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

The CEPC Project Status

J. Gao

IHEP

On behalf of CEPC-SppC team

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Moscow State University, Moscow, Russia

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- CEPC detector TDR reference design status
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A Brief Historical Recall: High Energy Colliders and Factories

The era of Higgs boson started from 2012， and we entered the BEST EPOCH of High Energy Physics

In the last 60 years we have made a tremendous progress in particle physics, and we have to prepare for the next exciting and discovering years of human being

In 60's, Ada, VEP-I, VEPP-II, ACO…

Year

Next?

2018

2012

2010

2006

2002

1999

1994

1990

1988

1980

1972

SppC, FCC-hh
Muon collider
FCC-ee
(H,t, Z,W…Dark matter)
CEPC/ILC/CLIC: new e^+e^- collider
(B physics…)
SuperKEKB: $\sqrt{s} \simeq 10\ \mathrm{GeV}, \mathcal{L} \simeq 10^{35}$
LHC: $\sqrt{s} \simeq 14\mathrm{TeV}, \mathcal{L} \simeq 10^{33}$
(τ − charm,…)
BEPCII: $\sqrt{s} \simeq 2-5\ \mathrm{GeV}, \mathcal{L} \simeq 10^{33}$
(τ mass, charmonium,…)
VEPP-4: $\sqrt{s} \simeq 1.5-2.0\mathrm{GeV}, \mathcal{L} \simeq 10^{33}$; DAFNE: $\sqrt{s}$ ~1GeV , $\mathcal{L} \simeq 10^{32}$
(B-quark, CP violation, CKM…)
KEKB/PEP-II
SSC: $\sqrt{s} \simeq 40\mathrm{TeV}, \mathcal{L} \simeq 10^{33}$ 1993 stopped
(Z, W bosons,…)
LEP/CERN, SLC/SLAC
(τ −charm,…)
BEPC: $\sqrt{s} \simeq 2-5\ \mathrm{GeV}, \mathcal{L} \simeq 10^{31}$
CESR: $\sqrt{s} \simeq 10\ \mathrm{GeV}$
(J/ψ,c-quark, t …)
SPEAR&BNL: $\sqrt{s}$

Future Large Colliders:
- new paradigm/theory
- new colliders equipped with advanced detectors

Higgs,…

LHC/CERN:

Higgs boson 2012

Crab-Waist in 2014 at DAFNE

CEPC-SppC was proposed by Chinese scientists in Sept. 2012 after Higgs Boson was discovered on July 4, 2012 at CERN

Top

Tevatron

Top quark 1995

HERA: ep

J. Gao, "Review of Different Colliders", **International Journal of Modern Physics A**, (2021) 2142002 (25 pages).

W, Z,…

SPS/CERN

W,Z bosons 1983

Bottom,…

PETRA: $\sqrt{s} \simeq 12\sim46.7$ GeV GeV

Gluon 1979

Fermilab: 400GeV p on Cu, Pt

Bottom quark 1977

(e^+e^- colliders)

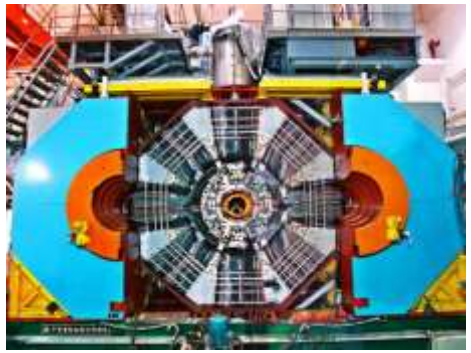
(proton accelerators)

From BEPC, BEPCII, BEPCII-U to CEPC

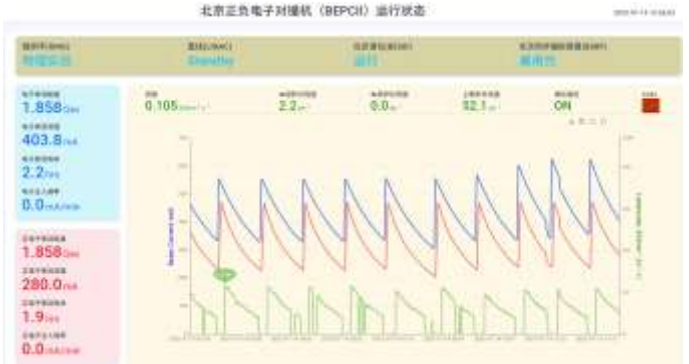
BEPC, the first collider in China, was completed in 1988 with luminosity $1\times10^{31}cm^{-2}s^{-1}$ @1.89GeV
BEPC II was completed in 2009
Luminosity reached on April 5, 2016: $10\times10^{32}cm^{-2}s^{-1}$ @1.89GeV

After BEPCII what is the next high energy collider?

Thanks to the discovery of Higgs at LHC@CERN in July 4, 2012, the answer is clear, CEPC!

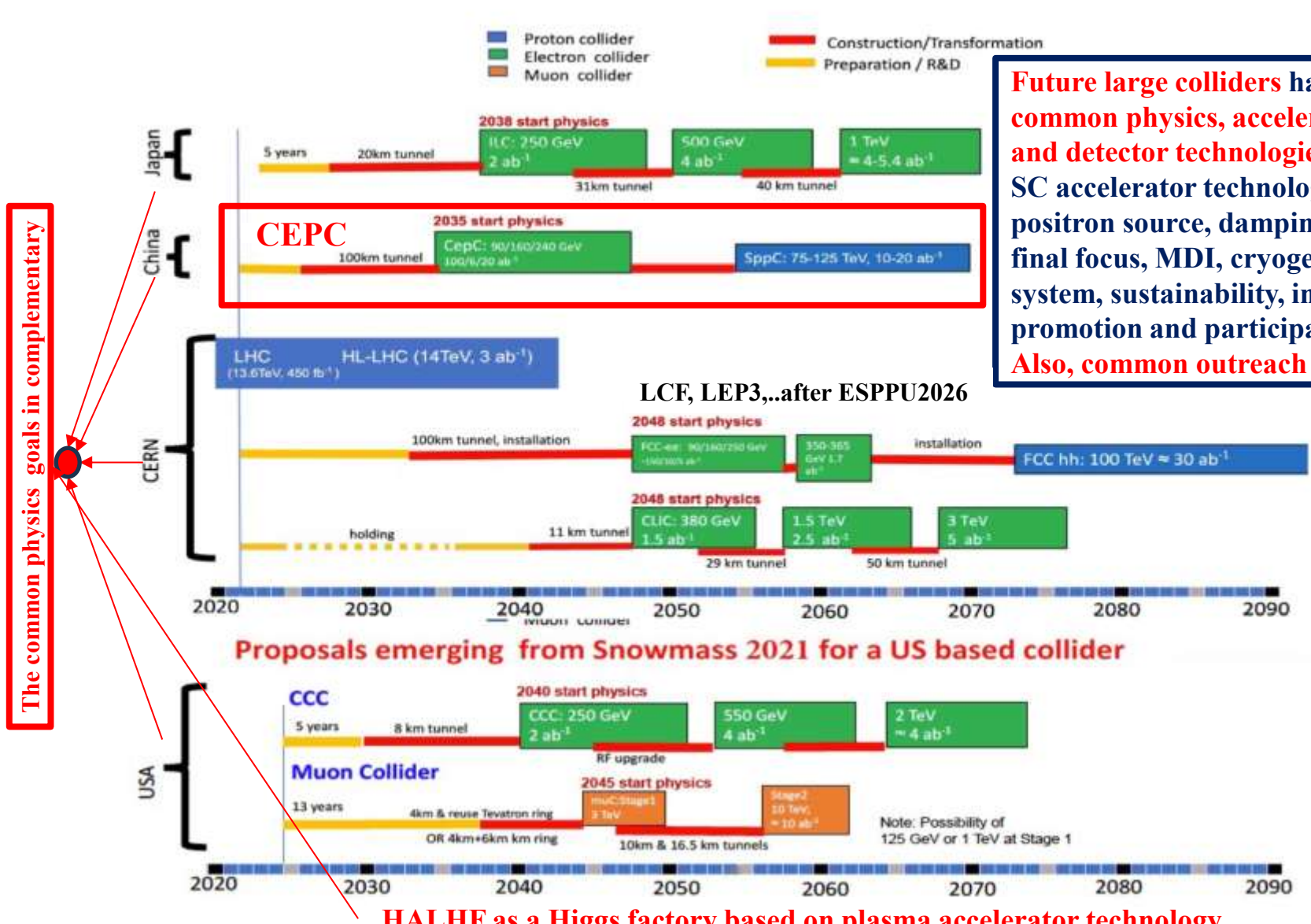


BEPCII-U under commissioning

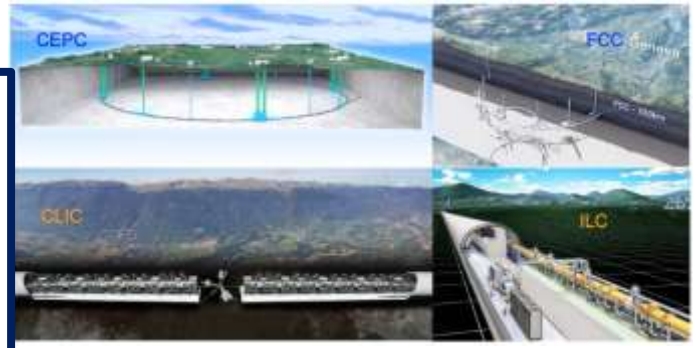


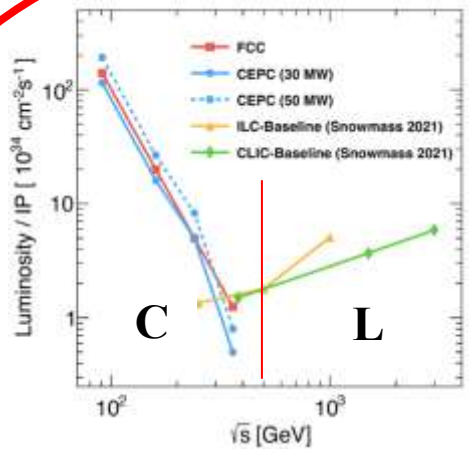
J. Gao, "BEPCII and CEPC", Proceedings of eeFACT 2025, arXiv:2505.02401, https://doi.org/10.48550/arXiv.2505.02401

Worldwide High Energy Physics Frontier Goals Timelines and Common Efforts



Future large colliders have the common physics, accelerator and detector technologies:
SC accelerator technologies, positron source, damping ring, final focus, MDI, cryogenic system, sustainability, industrial promotion and participation.
Also, common outreach activities





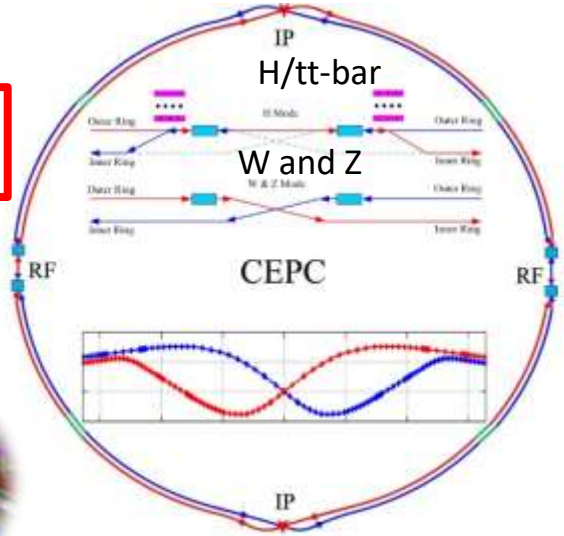
The complementarity between circular and linear Higgs factories

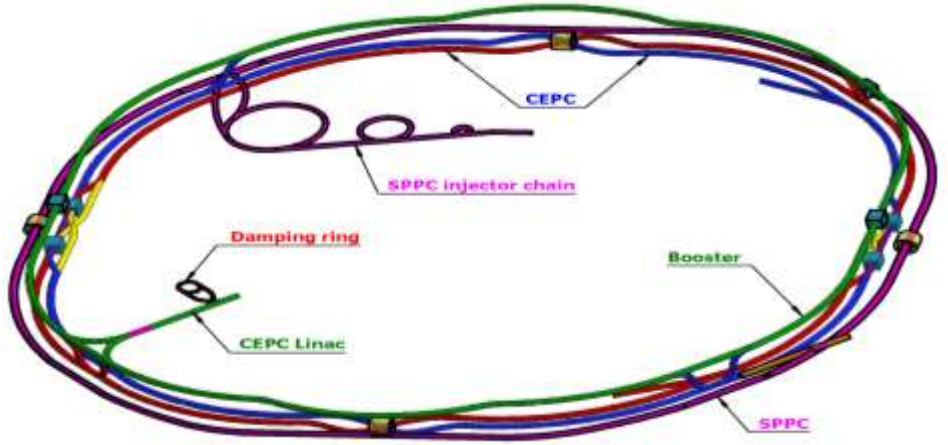
G. Arduini，et al, Future Colliders Comparative Evaluation - Working Group Report, ESPPU26, 2025,
https://indico.cern.ch/event/1439855/contributions/6542430/attachments/3076609/5444588/Future_Colliders_Comparative_Evaluation_WG_report.pdf

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

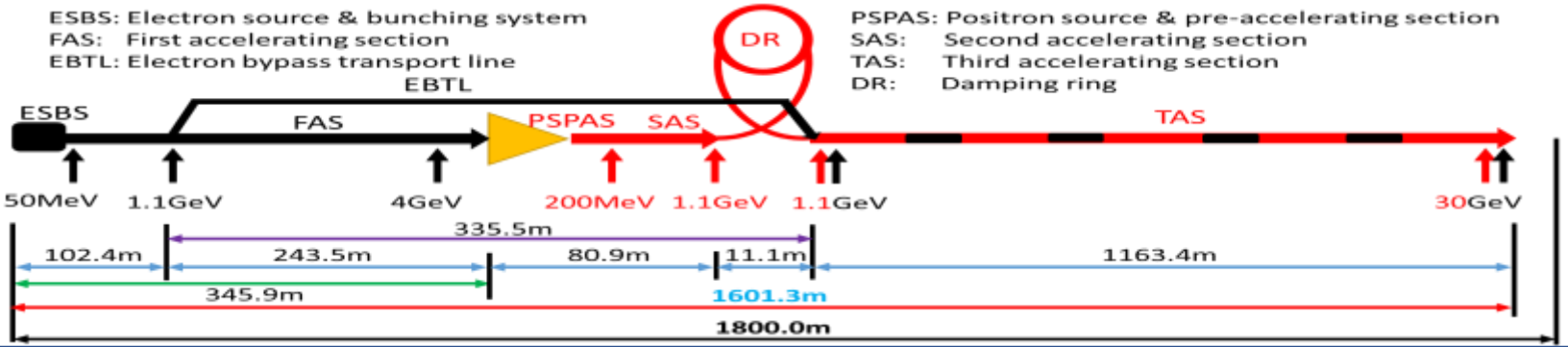


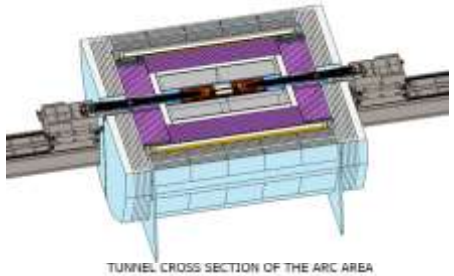


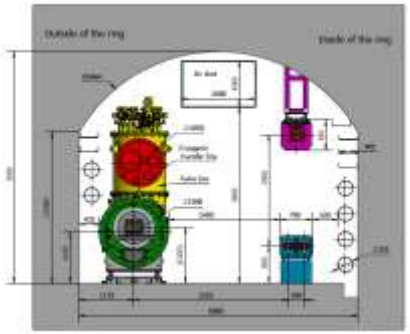
CEPC collider ring (100km)

CEPC booster ring (100km)

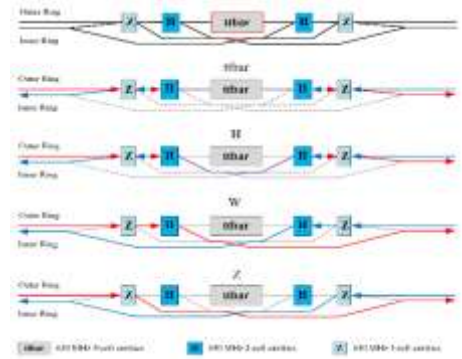
CEPC TDR S+C-band 30GeV linac injector







CEPC/SppC in the same tunnel



Z,W, Higgs and ttbar energies

CEPC Physics Goals, Operation Plan and Goals in TDR/EDR

Operation mode		ZH	Z	W⁺W⁻	$t\bar{t}$
$\sqrt{s}$ [GeV]		~240	~91	~160	~360
Run Time [years]		10	2	1	5
30 MW	L / IP [$\times 10^{34}$ cm^{-2}s^{-1}]	**5.0**	**115**	**16**	**0.5**
	$\int L\,dt$ [ab^{-1}, 2 IPs]	13	60	4.2	0.65
	Event yields [2 IPs]	2.6×10^{6}	2.5×10^{12}	1.3×10^{8}	4×10^{5}
50 MW	L / IP [$\times 10^{34}$ cm^{-2}s^{-1}]	**8.3**	**192**	**26.7**	**0.8**
	$\int L\,dt$ [ab^{-1}, 2 IPs]	21.6	100	6.9	1
	Event yields [2 IPs]	4.3×10^{6}	4.1×10^{12}	2.1×10^{8}	6×10^{5}

* Higgs is the top priority for CEPC

** Detector solenoid field is 3 Tesla for all other energies.

CEPC physics white papers:

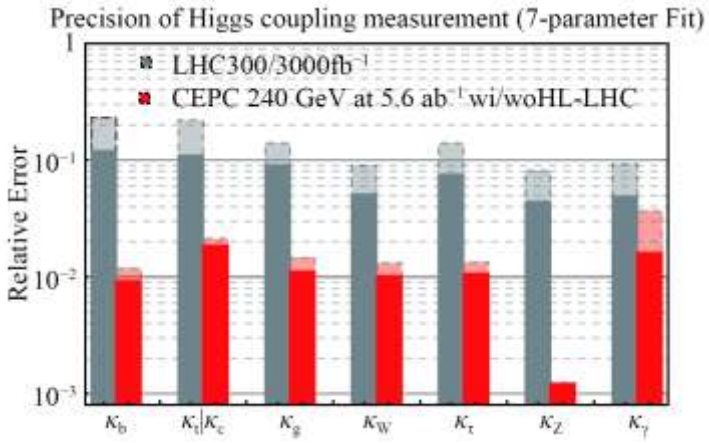
1: Higgs physics, Chinese Physics C Vol. 43, No. 4 (2019) 043002
https://arxiv.org/pdf/1810.09037

2: Flavor physics, https://arxiv.org/pdf/2412.19743 (2024)

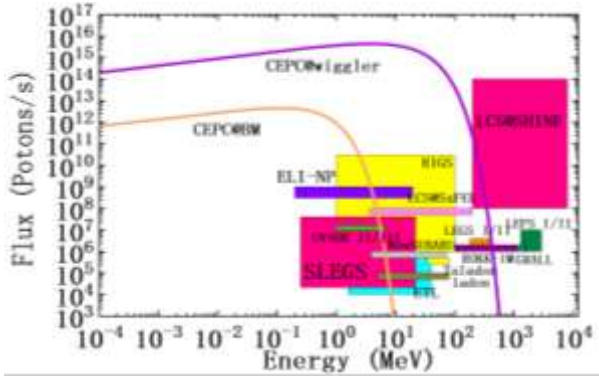
3: Electroweak physics, to be published

4: New Physics Search at the CEPC: a General Perspective
https://doi.org/10.48550/arXiv.2505.24810 （2025）

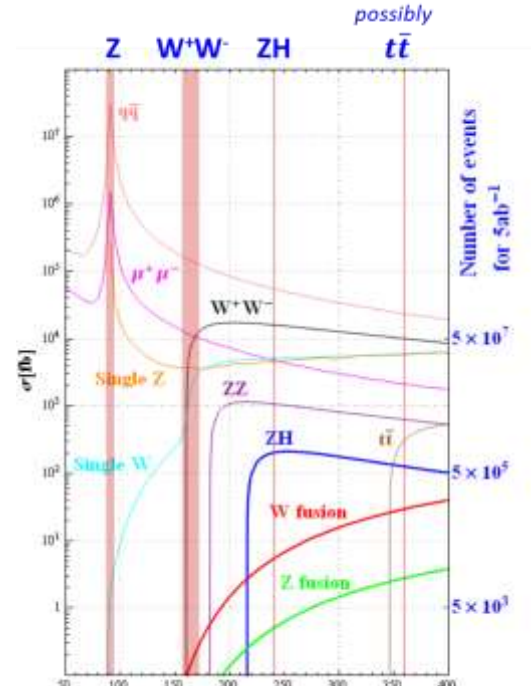
5: QCD, to be published

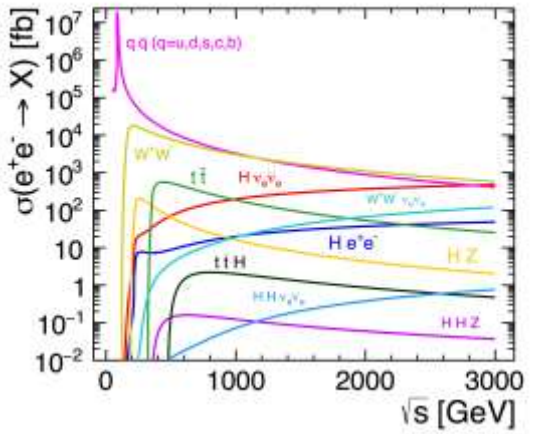


CEPC operation scenarios:
Higgs 10 years, Z-pole 2 years,
W 1 year, ttbar 5 years as upgrade



CEPC as high energy SR light source





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

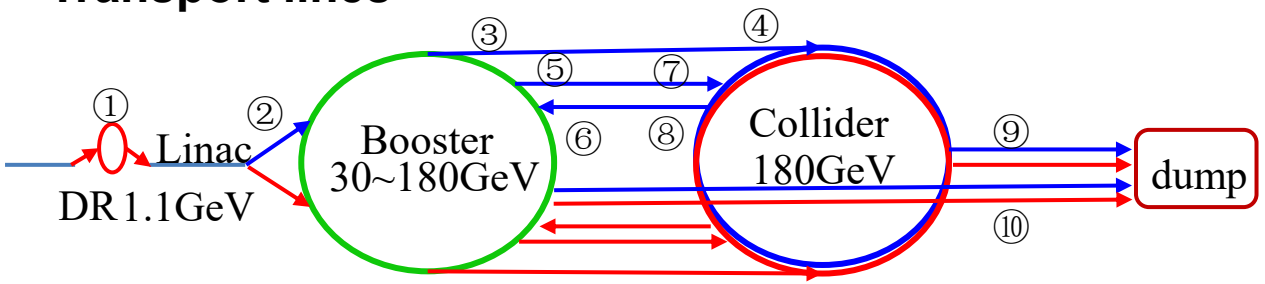
Collider

	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

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

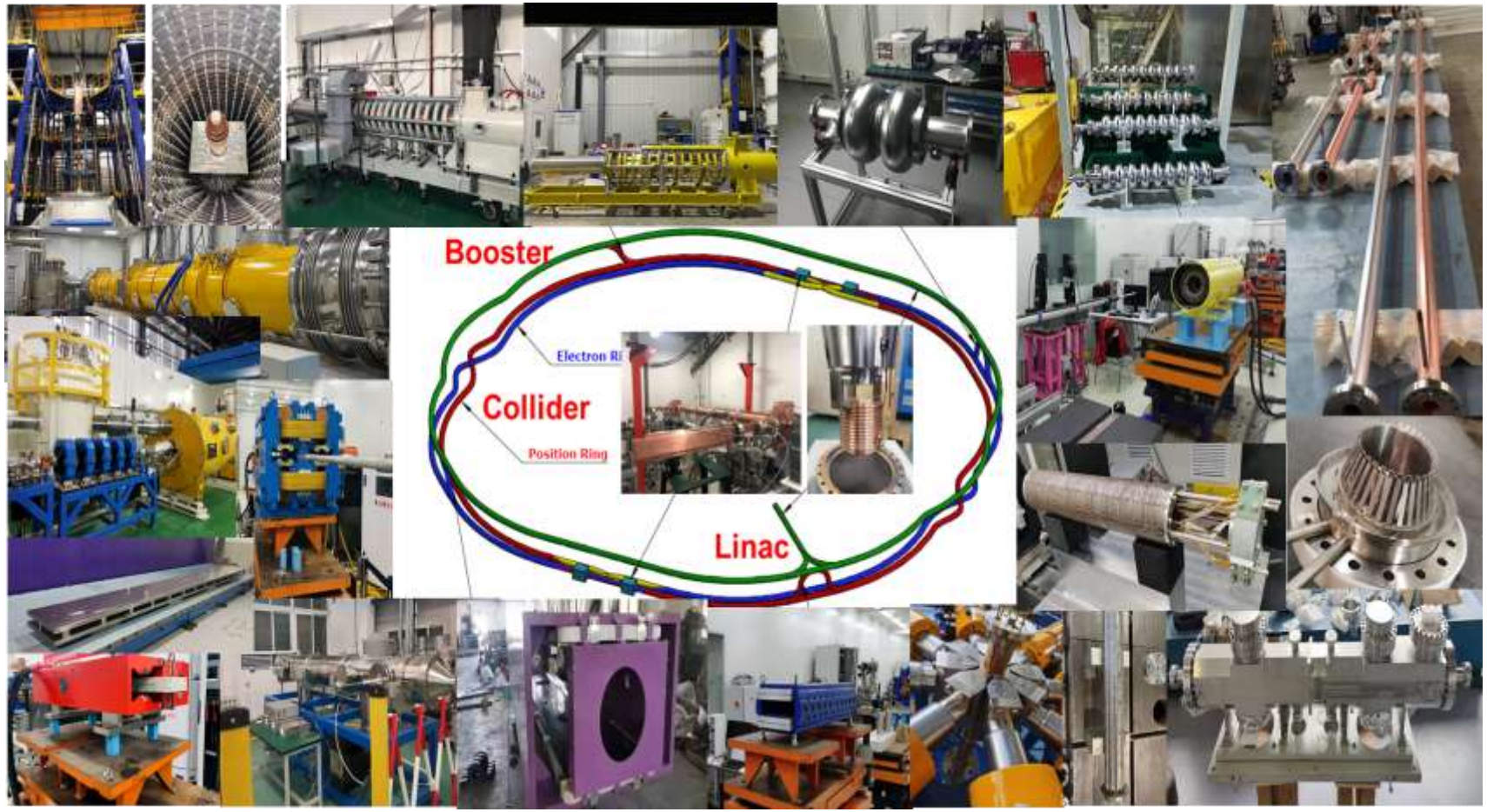
Transport lines



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 2025, and will be released in 2025

CEPC Accelerator TDR R&D Completed in 2023

- Key technologies R&D span over all components listed in CDR/TDR
- About 10% remaining (eg. RF power source, control, alignment, SC magnets, machine integration) to be completed by 2026.



✓ **Specification Met**

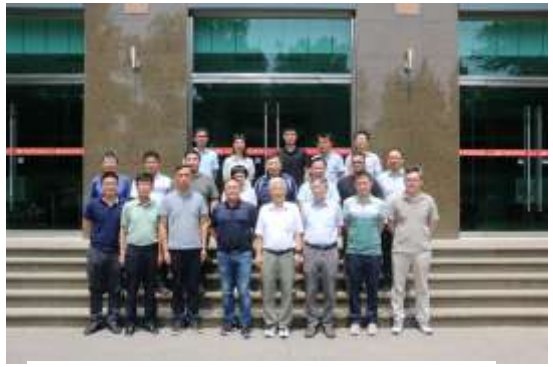
✓ **Prototype Manufactured**

Accelerator	Fraction
✓ Magnets	27.3%
✓ Vacuum	18.3%
✓ RF power source	9.1%
✓ Mechanics	7.6%
✓ Magnet power supplies	7.0%
✓ SC RF	7.1%
✓ Cryogenics	6.5%
✓ Linac and sources	5.5%
✓ Instrumentation	5.3%
✓ Control	2.4%
✓ Survey and alignment	2.4%
✓ Radiation protection	1.0%
✓ SC magnets	0.4%
✓ Damping ring	0.2%

CEPC Accelerator International TDR Review and Cost Review June 12-16, and Sept. 11-15, 2023, in HKUST-IAS, Hong Kong

CEPC Accelerator TDR Review
June 12-16, 2023, Hong Kong

CEPC Accelerator TDR Cost Review
Sept. 11-15, 2023, Hong Kong

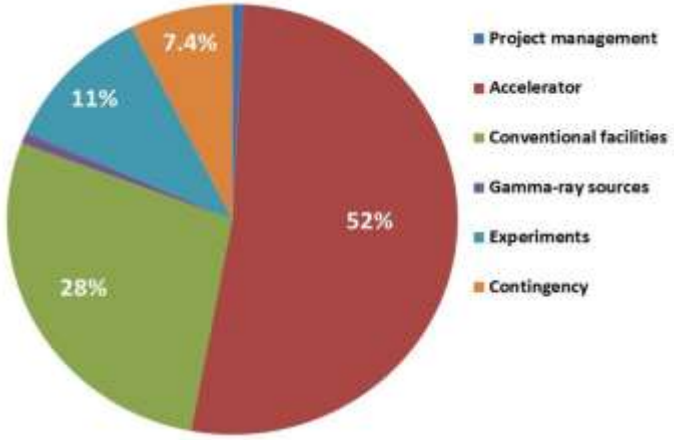


Domestic Civil Engineering
Cost Review, June 26, 2023, IHEP

9th CEPC IAC 2023 Meeting
Oct. 30-31, 2023, IHEP

Table 12.1.2: CEPC project cost breakdown, (Unit: 100,000,000 yuan)

Total	364	100%
Project management	3	0.8%
Accelerator	190	52%
Conventional facilities	101	28%
Gamma-ray beam lines	3	0.8%
Experiments	40	11%
Contingency (8%)	27	7.4%



Distribution of CEPC Project total TDR cost of **36.4B RMB (~5.2USD)**

CEPC accelerator TDR has been completed and formally released on December 25, 2023:
http://english.ihep.cas.cn/nw/han/y23/202312/t20231229_654555.html
CEPC accelerator TDR has been published formally in Journal Radiation Detection Technology and Methods (RDTM) on June 3, 2024:
DOI: 10.1007/s41605-024-00463-y
https://doi.org/10.1007/s41605-024-00463-y

CEPC Magnet Automatic Production Line in EDR

4 booster magnets fabricated per day

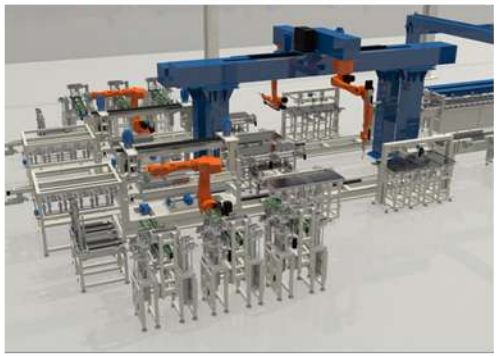
~15000 dipole magnets in the CEPC booster

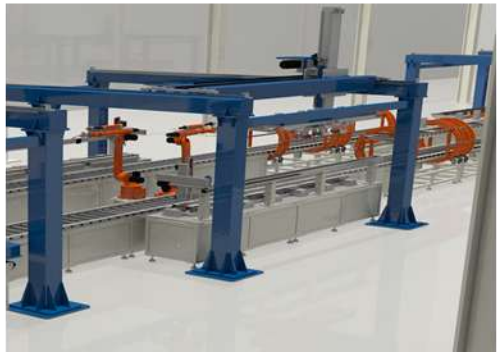
Stacking of 1/3 length core

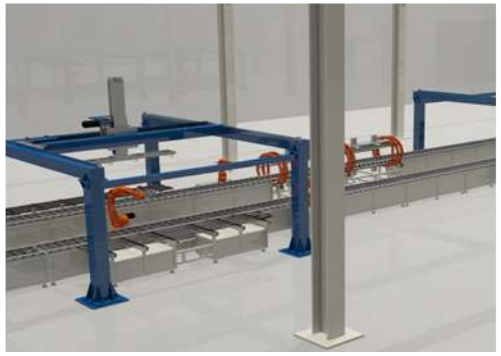
Production of full length cores

Assembly of the magnet

Field measurement of the magnet

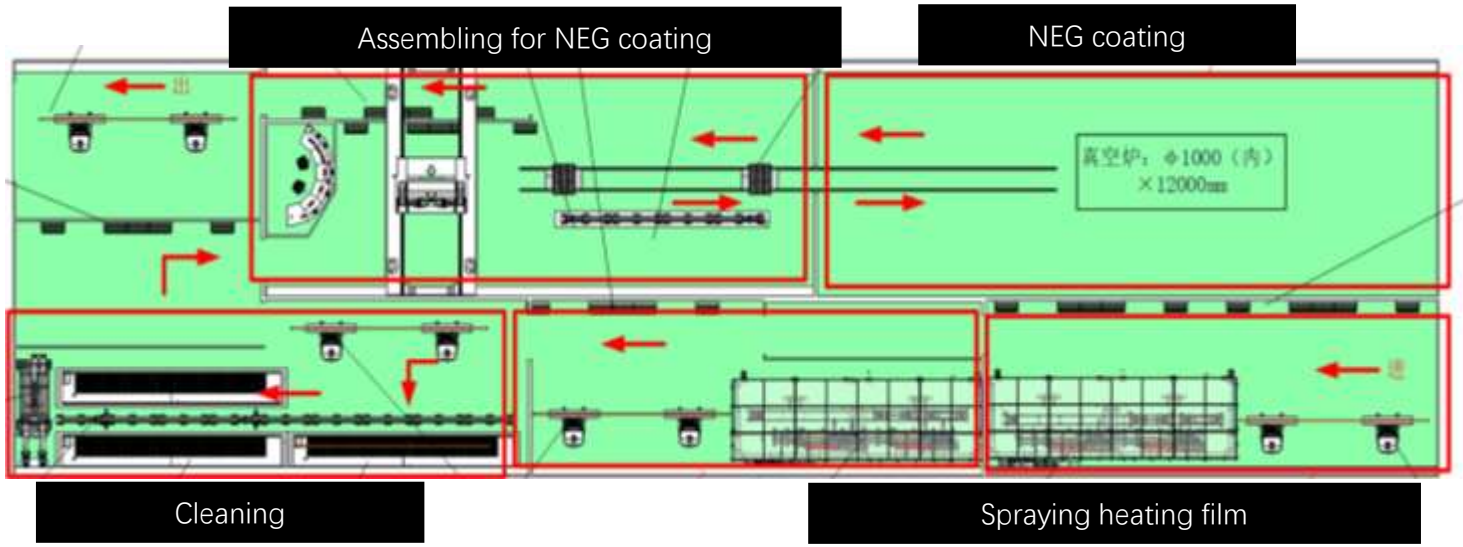


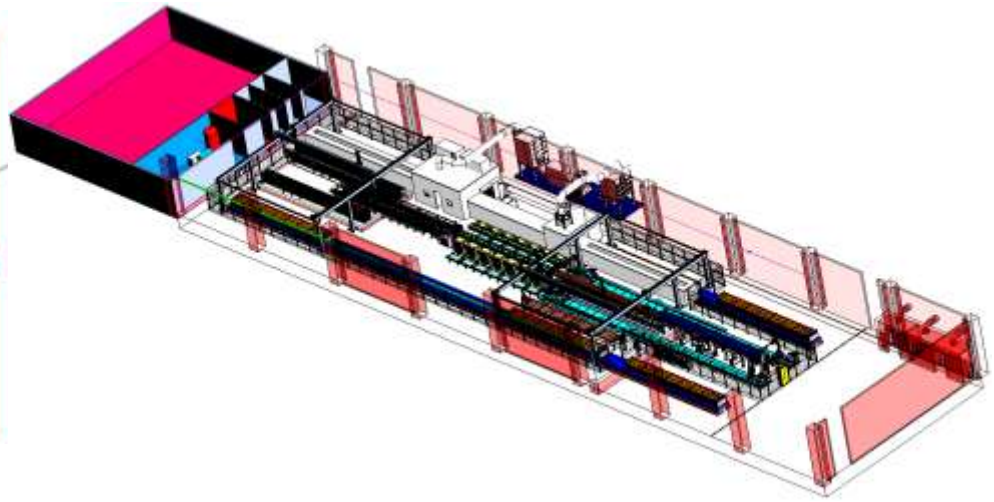




Status： construction started, to be completed in 2025

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



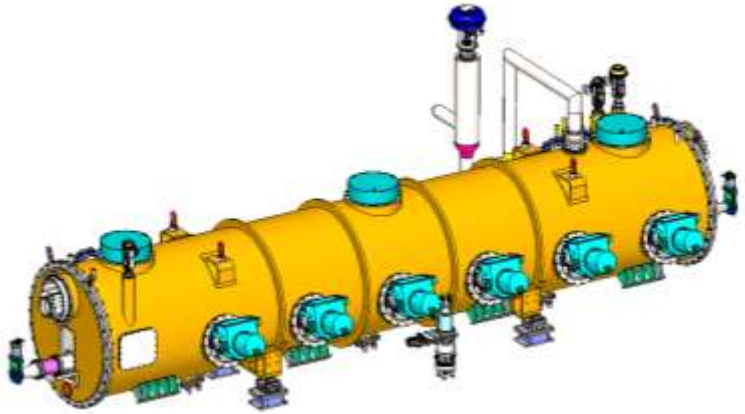


Layout of production line

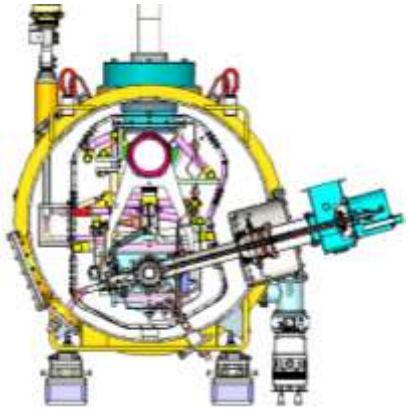
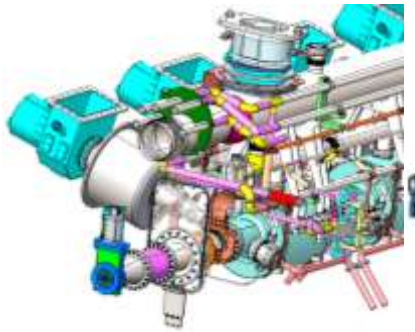
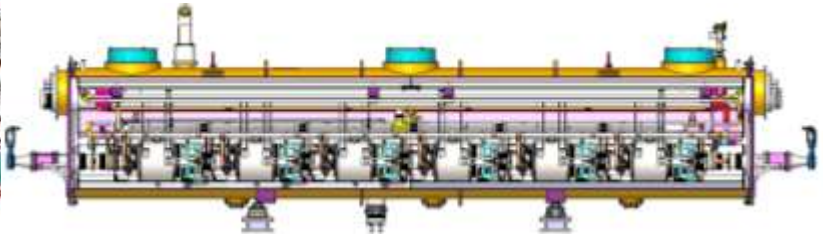
Status：construction started, to be completed in 2025

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

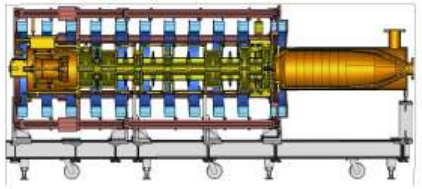
CEPC High Efficiency and High Power Klystrons

Klystron R&D

Klystron No. 1
Efficiency 65%
(2020)

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

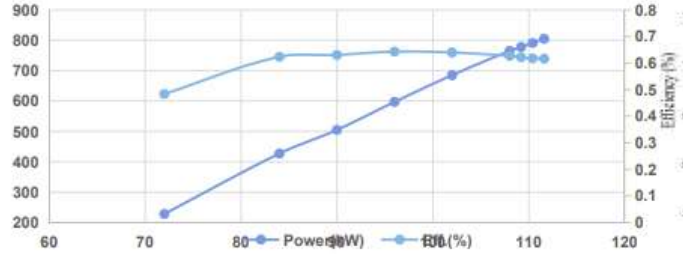
Klystron No. 2
Efficiency 77%
(2021)

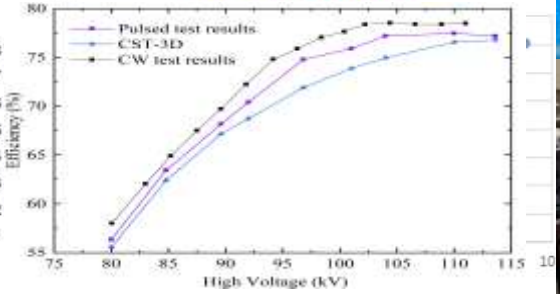


78.5%@803kW CW in 2024

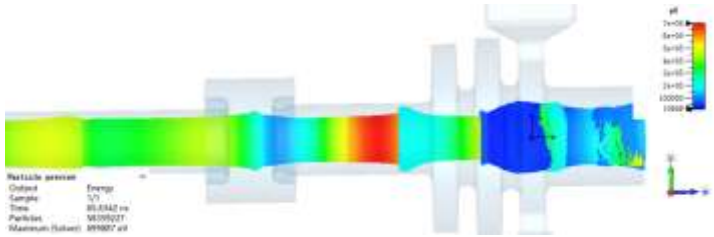
Klystron No. 3 （MBI
Efficiency 80.5%
To be completed in 2025

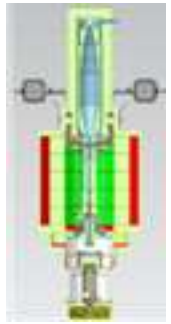
High Voltage vs. Power&Efficency

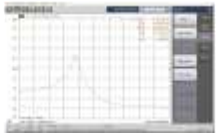




CEPC collider ring 650MHz klystron development in TDR/EDR phase

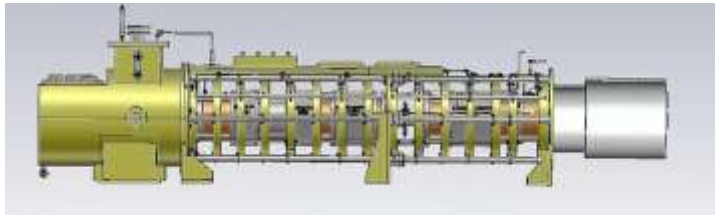


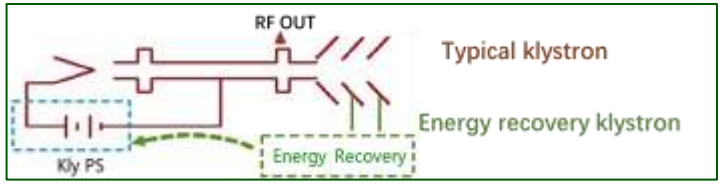




C band 5720MHz 80MW
Klystron design completed
to be completed on 2025

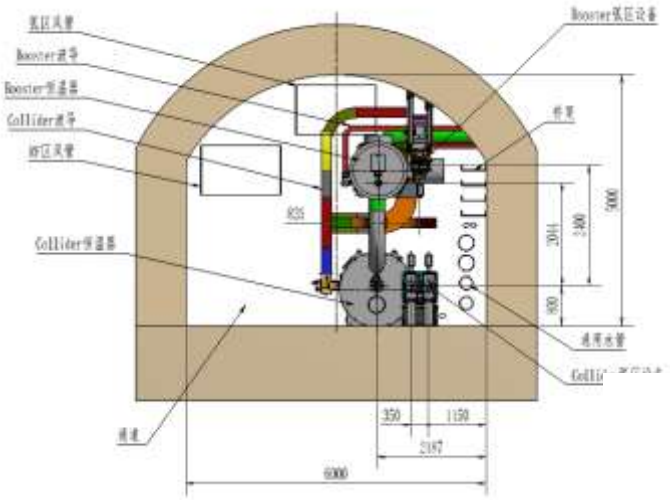
CEPC 650Mhz Energy Recovery Klystron

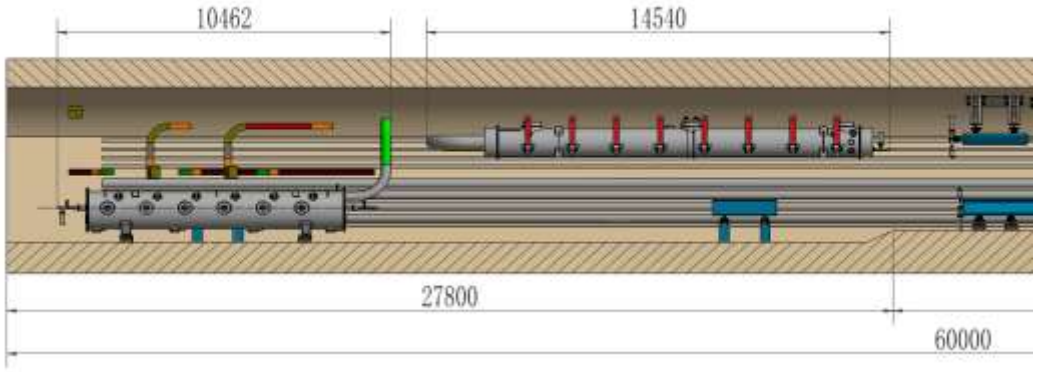


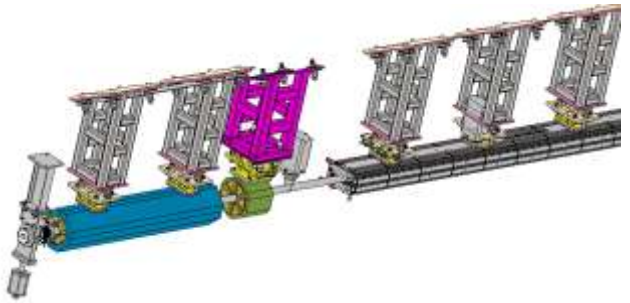


Parameter	Value
Operating frequency	650 MHz
Beam Voltage	113 kV
Efficiency	77.5%
Output power	800 kW
Beam perveance	0.25 μP
Beam current	9.5A
Efficiency (one-stage depressed collector)	85%

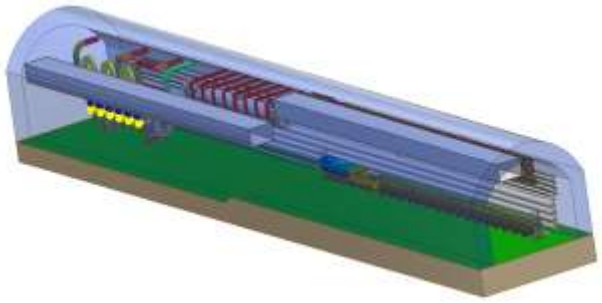
CEPC Tunnel Mockup for Installation in EDR

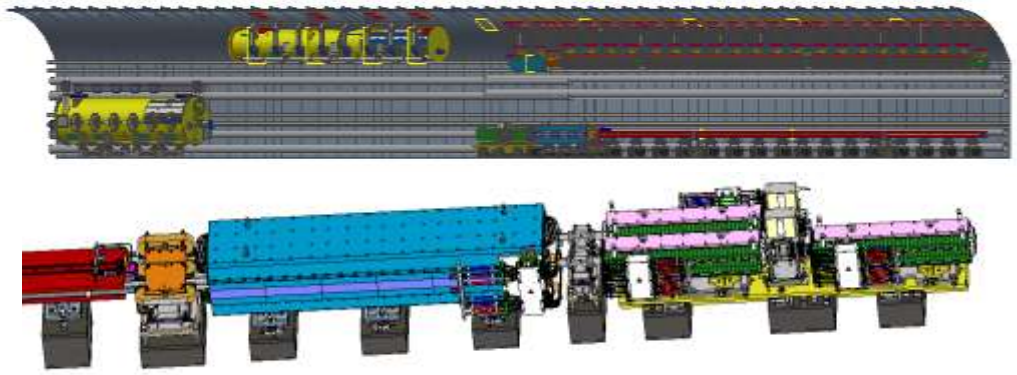


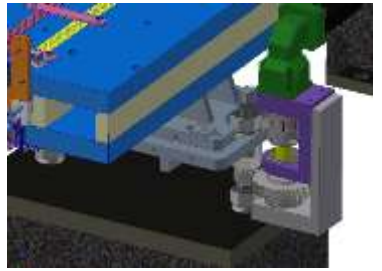


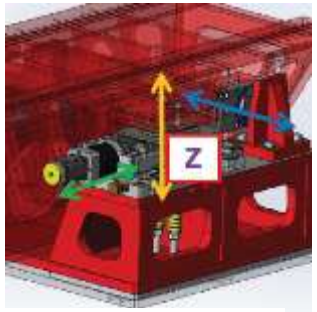


Booster magnets installation









Collider ring magnets supports

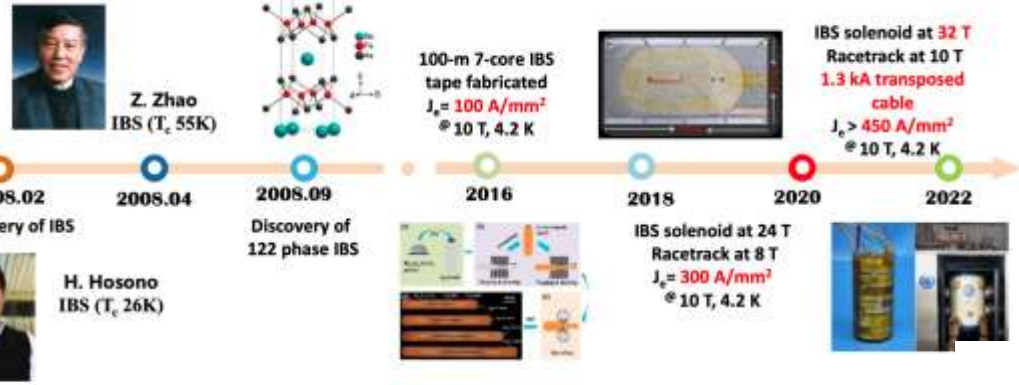
A 60 m long tunnel mockup, including parts of arc section and part of RF section

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

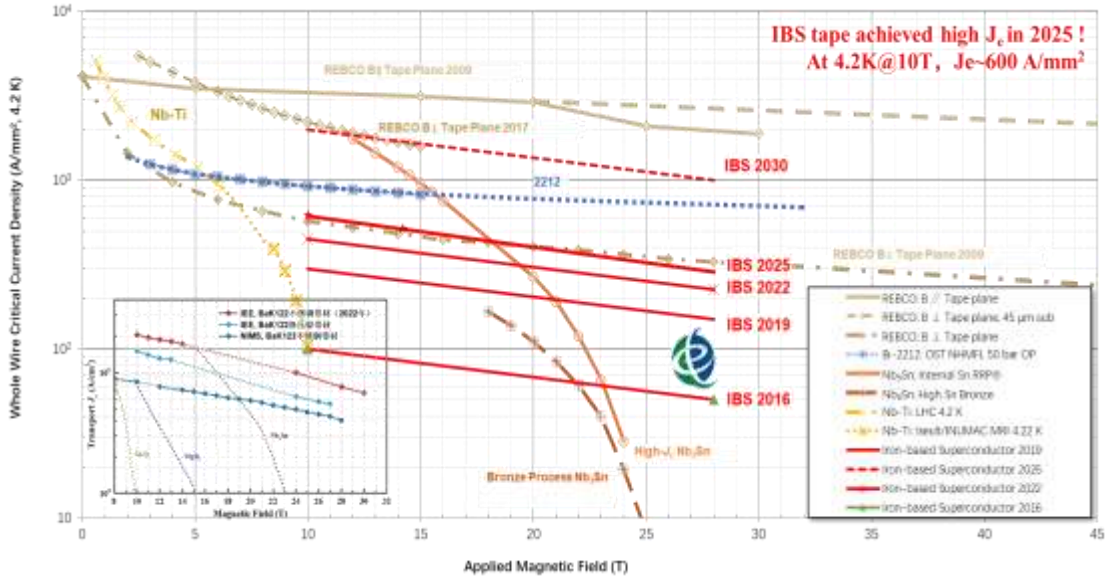
Plan：to be completed in 2026

Advanced Technologies Development in Progress

IBS Technology for High Field Magnets

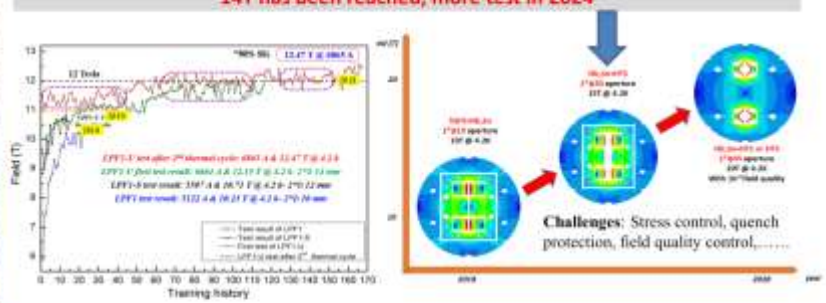


J_e of IBS expected to be similar as ReBCO in 5 years with better mechanical properties and lowe



SppC HF Magnet Development

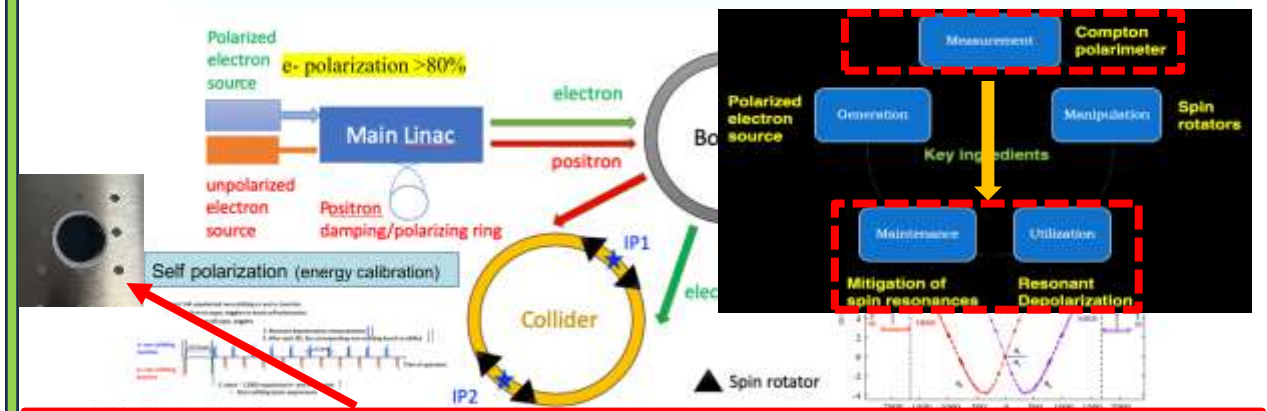
SppC 16 T Model Dipole: Nb_3Sn 12~13 T + HTS 3~4 T;
14T has been reached, more test in 2024



Picture of LPF1-U

Dual aperture superconducting dipoles achieve 12T@4.2 K and 14T@4.2K entirely fabricated in China. The next step is reaching 16-20T

CEPC Polarized Beam Studies(alternative option)

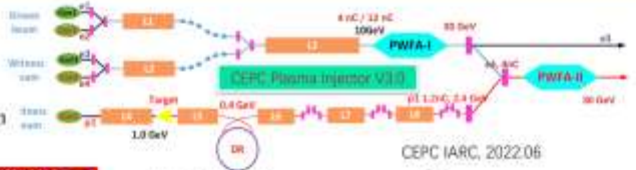


Polarized electron cathode chip (diameter ~5cm) has been fabricated in June 2025: Polarization of 85%, for 1ns laser (780nm) pulse length, several nC polarized electron charge will be obtained with the expected cathode lifetime ~6 months

BEPCII-based PWFA Test Facility Development Status

CEPC Plasma Injector (alternative option) and TF Plan

CEPC plasma injector scheme:
From 10 GeV → 30 GeV → TR ≥ 2



Simulation results show that it works on paper with reasonable error tolerances for both electron and positron beams injected to the booster

CEPC IARC, 2022.06

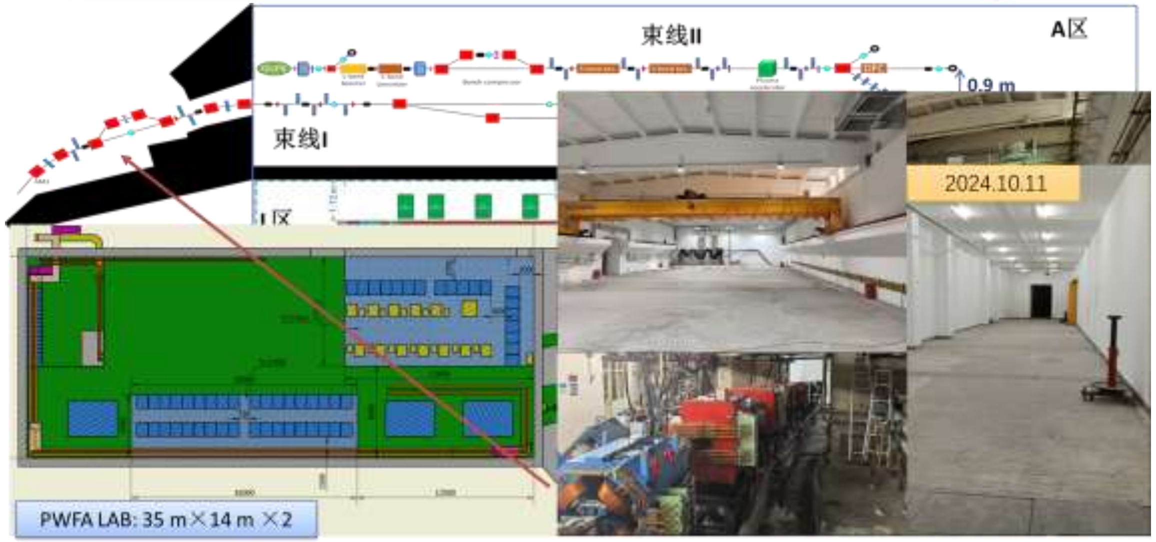
PWFA/LWFA TF based on BEPC-II Linac and HPL has been founded by CAS 90M RMB in Sept. 2023
Under development in the experimental hall #10 of BEPC-II

- From 2023.09 to 2028.08
- Unique TF for e+ and cascaded PWFA

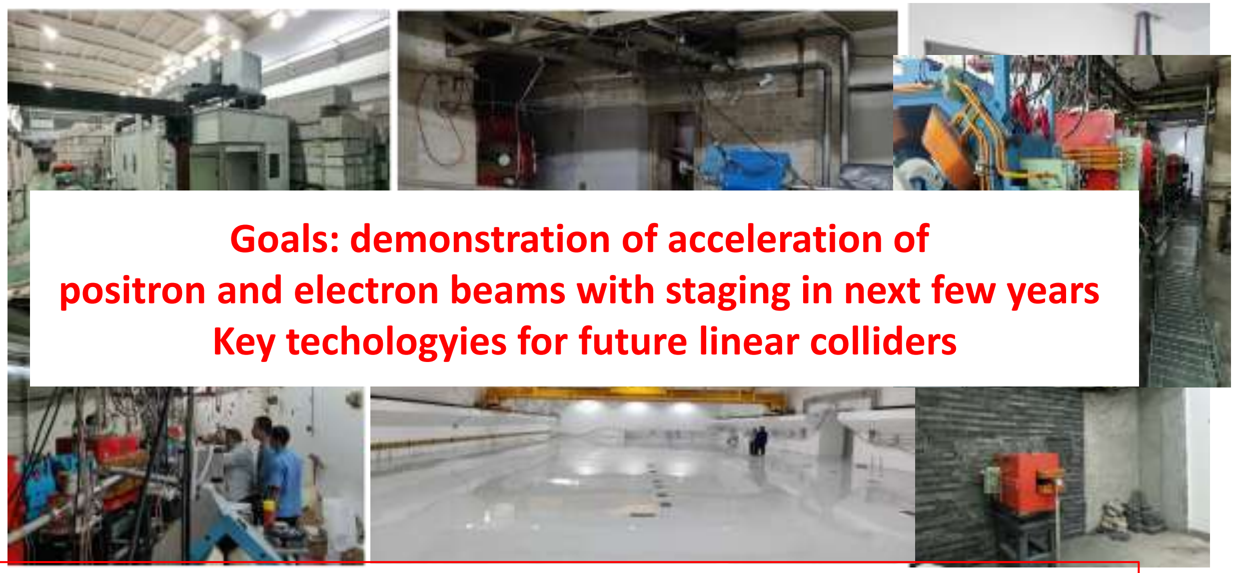
Beam quality → Beamline I

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



PWFA LAB: 35 m×14 m ×2

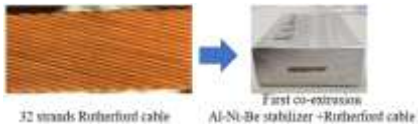


Goals: demonstration of acceleration of positron and electron beams with staging in next few years
Key techologyies for future linear colliders

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

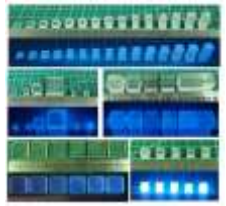
CEPC Detector Reference TDR Design

3T Magnet
(SC Solenoid)



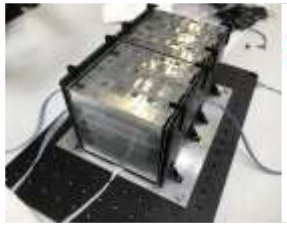
Yoke +
MU (PS+SiPM)

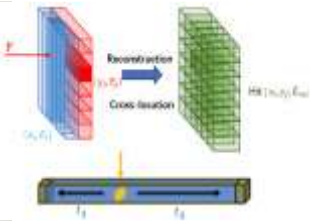
PFA HCAL
(Glass Scintillator)



$\gamma - \gamma$ separation for 5 GeV photons

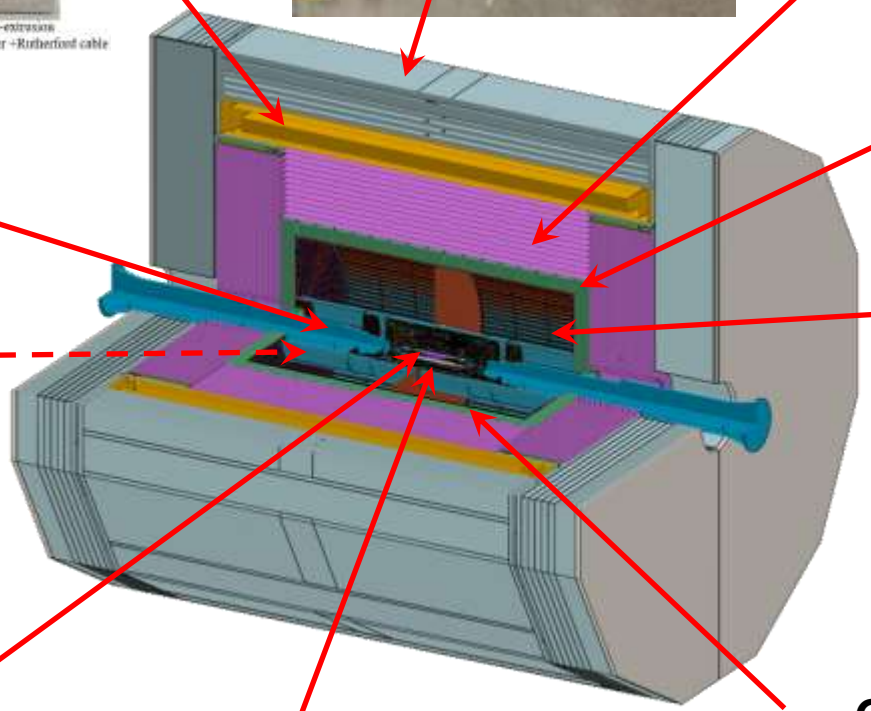
Crystal **PFA ECAL**
(Transverse bar)



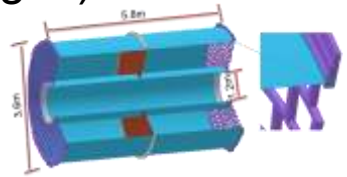


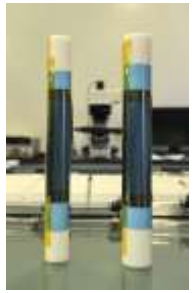
LumiCal
(SiDet + LYSO)

Potential
Endcap PID

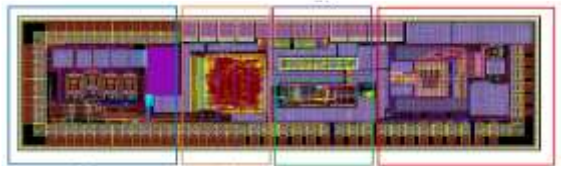


TPC
(Pixelated Micromegas)

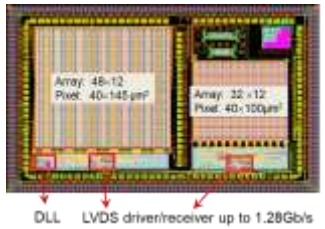




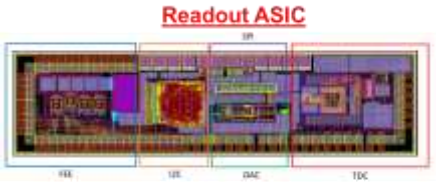
VTX
(MAPS SiPixel
+ Stitching + Bending)

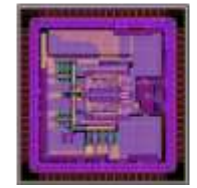


ITK
(MAPS SiPixel)



OTK
(AC-LGAD strip)



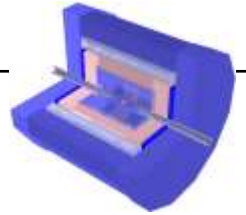
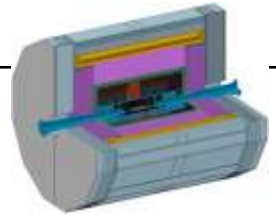


TDC delay line layout

CEPC Detector Reference Tchnical Design Report reviewed by IDRC in April 2025

Ref-TDR is based on this configuration

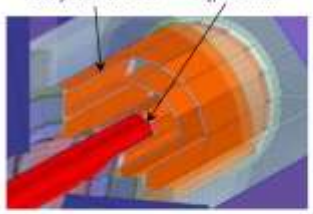
CEPC Detector from CDR to Ref-TDR

	CDR 	RefDet-TDR 
VTX	Inner radius of **16 mm**	Inner radius of **11 mm**
	Material Budget: 0.15%*6+0.14%(beampipe)= **1.05% X0**	Material Budget: 0.06%*4(inner)+0.165%*2(outer)+0.2%(beampipe)= **0.77% X0**
Gaseous Tracker	TPC with **1 mm* 6 mm** readout	TPC with **0.5 mm* 0.5 mm** readout **dN/dx resolution 3%**
ToF & Outer tracker	-	AC-LGAD, with **50 ps** per MIP, 10 um
ECAL	Si-W-ECAL: **17%**/√E ⊕ 1%	Crystal Bar-ECAL: **1.3%**/√E ⊕ 0.7%
HCAL	RPC-Iron: **60%**/√E ⊕ 2%	Glass-Steel: **30%**/√E ⊕ 6.5%

CEPC Detector R&D Progresses-1

Vertex detector

2 layers / ladder R_n~16 mm

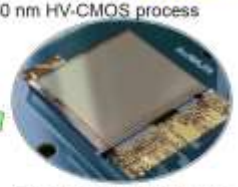


Goal: σ(IP) ~ 5 μm for high P track

CDR design specifications
- Single point resolution ~ 3μm
- Low material (0.15% X_0 / layer)
- Low power (< 50 mW/cm²)
- Radiation hard (1 Mrad/year)

Silicon pixel sensor develops in 5 series: JadePix, TaichuPix, CPV, Arcadia, CEPCPix

Develop **CEPCPix** for a CEPC tracke basing on **ATLASPix3** CN/IT/UK/DE
TSI 180 nm HV-CMOS process



Arcadia by Italian groups for IDEA vertex detector
LFoundry 110 nm CMOS

JadePix-3 Pixel size ~16×23 μm²

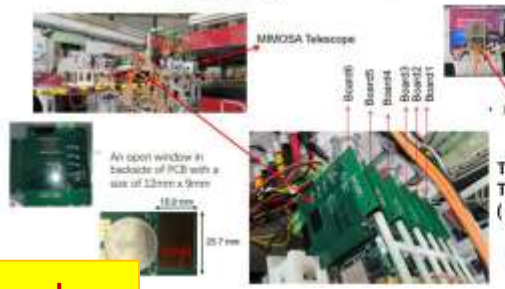
Tower-Jazz 180nm CIS process
Resolution 5 microns, 53mW/cm²

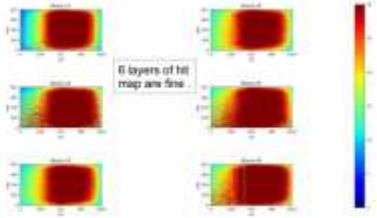
TaichuPix-3, FS 2.5x1.5 cm² 25×25 μm² pixel size

CPV4 (SOI-3D), 64×64 array ~21×17 μm² pixel size

Full vertex detector prototype (TaichuPix-3, JadePix-3) has TB at DESY in Dec. 2022.

Hitmap of 4 GeV e⁺/e⁻ beam

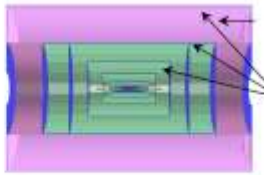




particle ID +main tracker

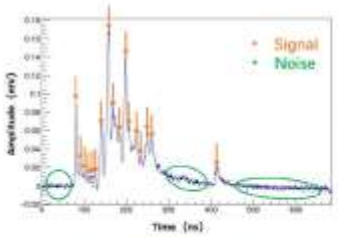
Goal: 3σ π/K separation up to ~20 GeV/c.

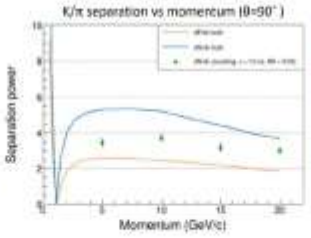
- Cluster counting method, or **dN/dx**, measures the number of primary ionization
- **Can be optimized specifically for PID**: larger cell size, no stereo layers, different gas mixture.
- Garfield++ for simulation, realistic electronics, peak finding algorithm development.



2 outer layers

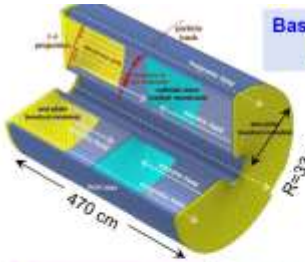
Full silicon trackers

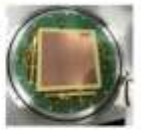




IHEP and Italian INFN groups have close collaboration and regular meetings.
IHEP joined the TB (led by INFN group) in 2021 and 2022

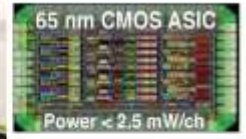
Baseline main tracker
σ(r-φ) ~100 μm





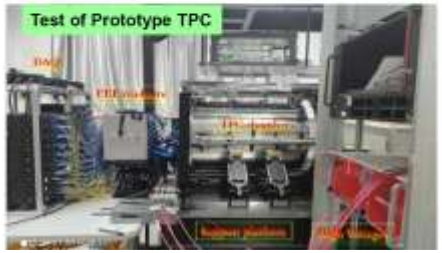
GEM-MM cathode TPC Prototype + UV laser beams

MOST 1 (IHEP+THU)

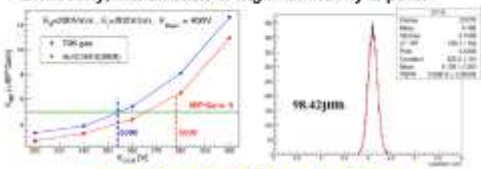


Low power FEE ASIC

Test of Prototype TPC



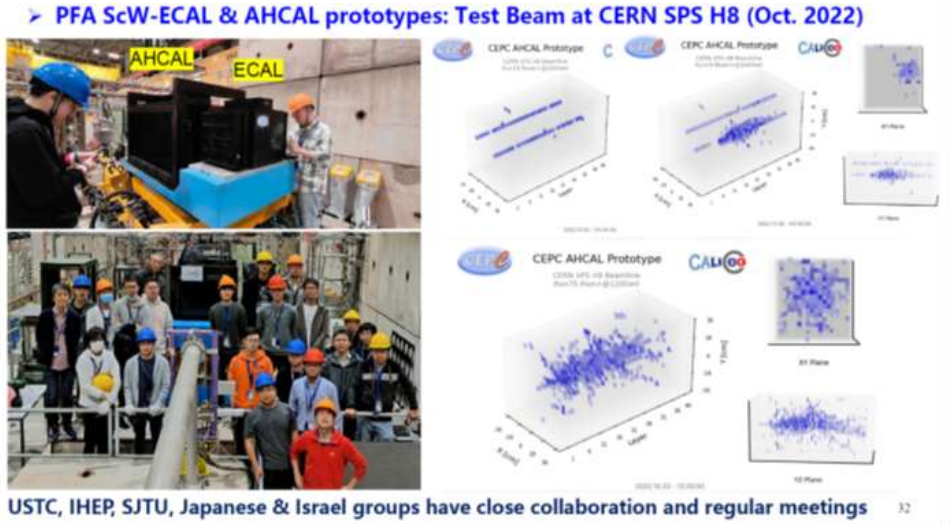
Challenge: Ion backflow (IBF) affects the resolution. It can be corrected by a laser calibration at low luminosity, but difficult at high luminosity Z-pole.



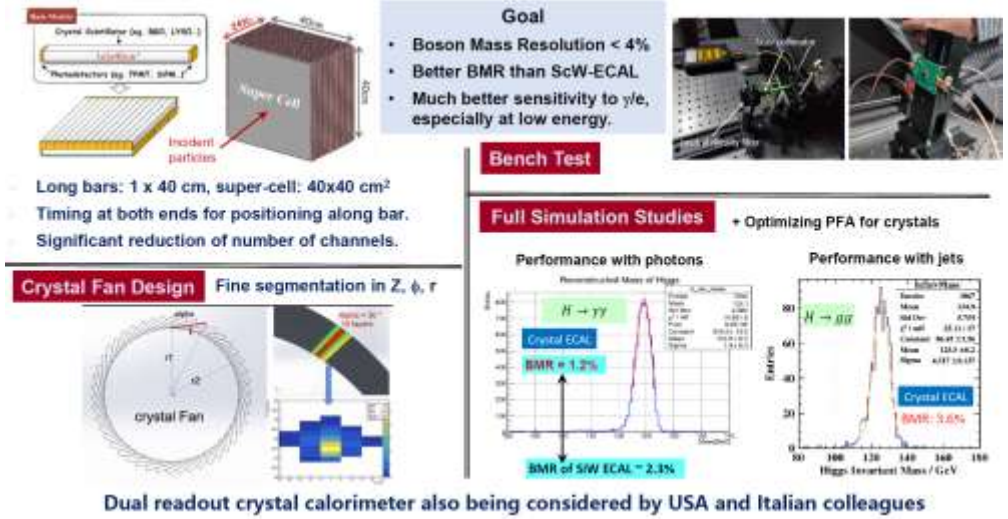
$\sigma_{r\phi}$ < 100 μm for drift length of 27cm

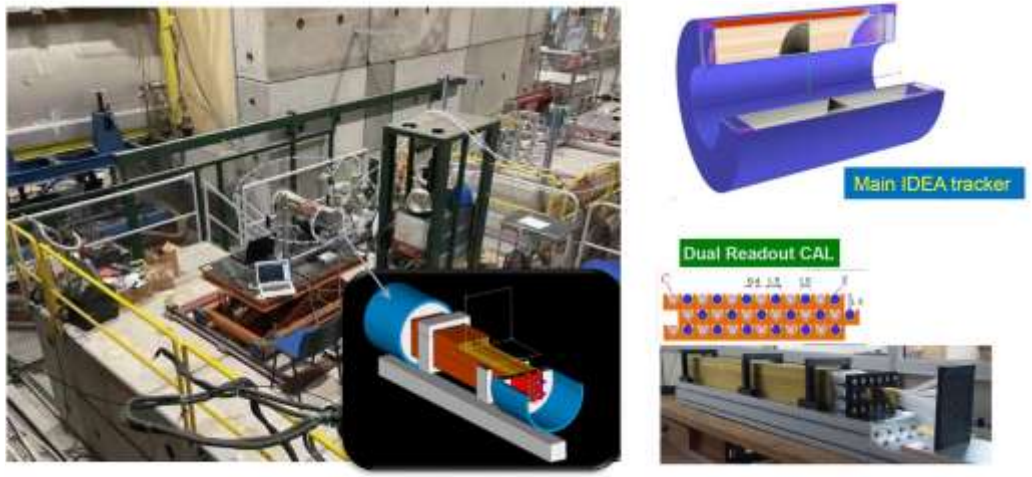
CEPC Detector R&D Progresses-2

EM + hadron colarimeters： prototypes

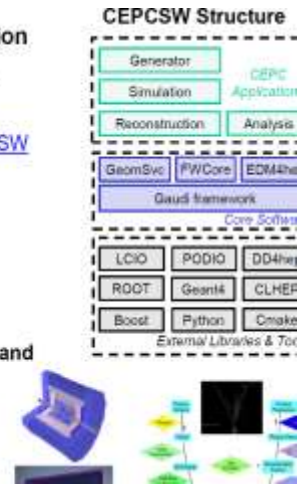


new crystal EM calorimeter for better resolution





software



Key4hep: an international collaboration with CEPC participation

CEPCSW: a first application of Kep4hep – Tracking software

CEPCSW is already included in Key4hep software stack

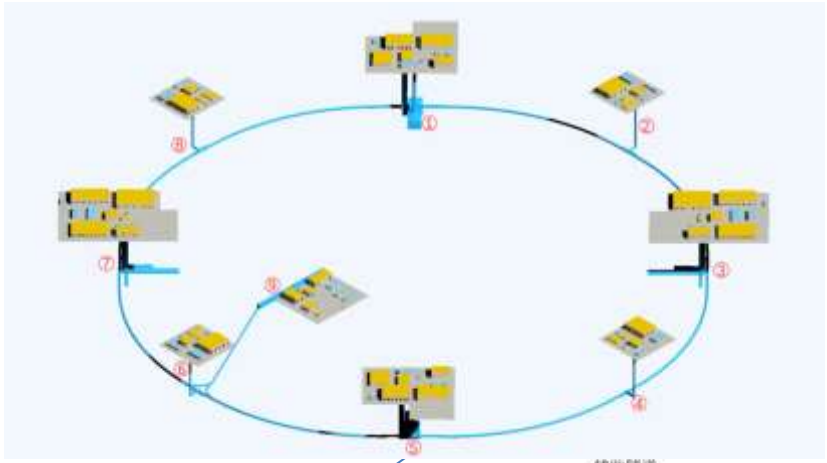
https://github.com/cepc/CEPCSW

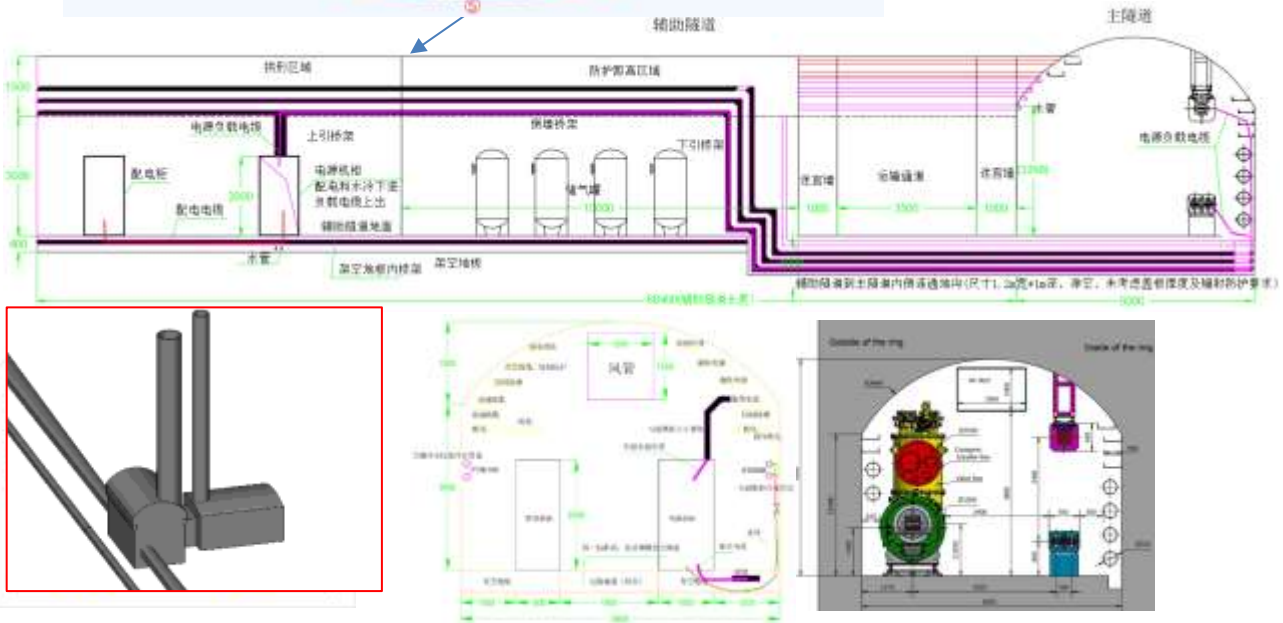
Architecture of CEPCSW
- External libraries
- Core software
- CEPC applications for simulation, reconstruction and analysis

Core Software
- Gaudi framework: defines interfaces of all software components and controls the event loop
- EDM4hep: generic event data model
- FWCore: manages the event data
- GeomSvc: DD4hep-based geometry management service

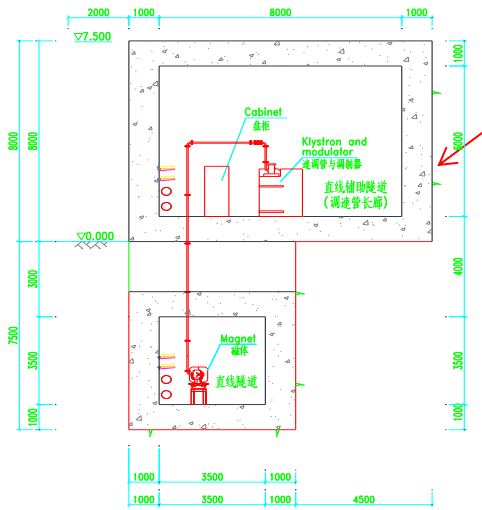
CEPC Civil Engineering and Conventional Facilities in EDR

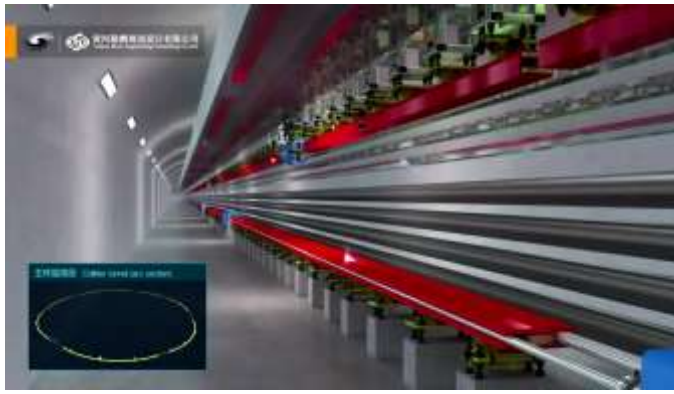
CEPC general layout and auxiliary tunnel /500m along 100km

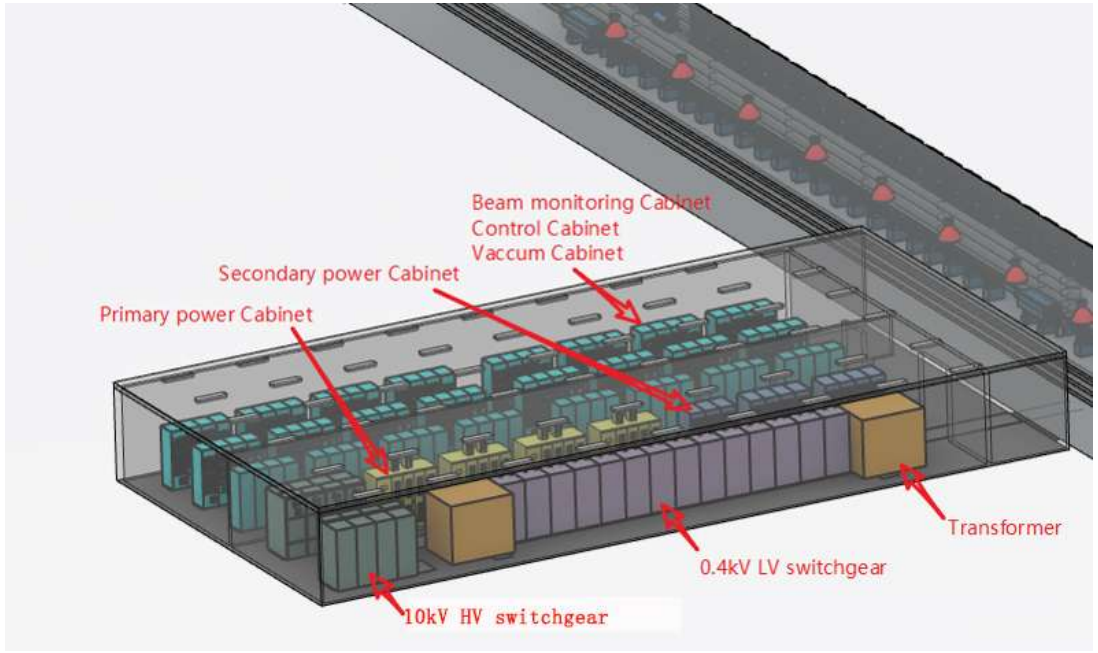




CEPC linac cross section







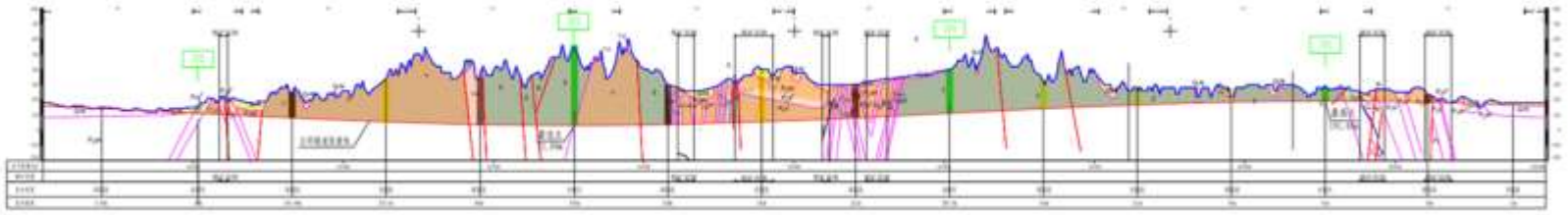
CEPC EDR Site Investigation

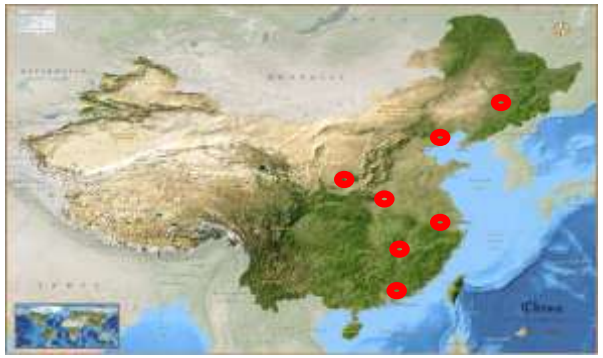
CEPC EDR site implementation plan

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 Seletion & Project Proposal)				Site Selection																				
				Feasibility Study																				
										Project Proposal														
Preliminary Design													Feasibility Study											
Tender Design																								
Tender																								

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

CEPC construction plan





Green CEPC and Sustainability

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

Prototypes have been developed addressing green collider technologies

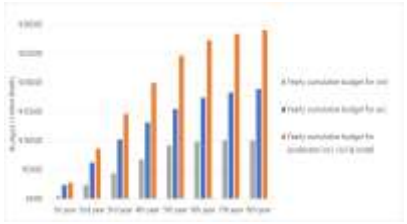
Power efficiency, energy recycling, and clean energy generation are being addressed as comprehensive measures for sustainable operation

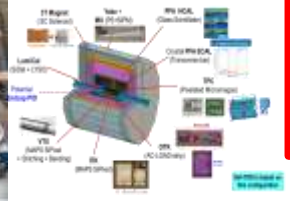
Publication: Dou Wang; Jie Gao; Yuhui Li; Jinshu Huang; Song Jin; Manqi Ruan; Mingshui Chen; Shanzhen Chen, "The carbon footprint and CO2 reduction optimization of CEPC", *RDMT*, https://doi.org/10.1007/s41605-025-00535-7 (2025).

CEPC Milestones, Timeline and Human Resources

Year	2012	2013	2015	2017	2018	2023	2025	2027	2030	2035
Human resources			~50		~100	~200	~300	~500	~2800	~2500

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 (2025) for CEPC entering 15th five-year-plan

CEPC kickoff meeting in Sept. 2013

CEPC detector reference design completed in June 2025

2025

CEPC EDR site study and civil engineering design

36.4B RMB
Total construction

2036-2037
CEPC commissioning

2012.9	2013.9	2015.3	2017.4	2018.11	2023.12	2024 ~ 2027	~2035
CEPC proposed		Pre-CDR	Progress report	CDR	TDR	EDR start of construction	Completion

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

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

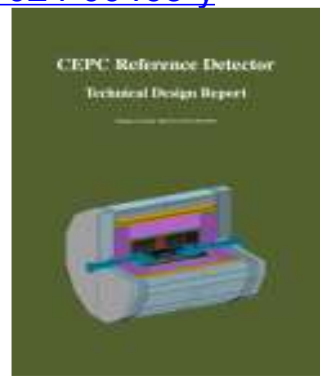
CEPC Industrial Promotion Consortium (CIPC, established in Nov. 2017)

Potential international collaborating suppliers worldwide

CEPC International Collaboration-1

CEPC attracts significant International participation and collaborations

CEPC Accelerator TDR report: 1114 authors from 278 institutes (including 159 International Institutes, 38 countries) Published in **Radiation Detection Technology and Methods (RDTM)** on June 3, 2024:
DOI: 10.1007/s41605-024-00463-y
https://doi.org/10.1007/s41605-024-00463-y



CEPC Detector Reference TDR report has been completed and reviewed by IDRC in April 14-16, 2025

- 27 MoUs have been signed with international institutions and universities
- CEPC International Workshop since 2014-now
- EU and US versions of CEPC WS since 2018-now
- Annual working month at HKUST-IAS (mini workshops and HEP conference), Hong Kong, since 2015-now

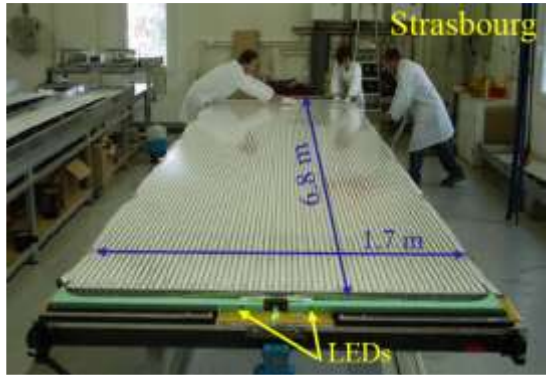
CEPC International Collaboration-2

- CEPC will be an international project, following the HEP tradition
- Internationalization will distinguish CEPC from other proposals to NDRC, enhance the successful chance
- IHEP successfully organized large international projects such as BESIII, Daya Bay and JUNO with international in-kind contributions of ~5%, ~30%, and ~15% respectively
  - BESIII has >600 members from 84 institutions in 17 countries and regions
  - Daya Bay had >250 members from 40 institutions in 6 countries and regions
  - JUNO has >700 members from 72 institutions in 17 countries and regions
- Based on the experience from above experiments, our plan for CEPC is the following:
  - Goal: international contributions at the level of ~10-30%
  - Although the management system is yet to be settled, most likely IHEP will be the host lab
  - A concept of the management structure has been endorsed by IAC, further discussion needed
  - Once CEPC is approved in China(~ CD0 in DOE), international collaboration can be formally started
    - Discussion with partners about the management
    - Form various committees
    - call for detector proposals, and select proposals
    - Form international collaborations, deliver TDRs
  - Civil construction and most of the accelerator construction can start after the CD3 approval by NDRC, internationalized construction of detectors and other accelerator equipment may come a few years later

CEPC International Collaboration-3 (examples)

INFN/Italy collaboration on JUNO and BEPCII-U

IN2P3/France collaboration on JUNO



CEPC in Synergy with other Accelerator Projects in China

Project name	Machine type	Location	Cost (B RMB）	Completion time
CEPC	Higgs factory Upto ttar energy	Led by IHEP, China	**36.4 (where accelerator 19)**	Around 2035 (starting time around 2027)
BEPCII-U	e+e-collider 2.8GeV/beam	IHEP (Beijing)	**0.15**	2025
HEPS	4th generation light source of 6GeV	IHEP (Huanrou)	**5**	2025
SAPS	4th generation light source of 3.5GeV	IHEP (Dongguan)	**3**	2031 (in R&D, to be approved)
HALF	4th generation light source of 2.2GeV	USTC (Hefei)	**2.8**	2028
SHINE	Hard XFEL of 8GeV	Shanghai-Tech Univ., SARI and SIOM of CAS (Shanghai)	**10**	2027
S3XFEL	S3XFEL of 2.5GeV	Shenzhen IASF	**11.4**	2031
DALS	FEL of 1GeV	Dalian DICP	**-**	(in R&D, to be approved,)
HIAF	High Intensity heavy ion Accelerator Facility	IMP, Huizhou	**2.8**	2025
CIADS	Nuclear waste transmutation	IMP, Huizhou	**4**	2027
CSNS-II	Spallation Neutron source proton injector of 300MeV	IHEP, Dongguan	**2.9**	2029

The total cost of the accelerator projects under construction:39B RMB more than CEPC cost of 36.4B RMB

Relevant accelerator human resources and industrial capabilities in China could be measured in relation with these massive investments

Experience at HEPS/BEPCII/BEPCII-U

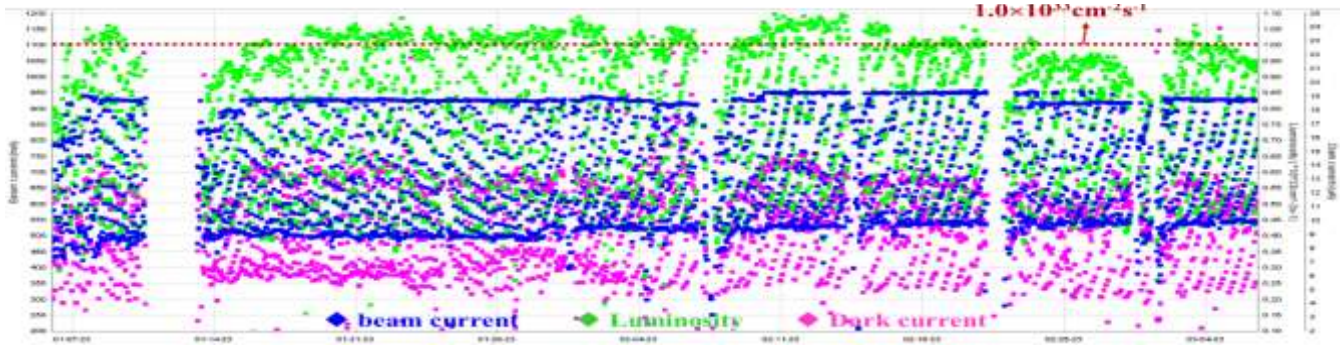
Magnets & alignment

Vacuum pipe and NEG coating

L. Feedback kicker

HEPS 6 GeV, 36 nm·rad, 4th generation light source, 1.3 km circumference construction completed in 2025

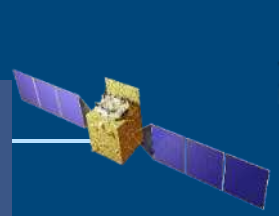
BEPCII high luminosity top-up injection physics data taking operation



CEPC Host Lab IHEP and its Large Science Facilities

HERD (2027) on Chinese Space Station

HXMT
Insight Hard X-ray Modulation Telescope



GECAM
Gravitational wave EM Counterpart All-sky Monitor

Huairou Campus

HEPS High Energy Photon Source

YBJ (retired)
International Cosmic Ray Observatory

IHEP, Beijing Campus

BEPC Beijing Electron-Positron Collider

IHEP Plasma Accelerator Test Facility

Jinan Campus

HUNT, underwater in south China Sea

AliCPT
Ali CMB Polarization Telescope

Daya Bay (retired)
Daya Bay reactor Neutrino Experiment

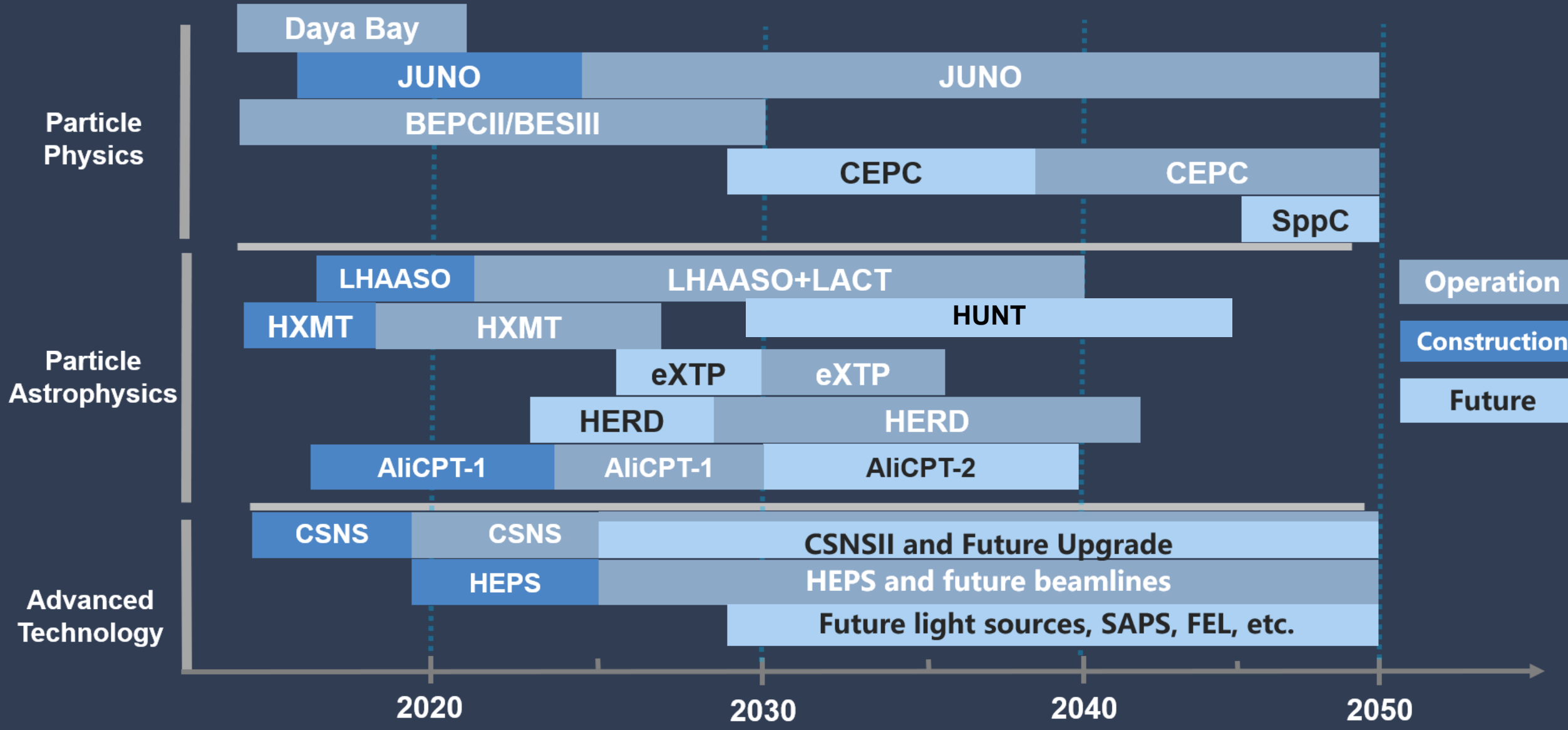
LHAASO
Large High-Altitude Air Shower Observatory

JUNO
Jiangmen Underground Neutrino Observatory

Dongguan Campus

CSNS China Spallation Neutron Source

Road Map of CEPC Host Lab: IHEP



Summary

- BEPCII@1.89GeV has reached luminosity of $1*10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}$ during routine operation. BEPCII-U@2.35GeV will reach luminosity of $1.1*10^{33}\mathrm{cm}^{-2}\mathrm{s}^{-1}$. BEPCII-U is under commissioning from March 2025.
- CEPC accelerator **TDR international review and cost review** were held from **June 12-16, 2023 and Sept. 11-15, 2023**, respectively, and endorsed by **IAC meeting** held from **Oct. 30-31, 2023**. **CEPC Accelerator TDR has be released formally on December 25, 2023 (arXiv：2312.14363) and published in Journal Radiation Detection Technology and Methods (RDTM) on June 3, 2024:** DOI: 10.1007/s41605-024-00463-y https://doi.org/10.1007/s41605-024-00463-y .
- **CEPC accelerator EDR including EDR site geological investigation and civil engineering design have progressed well with corresponding EDR funds and EDR human resources available**
- **CEPC detector reference design report has been reviewed by IDRC in April 2025.**
- **EDR site selection and geological feasibility studies have been started and will be completed in 2025.**
- Detailed preparation of **CEPC EDR** phase (**2024-2027**) before construction working plan and beyond have been established and executed with the aim for **CEPC proposal** to be presented to and selected by Chinese government around **2025** for the construction start during the ”**15th five-year-plan (2026-2030)”** (for example, around **2027**) and completion around **2035**.
- **CEPC is an international project and international collaborations and participations are warmly welcome.**

Thanks

CEPC International Collaboration

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/