中国科学院高能物理研究所
Institute of High Energy Physics
Chinese Academy of Sciences

CEPC

The CEPC Accelerator EDR Status and Plan

J. Gao

IHEP

On behalf of CEPC-SppC Accelerator team

The 2025 International Workshop on the High Energy Circular Electron Positron Collider (CEPC2025)
November 6-10, 2025, Guangzhou, China

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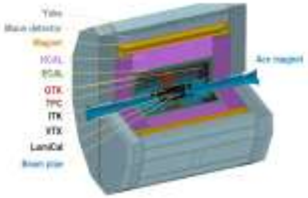
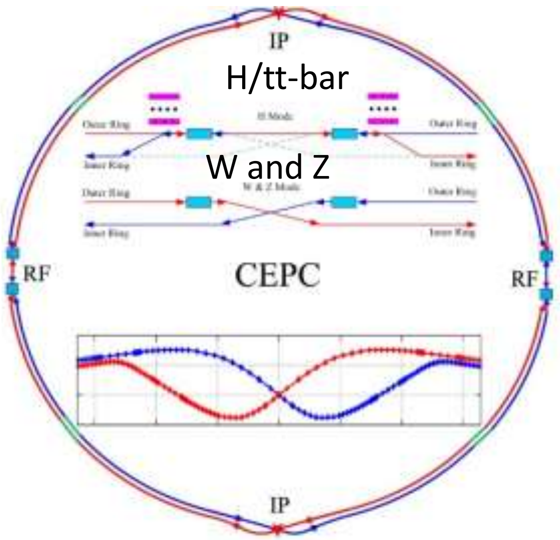
CEPC Higgs Factory and SppC Layout in TDR/EDR

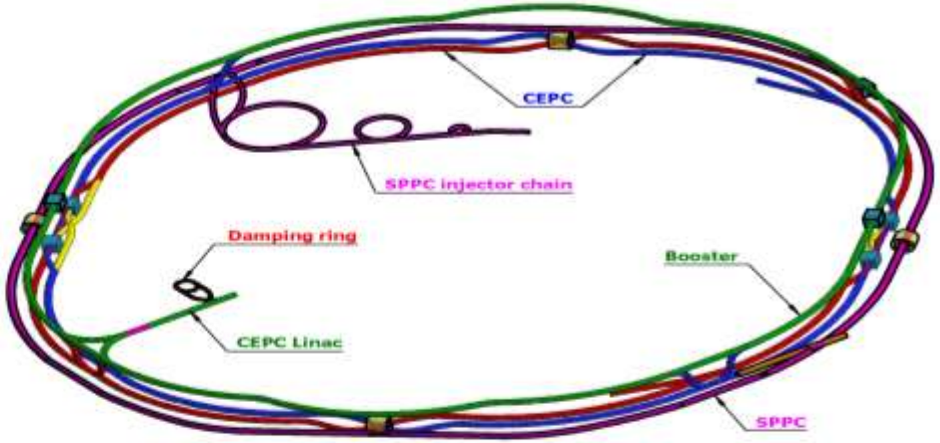
CEPC as a Higgs Factory： H, W, Z, upgradable to ttbar, followed by a SppC (a Hadron collider) ~125TeV
30MW SR power per beam (upgradable to 50MW) , high energy gamma ray 100Kev~100MeV

CEPC has two detectors



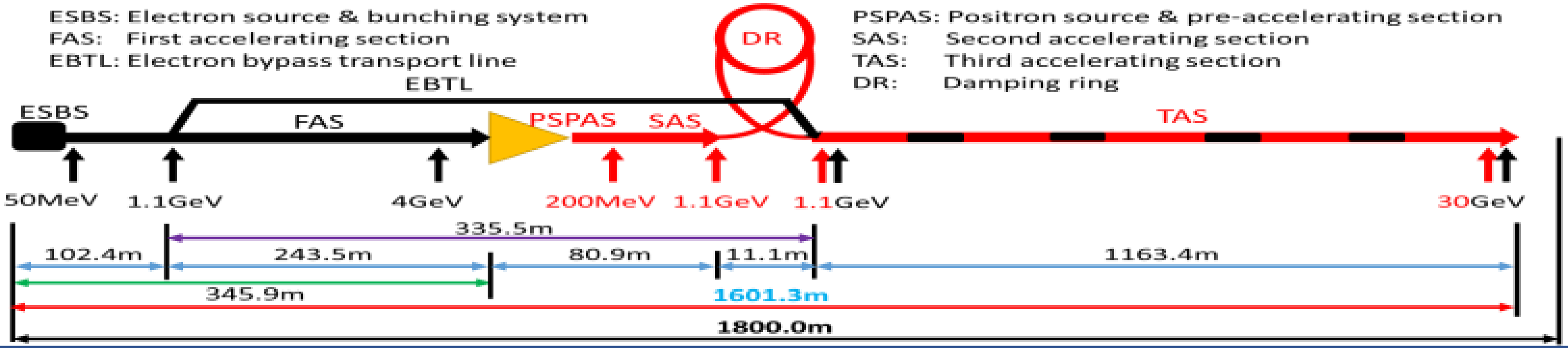


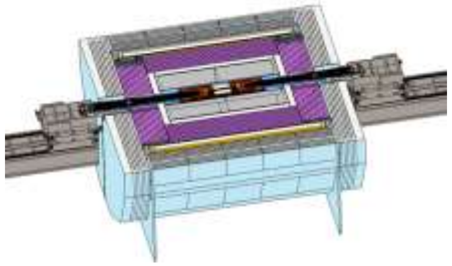
CEPC collider ring (100km)

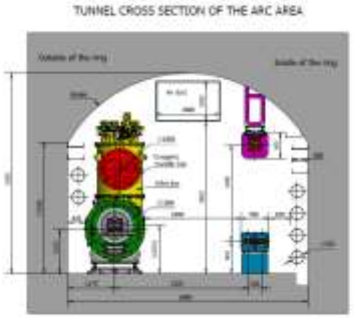


CEPC booster ring (100km)

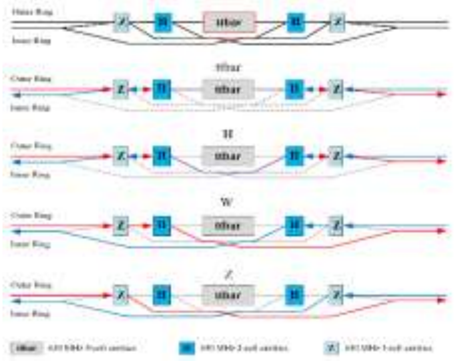
CEPC TDR S+C-band 30GeV linac injector







CEPC/SppC in the same tunnel



Z,W, Higgs and ttbar energies

CEPC Accelerator System Parameters in TDR/EDR

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

		tt	*H*		*W*	*Z*	
		Off axis injection	Off axis injection	On axis injection	Off axis injection	Off axis injection	
Circumfer.	km	99.955					
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

	Higgs	Z	W	$t\bar{t}$
Number of IPs	2			
Circumference (km)	99.955			
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} cm^{-2} s^{-1})	**5.0**	**115**	**16**	**0.5**
Luminosity per IP (10^{34} cm^{-2} s^{-1}) From J. Gao's formula below	**5**	**115**	**12**	**0.59**

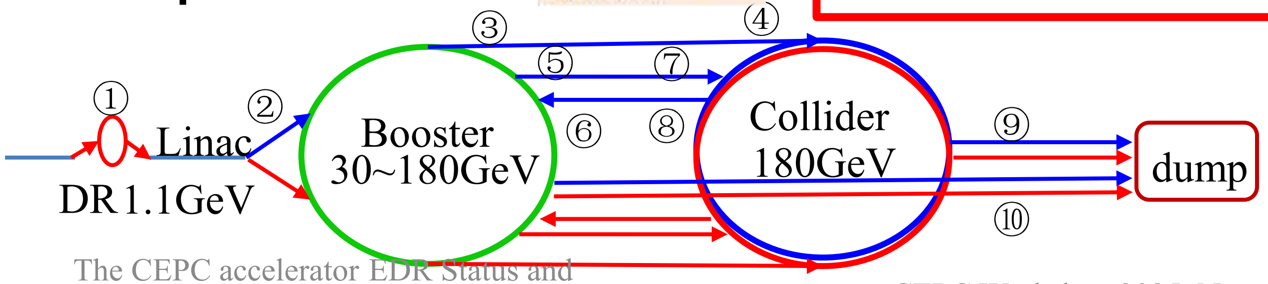
Running scenarios: Higgs 10 years, Z 2 years, W 1 year, ttbar 5 years

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

Lmax $[cm^{-2}\ s^{-1}] = 0.158\times10^{34}\frac{(1+r)}{\beta_y[mm]}\sqrt{\frac{R[m]}{C_\gamma[mGeV^3]N_{IP}}}(P_b[MW]/E[GeV]^2)e^{\frac{\sqrt{\Phi_p}}{3.22}}(1+0.000505*\Phi_p^2)$ (J. Gao's formula)

for isomagnetic machine with crab-waist collision

Transport lines

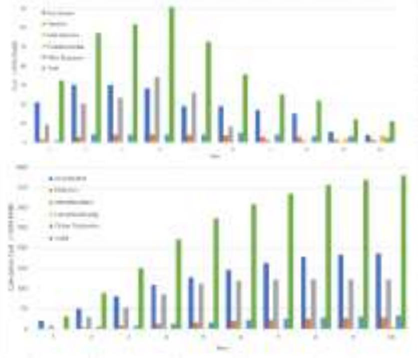


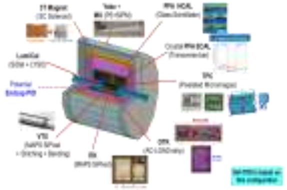
CEPC Technical Design Report (TDR) includes:
1) CEPC Accelerator TDR released on Dec. 25, 2023
2) CEPC Detector ref-TDR (reference design) has been completed and reviewed by IDRC in April and Sept. 2025, and will be released in 2025

CEPC Milestones and Timeline

Year	2012	2013	2015	2017	2018	2023	2025	2027	~2030's construction

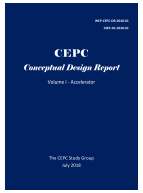
Year	Accelerator human resource	Accumulated accelerator spending Billion RMB
2015	50	-
2018	100	-
2023	200	0.2
2025	300	0.3
2027	500	0.4
2031	2800	9
2035	2500	20





Proposal (2030) for CEPC entering 16th five-year-plan

CEPC kickoff meeting in Sept. 2013



36.4B RMB Total construction

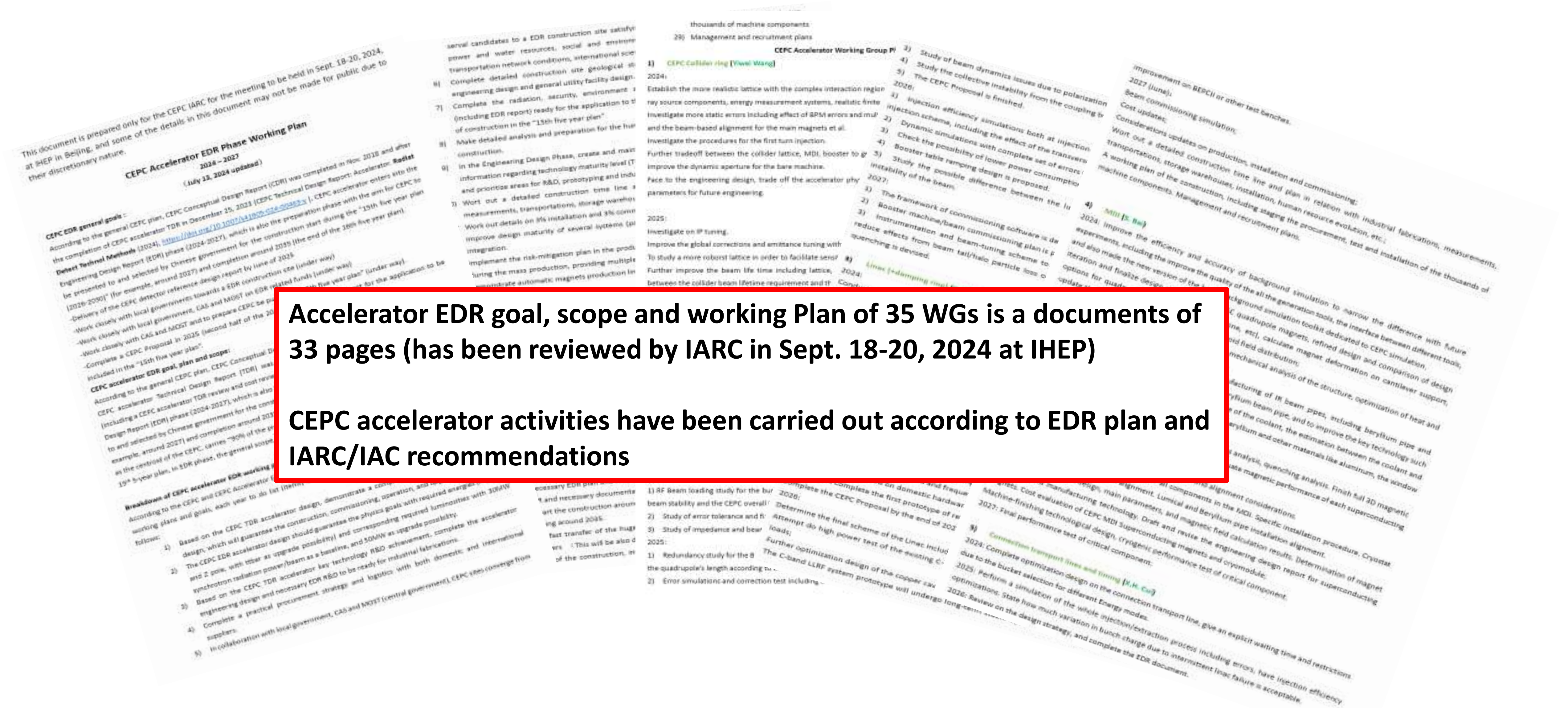
CEPC detector reference design released in Oct. 2025

CEPC EDR site study and civil engineering design

2012.9 CEPC proposed — **2013.9** — **2015.3** Pre-CDR — **2017.4** Progress report — **2018.11** CDR — **2023.12** TDR — **2024 ~ 2027** EDR — **~2030's construction**

J. Gao, "The Status of the CEPC Project in EDR", submitted to IJMPA , 2025, arXiv:2505.04663, https://doi.org/10.48550/arXiv.2505.04663

CEPC EDR Goal, Scope and Plan



Accelerator EDR goal, scope and working Plan of 35 WGs is a documents of 33 pages (has been reviewed by IARC in Sept. 18-20, 2024 at IHEP)

CEPC accelerator activities have been carried out according to EDR plan and IARC/IAC recommendations

CEPC Key System EDR Progresses-1

CEPC Accelerator Key System EDR Progresses

-2025 March 20, CEPC booster magnet automatic fabrication line ready for construction (under construction, to be completed in 2025-2026)
-2025 April 17, CEPC polarization cathode material and test facility ready for fabrication
-2025 April 25, CEPC vacuum chamber NEG coating automatic fabrication line ready for construction (under construction, to be completed in 2025-2026)
-2025 April 28, 650MHz full size cryomodule ready for construction (under construction, to be completed in 2025-2026)
-2025 Feb. CEPC accelerator survey started (99.955428km)
-2025 July, CEPC accelerator components, vertical shafts (10) and horizontal access tunnels (12) naming systems are decided
-2025 July, CEPC booster detailed installation scheme studies started

CEPC Accelerator Key System EDR International Mini Reviews (Required by IARC)

-2025 April 24, CEPC alignment and installation EDR international mini review
-2025 May 14,15, CEPC cryogenic system (+650MHz cryomodule) EDR international mini review
-2025 May 29, CEPC booster dipole and sextupole combined magnet EDR international mini review
-2025 June 9-10, CEPC MDI EDR international mini review
-2025 June 9-10, CEPC EDR site geological feasibility study review
-2025 July 31, CEPC vacuum chamber type EDR international mini review

J. Gao, "The Status of the CEPC Project in EDR", submitted to IJMAPA , 2025, arXiv:2505.04663, https://doi.org/10.48550/arXiv.2505.04663

CEPC Accelerator EDR Key Progresses-2

-2024 Dec 9, CEPC EDR site geological study and civil engineering design tasks Have been assigned to “Power China Hua Dong Engineering Corporation Limited (HDEC)”

-2025 June 9-10, CEPC site geological study and site selection choice review meeting was held and CEPC Xinmi Site of Henan province was recommended as the proposed construction site to Chinese government, and more detailed studies will be completed by the end of 2025.

-2025 Sept . 5, CEPC EDR accelerator and civil engineering cost have been updated.

-2025 Sept. 8, CEPC accelerator/auxiliary facilities TDR/EDR progresses and site geological study/selection/civil engineering design status and progresses have been included in the CEPC Proposal

IARC+IAC 2024 Recommendations and Reactions

CEPC Alignment Review Meeting Timetable

April 24-25, 2025, IHEP, HEPS Campus

Date & Time: April 24-25, 2025, 9:00-18:00 Beijing Time (UTC+8)

Format: Online Meeting & Onsite

ZOOM Meeting ID: 95671697572

Password: 250421

Review Committee

No	Name	Institution	Title
1	He Xiaoye (chair)	USTC	Professor
2	Hélène Mainaud Durand	CERN	Professor
3	Li Zongchun	Information Engineering University	Professor
4	Ding Keliang	BUCEA	Professor
5	Zhang Chao	USTC	Professor
6	Jiang Zhiqiang	SARI	Professor
7	Gao Jie	IHEP	Professor
8	Liu Zhanke	The First Geodetic Survey Team of the Ministry of Natural Resources	Principal Engineer
9	Fan Baixing	Information Engineering University	Associate Professor

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CEPC SRF Cryogenic System
EDR Design Peer Review

Brochure

Date & Time: Tuesday, May 13, 2025, 3:00 PM Beijing Time (UTC+8)

Format: Online Meeting & Onsite:

Topic: CEPC Cryogenic System Design Peer Review
Meeting ID: 98679216208
Begin Time: 2025-05-13T15:00:00
Duration: 180
Meeting URL: https://zoom.us/j/98679216208?pwd=[illegible]
Password: 250513
Onsite meeting room: IHEP Main building A415

Review Committee:

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Mini-Review for CEPC Booster Combined Magnets

Brochure

Date & Time: Thursday, May 29th, 2025, 3:00 PM Beijing Time (UTC+8)

Format: Online Meeting & Onsite:

Topic: Mini-Review for CEPC Booster Combined Magnets
Meeting ID: 98353925325
Begin Time: 2025-05-29T15:00:00
Meeting URL: https://zoom.us/j/98353925325?pwd=[illegible]
Duration: 180 min
Password: 539795
Onsite meeting room: IHEP Main building A419

Review Committee:

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Mini-Review of CEPC MDI

CEPC MDI Mini-Review Committee

9-10 June 2025

The CEPC Study Group, based at the Institute of High Energy Physics (IHEP), has been developing a next generation e^+e^- collider initially as a Higgs factory, with energy reach extending to Z, WW, and top-quark pair production, and upgrade potential to a high-energy pp collider. The CEPC project has progressed significantly since the 2018 Conceptual Design Report, focusing on design optimization, key technology R&D, and technical system studies. A Technical Design Report was released in December 2023. Presently the project is the Engineering Design Report (EDR) Phase.

The International Review Committee, chaired by Dr. Manuela Boscolo (INFN), was asked to conduct a review of the Machine-Detector-Interface (MDI) of CEPC. This review shall cover all aspects of the design of the CEPC MDI.

The CEPC MDI Review Committee meeting was held virtually from 9 to 10 June 2025. A total of 9 talks were presented on a variety of topics. The charge to the review committee was:

1. Is the MDI system design is complete?
2. Does the sc quadrupole and cryostat design satisfy the design requirements?
3. Will the MDI mechanical system design reach the design goal?
4. Will the MDI system alignment scheme reach the design goal?
5. Is the beam induced background well considered and controlled?

The Review Committee was invited to evaluate the progress on the MDI design and to make comments.

It was requested that this Committee report responding to the above charge be forwarded to Prof. Jie Gao and Dr. Haoyu Shi by July 4th.

1 Executive Summary

After the CEPC TDR release in December 2023, the critical Engineering Design Report (EDR) Phase has started. Prototypes on key technologies are ongoing, and more are planned to start in the near future.

The Committee wishes to congratulate the CEPC MDI team on the great progress and on the excellent quality of the work.

The next section provides answers to the different charge questions, the following sections contain comments and recommendations related to the individual presentations.

According to the recommendations of IARC and IAC in 2024, all five International mini-reviews have been carried out in 2025:

1) Alignment (April 24-25, 2025)
2) SRF cryogenic system (May 13, 2025)
3) Combined booster magnet (May 29, 2025)
4) MDI (June 9-10, 2025)
5) Vacuum chamber (July 31, 2025)

Preliminary replies to the mini review reports have been sent to mini review committee chairs and IARC/IAC chairs also

CEPC Synchrotron Radiation Shielding Schemes

Review Meeting

31th July, 2025, Online & Beijing

Topic: Verification of the CEPC TDR vacuum chamber shielding design in comparison with antechamber vacuum system with photon absorbers

Final Committee Report

Submitted 19th August, 2025

Committee Members

Markus Widorski, CERN
Adolfo Esposito, INFN
Roberto Kersevan, CERN
Mika Masuzawa, KEK
Wen Kang, IHEP
Guanghong Wang, SARI

C CEPC-MDI-Mini-Review Committee Members

Manuela Boscolo	INFN Frascati, Chair
Xiaoye He	UTSC
Qu Huamin	IHEP
Roberto Kersevan	CERN/Transmutex SA
Michael Koratzinos	PSI
Hiroyuki Nakayama	KEK

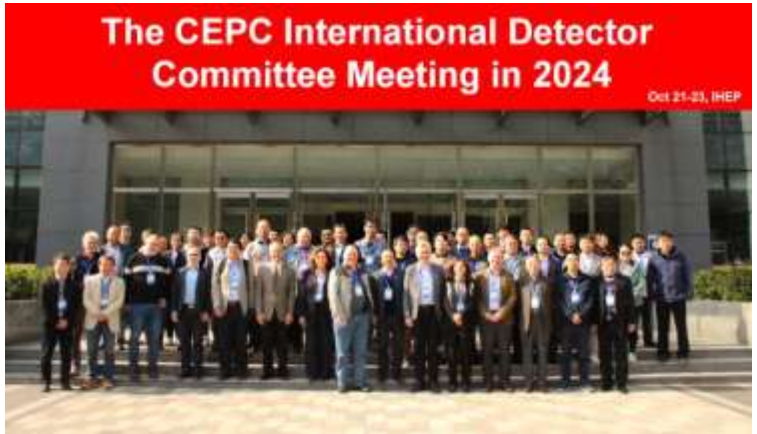
Preliminary replies to the IARC (2024) report has been sent to IARC/IAC chairs

CEPC IARC, IDRC and IAC Meetings since EDR

CEPC IARC meeting was held from Sept. 18-20, 2024

https://indico.ihep.ac.cn/event/22311/

CEPC IARC meeting was held from Sept. 16-19, 2025



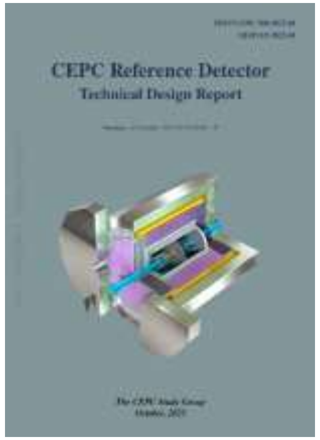
The International Detector Review Committee (IDRC) held its inaugural meeting at IHEP, Oct 21-23, 2024, to review the status and plan of Ref-TDR.

https://indico.ihep.ac.cn/event/23265/

CEPC IAC meeting in 2024 was held from Oct. 29-30, 2024

https://indico.ihep.ac.cn/event/23450/timetable/

CEPC IAC meeting will be held from Nov. 20-21, 2025



CEPC Detector Reference Design Report submitted to arXiv on Oct. 7, 2025

https://arxiv.org/abs/2510.05260

CEPC IDRC meeting was held from April 14-16, 2025

https://indico.ihep.ac.cn/event/25539

CEPC IDRC meeting was held on Sept. 10, 17 and 24, 2025

2nd IARC EDR Review Meeting Talks (2025)

	Beijing time	Talk time	Speaker	Title	Talk n.
Sep 16th 2025	9:00	15'	IARC preparation meeting (closed)		
Tuesday	9:05	5'	Yifang Wang	Welcome	
	9:10	15'	Xinchou Lou	CEPC general status and news	1
	9:25	30'+5'	Jie Gao	CEPC Accelerator EDR Status and beyond	2
	10:00	30'	Coffee break		
	10:30	25'+5'	RuiGe/Mei Li	Summary of cryogenic system mini review	3
	11:00	25'+5'	Xiaolong Wang	Summary of alignment mini review	4
	11:30	25'+5'	Sha Bai/Haoyu Shi	Summary of MDI mini review	5
	12:00	25'+5'	Dou Wang	Summary of booster dipole magnet+sextupole mini review	6
	12:30	90'	Lunch		
	14:00	25'+5'	Guangyi Tang	Summary of vacuum chamber mini review	7
	14:30	25'+5'	Haijing Wang	CEPC survey and hardward design status	8
	15:00	25'+5'	Xiaolong Wang	Installation procedures of the Booster magnets beam pipe	9
	15:30	30'	Coffee break		
	16:00	25'+5'	Yiwei Wang	Solenoid compensation scheme and alternative schemes	10
	16:30	25'+5'	Daheng Ji	Simulation of injection at commissioning and orbit correction	11
	17:00	25'+5'	Yiwei Wang/Bin Wang	Studies of the tolerance to machine errors at all energies	12
	17:30	30'	IARC members	Closed session	

	Time	Talk time	Speaker	Title	Talk n.
Sep 17th 2025	9:00	25'+5'	Luyang Zhao	Conventional facility and control methods for the tunnel temperature	0
Wednesday	9:30	25'+5'	Wen Kang	CEPC booster magnet production line	14
	10:00	25'+5'	Yongsheng Ma	CEPC vacuum chamber production line	15
	10:30	30'	Coffee break		
	11:00	25'+5'	Dapeng Jin	Control system	16
	11:30	25'+5'	Xiaohao Cui	Collimators in the collider rings	17
	12:00	25'+5'	Song Jin/Lei Ye	DeepC electronic documentation system	18
	12:30	90'	Lunch		
	14:00	25'+5'	Zusheng Zhou	CEPC high efficiency klystron development	19
	14:30	25'+5'	Na Wang/Yudong Liu	CEPC collective effects	20
	15:00	25'+5'	Zhe Duan	CEPC polarization studies	21
	15:30	30'	Coffee break		
	16:00	30'	IARC discussion and Q/A with CEPC accelerator speakers (partly closed if needed)		
	17:00	60'	IARC members	Closed session	
Sep 18th 2025	9:00	25'+5'	Jinhui Chen	Injection/extraction system	22
Thursday	9:30	25'+5'	Jingyu Zhang	CEPC linac injector	23
	10:00	25'+5'	Dazhang Li	CEPC plasma injector	24
	10:30	30'	Coffee break		
	11:00	25'+5'	Daheng Ji	HEPS and BEPCII-U commissioning experiences	
	11:30	25'+5'	Jianfeng Liu	Civil engineering design	25
	12:00	25'+5'	Qingjin Xu	SppC high field magnet dipole development	26
	12:30	90'	Lunch		
	14:00	90'	IARC discussion and Q/A with CEPC accelerator speakers (partly closed if needed)		
	15:30	30'	Coffee break		
	16:00	120'	IARC members	Closed session	
	18:30	180'	Banquet		

The talks in red are required by IARC

CEPC IARC EDR Review Report (2025)

Second CEPC IARC EDR Review Report

CEPC IARC EDR Review Committee

19 September 2025

The CEPC Study Group, hosted by the Institute of High Energy Physics (IHEP), has been working on the design and development of a forefront e^+e^- collider as a Higgs factory that can extend to energies corresponding to the production of Z, WW and top-quark pairs, with the upgrade potential to a ~100 TeV pp collider. The CEPC represents a grand plan proposed, studied, and to be constructed by Chinese scientists in close collaboration with international partners. The CEPC Accelerator Technical Design Report was released in December 2023, which documents the design, the outcomes of the R&D of key technologies, the technical systems, and the cost estimate of the CEPC e^+e^- collider. Going beyond the accelerator TDR and preparing the CEPC for the construction that may begin in 2027-8, the CEPC Study Group has started the Engineering Design Study for which the outcome will be documented in a formal report (EDR). The CEPC Study Group plans to submit a proposal to the Chinese government requesting the inclusion of the CEPC in the 15th Five Year Plan. The International Accelerator Review Committee (IARC), chaired by Dr. Maria Enrica Biagini (INFN, Frascati) is asked to conduct the review on the development of the CEPC accelerator technical systems within the context of the EDR study. The Committee is specifically asked to review and comment on the following aspects:

1. Have the CEPC accelerator activities been carried out according to the EDR plan?
2. Has the CEPC accelerator team implemented or been addressing the recommendations and suggestions given by the IARC and the IAC in 2024?
3. Are the studies and replies to the concerns of the IARC's and the IAC's concerns satisfactory?
4. Is the overall EDR progress on track since the 2024 review?
5. Are there weak points in the CEPC accelerator EDR program? If so how can they be remedied?
6. Any other issues you notice or any improvements you may suggest.

It is requested that a Committee report responding to these charges be forwarded to the CEPC Steering Committee Chair, Professor Yifang Wang by October 20, 2025.

CEPC accelerator team will continue to work EDR and address the recommendations from IARC towards the goal for construction

1 Executive Summary

The second CEPC IARC EDR Review meeting was held in-person (with a few members joining on Zoom) at IHEP over the period of September 16-19, 2025.

The committee was invited to evaluate the advancement made since last year's review (September 2024) of the Engineering Design Study towards the construction of CEPC. A total of 26 talks were presented on the most challenging topics.

The committee wishes to congratulate the CEPC accelerator team for the excellent progress toward completion of the EDR phase.

The committee appreciated the quality of most of the presentations and was impressed by the achievements shown. The committee was pleased to see that many of the key systems, such as, for example, the high-efficiency klystron R&D, are progressing at full speed and with successful results.

An important change since the previous meeting of the committee is the choice of the site, which represents a major milestone for the project. Many work packages can now become more concrete.

2.5 Key Recommendations

The Committee has issued comments and recommendations for the different topics and presentations, which are given in Section A. The most significant of these recommendations are shown below:

1. (**A.3.2.2**) Pursue a highly reliable and sustainable CEPC cryogenics system enabling to realize full helium resource recovery and conservation in any major failures in superconducting magnets, RF system operations associated by fundamental infrastructure;
2. (**A.4.2.2**) Define, build and measure the surface geodetic network; prepare the corresponding geodetic reference frames and the related transformation systems to be used for the civil engineering tender documents, survey layouts and CAD systems;
3. (**A.4.2.4**) Develop and qualify an automated measurement system and its specific alignment targets to fulfill the alignment requirements in the arcs;
4. (**A.5.2**) Progress and optimize the MDI region design, after deciding on the compensation scheme, and start prototyping work, especially for the final focus quadrupoles;
5. (**A.13.2.2**) For conventional facilities, analyze dynamic changes on various timescales to ensure that the necessary stability and environmental condition can be maintained during operation and periods of shutdowns and access;
6. (**A.25.2.2**) As civil engineering work now concentrates on a specific site, exploit the new opportunities to make rapid progress on the many systems that are closely connected to civil engineering and need site-specific guidelines and parameters.

CEPC EDR Milestones

Year: 2024 2025 2026 2027 2028

EDR period (2024-2027)

- **2025:** Start EDR site geological studies by civil engineering company; EDR items started to be executed in an industrial way, such as magnet and vacuum NEG coating automatic lines, 650MHz full size cryomodule, C-band 80 MW klystron, C-band accelerator test band, CEPC 60m mockup tunnel, MDI SC CCT type quadrupole magnet, MDI design with SC quadrupole cryomodule, booster and collider ring magnets, civil engineering design, etc.

- Complete Detector TDR ref Design report

- EDR site geological study completed with good understanding of EDR site for starting site dependent civil engineering design; Complete following key EDR items: magnet and vacuum NEG coating automatic lines, 650MHz full size cryomodule, C-band 80 MW klystron, CEPC 60m mockup tunnel, etc. ; Continue C-band accelerator test band, MDI SC CCT type quadrupole magnet, MDI design with SC quadrupole cryomodule, booster and collider ring magnets, civil engineering design, etc. Obtaining government approval.

- EDR site dependent civil engineering design completed; Complete EDR report with following key EDR items completed: magnet and vacuum NEG coating automatic lines in operation, 650MHz full size cryomodule, C-band 80 MW klystron, CEPC 60m mockup tunnel, C-band accelerator test band, MDI SC CCT type quadrupole magnet, MDI design with SC quadrupole cryomodule, booster and collider ring magnets, etc., ready for construction with government approval.

CEPC Accelerator Parameter in EDR-1

Table 1: CEPC 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
[× 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 (°)	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 x_x/x_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
[× 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 (°)	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 in EDR-2

The Z mode running of the CEPC detector Ref Technical Design Report has been based on the 3T detector magnetic field, and TPC technology has been adopted

Table 3: CEPC low lum. with 3T detector @ Z for 1st stage running

	Z (3T)	
Number of IPs	2	
Circumference (km)	99.955	
SR power per beam (MW)	8.7	12.1
Half crossing angle at IP (mrad)	16.5	
Bending radius (km)	10.7	
Energy (GeV)	45.5	
Energy loss per turn (GeV)	0.037	
Damping time $\tau_x/\tau_y/\tau_z$ (ms)	816/816/408	
Piwinski angle	24	
Bunch number	3978	
Bunch spacing (ns)	69.2	
Bunch population (10^{11})	1.22	1.7
Beam current (mA)	233.2	325.0
Phase advance of arc FODO (°)	90	60
Momentum compaction (10^{-5})	0.71	1.43
Beta functions at IP β_x^*/β_y^* (m/mm)	0.2/1.0	0.13/1.0
Emittance $\varepsilon_x/\varepsilon_y$ (nm/pm)	0.092/1.7	0.27/5.1
Betatron tune ν_x/ν_y	445/445	317/317
Beam size at IP σ_x/σ_y (um/nm)	4/42	6/72
Bunch length (natural/total) (mm)	2.1/8.3	2.1/8.8
Energy spread (natural/total) (%)	0.04/0.11	0.04/0.15
Energy acceptance (DA/RF) (%)	1.0/1.9	1.0/2.2
Beam-beam parameters ξ_x/ξ_y	0.0065/0.11	0.0053/0.082
RF voltage (GV)	0.09	0.16
RF frequency (MHz)	650 (2 cell cavity)	
Longitudinal tune ν_s	0.021	0.041
Beam lifetime (Bhabha/beamstrahlung) (min)	120/200	150/180
Beam lifetime requirement (min)	68	
Hourglass Factor	0.97	
Luminosity per IP (10^{34} cm^{-2} s^{-1})	24	26

Table 4: CEPC high lum. with 3T detector @Z assuming for 2nd stage running

	Z	
Number of IPs	2	
Circumference (km)	99.955	
SR power per beam (MW)	**30**	50
Half crossing angle at IP (mrad)	16.5	
Bending radius (km)	10.7	
Energy (GeV)	45.5	
Energy loss per turn (GeV)	0.037	
Damping time $\tau_x/\tau_y/\tau_z$ (ms)	816/816/408	
Piwinski angle	24.2	29.5
Bunch number	11934	13104
Bunch spacing (ns)	23.1 (17% gap)	23.1 (9% gap)
Bunch population (10^{11})	1.4	2.1
Beam current (mA)	806.9	1345.2
Phase advance of arc FODO (°)	60	
Momentum compaction (10^{-5})	1.43	
Beta functions at IP β_x^*/β_y^* (m/mm)	0.13/1.0	
Emittance $\varepsilon_x/\varepsilon_y$ (nm/pm)	0.27/5.1	
Betatron tune ν_x/ν_y	317/317	
Beam size at IP σ_x/σ_y (um/nm)	6/72	
Bunch length (natural/total) (mm)	2.5/9.3	2.2/10.6
Energy spread (natural/total) (%)	0.04/0.15	0.04/0.15
Energy acceptance (DA/RF) (%)	1.2/1.7	1.2/2.1
Beam-beam parameters ξ_x/ξ_y	0.0045/0.069	0.0046/0.074
RF voltage (GV)	0.12	0.15
RF frequency (MHz)	650 (1 cell cavity)	
Harmonic number	216720	
Longitudinal tune ν_s	0.035	0.040
Beam lifetime (Bhabha/beamstrahlung) (min)	170/95800	120/932
Beam lifetime requirement (min)	77	81
Luminosity per IP (10^{34} cm^{-2} s^{-1})	**50.3**	95.2

CEPC Accelerator Parameter in EDR-3

Table 5: Main Booster parameters at injection energy.

	Unit	*tt*	*H*	*W*	*Z*	
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 6: Main Booster parameters at extraction energy.

	Unit	*tt*	*H*		*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 in EDR-4

Table 7: 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

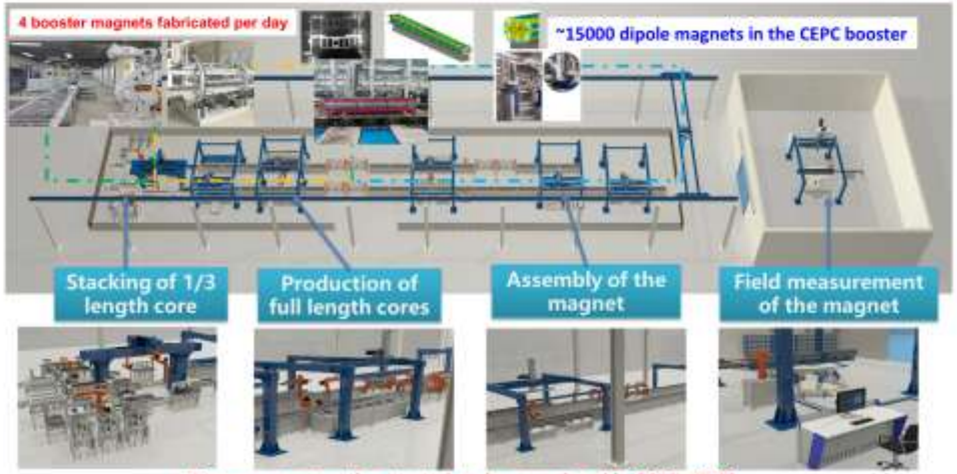
Parameter	Unit	S-band		C-band
Frequency	MHz	2860		5720
Length	m	3.1	2.0	1.8
Cavity mode		2π/3		3π/4
Aperture	mm	19~26	25	12~16
Gradient	MV/m	22/27	22	40
Cells		86	55	89
Number of Acc. Stru.		93	16	470
Number of Klystron		34		236
Klystron Power	MW	80		50

Table 8: 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/trian	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 emittancce 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

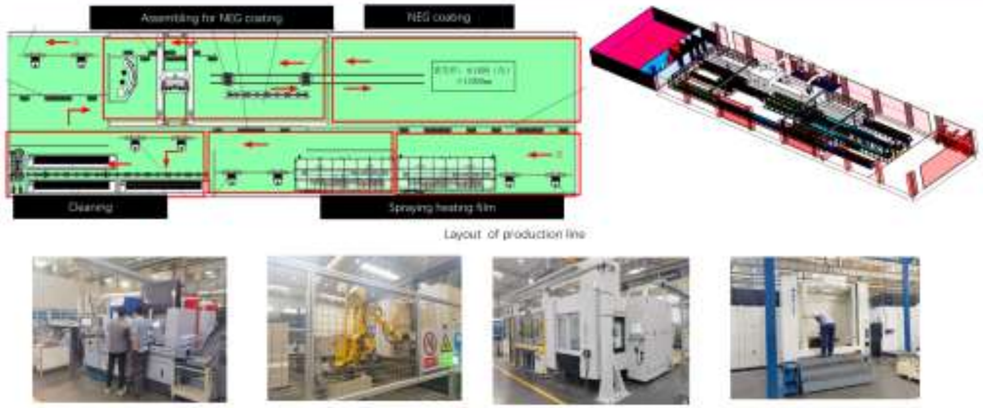
CEPC Key Taks in EDR-1

CEPC Booster Magnet Automatic Production Line in EDR



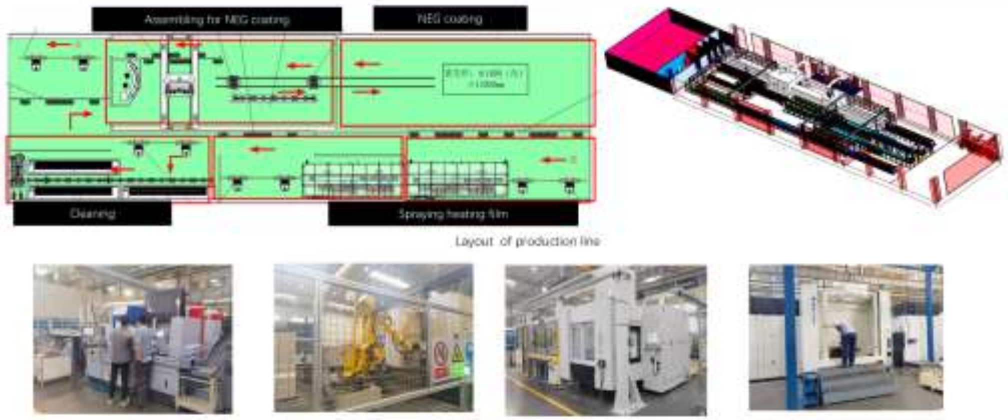
Status: construction started, to be completed in 2025~2026

CEPC NEG Coated Vacuum Chamber (200km) Automatic Production Line in EDR



Status: construction started, to be completed in 2025~2026

CEPC NEG Coated Vacuum Chamber (200km) Automatic Production Line in EDR



Status: construction started, to be completed in 2025~2026

CEPC 650MHz SRF Development in EDR

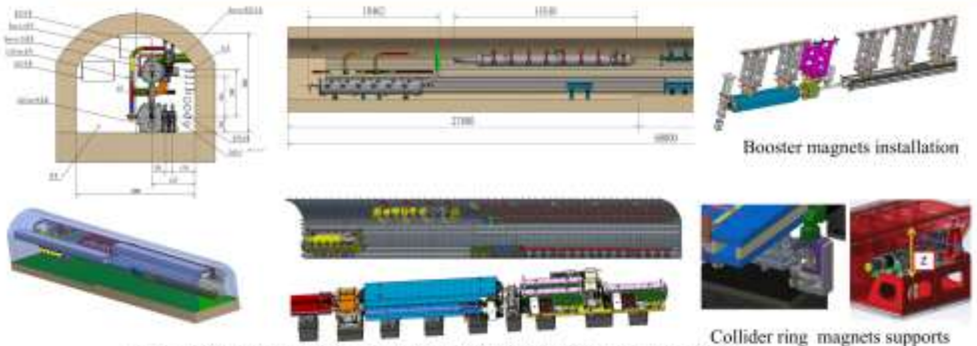
CEPC collider ring 650MHz 2*cell short test module has been completed in TDR phase

The collider Higgs mode for 30 MW SR power per beam will use 32 units of 11 m-long collider cryomodules will contain six 650 MHz 2-cell cavities, and therefore, a full size 650 MHz cryomodule will be developed in EDR

Status: construction started, to be completed in 2026

CEPC Key Taks in EDR-2

CEPC Tunnel Mockup for Installation in EDR



Booster magnets installation

Collider ring magnets supports

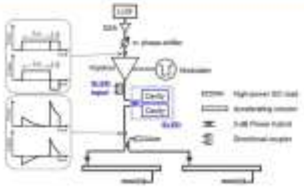
A 60 m long tunnel mockup, including parts of arc section and part of RF section

To demonstrate the inside tunnel alignment and installation, especially for booster installation on the roof of the tunnel

Plan：to be completed in 2026

CEPC C-Band Linac Test Bench 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. as a basic unit of CEPC C-band linac
- 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

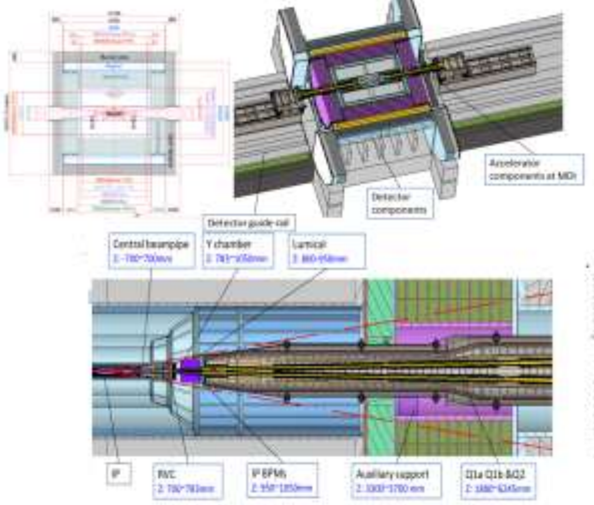
Cavity shape

The deformation caused by temperature variation

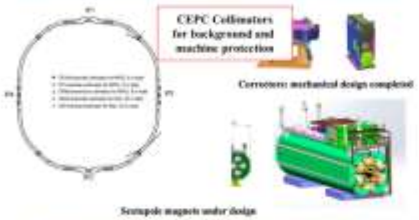
CEPC C-band linac test band will be completed in 2026

Other CEPC Accelerator and MDI EDR Activities

CEPC MDI designs



CEPC Collider Ring Magnets in EDR



CEPC Alignment and Installation Plan in EDR

Design parameters of SC quadrupoles with CCT coil

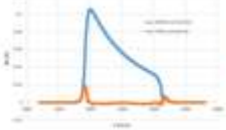
- Design parameters of Q1a, Q1b, Q2 magnet with iron-free CCT coil @ Higgs

	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		$<2\times10^{-4}$	
(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	

Direct winding CCT coil is preferred for CEPC

IHEP fabricated CEPC CCT coil prototype with direct winding, inner diameter 40mm, 600mm long

Q1a Direct winding CCT coil
Preliminary design
Round 0.7mm conductor, canted angle: 24 deg
8 layers CCT quadrupole coil. The inner radius of the coil is 20mm
Excitation current: 730A @4.2K (2K is also under study)
3D calculation in OPERA-3D
Radius of single aperture ~31mm



Q1b Q2 Direct winding CCT coil
Round 0.8mm conductor, canted angle: 24 deg
8 layers CCT quadrupole coil.
After correction, local dipole field decreases to less than 150Gs (Higgs)
Calculated integrated field harmonics are smaller than 2×10^{-4}

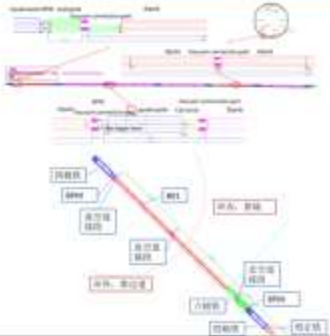
CEPC Key Taks in EDR-3

CEPC Accelerator EDR: Survey and Mechanical 2D/3D Design

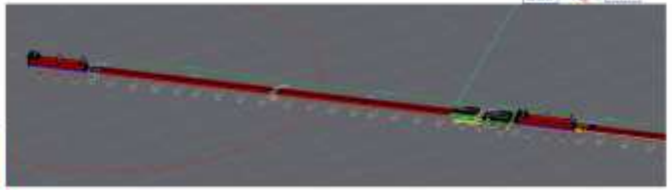
CEPC Facility components' naming sysem established

2D/3D linkage design for CEPC accelerator survey:

- If the 3D model is changed or replaced, the 2D model will be updated.
- If the 2D model is replaced or its location is changed, the 3D model will be updated.



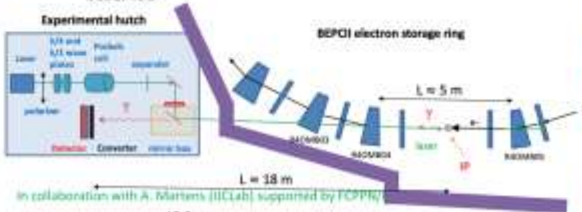
CEPC 10 vertical shafts and 12 horizontal access tunnel distribution

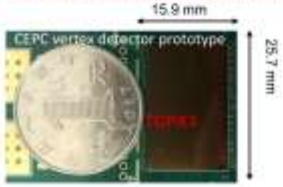


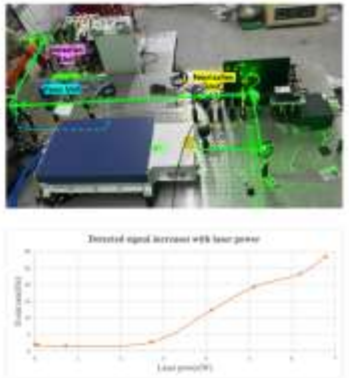
CEPC Polarization in Preparation Study

-Compton Polarimeter at BEPCII-U

- A Compton polarimeter is now under commissioning at BEPCII-U
  - simulated performance: ~1% stats uncertainty within 20 second
  - Ready for tuning of laser-electron collision-> backscattered gamma signal from laser-electron collision has been observed





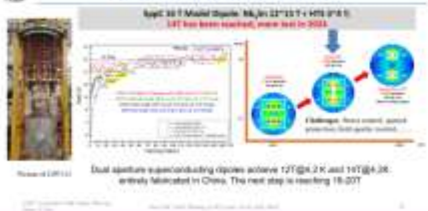


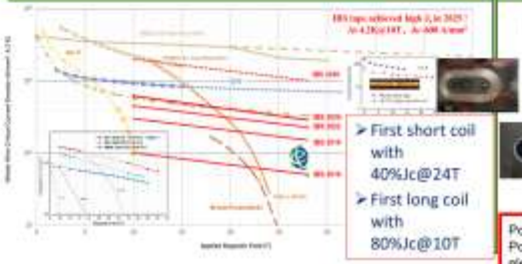
Advanced Technologies Development in Progress

IBS Technology for High Field Magnets

J_c of IBS expected to be similar as ReBCO in 5 years with better mechanical properties and lower cost

SppC HF Magnet Development





- First short coil with 40%Jc@24T
- First long coil with 80%Jc@10T

CEPC Polarized Beam Studies(alternative option)

Polarized electron cathode chip (diameter ~5cm) has been fabricated in June 2025: Polarization of 85%, for 1ns laser (780nm) pulse length, several nC polarized electron charge will be obtained with the expected cathode lifetime ~6 months

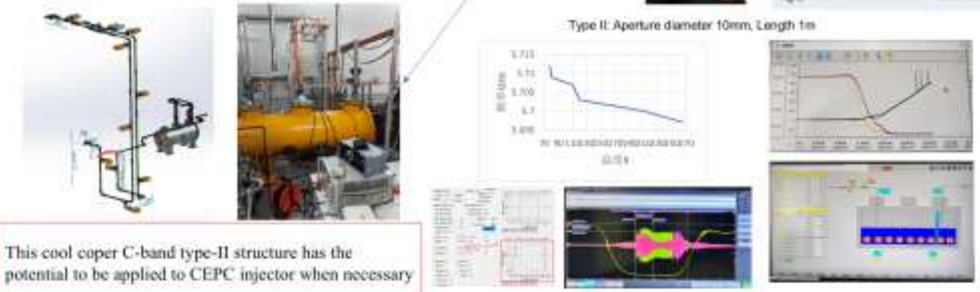
CEPC Cool Copper C-Band Linac Technology R&D

- CEPC is exploring the Cool Copper C-band linac technology (5712MHz is the test facility frequency)
- Two types of structures have been studied, type I and type II
- Type I has reached Eac 92.08MV/m, Q0 26162 with 20MW input (80MW input will reach Eac 199.2MV/m) (Iris diameter 5.25mm)
- Type II will reach 144MV/m with 80MW input (Iris diameter 10.49mm)

Type I: Aperture diameter 5mm, Length 0.5m

Type II: Aperture diameter 10mm, Length 1m

Parameters	Value
Fre (MHz)@77K	5712
Mode	Pi
Cavity numbers	20
Shunt impedance per meter(MΩ/m)@77K	303
E_s/E_a	2.42
Q_0@77K	31905



This cool coper C-band type-II structure has the potential to be applied to CEPC injector when necessary

CEPC Accelerator Components-Types and Quantities

There are 244 types of hardware along beam, with a total quantity of **105354***.

*When counting the quantity, the vacuum chambers are not included, because the detailed vacuum chambers should be designed after the vacuum segmentation and layout definition.

Collider	Hardware types	Quantity
Magnets	58	25280
EMS	1	32
RF modules	1	32
Collimators	5	64
Beam instrument	7	7134
Vacuum devices	4	19130
Waveguides	1	32
Cryogenic devices	1	32
MDI devices	5	20
Total	83	51756

Booster	Hardware types	Quantity
Magnets	18	19610
RF modules	1	12
Beam instrument	6	2418
Vacuum devices	3	18402
Waveguides	1	12
Cryogenic devices	1	12
Total	30	40466

Linac	Hardware types	Quantity
Magnets	34	690
Accelerator devices	14	1164
Beam instrument	10	244
Vacuum devices	4	7585
RP devices	7	7
Total	69	9690

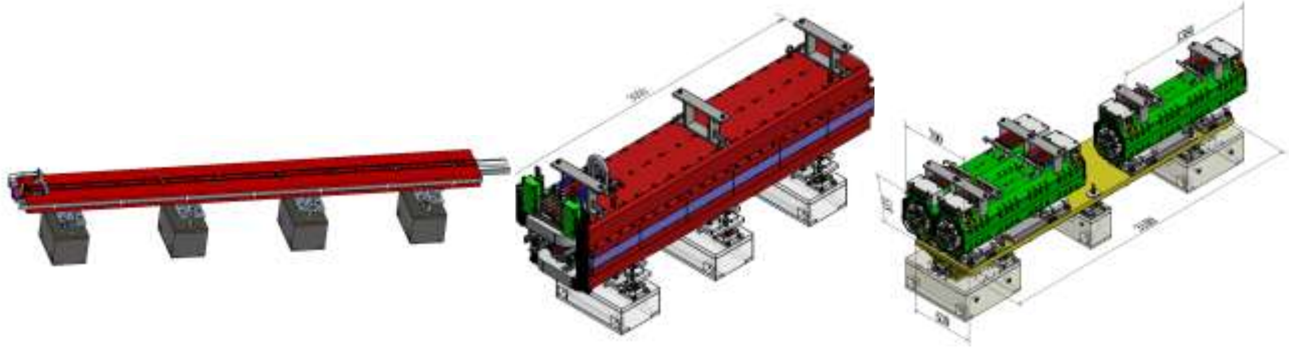
Damping Ring	Hardware types	Quantity
Magnets	8	310
Cavity	1	2
Beam instrument	3	42
Vacuum devices	3	144
Total	15	498

INJ&EXT	Hardware types	Quantity
LSM	23	134
Kicker	4	52
Total	27	186

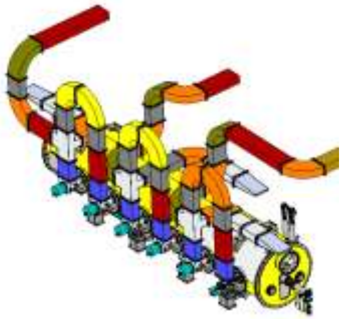
Transport line	Hardware types	Quantity
Magnets	9	752
Beam instrument	5	86
Vacuum devices	5	1912
DUMP	1	2
Total	20	2758

CEPC Accelerator Components Types

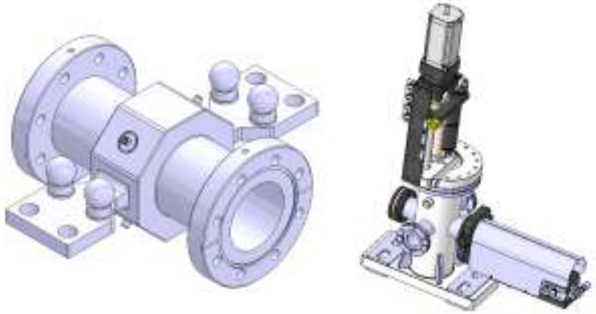
Magnet assembly in collider



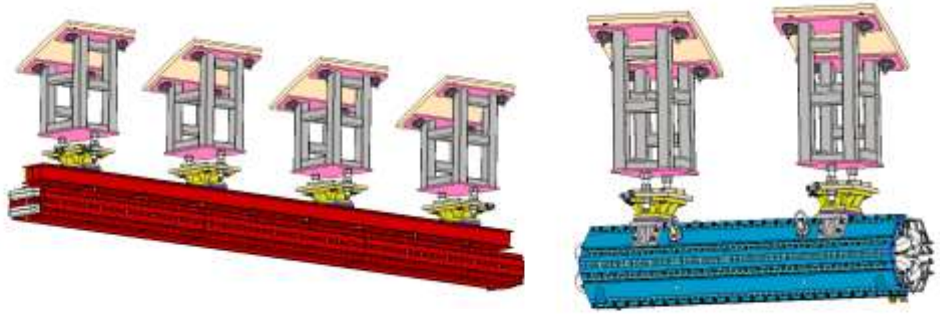
RF module in Collider



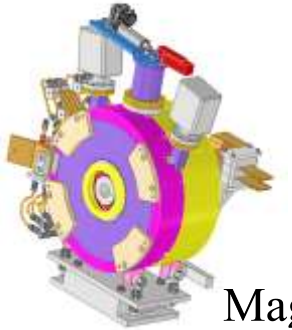
Some instruments



Magnet assembly in Booster

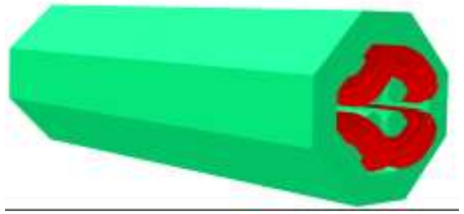


PT & AMD for Linac

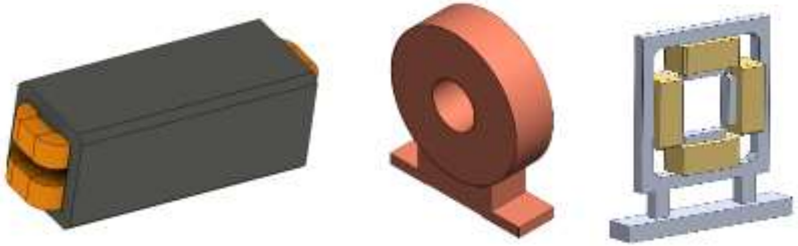


INJ & EXT magnets

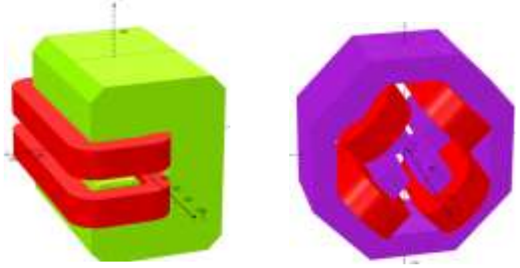
QRFB in collider



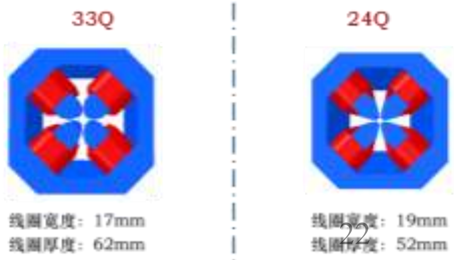
Magnets for Linac



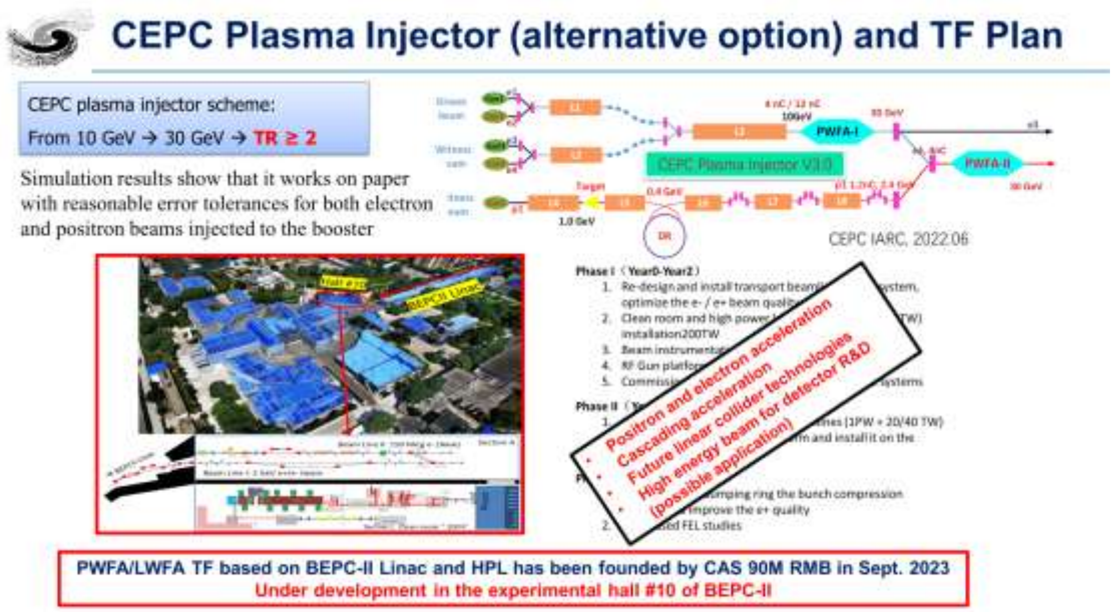
Magnets for damping ring

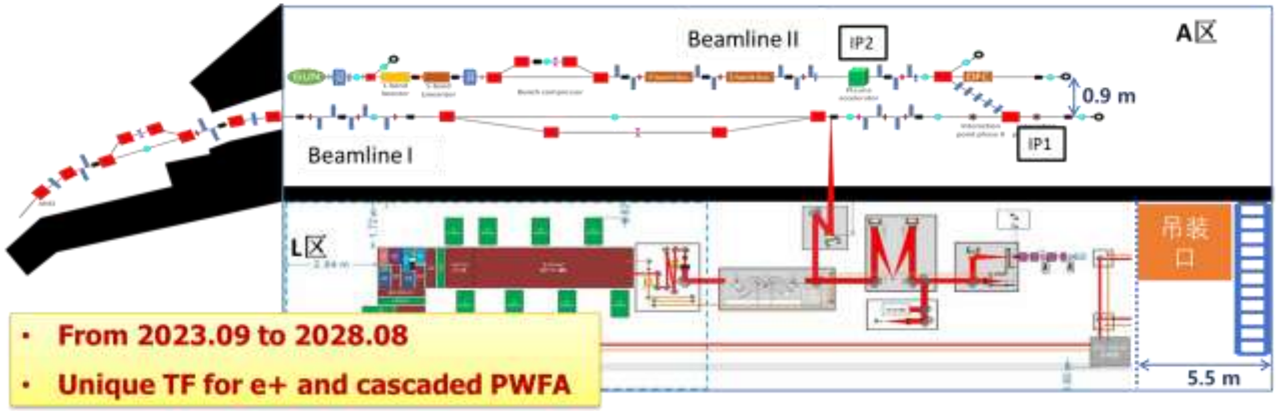


Quadrupoles in TL



BEPCII-based PWFA Test Facility Development Status

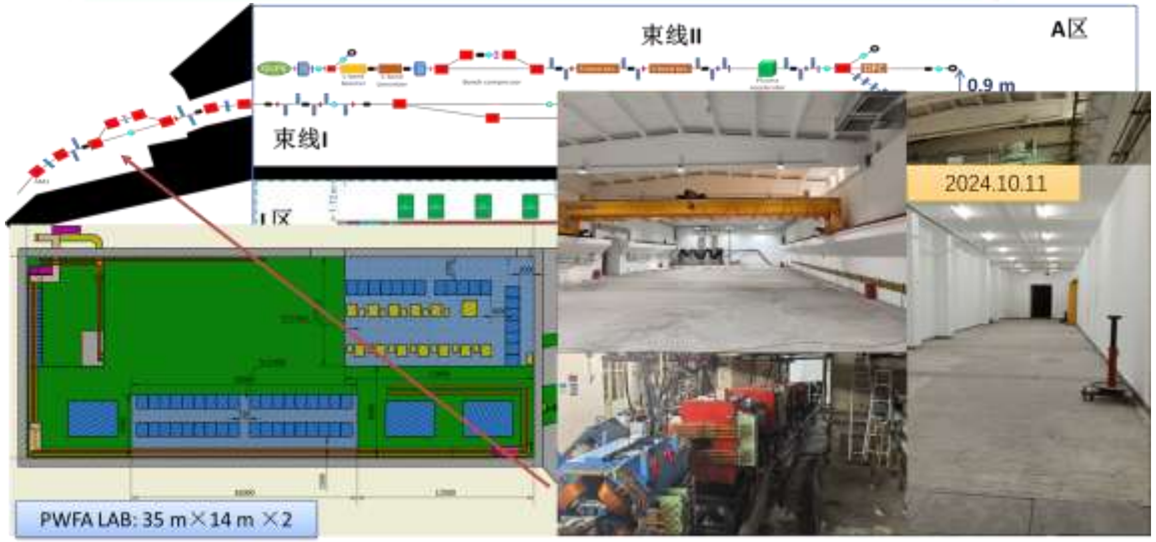


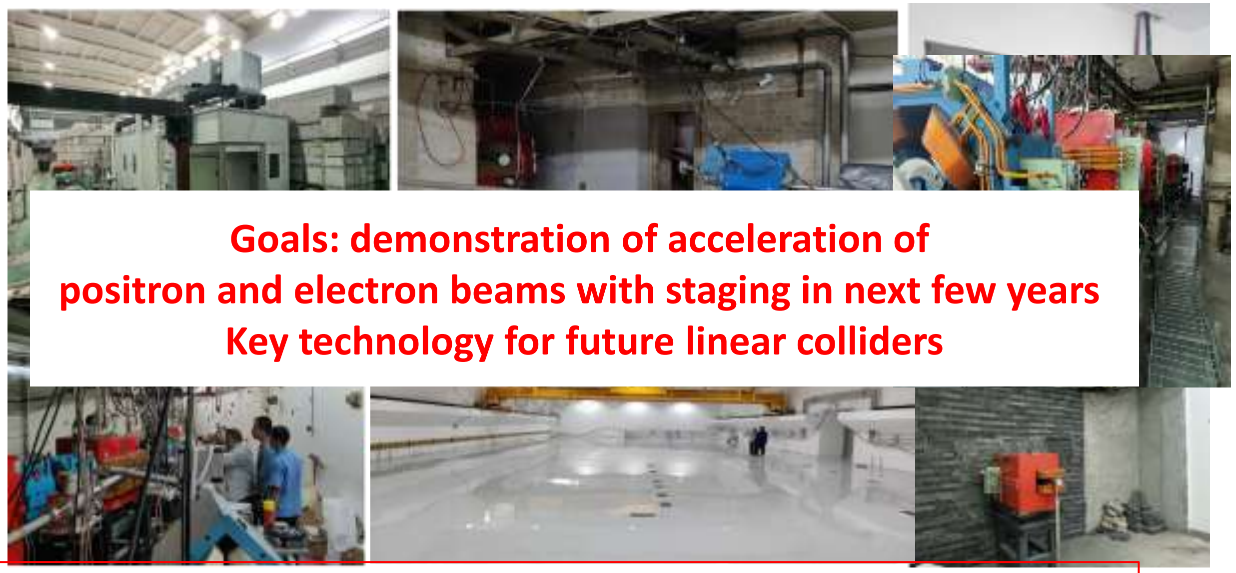


Beam quality → Beamline I

Parameters	Unit	BL-I e- (AM3)	BL-I e- (IP1)	BL-I e+ (AM3)	BL-I e+ (IP1)	BL-I e- (IP1, block)	BL-I e+ (IP1, block)
Energy	GeV	2	2	2	2	2	2
Charge	pC	2000	2000	100	100	9.4	0.2
bunch length	ps	10	1	10	1	~1	~1
Geo. emittance	mm·mrad	0.1/0.1	0.1/0.1	0.4/0.4	0.4/0.4	0.011/0.005	0.04/0.02
RMS beam size	μm	-	150/150	-	300/300	30/40	54/76

33





Goals: demonstration of acceleration of positron and electron beams with staging in next few years
Key technology for future linear colliders

Dazhang Li, Wei Lu and Jie Gao, Research highlights on plasma-based acceleration at IHEP, AAPPS Bulletin (2025) 35:3, https://doi.org/10.1007/s43673-025-00143-z

Green CEPC and Sustainability Efforts

- **SR power per beam: 30 MW** (CEPC-TDR p965)
  - Total electricity consumption: 262 MW
    - RF power (109 MW)
    - Magnet (58 MW)
    - Utilities (44 MW)
    - Cryogenics (11.6 MW)
    - Other auxiliary power combined (29 MW)

  Need to improve these

- **SR power per beam: 50 MW** (CEPC-TDR p967)
  - Total electricity consumption: 340 MW
    - RF power (177 MW)
    - Magnet (58 MW)
    - Utilities (54 MW)
    - Cryogenics (11.1 MW)
    - Other auxiliary power combined (29 MW)

  Need to improve these

Participated the 4th edition of the Sustainable High Energy Physics (HEP) workshop, May 12-15, 2025, with green CEPC and sustainability presentation and Panel discussions https://indico.global/event/4745/

On-going sustainability projects:

- High efficiency klystron:
  - 650 MHz
  - 80 MW C-band

- Permanent magnets transport lines
- High Q-factor SRF cryogenic-modules
- Recovery of waste heat (HEPS)
- Recovery and recycling of Helium
- Photovoltaic (PV) power generation systems (HEPS)

Permanent quadrupole's prototypes for CEPC collider rings

Prototypes have been developed addressing green collider technologies

Power efficiency, energy recycling, and clean energy generation are being addressed as comprehensive measures for sustainable operation

Publication: Dou Wang; Jie Gao; Yuhui Li; Jinshu Huang; Song Jin; Manqi Ruan; Mingshui Chen; Shanzhen Chen, "The carbon footprint and CO2 reduction optimization of CEPC", *RDMT*, https://doi.org/10.1007/s41605-025-00535-7 (2025).

Participating and Potential Collaborating Companies in China (CIPC) and Worldwide

	System
1	Magnet
2	Power supplier
3	Vacuum
4	Mechanics
5	RF Power
6	SRF/ RF
7	Cryogenics
8	Instrumentation
9	Control
10	Survey and alignment
11	Radiation protection
12	e-e+Sources

CEPC Industrial Promotion Consortium (CIPC, established in Nov. 2017)

Potential international collaborating suppliers worldwide

CEPC Industrial Preparation

Large-scale Cryogenic Refrigeration & Liquefaction Equipment 中科富海 (CIPC member)

First 18kW@4.5K helium refrigerator fabricated in in China passes inspection

-It was developed by the Institute of TIPC,CAS, and integrated and manufactured by Fullcryo.

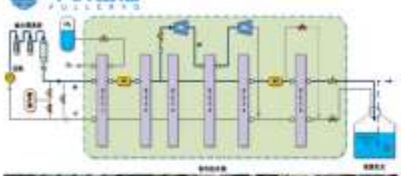
-The super large horizontal cold box with a length of 28m and a diameter of 4.2m achieves ultra-high vacuum and extremely low leakage.

-The horizontal cold box at megawatt-level is the largest of its kind in China and even in the world.

-The horizontal cold box system has exceeded the set targets.

-On-site testing: 1. The airtightness test of each internal channel revealed a pressure drop of 0, surpassing the target value of 0.02 bar. 2. The overall leakage rate is 9.1×10^{-10} Pa.m³/s, surpassing the target value of 1×10^{-7} Pa.m³/s.

-Expected Goals: Achieving 3 operational mode adjustments: the cooling capacity ≥ 18kW@4.5K; the cooling capacity in the superfluid helium temperature range ≥4kW@2K.

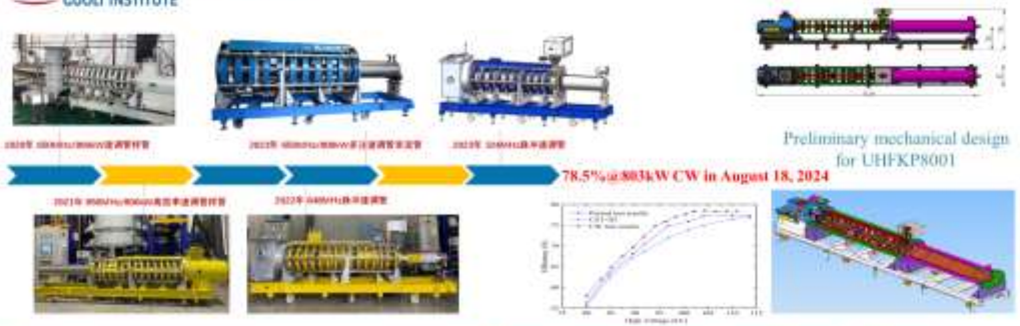


北京中科富海低温科技有限公司
Beijing Sinoscience Fullcryo Technology CO., Ltd. (CIPC member)

CEPC cryogenic system need four 14kW@4K cryogenic refrigerators
SppC needs 18kW@4.5K helium refrigerator as well

CEPC 650MHz 800kW CW High Efficiency Klystrons

国力研究院 GUOLI INSTITUTE (CIPC member)



Kunshan National Research Institute has successively developed **650MHz/800KW klystron sample tubes, 650MHz/800KW high-efficiency klystron sample tubes, 648MHz pulse klystron tubes, 650MHz/800KW multi-injection klystron beam tubes,** and the latest 324MHz pulse klystron tubes Electro vacuum products for 50 years. Provide high power thyristor of GL1536A in batches for BEPCII in 2012.

HE-RACING Technology and OTIC on SRF Technologies (CIPC members)

高能锐新 (CIPC member)

1.3GHz cryomodule assembly

东方钽业 OTIC (CIPC me...

2011 DESY - XFEL

RRR300 Nb: 8 ...

2013 ...

... the project

... 5 tons, 50% of the project

2017 INFN and STFC - ESS

RRR300 Nb: 12.5 tons, 100% of the project

2019 IBS - RISP, CERN - HL-LHC, Fermilab - PIP-II, Shanghai - SHINE

RRR300 niobium material procurement in progress

We had built the business relationship with many great customers such as DESY, MSU, Fermilab, JLAB, INFN, STFC, CERN, TRIUMF, RI, ZANON, IHEP, IBS, RRCAT etc.

High RRR Nb sheet | High RRR Nb ingod | High RRR large grain Nb

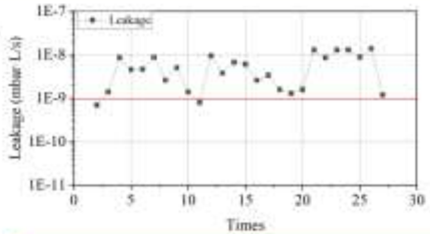
CEPC booster and colliders: 2GeV 1.3GHz and 650MHz SRF accelerators (Higgs); 10GeV 1.3GHz and 650MHz SRF accelerators (ttar)

The Key industries also for ILC and LCF

RF Shielding all Metal Gate Vacuum Valve

日揚科技 SHZK BE PROFESSIONAL, BE BETTER

- Two prototypes of RF shielding All metal ...en developed, and the leakage of one of them have been tested.
- The delivery inspection leakage test results for two valves, conducted by the manufacturer, were found to be < 1×10^{-9} mbar ·L/s (30 times open and closed).
- The difference of leakage by IHEP & manufacture will be checked and retested in next.



- Tested by IHEP
- Expectation leakage < 1×10^{-9} mbar ·L/s

CEPC needs ~1700 all metal valves

CEPC International Collaboration-1

HKUST IAS23 HEP Conference, Feb. 14-16, 2023, Hong Kong

https://indico.cern.ch/event/1215937/

The 2024 HKUST IAS Mini workshop and conference were held from Jan. 18-19, and Jan. 22-25, 2024, respectively.

https://indico.cern.ch/event/1335278/timetable/?view=standard

The 2025 HKUST IAS fundamental physics conference: Jan. 14-17, 2025, Hong Kong

https://indico.cern.ch/event/1454867/overview

CEPC Workshop EU Edition (Barcelona, Spain) June 16-19, 2025

https://indico.ifae.es/event/2054/overview

The 2026 HKUST IAS fundamental physics conference Jan. 12-16, 2026, Hong Kong

CEPC Workshop EU, April 7-10, 2026, Lisbon, Portugal

The 2023 International Workshop on Circular Electron Positron Collider, EU Edition, University of Edinburgh, July 3-6, 2023

https://indico.ph.ed.ac.uk/event/259/overview

The 2024 international workshop on the high energy Circular Electron Positron Collider (CEPC) was held from Oct. 23-27, 2024, Hangzhou, China

https://indico.ihep.ac.cn/event/22089/

The 2025 international workshop on the high energy Circular Electron Positron Collider (CEPC) will be held from Nov. 6-10, 2025, Guangzhou, China

https://indico.ihep.ac.cn/event/25300/

The 2023 international workshop on the high energy Circular Electron Positron Collider (CEPC)

https://indico.ihep.ac.cn/event/19316/

The 2024 international workshop of CEPC EU-Edition were held in Marseille, France, April 8-11, 2024.

https://indico.in2p3.fr/event/20053/overview

FCPPNL, Bordeaux, France, June 10-14, 2024
https://indico.in2p3.fr/event/20434/overview

FCPPNL, Qingdao, China, July 21-25, 2025
https://indico.ihep.ac.cn/event/25400/

CEPC International Collaboration-4

Since March 4th 2025 (kick off meeting), IHEP has joined an international collaboration on beam-beam effects at SuperKEKB among CERN, IHEP, KEK and USTC. **(As recommended and encouraged by IARC and IAC)**

IHEP has participated all SuperKEKB international collaboration meetings and one Ph.D student Meng Li and one Post Doc. Chuntao Lin from IHEP have long stay at KEK on SuperKEKB injection related background and beam-beam effects joint studies.

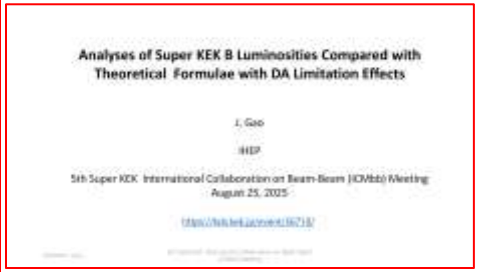
Prof. Jie GAO from IHEP has sent presentations to the collaboration about the possible reason why SuperKEKB's design luminosity (80*10^34@βy=0.3mm) could not be achieved, and it is recommended that the next round SuperKEKB experiment go to βy=1.79mm (instead of stay at βy=1mm and smaller) possibly achieved luminosity would be around 8.7*10^34cm^-2s^-1 (about a factor of ten lower than the design goal), close to the Super KEK B post-LS1(1) luminosity target goal of 10*10^34cm^-2s^-1. If on axis injection is adopted, the luminosity could reach 14.6*10^34cm^-2s^-1 with βy=1mm.

$$L_{max}[cm^{-2}s^{-1}] = \frac{0.158\times 10^{34}(1+r)}{\beta_y^*[mm]} I_b[mA]\sqrt{\frac{U_0[GeV]}{N_{IP}}}\; e^{\frac{\sqrt{\Phi p}}{3.22}}(1+0.000505\cdot\Phi p^2) \quad \text{Eq. 1}$$

$$L_{max}[cm^{-2}s^{-1}] = \frac{0.158\times 10^{34}(1+r)}{\beta_y^*[mm]} I_b[mA]\sqrt{\frac{U_0[GeV]}{N_{IP}}}\; e^{(\frac{\sqrt{\Phi p}}{3.22}\;\frac{A}{\beta_{y(mm)}^2})}(1+0.000505\cdot\Phi p^2) \quad \text{Eq. 2}$$

for Super KEK B: A=1.6mm^2 (off axis injection)
for Super KEK B: A=0.56mm^2 (on axis injection)

Super KEK B is an important high luminosity e+e- collider in operation with crab waist scheme, and it is important to learn the experimental experiences for future advanced colliders such as Higgs factories of CEPC and FCC



Analyses of Super KEK B Luminosities Compared with Theoretical Formulae with DA Limitation Effects

J. Gao

IHEP

5th Super KEK International Collaboration on Beam-Beam (ICMbb) Meeting

August 25, 2025

The oral presentation will be in Nov. 2025

The luminosities of Super KEK B without (Eq. 1) and with (Eq. 2) DA limitation effects as shown in Figure 1.

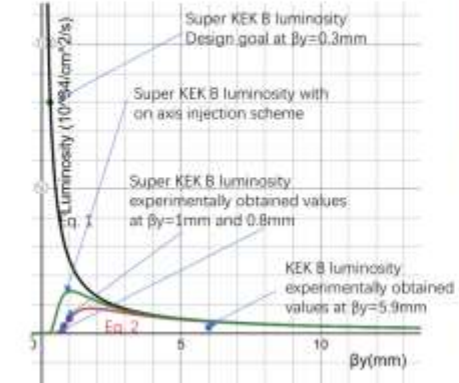


Figure 1: Super KEK B luminosities from the experiments and the analytical formulae Eq. 1 and Eq. 2

βy (mm)	Luminosity of Super KEK B (10^34/cm^2/s) (Experiments and designed)	Luminosity of Super KEK B (10^34/cm^2/s) (Jie Gao formulae, no DA effects, Eq. 1)	Luminosity of Super KEK B (10^34/cm^2/s) (Jie Gao formulae considering DA effects, Eq. 2) (Off axis injection)	Luminosity of Super KEK B (10^34/cm^2/s) (Jie Gao formulae considering DA effects, Eq. 2) (On axis injection)
0.3	80 (designed value from Table 1)	85	0	0.17
0.8	2.5 (2022abRun)	32	2.6	13.3
1	5.1 (Dec. 27, 2024)	26	5.1	14.6
1.788	To be experimented (recommended)	14.2	8.65	12
2	To be experimented	12.8	8.55	11.1
3	To be experimented	8.5	7.1	8
6	To be experimented	4.25	4.25	4.2

Table 2: Comparison of Super KEK designed and experimental luminosities with Jie Gao's luminosity analytical formulae, Eq. 1 and Eq. 2

Eq. 1 and Eq. 2 could be found in following reference:
J. Gao, "The CEPC Project Status", Nov. 2025, arXiv:2505.04663, https://doi.org/10.48550/arXiv.2505.04663

Summary

- CEPC accelerator full spectrum EDR activities including EDR site geological investigation and civil engineering design have progressed well according to EDR plan
- IARC/IAC recommendations have been well taken into account and all five international mini reviews have been conducted in 2025
- CEPC detector reference design report has been reviewed by IDRC in April and Sept. 2025, which promote also MDI activities in general
- CEPC IARC 2025 meeting report is a good guide for the following EDR works
- CEPC will keep and strengthen strong international and industrial collaborations
- CEPC goal is to complete EDR and continue to prepare and apply for construction in the 16th five year plan and start construction around 2030's

Acknowledgements

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

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

Thanks for your attention