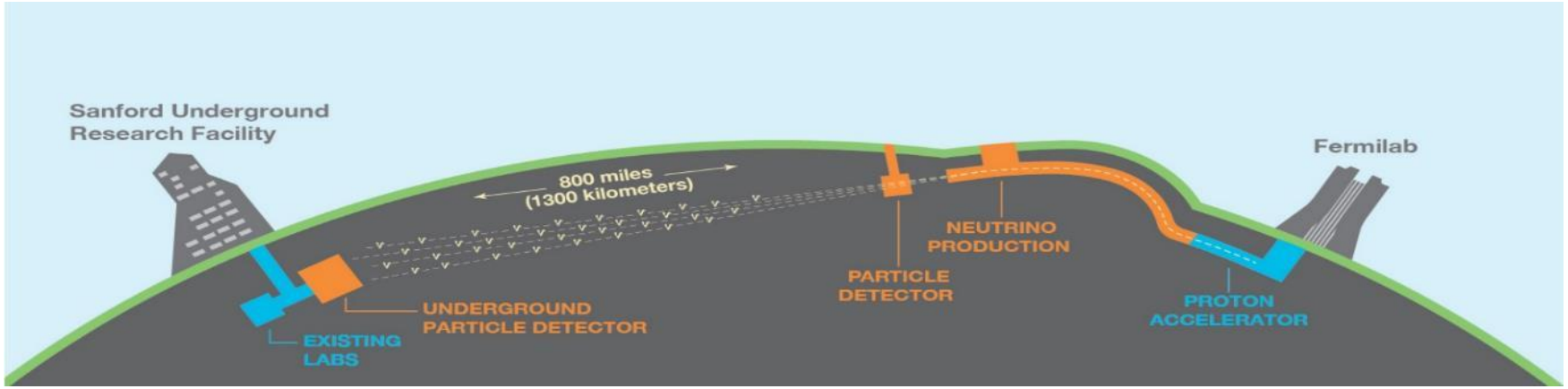
Why are we here?
DUNE?
LBNF?

World-Class Facility supporting World-Class Experiment



- The **Deep Underground Neutrino Experiment** will be a **game-changing experiment for neutrino science**, potentially transforming our understanding of why the universe exists as it does.
- The **Long-Baseline Neutrino Facility** is the **infrastructure** necessary to send a powerful beam of neutrinos 800 miles through the earth, and measure them deep underground at South Dakota's Sanford Underground Research Facility.
- The DUNE/LBNF project will be the **first internationally conceived, constructed, and operated mega-science project** hosted by the Department of Energy in the United States.

LBNF will drive neutrino science forward the way CERN's Large Hadron Collider drove Nobel Prize-winning Higgs discovery

…minimum requirements are not met by the current LBNE project's CD-1 minimum scope. The long-baseline neutrino program plan has undergone multiple significant transformations since the 2008 P5 report. Formulated as a primarily domestic experiment, the minimal CD-1 configuration with a small, far detector on the surface has very limited capabilities. A more ambitious long-baseline neutrino facility has also been urged by the Snowmass community study and in expressions of interest from physicists in other regions. **To address even the minimum requirements specified above, the expertise and resources of the international neutrino community are needed. A change in approach is therefore required. The activity should be reformulated under the auspices of a new international collaboration, as an internationally coordinated and internationally funded program, with Fermilab as host.** There should be international participation in defining the program's scope and capabilities. The experiment should be designed, constructed, and operated by the international collaboration. The goal should be to achieve, and even exceed if physics eventually demands, the target requirements through the broadest possible international participation. – P5 Report, 2014, Charged by DOE and NSF

***Fermilab as host** is a deliberate part of the LBNF/DUNE model!*

LBNF/DUNE Program or Enterprise

Fermilab – Host Lab for Program

DUNE Project/Experiment/Int'l Collaboration

LBNF/DUNE-US Line-item 413.3b project with 5 subprojects		
Subproject Name	Subproject Components	
	LBNF (Facilities)	**DUNE-US** (Detectors)
FSCF-EXC	FS Excavation	None
FSCF-BSI	FS Infrastructure	None
FDC	Cryogenics*	FD1 & FD2
NSCF+B	NSCF + Beamline*	None
ND	Cryogenics	ND

Detector Project Phase
Detector Design
Fabrication
Installation
Commissioning

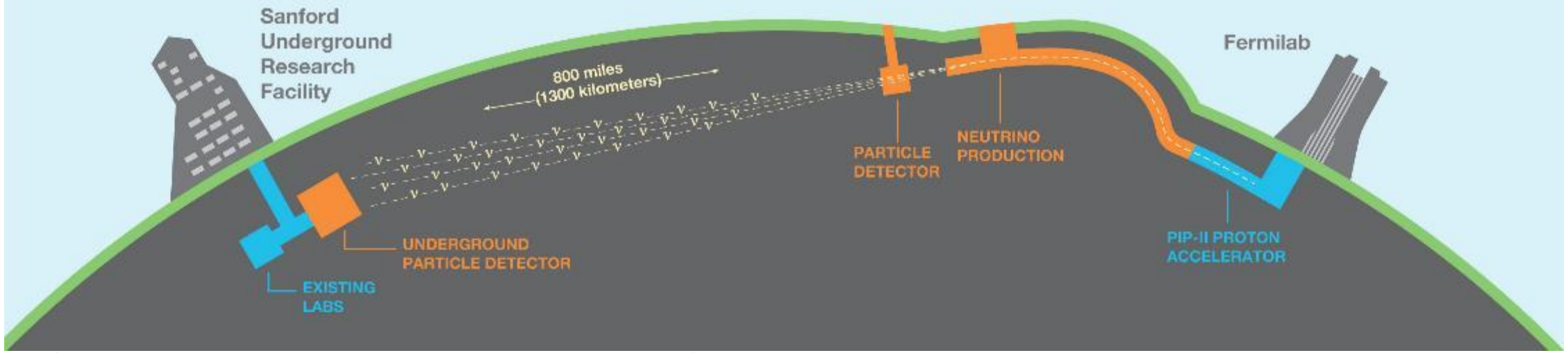
Experiment Phase
Operations
and
Data analysis

* Includes international contributions to the LBNF facilities

DOE Project Scope - Delivered at Two Sites through Five Subprojects

Far Site – SURF in Lead, SD
Facility/Infrastructure and Far Detectors

Near Site – FNAL in Batavia, IL
Facility/Infrastructure, Neutrino Beamline, and Near Detectors



Three subprojects

Two subprojects

- **FSCF-EXC** – Far Site Excavation
- **FSCF-BSI** – Far Site Building & Site Infrastructure
- **FDC** – Far Detectors and Cryogenic Infrastructure

- **NSCF+B** – Near Site Conventional Facilities + Beamline
- **ND** – Near Detectors

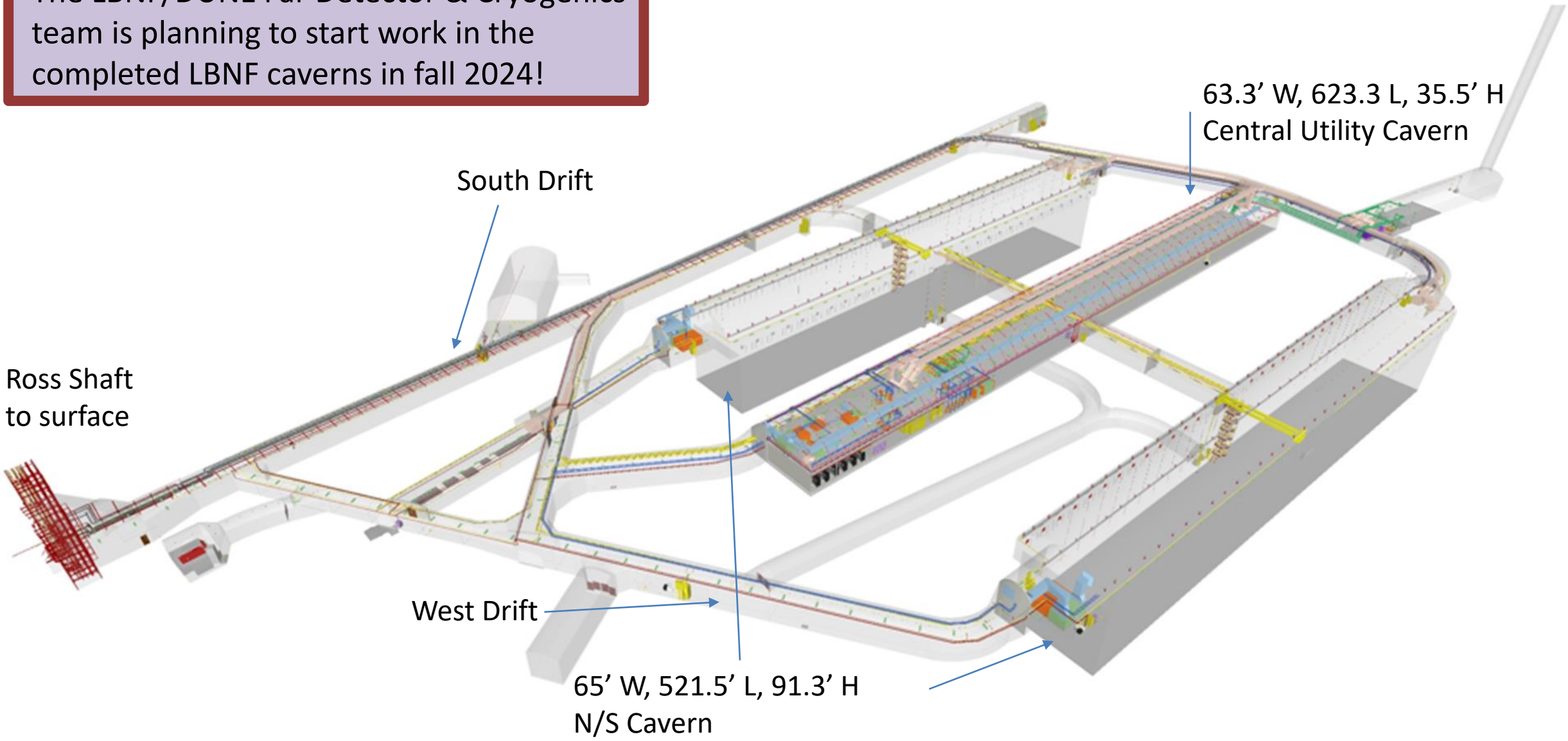
Far Detectors & Cryogenics Infrastructure

Jolie Macier

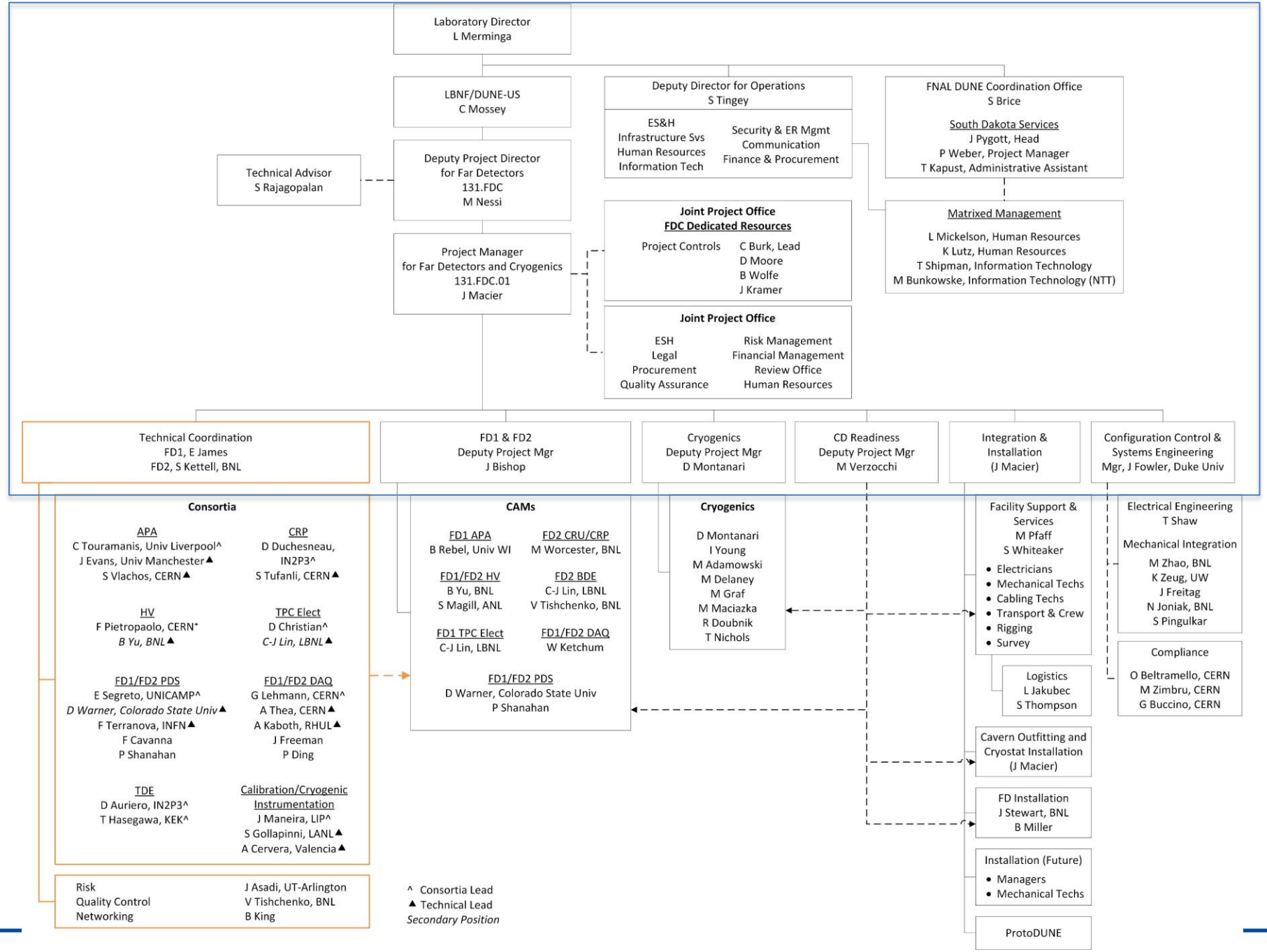
FDC PM

27 September 2023

The LBNF/DUNE Far Detector & Cryogenics team is planning to start work in the completed LBNF caverns in fall 2024!




LONG-BASELINE
NEUTRINO FACILITY
Far site underground location


Laboratory Director
L Merminga
LBNF/DUNE-US
C Mossey
Deputy Director for Operations
S Tingey
ES&H
Infrastructure Svs
Human Resources
Information Tech
Security & ER Mgmt
Communication
Finance & Procurement
FNAL DUNE Coordination Office
S Brice
South Dakota Services
J Pygott, Head
P Weber, Project Manager
T Kapust, Administrative Assistant
Technical Advisor
S Rajagopalan
Deputy Project Director
for Far Detectors
131.FDC
M Nessi
Joint Project Office
FDC Dedicated Resources
Project Controls
C Burk, Lead
D Moore
B Wolfe
J Kramer
Matrixed Management
L Mickelson, Human Resources
K Lutz, Human Resources
T Shipman, Information Technology
M Bunkowske, Information Technology (NTT)
Project Manager
for Far Detectors and Cryogenics
131.FDC.01
J Macier
Joint Project Office
ESH
Legal
Procurement
Quality Assurance
Risk Management
Financial Management
Review Office
Human Resources
Technical Coordination
FD1, E James
FD2, S Kettell, BNL
FD1 & FD2
Deputy Project Mgr
J Bishop
Cryogenics
Deputy Project Mgr
D Montanari
CD Readiness
Deputy Project Mgr
M Verzocchi
Integration &
Installation
(J Macier)
Configuration Control &
Systems Engineering
Mgr, J Fowler, Duke Univ
Consortia
APA
C Touramanis, Univ Liverpool^
J Evans, Univ Manchester▲
S Vlachos, CERN▲
CRP
D Duchesneau,
IN2P3^
S Tufanli, CERN▲
HV
F Pietropaolo, CERN+
B Yu, BNL▲
TPC Elect
D Christian^
C-J Lin, LBNL▲
FD1/FD2 PDS
E Segreto, UNICAMP^
D Warner, Colorado State Univ▲
F Terranova, INFN▲
F Cavanna
P Shanahan
FD1/FD2 DAQ
G Lehmann, CERN^
A Thea, CERN▲
A Kaboth, RHUL▲
J Freeman
P Ding
TDE
D Auriero, IN2P3^
T Hasegawa, KEK^
Calibration/Cryogenic Instrumentation
J Maneira, LIP^
S Gollapinni, LANL▲
A Cervera, Valencia▲
CAMs
FD1 APA
B Rebel, Univ WI
FD2 CRU/CRP
M Worcester, BNL
FD1/FD2 HV
B Yu, BNL
S Magill, ANL
FD2 BDE
C-J Lin, LBNL
V Tishchenko, BNL
FD1 TPC Elect
C-J Lin, LBNL
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W Ketchum
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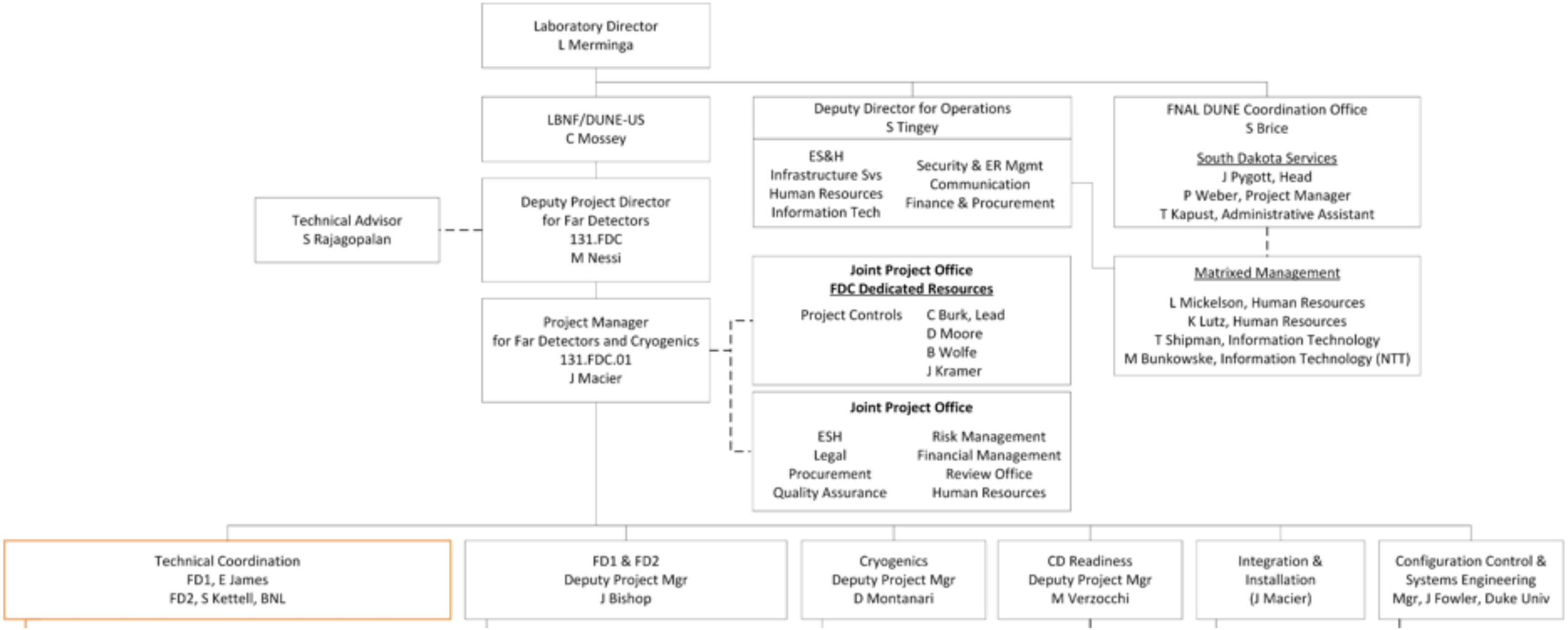
P Shanahan
Cryogenics
D Montanari
I Young
M Adamowski
M Delaney
M Graf
M Maciazka
R Doubnik
T Nichols
Facility Support &
Services
M Pfaff
S Whiteaker
Electricians
Mechanical Techs
Cabling Techs
Transport & Crew
Rigging
Survey
Logistics
L Jakubec
S Thompson
Electrical Engineering
T Shaw
Mechanical Integration
M Zhao, BNL
K Zeug, UW
J Freitag
N Joniak, BNL
S Pingulkar
Compliance
O Beltramello, CERN
M Zimbru, CERN
G Buccino, CERN
Cavern Outfitting and
Cryostat Installation
(J Macier)
FD Installation
J Stewart, BNL
B Miller
Installation (Future)
Managers
Mechanical Techs
ProtoDUNE
Risk
Quality Control
Networking
J Asadi, UT-Arlington
V Tishchenko, BNL
B King
^ Consortia Lead
▲ Technical Lead
Secondary Position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Integration &
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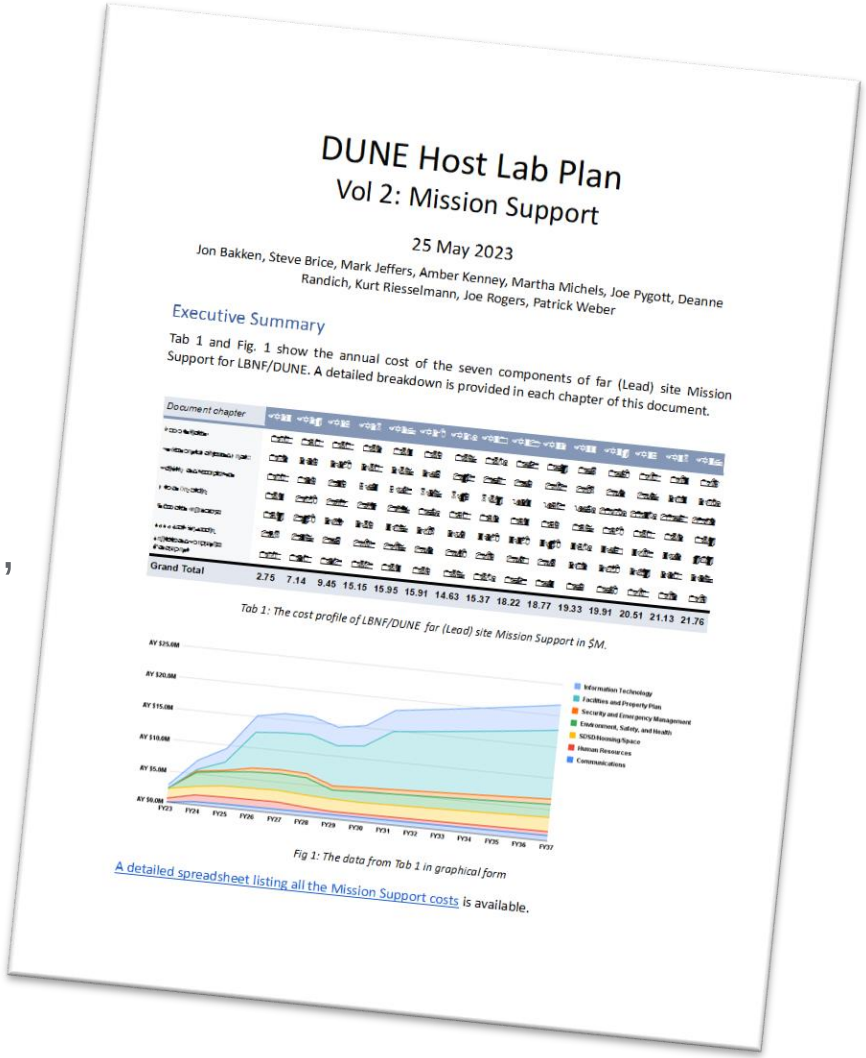
(J Macier)
Configuration Control &
Systems Engineering
Mgr, J Fowler, Duke Univ

Project executes Project Scope while Mission Support Divisions provide services

- DUNE Coordination Office
  - Interface with Collaboration
- Communications
  - Community interactions & engagement
- Environment, Safety & Health
  - Addresses SME support for IH, Laser Safety, Rad Protection, Regulated Waste
  - Occupational Medicine
  - Training
  - Operational Readiness Clearance
- South Dakota Services
  - Office leases & Housing Coordination



DUNE Host Lab Plan
Vol 2: Mission Support

25 May 2023

Jon Bakken, Steve Brice, Mark Jeffers, Amber Kenney, Martha Michels, Joe Pygott, Deanne Randich, Kurt Riesselmann, Joe Rogers, Patrick Weber

Executive Summary

Tab 1 and Fig. 1 show the annual cost of the seven components of far (Lead) site Mission Support for LBNF/DUNE. A detailed breakdown is provided in each chapter of this document.

Document chapter													
Grand Total	2.75	7.14	9.45	15.15	15.95	15.91	14.63	15.37	18.22	18.77	19.33	19.91	20.51	21.13	21.76

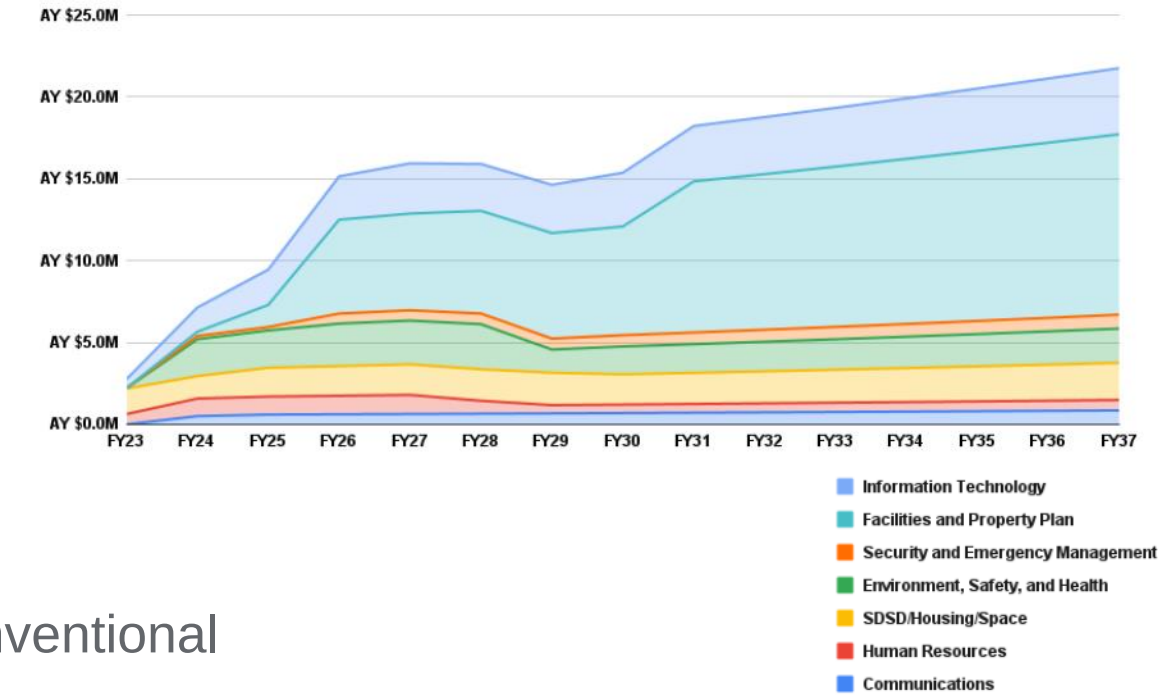
Tab 1: The cost profile of LBNF/DUNE far (Lead) site Mission Support in $M.

Fig 1: The data from Tab 1 in graphical form

A detailed spreadsheet listing all the Mission Support costs is available.

Project executes Project Scope while Mission Support Divisions provide services

- Human Resources
  - Support hiring of 100+ persons to support FDC activities; Optimize processes to enable Project activities to proceed; Support retention of staff
- Information Technology
  - Networking, authentication, computing services, database services, applications, support services
- Security & Emergency Management
  - Site Access & Visa support
- Infrastructure Services
  - Facility maintenance following completion of conventional facilities scope



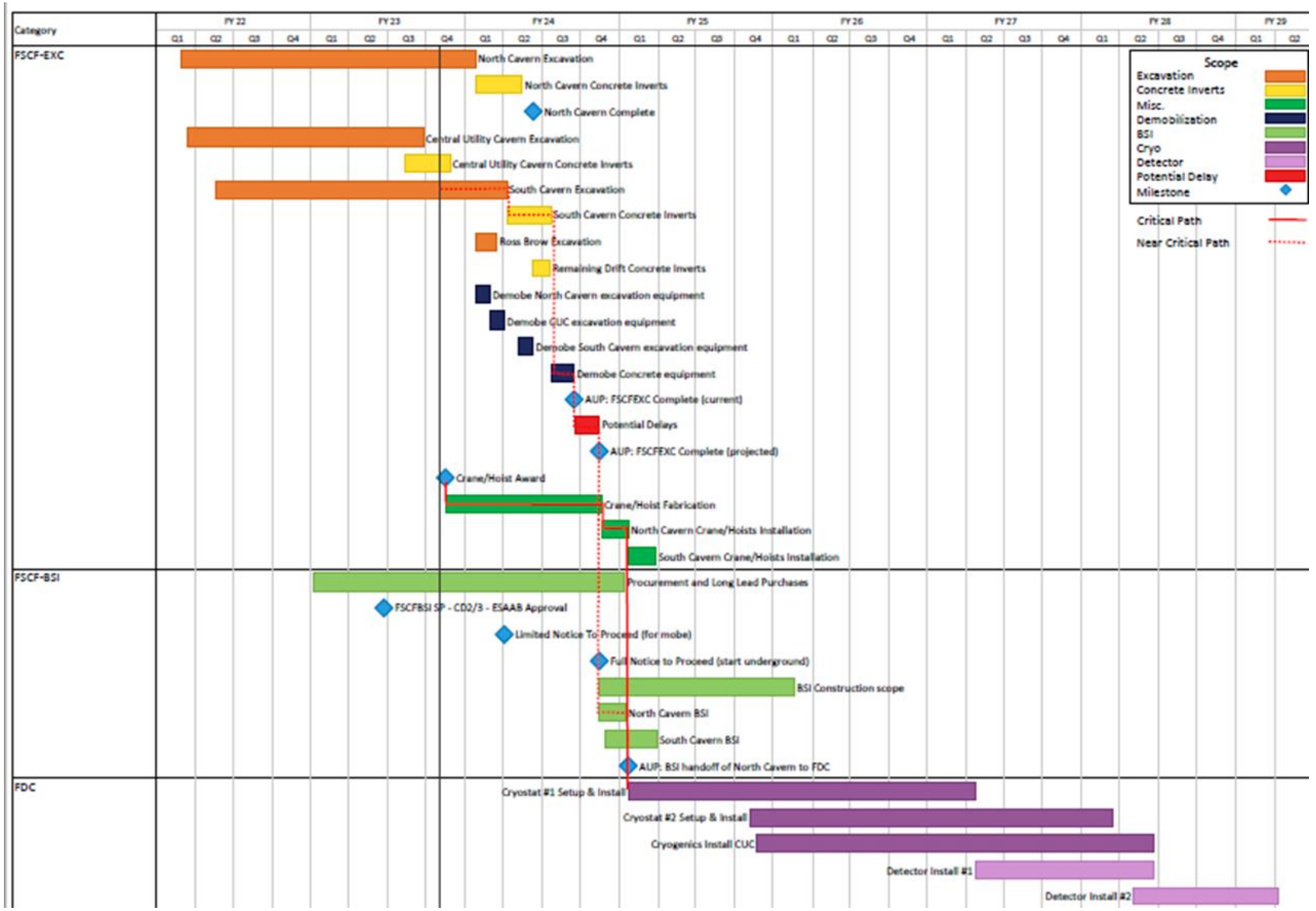
Thank you for assessing the Far Site Project & Operational needs!

LBNF/DUNE-US Far Site Schedule

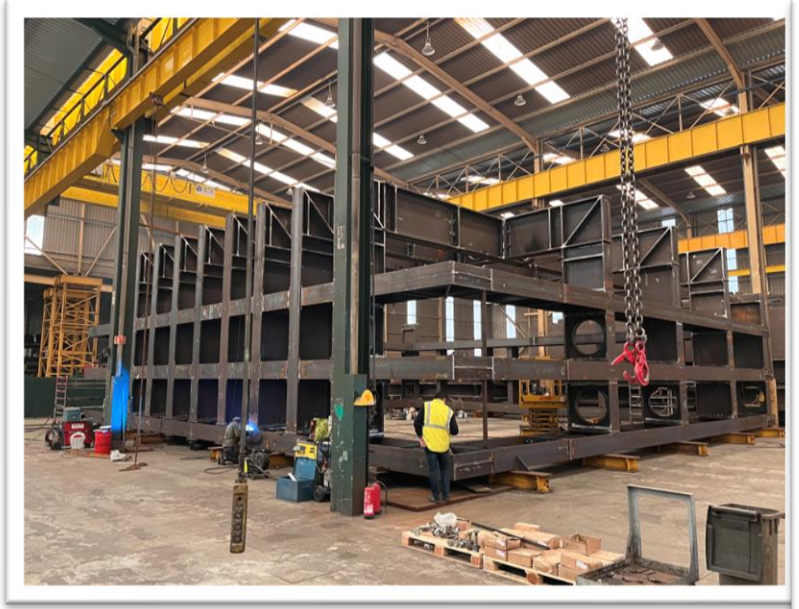
Excavation subproject creates the underground cavern space, installs cranes, wall supports & ceiling anchors for cryogenics mezzanine

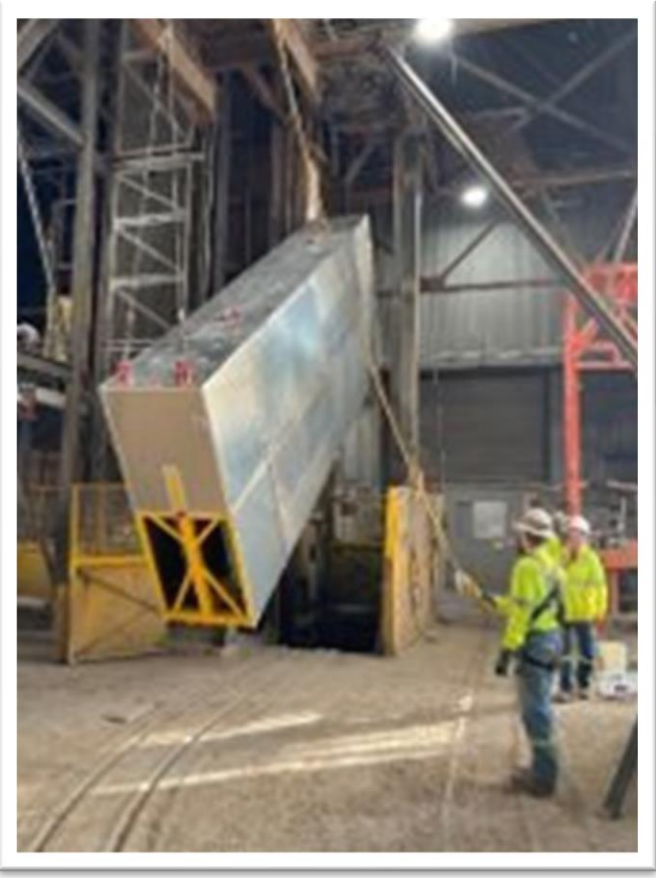
Buildings & Site Infrastructure subproject installs all house services: electrical, ventilation, architectural, chilled water, fire protection

FDC subproject installs cryostats, detectors & cryogenics; LAr filling



FDC Scope Overview



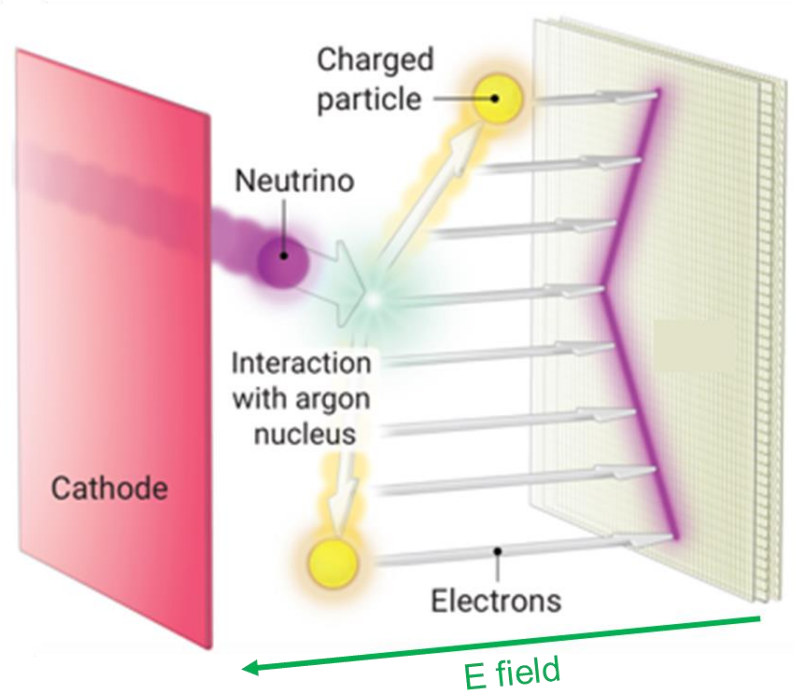


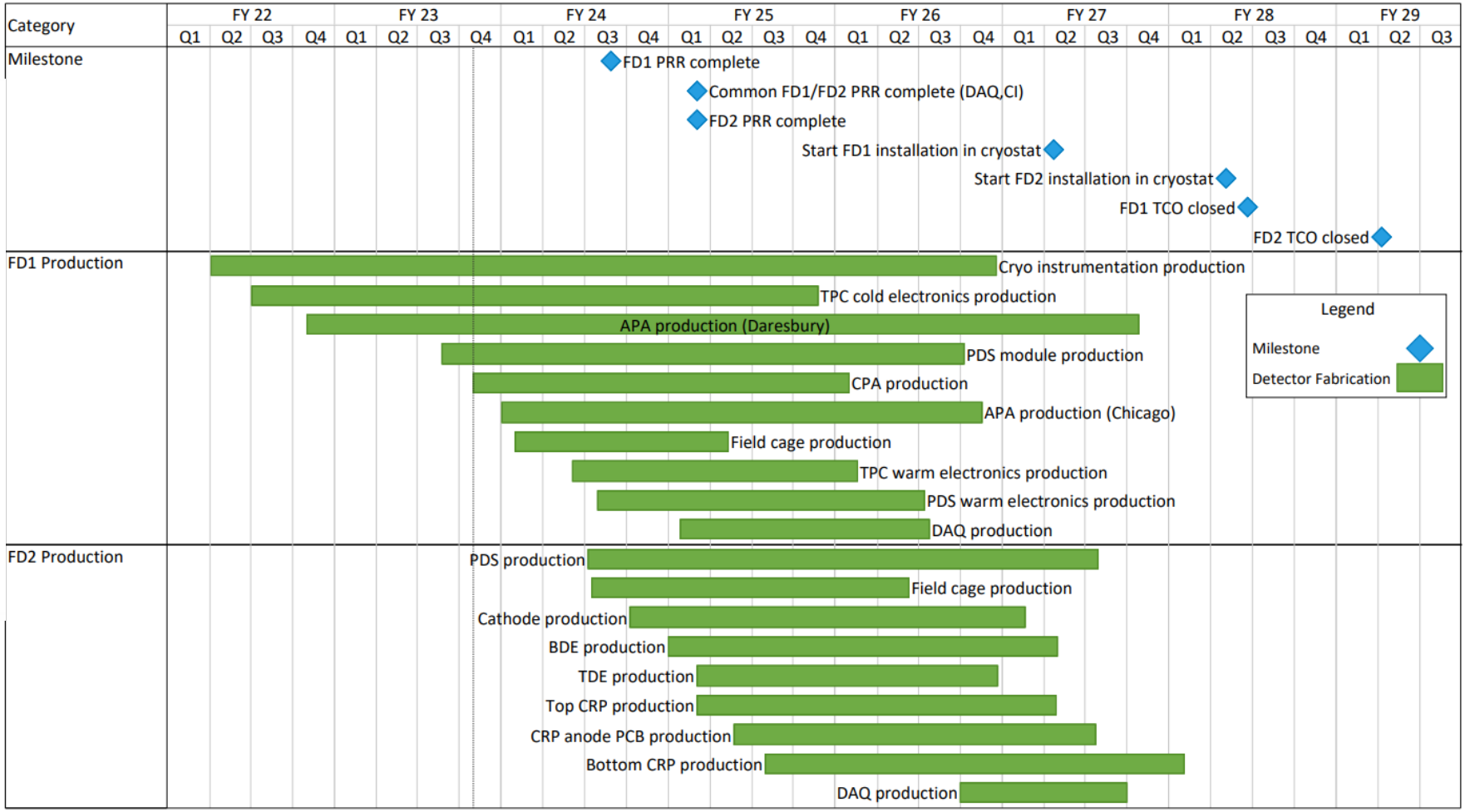
- Construct **cryostats** (CERN contribution)
- Design, build & install two **detectors** (Time Projection Chambers), split between US and nonUS
- Install **cryogenics systems** (subcontracted & contributions)
- Provide services (logistics, rigging, survey, material handling) to support all installation activities
- Have completed full-scale prototyping of all elements: cryostat, cryogenics, detector & installation processes
- Planning for movement of all material (steel, detector components through Ross Shaft); all elements modular for transport
- Small team to be retained for DUNE Experimental Operations following installation

Far Site Integration & Installation Team

- Lead-based: 80, including FNAL staff + subcontractors starting in 2024, up to 130
- Visiting: 20/year, FNAL Staff + subcontractors + visitors (other national lab & universities) starting at AUP (Authorization for Use & Possession)

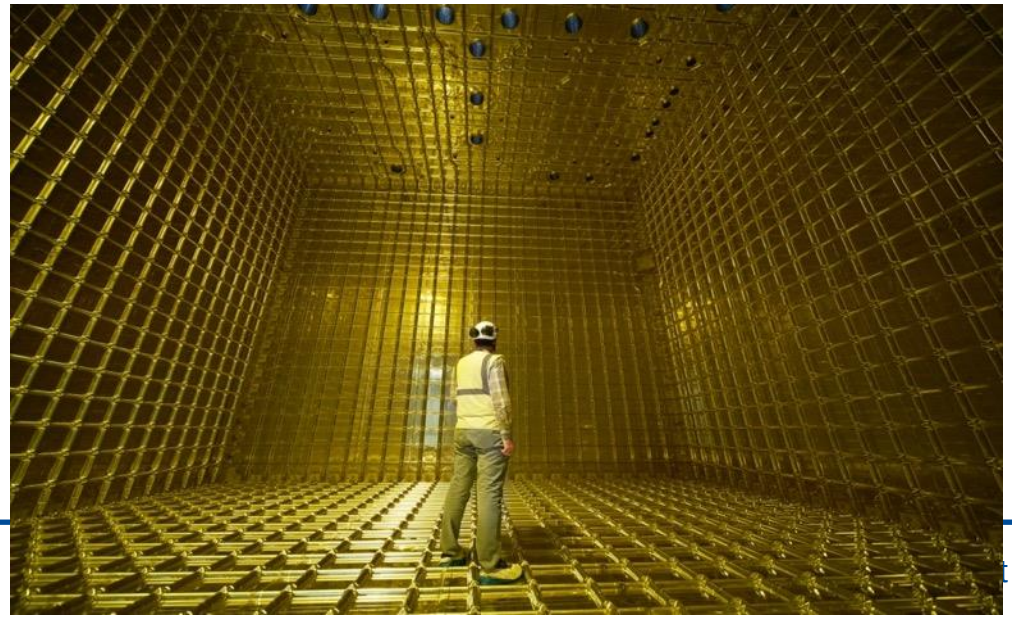
DUNE Far Detectors Production Schedule Schedule

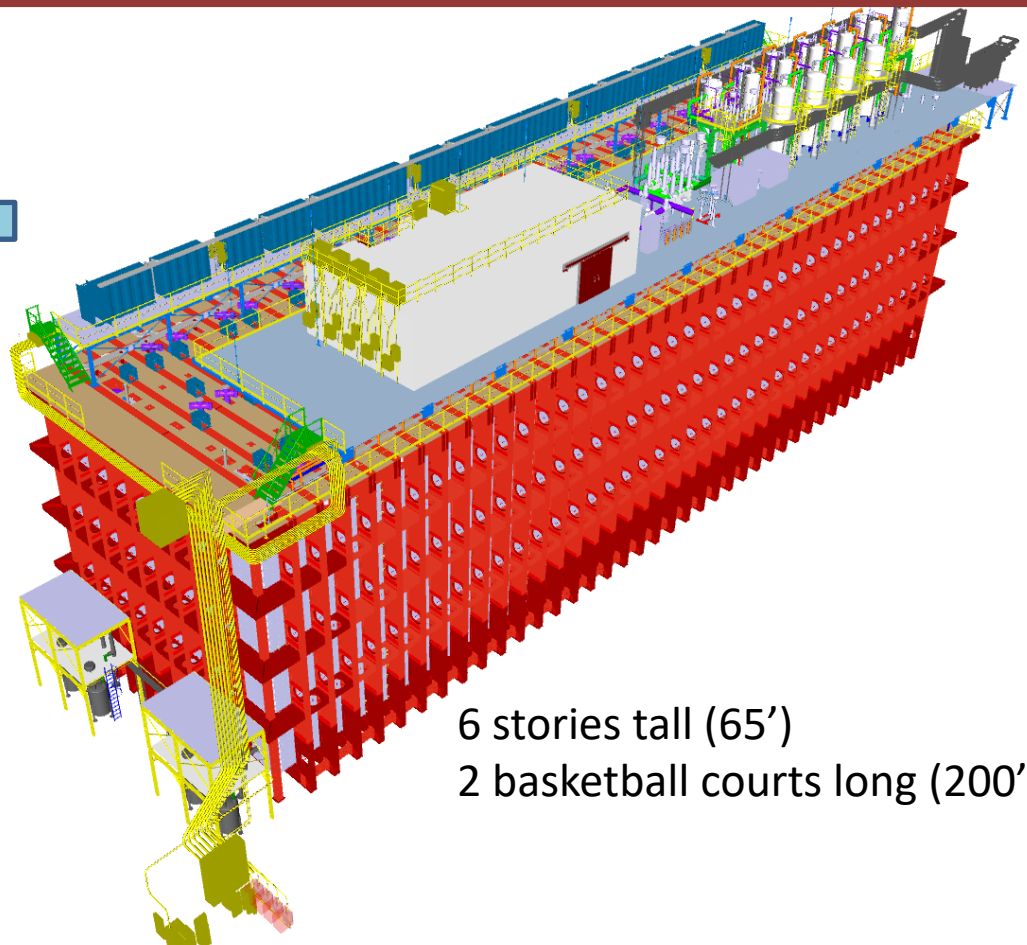




Cryostat Installation

- Cryostats (2) are an in-kind contribution from CERN (material + installation)
- First activity after AUP in October 2024
- Two phases: 1 - warm (steel structure, left) and 2 - cold (insulation, bottom left)
- 50 persons per phase; including 30 staff
- Phase 1: mostly subcontractors (US) + non-US CERN visitors
- Phase 2: all non-US subcontractors + non-US CERN visitors
- NOTE: phase 1 and Phase 2 overlap, starting in mid-2025 with work occurring in both North and South Caverns.

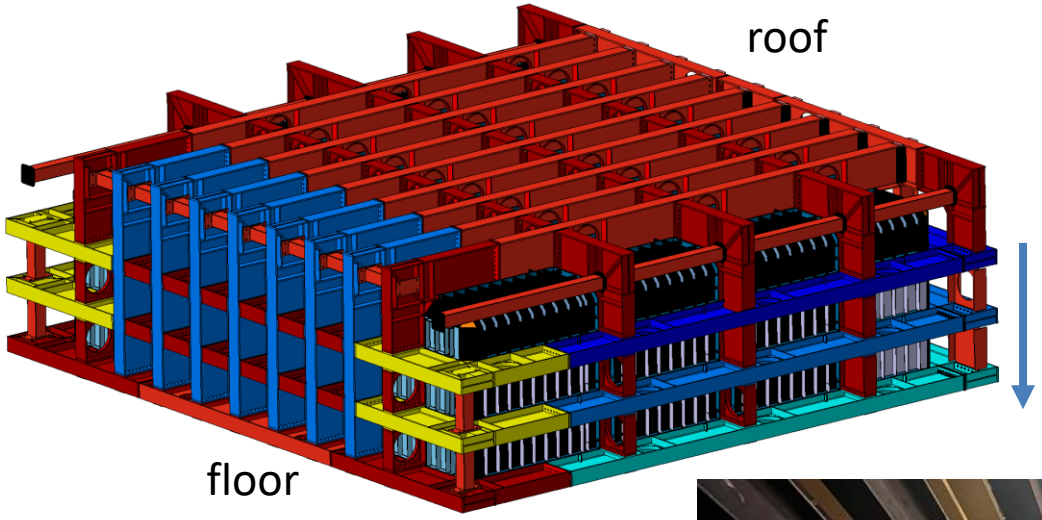




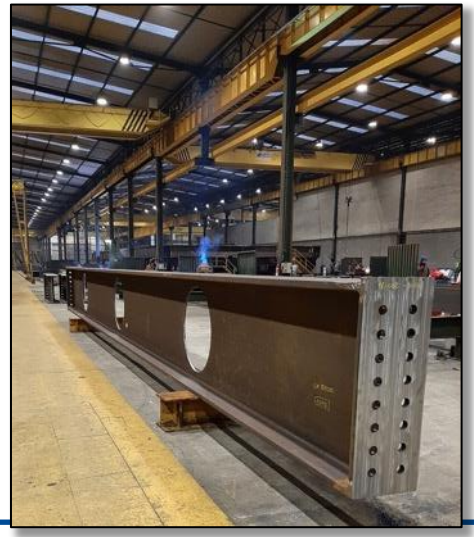
6 stories tall (65’)
2 basketball courts long (200’)

Cryostats status : Warm structure components in construction

Raw beams cryostat #1 @ steel structure manufacturer site

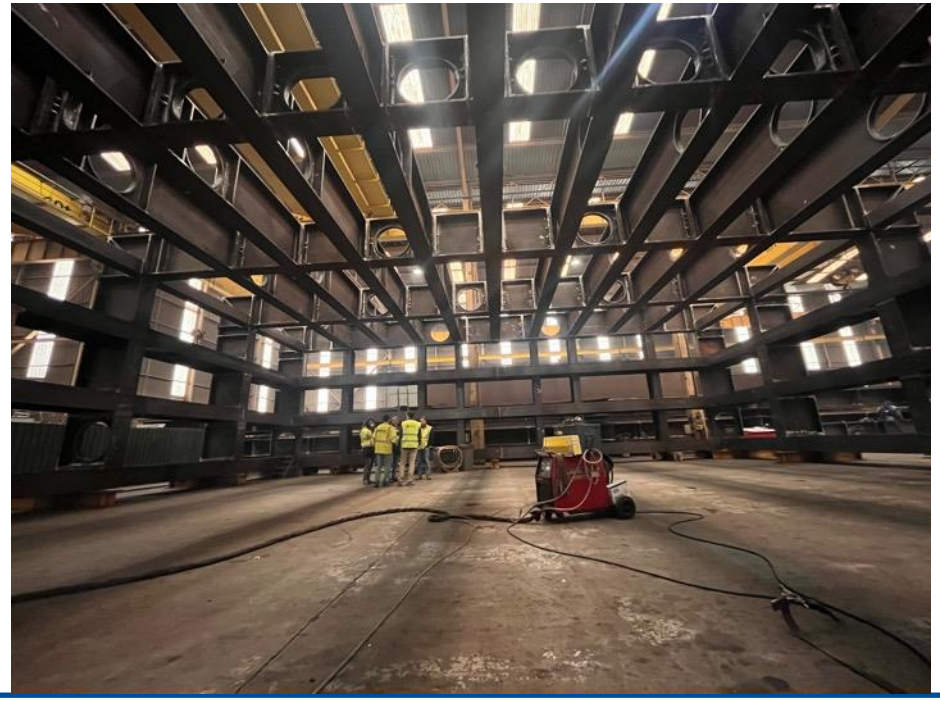


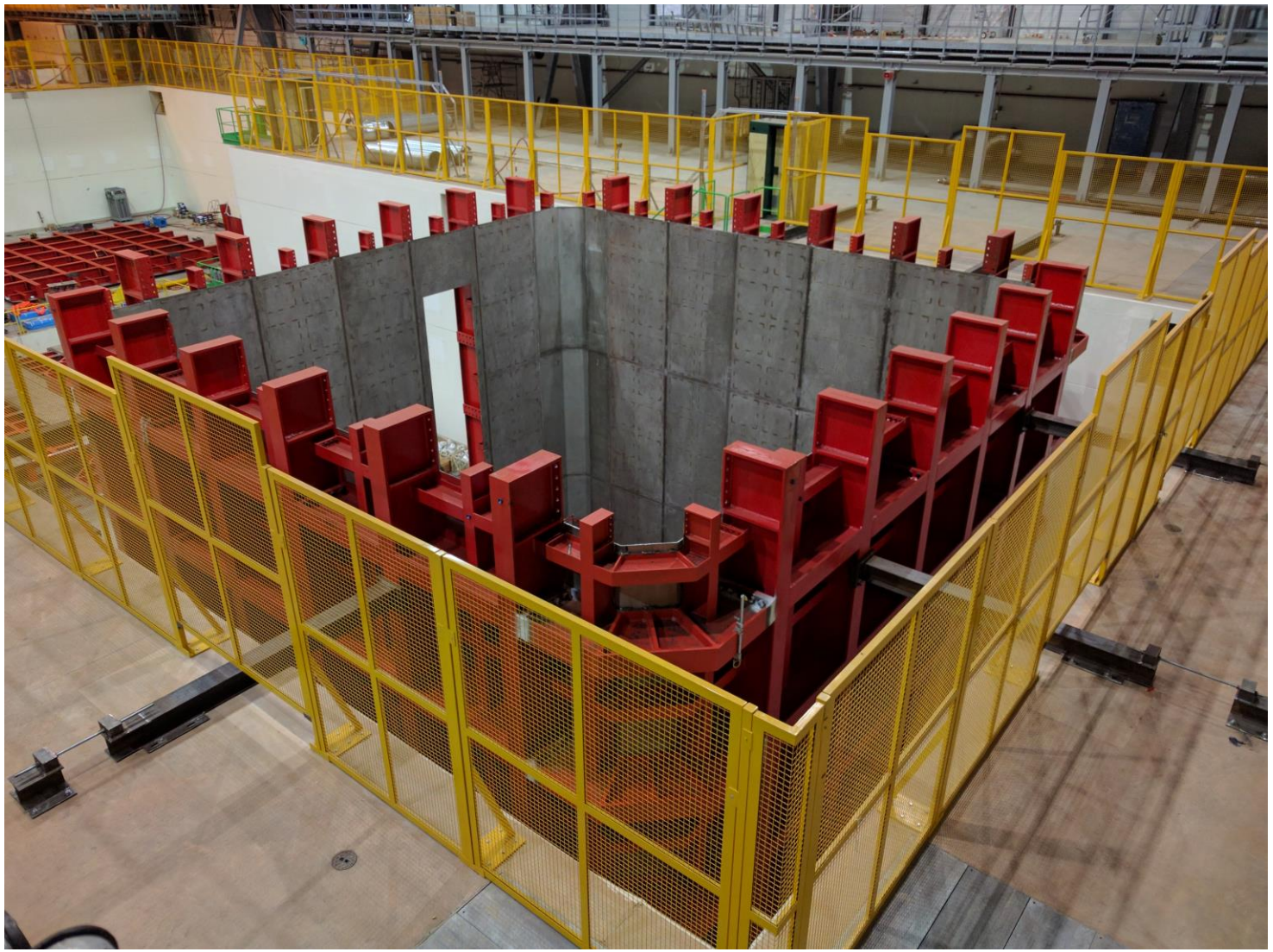
3 layers in z
out of 39



Elements front Small Wall

3 layers in z
out of 39

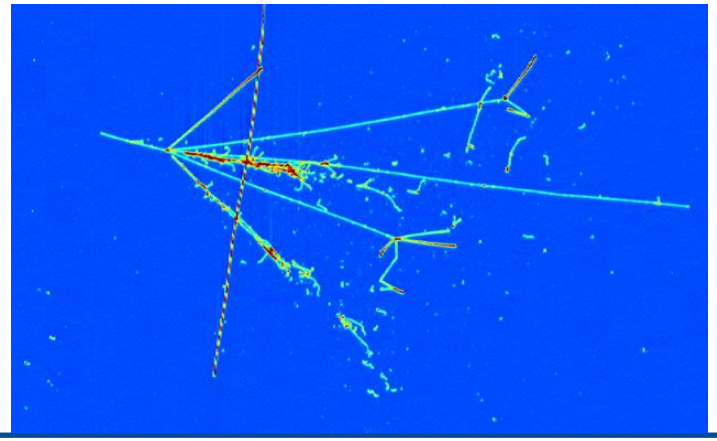




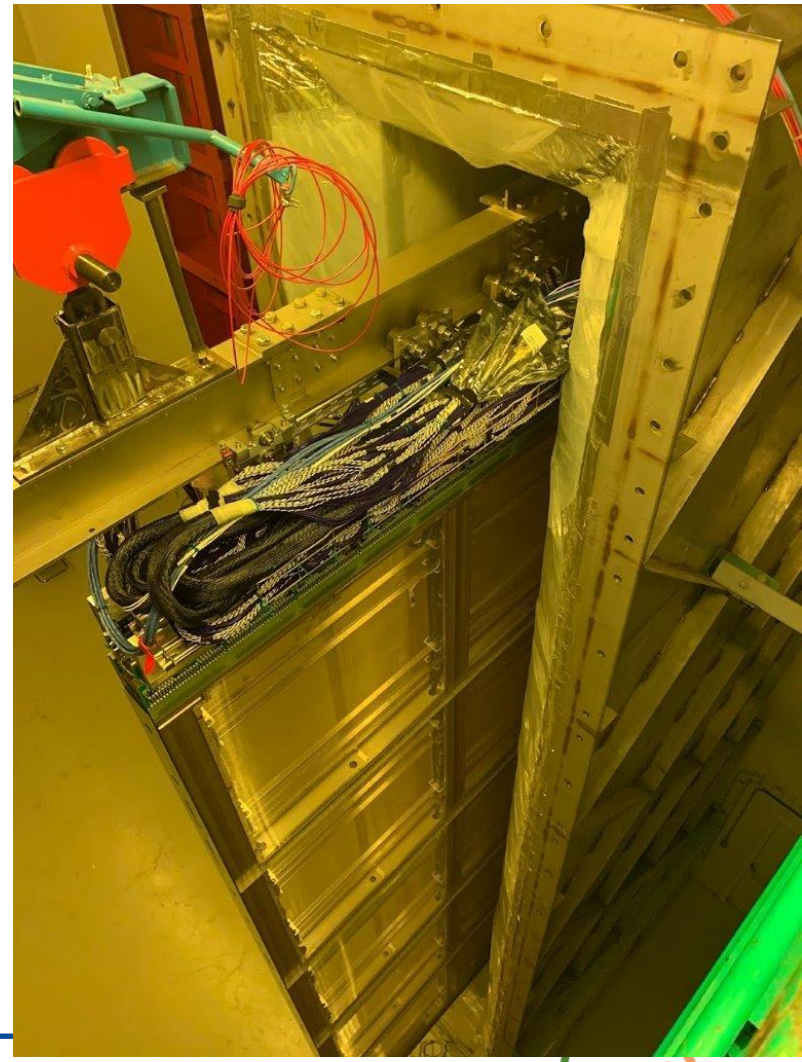

Bonfanti

Prototyping – ProtoDUNE NP04 & NP02 at CERN Neutrino Platform

- Full-scale detector components
- Cryogenics system
- Installation processes
- Integrated teams accomplishing work
- 1/20th scale cryostats



Anode Plane Assemblies (APA) in ProtoDUNE NP04 (left, below); Integrated APA in NP04 cold box (right, below)

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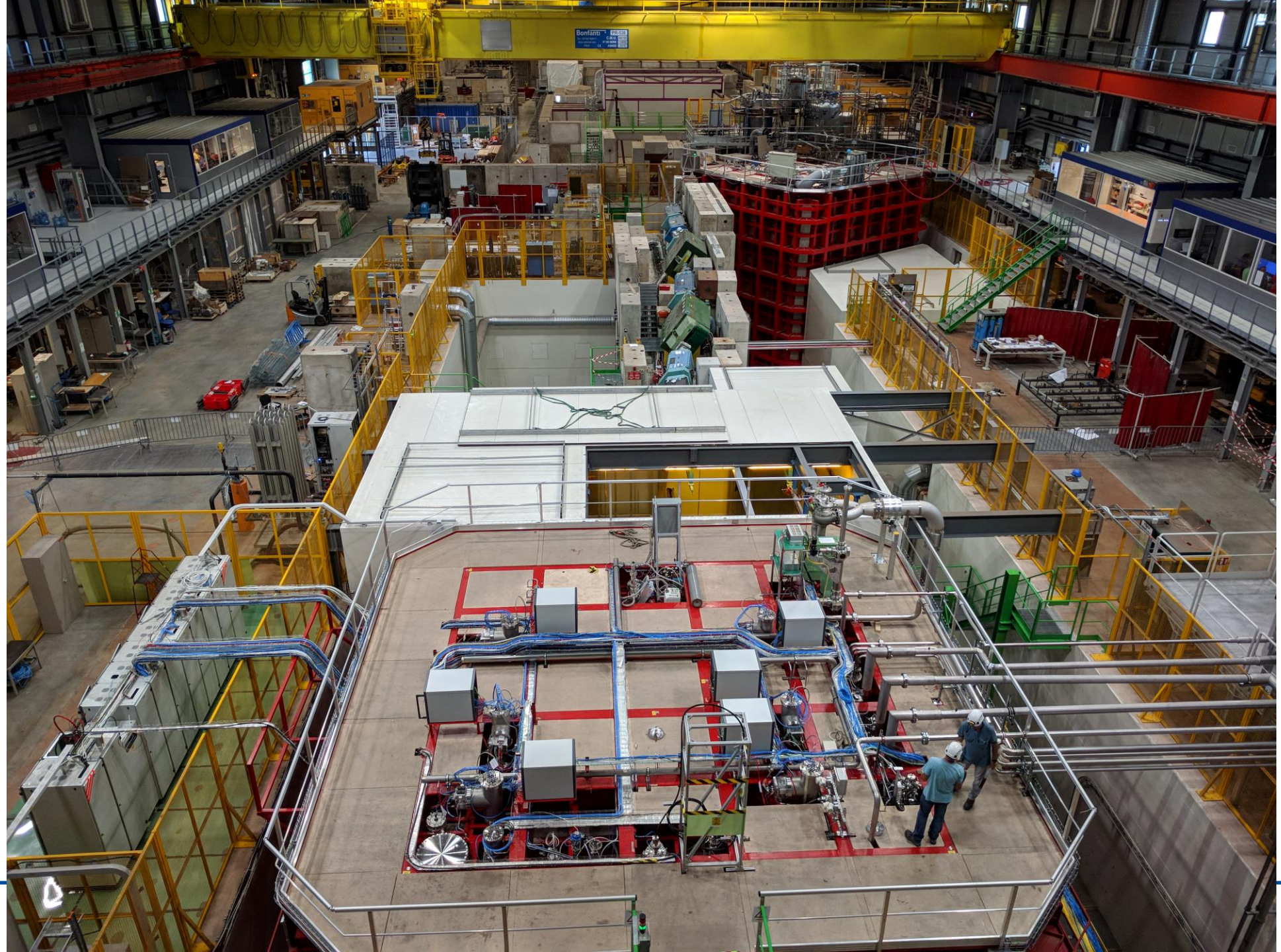

Bonfanti

The world is coming to Lead

LBNF excavation at Sanford Lab on schedule for June 2024 completion

By Wendy Pitlick Black Hills Pioneer May 13, 2023 0

A drill and mucker are seen excavating for the Deep Underground Neutrino Experiment at the 4850 Level at SURF. Photo by Matthew Kapust, Sanford Underground Research Facility

Matthew Kapust

Listen to this article now

Powered by Trinity Audio

00:00 06:06

LEAD — The world is coming to Lead and anxiously awaiting the excavation and outfitting of the Long Baseline Neutrino Facility that will house the Deep Underground Neutrino Experiment.

On Wednesday, representatives from Fermilab, along with scientists and engineers involved with building DUNE and officials from the Sanford Underground Research Facility hosted a community information meeting to provide updates about progress for the massive facility and experiment, and answer any questions. Lead residents and interested stakeholders filled the conference room at the Sanford Lab Homestake Visitor's Center.

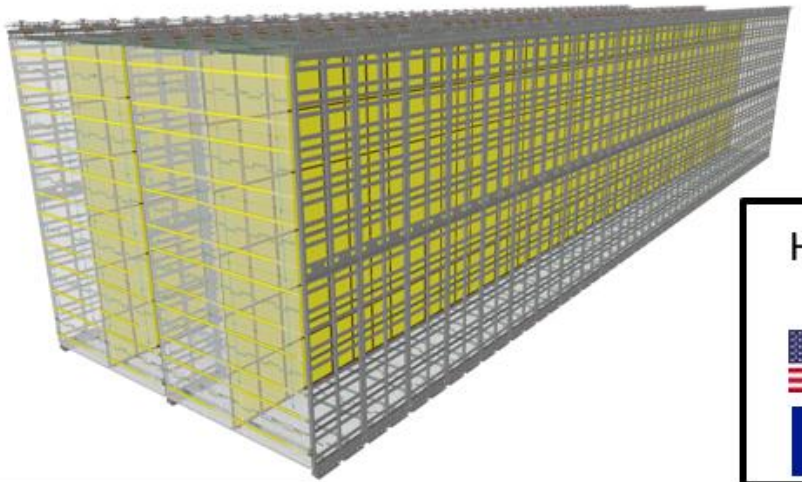
"The world is coming to Lead," Fermilab's Jolie Macier, who is involved with building the DUNE experiment, told the residents as she explained the global involvement for DUNE that includes 1,300 collaborators from 33 countries and CERN, and 200 institutions. DUNE is being hailed as the largest neutrino experiment in the world.

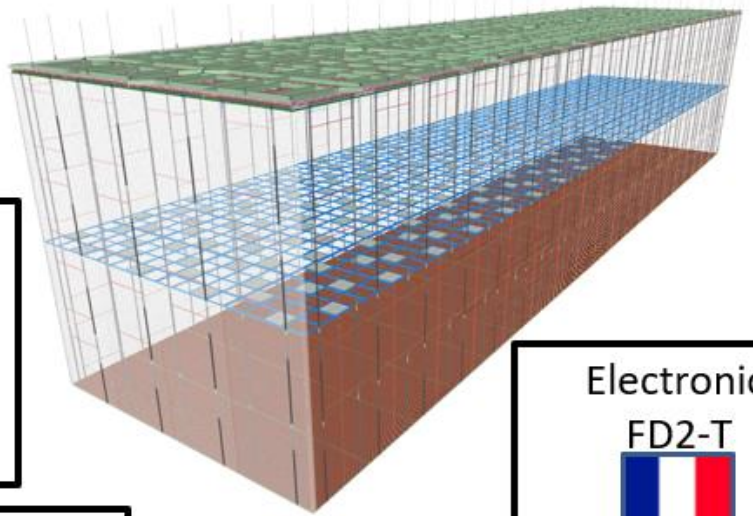
Most Popular

Articles

- Flagship Rocksino by Hard Rock co Deadwood
- Williams selected as the new Spearf School principal
- Jack receives his wish
- Deadwood Chamber of Commerce executive director
- Walters named region Teacher of the
- Playground construction at Evans P into action
- BHSU celebrates graduates at 185th commencement ceremony
- Spearfish softball ends season
- USA has smallest beef herd in 60 ye
- Former Pennington Co. sheriff deput student killed during traffic stop

Far Detector Partners





High Voltage
FD1, FD2

Electronics
FD2-T

Anode Plane
Assemblies - FD1

Photon Detection
FD1, FD2

Charge Readout
Planes - FD2

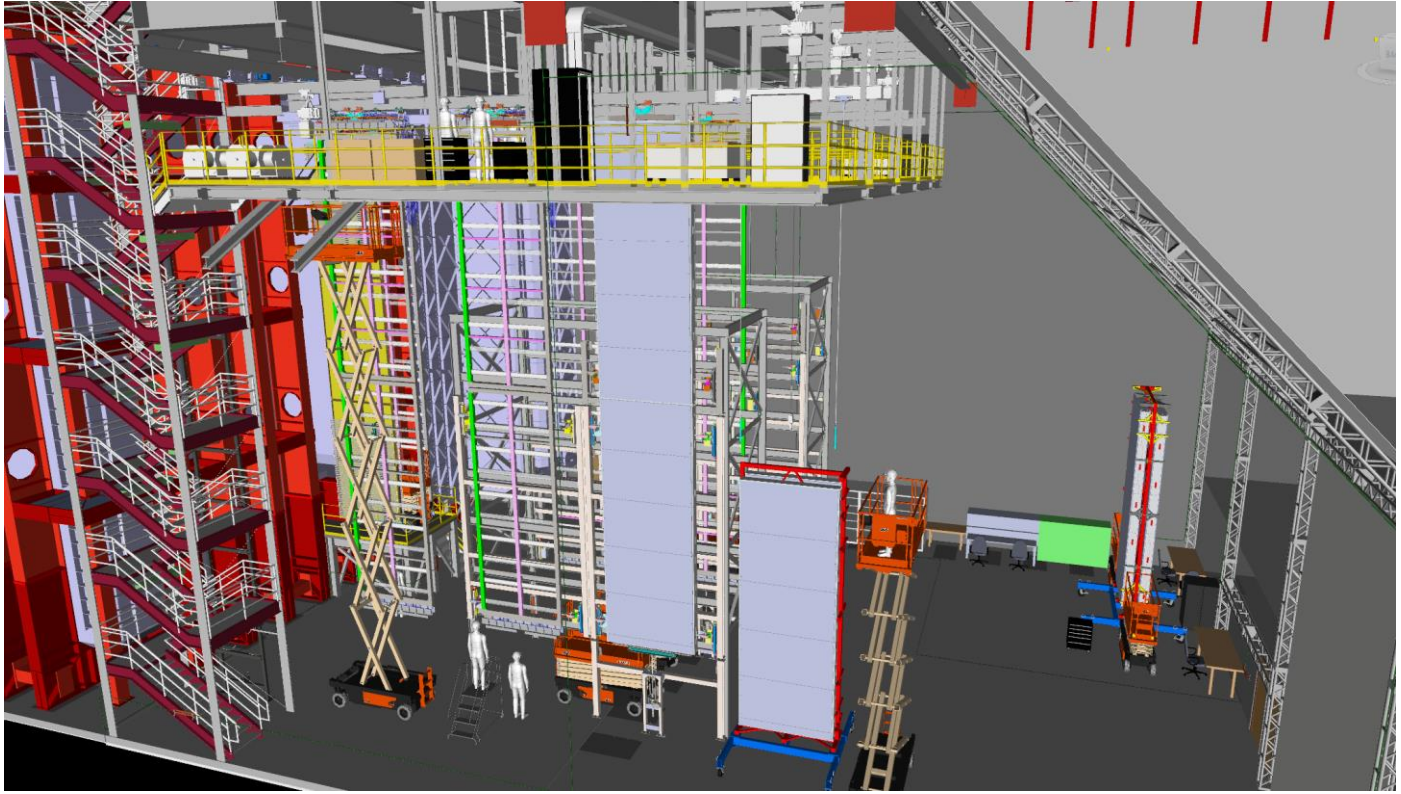
TPC
Electronics
FD1, FD2-B

CALCI
FD1, FD2

Data Acquisition
FD1, FD2, ND

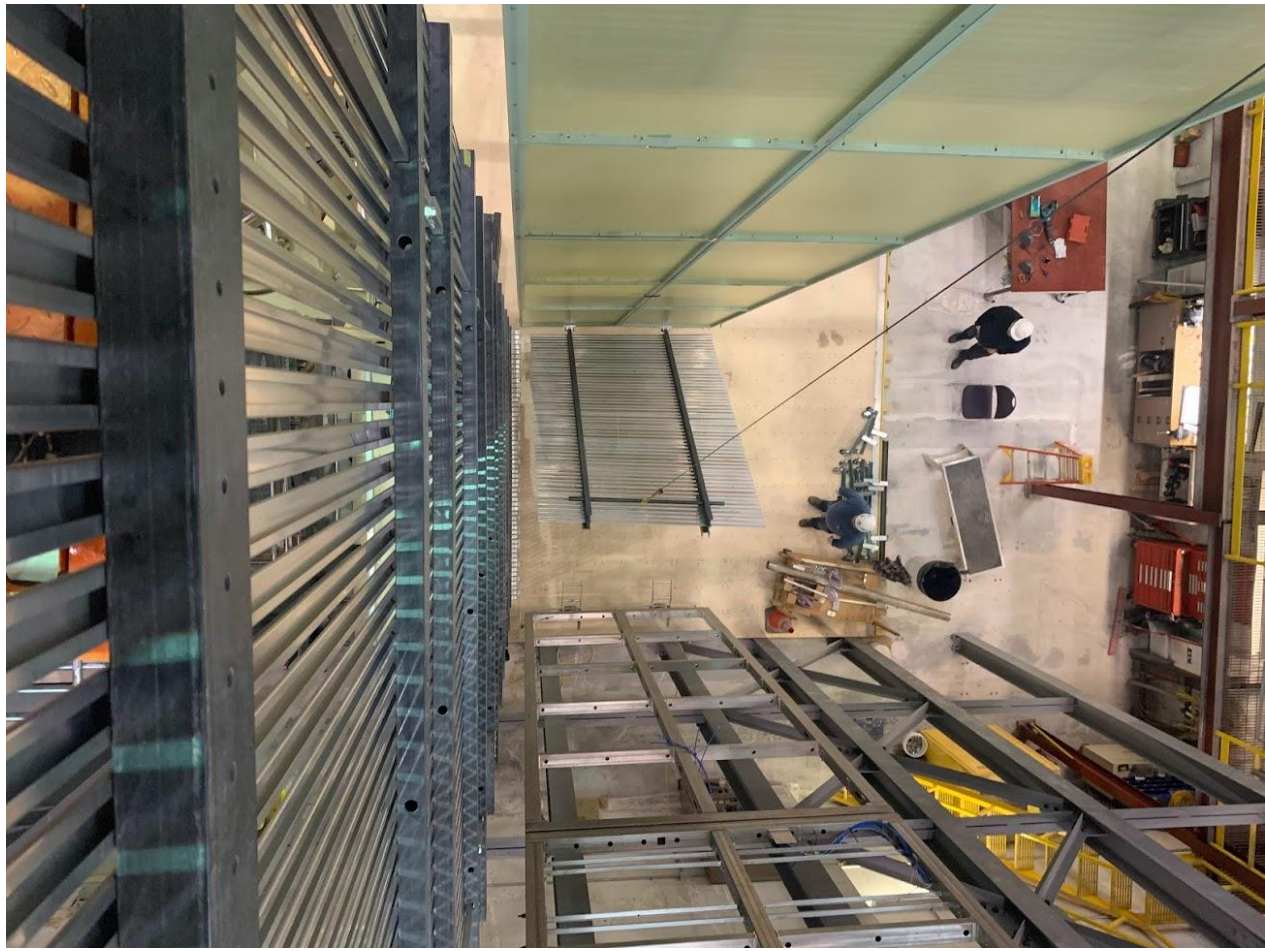
Detector components are installed inside the cryostats

- 1300+ collaborators
- 204 institutions in 33 countries + CERN
- Expect 40 scientists / month starting mid-2026 (US/nonUS)



Installation Prototyping – Ash River, Minnesota

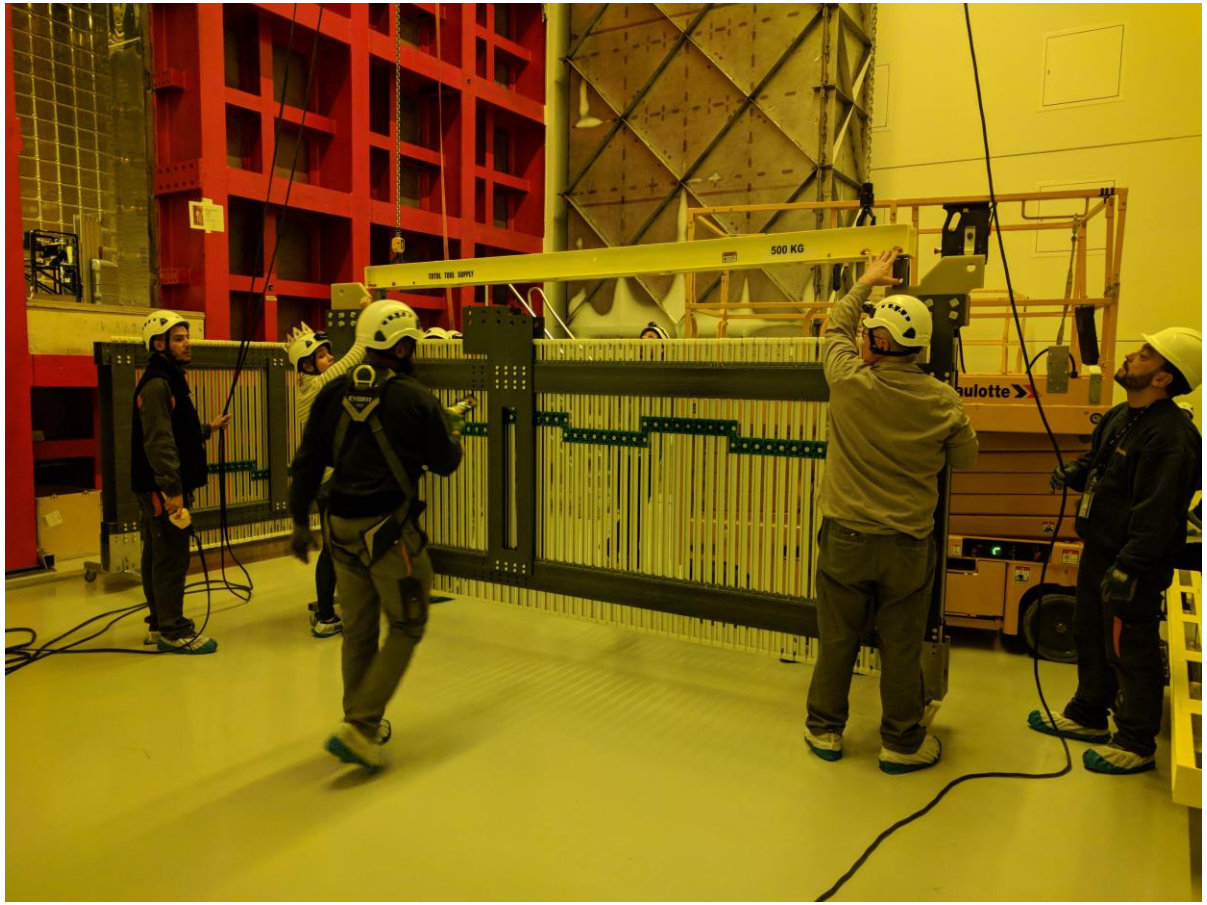
- Prototyping set-up at NOvA far detector
- Full-scale testing
- Participation from across consortia and installation planning teams
- Identify lessons learned
- Informs procedures and labor estimates



Full-height (12 meter) prototyping at Ash River, Minn (NOvA Far Detector)

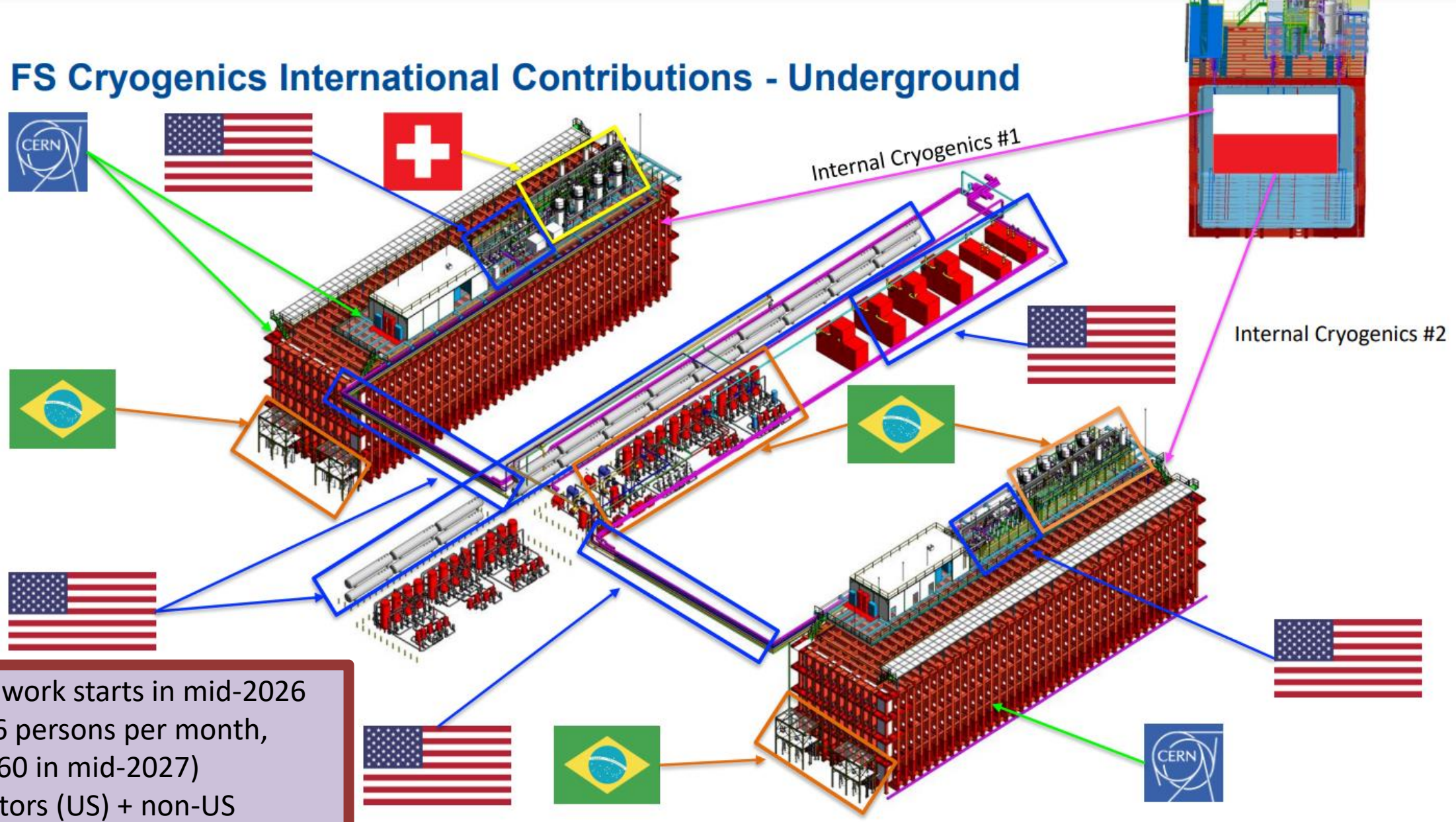
Building a Team to Install Detectors

- Key skills: material handling, work planning, mechanical acumen
- Hiring starts in late 2025
- Build the world's largest neutrino detector - one mile underground
- Work side-by-side with engineers, physicists from around the world
- Four-year installation process



- Increase to 80 staff persons
- Work from heights (more than 50 feet)
- Modular components
- Operate forklifts, scissor lifts, pallet jacks
- Team of technicians support cryostat & detector installation

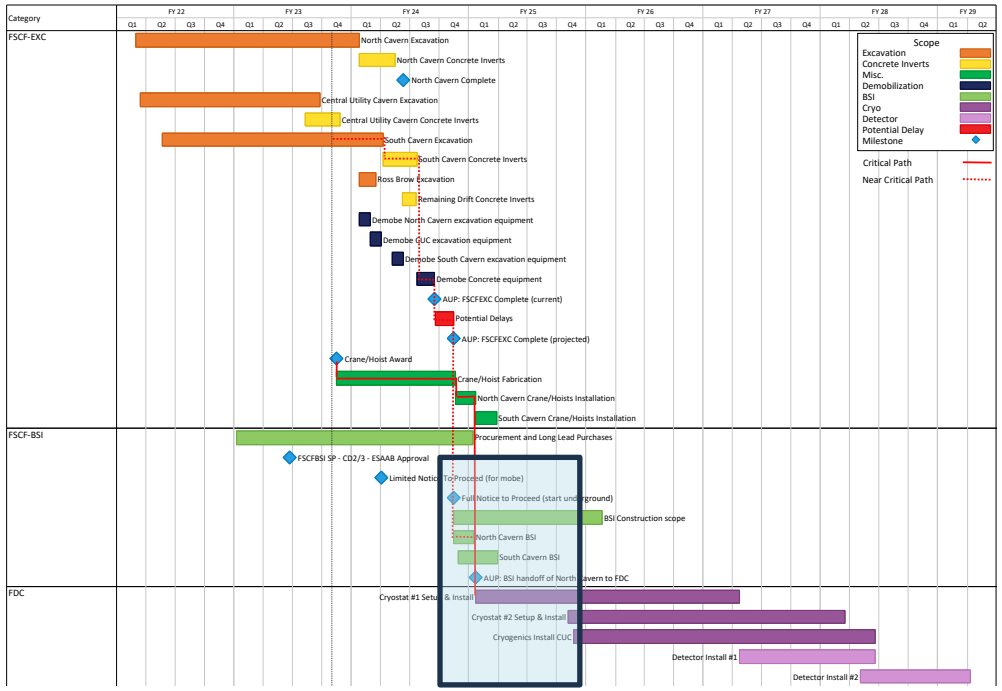
FS Cryogenics International Contributions - Underground

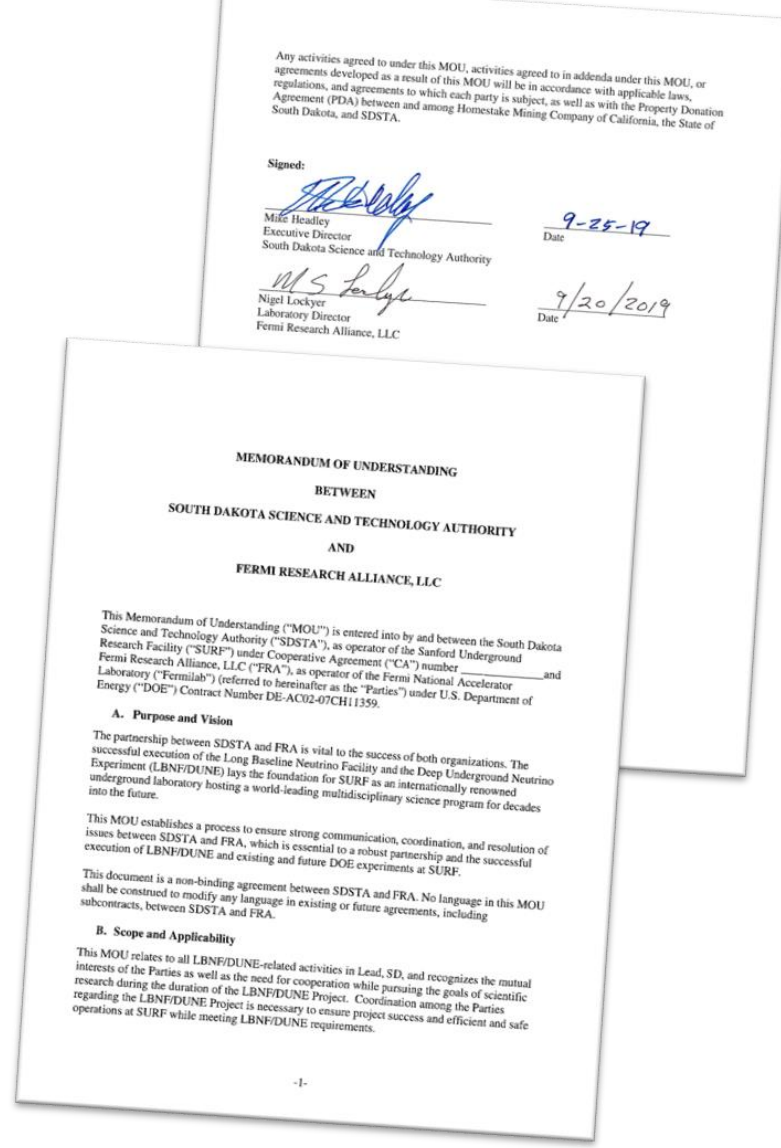


- Cryogenics work starts in mid-2026 (Average 26 persons per month, peaking at 60 in mid-2027)
- Subcontractors (US) + non-US experts
- Filling of cryostats is the final LBNF Project activity

Coordinating with Partners at the Far Site

- LBNF/DUNE-US FS subprojects FSCF/EXC & FSCF/BSI
  - Requirements/interfaces
  - Co-working period
- Mission Support / DUNE Coordination Office / South Dakota Services
- SDSTA
- Joint Coordination Team





Any activities agreed to under this MOU, activities agreed to in addenda under this MOU, or agreements developed as a result of this MOU will be in accordance with applicable laws, regulations, and agreements to which each party is subject, as well as with the Property Donation Agreement (PDA) between and among Homestake Mining Company of California, the State of South Dakota, and SDSTA.

Signed:

Mike Headley
Executive Director
South Dakota Science and Technology Authority
Date 9-25-19

Nigel Lockyer
Laboratory Director
Fermi Research Alliance, LLC
Date 9/20/2019

MEMORANDUM OF UNDERSTANDING
BETWEEN
SOUTH DAKOTA SCIENCE AND TECHNOLOGY AUTHORITY
AND
FERMI RESEARCH ALLIANCE, LLC

This Memorandum of Understanding ("MOU") is entered into by and between the South Dakota Science and Technology Authority ("SDSTA"), as operator of the Sanford Underground Research Facility ("SURF") under Cooperative Agreement ("CA") number _____and Fermi Research Alliance, LLC ("FRA"), as operator of the Fermi National Accelerator Laboratory ("Fermilab") (referred to hereinafter as the "Parties") under U.S. Department of Energy ("DOE") Contract Number DE-AC02-07CH11359.

A. Purpose and Vision

The partnership between SDSTA and FRA is vital to the success of both organizations. The successful execution of the Long Baseline Neutrino Facility and the Deep Underground Neutrino Experiment (LBNF/DUNE) lays the foundation for SURF as an internationally renowned underground laboratory hosting a world-leading multidisciplinary science program for decades into the future.

This MOU establishes a process to ensure strong communication, coordination, and resolution of issues between SDSTA and FRA, which is essential to a robust partnership and the successful execution of LBNF/DUNE and existing and future DOE experiments at SURF.

This document is a non-binding agreement between SDSTA and FRA. No language in this MOU shall be construed to modify any language in existing or future agreements, including subcontracts, between SDSTA and FRA.

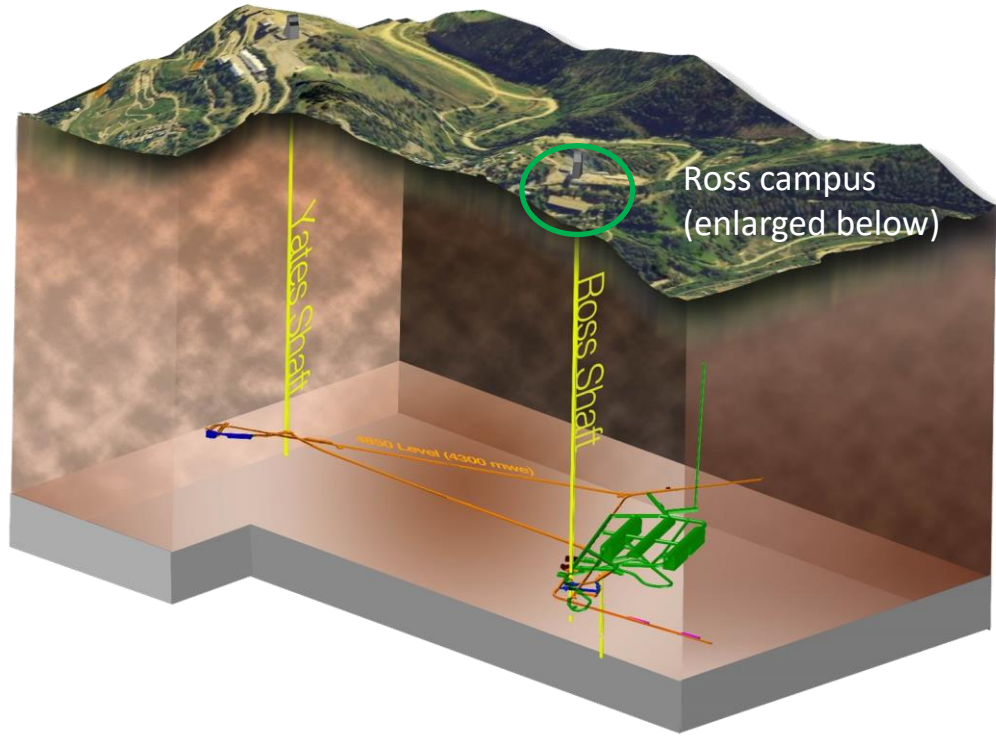
B. Scope and Applicability

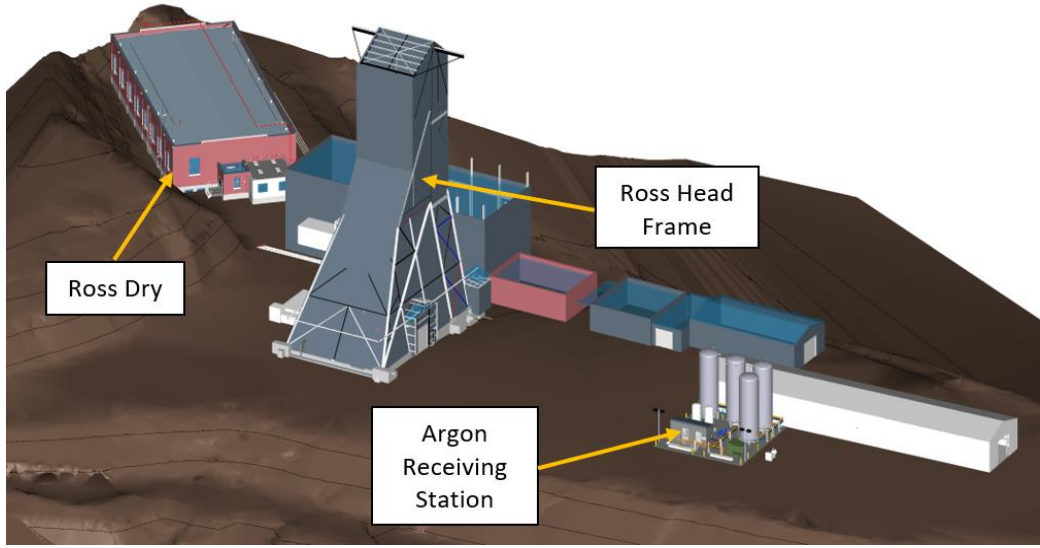
This MOU relates to all LBNF/DUNE-related activities in Lead, SD, and recognizes the mutual interests of the Parties as well as the need for cooperation while pursuing the goals of scientific research during the duration of the LBNF/DUNE Project. Coordination among the Parties regarding the LBNF/DUNE Project is necessary to ensure project success and efficient and safe operations at SURF while meeting LBNF/DUNE requirements.

-1-

Key FDC Assumptions (i)

- Contributions to LBNF are documented in Project Planning Documents; DUNE deliverables are delineated in the DUNE MOU Annexes
- Installation activities take place in Lead, SD, at Sanford Underground Research Facility (SURF)
- SURF's Ross Shaft is available for LBNF/DUNE-US Project use; Yates Shaft is for emergency secondary egress
- At SURF, FDC activities (surface & underground) occur in DOE-leased space, adhering to Fermilab ESH governance (10 CFR 851) and SURF access rules
- Underground activities occur in the LBNF campus at 4850 and 4910 levels, beginning first in the North Detector Cavern. There will be a period of concurrent work at SURF with FSCF/Buildings & Site Infrastructure



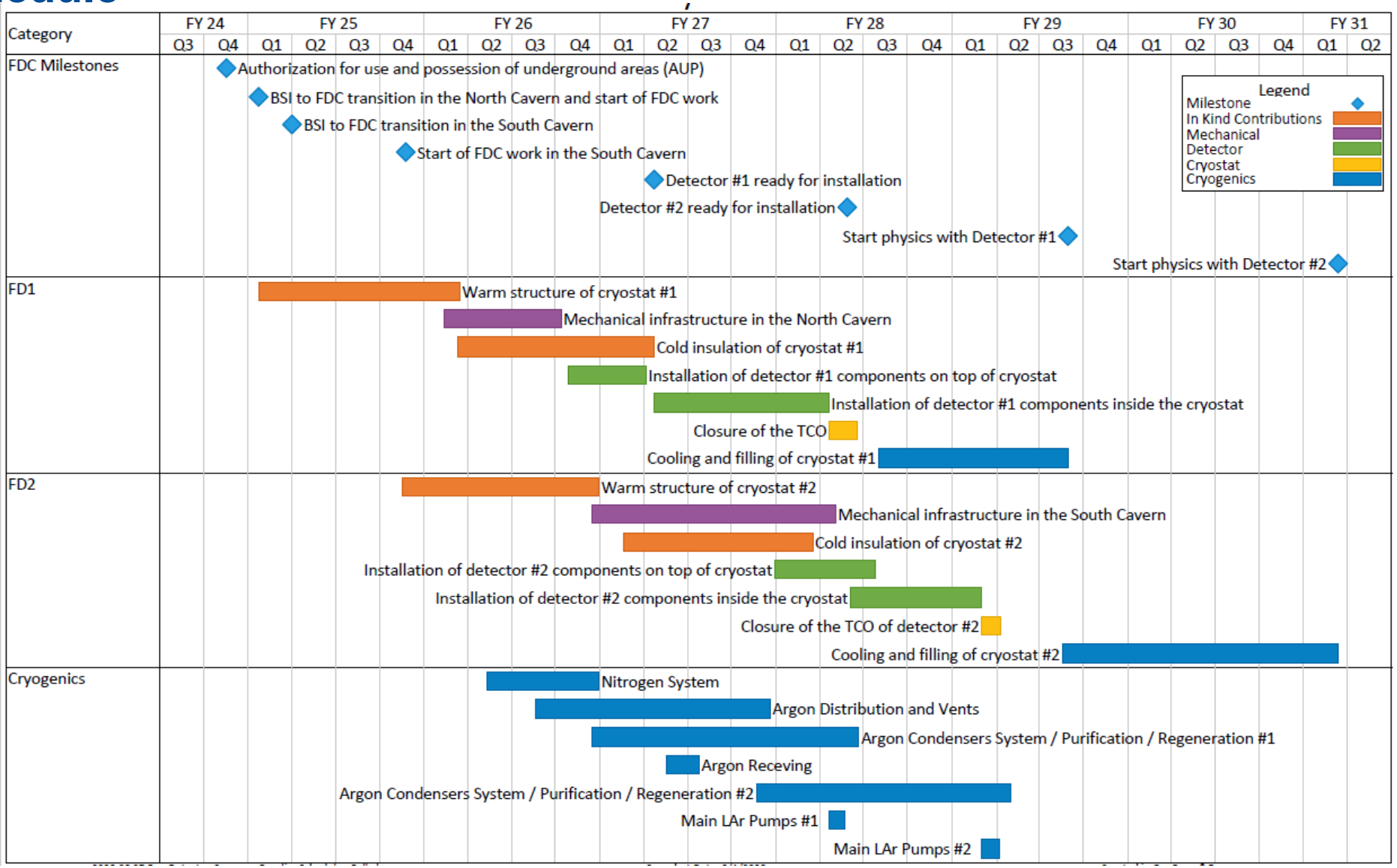


Key FDC Assumptions (ii)

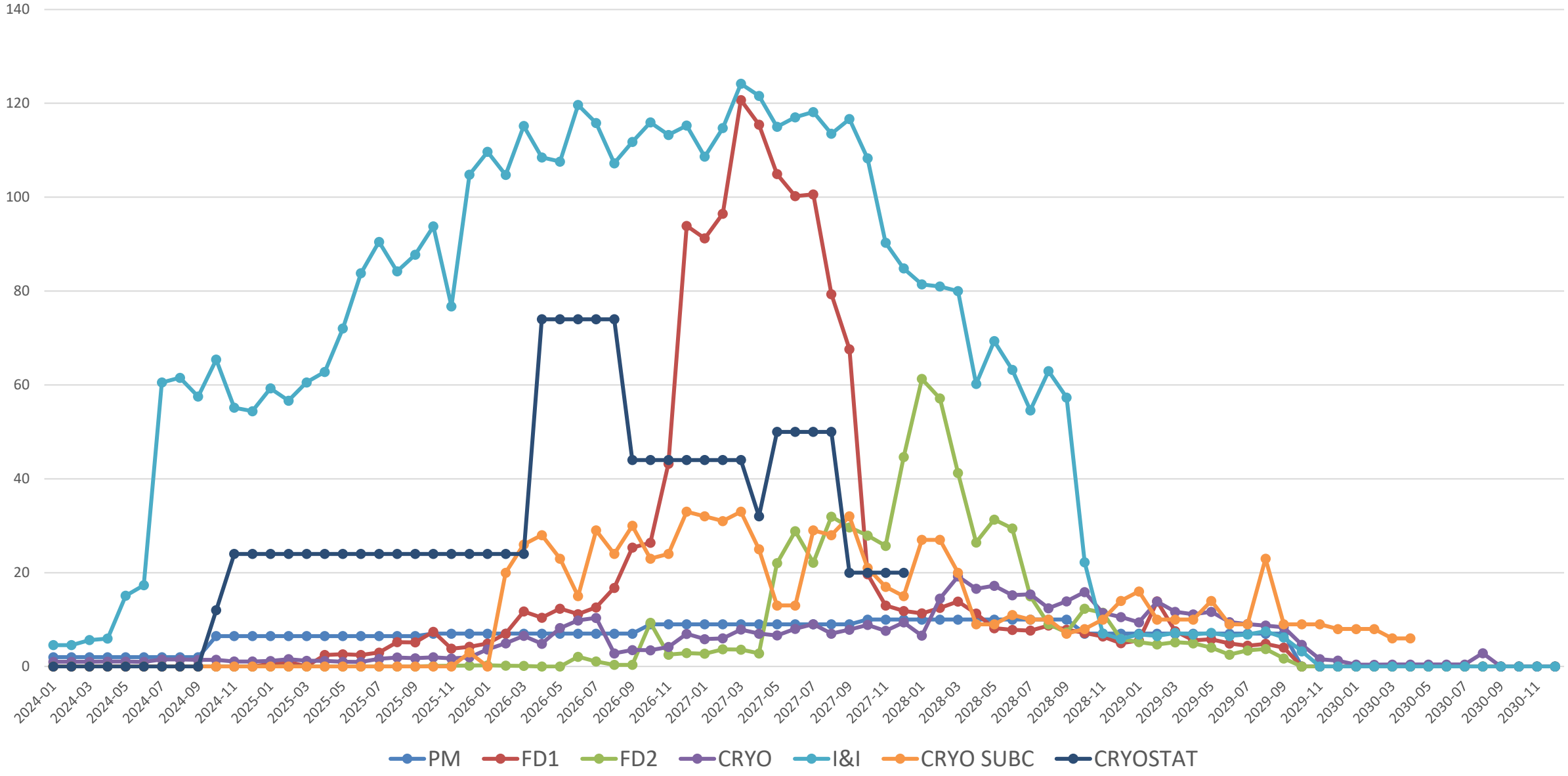
- There is insufficient laydown space at the SURF site; FDC provides its own SD **regional storage**
- Shift work is optimized to support partners & compliance with **underground headcount limits**. SDSTA refuge chamber will be expanded to support 250 persons
- FDC access at SURF must comply with the requirements of their Risk Transfer Protocol including **insurance**
- FDC costs include **power & Ross Shaft hoisting**
- **Maintenance of conventional facilities** is the responsibility of Infrastructure Service Division, based on the FSCF/BSI Transition to Operations
- DUNE Coordination Office & SDSD facilitate **host lab services** to FDC
- LBNF/DUNE-US Project Assumptions document summarizes project-level assumptions

FDC Installation Schedule

- FDC underground work in SD begins with warm cryostat (CERN IKC) installation
- Storage supports delivery of cryostat components prior to start of underground work
- FDC activities continue on surface and underground as FSCF/BSI is completed
- Detector installation activities supported by FD1/FD2 consortia

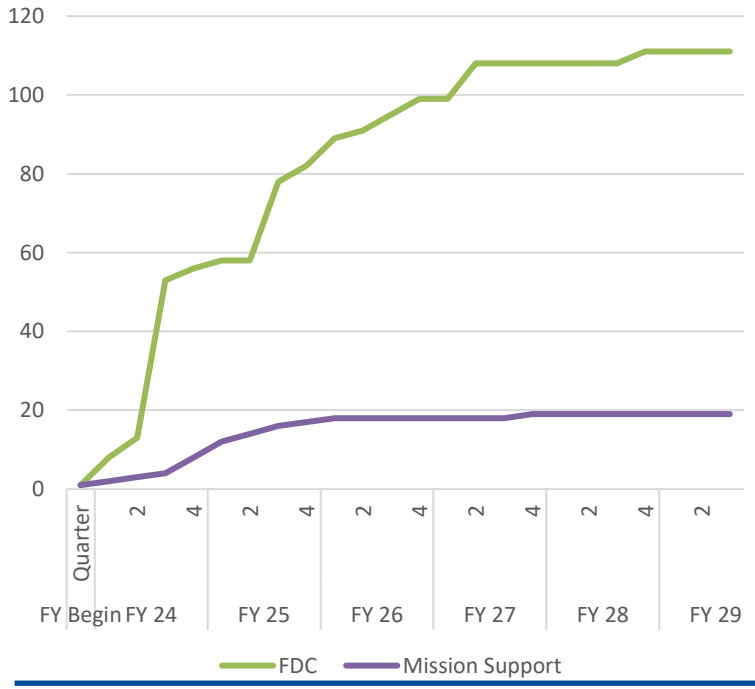


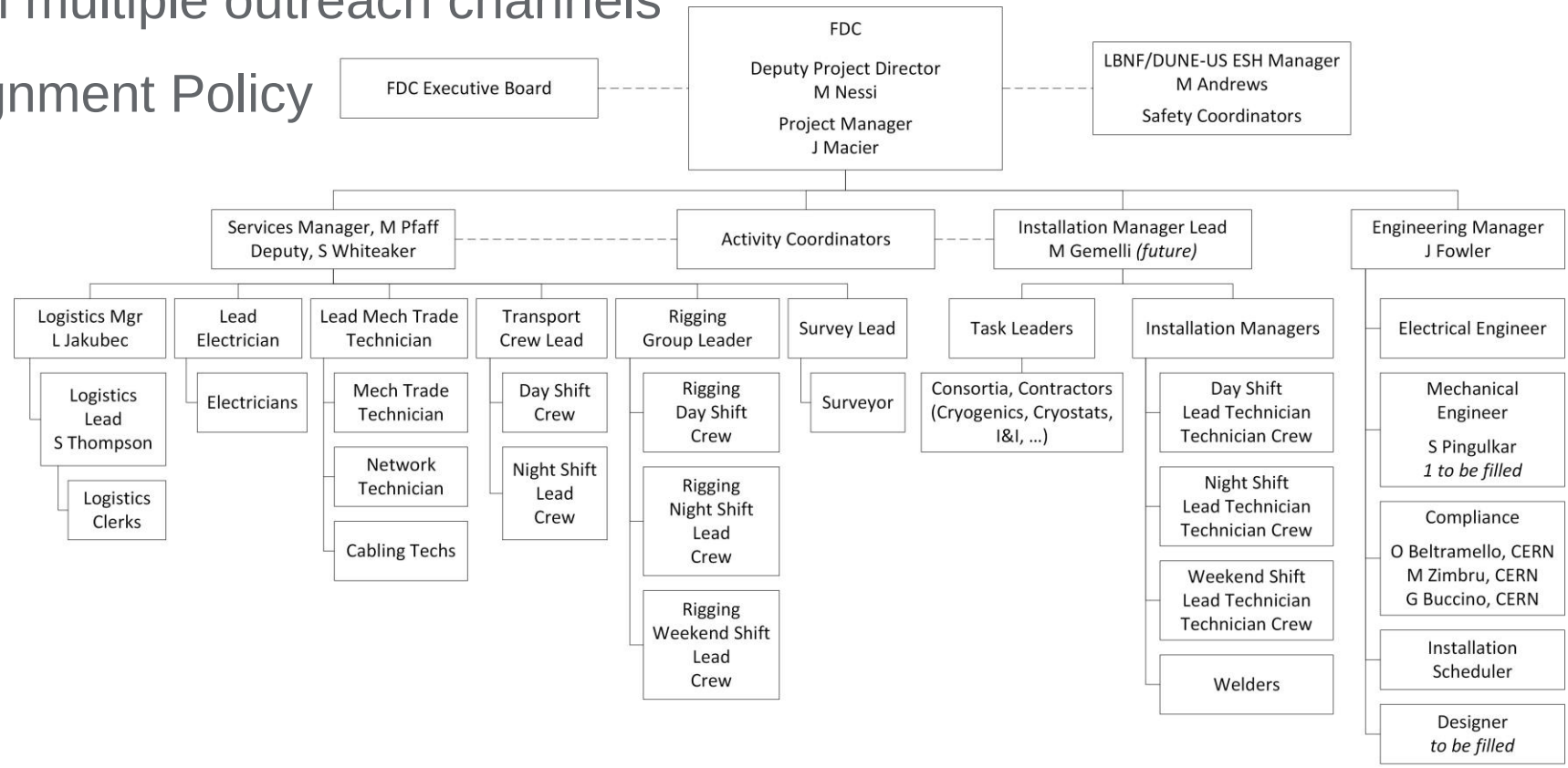
FDC SD Resources



How to accomplish all of this?

- Hiring underway with strong engagement from Fermilab HR
  - Job descriptions, on-boarding program and training plans developed
- Building the team through multiple outreach channels
- Domestic Extended Assignment Policy

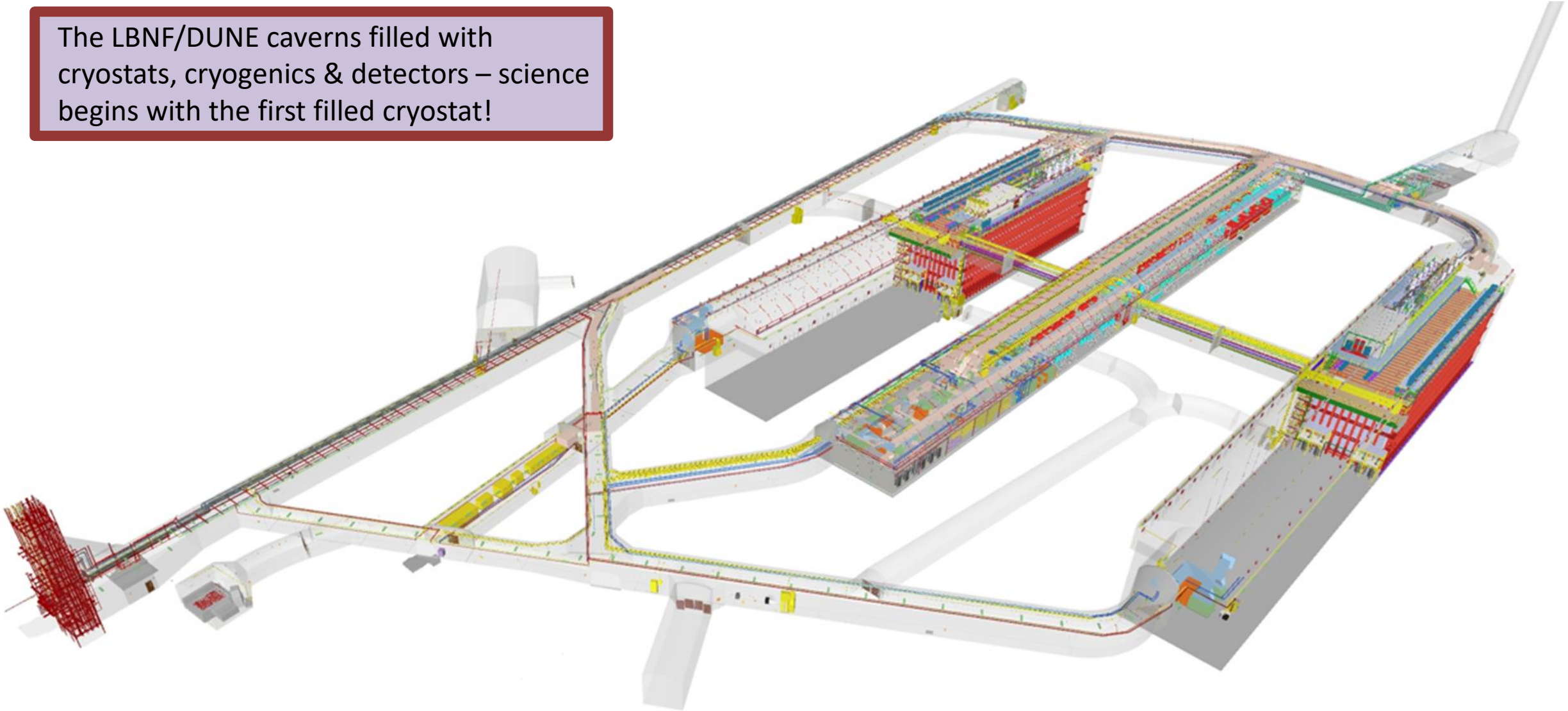




Jobs to support Installation activities in South Dakota

- Engineering Office
  - Electrical Engineer
  - Designer
  - Installation Scheduler/Work Planner
- Services
  - Logistics Clerks
  - Electrician
- Installation
  - Installation Manager Deputies
  - Mechanical Technicians
  - Mechanical Senior Technicians
  - Electronics Technicians
  - ESH Specialists

The LBNF/DUNE caverns filled with cryostats, cryogenics & detectors – science begins with the first filled cryostat!




Thank you!

Site Orientation – Underground (~2029)