2021 Second CEPC IARC Meeting

IARC Committee

October 20th, 2021

The Circular Electron Positron Collider (CEPC) and Super Proton-Proton Collider (SppC) Study Group, currently hosted by the Institute of High Energy Physics of the Chinese Academy of Sciences, completed the conceptual design of the CEPC accelerator in 2018. As recommended by the CEPC International Advisory Committee (IAC), the group began the Technical Design Report (TDR) phase for the CEPC accelerator in 2019, with a completion target year of 2022. Meanwhile an International Accelerator Review Committee (IARC) has been established to advise on all matters related to CEPC accelerator design, the R&D program, the study of the machine-detector interface region, and the compatibility with an upgrade to the t-tbar energy region, as well as with a future SppC.

The second 2021 CEPC International Accelerator Review Committee was held remotely due to the Covid-19 pandemic on October 11th to 14th 2021.

A total of 22 talks were presented on a variety of topics.

1 General comments

The Committee congratulates the CEPC team for the work performed in the last months and presented at this meeting. In particular, the progress on the R&D of the hardware components looks very promising. The team has updated the table of parameters for the high-luminosity running, as well as the lattices and components for all accelerator systems: sources, Linac, Booster and Collider.

Recommendations

1. The Committee regrets that the talk on the civil engineering and auxiliary facilities was not delivered, so it was not possible to review this work. These topics are very important for the TDR completion and should be carefully studied before the end of the year 2022;

2. A clear alignment strategy was not presented, although a new instrument for alignment is being developed and was presented. Since there will be a

total of about 310 km to align (Linac, Booster, two rings), the Committee suggests that a strategy be developed and presented at the next meeting;

3. It was sometimes unclear which developments were intended to be included in the TDR and which were intended for possible future updates. These issues should be clarified at the next meeting. Costs, power and an overall construction and installation schedule were not presented or lacked details. These topics should be covered in the TDR and need to be scrutinised;

4. In order to assure that the parameters chosen for the luminosity are indeed achievable, the experience of the SuperKEKB operation and luminosity tuning should be looked at. A closer collaboration between the CEPC and SuperKEKB team, which is already partly going on, would be advisable;

5. A plan for the future 3-year phase of the EDR should be presented.

The next section gives detailed remarks and recommendations on the topics presented. Once again, the IARC wishes to congratulate the CEPC team on the excellent progress that these represent.

2 Reports on single presentations

2.1 CEPC accelerator TDR status overview (Jie Gao)

Comments:

A 60 slides report was presented, covering four main topics including CEPC accelerator system optimisation in the TDR, key hardware R&D progress, civil engineering and siting including international collaboration, timeline and plans. The main parameters and configuration of the collider rings, booster ring, 20 GeV electron and positron linacs, key dynamical issues like storage ring impedances, timing system requirements, ramping study, etc., were reviewed. However, sometimes not enough detail is given to understand the results. For example, the sources of non-linearities whereby such a nice collider dynamic aperture is obtained are unclear.

The development of key CEPC components is very impressive, especially the superconducting cavities and accelerating structure design and production, magnets study (both for collider and booster), injection and extraction hardware, etc. New alignment instruments (photogrammetry cameras) seem promising but need additional experimental study on measurement accuracy.

CEPC site selection is considered and the project schedule was discussed.

Recommendations:

1. Continue development of key accelerator components with more extensive involving of international collaboration;

2. Consider how recent results from SuperKEKB operation can be related to CEPC (for instance, CEPC MDI collimators look very similar to those at

SuperKEKB but according to the recent results from Japan, they introduce large impedance and limit the maximum current).

2.2 CEPC collider-ring lattice and error study for high luminosity (Yiwei Wang)

Comments:

A review of the lattices for all modes of operation was presented. The committee is impressed by the amount of work performed on this topic, which is crucial for the success of the collider.

The higher luminosity W and Z operation required a change of the FODO lattice in the arcs from 90-degree cells to 60-degree cells, for a larger momentum-compaction factor and thus larger horizontal emittance and synchrotron tune. A 90-degrees FODO is still the baseline lattice for the Higgs and ttbar.

A new arc sextupoles scheme for the correction of the second-order horizontal chromatic aberrations, with 8 paired sextupoles instead of the previous 2 pairs, was presented. The pairing will be different for Higgs/ttbar and W/Z modes of operation. This new arrangement will allow a reduction of about 30% in the number of sextupoles needed.

An alternative separation scheme at the RF sections with a kicker instead of an electrostatic separator was studied.

Dynamic-aperture requirements are met for Higgs and mostly (with a 2% momentum aperture) for t-tbar, to be optimized. For the Z the DA momentum acceptance is much lower (below 1%), however different sextupole pairing patterns are being studied for increasing it.

A machine error-correction procedure was started and is in progress. An iterative approach is needed. The displacement error for the IR quadrupoles was set to 50 microns, even though the best the alignment team could promise is 100 micron. Once the correction tool is in place, and good results for 50 micron errors are achieved, further optimisations will be done to verify that 100 micron are still acceptable to achieve the design peak luminosity for all modes.

The dynamic aperture with errors for Higgs operation was presented. While for the vertical plane there is a large stable area, for the horizontal one the stable area is much reduced for some seeds, although it seems still capable of complying with the on-axis injection requirements.

Recommendations:

1. The error-correction procedure could benefit from other tools developed for the vertical emittance correction in synchrotron-light sources, as for example the Machine Learning technique or other iterative methods as done for ESRF. Contact with the SLS community could be beneficial;

2. Verify that the stability of the correction procedure complies with the 100-micron misalignment resolution in the IR quadrupoles set by the mechanical-engineering team;

3. The influence of the errors on the emittance, especially for the vertical one, which is important for the luminosity, should be simulated;

4. Since off-axis injection at all energies would be preferable, further studies on the errors correction, to increase the dynamic aperture at the Higgs, where on-axis injection is preferred, would be needed. A beta-beating correction scheme should be developed and implemented, which will improve the DA.

5. Increase the momentum aperture at lower energies, to be able to inject from the booster even with an energy deviation larger than 1-2%.

6. Although the beam-dump strategy was shown in a separate talk, the Committee is concerned that this topic may be difficult to solve and needs much more attention.

2.3 CEPC Booster and Damping Ring update (Dou Wang)

Comments:

The Booster and Damping Ring updated versions have been presented. The Booster is an essential and challenging component of the injection system: it has to ramp quickly in energy, from 20 to 180 GeV and deliver the current for top-up injection into the collider rings. It has to be efficient and reliable. The requirements on Dynamic Aperture for the collider are limited by the booster emittance, so that the booster horizontal emittance at the Higgs is now half of the CDR value. This means that even if the DA limit in the collider is just 8 σ_x, it is still possible to inject on-axis from the booster. However the procedure for on-axis injection at the Higgs (swap-out bunches? longitudinal? synchrotron phase?) has not been shown in detail.

The Booster lattice was upgraded for the new injection energy, 20 GeV, and a new TME cell has been preferred to the CDR's FODO cell. This new lattice has a lower number of magnetic elements and better dynamic aperture. The dipoles are combined function: dipole and sextupole. So, no single sextupole magnets are installed. The dynamic aperture at 20 GeV looks large enough for the beam stay-clear only up to a 0.5% momentum deviation. Both alignment errors and multipole magnet errors were simulated and corrected (but only for 100 seeds). The resulting dynamic aperture is about ± 2 cm, the beam-stay clear being ± 1 cm, so injection should be safe. The dynamic aperture at the other running energies was not shown: in case the sextupolar component in the combined-function dipoles should be not enough to ensure a proper dynamic aperture, it would be good to foresee the installation of some isolated sextupoles for additional corrections.

The beam-beam instability for on-axis injection has been simulated and seems under control for a positron beam much smaller than the electron one (horizontal emittance about a half, coupling 5 times smaller).

The booster maximum beam current is limited by the RF power available. This makes the injection at the high-luminosity Z operation, where 12000 bunches are to be filled, complicated. A 200 Hz injection rate or two-bunches injection are being considered. The final strategy and what will be the injection efficiency at the Z are as yet unclear.

A strategy for dealing with the Earth's magnetic field at 20 GeV by tuning the dipole field has been studied. About 20% of the ring will be subject to it, a global orbit-correction procedure was shown to be able to keep the dynamic aperture mostly unperturbed.

The energy-ramping scheme has been studied; at the Z about 68 sec are needed. The increase of energy spread and bunch length during this process should be checked to ensure compliance with injection requirements at all energies.

The Damping Ring (DR) for the positrons has also been updated. Due to the smaller emittances in the collider and Booster, the output DR emittance also has to be reduced. A lattice with reverse bends is used (no details given) that should provide extraction after 20 ms. Two schemes with 200 Hz repetition rate or with 2 bunches have been studied. The dynamic aperture for the 60-degree FODO lattice shows a satisfactory dynamic aperture, while the 75-degree FODO lattice (which was not described) has clearly worse results. The committee assumes that the 60-degree lattice will be selected.

The design bunch current is under the threshold of the computed (analytically? simulation?) Transverse Mode Coupling Instability, which is presently an issue for the SuperKEB B-Factory.

The presented parameters for the damping ring (DR) seem not mature enough. For instance, it is not clear how the assumptions on the injected emittances are justified, since it is said the simulations have not been done for the positrons from the target to the DR. Actually δ_{inj} in the table on page 23 seems too small, as the injected beam will not be a Gaussian at all.

The requirements for the longitudinal damping are not clearly shown. Actually, if only the transverse damping is necessary, as was presented, the need for the DR is probably quite weak.

Recommendations:

1. Develop an error-correction procedure for the Booster at each operation energy (for more than 100 seeds) and check that the resulting dynamic apertures comply with the needed transverse apertures and momentum acceptance;

2. Check that the Booster combined-function magnets are strong enough to ensure the required dynamic aperture at all operational energies;

3. The procedure for on-axis injection from the Booster to the Collider at the Higgs should be given in more detail;

4. Reconsider the design of the DR based on simulated positrons from the target through the linac and the energy compressor with realistic distributions of particles.

2.4 Analysis of coherent beam-beam instability with longitudinal impedance (Chuntao Lin)

Comments:

The important topic of the beam-coupling impedance effect on parameters and stability of the colliding beams in CEPC is considered with a home-made beam-beam code IBB, which includes in the simulation the longitudinal coupling impedance. At first glance, IBB results agree with LIFETRAC code. This code was used recently to simulate the combined effect of Beamstrahlung and longitudinal impedance on the bunch length and energy spread in CEPC in comparison with an independent semi-analytical model. The results seem consistent. Thus IBB seems to be a valid simulation.

The beam-beam limit with respect to the bunch population is studied including new set of parameters at the t-tbar energy. Limitations for the colliding bunches intensity are presented.

The longitudinal impedance (ZL) has been included in the beam-beam simulation with a newly developed analysis method. The beamstrahlung lifetime has been increased by the longitudinal impedance, while the X-Z instability is enhanced. The X-Z instability is highly suppressed at W/Z for the newest machine parameters. The stable region of the working point for CEPC-Higgs is about $Q_x \sim 0.004$ when considering the longitudinal impedance. About 10% imbalance of bunch population could be acceptable for ttbar/Higgs/W, while 5% asymmetry is acceptable for Z. The total longitudinal impedance in the ring is summed and applied once per turn at the IP; since its major source is the resistive wall in the arc, the effect of dispersion around the ring is not taken into account. The effect of the transverse impedance has been said to be small, but it may depend on the number and the aperture of the collimators. The transverse impedance can cause a localised effect, as seen in SuperKEKB.

Recommendations:

1. Continue to refine the simulation, to include all possible effects, such as the dispersion effect on the impedance and the transverse impedance with realistic numbers and apertures of the collimators.

2.5 CEPC instrumentation update, BPM etc. (Yanfeng Sui)

Comments:

An update of CEPC beam-instrumentation system design, progress of the R&D, especially on the BPM electronics and feedthrough, were shown. The diameter of the button pickup has been reduced from 10 mm to 5 mm. Longer stripline kickers for bunch feedback have been studied to overcome the deformation of the rod. The R&D has been performed mainly with a view to reducing the construction cost, achieving key technologies and for better maintenance and upgrade.

The development of BPM electronics was started from 2015 and has already been tested using BEPCII accelerators. The cross talk is better than -80dB and a dynamic range of 60dB has been achieved in the front-end module. The digital data-acquisition module has already been developed with enough functionality to measure closed-orbit distortion (COD). Comparison between a commercial device (Libera) and the system at the BEPCII ring shows fairly comparable results.

For the feedthrough development, a button electrode and high-power feedthrough for the bunch-feedback system has been developed. A reverse-type connector on the air side has been selected, which should greatly improve the reliability of the connection. The test result showed the mechanical properties, frequency response and vacuum performance will meet the demands of the CEPC accelerators.

Recommendations:

1. For the longer stripline kicker, design a support structure strong enough to keep the rod in the vacuum;

2. Consider evaluating the performance of the high-power amplifiers for bunch feedback, especially on the time-domain response to both rising and falling behavior. The tolerance to the reflection (or beam-induced power) should also be checked. A high-power low-pass filter just after the amplifier to protect from the beam-induced power should also be considered;

3. The required cycle of the COD measurement and support of the orbit feedback, especially in the region where very fast and accurate COD stability is required by the beam optics, should be considered.

2.6 Progress on the normal conducting magnets for CEPC (Mei Yang)

Comments:

The normal conducting magnet team has made great progress in the development of the magnets for the booster ring and the collider rings. The IARC congratulates them on this progress.

Two types of the normal dipole magnet for the booster ring were studied. One is the CT coil dipole magnet, and the other is the iron-core dipole magnet. The required dipole field strength is in the range of 28 Gauss to 500 Gauss; the team gave full consideration to the Earth's field and the remnant field of the iron core in the magnet design. The construction of the prototype CT dipole magnet is in progress. In this process, deformation of the conductor was found, and some counter-measures have been taken in the magnet production. As for the iron-core magnet, its magnetic field was calculated in the 2D model. The remnant field effect of the core on the magnetic-field quality was evaluated for the 20 GeV injection energy; it was confirmed to be acceptable for beam operation of the booster. The costs of the two types were compared; that for the iron-core dipole magnet is 40% smaller than that of the CT magnet. Given these careful studies, the iron-core dipole was chosen for the booster ring, which the IARC supports.

The field-measurement system has already been constructed. Its measurement accuracy needs to be checked because of the low field strength and the required field uniformity (higher-order field components).

In the developments of the normal-conducting magnets for the collider, there is a lot of progress in the magnet design and the dual-aperture quadrupole prototype. The collider dual-aperture dipole magnet of 5.7 m length is scheduled to be constructed. The IARC would like the magnetic performance of this R&D magnet to be confirmed. The first prototype of the dual-aperture quadrupole magnet was constructed and the trim-coil configuration was studied with the 3D magnet model. The calculation results and the modification of the trim-coil design are acceptable. The committee would also like the magnetic performance of the quadrupole magnet and the trim coil to be confirmed by the field measurement.

Recommendations:

1. The IARC expects the normal conducting magnet team to push the magnet study with the prototype in calculation and production forward to the production magnet;

2. The magnetic-field performance of the prototypes should be confirmed by magnetic-field measurements as soon as possible to allow the final design of the production magnets;

3. The measurement accuracy of the harmonic coil system should be checked for the low-field and high-quality magnets.

2.7 Investigation on the CEPC polarization (Zhe Duan)

Comments:

A program for obtaining the transverse and longitudinal polarization in CEPC is presented. It is consistent with previous studies carried out but in addition, the possibility of polarization measurement in the collider was presented, as well as optional production of the polarized beam in the booster. However, the parameters of the asymmetric wigglers to speed up the polarization are not discussed and, since they increase the spin-frequency spread, they produce a decrease of the equilibrium degree of transverse polarization.

Acceleration of a polarized beam in the Booster with a Partial Siberian Snake seems interesting, particularly in view of spin-resonances crossing.

The IARC was unclear whether this scheme is a future option or is intended to be a part of the CEPC baseline design. This should be clarified at the next meeting, since it would represent a major change to the machine lattice, DA, etc., and has an impact on the luminosity.

Recommendations:

1. Consider combination of two Partial Siberian snakes (solenoid+helix magnet). For that system, the spin-rotation angle does not depend on energy and this fact may facilitate spin-betatron-resonance crossing;
2. Background sources need to be evaluated in the design of the polarimeter, e.g. from physical processes resulting in beam-particle loss in the area close to the polarimeter, such as scattering on beam-gas molecules and on thermal photons, as well as from electron-positron interactions at the main IP with very small transverse momentum exchange;
3. Whether the beam polarisation should be measured upstream or downstream of the IP, or both, should be clarified. This might depend on the background conditions upstream and downstream, and on the capacity to evaluate beam-beam depolarisation effects using simulations for reliably extrapolating the foreseen polarisation measurements to the IP.

2.8 Collective instabilities in collider, booster and damping rings with the high luminosity parameters (Na Wang)

Comments:

The requirement for the transverse feedback damping time of 3 turns is difficult to realize both because of the fundamental stability limitation of the feedback system coming from the large delay time (one turn or more) of the system (see V. M. Zhabitsky et. al., NIM A391(1997)96), and because the broadband noise injected to the feedback system works to excite the beam. Even without considering the external noise in the feedback system, the usable minimum damping time will be around 10 turns: 5 turns might be possible with very short FIR tap of the filter (¡3 taps) but the system will not be easy to handle. Though this limitation could be relaxed to some extent by using multiple systems together, another challenge due to high feedback gain arises. Broadband noise naturally injected / induced in the system will be amplified with the high feedback gain and applied to the beam. During collision, due to the beam-beam effect, the beam could be excited by the amplified feedback noise in the region of roughly the tune plus the beam-beam tune shift. This enlarges the effective vertical beam size which results in a large reduction of the luminosity, as found and corrected in KEKB and SuperKEKB. Although the effect could be suppressed to some extent by a good feedback detector and digital filter with very low-noise characteristics, it is very risky to assume extremely large feedback gain. Note that increasing the number of Taps in the digital filter could reduce the noise far from the tune, but it also reduces the maximum stable feedback gain due to the extremely large delay in the system. It is necessary to reduce the source of the instability, which means to try to reduce the resistive-wall impedance, to get stable beam.

A possible solution for the feedback issue above is to use a narrow-band feedback, not in a turn-by-turn mode. As the resistive coupled-bunch instability is highly correlated between bunches, feedback can be effective even without waiting for the next turn. The feedback can be applied to successive bunches, as they have the same unstable modes. Actually, the growth rate seems very fast in terms of turns, but it is still reasonable in terms of seconds. Such a narrow-band scheme will be applied at FCC-ee, which has a similar situation.

Recommendations:

1. Develop a dedicated feedback system for the resistive-wall instability.

2.9 MDI Studies for CEPC (Sha Bai)

Comments:

The studies of the MDI, while still preliminary in many ways, certainly demonstrate continuing progress in analysing several of the main aspects, including the impact of synchrotron radiation, beam loss from radiative Bhabha scattering, beam-gas Bremsstrahlung and scattering on thermal photons, and an initial collimation system for mitigation. Shielding of the superconducting quads is necessary and a Tungsten beam pipe has been proposed. FLUKA simulations performed show an acceptable accumulated absorbed dose over the life of the experiment (although with a safety factor of only 3). A first analysis of detector background rates was presented, but which needs to be completed with a full GEANT4 setup including the beam elements near the IP in addition to the detector model. The coil of a prototype IR superconducting magnet has been completed.

Recommendations:

1. Particle-loss maps were computed in the IR from processes such as radiative Bhabha scattering, beam-gas Bremsstrahlung and thermal photons, randomly adding multipole field errors in the magnets. In the case of the radiative Bhabhas, a significant enhancement of losses downstream of the IP was observed. However, what was shown was for specific seeds of the random magnet errors; it would be more meaningful to show averages over many random seeds. Moreover, such studies should be better performed by studying the tolerances of the magnets to each multipole error individually, in order to translate into specifications where needed. Such a more complete study would perhaps give insight as to why only the radiative Bhabhas show such enhanced losses, and not the beam-gas Bremsstrahlung, in spite of the physical mechanism for losses downstream of the IP being very similar for both;

2. Detector background rates resulting from beam-induced particle losses around the IP were estimated using only a full detector model, without the nearby beam-line elements. In that sense, rescattered secondary particles

from losses on masks, beam pipe and other elements are not included. It would be good to extend the detector GEANT4 simulation to include the beam-line components some meters around the IP on both sides;

3. Synchrotron radiation was studied using perfect (nominal) beams and found not to be an issue in the sense that there are no direct hits on the central beam pipe in normal conditions. It was checked that this remains true up to 40 sigma of the nominal distribution in the near-IP quadrupoles. It was not clear whether only a Gaussian distribution was used, and it would be useful to explore what effects may arise using, for instance, an *ad hoc* polynomial-tail model with say 0.1% of the bunch charge beyond 10 sigma;

4. The effects from the continuous top-up injection on potential beam-loss-induced backgrounds in the IR needs to be analysed. For that purpose, a basic working assumption on the errors from the kicker (e.g. rotational error) and from imperfectly corrected X-Y coupling after the injection point could be used to estimate the presence of tails and the ability of the collimation system to cope with them before they are damped by the radiation damping and/or transverse-feedback system. Moreover, some tolerances to imperfect beams from the booster (e.g. too large emittances) should be determined as a function of the collimation-system parameters;

5. The possibility of non-Gaussian distributions existing/building up in the booster and being injected into the main rings should be evaluated, also checking the capacity of the collimation system to cope;

6. The FLUKA dose calculations for the Tungsten beam pipe used for shielding should include some "realistic" beam-loss conditions, taking into account the possibility of larger than expected beam tails, e.g. arising from imperfect continuous injection.

2.10 CEPC mechanical systems and MDI pipes and supporting structure (Haijing Wang)

Comments:

The presentation contained three major subjects: 1. MDI mechanics; 2. Collimator and machine protection scheme; 3. Supports for regular magnets. Studies continue and progress is reported in all three areas, as discussed below:

1. **MDI layouts** The report shows that all devices are within the detection angle acos(0.99). From the design drawing of the cross section of the detectors and the accelerator components, the space for the detector and BPM signal cables and the pipes for coolant and pressure gas is not considered because the gap distance between the line of the detection angle and the outer surface of the cryostat is only 10.5 mm, which also contains part of a detector component. The design of the RVC has been progressed

by using an improved inflatable seal. The vacuum sealing is still being studied. For the complete positioning of the sealing surfaces of the IP chamber and the cryostat side, a self-positioning concept is required. In the mechanical design of the cryostat, a support-rod system for the helium vessel that contains the superconducting magnets is proposed. The calculations presented did not show the effect on the magnet position of the thermal contraction on cooling the magnet down to 4 K. The cryostat design should include this effect. The displacement of the components due to the electromagnetic force of 270 kN should be evaluated by the mechanical model including the adjusting mechanism.

2. **Collimator and machine-protection scheme** Four collimators per IP and per ring are designed to decrease the background. The design of the collimators and the machine-protection scheme is in progress, informed by the experience of KEKB, SuperKEKB, APS and LHC. The preliminary design of machine protection proposes primary and secondary collimators and auxiliary solenoids on the vacuum chamber with reverse switching. These schemes need more technical studies. Building a fast sensor system to detect the beam loss, such as the diamond sensor in SuperKEKB, is recommended for the machine-protection system.

3. **Supports for the regular magnets** The supports for the magnets of 138 types are now being designed, and the transportation and preliminary locations for the magnets in the ring are proposed.

Recommendations:

1. The MDI layout, the space of the detector signal cables, cooling pipes, pressure gas pipe for RVC and the BPM signal cables between the acos(0.99) line and the outer surface of the magnet cryostat is required;

2. In the mechanical calculation model, the adjustment mechanism for evaluating the deformation of the component due to the electromagnetic field of 270 kN should be included;

3. For evaluating the magnet displacement during beam operation, the thermal contraction of the cold mass and the support rods should be included;

4. In the study of the machine protection, fast sensors to detect the beam loss must be designed and included.

2.11 Design consideration and optimization for the CEPC cryogenic system (Rui Ge)

Comments:

In the last presentation in November 2019, a conceptual design of the CEPC cryogenic system was given together with a detailed cooling scheme for the accelerator complex. From the presentation, the high competence and experience of the IHEP cryogenic group in confronting the challenging tasks to be performed was evident. The successful production in cooperation with domestic companies of 58 cryomodules for the European XFEL was a significant qualification step. In the path towards the TDR, a preliminary design of the very large CEPC refrigerator complex was also outlined, together with the detailed plans of the new R&D and SCRF test infrastructure, called PAPS, under construction in the Huairou district near Beijing.

Two years later, the IARC was impressed by the progress that has been presented both on the refinement and optimization of the CEPC Cryogenic System, but also on the realization of the PAPS infrastructure. The cooling scheme of the SCRF cryomodules of both booster and collider has been modified, from parallel to series, and optimized to improve cavity performances while reducing cost. The design of both cryomodules has been reviewed and improved based on the growing experience of the IHEP cryogenics group. Prototypes for booster and collider have been built in collaboration with the domestic qualified companies and will be tested soon in the PAPS infrastructure with the aim of further improvements. The IARC had the clear impression that all details are being addressed and reviewed, and that prototypes of subcomponents are fabricated and tested for qualification whenever it is useful. The optimisation of multichannel transfer lines is one of the key points and the design of components is proceeding with close links with the other main CEPC subsystems to ensure an optimum sharing of the limited space.

The IARC took note of the new design of the SC-magnet cryogenic system, following the progress of a multiple technology strategy under development for the IR magnets, with normal-conducting sextupoles. The choice of the use of large refrigerators for operational stability and cost was appreciated by the IARC.

In the second part of the presentation, the new PAPS infrastructure was presented in some detail. Most of the large new equipment has been installed and commissioned. The development of an advanced control system, which is based on the Model Prediction method (MPC) as a control algorithm, was presented and discussed. The cooldown tests performed so far in the PAPS BCTM cryostat verified the expected improvement of the control stability. The IARC appreciated the innovative use of the neural-network construction inversion model.

In summary, the IARC has been impressed by the quantity and quality of scientific and technological developments so far, which includes several key components and systems. The path to the TDR is well underway.

Recommendations:

1. Maintain and extend collaboration with laboratories that have designed and operated large cryogenic systems;
2. Further improve the collaboration with the cryogenics groups in China engaged in the implementation of large scientific infrastructures for FEL and ADS;

3. Continue the effort to develop a large cryo-plant (10-20 kW at 4.5K) with national companies, including all the critical sub-components for 2K operation;

4. Maintain the good discipline of testing all new idea on prototypes before their implementation in the TDR.

2.12 Progress on the 650MHz high efficiency klystron (Zusheng Zhou)

Comments:
The progress on the RF power sources, klystrons for Injectors, and Collider ring, and solid-state amplifiers for the Booster, was presented. The work continues along the lines presented in the IARC meeting in May 2021, and, as then, the progress in design, prototyping and tests was greatly appreciated by the committee. In particular, the fast and efficient work with industry partners and PAPS is very important, as commercial suppliers of klystrons are very few world-wide. The S-band klystrons and modulators for the injector were briefly discussed, however the C-band system was not discussed. The SSAs for the 1.3 GHz Booster was mentioned without a detailed description. Most of the prototyping is focused on the 650 MHz RF collider system, where high efficiency is particularly crucial. A high-efficiency klystron aiming for efficiency above 70% is constructed and a 130kV/16A PSM power supply being set up at the test-site at PAPS. In parallel the design of a 80% efficient MBK (Multi-Beam Klystron) is made and the mechanical drawings prepared.

Recommendations:

1. The strategy for the injector C-band klystron and modulator system should be included in the plans;

2. A more detailed description of the injector and booster RF systems should be presented at the next meeting;

3. In similar efforts for MBKs for other projects, collector stability, in some cases not seen in the simulations, has been a concern. This should be watched.

2.13 CEPC plasma injection update (Dazhang Li)

Comments:
The IARC was impressed by the continuing high quality of the work that was presented in this talk. It congratulates the group and thanks it for the positive and comprehensive answers prepared to the recommendations of the previous review. The committee notes that the conceptual design presented still assumes a 10 GeV initial energy from the linac, rather than the 20 GeV that is now the baseline. The work since the last presentation mostly concentrates

on simulation studies of the symmetry and length of the drive beam and the properties necessary to avoid or at least mitigate the hosing instability. Some very nice work comparing analytic asymptotic solutions with particle-in-cell simulations was presented. From this point of view, running with a reduced transformer ratio of 1 - 1.5 seems to give improved stability compared to the original value of around 3.5 and is capable of achieving acceleration of bunches to 45 GeV. The work on linac optimization from the point of view of injection into a plasma stage is important. The IARC does not clearly see the connection between this work and that done by the linac group and how or indeed whether it is possible to produce a linac that can both act as an injector for a PWFA stage and operate as a stand-alone injector into the booster ring. The work done on simulation of the positron acceleration is interesting. In particular the pending PRL paper by the group represents a very interesting idea that should be tested in the future. The work on plasma dechirping at THU also represents an interesting line of study which ought to be pursued. The committee was also pleased to note the plans for experimentation at SXFEL and the plans that were mentioned for a dedicated facility to study the techniques discussed here. The IARC concludes that the suite of possible techniques presented in this talk promises a PWFA device that might well be able to take beams from an initial linac or photo injector and produce beams with the appropriate characteristics for injection directly into the CEPC without the necessity for the booster ring, with significant savings in cost.

However, while such a possibility exists in principle, in practice the time scales are such as to make it incompatible with the milestones that the IARC is asked to consider for the CEPC project. The imminent completion of the TDR and the timescale forseen for the EDR and start of construction are incompatible with the development of the ideas presented in this talk from the area of pure PWFA research into a working and reliable device suitable for incorporation into a mature accelerator construction programme. As remarked at the previous review, the timescales even for the possibility of positron experimentation in FACET II are incompatible with the current CEPC milestones. Although something can no doubt be learnt from exploring the fields of the positron-acceleration bubbles with electrons, a positron-acceleration scheme suitable for an accelerator construction project would have to be fully explored experimentally with positrons before such a design could be approved. The IARC therefore believes that the current activity on PWFA is interesting and high-quality research that should be continued as a parallel development path. This may become possible for consideration within the mainstream accelerator project as it becomes more mature, if the realities of timescales for approval and construction of the CEPC are such as to allow it.

Recommendations:

1. Continue the excellent work on simulation of the PWFA acceleration process for electrons and the experimental work on plasma dechirping and plasma lenses;

2. Draw up a programme to test the ideas of positron acceleration for submission to FACET II, with milestones;
3. Collaborate with the linac group to understand to what extent the requirements of the PWFA injection can be met by hardware that would be suitable both for PWFA injection or direct injection into the booster ring and discuss the optimum joint design that would allow a PWFA stage to be introduced at some future date with minimum disturbance to the current baseline design, including what the optimum injection energy into a PWFA stage would be;
4. Continue to investigate the possibility of a dedicated experimental facility to test the ideas outlined here.

2.14 CEPC SRF system progress on cavities, modules, etc. (Jiyuan Zhai)

Comments:

At the previous meeting in May 2021, the IARC had a detailed presentation on the progress of the CEPC RF System occurred in the past 18 months from its previous meeting in November 2019. The IARC was very impressed by the quality and quantity of the achievements, concerning both a substantial reviewing of the CEPC layout and parameters for high luminosity, with staging and bypass, and the impressive preliminary test results obtained on prototypes of most of the key SCRF components, including cavities and couplers for feeding power and extracting high-order modes. All the items were produced in China, most by an IHEP start-up recently created. The impressive results on single cells at 650MHz and 9-cell at 1.3 GHz demonstrated that the SCRF team has reached a world-class level on superconducting-cavity fabrication and surface treatments. The ongoing activity on cryostat design and cavity integration was presented in detail and the approaching completion of the construction and commissioning of the new PAPS infrastructure was documented.

The IARC appreciated and congratulated the further achievements on the path anticipated previously. The presentation covered the two CEPC SCRF systems, at 650 MHZ for the collider and at 1.3 GHz for the booster. The status of cavities and cryomodules was described for both systems.

Thanks to the very promising results obtained on single-cell prototypes, the EP-based infrastructure for processing the 2-cell cavities at 650 MHz has been upgraded and the full process optimized through a complete analysis of the parameters involved. The cavities treated with the new infrastructure will soon be ready for cold test at PAPS. The assembly of the 650 MHz short cryomodule prototype, hosting 2 cavities rather than 6, has been completed. Cavities, couplers, and ancillaries were installed at IHEP, and the cryomodule successfully moved to PAPS for installation and test. After the installation was completed with cryogenics, high-power RF and the beam line connected, a cool-down has been performed and all subcomponents successfully tested. A very good vacuum was maintained, while a remnant magnetic field lower then 3 mGauss was measured on the cavity wall. The power test of cavities will follow soon after coupler conditioning at full power.

Concerning the 1.3 GHz SCRF system, the optimisation of the cavity fabrication and processing for high Q is ongoing in close connection with the other Chinese labs engaged in big XFEL projects in Shanghai, Shenzhen and Dalian. The 3 XFEL projects are funded; in the next few years, they need a total of almost one thousand 1.3 GHz 9-cell TESLA-like cavities to be operated in CW with maximum-possible Q. Like CEPC, the three XFEL projects are basing their cryomodules on the one developed for the European XFEL with the modification for CW implemented for LCLS-2. In this national SCRF context, IHEP is playing a leading role and the Research and Development for optimum cavity production and treatment is continuing at IHEP, in connection with industry, now also taking advantage of the new PAPS infrastructure. Because of the funded XFEL projects, the 1.3 GHz system is moving faster and the process for efficient industrial production of cavities and subcomponents is well advanced.

Recommendations:

1. Further improve the collaboration with the SCRF groups in China engaged in the implementation of large scientific infrastructures for FEL and ADS;
2. Maintain and extend collaboration with international laboratories which have a strong expertise in SCRF;
3. Pay due attention to the Niobium material and avoid a single-supplier situation. An internal strong expertise with proper supporting instrumentation is crucial.

2.15 Installation, alignment technologies (Xiaolong Wang)

Comments:

The IARC was pleased to see the progress with technologies for alignment hardware. The talk presented the ongoing work for a vision instrument for photogrammetry that is foreseen to align the machine components during installation. Impressive R&D results were shown for this instrument. However, no overall strategy was presented that would allow the committee to assess the feasibility of using combinations of in-situ measurements and beam-based methods, and other hardware needed to create and maintain an overall reference system and the position of the components wrt to it. Also the requirements, which are quite different for the various parts of the facility, were not presented. The strategy for keeping the machine components aligned over the operational lifetime of the machine was not described. The committee therefore had difficulty in judging the relevance and priority given to development of such an instrument, although it appreciated that the R&D efforts are good and well described.

Recommendations:

1. It will be important to present a plan for all parts of the alignment systems and methods suggested for CEPC alignment, including the specifications for all parts of the facility;
2. Consider the effect of global deformation of the tunnel as well as the inevitable long-range misalignment of the beam lines, after installation, during operation and after maintenance/upgrade periods of the CEPC.

2.16 Start to end simulations for the Linac new baseline and progress on the crucial components (Jingru Zhang)

Comments: The presentation contained the new baseline of the electron and positron injector with increased output energy up to 20 GeV and decreased beam emittance at the Linac output down to 10 nm. The injector consists of the following main elements: electron source and bunching system (ESBS); first accelerating section (FAS); positron source and pre-acceleration section (PSPAS); second acceleration section (SAS); positron dumping ring (DR); third acceleration section (TAS). The electrons are accelerated in the FAS up to an energy of 1.1 GeV, and subsequently transferred via electron bypass transport line (EBTL) to the entrance of the TAS, where the energy is increased to 20 GeV. For the positron-beam generation, the electrons, after acceleration in the FAS up to 4 GeV, are converted in the target into the positrons that are accelerated up to 1.1 GeV in the SAS. Then the positron bunches are injected into the DR and after decrease of the emittance are extracted and transported to the entrance of the TAS. The FAS and SAS are based on S-band structures. The fact that the energy is larger than 1.1 GeV permits C-band structures to be used, which is the basis of the TAS. Before injection into the C-band structure, the bunch length is reduced by a factor of two using a chicane-type compressor. In the presented design, the total length of the injector is about 1215 m from the electron gun to the Linac exit. The length of the tunnel is chosen to be about 1400 m to reserve a certain margin to cope with future changes. The presented parameters are a good basis for the TDR preparation. The committee appreciates the excellent progress in design and R&D works for all elements of the injector.

The linacs layouts are given but without phase shifters. It is unclear how to adjust the phase in different acceleration structures powered by a single klystron.

The 100 Hz operating frequency produces a large average power but no thermostabilization system is presented. It is unclear whether the water cooling tubes are sufficient to cope with the high power dissipation.

Recommendations:

1. The reason of the beam-emittance growth after about 800m is not clear. The growth takes place even without taking into account errors. Indeed, it is unclear if the emittance growth is still acceptable. This study should be clarified and further optimisation carried out if necessary;

2. All the parameters are related to t-tbar, W and Higgs modes of the CEPC operation. The high luminosity Z mode requires modification of the operation scenario and upgrade of the equipment. At this stage, it would be fruitful to specify all the required modifications in the equipment parameters and ensure that such modifications can be accommodated within the current design.

2.17 Timing, strategies and philosophy of the injection and extraction (Xiaohao Cui)

Comments:

The talk presented gave a general overview of the process of CEPC injection. The collider filling with the beams is realized by the following steps: 1. Inject 240 small bunches into the booster; 2. Ramp the booster to high energy and inject several bunches from the collider into the booster; 3. Booster remains at 120 GeV for 4 damping times (200ms), so that the injected large bunches merge with small bunches; 4. Inject the merged large bunches back to the same empty buckets left by the last step; 5. Repeat from the last step. The high luminosity Z mode of the collider operation is the most challenging for the injection and extraction.

Recommendations:

1. For the high-luminosity Z mode of the CEPC operation, an optimum scenario for the beam formation in the linac must be chosen and the required upgrade of the Linac and Damping ring systems specified.

2.18 Hardware preparation and requirement for the CEPC injection and extraction (Jinhui Chen)

Comments:

The CEPC accelerator complex contains 9 injection and extraction systems, which are critical for the collider performance. The IARC compliments the CEPC team on the design and development progress of these injection and extraction systems.

The hardware development for both the High Energy Photon Source (HEPS) and CEPC achieved encouraging progress; one team works to develop all the injection/extraction system of these two facilities, greatly benefiting the CEPC project. This is a very effective work arrangement that can completely share the R&D know-how. Prototypes for HEPS are extremely helpful, laying the technical foundation for the CEPC injection/extraction systems.

The physics design of the Lambertson magnets for DR, Booster and CR were completed with detailed specifications, which are being verified by a Lambertson-magnet prototype under fabrication for the HEPS Booster.

Based on the experience from BEPCII, the physics design and engineering design of the slotted-pipe kicker were completed for the DR, together with a 250ns fast-kicker pulser that was designed at the same time. A kicker prototype for HEPS Booster was manufactured and integrated; its test results will be very useful to check the field quality, impedance and associated technical issues, like water cooling, insulation support and HV feedthroughs.

The physics design of ferrite-core kicker magnets for the CEPC Booster extraction system was initiated and carried out with the required performance, including the designs for a lumped parameter dipole system with novel half-sine-wave pulser and a dual C-type delay-line dipole kicker system with trapezoidal wave pulser. These designs need further detailed work.

For the ceramic vacuum-chamber coating, in addition to the analysis and evaluation of magnetic-field deformation and delay, the beam-coupling impedance needs to be further analyzed and calculated, especially the impedance at the end transition parts of the ceramic vacuum chamber. A prototype would also be useful.

Recommendations:

1. Check the field quality, impedance and associated technical issues, like water cooling, insulation support and HV feedthroughs of the kicker prototype;
2. The designs of the dipole and kicker systems need further detailed work;
3. Investigate further the beam-coupling impedance for the ceramic vacuum-chamber coating.

2.19 Prototype properties of the electromagnet separators and power source (Bin Chen)

Comments:

The electromagnetic separator, a combined device of electrostatic separator and dipole magnet, is employed to deflect electrons or positrons from the outer to the inner ring of the collider, while keeping positrons and electrons circulating undisturbed in the opposite direction. The engineering design of the electrostatic separator with detailed consideration of the UHV tank, electrode, ground electrode, high-voltage metal-ceramic support and high-voltage feedthrough was completed. An electrostatic-separator prototype was manufactured, assembled and tested at a factory, but it did not reach the high-voltage design value and needs to be improved. The physics design and mechanical design of the matched dipole magnet for the electromagnetic separator were completed; its prototype is being manufactured and assembled. Tests of this electromagnetic separator system need to be carried out. In addition, the prototypes of magnet power supplies are being developed and tested.

Recommendations:

1. Carry out tests of the dipole-magnet prototype to achieve the required performance.

2.20 Challenges to the CEPC control system and possible international collaborations (Gang Li)

Comments:

The general scope of the control system, structure of the system and subsystems were shown. EPICS will be used for the software platform. The challenge and characteristic of the CEPC control system on the possible potential bottlenecks such as the data rate/ traffic in the network, travel time / response of the command, high availability of the system, and database and management of the system were discussed. On the potential international collaboration, deep collaboration with the EPICS council, general timing system, database for user and redundant IOC were shown. On the general timing system, some anxiety on the distance between the local control rooms was also discussed. The coverage range of the control system, such as whether the control group will take care of the RF, fiducial, injection and extraction timing signals is still unclear. The abort-timing transportation, including the requirement from the detector is also unclear. Documents in English will be provided for important manuals for international collaborators and detector users.

Recommendations:

1. The IARC strongly encourages international collaboration and continuous contributions to the EPICS system;

2. Evaluate the amount of the broadcast messages from EPICS IOCs on the network and possible trouble with the devices on the network. Even on the SuperKEKB accelerator, whose size is only 1/33 of the CEPC rings, communication on many devices fails due to huge broadcasts on the network. Consider dividing the network into several groups and the use of the gateways, nameserver or related techniques to reduce the amount of signals broadcast;

3. Examine the possible limitation of the general timing system based on the signal distance between realistic points on the rings and linac;

4. Determine the responsibility, including development and support, of the timing system where this currently unclear, such as RF (650 MHz, and 1.3 GHz), fiducial (3 kHz), injection and extraction timing, etc.;

5. Design the signal and timing distribution for the beam-abort request and the abort fire, including slow MPI signals from many devices. A fine timestamp system will be required to check the abort timing;

6. First thoughts should be given to the interface between the machine and detector control systems. In particular, essential data and information that will need to be exchanged between both systems should be identified, together with how fast they should be made available (depending on the kind of information).

2.21 Progress of the High-Field Magnet R&D for CEPC/SPPC (Qingjin Xu)

Comments:

Since the last CEPC IARC in May, 2021, the HFM team achieved two important milestones in the high-field magnet development for SPPC. One is the increment of the current density of Iron-Based-Superconducting (IBS) tape, 500 A/mm^2 at 4.2 K and 10 T. The other is that the 10+ dual-aperture model dipoles reached 12.47 T at 4.2 K. With these remarkable achievements, the team has shipped the 1st series CCT magnet to CERN. The following text expands on these advances.

1. **IBS cable development**. The history of the cable development in the fourth page of the report presented shows the critical current density at 10 T was 100 A/mm^2 in 2016 and 300 A/mm^2 in 2018, and the collaborator, Prof. Y. Ma, increased the current density to 1100 A/mm^2 at 10 T and 4.2 K in the paper (ref Doi:10.1007/s40843-020-1643-1). This result shows that the target current density of 2000 A/mm^2 in 2025 is still reachable in the cable-development schedule. The IBS cable development is in progress for manufacturing the 100-m-long tape cable. The critical current density of the cable reached 500 A/mm^2 at 10 T and 4.2 K and the cable transported a current of 67 A at 30 T. These achievements represent excellent progress. However, the superconducting performance of the cable was not uniform along its length, resulting from the Jc variation in the longitudinal direction and the resistive voltage differences of the test solenoids in the background field at 20 T. While increasing Jc to 2000 A/mm^2 is the most important target at present, production of cable with uniform performance along its length will become the next important subject for magnet construction. The quality control of the IBS cable production should be included within the scope of the HFM R&D.

   The cracks in the bent IBS cable under tensile stress is a problematic matter in the HFM, and it leads to Ic degradation. The HFM team measured the Ic degradation of the bent cable as a function of the bending diameter. The bent cable Ic of the bending diameter at 30 mm is 80% of the straight tape Ic. The HFM team has constructed two IBS racetrack coils; the second coil reached 86.7% of short sample Ic at 10 T and 4.2 K, in good agreement with the bent-cable test. This experimental result is an important step to realise the IBS dual-aperture high-field dipole magnet.

2. **R&D for high-field accelerator magnets.** The NbTi + Nb3Sn mag-

net, LPF1-U, reached 12.47 T at 4.2 K after the 2nd thermal cycle. This is a remarkable result, resulting from the hard efforts of the team. The experience of the magnet production and the analysis of the performance tests are quite important. Especially, identifying the source of the long quench training is important to feed back to the 16T magnet design.

In the development of the 16 T hybrid dipole magnet, the combination of the Nb3Sn magnet of 12 13 T and the HTS magnet of 3 4 T is now planned. The novel HTS cable of REBCO is being developed, and the cable production and performance test are going on. Progress of the HTS magnet design for the 16 T magnet with the mechanical analysis is expected.

The highest risk in the R&D roadmap of this Nb3Sn + HTS aperture magnet was considered to be that the present Jc of IBS was still lower than REBCO, and the highest risk in the road map was the performance improvement of IBS in the R&D schedule.

Recommendations:

1. The development items for increasing the Jc of the IBS cable higher than the BEBCO cable should be clarified. This is required for evaluating the risk of IBS cable for the 16 T magnet R&D;

2. The study for the process control of the uniform cable performance along the length needs to be involved in the IBS cable development;

3. Sources of the long quench training in LPF1-U should be studied. The analysis result should be reflected in the 16 T magnet design.

2.22 Electron dump system and safety issues (Zhongjian Ma)

Comments:

An initial investigation of beam dumps and related safety issues was presented, including the scheme envisaged for the main-ring dump, with a set of kickers to dilute the beam in 2 dimensions on the dump, calculations of maximum temperature rises, identification of other hot spots expected in the linac and the shielding that will be required and shielding and dose calculations associated with synchrotron radiation losses in magnets.

Recommendations:

1. The concept for the main-dump design, and its basic specifications must be clarified;

2. A general specification for all the different beam-dumping scenarios would be important to formulate, for the main dump, for tune-up dumps at different locations, and for emergency beam-abort dumps;

3. One question is whether or not there should be emergency beam-abort dumps immediately upstream of each detector, for fast-enough beam dumping following an abort signal. In that respect, and more generally, specifications for dumps should also be evaluated in the context of the MPS;

4. Concerning hot spots, relatively large losses can be expected on the beam pipe just after each IP from the radiative Bhabha scattering process. Such losses need to be evaluated from the point of view of the accumulated dose and associated safety considerations for worker interventions during access time when beams are stopped;

5. The main beam dump uses kickers to extract and dilute the beam on a dump located in a separate 100-meter-long beam line. Since kickers are active devices, the safety implications must be evaluated, e.g. in case of misfiring of one of the dilution kickers. The question of whether sufficient dilution could also be achieved by designing appropriate optics in the extraction beam line (linear or even non-linear optics) to defocus the beam should be considered;

6. The consequences from adding lead shielding inside the magnets, from the point of view of the magnetic-field distribution and mechanical support and stability should be evaluated.

3 Program and IARC members

Oct 11th 2021	EU time	Beijing time	Talk time	Speaker	Title
	09:00	15:00	15'	IARC members	Closed session
	09:15	15:15	25'+5'	Jie Gao	CEPC accelerator TDR status overview
	09:45	15:45	25'+5'	Yiwei Wang	CEPC collider ring lattice & error study for the high luminosity
	10:15	16:15	25'+5'	Dou Wang	CEPC booster and damping ring update
	10:45	16:45	25'+5'	Chuntao Lin	Analysis of coherent beam-beam instability with longitudinal impedance
	11:15	17:15	25'+5'	Yanfeng Sui	CEPC instrumentation update, BPM etc.
	11:45	17:45	25'+5'	Mei Yang	Progress on the normal conducting magnets for CEPC
	12:15	18:15	30'	IARC members	Closed session
	12:45	18:45			IARC Adjourn
Oct 12th 2021	09:00	15:00	25'+5'	Zhe Duan	Investigation on the CEPC polarization
	09:30	15:30	25'+5'	Na Wang	Collective instabilities in collider, booster and damping rings with the high luminosity parameters
	10:00	16:00	25'+5'	Sha Bai	MDI Studies for CEPC
	10:30	16:30	25'+5'	Haijing Wang	CEPC mechanical systems and MDI pipes and supporting structure
	11:00	17:00	25'+5'	Rui Ge	Design consideration and optimization for the CEPC cryogenic system
	11:30	17:30	25'+5'	Zusheng Zhou	Progress on the 650MHz high efficiency klystron
	12:00	18:00	30'	IARC members	Closed session
	12:30	18:30			IARC Adjourn
Oct 13th 2021	09:00	15:00	25'+5'	Dazhang Li	CEPC plasma injection update
	09:30	15:30	25'+5'	Jiyuan Zhai	CEPC SRF system progress on cavities, modules, etc.
	10:00	16:00	25'+5'	Jinshu Huang	CEPC civil engineering and auxiliary facility
	10:30	16:30	25'+5'	Xiaolong Wang	Installation, alignment technologies
	11:00	17:00	25'+5'	Jingru Zhang	Start to end simulations for the Linac new baseline and progress on the crucial cc
	11:30	17:30		Xiaohao Cui	Timing, strategies/philosophy of the injection/extraction
	12:00	18:00	30'	IARC members	Closed session
	12:30	18:30			IARC Adjourn
Oct 14th 2021	09:00	15:00	25'+5'	Jinhui Chen	Hardware preparation/requirement for the CEPC injection/extraction
	09:30	15:30	25'+5'	Bin Chen	Prototype properties of the electromagnet separators and power source
	10:00	16:00	25'+5'	Gang Li	Challenges to the CEPC control system and possible international collaborations
	10:30	16:30	25'+5'	Qingjin Xu	Progress of the High Field Magnet R&D for CEPC-SPPC
	11:00	17:00	25'+5'	Zhongjian Ma	Electron dump system and safety issues
	11:30	17:30	30'	IARC members	Closed session
	12:00	18:00			IARC Adjourn

Presentations are available at:
`https://indico.ihep.ac.cn/event/15177/`

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- Brian Foster (John Adams Institute, Oxford)
- Eugene Levichev (BINP)
- Katsunobu Oide (CERN/KEK)
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- Carlo Pagani (INFN Milan)
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