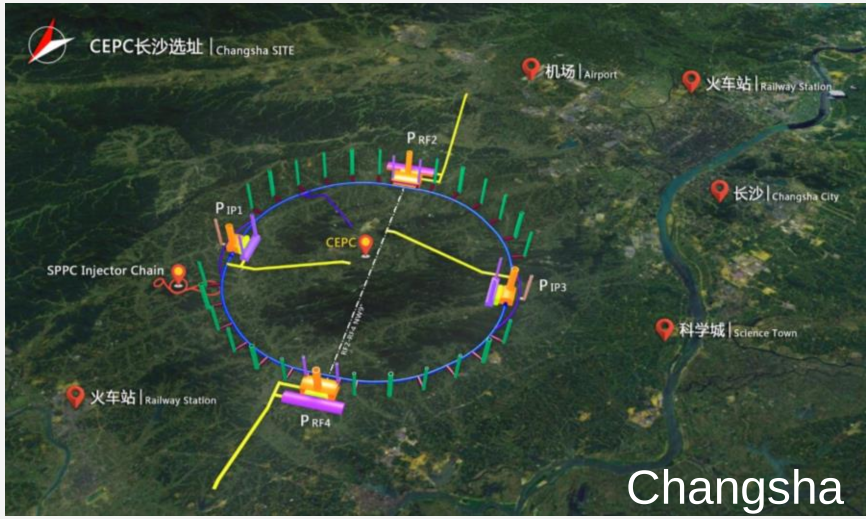
Infrastructure and Auxiliary Facility



Yu XIAO

Yellow River Engineering Consulting Co., Ltd.

June 10, 2022

Contents

01

Design Progress of Sites

YREC

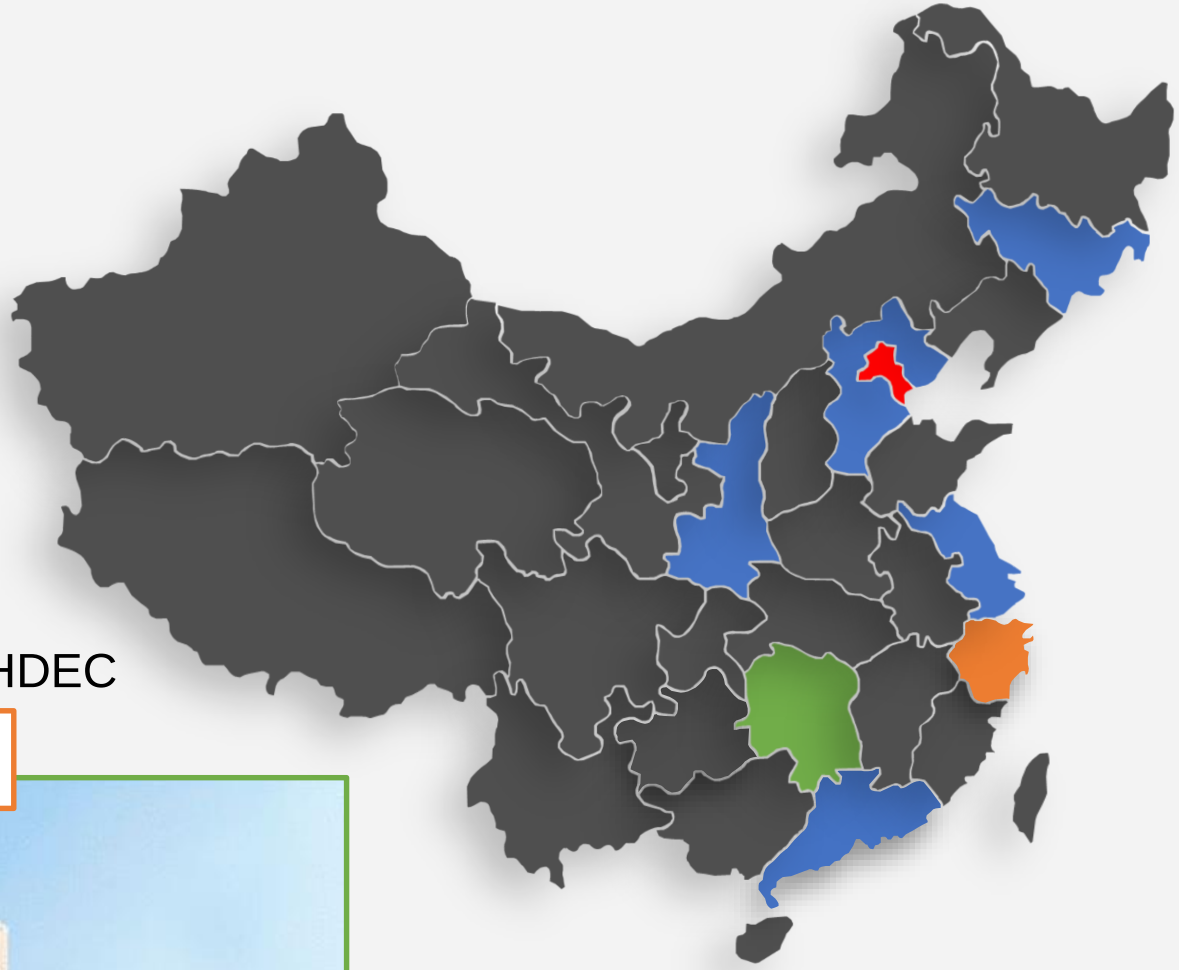
黄河勘测规划设计研究院有限公司
Yellow River Engineering Consulting Co., Ltd.

HDEC

中国电建
POWERCHINA
中国电建集团华东勘测设计研究院有限公司
HUADONG ENGINEERING CORPORATION LIMITED

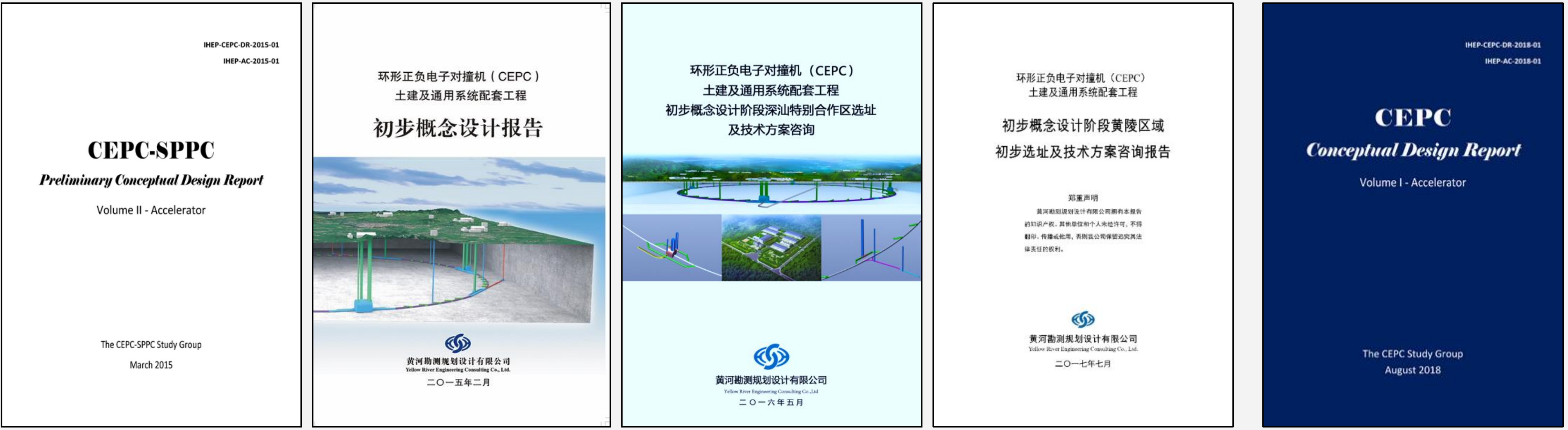
ZNEC

中国电建
POWERCHINA
中南勘测设计研究院有限公司
ZHONGNAN ENGINEERING CORPORATION LIMITED



黄河勘测规划设计研究院有限公司
Yellow River Engineering Consulting Co., Ltd.

Pre-CDR | CDR | TDR



2013.4 ~ 2015.3	2014.5 ~ 2016.8	2014.6 ~ 2017.7	2016.9	2017.7 ~ 2017.9	2017.9 ~ 2018.8	2018.9 ~ 2022
• Site selection in Hebei	• Site selection in Guangdong	• Site selection in Shaanxi	• Site selection in Jiangsu	• Site selection in Baoding, Hebei & Zhejiang	• 100km design of Qinhuangdao	• TDR design (Qinhuangdao, Changchun)

From March 25 to 29, 2018

The starting point of Huzhou site

the General Office of the Zhejiang Provincial People's Government invited CEPC-SPPC project experts from The High Energy Institute to visit the four sites preselected in Zhejiang province, and organized a CEPC-SPPC site evaluation meeting in Zhejiang. Huzhou site was preliminarily recommended as candidate site of Zhejiang Province after analysis and study.

By October 2021

the work that has been done is as follows

- **CEPC report on site selection (Zhejiang Huzhou)**

  Answer the questions-Why did CEPC choose huzhou

- **CEPC report on socio-economic assessment**

  Answer the questions-Why did huzhou choose CEPC

- **CEPC Technology Design Report on Civil engineering of the first stage**
- **CEPC report on science city concept plan**

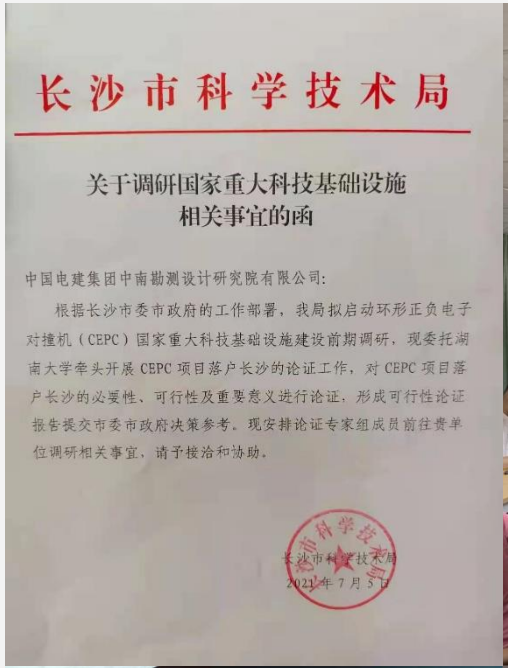
  Find a comfortable home for scientists

From December, 2018

The starting point of Changsha site

ZNEC continually carries out necessity demonstration and study on construction technology on CEPC Changsha Site.

- In July 2021, the government of Changsha City entrusted Hunan University to take the lead in the demonstration of the settlement of the CEPC Project in Changsha.
- In September 2021, Hunan University organized the site review meeting of the *Demonstration Report of China (Changsha) CEPC and New International Science City Project*.


长沙市科学技术局

关于调研国家重大科技基础设施相关事宜的函

中国电建集团中南勘测设计研究院有限公司:

根据长沙市委市政府的工作部署，我局拟启动环形正负电子对撞机（CEPC）国家重大科技基础设施建设前期调研，现委托湖南大学牵头开展 CEPC 项目落户长沙的论证工作，对 CEPC 项目落户长沙的必要性、可行性及重要意义进行论证，形成可行性论证报告提交市委市政府决策参考。现安排论证专家组成员前往贵单位调研相关事宜，请予接洽和协助。

长沙市科学技术局

2021年7月5日

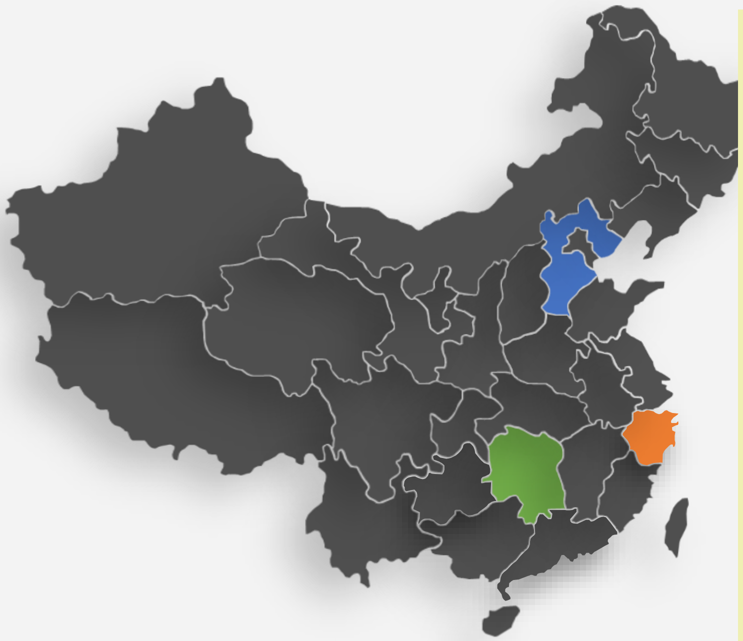
02

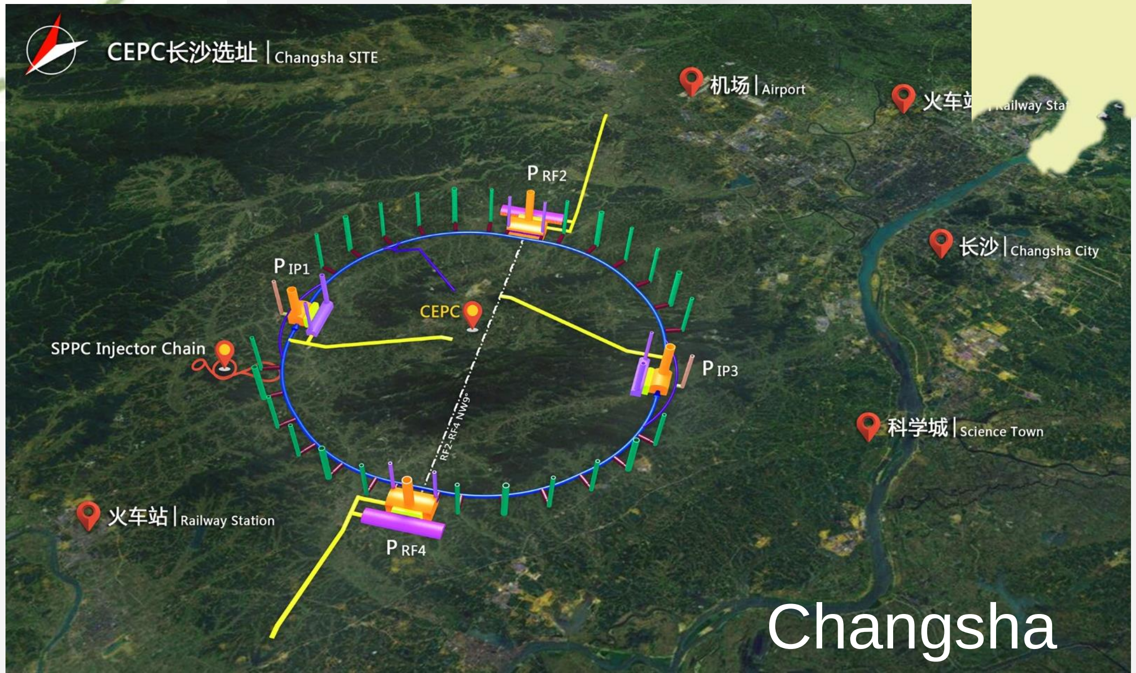
Civil Engineering

—— Qinhuangdao
Huzhou
Changsha

2.1 Location

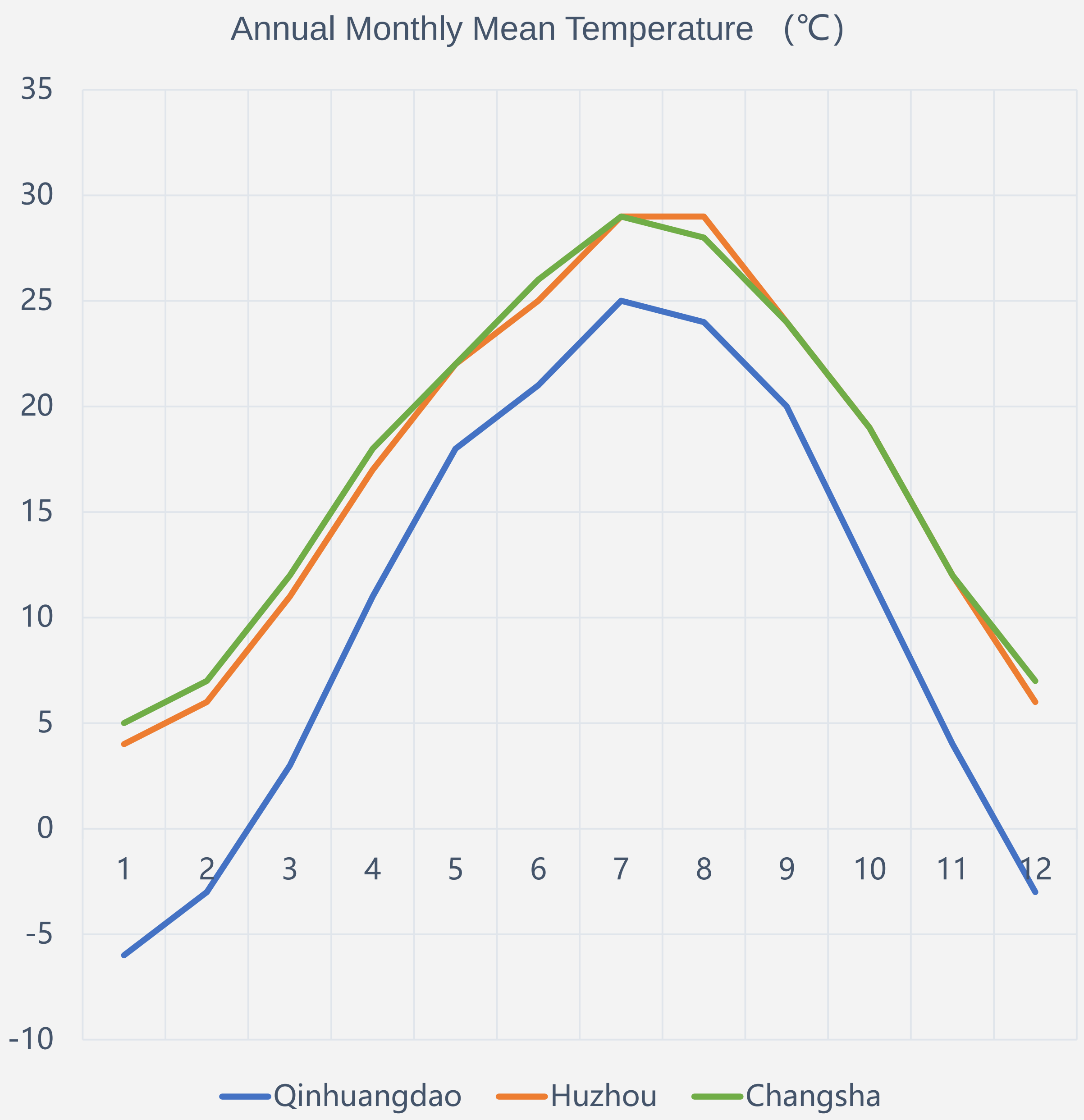

300km
150km
Beijing Metropolitan Area Development
承德
Chengde
张家口
Zhangjiakou
怀来
Huailai
北京
Beijing
唐山
Tangshan
秦皇岛
Qinhuangdao
廊坊
Langfang
天津
Tianjin
保定
Baoding
沧州
Cangzhou
石家庄
Shijiazhuang
Qinhuangdao

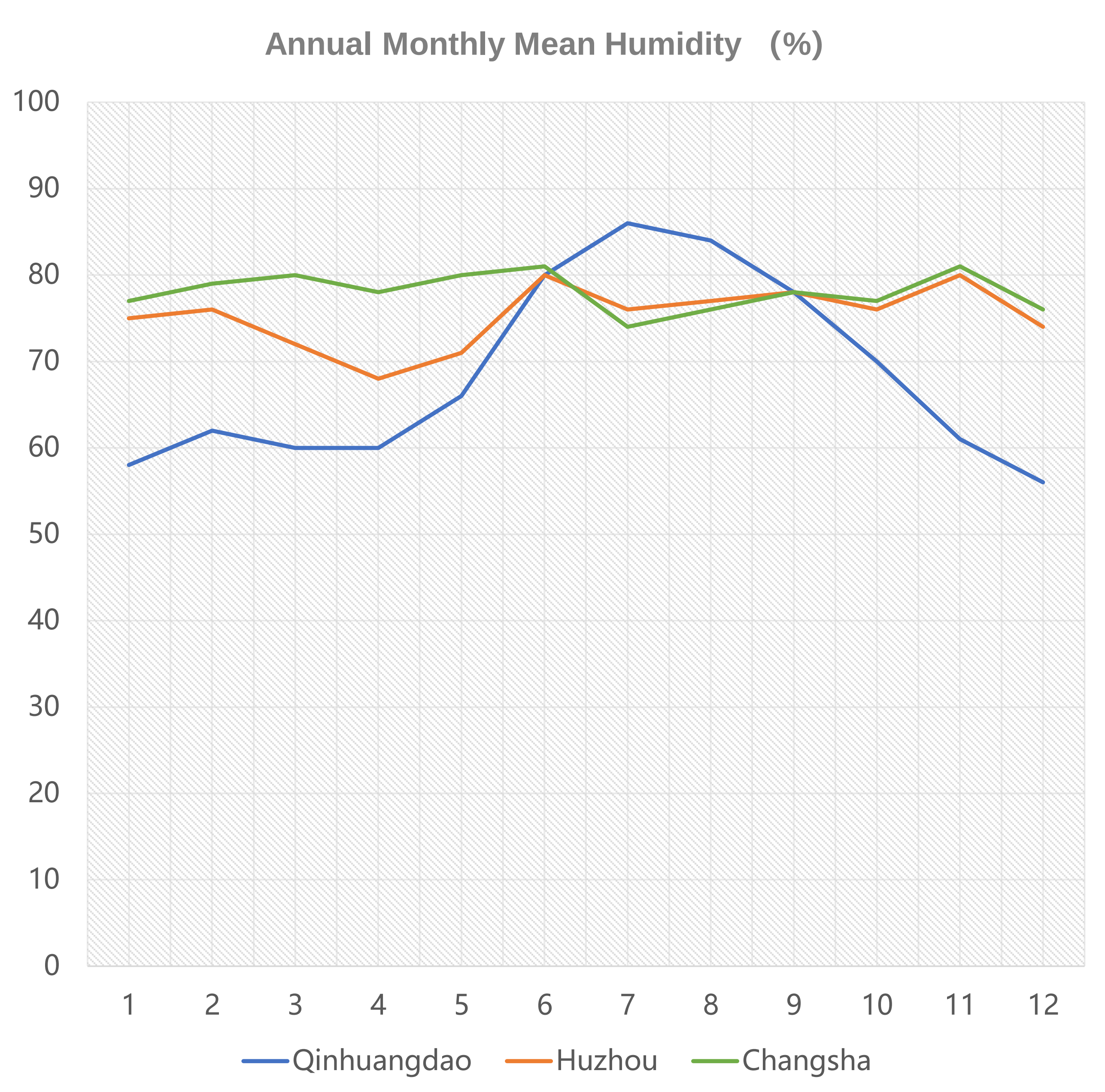



CEPC长沙选址 | Changsha SITE
机场 | Airport
长沙 | Changsha City
科学城 | Science Town
火车站 | Railway Station
P RF2
P IP1
P IP3
P RF4
CEPC
SPPC Injector Chain
Changsha


江 苏 省
安 徽 省
扬州市
南通市
南京市
镇江市
合肥市
常州市
无锡市
苏州市
芜湖市
上海市
湖州市
宣城市
嘉兴市
杭州市
绍兴市
宁波市
黄山市
浙 江 省
衢州市
金华市
台州
丽水市
温州市
Huzhou

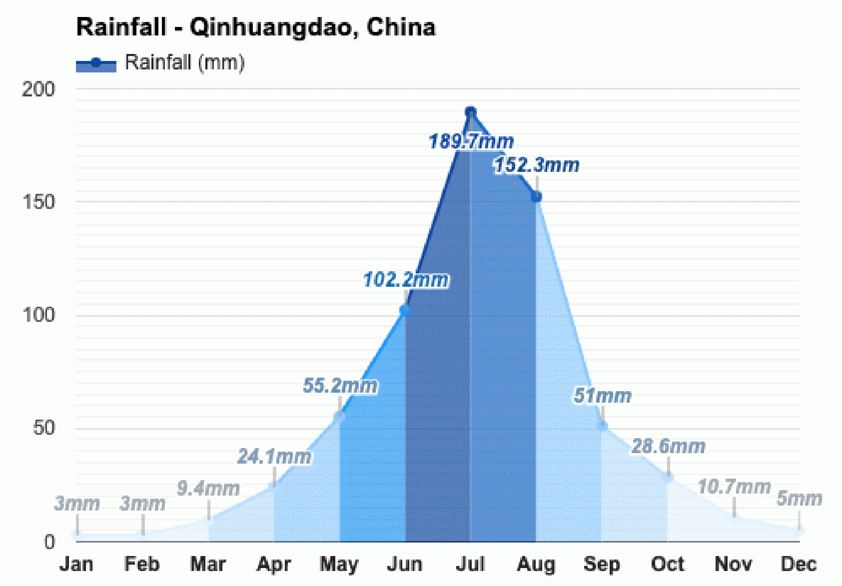
2.2 Climate

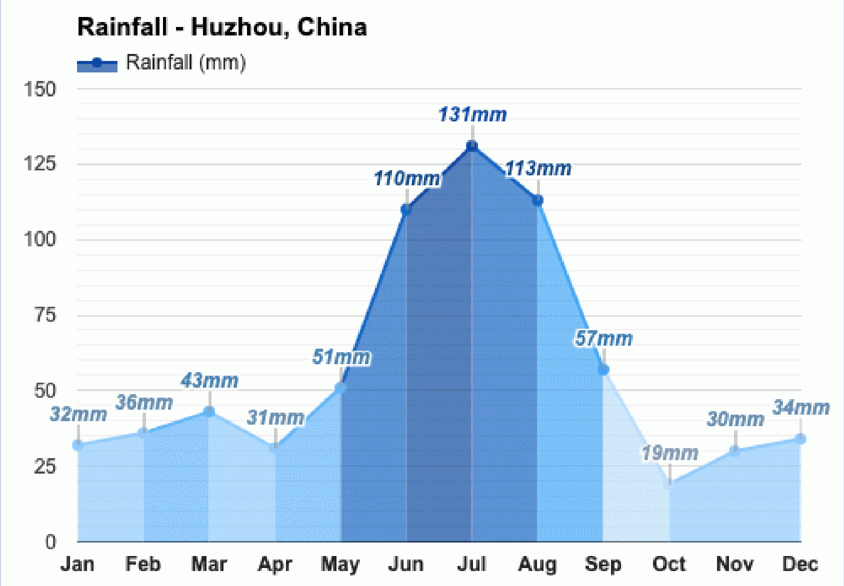

Annual Monthly Mean Temperature （℃）
35
30
25
20
15
10
5
0
-5
-10
1
2
3
4
5
6
7
8
9
10
11
12
Qinhuangdao
Huzhou
Changsha

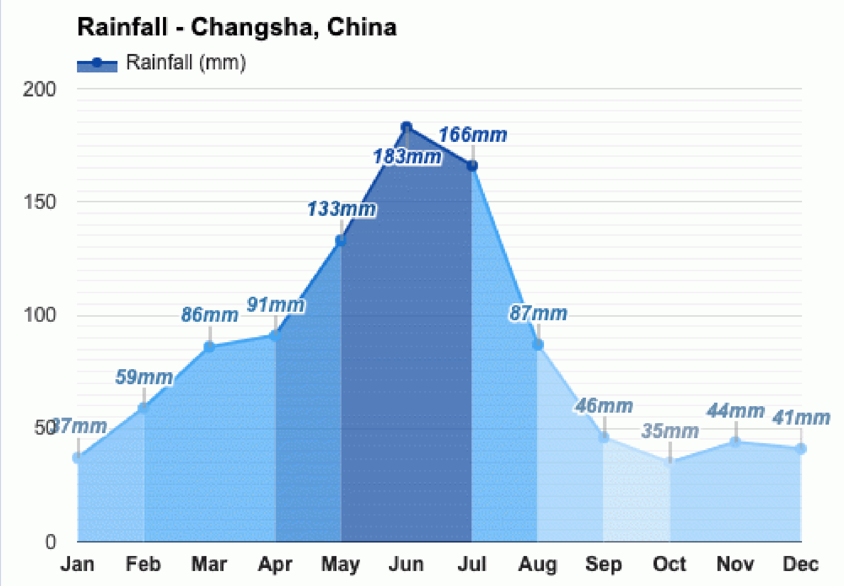

Annual Monthly Mean Humidity （%）
100
90
80
70
60
50
40
30
20
10
0
1
2
3
4
5
6
7
8
9
10
11
12
Qinhuangdao
Huzhou
Changsha

2.2 Climate

Qinhuangdao	Huzhou	Changsha

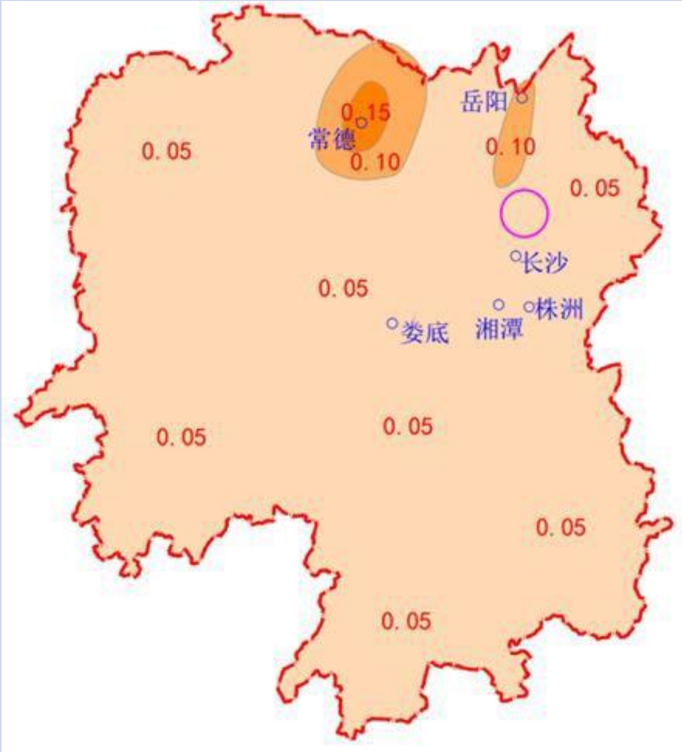






	Annual mean precipitation	
630mm	1023mm	1362mm

2.3 Engineering Geology

<table>
<tr><th>Qinhuangdao</th><th>Huzhou</th><th>Changsha</th></tr>
<tr>
<td>
</td>
<td>
</td>
<td>
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<tr><td></td><td>Seismic peak acceleration</td><td></td></tr>
<tr><td>0.10g~0.15g</td><td>0.05g</td><td>0.05g</td></tr>
<tr><td></td><td>Basic seismic intensity</td><td></td></tr>
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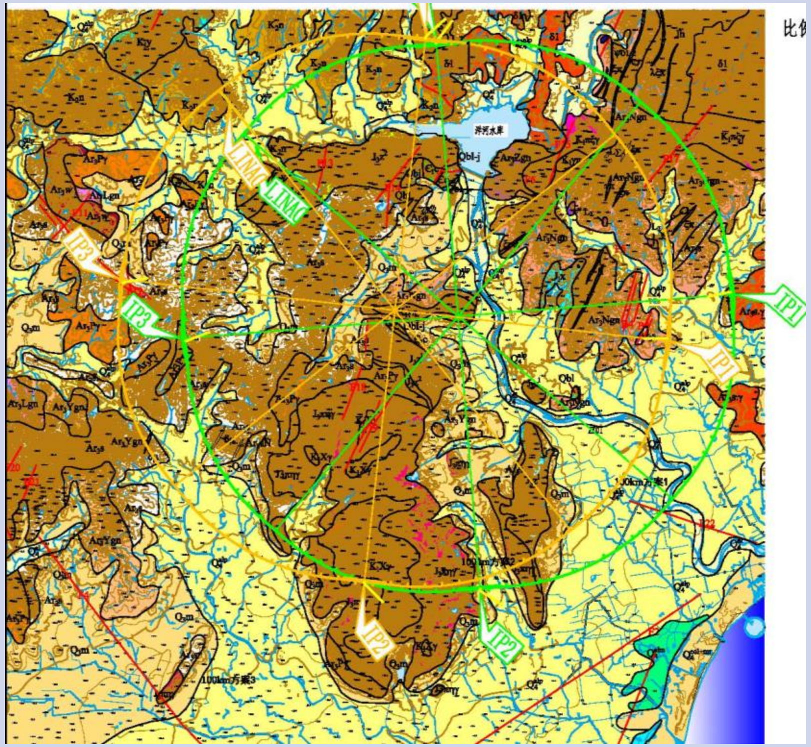
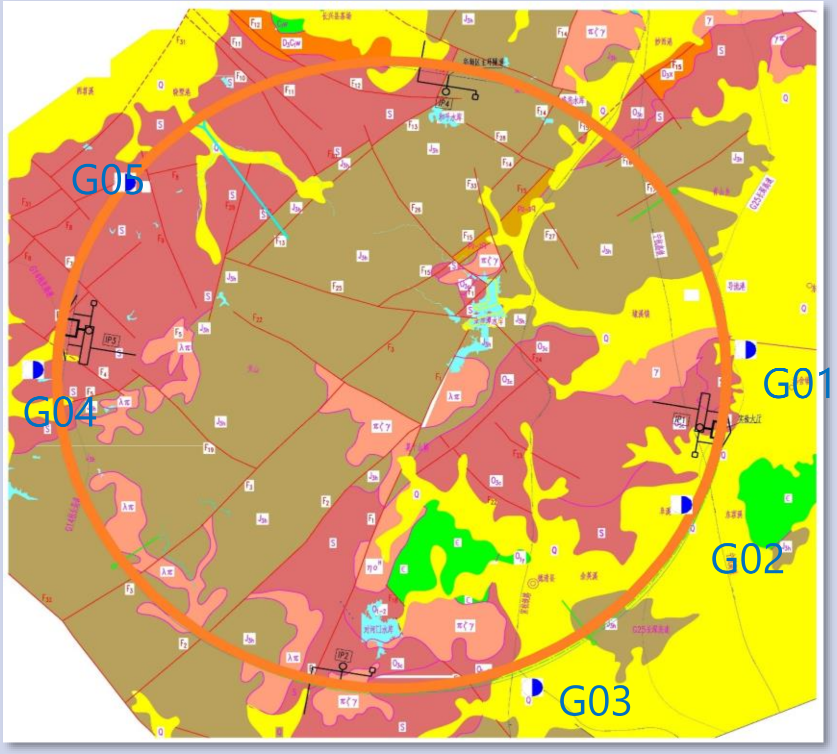
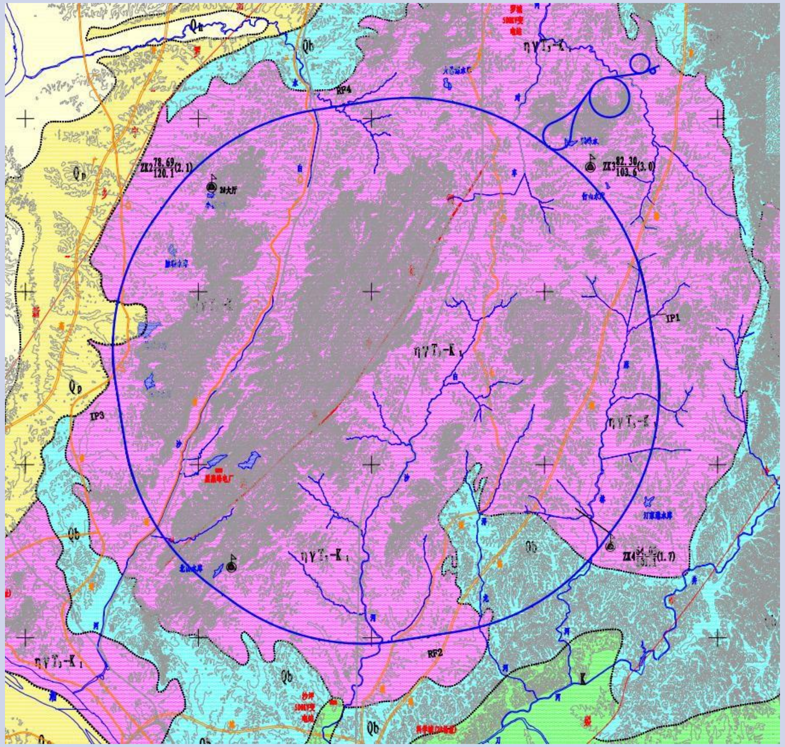
2.3 Engineering Geology

Qinhuangdao	Huzhou	Changsha





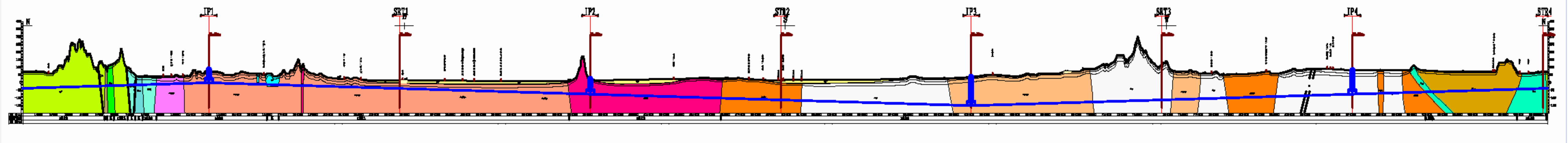


	Stratum Lithology	
Gneiss Granite	Sandstone Tuff	Granite Sandstone, Slate

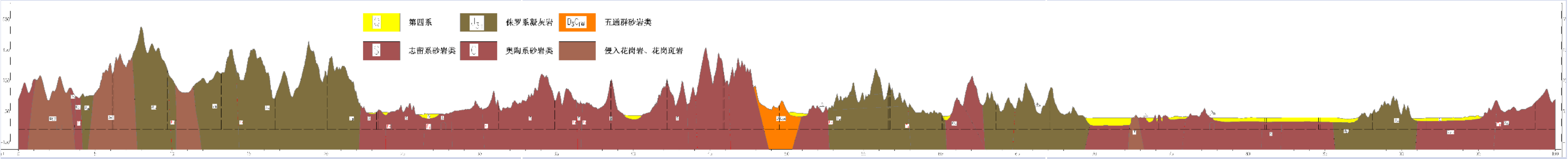
2.3 Engineering Geology

Qinhuangdao	Huzhou	Changsha

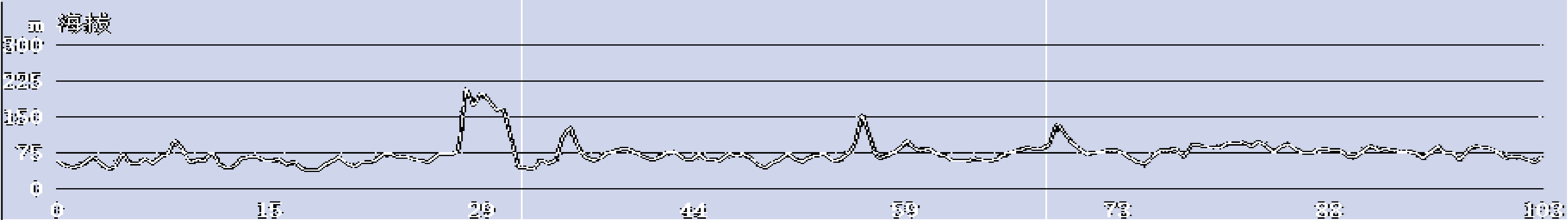
Qinhuangdao



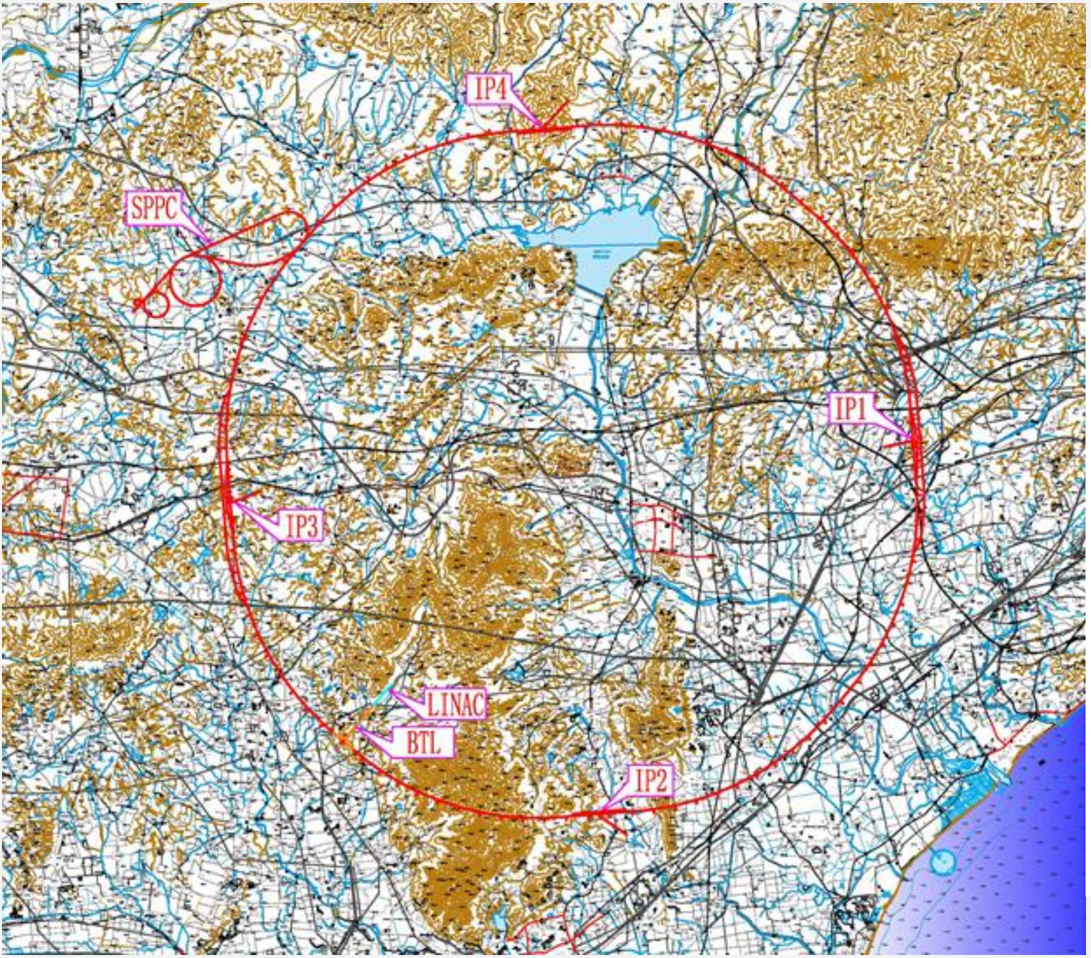
Huzhou

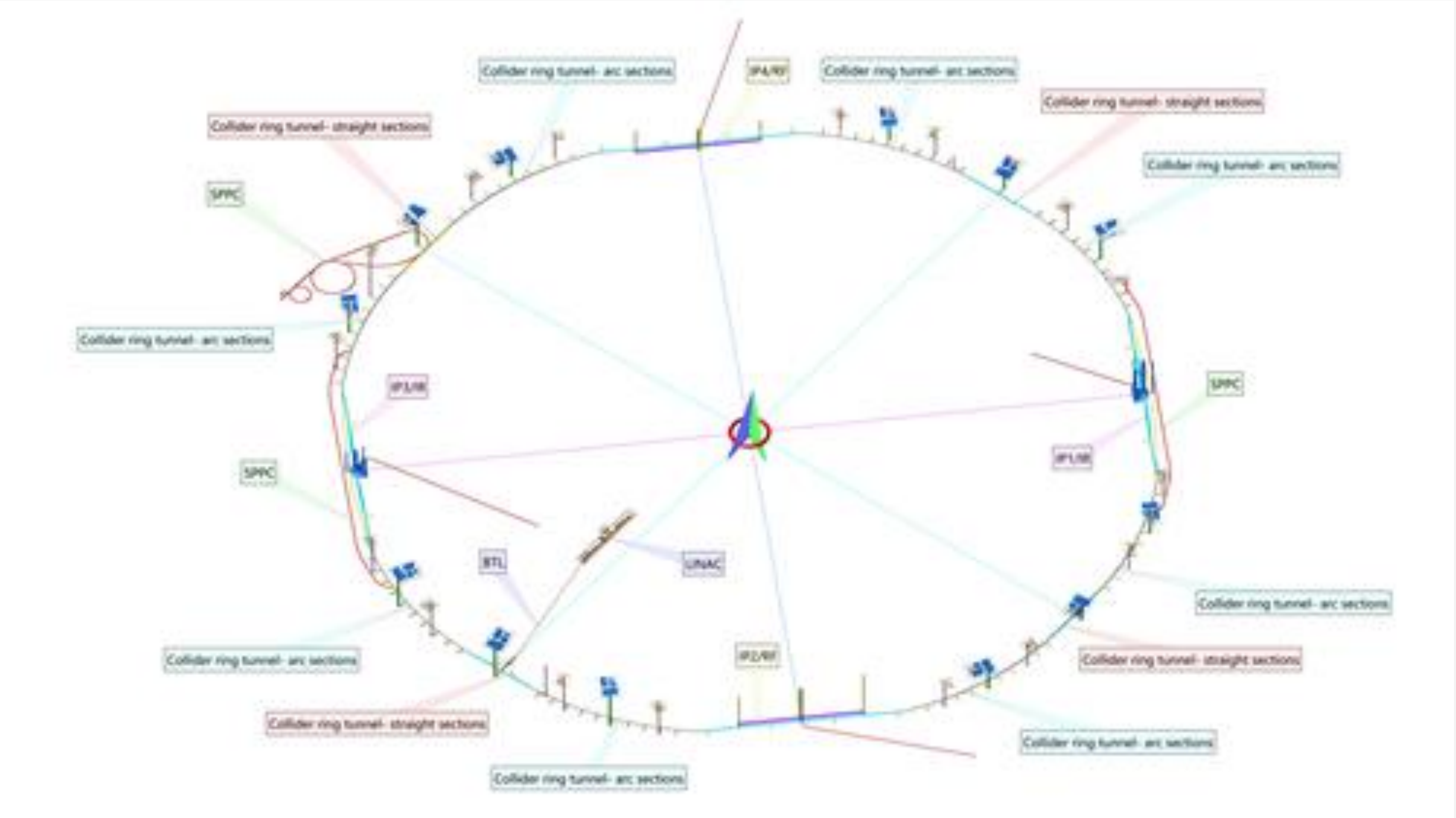


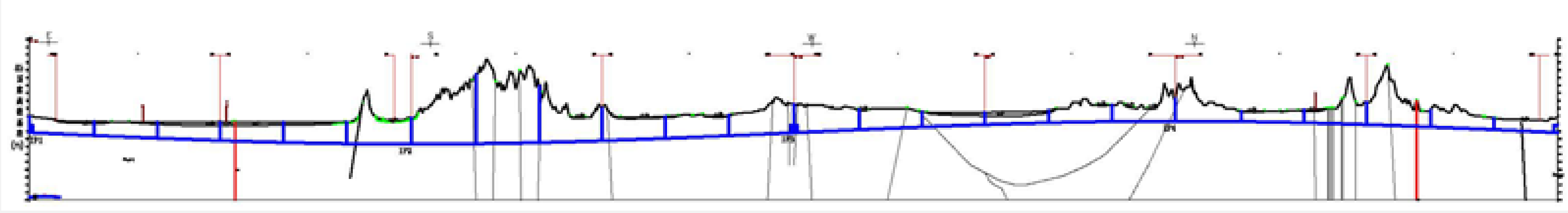
Changsha



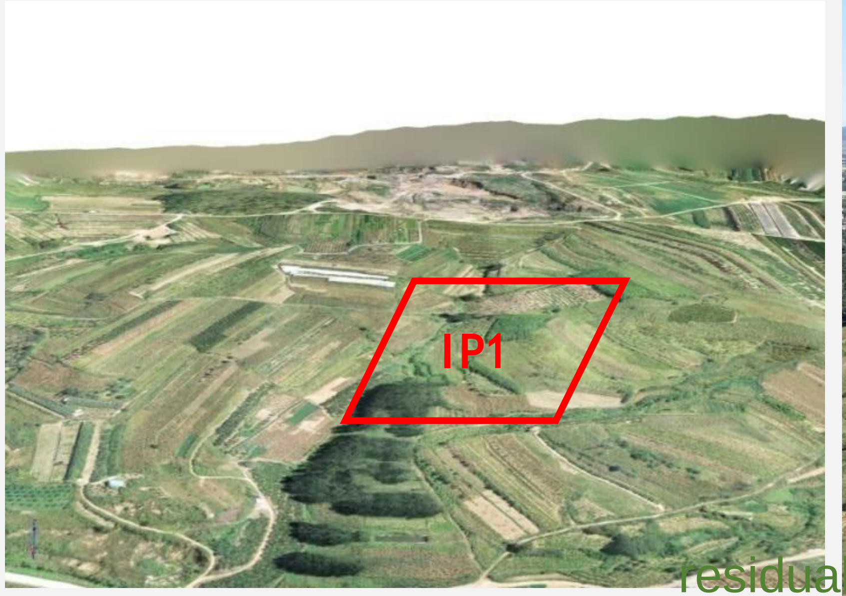
2.4 Project Layout



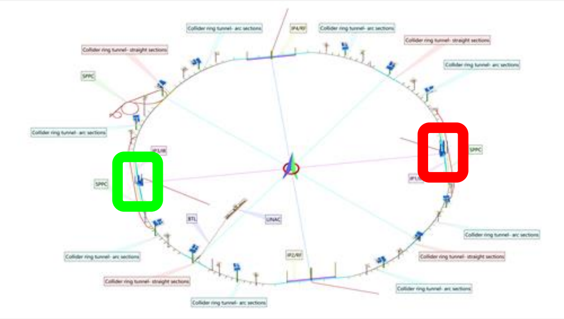


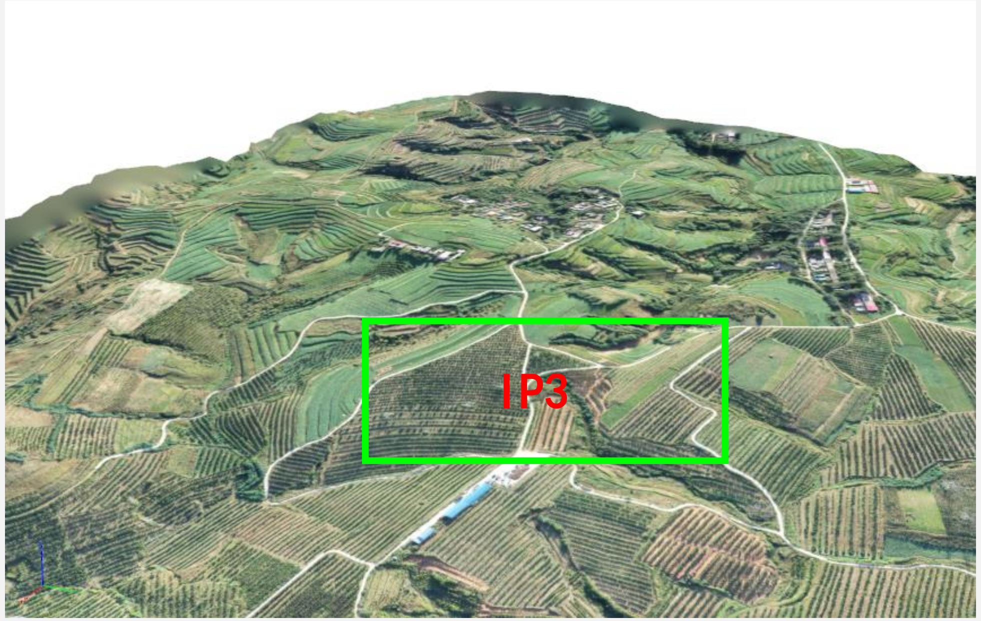


Preferred Option

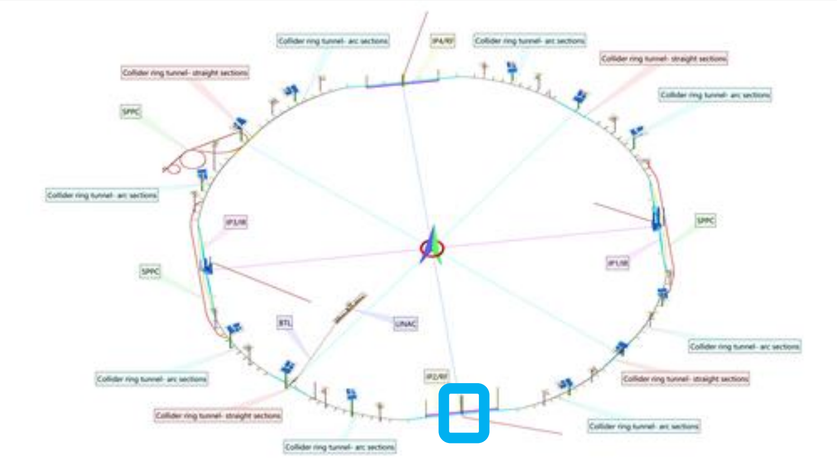


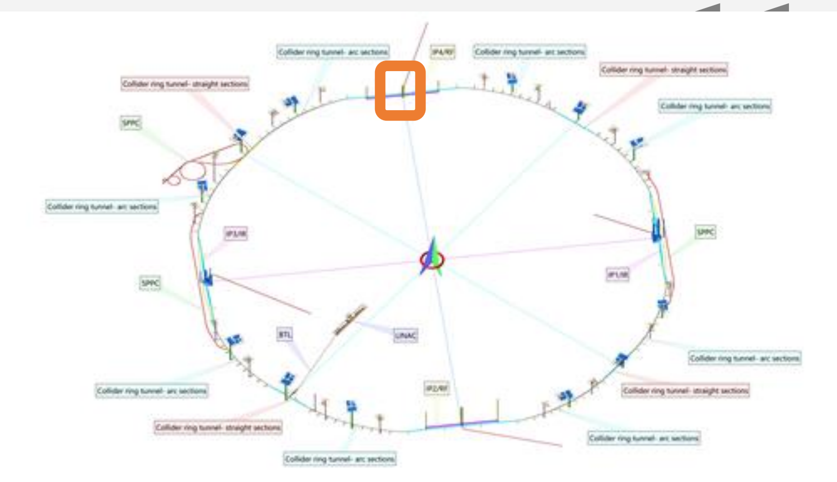
residual

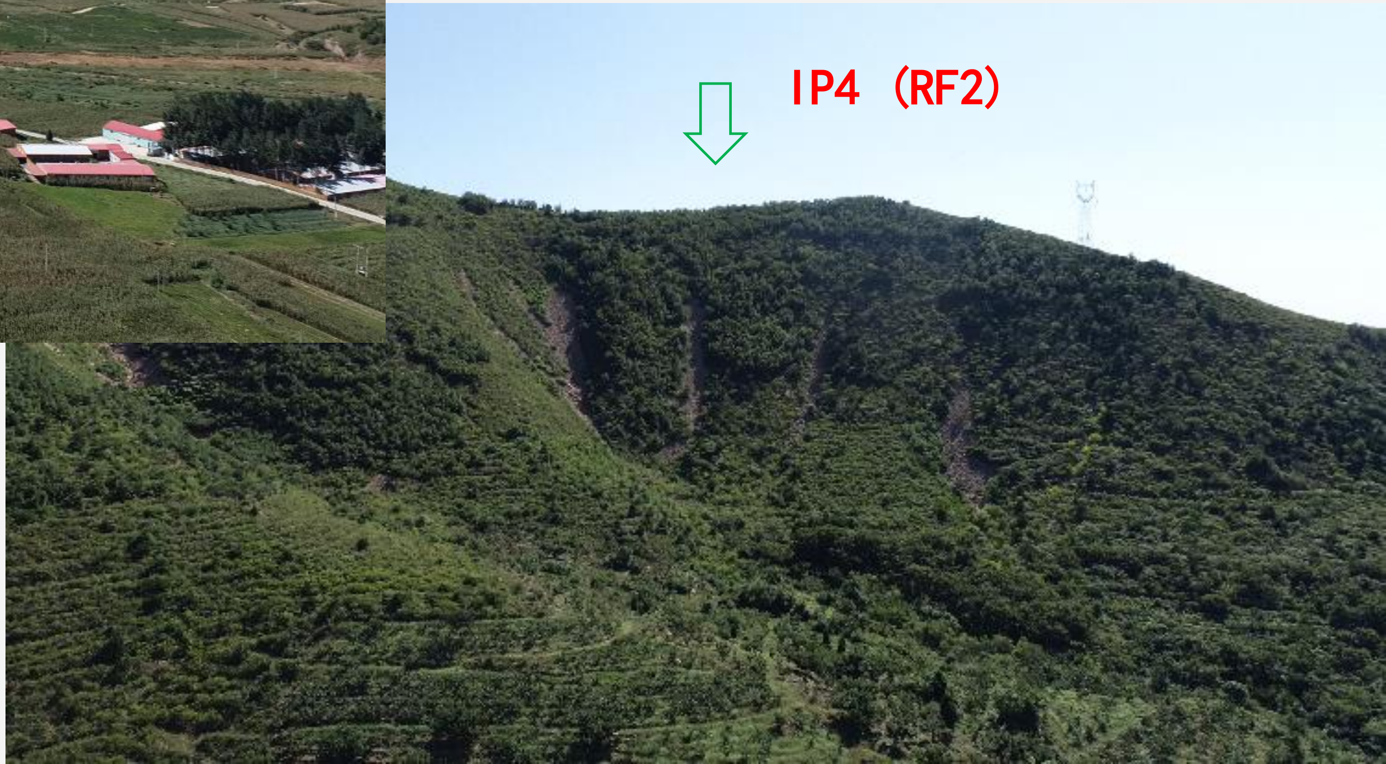





IP2（RF1）


Collider ring tunnel- arc sections
IP4/RF
Collider ring tunnel- arc sections
Collider ring tunnel- straight sections
Collider ring tunnel- straight sections
Collider ring tunnel- arc sections
SPPC
Collider ring tunnel- arc sections
IP3/IR
SPPC
IP1/IR
SPPC
BTL
LINAC
Collider ring tunnel- arc sections
Collider ring tunnel- arc sections
IP2/RF
Collider ring tunnel- straight sections
Collider ring tunnel- straight sections
Collider ring tunnel- arc sections
Collider ring tunnel- arc sections

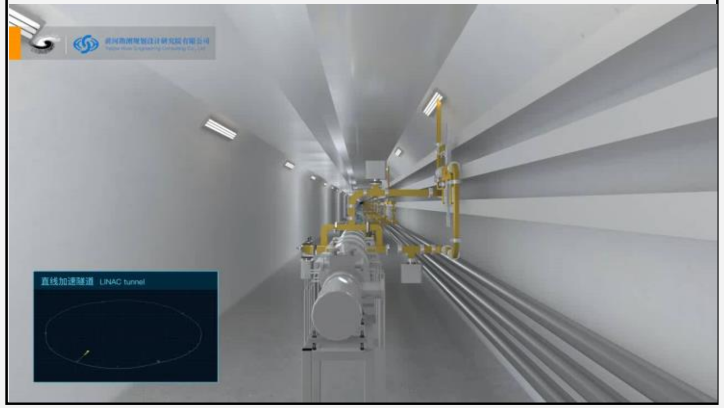

Collider ring tunnel- arc sections
IP4/RF
Collider ring tunnel- arc sections
Collider ring tunnel- straight sections
Collider ring tunnel- straight sections
Collider ring tunnel- arc sections
SPPC
Collider ring tunnel- arc sections
IP3/IR
SPPC
IP1/IR
SPPC
BTL
LINAC
Collider ring tunnel- arc sections
IP2/RF
Collider ring tunnel- straight sections
Collider ring tunnel- arc sections
Collider ring tunnel- straight sections
Collider ring tunnel- arc sections
Collider ring tunnel- arc sections


IP4 (RF2)

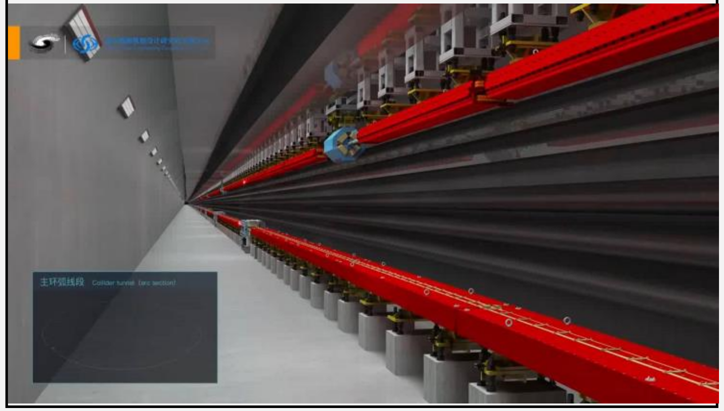
2.5 Equipment Layout

Klystron Gallery

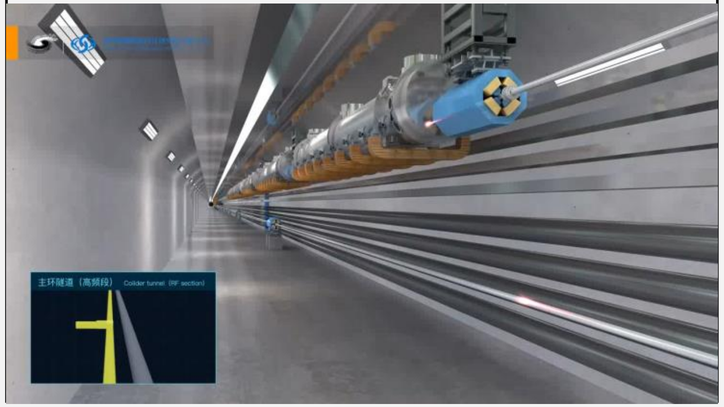
Linac & BTL Tunnel



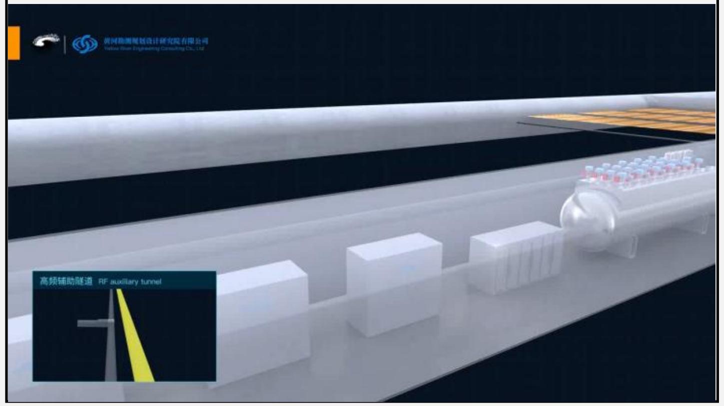
Collider ring tunnel



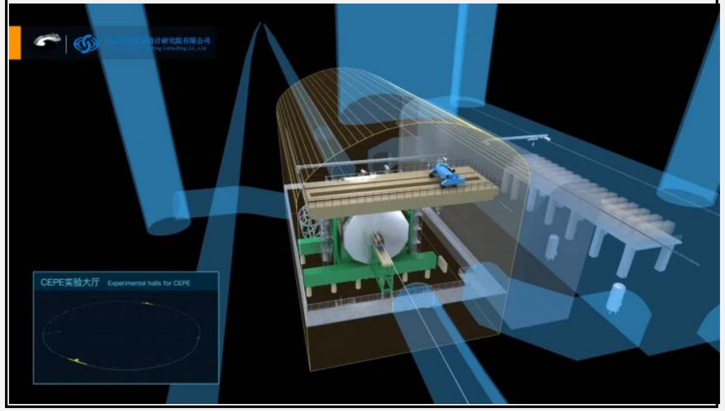
Collider ring tunnel (RF)



RF Auxiliary Tunnel



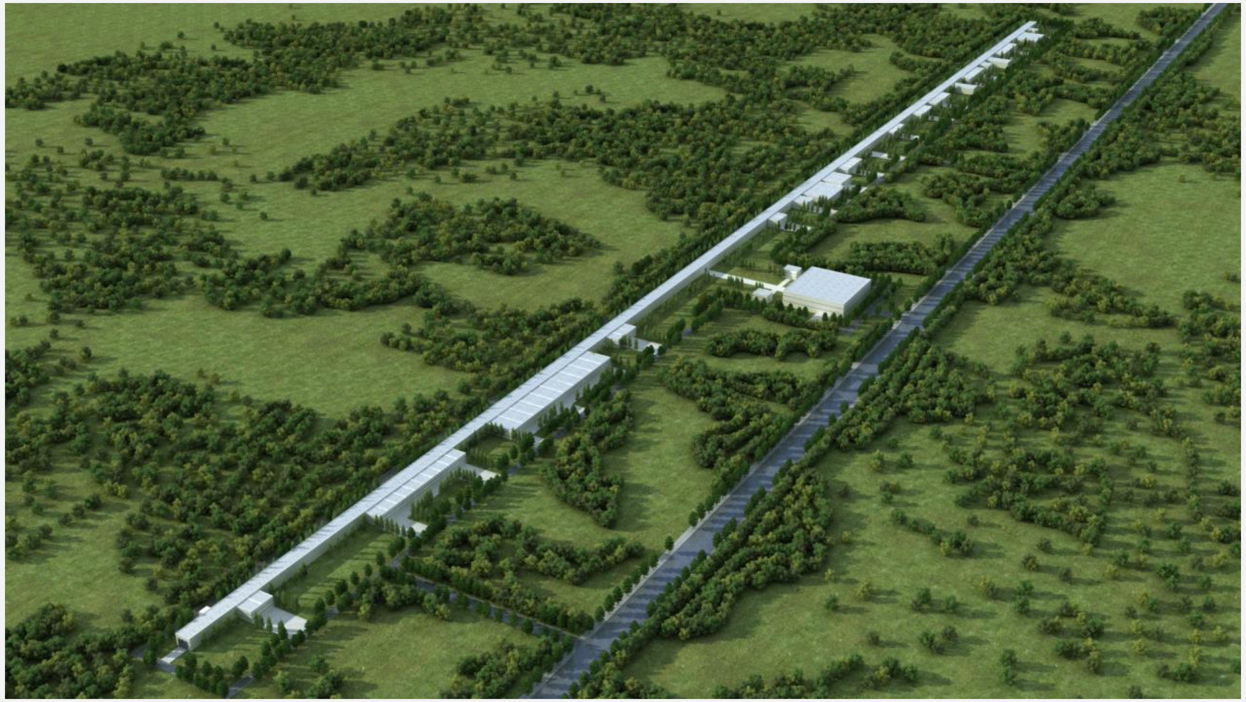
IP1 / IP3



2.6 Surface Buildings

IP1

LINAC



2.7 International Science City

Huzhou

中国电建 POWERCHINA 中国电建集团华东勘测设计研究院有限公司 HUADONG ENGINEERING CORPORATION LIMITED

Changsha

中国电建 POWERCHINA 中南勘测设计研究院有限公司 ZHONGNAN ENGINEERING CORPORATION LIMITED

03

Auxiliary Facilities

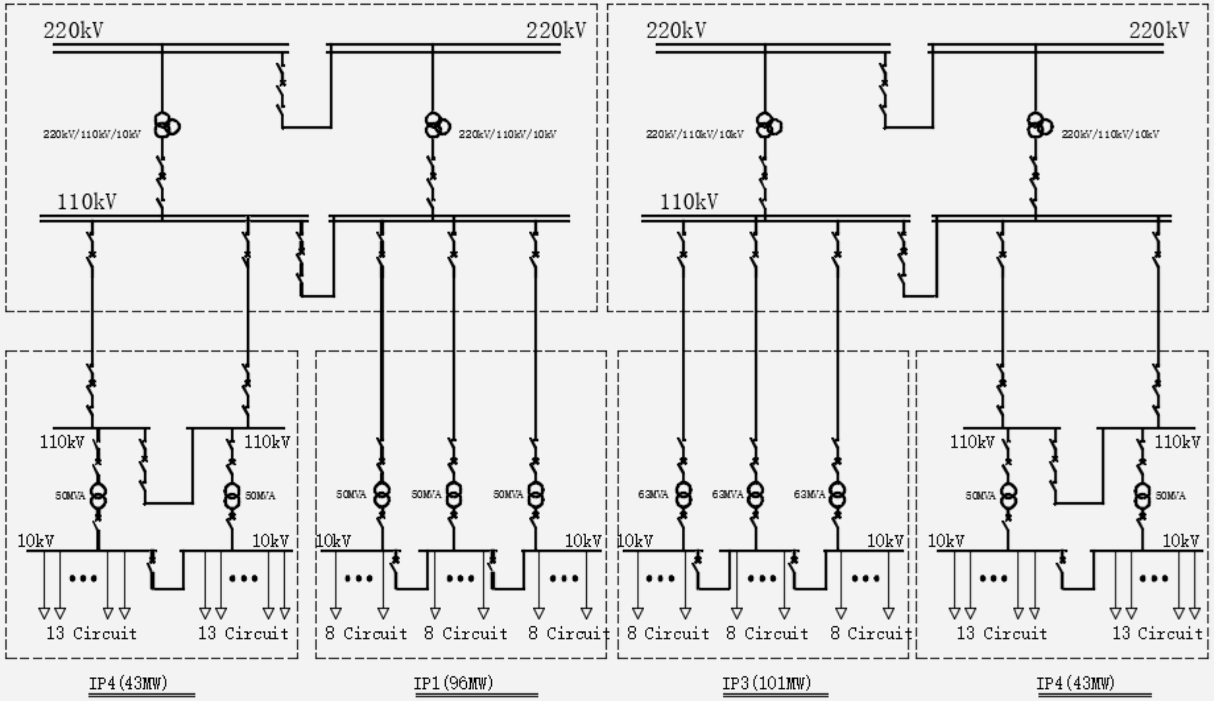
3.1 Electric engineering

- **Electric power demand**
  - Total: 270.37MW

	System for Higgs (30 MW /beam)	Location and Power Requirement (MW)						Total (MW)
		Collider	Booster	Linac	BTL	IR	Surface building	
1	RF Power Source	103.8	0.15	5.8				109.75
2	Cryogenic System	15.67	0.89			1.8		18.36
3	Vacuum System	9.784	3.792	0.646				14.22
4	Magnet Power Supplies	47.21	11.62	1.75	1.06	0.26		61.9
5	Instrumentation	0.9	0.6	0.2				1.7
6	Radiation Protection	0.25		0.1				0.35
7	Control System	1	0.6	0.2	0.005	0.005		1.81
8	Experimental Devices					4		4
9	Utilities	31.79	3.53	1.38	0.63	1.2		38.53
10	General Services	7.2		0.2	0.15	0.2	12	19.75
	Total	213.554	20.972	10.276	1.845	7.385	12	270.37

3.1 Electric engineering

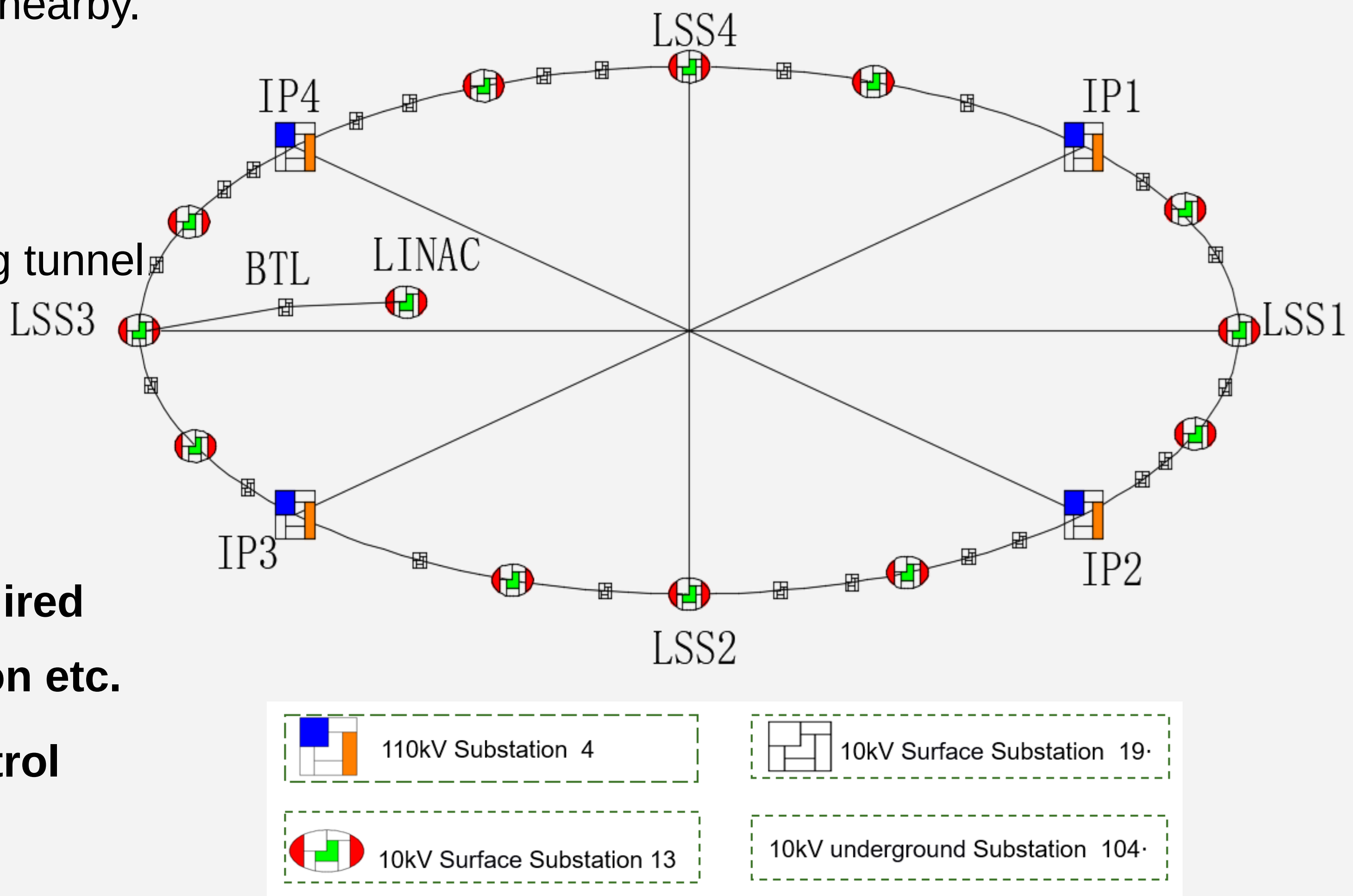
- **Power supplies and schemes**
  - **The voltage levels on the site**
    - 220kV incomer of CEPC master substation.
    - 110kV power distribution system.
    - 10kV power distribution system for HV power equipment and step-down substation incomer.
    - 0.4kV power distribution system for dedicated and general services.
  - **220kV/110kV Master substation**
    - 2 substations
    - Rated capacity of transformer: 2*210MW (220/110kV/10kV).
    - 220kV feeds connected to grid station nearby (State Grid Corporation of China).
    - Three-phase three-volume natural oil circulating air-cooled on-load regulating.



- **110kV/10kV step-down substations**
  - 4 substations(IP1~IP4)
  - Rated capacity of transformer: 7*50MW+3*63MW

3.1 Electric engineering

- **10kV step-down substations**
  - 10kV feeders from 110kV/10kV substation nearby.
  - Surface 10kV loop : 40
  - Underground 10kV loop
    - -- 96 substations (10/0.4kV) along the ring tunnel
    - -- near the load points.
  - Dry-type transformers
  - Centralized reactive compensation
- **Back up diesel generator sets maybe required for personnel safety: lifts, smoke extraction etc.**
- **Instrumentation and power converter control systems may require uninterrupted power supplies (UPS).**



3.1 Electric engineering

- **110kV Substation load distribution**
  - IP1: 96MW
  - IP2: 42MW
  - IP3: 101MW
  - IP4: 42MW

Power supply load statistics of substation — IP1

System for Higgs 30MW	Location and electrical demand(MW)					
	Ring	Booster	LINAC	BTL	Surface building	TOTAL
RF Power Source	51.90	0.08				51.98
Cryogenic System	7.84	0.45				8.28
Vacuum System	2.45	0.95				3.39
Magnet Power Supplies	11.80	5.80				17.60
Instrumentation	0.23	0.15				0.38
Radiation Protection	0.06					0.06
Control System	0.25	0.15				0.40
Utilities	7.95	0.88				8.83
General services	1.80				3.00	4.80
Total	84.27	8.45			3.00	95.72

Power supply load statistics of substation — IP2/4

System for Higgs 30MW	Location and electrical demand(MW)					
	Ring	Booster	IR	–	Surface building	TOTAL
RF Power Source			0.90			0.90
Cryogenic System	2.55	5.79				8.34
Vacuum System	9.25	0.01	0.13			9.40
Magnet Power Supplies	2.45	0.95				3.39
Instrumentation	0.23	0.15				0.38
Radiation Protection	0.06		0.00			0.07
Control System	0.25	0.15	2.00			2.40
Utilities	7.95	0.88	0.60			9.43
General services	1.80		0.10		6.00	7.90
Total	24.53	7.93	3.73		6.00	42.19

Power supply load statistics of substation — IP3

System for Higgs 30MW	Location and electrical demand(MW)					
	Ring	Booster	LINAC	BTL	Surface building	TOTAL
RF Power Source	51.90	0.08	5.80			51.98
Cryogenic System	7.84	0.45				8.28
Vacuum System	2.45	0.95	0.65			4.04
Magnet Power Supplies	11.80	5.80	1.75	1.06		19.41
Instrumentation	0.23	0.15	0.20			0.58
Radiation Protection	0.06		0.10			0.16
Control System	0.25	0.15	0.20	0.01		0.58
Utilities	7.95	0.88	1.38	0.63		10.84
General services	1.80		0.20	0.15	3.00	5.15
Total	84.27	8.45	10.28	1.85	3.00	100.66

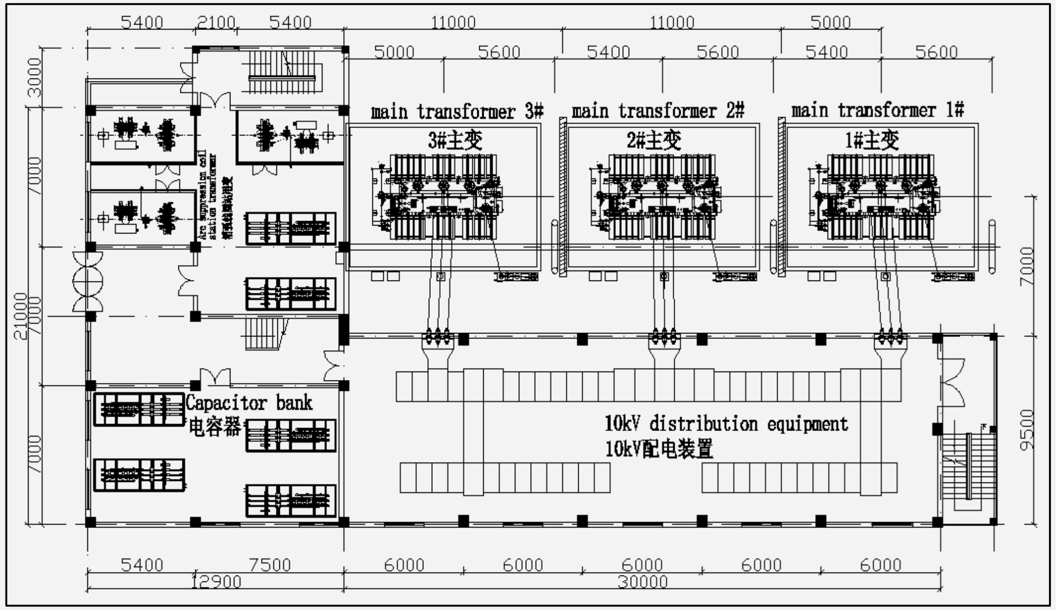
3.1 Electric engineering

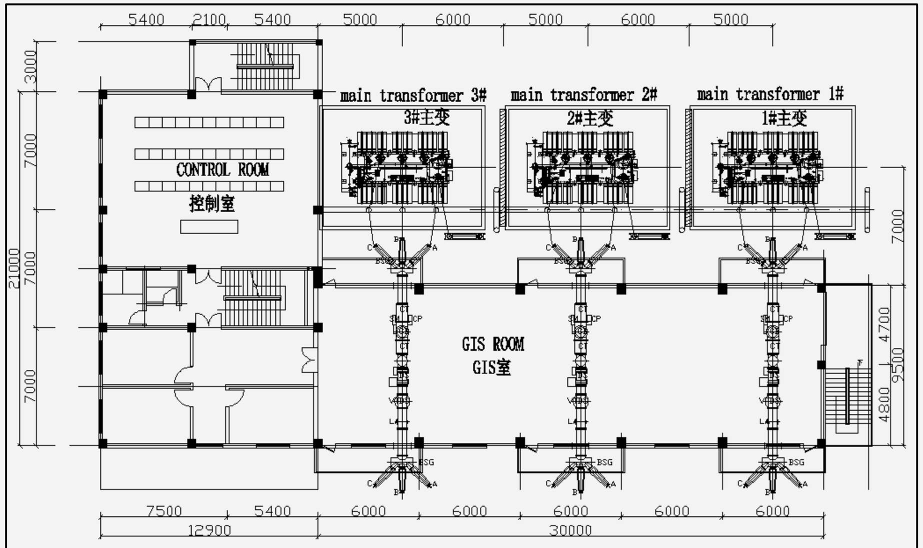
- **110kV Substation layout**
  - **IP1/IP3**
    - Main electrical wiring of 110kV substation

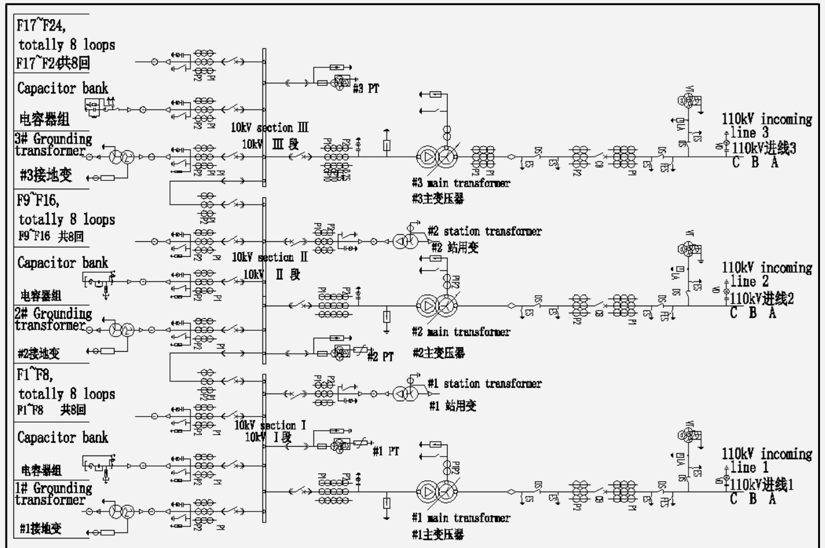
-- 110kV lines connected by the line transformer bank.

-- 10 kV lines connected by sectionalized single busbar.

- Main transformer Outdoor;
- 10 kV Switchgear indoor
- Double-row arrangement;
- Outgoing line by cables.
- 110 kV GIS equipment in single row.







3.1 Electric engineering

- **Detailed statistics and construction scale of 10kV substations**

	Substation Name	Num. of Substation	Diagram of 10kV	Circuit Num.	Load of 10kV Substation	Scale of Substation (0.4kV)	Location of Substation
1	IP1，IP3 10kV Substation	2	Single Bus section	3 incoming 24 outgoing	53.63MW(10kV) 10.17MW （0.4kV)	2x2000kVA	Nearby 1# &2# RF Power Tunnel 1#~2# Power Hall
2	IP2，IP4 10kV Substation	2	Single Bus 2 section	2 incoming 26 outgoing	2.73MW(10kV) 4.57MW(0.4kV)	4x2000kVA	1# & 2# IR Equipment Hall 3#~4# Power Hall
3	LSS1~LSS4 10kV Substation	4	Single Bus 2 section	3 incoming 10 outgoing	2.73MW(10kV) 0.82MW(0.4kV)	2x1250kVA	5#~8# Power Hall
4	LINAC 10kV Substation （31# ）	1	Single Bus 2 section	2 incoming 10 outgoing	5.8MW(10kV) 4.476MW	2x2500kVA	LINAC
5	BTL 10kV Substation（32# ）	1	Single Bus 2 section	2 incoming 2 outgoing	1.845MW	2x2000kVA	BTL
6	1#~30# grounding 10kV Substation	30	Single Bus 2 section	2 incoming 10 outgoing	0.96MW	2x1250kVA	Surface Substation
7	1#~96# Auxiliary Tunnel	96	Single Bus 2 section	2 incoming 2 outgoing	0.78MW	2x1000kVA	Auxiliary Tunnel
	Total Load：2xIP1 Load+2xIP2 Load+4x LSS1 Load+ 1xLINAC Load+1x BTL Load+30x Grounding Load+96x Auxiliary Load=272.2MW						

3.2 HVAC

- **Estimated cooling loads of HVAC**
  - Ring tunnel: **6MW**
  - Service buildings: (200W/m^2) 28MW

  Total: **34MW**
- **Coolant for air conditioning: chilled water**
- **Heat source for heating system in winter**
  - Heat pump -- heat recover from cooling system.
  - Backup boiler

Design Parameter	Unit	Quantity
Total cooling load	MW	34
Total chilled water flow rate	m^3/h	5850
Total cooling tower water flow rate	m^3/h	7016
Total capacity of cooling towers	MW	41

- **Indoor Design Parameters**
  - **Tunnel**
    - Temperature: within 30-34℃ and shall be kept below 35℃

      -- Inlet: 18~20℃

      -- Outlet: less than 35℃
    - Relative humidity: 50% ~ 60%, and shall be lower than 65%
  - **Experimental halls**
    - Temperature: about 26℃(summer), 20℃(winter)
    - Relative humidity: 50% ~ 60%, and shall be lower than 65%.
  - **Control room (or electronics)**
    - Temperature: about 20-25℃
    - Relative humidity: 45% ~ 60%
  - **Other service building**
    - Temperature: about 28℃(summer), 18℃(winter),
    - Relative humidity: lower than 65%

3.2 HVAC

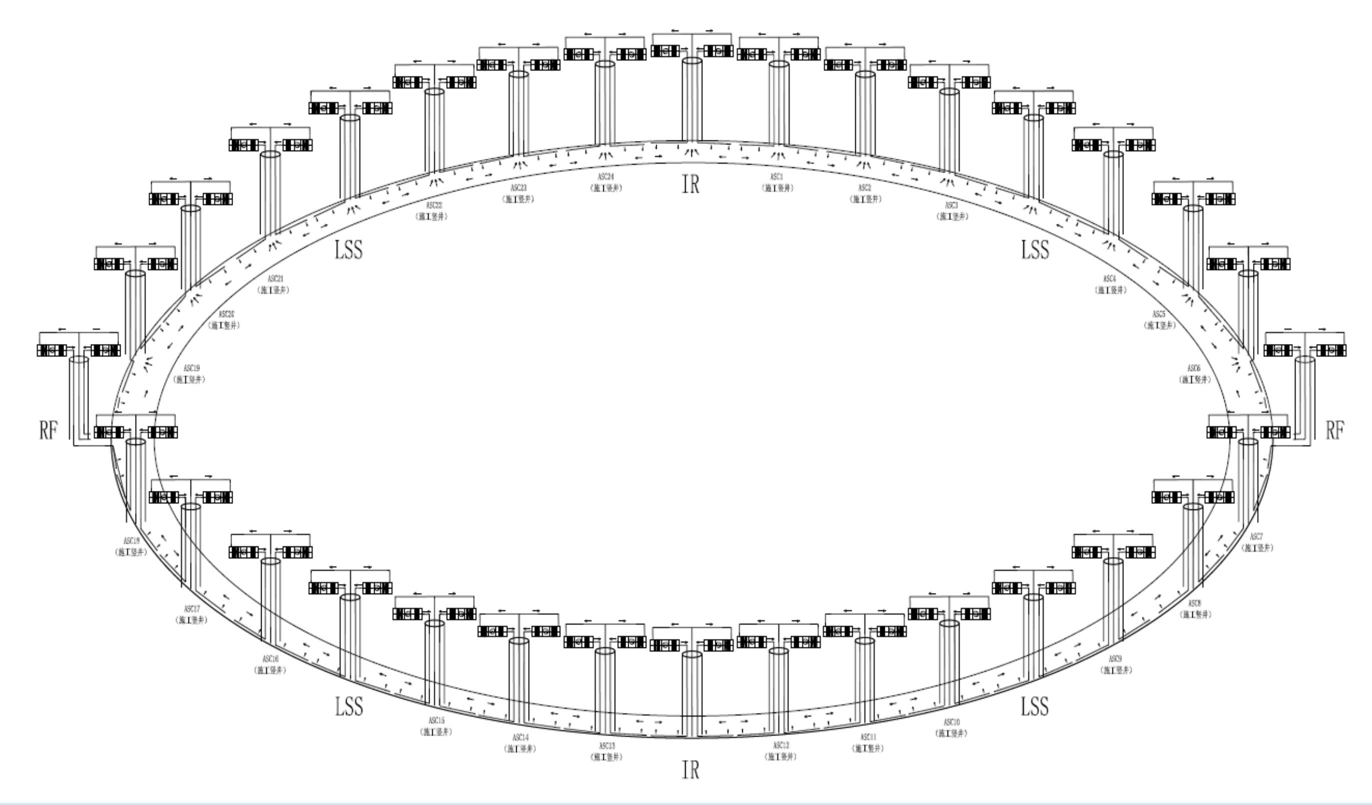
- **Air-conditioning system in tunnel**
  - Layout
    - The ring tunnel is divided into 32 independent sections.
    - Each shaft serves as a ventilation and exhaust passage for the collider ring tunnel, and a ventilation pipe and a smoke exhaust pipe are arranged therein.
  - Operation scenario
    - **Machine operation mode**

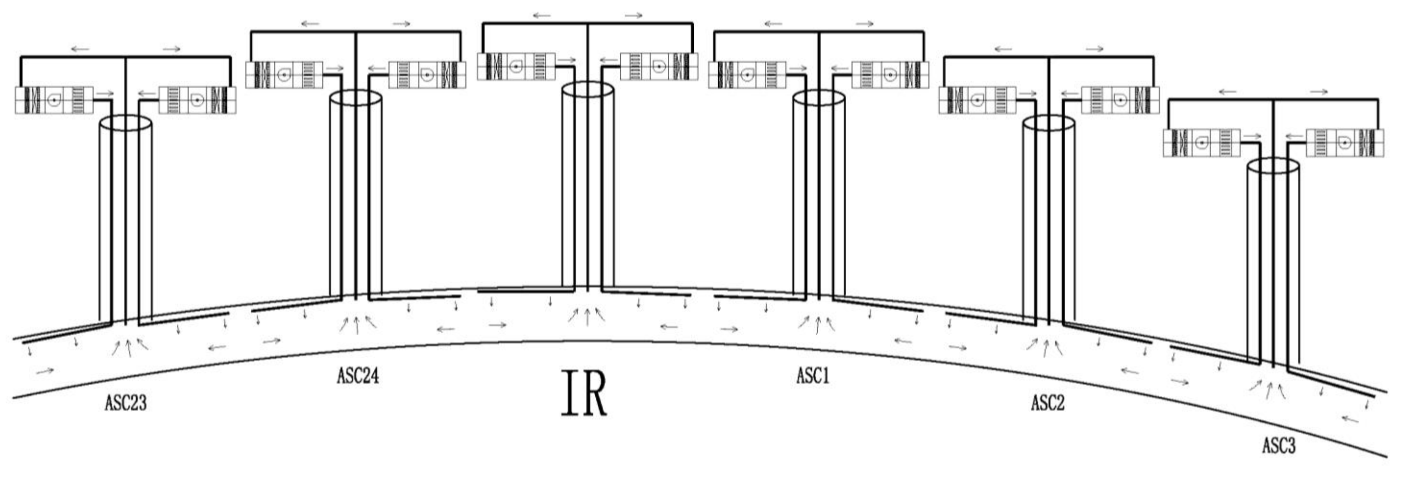
      -- Temperature and humidity in tunnel are maintained by inlet air.
    - **Transitional mode**

      -- To purge air in the tunnel before access.
    - **Accessible mode**

      -- The air flow rate could be cut down.
    - **Emergency mode**

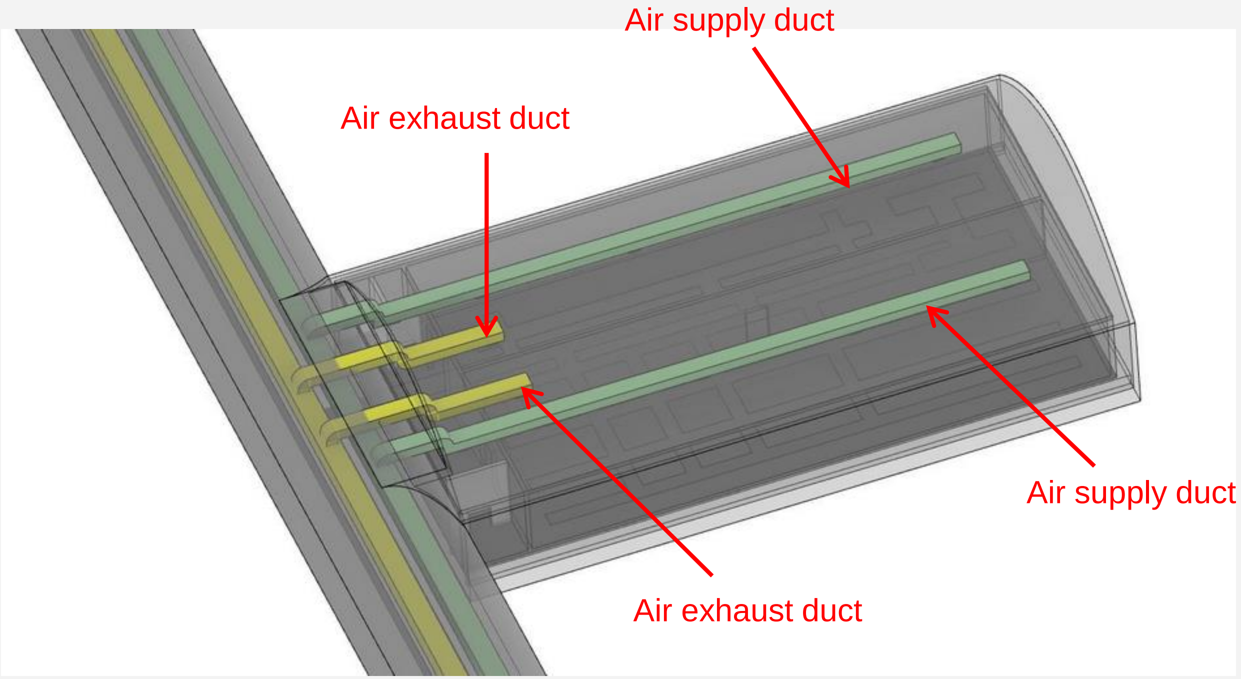
      -- In case of smoke and gas extraction.

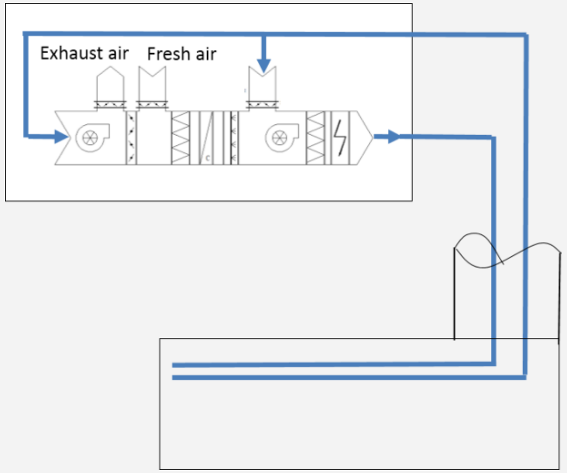




3.2 HVAC

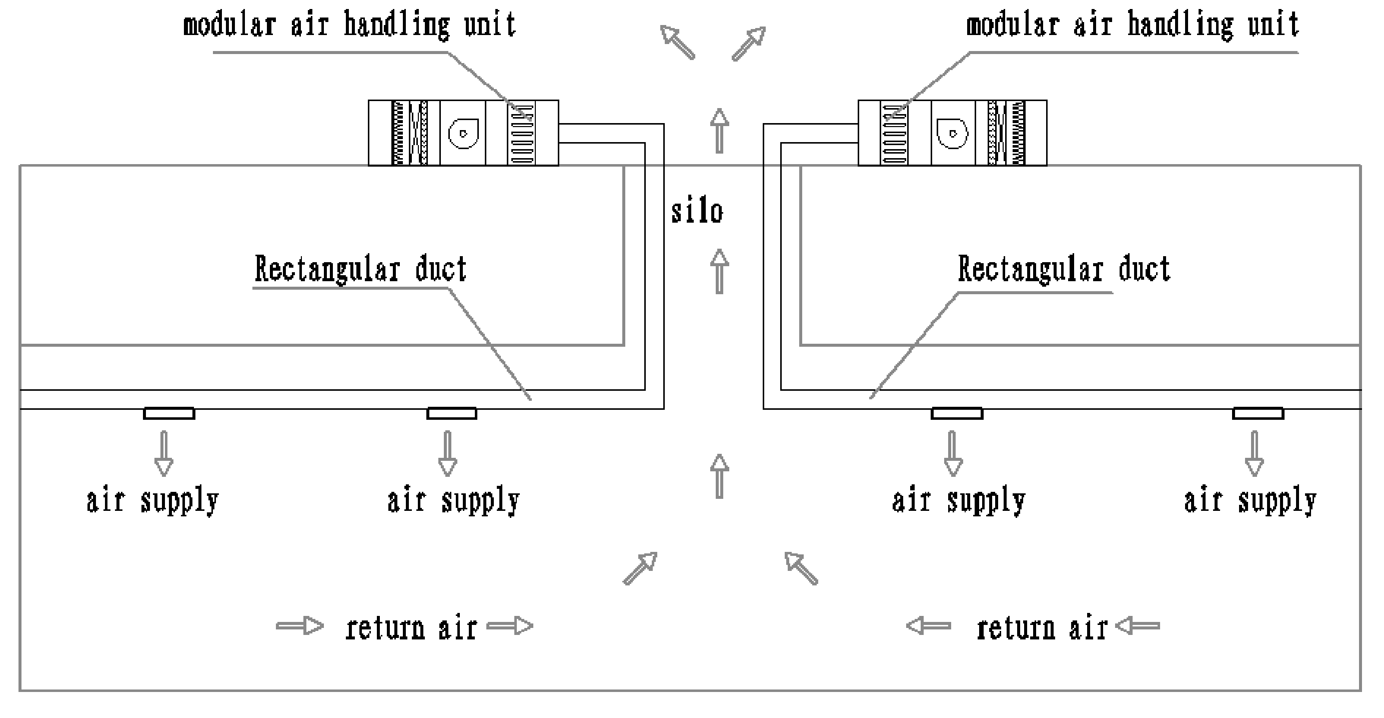
- **RF auxiliary tunnels and experiment halls**
  - Air conditioned and ventilated by mechanical supply and extraction of air via ducts in access shaft.
  - AHU is on ground level.
  - Dedicated smoke, gas extraction systems
- **Auxiliary stub tunnels**
  - Air supply ducts are led out from the air supply trunk duct in the collider ring tunnel to feed cold air into the auxiliary stub tunnel, and then air exhaust ducts are connected to the air exhaust trunk duct in the collider ring tunnel for exhausting hot air from the stub tunnel.
- **Other service buildings**
  - AHU
  - fan-coil + fresh air system





3.2 HVAC

- **Ventilation and smoke exhaustion system**
  - It is proposed to combine the smoke exhaust system with the mechanical air exhaust system based on the layout features of underground caverns. Emergency smoke exhaust is applied to both the collider ring tunnel and the experiment halls.

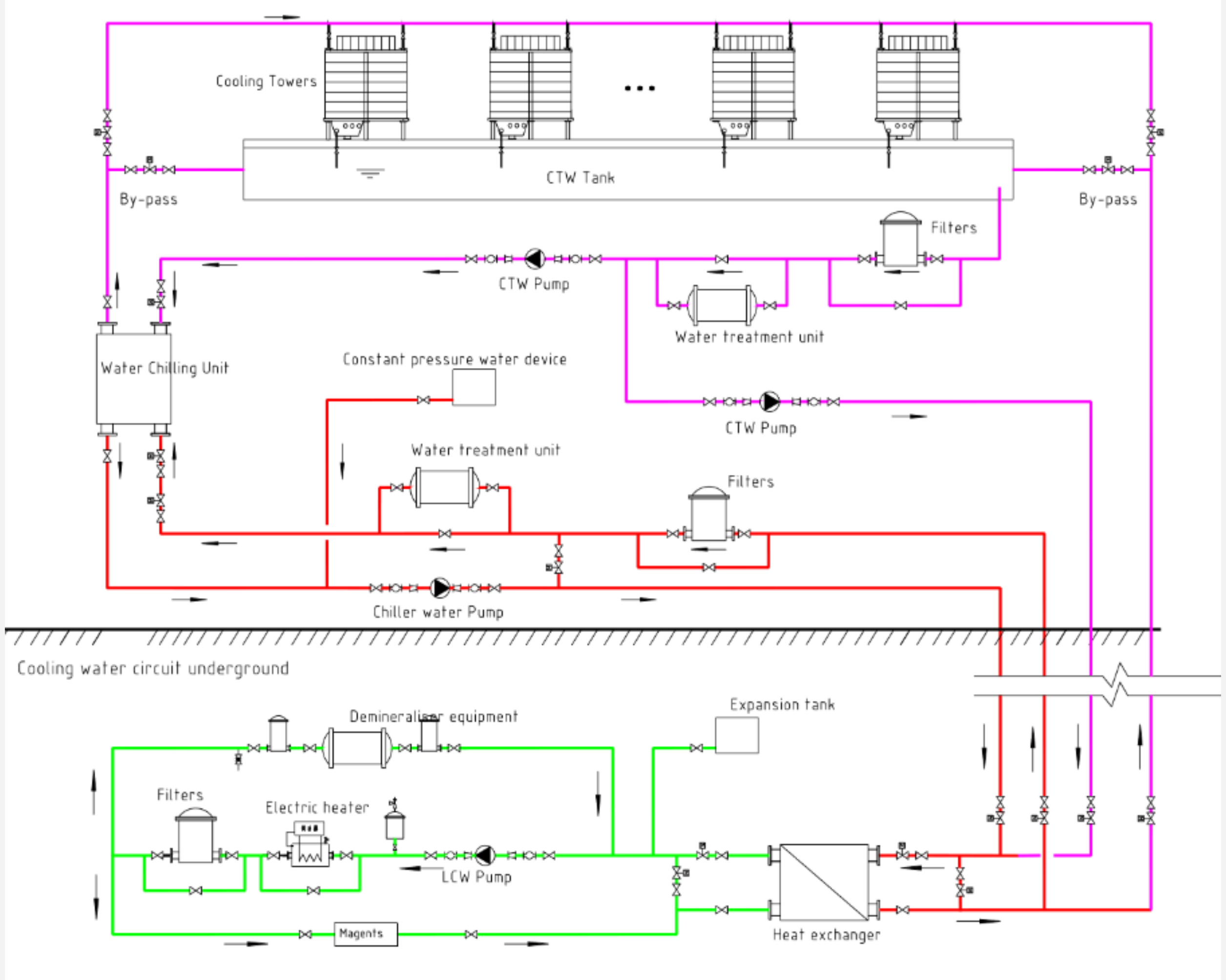


3.3 Cooling water system

- **Function:**
  - Absorb heat, cooling process equipment.
  - Provide a constant temperature environment.
  - Adjusting resonant frequency.
  - ——
- **Composition:**

  Dual circuit cooling mechanism

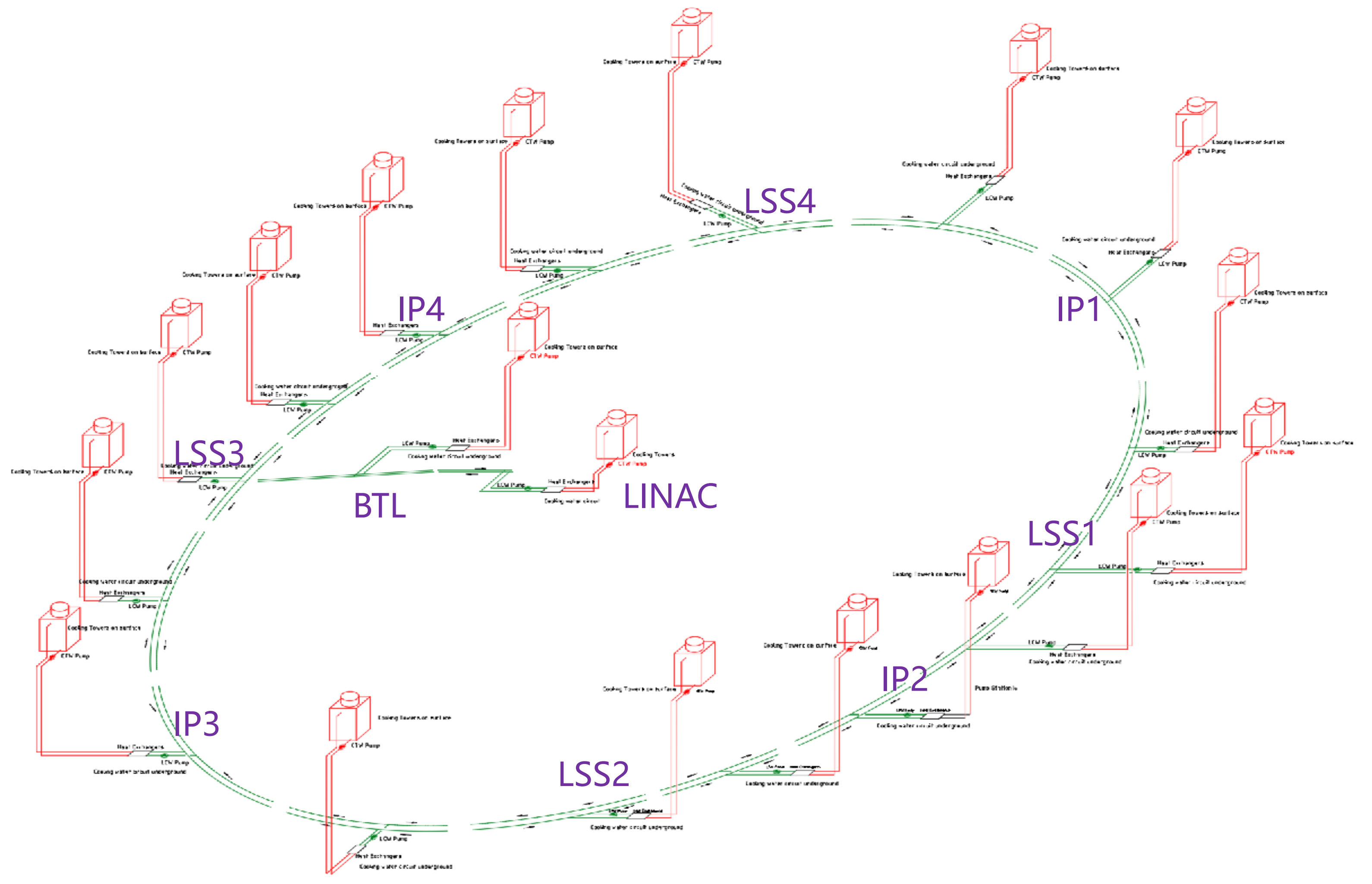
  - LCW — Direct cooling process equipment.
  - CTW — Provide cold source for LCW.
  - DW—Supply low-conductivity water for makeup.
  - Waste water collection and discharge system
  - Cooling water control system



Process flow diagram of cooling water system

3.3 Cooling water system

- **Layout principle**
  - **Close to the heat load center.**
  - **Relatively concentrated.**
  - **Reasonable water supply radius.**
  - **Minimize operating pressure.**
- **Layout scheme**
  - **Centralized water supply station:20**
    -- Linac—1
    -- BTL—1
    -- IR—2
    -- Ring/Booster—16
  - **Site**
    CTW and DW on surface;
    LCW are underground.



Cooling water system layout of CEPC

3.3 Cooling water system

- **Subsystem partition**

There are **50 closed-loop LCW and 20 CTW** subsystems in the LINAC, BTL, main ring, and experimental areas. They are defined **by equipment characteristics**, **operational requirements** (temperature, pressure, water quality, radiation dosage), and **location。**

Subsystem partition of Cooling water

System name	Location	Number	Main technical parameters	Number
Accelerating tube / Waveguide circuit	Linac	LCW-1	Q1=419m3/h，H=60m；Q2=476m3/h，H=40m；P=2519Kw	1
Power source （Linac）circuit	Linac	LCW-2	Q1=314m3/h，H1=40m；Q2=698m3/h，H2=40m；P=3692Kw	1
Power convert for Magent（Linac） circuitt	Linac	LCW-3	Q1=148m3/h，H1=55m；Q2=196m3/h，H2=40m；P=1035Kw	1
Magenet （Linac） ccircuit	Linac	LCW-4	Q1=244m3/h，H1=85m；Q2=280m3/h，H_2=40m；P=1483Kw	1
Cooling tower water circuit of Linac	Linac	CTW-1	Q1=1500m3/h，H1=40m，P1=8733KW；Q2=210m3/h，H2=40m，P2=1200KW	1
Power convert of Magent （BT） circuit	BT	LCW-5	Q1=17m3/h，H1=55m；Q2=22m3/h，H2=40m；P=120Kw	1
Magenet （BT） circuit	BT	LCW-6	Q1=151m3/h，H1=100m；Q2=176m3/h，H2=40m；P=931Kw	1
Cooling tower water circuit of BT	BT	CTW-2	Q1=198m3/h，H1=40m，P=1052KW；Q2=21m3/h，H2=40m，P=120KW	1
Magenet and condenser（Collide and Booste）circuit	Ring（Collide and Booste）	LCW-7	Q1=749m3/h，H1=120m；Q2=835m3/h，H2=40m；P=4427Kw	16
Vacum chamber circuit	Ring	LCW-8	Q1=677m3/h，H1=85m；Q2=762m3/h，H2=40m；P=4029Kw	16
Power source（Collide and Booste） circuit	Ring（Collide and Booste）	LCW-9	Q1=1984m3/h，H1=40m；Q2=4405m3/h，H2=40m；P=22839Kw	2
Power convert of Magent（Collide and Booste） circuit	Ring（Collide and Booste）	LCW-10	Q1=44m3/h，H1=55m；Q2=61m3/h，H2=40m；P=322Kw	8
Cooling tower water circuit of Ring — A	Ring	CTW-3	Q1=1380m3/h，H1=40m，P1=8009KW	8
Cooling tower water circuit of Ring — B	Ring	CTW-4	Q1=1440m3/h，H1=40m，P1=8334KW；Q2=60m3/h，H2=40m，P2=325KW	6
Cooling tower water circuit of Ring — C	Ring	CTW-5	Q1=5500m3/h，H1=40m，P1=31948KW；Q2=60m3/h，H2=40m，P2=325KW	2
Circuit for experiment area	IR	LCW-11	Q1=226m3/h，H1=80m；Q2=261m3/h，H2=40m；P=1380Kw	2
Cooling tower water circuit of experimeng area	IR	CTW-6	Q1=500m3/h，H1=40m，P1=2366KW；Q2=240m3/h，H2=40m，P2=1350KW	2
Cryogenic circuit	Ring（EX）	LCW-13	Q1=82m3/h，H1=50m；Q2=261m3/h，H2=40m；P=1380Kw	2
Cryogenic circuit	Ring（Collide and Booste）	LCW-12	Q1=555m3/h，H1=50m；Q2=1254m3/h，H2=40m；P=6630Kw	2
Deionized water system	Ring（Collide and Booste）	DW	Q=5m3/h，12MΩ•cm	18

3.3 Cooling water system

- **Key requirements and parameters**
  - **Total heat load** : **212.186MW**

  -- The heat load of 190.915MW dissipated by CEPC machine.

  -- The heat load of 21.945MW dissipated by the motors of cooling water system.
  - **Total flow rate of LCW**: **30157 m^3/h**
  - **Total flow rate of CTW**: **40092 m^3/h**
  - Cooling water temperature

  -- **Cooling tower water temperature**: **< 29℃**

  (Base on wet-bulb air temperature of 27℃ ambient; **machine shut down in summer**)

  -- **LCW cooling water temperature**: **< 32 ℃**
  - DW: Single DW unit can produce **3~5t/h** deionized water with the effluent quality meets the following standards.

  -- Resistivity reach **18 MΩ•cm**

  -- Other parameters satisfy **EW-1** requirements.
  - Water consumption: **14011m^3/d** (1.5% CTW)
  - Storage capacity of low-level radioactive wastewater : **12150**m^3

3.3 Cooling water system

- **LCW** (Low-conductivity water system)
    - Flow diagram :Take Accelerating tube / Waveguide circuit for example.

-- Main loop

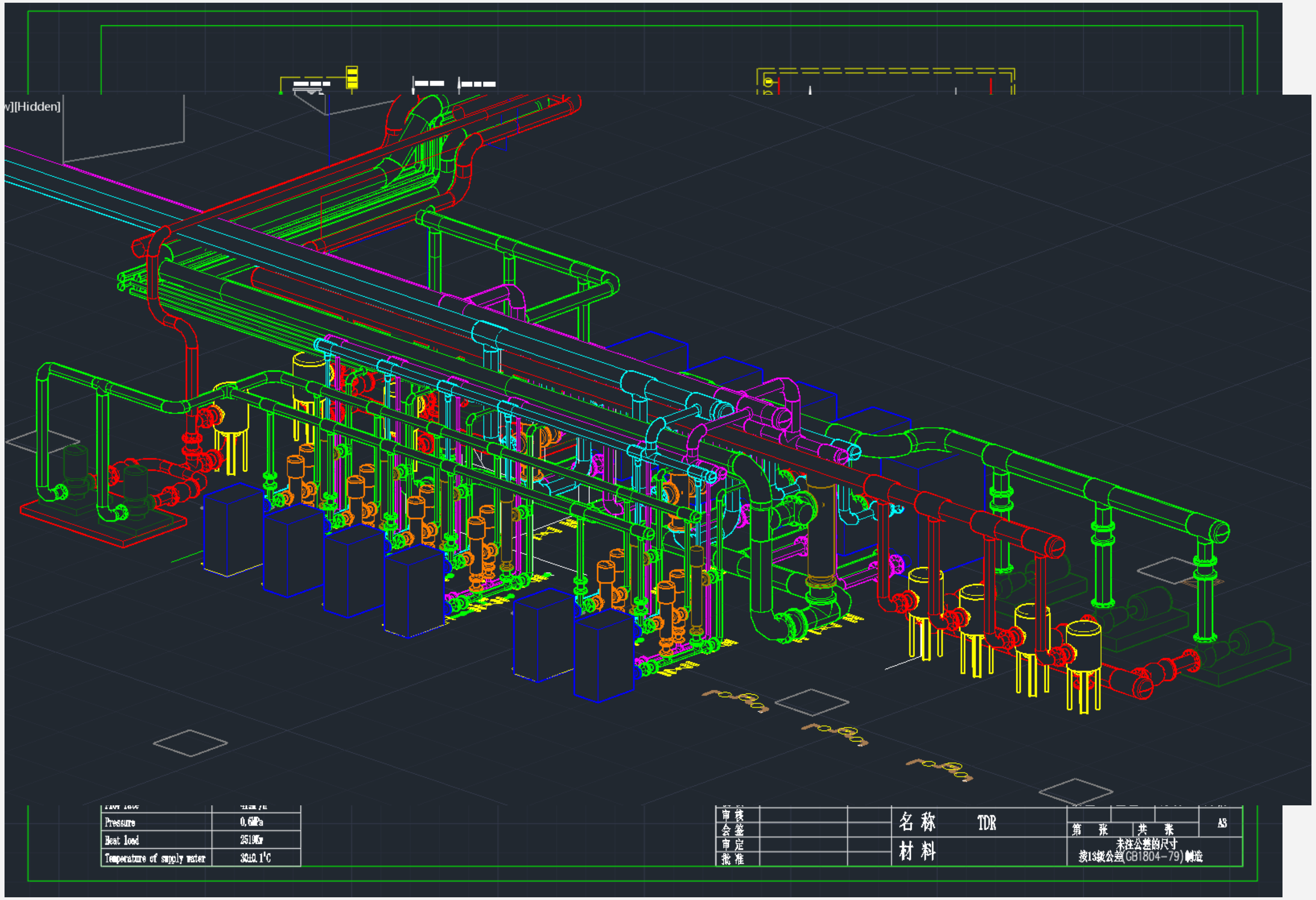
Various measures are set up to ensure flow distribution and pressure balance.

Trap particulate matter to prevent process equipment from blocking waterways.

Keep the system temperature stable through **constant temperature control.**

-- Bypass circulation

The main function of bypass system is to **regulate the water quality** and **maintain the microenvironment** of the LCW system.



3.3 Cooling water system

- **LCW**
  - In order to **slow down the corrosion rate** of copper, iron and other metals as much as possible, the water quality of the system needs to be stable at a certain level. Specific parameters are as follows：

-- Conductivity： **0.2~1μS/cm**

-- PH: **6.7~7.5**

-- DO: **≤20**

-- Total bacteria: ≤10 CFU/mL

-- TOC: ≤1mg/L

-- PM: ≤10/mL （>1um）

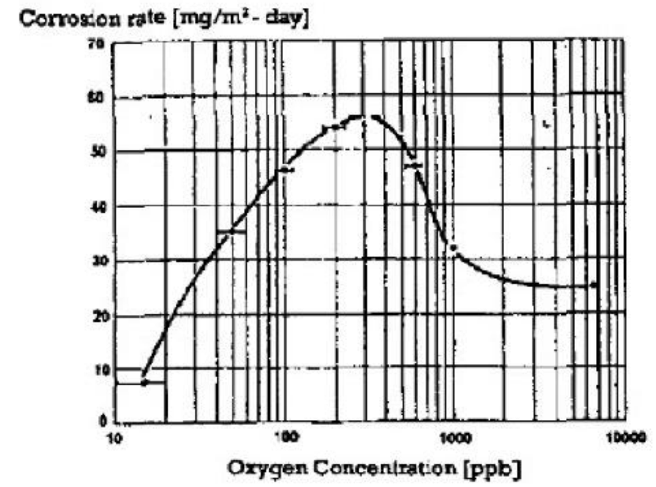


Figure 1: Corrosion rate vs. DO.

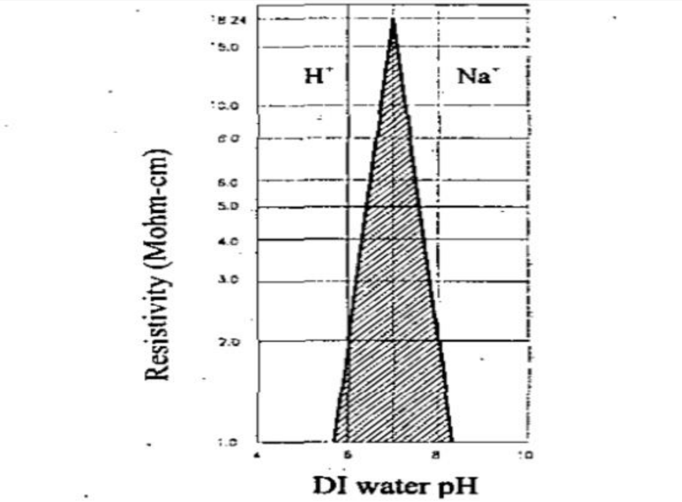


Figure 7: Resistivity limits of DI water.

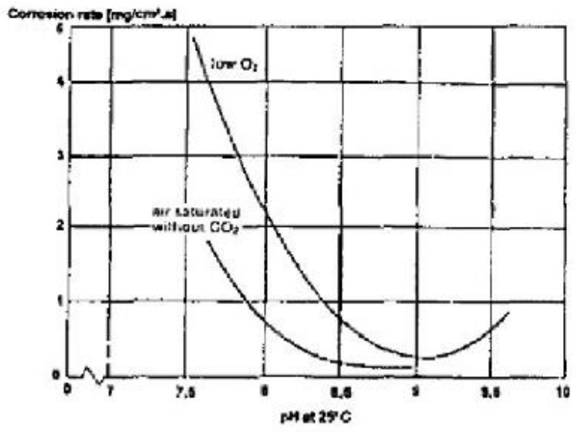


Figure 2: Corrosion rate vs. pH.

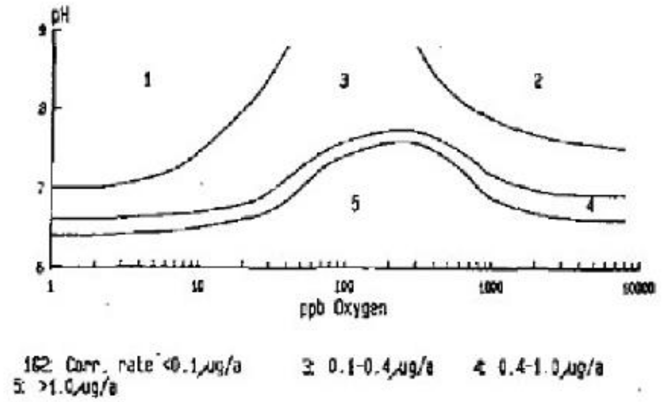


Figure 6: Corrosion data at various operating regimes.

3.3 Cooling water system

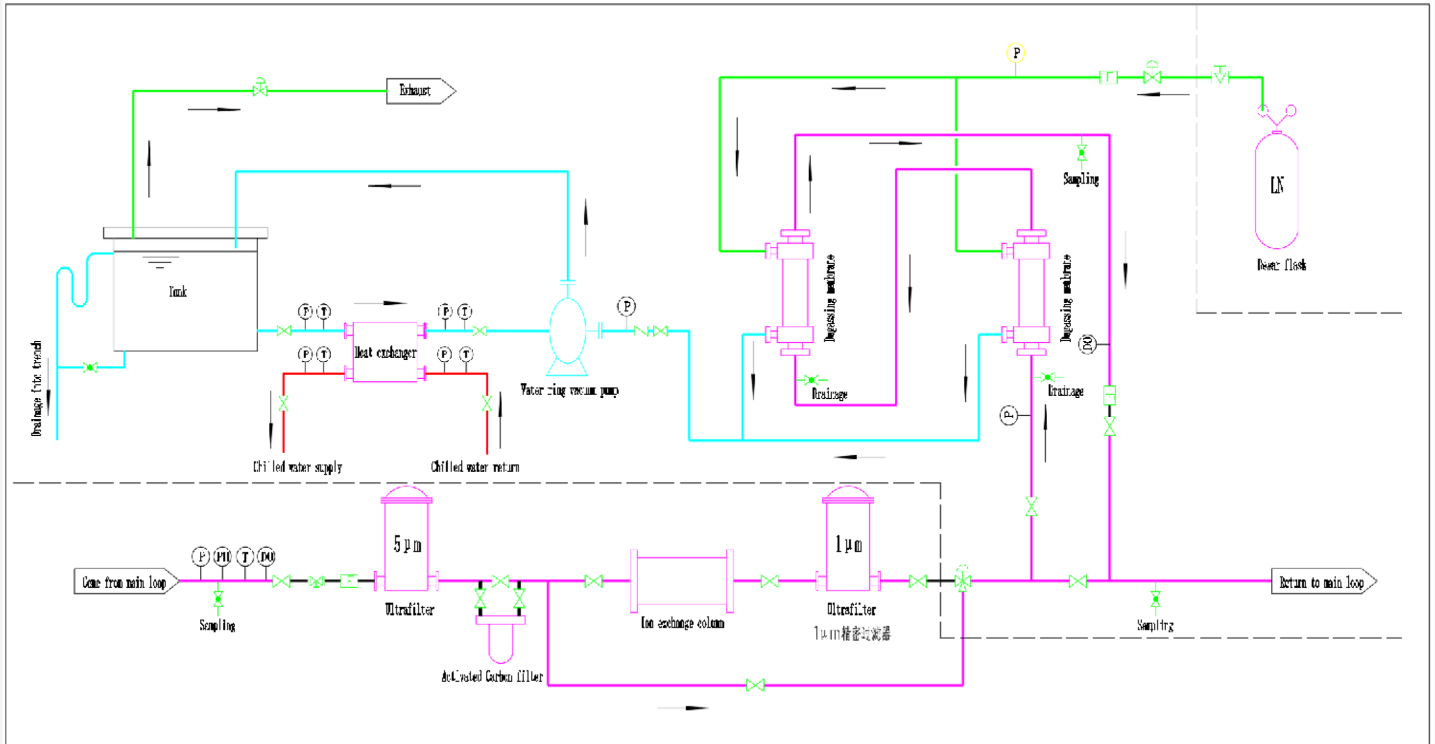
- **LCW**
  - A variety of measures will be adopted to achieve these water quality objectives

-- The flow rate through ion-exchange resin is about **1~5%**.

-- **H^+ and Na^+ type resin** are used to adjust the PH value of the LCW system.

-- **Degassing device** is designed to remove dissolved oxygen in the LCW system,.

-- **Nitrogen isolation** is adopted to avoid LCW system contact with air.



Flow diagram of LCW side-stream treatment

3.3 Cooling water system

- **CTW (Cooling tower water)**
  - Flow diagram :Take CTW station of LINAC for example.

  This process can realize different operation modes and provide cold source for LCW and hot sources for HVAC.

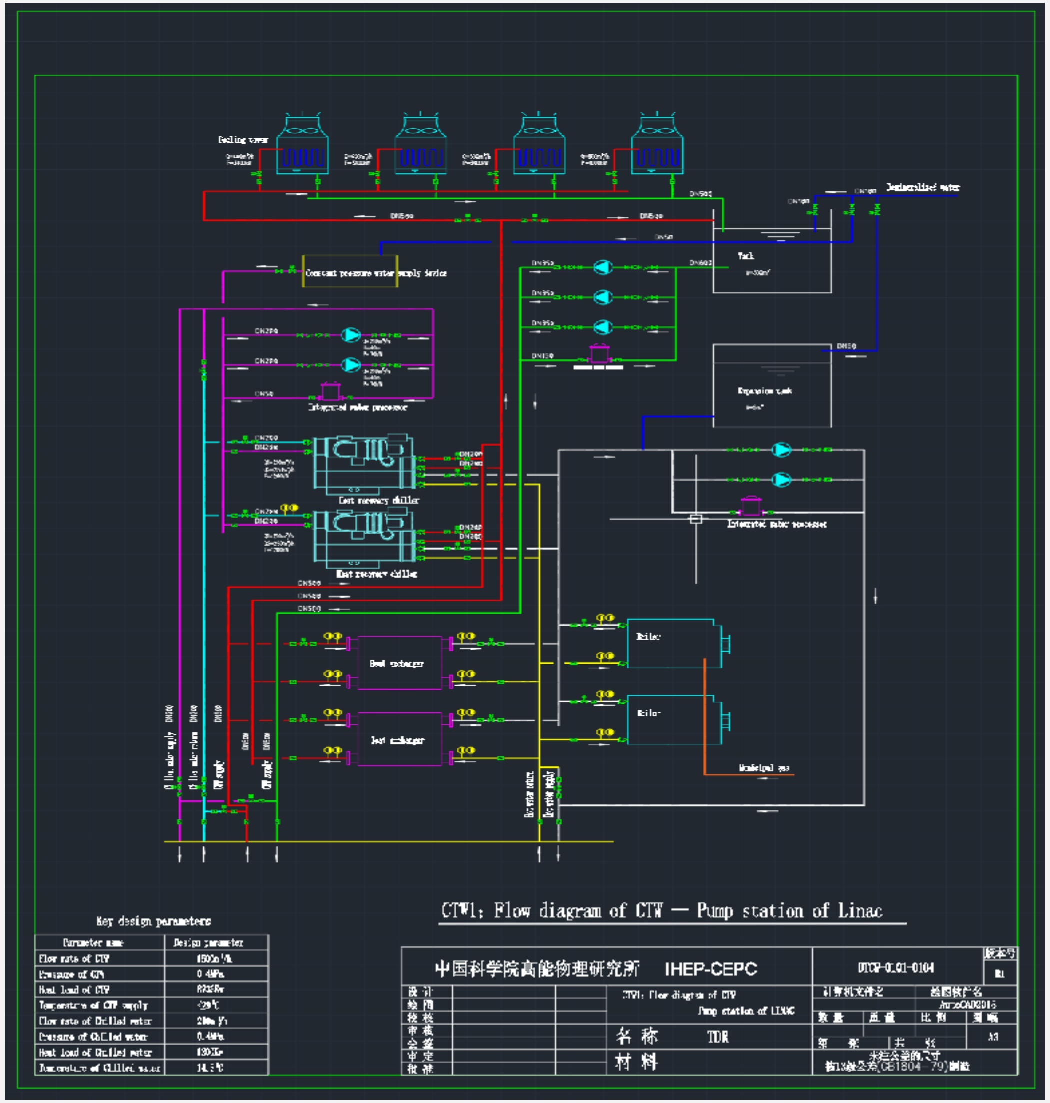
  -- CTW≤ 29℃ (by cooling tower)

  -- chilled water ≤ 14.5℃

  (by Heat recovery chiller or cooling tower)

  -- hot water

  (by Heat recovery chiller, heat exchange and backup boil)



3.3 Cooling water system

- **DW(**Deionized water**)**

DW system provides deionized water for LCW and laboratory. The system consists of three parts: Ultra-pure Water Treatment System, water distribution network and water terminal.

- Ultra-pure Water Treatment System

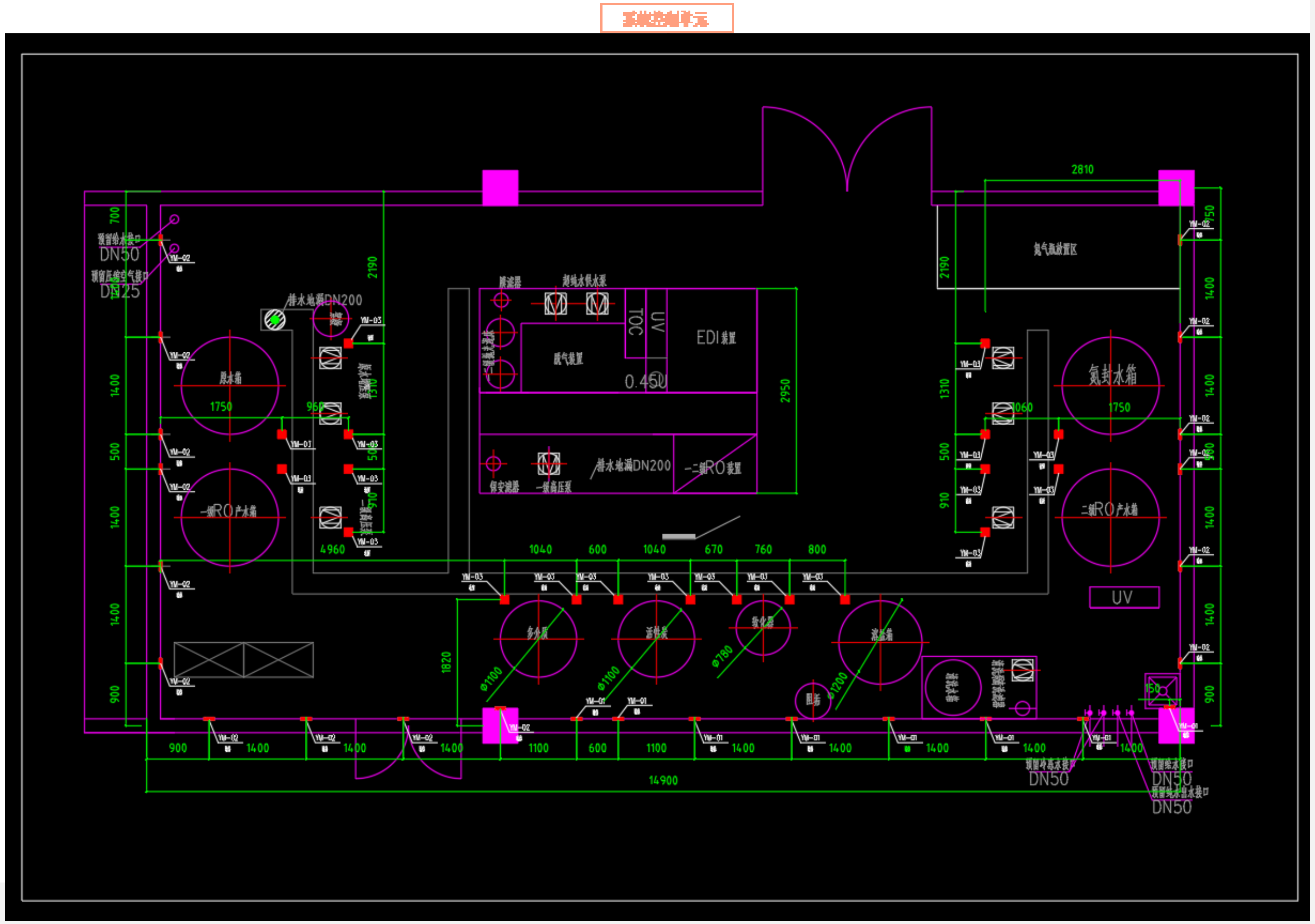
  -- Adopt **two-stage RO(reverse osmosis) and EDI process**.

  -- The device can provide ultra-pure water with a resistivity of 18MΩ•cm.

- Water distribution pipe network

  -- CPVC, S316L or PVDF

- Experimental water requirements can satisfied by **adding terminal filtration and water quality lifting devices.**



3.3 Cooling water system

- **WW(Waste water collection and discharge system)**
  - Process wastewater of CEPC consists of ordinary wastewater and low-level radioactive wastewater.

-- Ordinary process wastewater is discharged directly or recycled after treatment.

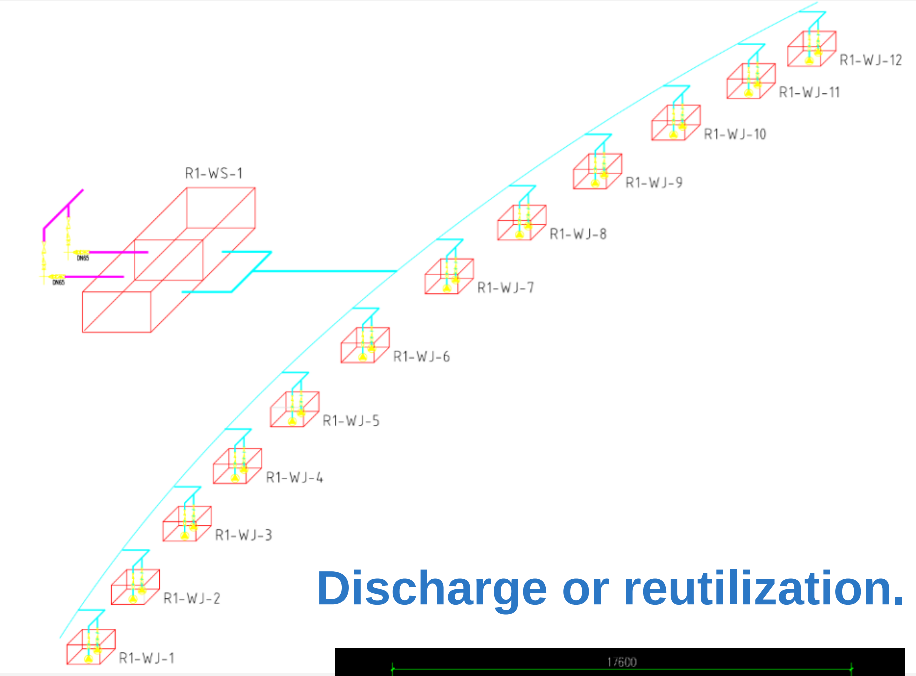
-- Low-level radioactive wastewater should be collected and stored for **natural attenuation**, and discharged or recycled according to relevant national standards and regulations after testing.

  - According to the distribution of low-level radioactive wastewater discharge points and the possible discharge volume, many facilities need to be set up to collect and store.

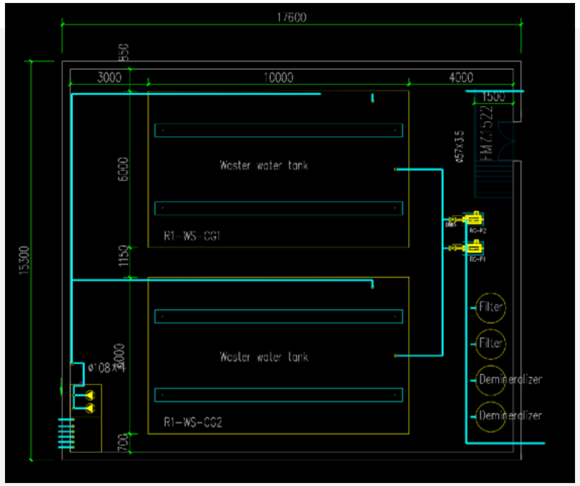
-- Drainage ditches and catchment wells need to be set up along the tunnel , with the preliminary design of collecting well($V=2m^3$) is **one every 500 meters, with the drainage slope is about 1‰.**

-- There are 18 storage areas for low-level radioactive waste water underground. each storage volume is **the maximum volume of the water cooling subsystems in the area**.

(Storage volume： **$9800m^3$**=100+100+16*600)



Discharge or reutilization.



3.4 Compressed Air System

- **System Configuration**

Operating Pressure 0.6~0.8MPa	Plant Quantities 20	Single Plant Capacity 22.1 m^3/min
Particle Removal Efficiency ≥99.97%	Pressure Dewpoint Temp. -40℃	Oil Content ≤0.01ppm

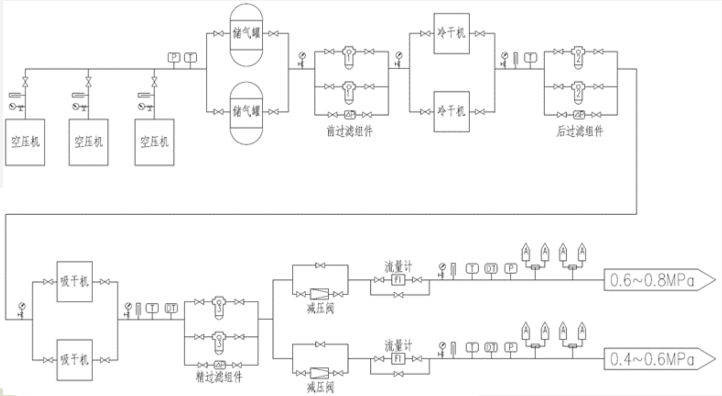
- **Design Characteristics**

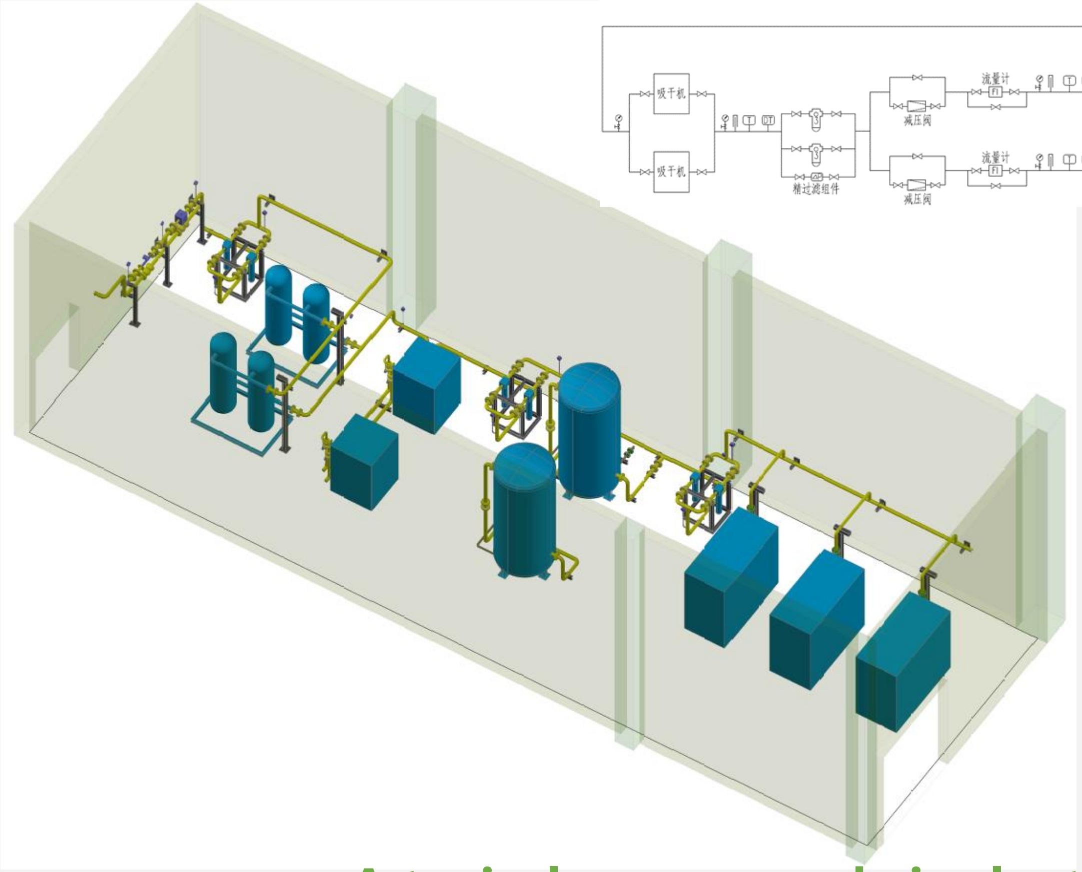
  ✓ High reliability（fast-switch/pressure protection/mutual standby)
  ✓ Simplified specifications（pipes and pipe components, valves, instruments, etc.)
  ✓ Leakage limited （easy measuring and analyzing)

3.4 Compressed Air System

- **Plant Design Principle**
  - ✓ Easy to replace any equipment
  - ✓ Compact procession layout
  - ✓ Reasonable cooling system

- **Distribution Design Principal**
  - ✓ Coordinate with other pipeline and accelerator equipment
  - ✓ Easy to add pneumatic actuator
  - ✓ Field personal protection (outlet safety design/warning sign/noise protection/etc.)





A typical compressed air plant

04

Construction Schedule

General Construction Schedule

The total construction period is 54 months, including preparatory work of 8 months, main works of 43 months and completion work of 3 months.

The critical activities are:

- Preparation 8 months
- Construction shafts 5 months
- Main tunnel excavation 24 months
- Tunnel lining & water prevention 10 months
- Ventilation installation in shafts 4 months
- Completion work 3 months

The surface buildings and electrical installation are carried out in parallel and not on the main path.

In-depth study of the Jiang Huzhou Site

Overlap

2026 | 2027 | 2028 | 2029 | 2030 | 2031 | 2032 | 2033

① ② ③ ④ ⑤ ⑥ ⑦ ⑧

51 months (including project preparation) 2026.1~2030.3 TBM excavation

Total duration of CEPC project is 96 months

63 months 2026.1~2031.3 Drilling & Blasting excavation

2030.1~2030.12 First-stage Control network construction and survey — 12months

2030.10~2031.9 Second-stage Control network construction and survey — 12months

2031.1~2032.6 Support installation and alignment — 18 months

2031.3~2032.8 Dipole magnets installation — 18 months

2032.9~2033. Installation of other equipment — 10 months

2033.7~2033.12 Overall alignment and commissioning — 6 months

1.CEPC production Including civil works and installation of physical equipment. It will begin in 2026 and end in 2033, The total duration of CEPC project is 96 months.

2.The total civil works period is 63 months.

3.The total installation period of physical equipment is 48 months.

4. The Overlapping period of civil works and equipment installation is 15 months.

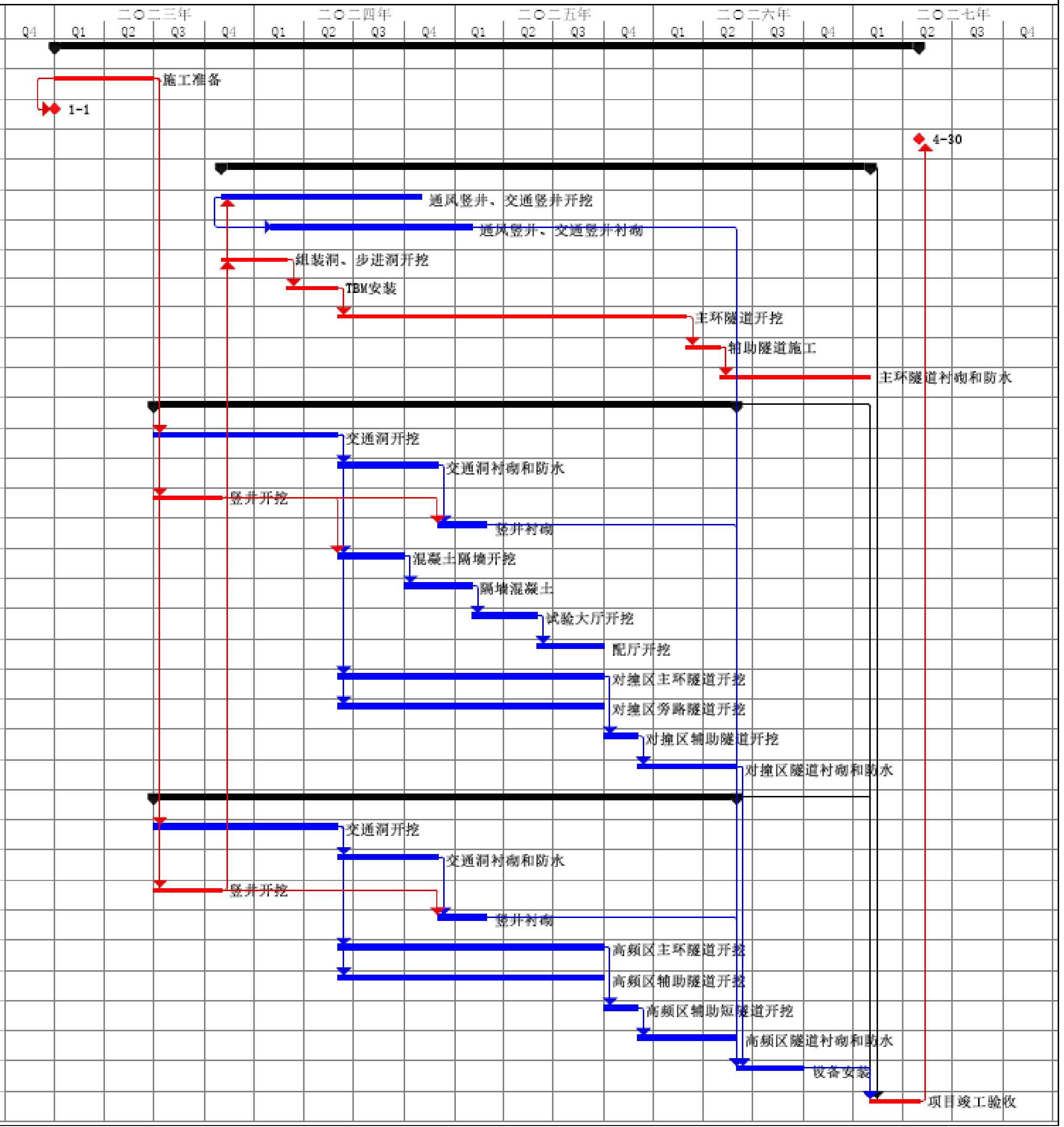
中国电建 POWERCHINA 中南勘测设计研究院有限公司 ZHONGNAN ENGINEERING CORPORATION LIMITED

■ Construction Organization Design

- Eight open-type TBMs will be adopted for construction, and the shafts of permanent structures can be used as launch shaft and receiving shaft of the TBMs.
- The total TBM construction period is 52 months, including 6 months for construction preparation, 43 months for construction of main works, and 3 months for completion.

环形正负电子对撞机(CEPC)项目（长沙场址） 土建工程控制性施工进度表(TBM法)

标识号	任务名称	工期	开始时间	完成时间
1	环形正负电子对撞机(CEPC)项目土建工程	1581 d	2023年1月1日	2027年4月30日
2	施工准备	181 d	2023年1月1日	2023年6月30日
3	开工时间	0 d	2023年1月1日	2023年1月1日
4	完工时间	0 d	2027年4月30日	2027年4月30日
5	主环隧道工程（含直线加速器、伽马源等）	1188 d	2023年11月1日	2027年1月31日
6	通风竖井、交通竖井开挖	366 d	2023年11月1日	2024年10月31日
7	通风竖井、交通竖井衬砌	366 d	2024年2月1日	2025年1月31日
8	组装洞、步进洞开挖	121 d	2023年11月1日	2024年2月29日
9	TBM安装	92 d	2024年3月1日	2024年5月31日
10	主环隧道开挖	638 d	2024年6月1日	2026年2月28日
11	辅助隧道施工	61 d	2026年3月1日	2026年4月30日
12	主环隧道衬砌和防水	276 d	2026年5月1日	2027年1月31日
13	对撞区（IR）	1066 d	2023年7月1日	2026年5月31日
14	交通洞开挖	336 d	2023年7月1日	2024年5月31日
15	交通洞衬砌和防水	183 d	2024年6月1日	2024年11月30日
16	竖井开挖	123 d	2023年7月1日	2023年10月31日
17	竖井衬砌	90 d	2024年12月1日	2025年2月28日
18	混凝土隔墙开挖	122 d	2024年6月1日	2024年9月30日
19	隔墙混凝土	123 d	2024年10月1日	2025年1月31日
20	试验大厅开挖	120 d	2025年2月1日	2025年5月31日
21	配厅开挖	122 d	2025年6月1日	2025年9月30日
22	对撞区主环隧道开挖	487 d	2024年6月1日	2025年9月30日
23	对撞区旁路隧道开挖	487 d	2024年6月1日	2025年9月30日
24	对撞区辅助隧道开挖	61 d	2025年10月1日	2025年11月30日
25	对撞区隧道衬砌和防水	182 d	2025年12月1日	2026年5月31日
26	高频区（RF）	1066 d	2023年7月1日	2026年5月31日
27	交通洞开挖	336 d	2023年7月1日	2024年5月31日
28	交通洞衬砌和防水	183 d	2024年6月1日	2024年11月30日
29	竖井开挖	123 d	2023年7月1日	2023年10月31日
30	竖井衬砌	90 d	2024年12月1日	2025年2月28日
31	高频区主环隧道开挖	487 d	2024年6月1日	2025年9月30日
32	高频区辅助隧道开挖	487 d	2024年6月1日	2025年9月30日
33	高频区辅助短隧道开挖	61 d	2025年10月1日	2025年11月30日
34	高频区隧道衬砌和防水	182 d	2025年12月1日	2026年5月31日
35	设备安装	122 d	2026年6月1日	2026年9月30日
36	项目竣工验收	89 d	2027年2月1日	2027年4月30日



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Summary

Advance the preliminary civil engineering design as soon as possible.

In the early stage, comprehensive demonstration on technology, economy, social and environmental impact, water and energy conservation will be carried out to determine basically the sites through comparison. The demonstration will focus on project scale, technical proposal, land acquisition and resettlement, environmental impact and investment, and special demonstration will be conducted for key technical issues.

All sites can satisfy requirements for CEPC construction.

Construction method

Both drilling & blasting and TBM are feasible. Construction periods of the two methods are similar, and overall cost of drilling & blasting is lower.

With the continuous advancement of TBM technology, the cost of TBM equipment and operation are gradually reduced, while the labor cost of drilling & blasting method increases year by year. The advantages of TBM will be increasingly prominent for implementation of the Project.

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THANK YOU FOR LISTENING