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Preliminary design of CEPC detector installation scheme

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2. The investigate of heavy duty guide
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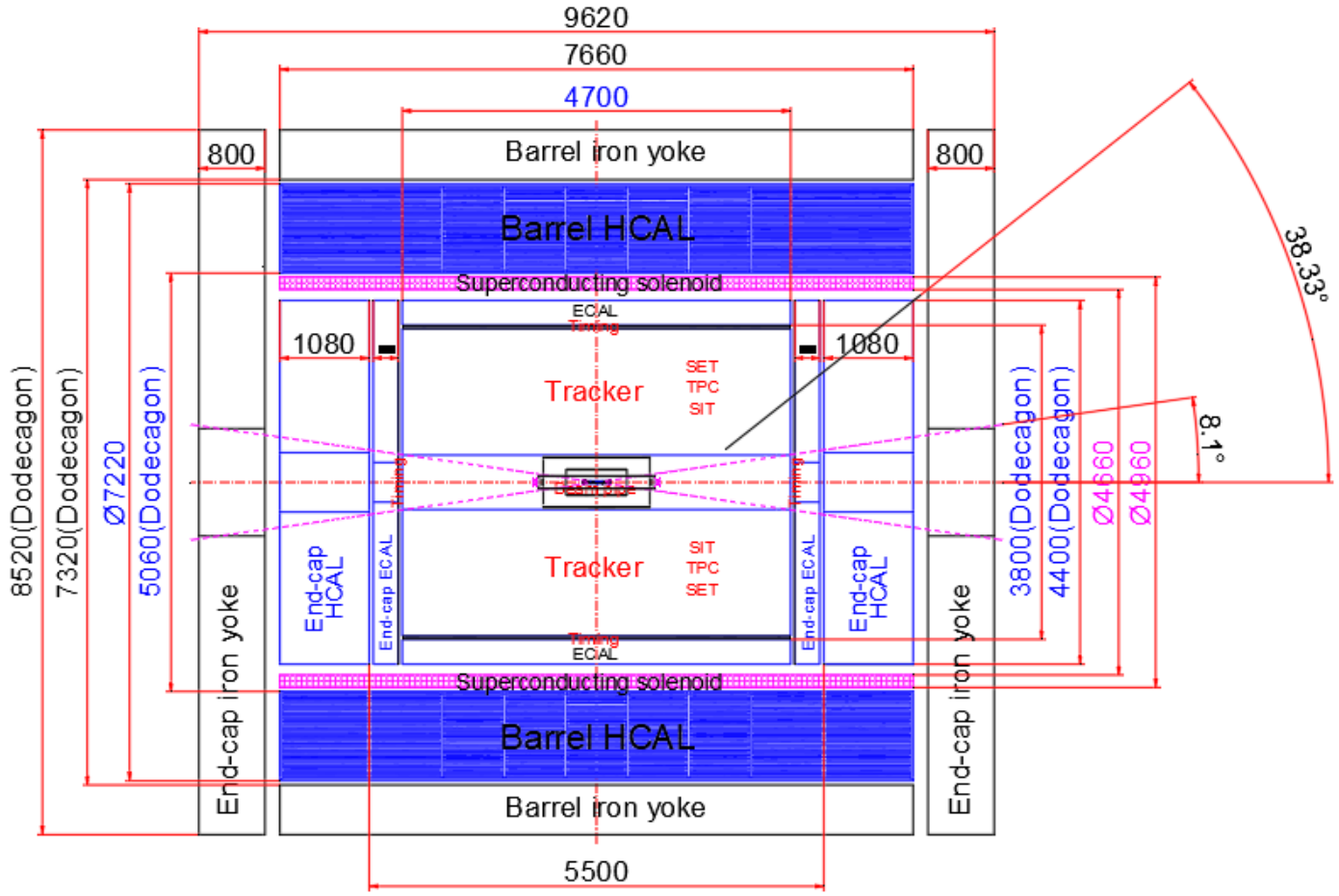
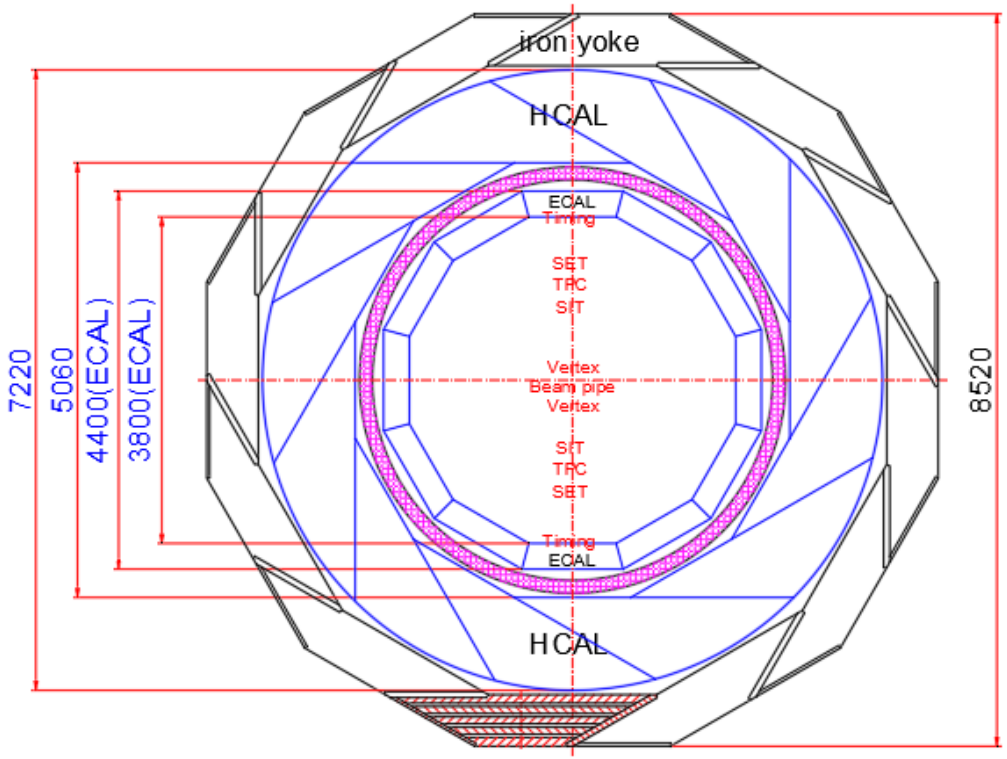
5. Summary

1. Overview

- CEPC detectors are multi-level nested structure.
- The total length is 9620mm,the height is 8520mm.

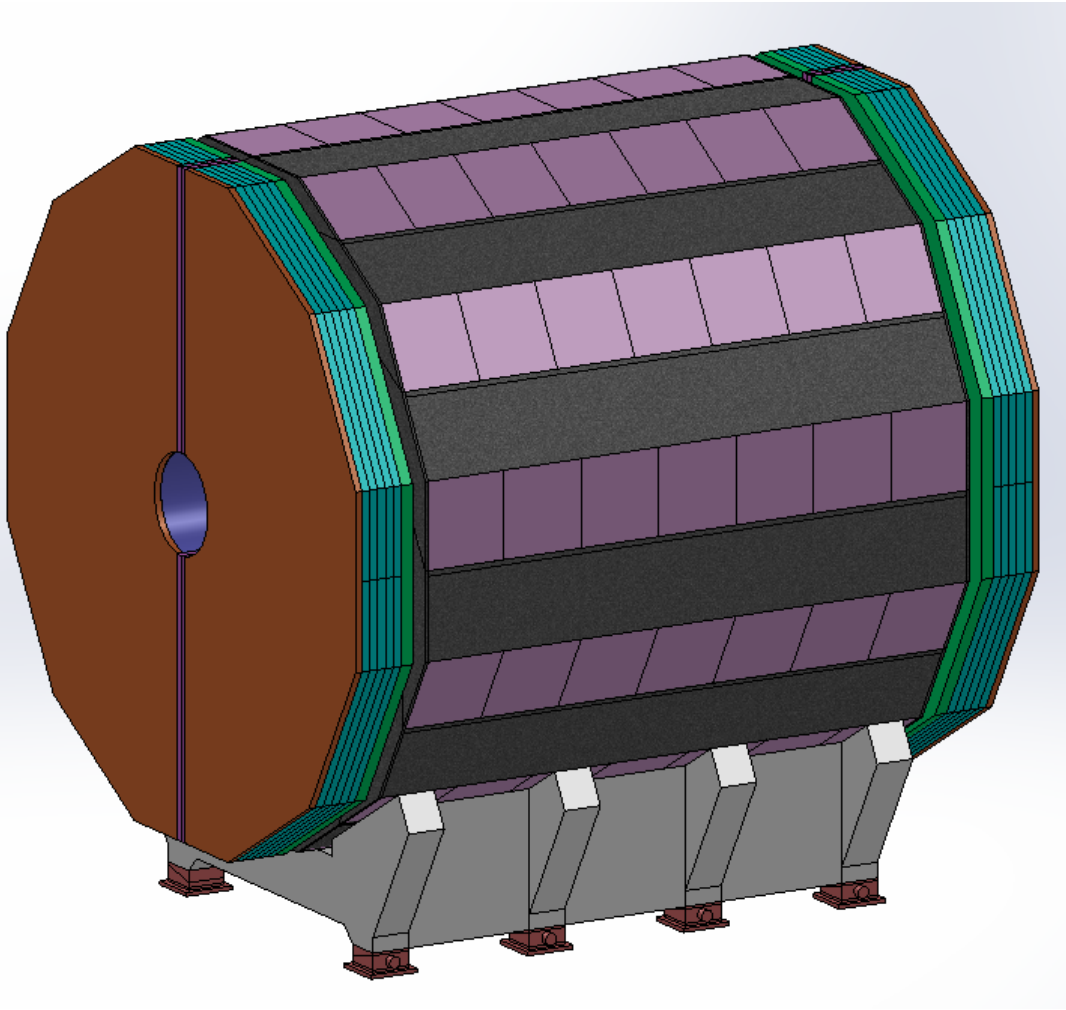




1. Overview

- The total weigh is about 3,000 tons,
- The structure of the lightweight detector has not yet been determined.

SN	Name	Total weight（ton）	Number	Weight of each（ton）	Boundary Dimension	mounting clearance
1	Barrel iron yoke	1200	12	100	Φ8520, L:7660mm	/
2	HACL	1200	12	100	Φ7220, L:7660mm	50mm
3	Superconducting solenoid	30	1	30	Φ4960, L:7660mm	50mm
4	ECAL	120	12	10	Φ4400, L:4700mm	50mm
5	SET+TPC+SIT (Lightweight detector)	?	?	?	Φ3800, L:4700mm	/
6	End-cap iron yoke	500	5	100	Φ8520, L:800mm	180mm
7	End-cap ECAL	100	1	100	Φ7220, L:1080mm	50mm

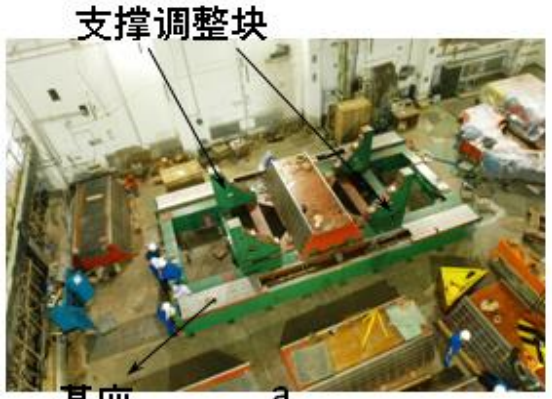


2.1 Installation experience of BESIII

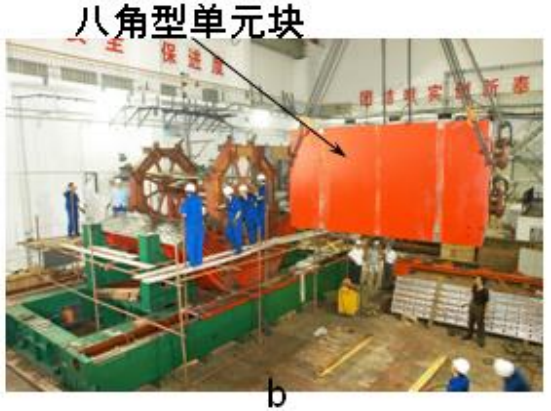
- The dimensions of the detector are 5.1 m in height and 5.8 m in length. The overall weight of the detector is approximately 500 tones.
- **Features:** the detectors are pushed into the center by roller guide rail, the total detectors are pushed to the collision point at last after assembled at the side by slide guide.

a

b



a



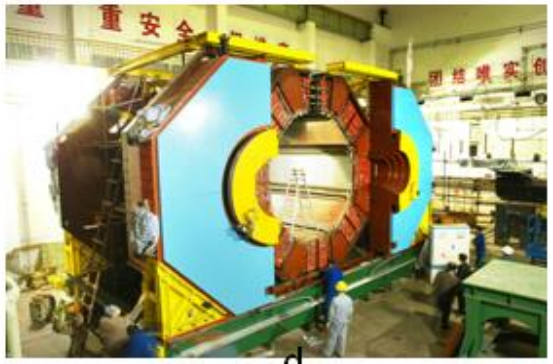
b

a

b

导向支撑架

c



d

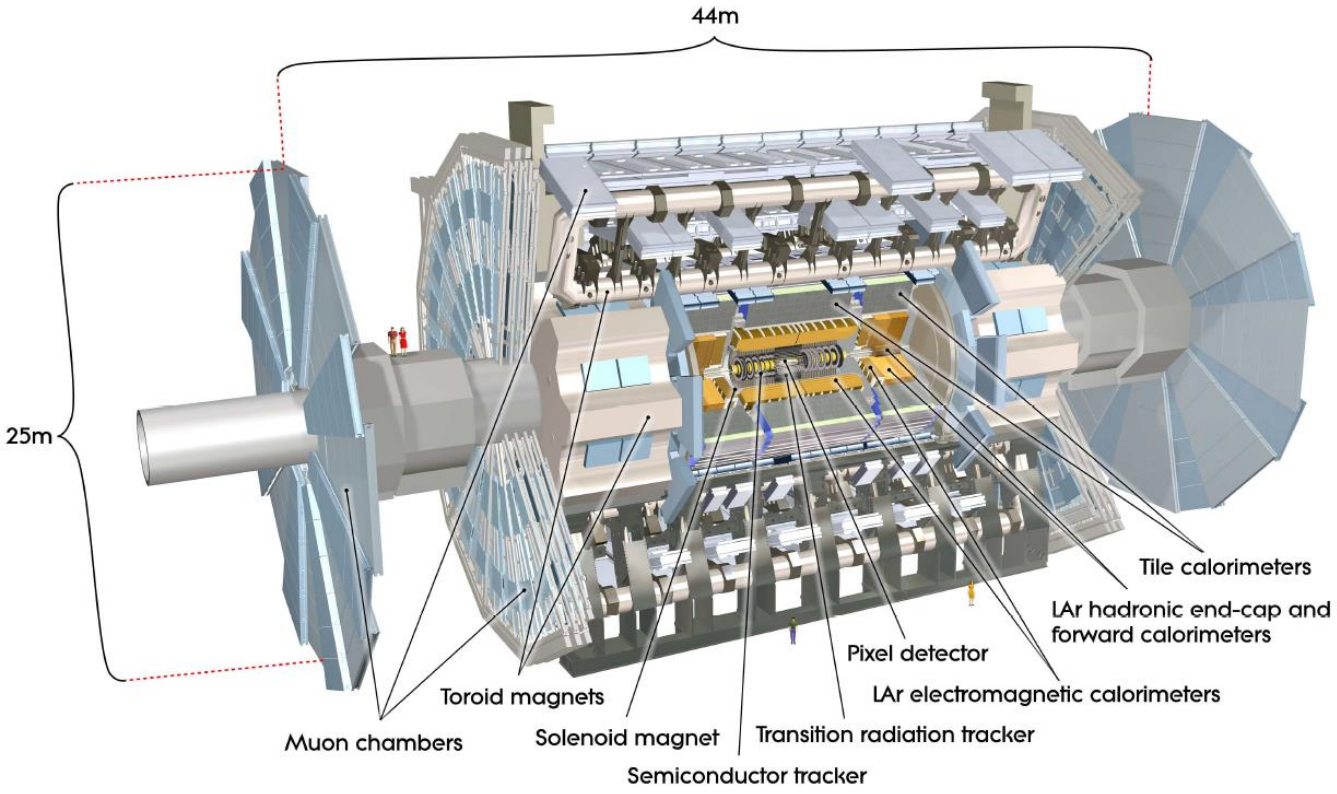
a

b

导向支撑座

2.2 Installation experience of ATLAS

- The dimensions of the detector are 25 m in height and 44 m in length. The overall weight of the detector is approximately 7000 tones.
- **Features:** the yoke iron and guide base combined together, and the guide rail is mounted internally, the internal equipment are pushed in by hydraulic cylinders with air pad support.



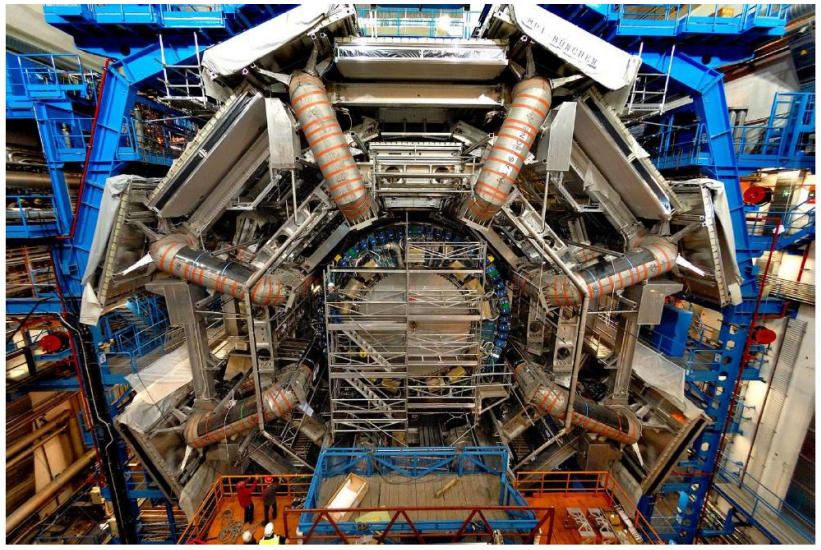
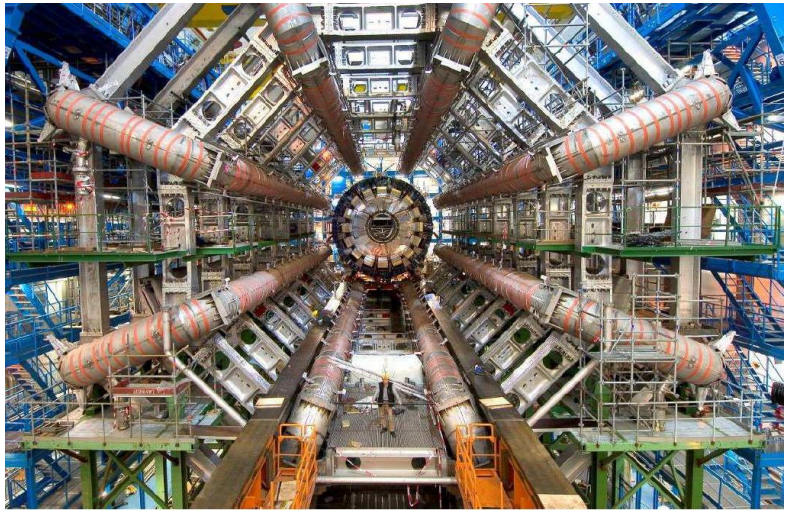
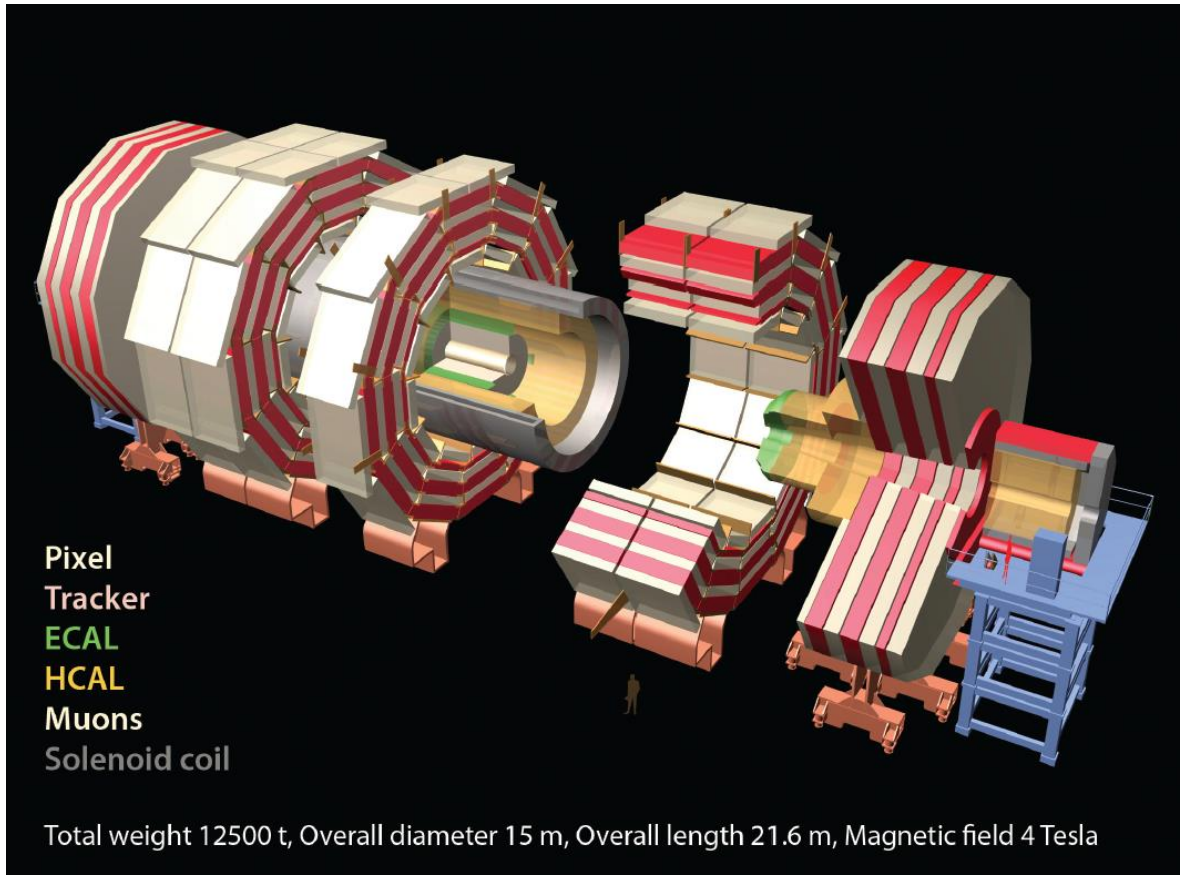


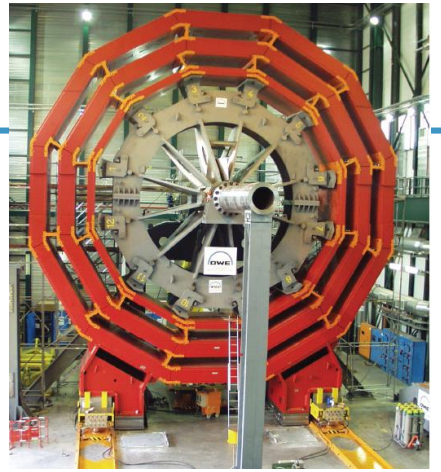
Figure 9.14: View of installed barrel muon spectrometer stations and end-cap calorimeter on side A.

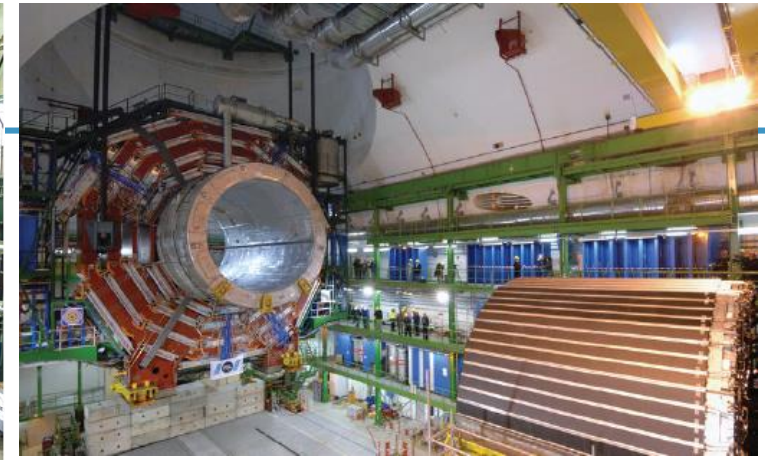


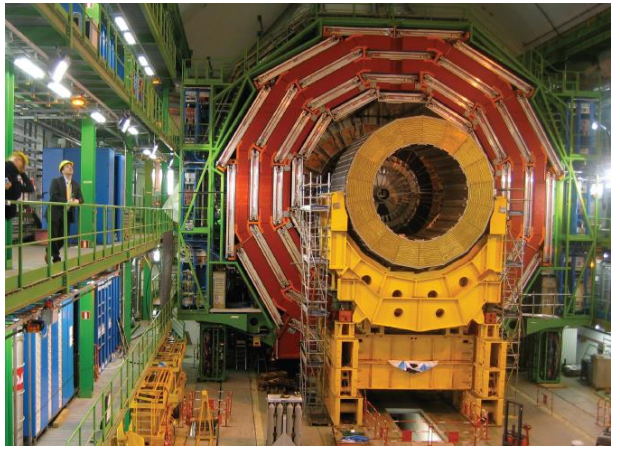
2.3 Installation experience of CMS

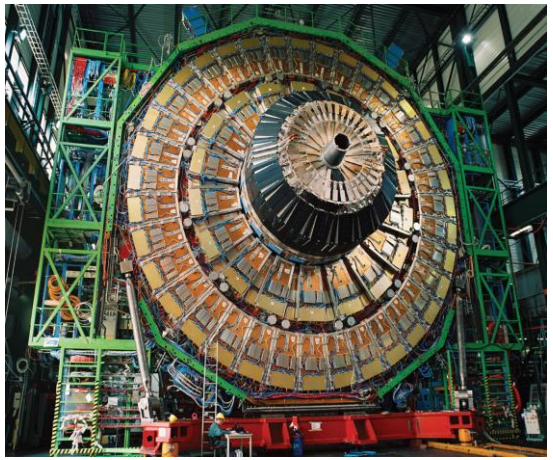
- The dimensions of the detector are 15 m in height and 21.6 m in length. The overall weight of the detector is approximately 12500 tones
- **Features:** the detectors are divided into five parts, each part supported by several air pads, and each part is moved by hydraulic driven.











3. Preliminary design of installation scheme by air pad support

3.1The investigate of heavy duty guide

Question： The weight of HCAL of CEPC is about 1200 tons, the gap is only 50mm, which guide can be use?

$$F_{push} = mg\mu$$

So Low friction coefficient of the guide, the installation will be easy.

	Friction coefficient	Application area	Push Force(KN)
Roller guide	0.01	CNC	120
Plastic coated guide（Teflon）	0.05	BESIII	600
Cast iron rail	0.15	center lathe	1800
Guide rail inlaid with metal composite board	0.1	Power tool	1200
Air pad bearing	0.01	High precision positioning	120

•Rolling guide has small friction coefficient, but the load capacity is very small, and the rigidity is very poor.

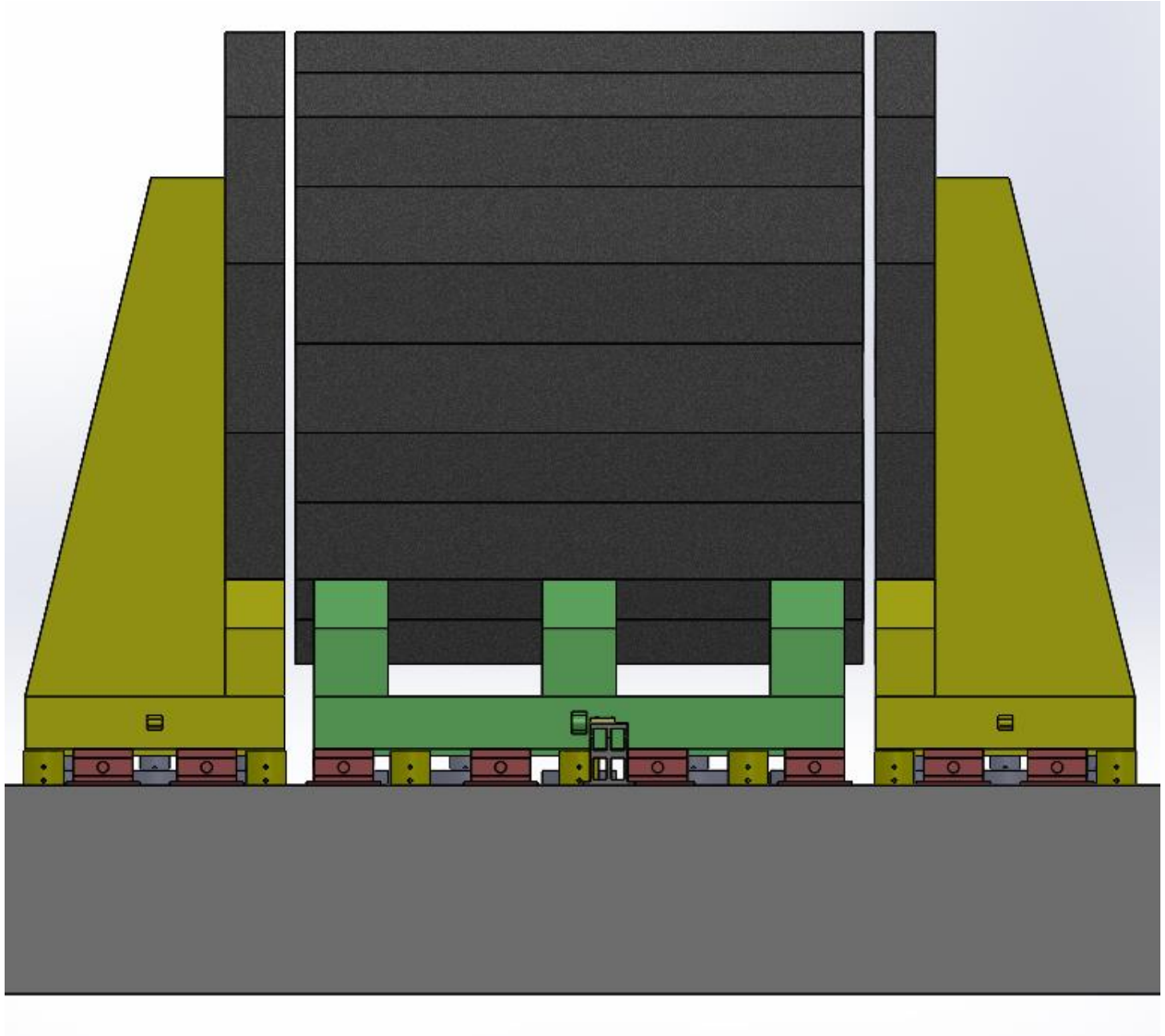
•The rigidity of slide guide is very good, but the friction coefficient is very high. The slide guide is used to support the total detectors in BESIII.

•The advantage of air pad bearing is no contact and no friction, Large supporting area and high rigidity. The air pad bearings are used to support the detectors in ATLAS and CMS.

3. Preliminary design of installation scheme by air pad support

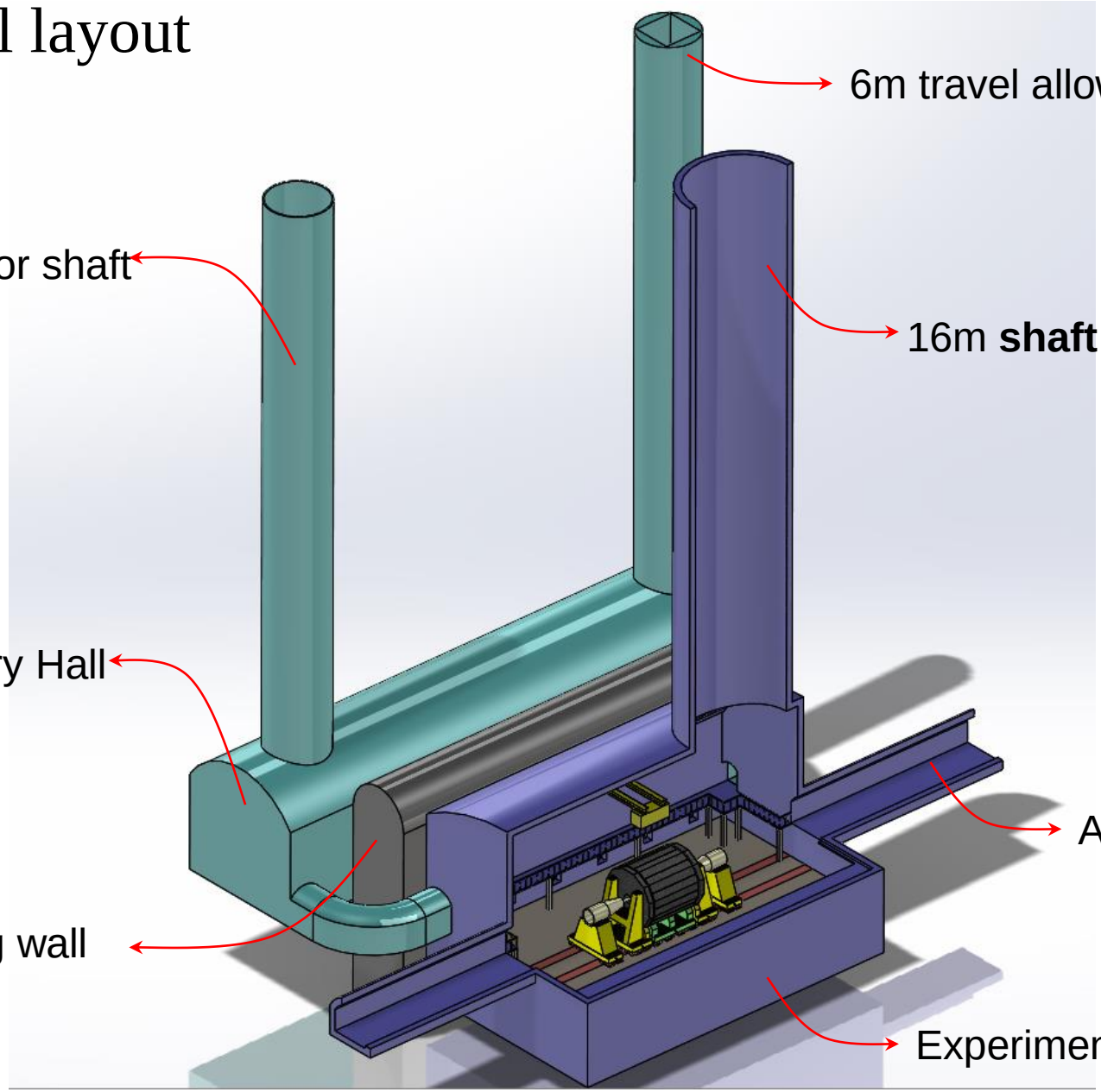
3.2The overall layout

- Due to the heavy weight of the CEPC detector, we also chose the air pad bearings to support.
- The end yoke is supported separately from the center.
- The center part is supported by 12 sets of air pads, which is used for moving and horizontal adjusting. The single air pad capacity may be about 250 tons.
- 6 sets of hydraulic cylinders are used to adjust the height, the capacity of which is 800 tons .
- 8 sets of tapered iron support are used to the final support.



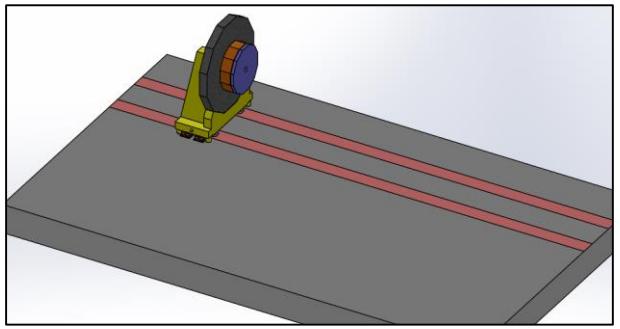
3. Preliminary design of installation scheme by air pad support

3.2The overall layout

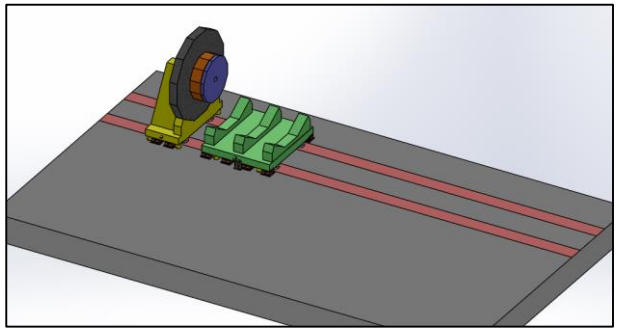


3. Preliminary design of installation scheme by air pad support

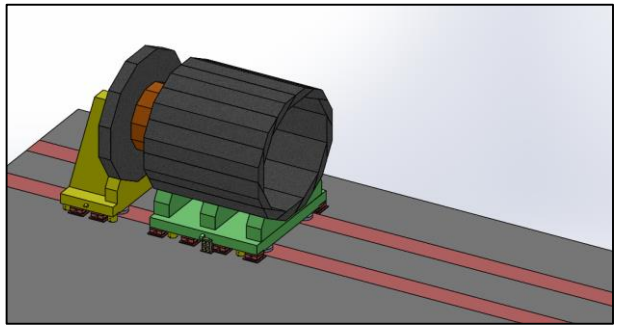
3.3 Installation process



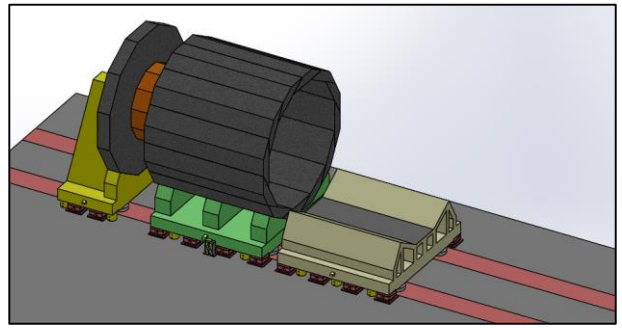
1. End yoke assemble



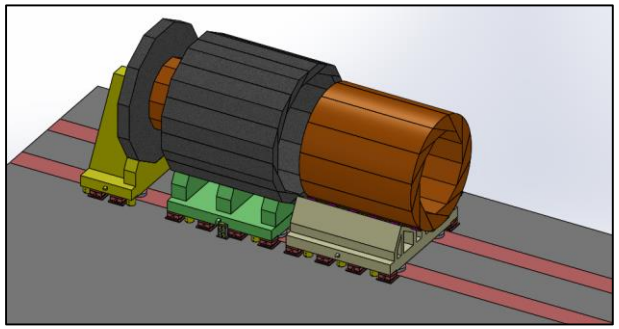
2. Iron yoke base assemble



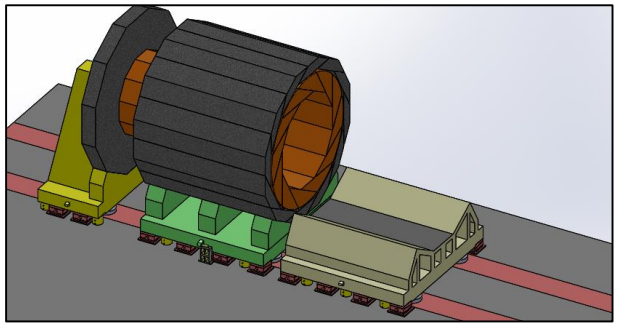
3. Barrel ion yoke assemble



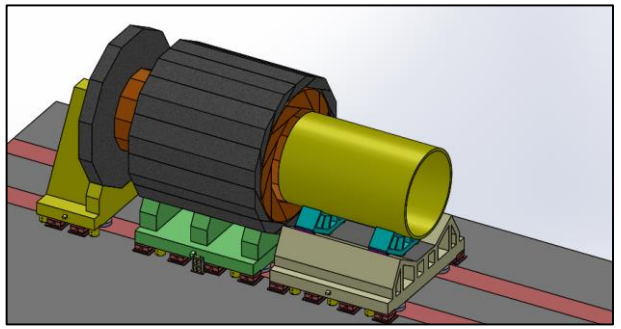
4. Temporary mounting base assemble



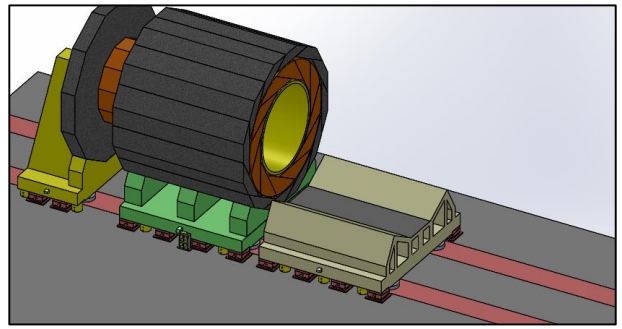
5. HCAL assemble



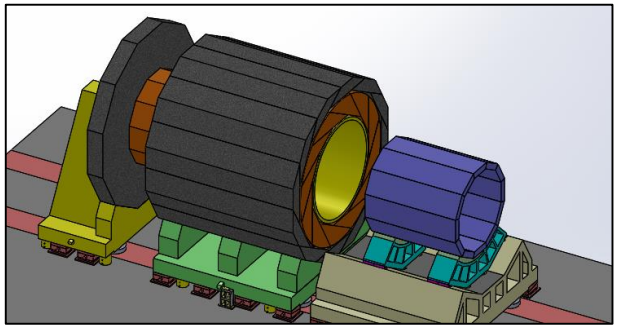
6. HCAL is pushed in



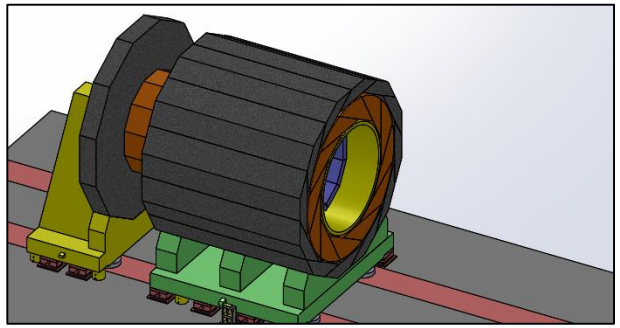
7. Superconducting solenoid assemble



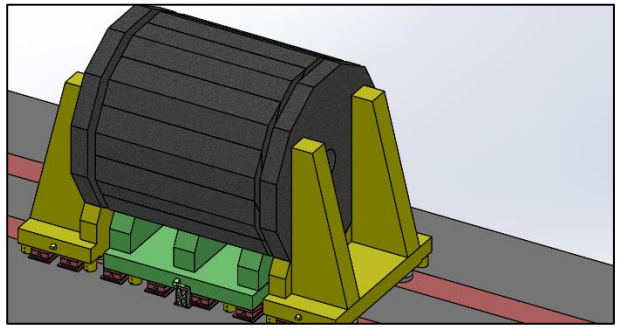
8. Superconducting solenoid is pushed in



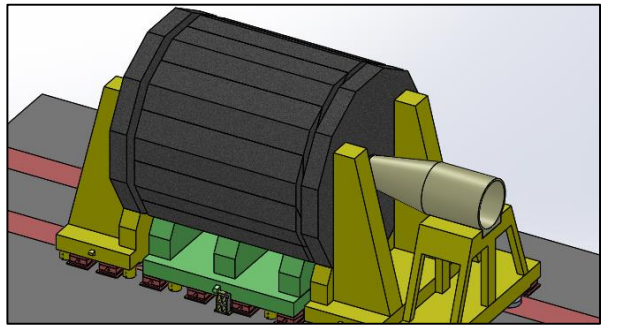
9.ECAL is pushed in



10. Remove the temporary base



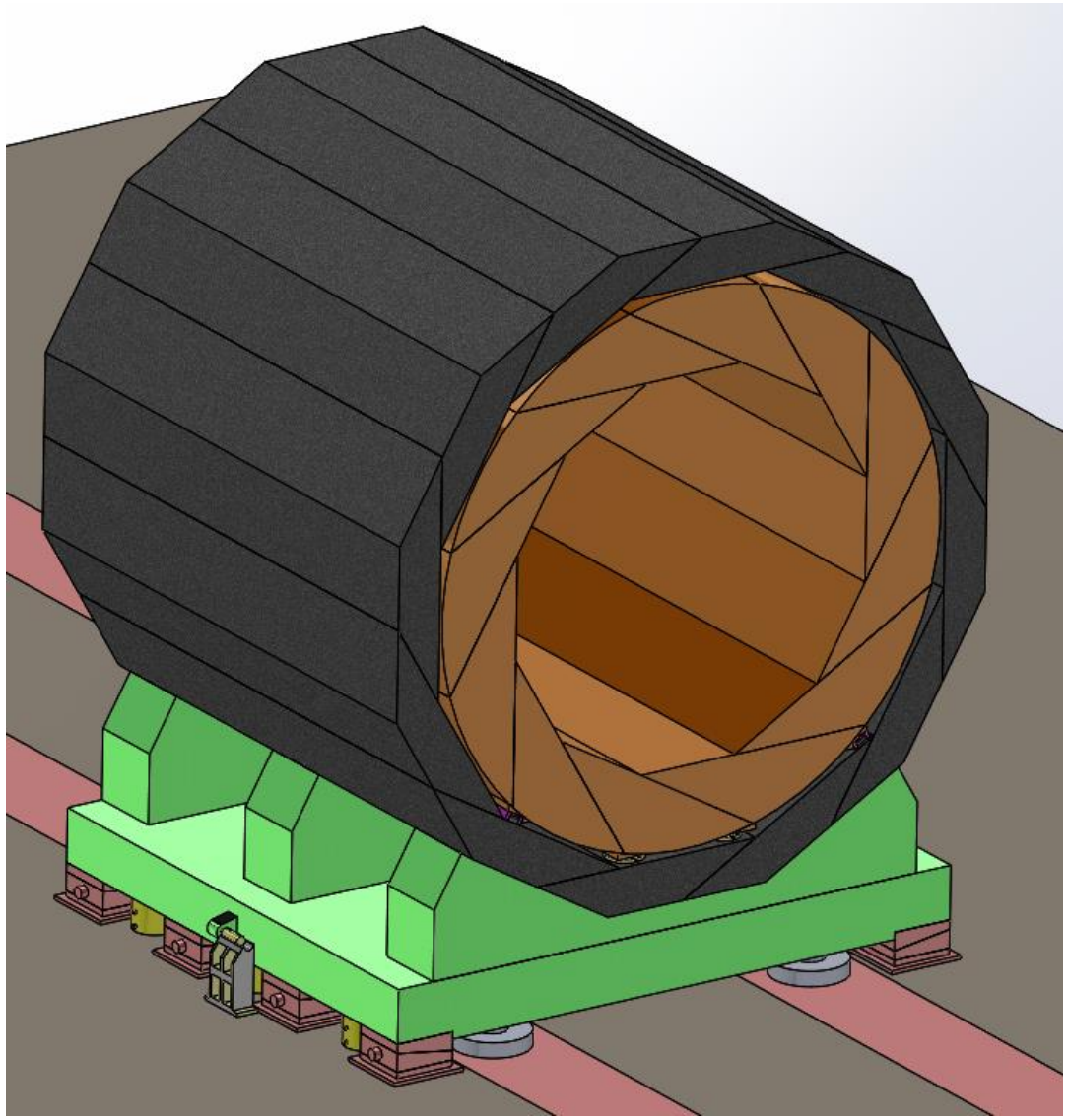
11. End yoke is push in

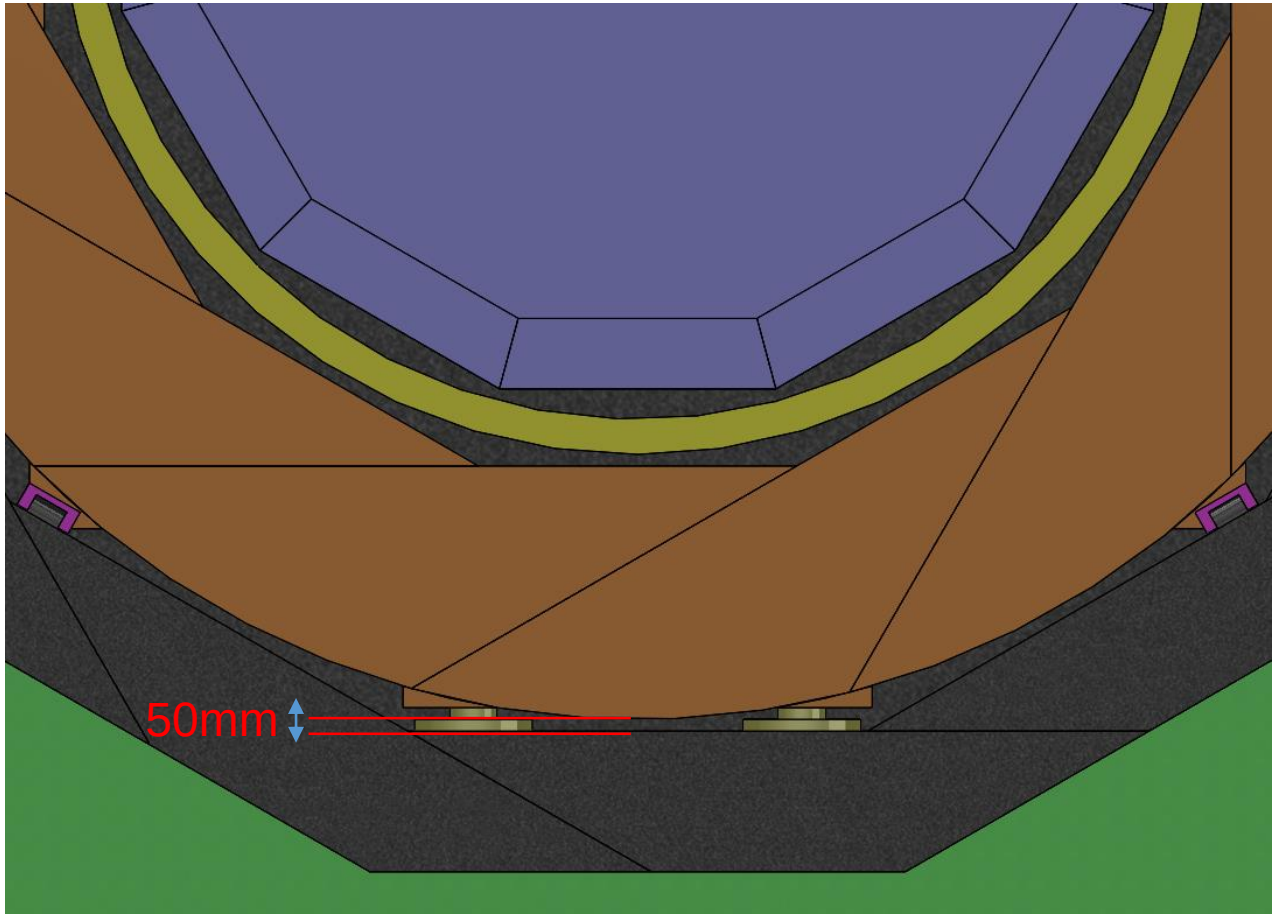


12.MDI docking

3. Preliminary design of installation scheme by air pad support

3.4 Technical difficulties of sharing guide rail

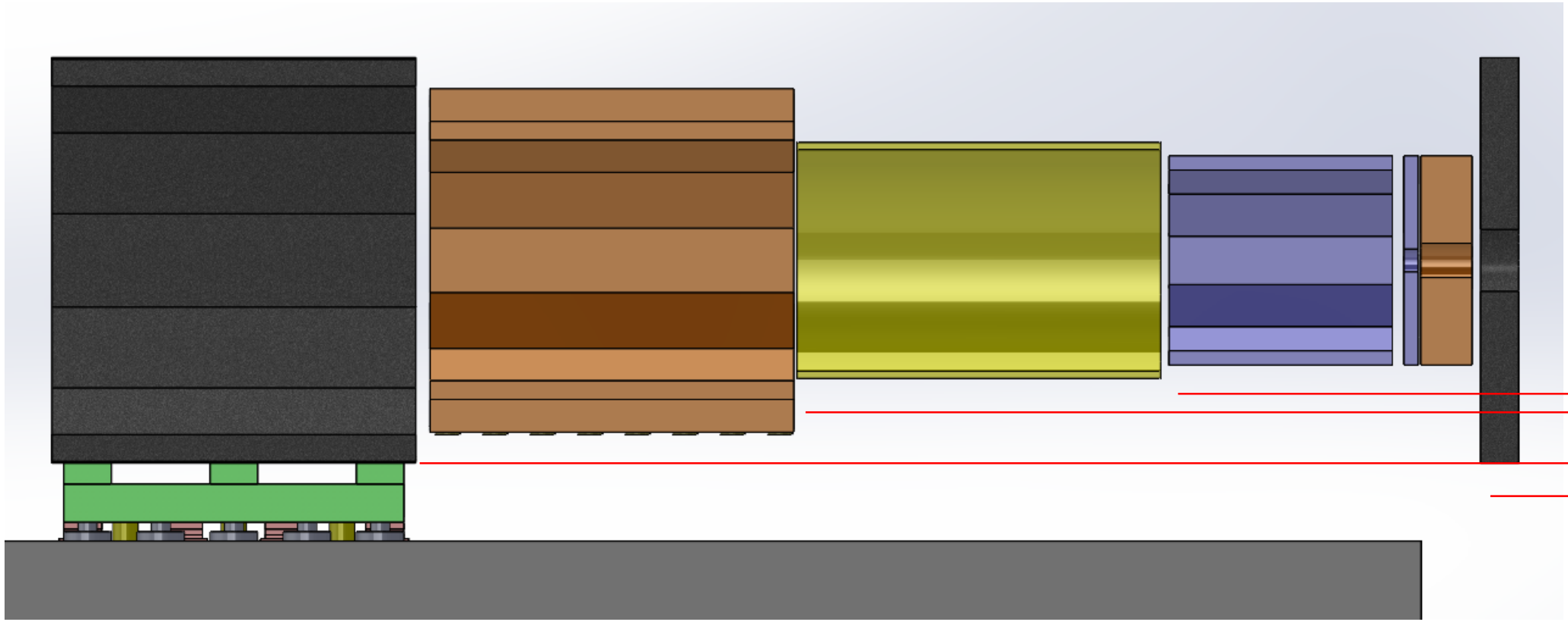




Difficult： the clearance between Barrel iron yoke and HCAL is only 50mm. There is no enough space for support and adjustment mechanism within 50mm clearance.

3. Preliminary design of installation scheme by air pad support

3.4 Technical difficulties of sharing guide rail



Difficult：

1. External air pad can be shared, but the air pad in the yoke iron can not be shared 。
2. Each part must be pushed in, but the bottom height of each part is different, which make temporary platform must be used。
3. The end yoke height is the lowest, so the temporary mounting base must be removed， then there will be enough space to push the end yoke next to the barrel yoke。

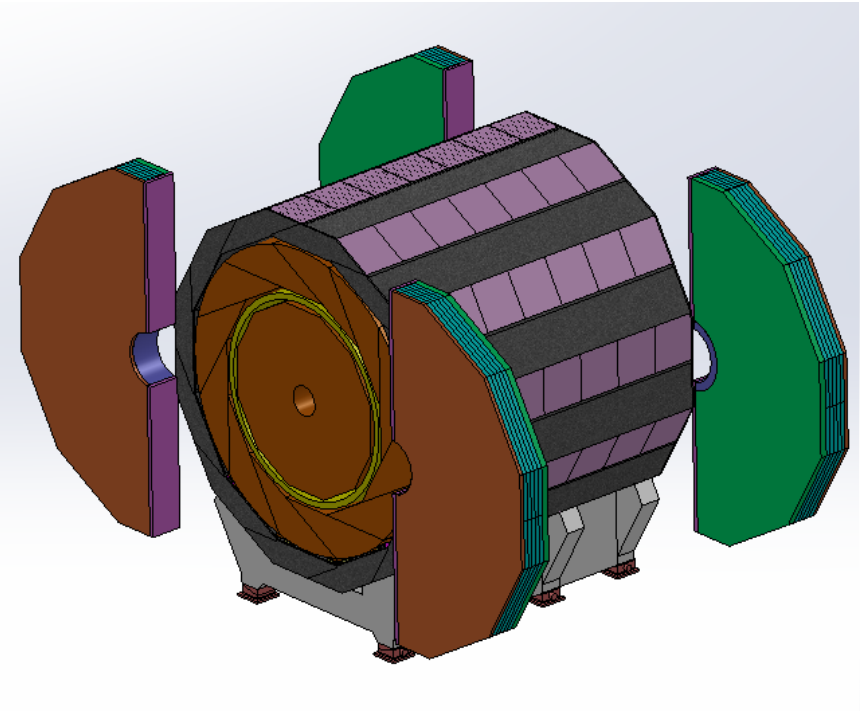
3. Preliminary design of installation scheme by air pad support

3.5 Other feasible options

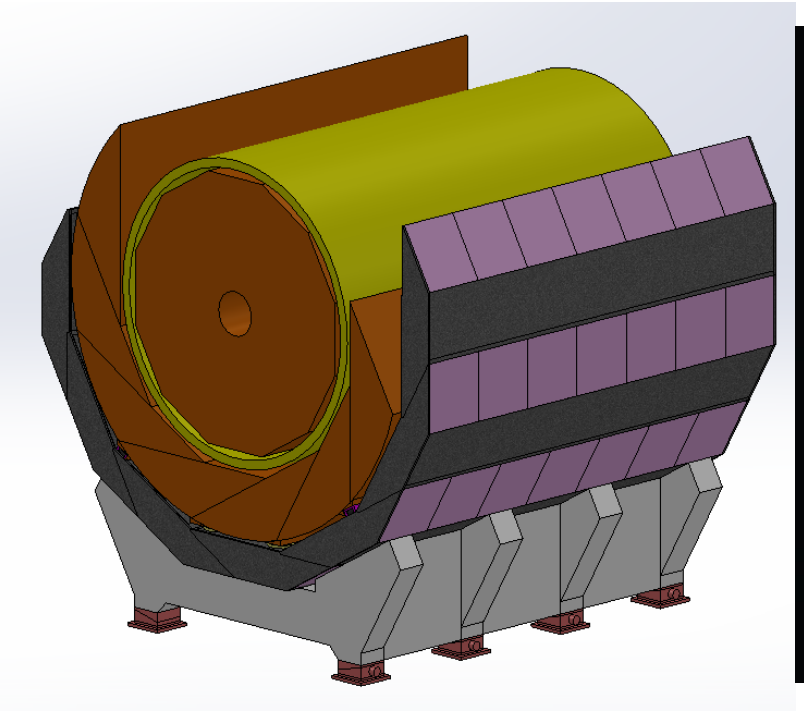
Options 1: The end yoke can be designed to open left and right like BESIII, the temporary mounting base will not be required.

Options 2: The top of the iron yoke and the HCAL can be opened,then the HCAL and superconducting solenoid can be installed from the top .

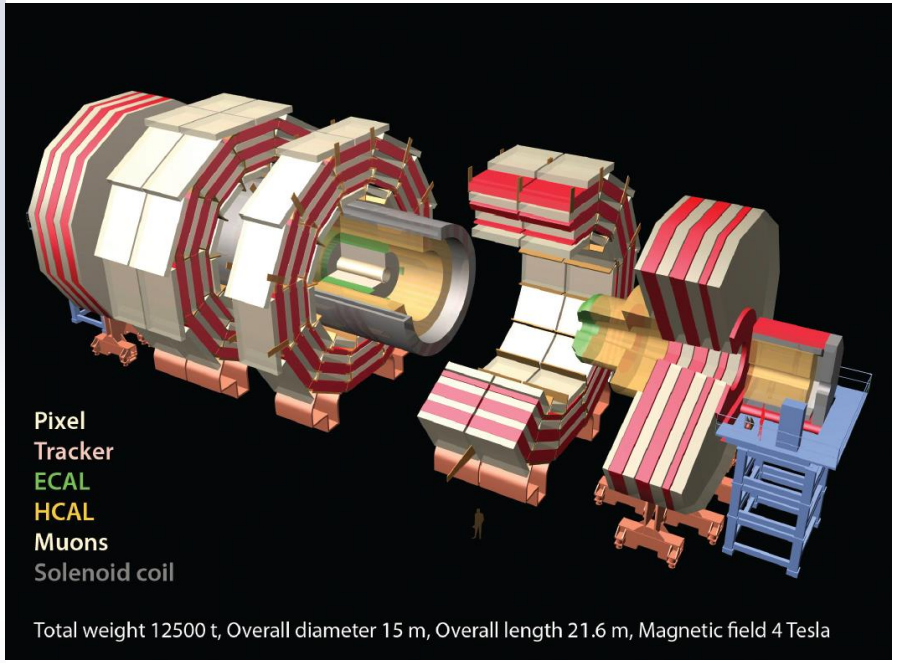
Options 3: The Iron yoke and HCAL are a whole component, and which are divided into several parts as CMS.



Options 1



Options 2



Options 3

4.Summary

- Air pad support installation scheme is feasible.
- Air pad support can achieve low friction coefficient, small driving force of detector movement .
- The flatness of the bottom support surface is greatly reduced, Air gap can be about 1mm.
- At present, the scheme is only preliminary and there are still many problems need to be solved.

Thank you for your attention