# Interface management

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LBNC

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# Charge point

- Provide an update on the status of interface management planning for Far Site. Are the plans for identifying, recording, disseminating, and controlling all the interfaces needed for LBNF and DUNE, with a complete set of managed ICD's and associated documentation in place? Status of ongoing mezzanine, cryo, and detector interface design work including updates on schedule and milestone development.

# Interfaces

- Interfaces between LBNF, cryogenics, cryostat and DUNE are documented using Interface Control Documents (ICD).
- These are organized in a matrix that can be found on docdb #110
  - https://docscert.dunescience.org/cgi-bin/cert/ShowDocument?docid=110

| LBNF-DUNE Far Site Interface Control Documents Chart | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **Far Site Entity** | CF, Far Site - Surface | CF, Far Site - Shafts & Drifts | CF, Far Site - Caverns | Far Detector | Cryostat | Infrastructure/External Cryogenics | Proximity Cryogenics | Internal Cryogenics | Cryogenic Fluids | SURF |
| CF, Far Site - Surface | | | | | | | | | | |
| CF, Far Site - Shafts & Drifts | | | | | | | | | | |
| CF, Far Site - Caverns | | | | | | | | | | |
| Far Detector | 199 | 197 | 201 | | | | | | | |
| Cryostat | 433 | 483 | 492 | 102 | | | | | | |
| Infrastructure/External Cryogenics | 3390 | | | 77 | 106 | | | | | |
| Proximity Cryogenics | 3393 | | | | | | | | | |
| Internal Cryogenics | 3396 | | | 75 | 105 | 74 | | | | |
| Cryogenic Fluids | 216 | | | 104 | | | | | | |
| SURF | | | | 195 | 514 | 202 | 209 | 204 | 215 | |

# ICD sample

- ICDs convey the various interfaces between subsystems, the responsible parties and the details of the situation as they are known today.
- As the designs of the subsystems mature, these documents will get more specific and detailed. This will include the addition of interfaces and envelope drawings.

LBNF/DUNE Interface Control Document

| Item | LBNF Far Site CF Shafts & Drifts Provides | DUNE Far Detector Provides | Interface Point |
|---|---|---|---|
| **Drift Infrastructure** | CF provides rails, power, lighting, ventilation and a concrete floor in the drifts | Far detector provides a plan for installation that utilizes the existing infrastructure. Special cases are negotiated.<br><br>Any surface finish requirements. | Underground drifts. Drawings describing drift infrastructure. |
| **Access shafts dimensions and loads** | Define the minimum available cross section through the shafts per Doc-328. Define the max loads for the cages and hoists as per docdb-3582. Provide guidance for developing slung load procedures. Approve slung load procedures. | Far Detector component(s)/shipping containers dimensions to fit within the cage. Procedures for slung loads for items which do not fit in the cage. | Shaft Cage and Skips. |
| **Conveyance through shafts** | Provide shaft conveyance systems. Provides manpower to load and unload the cages and skips | Additional equipment needed such as special fixtures and crates. Procedures for usage and any safety/engineering documentation. | Cage and skips |
| **Conveyance through drifts** | Will move the equipment from the shafts to the cavern. | Additional equipment needed beyond SURF's existing equipment. Procedures for usage and any safety/engineering documentation. | Drifts |
| **Conventional utilities from surface** | Design of infrastructure that | Specify utility needs in requirements. | Shafts and drifts |

# DUNE Interface Documents

- All DUNE far detector consortia have begun negotiations on their interfaces
- Interface definitions begin from ProtoDUNE construction experience
- Necessary modifications for DUNE are being worked through
- Initial draft documents are in place for most key consortia interfaces (see https://web.fnal.gov/collaboration/DUNE/DUNE%20Project/SitePages/DUNE%20Far%20Detector%20Interfaces.aspx)
- Many initial draft documents between Consortia and Technical Coordination exist (includes interfaces with installation, integration facility and LBNF)

# DUNE consortia matrix

Fermilab

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DUNE DEEP UNDERGROUND NEUTRINO EXPERIMENT

DUNE at Work DUNEscience.org LBNF at Work LBNF

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## DUNE Far Detector Interfaces

- Home
  - DUNE Project
  - DUNE Project Office
  - CENF at CERN
  - DUNE Reviews
  - Joint LBNF/DUNE Reviews
  - CDR
  - EDMS
  - DocDB
  - DUNE Indico
  - ProtoDUNE ELOG
- TDR
  - ProtoDUNE-SP
  - ProtoDUNE-DP
  - Technical Proposal
  - Technical Proposal Dual Phase Text
  - Technical Proposal Single Phase Text

Schedule | WBS | Interfaces | Requirements | Risks | Strategy

## DUNE Far Detector Interfaces

### Detector Subsystems to Each Other

| | 1 SP APA | 2 SP PD | 3 SP CE | 4 DP CRP | 5 DP PD | 6 DP Elec | 7 HV | 8 DAQ | 9 CISC |
|---|---|---|---|---|---|---|---|---|---|
| 1 SP APA | | 6667 (cert link) | 6670 (cert link) | 6709 | 6712 | 6715 | 6673 (cert link) | 6676 | 6679 (cert link) |
| 2 SP PD | | | 6718 (cert link) | 6763 | 6796 | 6733 | 6721 (cert link) | 6727 (cert link) | 6730 (cert link) |
| 3 SP TPC Elec | | | | 6766 | 6769 | 6793 | 6739 (cert link) | 6742 (cert link) | 6745 (cert link) |
| 4 DP CRP | | | | | 6748 | 6751 | 6754 (cert link) | 6757 | 6760 (cert link) |
| 5 DP PD | | | | | | 6772 (cert link) | 6799 (cert link) | 6802 | 6781 (cert link) |
| 6 DP TPC Elec | | | | | | | 6775 | 6778 (cert link) | 6784 (cert link) |
| 7 HV | | | | | | | | 6736 | 6787 (cert link) |
| 8 DAQ | | | | | | | | | 6790 (cert link) |

# Sample DUNE consortia ICD

- These are text documents that describe the various stages of the development process.
- The responsibilities and deliverables are listed in these documents.

**DUNE Interface Document: SP-APA/PDS**

**Definition:**

This document describes the interface between the DUNE single-phase far detector Anode Plane Assembly (APA) consortium and the Photon Detection System (PDS) consortium. This document describes the necessary interfaces for APA and PDS consortia to complete the design, fabrication, and installation of their subsystems. This document describes the elements of the scope of each subsystem at the interface between them.

**Hardware:**

The PDS is integrated in the APA frame to form a single unit for the detection of both ionization charge and scintillation light. The hardware interface between APA and PDS has two components:

1. Mechanical: a) supports for the PDS detectors; b) access slots for installation of the detectors, if, as in the present baseline design, the detectors will be installed after the wire winding is completed; c) access slots for the cabling of the PDS detectors; d) routing of the PDS cables inside the side beams of the APA frame.
2. Electrical: grounding scheme and electrical insulation, to be defined together with the CE consortium, given the CE strict requirements on noise.

**Design:**

The design of the PDS detectors is still under evolution. The APA consortium will evaluate different solutions proposed by the PDS consortium that may require modifications of the structure of the APA frame. We expect this evaluation phase to be concluded by Spring 2018 for the main structural components of the APA frame.

The PDS consortium will provide detailed engineering drawings of the detectors and specifications on the size and number of cables, and of any connectors required.

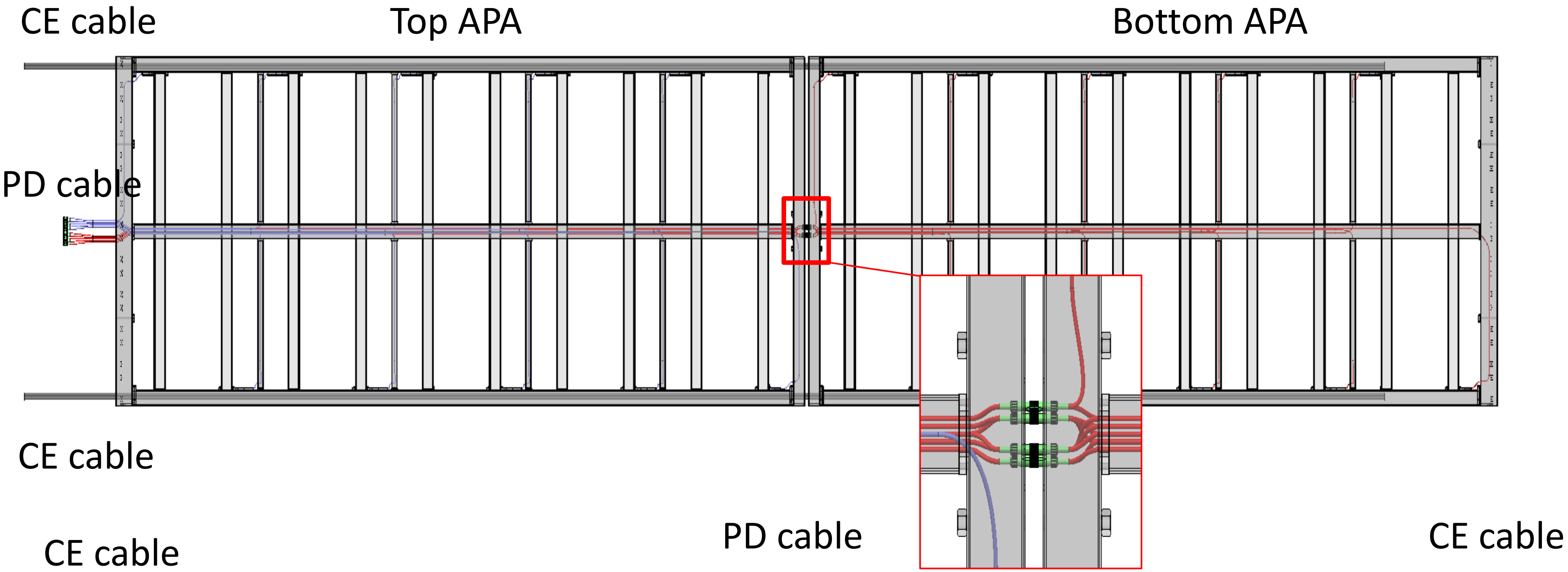
If the PDS detectors will be installed after the wire winding is completed, as in the present baseline design, the APA consortium will evaluate possible variations of the baseline geometry, as suggested by

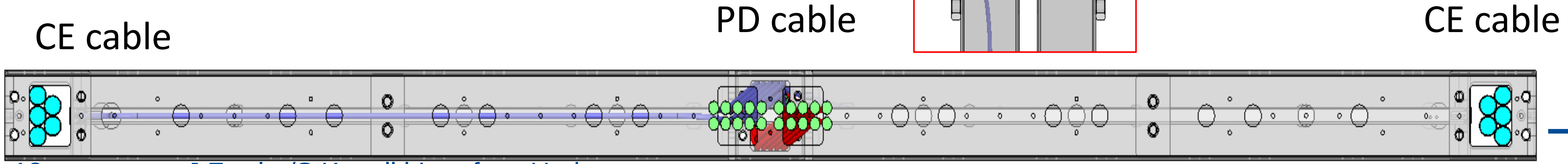
# Cabling in Bi-APA assembly

In the top APA frame, 10 PD cables (BLUE) are pre-routed to connect to 10 PD modules, and another 10 PD cables (RED) pass through the center tube and are ended with connectors.

In the bottom APA frame, 10 PD cables (RED) are pre-routed to connect to 10 PD modules. These 10 PD cables (RED) are connected to the 10 PD cables (RED) from the top APA frame with connectors.


CE-APA cable mockup

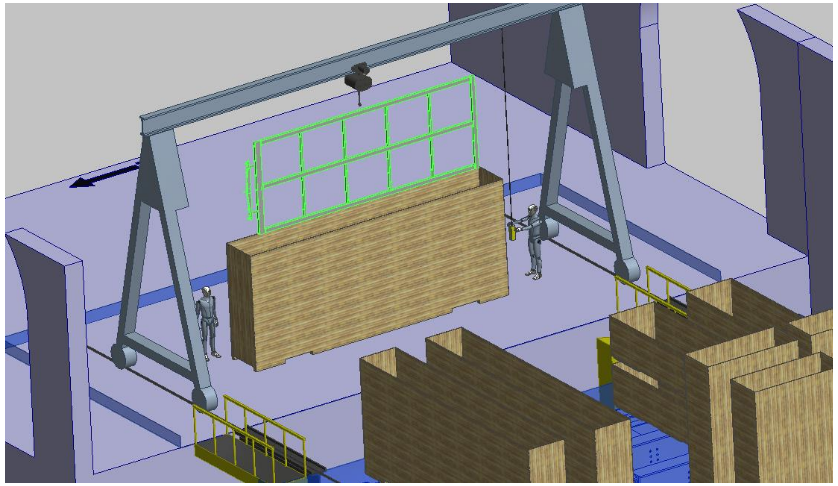


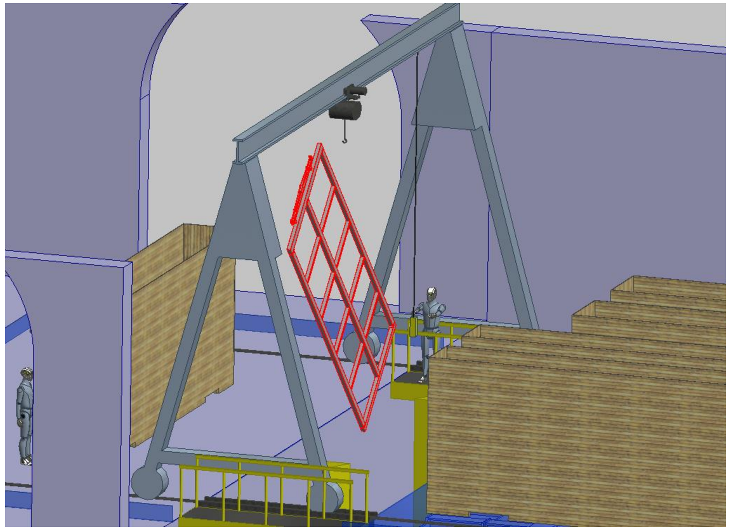

Top view

# DUNE Far Detector
## Scenario #1

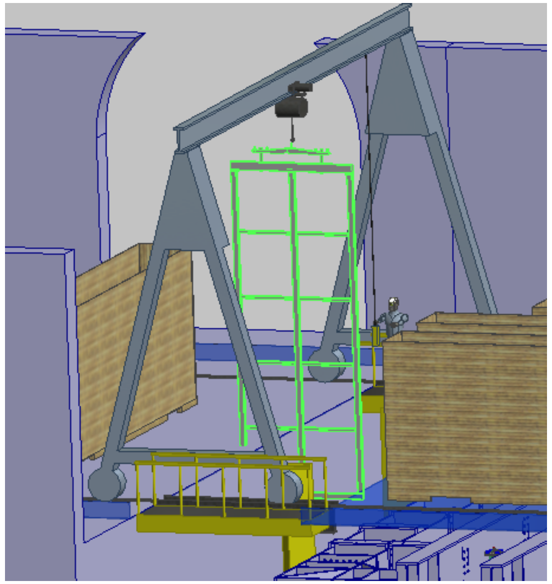
**1) Half (~6m) of APA removed from crate**



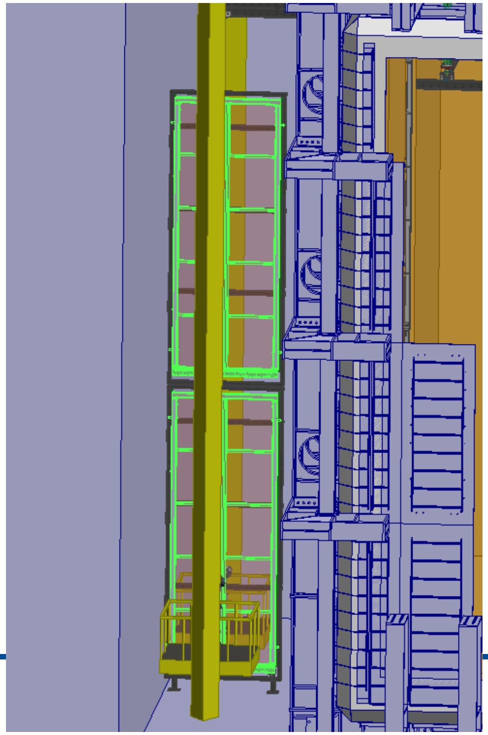
**2) Rotated to stand vertically**



**3) Rotated to align with assembly fixture**



**4) Lowered into Assembly fixture**

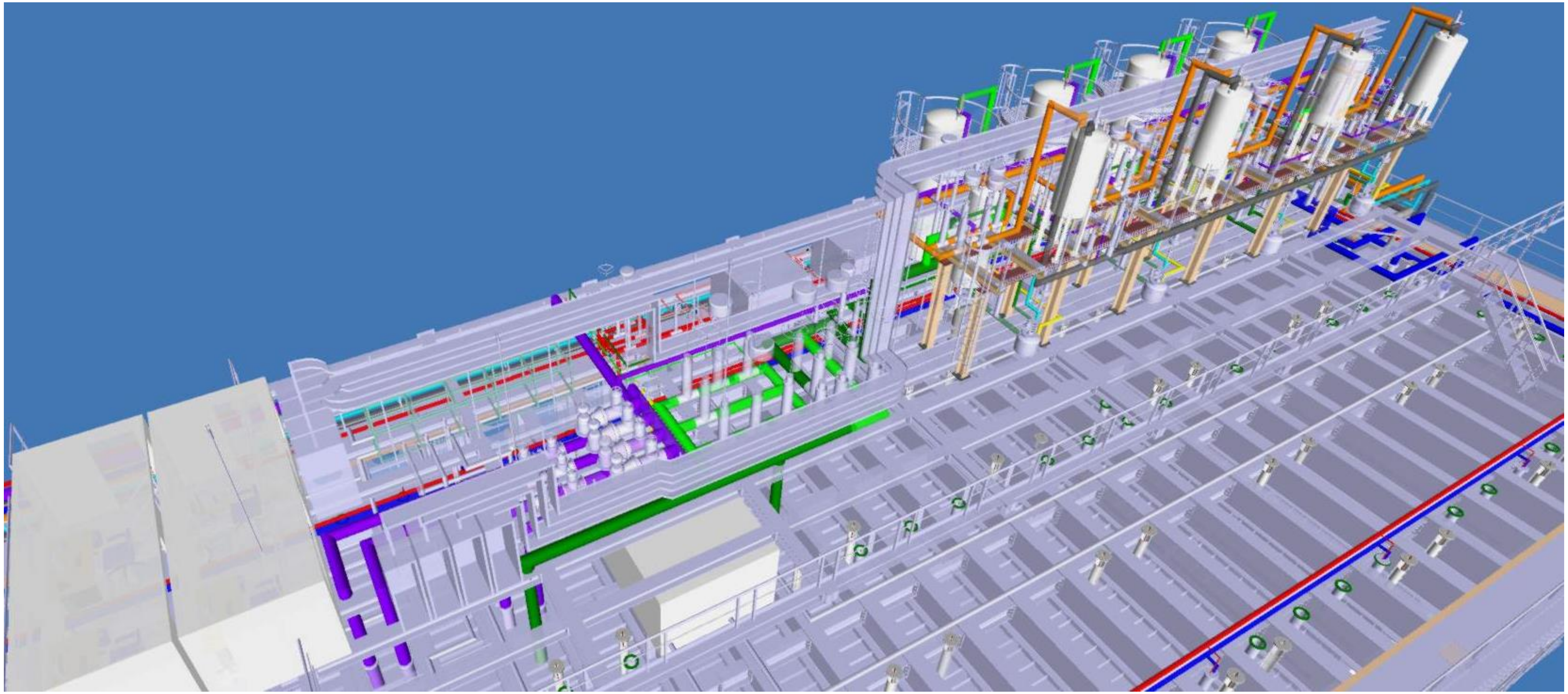


APA crates are not designed so assuming vertical lift out of crate

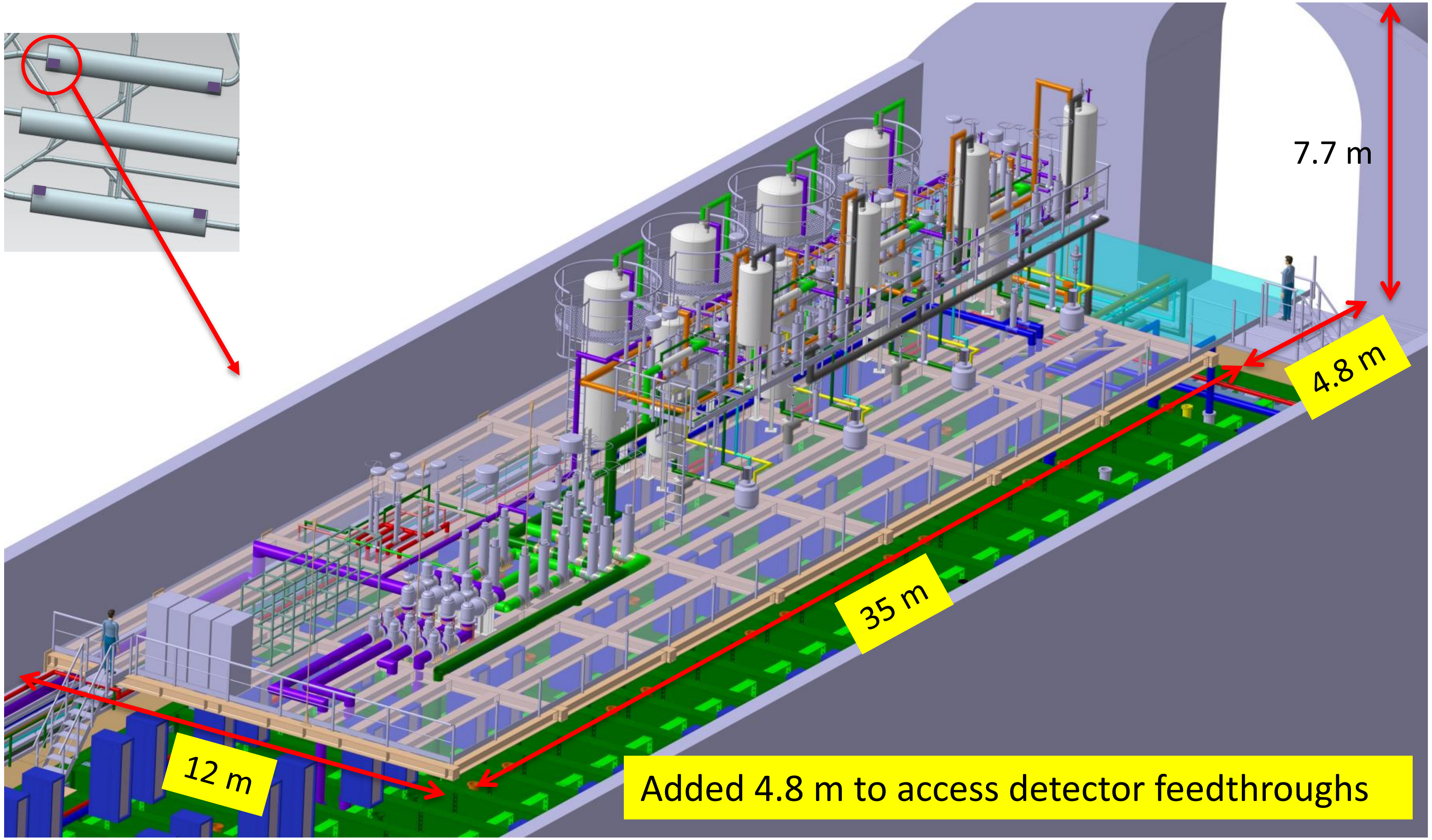
# DUNE Interface Documents

- Defining and managing interfaces is critical for success of the project.
- Definitions are key for bounding each Consortium scope, for defining the installation concepts, for defining the integration facility and for migrating designs from ProtoDUNE to DUNE
- Interface definitions are making good progress

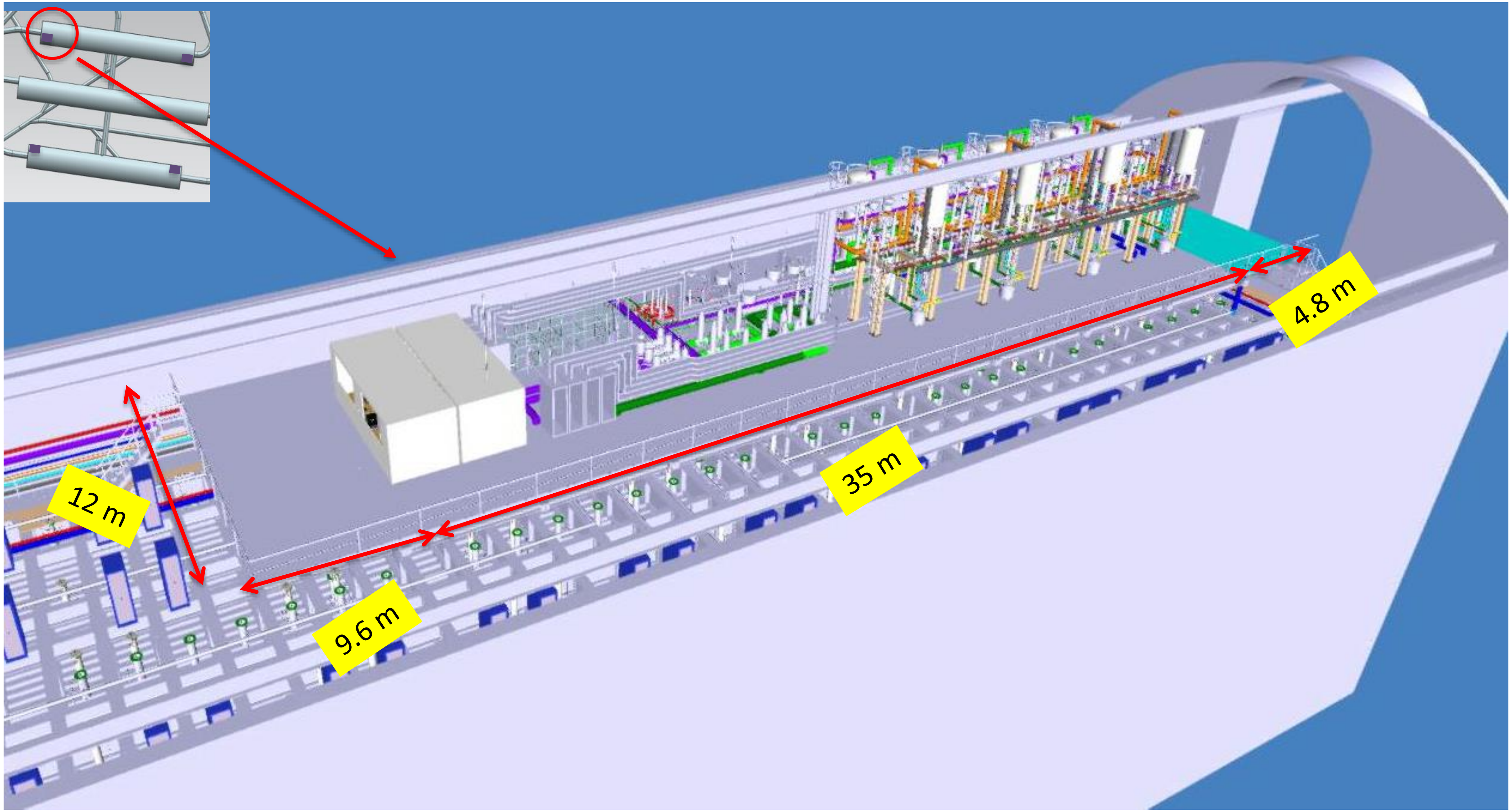
# Mezzanine Update



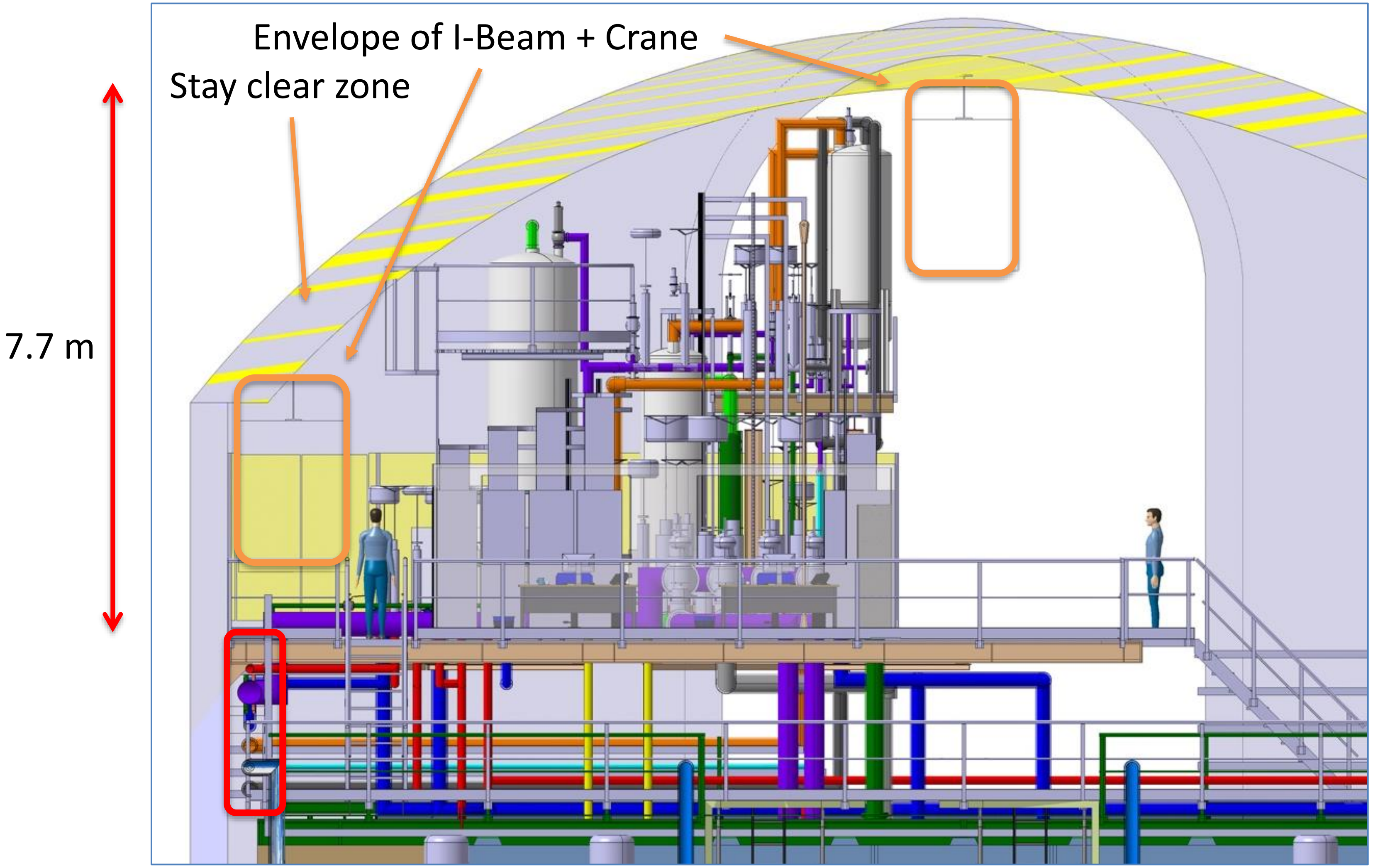
# Proximity Cryogenics on Mezzanine – Iso View (as Oct 2017)



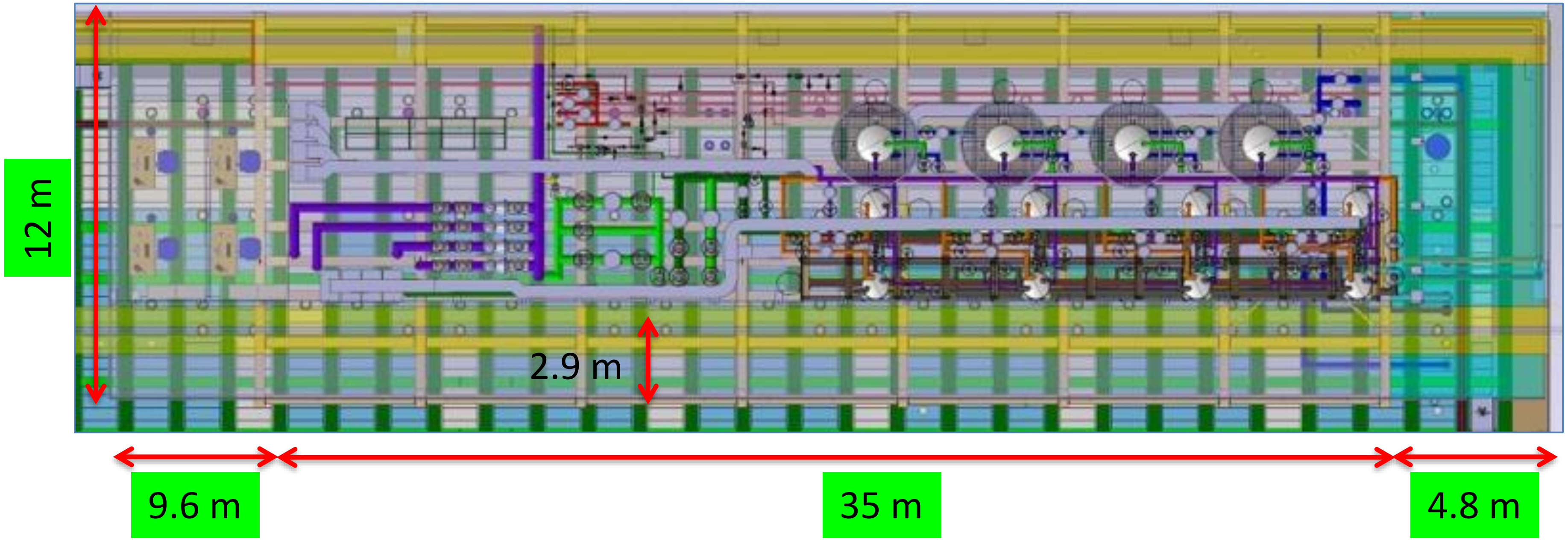
# Proximity Cryogenics on Mezzanine – Iso View (Current)



# Proximity Cryogenics on Mezzanine – Side View



# Proximity Cryogenics on Mezzanine – Top View

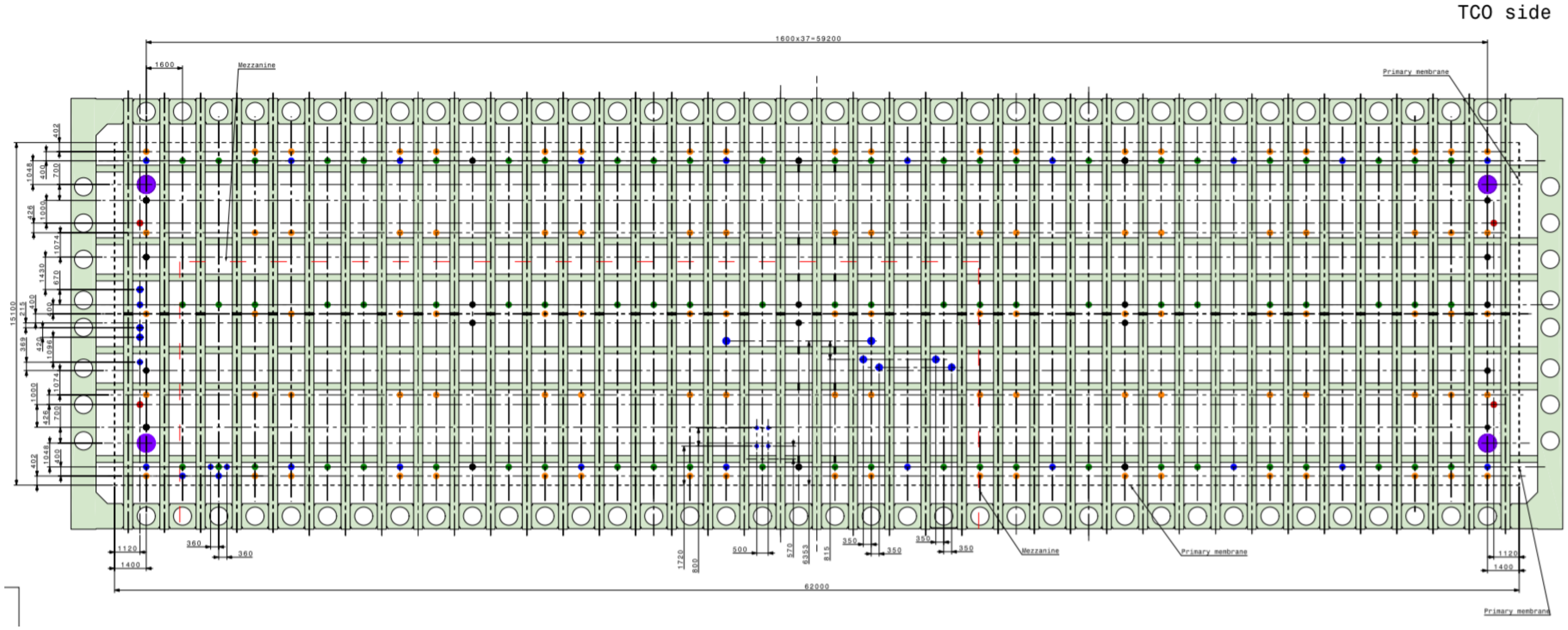



+9.6 m for office type spaces and extras

# Proximity Cryogenics on Mezzanine – Highlights

- Extended mezzanine platform by 9.6 m (Was 39.8 m, now 49.4).
- Added two office-type spaces.
- Increased number of controls racks (from 4 to 8).
- Added collectors for purges in feedthroughs.
- Added panel for GAr Analyzers to collect lines from purges.
- Cleanup and minor modifications to pipe routing.
- Added space for detector power transformers.

# Cryostat feed thrus




| Pos. | Diameter [mm] | Quantity | Description |
|---|---|---|---|
| 1 | Ø250 | 100 | Support |
| 2 | Ø250 | 75 | Cable |
| 3 | Ø250 | 4 | High voltage |
| 4 | Ø250 | 21 | Instrumentation |
| 5 | Ø800 | 4 | Manholes |

Cryogenic penetrations - 39 ps.

| Pos. | Diameter [mm] | Quantity | Description |
|---|---|---|---|
| 20.1 | Ø250 | 20 | L+G Ar cool down |
| 20.2 | | 3 | Spare |
| 21.1 | Ø152 | 4 | G Ar Controled vent |
| 22.1 | Ø304 | 2 | G Ar Boil off |
| 22.2 | | 4 | G Ar Relief/Safety |
| 23.1 | Ø273 | 2 | L Ar Return |
| 23.2 | | 1 | L Ar Emergency return |
| 25.1 | Ø219 | 1 | G Ar Purge |
| 25.2 | | 1 | G Ar Make up |
| 25.3 | | 1 | G Ar Momentum |

# Cryostat feed thru design

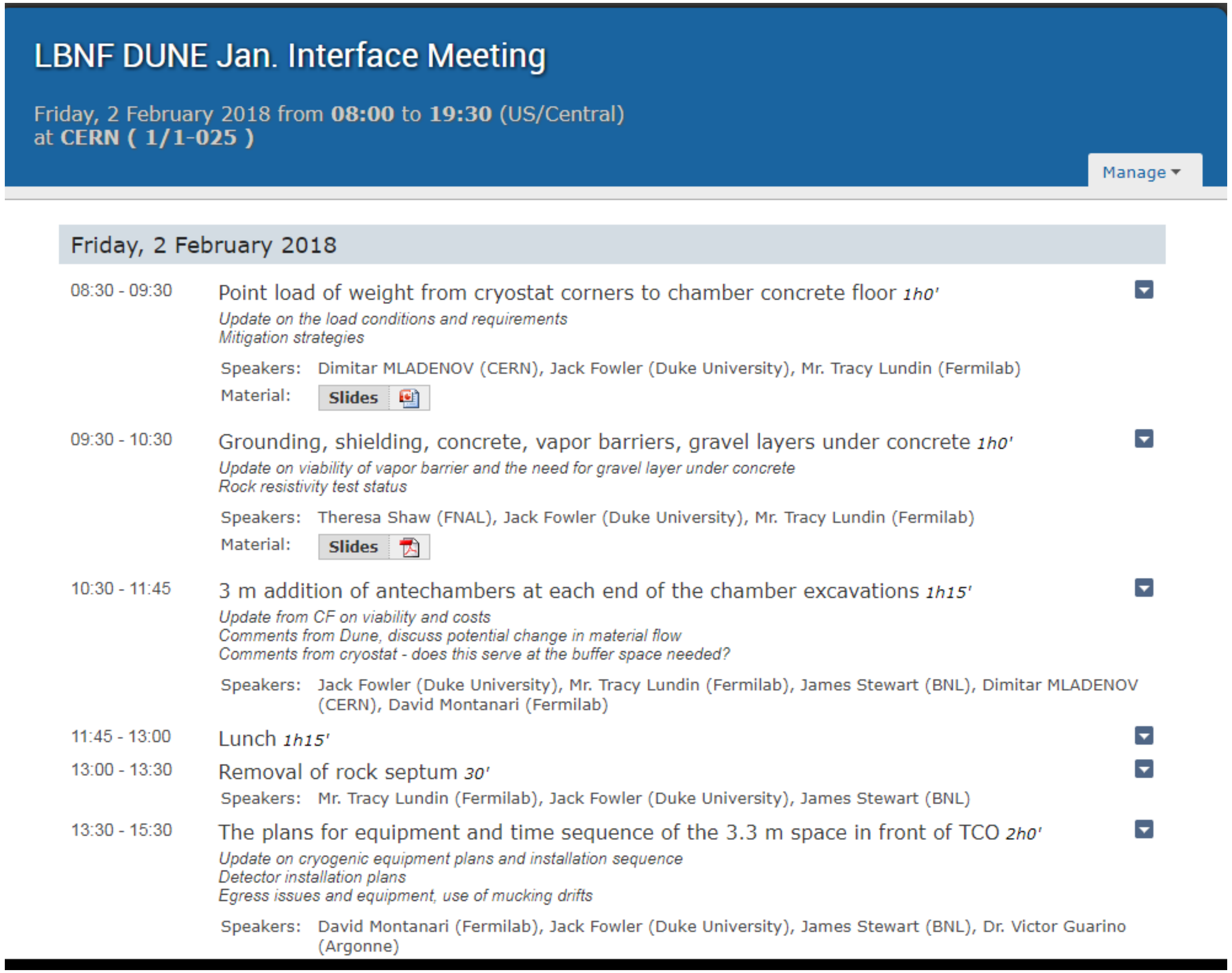
- In Dec ‘17, we finalized the layout of the SP and DP feed thrus for submission to GTT to begin their design study for the membrane design.  5 sides of the cryostat will be identical, however there will be two different roof layout/designs.
- We expect to get feedback from GTT in the spring on the design with any small adjustments in the feed thru locations.  There may be a small iteration process to finalized the layout and move the design forward.
- Cryostat requirements and other technical documents are located
  - https://edms.cern.ch/document/1834010/1

# LBNF/DUNE interface meetings

- Multiple times a year, we have cross project interface working meetings. In 2017, we had meetings at FNAL in May, Dec, at SURF in Aug and at CERN in June. We had meetings in 2018 in Feb at CERN and are having another meeting this Wed. These meetings include CERN Neutrino platform, Cryostat design, Cryogenic design, Conventional Facilities, DUNE integration/installation and LBNF/DUNE management.
- These meetings have been very beneficial to working out specific interfaces, resolving design issues, incorporate lessons from the ProtoDUNE experience and the expertise of the Neutrino Platform.

# Interface meeting agenda

- Links to agendas can be found at
  - https://indico.fnal.gov/category/730/



## LBNF DUNE Jan. Interface Meeting

Friday, 2 February 2018 from **08:00** to **19:30** (US/Central)
at **CERN ( 1/1-025 )**

Manage

**Friday, 2 February 2018**

08:30 - 09:30 Point load of weight from cryostat corners to chamber concrete floor *1h0'*

*Update on the load conditions and requirements*
*Mitigation strategies*

Speakers: Dimitar MLADENOV (CERN), Jack Fowler (Duke University), Mr. Tracy Lundin (Fermilab)
Material: **Slides**

09:30 - 10:30 Grounding, shielding, concrete, vapor barriers, gravel layers under concrete *1h0'*

*Update on viability of vapor barrier and the need for gravel layer under concrete*
*Rock resistivity test status*

Speakers: Theresa Shaw (FNAL), Jack Fowler (Duke University), Mr. Tracy Lundin (Fermilab)
Material: **Slides**

10:30 - 11:45 3 m addition of antechambers at each end of the chamber excavations *1h15'*

*Update from CF on viability and costs*
*Comments from Dune, discuss potential change in material flow*
*Comments from cryostat - does this serve at the buffer space needed?*

Speakers: Jack Fowler (Duke University), Mr. Tracy Lundin (Fermilab), James Stewart (BNL), Dimitar MLADENOV (CERN), David Montanari (Fermilab)

11:45 - 13:00 Lunch *1h15'*

13:00 - 13:30 Removal of rock septum *30'*

Speakers: Mr. Tracy Lundin (Fermilab), Jack Fowler (Duke University), James Stewart (BNL)

13:30 - 15:30 The plans for equipment and time sequence of the 3.3 m space in front of TCO *2h0'*

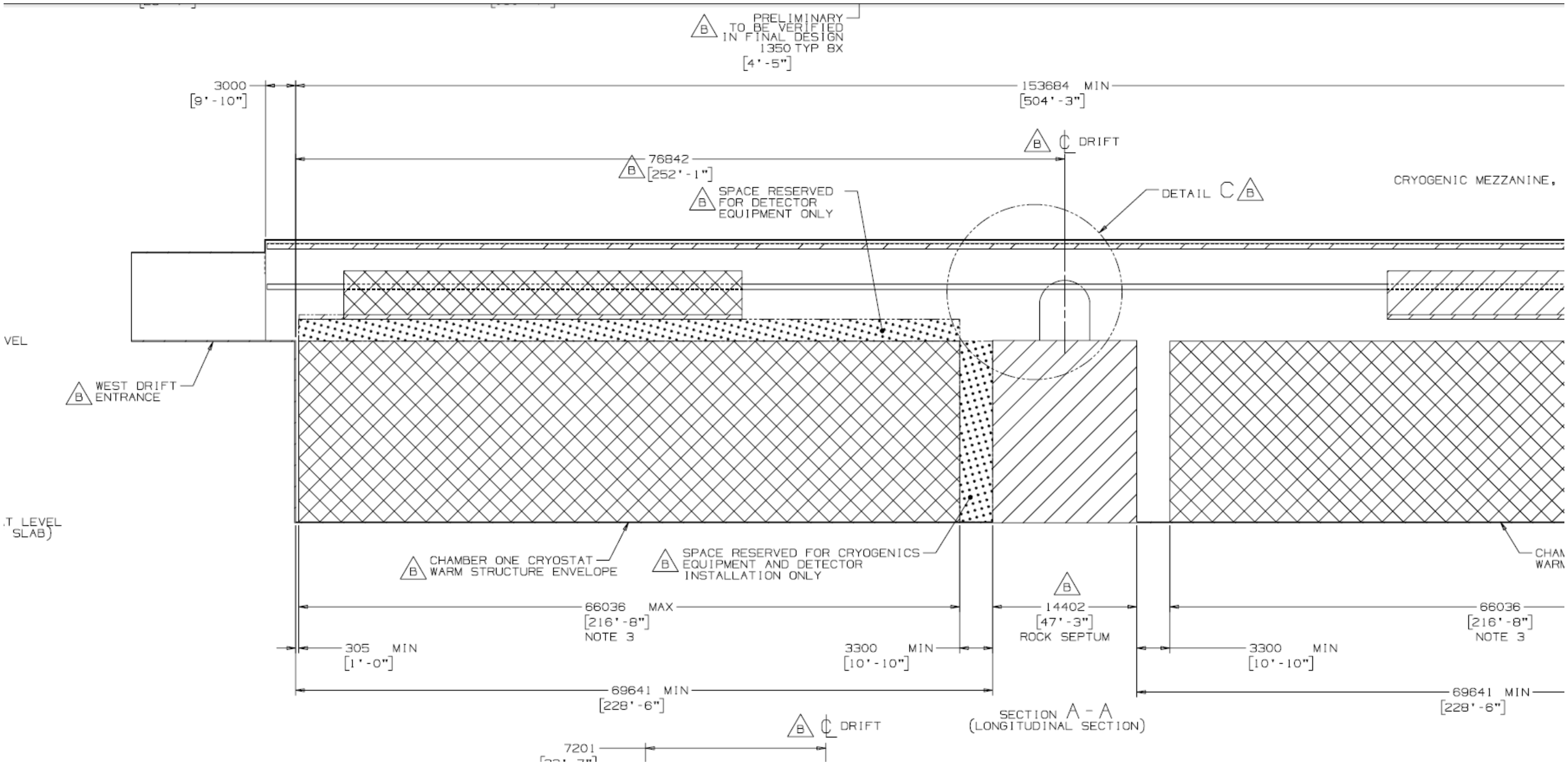
*Update on cryogenic equipment plans and installation sequence*
*Detector installation plans*
*Egress issues and equipment, use of mucking drifts*

Speakers: David Montanari (Fermilab), Jack Fowler (Duke University), James Stewart (BNL), Dr. Victor Guarino (Argonne)

# Proposed changes from the Feb 2018 meeting

- Addition of a 3 m antechamber at each end of the chamber excavations to aid in crane design and material handling.
- Adding the requirement for a full gantry crane for the warm structure installation.
  - This will be revisited when the cost estimates are generated.
- Revisiting the size and the configuration of the rock septum between the two cryostats.
- Addition of electrical equipment onto the mezzanine.

# Cryostat envelope drawing for discussion



# Future steps

- Evaluate the use of docdb as the configuration management tool for LBNF/DUNE. Other PLM software packages are being evaluated. These all need to be easily accessible to collaborators, effectively maintain change control and be flexible to work across LBNF/DUNE and the consortia.
- Develop a Systems Engineering Management Plan. A very early draft is on docdb.
- Develop the list of configuration items.