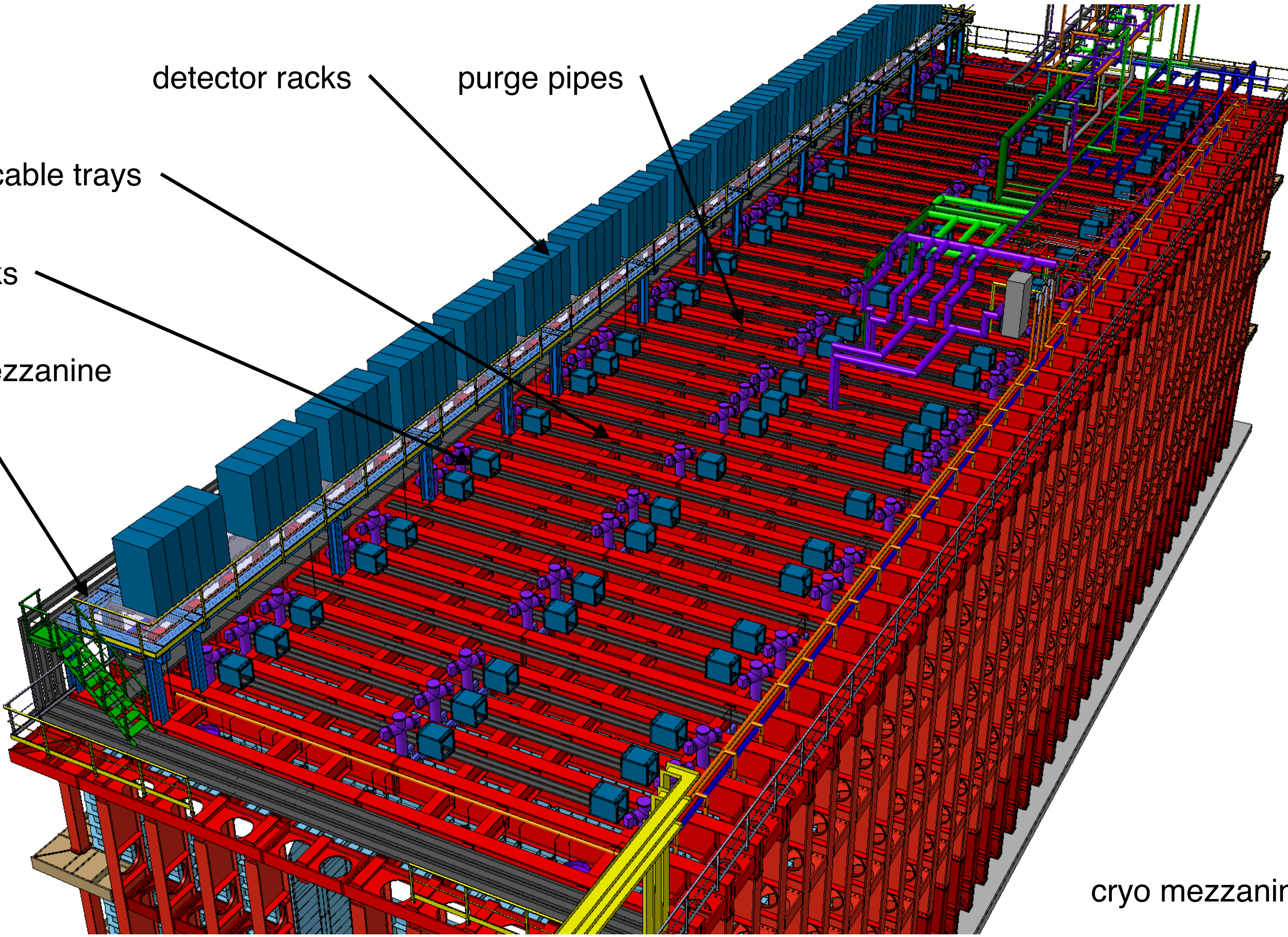
Cryostat Roof Infrastructure and Installation

Filippo Resnati (CERN)

FS Integration/Installation Workshop - Kartause Ittingen - 3rd February 2020

Overview



cryo mezzanine removed

List of items

- Welded flanges on the pipe penetrations

- Mechanical supports for flanges supporting significant load

- Manifold for air purging and argon gas circulation

- Gas trace analysers

- Racks and supports on the roof and mezzanine

- Cable trays, lighting and grounding on the roof and mezzanine

- GN2 management for insulation and HV + pumps + gas analysers

- False floor

A note

- Cryo and detector mezzanines are completed at the same time as the warm cryostat.

- Roof infrastructure installation is done while cold cryostat is being installed.

- Roof infrastructure must be ready before the cold cryostat completion to allow detector component to be installed on the roof timely.

- According to today's P6 schedule the roof infrastructure installation is supposed to happen between July to October '25 (~3 months).

- Major constraint to the installation is the co-activity on the roof which would be dramatically reduced if the installation can take more time (start before?).

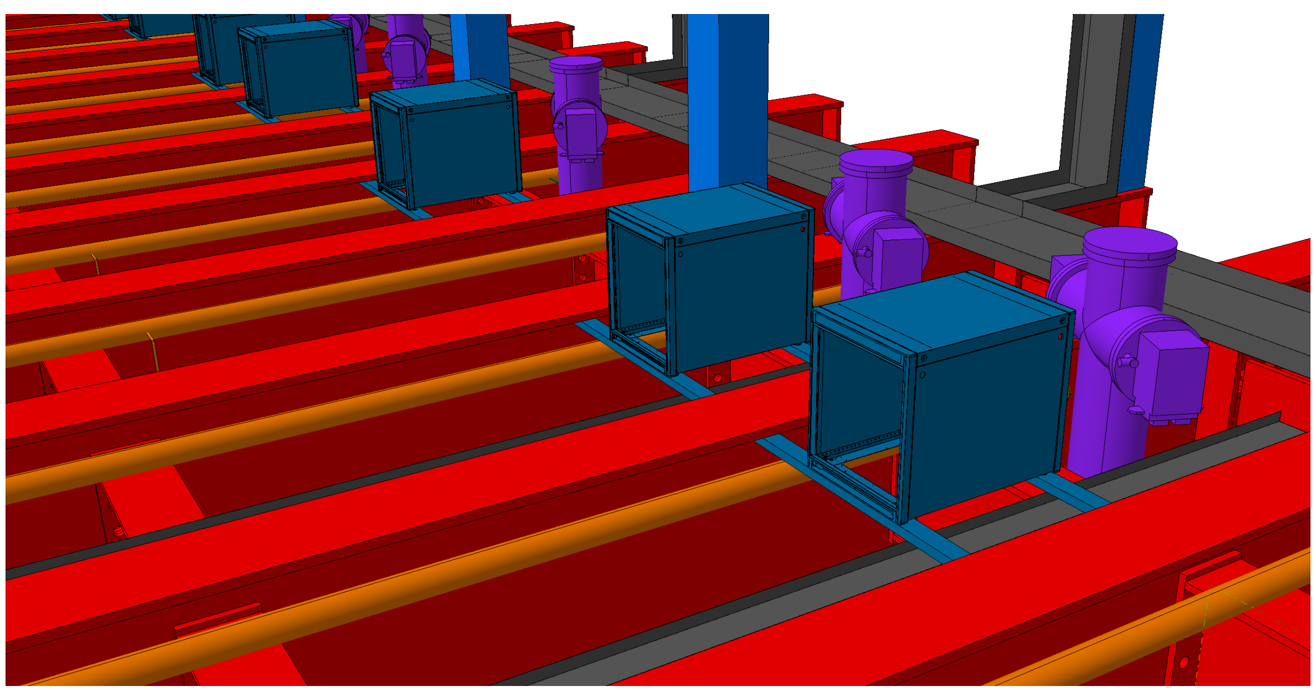
- Three welders / pipe fitters per cryostat for one year are considered to be sufficient to assemble, construct and instal the roof infrastructure items.

- Two shifts/days seems unavoidable given the actual schedule.

Rack supports

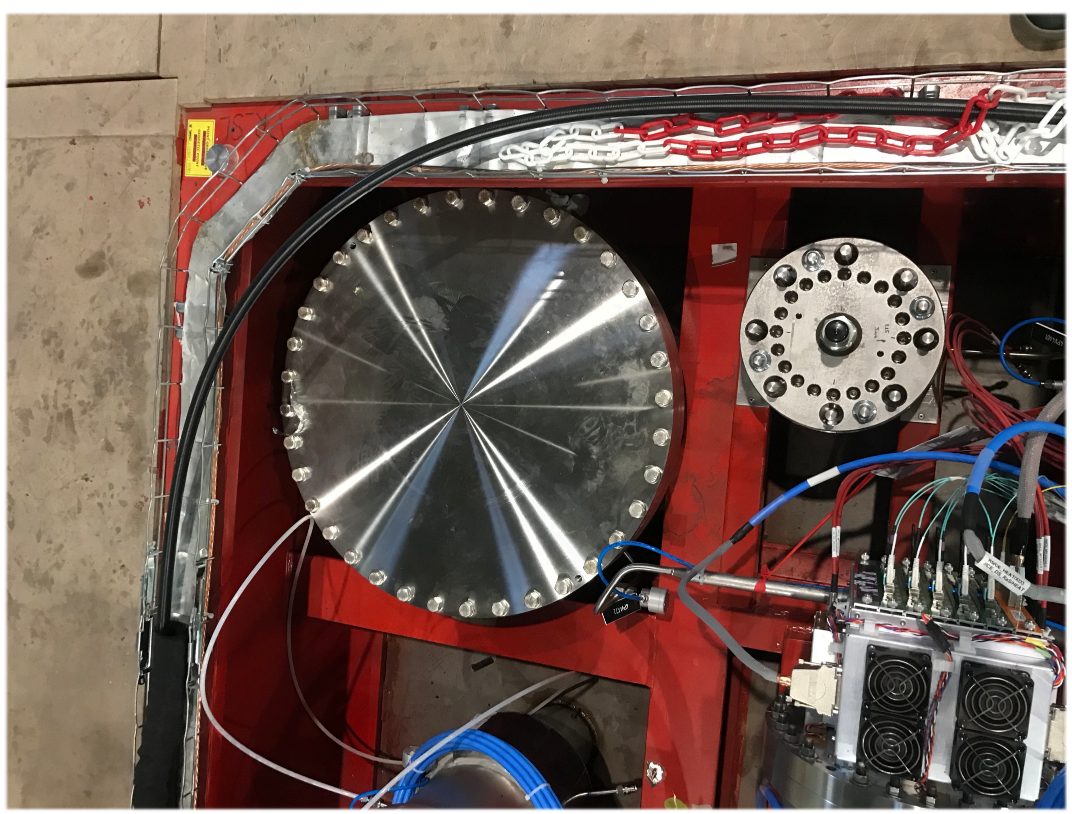
80x 42U air cooled racks installed and anchored on the detector mezzanine.
75x 12/15U racks installed on the roof (very close/above some DSS penetrations).
Position of the racks chosen to stay as close as possible to the relevant penetration.
Constraints on the maximum lengths of cables/fibres to optimise the position of the racks.

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.



Flanges

Penetration pipes are installed together with the insulation.
239 CF flanges (mostly CF200/CF250) with holes in general NOT threaded.
4 man holes 80 cm in diameter (welded and bolted flange).
Need to know critical requirements on verticality/alignment.
Tack weld alignment can be done with actual component installed.
Gasket, 7700 bolts + washer + nuts provided with the feedthroughs.
On average 10 flanges/shift/welder can be installed, aligned and welded.
Should the welds be leak tested with helium prior feedthrough installation?
Flanges should then be covered with protecting flanges.



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

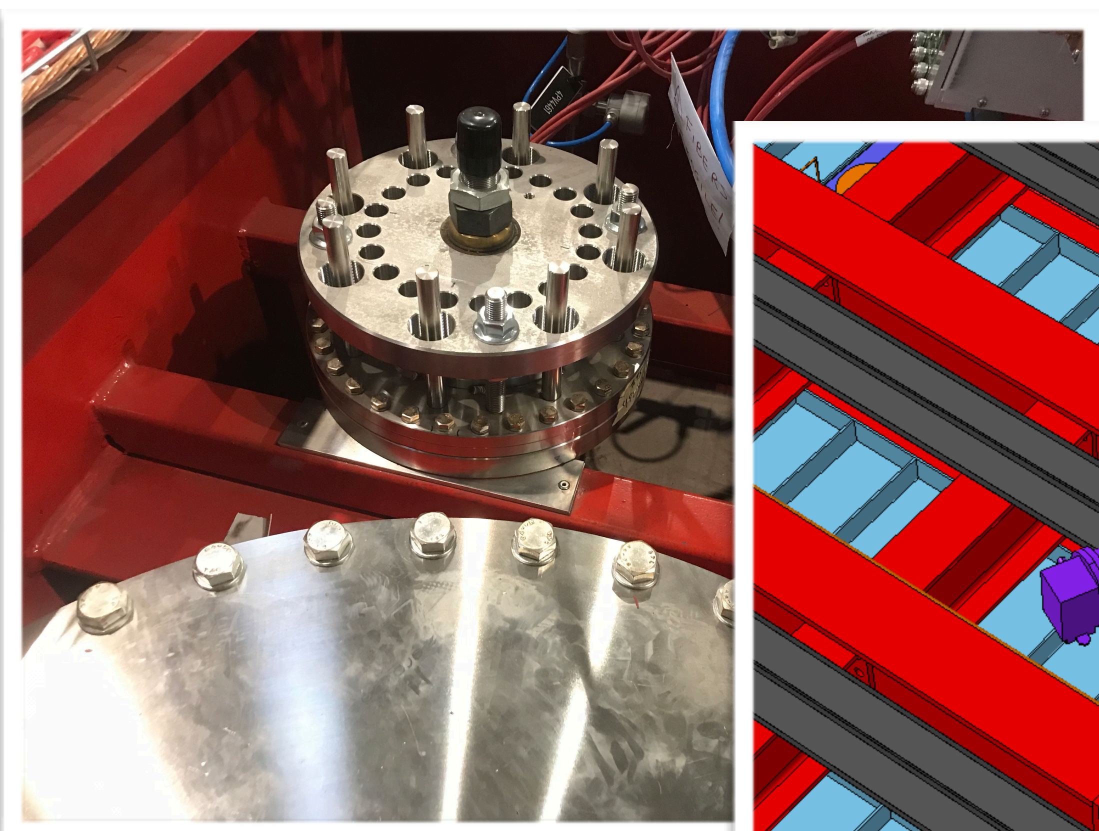
Cryogenic penetrations - 39 ps.

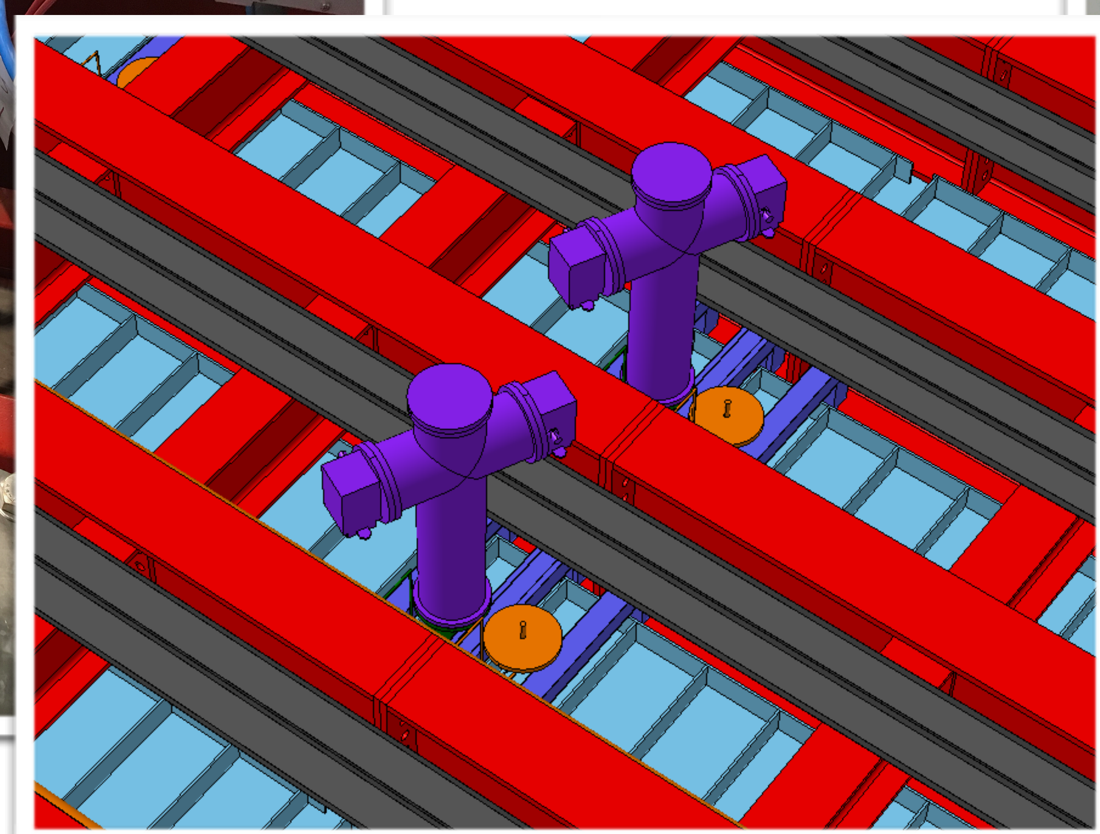
Pos.	Diameter [mm]	Quantity	Description
20.1	Ø250	20	L+G Ar cool down
20.2	Ø200	3	Spare
21.1	Ø152	4	G Ar Controled vent
22.1	Ø304	2	G Ar Boil off
22.2		4	G Ar Relief/Safety
23.1	Ø273	2	L Ar Return
23.2		1	L Ar Emergency return
25.1	Ø219	1	G Ar Purge
25.2		1	G Ar Make up
25.3		1	G Ar Momentum

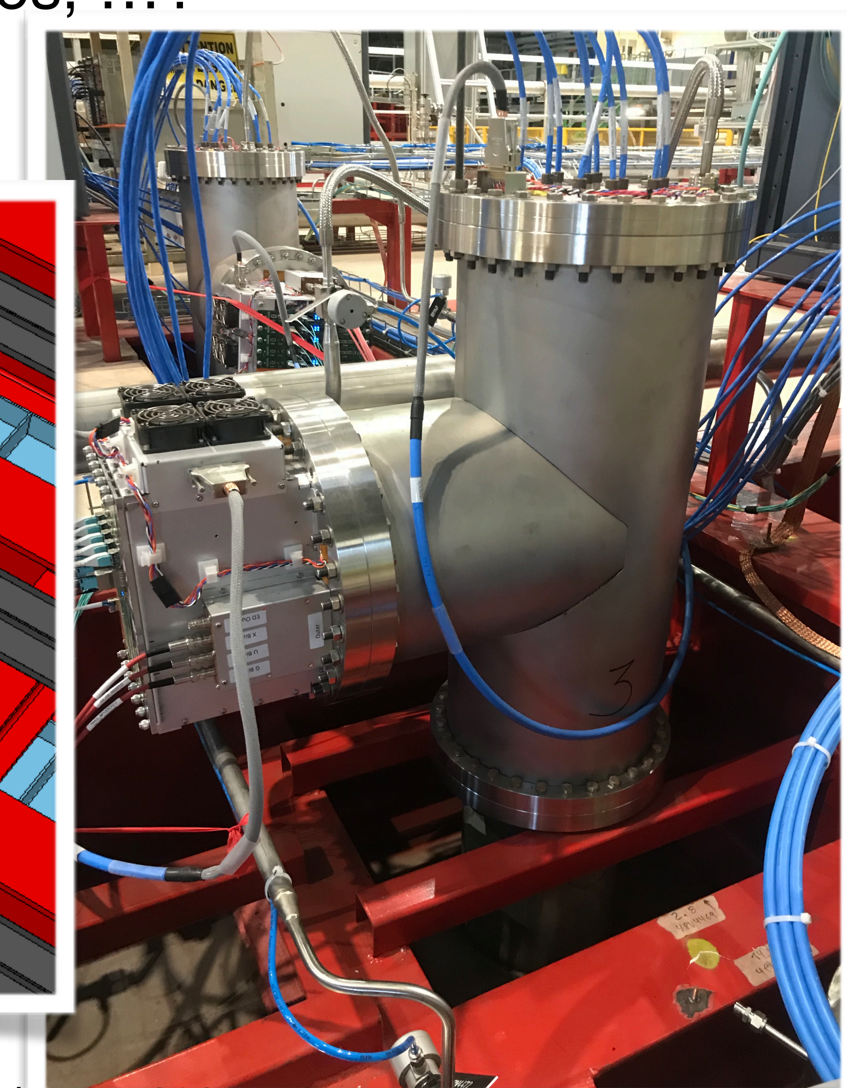
Supports

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

At ProtoDUNEs: hollow square section welded on the warm structure I-beam.
Design not yet detailed. It should be compatible with (comfortable) bolting of the flanges.
Supports are meant to take the load instead of the penetration pipe. Calculation still needed.
Need quality control to ensure that the load is actually taken by the support.
Additional supports for purity monitors, HV filter, cryogenic pipes, …?







GAr circulation manifold

- Gas pickup points on all the chimneys/feedthroughs gathered into a pipe manifold with flexible SS tubes connected to the cryo system.
- One pick up point in each pipe penetration foreseen.
- Additional pickup point on feedthroughs is possible.
- Eventually a fraction of the flow goes through trace analysers.
- Manifold (DN100) welded in place and pressure tested.
- ~4 months for one welder and one technicians.

Trace analysers

1) Measure the argon vapour quality to the ppb level:
- This can be achieved by very sensitive and quite expensive devices measuring traces of water, oxygen and nitrogen in argon in a fraction of the total flow coming from the chimneys.
- As of today, no warm gas purification is foreseen.

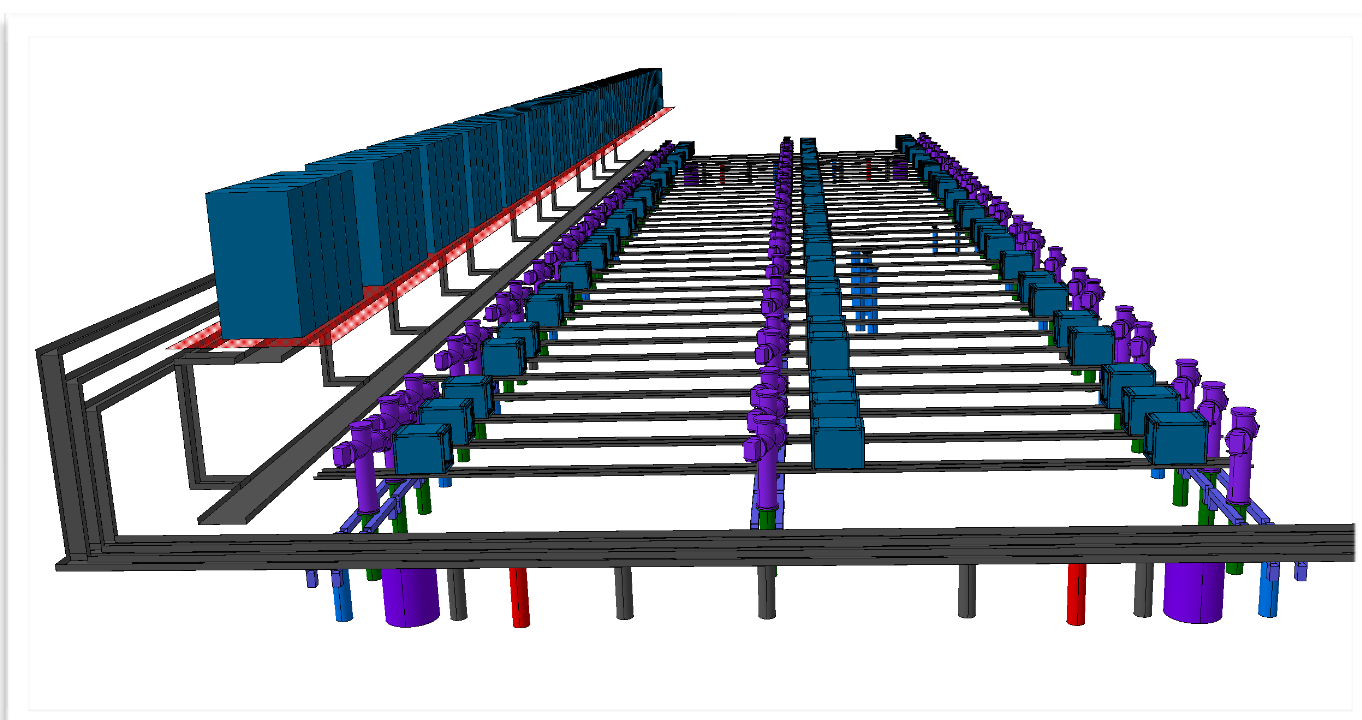
If things change, argon quality should be checked after the filters too.

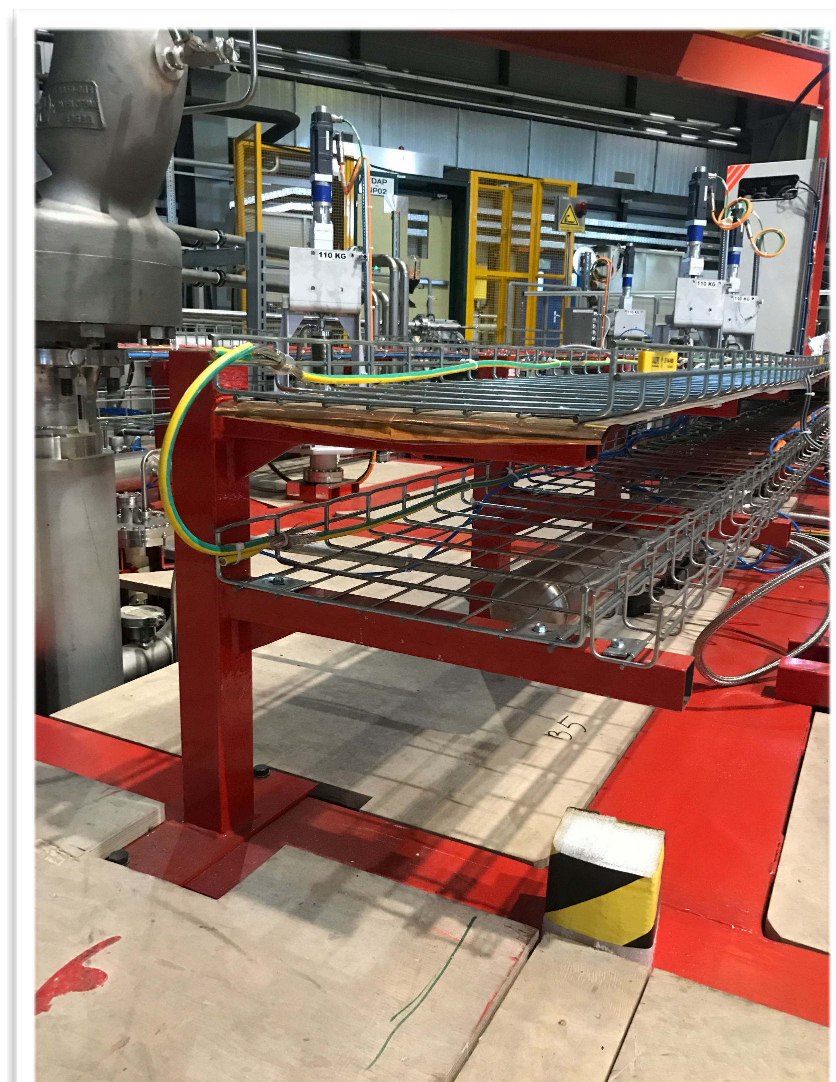
For instance

2) Detect leaks at the level of the flanges and other critical equipments during cool down and operation:
- Sensitivity to a single leak reduces the larger is the gas flow.
- Dedicated *cheaper* O_2 sensors every few (5-10) feedthroughs installed on the manifold and other strategic point.
- On/off valves to exclude some of the chimneys controlled with compressed air.

Cable trays

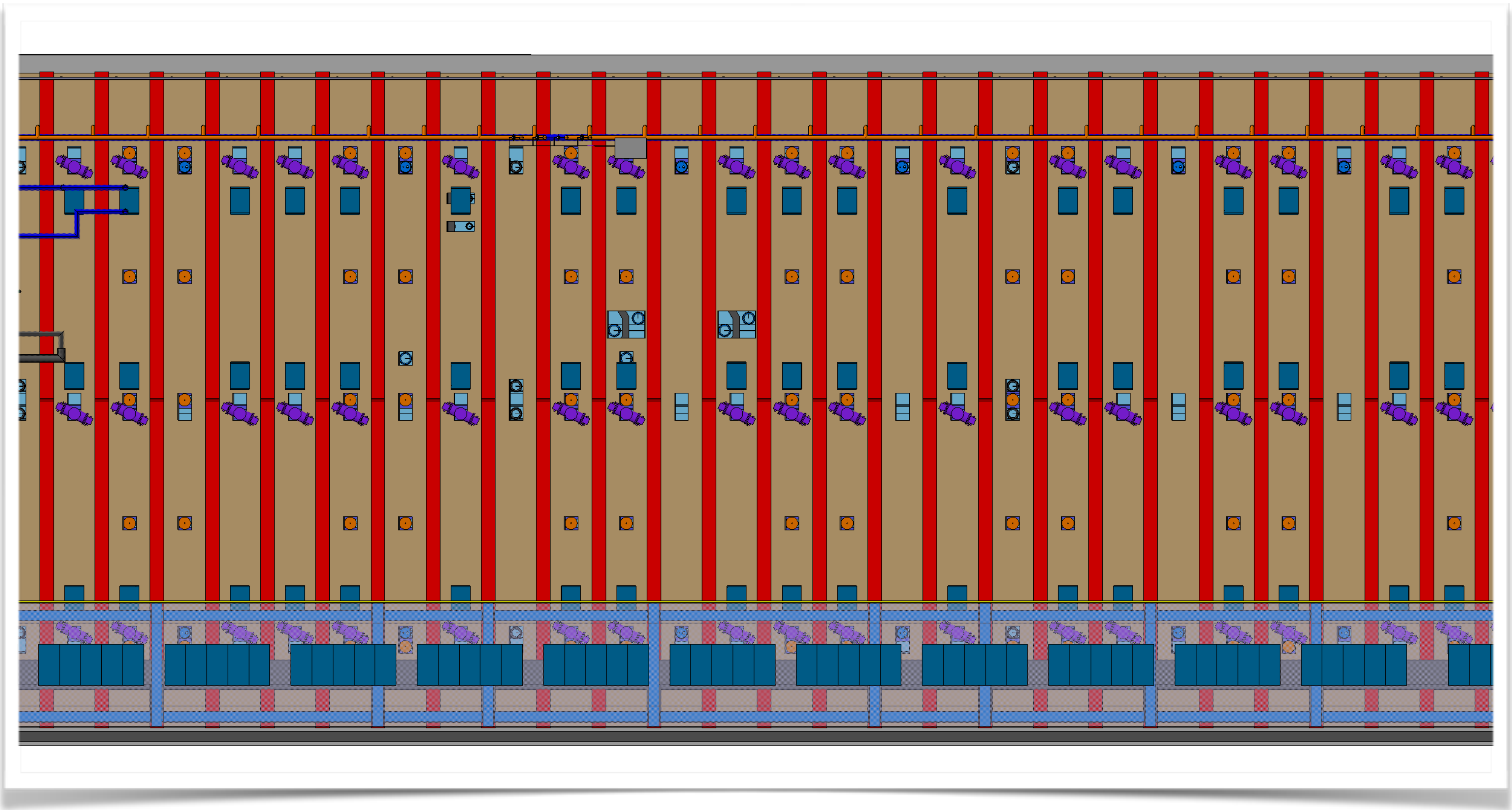
- 36x 2x (signal and power) 200 mm (preliminarily) width along the cryostat width
- 2x 2x (under/below the detector mezzanine) 600 mm width along the cryostat length
- 1x plastic cable tray for optical fibres to the cryo-mezzanine to be added
- Cable trays for the cold boxes to be added
- Cable trays for HV and support for HV filters to be added
- Dedicated cable trays for compressed air and optical fibres?
- More cable trays required by CALCI?
- Typically cable trays delivered in 3 m long sections simple and quick to install
- To be installed after the purge manifold is place





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 at all times slight overpressure with respect to the atmosphere in the two insulation spaces and the HV feedthroughs to avoid moisture back flow.

The system must cope with the variation of the atmospheric pressure and with the filling.
GN_2 is provided by Cryo. Consumption:
- During normal operation O(m^3/h) - small (can be released in the atmosphere).
- During cool-down and filling expected larger and depending on the cool-down *speed*.

Two input and two output in the two independent insulation spaces + pressure measurements.
The relative pressure P is regulated as following (P in the order of 5 - 10 mbarg):
- Input valve opens when $P < P^{in}_{min}$ and closes when $P > P^{in}_{max}$
- Output valve opens $P > P^{out}_{max}$ and $P < P^{out}_{min}$

Who is in charge of the controls?
In ProtoDUNE, at the beginning DCS was in charge (because of the detector/building ground separation), finally Cryo took over (because of the long lasting UPS).

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

For the HV feedthroughs, the regulating pressure is within ~30 - 50 mbarg.

GN_2 management

Question/comment form David and colleagues:

Based on some LNG studies, using argon (ora argon/nitrogen mixture) instead of nitrogen in the insulation space could result in saving 10-20% of heat input from the gas conduction.

Given the operational pressure difference between the cryostat and the insulation spaces it is unlikely that the argon will condense in the insulation space.

Drawback: during cooling and filling impossible to monitor argon traces in insulation space.

Question from David forwarded to GTT, waiting for feedback.

Should this be tested in ProtoDUNE?