

ND-LAr Cryostat Installation and Integration Overview

Peter Tennessen

2021-04-02

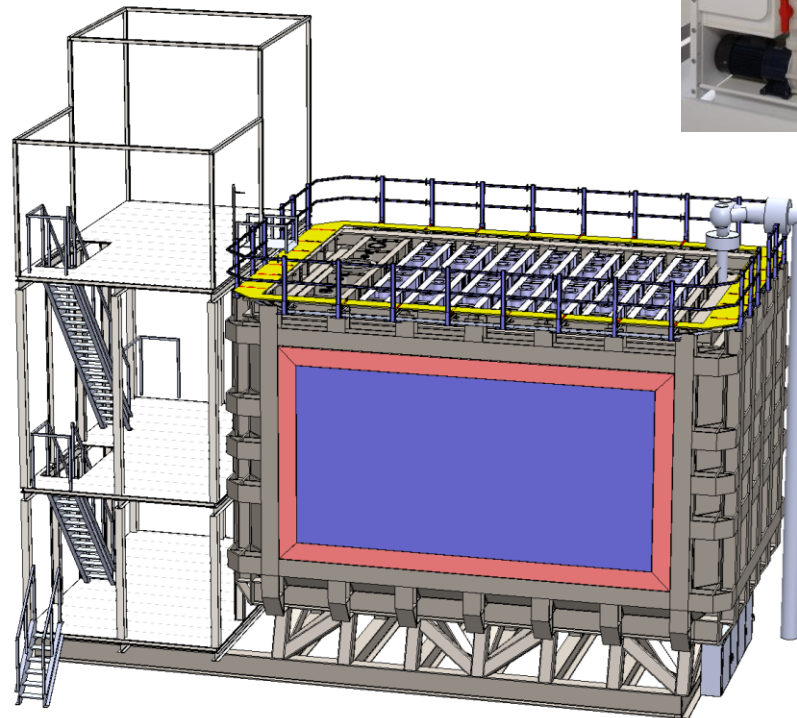


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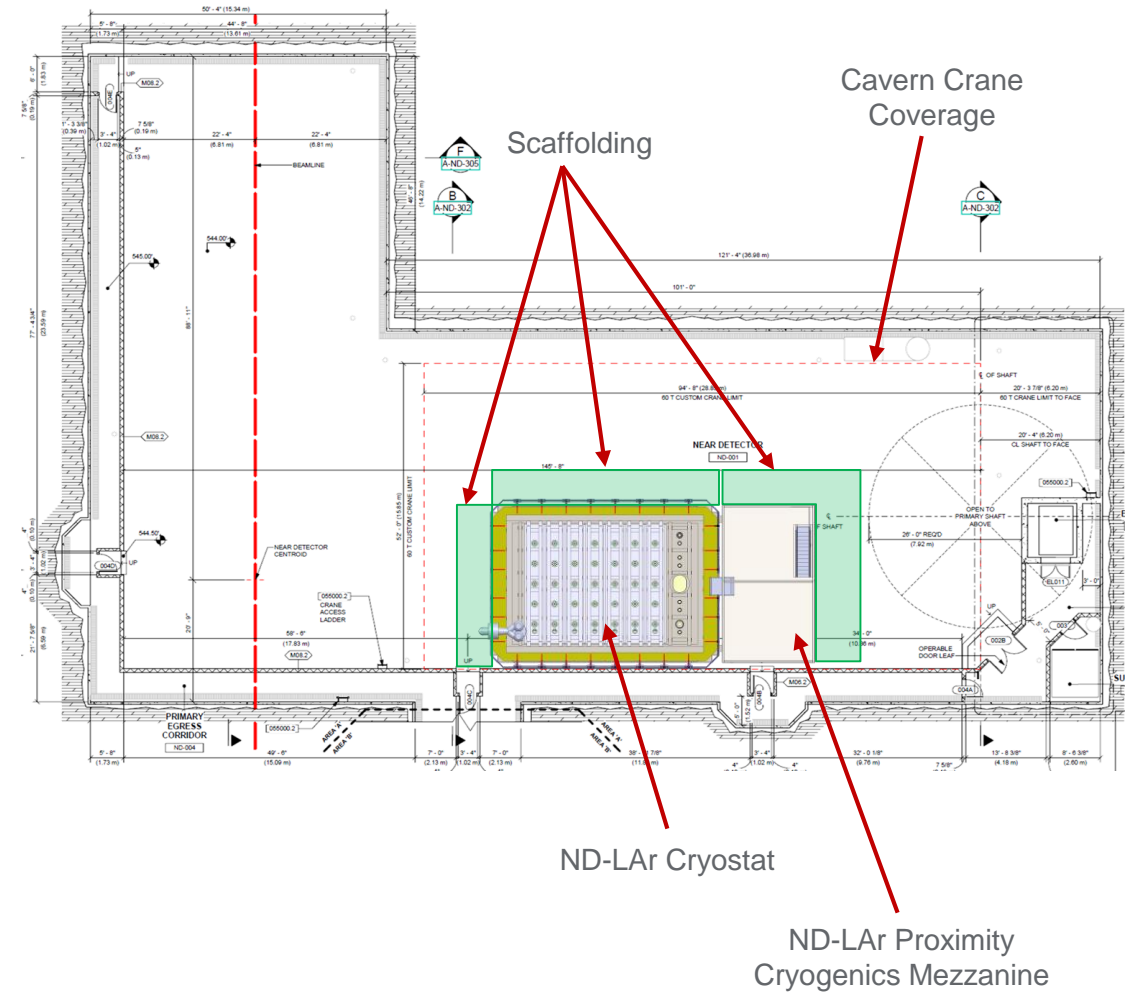
Introduction

- Peter Tennesen
 - BSME, Northwestern University
 - 6 months at Berkeley Lab
 - 14 years at energy storage startups
- ND-LAr Cryostat Project
 - Cryostat warm and cold structure
 - Support frame for PRISM system
 - Cryogenics mezzanine
 - TPC mezzanine

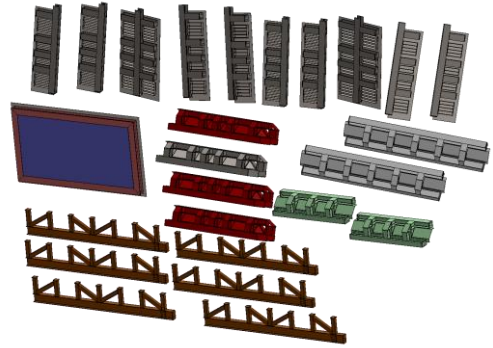


I& Strategy

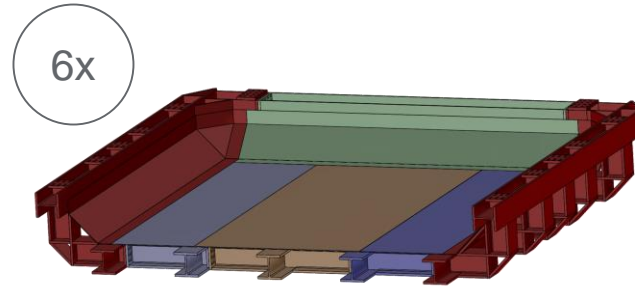
- Maximize vendor work
 - Push specialized fabrication to specialized vendors
 - Perform QC inspections before shipment
 - Limited by flatbed truck size and DOT weight limits
- Maximize near site surface work
 - Leverage large surface storage and assembly space (relative to cavern)
 - Simplify personnel access
 - Limited by shaft size and crane capacity
- Enable progress on other systems
 - Minimize cavern lane blockage
 - Minimize use of Hilman rollers
 - Perform gating work as early as possible



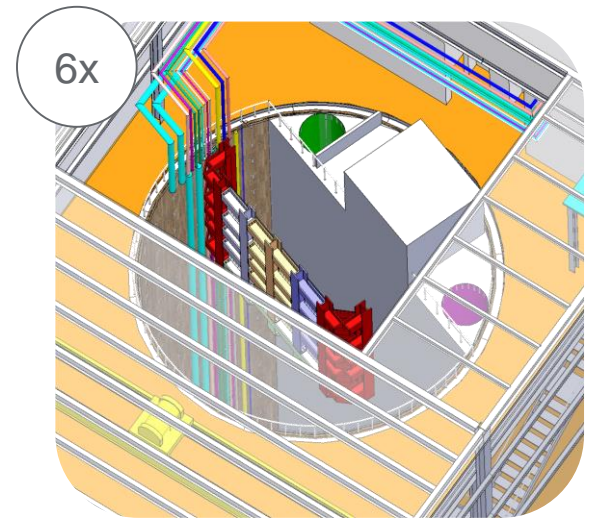
I&I Process Overview



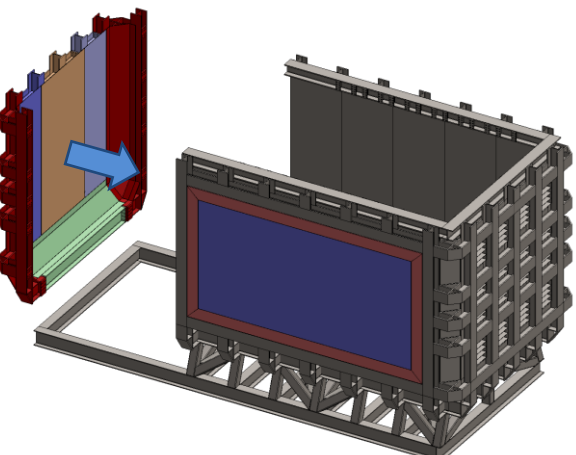
1. Receive 160 metric tons of warm structure parts in 40 pieces



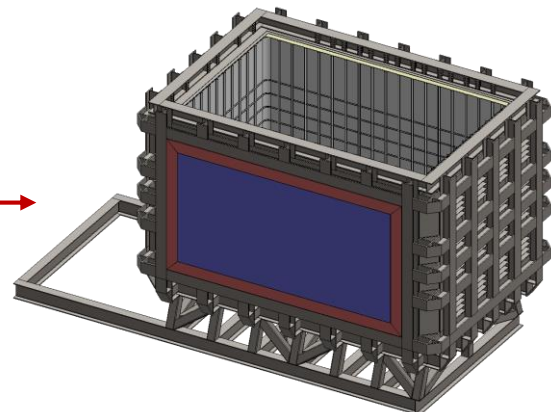
2. Align, bolt and weld pieces into subassemblies



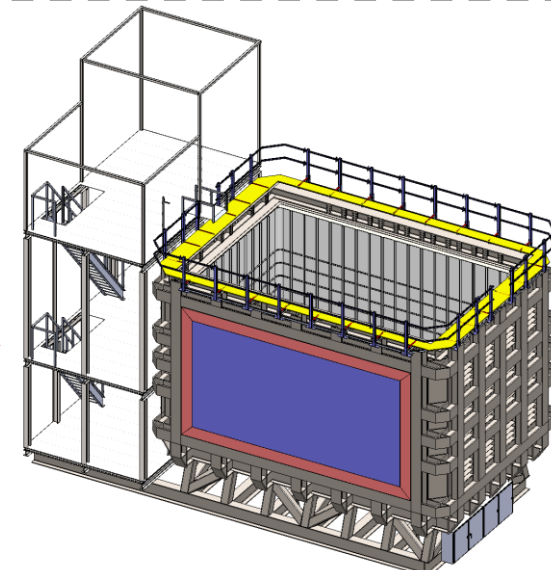
3. Lower 15-50 metric ton subassemblies into cavern



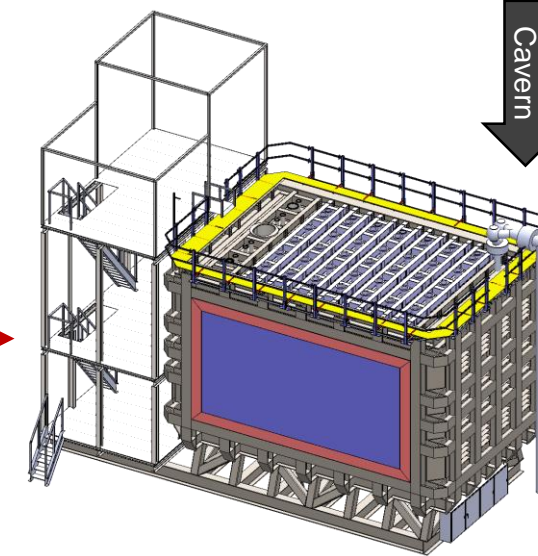
4. Align, bolt and weld subassemblies to form warm structure



5. Install cold structure



6. Install mezzanines



7. Install TPC rows and lid sections

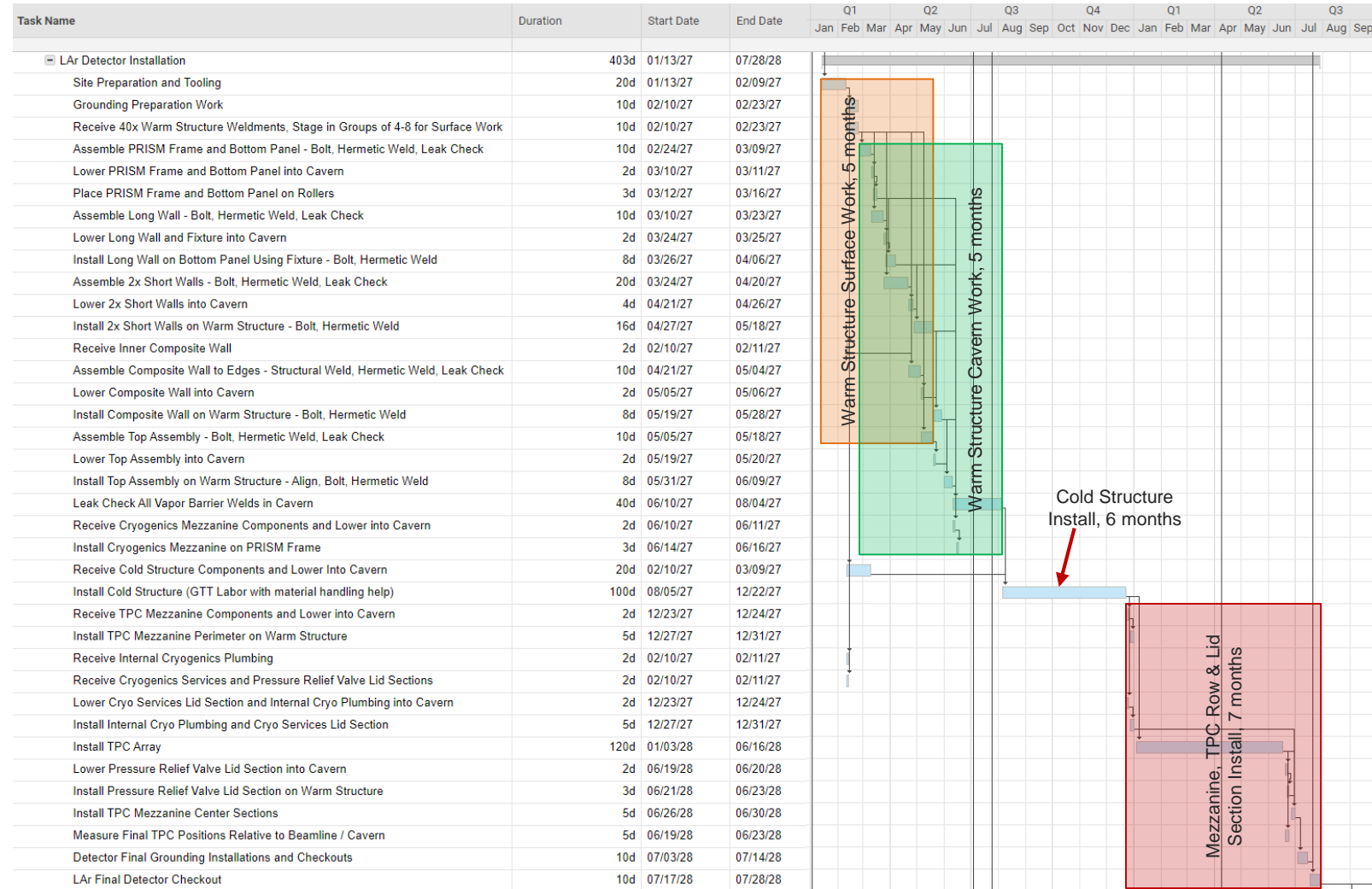
Major I&I Resources

Resource	Cumulative Usage (months)	Notes
Surface Crane or Forklift	3	Unload and stage 40 warm structure parts on surface, unload 20 tons total cold structure parts. Typical package weight 5 metric tons each.
External Rental Crane	3	Lower warm structure subassemblies (2.5 months) and mezzanines (0.5 months) down shaft. Likely 6 month break between the two while cold structure is installed. \$160k/month
Cavern Crane	6	Position warm structure subassemblies and mezzanines for installation, move cold structure material from shaft to inside of cryostat
Scaffolding	15	Access outside of 10m high warm structure (3 months), access inside of 6.5m deep cold structure (6 months), work on top of open cryostat during lid installation (6 months)

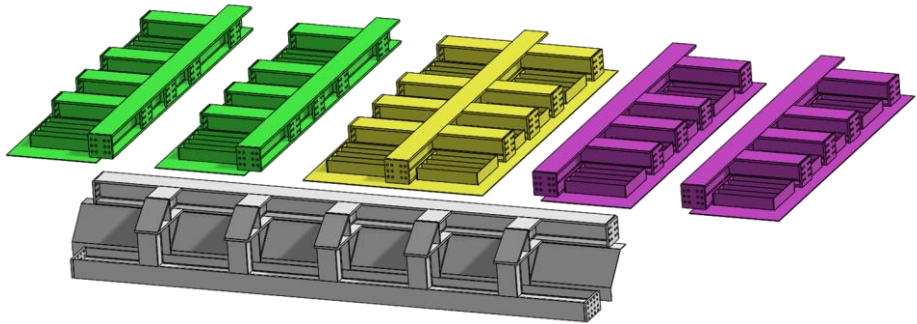
- Potential surface crane upgrade from 15 to 60 US ton
 - Cryostat would no longer require external crane, ~\$480k savings
 - Cavern crane 15 to 60 US ton upgrade was ~\$550k
 - Possible benefits to other detectors

Schedule

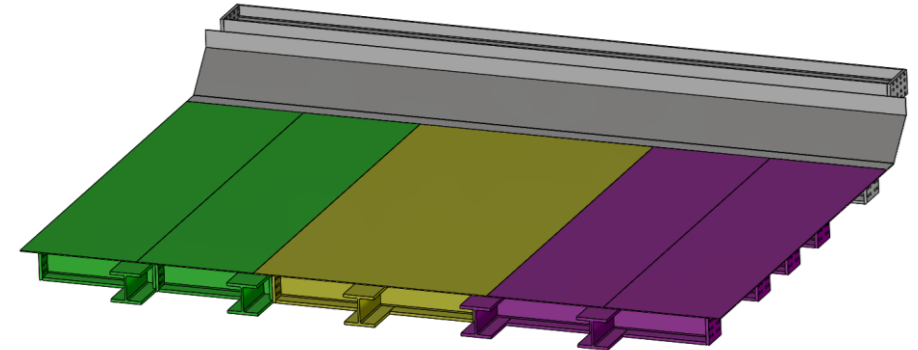
- Overall timeline 19 months with 6 months of TPC row installation
 - Nominal Jan 2027 – Jul 2028
- Predecessors
 - Surface building occupancy
 - Cavern occupancy
 - ND-LAr Hilman rails and rollers
 - ND-LAr energy chain
- Successors
 - ND-LAr Hilman cabinet and operation
 - TPC row installation
 - LBNF proximity cryogenics installation
 - LAr fill
 - ND-LAr detector commissioning



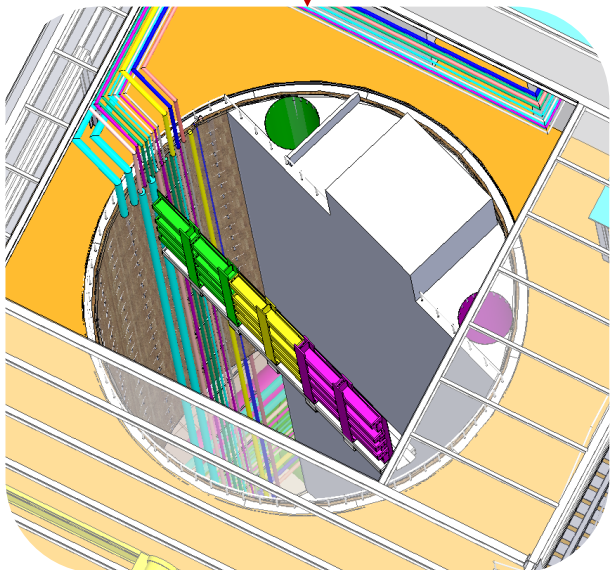
Warm Structure Wall Assembly (6x)



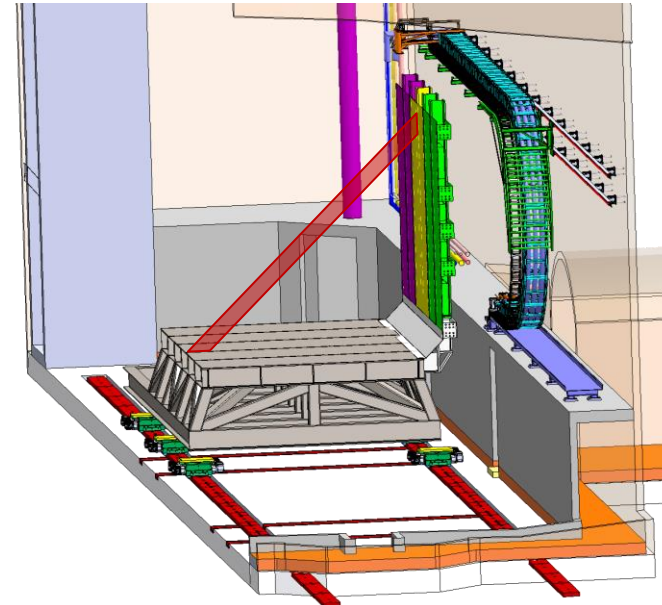
1. Align and bolt 4-8 weldments, typical 5 metric tons each. 7 days.



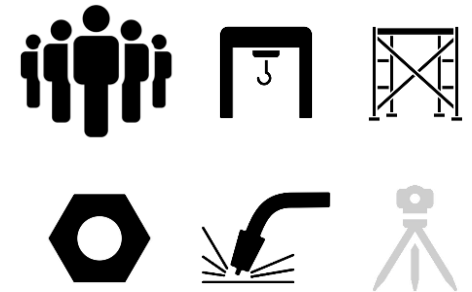
2. Weld and helium leak check vapor barrier panels. 3 days.



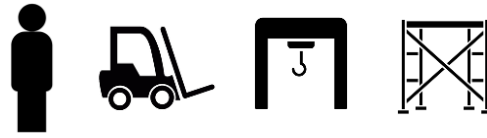
3. Lower 15-50 metric ton subassembly into cavern. 2 days.



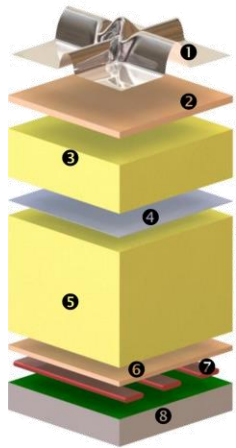
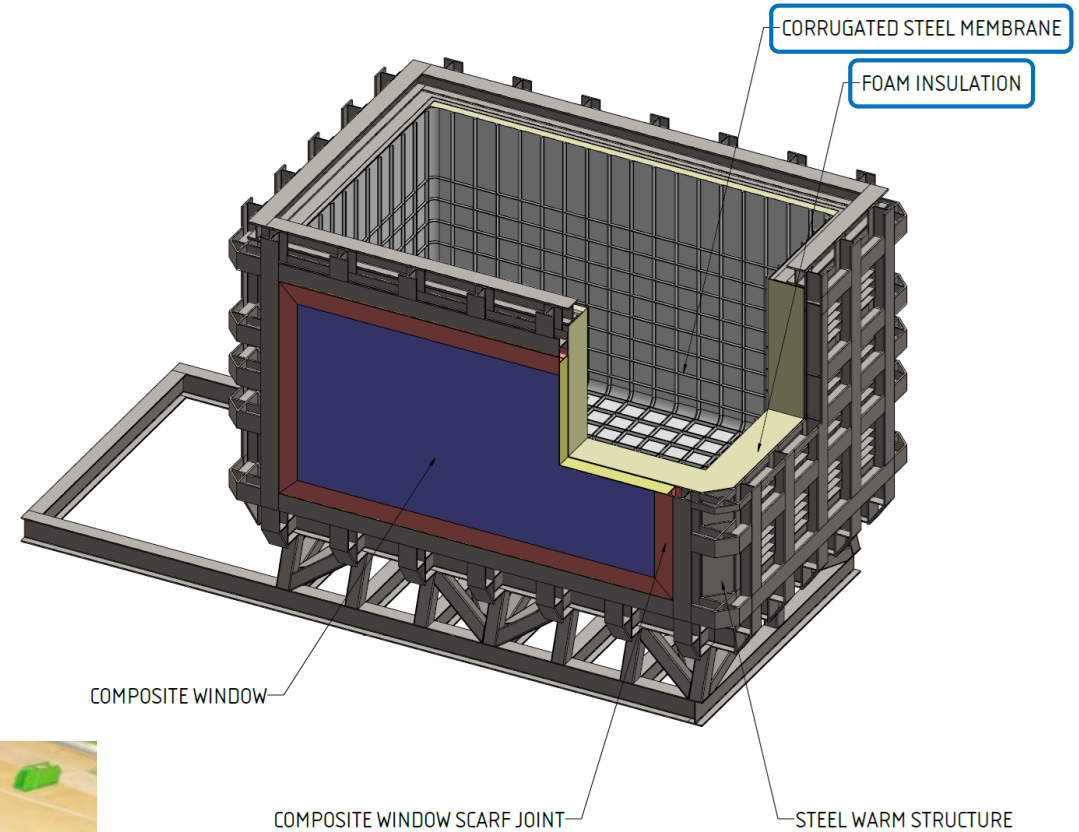
4. Align, bolt and weld to rest of warm structure. 8 days.



Cold Structure



- GTT provides:
 - Labor
 - Interior scaffolding?
- DUNE project provides:
 - Material handling from surface to cryostat
 - 20 tons of foam insulation
 - ~100 corrugated steel panels
 - Exterior scaffolding



- 1 Stainless steel primary membrane
- 2 Plywood board
- 3 Reinforced polyurethane foam
- 4 Secondary barrier
- 5 Reinforced polyurethane foam
- 6 Plywood board
- 7 Bearing mastic
- 8 Steel structure with moisture barrier

Cold Structure Construction
(Courtesy GTT)

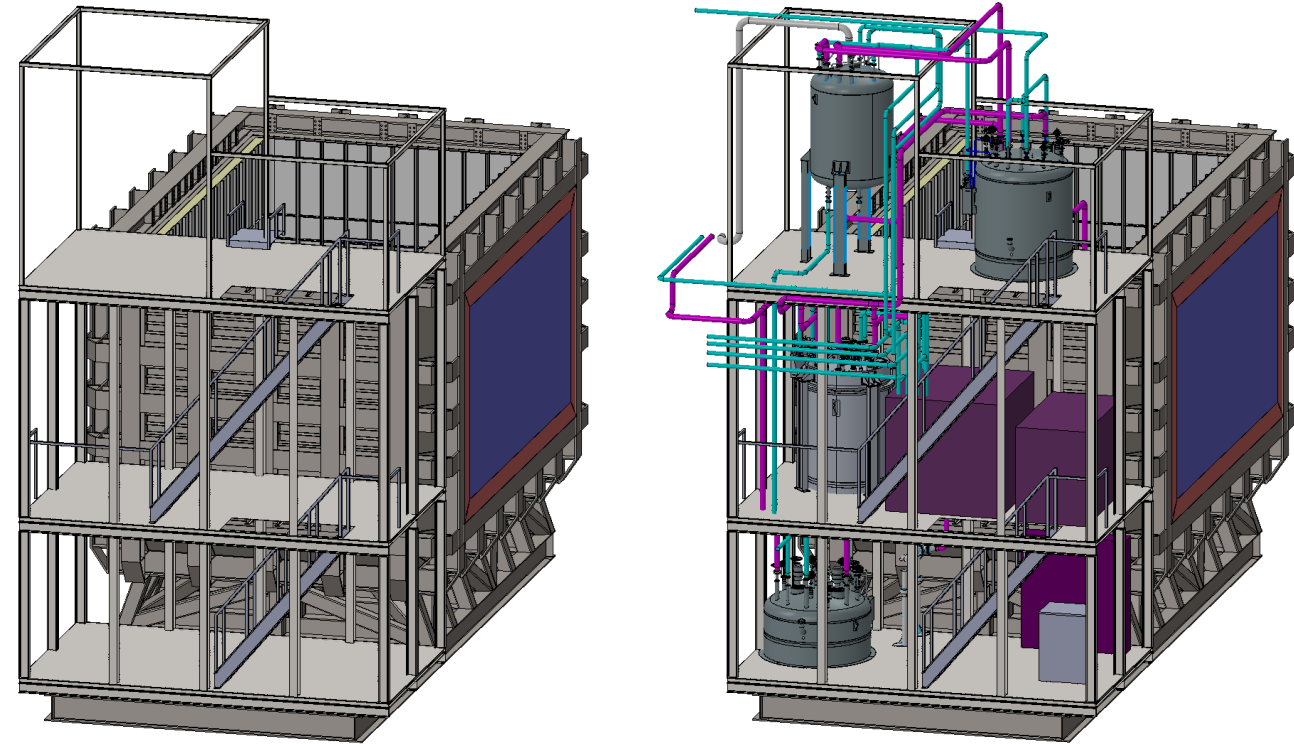


Completed Cold Structure Example

Cryogenics Mezzanine



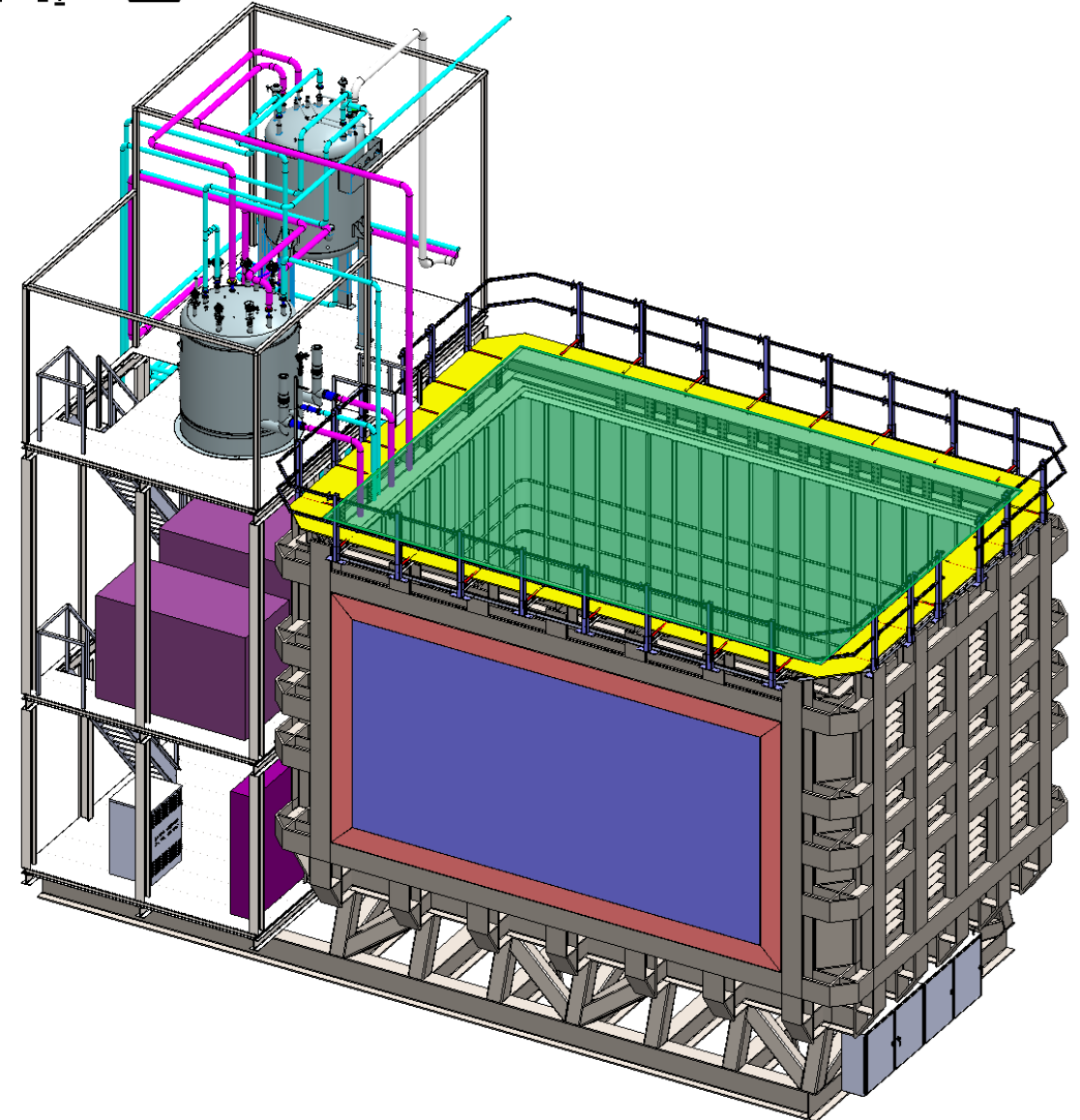
- Can be installed any time after warm structure is completed
- Potential time savings by installing and populating mezzanine in parallel with cold structure work
- Populated with components by LBNF cryogenics group
- Supports detector side of ND-LAr energy chain



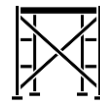
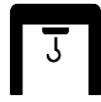
TPC Mezzanine



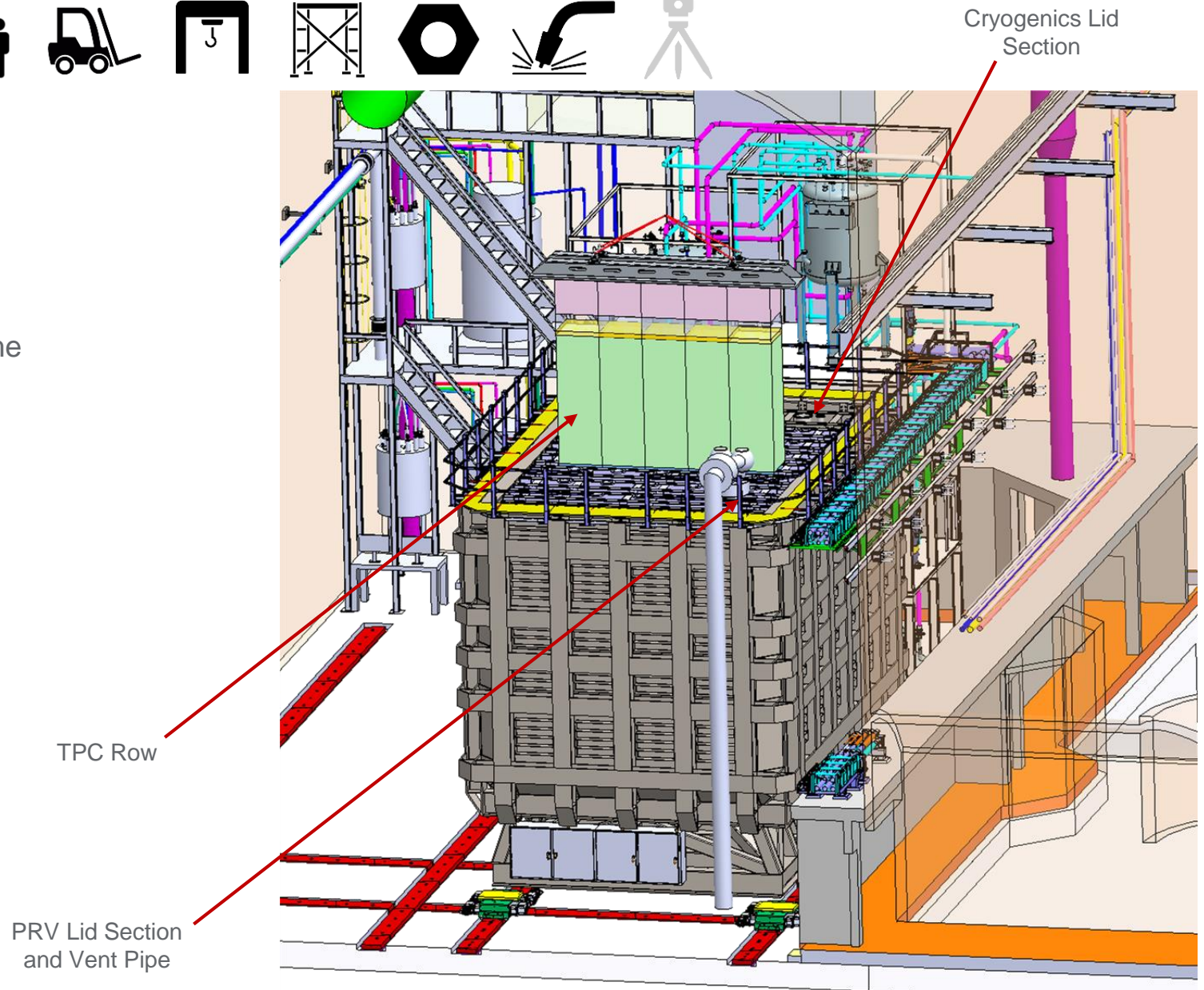
- Install perimeter of TPC mezzanine before TPC rows or lid sections
 - Improved personnel access
- Use blanking panels to close top of cryostat
 - Personnel safety
 - Contamination prevention



Lid Sections

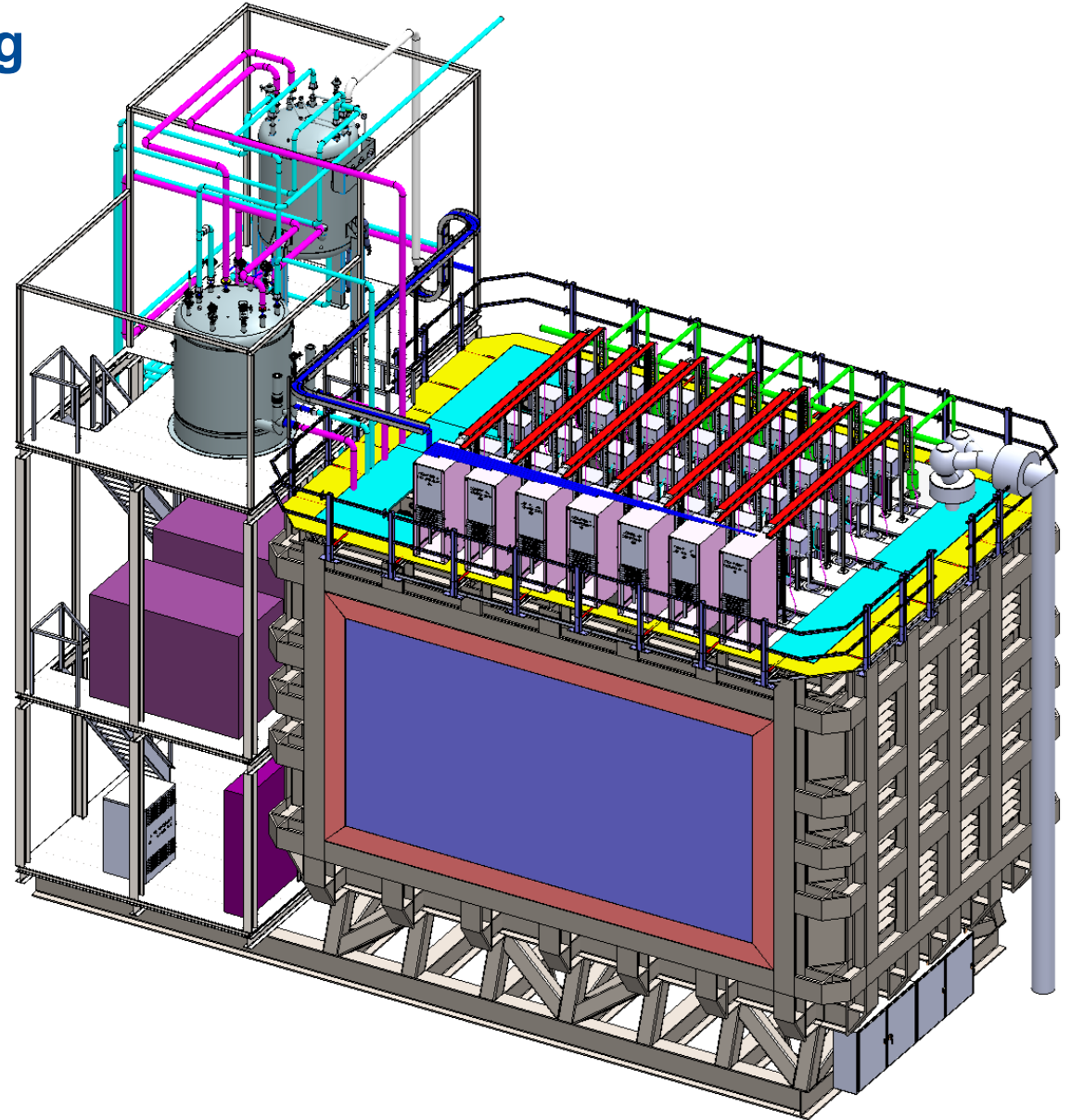


- All lid sections bolt in place then receive serviceable hermetic weld
- Cryogenics lid section
 - Lift with cavern crane
 - Install internal cryostat plumbing at same time
- 7x TPC rows
 - See Andrew Lambert's LAr-TPC plan
 - Lifting method TBD, cavern crane too low
- Pressure relief valve (PRV) lid section
 - Lift with cavern crane



Detector Final Integration & Commissioning

- ND-LAr Cryostat
 - Monitor warm structure strain during LAr fill
 - Inspect for heat leaks
- LBNF Cryogenics
 - Final welded pipe connections between cryogenics mezzanine and cryostat plumbing
 - LAr fill
- ND-LAr Consortium
 - See DU-1003-6568 ND-LAr Pre-operations and Commissioning Procedure (Asaadi / Lambert)



Reference

- EDMS Project CERN-000213956:
<https://edms.cern.ch/ui/#!/master/navigator/project?P:100729005:100729005:subDocs>
- Windchill assembly DU-1003-4680
- Smartsheet working schedule:
<https://app.smartsheet.com/sheets/xwFpXqq4FvfXFmfXfHHcwXCx7V5ChWqrXH8HJRj1?view=gantt>

Legend

Forklift / Surface Crane	External Crane	Cavern Crane	Scaffolding	Alignment	Bolted Joints	Welding	Helium Leak Check	4-6 People	1-3 People
