

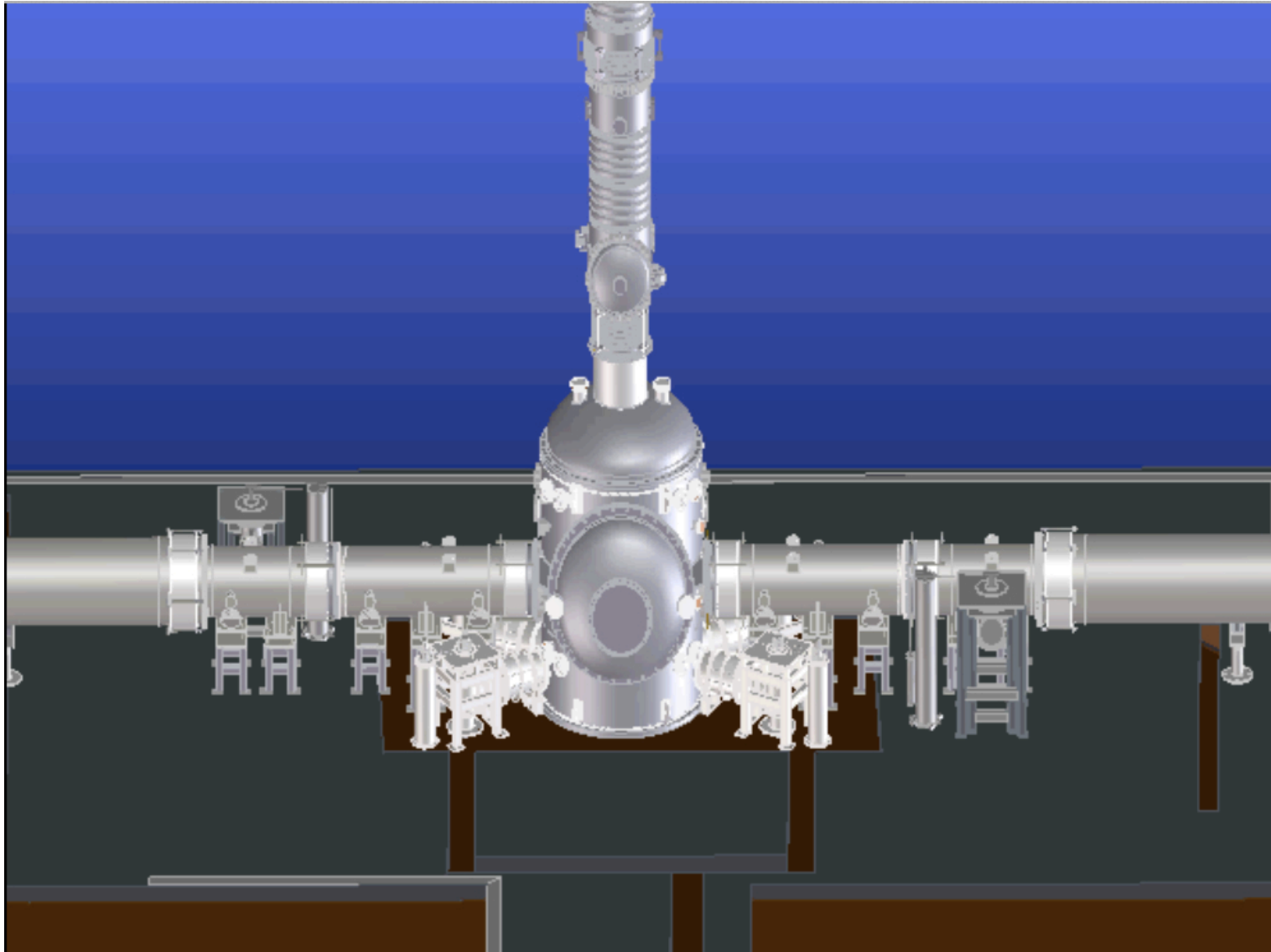
KAGRA cryogenic system installation



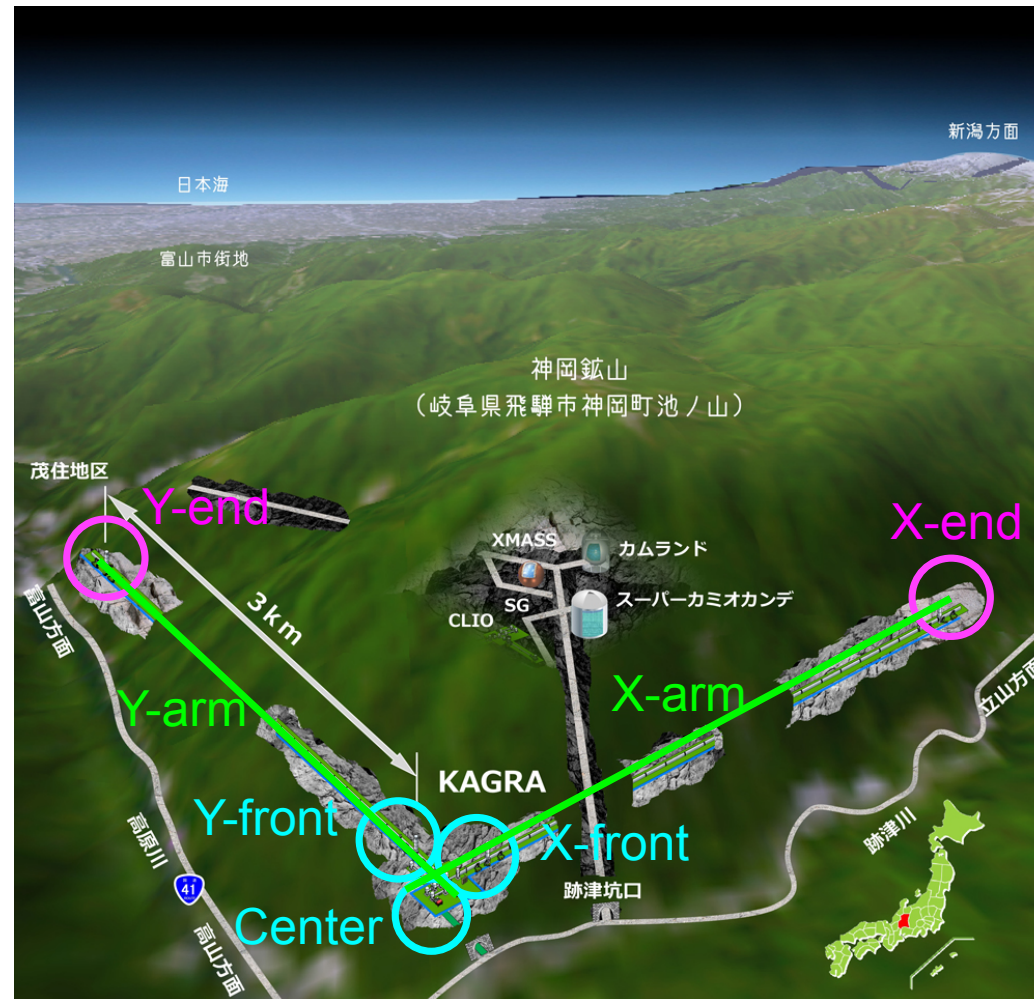
T. Suzuki
KEK / ICRR

2015.02.09
ELITES 3rd Meeting

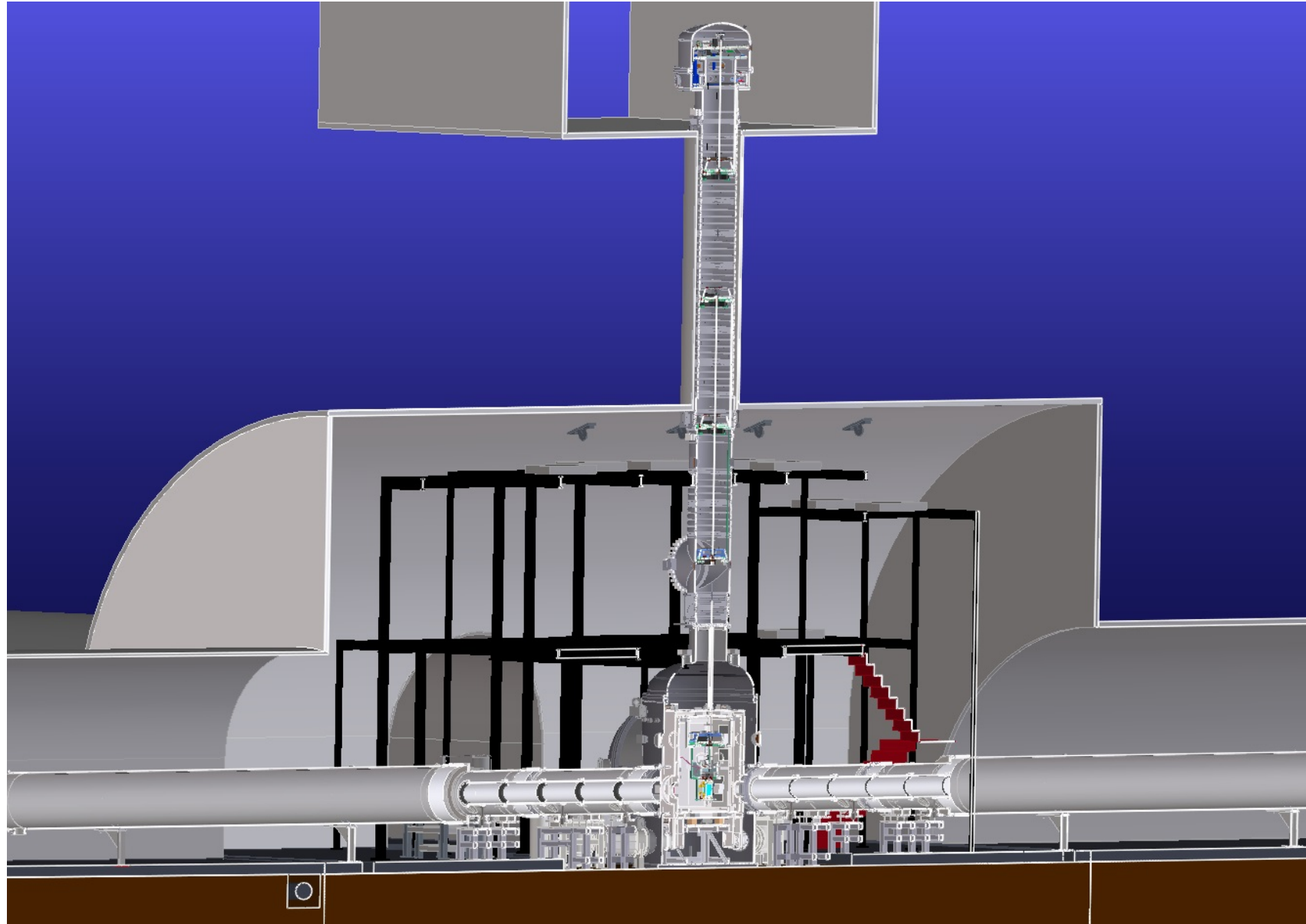
KAGRA Cryogenic Instruments External Appearance



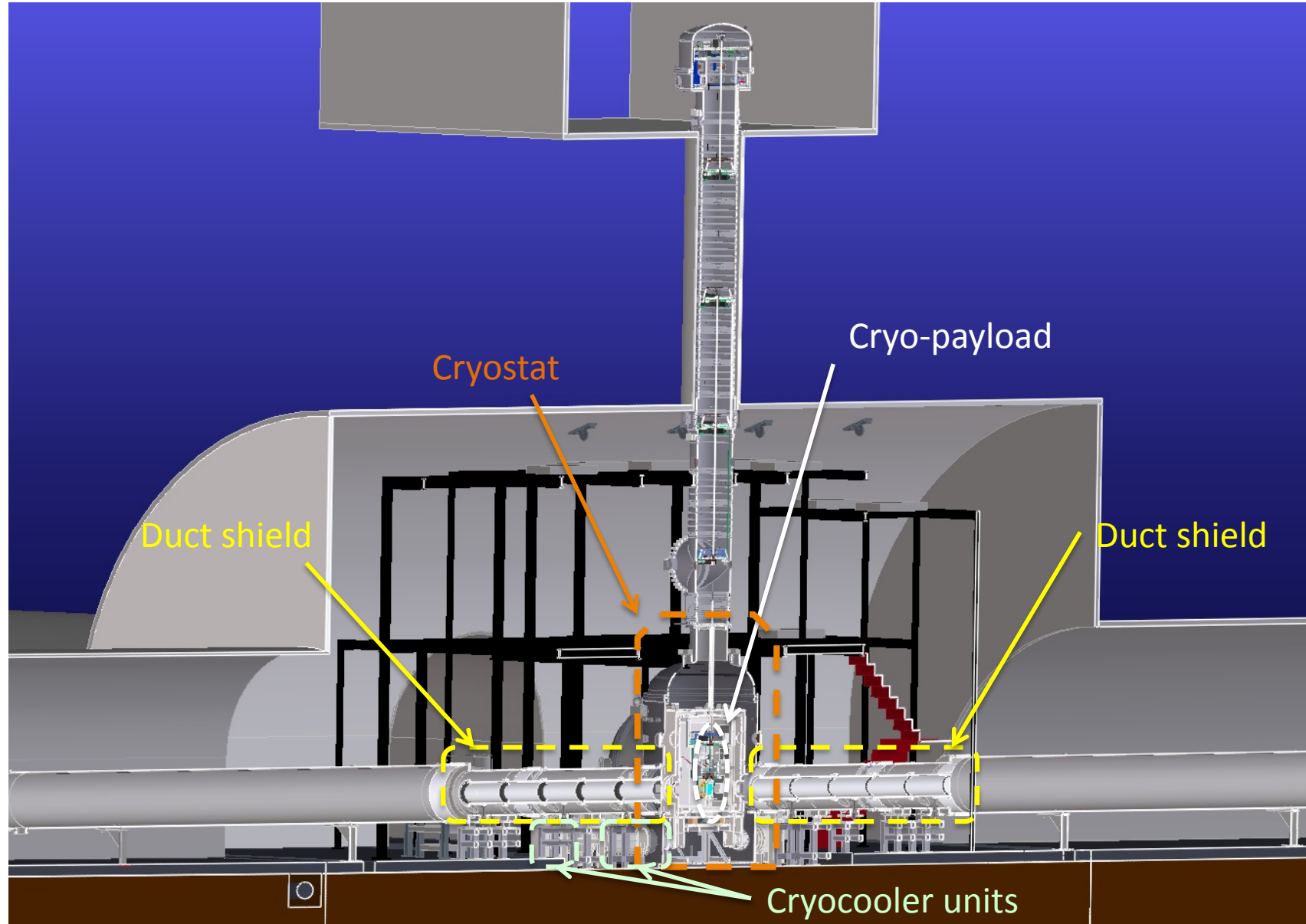
Cryogenic instruments on both ends and fronts



KAGRA Cryogenic Instruments

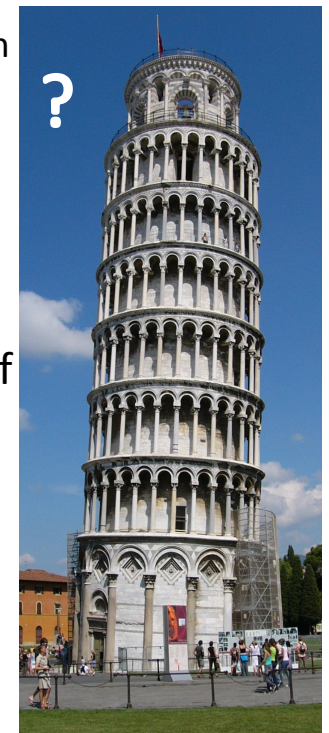


KAGRA Cryogenic Instruments

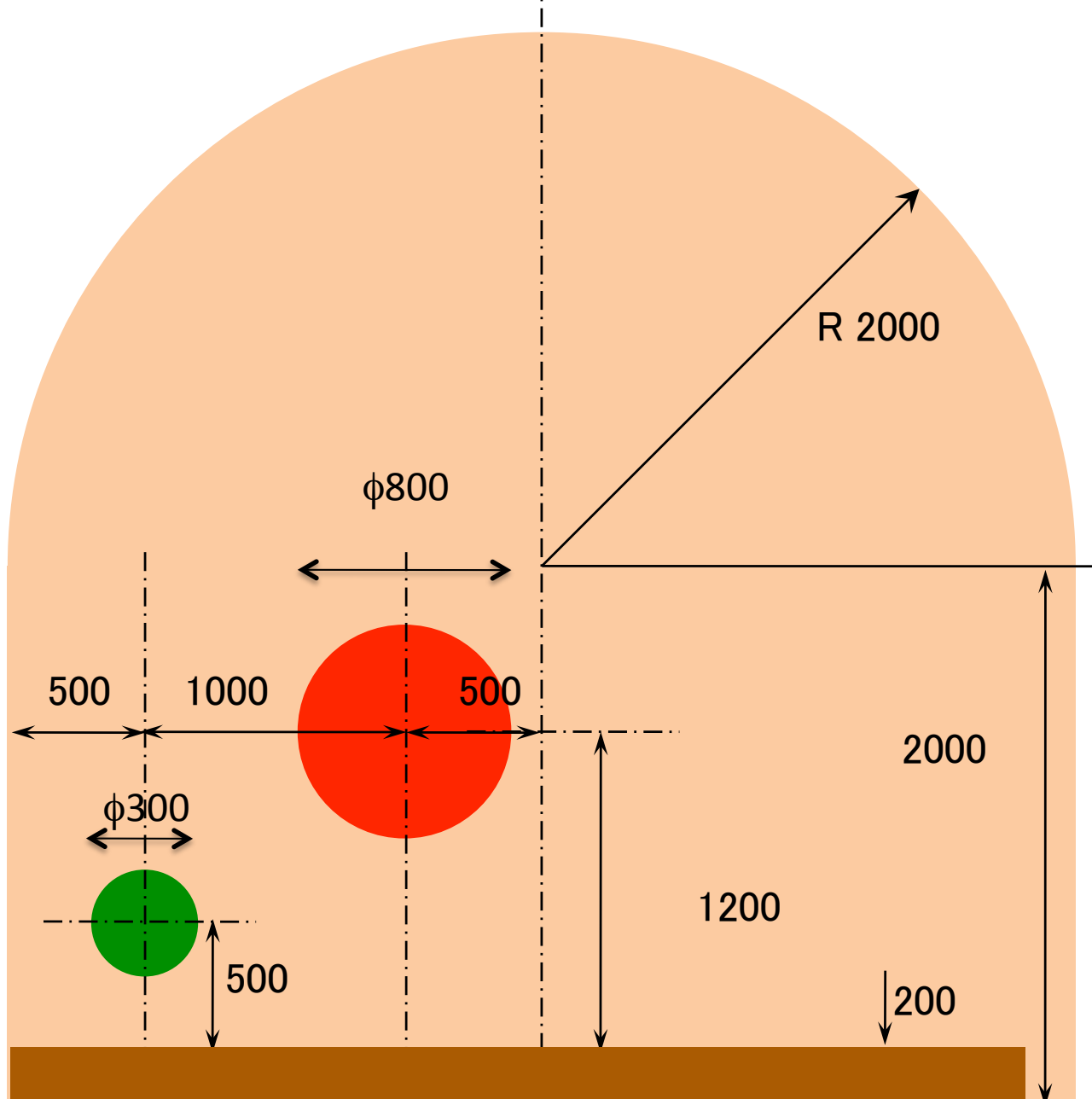


Installation of Cryostats

- Fabrication was finished until 2013FY. Four cryostats were stored in Sunouchi warehouse.
- Transportation and installation on the target position
 - Cryostats must pass arm tunnels before installation of vacuum ducts.
 - Route : Sunouchi warehouse →(public road, on trailer and truck)-> Shin-atotsu entrance →(tunnel, on the low-floor cart)-> target position.
 - Temporary installed to Y-end on 13th~19th Aug. 2014, to X-end on 15th~17th Oct. 2014 and to XY-front on Nov. 2014.
- Assembling and leak test
 - Set vertical shield
 - Set $\phi 2400$ upper flange with a metal gasket. This flange will not open after the construction of clean booth.
 - Leak test confirms this flange to satisfy the requirement of KAGRA vacuum specification.
- Alignment of cryostat
 - Initial alignment : positioned on the chalked lines on the floor. A vertical direction was adjusted by sims on 19th Aug. at Y-end.
 - Some inclination was found to the cryostat at Y-end on 8th~11th Oct. Size of the inclination seemed a few mili-radians.
 - If it means an uneven subsidence of the floor, it may affect connections to other vacuum instruments.
 - Observation of the position will be continued.



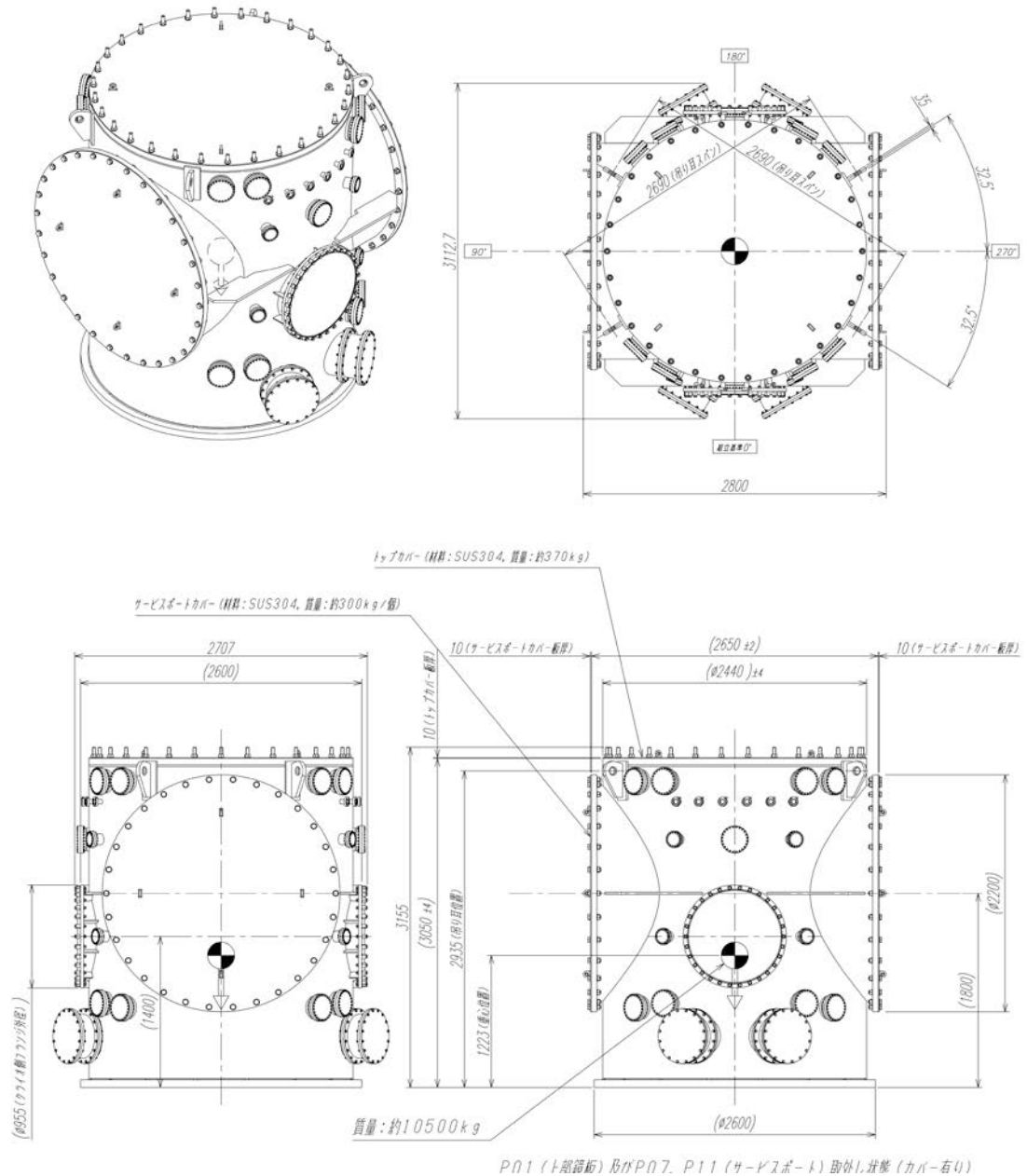
Cross sectional view of KAGRA tunnel



Cryostat Vacuum Chamber



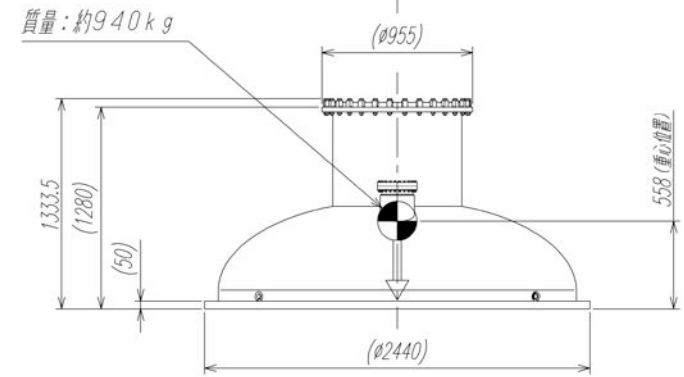
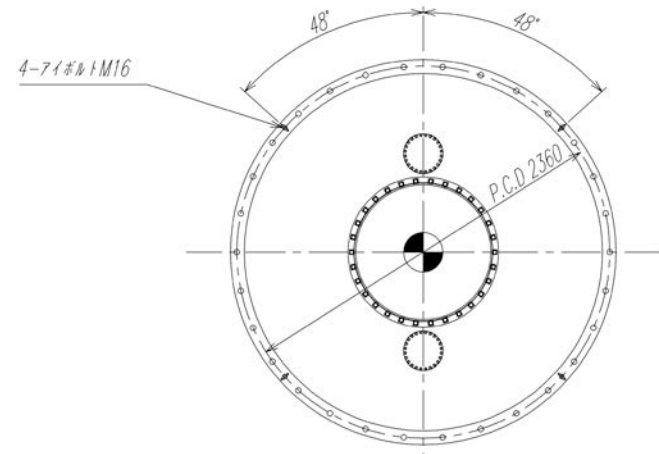
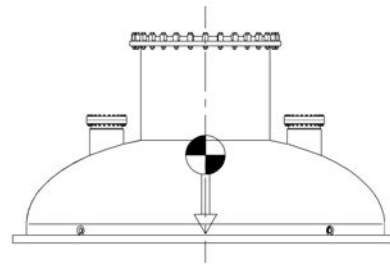
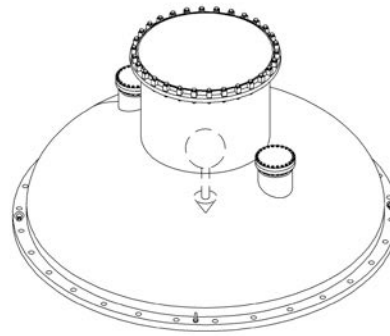
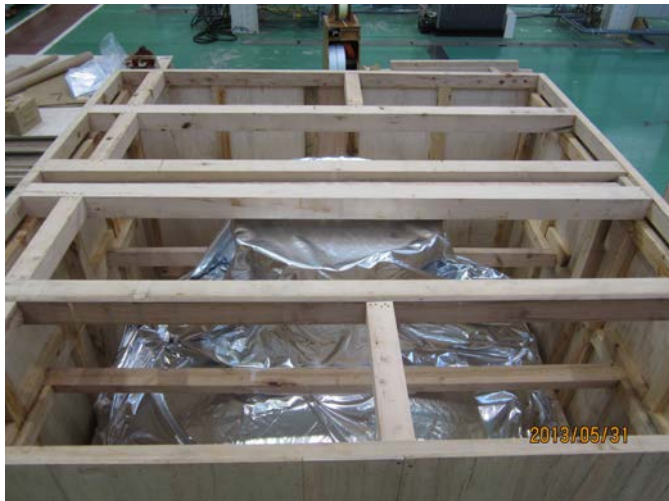
W2900 L3150 H3200
11700 kg



Wooden Box Package of Upper Flange

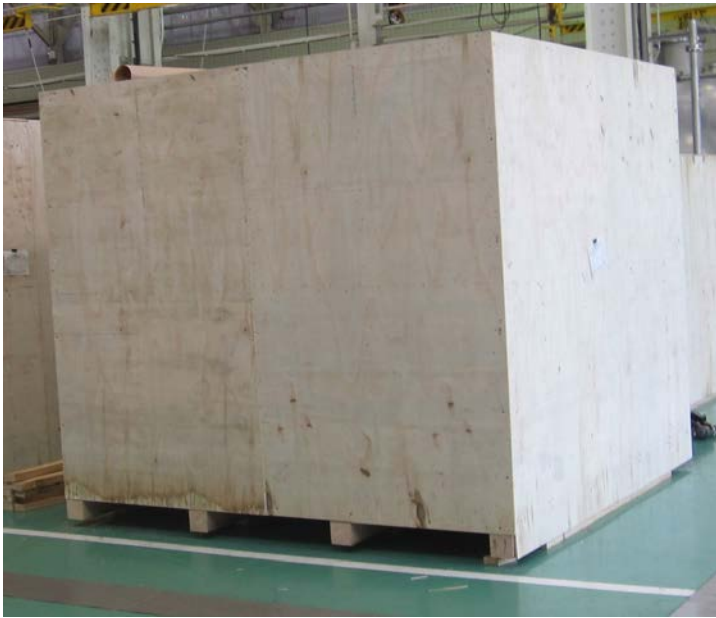


W2720 L2720 H1810 M=2330 kg

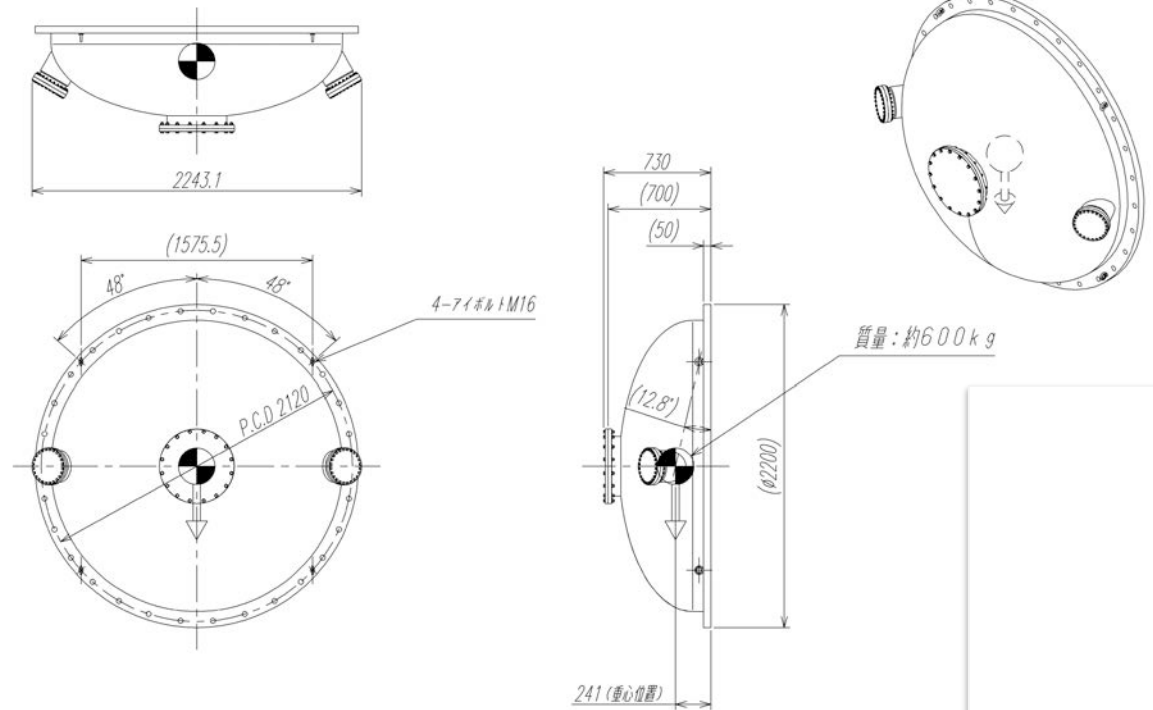


P01 (上部鏡板) 組立

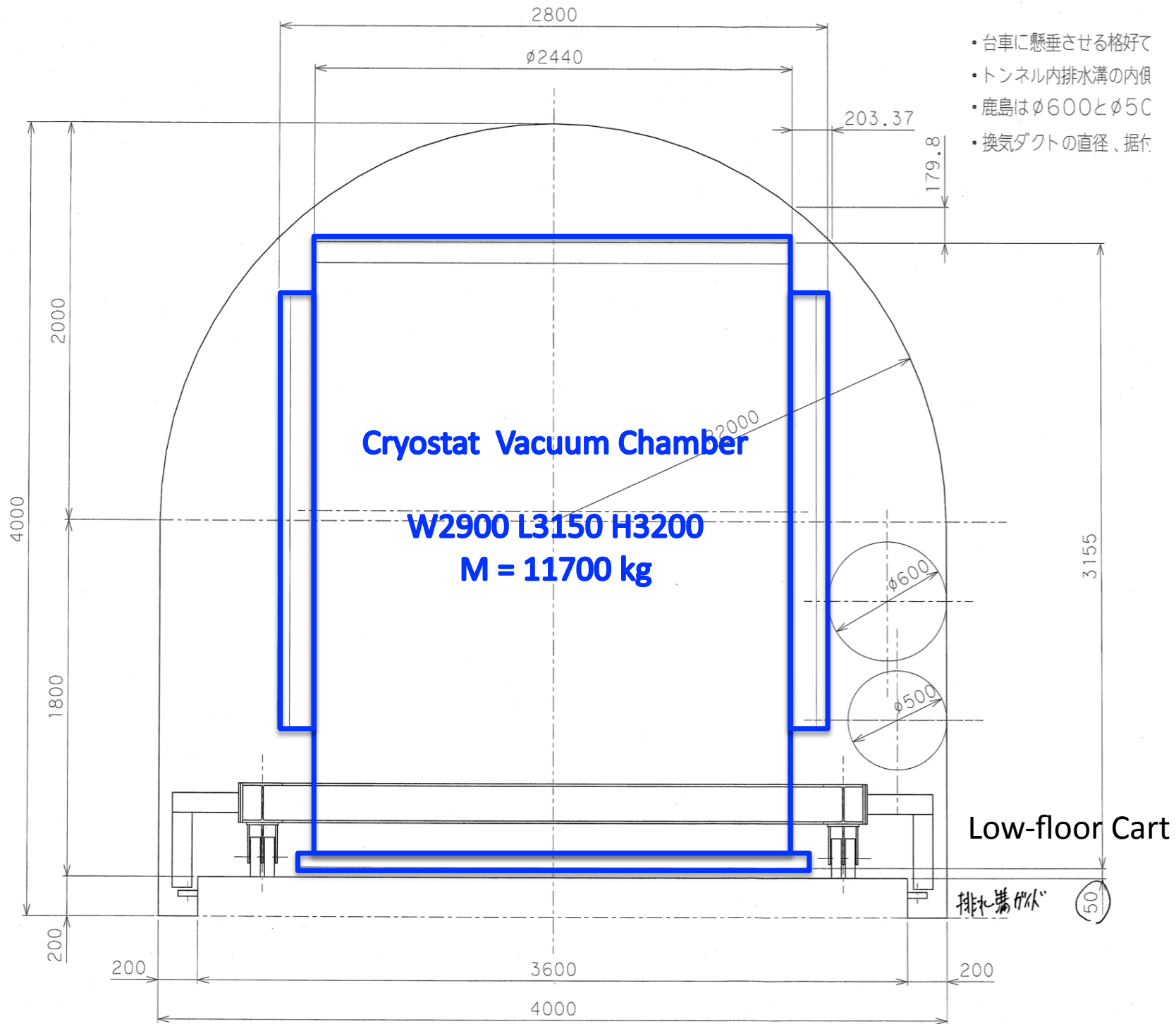
Wooden Box Package of Side Ports



W2480 L2480 H2230 M=3390 kg

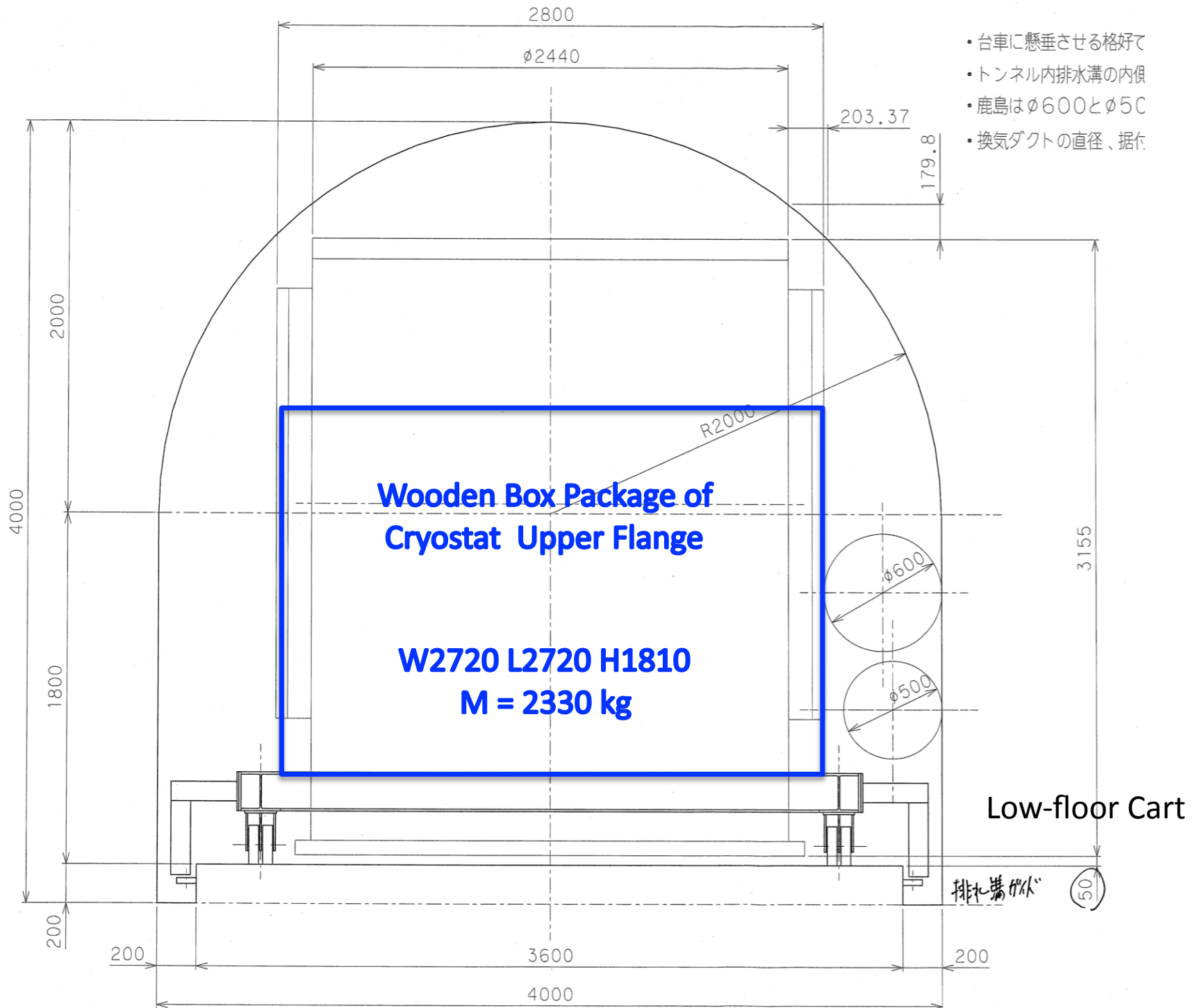


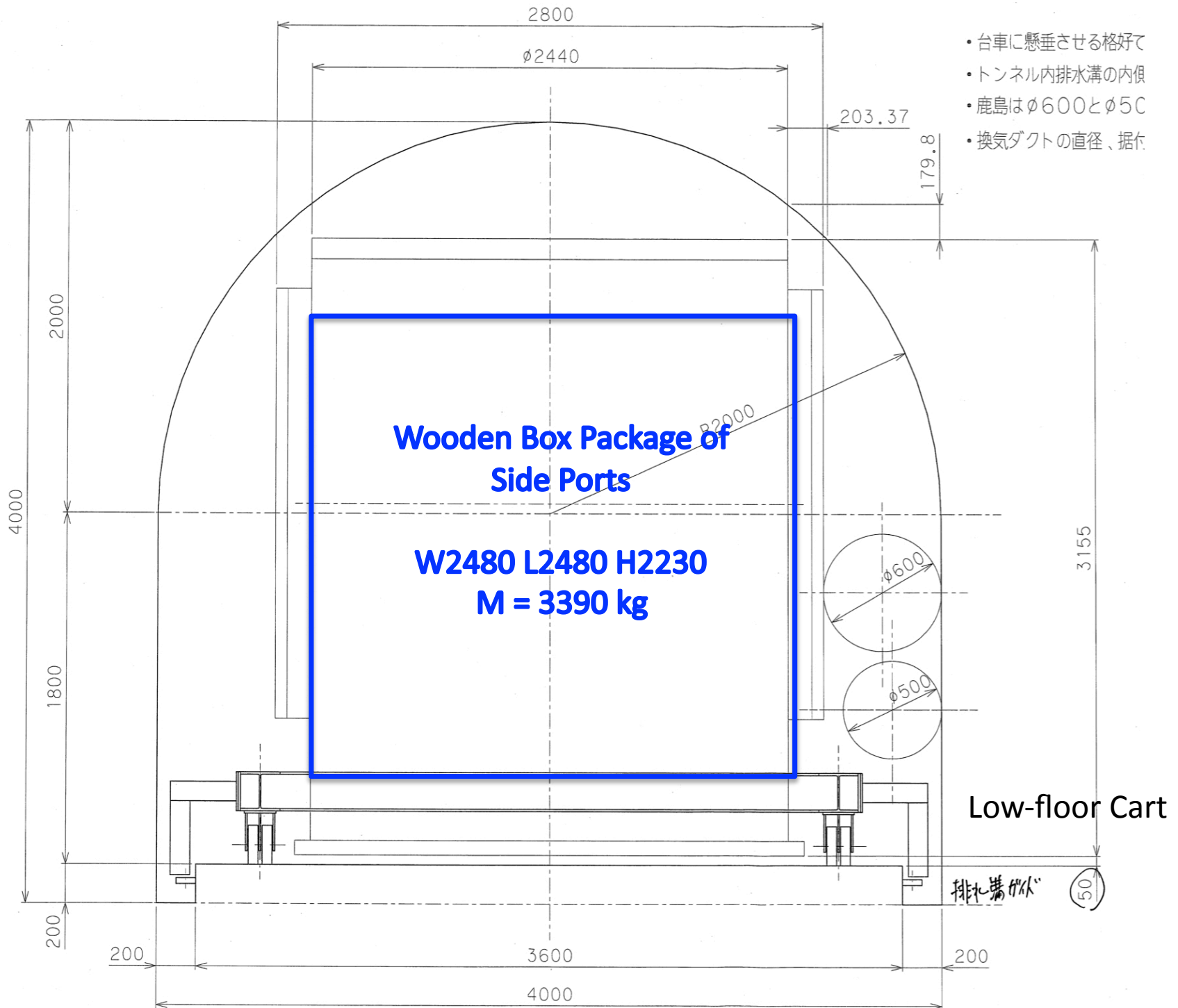
P07, P11 (サービスポート) 組立



- 台車に懸垂させる格好で
- トンネル内排水溝の内側
- 鹿島は $\phi 600$ と $\phi 500$
- 換気ダクトの直径、据付

排水溝内側





- 台車に懸垂させる格好で
- トンネル内排水溝の内側
- 鹿島はφ600とφ50
- 換気ダクトの直径、据付

**Wooden Box Package of
Side Ports**

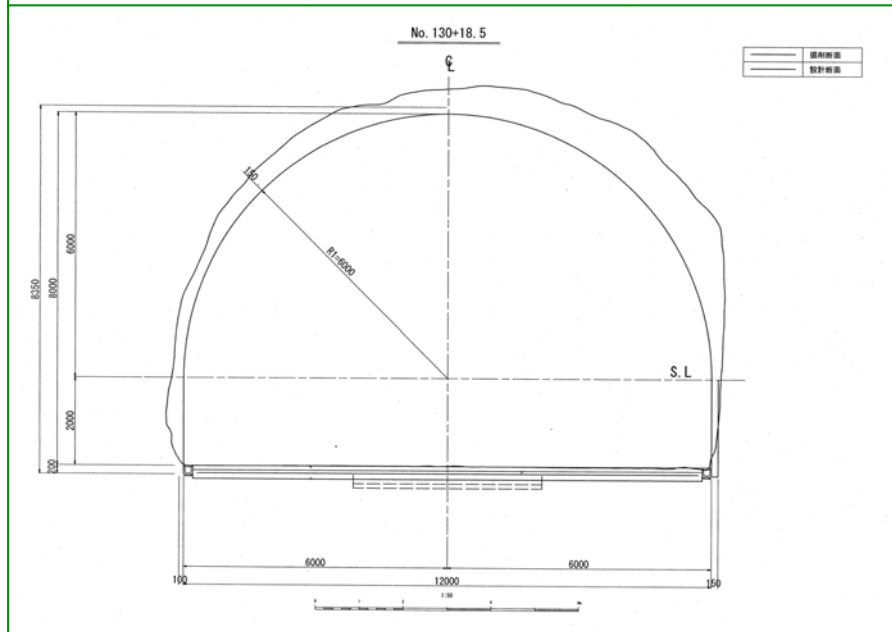
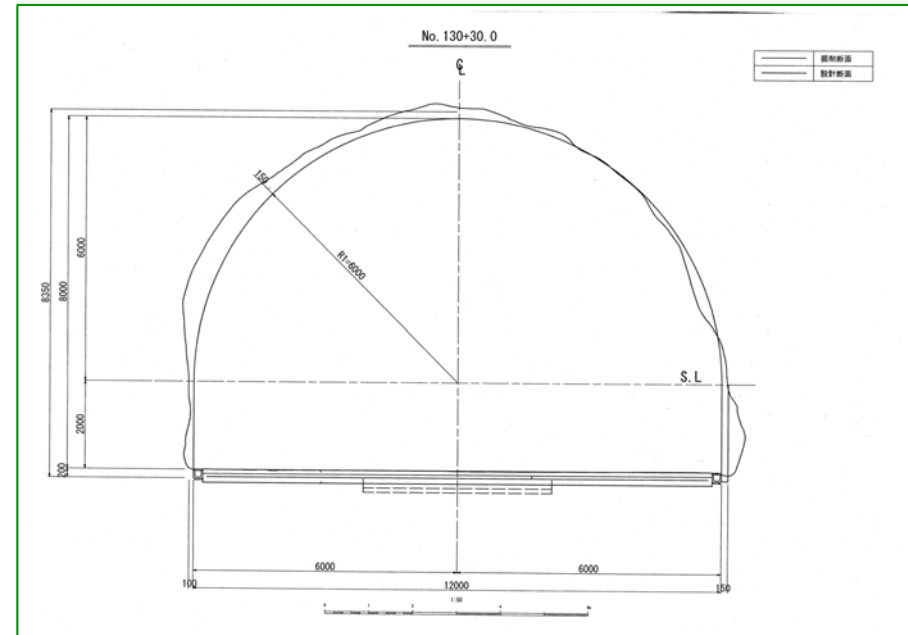
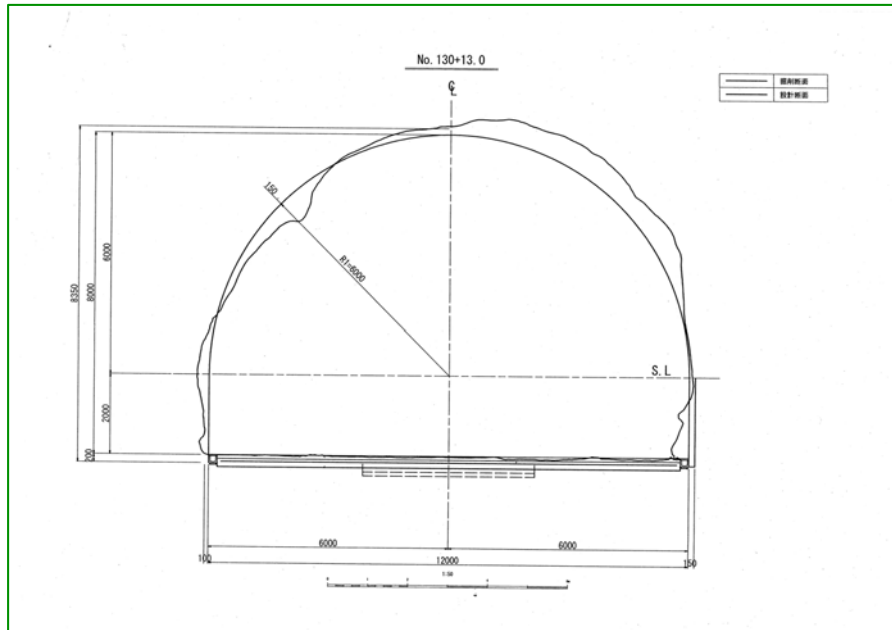
**W2480 L2480 H2230
M = 3390 kg**

Low-floor Cart

排水溝

φ500

Tomogram of experimental hall at Y-end (Mozumi end)



Semi-circular line : designed tunnel shape

If unevenness of tunnel wall makes narrow part on arm tunnels, it is impossible to carry cryostat through arm tunnel.

A trial transportations were carried out by mock-up gauge.

Projected parts were shaved by rock drill.

Trial transportation



Assembling a mock-up gauge on a low-floor cart

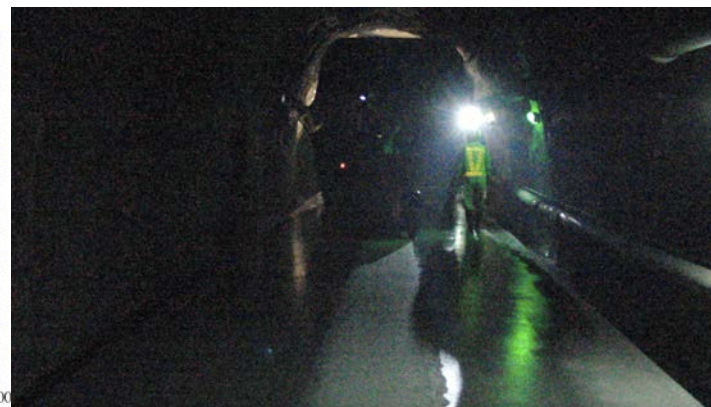
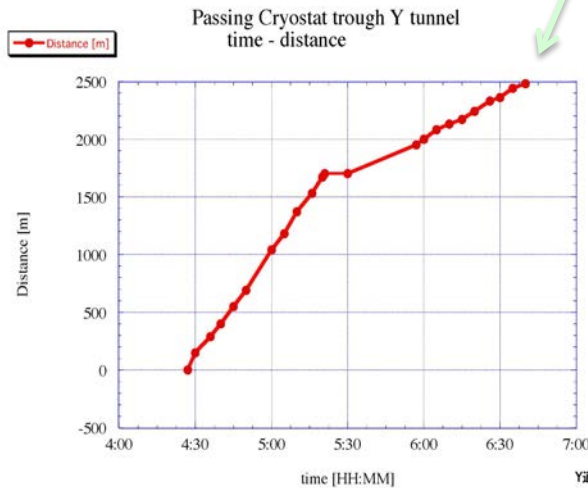
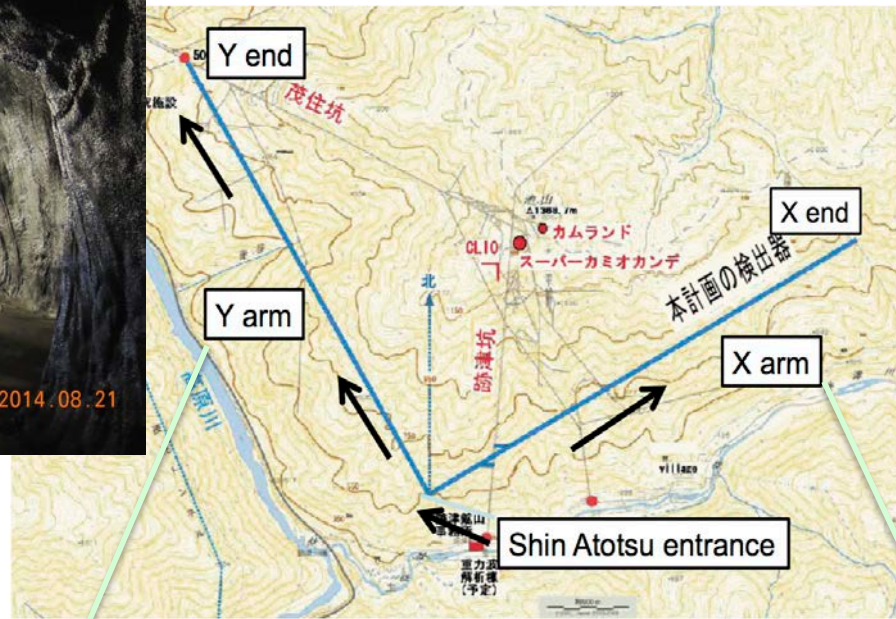


Approach tunnel

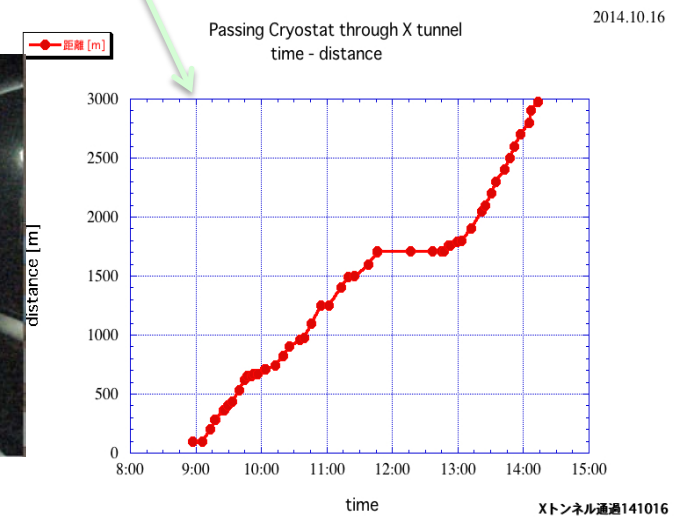


Y-arm tunnel

Transportation of cryostats to X and Y ends



Yトンネル通過140812



Xトンネル通過141016

Assembling and leak test of $\phi 2400$ upper flange

- Construct a simple clean booth around a cryostat.
- Set blower to supply filtered air.
- Put a metal gasket to the upper flange and fasten the flange.
- Set side port flanges.

< Leak test >

KAGRA requirement $< 1 \times 10^{-10} \text{ Pa} \cdot \text{m}^3/\text{sec}$

Detector background $1 \times 10^{-12} \text{ Pa} \cdot \text{m}^3/\text{sec}$

No excess leak found above the background.



Surveying and alignment of the cryostats

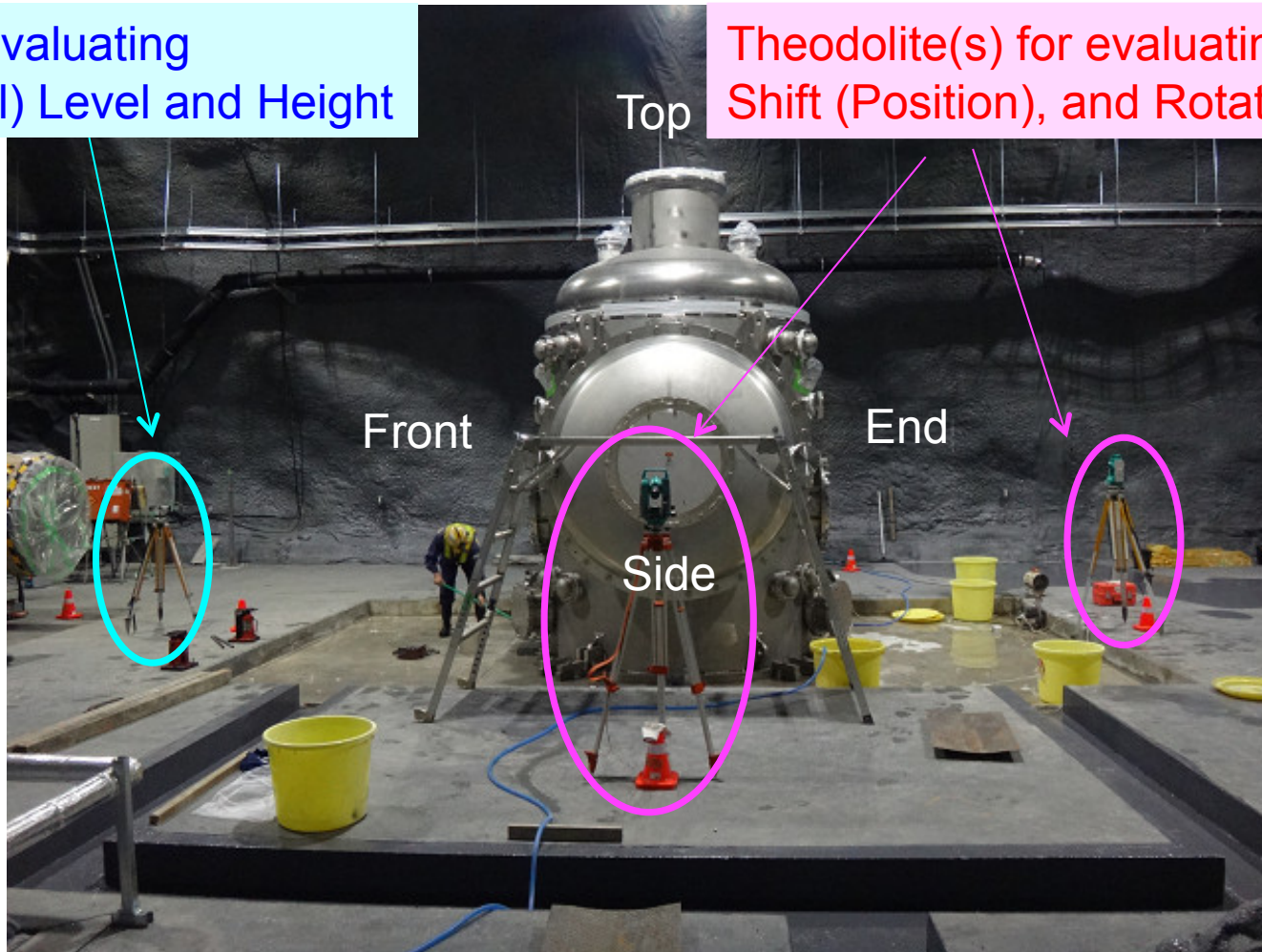
(Jan., 2015, X, Y-ends)

T.Kume

Level for evaluating
(Horizontal) Level and Height

Theodolite(s) for evaluating Tilt,
Shift (Position), and Rotation

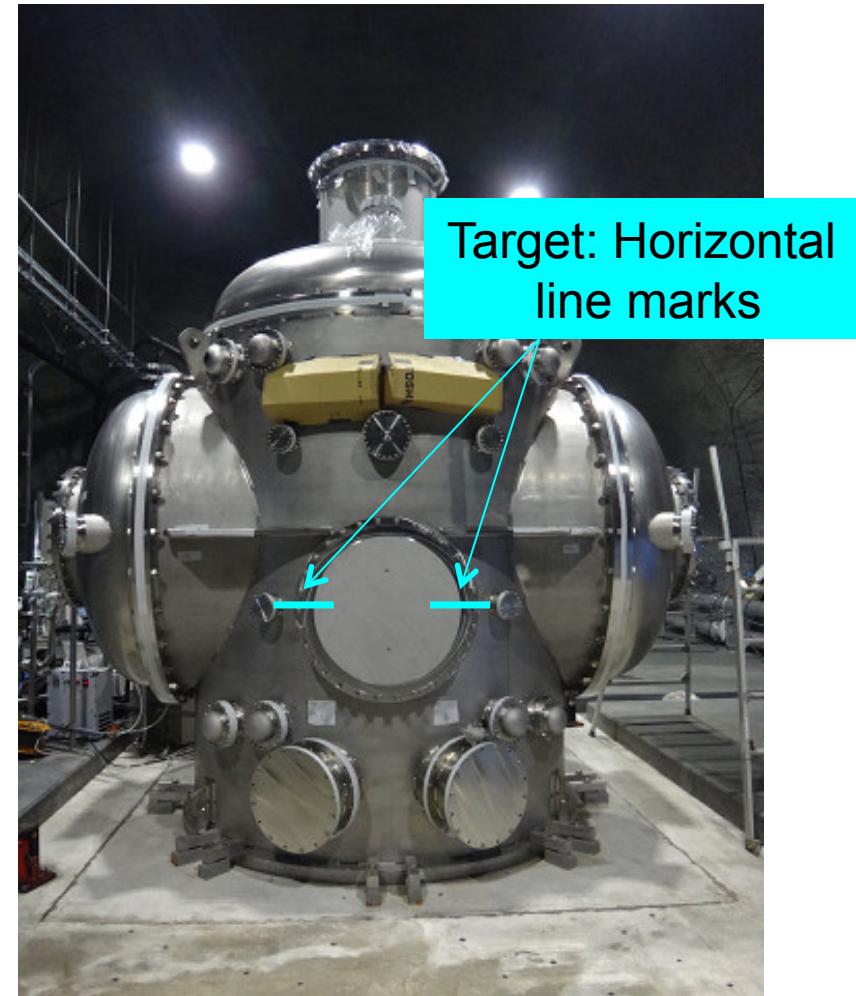
←
Center



→
(Arm)
End

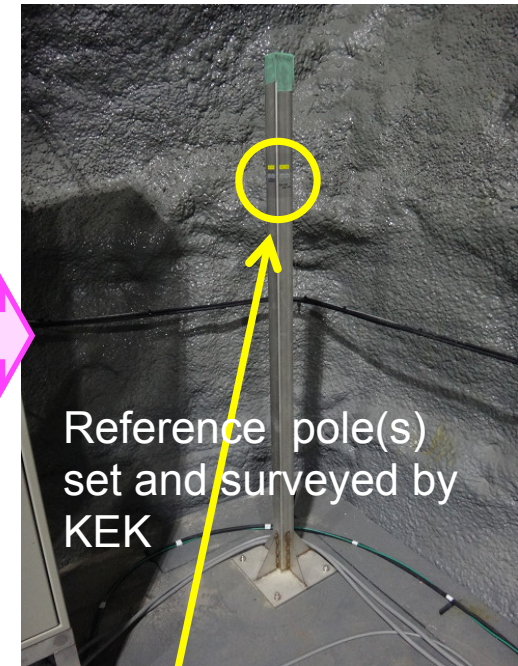
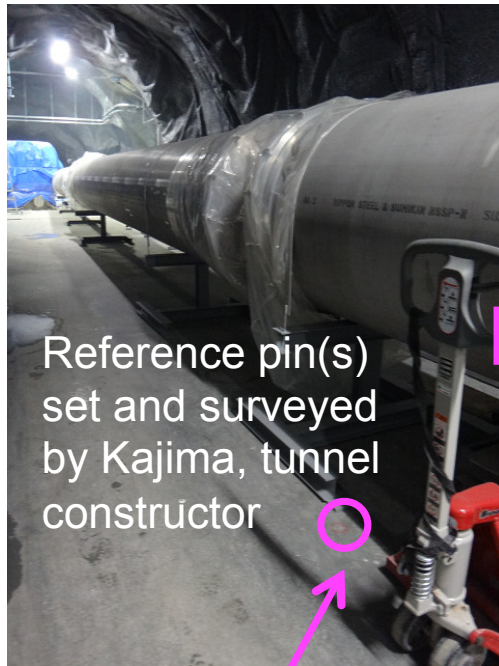
Height and Horizontal level survey by using a level

T.Kume



Height (Altitude) reference(s)

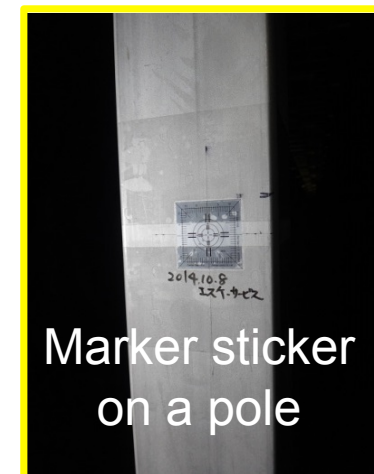
T.Kume



- Absolute height (Altitude) of the pins had been surveyed by Kajima.
- Relative height between the pin and the pole had been surveyed.

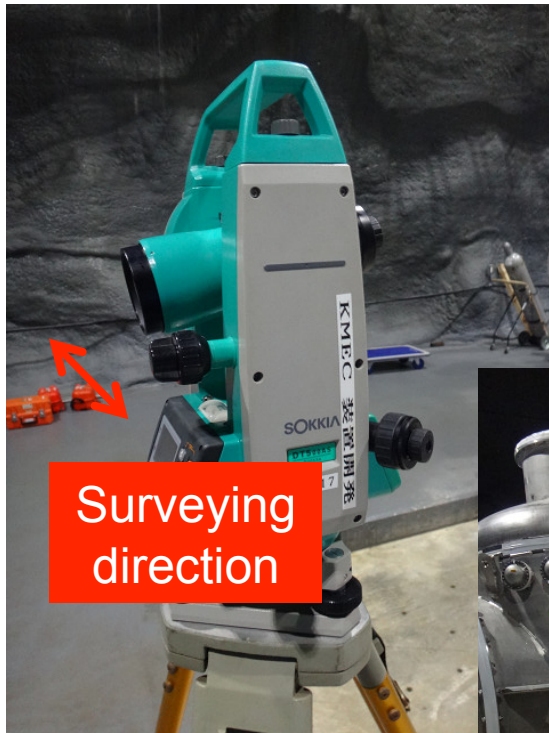


Absolute heights (Altitudes) of the sticker marks can be obtained.



Tilt and position survey by using a theodolite

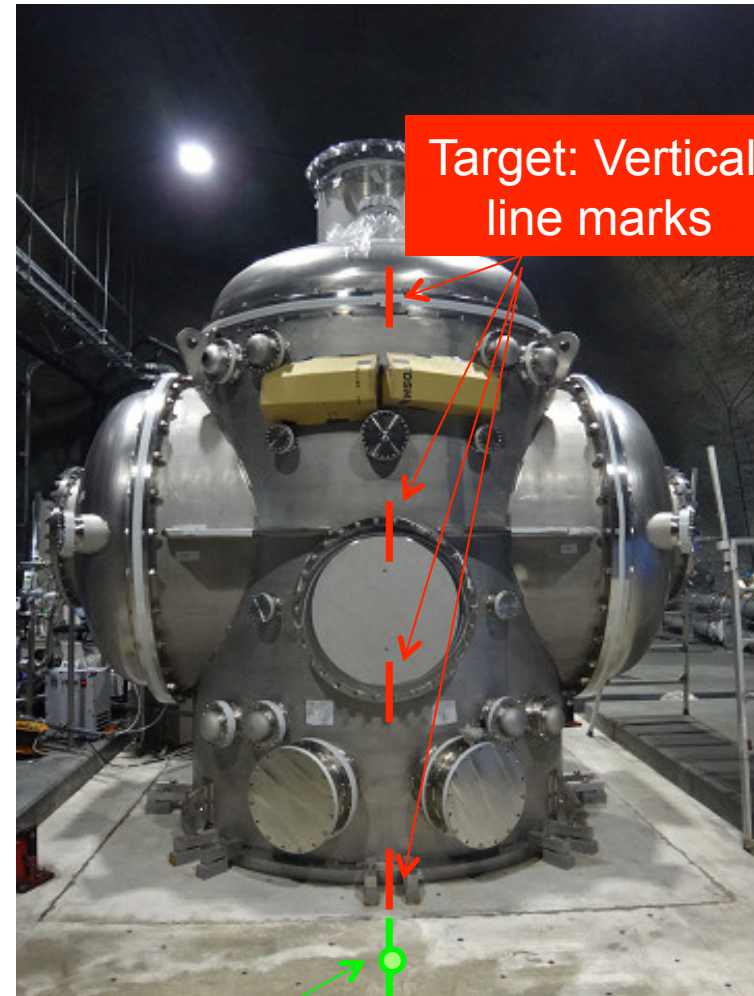
T.Kume



Surveying direction



Surveying direction

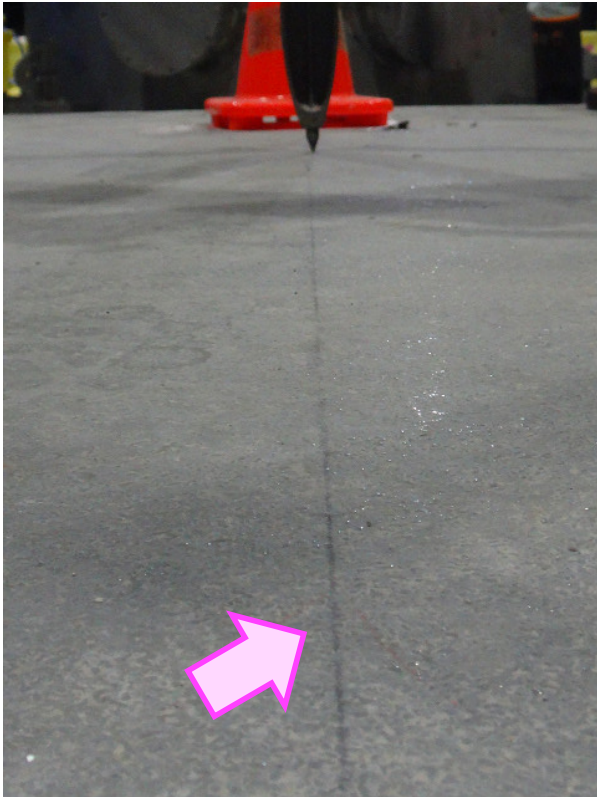


Target: Vertical line marks

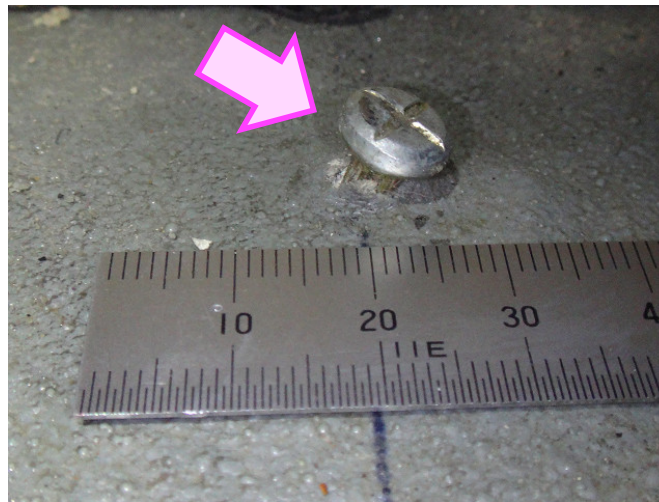
Reference mark/line on floor

References and target markers for surveying by using a theodolite

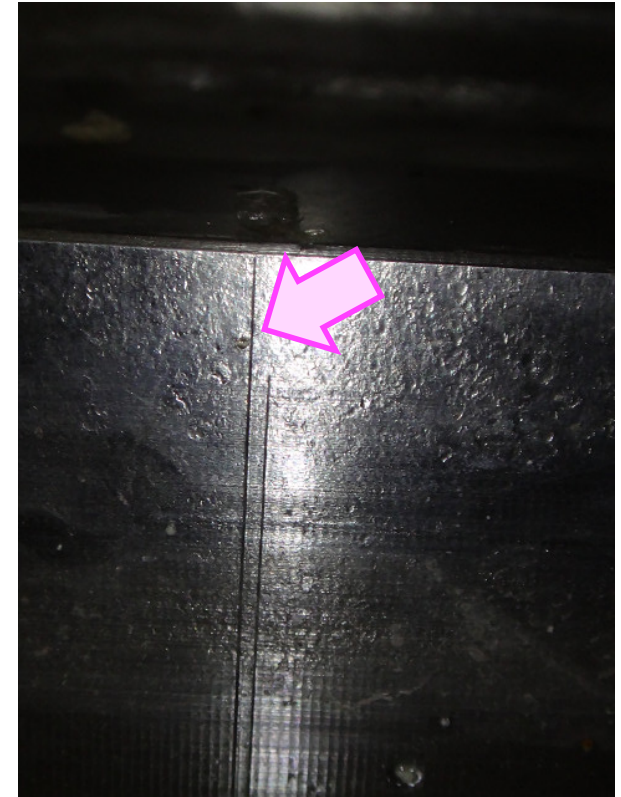
T.Kume



Marker line drawn on floor by MESCO, installer



Marker pin knocked on floor by MESCO



Marker line scratched on the cryostat by Toshiba, manufacturer

Summary: Errors after alignment [mm]

(X, Y-end, Jan. 23, 2015)

T.Kume

	X-end	Y-end
Requirements	Sub-mm (< 1 mm, < 1 mrad)	
Level	< 1 mrad	< 1 mrad
Height	+2~3 mm	+5~6 mm
Shift	Zero?	Zero?
Tilt	< 1 mrad	<1 mrad?
Rotation	~1 mrad-CW	<1 mrad?
Other(s)	-	5~6 mm of torsion?
Judge	So-so, Rotation and Height alignment	Further investigation

Installation of duct shields, cryocoole units and cryo-payload

- Those instruments can be transported through arm tunnel after installing $\phi 800$ ducts.
- Fabrication of duct shields and cryocooler units.
 - Six of 8 of duct shields will be finished until March 2015.
 - Another two will be fabricated in 2015FY.
 - Fabrication of 4K cooler units were finished. (16 units)
 - Fabrication of 80K cooler units will finish on March 2015. (8 units)
- Installation of cryogenic instruments for X-front and Y-front are going.
- For cryo-payload, details of installation plan has not been fixed.

Summary

- Installation
 - Two cryostats installed to X-end and Y-end.
 - Another two will be installed to X-front and Y-front in Feb. and Mar. 2015. Assembling will follow the installation.
 - No leak was found for the cryostat in X-end.
 - Installation of duct shields and cryocooler units are going.
- Surveying
 - Some position errors were found from the local standard for cryostats on X-end and Y-end.
 - Surveying will be continued.

KAGRA Cryogenics Group

2015.02.09

T.Tomaru



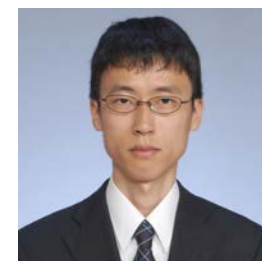
Toshikazu SUZUKI
Chief, mine worker
KEK, Prof.



Takayuki TOMARU
Cryo-Payload
KEK, Assoc. Prof.



Shinichi TERASHIMA
Machining
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Dan CHEN
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Kazuhiro YAMAMOTO
Cryo-Payload sub-chief
ICRR, Assist. Prof.



Rahul KUMAR
Simulation, Payload
KEK, PD



Ayako HAGIWARA
CAD
KEK, Technical Staff



Rookie

Suguru TAKADA
Cryogenics
NIFS, Assist. Prof.

Tunnel excavation NATM



Preparation of blasting



Mucking



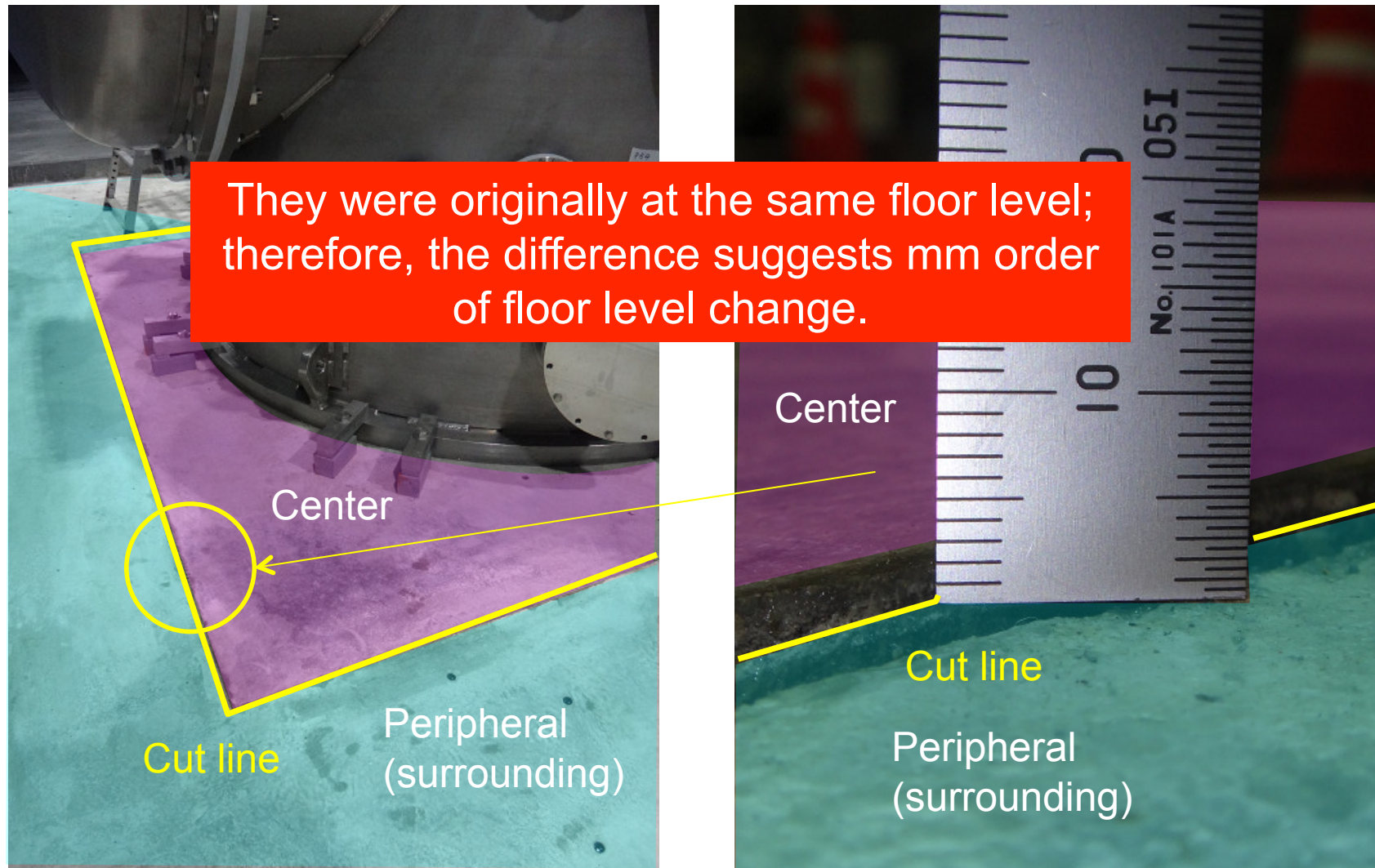
Shotcrete (spray gunite)



Rock-bolt

Step (floor height difference) along the cut line on floor (Y-end, Jan. 23, 2015)

T.Kume



Example for the floor, on which the cryostat had been set at the Y-end, there can be observed 2~3 mm of step. The center is higher than the peripheral.