

# **China Industry Status**

J. Gao

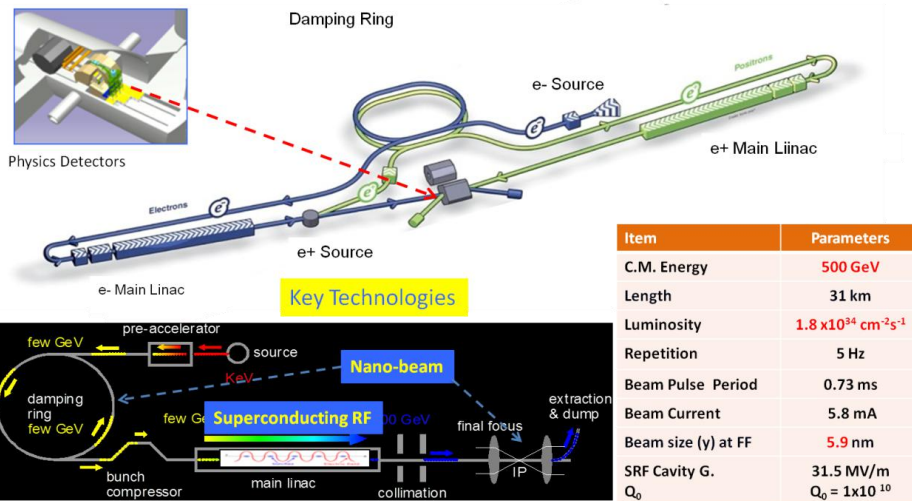
Institute of High Energy Physics

**International Workshop on Future Linear Colliders**

**LCWS2019, Sendai, Japan**

**Oct. 28-Nov. 1, 2019**

# China ILC Collaboration



China has been working ILC collaboration since 2005 as ILC GDE member (IHEP)

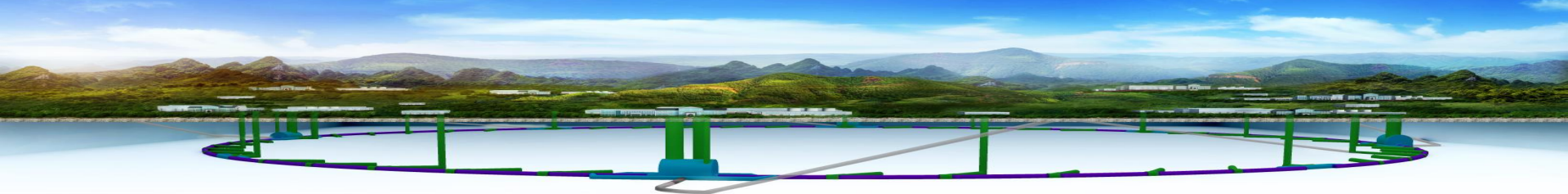
ILC 500GeV needs ~16000  
1.3GHz 9cell cavities



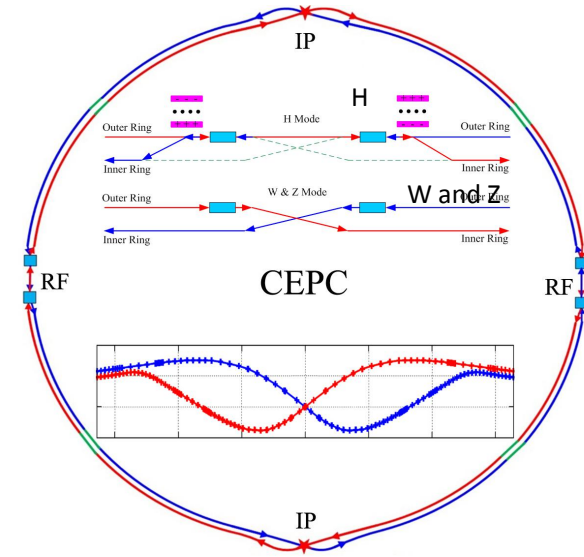
Cost reduction by compact ILC

Since 2017

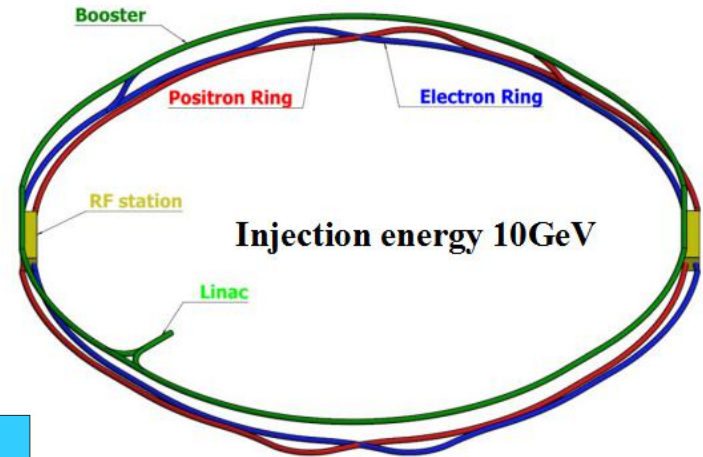
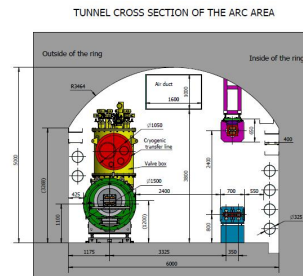
ILC 250GeV Higgs factory needs  
~8000 1.3GHz 9cell cavities



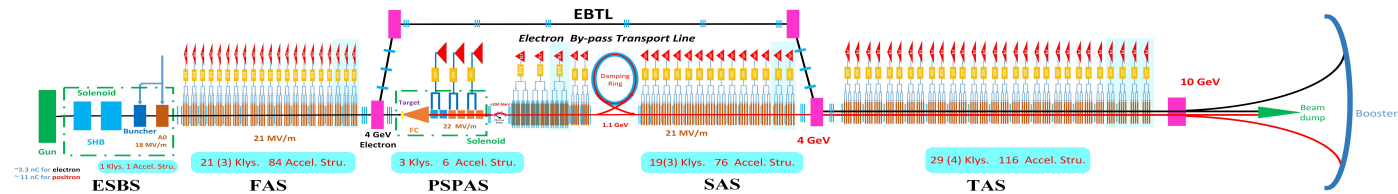
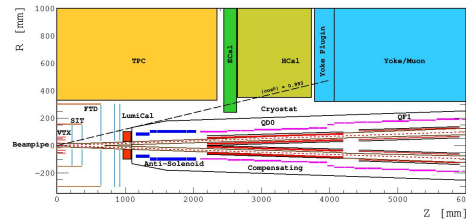
# CEPC CDR Baseline Layout



CEPC collider ring (100km)



CEPC booster ring (100km)



CEPC Linac injector (1.2km, 10GeV)

# CEPC Industrial Promotion Consortium (CIPC) Collaboration Status



Established in Nov. 7, 2017  
CIPC Annual Meeting, July 26, 2018

- 1) Superconducting materials (for cavity and for magnets)
- 2) Superconducting cavities
- 3) Cryomodules
- 4) Cryogenics
- 5) Klystrons
- 6) Vacuum technologies
- 7) Electronics
- 8) SRF
- 9) Power sources
- 10) Civil engineering
- 11) Precise machinery.....

Now:

- Huanghe Company, Huadong Engineering Cooperation Company, on CEPC civil engineering design, site selection, implementation...
- Shenyang Huiyu Company on CEPC MDI mechanical connection design
- Zhongxin Heavy Industry on Electric-magnetic separator design
- China Astronautics Department 508 Institute on CEPC MDI supporting design and CEPC magnets mechanical designs...
- Kuanshan Guoli on CEPC 650MHz high efficiency klystron
- Huadong Engineering Cooperation Company, on CEPC alignment and installation logistics...





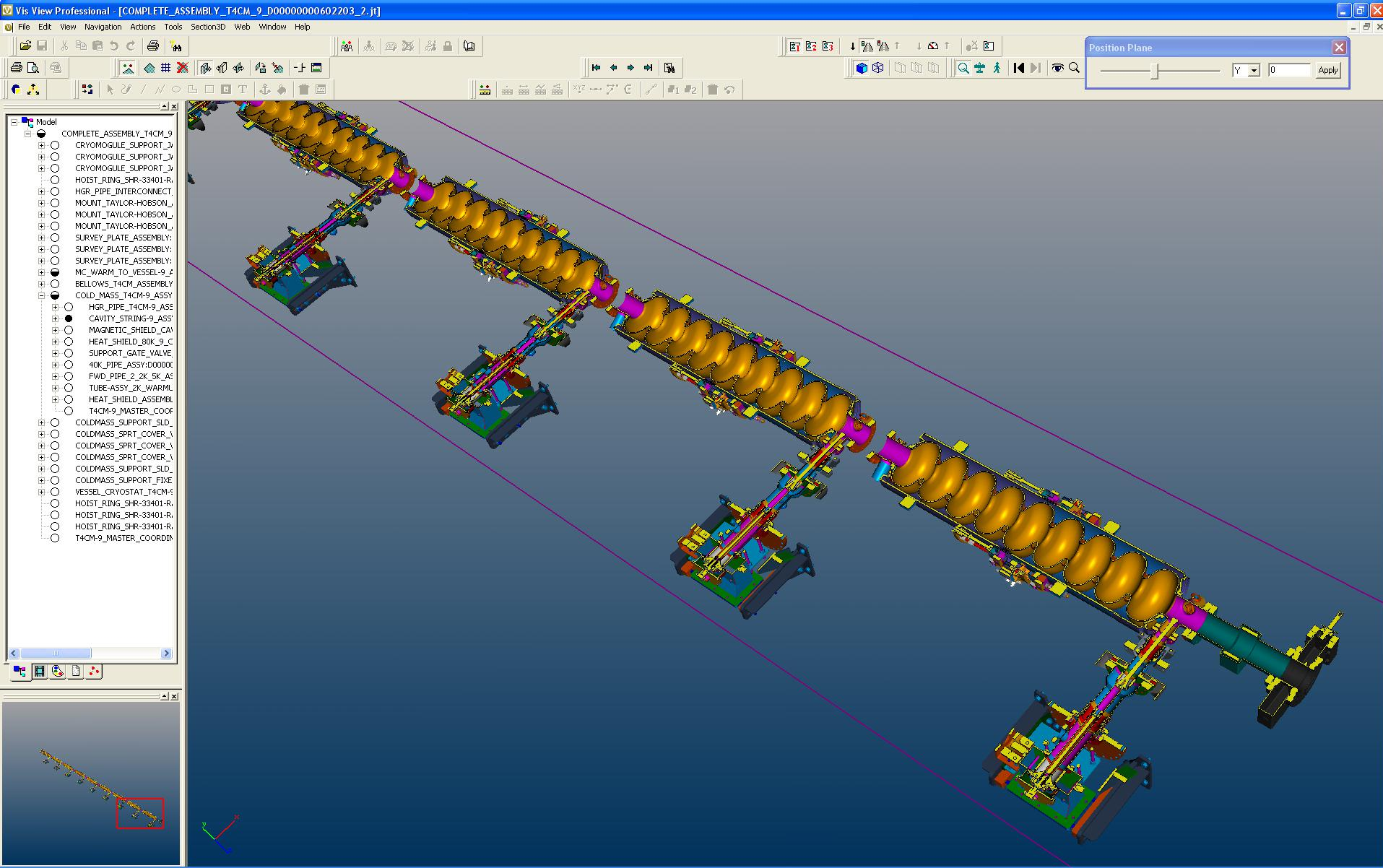
# Ningxia Orient Tantalum Industrial Co.,Ltd.

## OTIC SCRF Activities and Industrialization



# SC Cavities in a Superconducting Accelerator such as in ILC, CEPC booster and XFELs

## 1.3GHz 9-cell Superconducting Cavity in Linear Accelerator



# Brief Introduction of OTIC

Ningxia Orient Tantalum Industry Co., Ltd  
(OTIC)

stocking

Ningxia Nonferrous Imp. & Exp.  
Corp.

Ningxia Orient Superconductor  
Technology Co.,Ltd.

Ores Supply

Hydrometallurgy  
Plant

Pyrometallurgy  
Plant

Tantalum  
Powder  
Plant

Tantalum  
Wire  
Plant

MillProduct  
Plant

Engineering  
Ceter

Analysis  
Ceter

Dissolving of ores  
by acids

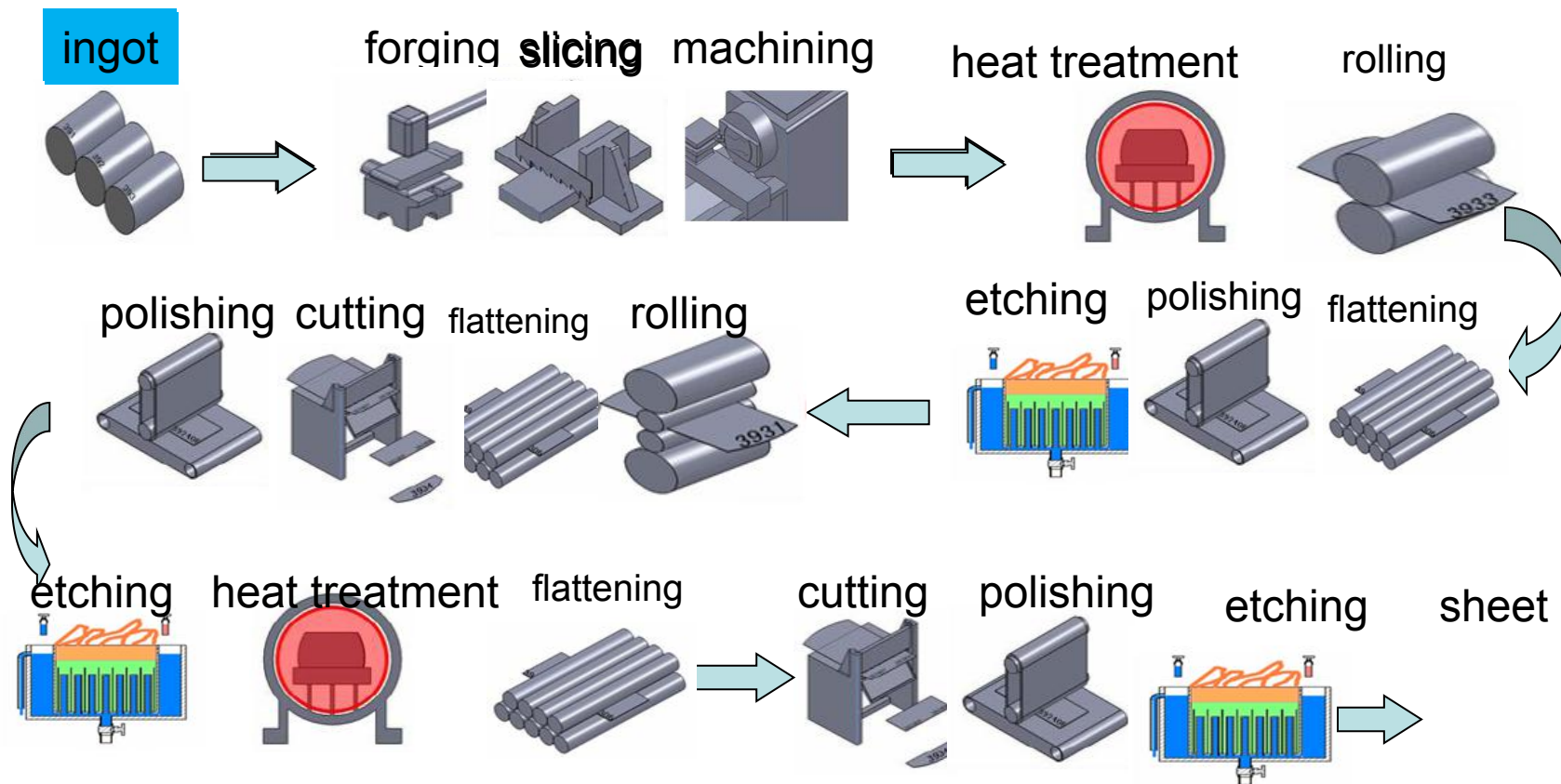
Reducing  
Refining

Forging Rolling  
Machining

Cavities  
manufacturing

# Brief Introduction of OTIC

## Process Flow of Nb-sheet for Cavity





## Brief Introduction of OTIC

### Capacity

Products	Annual capacity	Spec.
RRR Nb sheet	30 Tons	RRR40, RRR250, RRR300
RRR Nb tube	5 Tons	RRR40, RRR250, RRR300
RRR Nb rod	10 Tons	RRR40, RRR250, RRR300

# Brief Introduction of OTIC

## Achievements



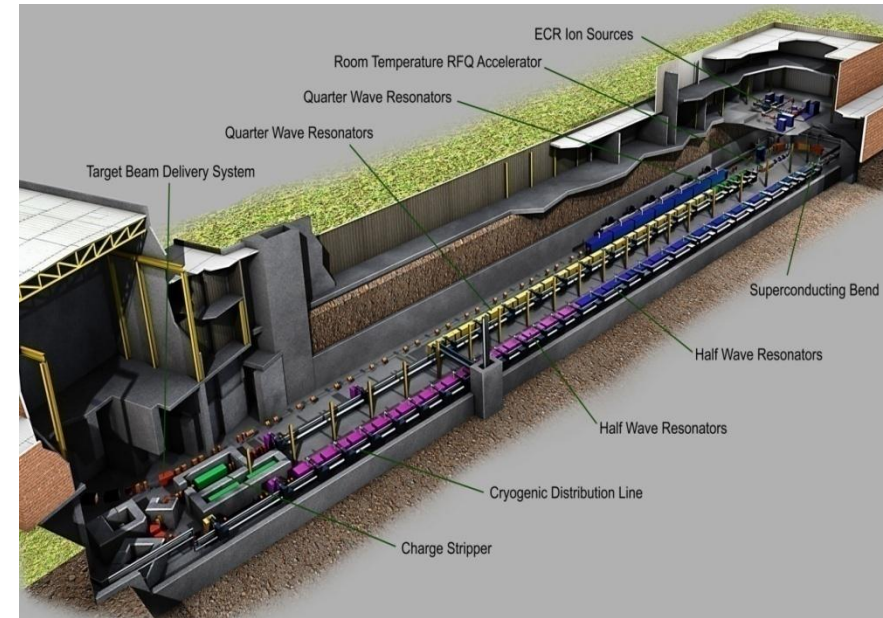
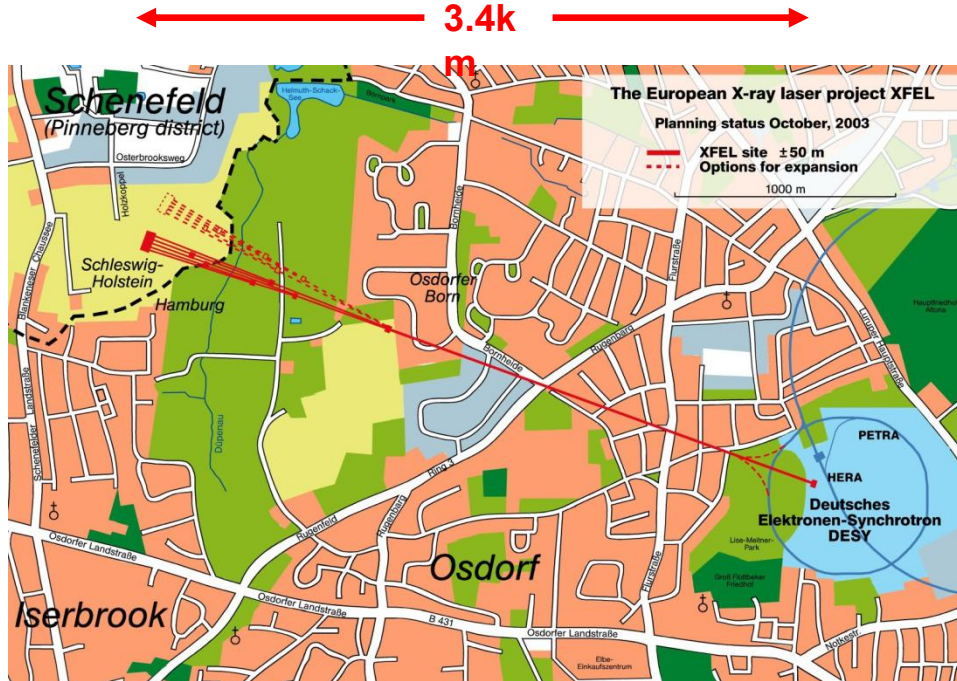
**On-site inspection by INFN**



**On-site inspection by SHINE**

# Brief Introduction of OTIC

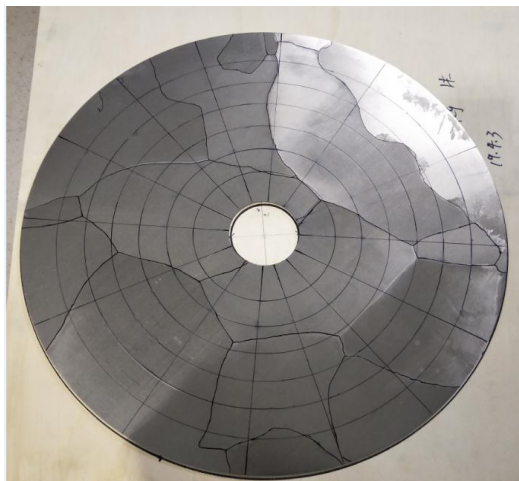
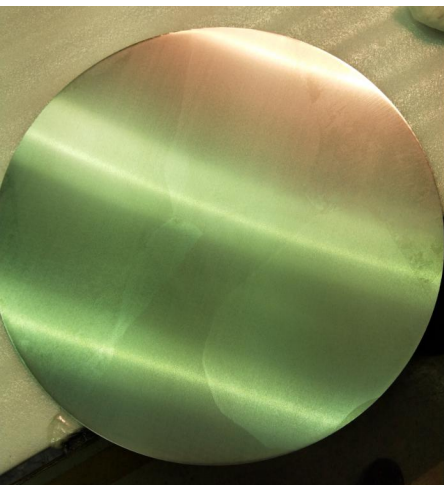
## Achievements



- 2011 DESY – XFEL: 8 tons RRR300 Nb sheets, 30% of the project
- 2012 Michigan State University – FRIB: 8.5 tons RRR250 Nb sheets, 70% of the project
- 2014 Fermilab - LCLS II: 5 tons RRR300 Nb sheets, 50% of the project
- 2017 INFN & STFC – ESS: 10 tons RRR300 Nb sheets, 100% of the project



# Study and manufacture for SCRF

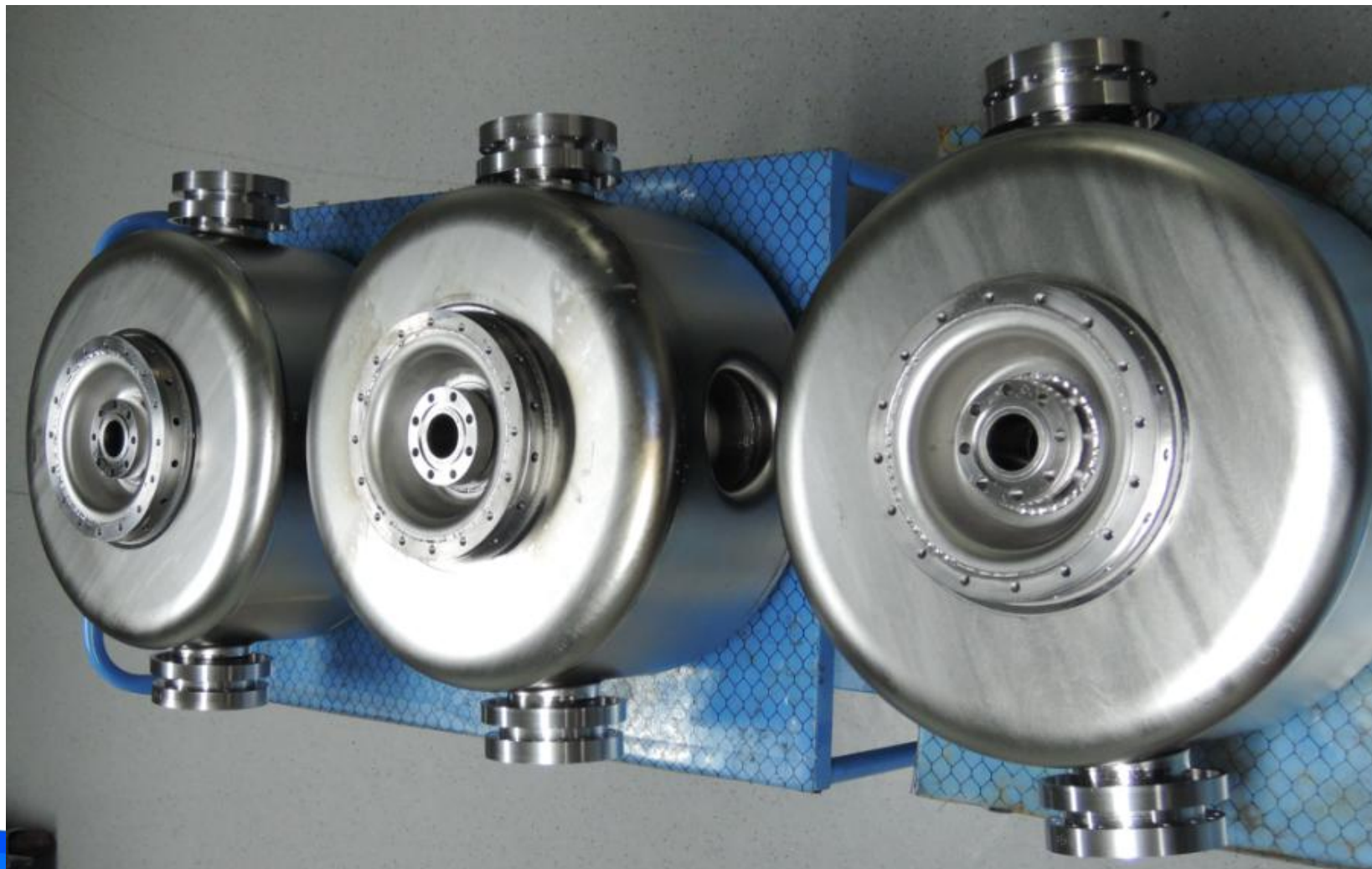


The maximum diameter of RRR300 Nb disc with large grain at OTIC can be machined to  $\Phi 540\text{mm}$ , which can meet the manufacturing requirement of CEPC 650MHz superconducting cavity. At present, large-scale Nb material with large grain is being supplied to Shanghai Hard X-ray Big Science Facility.

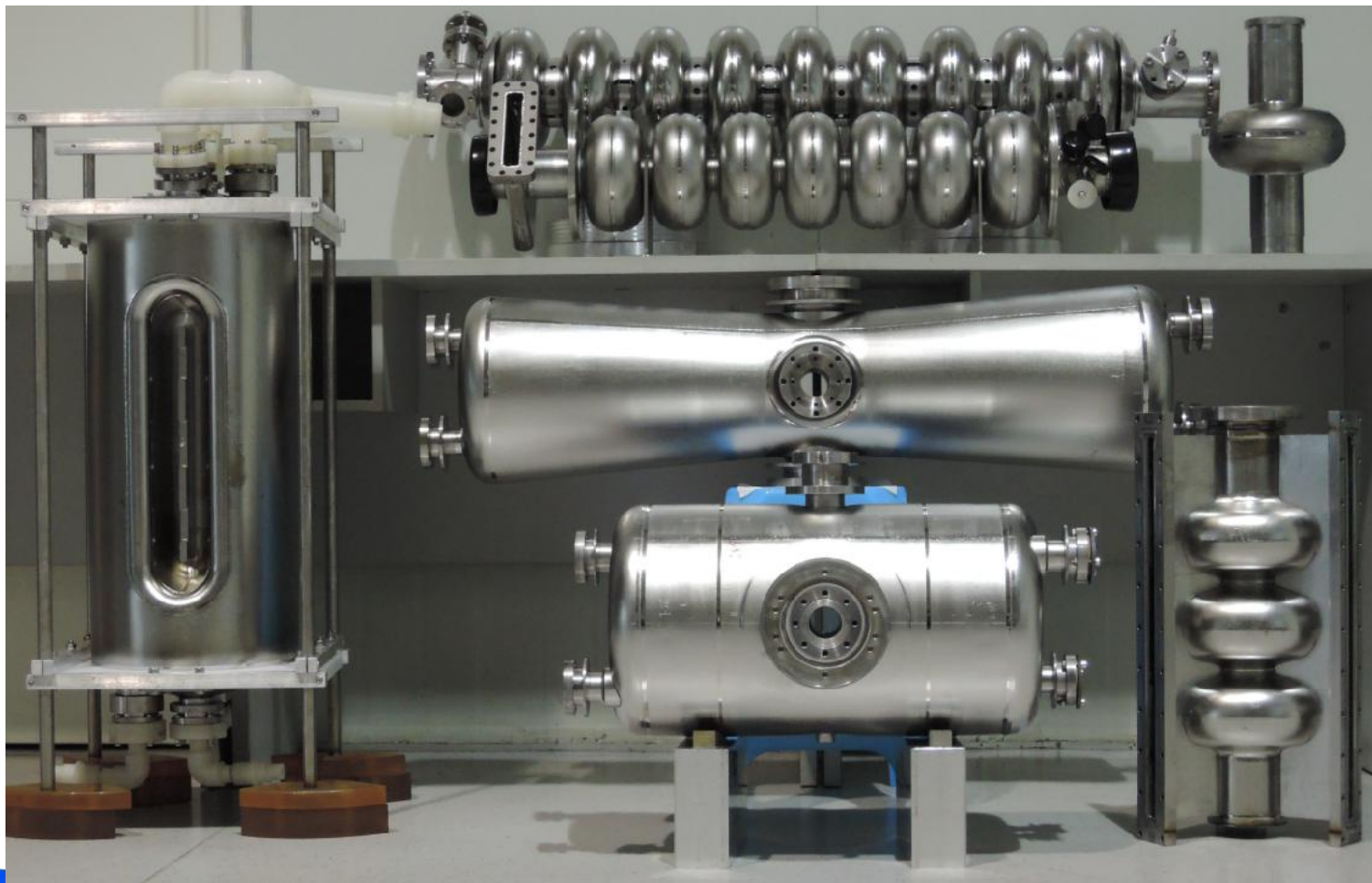
**Large grain Nb disc and cavity manufacture**



# Study and manufacture for SCRF

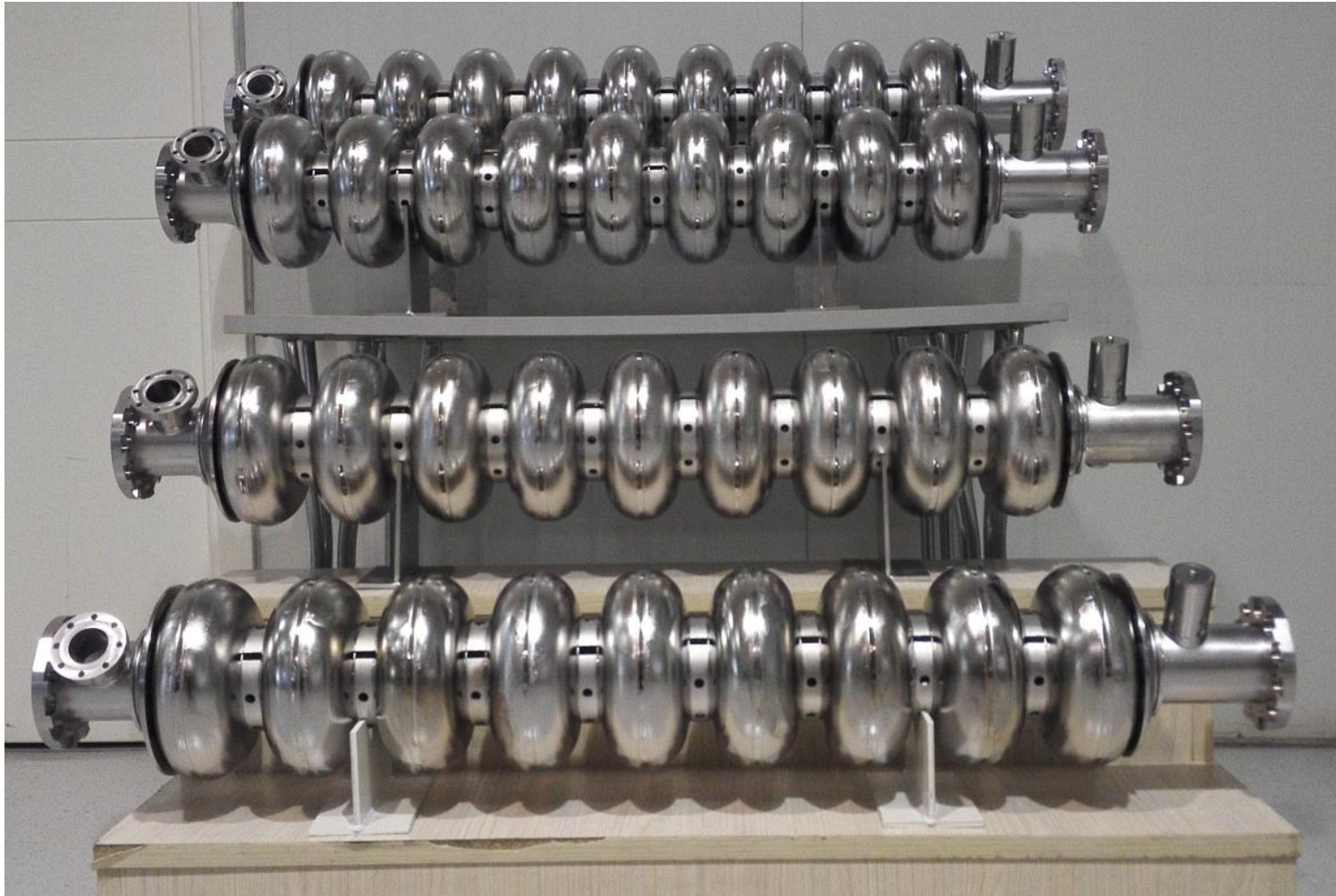


## Collaboration with main Agencies



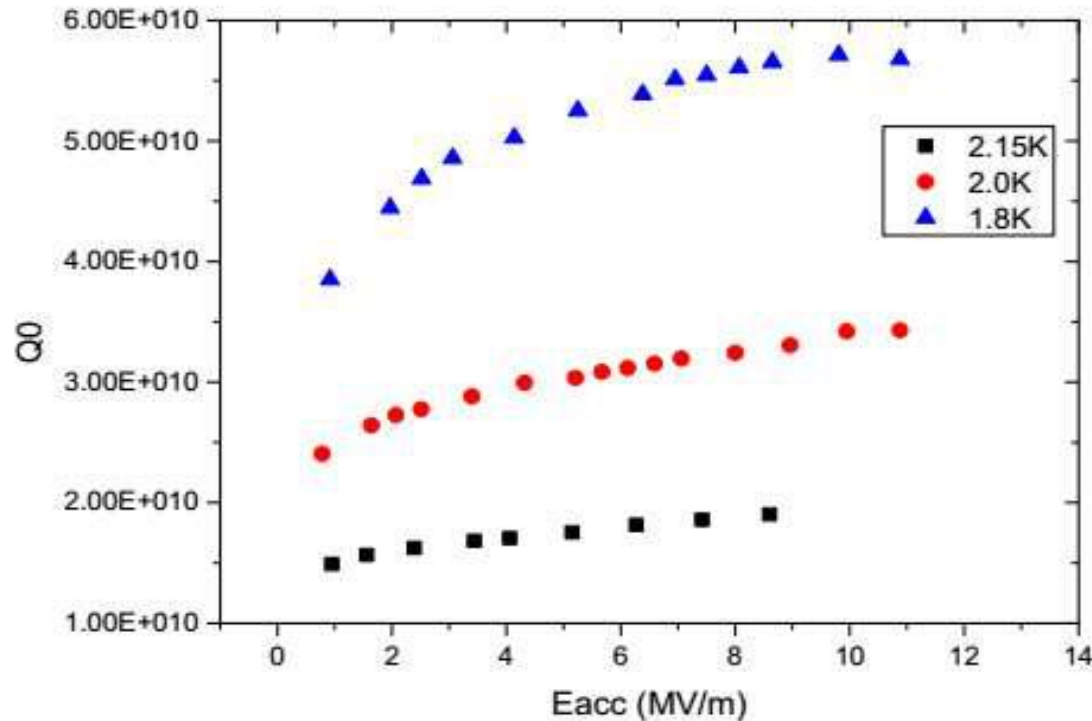


# Collaboration with main Agencies



**1.3GHz 9cell large grain superconductor cavities**

# Study and manufacture for SCRF



In cooperation with IHEP and Peking University, OTIC established BCP and HPR post-processing facilities, improved nitrogen doping process and EP facilities, and possessed the capability of post-processing of superconducting cavity in the first half of 2019.

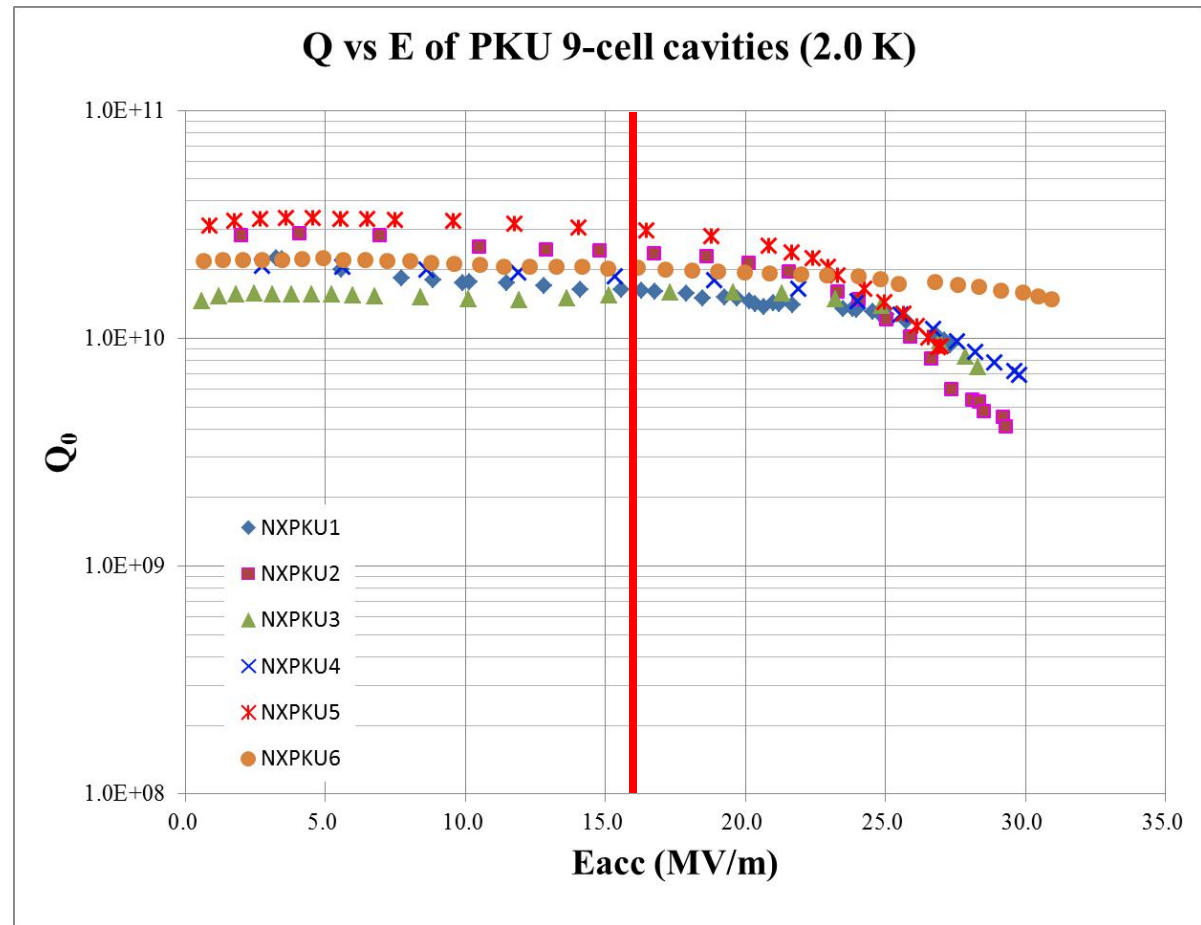
N-doping in Peking University  
1.3GHz large grain single cell cavity



# Study and manufacture for SCRF

1.  $E_{acc}$  of all 6 cavities larger than 25 MV/m
2.  $Q_0 \sim 1.6-2.4E10$  @ 16 MV/m

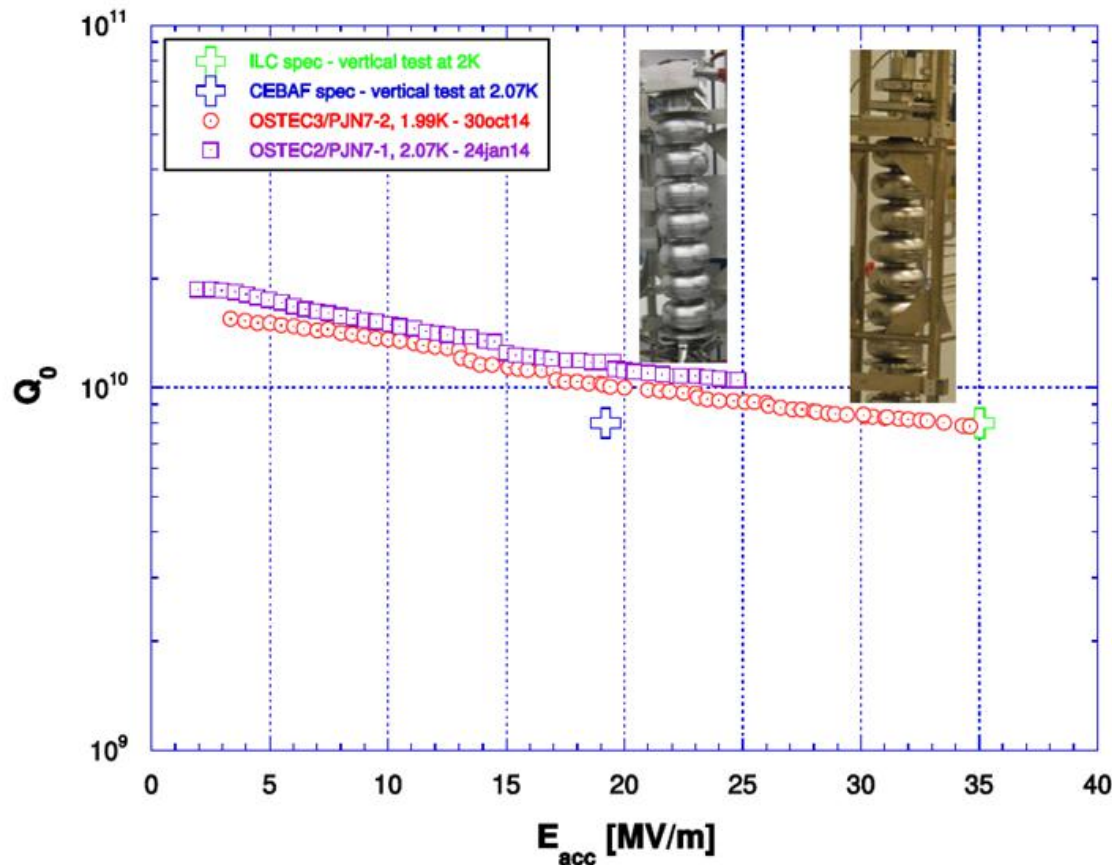
#3, 2<sup>nd</sup> test (Sept. 2017), with additional BCP & HPR



VT result for 6 9-cell large grain cavities after BCP & HPR

# Study and manufacture for SCRF

Two 7-Cell 1.5 GHz Full-Scale CEBAF 12 GeV SStyle Niobium Cavity

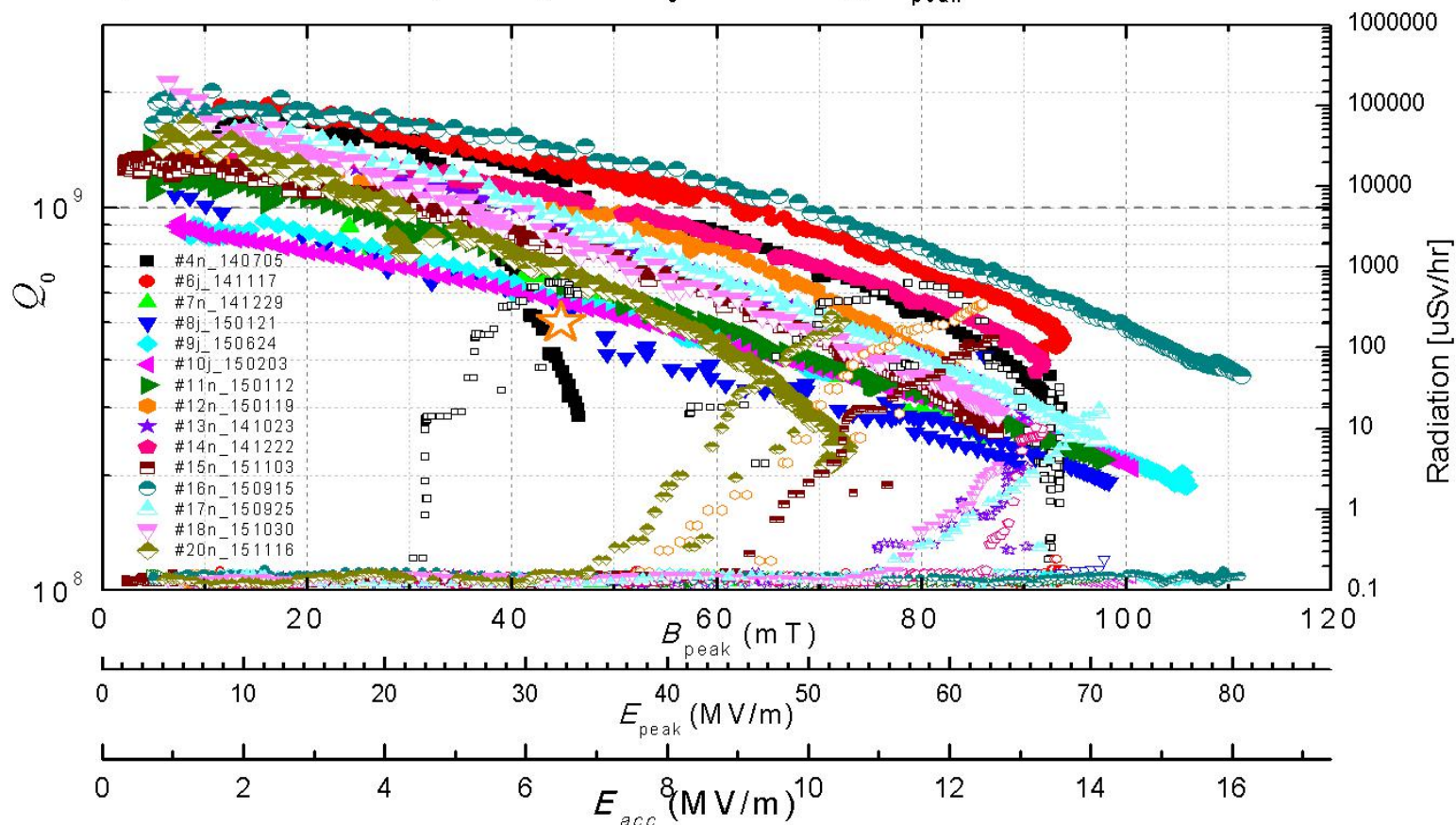


In 2013, OTIC cooperated with Jlab for the first time to develop a 1.5GHz 7-cell superconducting cavity for CEBAF upgrade. Superconducting cavity was tested at 2K low temperature and the acceleration gradient reached 36MV/m. It was the first time for OTIC to have the manufacturing capability of superconducting cavity.



# Study and manufacture for SCRF

Spoke012 4.2K VT, Designed  $Q_0 = 5 \times 10^8$  @  $E_{\text{peak}} = 31.5$  MV/m

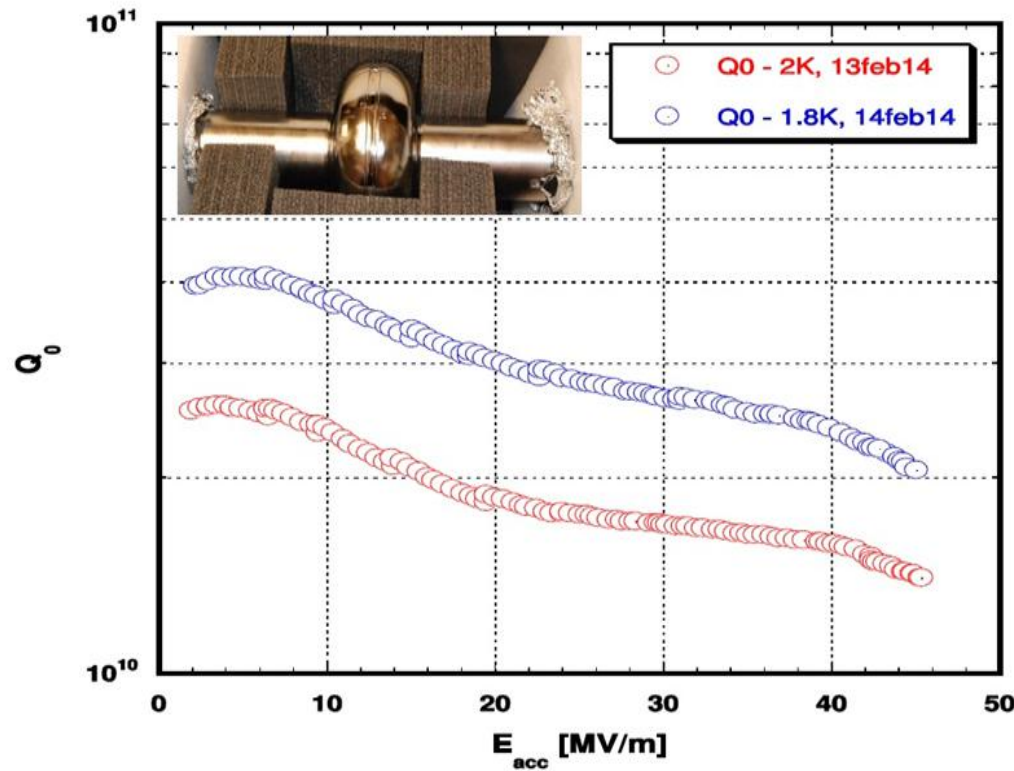


21 SPOKE012 cavities for IHEP, #14-#18 were manufactured by OTIC.

# Study and manufacture for SCRF

First superconducting niobium cavity built by OSTEC. Maximum gradient 46 MV/m with excellent Q0

## OCTEC1 (1-Cell Large-Grain Nb Cavity)



Prior history since last test on November 4, 2013:

electropolishing for 30 micron removal followed by baking at 120 degree Celsius for 18 hours

1.5GHz large grain single cell superconducting Nb cavity, its maximum acceleration gradient reached 46MV/m. It was the first Nb cavity which was manufactured in OTIC in 2013.

## Results of 1.5GHz large grain single cell superconductor cavity





# Beijing HE-Racing Technology Co., Ltd.



**北京高能锐新科技有限责任公司**

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*Beijing HE-Racing Technology Co., Ltd.*

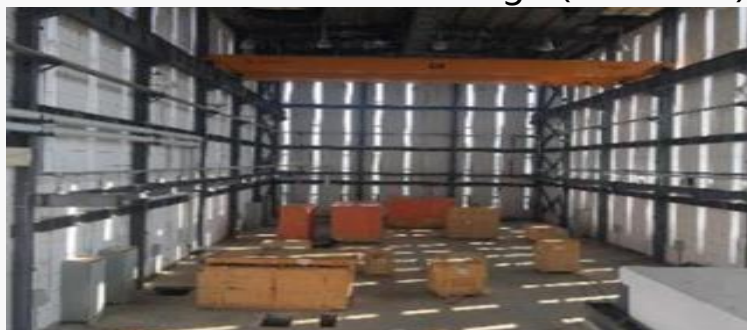
## IHEP New SC Lab under Construction (Status August 2019)



New SC Lab Design (4500m<sup>2</sup>)



Bird view in August 2019



Experimental hall



Helium recirculating tanks [2.5KW@4.5K cold box](#)



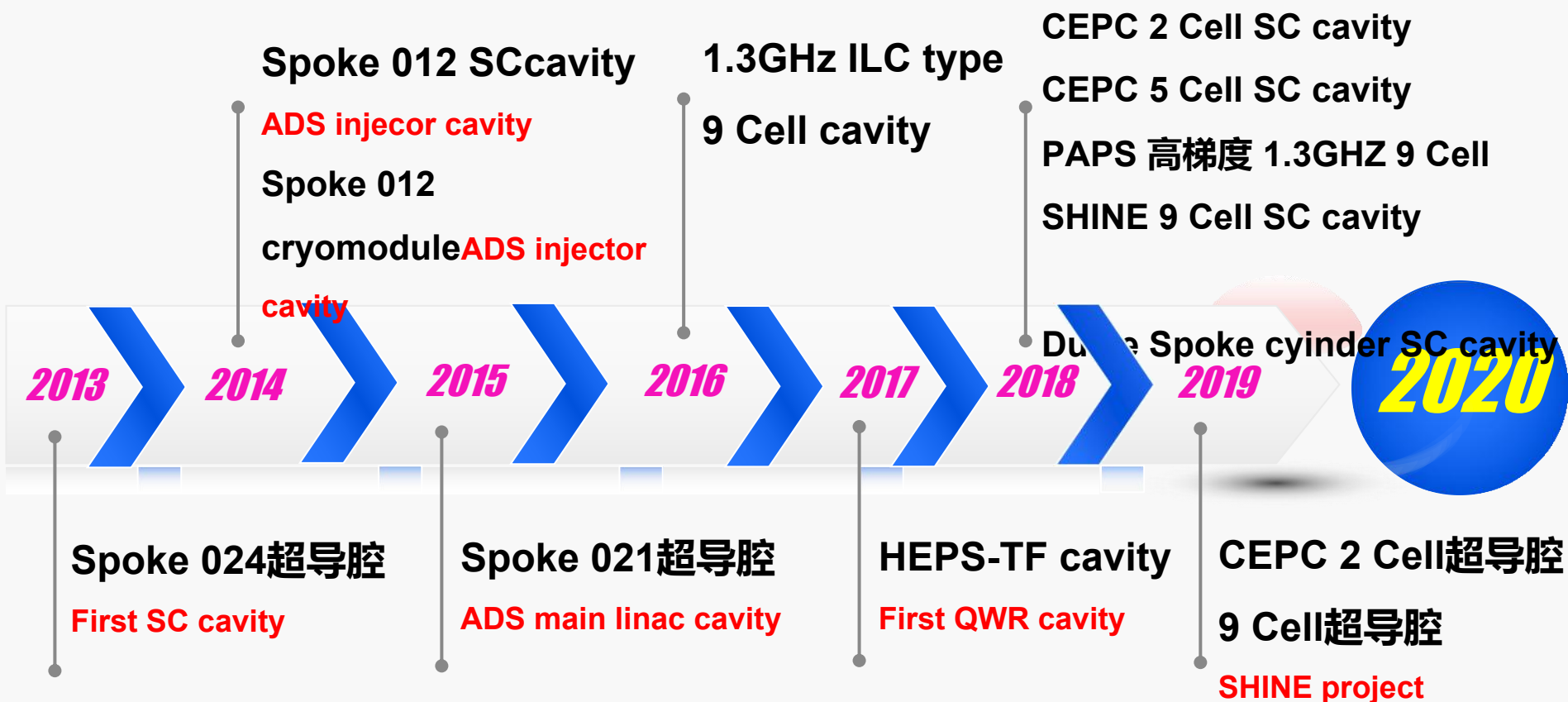
2K JT heat exchanger

## SC cavity production factory with facilities (Beijing branch)





## SC Cavity Production History





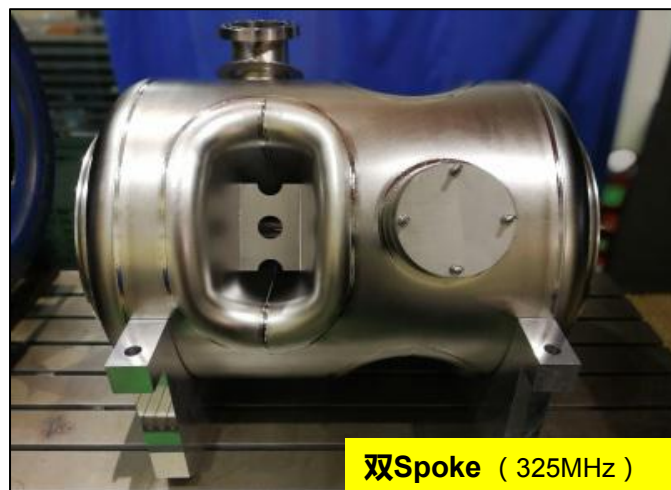
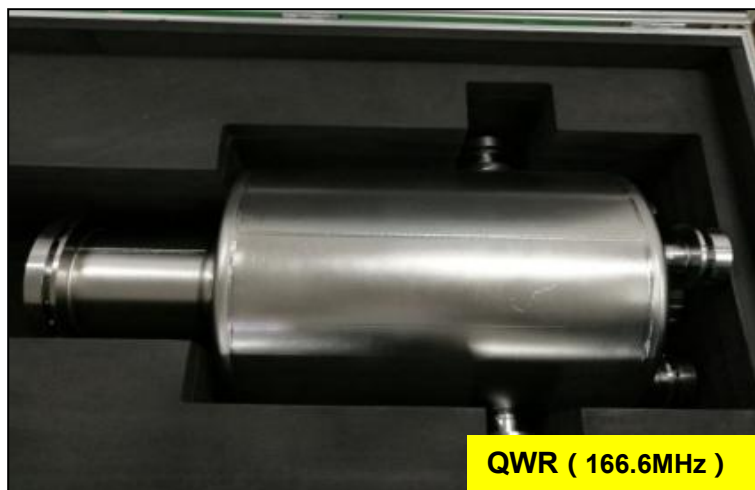
## SC Cavity Product Parameters

8 types , 4 frequencies , totally 39 pieces

No.	Facility	SC cavity type	Frequency (MHz)	Number (piece)	E (MV/m)	Status
1	HEPS-TF	QWR	166.7	2	29	Vertical test
2	C-ADS	Spoke, $\beta=0.12$	325	4	11.5	Operation with beam
3	C-ADS	Spoke, $\beta=0.21$	325	5	12	Operation with beam
4	C-ADS	Spoke, $\beta=0.24$	325	1	11.2	Vertical test
5	C-ADS	双Spoke,	325	1	/	Waiting vert. test
6	CEPC	2 cell 椭球腔	650	1	24	Vertical test
7	CEPC	5 cell 椭球腔	650	1	12	Vertical test (4K)
8	PAPS	2 Cell 椭球腔	650	3	/	Waiting vert. test
9	PAPS	单cell 椭球腔	1300	10	36	Vertical test
10	ILC R&D	9 cell 椭球腔	1300	1	24	Vertical test
11	PAPS	9 cell 椭球腔	1300	2	25	Vertical test
12	SHINE	9 cell 椭球腔	1300	8	25	Vertical test (4 )



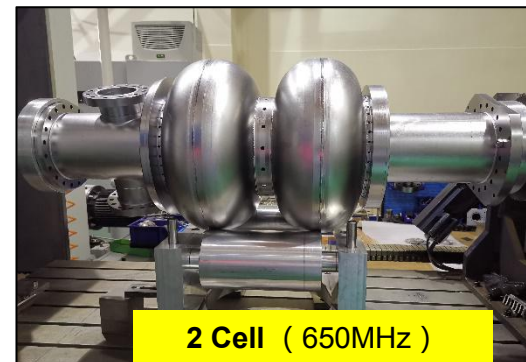
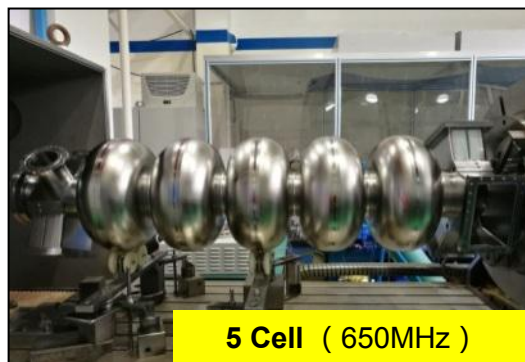
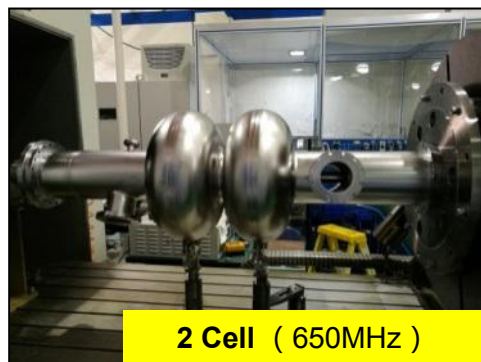
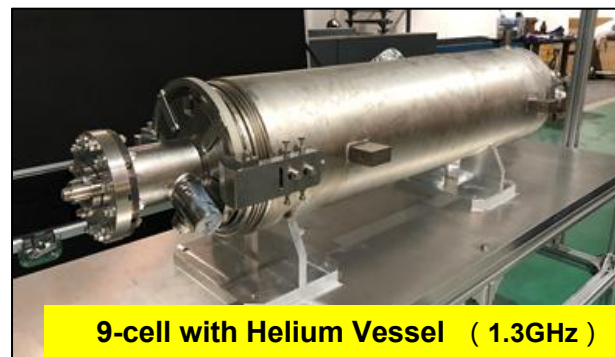
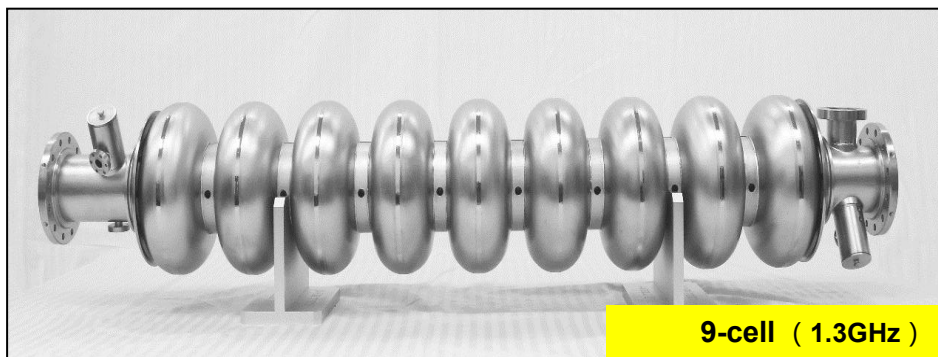
## SC Cavities ( Photos )





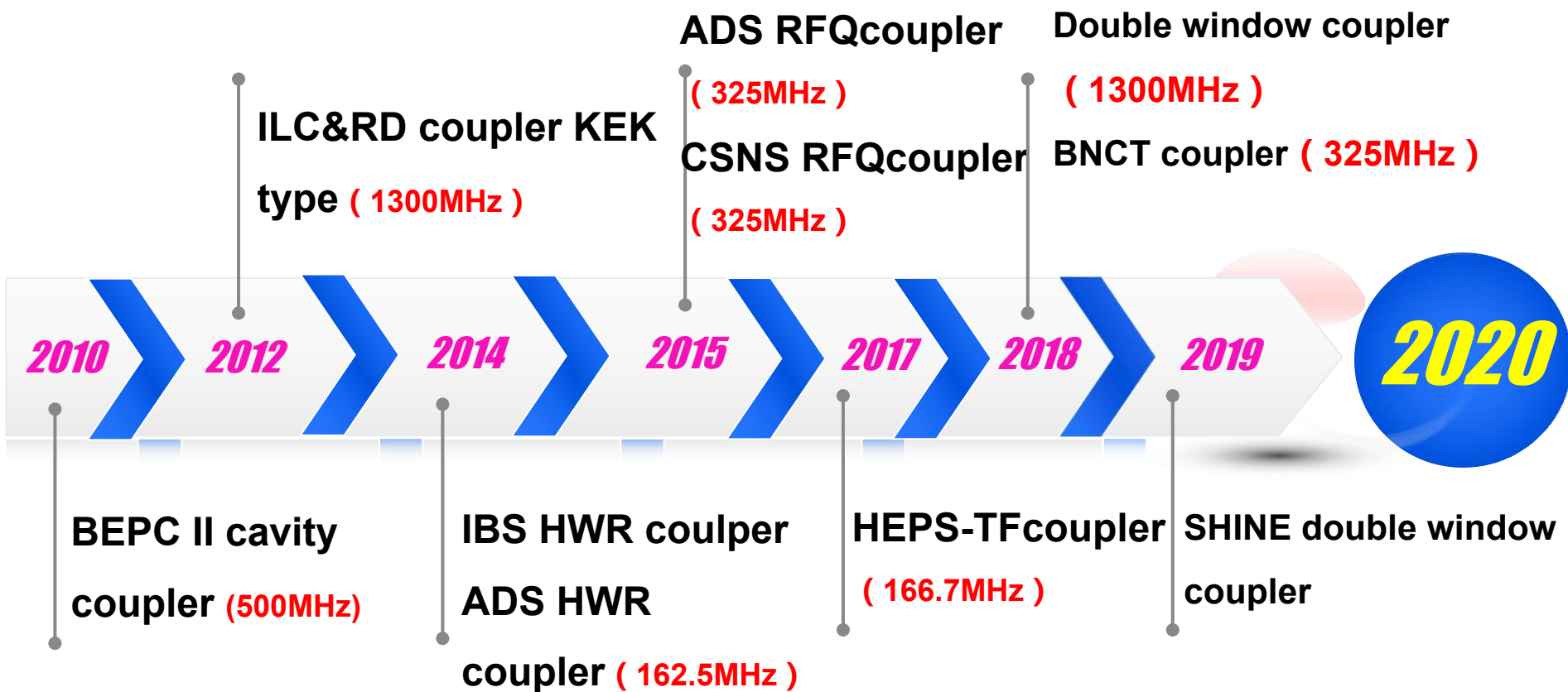


## SC Cavities ( Photos )





## Couper R&D(History)





## Coupler ( Parameters )

12types , 6frequencies , total 50piece

No.	Facility	Type	Freq. (MHz)	Cupler type	Num.	Power (kW)	Status
1	IBS	HWR (SCC)	162.5	Coaxial	2	Test: CW, 15 kW	Test
2	C-ADS	HWR (SCC)	162.5	Coaxial	2	Oper: CW, 80 kW	Oper
3	HEPS-TF	QWR (SCC)	166.7	Coaxial	2	/	Test
4	C-ADS	RFQ (NC)	325	Coaxial	8	Test: CW, 105 kW Oper: CW, 100 kW	Oper
5	C-ADS	Spoke (SCC) $\beta = 0.12$	325	Coaxial	7	Test: CW, 10 kW Oper: CW, 10 kW	Oper
6	C-ADS	Buncher (NC)	325	Coaxial	3	/	Oper
7	CSNS	RFQ (NC)	325	Coaxial	5	/	Oper
8	BNCT	RFQ (NC)	325	Coaxial	5	/	Oper
9	BEPCII	1 cell (SCC)	500	Coaxial	4	Test: CW, 420 kW Oper: CW, 150 kW	Oper
10	PAPS	20cell (SCC)	650	Adjustable, single window	2	/	R&D
11	ILC R&D	9cell (SCC)	1300	Adjustable, double window	2	Oper: CW, 70 kW	Test
12	SHINE	9cell (SCC)	1300	Adjustable, double window	8	/	Waiting test





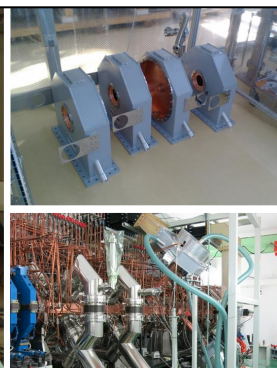
## Couplers (Normal conducting)



BEPC II ( 500MHz )



ADS ( 325MHz )



CSNS 聚束腔 ( 325MHz )



CSNS RFQ腔 ( 325MHz )



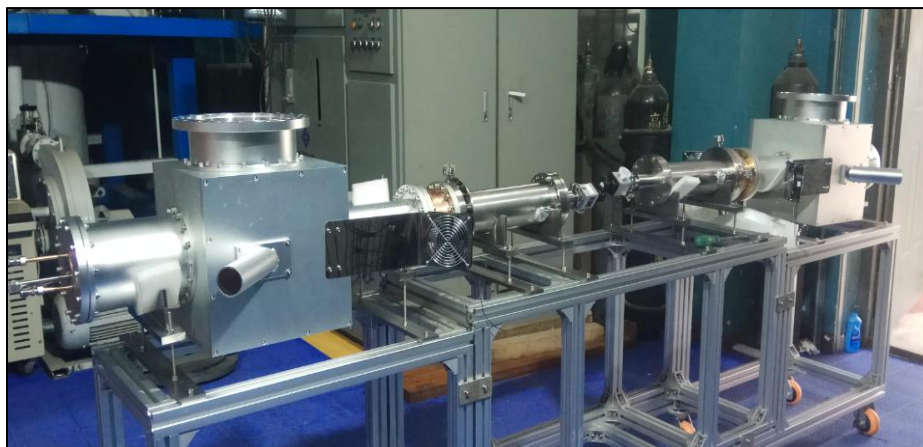
BNC耦合器 ( 325MHz )



## Coupler ( SC coupler )



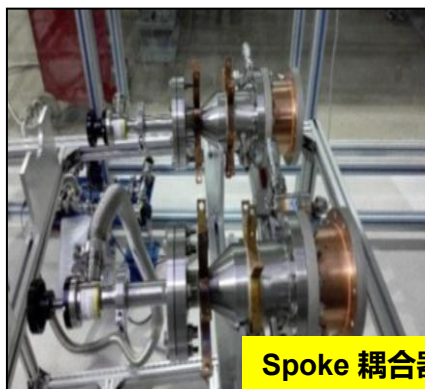
HWR 耦合器 ( 162.5MHz )



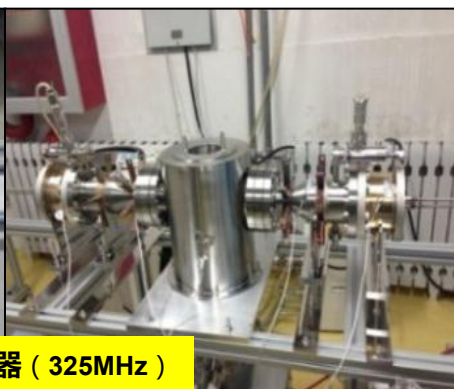
QWR 耦合器 ( 162.5MHz )



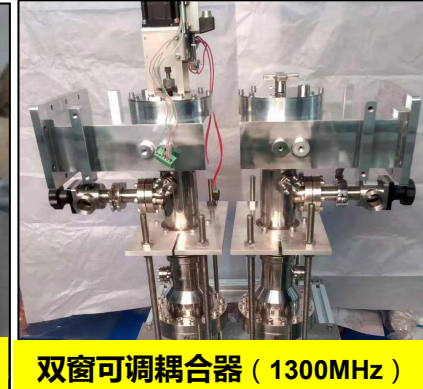
双窗可调耦合器 ( 1300MHz )



Spoke 耦合器 ( 325MHz )



双窗可调耦合器 ( 1300MHz )



双窗可调耦合器 ( 1300MHz )



# ChaoGao Zhuang (zhongshan) Scientific Technology Co., Ltd.

和超高装（中山）科技有限公司

单晶腔



9cell铜腔



大晶腔系列



细晶腔系列



1.3G SC cavities



# haoGao Zhuang (zhongshan) Scientific Technology Co., Ltd.

和超高装（中山）科技有限公司



25MeV连续波超导质子直线加速器（二）



Completed **7 types** and **60 pieces**

Nb SCCavities

1.3G-TESLA3+1/2Cell Cavity

1.3G-TESLA9Cell Cavity

325M-Spoke012 Cav162.5M-HWRCavity

500M single Cell Cavity

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# Beijing Sinoscience Fullcryo Technology Co., Ltd.



**Aims to promote the industrial application of cryogenic technologies coming from TIPC**



- Founded in **August 2016** with a registered capital of **RMB 131 million**.
- **High-tech company** based on the cryo-technologies coming from **TIPC**, CAS
- Focus on Cryogenic Engineering

**CEPC18KW@4K Cryogenics and System :**

# Milestone of Domestic Cryogenic activities



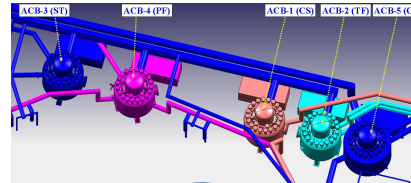
1959

**Initial helium liquefaction**



1976

**Helium cryogenic system of KM-4**



2008

**Distribution valve boxes for "ITER" large-scale cryogenic system ; PKU-FEL 2K cryogenic system**



2012

**2kW@20K helium refrigerator**



2013

**Participated in "SSRF" cryogenic system construction**

**1000W@4.5K helium refrigerator ; 10000W@4.5K helium refrigerator**

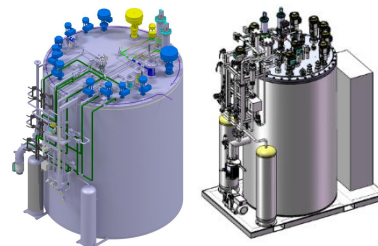


**40L/h helium liquefier**

2015

**1000L/h H2 liquefier 200W@4.5K helium refrigerator for NFRI**

2018



**2500W@4.5K & 500W@2K helium refrigerator 500W@4.5K helium refrigerator**

2019

2020

2023

**18000W@4.5K helium refrigerator**

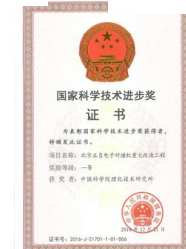
2017

**250W@4.5K helium refrigerator**



20

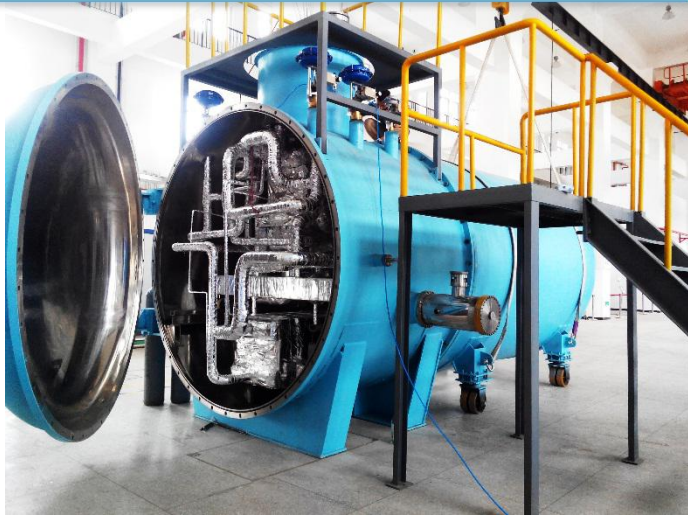
**Participated in "BEPc II" cryogenic system construction**



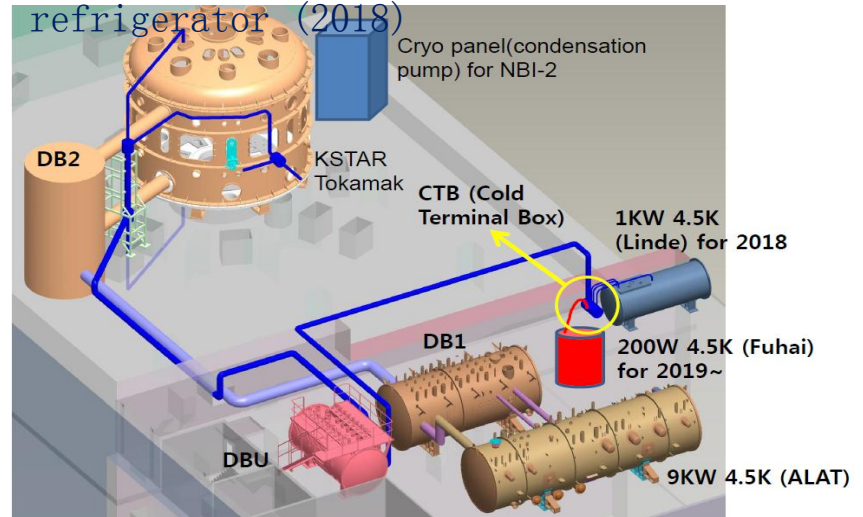


# Application

Successful operation of **10kW@20K** refrigerator (2014)



Providing Korea National Fusion Research Institute (NFRI) with a **200W@4.5K** helium refrigerator (2018)



Successful operation of **250W@4.5K** refrigerator or (2017)



Successful application of **40L/h** LHe liquefier (2016)







Wuxi Creative Technologies Co.,Ltd

**WuXi Creative Technoloies Co. Ltd. (WXCX)**

Wuxi Creative Technologies Co.,Ltd(WXCX) is a professional manufacturer in Cryomodule Vacuum Vessel, Cryogenics system, Cryomodule Transfer Lines Sections, Indoor environmental simulator chambers and general precision machining parts.

WXCX holds ISO9001 Certification, ASME Vessel manufacture certificate, NBBI certificate, as well as European Pressure Equipment certificate.

WXCX holds 17 patents in Cryomodule and Vacuum Vessel fabrication in China, and is certified as the provincial engineering center in Jiangsu.

WXCX has various fabrication equipments as well as inspection labs in house. Our national and international customers are satisfied with our products in several researching projects.





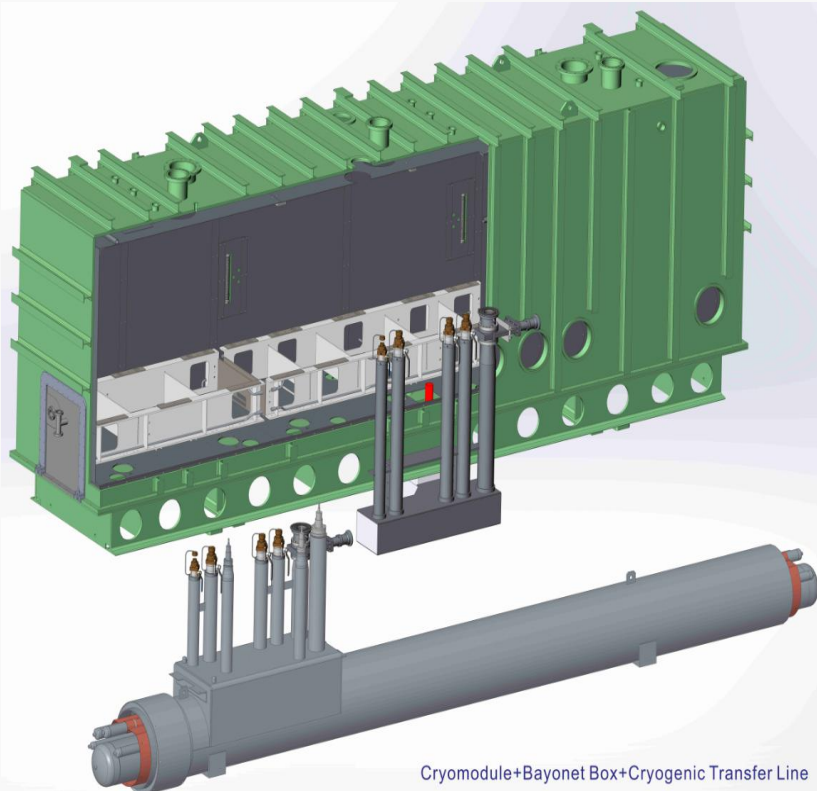
# Cryomodules for EXFEL



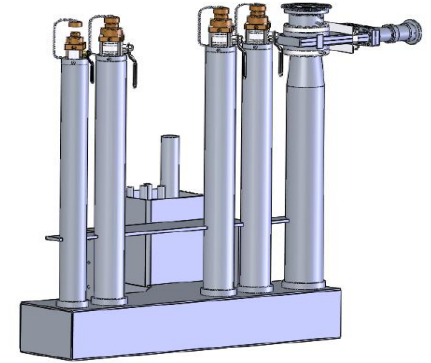
**WXCX manufactured the first set Cryomodule cooperated with IHEP in 2010. It passed the technical test in German. And then we got 58 sets Cryomodule order for EXFEL project in 2011. We finished and delivered all cryomodule in 2 years.**



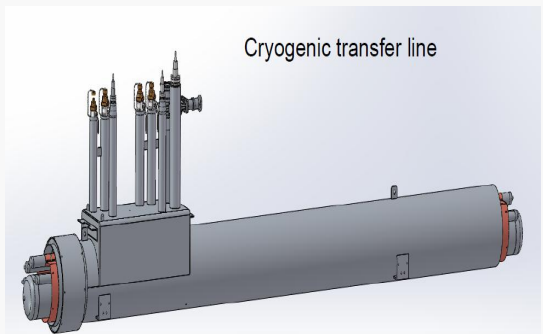
# Cryomodules for FRIB at MSU



Based on the manufacture experience on cryomodule of EXFEL project, we won the whole order including 49 sets cryomodule, 49 sets bayonet box and 49 sets cryogenic transfer line from MSU in 2016. And we became the excellent supplier of MSU in 2017.



Bayonet box



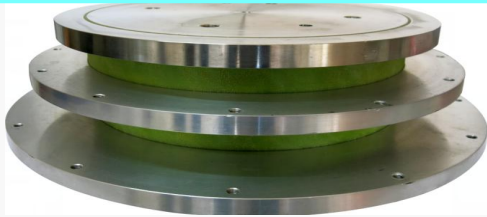
Cryogenic transfer line





# Cryomodules for LCLS II

Also in 2016, we got the cryomodule order from Fermilab through LCLS II international bidding because of the manufacture experience on cryomodule of EXFEL project. Until now we have finished and delivered 38 sets 1.3G cryostat and 3sets 3.9G cryostat.



LCLS II POST



LCLS II Coldmass Upper Assembly



LCLS II Vessels

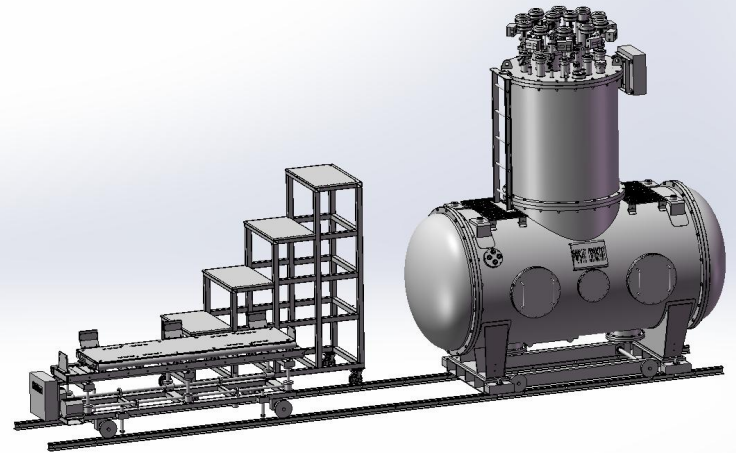


# Cryomodules for IHEP ILC Test and CEPC Test



We manufactured one set ILC cryomodule cooperated with IHEP, and it has been sent to the site and put into use .

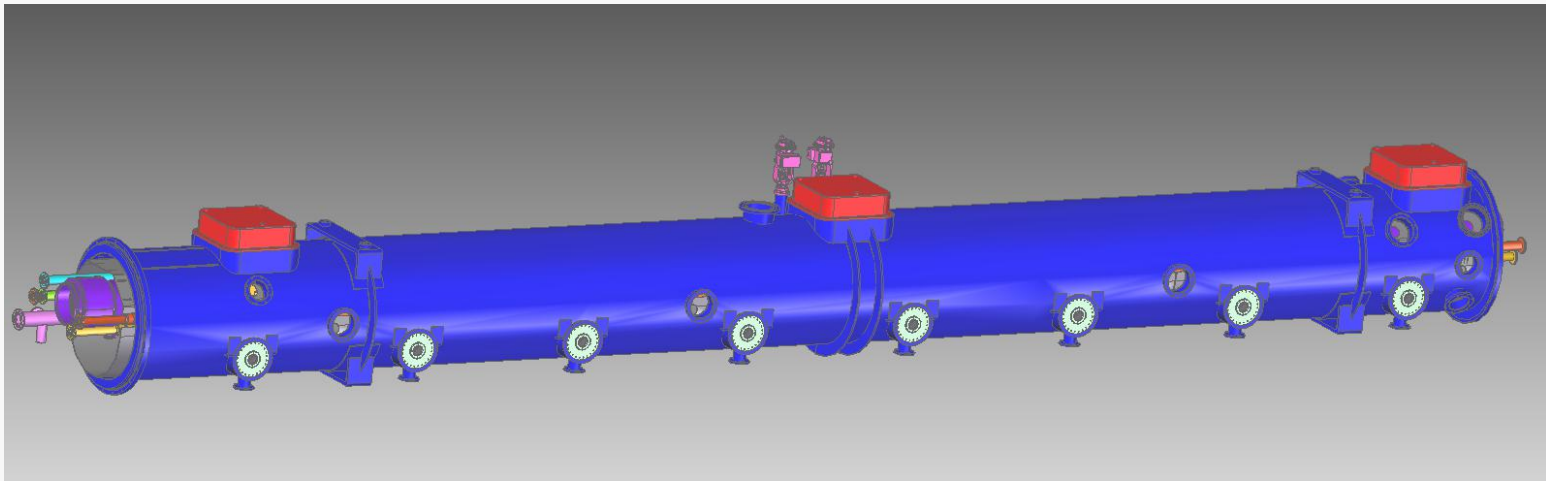
In 2018, we won the CEPC test cryomodule bidding of IHEP, it is in production.





# Cryomodule for SHINE (Shanghai XFEL)

**In 2018, we research and fabricate one set 1.3G cryostat cooperate with SHINE, SINAP, and estimated delivery time is November of 2018.**







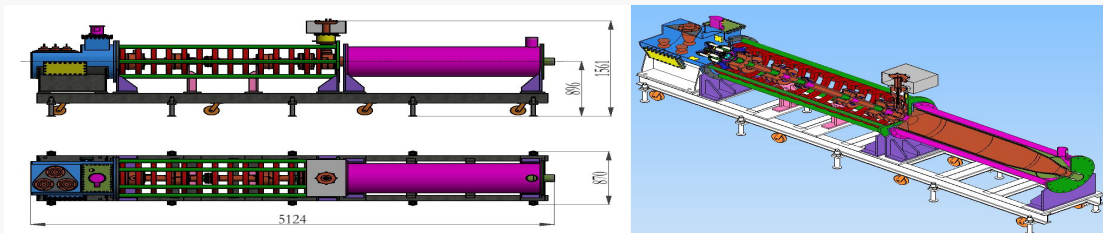
# Precision structure



**Undulators, bobbin cores, magnet steel and so on**



# Kunshan GuoLi Electronic Technology Co., Ltd.



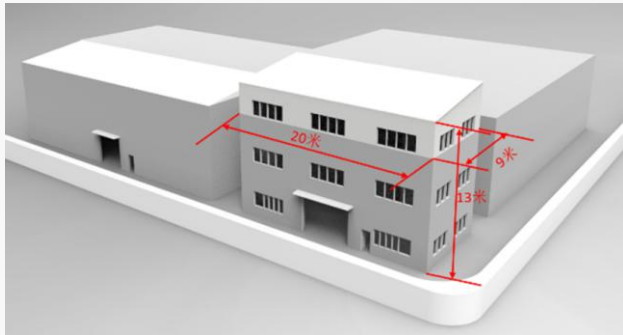
Preliminary mechanical design for  
UHFKP8001

CEPC 650MHz Klystron

# Kunshan GuoLi Electronic Technology Co., Ltd.

## 1<sup>st</sup> 650Mhz Klystron Prototype Manufacture Facility

### Infrastructure preparation



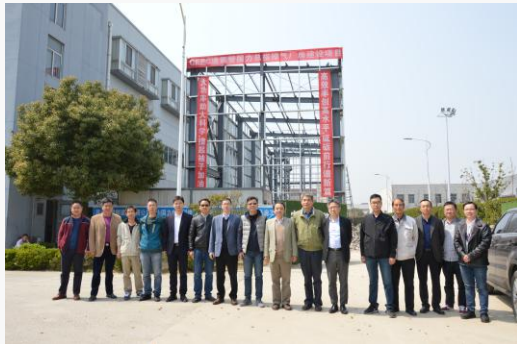
Plant



2018.12



2019.1



2019.3



2019.5



2019.5<sub>46</sub>

46

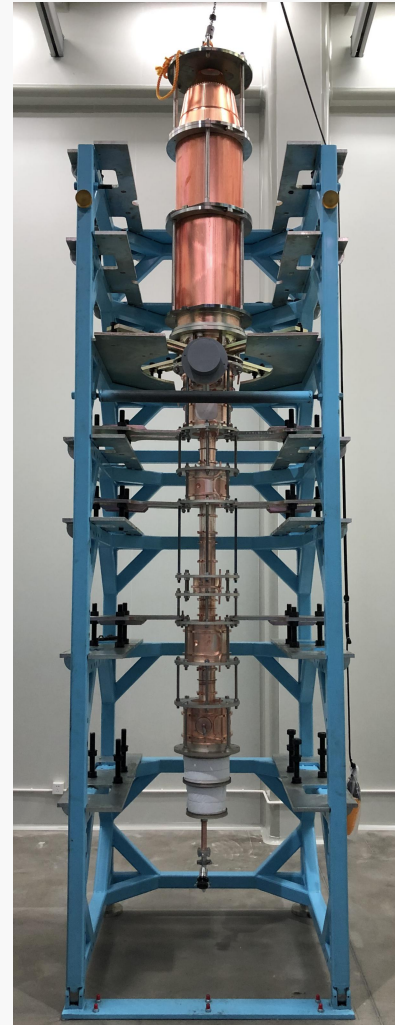


# Kunshan GuoLi Electronic Technology Co., Ltd.

## 1<sup>st</sup> 650Mhz Klystron Prototype Manufacture



Baking furnace



The first CEPC 650MHz 800kW Klystron

# SppC related Domestic Collaboration

“Applied High Temperature Superconductor Collaboration” was established in Oct. 2016.

➤ **Goal:**

- 1) To increase the  $J_c$  of **IBS** by 10 times, reduce the cost to **20 Rmb/kAm @ 12T & 4.2K**;
- 2) To reduce the cost of **ReBCO and Bi-2212** conductors to 20 Rmb/kAm @ 12T & 4.2K;
- 3) Realization and Industrialization of iron-based magnet and SRF technology.

➤ **Working groups:** 1) **Fundamental science** investigation; 2) **IBS** conductor R&D; 3) **ReBCO** conductor R&D; 4) **Bi-2212** conductor R&D; 5) **performance** evaluation; 6) **Magnet and SRF** technology.

➤ **Collaboration meetings:** every 3 months, to report the progress and discuss plan for next months.



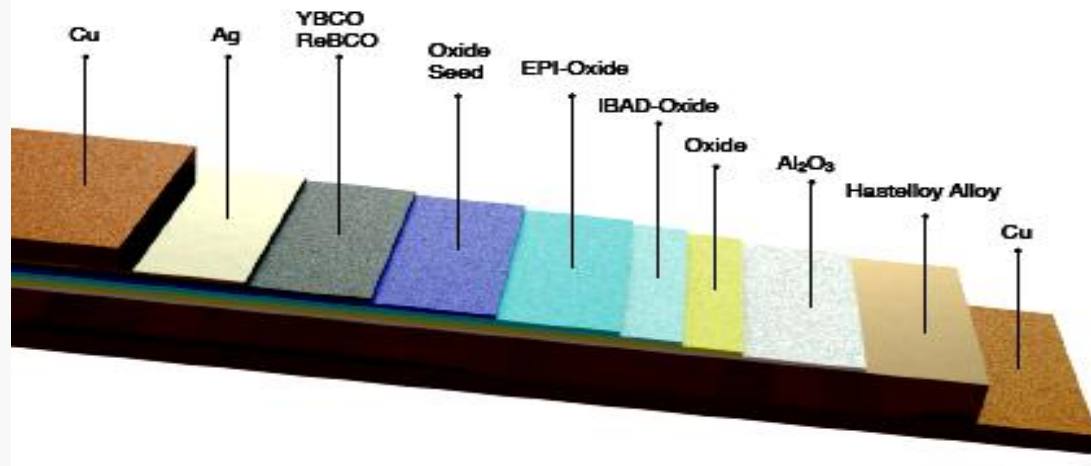


上海上创超导科技有限公司  
**Shanghai Creative Superconductor Technologies Co., Ltd.**  
**强磁体用第二代高温超导带材**  
**The second generation high-temperature SC tapes**

## 产品简介 Product Introduction

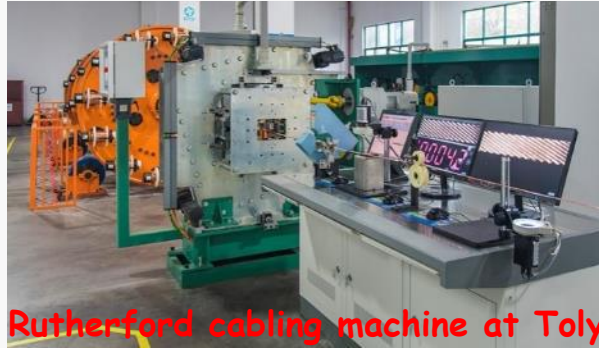
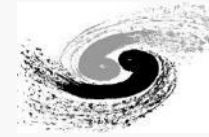
上创超导生产的第二代高温超导带材采用哈氏合金作为基带，YBCO为超导层，使用铜作为加强封装层，可绕包聚酰亚胺作为绝缘层。

SCSC product 2G-HTS wire, Hastelloy Alloy as substrate, YBCO/ReBCO as superconducting layer, Copper/Brass/Stainless Steel as stabilizer, Polyimide Insulating Barrier as option.



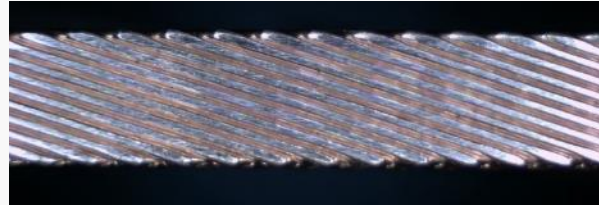


# Collaboration between WST, NIN, Toly Electric and IHEP

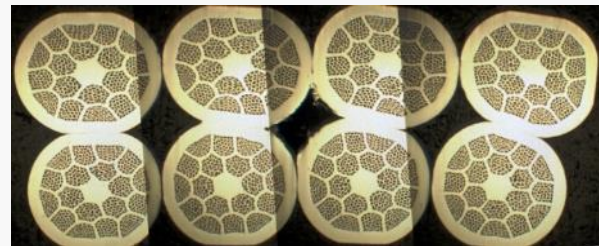


Rutherford cabling machine at Toly

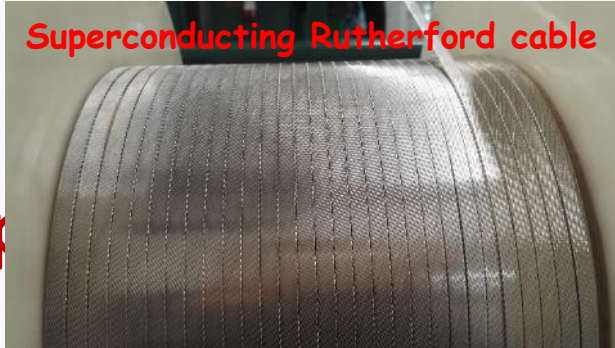
$\text{Nb}_3\text{Sn}$  Rutherford cable



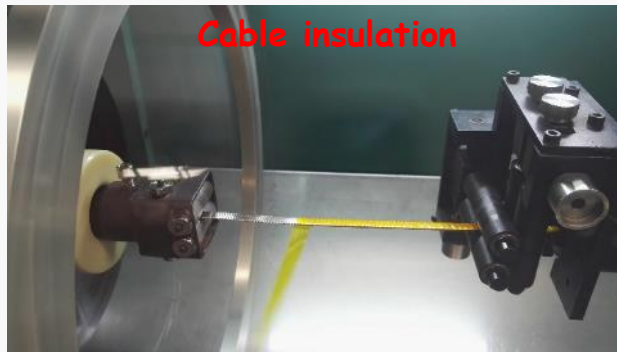
Bi-2212 Rutherford cable



Superconducting Rutherford cable



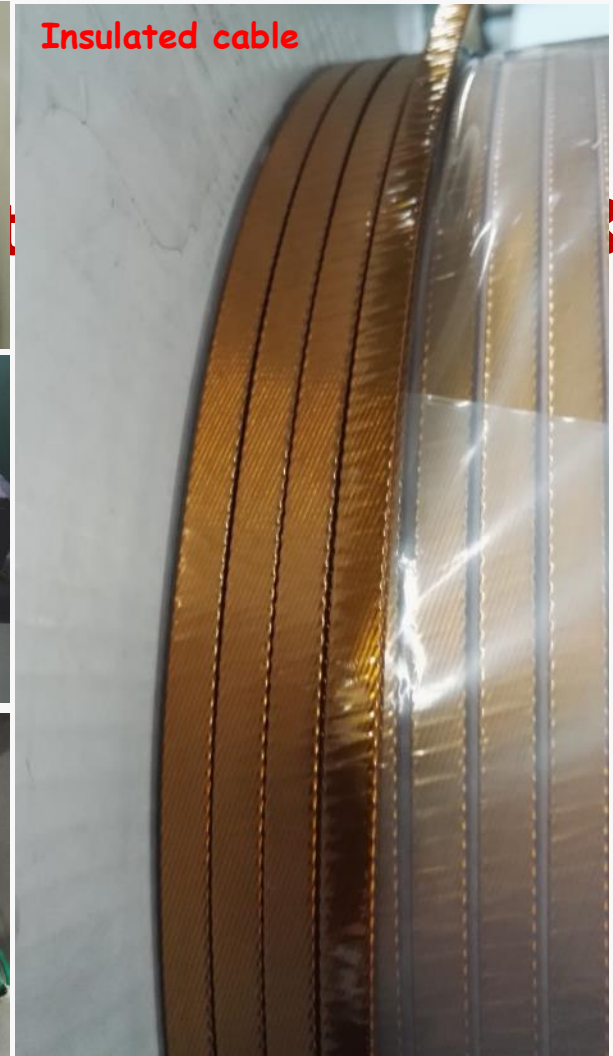
Cable insulation



Dielectric strength test ~5kV



Insulated cable



# Avic Chendu Aircraft Industrial (Group) Co, Ltd.



Chengfei undertook the development the core component of BEPC collider, such as **the special vacuum box** in the detector and the **high performance drift chamber**. This work was began in September 2003

## CEPC Detector Precision Machining

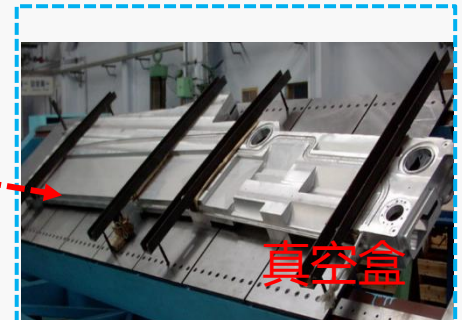
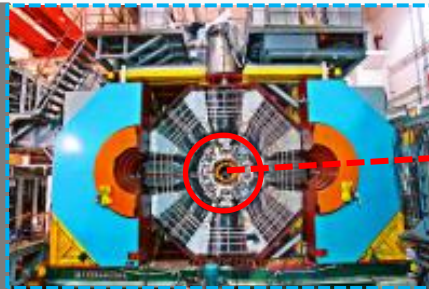
The original tunnel of accelerator BEPC is short and round only 240m  
(The international success case is more than 2km)

The height of the collision zone of the detector is limited, and the diameter is 5.44 M. In order to achieve the required measurement accuracy, the manufacture and assembly of the detector components are required to be extremely high.

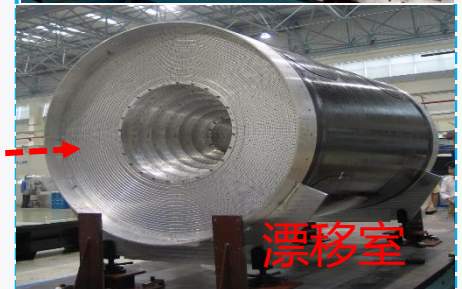
加速器



探测器



真空盒



漂移室



# Yellow River Conservancy Commission

## Project Case—Daya Bay Reactor Neutrino Experimental Station Construction Supporting Project



### China•Shenzhen•Infrastructure Project

Underground works mainly include five underground laboratory halls, tunnels and a small amount of ground construction and facilities.

The main tunnel section is 2176m x 6.2m x 7.1m (length x width x height), and the size of the largest experiment hall(1#) is 42m x 19.30m x 25.15m (length x width x height).



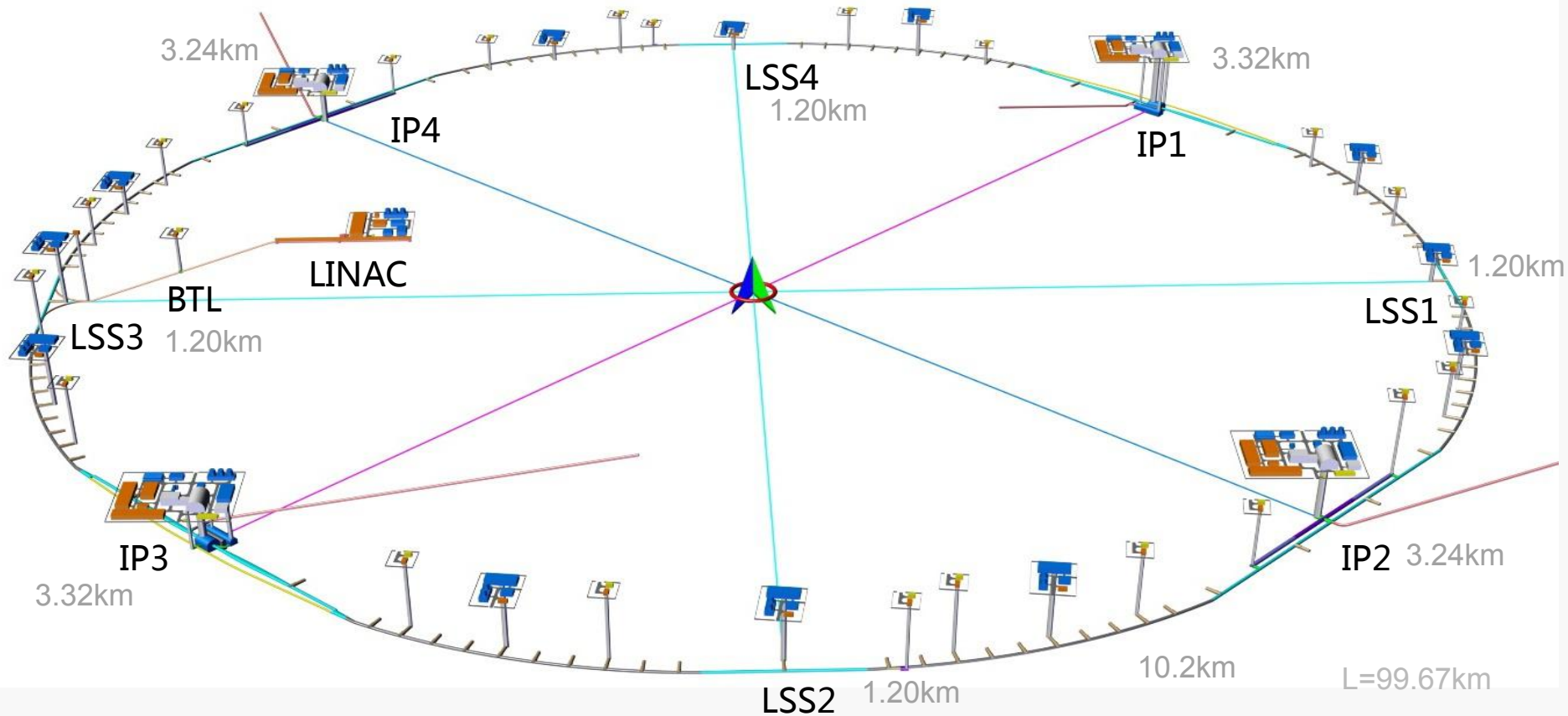




# Yellow River Conservancy Commission

## CEPC Civil Engineering, Siting and Implementation

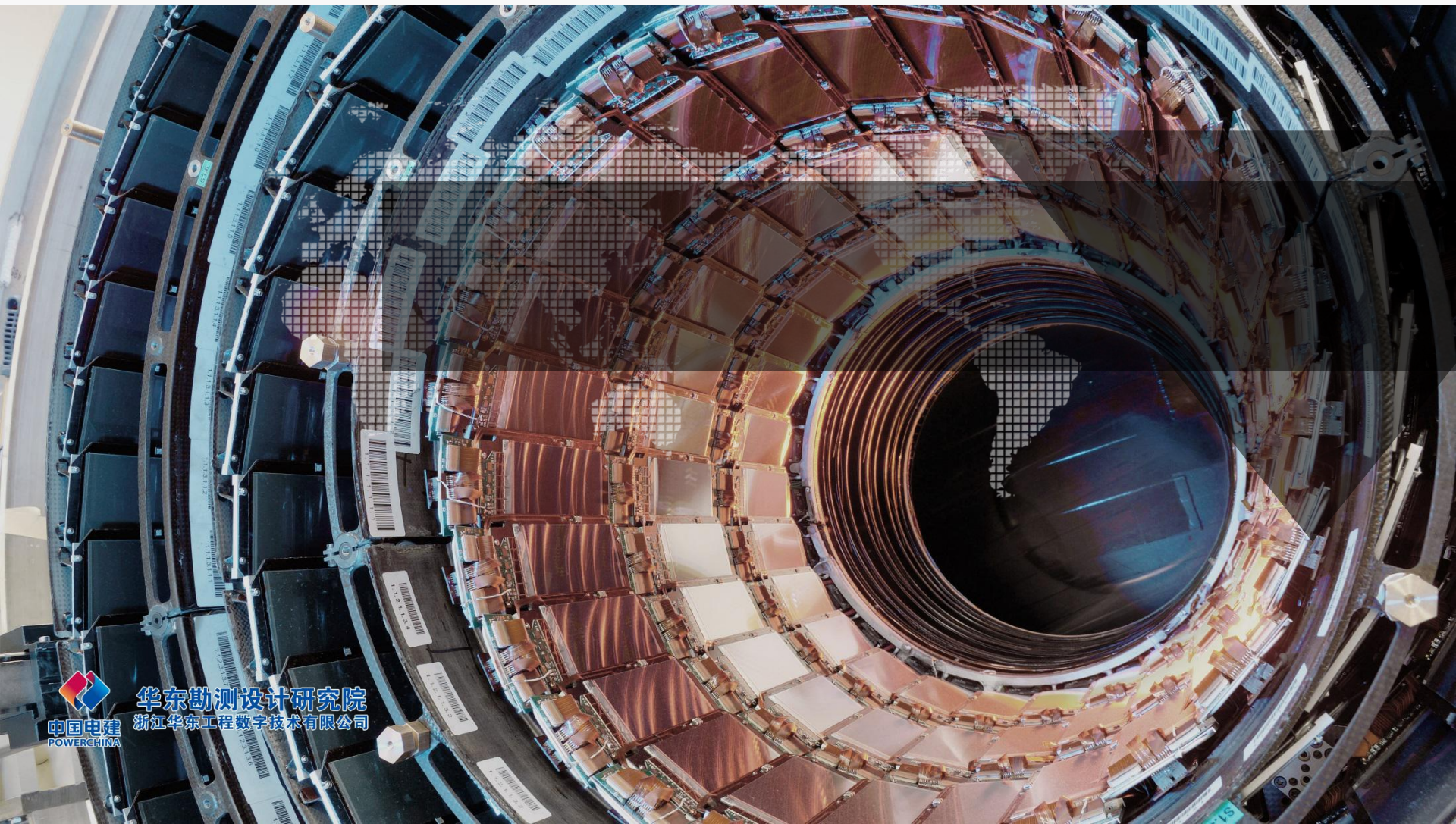
CEPC General Layout





# HUADONG Engineering Corporation Limited

## (HDEC)





# HUADONG Engineering Corporation Limited

## (HDEC)

### Jinping II Hydropower Station

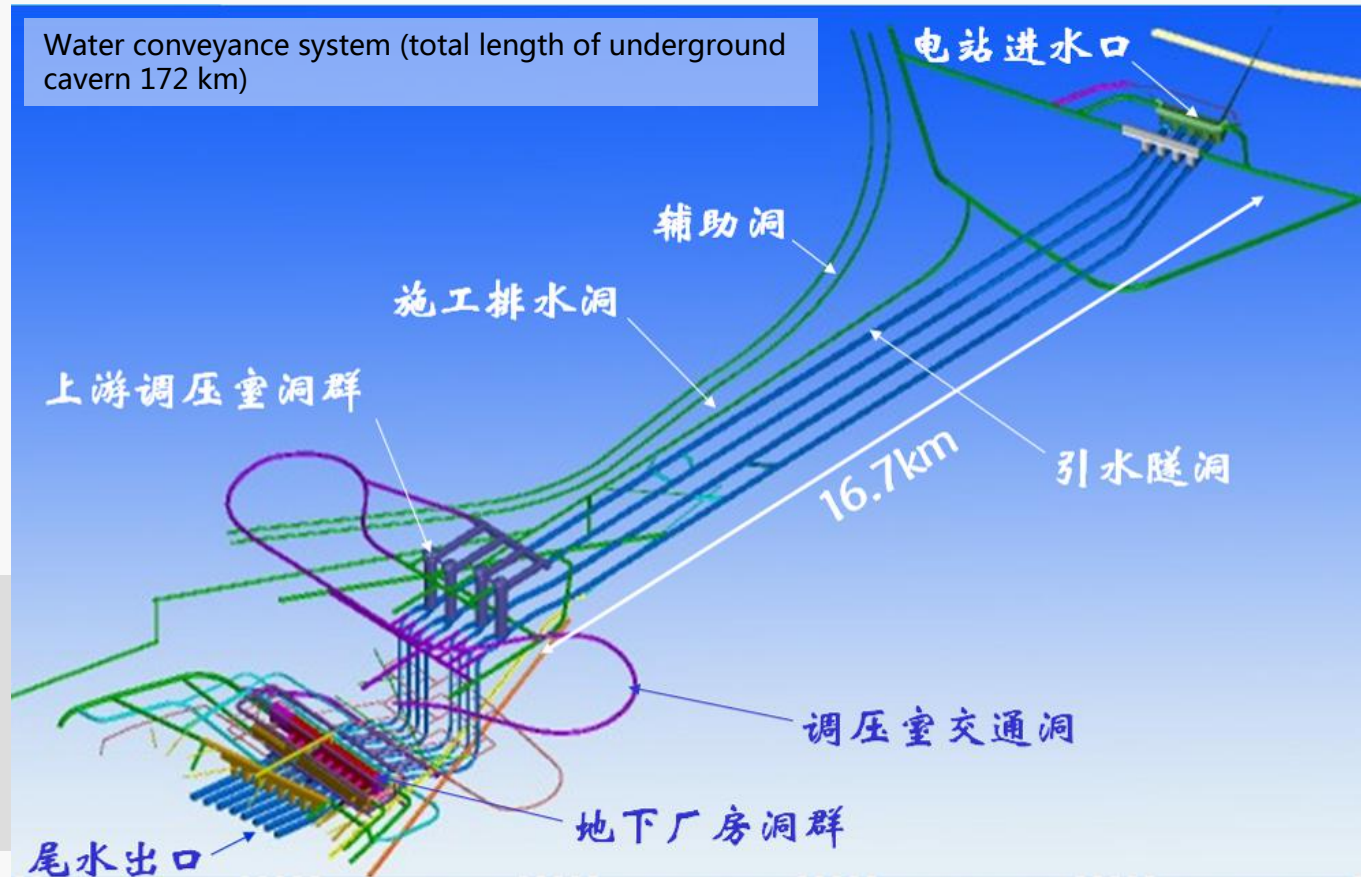
Location: Sichuan Province, China

Installed Capacity:  
4,800MW(8X600MW)

Completion Year: 2012

#### Project Characteristics:

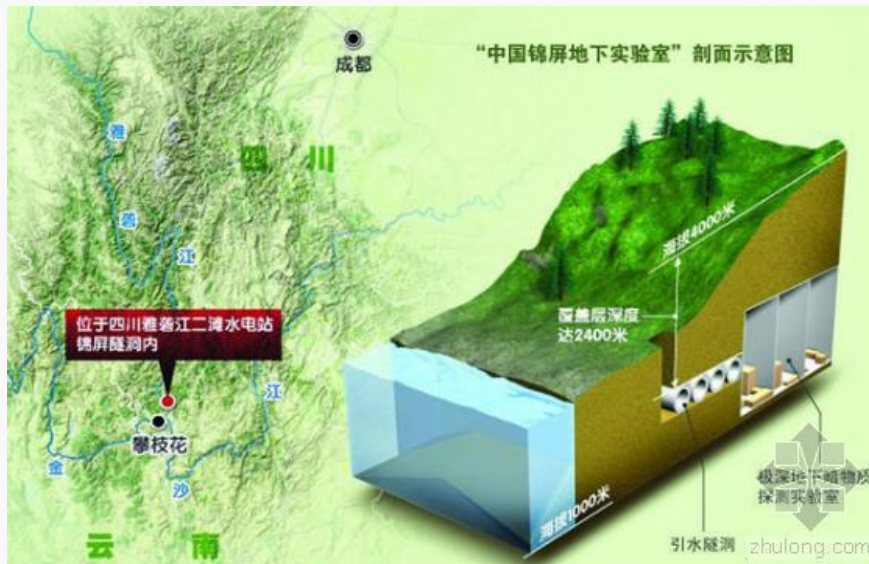
It is the hydropower station with highest head, largest installed capacity and best efficiency on the Yalong River, and the long diversion-type development is adopted. There are four diversion tunnels with a length of about 17.6 km each, maximum overburden thickness of 2525m and max. tunnel diameter of 13m. It is the hydraulic tunnel of the largest comprehensive scale in the world. Thick overburden, high geostress, groundwater and rock outburst involved in design and construction are all of the world-class technical problems.



# HUADONG Engineering Corporation Limited

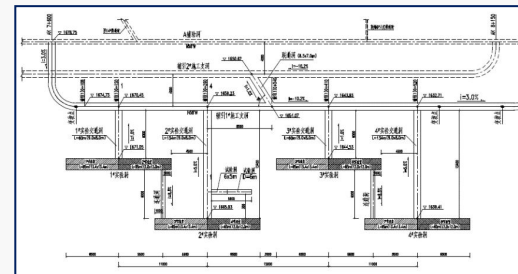
(HDEC)

## Basic Physics Laboratory-Jinping Dark Matter Experimental Hall



Underground Basic Physics Laboratory in Jinping II Hydropower Station

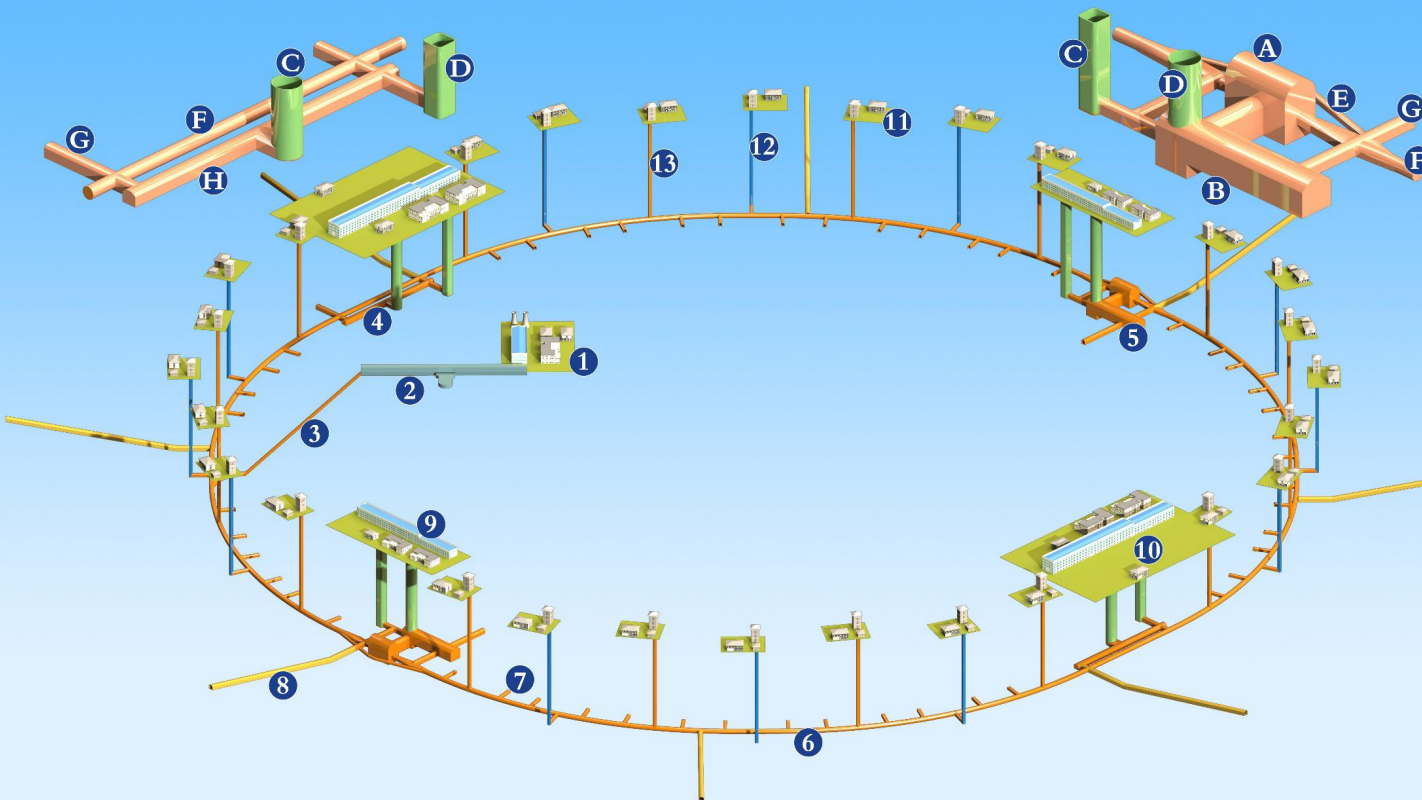
- ❑ The first deep underground laboratory in China
- ❑ 4,000 m<sup>3</sup> (Phase 1)  
120,000 m<sup>3</sup> (Phase 2)
- ❑ Experiments conducted:  
Rock mechanics, Basic physics,  
Seismic research



# HUADONG Engineering Corporation Limited

(HDEC)

CEPC



## Accelerator Region Caverns:

1. Surface Buildings of Linac Segment
2. Linac Segment
3. Transfer Line
4. Tunnel Complex of RF Region
5. Detector Region Caverns
6. Main Ring Tunnel
7. Auxiliary Tunnel
8. Access Tunnel
9. Surface Buildings of Experiment Hall
10. Surface Buildings of RF Region
11. Surface Buildings of Shaft for Access and Cable
12. Shaft for Access and Cable
13. Shaft for Access, Cable and Measure

## Detector Region Caverns:

- A. Experiment Hall
- B. Service Cavern
- C. Transport Shaft
- D. Shaft for Access, Cable and HVAC
- E. Booster Bypass Tunnel
- F. Main Ring Tunnel
- G. Traffic Tunnel
- H. Auxiliary Tunnel of RF Region



# Zhongnan Engineering Cooperation Limited



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

## 中南院简介

[www.msdi.cn](http://www.msdi.cn)

# Zhongnan Engineering Cooperation Limited

## NEW ENERGYS

### GNP Wind Electric Power Thailand



装机容量67.5MW，安装33台Gamesa G114 2.0MW/2.1MW STD2 153m风力发电机组。以153m高度打破内陆最高柔性风机塔筒应用的世界纪录。

承担工作：EPC总承包

获奖情况：中国勘测设计行业优秀QC小组二等奖  
中国电建国际工程优秀项目经理部

### Wind Electric Power Hunan, China



装机容量50MW。

承担工作：EPC总承包

获奖情况：中国电建优质工程（产品）奖

# Zhongnan Engineering Cooperation Limited

## 233MW Photovoltaics power station, Algeria



装机容量233MW，撒哈拉沙漠地区，场址多，地质条件各异，是非洲规模最大、单次投资额最大的光伏项目。  
承担工作：EPC总承包

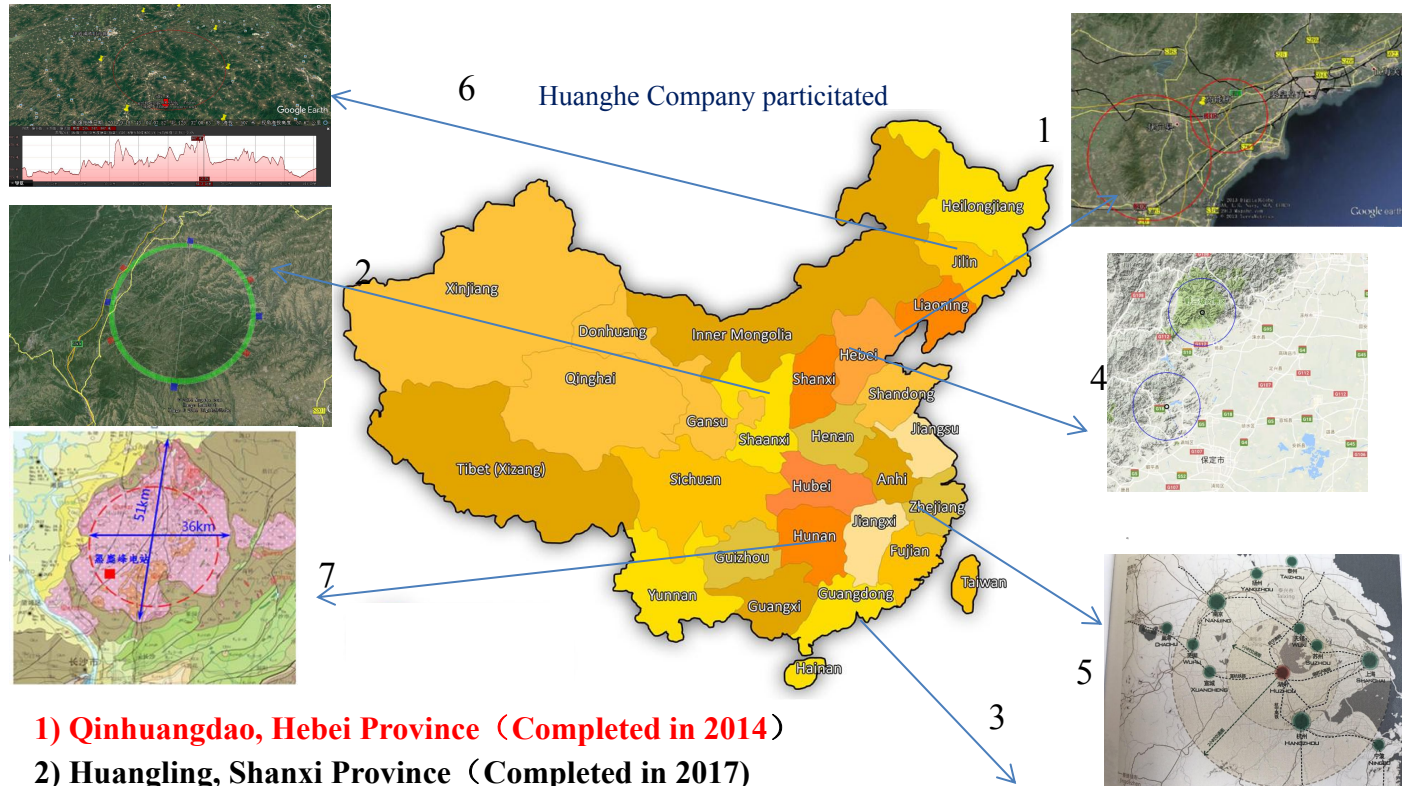
## 50MW Duanhuang Photovoltaics power station, Gansu, China



装机容量50MW，是国内首批20个光热示范项目之一，全球首套熔盐线性菲涅尔光热商业化机组。  
承担工作：F+EPC总承包



# CEPC Site Selections



**1) Qinhuangdao, Hebei Province (Completed in 2014)**

**2) Huangling, Shanxi Province (Completed in 2017)**

**3) Shenshan, Guangdong Province(Completed in 2016)**

**4) Baoding (Xiong an), Hebei Province (Started in August 2017)**

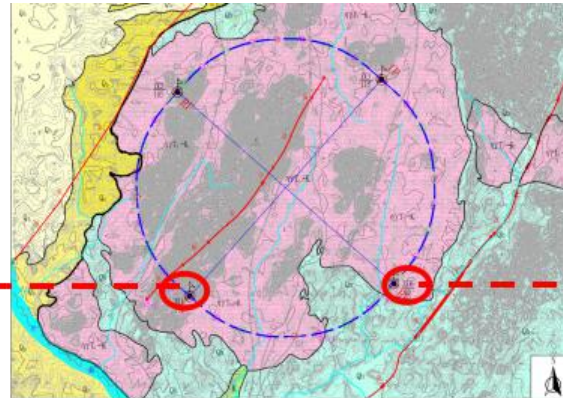
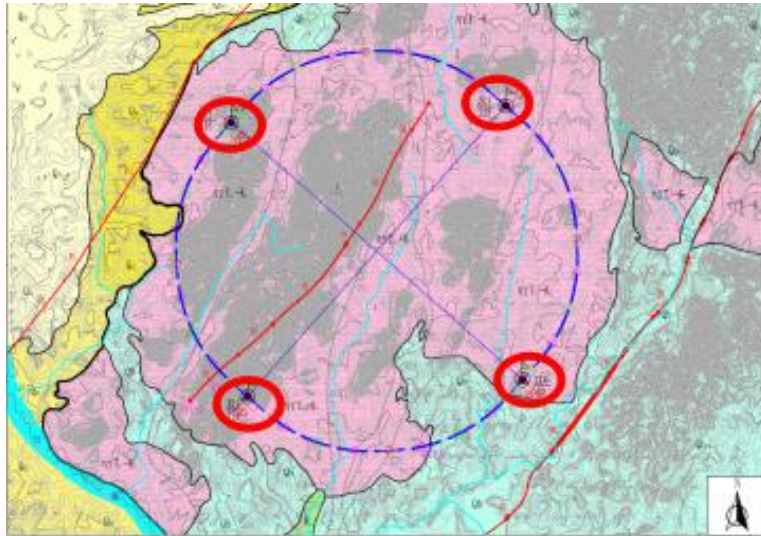
**5) Huzhou, Zhejiang Province (Started in March 2018)**

**6) Chuangchun, Jilin Province (Started in May 2018)**

**7) Changsha, Hunan Province (Started in Dec. 2018)**



# CEPC Site Selection in Changsha (Hunan Province)



# CEPC Tunnel Construction Methods Comparison

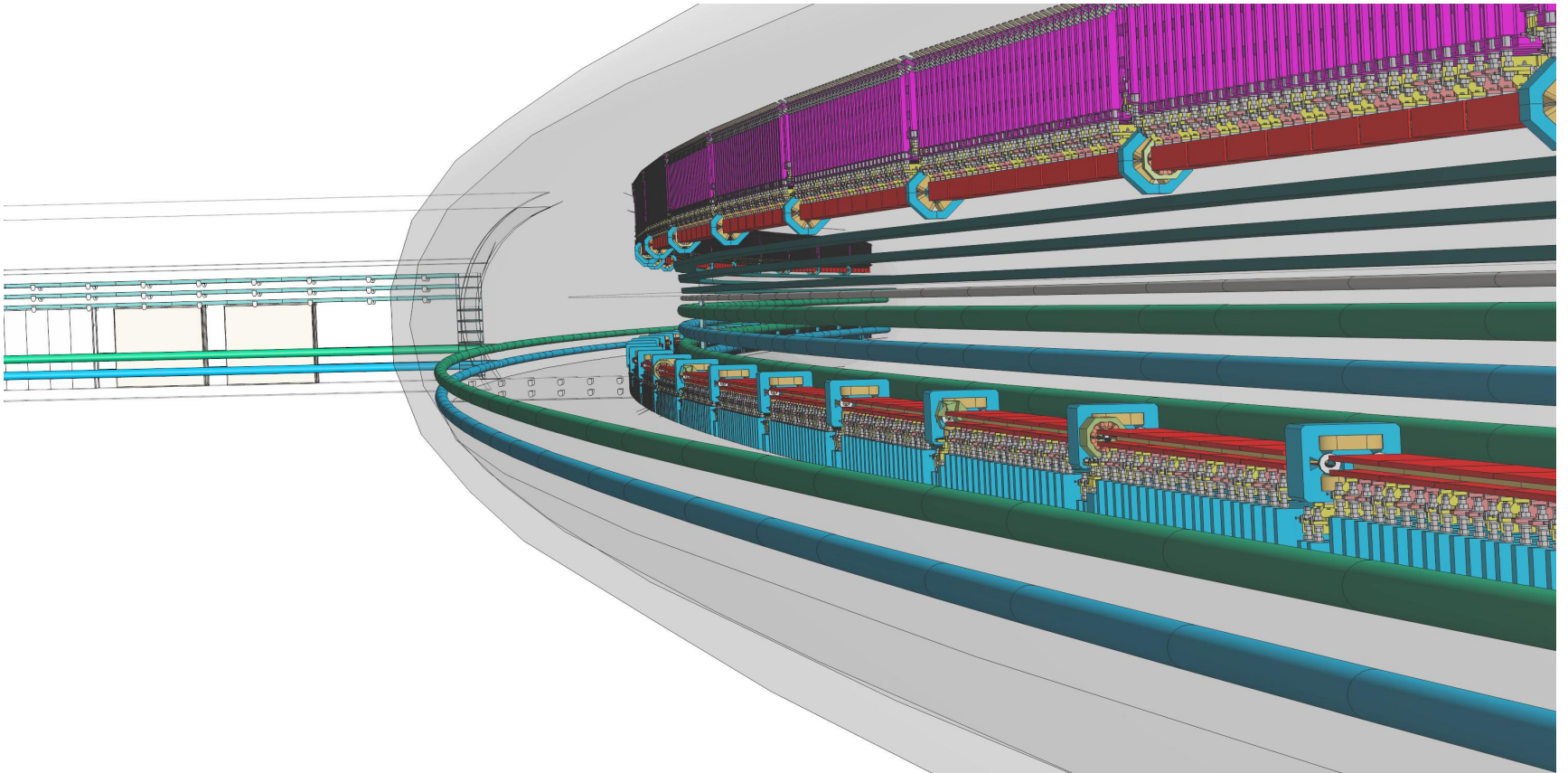


**Tunnel construction  
arrangement**

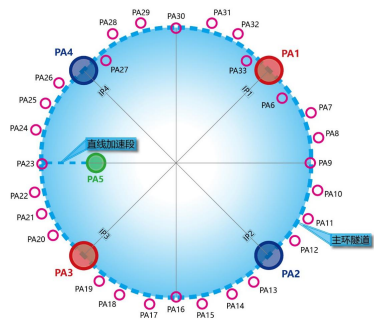
	<b>Blast and drill</b>	<b>Double shield TBM</b>
<b>Construction tunnel arrangement</b>	Construction tunnel arrangement every 6.25km	Construction tunnel aarangement every 12.5km
<b>Section drill distance</b>	Single direction maxium length 4.325km (1.2km adit +3.125km Main tunnel)	<b>Double shield TBM</b> 53km ( 5 Machines )
<b>Drill length parameter</b>	Drill 100m/Month Shield 2x85m/Month	Drill/shield : 405m/Month
<b>Construction period</b>	52Months ( not including preparation )	40Months ( no including preparation )



# CEPC Main Tunnel and Auxiliary Tunnel Connection



# CEPC Surface Unitity Buidings (Bird view)



Interaction region IP1



SCRF regions 1, 2



Interaction region IP2



Linac injection accelerator



Electric power, cooling and ventilation stations in PA9, PA16, PA23, PA30



Electric power, cooling and ventilation stations in other places



# CEPC Science City

URBAN DESIGN

CEPC-SPPC项目国际科学城概念规划

CEPC-SPPC Project International Science City Concept Planning

## Core Area



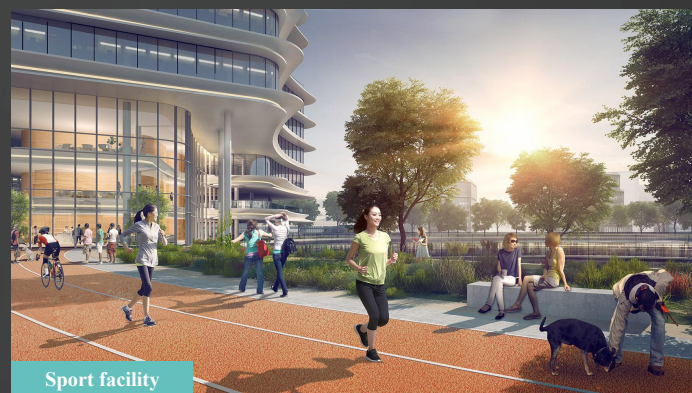
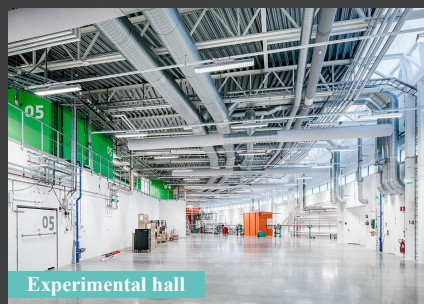


# CEPC Core Building

ARCHITECTURE

CEPC-SPPC项目国际科学城概念规划  
CEPC-SPPC Project International Science City Concept Planning

## Functional Area





中国铁建

中国铁建重工集团有限公司

CHINA RAILWAY CONSTRUCTION HEAVY INDUSTRY CO.,LTD.

**World's Leading Provider of Whole Solutions  
for Intelligent Tunneling Equipment and  
High-end Rail Track Equipment**

**China Railway Construction Heavy Industry Co., Ltd.**

**CRCHI**

**Credibility-Innovation Eternal  
Masterpiece-Integrity Coexisting**





# China Railway Construction Heavy Industry Co., Ltd.

## Products•Tunnel boring machine (TBM)



中国铁建重工集团股份有限公司

CHINA RAILWAY CONSTRUCTION HEAVY INDUSTRY CORPORATION LIMITED

- ❑ CRCHI is a TBM manufacturer with **the largest production scale, the highest market share and the most complete product range**. CRCHI TBMs take **half** the domestic market in sales, of which large-diameter hard-rock TBM occupies over **85%** of Chinese market share.
- ❑ It has produced more than **600 sets** of TBMs which have been widely used in national important projects of metro, railway, mining and water diversion in over **30 cities**, and also exported to Russia, Turkey, India, Sri Lanka, Katar, Korea and other countries.





## Products•Tunnel Boring Machine (TBM)



## Series

## Mini dia.

**10-16m**



### Diameter Range

# 10-16

Mega

## Case









- |   |  |   |  |   |  |
|---|--|---|--|---|--|
| <ul style="list-style-type: none"> <li>● 0.7m pipe jacking machine in Chongqing ;</li> <li>● 0.5m gravity testing machine for Hunan University</li> </ul> | <ul style="list-style-type: none"> <li>● 3.6m &amp; 3.7m EPB in Iran;</li> <li>● 3.7m EPB in Urumchi;</li> <li>● 3.6m teaching-use EPB for Railway Institutes of Shijiazhuang</li> </ul> | <ul style="list-style-type: none"> <li>● 5.5m hard-rock TBM in Lanzhou and Xinjiang;</li> <li>● 5.3m EPB in Turkey;</li> <li>● 4m EPB for Beijing South-to-North Water Transfer Tunnel ;</li> <li>● 4m hard-rock TBM in Zhejiang province ;</li> <li>● 5.6m SPB for PetroChina</li> </ul> | <ul style="list-style-type: none"> <li>● Over 550 TBMs of this kind have been used in national key projects of municipal construction, railway, water diversion tunnel and exported to Russia, Turkey, Korea, Sri Lanka and others.</li> </ul> | <ul style="list-style-type: none"> <li>● Zhengzhou Airport Line 12.7m SPB;</li> <li>● 10.8m SPB for Wangjing Two-way Tunnel;</li> <li>● 11.4m SPB for under-river tunnel in Changde;</li> <li>● 11.7m SPB for Hangzhou metro</li> </ul> | <ul style="list-style-type: none"> <li>● 14.95m SPB for Xiangya Road tunnel in Changsha</li> <li>● 14.95m SPB for Genshan Road tunnel in Hangzhou</li> </ul> |
|---|--|---|--|---|--|

# China Railway Construction Heavy Industry Co., Ltd.

## Products•Tunnel Boring Machine (TBM)



中国铁建重工集团有限公司  
CHINA RAILWAY CONSTRUCTION HEAVY INDUSTRY CO.,LTD

Earth pressure shield machine ( ZTE serie )	Slurry pressure shield machine ( ZTS serie )	Hard-rock TBM ( ZTT serie )	Dual-mode TBM ( ZT**serie )	Pipejacking machine ( ZTPserie )	Vertical shaft/inclined shaft TBM ( ZTJ serie )	Rectangular TBM ( ZTR serie )	Multi-function soft soil TBM ( ZT** serie )
 <b>77 kinds</b> 1. Small diameter 2. Fast tunneling 3. Construction in extremely cold weather 4. Super small turning 5. Gernal type .....	 <b>21 kinds</b> 1. Economy 2. Gernal type 3. Small diameter 4. Big diameter .....	 <b>17 kinds</b> 1. Long-distance tunneling & long service time 2. Small type 3. Gernal type .....	 <b>6 kinds</b> 1. Slurry&Earth pressure off-line dual mode 2. Hard rock TBM/Earth pressure dual mode 3. Inclined shaft dual mode 4. Hard rock TBM/Earth pressure online dual mode.....	 <b>5 kinds</b> 1. Super small type 2. Retractable 3.Quick drill -one-time vertical drilling 4. Long distance 5. Muck discharge by a screw .....	 <b>2 kinds</b> 1. Vertical shaft TBM 2. Inclined shaft single-shield TBM .....	 <b>2 kinds</b> 1.Rectangular pipejacking machine 2. Pipe gallery operating vehicle	 <b>1 kind</b> 1. Special-section TBM

**8 categories of TBMs**  
Application range covers:

- ❑ Soft soil, hard rock and other complicated geologies
- ❑ Rong, rectangular and other section shape
- ❑ Single mode, dual mode and other tunneling modes
- ❑ Straight, curve and inclined shaft and other alignment

# China Railway Construction Heavy Industry Co., Ltd.

## Products•Specialized Tunneling Equipment



中国铁建重工集团股份有限公司

CHINA RAILWAY CONSTRUCTION HEAVY INDUSTRY CORPORATION LIMITED

- ❑ CRCHI is a drilling-blasting equipment manufacturer with **the world's largest production scale, highest market share, most comprehensive product range and highest intelligent level.**
- ❑ The company produces **mechanized and smart** construction equipment for drilling and blasting method, providing whole underground construction solutions.
- ❑ CRCHI products have been applied in railway construction like **Zhengzhou-Wanzhou High-speed Railway, Anqing-Jiujiang High-speed Railway and Yuxi-Mohan Railway**, and other fields like **national defense, water conservancy, subway, highway and coal mine.**





# China Railway Construction Heavy Industry Co., Ltd.

## Products • Specialized Tunneling Equipment



中国铁建重工集团股份有限公司

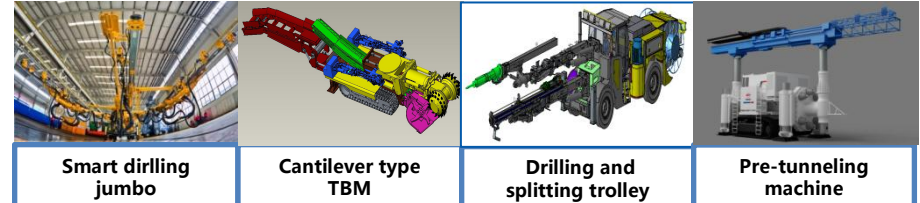
CHINA RAILWAY CONSTRUCTION HEAVY INDUSTRY CORPORATION LIMITED

Provide whole underground construction solutions for drilling-blasting method

### Advance drilling or advance grouting (5 kinds)



### Boring & Excavation (26 kinds)



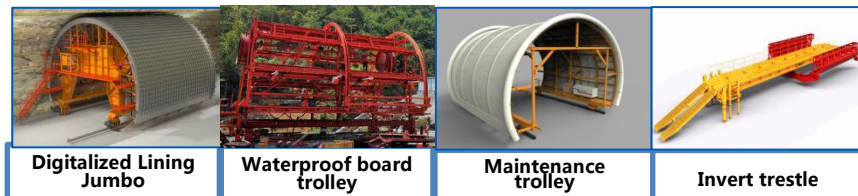
### Muck loading and conveying (5 kinds)



### Primary Supporting (31 kinds)

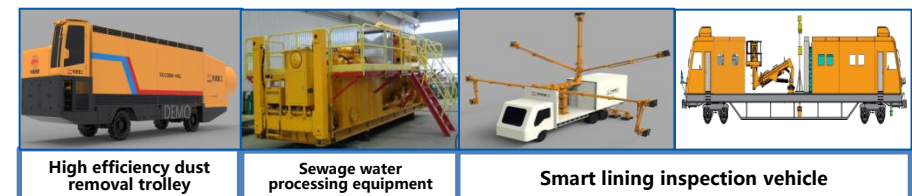


### Secondary Lining (15 kinds)



### Auxiliary Equipment (4 kinds)

### Inspection and Maintenance (3 kinds)



# Acknowledgements

Many thanks to CIPC colleagues, especially:

- Ningxia Orient Tantalum Industrial Co.,Ltd.
- Beijing HE-Racing Technology Co., Ltd.
- ChaoGao Zhuang (zhongshan) Scientific Technology Co., Ltd.
- Beijing Sinoscience Fullcryo Technology Co., Ltd.
- WuXi Creative Technoloies Co. Ltd. (WXCX)
- Kunshan GuoLi Electronic Technology Co., Ltd.
- Shanghai Creative Superconductor Technologies Co., Ltd.
- Avic Chendu Aircraft Industrial (Group) Co, Ltd.
- Yellow River Conservancy Commission
- HUADONG Engineering Corporation Limited
- Zhongnan Engineering Cooperation Limited
- China Railway Construction Heavy Industry Co., Ltd.

**Thank you for your attention**