Opportunities for Participation in DUNE

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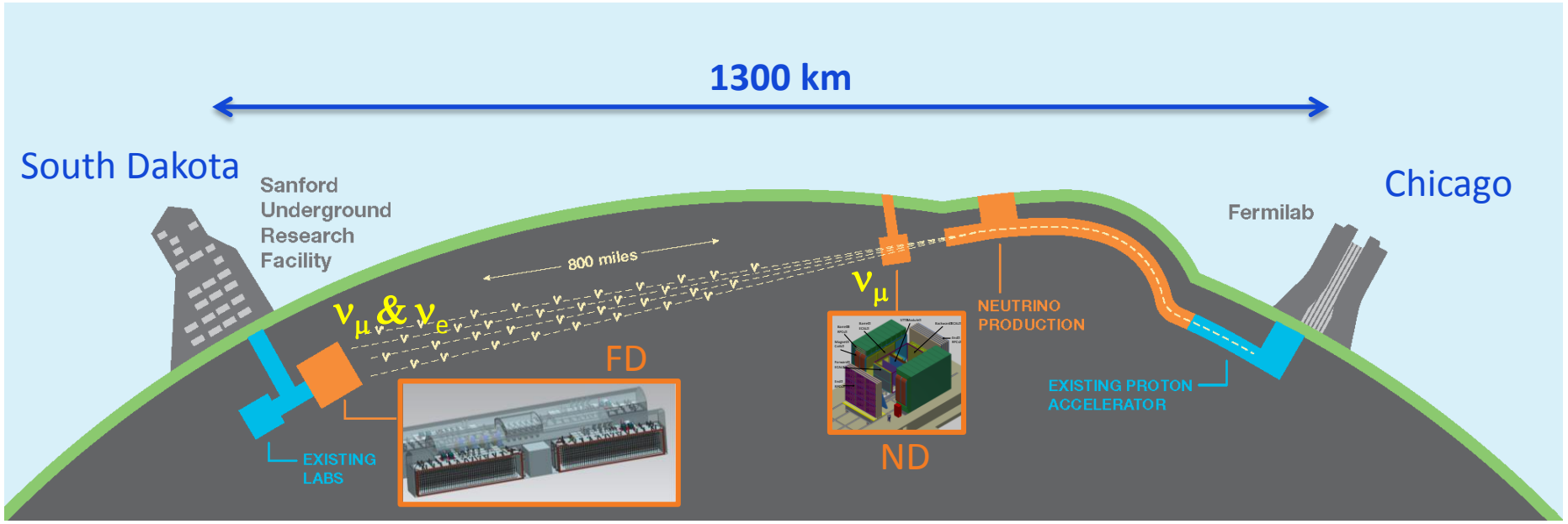
Neutrino – Latin America Workshop

April 28, 2016

LBNF/DUNE


1300 km
South Dakota
Sanford
Underground
Research
Facility
800 miles
Chicago
Fermilab
ν_μ & ν_e
ν_μ
NEUTRINO
PRODUCTION
FD
ND
EXISTING PROTON
ACCELERATOR
EXISTING
LABS

LBNF/DUNE

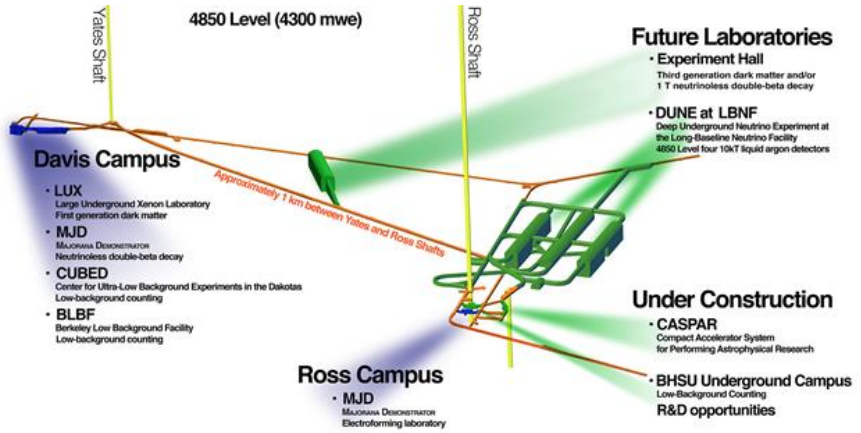
- LBNF (75% U.S. – 25% International)
  - Far Site Facilities
  - Cryostats/Cryogenics
  - Near Site Facilities
  - Beamline
- DUNE (25% U.S. – 75% International)
  - Far Detector (Four 10 k-ton Fiducial Modules)
  - Near detector

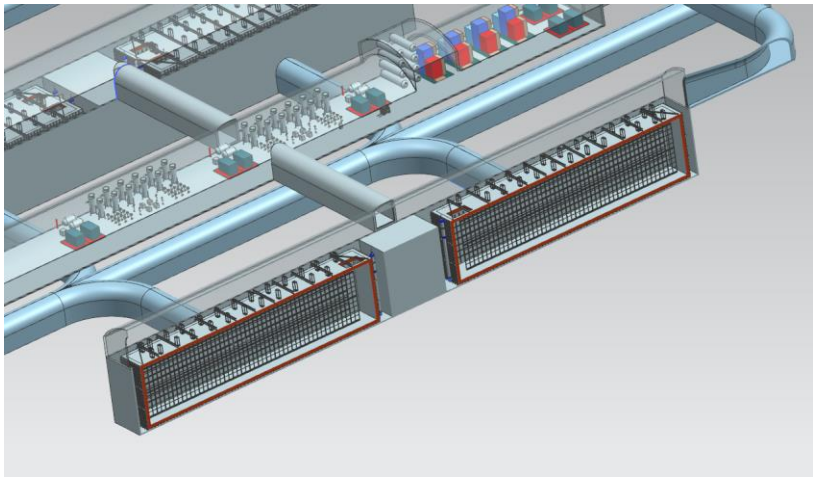
DUNE Project Scope

- Design, construct, and install four 10-kton fiducial mass Liquid Argon detectors for operation within the deep underground area of the Sanford Underground Research Facility (SURF) in South Dakota.

- Design, construct, and install a near neutrino detector at Fermilab to provide the necessary inputs for constraining systematic uncertainties on the precision measurements to be extracted from the deep underground detectors.

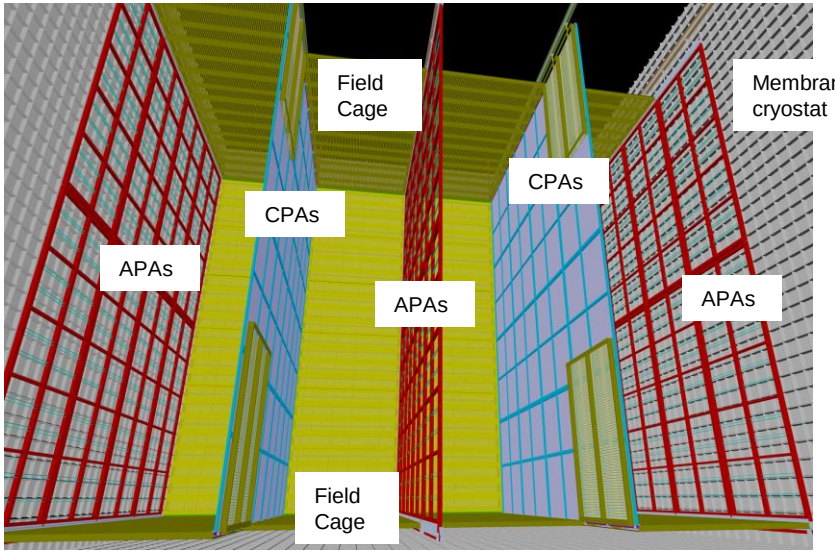
DUNE Far Detector Scope

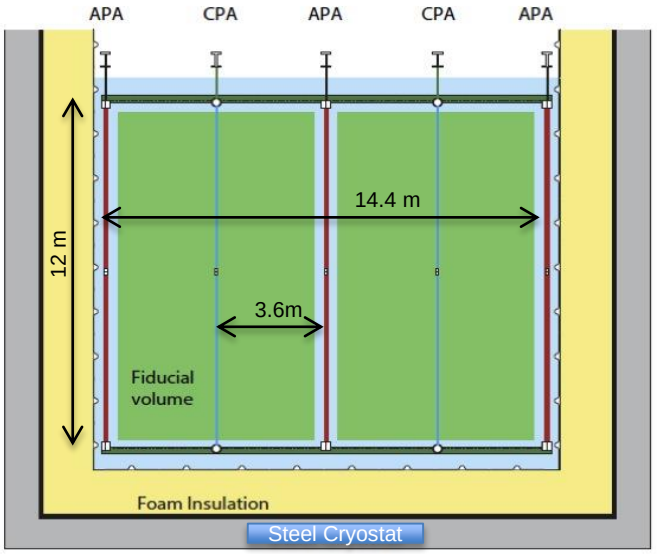




- Detection Capabilities
  - Full reconstruction of neutrino (accelerator, atmospheric, and supernova) interactions and nucleon decays
  - Photon collection for event timing (non-accelerator)
- Scope is the active detector: Time Projection Chamber (TPC), photon detection system, readout electronics, DAQ, installation, and integration

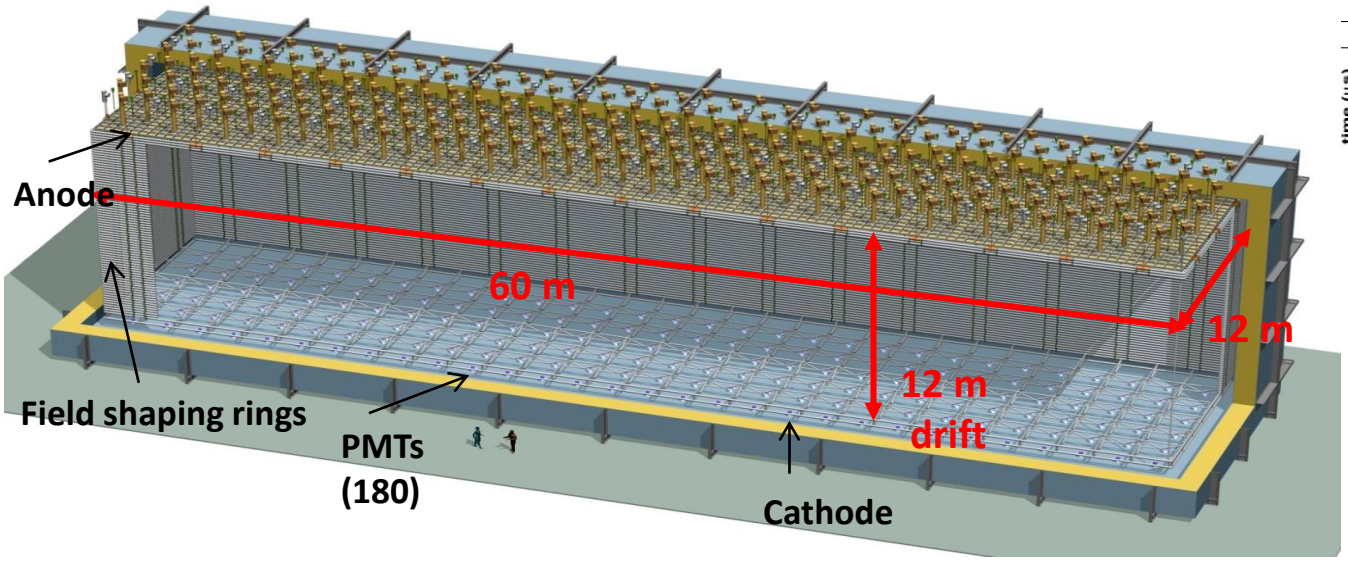
DUNE Far Detector Conceptual Design

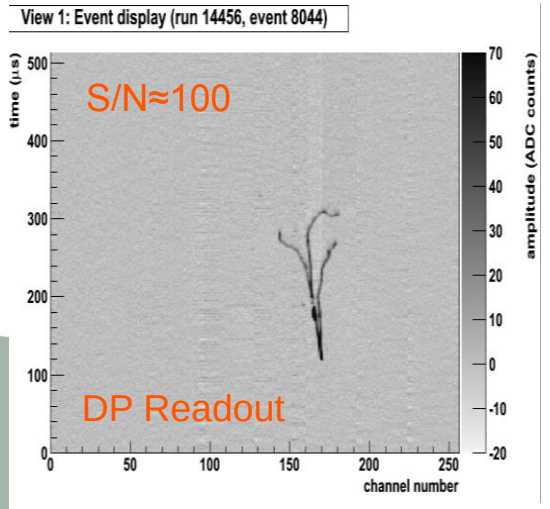




- Detector Parameters (One 10-kton Module)
  - 58 m x 12 m x 14.4 m (~50 times larger than ICARUS)
  - Alternating Anode and Cathode Plane Assemblies resulting in four 3.6 m drift volumes
  - Modular design to facilitate underground transport and installation

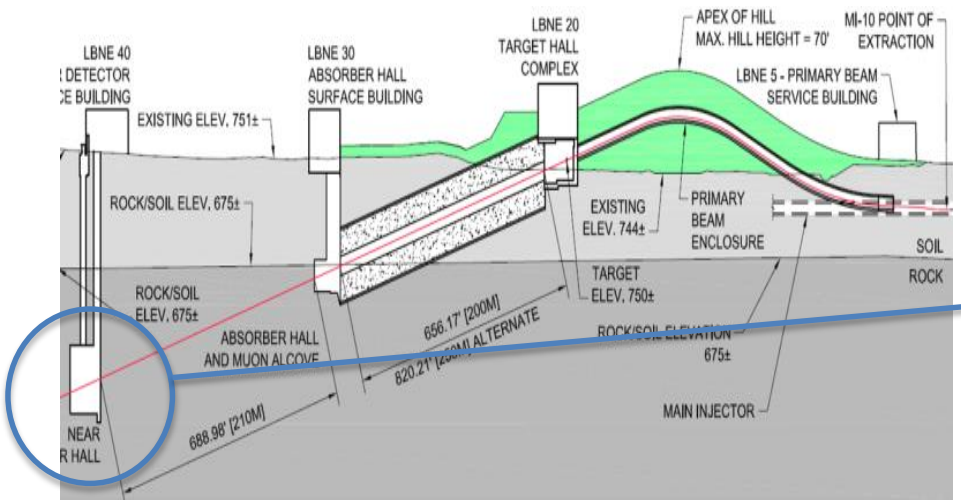
DUNE Far Detector Alternative Design

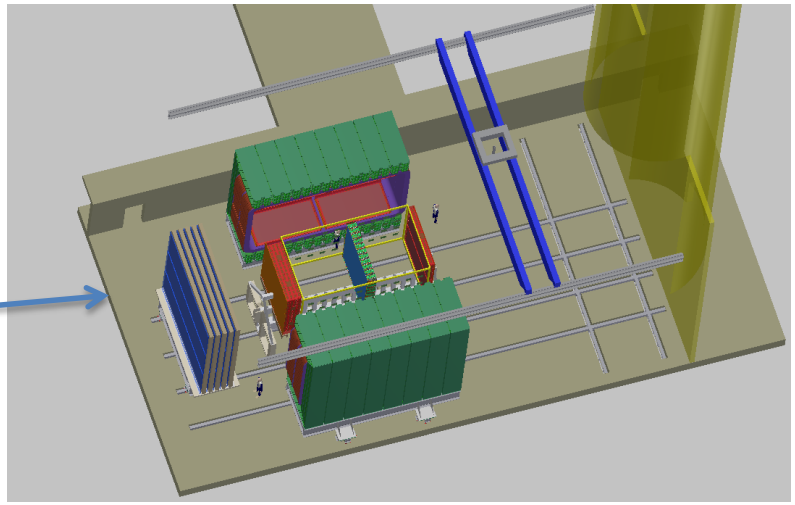




- Alternative Design Features
  - One drift region (bottom to top)
  - Modular design to facilitate underground transport and installation
  - Large S/N possible due to signal amplification in gas phase

DUNE Near Detector Scope

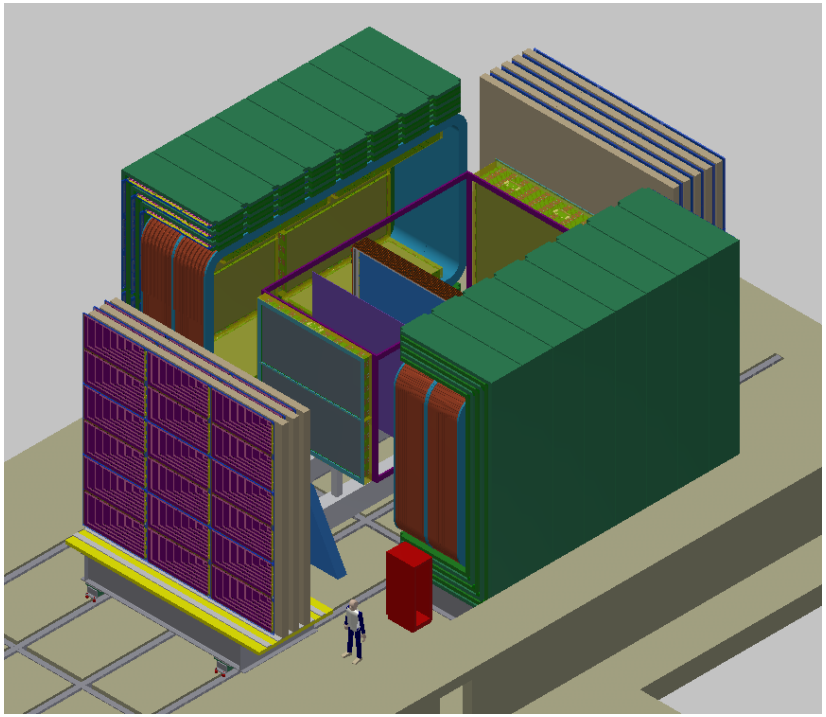


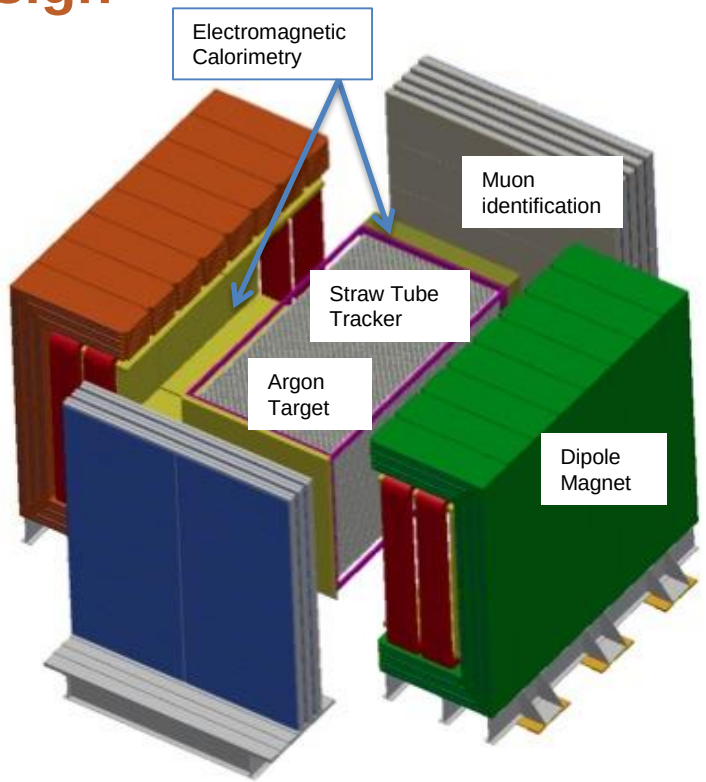


- Detection Capabilities
  - Measurement of absolute and relative electron neutrino, electron anti-neutrino, muon neutrino, and muon anti-neutrino spectra in the neutrino beam produced at Fermilab
  - Ability to operate in a higher-rate environment

- Scope is the active detector: dipole magnet, targets, straw tube tracker, electromagnetic calorimetry, muon ID detectors, readout electronics, DAQ, installation, and integration

DUNE Near Detector Conceptual Design





- Detector Parameters
  - 3.5 m x 3.5 m x 7 m Straw Tube Tracker
  - 4π electromagnetic calorimetry and muon ID in dipole B field (0.4T)
  - Pressurized Argon Target

DUNE Priorities

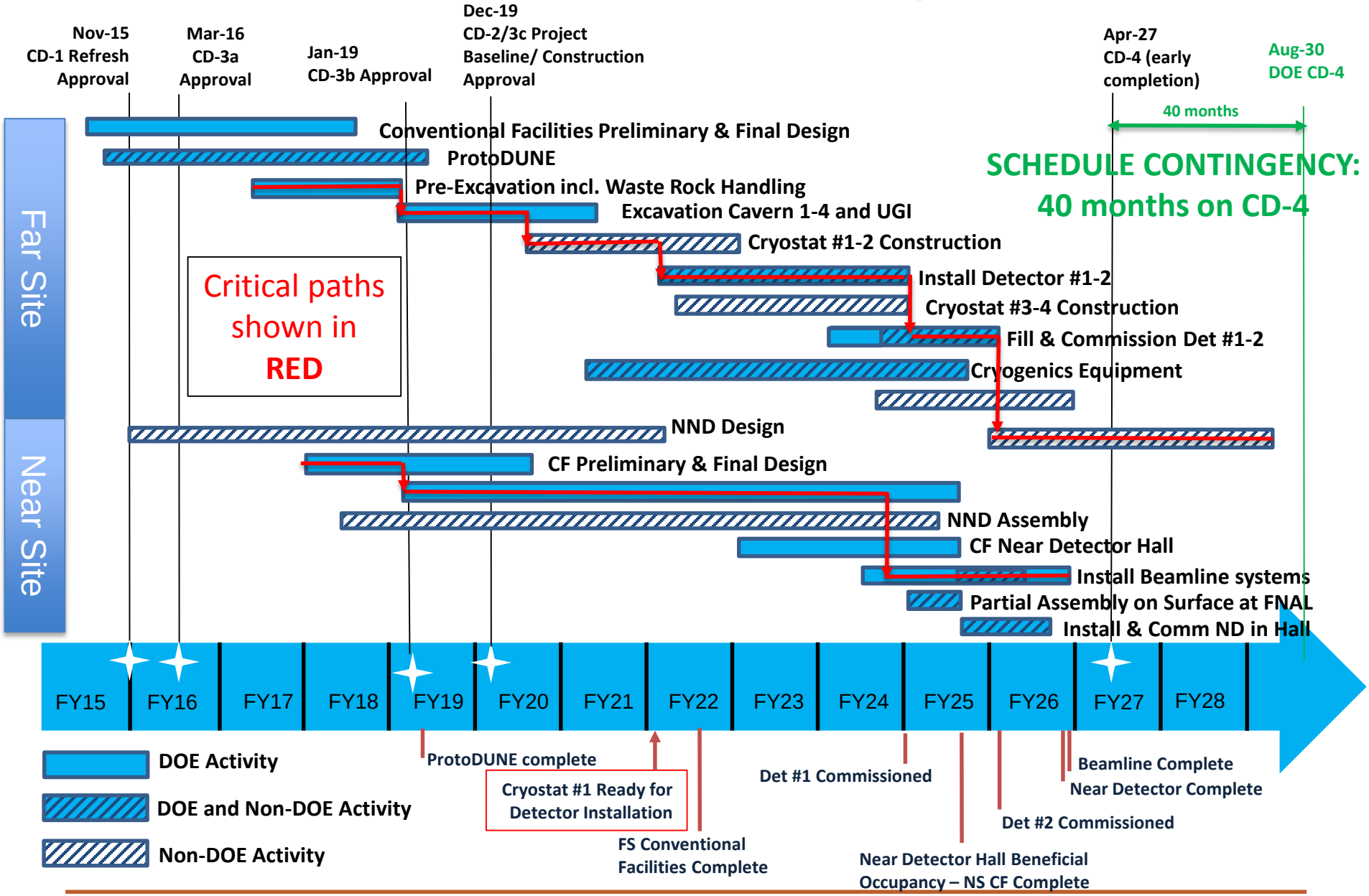
- Two equally important (and competing) priorities for DUNE from now through 2019 are
  - Design, construction, installation, commissioning, and operation of ProtoDUNE Detectors
  - Preparations for CD-2
- These are the key activities that get DUNE to the planned installation of the first 10-kton far detector at SURF in the early 2020's and ensure its leadership position within the international landscape for the CP-violation measurements

Opportunities with DUNE

From Mark's Presentation

- ★ **DUNE is a long-term scientific program**
  - New collaborators are welcome
  - Potential to start small and ramp-up over the coming years
- ★ **Opportunities exist in many areas**
  - Hardware development
    - Particularly within protoDUNE @ CERN
  - Simulation and Reconstruction
  - Scientific studies
  - Theoretical input
  - Accelerator and beam-line
- ★ **Opportunities to build long-term scientific partnerships**
  - DUNE is a major "LHC-experiment-scale" international collaboration
    - foresee partnerships crossing national boundaries
    - Should aim to use DUNE to help strengthen/broaden scientific/technical base in participating institutes/countries

LBNF/DUNE - Schedule Summary Overview



Fermilab DUNE

Far Detector Opportunities

- The four 10 k-ton fiducial modules will be constructed sequentially
  - Collaboration strategy allows for evolution of detector design from module to module
  - Dual-phase approach is considered an option for 2nd and subsequent modules
- Expressions of interest from collaboration institutes who would like to take responsibility for production of module 1 & 2 detector components will be solicited in late 2017
  - Allows time for interaction with funding agencies to secure funding on timescale of 2019

Involvement in Detector Prototyping

- The DUNE collaboration considers both the single-phase and dual-phase development paths to be critical program components and places a high-value on contributions to these efforts
- Additional resources are needed to fully maximize the scientific impact of the prototyping program
- Relatively modest contributions to this program can have a big impact on the final designs for the far detector modules

Level of Involvement

- The timescale for the DUNE prototyping efforts is short and not everyone interested in participating in DUNE will be able to make significant capital contributions on this timescale

- However, contributions of scientific and engineering resources to these efforts are invaluable and create a path towards opportunities for future, more-significant involvement in far detector construction
  - Allows for intellectual participation in the detector designs at the earliest stages
  - Provides experience with detector construction techniques developed during prototype development

Far Detector Prototyping Program

- DUNE has well-developed plans for a series of detector prototypes that will provide input to the process leading to the final design(s) for the DUNE far detector modules

- Benefits of the prototyping program are
  - Mitigation of risks associated with current detector designs
  - Establishment of construction facilities required for full-scale production of detector components
  - Early detection of potential issues with construction methods and detector performance
  - Provides required calibration of detector response to particle interactions in test beam

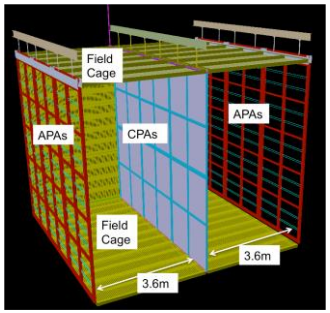
DUNE Far Detector Prototyping

Single-Phase

35-TON

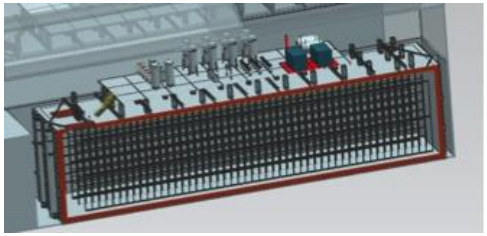
2015

protoDUNE



2018

DUNE Reference Design



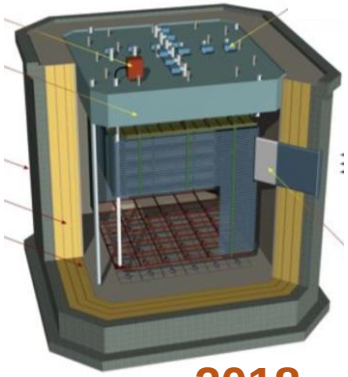
2021

Dual-Phase

WA105 (1x1x3 m^3)

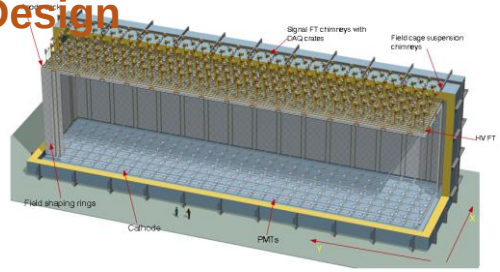
2016

WA105 (6x6x6 m^3)

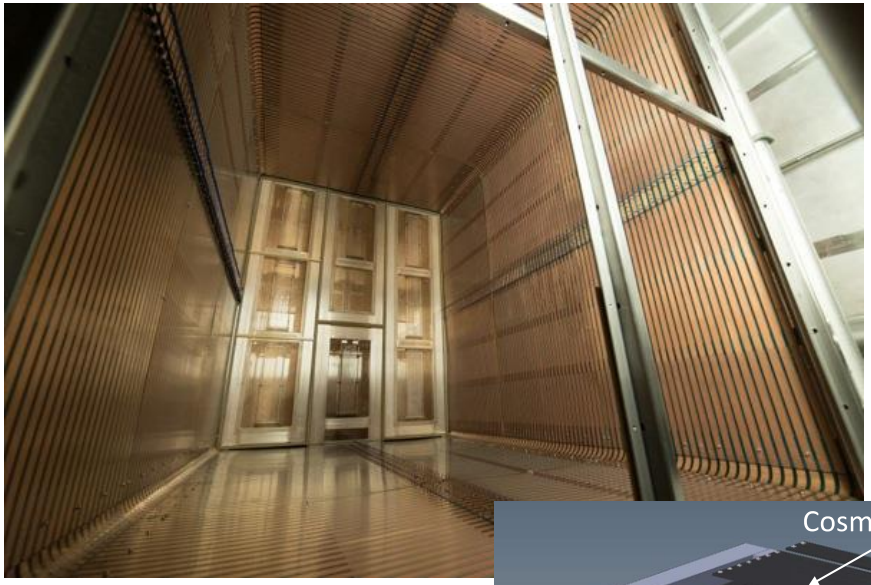


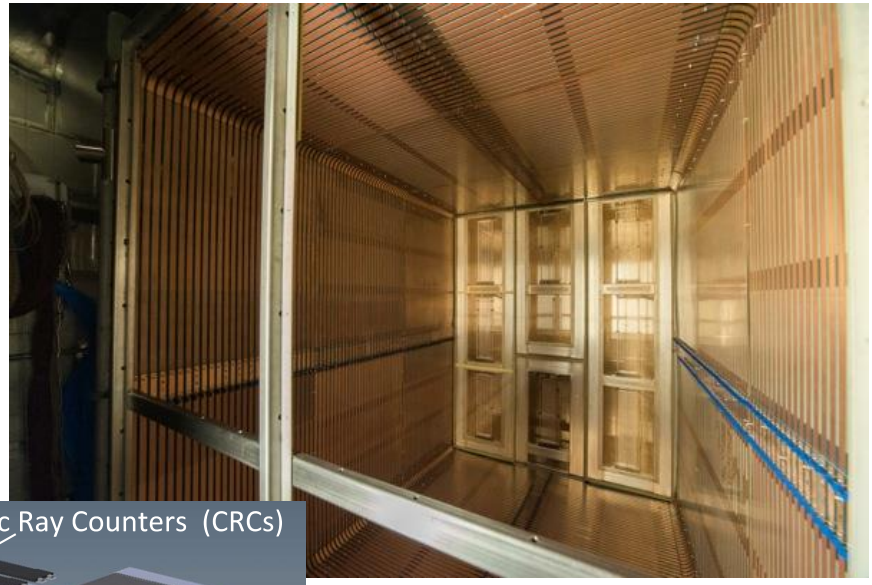
2018

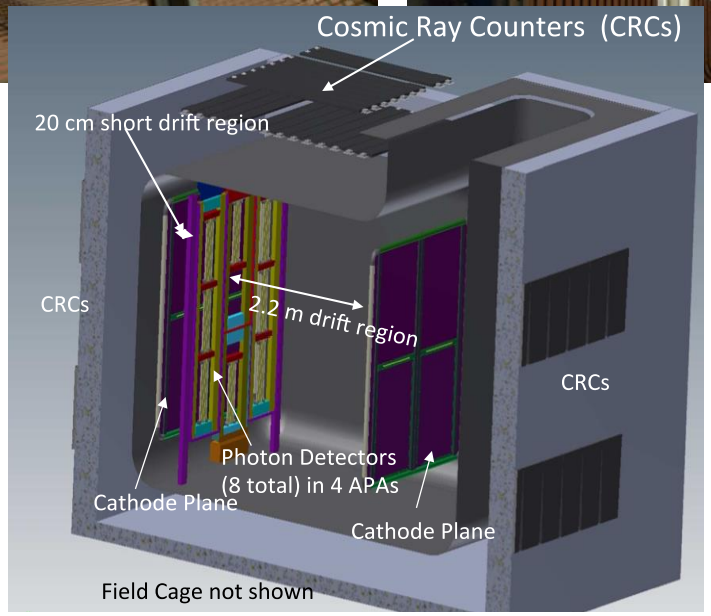
DUNE Alternative Design



35-ton (Fermilab)

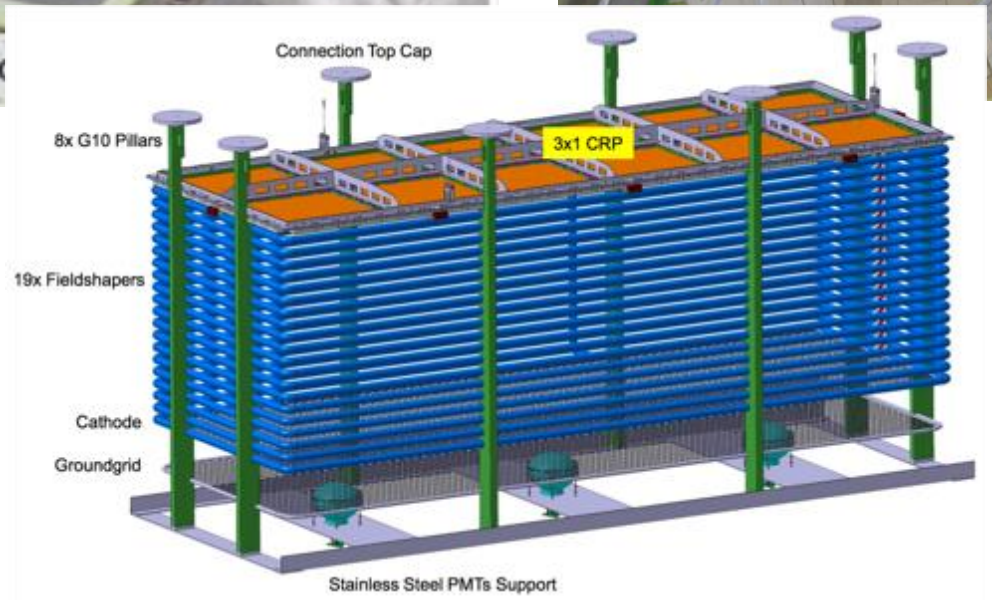






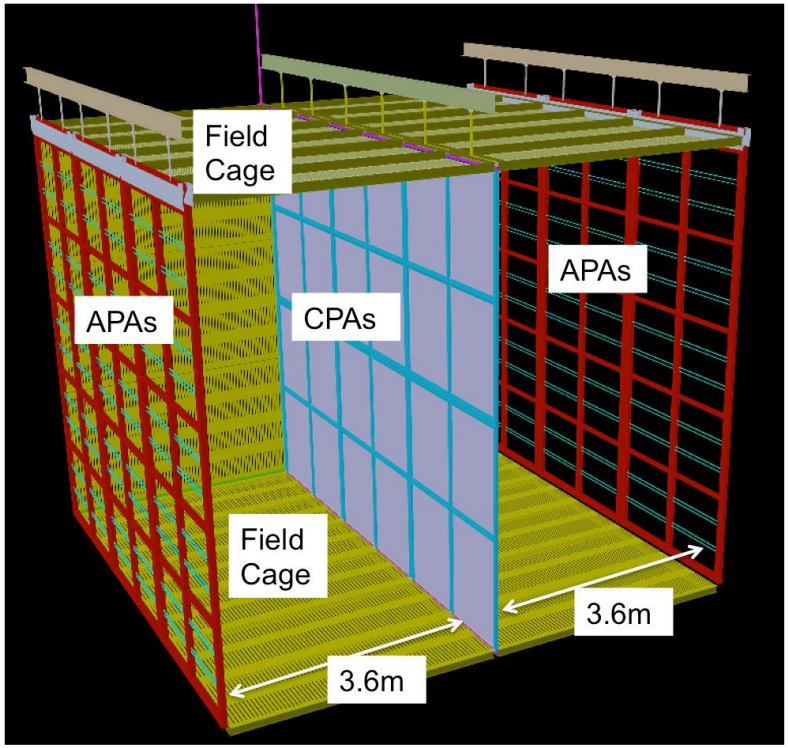
Operations completed April 4th

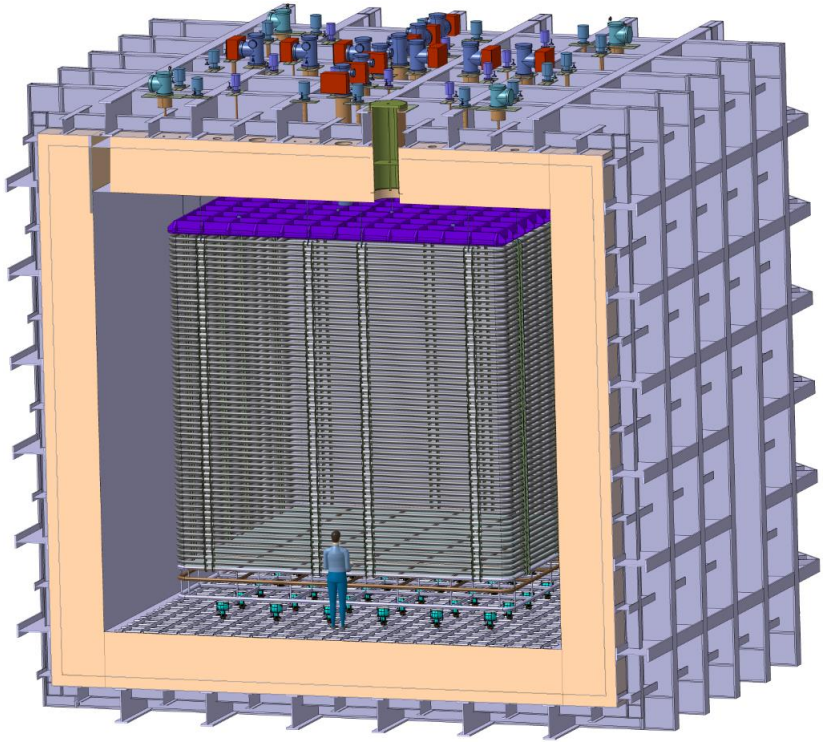
WA105 1x1x3 m^3 (CERN)



Operation in Fall 2016

ProtoDUNEs





ProtoDUNE Schedule Highlights

- Test Beam Facility available – August 2016
- Begin Production of first APA Plane – October 2016
- Cold Electronics Production Run – March 2017
- ProtoDUNE Cryostat available – April 2017
- First APA Planes Arrive at CERN – May 2017
- Detector Installation Complete – February 2018

Near Detector Opportunities

- Current planning calls for installation of the near detector on the timescale of 2026
  - Allows for further development of the current conceptual design
  - Other options including liquid argon and high-pressure gas TPCs are under study
- Collaboration task force has been charged with developing the simulation tools needed to study these different options
  - Goal is to be able to provide these tools on the timescale of spring 2017

Near Detector Opportunities

- As in the case of the far detector, the collaboration plans to solicit expressions of interest from collaboration institutes who would like to take on responsibilities for construction of near detector components

- The timescale for assigning these responsibilities is still under discussion
  - First step is to perform the physics studies necessary to settle on the final design

Summary

- DUNE is ballistic and goals are ambitious
  - Operating full-scale prototypes in 2018
  - Beginning far detector construction in 2020
  - Near-term decisions on near detector design
- Opportunities exist for getting involved at levels within the collaboration
- Involvement in the near-term prototyping program is an opportunity for creating a pathway towards future participation in the far detector construction project