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The new underground facility in Korea, Yemilab

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Abstract. A new underground facility called Yemilab with a depth of 1,000 m will be constructed for studies on neutrinos and dark matter search. The new underground facility is located within the site of an iron mine in Jeongseon-gun, Gangwon-do, South Korea. Since the mine has a vertical shaft with a diameter of 6 m and a length of 600 m, the facility uses this shaft. The construction of the new underground facility consists of a cage for passengers (man-cage) to enter the underground, excavation of tunnels with a total area of 10,000 m^2 including a dedicated area of 2,600 m^2 for experiments, and construction of electrical and mechanical facilities for operation. The construction is carried out in two phases. In the first phase, man-cage manufacturing/installation and most of the tunnel excavation were carried out. In the second stage, excavation of a large cylindrical pit with dimensions of 20 m (D) $\times$ 20 m (H) is being carried out together with the installation of a 2 MW power supply and construction of facilities for ventilation, drainage, and fire prevention. The first phase construction started in 2018 and was completed in August 2020. The second phase construction started in May 2021 and is going to be completed in May 2022.

1. Introduction

When the pumped-storage power plant was built in Yangyang, Gangwon-do, Korea in 2003, the Dark Matter Research Center (DMRC) built a 100 m^2 Y2L (YangYang Laboratory) at a depth of 700 meters. The DMRC constructed and operated an experiment using CsI(Tl) detectors to directly observe the dark matter candidate Weakly Interacting Massive Particle (WIMP) in Y2L [1]. In addition, High Purity Germanium (HPGe) detectors have been installed and operated until now. Since 2014, CUP (Center for Underground Physics) has been in charge of the operation of Y2L and has been conducting AMoRE [2, 3] and COSINE [4] experiments after a little expansion. However, since there were many limitations in conducting next-generation dark matter or neutrinoless double beta decay experiments at Y2L, CUP needed a new underground laboratory that is larger and deeper than Y2L.

For two years from 2014, a number of CUP members had traveled all over the country to find a suitable place to build a new underground laboratory. In early 2016, an iron mine operated by Handuk Iron Mining Industry Co., Ltd. was chosen as the location of the new underground laboratory. This mine is located in Jeongseon, Gangwon-do. The new underground laboratory, named Yemilab, has an overburden of 1,000 meters and an experiment area of 2,600 m^2. The reduction rate of cosmic muons compared to the ground in Yemilab using a computer simulation was 8.2×10^{-6}, which is about 5 times lower than that at Y2L's depth [5]. Figure 1 shows the location of Yemilab and the view of the Handuk Mine.

Yemilab was designed to take advantage of the convenient accessibility to Handuk Mine. It has a 600 m deep shaft called the second shaft (the first shaft is old and only 300 m deep).

(a) (b)

Figure 1: (a) Location of Yemilab, it is 2.5 hours by car from Daejeon, where IBS CUP is located. (b) A bird eye view of Handuk Mine

It also has a 6 km long transport tunnel (rampway). The two entry capabilities are one of important reasons for choosing this place. In particular, we can use the second shaft as the main entrance for construction and operation by allowing quick access to the underground. The rampway having a cross section of 5 m $\times$ 5 m is used to transport large equipment that cannot be moved via the shaft.

A construction plan was established in mid-2014. After completing all necessary administrative procedures, construction began in September 2017. The construction of Yemilab is underway in two phases. The first phase was completed in August 2020, excavating 2,000 m^2 of experimental space, including the installation of a man-cage in the shaft. The second is to excavate 700 m^2 of experimental space and install electricity, ventilation and machinery, which is expected to be completed in March 2022. Construction work is currently proceeding as planned.

2. Man-cage

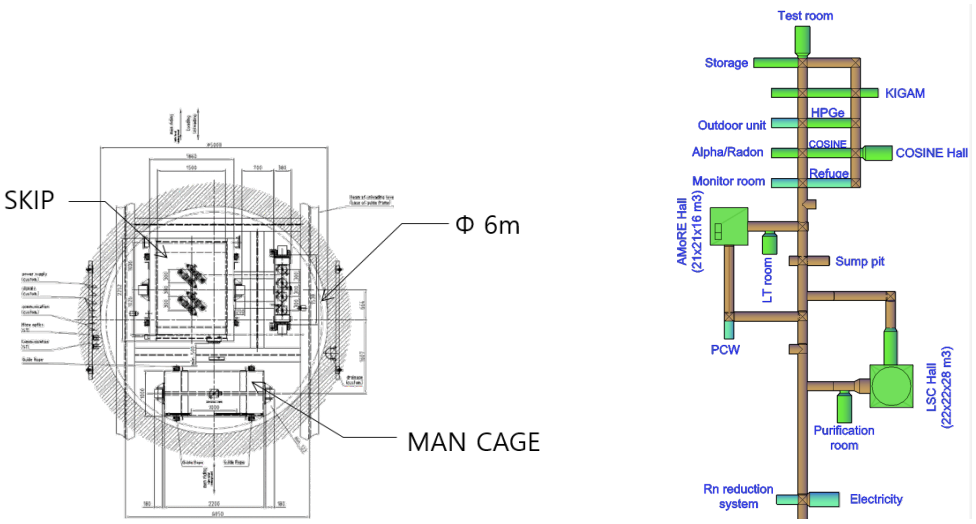
The second shaft is the main entrance to the underground. It is a 600 m long vertical tunnel with a diameter of 6 m. The cage on the second shaft, which carries people and some cargo, and runs on the second shaft, was designed by SIEMAG TECBERG GmbH [6] of Germany and built by Handuk. The total transport weight is 1.5 tons and the travel time of the shaft at a speed of 4 m/s is about 2.5 minutes. This cage is operated together with the skip, which carries iron ore from the mine. In an emergency, cage passengers can safely escape to the ground using the skip. A cross-section of the shaft and the man-cage and skip facilities can be seen in Figure 2(a).

3. Tunnel Excavation

Yemilab has an access tunnel with a length of 782 m and an experimental tunnels with an area of 2,600 m^2. Figure 2(b) shows the structure of the tunnel and the layout of the experimental space. The entrance tunnel has a slope of 12% and has a total of 6 turning sections for vehicles at an interval of 80 m. The experimental tunnel consists of spaces for AMoRE, COSINE and the upcoming LSC (Large Scintillation Counter) experiments, and several additional tunnels in a ladder type. Table 1 summarizes the specifications of experimental areas.

4. Surface office

The ground office will be prepared by renovating an abandoned school about 2.3 km from the Handuk Mine. It takes about 5 minutes by car, so moving to Yemilab would be quite quick. It



(a) (b)

Figure 2: (a) A cross sectional design of the second shaft and (b) a schematic design for experimental areas

Table 1: Specification of experimental areas

Item		Width[m]	Height[m]	Length[m]	Area[m^2]	Volume[m^3]
AMoRE	hall	21	16	21	441	7,056
	pliot room	8	8	13	104	832
LSC	hall	22	8	22	484	3,872
	pit	20(D)	20	N/A	314	6,280
	purification	8	8	18	144	1,152
	accelarator	7	7	20	140	980
COSINE	hall	8	8	18	144	1,152
	etc	5	5	25	125	625
HPGe		5	5	25	125	625
Alpha & Rn		5	5	15	75	375
Test room		8	8	18	144	1,152
Storage		5	5	25	125	625
Outdoor unit		5	5	15	75	375
KIGAM		5	5	10	50	250
Extra		5	5	25	125	625
Extra		5	5	15	75	375
Total					2,690	26,351

is a three-story building with 23 classrooms, each classroom measuring 8 m × 8 m. After the repair work will be completed in early 2022, an office space for researchers and a research space for various R&D will be prepared.

5. Electricity, machinery and support system

The total power supplying to Yemilab is 2 MW with three-phase 380 V and single-phase 220 V are supported. In addition, a UPS with a capacity of 120 kVA, capable of supplying power for 30 minutes in emergencies, and a diesel generator capable of generating 360 kW of electricity will be installed. Groundings for safety of general equipment and reducing noise of experimental equipment are being prepared separately.

For a pleasant research environment, a total of 39,000 m^3/h of fresh air will be supplied to the entire tunnel, which is enough to exchange the air in the tunnel 6 times a day. Radon-free air from a radon reduction system wit a capacity of 140 m^3/h will be supplied to laboratories where necessary, and about 6,000 m^3/h of radon-less air will be supplied by drawing air from the ground. In the outdoor cooling unit room, fresh air will be supplied more than 800 times a day to cool the facilities with a heating power of about 200 kW. The PCW (Process Cooling Water) system supplies cooling water to equipment that needs cooling, including radon reduction system.

The groundwater that leaks out about 30 tons per day will be used to supply water to each facility for various purposes. Clean water for washing will be supplied using a facility that can purify 4 tons per day.

6. Summary

Yemilab is a new underground experimental facility built at a depth of 1,000 m and has 16 research spaces with a total area of 2,600 m^2. The construction work, which has been carried out in two stages since 2017, is currently proceeding as planned, and the construction is expected to be completed in May 2022. Also, construction for the AMoRE-II experimental area is currently in progress, and from 2023, the experimental facilities in Y2L will be transferred to Yemilab.

References

[1] Kim S C et al 2012 Phys. Rev. Lett. 108 181301
[2] Alenkov et al 2015 Preprint arXiv:1512.05957v1
[3] Lee M H 2020 JINST 15 C08010
[4] Adhikari et al 2018 Eur. Phys. J. C 78 107
[5] Zhu J J et al 2005 Chinese Physics C 29 721
[6] https://siemag-tecberg.de