Update of Utility/Service Cavern

2018/2/23

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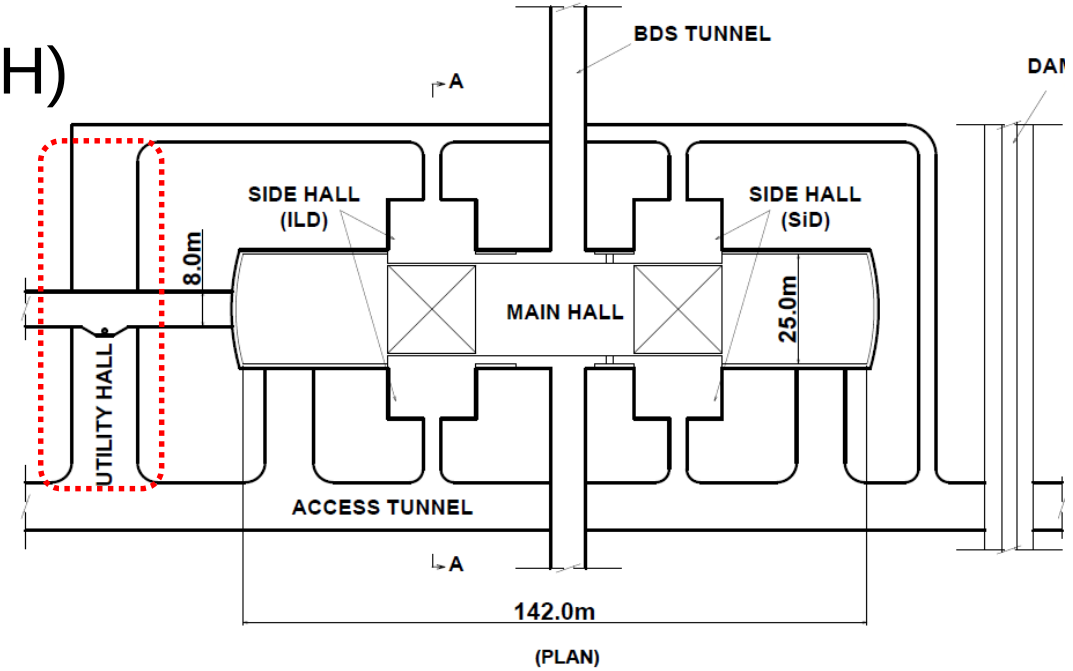
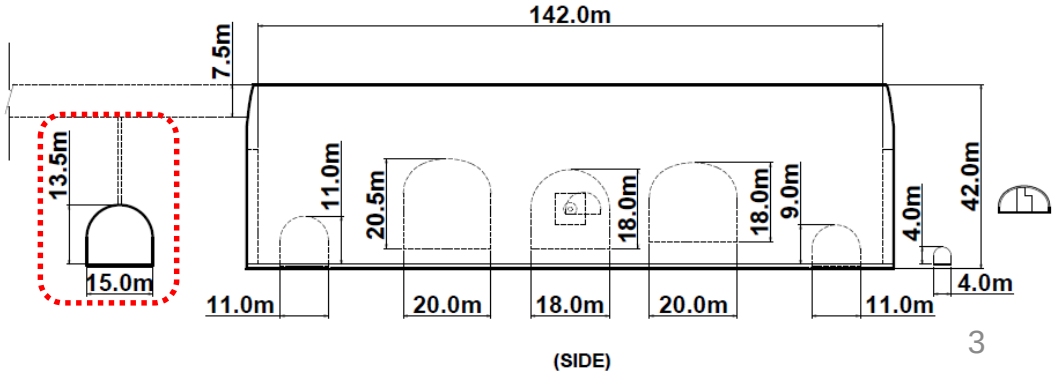
DESIGNS OF UTILITY CAVERN SO FAR

TDR

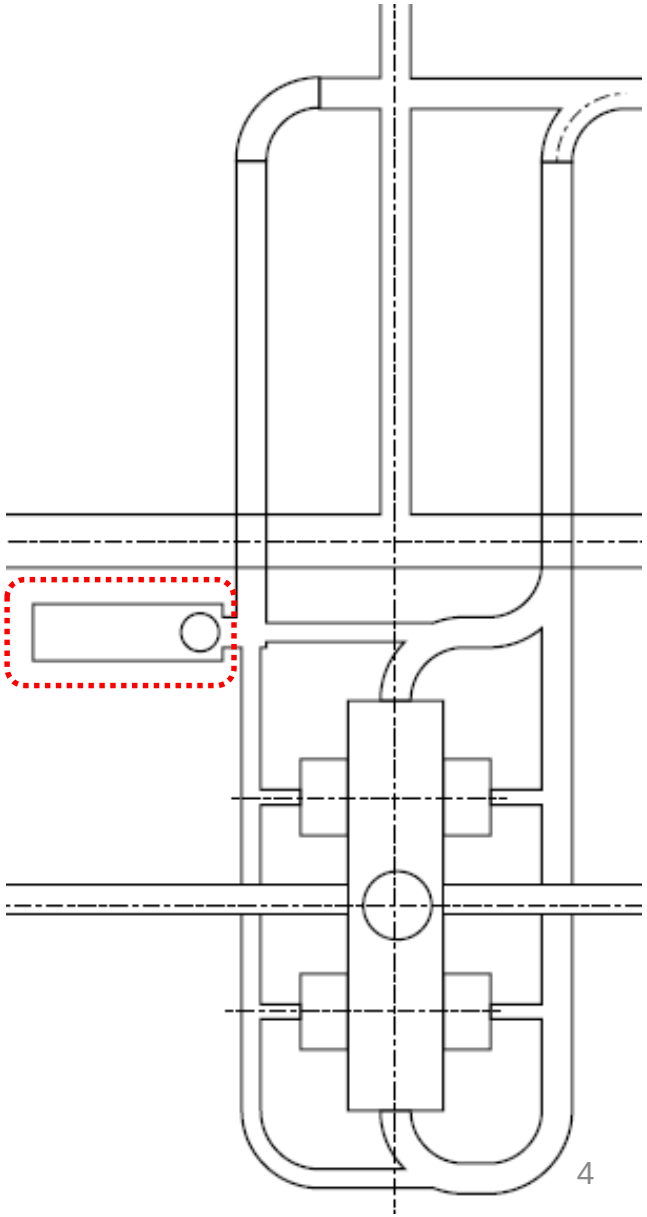
- 15m(W)x80m(L)x13.5m(H) (1200m^2)
- Asymmetric with respect to detectors





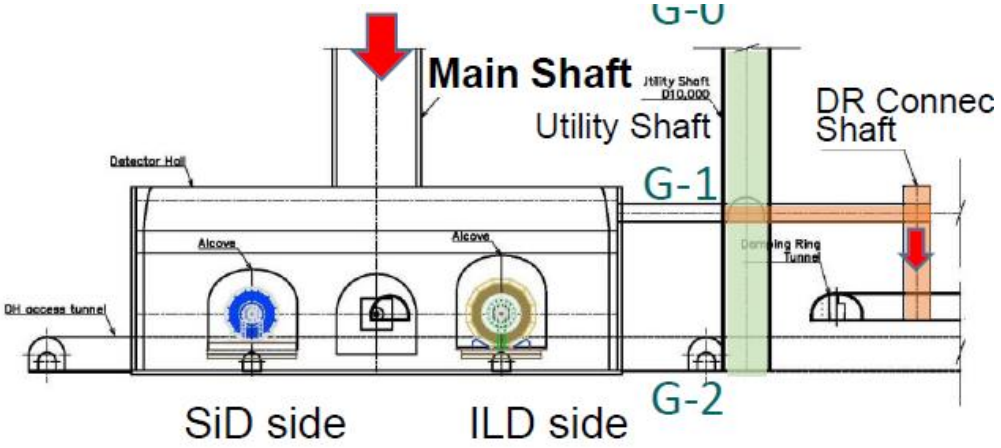
TDR-mod

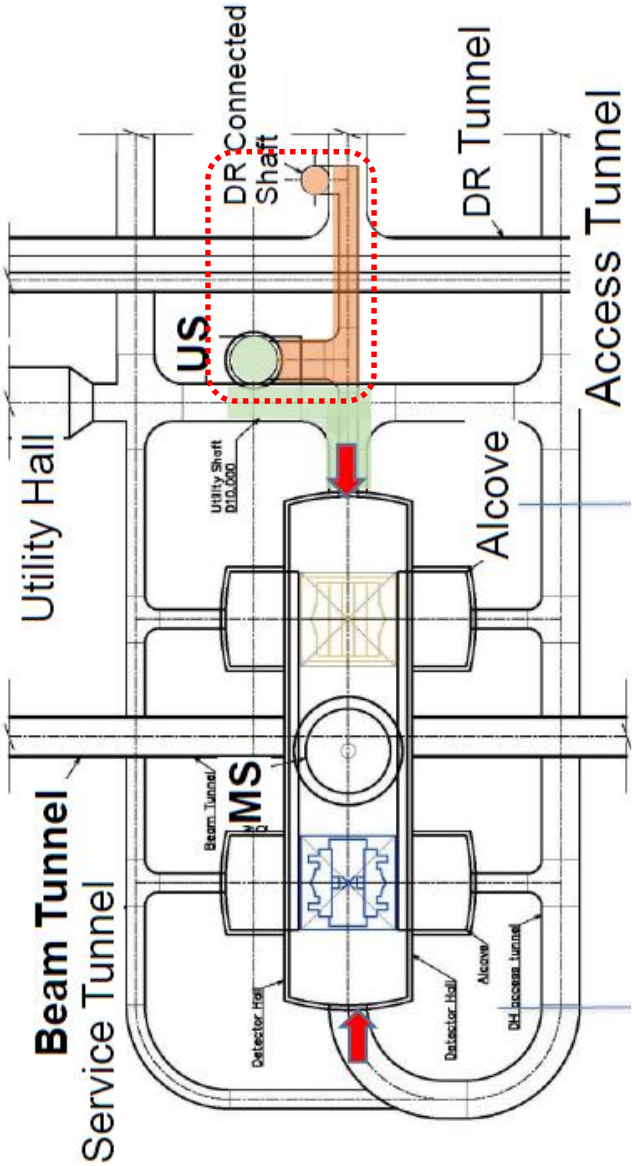
- Present baseline
- Proposed when the vertical shaft access is adopted
- 15m(W)x50m(L)x12m(H) (750m^2)
- Elevator Hall (for Utility Shaft) is included
- Asymmetric wrt detectors
- Dead-end region exists
- No body was seriously thinking about the necessary space for detectors



TDR-mod’

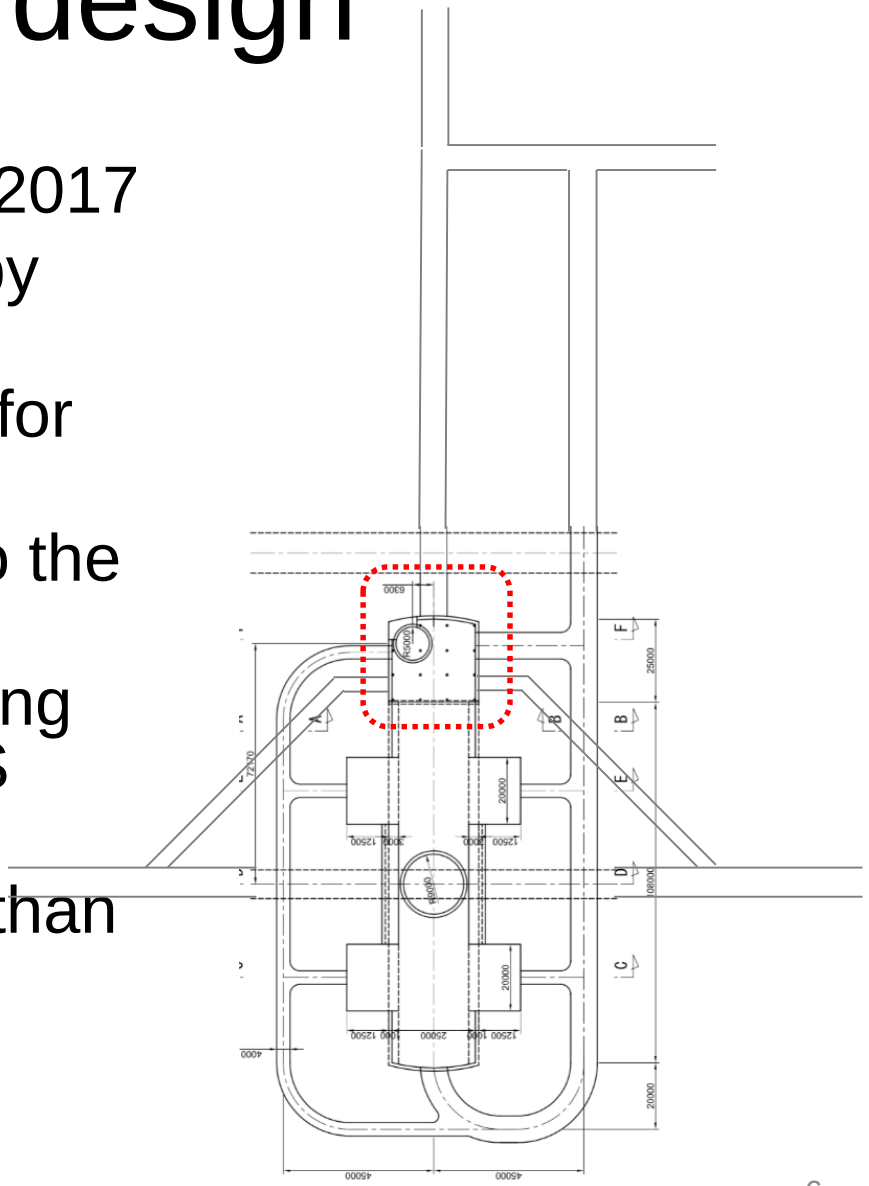
- Utility Shaft (US) is moved
- New tunnel connecting US and Damping ring
- Utility Cavern has the same size as TDR-mod





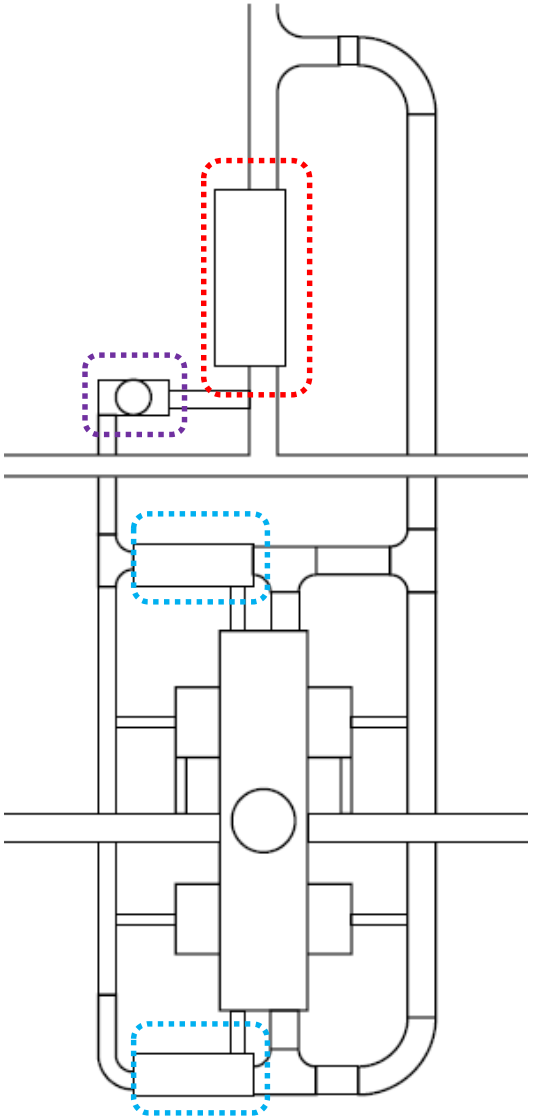
Tohoku design

- Presented at SLAC WS in 2017
- Detector Hall is extended by 25m
- The extended part is used for (accelerator) utilities
- Utility Shaft is connected to the extended part
- Additional tunnels connecting the extended part and BDS tunnel/DR tunnel
- Larger excavation volume than TDR design
- No space for detector utilities/services



Counter proposal (by Y.S.)

- Presented at Strasbourg LCWS 2017, and modified slightly later
- Separated utility/service caverns for accelerator, ILD, and SiD
- 12m(W)x34m(L)x12m(H)x2 (816m^2)
- Separated elevator hall
- New small tunnels connecting Alcove and BDS tunnel (for QF1 cryogenics)
- Merits
  - Less conflicts between groups
  - Easy to put fire-walls
  - Symmetric with respect to detectors
  - Similar excavation volume as TDR design
- It has to be clarified if this size is large enough



UTILITIES/SERVICES FOR DETECTORS

What we have to do

- In order to make a design of Utility/Service Cavern and surface facilities, we have to clarify requirements for detector services and utilities
- Each sub-detector group should clarify the following needs
  - Electric power consumption underground
  - Electric power consumption on surface
  - Cooling water (type and heat load)
  - Location and space requirements of apparatus for detector services
  - Other requests

Electric Power

- Basic concept
  - On surface: 275(154)kV → (66kV) → 6.6kV
  - 6.6kV AC is sent to underground Utility/Service Cavern (USC) through Utility Shaft
  - In USC: 6.6kV → 400(3ϕ) / 200(3ϕ,1ϕ) / 100V(1ϕ)
  - Power dissipation is eventually extracted by cooling water (→ cooling tower on surface)

Electric Power

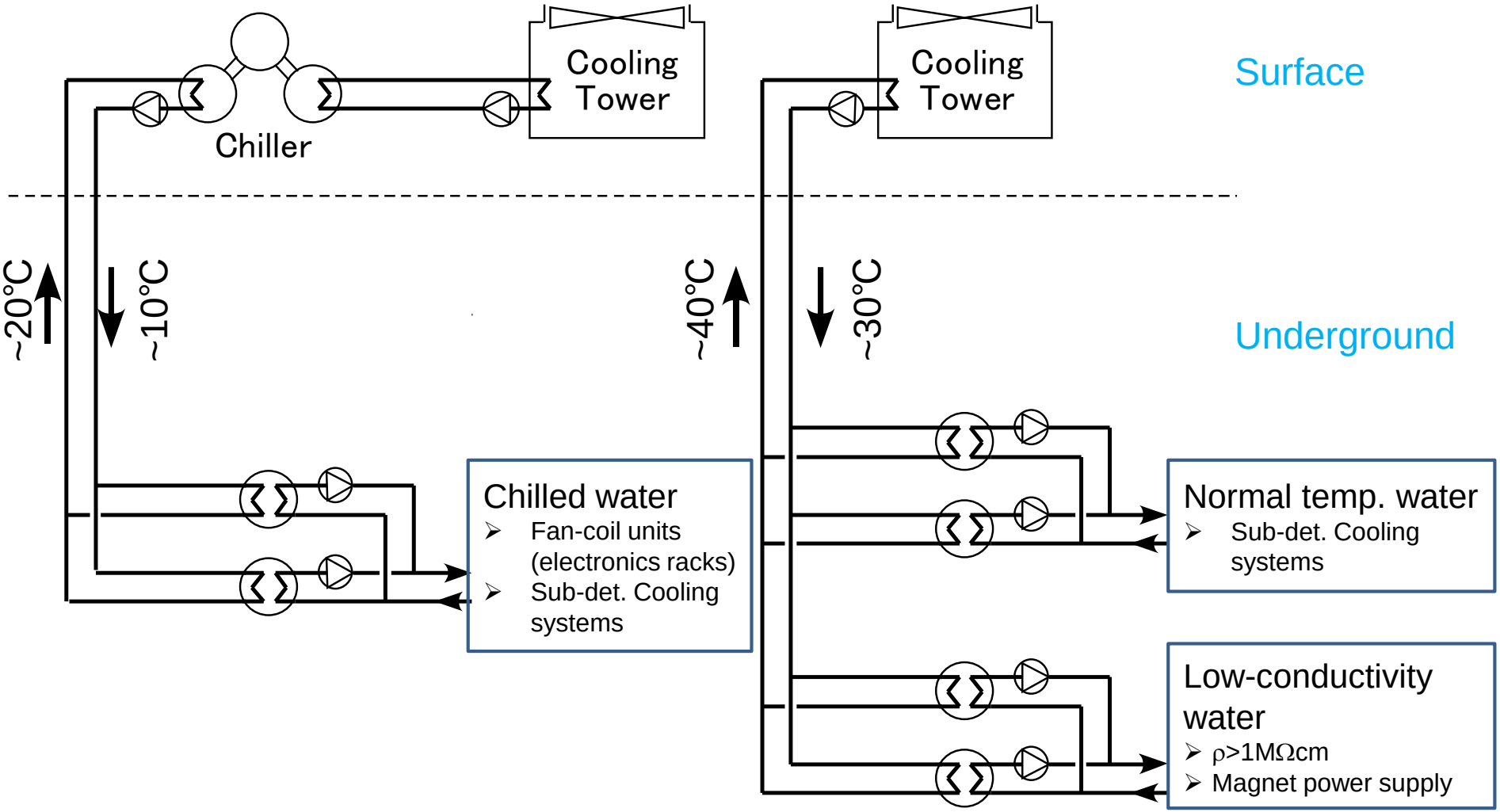
- Estimation by CLIC (LCD-Note-2013-011)

System	CMS (kW)	CLIC (kW)	Note
Detector Magnet	900	900	cryogenics+power
Detector Electronics	2050	1020	
Front-End Electronics	600	<10	
DAQ Electronics	650	<10	
Off-line Electronics	800	1000	
Cooling	600(w)-850(s)	500(w)-750(s)	w: winter
HVAC	600(w)-400(s)	600(w)-400(s)	s: summer
Detector Total	4200	3050	

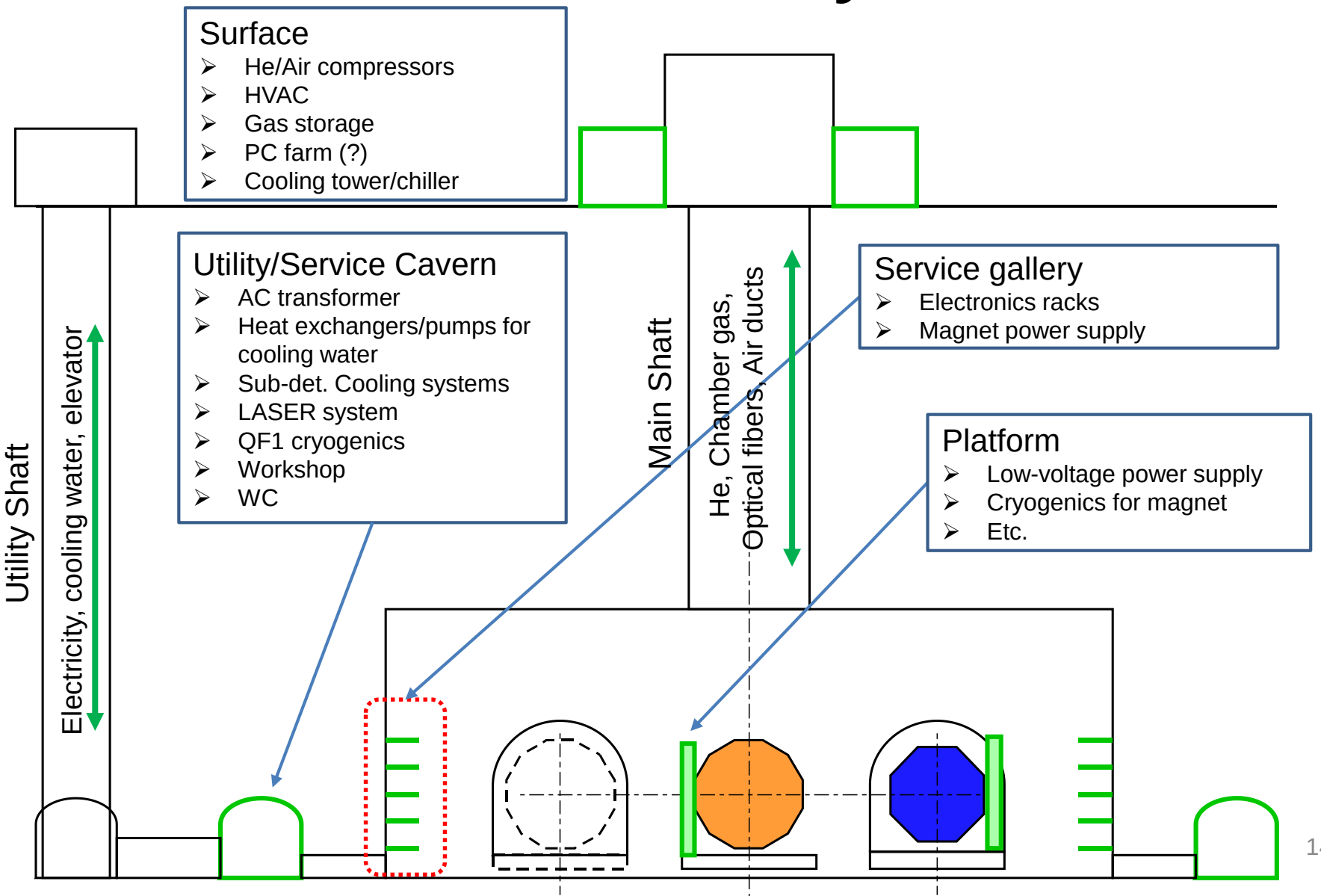
Cooling water

- Two types of water are supplied from surface
  - Normal temp. water: T~30 ℃
  - Chilled water: T~10 ℃ (TBD)
  - High pressure due to Δh~100m can be isolated by heat exchangers in USC
- Sub-detectors are cooled by sub-detector cooling systems
  - Coolant could be CO2, water, or something else
  - Sub-detector cooling systems are cooled by cooling water
- Electronics racks are cooled by fan-coil units
  - Cool air flow generated by chilled water extracts heat, and returns to room temperature

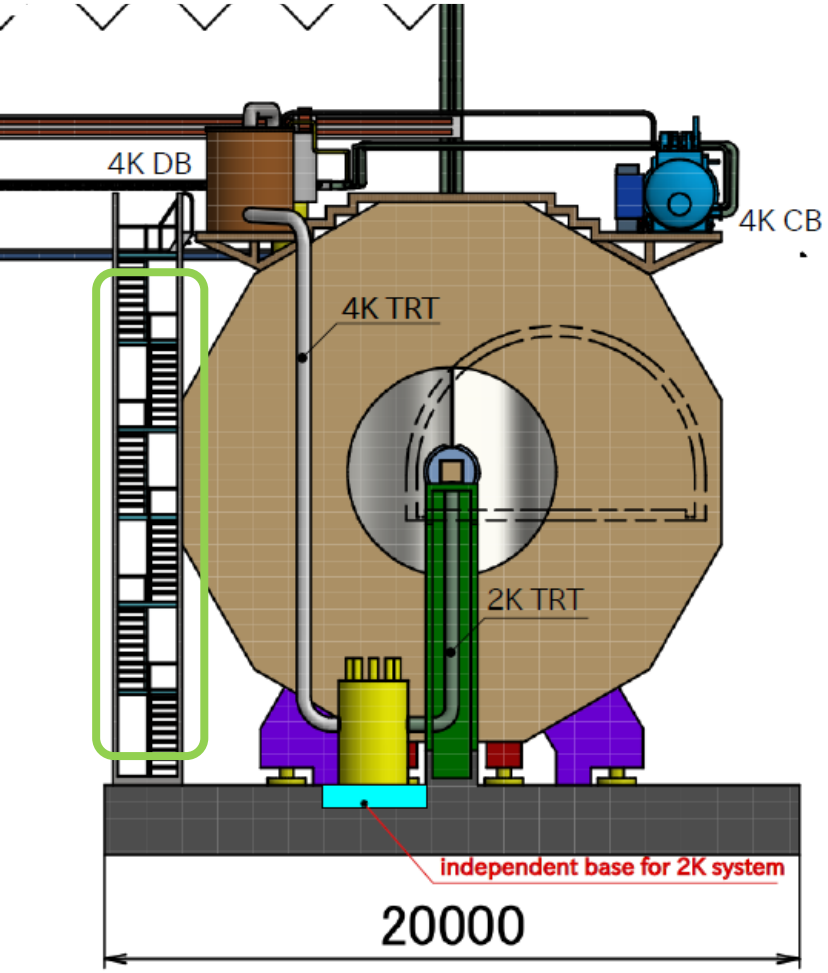
Cooling water

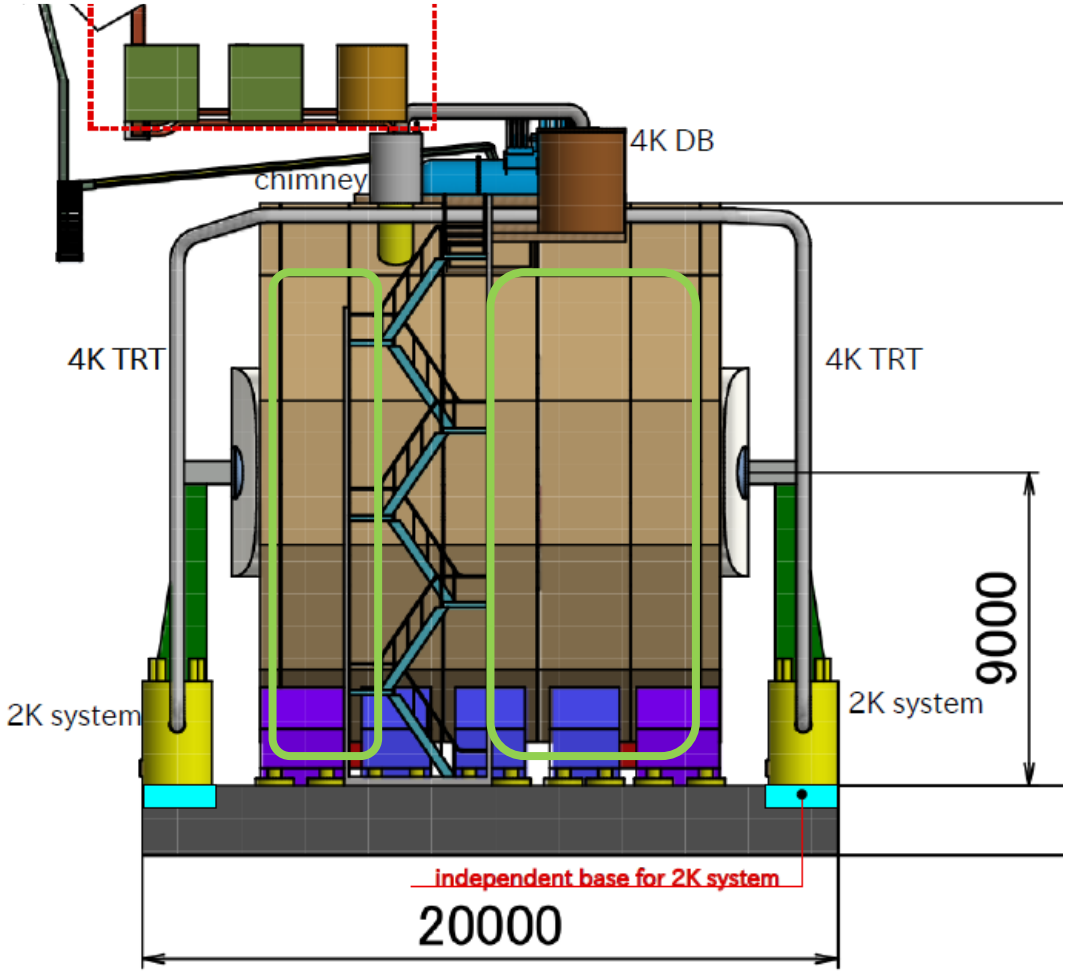


Location of Utility/Service



Detector Platform

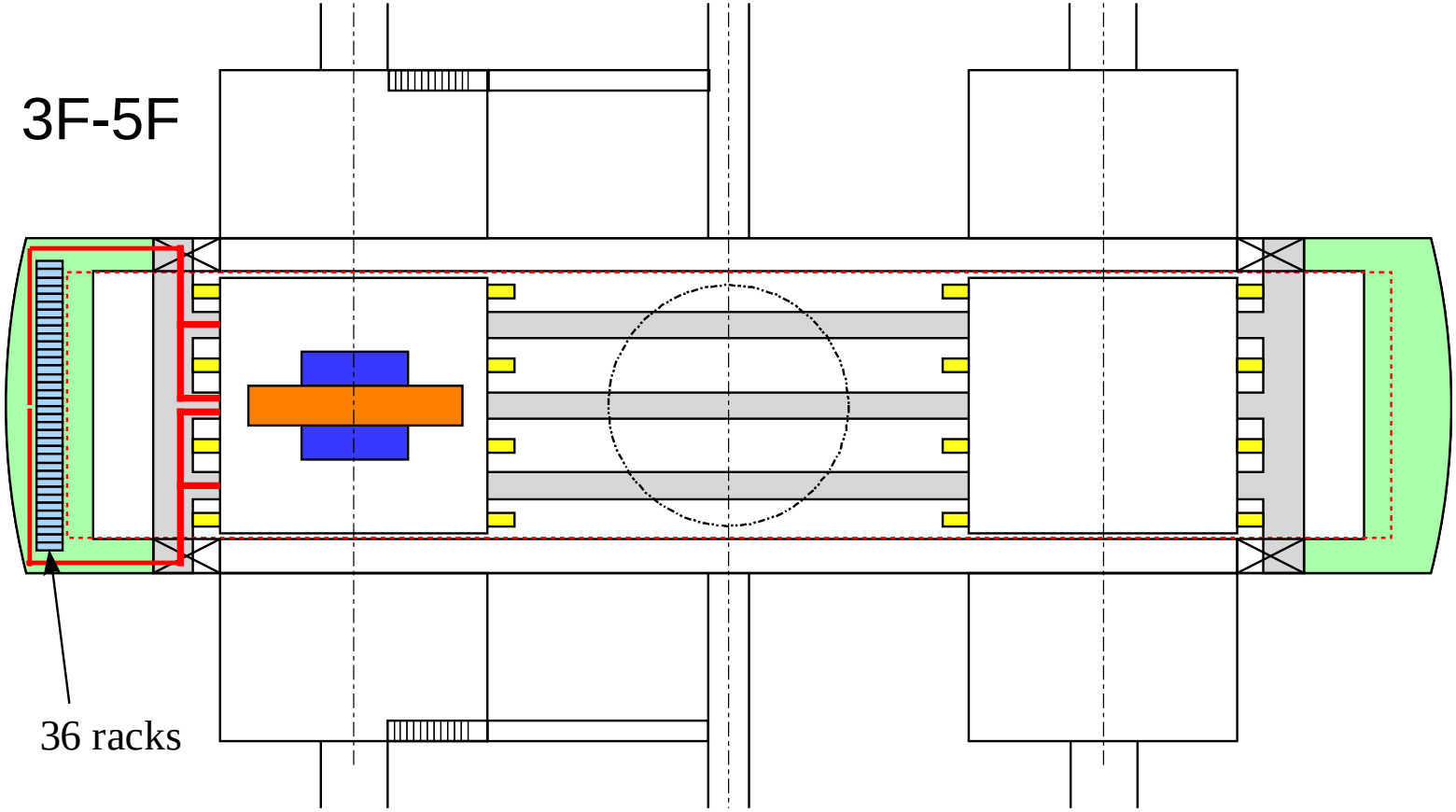




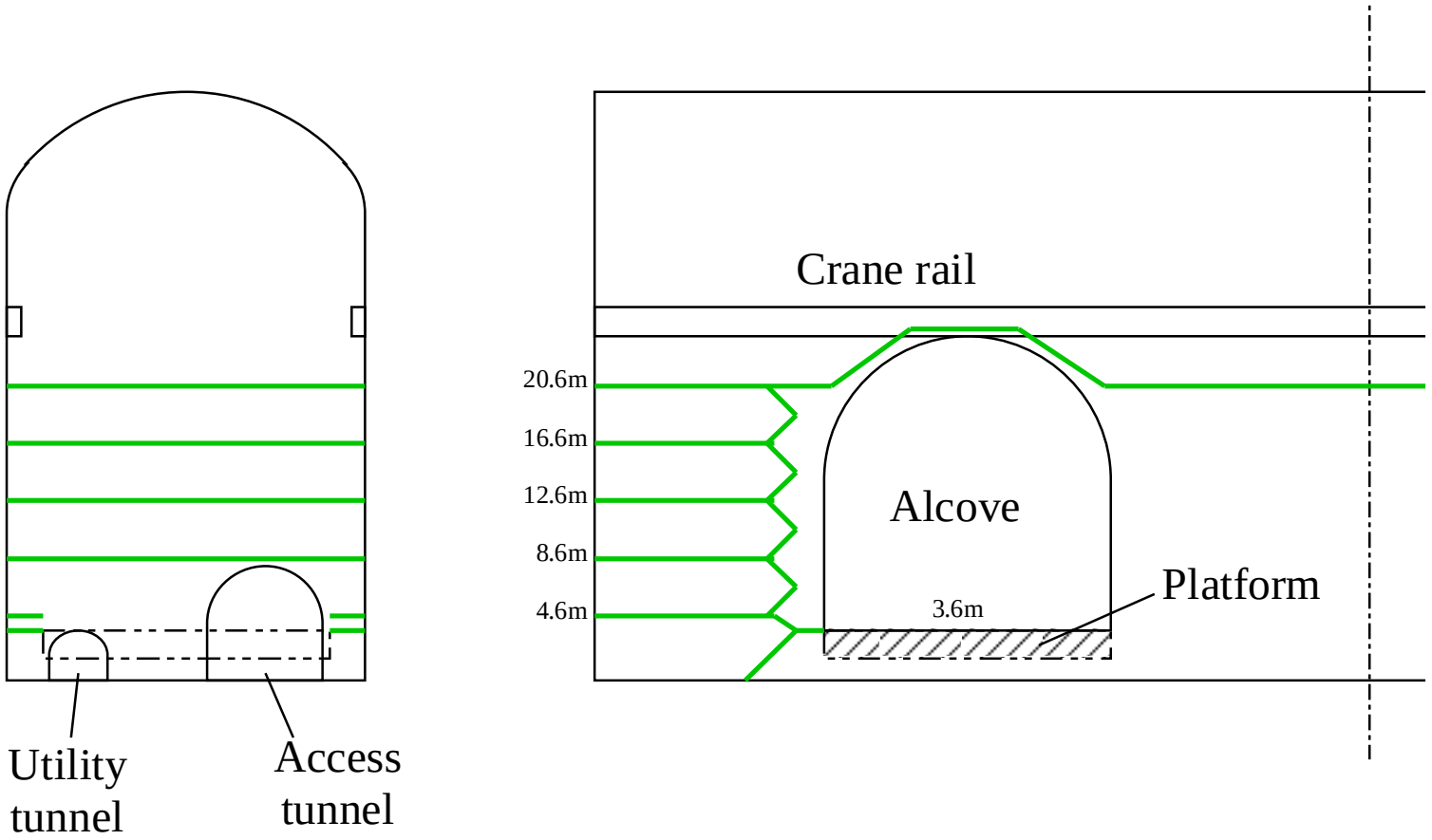
: Space for electronics racks

Service gallery

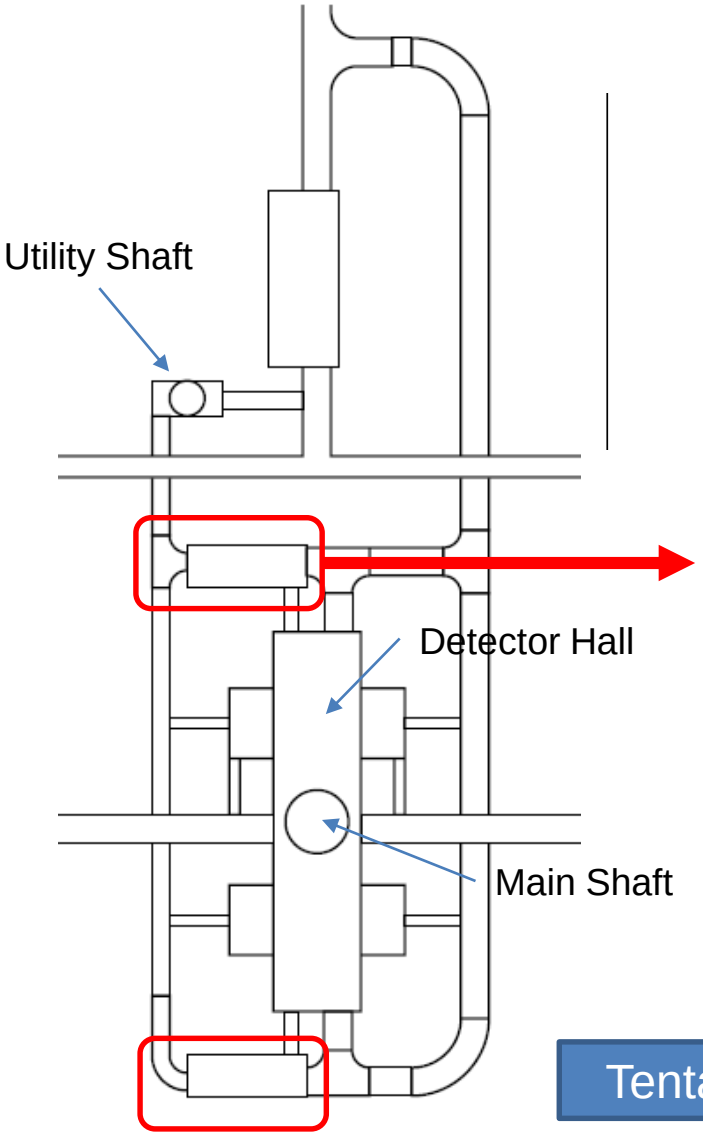
- 2F is just a path to platform
- 3F-5F are used for electronics racks
- 6F is for magnet power supply

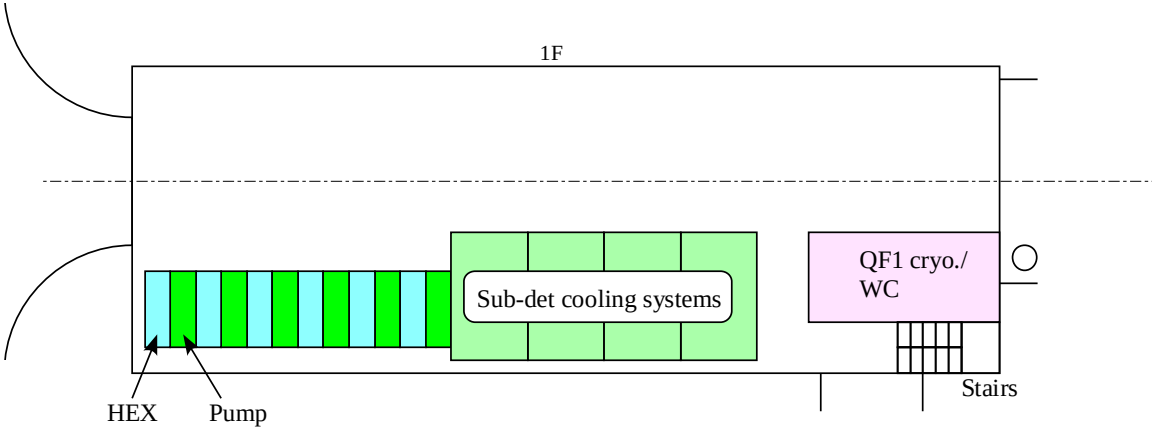


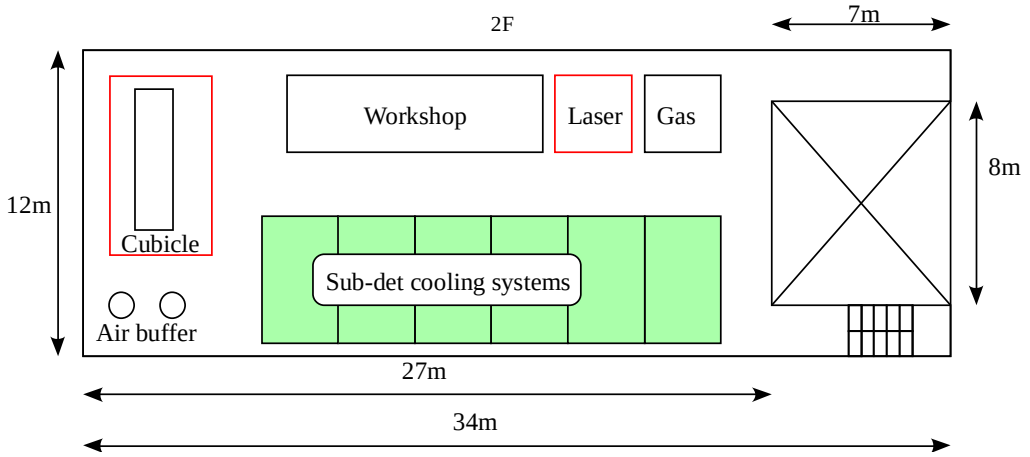
Service gallery



Utility/service cavern







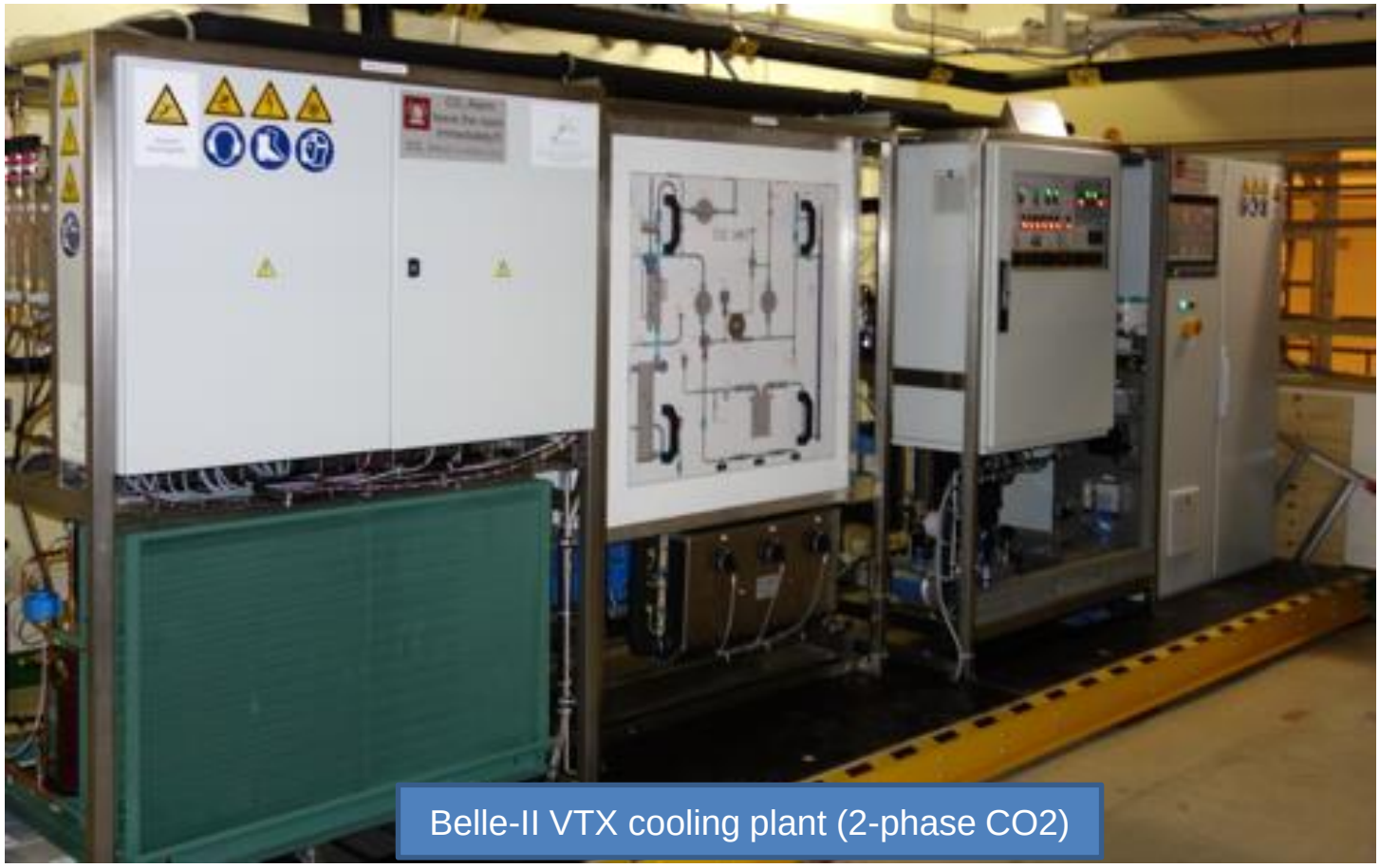
Tentative design

Items to be clarified

- Electronics (19 inch) racks
  - Number and location (platform, service gallery, or somewhere else)
  - AC power (Quite large power consumption (>1 MW) for CMS or ATLAS. What about in the ILD case?)
  - Heat loss (= AC power-DC power to the detector)
- Sub-detector cooling system
  - Location (Utility/Service Cavern?) and space requirement (Don't underestimate the necessary space → next pages)
  - Request for the cooling water (LCW, chilled, or normal?, how much power?)
- Gas system
  - Location and space requirement
- Laser system
  - Location (Utility/Service Cavern?) and area
- PC farm for data processing (data reduction, event build, etc.)
  - Location (Underground or surface?) and area
  - AC power consumption

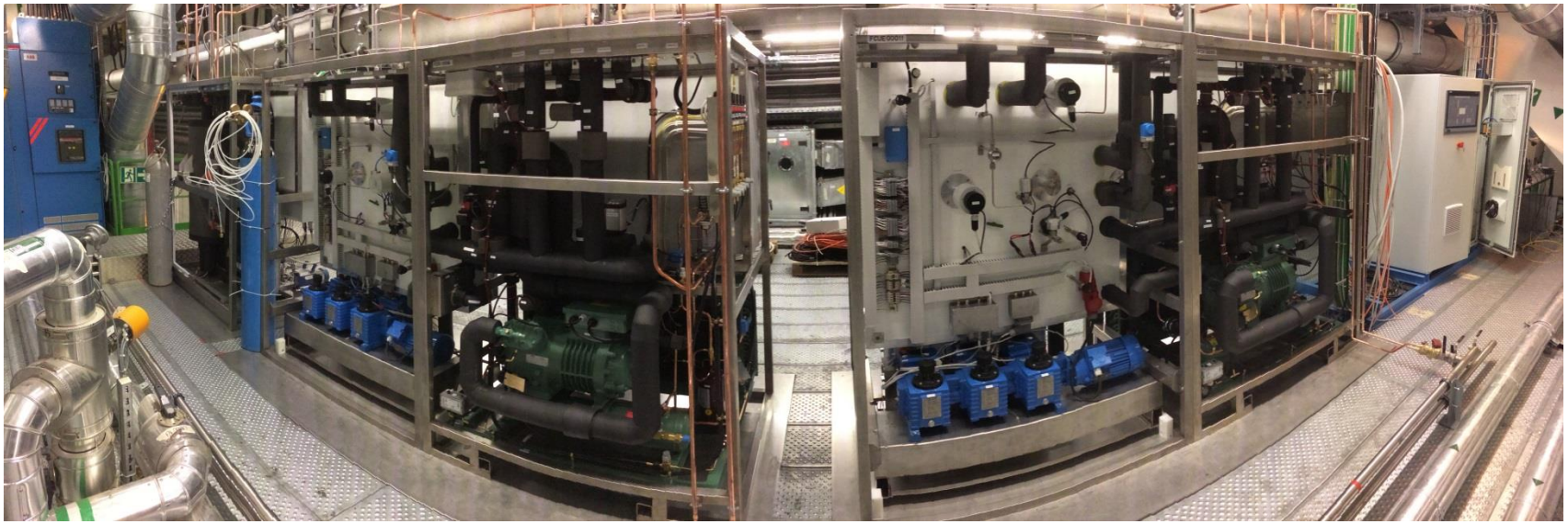
Sub-detector cooling plants

- Sub-detector cooling plants require quite large space
- Some of them (ECAL cooling system) have to be put on the level of 1F of DH or below



Belle-II VTX cooling plant (2-phase CO2)

Sub-detector cooling plants



ATLAS IBL (Si detector) cooling system (2-phase CO2) in the service cavern

Items to be clarified

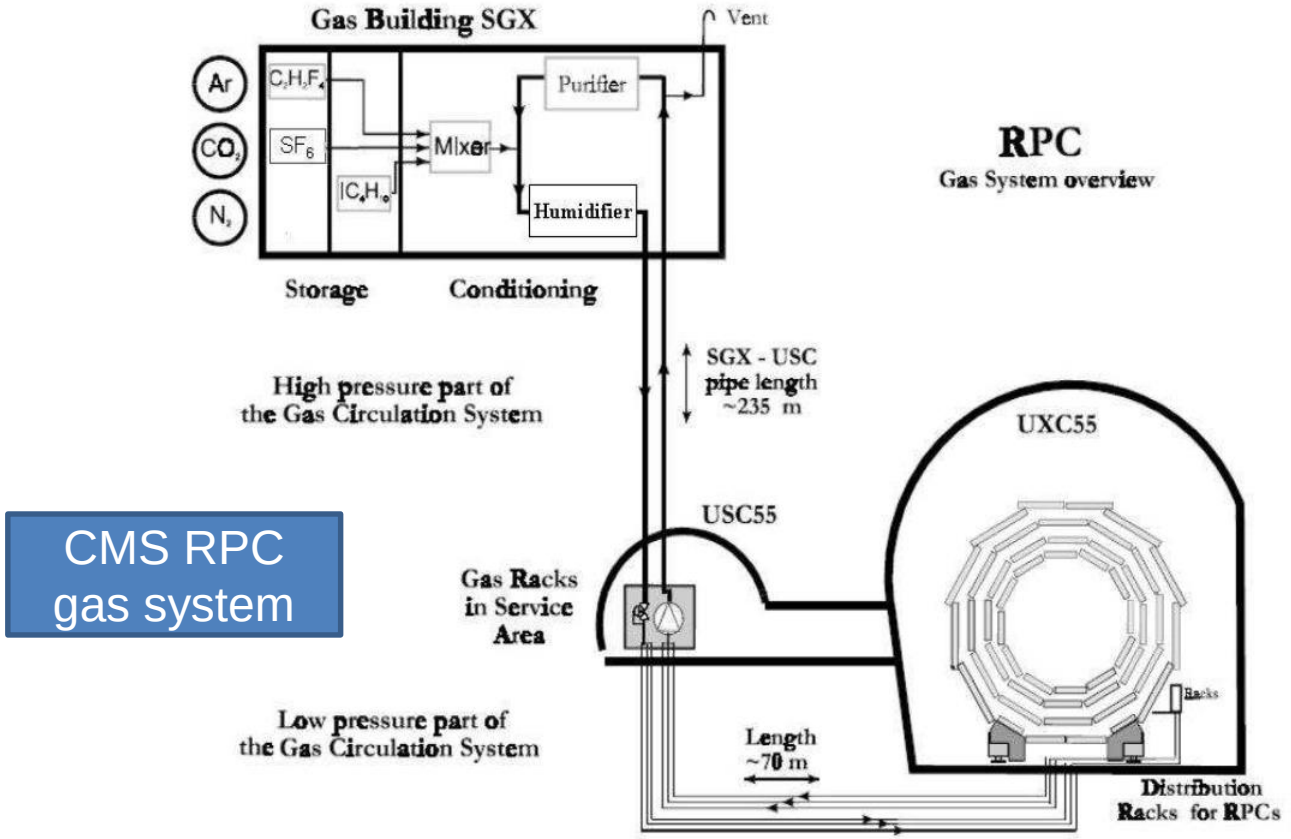
- An excel file for survey
  - Each number could be picked up from the ICD, in principle
  - 1st (rough) estimation should be given by Kyushu LC Workshop

2018/2/23			VTX	SIT	FTD	TPC	ECAL	AHCAL	SDHCAL	Muon	FCAL	PC farm	Off-line	Solenoid	QD0	QF1	Crab Cavity
Electronics Racks	Platform	Number															
		AC power (kW)															
		Heat loss (kW)															
	Service gallery	Number															
		AC power (kW)															
		Heat loss (kW)															
	U/S cavern	Number															
		AC power (kW)															
		Heat loss (kW)															
	Surface	Number															
		AC power (kW)															
		Heat loss (kW)															
Cables	Detector Hall	Heat loss (kW)															
Sub-detector cooling system	USC	Floor															
		WxDxH (m^3)	5x3x2														
		AC power (kW)															
	Cooling water	Type	Chilled														
		Heat load (kW)	1														
Gas system	Platform	WxD (m^2)															
	Service gallery	WxD (m^2)															
	U/S cavern	WxD (m^2)															
	Surface	WxD (m^2)															
Laser system	Space requirement	Location															
		WxD (m^2)															
Magnet ancillaries	DC power supply	AC (3P400V) power (kW)												250	200	200	200
	Cooling water for power supply	Type												LCW	LCW	LCW	LCW
		Heat load (kW)												250	200	200	200
	Cryogenics	AC power (kW)												52	52	52	52
	Space requirement (Underground)	Location												Platform	Platform	USC	USC
		WxDxH (m^3)															
	Cooling water for cryogenics	Type												Normal	Normal	Normal	Normal
		Heat load (kW)													200	200	200
	He Compressor	AC power (kW)															
		WxDxH (m^3)															
	Cooling water for compressor	type															
		Heat load (kW)															
	Cooling water for dump resister	Type												LCW			
		Heat load (kW)															

BACKUP SLIDES

Chamber gas

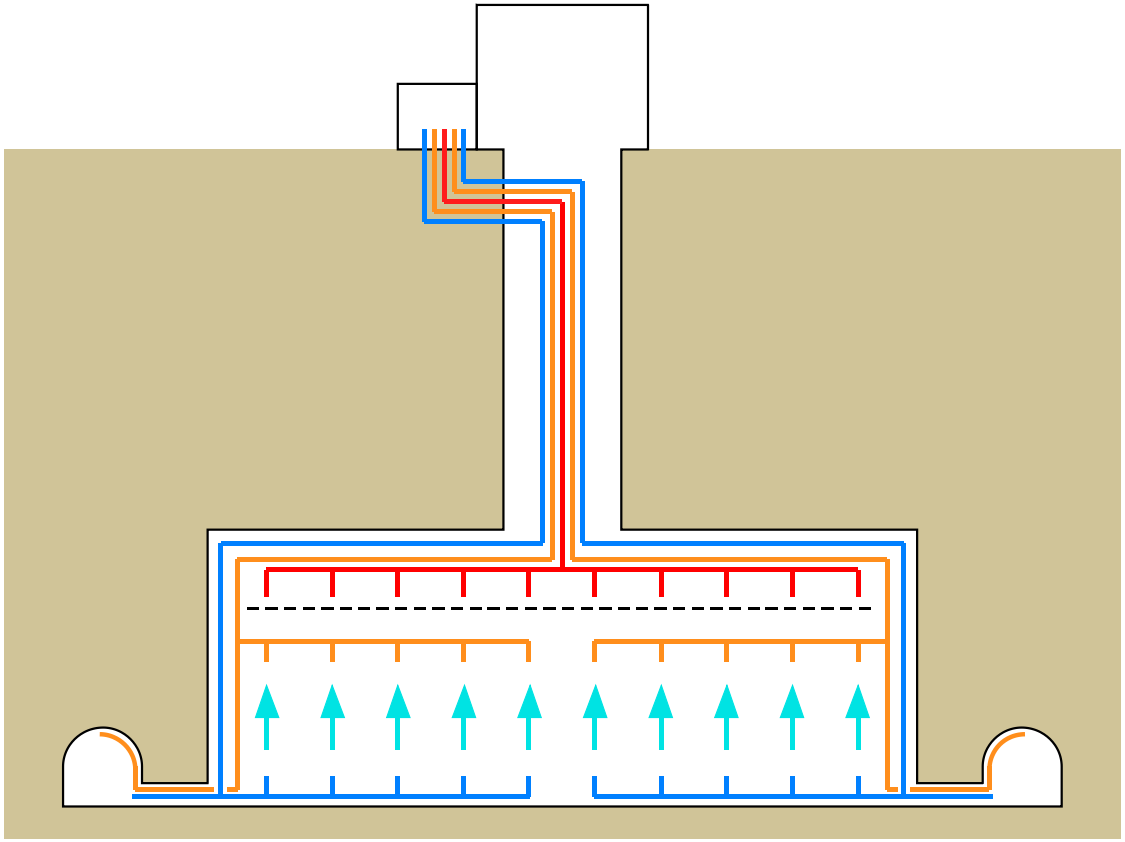
- Chamber gas is necessary for TPC and SDHCAL
- Gas storage on surface like CMS?



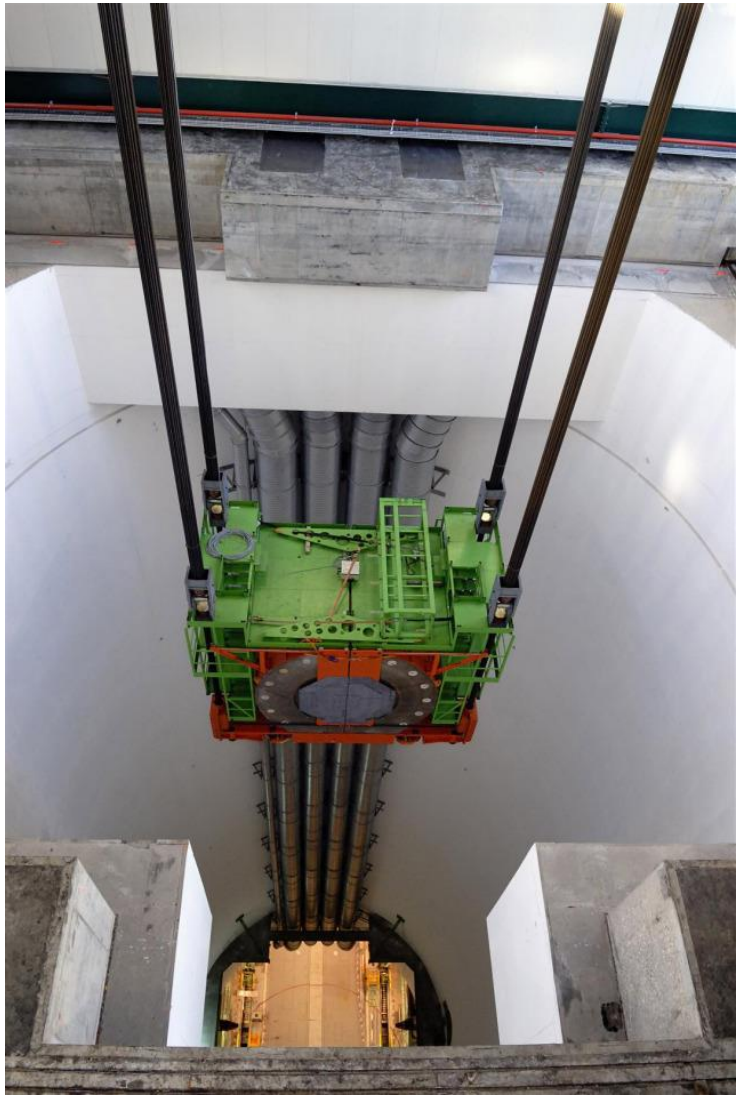
CMS RPC gas system

HVAC

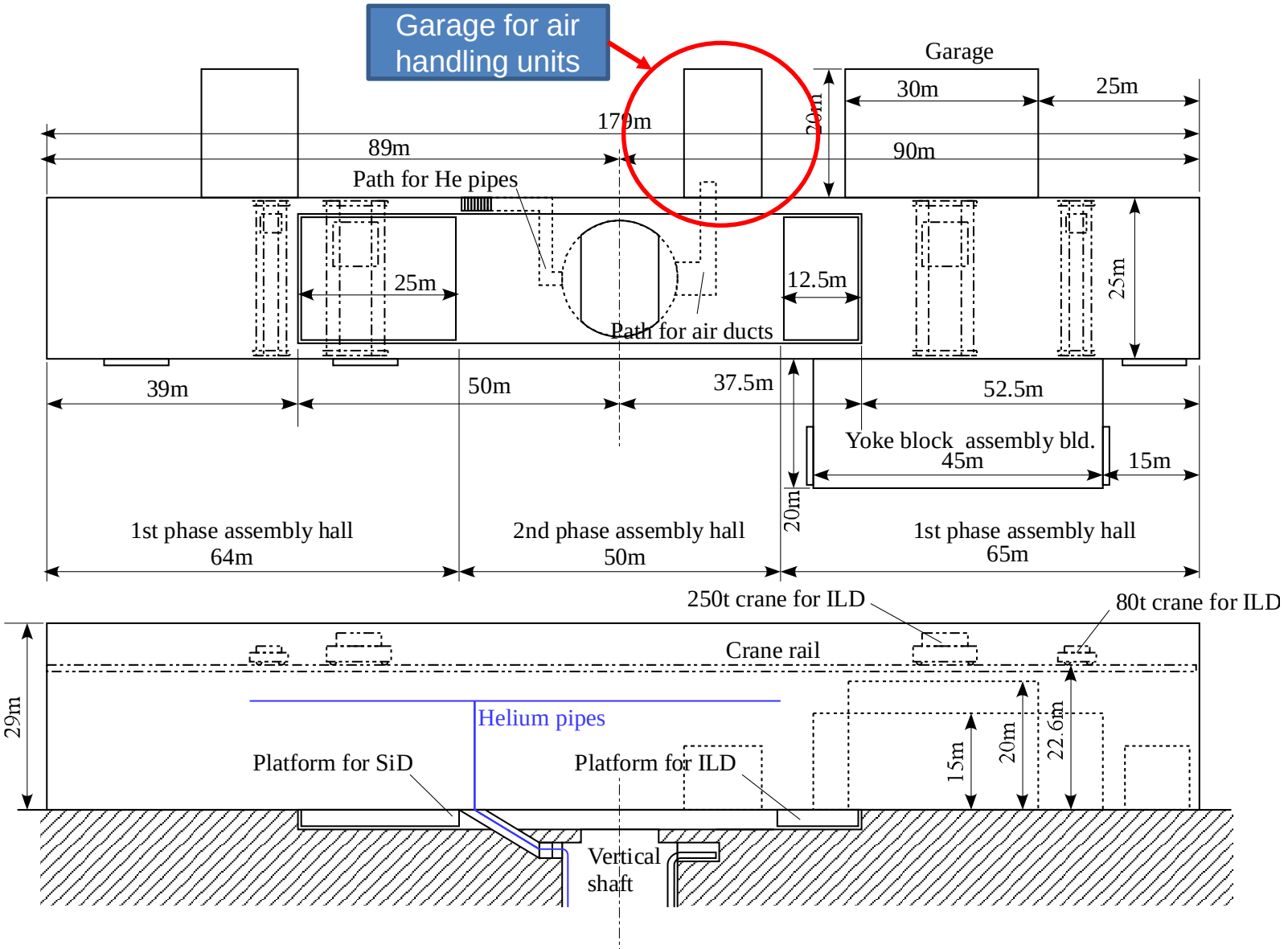
- Air handling units on surface (next to assembly hall)
- Air ducts through main shaft



HVAC - CMS

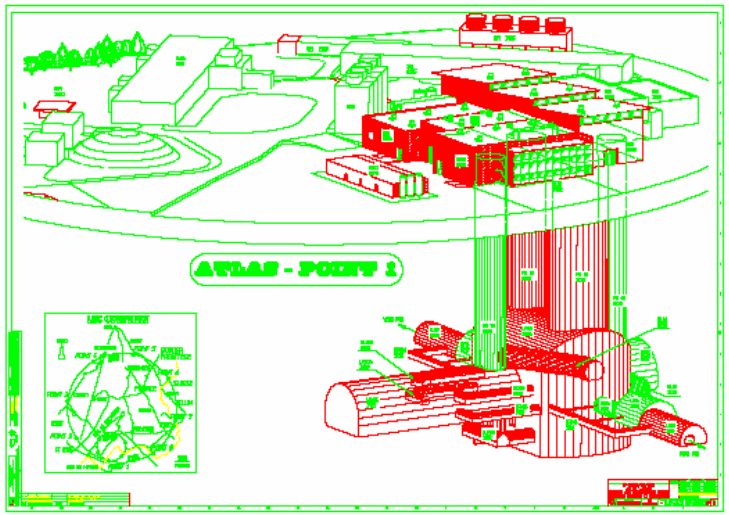


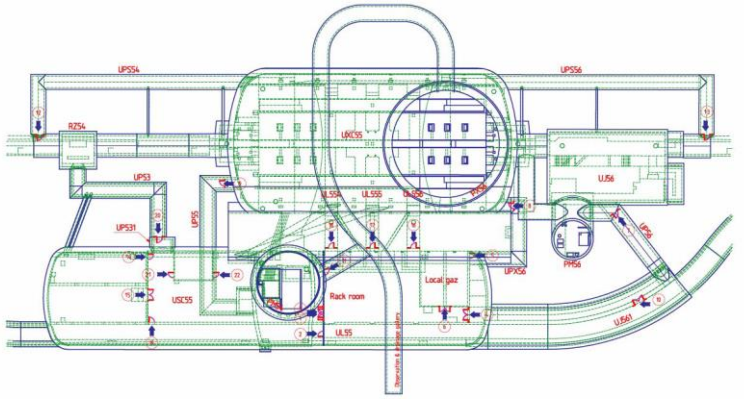
HVAC – Assembly Hall



Service cavern of LHC exp.

- ATLAS
  - USA15
    - Size: 20mx62m = 1240 m^2 (height=13.5m)
    - 2~3 floors
    - Separated from UX15 by 2m thick wall
  - Another small service cavern US15
  - ~100 electronics racks are placed in the detector hall
- CMS
  - USC55
    - Size: 18mx85m = 1530 m^2
    - Two floors
    - ~1/3 is used for electronics racks
    - Bypass tunnel for accelerator





ATLAS

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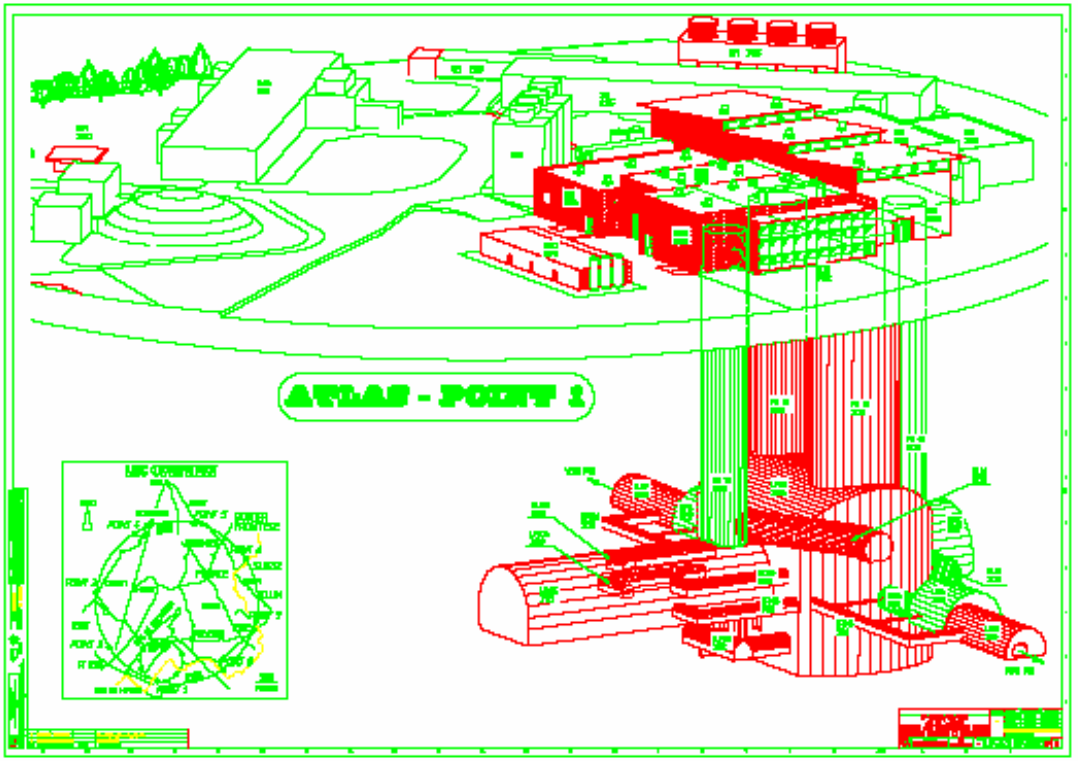

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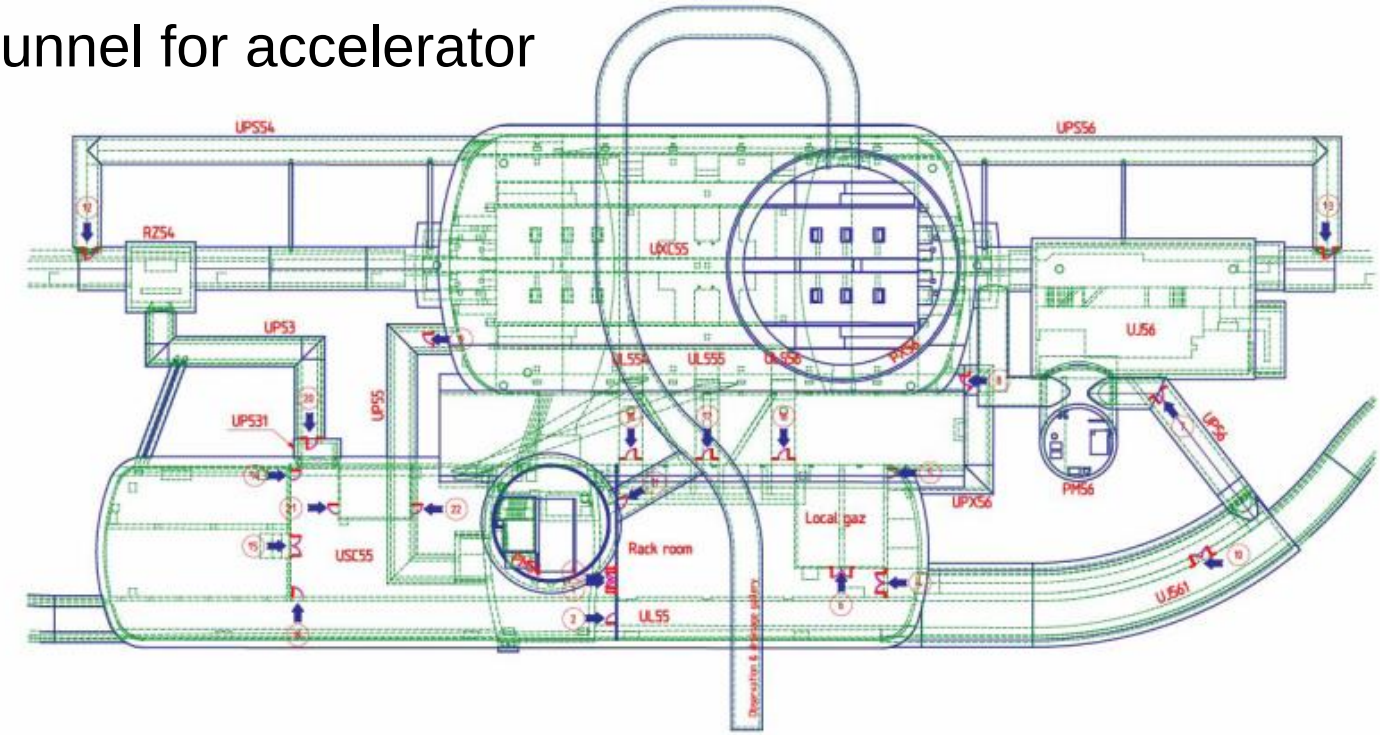
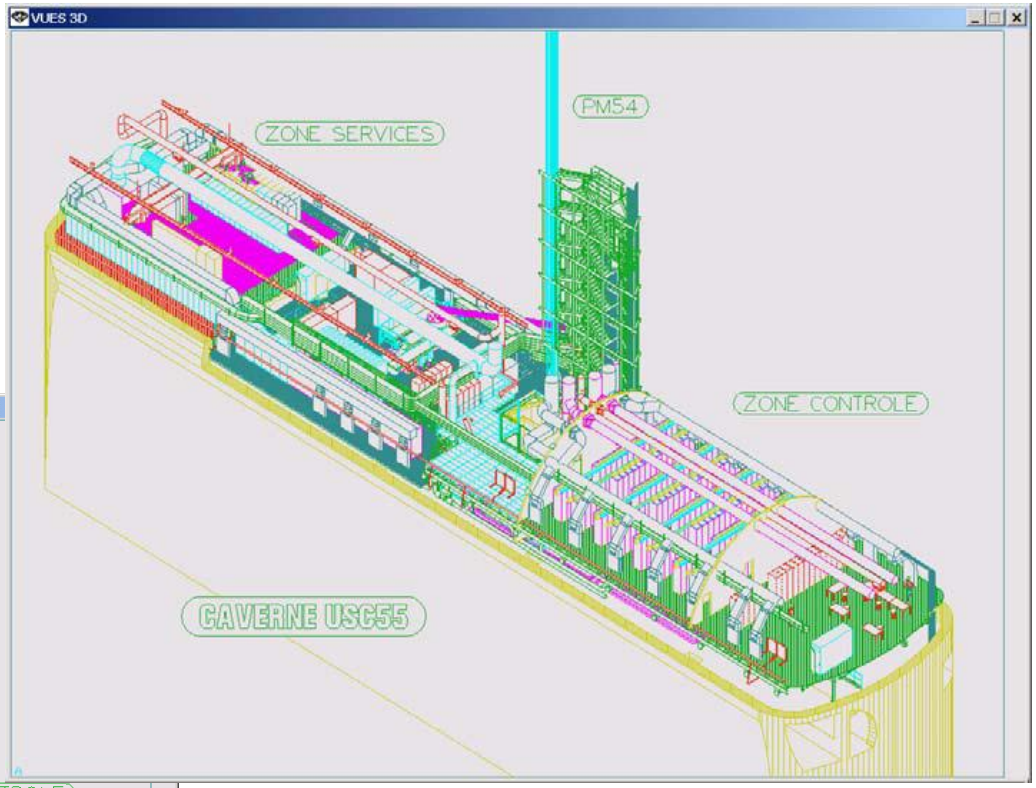
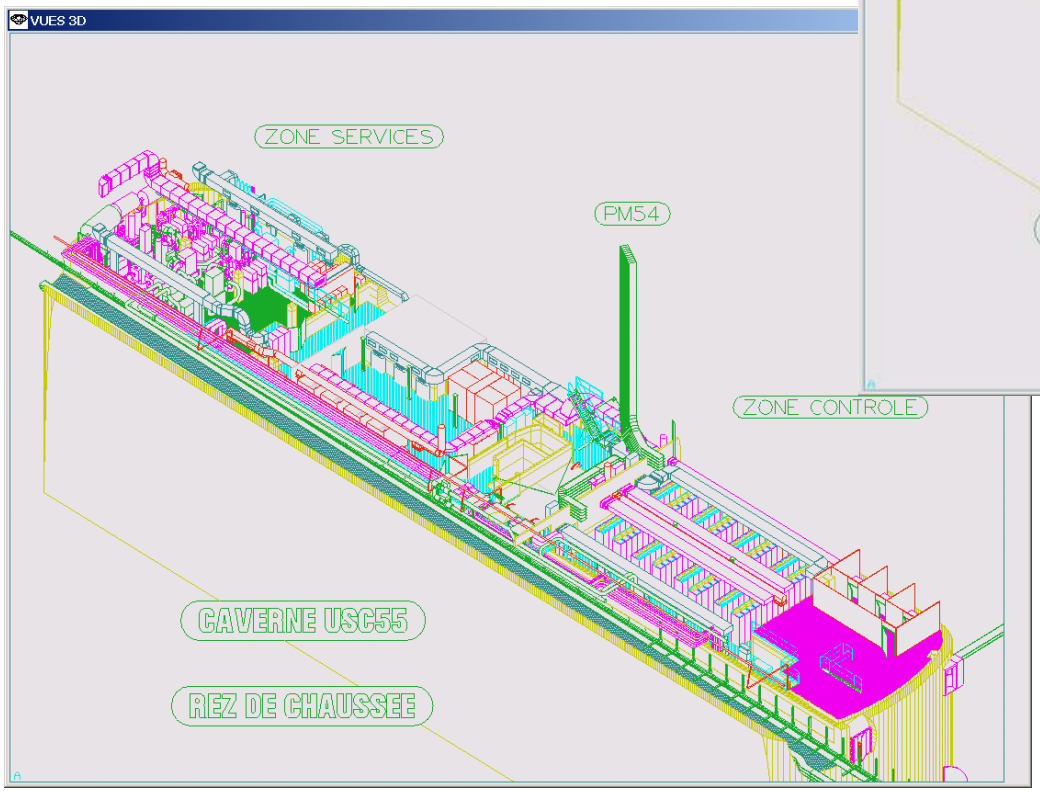


CMS


VUES 3D
ZONE SERVICES
PM54
ZONE CONTROLE
CAVERNE USC55


VUES 3D
ZONE SERVICES
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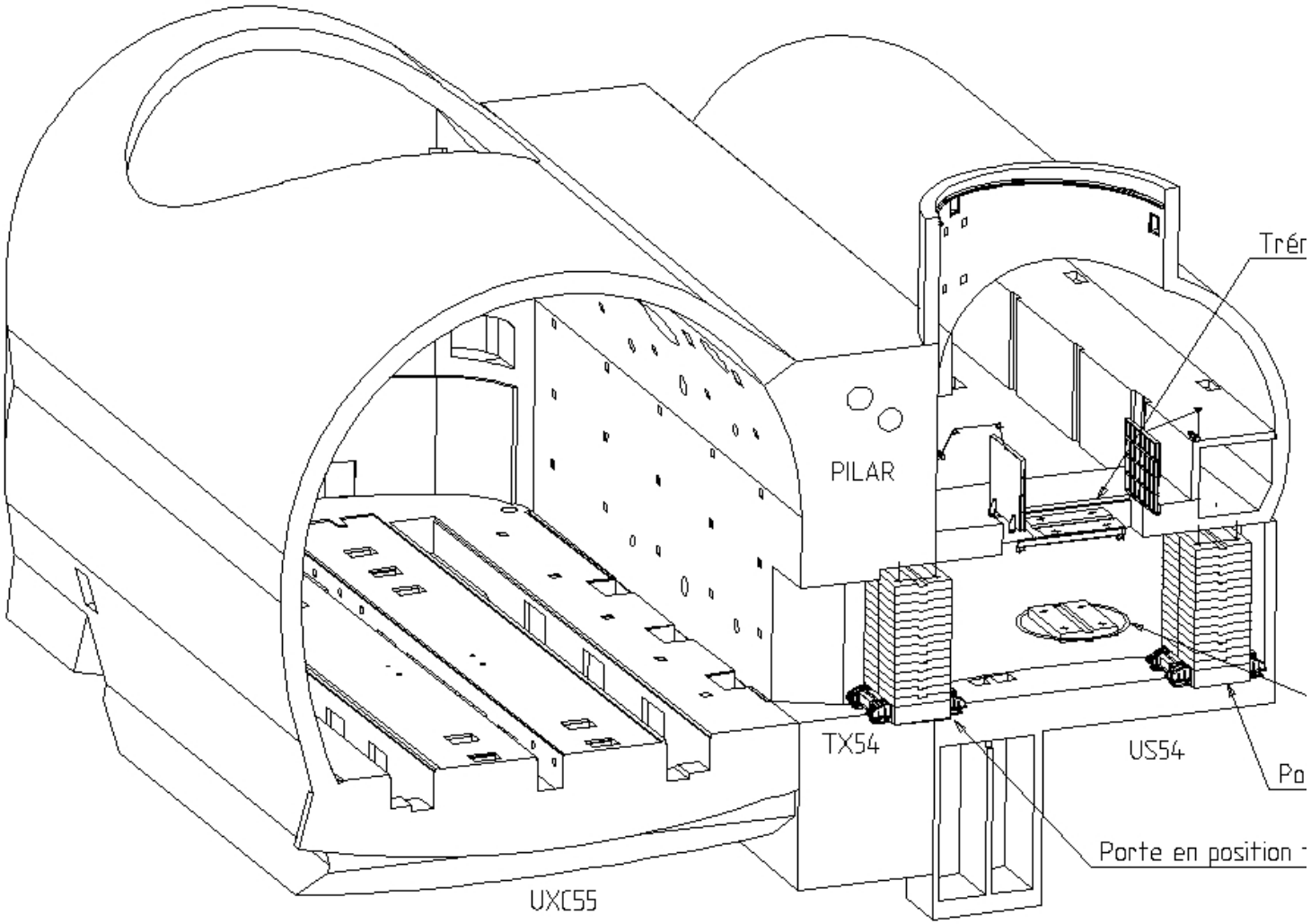
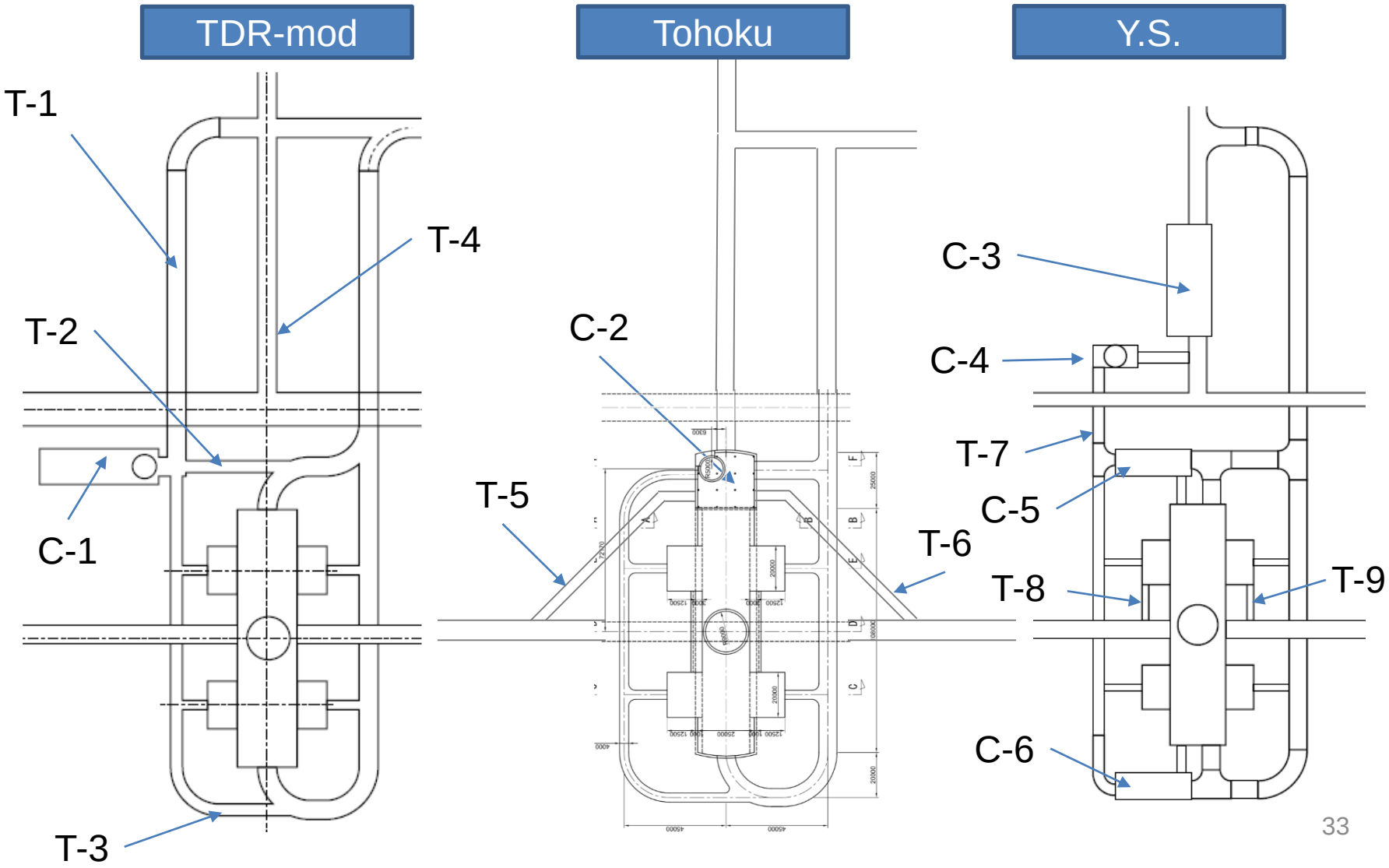
ZONE CONTROLE
CAVERNE USC55
REZ DE CHAUSSEE

CMS



Comparison of excavation volume



Comparison of excavation volume

	W (m)	H (m)	L (m)	V (m^3)	TDR-mod	Tohoku	Y.S.
T-1	8	7.5	170	10200	10200		
T-2	6	6	40	1440	1440	1440	
T-3	6	6	40	1440	1440	1440	
T-4	8	7.5	45	2700	2700	2700	
T-5	6	6	60	2160		2160	
T-6	6	6	60	2160		2160	
T-7	6	6	40	1440			1440
T-8	3	3	16	144			144
T-9	3	3	16	144			144
C-1	15	12	50	9000	9000		
C-2	25	43	25	26875		26875	
C-3	20	12	50	12000			12000
C-4	10	8	20	1600			1600
C-5	12	12	34	4896			4896
C-6	12	12	34	4896			4896
VS			-πx5x5x43	-3377		-3377	
Total					**24780**	**33398**	**25120**

(V=W*H*L)