CEPC Accelerator EDR Phase Working Plan (preliminary)

2023 – 2025

（draft）

General CEPC EDR goals

According to the general CEPC plan, CEPC Conceptual Design Report (CDR) was completed in Nov. 2018, and the CEPC accelerator Technical Design Report (TDR) will be completed in 2023 after international review(s) (including a CEPC accelerator cost review). Thereafter, CEPC accelerator will enter into the Engineering Design Report (EDR) phase (2023-2025), which is also the preparation phase with the aim for CEPC to be presented to and selected by Chinese government for the construction start during the ”15^{th} five year plan (2026-2030)” (for example, around 2027) and completion around 2035 (the end of the 16^{th} five year plan). CEPC accelerator complex as the centroid of the CEPC, carries ~90% of the project cost, with regard to the country's selection decision of the 15^{th} 5-year plan, in EDR phase, the general goals for CEPC accelerator complex are:

(A) Guarantee the physics goals with required energies (Higgs, W, and Z-pole) and corresponding luminosities with 30MW cap on the synchrotron radiation power/beam as a baseline, and 50MW and ttbar energy as upgrade possibilities.

(B) Demonstrate the complete and coherent feasibility design.

(C) Demonstrate the feasibility of fully verified technologies through R&D with engineering design of CEPC accelerator systems and components towards fabrication in an industrial way (with both domestic and international suppliers).

(D) Well prepared for the realization of the CEPC facility with good understanding of the cost, and industrial involvement.

(E) Analysis and preparation for the human resources for the completion of CEPC construction.

(F) Continue to strengthen the international collaborations and welcome international participation.

(G) CEPC site selection study converges to (at least) two candidate sites in EDR phase with compatibility with the TDR (tunnel, infrastructure and environment), and recommend them to the government who will make the final decision on the site selection.

(H) EDR documentation preparations (both Electronic Documentation for construction and reports to government for application).

(I) Ready for final selection of the 15^{th} 5-year plan.

Breakdown of CEPC Accelerator EDR working plan and goals (2023-2025)

According to the CEPC and CEPC Accelerator EDR general goals described above, CEPC accelerator key subsystems working plans and goals (2023, 2024, 2025), each year to do list (items) and deliverables, milestones, etc. are briefly described as follows:

1) CEPC Collider ring (Yiwei Wang)

Lattice and beam beam

2023: Investigate on the dynamic error effects, esp. the ground motion with realistic data from the candidate sites. Establish the more realistic lattice with energy measurement systems, synchrotron radiation lines, polarization systems, the complex interaction region components, realistic finite length fringe field, twin aperture coupling of the dual aperture of arc magnets and so on. Combined effect between beam-beam and lattice nonlinearity, which help ensure the dynamic aperture is large enough and beam lifetime is long enough in more realistic case.

2024: Design of beam-beam performance tuning to mitigate the luminosity reduction induced by lattice error. Continuously optimize the lattice with more realistic models to get an enough beam lifetime.

Code

2023: Development of high-performance parallel (MPI/GPU) tracking beam dynamics code.

2024: Self-consistent performance evaluation by simulation considering lattice nonlinearity, collective effect, feedback system and beam-beam effect. Development of beam dynamics code considering combined effect of spin/beam-beam.

2025: Development of lost particle generator used to MDI study based on whole self-consistent beam-dynamics model.

Analysis study/Performance

2023-2025: Mitigation of instability considering combined effect by analysis/simulation study, which include (LATTICE, COLLECTIVE EFFECT, BEAM-BEAM SPIN).

2024: Face to the engineering design, trade off the accelerator physics requirements and the technology to establish parameters for future engineering.

2025: Establish the detailed procedures for the first turn injection, tuning, operation, different modes switching et al. Establish the tools and soft wares for tuning and operation.

2) Booster ring (D. Wang)

2023: RF Beam loading study for the bunch structure with half ring distribution (Higgs mode & ttbar) to confirm the beam stability and the CEPC overall timing structure. Redundancy study for the BPM and correctors. Try to reduce the number of BPM, correctors, and also optimize the quadrupole's length according to the cost issue.

2024: Injection efficiency simulations both at injection energy and extraction energy, especially for the swap-out injection scheme. Dynamic simulations with complete set of errors to check the transmission efficiency. Check the possibility of lower power consumption with faster booster ramping scheme.

2025: Booster table ramping design is proposed. Booster machine/beam commissioning plan is proposed. Instrumentation and beam-tuning scheme to control beam parameters in top-up injections, including to reduce effects from beam tail/halo particle loss on detector backgrounds and the final focus (FF) quadrupole quenching is devised.

3) Linac (+damping ring) (C. Meng, J.R. Zhang, D. Wang)

2023: Optimization of the physics design; Availability analysis of the Linac; Error study of damping ring; We will try to apply for the funding for C-band accelerating structure and normal conducting 5-cell cavity. Optimized design of C-band accelerating structure; if there is funding, we will process the prototype. If there is funding, we will process the DR normal conducting 5 cell cavity.

2024: Error study and preliminary engineering design; if there is funding, we will build a C-band high power test bench. Develop C-band RF element, such as pulse compressor, load, directional coupler etc. If there is funding, we will test the DR normal conducting 5 cell cavity.

2025: Determine the final scheme of the Linac including damping ring; If there is funding, high-power test of C-band accelerating structure will be performed to verify the accelerating gradient. The accelerating gradient aim of CEPC is very high, say 45MV/m, the high power test is necessary and important. If there is funding, we will do the high-power test of the DR normal conducting 5 cell cavity.

4) MDI (S. Bai)

2023: Improve the efficiency and accuracy of background simulation to narrow the difference with future experiments, including the improve the quality of the all the generation tools, the interface between different tools, and also made the new version of the beam background simulation toolkit dedicated to CEPC simulation. Try to apply and test the toolkit on existing machines like BEPCII and SuperKEKB, to validate the toolkit, and use the new toolkit to simulate CEPC beam backgrounds, to estimate the background level in whole interaction region, including the detector and also the accelerator components, and optimize the interaction region layout based on the estimation.

2024: Processing and manufacturing of IR beam pipes, including beryllium pipe and tungsten alloy beam pipe. To make prototypes of the beryllium beam pipe, and to improve the key technology such as the manufacture of the pure beryllium pipe, the choice of the coolant, the estimation between the coolant and the pipe in radiation environments, the welding between beryllium and other materials like aluminum, the window to LumiCal, and so on.

2025: Overall integration and installation for all components in the MDI.

Specific installation procedure. Cryostat including Final doublet installation alignment. Lumical and Beryllium pipe installation alignment.

5) Connection transport lines and timing (X.H. Cui)

2023: Complete optimization design on the connection transport line, give considerations on the timing of CEPC considering all sub-systems and all working energies.

2024: Complete start to End simulation of the beam transport line, demonstrate the condition of the beam transport efficiency and timing.

2025: Review on the design strategy, and complete the EDR document.

6) Collider magnets (M. Yang)

2023: Complete the Preliminary Engineering Design Report for CEPC Collider magnet system. Complete the magnetic field measurement and performance analysis of the long prototype of the dual aperture dipole magnet, and optimize the design further. Complete the optimization design of dual aperture quadrupole magnet. Complete the physical and mechanical design of the sextupole and corrector magnet.

2024: Considering construction cost, a short dual aperture dipole magnet is made of carbon steel material to study its magnetic properties. Develop a new prototype of double aperture quadrupole magnet. Develop a sextupole magnet prototype.

2025: Complete the magnetic field measurement and analysis of dual aperture quadrupole magnet and sextupole magnet. Complete the final

Engineering Design Report of Collider magnet system.

7) Booster magnets (W. Kang)

2023: Complete the performance test of the full scale prototype dipole magnets and verify the technologies that were adopted in the R & D of the TDR stage. Try the best to make the field quality of the full scale prototype dipole magnets meet the physical requirements

2024: Demonstrate the feasibility of fully verified technologies of the prototype magnets through R&D with engineering design of CEPC booster magnets towards the mass production of the booster magnets in an industrial way.

2025: Well prepared for the realization of the CEPC booster magnets with good understanding of the cost and industrial involvement.

8) Magnet power sources (B. Chen)

2023: According to the design of accelerator physics requirements, fully communication with magnet system, in order to choose the optimal magnet electrical parameter; and carry out the research and simulation of power supply topology mode; Analyze the hardware requirements of the functions required by the digital control board, and design the schematic diagram of the digital control board according to the analysis results.

2024: According to the result of topology simulation, cooperate with the manufacturer to design power supplies electronics circuit and mechanical structure. The design should consider the high availability, high reliability, electromagnetic compatibility, as well as the convenience of future maintenance and replacement; Digital control board hardware development.

At the same time, carry out hardware description program design and soft core design, and complete the function test on the hardware.

2025: Develop the prototype of the power supply, embed the digital control board. Test the power supply performance and optimize the digital control program and structure according to the test results. Make it finally reach the reaches the target.

9) Electrostatic-magnet separator (B. Chen)

2023: According to the requirements of accelerator physical parameters, completed the physical design of electrostatic separator and dipole magnet (including 3D finite element analysis of electrostatic field and magnetic field). Then completed the preliminary design of the overall mechanical structure of the Electrostatic-magnet separator.

2024: Carry out mechanical structure design and development of key components (including Electrode, Vacuum chamber, HV metal-ceramic support, HV feedthrough, magnet coil and overall support, etc.). On this basis, complete the overall mechanical design of Electrostatic-magnet separator.

2025: Build a test platform; Assemble electrostatic separator and perform high voltage and high vacuum tests. At the same time, the magnet also needs to complete the magnetic measurement; Then the whole Electrostatic-magnet separator is tested at high vacuum and high voltage, and overall performance reaches the target.

10) SC quadrupoles (Y.S. Zhu)

In EDR phase, the general goals for superconducting magnets in CEPC Interaction Region are:

Complete the Engineering Design Report for superconducting magnets in CEPC Interaction Region, including double aperture quadrupole magnet Q1a, Q1b, Q2 and anti-solenoid.

Demonstrate the feasibility of key technologies of double aperture superconducting quadrupole magnet to meet all the magnetic field performance requirements, by developing a 0.5m double aperture superconducting quadrupole model magnet (LTS NbTi, coil inner diameter 40mm, field gradient 142T/m).

Complete the pre-research on superconducting quadrupole coil using high-temperature superconductor (HTS Bi-2212 or YBCO).

2023: Complete the Preliminary Engineering Design Report for superconducting magnets in CEPC Interaction Region. Finish Engineering Design of 0.5m double aperture superconducting quadrupole model magnet. Complete the conceptual design of quadrupole magnet Q1a using high temperature superconductor

2024: Finish the manufacture of 0.5m double aperture superconducting quadrupole model magnet. Complete the performance test and experimental research on high temperature superconductor for Q1a

2025: Finish the cryogenic vertical test and magnetic field measurement of 0.5m double aperture superconducting quadrupole model magnet. Finish the fabrication and cryogenic test of a short model superconducting quadrupole coil using high temperature superconductor. Finalize the engineering design report for superconducting magnets in CEPC Interaction Region

11) SRF system for collider ring (J. Y. Zhai, P. Sha)

2023: Engineering design of the 650 MHz cryomodule for the Higgs mode. Beam operation of the 2x2-cell 650 MHz test cryomodule and replace with the high Q cavities and high power HOM couplers.

2024: Fabrication of the 650 MHz cavities and prototype cryomodule components for the Higgs mode. Engineering design of the 650 MHz cryomodule for the high luminosity Z mode. Beam operation of the 2x2-cell 650 MHz test cryomodule with high Q cavities.

2025: Assembly and testing of the prototype full-scale 650 MHz cryomodule for the Higgs mode. Reach the TDR specifications of the collider ring cavity and cryomodule.

12) SRF system for booster ring (J.Y. Zhai, P. Sha)

2023: Engineering design of the high current high Q 1.3 GHz cryomodule.

2024: Fabrication of the high current high Q 1.3 GHz cavities and prototype cryomodule components.

2025: Assembly and testing of the prototype high current high Q 1.3 GHz. Reach the TDR specifications of the booster ring cavity and cryomodule.

13) Cryogenic system (R. Ge and Mei Li)

2023: Continue to deeply optimize the cooling scheme design of the CEPC superconducting cavity and superconducting magnet side (particularly the detector magnet), combining the 3D mechanical layout and more detailed process calculations to optimize a cryogenic cooling scheme that can meet the actual functional requirements while also facilitating later maintenance and requiring less construction investment.

2024: Discuss the technical parameters and development progress of key equipment with domestic manufacturers, such as a large helium refrigerator, a 2K JT heat exchanger, and multiple cryogenic transfer lines, in order to promote the continued development of the CEPC industrial alliance.

2025: Complete EDR documentation and optimize the power consumption and construction cost tables of the cryogenic system.

14) RF power sources and power distribution (collider, booster and linac) (Z.S. Zhou)

2023: Accomplishment of High power test for P band high efficiency klystron, Starting of high power test for MBK

2024: Accomplishment of High power test for MBK, Development of muti-stage collector klystron.

2025: High power test of high efficiency klystron with muti-stage collector design

15) Instrumentation and feedbacks (Y.F. Sui and Y.H. Yue)

2023: Continued certificating beam measurement technologies at BEPCII and HEPS, such as beam position monitor electronics, beam loss detector and synchrotron radiation-based measurement. Carry out the experiment of beam feedback system at BEPCII and HEPS.

2024: Carry out research on the industrialization of BPM electronics and beam loss monitor systems with CIPC member or other potential partners. Find out the final solution of BI device batch manufacturing.

2025: Training people in HEPS and BEPCII for the completion of CEPC construction. Prepare the EDR of beam instrumentation system.

16) Mechanical system (H.J. Wang and Minxian Li)

2023: The final magnet support scheme (such as individual girder or common girder), the structure design of some typical magnet supports. The structure design of the collimator for background, and the rough scheme of the collimator for machine protection. Further assessment and mechanical design of the remote vacuum connector at MDI. A basically determined design of the support for cryostats at MDI.

2024: The structure design of more magnet supports. The structure design of the collimator for machine protection and begin the necessary technique study if possible. The development and test of the remote vacuum connector if possible. The structure design of the support for cryostat at MDI, including the detailed FEA, and begin the necessary technique study if possible.

2025: The structure design of all kinds of supports which needs to be finished at EDR stage. Finish all the development and technique studies if there has any. Optimize all the designs. Finish the EDR report.

17) Vacuum system (Y.S. Ma)

Optimization of NEG coating:

NEG coating is used to sustain the vacuum of beam pipe and suppress the e-cloud of positron ring. Because the resistance of NEG coating increases with the thickness increases, but the life of the NEG coating decreases significantly when the thickness is less than 200nm, it is necessary to optimize the thickness of the coating.

2023: Optimization the thickness of NEG coating distribution along the vacuum chamber.

2024-2025: Optimization the resistance of NEG coating.

Optimization the layout of vacuum system.

2023-2025: The vacuum layout is strongly dependent on physics, magnets, mechanics, etc. It is necessary to optimize the length of vacuum chambers, RF shielding bellows, and the distribution of ion pumps with the other system changes.

18) Control system (G. Li)

2023: Further discuss with the device group and confirm accelerator control requirements and specifications. Build a prototype platform to research and solve key technologies such as timing， MPS， Network and database, etc. Meanwhile, actively establish and deepen cooperative relations with the international EPICS community。 Also pay attention to the application of new technologies in accelerator control systems such as artificial intelligence, Internet of Things, edge computing and machine learning。

2024: On the basis of the prototype, test parameters and performance specifications of above systems, such as the delay of timing signals in long-distance transmission, jitter, etc., the response time of the machine protection system, the latency of the network system, massive database storage technology and so on. Propose suggestions for improvement and optimize the design scheme.

2025: Discuss the control requirements again with the equipment groups， who sign a technical contact list with. Continue prototype research on key technologies. Evaluate budgets and CPM plans。Specify various types of control rules and specifications, manage and constrain control system development including third-party partner companies。 Be ready for the design and construction of CEPC control system

19) Conventional facilities (J.S. Huang)

2023: The investigation of alternative sites will continue. The requirement of the accelerator for conventional facilities will be identified and classified.

2024: The engineering design will be carried out in depth, including civil construction, electric distribution system, ventilation and air conditioning system, cooling water system and compressed air system, etc. The overall planning of civil construction will be gradually improved. The design of electric distribution scheme of the project and the process flow of other systems should be completed.

2025: The engineering design report for conventional facilities will be completed, and a preliminary budget will be prepared.

20) Environment, health and safety issues (Guang Yi Tang and Zhongjian Ma)

2023: For environment issues, confirm the beam-losses along linac, transport line and dump hall. Estimate the productions of the radionuclides and the toxic gas. Estimate the radioactivity for the beam-pipes and magnets.

For magnets safety, according to the engineering design of magnets and beam-pipes flanges, design the lead shielding between magnets.

2024: Engineering design of fire protections. Finish radionuclides productions estimations for linac, transport line and dump hall.

2025: Review the engineering design of lead shielding and the estimation of the radionuclide's productions, the toxic gas productions and the radioactivity of the beam-pipes and magnets. Prepare documentations for environmental impact assessment.

21) Machine protection beam dump (Zhongjian Ma and X.H.Cui)

2023: The reliability study of the present scheme includes the detailed design of the transport line of the dump shared by the booster and the main ring, the specific design of the injection and extraction mode and the dilution kicker magnet parameters design and optimization.

2024: Detailed design of beam transport line and beam dump, including beam dump window, transport line layout in the tunnel, beam dump installation and maintenance mode.

2025: Review the design scheme and completed the design report.

22) CEPC high energy gamma ray beamlines (Y.W. Wang and Y.S. Huang)

2023: Further optimization of the lattice with wigglers to get a local higher quality beam for the synchrotron radiation. Complete the static and dynamic error correction or mitigations for the beam and SR lines. Complete the optimization design and prototype testing the gamma camera.

2024: Complete the engineering design of the magnets, vacuum system and mechanics system for synchrotron radiation station. Complete the optimization design of the gamma-ray focusing system.

2025: Complete the engineering design of the tunnel and experimental hall, vertical shafts for synchrotron radiation station. Complete the engineering designs of the gamma camera and the gamma-ray focusing system. Complete the Validation tests of gamma cameras and gamma focusing lenses on inverse Compton gamma light sources. Summarize the engineering designs for the CEPC high energy gamma ray station and applications.

23) Alignment and installation (X. L. Wang)

2023: Carry out error accumulation control research. Compared with existing accelerator complexes, CEPC has a much larger scale. Error accumulation will become a serious problem. To realize error accumulation control, it needs to research datum establish methods, new measurement methods and new data processing methods. The goal is to establish an error accumulation control scheme which can be applied for CEPC alignment.

2024: Verify CEPC alignment design. Rely on BEPCII, CSNS, HEPS, CEPC prototype component and CEPC simulation tunnel to verify the alignment scheme. The goal is to demonstrate the complete and coherent feasibility of CEPC alignment design.

2025: Detail the installation scheme. With the further research of CEPC, the type and number of components and the engineering progress arrangement will become more detail, the installation scheme need to be adjusted accordingly. The goal is to give a detailed installation plan, including the installation work content, work schedule, human resources and component installation scheme.

24) Beam driven plasma injector for CEPC (D.Z. Li)

2023： Detailed error tolerance analysis for new baseline design (10GeV -> 30GeV). Further optimization of the Linac for plasma injector. Passive plasma dechirper and e- acceleration experiments at SXFEL facility

2024: Improve the energy transfer efficiency for e- and e+ plasma acceleration. Experiments at SXFEL: HTR e- acceleration experiment and stable mode in hollow channel for e+ acceleration. Demonstrate the prototype of 5m plasma channel based on laser ionized noble gas

2025: Finish the dedicated plasma acceleration TF based on BEPC-II linac. Start-to-end simulation studies on staging and full energy (Z, Higgs and ttbar) plasma injector.

25) CEPC polarization design (Z. Duan)

2023: Summarize the work on beam polarization that has been so far focused on the Z-pole energies. Identify the necessary modifications of the injector chain, to facilitate polarized beam generation, transmission and injection into the collider rings. Identify the boundary conditions that spin rotators and polarimeters be implemented into a future version of the collider ring lattice. Discuss and work with colleagues to implement these modifications into the lattice designs. Carry out preliminary experiments of resonant depolarization technique at BEPCII.

2024: Clarify the hardware specifications of polarized electron sources, asymmetric wigglers, solenoid spin rotators and Compton polarimeters. Discuss with related hardware systems to establish a plan for hardware design and R&D for key items. Extend the study of beam polarization operation to higher beam energies, like W and Higgs energies. Continue the experiments of resonant depolarization at BEPCII, as a test of concepts for CEPC.

2025: Summarize the work on beam polarization at W and Higgs energies. Work with colleagues in the iterations of lattice design and hardware specifications, in terms of requirements from beam polarization operation. Establish the overall design that beam polarization is implemented for resonant depolarization and longitudinal colliding beams, to facilitate an upgrade with insertion of specified hardware to realize polarized beam operation, if beam polarization is not included in the baseline for Day 1 operation.

26) SppC design and compatibility with CEPC (Jingyu Tang and Y.W. Wang)

SppC collider ring lattice and CEPC-SppC compatibility

2023-2025: Optimize the SPPC lattice to follow the layout evolution of the CEPC lattice design; study nonlinear beam dynamics with more-or-less realistic error models; study synchrotron radiation effects and beam screen design; further studies on the beam-beam effects and longitudinal dynamics; study possible bypass schemes for hosting entire CEPC and SPPC colliders including detectors in the same tunnel.

27) SppC high field magnet (Q.J. Xu)

Goal of the EDR phase: increase the field strength of the model dipole magnet to 16 Tesla with combined Nb3Sn and HTS coils; complete the engineering design of the 20-T dipole magnet with accelerator-level field quality.

2023: Fabrication and test of the 16-T model dipole magnet: complete the fabrication of the outer Nb3Sn coils and inner HTS coils, assembling of the magnet and the preliminary performance test.

2024: Test and training of the 16-T model dipole magnet, study of its quench and dynamic characteristics; improvement of components or structure if necessary. Magnetic and mechanical design of the 20-T model dipole magnet based on the performance of 16-T model dipole magnet.

2025: Summary report of the 16-T model dipole magnet R&D. Engineering design of the 20-T model dipole magnet.

28) CEPC electronic documentation system (K. Huang and S. Jin)

2023: Complete the web and mobile APP development of DeepC system, and digitally empower CEPC-EDR report and document data management with DeepC.

2024: Optimize and update the DeepC system according to user feedback. Establish a CEPC-EDR database, and complete the function templates including schedule management, conference management, promotion and presentation, and domestic and international enterprise alliance site cluster.

2025: DeepC system will be widely used in numerous projects, and iterative development and update according to the practical requirements of CEPC.

29) CEPC site selection and civil engineering design in Qinhuangdao and Chuangchun (Y. Xiao)

2023: Carry out research on major technical issues such as site comparison and selection, tunnel section type research, underground cavern structure research, waterproof and drainage system research, large-span underground cavern construction scheme research, fire protection design, etc.

2024: Carry out the survey and design work in the feasibility study stage and complete the Engineering Geological Survey Report in the feasibility study stage.

2025: Complete the Feasibility Study Report, flood control impact assessment, water resources demonstration, land acquisition and resettlement planning for construction, environmental impact assessment, water and soil conservation plan report, geological hazard assessment report, overburden mineral assessment report and other special reports.

30) **CEPC site selection and civil engineering design in Changsha (Yangjiang Pan and Zhiji Li)**

With the goal of completing the technical design report in 2023, The preliminary planning of monographic research and the completion time nodes are as following:

a) In February 2023, Monographic study on the general structures arrangement (equivalent to the topic of selecting the general layout of the hydropower complex, the electromechanical specialty collects and regulates out the requirements for the layout of professional equipment in IHEP, and completes the layout design of supporting equipment. The civil engineering discipline carries out the building layout design according to the equipment layout results, the architectural discipline completes the overall plane layout planning and coordinates with the urban planning.

b) In February 2023, The special report on the general layout planning of construction (Determining the scope of land use)

c) In March 2023, The planning report of land acquisition and resettlement (Determining the land acquisition and resettlement investment)

d) In May 2023, Environmental impact assessment report (Determining the environmental protection investment)

e) In June 2023, Water and soil conservation scheme report (Determining the Water and soil Conservation Investment)

f) In June 2023, The special topic of labor safety (including anti-terrorism topics, industrial disease topics, and safety pre-assessment of project, to determine the labor safety investment)

g) In August 2023, The special topic of safety monitoring (Determining the monitoring investment)

h) In May 2023, The special topic on alignment and surveying control network design (Determining the measuring investment)

i) In June 2023, The special topic of access system and power supply for construction (Determining the power supply investment)

j) In June 2023, Supplementing the geological Exploration and prospecting work, ascertaining to the relation of underground construction to regional road、railways、pipeline.

k) In August 2023, Monographic Study on the earthquake-preparedness and anti-seismic (study on the effect of earthquake, and the impact of Surface road、Railways、High-speed Rail on the vibration of underground chamber, and determining the seismic fortification measures and buried depths of openings)

l) In September 2023, the technical design report， determine the budgetary estimate.

The preliminary planning of monographic research and the completion time nodes in the Engineering Design Review stage from 2023 to 2025 are as following:

a) In December 2024， Completing the civil engineering design of the underground part, including layout design of underground opening、excavation and support design、structural design.
b) In June 2025, Completing the electromechanical devices design of the underground part.
c) In September 2025, Completing the buildings and electromechanical equipment design of the ground part.

31) CEPC site selection and civil engineering design in Huzhou (K. Huang)

2023: Compare the CEPC’s civil construction scheme and complete the structural design for key underground buildings.

2024: Deepen the design of general supporting facilities for civil construction, including the power supply system, control communication, firefighting, HVAC system, etc. Improve the construction organization design and construction schedule management of CEPC.

2025: Refine the volume of civil work, determine the total investment based on the civil construction plan, and complete all civil engineering design work.

32) CEPC domestic and international industry preparations (S. Jin)

2023: Invite experts from CIPC, CEPC group, or recommended by IARC if possible to organize a group for the estimation of following questions: What kinds of equipment are needed for the CEPC components? How many the machines are needed if the production time is fixed? Whether the special training is needed for the workers and how many human power (FTE) will be needed. Make a standard table used to estimate the capability of suppliers. Ask for the recommendation of possible suppliers from the group to make potential list.

2024: Survey the potential suppliers and estimated their capability.

2025: Estimate whether the suppliers are enough. If not, to estimate how to resolve it, by survey for new suppliers or extension the capability of existed suppliers. Based on the software of DeepC, build a standardization digital management system for the suppliers' collaboration. Complete the EDR report.

33) Injector linac and damping ring R&D (J.R. Zhang) (combined in 3)

34) CEPC Injection/extraction system (Jinhui Chen)

2023： Complete the engineering design of trapezoidal-wave kicker system. Complete the engineering design of Lambertson magnets with septum thickness of 2mm and 6mm.

2024： Trapezoidal-wave kicker system prototype R&D.

2025： Complete the trapezoidal-wave kicker system prototype R&D.

35) Collective effects and impedance (Yudong Liu, Na wang)

2023: Developing of the impedance model with more realistic hardware designs; developing investigating tools for the self-consistent simulations with both beam-beam and impedance; initial modeling of feedback system in the beam dynamics analysis; more detailed simulations on beam ion instabilities and electron cloud effects.

2024: Impedance optimization based on iteration with hardware designs; investigating the crosstalk between the beam-beam and impedance and possible mitigations; investigate the perturbation of the feedback on the beam instabilities; detailed experimental measurements on secondary electron yield for NEG coating.

2025: Perform impedance measurements on the key vacuum components and test possible impedance mitigations; convergence simulations on beam ion instabilities and electron cloud effects; self-consistent studies on the collective instability mitigations and lattice optimizations.