Update on LBNF Status to the Long-Baseline Neutrino Committee

Chris Mossey, Deputy Director for LBNF

LBNF/DUNE DOE IPR

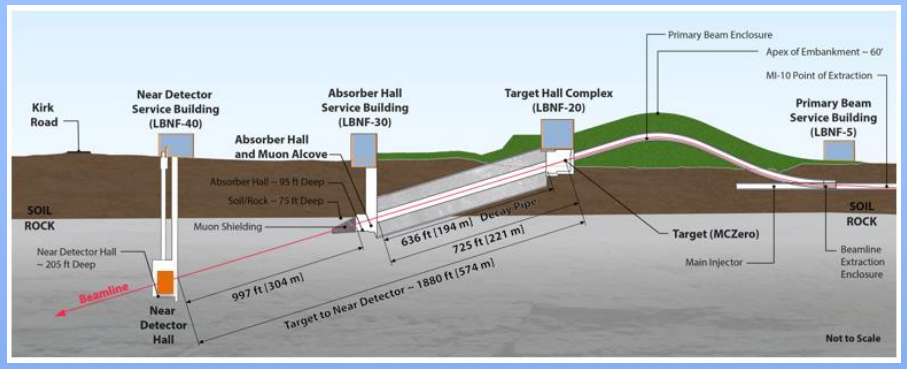
5 Dec 2019

Outline

- Project Scope
- Updates
  - Far site
  - Near Site
- Management Issues Update
- Summary

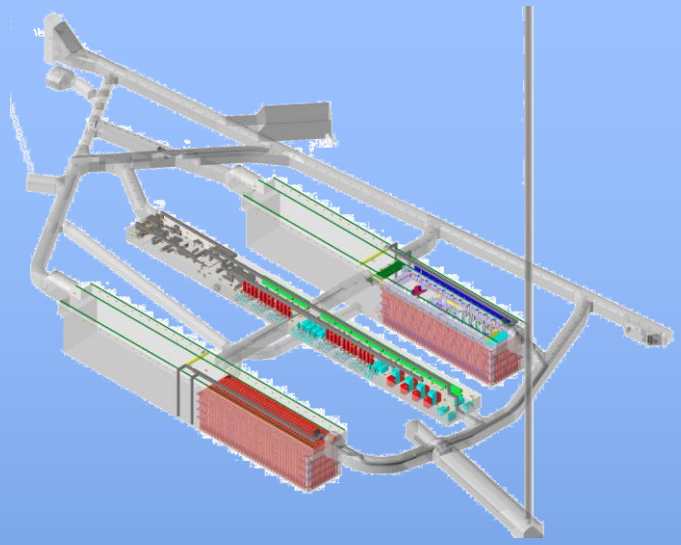
Project Scope and Future Capability

Near Site



Near Site Component	Project Scope	Future Capability
Neutrino Beamline	1.2MW output, designed to be upgradeable	2.4MW capable, with new targets, horns, add'l select cooling and shielding
Conventional Facilities	Support 1.2MW upgradable B/L and ND Ref. Design	In project scope
Near Detector	Prioritized Day One Components	Full ND Reference Design

Far Site



Far Site Component	Project Scope	Future Capability
Conventional Facilities	Surface and u/g facilities & infrastructure for 4 detector modules	In project scope
Cryostat; cryogenics	Two modules	Two addn'l LAr TPC detectors and supporting Infrastructure
Argon	35 ktons	
Far Detectors	Two detectors	

Updates – Far Site

Reliability Projects

Pre-Excavation Work

Excavation/Buildings & Site Infrastructure

Cryogenic Systems

Sanford Lab Reliability Projects Summary

- Projects to upgrade, replace, or make SURF infrastructure more resilient and reliable for duration of LBNF/DUNE project and DUNE experiment.
- There are nine reliability projects valued at approximately $36M in total:

Entrance to newly upgraded refuge camber

Completed:
- Oro Hondo VFD replacement
- Refuge chamber upgrade
- Rock transport skips

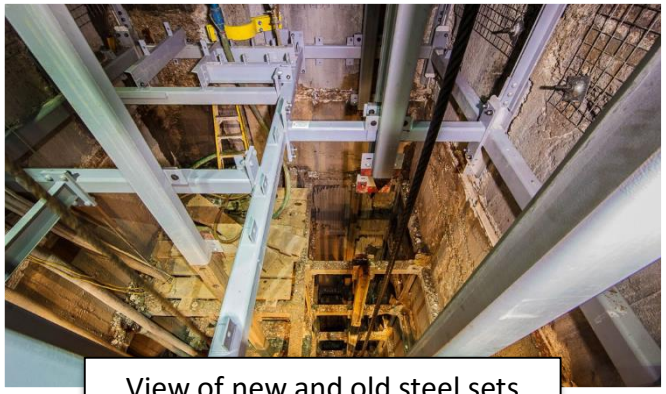
In progress:
- Ross shaft refurbishment
- Cage replacement
- Replace hoist drives, brakes, and clutches
- Ross Shaft crusher roof upgrade
- Ross Hoist Drum Bearings and Bushings

Pending contract award:
- Hoist motor refurbishment

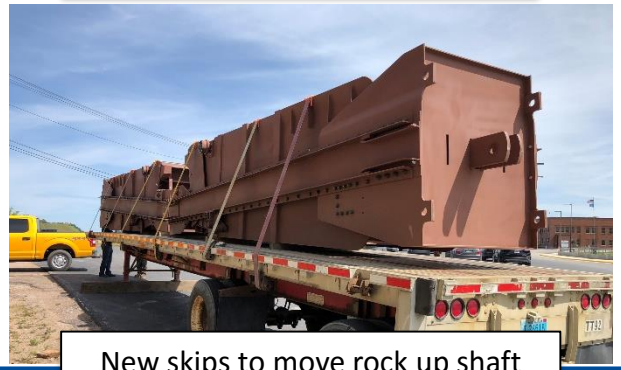
All reliability projects on track to be completed prior to the start of excavation.

Key Reliability Project – Ross Shaft Rehabilitation

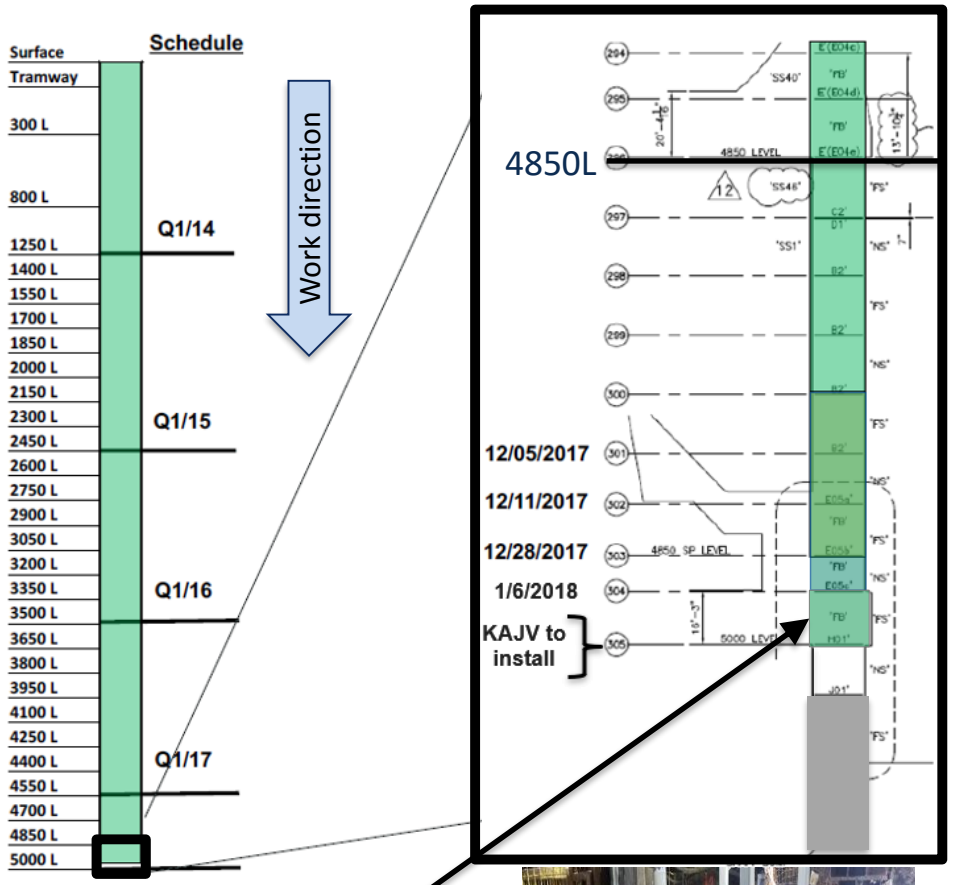
- As of early Nov, have completed installation of all 305 new steel sets.
- Shaft is now fully operational from Ross headframe to 5000L @ 500 fpm
- Work remaining: install cages/skips, remaining brattice, final certification.



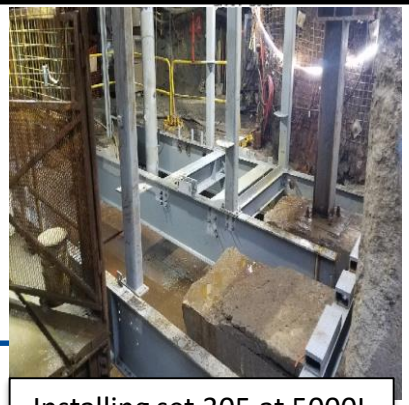
View of new and old steel sets



New skips to move rock up shaft



Set 305 steel delivered



Installing set 305 at 5000L

Oro Hondo Fan Variable Frequency Drive Replacement

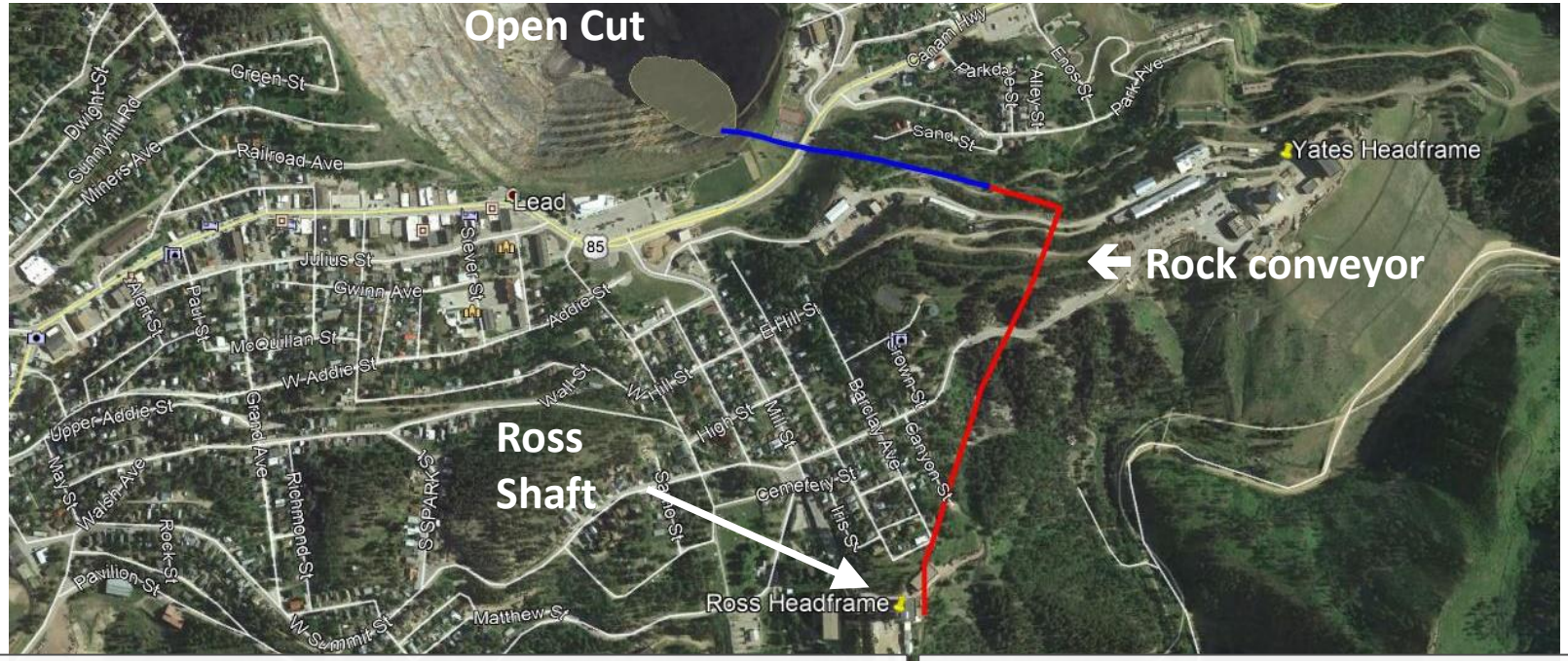
Refurbishing Oro Hondo Fan bearings.

Installing new “e-house” that shelters the Variable Frequency Drive for 3000 HP fan motor.

Fan was commissioned on 28 Sep 2019 and placed back into operation on 8 Oct 2019

Pre-Excavation Construction at Far Site

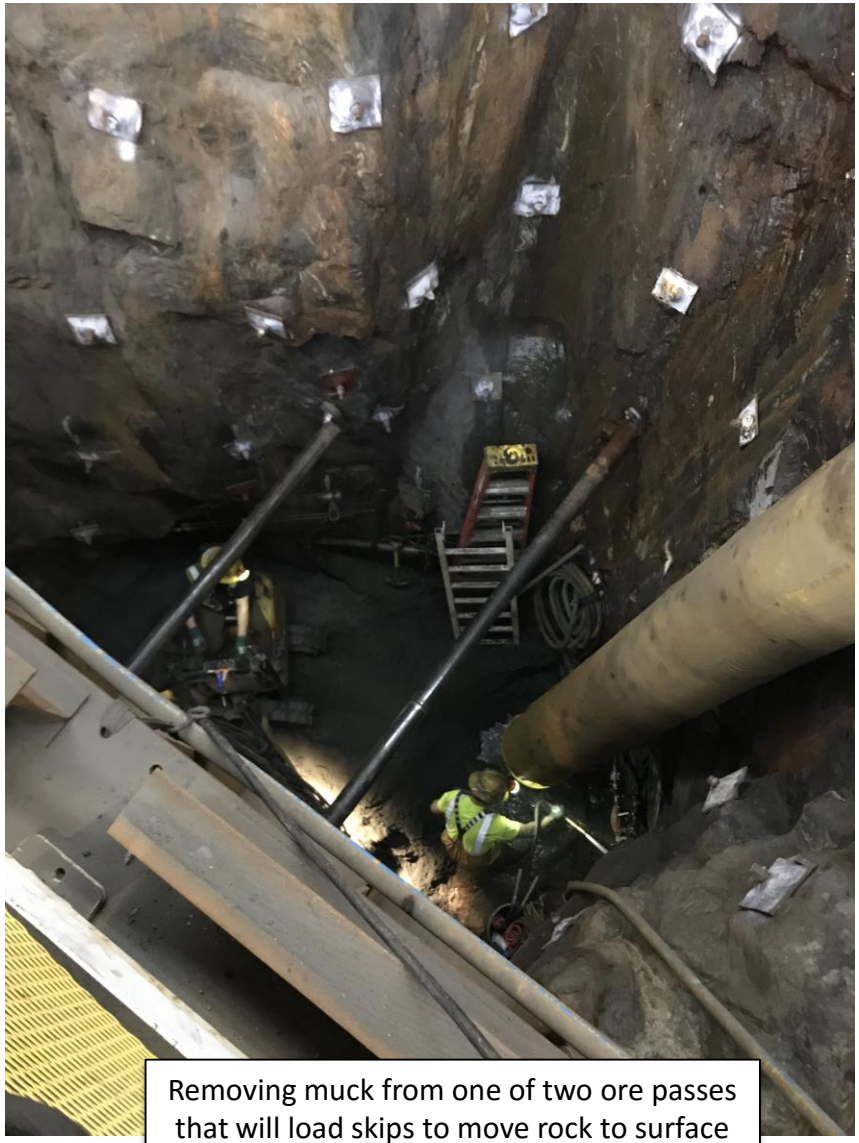
- Work to construct the systems to transport ~800,000 tons of rock from underground blast area to “Open Cut” in downtown Lead, SD.
- All 31 work packages totaling $92M awarded to KAJV in Nov 2018; work fully underway.
- Approximately 90 people on site now; work scheduled to complete Dec 2020.



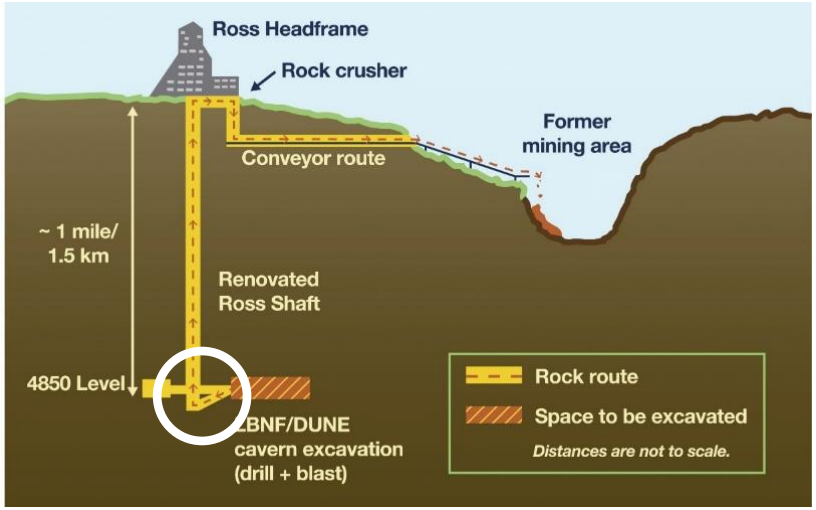
- **Underground rock handling systems (ore passes, skip loading, temporary grizzly, rock spill collection system)**
- **Rock crushing system at Ross Headframe**
- **Installing 4200’ surface rock conveyor to open cut**

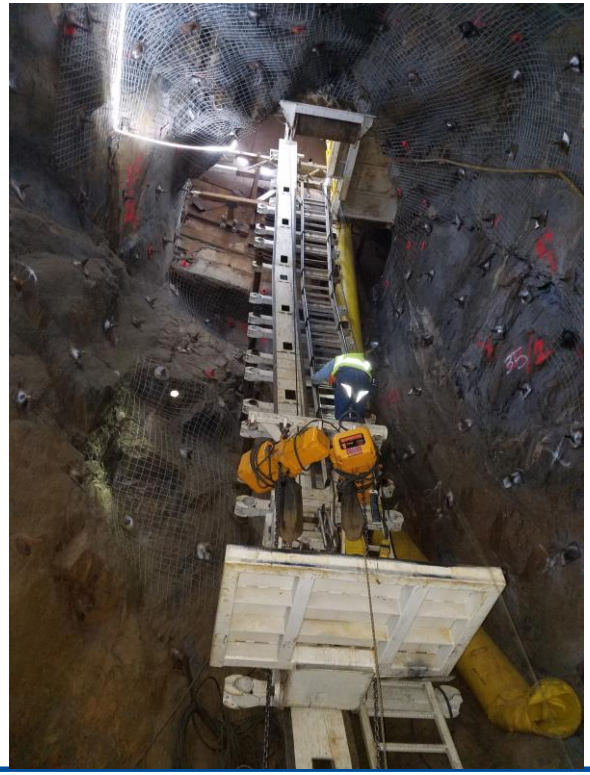
- **Ross headframe reinforcement**
- **Shaft utilities: fiber optic and power cables, water and gas piping**
- **Electrical service on the surface to the shaft**

Pre-Excavation Construction



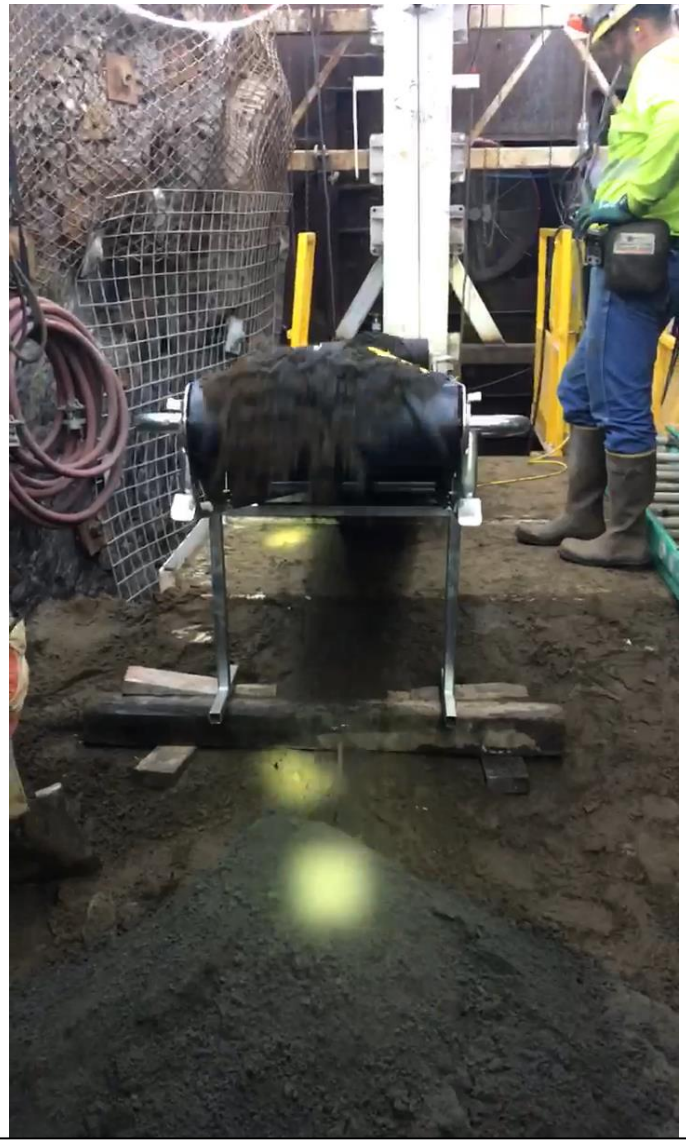
Removing muck from one of two ore passes that will load skips to move rock to surface





LBNF Pre-EXC

60’ down – opening to south Ore Pass appearing

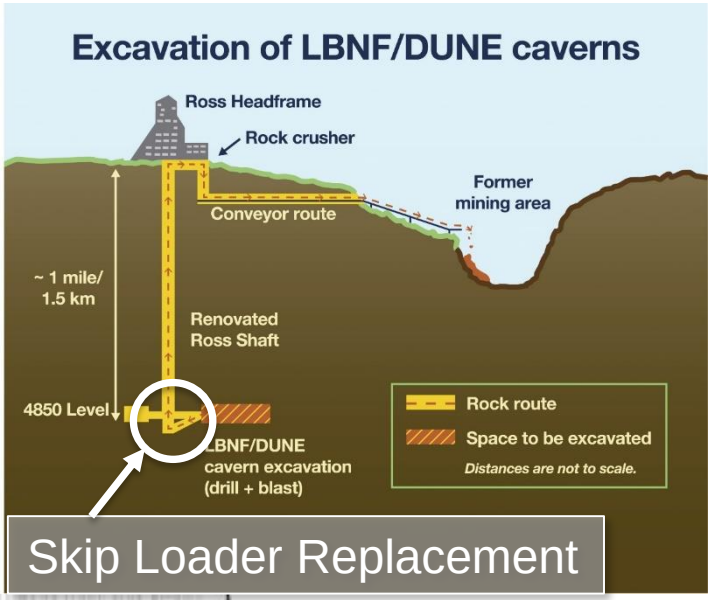


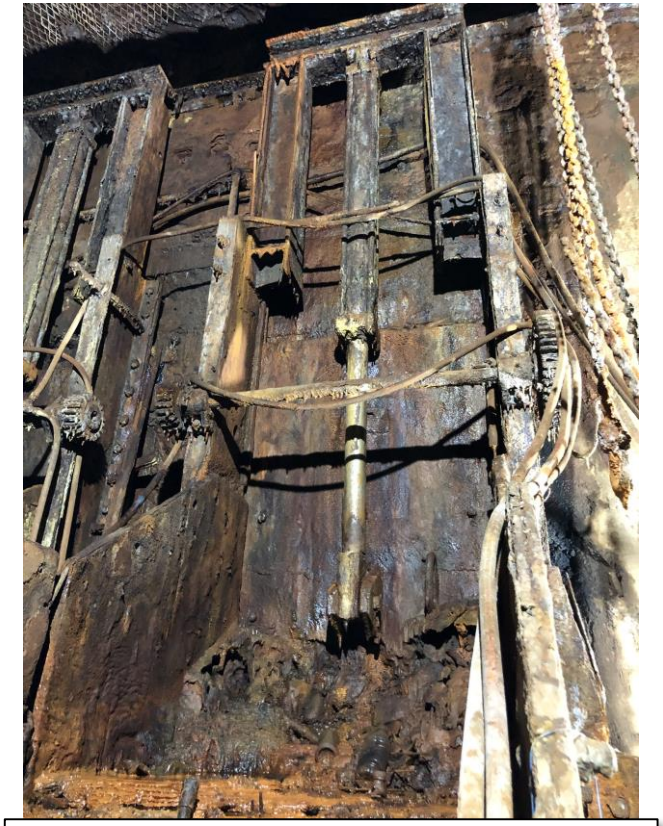
Start of removal of muck from north Ore Pass

LBNF Pre-EXC

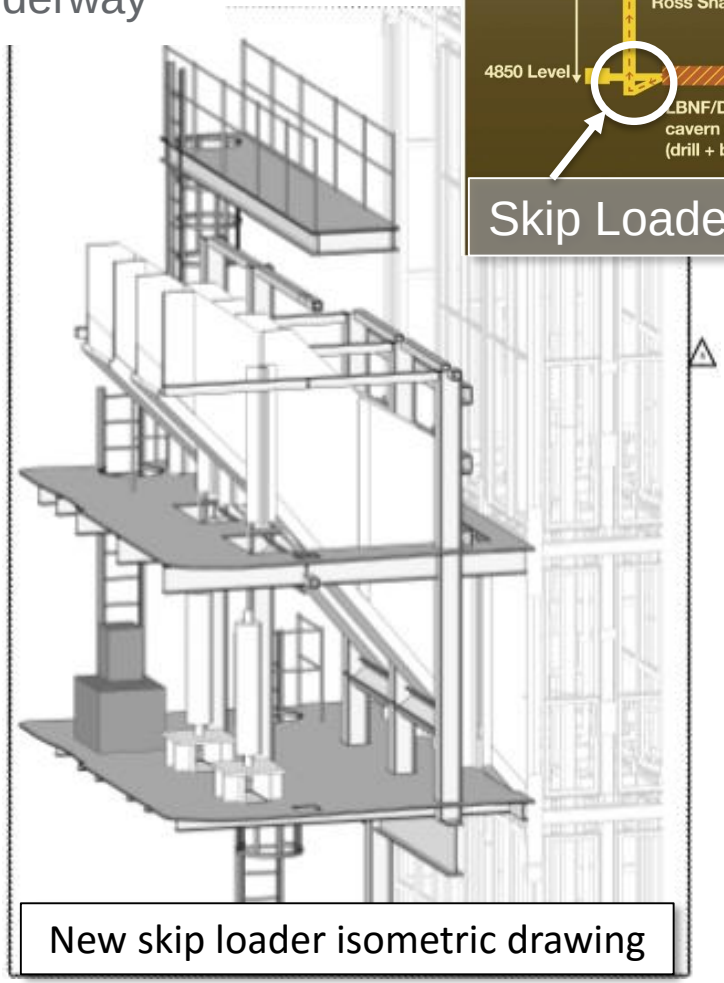
Skip Loader

- Shop drawings being finalized
- Demolition of old system underway



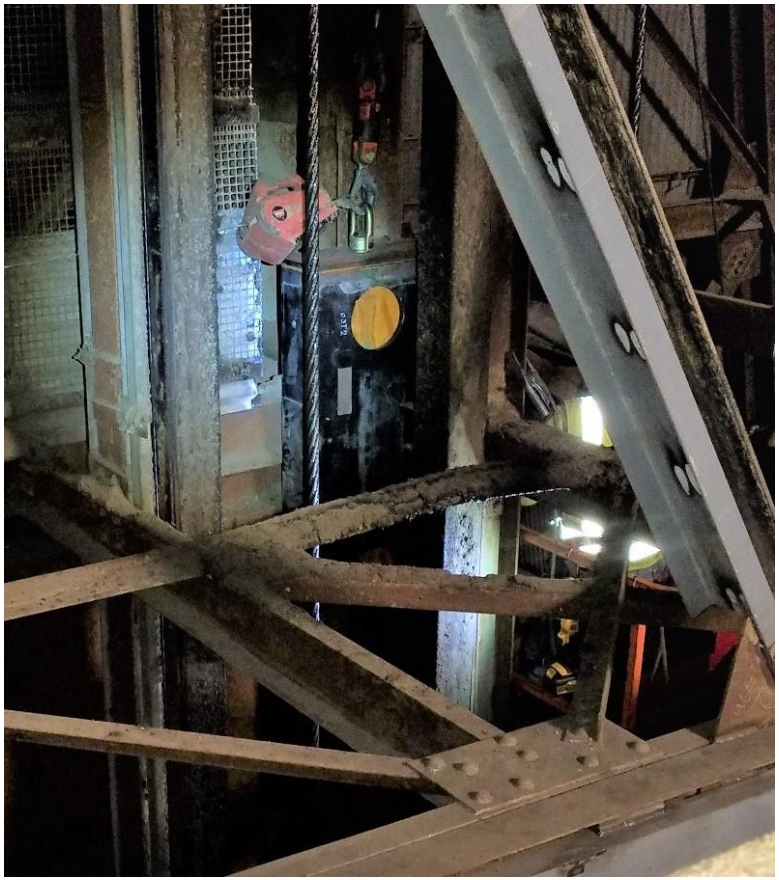


Existing skip loaders to be replaced



New skip loader isometric drawing

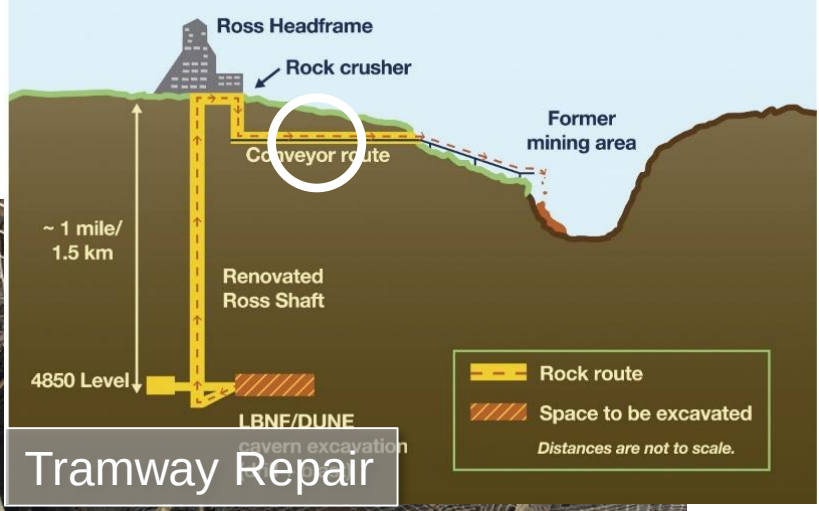
LBNF Pre-EXC



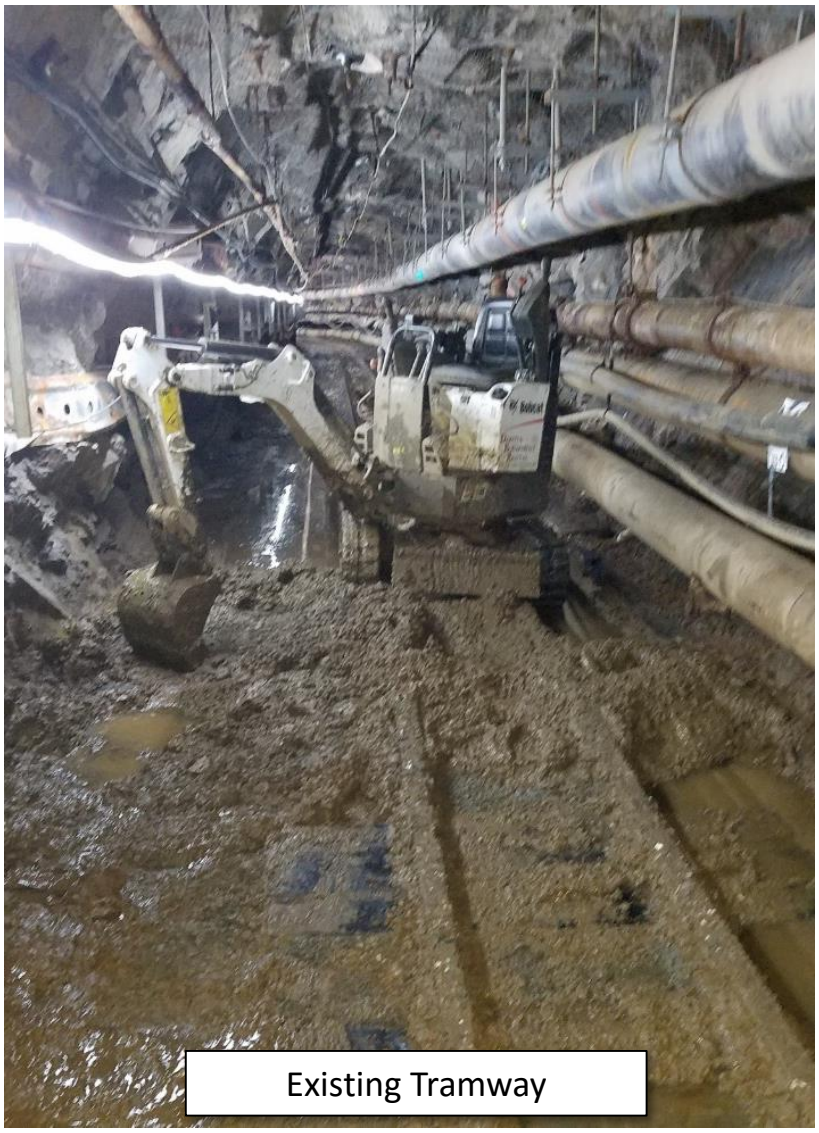
Ross Headframe Reinforcement

- Phase 1 was completed end of September, allowing access to work platform from Ross collar down to 4850L, and conveyance speed increased to 500 fpm
- Phase 2 (rest of reinforcement not related to shaft) to be completed by June 2020

LBNF Pre-EXC



Tramway Repair



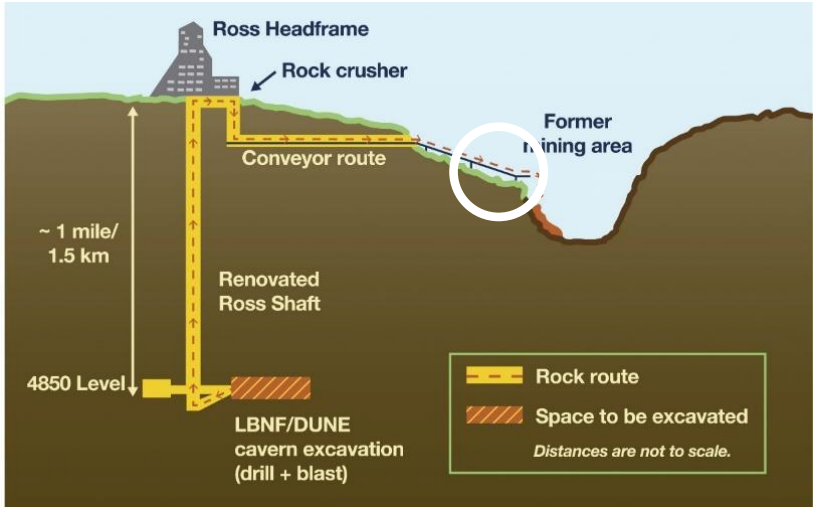
Existing Tramway

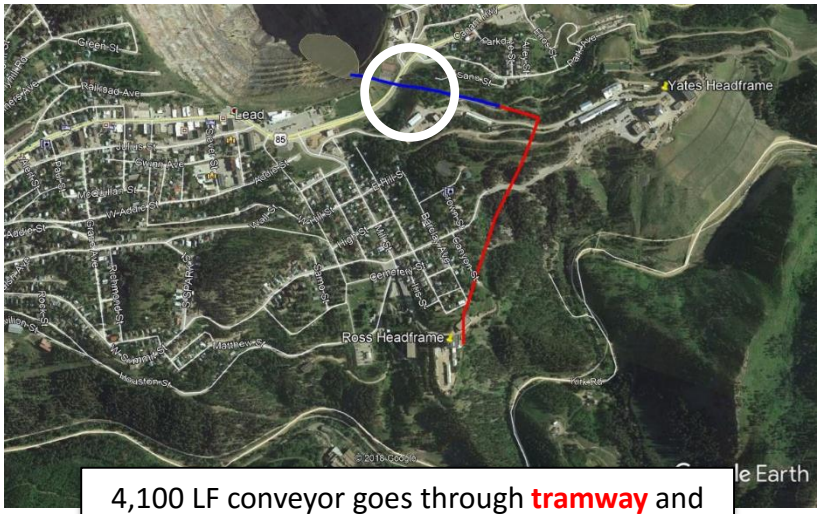
New ground support

LBNF Pre-EXC

Renovating and making tramway safe to support rock transport conveyor

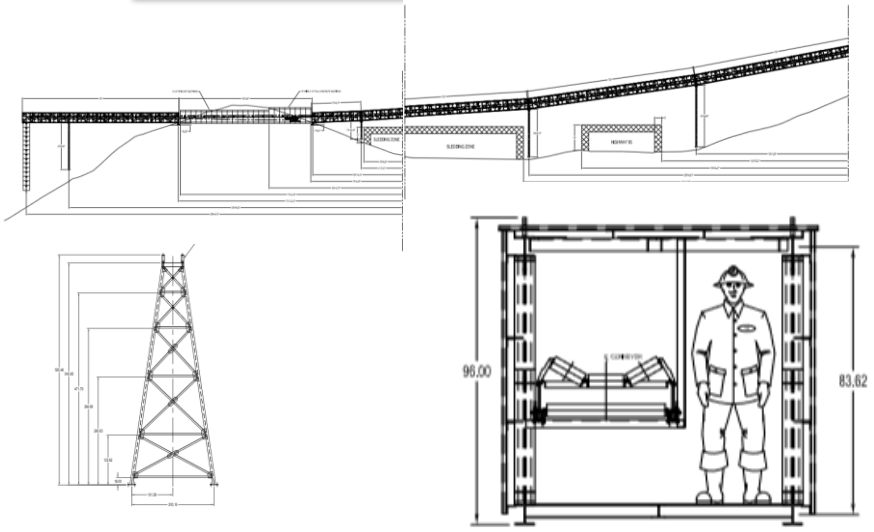
LBNF Pre-EXC





4,100 LF conveyor goes through **tramway** and **overhead** to place rock in Open Cut

Clearing path for elevated conveyor to open cut



Rock conveyor design @ 90% complete

LBNF Pre-EXC

Rerouting power underground so elevated conveyor can cross state highway

Upgrading power to Ross complex at SURF to support LBNF/DUNE systems:
New 20 MVA transformer and 12.5 kV power feeds

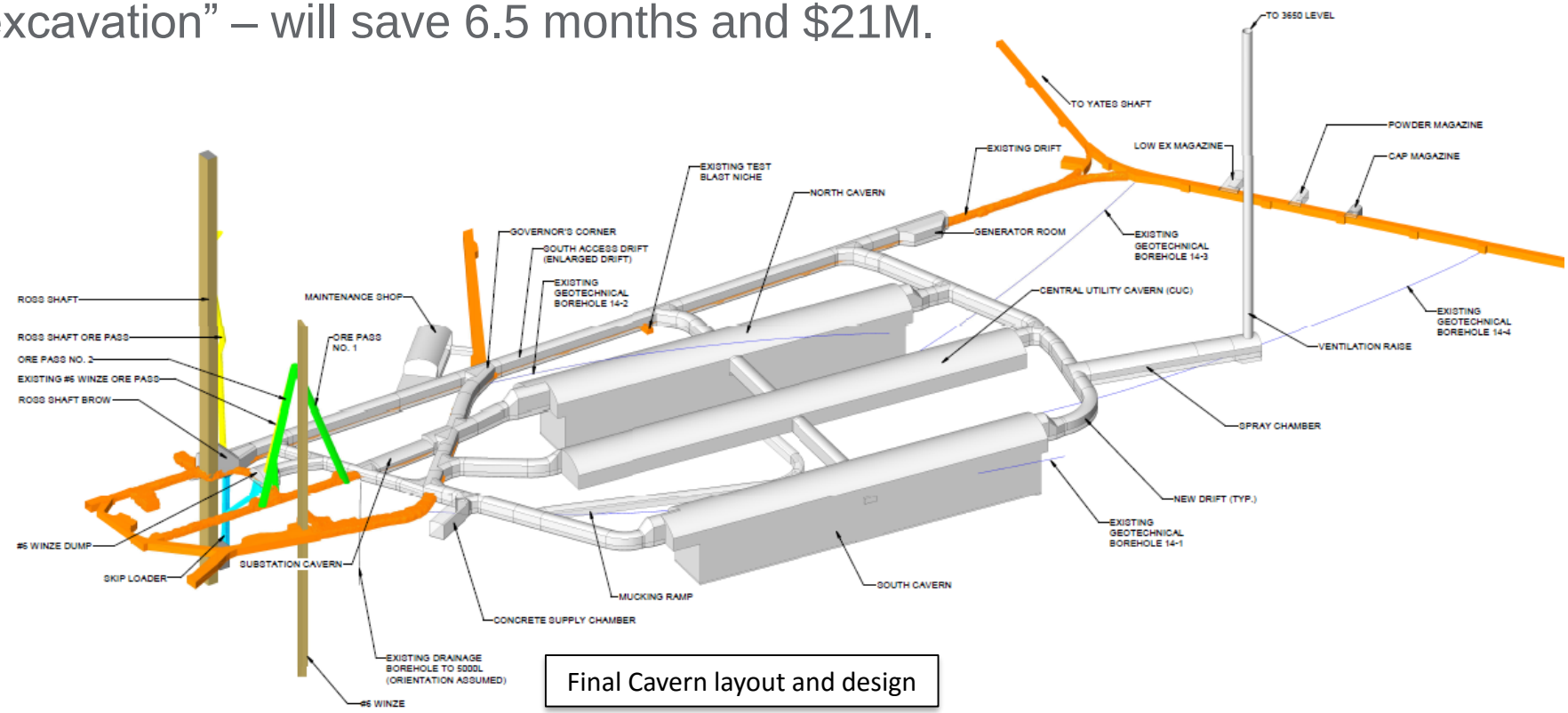
FSCF Pre-Excavation Construction Status

- As of October 1, 2019, 305 calendar days have been used (40.8%) of the contract duration, KAJV has billed 27.5% ($25.7M/$93.6M).
- Contract Completion Date was extended 28 days to November 30, 2020, due to required redesign of Ross Shaft set 305. Another 17 days to settle a dispute to the overall schedule impact from the Ross Shaft Bottom Change is in a pending change.
- KAJV currently showing 0 days of float based on October 1, 2019 CPM update.
  - Critical path still running thru Ross Shaft, Skip Loader and Ross Shaft Utilities
- SAFETY: Zero recordables (RC) and Zero days away from work (DART) as of 5 Dec 2019
- QUALITY: 3 NCRs and 3 Deficiencies, all closed out except one NCR that was just identified last week

Excavation and Building & Site Infrastructure (BSI) Work Update

Excavation/Buildings & Site Infrastructure (BSI) Construction

- RFP for excavation work (~75% of remaining CF work to be put under contract) was put out for bids by Kiewit-Alberici JV on 1 Oct.
- Bids to be in hand in early February 2020, award by July.
- Just awarded five work packages @ $23M to KAJV to start “early excavation” – will save 6.5 months and $21M.



Final Cavern layout and design

Proposed Working Schedule to turn over Detector Caverns

- Plan to turn over excavation in two phases. Our working schedule has been:
  - ~Oct 2022 for north cavern, and
  - ~July 2023 for south cavern
- As reported at last LBNC, Oct 2022 does not appear achievable based on our reconciled final design schedule analysis (CM/GC, A/E, Project). Working to compress schedule by:
  - Implementing plan previously mentioned that will save 6.5 months on schedule.
  - Excavation sub-contract – selection criteria includes, among other factors, proposed schedule duration.
  - Analyzing opportunities for “early handover” of first detector cavern to push start of cryostat construction earlier. Handover timing will be determined after evaluating schedules/pricing from excavation bids received in February 2020 timeframe.
  - Looking for additional opportunities to recover schedule by either decoupling activities and/or finding alternative approaches. Examples on next slide.
- Early in process, but it may be possible to pull schedule back to within 6 months of working schedule for north cavern.

Value Engineering Concepts to save schedule

Under assessment:

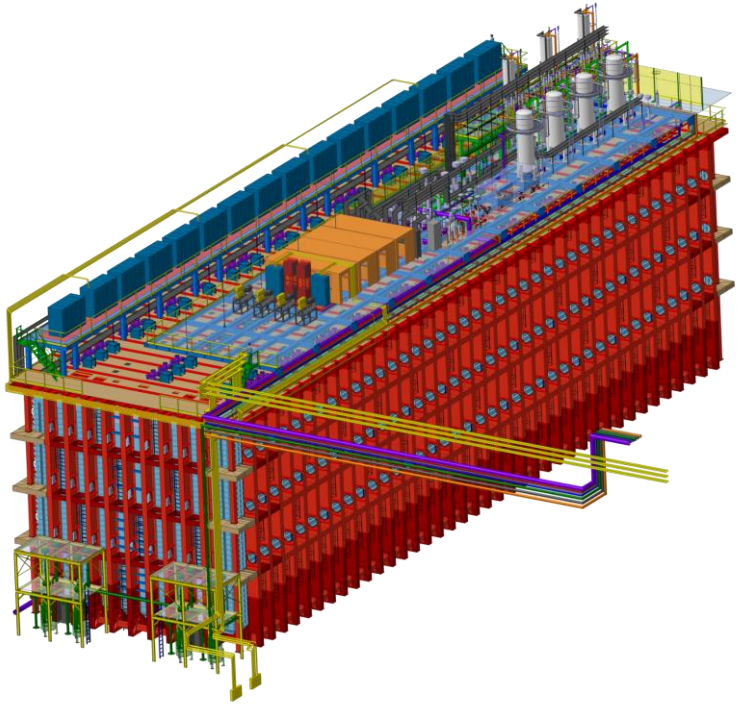
- Begin delivery of the cryostat components while completing excavation of the South Cavern.
  - STATUS: assessing, will determine viability upon receipt of excavation bids, early 2020
- Alternative approach for delivering nitrogen and argon gases to the underground area that could eliminate requirement to install piping in the Ross shaft and reduce the amount of time required to fill the cryostats.
  - STATUS: assessing, determination in early 2020
- Evaluate if excavation can be executed on an up to 24 x 7 shift schedule
  - STATUS: assessing, will determine viability upon receipt of excavation bids, early 2020

Continually working to develop schedule compression opportunities as work sequencing/interrelationship understanding matures.

Cryostats and Cryogenics Systems Update

Far Site Cryostat/Cryogenics

- Cryostat:
  - Warm structure final design completed in Nov 2018
  - Membrane design completed by GTT in Apr 2019.
- Nitrogen System
  - To be procured via contract for design/fab/install. Working though a contract terms & conditions issue as well as evaluating VE related to l ocation of system (surface vs. underground).
  - Do not need contract in place until September 2022.
- Argon Cryogenic Systems: Preliminary design reviews complete, working with potential partners on in-kind contributions.
- Process controls, surface receiving facilities: preliminary design reviews complete.



Cryostat engineered, prototyped and to be installed by CERN

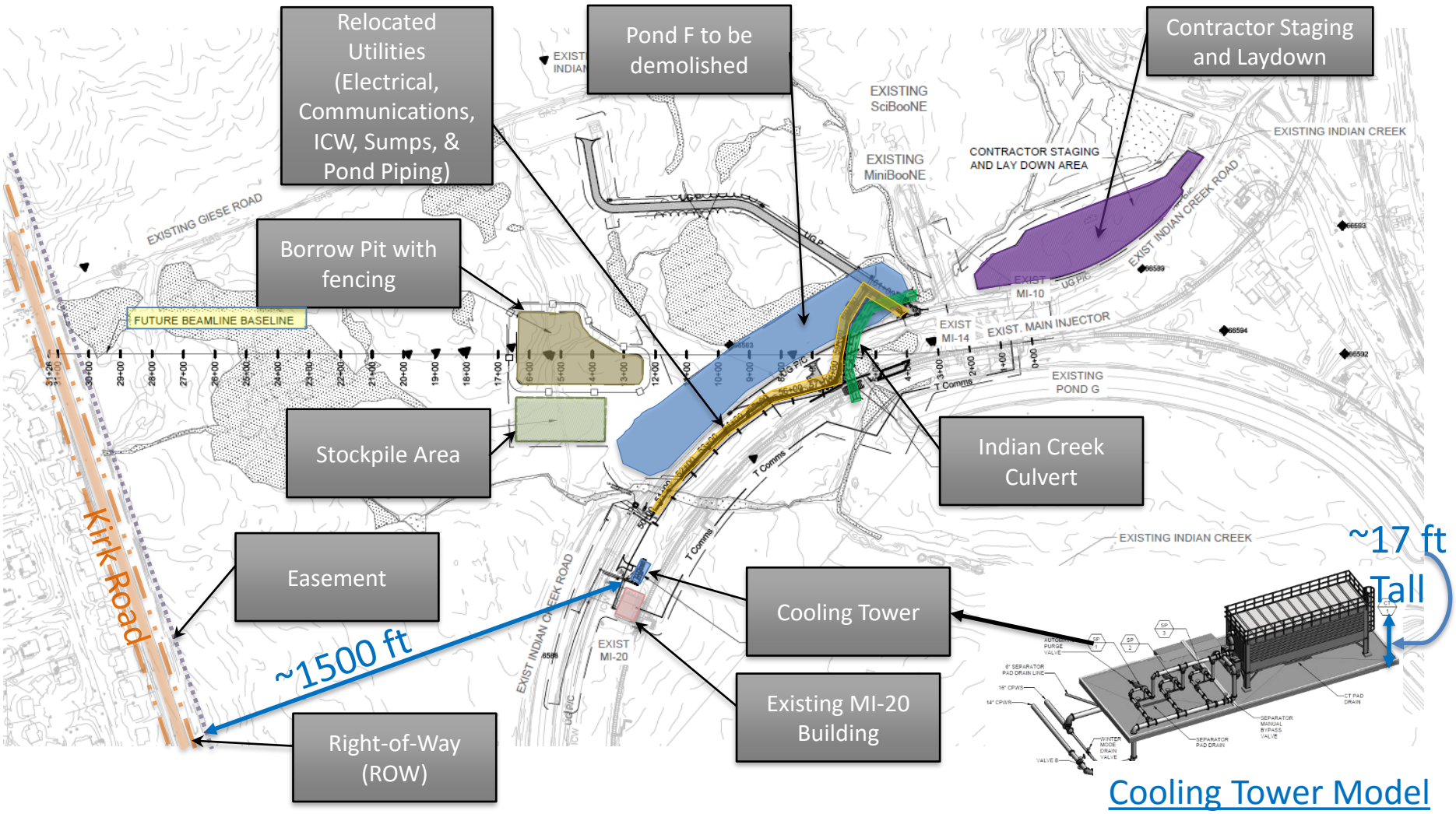
Updates – Near Site

Near Site Conventional Facilities Status

- Recent key milestones:
  - Awarded Architect/Engineer design contract (>$25M) for all conventional facilities in August; preliminary design is now underway. First value-engineering conference completed yesterday.
    - 100% preliminary design to be finished by end of March 2020.
    - Cost and schedule data based on 50% preliminary design available by end of Feb 2020; data based on 100% preliminary design available by end of May 2020.
  - Have finalized basic Near Detector facility requirements with the collaboration.
  - Awarded site preparation contract (~$15M); construction has started and continue through CY2020 (see next slide).

LBNF Near Site Groundbreaking – Nov 14, 2019

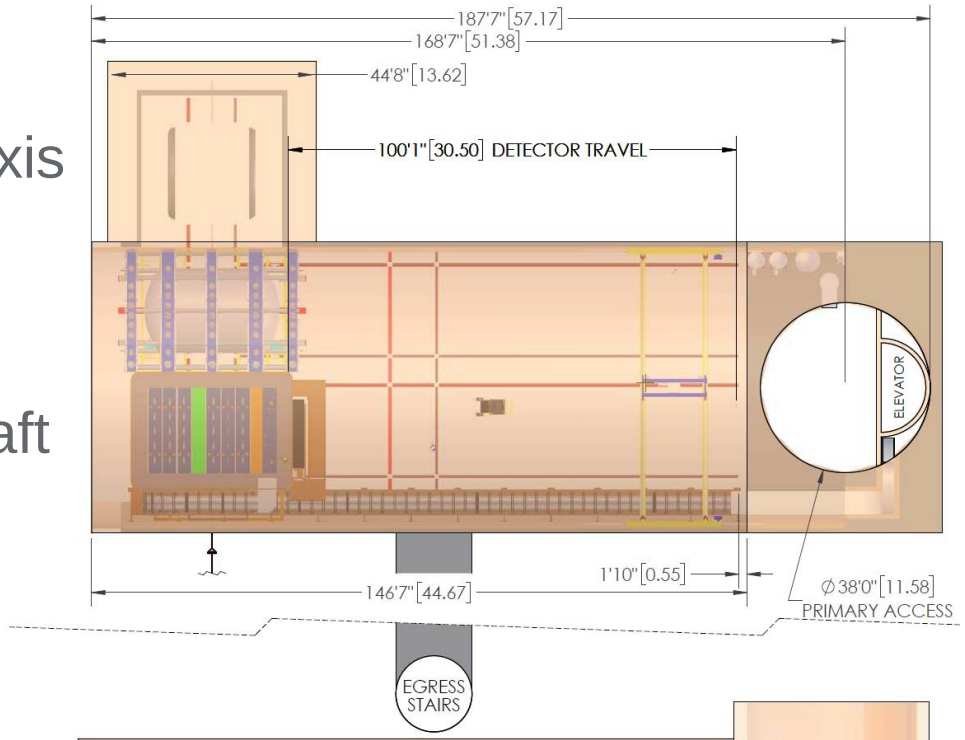
NS CF Site Preparation Work

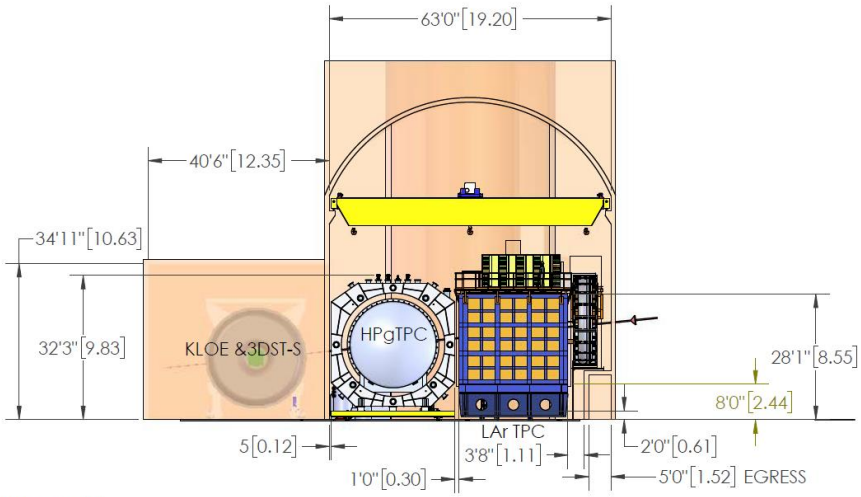


Cooling Tower Model

Near Detector Complex

- Lengthened Cavern for Off-Axis Measurements
- KLOE Alcove
- 38-foot Diameter Primary Shaft
- 50-ton Crane





09-05-2019, R FLIGHT
UNIV OF ROCHESTER

Beamline Design Status

Separate breakout session tomorrow

- Preliminary design progressing
  - Design maturity advancing according to plan (see next slide)
  - Necessary engineering resources secured
  - Continue to mature 3D CAD integration models
- Working with professional estimator to update basis of estimates for all procurements
- Completed all high-level interface specifications and requirements between Beamline and Near Site Conventional Facilities
- Working on interface definitions within beamline systems
  - 60% of interfaces completed
  - On plan to complete >90% interfaces by end of CY19.

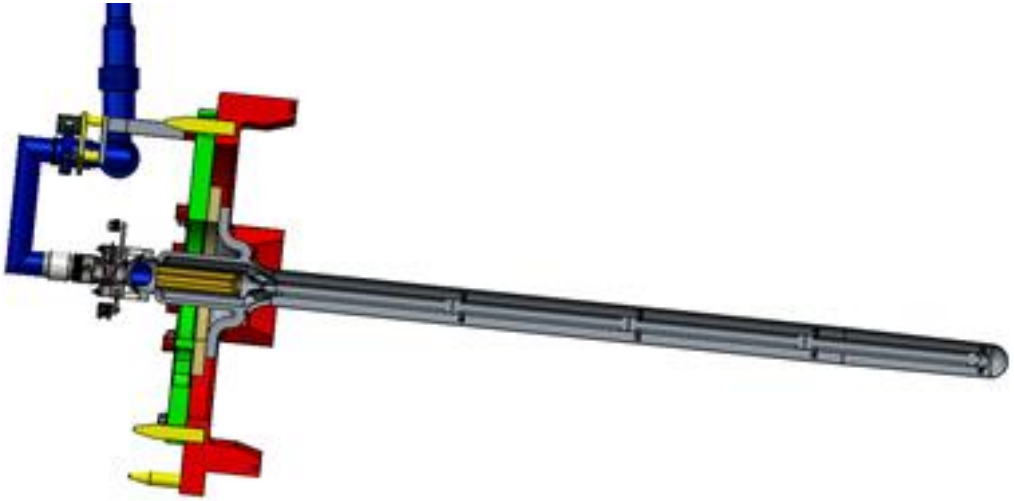
Design Maturity

- Maturity as of 9/30/19
- Maturity of Primary Beam, Target Complex, Decay Pipe & Absorber Complex, and Systems Integration weighted by BCWS costs of each element.
  - Project Management excluded
- **Overall: 52%**

WBS Name	Design Maturity
Primary Beam	0.76
Magnet Production	0.90
Magnet Power Supplies	0.75
Primary Water System	0.50
Primary Beam Instrumentation	0.80
Primary Vacuum	0.64
Lattice Optics	0.92
Magnet Installation	0.53
Target Complex	0.45
Targetry	0.18
Horns	0.25
Horn Power Supplies	0.30
Target Hall Shield Pile	0.65
RAW Water Systems	0.40
Remote Handling Equipment	0.50
Decay Pipe and Absorber Complex	0.39
Decay Pipe	0.30
Absorber	0.65
Beam Windows	0.20
Neutrino Beam Instrumentation	0.25
System Integration	0.52
Controls	0.65
Interlocks	0.63
Alignment	0.38
Beamline Installation Coordination	0.50

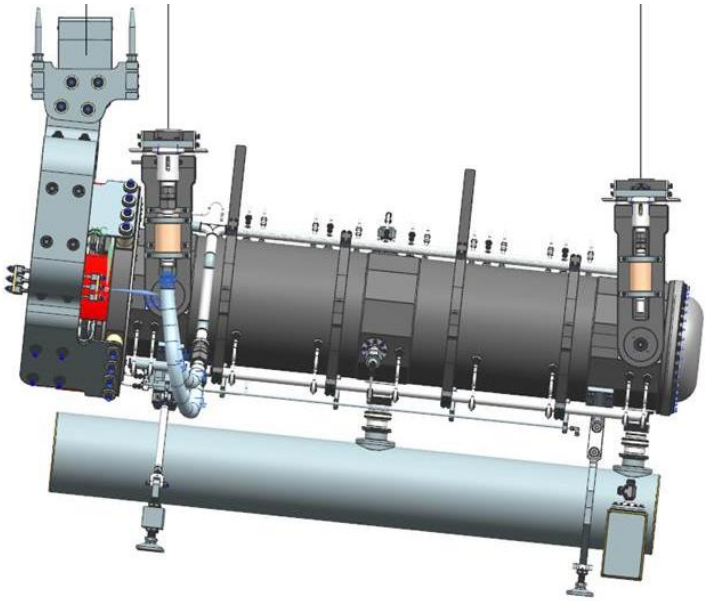
Target Complex Progress

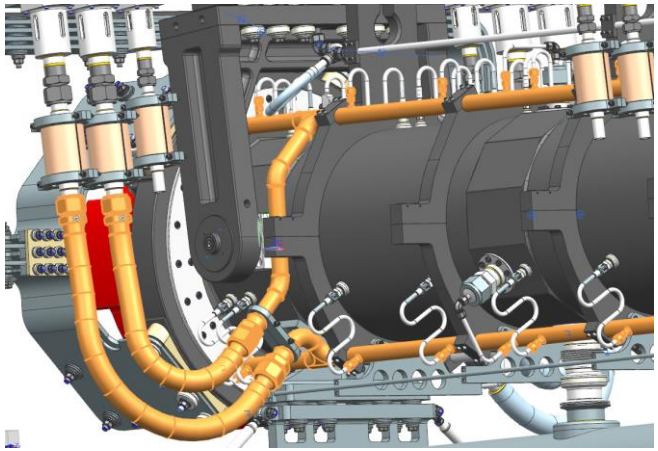
- Target conceptual design approved
  - Target is major deliverable of RAL collaboration
  - Conceptual design approved at Aug. 21 review
    - Significant decision point to drive further design
  - 1.5-1.8m cantilevered, helium-cooled graphite cylinder

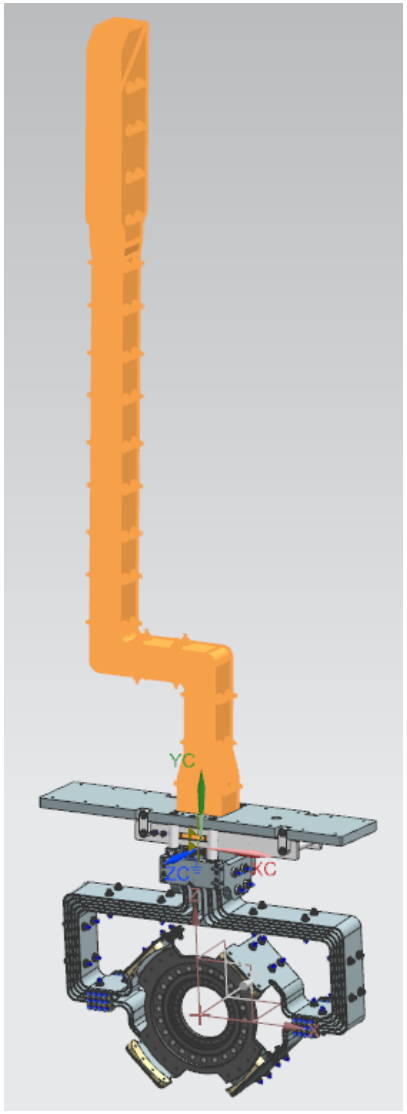


Target Complex Highlights

- Advanced Horn A and module design. Working with RAL on the target interface and exchange mechanism including layout of all the utilities.
- Several technical reviews completed: Horns and stripline FE analysis review, Cooling panel prototype design review.







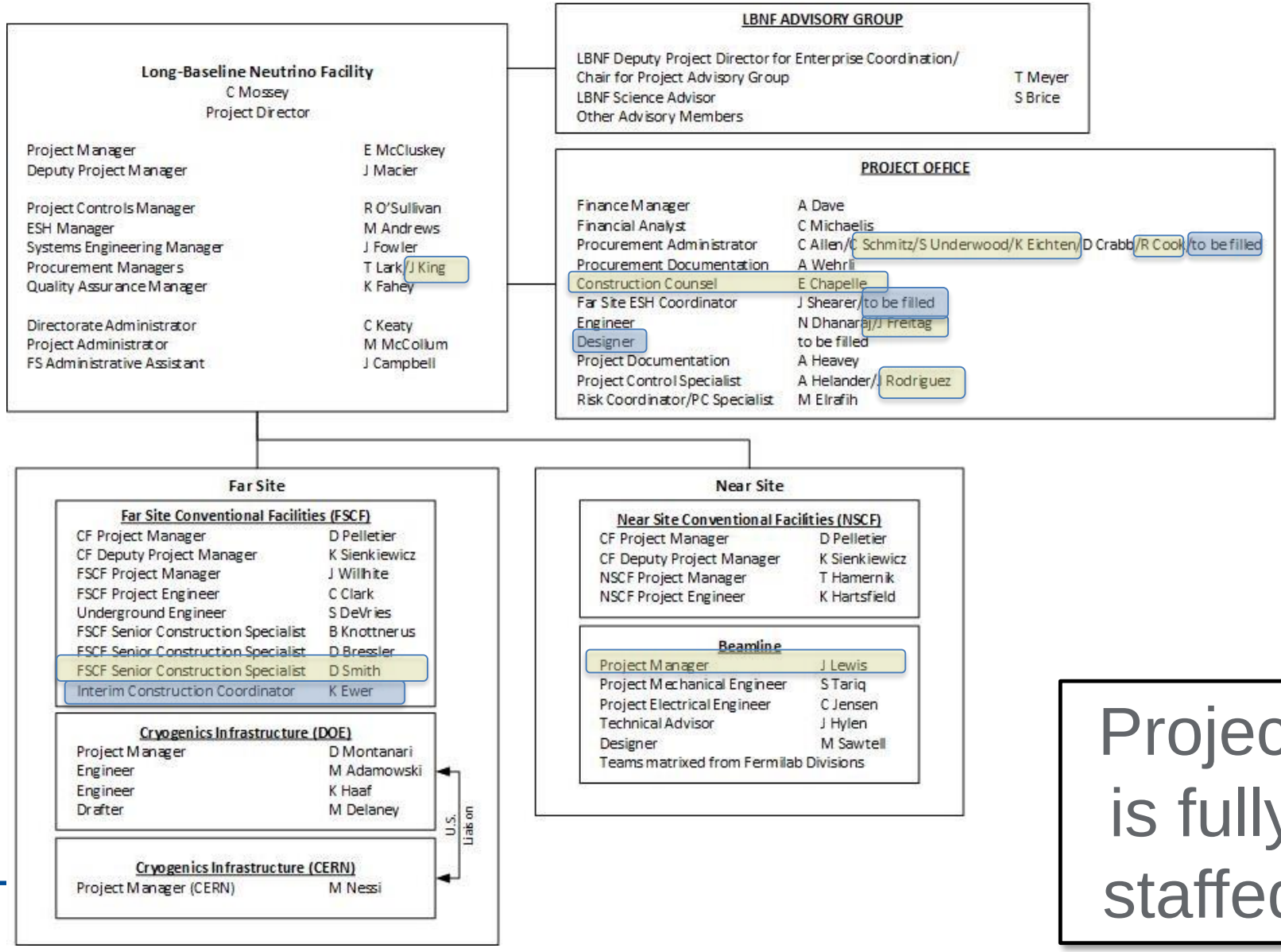
Management Issues Update

Staffing update

- New position: LBNF Deputy Project Director for Enterprise Coordination
  - Tim Meyer – former COO and Deputy Director for Administration for Fermilab.
  - Provides 0.5 FTE support to both LBNF and DUNE (through SDSD) by working across laboratory organizations (procurement, legal, HR, finance, etc) to ensure timely support of LBNF/DUNE requirements.
  - Coordinating LBNF international contributions with FNAL Special Assistant for International Engagements
  - Chairs LBNF Advisory Group, reporting to LBNF Project Director
- Hired new key position: Associate General Counsel for Construction.
- Filled all construction coordinator positions at far site (4 positions).
- Filled safety position at far site.
- LBNF organization staffing summary on next slide…

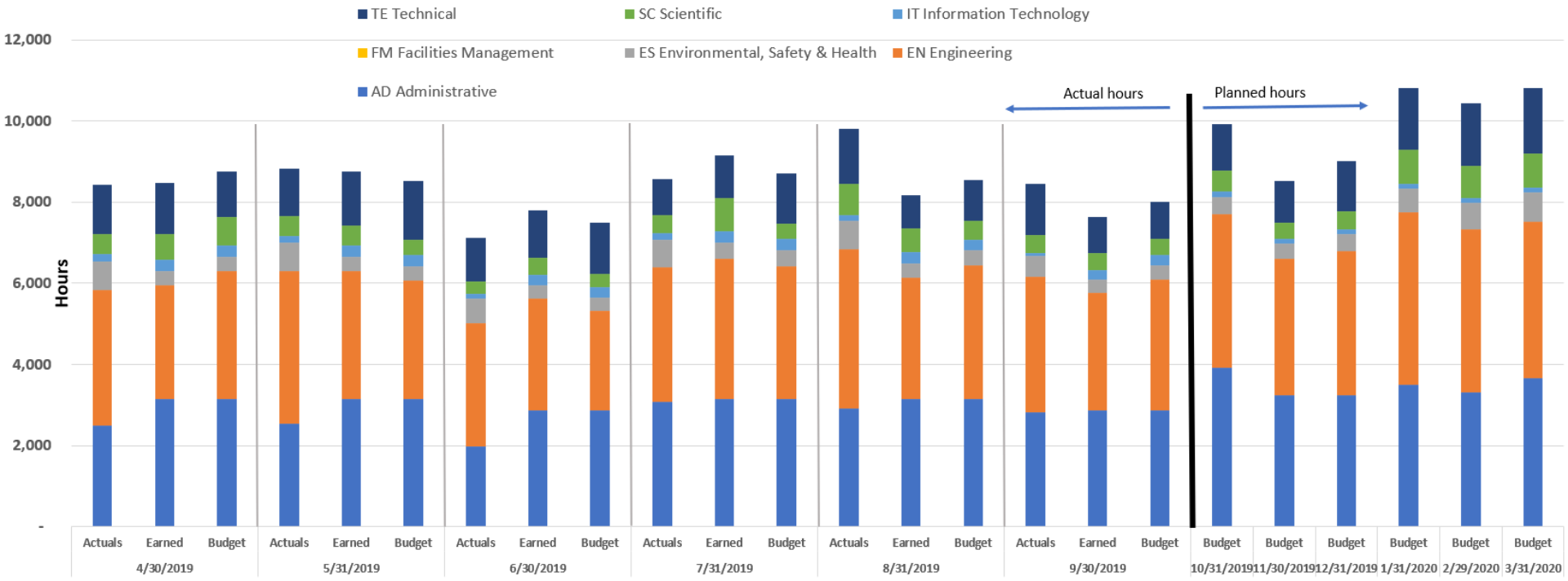
LBNF Organization

- 10 new staff since Jan-19
- Includes 6 replacements for existing staff turnover
- 4 positions to be filled in next 2 yrs



Project is fully staffed

LBNF Hours
6-month past performance / 6-month look-ahead



- Response to July LBNC recommendation

Safety: LBNF/DUNE-US Incident Statistics

	Current Calendar Year to Date					Cumulative to Date				
Organization	Manhours*	DART Cases	DART Rate	TRC Cases	TRC Rate	Manhours*	DART Cases	DART Rate	TRC Cases	TRC Rate
LBNF/DUNE-US	113,123	0	0	0	0	832,323	0	0	0	0
SDSTA	43,224	0	0	0	0	119,312	1	1.7	2	3.4
KAJV	82,841	0	0	0	0	82,841	0	0	0	0
Total	239,188	0	0	0	0	1,034,476	1	0.2	2	0.4

*Reflects manhours through September 2019

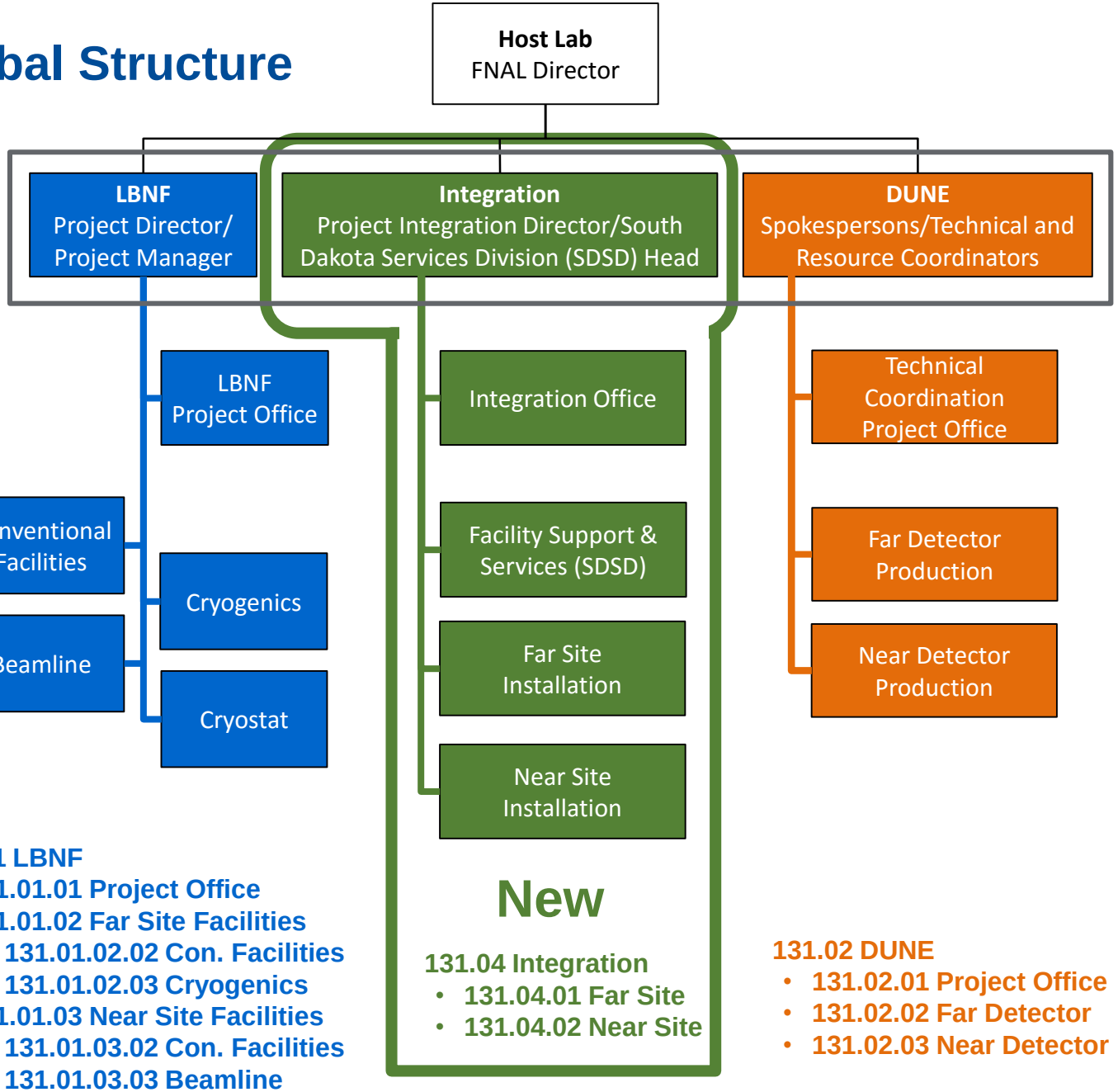
- Safety is critical focus for project. Must safely execute construction in a 130-year old former gold mine at far site.
- KAJV has demonstrated mature ESH culture and processes, as expected.
- Completed a very successful assist visit by the DOE Office of Enterprise Assessment (OEA) in August 2019. OEA complimented Fermilab, SDSTA, and KAJV management and worker commitment to safety.

Briefing DOE/OEA reviewer at 4850L

January DOE Review

- Recommendation from Jan 2019 review was to conduct an analysis of ***all projected DOE expenditures*** (project + non-project) necessary to ensure LBNF/DUNE success.
  - Worked with DOE/OHEP to assign costs: on-project vs. non-project.
- As a result of this analysis:
  - Created new $290M “Project Integration” element and put all these costs on project.
  - Identified $91M in non-project “DUNE Support” costs over 10 year project period necessary to ensure project success.
- All of above consistent and within current DOE funding guidance.

LBNF/DUNE Global Structure



EFIG

Project elements

Work breakdown

131.01 LBNF
- **131.01.01 Project Office**
- **131.01.02 Far Site Facilities**
  - **131.01.02.02 Con. Facilities**
  - **131.01.02.03 Cryogenics**
- **131.01.03 Near Site Facilities**
  - **131.01.03.02 Con. Facilities**
  - **131.01.03.03 Beamline**

New

131.04 Integration
- **131.04.01 Far Site**
- **131.04.02 Near Site**

131.02 DUNE
- **131.02.01 Project Office**
- **131.02.02 Far Detector**
- **131.02.03 Near Detector**

October DOE Review Summary

- DOE review noted project “accomplished a great deal… over last 10 months” but did not support baselining until “credible Total Project Cost” established. Issues of concern raised:
  - Definitive excavation cost (bids due to project in February).
  - Need to close international contribution gaps.
  - Need to mature LBNF/DUNE-US Near Site designs and cost estimates.
- Review committee did specifically cite support to award of excavation contract on schedule – but their proposed approach of increasing current “advance construction authority” (CD-3a) was not supported by DOE. Working alternatives.
- Other key review take-aways:
  - Committee felt clear leadership accountability for all parts of DOE project (LBNF + DUNE-US) and dedicated responsibility for entire initiative (DOE Project + DUNE International Experiment) were missing.
  - Highlighted need to continue to mature the procurement organization.

Full Committee Summary Comments

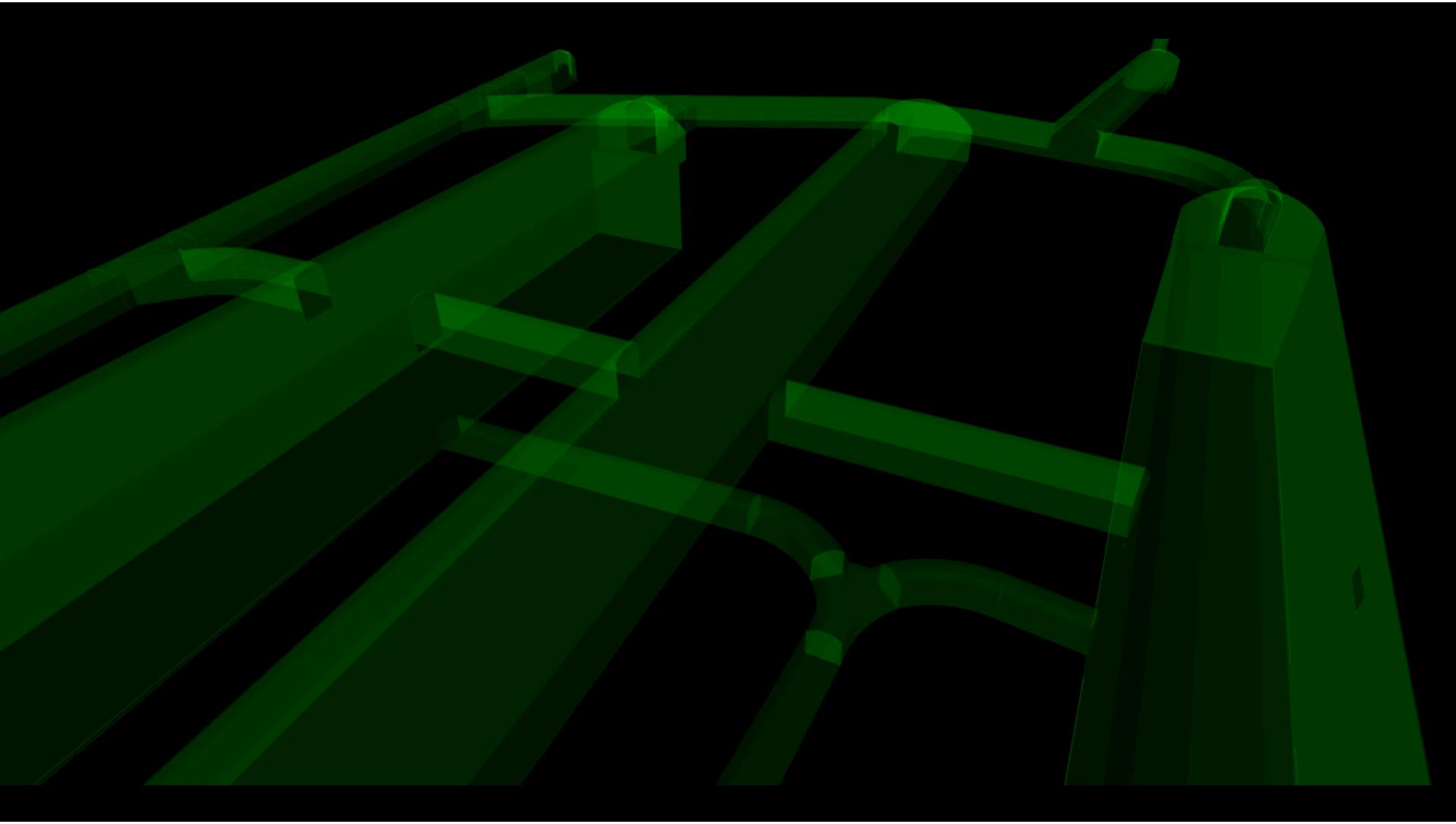
- **The project has accomplished a great deal and made good progress in many areas over the last 10 months**
- **There considerable strength in the management of the project and throughout the project team, but …**
  - **Top-level management restructuring and strengthening is required**
  - **Strategic experienced capabilities are needed to further strengthen the team**
  - **Streamlining must be pursued**
  - **Open clear, concise, and candid communication must be nurtured**
- **The excavation should not be delayed, but**
  - **The project must focus on establishing a credible not-to-exceed CD-2 project baseline**
- **Continue accelerating the progress and momentum you have established**

THIS IS AN EXCITING AND IMPORTANT PROJECT

Systems Engineering - 3D model update

- Near Site - Establishing boundaries for stakeholders, A&E and SE for model development and control. Using Far Site effort as guide.
  - First deliverable from A&E due in early Jan and first integrated models to follow.
- Far Site – Release of version 5 planned for mid-Dec.
  - To include updated: DSS, TPC, detailed cable management, more mature cryogenic piping, detailed design of detector mezzanine and access
  - Developing a 4 dimensional model, adding time/schedule. This will assist in space planning and interfaces throughout the various phases of the project. (see very early version on next slide)

Far Site Installation – time phasing the integrated model



Fermilab at Sanford Underground Research Facility (SURF)

- Sanford Underground Research Facility, managed by the SD Science and Technology Authority (SDSTA), is key partner in the success of LBNF/DUNE.
  - SDSTA entered a cooperative agreement with the DOE for SURF operations on 1 Oct 2019, replacing the operations contract managed by Fermilab.
  - FRA and SDSTA updated our existing Memorandum of Understanding (MOU) to ensure efficient coordination of all activities moving forward. Document signed by both lab directors in Sep 2019.

Summary

- Execution at far site progressing well:
  - All reliability projects on track; Ross Shaft is fully operational.
  - Pre-excavation construction fully underway, on cost and schedule.
  - Final design for all excavation work completed; contracting process on track.
  - Just awarded $23M work package for early excavation work that will save 6.5 months of schedule. Working other schedule saving opportunities.
- Near site rapidly maturing:
  - Contract for all conventional facilities design work awarded; preliminary design underway and on schedule for delivery in March 2020.
  - Site preparation contract awarded and underway.
- DOE and Fermilab continuing to engage international partners to solicit in-kind contributions necessary for project success
- Working to obtain DOE support to award excavation contract on schedule in July 2020.
- Updating baselining plan for 2020.

Questions?

Animation Links:

- LBNF/DUNE animation (YouTube)
- Video page (FNAL website)

Social Media Links:

- LBNF Facebook
- DUNE Facebook
- LBNF Twitter
- DUNE Twitter