



中国科学院高能物理研究所  
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# Circular Electron Positron Collider (CEPC)

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On behalf of CEPC Accelerator Group

65th ICFA Advanced Beam Dynamics Workshop on High Luminosity

Circular e+e- Colliders (eeFACT2022)

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# Contents

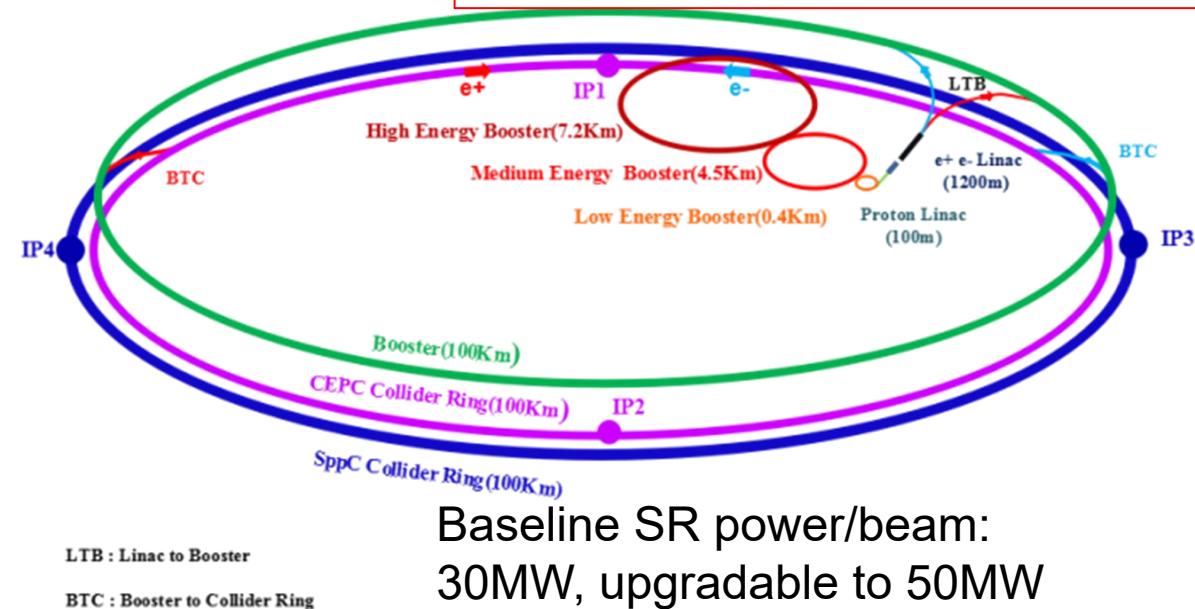
- **Introduction**
- **Review of CEPC Accelerator System Design and Power Consumptions in CDR**
- **CEPC TDR Accelerator System Design and Power Consumptions with Linac  
Injector Energy of 30GeV**
- **CEPC Accelerator System Key Hardware R&D Progresses in TDR**
- **CEPC TDR Siting and Civil Engineering**
- **CEPC TDR and EDR Schedules and CEPC Timeline**
- **Summary**

# CEPC-SppC Physics Goals in TDR

## Introduction

- Circular Electron-Positron Collider (91, 160, **240 GeV**, 360GeV)
  - Higgs Factory ( $10^6$  Higgs) :
    - Precision study of Higgs( $m_H$ ,  $J^{PC}$ , couplings), Similar & complementary to Linear Colliders
    - Looking for hints of new physics
  - Z & W factory ( $10^{10} \sim 10^{12} Z^0$ ) :
    - precision test of SM
    - Rare decays ?
  - Flavor factory: b, c,  $\tau$  and QCD studies
- Super proton-proton Collider(~125 TeV)
  - Directly search for new physics beyond SM
  - Precision test of SM
    - e.g.,  $h^3$  &  $h^4$  couplings

The discoveries of Higgs boson around 125GeV at CERN on LHC on July 4, 2012 and the gravitation waves on LIGO in USA on February 11, 2016 provide unprecedented opportunities to our better understandings of mysterious universe

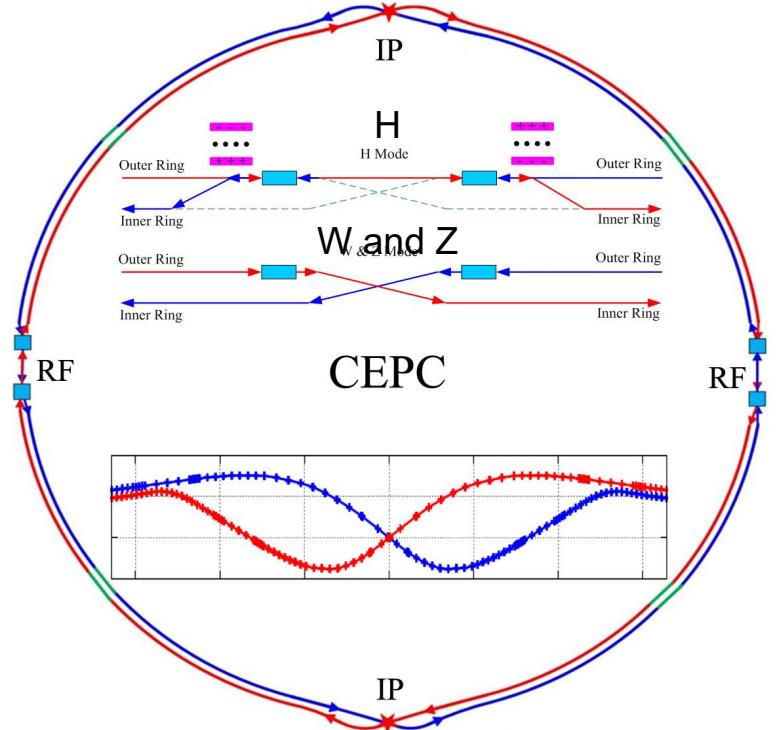


Baseline SR power/beam:  
30MW, upgradable to 50MW

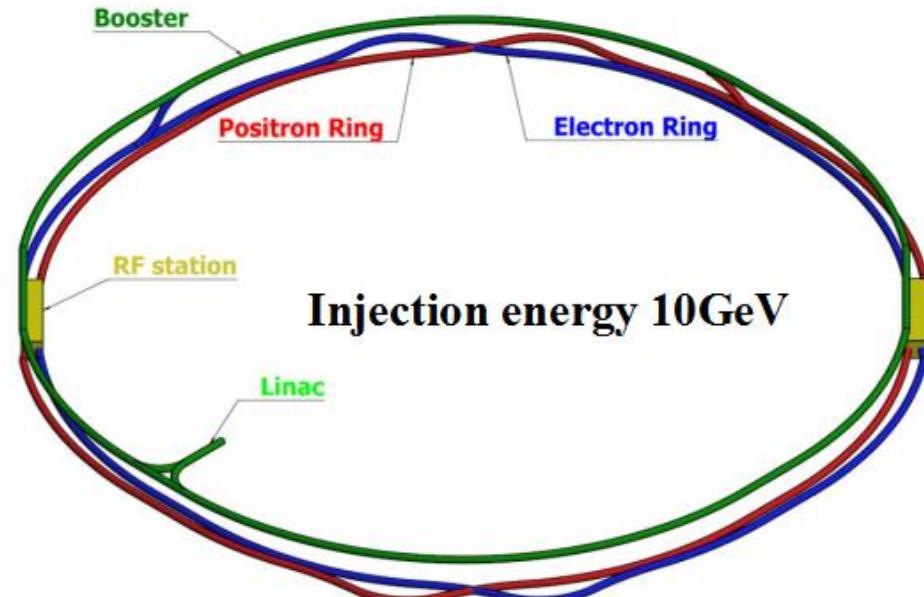
# **Review of CEPC Accelerator System Design and Power Consumptions in CDR**

# CEPC CDR Baseline Layout

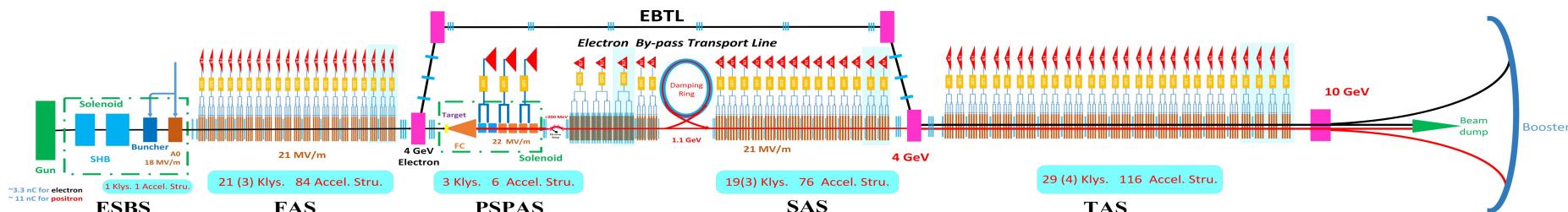
CEPC as a Higgs Factory: H, W, Z, followed by a SppC ~100TeV



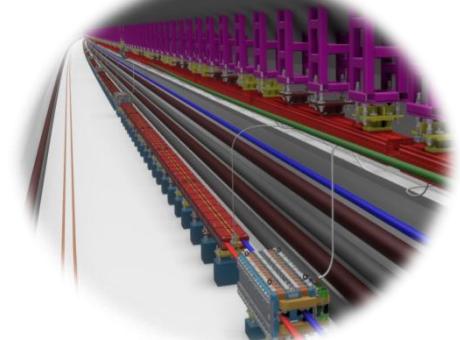
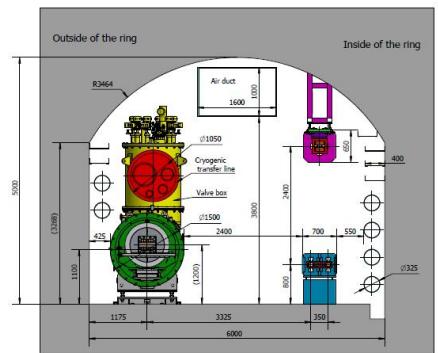
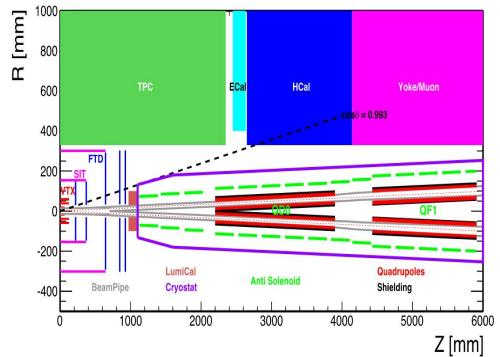
CEPC collider ring (100km)



CEPC booster ring (100km)



CEPC Linac injector (1.2km, 10GeV)



# CEPC CDR Parameters (30MW)

	<i>Higgs</i>	<i>W</i>	<i>Z (3T)</i>	<i>Z (2T)</i>
Number of IPs		2		
Beam energy (GeV)	<b>120</b>	<b>80</b>	<b>45.5</b>	
Circumference (km)		100		
Synchrotron radiation loss/turn (GeV)	1.73	0.34		0.036
Crossing angle at IP (mrad)		$16.5 \times 2$		
Piwnski angle	2.58	7.0		23.8
Number of particles/bunch $N_e (10^{10})$	15.0	12.0		8.0
<b>Bunch number (bunch spacing)</b>	<b>242 (0.68μs)</b>	<b>1524 (0.21μs)</b>	<b>12000 (25ns+10%gap)</b>	
Beam current (mA)	17.4	87.9		461.0
<b>Synchrotron radiation power /beam (MW)</b>	<b>30</b>	<b>30</b>	<b>16.5</b>	
Bending radius (km)		10.7		
Momentum compact ( $10^{-5}$ )		1.11		
<b>β function at IP <math>\beta_x^*/\beta_y^*</math> (m)</b>	<b>0.36/0.0015</b>	<b>0.36/0.0015</b>	<b>0.2/0.0015</b>	<b>0.2/0.001</b>
Emittance $\varepsilon_x/\varepsilon_y$ (nm)	1.21/0.0031	0.54/0.0016	0.18/0.004	0.18/0.0016
Beam size at IP $\sigma_x/\sigma_y$ (μm)	20.9/0.068	13.9/0.049	6.0/0.078	6.0/0.04
Beam-beam parameters $\xi_x/\xi_y$	0.031/0.109	0.013/0.106	0.0041/0.056	0.0041/0.072
RF voltage $V_{RF}$ (GV)	2.17	0.47		0.10
RF frequency $f_{RF}$ (MHz) (harmonic)		650 (216816)		
Natural bunch length $\sigma_z$ (mm)	2.72	2.98		2.42
Bunch length $\sigma_z$ (mm)	3.26	5.9		8.5
HOM power/cavity (2 cell) (kw)	0.54	0.75		<b>1.94</b>
Natural energy spread (%)	0.1	0.066		0.038
Energy acceptance requirement (%)	<b>1.35</b>	<b>0.4</b>	<b>0.23</b>	
Energy acceptance by RF (%)	2.06	1.47		1.7
Photon number due to beamstrahlung	0.1	0.05		0.023
Lifetime _simulation (min)	100			
Lifetime (hour)	<b>0.67</b>	<b>1.4</b>	<b>4.0</b>	<b>2.1</b>
$F$ (hour glass)	0.89	0.94		0.99
<b>Luminosity/IP <math>L (10^{34}cm^{-2}s^{-1})</math></b>	<b>2.93</b>	<b>10.1</b>	<b>16.6</b>	<b>32.1</b>

# CEPC Collider Ring SRF Parameters (CDR)

J.Y. Zhai

Collider parameters: 20180222	H	W	Z
SR power / beam [MW]	30	30	16.5
RF voltage [GV]	2.17	0.47	0.1
Beam current / beam [mA]	17.4	87.9	461
Bunch charge [nC]	24	24	12.8
Bunch number / beam	242	1220	12000
Bunch length [mm]	3.26	6.53	8.5
Cavity number (650 MHz 2-cell)	240	2 x 108	2 x 60
Cavity gradient [MV/m]	19.7	9.5	3.6
Input power / cavity [kW]	250	278	276
Klystron power [kW] (2 cavities / klystron)	800	800	800
HOM power / cavity [kW]	0.54	0.86	1.94
Optimal Q <sub>L</sub>	1.5E6	3.2E5	4.7E4
Optimal detuning [kHz]	0.17	1.0	18.3
Total cavity wall loss @ 2 K [kW]	6.6	1.9	0.2

# CEPC Booster Parameters @ injection (10GeV)(CDR)

D. Wang

		<i>H</i>	<i>W</i>	<i>Z</i>
Beam energy	GeV		10	
Bunch number		242	1524	6000
Threshold of single bunch current	$\mu$ A		25.7	
Threshold of beam current (limited by coupled bunch instability)	mA		127.5	
Bunch charge	nC	0.78	0.63	0.45
Single bunch current	$\mu$ A	2.3	1.8	1.3
Beam current	mA	0.57	2.86	7.51
Energy spread	%		0.0078	
Synchrotron radiation loss/turn	keV		73.5	
Momentum compaction factor	$10^{-5}$		2.44	
Emittance	nm		0.025	
Natural chromaticity	H/V		-336/-333	
RF voltage	MV		62.7	
Betatron tune $\nu_x/\nu_y/\nu_s$			263.2/261.2/0.1	
RF energy acceptance	%		1.9	
Damping time	s		90.7	
Bunch length of linac beam	mm		1.0	
Energy spread of linac beam	%		0.16	
Emittance of linac beam	nm		40~120	

# CEPC Booster Parameters @extraction (CDR)

		<b><i>H</i></b>		<b><i>W</i></b>	<b><i>Z</i></b>
		Off axis injection	On axis injection	Off axis injection	Off axis injection
Beam energy	GeV	120		80	45.5
Bunch number		242	235+7	1524	6000
Maximum bunch charge	nC	0.72	24.0	0.58	0.41
Maximum single bunch current	$\mu$ A	2.1	70	1.7	1.2
Threshold of single bunch current	$\mu$ A	300			
Threshold of beam current (limited by RF power)	mA	1.0		4.0	10.0
Beam current	mA	0.52	1.0	2.63	6.91
Injection duration for top-up (Both beams)	s	25.8	35.4	45.8	275.2
Injection interval for top-up	s	73.1		153.0	438.0
Current decay during injection interval		3%			
Energy spread	%	0.094		0.062	0.036
Synchrotron radiation loss/turn	GeV	1.52		0.3	0.032
Momentum compaction factor	$10^{-5}$	2.44			
Emittance	nm	3.57		1.59	0.51
Natural chromaticity	H/V	-336/-333			
Betatron tune $\nu_x/\nu_y$		263.2/261.2			
RF voltage	GV	1.97		0.585	0.287
Longitudinal tune		0.13		0.10	0.10
RF energy acceptance	%	1.0		1.2	1.8
Damping time	ms	52		177	963
Natural bunch length	mm	2.8		2.4	1.3
Injection duration from empty ring	h	0.17		0.25	2.2

D. Wang

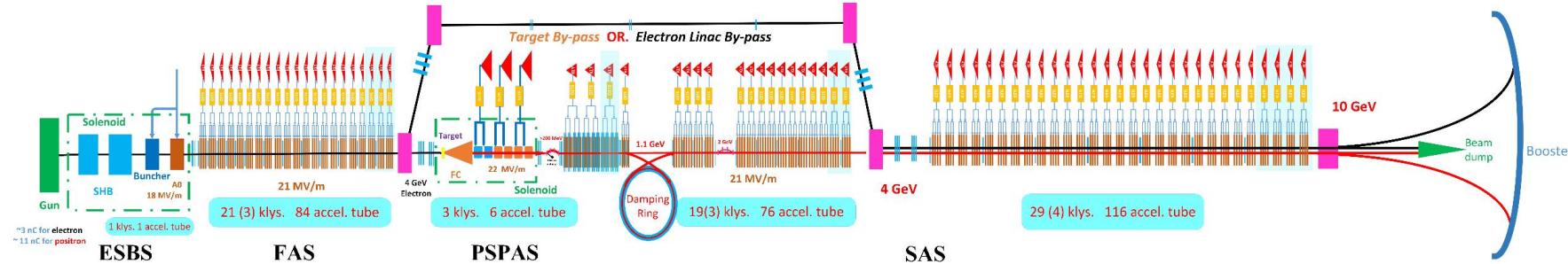
# CEPC Booster SRF Parameters (CDR)

10 GeV injection	H	W	Z
Extraction beam energy [GeV]	120	80	45.5
Bunch number	242	1524	6000
Bunch charge [nC]	0.72	0.576	0.384
Beam current [mA]	0.52	<b>2.63</b>	<b>6.91</b>
Extraction RF voltage [GV]	1.97	0.585	0.287
Extraction bunch length [mm]	2.7	2.4	1.3
Cavity number in use (1.3 GHz TESLA 9-cell)	<b>96</b>	<b>64</b>	<b>32</b>
Gradient [MV/m]	19.8	8.8	8.6
Q <sub>L</sub>	1E7	6.5E6	1E7
Cavity bandwidth [Hz]	130	200	130
Beam peak power / cavity [kW]	8.3	12.3	6.9
Input peak power per cavity [kW] (with detuning)	18.2	12.4	7.1
Input average power per cavity [kW] (with detuning)	0.7	0.3	0.5
SSA peak power [kW] (one cavity per SSA)	25	<b>25</b>	<b>25</b>
HOM average power per cavity [W]	0.2	0.7	<b>4.1</b>
Q <sub>0</sub> @ 2 K at operating gradient (long term)	1E10	1E10	1E10
Total average cavity wall loss @ 2 K eq. [kW]	0.2	0.01	0.02

J.Y. Zhai

# CEPC Linac Injector-CDR

J. R. Zhang  
C. meng



Parameter	Symbol	Unit	Baseline	Design reached
e <sup>-</sup> / e <sup>+</sup> beam energy	$E_e/E_{e+}$	GeV	10	10
Repetition rate	$f_{rep}$	Hz	100	100
e <sup>-</sup> / e <sup>+</sup> bunch population	$N_e/N_{e+}$		$> 9.4 \times 10^9$	$1.9 \times 10^{10} / 1.9 \times 10^{10}$
		nC	$> 1.5$	3.0
Energy spread (e <sup>-</sup> / e <sup>+</sup> )	$\sigma_e$		$< 2 \times 10^{-3}$	$1.5 \times 10^{-3} / 1.6 \times 10^{-3}$
Emittance (e <sup>-</sup> / e <sup>+</sup> )	$\varepsilon_r$	nm· rad	$< 120$	5 / 40 ~ 120
Bunch length (e <sup>-</sup> / e <sup>+</sup> )	$\sigma_l$	mm		1 / 1
e <sup>-</sup> beam energy on Target		GeV	4	4
e <sup>-</sup> bunch charge on Target		nC	10	10

# CEPC 30MW (CDR)

	System for Higgs (30MW)	Location and electrical demand(MW)						Total (MW)
		Ring	Booster	LINAC	BTL	IR	Surface building	
1	<b>RF Power Source</b>	<b>103.8</b>	<b>0.15</b>	<b>5.8</b>				<b>109.75</b>
2	<b>Cryogenic System</b>	<b>10.55</b>	<b>0.64</b>			<b>1.72</b>		<b>12.9</b>
3	<b>Vacuum System</b>	<b>9.784</b>	<b>3.792</b>	<b>0.646</b>				<b>14.222</b>
4	<b>Magnet Power Supplies</b>	<b>47.21</b>	<b>11.62</b>	<b>1.75</b>	<b>1.06</b>	<b>0.26</b>		<b>61.9</b>
5	<b>Instrumentation</b>	<b>0.9</b>	<b>0.6</b>	<b>0.2</b>				<b>1.7</b>
6	<b>Radiation Protection</b>	<b>0.25</b>		<b>0.1</b>				<b>0.35</b>
7	<b>Control System</b>	<b>1</b>	<b>0.6</b>	<b>0.2</b>	<b>0.005</b>	<b>0.005</b>		<b>1.81</b>
8	<b>Experimental devices</b>					<b>4</b>		<b>4</b>
9	<b>Utilities</b>	<b>31.79</b>	<b>3.53</b>	<b>1.38</b>	<b>0.63</b>	<b>1.2</b>		<b>38.53</b>
10	<b>General services</b>	<b>7.2</b>		<b>0.2</b>	<b>0.15</b>	<b>0.2</b>	<b>12</b>	<b>19.75</b>
	<b>Total</b>	<b>212.484</b>	<b>20.932</b>	<b>10.276</b>	<b>1.845</b>	<b>7.385</b>	<b>12</b>	<b>264.912</b>

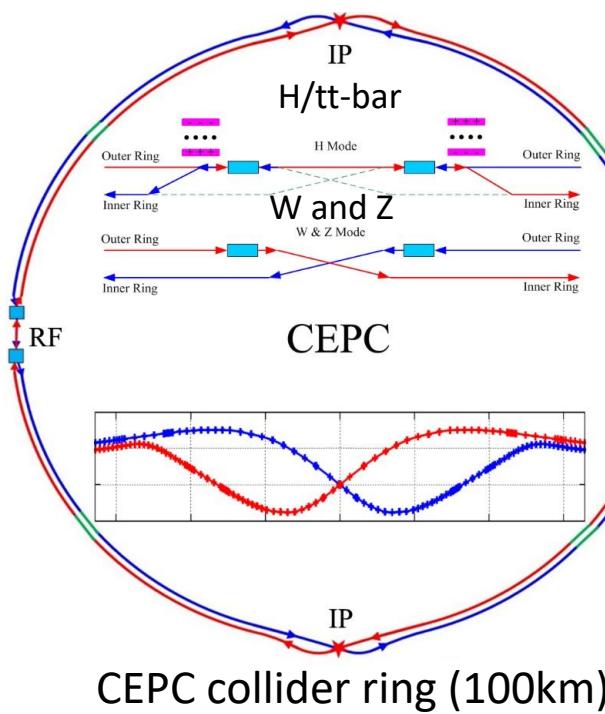
# CEPC 50MW (CDR) (rough estimate)

	Higgs (50MW)	Location and electrical demand(MW)						Total (MW)
		Ring	Booster	LINAC	BTL	IR	Surface building	
1	<b>RF Power Source</b>	<b>182.238</b>	<b>0.15</b>	<b>5.8</b>				<b>187.188</b>
2	<b>Cryogenic System</b>	<b>10.55</b>	<b>0.64</b>			<b>1.72</b>		<b>12.9</b>
3	<b>Vacuum System</b>	<b>9.784</b>	<b>3.792</b>	<b>0.646</b>				<b>14.222</b>
4	<b>Magnet Power Supplies</b>	<b>47.21</b>	<b>11.62</b>	<b>1.75</b>	<b>1.06</b>	<b>0.26</b>		<b>61.9</b>
5	<b>Instrumentation</b>	<b>0.9</b>	<b>0.6</b>	<b>0.2</b>				<b>1.7</b>
6	<b>Radiation Protection</b>	<b>0.25</b>		<b>0.1</b>				<b>0.35</b>
7	<b>Control System</b>	<b>1</b>	<b>0.6</b>	<b>0.2</b>	<b>0.005</b>	<b>0.005</b>		<b>1.81</b>
8	<b>Experimental devices</b>					<b>4</b>		<b>4</b>
9	<b>Utilities</b>	<b>31.79</b>	<b>3.53</b>	<b>1.38</b>	<b>0.63</b>	<b>1.2</b>		<b>38.53</b>
10	<b>General services</b>	<b>7.2</b>		<b>0.4</b>	<b>0.15</b>	<b>0.2</b>	<b>12</b>	<b>19.95</b>
	<b>Total</b>	<b>291.295</b>	<b>20.932</b>	<b>10.476</b>	<b>1.845</b>	<b>7.385</b>	<b>12</b>	<b>342.55</b>

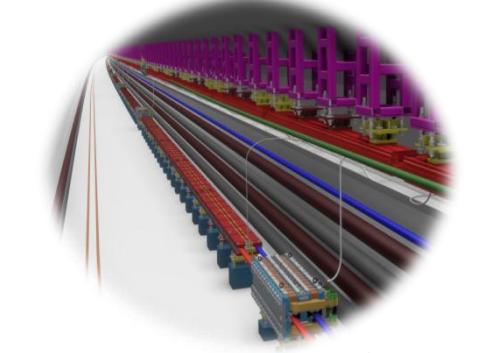
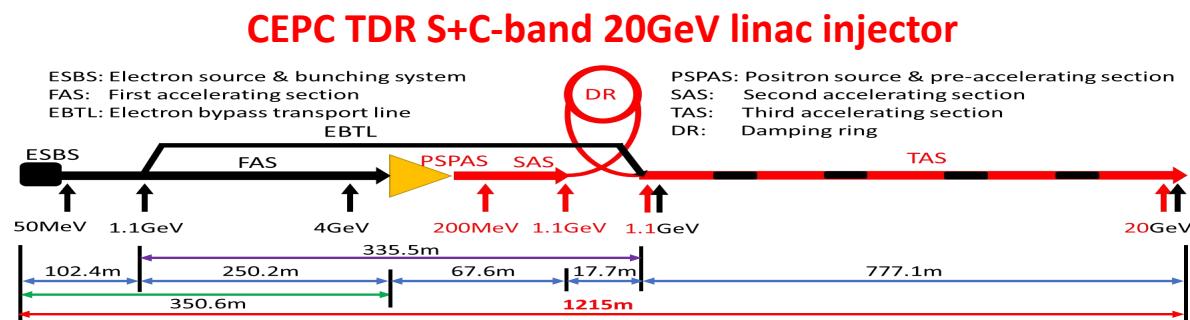
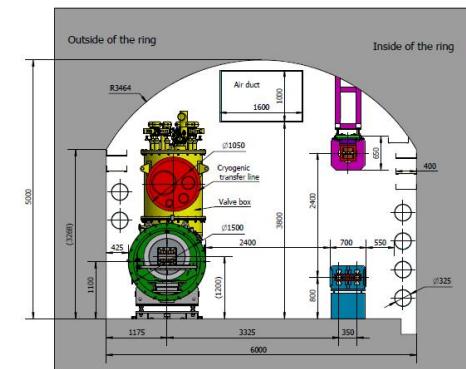
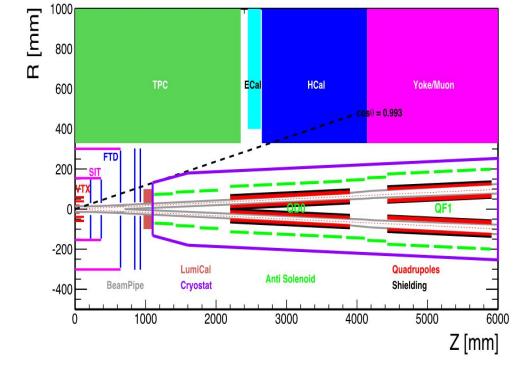
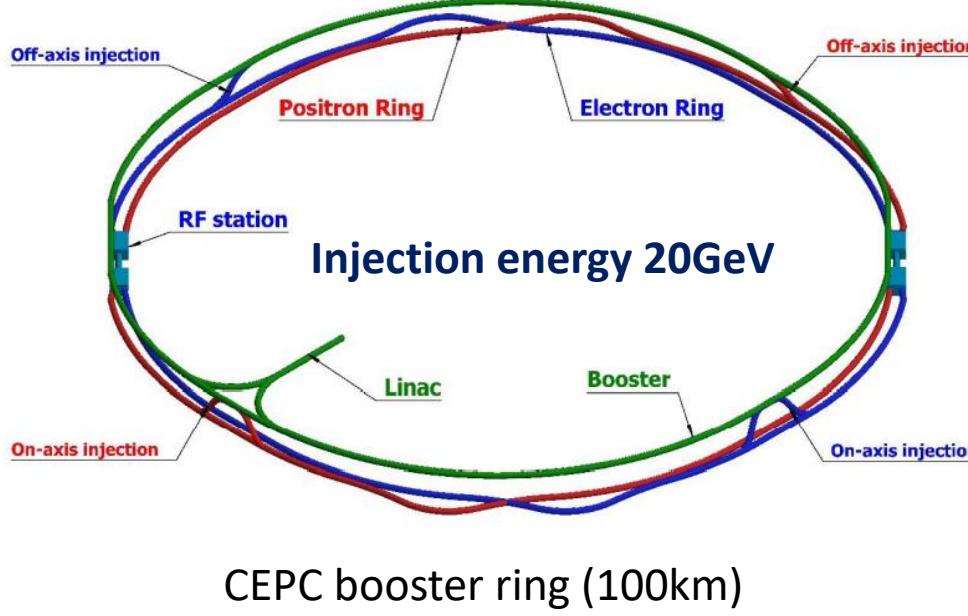
# **CEPC TDR Accelerator System Design and Power Consumptions with Linac Injector Energy of 30GeV**

# CEPC TDR Layout@20GeV Linac

CEPC as a Higgs Factory: **H**, W, Z, upgradable to tt-bar, followed by a SppC ~125TeV

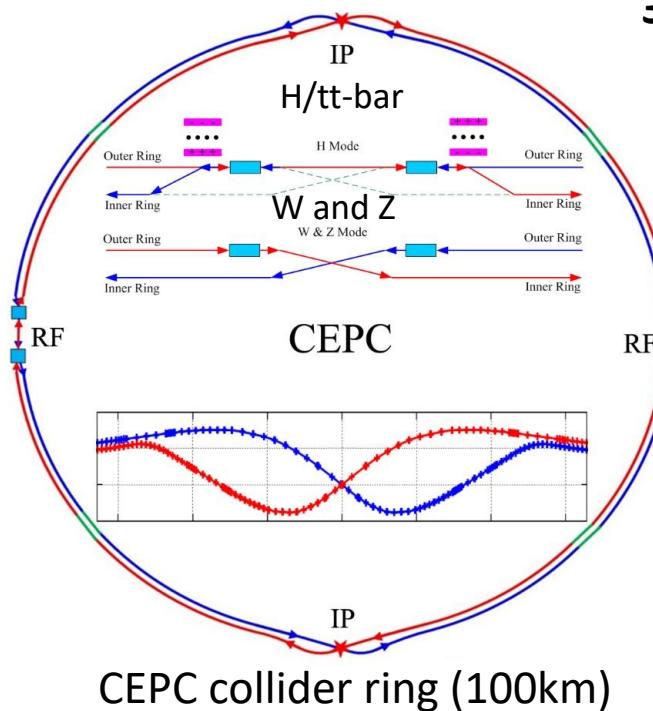


30MW SR power per beam (upgradale to 50MW)

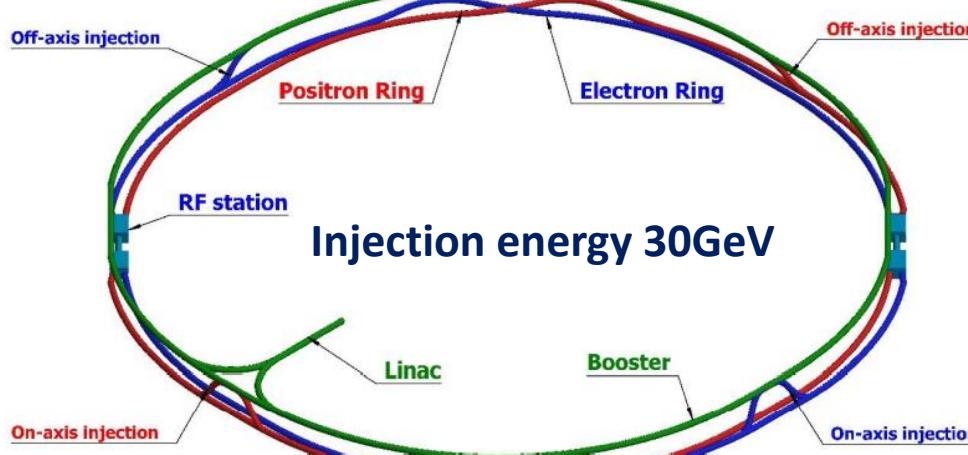


# CEPC TDR Layout@30GeV Linac

CEPC as a Higgs Factory: **H**, W, Z, upgradable to tt-bar, followed by a SppC ~125TeV



30MW SR power per beam (upgradale to 50MW)

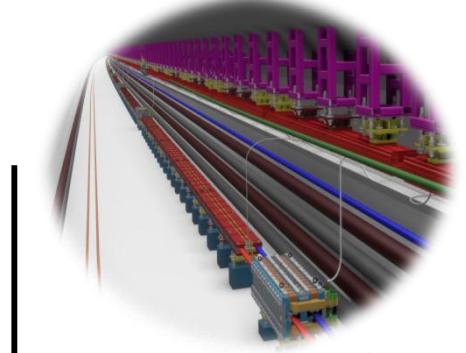
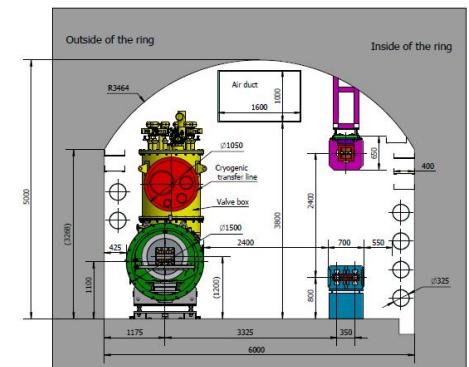
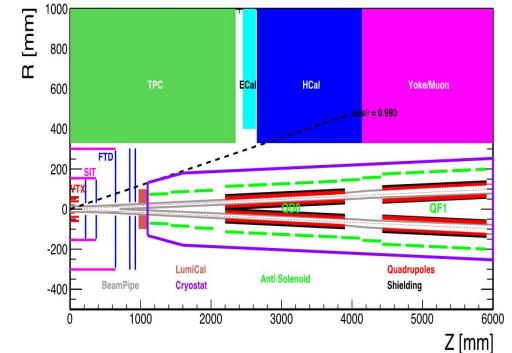
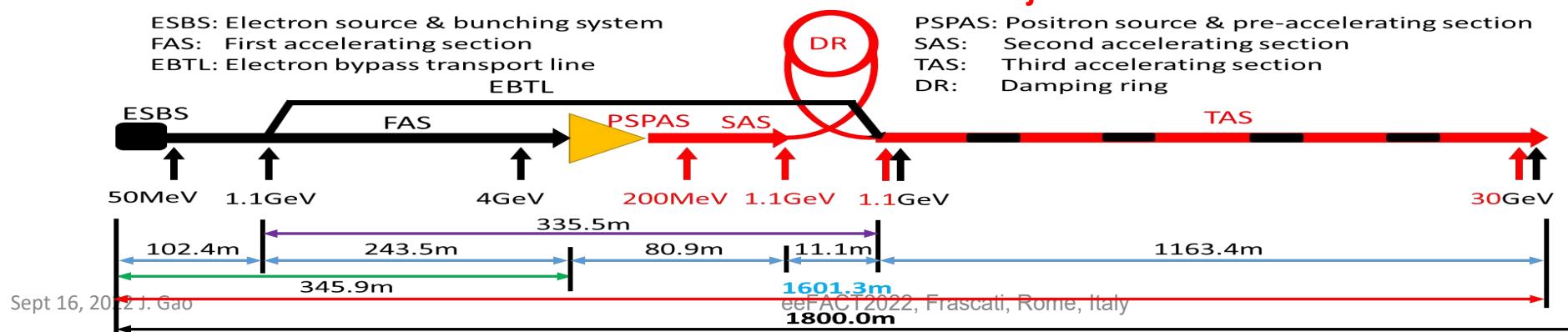


CEPC collider ring (100km)

## CEPC TDR S+C-band 30GeV linac injector

ESBS: Electron source & bunching system  
FAS: First accelerating section  
EBTL: Electron bypass transport line

PSPAS: Positron source & pre-accelerating section  
SAS: Second accelerating section  
TAS: Third accelerating section  
DR: Damping ring



# CEPC TDR Parameters (30MW)

	Higgs	Z	W	ttbar
Number of IPs		2		
Circumference [km]		100.0		
SR power per beam [MW]		30		
Half crossing angle at IP [mrad]		16.5		
Bending radius [km]		10.7		
Energy [GeV]	120	45.5	80	180
Energy loss per turn [GeV]	1.8	0.037	0.357	9.1
Piwinski angle	5.94	24.68	6.08	1.21
Bunch number	268	11934	1297	35
Bunch spacing [ns]	591 (53% gap)	23 (18% gap)	257	4524 (53% gap)
Bunch population [ $10^{10}$ ]	13	14	13.5	20
Beam current [mA]	16.7	803.5	84.1	3.3
Momentum compaction [ $10^{-5}$ ]	0.71	1.43	1.43	0.71
Beta functions at IP ( $b_x/b_y$ ) [m/mm]	0.3/1	0.13/0.9	0.21/1	1.04/2.7
Emittance ( $\epsilon_x/\epsilon_y$ ) [nm/pm]	0.64/1.3	0.27/1.4	0.87/1.7	1.4/4.7
Beam size at IP ( $\sigma_{x/y}$ ) [um/nm]	14/36	6/35	13/42	39/113
Bunch length (natural/total) [mm]	2.3/4.1	2.5/8.7	2.5/4.9	2.2/2.9
Energy spread (natural/total) [%]	0.10/0.17	0.04/0.13	0.07/0.14	0.15/0.20
Energy acceptance (DA/RF) [%]	1.6/2.2	1.3/1.7	1.2/2.5	2.3/2.6
Beam-beam parameters ( $k_{six}/k_{siy}$ )	0.015/0.11	0.004/0.127	0.012/0.113	0.071/0.1
RF voltage [GV]	2.2	0.12	0.7	10
RF frequency [MHz]	650	650	650	650
Longitudinal tune $Q_s$	0.049	0.035	0.062	0.078
Beam lifetime (bhabha/beamstrahlung)[min]	39/40	80/18000	60/700	81/23
Beam lifetime [min]	20	80	55	18
Hour glass Factor	0.9	0.97	0.9	0.89
Luminosity per IP[ $1e34/cm^2/s$ ]	5.0	115	16	0.5

# CEPC TDR Parameters (50MW upgrade)

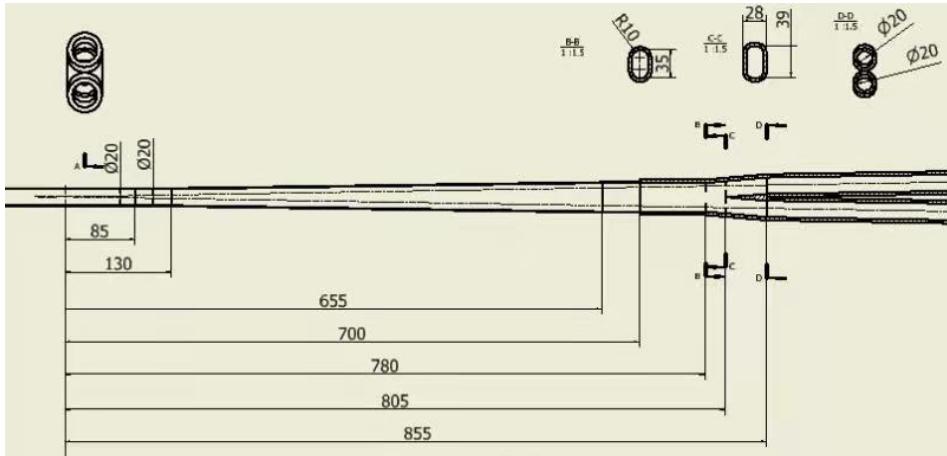
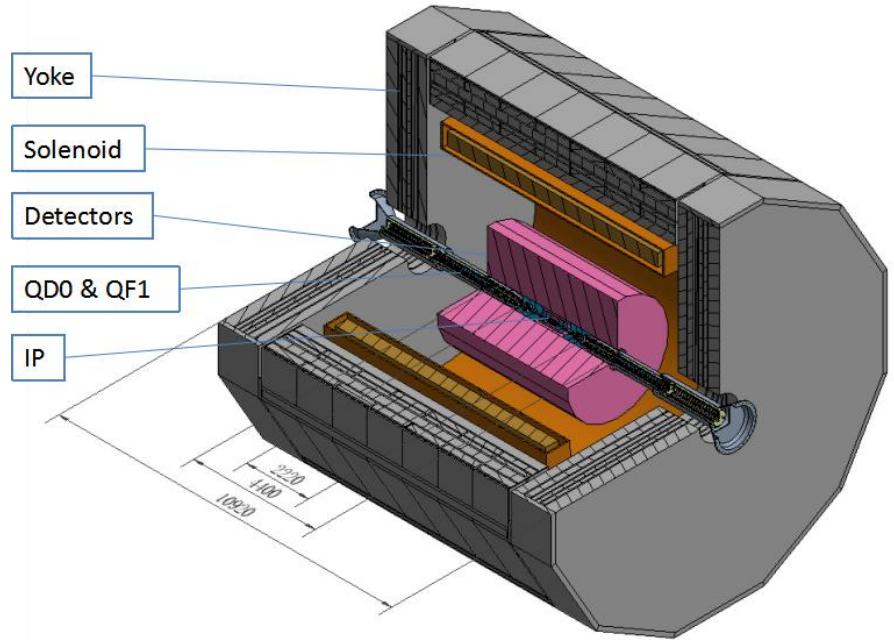
	Higgs	W	Z	ttbar
Number of IPs		2		
Circumference [km]		100.0		
SR power per beam [MW]		50		
Half crossing angle at IP [mrad]		16.5		
Bending radius [km]		10.7		
Energy [GeV]	120	80	45.5	180
Energy loss per turn [GeV]	1.8	0.357	0.037	9.1
Piwinski angle	5.94	6.08	24.68	1.21
Bunch number	415	2162	19918	58
Bunch spacing [ns]	385	154	15(10% gap)	2640
Bunch population [ $10^{10}$ ]	14	13.5	14	20
Beam current [mA]	27.8	140.2	1339.2	5.5
Momentum compaction [ $10^{-5}$ ]	0.71	1.43	1.43	0.71
Phase advance of arc FODOs [degree]	90	60	60	90
Beta functions at IP ( $b_x/b_y$ ) [m/mm]	0.33/1	0.21/1	0.13/0.9	1.04/2.7
Emittance ( $\epsilon_x/\epsilon_y$ ) [nm/pm]	0.64/1.3	0.87/1.7	0.27/1.4	1.4/4.7
Beam size at IP ( $s_x/s_y$ ) [um/nm]	15/36	13/42	6/35	39/113
Bunch length (SR/total) [mm]	2.3/3.9	2.5/4.9	2.5/8.7	2.2/2.9
Energy spread (SR/total) [%]	0.10/0.17	0.07/0.14	0.04/0.13	0.15/0.20
Energy acceptance (DA/RF) [%]	1.7/2.2	1.2/2.5	1.3/1.7	2.3/2.6
Beam-beam parameters ( $xx/xy$ )	0.015/0.11	0.012/0.113	0.004/0.127	0.071/0.1
RF voltage [GV]	2.2 (2cell)	0.7 (2cell)	0.12 (1cell)	10 (5cell)
RF frequency [MHz]		650		
Beam lifetime [min]	20	55	80	18
Luminosity per IP [ $10^{34}/cm^2/s$ ]	8.3	26.6	191.7	0.8

This parameter table  
is used by US  
Snowmass21  
for CEPC physics  
performance potential  
evaluation

CEPC Accelerator white  
paper to Snowss21  
arXiv:2203.09451

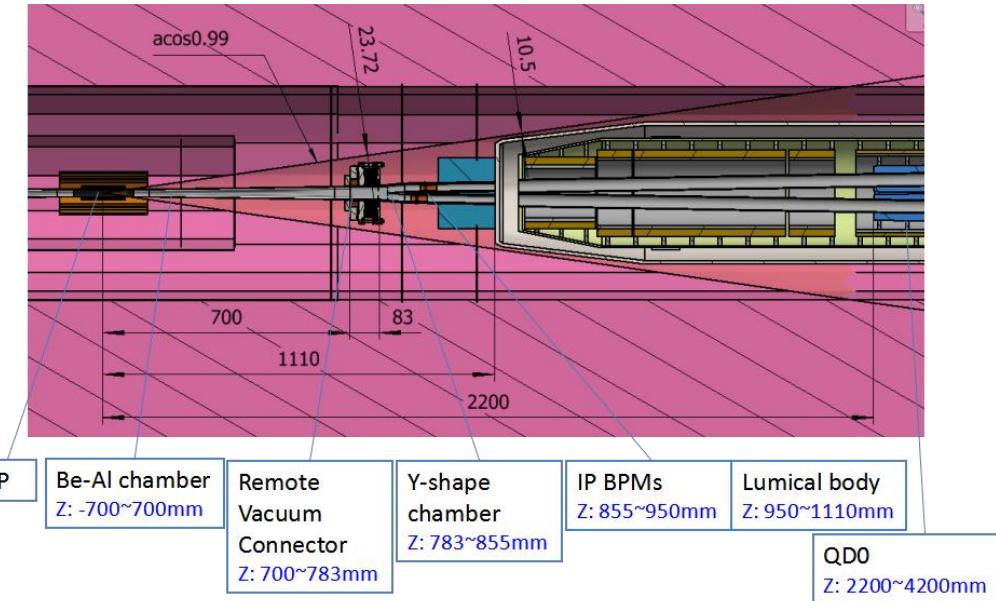
# CEPC MDI

S. Bai



- IR Superconducting magnet design
- IR beam pipe
- Synchrotron radiation
- Beam loss background
- Shielding
- Mechanical support
- Full detector simulation

- Central beryllium pipe inner diameter changes from 28mm(CDR) to 20mm
- There is no SR photons hitting the central beam pipe in normal conditions.
- Single layer beam pipe with water cooling, SR heat load is not a problem.



$$L^*=1.9\text{m}, \theta_c=33\text{mrad}, \beta_x^*=0.33\text{m}, \beta_y^*=1.0\text{mm}, \text{Emittance}=0.68\text{nm}$$

- Strength requirements of anti-solenoids (peak field  $B_z \sim 7.2\text{T}$ )
- Two-in-one type SC quadrupole coils (Peak field  $3.8\text{T}$  &  $141\text{T/m}$ ) with room temperature vacuum chamber & Iron yoke

# CEPC TDR RF Parameters (Collider Ring)

J.Y.Zhai

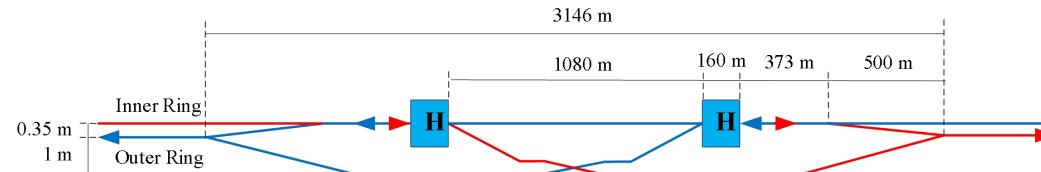
30 MW SR power per beam for each mode. ttbar and Higgs half fill with common cavities for two rings, W and Z with separate cavities for two rings.	ttbar		Higgs	W	Z bypass with 1-cell cavities
	additional 5-cell cavities	existing 2-cell cavities			
Luminosity / IP [ $10^{34} \text{ cm}^{-2}\text{s}^{-1}$ ]	0.5		5	16	115
RF voltage [GV]	10 (7.8 + 2.2)		2.2	0.7	0.12
Beam current / beam [mA]	3.3		16.7	84.1	803.5
Bunch charge [nC]	32		20.8	21.6	22.4
Bunch length [mm]	2.9		4.1	4.9	8.7
650 MHz cavity number	240	240	240	120/ring	30/ring
Cell number / cavity	5	2	2	2	1
Gradient [MV/m]	28.5	20	20	12.7	8.7
Q <sub>0</sub> @ 2 K at operating gradient (long term)	5E10		2E10		
HOM power / cavity [kW]	0.4	0.16	0.45	0.93	2.9
Input power / cavity [kW]	194	56	250	250	1000
Optimal Q <sub>L</sub>	1E7	7E6	1.6E6	6.4E5	7.5E4
Optimal detuning [kHz]	0.01	0.02	0.1	0.9	13.3
Cavity number / klystron	4	12	2	2	1
Klystron power [kW]	1400	1400	800	800	1400
Klystron number	60	20	120	60	60
Cavity number / cryomodule	4		6		1
Cryomodule number	60		40		30
Total cavity wall loss @ 2 K [kW]	9.5		4.7	1.9	0.45

# CEPC TDR RF Scheme Updated

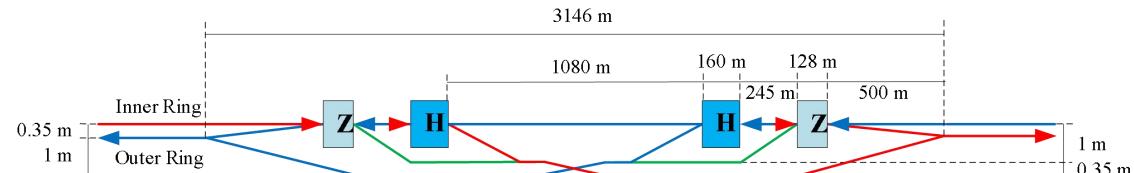
J.Y. Zhai  
Y.W. Wang

- Aiming for **all-mode seamless switching** in whole project lifecycle without hardware movement
- Highest luminosity in each energy. Maximize performance and flexibility for future circular electron positron collider
- Remained issue: Higgs operation after ttbar upgrade. Solution: add center connection line (short black line). **Need to check if the dipole SR light will still hit the cavity after effective shielding.**

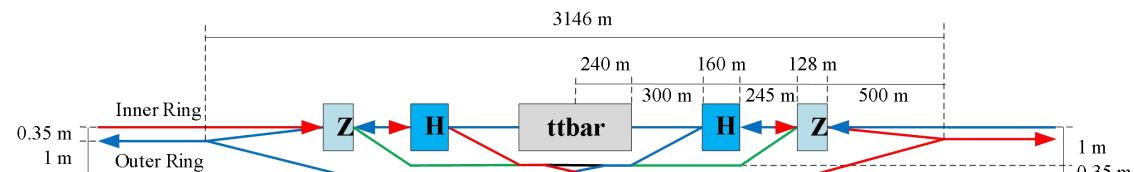
Stage 1: H/W/LL-Z (and HL-H/W upgrade)



Stage 2: HL-H/W/Z (HL-Z upgrade)



Stage 3: HL-H/W/Z/ttbar (ttbar-upgrade)



H  
650 MHz 2-cell cavity  
6 cavities in 1 CM

Z  
650 MHz 1-cell cavity  
1 cavity in 1 CM

ttbar  
650 MHz 5-cell cavity  
4 cavities in 1 CM

# CEPC Booster TDR Parameters

D. Wang

- Injection energy:  $10\text{GeV} \rightarrow 20\text{GeV}$
- Max energy:  $120\text{GeV} \rightarrow 180\text{GeV}$
- Lower emittance — new lattice (**TME**)

Injection		<i>t</i>	<i>H</i>	<i>W</i>	<i>Z</i>
Beam energy	GeV			20	
Bunch number		35	268	1297	3978
Threshold of single bunch current	$\mu\text{A}$	5.79	4.20		3.92
Threshold of beam current (limited by coupled bunch instability)	$\text{mA}$			27	
Bunch charge	nC	1.1	0.78	0.81	0.87
Single bunch current	$\mu\text{A}$	3.4	2.3	2.4	2.65
Beam current	$\text{mA}$	0.12	0.62	3.1	10.5
Growth time (coupled bunch instability)	ms	1690	358	67	19.4
Energy spread	%			0.016	
Synchrotron radiation loss/turn	MeV			1.3	
Momentum compaction factor	$10^{-5}$			1.12	
Emittance	nm			0.035	
Natural chromaticity	H/V			-372/-269	
RF voltage	MV	531.0	230.2		200.0
Betatron tune $\nu_x/\nu_y$				321.23/117.18	
Longitudinal tune		0.14	0.0943		0.0879
RF energy acceptance	%	5.9	3.7		3.6
Damping time	s			10.4	
Bunch length of linac beam	mm			0.5	
Energy spread of linac beam	%			0.16	
Emittance of linac beam	nm			10	

Extraction		<i>t</i>	<i>H</i>	<i>W</i>	<i>Z</i>	
		Off axis injection	Off axis injection	On axis injection	Off axis injection	Off axis injection
Beam energy	GeV	180		120	80	45.5
Bunch number		35	268	261+7	1297	3978
Maximum bunch charge	nC	0.99	0.7	20.3	0.73	0.8
Maximum single bunch current	$\mu\text{A}$	3.0	2.1	61.2	2.2	2.4
Threshold of single bunch current	$\mu\text{A}$	91.5		70	22.16	9.57
Threshold of beam current (limited by RF system)	mA	0.3		1	4	16
Beam current	mA	0.11	0.56	0.98	2.85	9.5
Growth time (coupled bunch instability)	ms	16611	2359	1215	297.8	49.5
Bunches per pulse of Linac		1		1	1	2
Time for ramping up	s	7.3		4.5	2.7	1.6
Injection duration for top-up (Both beams)	s	30.0	23.3	32.8	39.4	139.0
Injection interval for top-up	s	65		38	155	153.5
Current decay during injection interval					3%	
Energy spread	%	0.15		0.099	0.066	0.037
Synchrotron radiation loss/turn	GeV	8.45		1.69	0.33	0.034
Momentum compaction factor	$10^{-5}$			1.12		
Emittance	nm	2.83		1.26	0.56	0.19
Natural chromaticity	H/V			-372/-269		
Betatron tune $\nu_x/\nu_y$				321.27/117.19		
RF voltage	GV	9.7		2.17	0.87	0.46
Longitudinal tune		0.14		0.0943	0.0879	0.0879
RF energy acceptance	%	1.78		1.59	2.6	3.4
Damping time	ms	14.2		47.6	160.8	879
Natural bunch length	mm	1.8		1.85	1.3	0.75
Full injection from empty ring	h	0.1	0.14	0.16	0.27	1.8

\*Diameter of beam pipe is 55mm for re-injection with high single bunch current @120GeV.

# CEPC TDR SRF Parameters (Booster Ring)

30 MW Collider SR power per beam for each mode. 20 GeV injection.	<b>ttbar</b>	Higgs off/on-axis	<b>w</b>	<b>z</b> high current
Extraction beam energy [GeV]	180	120	80	45.5
Extraction average SR power [MW]	0.087	0.09	0.01	0.004
Bunch charge [nC]	0.96	0.7	0.73	0.83
Beam current [mA]	0.11	0.56/0.98	2.85	14.4
Injection RF voltage [GV]	0.438	0.197	0.122	0.122
Extraction RF voltage [GV]	9.7	2.17	0.87	0.46
Extraction bunch length [mm]	1.8	1.85	1.3	0.75
Cavity number (1.3 GHz 9-cell)	336	96	64	32
Extraction gradient [MV/m]	27.8	21.8	13.1	13.8
Q <sub>0</sub> @ 2 K at operating gradient (long term)	1E10			
Q <sub>L</sub>	4E7	1E7		
Cavity bandwidth [Hz]	33	130		
Peak HOM power per cavity [W]	0.4	1.4/2.7	9.8	108.5
Input peak power per cavity [kW]	7.9	15.3/21.3	15	33
SSA peak power [kW] (one cavity per SSA)	10	25	25	40
Cryomodule number (8 cavities per module)	42	12	8	4

**CDR Higgs energy:** J.Y. Zhai

-collider ring: 240 2cell 650MHz cavities

-booster: 96 1.3GHz 9cell cavities

**-Nb consumption: 20 tons**

**For ttbar energy:**

In addition to CDR Higgs energy, SRF cavity numbers have to be increased:

-collider ring:+350 5cell 650MHz cavities

-booster ring:+350 1.3GHz 9 cell cavities

**-Additional Nb consumption:65 tons**

For 30MW SR/beam Mode at Higgs energy, the cryogenic system need **32000liter**

**Helium**

For 50MW/beam SR Mode:

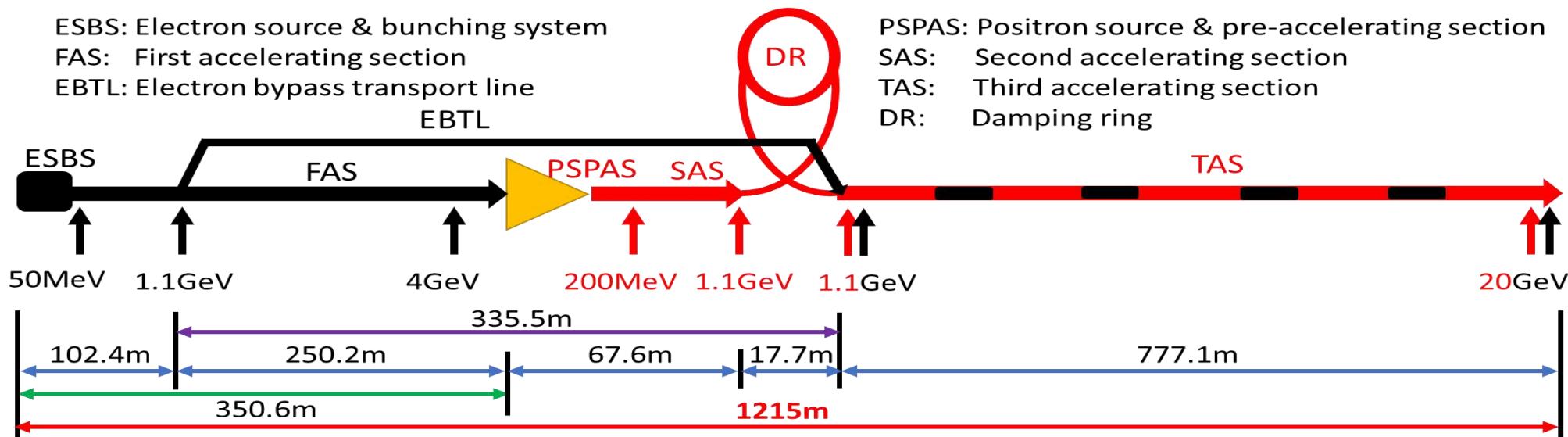
at Higgs energy, the cryogenic system needs 42000liter Helium; at ttbar energy

**130000liter Helium needed**

# CEPC 20GeV Linac for TDR

J.R. Zhang  
C. Meng

- EBTL is in vertical plane with 1.2 m separation
  - Avoid interference with energy analyzing station, transport lines between the Linac and damping ring, waveguide and positron source
  - Reduce the tunnel width
- Accelerating structure
  - S-band: FAS/PSPAS/SAS
  - C-band: TAS



# CEPC 20GeV Linac TDR Parameters

J.R. Zhang  
C. Meng

- Baseline scheme

- 20 GeV
  - Low magnetic field & large magnetic field range
  - C-band
    - Higher gradient → Shorter linac tunnel length
    - Small aperture & Strong wakefield
- 10 nm
  - High luminosity
- 100 Hz
  - Injection efficiency
  - High luminosity Z need faster injection process
    - 200 Hz
    - 100 Hz & two-bunch-per-pulse
    - 200 Hz & two-bunch-per-pulse (?)

Parameter	Symbol	Unit	Baseline
e <sup>-</sup> / e <sup>+</sup> beam energy	$E_{e^-}/E_{e^+}$	GeV	20
Repetition rate	$f_{rep}$	Hz	100
e <sup>-</sup> / e <sup>+</sup> bunch population	$N_{e^-}/N_{e^+}$	$\times 10^{10}$	0.94(1.88)
		nC	1.5 (3)
Energy spread (e <sup>-</sup> / e <sup>+</sup> )	$\sigma_E$		$1.5 \times 10^{-3}$
Emittance (e <sup>-</sup> / e <sup>+</sup> )	$\varepsilon_{x,y}$	nm	10

Parameter	Unit	S-band	C-band
Frequency	MHz	2860	5720
Length	m	3.1	1.8
Cavity mode		$2\pi/3$	$3\pi/4$
Aperture diameter	mm	20~24	11.8~16
Gradient	MV/m	21	45

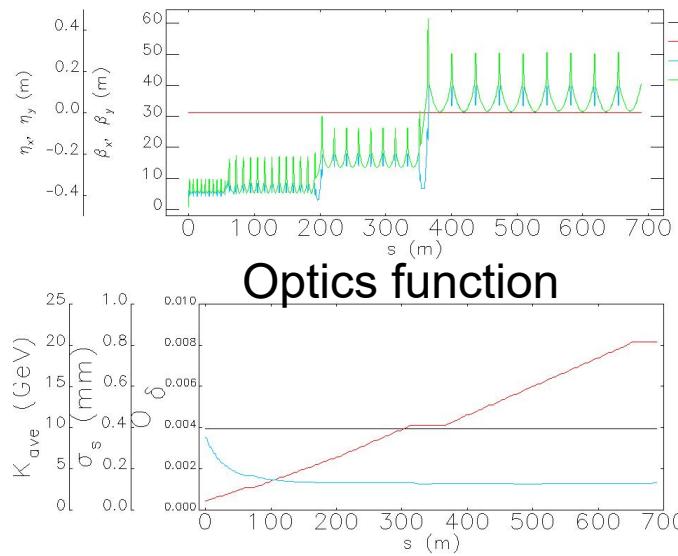
# CEPC 20GeV Positron Linac Design

J.R. Zhang,  
C.Meng

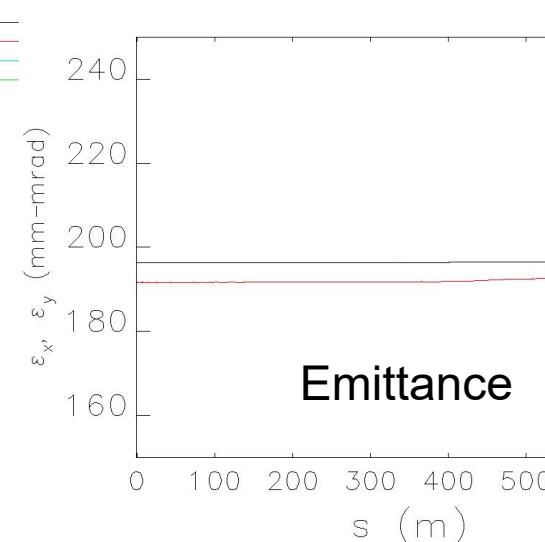
- Positron Linac

- Wakefield & CSR
- Emittance(w/o error)
  - Growth: 5%
  - 5.2nm@20GeV

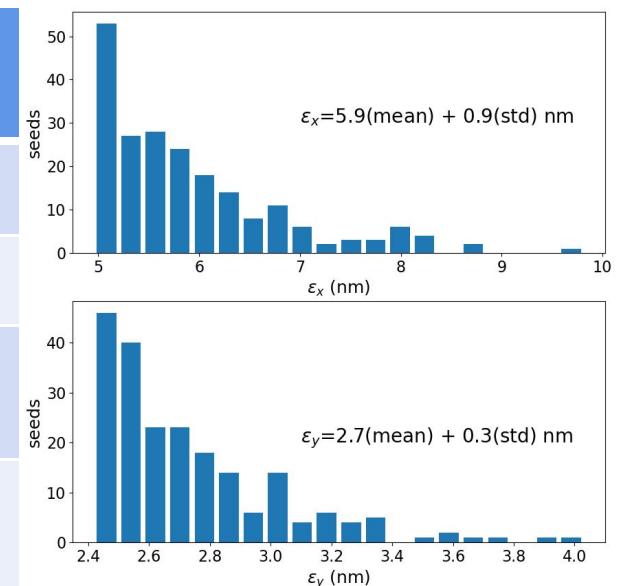
Parameter	Unit	Baseline	Electron	Positron
e <sup>-</sup> / e <sup>+</sup> beam energy	GeV	20	20.38	20.37
Repetition rate	Hz	100	100	100
e <sup>-</sup> / e <sup>+</sup> bunch population	×10 <sup>10</sup>	0.94(1.88)	1.88	1.88
	nC	1.5 (3)	3	3
Energy spread (e <sup>-</sup> / e <sup>+</sup> )		1.5×10 <sup>-3</sup>	1.3×10 <sup>-3</sup>	1.3×10 <sup>-3</sup>
Emittance (e <sup>-</sup> / e <sup>+</sup> )	nm	10	2.5	5.2



Energy/bunch length/energy spread



Error description	Unit	Value
Misalignment error	mm	0.1
Rotation error	mrad	0.2
Magnetic element field error	%	0.1
BPM uncertainty	μm	30



# CEPC LINAC Design Evolution

The Linac energy was chosen as 30GeV at June 22, 2022

J.R. Zhang  
C. Meng

Energy: 30 GeV Emittance: 6.5nm

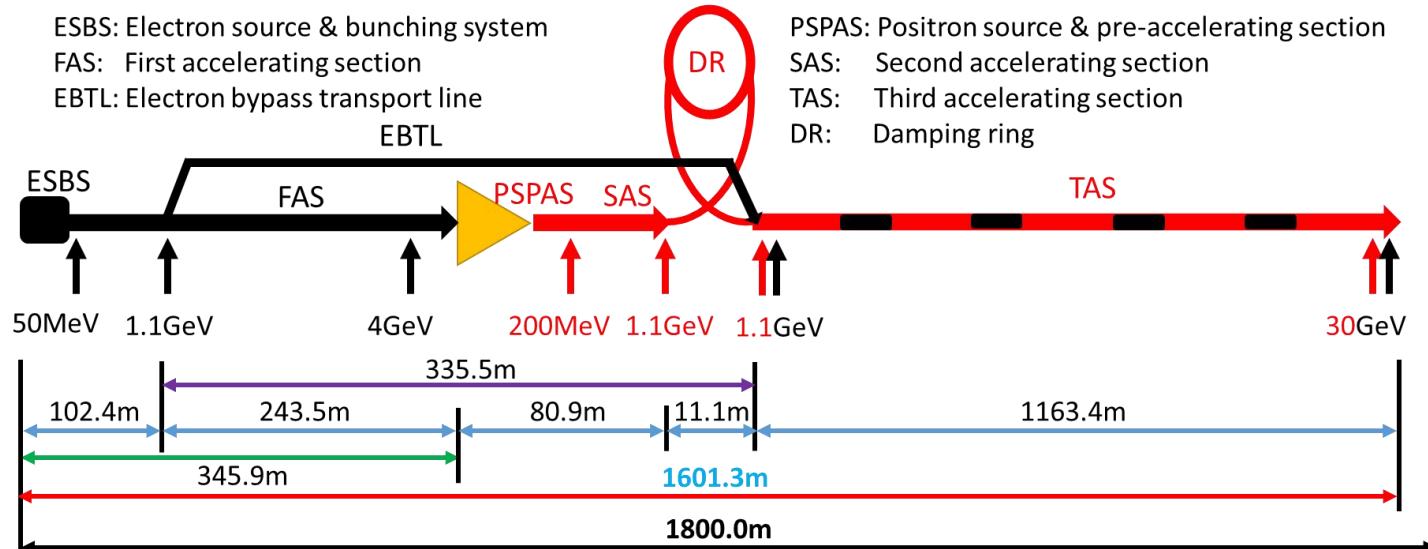
Stage			PreCDR	CDR									TDR														
Parameter	Unit	V1	V2			V3						V4															
			V2.1	V2.2	V2.3	V3.1	V3.2	V3.3	V3.4	V3.5	V3.6	V3.7	V3.8	V4.1	V4.2	V4.3											
Beam energy ( $e^-/e^+$ )	$E_{e^-}/E_{e^+}$	GeV	6	10			4	10			20	10/20	20			30											
Repetition rate	$f_{rep}$	Hz	50			100																					
Bunch number per pulse			1						1&2																		
Bunch population ( $e^-/e^+$ )	$N_{e^-}/N_{e^+}$	$\times 10^9$	20			6.25		6.25(18.8)		9.4 (18.8)																	
		nC	3.2			1		1(3)		1.5 (3)																	
Energy spread ( $e^+/e^-$ )	$\sigma_E$	$\times 10^{-3}$	1			2						1.5															
$e^-$ bunch charge at target		nC	10																								
$e^-$ beam energy at target		GeV	4			2		4																			
Emittance	$\epsilon$	nm	300						120		60	40	10			6.5											
Damping Ring			Yes			No						Yes			Yes												
	$E_{e^+}$	GeV	1.1									1.1			1.1												
	$C$	m	58.5									58.5			75.4			147									
	$\epsilon_0$	mm-mrad	287									287			377			94									
Bunch compressor			No						Yes		No		Yes														
Accelerating structure			S-band												S-band+C-band												
RF frequency	$f_{RF}$	MHz	2856.75						2860		2860/5720																
Accelerating gradient		MV/m	15/27	18/27 or. 18/21			21						22 & 27/45														
Klystron-to-ACC.Struc.			1-t-2	1-t-2 or. 1-t-4			1-t-4						1-t-4 & 1-t-2(S)/1-t-2(C)														
Shared Linac Energy range		MeV	200-1100									No															
Linac tunnel length		km	600	1200			500	1200			1400			1800													
Collider circumference		km	54 & 61	61			100																				
Layout			shared Linac	3 layout schemes			TGB or EBTL	Pre-BST							EBTL												
Date			Apr-16	Nov-16			Dec-16	Apr-17	Aug-17	Oct-17	Dec-17	Jul-18	Mar-19	Sep-19	May-21	Mar-22	Jun-22										

# CEPC LINAC of 30GeV

C. Meng

- 30GeV-Linac Scheme
  - C-band accelerating structure is used in TAS from 1.1GeV to 30GeV
  - S-band accelerating structure is used in FAS with energy of 4GeV and SAS with energy of 1.1 GeV
  - The bunch charge is 1.5nC and have the capability to reach 3nC both for electron and positron beam
- Electron Linac
  - ESBS+FAS+EBTL+TAS
- Positron Linac
  - ESBS+FAS+PSPAS+SAS+DR+TAS
- The Linac length is 1.6km and there is still 0.2km as reserved space, the Linac tunnel length is 1.8km
  - The circumference of the damping ring is about 0.15km

Parameter	Symbol	Unit	Baseline
Beam energy	$E_e/E_{e+}$	GeV	30
Repetition rate	$f_{rep}$	Hz	100
Bunch population	$N_{e^-}/N_{e^+}$	$\times 10^{10}$	0.94
		nC	1.5
Energy spread	$\sigma_E$		$1.5 \times 10^{-3}$
Emittance	$\varepsilon_r$	nm	6.5

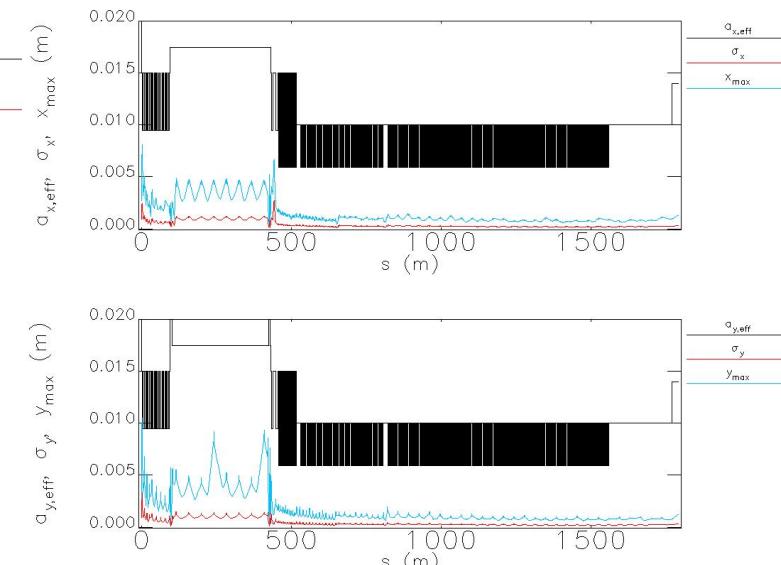
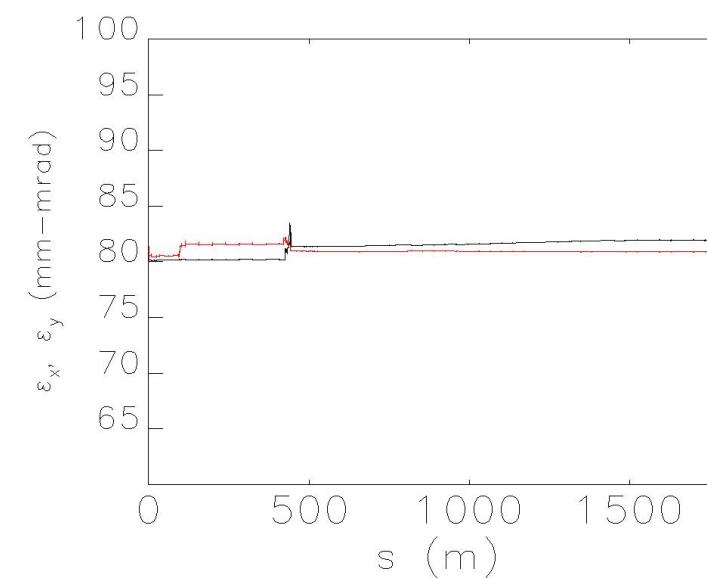
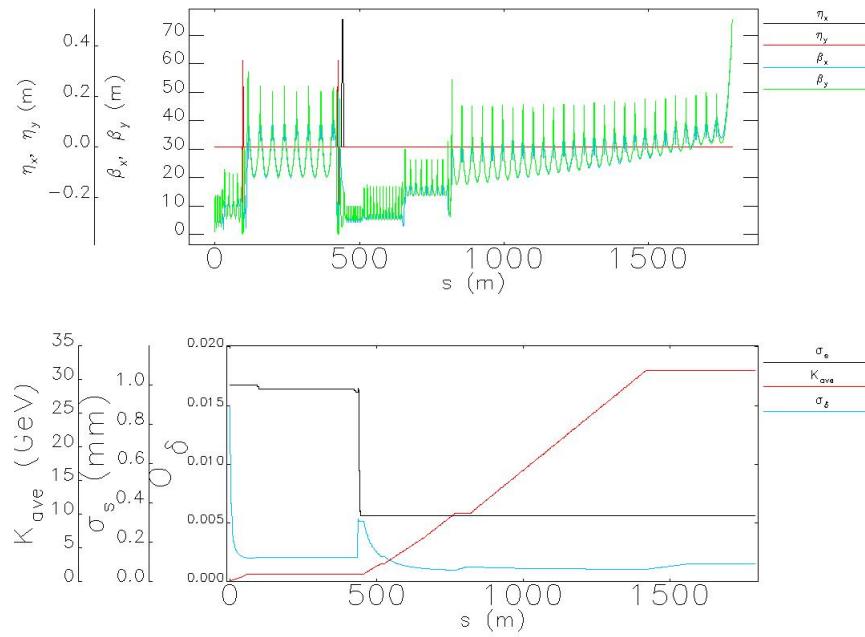


# CEPC LINAC Design (30GeV)

C. Meng

- Simulation results

Parameter	Unit	Value	Simulated			
			Electron		Positron	
Beam energy	GeV	30	31.3	30.8	31.1	30.8
Repetition rate	Hz	100			/	
Bunch charge	nC	1.5	1.5	3.0	1.5	3.0
Energy spread		$1.5 \times 10^{-3}$	$1.4 \times 10^{-3}$	$1.7 \times 10^{-3}$	$1.4 \times 10^{-3}$	$1.9 \times 10^{-3}$
Emittance	nm	6.5	1.4	1.5	3.3(H)/1.7(V)	3.5(H)/1.8(V)
Bunch length (RMS)	mm	/			0.4	



# CEPC-LINAC-TDR-POWER@30MW and 50MW

	Power [MW]	CDR	TDR
1	RF system	0.48	0.81
2	RF power source	5.77	11.12
3	Magnets	/	/
4	Magnet power supplies	1.75	2.42
5	Vacuum system	0.65	1.77
6	Instrumentation	0.20	0.20
7	Control system	0.20	0.20
8	Mechanical systems	/	/
9	Radiation Protection	0.10	0.10
10	Experimental devices	/	/
11	Utilities	1.38	1.98
12	General services	0.20	0.29
<b>Total</b>		<b>10.7</b>	<b>18.9</b>

For 50MW operation, CEPC linac injector will use two bunch scheme, there is very small difference 30MW and 50MW operation modes for electron and positron source.

C. Meng

# CEPC TDR Power Consumption Breakdowns@Higgs with 30GeV injection Linac and 30MW SR/beam

	Location and electrical demand(MW)					Surface building	TOTAL
	Ring	Booster	LINAC	BTL	IR		
RF Power Source	96.9	1.4	11.1				109.5
Cryogenic System	11.6	0.6	-		1.1		13.4
Vacuum System	1.0	3.8	1.8				6.5
Magnet Power Supplies	52.3	7.5	2.4	1.1	0.3		63.5
Instrumentation	1.3	0.7	0.2				2.2
Radiation Protection	0.3		0.1				0.4
Control System	1.0	0.6	0.2	0.0	0.0		1.8
Experimental devices					4.0		4.0
Utilities	31.8	3.5	2.0	0.6	1.2		39.1
General services	7.2		0.3	0.2	0.2	12.0	19.8
RF system			0.8				0.8
TOTAL	203.4	18.2	18.9	1.8	6.8	12.0	261.1

# CEPC TDR Power Consumption Breakdowns@Higgs with 30GeV injection Linac and 50MW SR/beam

		Location and electrical demand(MW)							
		Ring	Booster	LINAC	BTL	IR	Surface building	TOTAL	
1	RF Power Source	161.5	1.4	11.1				174.1	
2	Cryogenic System	15.5	0.6	-		1.7		17.9	
3	Vacuum System	1.0	3.8	1.8				6.5	
4	Magnet Power Supplies	52.3	7.5	2.4	1.1	0.3		63.5	
5	Instrumentation	1.3	0.7	0.2				2.2	
6	Radiation Protection	0.3		0.1				0.4	
7	Control System	1.0	0.6	0.2	0.0	0.0		1.8	
8	Experimental devices					4.0		4.0	
9	Utilities	42.4	3.5	2.0	0.6	1.2		49.7	
10	General services	7.2		0.3	0.2	0.2	12.0	19.8	
11	RF system			0.8				0.8	
12	TOTAL	282.4	18.2	18.9	1.8	7.4	12.0	340.7	

# CEPC TDR Power Consumption Breakdowns@ttbar with 30GeV injection Linac and 50MW SR/beam

		Location and electrical demand(MW)							
		Ring	Booster	LINAC	BTL	IR	Surface building	TOTAL	
1	RF Power Source	161.5	1.4	11.1					174.1
2	Cryogenic System	25.2	0.6	-		1.1			26.9
3	Vacuum System	2.0	3.8	1.8					7.6
4	Magnet Power Supplies	118.8	16.8	2.4	1.1	0.3			139.3
5	Instrumentation	1.3	0.7	0.2					2.2
6	Radiation Protection	0.3		0.1					0.4
7	Control System	1.0	0.6	0.2	0.0	0.0			1.8
8	Experimental devices					4.0			4.0
9	Utilities	68.9	3.5	2.0	0.6	1.2			76.2
10	General services	7.2		0.3	0.2	0.2	12.0		19.8
11	RF system			0.8					0.8
12	TOTAL	386.1	27.5	18.9	1.8	6.8	12.0		453.1

# CEPC TDR Power Consumption Breakdowns@Z with 30GeV injection Linac and 30MW SR/beam

		Location and electrical demand(MW)						
		Ring	Booster	LINAC	BTL	IR	Surface building	TOTAL
1	RF Power Source	96.9	0.1	11.1				108.1
2	Cryogenic System	4.1	0.6	-		1.1		5.9
3	Vacuum System	1.0	3.8	1.8				6.5
4	Magnet Power Supplies	9.6	1.4	2.4	1.1	0.3		14.7
5	Instrumentation	1.3	0.7	0.2				2.2
6	Radiation Protection	0.3		0.1				0.4
7	Control System	1.0	0.6	0.2	0.0	0.0		1.8
8	Experimental devices					4.0		4.0
9	Utilities	28.1	3.5	2.0	0.6	1.2		35.5
10	General services	7.2		0.3	0.2	0.2	12.0	19.8
11	RF system			0.8				0.8
12	TOTAL	149.4	10.8	18.9	1.8	6.8	12.0	199.7

# Snowmass Luminosity and Power Consumption Evaluations (CEPC)

Y.W.Wang

Proposal name	CEPC	CEPC	CEPC	CEPC
Beam energy [GeV]	45.5	120.0	120.0	180.0
Average beam current [A or mA]	803.5	16.7	27.8	5.5
SR power [MW]	30.0	30.0	50.0	50.0
Collider cryo power [MW]	5.2	12.7	17.2	26.3
Collider RF power [MW]	96.9	96.9	161.5	161.5
Collider magnet power [MW]	9.8	52.6	52.6	119.1
Cooling & ventilation power [MW]	35.5	39.1	49.7	76.2
General services power [MW]	19.8	19.8	19.8	19.8
Injector cryo power [MW]	0.6	0.6	0.6	0.6
Injector RF power [MW]	0.1	1.4	1.4	1.4
Injector magnet power [MW]	1.4	7.5	7.5	16.8
Pre-injector power (where applicable) [MW]	17.7	17.7	17.7	17.7
Detector power (if included) [MW]	4.0	4.0	4.0	4.0
Data center power (if included) [MW]	-	-	-	-
Total power [MW]	191.1	252.4	332.1	443.5
Luminosity [ $10^{34} / \text{cm}^2/\text{s}$ ] (total 2 IP values)	230.0	10.0	16.7	1.7
Total integrated luminosity / year [1/fb/yr]	29900.0	1300.0	2171.0	217.1
Effective physics time per year assumed/needed to achieve integrated annual luminosity [ $10^7 \text{ s}$ ]	1.3	1.3	1.3	1.3
Energy Consumption / year [TWh]	0.7	0.9	1.2	1.6

The items listed in the Snowmass Luminosity Power table are less than the complete power budgets for a real machine on site

# SppC Collider Parameters

## -Parameter list (updated Feb. 2022)

Jingyu Tang  
Haocheng Xu

Main parameters						
Circumference	100	km	Normalized rms transverse emittance	1.2	μm	
Beam energy	62.5	TeV	Beam life time due to burn-off	8.1	hour	
Lorentz gamma	66631		Turnaround time	2.3	hour	
Dipole field	20.00	T	Total cycle time	10.4	hour	
Dipole curvature radius	10415.4	m	Total / inelastic cross section	161	mbarn	
Arc filling factor	0.780		Reduction factor in luminosity	0.81		
Total dipole magnet length	65442.0	m	Full crossing angle	73	μrad	
Arc length	83900	m	rms bunch length	60	mm	
Total straight section length	16100	m	rms IP spot size	3.0	μm	
Energy gain factor in collider rings	19.53		Beta at the 1st parasitic encounter	28.625	m	
Injection energy	3.20	TeV	rms spot size at the 1st parasitic encoun	22.7	μm	
Number of IPs	2		Stored energy per beam	4.0	GJ	
Revolution frequency	3.00	kHz	SR power per ring	2.2	MW	
Revolution period	333.3	μs	SR heat load at arc per aperture	26.3	W/m	
Physics performance and beam parameters						
Initial luminosity per IP	4.3E+34	cm <sup>-2</sup> s <sup>-1</sup>	Critical photon energy	8.4	keV	
Beta function at initial collision	0.5	m	Energy loss per turn	11.40	MeV	
Circulating beam current	0.19	A	Damping partition number	1		
Nominal beam-beam tune shift limit per	0.015		Damping partition number	1		
Bunch separation	25	ns	Damping partition number	2		
Bunch filling factor	0.756		Transverse emittance damping time	0.51	hour	
Number of bunches	10080		Longitudinal emittance damping time	0.25	hour	
Bunch population	4.0E+10					
Accumulated particles per beam	4.0E+14					

## CEPC CDR-Higgs

Peak Luminosity =  $3 \times 10^{34} \text{cm}^{-2}\text{s}^{-1}$

Ingetrated Luminosity =  $5.6 \text{ ab}^{-1}$

Higgs annual luminosity =  $0.8 \text{ ab}^{-1}$

## CEPC TDR-Higgs

Peak Luminosity =  $5 \times 10^{34} \text{cm}^{-2}\text{s}^{-1}$

Ingetrated Luminosity =  $9.3 \text{ ab}^{-1}$

Higgs annual luminosity =  $1.3 \text{ ab}^{-1}$

## CEPC TDR-Higgs (upgrade)

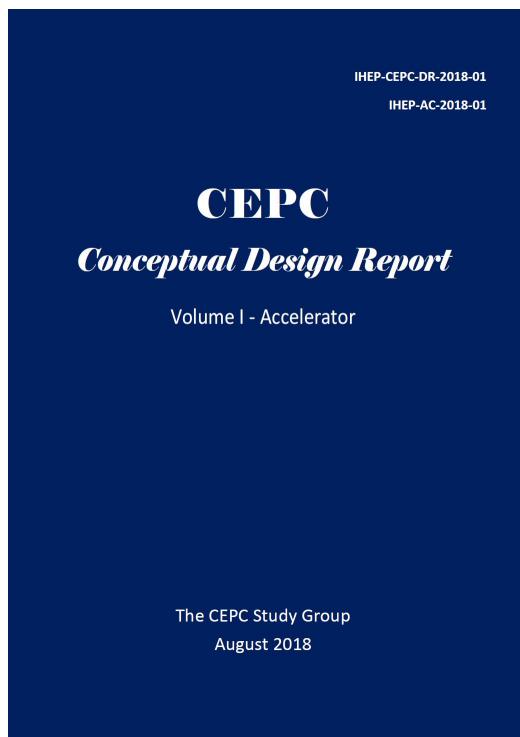
**Peak Luminosity =  $8.3 \times 10^{34} \text{cm}^{-2}\text{s}^{-1}$**

**Ingetrated Luminosity =  $15.4 \text{ ab}^{-1}$**

**Higgs annual luminosity =  $2.2 \text{ ab}^{-1}$**

**These parameters are used for Snowmass21**

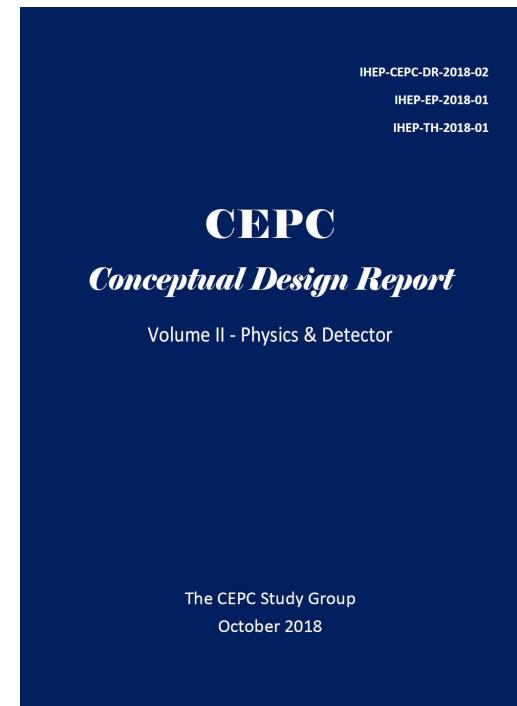
## CEPC CDR Vol. I, Accelerator



## CEPC Accelerator Snowmass 21 AF White Paper

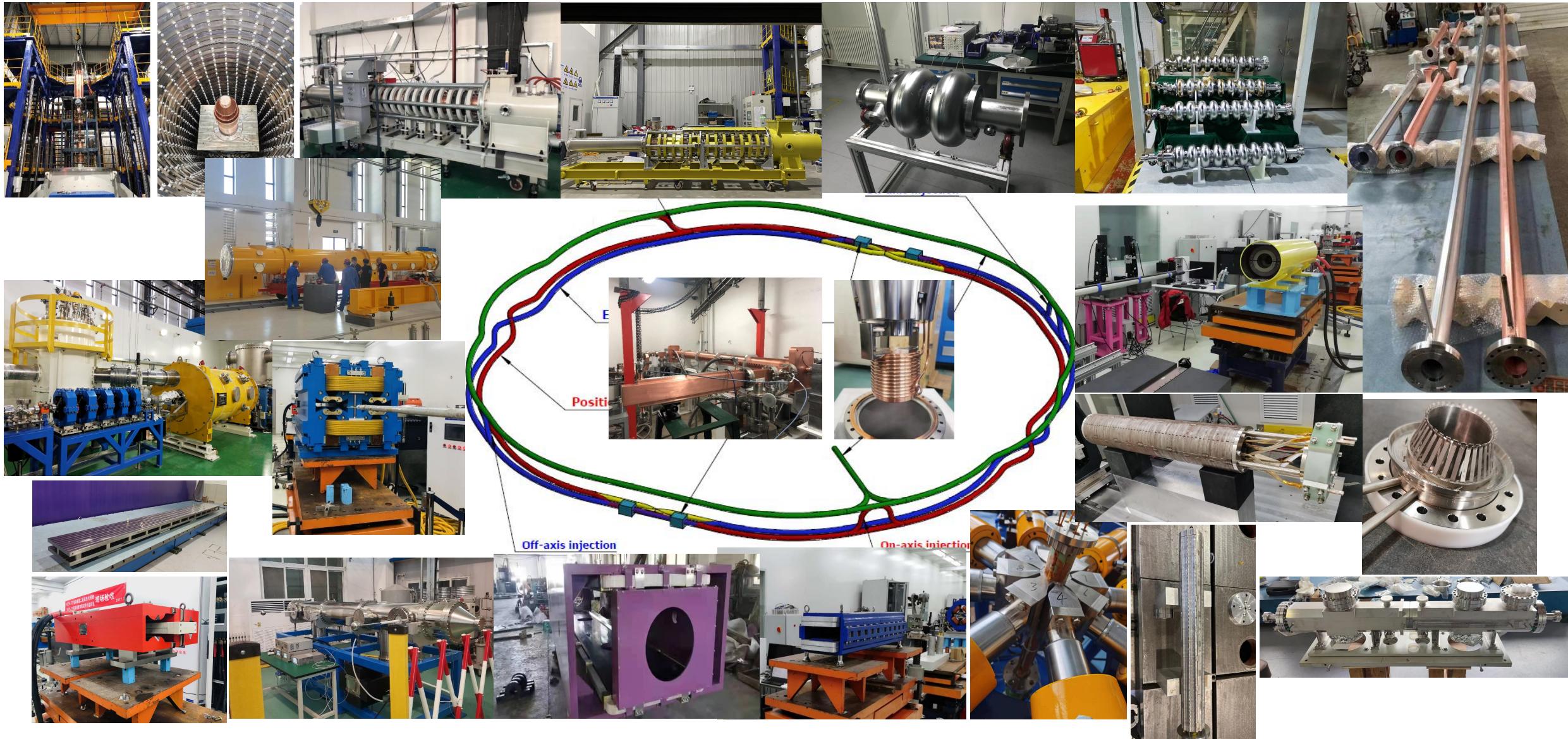
- 1) CEPC Accelerator white paper**  
to Snowmass21, arXiv:2203.09451
- 2) CEPC CDR Vol. I, Accelerator**  
[http://cepc.ihep.ac.cn/CEPC\\_CDR\\_Vol1\\_Accelerator.pdf](http://cepc.ihep.ac.cn/CEPC_CDR_Vol1_Accelerator.pdf)
- 3) CEPC CDR Vol. II, Physics and Detector**  
[http://cepc.ihep.ac.cn/CEPC\\_CDR\\_Vol2\\_Physics-Detector.pdf](http://cepc.ihep.ac.cn/CEPC_CDR_Vol2_Physics-Detector.pdf)  
**CEPC Video (BIM design)**
  - 1) [http://cepc.ihep.ac.cn/Qinhuang\\_Island.mp4](http://cepc.ihep.ac.cn/Qinhuang_Island.mp4)
  - 2) <http://cepc.ihep.ac.cn/Huzhou.mp4>
  - 3) <http://cepc.ihep.ac.cn/Changsha.mp4>

## CEPC CDR Vol. II, Physics/Detector



# **CEPC Accelerator System Key Hardware R&D Progresses in TDR**

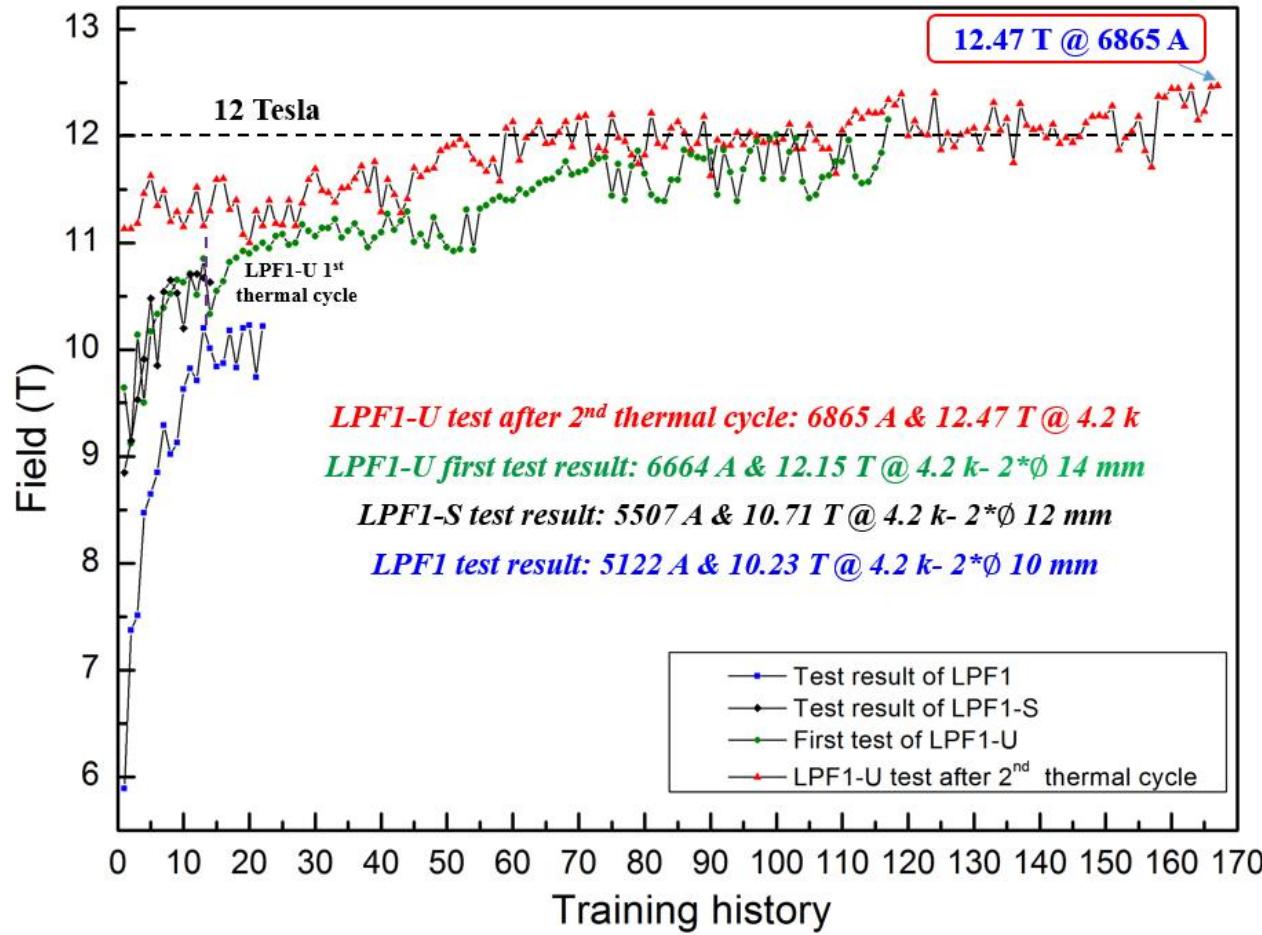
# CEPC TDR R&D Status of Key Technologies



# Latest performance of LPF1-U (SppC)



Picture of LPF1-U

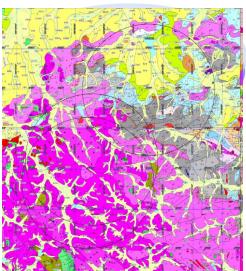


Qingjin Xu

Dual aperture superconducting dipole achieves 12.47 T at 4.2 K  
Entirely fabricated in China. The next step is reaching 16-19T field

# **CEPC TDR Siting and Civil Engineering**

# CEPC Siting Status

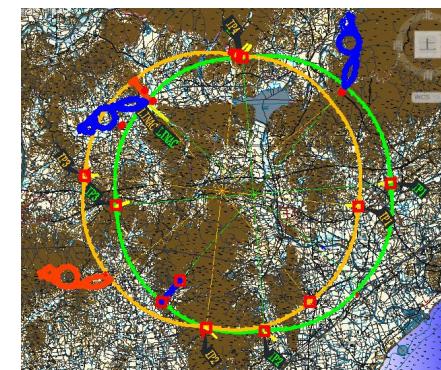


5

Three companies are working  
on siting and issues

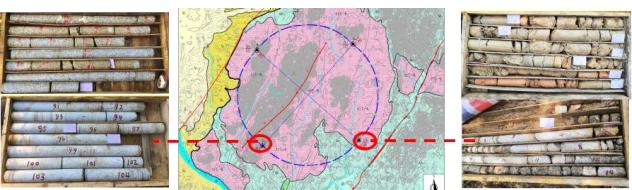


1



2020.9.14-18 Qinhuangdao updated

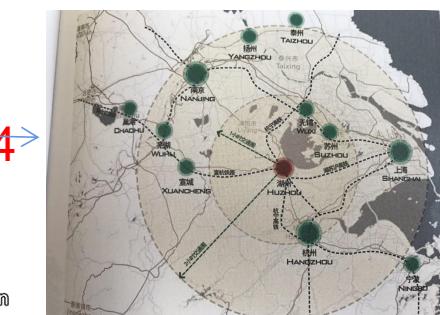
2019. 12月8-11 and 2020. 1. 8-10  
Chuangchun sitings update



6



2019. 08. 19-20 Changsha  
siting update



4



2019. 12. 16-17 Huzhou siting update

1) Qinhuangdao, Hebei Province (Completed in 2014)

2) Huangling, Shanxi Province (Completed in 2017)

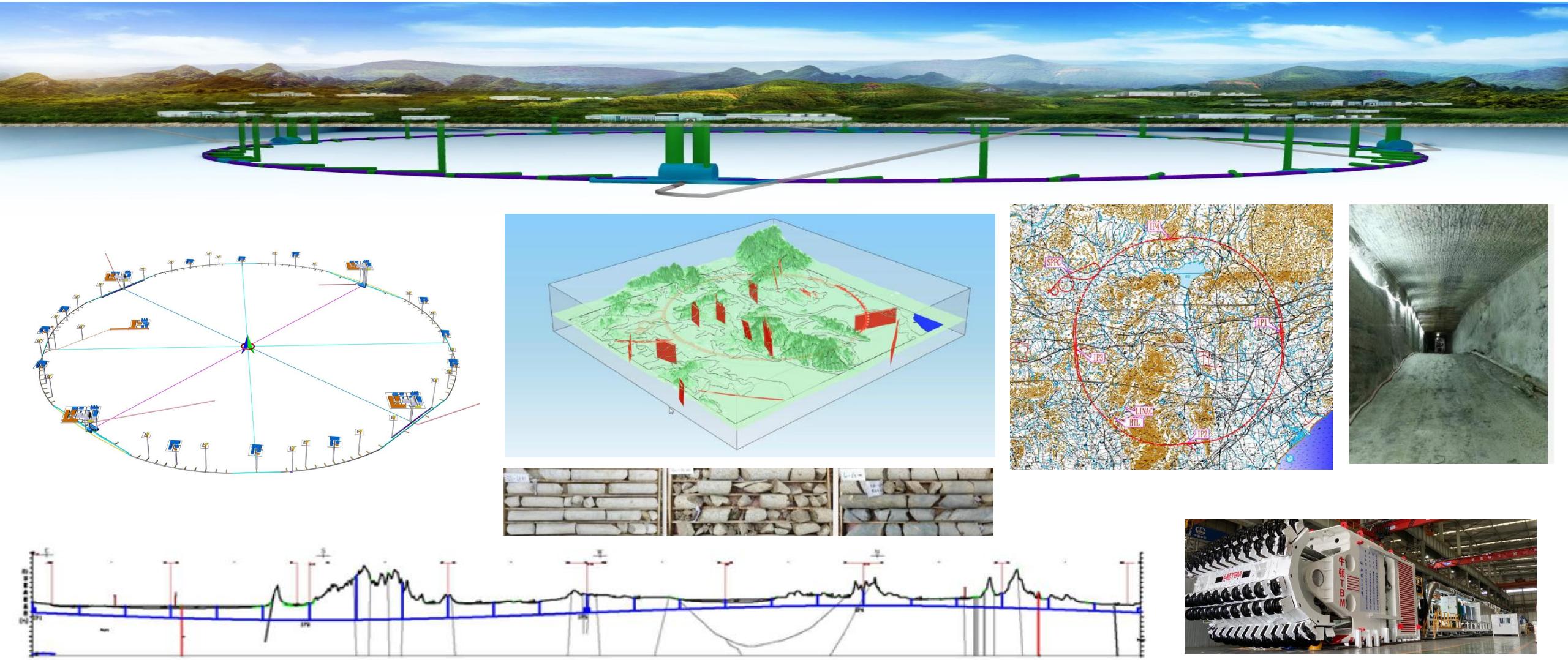
3) Shenshan, Guangdong Province(Completed in 2016)

4) Huzhou, Zhejiang Province (Started in March 2018)

5) Chuangchun, Jilin Province (Started in May 2018)

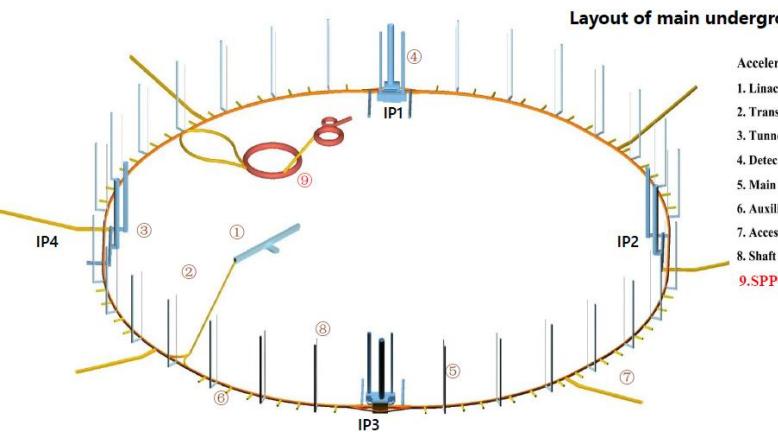
6) Changsha, Hunan Province (Started in Dec. 2018)

# CEPC Siting and Civil Engineering (Qinhuangdao TDR site as an example)



# CEPC Siting and Civil Engineering (Huzhou TDR site as an example)

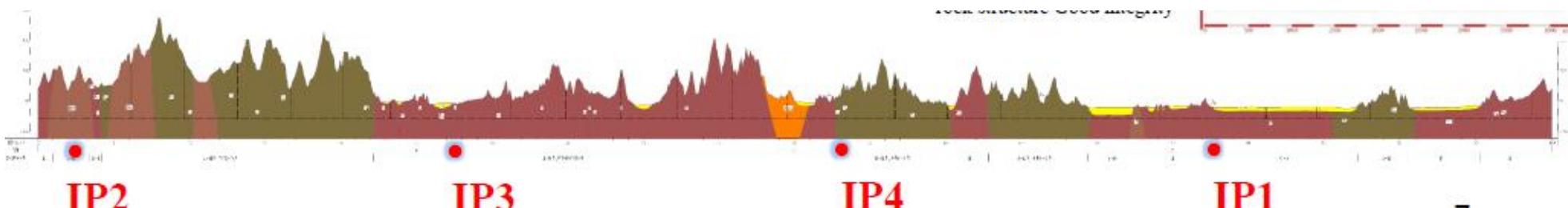
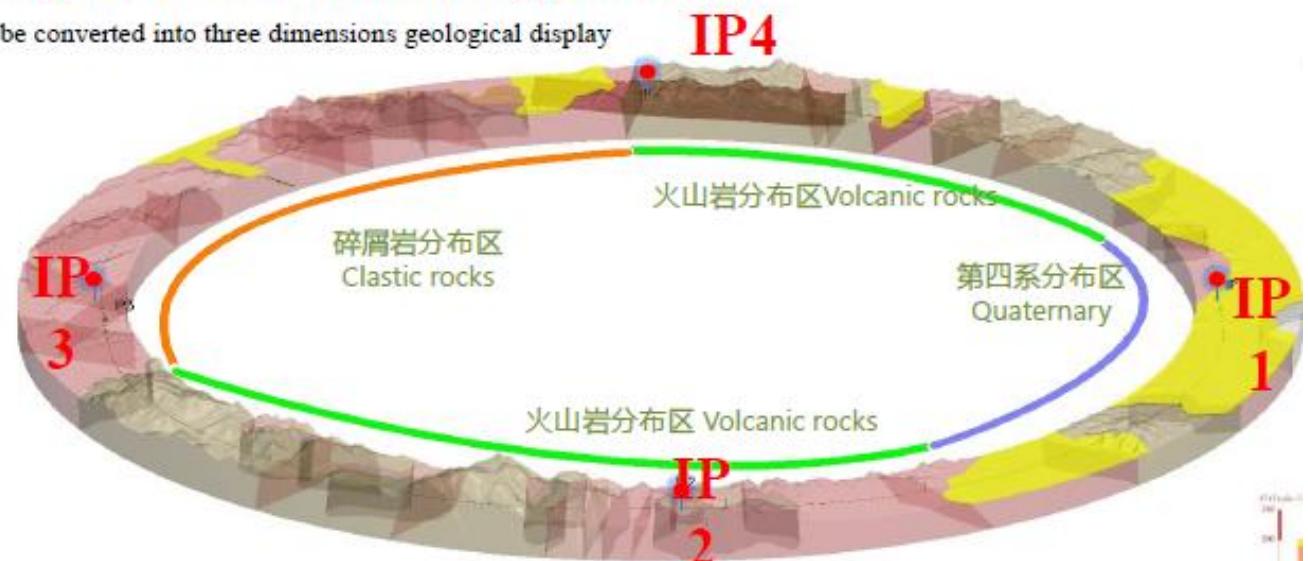
The minimum depth of the main ring is 70m



The geological work can be converted into three dimensions geological display

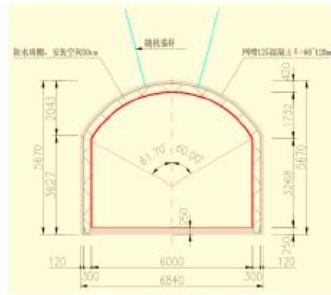
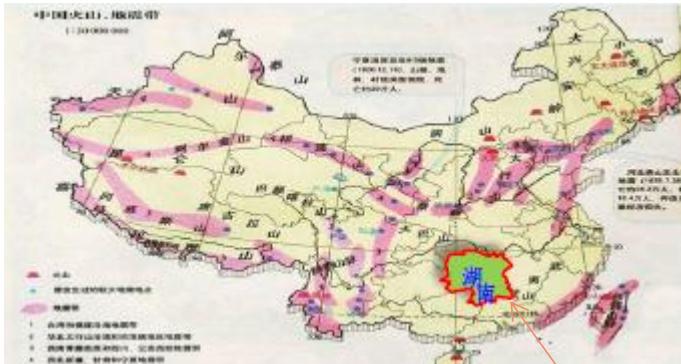
The sandstone and welded tuff in the site are relative moderate hard and stiff, respectively. The rock mass is intact along the tunnel.

Therefore, it is believed that the rock shows high engineering quality here, and is suitable for the project constructions.

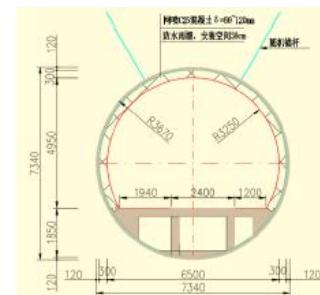


# CEPC Siting and Civil Engineering (Changsha TDR site as an example)

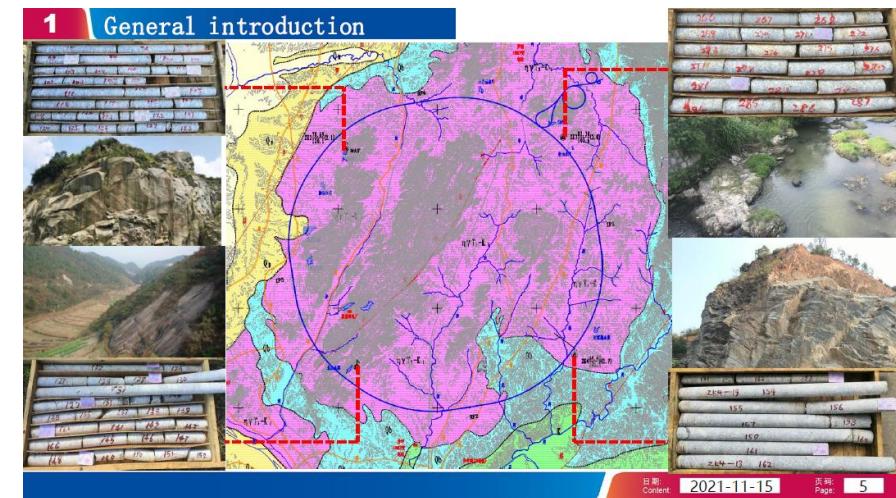
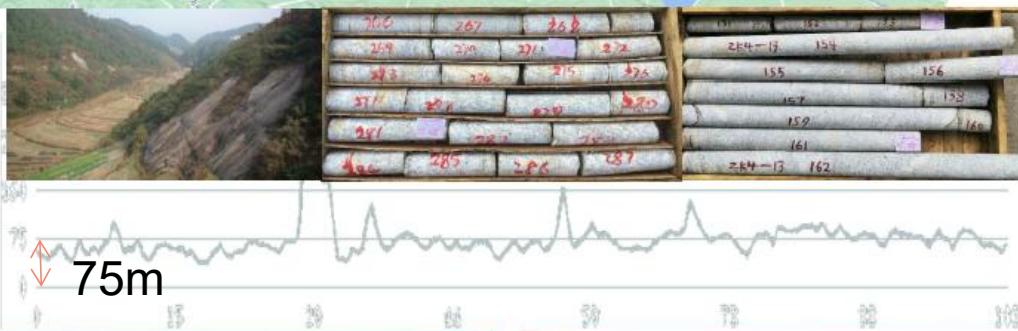
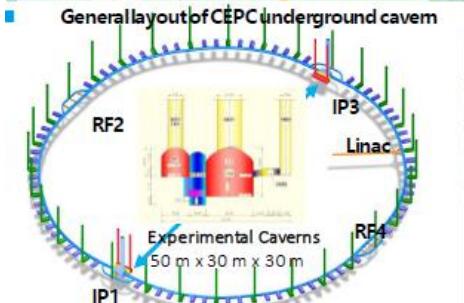
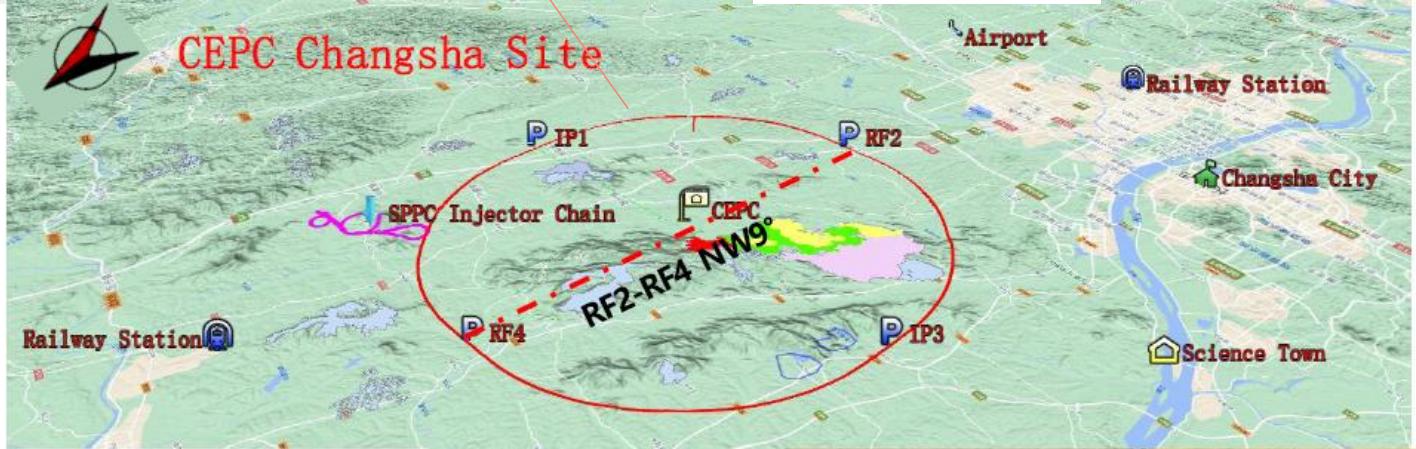
Very good geological condition



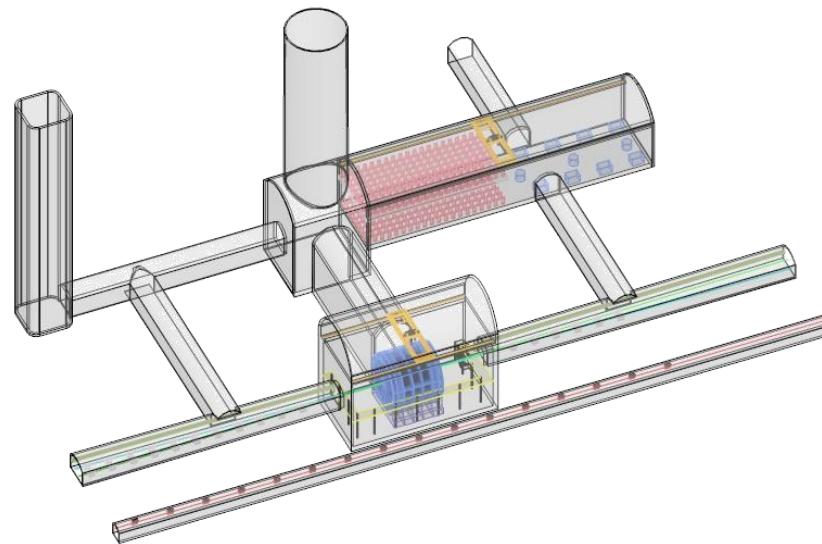
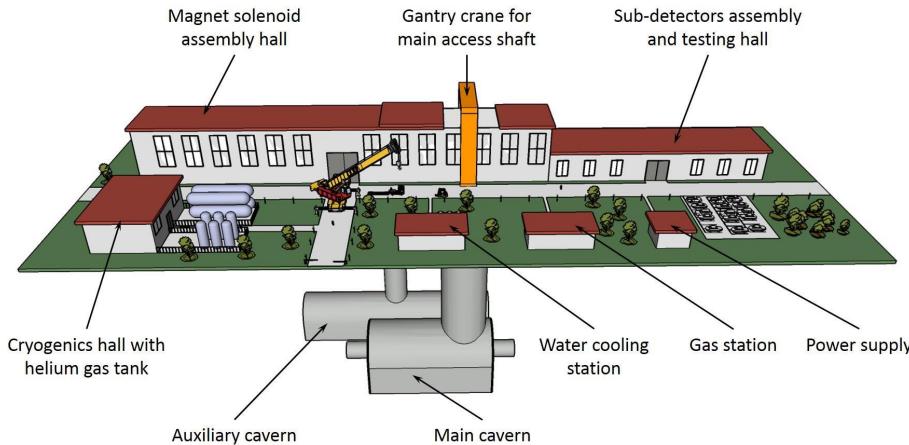
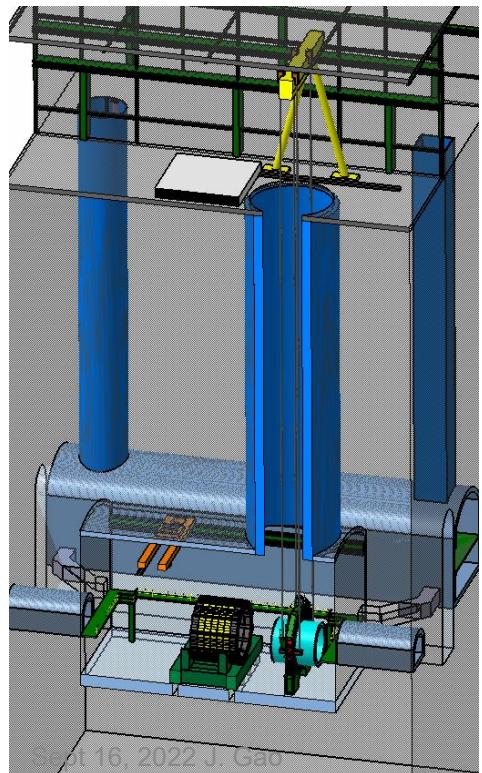
Drill-blast tunnel  
(6.0m × 5.0m)



TBM tunnel (D6.5m)

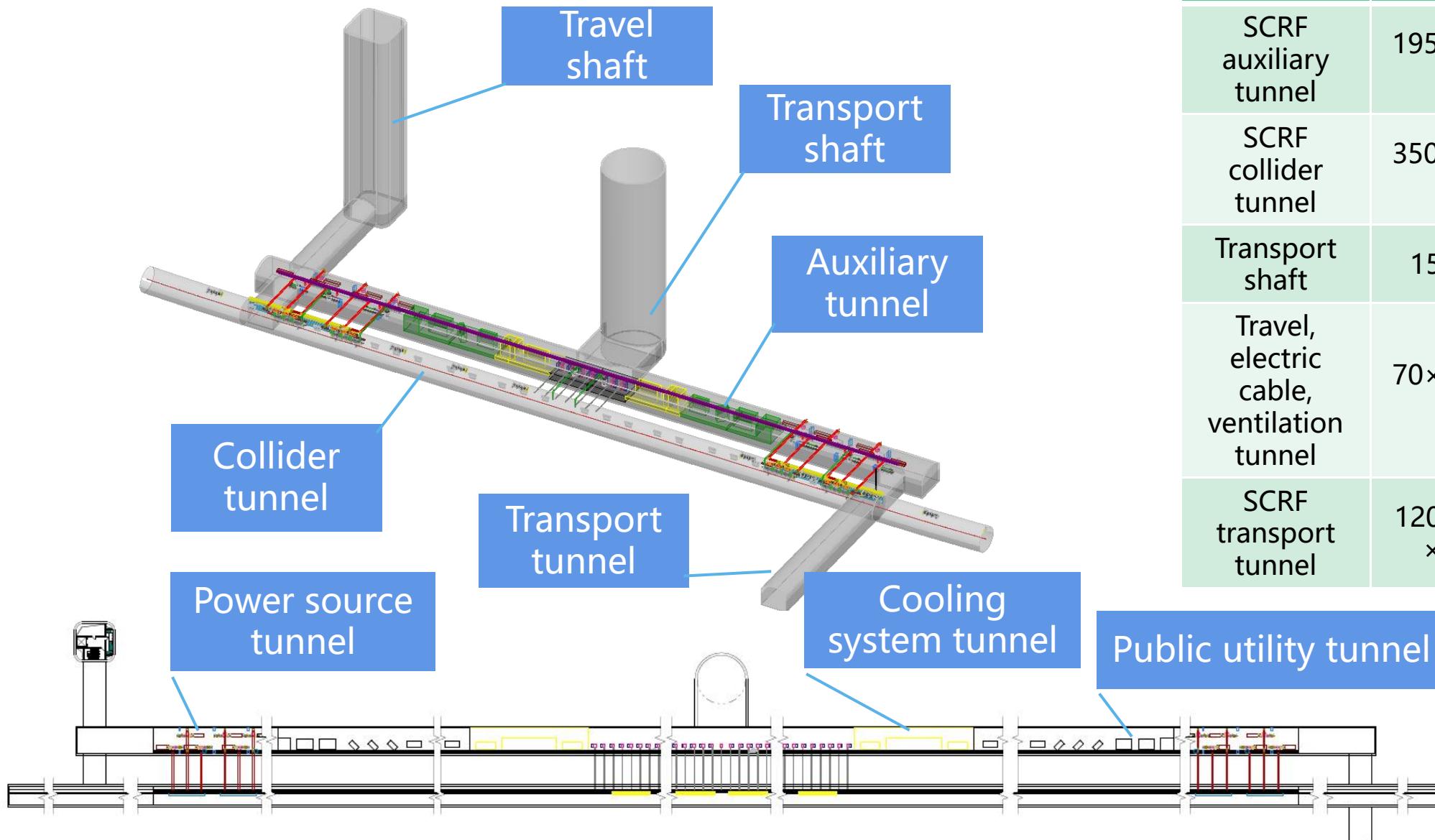


# CEPC IR Region



Name	L×W×H	Numb.
Experimental hall	39.4×20.4×31	×2
Axiliary hall	101.4×20×26.2	×2
Booster tunnel	1679×3.5×3.5	×4
Collider tunnel	1659.3x(6~11.4)x5	×4
Travel shaft	1200x7.5x7.5	×2
Connection, electric cable and ventilation shaft	70x10x10	×2

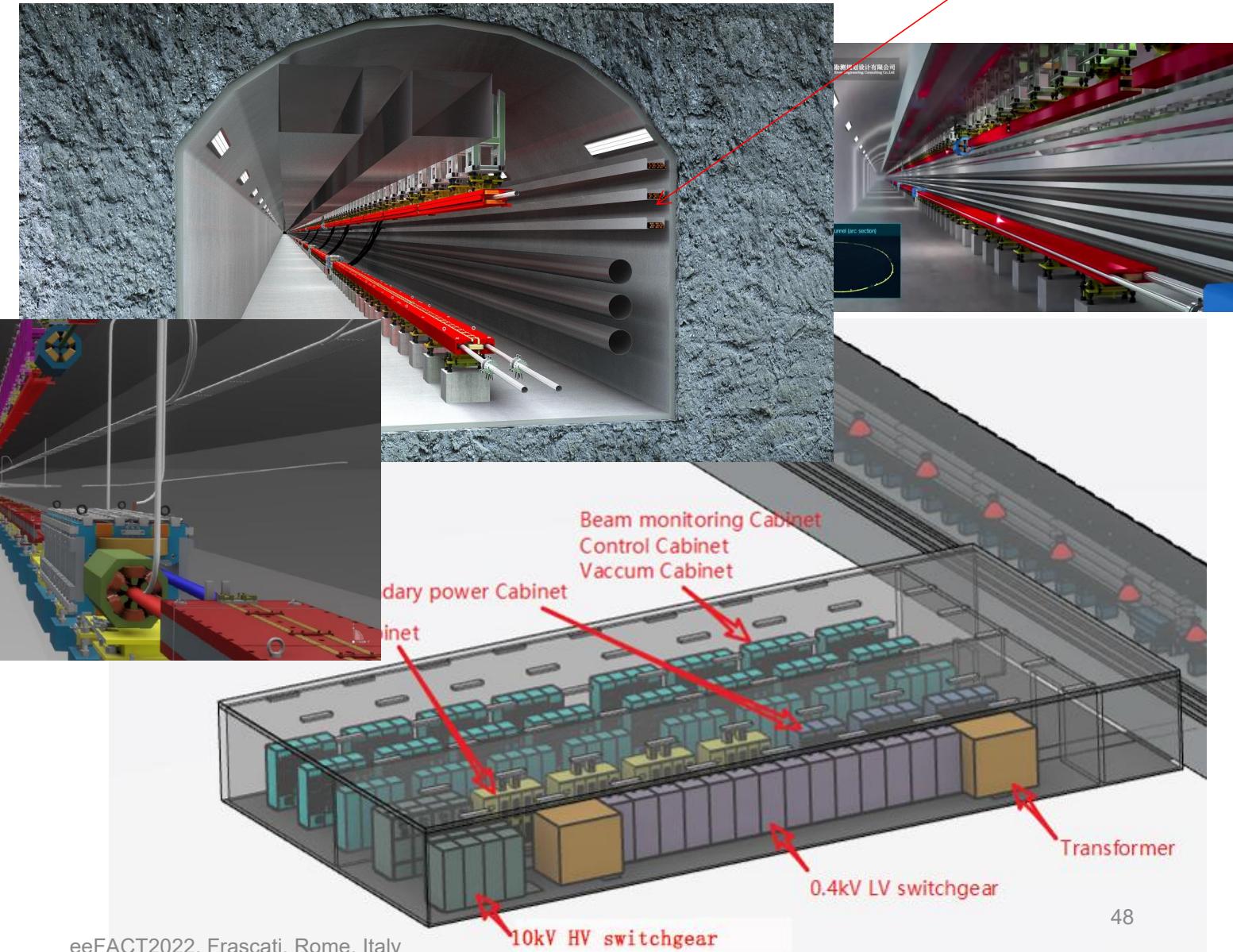
# CEPC SCRF Region



Name	L×W×H	Numb.
SCRF auxiliary tunnel	1950×8×7	×2
SCRF collider tunnel	3500×6×5	×2
Transport shaft	15×70	×2
Travel, electric cable, ventilation tunnel	70×10×10	×2
SCRF transport tunnel	1200×88×7.5	×2

# CEPC Civil Engineering Design (BIM)

## Electrical Equipment General Layout in Auxiliary



# **CEPC TDR and EDR Schedules and CEPC Timeline**

# **CEPC Accelerator TDR Documentation Preparation and EDR Plans**

## **TDR timeline:**

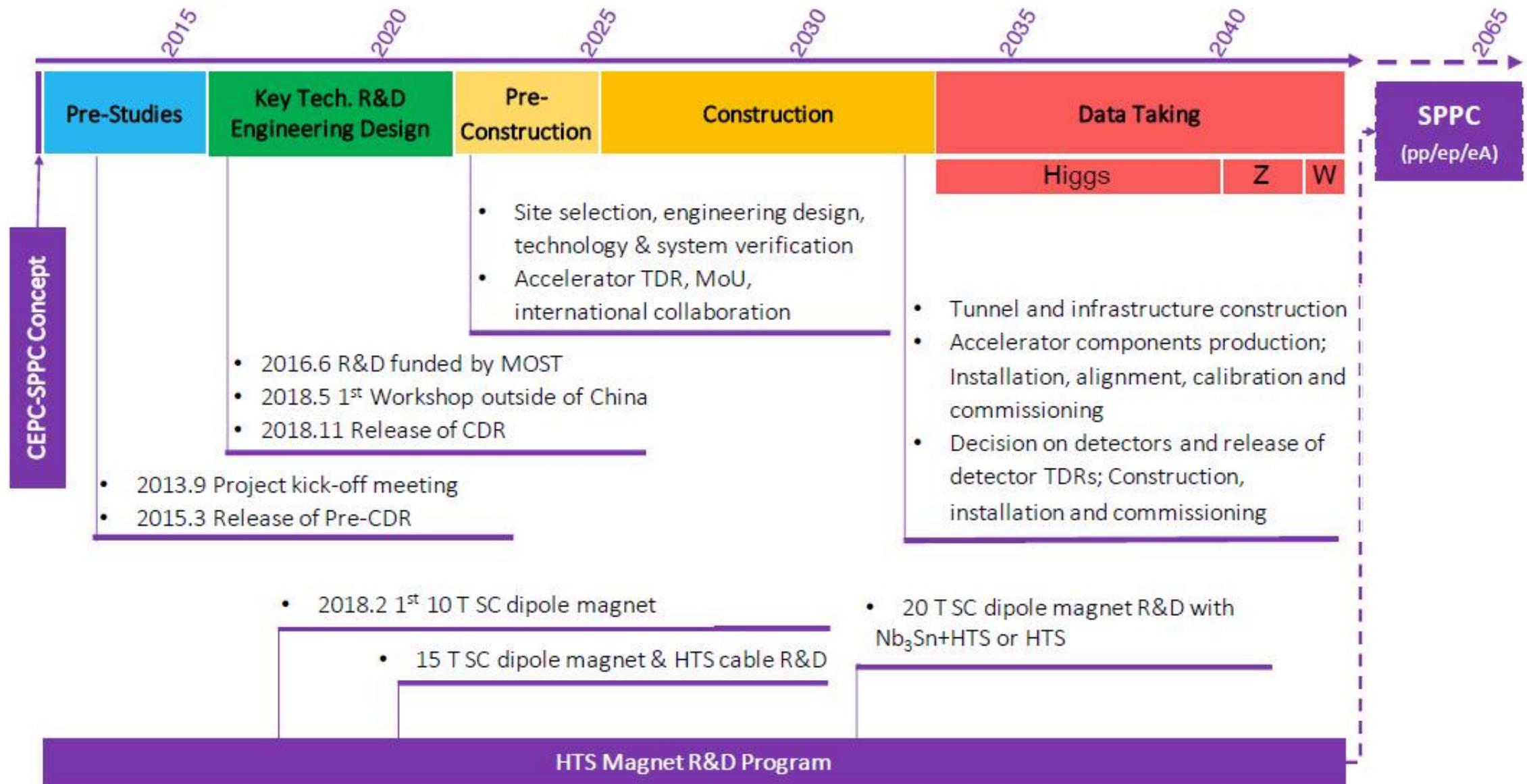
TDR started to write after the first IARC review in June 2022

TDR completes in Dec. 2022 (with IARC review, SC and IAC approval)

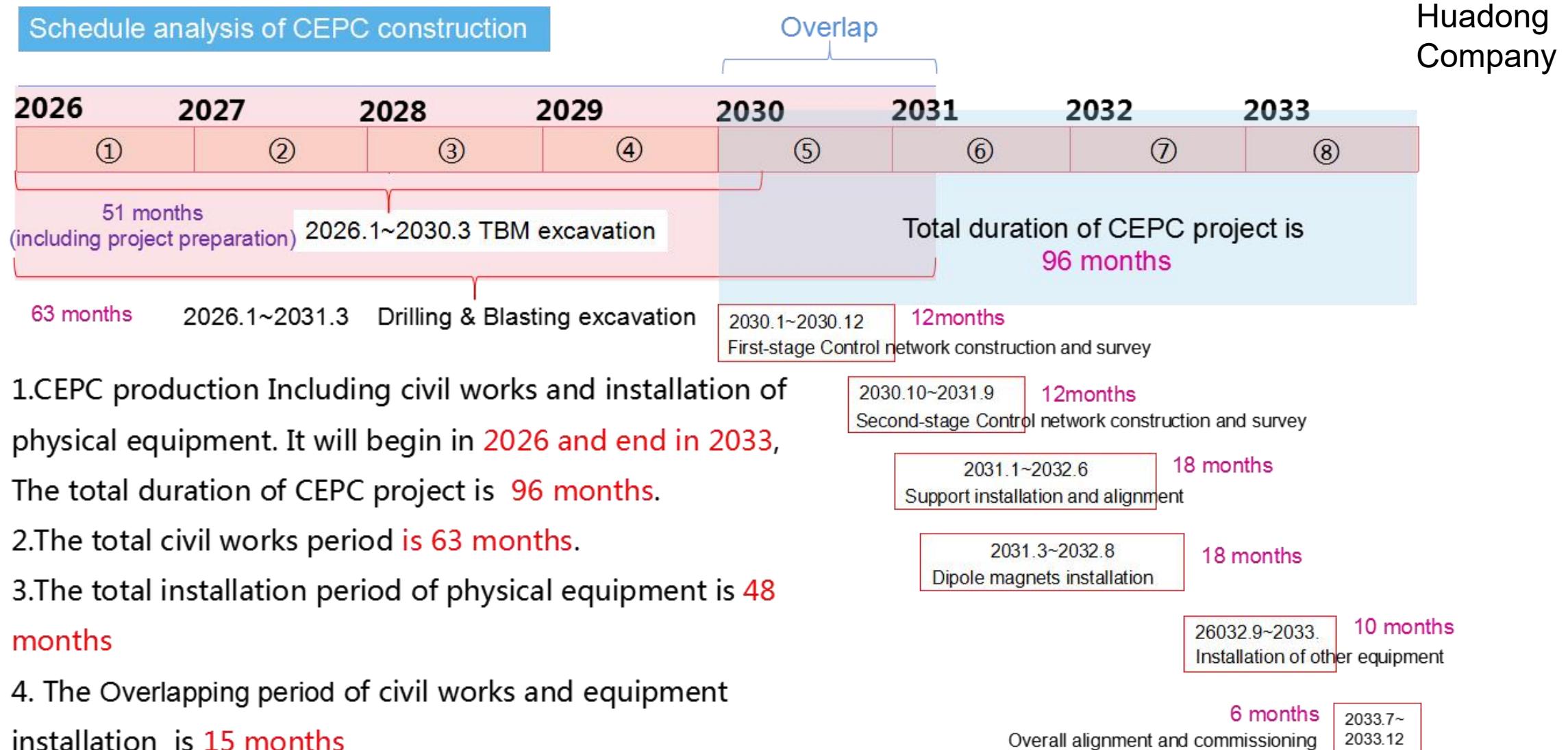
## **CEPC Accelerator EDR Phase Plan:Jan. 2023-Dec. 2025**

- CEPC site study converging to one or two with detailed feasibility studies (tunnel and infrastructures, environment)
- Engineering design of CEPC accelerator systems and components towards fabrication in an industrial way
- Site dependent civil engineering design implementation preparation
- Work closely with CAS and MOST to prepare CEPC be put in the “15th five year plan”  
**(under way)**
- EDR document completed for government’s approval of starting construction around 2026  
(the starting of the  
“15th five year plan”)

# CEPC Project Timeline



# Civil Construction and Installation Timeline



# Summary

- CEPC CDR parameters, designs and AC power consumptions are reviewed
- CEPC TDR parameters, designs and AC power consumptions are presented.
- **CEPC TDR AC power consumption has not been fully optimized, such as RF operation modes, magnets' power distribution networks, utilities, etc., further power reduction optimization will be conducted.**
- estimation is still on going to be more complete and precise
- CEPC accelerator key hardware R&D, CEPC TDR siting and civil engineering design are presented
- CEPC TDR and EDR Schedules and CEPC Timeline are given

# Acknowledgements

- Thanks go to CEPC-SppC accelerator team's hardworks, international and CIPC collaborations
- Special thanks to CEPC SC, IAC and IARC's critical comments, suggestions and encouragement