

# Introductory remarks and IAC recommendations

João Guimarães da Costa

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中国科学院高能物理研究所

*Institute of High Energy Physics  
Chinese Academy of Sciences*



# CEPC-related Events

- **CEPC Day, Monday Dec 28**
  - Physics/Detector Session in the afternoon in Beijing
    - Two more Physics/Detector plenary meetings before this date
- **2021 Hong Kong Conference and Program**
  - Full event to be held online
  - Mini-workshop, January 14-15, 2020
    - Particle Identification: Detectors and Physics
    - Organizers: Joao, Kirill Prokofiev, Mogens Dam
  - Conference, January 18-21, 2020
    - Parallel sessions in afternoon
    - Plenary sessions in the evening
- **Past: CEPC international workshop on Oct. 26-28, 2020**
  - <https://indico.ihep.ac.cn/event/11444/>
- **Past: 4th FCC Physics and Experiments Workshop on Nov. 10-13, 2020**
  - <https://indico.cern.ch/event/932973/>



# IAC Report - Recommendations

## Report:

### The Sixth Meeting of the CEPC-SppC International Advisory Committee

November 19, 2020





# IAC Report - Recommendations

## The IAC committee

Present:

- Barry Barish, Caltech
- Hesheng Chen, IHEP, Chinese Academy of Sciences
- Michel Davier, LAL
- Marcel Demarteau, ORNL
- Brian Foster, DESY/University of Hamburg & Oxford University
- Rohini Godbole, CHEP, Bangalore
- David Gross, University of California, Santa Barbara
- George Hou, Taiwan University
- Peter Jenni, CERN & Albert-Ludwigs-University Freiburg
- Young-Kee Kim (Chair), University of Chicago
- Eugene Levichev, BINP
- Lucie Linssen, CERN
- Luciano Maiani, University of Rome
- Michelangelo Mangano, CERN
- Tatsuya Nakada, EPFL
- Katsunobu Oide, CERN & KEK
- Ian Shipsey, Oxford University
- Steinar Stapnes, CERN
- Geoffrey Tayler, University of Melbourne

### Apologies received:

- Joe Lykken, Fermilab
- Hitoshi Murayama, University of California, Berkeley & Kavli IPMU
- Robert Palmer, BNL
- John Seeman, SLAC





# IAC Report - Recommendations

## Introduction/General

**Recommendation 1:** *Update the timeline* and include two separate accelerator and detector roadmaps in the timeline by the next IAC meeting. (to happen within 1 year)

**Recommendation 2:** *Hold the International Accelerator Review Committee and the International Detector R&D Review Committee twice a year in person or virtually. The next meetings should take place within six months.*



**Action Item:** organize a **second** International Detector R&D Review Committee meeting by May 2021 — virtual meeting and decoupled from a CEPC workshop.  
**Third** meeting could be coupled with October 2021 workshop.

**First step:** Need to finalize support documents



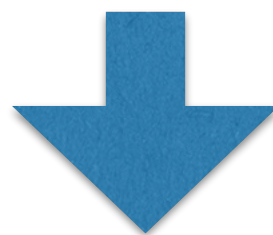
# IAC Report - Recommendations

## Management

**Recommendation 3:** *Explore a possibility of commissioning an economics department of a prestigious Chinese university to carry out such an **economic benefits** study.*  
(economic benefits to China from CEPC)

**Recommendation 4:** *Explore the CERN-Chinese relation as much possible. The IAC would like to hear a report on this matter at the next meeting, with an evaluation of the benefits to date, the strengths and weaknesses, and how it might be further improved.*

The IAC suggests further enhancement of the CEPC and FCC-ee collaboration, and building international strength through bi-lateral arrangements.



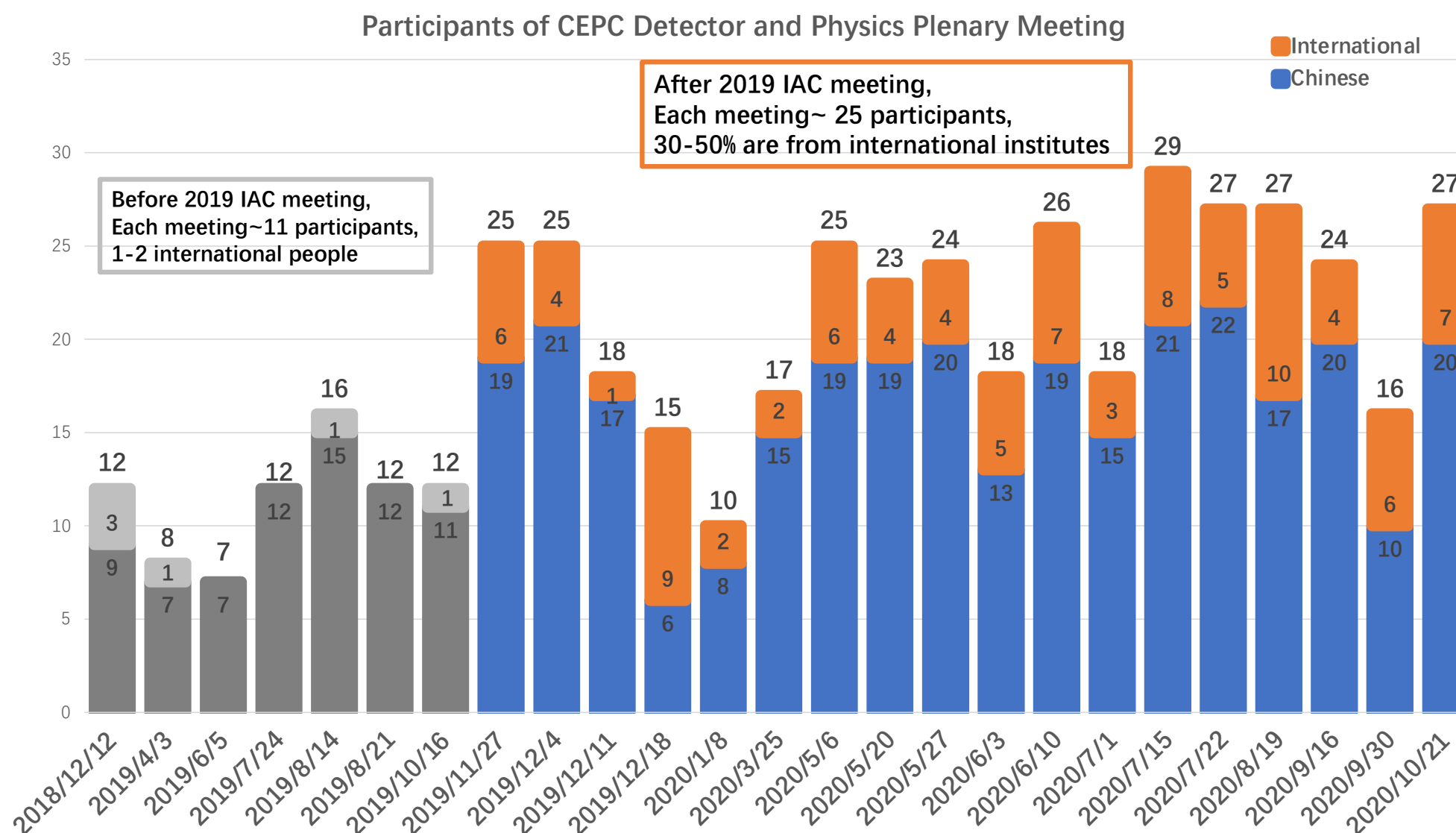
**Action Item:** expand our relationships with FCC-ee and LHC involvement



# IAC Report - Recommendations

## Detector R&D and Physics Studies

The IAC congratulates the CEPC team for the significant progress since last year on the detector and physics aspects. Following up on last year's recommendations, the IAC was pleased to see regular meetings taking place within the various topical groups and with significant participation from outside China.





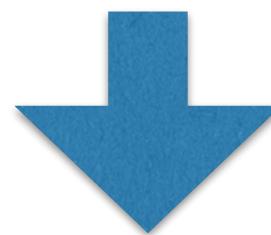
# IAC Report - Recommendations

## Detector R&D and Physics Studies

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<https://indico.ihep.ac.cn/category/214/>

Physics and Detector Meetings		
Physics and Simulations	416 events	⇒
Vertex	12 events	⇒
Tracker	128 events	⇒
Calo&Muon	160 events	⇒
MDI	52 events	⇒
General	138 events	⇒
100 TeV Simulation	12 events	⇒
Pure Silicon Detector	8 events	⇒
Offline Software	1 event	⇒
Mechanics	3 events	⇒



### Action Item:

Organize meetings through the proper indico interface for our group

Create a proper paper trail that can be used for reporting on the progress





# IAC Report - Recommendations

## Detector R&D and Physics Studies

The IAC noted an increase in the number of sub-detector R&D projects, many of them involving non-Chinese groups. The ongoing effort to create a summary document describing the different detector R&D activities and their current status is recognized. It will be very helpful to maintain overview and to facilitate the integration of external groups. (see discussion next)

The active participation of CEPC experts, together with experts from ILC, CLIC and FCC, in the common Key4hep / EDM4hep / DD4hep software infrastructure for detector description, event simulation and event reconstruction is seen as a big step forward since last year.

The purely phenomenological/theoretical work on the CEPC physics potential is in excellent shape, as shown during the Workshop. The worldwide theory community contributes to these studies as part of the global effort to expand the science impact of circular colliders. The CEPC team is a driving force behind these efforts, particularly in the context of Higgs and BSM physics. There are further opportunities, however, to exploit the particular competence of Chinese theorists in areas like flavor, hadronic spectroscopy and higher-order calculations for QCD and EW precision observables.



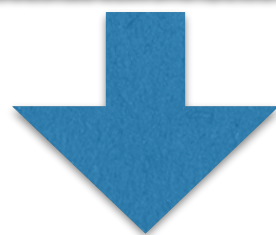
# IAC Report - Recommendations

## Detector R&D and Physics Studies

the overall optimization process for the detector still needs further in-depth studies driven by the various physics objectives. Measurements at the different center-of-mass energies will each add specific, and sometimes competing, requirements.

Continue effort in performant software and detector optimization

**Recommendation 11:** *Not to tighten the R&D towards a predefined tight schedule.* The IAC believes that R&D within a technically driven schedule is optimal. Given the longer timescale this allows, it is important to develop the best possible detector design. **Innovation and creativity** (i.e. new ideas) in the R&D leading to the development of a cutting-edge holistic detector design should be a goal.



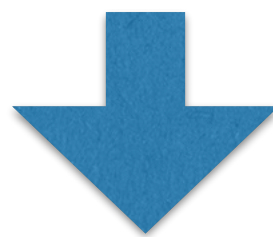
**Action Item:** Rework the CEPC general timeline; Keep open higher risk options that require more R&D; Invest on innovative solutions — highlight these in next report



# IAC Report - Recommendations

## Detector R&D and Physics Studies

**Recommendation 12:** *Reinforce the engineering efforts related to the detector design.* Engineering studies are essential and now timely, for example in the following domains: cooling integration studies for the vertex detector, the beam pipe and the PFA calorimeters; light-weight supports and integration of the vertex detector; scalability of the calorimeters.



**Action Item:** Ji Quan already acting as project engineer overseeing many of these issues.

Identify more engineers involved at the detector level and ensure that the communication is optimized

Try to get international participation at this level as well



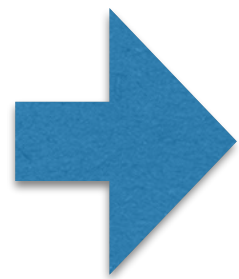


# IAC Report - Recommendations

## Detector R&D and Physics Studies

**Recommendation 13:** *Assess the CEPC physics potential of the 360 GeV stage in full, including a demonstration that the accelerator design optimally fits the physics objectives at this stage. Even if the 360 GeV stage is still far away in time, it is an important element to the attractiveness of CEPC as a whole. Not emphasizing it strongly in the presentation of the CEPC program may discourage potential partners.*

**Recommendation 14:** *Assess the CEPC physics potential for the high luminosity Z factory stage. In particular it is important to fully develop the flavor physics program for this stage, from the perspective of weak interactions (e.g., precision measurements and rare and forbidden decays in the SM and in BSM scenarios), as well as from the perspective of strong interactions (e.g., in the area of exotic hadrons, where unique studies of doubly heavy or fully heavy tetraquarks, also including b quarks, would be possible).*



**Action Item:** Continue to expand the team working on flavor physics and strong interactions

Promote engagement from university physicists





# IAC Report - Recommendations

## Detector R&D and Physics Studies

**Recommendation 15:** *Further develop close relationships with FCC-ee colleagues in detector designs.*

 **Action Item:** IDEA colleagues already involved in both projects, but expand beyond that to include common detector R&D projects. Some of these already starting.

Common workshops/discussions regarding challenges of circular  $e^+e^-$  collider physics

3. *In light of the new global reality, how should we carry out international collaboration with the CEPC?*

The IAC believes it is important to engage more frequently with the experienced scientists that serve on the **International Detector R&D Committee**. A meeting next Spring, as proposed, is desirable. In future these should be regular meetings perhaps on a cadence of every six months. See Recommendation 1.



# IDRDC: Preparation for Next Meeting Preparation

Need to finalize documents to submit to committee

17 documents, 95 subtasks, 80 pages

**Goal: Submission to committee by Jan 15? ==> Your input by end of year**

PBS	Task Name	Page	Subtasks	Context	Team	Document Responsible
	<b>CEPC Detector R&amp;D Project</b>					
<b>1</b>	<b>Vertex</b>					
<b>1.1</b>	<b>Vertex Prototype</b>	5	9	CEPC	China+ international collaborators	Zhijun, Ouyang
<b>1.2</b>	<b>ARCADIA CMOS MAPS</b>	6	6	Generic	INFN, Italy	Manuel Rolo
<b>2</b>	<b>Tracker</b>					
<b>2.1</b>	<b>TPC Module and Prototype</b>	6	12	CEPC	IHEP, Tsinghua	Huirong
<b>2.2</b>	<b>Silicon Tracker Prototype</b>	6	8	Generic	China, UK, Italy	Harald Fox, Meng Wang
<b>2.3</b>	<b>Drift Chamber Activities</b>	4	3	FCC-ee/CEPC	INFN, Novosibirsk	Franco Grancagnolo
<b>3</b>	<b>Calorimetry</b>					
<b>3.1</b>	<b>ECAL Calorimeter</b>					
3.1.1	Crystal Calorimeter	5	6	CEPC	IHEP, Princeton + others	Yong Liu
3.1.2	PFA Sci-ECAL Prototype	3	3	CEPC	USTC, IHEP	Jianbei Liu
<b>3.2</b>	<b>HCAL Calorimeter</b>					
3.2.1	PFA Digital Hadronic Calorimeter	4	5	CEPC	SJTU, IPNL, Weizmann, IIT, USTC	Haijun Yang, Imad Laktineh, Shikma Bressler
3.2.2	PFA Sci-AHCAL Prototype	4	4	CEPC	USTC, IHEP, SJTU	Jianbei Liu
<b>3.3</b>	<b>Dual-readout Calorimeter</b>	5	5	FCC-ee/CEPC	INFN, Sussex, Zagreb, South Korea	Roberto Ferrari
<b>4</b>	<b>Muon Detector</b>					
4.1	Scintillator-based Muon Detector	4	5	CEPC	Fudan, SJTU	Xiaolong Wang, Liang Li
<b>4.2</b>	<b>Muon and pre-shower <math>\mu</math>RWELL-</b>	5	4	FCC-ee/CEPC	INFN, LNF	Paolo Giacomelli
<b>5</b>	<b>Solenoid</b>					
5.1	LTS solenoid magnet	4	4	CEPC	IHEP+Industry	Zhu Zian
5.2	HTS solenoid magnet	4	4	CEPC	IHEP+Industry	Zhu Zian
<b>6</b>	<b>MDI</b>					
<b>6.1</b>	<b>LumiCal Prototype</b>	4	2	ILC/CEPC	AC, IHEP	Suen Hou
6.2	Interaction Region Mechanics	3	4	CEPC	IHEP	Hongbo Zhu
<b>8</b>	<b>Software and Computing</b>	7	11	CEPC	IHEP, SDU	Li Weidong, Ruan Manqi, Sun Shengseng, Li Gang

# IDRDC: Preparation for Next Meeting Preparation

Update time schedule for projects? Add new ones?

PBS	Task Name	Finish	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
			H1	H2	H1	H2	H1	H2	H1	H2	H1	H2
	<b>CEPC Detector R&amp;D Project</b>	<b>26/12/31</b>	<b>CEPC Detector R&amp;D Project</b>									
<b>1</b>	<b>Vertex</b>	<b>23/12/29</b>	<b>Vertex</b>									
1.1	Vertex Prototype	23/12/29	Vertex Prototype									
1.2	ARCADIA CMOS MAPS	23/12/29	ARCADIA CMOS MAPS									
<b>2</b>	<b>Tracker</b>	<b>24/12/31</b>	<b>Tracker</b>									
2.1	TPC Module and Prototype	23/12/29	TPC Module and Prototype									
2.2	Silicon Tracker Prototype	23/10/31	Silicon Tracker Prototype									
2.3	Drift Chamber Activities	24/12/31	Drift Chamber Activities									
<b>3</b>	<b>Calorimetry</b>	<b>24/12/31</b>	<b>Calorimetry</b>									
<b>3.1</b>	<b>ECAL Calorimeter</b>	<b>24/12/31</b>	<b>ECAL Calorimeter</b>									
3.1.1	Crystal Calorimeter	21/12/31	Crystal Calorimeter									
3.1.2	PFA Sci-ECAL Prototype	24/12/31	PFA Sci-ECAL Prototype									
<b>3.2</b>	<b>HCAL Calorimeter</b>	<b>22/12/30</b>	<b>HCAL Calorimeter</b>									
3.2.1	PFA Digital Hadronic Calorimeter	21/12/31	PFA Digital Hadronic Calorimeter									
3.2.2	PFA Sci-AHCAL Prototype	22/12/30	PFA Sci-AHCAL Prototype									
<b>3.3</b>	<b>Dual-readout Calorimeter</b>	<b>24/12/31</b>	<b>Dual-readout Calorimeter</b>									
<b>4</b>	<b>Muon Detector</b>	<b>24/12/31</b>	<b>Muon Detector</b>									
4.1	Scintillator-based Muon Detector Prototype	23/12/29	Scintillator-based Muon Detector Prototype									
4.2	Muon and pre-shower $\mu$ RWELL-based detectors	24/12/31	Muon and pre-shower $\mu$ RWELL-based detectors									
<b>5</b>	<b>Solenoid</b>	<b>26/12/31</b>	<b>Solenoid</b>									
5.1	LTS solenoid magnet	25/12/31	LTS solenoid magnet									
5.2	HTS solenoid magnet	26/12/31	HTS solenoid magnet									
<b>6</b>	<b>MDI</b>	<b>22/12/30</b>	<b>MDI</b>									
6.1	LumiCal Prototype	20/12/31	LumiCal Prototype									
6.2	Interaction Region Mechanics	22/12/30	Interaction Region Mechanics									
<b>8</b>	<b>Software and Computing</b>	<b>20/12/31</b>	<b>Software and Computing</b>									

Submitting document by Jan 15 would allow to schedule committee meeting on Mar/Apr, giving about 6-months for the next meeting in ~October





# Snowmass Letter of Intent

Need to follow up on progress in this area → reports

Manqi organizing progress on Physics LoI

<https://indico.ihep.ac.cn/event/12410/>

## Detector 14 LoI

Detector R&D	
Conveners: Joao Guimaraes Costa, WANG Jianchun, Mr. Manqi Ruan (IHEP)	
15:00	<b>CEPC Detectors Overview LoI 1'</b> CEPC Detector Overview LOI SNOWMASS21-EF1_EF4-IF9_IF0-260.pdf Speakers: Joao Guimaraes Costa, Mr. Manqi Ruan (IHEP), WANG Jianchun Material: <a href="#">Paper</a> <a href="#">Slides</a>
15:02	<b>IDEA Concept 1'</b> Speaker: Franco Bedeschi (INFN-Pisa) Material: <a href="#">Paper</a>
15:03	<b>Dual Readout Calorimeter 1'</b> Speaker: Roberto Ferrari (INFN) Material: <a href="#">Paper</a>
15:04	<b>Drift Chamber 1'</b> Speaker: Franco Grancagnolo Material: <a href="#">Paper</a>
15:06	<b>mu-RWELL (muons, preshower) 1'</b> Speaker: Paolo Giacomelli (INFN-Bo) Material: <a href="#">Paper</a>
15:08	<b>Time Detector LoI 1'</b> Speaker: Prof. Zhijun Liang (IHEP) Material: <a href="#">Slides</a>
15:09	<b>Key4hep 1'</b> Speakers: Dr. Weidong Li (高能所), Dr. Tao LIN (高能所), Prof. Xingtao Huang (Shandong University), Wenxing Fang (Beihang University) Material: <a href="#">Slides</a>
15:10	<b>PFA Calorimeter 1'</b> Speakers: Haijun Yang (Shanghai Jiao Tong University), Dr. Jianbei Liu (University of Science and Technology of China), Dr. Yong Liu (Institute of High Energy Physics) Material: <a href="#">Slides</a>
15:11	<b>High Granularity Crystal Calorimeter 1'</b> Speaker: Dr. Yong Liu (Institute of High Energy Physics) Material: <a href="#">Paper</a> <a href="#">Slides</a>
15:12	<b>Muon Scintillator Detector 1'</b> Speaker: Dr. Xiaolong Wang (Institute of Modern Physics, Fudan University) Material: <a href="#">document</a>
15:13	<b>Vertex LoI 1'</b> Speaker: Prof. Zhijun Liang (IHEP) Material: <a href="#">Slides</a>
15:15	<b>MDI LoI 1'</b> Speaker: Dr. Hongbo ZHU (IHEP) Material: <a href="#">Slides</a>
15:16	<b>TPC LoI 1'</b> Speaker: Dr. Huirong Qi (Institute of High Energy Physics, CAS) Material: <a href="#">Slides</a>
15:17	<b>Solenoid R&amp;D LoI 1'</b> Speaker: Dr. Felpeng NING (IHEP) Material: <a href="#">Slides</a>

## Physics 17 LoI

Open Physics Questions	
Conveners: Mr. Manqi Ruan (IHEP)	
16:00	<b>EF01-Higgs boson CP properties at CEPC 3'</b> Speakers: Meng Xiao, Xin Shi Material: <a href="#">Slides</a>
16:03	<b>EF01-Measurement of branching fractions of Higgs hadronic decays 3'</b> Speaker: Yanping Huang Material: <a href="#">Slides</a>
16:06	<b>EF02-Study of Electroweak Phase Transition in Exotic Higgs Decays with CEPC Detector Simulation 3'</b> Speaker: Shu Li Material: <a href="#">Slides</a>
16:09	<b>EF03-Feasibility study of CP-violating Phase <math>\phi_s</math> measurement via <math>B_s \rightarrow J/\psi \phi</math> channel at CEPC 3'</b> Speaker: Mingrui Zhao Material: <a href="#">Slides</a>
16:12	<b>EF03-Probing top quark FCNC couplings <math>tq_Y</math>, <math>tq_Z</math> at future <math>e^+e^-</math> collider 3'</b> Speaker: Peiwen Wu Material: <a href="#">Slides</a>
16:15	<b>EF03-Searching for <math>B_s \rightarrow \phi \nu \nu</math> and other <math>b \rightarrow s \nu \nu</math> processes at CEPC 3'</b> Speaker: Lingfeng Li Material: <a href="#">Slides</a>
16:18	<b>EF04-Measurement of the leptonic effective weak mixing angle at CEPC 3'</b> Speaker: Siqi Yang Material: <a href="#">Slides</a>
16:21	<b>EF04-Probing new physics with the measurements of <math>e^+e^- \rightarrow W+W^-</math> at CEPC with optimal observables 3'</b> Speaker: Jiayin Gu Material: <a href="#">Slides</a>
16:24	<b>EF05-Exclusive Z decays 3'</b> Speaker: Qin Qin Material: <a href="#">Slides</a>
16:27	<b>EF05-NNLO electroweak correction to Higgs and Z associated production at future Higgs factory 3'</b> Speaker: Zhao Li Material: <a href="#">Slides</a>
16:30	<b>EF08-SUSY global fits with future colliders using GAMBIT 3'</b> Speaker: Peter Athron Material: <a href="#">Slides</a>
16:33	<b>EF08-Probing Supersymmetry and Dark Matter at the CEPC, FCCee, and ILC 3'</b> Speaker: Tianjun Li Material: <a href="#">Slides</a>
16:36	<b>EF09-Search for Asymmetric Dark Matter model at CEPC by displaced lepton jets 3'</b> Speaker: Mengchao Zhang Material: <a href="#">Slides</a>
16:39	<b>EF09-Search for <math>t + j + \text{MET}</math> signals from dark matter models at future <math>e^+e^-</math> collider 3'</b> Speaker: Peiwen Wu Material: <a href="#">Slides</a>
16:42	<b>EF0910-Dark Matter via Higgs portal at CEPC 3'</b> Speaker: Xin Shi Material: <a href="#">Slides</a>
16:45	<b>EF0910-Lepton portal dark matter, gravitational waves and collider phenomenology 3'</b> Speaker: Ke-Pan Xie Material: <a href="#">Slides</a>
16:48	<b>RF1-Exploring new physics with <math>B_c \rightarrow \tau \nu_\tau</math> 3'</b> Speaker: Taifan Zheng Material: <a href="#">Slides</a>