

# **Report:**

## **The Fourth Meeting of the CEPC-SppC International Advisory Committee**

**November 27, 2018**



The fourth meeting of the CEPC-SppC International Advisory Committee was held at the Institute for High-Energy Physics in Beijing on November 15 and 16, 2018. The appendices to this report contain the charge for the meeting (Appendix A), the members of the IAC (Appendix B), and the agenda of the meeting (Appendix C). The IAC thanks the CEPC-SppC team for their presentations, informative and helpful discussions, and cooperation and support for this meeting.

The IAC congratulates the CEPC team for the successful completion of the Conceptual Design Report (CDR) with 1143 authors from 221 institutions and 24 countries. This is a remarkable achievement. The CDR was publicly released during the 2018 International Workshop on the High Energy Circular Electron Positron Collider which took place between November 12 and 14 with about 350 participants. The CEPC received large media coverage from this public release. A number of IAC members participated in the workshop and the CDR public release event. The coincidence of the workshop and the IAC meeting was beneficial.

The CDR provides a comprehensive description of the conceptual designs of the CEPC  $e^+e^-$  collider and experiments with plausible solutions to address the main challenges. A detailed list of comments and recommendations has been provided by international review committees at the final draft stage of the CDR. The scientific goals presented in the CDR are well motivated and aligned with the priorities of the international particle physics community. The IAC believes that the studies reported in the CDR fully achieved the goals appropriate at this stage of the project and the team is positioned to begin the designs of the technical components and R&D of the critical technologies related to the CEPC.

The IAC is impressed with the activities of the CEPC Industrial Promotion Consortium membership (CIPC) and its engagement at the 2018 November workshop. With 13 companies joining in the past year, the total number of the CIPC members has reached 67.

The IAC acknowledges that much progress has been made with the internationalization of the project. About 30% of the 2018 November workshop participants were from foreign institutions. The international community started playing convenorship-roles for various detector and physics performance groups. The first CEPC international workshop outside of China was held in Rome in May 2018 and there will be another one in Oxford Spring 2019. The IAC commends the CEPC team's efforts in strengthening its cooperation with CERN (e.g., the collaboration agreement with CERN concerning HL LHC orbit corrector magnets), its interactions with SuperKEKB/Belle II to get familiar with the Machine-Detector Interface challenges, and its connection to the international detector community by joining the CALICE, LCTPC and other R&D collaborations.

The most likely path to realize the CEPC is via the Chinese government's initiative on major-international science projects. This initiative focuses on projects with "*frontier science, large fundamental science, global focus, and international collaboration*". By year 2020, 3-5 projects will be chosen to go into the "*preparatory stage*", among which 1-2 projects will be selected for construction. More construction projects are expected to be selected in later years. The selection process is managed by the Ministry of Science and

Technology (MOST). Committees commissioned by the MOST are currently writing the guidelines. The CEPC team has been paying close attention to this process and opportunity.

The European particle physics community is preparing for updating its strategy. The formal opening of the process began with appointments of two groups by the CERN Council in September 2018: the European Strategy Group (ESG) will establish the updated draft of the strategy and the Physics Preparatory Group (PPG) will prepare the scientific input for the work of the ESG via the “Briefing Book”, which is based on the input it gathers from the world-wide community. The CERN Council aims to adopt the updated strategy in May 2020. The IAC is pleased to learn that Xinchou Lou, the Project Director of the CEPC, is a member of the PPG and the participants of the 2018 November workshop are preparing a white paper which will be submitted to the PPG.

Comments and recommendations related to the charges given to the IAC are presented in the following sections.

## **1. Management**

The charge for the IAC meeting states *“The current goals of the CEPC are to complete the necessary R&D work and the Technical Design Report (TDR), and to demonstrate the validity of critical subsystems, as well as to enhance the organization and global collaboration, all in about 3-5 years from now, such that the CEPC project will be in an adequate state to be proposed to the national government for realization.”*

The IAC believes that producing the TDR for accelerator systems on the time scale of 3-5 years is a good and achievable goal, and that it is essential to form an International Accelerator Review Committee which advises the team on all matters related to CEPC accelerators.

The IAC believes that now is too early to start preparing the TDR for the experiments. Rather, collaborative R&D work on each of subdetector systems (e.g., silicon detectors, gas trackers, calorimeters, muon systems, trigger and DAQ, magnets, and detector simulation) should be the immediate focus. The 31 MRMB grant from the MOST will help detector R&D between 2018 and 2023. However, in order for international participants to make meaningful contributions, they would need funds from their funding agencies. One mechanism to help the community in this regard is for the CEPC project team to establish a Detector R&D Committee which reviews detector R&D proposals submitted by the international community. The international community could use the report of this committee to request funds from their agencies.

The TDRs for detectors should be prepared only after the CEPC is chosen to go into the *“preparatory stage”* around 2020 at the earliest. The process should begin with a call for Letters of Intent that will foster international collaborations of potential experiments. An experimental committee (similar to LHCC) which could be evolved from the Detector

R&D Committee could review the submitted LOIs and select the experiments. After this process, TDRs could be produced by international experimental collaborations.

The IAC notes that its recommendations from the November 2017 meeting have been addressed and have partially been implemented. These recommendations remain valid and the IAC looks forward to further responses at the next meeting.

The following recommendations are concentrated on the near-term concerns.

*Recommendations:*

- 1) Establish an Accelerator Review Committee which advises on all matters related to CEPC accelerator design and R&D including the Machine-Detector Interface and compatibility with operation at energies above the tt-bar production threshold and with operation of the SppC, and which reports to the Project Director. The committee should have external members including 3-4 IAC members and meet roughly every 6 months. One meeting should take place just before the IAC meeting, and give a report at the IAC meeting.
- 2) Establish a Detector R&D Committee with external members which reviews detector R&D proposals and reports to the Project Director. Its members should be chosen based on the input from the international community. The IAC looks forward to a report from this committee at the next IAC meeting.
- 3) Produce a near-term organization chart that includes the Accelerator Review Committee and the Detector R&D Committee and reflects the participation of the international community.
- 4) Produce a rough timeline and a process from now to the call for Letters of Intent and the formation of CEPC experimental collaborations, and communicate this to the international community.

## **2. Physics Studies and Detectors**

The CDR on Physics & Detectors is an impressive achievement. The CEPC Study Group deserves our strong congratulations for this comprehensive documentation of a huge amount of work and major progress made over the past few years. A very detailed list of comments and recommendations has been provided by an international review committee chaired by Prof. M. Vos at the final draft stage of the CDR, based on an in-depth scrutiny of the document. Some of their recommendations have already been implemented in the final version. The IAC concurs with the conclusions of this peer-review process.

The IAC notes that its recommendations from the previous meeting in November 2017 have been addressed, even though their implementation remains in several cases only partial. These recommendations remain valid as long-term goals.

The IAC acknowledges several steps taken by the CEPC team towards engaging more strongly with the international community, in particular the official joining of R&D collaborations for some key components of future CEPC detectors.

The main discussion of the IAC with the CEPC team focused on the next steps after the CDR towards future TDRs. The IAC finds that, in the case of the detectors, taking a step from the CDR to TDRs would be premature; full TDRs will be only relevant at the stage of concrete collaborations approved to work out final designs of their specific detector. The IAC considers that the next step should concentrate on peer-reviewed focused and coherent R&D, continuing still in an overall detector community, but also with a view that this environment may well incubate future concrete experimental proposals.

An expert R&D committee, set up with input from the international community, should oversee detector-related R&D activities. Once established, this committee could become recognized by the international authorities (e.g. funding agencies). Such a committee could evolve in due time to become the body reviewing, and recommending for approval, of the CEPC detector collaborations. Such a process would open in a transparent way access for international groups to join officially the CEPC detector group towards future collaborations, and enable them to obtain major resources needed for the forthcoming detector design stage.

The IAC observed that many young scientists in China became energized by the CEPC project. This is a welcome phenomenon enlarging the Chinese particle-physics community. There are identifiable leaders in detector and accelerator developments at Chinese institutions, while the theory effort is largely guided by senior scientists outside China.

*Recommendations:*

- 1) Establish an expert Detector R&D Committee, set up with input from the international community, which should oversee detector-related R&D activities. Once established, this committee could become recognized by the international authorities (e.g. funding agencies). Such a committee could evolve in due time to become the body reviewing, and recommending for approval, of the CEPC detector collaborations. This committee should be established expeditiously.
- 2) Prepare comprehensive progress reports on detector development work (R&D of technologies, engineering and integration studies, software and computing, and physics performance) in due time (2-3 years), preceding Letters of Intent, to be reviewed by the Detector R&D Committee.
- 3) Strengthen the theoretical physics effort from Chinese institutions for the CEPC.
- 4) Incorporate in the physics studies the implications of a run at collision energies at and above the  $t\bar{t}$  threshold. This will have an impact not only on the

determination of the top quark properties (mass, EW couplings, and indirect sensitivity to the ttH vertex), but also on Higgs measurements, via the vector boson fusion process.

### **3. Accelerator**

The IAC congratulates the CEPC team on the successful completion of the CDR.

A set of recommendations has been given for accelerator issues in the previous IAC meeting. The IAC appreciates the preliminary responses by the CEPC team for each item. Although some of these issues, such as the beam pipe material and coating and the mechanical support of QD0, still need further investigation, at least the CEPC team and the IAC now understand each other's position. Some of the issues are highly linked to the upgradability of this machine towards higher energy (tt-bar) and higher luminosity.

The IAC looks forward to seeing the CEPC team's response to the detailed recommendations made by the accelerator CDR review, which the IAC endorses. The IAC believes that its recommendation from the 2017 meeting that an Accelerator Review Committee should be formed should be implemented expeditiously. This is necessary to allow the IAC properly to fulfil its functions of oversight of the accelerator project in the TDR phase. This committee should have around three-four members from the IAC on it, to facilitate communication with the IAC, as specified in the 2017 recommendation. As the project moves into the TDR phase, it is important that management responsibilities are coherent and that the strategic direction of the project is clear.

The IAC would like to congratulate the CEPC team on the success of CEPC Industry Promotion Consortium (CIPC) and encourage its further evolution. The new CIPC has been quickly formed and started the R&D activities for the next phase with remarkable speed and with a large number of participating companies. This is an adequate and necessary action to complement the resources available at IHEP for the R&D necessary for the TDR phase, such as superconducting RF, high-efficiency klystrons, mechanical structure for the Machine-Detector Interface, electronics and instrumentation and civil engineering. However, the IAC notes that there are several issues, such as the design of the Machine-Detector Interface, which must be solved by the collaboration of detector and accelerator physicists as well as industry. Contributions to the project from international partners are likely to be in kind. The project should start devising ways to facilitate this process.

The IAC welcomes the direction of the R&D on superconducting magnets for the SppC. It believes that the approach using iron-based IBS High-Tc material is potentially promising and recommends that the R&D should focus on cost reduction and a cost analysis of the entire magnet, including assembly and testing.

The IAC notes the plasma wakefield acceleration alternative to the conventional scheme for injection. It also recommends that the team examine a C-band solution, as mentioned in the CDR review recommendations.

*Recommendations:*

- 1) Establish an Accelerator Review Committee in line with the IAC recommendation of the 2017 meeting. This committee should meet roughly every 6 months, once just before the IAC meeting, and the IAC looks forward to a report from the committee at the next IAC meeting. This committee should be established expeditiously.
- 2) Design the accelerator which is fully compatible with operation at tt-bar energy and the infrastructure that is fully compatible with operation of the SppC. Additionally, compatibility with running at luminosities significantly higher than the baseline at Z&W, and higher beam currents at all energies, should be ensured.
- 3) Enlarge collaborations with other projects including SuperKEKB and FCC, especially bidirectional transfer of knowledge and experience.
- 4) Produce a plan ready to begin civil engineering work rapidly in case early funding became available.

## Appendix A: Charge

The Circular Electron Positron Collider (CEPC + SppC) Study Group, currently hosted by the Institute of High Energy Physics of the Chinese Academy of Sciences, has completed the conceptual designs of the CEPC  $e^+e^-$  collider and the detector-physics program. The Conceptual Design Reports will be available during the 2018 IAC meeting. The Study Group is positioned to begin the designs of the technical systems and of the R&D of the critical accelerator and detector technologies related to the CEPC.

In the past year the Study Group has also made progress with the internationalization of the project, and as a result the first CEPC workshop outside China has taken place in Rome, the international participation in the CEPC workshop 2018 has increased over the past year.

The current goals of the Study Group are to complete the necessary R&D work and the technical design report, and to demonstrate the validity of critical subsystems, as well as to enhance the organization and global collaboration, all in about 3-5 years from now, such that the CEPC project will be in an adequate state to be proposed to the national government for realization.

The CEPC International Advisory Committee shall advise on all related matters for the CEPC project, specifically on the following aspects related to the **TDR, R&D** and the **international collaboration**:

1. Given the time scale of 3-5 years, how can we best complete the TDR and the R&D projects?
2. How can we improve the organization and enhance the international participation in the TDR and R&D projects, and proceed with the formation of the international detector collaborations?

We will report on the progress, and present the challenges and difficulties encountered. We would very much appreciate additional guidance on global TDR and R&D and international collaborations.

The committee is invited to give suggestions or advice on any aspect of CEPC beyond those specifically included in this charge.



## **Appendix B: Members of the International Advisory Committee**

- \* Young-Kee Kim (Chair), University of Chicago (USA)  
Barry Barish, Caltech (USA)  
Hesheng Chen, IHEP (China)
- \* Michel Davier, LAL (France)  
Marcel Demarteau, ANL (USA)
- \* Brian Foster, DESY/U. Hamburg (Germany) & Oxford (UK)  
Rohini Godbole, CHEP, Bangalore (India) via Video  
David Gross, UC Santa Barbara (USA)
- \* George Hou, Taiwan U. (Taiwan)
- \* Peter Jenni, CERN & Albert-Ludwigs-University Freiburg (Germany)  
Eugene Levichev, BINP (Russia)  
Lucie Linssen, CERN  
Joe Lykken, Fermilab (USA)
- \* Luciano Maiani, U. Rome (Italy)
- \* Michelangelo Mangano, CERN
- \* Hitoshi Murayama, IPMU/UC Berkeley (Japan/USA)
- \* Tatsuya Nakada
- \* Katsunobu Oide, KEK (Japan)  
Robert Palmer, BNL (USA)  
John Seeman, SLAC (USA)
- \* Ian Shipsey, Oxford (UK)
- \* Steinar Stapnes, CERN
- \* Geoffrey Tayler, U. Melbourne (Australia)
- \* Henry Tye, IAS, HKUST (Hong Kong)

\* indicates IAC members who attended the meeting.

## Appendix C: Agenda of the meeting

November 14, 2018

November 14, Location: Holiday Inn				
Time	Topic	Chair	Speaker	Participants
19:00 – 20:30	Overview of CEPC	Y.-K. Kim	Yifang Wang	IAC
20:30 – 20:40	Charge	Y.-K. Kim	XinChou Lou	IAC
20:40 – 21:00	Meeting Organization	Y.-K. Kim	Y.-K. Kim	IAC

November 15, 2018

November 15, Location: Room A415, IHEP Main Building				
Time	Topics	Chair	Speaker	Participants
8:30 - 8:45	Welcome and Information	Prof. Gang CHEN	Yifang WANG	OPEN
8:45 - 9:15	Overview of the CEPC Project Report on the IAC Recommendation Implementation	Professor Y.-K. Kim	XinChou LOU	IAC+PM+SP
9:15-10:00	CEPC Accelerator : CDR and Future	Professor Y.-K. Kim	Jie GAO	IAC+PM+SP
10:00-10:30	Photo session and Coffee Break			
10:30-11:00	SppC Accelerator: CDR and Future	Professor Y.-K. Kim	Qingjin XU	IAC+PM+SP
11:00-12:00	IAC Executive Session	Professor Y.-K. Kim		IAC
12:00-13:15	Lunch at IHEP Guest House (IAC Committee)			
13:30-14:00	Sites and Civil Engineering		TBD	
14:00-14:30	CEPC Detector: CDR and Future		Joao Guimaraes da Costa	
14:30-14:50	CEPC Physics Performance : CDR and Future		Manqi RUAN	
14:50-15:30	IAC Executive Session	Professor Y.-K. Kim		IAC
15:30-16:00	Coffee break			
	Breakout Session I (Room) Meeting with Management	Professor Y.-K. Kim	YFW XCL YNG QQ,...	IAC+PM
16:00-17:30	Breakout Session II (Room) Meeting with accelerator group		JG YLC WRC FYT,QJX,...	IAC+SP
	Breakout Session III (Room) Meeting with detector group		JMQ JGC MQR ...	IAC+SP
17:30-18:30	IAC Executive Session	Professor Y.-K. Kim		IAC
18:30	Board Shuttle Bus to Restaurant			

November 16, 2018

November 16: Location: A415, IHEP Main Building				
Time	Topics	Chair	Speaker	Participants
8:30-11:00	IAC Executive Session	Professor Y.-K. Kim		IAC
11:00-11:30	IAC presents preliminary recommendations			Open
11:30	Return to hotel or railway station or airport			

**IAC:** International Advisory Committee

**PM:** CEPC Project Management

**SP:** Speakers

**ALL:** Open to public