Progress of the Hyper-Kamiokande project

C. Bronner on behalf of the Hyper-Kamiokande collaboration

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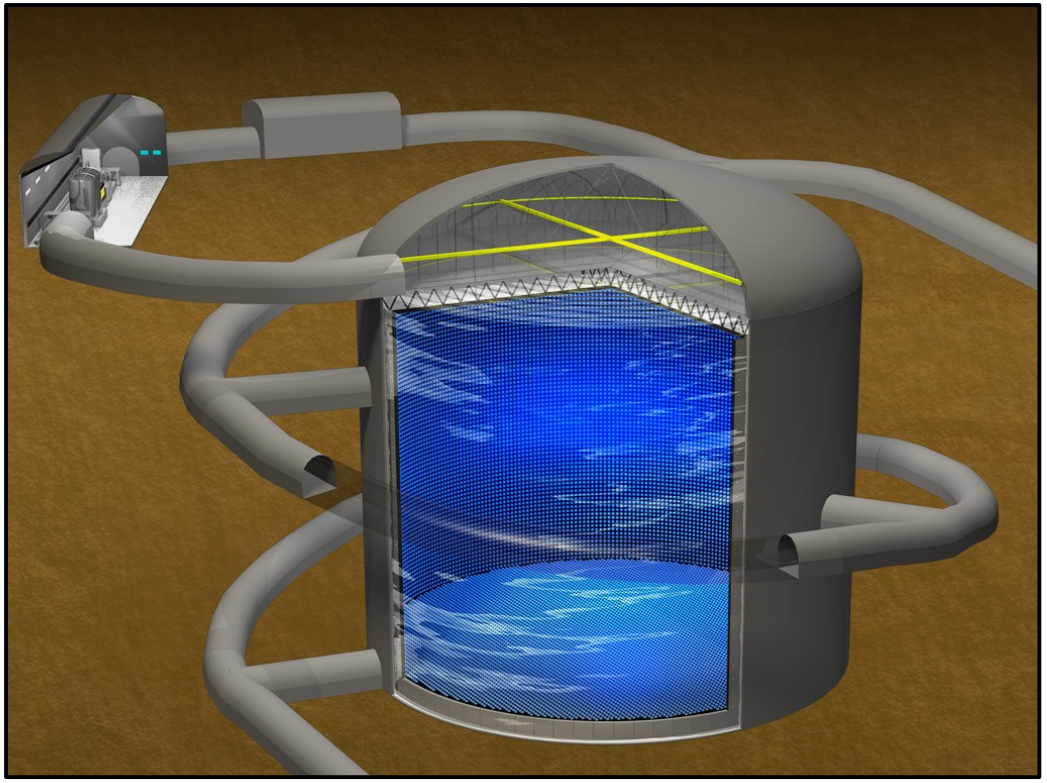
ICRR
Institute for Cosmic Ray Research
University of Tokyo

KAMIOKA OBSERVATORY

Hyper-Kamiokande project overview

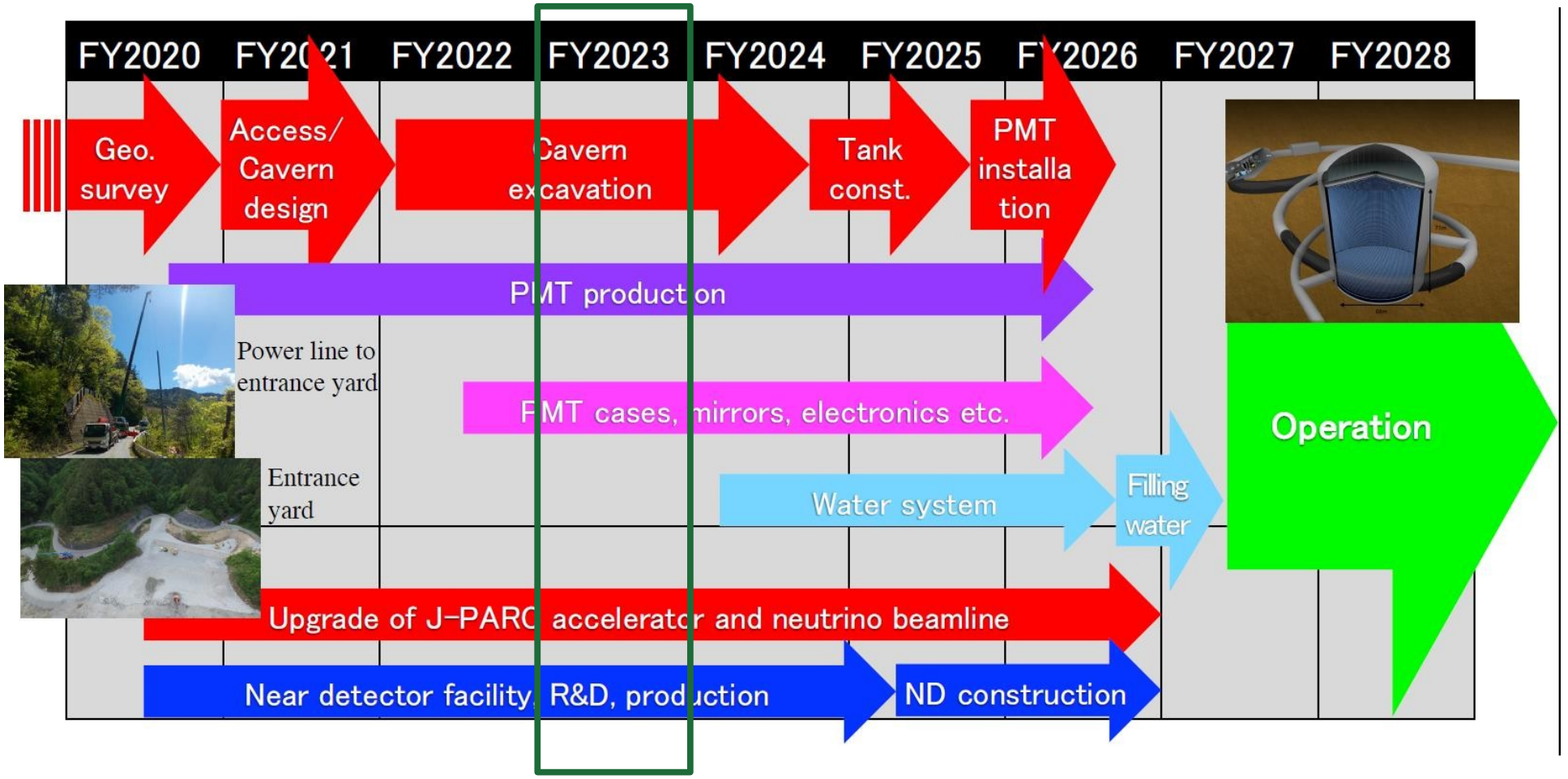


Wide physics program:
- Atmospheric neutrinos
- Accelerator neutrinos
- Solar neutrinos
- Supernova neutrinos
- Proton decay
- Dark matter indirect detection

Builds on the successful strategies used in Super-Kamiokande (SK), K2K and T2K with:
- Larger detector for increased statistics
  72m height x 68m diameter tank, 188.4 kton fiducial volume (SK:22.5 kton)
- Improved photo-sensors for better efficiency
- Higher intensity beam and updated/new near detector for accelerator neutrino part

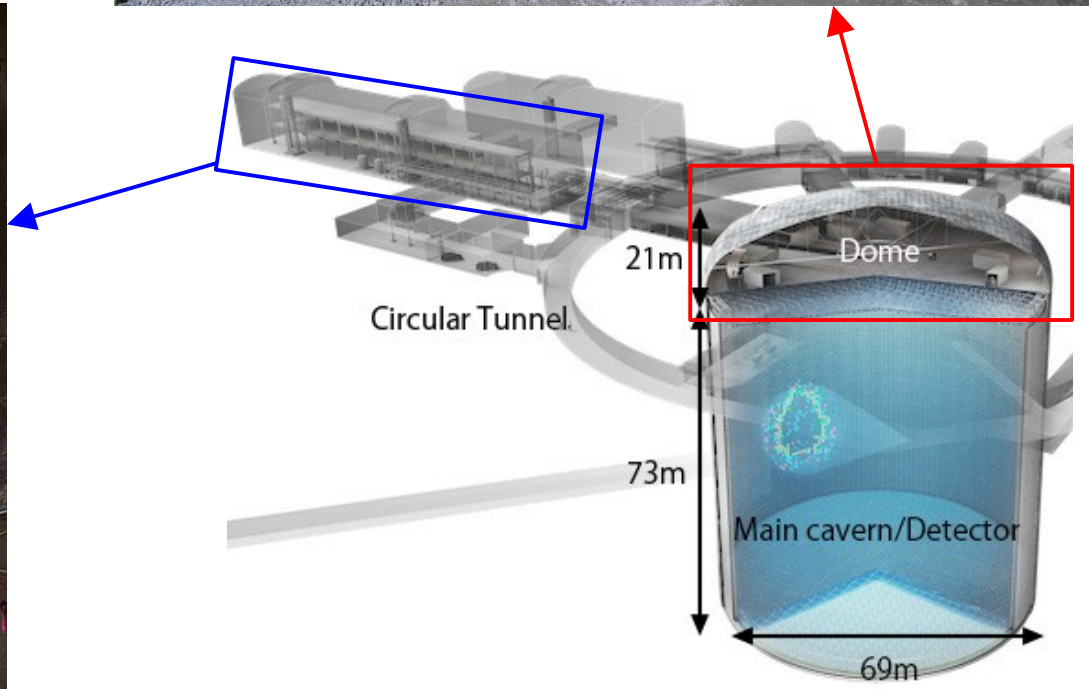
Schedule

- Large project with construction scheduled over a number of years
- Progress in many areas since last year: cavern excavation, PMT production, electronics, upgrade of neutrino beam and near detector



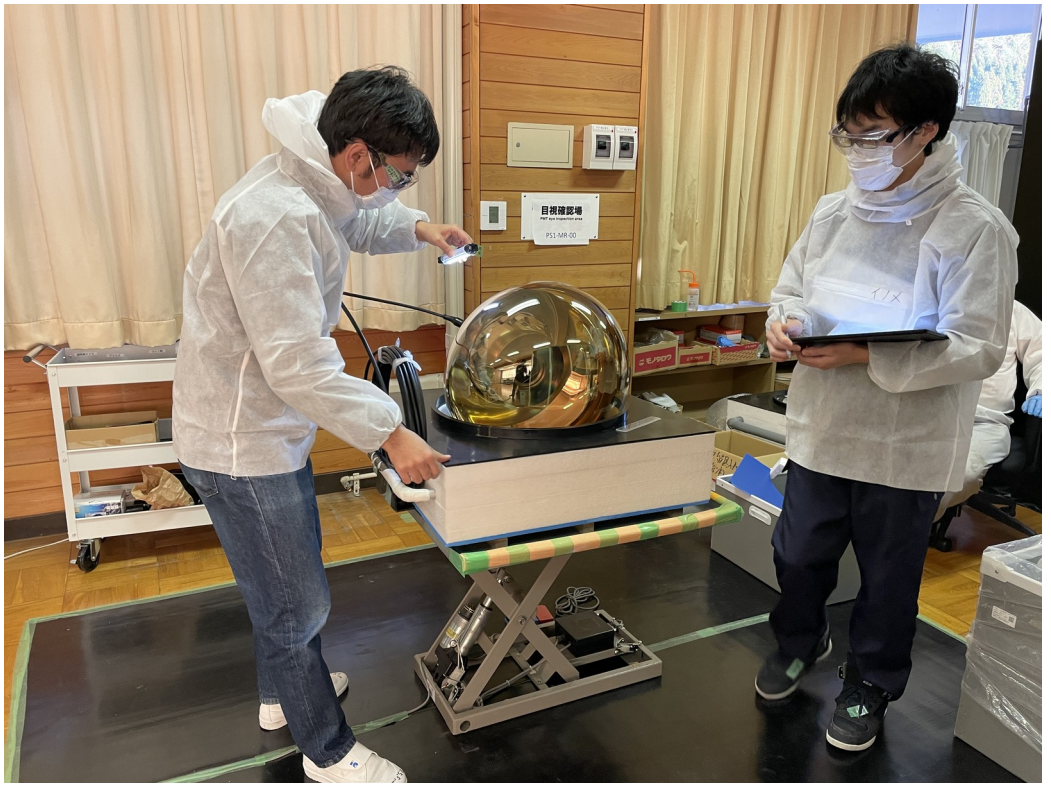
Cavern excavation

- Highlight of 2023 was completion of excavation of dome part (oct 2023)
- Most challenging part and main schedule risk for excavation part
- Cavern for water purification system was also completed
- Excavation of barrel part on-going, will be completed in 2024



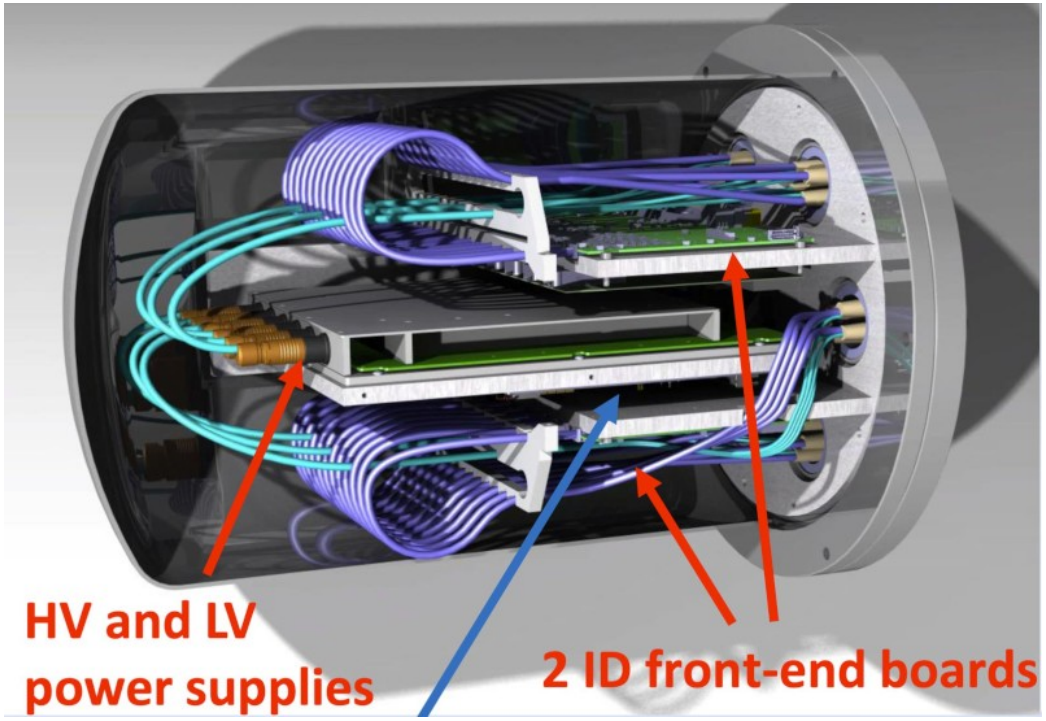
20” Photomultiplier tubes

- 20k high performance 20” PMTs will equip the HK Inner Detector
- One year ago, mass-production was still suspended due to higher than expected failure rate
- New large scale test facility at Kamioka allowed to validate improved PMT design and QC by Hamamatsu Photonics
- PMT delivery restarted in May 2024, with sampling test of delivered PMTs at Kamioka
- >8k 20” PMTs delivered so far, in line to complete delivery by Sep. 2026



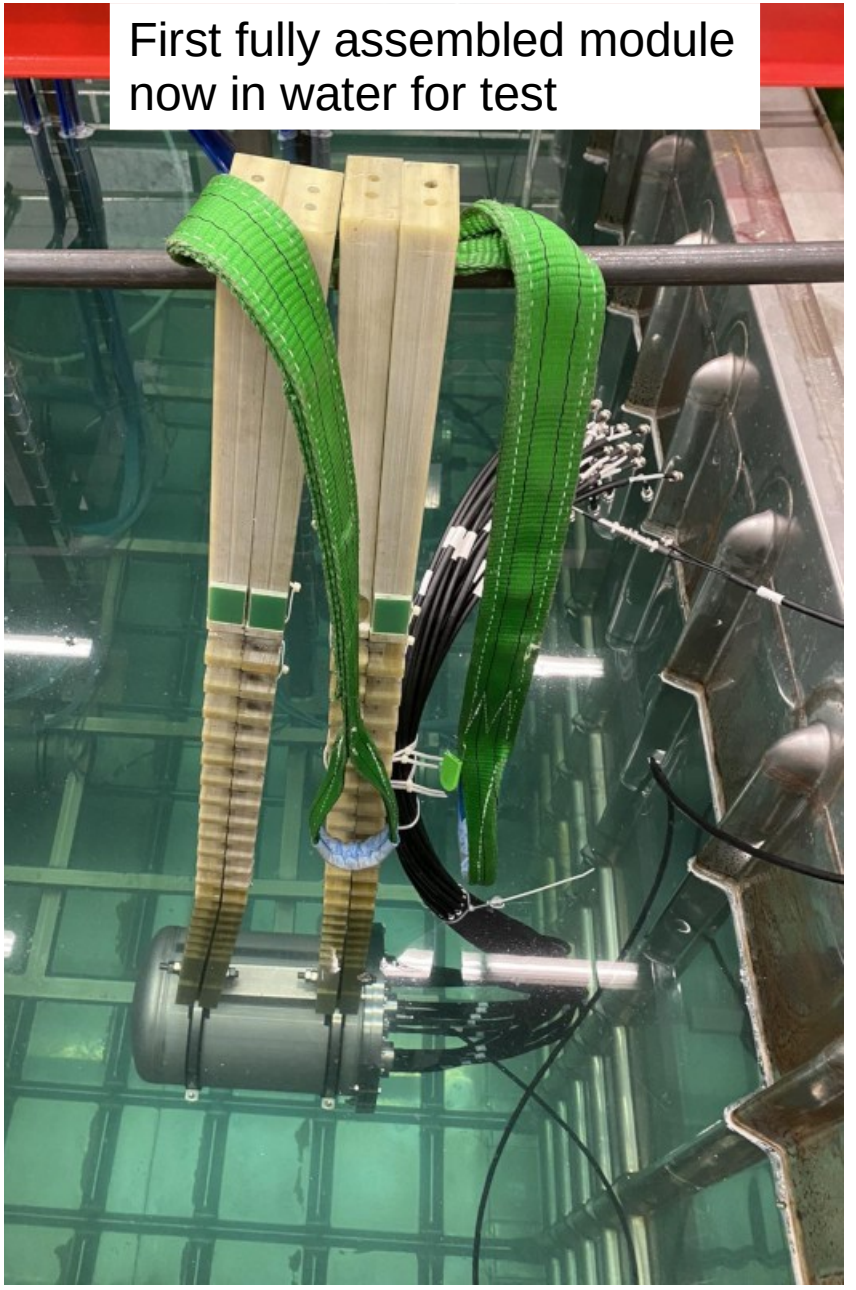
Electronics

- Complex project with different parts produced by different countries
- Electronics will be underwater, in pressure vessels
- Prototypes of all the components are produced, assembled and put in the water and starting evaluation
- Vessel design was fixed and procurement is starting.



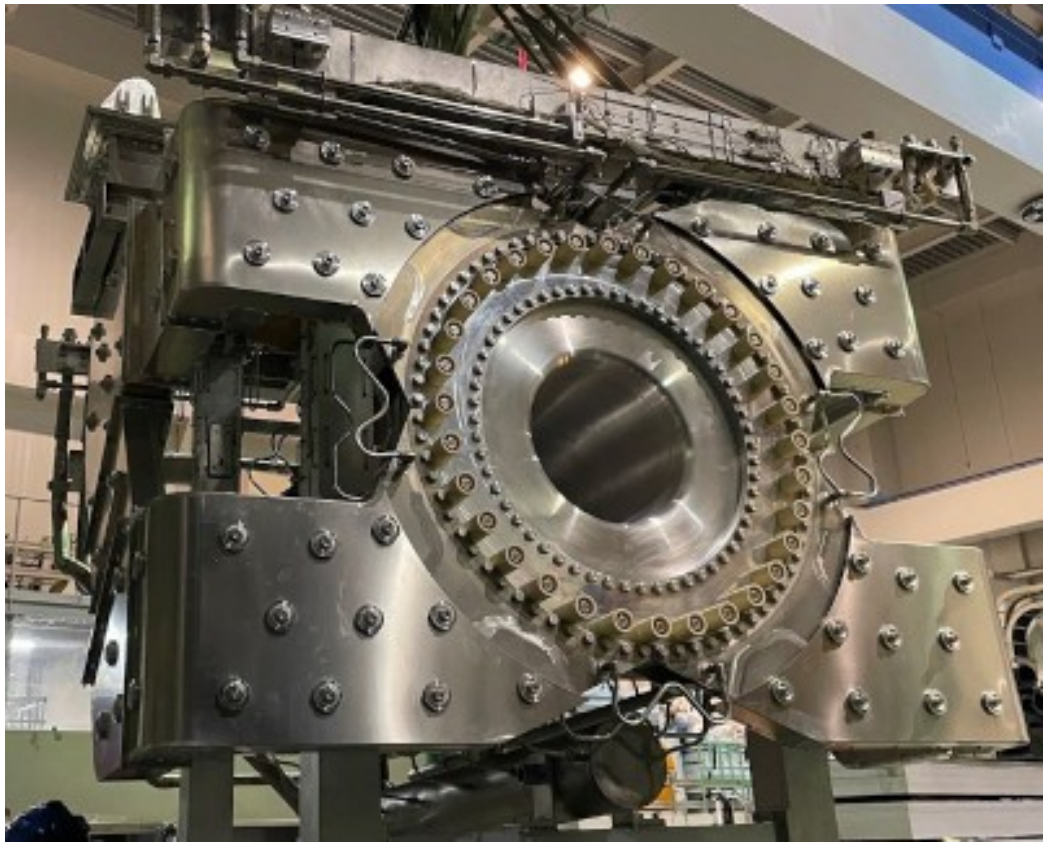
Data processing and timing boards

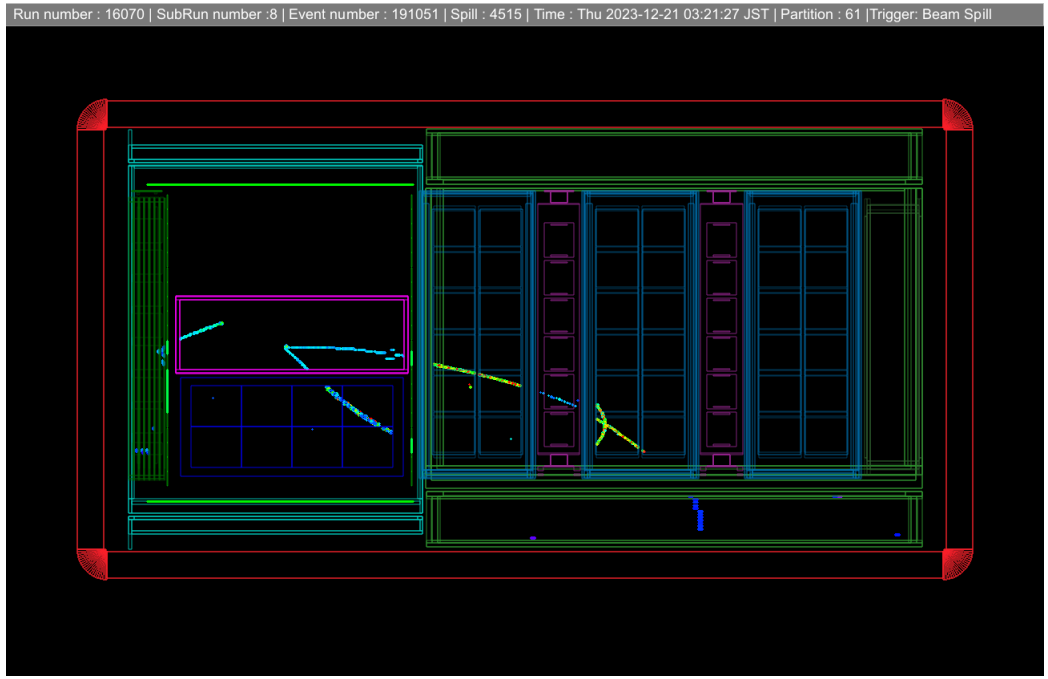
First fully assembled module now in water for test



Beam and near detector

- J-PARC neutrino beamline and near detector currently part of T2K
- Will be key parts of the Hyper-K long baseline oscillation program
- Significant milestones in 2023:
  - Operation at increased beam intensity and horn current following beamline upgrade
  - Installation and first events observed in upgraded near detector ND280

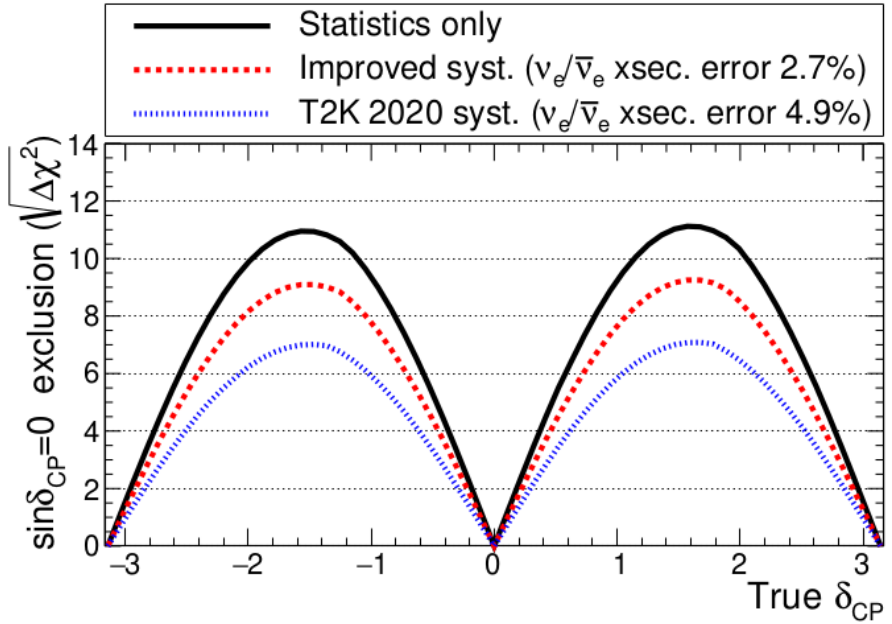




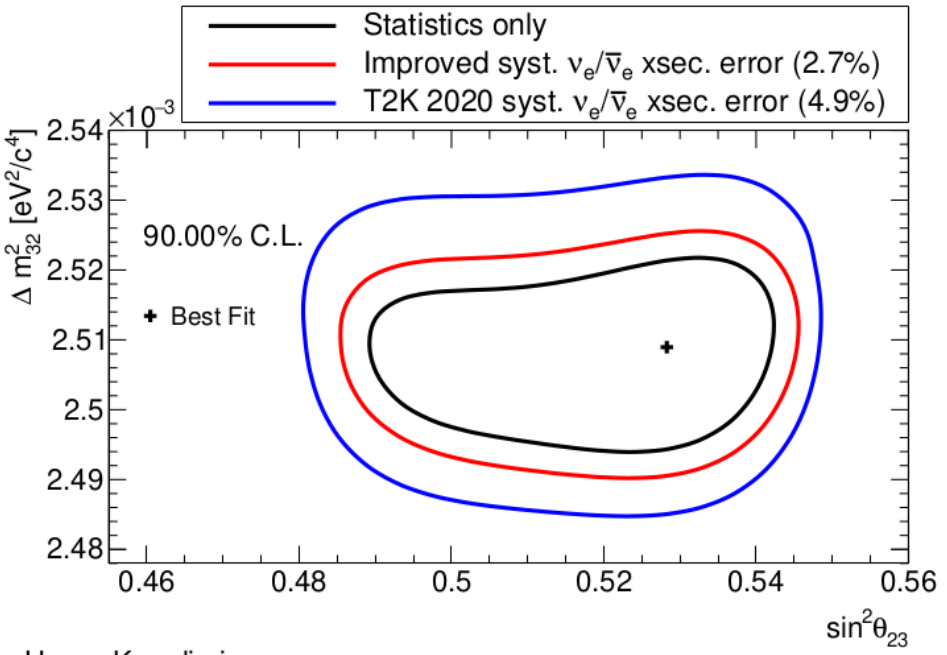
https://www.kek.jp/en/press-en/202401171405/

Updated physics sensitivity

- New sensitivity studies produced for the accelerator neutrino part
- Use more recent version of T2K analysis than previous studies
- Study in particular impact of systematic uncertainties
  Error on $\nu_e/\bar{\nu}_e$ cross-section ratio will be particularly important for CP violation discovery
- Allows to set targets for measurements by near detectors to reach the experiment target sensitivity



Hyper-K preliminary
True normal ordering (known), 10 years (2.7×10^{22} POT 1:3 ν:$\bar{\nu}$)
$\sin^2\theta_{13}$=0.0218±0.0007, $\sin^2\theta_{23}$=0.528, Δm^2_{32}=2.509×10^{-3}eV^2/c^4



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Summary

- The next generation water Cherenkov experiment Hyper-Kamiokande is currently in construction

- Several significant progress in 2023:
  - Excavation of the dome section and water purification system room completed
  - Restart of the delivery of 20” PMT, with large scale testing for QA
  - Final prototypes for several parts of the electronics, and start of integrated tests
  - Start of data taking with upgraded neutrino beamline and near detector in T2K
  - Updated sensitivity studies looking at the impact of systematic uncertainties