AFAD 2018

Circular Electron-Positron Collider
Status and Progress

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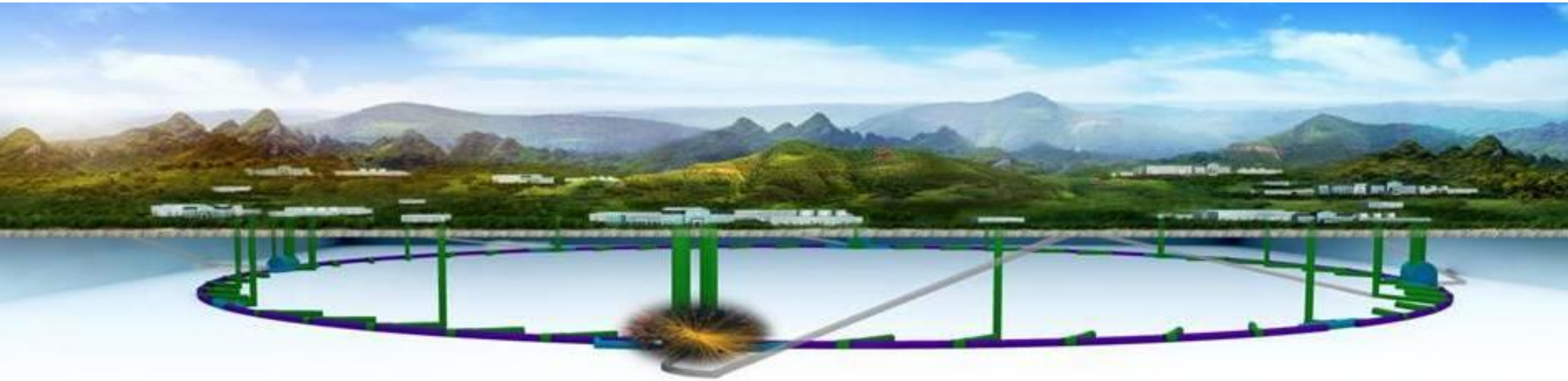
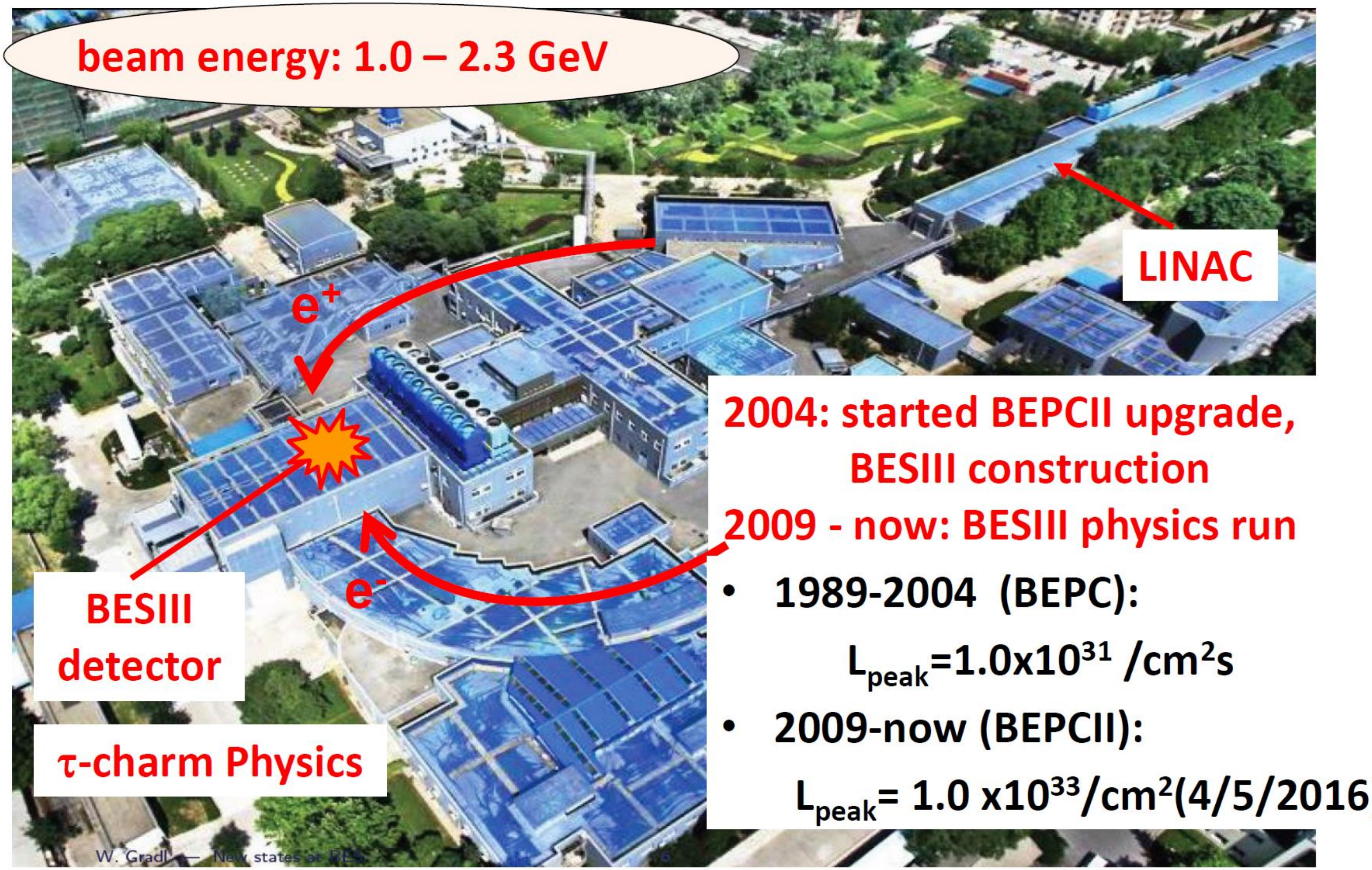
Institute of High Energy Physics, Beijing



Outline

- Reminder & introduction
- Baseline CEPC
- The Conceptual Design Report
- Status and major development
- Summary

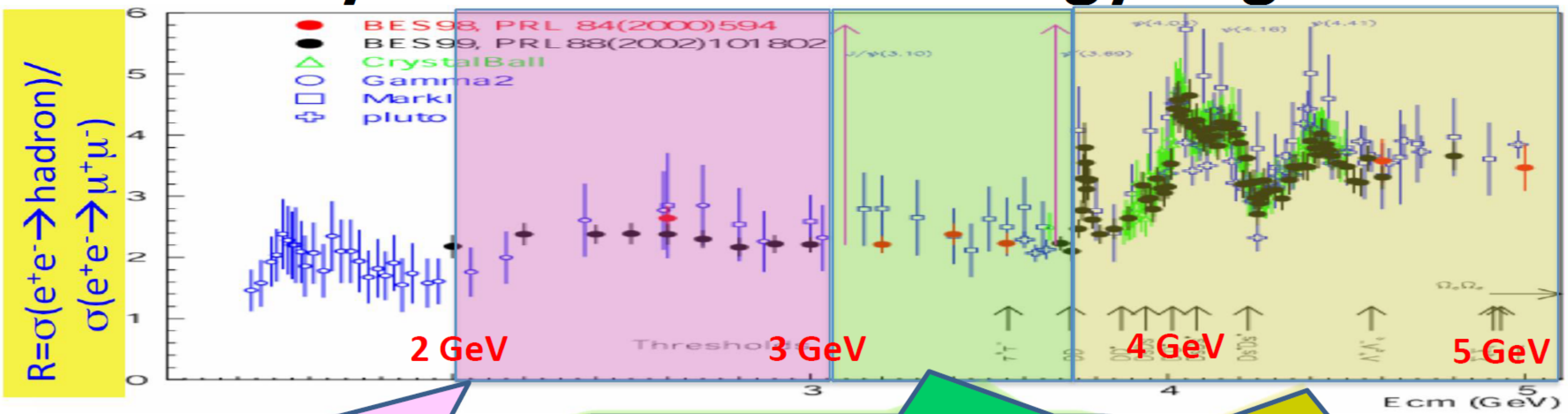
Beijing Electron Positron Collider (BEPC)



Xiaoyan Shen
IHEP

present collider for particle physics in China

Physics at τ - charm Energy Region



- Hadron form factors
- Y(2175)
- Zs states ?
- QCD test

- Light hadron spectroscopy
- Glueballs, hybrids, multi-quark states
- Rare decays
- Tau physics

- XYZ
- D and Ds physics (f_D and f_{Ds}, mixing, ~~CP~~)
- Charmed baryons

- Rich of **resonances:** charmonia, charmed mesons, charmed baryons
- **Threshold** characteristics (pairs of τ, D, D_s, …) -- **low BG at threshold, high X-section -- indirect probe of NP**
- **Transition between** pQCD and non-pQCD
- Energy location of the **new forms of hadrons**

What's next?
China is considering the next accelerator beyond the BEPCIII

Xiaoyan Shen
IHEP

Introduction to CEPC-SppC

e^+e^- Higgs (Z) factory

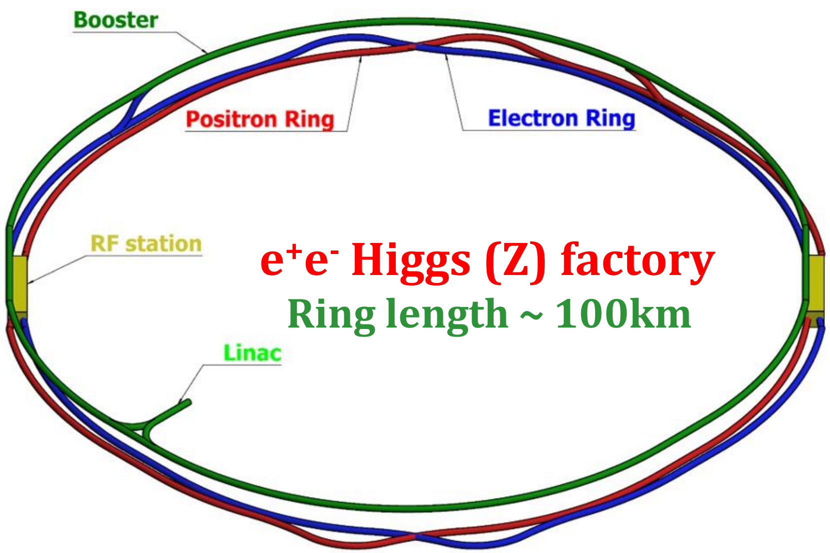
$E_{cm}\approx 240$GeV, luminosity $\sim 2\times10^{34}\ cm^{-2}s^{-1}$, 2IP, 1M H in 10 years
at the Z-pole 10^{10}Z bosons/yr

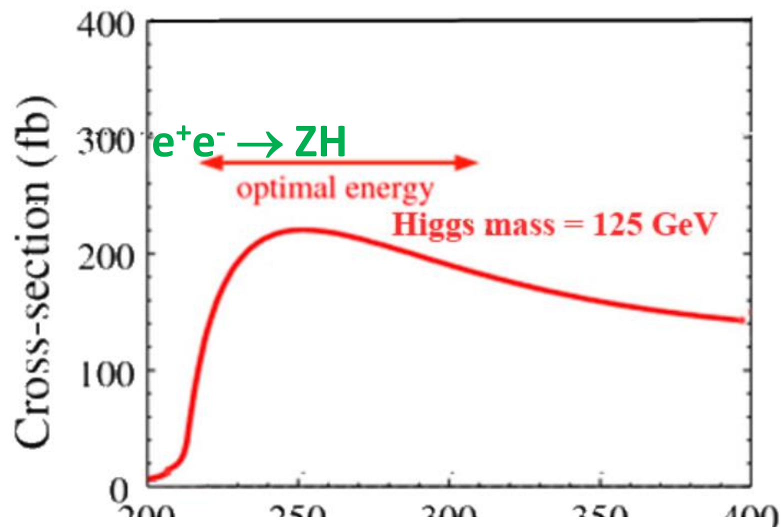
Precision measurement of the Higgs boson (and the Z boson)

Higgs precision 1% or better

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

A discovery machine for BSM new physics





BEPCII will likely complete its mission ~2020s;
CEPC – possible accelerator based particle physics program in China after BII

CEPC Schedule (ideal)

design issues
R&D items
preCDR

design, funding
R&D program
Intl. collabration
site study

seek approval, site decision
construction during 14th 5-year plan
commissioning

- **CEPC data-taking starts before the LHC program ends**
- **Possibly con-current with the ILC program**

Baseline CEPC

Baseline CEPC

- **Baseline design & options for the Conceptual Design Report**

  circumference=100km， E_{cm}=240 GeV, power per beam≤30MW，

  design luminosity ≥ $2\times10^{34}cm^{-2}s^{-1}$ (240 GeV)

  ≥ $1\times10^{34}cm^{-2}s^{-1}$ (91 GeV)

  two layouts:

  double ring as the default;

  advanced local double ring as an option

  two independent detectors

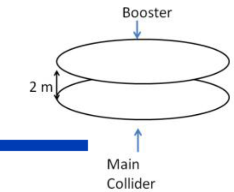
- **Benefits**

  mature technologies, Z+ZH program

  high energy pp option

  γ synchrotron light source (?)

CEPC Accelerator Chain



10 GeV

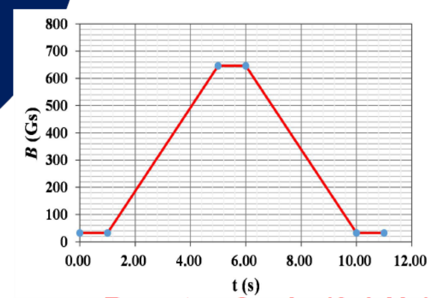
Injector

Electron

Positron

Booster

Energy Ramp
10 ->45/120GeV



Booster Cycle (0.1 Hz)

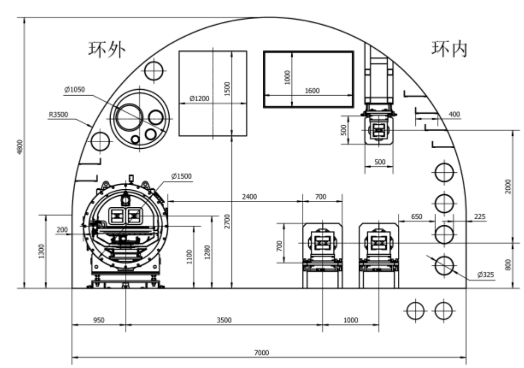
Three rings in the sane channel:

- **CEPC & booster**
- **SppC**

- Double Ring
- Common cavities for Higgs
- Two RF sections in total
- Two RF stations per RF section
- 14 modules per RF station
- 28 modules per RF section
- 56 modules in total
- Six 2-cell cavities per module
- One klystron for two cavities

对撞环

45/120 GeV



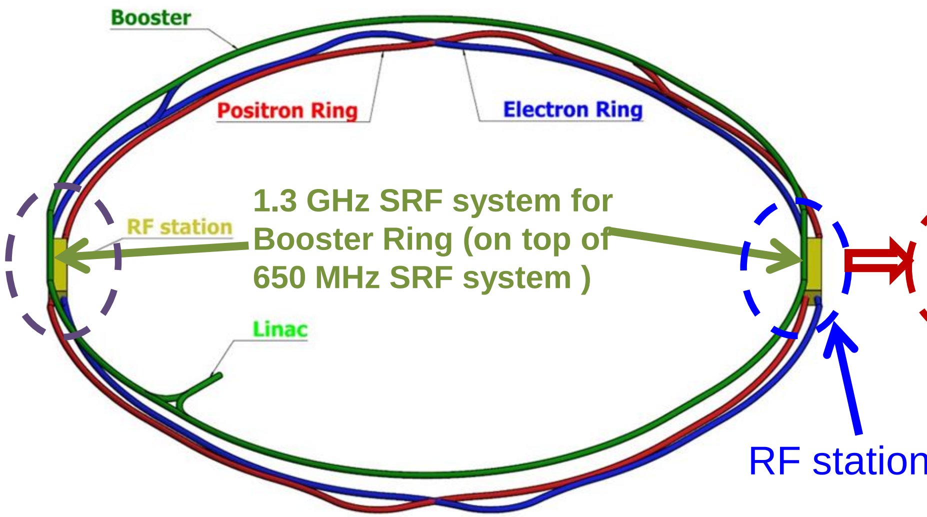
The Conceptual Design Report

- **The CEPC accelerator design**
- **The detector design**
- **Physics performance**

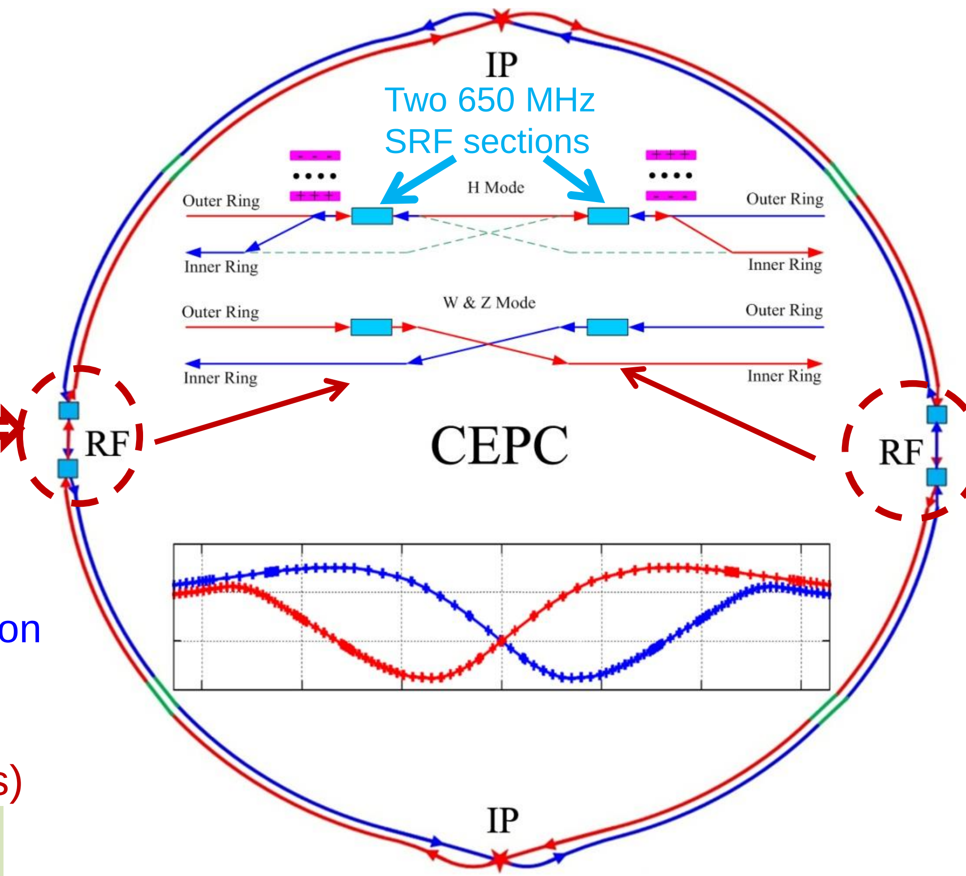
CDR drafts by early 2018, reviews and finalization mid-2018

CEPC SRF System Layout

- 336 650MHz 2-cell cavities for Collider Ring + 96 1.3GHz 9-cell cavities for Booster Ring
- All those cavities are distributed equally to two RF stations.
- For Collider Ring, each RF station consists of two SRF sections.



SRF system location of CEPC (two RF stations)



Layout of 650 MHz SRF system for Collider Ring

Layout -hardware satisfying both Z and H programs

$L \geq 2\times10^{34} cm^{-2}s^{-1}$ (at E_{cm}=240 GeV)

$L \geq 1\times10^{34} cm^{-2}s^{-1}$ (at E_{cm}=91 GeV)

CEPC CDR Baseline Parameters (Jan. 2018)

D. Wang

	Higgs	W	Z
Number of IPs		2	
Energy (GeV)	120	80	45.5
Circumference (km)		100	
SR loss/turn (GeV)	1.73	0.34	0.036
Half crossing angle (mrad)		16.5	
Piwinski angle	2.58	4.29	16.4
N_e/bunch (10^{10})	15	5.4	4.0
Bunch number (bunch spacing)	242 (0.68us)	3390 (98ns)	8332 (40ns)
Beam current (mA)	17.4	88.0	160
SR power /beam (MW)	30	30	5.73
Bending radius (km)		10.6	
Momentum compaction (10^{-5})		1.11	
β_{IP} x/y (m)	0.36/0.0015	0.36/0.0015	0.2/0.0015
Emittance x/y (nm)	1.21/0.0031	0.54/0.0016	0.17/0.004
Transverse σ_{IP} (um)	20.9/0.068	13.9/0.049	5.9/0.078
ξ_x/ξ_y/IP	0.031/0.109	0.0148/0.076	0.0043/0.04
V_{RF} (GV)	2.17	0.47	0.054
f_{RF} (MHz) (harmonic)		650 (216816)	
Nature bunch length σ_z (mm)	2.72	2.98	3.67
Bunch length σ_z (mm)	3.26	3.62	6.0
HOM power/cavity (kw)	0.54 (2cell)	0.47(2cell)	0.49(2cell)
Energy spread (%)	0.1	0.066	0.038
Energy acceptance requirement (%)	1.52		
Energy acceptance by RF (%)	2.06	1.47	0.76
Photon number due to beamstrahlung	0.29	0.16	0.28
Lifetime due to beamstrahlung (hour)	1.0		
Lifetime (hour)	0.67 (40 min)	2	4
F (hour glass)	0.89	0.94	0.99
L_{max}/IP ($10^{34}cm^{-2}s^{-1}$)	**2.93**	**7.31**	**4.1**

J. Gao, IAS2018

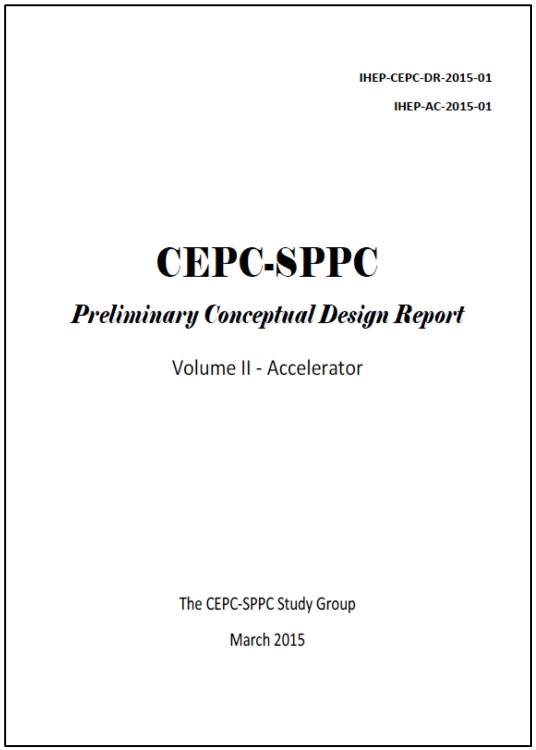
without bootstrapping

Preliminary results shows co-existence of Z/H programs are possible

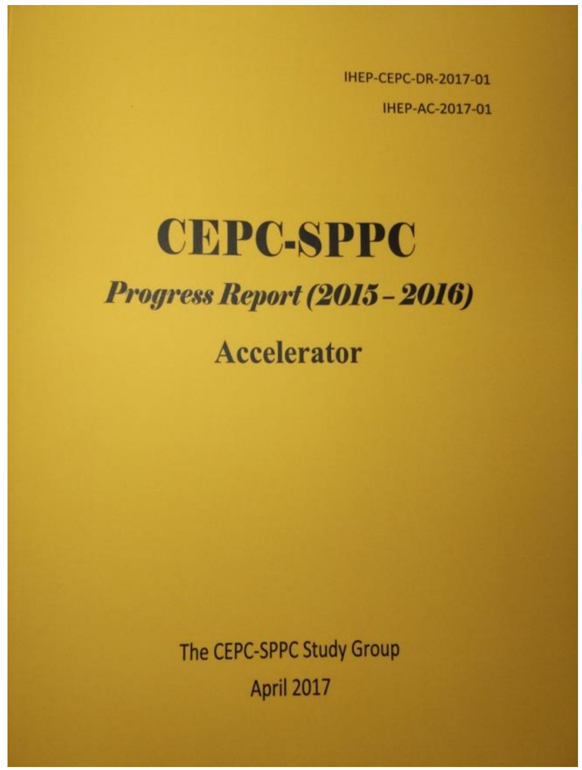
Reconfiguration of CEPC can lead to much better luminosity at the Z pole → Z factory

CEPC-SppC from Pre-CDR towards CDR

http://cepc.ihep.ac.cn

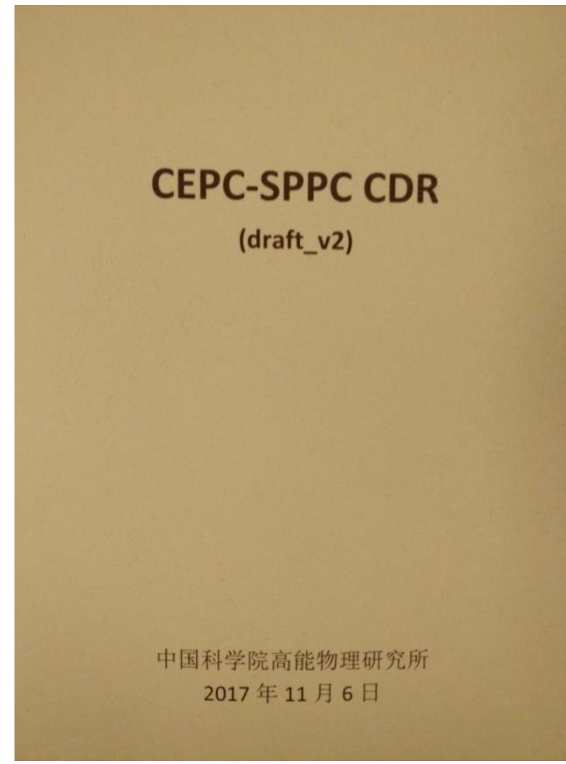


March 2015



April 2017

CEPCSppC baseline and alternative decision processe recorded



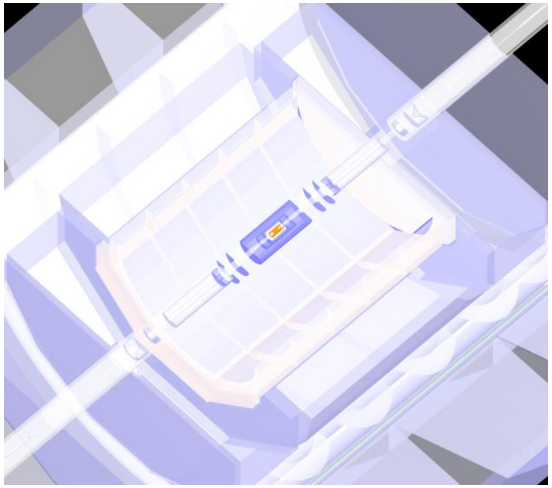
Nov 2017

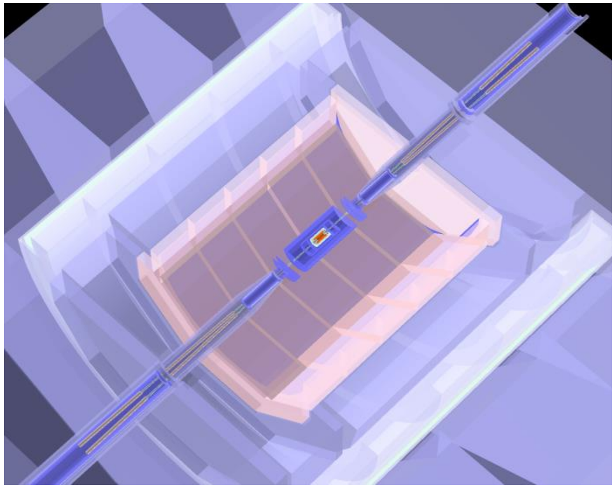
CEPC-SppC CDR Preliminary Draft during CEPC-SppC Mini review

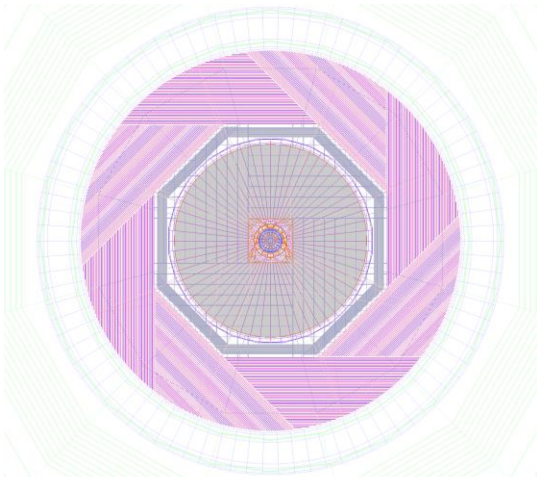
CEPC-SppC CDR will be printed before May 2018

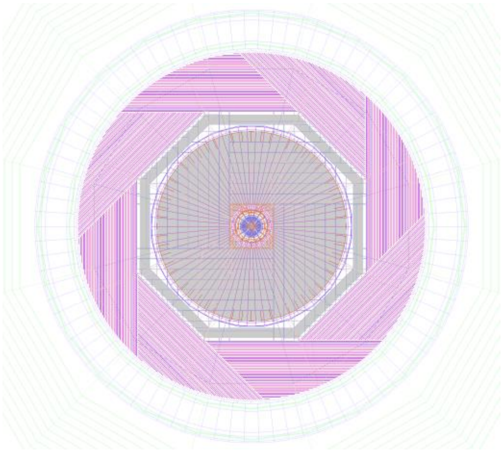
CEPC Detector: more compact & updated for CDR

preCDR (2015) → CDR (2017)

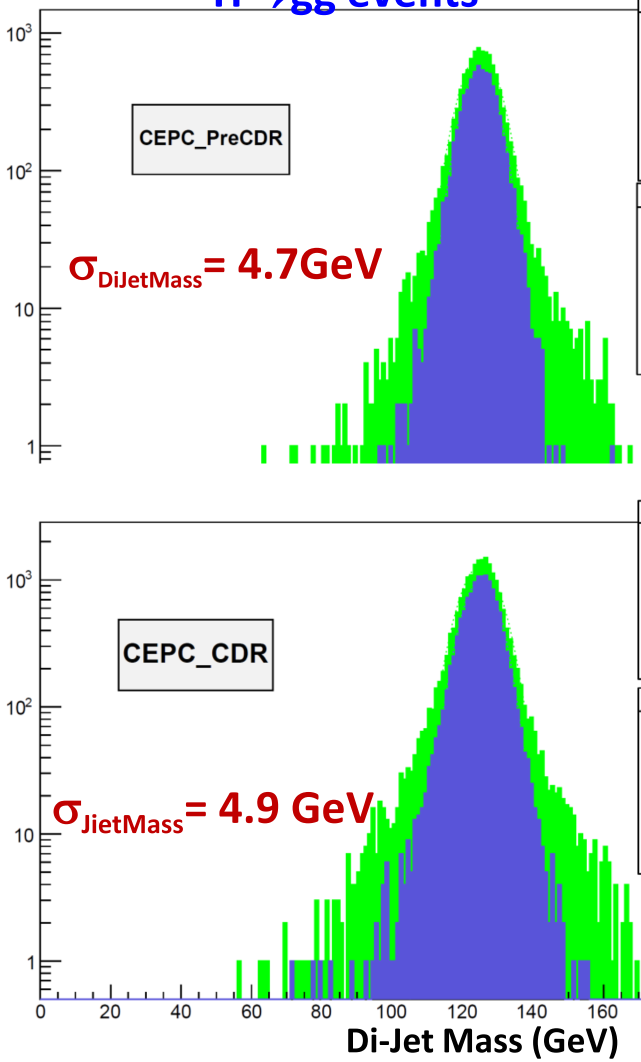








H→gg events



CDR CEPC detector:
Double ring geometry & MDI design implemented
HCAL reduced to 40 layers (from 48 in preCDR)

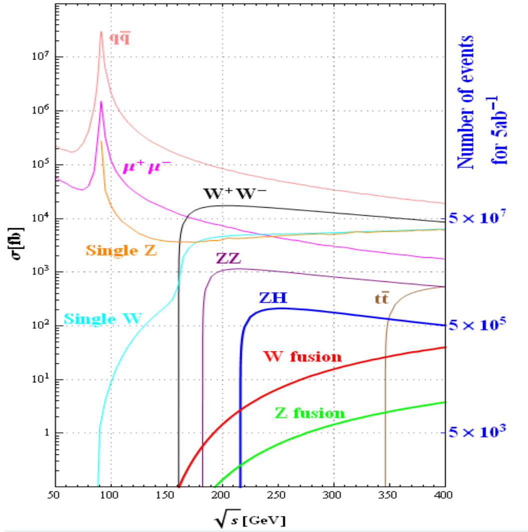
No visible impact on physics performance

Feasibility & Optimized Parameters

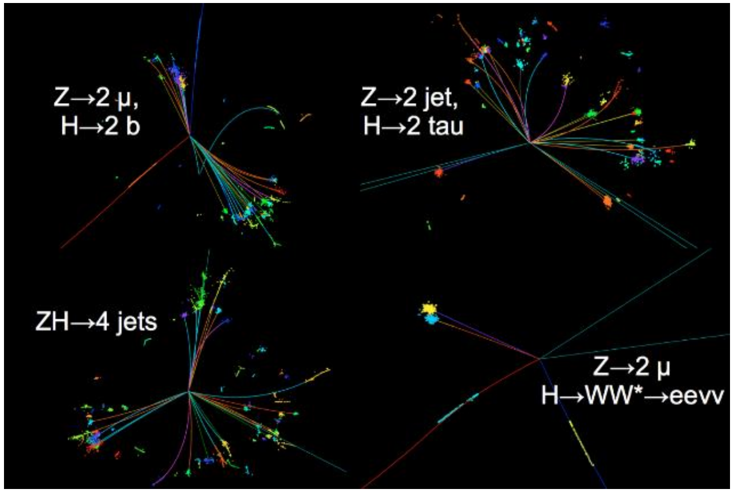
Feasibility analysis: TPC and Passive Cooling Calorimeter is valid for CEPC

	CEPC_v1 (~ ILD)	Optimized (Preliminary)	Comments
Track Radius	1.8 m	>= 1.8 m	Requested by Br(H->di muon) measurement
B Field	**3.5 T**	**3 T**	**Requested by MDI**
ToF	**-**	**50 ps**	**Requested by pi-Kaon separation at Z pole**
ECAL Thickness	84 mm	84(90) mm	84 mm is optimized on Br(H->di photon) at 250 GeV;
ECAL Cell Size	5 mm	10 – 20 mm	Passive cooling request ~ 20 mm. 10 mm should be highly appreciated for EW measurements – need further evaluation
ECAL NLayer	30	20 – 30	Depends on the Silicon Sensor thickness
HCAL Thickness	**1.3 m**	**1 m**	-
HCAL NLayer	**48**	**40**	Optimized on Higgs event at 250 GeV;

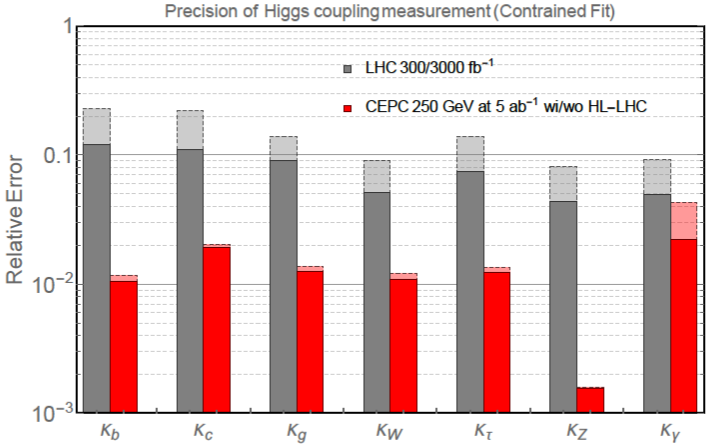
CEPC physics potentials



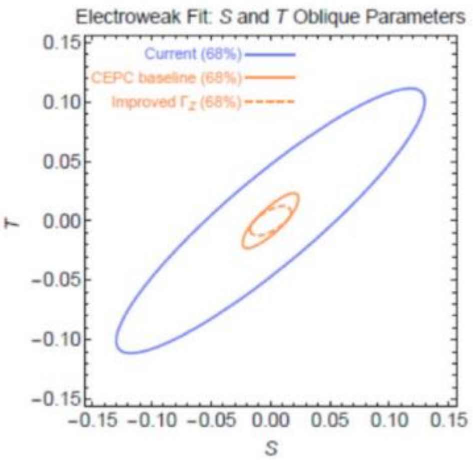
Cross sections for Major SM physics processes at the electron positron collider (without beam polarization)



Simulated Higgs signal with different decay final states at 250 GeV center of mass electron positron collisions, using PFA oriented detector design



Anticipated accuracy on Higgs properties at CEPC and at LHC/HL-LHC



Anticipated electro-weak precision of the CEPC and comparison to current accuracy

Status and major development

- The R&D program
- Funding and support
- Site selection
- IAC and International collaboration
- Reach-out & engagement with the public

CEPC “R&D”

preCDR identified: designs issues, site, key technologies and development plan

加速器、探测器的概念设计，工程设计

土建方面的选址、规划、地质勘探、设计、评估、评审等

关键技术预研、验证

超导射频加速腔

- 用于各种加速器，国内有样机但尚未实用，指标需提高，没有生产能力
- 目标：达到高性能(Q值2×10¹⁰，、加速梯度等)，实现国产化，批量生产能力

微波功率源（大功率速调管、固态功率源）

- 广泛用于加速器、广播、通讯、雷达等。大功率速调管依赖进口
- 目标：达到高性能(效率>80%、功率800kW、寿命等), 国产化，批量生产

大型低温制冷机

- 广泛用于民用、科研、航天等。基本依赖进口, 大型制冷机禁运。国内有样机
- 目标：达到高性能(功率12kW@4.5K/2.5kW@2K)、高可靠性，国产化

高温超导线

- 广泛用于民用、科研等。国内水平较好，性能与价格有待大幅度提高
- 目标：大大提高性价比，实现输电等民用领域的应用

抗辐照半导体径迹探测器及读出芯片　国内高能加速器物理实验上的硅径迹探测器是空白

- 目标：自主设计芯片，工业流片，建造CEPC顶点探测器部件单元

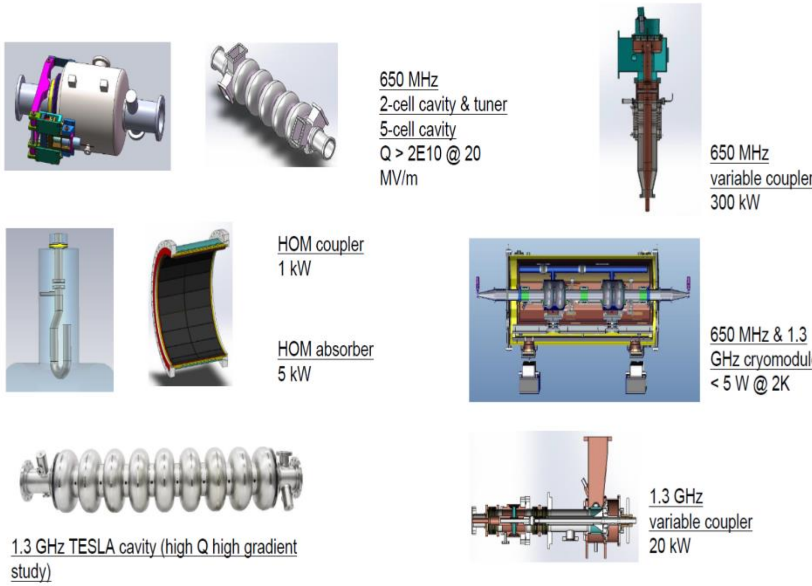
成像型高精度量能器及前端电子学　国内高能加速器物理实验上的此类量能器是空白

- 目标：选型、优化探测器，自主设计ASIC芯片，建造量能器部件单元

高场超导磁铁，束流测量与诊断，自动控制、计算机, 精密机械，…

……

Key Components



✓to learn, develop and master the processing and production skills for making CEPC components;

✓enhance quality and cost-reduction of elements

Main CEPC Ring SCRF Hardware Specification

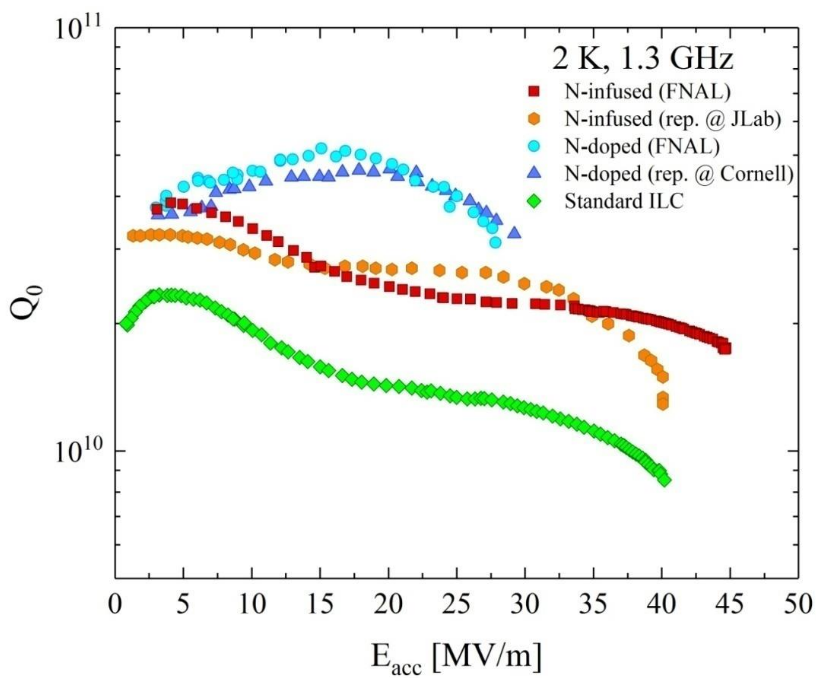
Hardware	Qualification	Normal Operation	Max. Operation
650 MHz 2-cell Cavity	VT 4E10 @ 22 MV/m HT 2E10 @ 20 MV/m	1E10 @ 16 MV/m (long term)	2E10 @ 20 MV/m
1.3 GHz 9-cell Cavity	VT 3E10 @ 25 MV/m	2E10 @ 20 MV/m	2E10 @ 23 MV/m
650 MHz Input Coupler	HPT 400 kW sw	300 kW	400 kW
1.3 GHz Input Coupler	HPT 20 kW peak, 4 kW avr.	< 15 kW peak	18 kW peak
650 MHz HOM Coupler	HPT 1 kW	< 0.2 kW	1 kW
650 MHz HOM Absorber	HPT 5 kW	< 2 kW	5 kW
650 MHz Cryomodule (six 2-cell cavities)	static loss 5 W @ 2 K	static loss 8 W @ 2 K	static loss 10 W @ 2 K
Tuner (MR & Booster)	tuning range and resolution 400kHz/1Hz	200 kHz / 1 Hz	400 kHz / 1 Hz
LLRF (MR & Booster)	amp & phase stability 0.1%, 0.1 deg	amp & phase stability 1%, 1 deg	amp & phase stability 0.1%, 0.1 deg

✓ **benefit from the ILC development;**

✓ **“R&D” will in turn contribute to the ILC construction**

N-doping

The cavity loss is inversely proportional to Q (Quality Factor). If Q is increased by 100%, cavity loss would be reduced by 50%. Therefore, CEPC cavities should **achieve high Q** to reduce the construction and operation cost of the cryogenic system.

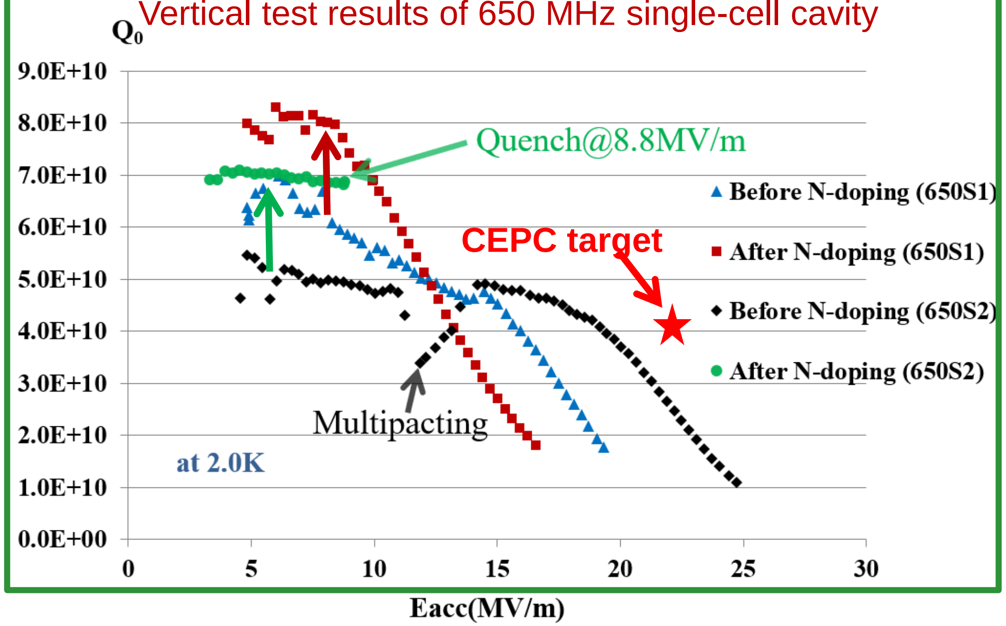


A. Grassellino, ICFA seminar 2017

Effort at IHEP –-

Post N-doping Q increased obviously at low field for both cavities. Next, Increase Q at high field by improving N-doping technology. A long way to go.

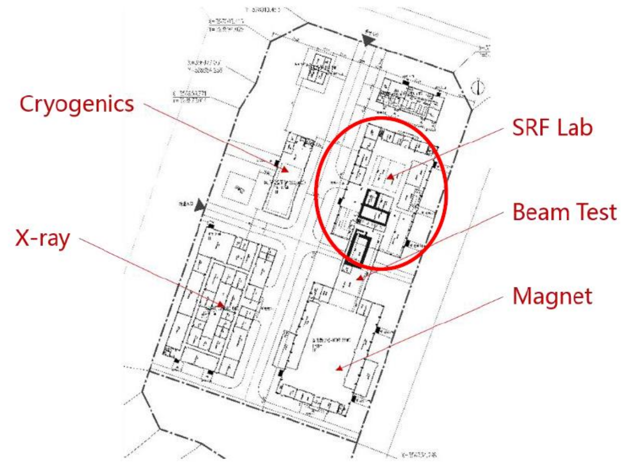
Vertical test results of 650 MHz single-cell cavity



A New SRF Facility

Platform of **A**dvanced **P**hoton **S**ource Technology R&D, Huairou Science Park, Huairou, Beijing

Construction: 2017 - 2019
Ground Breaking: May 31, 2017

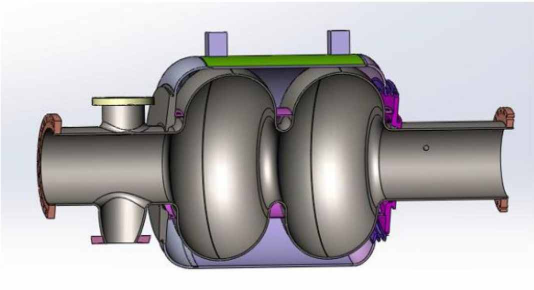


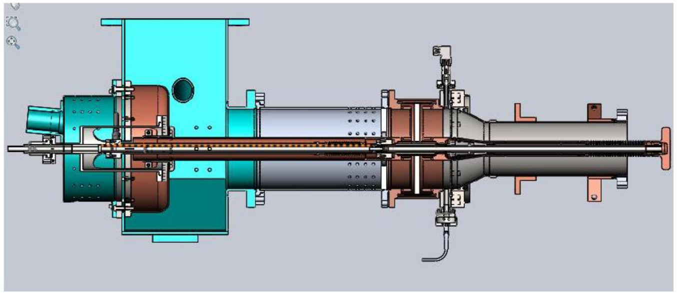
4500 m^2 SRF lab

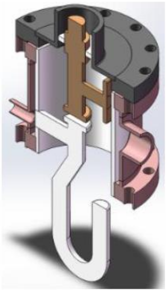
- **500M RMB funded by city of Beijing**
- **Construction: May 2017 – June 2020**
- **Include RF system & cryogenic systems magnet technology, beam test, etc.**

CEPC SRF R&D and Test at the PAPS Facility

- **Advanced Superconducting RF Technology R&D for CEPC**
  - **Preparation, diagnostics and test tools for high performance cavity**
    - **Nitrogen-doping & infusion**, Nb_3Sn thin film for high Q and high gradient
    - High resolution optical inspection, temperature and X-ray mapping, second sound quench detection, defects local grinding …
  - **Test facilities for key components of SRF accelerator**
    - **Very high power variable input coupler** with low heat load
    - **High power HOM coupler and absorber**
    - Components horizontal test with tuner and LLRF in low magnetic field
  - **Common cutting-edge research with ILC and SCLF (Shanghai XFEL) and possible breakthroughs in Fe-pnictides superconducting cavity**

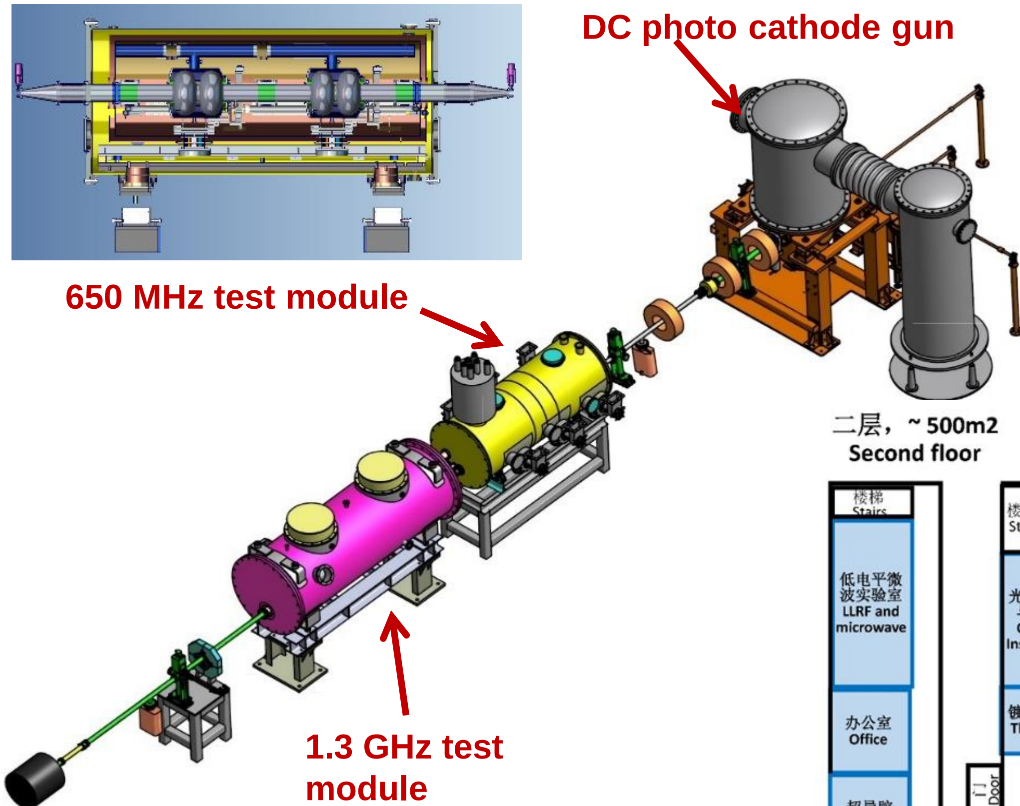






Preparation for mass cavities

- 1st: Two Test Cryomodules (two 650 MHz 2-cell cavities, two 1.3 GHz 9-cell cavities) ----**2019~2020**
- 2nd: Two full scale Prototype Cryomodules (six 650 MHz 2-cell cavities, eight 1.3 GHz 9-cell cavities) ----**2021~2022**
- 3rd: More Cryomodules and cavities

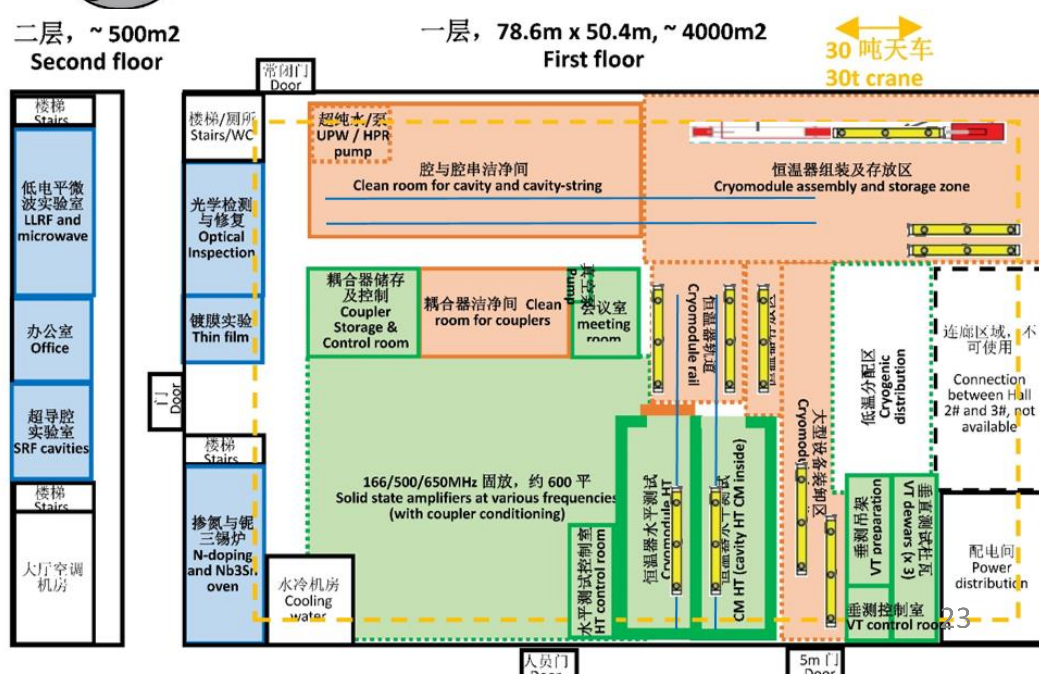


IHEP New Large SRF Facility (4500 m^2) in the Platform of Advanced Photon Source Technology R&D (PAPS), Huairou Science Park, Beijing.

Mission: World-leading SRF Lab for Superconducting Accelerator Projects and SRF Frontier R&D.

Mass Production: 200 ~ 400 cavities (couplers) test per year, **20 cryomodules** assembly and horizontal test per year. **It's enough for CEPC!**

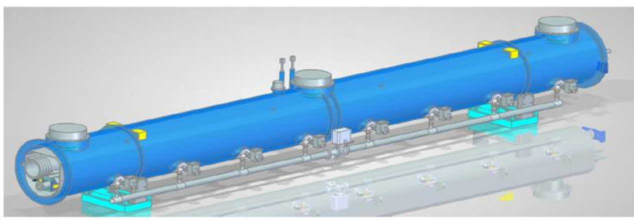
Construction: 2017 - 2020



Cryomodule Development and Production for SCLF

SCLF Cryomodule Performance

- 1.3GHz 8x9cell cavity-string
- 8 tunners
- 8 power couplers
- 16个HOM couplers
- 1 Magnetic shielding
- 1 sc magnet
- 1 BPM
- 1 cryotat
- …



Cavity Performance

RF frequency	1.3 GHz
Temperature	2.0 K
Cavity length	1.038 m
Vertical test	>25 MV/m
Operation	>16 MV/m
Q0	> 2.7×10^{10}

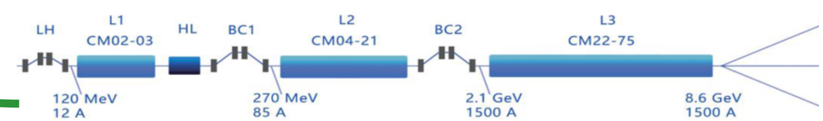
Cryomodule Performance

CW RF Voltage	≥ 128 MV
Dark current	< 1 nA
Heat load 2 K	< 93 W
5 K	< 25 W
45 K	< 215 W

Shanghai Coherent Light Facility (SCLF)

- SCLF is a newly proposed MHz high rep-rate XFEL, based on an 8 GeV CW SRF linac;
- This facility will be built in a 3.2 km long tunnel (38m underground) at Zhang-Jiang High Tech Park, across the SSRF campus in Shanghai;
- This XFEL facility includes 3 undulator lines and ~10 experimental stations in phase one, it can provide the XFEL radiation in the photon energy range of 0.2 -25 keV.
- The project proposal was recently approved by the central government in April 2017, and now it is in the feasibility study phase, aiming at commencing the tunnel construction in 2018.

Nominal performance of the SCLF linac



	No. of CM's	Avail. Cavities	Powered. Cavities	Gradient (MV/m)	E_{out} (MeV)	σ_z-out (mm)	σ_δ-out (%)	ϕ_{rf}	R_{56} (mm)
L0	1	8	7	16.3	120	1	0.04	0	
L1	2	16	15	13.6	326	1	0.383	-12.7	
HL	2	16	15	12.5	270	1	1.468	-150	
BC1	-	-			270	0.144	1.468		-55
L2	18	144	135	15.5	2148	0.144	0.368	-29	
BC2	-	-			2148	0.0072	0.368		-37
L3	54	432	406	15.5	8653	0.0072	0.086	0	

IHEP will provide one test cryomodule (8-cavities), and 100 9-cell cavities for SCLF

excellent exercise for CEPC

SppC Design Scope (201701 version)

Top priority: reducing cost!
Instead of increasing field

- **Baseline design**
  - Tunnel circumference: 100 km
  - Dipole magnet field: 12 T, iron-based HTS technology (IBS)
  - Center of Mass energy: >70 TeV
  - Injector chain: 2.1 TeV
- **Upgrading phase**
  - Dipole magnet field: 20 -24T, IBS technology
  - Center of Mass energy: >125 TeV
  - Injector chain: 4.2 TeV (adding a high-energy booster ring in the main tunnel in the place of the electron ring and booster)
- **Development of high-field superconducting magnet technology**
  - Starting to develop required HTS magnet technology before applicable iron-based wire is available
  - ReBCO & Bi-2212 and LTS wires be used for model magnet studies and as an option for SPPC: stress management, quench protection, field quality control and fabrication methods

Collaboration on HTS

"Applied High Temperature Superconductor Collaboration (AHTSC)" was formed in Oct. 2016. with >13 related institutes & companies and 50 scientists & engineers to advance HTS R&D and Industrialization.

- **Goal：**
  1) To increase the J_c of IBS by 10 times, reduce the cost to 20 Rmb/kAm @ 12T & 4.2K in 10 years, and realize the industrialization of the conductor;
  2) To reduce the cost of ReBCO and Bi-2212 conductors to 20 Rmb/kAm @ 12T & 4.2K in 10 years;
  3) Realization and Industrialization of iron-based SRF technology.
- **Working groups：** 1) Fundamental science investigation; 2) IBS conductor R&D; 3) ReBCO conductor R&D; 4) Bi2212 conductor R&D; 5) performance evaluation; 6) Magnet and SRF technology.
- **Collaboration meetings**: every 2~3 months.

Funded by CAS, more expected from MOST

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CEPC 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**

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

R&D Funding - NSFC

Increasing support for CEPC D+RDby 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 Tsinghua IHEP
成像型电磁量能器关键技术研究(2016)	重点基金	刘树彬	中国科技大学 USTC
CEPC局部双环对撞区挡板系统设计及螺线管场补偿(2016)	面上基金	白莎	高能物理研究所
用于顶点探测器的高分辨、低功耗SOI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
高粒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	王逗	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

~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

funding needs for carrying out CEPC design and R&D should be fully met by end of 2018

CEPC Site Selections

Bejing

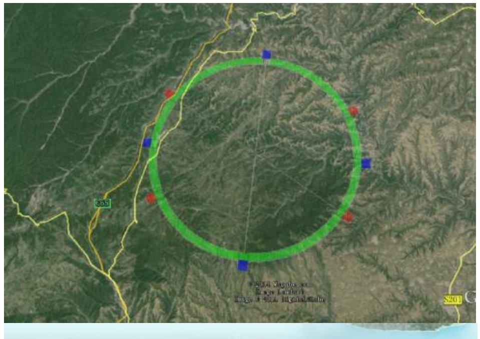
Baoding
(xiong an)

Tianjin

4

1

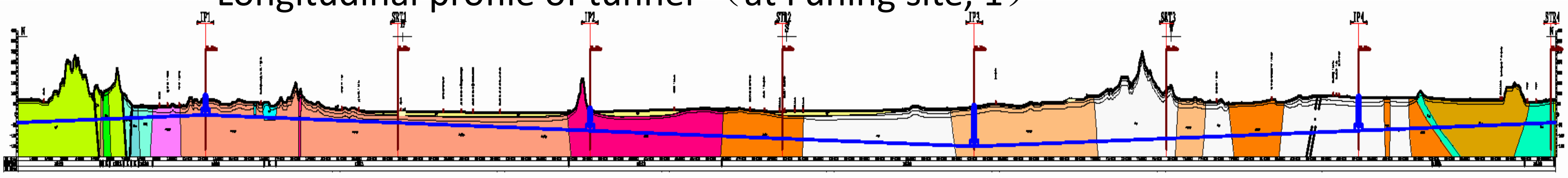
2

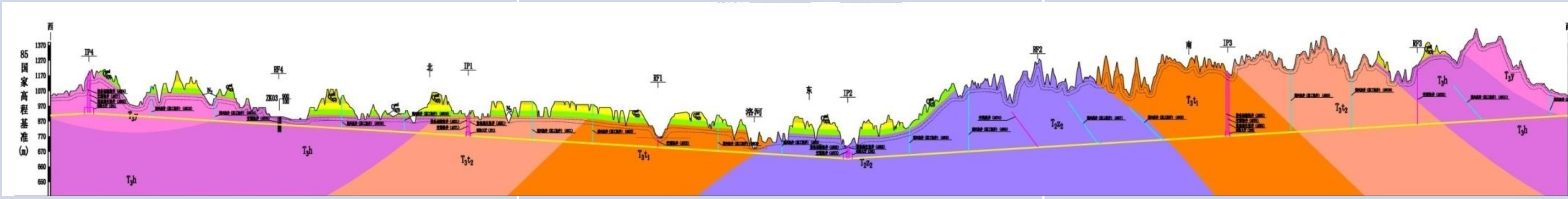
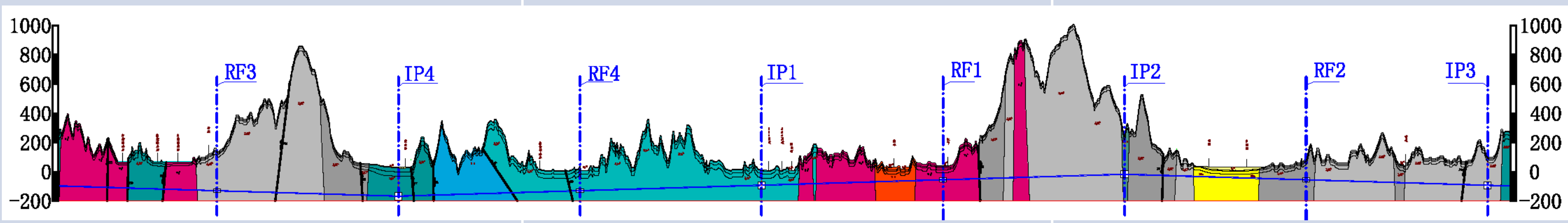


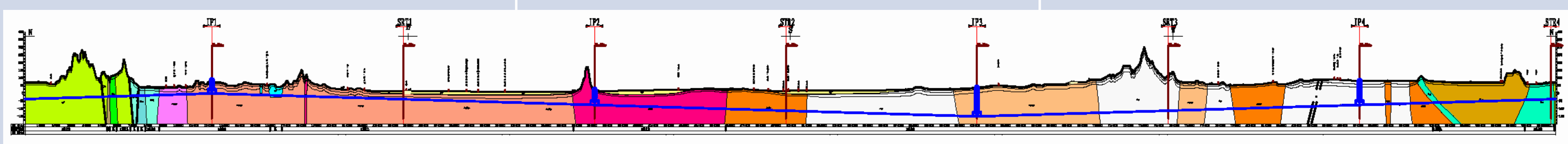
3

1) Qin huang dao， Heihe （Completed in 2014）
2) Huanging， Shanxi（Completed in 2017)
3)Shen shan， Guangdong (Completed in 2016)
4) Baoding (Xiong an), Hebei (Started in August 2017, near Beijing
5) Zhejiang (under contact)
6) Jiangsu (under contact)

Longitudinal profile of tunnel （at Funing site, 1）



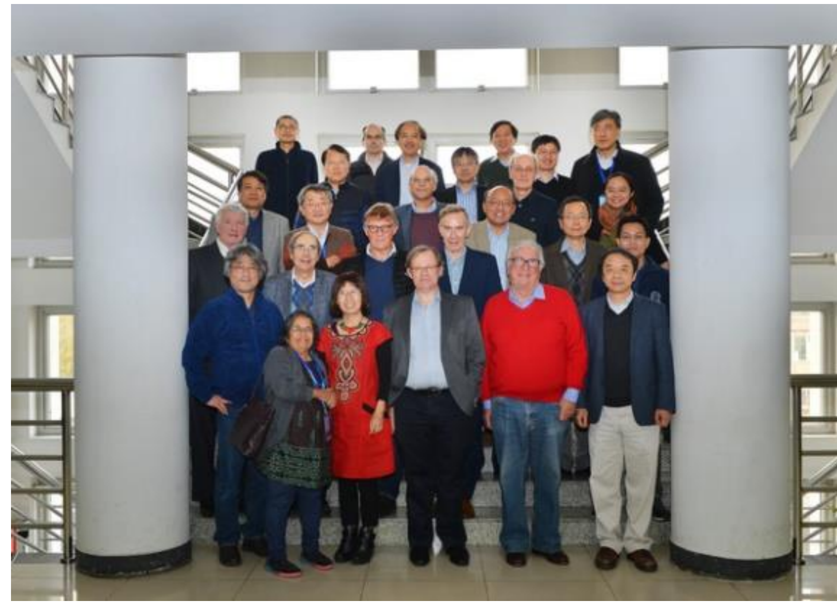
<table>
<tr><th>Item</th><th>Huangling</th><th>Shen-Shan</th><th>Funing</th></tr>
<tr><td>Project layout</td><td colspan="3">Huangling（100km）

Shen-Shan（100km）


Funing（100km）
</td></tr>
<tr><td>Construction difficulty</td><td>Moderate</td><td>Relatively difficult</td><td>Relatively easy</td></tr>
</table>

CEPC International Collaboration

The first CEPC-SppC international
Collaboration Workshop
Nov 6-8, 2017, IHEP, Bejing
http://indico.ihep.ac.cn/event/6618

- a major workshop on CEPC
- global collaboration
- examines R&D status
- CDR – draft chapters
  - a major push
- CEPC organization update



The thhird CEPC-SppC International Advisory
Committee Meeting
Nov 8-9, 2017, Beijing

CEPC Industrial Promotion Consortium (CIPC)

Established in Nov. 7 , 2017

1) Superconduting materials (for cavity and for magnets)
2) Superconductiong cavities
3) Cryomodules
4) Cryogenics
5) Klystrons
6) Vacuum technologies
7) Electronics
8) SRF
9) Power sources
10) Civil engineering
11) Precise machinary.....

More than 50 companies joined in first phase of CIPC，
and more will join later....

大型环形正负电子对撞机

中国物理协会高能物理分会达成共识

中国物理学会高能物理分会第九届常务委员会

第四次（扩大）会议

中国物理学会高能物理分会

关于基于加速器的中国高能物理未来发展的意见

2016 年 8 月 20 日至 21 日，中国物理学会高能物理分会第六次战略研讨会在中国科学技术大学召开。2016 年 8 月 24 日经过高能物理分会常务委员会议讨论，形成了关于基于加速器的中国高能物理未来发展的意见。

The HEP division of the Chinese Physical Society reached a consensus in August, 2016 that placed CEPC as the top priority accelerator based program for the future and endorsed CEPC design and R&D

中国高能物理未来发展的可能选项有大型环型正负电子对撞机（CEPC：Circular Electron Positron Collider，它包括 Higgs 工厂和 Z 工厂）、高亮度正负电子加速器(HIEPA：High Intensity Electron Positron Accelerator)。 委员会 对它们的前沿科学问题、技术先进性及在国际上的地位进行了深入分析和讨论。认为 CEPC 是我国未来高能加速器物理发展的首选项目。我国高能物理学界应该以 CEPC 作为发展战略目标，积极争取成为中国发起的国际大科学工程之一。在实现这一战略目标的过程中，要充分发挥和利用现有的 BEPC 的作用（包括升级改造及在该能区进一步发展），布置力量在高能量和高亮度前沿开展相关的预研究，培养和储备科研力量，掌握关键核心技术。在兼顾 Higgs 和 Z 工厂物理目标的前提下优化 CEPC 加速器和探测器的设计。高能物理分会将尽快组织制定基于加速器的中国高能物理发展路线图。

高能物理学界将同心协力，分工合作，全力以赴，推动我国高能物理的持续发展。

中国物理学会高能物理分会

2016 年 9 月 12 日

Summary

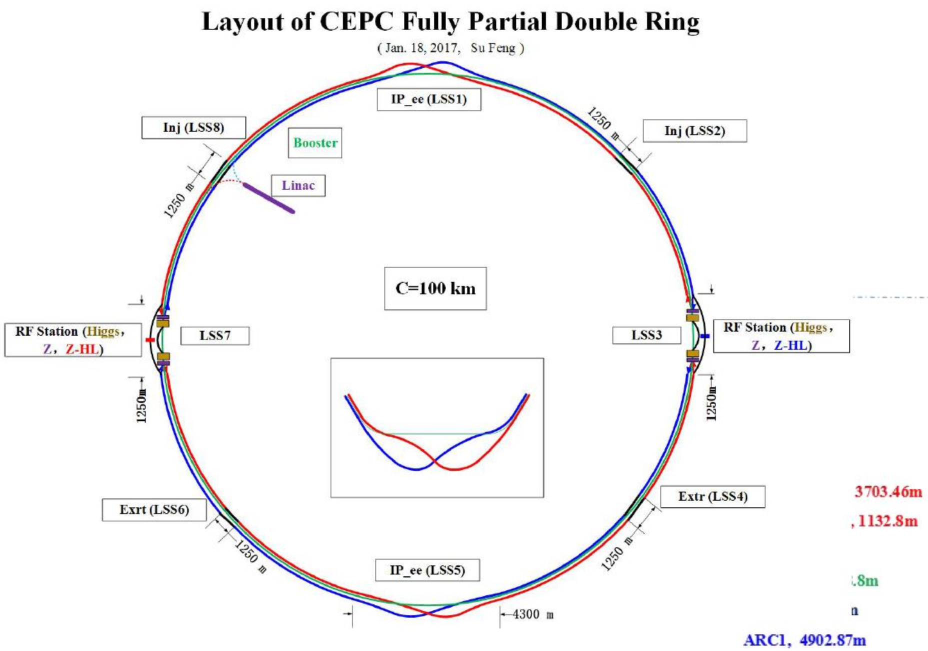
- CEPC CDR is progressing and will be completed in 2018
- Design + R&D needs are largely met with various sources of funding and support; people are hard working on DRD
- Build a stronger CEPC team w. intl. collab. & participation
- For the very long future, economic HTS magnet program is being explored in China with a carefully constructed consortium
- Infrastructure, experience and engineering proficiency gained through current projects (light source, CSNS, etc.) helpful for the CEPC
- Upon successfully completing the DRD program, we expect to make the case to the national government for building CEPC (~5 years from now)

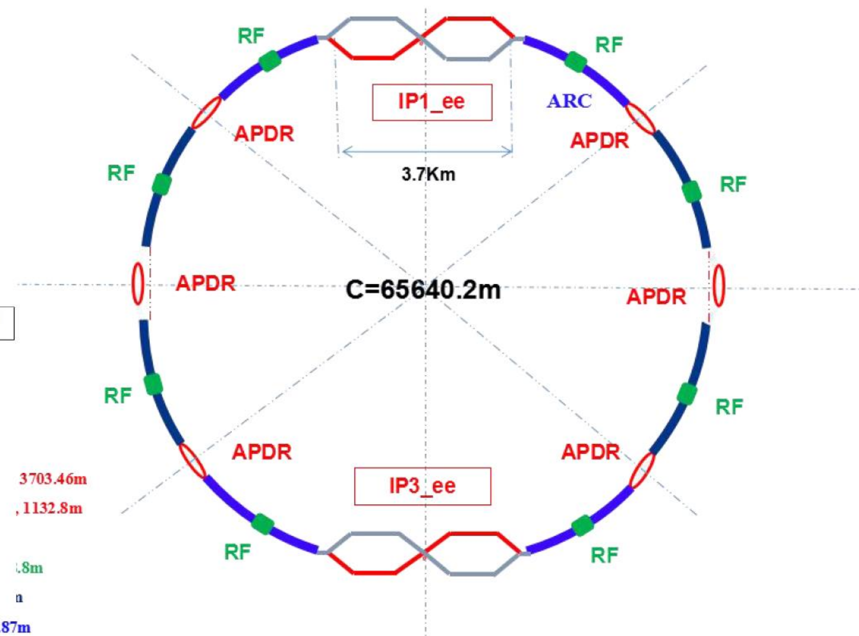
Cryomodule R&D and Test at the PAPS Facility

CEPC SRF R&D Plan (2017-2022)

- **Two small Test Cryomodules** (650 MHz 2 x 2-cell, 1.3 GHz 2 x 9-cell)
- **Two full scale Prototype Cryomodules** (650 MHz 6 x 2-cell, 1.3 GHz 8 x 9-cell)
- **Schedule**
  - 2017-2018 (key components, IHEP Campus)
    - high Q 650 MHz and 1.3 GHz cavities, N-doping + EP
    - 650 MHz variable couplers (300 kW) , 1.3 GHz variable couplers (10 kW)
    - high power HOM coupler and damper, fast-cool-down and low magnetic module, reliable tuner
  - 2019-2020 (test modules integration, Huairou PAPS)
    - Horizontal test 16 MV/m, Q_0 > 2E10
    - beam test 1~10 mA
  - 2021-2022 (prototype modules assembly and test, Huairou PAPS)

CEPC two shcemes towards CDR





CEPC Baseline Design

Better performance for Higgs and Z compared with alternative scheme, without bottle neck problems, but with higher cost

CEPC Alternative Design

Lower cost and reaching the fundamental requirement for Higgs and Z luminosities, under the condition that sawtooth and beam loading effects be solved