Laboratori Nazionali del Gran Sasso

Cryostat Clean Room and Hall C cranes for ID assembly

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Cryostat clean room

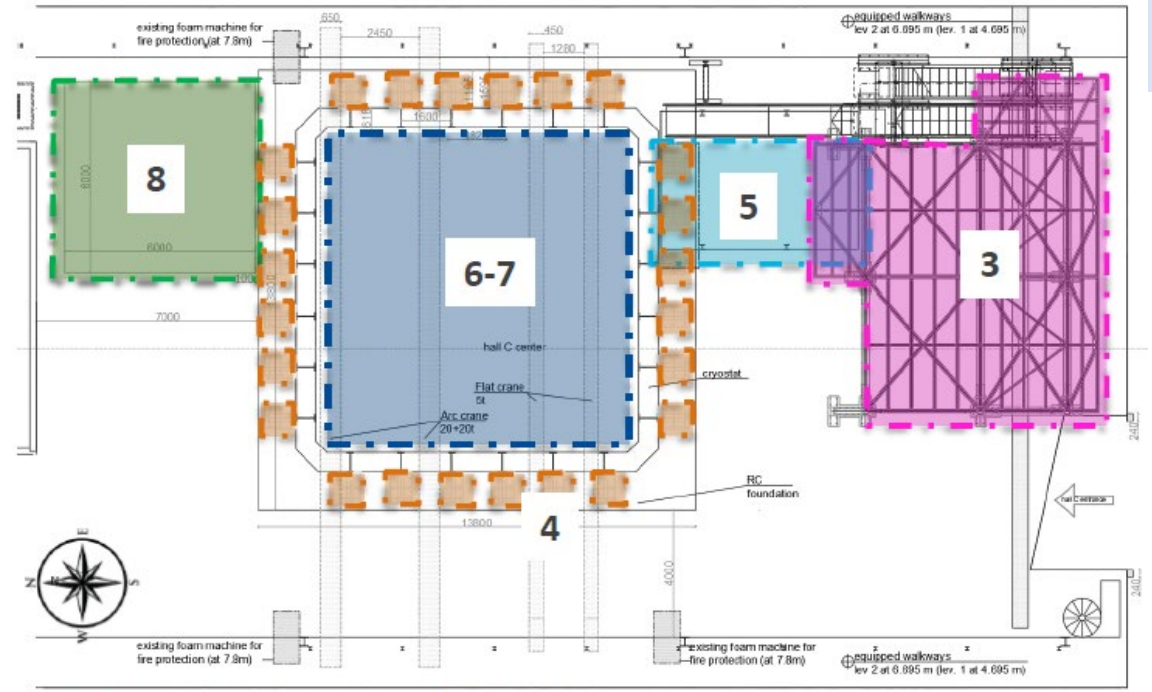
Cryostat clean room: requirements and main features

Build a suitable environment for the assembly of the DS-20k detector, in terms of spaces, handling of pieces, air purity (dust and Rn), safety of people and equipment.

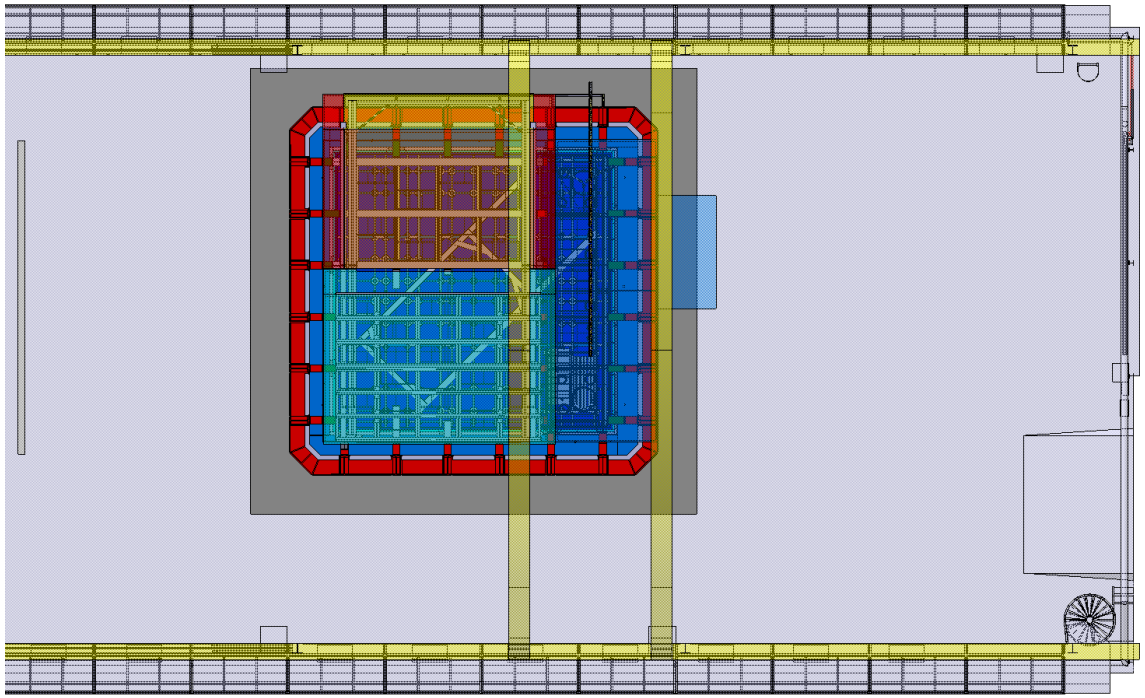
- maintain an ISO 7 particulate class (ideally ISO 6)
- maintain Rn level < 100 mBq/m^3
- maintain temperature of 20 °C +- 1 °C
- minimize humidity
- insert large pieces without spoiling the air quality inside the CR
- lower the pieces into the CR assembly space
- move the detector inside the CR without damaging the delicate cryostat floor (and walls) primary membrane
- provide air-lock and infrastructure for people access
- possibility to dismount “easily” part of the CR for big assemblies insertion/extraction
- provide safety infrastructures/systems to allow for work in confined space

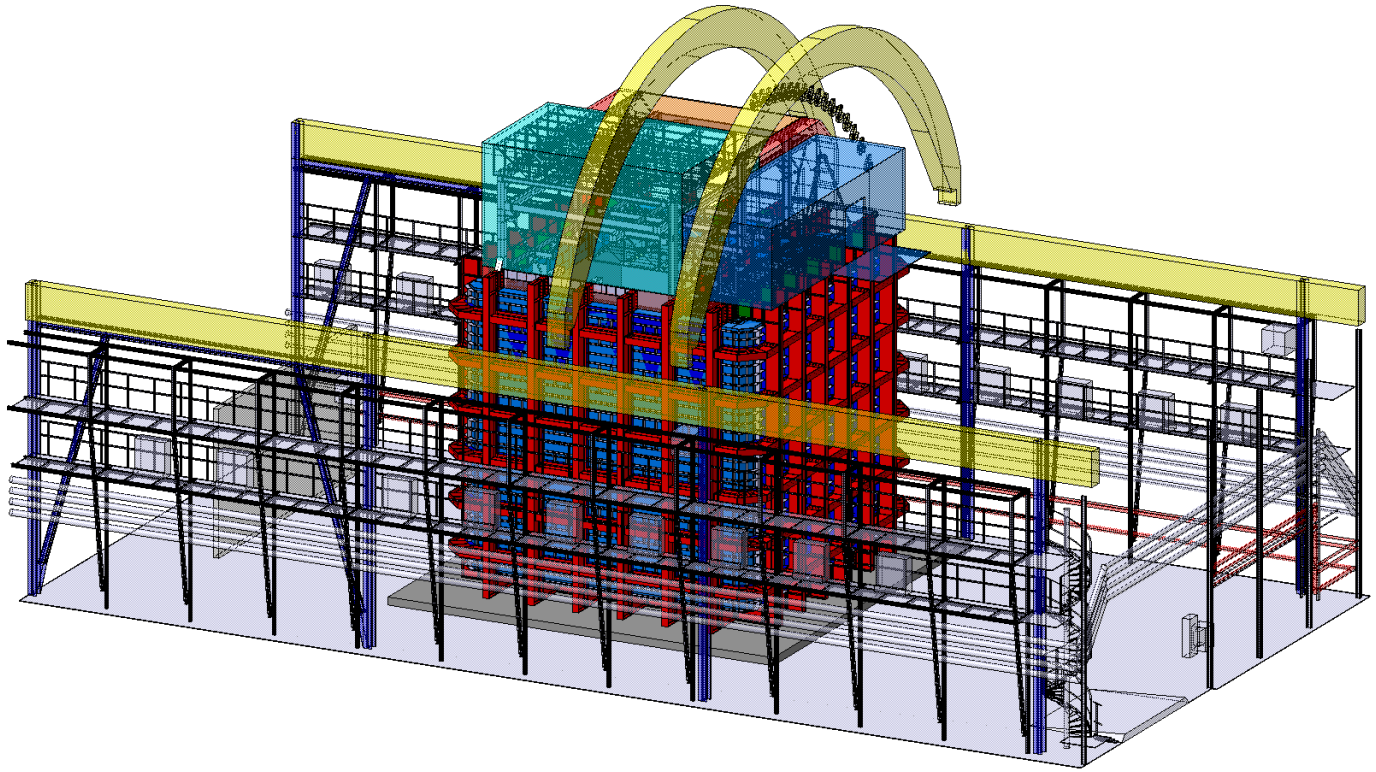
Assembly volume dimensions b x l x h	8437 mm x 8437 mm x 7900 mm
Insertion volume dimensions b x l x h	4800 mm x 7300 mm x 4080 mm
CR total main volume	700 m^3
Number of HEPA filter units	25
Recirculation air flow	30'000 m^3/h
Makeup air flow	250 m^3/h
Makeup air Rn level	1-10 mBq/m^3
HEPA filters maximum heat load	12.5 kW
Air Treatment Unit capacity	7'500 m^3/h
Target Relative Humidity	0 %
Target Temperature	20 °C? +- 1°C
Target ISO14644-1 particulate class	ISO 7 (ideally ISO 6)
Target Rn level	< 100 mBq/m^3

Cryostat clean room: layout

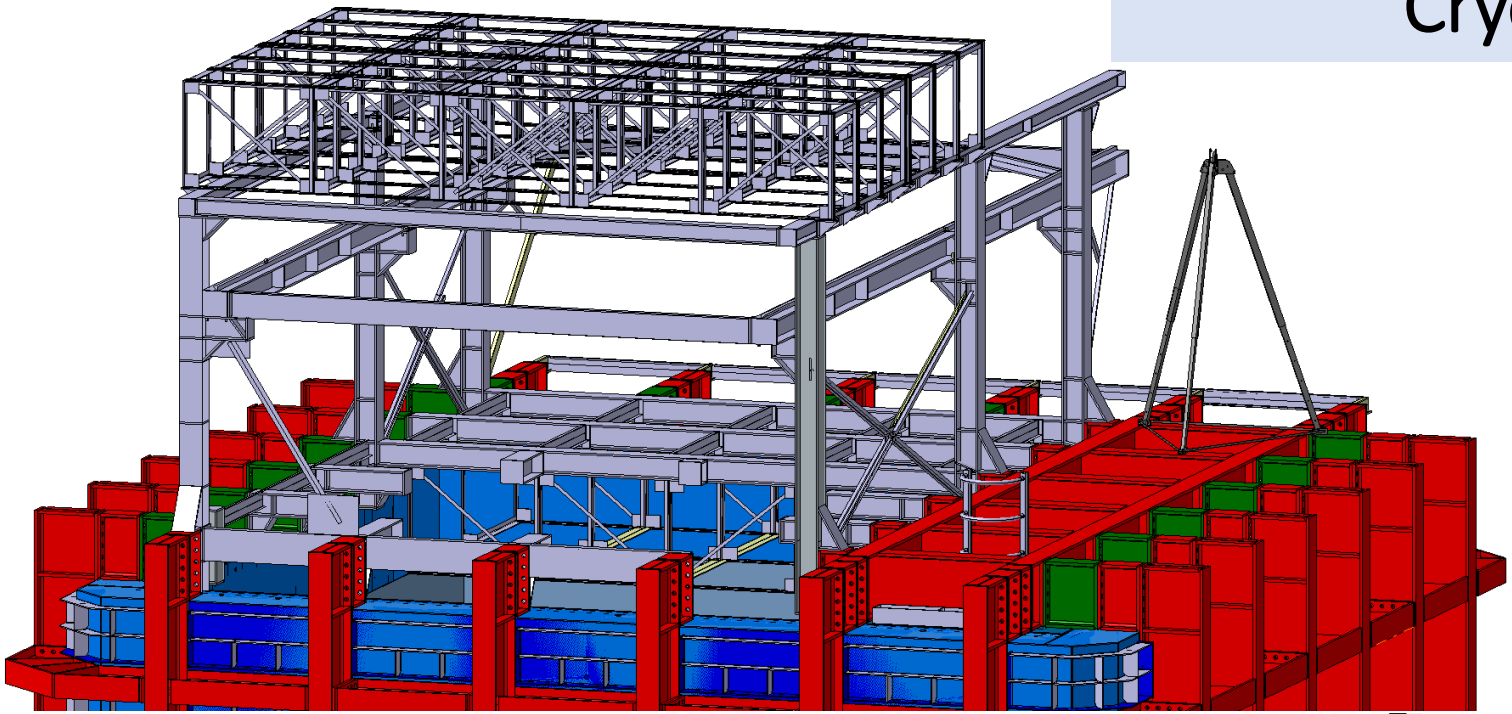


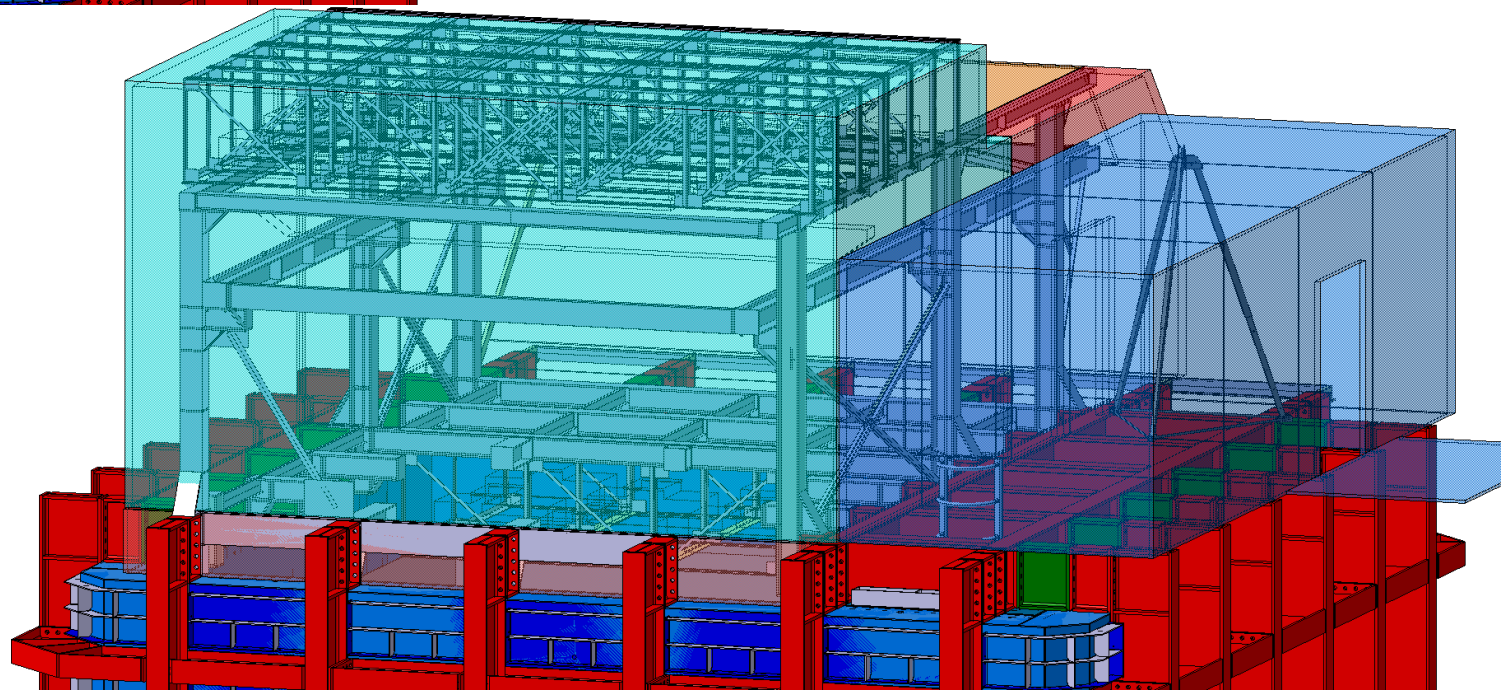
Planimetry: Future state of the Hall C



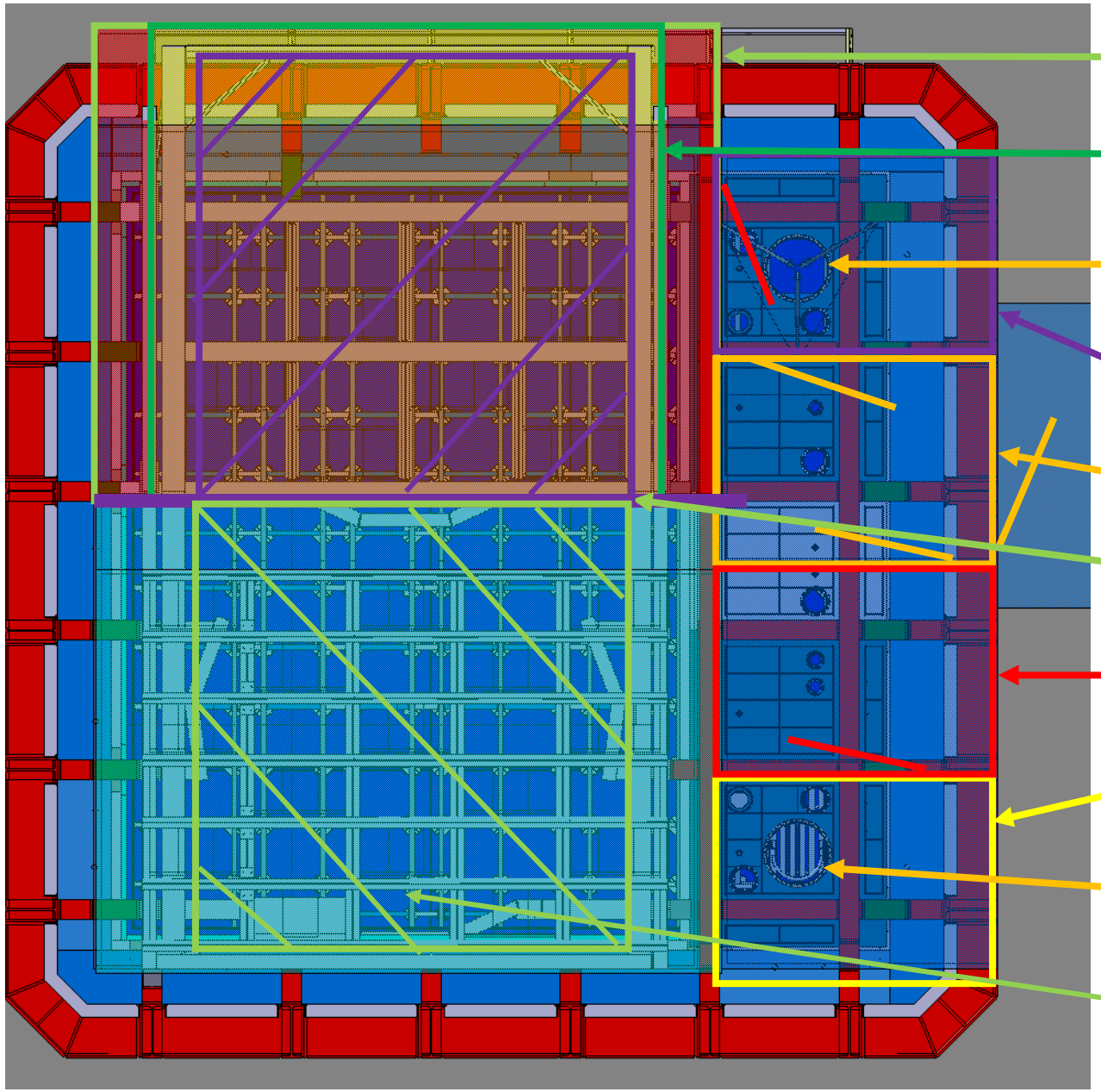


Cryostat clean room: layout





Cryostat clean room: layout



material airlock (MA)

removable roof panels (5.5m x 5.9m)

rescue manhole DN700

people airlock to MA

gowning room

sliding door from MA to CR

people airlock to CR

entrance to CR

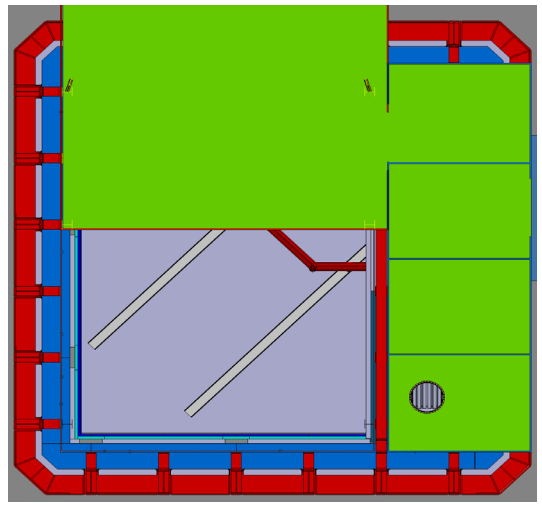
access manhole DN700

CR main volume

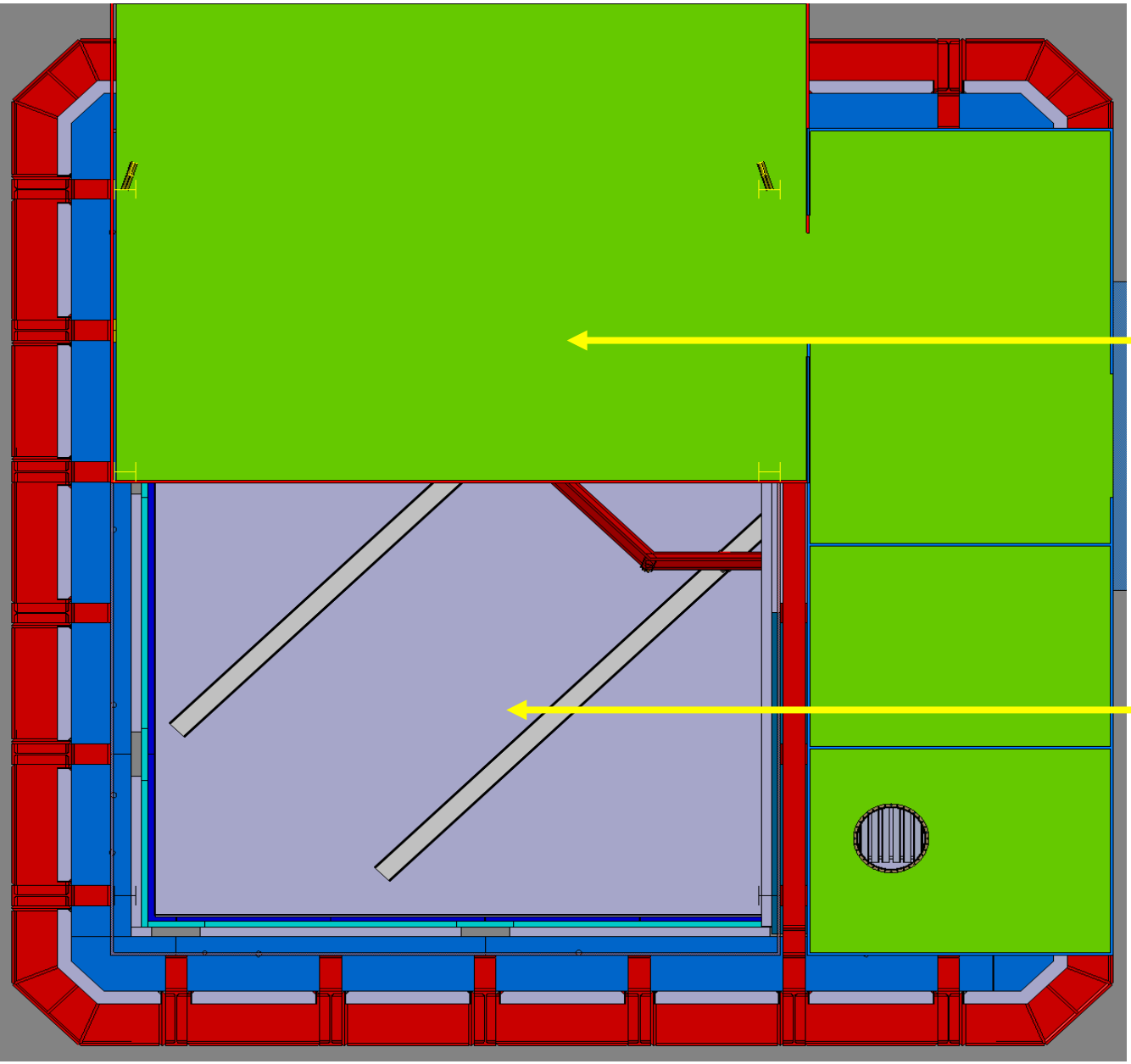
MA crane area

MV crane area

Walkable floor at the level of cryostat roof



Clean room: layout

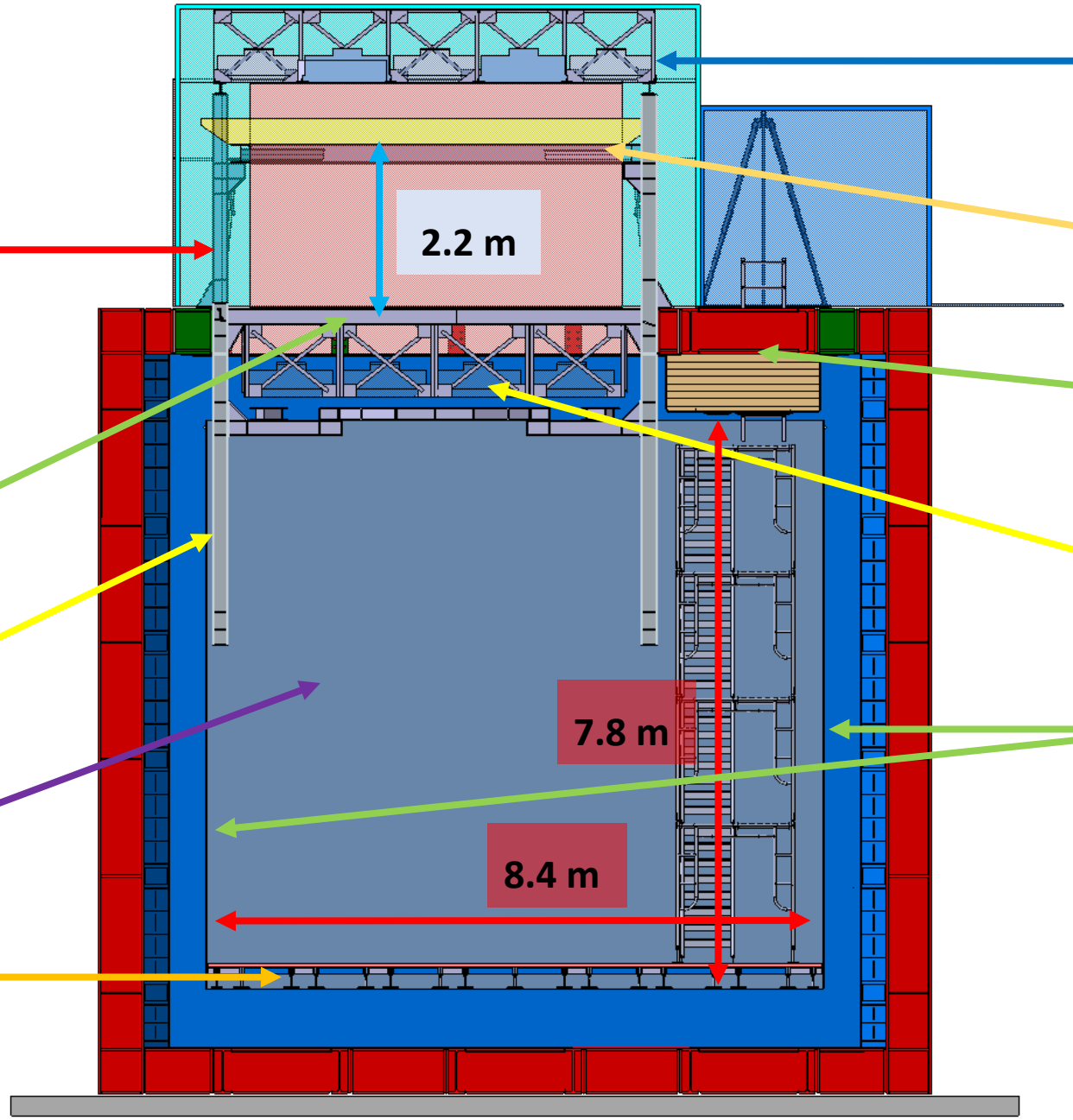


Walkable floor at the level of cryostat roof

material airlock floor (5.5m x 7.1m)

clearance for lowering material into CR main volume (5.0m x 5.9m)

Cryostat clean room: layout



n. 15 HEPA filters (top array)

superstructure

CR crane (4 ton)

cryogenics top cap

material airlock floor

n. 10 HEPA filters (bottom)

dome tower

primary membrane

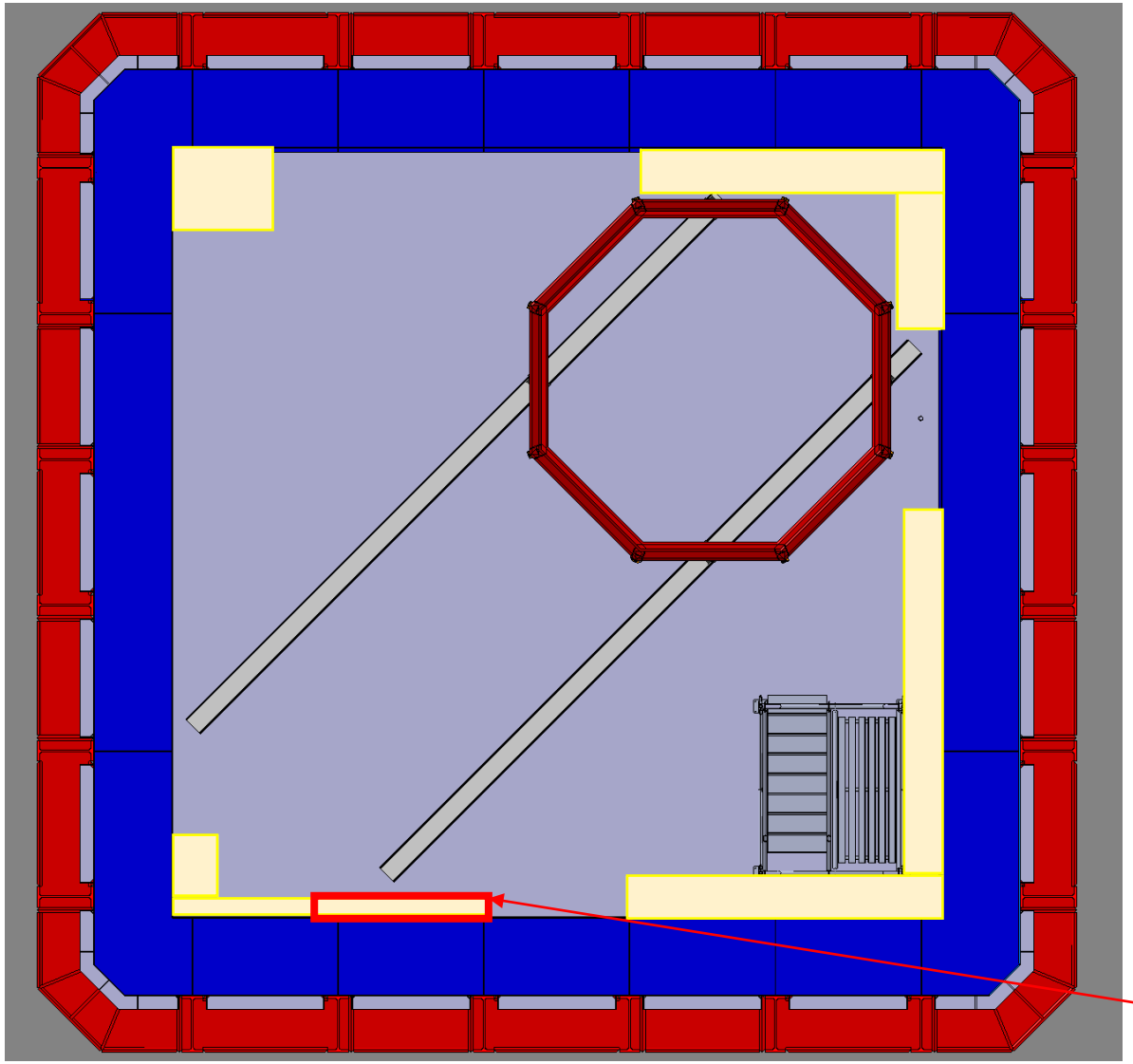
TOTAL INNER CR VOLUME: 700 m^3

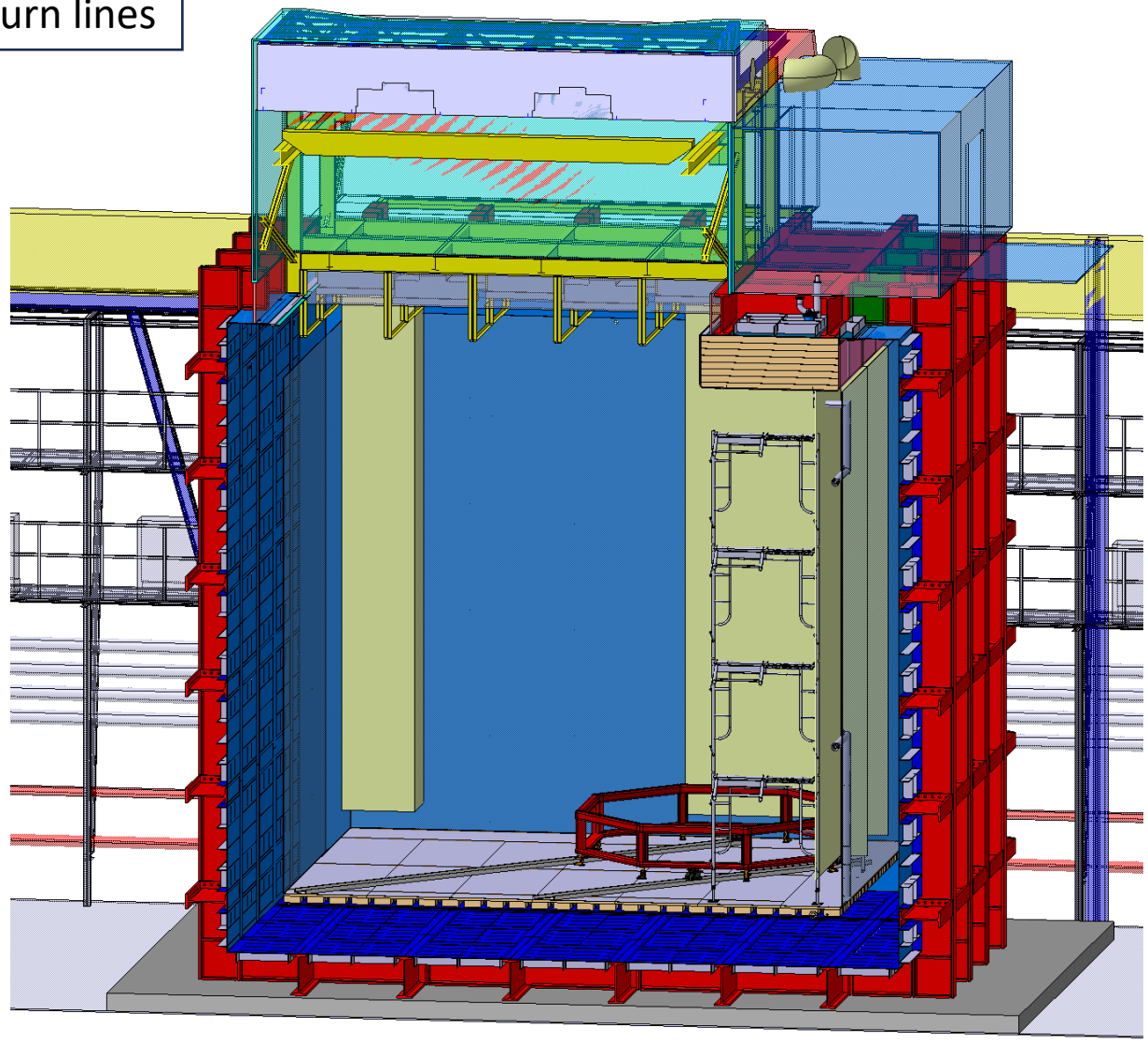
false floor

Aeraulic system integration

air return lines shape being optimized to trade-off between aeraulic constraints and assembly operation space requirements

air return lines



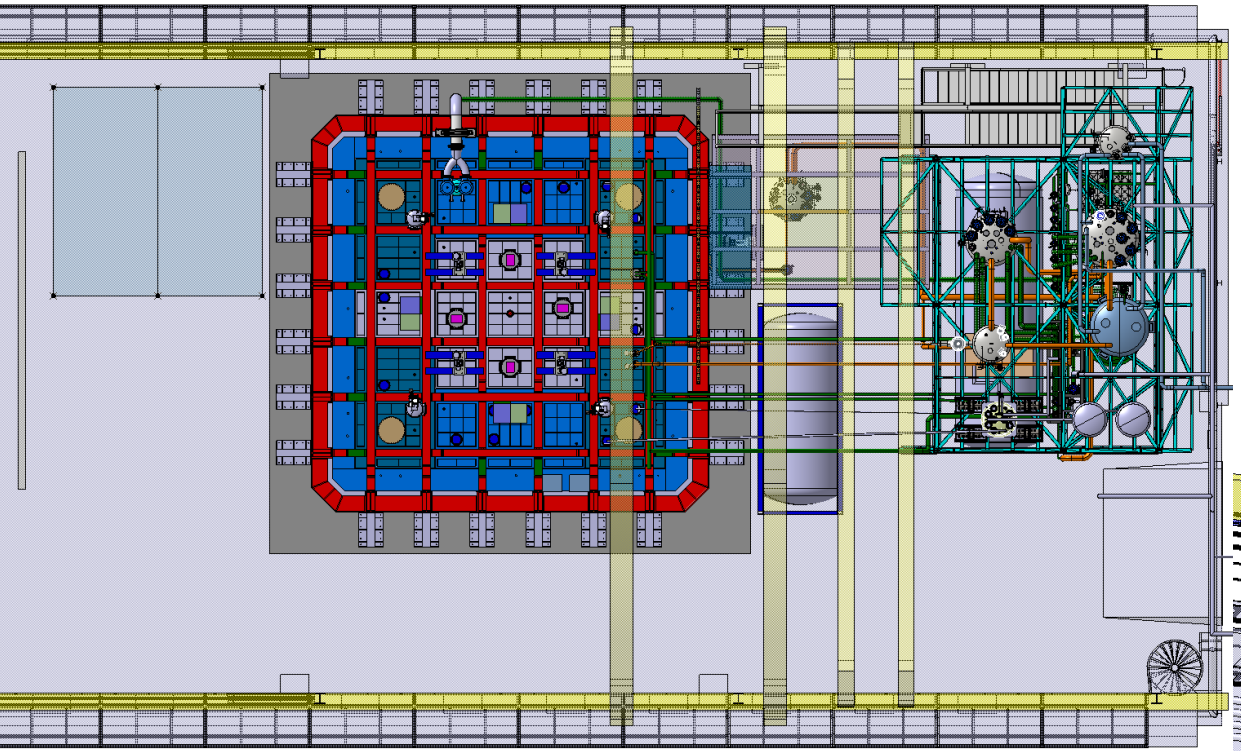


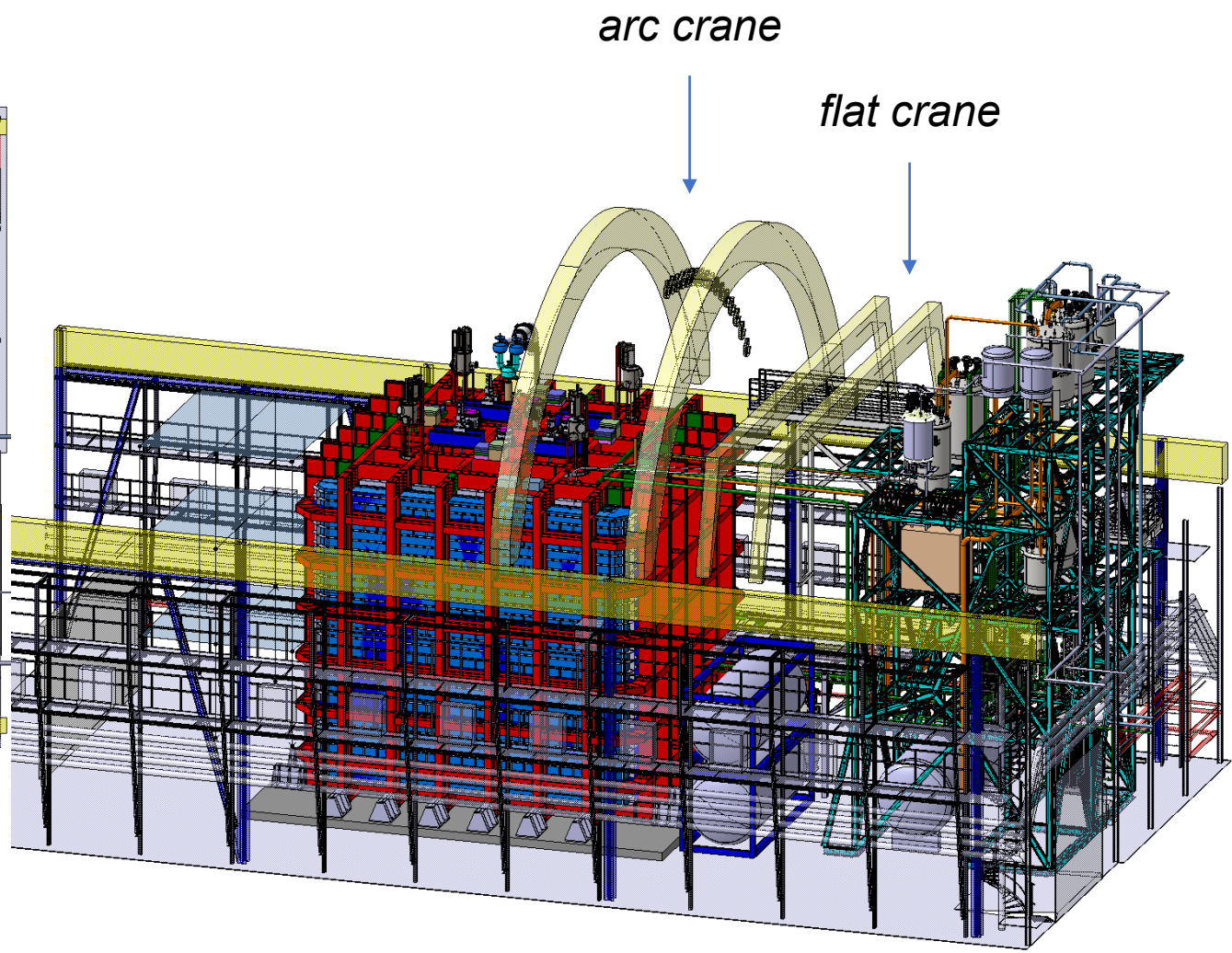
probably we will cut this part

Hall C cranes for ID assembly

Hall C cranes

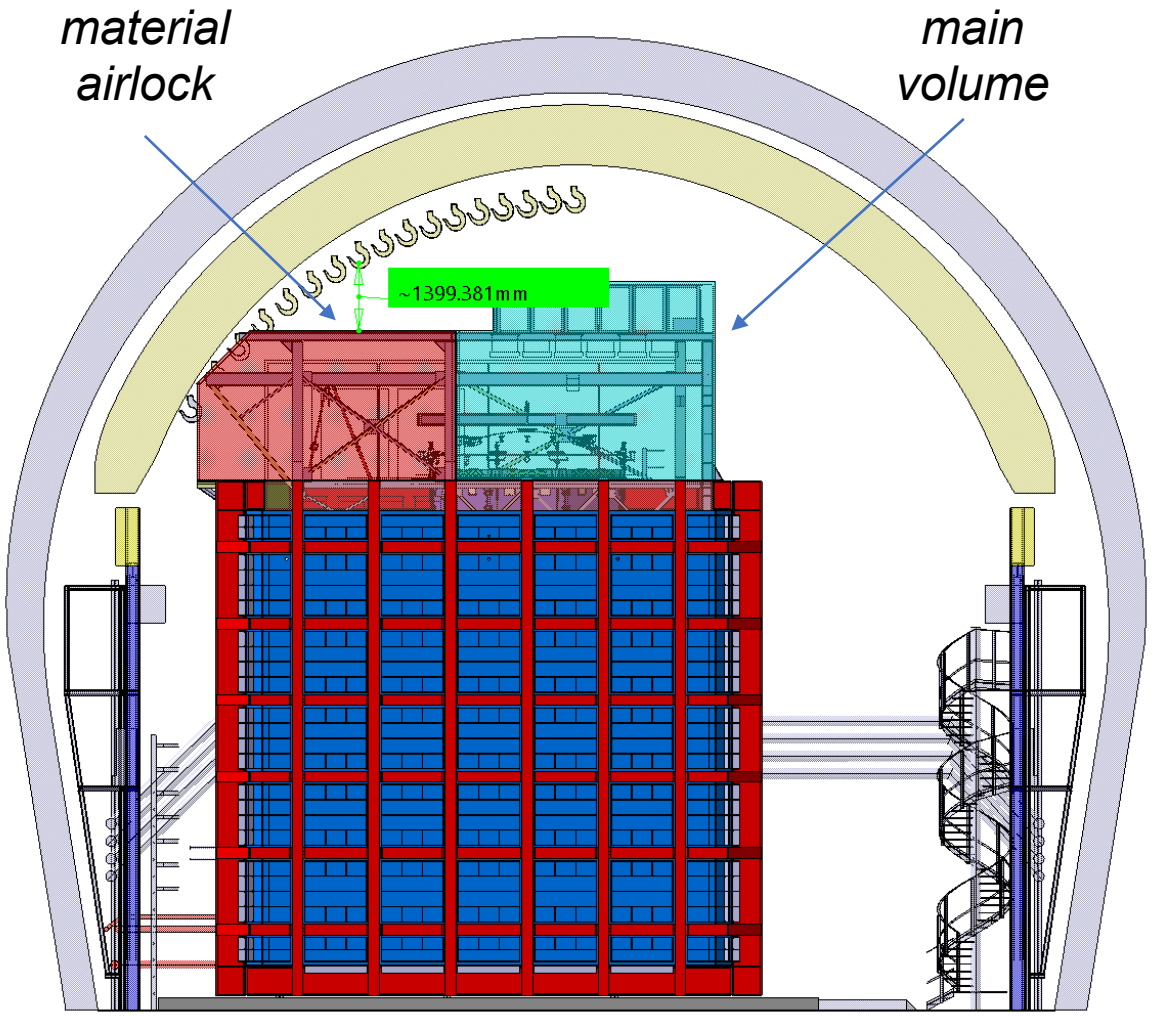
- Hall C is equipped with 2 overhead cranes:
  - an arc crane with 2 independent hooks, each one with 20 t working load limit (WLL)
  - a flat crane with 1 hook, with 5 t WLL





Hall C cranes for ID assembly in clean room

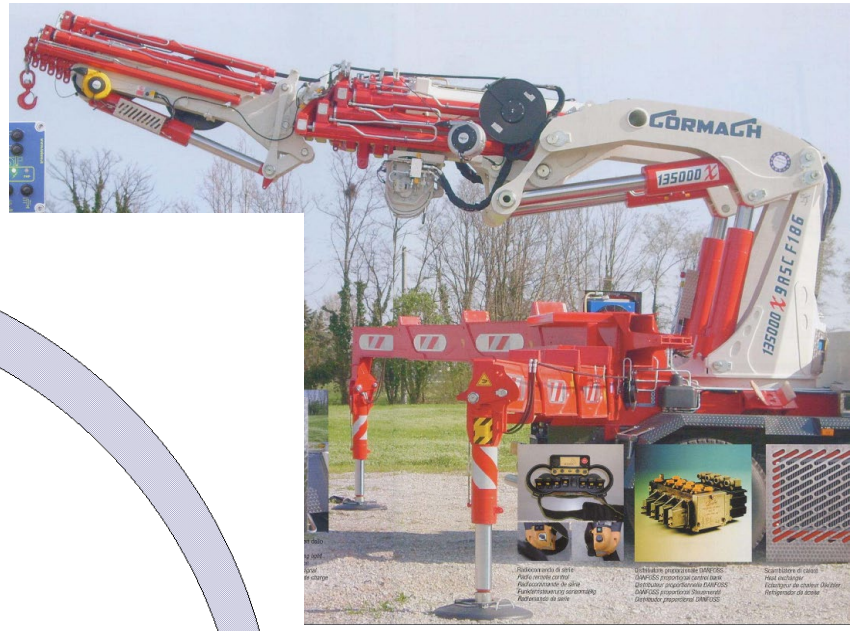
- **for ID assembly purposes, only the arc crane is usable** due to height limitations wrt the Clean Room envelope
- a complete mapping of the arc crane hooks position is available
- the flat crane will be ‘’parked’’ on the south side of Hall C (between the cryostat and the cryo support structure)

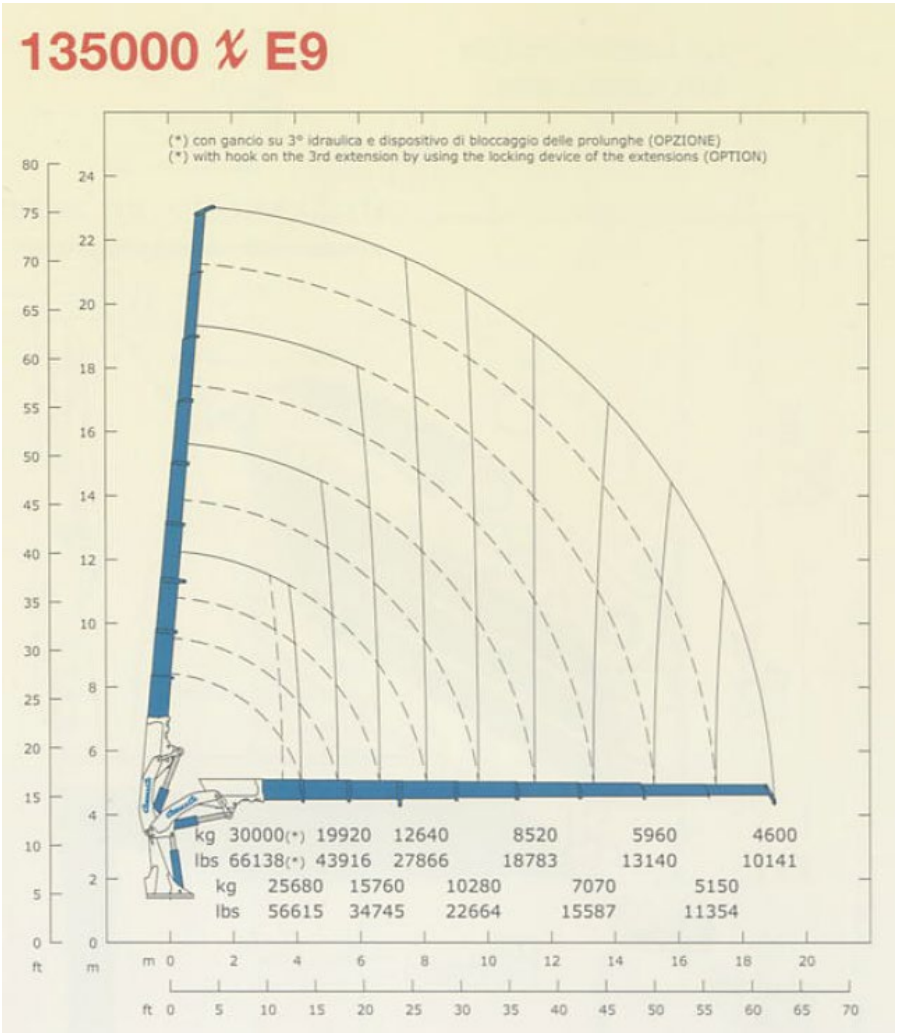


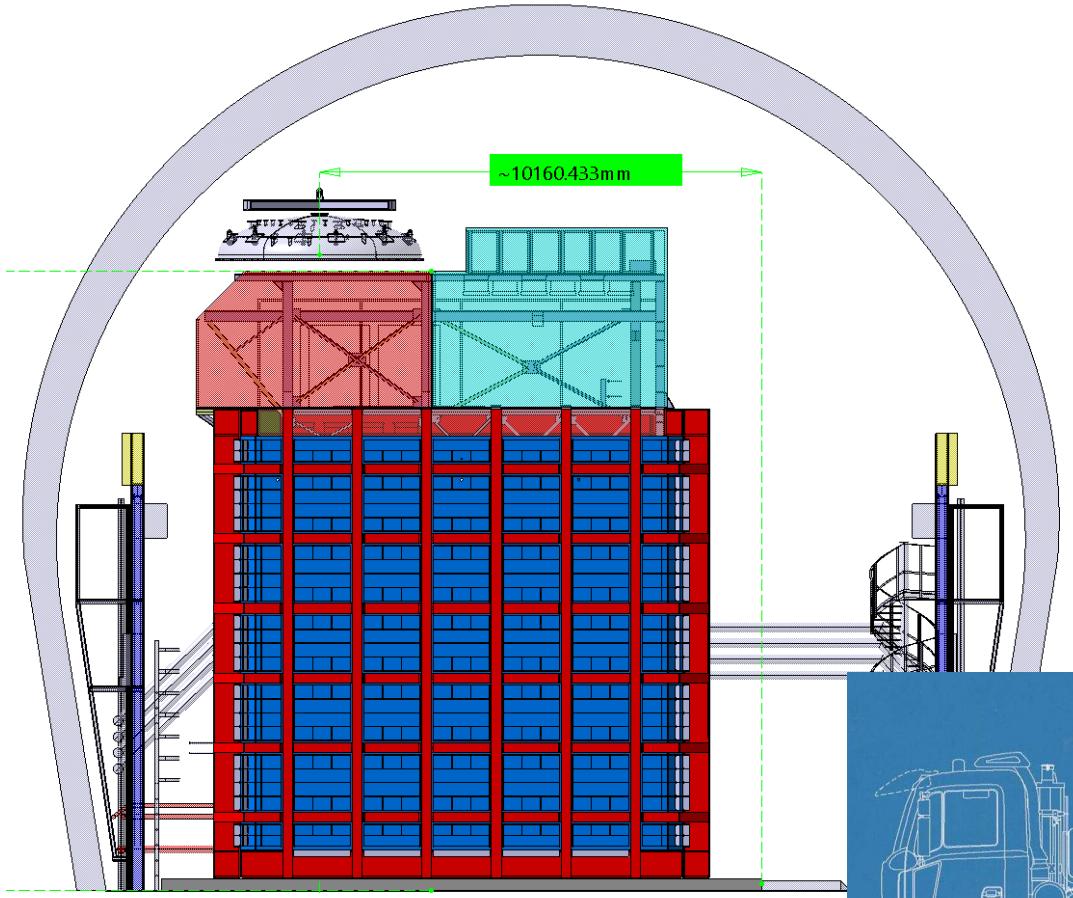
- for the ID assembly, the pieces (i.e. anode, cathode, barrel, grid, BOP, TOP and SS vessel top dome) will be inserted first in the material airlock (MA)
- the limited vertical clearance on top of the MA forces us to use lifting beams instead of slings or chains
- it would be good to have one single **lifting tool** (telescopic beam?) for all the pieces (whose responsibility is this?)
- **for the cathode and SS vessel top dome, dimensions are such to require the use of an external crane**
- a detailed study of insertion of each piece (along with their exoskeletons) inside the MA has to be carried out (we would require to get the step files of the exoskeleton being worked out by UAlberta team)
- if issues arise we still have some (little) margin to reduce the height of the MA

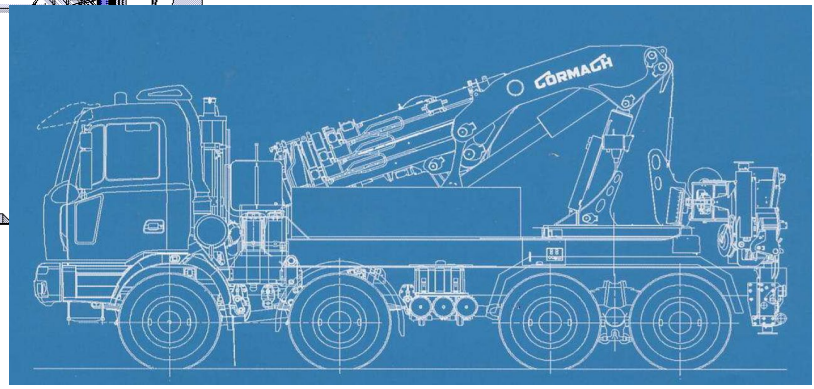
External cranes for ID assembly in clean room

- **for the cathode and SS vessel top dome, dimensions are such to require the use of an external crane**
- we are in contact with a local company which performed already other works for DS [CretoneRex]









Backup slides

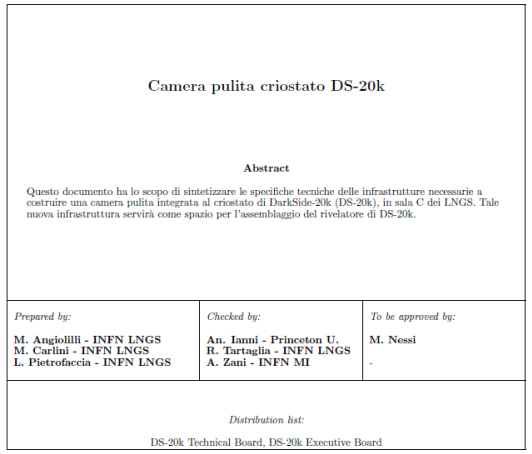
Cryostat clean room: current status of the design

CR technical specifications (in work)

DARKSIDE-20k project

https://edms.cern.ch/document/3016943

EDMS ID	DS DocDB ID	Creato: 19 Dicembre, 2023	
3016943	-	Ultima modifica: 5th June, 2024	Rev. n. 1.0



Camera pulita criostato DS-20k

Abstract

Questo documento ha lo scopo di sintetizzare le specifiche tecniche delle infrastrutture necessarie a costruire una camera pulita integrata al criostato di DarkSide-20k (DS-20k), in sala C dei LNGS. Tale nuova infrastruttura servirà come spazio per l'assemblaggio del rivelatore di DS-20k.

Prepared by:	*Checked by:*	*To be approved by:*
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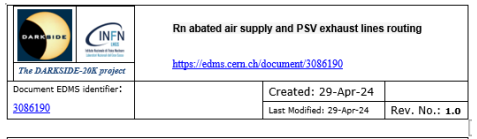
Distribution list:

DS-20k Technical Board, DS-20k Executive Board

Rn abated air supply pipe and PSV exhaust routing (released)

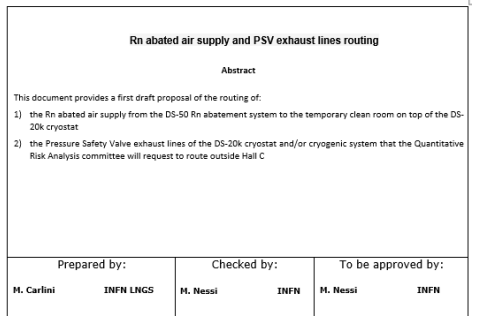


The DARKSIDE-20K project

Rn abated air supply and PSV exhaust lines routing

https://edms.cern.ch/document/3086190

Document EDMS identifier:		Created: 29-Apr-24	
3086190		Last Modified: 29-Apr-24	Rev. No.: 1.0



Rn abated air supply and PSV exhaust lines routing

Abstract

This document provides a first draft proposal of the routing of:

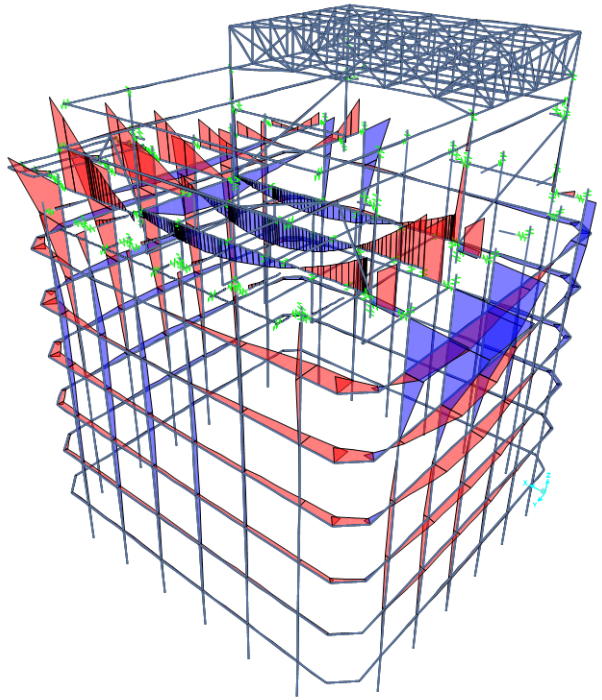
1) the Rn abated air supply from the DS-50 Rn abatement system to the temporary clean room on top of the DS-20k cryostat
2) the Pressure Safety Valve exhaust lines of the DS-20k cryostat and/or cryogenic system that the Quantitative Risk Analysis committee will request to route outside Hall C

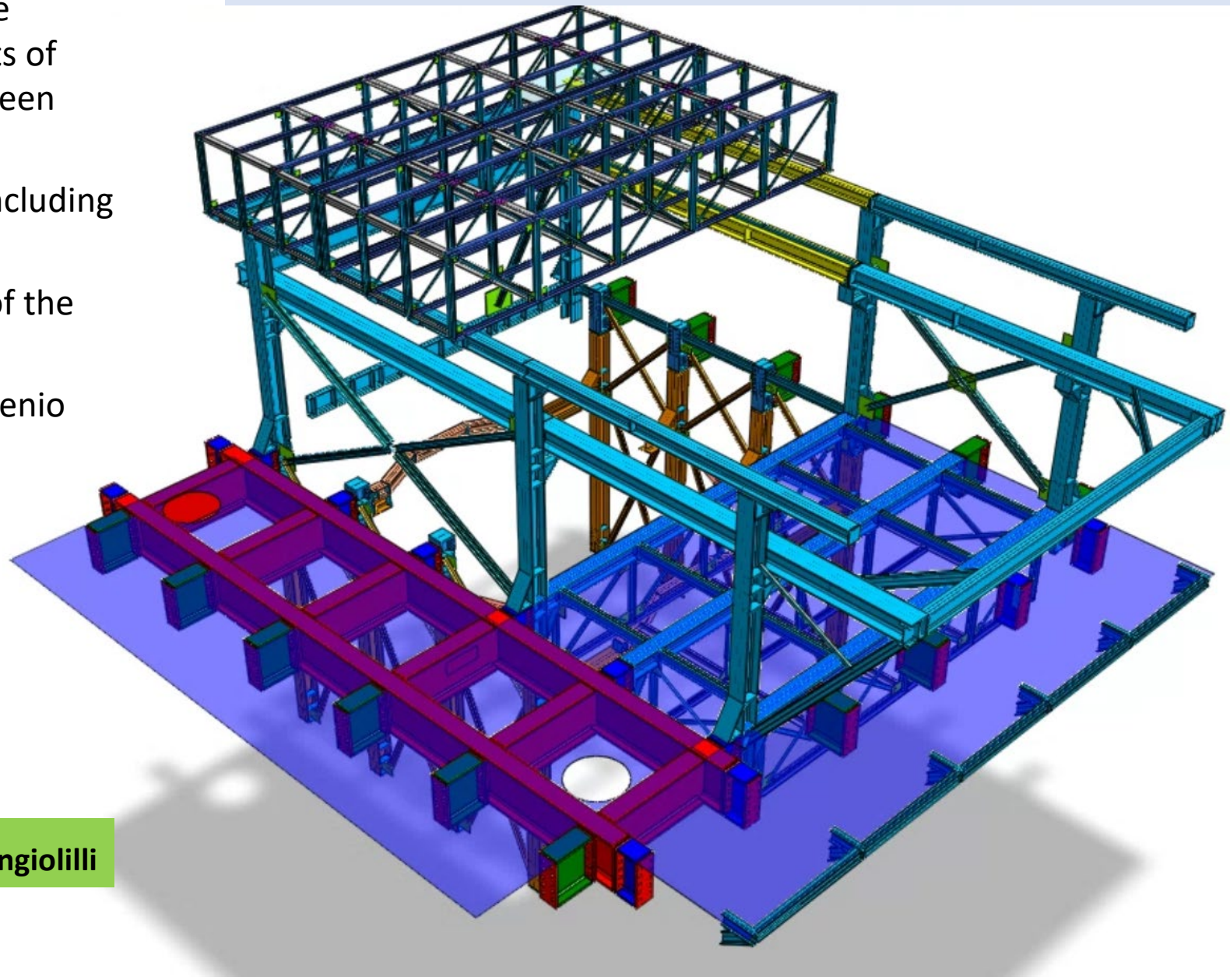
Prepared by:	Checked by:	To be approved by:
M. Carlini INFN LNGS	M. Nessi INFN	M. Nessi INFN

- a preliminary design of the *superstructure* is now completed and a quotation is available
- a quotation of the internal 4-t crane is available
- currently working on the structural design of the *dome tower*, a frame which will support the SS vessel dome during cabling, connection to the ID, final integration
- the preliminary aeraulic design of the CR is completed, including CFD simulations of the air exchange rate and dimensiong of the Air Handling Unit
- work is ongoing to define the safety procedures for access and rescue (confined space)
- constant interaction with the ID assembly team to keep under control integration issues between the tooling and CR
- routing proposal of the Rn-abated air from the DS-50 Rn abatement system to the CR has been shared with the lab
- in work document on technical specifications of the CR (currently 60 % completed)
- planning to proceed soon with 3 INFN tenders:
  - superstructure
  - CR crane
  - CR panels, plants and safety systems
- planning to integrate the updated infrastructures models with the tooling from UAlberta team for the finalization of the ID installation book

Cryostat clean room: superstructure

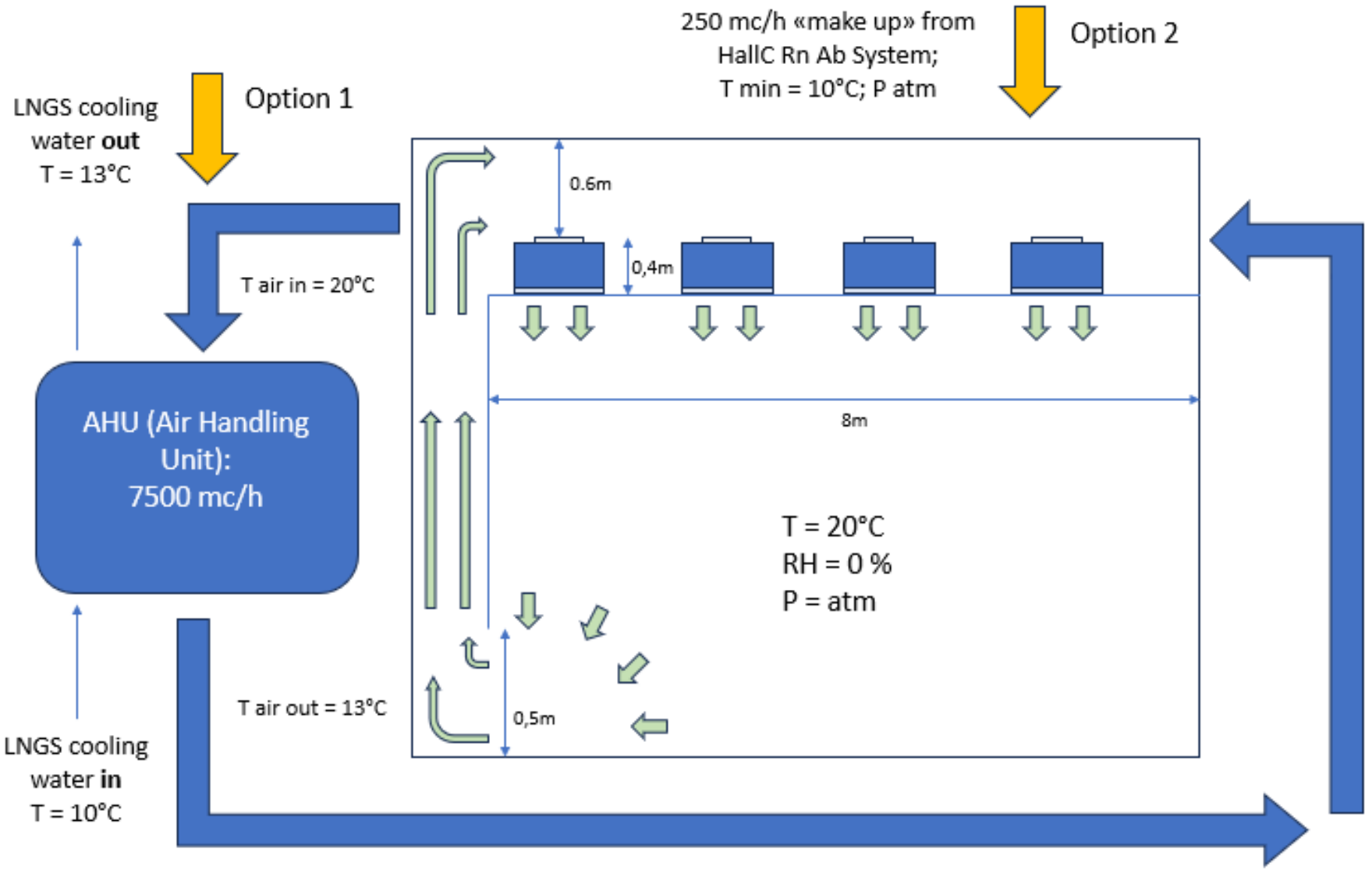
- Several iterations for the optimization of the structural design vs. functional requirements of the CR and installation interferences have been carried out
- preliminary design of the *superstructure*, including FEAs and 3D models is completed
- currently working on the structural design of the *dome tower*
- next steps: filing of the documentation to Genio Civile + tender





by Michele Angiolilli

Cryostat clean room: aeraulic design (1)



- 250 m^3/h Rn-abated make-up air from DS-50 system
- n. 25 (15+10) HEPA filters for CR recirculation of 30'000 m^3/h
- n. 2 0.6 m high air plenum (one for each HEPA filters array) with pressure balance connection
- an external 7500 m^3/h capacity Air Treatment Unit dimensioned for 17.5 kW heat load
- 1 l/s water cooled coil (from LNGS chilled water circuit)
- n. 4 internal air return ducts
- portable H14 air purifiers (eff ≥ 99.995%) for the material airlock

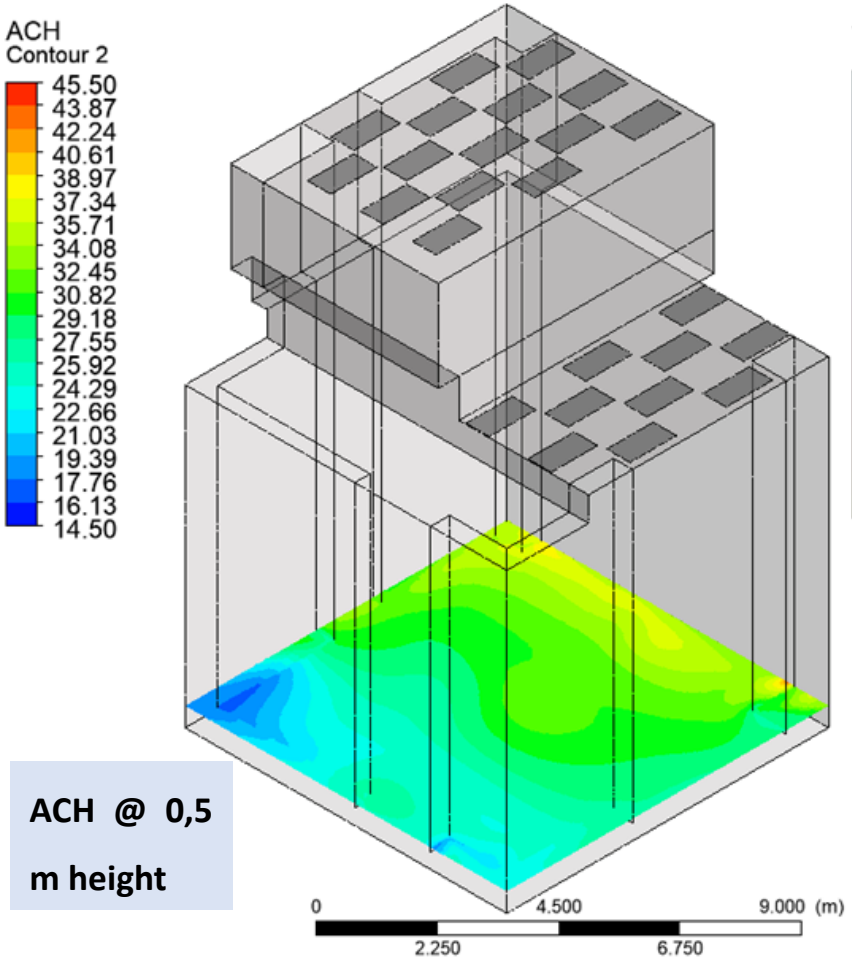
by Lidio Pietrofaccia

Cryostat clean room: aeraulic design (2)

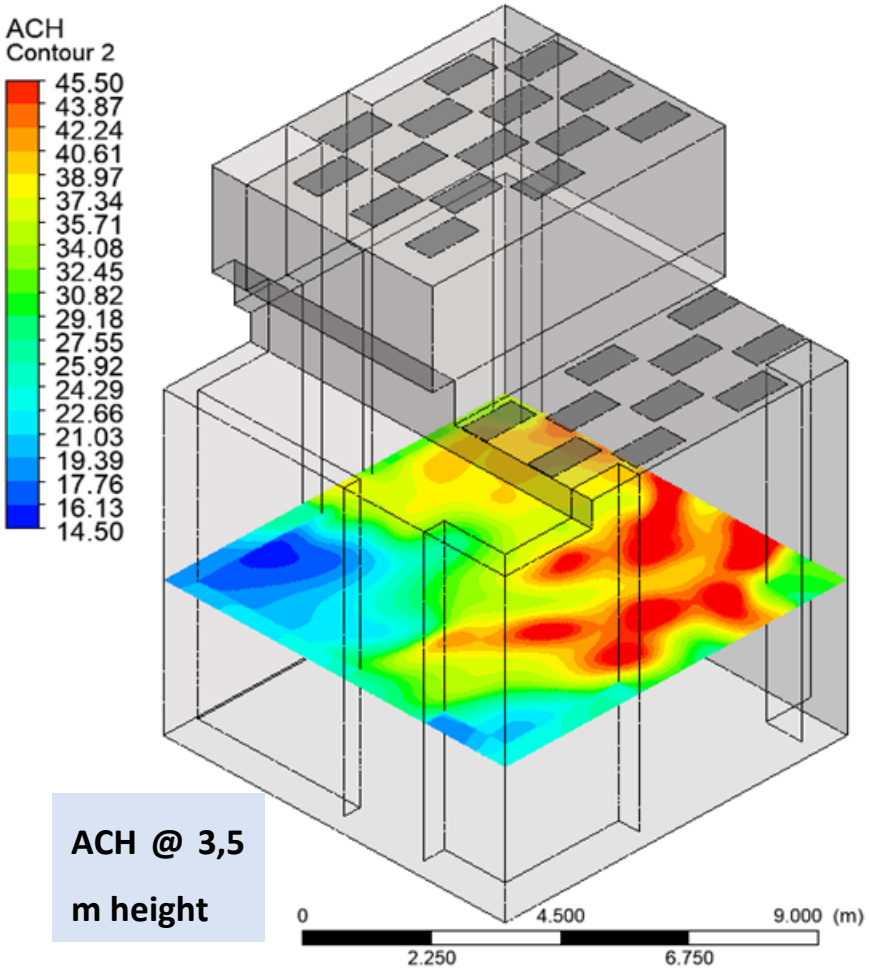
ACH = Air Change per Hour

FLUSSO NON UNIDIREZIONALE E MISTO TIPO VERTICALE
Numero di ricambi d'aria raccomandati in clean rooms.

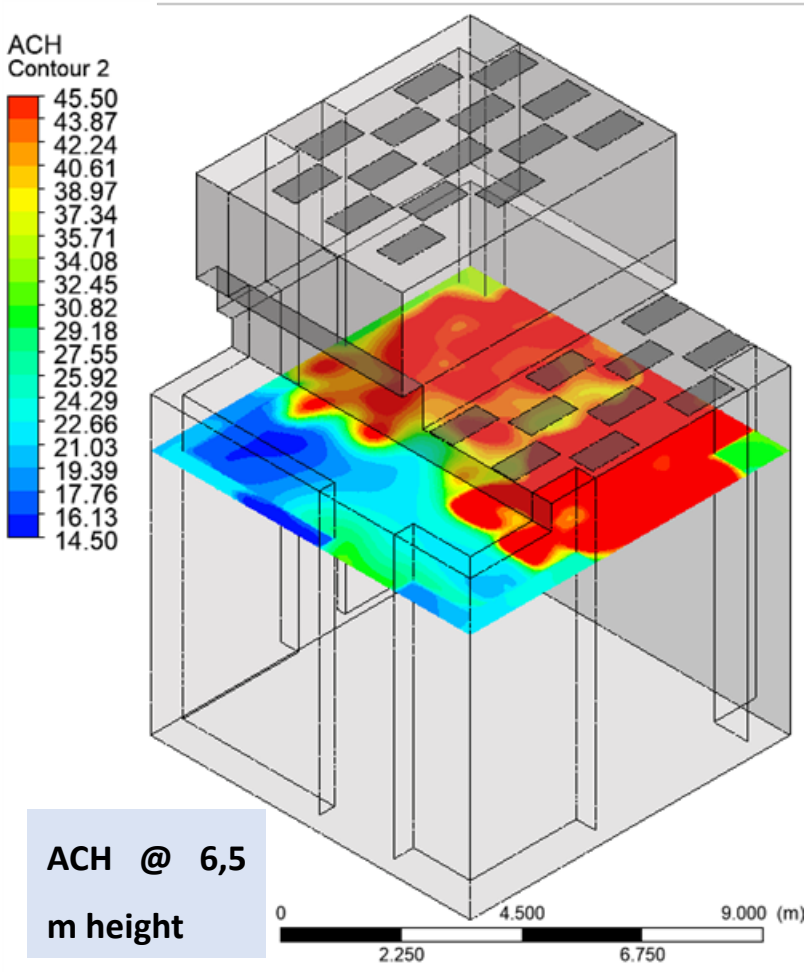
Classe di purezza dell'aria	Cleanliness Class	Velocità media su filtri finali	Ricambi d'aria	Efficienza min. filtri finali	Ubicazione dei filtri finali	Area occupata dai filtri**
Fed. Std. 209E	Unità Inglesi	m/s	vol/h	%		%
M 3.5 e M 4	100 e 300	0,40 - 0,80	240 - 480	99,9995	Terminale	20 - 50
M 4.5 e M 5	1 000 e 3 000	0,45 - 0,85	40 - 120	99,999	Terminale	10 - 20
M 5.5 e M 6	10 000 e 30 000	0,75 - 2,50	20 - 40	99,99	Term./Canal.	10 - 20
M 6.5 e M 7	1000 000 e 3 000 000	0,75 - 3,00	10 - 20	95	Canalizzata	5 - 10



ACH @ 0,5 m height



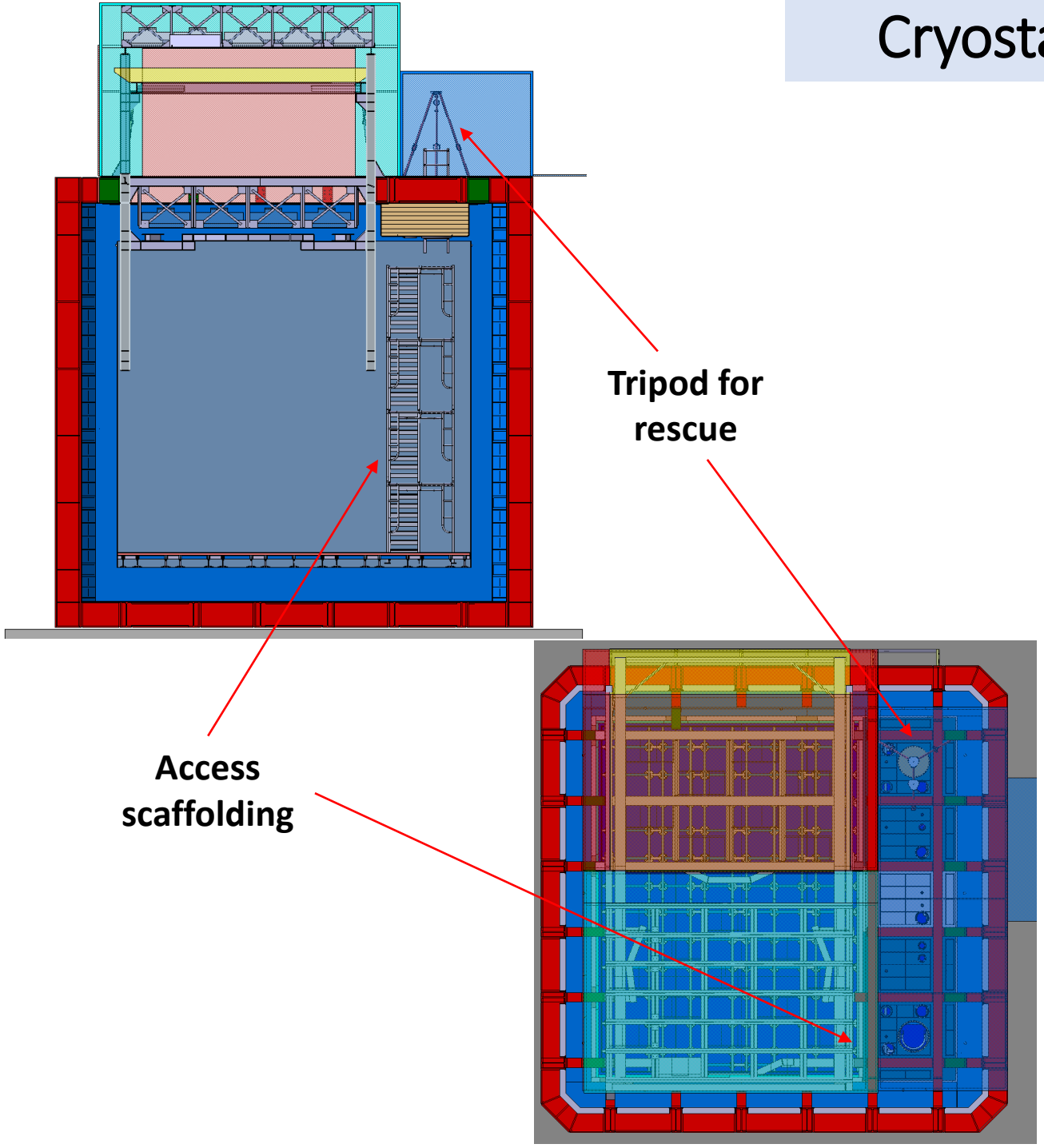
ACH @ 3,5 m height



ACH @ 6,5 m height

by Valentino Di Marcello (LNGS Technical Division)

Cryostat clean room: access, rescue, safety



- cryostat CR will be a confined space work environment, which is subject to specific safety rules by the Italian law (DPR 177/2011, D. Lgs. 81/08)
- access and rescue procedures document in preparation, possible aspects to discuss/consider:
  - operators must follow specific training courses (work in confined space, work at height?)
  - presumably, a foreman will need to be present for supervision of the works from outside the CR for 100 % of the time with proper access to the camera and CR safety system
  - access and rescue procedures must be discussed and agreed with the lab
- safety systems (i.e. ODH, fire detection, camera systems,…) are being planned and included in the technical specifications