Hyper-K
Liner and PMT Support

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for the Cavity and Tank WG

HK 2nd Open Meeting, Jan. 14th, 2013

Outline

- Introduction

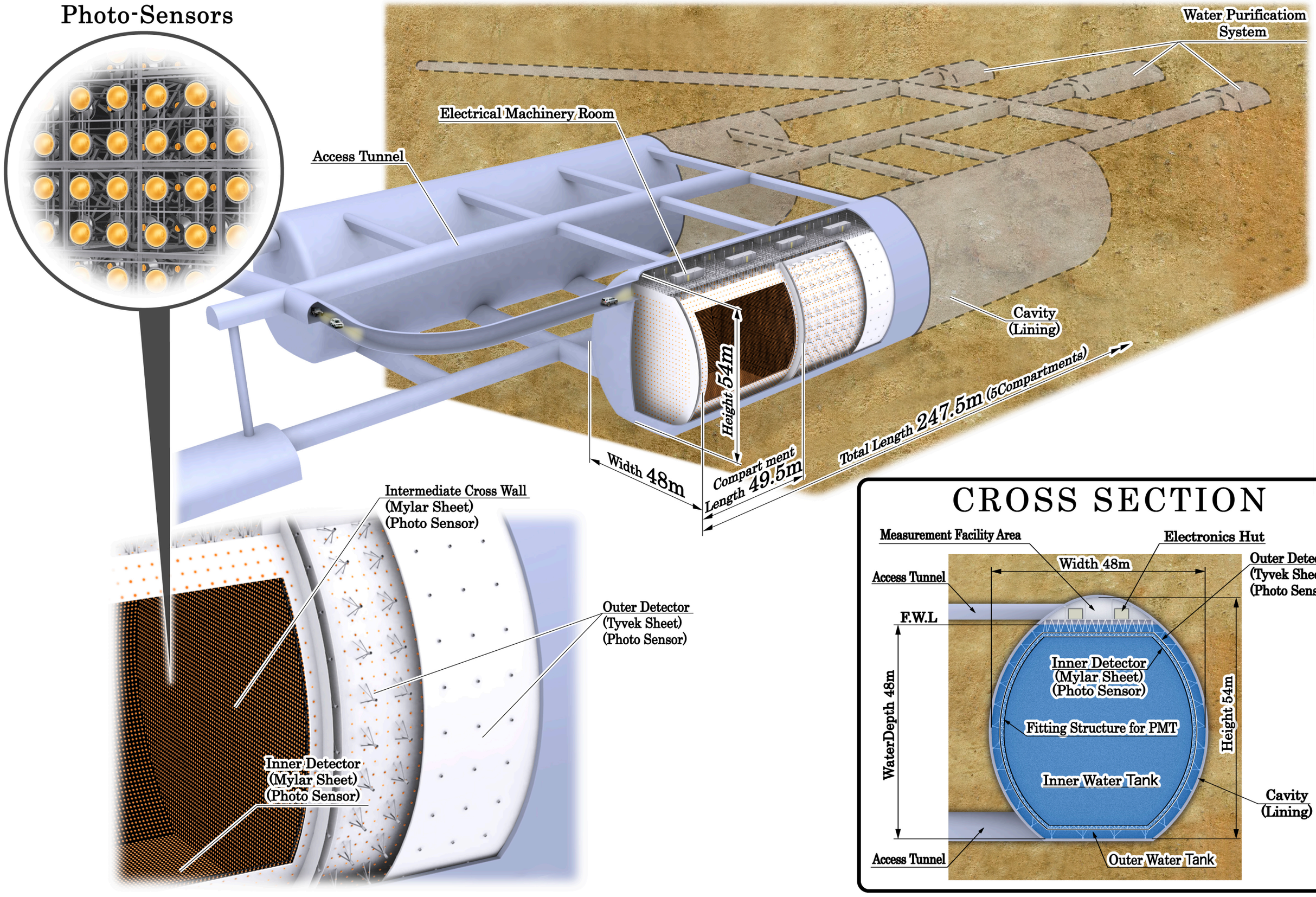
- Updates from the last meeting
  - Water piping, cable layout of online system, calibration holes, manholes

- On-going work...

- Discussion
  - HK tank compartments / segmentation walls

Introduction

Schematic View of the Hyper-Kamiokande



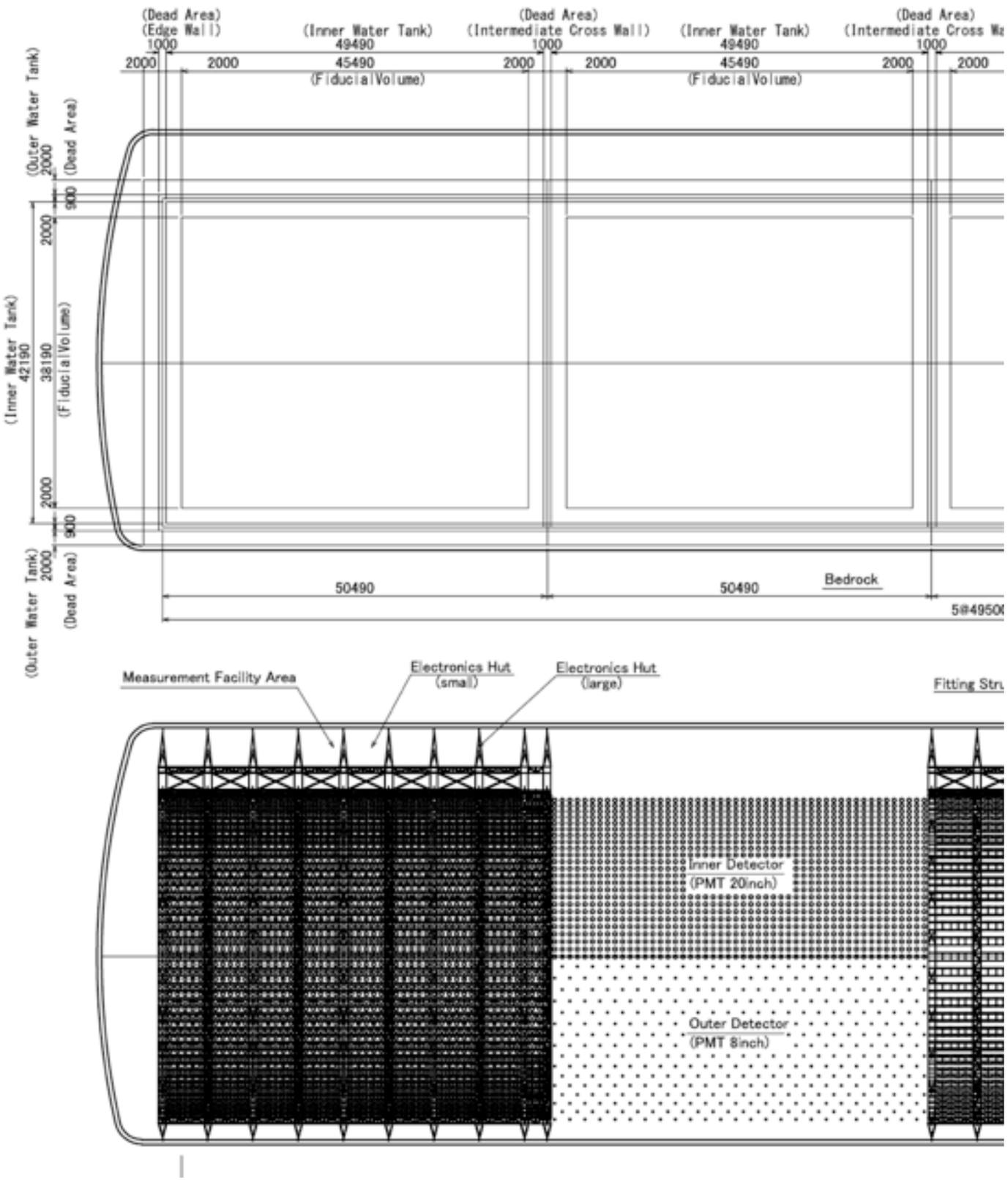
Key parameters on the baseline design

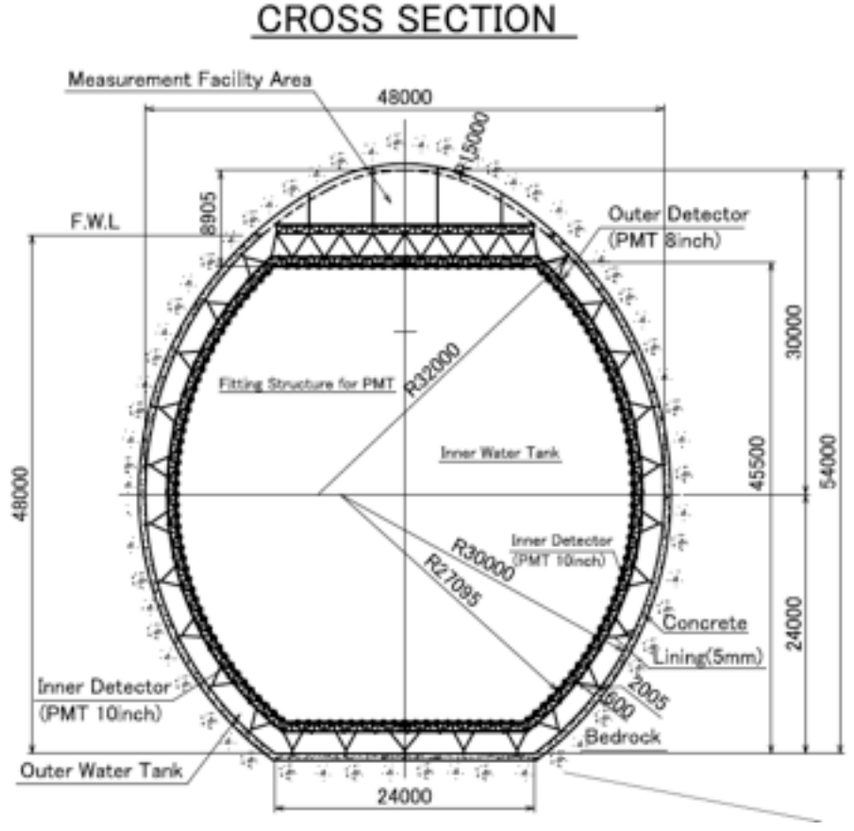
- Depth of tank water: 48m
- Cavern size: 48m(W) x 54m(H) x 250m(L) x 2 caverns
- Optically separated compartments: 5x2 = 10
- Water Volume:
  - Total: 0.496x2=0.992 Megaton
  - ID volume: 0.74 Mton
  - Fiducial Volume: 0.056x10 = 0.56 Mton (25 x Super-K)
- PMT
  - ID: 99,000 20" PMTs (20% photo-coverage)
  - OD: 25,000 8" PMTs (same coverage as SK)

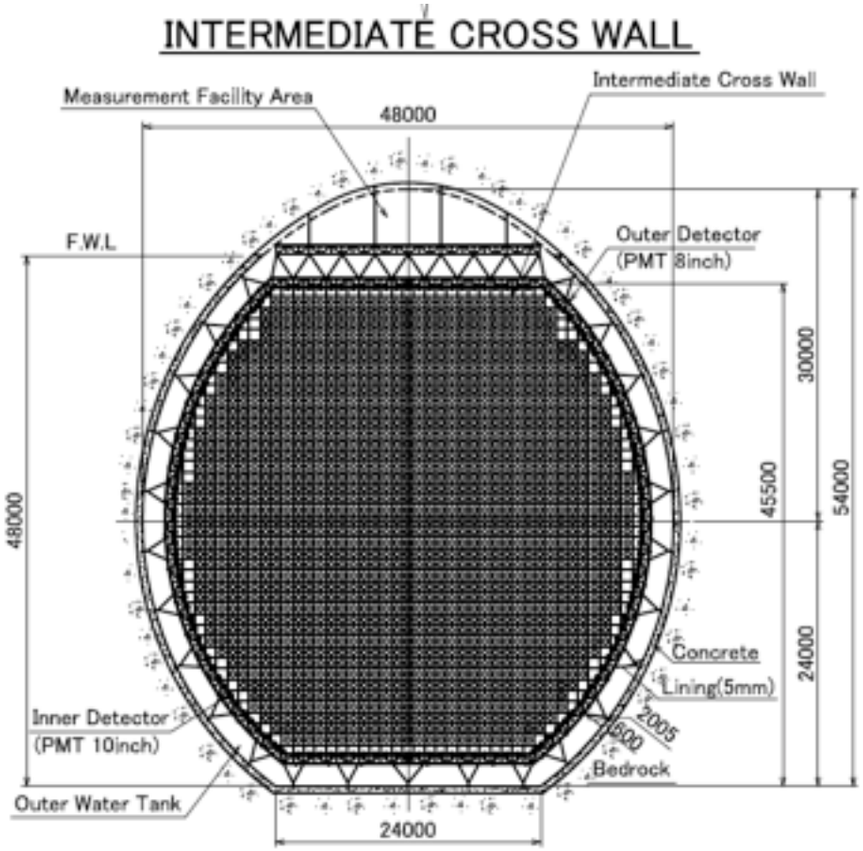
Conditions for the PMT support design

	Parameters	Remark
PMT total weight	Inner (20”): 29.8kg Outer (8”): 3.7kg	Everything around PMT (PMT, housing, cable, mounting parts, etc.)
PMT cable	Inner: 10m long, 2kg Outer: 10m long, 2kg	Cable from hub to PMT
PMT housing	[Inner] Housing weight: 15kg, Mounting parts: 0.35 kg, Buoyancy: 2.5kg	
	[Outer] No housing	
Network/ Power cable	Inner: 10m long, 2kg Outer: 10m long, 2kg	Cable between hubs
Hub	Dimension: 500x500x150, Weight: 5kg Buoyancy: 37.5kg	

Drawing of the tank







Updates from last mtg

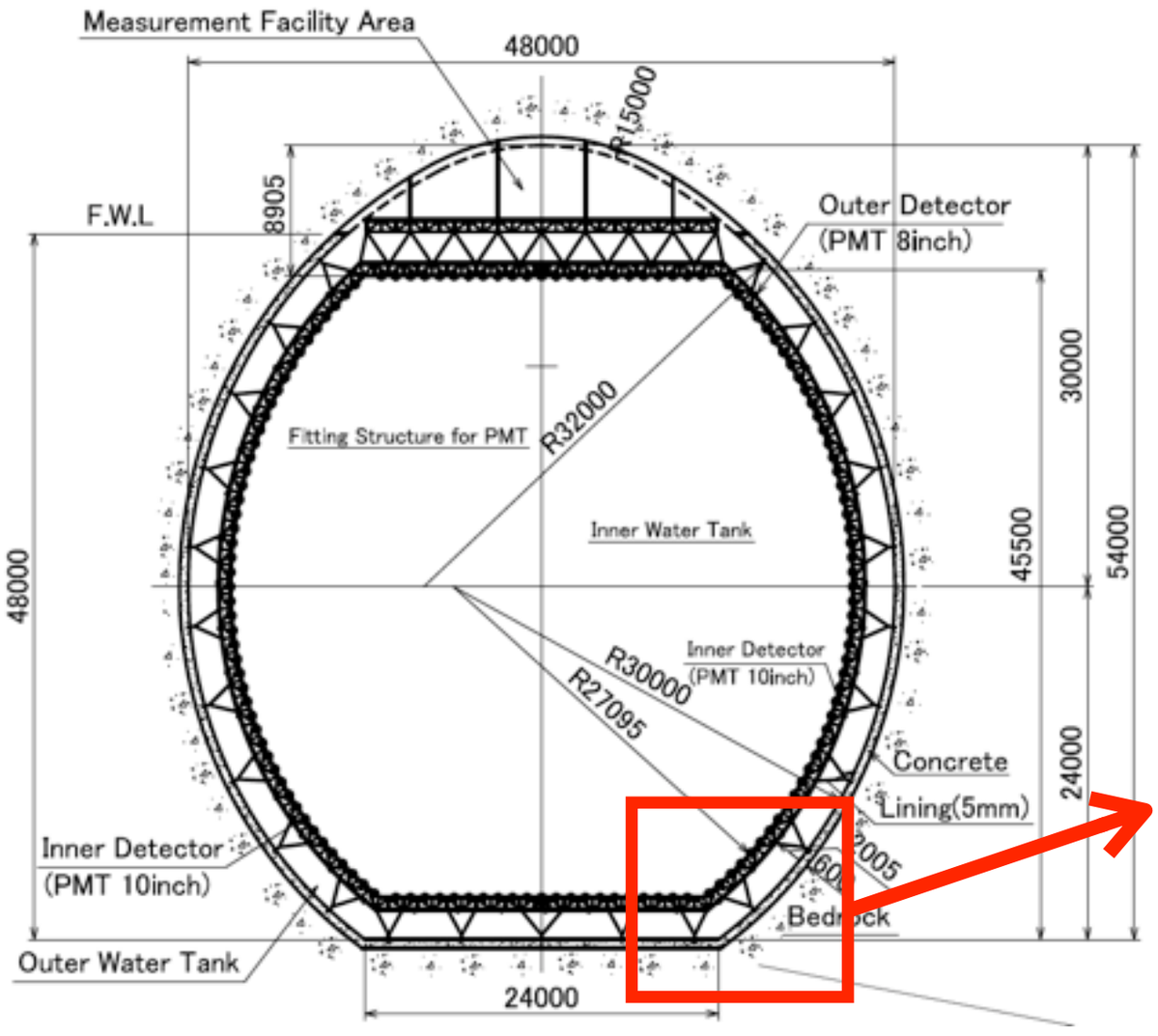
- Deck load capacity defined to be 100 kg/m^2 at safety-factor 2.0 (consistent with SK)

- Preliminary design
  - PMT layout (inner and outer detectors)
  - Online system layout (cable, electronics),
  - Water pipe layout,
  - Calibration holes,
  - Manholes

PMT layout

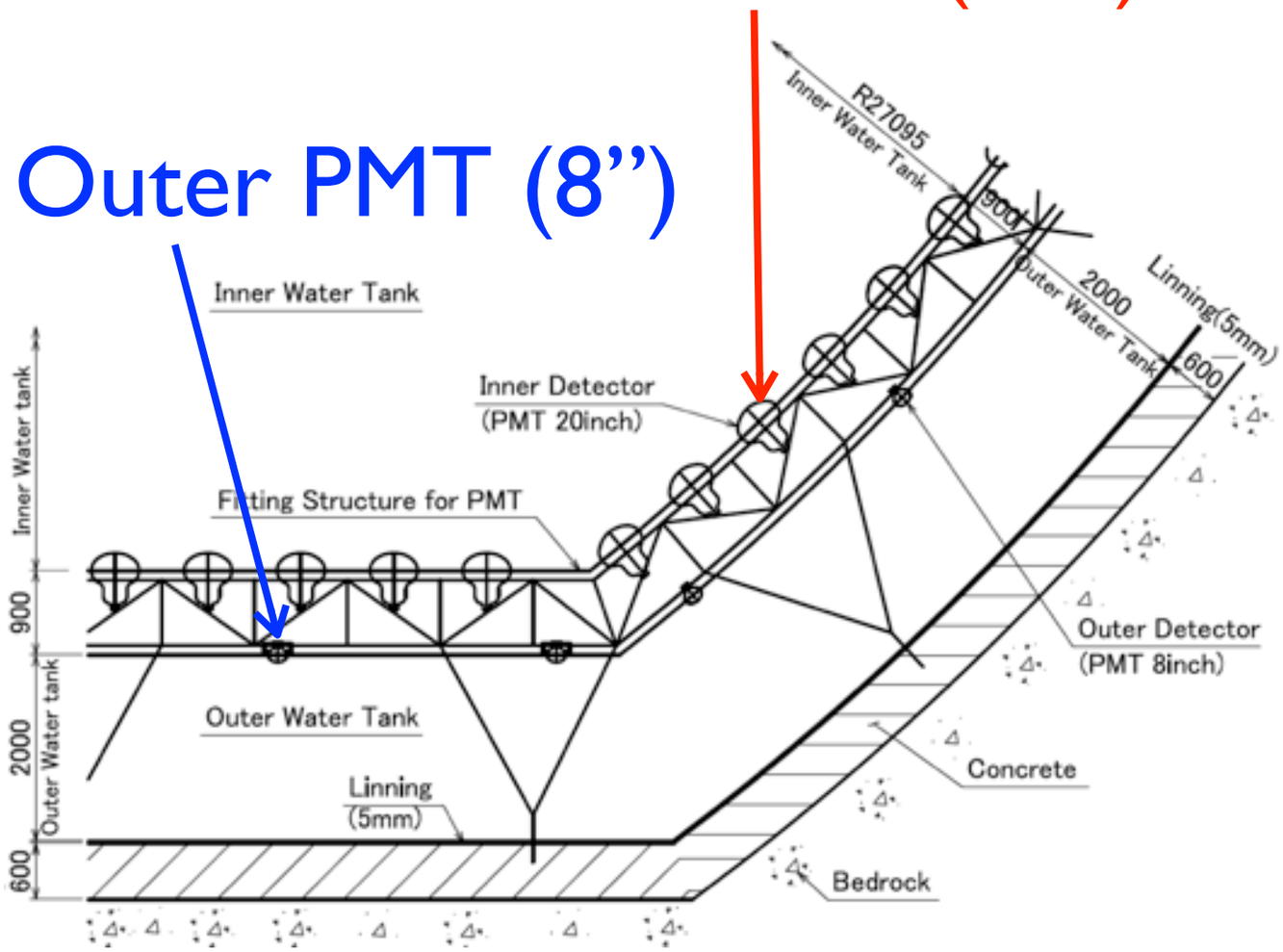
PMT layout

- Number of PMTs
  - ID: ~99,000 of 20” PMTs (20% photo-coverage)
  - OD: ~25,000 of 8” PMTs (same coverage as SK)



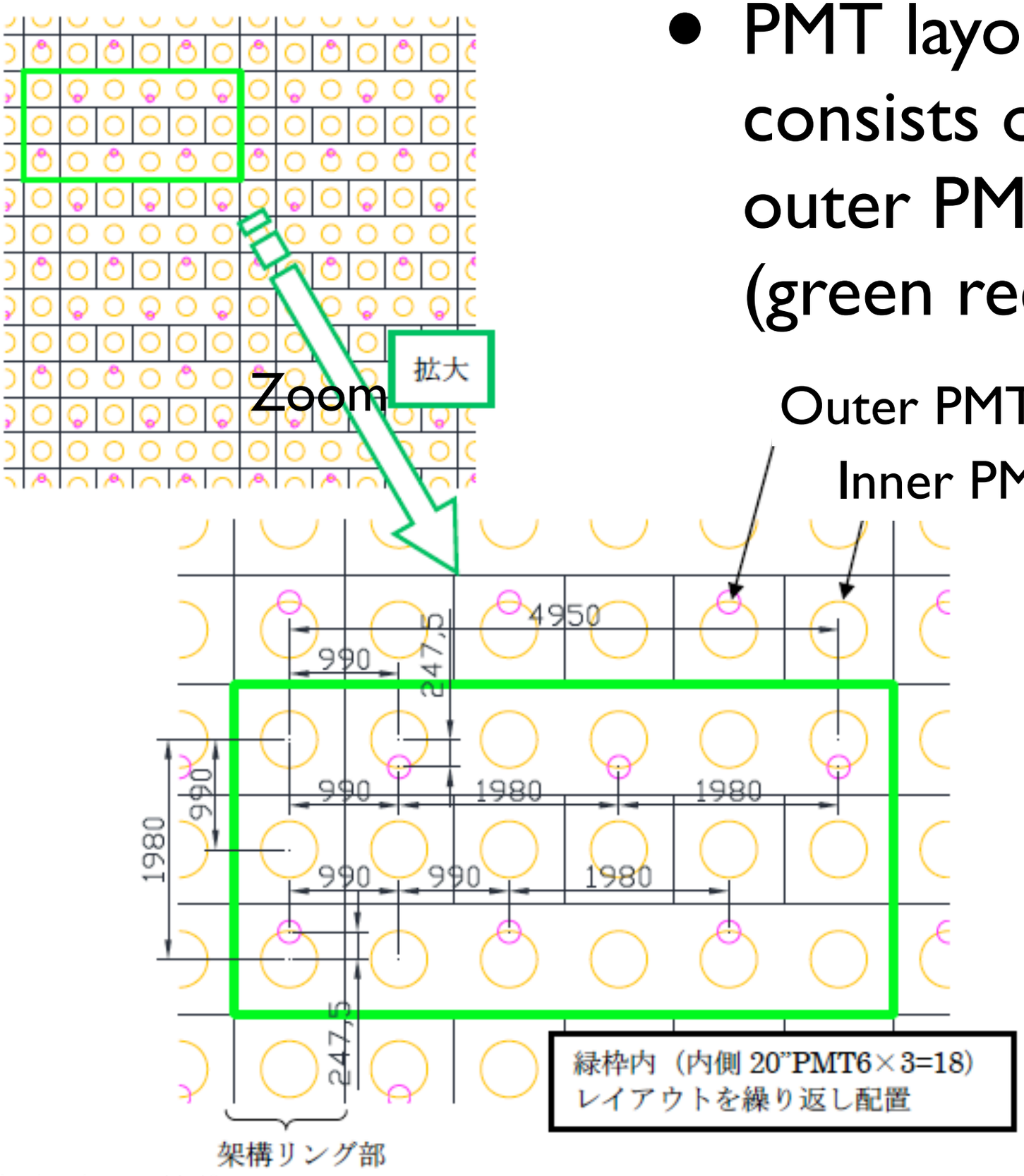
Inner PMT (20”)

Outer PMT (8”)



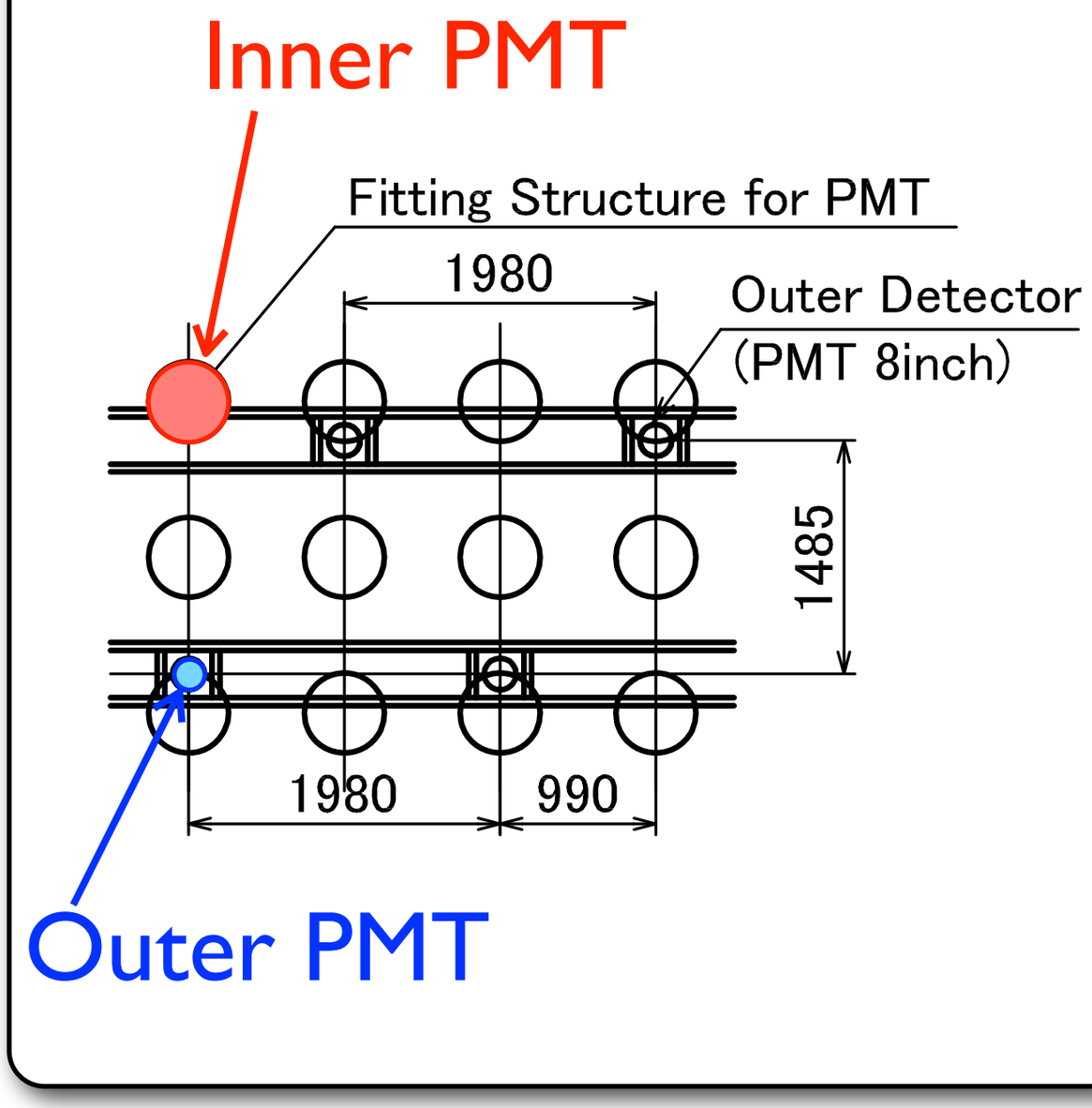
PMT layout

- PMT layout defined by a pattern consists of 18 inner PMTs and 6 outer PMTs
(green rectangle in the figure)

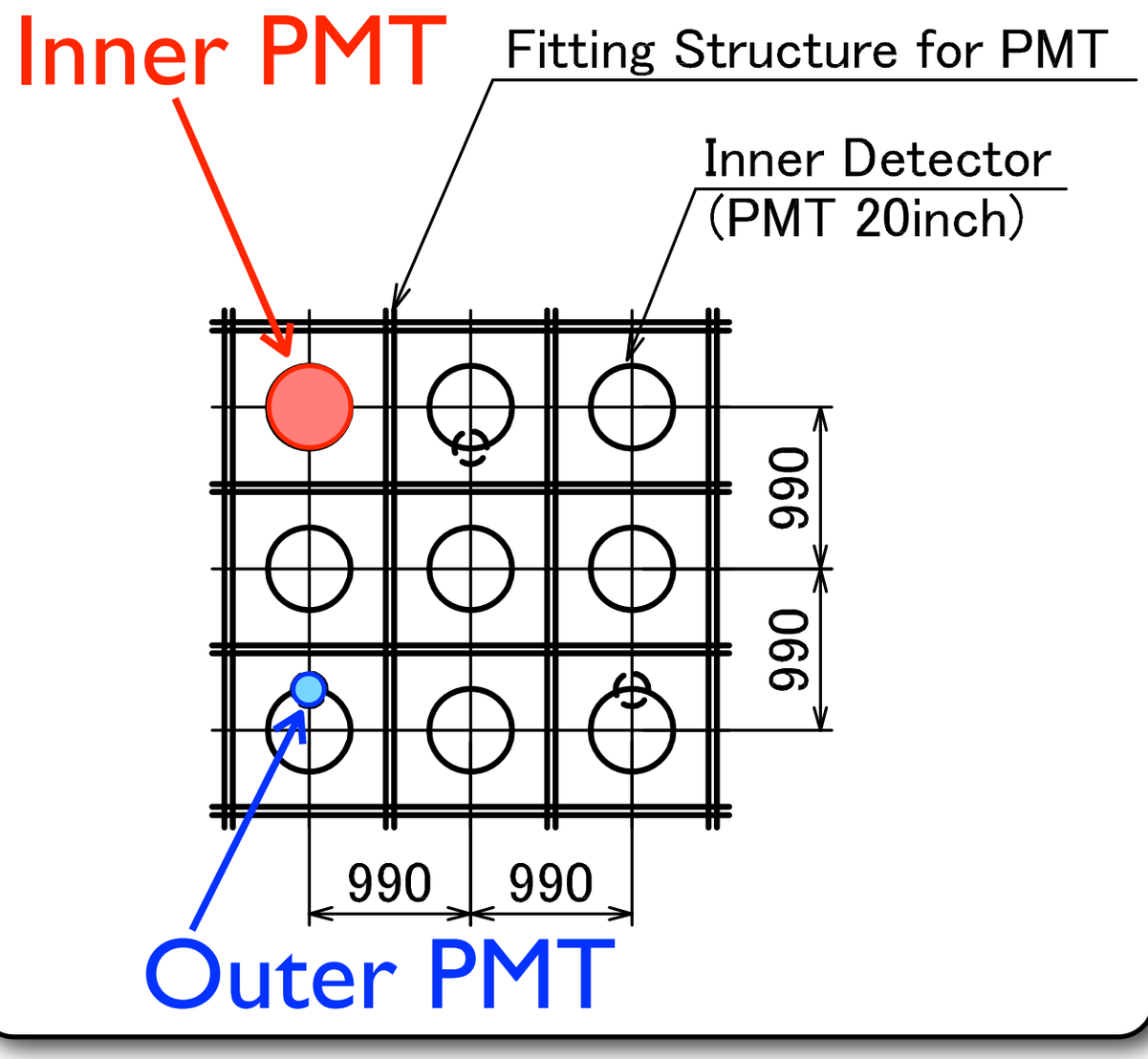


Dimensions of PMT layout

Barrel



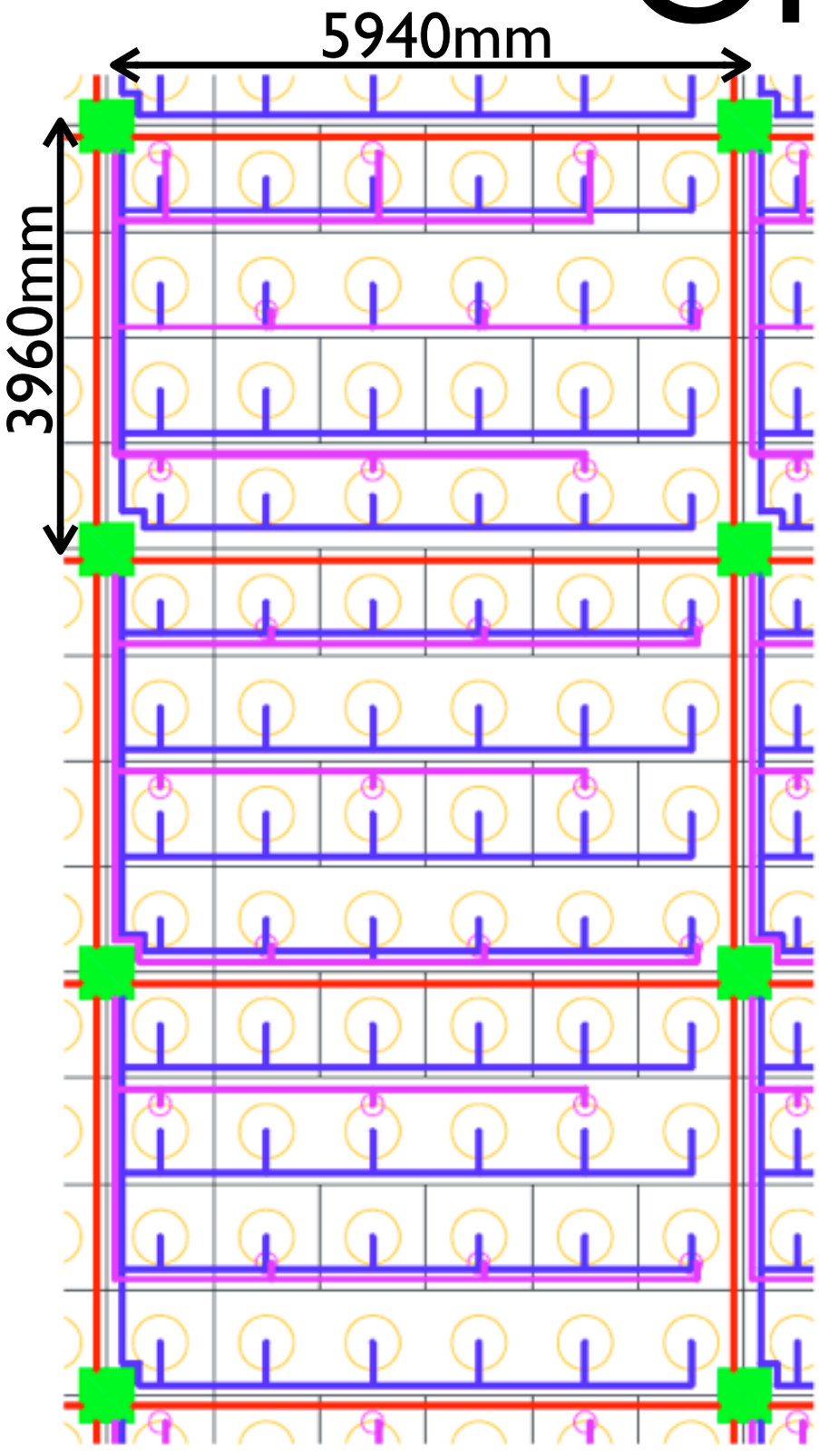
Segmentation Wall



- Inner PMTs (20”): 990 mm apart
- Outer PMTs (8”): 1980 mm / 1485 mm apart

Online System

Cables routing for Online System



: Cable for inner PMT

: Cable for outer PMT

: Network/Power cable

: Hub / Front End Electronics

: Inner PMT (20”)

: Outer PMT (8”)

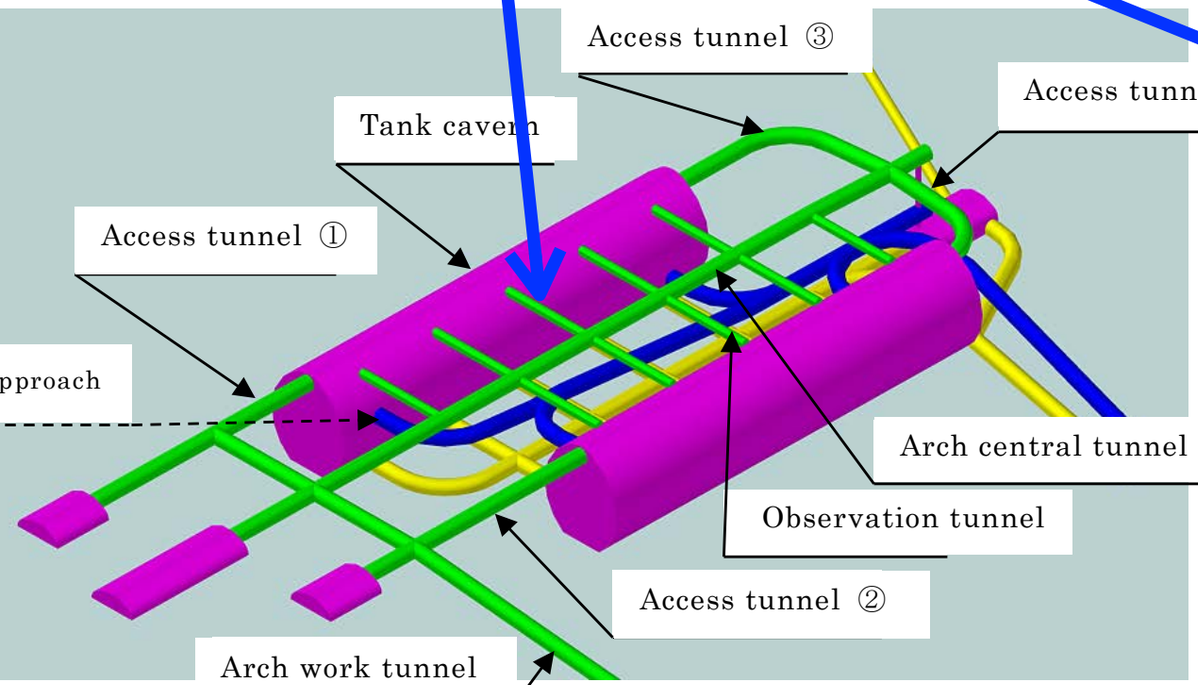
One hub can handle 24 PMTs.

Hubs are daisy-chained by network/ power cables to reduce the number of cables come out of tank.

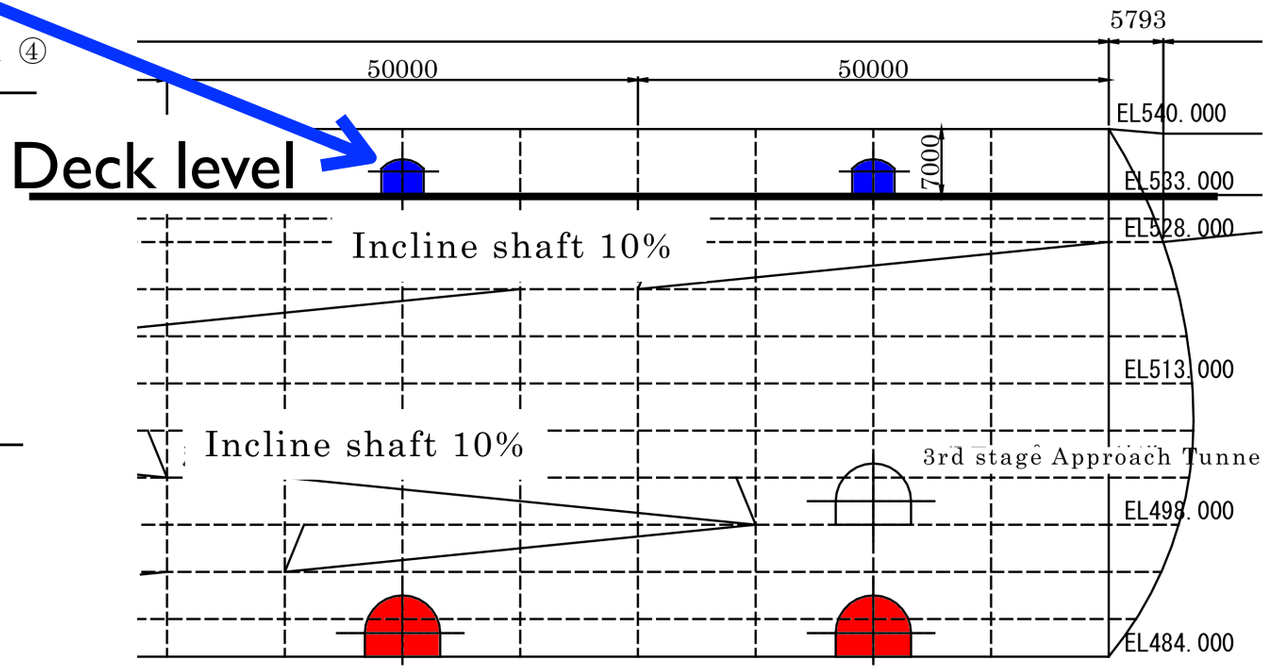
Electronics Hut

- Electronics huts are in "Observation Tunnels"
  - No electronics hut on the deck

Observation Tunnels



Side view of the tank



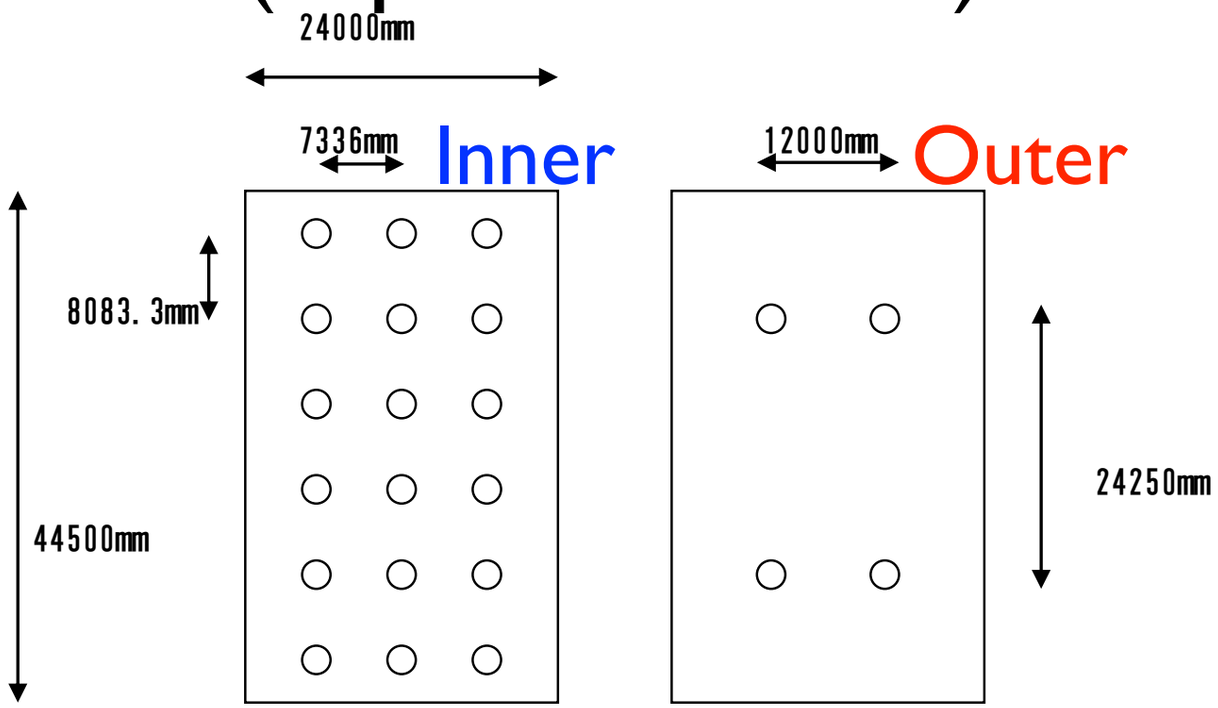
Observation tunnels are connected to the deck. Each compartment has one Observation Tunnel where the electronics/computers are installed.

Water Pipe

Water Pipe Layout

- Water inlet on bottom and outlet on top
- Inlets/outlets on barrel give additional control of water flow
- Number of water pipes / compartment
  - Inner Detector
    - Top (outlet): 18, Bottom (inlet):18, Barrel (inlet/outlet): 30 x 2
  - Outer Detector
    - Top (outlet): 4, Bottom (inlet): 4, Barrel: (inlet/outlet): 10 x 2

Inner and Outer pipe layout (top and bottom)



Barrel pipe layout

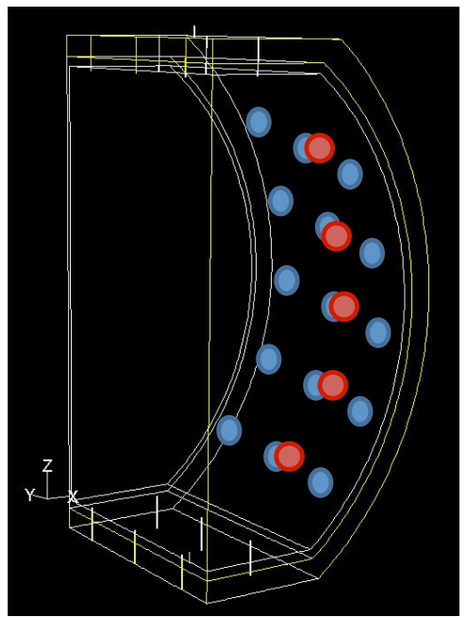


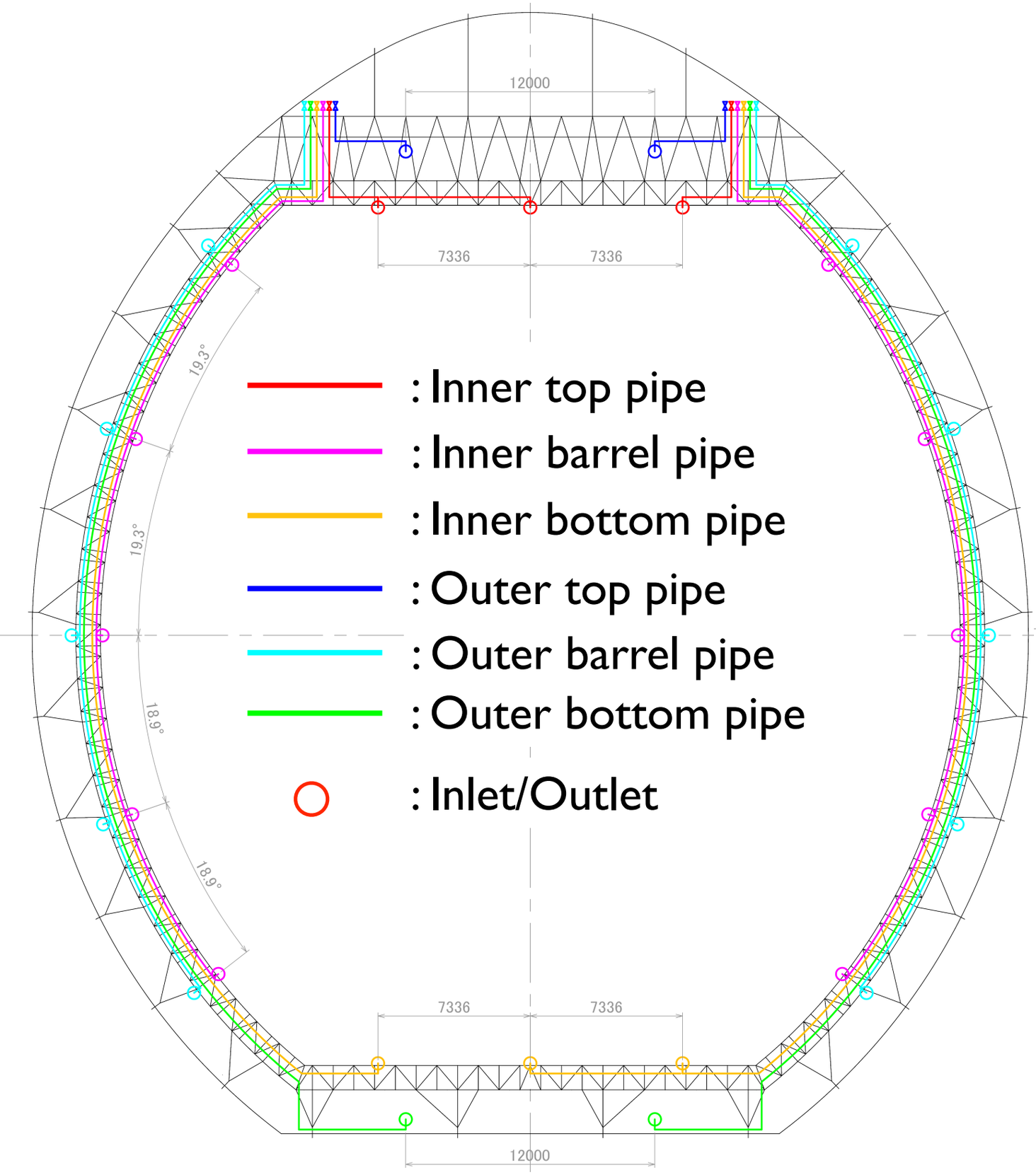
Figure shows 1/4 of a compartment

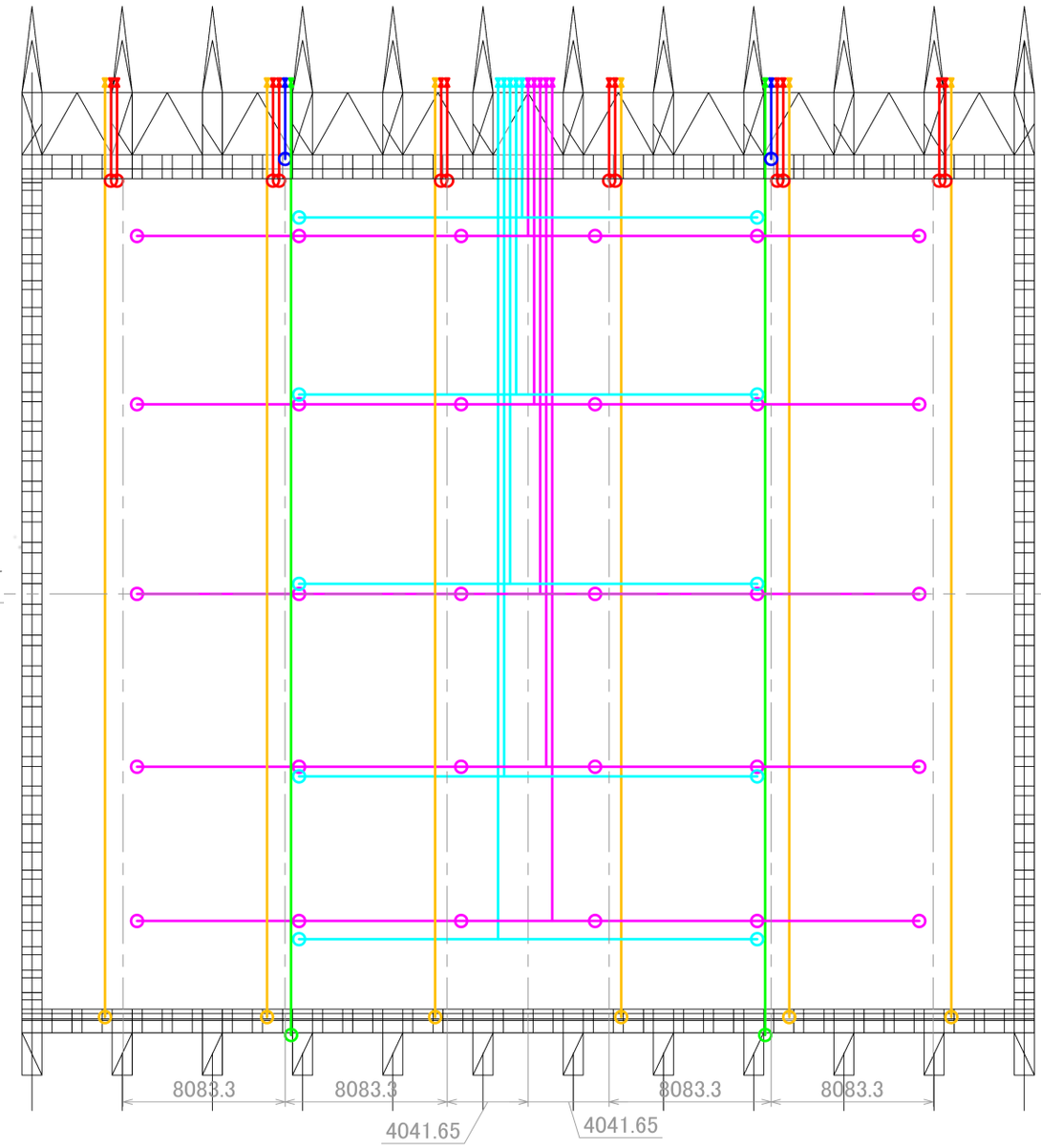
Inner: 8083.3 mm apart in z-dir

Outer: 24250 mm apart in z-dir

Water Pipe Routing

Water pipes in barrel
(one compartment)

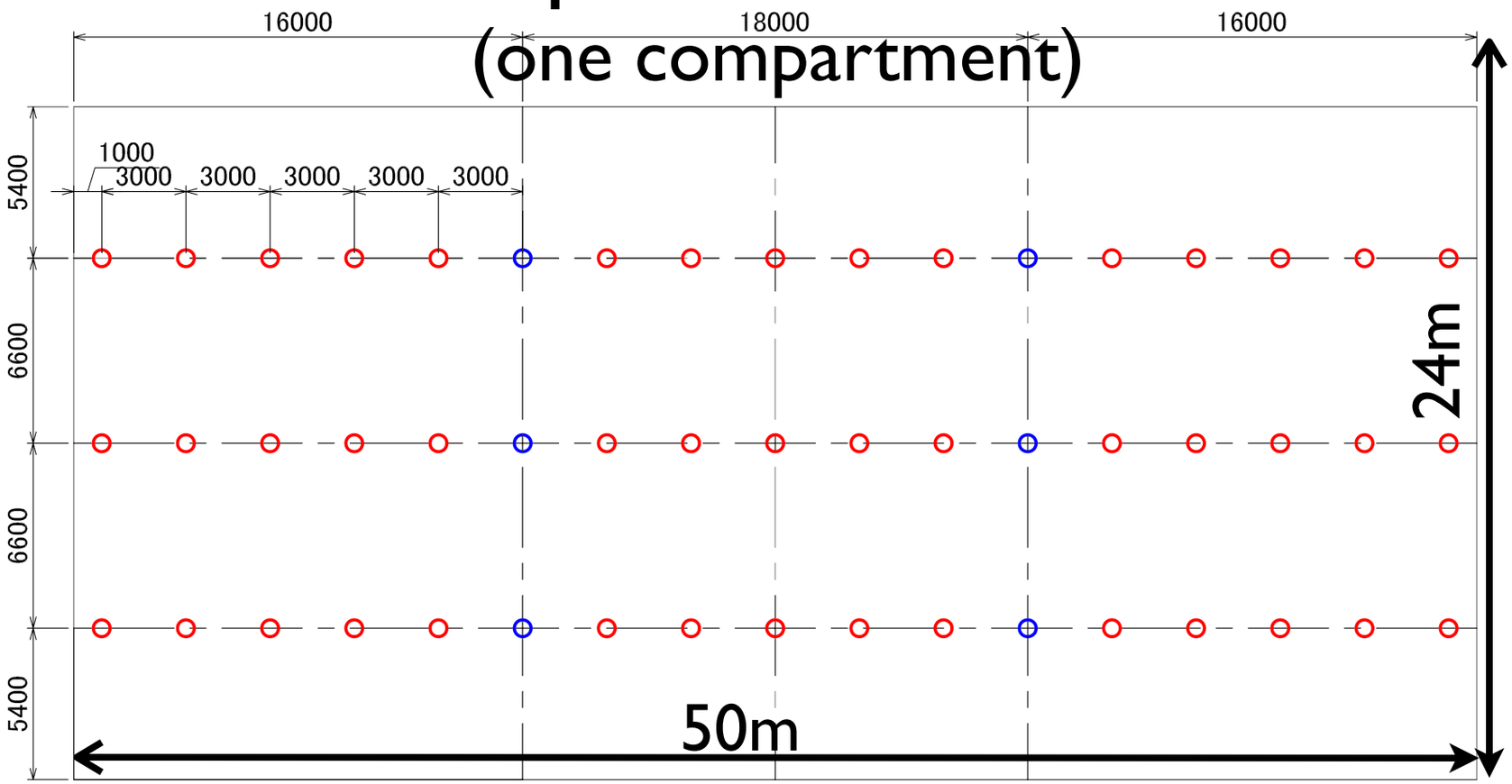




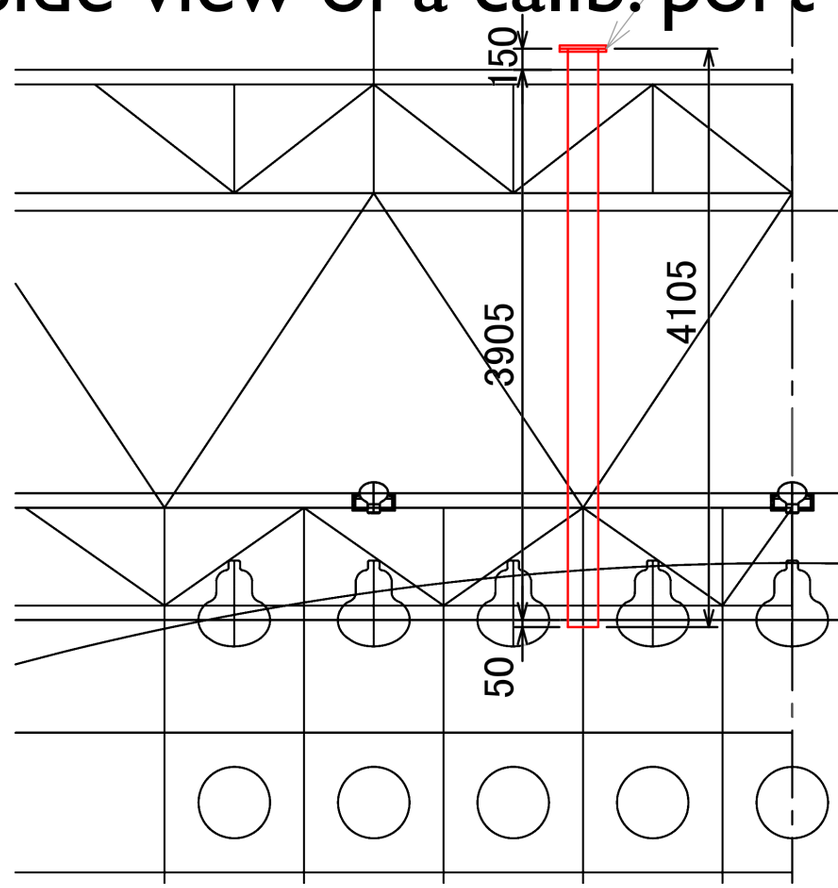
Calibration Holes and Manholes

Calibration hole layout

Top view of deck (one compartment)



Side view of a calib. port



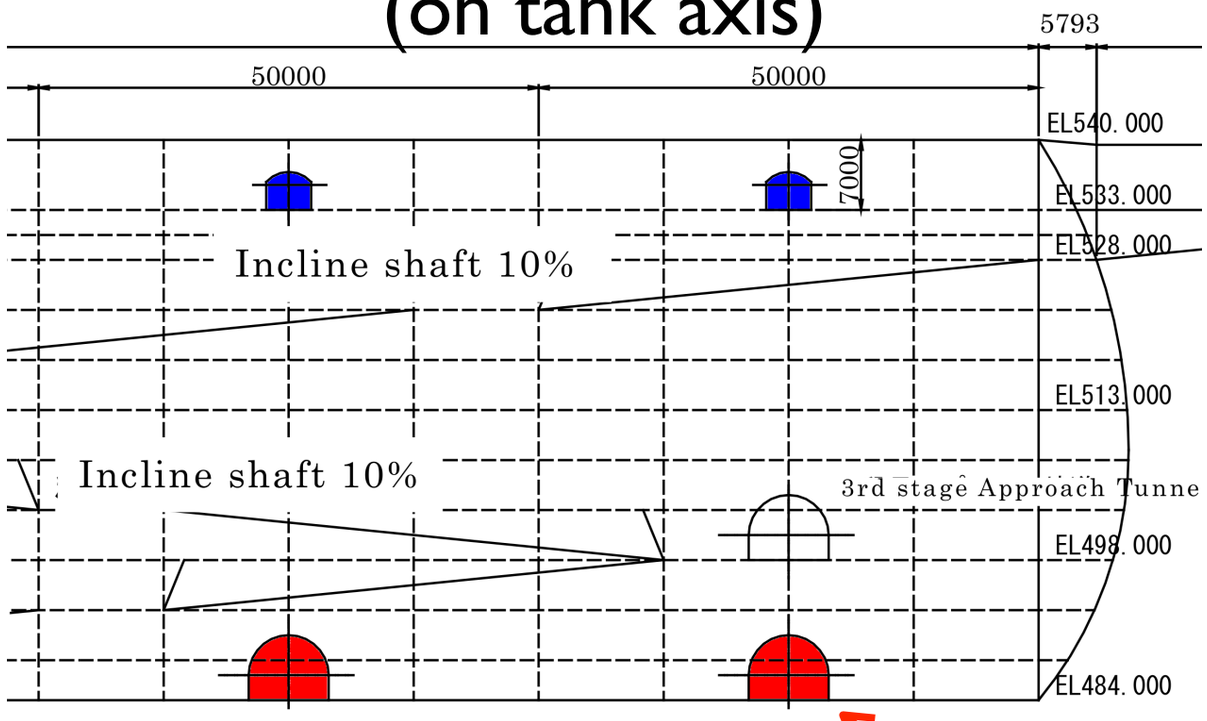
○: Calibration hole
- blue: 1 ton load capacity (for main calib systems)
- red: 100 kg load capacity (for sub/movable calib systems)

- Calibration holes aligned along with tank axis, each hole located 3m apart.
- ~50 calib holes in one compartment.
- Calib nozzle extended into inner detector volume (4m long).
- Hole diameter 22.2cmϕ (identical to SK)

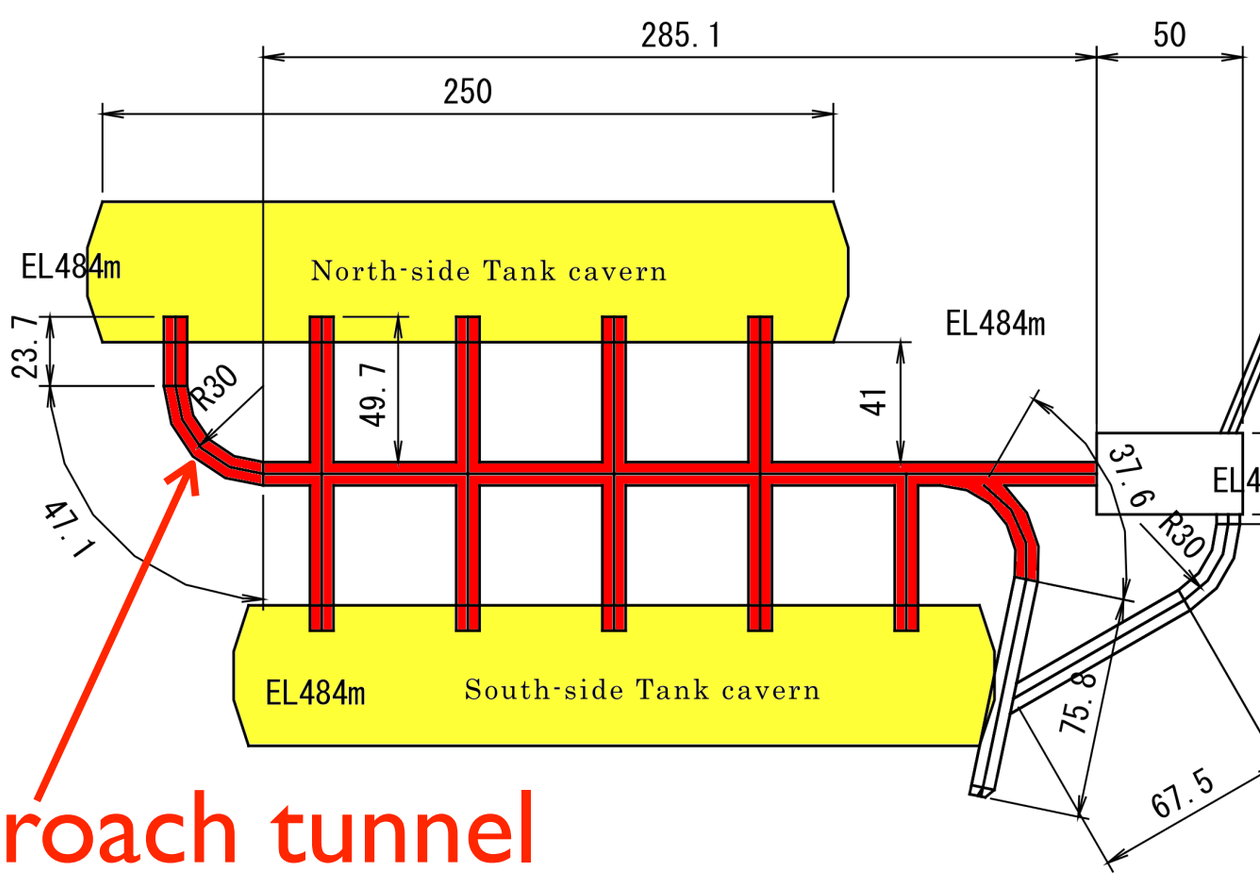
Manholes

- Aimed to use for access inside the tank for maintenance of detector, etc.
- Manholes located at bottom of the tank, and connected to "4th-stage approach tunnel".

Side view
(on tank axis)



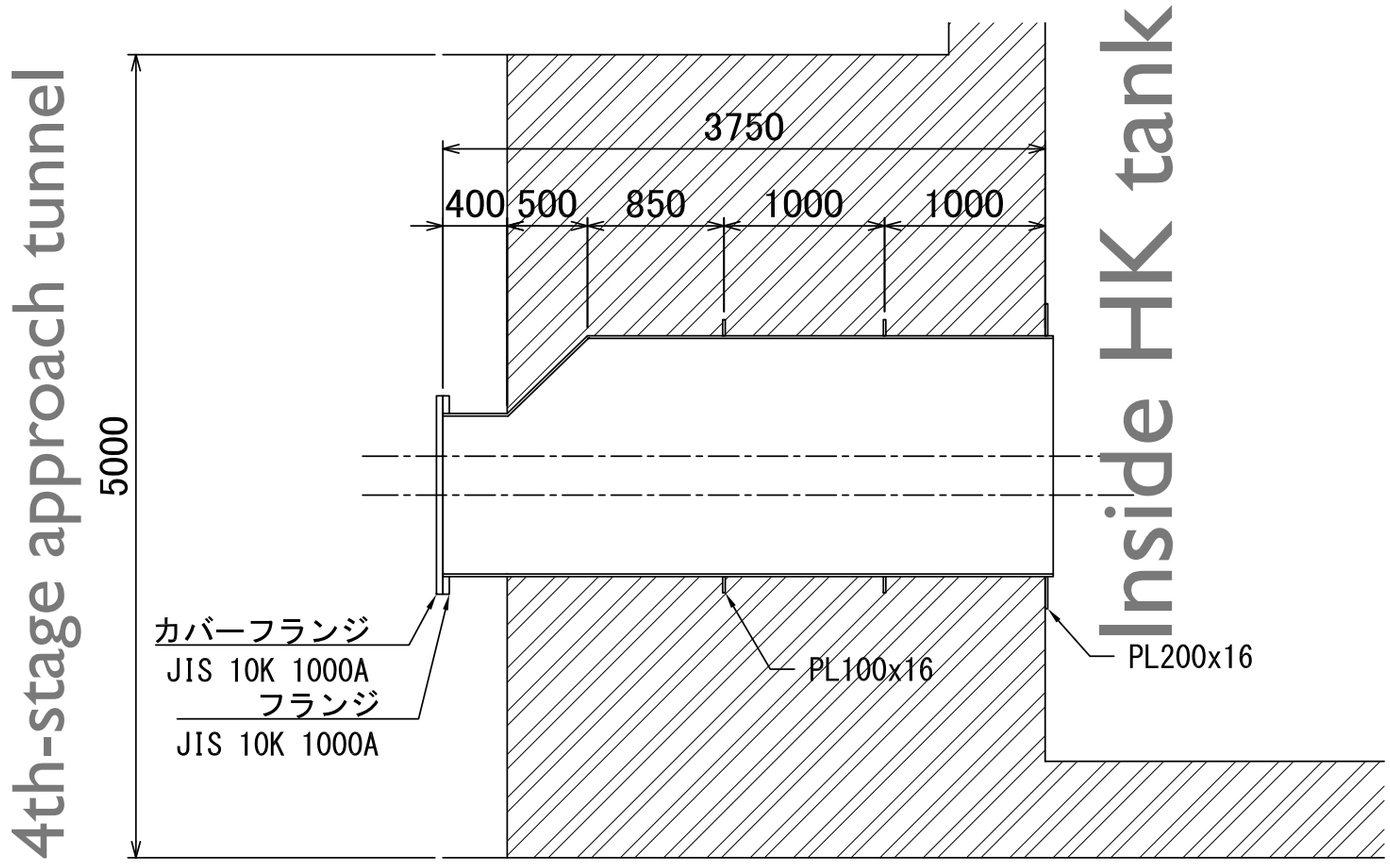
Top view



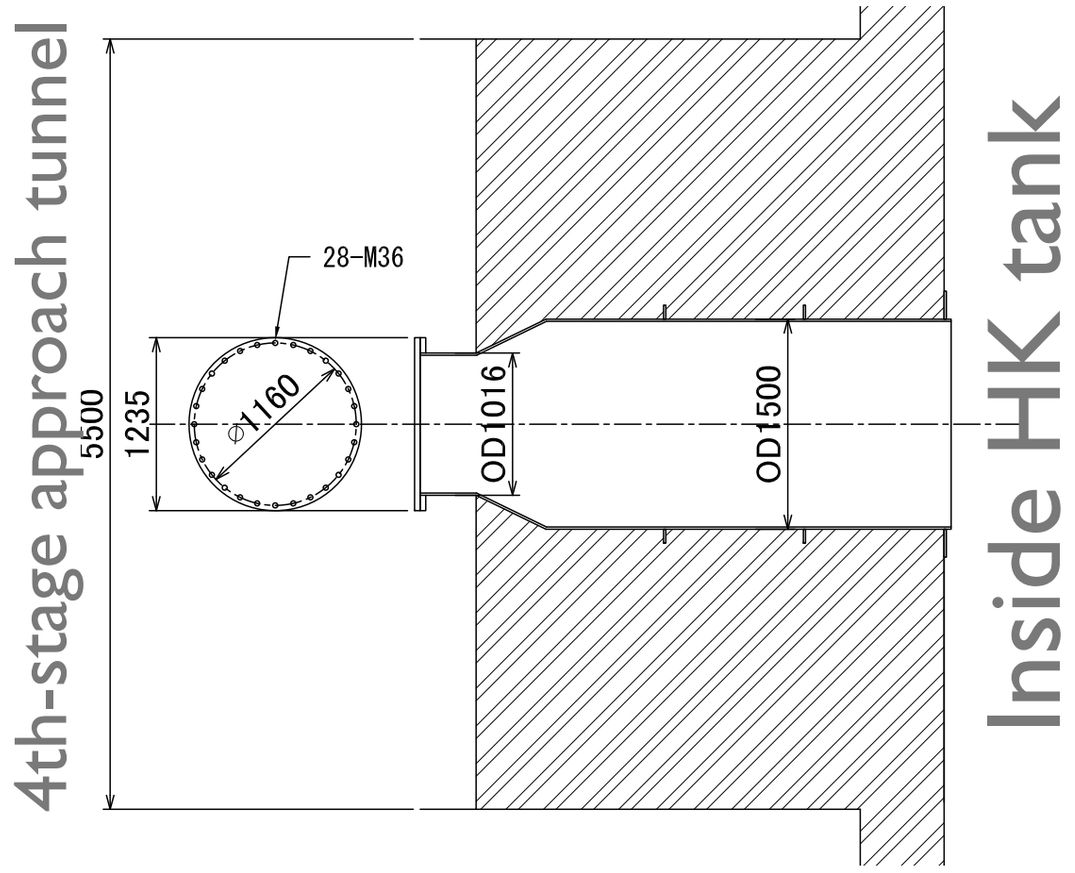
4th-stage approach tunnel

Manhole dimensions

Side view



Top view



- Manhole diameter: ~1mϕ (1.5m at maximum) and ~3.8m long

On-going work

On-going work

- "Wire option" for PMTs support (like LBNE)
  - will be available in a few months
- Tank water leak detection/draining system
  - Note: drain system for water from rock has already been designed.
- PMT housing design/prototype & implosion test

- Establish the details of construction procedure of the tank, and estimate the overall cost.
  - by end of January
- Technical document of the baseline design of tank.
  - Doc. v1 (in Japanese) by end of January

Discussion

Segmentation walls?

- Removing/reducing the segmentation walls is an option to "optimize" the project cost.
- If we remove all segmentation walls, the total PMTs cost is reduced by ~23% (~6 billion yen).
- Also, lead reduction of other costs:
  - Reduce the costs of PMT support structure, PMT housing, readout electronics, cables, and shorten the tank construction schedule (final const estimation will be available in this month)
- ➜ Large impact to the tank construction cost.
- Would start discussion with Physics WGs on whether this can be an option <u>in physics point of view.</u>

Summary

- Details of tank design have been made for:
  - PMT layout, online system cable/electronics layout, water system piping, calibration holes, manholes

- Removing/reducing the number of segmentation walls will make a large impact to the cost of tank construction.
  → Would consider this option seriously.
  ➜ Need physics sensitivity studies.