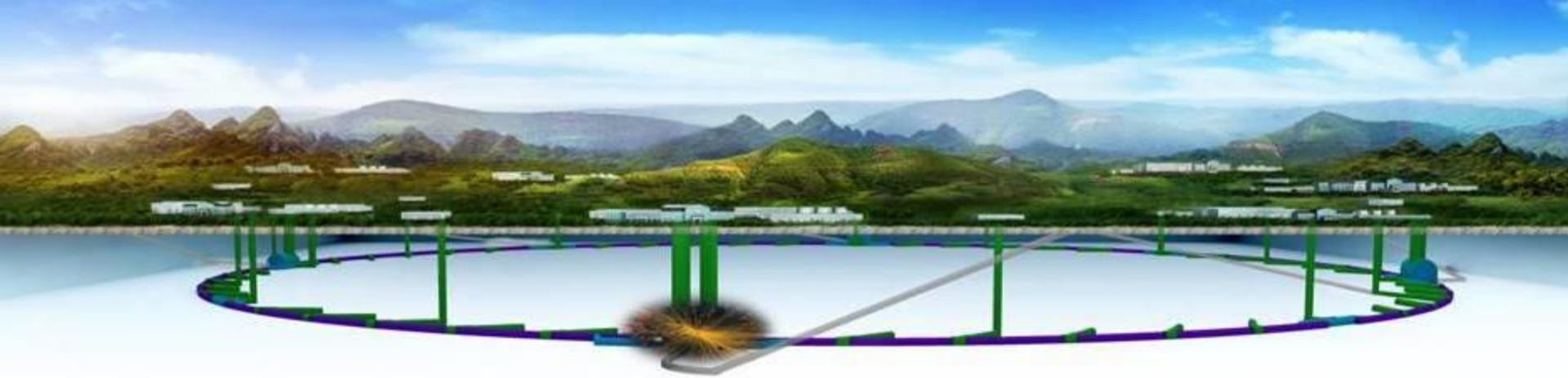


Overview & IAC Recommendation Implementation



XinChou Lou (IHEP)
For the CEPC-SppC Study Group

November 15, 2018

Outline

Part I – Overview

- Progress and updates
- Plan and goals

Part II – IAC Report Implementation

Part III – Discussion

CEPC Overview

Progress and Status

Much more details will be presented by my colleagues at this meeting

Reminder about the CEPC-SppC

e^+e^- Higgs (Z) factory

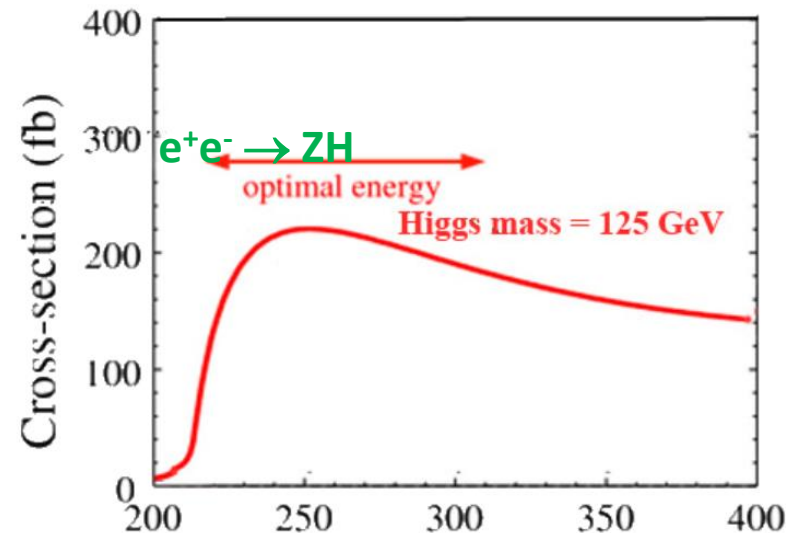
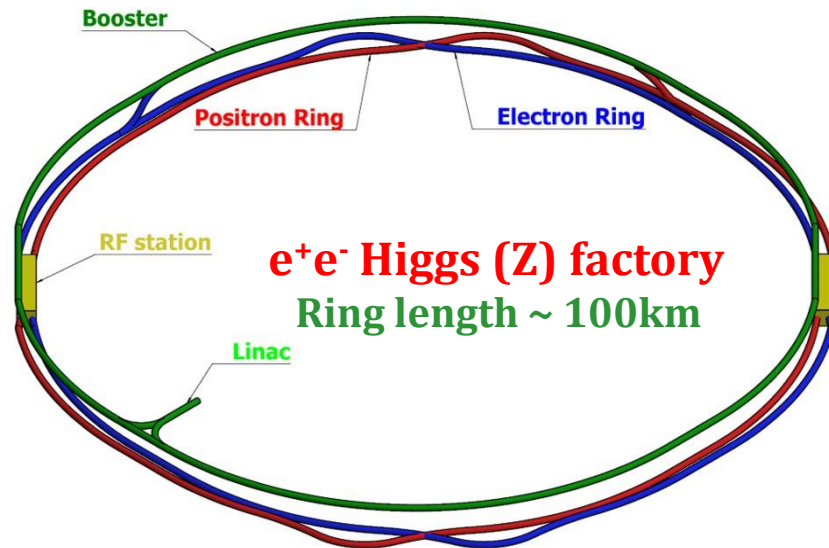
$E_{\text{cm}} \approx 240 \text{ GeV}$, luminosity $\sim 2 \times 10^{34} \text{ cm}^{-2} \text{ s}^{-1}$, 2IP, 1M H in 10 years
at the Z-pole 10^{10} Z bosons/yr

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 $\sim 2020\text{s}$;

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

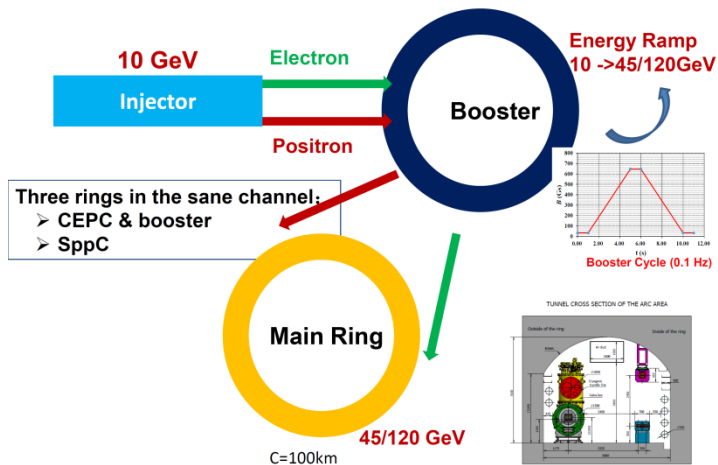
CDR, August-October 2018 – scientific goals well justified & aligned with intl priorities; endorsement for moving towards TDR, and ...

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 - 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'**

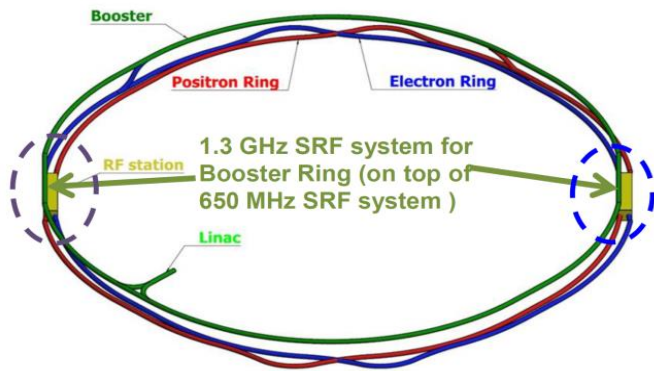
Speaker: Prof. Xinchou Lou (IHEP)

09:10 **Physics motivation 30'**

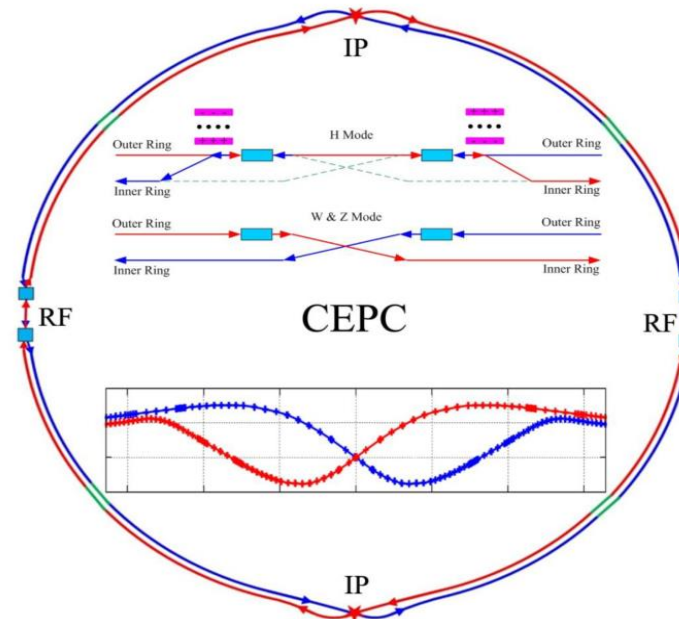
Speaker: Prof. Nathaniel Craig (UC Santa Barbara)

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)

Thursday, June 28		Friday, June 29		Saturday, June 30	
8:30-9:00 Committee Executive Session Chair: K. Oide		8:30-9:00 SIF system RF power source Cryogenic system CEPC collider ring Magnet CEPC booster ring magnet Coffee break(30')		8:30-9:00 Survey and alignment Mechanics Conventional facilities Site investigation Coffee break (30')	Xiaolong Wang Haijing Wang Guoping Lin Yu Xian
9:00-9:05 Welcome Chair: Qinglin	Yifang Wang Jie Guo Chenghui Yu Yuan Wang Yuan Zhong	9:00-9:30 Overview of CEPC CEPC collider lattice design CEPC beam-line and DA Coffee break(30')		9:30-10:00 Discussion with CEPC team Lunch break	
9:05-9:30 Overview of beam dynamics		9:30-10:00 SC magnet for CEPC-IR Power supplies Vacuum		10:00-10:30 Coffee break (30')	
9:35-10:00 CEPC beam-line and DA		10:00-10:30 Coffee break(30')		11:00-12:00 Discussion with CEPC team Lunch break	
10:05-10:35 Coffee break(30')		11:00-11:30 SC magnet for CEPC-IR Power supplies Vacuum		12:00-14:00 Lunch break	
11:05-11:35 Chair: K. Oide Installation Machine-detector interface	No Wang Shu Bai	11:30-12:00 Coffee break(30')		14:00-16:00 Committee Executive Session Coffee break (30')	
12:05-14:00 Lunch break		12:00-12:30 Coffee break(30')		16:30-17:30 Close out	
14:00-14:30 Reactor Injection and extraction Linac injector Coffee break(30')	Duo Wang Xiaohua Cai Ca Meng	12:30-14:00 Chair: K. Oide Instrumentation Control Synchrotron radiation Radiation shielding Coffee break(30')		18:00-19:00 Banquet	
16:30-18:30 Committee Executive Session		16:30-18:30 Committee Executive Session			
19:00 Dinner of Committee					

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_{beam} = 120 GeV), 76 (80 GeV), and 240 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:

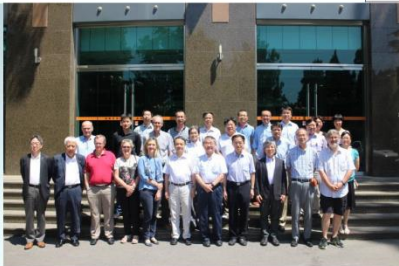
- (1) Experiments for ttbar production (E_{beam} = 180 GeV);
- (2) Even higher luminosity (~x10) at Z and W;
- (3) Higher beam current, up to 50 MW/beam synchrotron radiation loss;
- (4) More interaction points;
- (5) Polarized beams.

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.

- 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

J Gao

Progress and updates - CEPC CDR

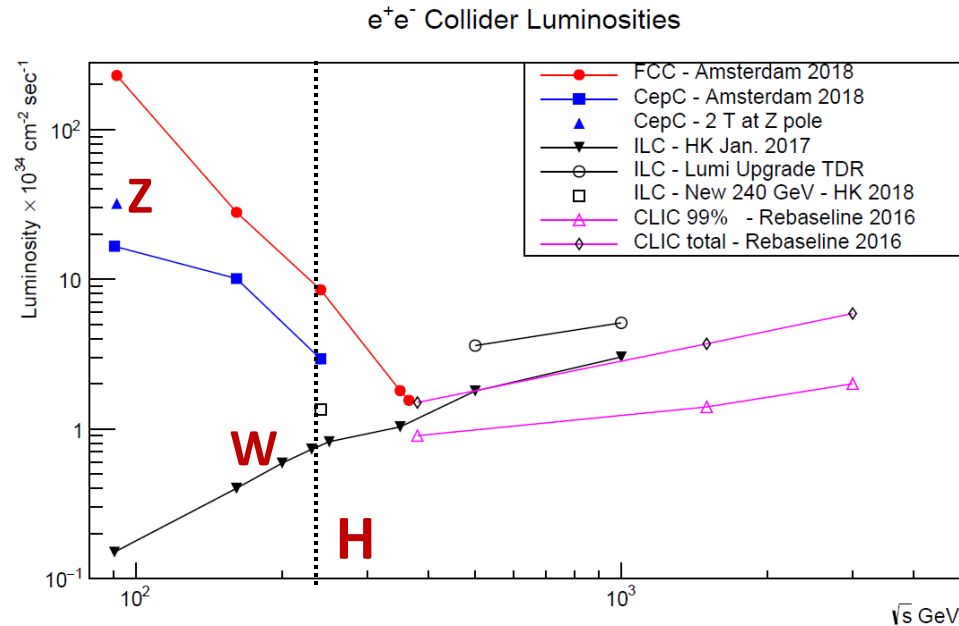
Luminosity vs. CM energy

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

Baseline CEPC

➤ Baseline design & options for the Conceptual Design Report

circumference=100km, $E_{\text{cm}}=240$ GeV, power per beam ≤ 30 MW,
design luminosity $\sim 2 \times 10^{34} \text{cm}^{-2} \text{s}^{-1}$ (240 GeV)

$1 \times 10^{34} \text{cm}^{-2} \text{s}^{-1}$ (91 GeV)

two layouts:

double ring as the default;

advanced local double ring as an option

two independent detectors

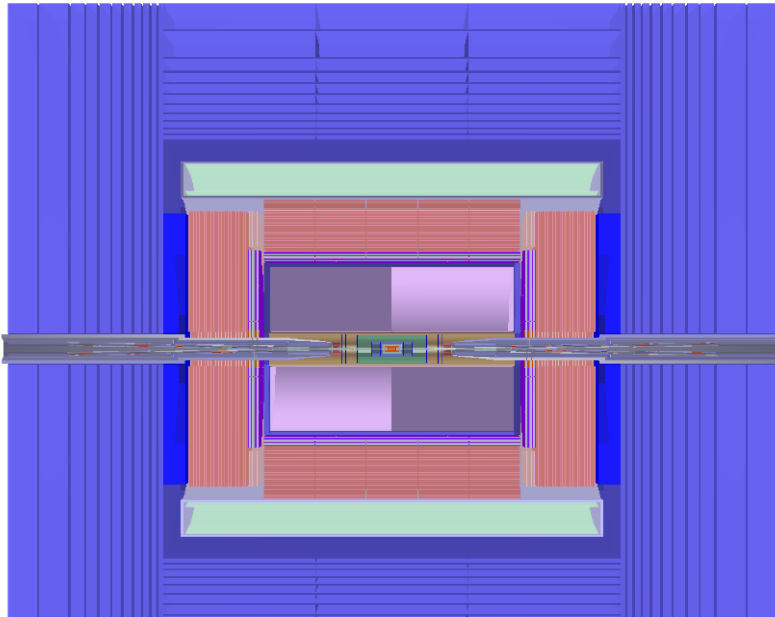
➤ Benefits

mature technologies, Z+ZH program

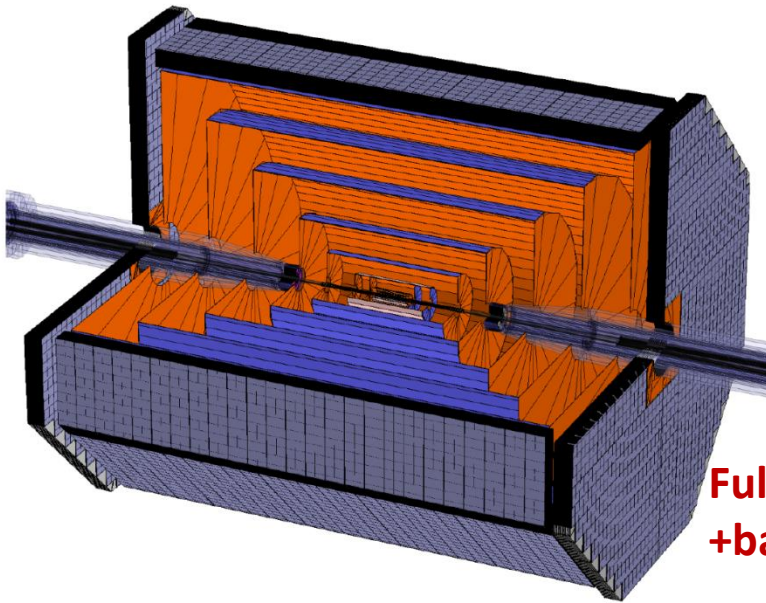
high energy pp option beyond the Higgs(Z) factory

γ synchrotron light source (?)

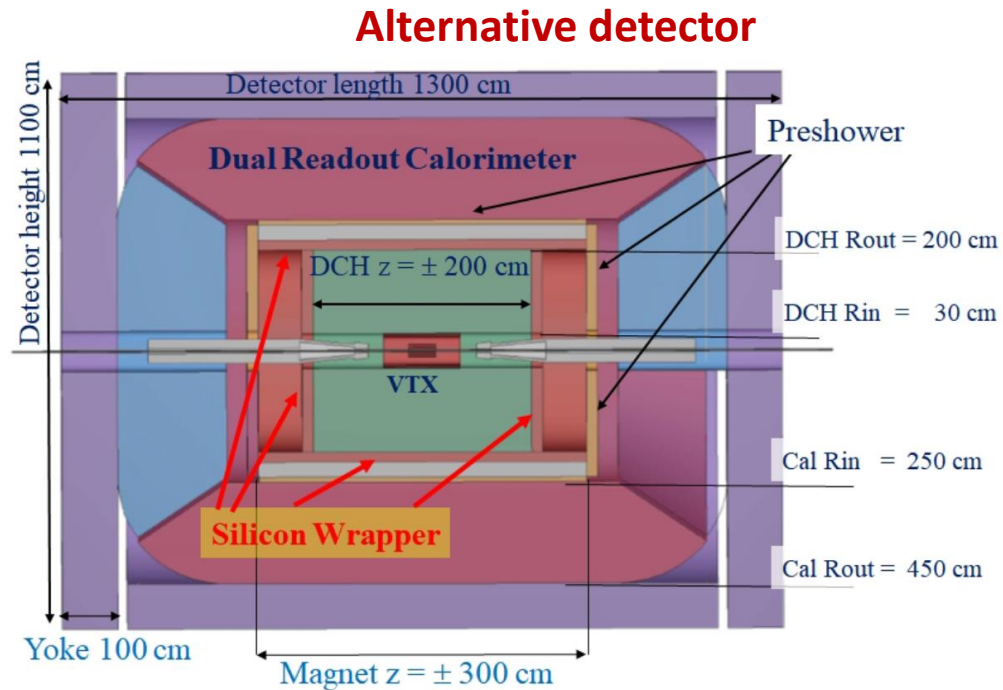
Progress and updates - Detector-Physics



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

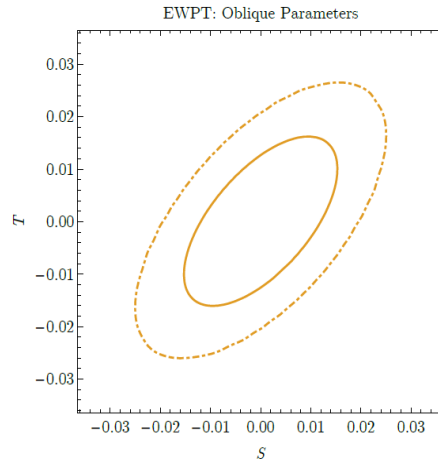
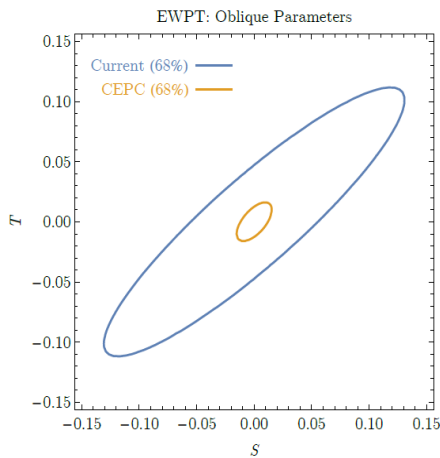
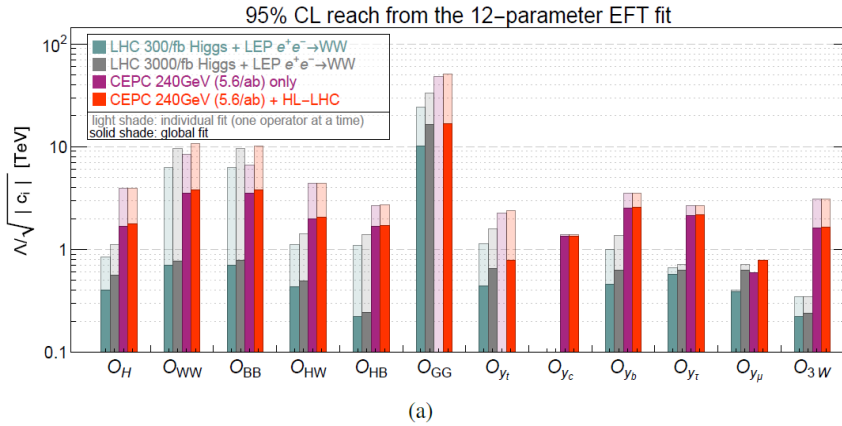


**Full silicon tracker
+baseline detector**



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

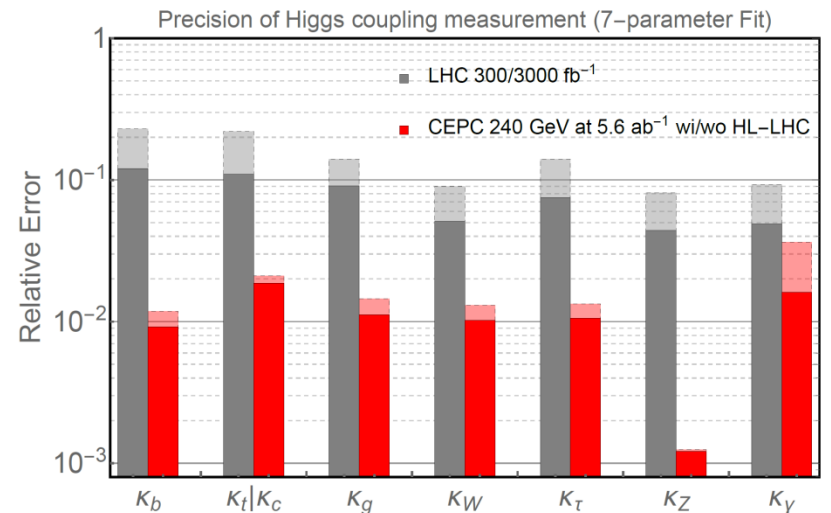
Plenary: Session III

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/>

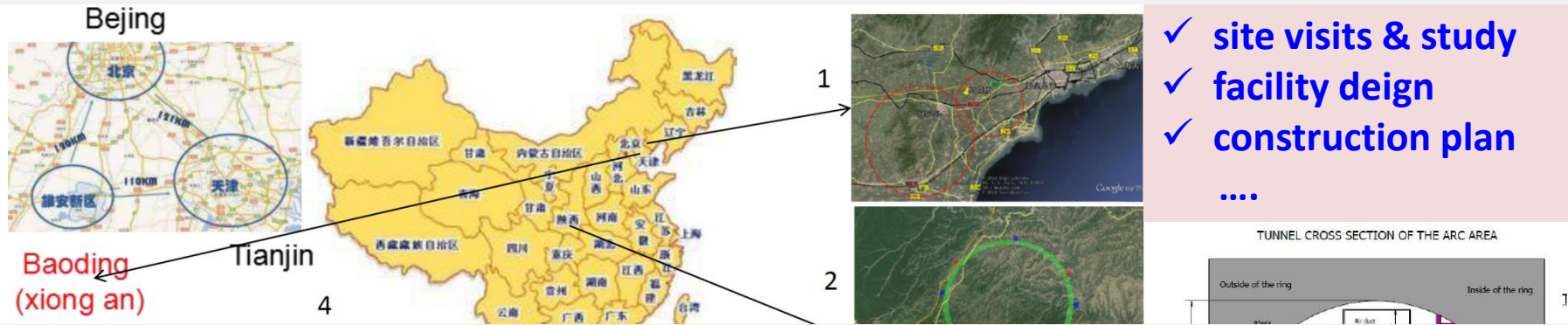


CDR Volumes 1 (Accelerator) and 2 (Physics-Detector) , are available at

<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与螺线管场补偿 (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**

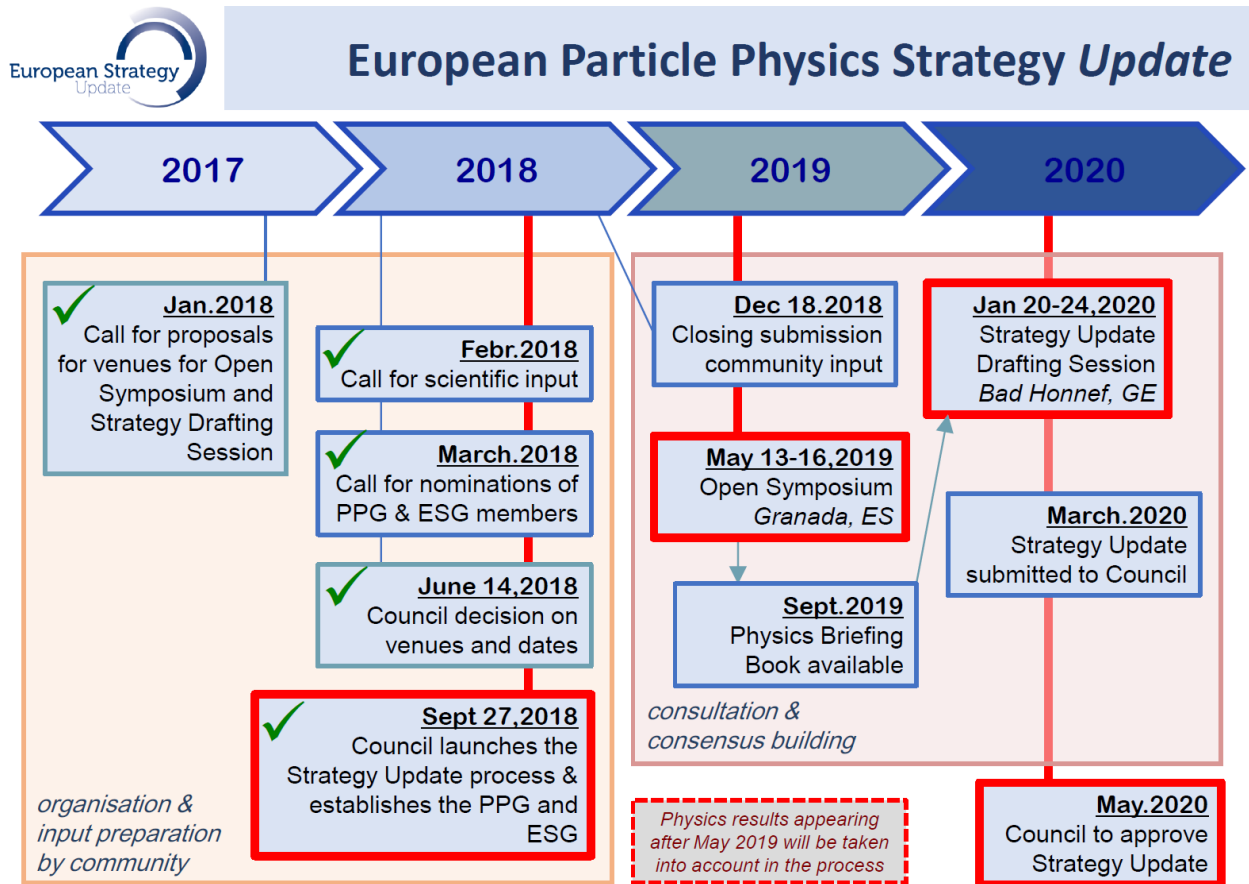
- **Next one will in Oxford, UK, April 15-17, 2019**

- ...

- **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

- 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**

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

2018 Workshop and Future

2018 CEPC 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. ANL (USA)

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

2018 CEPC 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**

Report to the IAC

Implementation of Recommendations

November 15, 2018

Implementation of Recommendations

R1: The level of international participation should be increased at all levels. The IAC reiterates the desirability of adding international conveners in each of the main detector areas. International participation in the accelerator design process is also highly desirable.

- Solicit nominations for international WG conveners;
- Well mixed scientific community at this workshop; hope to retain some
- A number of collaboration and MOUs (LC-TPC, HL-LHC, lab-univ. groups)
- Strengthen cooperation with CERN
- ✓ Obtained a dedicated grant to support international collaboration on CEPC

It is difficult with US DOE labs

“We noticed that some US lab based physicists not getting DOE approvals for travel to attend this workshop(2017)”

It is getting worse

2018 CEPC Workshop

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

Implementation of Recommendations

R2: It is essential that CEPC makes a strong input into regional road map discussions. This is urgent for the European Strategy process, which will begin in 2018. Plans must be drawn up to write a suitable document as input to this process. The ICHEP conference in Seoul in 2018 is a good opportunity to increase the visibility of the project and to enhance international partnerships..

- **Satellite CEPC meeting at ICHEP2018 (thanks to Young-Kee)**
- **Have representative in PPG, will attend Open Symposium in May 2019 (Granada Spain)**
- **CEPC input drafts available, being revised, to submit around Nov. 26**

Implementation of Recommendations

R3: The IAC has decided to appoint two subcommittees to advise and monitor progress on the accelerator and physics/detector activities. These subcommittees should consist of 3-4 IAC members plus 3 other experts as permanent members plus 3-4 other experts invited as required for their expertise. The subcommittees will meet as requested either by the IAC or the project management and their reports will be presented to the IAC.

- **CEPC is entering the TDR process, needing advice here**
- **Technical reviews and hand holding**

Implementation of Recommendations

R4: Project Plan outlining organization and management, with a top-level resource loaded organization chart, should be provided. It should include R&D, the path to industrial production and prototyping, human resources & skill sets required for the next five years, to the TDR stage..

➤ **Start to consider this more broadly ...**

Implementation of Recommendations

R5: Industrialization of components should continue to be explored both in China and also internationally. It is essential to begin discussions to explore potential in-kind contributions that international partners might be interested in contributing.

- **Domestic CIC active, needs systematic survey and plan ...**
- **International industrial partners not well explored ...**
- **Have some ideas about the percentage, but no substantive activity**

Implementation of Recommendations

R6: The current layout of the physics CDR focuses on the expected performance of the baseline design, namely 10^{10} Z events collected at the Z pole and 10^6 ZH and 10^8 WW events collected at 240 GeV. A section should be included to document the expected physics gains emerging from a higher event yield at the Z pole, from running at the WW threshold and at/above the tt-bar threshold, addressing the implications for precision EW and Higgs studies, very rare decays, and flavor physics..

- adopted partially
- Trying to get more theorists to join us explore the potentials with the Z,WW...

The CDR includes a much expanded section on electroweak physics at the Z pole, and WW threshold physics. The chapter is already taking into account a much higher rate of Z events, 7×10^{11} . This work was done by including two foreign colleagues that are also editors of that chapter, Maarten Boonekamp and Fulvio Piccinini.

We have not done anything on ttbar, for the reasons we all know.

Implementation of Recommendations

R7: The international participation appointment of an international page of the CDR section.

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Implementation of Recommendations

R8: Ways should be found to facilitate the growth of a theoretical particle physics community in China focused on CEPC, e.g. through the creation of a database of available openings, documented on the web, to enhance the visibility of such opportunities.

R9: A stronger permanent presence of theoretical particle physicists in CFHEP could help establishing a more structured activity around CEPC.

- **CFHEP at IHEP, junior hires in recent years**
- **LHCC community and annual meetings are the pool and the draw**
- **...**

Discussion

November 15, 2018