# Cryostat top infrastructure

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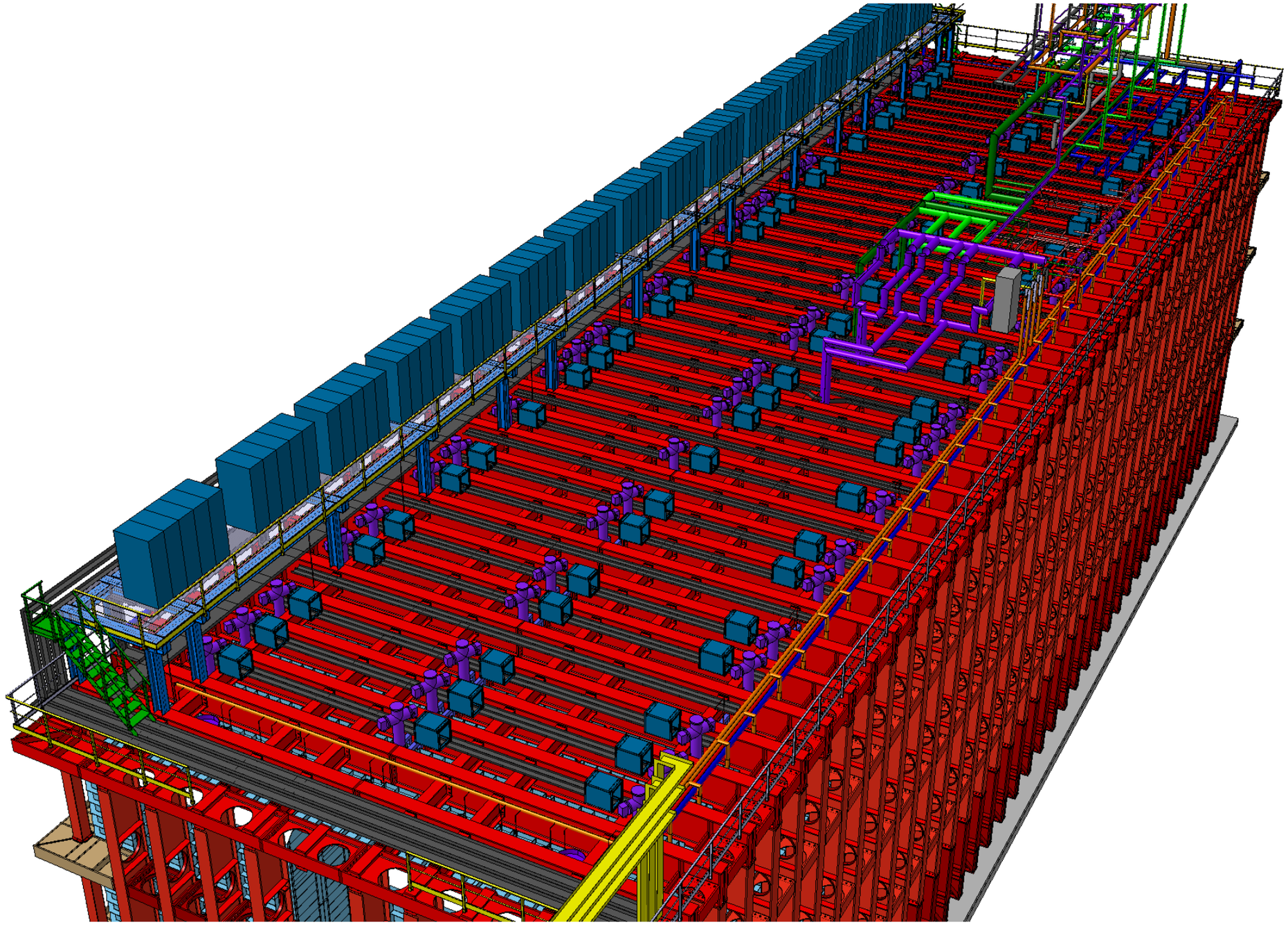
# Item list

- Welded flanges on the pipe penetrations
- Mechanical supports for flanges supporting significant load
- Manifold for air purging and argon gas recirculation
- Racks and supports on the roof/mezzanine (light under the mezzanines?)
- Cable trays on the roof and mezzanine
- $GN_2$ management for insulation
- False floor

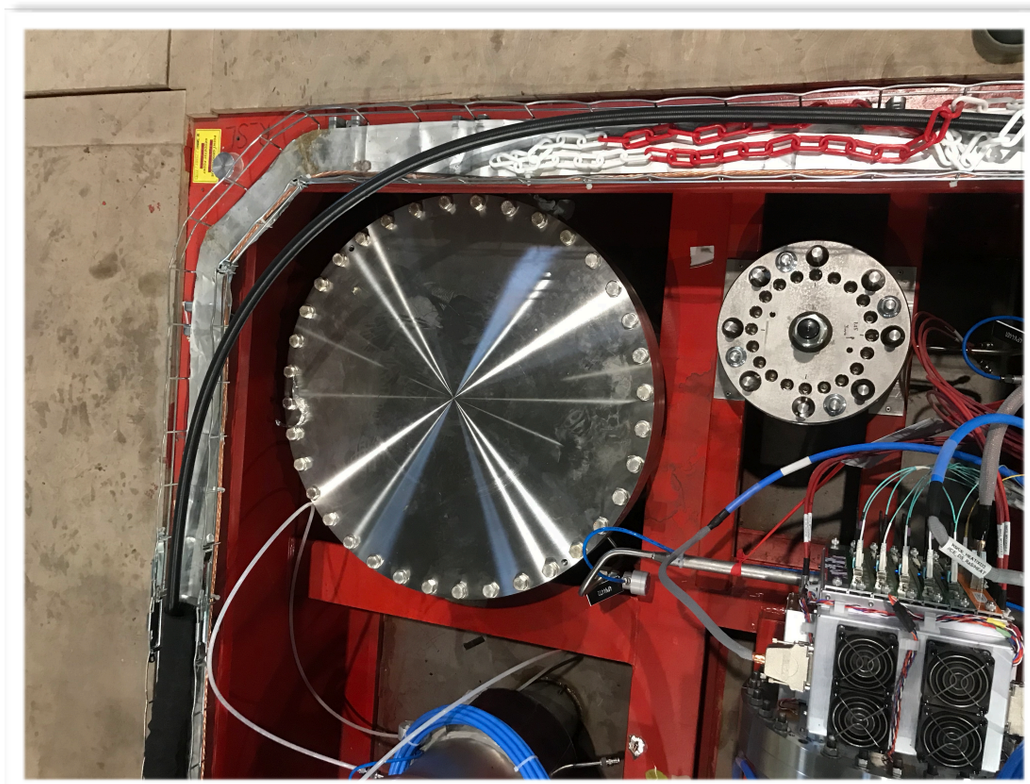
Three welders / pipe fitters per cryostat for one year considered to be sufficient to assemble and construct this list of items.

# Overview



# Flanges

239 CF flanges (mostly CF200/CF250) threaded? ~1.2 ton
Special requirements on the alignment (DSS?)
Gasket, 7700 bolts + washer + nuts provided with the feedthroughs?
Weld more than 10 flanges/day/welder when flanges are in place
4 man holes 80 cm in diameter (welded and bolted flange)
To be leak tested (helium sniffing). Helium injected from the GAr purge.



| Pos. | Diameter [mm] | Quantity | Description |
|---|---|---|---|
| 1 | Ø200 | 100 | Support |
| 2 | Ø250 | 75 | Cable |
| 3 | Ø250 | 4 | High voltage |
| 4 | Ø250 | 21 | Instrumentation |
| 5 | Ø800 | 4 | Manholes |
| | | | |
| | | | |
| | | | |
| | | | |

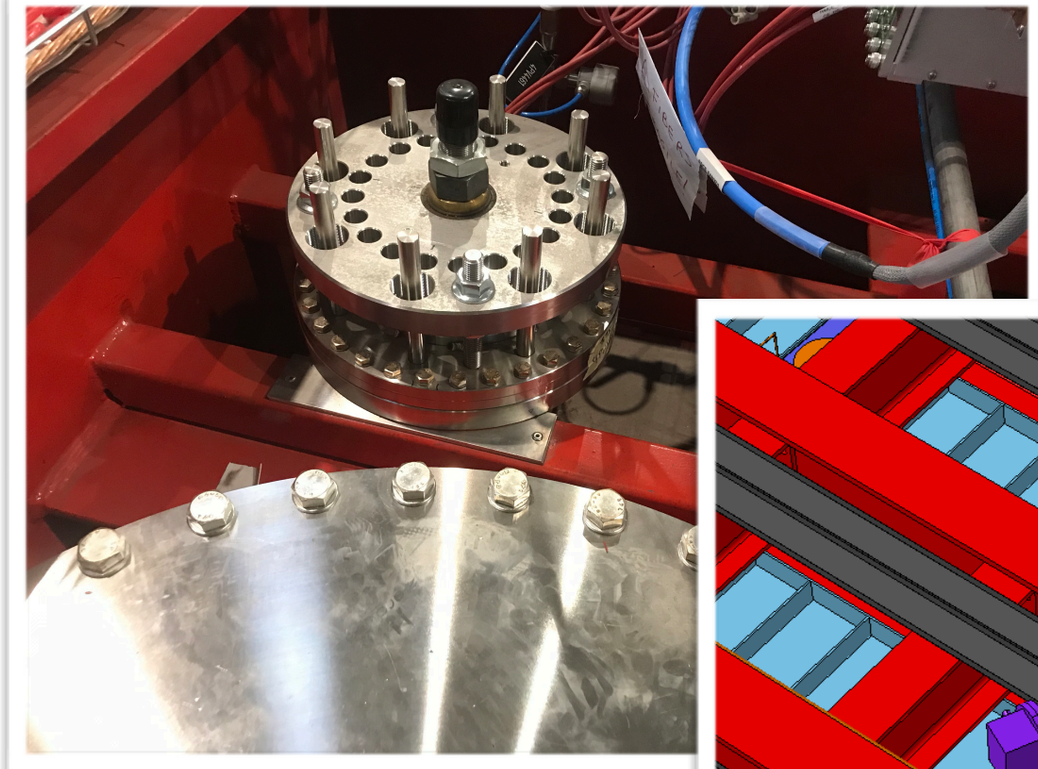
Cryogenic penetrations - 39 ps.

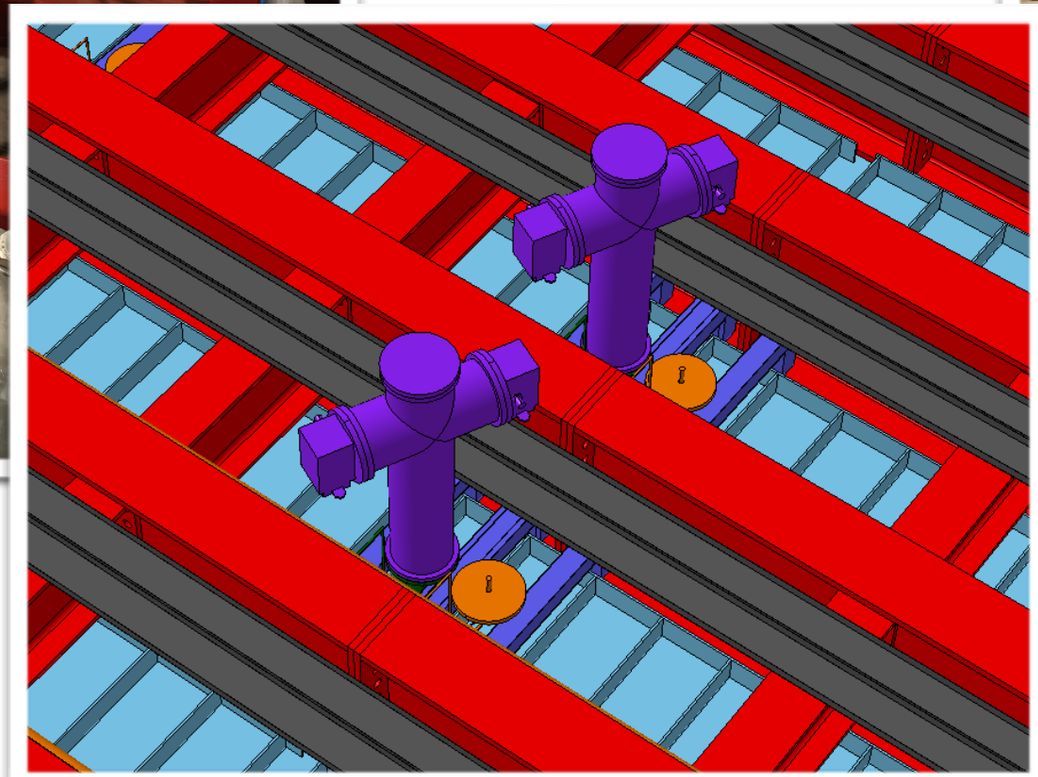
| Pos. | Diameter [mm] | Quantity | Description |
|---|---|---|---|
| 20.1 | Ø250 | 20 | L+G Ar cool down |
| 20.2 | Ø200 | 3 | Spare |
| 21.1 | Ø152 | 4 | G Ar Controled vent |
| 22.1 | Ø304 | 2 | G Ar Boil off |
| 22.2 | | 4 | G Ar Relief/Safety |
| 23.1 | Ø273 | 2 | L Ar Return |
| 23.2 | | 1 | L Ar Emergency return |
| 25.1 | Ø219 | 1 | G Ar Purge |
| 25.2 | | 1 | G Ar Make up |
| 25.3 | | 1 | G Ar Momentum |

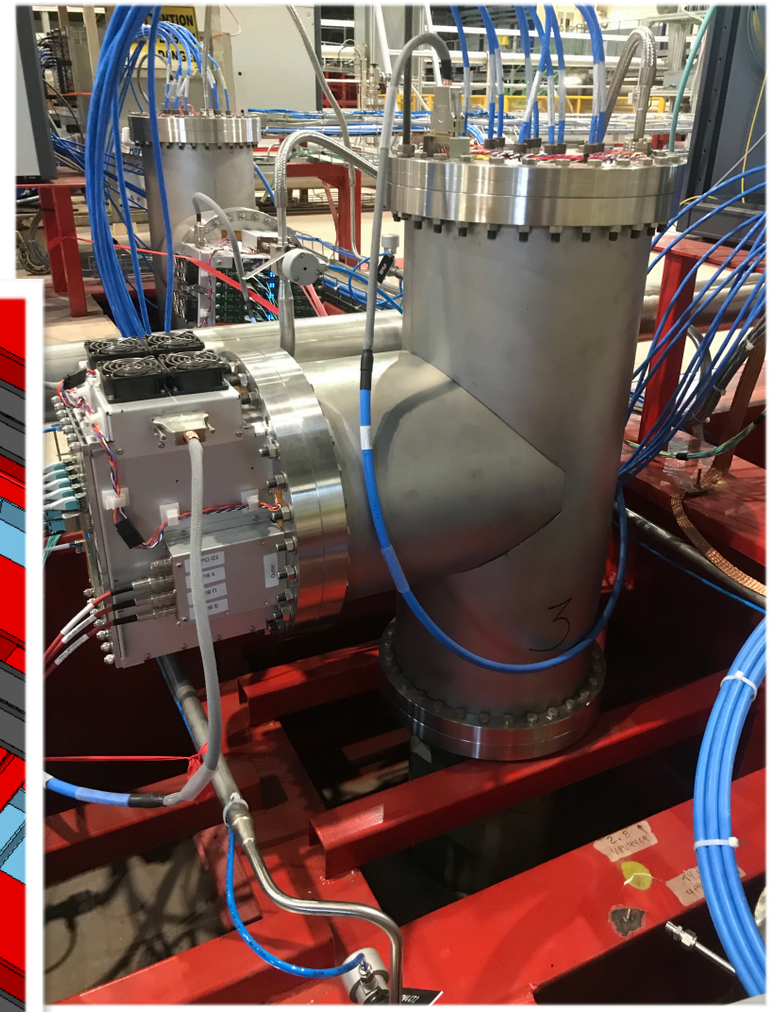
# Supports

Mechanical supports needed for flanges that support significant weight:
- the DSS penetrations
- the cold electronics penetrations

Hollow square section welded on the warm structure I-beam.
Size based on the ProtoDUNEs supports. Calculation needed.
Need to be welded after the the flanges are in place.
Additional supports for purity monitors, HV filter, cryogenic pipes, …?







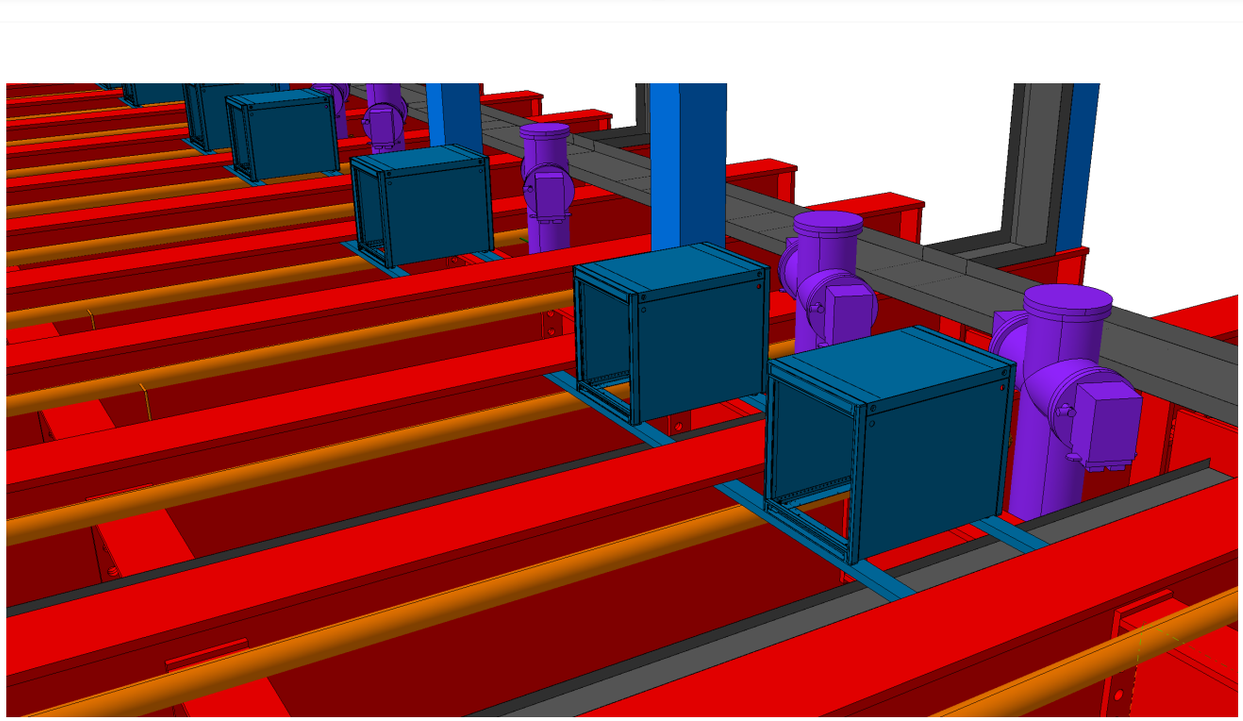
# GAr recirculaation manifold

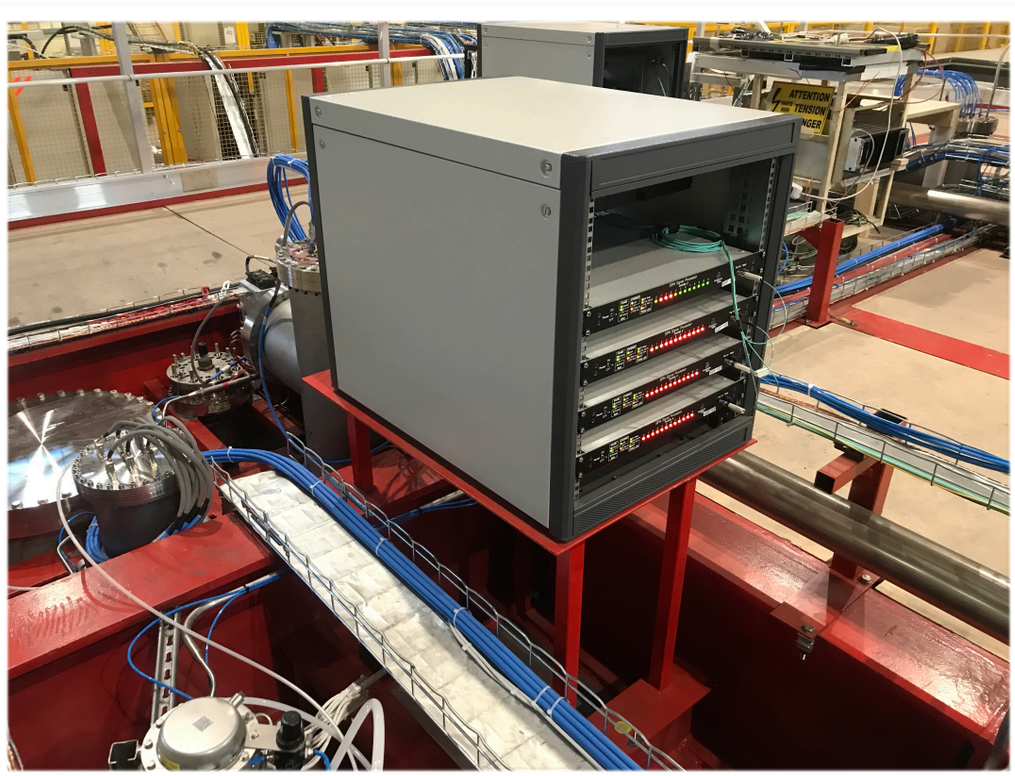
- Gas pickup points on all the chimneys/feedthroughs gathered into a pipe manifold with flexible SS tubes connected to the cryo system.
- Eventually (a fraction of the flow) goes through trace analysers.
- On/off valves to exclude some of the chimneys
single valve can group the flow of several chimneys (to be defined).
- Control to operate the valves (compressed air pipes to each valve).
- Manifold (DN100) welded in place and pressure tested
~3 months for one welder and one technician.

# Rack and supports

80x 42U racks installed (on detector ground) on detector mezzanine.
75x 12U racks installed on the roof (very close/above some DSS penetrations).

Supports welded/bolted to the warm structure
Simple hollow square bars sized as in ProtoDUNE.
Racks feet directly fixed to the bars.
At the moment supports run above the cable trays.
Design can be improved to simplify the cabling.

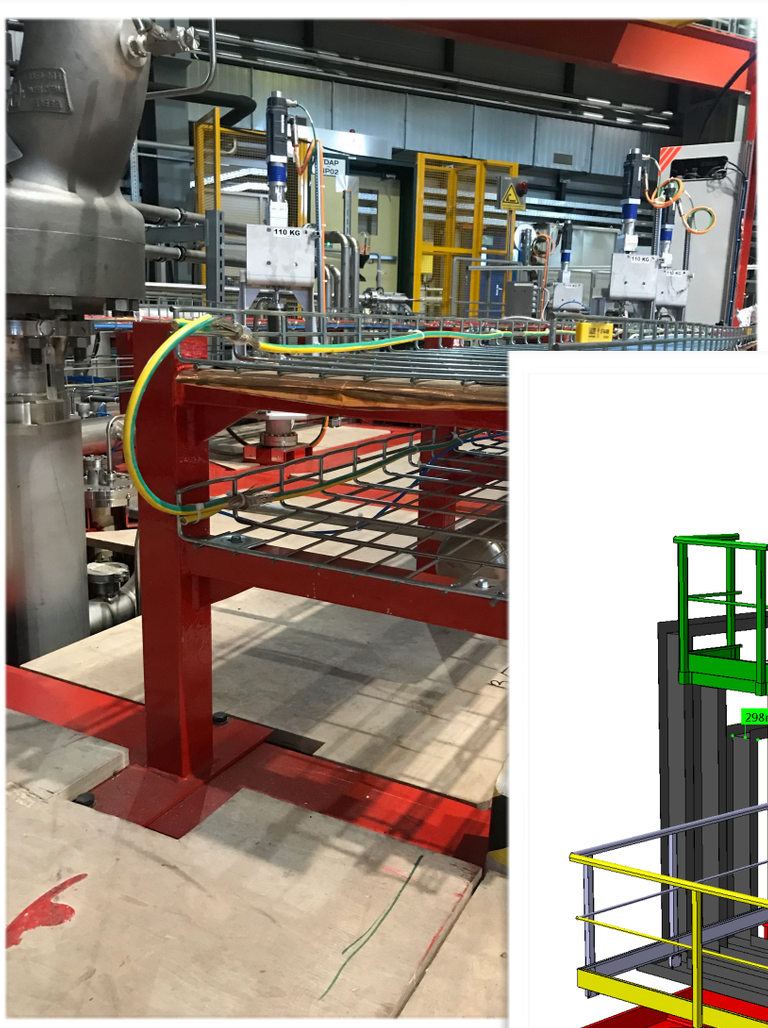


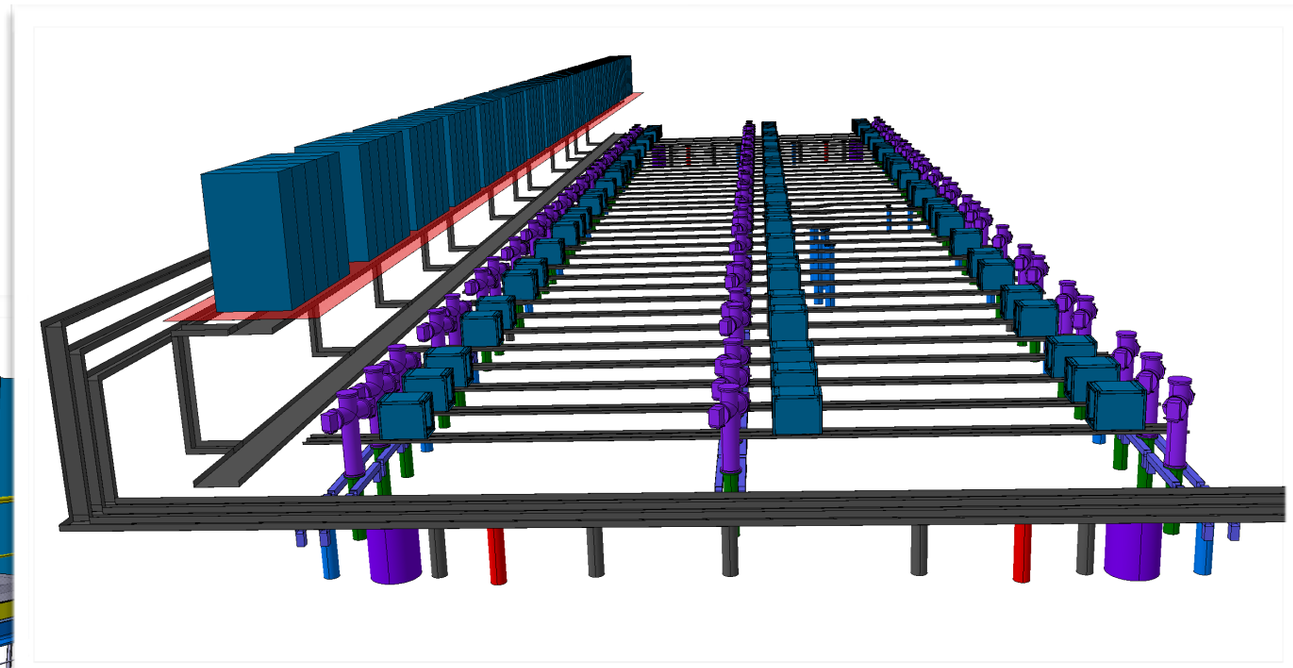


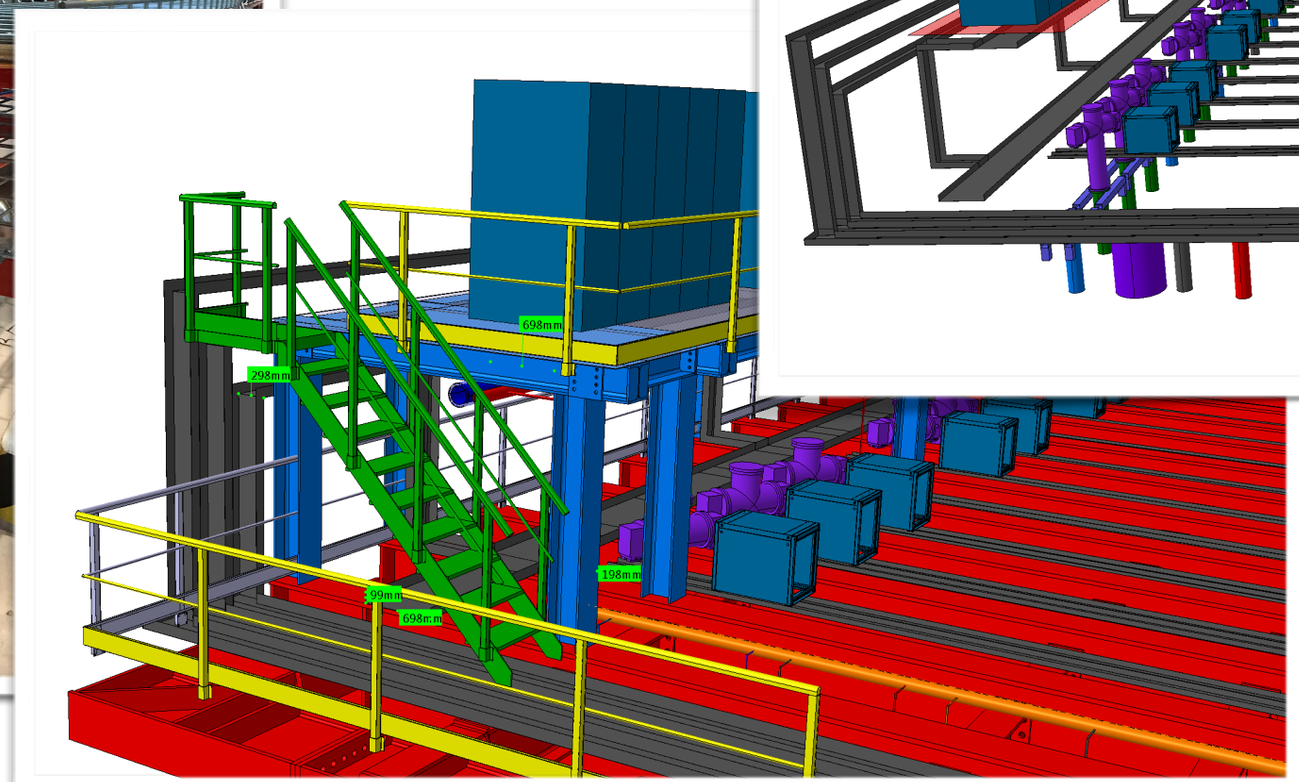
# Cable trays

- 36x 2x (signal and power) 200 mm width 15 m long along the cryostat width
- 2x 700 mm width 60 m long along the cryostat length (under the mezzanine)
- ~12x 400 mm width connecting the mezzanine to the cryostat
- Hollow square bars as support welded/bolted to the warm structure
- Typically cable trays arrive in 3 m long sections. Simple and quick installation.

Width of the cable trays based on NP04 (there is space to increase the width).

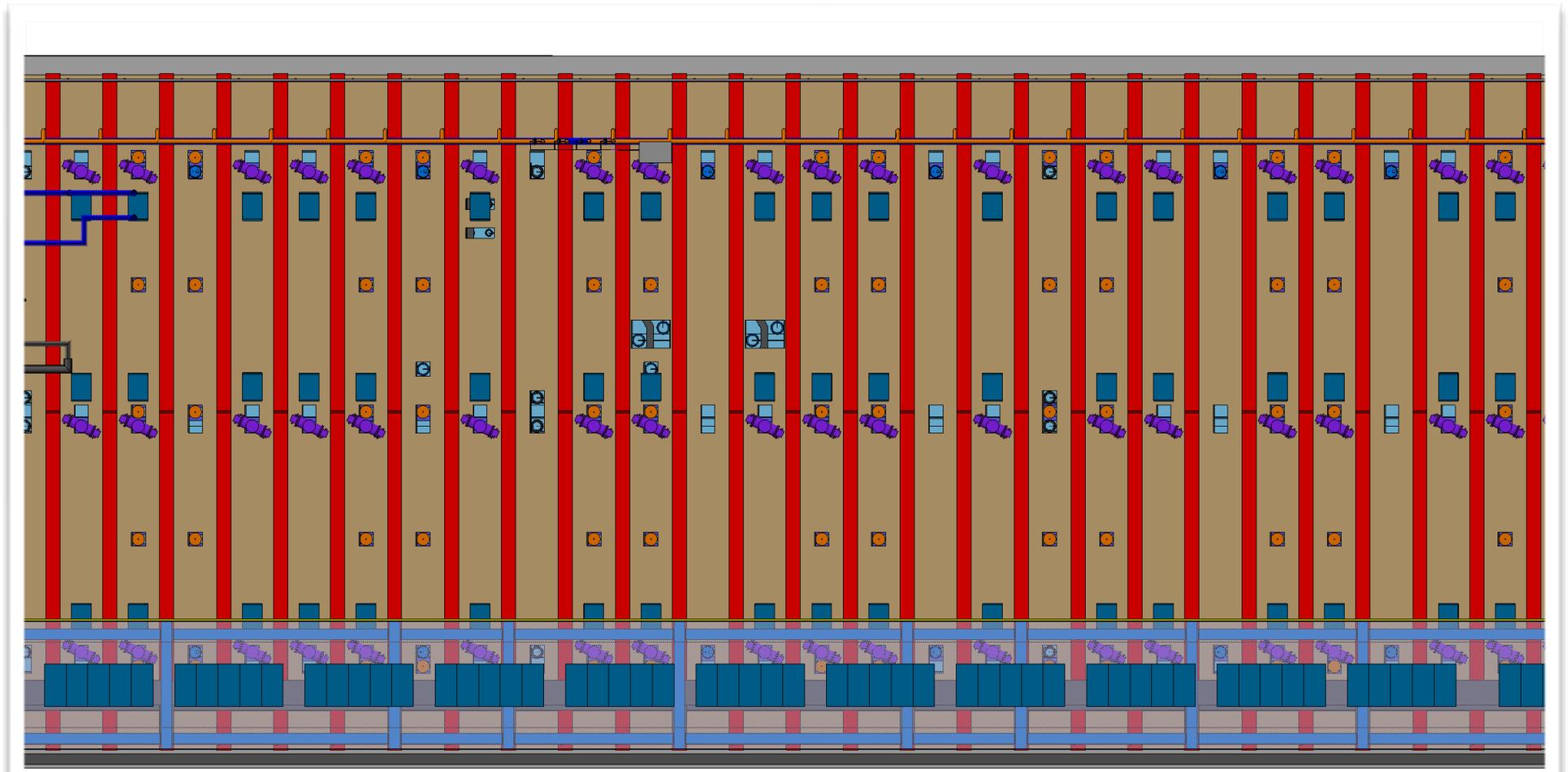






# False floor

Covering 100% of the walkable surface. Final material not identified (Plywood in ProtoDUNEs).
Simple to be cut (to go around obstacles). Limit steps as much as possible (ideal flat surface).
Naturally divided along the length of the cryostat. Additional segmentation to be defined.
Light for simple installation and easy to be removed to access underneath.
Each section should hold the weight of a person. The floor will be used to transfer material too.
Maximum load circumstance to be defined. False floor cover pipes and cable trays.



# $GN_2$ management

It consists of valves and controls to assure all the time slight overpressure with respect to the atmosphere in the two insulation spaces to avoid moisture back flow.
The system must cope with the variation of the atmospheric pressure and with the filling.
$GN_2$ provided by cryo. Consumption:
- during normal operation O(1 $m^3/h$) - quite small (can be released in the atmosphere).
- during cool-down and filling expected larger and depends on the “cool-down speed”.

Two input and two output in the two independent insulation spaces + pressure measurements.
The two volumes are connected outside (during operation pressure should always be the same).
Ideally pressure P is regulated within two values $P_{min}$ and $P_{max}$:
- Input valve opens when $P < P_{min}$ and closes when $P > P_{max}$
- Output valve opens $P > P_{max}$ and $P < P_{min}$

Gas analyser based on Residual Gas Analyser (RGA) installed on the output to monitor the gas composition.