



Sunrise from Mt Roosevelt

LBNF/DUNE-US Status Update

Jolie Macier, FDC Subproject Manager

Mission Support Workshop

30 January 2024



DUNE Collaboration Meeting

Collaboration Concerns regarding work in South Dakota – US Institutions

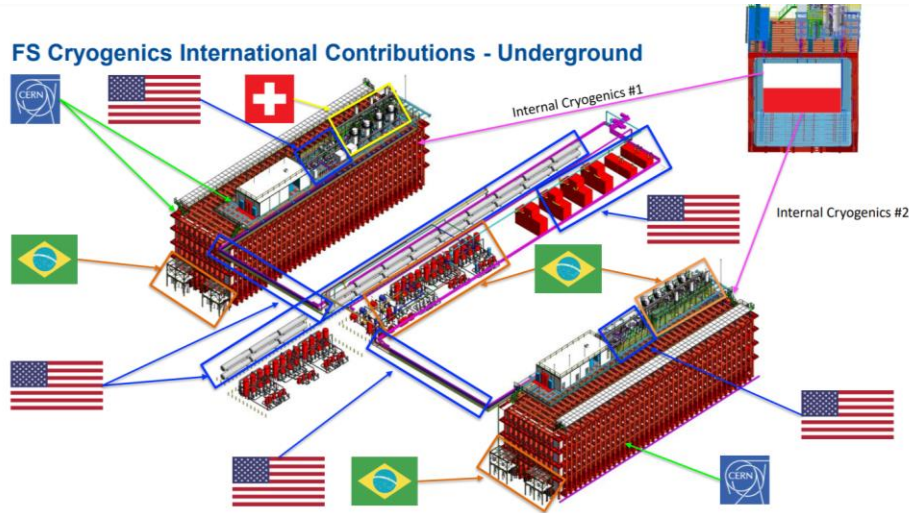
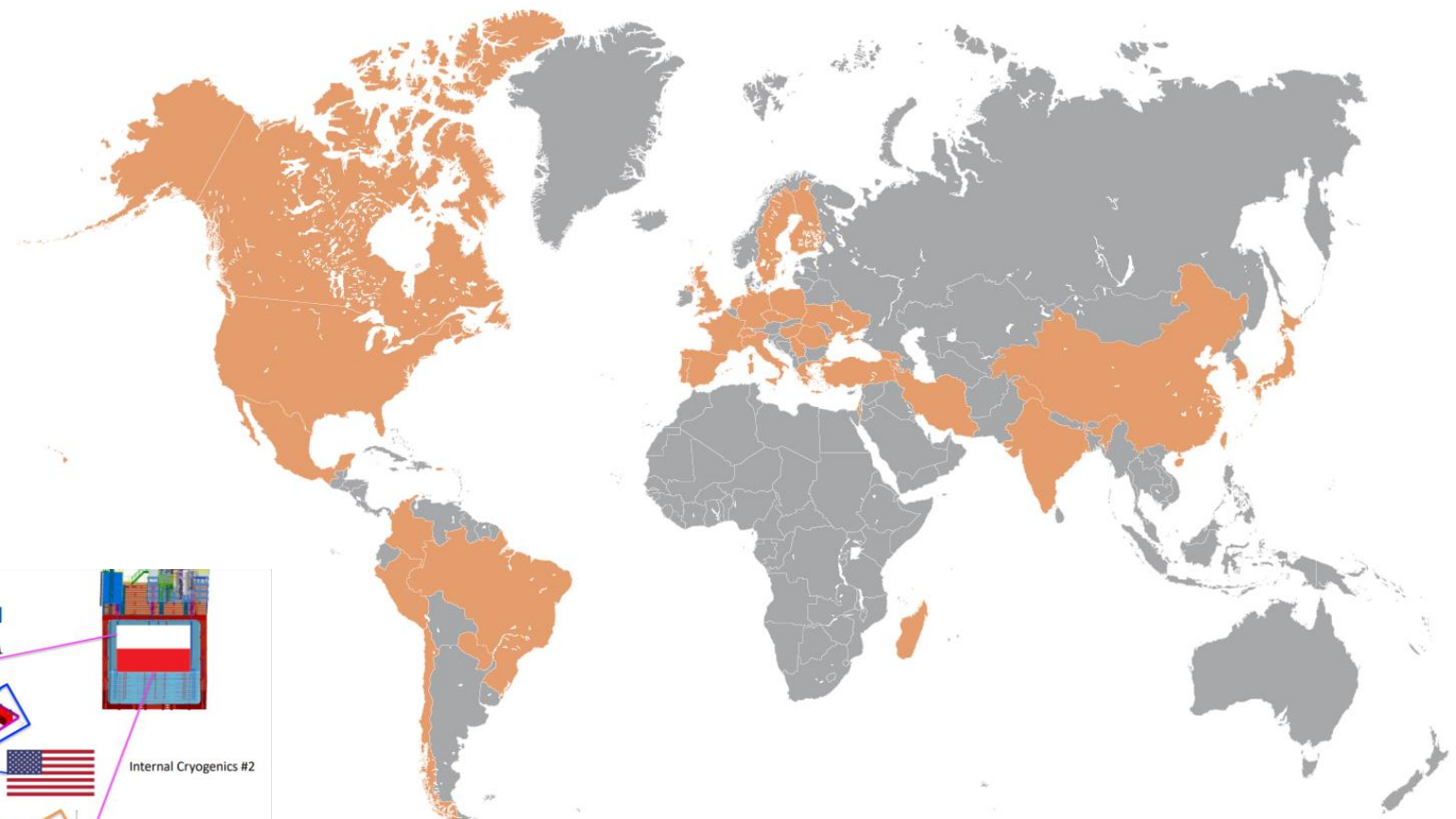
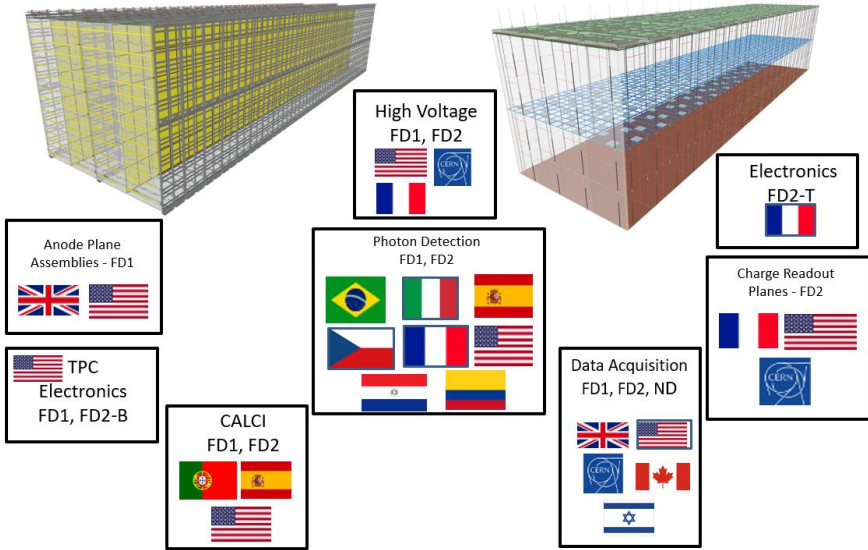
- How do you make it attractive?
- Is there a scientific community?
- How to have networking opportunities?
- Desire for an intellectual home for students & postdocs (seminars, social gatherings)
- Perception of low-level jobs
- Competition with other research areas

- **To support detector installation, it is anticipated that certain time periods need more than 70 persons at SURF**

- *DUNE WILL BE THE COMMUNITY – the Host Lab needs support the Experiment*

DUNE Participation (orange) + LBNF (Cryogenics) in-kind contributors

Far Detector Partners



DUNE Far Detector consortia are responsible to deliver their scope. DUNE-US is a contributor to DUNE.

--
 Cryostat & Cryogenics are in-kind contributions to LBNF

LBNF excavation at Sanford Lab on schedule for June 2024 completion

By Wendy Pittlick 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

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.

The world is coming to Lead





THE LOFTs

WELCOME
Please LEAD

RAMP
PARKING
Public
Parking

Dena Sheets
PROPERTY MANAGEMENT
Specializing in
Sturgis Realty Leasing
605-499-9068

Photo credit: Jack Fowler

FDC Integration & Installation Meeting – 16-20 October 2023

- 76 participants
- 20 institutions

- All FD consortia
- Collaboration Management
- Cryogenics
- Cryostat
- I&I
- Far Site Conventional Facilities
- ESH
- QA
- Compliance
- SDSTA
- DCO/SDS

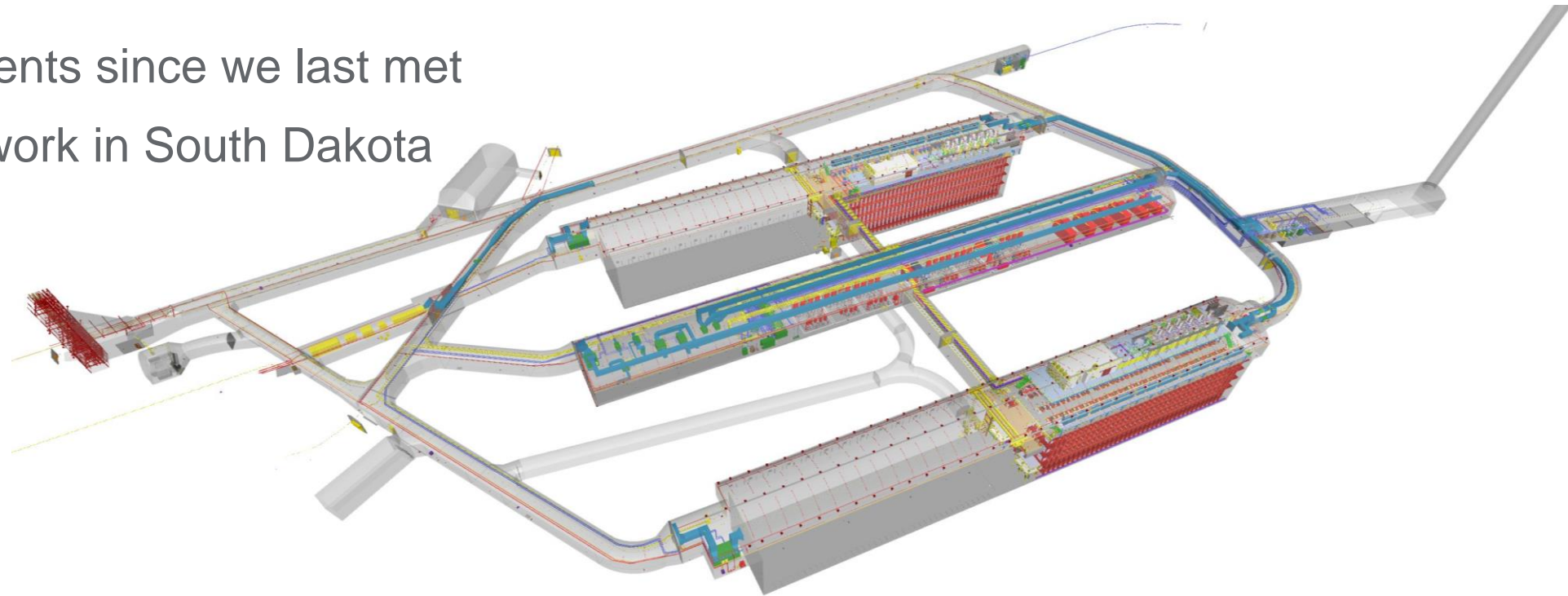




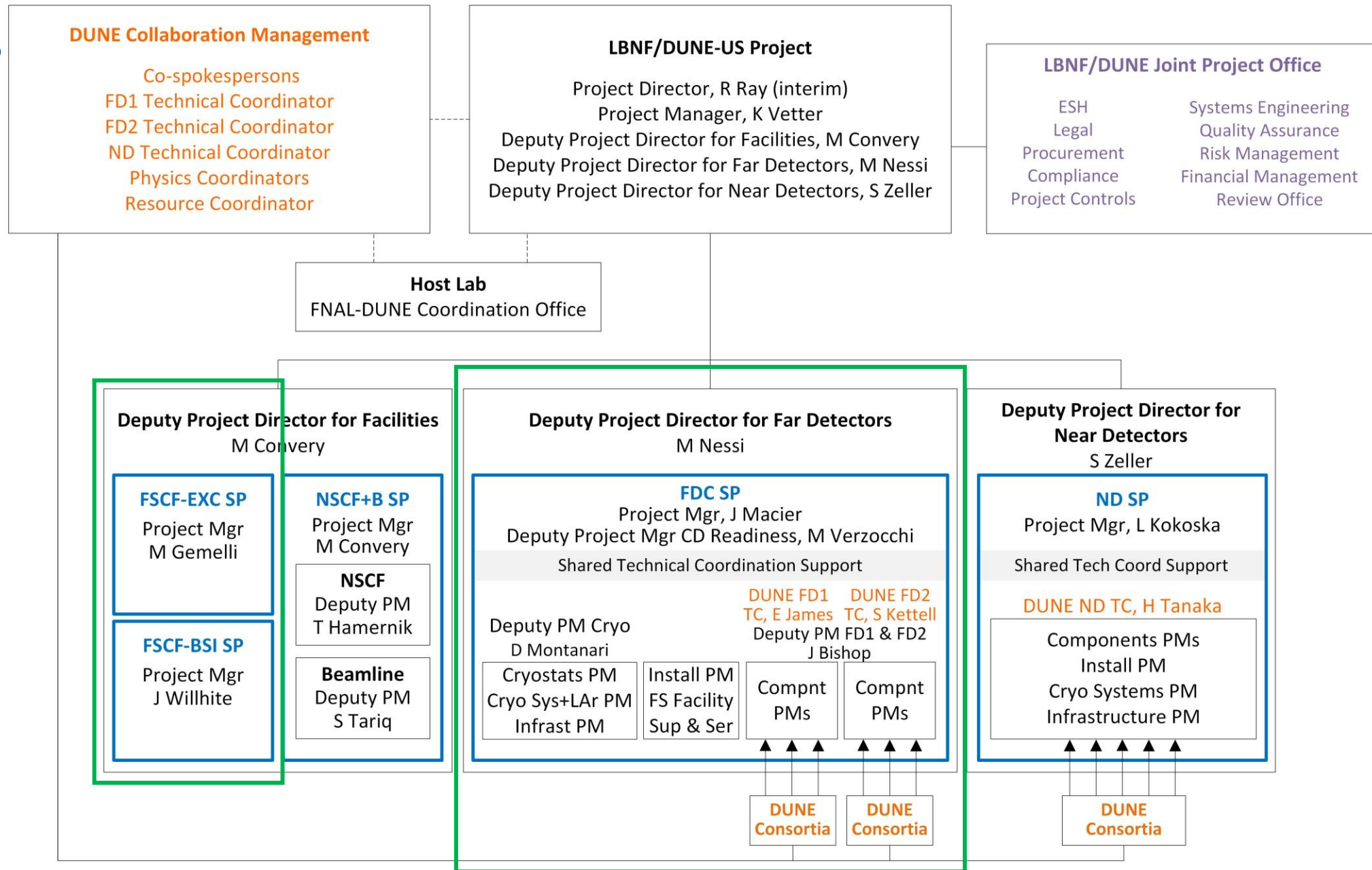
Ross Headframe

Outline

- Far Site subprojects & FDC as part of LBNF/DUNE
- EXC status
- BSI status
- FDC Scope
- FDC Accomplishments since we last met
- FDC Planning for work in South Dakota

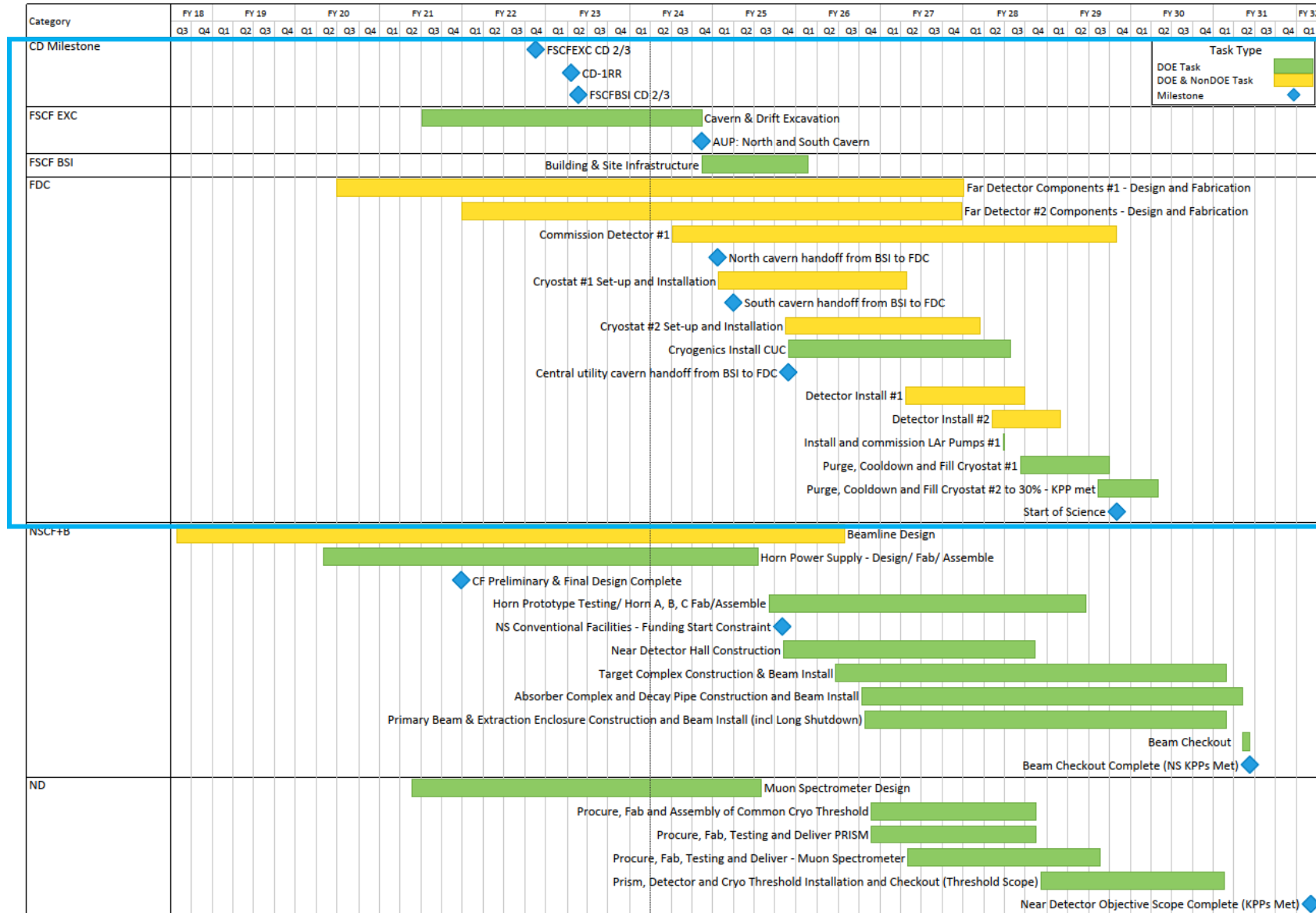


LBNF/DUNE-US Organization

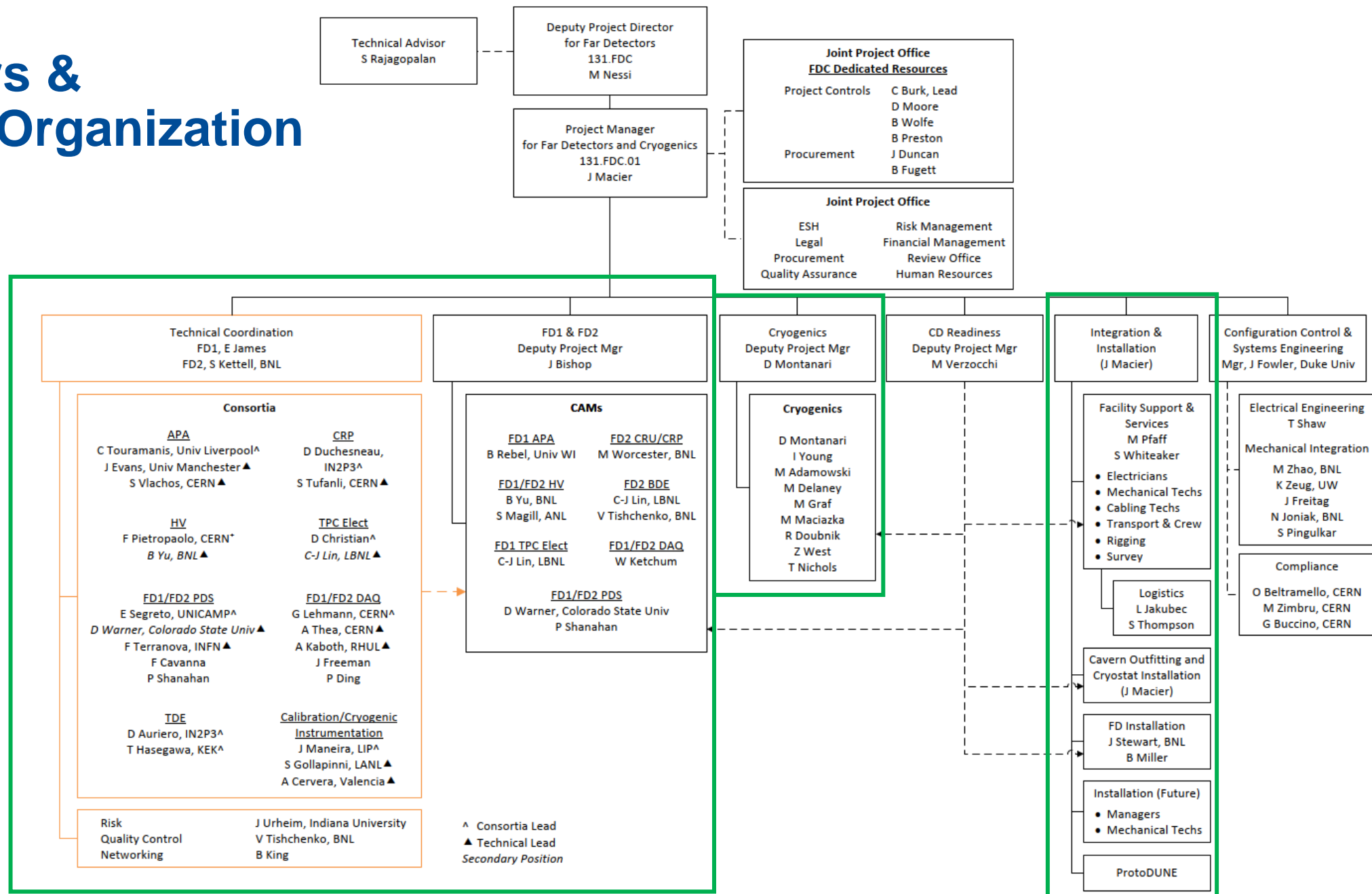


LBNF/DUNE-US Schedule

- Defined handoffs between Far Site subprojects
- FDC work begins in North Cavern with warm structure #1 installation (Oct 2024)
- Significant planning to understand and define conditions at handover and during co-working timeframe
- FDC interfaces to FSCF/EXC, FSCF/BSI defined
- Phased Transition to Operations for LBNF/DUNE

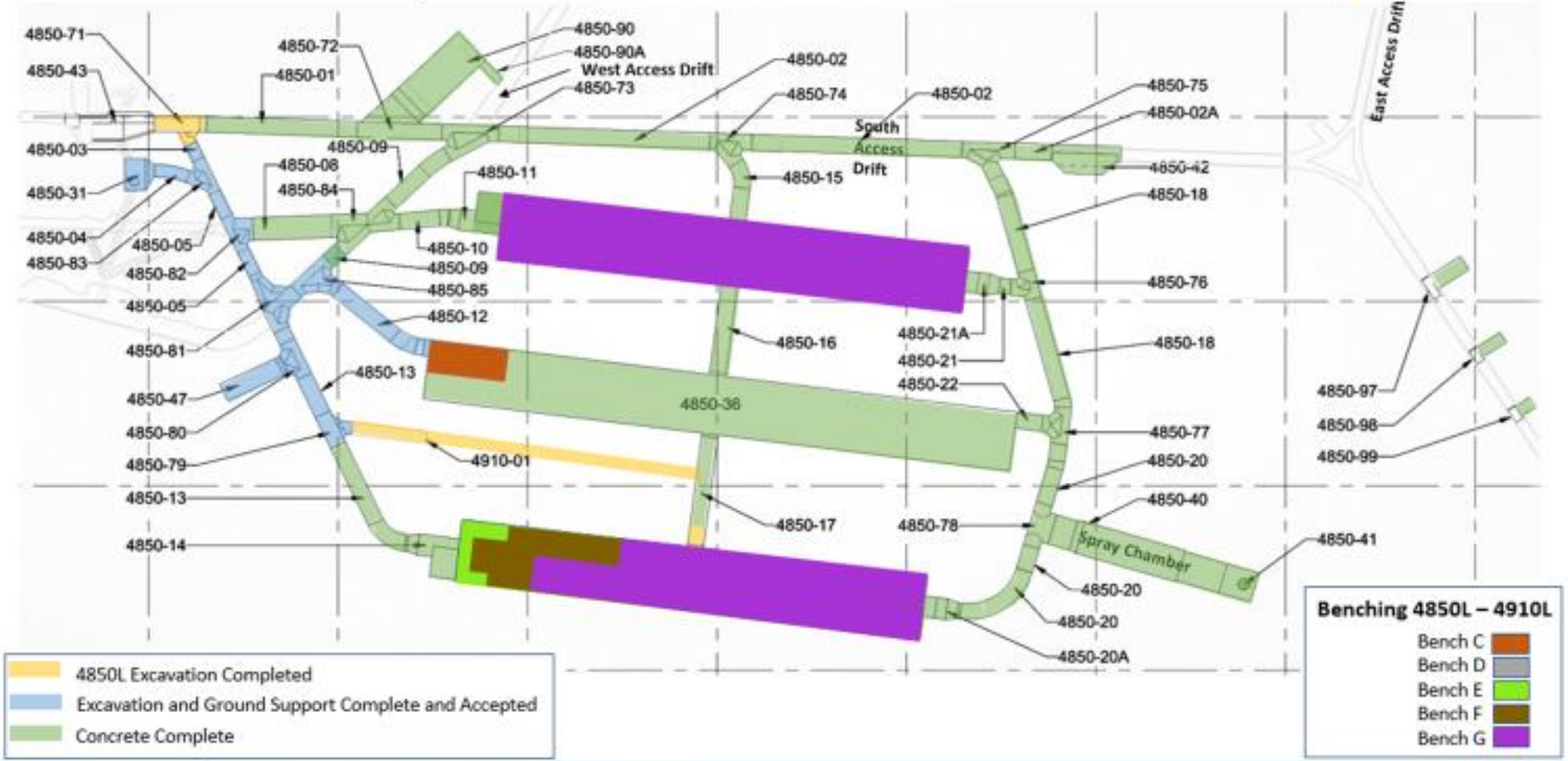


Far Detectors & Cryogenics Organization



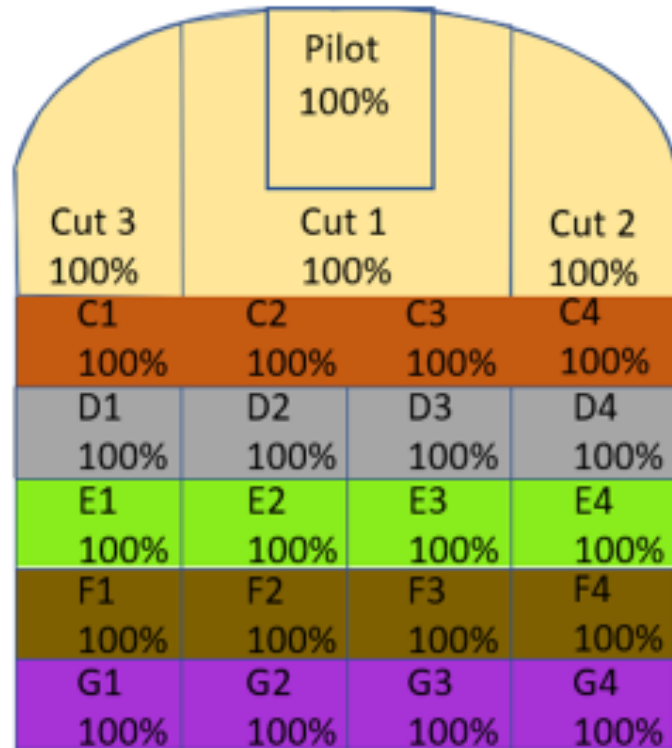
Total Excavation Completed to Date = 98%

January 19, 2024

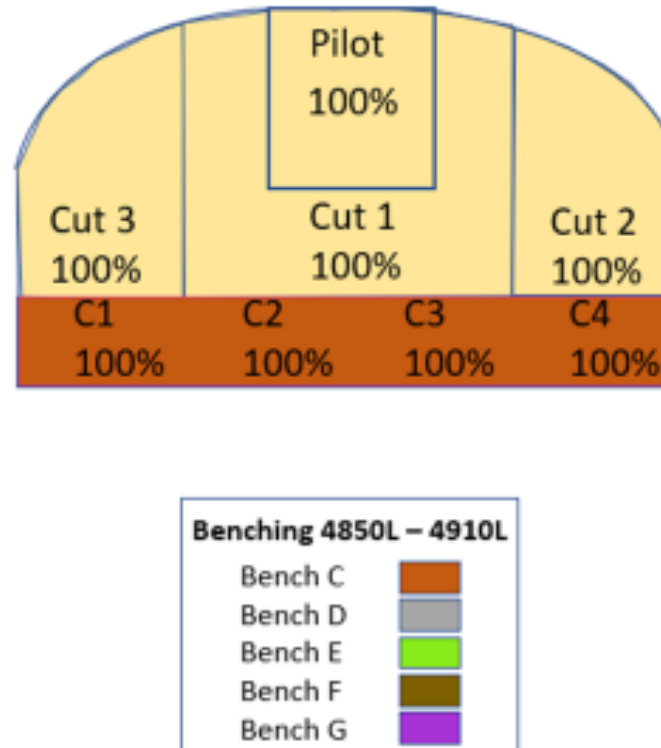


Cavern Excavation Completion Percentage

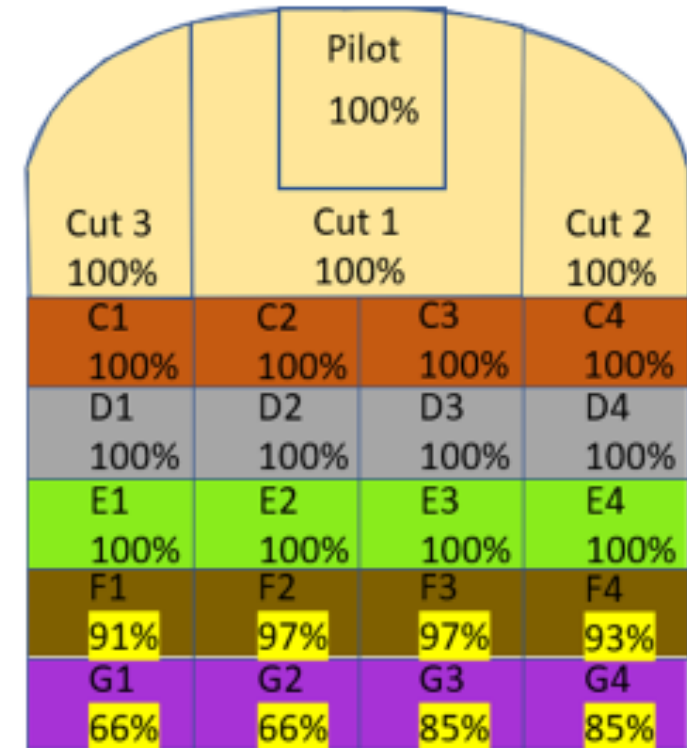
January 16, 2024



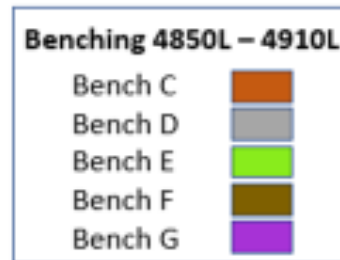
North Cavern
Completed



CUC Cavern
Completed

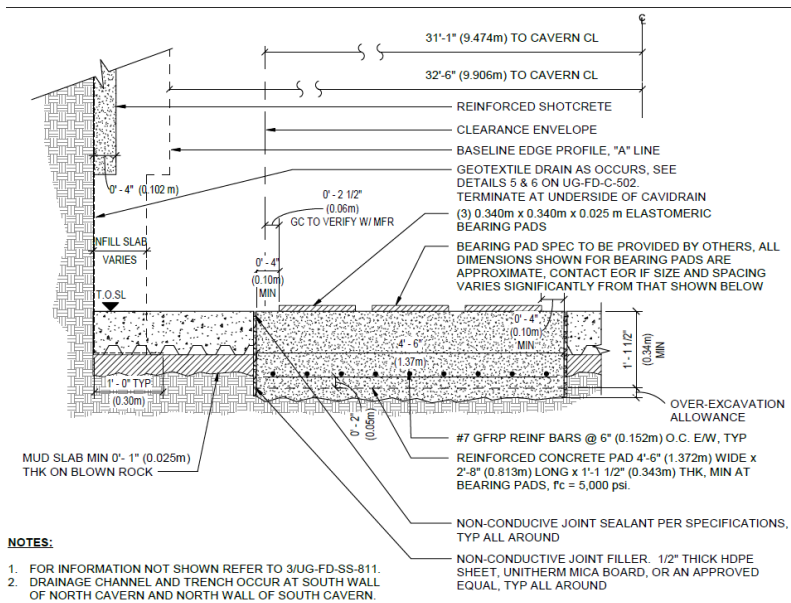


South Cavern



FSCF-EXC Status – North Cavern

- All excavation complete



DETAIL AT CONCRETE PADS IN EXPERIMENT CAVERN

SCALE: 1" = 1'-0"

2



FSCF-Buildings & Site Infrastructure (BSI) Work Packages

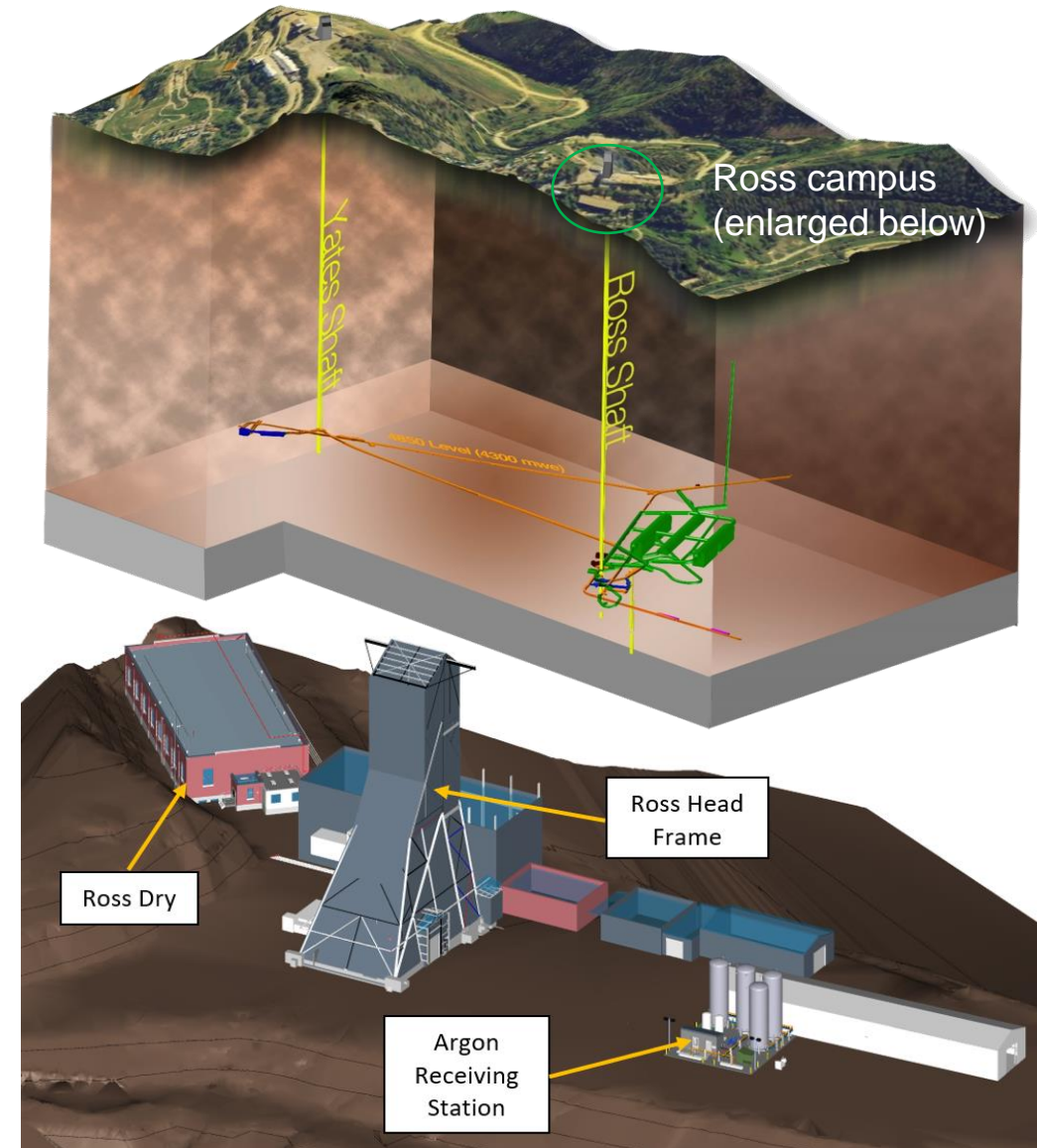
- BSI provide all infrastructure to support the experiment: power, HVAC, plumbing, fiberoptic networks, fire suppression and alarm, security, architectural features, etc.
 - Essentially builds out the “buildings” in which the detectors are installed
- Contracts have been awarded for all electrical and fiberoptic infrastructure, fire alarms, and sprinklers. Submittal reviews are under way
- Proposals are in the process of negotiation for mechanical, plumbing, surface civil, cavern elevators, QA/QC, commissioning, and logistics support.
- Remaining packages to propose include painting, masonry, and underground civil and metals.
- Have proposals for 89% of the work, including all schedule critical work.
- Plan to begin surface work as soon as weather allows in spring (April), Underground in summer when EXC demobilization allows



Sunrise from Bear Butte

Key FDC Assumptions (i)

- Installation activities take place in Lead, SD, at Sanford Underground Research Facility (SURF)
- There is insufficient laydown space at the SURF site; FDC must provide its own SD regional storage.
Laydown yard to be awarded January 2024.
- At SURF, FDC activities (surface & underground) occur in DOE-leased space, adhering to Fermilab ESH governance (10 CFR 851)
- SURF's Ross Shaft is available for LBNF/DUNE-US Project use; Yates Shaft is for emergency secondary egress
- Underground activities occur in the LBNF campus at 4850 and 4910 levels, beginning first in the North Detector Cavern. There is a period of concurrent work at SURF with FSCF/BSI.



Key FDC Assumptions (ii)

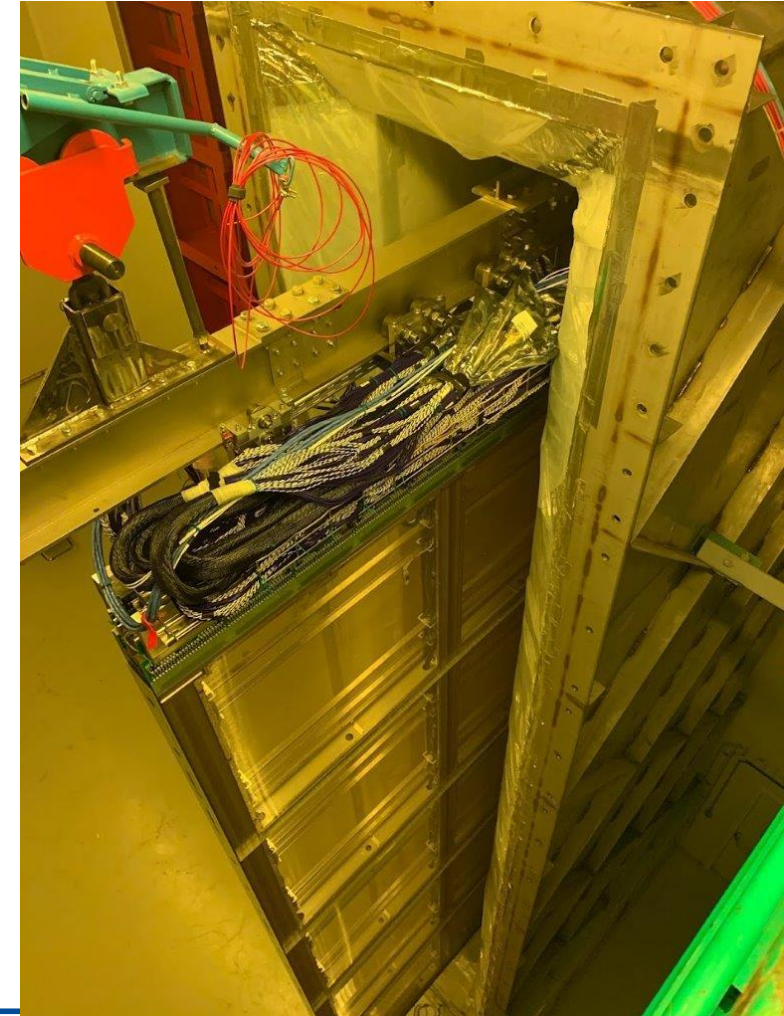
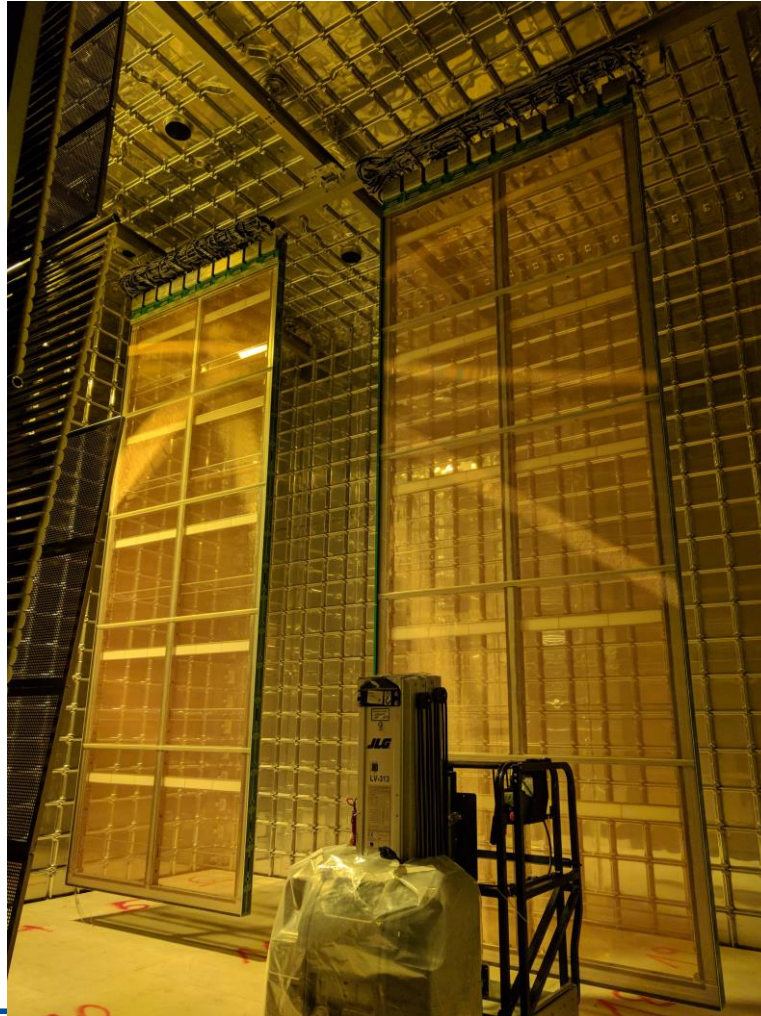
- Shift work is optimized to support partners & compliance with underground headcount limits. SDSTA refuge chamber will be expanded to support 250 persons **(expanded to 194 persons in Dec 2023)**.
- FDC access at SURF must comply with the requirements of their Risk Transfer Protocol. **The required insurance costs are supported by Host Lab.**
- FDC costs include power & Ross Shaft hoisting. **Costs are also supported by Host Lab.**
- Contributions to LBNF are documented in Project Planning Documents; DUNE deliverables are delineated in the DUNE MOU Annexes – **signed in November!**
- **Maintenance of conventional facilities is the responsibility of Fermilab Neutrino Division and Infrastructure Service Division**, based on the FSCF/BSI Transition to Operations Plan
- **DUNE Coordination Office & South Dakota Services facilitate host lab services to FDC**



Prototyping – ProtoDUNE NP04 & NP02 at CERN Neutrino Platform

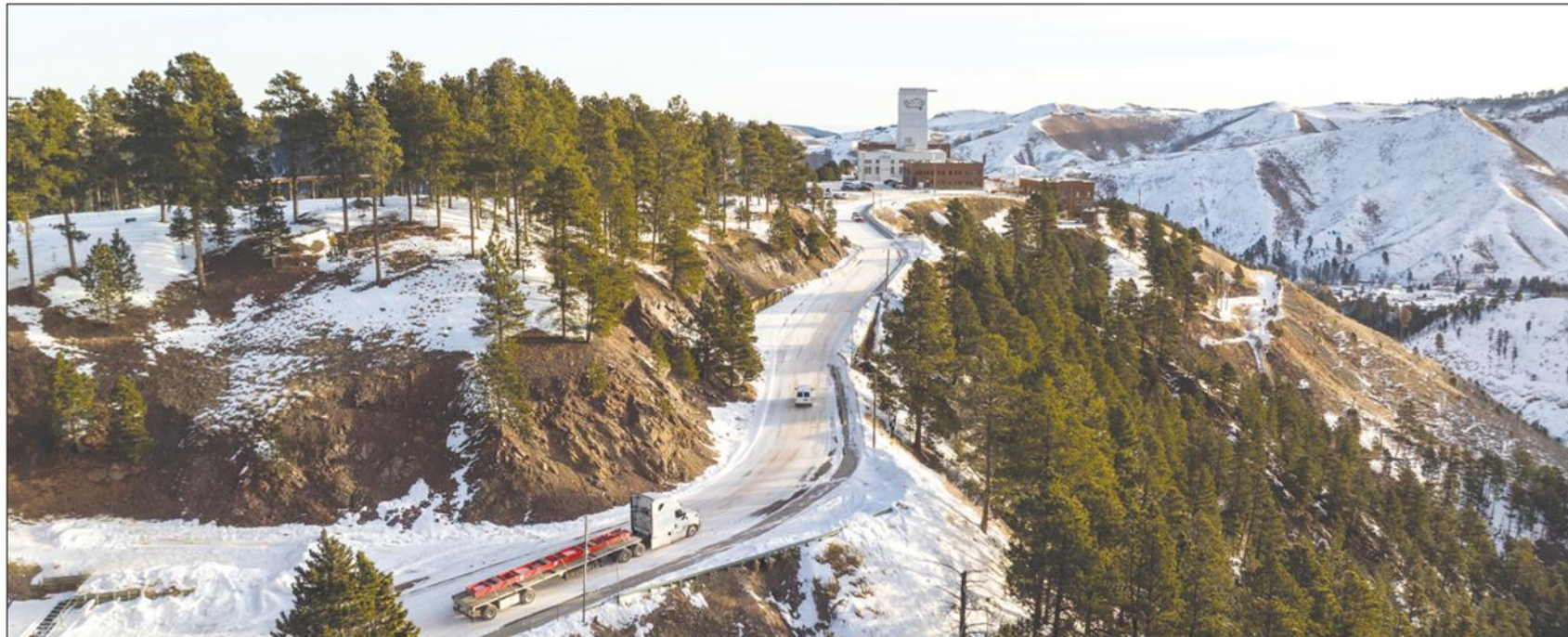
- Full-scale detector components
- Cryogenics system
- Installation processes
- Integrated teams accomplishing work
- 1/20th scale cryostats
- **LAr acquisition in process; deliveries to begin in February**

*Anode Plane Assemblies (APA)
in ProtoDUNE NP04; Integrated
APA in NP04 cold box*



Arrived 9 January!

First components for DUNE experiment in Lead



The first of what will eventually be 2,000 pieces of the cryostats for the deep underground neutrino experiment arrived in Lead last week. This spring members of the LBNF/DUNE team will work with Sanford Lab employees to begin tests to ensure the massive pieces can be safely and efficiently lowered down the Ross Shaft.

Photo by Stephen Kenny

BY WENDY PITLICK

Black Hills Pioneer

LEAD — The first components for the deep underground neutrino experiment have arrived in Lead, and starting this spring the LBNF/DUNE project team and officials with the Sanford Lab will begin tests to ensure cryostats for the experiment can be safely lowered down the Ross Shaft.

That's because the components are massive. The

first piece is more than 8 tons and 40 feet by 3 feet by 1.5 feet. The second piece is nearly 6 tons and 18 feet by 11 feet. Both pieces form just a corner of the massive cryostat for the deep underground neutrino experiment. When they're lowered down the Ross Shaft, they will have a clearance of about 3 inches on each side.

Jolie Macier, DUNE far detector and cryogenics project manager from Fermilab, said the size of the pieces present challenges that members of the collaboration

wanted to work out before it is time to actually assemble the cryostats underground. Besides the massive size of the first piece, the smaller piece, referred to as the "L beam," has its own set of complications, Macier said.

"It has a center of gravity that is a challenge," she said. "That's why we wanted some extra time to be able

from Pg 1

DUNE COMPONENTS

to do some test manipulations and test lifts with that piece in particular, such that we can be efficient when it comes to our move-in date. It's sensitive in so far as we have to make sure we can do this safely and no one is exposed to any kind of danger in the material handling."

The two massive pieces of heavy, industrial strength steel, are the largest parts of more than 2,000 pieces that will make up what is called the warm components to the cryostats, which will house the liquid argon and the detector for the deep underground neutrino experiment. The warm components are the room-temperature outer shell of a deeply insulated cryostat, which is specially designed to hold the argon at negative 387.67 degrees Fahrenheit (negative 230 degrees Celsius), in order for the element to maintain its liquefied state. The DUNE experiment includes two of these cryostats, each with dimensions of more than 195 feet long, 57 feet wide, and 54 feet high. Once the cryostats are filled they will contain about 17,000 metric tons of liquid argon.

"The most similar thing that you will find to it is a skyscraper," said Lluís Miralles Verge, CERN project leader for the construction of the DUNE cryostats.

As the flagship experiment for the Sanford Underground Research Facility, the deep underground neutrino experiment will have scientists shooting a beam of neutrinos from Fermilab in Batavia, Ill., through the earth to ultra sensitive detectors housed in the liquid argon, at the 4,850 level of SURF. By doing this, scientists hope to understand how neutrinos change form in transit. DUNE is the largest experiment in SURF in both scale and collaboration, with 200 institutions



This L-beam is nearly 6 tons and will form a corner of a massive cryostat after it is lowered 4,850 feet down the Ross Shaft. Photo by Stephen Kenny

made up of more than 1,400 collaborators from more than 80 countries.

DUNE is also the first experiment that CERN International Laboratory in Switzerland has been involved with outside of its borders. CERN is supplying the warm components of the cryostat. The two pieces that arrived in Lead for a test run down the shaft last week were built in Spain, which is one of the member countries of CERN.

"Typically, we may have contributed with some help with minimal things, but this is

the first time we got involved with an international collaboration where we are not the host," Miralles Verge said.

CERN's involvement in DUNE is part of the international lab's strategy to support neutrino physics around the world. The international lab is also involved in a neutrino experiment in Japan.

Miralles Verge said the warm components are part of technology that CERN developed in 2018. It is used in private industry to transport liquefied gas. Miralles Verge said the technology is cutting edge, and will significantly increase the efficiency of the experiment.

"What makes it unique is that it is able to keep the cryostatic temperature of the liquid with-

out active systems," he said. "We do not need a refrigerator to keep the liquid cold because of the efficiency of the insulation. Efficiency is the key in this technology."

The two cryostats used for DUNE cost CERN about 70 million Swiss Francs, or close to \$81 million — costs that will be borne by CERN's 23 member countries. Countries that are part of CERN include Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Israel, Italy, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovak Republic, Spain, Sweden, Switzerland, and the United Kingdom.

Following the test lift, the

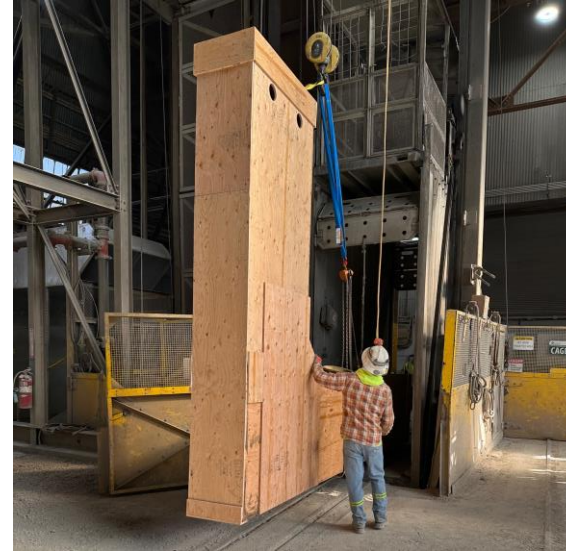
components will be again stored on the surface at SURF, until excavation and infrastructure outfitting is complete for the massive caverns that comprise the long baseline neutrino facility. Crews from Thyssen Mining, Inc. are expected to finish blasting and excavation this month, and then infrastructure construction for electrical, plumbing, ventilation, and other necessary components will start. Once the DUNE collaboration begins its work to assemble the cryostats, Macier said it will take about a year to lower all of the pieces down the Ross Shaft for assembly. Once the cryostats are assembled, the components for the neutrino detector can be installed.



Lluís Miralles Verge
CERN project leader for DUNE

Warm structure cryostat pieces – Spring 2024

- First L beam and I beam arrived at SURF Jan. 9th for trial manipulations and test lifts
- Preliminary movement trials performed by SDSTA with wood model
- Design and engineering underway for tooling, carts for manipulation and movement of L beam in/out of cage for transport underground



Warm structure cryostat pieces at SURF (above) and L-beam mock-up (left)

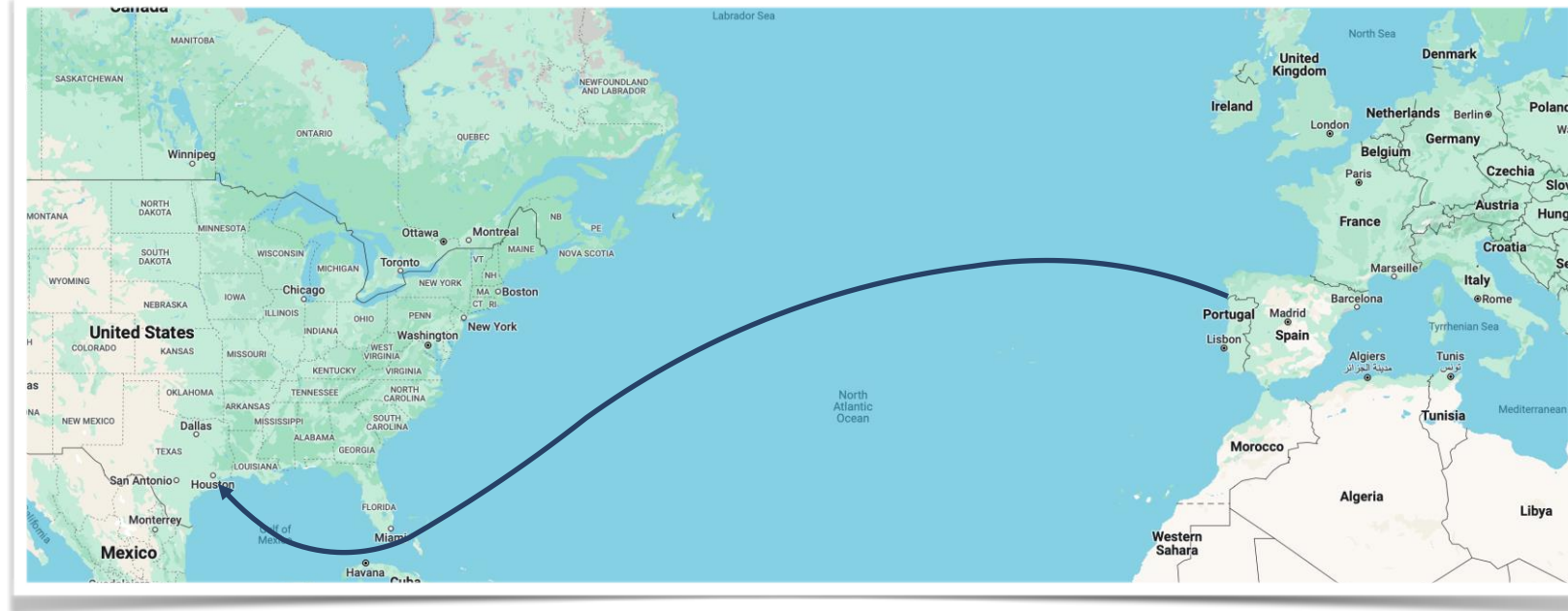


Steel for one cryostat (left)

Cryostat warm structure transport begins soon!

Contract for transport of Cryostat #1 established.

- Transport on truck from La Coruña to departing harbor (Vigo, Spain)
- Breakbulk vessel to Houston (TX)
- Truck transport to laydown yard in Rapid City (final destination to be defined)



Schedule:

- Shipment Cryo #1 beginning of March (few weeks from now!)
- The delivery concludes within 4 months after the start of the transport activities
- Shipment Cryo #2 (separate contracts) between 19th August 2024 and 31st January 2025

Quantities per cryostat:

- Warm structure: 2,300 tons (~1300 components various form and dimensions). Grouping under definition
 - Tertiary barrier: 588 tons (~900 components 1.6 m wide, various lengths)
 - Fasteners and fittings: 250 tons (150,000 components)

FDC preparing CD-2/3 ESAAB approval

- FDC held its DOE IPR for CD-2/3 in September 2023
- Three significant remaining to-do items prior to ESAAB:
 1. Work to further optimize the proposed partner contributions Being addressed separately
 2. Review and address concerns regarding adequacy of Integration & Installation plan
 - Hiring challenges
 - Efficiency (training, work schedule, underground impact)
 - Confirm assumptions and optimize/confirm optimization of project, SDSTA, Host Lab, and DUNE elements and support
 - Work force support – housing, access, office space, etc.Most significant area of Mission Support interaction!!
 3. Address FDC P6 schedule issues Being addressed separately
- FDC is tackling these to-do items systematically to accomplish CD-2/3 ESAAB in late summer 2024

Mission Support progress to support FDC activities

- FS Receiving in Oracle (for purchase orders)
- Determination & algorithm of cost assignments
- Communications
- Visa support
- Badging
- Human Resources

THANK YOU!!

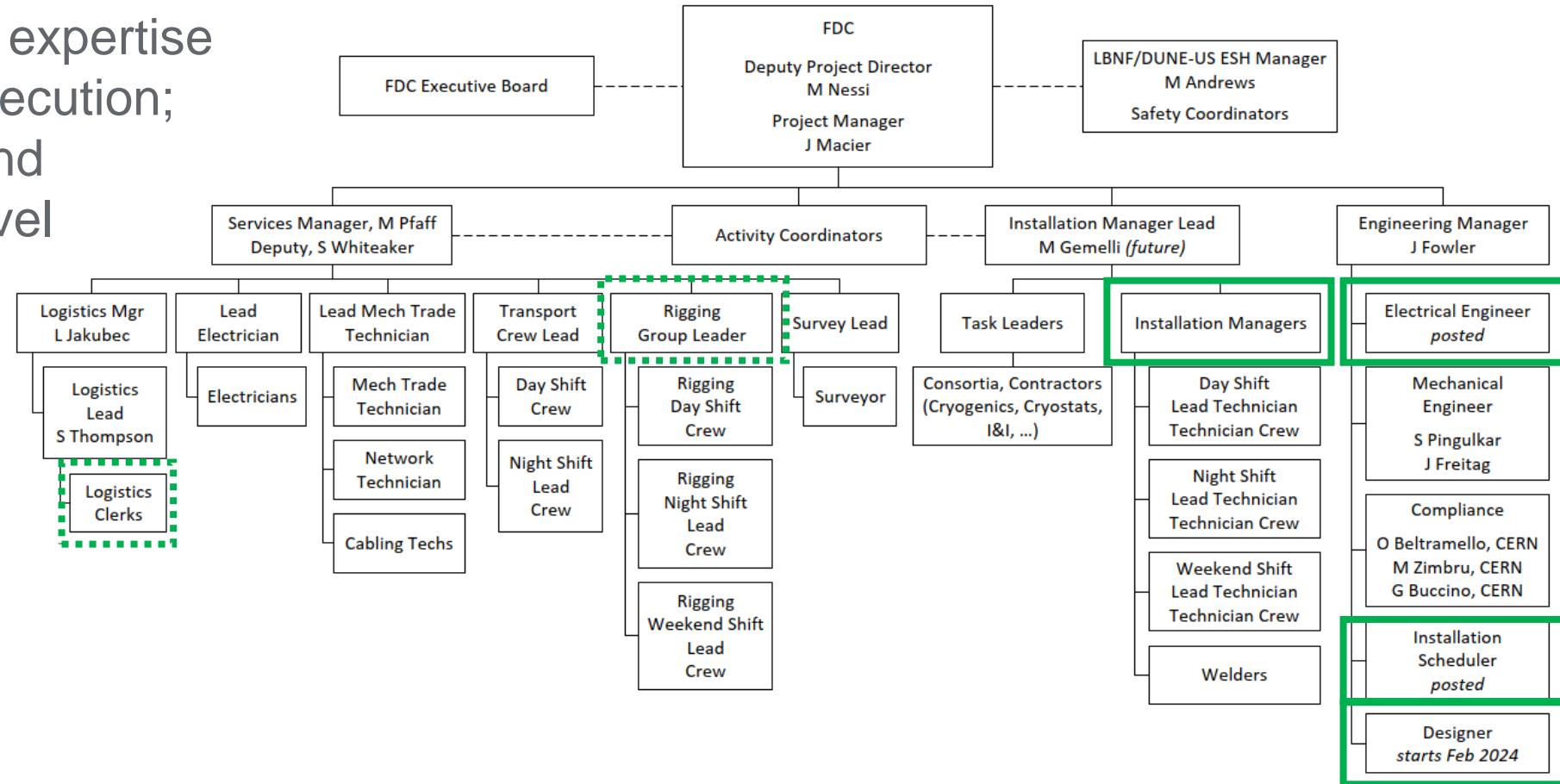
Continue to evaluate and optimize the roles and division of responsibilities between FNAL as the host lab, the LBNF/DUNE project, the DUNE Collaboration, and SDSTA (March 2024).

- IPR recommendation, September 2023



Executing FDC I&I Staffing Plan

- Hiring underway with strong engagement from Fermilab HR
- Participation in SD outreach events (career fairs) planned February through April
- Leveraging FNAL staff expertise is critical to efficient execution; intend to utilize DEA and extended business travel



I&I Risk Workshop held 16-17 January

- External participants – SBN, DEAP (SNOLAB), LUX-ZEPLIN, SDSTA
- Address multiple categories of risk, across the full range on FDC work in SD and risk owners including FD technical, FD installation, logistics/damage/supply chain, regulatory, procurement, host lab services
- Discussed **Delay to start of work** (FDC readiness & inherited risk from the FSCF EXC & BSI) and **delay in execution of work** (underground efficiency factor, personnel acquisition & retention, infrastructure, installation delays & logistics)
- Attentive to I&I era, not only I&I WBS risks – all of the work to be accomplished in South Dakota
- Reviewed ~60 risks; additional editing required to incorporate feedback
- Forthright discussion and strong engagement across all participants
- Identified new risks
- External input valuable
- Concerns reflected scale of LBNF/DUNE versus previous underground work & LAr cryostats



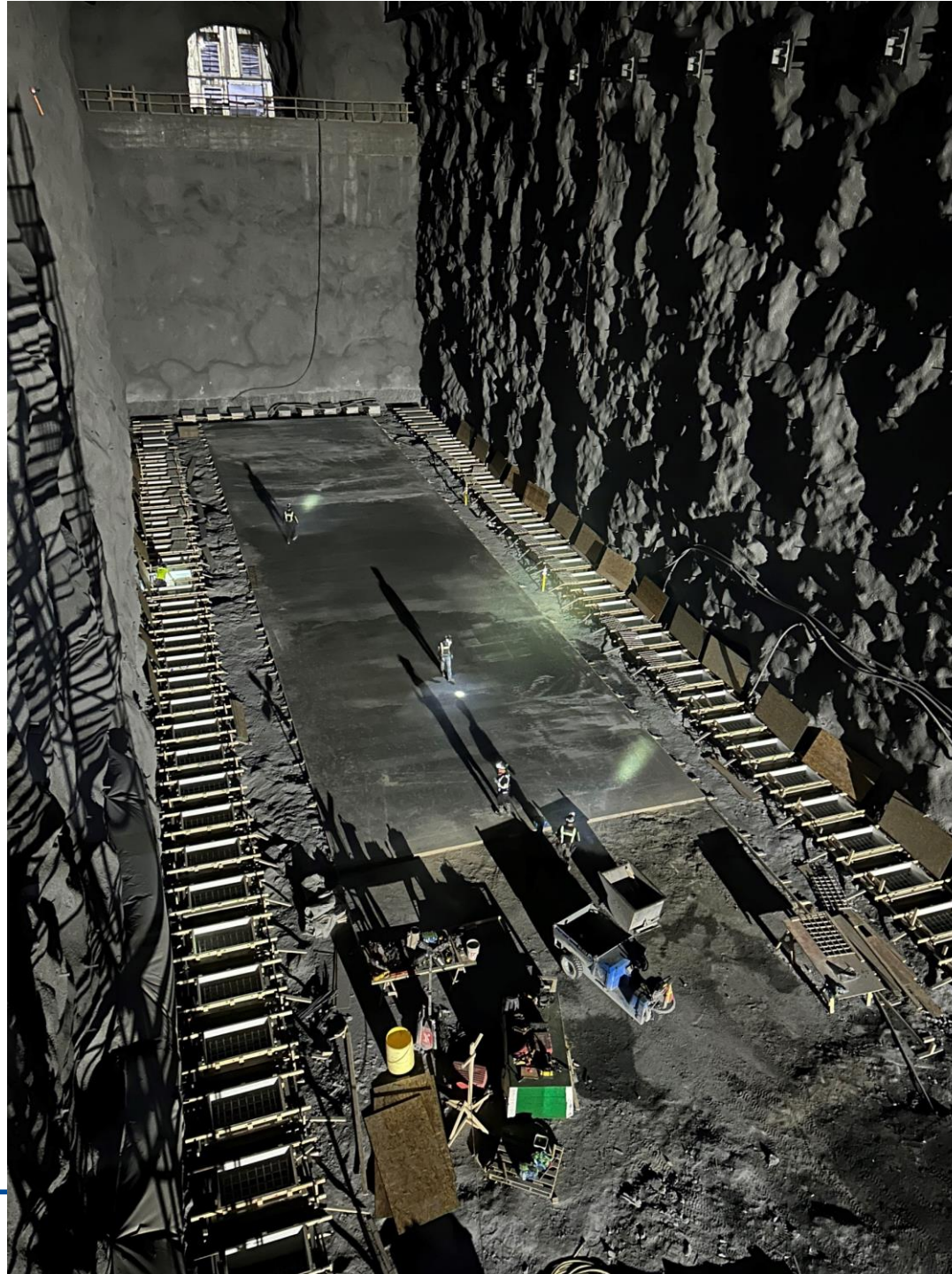
Photo credit: Sanmitra Pingulkar

Managing Interfaces

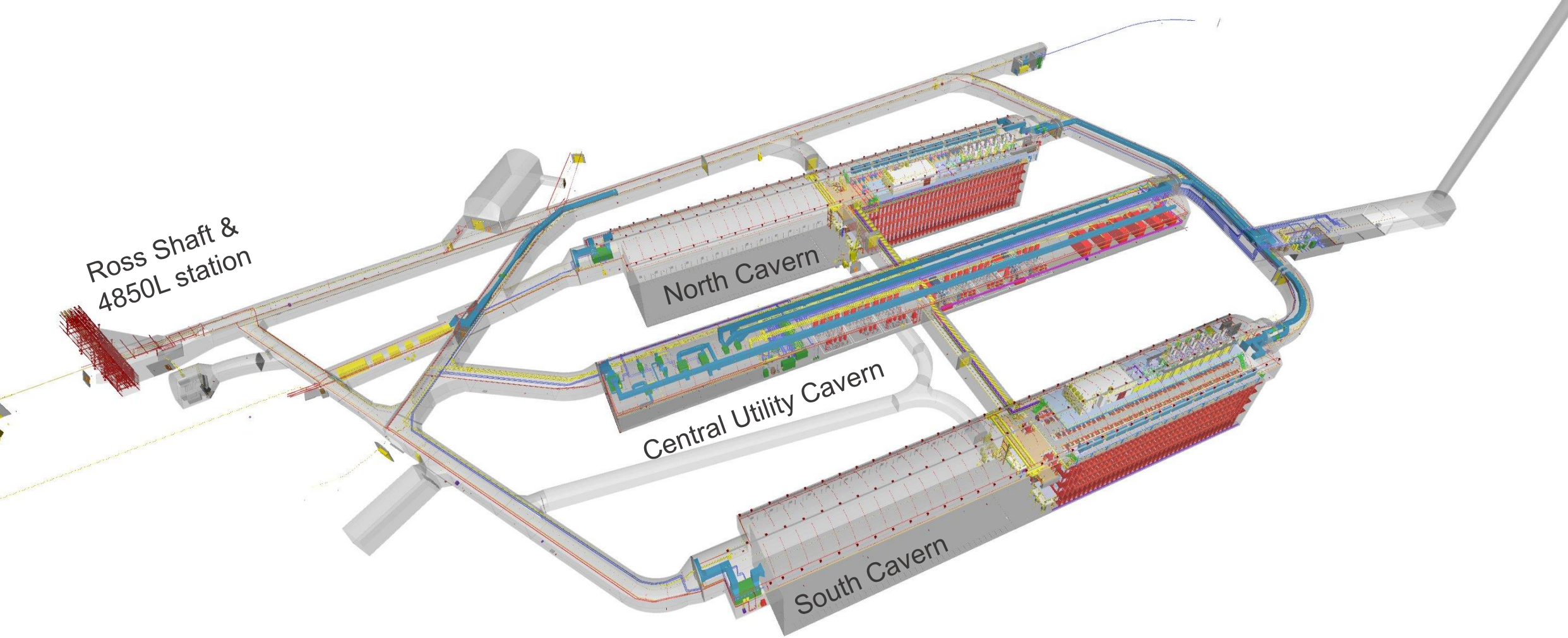
- Multi-layered interfaces reflect our integrated team
 - FDC to FSCF/EXC and BSI
 - Consortia to consortia
 - Consortia to I&I
 - FDC & Host Lab – MOA & Host Lab Plan
 - FDC & SDSTA - MOU
 - FDC within LBNF/DUNE-US - PMP



FDC team members at SURF



Thank You





View from Bear Butte