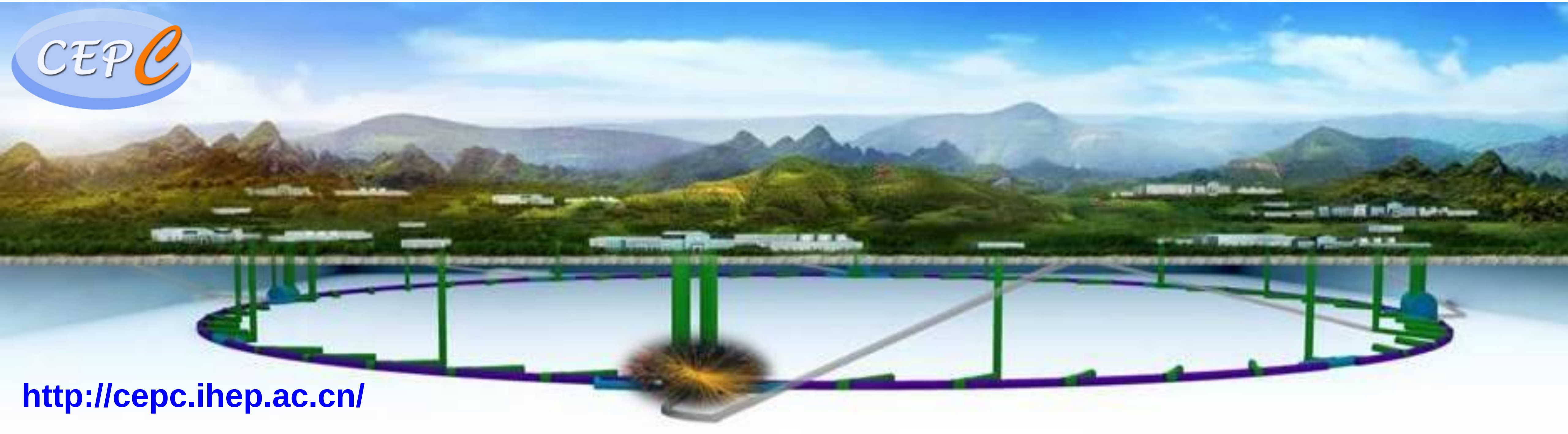
Overview of the CEPC Project
Implementation of 2021 IAC Recommendations

Haijun Yang (for the CEPC working group)

上海交通大學 SHANGHAI JIAO TONG UNIVERSITY | 李政道研究所 Tsung-Dao Lee Institute

The 8th CEPC IAC Meeting, Oct. 31 – Nov.4, 2022



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

List of talks for IAC Meeting

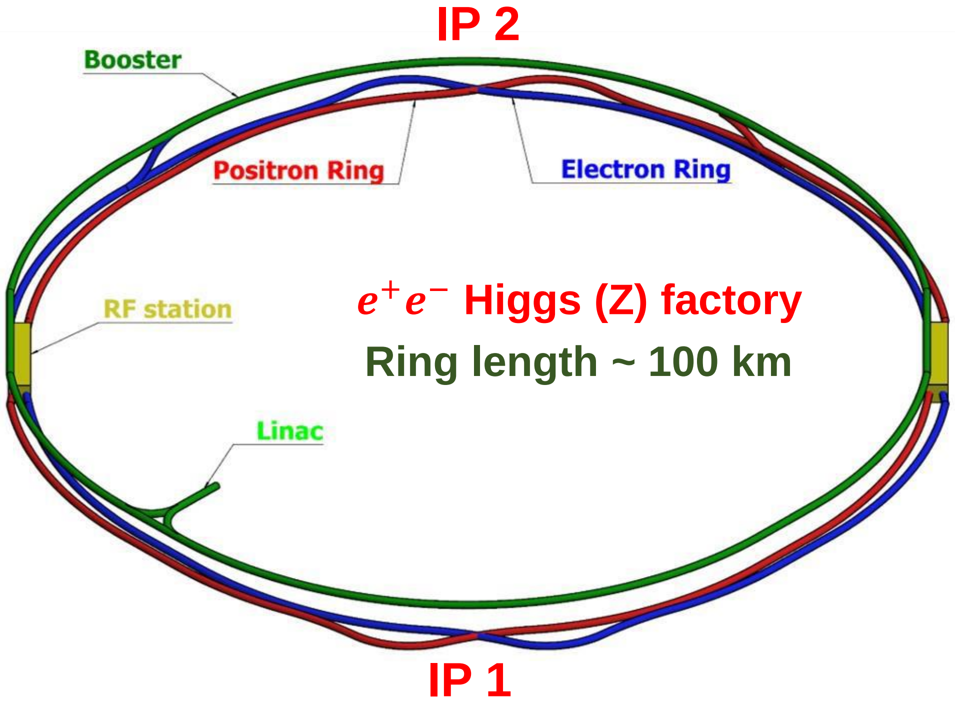
Date and Time	Topics	Speaker
Oct. 31, 20:10 – 20:55	Overview of the CEPC Project and Implementation of 2021 IAC Recommendations	Haijun Yang
Oct. 31, 20:55 – 21:45	CEPC Accelerator: TDR + R&D	Jie Gao
Oct. 31, 22:00 – 22:45	CEPC Detector R&D, Collaboration and Future	Joao G. da Costa
	IAC Accelerator Group	
Nov. 1, 20:00 – 20:25	Sources of components, vendors and partners	Song Jin
Nov. 1, 20:25 – 21:20	IARC Recommendation and Plan	Yuhui Li
Nov. 1, 21:20 – 21:55	Sites and Civil Engineering	Yu Xiao
	IAC Physics & Detector Group	
Nov. 1, 20:00 – 20:50	Detector and Validation	Jianchun Wang
Nov. 1, 20:50 – 21:35	Physics and White Papers	Manqi Ruan
Nov. 1, 21:35 – 22:00	Software Development	Weidong Li

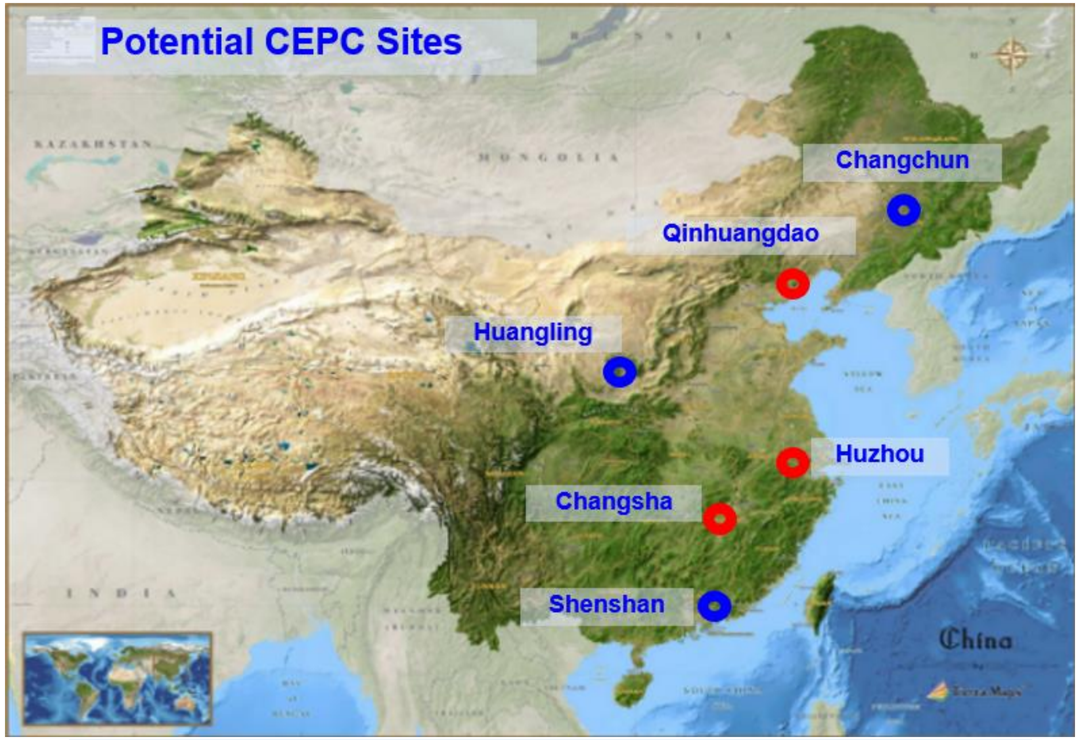
Outline

- Introduction to CEPC
  - Goal and Plan
  - Consensus on e^+e^- Higgs Factory
- Highlights of CEPC R&D
  - Physics Program
  - Accelerator R&D
  - Detector R&D
- Project Global Aspects
  - Core Team, Institutions, Internationalization
  - Funding for R&D and Industrial Engagement
  - Project Cost Estimation and Sharing
  - Project Timeline
- Implementation of IAC Recommendations
- Summary and Prospect

Circular Electron Positron Collider (CEPC)

- CEPC is an e^+e^- Higgs factory producing Higgs / W / Z bosons and top quarks, aims at discovering new physics beyond the Standard Model
- Proposed in 2012 right after the Higgs discovery
- Proposed to commence construction in ~2026 and start operation in 2030s.
- Upgrade: Super pp Collider (SppC) of $\sqrt{s}$ ~ 100 TeV in the future.





→ CEPC Accelerator： Jie Gao

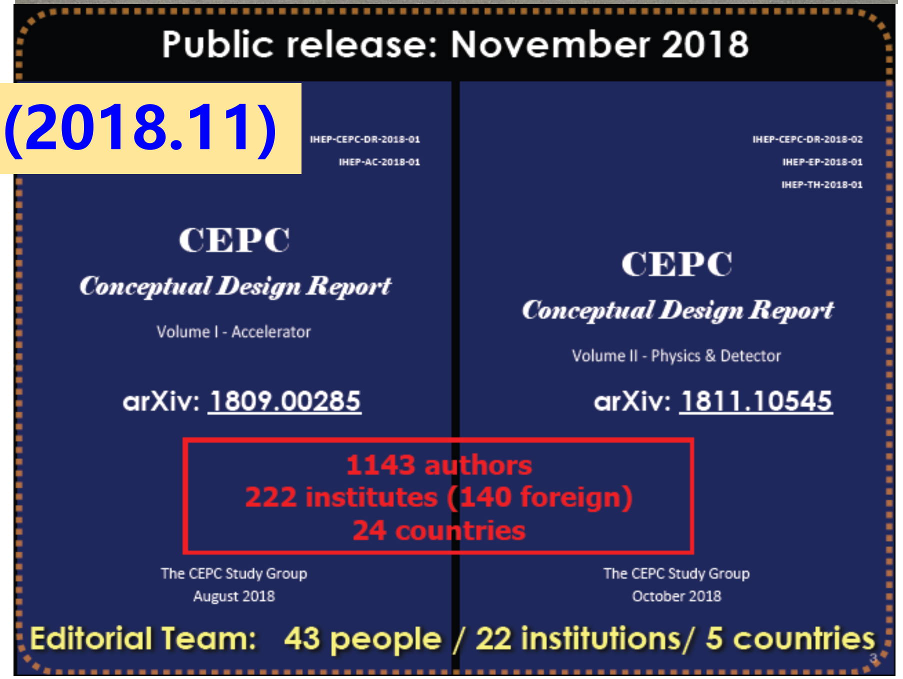
→ Sites and Civil Engineering: Yu Xiao

CEPC Major Milestones

CEPC-SPPC Kickoff (2013.9)

CEPC IAC Meeting (2015.9)

CEPC CDR Released (2018.11)



Consensus in HEP Community for e^+e^- Higgs Factory

The scientific importance and strategical value of an e^+e^- Higgs factory is clearly identified.

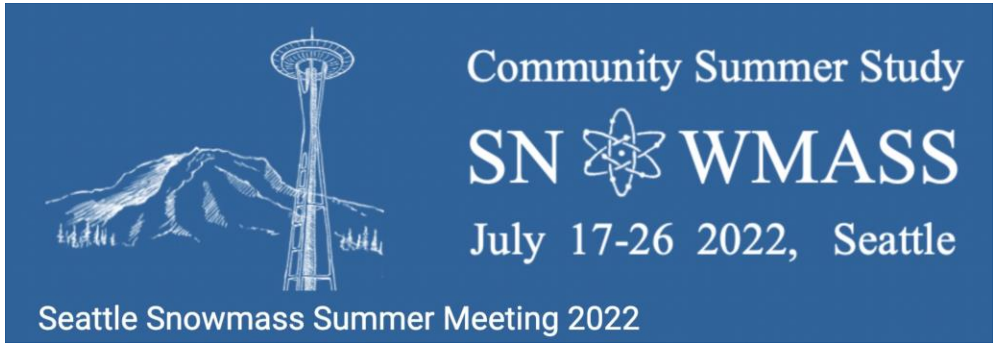
XIANGSHAN SCIENCE CONFERENCES

Clear consensus in HEP community

*2013, 2016: **the CEPC is the best approach** and a major historical opportunity for the national development of accelerator-based high-energy physics program.*

2020 European Strategy Update

An electron-positron Higgs factory is the highest-priority next collider. For the longer term, the European particle physics community has the ambition to operate a proton-proton collider at the highest achievable energy. Accomplishing these compelling goals will require innovation and cutting-edge technology:



Conclusion from Executive Summary

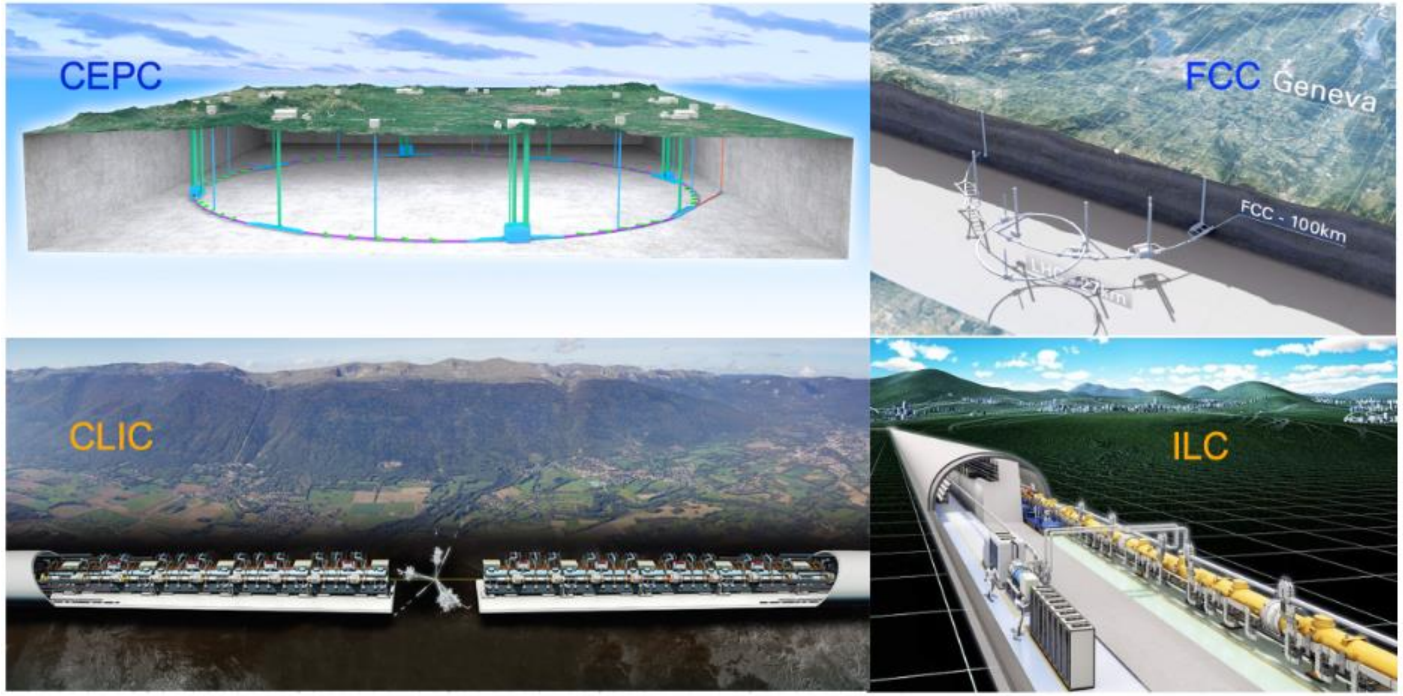
Given the **strong motivation** and existence of proven technology to build an e^+e^- **Higgs Factory in the next decade**, the **US should participate** in the construction of **any facility that has firm commitment** to go forward.

Sridhara Dasu (Wisconsin)

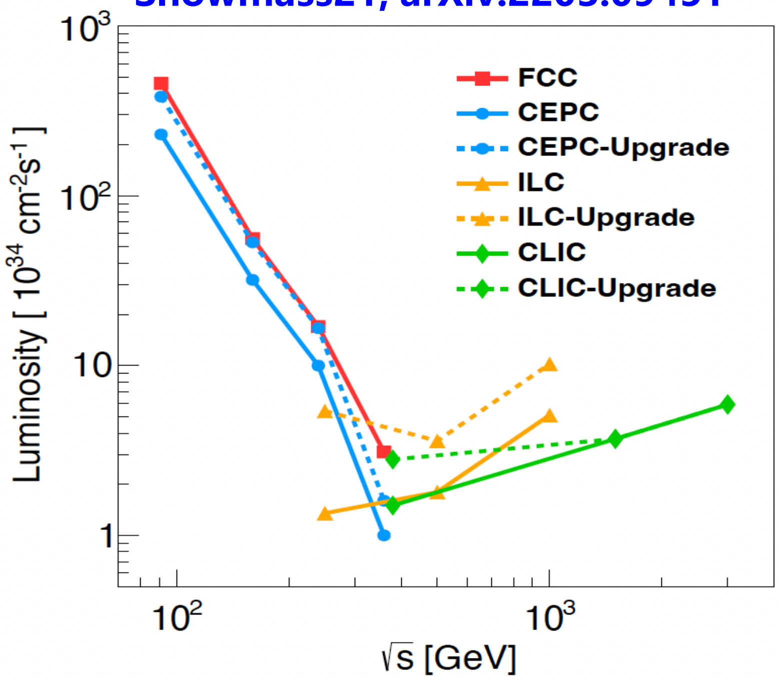
ICFA

*In April 2022, the International Committee for Future Accelerators (ICFA) "reconfirmed the international consensus on the importance of **a Higgs factory as the highest priority for realizing the scientific goals of particle physics**", and expressed support for the above-mentioned Higgs factory proposals. Recently, the United States also proposed a new linear collider concept based on the cool copper collider (C3) technology [31].*

Comparison with other international Higgs factories



CEPC Accelerator white paper for Snowmass21, arXiv:2203.09451



CEPC has substantive advantage among mature e+e- Higgs factories (design report delivered)

Versus FCC-ee

- Earlier data: collisions expected in 2030s (vs. ~ 2040s)
- Large tunnel cross section (ee & pp coexistence)
- Lower cost: ~ ½ the construction cost with similar luminosity up to 240 GeV

Versus Linear Colliders

- Higher luminosity for Higgs and Z runs
- Potential upgrade for pp collider

Highlights of CEPC R&D

CEPC Physics Program (White Papers)

CEPC Operation mode		ZH	Z	W^+W^-	ttbar
$\sqrt{s}$ [GeV]		~ 240	~ 91.2	~ 160	~ 360
Run time [years]		7	2	1	-
CDR (30MW)	*L* / IP [$\times10^{34}$ cm^{-2}s^{-1}]	3	32	10	-
	$\int L\,dt$ [ab^{-1}, 2 IPs]	5.6	16	2.6	-
	Event yields [2 IPs]	1×10^6	7×10^{11}	2×10^7	-
Run time [years]		10	2	1	5
Latest TDR (50MW)	*L* / IP [$\times10^{34}$ cm^{-2}s^{-1}]	8.3	191.7	26.6	0.8
	$\int L\,dt$ [ab^{-1}, 2 IPs]	20	96	7	1
	Event yields [2 IPs]	4×10^6	4×10^{12}	5×10^7	5×10^5

Yangzhou (2021)

Physics similar to FCC-ee, ILC, CLIC

- 2019.3 **Higgs** White Paper published *(CPC V43, No. 4 (2019) 043002)*
- 2019.7 Workshop@PKU: **EW, Flavor, QCD** working groups formed
- 2020.1 Workshop@HKUST-IAS: Review progress, EW draft ready
- 2021.4 Workshop@Yangzhou: **BSM** working group formed
- **2022.5 Workshop of CEPC physics, software and detector**
- **2022 Input for Snowmass study**

arXiv: 2205.08553

➔ Physics & White Paper: Manqi Ruan

CEPC Physics Program: Higgs and EW

- **Precision Higgs, EW, flavor physics & QCD measurements at unprecedented precision**
- **BSM physics (e.g. dark matter, EWPT, SUSY, LLP, …) up to ~ 10 TeV scale**

CPC Vol43, No.4 (2019) 043002

Precision Higgs Physics at the CEPC*

Fenfen An[4,23] Yu Bai[9] Chunhui Chen[23] Xin Chen[5] Zhenxing Chen[3] Joao Guimaraes da Costa[4] Zhenwei Cui[3] Yaquan Fang[4,6,34] Chengdong Fu[4] Jun Gao[10] Yanyan Gao[22] Yuanning Gao[3] Shao-Feng Ge[15,29] Jiayin Gu[13] Fangyi Guo[1,4] Jun Guo[10] Tao Han[5,31] Shuang Han[4] Hong-Jian He[11,10] Xianke He[10] Xiao-Gang He[11,10,20] Jifeng Hu[10] Shih-Chieh Hsu[32] Shan Jin[8] Maoqiang Jing[4,7] Susmita Jyotishmati[33] Ryuta Kiuchi[4] Chia-Ming Kuo[21] Pei-Zhu Lai[21] Boyang Li[5] Congqiao Li[3] Gang Li[4,34] Haifeng Li[12] Liang Li[10] Shu Li[11,10] Tong Li[12] Qiang Li[3] Hao Liang[4,6] Zhijun Liang[4,34] Libo Liao[4] Bo Liu[4,23] Jianbei Liu[1] Tao Liu[14] Zhen Liu[26,30] Xinchou Lou[4,6,33,34] Lianliang Ma[12] Bruce Mellado[17,18] Xin Mo[4] Mila Pandurovic[16] Jianming Qian[24] Zhuoni Qian[19] Nikolaos Rompotis[22] Manqi Ruan[4] Alex Schuy[32] Lian-You Shan[4] Jingyuan Shi[9] Xin Shi[4] Shufang Su[25] Dayong Wang[3] Jin Wang[4] Lian-Tao Wang[27] Yifang Wang[4,6] Yuqian Wei[4] Yue Xu[5] Haijun Yang[10,11] Ying Yang[4] Weiming Yao[28] Dan Yu[4] Kaili Zhang[4,6] Zhaoru Zhang[4] Mingrui Zhao[2] Xianghu Zhao[4] Ning Zhou[10]

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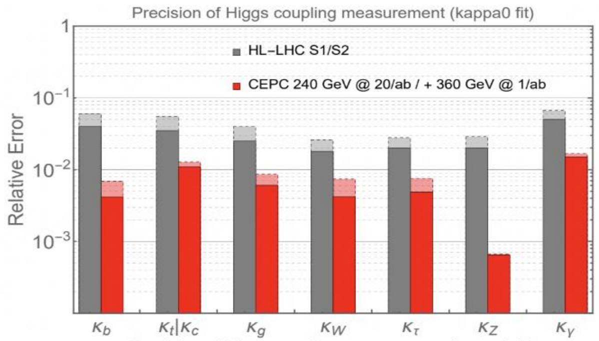
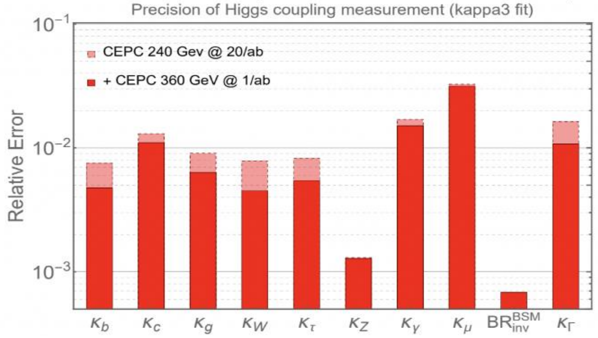
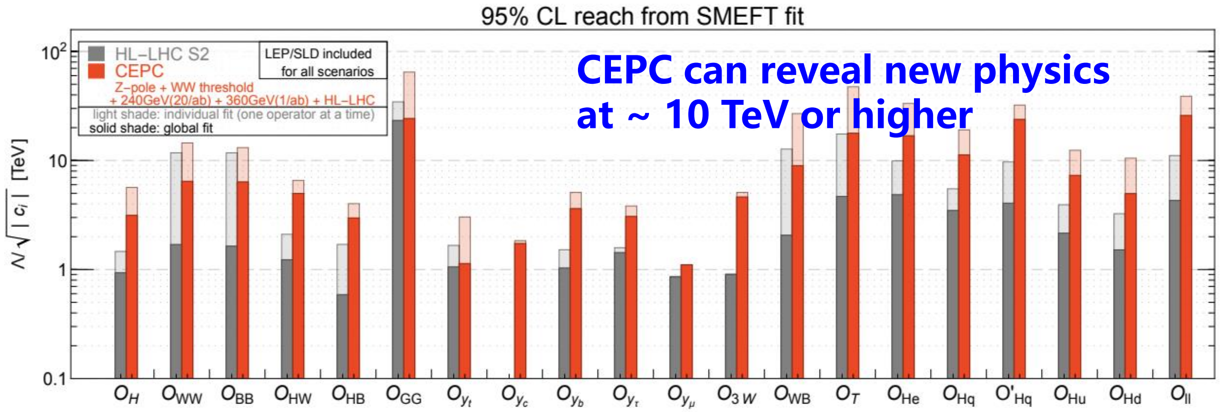
❖ **O(100) Journal / arXiv papers**

	240 GeV, 20 ab^{-1}		360 GeV, 1 ab^{-1}		
	ZH	vvH	ZH	vvH	eeH
inclusive	0.26%		1.40%	\	\
H→bb	0.14%	1.59%	0.90%	1.10%	4.30%
H→cc	2.02%		8.80%	16%	20%
H→gg	0.81%		3.40%	4.50%	12%
H→WW	0.53%		2.80%	4.40%	6.50%
H→ZZ	4.17%		20%	21%	
$H\to\tau\tau$	0.42%		2.10%	4.20%	7.50%
$H\to\gamma\gamma$	3.02%		11%	16%	
$H\to\mu\mu$	6.36%		41%	57%	
$H\to Z\gamma$	8.50%		35%		
$Br_{upper}(H\to inv.)$	0.07%				
Γ_H	1.65%		1.10%		





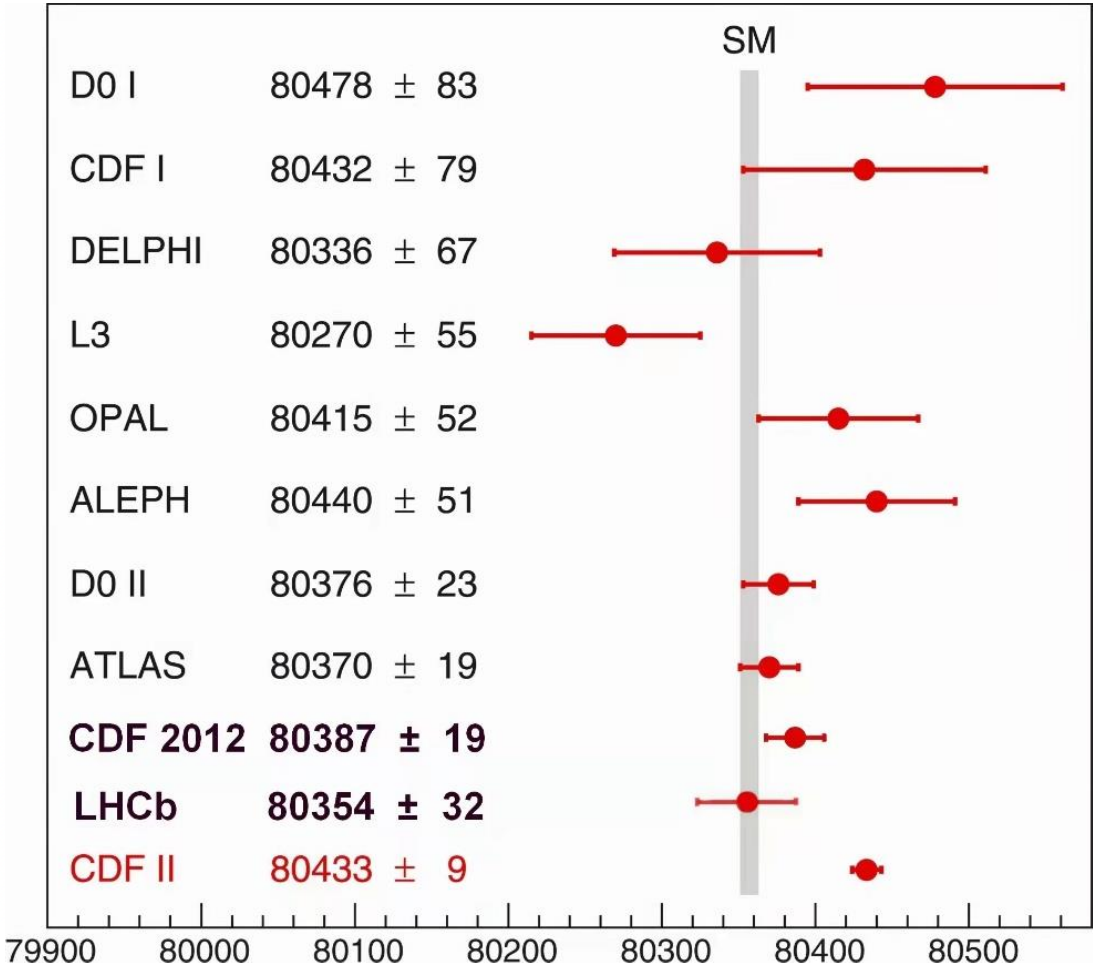


CEPC can reveal new physics at ~ 10 TeV or higher

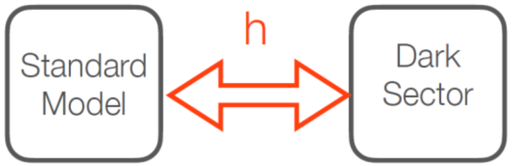
CEPC Physics Program: Higgs and EW

- **Precision Higgs, EW, flavor physics & QCD measurements at unprecedented precision**
- **BSM physics (e.g. dark matter, EWPT, SUSY, LLP, …) up to ~ 10 TeV scale**

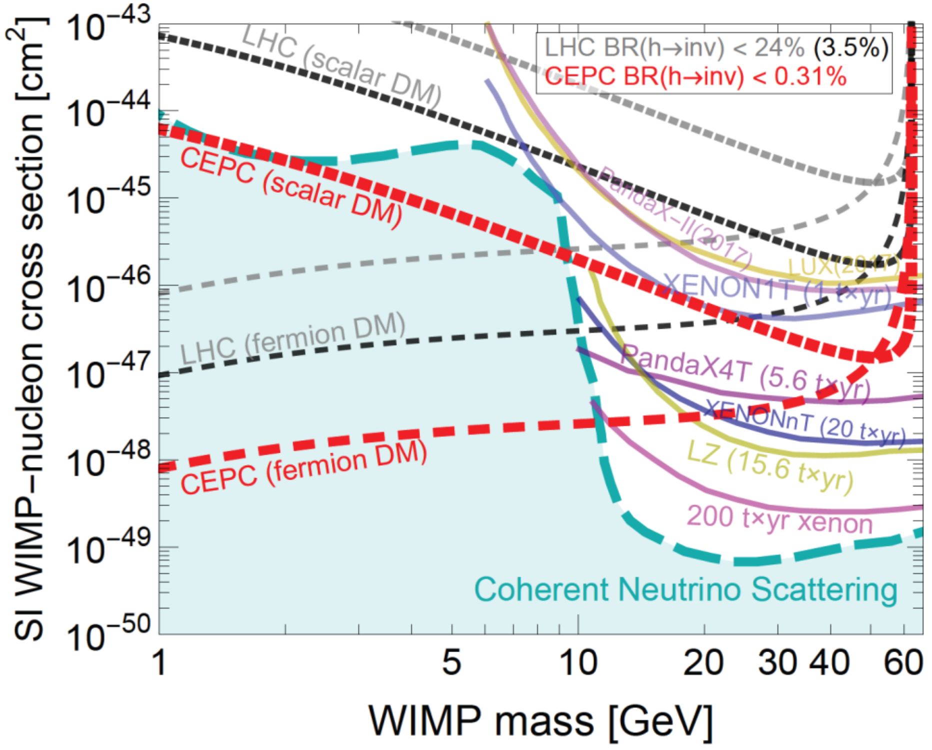
Observable	current precision	CEPC precision (Stat. Unc.)	CEPC runs	main systematic
Δm_Z	2.1 MeV [37–41]	0.1 MeV (0.005 MeV)	Z threshold	E_{beam}
$\Delta\Gamma_Z$	2.3 MeV [37–41]	0.025 MeV (0.005 MeV)	Z threshold	E_{beam}
Δm_W	9 MeV [42–46]	0.5 MeV (0.35 MeV)	WW threshold	E_{beam}
$\Delta\Gamma_W$	49 MeV [46–49]	2.0 MeV (1.8 MeV)	WW threshold	E_{beam}
Δm_t	0.76 GeV [50]	$\mathcal{O}(10)$ MeV[a]	$t\bar{t}$ threshold	
ΔA_e	4.9×10^{-3} [37, 51–55]	1.5×10^{-5} (1.5×10^{-5})	Z pole ($Z\to\tau\tau$)	Stat. Unc.
ΔA_μ	0.015 [37, 53]	3.5×10^{-5} (3.0×10^{-5})	Z pole ($Z\to\mu\mu$)	point-to-point Unc.
ΔA_τ	4.3×10^{-3} [37, 51–55]	7.0×10^{-5}(1.2×10^{-5})	Z pole ($Z\to\tau\tau$)	tau decay model
ΔA_b	0.02 [37, 56]	20×10^{-5} (3×10^{-5})	Z pole	QCD effects
ΔA_c	0.027 [37, 56]	30×10^{-5} (6×10^{-5})	Z pole	QCD effects
$\Delta\sigma_{had}$	37 pb [37–41]	2 pb (0.05 pb)	Z pole	lumiosity
δR_b^0	0.003 [37, 57–61]	0.0002 (5×10^{-6})	Z pole	gluon splitting
δR_c^0	0.017 [37, 57, 62–65]	0.001 (2×10^{-5})	Z pole	gluon splitting
δR_e^0	0.0012 [37–41]	2×10^{-4} (3×10^{-6})	Z pole	E_{beam} and t channel
δR_μ^0	0.002 [37–41]	1×10^{-4} (3×10^{-6})	Z pole	E_{beam}
δR_τ^0	0.017 [37–41]	1×10^{-4} (3×10^{-6})	Z pole	E_{beam}
δN_ν	0.0025 [37, 66]	2×10^{-4} (3×10^{-5})	ZH run ($\nu\nu\gamma$)	Calo energy scale

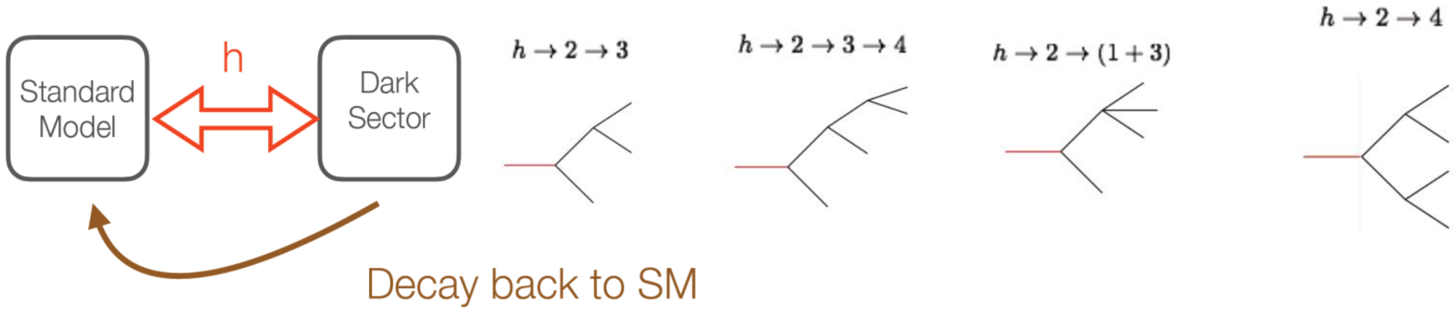


CEPC Physics Program: Discovery Potential

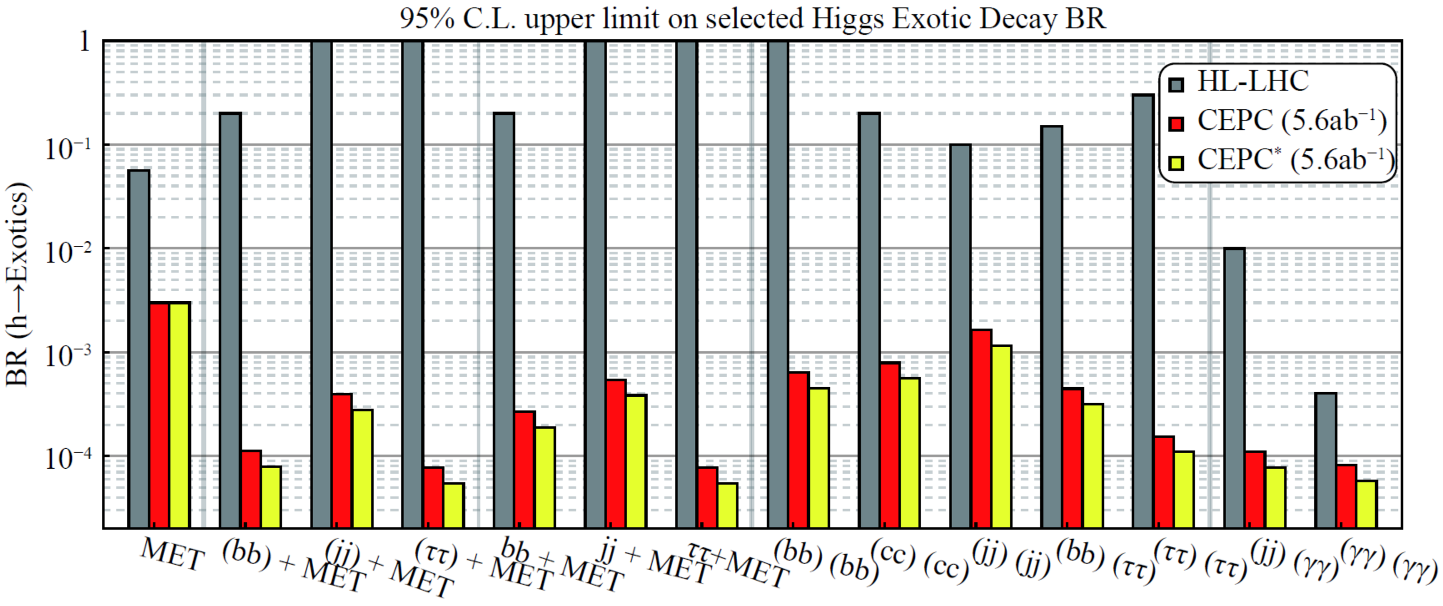


$$h \to X_{dm} X_{dm}$$





Higgs decays into BSM particles, H→ X_1X_2



CEPC has significantly better detection sensitivity for dark matter and selected Higgs exotic decays than HL-LHC

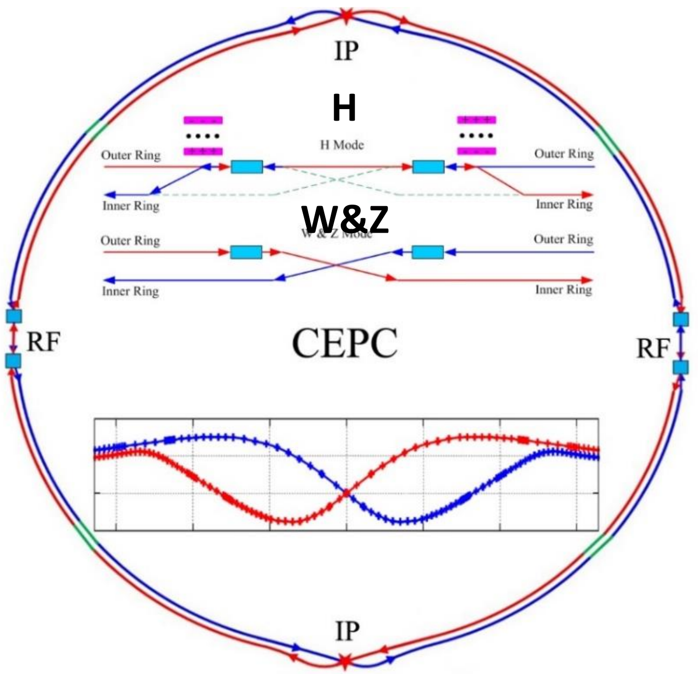
CEPC Design and Technical Requirements

Innovative Design	➢ 100km Full/Partial Double Rings ➢ Switchable operation for Higgs, W and Z ➢ Flexible injection modes to satisfy different energies ➢ World's 1st design of a high energy/flux γ-ray synchrotron light
Technical Performance	➢ High efficiency Klystron (aim at highest transfer efficiency) ➢ High performance SRF cavities (state-of-the-art Q and gradient) ➢ Novel magnets: Weak field dipole, dual aperture magnets (First Qualified Prototype)
Major Technology Breakthrough	➢ Plasma wakefield acceleration for Injector(New Acceleration Principle) ➢ High field superconducting magnet (Iron based HTS proposal)

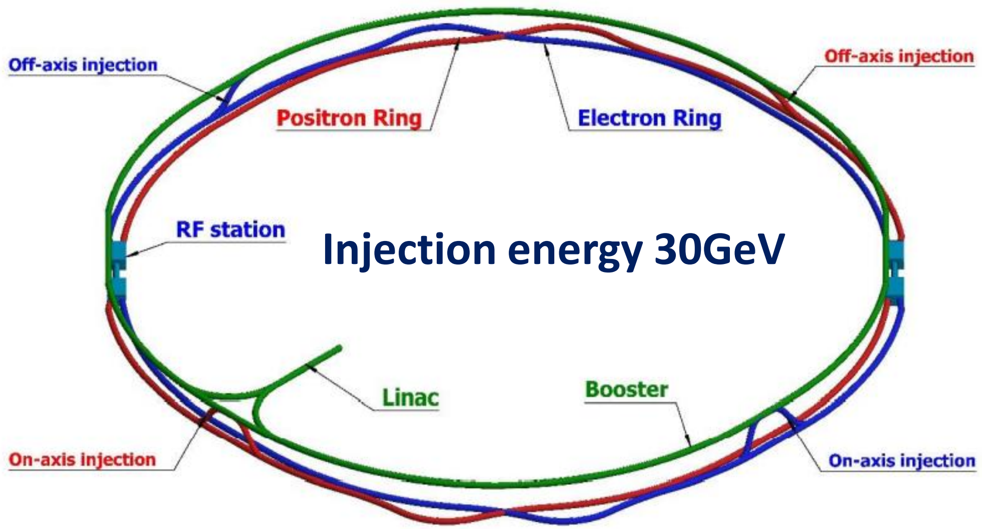
CEPC focuses on innovative designs and key technology R&D to fulfill the challenging design requirement !

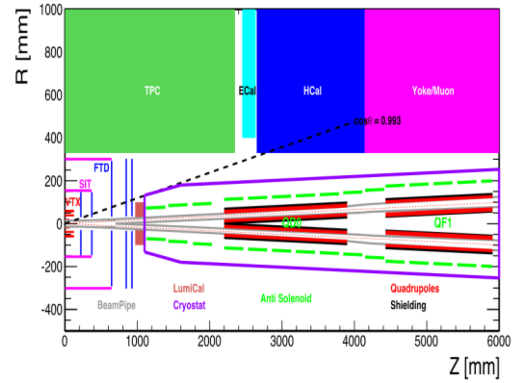
CEPC Accelerator Design Improvement & TDR

- 100 km double ring design (30 MW SR power, upgradable to 50MW).
- Switchable operation for H & Z, W modes without hardware change.

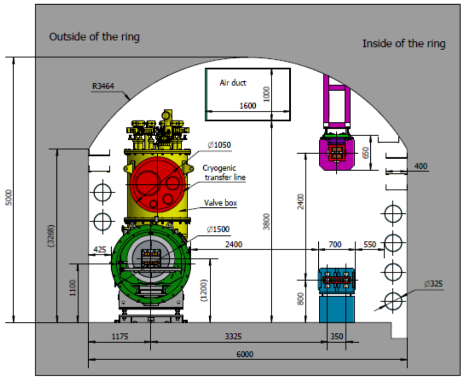


➔ Jie Gao' s talk

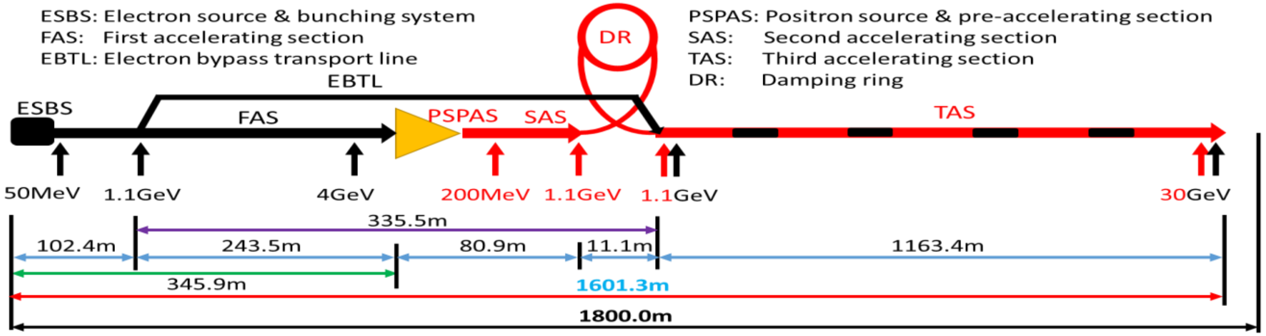




TUNNEL CROSS SECTION OF THE ARC AREA



CEPC TDR S+C-band 30GeV Linac Injector



Operation mode		ZH	Z	W^+W^-	tt
$\sqrt{s}$ [GeV]		~240	~91.2	158-172	~360
L / IP [$\times 10^{34}$ $cm^{-2}s^{-1}$]	CDR (2018)	3	32	10	-
	TDR (30MW)	5.0	115	16	0.5
	TDR (50MW)	8.3	191.7	26.6	0.8

Status of CEPC Accelerator R&D

✓ Specification Met

☑ Prototype Manufactured

	Accelerator	Cost (billion CNY)	Ratio
✓	Magnets	4.47	27.3%
✓	Vacuum	3.00	18.3%
☑	RF power source	1.50	9.1%
✓	Mechanics	1.24	7.6%
✓	Magnet power supplies	1.14	7.0%
✓	SCRF	1.16	7.1%
✓	Cryogenics	1.06	6.5%
✓	Linac and sources	0.91	5.5%
✓	Instrumentation	0.87	5.3%
☑	Control	0.39	2.4%
☑	Survey and alignment	0.40	2.4%
✓	Radiation protection	0.17	1.0%
☑	SC magnets	0.07	0.4%
✓	Damping ring	0.04	0.2%

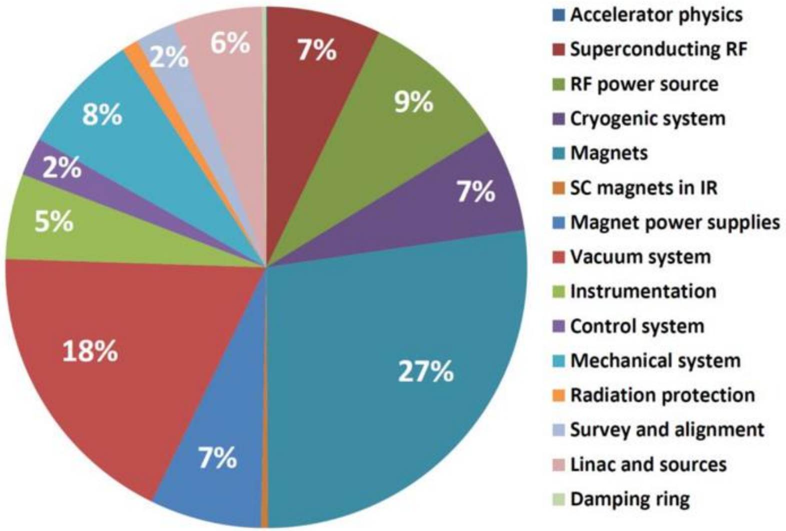
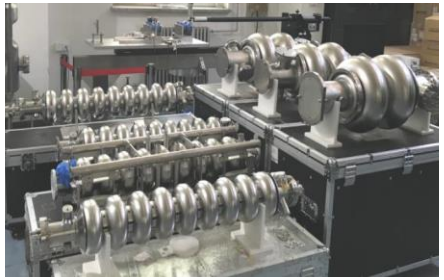


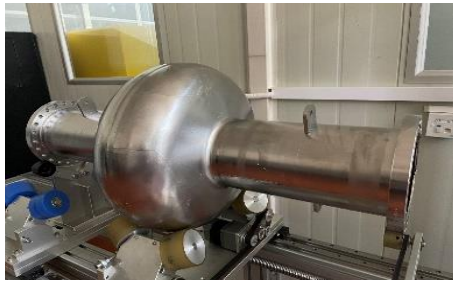
Figure 12.3: Cost breakdown of the CEPC accelerator technical systems.

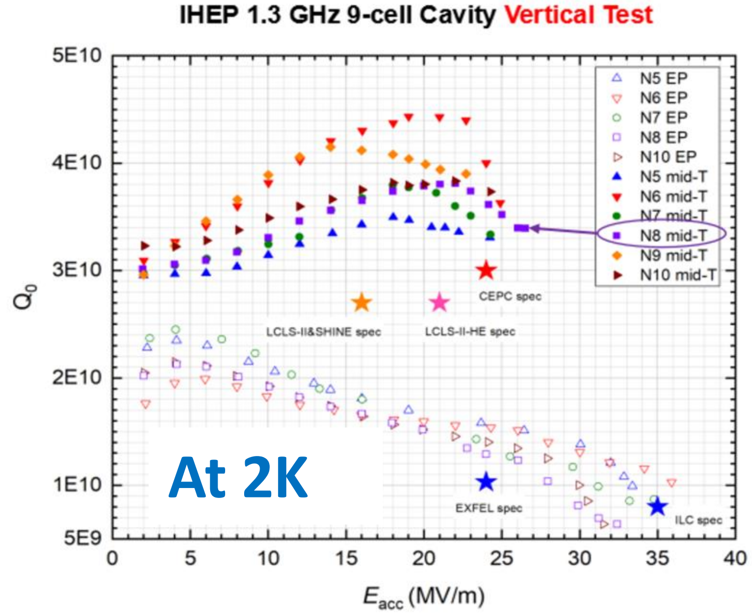
CEPC R&D: High Q SCRF Cavities

- 1.3 GHz 9-cell SCRF cavity for booster: Q_0 = 3.4E10 @ 26.5 MV/m
- 650 MHz 2-cell SCRF cavity for collider ring: Q_0 = 6.0E10 @ 22.0 MV/m
- 650 MHz 1-cell SCRF cavity for collider ring: Q_0 = 6.0E10 @ 31.0 MV/m

All SCRF satisfied CEPC design specifications.

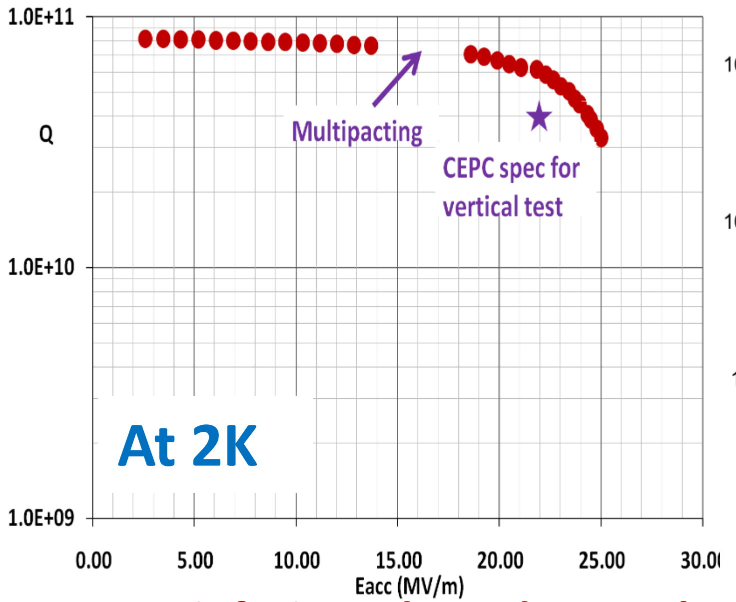






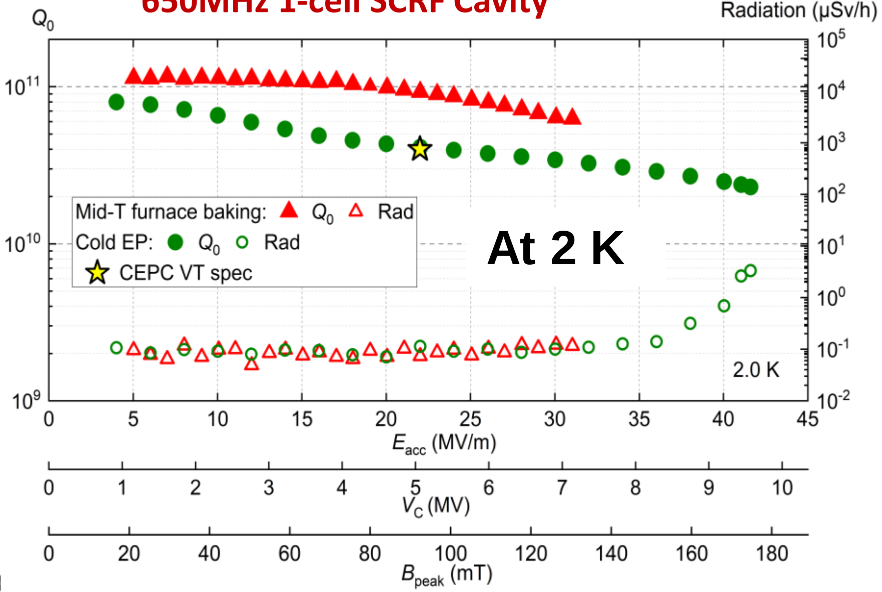
Medium-temperature (Mid-T) annealing adopted to reach Q_0 = 3.4E10 @ 26.5 MV/m

Vertical test of 650 MHz 2-cell cavity



N-infusion adopted to reach Q_0 = 6.0E10 @ 22.0 MV/m

650MHz 1-cell SCRF Cavity



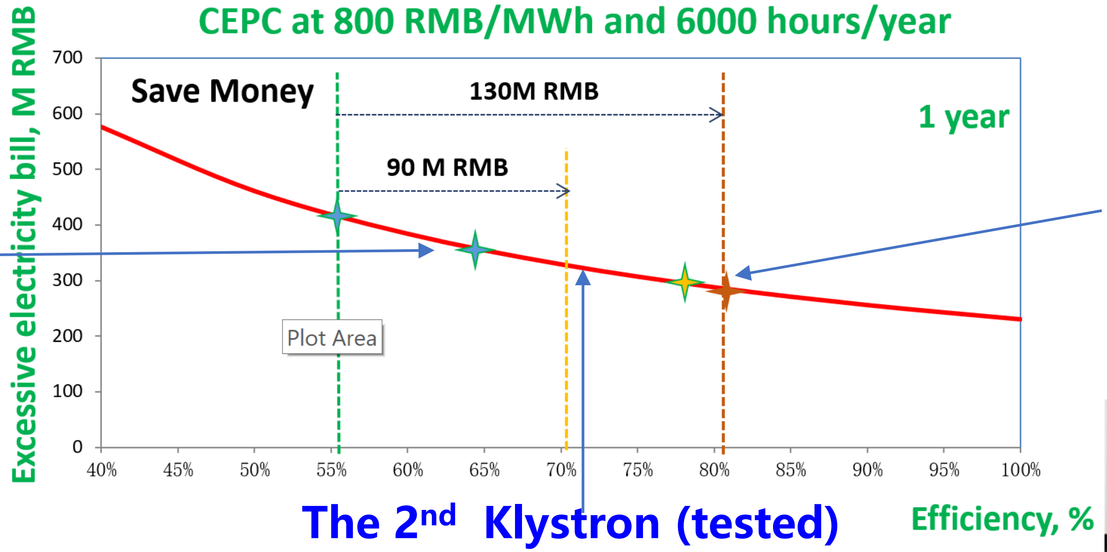
Q_0 = 6.0E10 @ 31 MV/m

Q_0 = 2.1E10 @ 42 MV/m

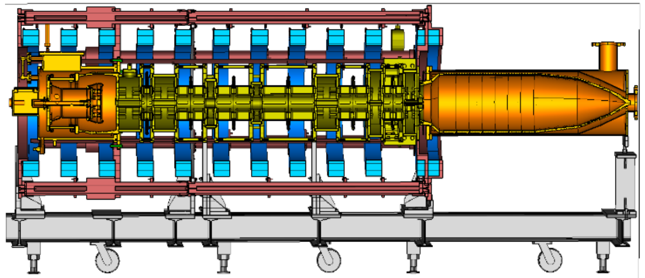
CEPC R&D: High Efficiency Klystrons

- The 1st Klystron prototype, achieved efficiency ~ 65%.
- The 2nd Klystron prototype tested at PAPS in 2022, design eff. is 77%, achieved eff. ~ 70.5%
- The 3rd Klystron (MBK) is under fabrication, design eff. is ~ 80.5%.
- High efficiency Klystron helps to reduce electricity consumption.

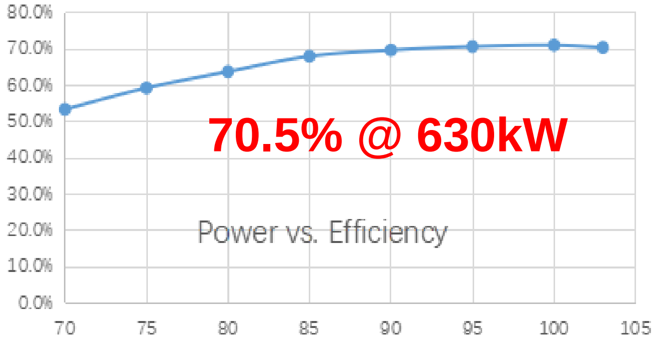
The 1st Klystron (tested)



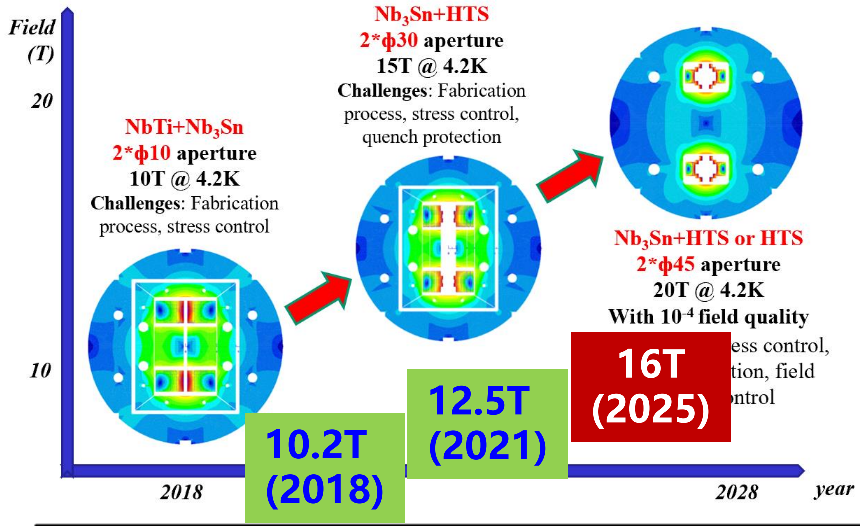
The 3rd multi-beam Klystron (MBK) under fabrication

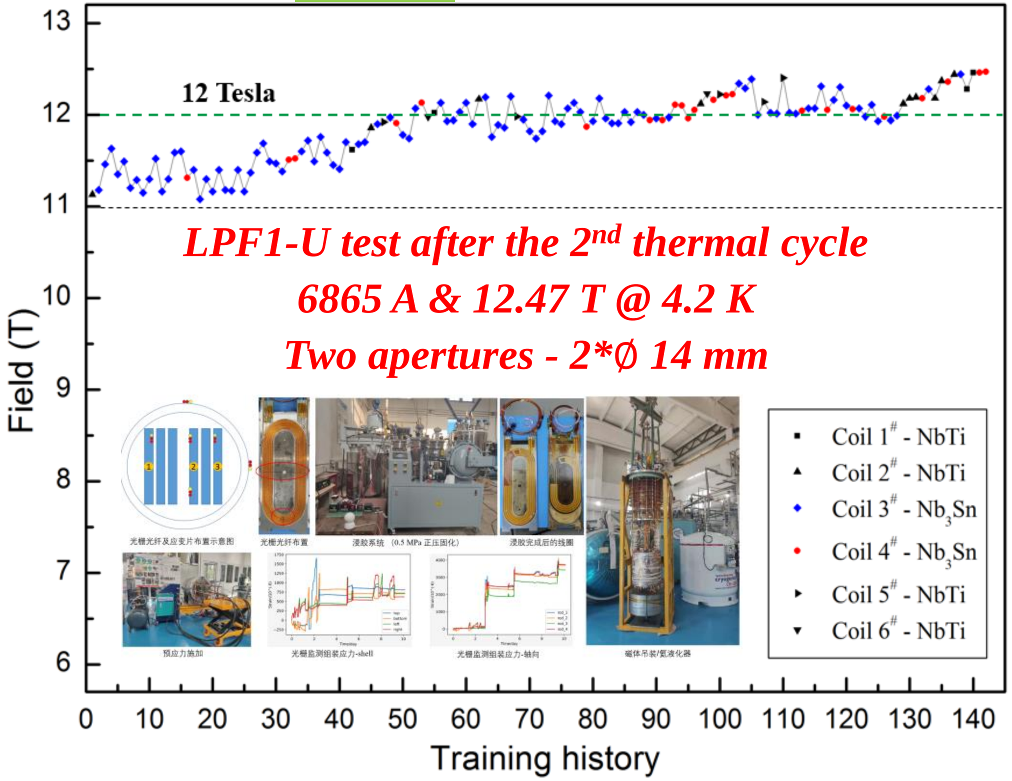


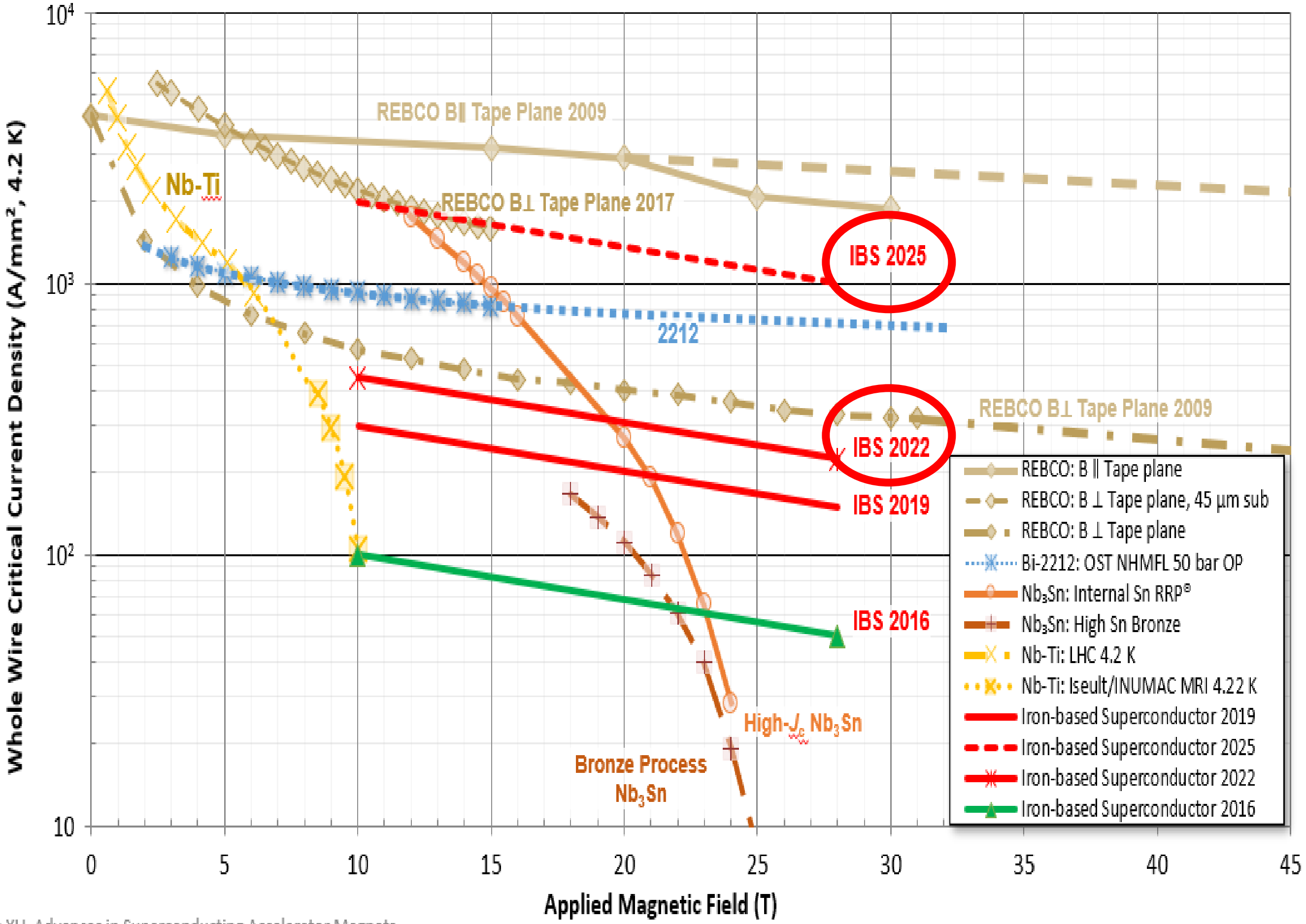
The 2nd Klystron (tested)



HTS SC Magnet and Iron-Based Superconductor



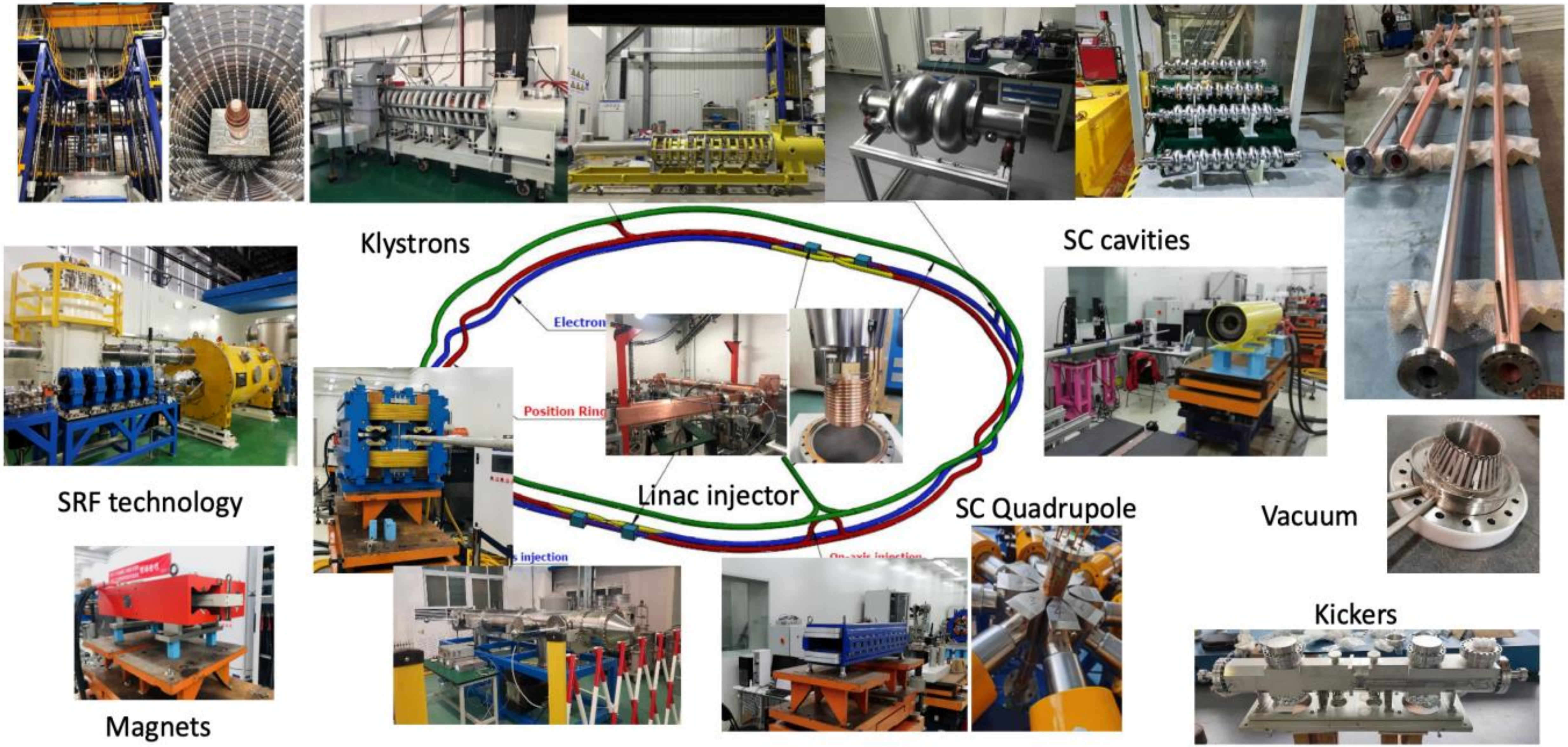




Q XU, Advances in Superconducting Accelerator Magnets

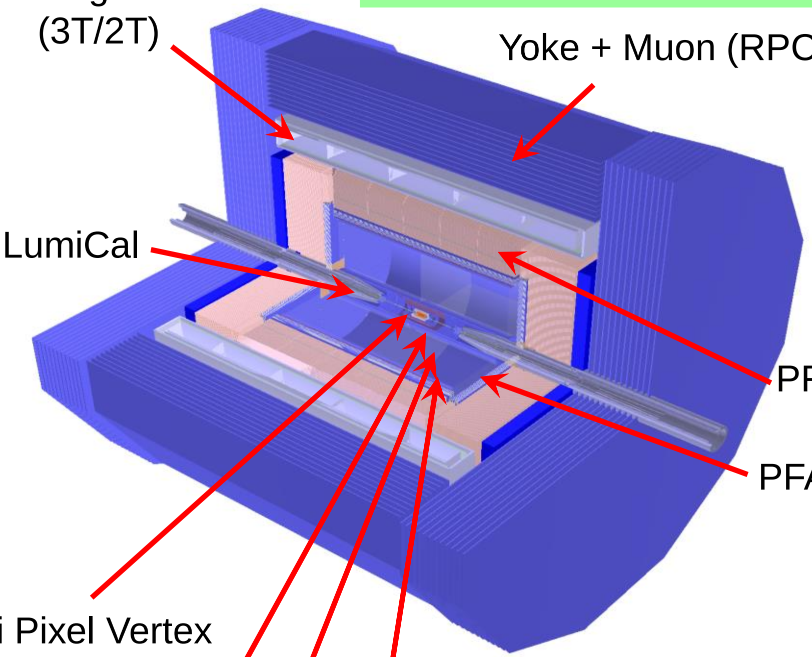
- **Stainless-steel stabilized IBS tape achieved the highest J_e in 2022**
- **Significantly reduced the cost and improve mechanical properties of IBS conductor.**

CEPC Key Technologies R&D

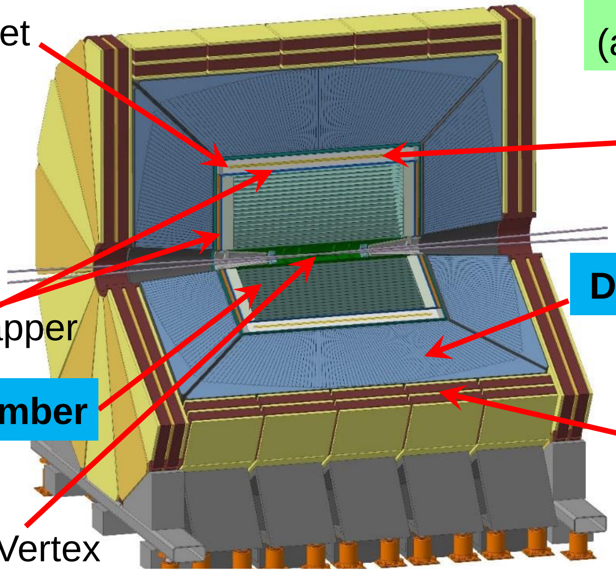


CEPC Conceptual Detector Designs

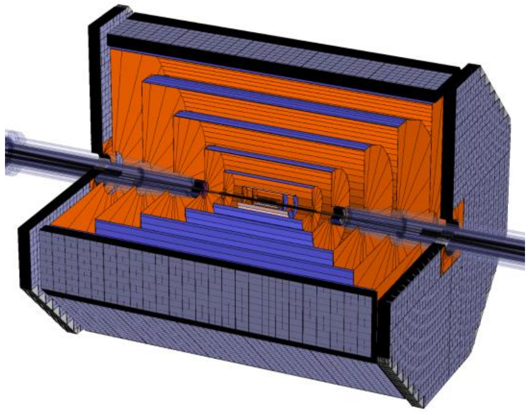
(Baseline Design)
Particle Flow Approach



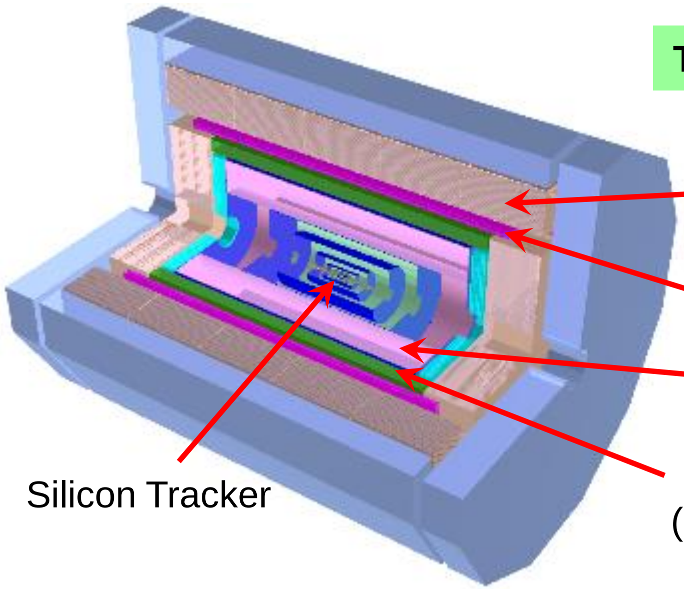
IDEA concept
(also proposed for FCC-ee)



FST concept
(Full Silicon Tracker)



The 4th Concept



Novel Conceptual Detector Design

Scint Glass PFA HCAL

Advantage: Cost efficient, high density
Challenges: Light yield, transparency, massive production.

Solenoid Magnet (3T / 2T) Between HCAL & ECAL

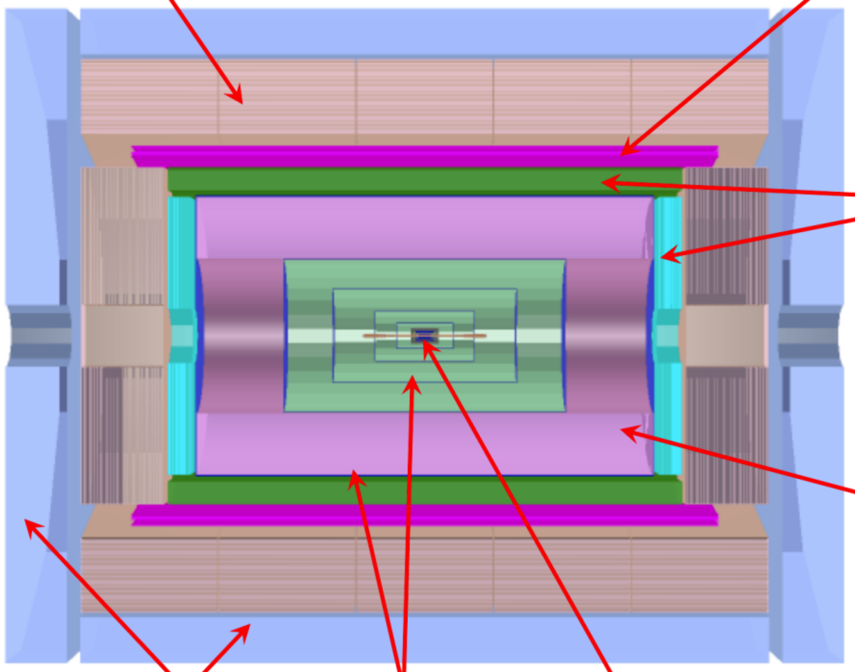
Advantage: the HCAL absorbers act as part of the magnet return yoke.
Challenges: thin enough not to affect the jet resolution (e.g. BMR); stability.

Transverse Crystal bar ECAL

Advantage: better π^0/γ reconstruction.
Challenges: minimum number of readout channels; compatible with PFA calorimeter; maintain good jet resolution.

A Drift chamber that is optimized for PID

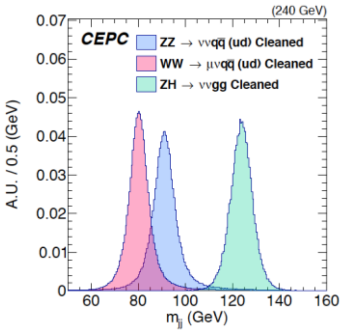
Advantage: Work at high luminosity Z runs
Challenges: sufficient PID power; thin enough not to affect the moment resolution.



Muon+Yoke **Si Tracker** **Si Vertex**

Det	Technology
Pixel Vertex	JadePix
	TaichuPix
	Arcadia
	CPV(SOI)
	Stitching
Tracker & PID	TPC
	CEPCPix
	Drift chamber
	PID DC
	LGAD
	Silicon Strip

Det	Technology
Calorimeter	Crystal ECAL
	Si+W ECAL
	Scint+W ECAL
	Scint AHCAL
	ScintGlass AHCAL
	RPC SDHCAL
	MPGD SDHCAL
	DR Calorimeter
Muon	Scintillation Bar
	RPC
	µ-Rwell
Lumi	SiTrk+Crystal ECAL
	SiTrk+SiW ECAL



Novel detector design based on PFA calorimeter. Aim at improving BMR 4% → 3%

Detector	World-class level	CEPC design
PFA based (ECAL)	～ 15% / √E	< 3% / √E (Crystal ECAL)
PFA based (HCAL)	～ 50% / √E	～ 40% / √E (Scintillating glass HCAL)

Status of CEPC Detector R&D

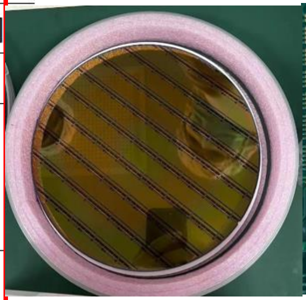
- **Extensive detector R&D benefitted from experience**
  - Silicon strip : from ATLAS detector upgrade
  - MDI, Drift chamber & SC magnet : from BESIII
- **CEPC R&D on key technologies**
  - Silicon pixel, silicon tracker and TPC
  - PFA calorimeter

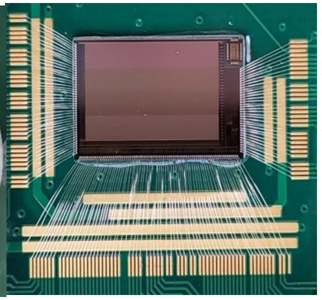
- **With international partners, all sub-detector covered**
  - PFA calorimeter: with CALICE Collaboration
  - TPC: with LCTPC Collaboration
  - Drift chamber: with Italian colleague
  - Silicon tracker: with UK/Germany/Italian colleague
  - Silicon vertex: with French/Spain colleague

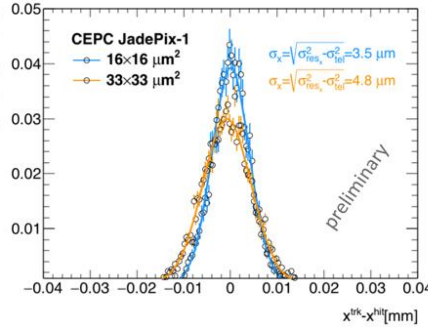
PFA calorimeter

Sub-detector	Specification	Requirement	World-class level	CEPC prototype
Pixel detector	Spatial resolution	$\sim 3\ \mu m$	$3-5\ \mu m$ [12, 13]	$3-5\ \mu m$ [14–16]
TPC/drift chamber	dE/dx (dN/dx) resolution	$\sim 2\%$	$\sim 4\%$ [17, 18]	$\sim 4\%$ [19–21]
Scintillator-W ECal	Energy resolution Granularity	$< 15\%/\sqrt{E(\mathrm{GeV})}$ $\sim 2\times 2\ \mathrm{cm}^2$	12.5% [22]	Prototype built to be measured $0.5\times 0.5\ \mathrm{cm}^2$
4D crystal ECal	EM energy resolution 3D Granularity	$\sim 3\%/\sqrt{E(\mathrm{GeV})}$ $\sim 2\times 2\times 2\ \mathrm{cm}^3$	$2\%/\sqrt{E(\mathrm{GeV})}$ [23, 24] N/A	Prototyping [25] $\sim 3\%/\sqrt{E(\mathrm{GeV})}$ $\sim 2\times 2\times 2\ \mathrm{cm}^3$
Scintillator-Steel HCal	Support PFA, Single hadron σ_E^{had}	$< 60\%/\sqrt{E(\mathrm{GeV})}$	$57.6/\sqrt{E(\mathrm{GeV})}\%$ [26]	Prototyping
Scintillating glass HCal	Support PFA Single hadron σ_E^{had}	$\sim 40\%/\sqrt{E(\mathrm{GeV})}$	N/A	Prototyping $\sim 40\%/\sqrt{E(\mathrm{GeV})}$
Low-mass Solenoid magnet	Magnet field strength Thickness	2 T – 3 T < 150 mm	1 T – 4 T [27–29] > 270 mm	Prototyping

Silicon vertex detector R&D (3-5μm)

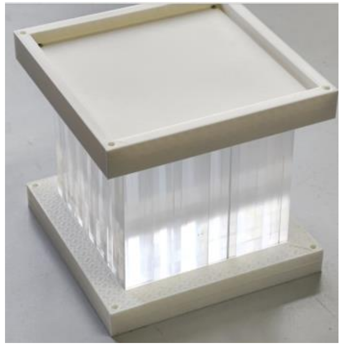






PFA ScW-ECAL and AHCAL

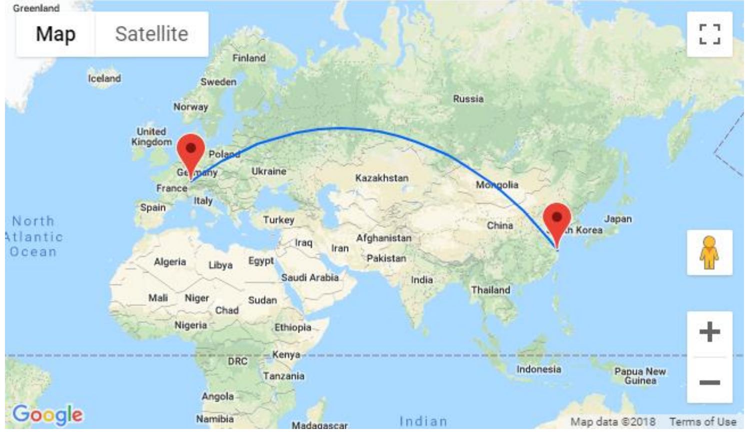
4D crystal ECAL

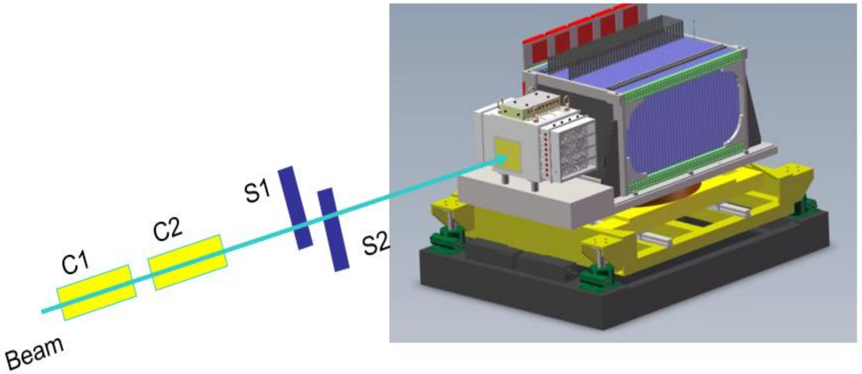


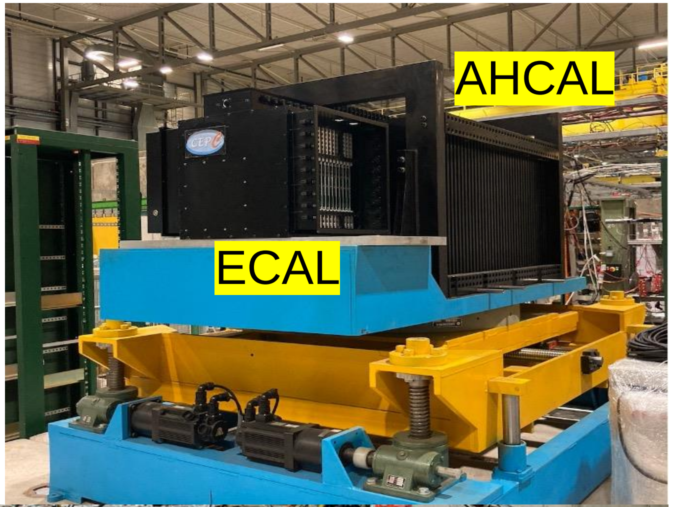
→ **CEPC Detector R&D: Joao G. da Costa**
→ **Detector and validation: Jianchun Wang**

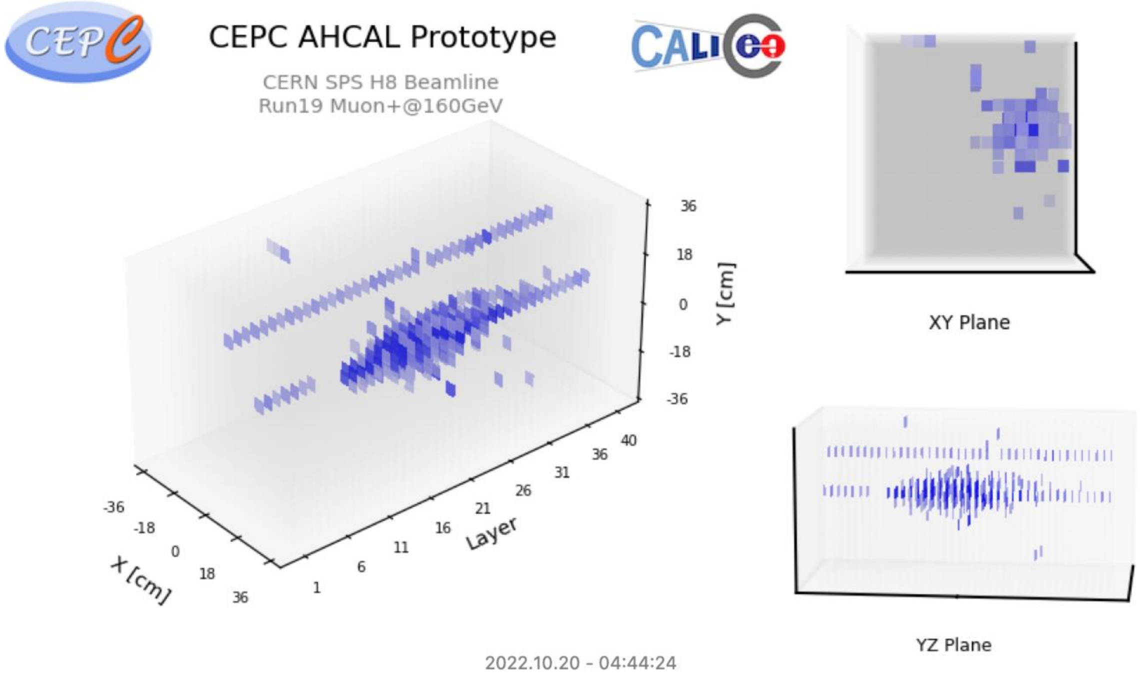
CEPC PFA Calorimeter Prototypes

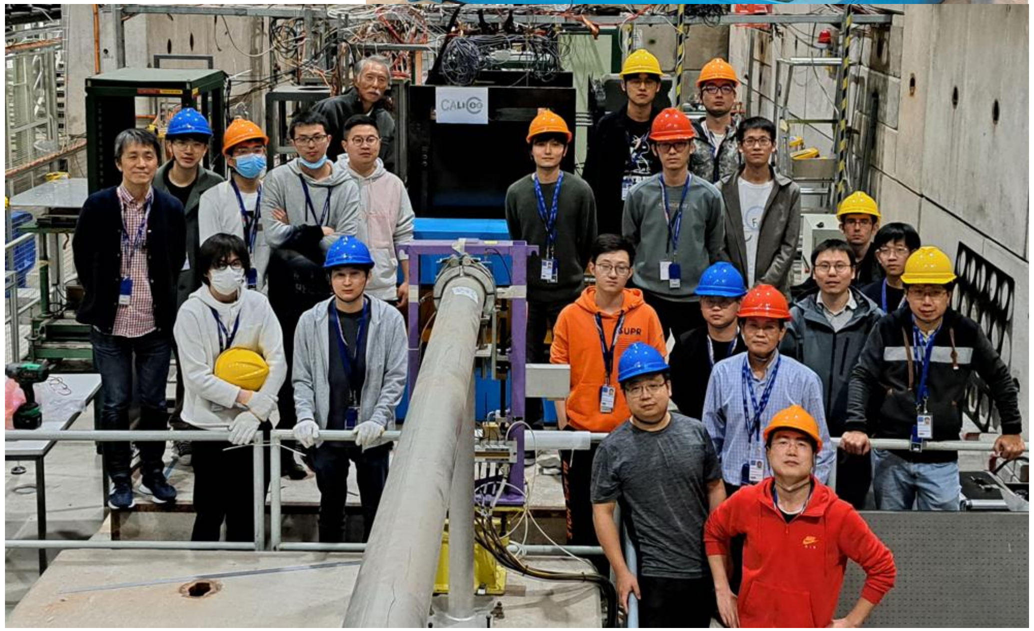
➢ **PFA ScW-ECAL & AHCAL prototypes: Test Beam at CERN (October, 2022)**





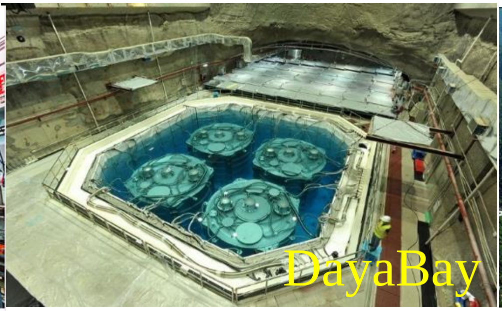






Project Global Aspects

Synergies: IHEP experience with large projects



- **IHEP is one of the few institutions in the world that can host a project like the CEPC:**
  - **It has rich management experience and successful constructed many large scientific facilities**
  - **It has full coverage of all technical disciplines for accelerators and detectors, in particular for the design and construction of circular e+e- collider (BEPCII) and the detector(BESIII)**
  - **It has all needed infrastructure for construction of large facilities**
  - **It has successfully hosted international projects such as BESIII, Daya Bay, JUNO, LHAASO, etc.**
- **CEPC is committed by IHEP and workplan endorsed by CAS**

CEPC R&D Status

- CEPC received ~ 260 Million CNY from MOST, CAS, NSFC, etc for R&D
- Large amount of key technologies validated in other projects: BEPCII, HEPS, …

CEPC R&D ~ 50% cost of acc. components	➢ High efficiency klystron ➢ 650MHz SRF cavities ➢ Key components to e+ source ➢ High performance Linac ➢ Electrostatic Deflector ➢ Cryogenic system	➢ Novel magnets: Weak field dipole, dual aperture magnets ➢ Extremely fast injection/extraction ➢ Vacuum chamber tech. ➢ Survey & Alignment for ultra large Acc. ➢ MDI
BEPCII / HEPS ~ 40% cost of acc. components	➢ High precision magnet ➢ Stable magnet power source ➢ Vacuum chamber with NEG coating ➢ Instrumentation, Feedback system ➢ Traditional RF power source ➢ SRF cavities	➢ Electron Source, traditional Linac ➢ Survey & Alignment ➢ Ultra stable mechanics ➢ Radiation protection ➢ Cryogenic system ➢ MDI

~ 10% missing items consist of anticipated challenges in the machine integration, commissioning etc. and the corresponding international contribution

CEPC Industrial Promotion Consortium (CIPC)

- CIPC, established in 2017, composed of ~ 70 high tech. enterprises, covers Superconducting materials, SC cavities, cryomodules, cryogenics, Klystrons, electronics, power source, vacuum, civil engineering, etc. CIPC actively joins the Key technology R&D and prepares for the mass production for the CEPC construction.
- CEPC strongly promote relevant technology development (cost-benefit).
- CEPC study group is surveying main international suppliers.

➔ Sources of components, vendors and partners ： Song Jin

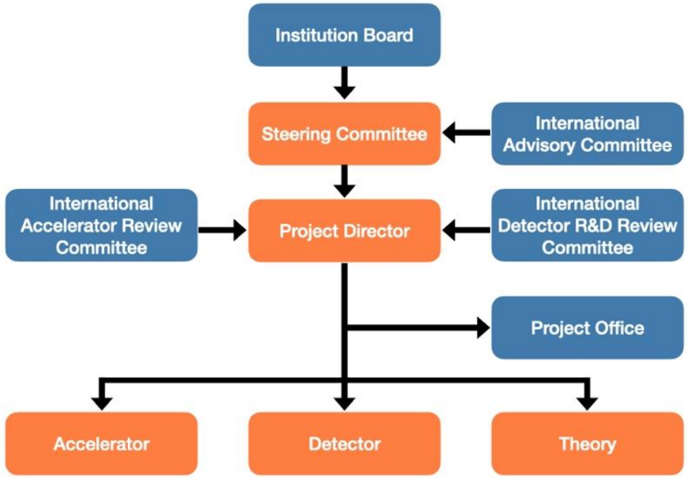
CCT SC Magnet

Klystron

SC Coil Winding

CEPC Team

CEPC Organization



- **Institution Board:** 32 institutes, top universities/institutes in China
- **Management team:** comprehensive management experience at construction projects of BEPCII/CSNS/HEPS, and international projects of BESIII/Daya Bay/JUNO/…
- **Accelerator team:** fully over all disciplines with rich experiences at BEPCII, HEPS…
- **Physics and Detector team:** fully over all disciplines with rich experiences at BESIII, Daya Bay, JUNO, ATLAS, CMS, LHCb …

Table 7.2: Team of Leading and core scientists of the CEPC

Name	Brief introduction	Role in the CEPC team
Yifang Wang	Academician of the CAS, director of IHEP	The leader of CEPC, chair of the SC
Xinchou Lou	Professor of IHEP	Project manager, member of the SC
Yuanning Gao	Academician of the CAS, head of physics school of PKU	Chair of the IB, member of the SC
Jie Gao	Professor of IHEP	Convener of accelerator group, vice chair of the IB, member of the SC
Haijun Yang	Professor of SJTU	Deputy project manager, member of the SC
Jianbei Liu	Professor of USTC	Convener of detector group, member of the SC
Hongjian He	Professor of USTC	Convener of theory group, member of the SC
Shan [illegible]	[illegible]	[illegible]
Nu Xu	Professor of IMP	Member of the SC
Meng Wang	Professor of SDU	Member of the SC
Qing[illegible]	[illegible]	[illegible]
Wei Lu	Professor of THU	Member of the SC
Joao Guimaraes da Costa	Professor of IHEP	Convener of detector group
Jianchun Wang	Professor of IHEP	Convener of detector group
Yuhui Li	Professor of IHEP	Convener of accelerator group
Chenghui Yu	Professor of IHEP	Convener of accelerator group
Jingyu Tang	Professor of IHEP	Convener of accelerator group
Xiaogang He	Professor of SJTU	Convener of theory group
Jianping Ma	Professor of ITP	Convener of theory group

Management team, leading scientists

Table 7.3: Team of the CEPC accelerator system

Number	Sub-system	Convener	Team (senior staff)
1	Accelerator physics	Chenghui Yu, Yuan Zhang	18
2	Magnets	Wen Kang, Fusan Chen	12
3	Cryogenic system	Rui Ge, Ruixiong Han	11
4	SC RF system	Jiyuan Zhai, Peng Sha	12
5	Beam Instrumentation	[illegible]	[illegible]
6	SC magnets	Qingjin Xu	10
7	Power supply	Bin Chen, [illegible]	[illegible]
8	Injection & extraction	Jinhui Chen	7
9	Mechanical system	Jianli Wang, Lan Dong	[illegible]
10	Vacuum system	Haiyi Dong, Yongsheng Ma	5
11	Control system	Ge lei, Gang Li	6
12	Linac injector	Jingyi Li, Jingru Zhang	13
13	Radiation protection	Zhongjian Ma	3
Sum			117

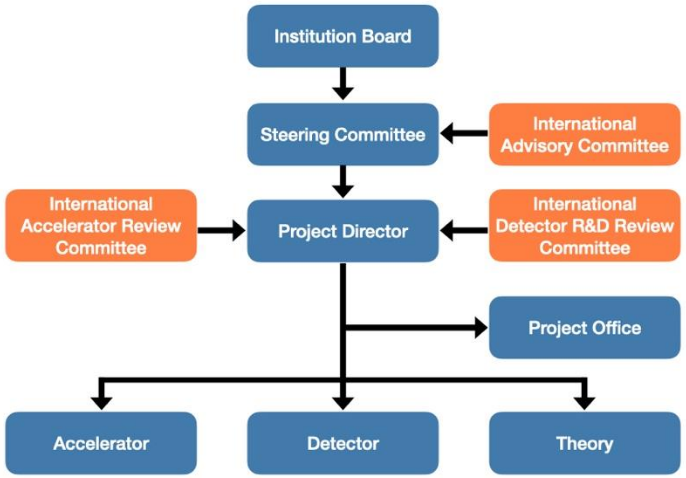
Table 7.4: Team of the CEPC detector system

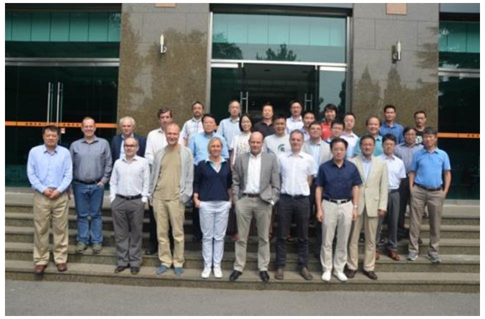
Number	Sub-system	Conveners	Institutions	Team (senior staff)
1	Pixel Vertex Detector	Zhijun Liang, Qun Ouyang, Xiangming Sun , Wei Wei	CCNU, IFAE, IHEP, NJU, NWPU, SDU, Strasbourg, ...	~ 40
2	Silicon Tracker	Harald Fox, Meng Wang, Hongbo Zhu	IHEP, INFN, KIT, Lancaster, Oxford, Queen Mary, RAL, SDU, Tsinghua, Bristol, Edinburgh, Livepool, USTC, Warwick, Sheffield, ZJU, ...	~ 60
3	Gaseous detector	[illegible]	[illegible], DESY, [illegible], IHEP, INFN, NIKHEF, THU ...	~ 30
4	[illegible]	[illegible]	IHEP	~ 10
5	Calorimetry	Roberto Ferrari, Jianbei Liu, Ha[illegible]un Yang, Yong Liu	CALICE Collab., IHEP, INFN, SJTU, USTC..	~ 40
6	Muon	[illegible] Giacomelli, Liang Li, Xiaolong Wang	FDU, IHEP, INFN, SJTU ...	~ 20
7	Physics	Manqi Ruan, Yaquan Fang, Liantao Wang, Mingshui Chen	IHEP, FDU, SJTU, ...	~ 80
8	Software	Shengseng Sun, Weidong Li, Xingtao Huang	IHEP, SDU, FDU, ...	~ 20
Sum				~ 300

117 accelerator + ~300 detector staffs currently, + ~ 400 from BEPC/BESIII/JUNO/HEPS/… once CEPC approved

CEPC International Committees

CEPC Organization





International Advisory Committees

Name	Affiliation	Country
Tatsuya Nakada	EPFL	Japan
Steinar Stapnes	CERN	Norway
Rohini Godbole	CHEP, Bangalore	India
Michelangelo Mangano	CERN	Switzerland
Michael Davier	LAL	France
Lucie Linssen	CERN	Holland
Luciano Maiani	U. Rome	San Marino
Joe Lykken	Fermilab	U.S.
Ian Shipsey	Oxford/DESY	U.K.
Hitoshi Murayama	IPMU/UC Berkeley	Japan
Geoffrey Taylor	U. Melbourne	Australia
Eugene Levichev	BINP	Russia
David Gross	UC Santa Barbara	U.S.
Brian Foster	Oxford	U.K
Marcel Demarteau	ORNL	USA
Barry Barish	Caltech	USA
Maria Enrica Biagini	INFN Frascati	Italy
Yuan-Hann Chang	IPAS	Taiwan, China
Akira Yamamoto	KEK	Japan
Hongwei Zhao	Institute of Modern Physics, CAS	China
Andrew Cohen	University of Science and Techbnology	Hong Kong, China
Karl Jakobs	University of Freiburg/CERN	Germany
Beate Heinemann	DESY	Germany

International Accelerator Review Committee

- Phillip Bambade, LAL
- Marica Enrica Biagini (Chair), INFN
- Brian Foster, DESY/University of Hamburg & Oxford University
- In-Soo Ko, POSTTECH
- Eugene Levichev, BINP
- Katsunobu Oide, CERN & KEK
- Anatolii Sidorin, JINR
- Steinar Stapnes, CERN
- Makoto Tobiyama, KEK
- Zhentang Zhao, SINAP
- Norihito Ohuchi, KEK
- Carlo Pagani, INFN-Milano

International Detector R&D Review Committee

- Jim Brau, USA, Oregon
- Valter Bonvicini, Italy, Trieste
- Ariella Cattai, CERN, CERN
- Cristinel Diaconu, France, Marseille
- Brian Foster, UK, Oxford
- Liang Han, China, USTC
- Dave Newbold, UK, RAL (chair)
- Andreas Schopper, CERN, CERN
- Abe Seiden, USA, UCSC
- Laurent Serin, France, LAL
- Steinar Stapnes, CERN, CERN
- Roberto Tenchini, Italy, INFN
- Ivan Villa Alvarez, Spain, Santader
- Hitoshi Yamamoto, Japan, Tohoku

- **IAC: global renowned scientists and top laboratory or project leaders who have ample experience in project management, planning, and execution of strategies, operating since 2015**
- **IARC & IDRC: leading experts of this field, provide guide to the project director**

CEPC International Efforts

CEPC attracts significant International participation

- Conceptual Design Report: 1143 authors from 221 institutes (including 140 Intl. Institutes)
- 20+ MoUs signed and executed

- Intensive collaboration on Physics studies
- Oversea scientists made substantial contributions to the R&D, especially the detector system

- CEPC International Workshop since 2014
- EU-US versions of CEPC WS: Next one at Marseille
- Annual working month at HKIAS (since 2015)
- Recent CEPC Workshop: Oct.24-28, 2022

  (423 registrants, 285 talks, 38 posters)

CEPC International Efforts

ESPPU input

CEPC Input to the ESPP 2018 - Physics and Detector

CEPC Physics-Detector Study Group

Abstract

The Higgs boson, discovered in 2012 by the ATLAS and CMS Collaborations at the Large Hadron Collider (LHC), plays a central role in the Standard Model. Measuring its properties precisely will advance our understandings of some of the most important questions in particle physics, such as the naturalness of the electroweak scale and the nature of the electroweak phase transition. The Higgs boson could also be a window for exploring new physics, such as dark matter and its associated dark sector, heavy sterile neutrino, et al. The Circular Electron Positron Collider (CEPC), proposed by the Chinese High Energy community in 2012, is designed to run at a center-of-mass energy of 240 GeV as a Higgs factory. With about one million Higgs bosons produced, many of the major Higgs boson couplings can be measured with precisions about one order of magnitude better than those achievable at the High Luminosity-LHC. The CEPC is also designed to run at the Z-pole and the W pair production threshold, creating close to one trillion Z bosons and 100 million W bosons. It is projected to improve the precisions of many of the electroweak observables by about one order of magnitude or more. These measurements are complementary to the Higgs boson coupling measurements. The CEPC also offers excellent opportunities for searching for rare decays of the Higgs, W, and Z bosons. The large quantities of bottom-quarks, charm-quarks, and tau leptons produced from the decays of the Z bosons are interesting for flavor physics. The clean collision environment also makes the CEPC an ideal facility to perform ... proposed for ... concepts can ... potential ... tail in the ... so outline ... scribe the planning and the international organization of the CEPC. The next step for the CEPC team is to perform detailed technical design studies. Effective international collaboration would be crucial at this stage. This submission for consideration by the ESPP is part of our dedicated effort in seeking international collaboration and support. Given the importance of the precision Higgs boson measurements, the ongoing CEPC activities do not diminish our interests in participating in the international collaborations of other future electron-positron collider based Higgs factories.

arXiv: 1901.03170
1901.03169

Snowmass input

Snowmass2021 White Paper AF3- CEPC

CEPC Accelerator Study Group[1]

1. Design Overview

1.1 Introduction and status

The discovery of the Higgs boson at CERN's Large Hadron Collider (LHC) in July 2012 raised new opportunities for large-scale accelerators. The Higgs boson is the heart of the Standard Model (SM), and is at the center of many biggest mysteries, such as the large hierarchy between the weak scale and the Planck scale, the nature of the electroweak phase transition, the original of mass, the nature of dark matter, the stability of vacuum, etc. and many other related questions. Precise measurements of the properties of the Higgs boson serve as probes of the underlying fundamental physics principles of the SM and beyond. Due to the modest Higgs boson mass of 125 GeV, it is possible to produce it in the relatively clean environment of a circular electron–positron collider with high luminosity, new technologies, low cost, and reduced power consumption. In September 2012, Chinese scientists proposed a 240 GeV *Circular Electron Positron Collider* (CEPC), serving two large detectors for Higgs studies and other topics as shown in Fig. 1. The ~100 km tunnel for such a machine could also host a *Super Proton Proton Collider* (SPPC) to reach energies well beyond the LHC.

The CEPC is a large international scientific project initiated and to be hosted by China. It was presented for the first time to the international community at the ICFA Workshop *"Accelerators for a Higgs Factory: Linear vs. Circular"* (HF2012) in Novemb... the White R... (the Yellow R... was made. T... [3] has been ... an internati... 018. In May ... ergy Physics ... DR, CEPC accelerator entered the phase of Technical Design Report (TDR) endorsed by CEPC International Advisory Committee (IAC). In TDR phase, CEPC optimization design with higher performance compared with CDR and the key technologies such as 650MHz high power and high efficiency klystron, high quality SRF accelerator technology, high precision magnets for booster and collider rings, vacuum system, MDI, etc. have been carried out, and the CEPC accelerator TDR will be completed at

[1] Correspondance: J. Gao, Institute of High Energy Physics, CAS, China
Email: gaoj@ihep.ac.cn

arXiv: 2203.09451
2205.08553

- ➢ **CEPC provides critical input to ESPPU & Snowmass as a major player**
- ➢ **Team member actively participated intl. study (ESPPU and Snowmass committees) and Panel discussions**
- ➢ **CEPC attracts intensive international collaboration, ensuring that the CEPC design and technology are among the most advanced in the world.**

CEPC Cost Estimation and Sharing

CDR Cost: ~ 1000 independent items added up

- Cost estimated with two indpendent methods, agrees at 10% level
- CEPC design relies on well studied, or mature technology reducing uncertainties on Cost estimation
- Cost estimation for TDR phase is progressing: no major change

Table 8.1: Cost estimation of the CEPC

Tier I	Tier II	Amount (100 M CNY)
Accelerator	Collider	99.2
	Booster	39.2
	Linac and sources	9.1
	Damping ring	0.44
	Common: Cryogenics	10.6
	Survey & alignment	4
	Radiation protection	1.7
Conventional facilities	-	102
Detectors	-	40
γ-ray beam lines	-	3
Project management (1%)	-	3
Contingency (15%)	-	46
Total	-	358

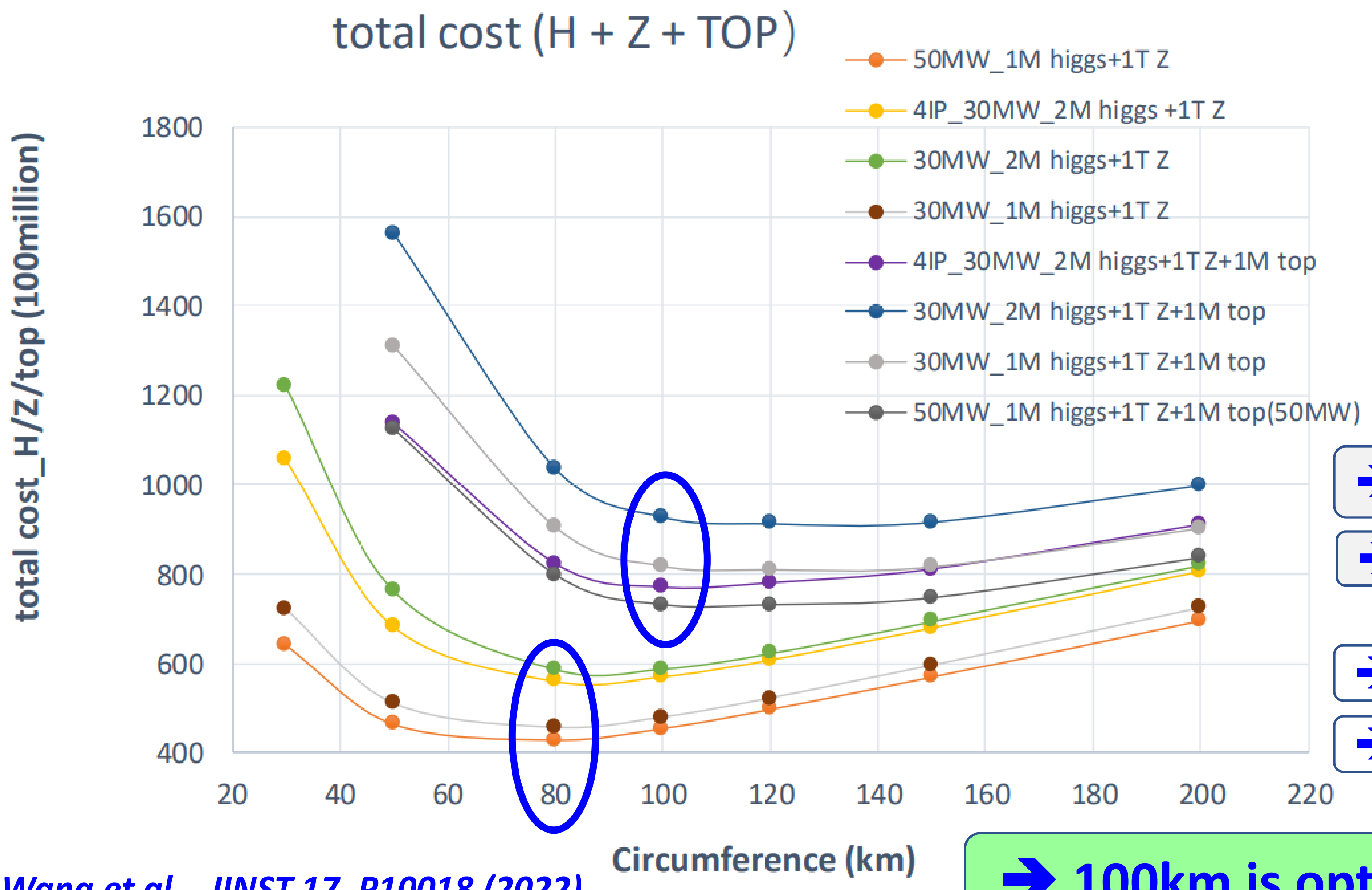
~ 5B CHF

Funding Sources	Funding Model #1 (Billion RMB)	Funding Model #2 (Billion RMB)
Central Government	25	10
Local Government	5	20
International Partners	6	6

CEPC Cost Estimation and Optimization

- **Optimization of CEPC total cost with physics operation vs. Circumference (km)**

$$\text{Cost}_{total} = \text{Cost}_{machine} + \text{Cost}_{detector} + \text{Cost}_{elect} + \text{Cost}_{repair} + \text{Cost}_{staff}$$



$$\text{Cost}_{machine} = \frac{C}{100} \bullet 24(billion) + 6(billion)$$

$$\text{Cost}_{detector} = 2(billion) \times N_{IP}$$

$$\text{Cost}_{elect} = P_{SR} \times 10 \times N_{year} \times month_{operation} \times 30 \times 24 \times 0.5$$

$$\text{Cost}_{repair} = \text{Cost}_{machine} \times 3\% \times N_{year}$$

$$\text{Cost}_{staff} = \left(\text{Cost}_{machine} \times 1\% + 0.1(billion)\right) \times N_{year}$$

➔ 2M H + 1T Z + 1M Top

➔ 1M H + 1T Z + 1M Top

➔ 100km

➔ 2M H + 1T Z

➔ 1M H + 1T Z

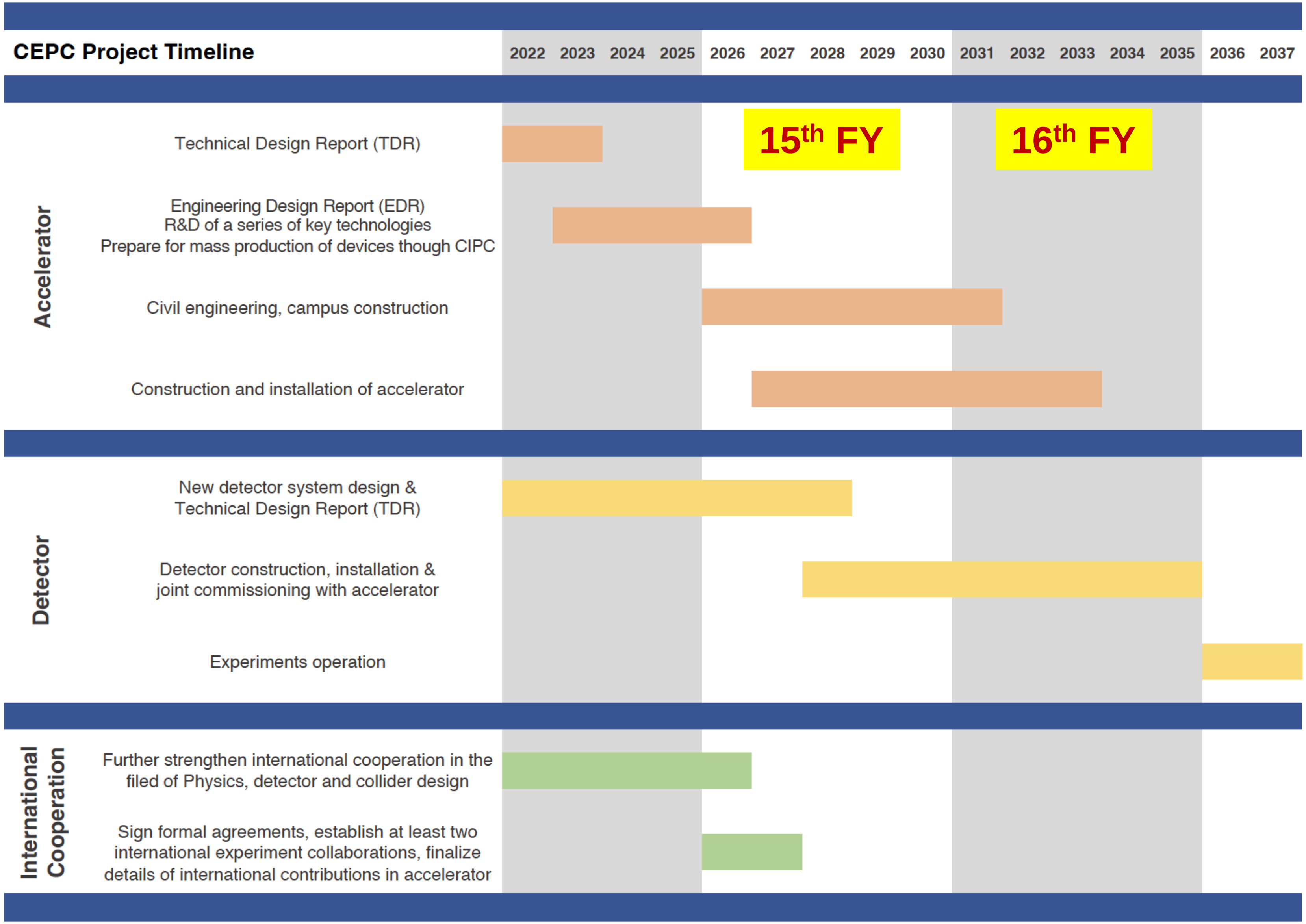
➔ 80km

D. Wang et al., JINST 17, P10018 (2022)

➔ 100km is optimal for CEPC and SppC

CEPC Project Timeline

➢ 2023: Accelerator TDR; 2026: EDR; Start construction upon approval



Implementation of IAC Recommendations

IAC Report: Recommendations - Overview

Recommendation 1: ***The CEPC team increase its effort on generic worldwide accelerator and detector R&D and explore further collaboration with the CLIC, ILC, FCC-ee, and SuperKEKB groups for common effort in the accelerator and detector technical development.***

Development:

We are gradually increasing collaboration with international colleagues for common efforts on generic worldwide accelerator and detector technical development.

- May, 30 2022, Xinchou Lou, **FCC** Week on "**Status of CEPC and possible synergies with FCC-ee developments**"
- Since Feb. 2022, the extension **MNPP-01** MoU of **IHEP** with **SuperKEKB** is ready for signatures.
- Jan. 1, 2022, J. Gao became **CERN Machine Advisory Committee (CMAC)** Member
- May 25, 2022, J.Gao became **TTC Executive Committee (EC)** member (**TTC** collab. with **ILC**)
- Feb. 16, 2022, the 10th **IHEP-KEK collaboration** meeting on SCRF technologies
- Oct. 12-14, 2022, attend **CALICE collaboration** meeting in Paris (in person)
- Oct. 25, 2022, attended **ECFA-WG3 meeting** aiming for Detector R&D Theme (DRDT) study

Joint research studies in 2022:

- FCC-ee tuning working group, FCC-ee beam-beam efforts
- SuperKEKB beam beam working group, simulations of injection eff. and detector background
- CMOS Pixel , LC-TPC, Drift Chamber, CALICE, Muon scintillator
- Key4hep software development
- …

➔ CEPC Detector R&D, Collaboration and Future: Joao G. da Costa

IAC Report: Recommendations - Overview

Recommendation 2: ***The IAC would like to understand the implications on the international nature of the project of a large contribution from local government.***

Development:

Although the CEPC project will be mostly covered by local government to fulfill the baseline design and infrastructure, it will still maintain strong international collaboration, eg:

- Accelerator (partial contribution from international partners)
- Detectors (50% or more from international institutes)
- Upgrade SR power: 30MW -> 50 MW (main contribution)
- Upgrade energy: 240 GeV -> 360 GeV (main contribution)

➔ CEPC Detector R&D, Collaboration and Future：Joao G. da Costa

IAC Report: Recommendations - Overview

Recommendation 3: ***The IAC looks forward to a presentation of independent assessment about social cost-benefit analysis of the CEPC project.***

Development:

Institute of Science and Technology Strategic Consulting, CAS is carrying out an independent assessment of Social Cost Benefit Analysis for the CEPC project since October 2021. The assessment includes:

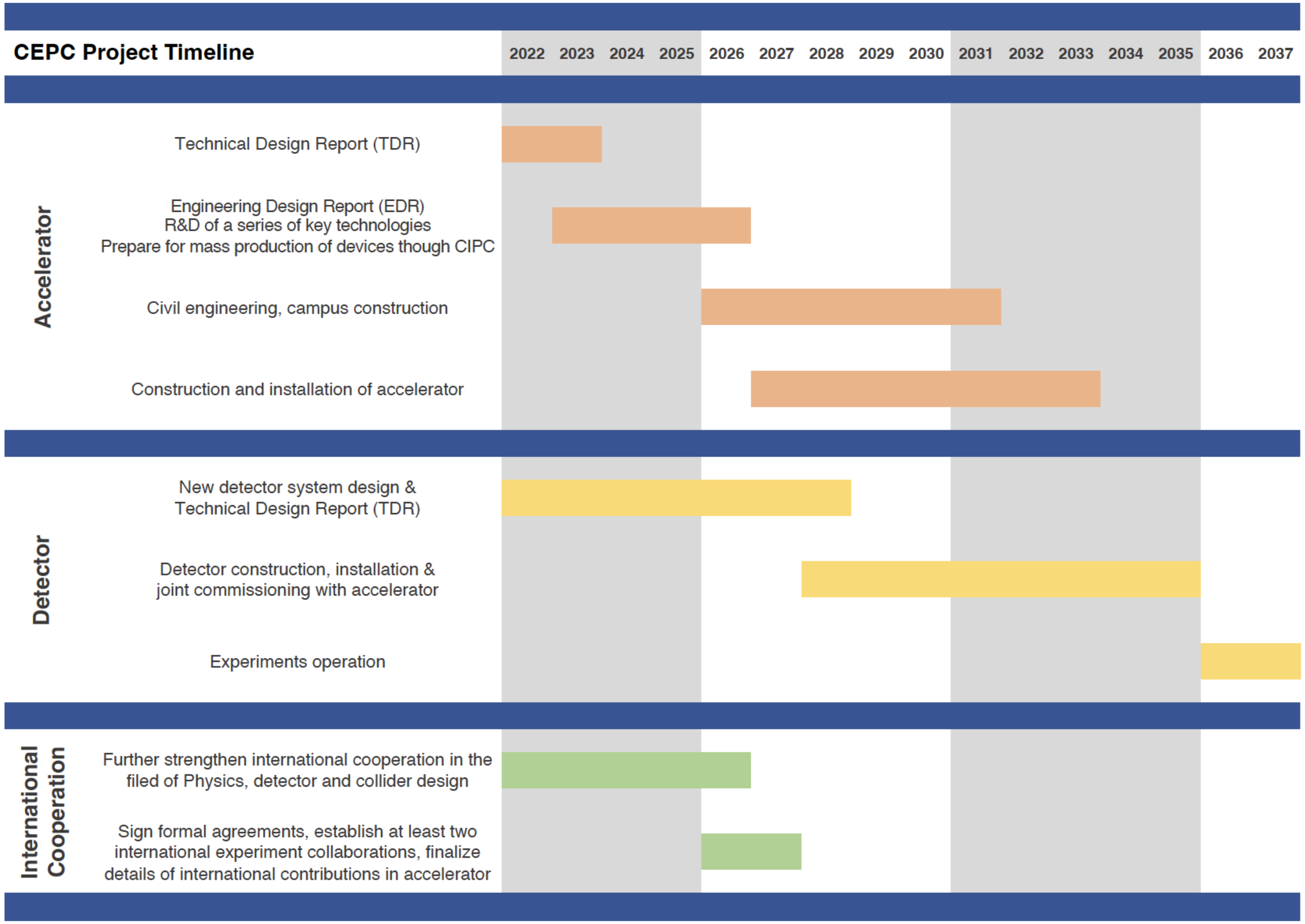
- Scientific impact
- Technology impact
- Economic impact
- Education and Training impact
- Social impact

The report is under preparation, it's expected to have a draft in Dec. 2022.

IAC Report: Recommendations - Overview

Recommendation 4: *The IAC would like to discuss the integrated high-level timelines for both the accelerator and the detector from now until the start of commissioning.*

Development:



IAC Report: Recommendations - Management

Recommendation 5: ***The IAC encourages further effort and is looking forward to seeing the complete roadmap for accelerator-based particle physics in China.***

Development:

- Two major projects are proposed for accelerator-based particle physics in China
  - CEPC: CDR(2018), TDR(2023), EDR(2026), Construction(2026-2034), Physics(2036-)
  - STCF: CDR(2021), TDR (2024), Construction(2024-2030), Physics (2031-)
- Both are under development, domestic and international review and evaluation.

STCF	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031-2040	2041-2042
CDR															
TDR															
Construction															
Physics Run															
Upgrade															

From Haiping Peng (USTC)

IAC Report: Recommendations - Management

Recommendation 6: *Exploitation of online communication with foreign collaborators such as remote meetings and workshops should continue and even be extended to educate and outreach activities by inviting prominent international scientists online. Planning for R&D and prototyping activities should take into account possible delays and cost increases due to disruption in the supply chain.*

Development:

- During the pandemic, it's difficult to have in-person meeting with foreign collaborators due to travel restriction.
- We organized online CEPC workshops (twice/year), CEPC Days (monthly), Topical workshops (e.g. Physics, Detector & Software, MDI), CEPC Physics and Detector Plenary meeting (weekly) and many subgroup meetings to continue the CEPC R&D activities and keep communication with foreign collaborators.
- Due to disruption in the supply chain, some ongoing R&D and prototyping activities have delays and cost increase, it will be considered in future plan.

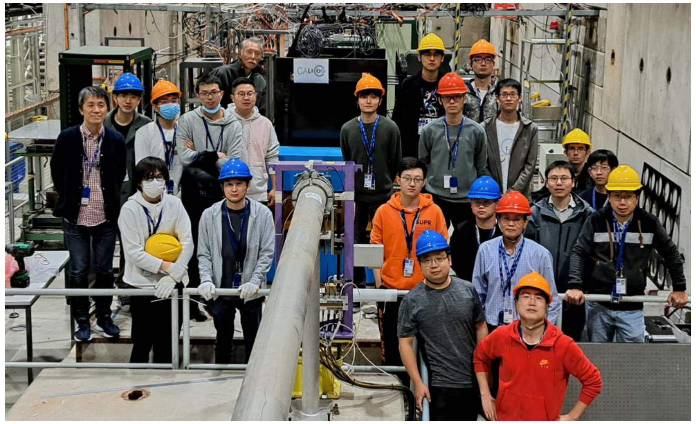
IAC Report: Recommendations - Management

Recommendation 7: ***Both the Chinese and international scientific community should maintain strong communication and try further to strength the existing cooperation, whenever possible.***

Development:

- We fully agree to maintain strong communication and further strength the existing cooperation between Chinese and international HEP community.
- China-CERN Joint Research Center, annual meeting since 2019
- IHEP-KEK Collaboration meeting on SCRF technologies
- Actively participate international collaborative R&D (e.g. CALICE, RD, LCTPC)
- CEPC colleagues attended international meetings (ICHEP in Italy, Snowmass in US, CALICE meeting in France, CALO2022 in UK etc.)

ICHEP 2022



IAC Report: Recommendations - Accelerator

Recommendation Acc#1: ***Make a detailed plan for the EDP work-packages, in such a way that international experts can be involved in the studies at work-package or overall integration level. Consider involvement at various levels, from advisory to execution of the WP tasks. The transition between TDR and EDP should be as seamless as possible.***

Development:

- Three IARC review meetings (online) were organized in 2021 and 2022. The progresses of design optimization and key technology R&D were reviewed. In the latest review meeting and written report, IARC advised that CEPC team can commence TDR writing.
- In the TDR study, various work-packages are established such as accelerator design, magnet, RF power source, SRF cavity, instrumentation, vacuum, MDI, etc. Each work-package has designated person in charge.
- Accelerator TDR will be completed in early 2023, followed by Engineering Design Report, similar work-packages will be created. This process makes the transition seamlessly.

→ IARC Recommendations and Plan：Yuhui Li

IAC Report: Recommendations - Accelerator

Recommendation Acc#2: ***Prepare a list of potential strategically important industrial partners outside China and work with international laboratory partners to explore if prototyping for the CEPC and the SppC can be executed as collaborative projects with these laboratories.***

Development:

- CEPC team has made numerous efforts to execute the key technology R&D and to be ready for CEPC construction. Mass production of components with high budget ratio are matured based on domestic industrial ability.
- CEPC team is open and welcome strategic international laboratory partner and industrial partners to address advanced key technologies. It is still progressing.

➔ Sources of components, vendors and partners：Song Jin

IAC Report: Recommendations - Accelerator

Recommendation Acc#3: ***Initiate the development of a high-level, integrated overview of the project identifying the many dispersed resource needs and potential gaps to increase the overall confidence in project success. This could be carried out in parallel to the revisited cost estimate.***

Development:

- With the completion of other large-scale scientific projects (e.g. HEPS, JUNO), CEPC will gain significant manpower and expertise with increasing confidence in project success.
- Although the major parts of key technologies are explored, there are still many design and technical challenges in accelerator construction. The potential gaps will be further closed down in the coming EDR with international collaborations.

IAC Report: Recommendations - Accelerator

Recommendation Acc#4: ***Increase the effort devoted to overall project integration issues, such as control systems, power, component series production and avoidance of dependence on single production sources, on-site storage facilities, scheduling, installation including transport and pinch planning, alignment both during installation and repeating as necessary thereafter etc;***

Development:

- IHEP has successfully constructed several large scale scientific facilities, and gain rich experience for project construction and management.
- The integration issues is still a weak point for current CEPC preparation. We will work intensively on this aspect in the EDR studies.
- We look forward to collaboration with international partners in the control system since many challenges are foreseen to control a 100km accelerator never built before.

IAC Report: Recommendations - Accelerator

Recommendation Acc#5: ***Carry out a comprehensive re-costing of the design at the time of the TDR. Organize a costing review under the supervision of an appropriately augmented IARC. Establish a comprehensive database system to document all aspects of the project and implement a formal change-control system to document the evolution of the TDR baseline.***

Development:

- Many efforts have been made to re-evaluate the construction cost which will be reviewed by augmented IARC and included in the TDR.
- We recognized the importance of a comprehensive database system. An appropriate database system was explored and in the optimization phase.

IAC Report: Recommendations – Detector & Physics

Recommendation DP#1: ***The group is encouraged to continue its physics studies in this domain and explore full detector optimization with optimal flavour physics outcomes in mind.***

Development:

- A dedicated task force is organized, aiming at Tera-Z flavor physics white paper.
  - It covers physics analyses, detector optimization and global interpretation.
  - Tera-Z has strong comparative advantages V.S. LHCb & Belle-II,
    i.e., time dependent CP measurement, measurement with Bs, LFU, LFV etc.
- From benchmark studies, we understand better the requirement to the detector. i.e.,
  - PID 3σ Pi-Kaon separation – equivalent to 3% dE/dx or dN/dx at Drift Chamber, together with 50 ps ToF measurement from Calorimeter or alternative, etc.
  - EM resolution < 3%/sqrt(E) ➔ B0/Bs meson can be separated with 2 π^0 final state
  - VTX: spatial resolution of 5-10 microns for secondary vertex ➔ provide excellent time resolution and support Jet Flavor tagging/Charge measurement, etc.

➔ Physics & White Paper: Manqi Ruan

IAC Report: Recommendations – Detector & Physics

Recommendation DP#2: ***Physics studies and detector optimisation for the central physics objectives towards precision measurements of H, tt-bar, Z and WW should continue in order to explore the full precision-physics potential and the cumulative added value of the four energy stages.***

Development:

- We synergize physics studies with Snowmass studies, submitted ~20 LoI and resulted in Journal/arXiv papers and CEPC Physics Whitepaper for Snowmass.
- We conclude on multiple core measurements (i.e., H->bb, cc, gg; H->μμ), and update anticipated precisions w.r.t. the latest CEPC beam parameter & operation scenarios. Global fitting is performed to understand the physics reach using SMEFT etc.

➔ Physics & White Paper: Manqi Ruan

IAC Report: Recommendations – Detector & Physics

Recommendation DP#3: ***The overall simulation and computing projects have reached a notable level of maturity, but we second the request by the coordinators to allocate more human resources to properly support these efforts, which are crucial to the study of the physics potential and detector performance.***

Development:

- The offline team has about 8 FTEs faculties working on software development.
- In the past year, additional temporary personnel was recruited to solve the problem of manpower shortage. New members include
  - 1 postdoc, 2 PhD students, 1 master student.
- For people from local universities, they are required to work at IHEP to facilitate teamwork and communication.
- Recently, a new job position related to CEPC software development is open to further boost the strength of the team. The team is expanding.

➔ Software Development: Weidong Li

IAC Report: Recommendations – Detector & Physics

Recommendation DP#4: ***It is crucial for the Chinese CEPC detector group to be even more involved and visible in the more generic worldwide R&D activities, as it did successfully for calorimetry in the CALICE collaboration.***

Development:

- CEPC detector group has more involvement and visibility in generic worldwide R&D activities including silicon vertex & tracker, TPC, DC, PFA calorimeters etc.
- Jianchun Wang and Haijun Yang are serving as CEPC contact persons at ECFA-WG3 which coordinates worldwide detector R&D activities for Higgs factories and general applications.

ECFA-WG3 Contacts

Group	contact 1	contact 2
ILD	Karsten Buesser	Ulrich Einhaus
SiD	Marcel Stanitzki	Andrew White
CLICdet (+CLD)	Dominik Dannheim	
CLD (+CLICdet)		Frank Simon
IDEA	Margherita Primavera	Romualdo Santoro
LAr	Nicolas Morange	Brieuc François
CEPC	Haijun Yang	Jianchun Wang
TF1 Gas	Riccardo Farinelli	Maxim Titov
TF3 Si	Daniela Bortoletto	Didier Contardo
TF4 PD/PID	Neville Harnew	Peter Krizan
TF6 Calo	Gabriella Gaudio	Vincent Boudry
TF7 Ele	Dave Newbold	Federico Faccio
TF8 Mech	Frank Hartmann	Werner Riegler

IAC Report: Recommendations – Detector & Physics

Recommendation DP#5: ***There should be regular meetings of the International Detector R&D Review Committee, IDRC. In future these should be regular meetings occurring at least annually.***

Development:

- An updated version of the document requested by the IDRC with the list of on-going CEPC detector R&D activities was produced and sent to the IDRC in April 2022.
- The IDRC chair made two attempts to organize a meeting in 2022, but unfortunately it was not possible to secure the presence of enough committee members.
- Following discussions with the IDRC chair, and in line of the current international situation, the chair suggested a modification of committee charge from "Evaluate International proposals for detector R&D relevant to the CEPC" to a more technical advisory capacity on detector R&D being pursued.
- Given that this committee was created following an IAC recommendation, we would like to discuss this possibility with the IAC committee, before calling for another committee meeting.

See Joao's presentation for further details

→ CEPC Detector R&D, Collaboration and Future: Joao G. da Costa

Summary and Prospects

Continuing R&D and deep understanding of physics potentials

- Made suggestions to **MOST for R&D support** and validations of key technologies & innovations
- Carrying out **design improvement, R&D**, site investigations-study
- R&D and made major **progress + breakthroughs** in common technologies
- **CEPC physics whitepaper**; physics potentials input for Snowmass

International Collaboration and Engagement

- Engaging actively in **ILC, FCC as well as HL-LHC upgrade** activities, enhancing CERN-China relationship
- Actively participating international **detector R&D** collaborations: CALICE, LPTPC, RD*, DRDT, …
- Finding and sharing solutions to common issues (design, accelerator/detector components, …)
- **Hope we will have in-person meeting and collaboration in the coming years**

Acknowledgements

**Many thanks to the CEPC working group,
IAC, IARC, IDRC, CIPC for enormous efforts !**