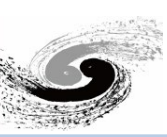


# CEPC Detector and Hall Issues

## 探测器大厅相关情况

Zhu Zian 朱自安

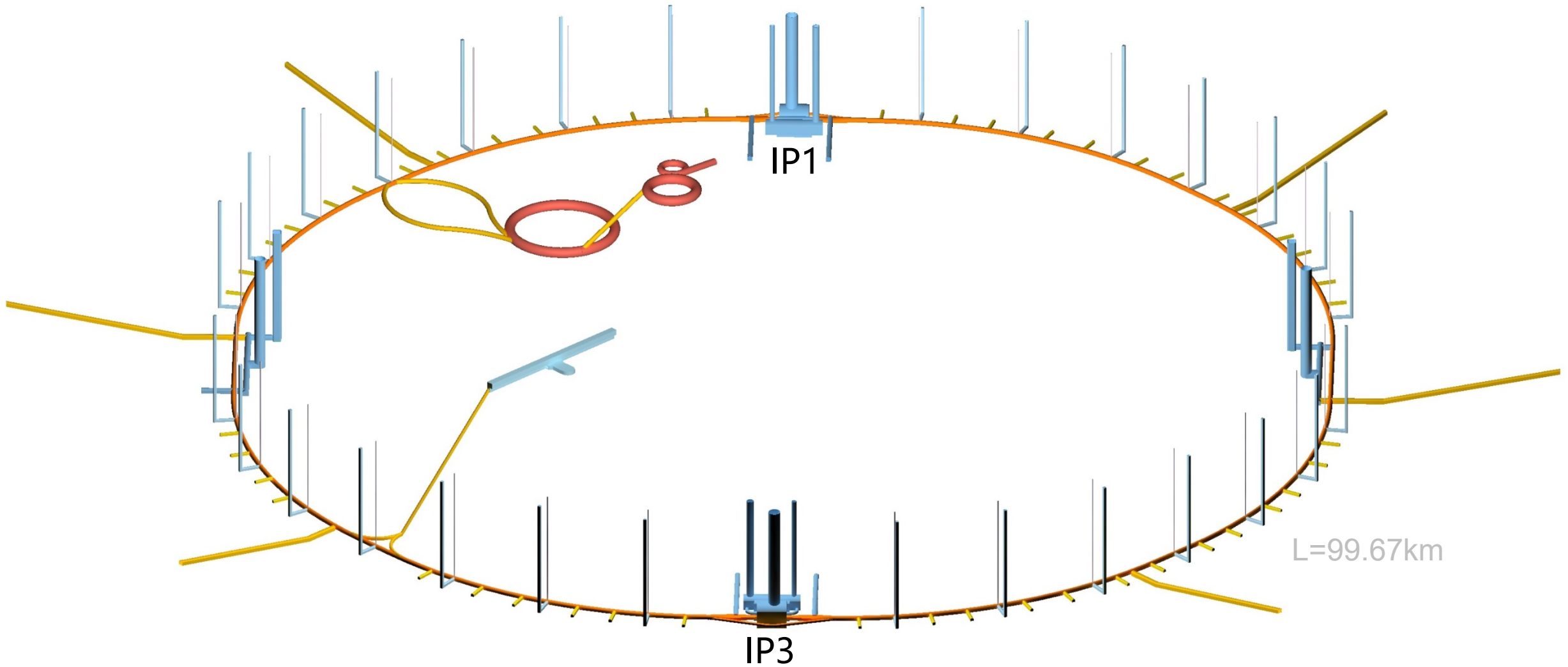
2020.8.29



**Meet the requirements from the following aspects**

- **Overall requirements of the detector physics**
- **MDI complexity**
- **Biggest device down to underground carven**
- **Arrangement of detector assembly procedure (ground and cavern process planning)**
- **Project schedule (priority, parallel/serial)**
- **Electricity, cooling, air, gas, magnetic leakage and coupling**
- **Working space management**
- **Costs**

# CEPC layout

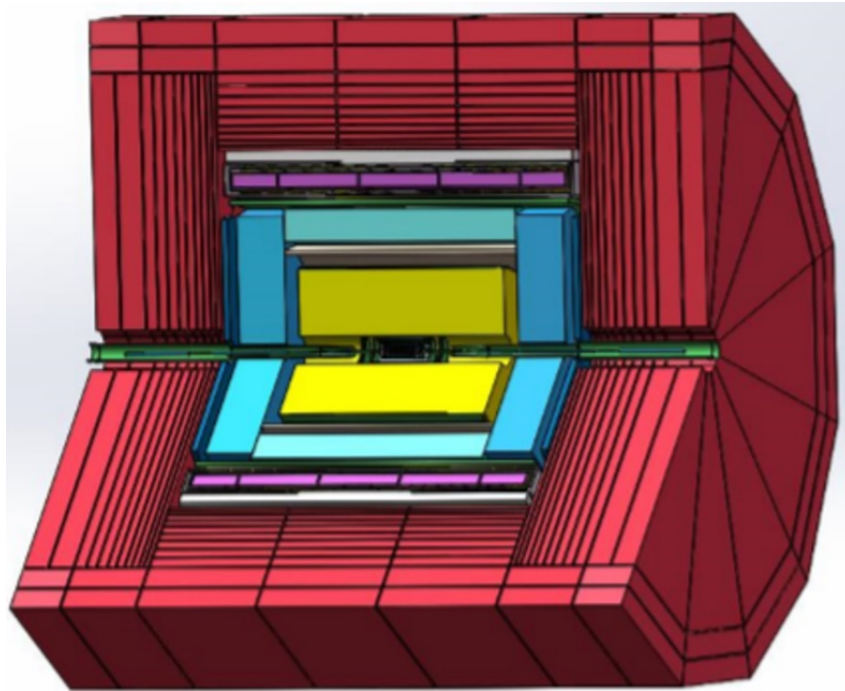


# Two Detectors for CEPC: old Scenario



## LTS Solenoid :

- Solenoid located outside calorimeter
- Inner diameter 7.2 m, length 7.4 m
- Central field: 3 T
- Superconductor: NbTi
- Operation temperature: 4.2 K

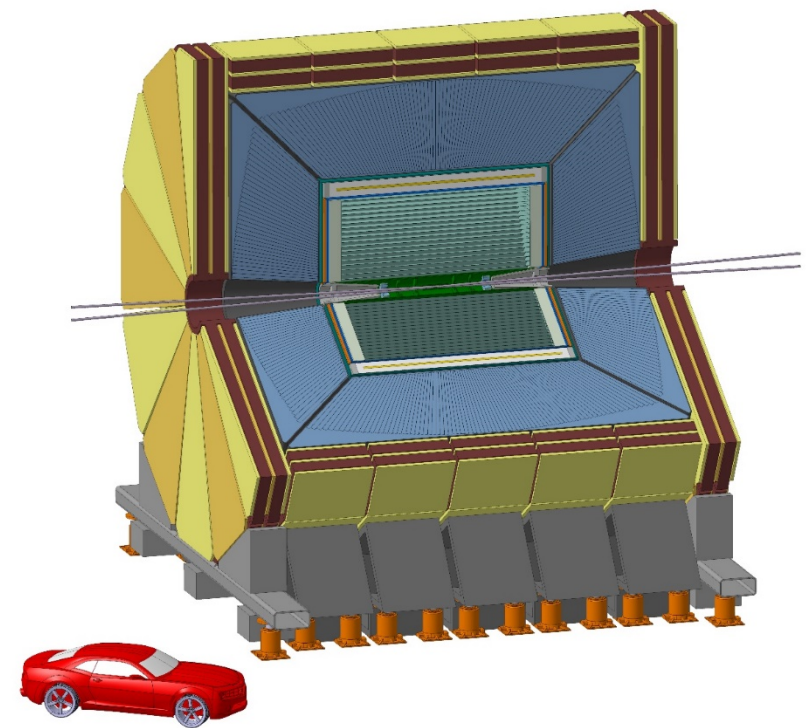


Baseline detector

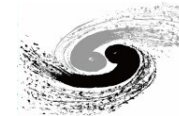
## HTS Solenoid :

- Solenoid located inside calorimeter/less material
- Inner diameter 4 m, length 6 m
- Central field: 2 T
- Superconductor: YBCO
- Operation temperature: 20 K

IDEA detector

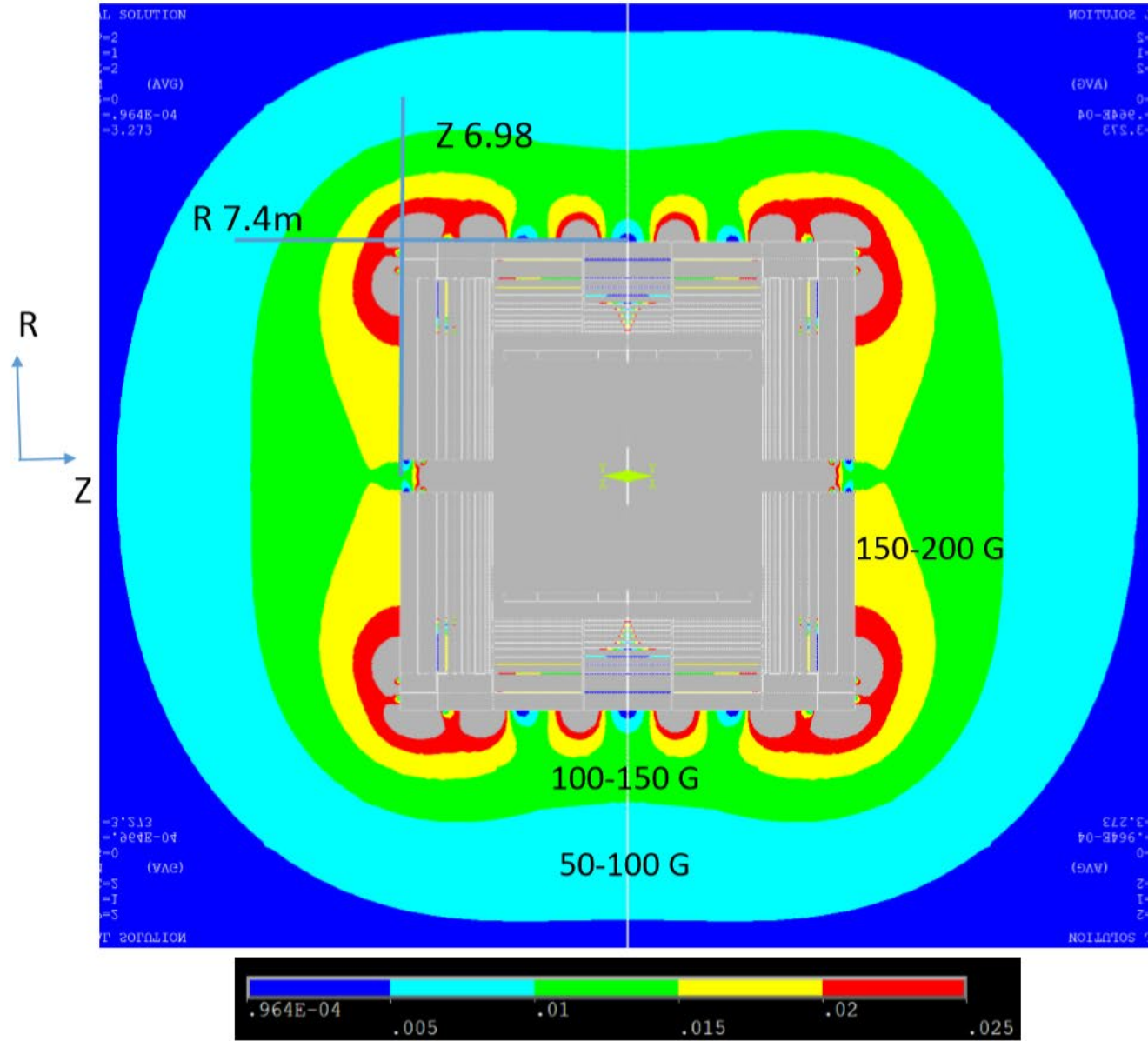
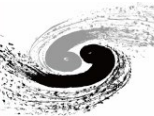


# Solenoid iron yoke comparison

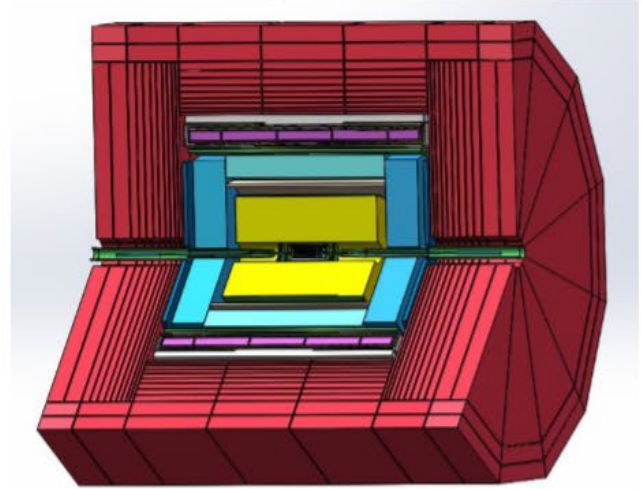


	<b>CMS</b>	<b>CEPC pre-CDR</b>	<b>CEPC Version 1</b>
<b>Central field (T)</b>	<b>4</b>	<b>3</b>	<b>3</b>
<b>Operating current (A)</b>	<b>19600</b>	<b>15779</b>	<b>16796</b>
<b>Inner diameter of coil (mm)</b>	<b>6360</b>	<b>7200</b>	<b>7200</b>
<b>Length of coil (mm)</b>	<b>12480</b>	<b>7606</b>	<b>7600</b>
<b>Barrel yoke inner diameter (mm)</b>	<b>9180</b>	<b>8800</b>	<b>9200</b>
<b>Barrel yoke outer diameter (mm)</b>	<b>14000</b>	<b>14480</b>	<b>12120</b>
<b>Total length of yoke (mm)</b>	<b>20040</b>	<b>13966</b>	<b>12020</b>
<b>Weight of barrel yoke (t)</b>	<b>6000</b>	<b>5940</b>	<b>3137</b>
<b>Weight of each end cap (t)</b>	<b>2000</b>	<b>3316.6</b>	<b>1144</b>
<b>Total weight of yoke (t)</b>	<b>10000</b>	<b>12573</b>	<b>5425</b>

# Stray field of detector magnet



Baseline design of CEPC detector

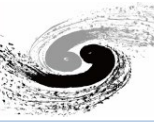


Stray field outside iron yoke

Stray field	R (m)	Z(m)
50 Guass	13.6	15.7
100 Guass	10.2	11.6
150 Guass	9.4	7.9

## Stray field distribution around detector

# Solenoid stray field comparison

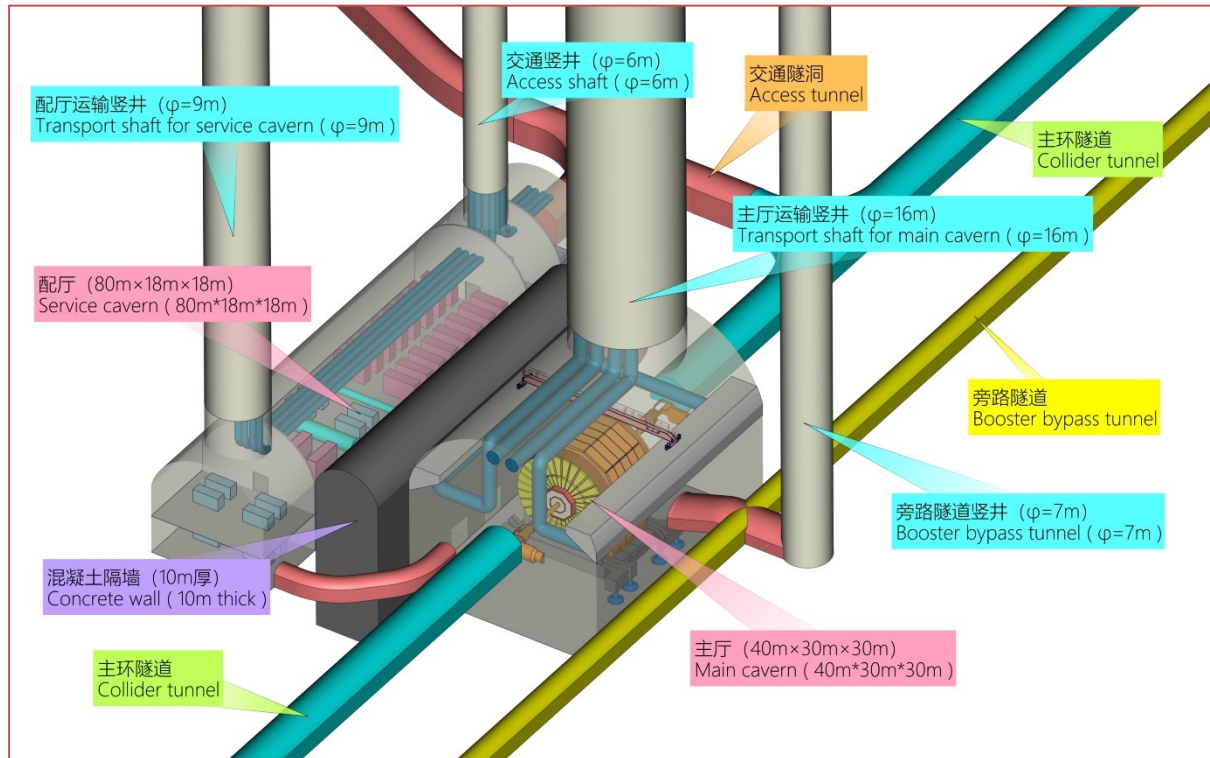
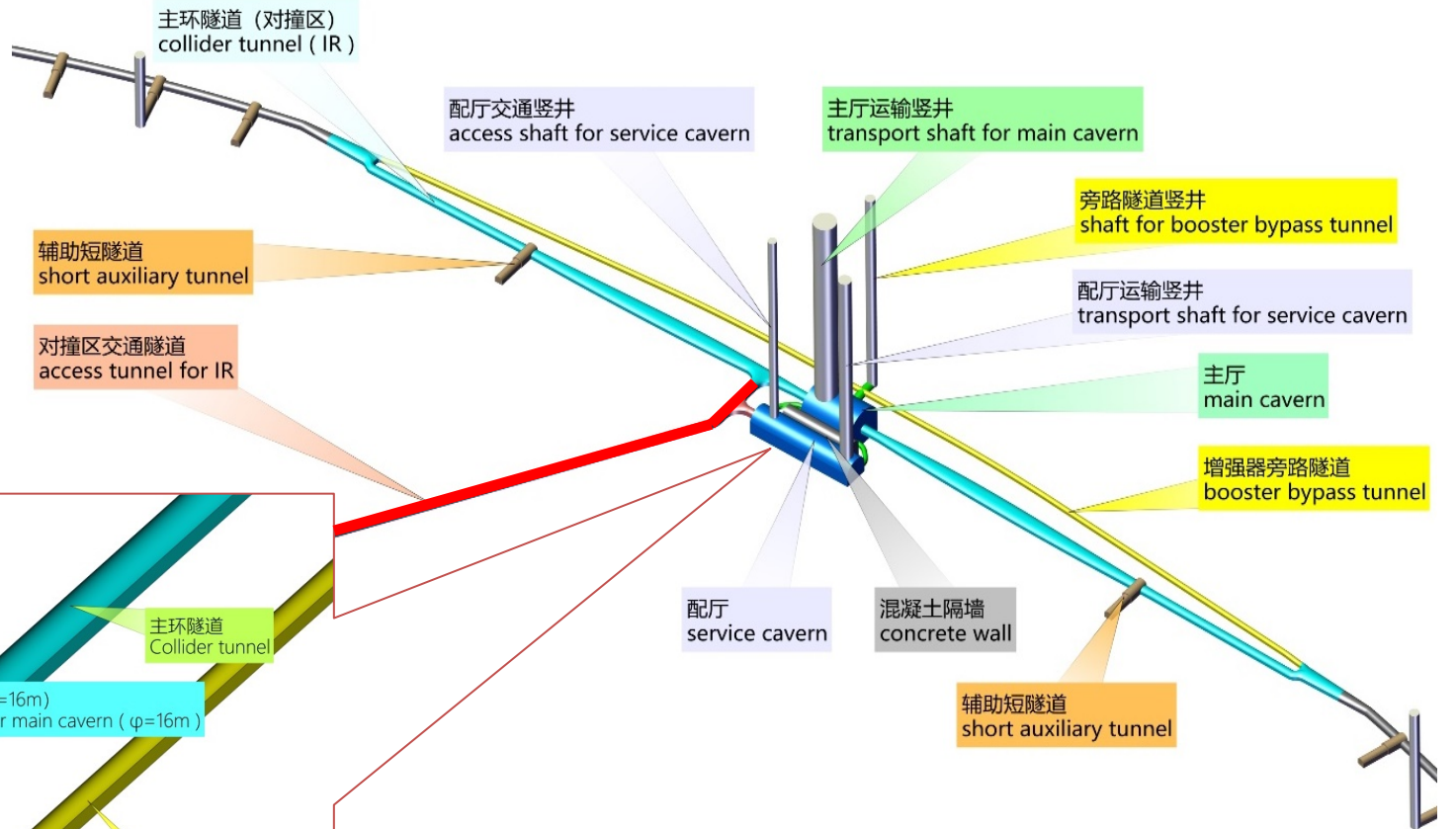
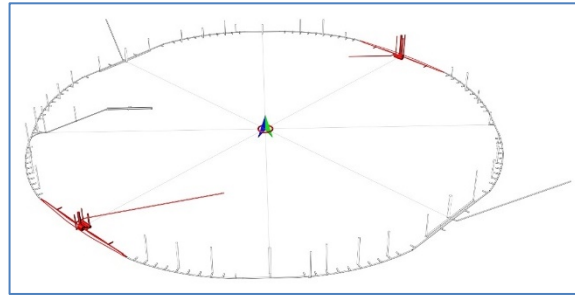
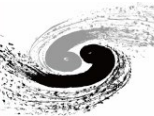


Stray field		CMS	CEPC pre-CDR	CEPC Version 1
50 Gs	R direction	25.2 m	13.6 m	20.6 m
	Z direction	32 m	15.7 m	25.5 m
100 Gs	R direction	19.2 m	10.2 m	16.4 m
	Z direction	25.2 m	11.6 m	20.1 m

**Field at booster location(R@25m)**

Pre-CDR	8.4 Gs
Version 1	28 Gs

# Cavern and Shafts



本图为黄河设计院提供



# Cavern and Shafts

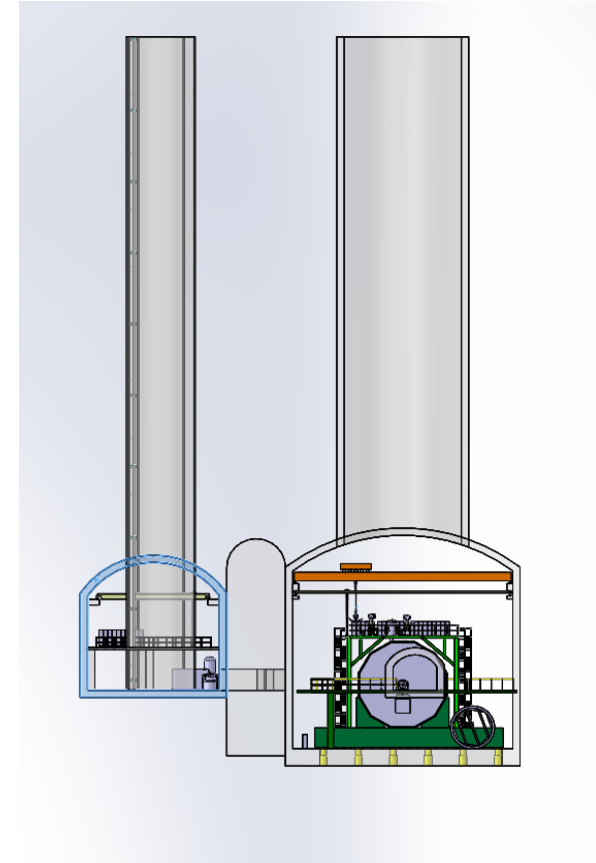


## Main cavern

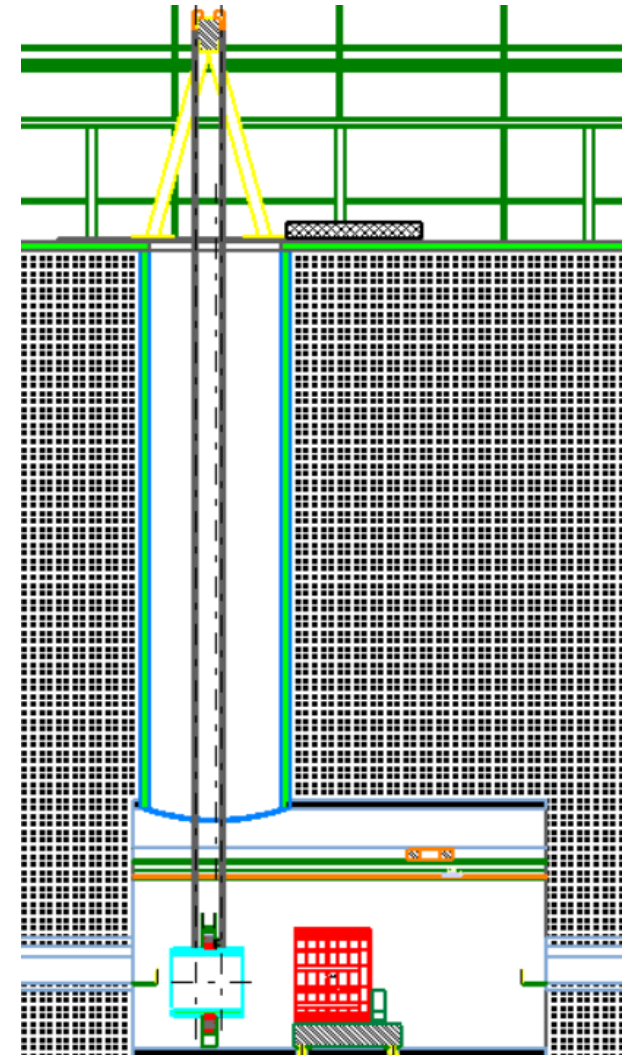
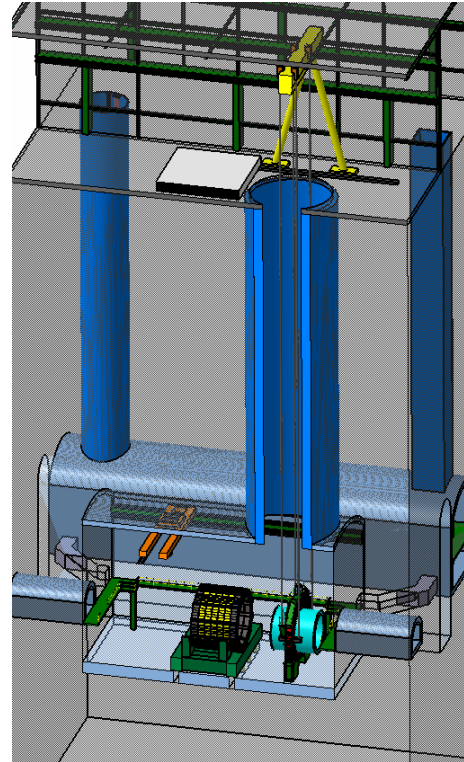
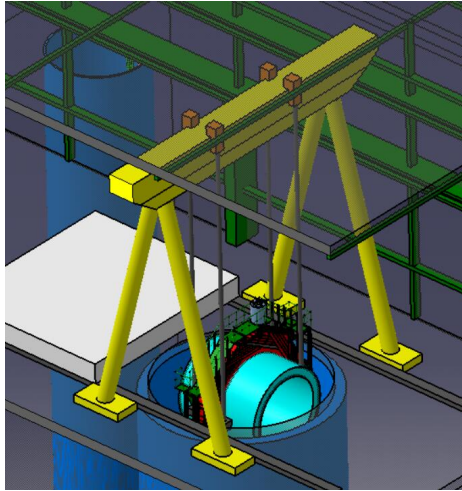
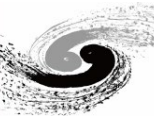
- **30\*30\*40 m(H\*W\*L)**
- **Host the detector and front-end electronics**
- **Host machine devices near colliding point**
- **Allow detector opening and maintenance**
- **equipped with two crane, 20 and 300 tons**
- **One main access shaft, Ø16 m, equipped with a 1000 tons gantry crane, permitting successive installation of the large detector pieces from ground**

## Auxiliary cavern

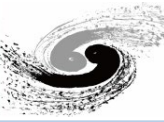
- **18\*18\*80 m(H\*W\*L)**
- **Parallel to the main cavern, accessible for maintenance during data taking**
- **One service shaft Ø9 m provides equipment access**
- **One personnel access shaft Ø6 m**
- **Electronics and power supply sub-detectors**
- **Detector working gas buffer and distribution**
- **Detector magnet power supply and quench protection device**
- **Cryogenic refrigerator and distribution for superconducting magnet**
- **Power supply and control cabinet of the machine colliding devices**



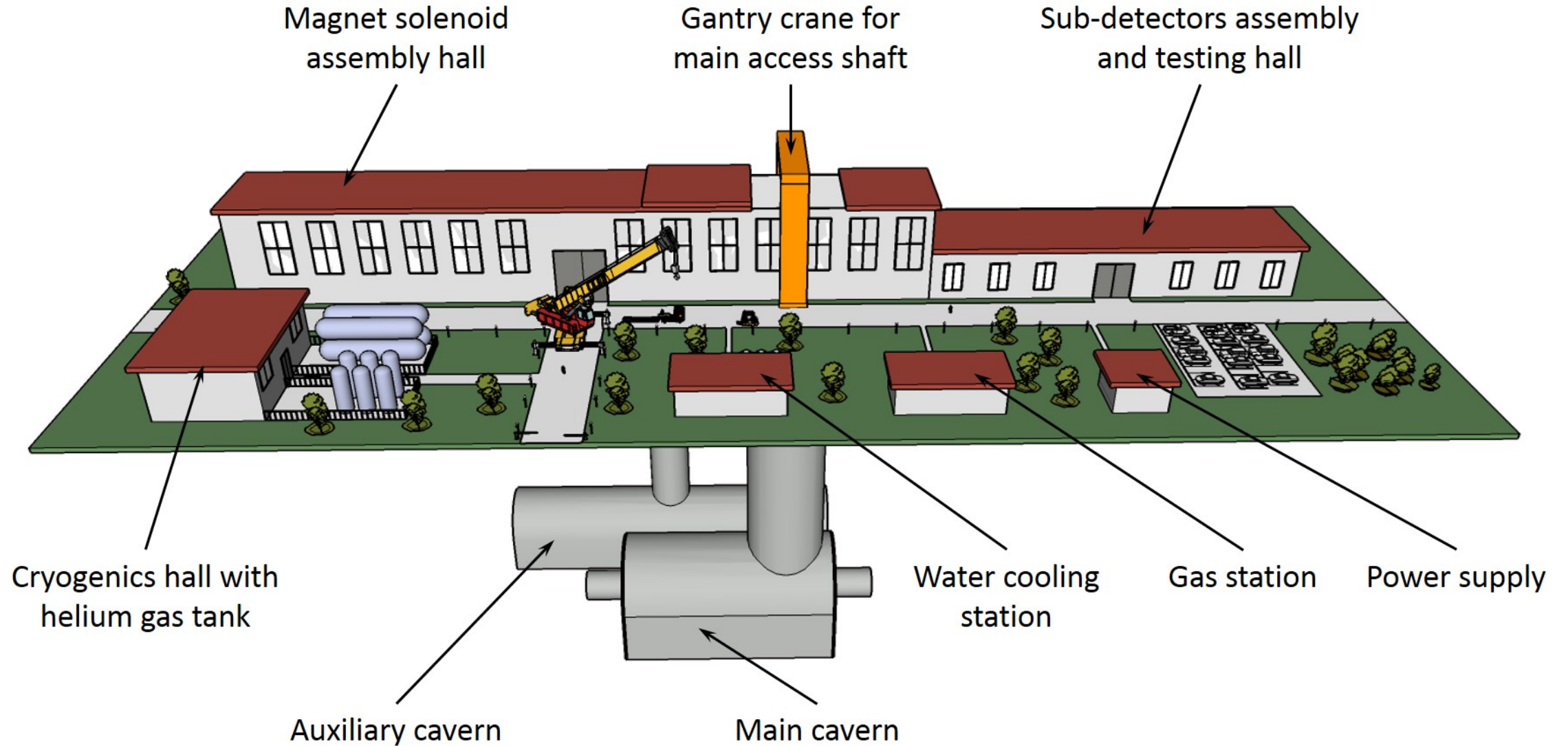
# Large part down to underground cavern

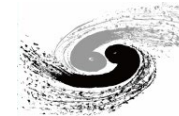


- Biggest and most heavy part to be lowered: detector solenoid magnet
- Solenoid are fully assembled and tested on the surface and descent into the cavern
- A temporarily yoke ring pre-assembled together with the solenoid, weight about 800 tons
- After landing, only moving longitudinally, no more lifting by heavy crane, to integrate with the yoke and sub-detectors
- To be optimized and improved with yoke assembly procedure

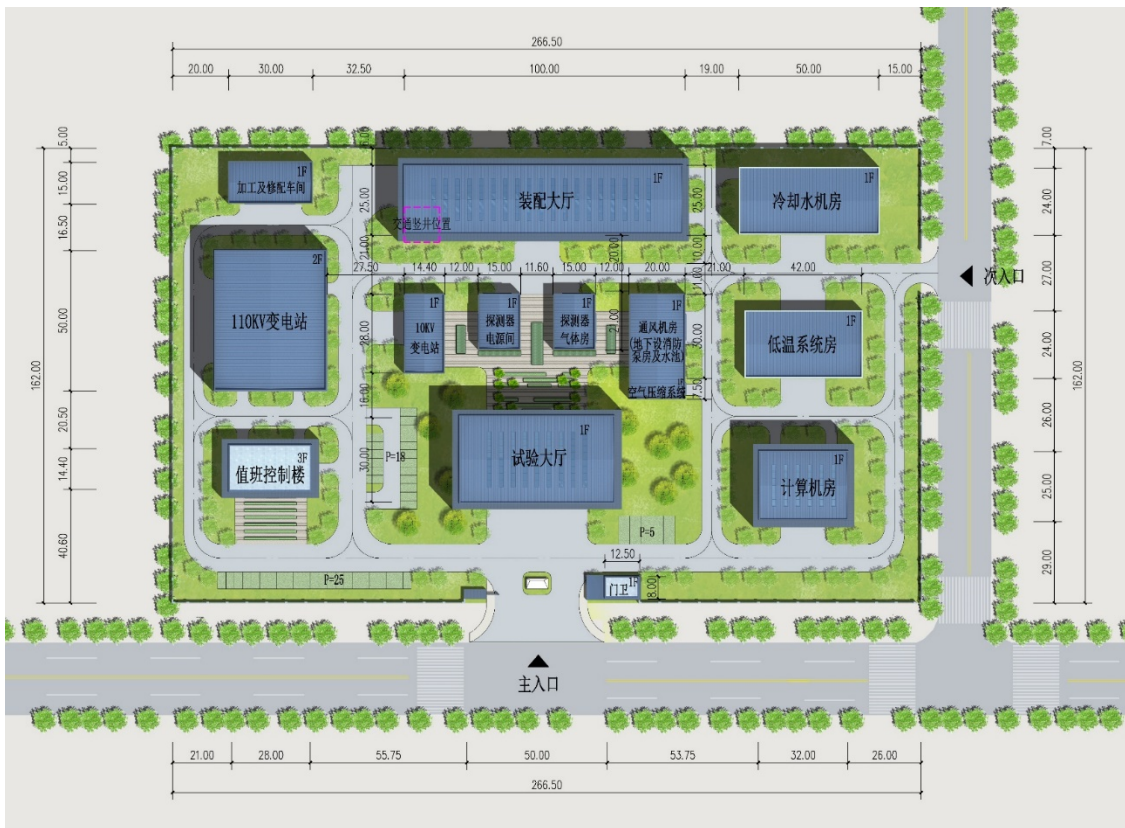


# Ground building





# Ground building



Layout of ground building around colliding area

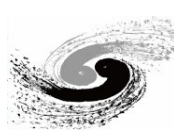
## Detector assembly and testing Hall:

- Most of sub-detector assemble and test here in series
- To avoid too many personal crowded in underground cavern
- Provides additional advantage of rehearsing the risky operations
- More convenience for hardware working groups



Latest design

# Equipment layout statistics of detector Hall



## CEPC 探测器大厅设备布局统计

V1.1, 2019.9.12.

CEPC 探测器大厅内部结构的设计及布局, 包括对撞区洞室实验大厅、实验辅助厅、竖井, 及两个厅之间的管线通道和检修通道, 它们里面的设备布局和水电气连接管线。暂不涉及地下设施与地面设施之间的工艺连接。

设备名称	外形尺寸	数量	安装位置	其它信息
探测器本体		1	实验大厅	
前端电子学机柜	标准机柜	20	实验大厅	
阀箱		1	实验大厅	
真空机组		2	实验大厅	
热虹吸冷却杜瓦		1	实验大厅	
super-module 安装架	30m <sup>2</sup>	1	实验大厅	电磁量能器 ScW ECAL
触发电子学前端系统	标准机柜	6	实验大厅	
Muon 高压和电子学	标准机柜	5	实验大厅	
DHCAL 高压和电子学	标准机柜	5	实验大厅	
TPC 高压电源及控制系统	标准机柜	2	实验大厅	
失超探测器	标准机柜	2	实验大厅	
天车一	横跨大厅, 起吊重量 300t, 起吊高度 20 米	1	实验大厅	
天车二	横跨大厅, 起吊重量 20t, 起吊高度 20 米	1	实验大厅	
探测器开闭控制机柜	标准机柜	4	实验大厅	
升降平台		2	实验大厅	
气液两相干冰冷却系统		1	实验辅助厅	TPC 子探测器
电源及读出电子学机柜			实验辅助厅	顶点探测器 (Vertex) 和硅径迹室 (Si-tracker)
冷却系统		1	实验辅助厅	顶点探测器 (Vertex) 和硅径迹室 (Si-tracker)

主电子学机柜			实验辅助厅	
超导磁体电源	8*5*3m(L*W*H)	1	实验辅助厅	
失超保护泄能电阻箱		1	实验辅助厅	
探测器低温制冷机冷却		1	实验辅助厅	
液氮杜瓦		1	实验辅助厅	
分配阀箱		1	实验辅助厅	
探测器低温设备端控制柜		4	实验辅助厅	
Muon 配气及控制系统		1	实验辅助厅	
Muon 气体缓冲罐		1	实验辅助厅	
TPC 配气及控制系统		1	实验辅助厅	
TPC 配气及控制系统		1	实验辅助厅	
TPC 气体缓冲罐		1	实验辅助厅	
水管水冷控制系统		1	实验辅助厅	
DAQ 交换机	标准机柜 1U 高度	60	实验辅助厅-电子学间	每个交换机占用 2U 空间
触发电子学后端系统	标准机柜	6	实验辅助厅	
天车三	横跨辅助厅, 起吊重量 10t	1	实验辅助厅	
介质气体管路			管线通道	
20kA 电流母排		1	管线通道	
真空泵机组水冷管道		1	管线通道	超导磁体
高压电源电缆			管线通道	?
信号电缆			管线通道	? 类型, 起始位置, 到达位置, 尺寸, 材质
龙门吊	起吊重量 1000t, 跨度 20m	1	竖井 1 正上方的探测器装配大厅	竖井 1 位于实验大厅, 直径 16m, 包括超导磁体在内的探测器大尺寸、大吨位的部件从该处吊入

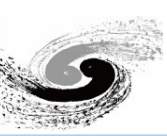
货梯	10t	1	竖井 2 内	竖井 2 位于实验辅助厅, 直径 9 米, 用于运输厅内设备等
电梯	15 人	1	电梯井内	电梯井位于实验辅助厅, 直径 6 米, 用于运输人员
实验大厅	40m*30m*30m (长*宽*高)			
实验辅助厅	80m*18m*18m (长*宽*高)			辅助厅地面与加速器主环隧道地面在高度上平齐
交通隧道				连接到主环隧道, 并留一条分支连接到配厅
变压器			电源间	地面
控制台			控制/值班室	地面
DAQ 服务器机柜	标准 42U 机柜 600*1200*2200	40	控制/值班室	地面实验间-在线机房, 200 平米
储气及检测系统	TPC 气体(60 瓶)及气体检测系统等, 100m <sup>2</sup> , MUON 气体	1	气体房	地面
探测器低温设备系统端设备			低温厅	地面

说明:

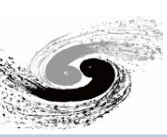
1、不包括通风、换气设施。

2、不包括消防设施, 如应急通道和楼梯、排烟系统。

# Summary & Discussion



- **A preliminary design for the detector overall facilities and layout presented**
  - **includes the underground experimental hall, auxiliary hall and shaft, surface building in the collision area**
- **Work to be done in the next**
  - **Connection between underground facilities and ground facilities**
  - **Pipelines, cable tray connecting with the detector**
  - **Peripheral equipment and devices will be updated gradually according to the progress of detector design**



**Thank you for the attention!**