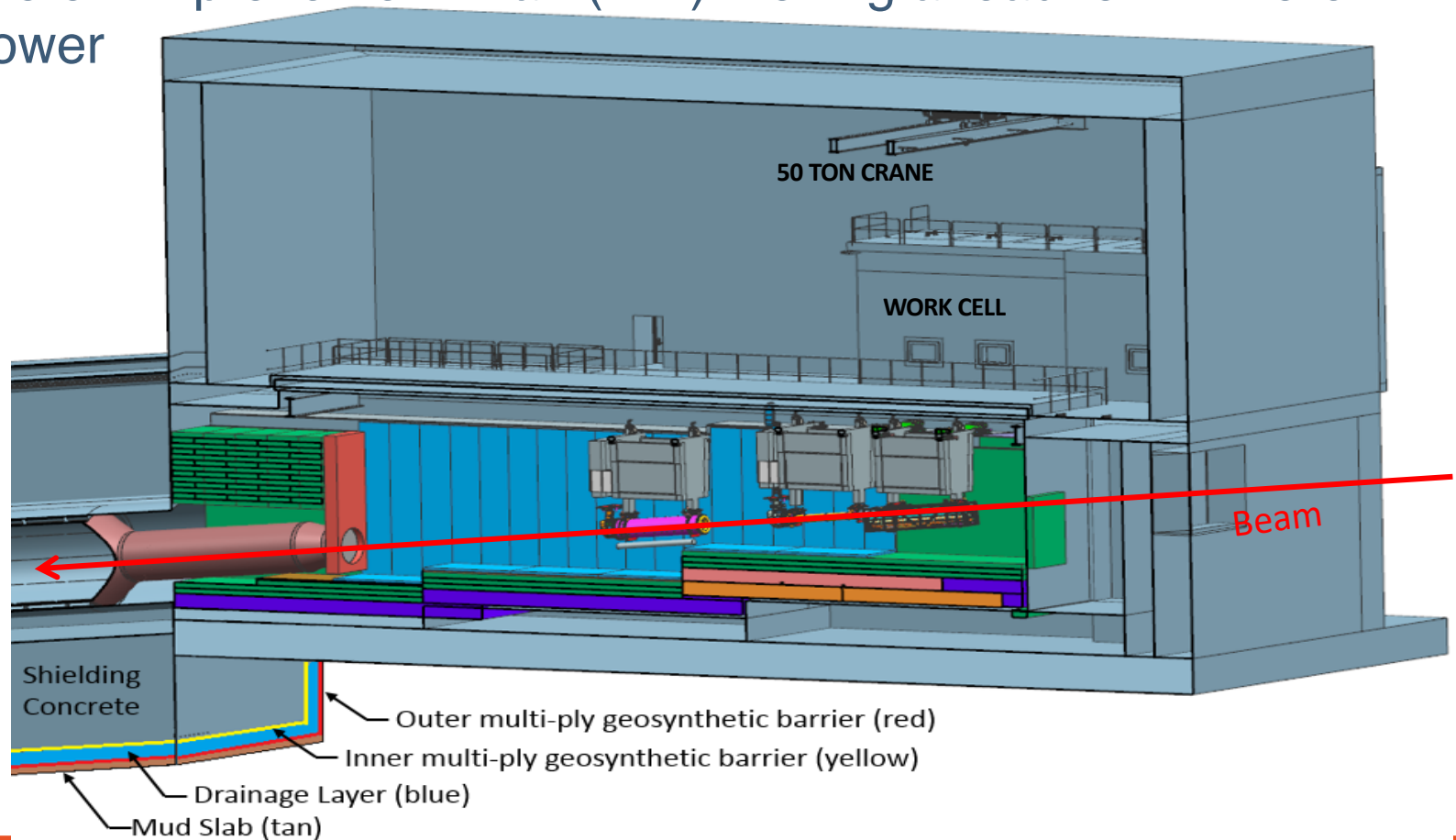
CP-violation and mass hierarchy show up in different energies

DUNE in 7 years: 1000's of events!



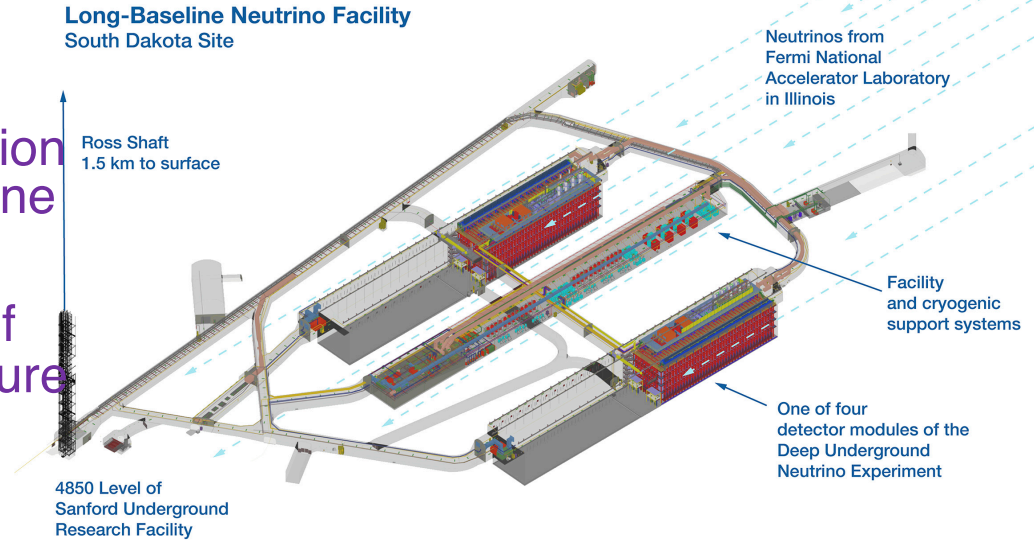
DUNE's Neutrino Beam (see talk by J. Lewis)

- Fermilab already at 750kW proton power (starting next week!)
- Proton Improvement Plan (PIP) moving ahead for x2 more power



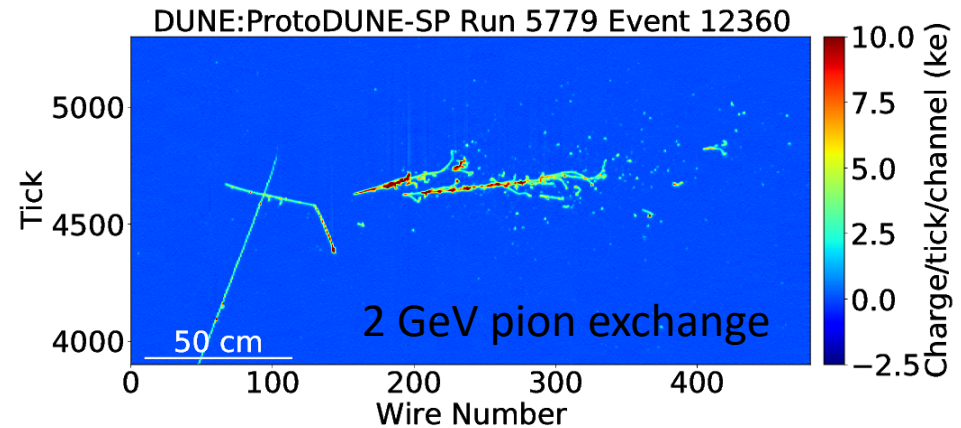
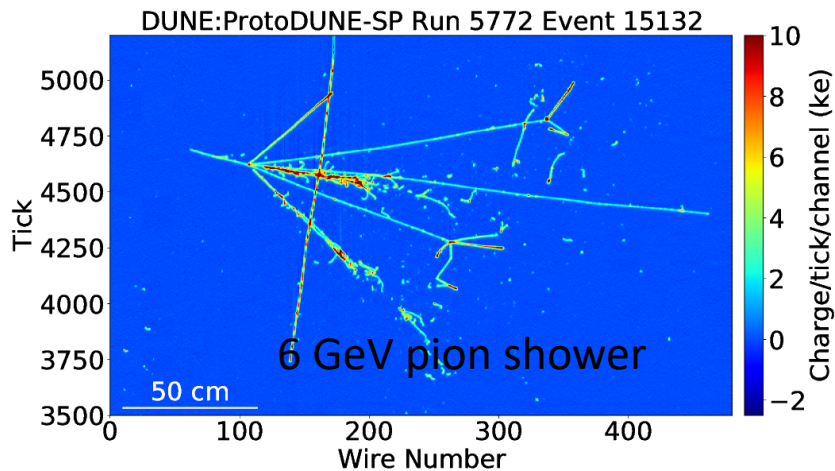
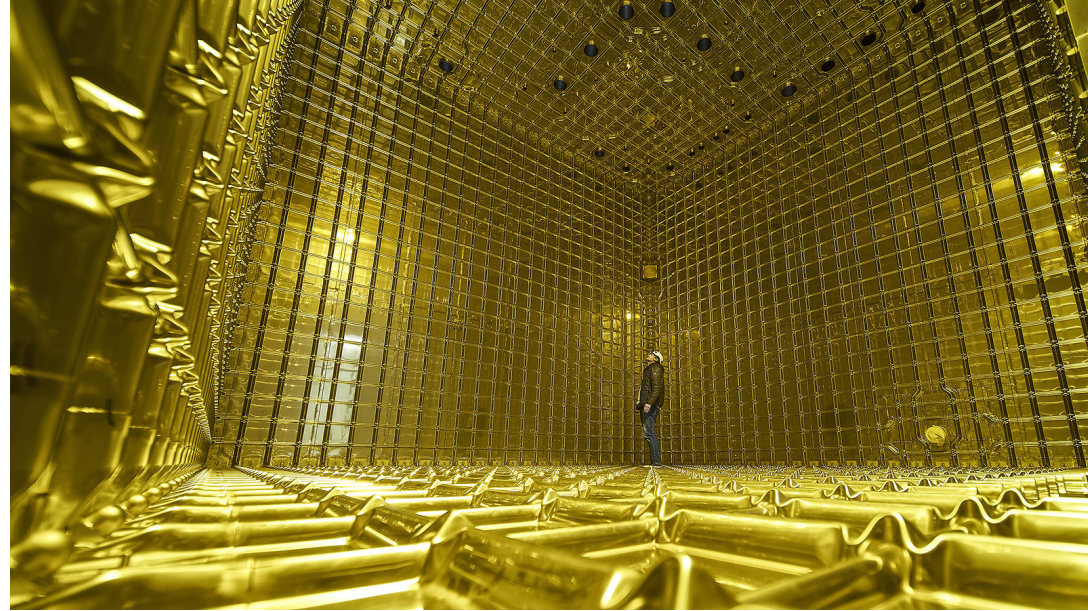
Far Detector News: Excavation Contract Awarded!

- Contract for Underground Excavation awarded last week—major milestone
- Drill, blast and remove 800kton of rock to make space for 4x17kton of liquid argon and related infrastructure
- Detector: Liquid Argon TPC for at least 3 out of 4 modules



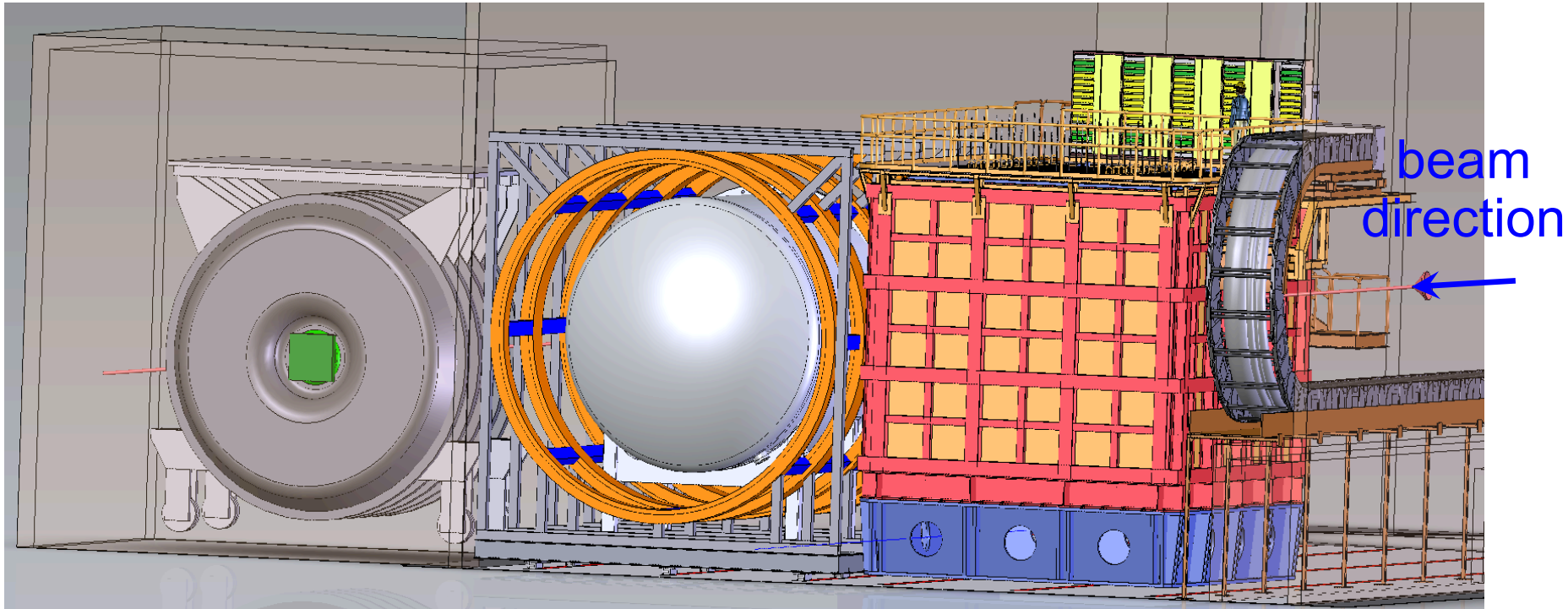
More Detector News

- ProtoDUNE: 1kton half-height test of Far detector construction techniques
- Performance in charged particle test beam published:
[arXiv:2007.06722](https://arxiv.org/abs/2007.06722)
- [physics.ins-det]



DUNE's Near Detector Plan

- Several different detector technologies to play different roles

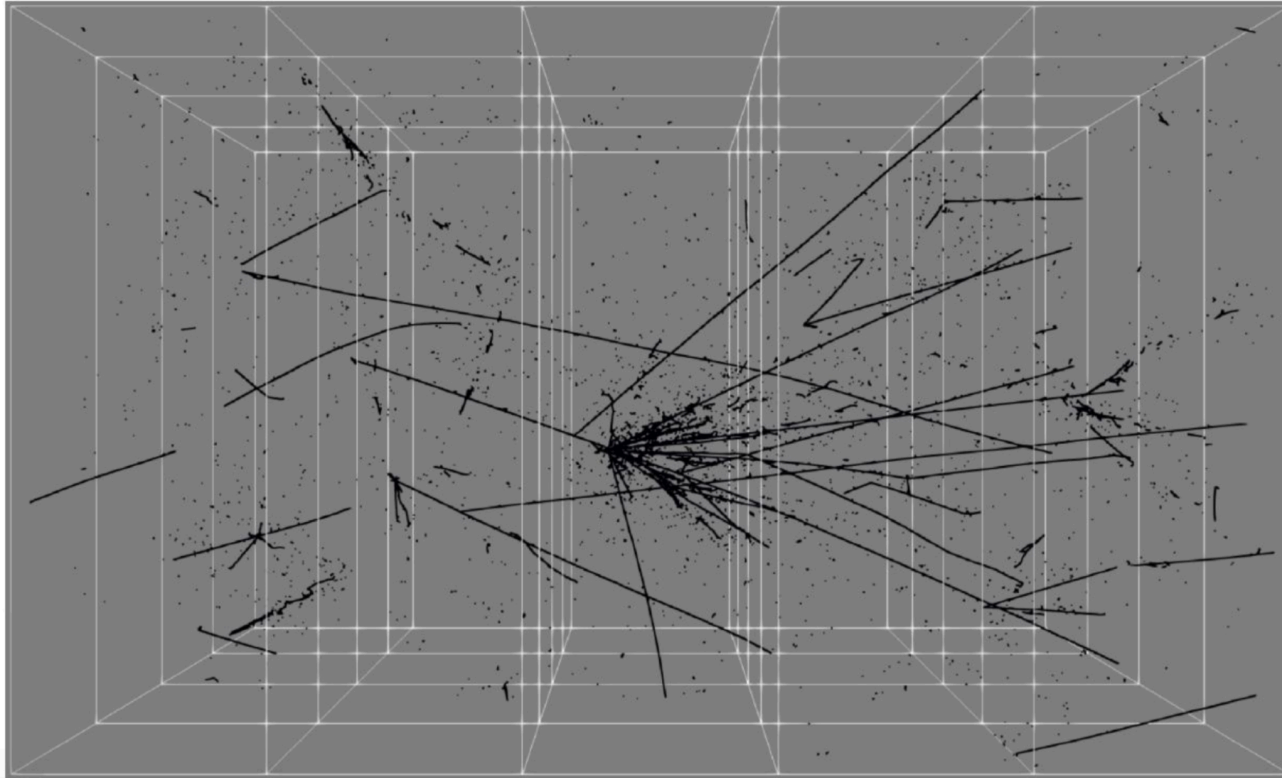


Scintillator cubes
For Beam monitor
and n measurements

Gaseous Argon TPC:
Study ν -Ar
interactions in detail

Liquid Argon TPC:
Most like Far
Detector

Near Detector Event Challenge

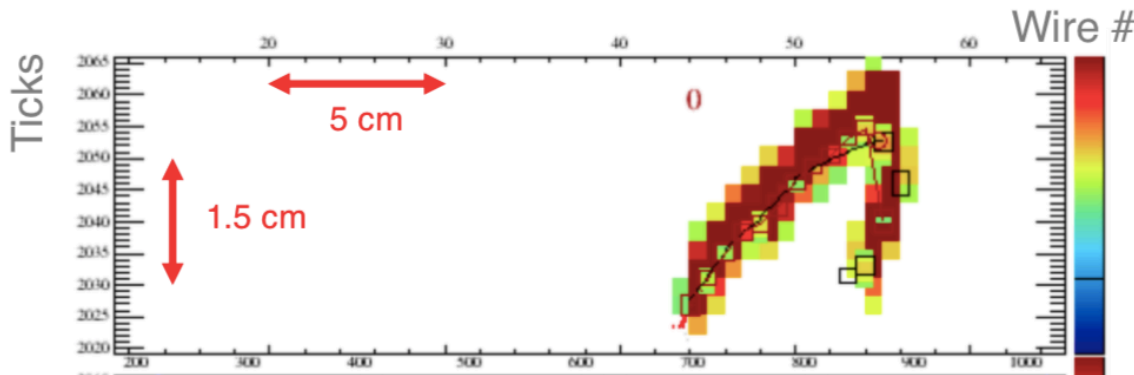


For a $4 \times 3 \times 5 \text{m}^3$ detector at $\sim 1 \text{km}$ distance: each color is different neutrino
37M Charged Current ν_μ interactions per year (80 GeV protons, 1.5×10^{21} POT)

- Beam is so intense in near detector hall, need design change
- Challenge: still need to measure how well the far detector design can identify interactions!
- Solution: Modular design, pixels instead of wires to read out signals

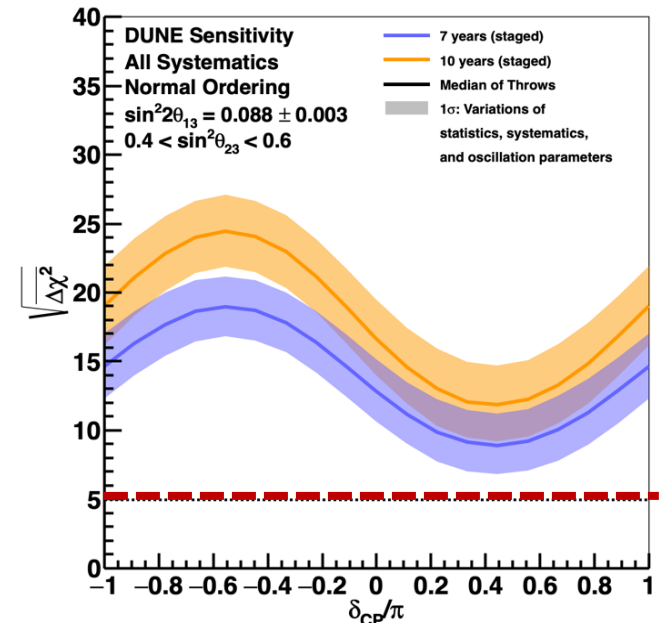
DUNE Physics Reach

- Mass Ordering: First results!
- CP Violation: "discovery reach" over much of phase space in 7-10 years
- Able to test the framework with broad energy range
- Sensitive to supernovae burst, expect 1000's of events

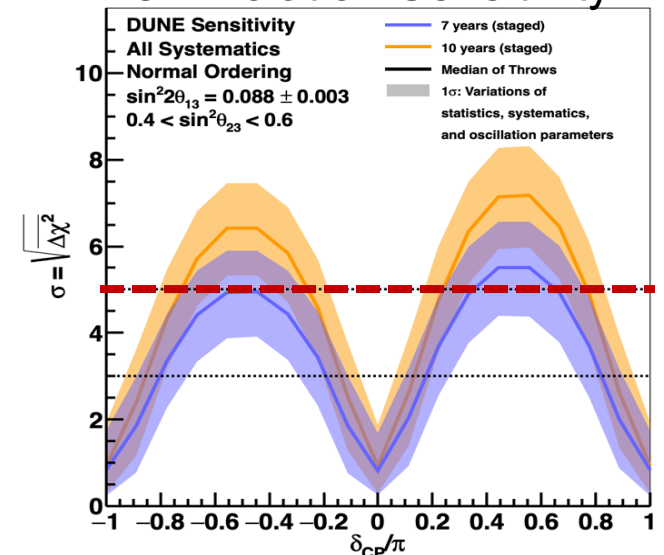


DUNE Simulation 30 MeV ν

Mass Ordering Sensitivity



CP violation Sensitivity



DUNE Schedule & Implications

R&D well underway now

DUNE Construction 2021-2029

Operation in Neutrino Beam 2029-2036

Operations begin with 1st module

Second module to start operations 1 year later

Later module schedules still being investigated

Later construction start means newer ideas can be implemented in the last module(s): “Module of Opportunity”

Continued physics exploitation beyond operation 2036 onward

Workshop Schedule

- Next talks:
 - Nikolina Ilic: Physics potential of DUNE beyond neutrinos
 - Claire David: DUNE-Canada activities
- Next Sessions:
 - Module of Opportunity
 - Photon Detection in Liquid Argon
 - Neutrino Beamline Construction
 - Hadron Production Measurements
 - Data Acquisition
- Many interesting talks over the next two days
- Wanted to have more discussion time

Backup slides

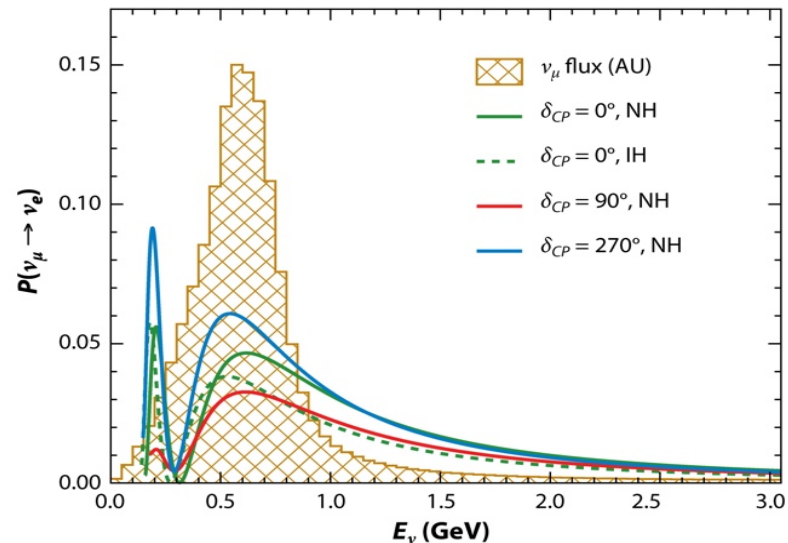
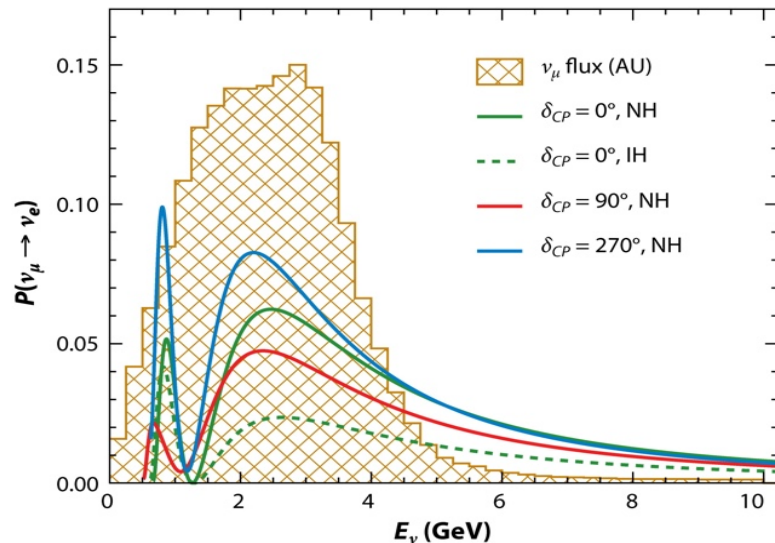
DUNE and HyperK ν Fluxes

- DUNE

- 1300km, 40kton
- Broad Band experiment: 1-6 GeV neutrinos
- Liquid Argon Detector (very fine granularity)

- Hyper-K

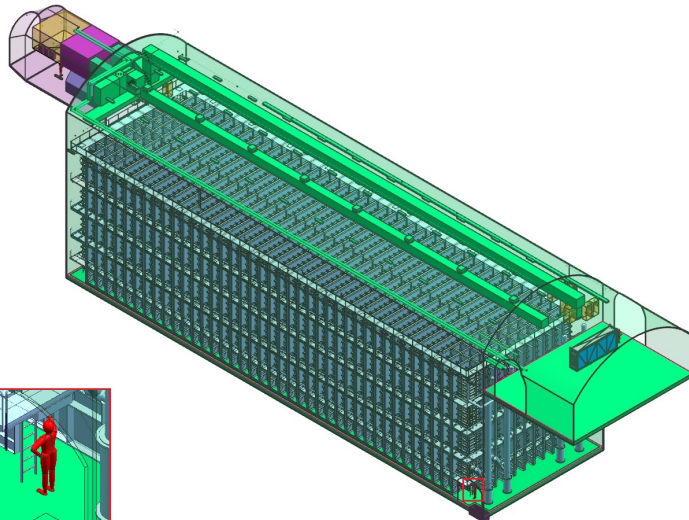
- 295km, ~1Mton
- 400-600MeV neutrinos
- Water Cerenkov detector (e and μ detection)



DUNE and HyperK Detectors

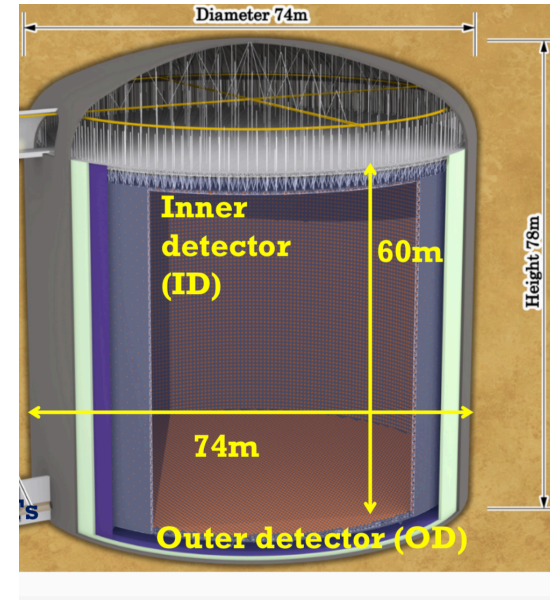
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Events in DUNE and Hyper-K

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 - Broad Band experiment: 1-6 GeV neutrinos
 - Liquid Argon Detector (very fine granularity)
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