SWISS PERSPECTIVES FOR THE DUNE EXPERIMENT

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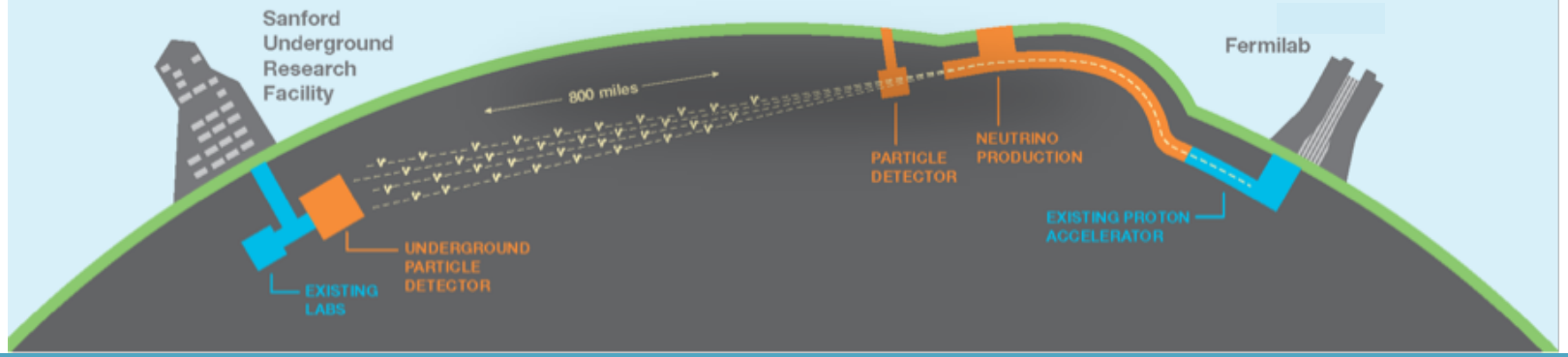
for the groups of Basel, Bern, ETHZ

DUNE Experiment

Neutrino beam physics: study LBL ν_e **appearance** and ν_μ **disappearance** in a WBB to measure **MH**, **CPV**, and neutrino mixing parameters in a single experiment. Deep underground location reduces cosmogenic background and enables sensitivity to low-energy physics.

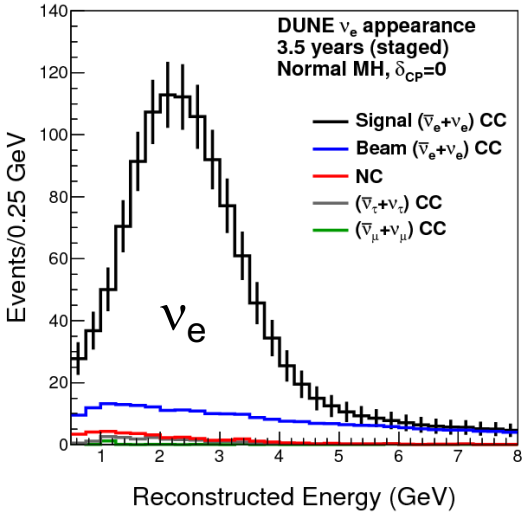
Underground neutrino observatory: unique opportunity for **matter instability** searches, **SN** neutrino detection, atmospheric neutrinos,…

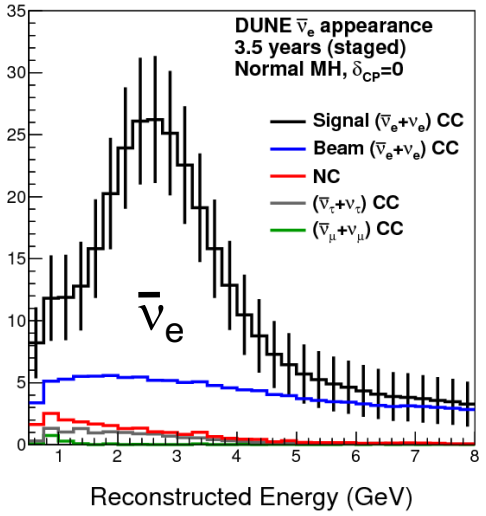


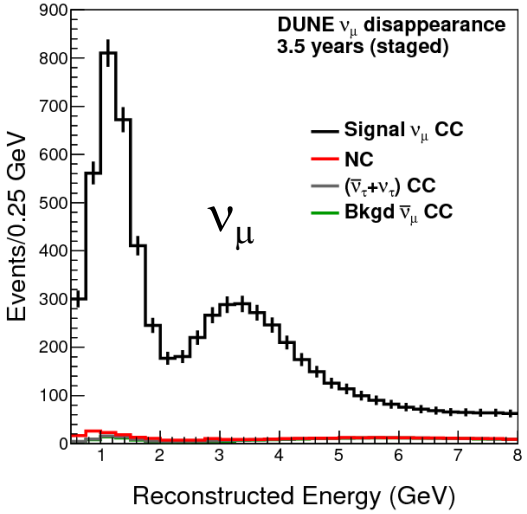
Oscillation sensitivity

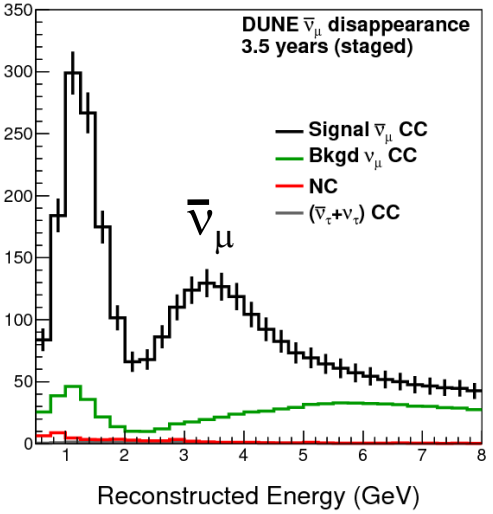
DUNE Conceptual Design Report (CDR)
arXiv:1512.06148

Order 1000 ν_e appearance events in ~7 years of equal running in neutrino and antineutrino mode





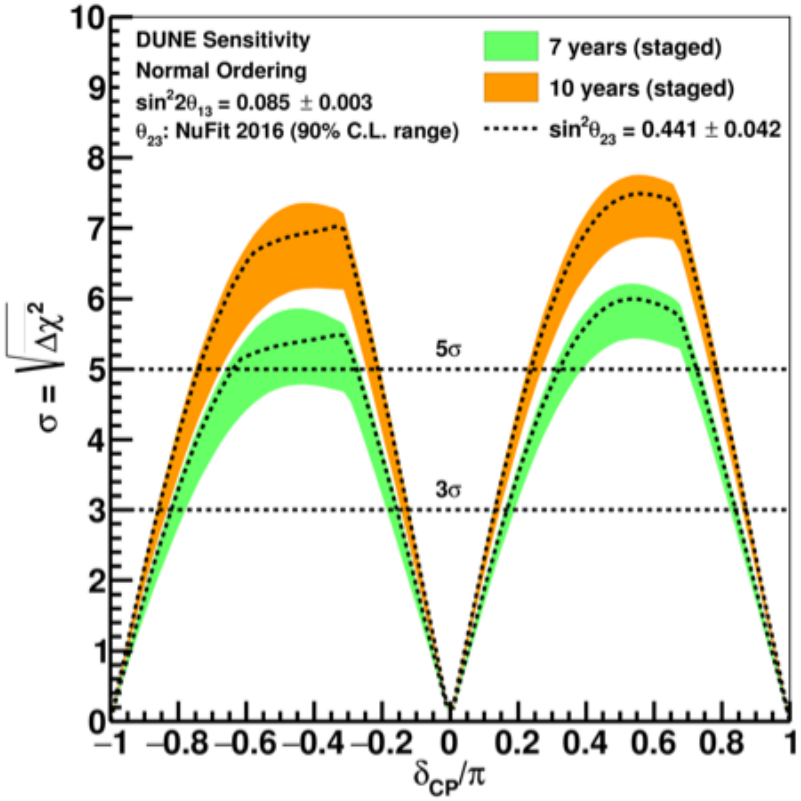


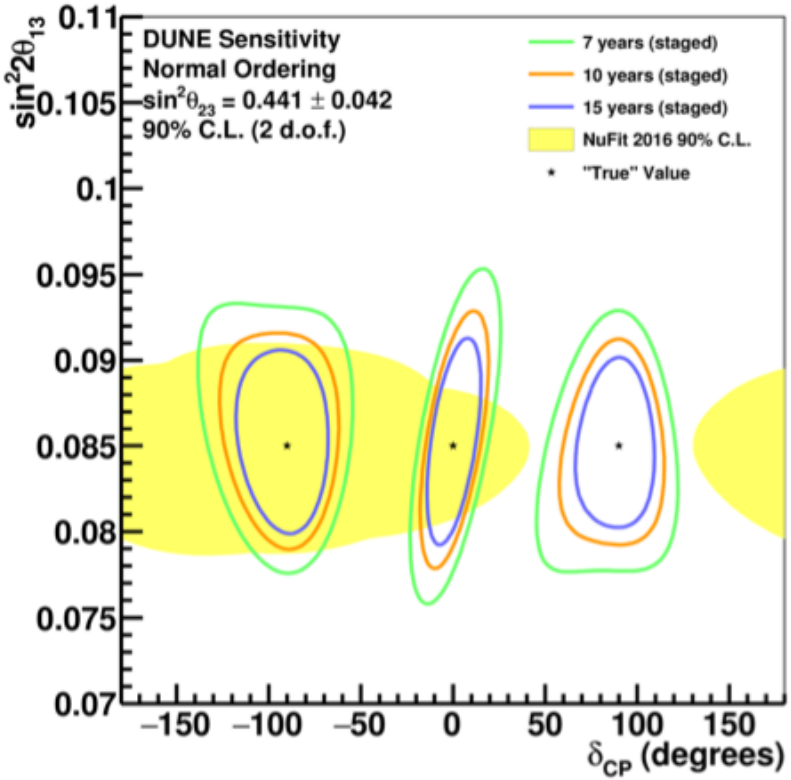


Sensitivity to CPV

DUNE CDR

CP Violation





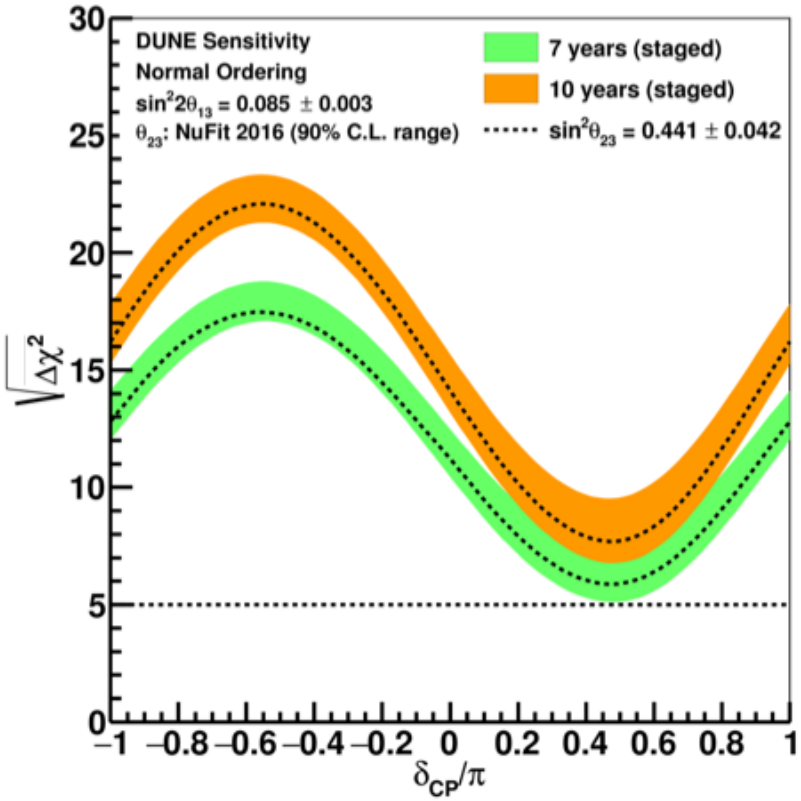
Width of band indicates variation in possible central values of θ_{23}

Simultaneous measurement of neutrino mixing angles and δ_{CP}

Other oscillation measurements

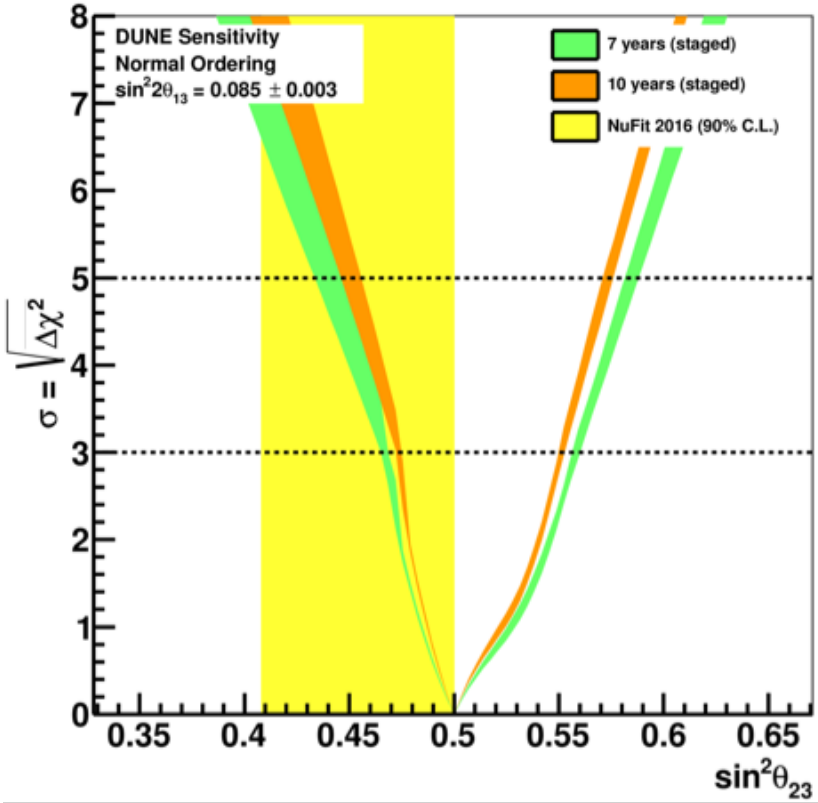
DUNE CDR

Mass Ordering



Width of band indicates variation in possible central values of θ_{23}

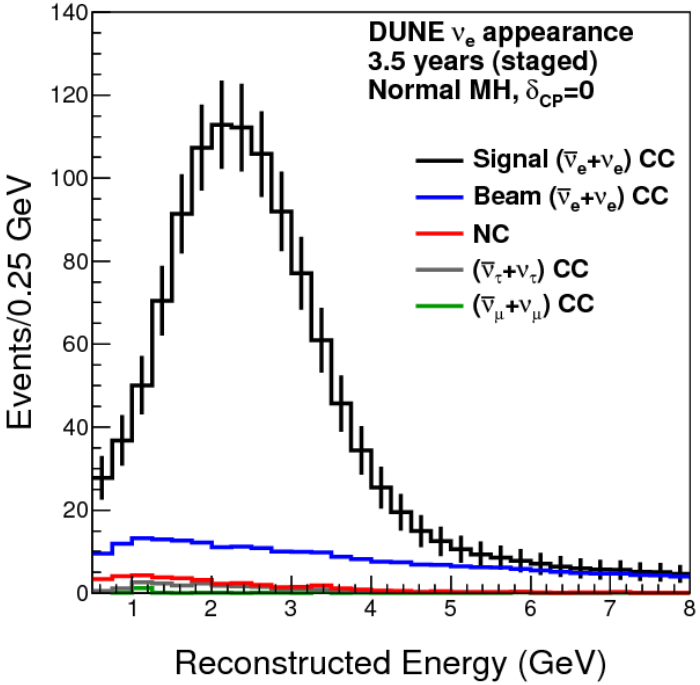
Octant



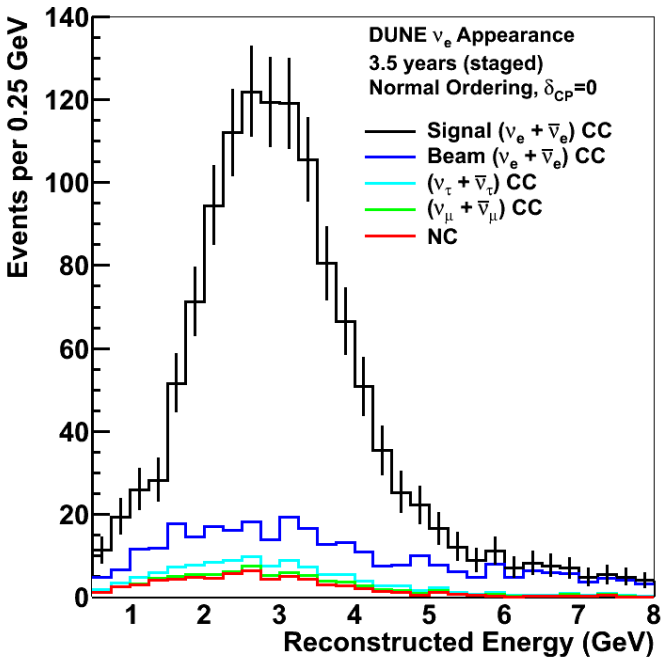
Width of band indicates variation in possible true value of δ_{CP}

Improved simulations (w.r.t. CDR)

CDR

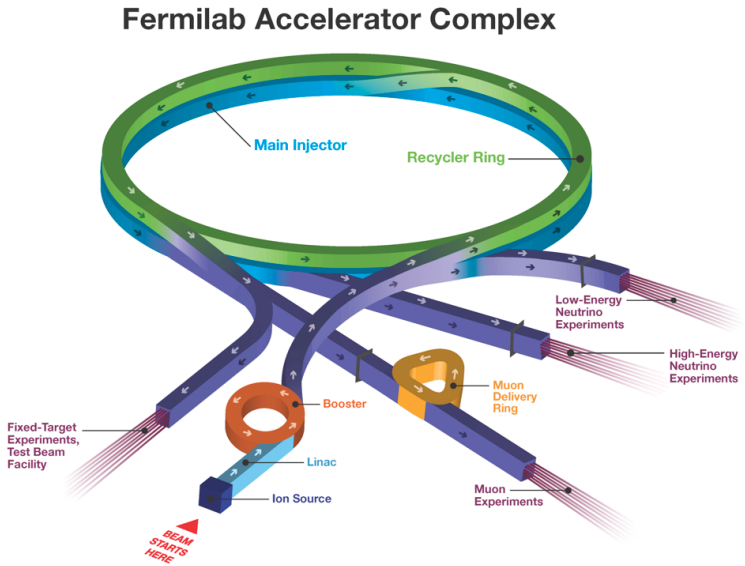


New!

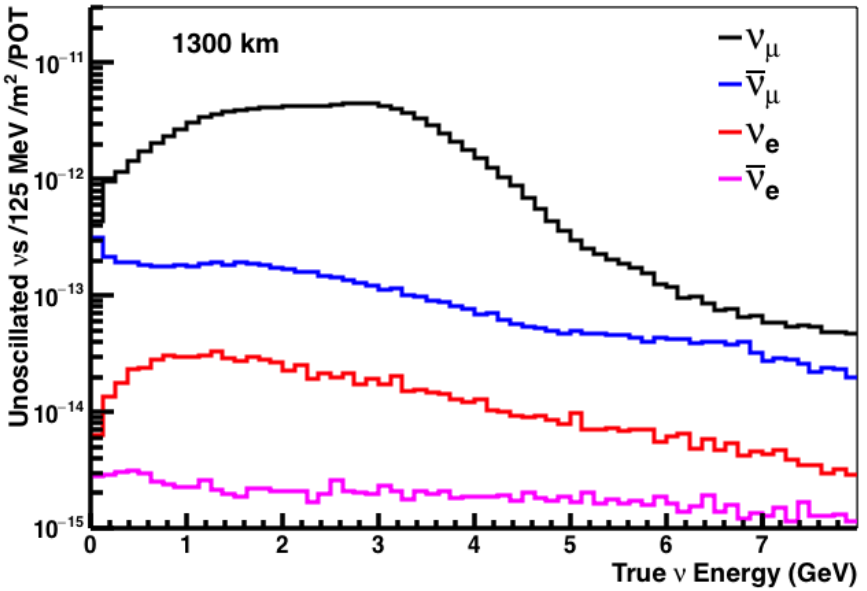


Sensitivity from MC-based analysis with automated reconstruction and event selection exceeds CDR sensitivity!

LBNF Beam

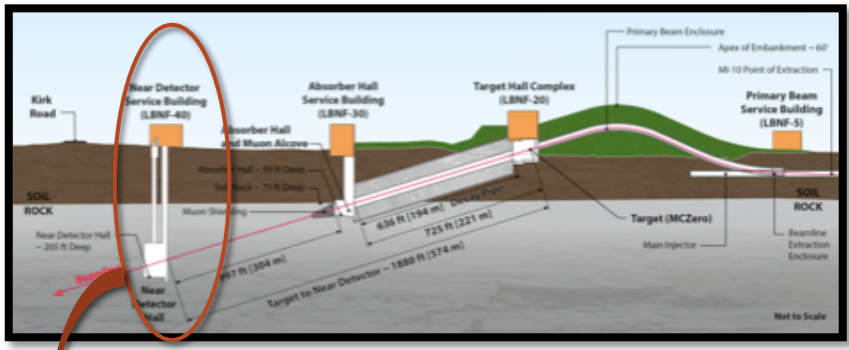


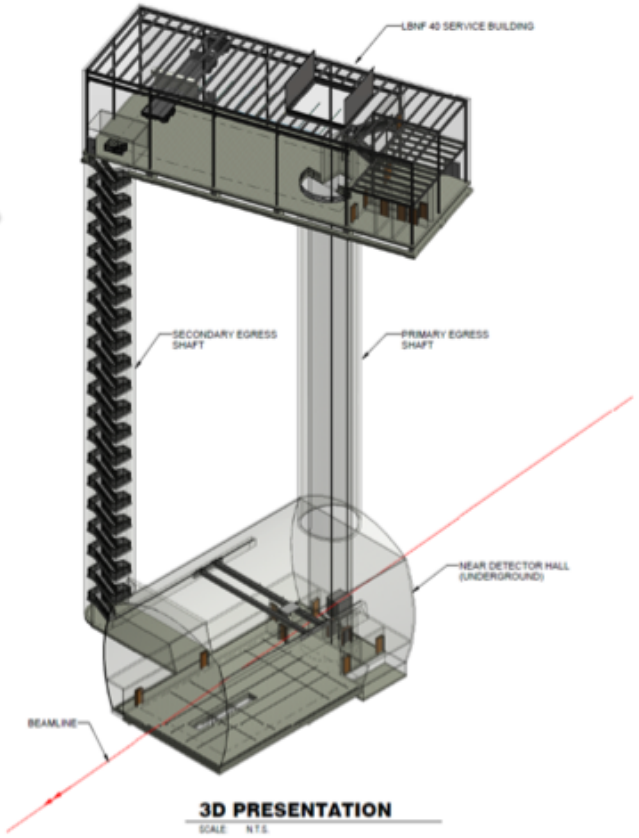
Neutrino Flux at 1300 km (CDR Optimized Beam)



- 60-120 GeV proton beam
- 1.2 MW, upgradeable to 2.4 MW
- Horn-focused neutrino beam optimized for CPV sensitivity
- Design of 3-horn focusing system based on optimized parameters (in progress)
- Neutrino and antineutrino modes

DUNE Near Detector

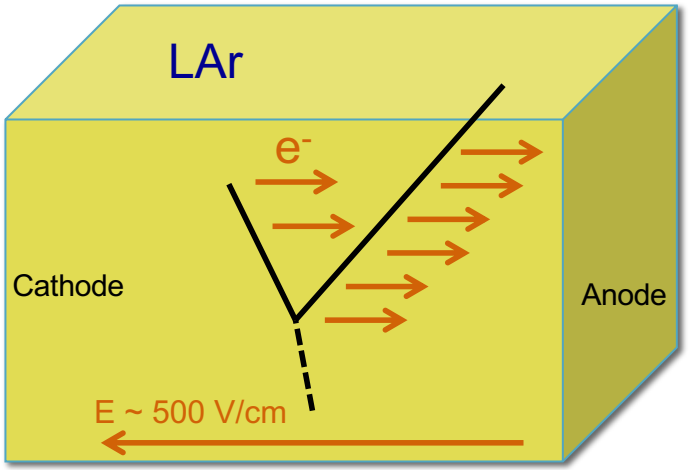




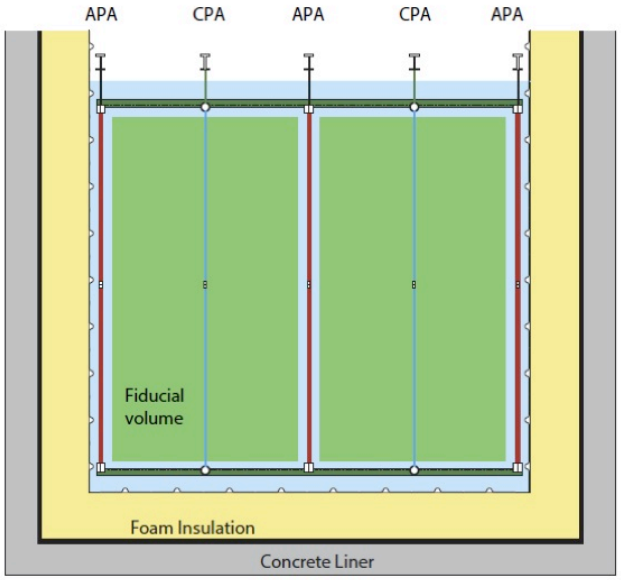
- Constrain systematics for long-baseline oscillation analysis: flux, cross-section, and detector uncertainties
- DUNE ND design concept near final (ND Design Group)
- Conceptual Design Report (CDR) planned for 2019
- DUNE ND design concept is an integrated system composed of multiple detectors:
  - Modular, pixel readout LAr TPC
  - Magnetized multi-purpose tracker
  - Electromagnetic calorimeter
  - Muon chambers
- Conceptual design will preserve option to move ND for off-axis measurements

DUNE Far Detector

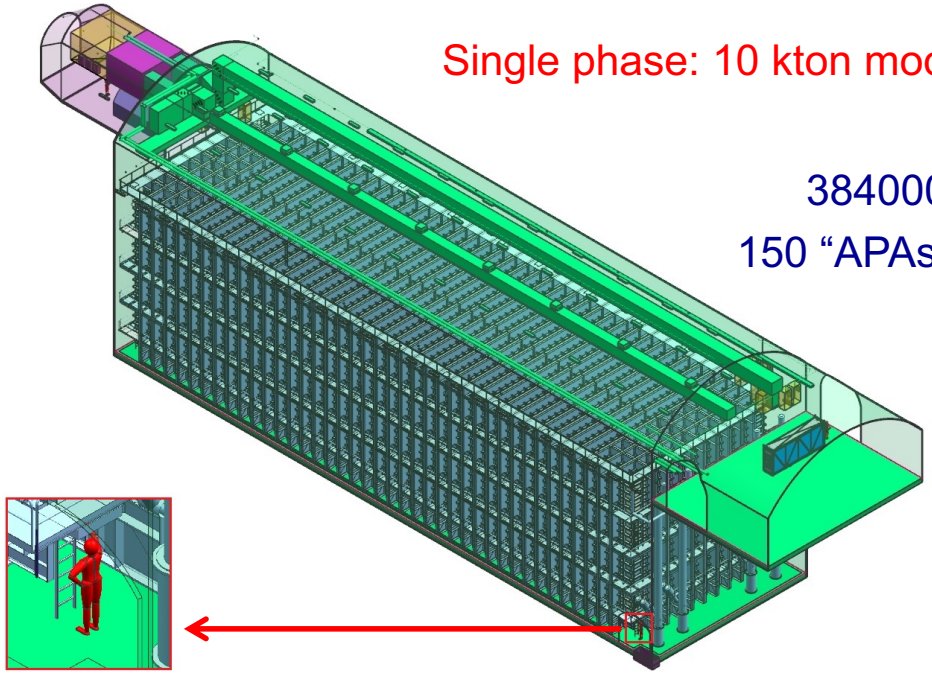
- 4 x 10-kton (fiducial) LAr TPC modules
- Single- and dual-phase detector designs
- Integrated photon detection
- Modules will not be identical



Single phase: modular wire-plane readout



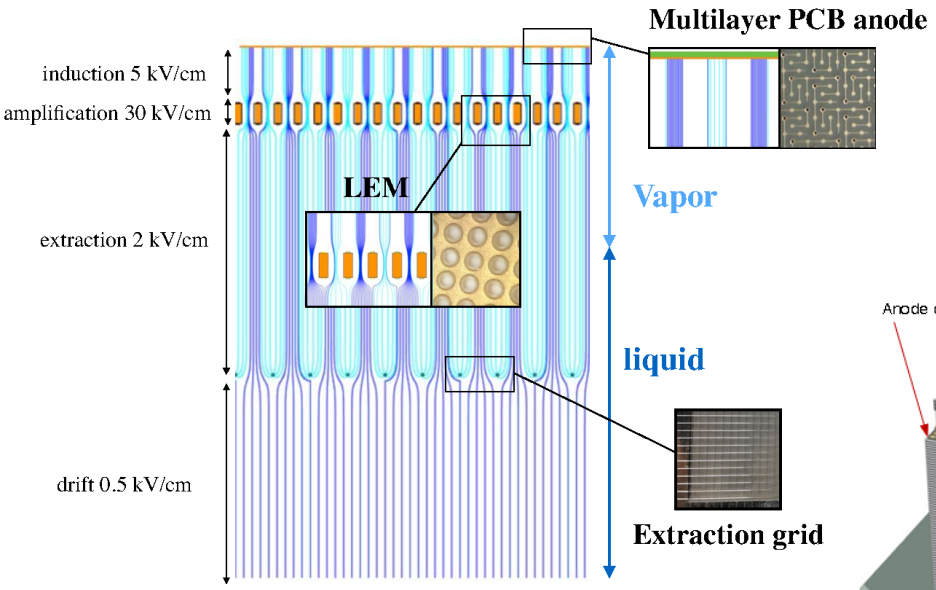
Single phase: 10 kton module

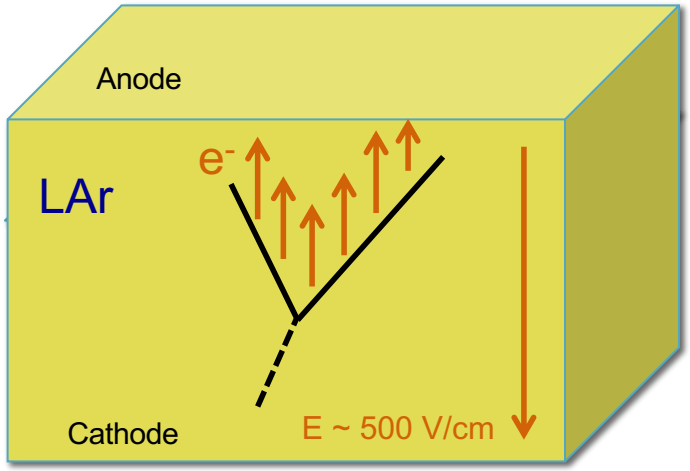


384000 readout wires
150 “APAs” (2.3 m x 6 m)
12 m high
15.5 m wide
58 m long

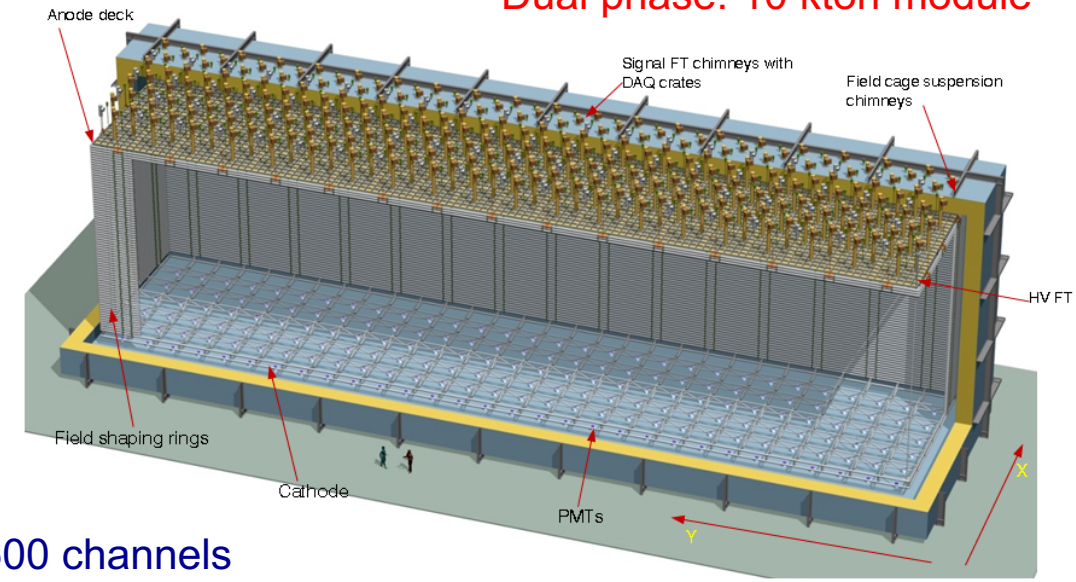
DUNE Far Detector

Dual phase: signal extracted and amplified in gas phase





Dual phase: 10 kton module

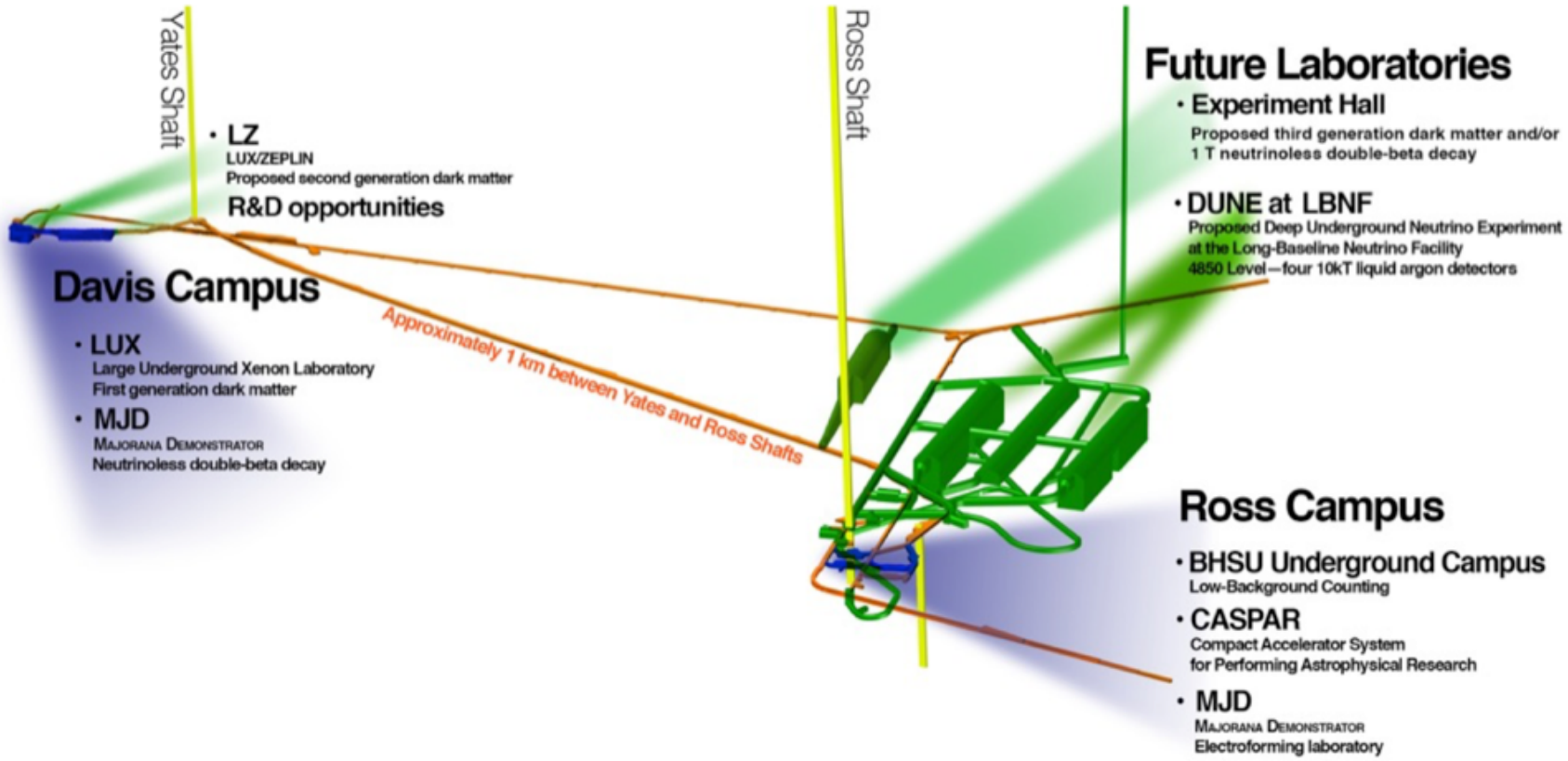


153600 channels

80 3x3 m^2 "CRPs" (Charge Readout Planes)

SURF

Sanford Underground Research Facility (Lead, SD)



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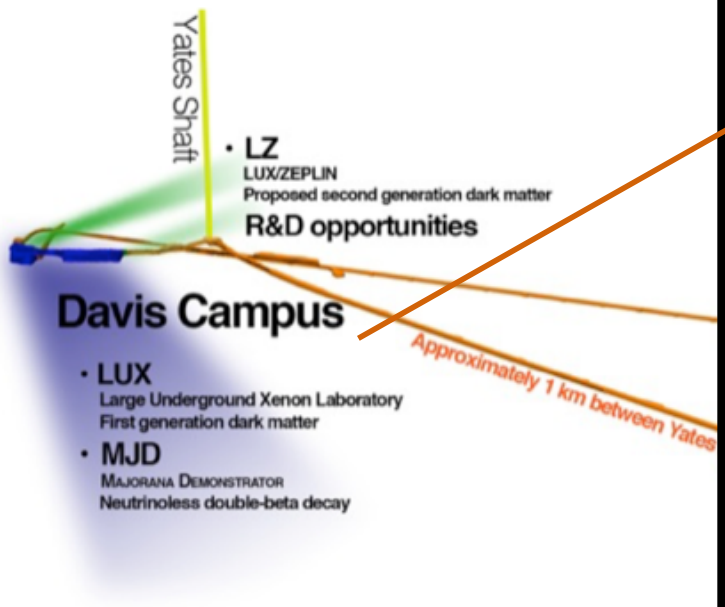
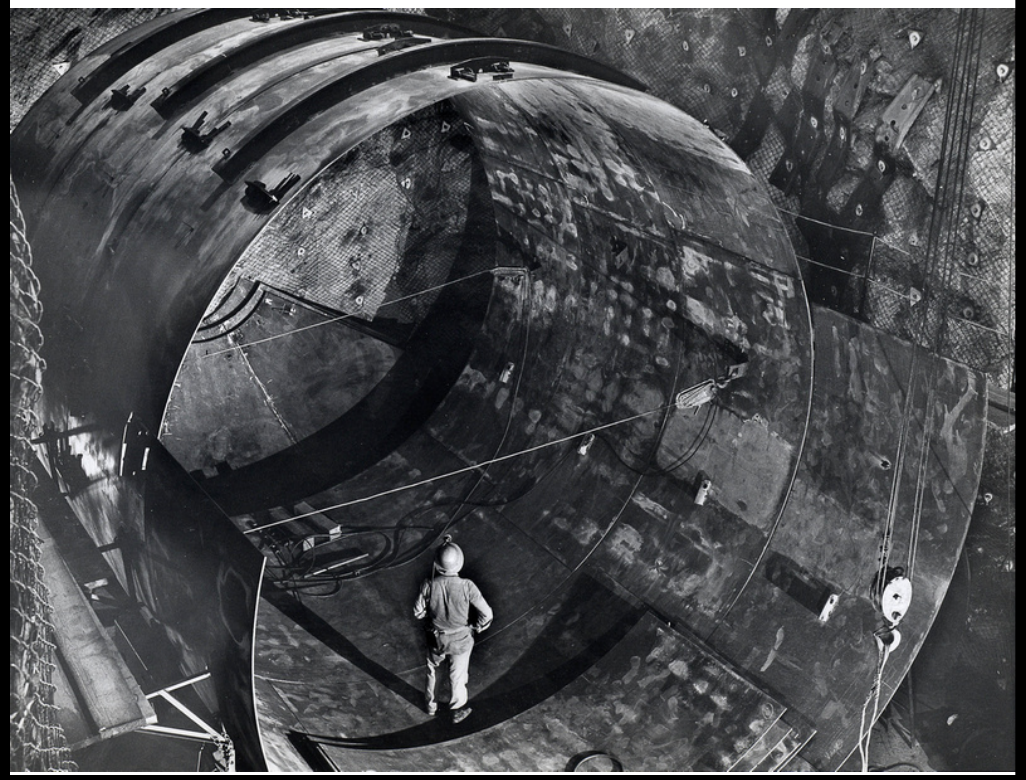


Site of Ray Davis solar neutrino experiment



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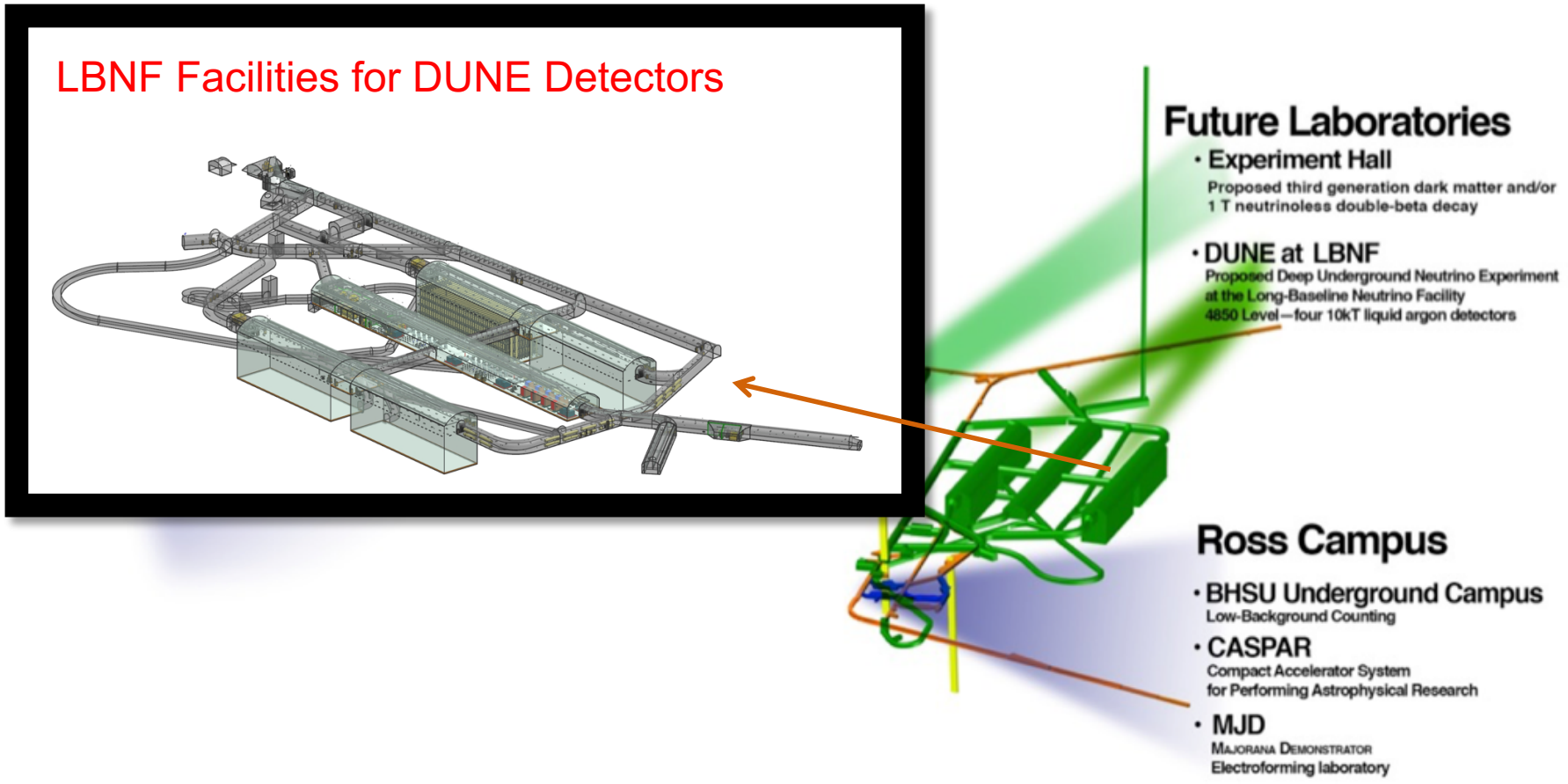

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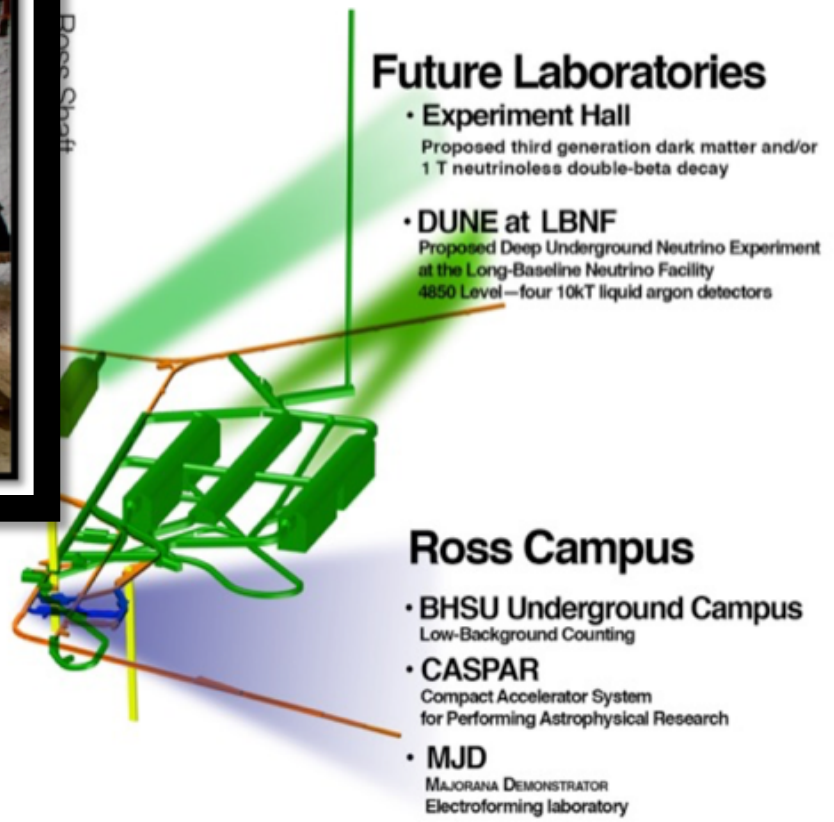


DUNE general timeline

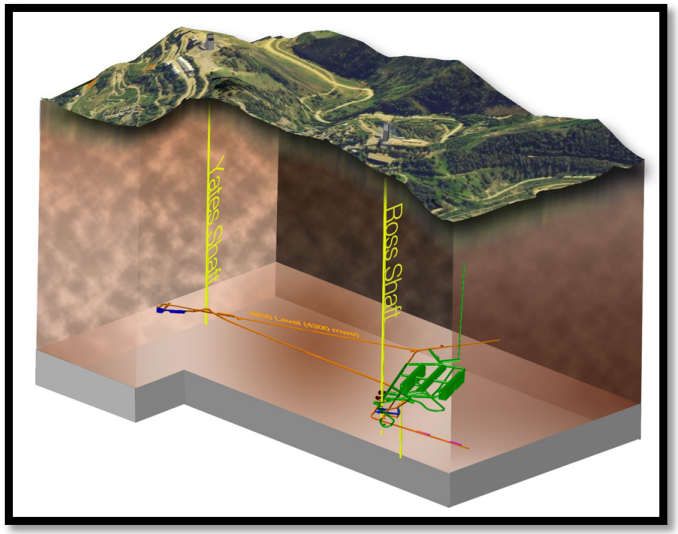
2018: ProtoDUNEs at CERN

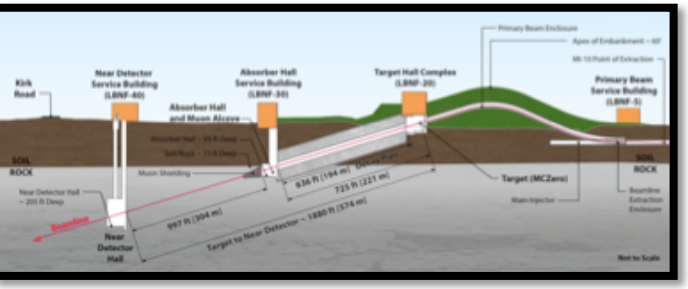
2019: Technical Design Report

2019: Far site primary excavation begins

2022: First module installation begins

2026: Neutrino beam available





Physics data as soon as 1st module complete

- Atmospheric ν
- SNB and solar ν
- Matter instability
- Detector calibration

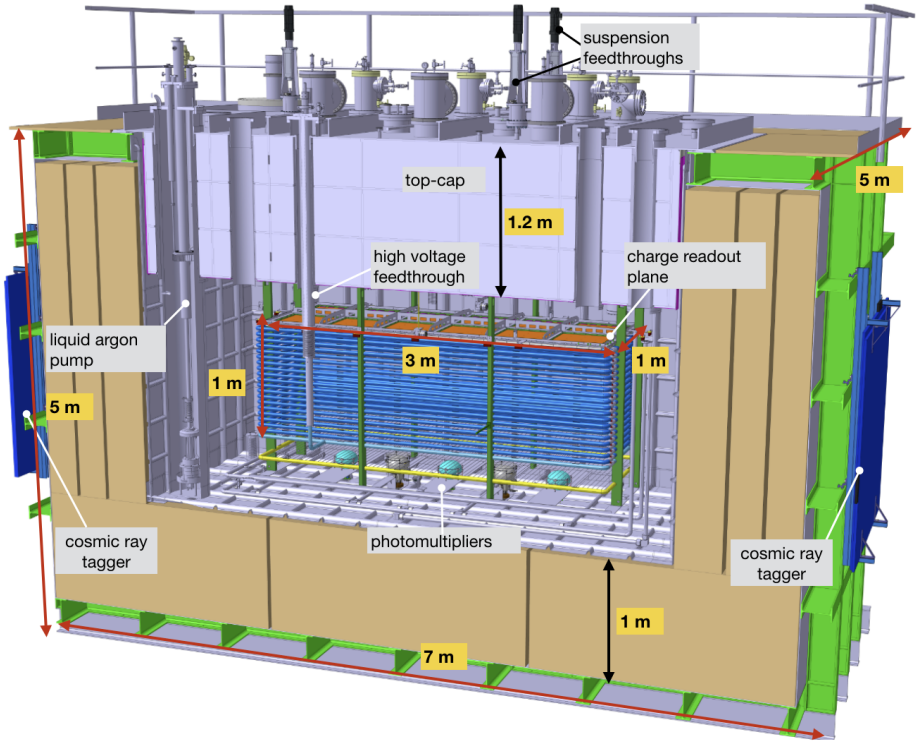
Swiss activities:

Seminal work for the establishment of the Collaboration and of the LBNF/DUNE project.

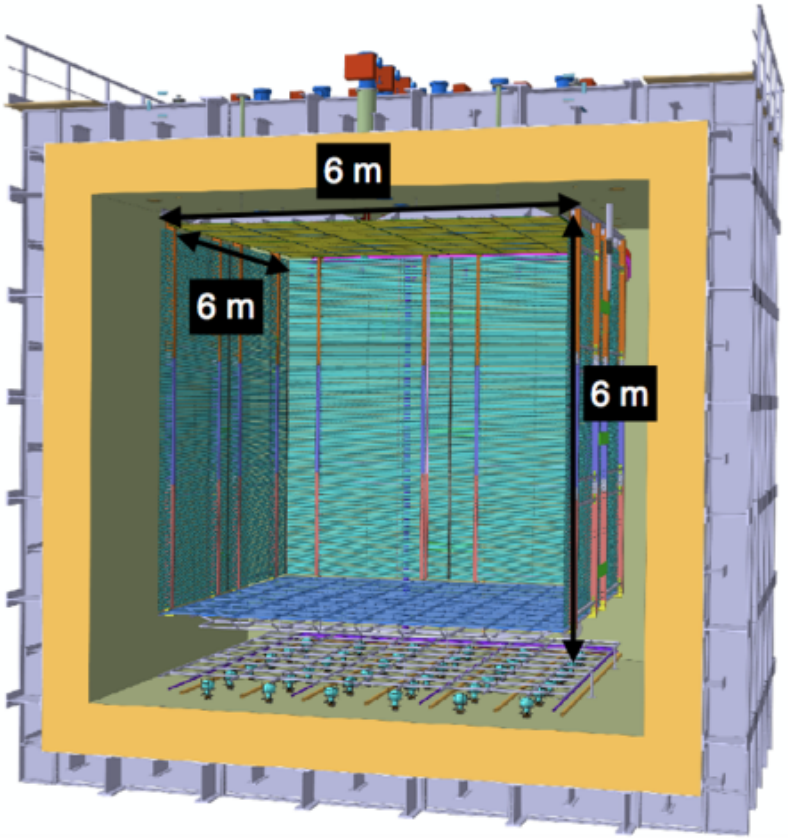
DUNE IIB 2014

A. Rubbia, first co-spokesperson of DUNE
A. Ereditato, member of the Fermilab Neutrino Council

Dual-phase prototypes @ CERN (ETHZ)



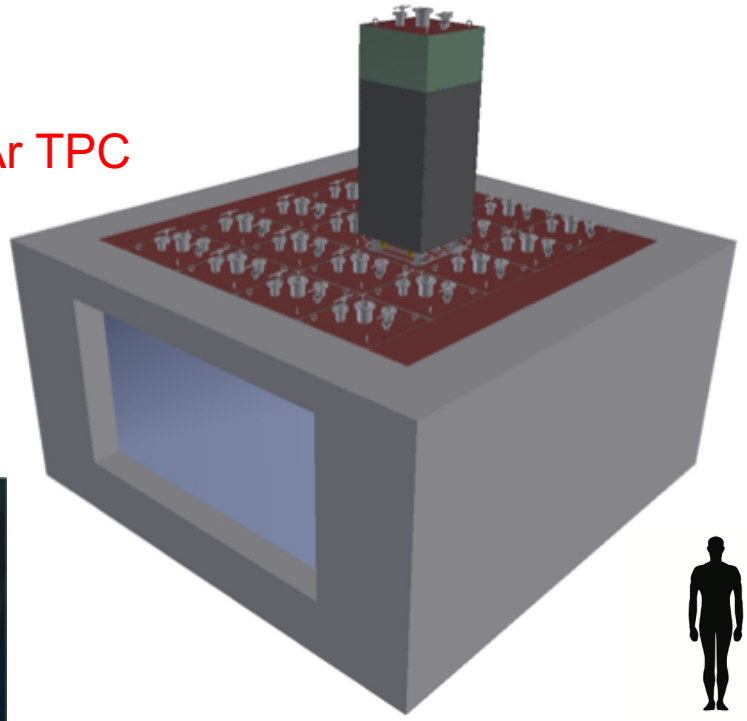
3x1x1



ProtoDune DP

ArgonCube for the ND (Bern)

DUNE LAr TPC



Detector prototypes in Bern

Financial considerations

Based on running regular SNSF grants:

FLARE 2017-2018:	received 1.5 MCHF
FLARE 2019-2020:	to be requested 1.5 MCHF
FLARE 2021 →	~1 MCHF/year

SERI FUNDING: requested 13 MCHF for LBNF (under evaluation)