

Status of **Hyper-Kamiokande**

Hide-Kazu TANAKA
(Kamioka Obs., ICRR, U. Tokyo)

for the Hyper-Kamiokande collaboration

TAUP 2025 at Xichang, August 29, 2025

Hyper-Kamiokande

- **Next generation water Cherenkov detector**
 - Filled with 260kton of ultra-pure water
 - **Fiducial mass: ~190kton**
 - ~8 x Super-K
 - **Photo-coverage: 20%** (Inner Detector)
 - ~20,000 of **new $\phi 50\text{cm}$ PMTs**
 - x2 higher photon sensitivity than Super-K PMT
- The detector construction began in 2020
- **Aim to start operation in 2028**

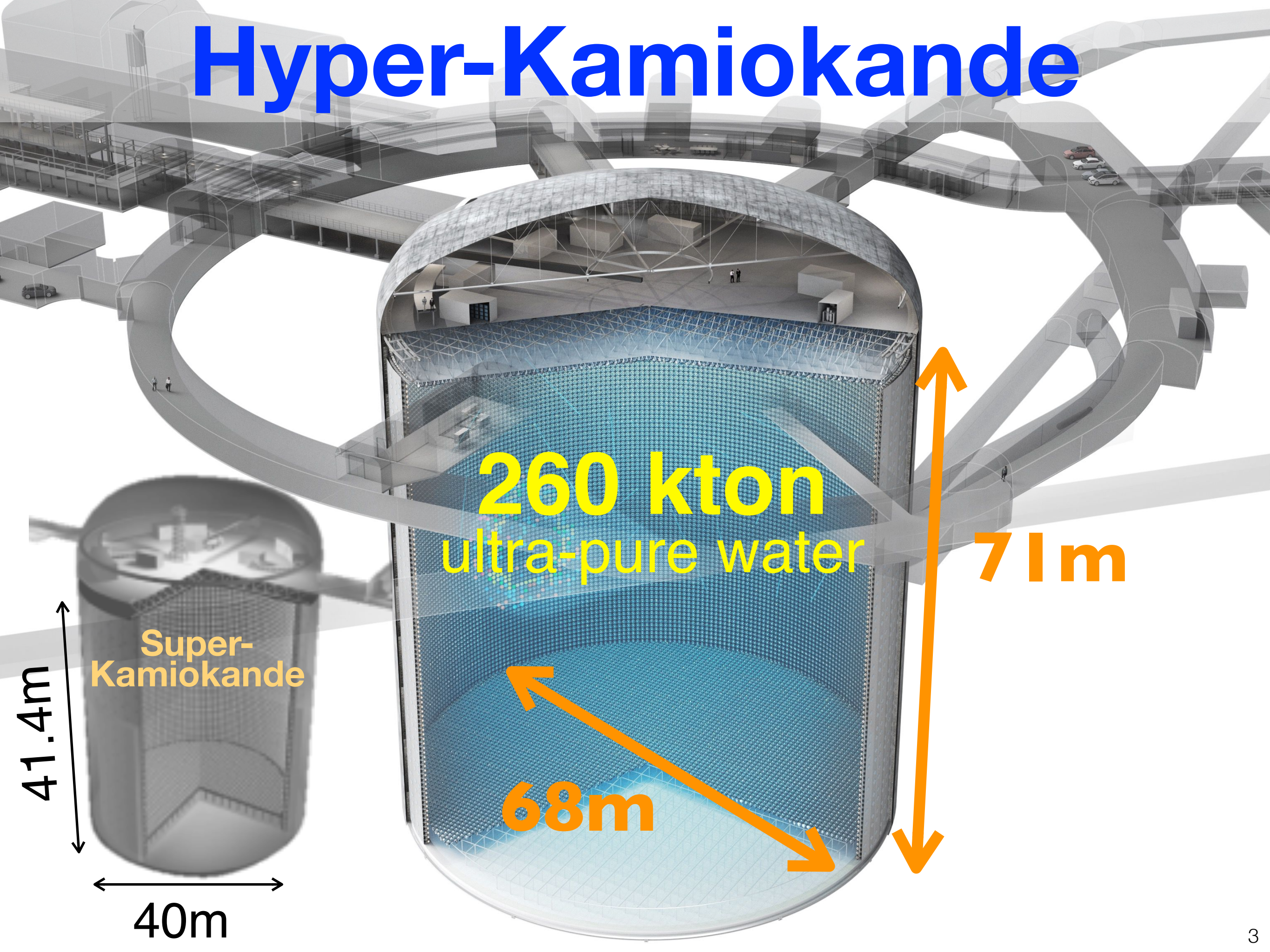
Hyper-Kamiokande

260 kton
ultra-pure water

71m

68m

Hyper-Kamiokande



260 kton
ultra-pure water

71m

68m

**Super-
Kamiokande**

41.4m

40m

Hyper-K collaboration

Collaborating Institutes



~630 members (as of March 2025)

- 105 institutes
- 22 countries

Two host institutes:

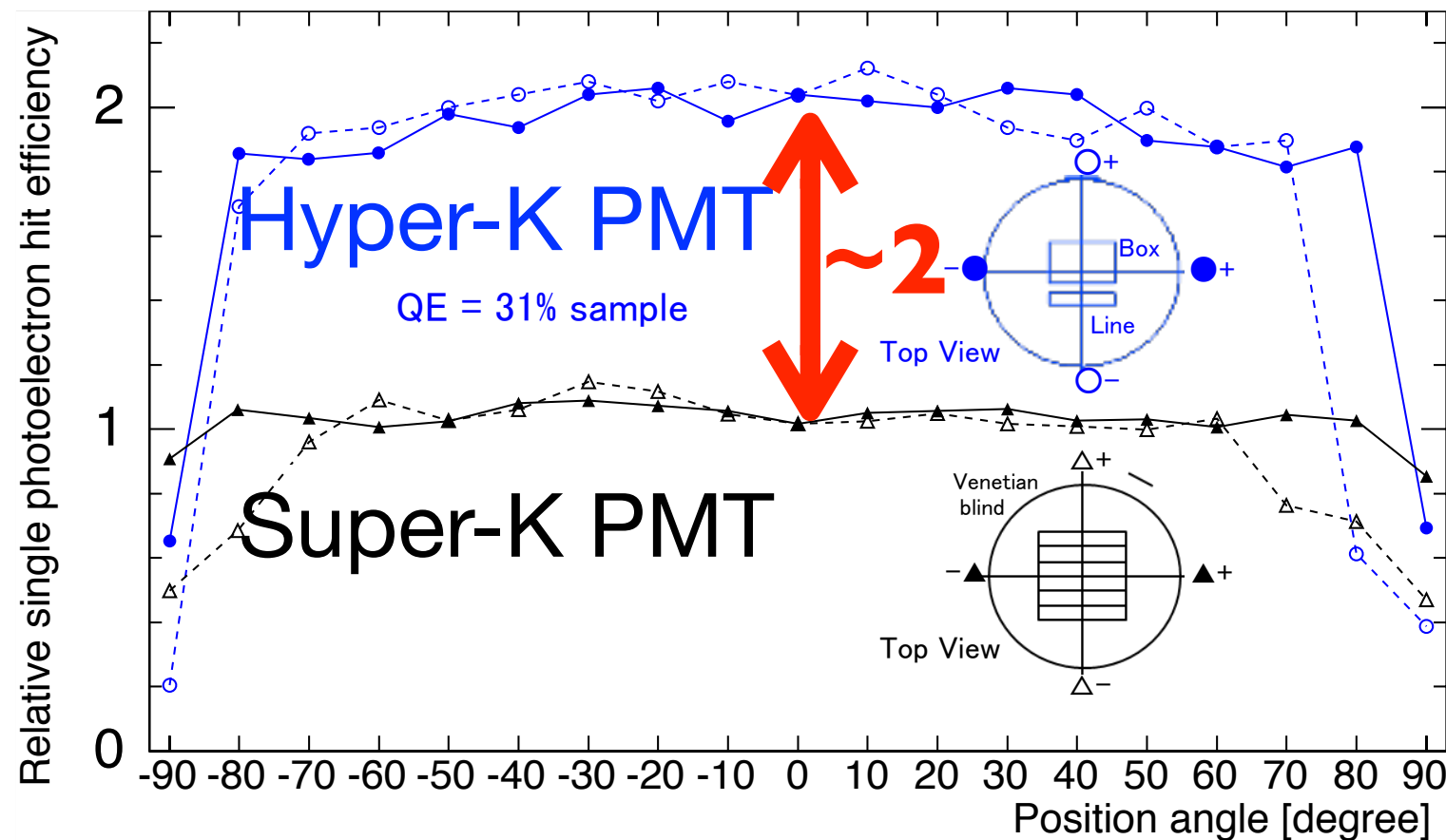
- **U.Tokyo** for HK detector
- **KEK J-PARC** for beam/ND



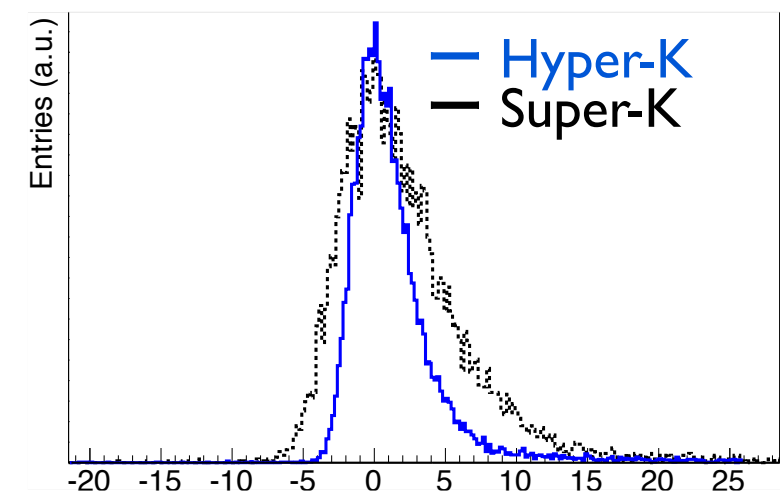
New $\phi 50\text{cm}$ PMT for Hyper-K

Photo-detection efficiency (1p.e.)

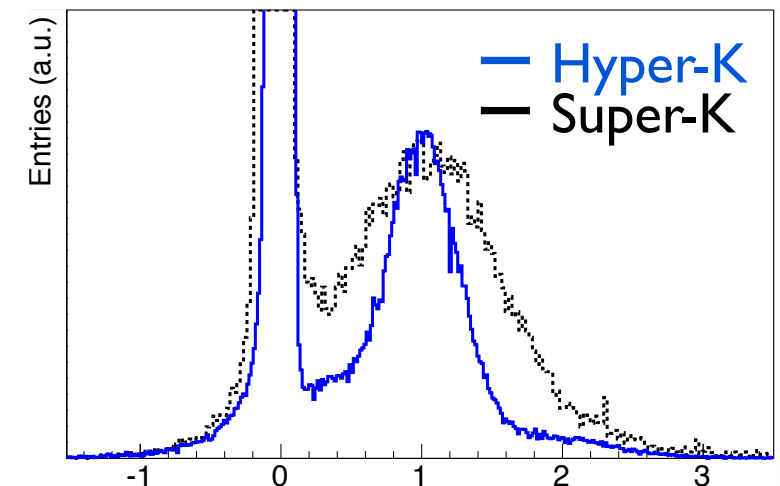
Box & line dynode PMT



- Twice better photo-detection efficiency than SK PMTs
- Timing resolution (TTS): 1.1ns
 - cf. SK PMT: 2.1ns
- Hyper-K = established detector technique + new technology (photo-sensor)



Transit time (ns)



Charge (p.e.)

Hyper-K: multi-purpose detector

- **Wide-variety of scientific goals:**

- **Nucleon decay**

- Probing grand unification

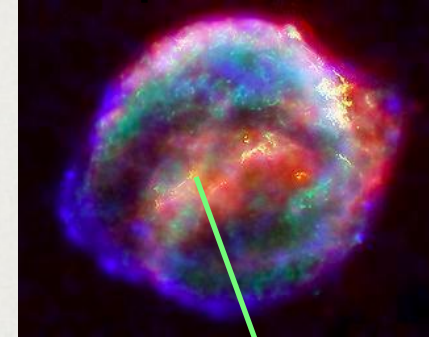
- **Accelerator and atmospheric neutrinos**

- Neutrino CP violation
- Neutrino mass ordering, mixing angles, mass difference
- See [arXiv:2505.15019](#) for details

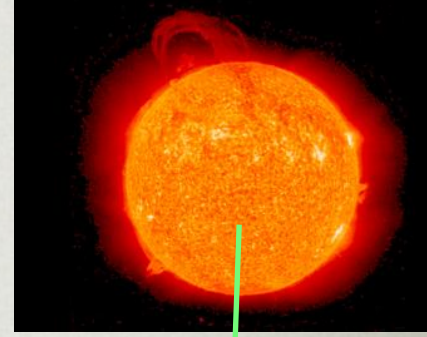
- **Astrophysical neutrinos**

- Solar ν , supernova burst ν , supernova relic ν , dark matter, ...

Supernova



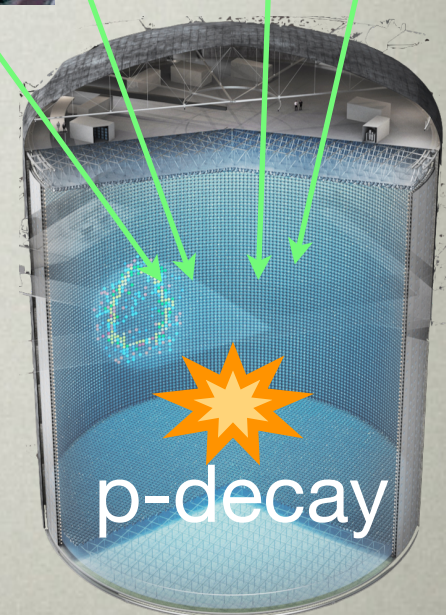
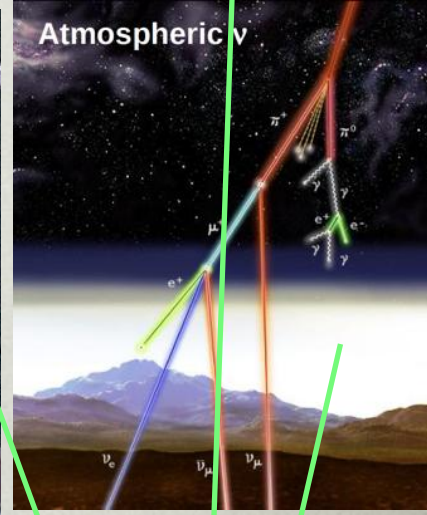
Sun



Accelerator

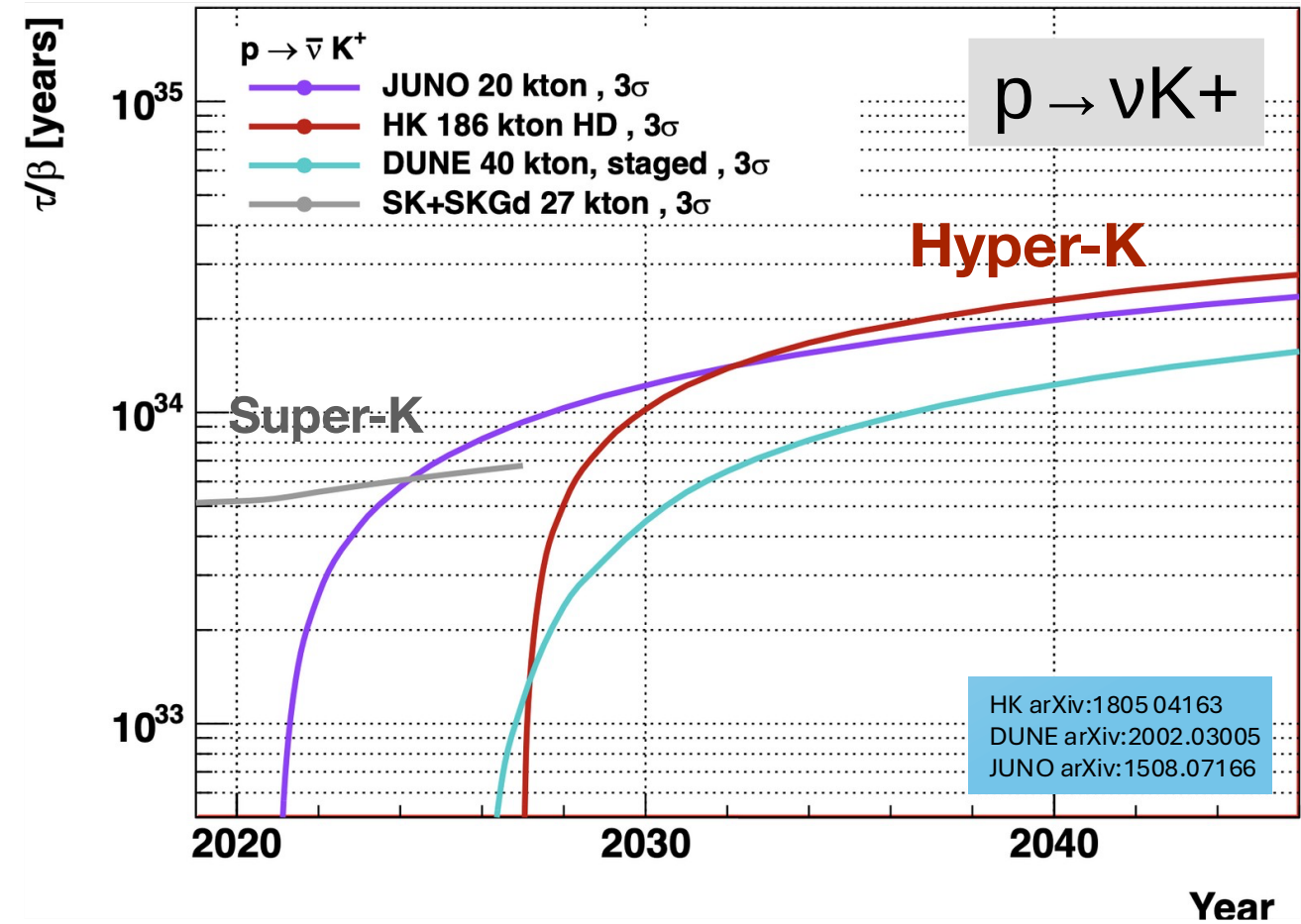
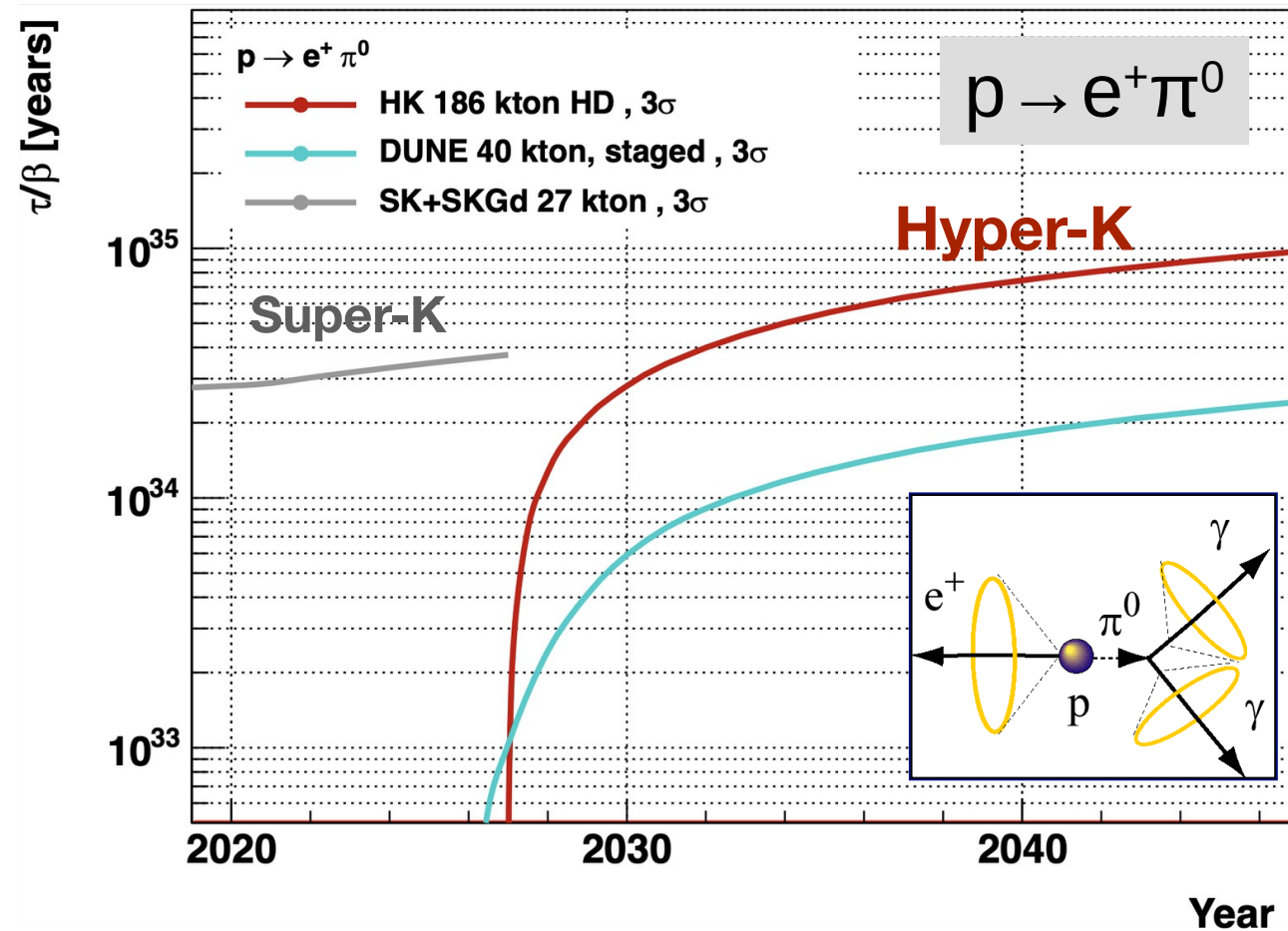


Atmospheric



Nucleon decay search

3 σ discovery potential



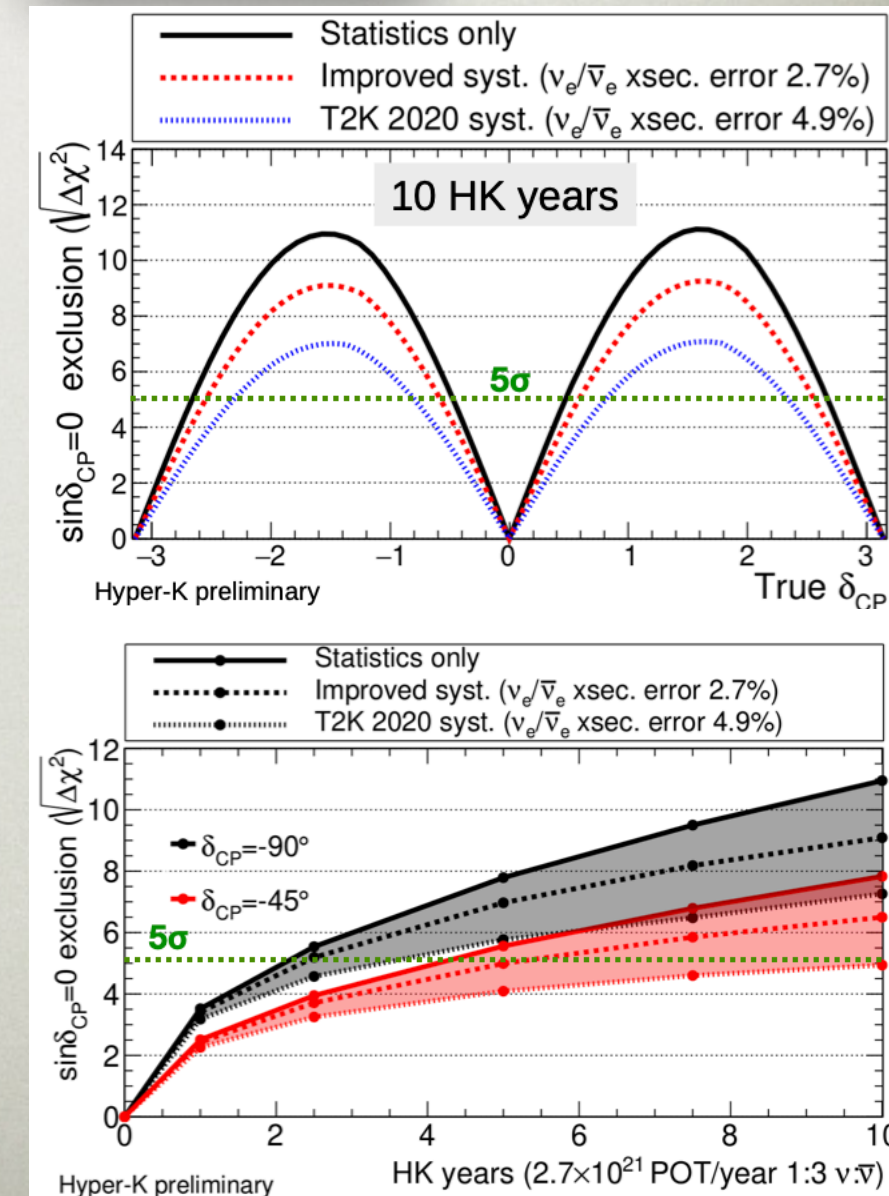
- World leading sensitivity for nucleon decay searches
 - Large detector mass
 - Able to use free protons to avoid problems of nuclear effect
 - High-efficiency background reduction using neutron-tagging thanks to new 50cm PMTs
- **3 σ discovery potential reaches 10^{35} years for $p \rightarrow e^+ \pi^0$ and 3×10^{34} years for $p \rightarrow \bar{\nu} K^+$ after 20 years**

Neutrino CP violation

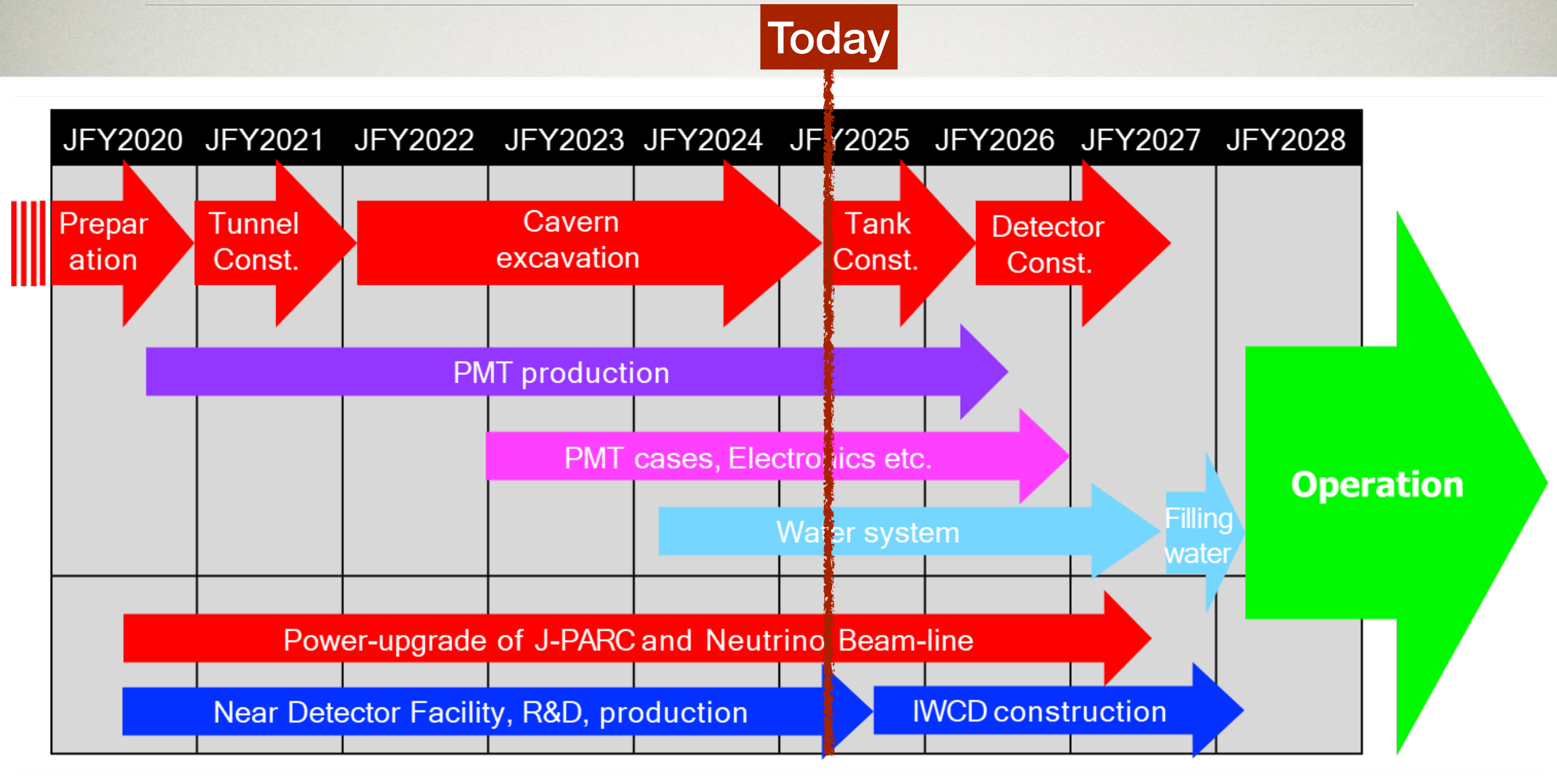


arXiv:2505.15019
for more details

- **J-PARC accelerator neutrino beam upgrade:** continuous beam power at 1.3 MW expected by start of Hyper-K data taking
 - Already performed 830kW continuous operation (T2K)
- With the combination of the gigantic detector and the high intensity beam, the **CP conservation hypothesis can be excluded within 3 years for most favorable case** (normal mass ordering, $\delta_{CP} = -\pi/2$, assuming improved systematic errors)



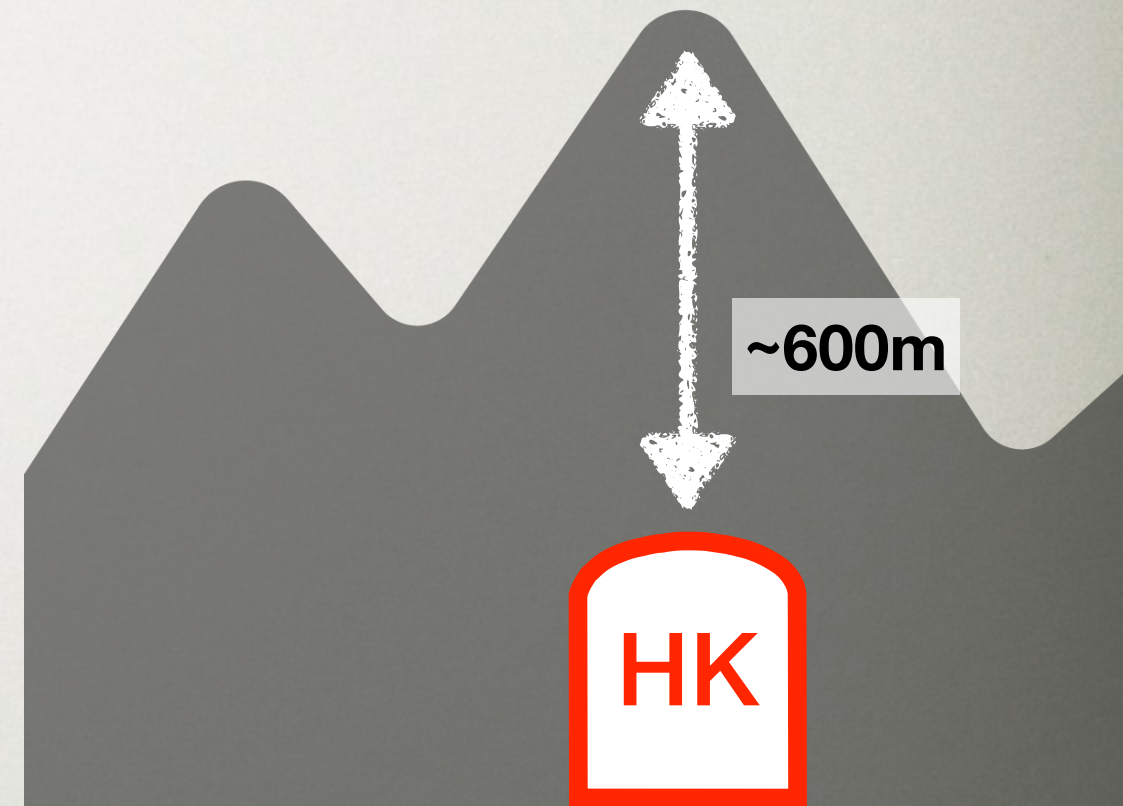
HK construction timeline



HK construction major milestones:

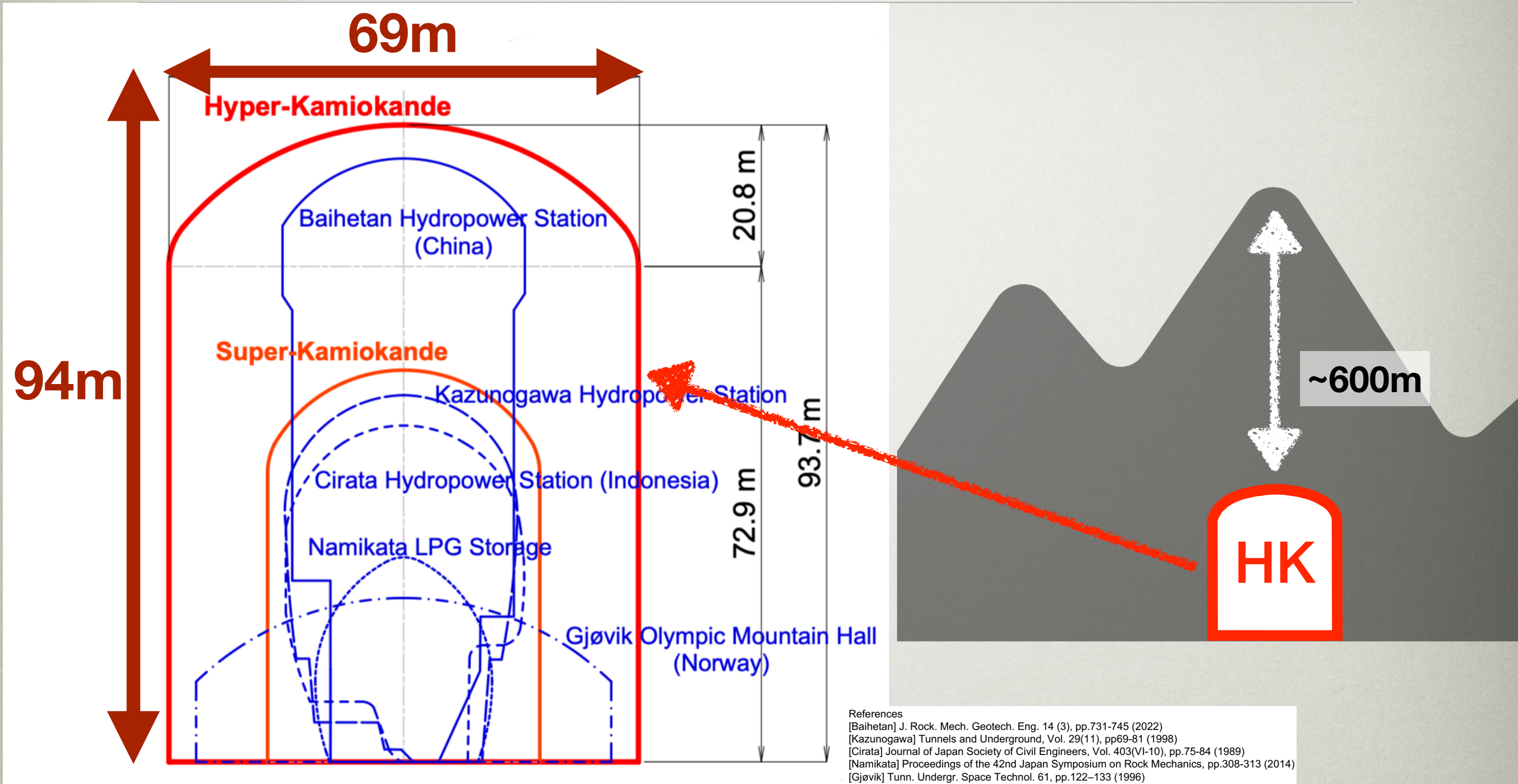
- **JFY 2025: HK cavern excavation completed** ←
- JFY 2026: HK tank lining construction complete
- JFY 2027: PMT installation complete → water filling
- **JFY 2028: Start of the operation**

HK large underground cavern



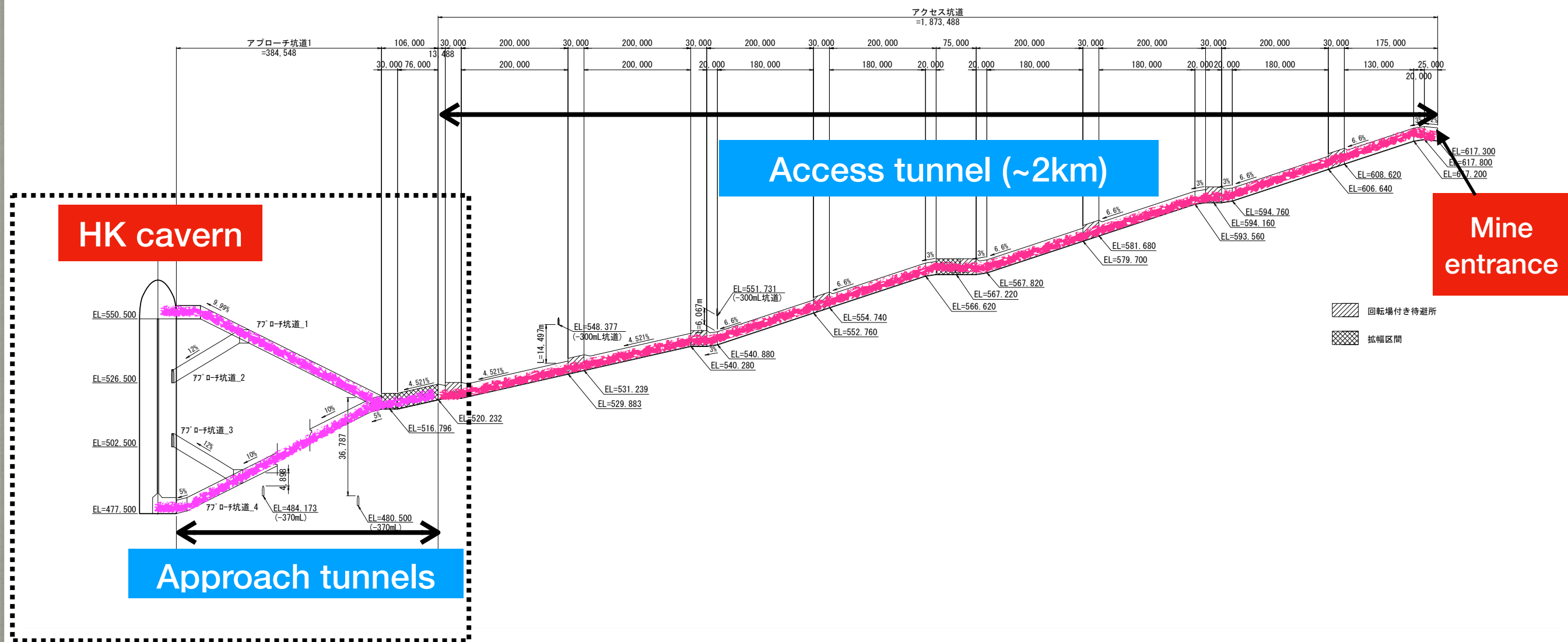
- The HK large underground cavern excavated ~600m beneath the summit of the Kamioka mine
- **The HK cavern is one of the largest man-made spaces ever excavated in bedrock**

HK large underground cavern

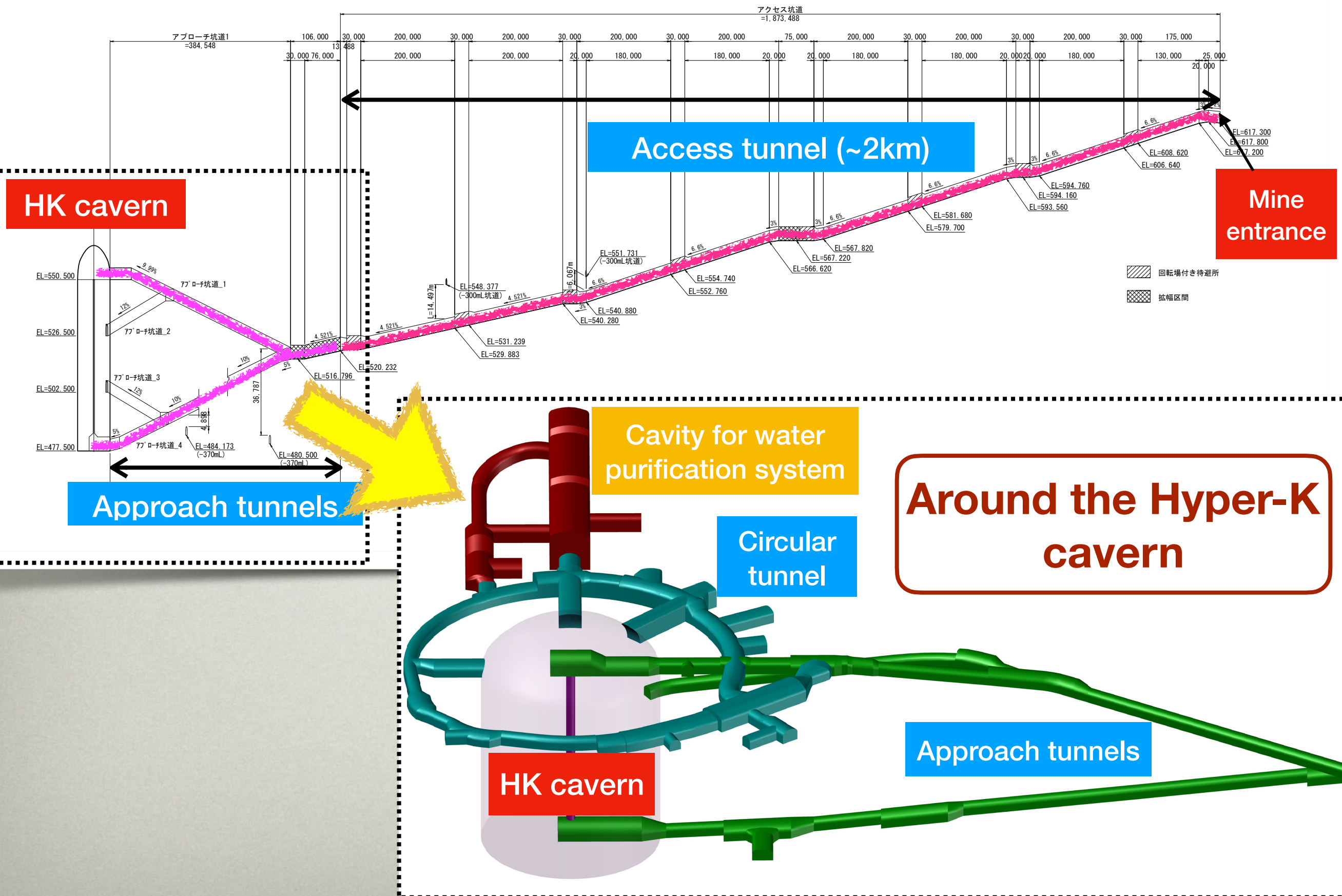


- The HK large underground cavern excavated ~600m beneath the summit of the Kamioka mine
- **The HK cavern is one of the largest man-made spaces ever excavated in bedrock**

Hyper-K cavern excavation



Hyper-K cavern excavation



Hyper-K construction began in 2021

Groundbreaking ceremony on May 28th, 2021



京大学
UNIVERSITY OF TOKYO

ハイパーカミオカンデ 着工記念式典
Hyper-Kamiokande Groundbreaking Ceremony



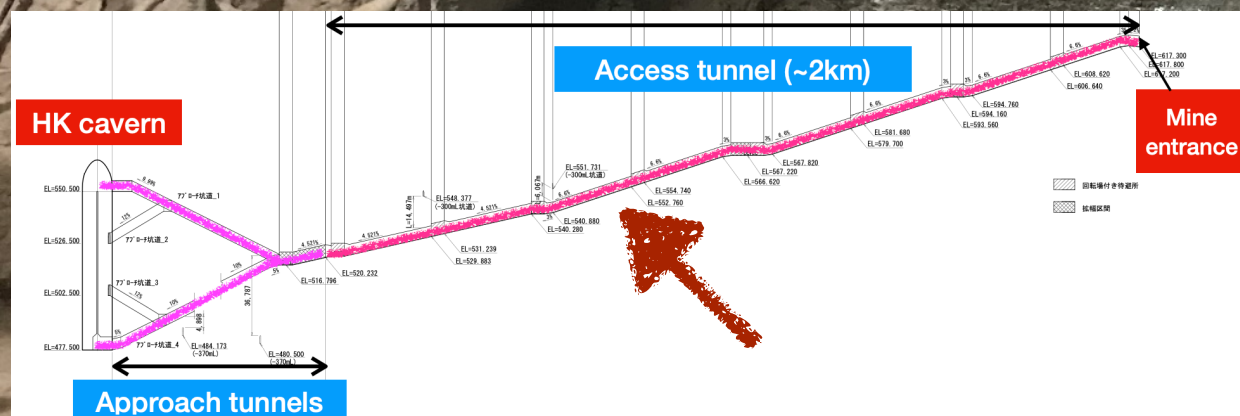
宇宙線研

©Institute for Cosmic Ray Research, The University of Tokyo

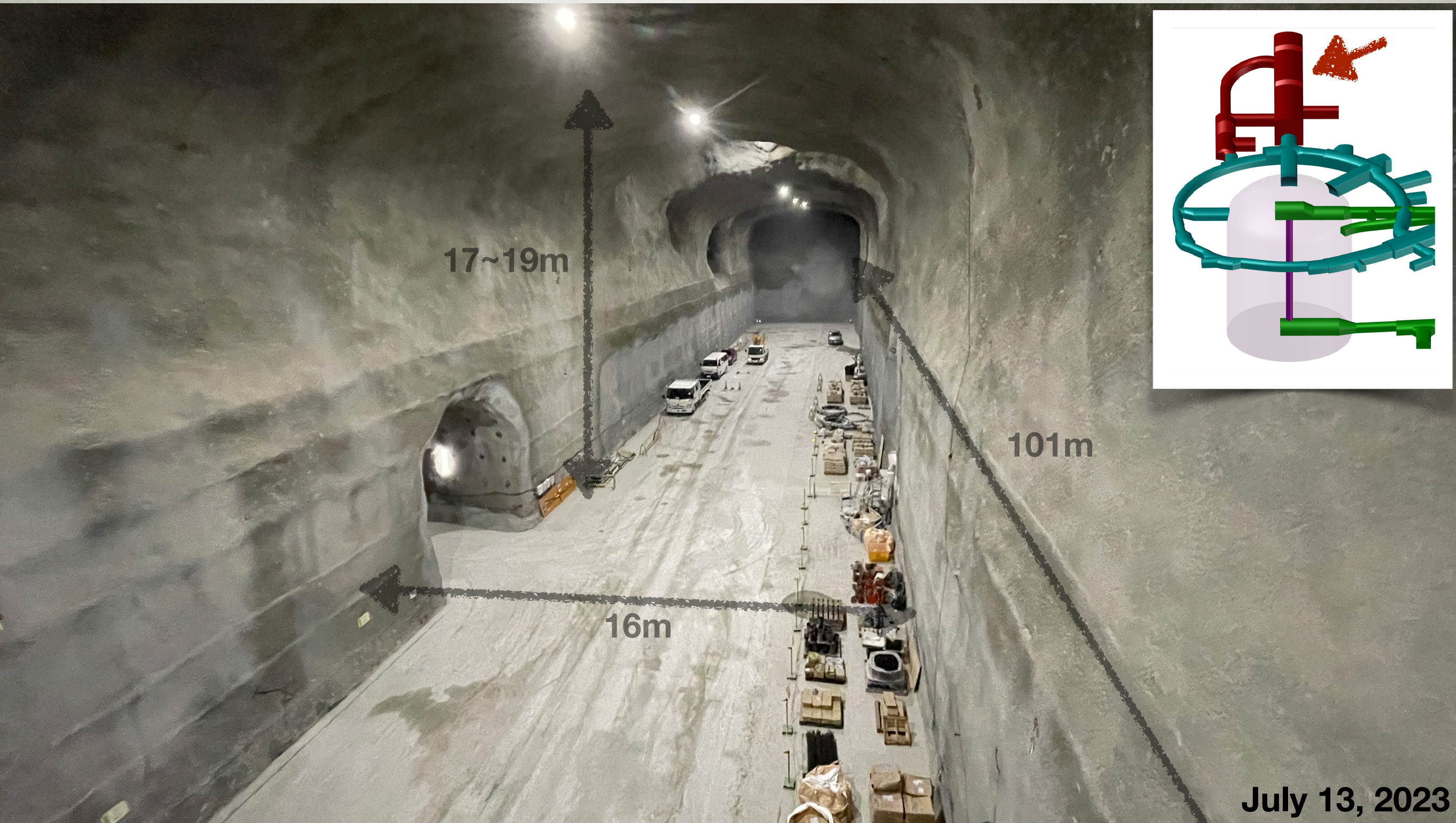
- Excavation work began in May 2021

Access and approach tunnels excavation completed June 2022

25



Cavity for water purification system



July 13, 2023

- The size of the cavity for the water purification system is approximately half that of Super-K tank

HK cavern 'dome section' completed

October 2023

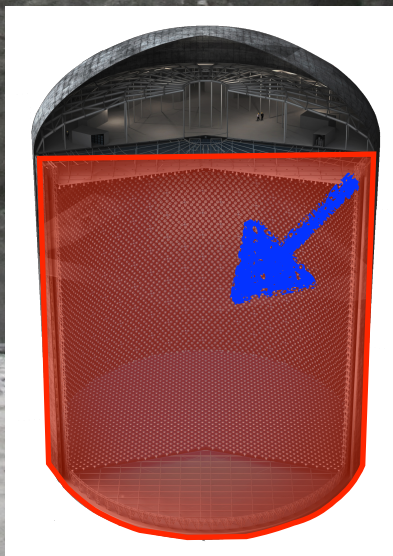


21m

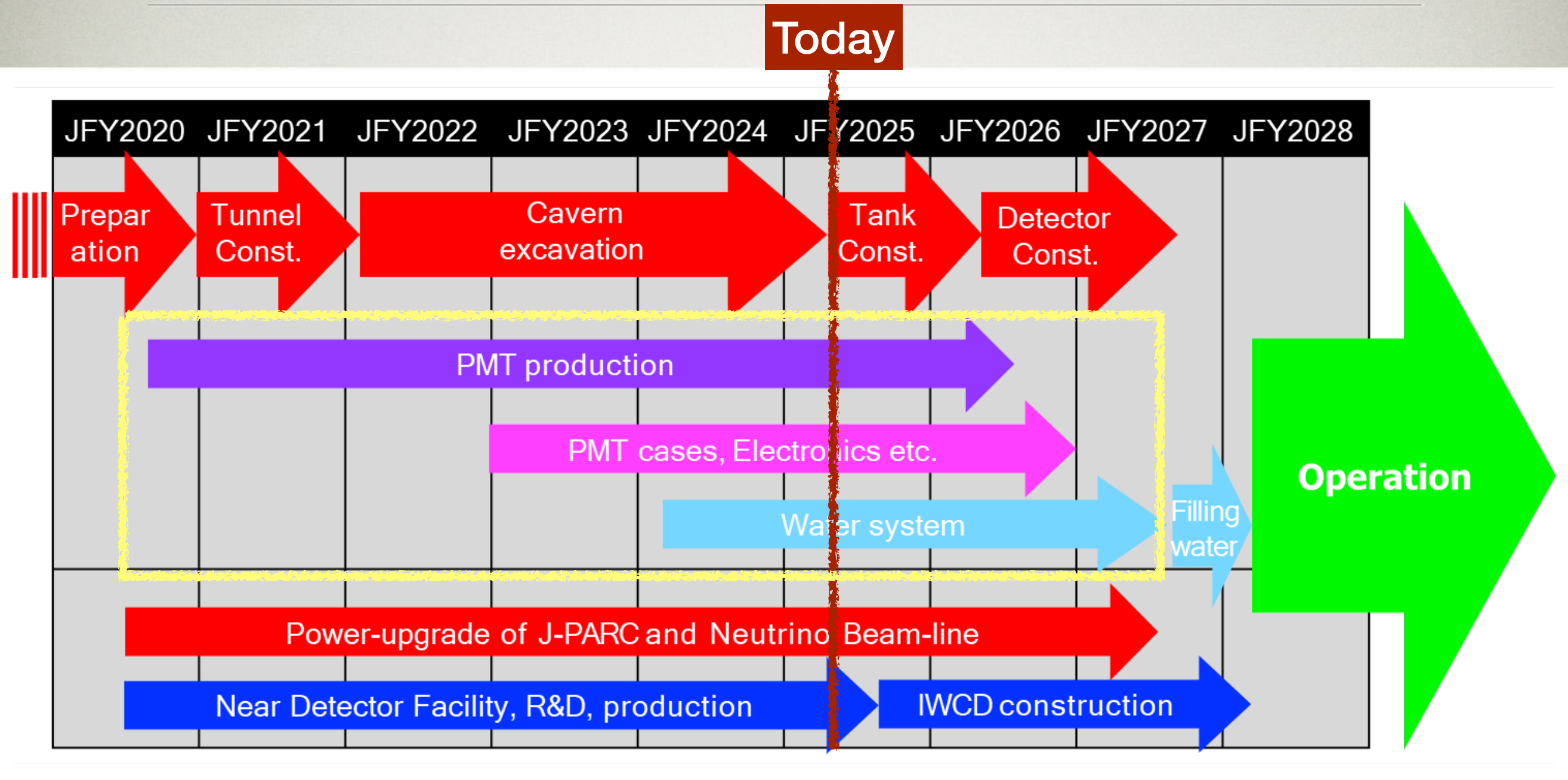
69m



HK cavern excavation completed in July 2025



HK construction timeline



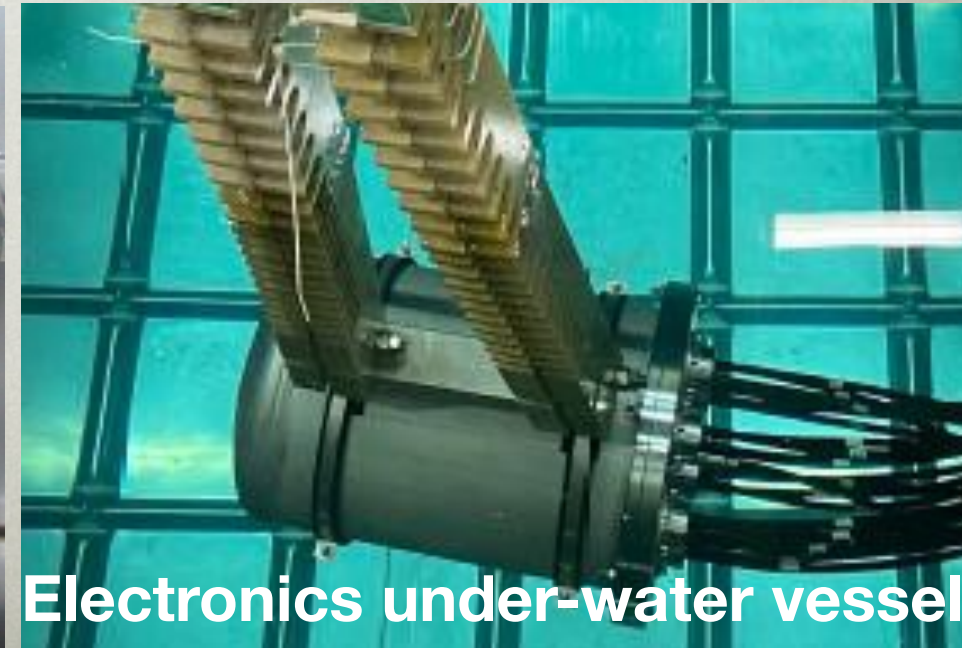
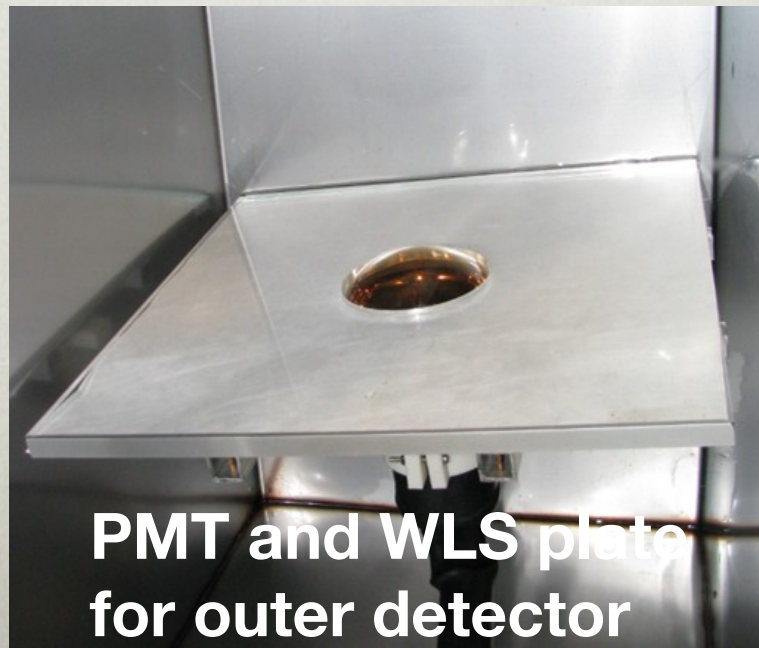
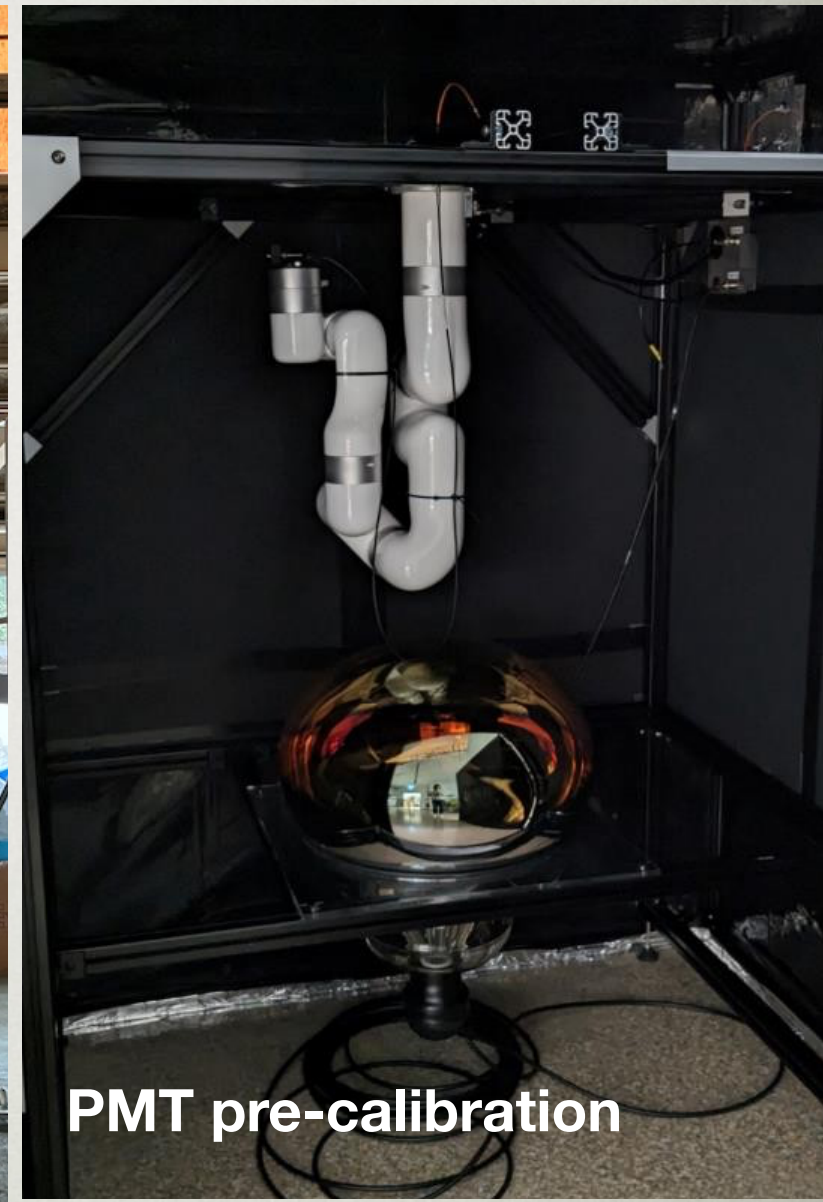
- **HK cavern excavation completed**
- **HK tank lining construction has started**
- Construction of the water purification system on-going
- Production and development of various detector components on-going

Mass production of 50cm PMTs

- >15k ϕ 50cm PMTs delivered (goal: 20k)



Getting ready for PMT/electronics installation

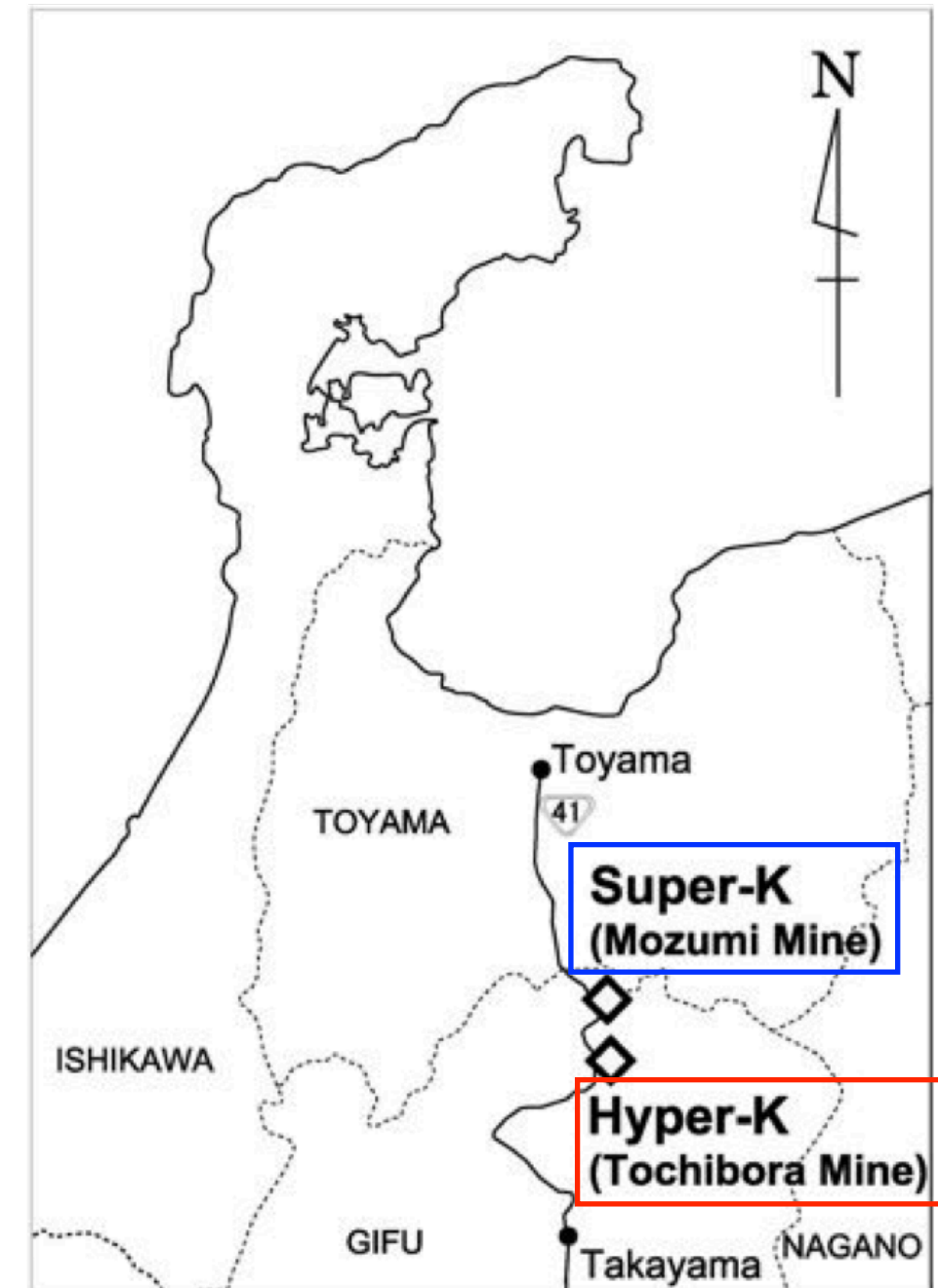
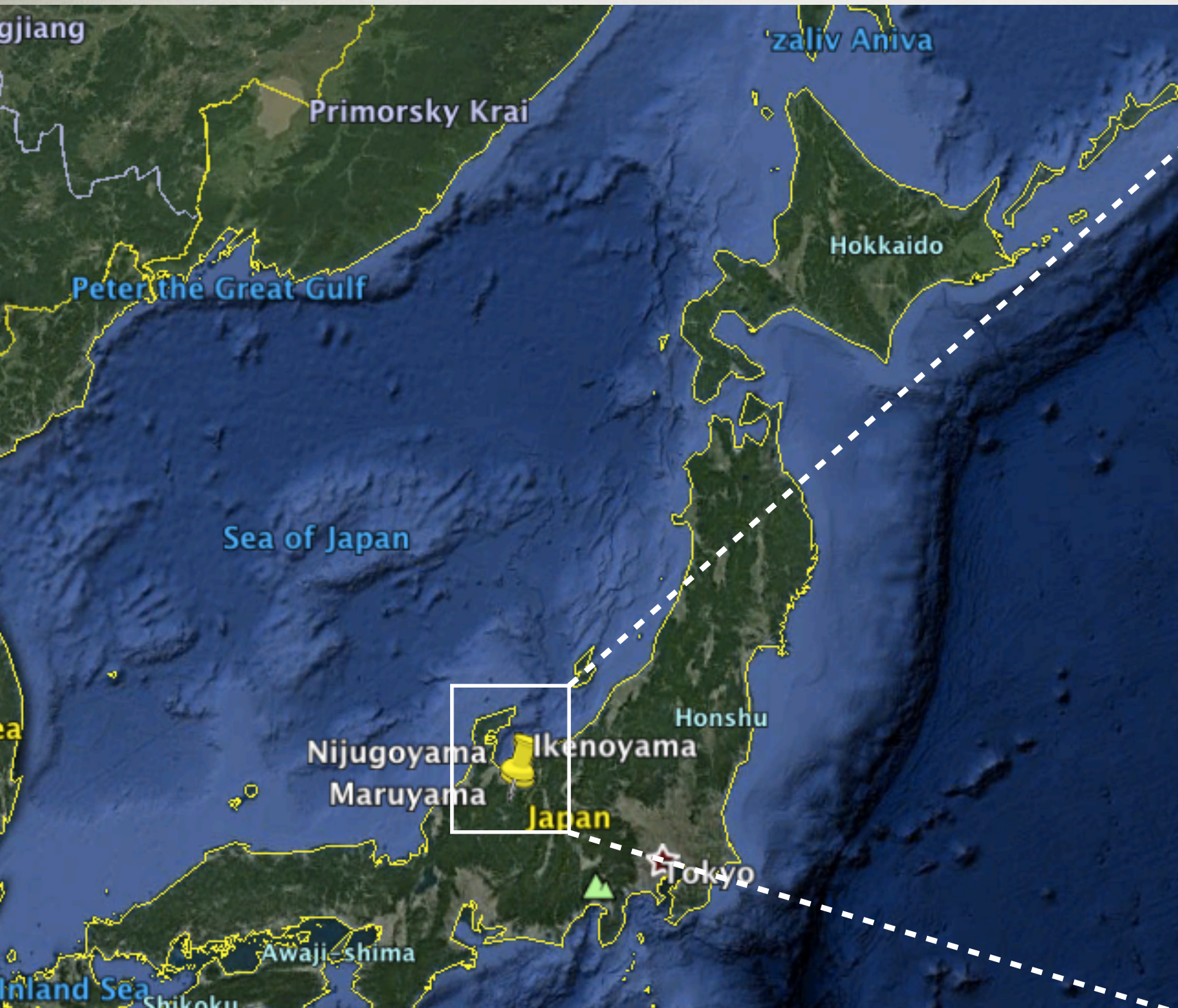


Summary

- Hyper-K is next generation water Cherenkov detector with wide-ranging potential for physics discoveries
 - Neutrino CP violation, nucleon decay, astrophysical neutrinos, ...
- **Hyper-K construction towards operation in 2028**
 - **Cavern excavation completed this July**
 - Tank lining construction has started
 - Production and development of various detector components on-going
- **J-PARC neutrino beam upgrade on-going**

Backup!

Hyper-K site



- Hyper-K site locates in Kamioka, Japan
- ~8km south from Super-Kamiokande
- Identical baseline (295km) and off-axis angle (2.5deg) to T2K