Hyper-Kamiokande Detector

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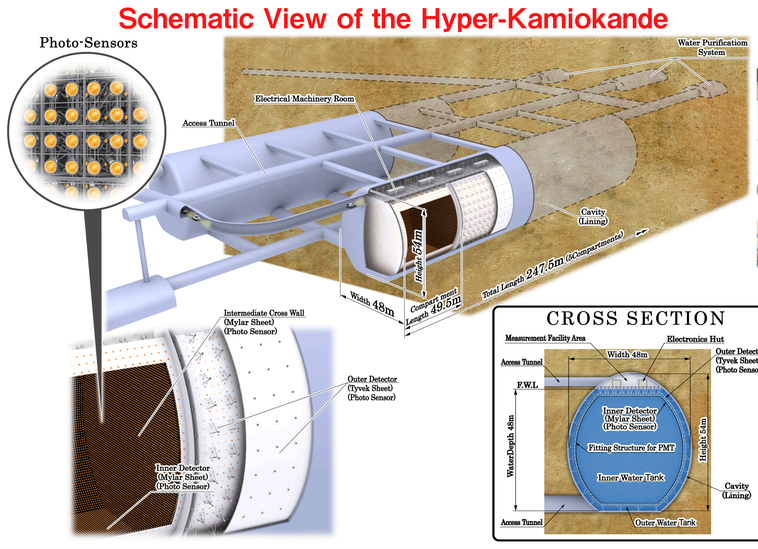
1. Hyper-Kamiokande Project

Hyper-Kamiokande (Hyper-K, HK) is a next generation underground water Cherenkov detector. It will serve as a far detector of a long baseline neutrino oscillation experiment envisioned for the upgraded J-PARC, and as a detector capable of observing -- far beyond the sensitivity of the Super-K detector -- proton decays, atmospheric neutrinos, solar neutrinos, supernova neutrinos, and dark matter.

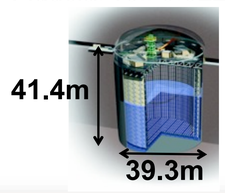
The total volume of Hyper-K is 0.99 Mton, and the fiducial volume is 0.56 Mton that corresponds to 25 times of Super-K.
Hyper-K detector consists of two oval shape tanks and each tank has five compartments that are optically separated.

Schematic View of the Hyper-Kamiokande



4th Open Hyper-K Meeting (January 2014)

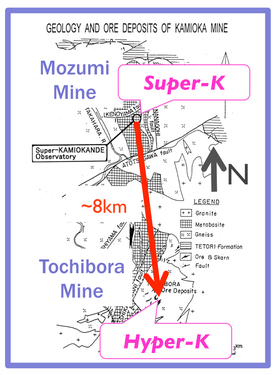
Super-Kamiokande
Total volume 0.05 Mt
Fiducial vol. 0.0225Mt

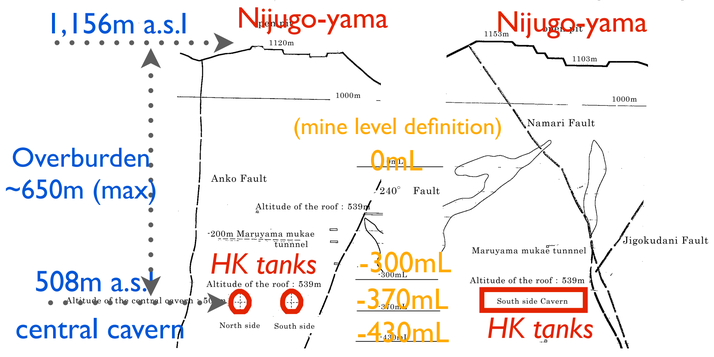


2. HK detector site candidate

The candidate site locates at Tochibora Mine, Kamioka Mine, Kamioka-cho, Hida City, Gifu Prefecture, Japan.
(36° 21′ 09″ North latitude, 137° 18′ 50″ East longitude; ~8km south of SK)

HK detector locates at elevation of +508m, under a mountain "Nijugo-Yama." Overburden on HK detector is ~650m (max).

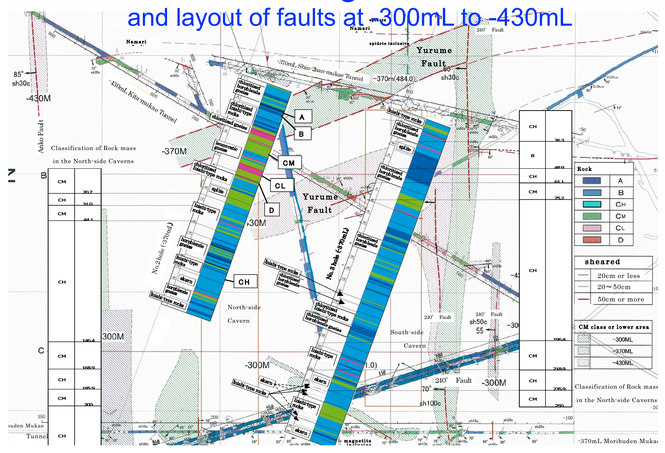




3. Geological survey at candidate site

The rockmechanical characterization at the candidate site has been accomplished by mapping the existing drifts, and by drilling and geotechnical logging of rock core samples in vicinity of the candidate site.

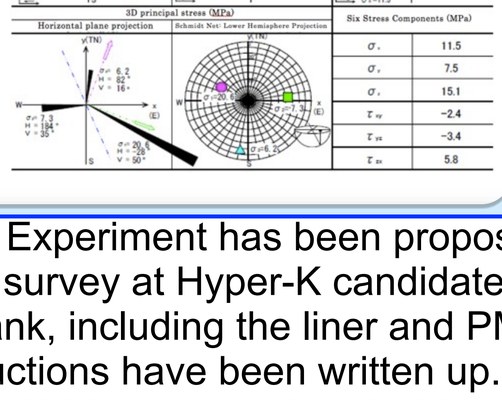
Classification of boring rock mass at -370mL and layout of faults at -300mL to -430mL



	Rock mass class (%)					
	A	B	CH	CM	CL	D
North-side Cavern	0.0	0.0	71.8	28.2	0.0	0.0
	71.8			28.2		
South-side Cavern	0.0	9.0	70.7	20.3	0.0	0.0
	79.7			20.3		
Total	0.0	4.5	71.3	24.2	0.0	0.0
	75.8			24.2		

Table 3.4 Input Property Values

Rock mass class	B	CH	CM
Young's modulus(kN/mm²)	10.10	3.43	1.22
Poisson's ratio	0.25	0.25	0.25
Cohesion(N/mm²)	4.90	2.40	1.40
Internal friction angle(deg)	60.00	50.00	45.00

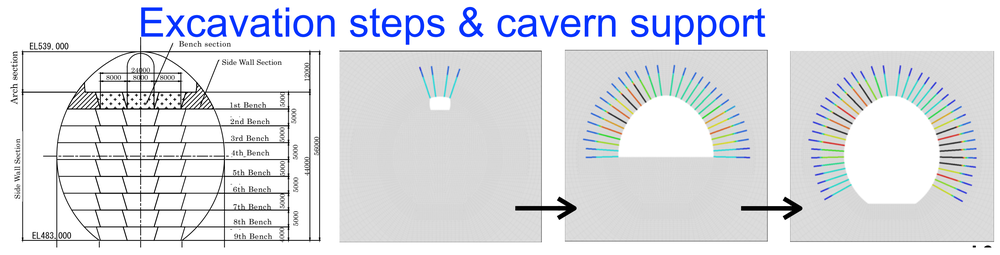


In-situ measurements of principal stress at -370mL (bottom of cavern) and at -300mL (top of cavern) has also been carried out.

4. Stability analysis & cavern design

Based on the results of geological surveys and principal stress measurements, structural stability of caverns has been studied (Elasto-plastic, static analysis adopting Hoek-Brown yield criteria). The stability analysis takes the excavation steps into account.

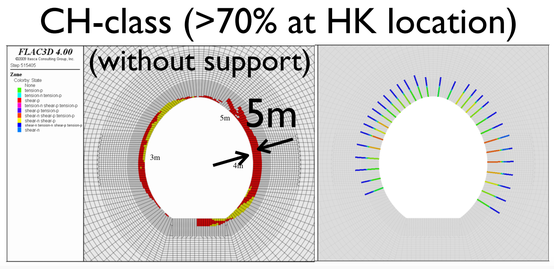
Excavation steps & cavern support



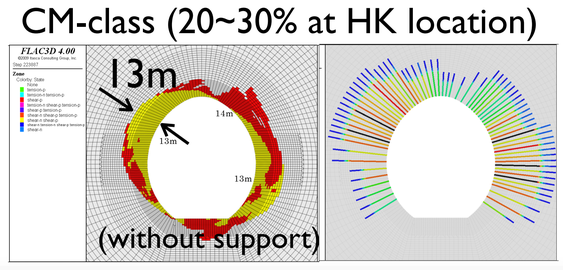
The HK cavern shape has been designed to be an oval-shape to ensure the structural stability of caverns.
The plasticity region depth is ~13m at most for CM-class rock, that can be supported with rock-bolts and pre-stressed anchors.
Confirmed that HK caverns can be constructed by the existing technologies for all rock mass classes (B, CH, CM).

Plasticity region depth and cavern support pattern

CH-class (>70% at HK location)

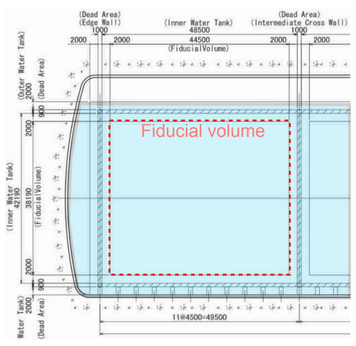


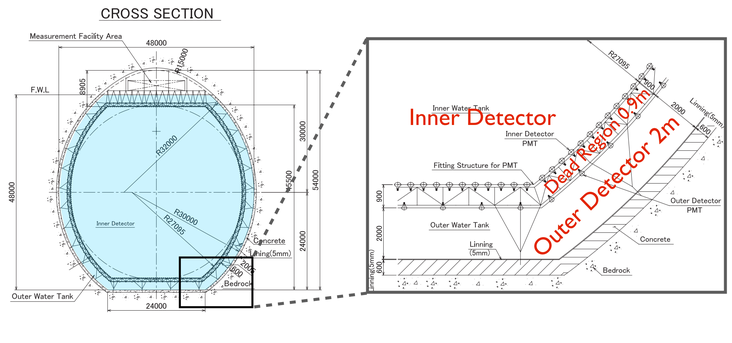
CM-class (20~30% at HK location)



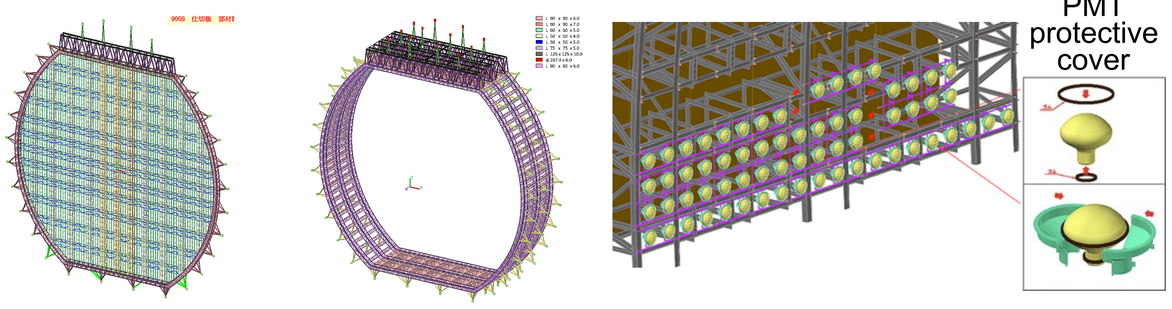
5. Tank and PMT support

HK tank, lined with concrete and HDPE sheet, is filled with pure water; the water depth is 48m. HK detector consists of Inner Detector (ID) and Outer Detectors (OD). The water volume of ID is 0.74 Mton in total, and fiducial volume is 0.56 Mton.





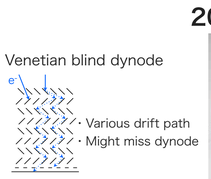
99,000 20" PMTs for ID (20% photo-coverage) and 25,000 8" PMTs for OD (same as SK) are installed. The PMTs are supported with stainless-steel frames.



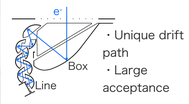
6. New photo-sensor R&D

New photo-sensors R&Ds are in progress, i.e. Hybrid Photo-detector (HPD), Box and Line (B&L) dynodes PMT, and High QE (HQE) PMT. The basic performance evaluation of new sensors have been carried out in 200t water Č detector (EGADS detector) and at a test-stand.

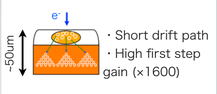
20" Super-K PMT



20" Box&line PMT



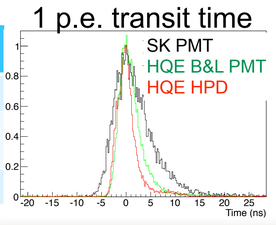
20" HPD



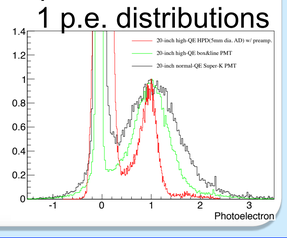
Compared 20" prototypes and confirmed that HQE-HPD and HQE-B&L PMT have better performance than SK PMT (R3600).

	SK PMT (R3600)	HQE HPD	HQE Box&Line PMT
Timing resolution σ	2.1ns	1.4ns	1.1ns
1 p.e. charge resolution (σ/mean)	53%	16%	35%
Peak to valley ratio	2.2	3.9	4.3

1 p.e. transit time



1 p.e. distributions



Summary

Hyper-Kamiokande Experiment has been proposed to explore new physics, such as neutrino oscillations and nucleon decay. A geological survey at Hyper-K candidate site has been carried out and confirmed the cavern construction is feasible. Hyper-K tank, including the liner and PMT support, has also been designed. Technical Design Documents for the detector constructions have been written up. Several R&D programs are progressing in International Working Group.

Next 'Open Hyper-K Meeting' will be held on July 19-22, 2014 at Vancouver, Canada ➜ http://bit.ly/5th-hyperk