XLZD at SURF

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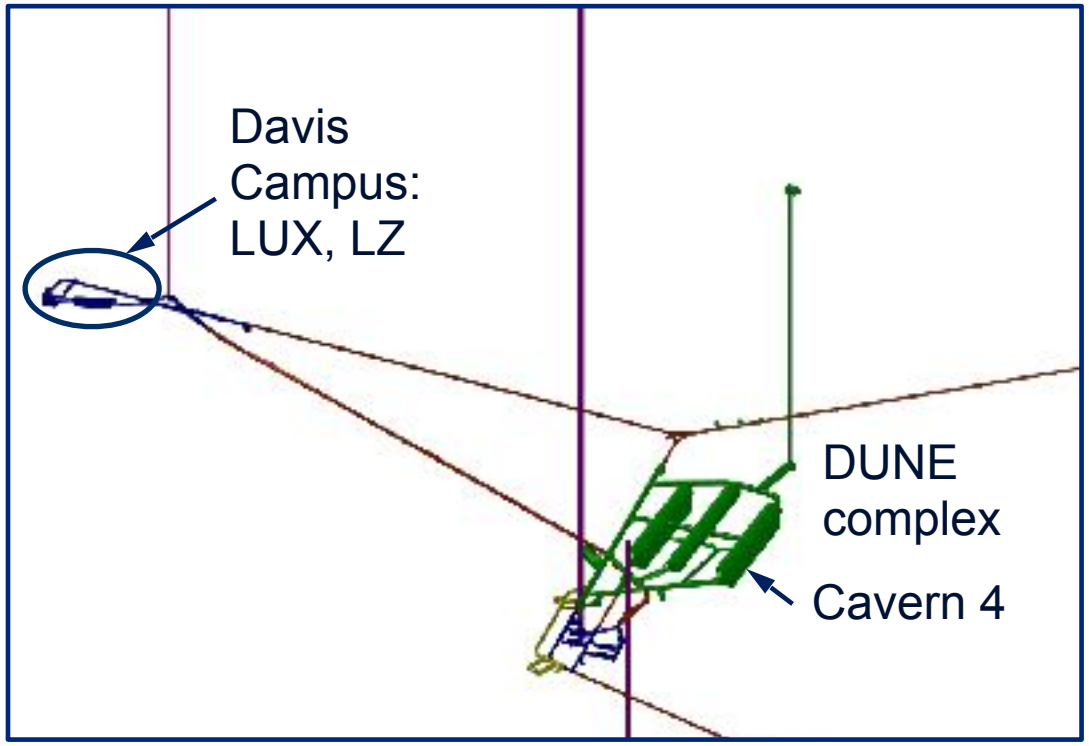
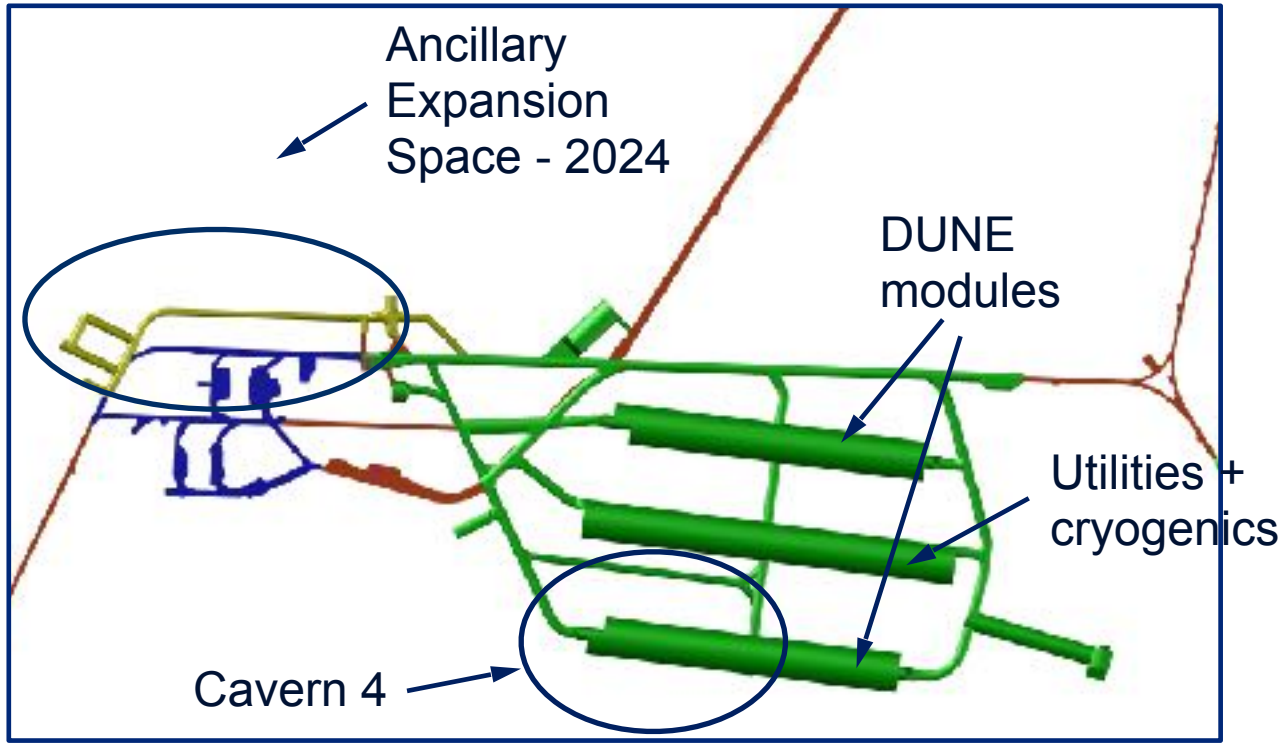
Opportunity for XLZD at SURF

- SURF is the only viable US based underground research laboratory.
- Two options have been considered:
  - New cavern(s), for which an ancillary expansion was completed in 2024
  - DUNE Cavern 4
- Will focus here on DUNE Cavern 4: most attractive option
- Ross Shaft and Crews currently demonstrating capabilities for movement of large scientific equipment
- SDSTA has track record of private and SD state support
  - Initial ~$100M investment to create SURF
  - ~$20M investment to create Davis campus, support LUX
  - Substantial investment in LZ, including LXe procurement.

4850’ level at SURF

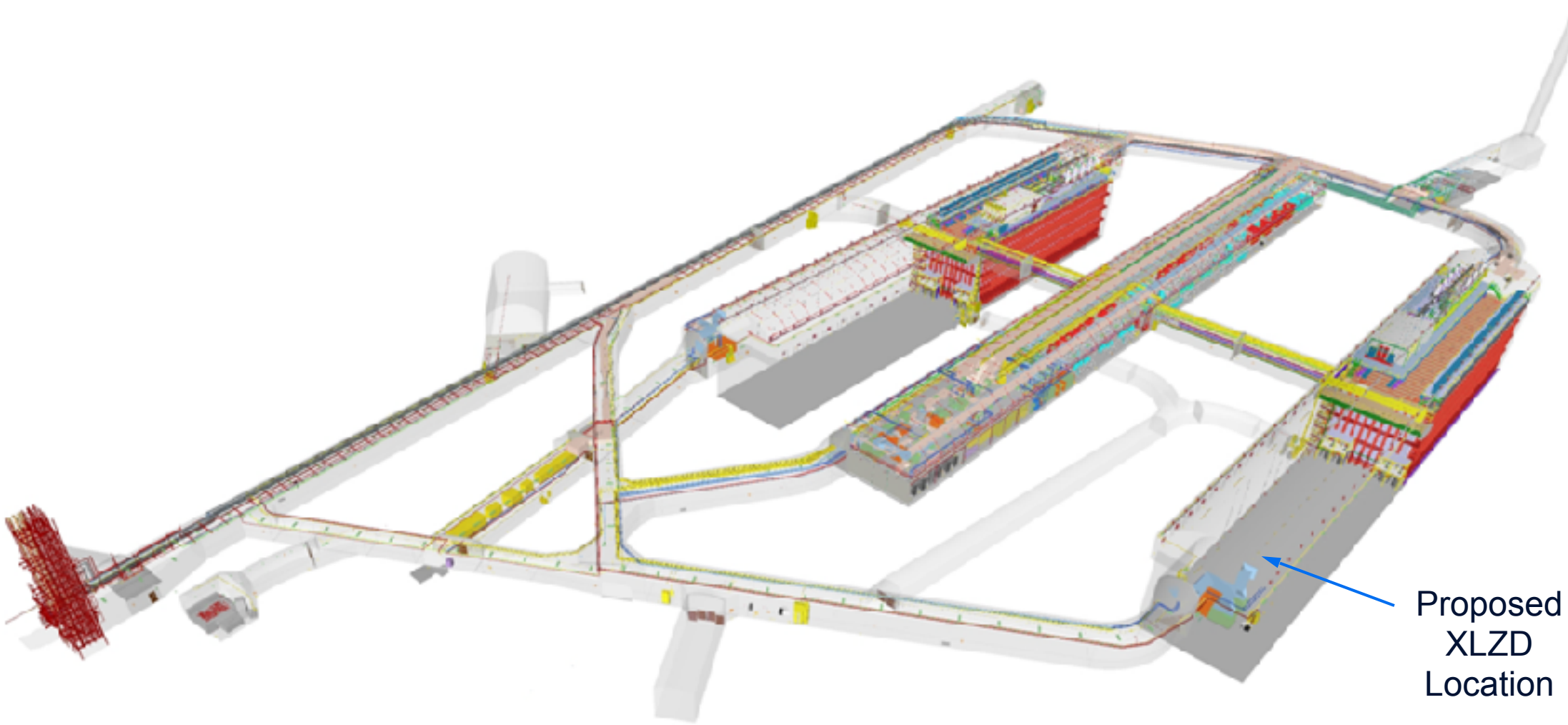


Isometric View of 4850



Plan View of Ross Campus
Highlighting Cavern 4

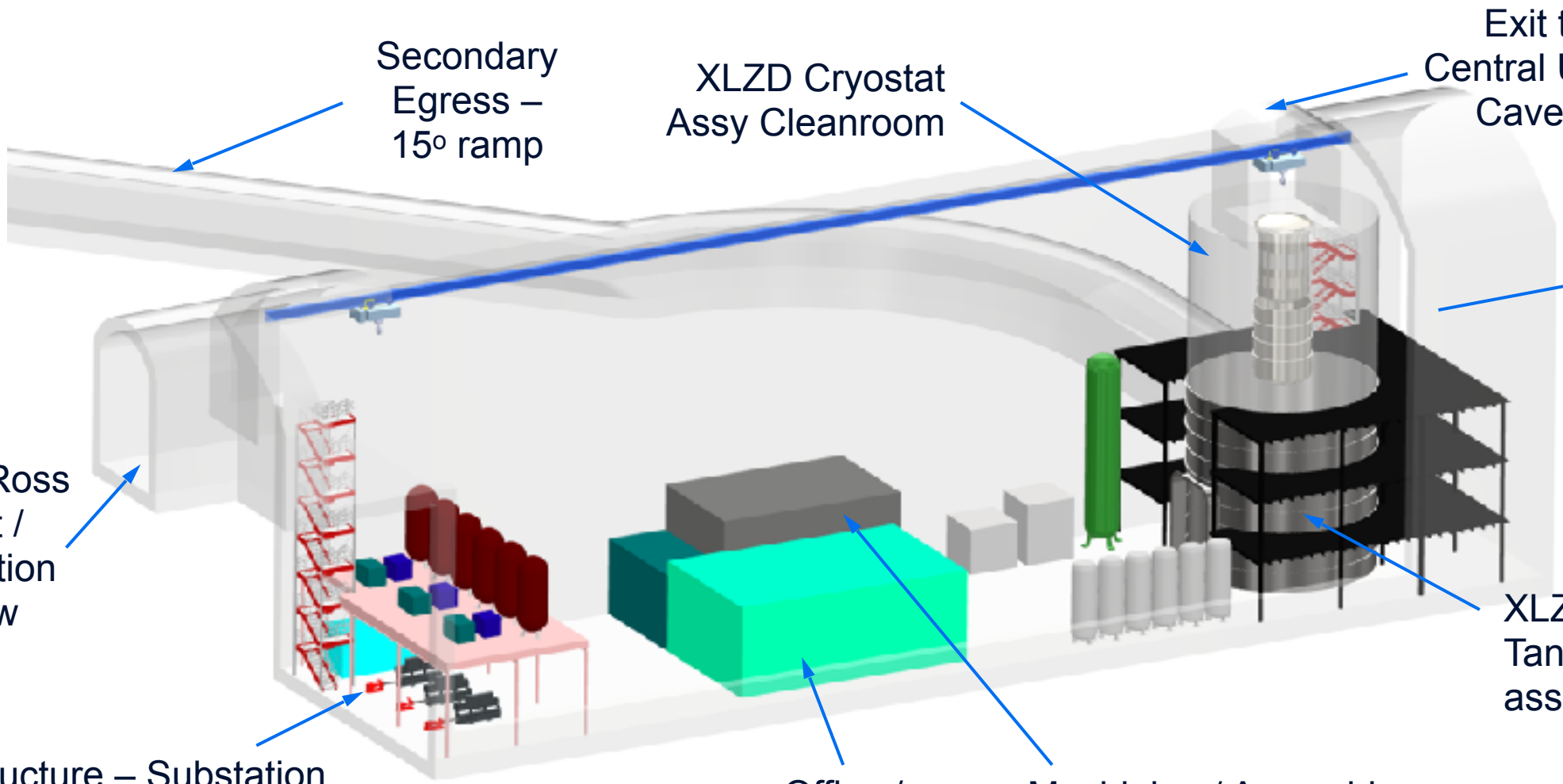
LBNF / DUNE Footprint



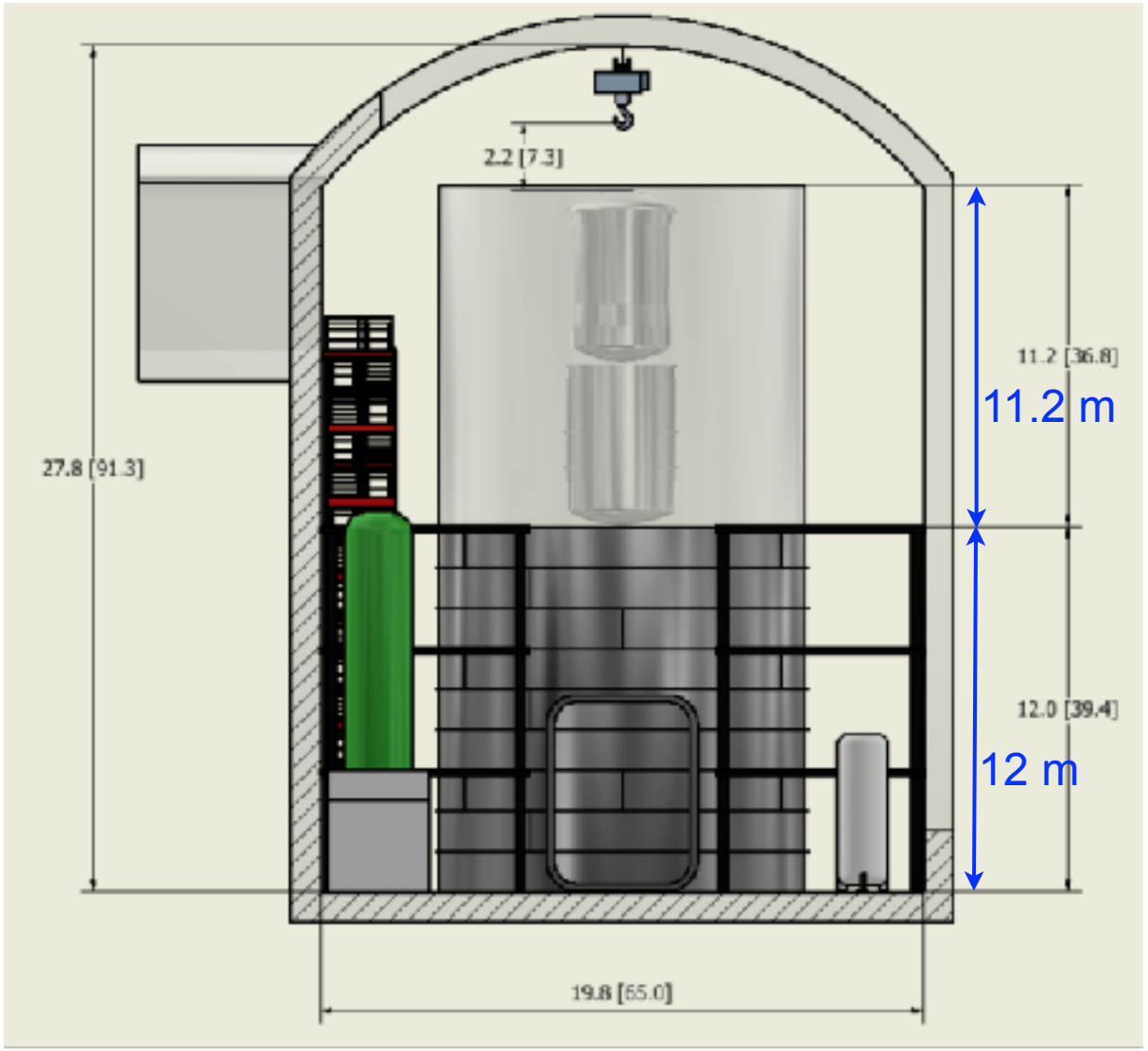
Cavern 4

- Size: 20m W x 28m H x 75m L (half the total hall length).
- Power – 500 kW installed
- HVAC – 15 m^3/s (30 kcfm) filtered flowthrough air with 7.2° C dewpoint

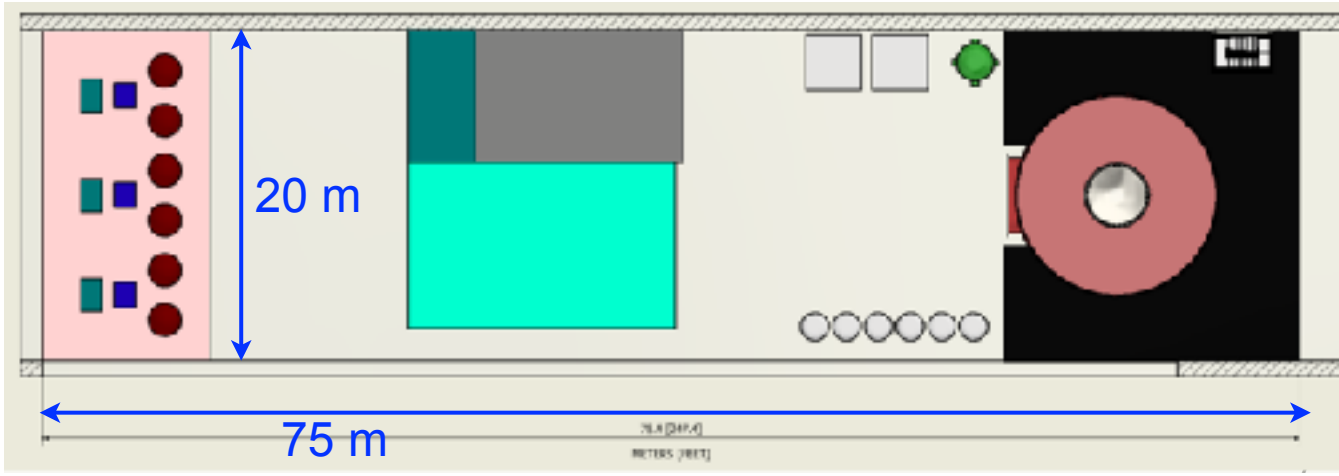
DUNE Cavern 4 – Experiment Layout



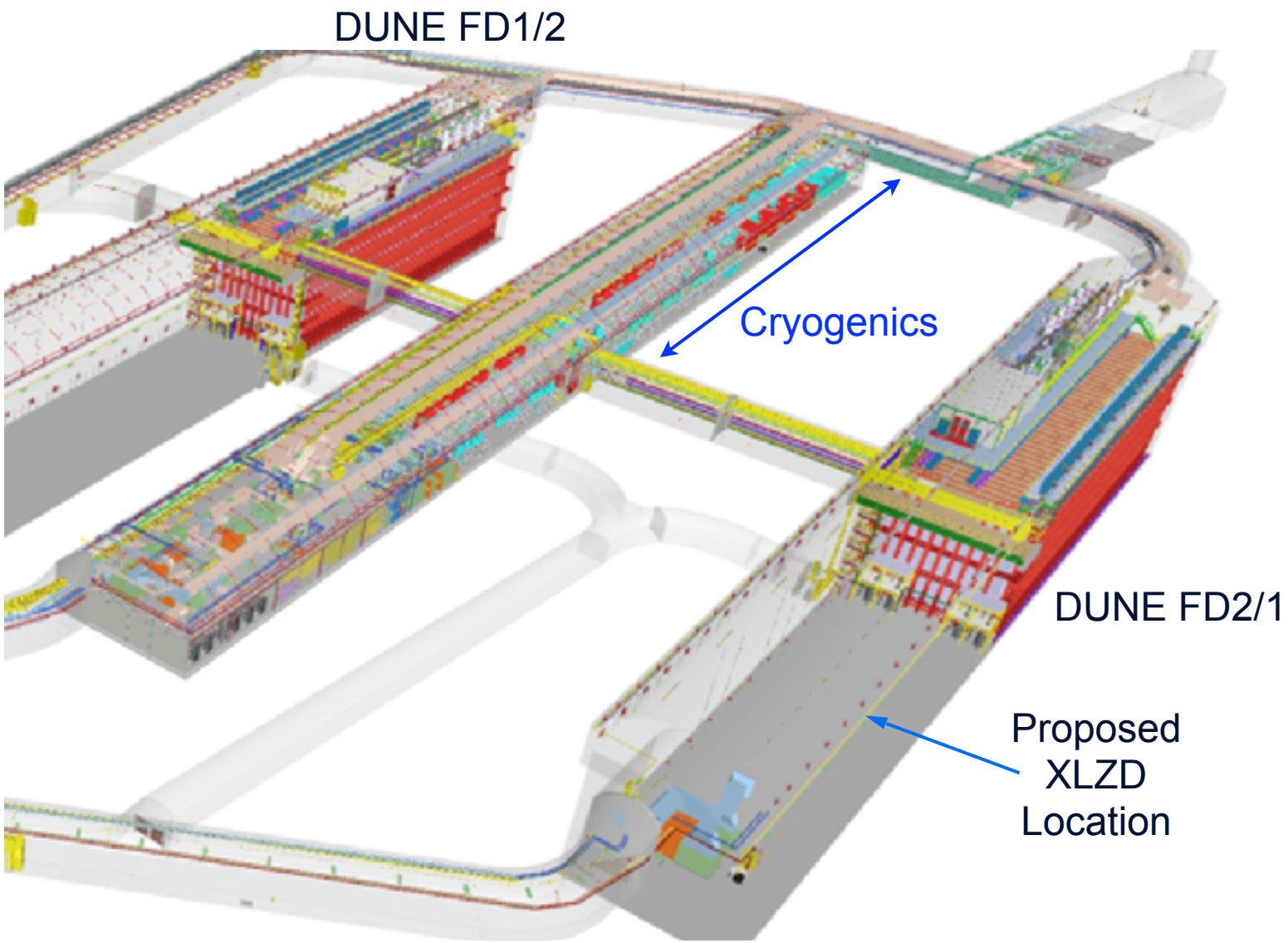
DUNE Cavern 4 Dimensions



- Tall cavern readily accommodates full vertical access
- Notion: Rn-scrubbed clean room above water tank.
- Ample floor space for



Cryogenics



- 3 x 100 kW LN2 modules under fabrication for FD1/2.
- 4th unit planned for FD3(/4).
- DUNE detectors require ~90 kW steady state
  - Much larger during filling.
- Opportunity for XLZD

Benefits of using DUNE Cavern 4

- Excavated Space is Complete
  - Dimensions exceed the requirements specified by XLZD Dark Matter Collaboration
  - Installed cranes meet the same requirements for lifting capacity and hook height
- Electrical, Ventilation, and Mechanical Infrastructure Are Under Construction
  - There is sufficient margin on conventional utilities
- Is substantial cryogenic infrastructure for DUNE, which we may leverage, though possibly with some supplement may be needed
- Cost of this space substantially less than a new cavern.

Initial Outfitting Cost Estimates

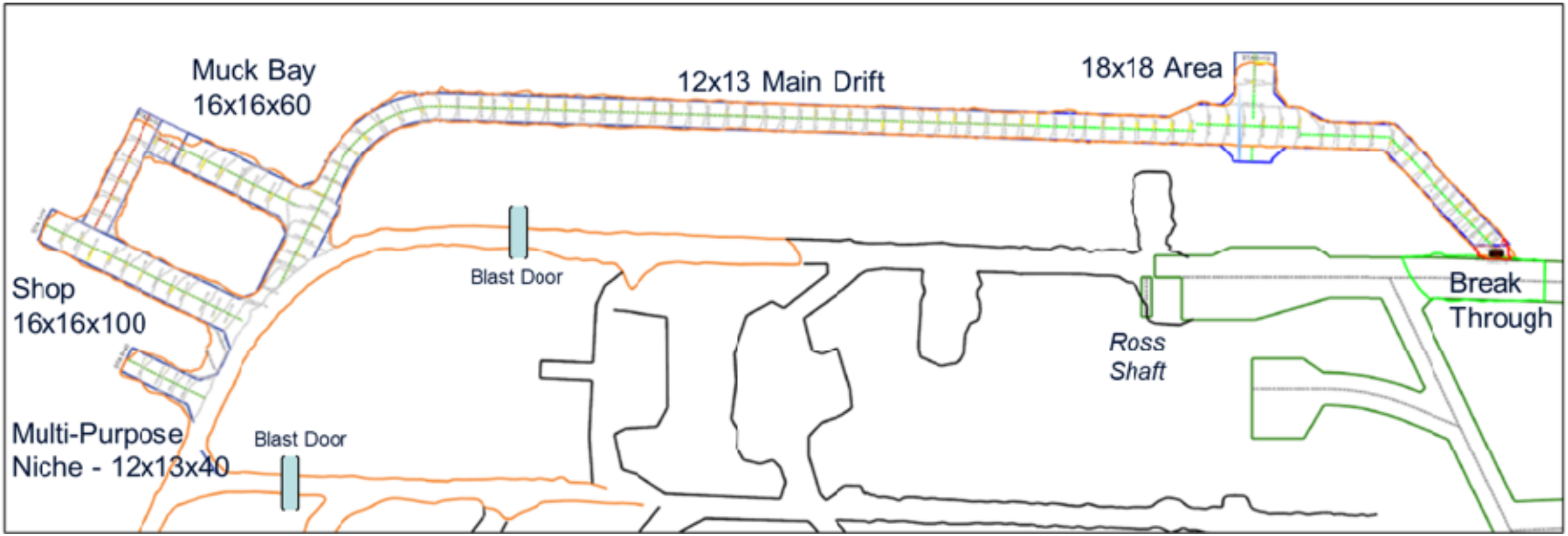
DUNE Cavern 4

DUNE FD4 Cavern Outfitting	
Project Mgt @1%	$217
Architect / Engineer @8% + Indirect	$1,736
FD4 Outfitting	$14,104
Escalation 1 - 2011 to 2023	$5,850
Contingency @40%	$8,763
Total Cost (Current Year $*1000)	$30,670
Future years escalation to 2030	$6,441
Total Cost (2030 $*1000)	**$37,110**

New Cavern

New Cavern Relevant Costs Pulled from DUSEL PDR	
Project Mgt @1%	$690
Architect / Engineer @5%	$3,284
Support Infrastructure	$21,543
Main Hall (like LM2)	$16,988
2nd Hall (like LM1)	$7,893
Construction Subtotal	$46,424
Escalation 1 - 2011 to 2023	$19,257
Design + Construction	$69,655
Contingency @40%	$27,862
Total Cost (Current Year $*1000)	$97,516
Future years escalation to 2030	$20,478
Total Cost (2030 $*1000)	**$117,995**

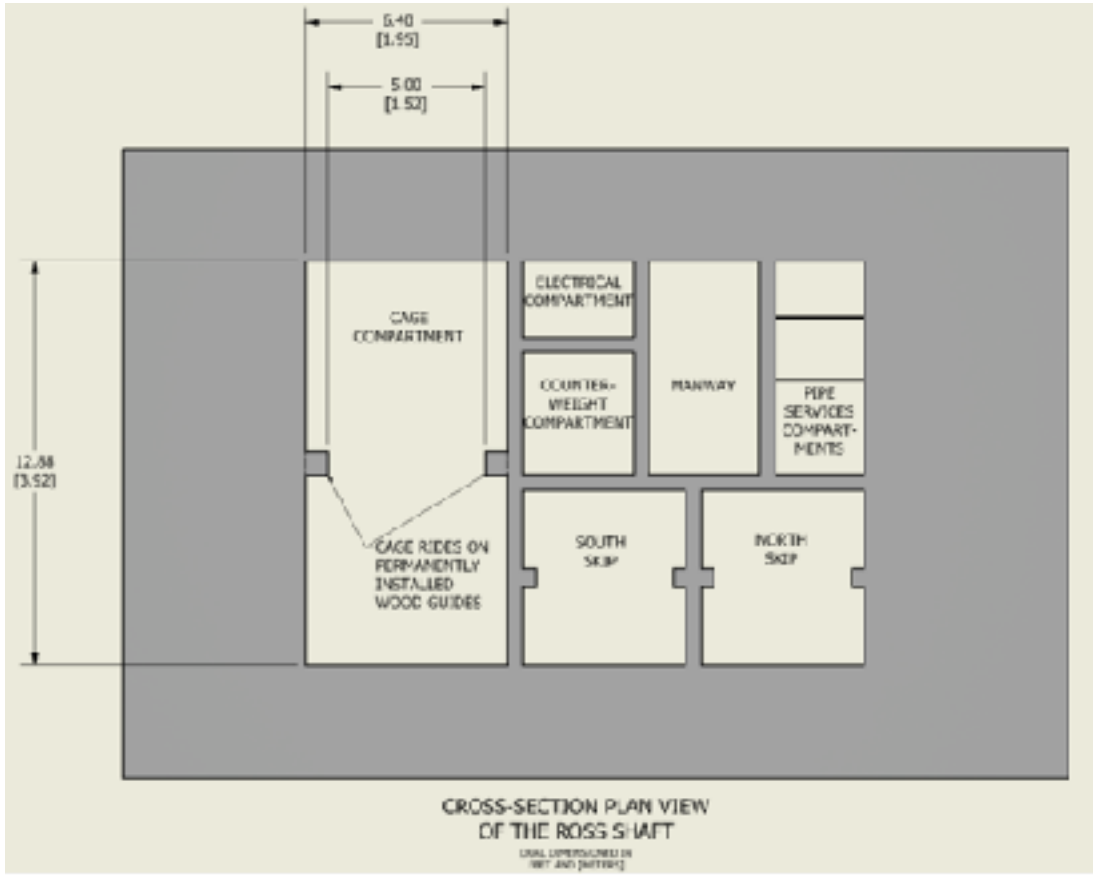
Expansion Drift to support New Cavern(s)



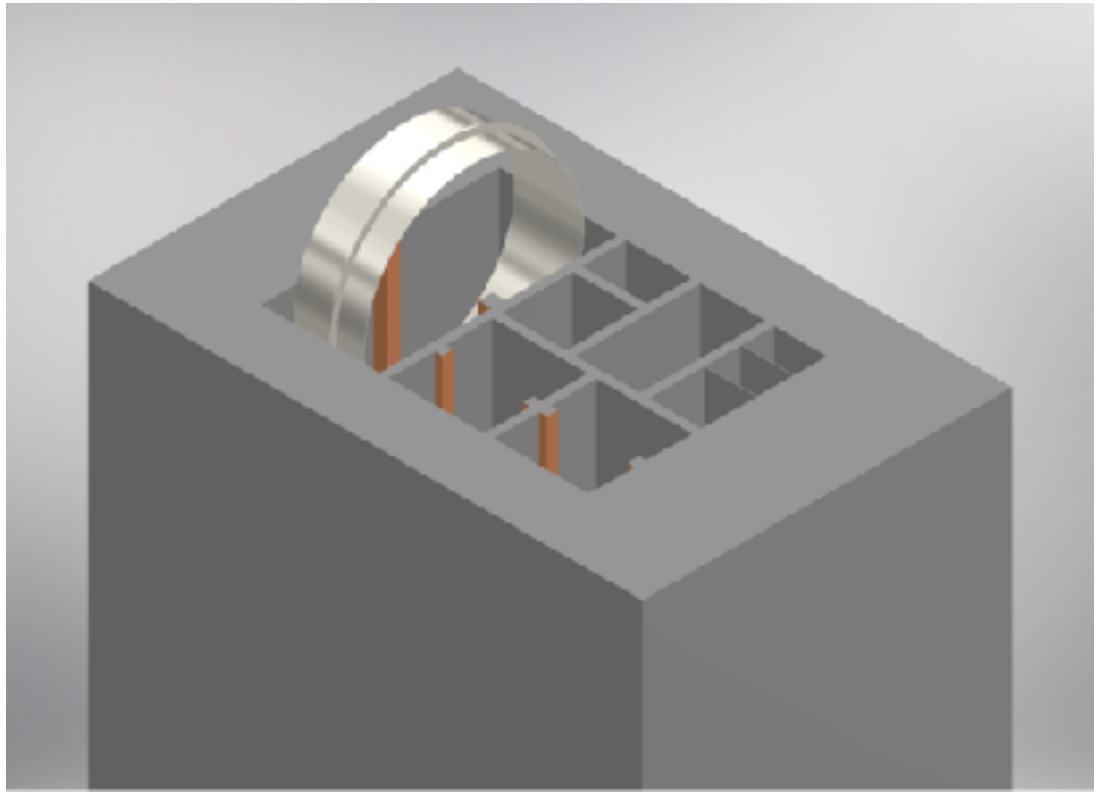
Ancillary Expansion Finished 2024

- Length of this drift exceeds 200m
- Overall volume of approximately 4,000 m^3
- Several shop areas sized for 5m x 5m with 5-ton hoist beams
- Excellent supplementary storage close to the Ross Shaft

4850 Access – Ross Shaft

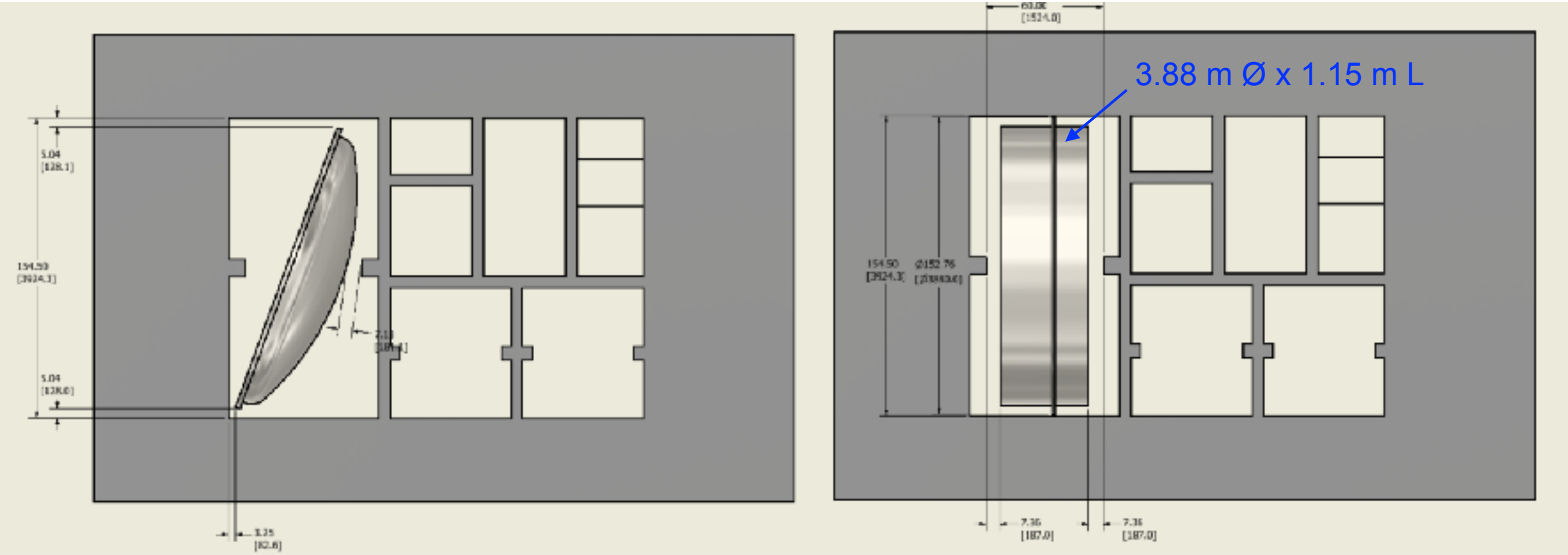


CAD Representation of Cylindrical Section in the Cage Compartment

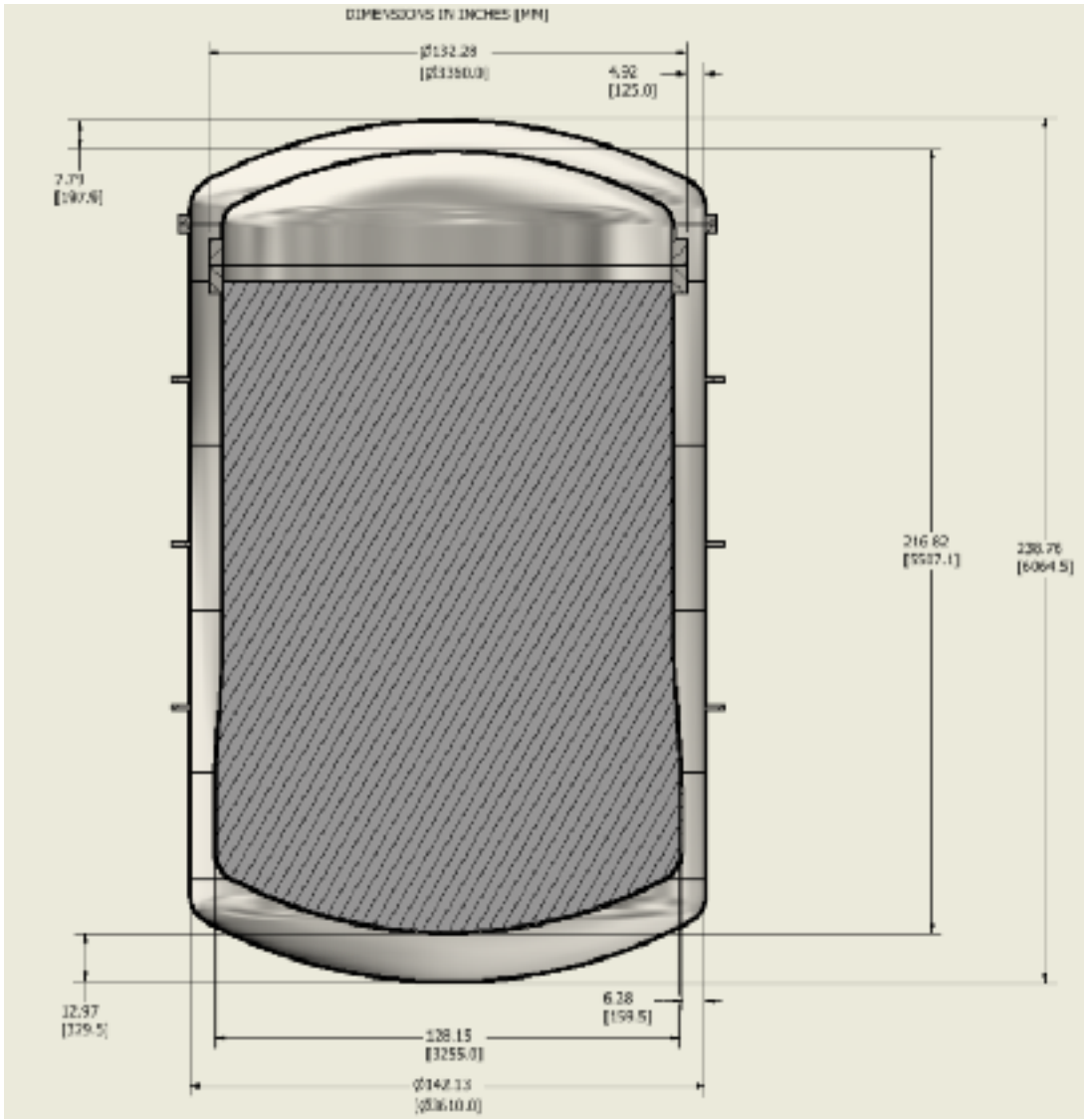


4850 Access – Ross Shaft

- Large Components are Slung Under the Cage Similar to LZ
  - Ross Shaft has been Laser Scanned for Accuracy
- Cylindrical OV Sections in the Cage Compartment



Estimated Allowed Cryostat Size

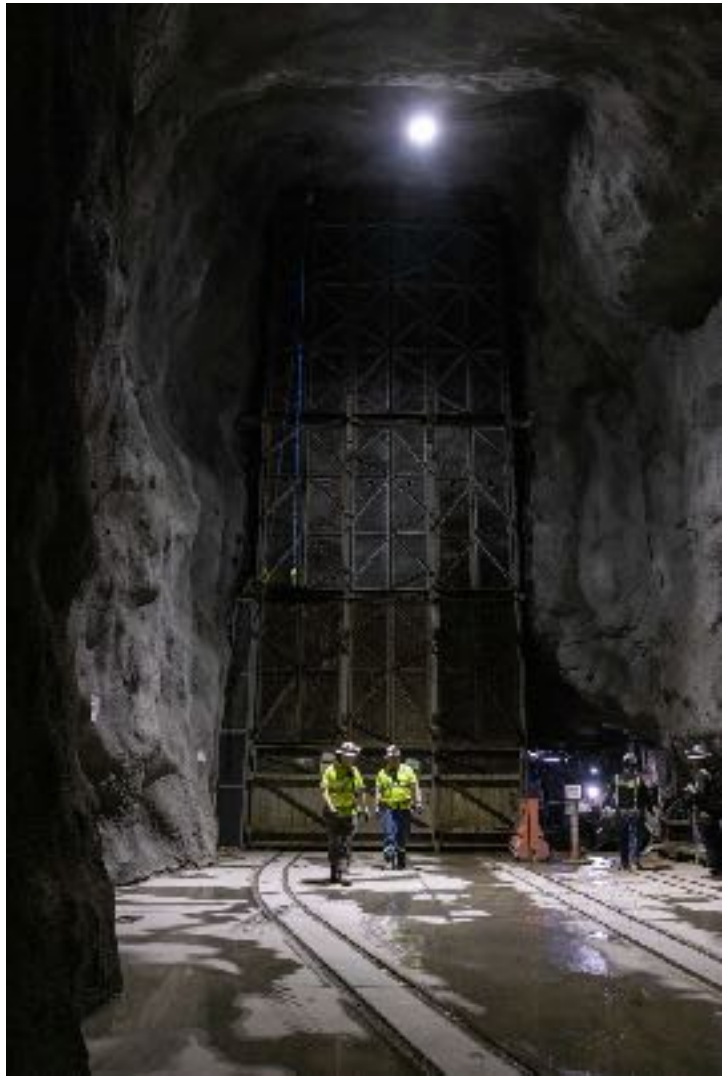


- Overall constraints similar to Boulby - OV in sections, IV will need to welded UG. Flanges transported intact.
- Based on the largest cylindrical section that can be slung under the Ross cage
- Comfortably large for 80 ton experiments:
  - Inner: 3.36 m Ø, 5.5 m H
  - Outer: 3.61 m Ø, 6.06 m H
- Grids readily transported intact.

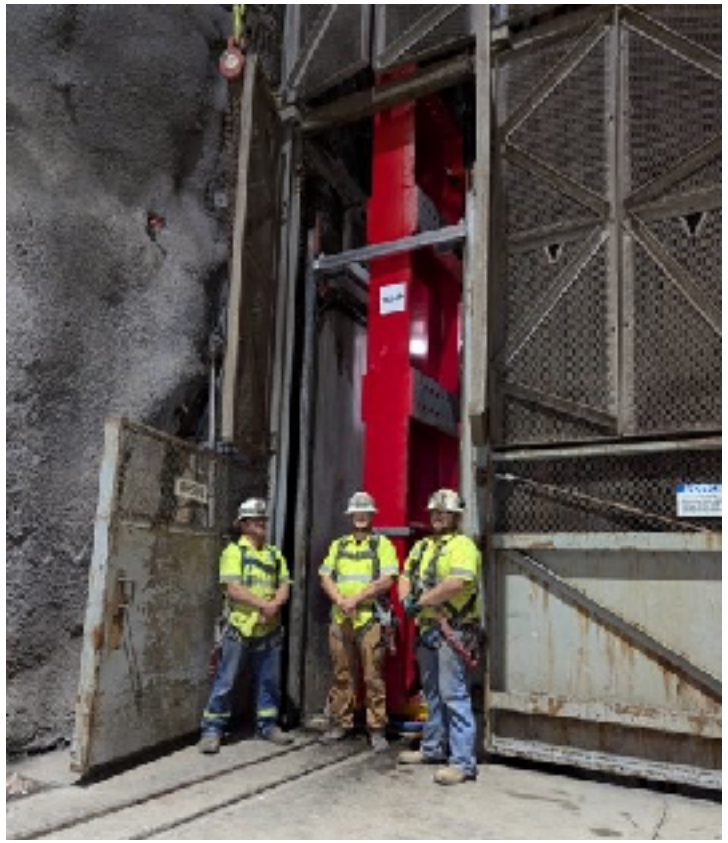
South Drift and Governor's Corner

5m X 5m
Access
Ways

Off-Loading at 4850



- Ross Station had Monumental Upgrade for large LBNF / DUNE Steel
- Access Drift to South Cavern – 5m X 5m

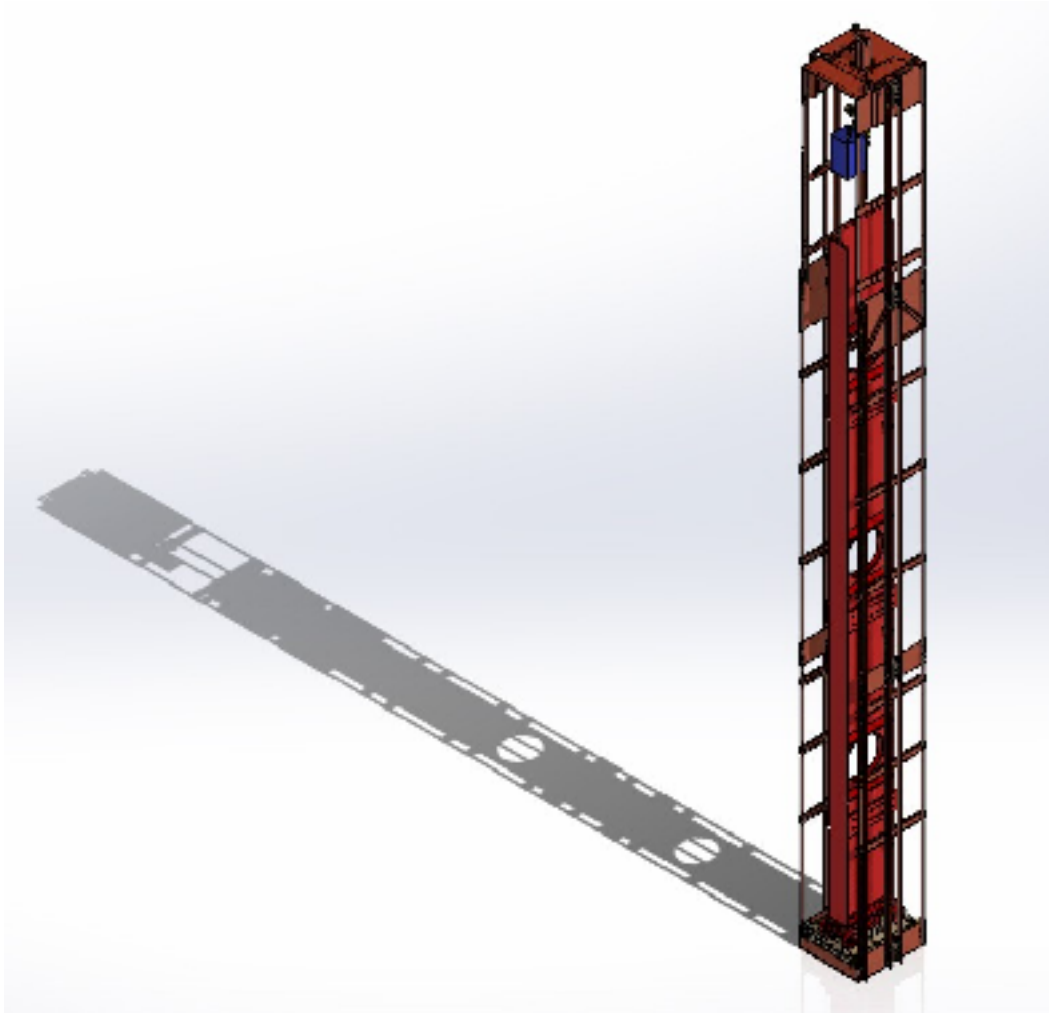


Shown:

LBNF / DUNE Cryostat L-Beam in Ross Cage

5.5 m tall x 3.6 m long
5400 kg (~12,000 lb)

Off-Loading at 4850



- Longer , Heavier Loads in the Skip Compartment Cage
- To Left: Simulation of 13.7m, 7500 kg (16,500 lb) LBNF / DUNE Cryostat Beam in Skip Cage

Summary

- DUNE Cavern 4 has more than adequate space for XLZD.
  - Required utilities are already under construction
  - Airflows sized for 10,000 tonne Argon detector
- Supplemental infrastructure needed for XLZD can be furnished with sufficient lead time:
  - XLZD-specific electrical substation with transformers
  - Radon mitigation equipment
  - Cooling water systems
  - Likely expansion of cryogenics
- Ross Shaft was refurbished for LBNF / DUNE – all modern hoisting equipment
- SDSTA has strong track record of raising both private and state funds to support science at SURF.