CEPC site choice and related technical challenges(Changsha)

环形正负电子对撞机(CEPC)项目

长沙场址

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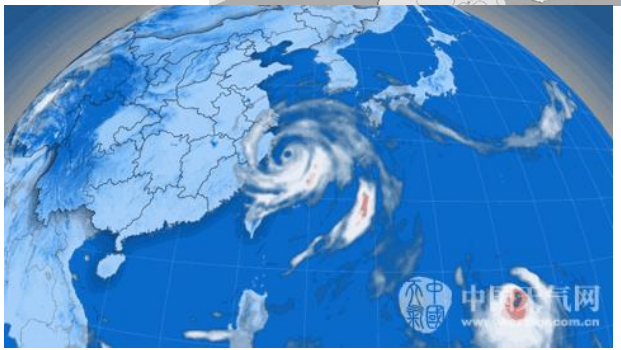
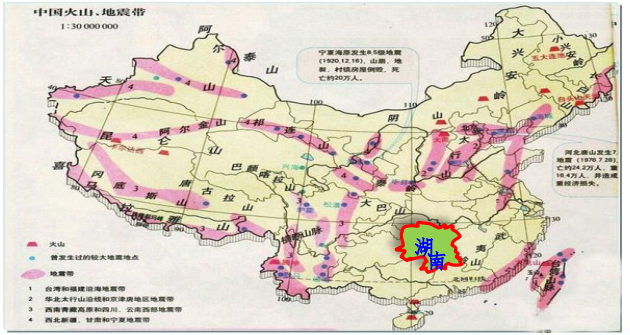
中国电建集团中南勘测设计研究院有限公司
POWERCHINA ZHONGNAN ENGINEERING CORPORATION LIMITED

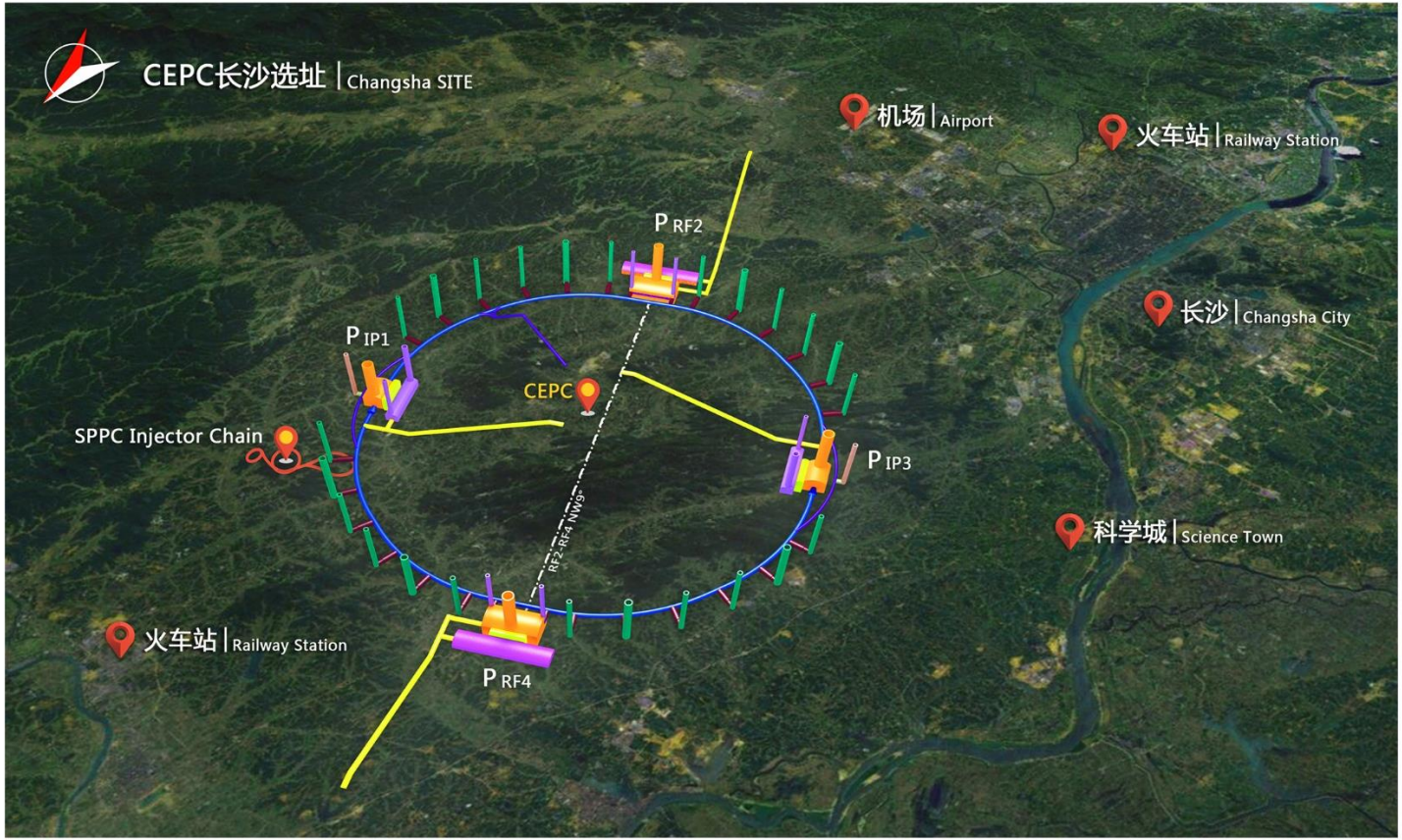
Contents

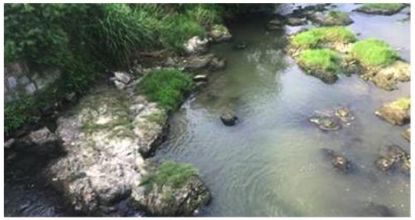
Changsha is the capital of Hunan Province

- Hunan is located in central south China, south of the middle reaches of Yangtze River. It has mild climate and little impact of Typhoon, and extreem climate, and is free of sandstorm .
- Hunan is located in the strategic hinterland of China, and is far away from sensitive areas, boasting harmonious and peaceful society, beautiful mountains and rivers, pleasant living environment, and profound culture.
- Hunan connects East China to West China, boasting developed infrastructure and good accessibility in terms of airway, high-speed railway, and expressway.

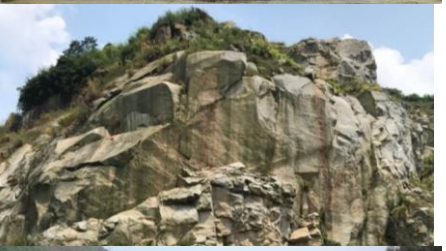


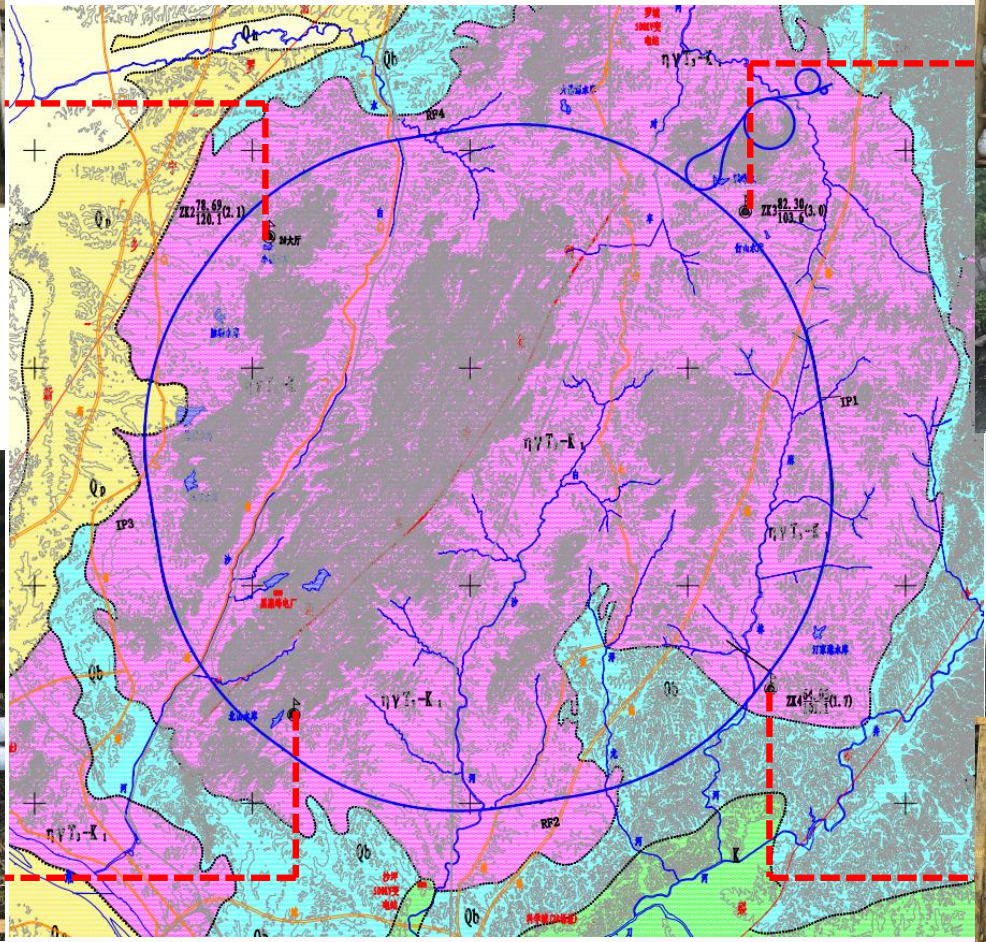


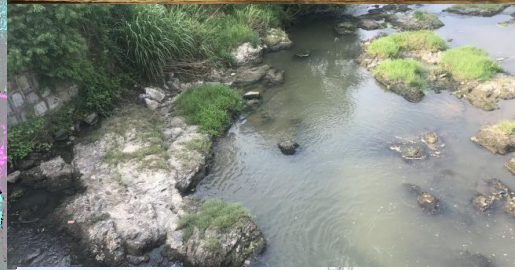

CEPC长沙选址 | Changsha SITE
机场 | Airport
火车站 | Railway Station
长沙 | Changsha City
科学城 | Science Town
火车站 | Railway Station
P RF2
P IP1
CEPC
SPPC Injector Chain
P IP3
RF2-RF4 NWG
P RF4



1 General introduction

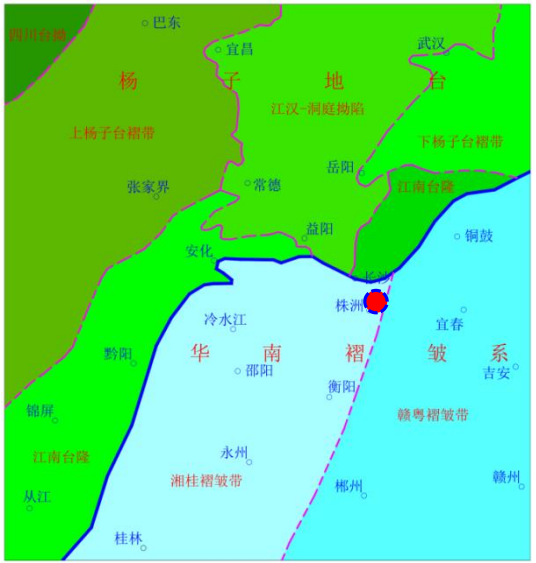


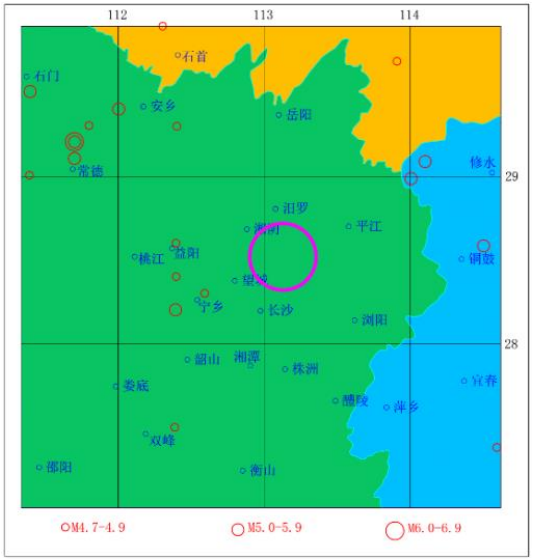


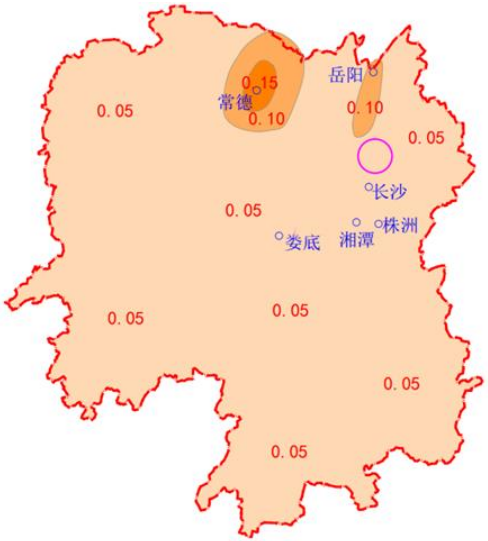


Regional Geology and Seismicity

- Changsha site and its surroundings have slight seismic activity in history, and are free of active faults. The peak ground acceleration is 50 gal, and the seismic intensity is VI. The tectonic structure is stable.

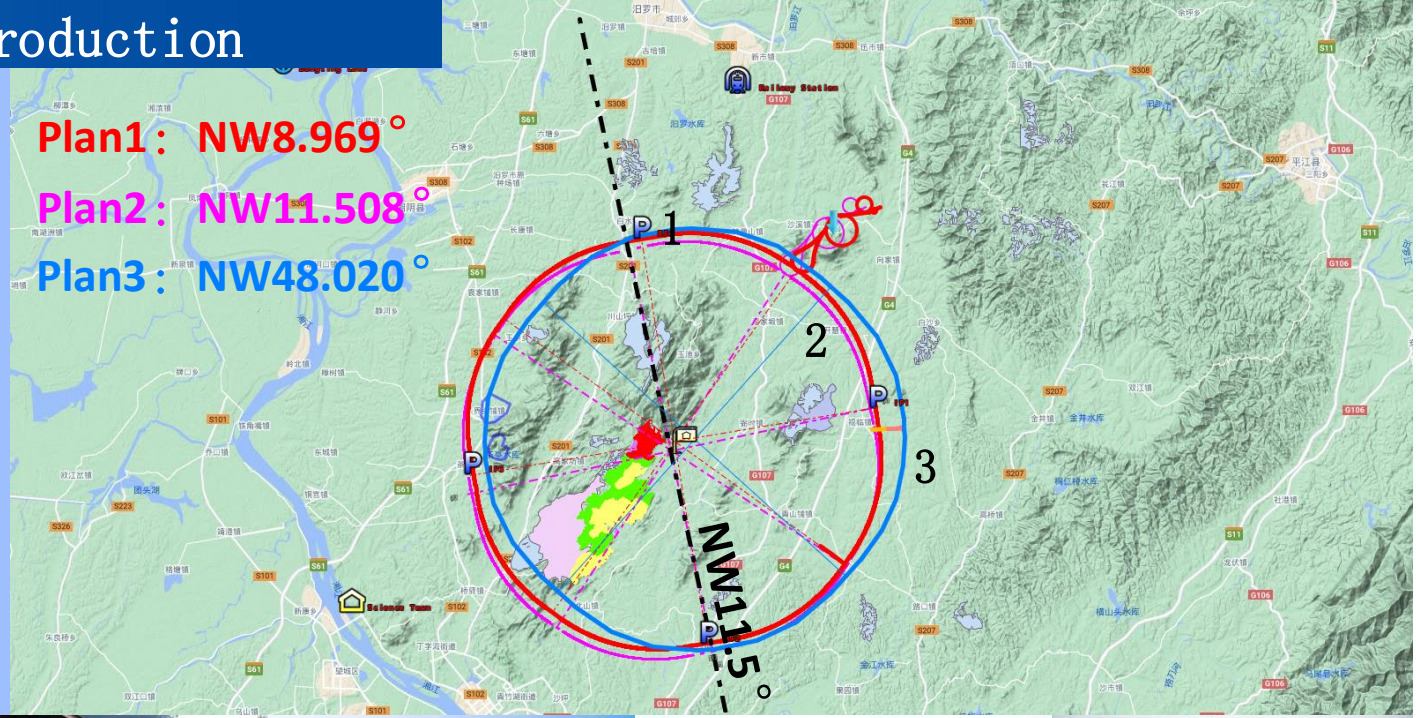






1 General introduction

Considering the influence of the geomagnetic field on the high frequency cavity, the best angle of the connection between RF2 and RF4 is NW11.5 ° from the physical point of view, and can be adjusted in a small range in the actual layout.



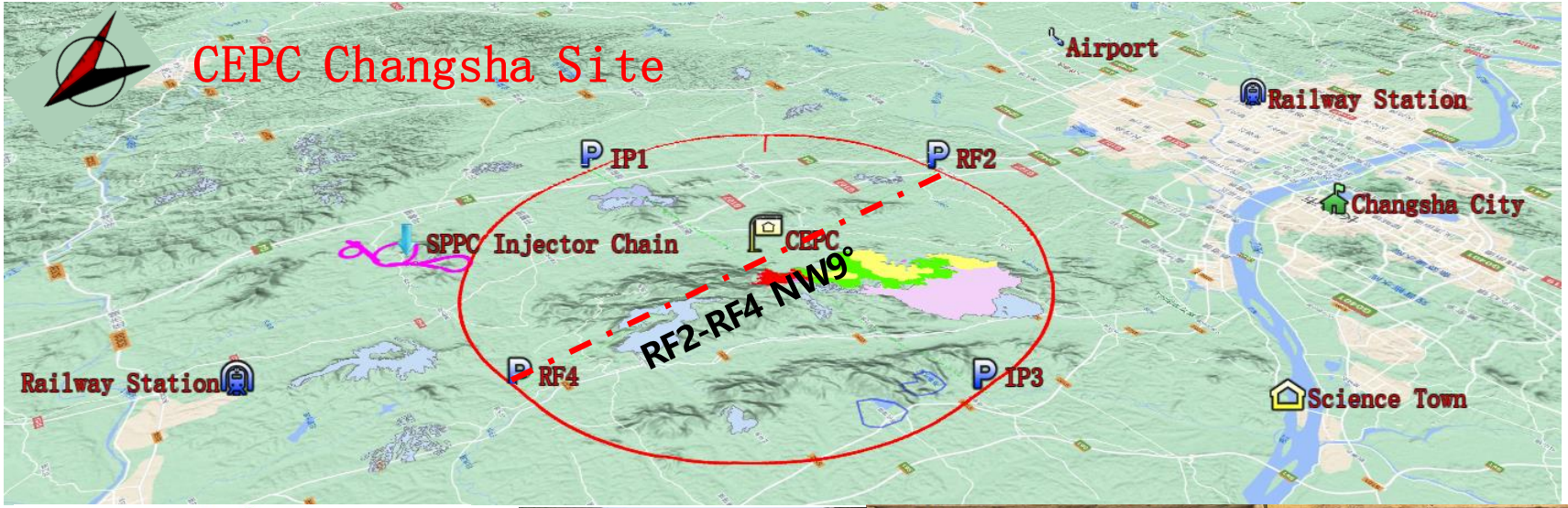
High-speed railway: ＞1000m

Ordinary Railway: ＞1000m

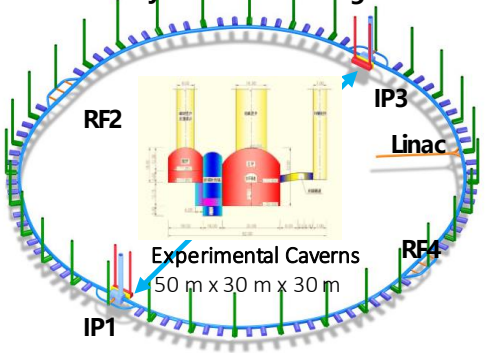
Freeway: ＞500m

Main roads: ＞200m

Avoid towns



- General layout of CEPC underground cavern



Contents

- In order to get the CEPC, Hunan Provincial Party Committee and Government have attached great importance to it. Former Governor Xu Dazhe, Vice Governor Chen Fei and other provincial leaders have coordinated and promoted it. Hunan Provincial Department of Science and Technology is very positive in communication and has headed to organize the related departments to carry out the preliminary works.
- Hunan Provincial Departments such as Science and Technology, Natural Resources, Forestry, Ecological Environment, Cultural Relics Protection, Changsha Municipal Government, and Yueyang Municipal Government have actively cooperated, providing the basic information and on-site cooperation required by the design.
- In September 2019, the Conceptual Design Report of CEPC Civil Engineering was officially listed as the Changsha-Zhuzhou-Xiangtan Landmark Project.

湖南省科学技术厅文件

湘科计〔2019〕50号

关于2019年度长株潭标志性工程计划项目立项的通知

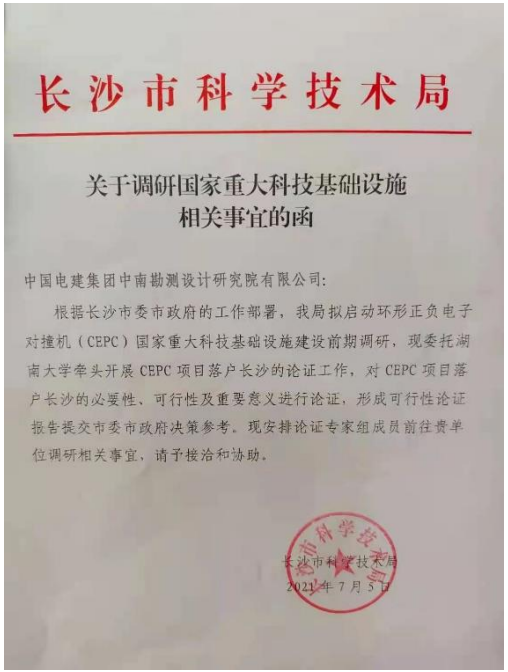
项目编号	项目名称	承担单位	参与单位	项目负责人/职称	起止年限
2019XK2005	高精度谐振陀螺及系统协同创新平台建设	湖南华天光电惯导技术有限公司	国防科技大学、俄罗斯梅吉科公司	罗晖/教授	2019-2022
2019XK2006	岳麓山实验室调研、方案设计与论证	湖南大学	/	段献忠/教授	2019-2020
2019XK2007	环形正负电子对撞机土建概念设计报告编制	中国电建集团中南勘测设计研究院有限公司	/	潘江洋/正高级高级工程师	2019-2020

附件：2019年度长株潭标志性工程计划省组织项目立项汇总表

湖南省科学技术厅
2019年9月29日

Changsha Municipal Party committee and government attached great importance to CEPC Changsha site

- 2021.7.5 Changsha Municipal Party Committee and Government carried out demonstration work of CEPC project settled in Changsha.



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报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。

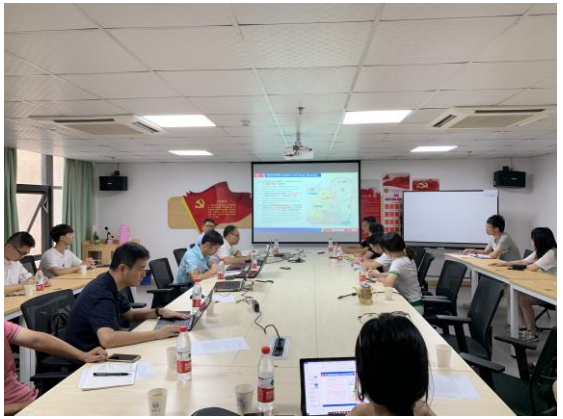
长沙市科学技术局

2021 年 7 月 5 日

Close cooperation with Hunan University

- 2021.7.11 Zhongnan Engineering Corporation Limited conducted preliminary research and exchange on CEPC construction.

- 2021.9.4 The on-site review meeting of the demonstration report of China (Changsha) CEPC and international science new town project was organized .



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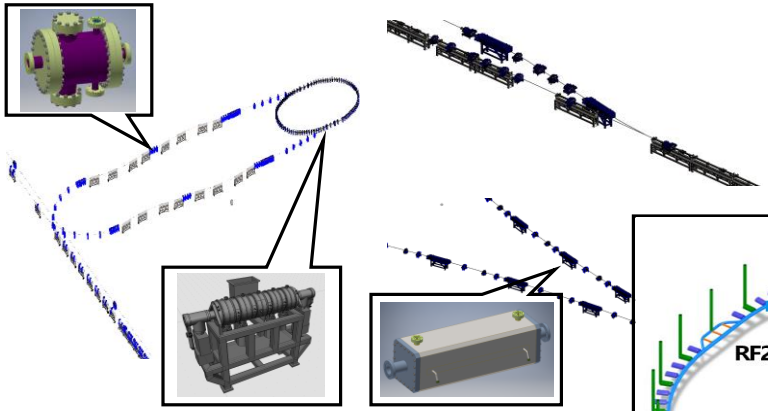
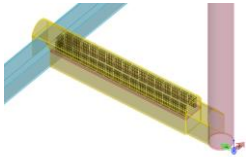
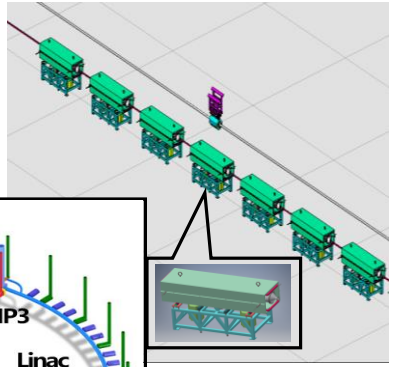
The equipment of the LINAC

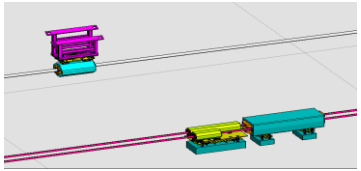


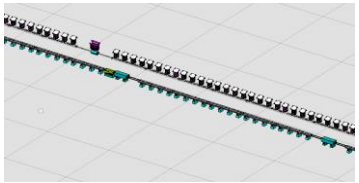
Reserved cabinet at SPPC

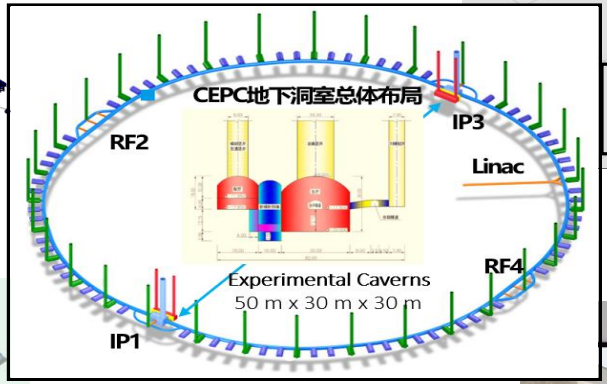


The equipment of the main ring

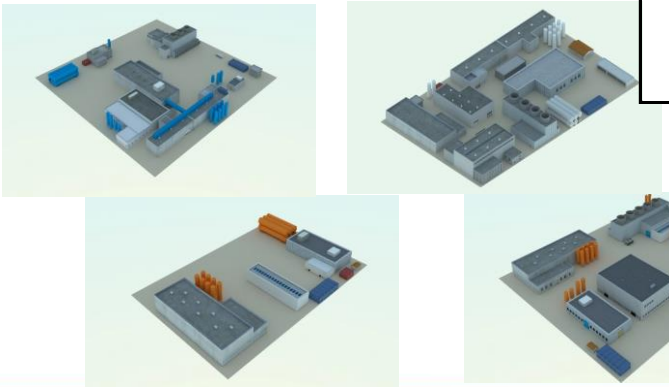






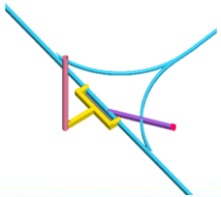


Optimization of ground buildings and layout



Add line control room and central control room

Garbage can transmission line



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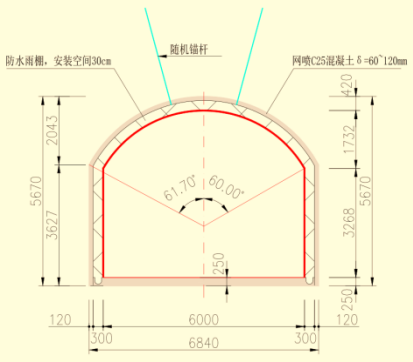
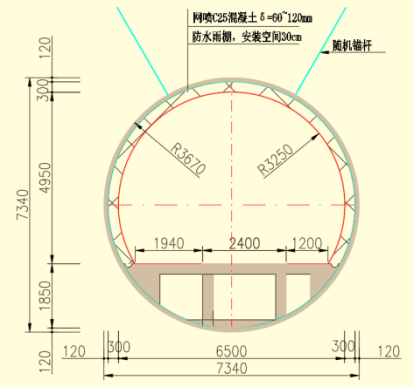


Drill-blast tunnel
(6.0m×5.0m)



TBM tunnel （D6.5m）

In the last stage

Main tunnel form comparison

Item	Unit	Drill-blast	TBM
The clearance cross section	㎡	27.00	33.20
Excavation unit price	Yuan/m³	278.28	617.00
Construction duration	Month	50	52

Investment: the TBM tunnels cost 2 billion yuan more than the drill-blast tunnels. Therefore, the drill-blast tunneling method is recommended in the last stage.

However, at present, TBM construction technology is becoming more and more mature and the price is lower. Therefore, we reconsider TBM tunnel on the current situation.

Equipment research, construction technology study

- The type, structure, equipment technology innovation, advantages and disadvantages of TBM and the construction situation of TBM in China are investigated.
- Experts from TBM Research Institute of Changsha Railway Construction Engineering were invited for technical exchange to discuss TBM construction technology.
- According to the structural layout and geological conditions, it is preliminarily judged that the TBM method is feasible for the construction of CEPC main ring tunnel.
- The feasibility of using TBM excavated material as concrete aggregate is preliminarily analyzed.

Equipment research, construction technology study

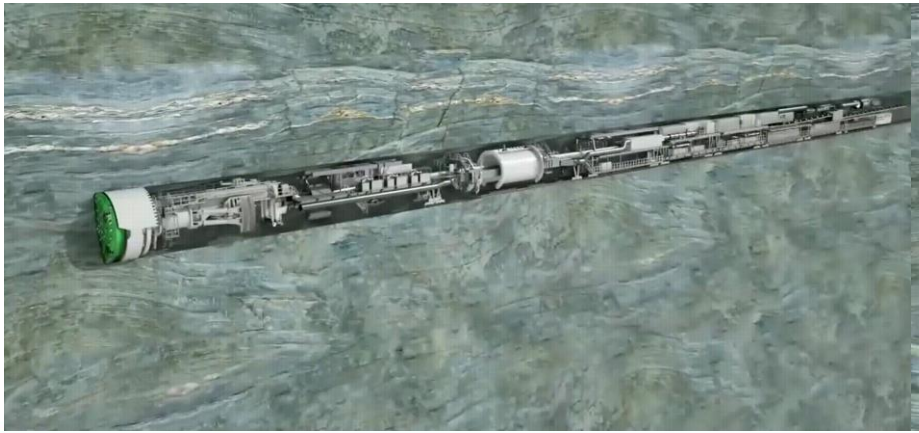
TBM is a machine that uses mechanical energy to dig rocks.

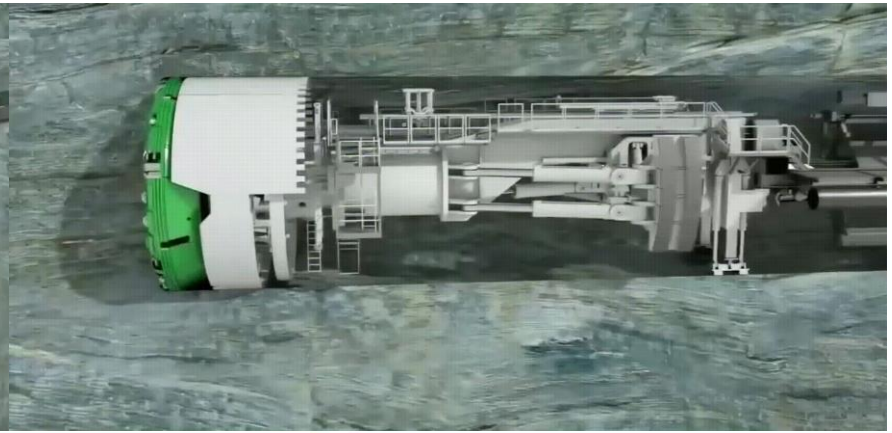
In terms of construction safety, TBM construction method avoids the safety risk of drilling and blasting operation, adopts mechanized construction means, reduces the number of operators, standardizes the construction ventilation conditions, improves the construction environment, and is more conducive to the safety of engineering construction.

In terms of construction quality, TBM excavation has less disturbance to surrounding rock, basically eliminates the occurrence of over excavation, over filling and under excavation and the problem of large unevenness of excavation surface, and the construction quality is better than drilling and blasting method.

In terms of construction period, the footage of TBM construction is 4 times that of drilling and blasting method, which can significantly save the construction period.

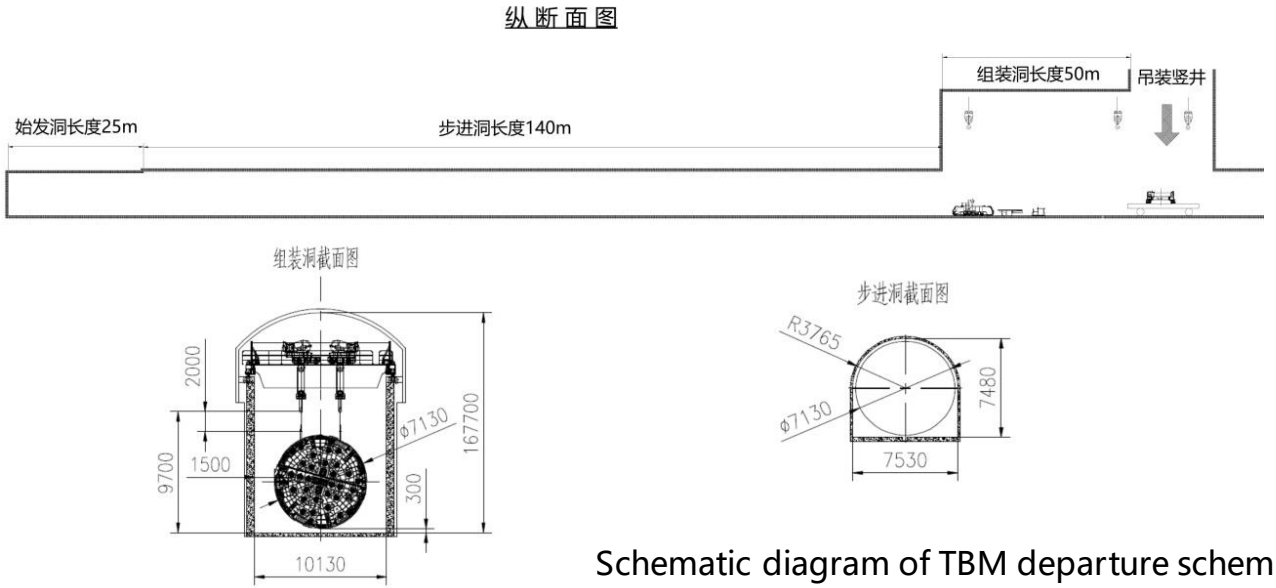
According to the geological conditions of tunnel surrounding rock, open-type TBM is recommended for tunnel excavation.





Equipment research, construction technology study

The TBM adopts the launching scheme in the tunnel, uses the test hall and the transportation shaft in the high-frequency area to hoist the TBM equipment, excavates the underground assembly tunnel and step-by-step tunnel by drilling and blasting method, assembles the TBM host and rear supporting equipment in the tunnel, then carries out equipment commissioning, and supports the wall of the launching tunnel through support shoes.



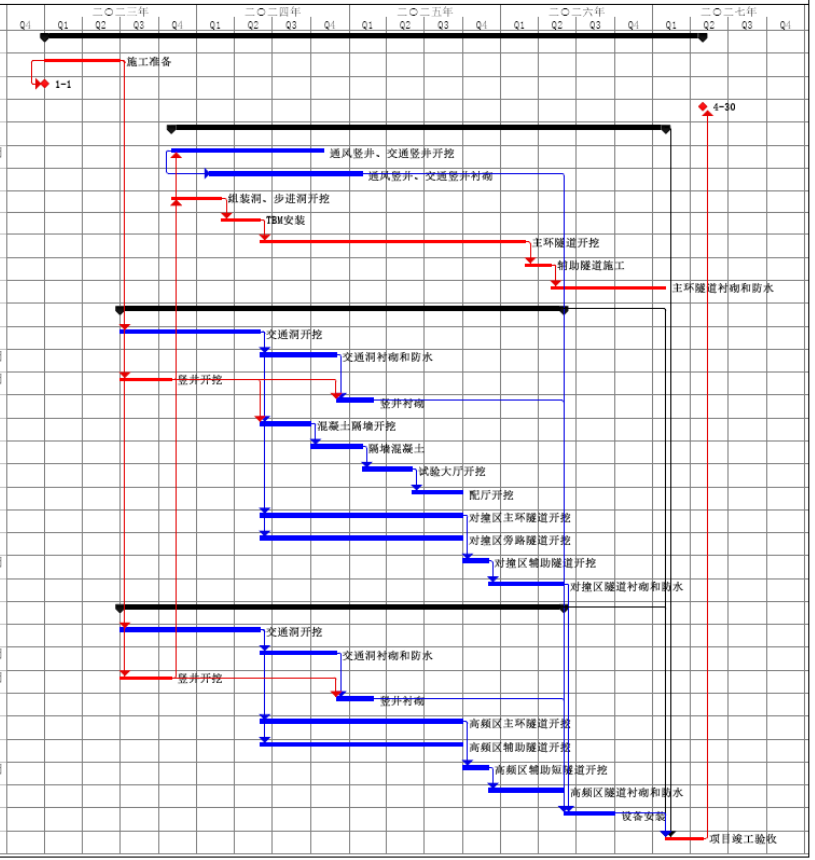
Schematic diagram of TBM departure scheme

Civil design tasks and completion

- Construction organization design
- Eight open-type TBMs are used for construction, and the TBM launching shaft and receiving shaft are combined with the vertical shaft of permanent buildings.
- The total construction period of TBM method is 52 months, including 6 months for preparation, 43 months for 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



Civil design tasks and completion

■ Construction Planning

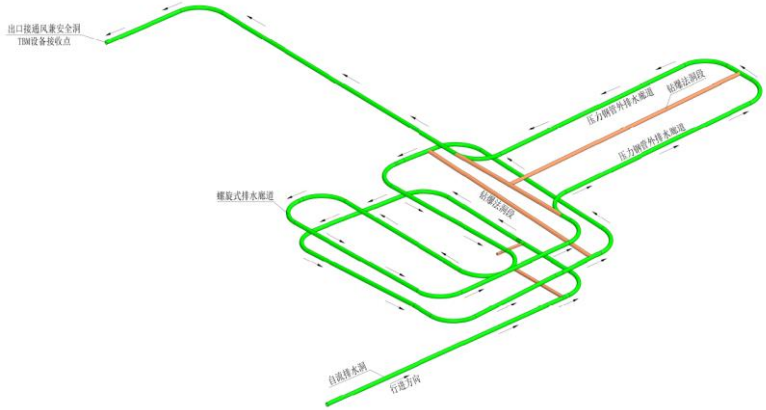
- The length of the main ring tunnel is up to 100km. From a technical point of view, TBM method is suitable for construction. However, a large number of ventilation shafts and traffic shafts are arranged in the project. In the drilling and blasting method scheme, multiple working faces can be opened by using these shafts. By increasing the working face and equipment investment, the construction period can be basically equivalent to that of TBM method, and the overall cost is low.
- With the continuous progress of TBM technology and its application, the TBM equipment cost and operation cost tend to decrease gradually, while the drilling and blasting method uses a large number of manual operations, and the labor cost increases year by year. During the implementation of the project, the advantages of adopting TBM construction scheme will gradually highlight.
- If the following measures are taken, the construction period of TBM method can be further optimized:
- 1) Increase the number of TBM equipment (for example, increasing 4 sets can shorten the excavation period by about 7 months);
- 2) Using shield TBM and tunnel excavation and lining at the same time can reduce the tunnel lining time by about 6 months.
- However, taking the above measures will increase part of the project investment.

TBM scheme of CEPC main ring tunnel

TBM construction technology is becoming more and more mature and the price is lower, which can be used for the construction of CEPC main ring tunnel.

At present, TBM equipment has been applied to Luoning pumped storage power station, Pingjiang pumped storage power station and other projects of Zhongnan engineering corporation limited.

TBM route map of Pingjiang pumped storage power station



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Changsha site has completed the demonstration work and further optimized the construction organization design. The main conclusions are as follows:

- Hunan Province has superior geographical location, rich tourism resources and high degree of internationalization, which meets the requirements of CEPC civil engineering site selection.
- Changsha Municipal Party committee and government attached great importance to it and carried out demonstration work on CEPC Changsha site.
- The construction organization design was further carried out to optimize the TBM construction scheme and shorten the construction period.
- Following the latest research results of physics, the BIM model of Changsha site has been updated.

Next work

- Analyze the vibration impact of equipment on surrounding utilities.
- Further carry out detailed geological exploration.
- Carry out detailed layout of buildings based on equipment layout.
- Establish real pipeline model based on the equipment process.
- Further carry out supporting facilities planning and construction preparation.

中国电建
POWERCHINA

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

秉责 创新 卓越

Thank you!

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