The Construction of New Deep Underground Facility in Jeongseon, Korea (Yemi-Lab)

Kangsoon Park

1. CUP's Infra
2. Introduction
3. Tunnel Excavation
4. Shaft Cage
5. Underground Laboratory
6. Surface Office/Lab.
7. Summary

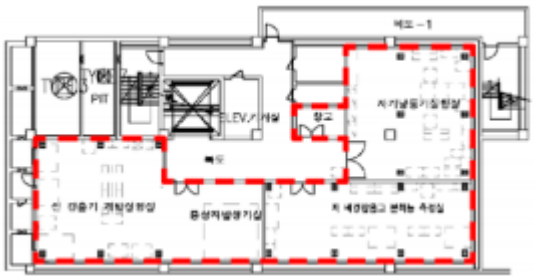
Korea-Italy Symposium 1 Oct, 2018 @ IBS Deajeon, Korea

1. CUP's Infra

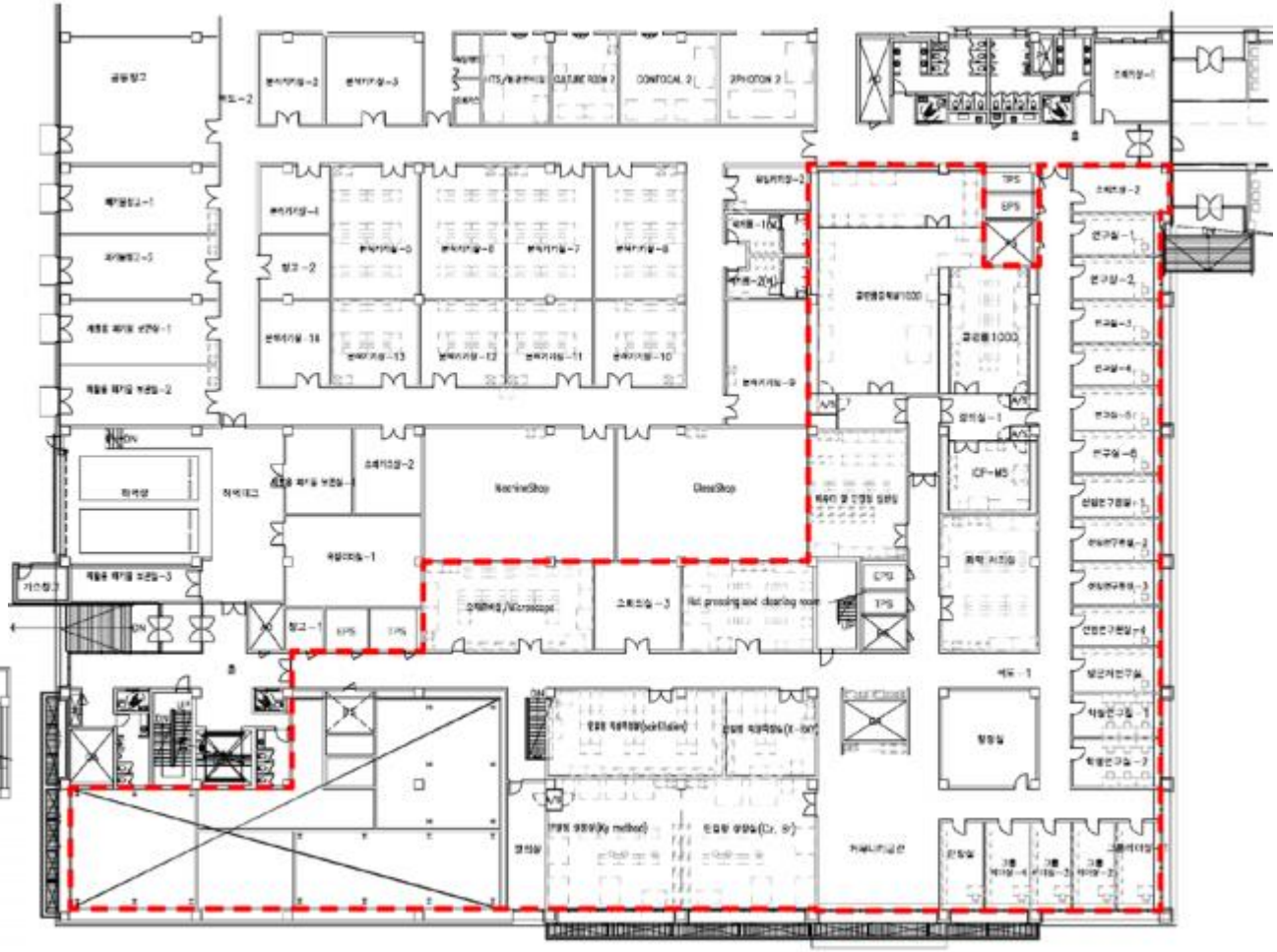

E
D
C
A
B
F
A : Administration building
B : Theory building
C : Experiment building
D : Laboratory Animal Resource
E : Dormitory
F : IBS Science Culture Center

❖ CUP's Laboratories in IBS HQ, Daejeon (Jan. 2018 ~)

- 21 Offices and meeting rooms
- 13 Laboratories



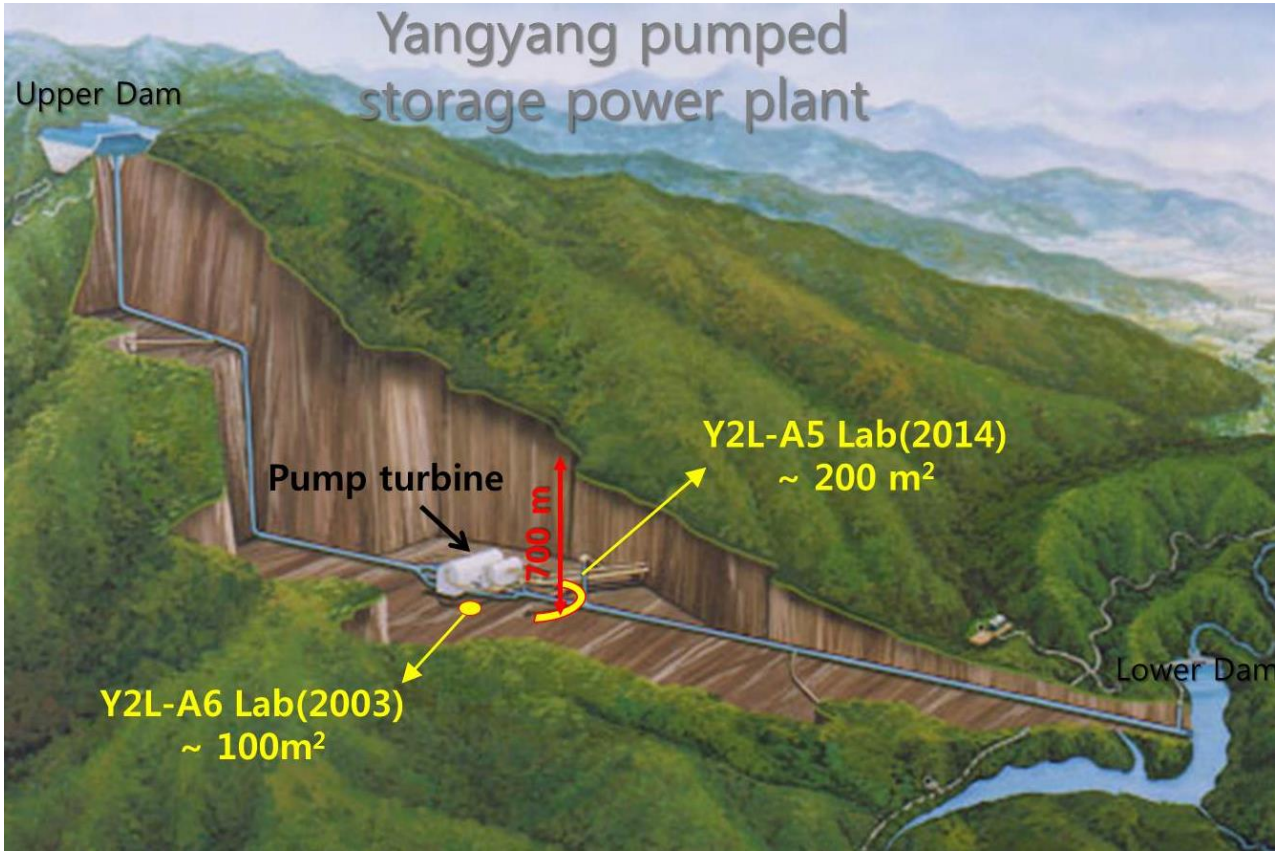
Below ground labs



1st floor labs and offices

❖ The Y2L (Underground laboratory)

- Since its construction, all systems have been working well so far



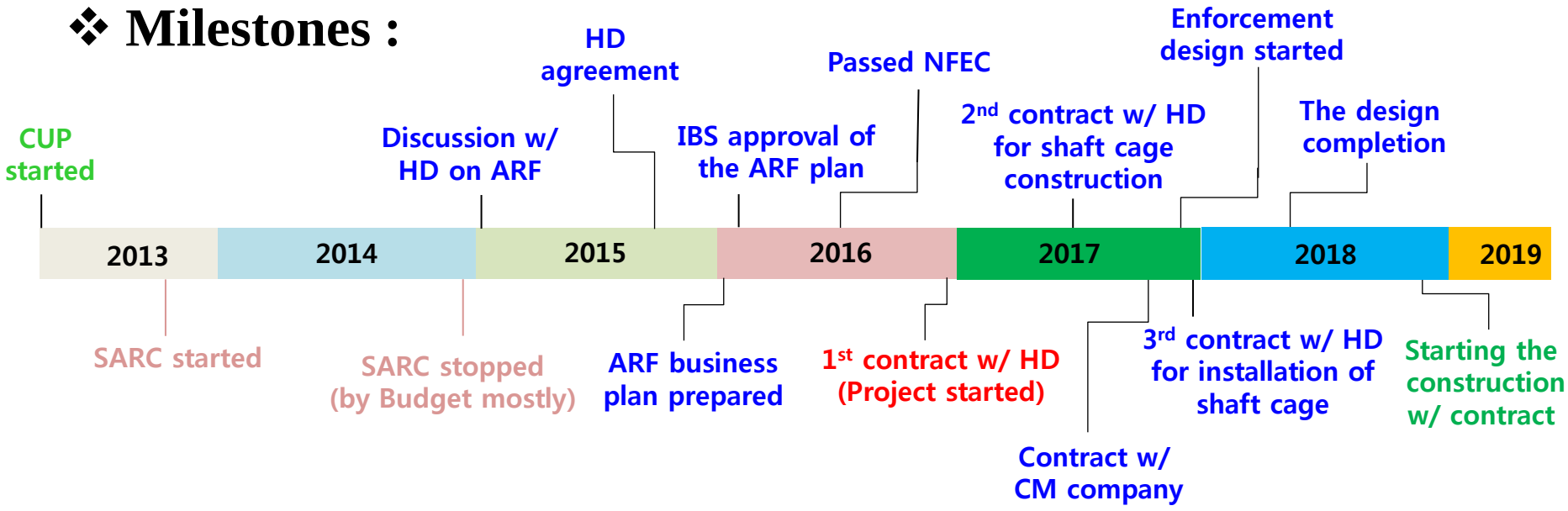
- 300m² area
- 12 rooms
- 3 experiments

2. Introduction: New Underground Lab.

❖ Motivation :

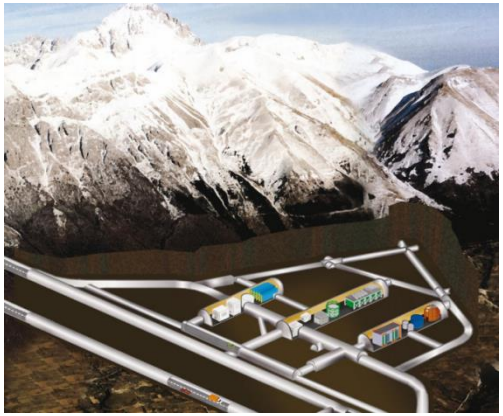
- AMoRE Phase-II and other future experiments need much bigger space than the Y2L (YangYang Lab.) space.
- The current Handeok mine (HD) site was found to be one of the best places to have the new UL.
- A construction plan of new UL was proposed five years ago with a different site.

❖ Milestones :

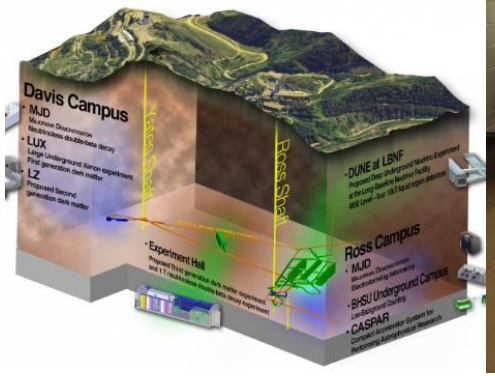


❖ Visiting the would class underground facilities

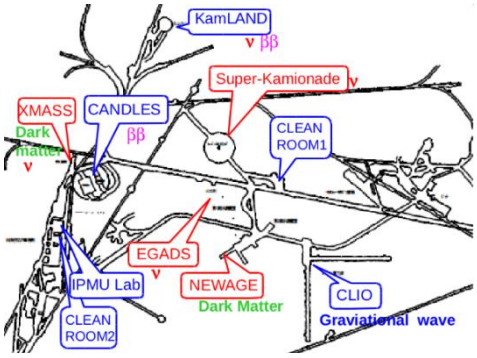
LNGS (Dec. 2013)



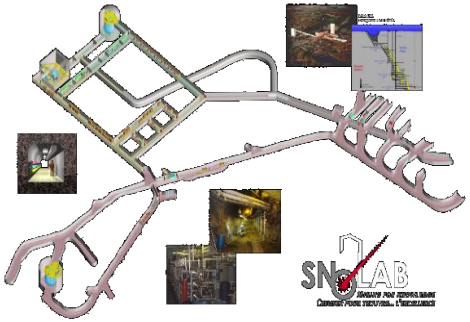
SURF (May 2017)



Kamioka (July 2017)



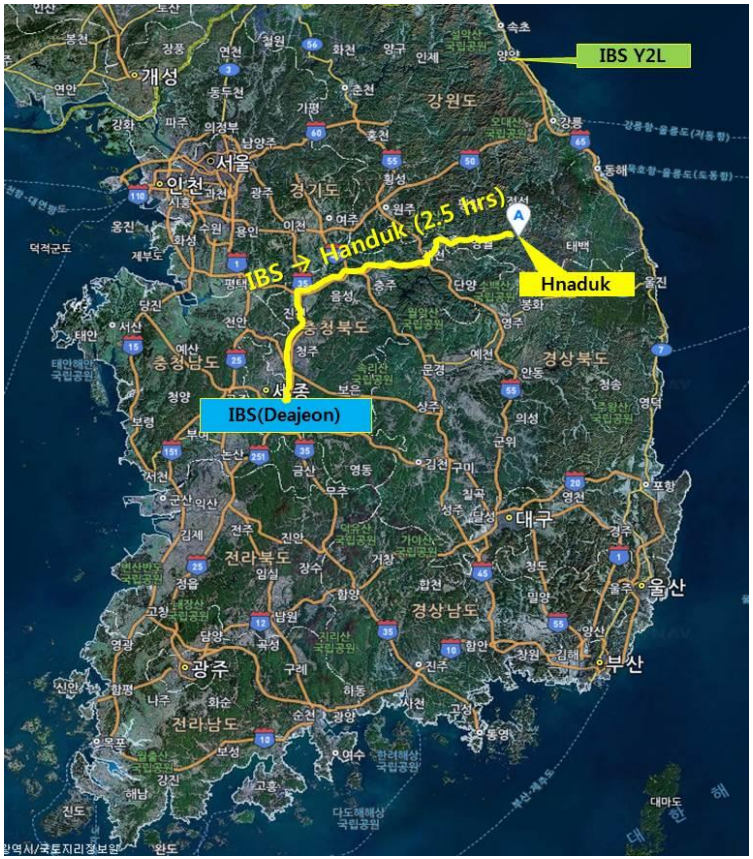
SNOLAB (Jan. 2018)



❖ Handeok mine

- The only operating iron ore mine in Korea.
- A 600 m long 2nd shaft already constructed.
- 0.7 million ton iron ores being produced per year

Handeok iron mine, Jeongseon, Gangwon, Korea

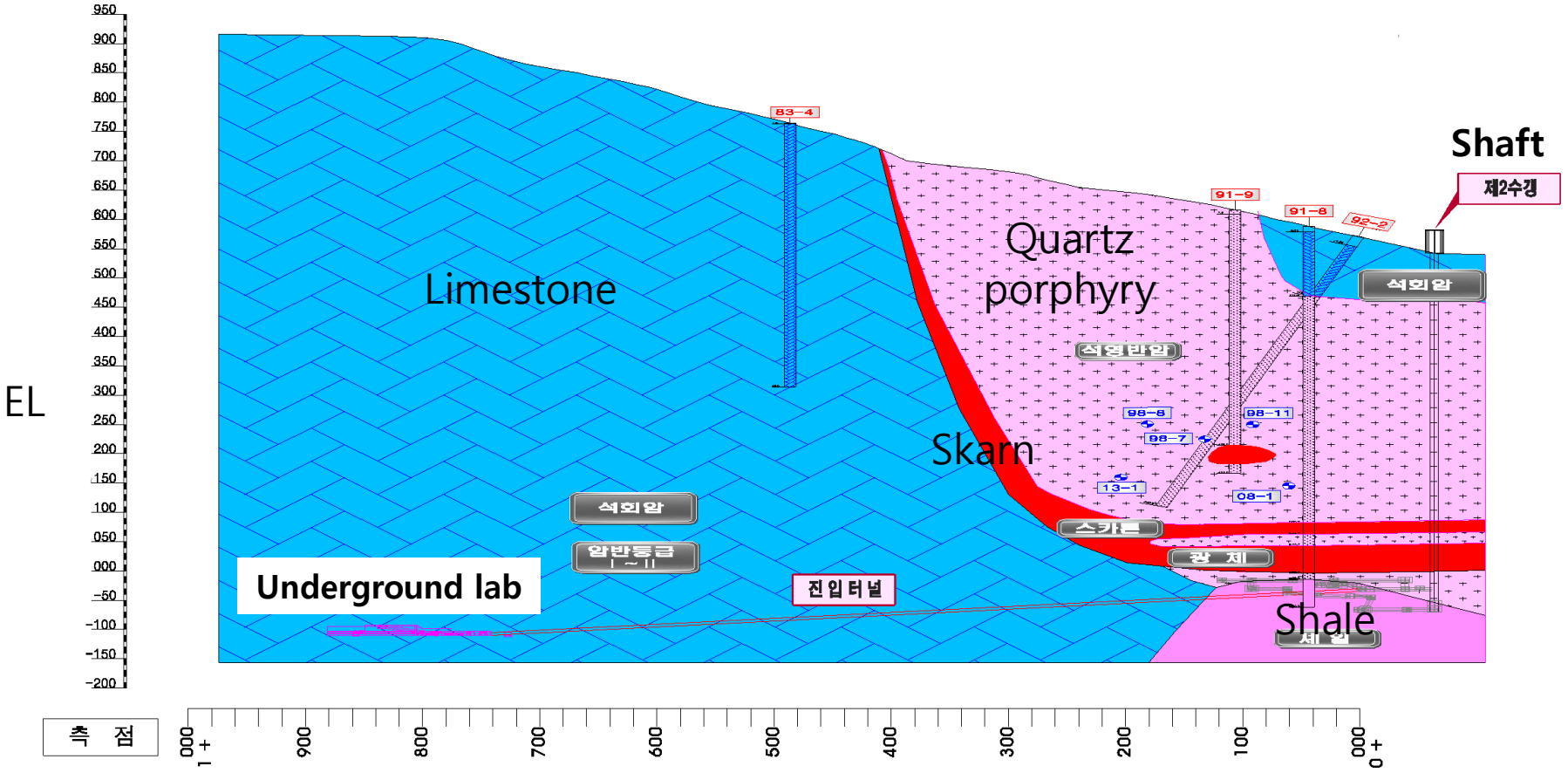


Bird view of Handeok Iron Mine

Handeok has two shafts for mining
1st shaft ~ 300 m long
2nd shaft 600 m long (NEW)

❖ Geological condition

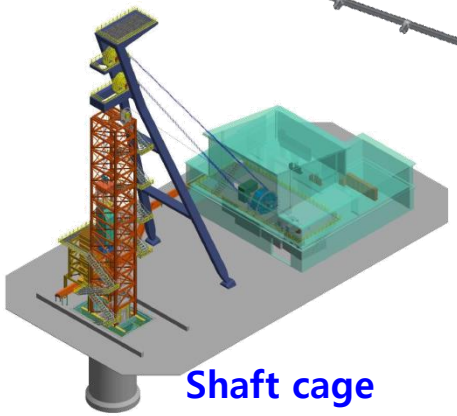
- Most of the tunnels pass through the limestone zone
- However, it is expected that the 200m beginning section of the tunnel will pass through the bad rocks



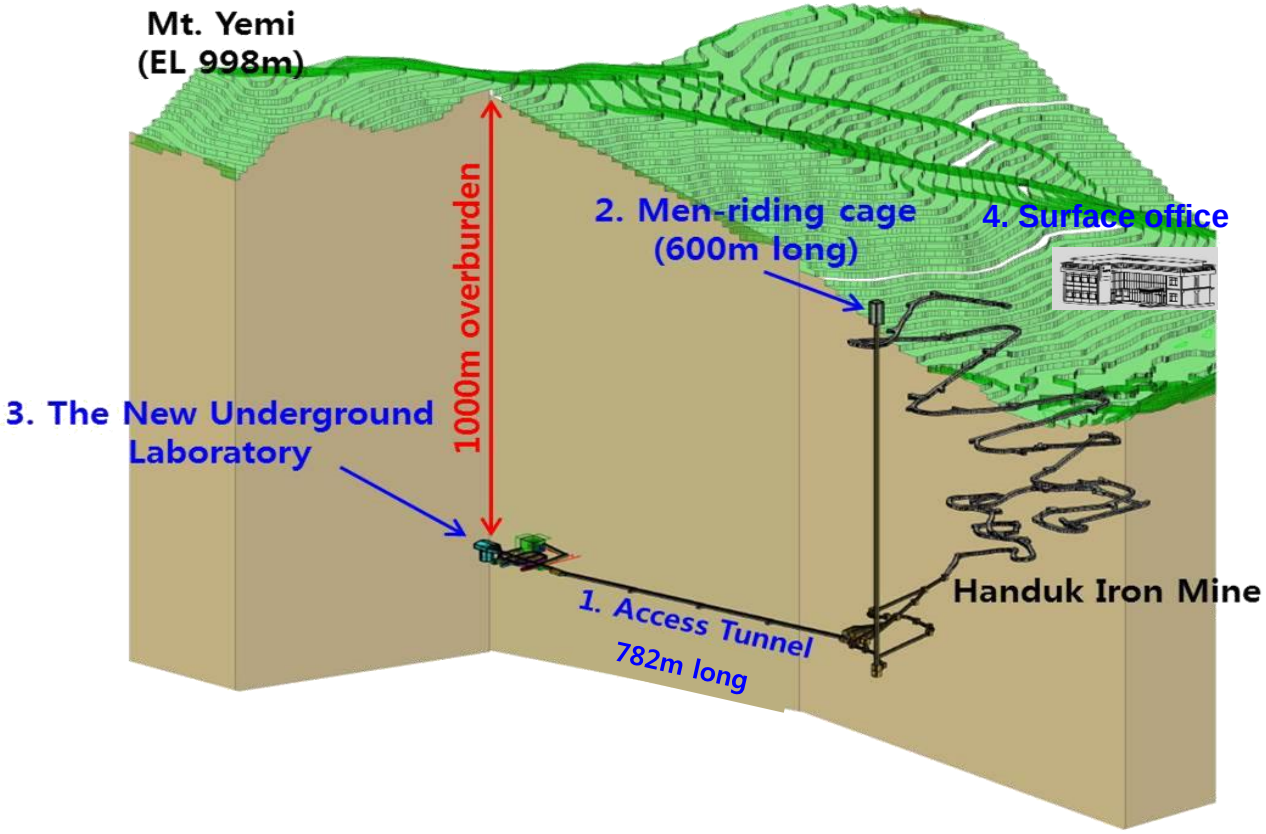
❖ The Construction of new UL(Yemi-Lab)

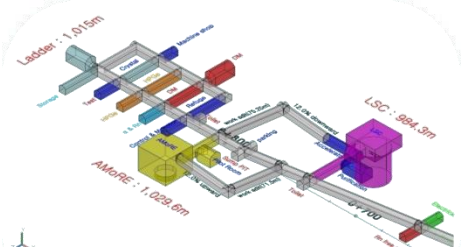
- 4 major sub-constructions
  1. Tunnel excavation
  2. Shaft cage
  3. Underground lab
  4. Surface office/lab

Tunnel Excavation

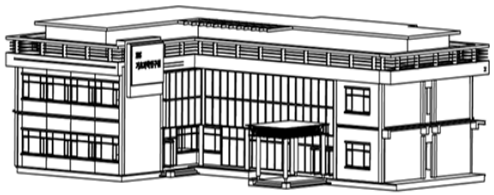


Shaft cage





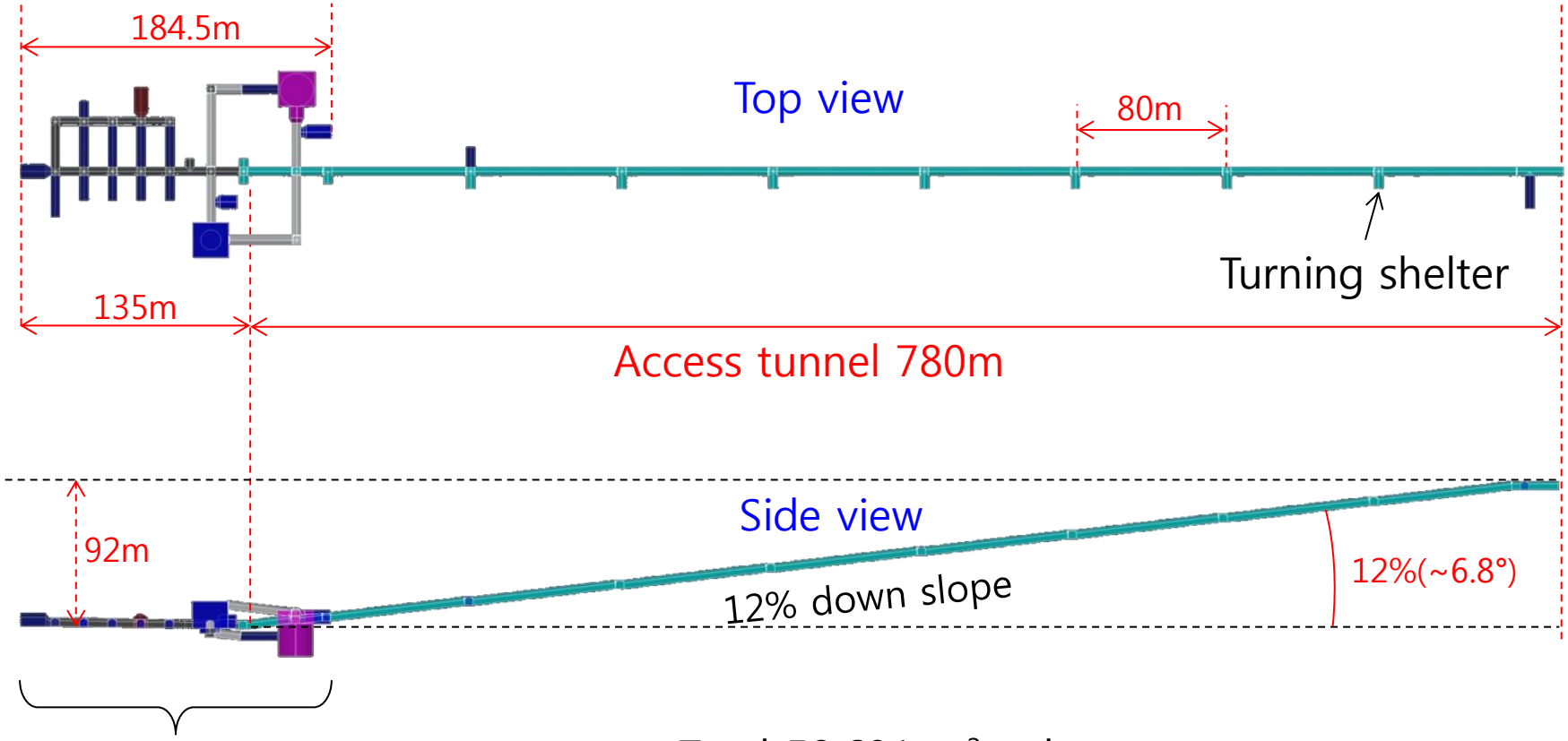
Underground lab



Surface office/lab

3: The tunnel excavation

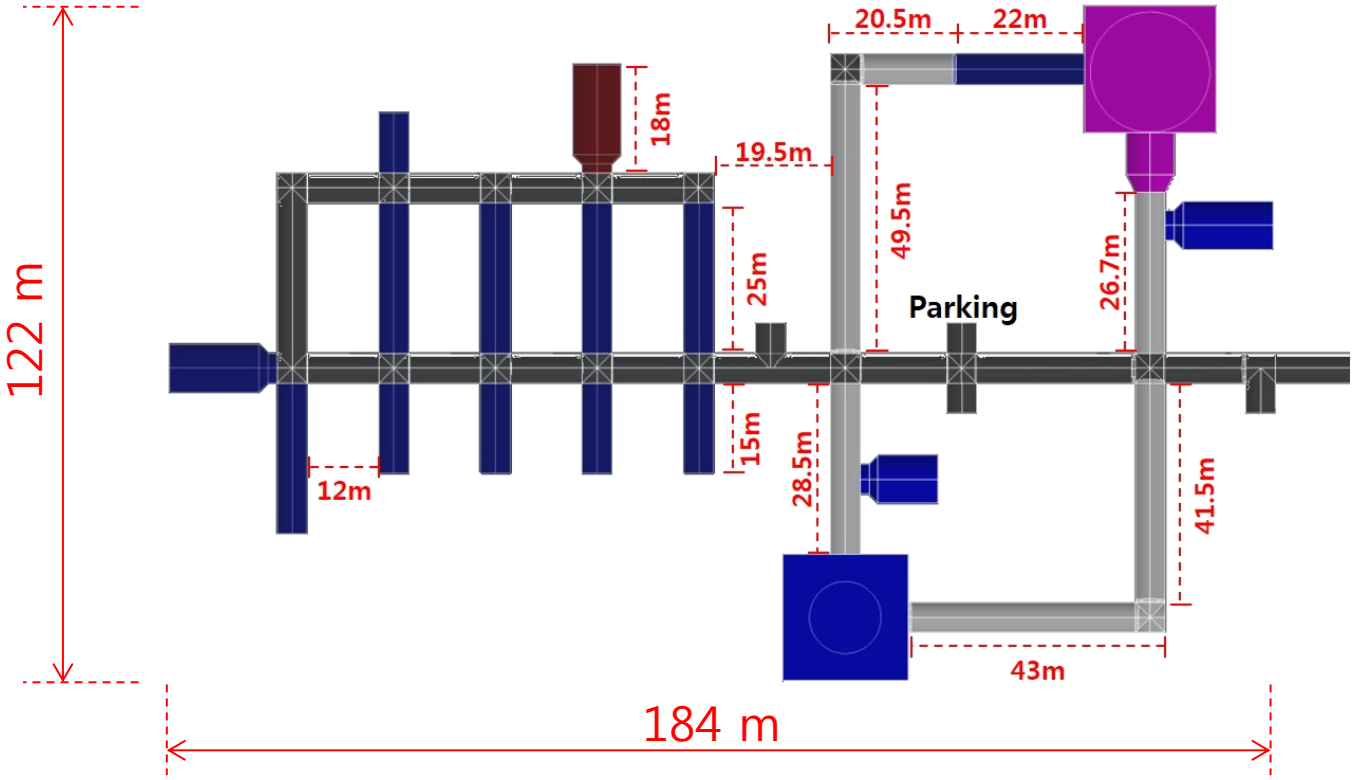
- Detail design has been done
- Tunnel excavation shall begin November 2018.
- The excavation completion by mid 2020



Experimental zone
~ 1000m depth

Total 58,691 m^3 volume

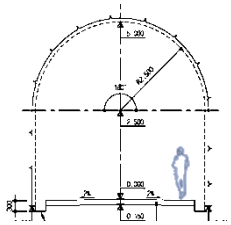
❖ Excavation of experimental region



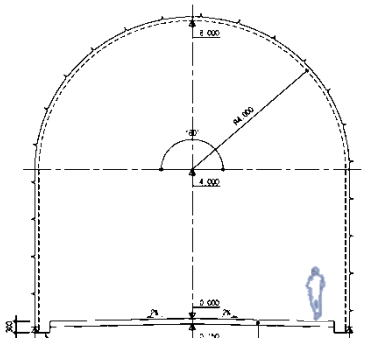
	Cross-section (W x H_{max} x L , m^3)	Area (m^2)	Volume (m^3)
Entrance	5 x 5 x 782.5	3,962	18,968
Experimental	**variable**	**2,716**	**25,562**
operational	variable	4,847	14,161
total		11,525	58,691

The quantity of excavation

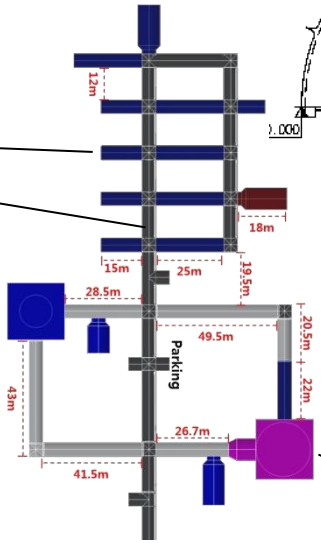
❖ Standard cross sections



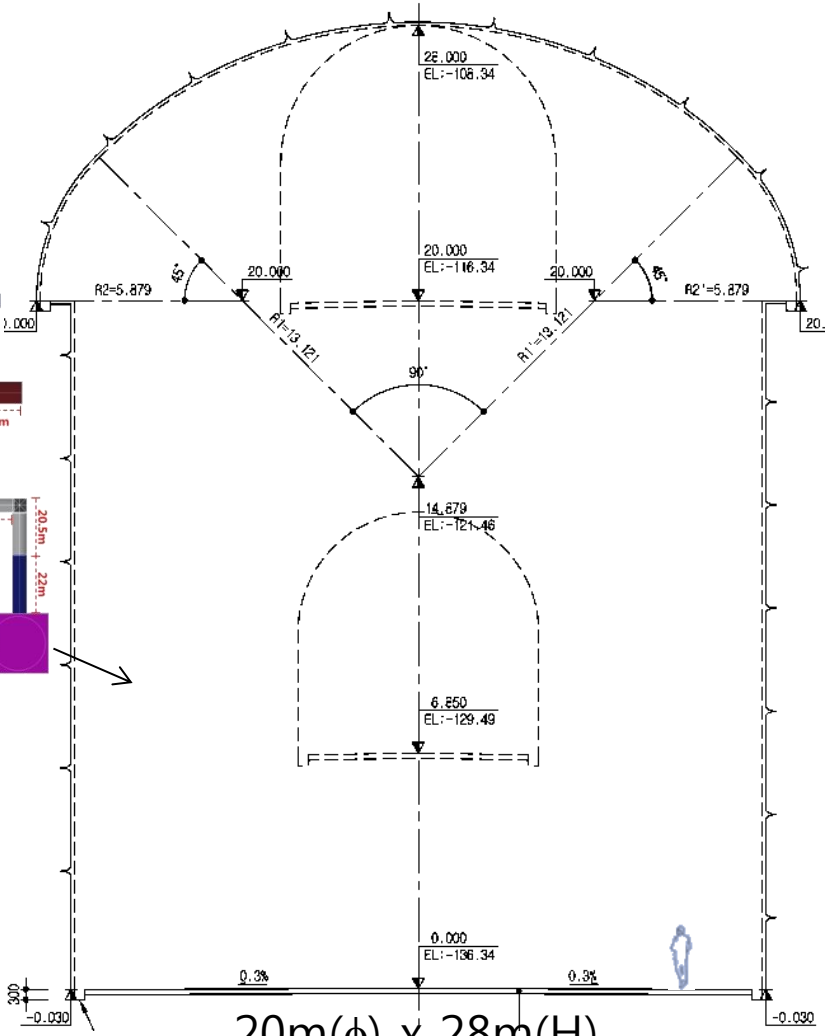
5m(W) x 5m(H)



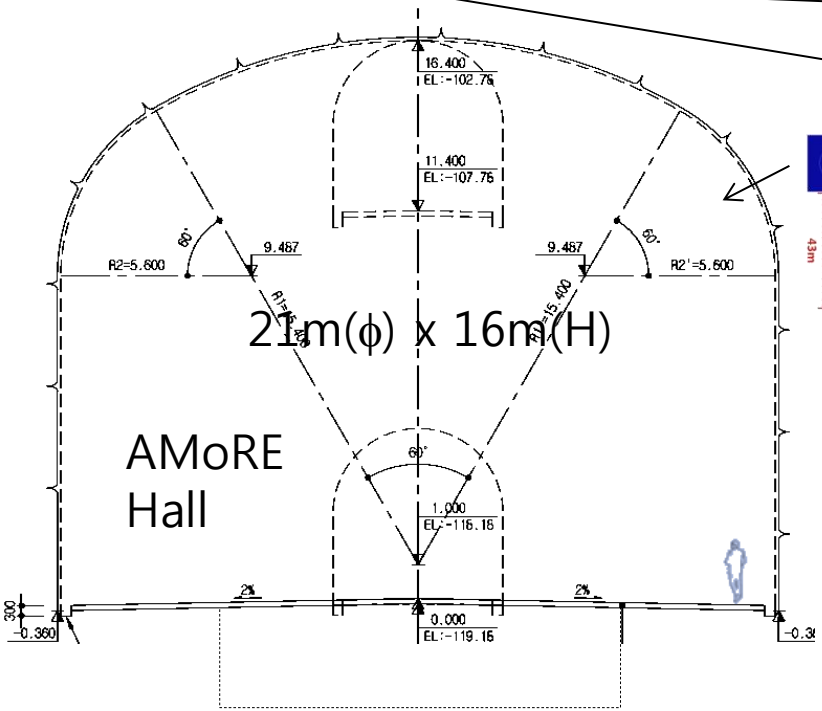
8m(W) x 8m(H)



LSC Hall



20m(ϕ) x 28m(H)

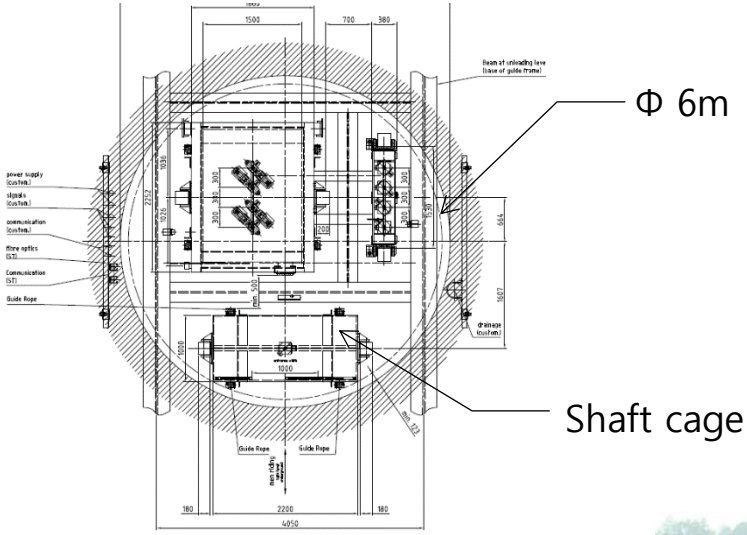


21m(ϕ) x 16m(H)

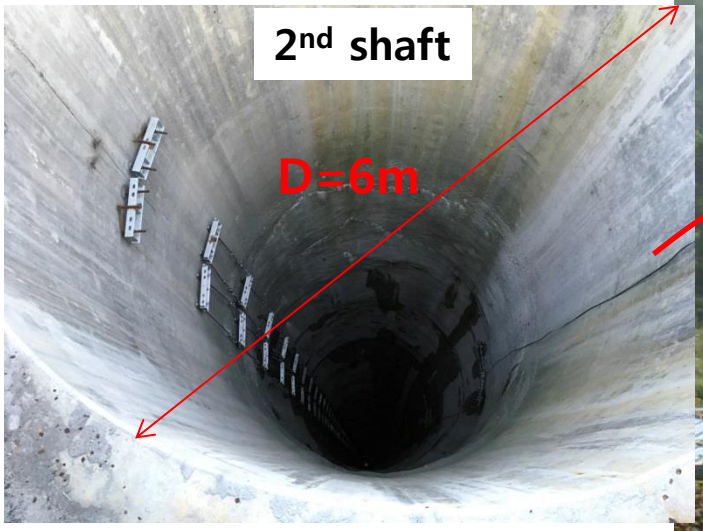
AMoRE Hall

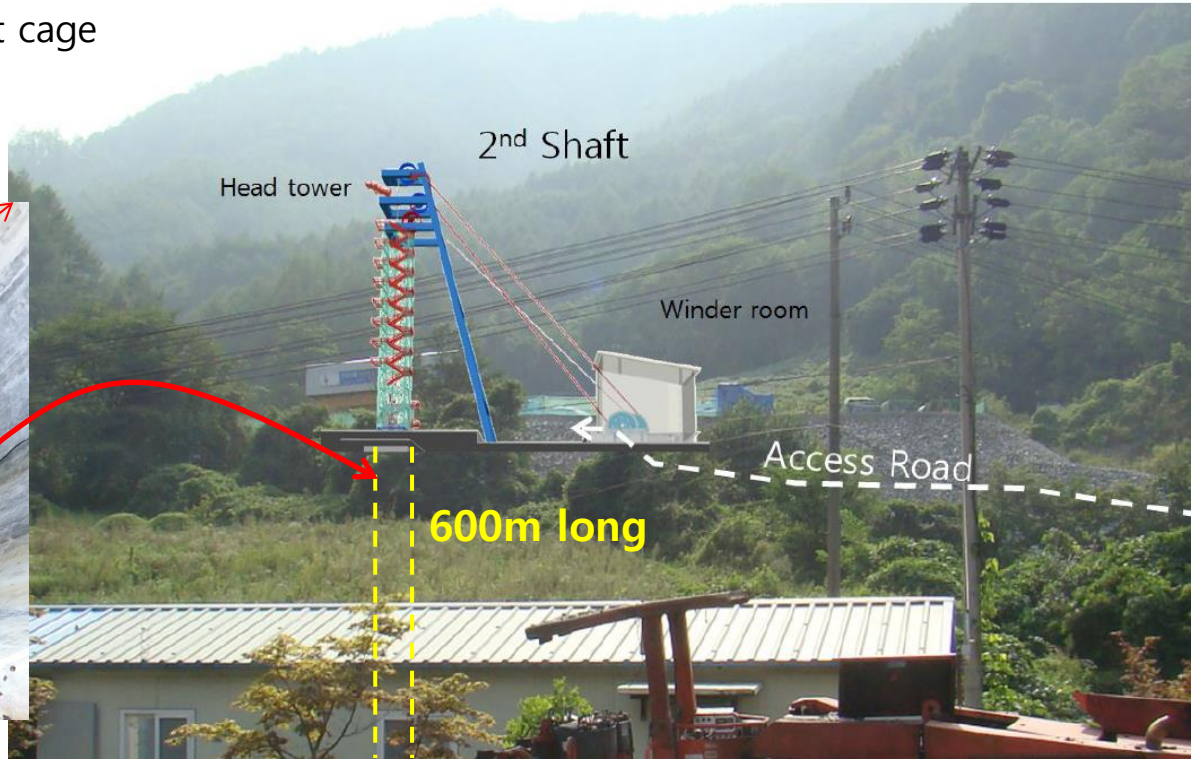
4. The construction of shaft cage

Tow view of the shaft



- 2nd shaft will be main entrance to UL
- SIEMAG Tecberg(Germany) design
- 600 m moving distance
- 4 m/s cage speed
- 1.5 ton payload
- Under construction by Handuk
- Completion by end of 2018

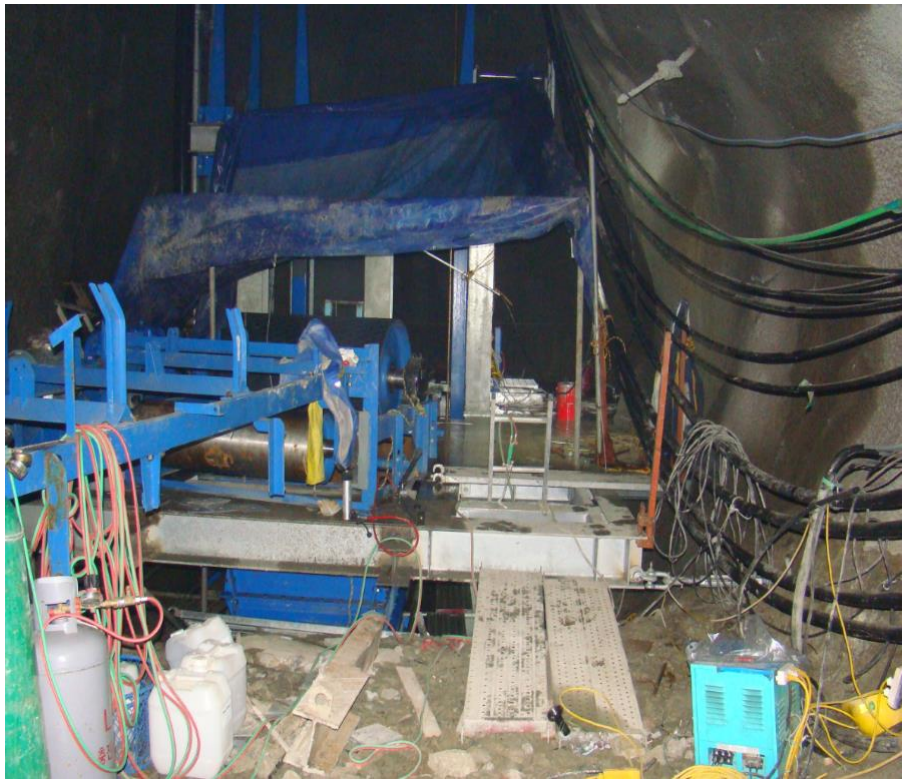




❖ The construction of tower & winding system

❖ Bottom structures for the shaft cage

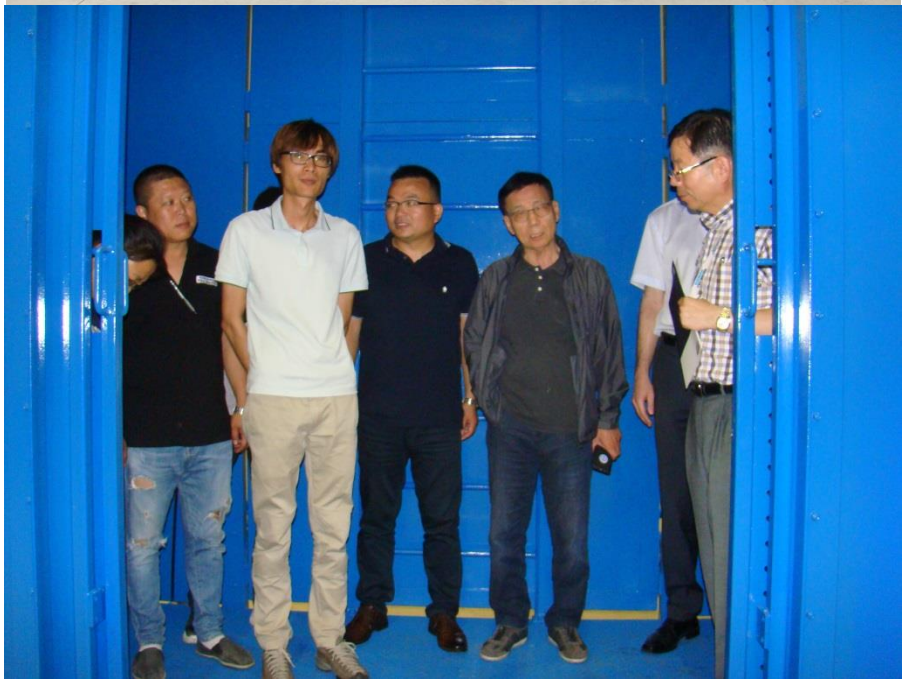
- It is under rope work for cage installation and bottom station work
- It will be completely done by end of this year



Bottom station -35EL(587m deep)

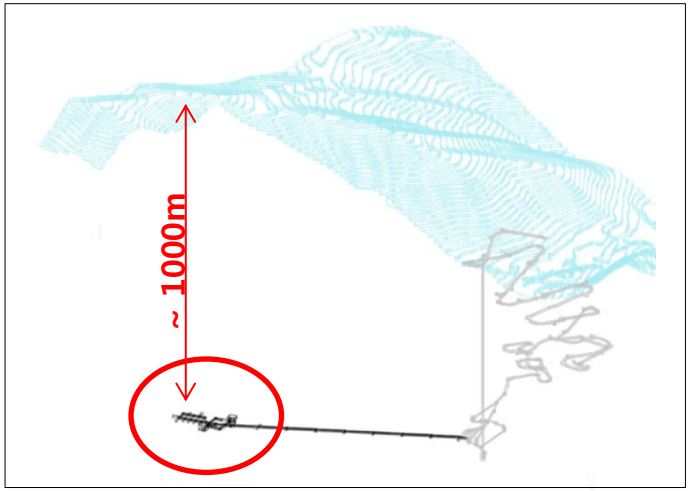
Guide weights at the -75EL(627m deep)

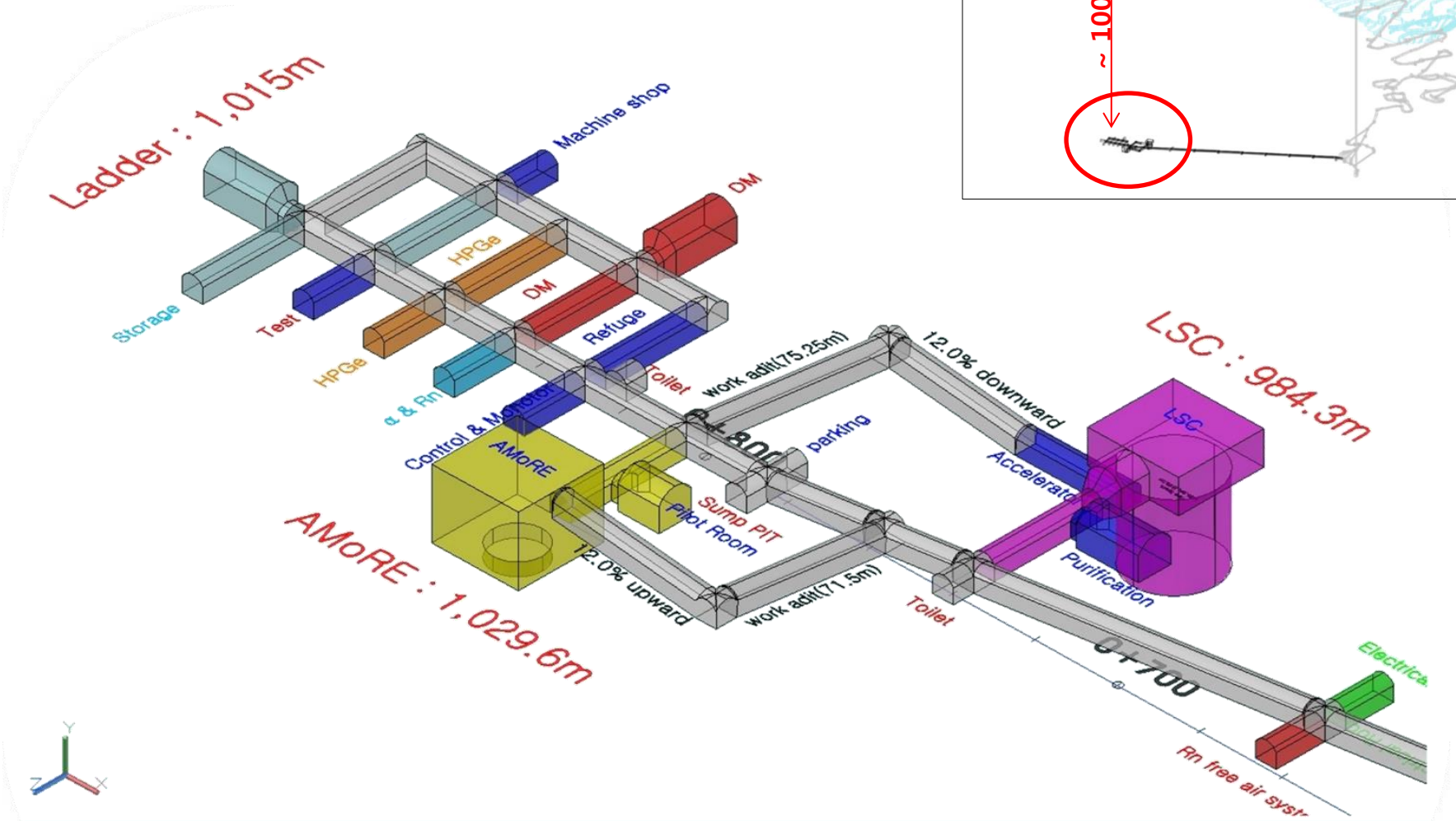
❖ Shaft cage & winder(drum)



5. The underground laboratories

- 7 experiments with 12 spaces
- 10 utility spaces

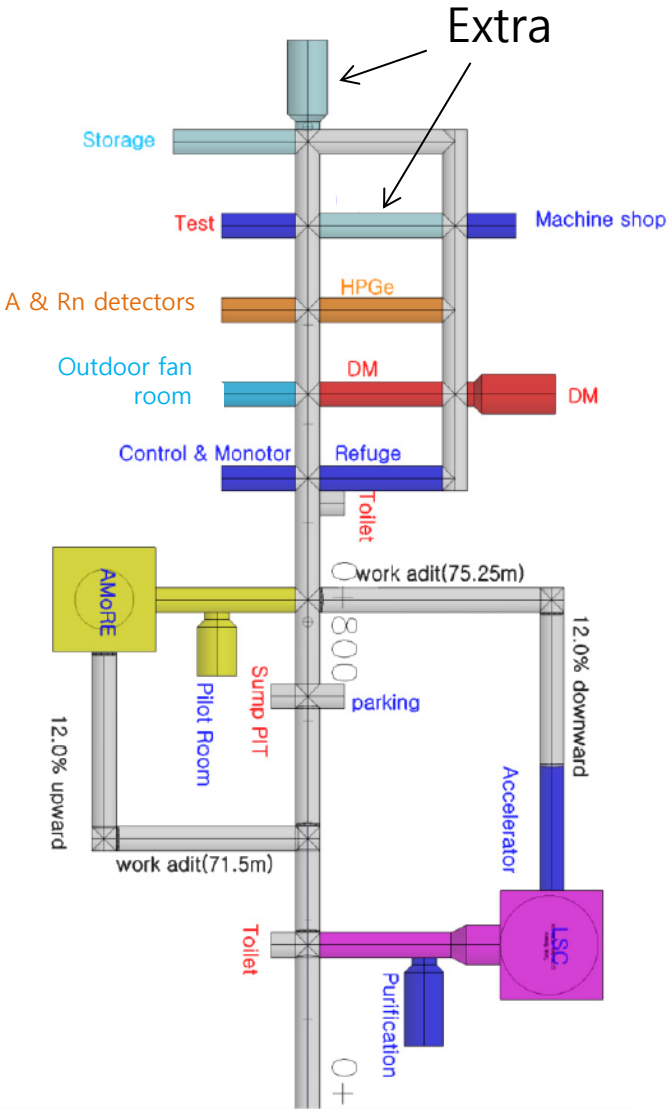




❖ Floor plan

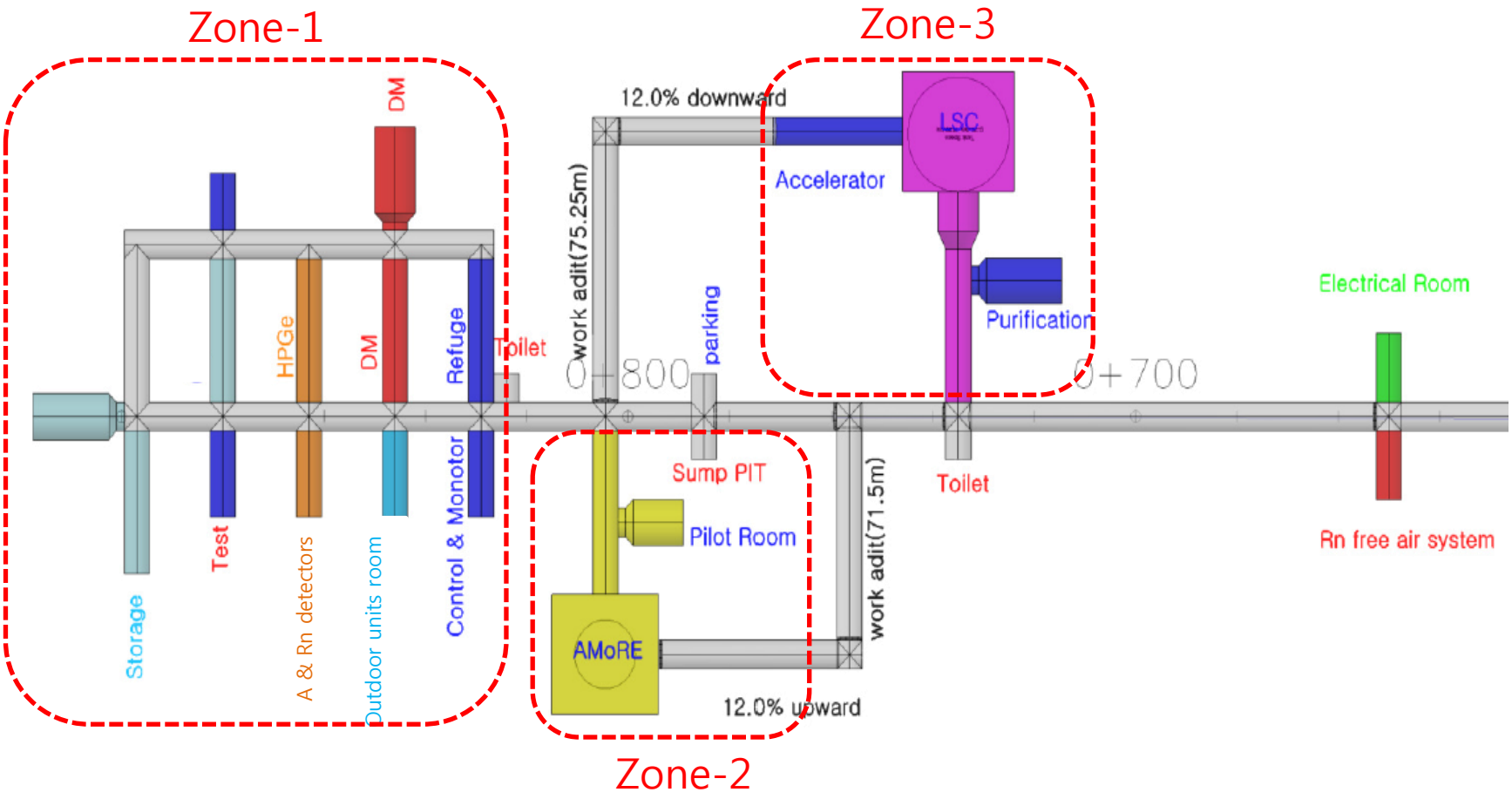
Spaces (experiments only)

item			W(m)	H(m)	L(m)	A(m^2)	V(m^3)
1	AMoRE	Cavern	21	16.4	21	441.00	8,260.99
2		PIT	12(D)	3.1	-	113.04	
3		Pilot room	8	8	13	104.00	
4	LSC	Cavern	21	8	22	462.00	11,476.80
5		PIT	20(D)	20		314.00	
6		purification	8	8	18	144.00	
7	DM	Detector	8	8	18	144.00	970.39
8		etc.	5	5	25	125.00	571.09
9	HPGe		5	5	40	200.00	913.74
10	Alpha & Rn		5	5	15	75.00	342.65
11	Test room		5	5	40	200.00	913.74
12	Machine shop						
13	Outdoor fan room						
14	Storage room		5	5	25	125.00	571.09
15	Extra		8	8	18	144.00	970.39
16	Extra		5	5	25	125.00	571.09
Total						2,716	25,562



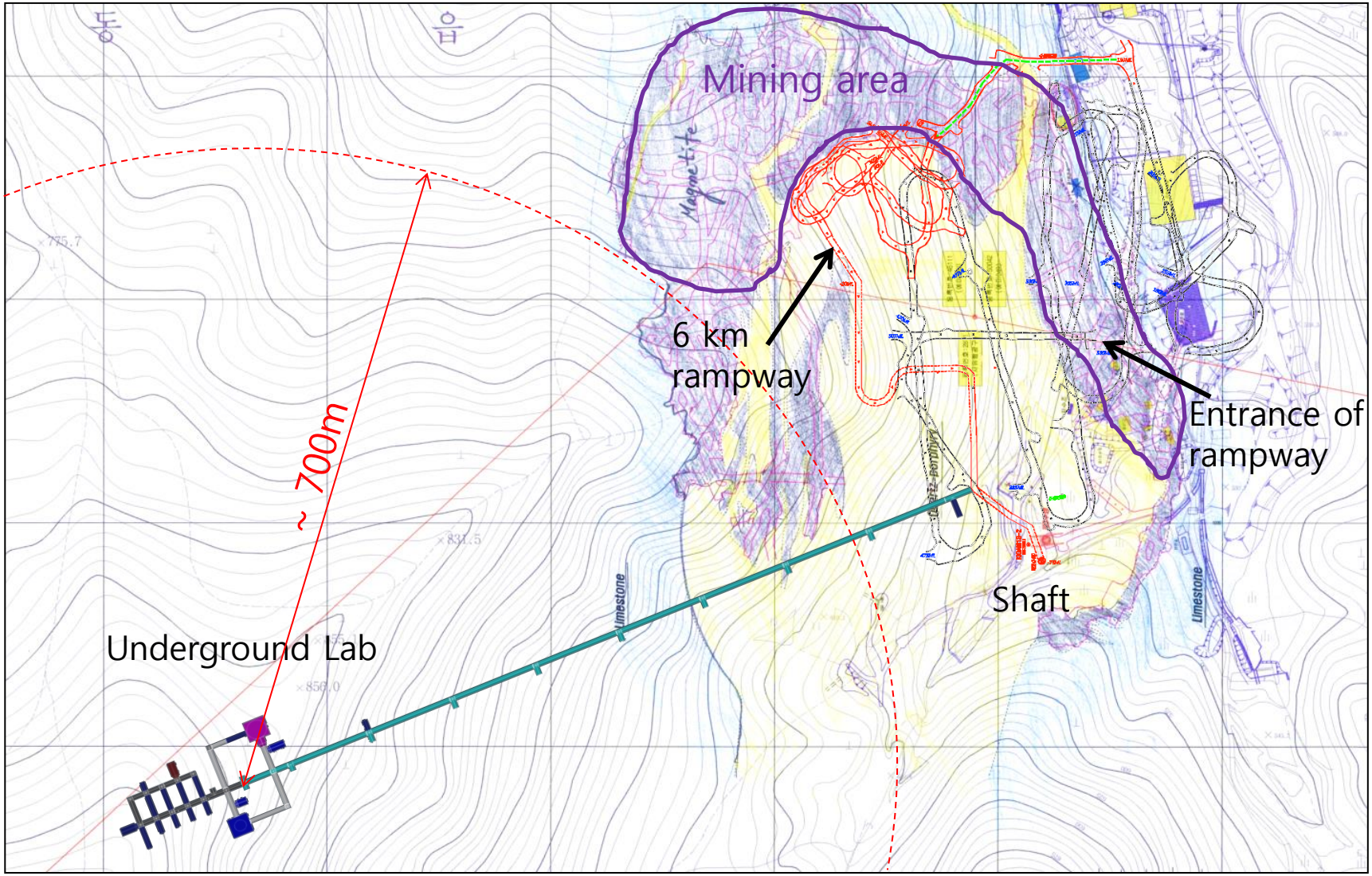
❖ Dividing clean zone

- 3 independent clean zone to avoid interferences each others by different experiment schedules



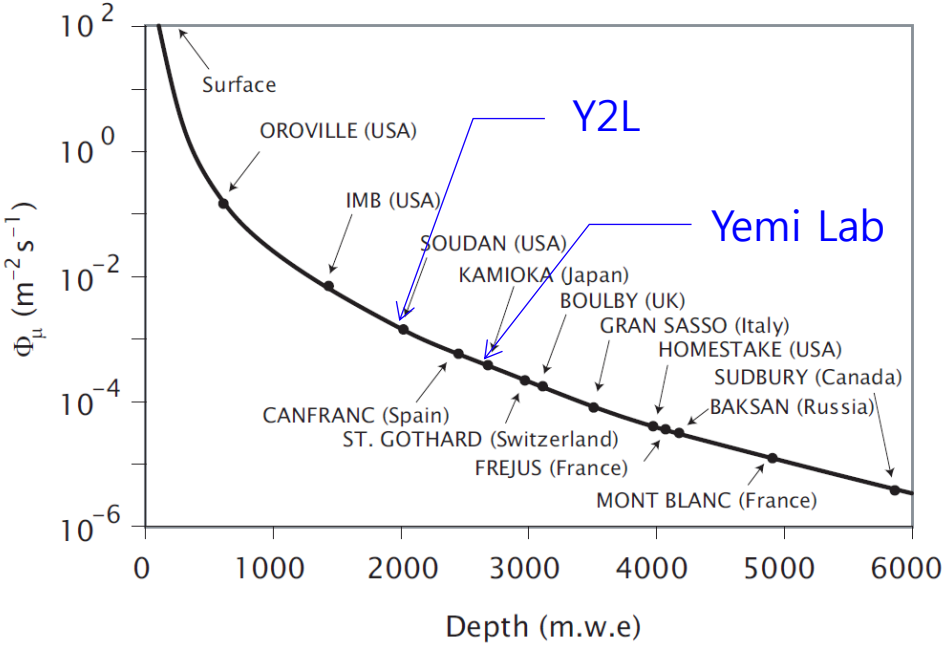
❖ Independent operation from the mining activity

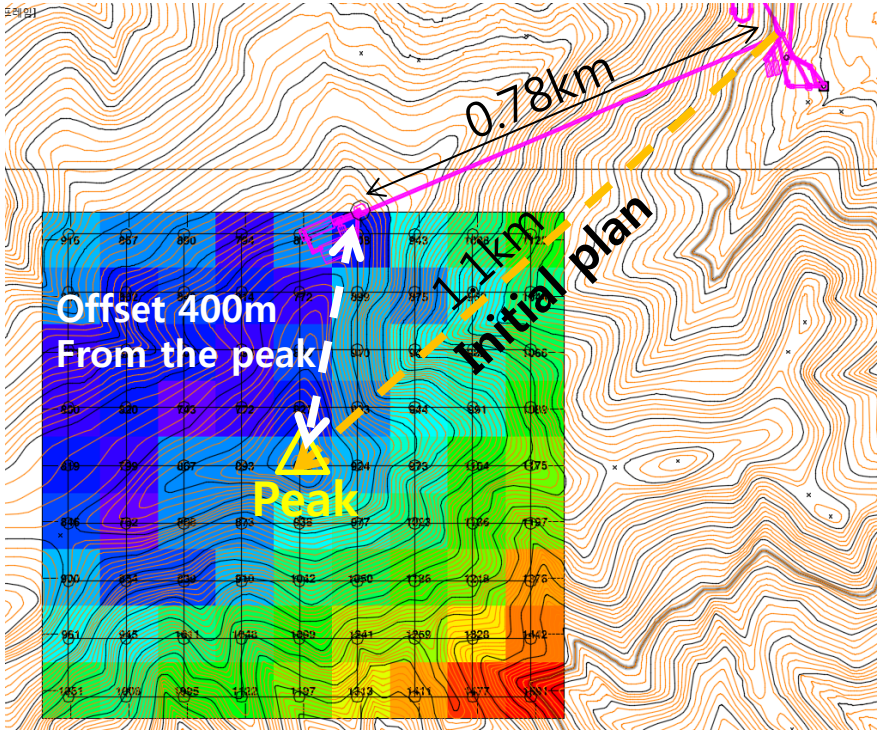
- The UL is going to be located further away from the active mining area by ~ 700 m



❖ Muon reduction

- Access tunnel for more overburden was shortened to 782m by a simulation study considering detail profile of the region

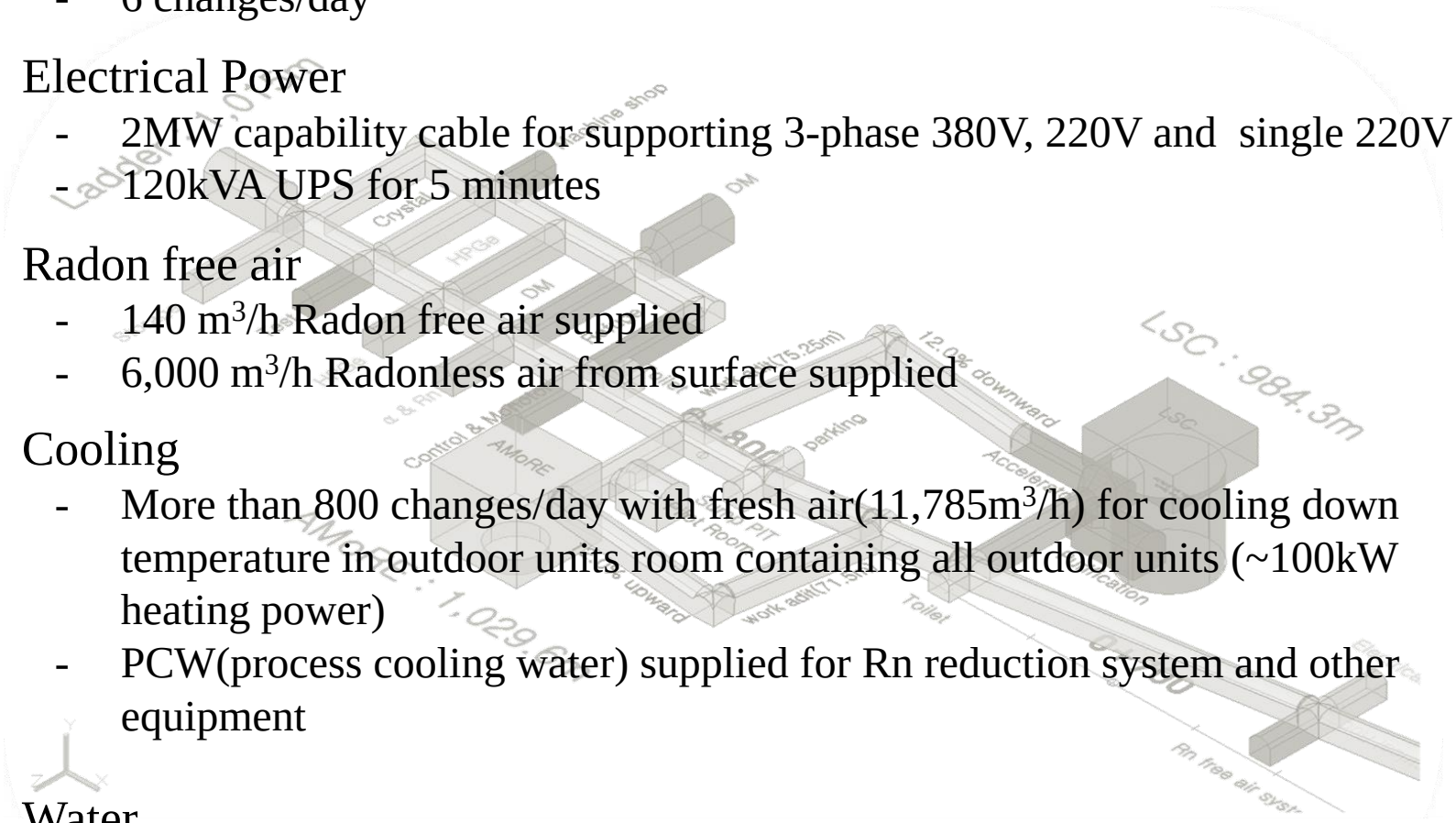




Muon reduction rate @ HD with simulation ~ 8 x 10^{-6} by S.H. Kim

❖ Support systems

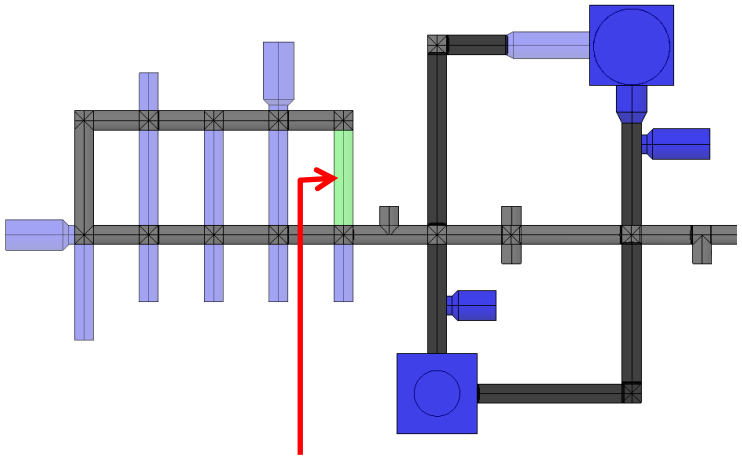
- Ventilation
  - 39,000 m^3/h total supply of fresh air
  - 6 changes/day
- Electrical Power
  - 2MW capability cable for supporting 3-phase 380V, 220V and single 220V
  - 120kVA UPS for 5 minutes
- Radon free air
  - 140 m^3/h Radon free air supplied
  - 6,000 m^3/h Radonless air from surface supplied
- Cooling
  - More than 800 changes/day with fresh air(11,785m^3/h) for cooling down temperature in outdoor units room containing all outdoor units (~100kW heating power)
  - PCW(process cooling water) supplied for Rn reduction system and other equipment
- Water
  - 33 tons/day underground water
  - 4 tons/day of filtered water supplied for only washing



❖ The SAFETY

- Refuges will be placed at the mid of experimental zone for quick escape
  → guarantee 3days for 30 people

- According to the simulation, we have enough time to escape in case of fire even we are at any position



Refuge, 5x5x25 m^3

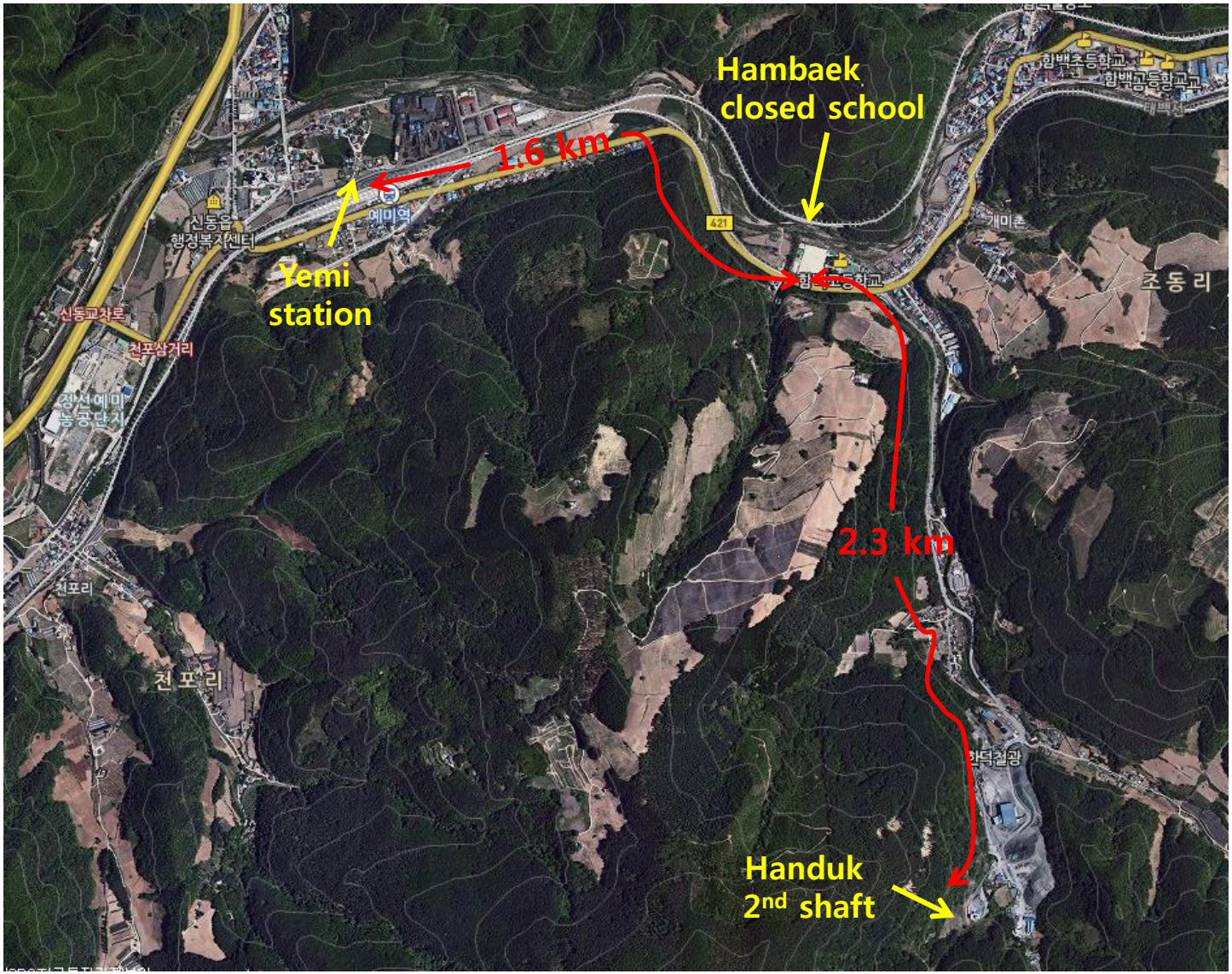
❖ The basic numbers

Item	value
Overburden	~ 1,000 m
Muon reduction rate	8 x 10^{-6}
Tunnel area	11,525 m^2
Tunnel volume	58,691 m^3
Expr. total area	2,716 m^2
Expr. reserved area	2,447 m^2
Expr. extra area	269 m^2

Item	value
Electric power	2,000 kW
Fresh air change	6/day
Underground water	33 ton/day
Sump pit capacity	3 days
Set temperature	23°C

6. Construction of the surface office

❖ Site of the surface office

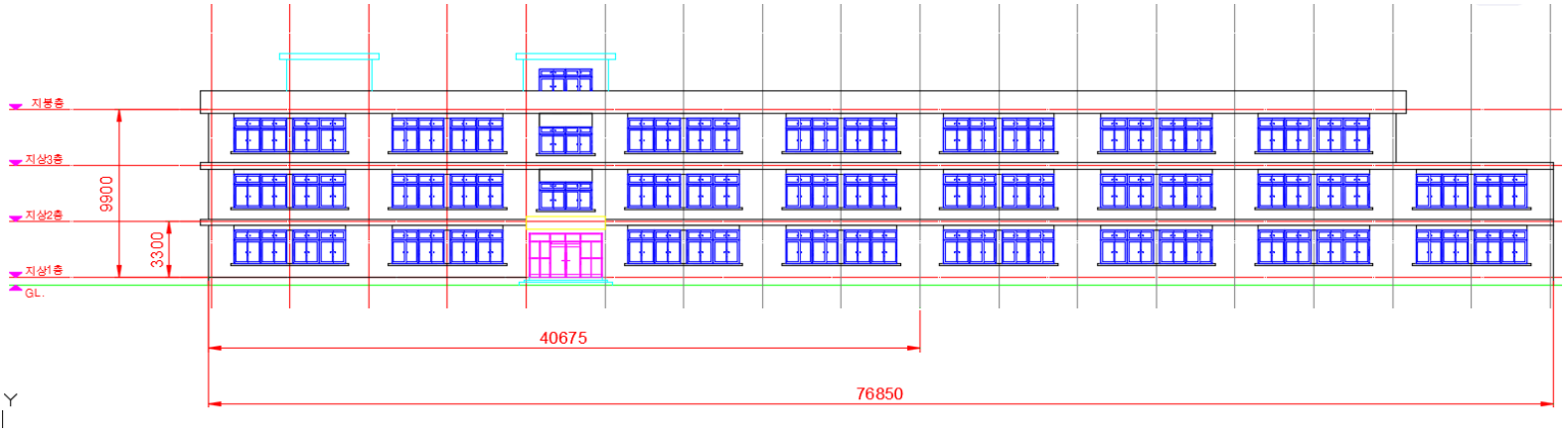


❖ Closed school

- One three-story building
- 12(W)x90(L)x12(H) m^3 (OD)
- Total area ~ 2500m^2 (OD)
- 23 class rooms,

  8(W)x8(L) m^2 each (ID)
- The remodeling will be started

  early 2020



7. Summary

❖ The Construction of Tunnels

- The detail design has been done (Decmber 2017 ~ May 2018 : 6 months)
- The UL excavation will be carried out for November 2018 ~ mid 2020

❖ The Construction of Shaft Cage

- It will be a main entrance
- All cage parts have been arrived to Handeok
- The construction/assembly are going to be completed by end of 2018

❖ The Construction of Surface Office/Laboratory

- 2500 m^2 available space with the closed school
- Remodeling the school is probably started early 2020