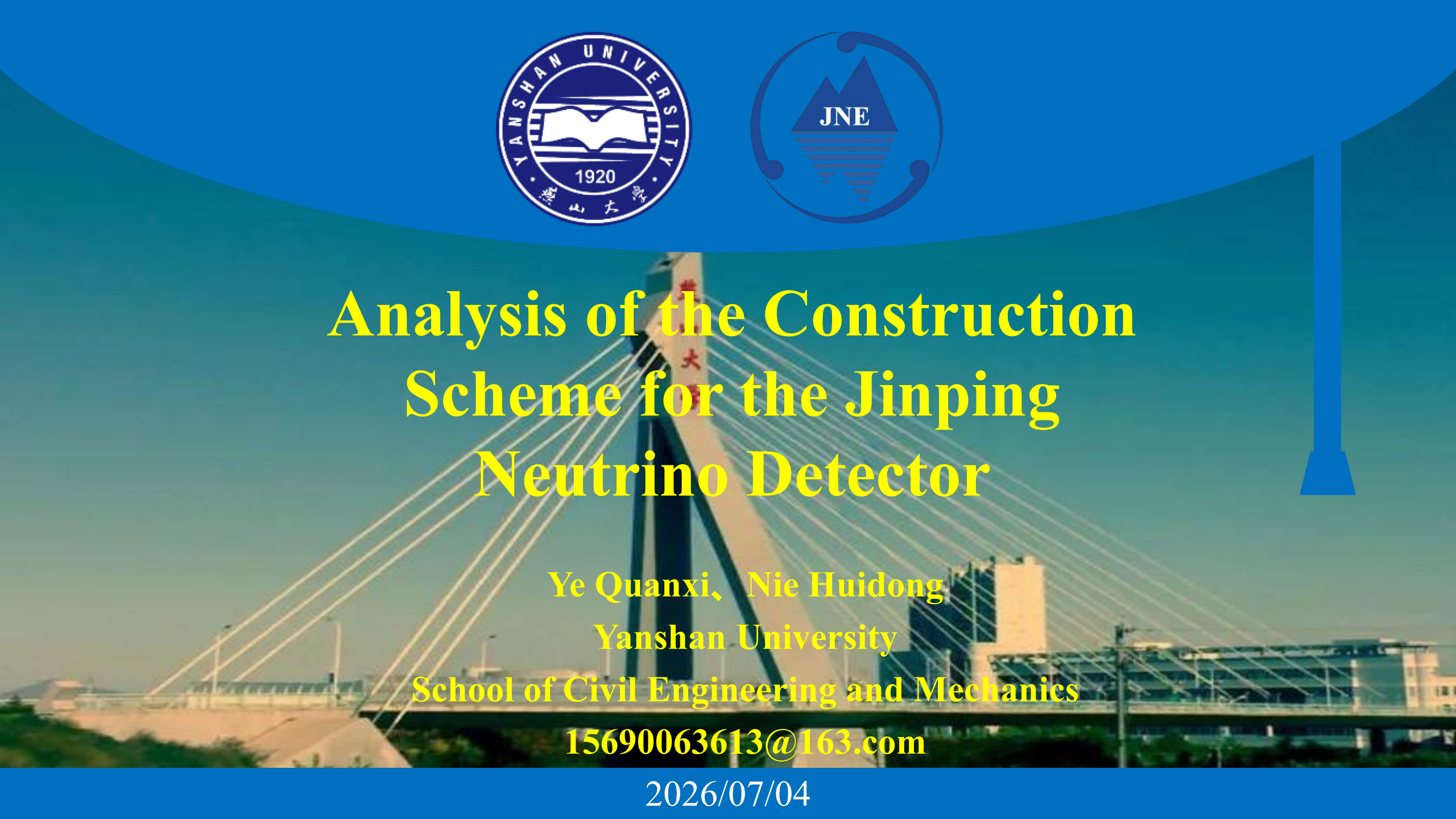
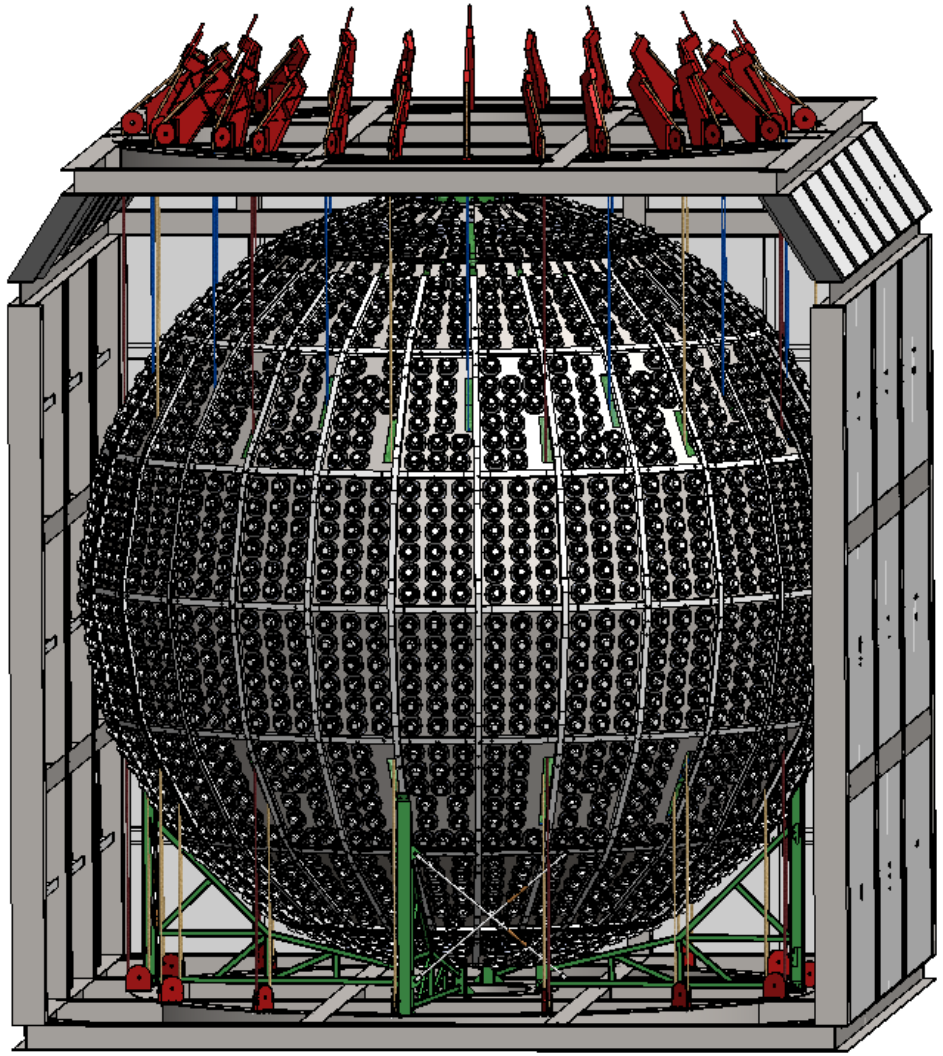


Analysis of the Construction Scheme for the Jinping Neutrino Detector

Ye Quanxi、 Nie Huidong
Yanshan University
School of Civil Engineering and Mechanics
15690063613@163.com

2026/07/04

Contents



01
Project Overview

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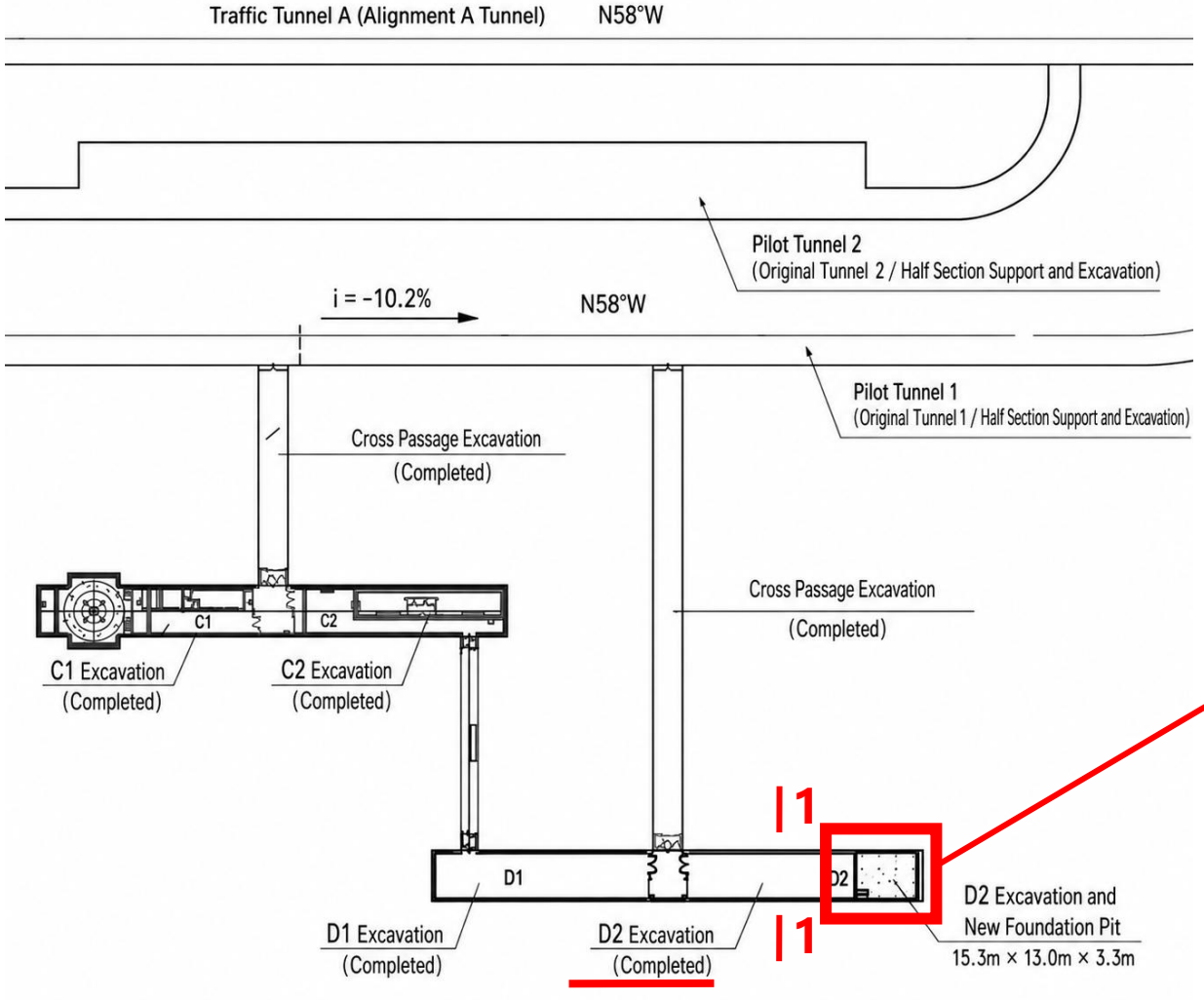
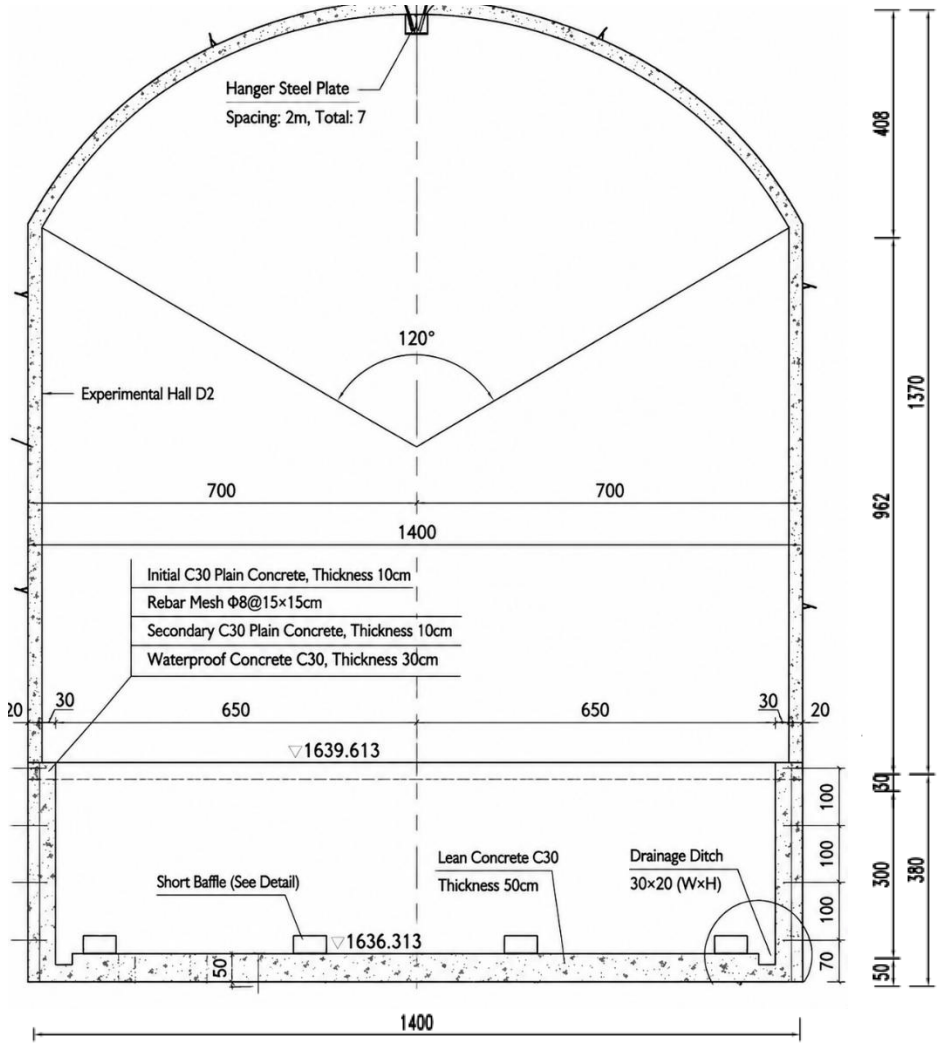
The D2 Test Hall is a tunnel structure with a dome roof, featuring a clear width of 14 m and a height of 13.7 m. A foundation pit is located at the far end of the test hall, and its dimensions are shown in the figure below.



Site Layout Plan



1-1

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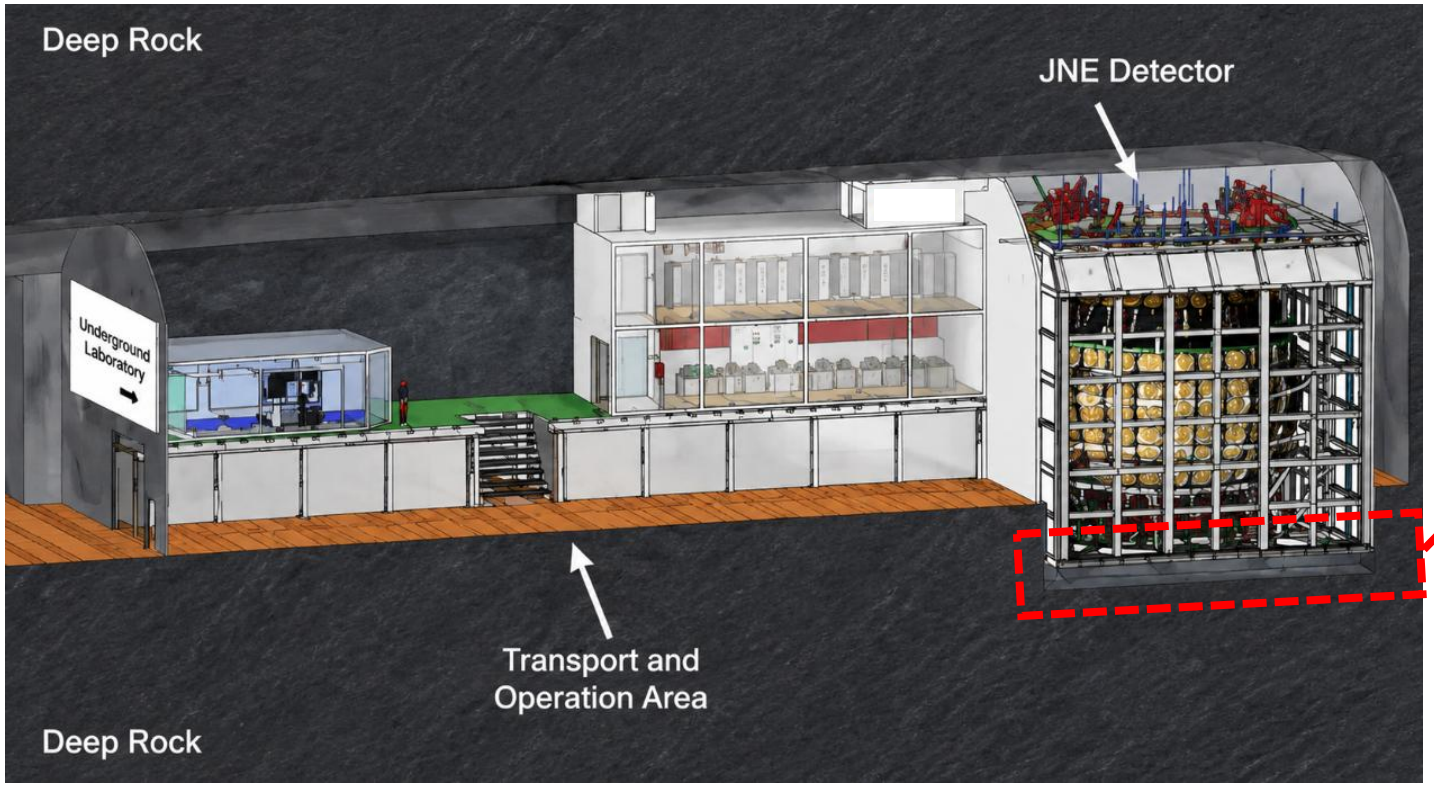

- **Site Arrangement: Detectors are placed inside the foundation pit, and electromechanical equipment is arranged on the outer side.**

02

Detector Structure

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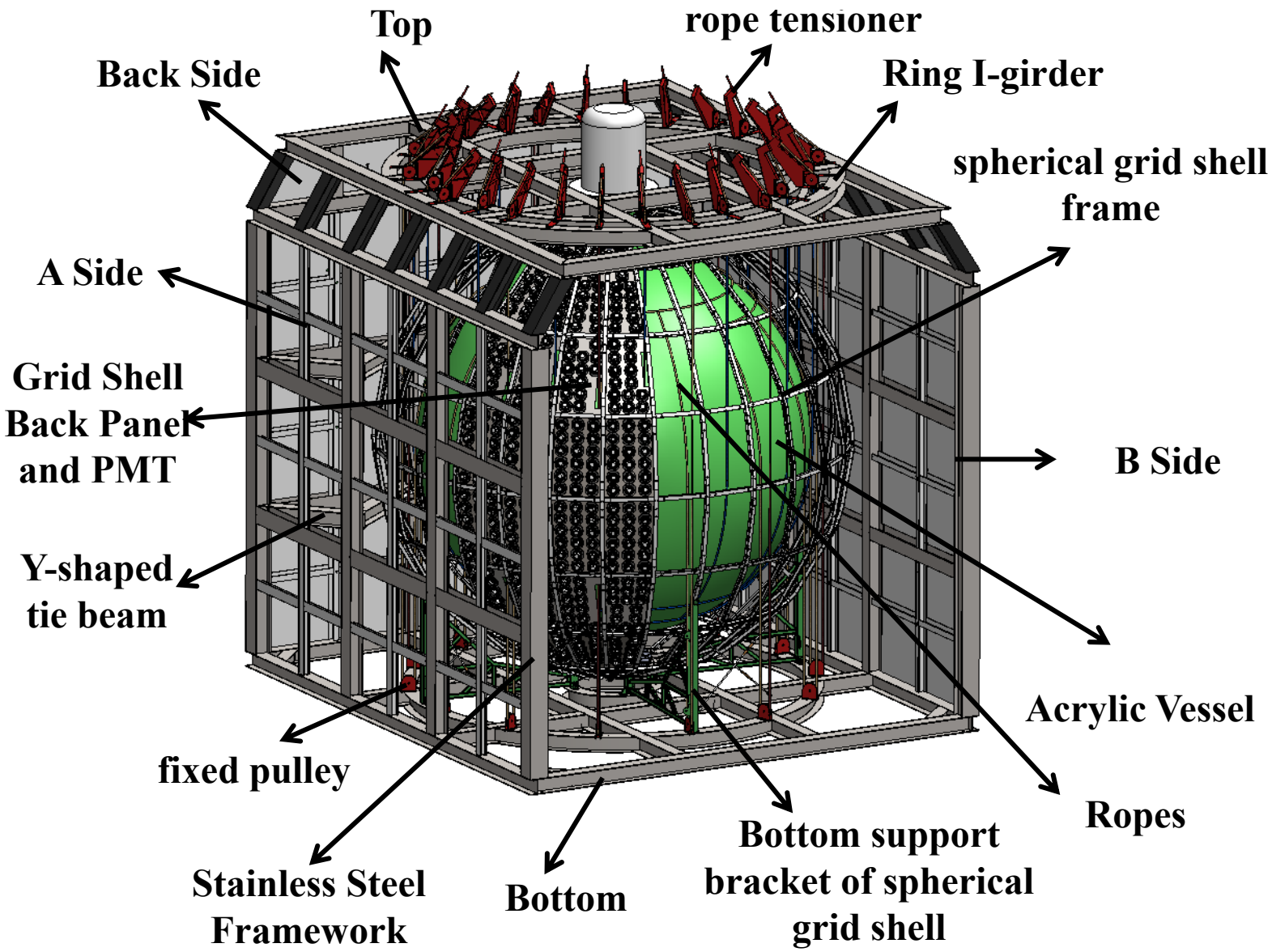

The installation mainly consist of four components:

- Stainless Steel Outer Frame: Prefabricated columns; on-site welding and assembly.
- Spherical Grid Shell: Half Prefabricated, half segmented assembly.
- Ropes: Pre-tensioned; on-site installation.
- Acrylic Vessel: Segmented Prefabrication; On-site Assembly and Integration.

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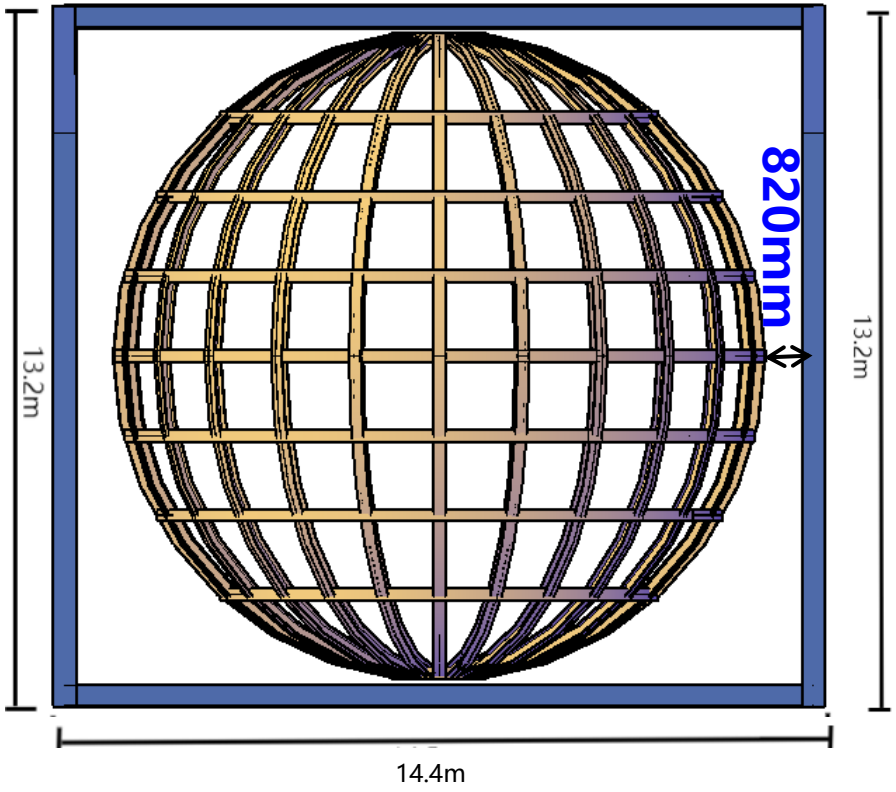

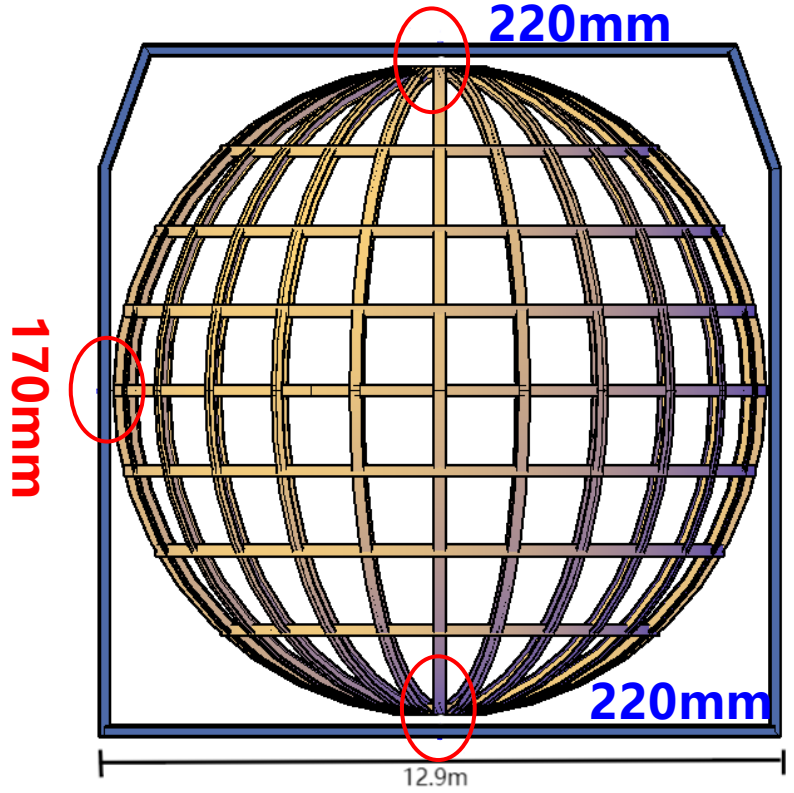

Structural size	
Width	12.9m
Length	14.4m
Height	13.2m
Acrylic Vessel Diameter	9.96m
Stainless Steel Grid Shell Diameter	11.96m

Dimensions and Clearances of Components:

- Frame: 12.9 m width (foundation pit limit), 14.4 m length for symmetric layout & higher water capacity.
- 9.96 m acrylic sphere; 900 mm PMT detection space → 11.96 m spherical steel shell.

03

Construction Sequence

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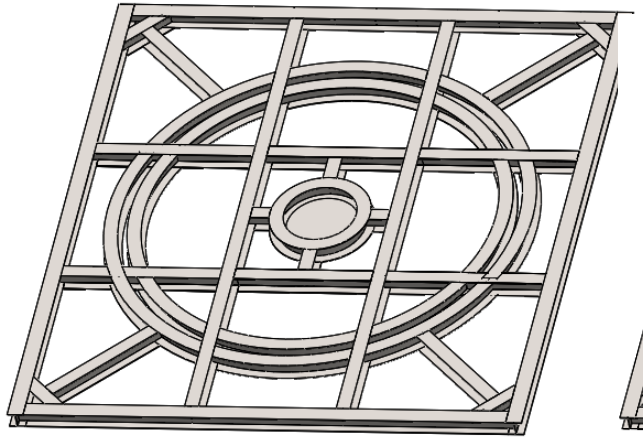
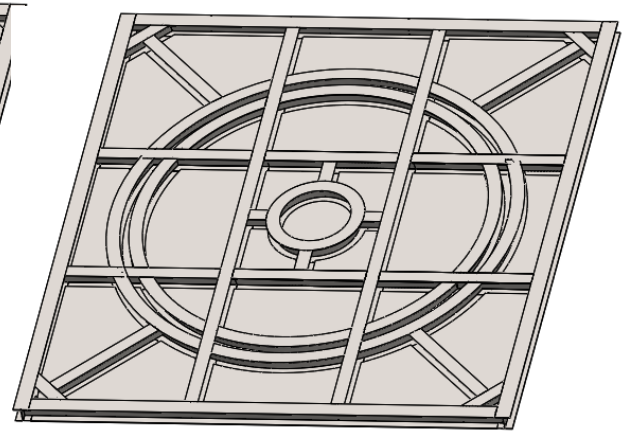
Stainless Steel Framework:

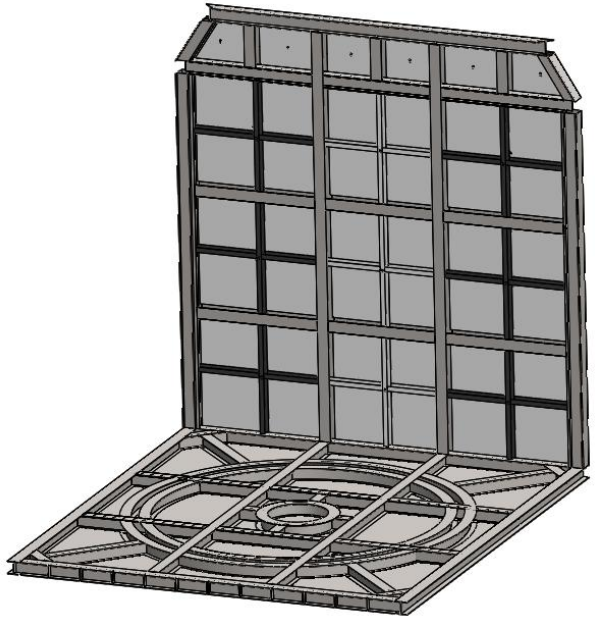
Construction and Installation Sequence



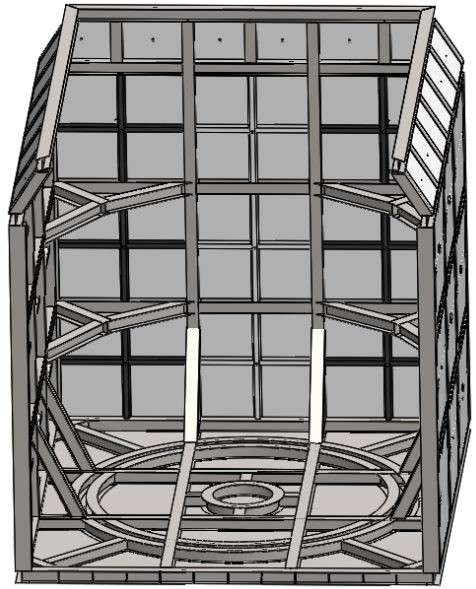
1. Install the bottom frame.



2. Install the bottom frame steel plate.



3. Install the back frame.



4. Install the side frame.

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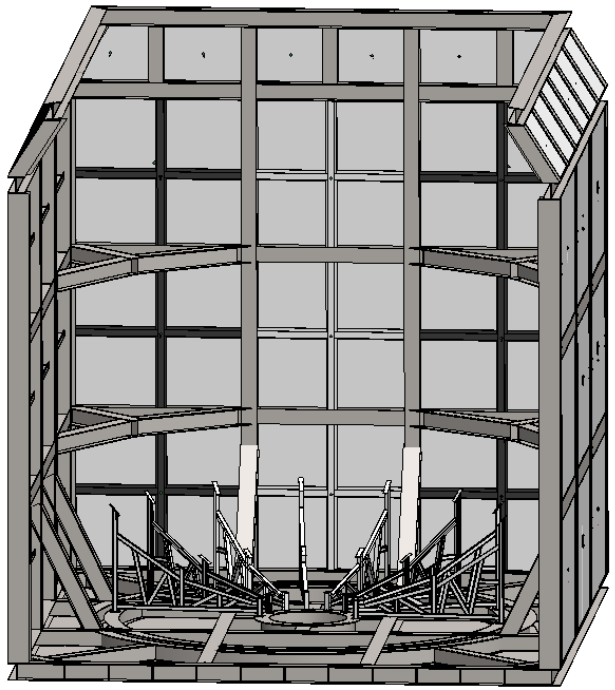
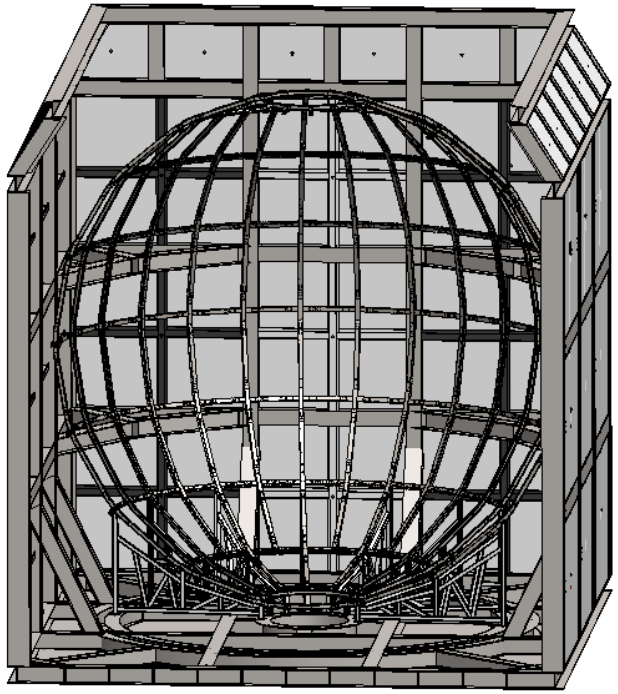
Spherical grid shell section: **The support frame is fixed to the bottom ring beam, followed by installation of the inner hemispherical shell.**

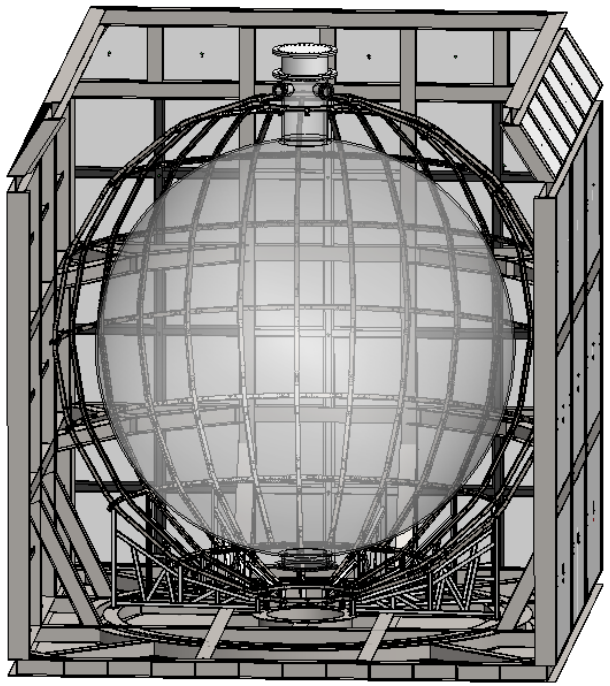
Construction and Installation Sequence

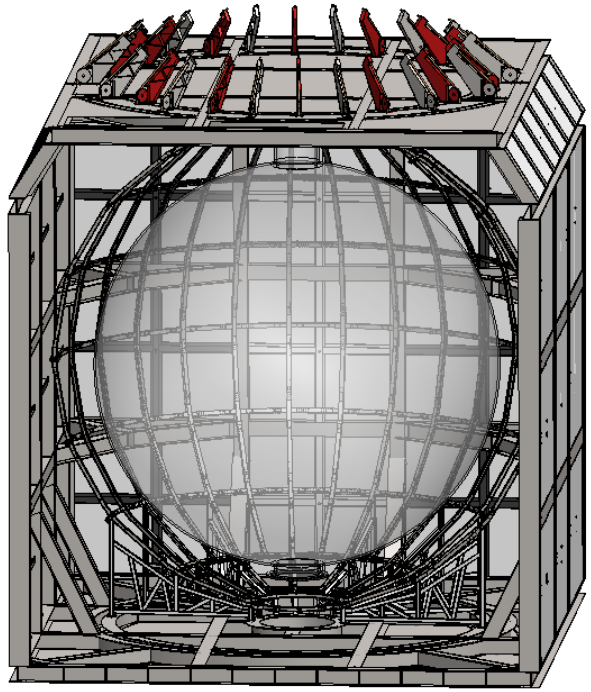


5.Install the bottom Surpport



6. Install the inner hemisphere.





7.Install the Acrylic Vessel

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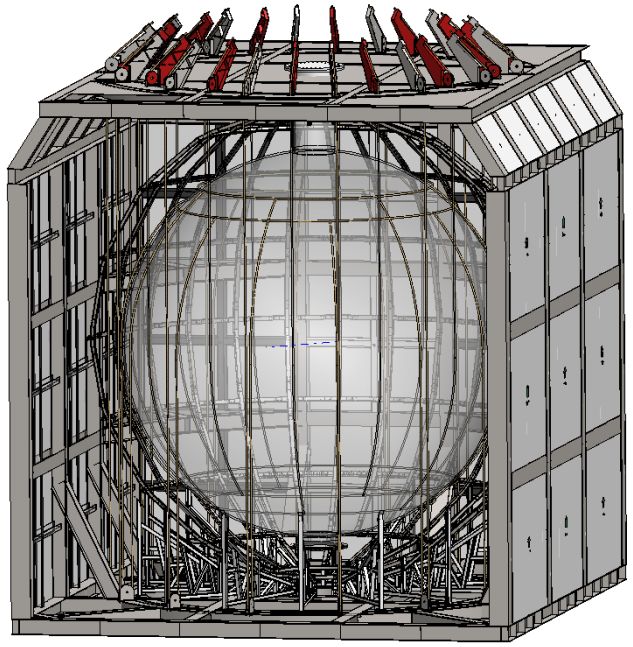
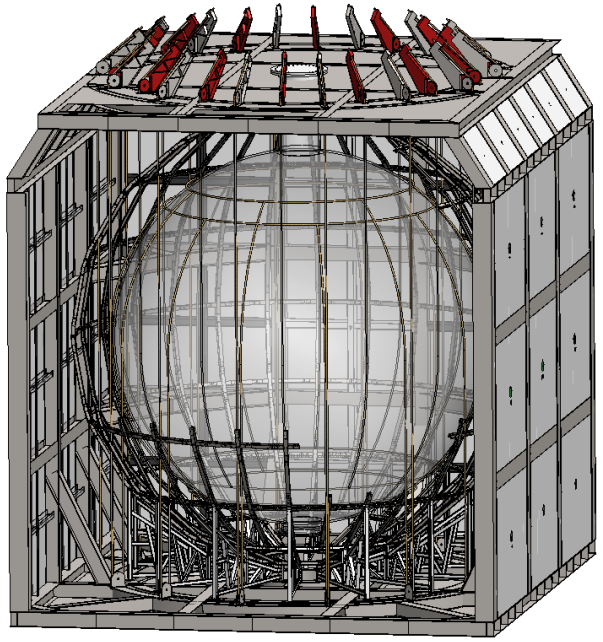
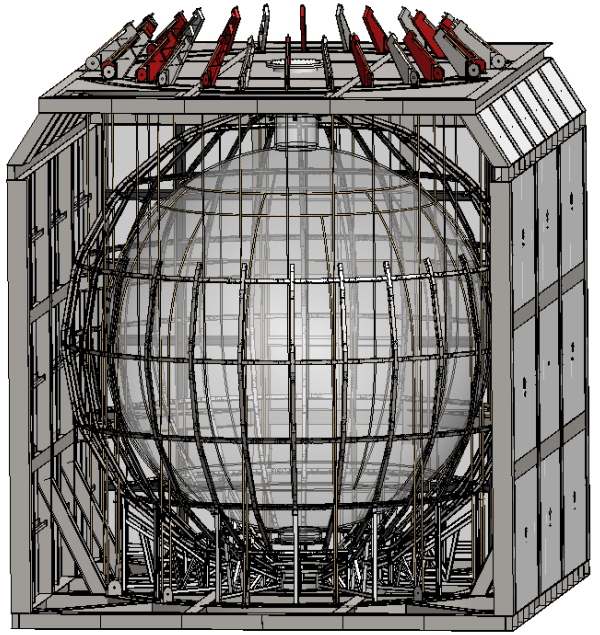
Spherical grid shell section: install the remaining ribs of the inner hemispherical shell from bottom to top.

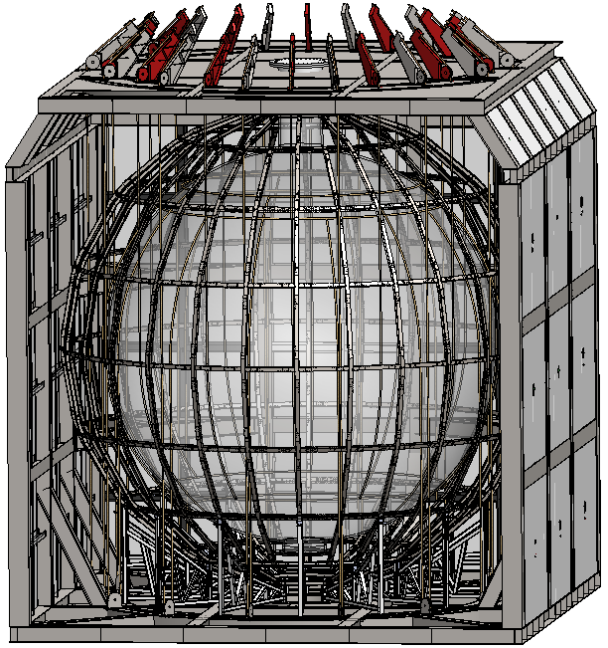
Construction and Installation Sequence



8.Install the ropes







9.Install the spherical grid shell ribs

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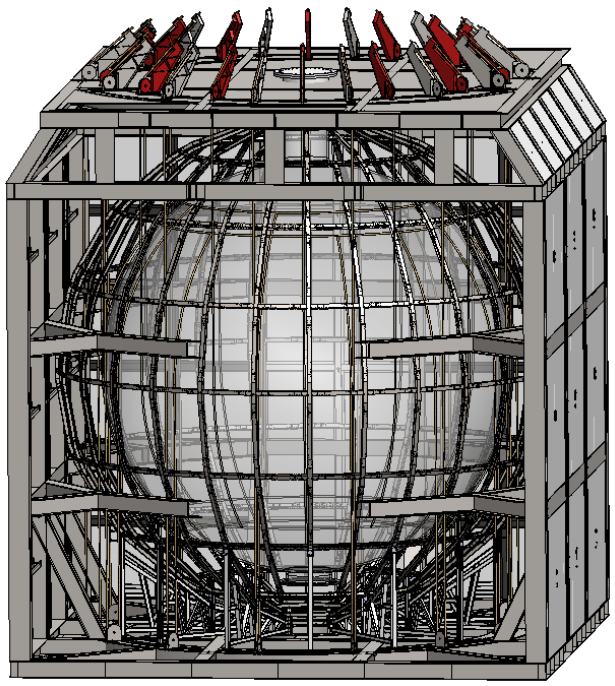
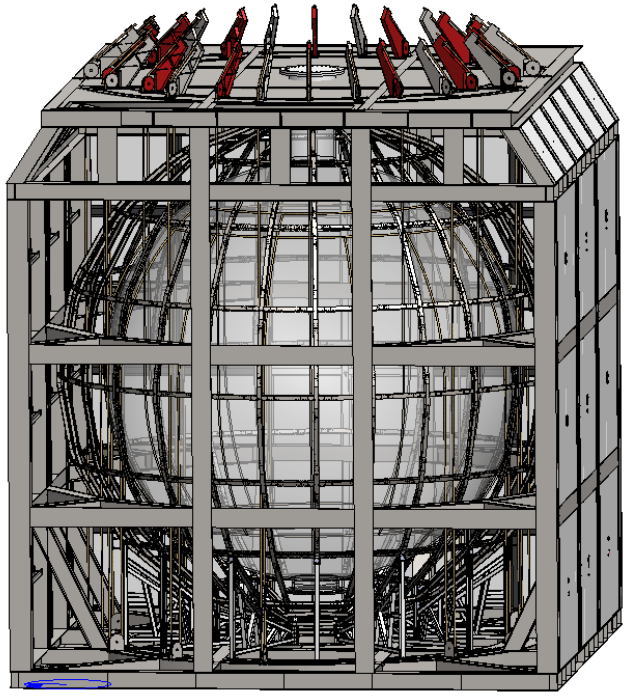
Install the front frame.

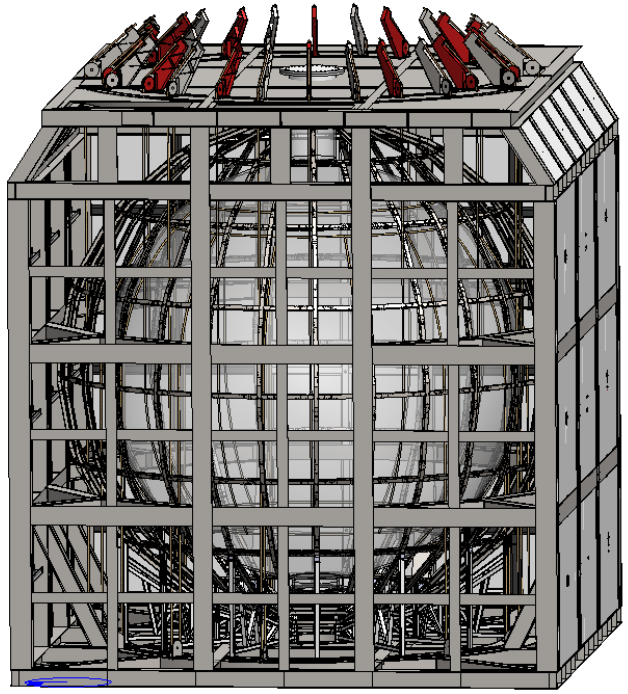
Construction and Installation Sequence:



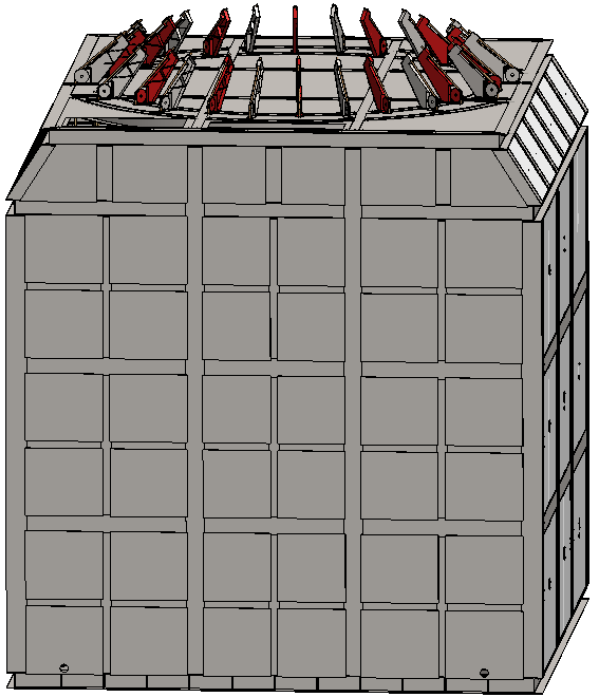
10. Install front frame Y-bracing



11. Install front frame beams and columns.



12. Install cross bracing ribs at front frame.

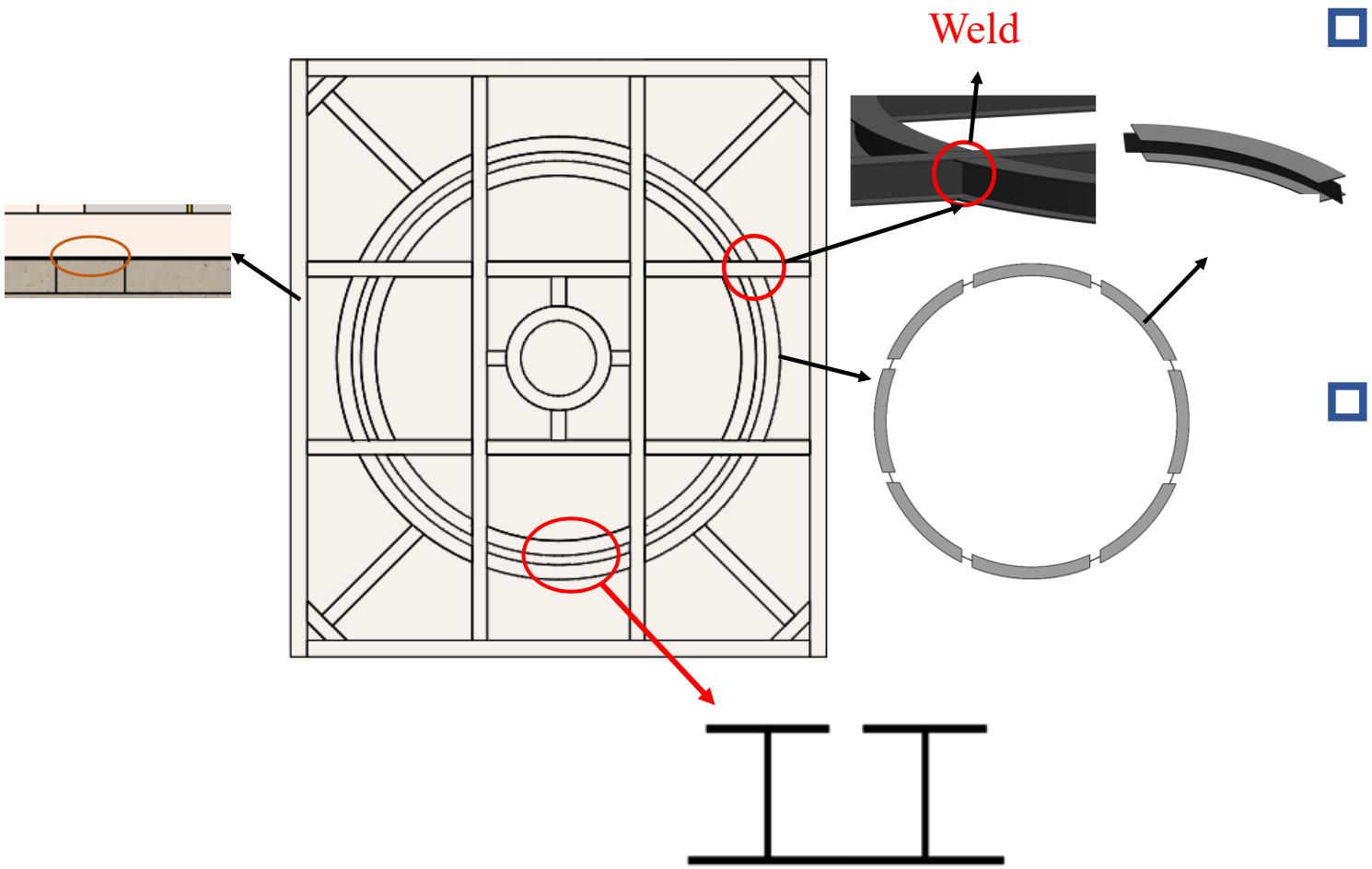


13. Install front frame steel plates.

04

Installation of Steel Frame

Bottom Frame Installation Sequence:



- Bottom frame is **key for sealing**; all parts must be welded.
- Install bottom steel plates after welding stainless rods. I-beams with unequal flanges is used with **long side outside**, **short side inside**.
- Steel plates are installed from short side to long side and welded after positioning.

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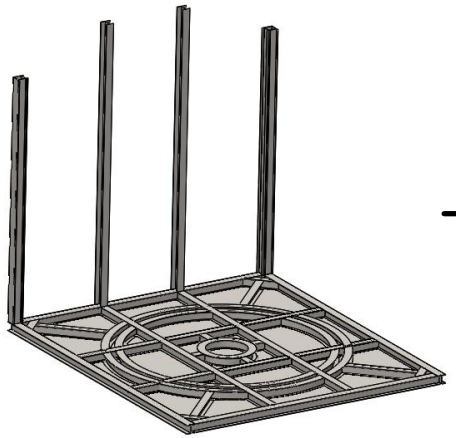
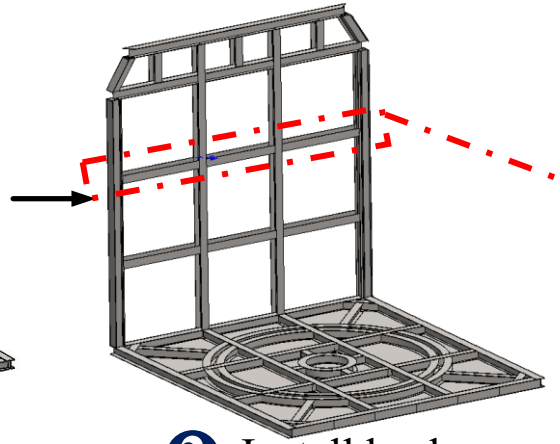
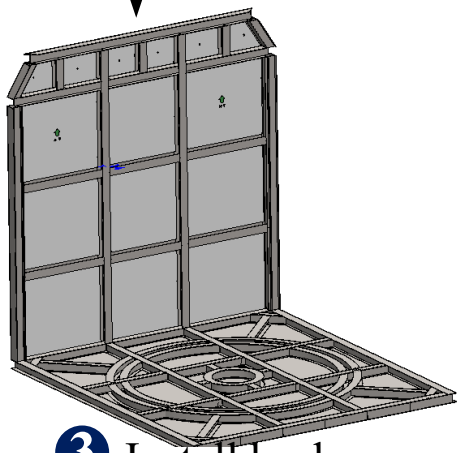
Back Frame Installation Sequence:



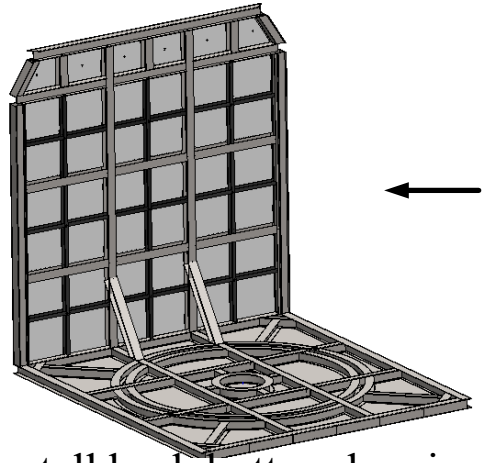
❶ Install back column



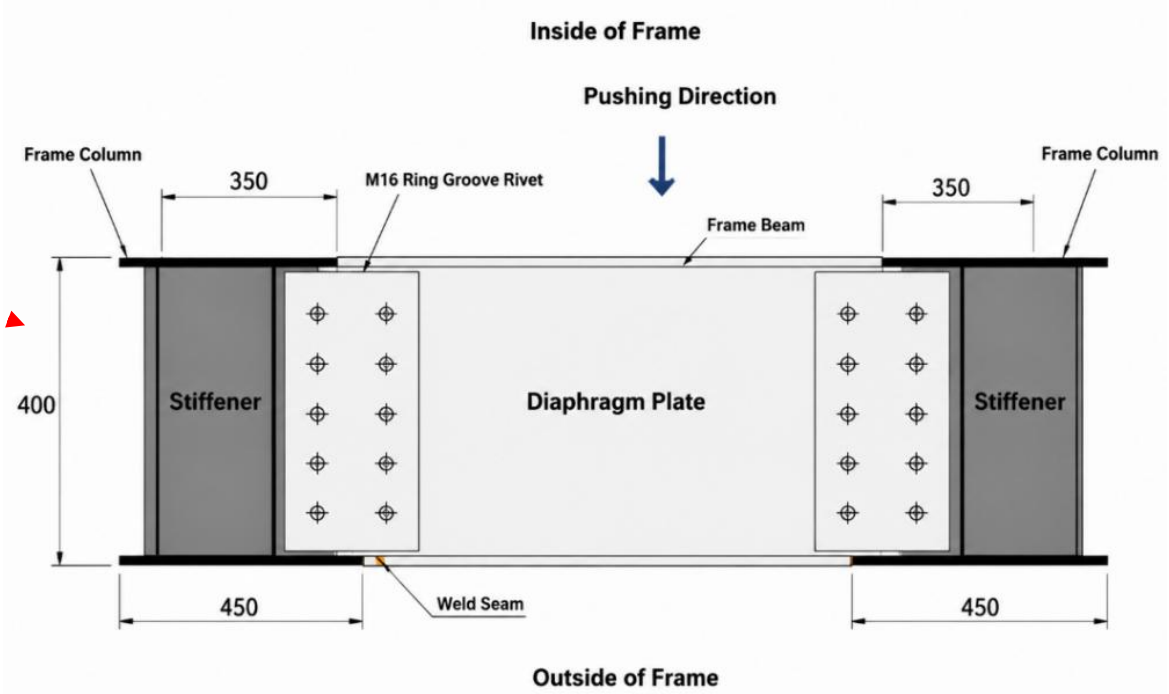
❷ Install back connecting beams



❸ Install back steel plate



❹ Install back bottom bracing and reinforement



- Install the vertical columns and weld them in place, then install the connecting beams and weld them to the columns for positioning.
- Install the steel plates, fix them through alignment holes, and weld them to the frame beams and columns.
- After installation, add diagonal bracing between the bottom and side frames for structural reinforcement.

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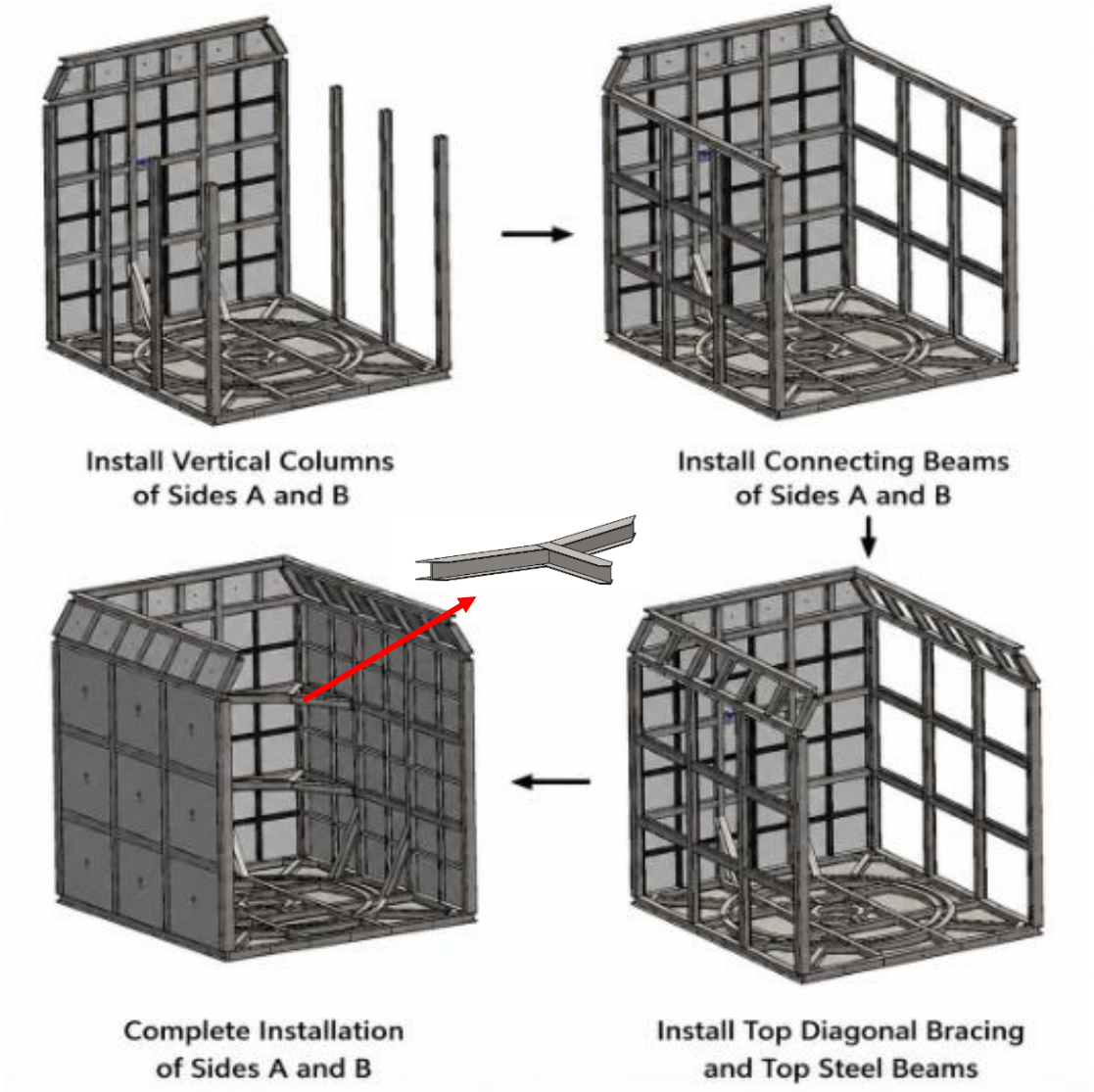
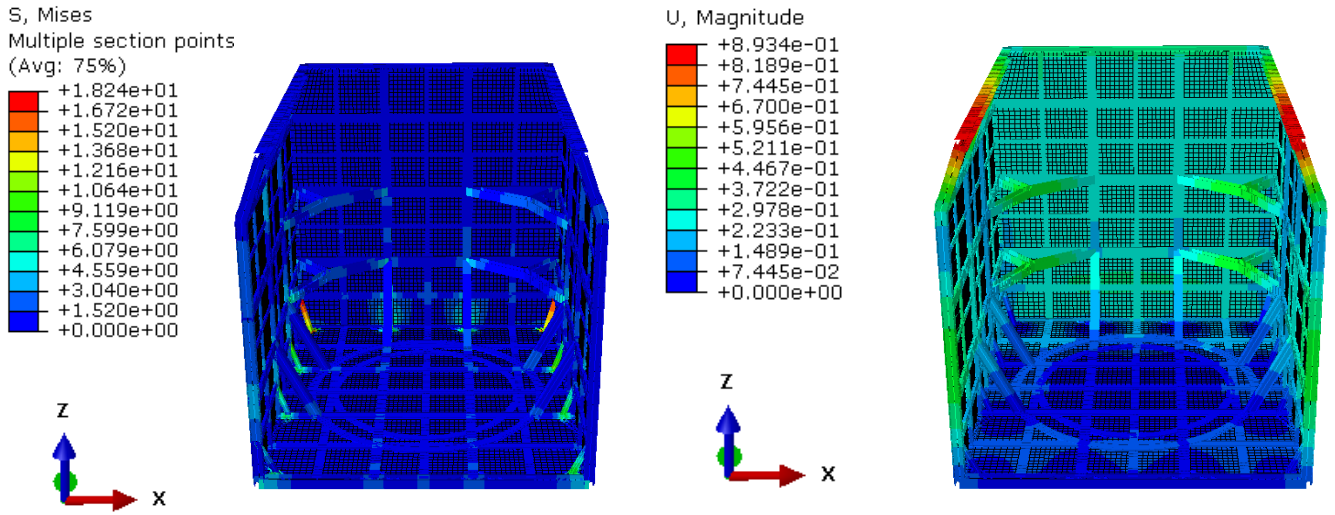
A、B Side Frame Installation Sequence:



- The installation sequence of the left and right side frames is the same as the back frame. Based on the bottom bracing, two additional Y-shaped tie rods are installed between the side frames and the back frame for structural reinforcement.



Meet national standards.

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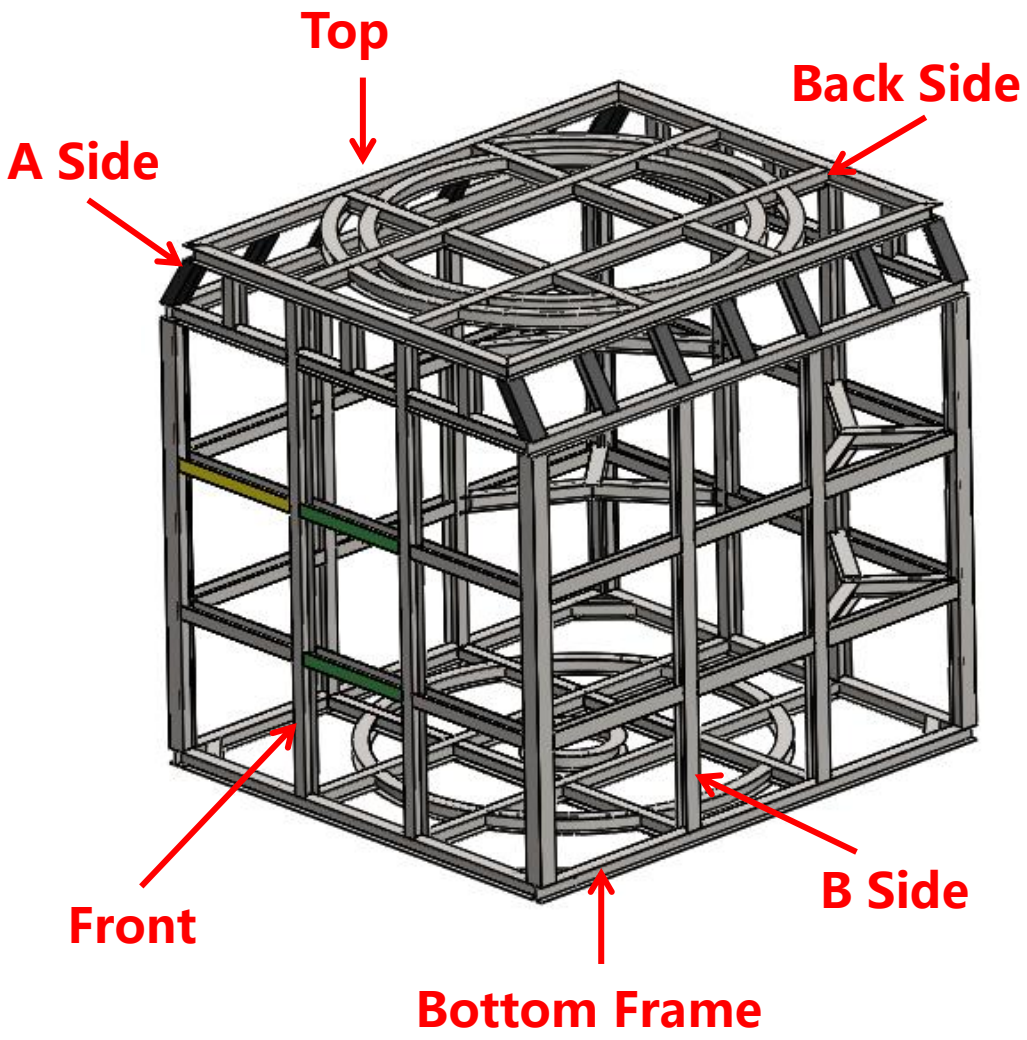
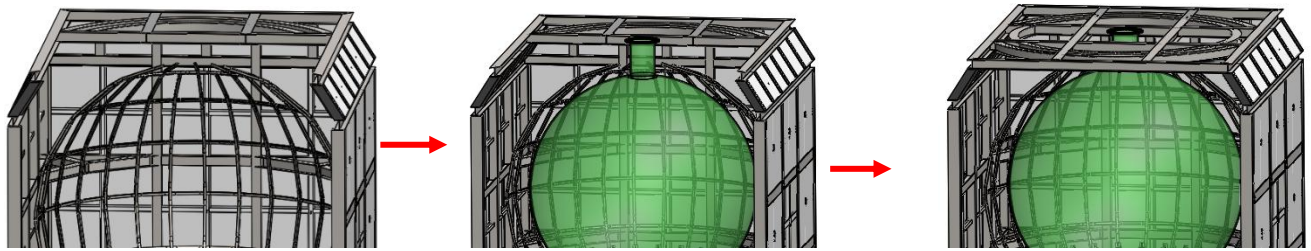
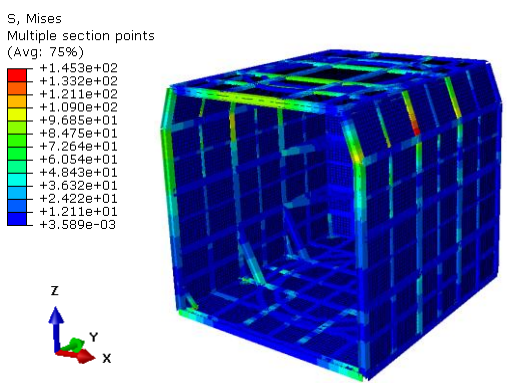
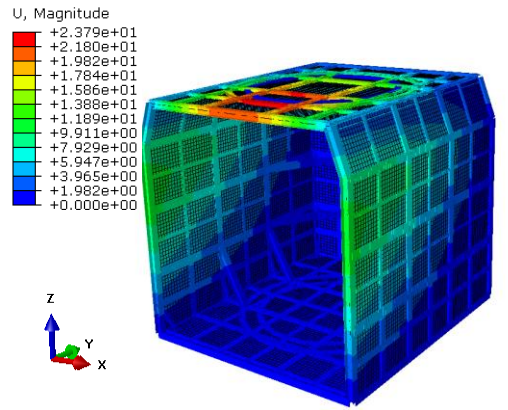
Top Frame Installation Sequence:



- The top stainless steel frame is installed in two sections: first install the inner half of the top frame, and after the acrylic vessel construction is completed, install the outer half of the top frame and steel plates.







Meet national standards.

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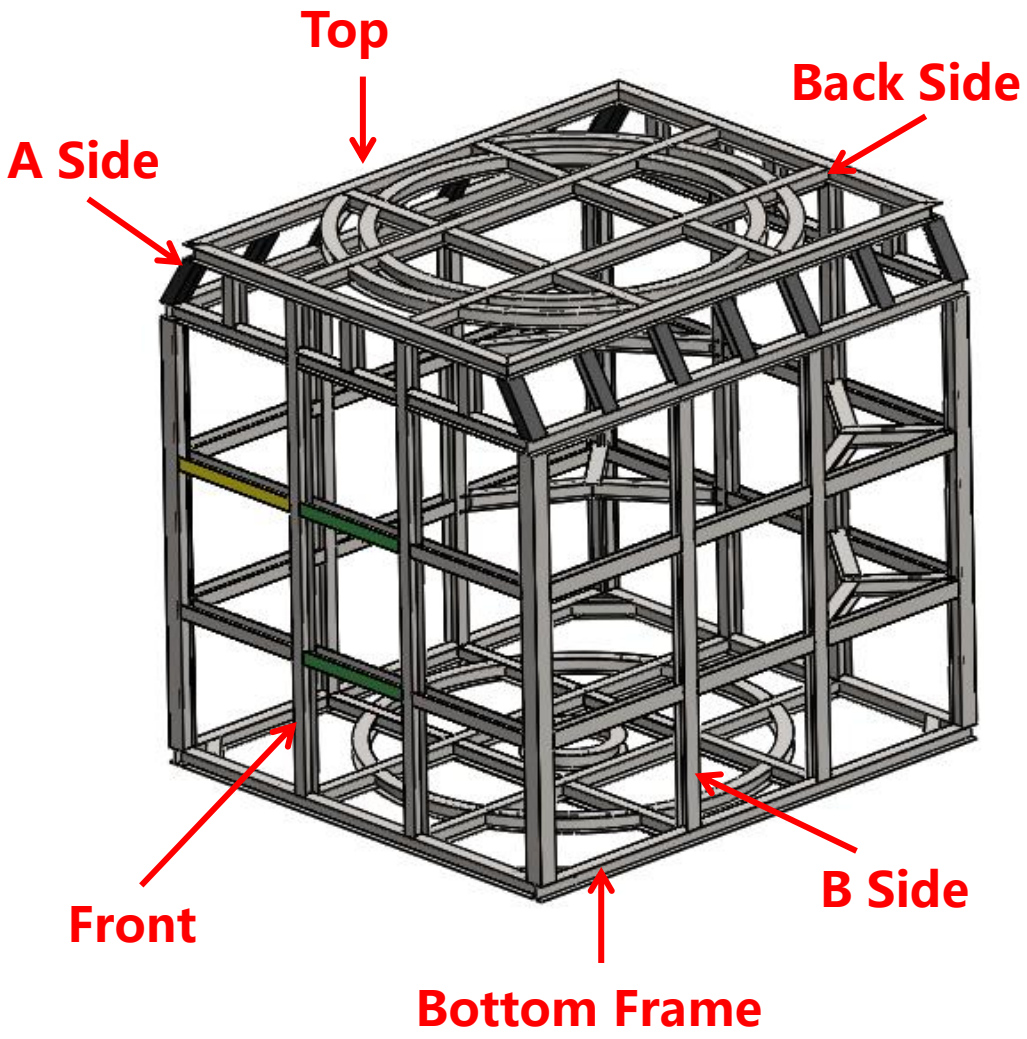
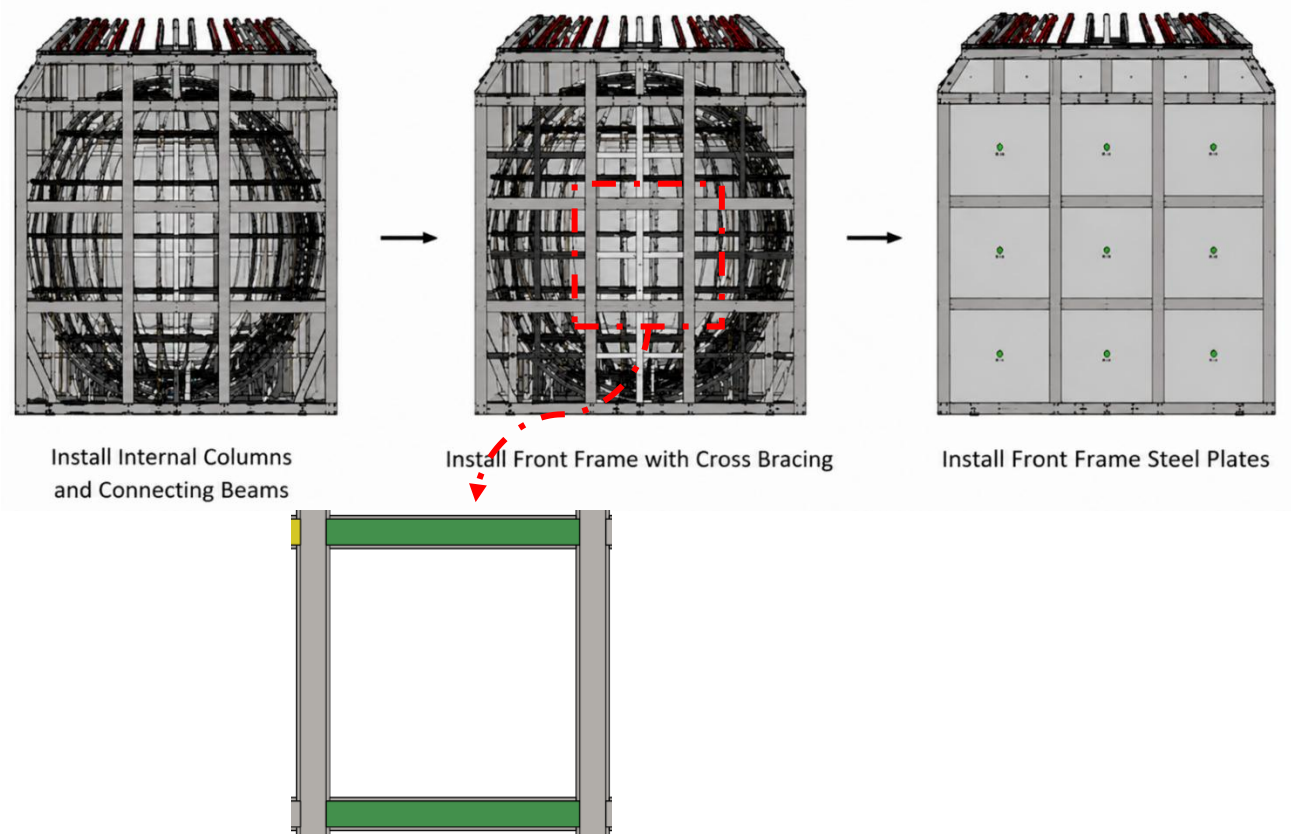
Front Frame Installation Sequence:



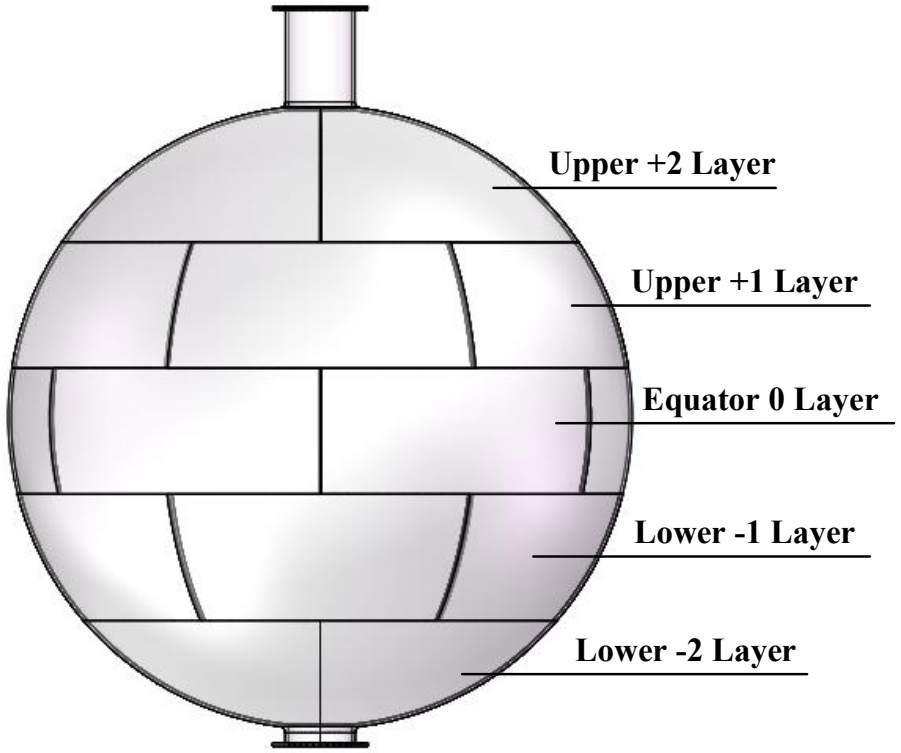
- Outside the foundation pit (D2 plant passage), install the stainless-steel frame at the entrance, stiffeners, and entrance steel plates; detector installation is completed.



Installation method of I-beam section at the entrance frame

05

Installation of Acrylic Vessel



Weight：Approx. 25 ton

1、Chimney flanged connection

2、Joint misalignment

Name	Type	Site	Diameter Maxumum	Split Quantity	Weight per Piece
Ø10000mm Sphere	Spherical shell layer 1	Upper & Lower 2 layers	Approx. 7842 mm	4	Approx. 250Kg
	Spherical shell layer 2	Upper & Lower 1 layers	Approx. 9652 mm	6	Approx. 660Kg
	Spherical shell layer 3	Equator (0 layer)	Approx. 9960 mm	6	Approx. 900Kg
Ø1000mm Cylinder	Chimney		1000mm		Approx. 350Kg

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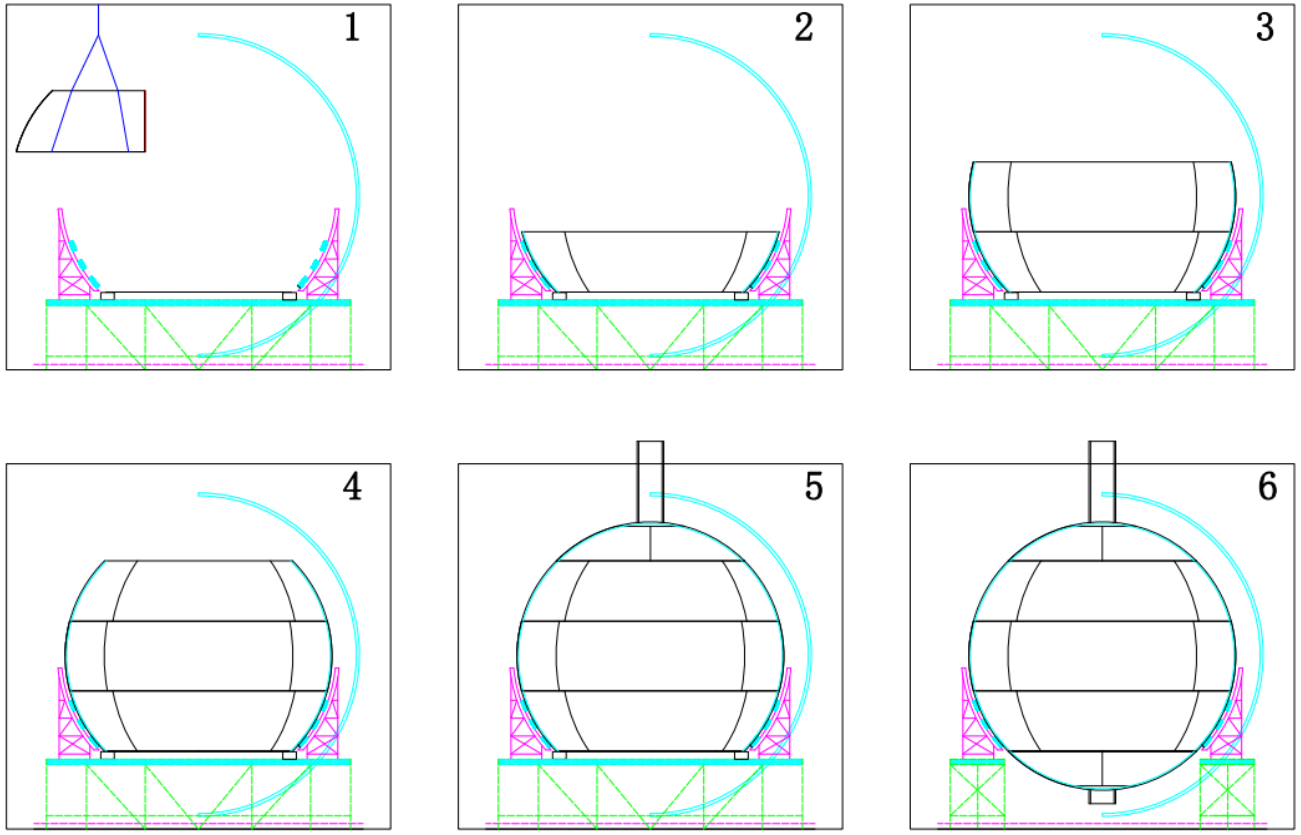
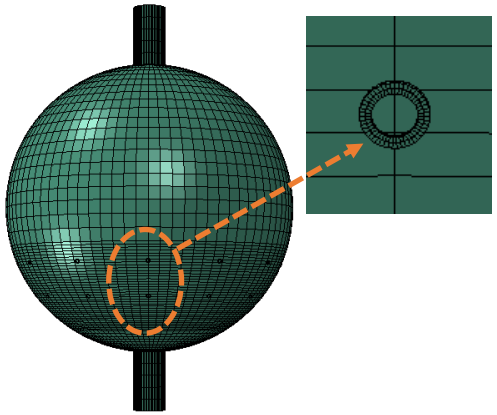
Installation Sequence of Acrylic Vessel:



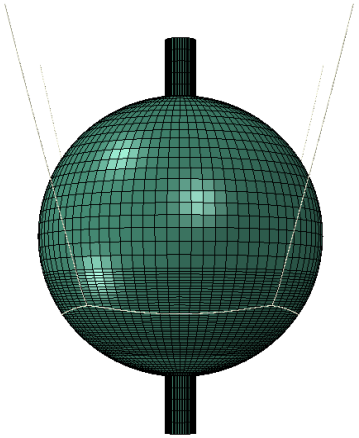
06

Installation of the Rope and Stainless Steel Grid Shell

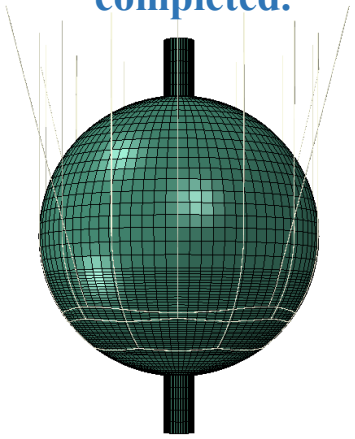
Installation of the high performance fiber rope:



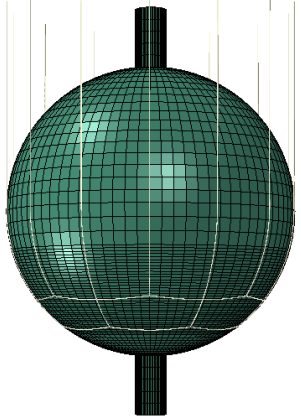
1.Spherical structure completed.



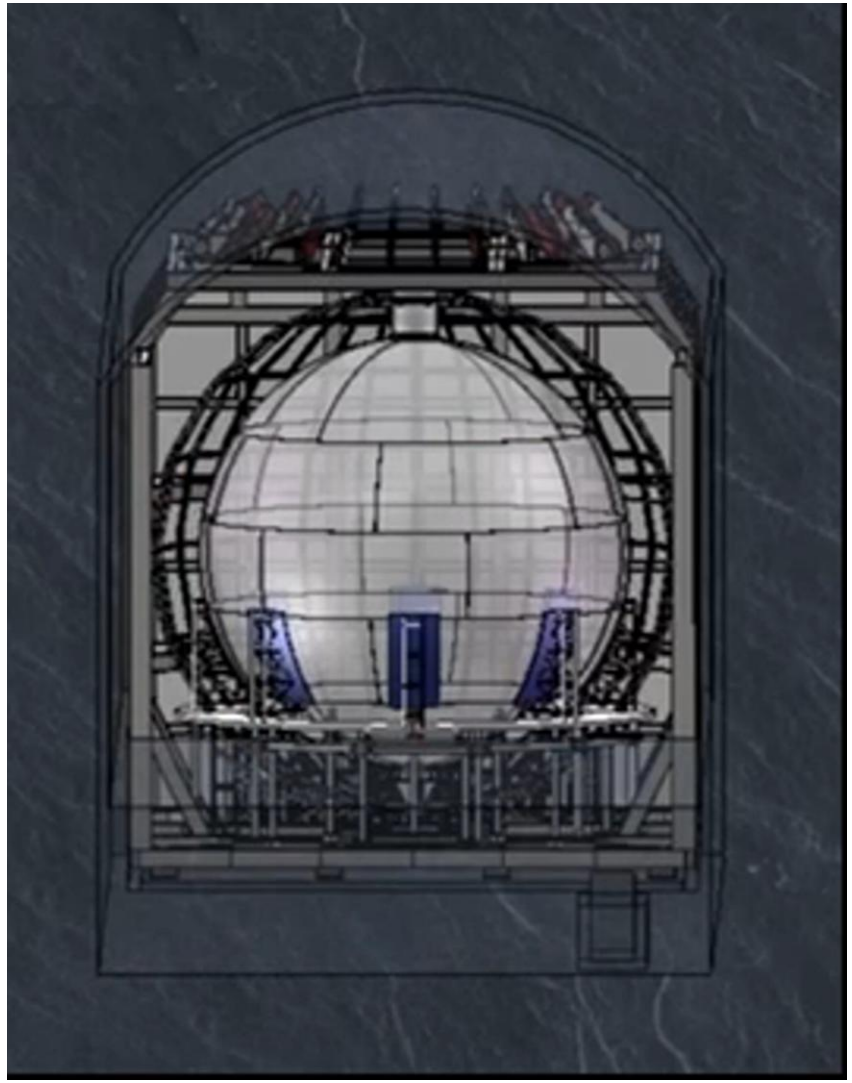
2.Lift the sphere using temporary ropes



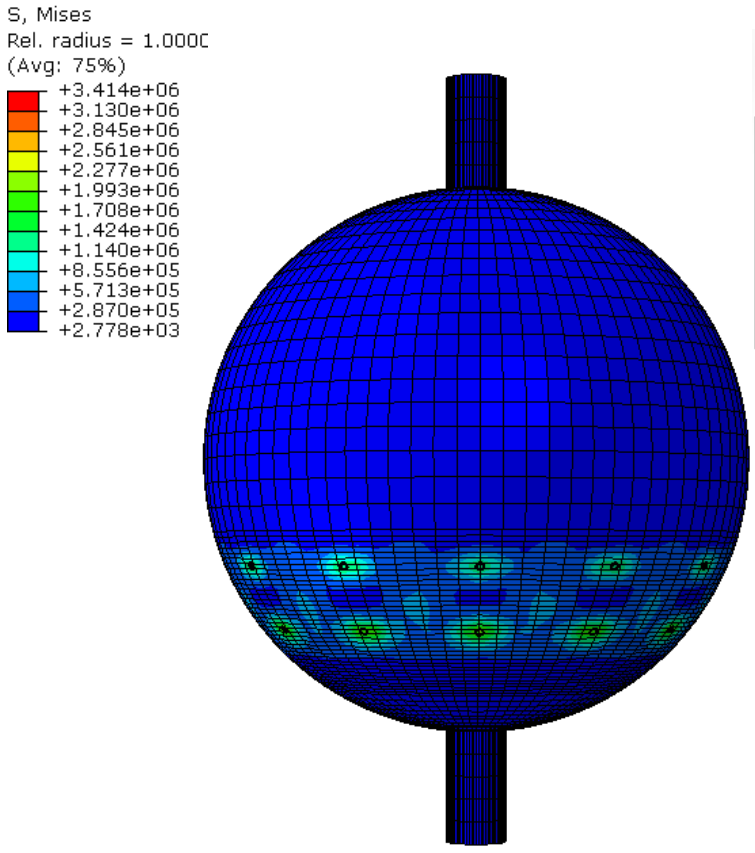
3. Transfer load slowly to spherical fixing ropes.



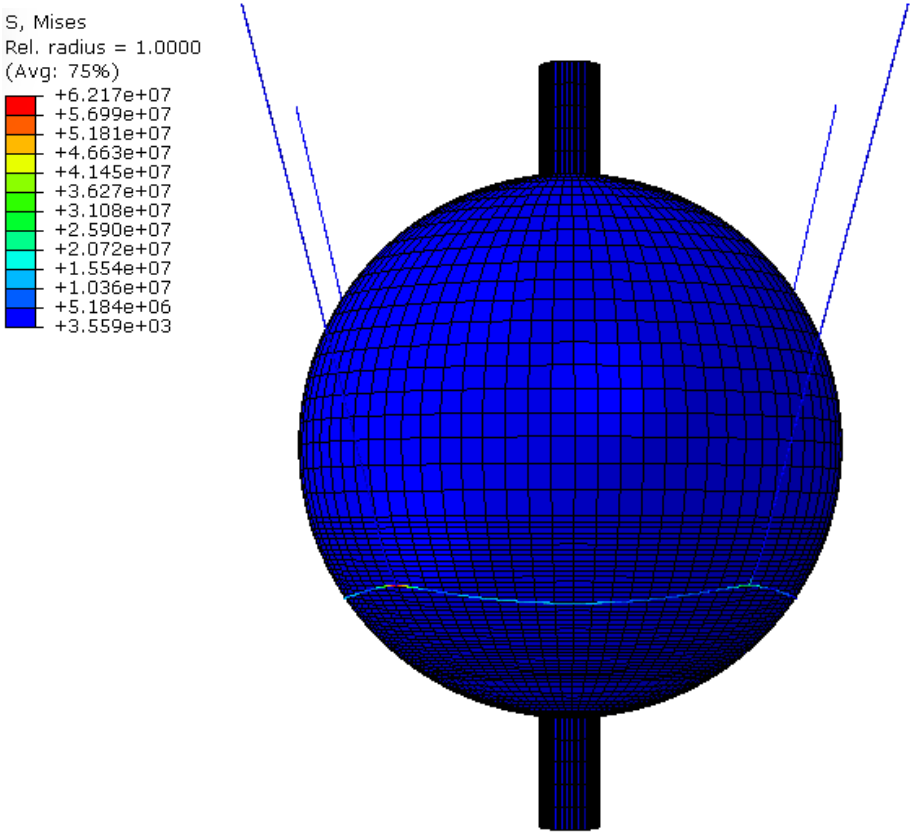
4. The sphere load is taken over by fixing ropes.



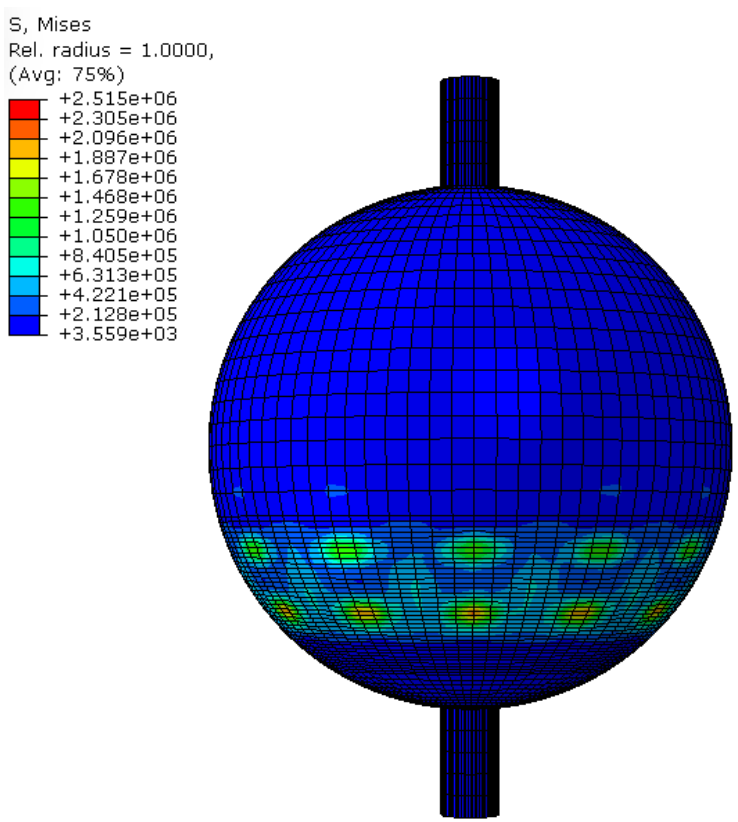
Calculation results:



No.1 Step



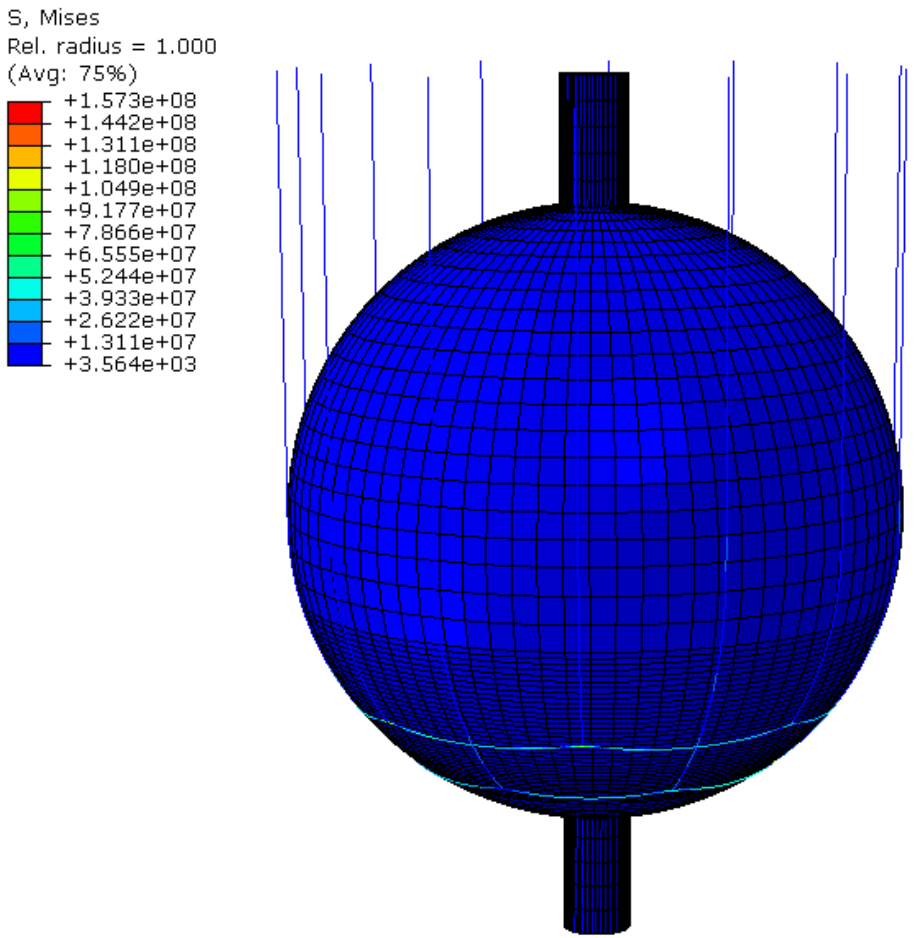
No.2 Step

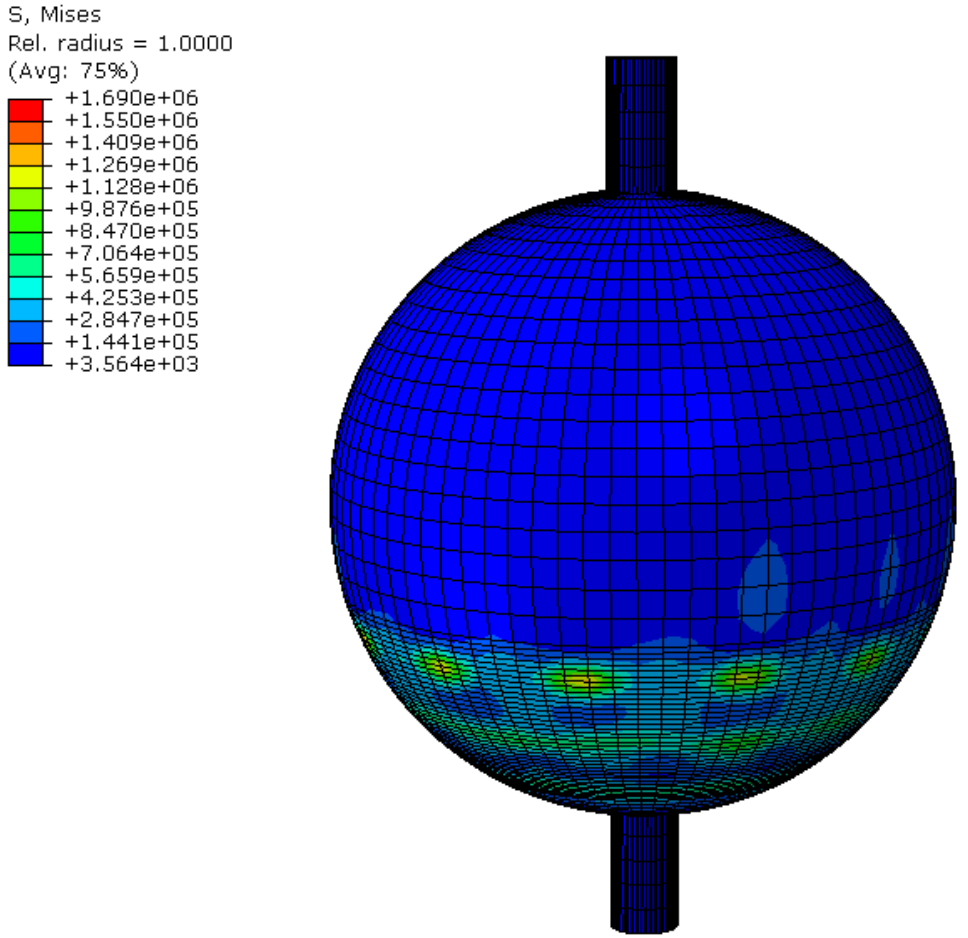


No.3 Step

Local stress in the sphere is less than 3.5 MPa, meeting the design requirements.

Calculation results:

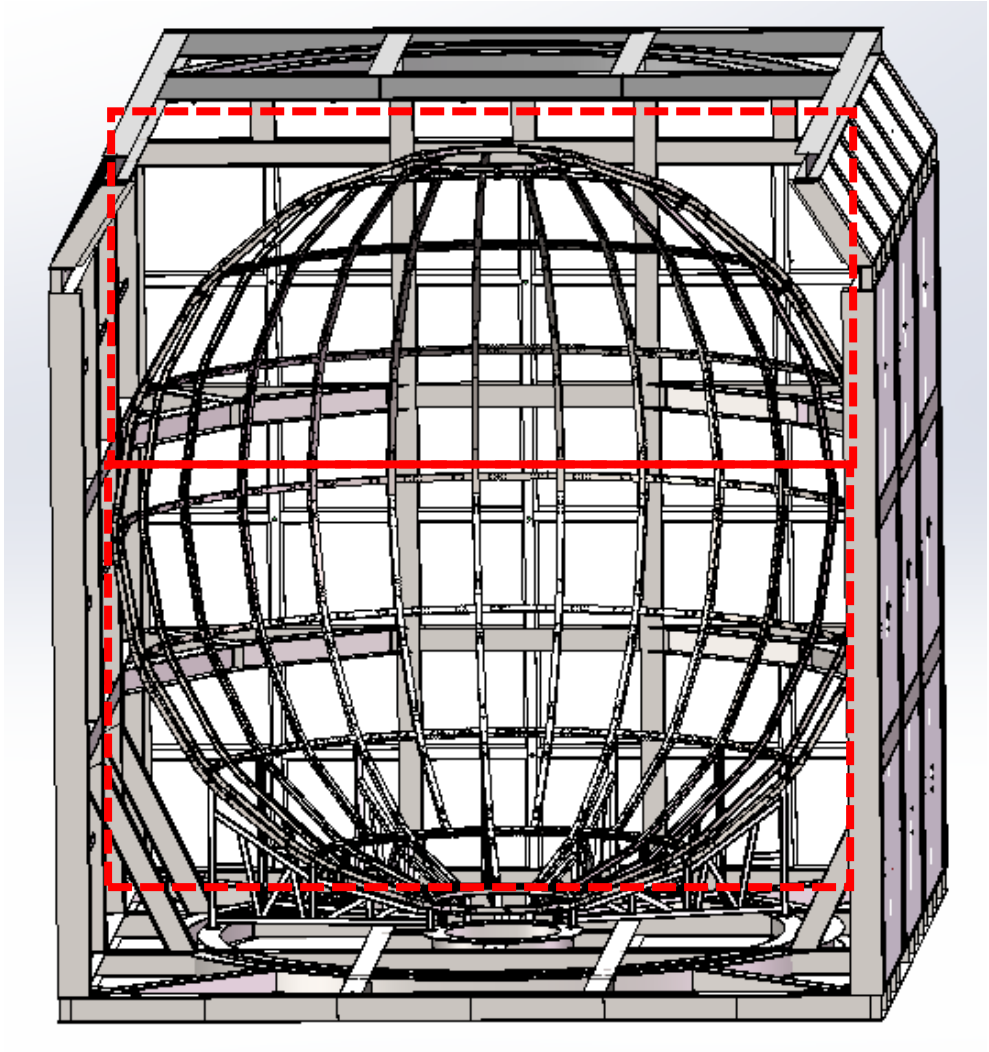


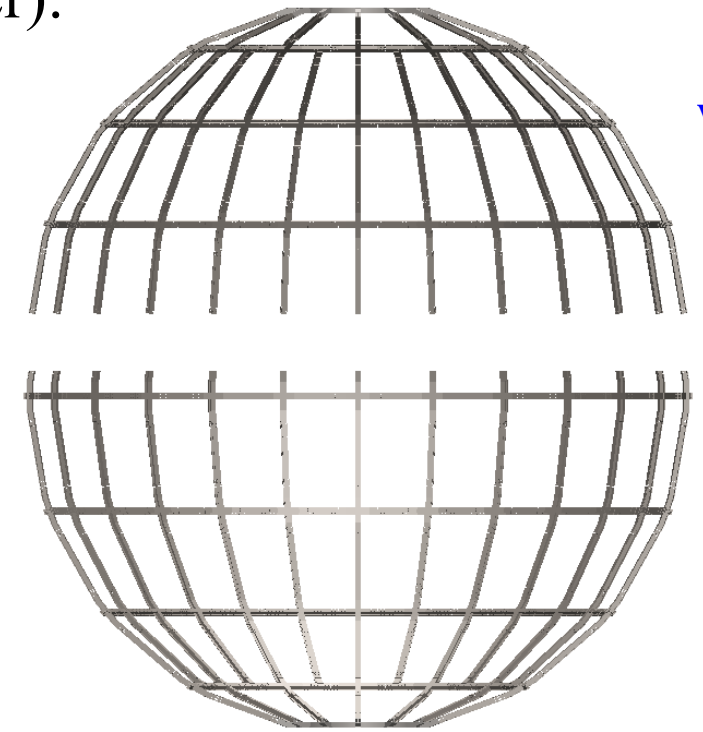


No.4 Step Stress

Local stress in the sphere is less than 3.5 MPa, meeting the design requirements.

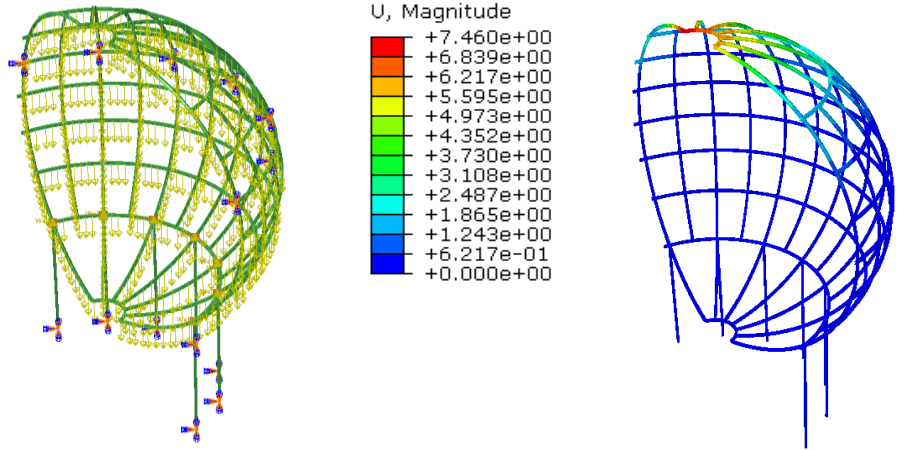
Grid Shell Structural Framing Installation(inner):





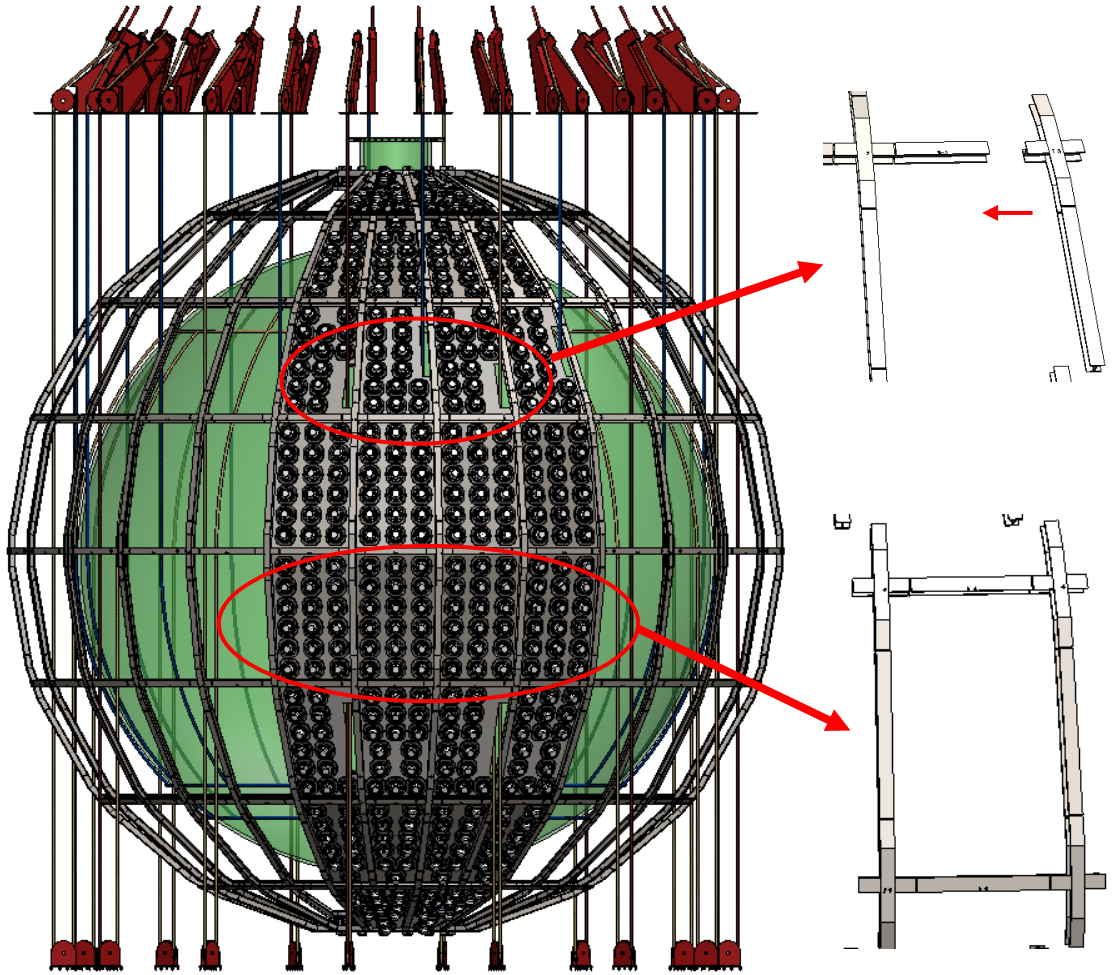
Weight Approx.
3 ton

Weight Approx.
3.2 ton

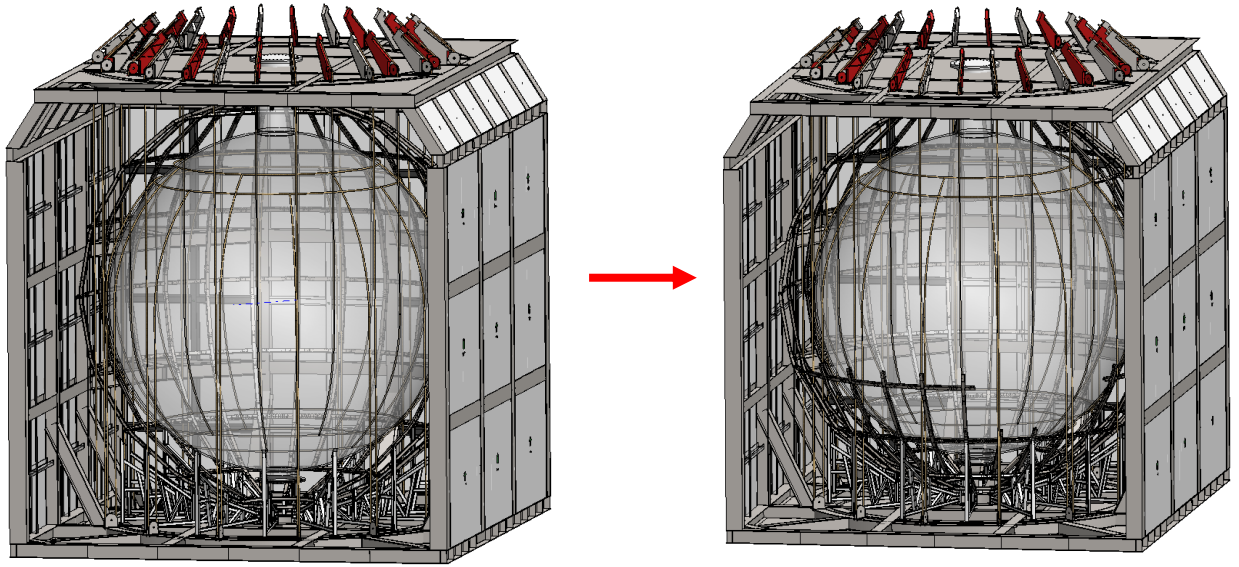


Meet national standards.

Grid Shell Structural Framing Installation(Outer)



- Secure the sphere, then assemble the outer framing from bottom to top.
- Due to rope interference, framing at the 3rd (alternate zones) and 6th layers must be assembled on-site.
- The remaining non-conflict sections can be pre-fabricated into small segments and then hoisted into place.



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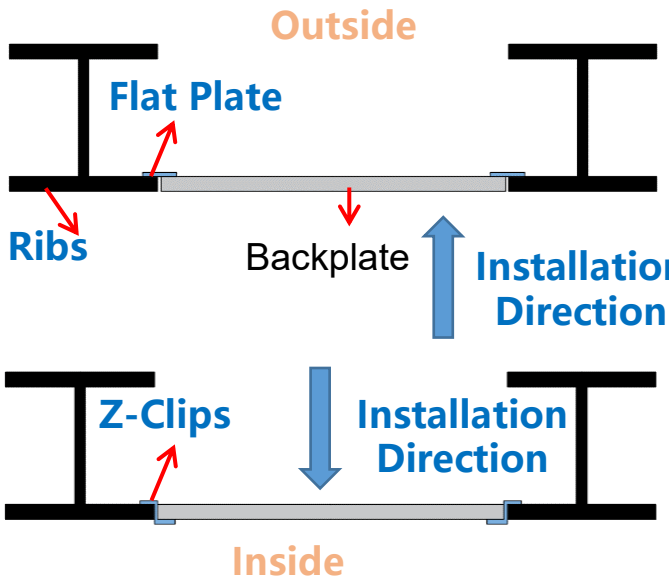
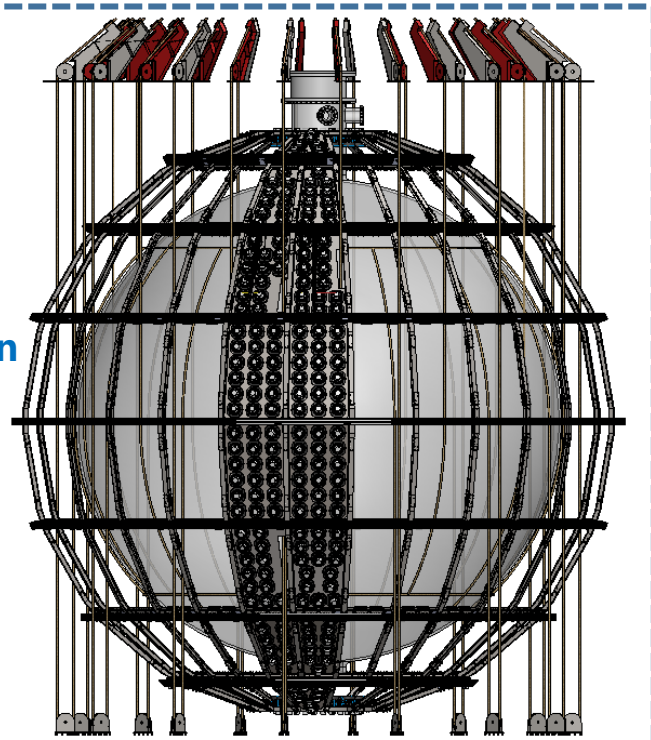
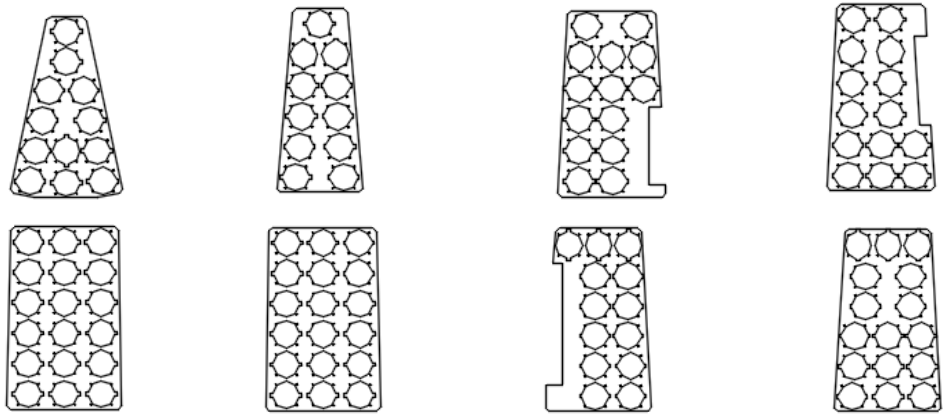
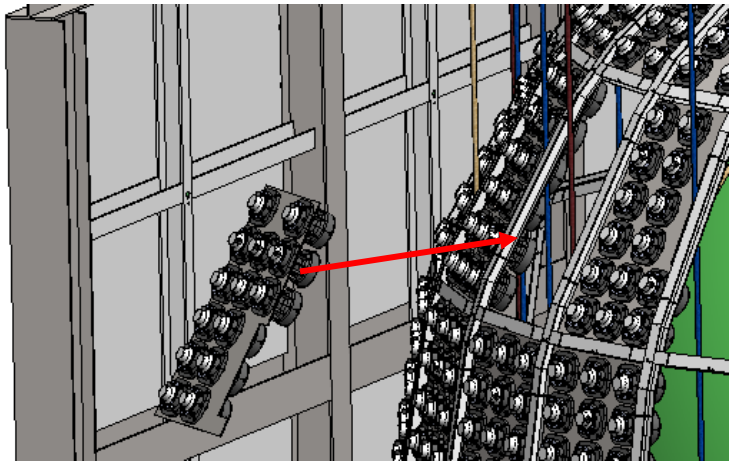
Steel Backing Plate for Grid Shell



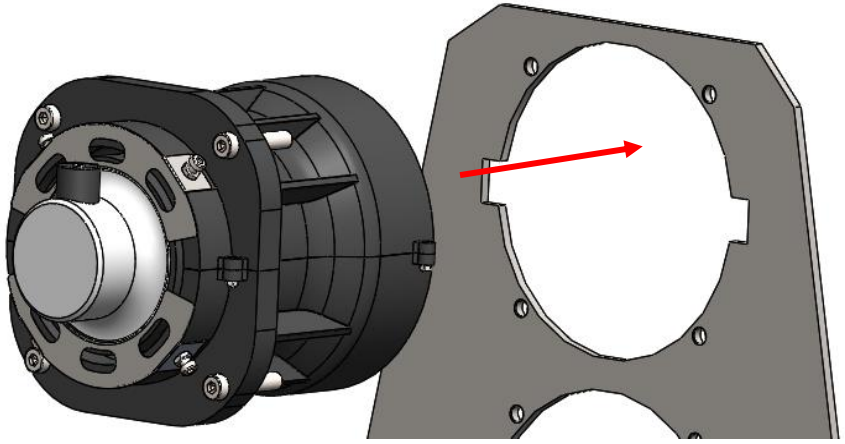




PMT:

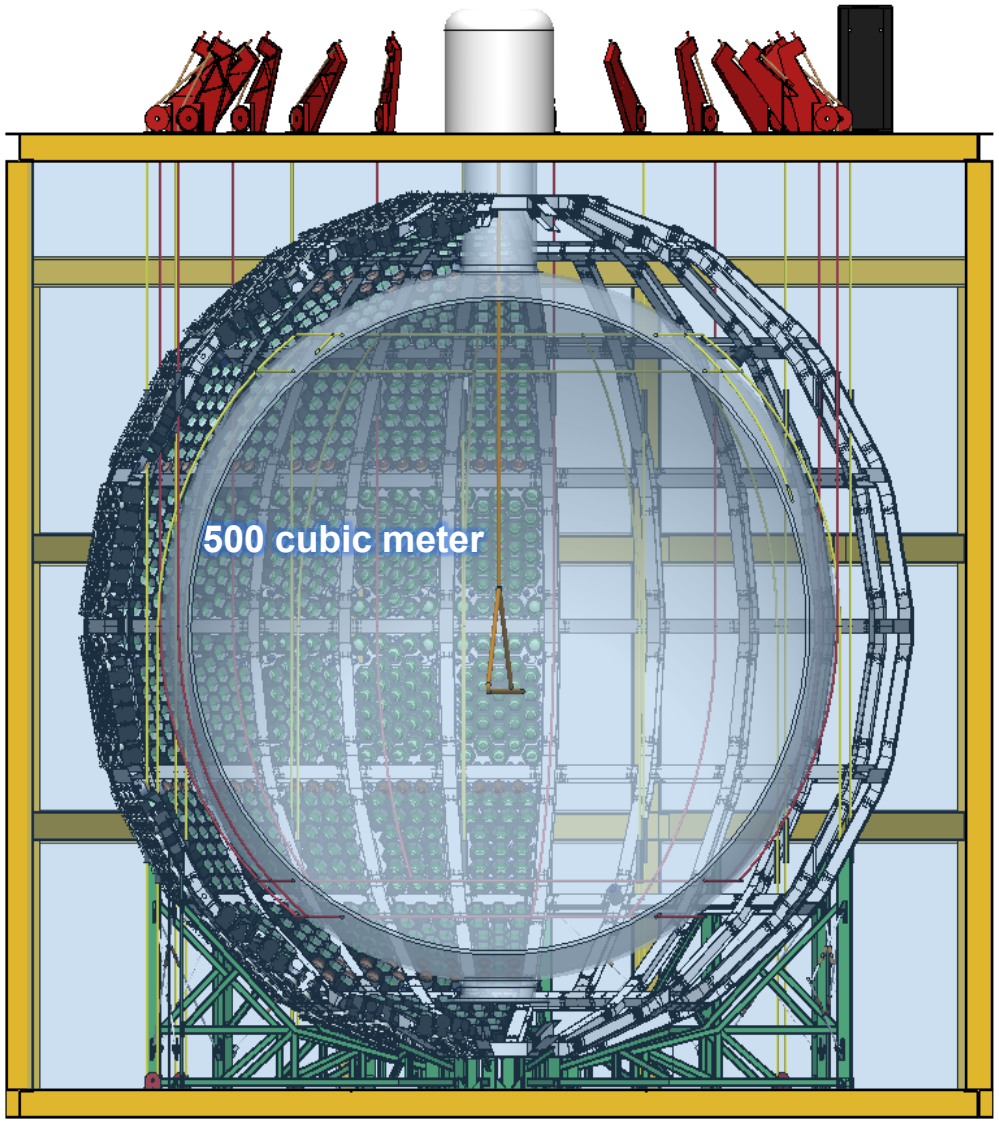


■ Overall lifting



■ Manual installation

Conclusion

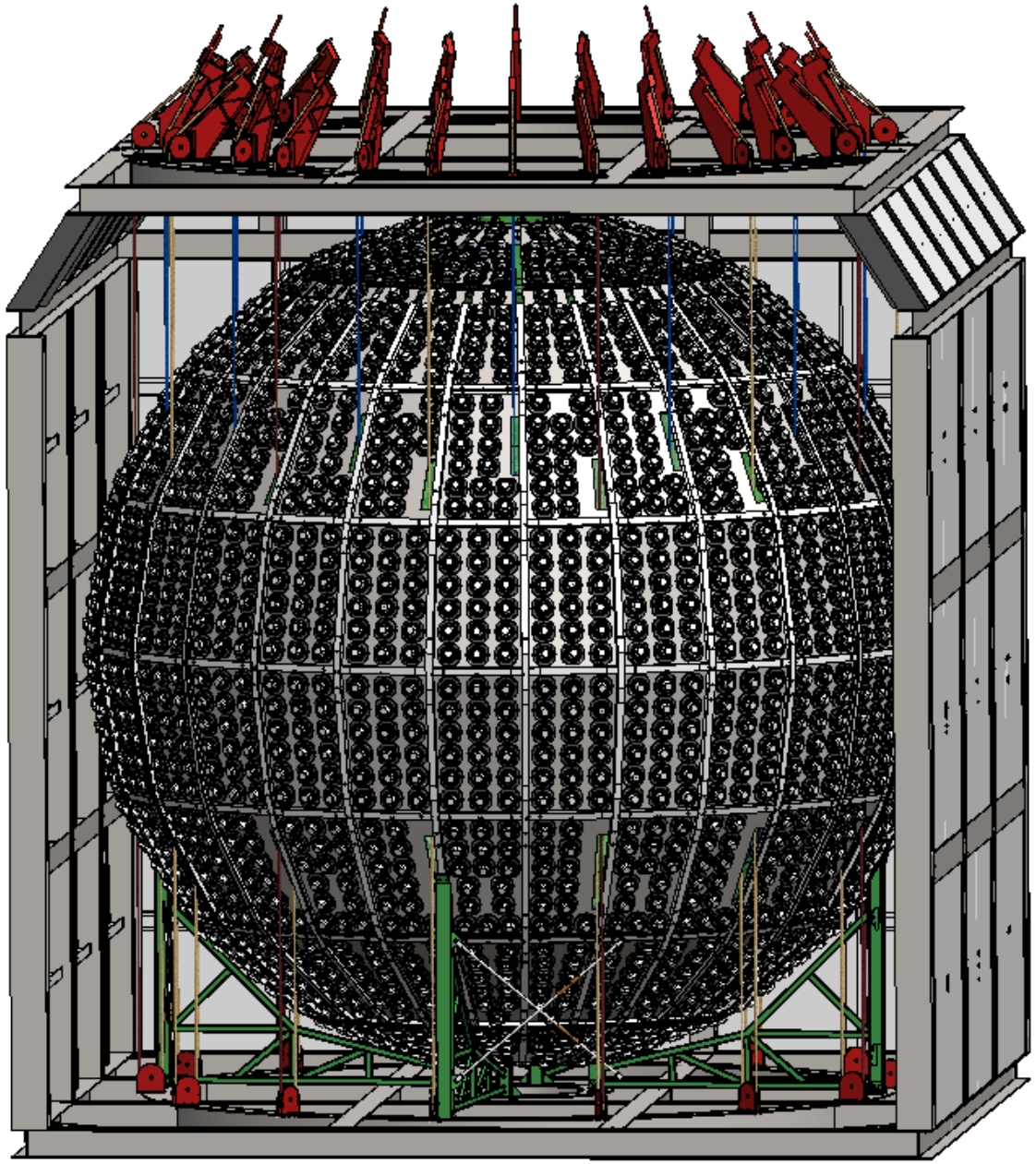


- All Stainless-steel frame are factory-prefabricated and assembled on-site after hoisting, with top frame installed in inner and outer halves under code-compliant deformation control.

- Inner steel grid shell is pre-assembled and lifted by monorail crane, while outer frame is installed in segments after sphere and ropes; PMTs are mounted after backing plate preparation.

- Acrylic vessel is installed layer-by-layer from bottom to top inside the frame, with final bottom layer installed last and thermal treatment applied via local and global annealing.

- Temporary ropes are used during fiber rope installation; final rope assembly is completed after removal of temporary acrylic vessel supports.



Thank you for your time and consideration.