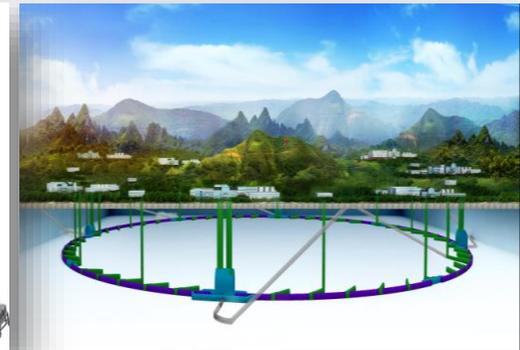
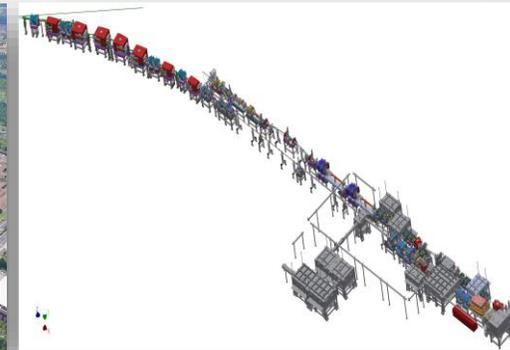


Introduction to Accelerator Division

Haisheng Xu

2026-02-02



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Brief introduction

PART 02

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Teams and research fields



Brief introduction to accelerator division

- The **Accelerator Division** designs, constructs and operates particle accelerators, and conducts research on accelerator physics and technology and their applications.
- Large accelerator projects:
 - the upgrade project of the Beijing Electron Positron Collider (BEPCII)
 - Design and construction the China Spallation Neutron Source (CSNS)
 - the Injector I of the Accelerator-Driven Sub-critical System (ADS)
 - the High Energy Photon Source (HEPS)
 - the Circular Electron Positron Collider (CEPC)
- R&D for small and medium scale accelerators for applications and technology transfer to industry.
 - Plasma wakefield acceleration, etc.



Brief introduction to accelerator division

- The **Accelerator Division** (including the Division of Accelerator Technology, Dongguan Campus) is the **largest accelerator research center in China**, and its long-term goal is to become an internationally important center for accelerator physics and technologies.
- R&D on novel acceleration technologies



Job openings

- We warmly welcome talents at all levels to join the Accelerator division, and we maintain long-term open positions across various career levels. Our disciplinary scope covers the research area of accelerator physics, accelerator technologies, and novel acceleration principles, etc..
- Colleagues interested in accelerator physics and technologies are welcome to contact us for further discussions on specific opportunities.
 - **Haisheng Xu, xuhs@ihep.ac.cn**



许海生 Haisheng Xu

北京 海淀





BEPCII



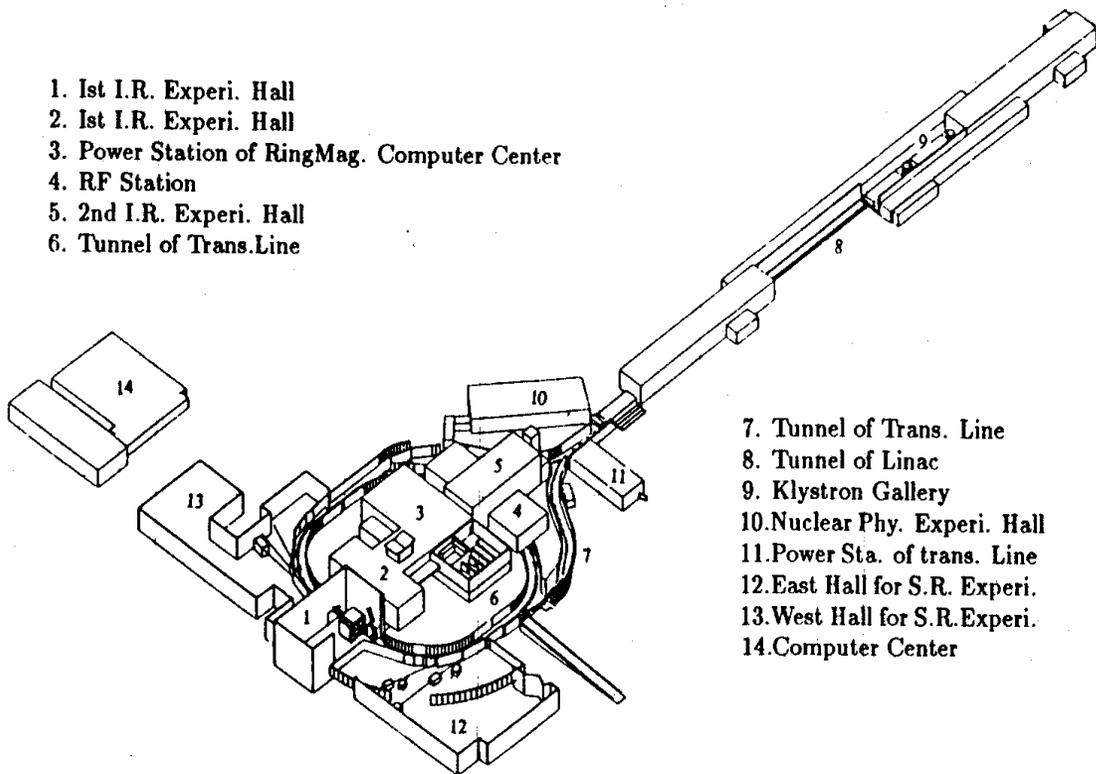


Switchable multi-operation modes in BEPC II

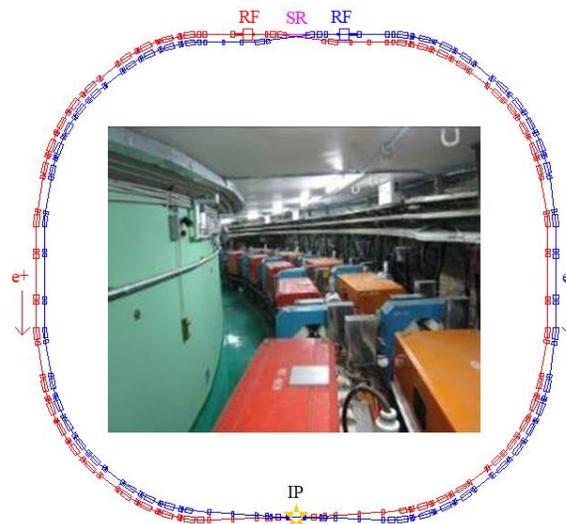
• BEPCII

- Upgrade project of BEPC, operated since 2009
- A double-ring factory-like collider
- Collider & SR operation modes

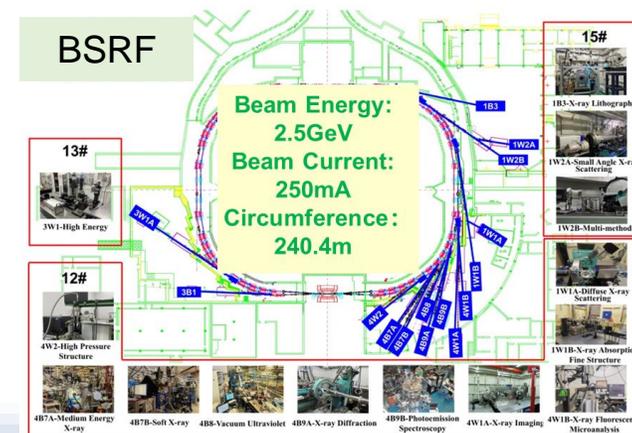
1. Ist I.R. Experi. Hall
2. Ist I.R. Experi. Hall
3. Power Station of RingMag. Computer Center
4. RF Station
5. 2nd I.R. Experi. Hall
6. Tunnel of Trans.Line



7. Tunnel of Trans. Line
8. Tunnel of Linac
9. Klystron Gallery
10. Nuclear Phy. Experi. Hall
11. Power Sta. of trans. Line
12. East Hall for S.R. Experi.
13. West Hall for S.R. Experi.
14. Computer Center



Main Parameters	Design
Energy (GeV)	1.89
Beam current (mA)	910
Bunch current (mA)	9.8
Bunch number	93
RF voltage	1.5
Beam-beam parameter	0.04
β_x^*/β_y^* (m)	1.0/0.015
Inj. Rate (mA/min)	200 e ⁻ / 50 e ⁺
Lum. ($\times 10^{33} \text{cm}^{-2}\text{s}^{-1}$)	1.0





BEPACII performance enhancement

- **Major achievements in the past five years**
 - Energy upgrade completed: Full energy injection and storage up to **2.472 GeV**
 - Top-up operation
 - Stable high-luminosity operation: beam current exceeds **900mA** with the instantaneous luminosity of **$1.1 \times 10^{33} \text{cm}^{-2}\text{s}^{-1}$** ; In the last operation year, the accumulated luminosity reached as high as **5307 Pb⁻¹**
-
- **Significance**
 - Better knowledge on operating a high-current machine for high luminosity
 - Better control over collective instabilities through feedback
 - Invaluable experience for CEPC design and construction



A recent upgrade of the BEPCII

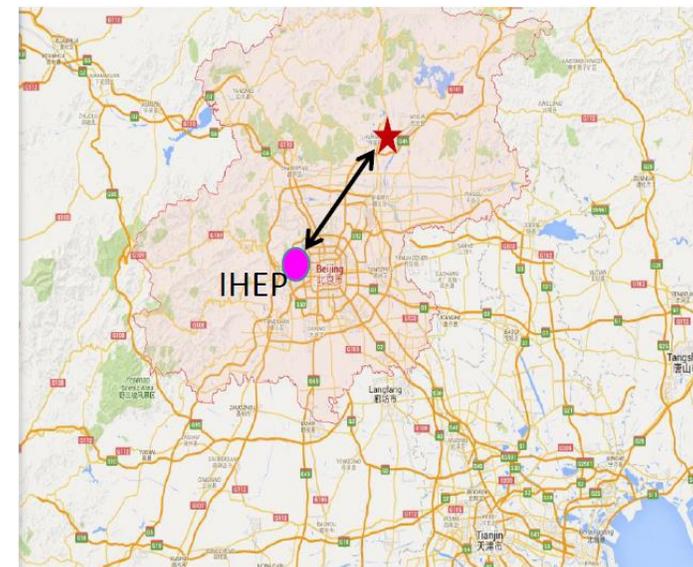
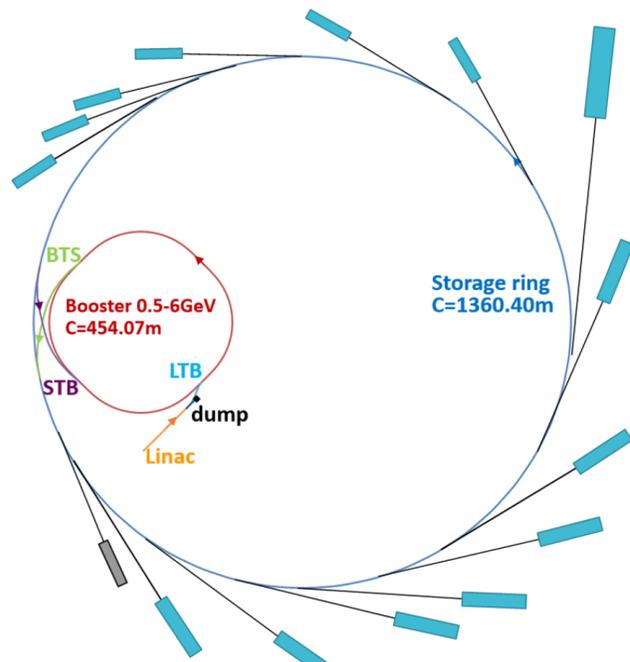






HEPS: 4th generation light source

Main parameters	Unit	Value
Beam energy	GeV	6
Circumference	m	1360.4
Emittance	pm·rad	< 60
Brightness	phs/s/mm ² /mrad ² /0.1%BW	>1x10 ²²
Beam current	mA	200
Injection		Top-up



- Advanced 4th generation light source, promoting multi-disciplinary researches
- Accumulate conventional key technologies for CEPC
 - Magnet - Vacuum - Power supply - Beam instrumentation
 - Alignment - Control - Mechanical system - Linac complex
 - RF - Cryogenics - Utilities

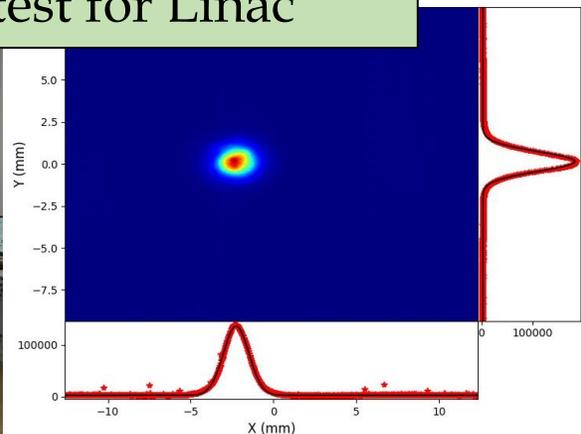


HEPS Progress

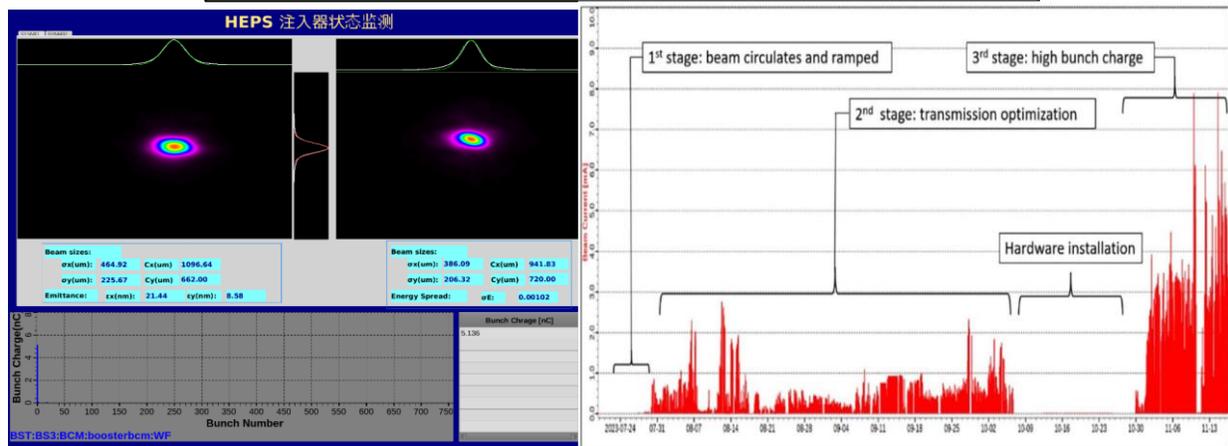
- Linac & Booster commissioning completed and passed the acceptance test
 - Boost alone is already the longest accelerator ring in main land China (circumference of 454m), with the highest electron-beam energy (6GeV), and the largest bunch charge
- Storage ring start commissioning on July 23 2024 and passed the acceptance test on Oct.29 2025.



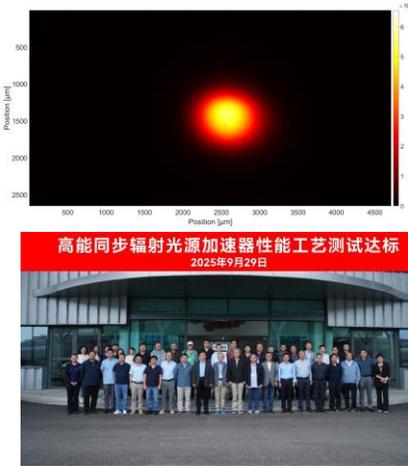
Acceptance test for Linac



Acceptance test for Booster



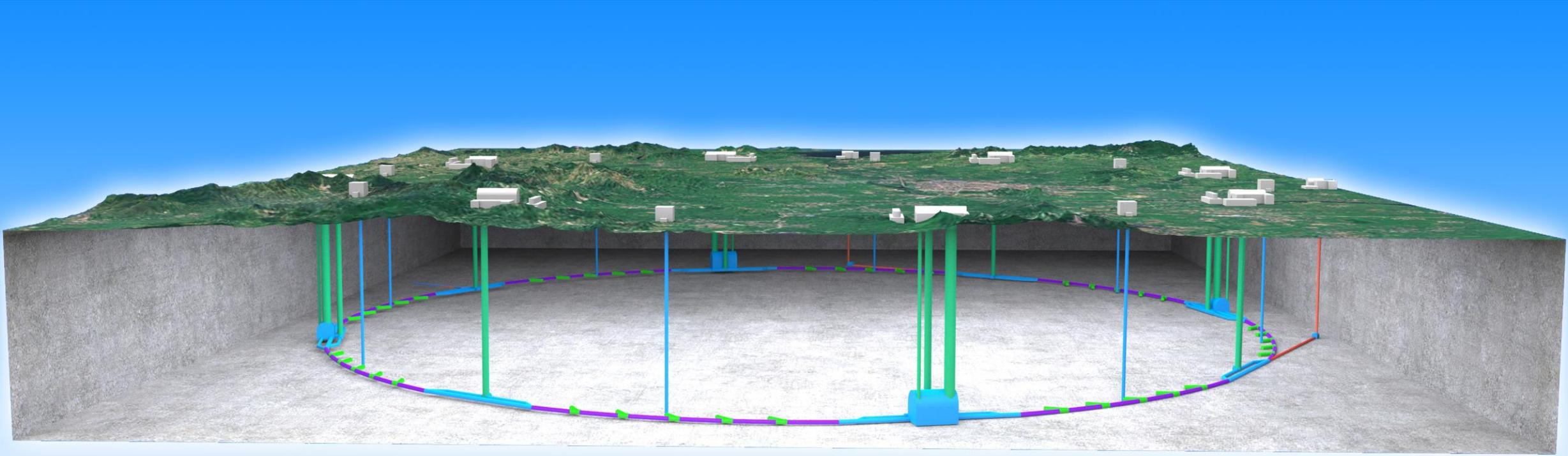
Acceptance test for Storage ring



高能同步辐射光源工艺验收会

2025年10月29日 北京·怀柔

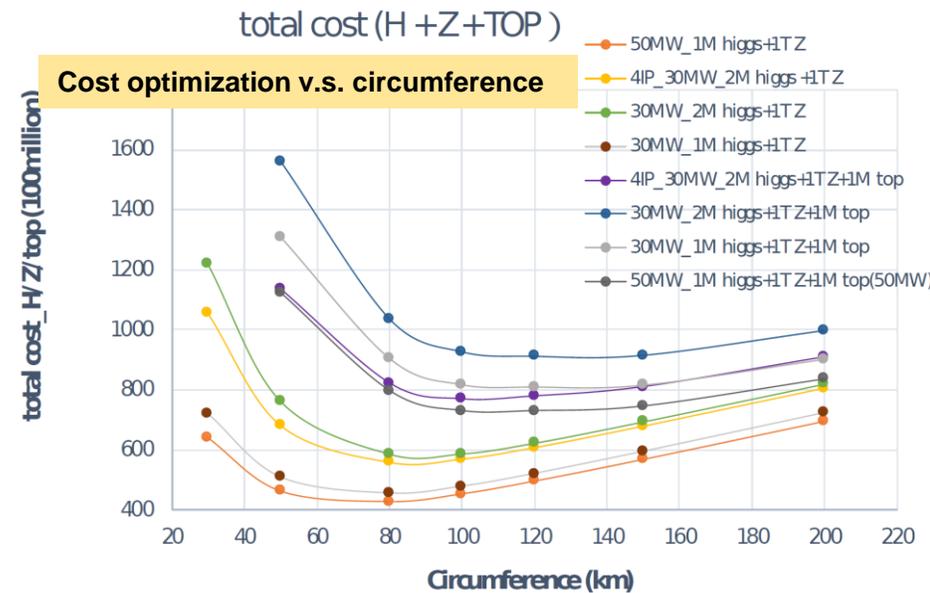
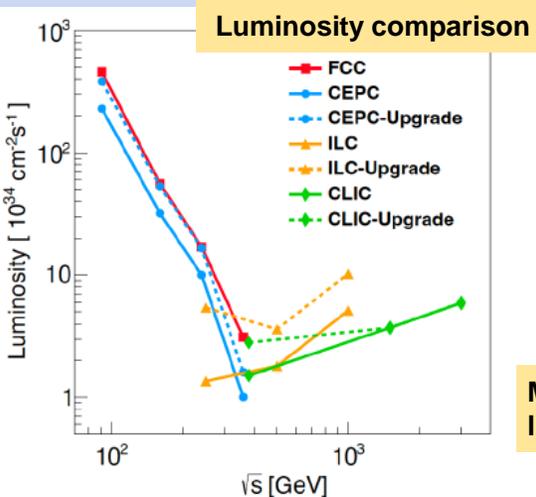
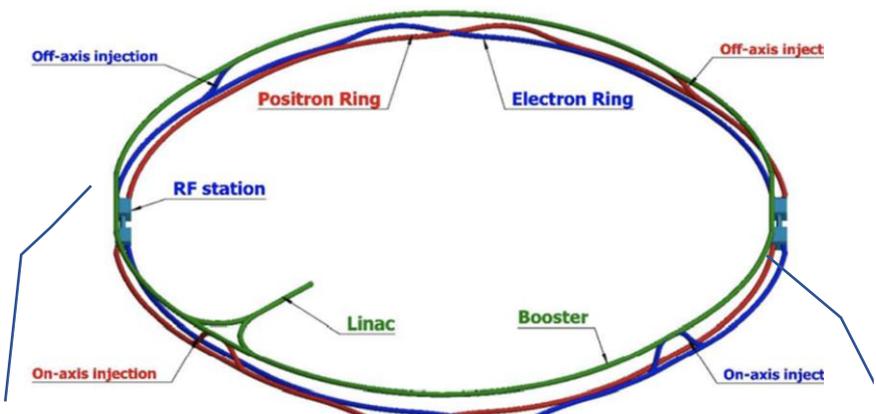






CEPC: Higgs factory

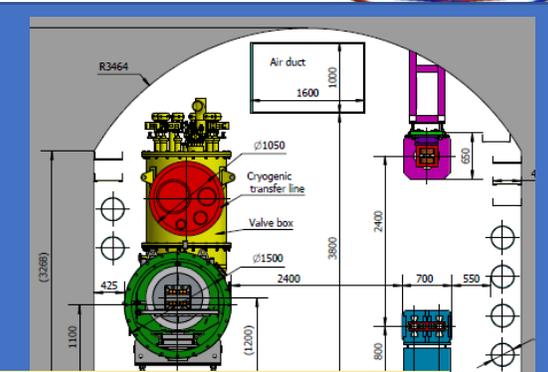
- **Circular collider:** Higher luminosity than a linear collider
- **100km circumference:** Optimum total cost
- **Shared tunnel:** Accommodate CEPC booster & collider and SppC
- **Switchable operation:** Higgs, W/Z, top



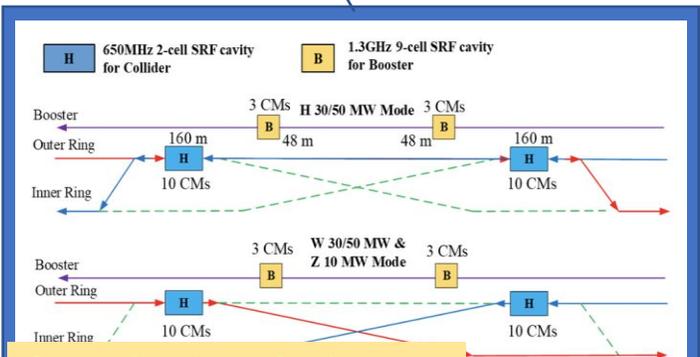
D. Wang et al 2022 JINST 17 P10018

Main Parameters: High luminosity as a Higgs Factory

	Higgs	W	Z	ttbar
Number of IPs	2			
Circumference [km]	100.0			
SR power per beam [MW]	50			
Energy [GeV]	120	80	45.5	180
Bunch number	415	2161	19918	59
Emittance (ϵ_x/ϵ_y) [nm/pm]	0.64/1.3	0.87/1.7	0.27/1.4	1.4/4.7
Beam size at IP (σ_x/σ_y) [$\mu\text{m}/\text{nm}$]	15/36	13/42	6/35	39/113
Bunch length (SR/total) [mm]	2.3/3.9	2.5/4.9	2.5/8.7	2.2/2.9
Beam-beam parameters (ξ_x/ξ_y)	0.015/0.11	0.012/0.113	0.004/0.127	0.071/0.1
RF frequency [MHz]	650			
Luminosity per IP [$10^{34}/\text{cm}^2/\text{s}$]	8.3	27	192	0.83



Common tunnel for booster/collider & SppC



Compatible Operation for Higgs W and Z



CEPC TDR formal release, EDR on going

● International TDR reviews

- ◆ 2023 June 12-16 : technical review; June 26: civil cost domestic review; September 11-15 : cost review
- ◆ 2023 October: CEPC International Advisory Committee meeting

Technical review



Cost review



Civil construction review



IAC meeting



June 12-16, 2023, in HKUST-IAS, Hong Kong

Chaired by Frank Zimmermann

Phase 1 CEPC TDR Review Report

CEPC TDR Technical Review Committee

15 July 2023

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 Z, WW and the top-quark pairs, with the upgrade potential to a high-energy pp collider. The CEPC represents a "grand plan" proposed, studied, and to be constructed by Chinese scientists in close collaboration with international partners. Since the release of the CEPC Conceptual Design Report in 2018, the CEPC Study Group has devoted significant effort to the design optimisation, the R&D of key technologies and the study of the technical systems of the CEPC.

The CEPC Study Group has produced a draft Technical Design Report (TDR). The International Review Committee, chaired by Dr. Frank Zimmermann (CERN), was asked to conduct a first phase review of this TDR draft. This first phase review shall cover all but the cost and site aspects of the CEPC.

The Phase 1 CEPC TDR Review Committee meeting was held in person at HKUST from 12 to 16 June 2023.

Sept. 11-15, 2023, in HKUST-IAS, Hong Kong

Chaired by Loinid Rivkin

CEPC Accelerator TDR Cost Review

The CEPC Accelerator TDR Cost Review committee examined the cost estimate of the TDR of accelerator systems for the first stage of the CEPC project operated as a Higgs factory with synchrotron radiation power up to 30 MW per beam (including all infrastructure that is not easily upgradeable and is already designed to operate up to the tbar energy and at 50 MW). The cost estimate under review does not include the civil engineering, the detectors at the IPs with their technical services, and the central computing services.

In the opinion of the committee the cost estimate presented is sufficiently complete to form a proper basis for the next iteration that will be done during the EDR stage.

Oct. 30-31, 2023, in IHEP

Chaired by Brian Foster

The Ninth Meeting of the CEPC-SppC International Advisory Committee

IAC Committee

M. E. Biagini, Y.-H. Chang, A. Cohen,
 M. Davier, M. Demarteau, B. Foster (Chair),
 B. Heinemann, K. Jakobs, L. Linssen,
 L. Maiani, M.L. Mangano, T. Nakada, S. Stapnes,
 G. N. Taylor, A. Yamamoto, H. Zhao

IHEP-CEPC-DR-2023-01

IHEP-AC-2023-01

CEPC

Technical Design Report

Accelerator

arXiv: 2312.14363

The CEPC Study Group
December 2023

**CEPC TDR -
Accelerator
formally released
on 25. Dec. 2023**





Supporting the development of SC cavities and cryomodules

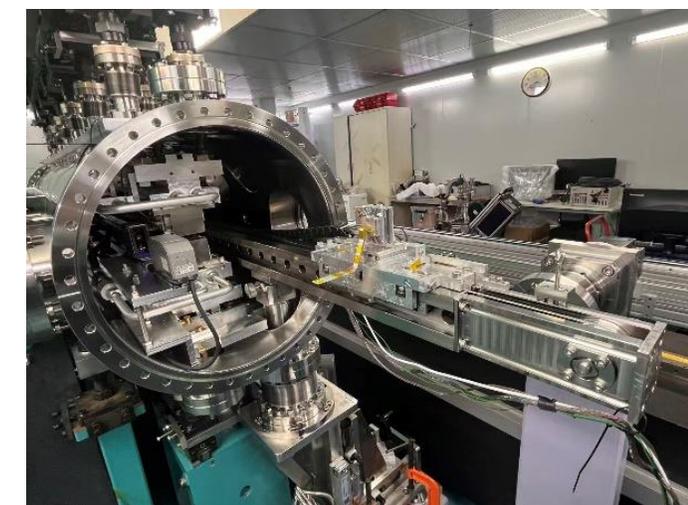
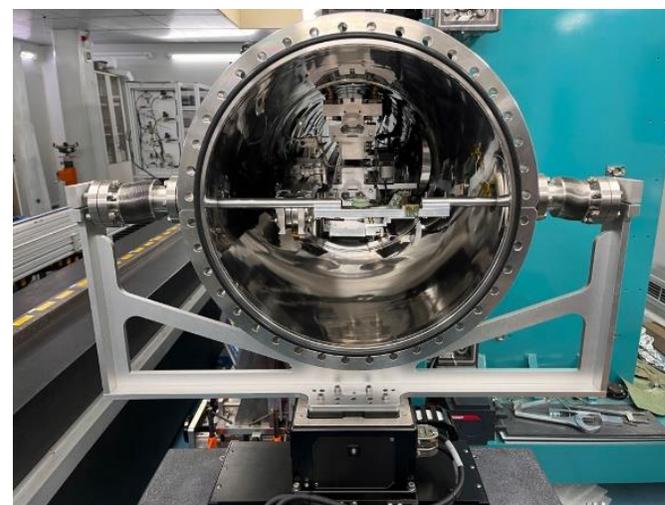
- Assembly and test of all the SC cavities and cryomodules.





Supporting the development of Undulators

- **Assembly and test of all the insertion devices of HEPS**

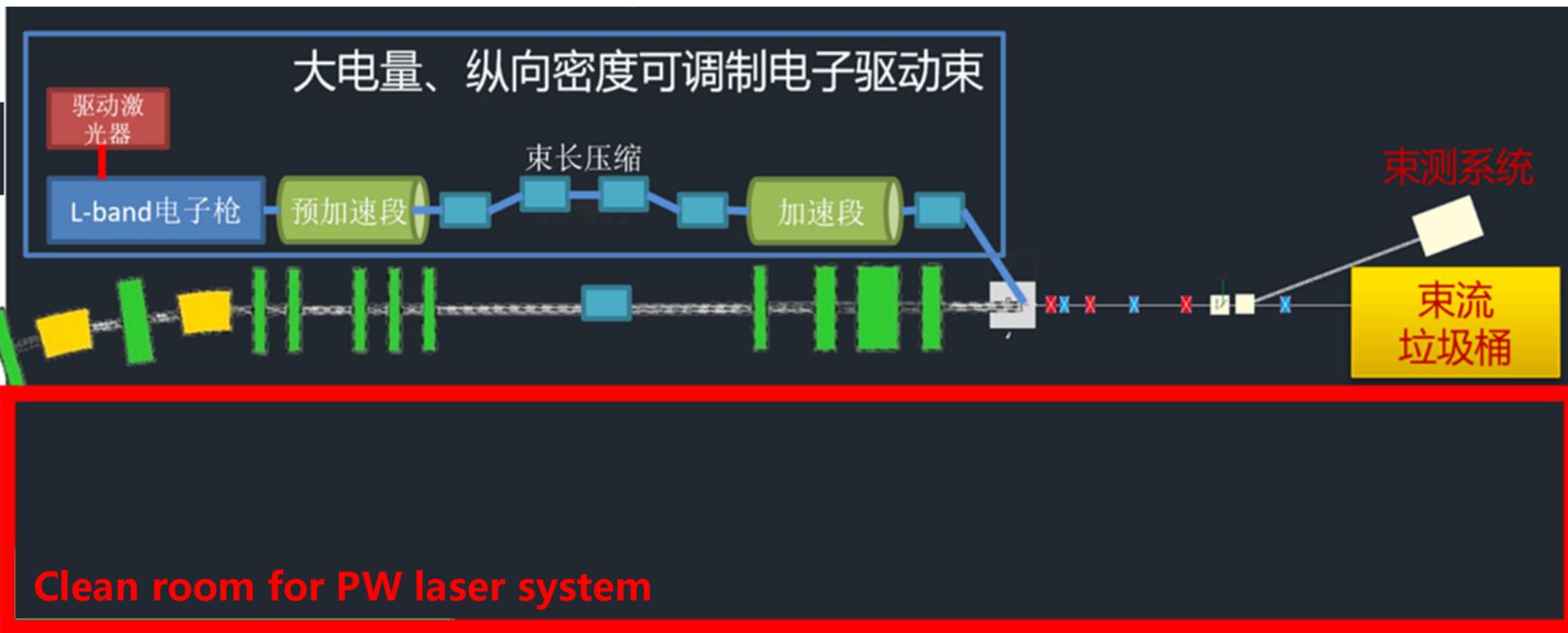




PWFA

Hall #10, 35m x 14m

BEPCLII linac 2 GeV e-/e+ beam



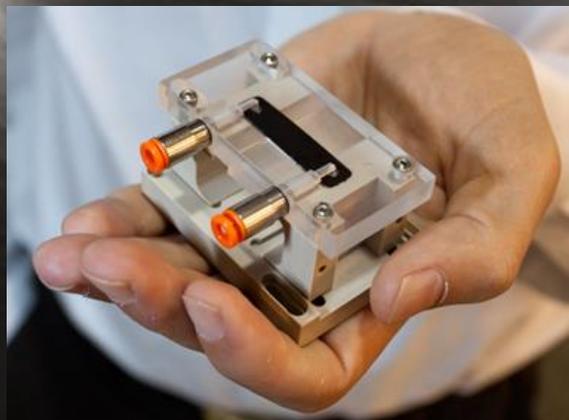


Significance of Plasma wakefield acceleration

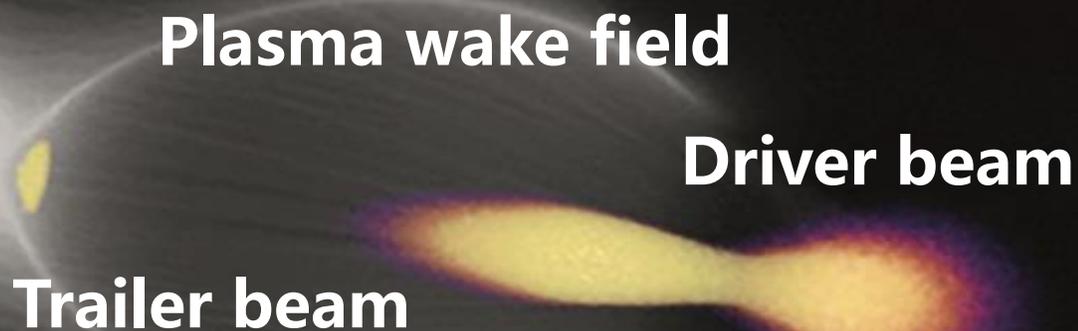
- **High gradient:** $\sim 10\text{-}100\text{GV/m}$, ~ 1000 times higher than conventional Acc.
- **High energy conversion rate**
- **High repetition rate possibility**
- **Focus on PWFA acceleration**



Conventional linac



1 GeV accelerator in hand





Hall #10 for Plasma acceleration research

L-band photocathode
RF gun



Optical tables inside
the cleaning room



Cabinets



Beamlines
installation



Interaction
chambers for
PWFA



PWFA control
room



Thanks!



2026

• Haisheng Xu • 2026-02-02