Construction Status and Prospects of the Hyper-Kamiokande Project

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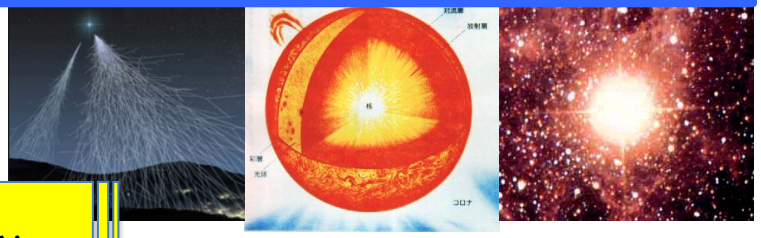
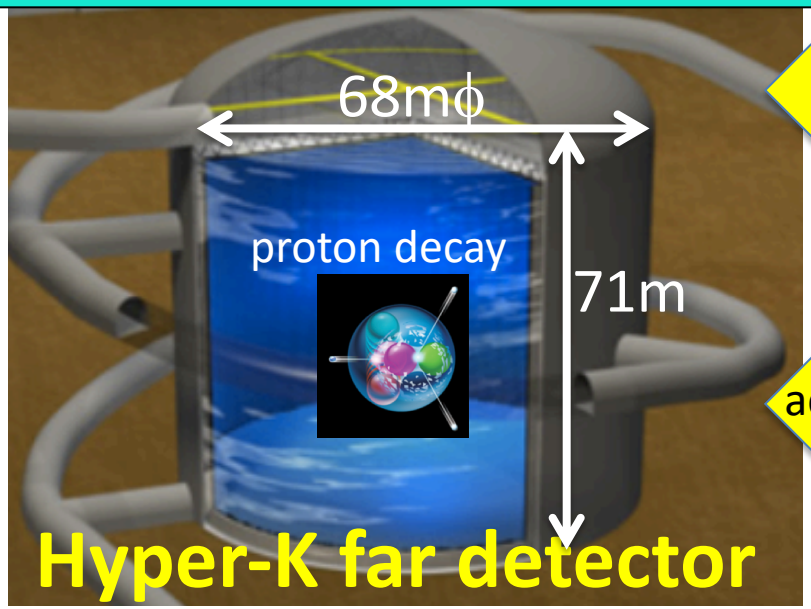
The Hyper-Kamiokande project

258kt water Cherenkov detector
188 kt fiducual : (x8 SK)
Hi-QE PD w/ 40% coverage eq. (x2 SK)

Atm-ν, Sol-ν, SN-ν, Astro-ν

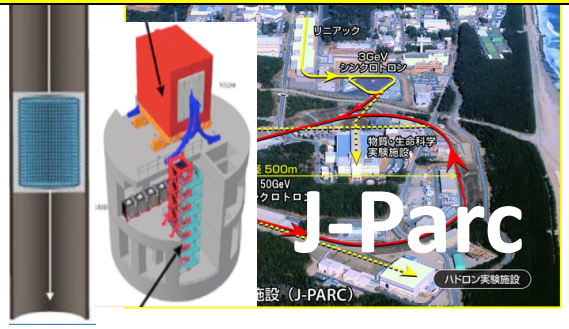




natural-ν

1.3 MW beam (x2 T2K)
Upgraded Near Detector/IWCD

accelerator-ν



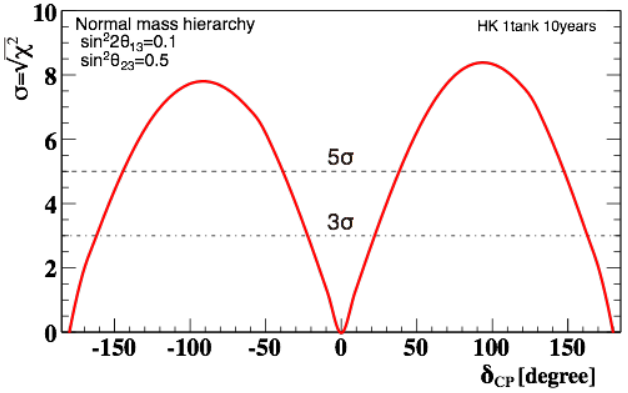
Precision ν osc. with LBLE and atm-ν
Construction & organizational status
→ This talk

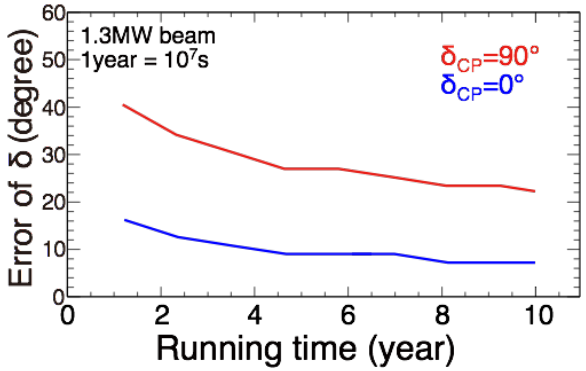
Prospects of neutrino astrophysics
→ NU 1189, T. Yano

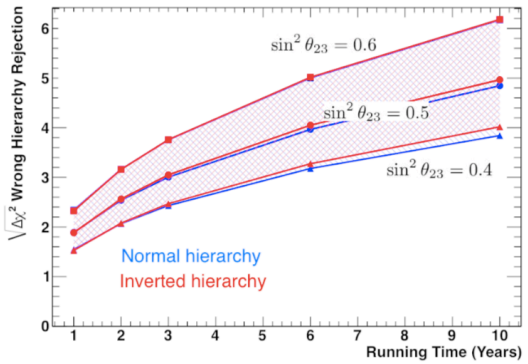
Hyper-K Physics

See Hyper-K Design Report
arXive:1805.04163

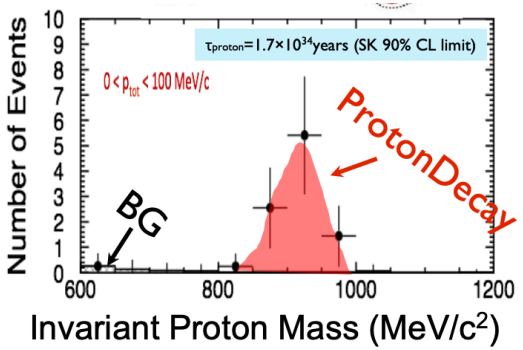
Neutrino CP violation and precision oscillations

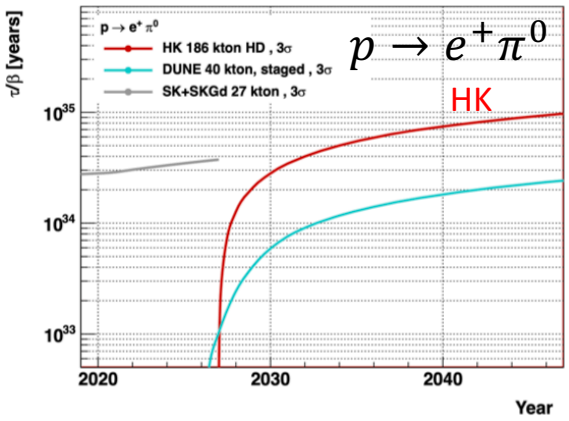


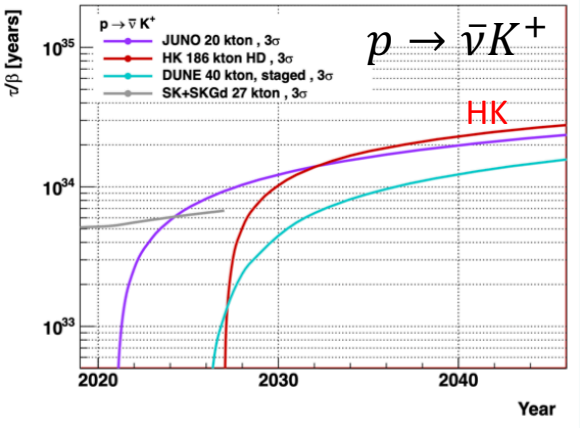




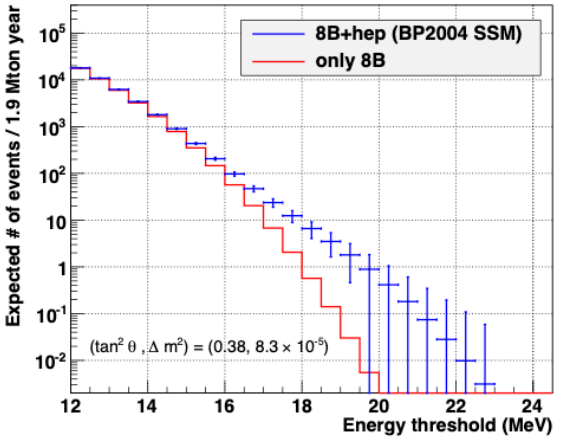
Proton decay



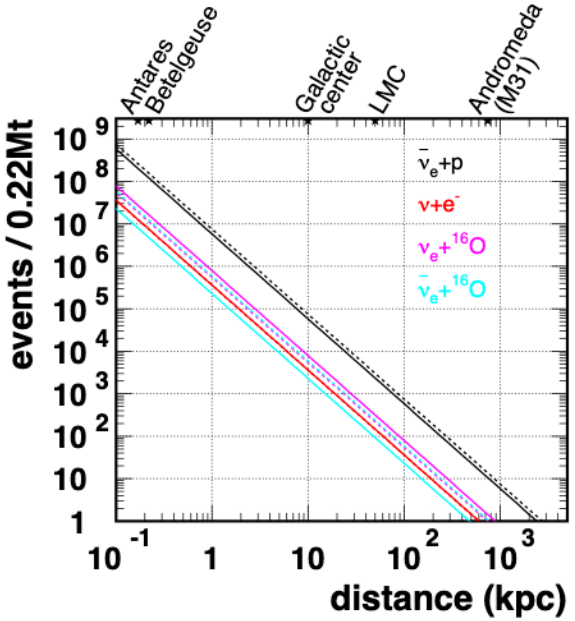




Precision solar neutrino

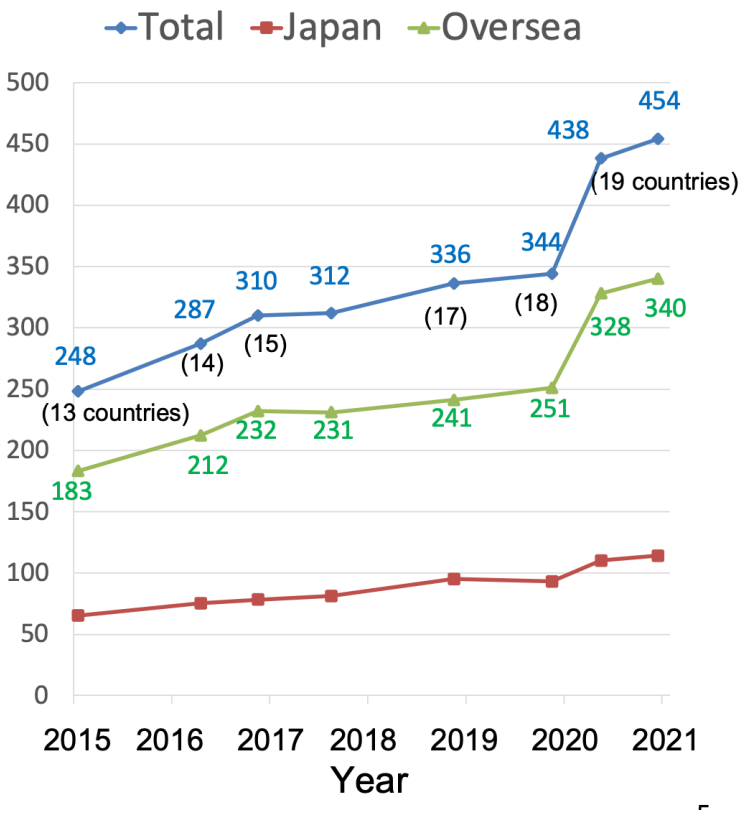


Precision SN neutrino



Hyper-K collaboration officially kicked off

- Proto-Collaboration to Collaboration at Sep 2020
- Collaboration structure reorganized for construction phase
- 19 countries, 93 institutes, ~450 people as of May 2021



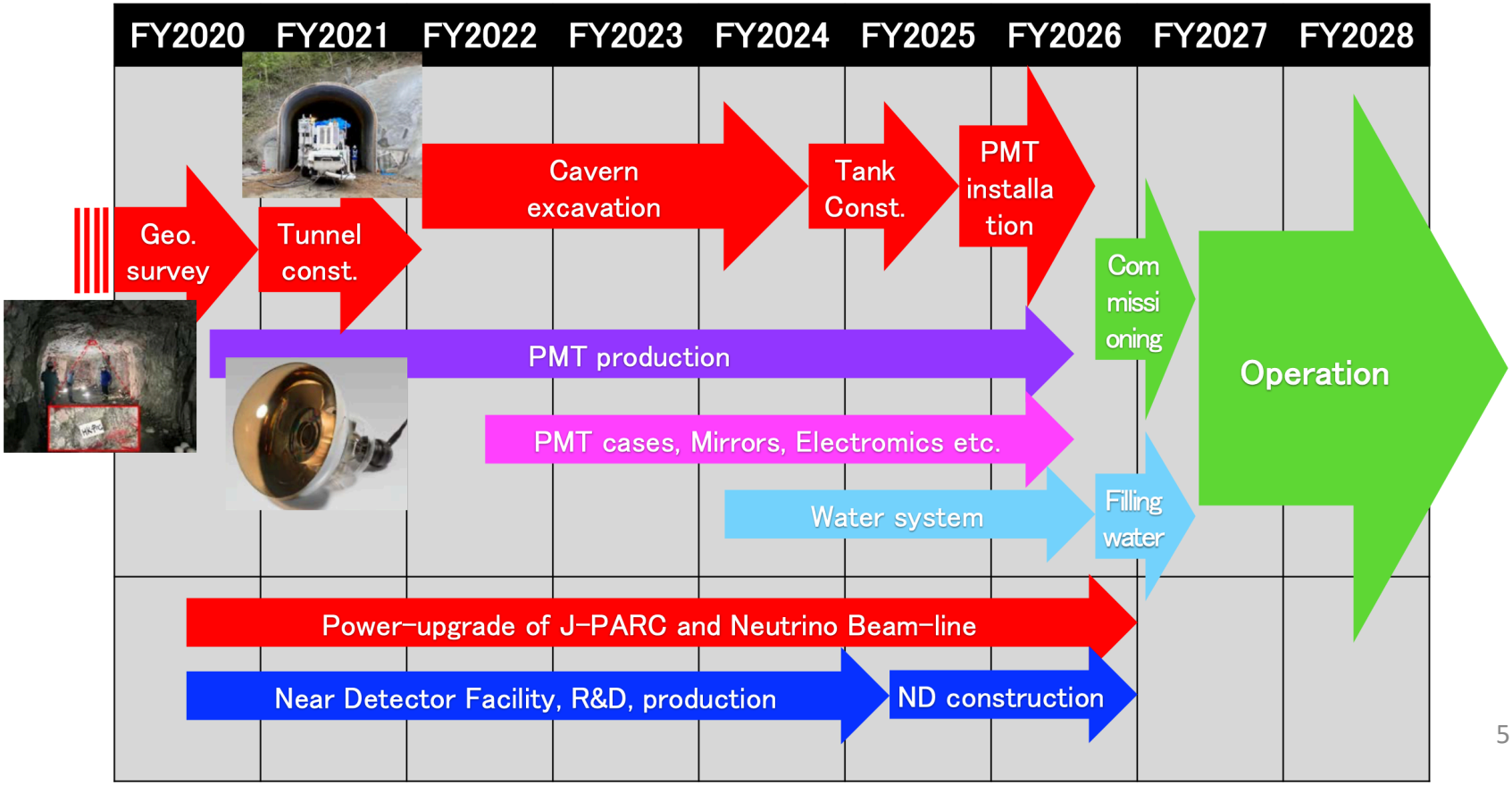
Europe	260 members
Armenia	3
Czech	3
France	28
Germany	1
Italy	53
Poland	37
Russia	21
Spain	26
Sweden	5
Switzerland	5
Ukraine	4
UK	74

Asia	142 members
India	10
Korea	18
Japan	114

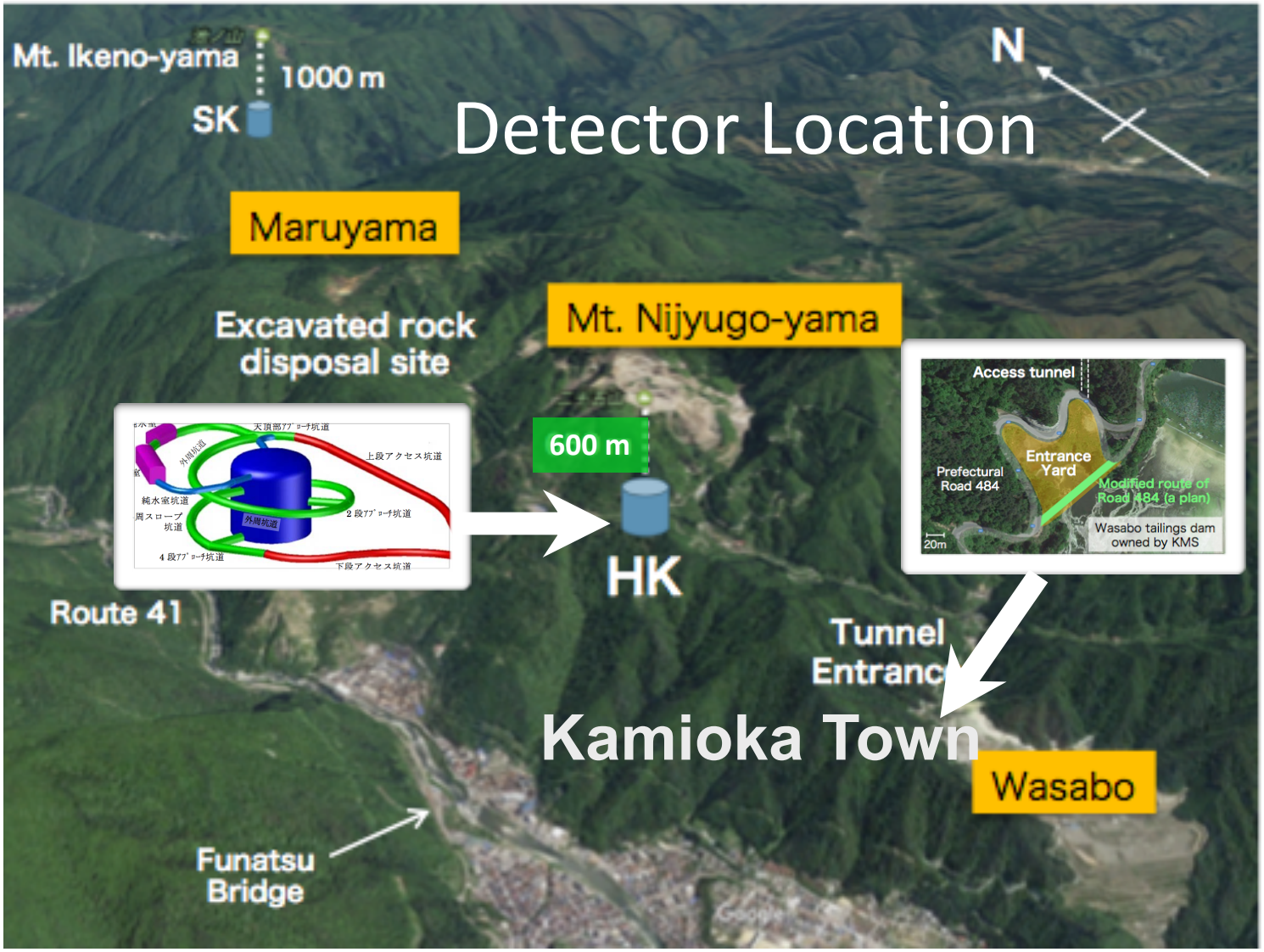
Americas	52 members
Brazil	3
Canada	29
Mexico	11
USA	9

Project time line and milestones

- 2020: project officially started, geo-survey was carried out
- 2021: Tunnel excavation started, followed by cavern excavation until 2024
- 2021: 20” PMT mass production started and covers/electronics will follow.
- Tank construction in 2024-2025, followed by PMT installations in 2025-2026.
- J-Parc beam upgrade also on-going. New IWCD detector is planed to built.
- Operation will get started in 2027.

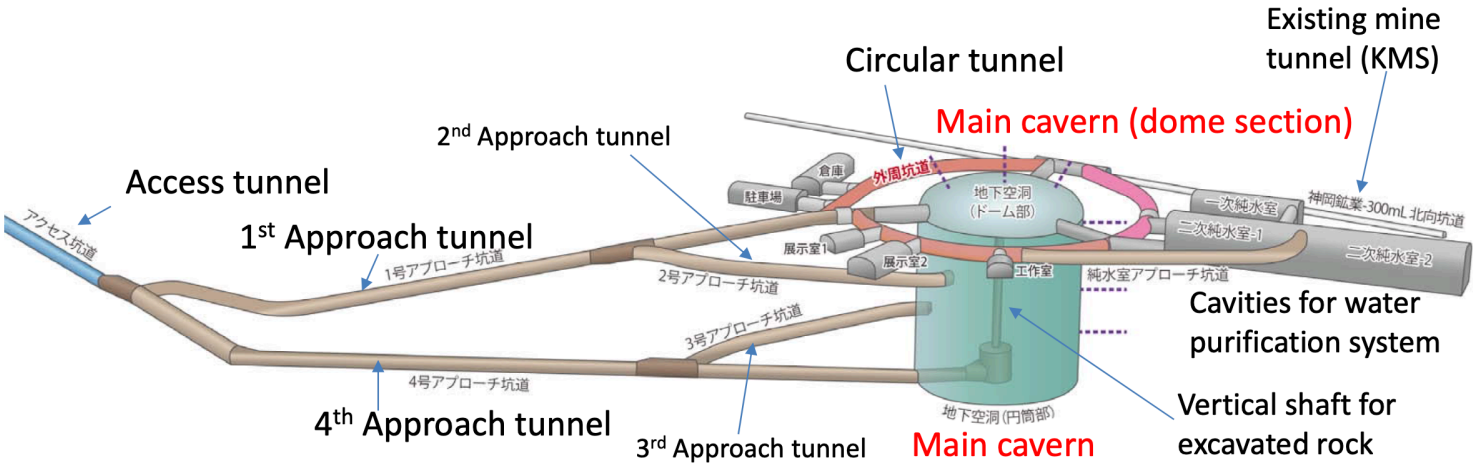


- 8km south of Super-K
- 295km from J-PARC and 2.5 deg. off-axis (same as Super-K)
- 600m rock overburden



Tunnel & Cavern excavation started !

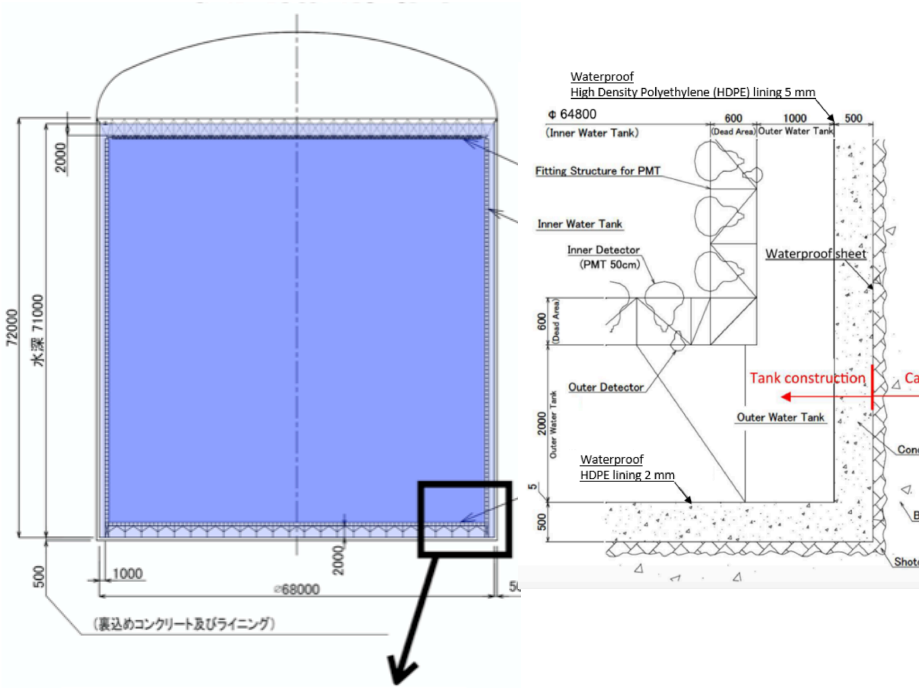
- Site construction officially started in 2020, entrance yard prepared.
- Geological survey performed and confirmed rock quality is excellent !
- Access tunnel excavation started 2021, followed by main cavity excavation in 2022

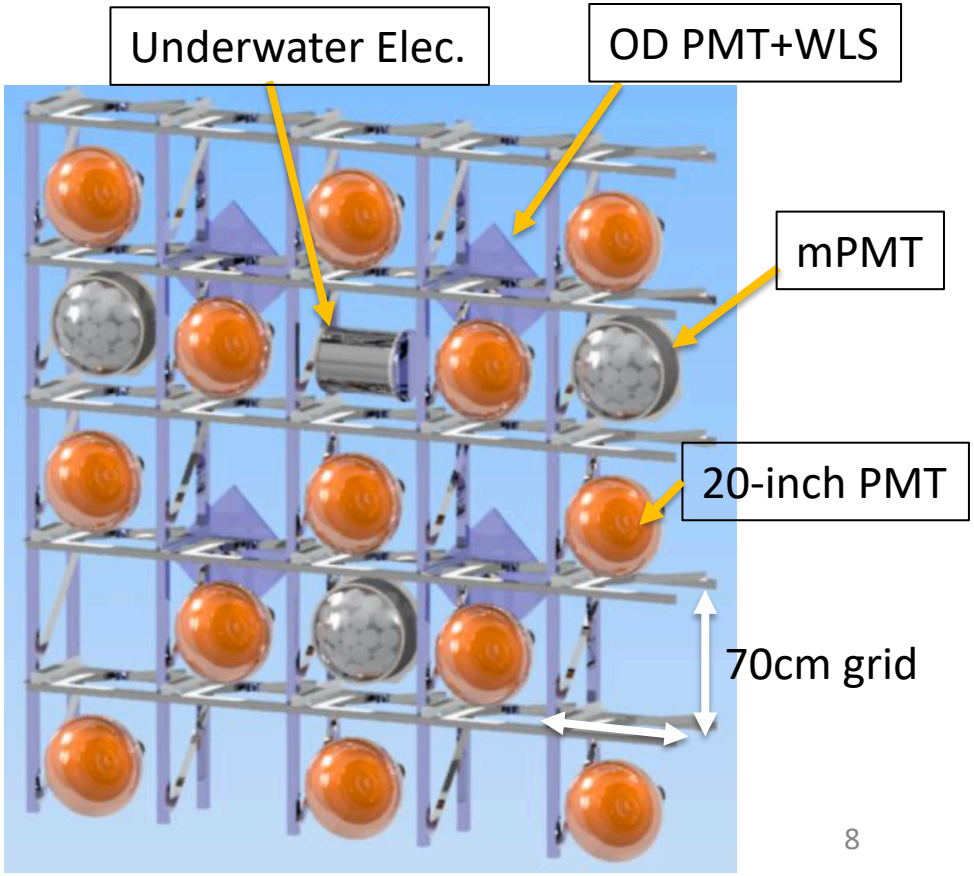


Ref.: KAJIMA Co.

Far detector : ID and OD configuration

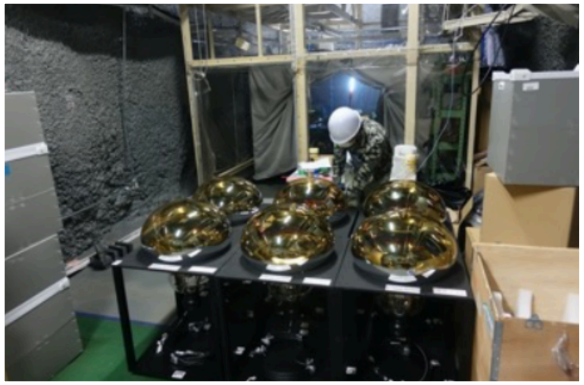
- 64.8mΦx65.8m Inner Detector (fiducial 188kt)
  - Aiming 40% photo-coverage with HighQE (x2 SK)
  - 20,000 HPK HiQE 20-inch PMTs will be installed
  - mPMT modules will be integrated as hybrid configuration.
- 1m(wall) or 2m(top/bottom) thick Outer Detector
  - 3” PMTs + WLS boards
- Under-water electronics module
  - Mitigate disadvantage of long cables





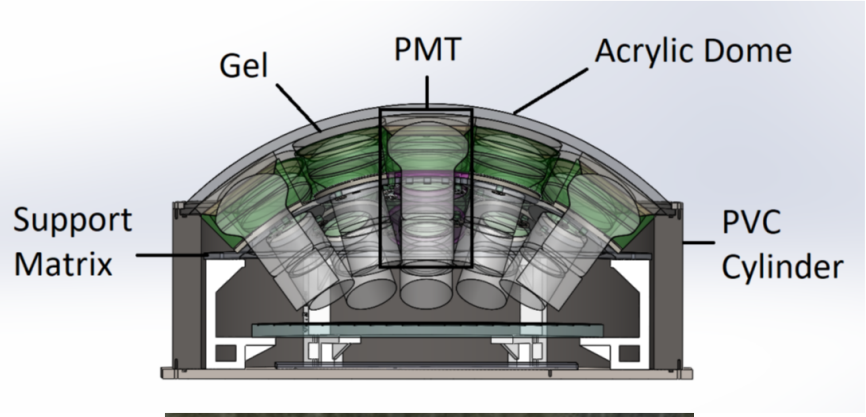
ID photo-detectors: 20-inch PMT

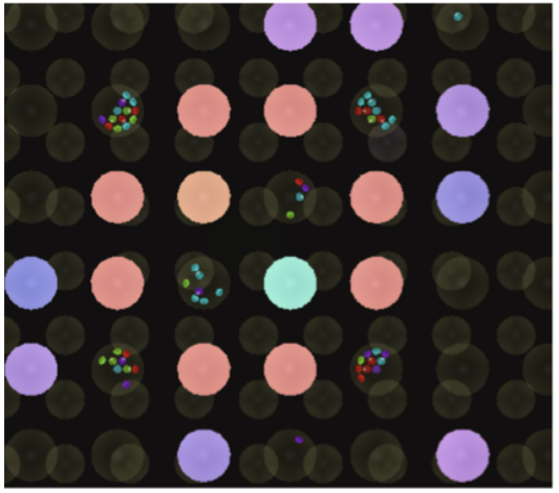
- New HPK Box&Line 20-inch PMT (R12860) R&D completed. Excellent performance.
  - High QE (x2 SK) w/ similar dark rate as SK (4kHz),
  - Better charge and timing resolution
  - 1.25MPa pressure tolerance
- 136 prototype PMTs installed in SK since 2018 for long term test.
- Mass production started. Total 20,000 20”PMTs delivered until 2026.
  - First 1,000 20”PMTs are delivered to Kamioka. Detail inspection is on-going.
- Prototypes PMT covers have been developed. Final test and design fixed soon.



ID photo-sensors: mPMT module

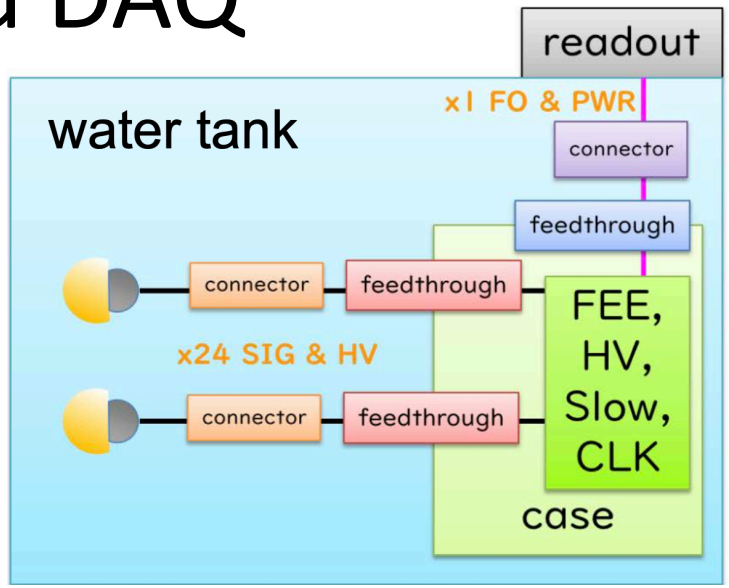
- Multi PMT module : 19 x 3-inch PMT with in-case electronics
- Increase photo-coverage
- Good TTS (1.3ns) and dark rate of 3-inch PMT
- High granularity and photon directional information
- Improve reconstruction at the fiducial edge, calibration reference

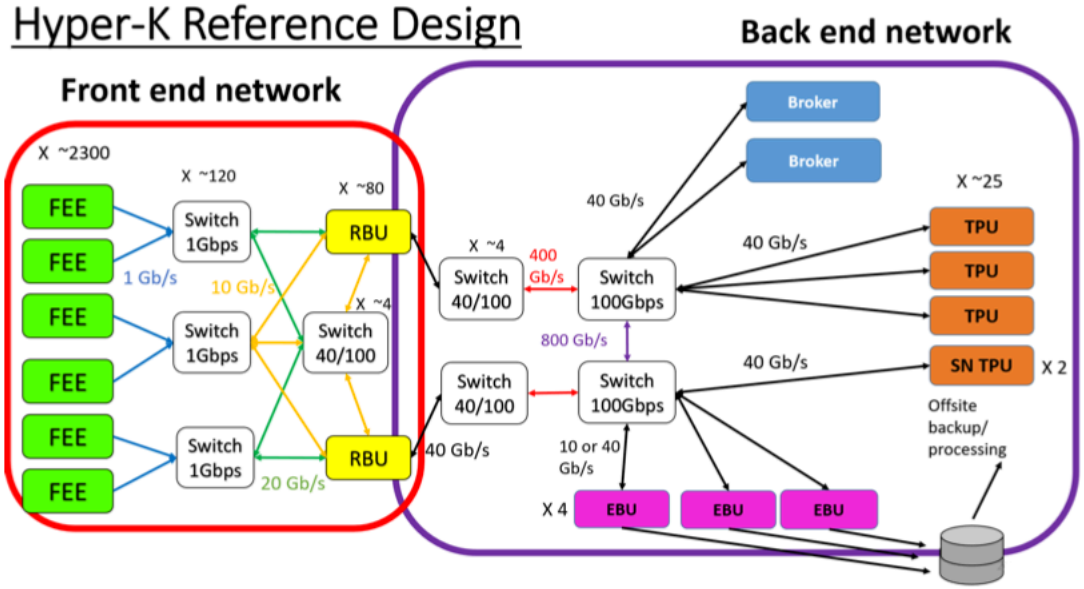




Electronics and DAQ

- Digitizer parts placed underwater to minimize cable lengths (and weight)
- Required small failure rate (<1%/yr total)
- 4 digitizer options under development
- Underwater electronics case under development



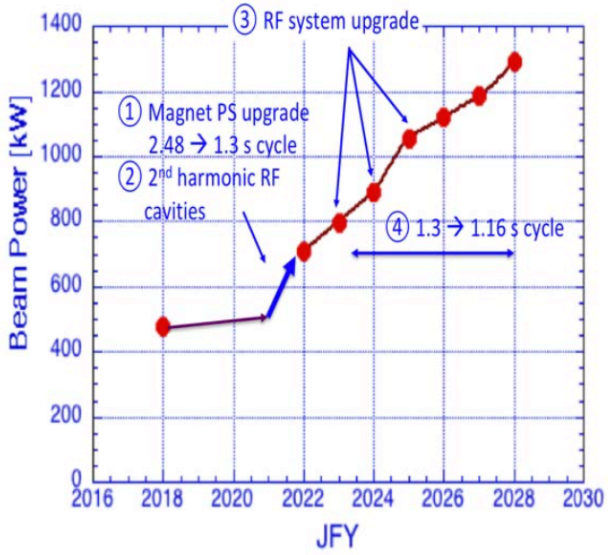


- Raw hits sent from Front End Electronics (FEE) in water via optical link
- All raw hits readout and buffered (RBU)
- Triggers issued by Trigger Processor Unit(TPU) / SN-TPU to send hits to Event Builder Unit (EBU)

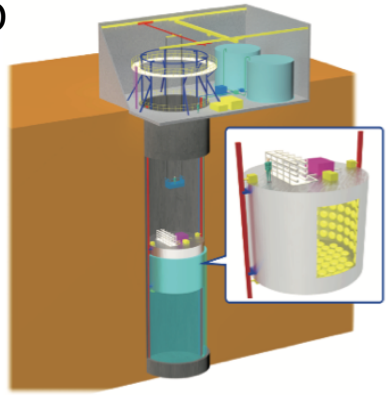
Near detectors & J-Parc ν beam

- J-Parc ν-beam upgrade is on-going toward 1.3MW at 2027
- New Intermediate Water Cherenkov Detector (IWCD) planned together with existing T2K ND currently being upgraded.

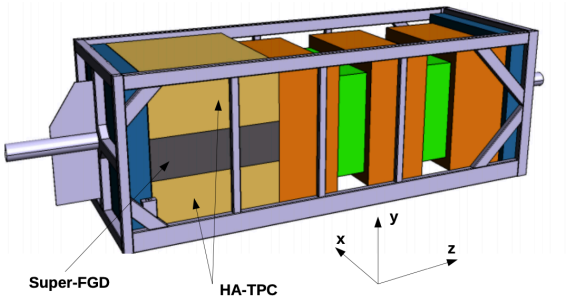
FY2020	FY2021	FY2022	FY2023	FY2024	FY2025	FY2026
Horn etc. for high rep. rate		Preparation for cooling capability upgrade			Cooling capability upgrade	
Primary-beamline upgrade					Remote handling upgrade	
NU2 Tank Upgrade		Radiation safety improvement				



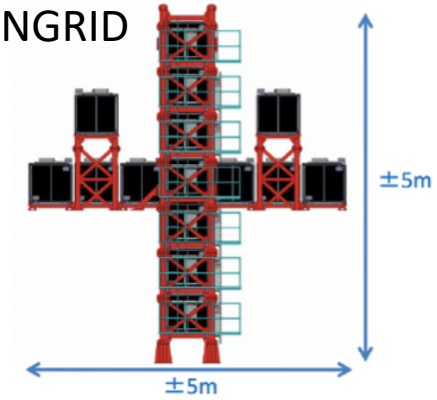
"Variable-axis"
Water Cherenkov
IWCD



Off-Axis
Magnetized tracker
(ND280UG+others…)



On-Axis ν monitor
INGRID



Take-home message

- Hyper-Kamiokande Project, next generation water Cherenkov detector + high-intensity neutrino beam
- Construction has started in 2020, official collaboration kicked-off
- In 2021, new mile stones,
  - Access tunnel excavation started
  - Mass production of new 20-inch PMTs started
  - Basic design of tank, mPMT, electronics, etc., will be finalized soon
  - PMT installation foreseen in 2025-2026
  - Will be online in 2027 !

New participation highly welcome !!