

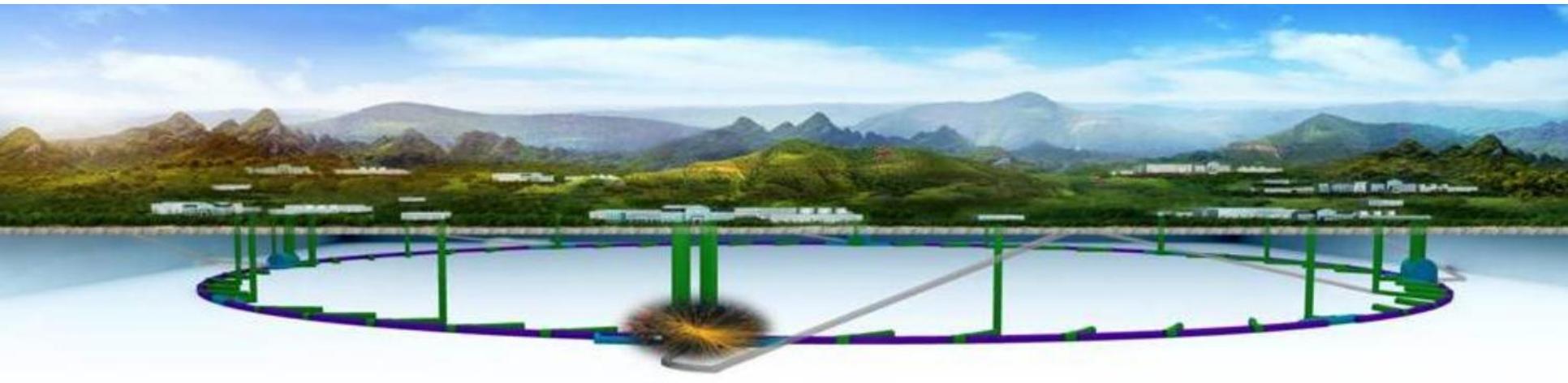


# CEPC Overview

XinChou Lou

Institute of High Energy Physics, Beijing

International Workshop on the Circular Electron-Positron Collider



# Outline

## Overview

- Introduction & reminders
- Progress and updates
- Goals and plan

## CEPC project development

- At this workshop & future

## Summary

# **Introduction & Reminders**

# Reminder about the CEPC-SppC

## $e^+e^-$ Higgs (Z) factory

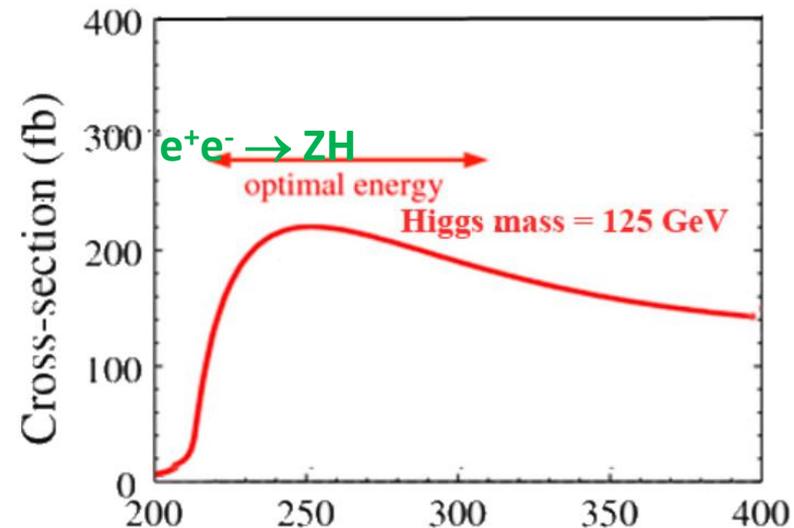
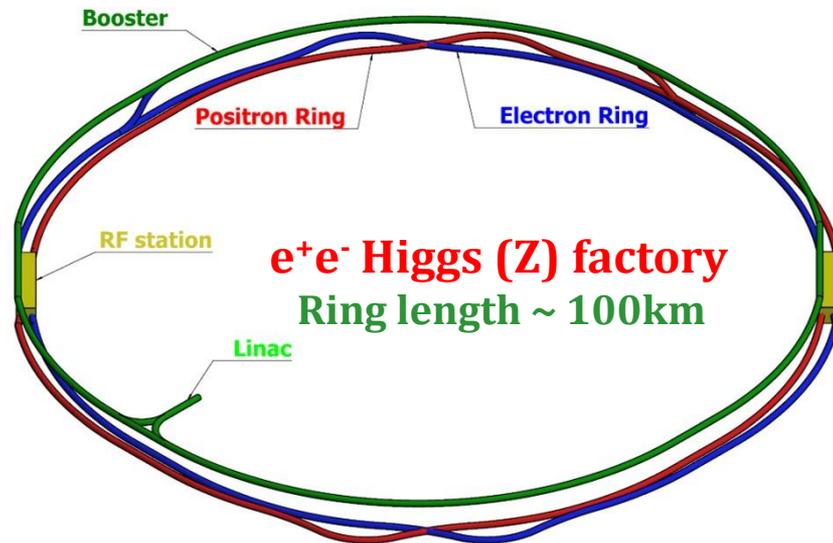
$E_{\text{cm}} \approx 240 \text{ GeV}$ , luminosity  $\sim 2 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$ , 2IP, 1M H in 10 years  
at the Z-pole  $10^{10}$  Z bosons/yr

Higgs precision  
1% or better

Precision measurement of the Higgs boson (and the Z boson)

Upgradable to pp collision with  $E_{\text{cm}} \approx 50\text{-}100 \text{ TeV}$  (with ep, HI options)

A discovery machine for BSM new physics



**BEPCII** will likely complete its mission  $\sim 2020$ s;

**CEPC** – possible accelerator based particle physics program in China after BII

# Reminder about the CEPC-SppC

**Kick-off on Sept. 13, 2013** - inspired by the discovery of the Higgs boson at the LHC



CEPC study group  
formed in Beijing

**PreCDR, March 2015** – initial investigations; no-show stoppers, identified issues & R&D

**Funding, R&D, international collaboration, ...** – continued effort since 2013

**CDR, August-October 2018** – scientific goals well justified & aligned with intl priorities; endorsement for moving towards TDR, and ...

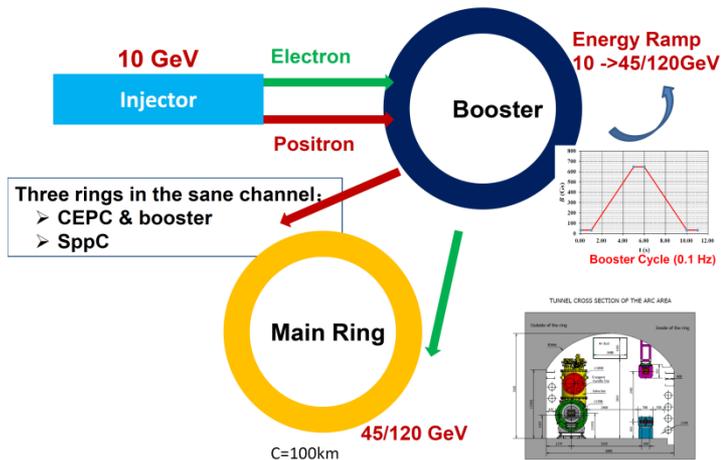
# CEPC Schedule (ideal)



- CEPC data-taking starts before the LHC program ends around 2035
- possibly con-current, and complimentary to the ILC

# **Progress and Updates**

# Progress and updates - CEPC CDR



Monday, November 12, 2018

08:30 - 10:10

Plenary: Plenary I

Convener: Prof. Guangda Zhao (Peking University)

Location: A214, Main building

08:30 **Welcome 10'**

Speaker: Prof. Yifang Wang (IHEP)

08:40 **Project Overview 30'**

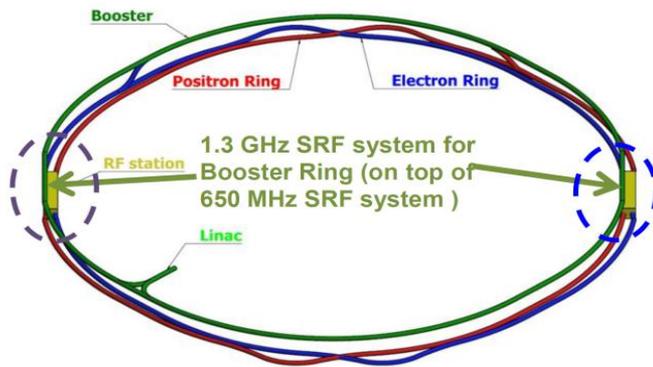
Speaker: Prof. Xinchou Lou (IHEP)

09:10 **Physics motivation 30'**

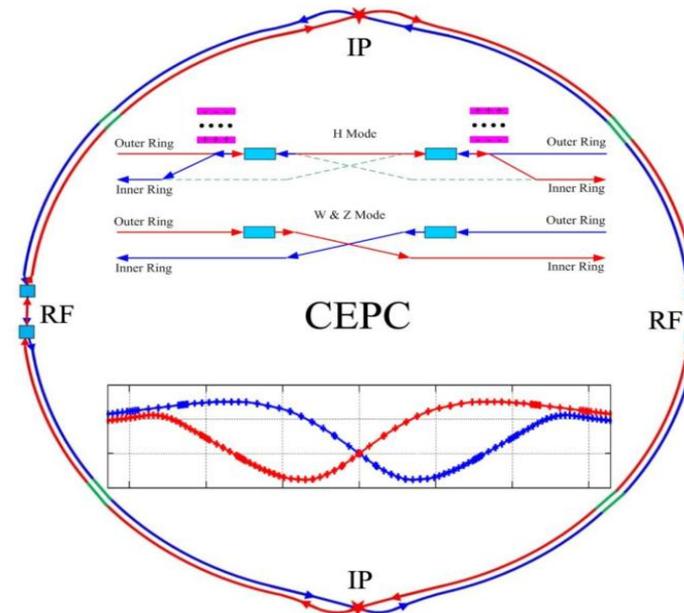
Speaker: Prof. Nathaniel Craig (UC Santa Barbara)

09:40 **CEPC Accelerator CDR and R&D towards TDR 30'**

Speaker: Prof. Jie Gao (IHEP)



SRF system location of CEPC (two RF stations)



Layout of 650 MHz SRF system for Collider Ring

details will be  
presented at  
parallel sessions  
at this workshop

# Progress and updates - CEPC CDR

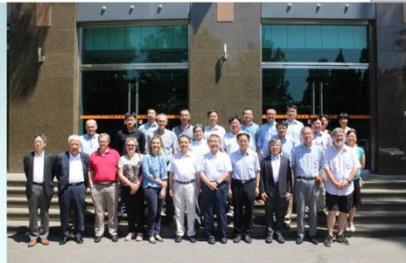
Lumi.	Higgs	W	Z	Z(2T)
$\times 10^{34}$	2.93	11.5	16.6	32.1

Luminosities exceeded those in the preCDR

- double ring baseline design (30MW/beam)
- switchable between H and Z/W w/o hardware change (magnet switch)
- use half SRF for Z and W
- can be optimized for Z with 2T detector

## International Review of CEPC CDR (June 28-30, 2018, IHEP)

International Review of CEPC CDR June 28 - 30, 2018, IHEP, Main Building, Room A415		Saturday, June 30	
<b>Thursday, June 28</b> 8:30-9:00 Chair: K. Oide Committee Executive Session Chair: Qing Qin Welcome Overview of CEPC Overview of beam dynamics CEPC collider lattice design CEPC beam lines and DA Coffee break(30') Chair: K. Oide Installation Machine-detector interface Lunch break Chair: K. Oide Booster Injection and extraction Linac injector Coffee break(30') Committee Executive Session Director of Commission		8:30-9:00 SRF system RF power source Cryogenic system CEPC collider ring Magnet CEPC booster ring magnet Coffee break(30') SC magnet for CEPC-IR Power supplies Vacuum 12:00-14:00 Chair: K. Oide Instrumentation Control Synchrotron radiation Radiation shielding Coffee break(30') Committee Executive Session Director	
9:00-9:05 Yifang Wang 9:05-9:30 Jie Guo 9:30-9:35 Chenghai Yu 9:35-10:00 Yuan Wang 10:00-10:30 Yuan Zhong 11:05-11:35 Chair: K. Oide 11:35-12:05 No Wang 12:05-14:00 Lunch break 14:00-14:30 Chair: K. Oide 14:30-15:00 Doo Wang 15:30-16:00 Xiaohua Cai 16:30-18:30 Committee Executive Session 19:00 Director of Commission		8:30-9:00 Chair: K. Oide Survey and alignment Mechanics Conventional facilities Site investigation Coffee break(30') 11:00-12:00 Discussion with CEPC team Lunch break 14:00-16:00 Committee Executive Session Coffee break(30') 16:30-17:30 Close out Banquet	



- Review Committee Members:**
- Brian Foster Oxford U./DESY
  - Eugene Levichev BINP
  - Katsunobu Oide (chair) CERN/KEK
  - Kazuro Furukawa KEK
  - Manuela Boscolo INFN
  - Marica Biagini INFN
  - Masakazu Yoshioka KEK/Tohoku University
  - Norihito Ohuchi KEK
  - Paolo Pierini ESS
  - Steinar Stappes CERN
  - Yoshihiro Funakoshi KEK
  - Zhengtang Zhao (absent) SINAP

J Gao

## International Review Report (draft) of CEPC CDR (June 28-30, 2018, IHEP)

International Review of the CEPC Conceptual Design Report  
-Accelerator Design-  
June 28 - 30, 2018  
IHEP, Beijing

This is the review report of the accelerator part of the CEPC CDR. The review is done for the presentations based on the draft version of the CDR. Extensive discussions have been held between the review committee members and the CEPC team during the review meeting.

**General remarks**

The Circular Electron-Positron Collider (CEPC) is a very ambitious and important project aimed at various physics at 24 (E<sub>beam</sub> = 120 GeV), 80 (80 GeV), and 240 (120 GeV) production which would produce the highest luminosity ever achieved by a collider in the world. The Superconducting Proton-Proton Collider (SppC) is planned as the second stage of the project using the same collider tunnel to explore the energy frontier of elementary particle physics.

The Review Committee unanimously congratulates the CEPC team on the completion of the CDR, with remarkable successes in various aspects of the design. The progress since the pre-CDR has been a major step in the project, especially the full double-ring scheme, lattice design, and various beam dynamics with beam-beam effects and collective phenomena. The design work on each system has verified the basic feasibility of the project, including the superconducting RF, normal and superconducting magnets, cryogenic system, vacuum system, injectors with a booster synchrotron and a linac, instrumentation, control, safety, civil engineering, etc.

The Committee believes that the CDR has already reached a sufficient level of maturity to allow approval to proceed to a Technical Design Report. On the other hand, we think that this machine has more potential for further extensions, including:

- (1) Experiments for ttbar production (E<sub>beam</sub> = 180 GeV);
- (2) Even higher luminosity (~x10) at Z and W;
- (3) Higher beam current, up to 50 MW/beam synchrotron radiation loss;
- (4) More interaction points;
- (5) Polarized beams.

These extensions will be achievable if the machine preserves the possibility to implement these possibilities by relatively small investments, such as longer quadrupole magnets, a less compressed layout around the interaction point (IP) with shallower bends, and sufficient length for the RF section. Actually, such improvements may even reduce the operation costs. The committee encourages the CEPC team to explore and preserve these possibilities, since once CEPC is built, no second machine with the same scale is likely to be built in the world.

The Review Committee unanimously congratulates the CEPC team on the completion of the CDR, with remarkable successes in various aspects of the design. The progress since the pre-CDR has been a major step in the project, especially the full double-ring scheme, lattice design, and various beam dynamics with beam-beam effects and collective phenomena. The design work on each system has verified the basic feasibility of the project, including the superconducting RF, normal and superconducting magnets, cryogenic system, vacuum system, injectors with a booster synchrotron and a linac, instrumentation, control, safety, civil engineering, etc.

The Committee believes that the CDR has already reached a sufficient level of maturity to allow approval to proceed to a Technical Design Report.

J Gao

# Progress and updates - CEPC CDR

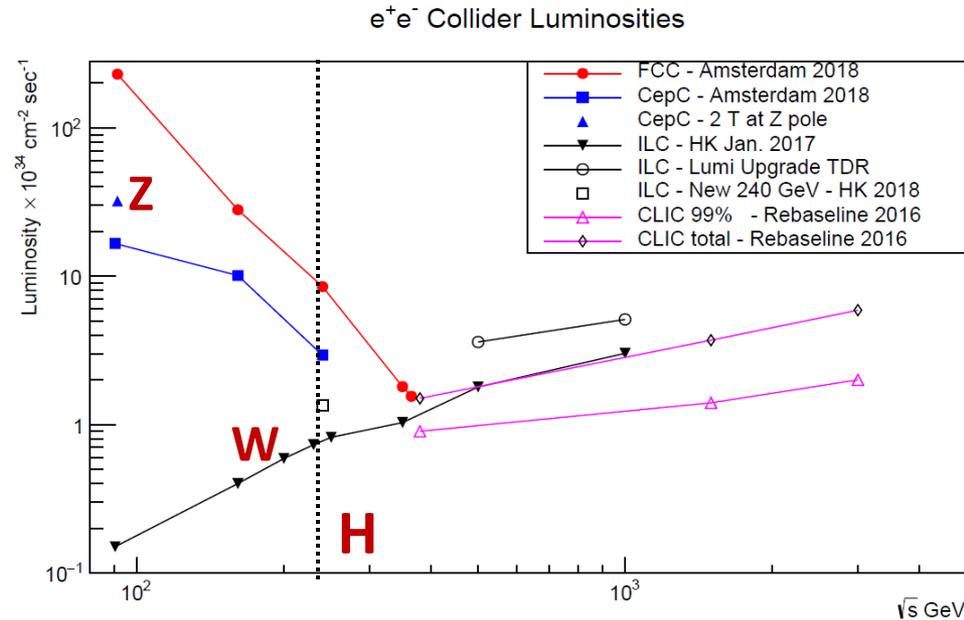
## Luminosity vs. CM energy

### Circular:

offers higher lumi. @ LE  
⇒unprecedented Z,W,+H program  
mature technology  
HE synchrotron light source (?)  
very long term: pp upgrade path

### Linear:

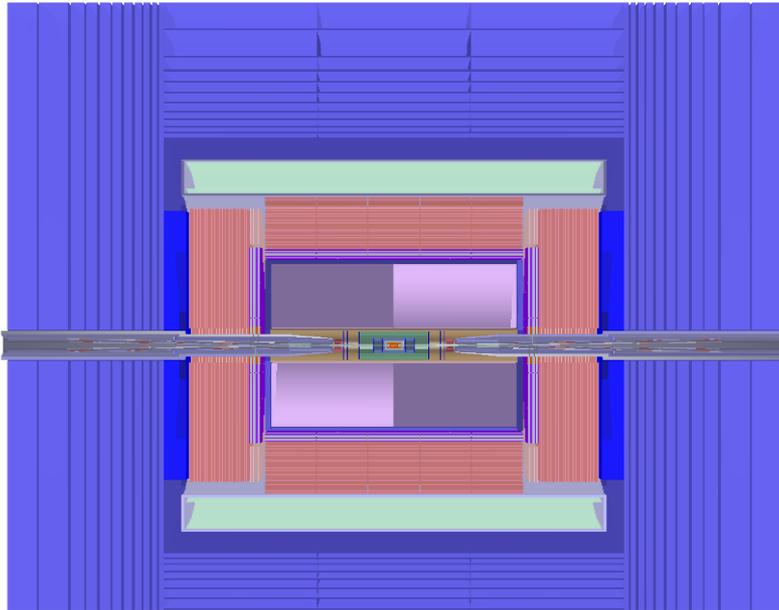
very impressive Higgs precision  
best Lumi. at higher energies, or only option for VHE



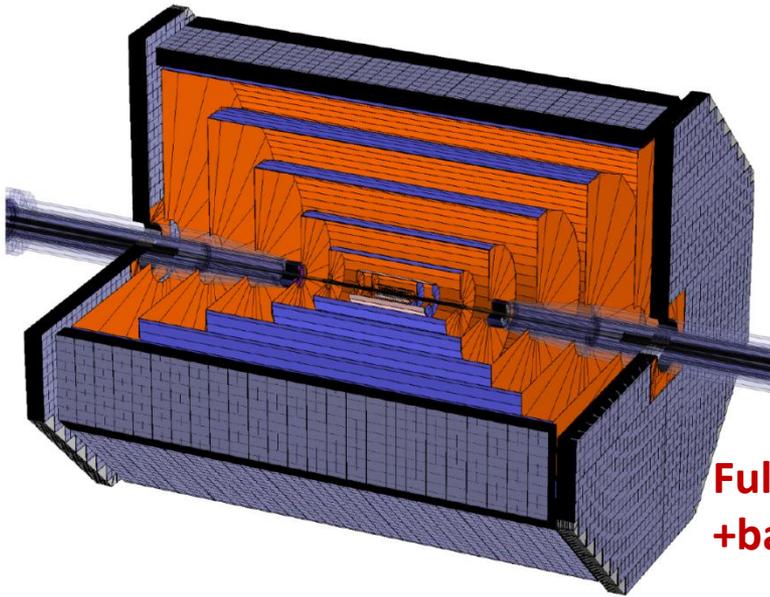
F. Bedeschi, INFN-Pisa

**circular & linear colliders are ideally complementary to each other**

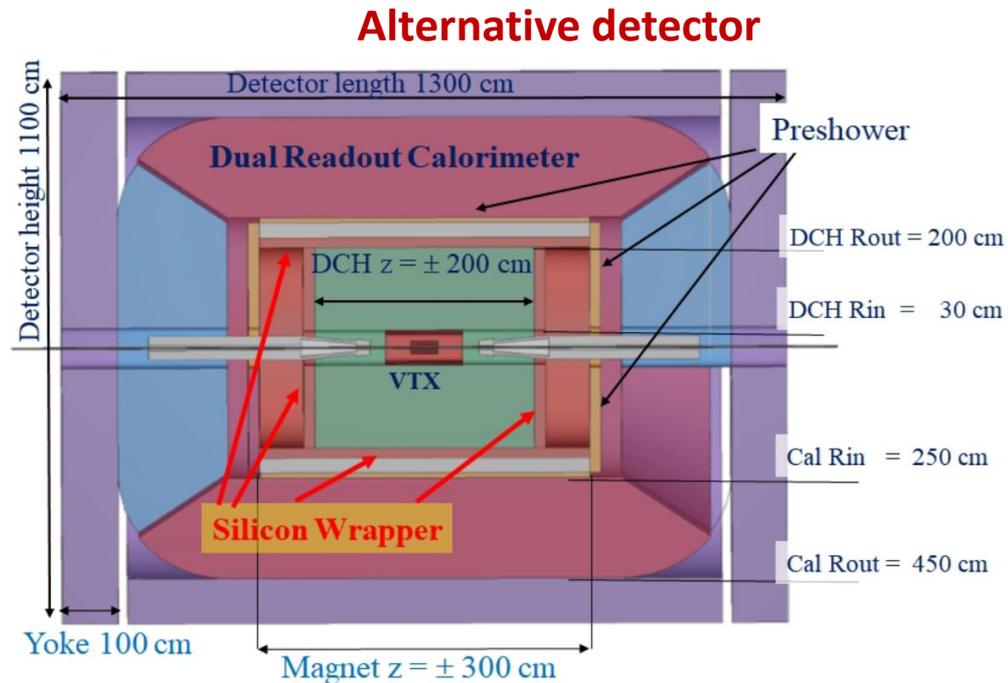
# Progress and updates - Detector-Physics



**Baseline detector:** pixel vertex detector, silicon inner tracker, a TPC, Si external tracker, ECAL, HCAL, 3 T B-field, embedded muondetector

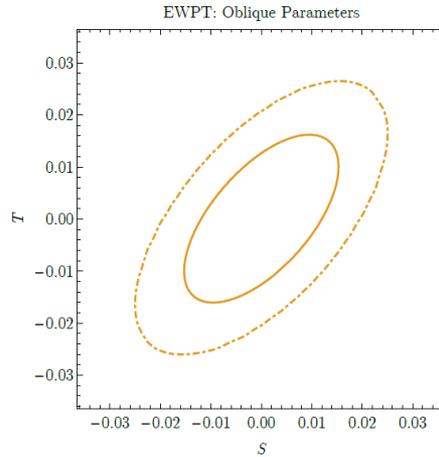
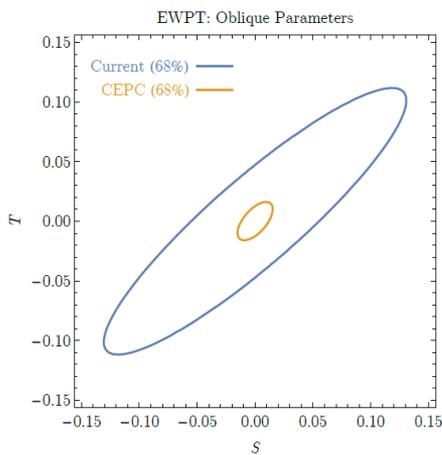
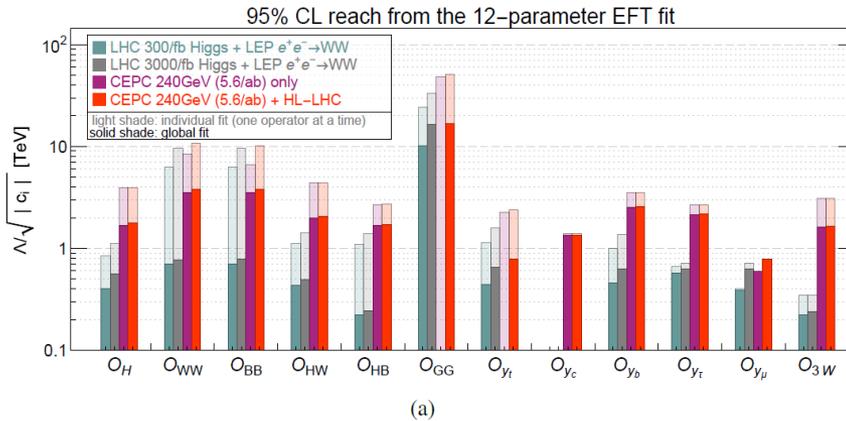


**Full silicon tracker  
+baseline detector**



# Progress and updates – Detector-Physics

## Physics Performance



10:40 - 12:30

Plenary: Plenary II

Convener: Prof. Suyong Choi (Korea University)

Location: A214, Main building

10:40 **CEPC detector and physics CDR 30'**

Speaker: Prof. Joao Guimaraes Costa (IHEP)

11:10 **CEPC detector performance and software 20'**

Speaker: Prof. Manqi Ruan (IHEP)

14:00 - 15:30

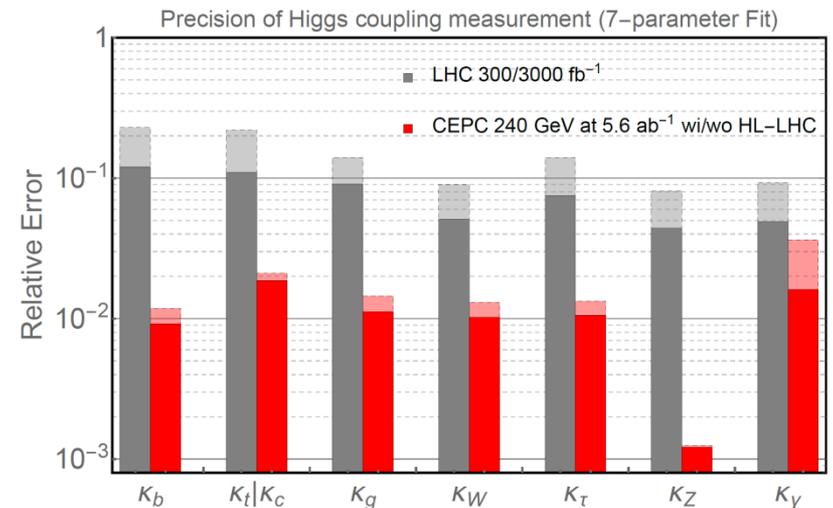
Plenary: Session III

Location: A214, Main building

4:00 **Physics studies and detector R&D towards the TDR 30'**

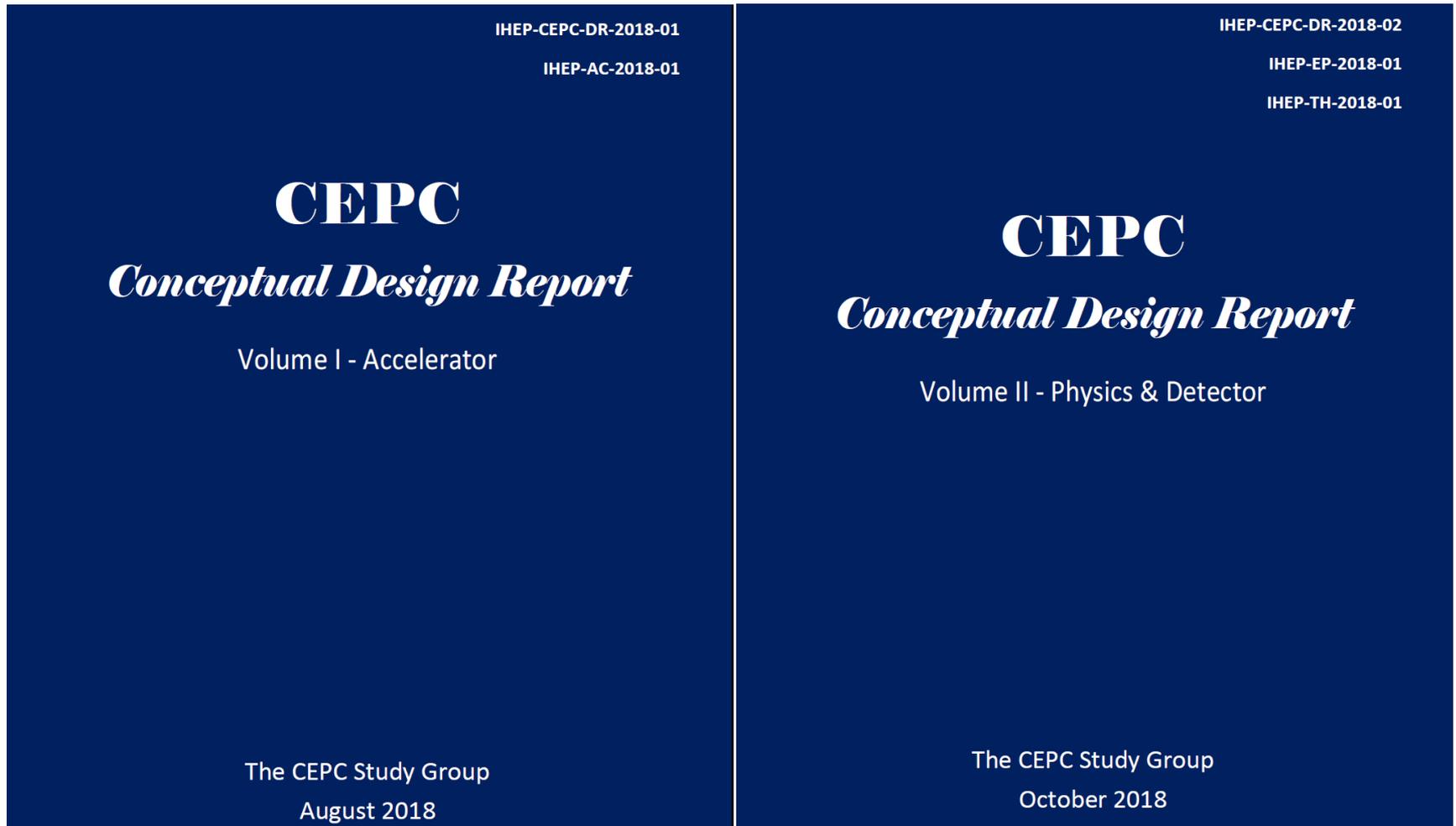
Speaker: Prof. Marcel Vos (IFIC (UVEG/CSIC), Spain)

**Man more talks at parallel sessions at this workshop**



CDR Volumes 1 (Accelerator) and 2 (Physics-Detector) , are available at

<http://cepc.ihep.ac.cn/>

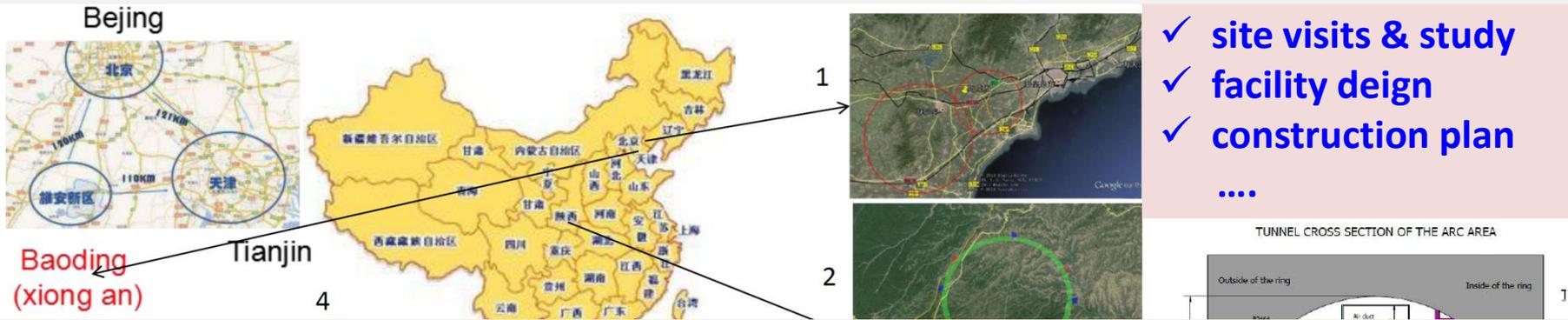


**CDR Volumes 1 (Accelerator) and 2 (Physics-Detector) , are available at**

**<http://cepc.ihep.ac.cn/>**

**Public release of printed CDR volumes  
14:40 November 14 in A415**

# Progress and updates - CEPC CDR



CEPC is conducting country wide site visits and study. Local government agencies are very receptive and supportive to CEPC. CDR study is based on site 1 (Qing Huang Dao).

.....  
14:00 - 15:30

Plenary: Session III

Location: A214, Main building

14:00 **Physics studies and detector R&D towards the TDR 30'**

Speaker: Prof. Marcel Vos (IFIC (UVEG/CSIC), Spain)

14:30 **SppC and HTS status and R&D 30'**

Speaker: Prof. Shinian Fu (IHEP)

15:00 **CEPC-SppC infrastructure 30'**

Speaker: Ms. Yu Xiao (Yellow River Engineering Consulting Co., Ltd)

# Progress and updates - Funding

**HEP seed money**  
**11 M RMB/3 years (2015-2017)**

国家重点研发计划  
 项目预申报书 **FY 2016**

Ministry of Science and Technology  
 Requested 45M RMB; **36M RMB approved**

**R&D Funding - NSFC**      Increasing support for CEPC D+RD by NSFC  
 5 projects (2015); 7 projects (2016)

CEPC相关基金名称 (2015-2016)	基金类型	负责人	承担单位
高精度气体径迹探测器及激光校正的研究 (2015)	重点基金	李玉兰/ 陈元柏	清华大学/ 高能物理研究所 IHEP Tsinghua
成像型电磁量能器关键技术研究(2016)	重点基金	刘树彬	中国科技大学 USTC
CEPC局部双环对撞区挡板系统设计及螺线管场补偿 (2016)	面上基金	白莎	高能物理研究所
用于顶点探测器的高分辨、低功耗SiP像素芯片的若干关键问题的研究(2015)	面上基金	卢云鹏	高能物理研究所
基于粒子流算法的电磁量能器性能研究 (2016)	面上基金	王志刚	高能物理研究所
基于THGEM探测器的数字量能器的研究(2015)	面上基金	俞伯祥	高能物理研究所
高精度量能器上的通用粒子流算法开发(2016)	面上基金	阮曼奇	高能物理研究所
正离子反馈连续抑制型气体探测器的实验研究 (2016)	面上基金	祁辉荣	高能物理研究所
CEPC对撞区最终聚焦系统的设计研究(2015)	青年基金	王遥	高能物理研究所
利用耗尽型CPS提高顶点探测器空间分辨精度的研究 (2016)	青年基金	周扬	高能物理研究所
关于CEPC动力学孔径研究(2016)	青年基金	王毅伟	高能物理研究所

项目名称: **高能环形正负电子对撞机相关的物理和关键技术预研究**  
 所属专项: **大科学装置前沿研究**  
 指南方向: **新一代粒子加速器和探测器关键技术和方法的预先研究**  
 推荐单位: **教育部**  
 申报单位: (公章) **清华大学**  
 项目负责人: **高原宁**

~60M RMB CAS-Beijing fund, talent program

~500M RMB Beijing fund (light source)

year 2017 funding request (45M) to MOST and other agencies under preparation

2017 workshop

Present day

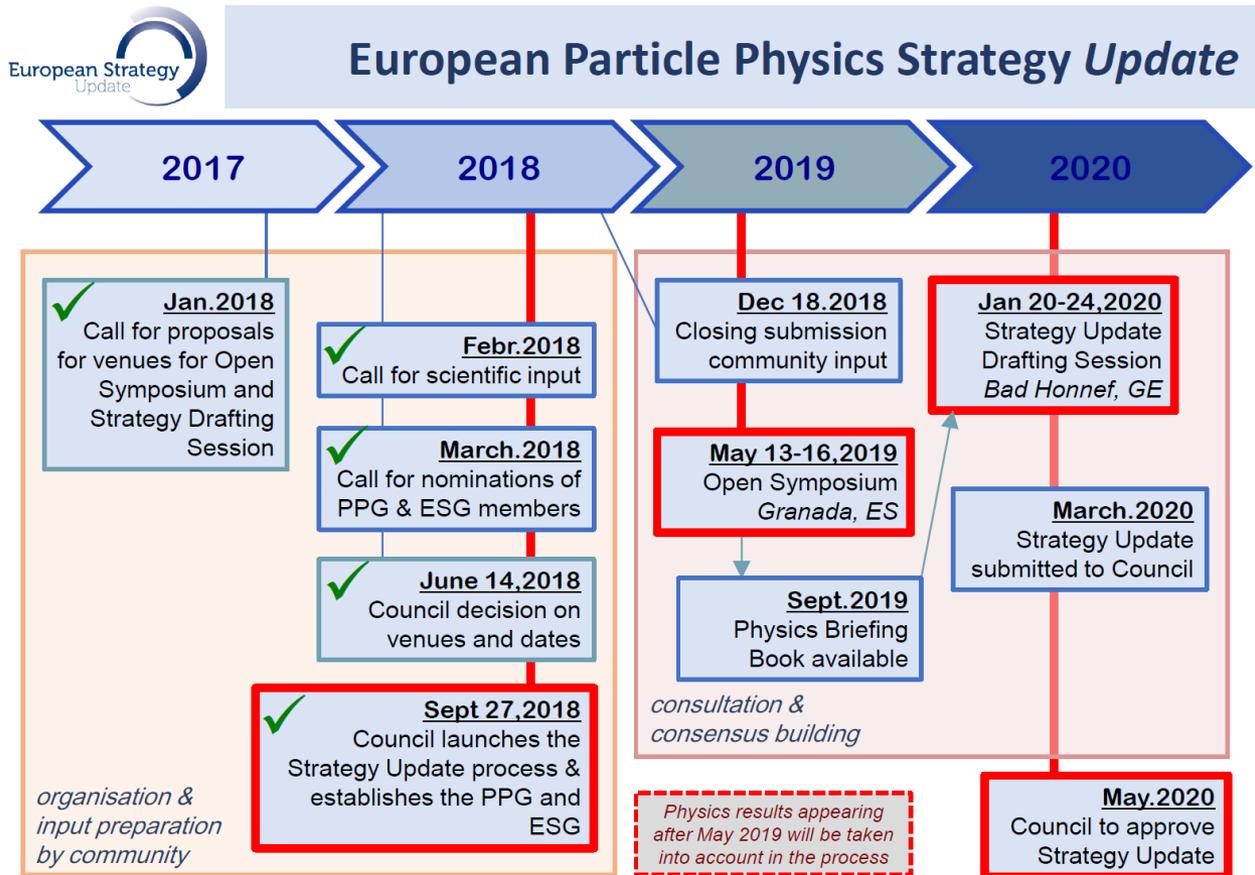
- **funding request (31M) to MOST approved**
- **funding needs for carrying out CEPC design and R&D basically met**

# Progress and updates – Intl Collaboration

- **Strengthen cooperation with CERN**
- **Joined CALICE collab., ILD TPC collab., RD collab.s**
  
- **First international workshop on CEPC in Europe – Rome 2017**
  
- **Next one will in Oxford, UK, April 15-17, 2019**
  
- ...
  
- **Fourth CEPC IAC meeting (Nov. 14-16, 2018)**  
**to focus on international collaboration and other aspects**

# Progress and updates – Intl Collaboration

Preparation for European Strategy for Particle Physics update  
Inputs (CEPC accelerator, physics-detector) have been drafted, under review-revision, will be submitted around November 26, 2018



# Progress and updates – Path to realization

**Chinese Government:** **“actively initiating major-international science project...”**

国发〔2018〕5号（2018.3.14）[http://www.gov.cn/zhengce/content/2018-03/28/content\\_5278056.htm](http://www.gov.cn/zhengce/content/2018-03/28/content_5278056.htm)

- focuses on **“frontier science, large-fundamental science , global focus, international collaboration, ...”**
- by year 2020, 3-5 projects will be chosen to go into “preparatory stage”, among which 1-2 projects will be selected. More projects will be selected in later years.
- The task of selecting the projects, and develop them further falls on the Ministry of Science and Technology (MOST)
- MOST committees formed, are writing the guidelines
- **This is a likely path to realize CEPC. We are paying close attention to this opportunity**

# Goals and Plan

# CEPC Schedule (ideal) – Goals and Plan



- R&D, validation, and industrial preparation
- Global collaboration and strategy
- Best positioning CEPC for national government's positive decision
- Realization of the CEPC project

# **This Workshop and Future**

# This Workshop

## International Advisory Committee Scientific Committee

Young-Kee Kim (Chair), University of Chicago  
Barry Barish, Caltech (USA)  
Hesheng Chen, IHEP(China)  
Michael Davier, LAL (France )  
Eckhard Elsen, DESY (Germany)  
Brian Foster, DESY/U. Hamburg (Germany)  
Rohini Godbole, CHEP, Bangalore (India)  
David Gross, UC Santa Barbara (USA)  
George Hou, Taiwan U. ( Taiwan)  
Peter Jenni, CERN & Albert-Ludwigs-Univ  
Freiburg  
Eugene Levichev, BINP (Russia)  
Lucie Linssen , CERN  
Joe Lykken, Fermilab (USA)  
Luciano Maiani, U. Rome (Italy)  
Michelangelo Mangano, CERN  
Hitoshi Murayama, IPMU/UC Berkeley (Ja  
Katsunobu Oide, KEK (Japan)  
Robert Palmer, BNL (USA)  
Ian Shipsey, Oxford (UK)  
Steinar Stapnes, CERN (Norway)  
Geoffrey Tayler, U. Melbourne (Australia)  
Henry Tye, IAS, HKUST (Hong Kong)  
Hendrik J. (Harry) Weerts <sup>ANU (USA)</sup>

Daniela Bortoletto, Oxford (UK), co-chair  
Jianming Qian, Univ. Michigan (USA), co-chair

### At-large members

Suyong Choi, Korea Univ. (South Korea) Joao Guimaraes Costa  
IHEP Jie Gao, IHEP Yuanning Gao, PKU Suen Hou, Academic  
Sinica (Taipei) Bill Murrav. Warwick (UK) Chris Tully. Princeton

### Paralle session conveners

*Silicon detector*: Massimo Caccia (Insubria, Italy), Qun Ouyang (IHEP)

*Gas detector*: Paolo Giacomelli (Bologna, Italy), Huirong Qi (IHEP)

*Calorimetry*: Jianbei Liu (USTC), Chris Tully (Princeton, USA), Haijun Yang (SJTU)

*Machine-Detector Interface*: Sha Bai (IHEP), Ivanka Bozovic (VINCA, Serbia), Hongbo  
Zhu (IHEP)

*Trigger/DAQ/Computing*: Wolfgang Kuehn (Giessen, Germany), Weidong Li (IHEP),  
Zhenan Liu (IHEP),

*Higgs physics*: Yaquan Fang (IHEP), Hong-Jian He (SJTU), Nathaniel Craig (UCSB, USA)

*Electroweak physics*: Maarten Boonekamp (Saclay, France), Ayres Freitas (Pittsburgh  
USA), Zhijun Liang (IHEP)

*Flavor and QCD physics*: Lars Eklund (Glasgow, UK), Peter Skands (Monash, Australia)  
Jianchun Wang (IHEP), HuaXing Zhu (ZJU)

*Beyond Standard Model*: Qiang Li (PKU), Andrew Long (Michigan/Rice, USA)

*Tools and performances*: Jean-Claude Brient (LLR, France), Manqi Ruan (IHEP)

**Global contribution to this workshop & record participants at~350**

# This Workshop and Beyond

**This workshop is very timely and important for CEPC to move beyond the CDR  
What does it take to make the design to a reality, so we will have an  $e^+e^-$  Higgs factory?**

09:40 **CEPC Accelerator CDR and R&D towards TDR 30'**  
Speaker: Prof. Jie Gao (IHEP)

14:00 **Physics studies and detector R&D towards the TDR 30'**  
Speaker: Prof. Marcel Vos (IFIC (UVEG/CSIC), Spain)

12:30 - 14:00 **IB meeting**  
Conveners: Prof. Yuanning Gao (Peking University), Prof. Jie Gao (IHEP)  
Location: B410, Main building

10:30 - 12:30 **Plenary: Session IV - discussion on future plan and organization**  
**Wed., Nov. 14** Conveners: Prof. Yuanning Gao (Peking University), Prof. Christopher Tully (Princeton, USA)  
Location: A214, Main building

- **Future plan and organization**
- **TDR details, schedule, organization - develop the plan and fill the holes**
- **Take on TDR tasks; industrial support and preparation**
- **Nominations for international conveners**
- **International collaboration and support Global effort to realize CEPC**

# Summary

- **CEPC CDR volumes (accelerator, detector-physics) completed**
- **Design + R&D funding needs are largely met with various sources; people are hard working on DRD**
- **Move towards the TDR, and build a stronger CEPC team w. intl. collab. & participation**
- **Infrastructure, experience and engineering proficiency gained through current projects (light source, CSNS, etc.) helpful for the CEPC**
- **Upon successfully completing the DRD program, we expect to make the case to the national government for building CEPC (in ~4-5 years)**