NEWS-G – 6th Collaboration Meeting

Implementation at SNOLAB

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Queen's University

Grenoble

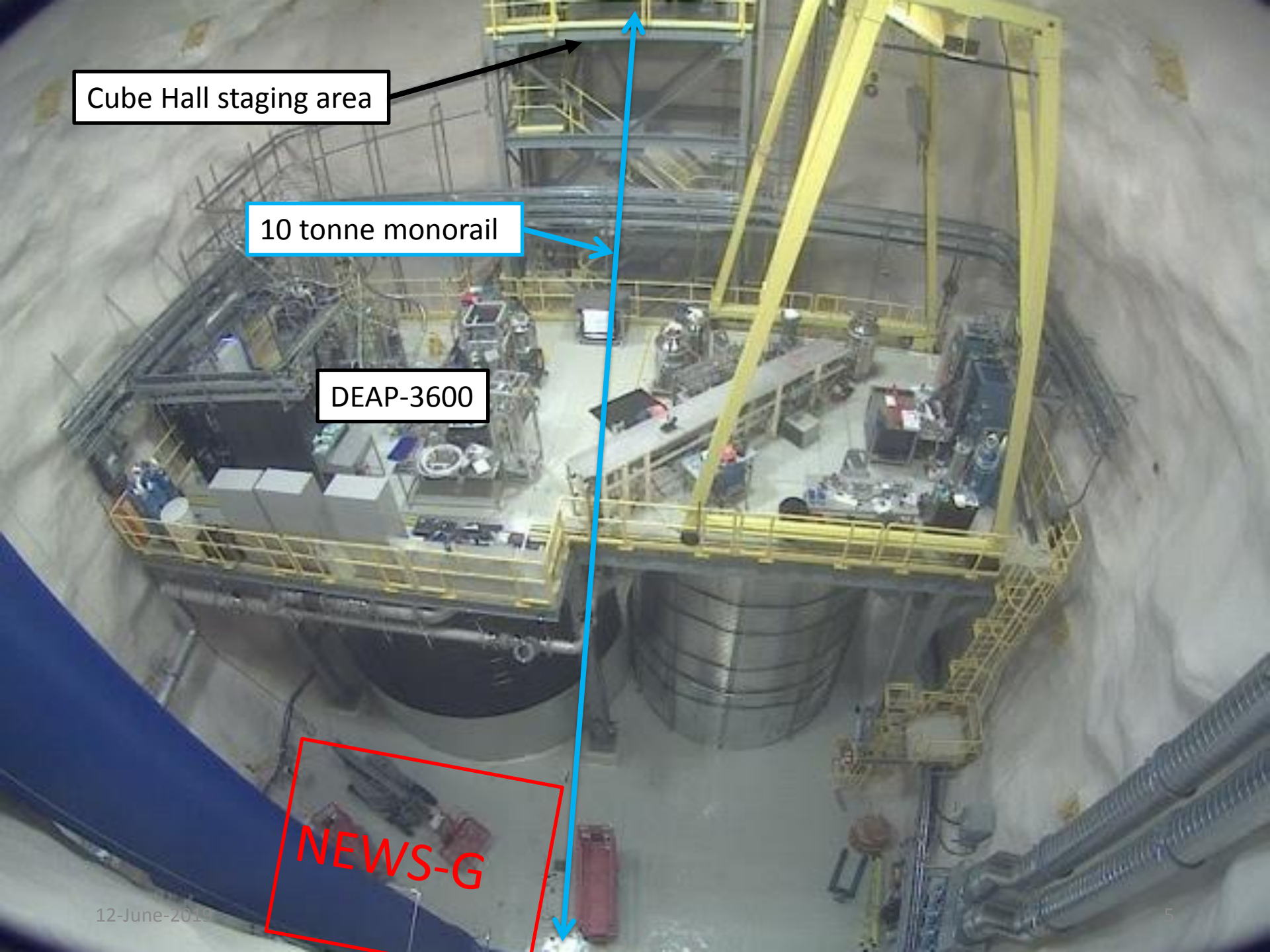
June 12, 2019

Outline – Installation Plan

- Layouts:
  - SNOLAB
  - NEWS-G
- Gantry crane
- GHS and cover gas
- Seismic platform
- PE shield
- Shipping Cu, Pb, PE underground
- Experiment construction sequence
- SNOLAB Lifecycle progress

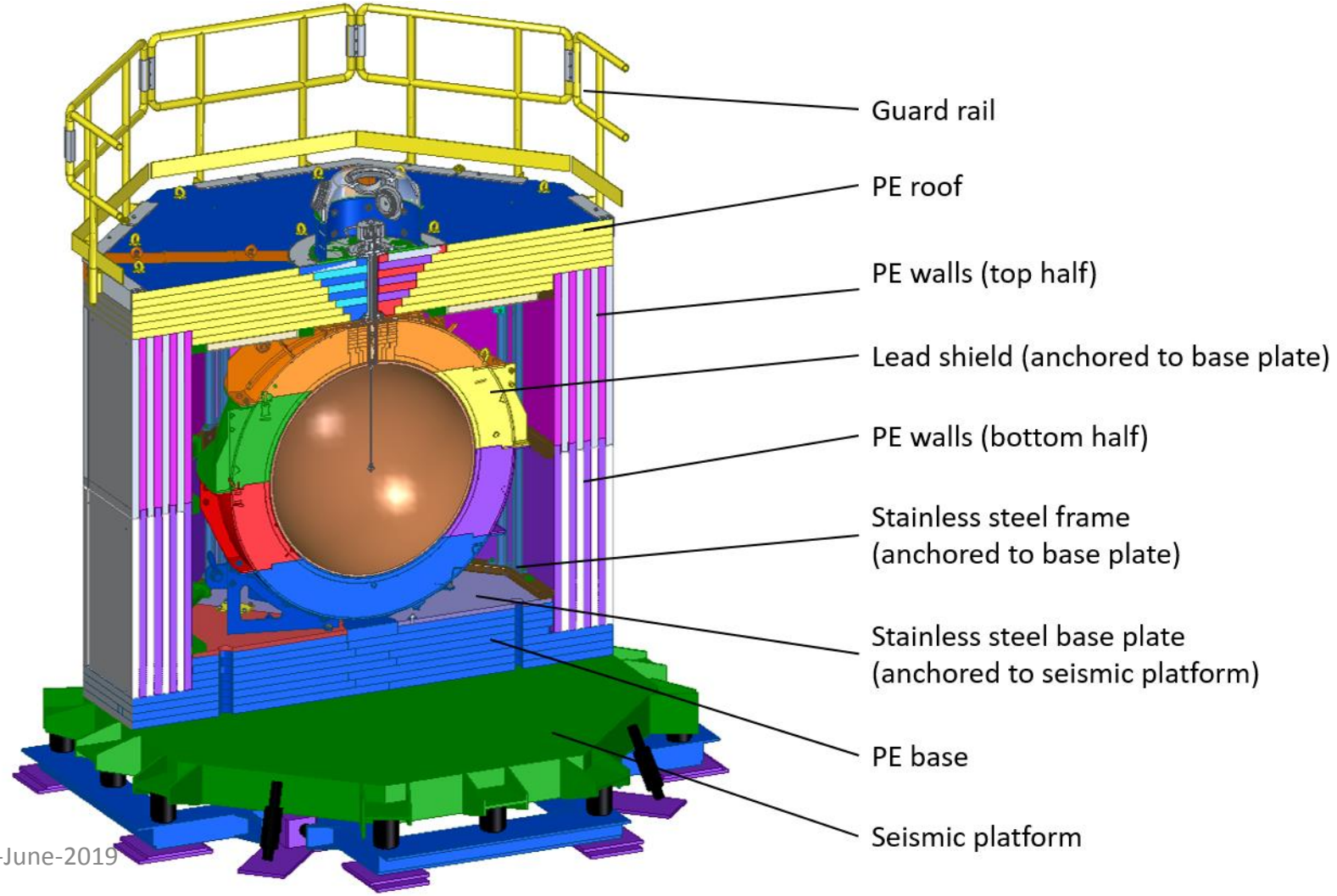

Cube Hall
Cryopit
HALO
Stub
J Drift
Ladder Labs
SNO
Cavern
South
Drift
Personnel
facilities
Utility
Area


10 tonne monorail
Cube Hall staging area

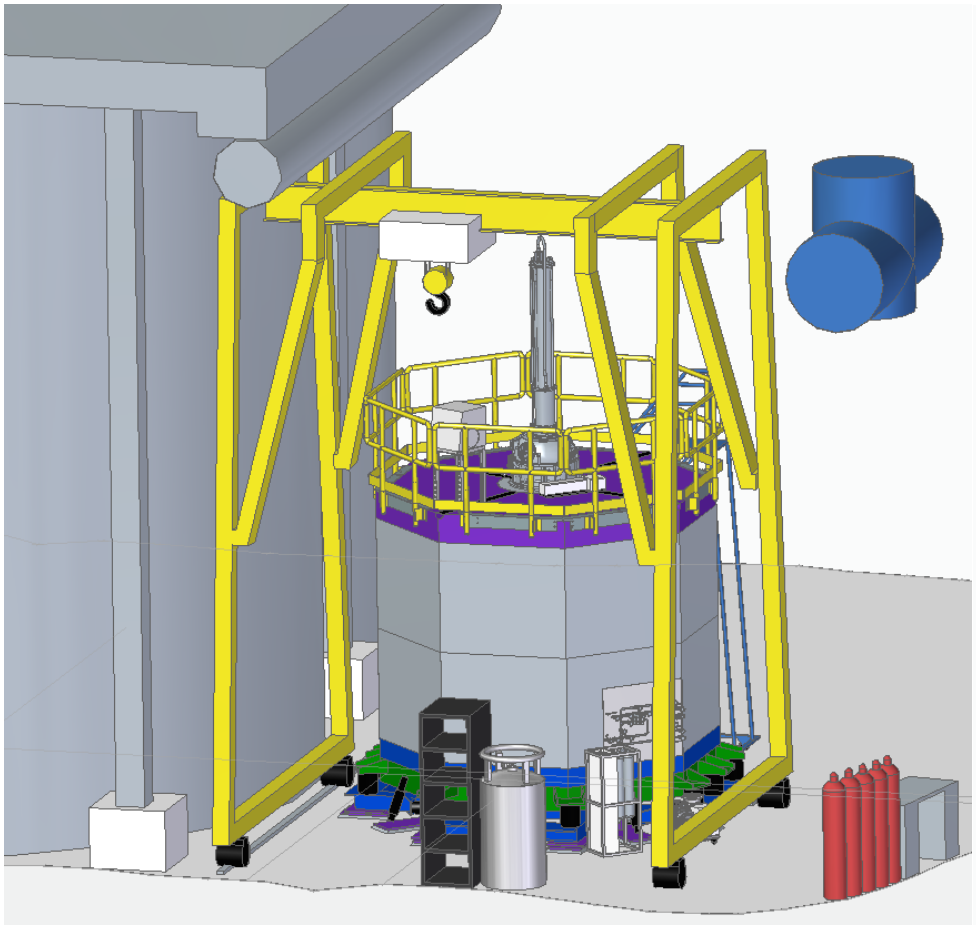

Cube Hall staging area
10 tonne monorail
DEAP-3600
NEWS-G

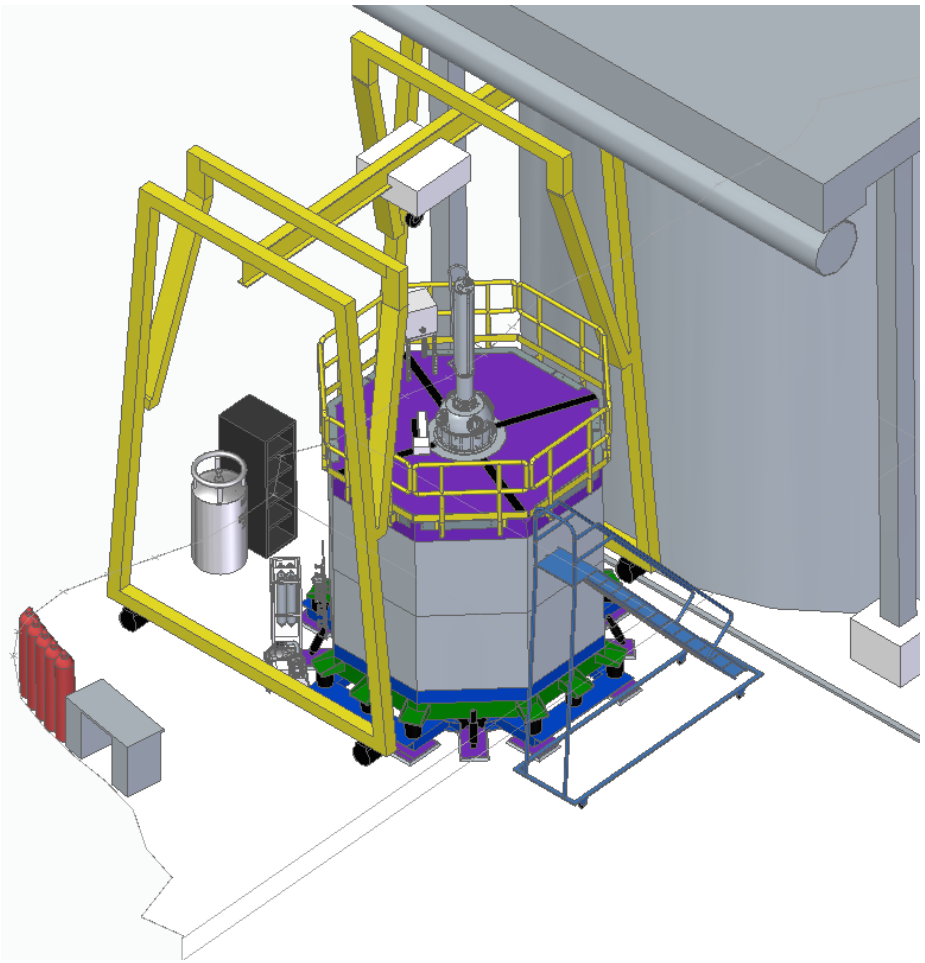

NEWS-G

NEWS-G Arrangement



Layout





Layout – Cube Hall

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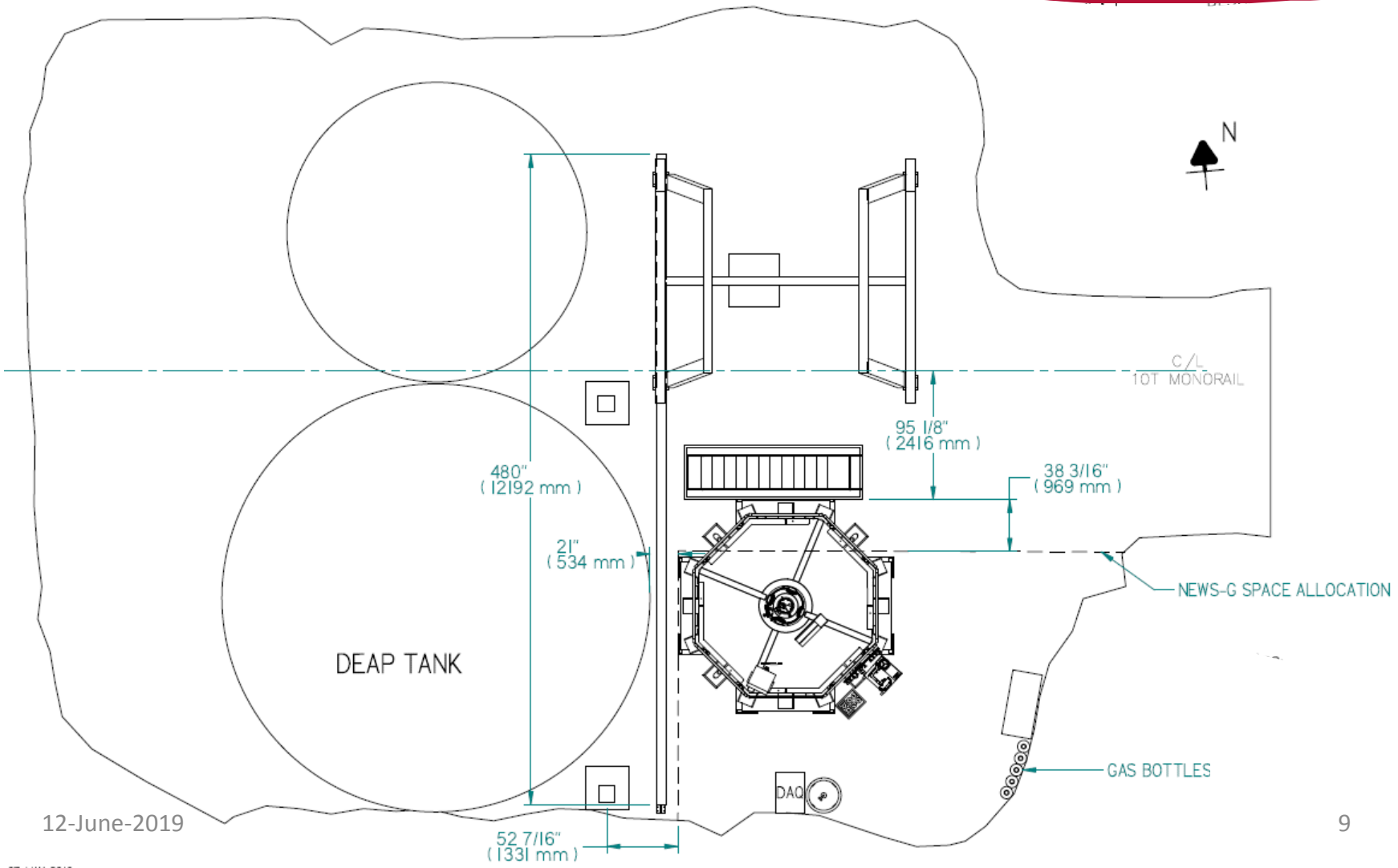

Layout – NEWS-G

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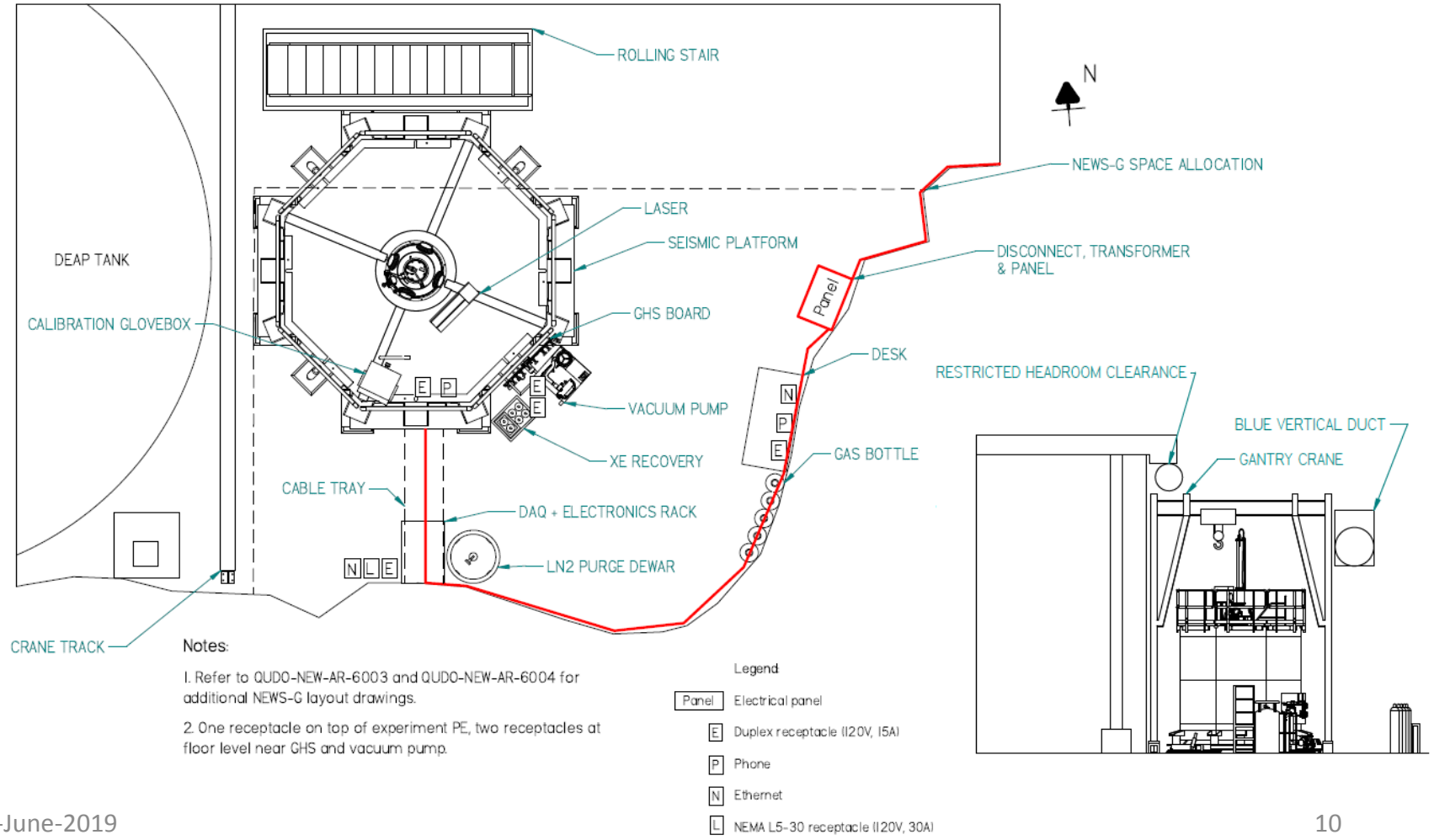
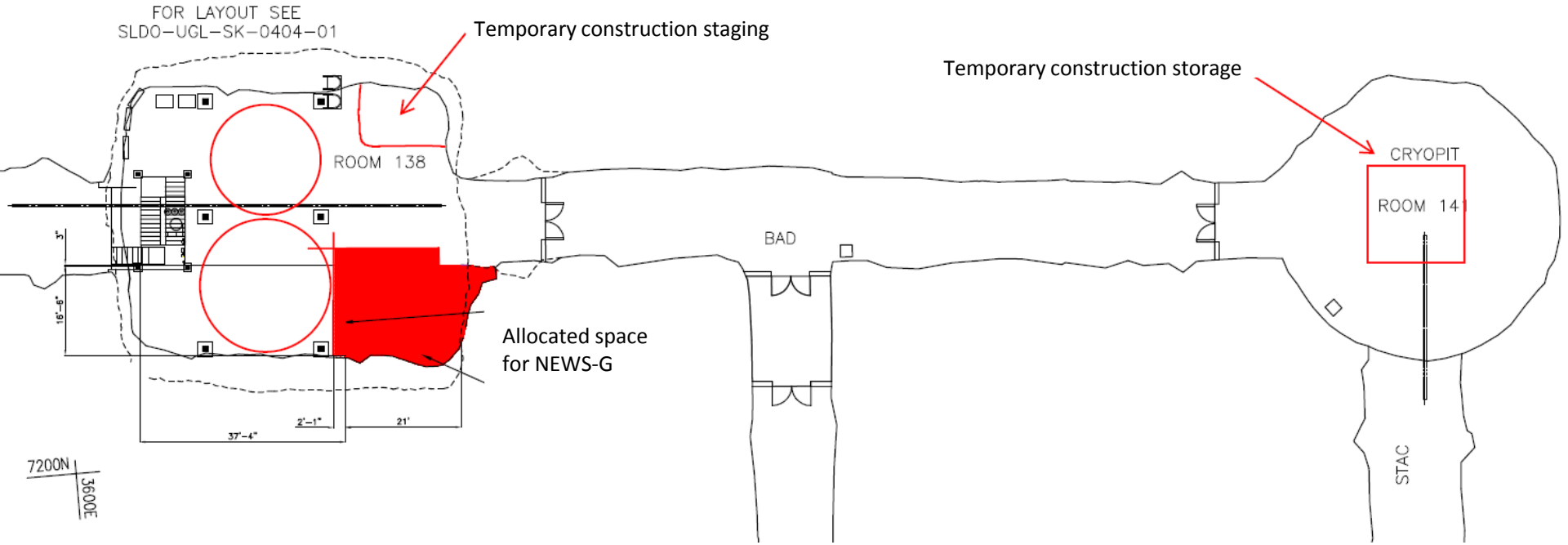
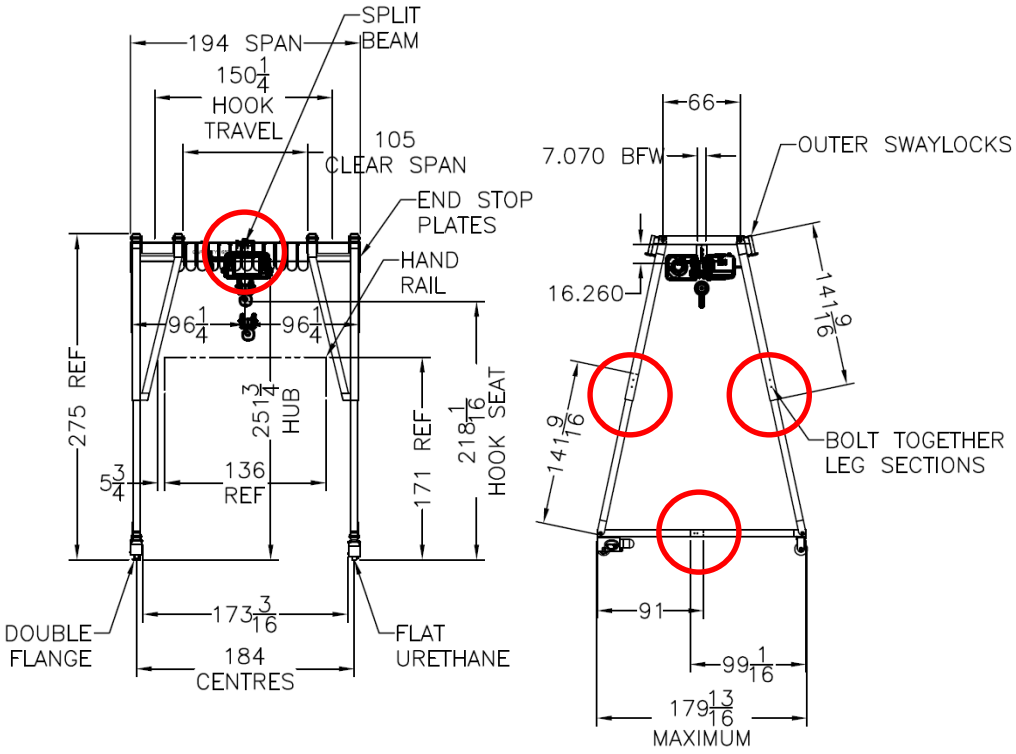


Layout – Construction Staging



Crane – Overview

- 7500 kg gantry crane, used for experiment construction and rod handling
- Long beams spliced for compatibility with standard railcar limits
- Installation by Kone Cranes and SNOLAB later this month
- Commissioning and testing by Kone Cranes (including supply of test load) under CSA B167 Section 7



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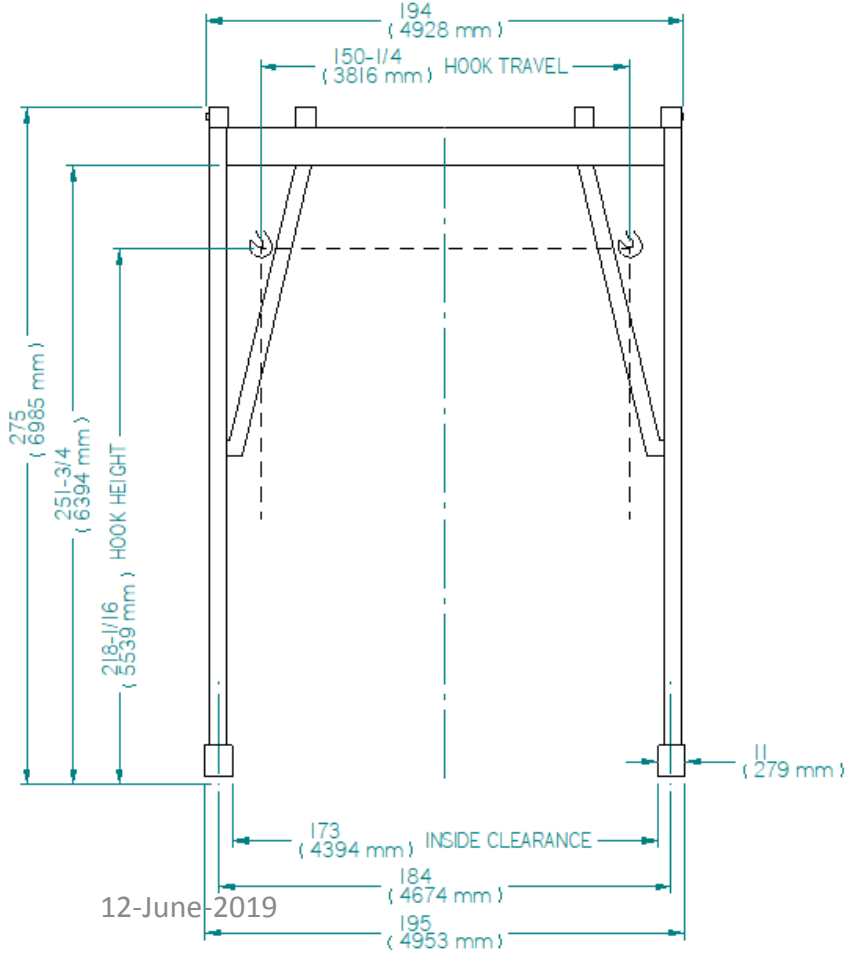
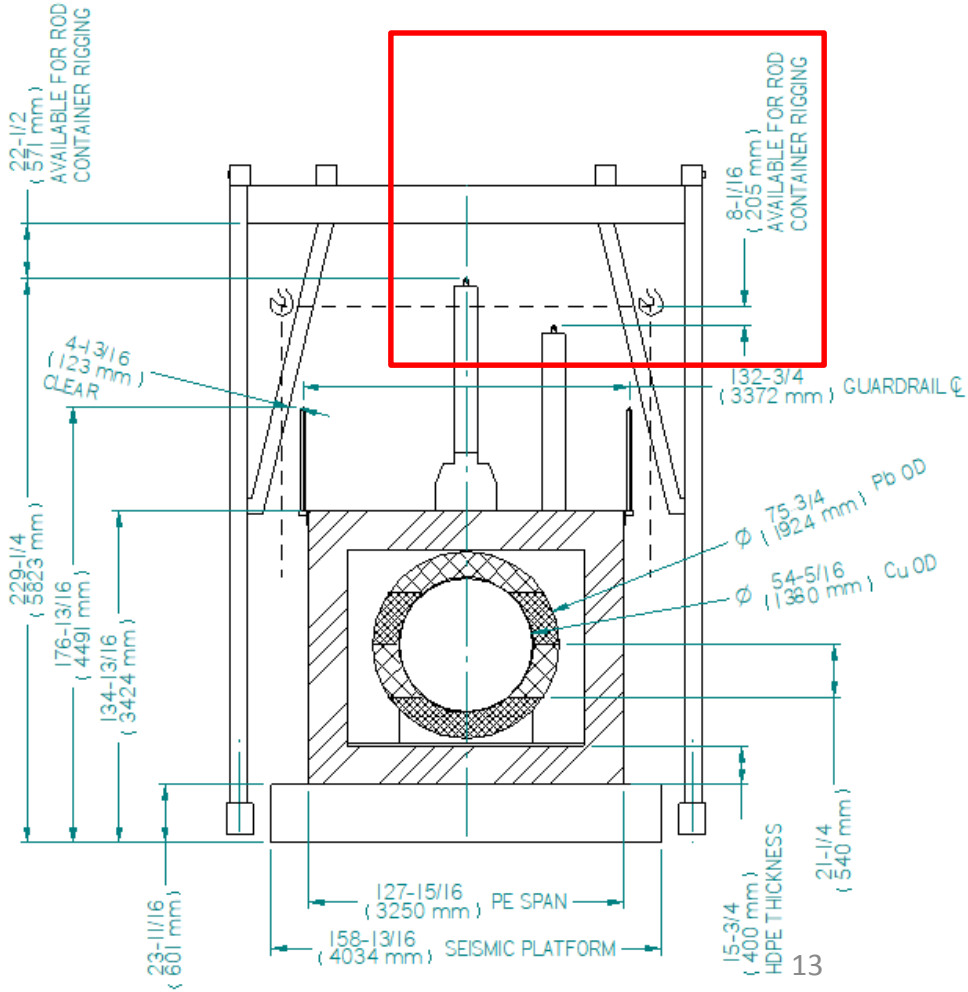
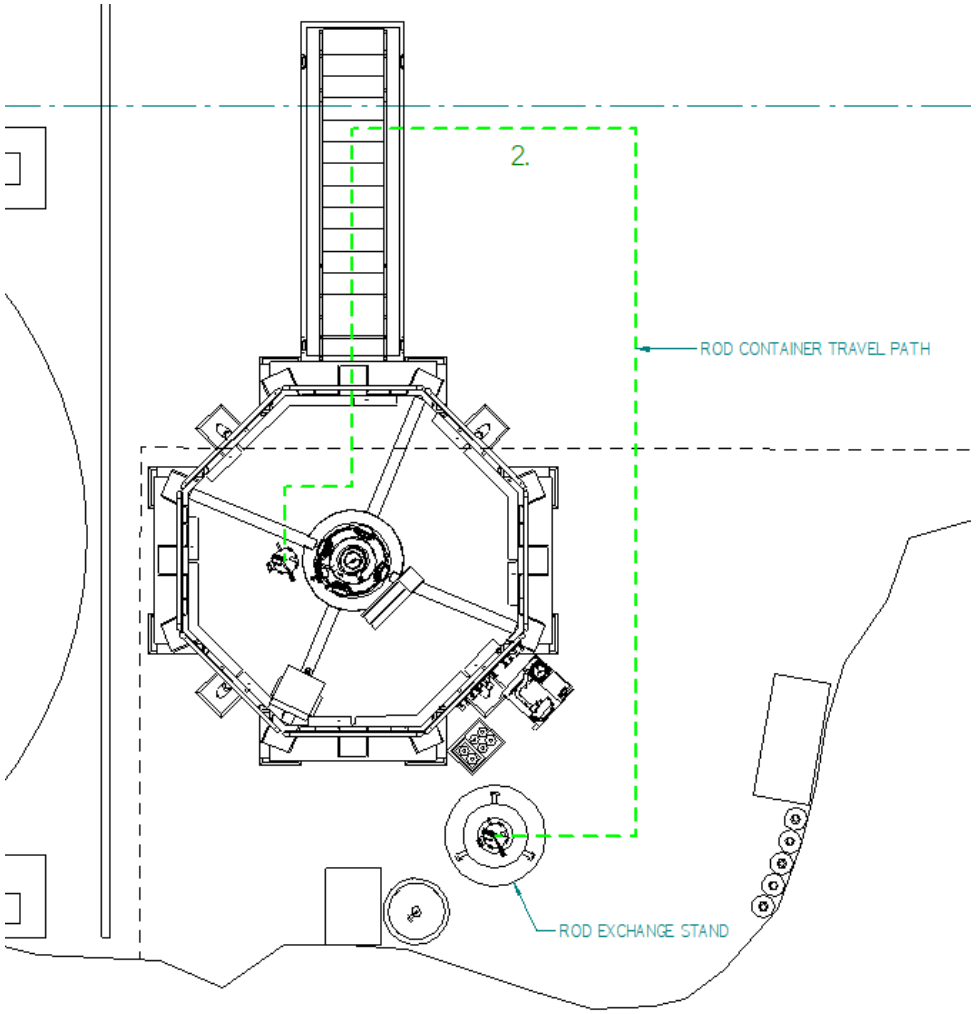
Crane – Overview

QUDO-NEW-AR-6003-01





Crane – Rod Exchange

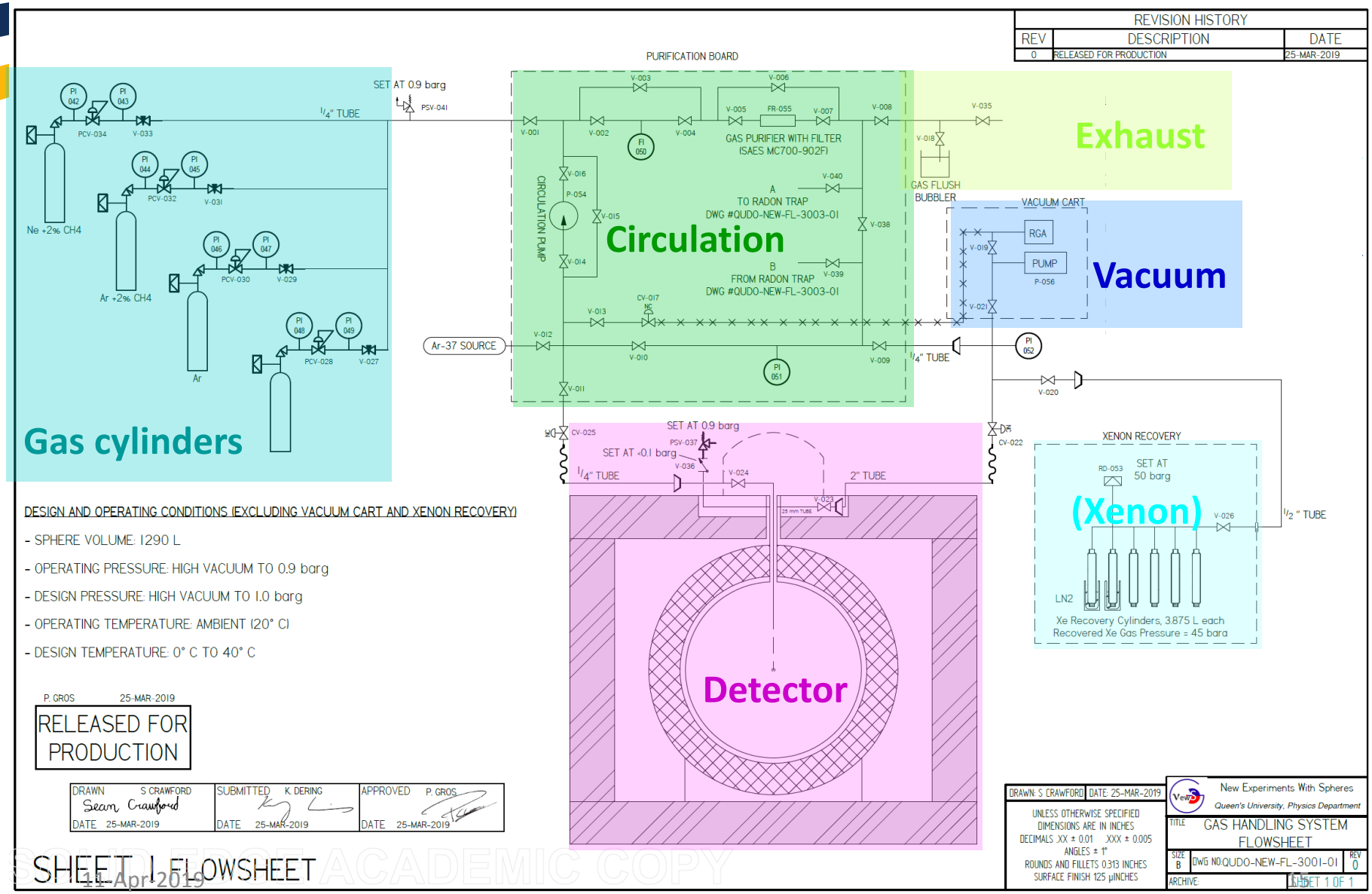


1. Lift rod container and set on top of PE with small (<250 kg) manual hoist.

2. Lift rod container and set on rod exchange stand on Cube Hall floor with 7500 kg hoist.

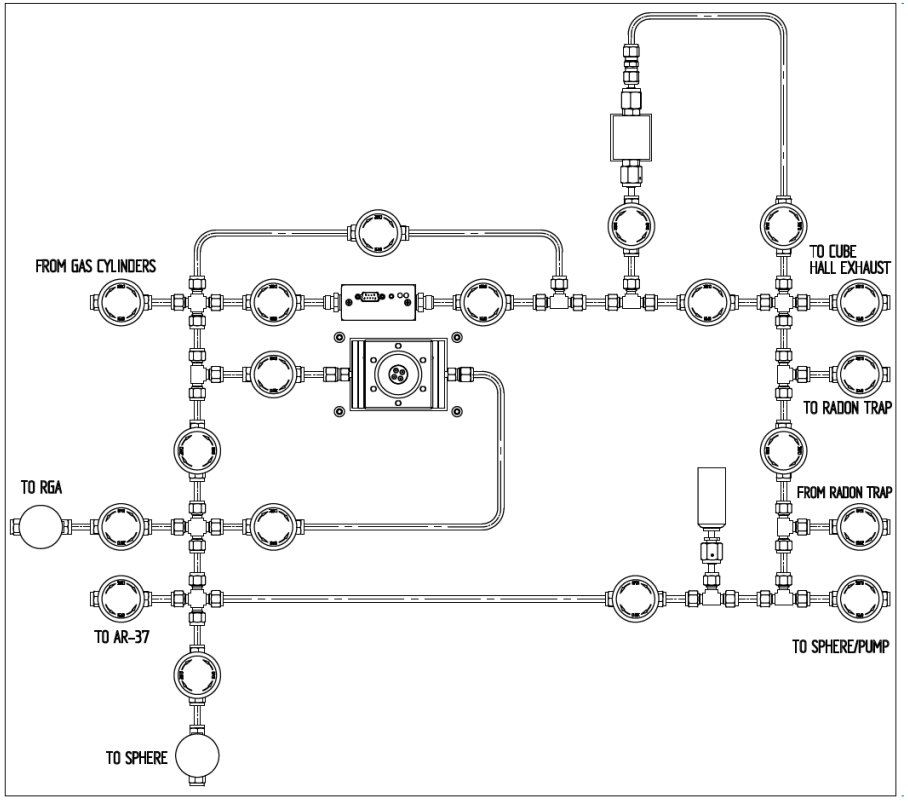
- Rod travel path through gate

GHS - Flowsheet

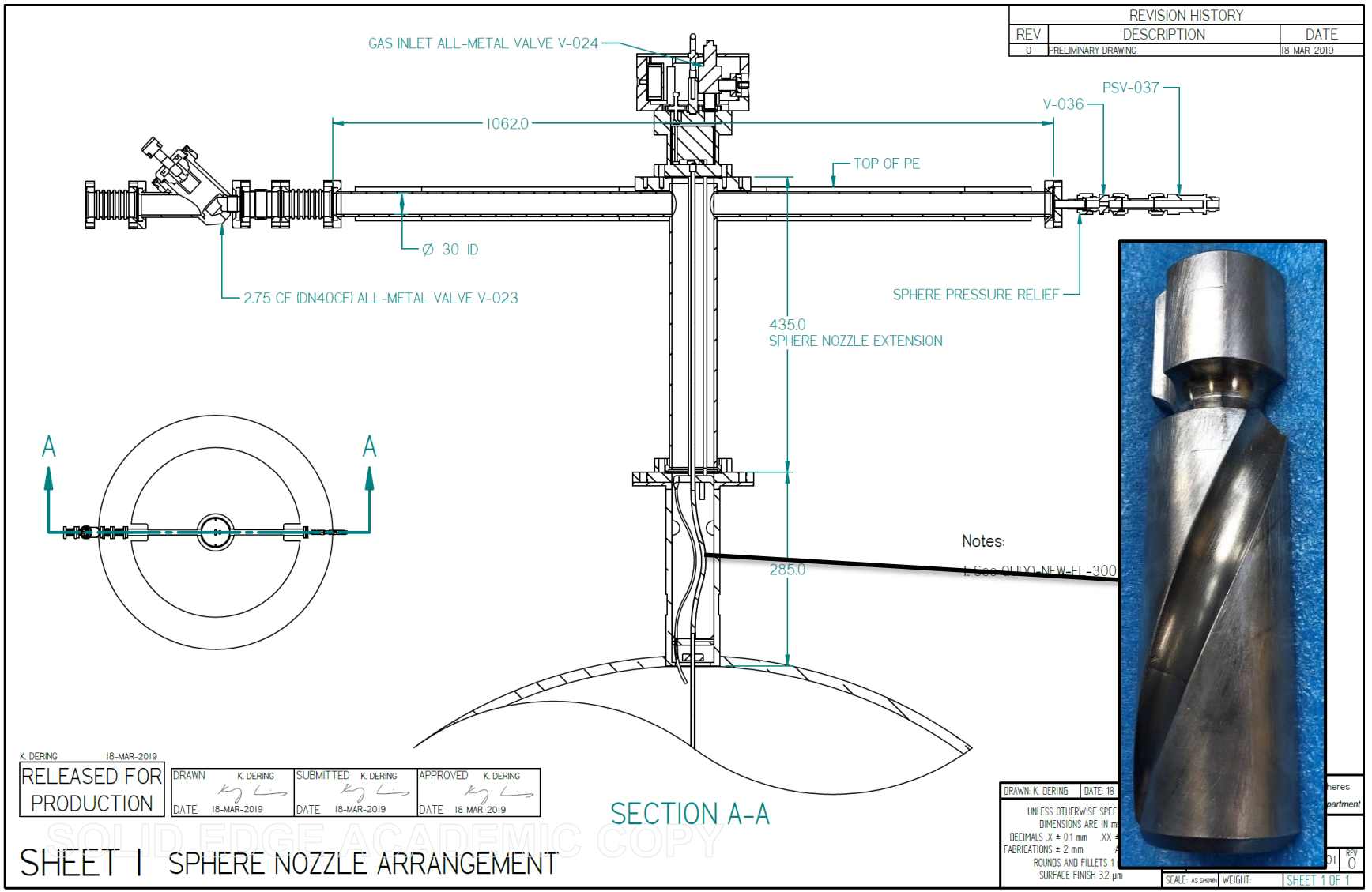


GHS - Status

- Gas board components at Queen's
- Assembly and testing this summer



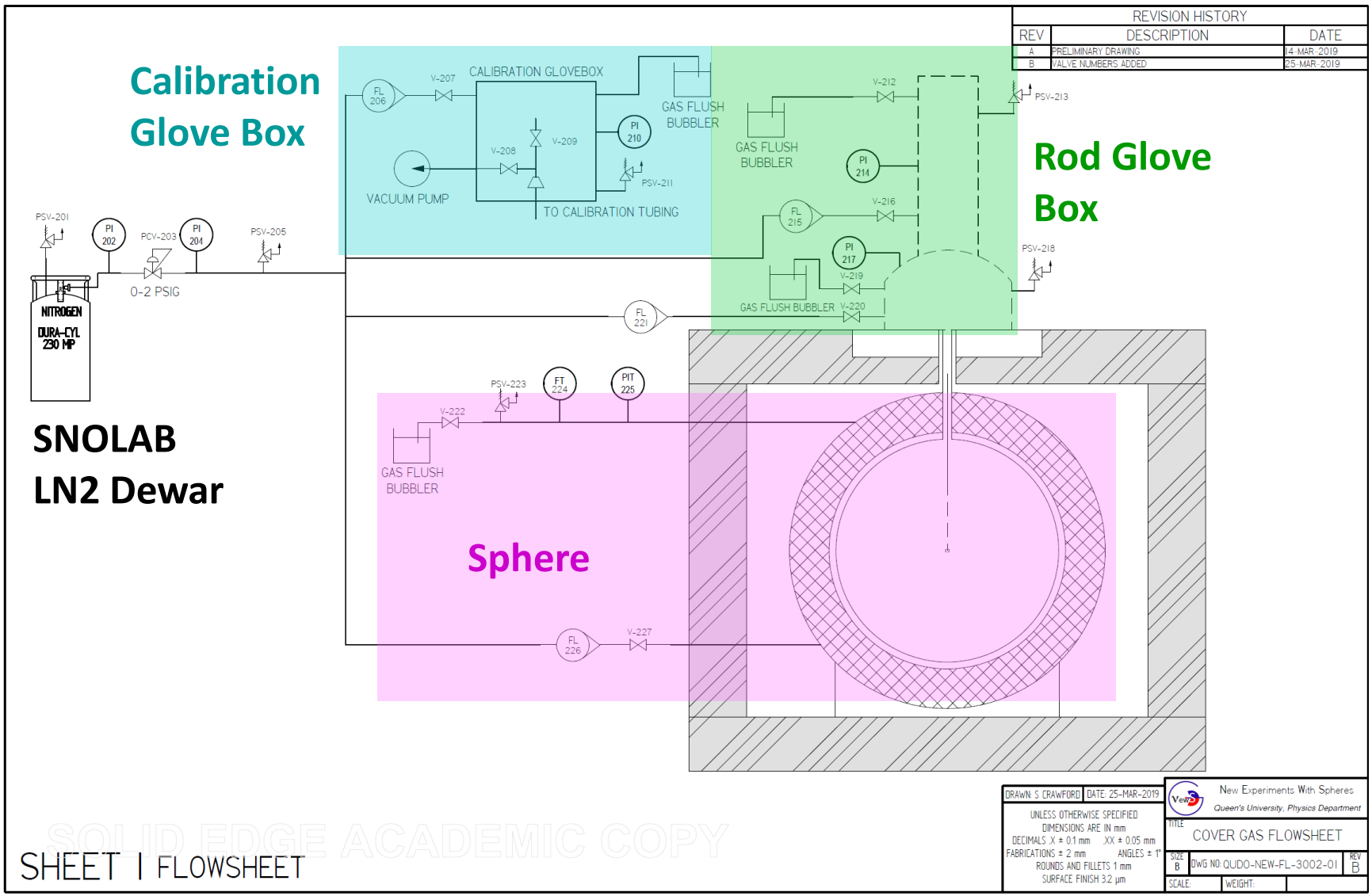
GHS – Interface with Sphere



Cover Gas

- N2 flushing around sphere
  - continuous
  - necessary flow unclear (depends on lead shield leaks)
- N2 flushing in glove box
  - only when operating (rod exchange), few times / year
- N2 flushing in calibration glove box
  - only when operating (source deployment), few times / month
- Estimate max 1 x 230 L LN2 dewar/week (conservative)

Cover Gas - Flowsheet

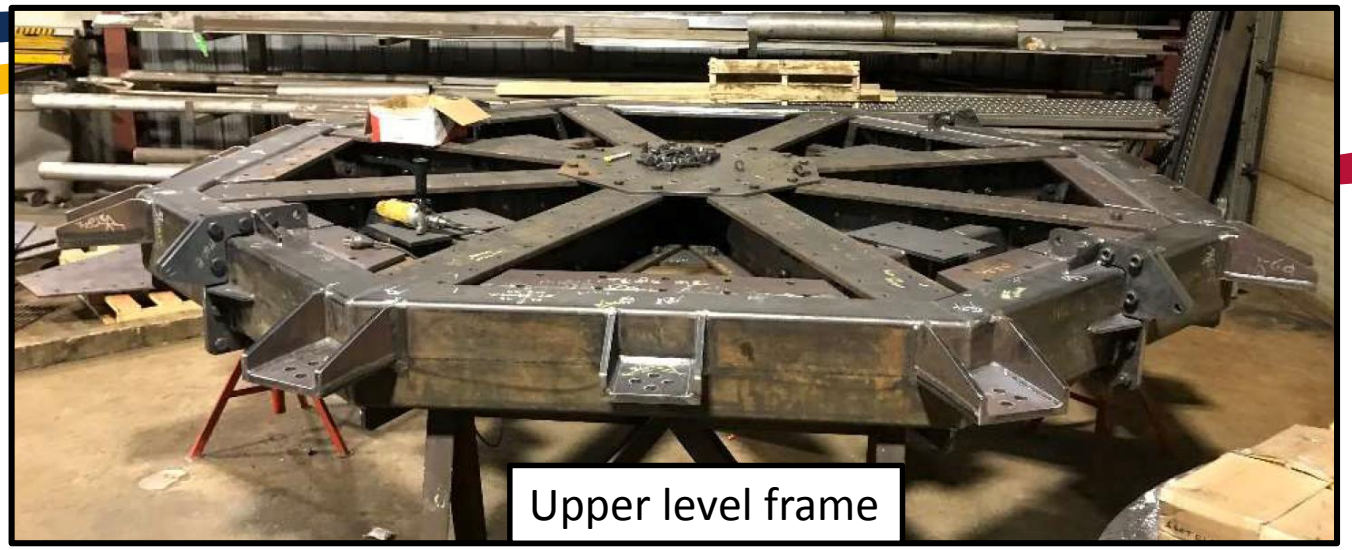


Seismic Platform – Overview

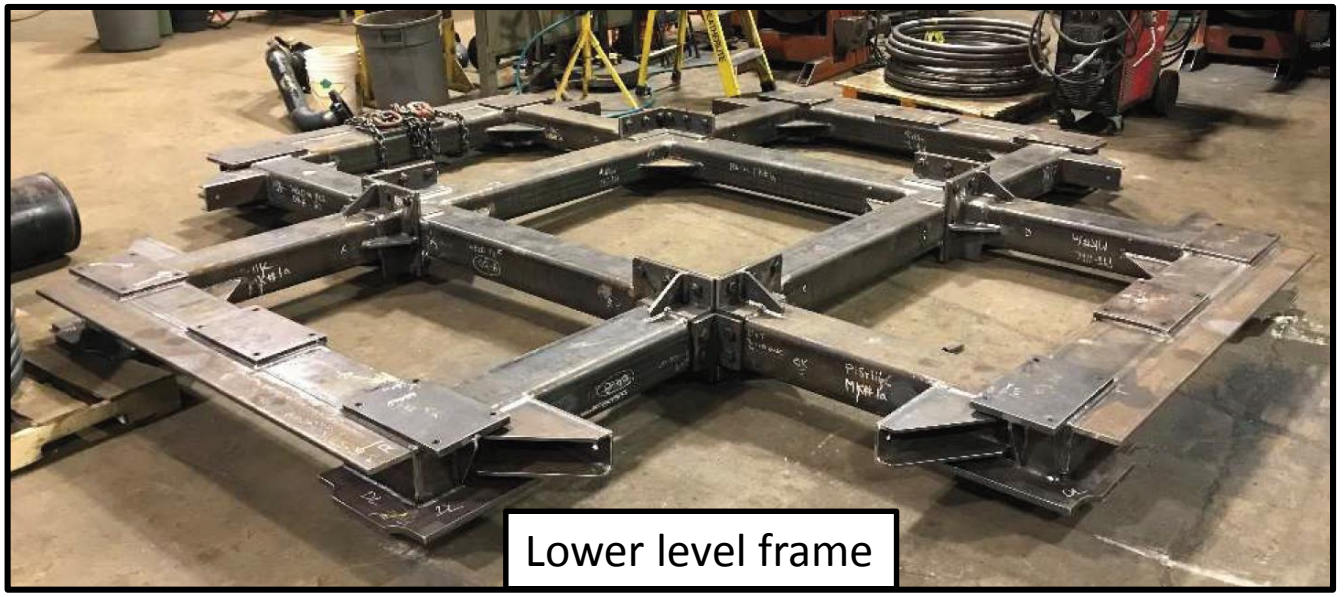
- Fabrication complete
- Scheduled for delivery to SNOLAB very soon (few days delay at paint shop)
- Arrangement:
  - Upper level frame supported on 12 vertical isolators
  - Lower level frame supported on ball bearings and isolated with 8 horizontal isolators
  - 4 inclined dampers
  - Lead anchored to 4 round posts that pass through the polyethylene base

Seismic Platform – Overview

Damper



Upper level frame



Lower level frame

Seismic Platform – Overview

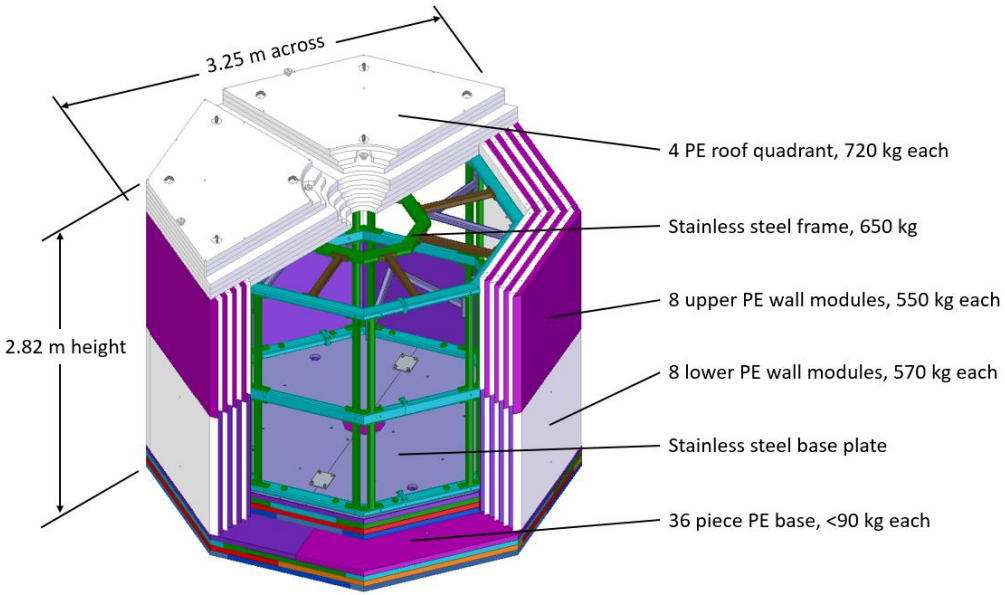
Seismic Platform – Installation Sequence

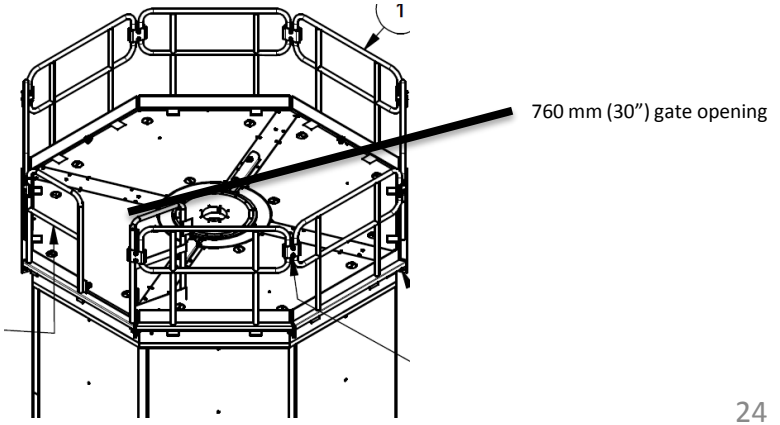
Installation Activity	Installation Phase
1. Assemble the structural steel according to PMLO-NEW-D-4303-07	
2. During steel assembly:	
i. Install the ball bearing plates	Part 1
ii. Adjust and install the horizontal isolators	(happening in July)
iii. Adjust and install the vertical isolators	
iv. Install the dampers	
3. Before installation of the NEWS-G experiment (lead, copper, PE):	
i. Preload the horizontal springs for 1” deflection each	Part 2
ii. Chair the horizontal springs	
iii. Hold for inspection by NEWS-G	
4. Construct the NEWS-G experiment	
5. Load the vertical springs	Part 3
6. Release the horizontal springs	

SDD-QUDO-NEW-MN-4306

PE Shield – Frame and Guardrail

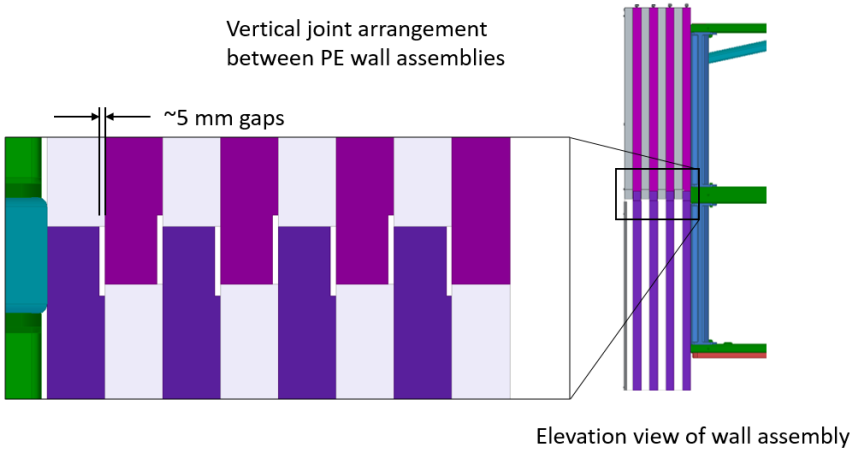
- Stainless steel frame supports the PE shield and allows work on top of the PE
  - Design by Fonderie de Gentilly
  - Engineering review and guardrail design by BESTECH in Sudbury
- Quotes received for fabrication of guardrail
- Quotes for frame fabrication and trial assembly of PE shield due next Friday, June 21
  - Looking at shops in Kingston and Sudbury



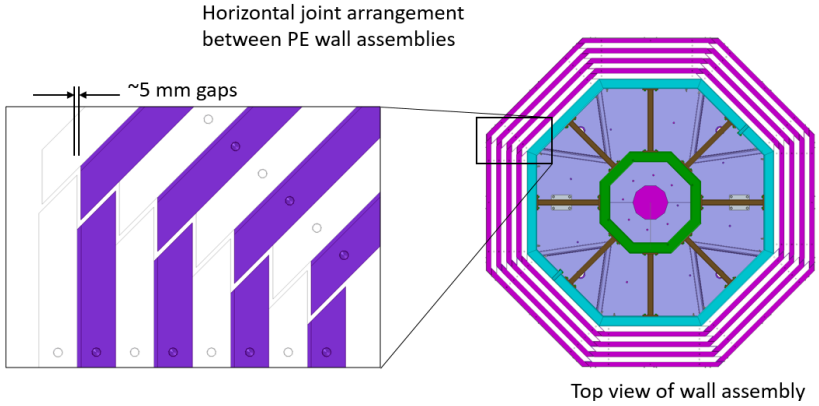


PE Shield – Walls

- 8 bottom walls + 8 top walls
- 8 x 50 mm thick HDPE layers each
  - Supposed to be 50 +/- 0.4 mm
  - Many are 50.8 +/- 0.4 mm
  - May need spacer plates/washers to correct
- Lifting plate bolted to each assembly
- As of last Wednesday, 32 of 128 parts machined at University of Alberta
- Extra temporary machinist has started for our project. Hoping to ramp up to 3 parts per day
- Planning for assembly and packing late August

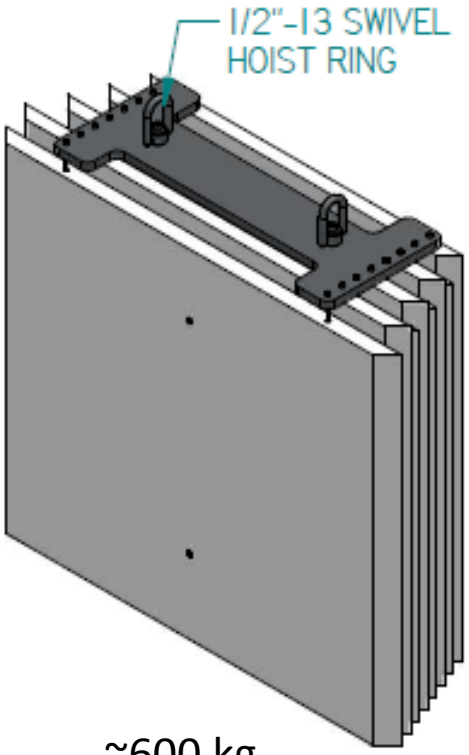


Elevation view of wall assembly

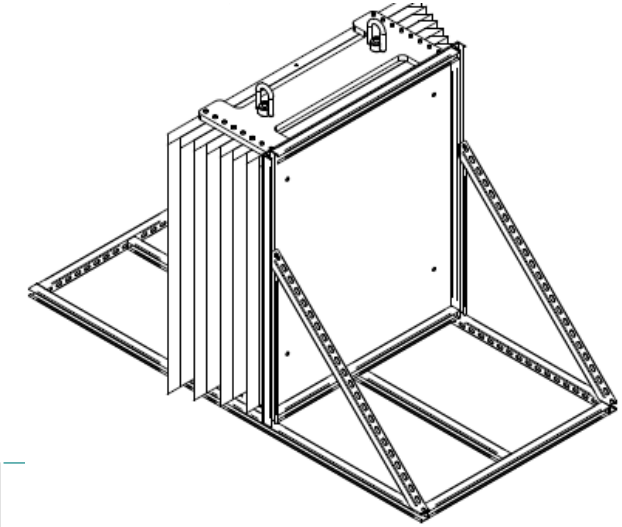


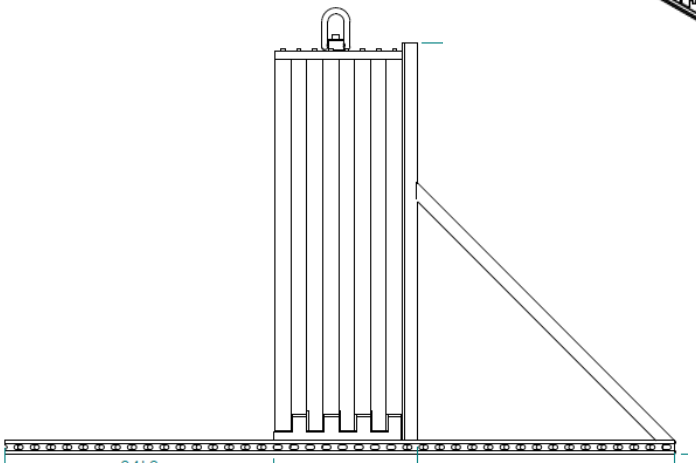
Top view of wall assembly

PE Shield – Walls

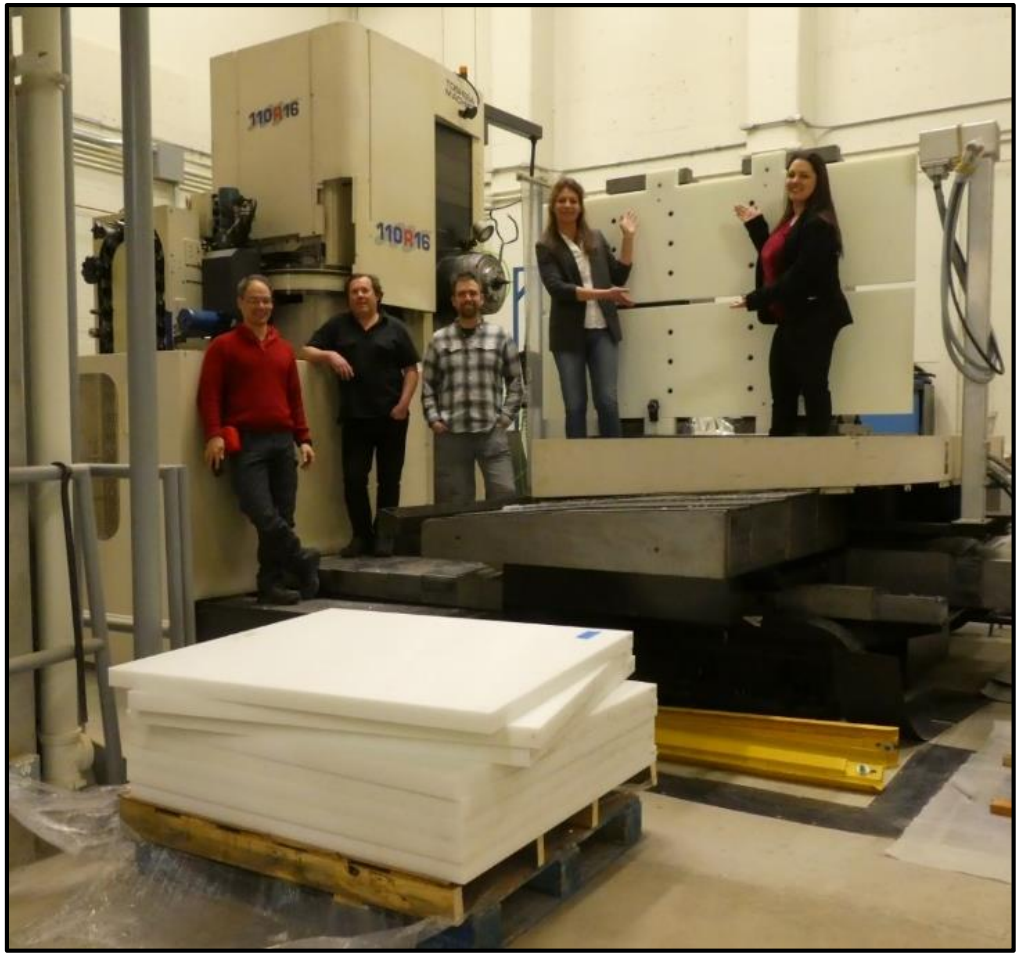


~600 kg



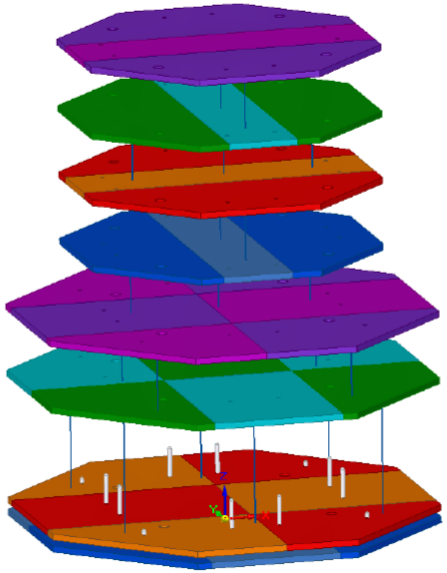


PE Shield – Walls



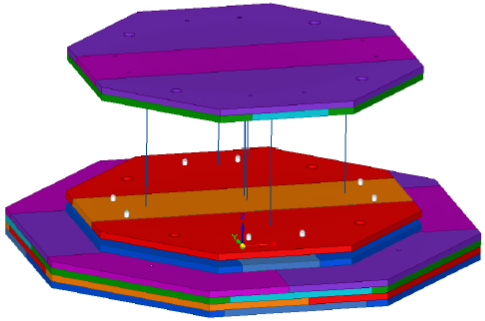
PE Shield – Base

- 50 +/- 0.4 mm thick HDPE with factory thickness measurements
- Material ready and at supplier in Ontario
- Parts will be cut on CNC router. Finalizing machining contract
- Should be complete early summer, then will ship for trial assembly



Lower level assembly (4 layers, 6 pieces each)
24 pieces total

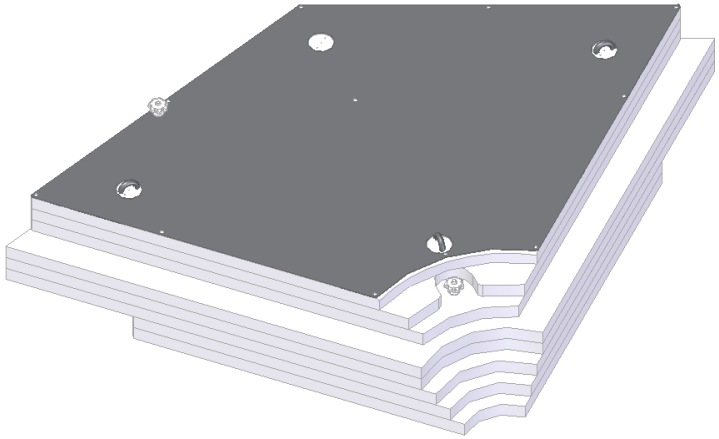
- 36 pieces total, <90 kg each
- Aligned with PE dowels
- Two M8 lifting points per piece

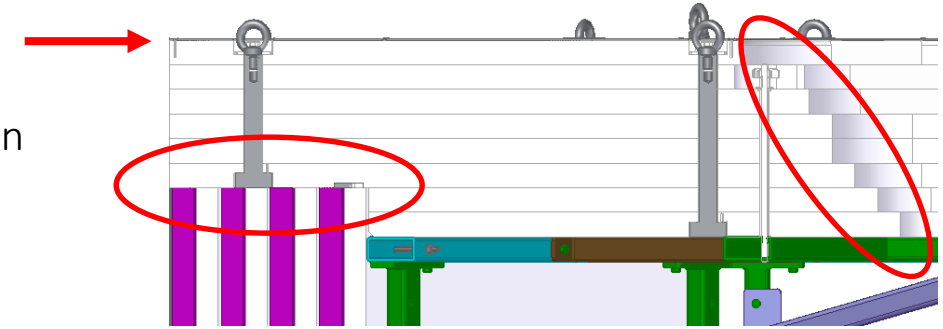


Upper level assembly (4 layers, 3 pieces each)
12 pieces total

PE Shield – Roof

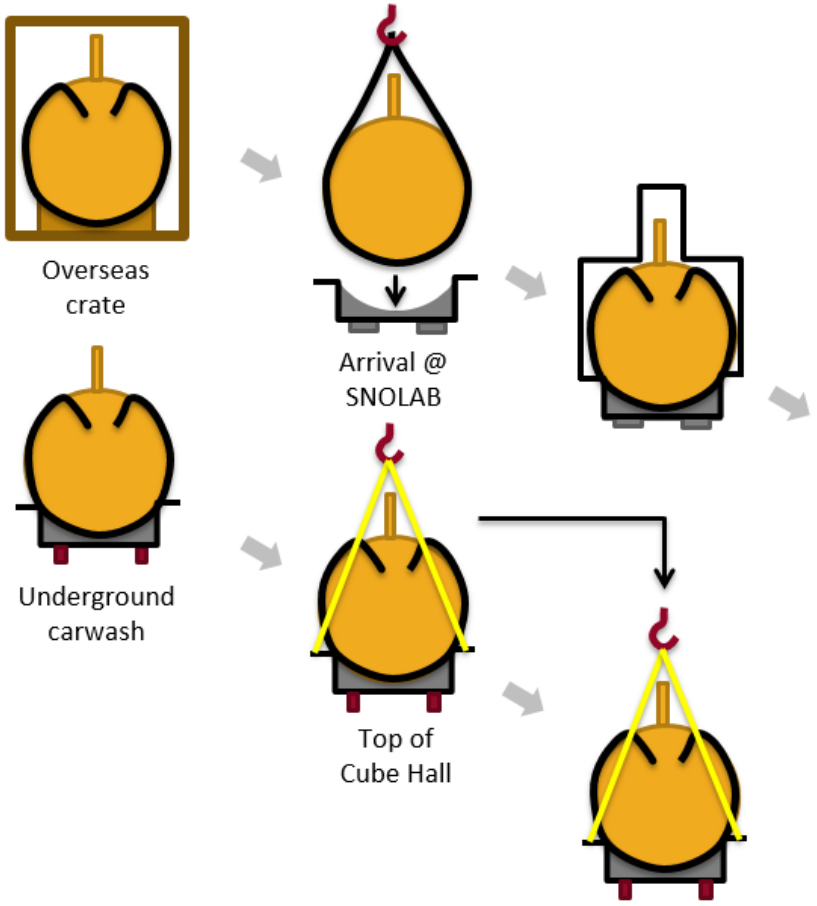
- PE roof requires very large sheets – 4120 mm x 2010 mm
- Ordered material in March
  - Setback in May, learning that the manufacturer would no longer be able to provide our material
- New supplier found with 5-6 week delivery, allowing us to catch up on some lost time
  - Sheets will be 50 mm with -0, +10 mm thickness tolerance
- Not as sensitive to tolerances for the roof, since we don't have as many overlapping features
- Parts will be machined on CNC router; anticipate machining the faces of certain parts where thickness is critical





Underground Shipping – Copper Sphere

1. Sphere filled with N_2 gas and sealed
2. Sphere secured in wooden crate for oversea transit
3. Sphere unpacked from wooden crate in Sudbury, and secured on cage container base
4. Sphere shipped underground to lab (car wash)
5. Wheels installed on cage container
6. Top and sides of container removed and sphere delivered to Cube Hall floor on support cradle



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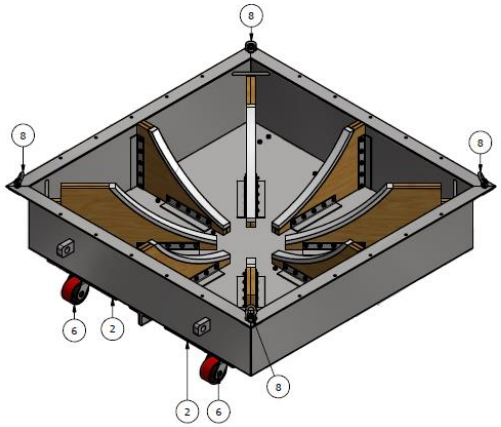
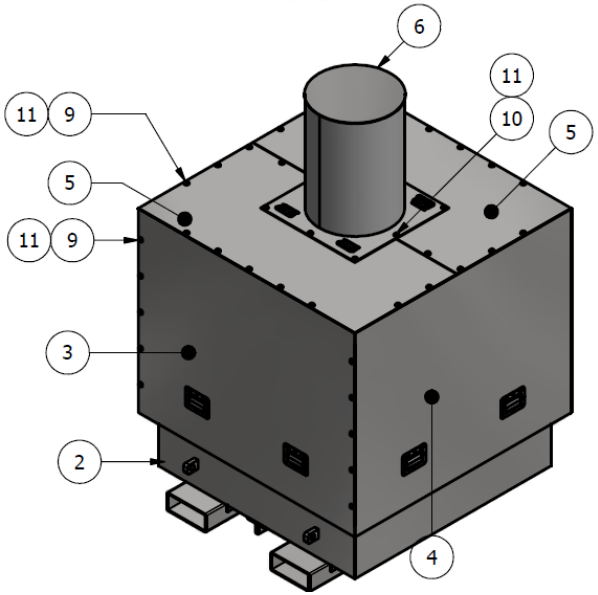
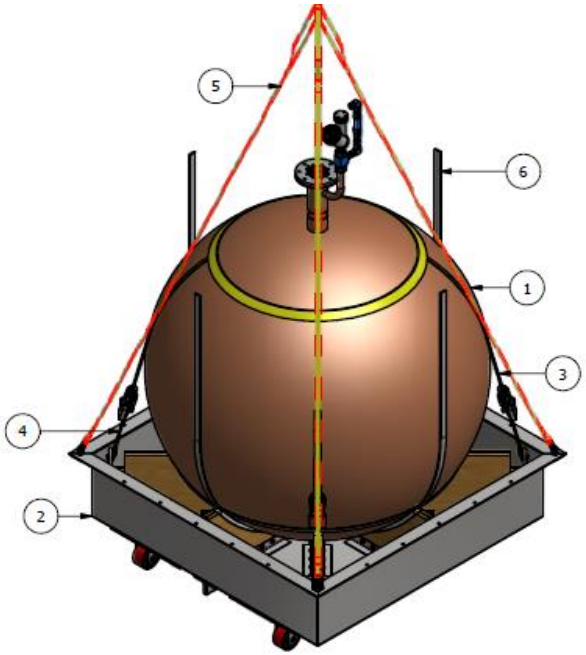
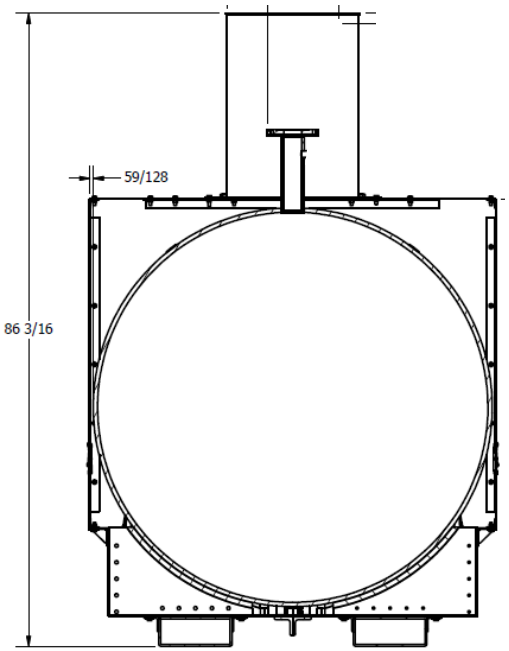








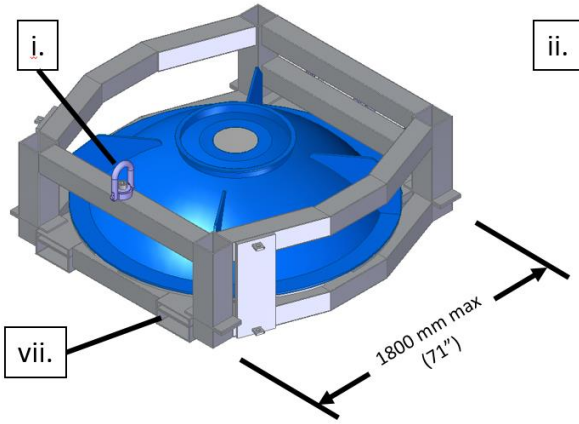
Design by SNOLAB
Fabrication ongoing

Underground Shipping – Lead

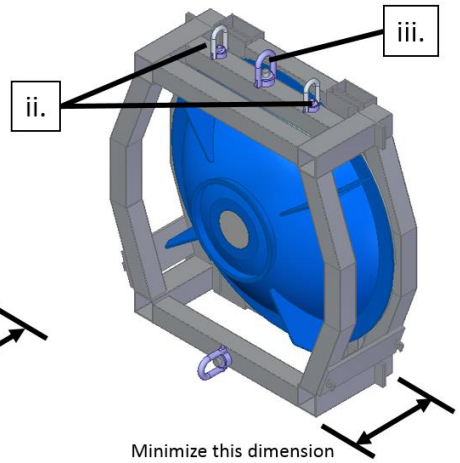
- Lead pieces will be among the heaviest items ever transported to SNOLAB. SNOLAB helping with logistics, including
  - Rental equipment on surface for handling lead
  - New 12 ton hitches are installed at the carwash to remove lead from railcars
- Lead should be sealed in plastic layers in France, and shipped in wooden crates to Canada, where it will be repackaged in steel crates for transport underground
- North and south pole are wider than the cage for shipping underground, and must be rotated to fit
- Equator pieces fit without issue
- Each crate will include wheels for towing through the lab
- Concept design done at Queen's. Quotes for detail design due next Friday, June 21

Underground Shipping – Lead

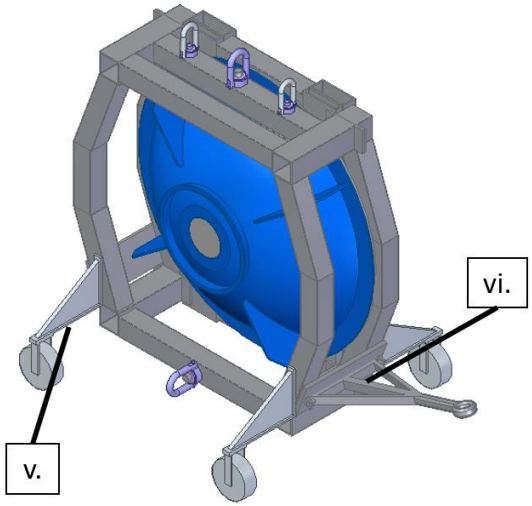
- Lead packed on crate for shipping UG
- Crate + lead wrapped in plastic
- *(rotate north and south pole)* Ship the crate underground on a railcar
- At the underground carwash, attach 4 caster wheels
- Use the 12 ton hitch to pull out the rail car
- Tow the pallet through the carwash and remove plastic layers
- Tow the pallet through the lab and lift to Cube Hall floor with monorail



Lead in upright orientation



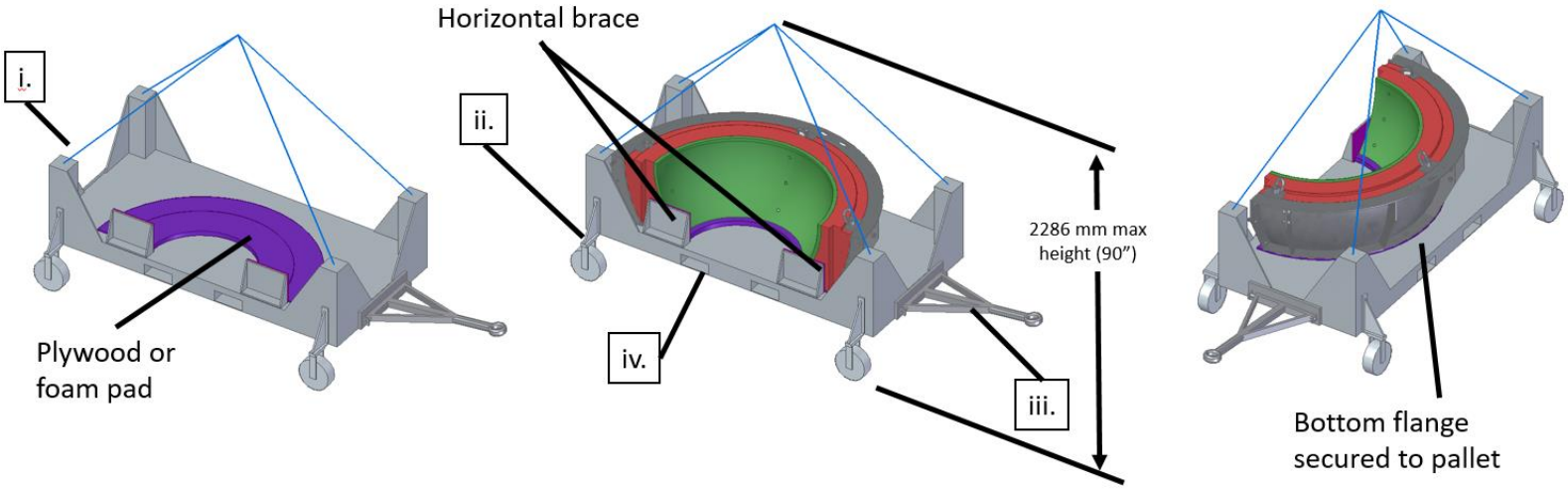
Lead rotated 90°



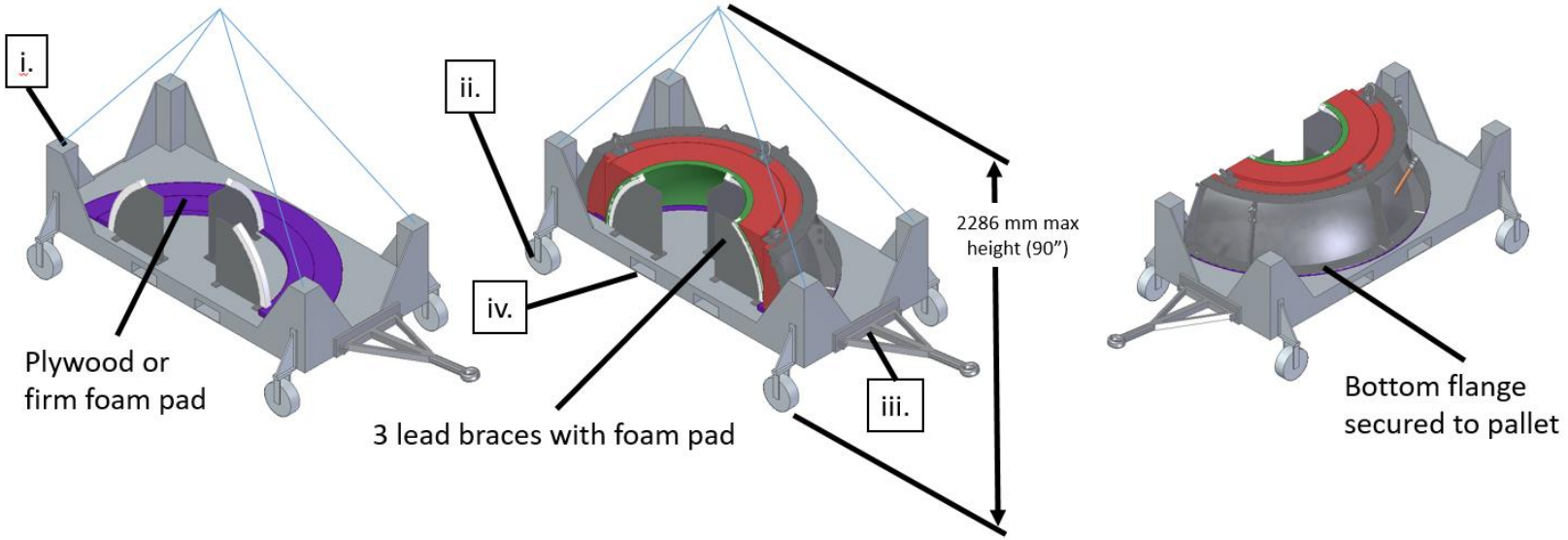
Lead rotated 90° with tow bar and casters installed

Underground Shipping – Lead

South Equator Configuration

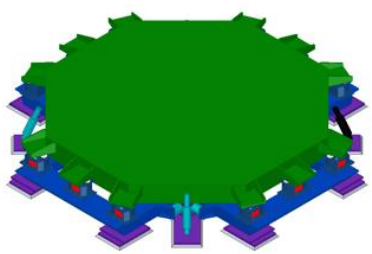


North Equator Configuration



Construction Sequence – Compact Shield & Sphere

- **Lay down PE base (36 pieces)**
- **Install stainless steel base plate**
- **Anchor base plate to seismic platform**
- Install Pb south pole (1 piece + 8 legs)
- Install Pb south equators (2 pieces)
- Lower and align sphere inside Pb southern hemisphere using alignment tool
- Install Pb north equators (2 pieces)
- Install Pb north pole
- Install small Pb pieces around Cu sphere nozzle
- Connect cover gas to Pb shield
- Assemble stainless steel frame around Pb shield
- Connect calibration tube to Pb north equator
- Install lower PE walls (8 pieces)
- Install upper PE walls (8 pieces)
- Install PE roof (4 quadrants)
- Install stainless steel cladding on walls



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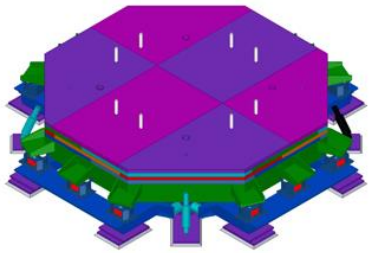

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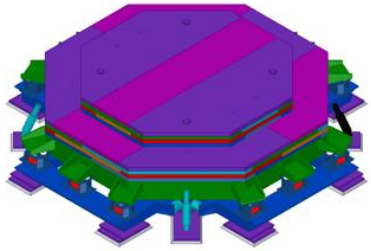

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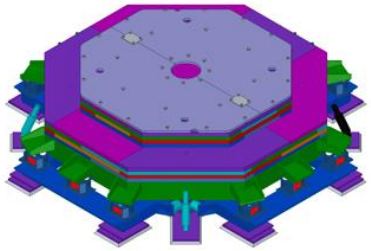

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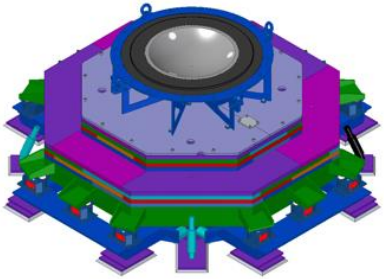

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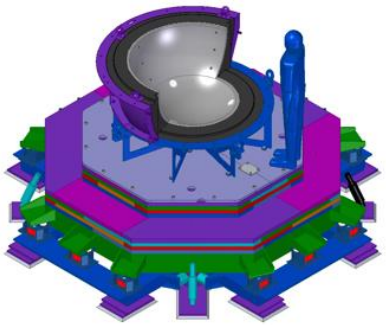

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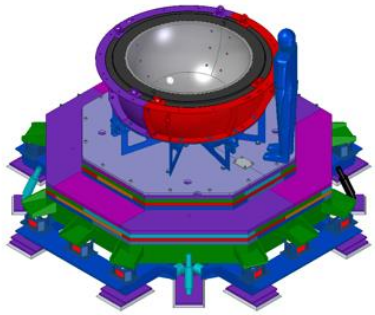

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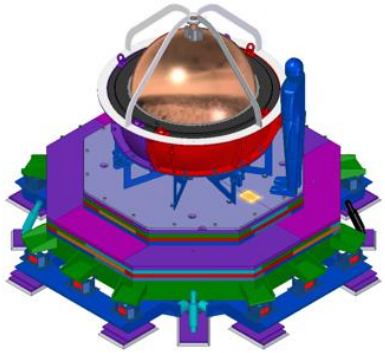
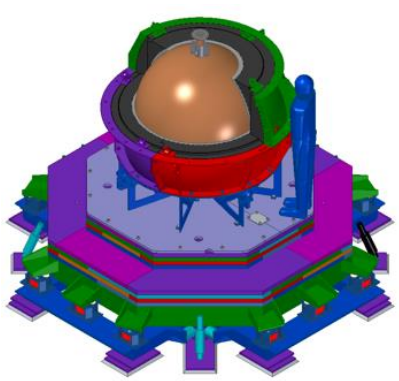


8

Construction Sequence – Compact Shield & Sphere

- Lay down PE base (36 pieces)
- Install stainless steel base plate
- Anchor base plate to seismic platform
- Install Pb south pole (1 piece + 8 legs)
- Install Pb south equators (2 pieces)
- Lower and align sphere inside Pb southern hemisphere using alignment tool
- **Install Pb north equators (2 pieces)**
- **Install Pb north pole**
- **Install small Pb pieces around Cu sphere nozzle**
- **Connect cover gas to Pb shield**
- Assemble stainless steel frame around Pb shield
- Connect calibration tube to Pb north equator
- Install lower PE walls (8 pieces)
- Install upper PE walls (8 pieces)
- Install PE roof (4 quadrants)
- Install stainless steel cladding on walls



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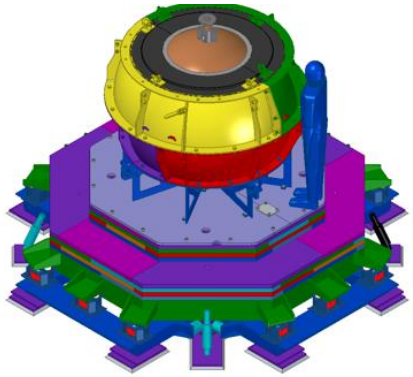

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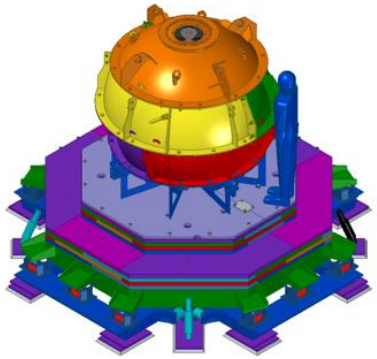

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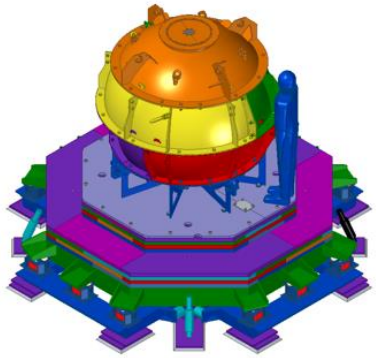

12

Construction Sequence – Compact Shield & Sphere

- Lay down PE base (36 pieces)
- Install stainless steel base plate
- Anchor base plate to seismic platform
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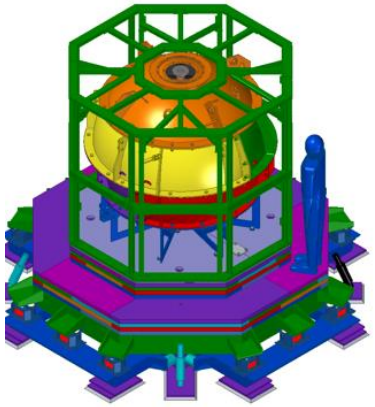
- Install Pb north equators (2 pieces)
- Install Pb north pole
- Install small Pb pieces around Cu sphere nozzle
- Connect cover gas to Pb shield
- **Assemble stainless steel frame around Pb shield**
- **Connect calibration tube to Pb north equator**
- **Install lower PE walls (8 pieces)**
- **Install upper PE walls (8 pieces)**
- Install PE roof (4 quadrants)
- Install stainless steel cladding on walls



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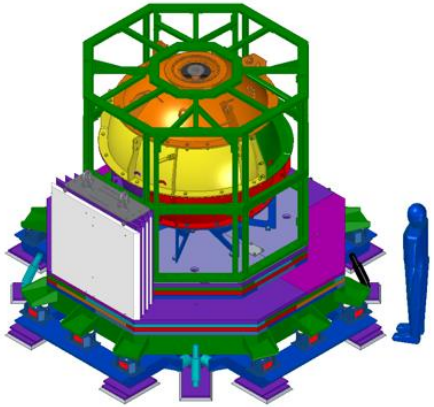

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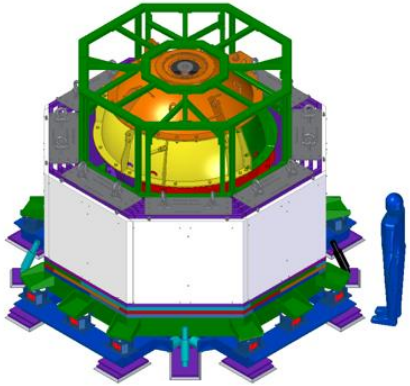

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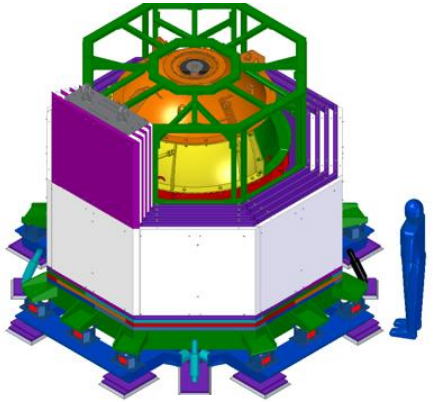

16

Construction Sequence – Compact Shield & Sphere

- Lay down PE base (36 pieces)
- Install stainless steel base plate
- Anchor base plate to seismic platform
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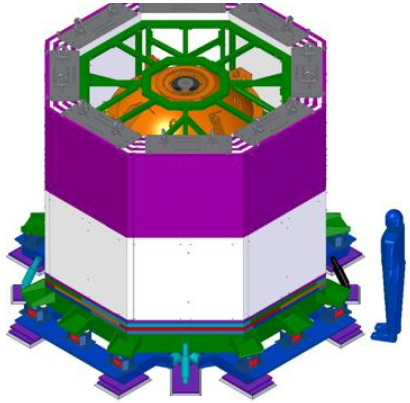
- Install small Pb pieces around Cu sphere nozzle
- Connect cover gas to Pb shield
- Assemble stainless steel frame around Pb shield
- Connect calibration tube to Pb north equator
- Install lower PE walls (8 pieces)
- **Install upper PE walls (8 pieces)**
- **Install PE roof (4 quadrants)**
- **Install stainless steel cladding on walls**



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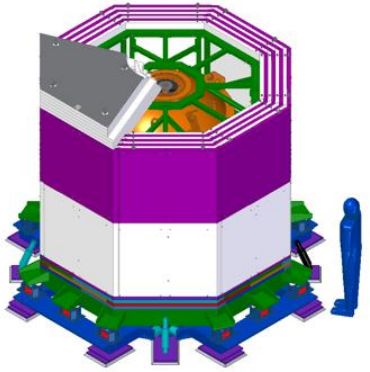

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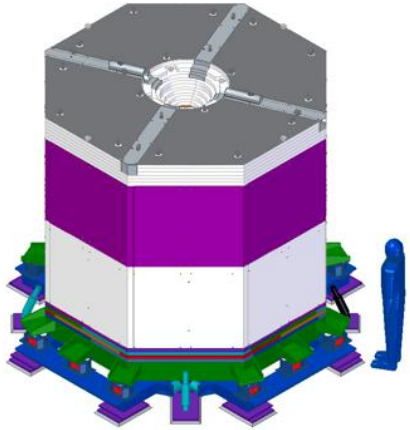

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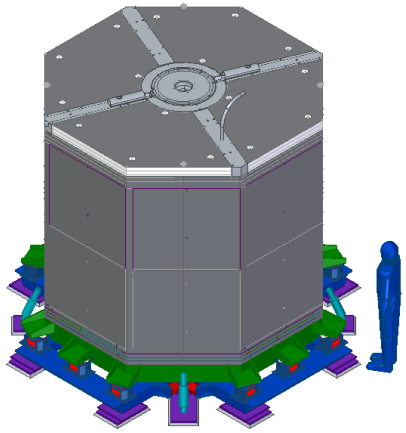


20

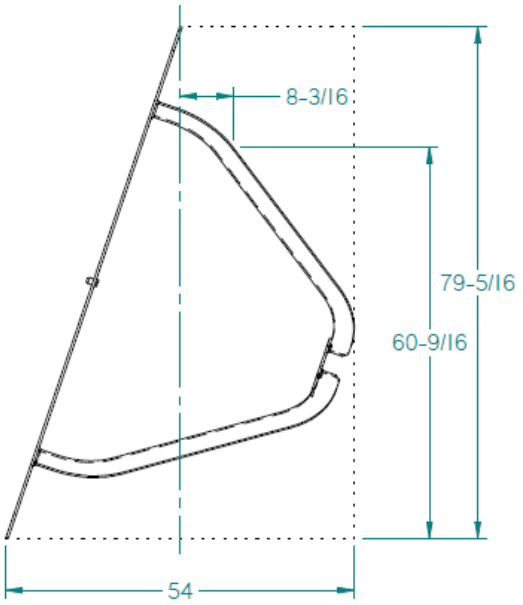
SNOLAB Lifecycle Progress

- Technical Design Review successfully completed on April 11, 2019
- Installation Review Part 1 successfully completed on May 22, 2019, covering installation of the following
  - Electrical infrastructure (breaker, disconnect, transformer, and panel)
  - Gantry crane
  - Seismic platform
- Next installation review in September, covering the remainder of installation
- More details in Gilles' talk

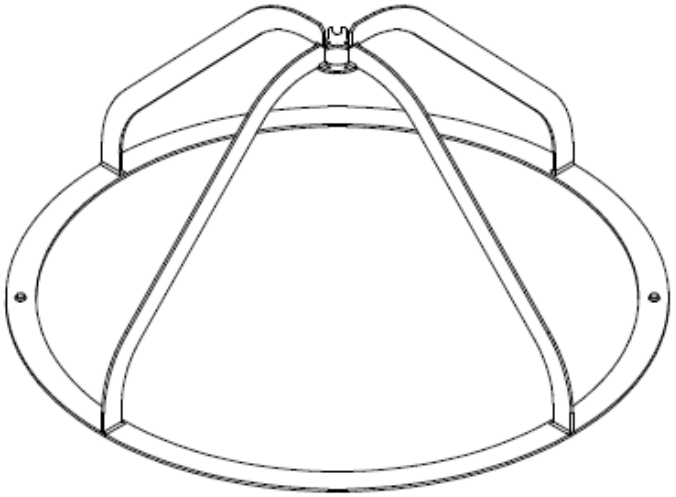
End

Underground Shipping – Alignment Tool

- Sphere alignment tool: forklift
- Packaging must minimize dimensions



EQUATOR RING
& ARMS, TILTED



Underground Shipping – Polyethylene

- 16 wall modules and 4 roof quadrants will arrive fully assembled
- 36 separate pieces for base
- PE arrival at SNOLAB beginning in September/October
  - PE base: 3 railcars (3 long skids)
  - PE walls: 4 railcars (8 skids)
  - PE roof: 2 railcars (4 crates; crates must be rotated)
- Stainless steel frame: 2 railcars
- Guardrails: 1 railcar