

CEPC Accelerator EDR Progress Status

J. Gao

IHEP

On behalf of the CEPC-SppC team

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Hong Kong



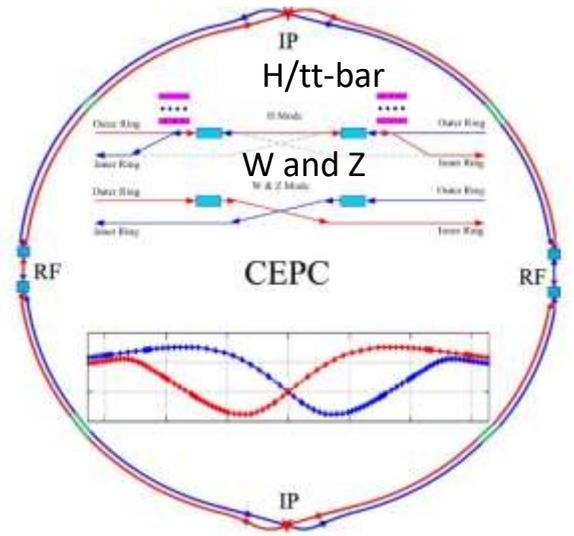
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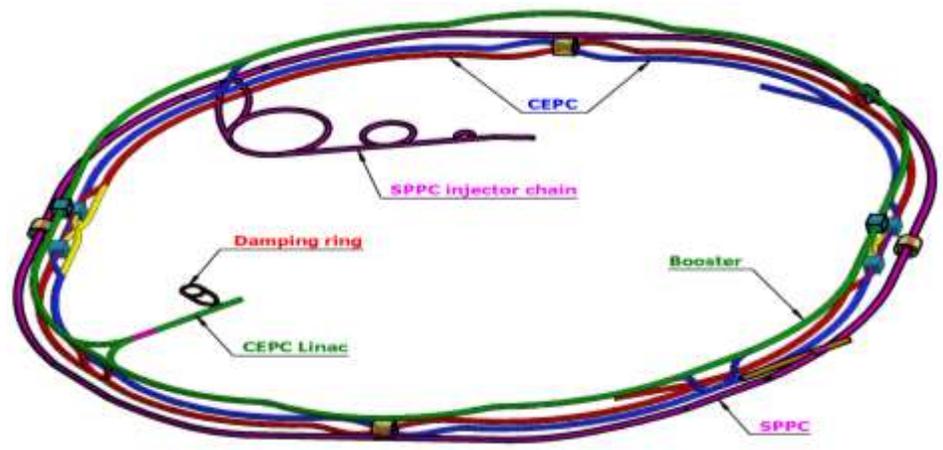


CEPC Higgs Factory and SppC Layout in TDR/EDR

CEPC as a Higgs Factory: **H, W, Z**, upgradable to **ttbar**, followed by a SppC (a Hadron collider) $\sim 125\text{TeV}$
 30MW SR power per beam (upgradable to 50MW), high energy gamma ray 100Kev \sim 100MeV

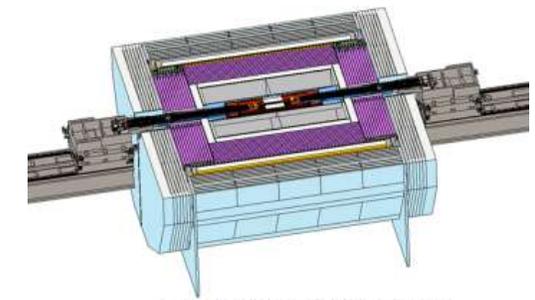
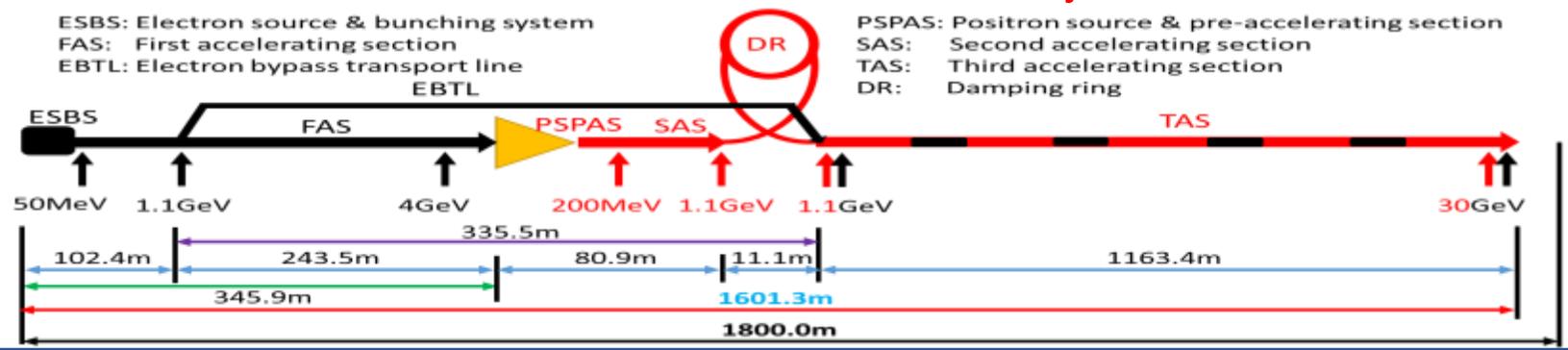


CEPC collider ring (100km)

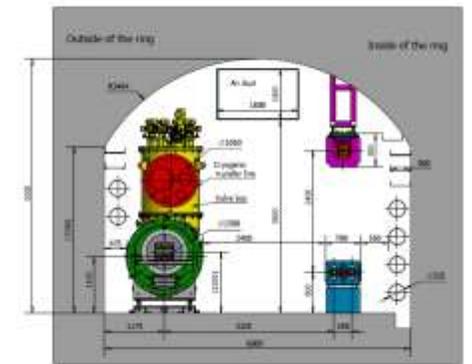


CEPC booster ring (100km)

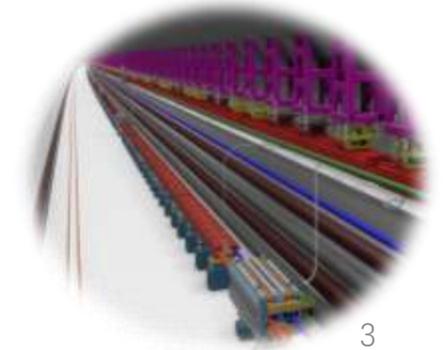
CEPC TDR S+C-band 30GeV linac injector



TUNNEL CROSS SECTION OF THE ARC AREA



CEPC/SppC in the same tunnel



CEPC Accelerator System Parameters in TDR

Linac

Parameter	Symbol	Unit	Baseline
Energy	E_e/E_{e^+}	GeV	30
Repetition rate	f_{rep}	Hz	100
Bunch number per pulse			1 or 2
Bunch charge		nC	1.5 (3)
Energy spread	σ_E		1.5×10^{-3}
Emittance	ε_r	nm	6.5

Booster

Parameter	Unit	$t\bar{t}$		H		W		Z	
		Off axis injection	Off axis injection	On axis injection	Off axis injection				
Circumfer.	km	100							
Injection energy	GeV	30							
Extraction energy	GeV	180	120		80	45.5			
Bunch number		35	268	261+7	1297	3978	5967		
Maximum bunch charge	nC	0.99	0.7	20.3	0.73	0.8	0.81		
Beam current	mA	0.11	0.94	0.98	2.85	9.5	14.4		
SR power	MW	0.93	0.94	1.66	0.94	0.323	0.49		
Emittance	nm	2.83	1.26		0.56	0.19			
RF frequency	GHz	1.3							
RF voltage	GV	9.7	2.17		0.87	0.46			
Full injection from empty	h	0.1	0.14	0.16	0.27	1.8	0.8		

Collider

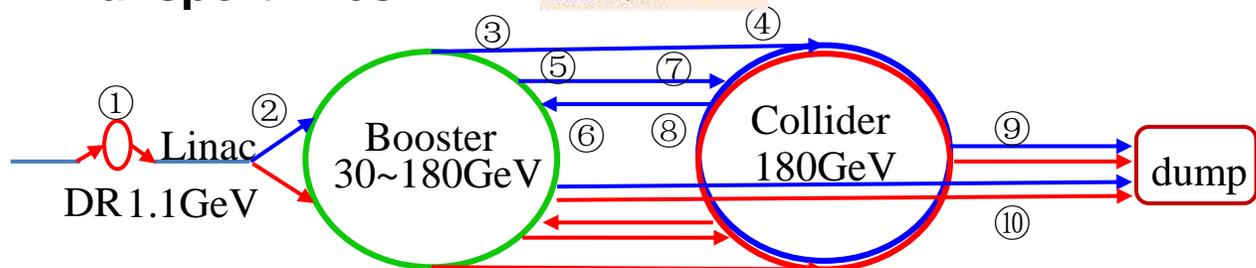
Parameter	Higgs		Z	W	$t\bar{t}$
	Number of IPs	2			
Circumference (km)	100.0				
SR power per beam (MW)	30				
Energy (GeV)	120	45.5	80	180	
Bunch number	268	11934	1297	35	
Emittance $\varepsilon_x/\varepsilon_y$ (nm/pm)	0.64/1.3	0.27/1.4	0.87/1.7	1.4/4.7	
Beam size at IP σ_x/σ_y (um/nm)	14/36	6/35	13/42	39/113	
Bunch length (natural/total) (mm)	2.3/4.1	2.5/8.7	2.5/4.9	2.2/2.9	
Beam-beam parameters ξ_x/ξ_y	0.015/0.11	0.004/0.127	0.012/0.113	0.071/0.1	
RF frequency (MHz)	650				
Luminosity per IP ($10^{34} \text{ cm}^{-2} \text{ s}^{-1}$)	5.0	115	16	0.5	
Luminosity per IP ($10^{34} \text{ cm}^{-2} \text{ s}^{-1}$) From J. Gao's formula below	5	115	12	0.59	

Running scenarios: Higgs 10 years, Z 2 years, W 1 year, $t\bar{t}$ 5 years

Factory of
4 Million Higgs
4 Trillion Z bosons
200 Million W+W pairs
600K $t\bar{t}$ pairs

$$L_{max} [cm^{-2} s^{-1}] = 0.158 \times 10^{34} \frac{(1+r)}{\beta_y [mm]} \sqrt{\frac{R[m]}{C_V [mGeV^3] N_{IP}}} (P_b [MW]/E [GeV]^2) e^{\frac{\sqrt{\Phi_p}}{3.22}} (1+0.000505 \cdot \Phi_p^2) \quad (\text{J. Gao's formula})$$

Transport lines



CEPC Technical Design Report (TDR) includes:
 1) CEPC Accelerator TDR released on Dec. 25, 2023
 2) CEPC Detector TDRrd (rd=reference design) will be completed by June 2025

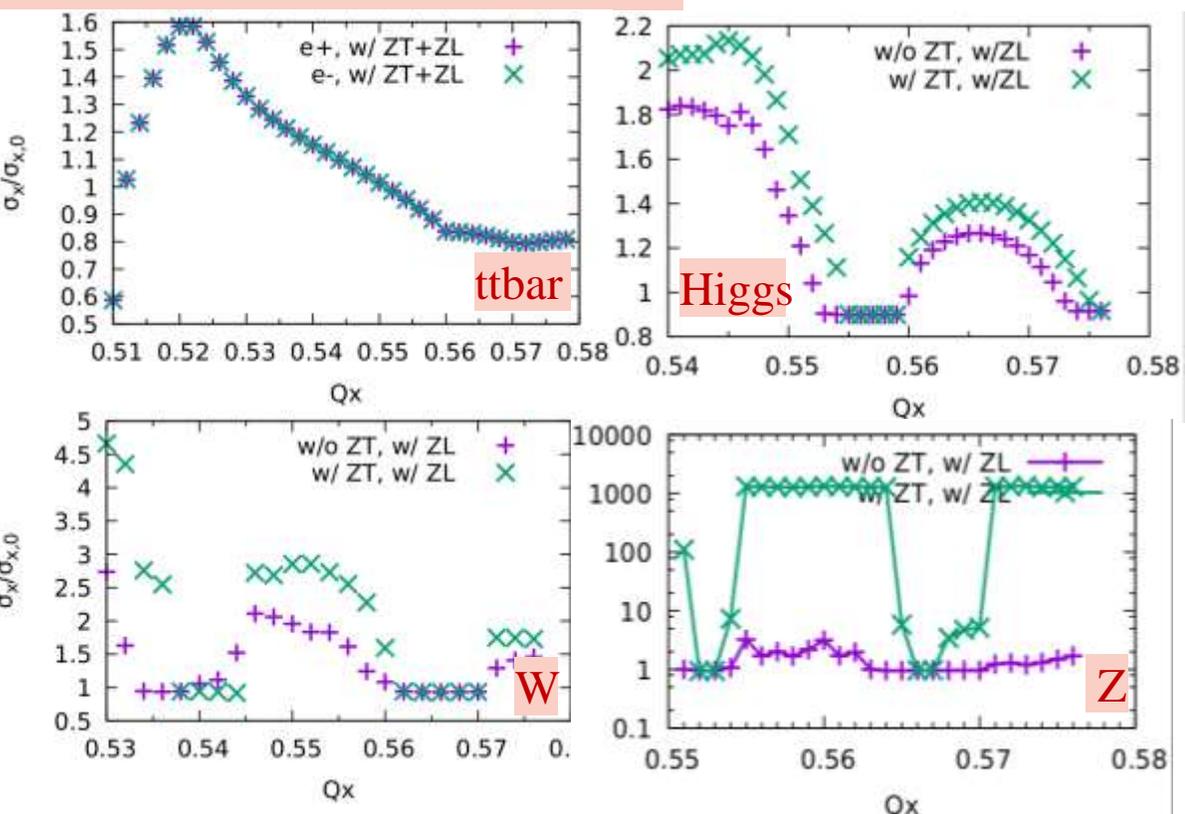
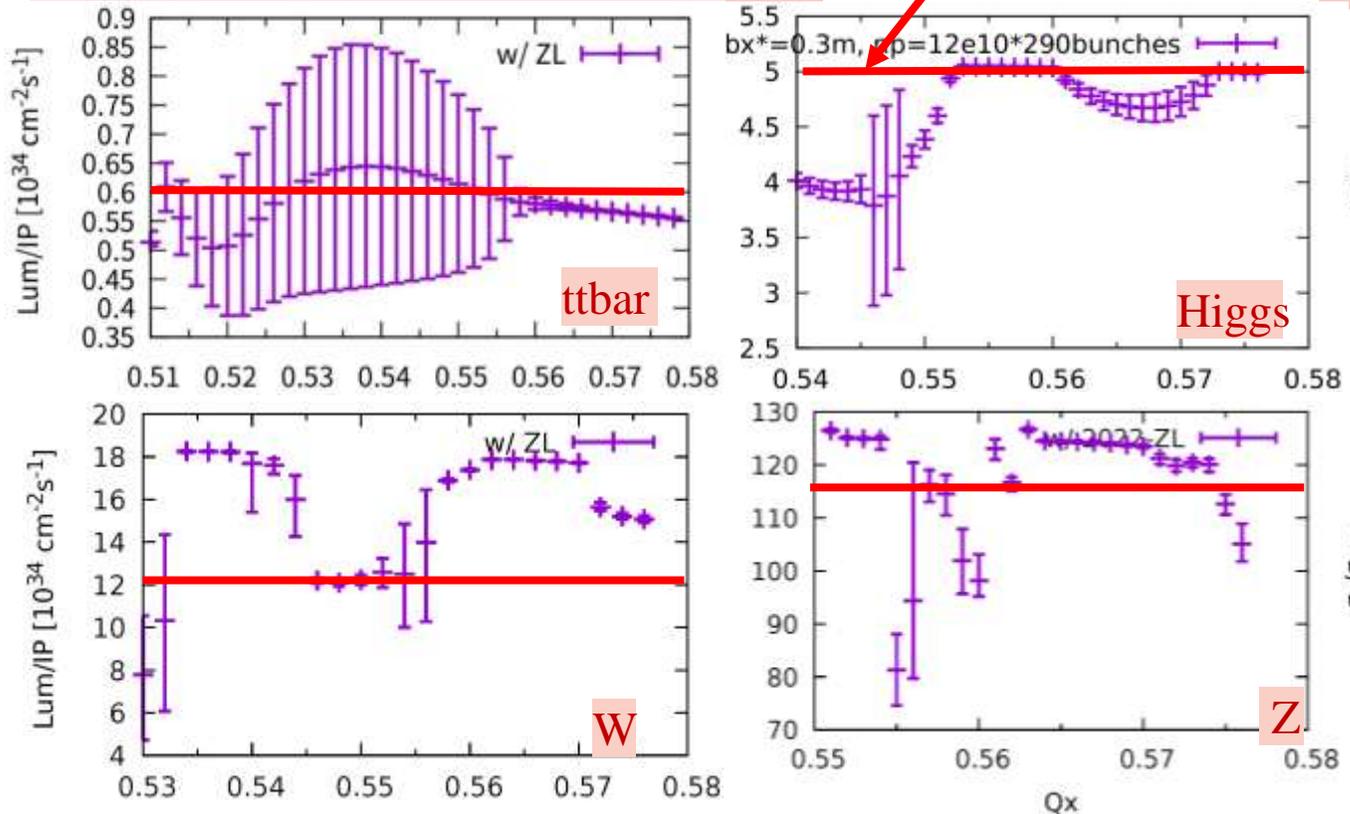
Studies of Beam-Beam Effects in CEPC



Results from J. Gao's formulae

Luminosity simulations w/ZL

Transverse size simulations



Above results from CEPC accelerator TDR: J. Gao, CEPC Technical Design Report: Accelerator. *Radiat Detect Technol Methods* (2024). <https://doi.org/10.1007/s41605-024-00463-y>

Beam-beam simulation results are consistent with the TDR parameter tables.

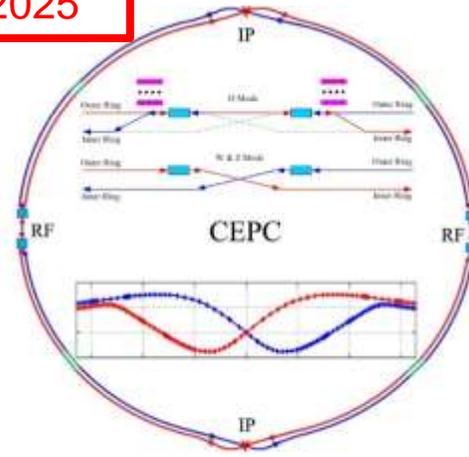
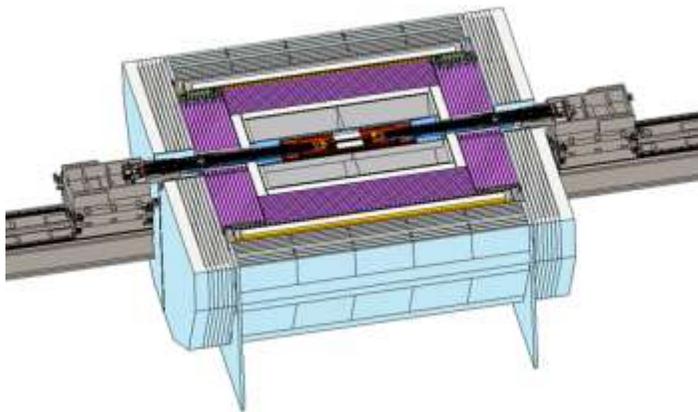
- Luminosity & Lifetime is evaluated by strong-strong simulation
- X-Z instability is well suppressed even considering Potential Well Distortion
- Lifetime optimization with both beam-beam\lattice nonlinearity is done

CEPC Accelerator Parameter Finetuning in EDR

The CEPC Clock Issue and Finetuning of the Circumference

Dou Wang, Jie Gao, Jianchun Wang, Dapeng Jin, Xiaohao Cui, Ge Lei, Cai Meng, Wei Wei, Jingbo Ye, Yiwei Wang, Jiyuan Zhai, Yuhui Li, Zhonghui Ma, Jun Hu, Shengsen Sun, Xiaolong

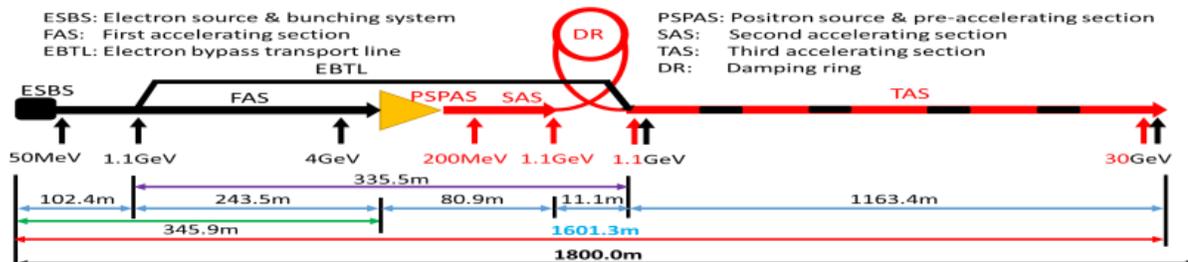
To be submitted to RDTM in 2025



CEPC Detector Ref-TDR

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CEPC Accelerator Parameter Finetuning in EDR-1

Table 1: CEPC baseline parameters in EDR

	Higgs (3T)		Z (2T)		W (3T)	t \bar{t} (3T)
Number of IPs	2					
Circumference (km)	99.955					
Half crossing angle at IP (mrad)	16.5					
Bending radius (km)	10.7					
SR power per beam (MW)	30	30	10	30	30	
Energy (GeV)	120	45.5		80	180	
Energy loss per turn (GeV)	1.8	0.037		0.357	9.1	
Damping time $\tau_x/\tau_y/\tau_z$ (ms)	44.6/44.6/22.3	816/816/408		150/150/75	13.2/13.2/6.6	
Piwinski angle	4.88	24.23		5.98	1.23	
Bunch number	268	11934	3978	1297	35	
Bunch spacing (ns)	553.9	23.1	69.2	184.6	3969.8	
[\times 23.08 ns]	24	1	3	8	172	
Train gap [%]	55	17		17	58	
Bunch population (10^{11})	1.3	1.4		1.35	2.0	
Beam current (mA)	16.7	803.5	267.8	84.1	3.3	
Phase advance of arc FODO ($^\circ$)	90	60		60	90	
Momentum compaction (10^{-5})	0.71	1.43		1.43	0.71	
Beta functions at IP β_x^*/β_y^* (m/mm)	0.3/1	0.13/0.9		0.21/1	1.04/2.7	
Emittance $\varepsilon_x/\varepsilon_y$ (nm/pm)	0.64/1.3	0.27/1.4		0.87/1.7	1.4/4.7	
Betatron tune n_x/n_y	445/445	317/317		317/317	445/445	
Beam size at IP s_x/s_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	1.0/1.7		1.05/2.5	2.0/2.6	
Beam-beam parameters χ_x/χ_y	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					
Harmonic number	216720					
Longitudinal tune n_s	0.049	0.035		0.062	0.078	
Beam lifetime (Bhabha/beamstrahlung) (min)	40/40	90/2800		60/195	81/23	
Beam lifetime requirement (min)	18	77		22	18	
Luminosity per IP (10^{34} cm $^{-2}$ s $^{-1}$)	5.0	115	38	16	0.5	

Table 2: CEPC main parameters with 50 MW upgrade

	Higgs (3T)		Z (2T)	W (3T)	t \bar{t} (3T)
Number of IPs	2				
Circumference (km)	99.955				
Half crossing angle at IP (mrad)	16.5				
Bending radius (km)	10.7				
SR power per beam (MW)	50				
Energy (GeV)	120	45.5	80	180	
Energy loss per turn (GeV)	1.8	0.037	0.357	9.1	
Damping time $\tau_x/\tau_y/\tau_z$ (ms)	44.6/44.6/22.3	816/816/408	150/150/75	13.2/13.2/6.6	
Piwinski angle	4.88	29.52	5.98	1.23	
Bunch number	446	13104	2162	58	
Bunch spacing (ns)	277.0	23.1	138.5	2585.0	
[\times 23.08 ns]	12	1	6	112	
Train gap [%]	63	9	10	55	
Bunch population (10^{11})	1.3	2.14	1.35	2.0	
Beam current (mA)	27.8	1340.9	140.2	5.5	
Phase advance of arc FODO ($^\circ$)	90	60	60	90	
Momentum compaction (10^{-5})	0.71	1.43	1.43	0.71	
Beta functions at IP β_x^*/β_y^* (m/mm)	0.3/1	0.13/0.9	0.21/1	1.04/2.7	
Emittance $\varepsilon_x/\varepsilon_y$ (nm/pm)	0.64/1.3	0.27/1.4	0.87/1.7	1.4/4.7	
Betatron tune ν_x/ν_y	445/445	317/317	317/317	445/445	
Beam size at IP σ_x/σ_y (um/nm)	14/36	6/35	13/42	39/113	
Bunch length (natural/total) (mm)	2.3/4.1	2.7/10.6	2.5/4.9	2.2/2.9	
Energy spread (natural/total) (%)	0.10/0.17	0.04/0.15	0.07/0.14	0.15/0.20	
Energy acceptance (DA/RF) (%)	1.6/2.2	1.0/1.5	1.05/2.5	2.0/2.6	
Beam-beam parameters ξ_x/ξ_y	0.015/0.11	0.0045/0.13	0.012/0.113	0.071/0.1	
RF voltage (GV)	2.2	0.1	0.7	10	
RF frequency (MHz)	650				
Harmonic number	216720				
Longitudinal tune ν_s	0.049	0.032	0.062	0.078	
Beam lifetime (Bhabha/beamstrahlung) (min)	40/40	90/930	60/195	81/23	
Beam lifetime requirement (min)	20	81	25	18	
Luminosity per IP (10^{34} cm $^{-2}$ s $^{-1}$)	8.3	192	26.7	0.8	

CEPC Accelerator Parameter Finetuning in EDR-2

Table 3: Main Booster parameters at injection energy.

	Unit	<i>t</i>	<i>H</i>	<i>W</i>	<i>Z</i>	
Circumference	km	99.955				
Beam energy	GeV	30				
Bunch number		35	268	1297	3978	5967
Threshold of single bunch current	μA	8.68	6.3	5.8		
Threshold of beam current (limited by coupled bunch instability)	mA	97	106	100	93	96
Bunch charge	nC	1.1	0.78	0.81	0.87	0.9
Single bunch current	μA	3.4	2.3	2.4	2.65	2.69
Beam current	mA	0.12	0.62	3.1	10.5	16.0
Growth time (coupled bunch instability)	ms	2530	530	100	29.1	18.7
Energy spread	%	0.025				
Synchrotron radiation loss/turn	MeV	6.5				
Momentum compaction factor	10 ⁻⁵	1.12				
Emittance	nm	0.076				
Natural chromaticity	H/V	-372/-269				
RF frequency	MHz	1300				
Harmonic number		433440				
RF voltage	MV	761.0	346.0	300.0		
Betatron tune ν_x/ν_y		321.23/117.18				
Longitudinal tune		0.14	0.0943	0.0879		
RF energy acceptance	%	5.7	3.8	3.6		
Damping time	s	3.1				
Bunch length of linac beam	mm	0.4				
Energy spread of linac beam	%	0.15				
Emittance of linac beam	nm	6.5				

Table 4: Main Booster parameters at extraction energy.

	Unit	^a	^b	^w	^z	
		Off axis injection	Off axis injection	On axis injection	Off axis injection	Off axis injection
Circumference	km	99.955				
Beam energy	GeV	180	120	80	45.5	
Bunch number		35	268	261+7	1297	3978 5967
Maximum bunch charge	nC	0.99	0.7	20.3	0.73	0.8 0.81
Maximum single bunch current	μA	3.0	2.1	61.2	2.2	2.4 2.42
Threshold of single bunch current	μA	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 14.4
Growth time (coupled bunch instability)	ms	16611	2359	1215	297.8	49.5 31.6
Bunches per pulse of Linac		1	1	1	2	
Time for ramping up	s	7.1	4.3	2.4	1.0	
Injection duration for top-up (Both beams)	s	29.2	23.1	31.8	38.1	132.4
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 ν_x/ν_y		321.27/117.19				
RF frequency	MHz	1300				
Harmonic number		433440				
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 0.8



CEPC Accelerator Parameter Finetuning in EDR-3

Table 5: Main parameters of the Linac.

Parameter	Symbol	Unit	Baseline
Energy	E_{e^-}/E_{e^+}	GeV	30
Repetition rate	f_{rep}	Hz	100
Bunch number per pulse			1 or 2
Bunch charge		nC	1.5 (3)
Energy spread	σ_E		1.5×10^{-3}
Emittance	ϵ_r	nm	6.5

Table 6: Main Parameters of the Linac Accelerating Structures

Parameter	Unit	S-band		C-band
Frequency	MHz	2860		5720
Length	m	3.1	2.0	1.8
Cavity mode		$2\pi/3$		$3\pi/4$
Aperture	mm	19~26	25	12~16
Gradient	MV/m	22/27	22	40
Cells		86	55	89
Number of Acc. Stru.		93	16	470
Number of Klystron		34		236
Klystron Power	MW	80		50

Table 7: Main Parameters of the Damping Ring

	DR V3.0
Energy (Gev)	1.1
Circumference (m)	147.5
Number of trains	2 (4)*
Number of bunches/train	1 (2)#
Total current (mA)	12.4 (24.8)*
Bending radius (m)	2.87
Dipole strength B_0 (T)	1.28
U_0 (keV/turn)	94.6
Damping time $\tau_x/\tau_y/\tau_z$ (ms)	11.4/ 11.4/ 5.7
Phase/cell (degree)	60/60
Momentum compaction	0.013
Storage time (ms)	20 (40)*
Natural energy spread (%)	0.056
Norm. natural emittance (mm-mrad)	94.4
Inject bunch length (mm)	4.4
Extract bunch length (mm)	4.4
Norm. inject emittance (mm-mrad)	2500
Norm. extract emittance x/y (mm-mrad)	166 (97)* / 75 (3)*
Energy spread inj/ext (%)	0.18 / 0.056
Energy acceptance by RF (%)	1.8
RF frequency f_{RF} (MHz)	650
Harmonic number	320
V_{RF} (MV)	2.5
Longitudinal tune	0.0387



CEPC Accelerator Parameter Finetuning in EDR-4

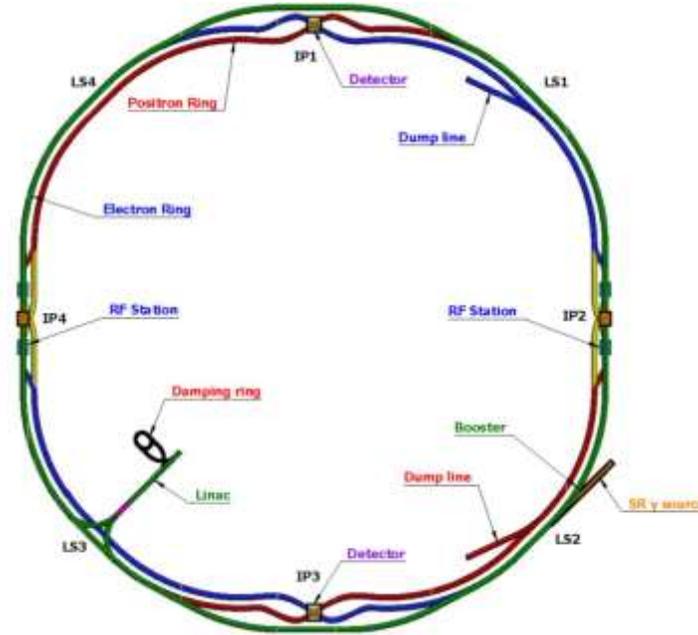


Table 8. CEPC RF frequency parameters in TDR/EDR

f (MHz)	Schemes	SHB1	SHB2	Linac_S	DR	Linac_C	Booster	Collider
CEPC	Baseline (thermal cathode gun)	158.89	476.76	2860	650	5720	1300	650
	Alternative (RF gun)	—	—	2860	650	5720	1300	650



CEPC Accelerator Parameter Finetuning in EDR-5

Table 9: CEPC bunch structure for TDR baseline.

SR 30 / 10 MW	H	Z		W	t \bar{t}
SR power per beam [MW]	30	30	10	30	30
Bunch number	268	11,934	3,978	1,297	35
Bunch spacing* [ns]	576.92	23.08	69.23	253.85	4523.07
[\times 23.08 ns]	25	1	3	11	196
Train gap [%]	54	17	17	1	53
Luminosity/IP [$\times 10^{34} \text{cm}^{-2} \text{s}^{-1}$]	5.0	115	38	16	0.5

Table 10: CEPC bunch structure for 50 MW upgrade

SR 50 MW	H	Z	W	t \bar{t}
SR power per beam [MW]	50			
Bunch number	446	13,104	2,162	58
Bunch spacing* [ns]	346.15	23.08	138.46	2700.00
[$\times 23.08$ ns]	15	1	6	117
Train gap [%]	54	9	10	53
Luminosity/IP [$\times 10^{34} \text{cm}^{-2} \text{s}^{-1}$]	8.3	192	26.7	0.8



CEPC Accelerator Parameter Finetuning in EDR-6

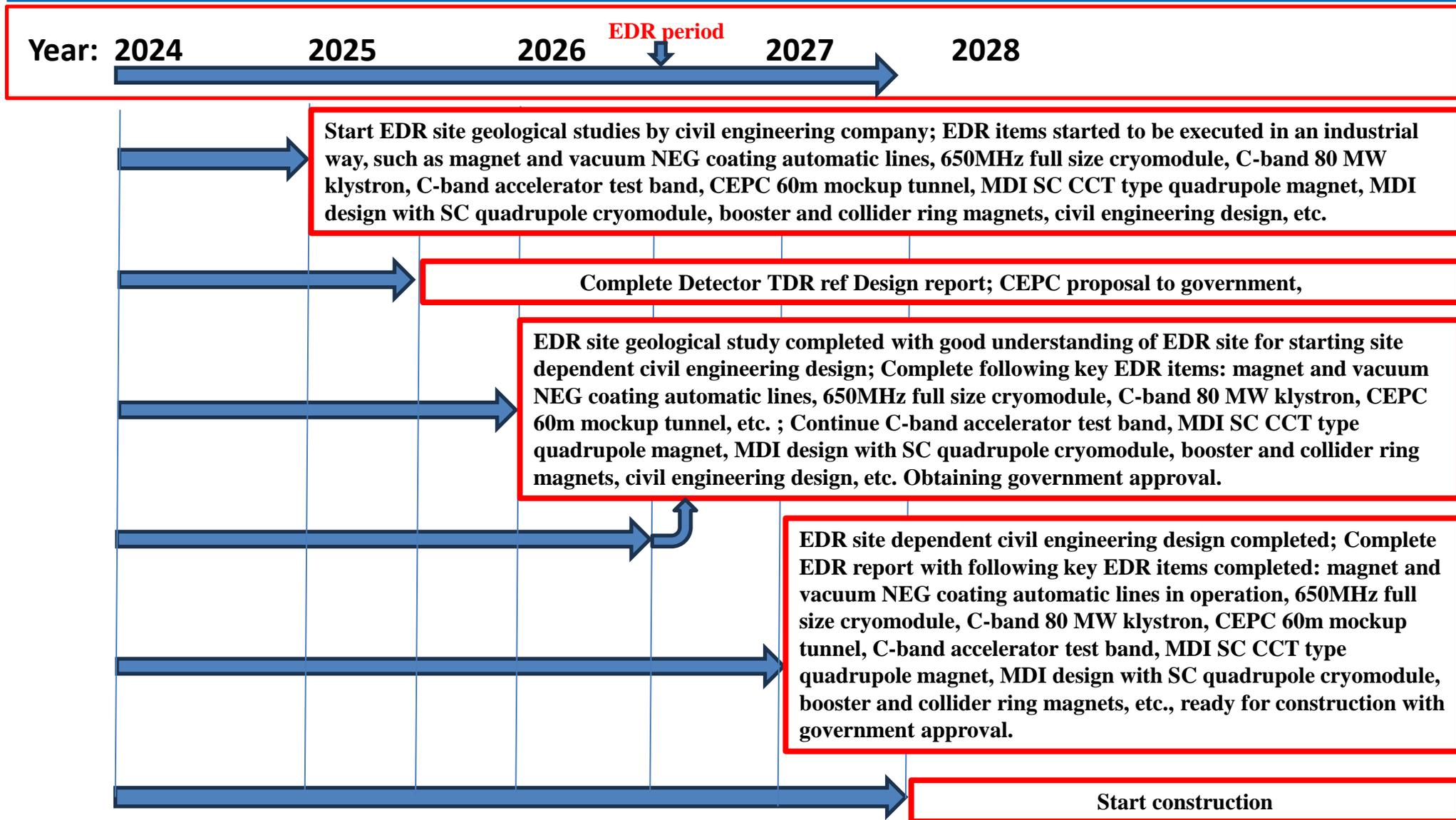
Table 12: CEPC bunch structure for 30/10 MW operation with circumference finetuning in EDR

SR 30 / 10 MW	H	Z		W	t\bar{t}
SR power per beam [MW]	30	30	10	30	30
Bunch number	268	11,934	3,978	1,297	35
Bunch spacing* [ns]	553.85	23.08	69.23	184.62	3969.23
[\times 23.08 ns]	24	1	3	8	172

Table 13: CEPC bunch structure for 50 MW operation with circumference finetuning in EDR

SR 50 MW	H	Z	W	t\bar{t}
SR power per beam [MW]	50			
Bunch number	446	13,104	2,162	58
Bunch spacing* [ns]	276.92	23.08	138.46	2584.62
[\times23.08 ns]	12	1	6	112

CEPC EDR Milestones before Construction



Preparing CEPC IARC Meeting in Sept. 2025

CEPC IARC Meeting talks in Sept. 2024

Xinchou Lou CEPC general status
Jie Gao CEPC accelerator EDR general scope, plan and status

Wen Kang/Mei Yang CEPC Magnets (both collider & booster)
Cai Meng/Jingru Zhang CEPC Linac EDR plan and status
Dou Wang CEPC booster and damping ring (DR) EDR plan and status

Yiwei Wang CEPC collider ring beam dynamics EDR plan and status
Sha Bai CEPC MDI EDR plan and status
Haijing Wang CEPC Interaction Region engineering design status
Guangyi Tang Radiation in the tunnel and its mitigation for CEPC EDR

Yingshun Zhu CEPC SC quadrupoles development plan in EDR and status
Haijing Wang CEPC Mechanical system EDR plan and status
Yongsheng Ma CEPC Vacuum system EDR plan and status

Jiyuan Zhai/Peng Sha CEPC SRF (both collider & booster) EDR plan and status
Rui Ge/Mei Li CEPC cryogenic system EDR plan and status
Zusheng Zhou CEPC RF power sources and power distribution EDR plan and status

Xiaolong Wang CEPC alignment and installation EDR plan and status
Yanfeng Sui CEPC accelerator instrumentation EDR plan and status
Yuhui Li CEPC sustainable development issues

CEPC IARC Meeting preliminary topics (to be submitted to and selected by IARC) in Sept. 2025

Xinchou Lou CEPC general status
Jie Gao CEPC accelerator EDR status

Xiaohao Cui, CEPC connection transport lines and timing in EDR
Bin Chen, CEPC magnet power sources in EDR
Bin Chen, CEPC electrostatic-magnet separator in EDR
Dapeng Jin, CEPC control system in EDR
Jinshu Huang, Conventional facilities in EDR
Guang Yi Tang, Zhongjian Ma Environment, health and safety issues
Xiaohao Cui/Zhongjian Ma CEPC machine protection beam dump in EDR
Yuhui Li, CEPC high energy gamma ray beamlines in EDR
Dazhang Li, Beam driven plasma injector for CEPC in EDR
Zhe Duan, CEPC polarization design in EDR
Yiwei Wang, SppC design and compatibility with CEPC in EDR
Qingjin Xu, SppC high field magnet in EDR
Song Jin/Lei Ye, CEPC electronic documentation system: DeepC
Jianfeng Liu, CEPC site selection and civil engineering design in EDR site
Song Jin, CEPC domestic and international industry preparations
Jinhui Chen, CEPC Injection/extraction system in EDR
Na Wang/Yudong Liu, CEPC collective effects and impedance in EDR

These 7 subjects will have mini workshops
or mini peer- reviews before June 2025

Sha Bai, MDI
Yingshun Zhu, SC quadrupoles
Xiaolong Wang, Alignment and installation
Rui Ge/Mei Li, Cryogenic system, MDI design
Haijing Wang, IR engineering design
Dou Wang/Wen Kang, Booster combined dipoles
Yongshengma, Vacuum system (comparing the TDR vacuum with antechamber vacuum)



CEPC Accelerator Main EDR Development: Klystrons

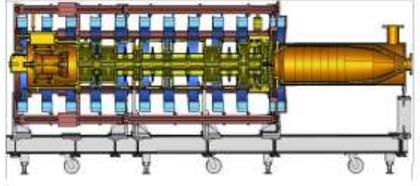
Klystron R&D



Klystron No. 1
Efficiency 65%
(2020)



Klystron No. 2
Efficiency 77%
(2021)

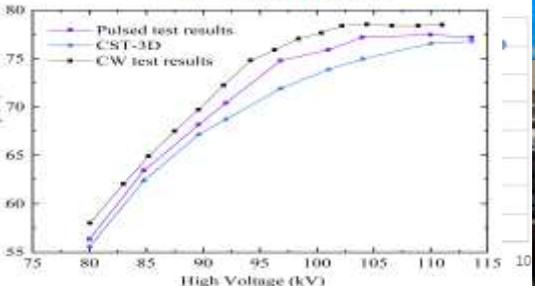
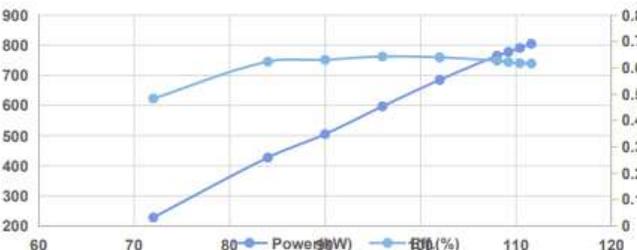


Klystron No. 3 (MBI)
Efficiency 80.5%
To be completed in 2024

Pulsed RF Mode (30% duty factor, 60ms/5Hz)

78.5% @ 803kW CW in 2024

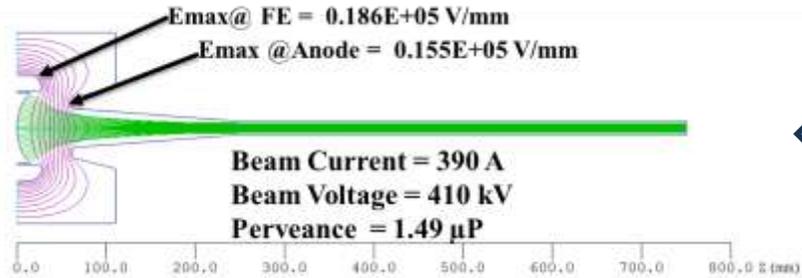
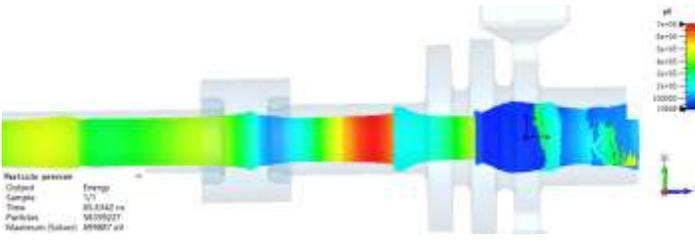
High Voltage vs. Power & Efficiency



Parameters	Value
Frequency	5720 MHz
Output Power	80MW
Pulsed width	2.5us
Repetition rate	100Hz
Gain	54 dB
Efficiency	47%
3dB bandwidth	±5MHz
Beam voltage	420 kV
Beam current	403 A
Focusing field	0.28 T

CEPC collider ring 650MHz klystron development in TDR phase

C band 5720MHz 80MW Klystron



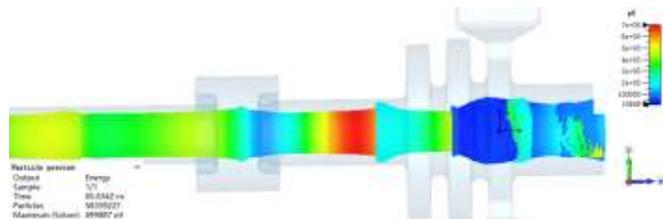
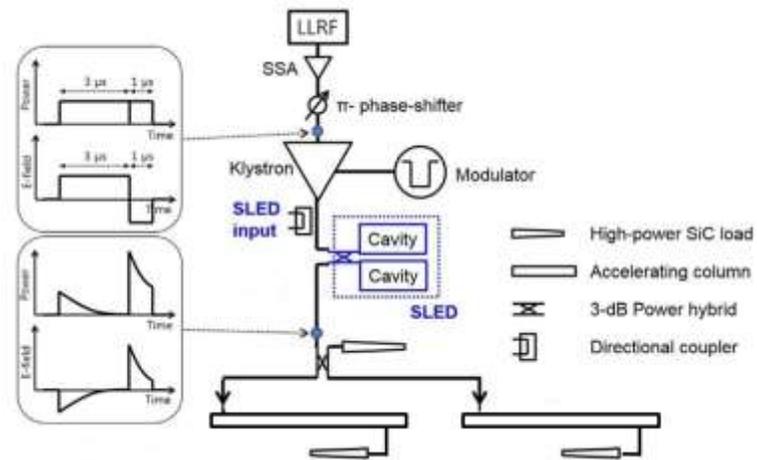
C band 5720MHz 80MW Klystron design completed

Technical assessment has been done on August 12, 2024, start construction Soon, to be completed on 2025

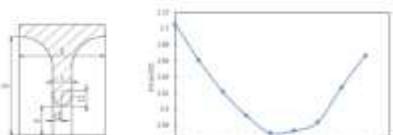
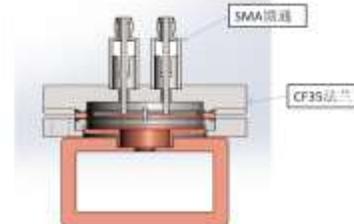


CEPC C-Band Linac Test Band in EDR

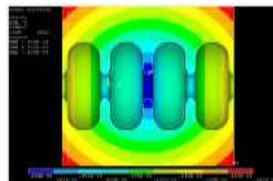
- CEPC EDR will establish the C-band test bench and test the components. With pulsed compressor, waveguides, directional couplers, loads, bend and straight waveguides, etc.
- The C-band test band is equipped with a CEPC 5720MHz 80MW power source
- The CEPC C-band test band will be completed in 2026



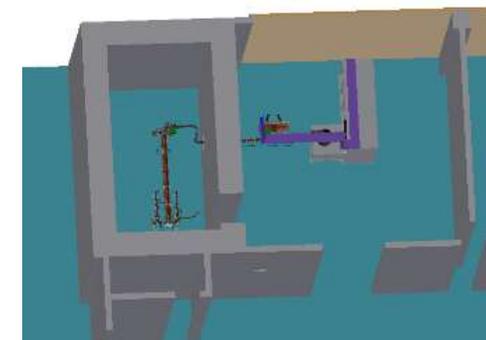
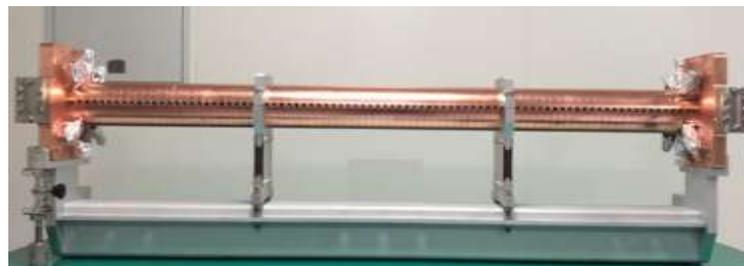
C band 5720MHz 80MW Klystron design completed, and fabrication will be completed in 2025



Cavity shape



The deformation caused by temperature variation



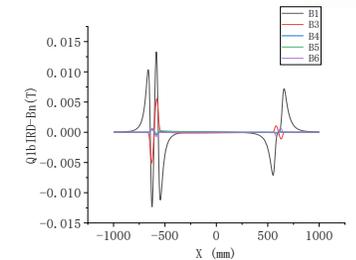
CEPC C-band linac test band will be completed in 2026



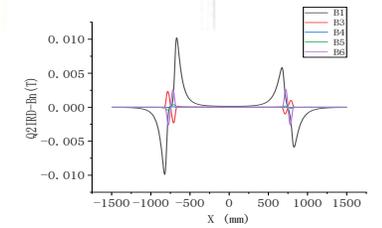
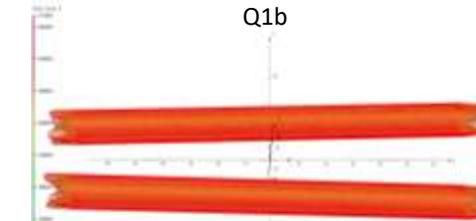
CEPC CCT Type SC Quadrupole in EDR

Design parameters of Q1a, Q1b, Q2 magnet with iron-free CCT coil @ Higgs

	Q1a	Q1b	Q2
Field gradient (T/m)	142.3	85.4	96.7
Magnetic length (m)	1.21	1.21	1.5
Excitation current (A)	780 (Traditional) 730 (Direct winding)	640	760
Conductor diameter (HTS or LTS, mm)	0.7	0.8	0.8
Current density (A/mm²)	2030 / 1900	1270	1510
Maximum dipole field in aperture (Gs)	226	124	127
Stored energy (KJ)	16.7	15.2	36.1
Peak field in coil (T)	4.3	3.8	4.2
Integrated field harmonics	$<2 \times 10^{-4}$		
(Single aperture) Coil inner radius (mm)	20	26	31
(Single aperture) Coil outer radius (mm)	30.5	39	44
Magnet mechanical length (m)	1.23	1.23	1.53
Net weight (kg)	25	32	43
Total weight of Q1a, Q1b, Q2 (kg)	100		
For comparison, old net weight with iron option (kg)	Q1a: 93, Q1b:124, Q2: 235 Total weight of Q1a, Q1b, Q2: 452		



Q1b



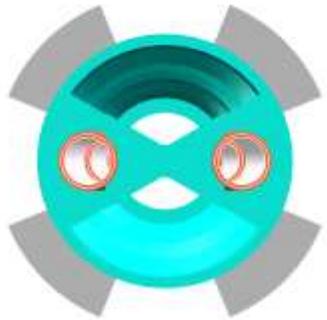
Q2

CEPC CCT type SC quadrupole EDR R&D will be completed in 2026

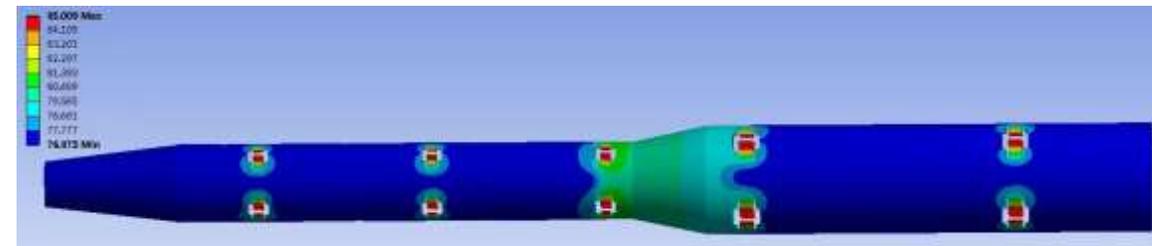
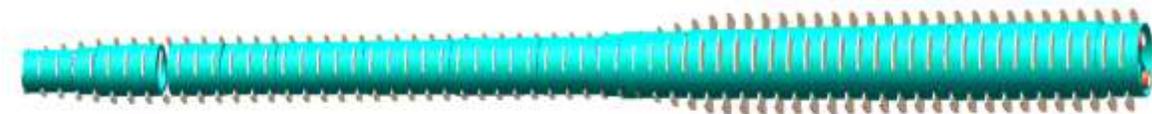
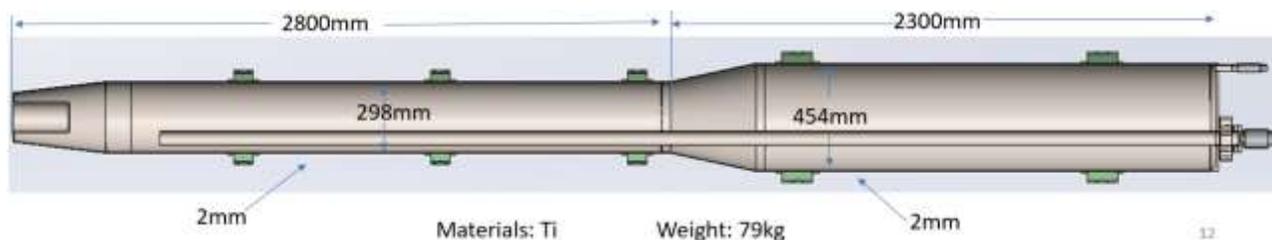
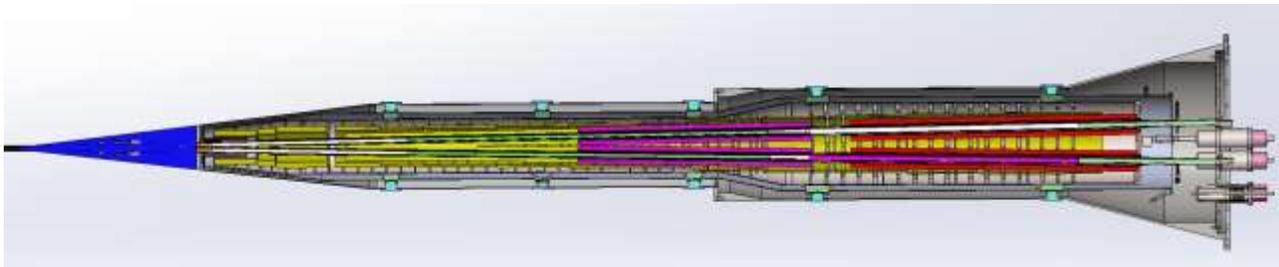
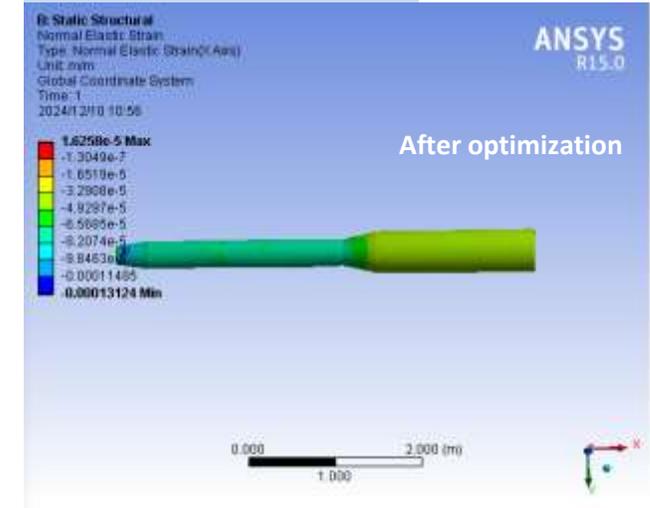
CEPC SC Q Cryostat Optimization in EDR

CEPC SC Q cryostat in EDR

Cryostat length: 5.75 m
Total weight: 1.109 ton



Items	Weight (kg)	Main materials
Vacuum vessel	510	Ti
Helium Vessel	74	SS
Thermal shield and pipes	43	Aluminum
SC quadrupoles	100	Copper & Aluminum
Anti-solenoids	302	Copper & Aluminum
Skeleton supports	92	Aluminum
Liquid Helium	90	Liquid Helium
Total weight	1109	



Other CEPC Accelerator EDR Activities in EDR

CEPC Booster Dipole Magnets in EDR

A) Studies on silicon steel; aluminum (plastic) ratios studies 1:1 and 1:2
Conclusion: 1:2 ratios could be used

B) Studies on silicon steel sheet thickness studies: 0.5mm and 1mm
Conclusion: 1mm thickness sheet could be used

C) Studies on dipole-sextupole combined booster magnet: design and mechanical design completed

CEPC Collider Ring Magnets in EDR

Dual aperture quadrupole: block iron core and new cooling and power line design in EDR

Correctors: mechanical design completed

Sextupole magnets under design

CEPC Accelerator Control and Timing in EDR

CEPC MDI in EDR

MDI Layout

General Parameters

SR Calculation

Radiation background
 Radiative barrier, Beam-Gas, beam thermal photon scattering

Injection background

Radiation Mitigation
 Masks, collimators, shielding

More detailed works on MDI need to be done in EDR together with detector group: Background, Be pipe, RVC, integration, alignment, mechanics,...

CEPC Alignment and Installation Plan in EDR

- Alignment accuracy requirement

Component	Δx (mm)	Δy (mm)	$\Delta \theta$ (mrad)
Dipole	0.10	0.10	0.10
Arc Quadrupole	0.10	0.10	0.10
IR Quadrupole	0.10	0.10	0.10
Sextupole	0.10*	0.10*	0.10

*implement beam-based alignment

GPS receiver

Surface Control network (14 Points)

Backbone Control network (short line: 300m; long line 600m)

Tunnel Control network (interval of 6 meters)

Component Pre-alignment

Wall Control Point

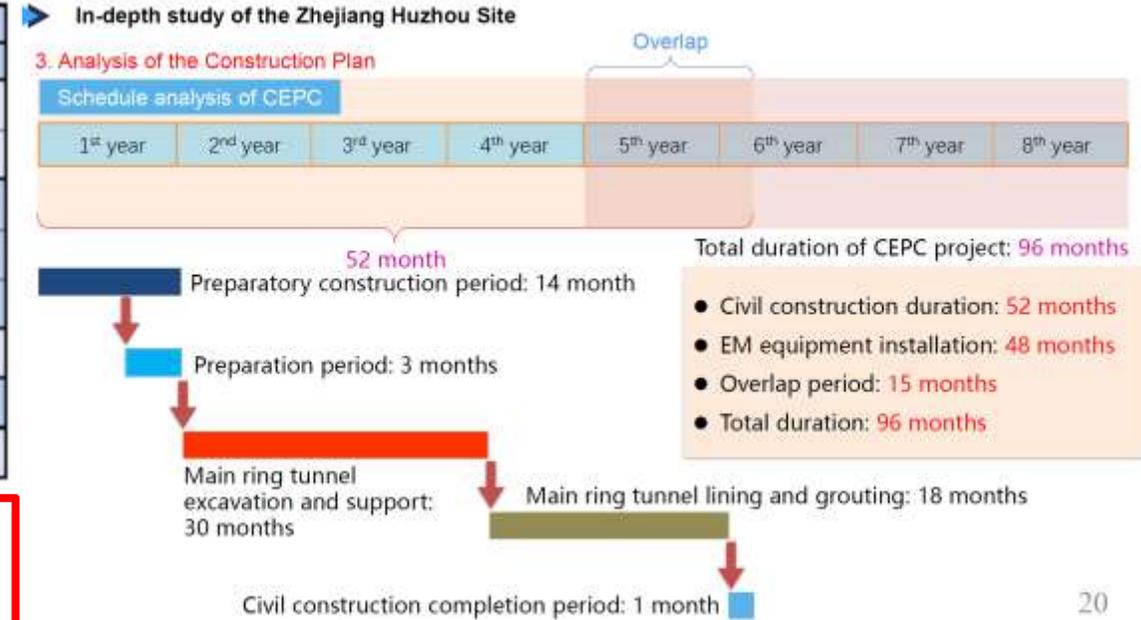
Ground Control Point

CEPC EDR Site Investigation and Construction Plans

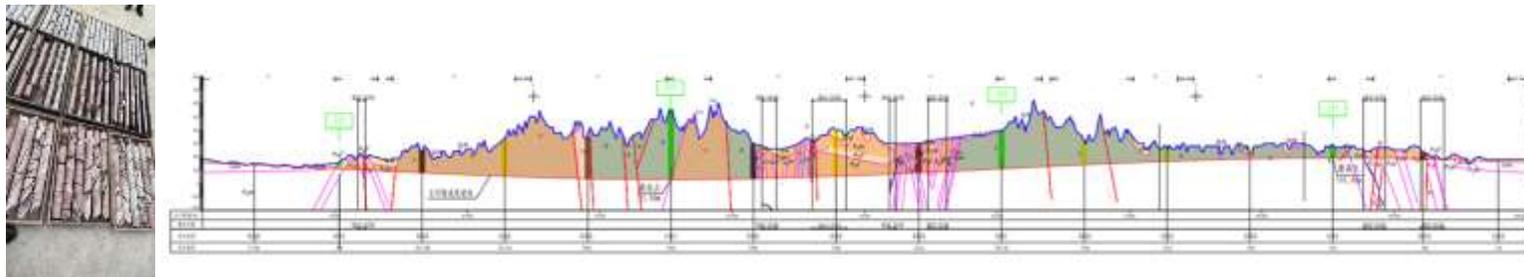
CEPC EDR site implementation plan

Design Stage	2024						2025						2026						2027					
	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12	2	4	6	8	10	12
Preliminary Site Selection	Preliminary Site Selection																							
	Preliminary Site Selection Report																							
Feasibility Study (including Site Selection & Project Proposal)							Site Selection																	
							Feasibility Study						Project Proposal											
Preliminary Design													Preliminary Design											
Tender Design													Tender Design											
Tender																			Tender					

CEPC construction plan



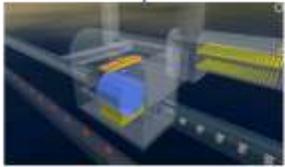
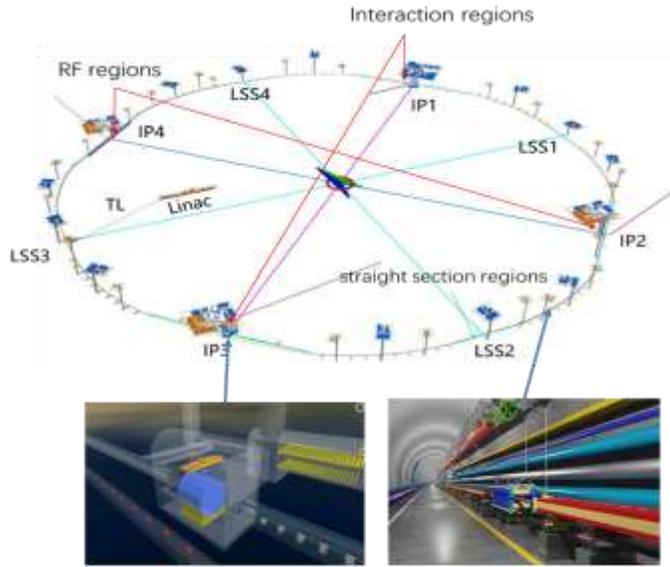
CEPC EDR site geological study has been started and the geological feasibility study will be completed in 2025



The number of shafts is under optimization (10 shafts)

CEPC Installation Strategy Study in EDR

CEPC component list and quantities

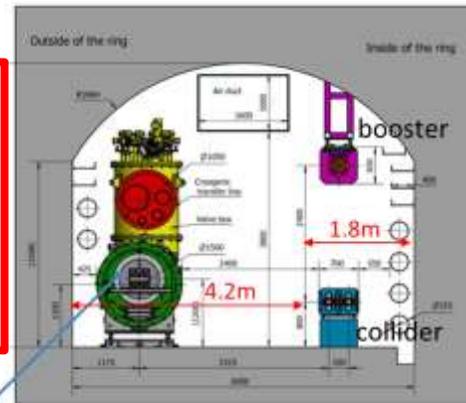


Detector



Ring tunnel

Linac: 1.6km
 TL: 1.5km
 Circumference of ring tunnel: 100km
 Collider: 100km
 Booster: 100km
 Tunnel cross section: 6X5m



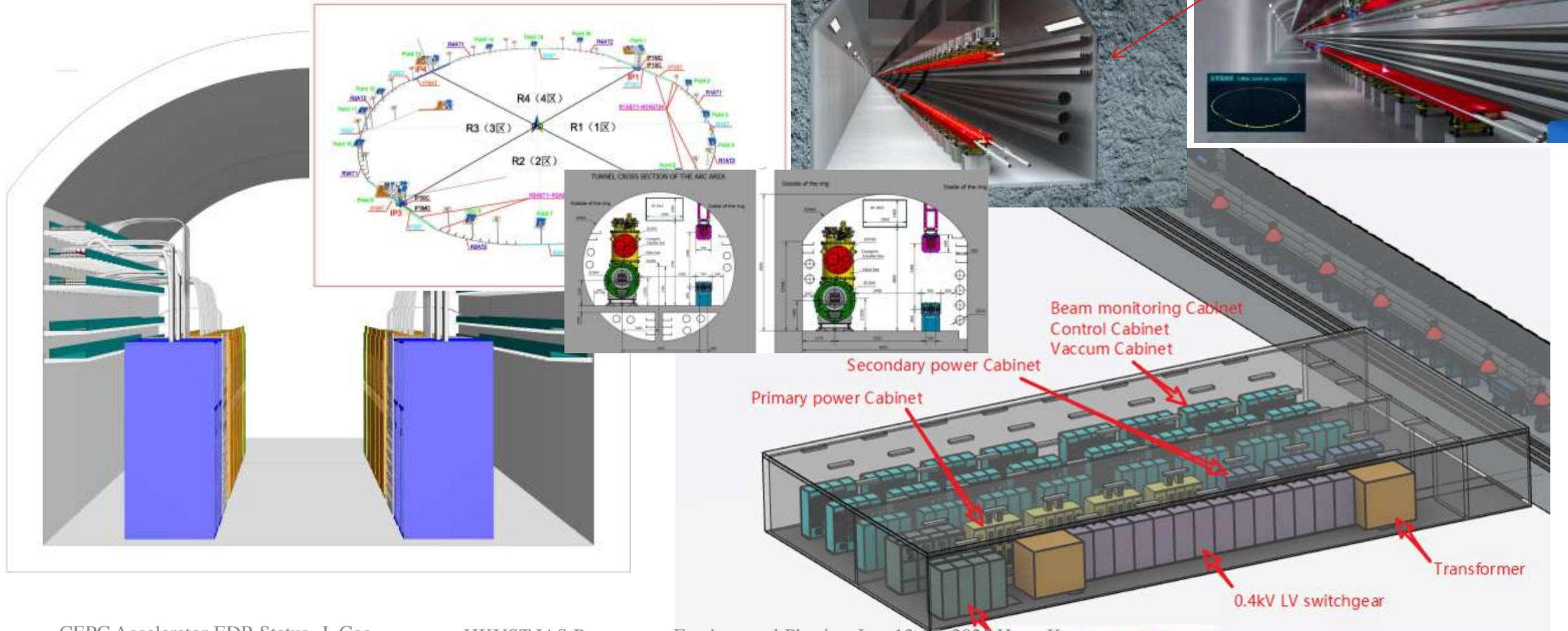
Tunnel cross section

Component	Collider Ring	Booster	Linac, DR, TL	Total
Dipole	16258	14866	135	31259
Quadrupole	4148	3458	714	8320
Sextupole	3176	100	72	3348
Corrector	7088	2436	275	9799
BPM、PR、DCCT、kicker	3544	2408	180	6132
Septum Magnet	68	32	2	102
Kicker	8	8	2	18
Cryomodule	32	12		44
Electrostatic separator	32			32
Collimator dump	36		8	44
Superconducting Magnets	4			4
Solenoid			37	37
Accelerating structure			577	577
Cavity			4	4
Electron Source			1	1
Positron Source			1	1
Detector	2			2
Total	34396	23320	2008	59724

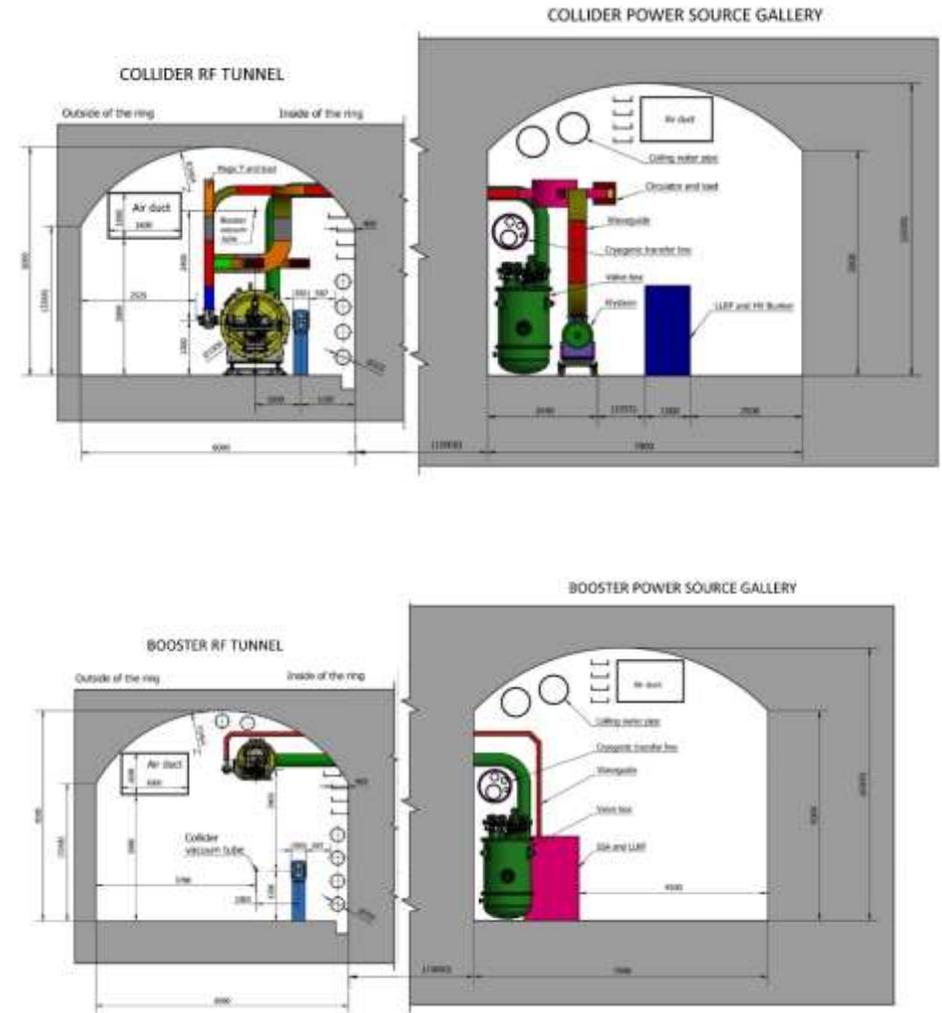
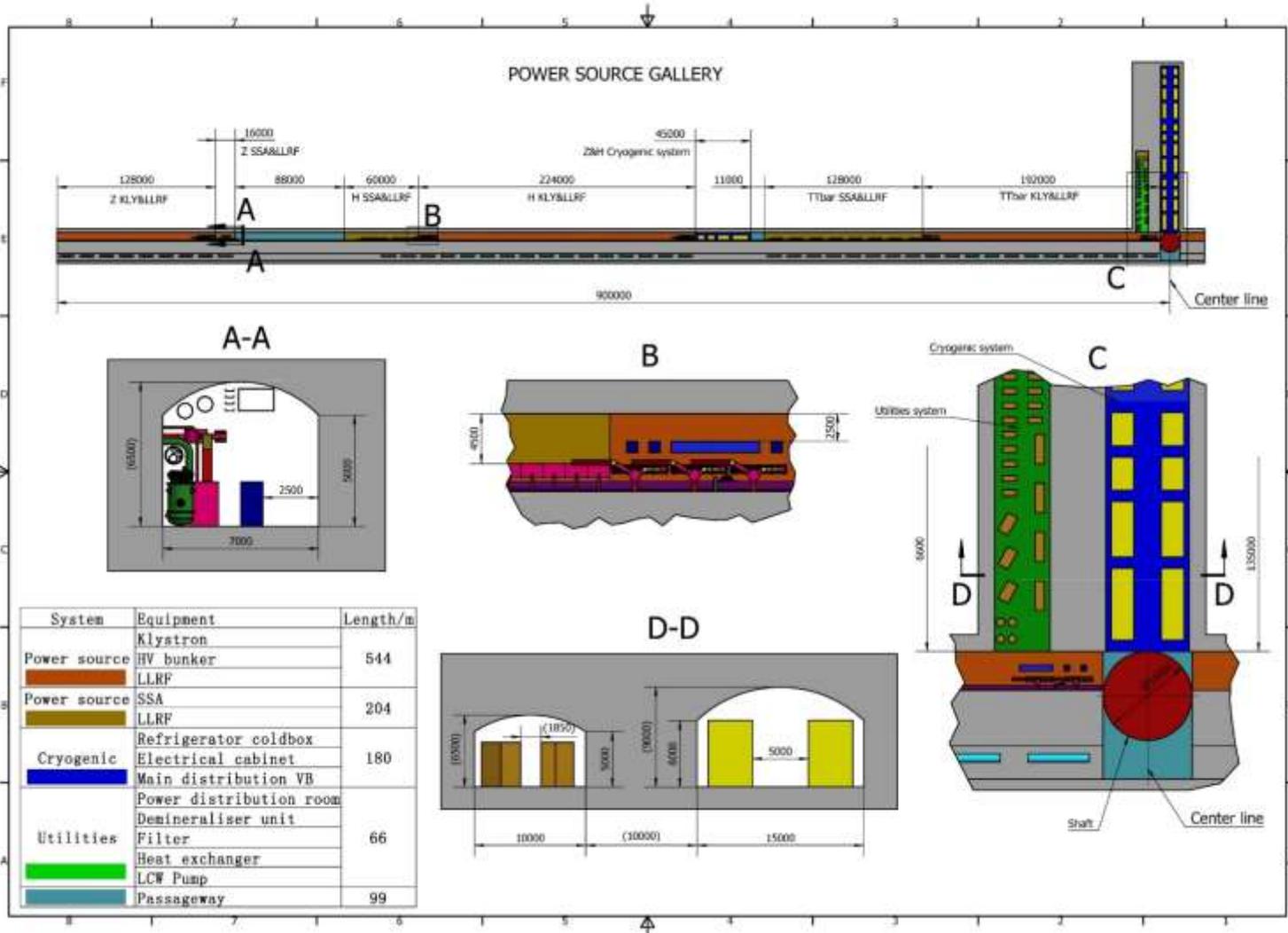
CEPC Civil Engineering and Conventional Facility in EDR

Cables installed!

Electrical Equipment General Layout in Auxiliary Tunnel/500m along 100km



CEPC SRF Region Tunnel Layout





CEPC EDR Site Implementation

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

Layout of the Surface Structures

The surface structures are located close to shafts. These buildings house water cooling facilities, low-temperature facilities, ventilation systems, air compression systems, substations, etc.

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

Layout of the Surface Structures

Surface Structure	Area of surface structures (m ²)										Total	TDR	EDR-TDR
	P1 (IP1)	P2	P3(IP2)	P4	P5 (IP3)	P6	P7(IP4)	P8	LINAC	BT			
Control and duty rooms	1200	300	300	300	1200	300	300	300	400		4600	4600	0
Magnet powers source	100	100	100	100	100	100	100	100	200	200	1200	13900	-12700
High-frequency power source			6000				6000		9800		21800	16400	5400
110kV substation	2000		3000		2000		3000				10000	14000	-4000
10kV substation	1000	800	1000	800	1000	800	1000	800	600		7800	11200	-3400
HVAC system	1200	1000	1200	1000	1200	1000	1200	1000	1500	300	10600	14500	-3900
Cryogenic system (helium compression system)	2500		6000		2500		6000				17000	10000	7000
Cooling water system	3000	2500	3000	2500	3000	2500	3000	2500	1500	300	23800	29800	-6000
Experimental assembly and storage hall	1500	1000	1000	1000	1500	1000	1000	1000	500		9500	6000	3500
Transfer system	500	300	400	300	500	300	400	300	200	150	3350	3550	-200
Air compression system	300	300	300	300	300	300	300	300	300	300	2700	1350	1350
Electronic room	1000	300	300	300	1000	300	300	300	200	100	4100	6150	-2050
Data Center	600				600						1200	0	1200
Miscellaneous	500	500	500	500	500	500	500	500	300	100	4400	9000	-4600
Total	15400	7100	23100	7100	15400	7100	23100	7100	15500	1150	122050	140450	-18400

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

General Layout Plan of IP1/IP3

Surface Structure	IP1/IP3 (m ²)
Control and duty rooms	1200
Magnet powers source	100
High-frequency power source	
110kV substation	2000
10kV substation	1000
HVAC system	1200
Cryogenic system (helium compression system)	2500
Cooling water system	3000
Experimental assembly and storage hall	1500
Transfer system	500
Air compression system	300
Electronic room	1000
Data Center	600
Miscellaneous	500
Total	15400

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

General Layout Plan of IP2/IP4

Surface Structure	IP2/IP4 (m ²)
Control and duty rooms	300
Magnet powers source	100
High-frequency power source	6000
110kV substation	3000
10kV substation	1000
HVAC system	1200
Cryogenic system (helium compression system)	6000
Cooling water system	3000
Experimental assembly and storage hall	1000
Transfer system	400
Air compression system	300
Electronic room	300
Data Center	
Miscellaneous	500
Total	23100



CEPC Proposal Preparation (2025)

**CEPC inputs to EPPSU2026
are also under way**

国家重大科技基础设施建设项目

环形正负电子对撞机 项目建议书

主管部门：中国科学院

项目法人单位：中国科学院高能物理研究所
共建单位：

2025 年 XX 月

**We will submit in 2025 the CEPC
Proposal (in Chinese) to China's
"15th five year plan" process**



Summary

- The CEPC accelerator TDR parameters have been finetuned in relation with CEPC detector operation in EDR with SR/beam **30MW and 50MW** operations for all four energies, **Higgs, W/Z and $t\bar{t}$** .
- CEPC **accelerator EDR milestones** have been defined
- CEPC IARC meeting in Sept. 2025 is under planning together with EDR progress
- Several key issues will be followed closely by IARC and relevant mini workshops or mini reviews will be held before June 2025
- EDR site selection and geological studies have been started in 2024
- CEPC proposal (preliminary) will be completed around June 2025
- International collaboration and participation are warmly welcome.



Acknowledgements

Thanks go to CEPC-SppC accelerator team's hard works,
international and CIPC collaborations

Special thanks to CEPC SC, IAC, IARC
committee's critical advices, suggestions and supports

Thanks for your attention