

# Coldbox Scope and Design

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PRR: FD-HD Coldbox

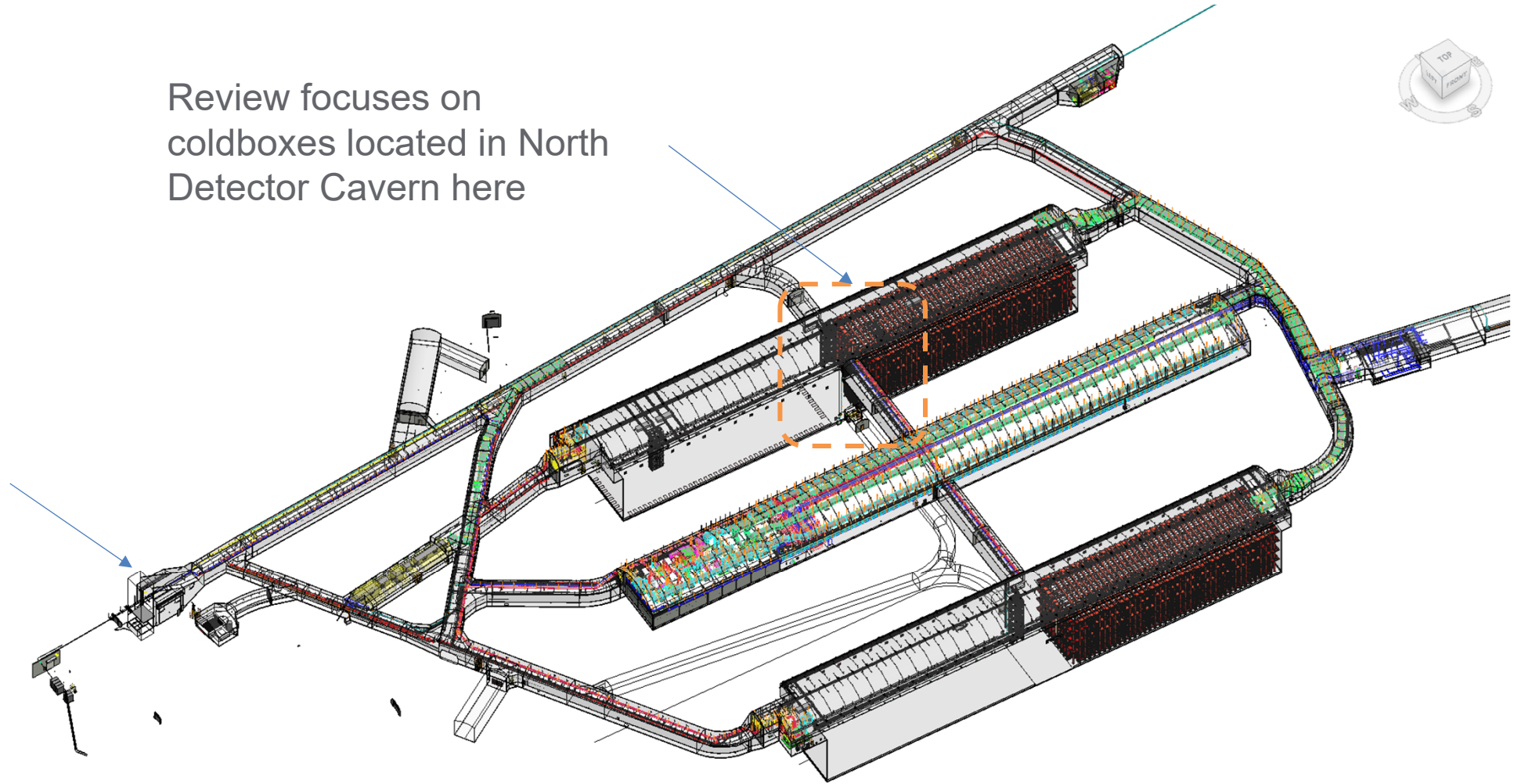
28 Oct. 2024

# Underground Key Plan

REVIEWING COLDBOX STEEL STRUCTURES ONLY. ADDITIONAL CONTEXT HAS BEEN INCLUDED FOR REFERENCE IN SLIDES

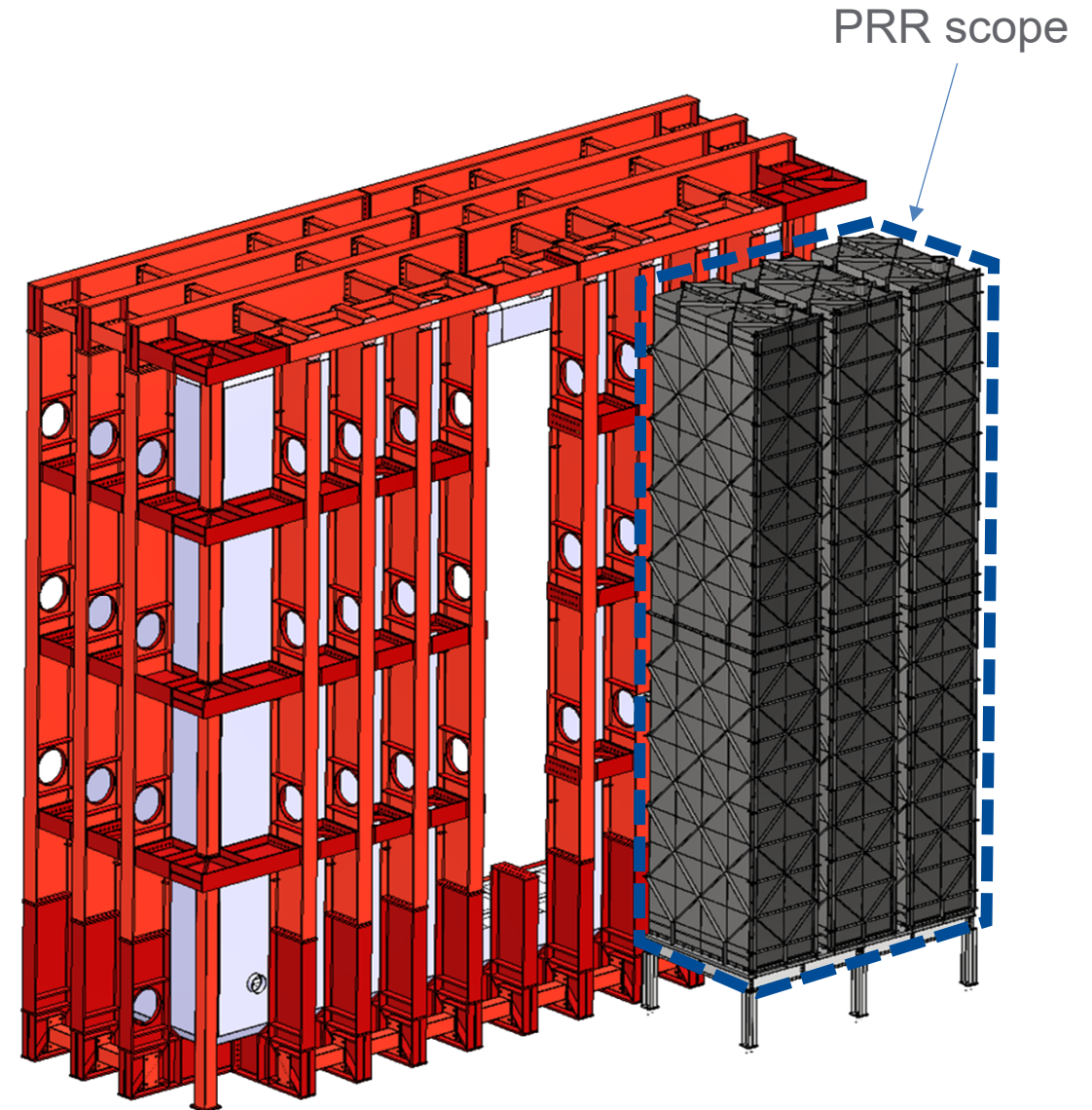
Review focuses on coldboxes located in North Detector Cavern here

Ross Shaft



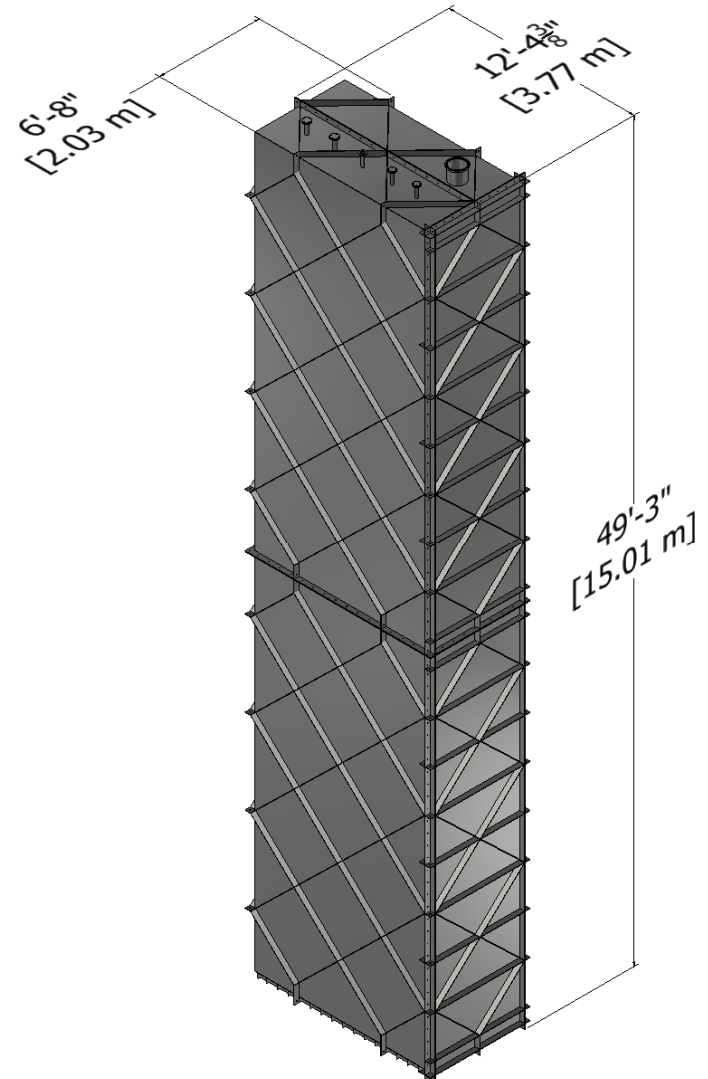
## Overall Design

- The coldboxes are used to cold cycle the HD APA's prior to entry into the cryostat final position
- Use vaporized cold GN2 to cooldown to ~90K and are tested for 24 hours
- Total (3) coldboxes located within the iso-8 cleanroom underground adjacent to the cryostat TCO (temporary construction opening)
- Constructed of 304 SS welded plates with internal and external welded ribs for strength and stability
  - Coldboxes are prefabricated offsite in subassemblies to transfer underground, where final overall assembly will be done
- Polyiso insulation layers line interior of coldbox
- Cryogenic pipe flanges/feedthroughs located on top of coldboxes
- Coldboxes sit on a structural platform



## Overview

- Internal dimensions: 108" [2.74m] depth x 40" [1.01m] width x 551" [14.0m] height
  - Driven by space required for APA, electronics patch panel, and cryogenic piping
- Overall dimensions: 12'-4 3/8" [3.77m] depth x 6'-8" [2.03m] width x 49'-3" [15.01m] height
  - Driven by internal dimensions required + insulation thickness
- Design temperature: 90K [-0K/+60K]
- Design pressure: 1.305psi [90mbarg]
- Qty (3) coldboxes required
- Structure mass (w/o insulation): 19T each



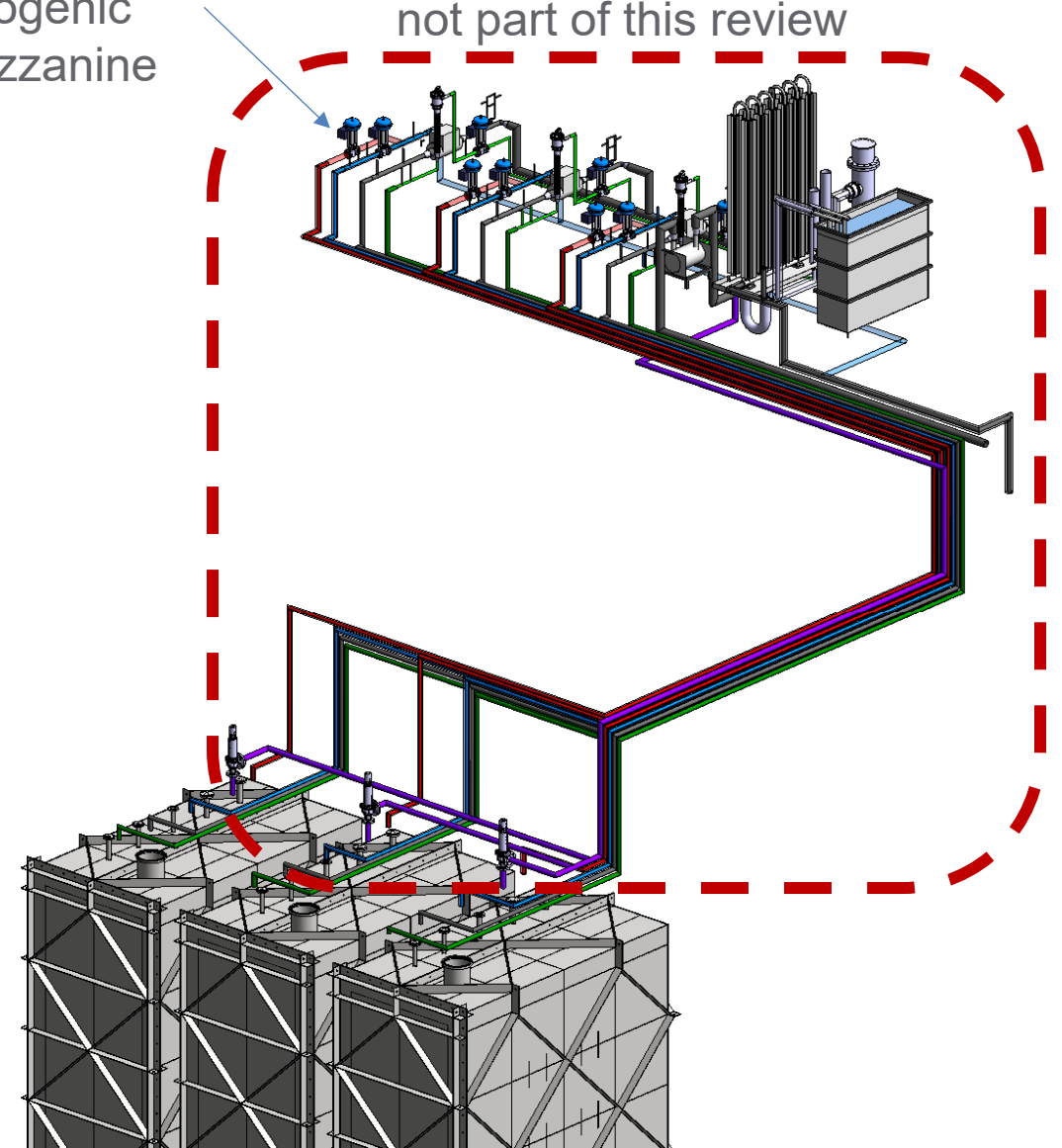


## Cryogenic Interfaces and Scope

- Cryogenics interfaces located at roof feedthrough flanges, shown here for context
- Coldbox steel structure scope includes:
  - Pipe penetrations and flange welded to coldbox roof
- Cryogenics responsibility: all upstream/downstream components and connections design

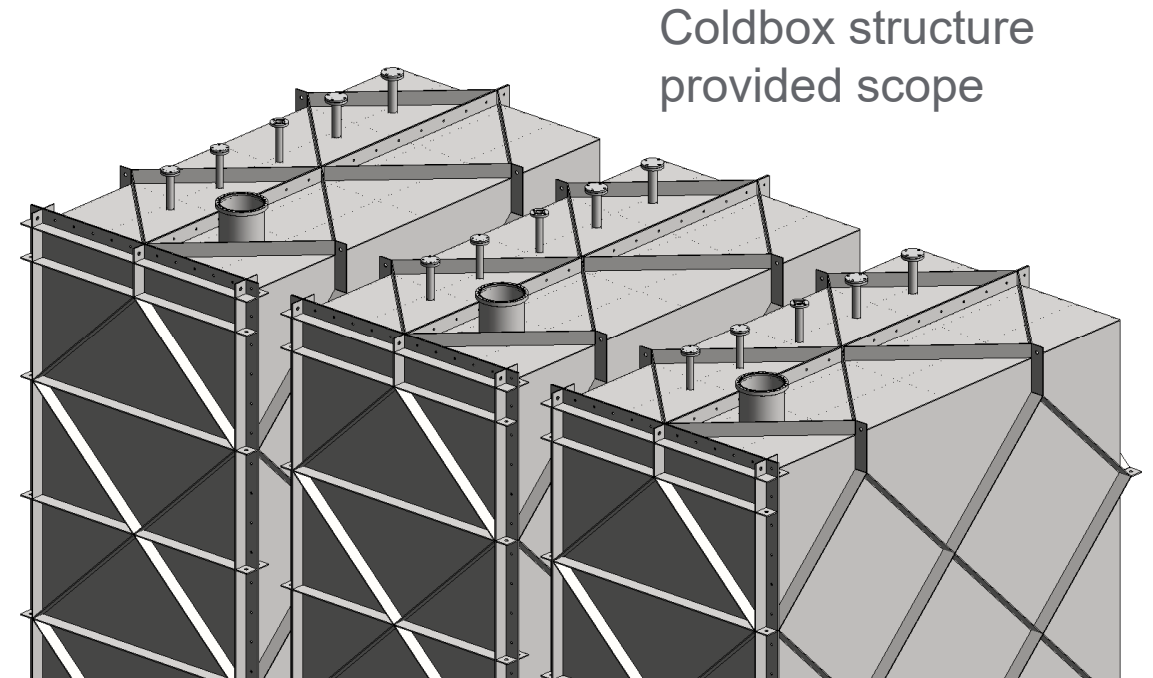
Located on  
cryogenic  
mezzanine

Cryogenics scope,  
not part of this review



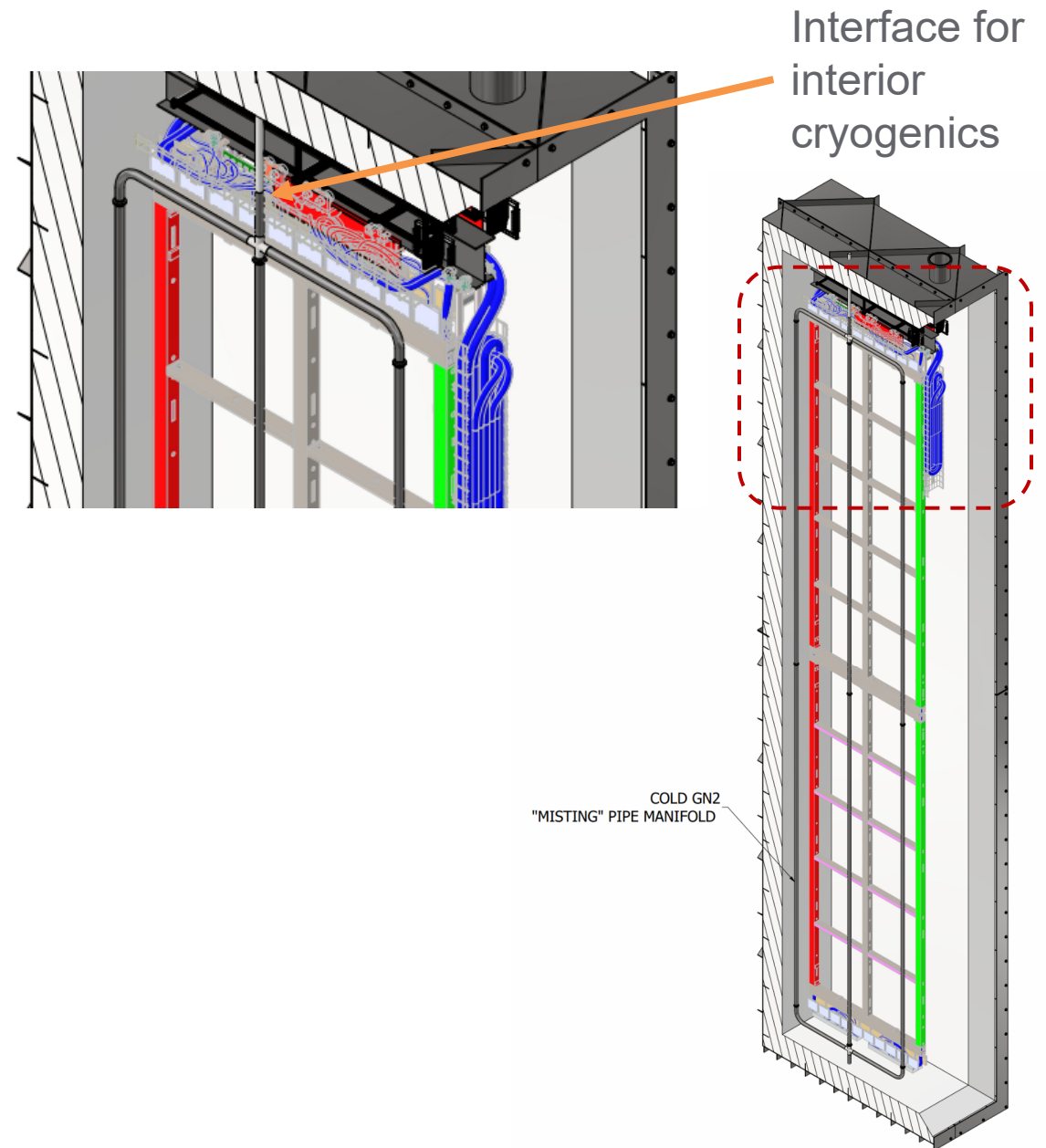
## Coldbox Roof Interfaces and Scope

- Cryogenic design team has defined interfaces to the coldbox structure
- The pipe penetration/flange specifications and locations are agreed upon with cryogenics design team



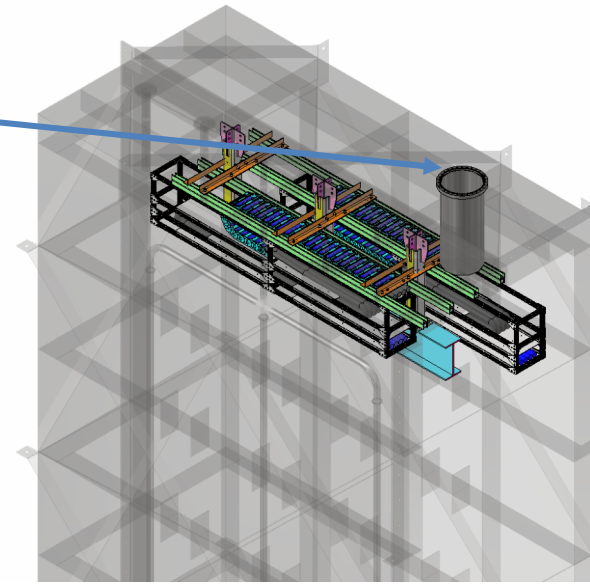
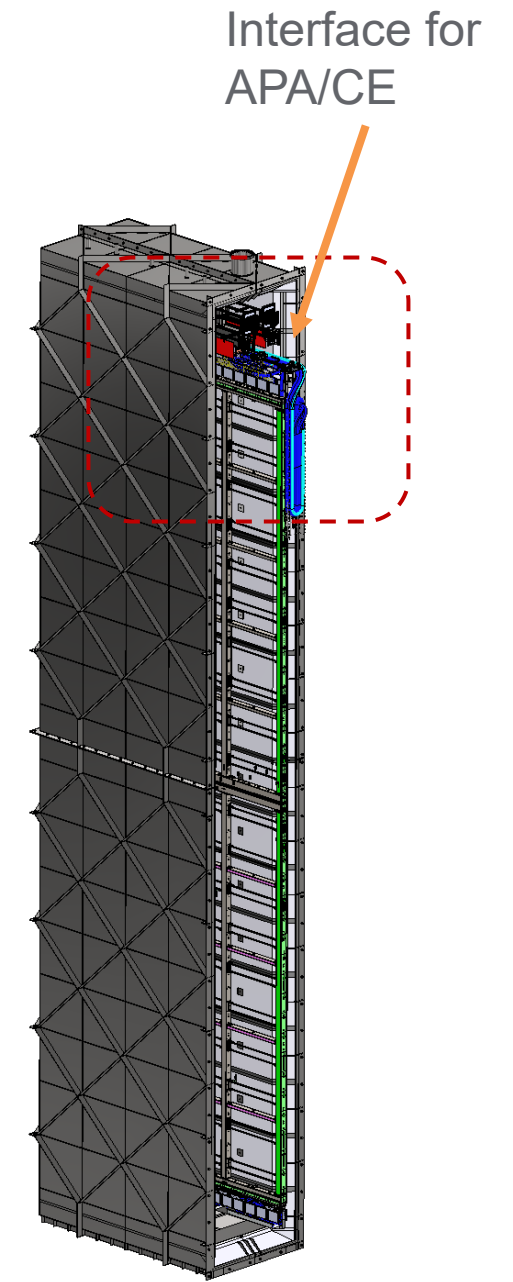
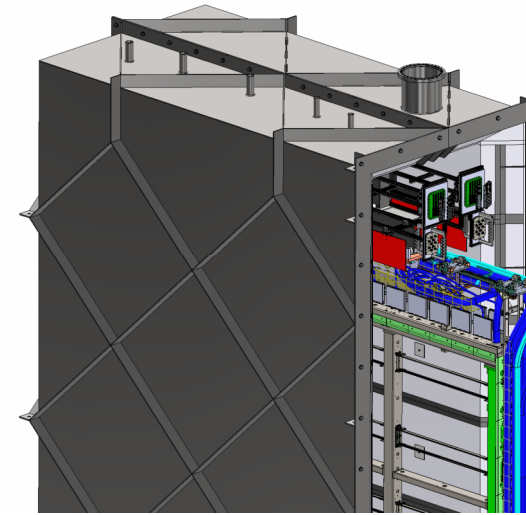
## Cryogenic Interfaces and Scope

- Cryogenics internal interfaces located at pipe penetration, KF flange
- Coldbox scope includes:
  - Pipe penetrations and flange welded to coldbox roof
- This slide shown for additional context



## APA & CE Interfaces and Scope

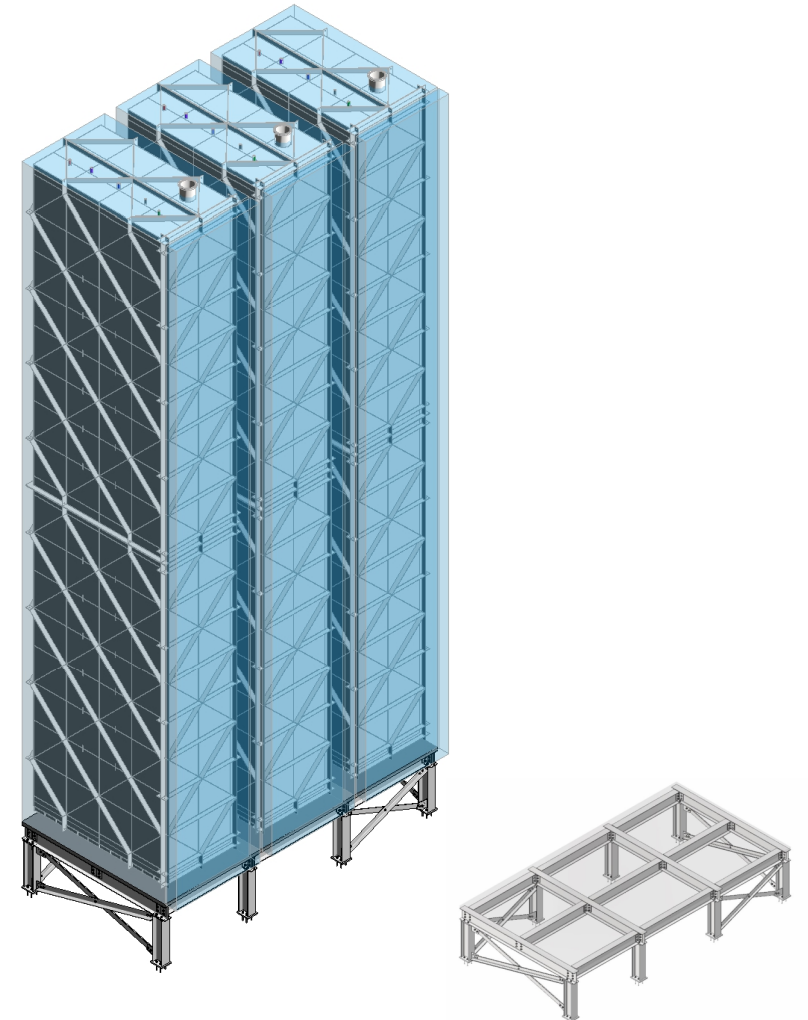
- APA rolls on the monorail via trolley
  - APA mass 3133lbm
- CE electronics patch panel/supports bolt to monorail support rail stub columns
- Penetration for detector electronics defined by electronics consortia and location agreed upon





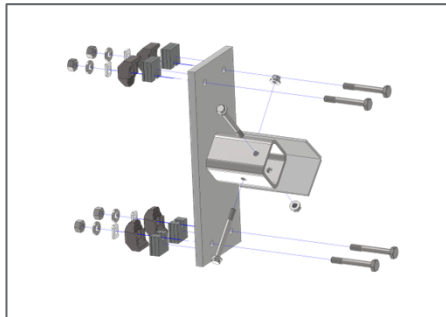
## Coldbox Platform Interfaces

- Structural platform supports all 3 coldboxes
- Platform structure is not part of the scope of this review.

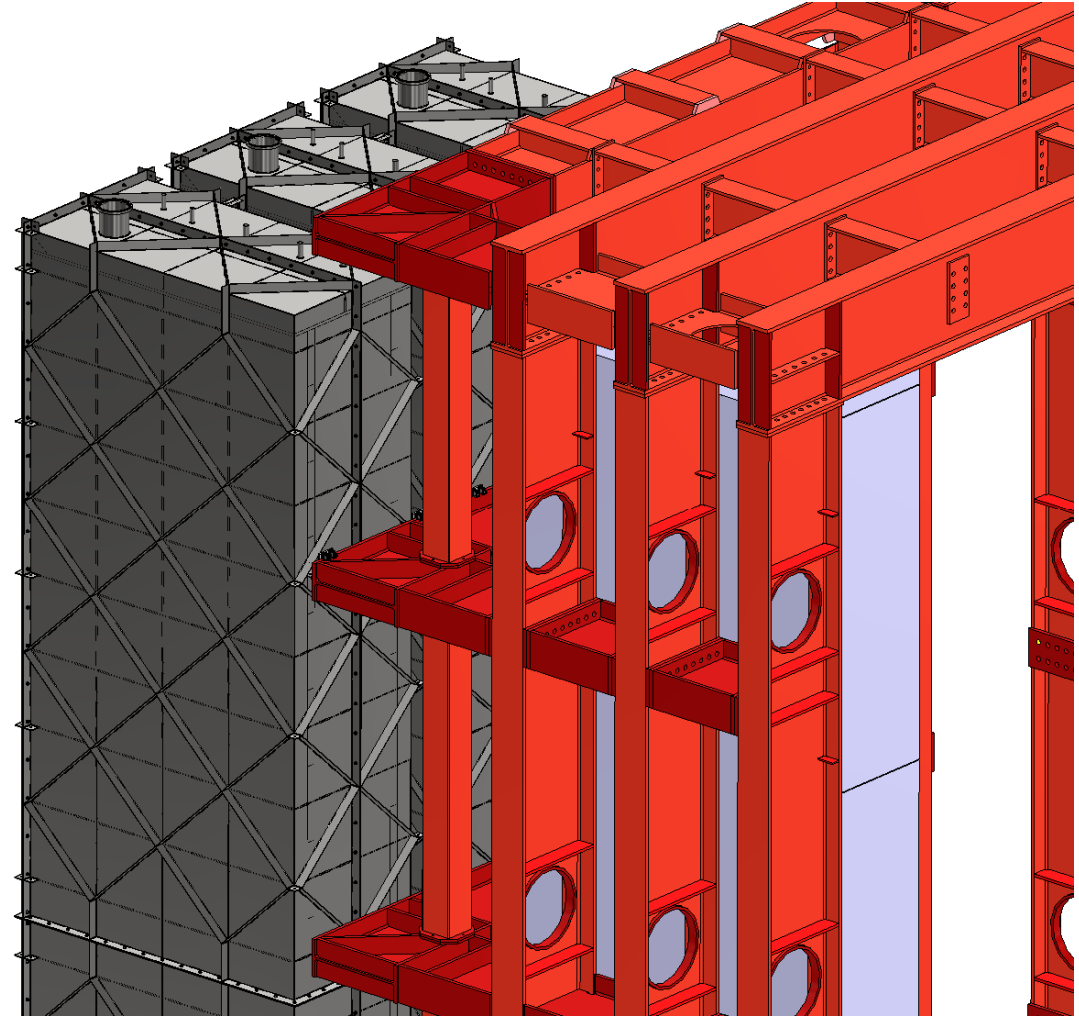
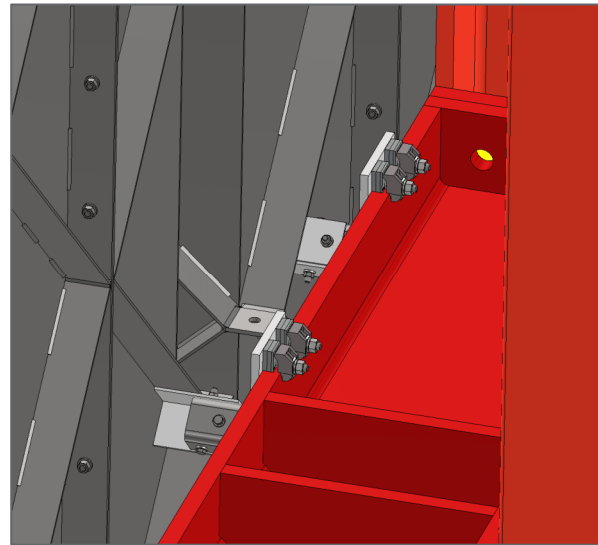


## Coldbox-Cryostat Interface

- Coldboxes laterally braced to cryostat via clamps
- Installed while placing coldboxes on structural platform

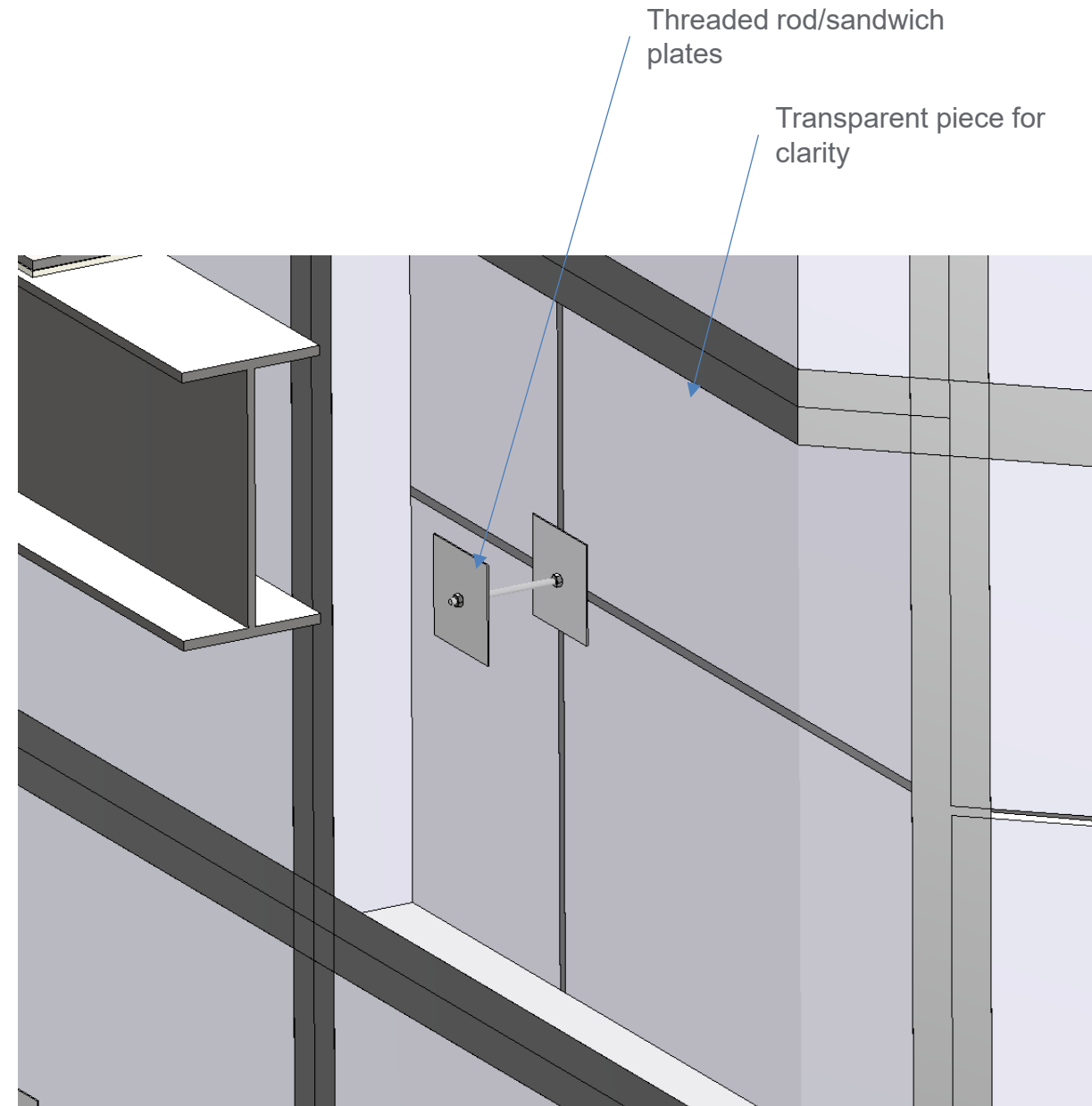


Coldboxes on detector ground



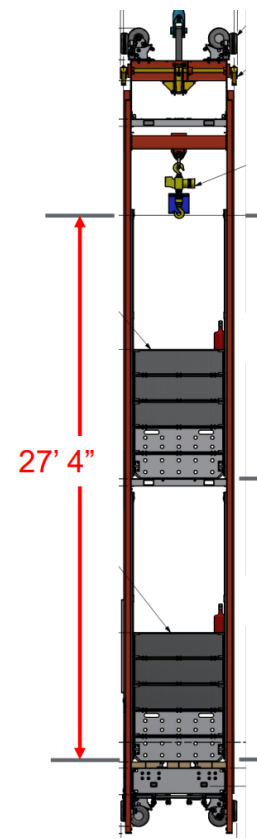
## Coldbox Insulation

- Not part of scope of this review, described for reference.
- Threaded rod epoxied/welded to rib edges provide connection for sandwich plates to hold insulation pieces in place.
- Insulation is 15.75" thick, which is where the internal clear open dimensions are derived from
- Precut squares of insulation, fit within ribs. Staggered secondary layer covers ribs and provide adequate thermal break

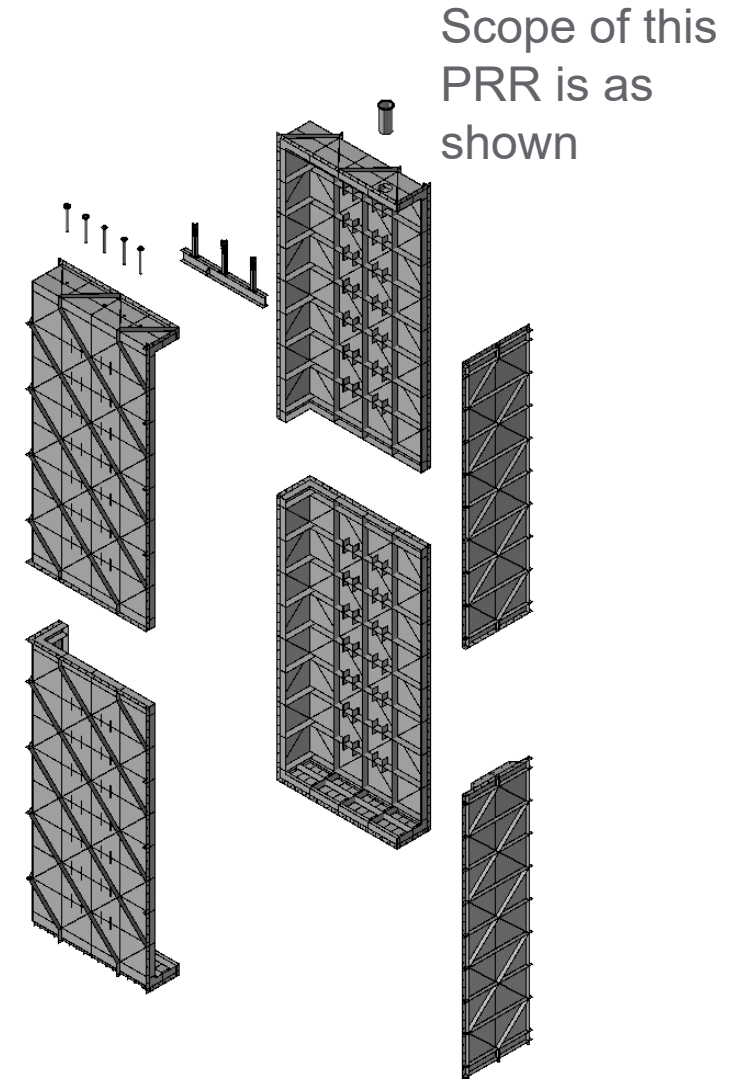


## Coldbox Assemblies

- Coldboxes shall be prefabricated of subassemblies as shown in the exploded view
- Each quadrant/ door designed to fit within the Ross Cage double deck cage, which reduces work required underground. Also does not require slung load.
- Ross cage double deck clearance: 145”  
Depth x 57.25” Width x 328” Height
- Ross cage payload limit: 13500lb



Ross double deck cage



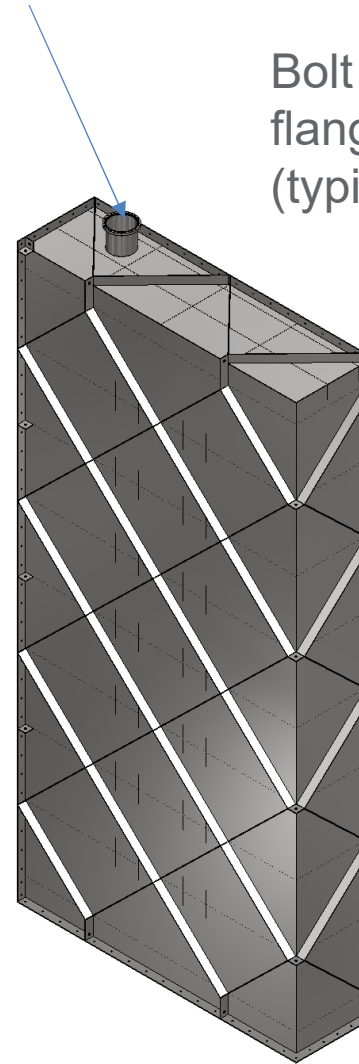


## Coldbox Quadrant-1

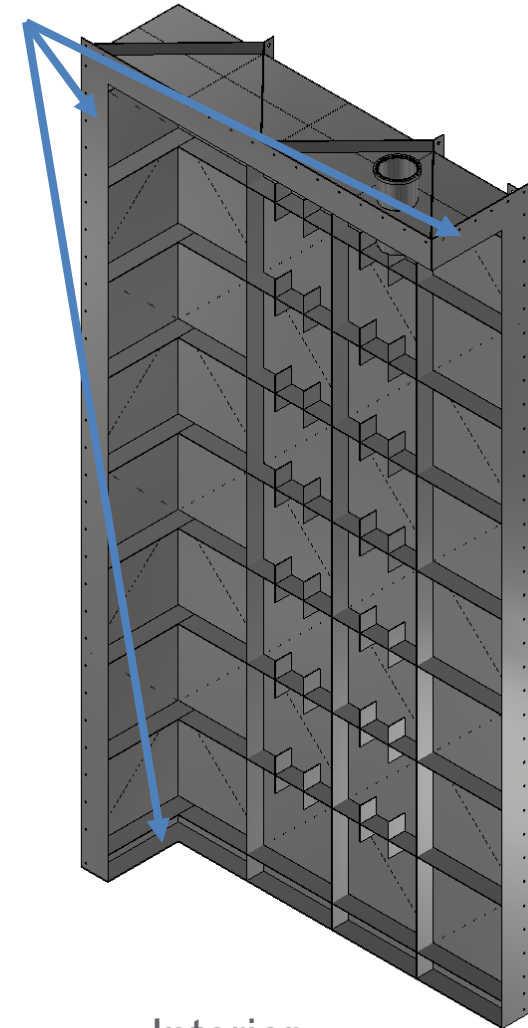
- Coldbox is prefabricated into “quadrants”, with flanges for bolted connection on the exterior of the coldbox shell
- Diagonal ribs welded to exterior of the coldbox shell
- Vertical/horizontal ribs welded to interior of coldbox shell
- Quad-1 mass: 7845lb
- Quadrants are same overall size with some minor feature differences.
  - Quadrant-1 contains the CE penetration and flange
  - Support tabs welded for monorail

CE  
penetration

Bolt  
flanges  
(typical)



Exterior



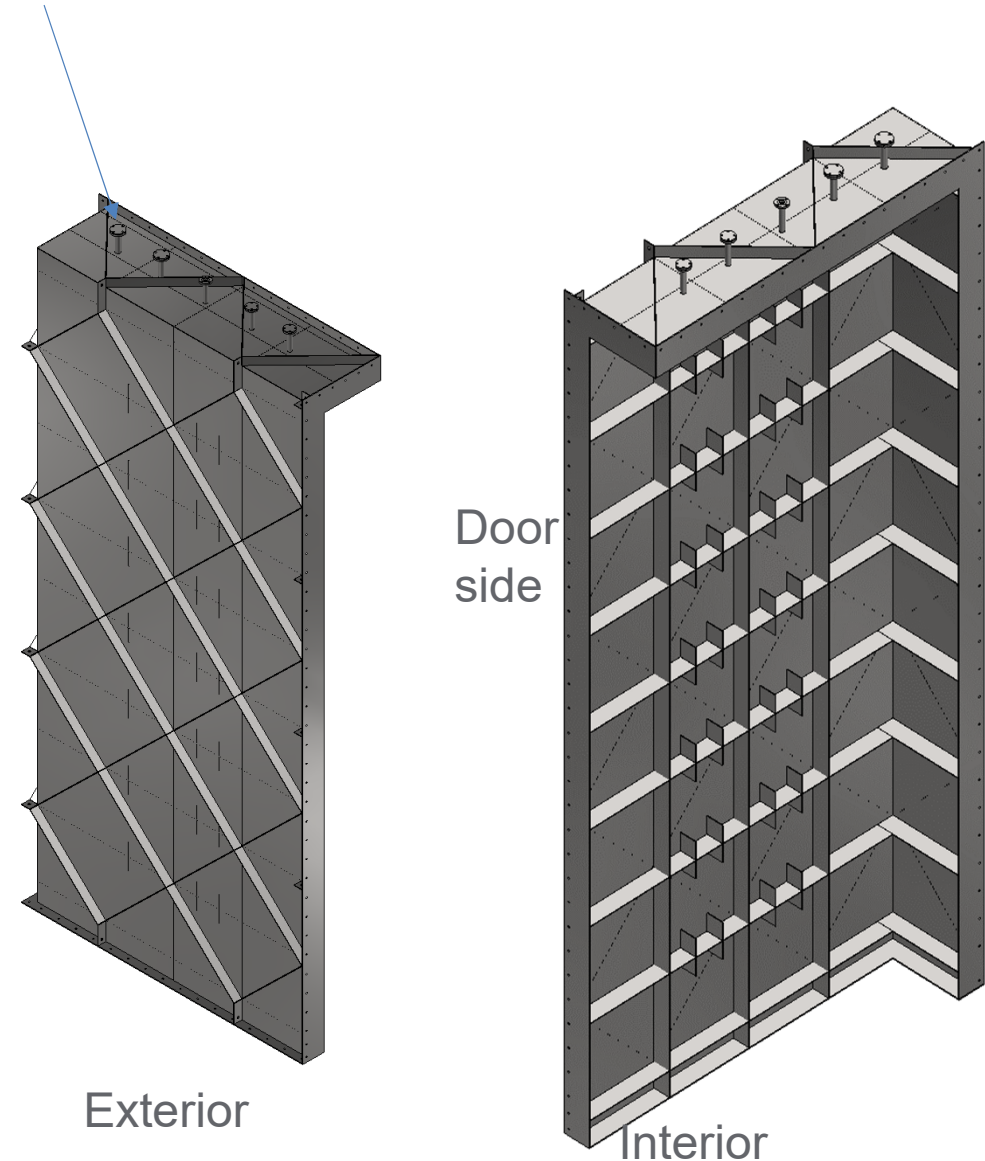
Interior

Door  
side

## Coldbox Quadrant-2

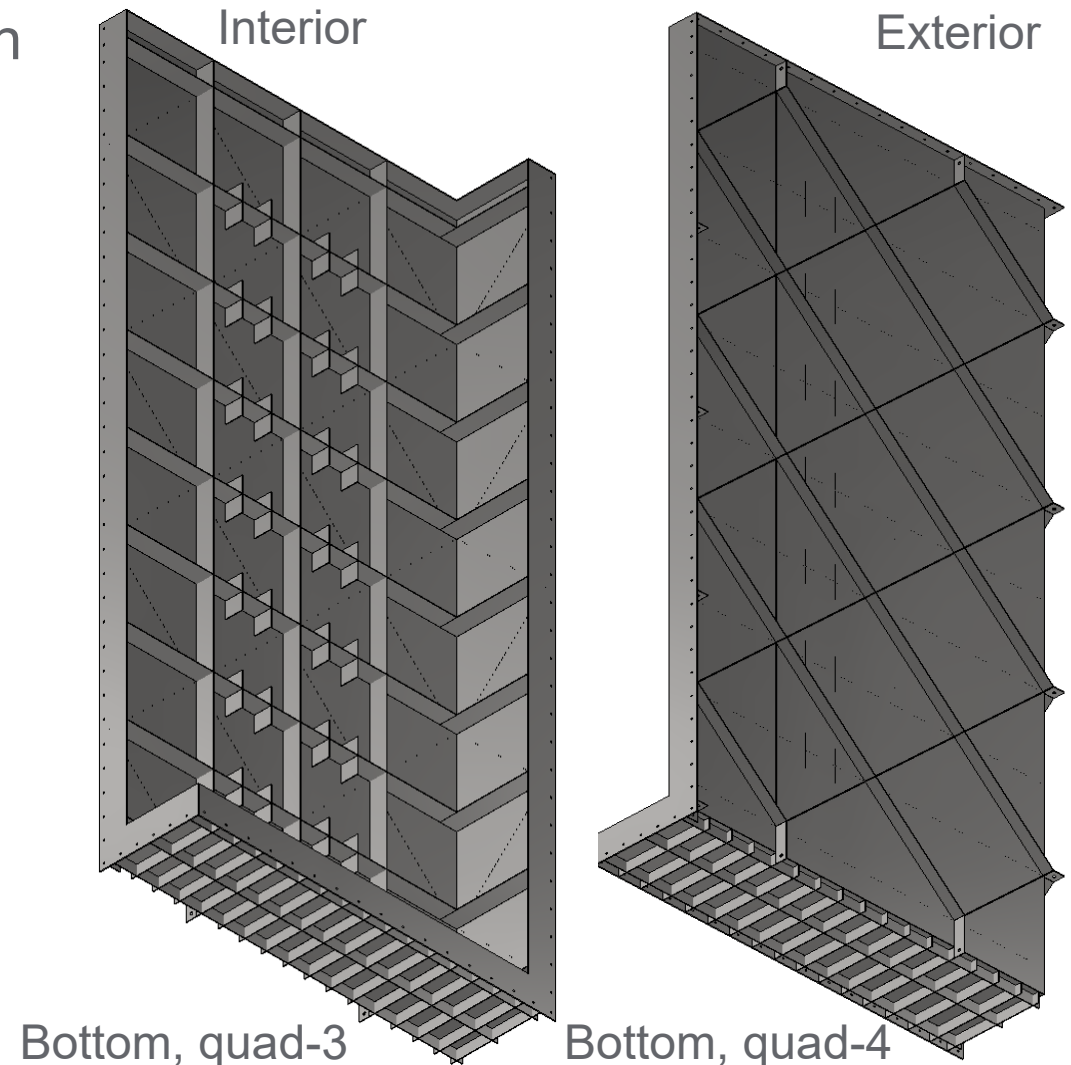
- Quadrant-2 contains the cryogenics penetrations and flanges
- Quad-2 mass: 7852lb

Cryogenic penetrations (5 PL)



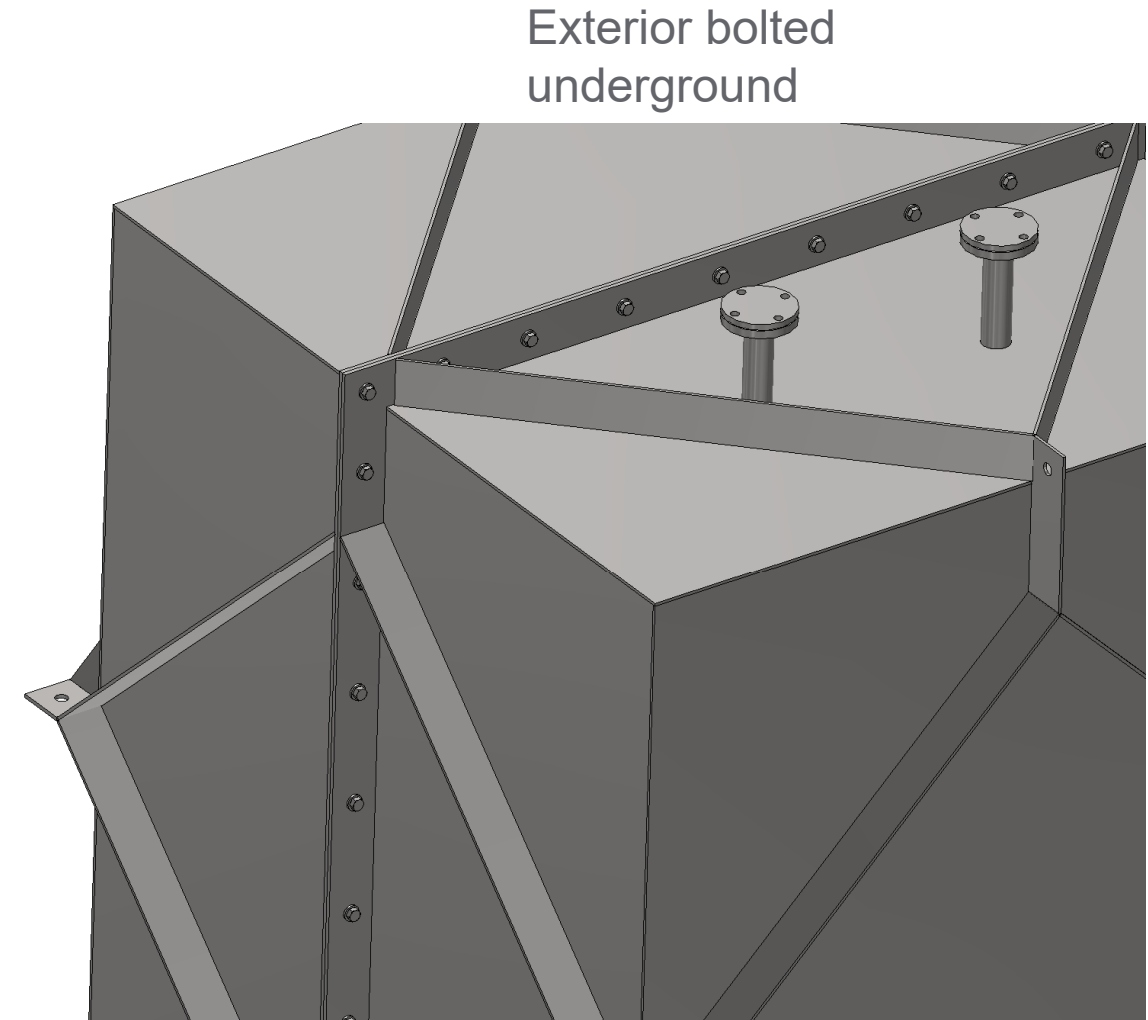
## Coldbox Quadrant-3&4

- Quadrants-3&4 are identical/mirrored, with additional ribs along the bottom for added structural support of the coldbox mass
- Quad-3&4 masses: 8044lbs



## Coldbox Assemblies

- Coldboxes are initially assembled via the bolted exterior connections all around the quadrant bolt connection flanges

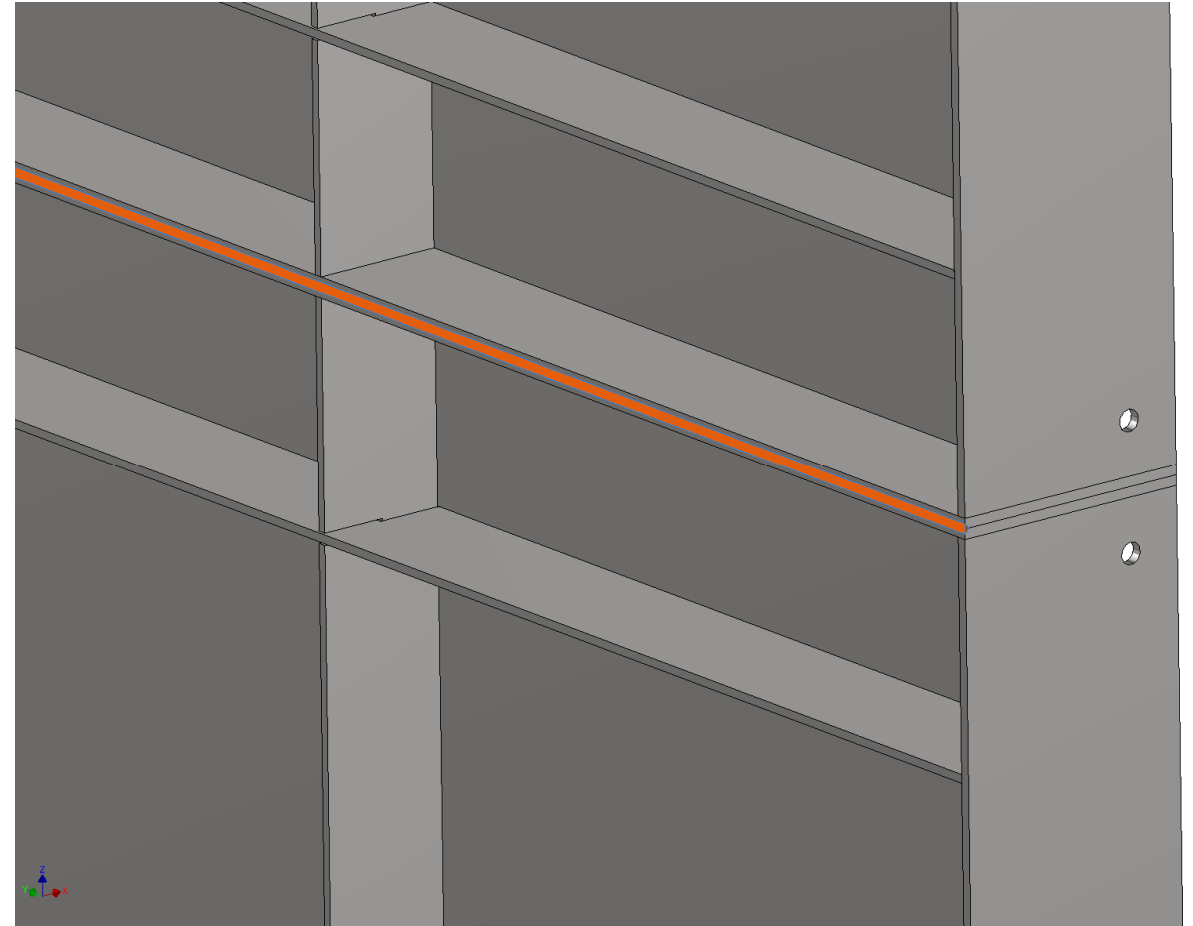




## Coldbox Assemblies

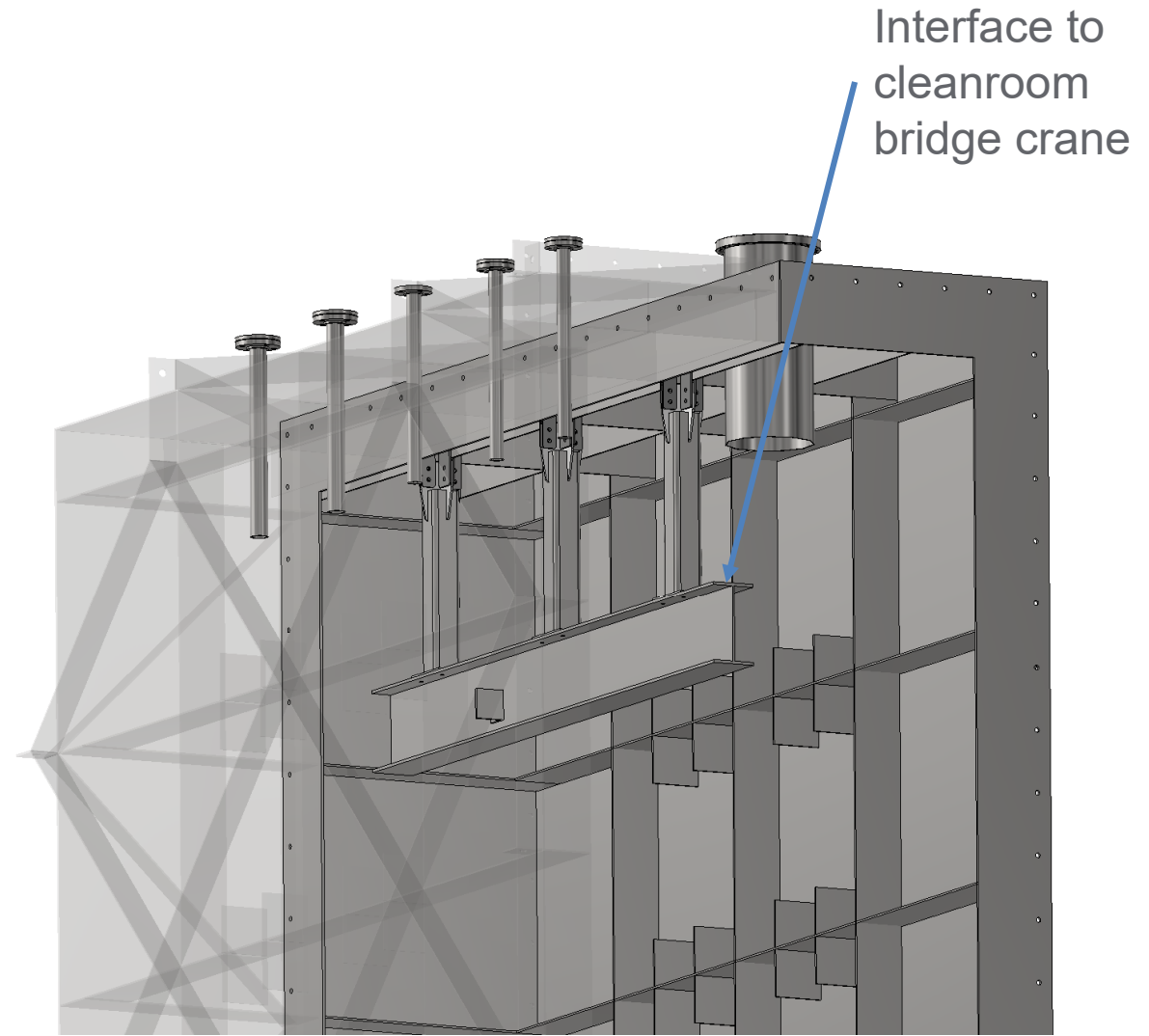
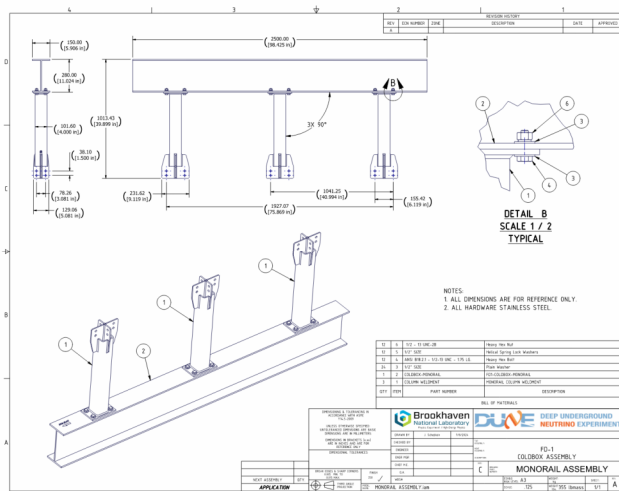
- Coldboxes are welded with a single pass groove weld along the inner seams of all bolted flanges. This forms an air-tight seal. Welds shall be inspected during the assembly process.
- The edges are chamfered from the fabricator as part of the weld preparation

Interior seam welded  
underground



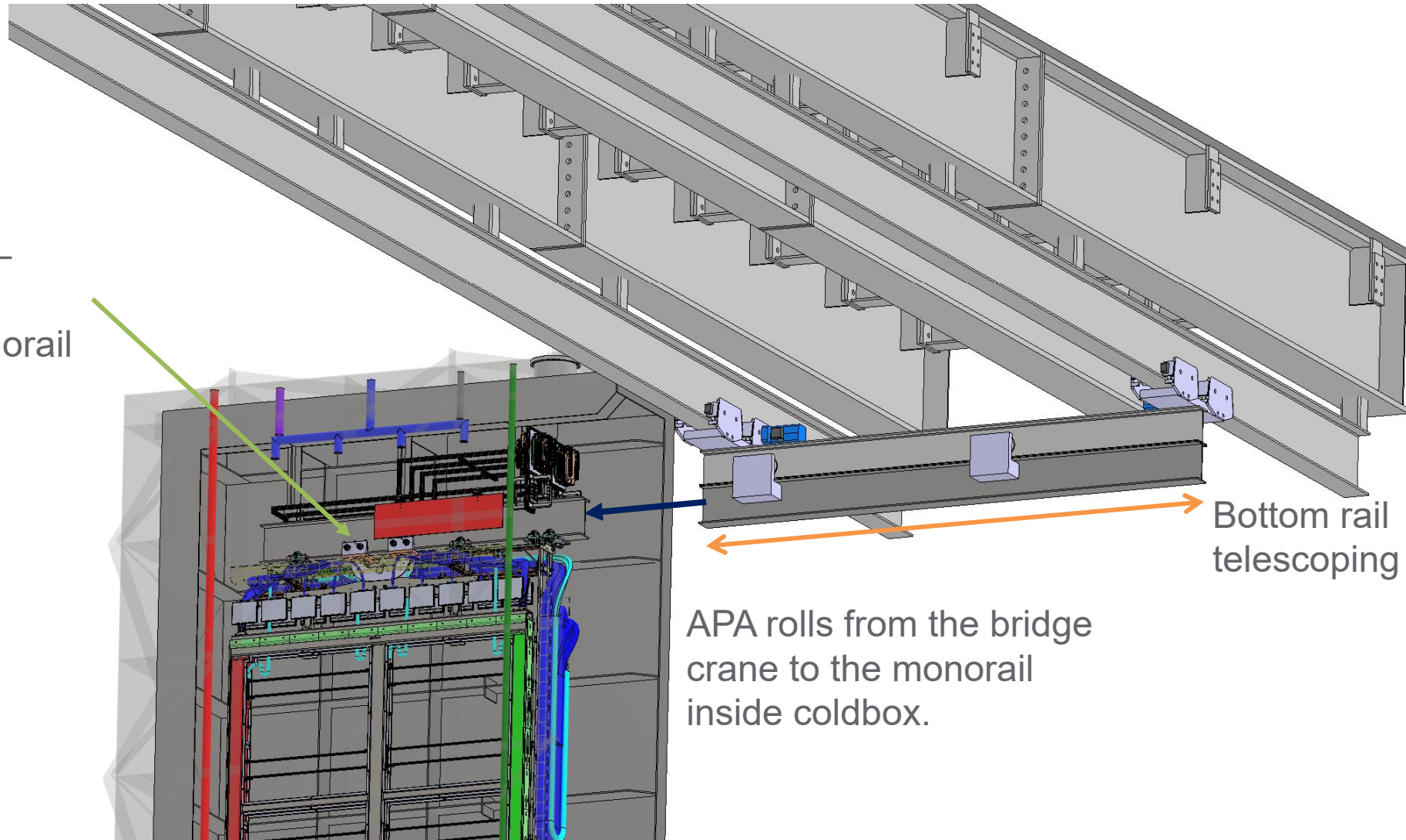
# Coldbox monorail assembly

- Monorail beam within coldbox matches the DSS beam profile (beam inside cryostat)
  - Load tested by fabricator
- APA rolls onto monorail from cleanroom bridge crane
- Tabs are welded to coldbox quadrant 1 with bolted connection to stub columns



# Coldbox monorail assembly

APA Trolley –  
interface to  
coldbox monorail

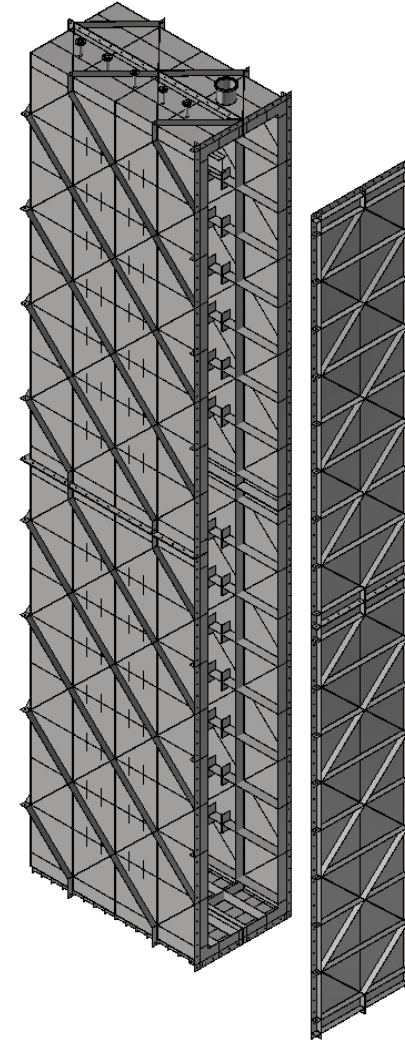
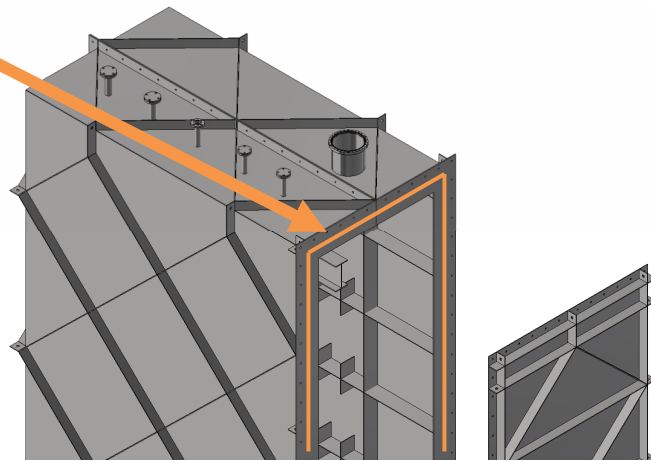


Bottom rail  
telescoping

APA rolls from the bridge  
crane to the monorail  
inside coldbox.

## Coldbox Door Removal

- Full height door is removed via hoist assembly within cleanroom.
- Door is fixed to coldbox via bolts along perimeter
- Gasket material based on CERN experience:
  - 40 mm wide, 1 cm thick. Adhered to stainless steel flange. Polyurethane + gluing DP190





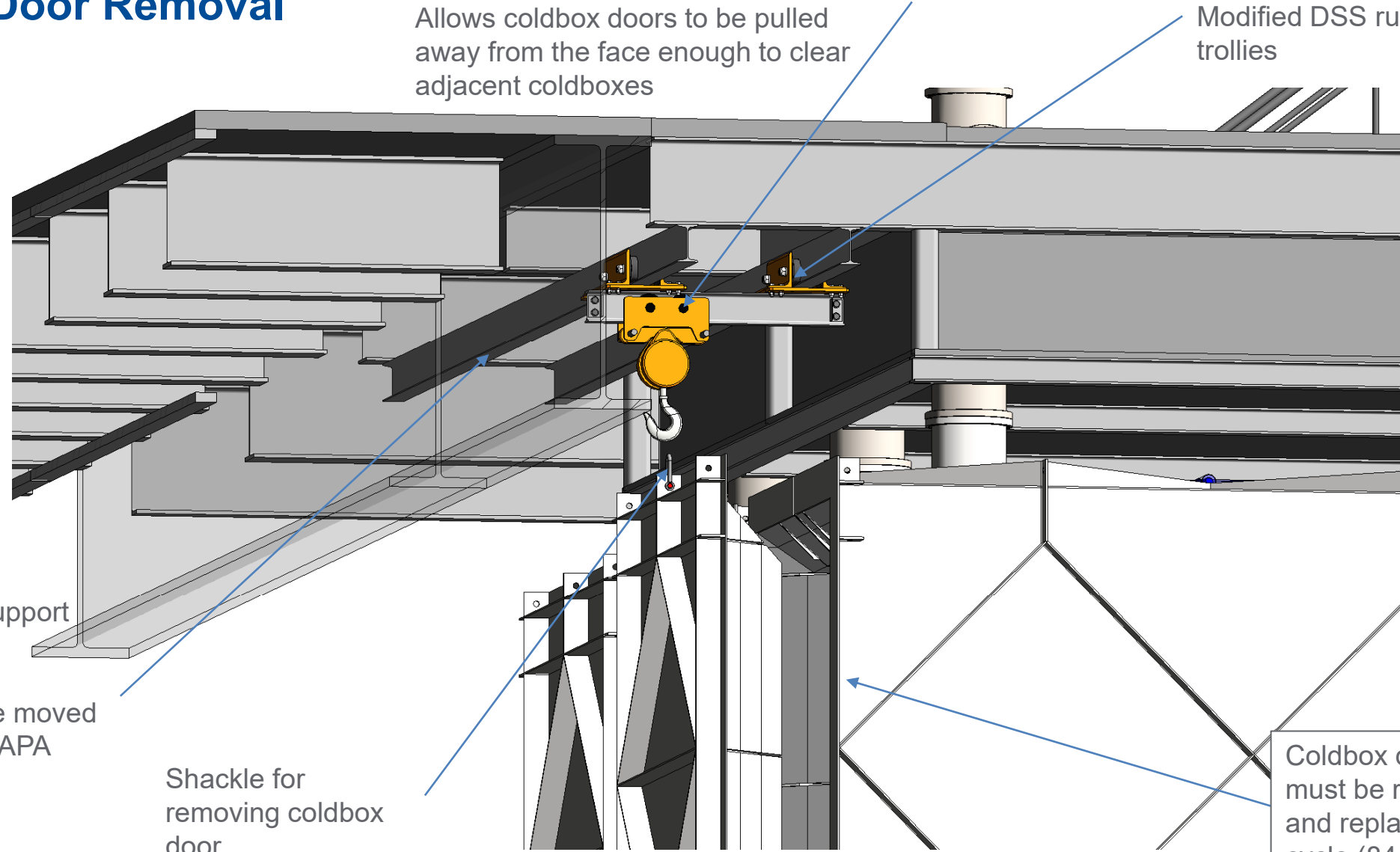
# Coldbox Door Removal

Ultra low headroom 3T hoist w/ trolley  
(10' lift height)

Not part of scope,  
for reference only

Allows coldbox doors to be pulled  
away from the face enough to clear  
adjacent coldboxes

Modified DSS runway  
trolleys



Runway rails to support  
hoist/ trolleys.

Allows doors to be moved  
to the side during APA  
insertion/removal

Shackle for  
removing coldbox  
door

Coldbox door bolts  
must be removed  
and replaced each  
cycle (84 total)

## Summary

- The scope of this PRR is strictly the coldbox stainless steel structure itself
- Many slides outlined the context to provide additional clarification to the reasoning behind certain design choices
- Coldbox is prefabricated offsite in subassemblies and delivered underground for final assembly
- Coldbox supports APA for a cooldown cycle with cold GN2
- (3) Coldboxes total required underground