CEPC workshop

Beijing 18-20 November 2019

https://indico.ihep.ac.cn/event/9960

Frank Zimmermann,

22 November 2019

CEPC 2019, 18-20 Nov. 2019

Statistics:

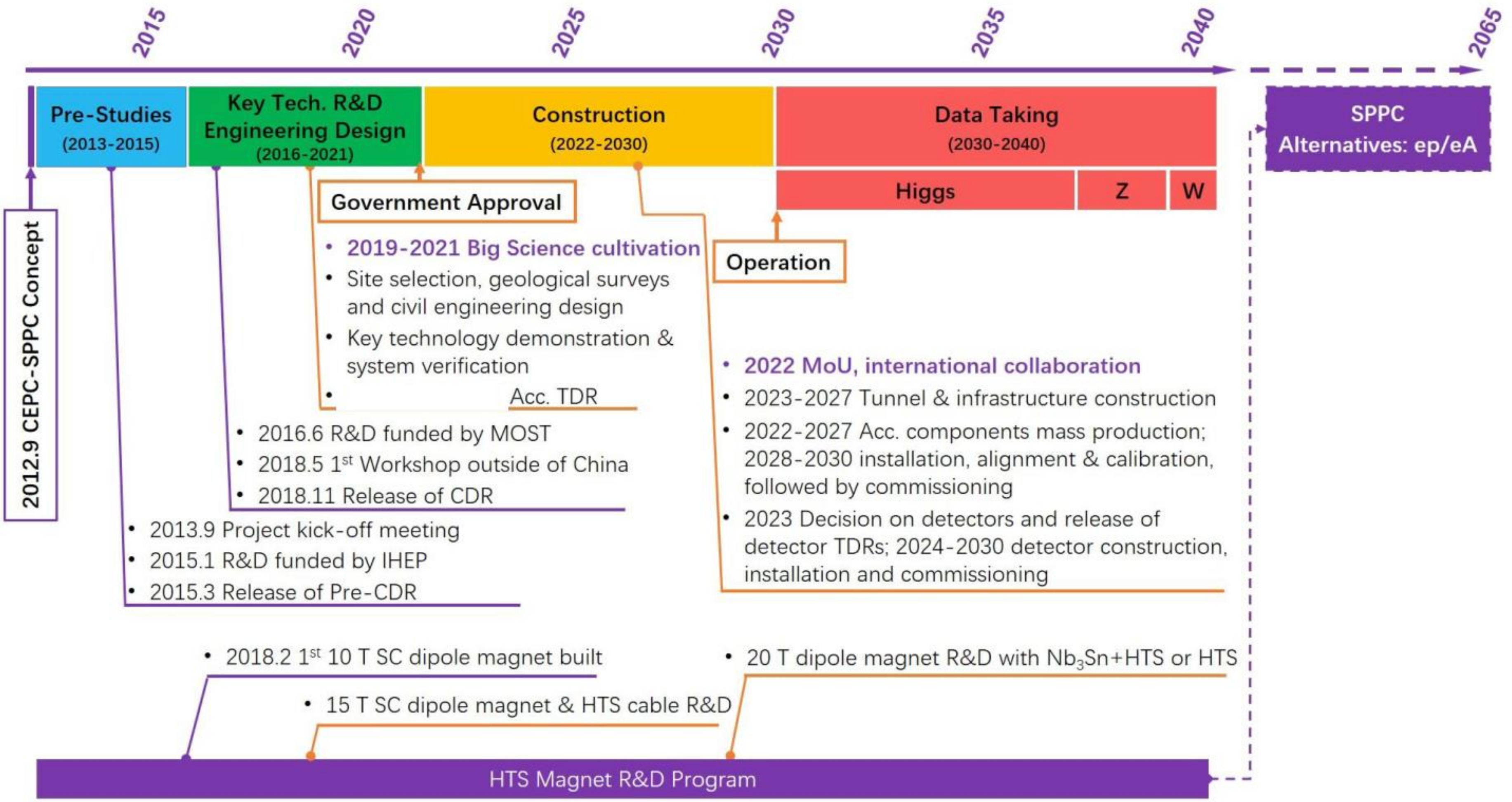
303 participants

Australia 3, Canada 1, China 205, Cyprus 1, France 10, Germany 3, Hong Kong 1, Israel 2, Italy 17, Japan 7, Korea 4, Netherlands 2, Norway 1, Pakistan 1, Russia 8, South Africa 1, Spain 1, Switzerland 8, Taiwan 2, UK 12, USA 13

including J. Brau, P. Jenni, Y.-K. Kim, L. Linssen, L. Maiani, A. Schopper, S. Stapnes, G. Taylor, H. Yamamoto, …

CEPC Roadmap and Schedule (ideal)

CEPC Project Timeline



Pre-Studies (2013-2015)

Key Tech. R&D Engineering Design (2016-2021)

Construction (2022-2030)

Data Taking (2030-2040)

Higgs | **Z** | **W**

SPPC
Alternatives: ep/eA

2012.9 CEPC-SPPC Concept

Government Approval

- **2019-2021 Big Science cultivation**
- Site selection, geological surveys and civil engineering design
- Key technology demonstration & system verification
- Acc. TDR

Operation

- **2022 MoU, international collaboration**
- 2023-2027 Tunnel & infrastructure construction
- 2022-2027 Acc. components mass production; 2028-2030 installation, alignment & calibration, followed by commissioning
- 2023 Decision on detectors and release of detector TDRs; 2024-2030 detector construction, installation and commissioning

- 2016.6 R&D funded by MOST
- 2018.5 1st Workshop outside of China
- 2018.11 Release of CDR

- 2013.9 Project kick-off meeting
- 2015.1 R&D funded by IHEP
- 2015.3 Release of Pre-CDR

- 2018.2 1st 10 T SC dipole magnet built
- 15 T SC dipole magnet & HTS cable R&D
- 20 T dipole magnet R&D with Nb_3Sn+HTS or HTS

HTS Magnet R&D Program

Xinchou Lou

Progress and updates – Funding Model

The cost of the CEPC accelerator and two detectors have been estimated to be 36 billion CNY (~ 5 billion US Dollars), under the assumption that the local government will provide the land, and the necessary infrastructure for the CEPC facility

Option 1：

32B CNY from Chinese central government + 4B CNY International
（1US$ = 7 CNY)

Option 2:

12B CNY from Chinese central government
10B CNY from MOST International science project
10B CNY from local government
4B CNY International

Under discussion: funding breakdown across various 5-yeatr periods

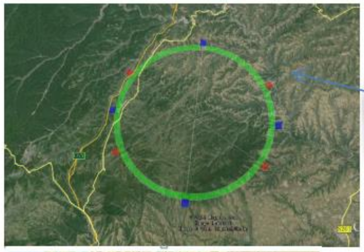
Xinchou Lou

CEPC Site Selections

Huanghe Company particitated

China at night

6



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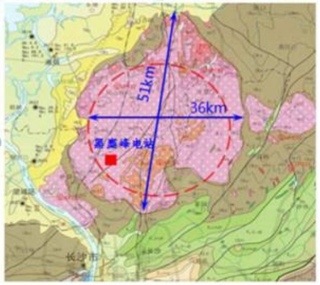

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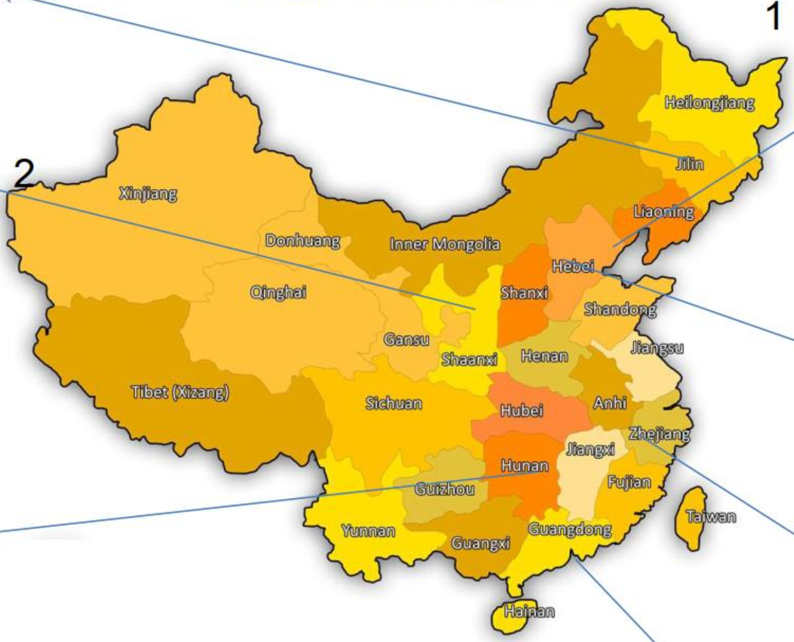

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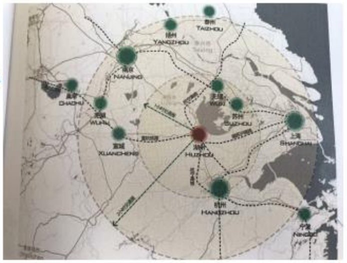

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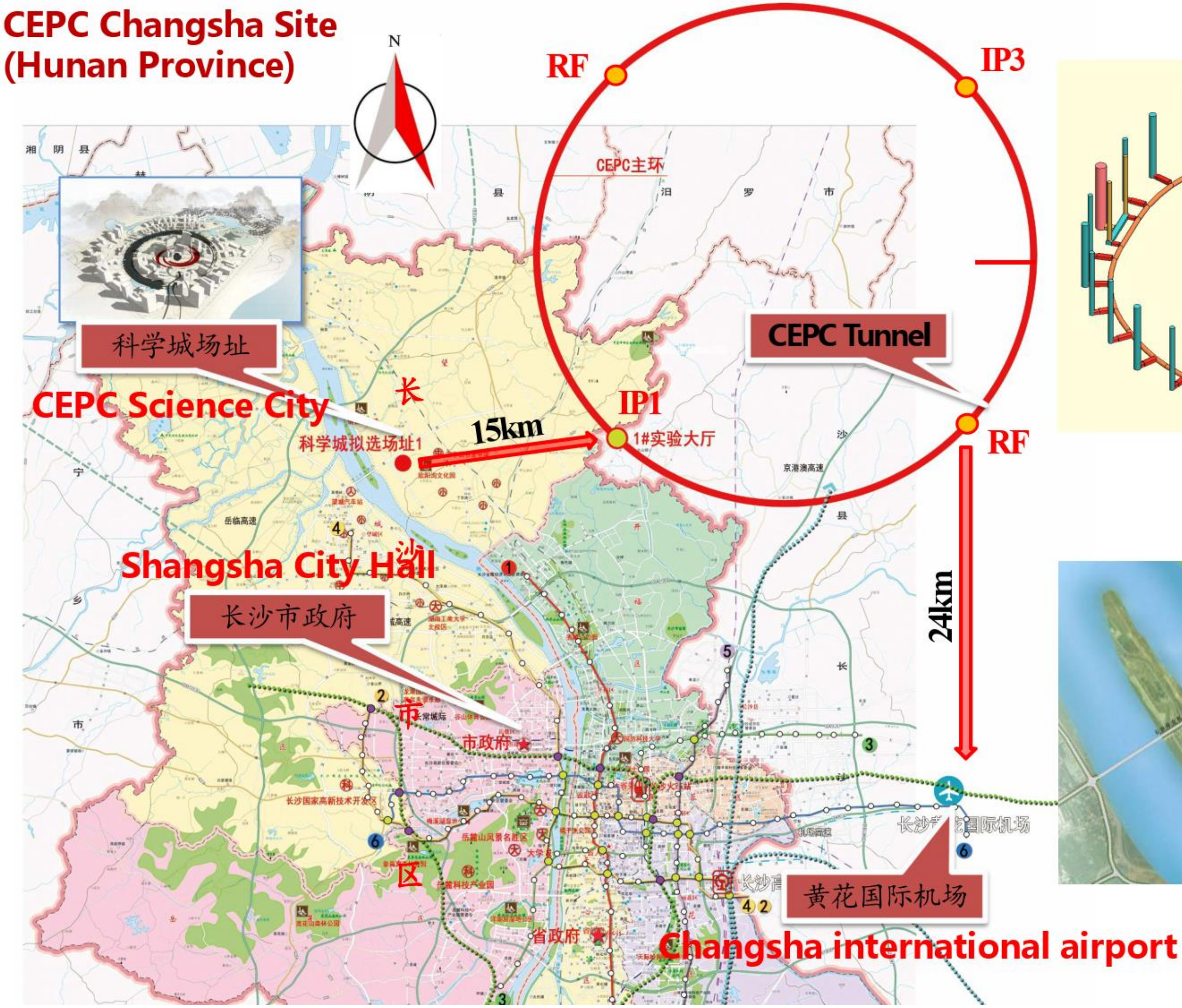
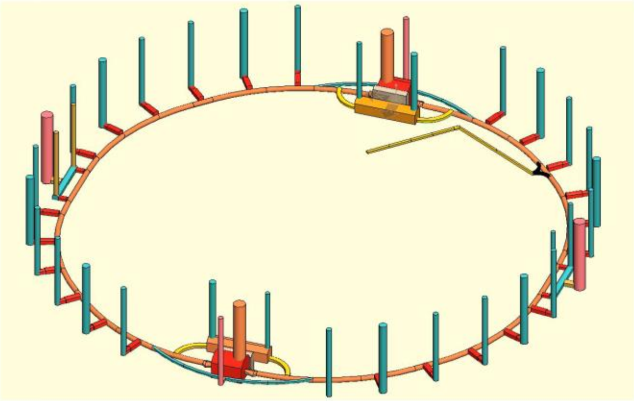
1) Qinhuangdao, Hebei Province（Completed in 2014）
2) Huangling, Shanxi Province（Completed in 2017)
3) Shenshan, Guangdong Province(Completed in 2016)
4) Baoding (Xiong an), Hebei Province (Started in August 2017)
5) Huzhou, Zhejiang Province (Started in March 2018)
6) Chuangchun, Jilin Province (Started in May 2018)
7) Changsha, Hunan Province (Started in Dec. 2018)

Jie Gao

Jie Gao

CEPC Changsha Site (Hunan Province)

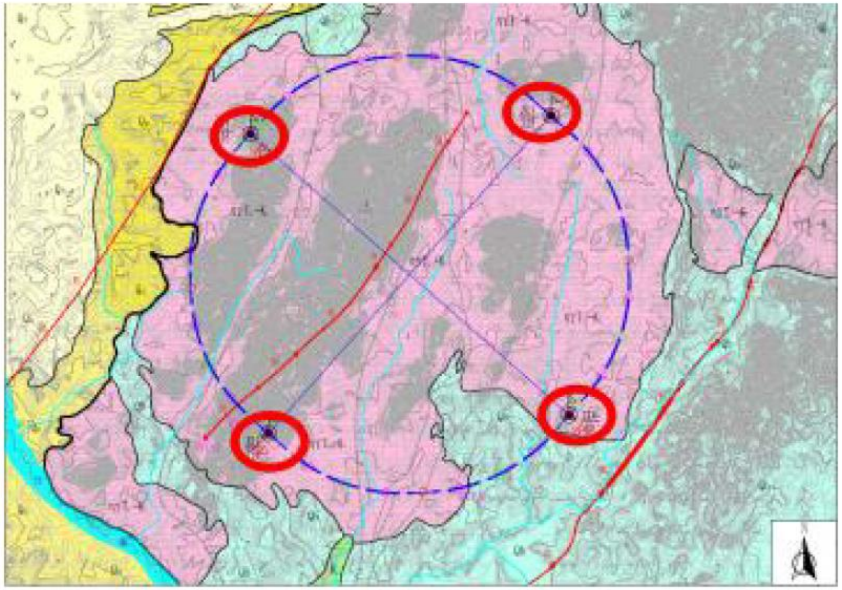


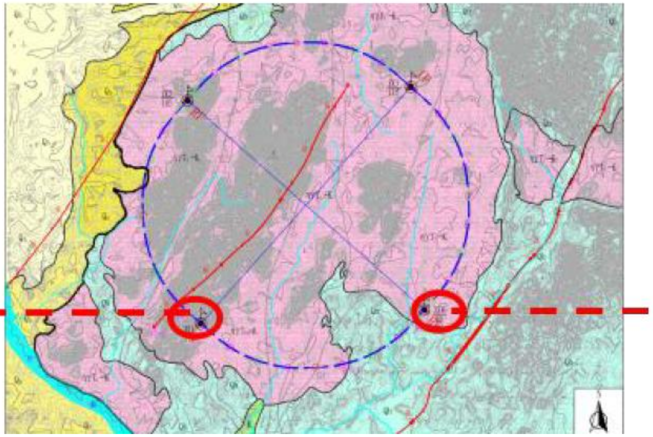


CEPC Tunnel Design

CEPC Scientific City

CEPC Site Selection in Changsha (Hunan Province)

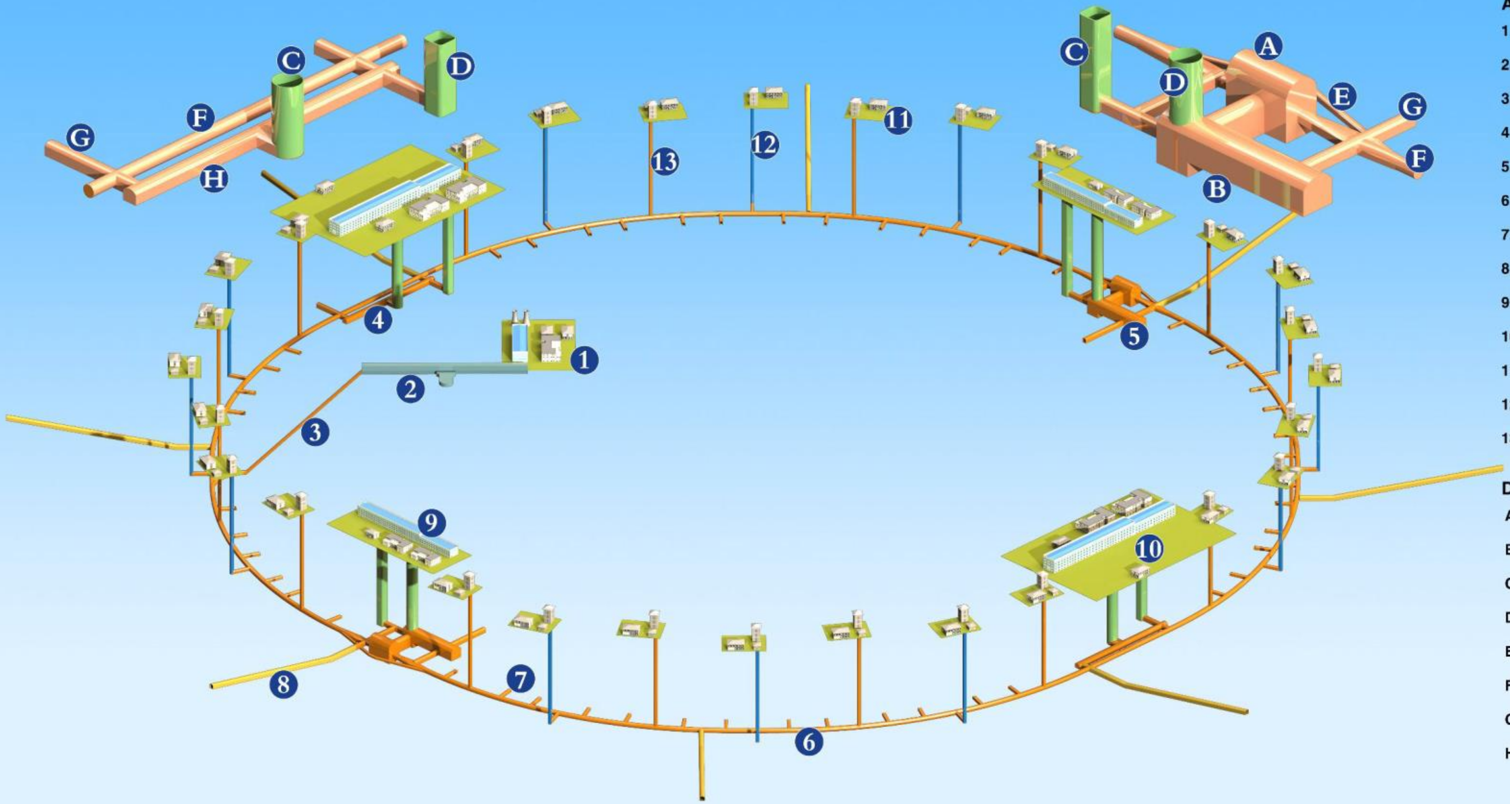




Jie Gao

Jie Gao

CEPC



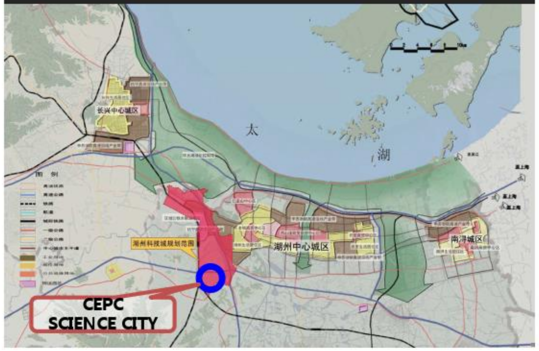
Accelerator Region Caverns:
1. Surface Buildings of Linac Segment
2. Linac Segment
3. Transfer Line
4. Tunnel Complex of RF Region
5. Detector Region Caverns
6. Main Ring Tunnel
7. Auxiliary Tunnel
8. Access Tunnel
9. Surface Buildings of Experiment Hall
10. Surface Buildings of RF Region
11. Surface Buildings of Shaft for Access and Cable
12. Shaft for Access and Cable
13、Shaft for Access，Cable and Measure

Detector Region Caverns:
A. Experiment Hall
B. Service Cavern
C. Transport Shaft
D. Shaft for Access, Cable and HVAC
E. Booster Bypass Tunnel
F. Main Ring Tunnel
G. Traffic Tunnel
H. Auxiliary Tunnel of RF Region

Science City Planning (Huzhou site as an example)

Science City is located in the southwest of Huzhou, south of Huzhou Scientific and Technological City, **5 kilometers** away from Huzhou High Speed Railway Station, **7 kilometers** away from CEPC, and the site area is about **3.92 square kilometers**.

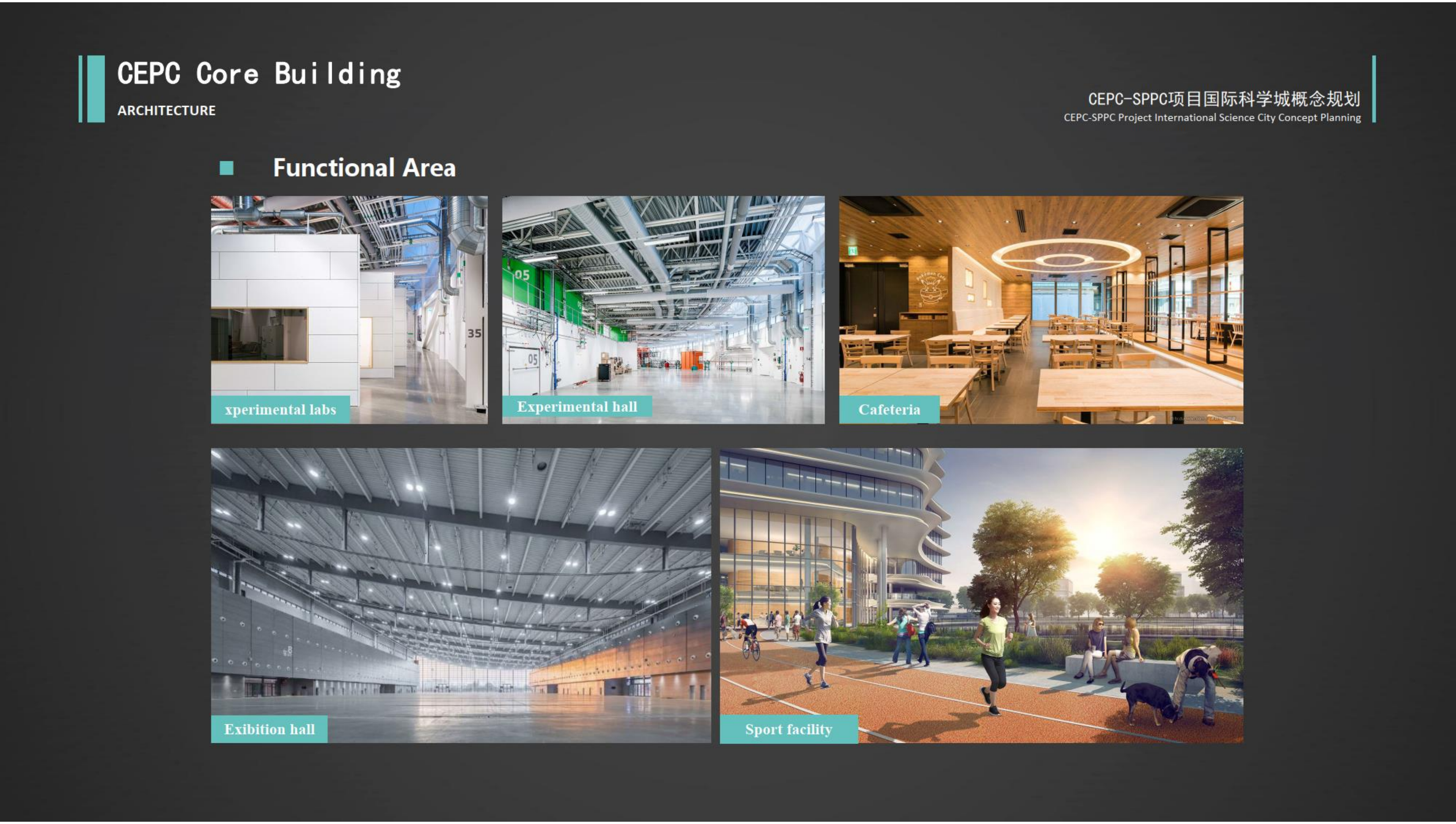
Huzhou Science And Technology City Location Map



Current Status Analysis Diagram

Jie Gao

Changsha example



CEPC Core Building

ARCHITECTURE

CEPC-SPPC项目国际科学城概念规划
CEPC-SPPC Project International Science City Concept Planning

Functional Area

xperimental labs

Experimental hall

Cafeteria

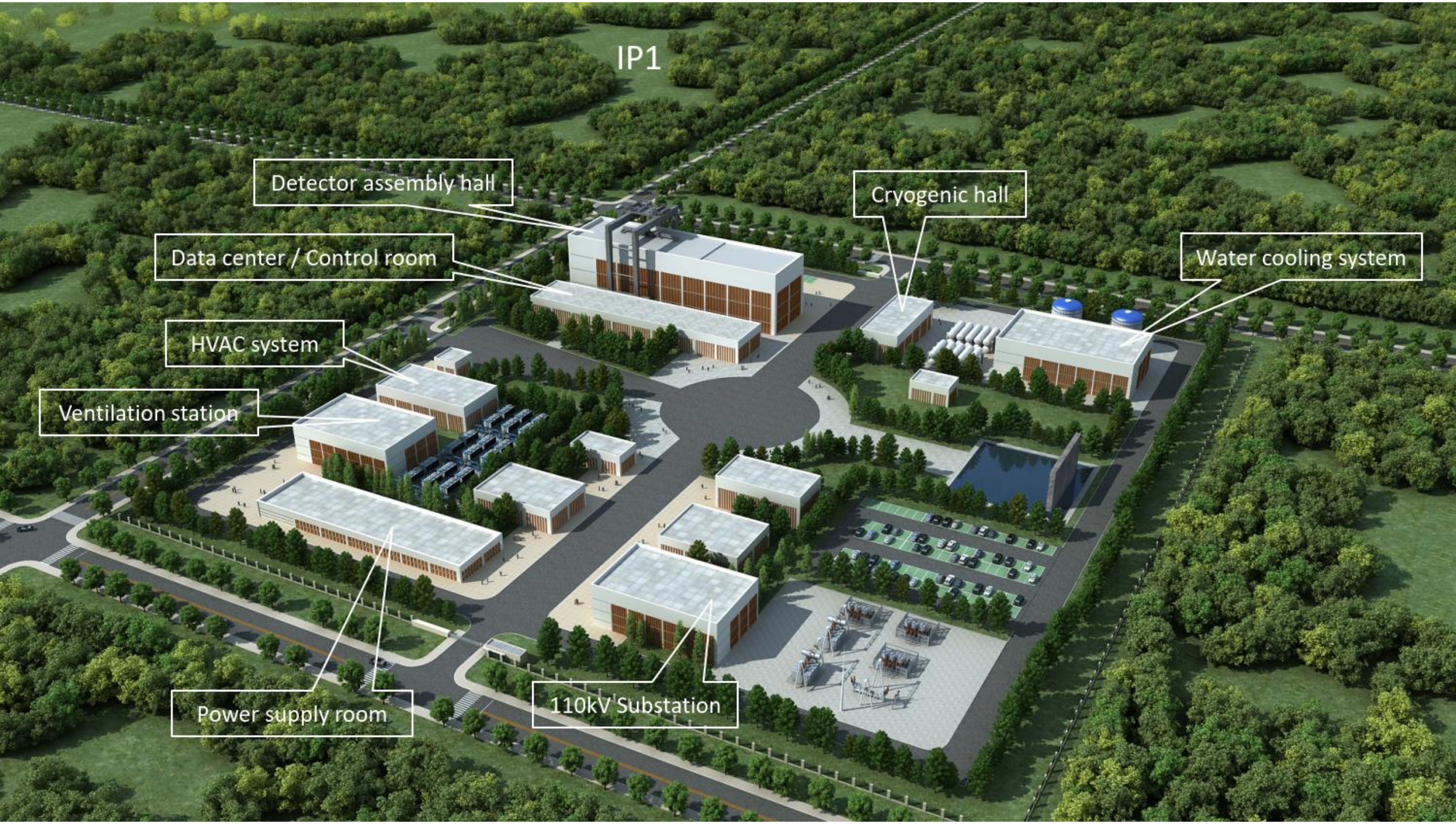
Exibition hall

Sport facility

Jie Gao

Yu Xiao

Qinghuangdao example



CEPC Industrial Promotion Consortium (CIPC) Collaboration Status

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

Established in Nov. 7 , 2017
CIPC Annual Meeting, July 26 , 2018

CEPC
环形正负电子对撞机
Circular Electron Positron Collider
Member of CEPC Industrial Promotion Consortium（CIPC）
CEPC产业促进会
成员单位
北京中科富海低温科技有限公司
BEIJING SINOSCIENCE FULLCRYO TECHNOLOGY CO., LTD.

Now:

-Huanghe Company, Huadong Engineering Cooperation Company, on CEPC civil engineering design, site selection, implementation...

-Shenyang Huiyu Company on CEPC MDI mechanical connection design

-Zhongxin Heavy Industry on Elecletric-magnetic seperator design

-China Astronotics Department 508 Institute on CEPC MDIsupporting design and CEPC magnets mechanical designs...

-Kuanshan Guoli on CEPC 650MHz high efficiency klystron

-Huadong Engineering Cooperation Company, on CEPC alignement and installation logistics...

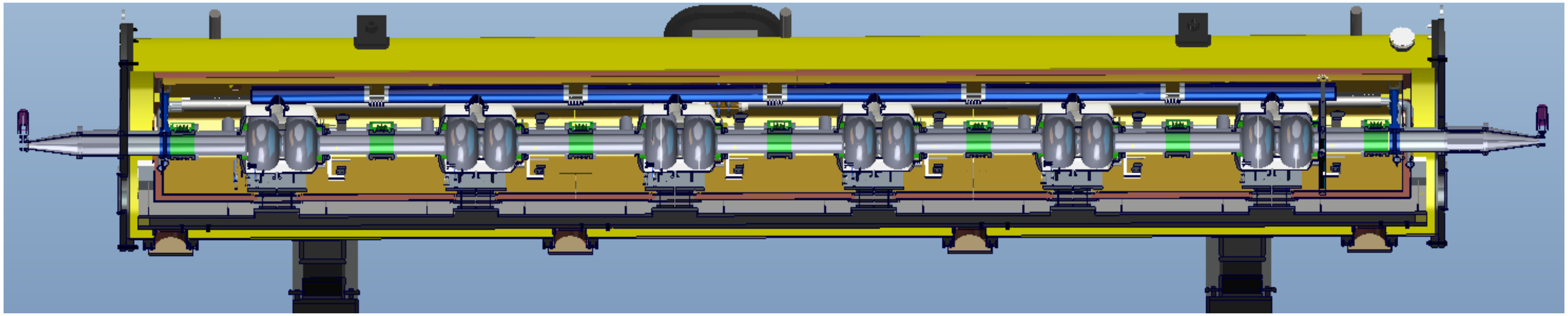
CIPC Member Logo (part of CIPC members' logo)

LEIKE 雷科电子
KAITENG SIFANG
汉光科技
北广科技 BBEF
上创超导
统力电工 TOLY ELECTRIC
高能锐新 HE-RACING TECHNOLOGY
Superconductor Technology 苏州八匹马超导科技有限公司
上海普束科技 PUSU
VACREE
慧宇 HUI YU
核工业井巷建设集团有限公司 HUZHOU CHINA
上海超导 SHANGHAI SUPERCONDUCTOR
地矿建设 DIKUANG CONSTRUCTION
昆山国力电子科技股份有限公司 Kunshan Guoli Electronic Technology Co., Ltd.
Western Superconducting Technologies Co.,Ltd.
中科富海 FULLCRYO
上海辰光医疗科技股份有限公司 Shanghai Chenguang Medical Technologies Co. Ltd
中船重工鹏力（南京）超低温技术有限公司 CSIC PRIDe (NANJING) CRYOGENIC TECHNOLOGY CO.,LTD.
爱科赛博 ACTIONPOWER
江苏克劳特低温 JiangSu Cryote Co., Ltd.
JJJvac 三井真空
普达迪泰 PRODETEC
北京航天广通科技有限公司 Beijing Grantel Technology Co., Ltd.
中铁装备 CREG
正帆科技 GENTECH
VACUUM PRODUCTS
SEALTECH
SKY
北京鼎荣达
HUALUN
瑞隆 Rui Long
BRARC
HDKY浩德科仪 HoldKY Vacuum Technologies
RuiYuan
天合精机 TIAN HE JING JI
CRCC 中国铁建
东方钽业 OTIC 中国有色集团成员企业
NVT
冰轮 MOON 冰轮环境 MOON-TECH
JST 金盘科技 JINPAN TECHNOLOGY
东方晨景 East Changing
EDWARDS
CBVAC
黄河勘测规划设计研究院有限公司 Yellow River Engineering Consulting Co., Ltd.
中国电建 POWERCHINA 华东勘测设计研究院 HUADONG ENGINEERING CORPORATION
中国电建 POWERCHINA 中国电建集团昆明勘测设计研究院有限公司 KUNMING ENGINEERING CORPORATION LIMITED
海南展创光电技术有限公司 HZC PHOTONICS
中国电建 POWERCHINA

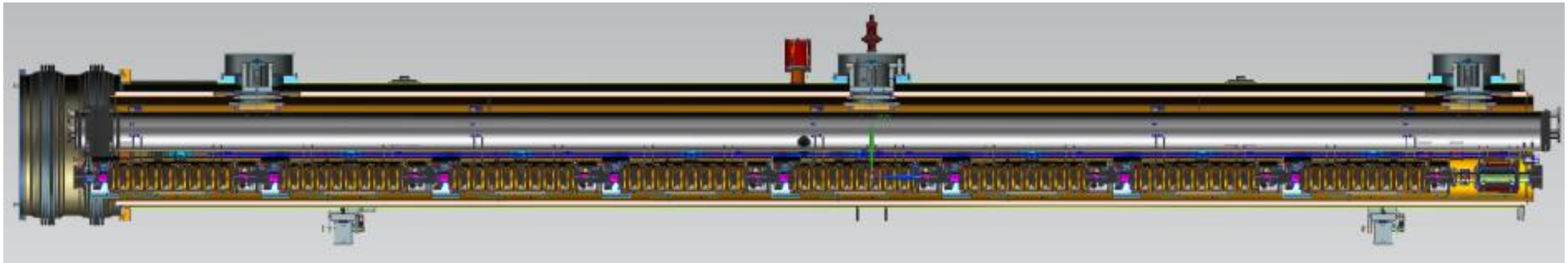
Jie Gao

SCRF growing very fast

CEPC SRF Cryomodules



Collider 650 MHz Cryomodule (6x2-cell, 10 m)



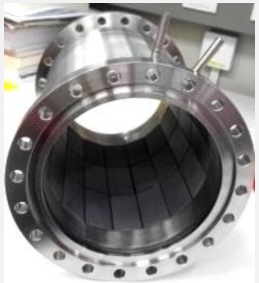
Booster 1.3 GHz Cryomodule (8x9-cell, 12 m)

Prototypes of CEPC 650 MHz SRF System

Three fine grain 650 MHz 2-cell cavities fabricated and processed (BCP). Vertical test and helium vessel weld with magnetic shield inside soon. Two for module horizontal test and beam test. Tuner fabrication completed and will test in a stand. *Cavity details and high Q study in Peng Sha's talk*.

Four high power HOM couplers fabricated and low power tested with cavity. Three will mount on the 2-cell cavities. Vertical test soon with the cavity to verify the notch properties. High power test (1 kW) at RT and 2 K planned with special rigid coaxial line.

High power test of one 650 MHz fixed coupling input coupler reached 150 kW SW (corresponding to 400 kW TW at the window). Another coupler's window broke due to excess ceramic heating. New window and two variable couplers in fabrication.



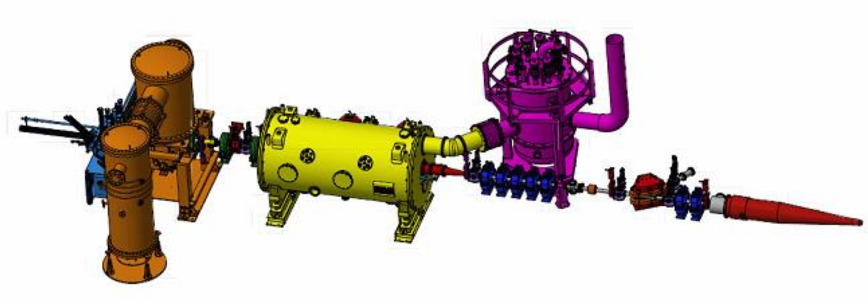
Wideband high power room temperature HOM absorber with SiC+AlN material. 5 kW high power test planned.

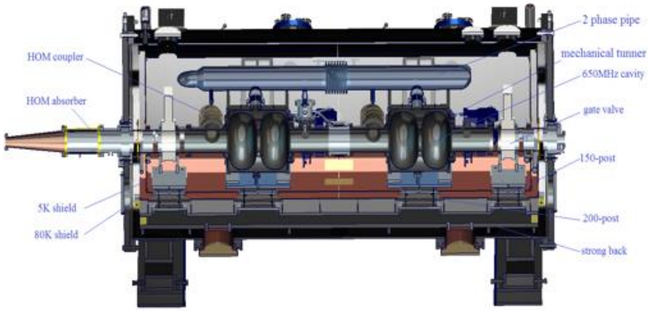
Cryomodule and valve box for two 650 MHz 2-cell cavities etc. Module assembly and beam test at PAPS in 2020.

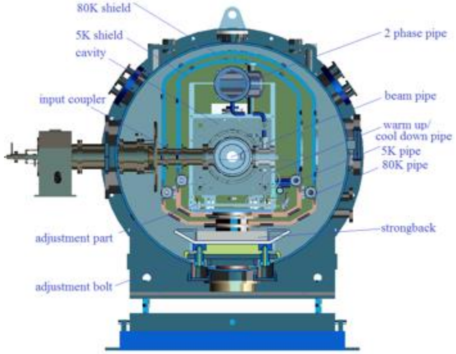
Jiyuan Zhai

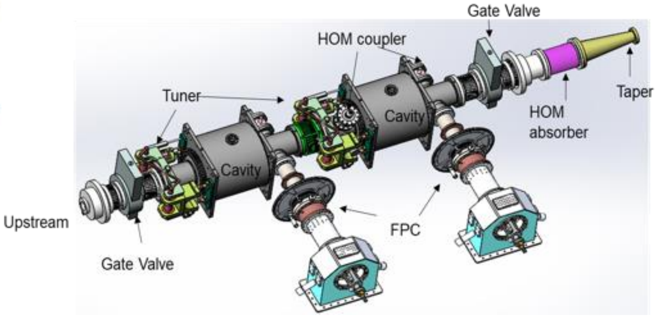
CEPC 650 MHz Test Cryomodule

- Two 650 MHz 2-cell cavities with input couplers, HOM couplers and absorbers, tuners etc.
- Module assembly and 15 MeV beam test with 1 ~ 10 mA from DC photo-cathode gun in 2020.
- Demonstrate system integration and performance of high Q 650 MHz cavity (but with low input power and HOM power) for the Collider Ring.









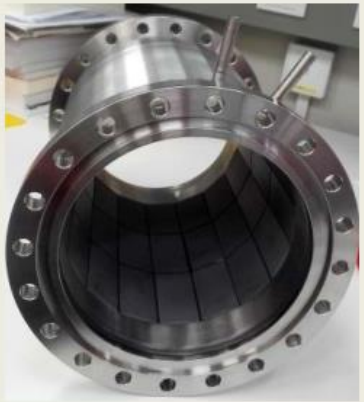
Jiyuan Zhai

CEPC R&D

CEPC SCRF R&D in Progress

High power coupler

HOM

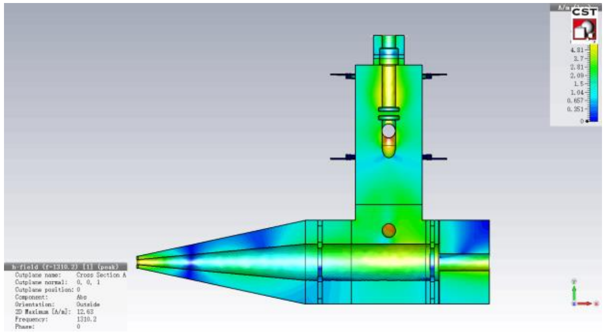


Absorber

CEPC 650 MHz Cryomodule

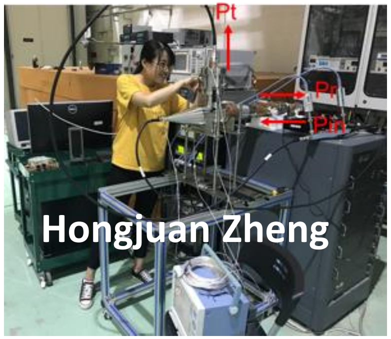
Xinchou Lou

650 MHz HOM Coupler Fabrication end Tests

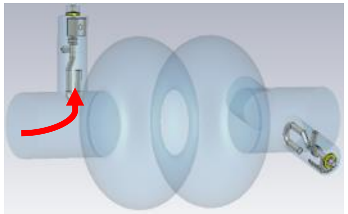


h-field (f=1310.2) [1] (peak)
Cutplane name: Cross Section A
Cutplane normal: 0, 0, 1
Cutplane position: 0
Component: Abs
Orientation: Outside
2D Maximum [A/m]: 12.63
Frequency: 1310.2
Phase: 0

End plate match at RT, rigid coaxial line



RT high power test stand

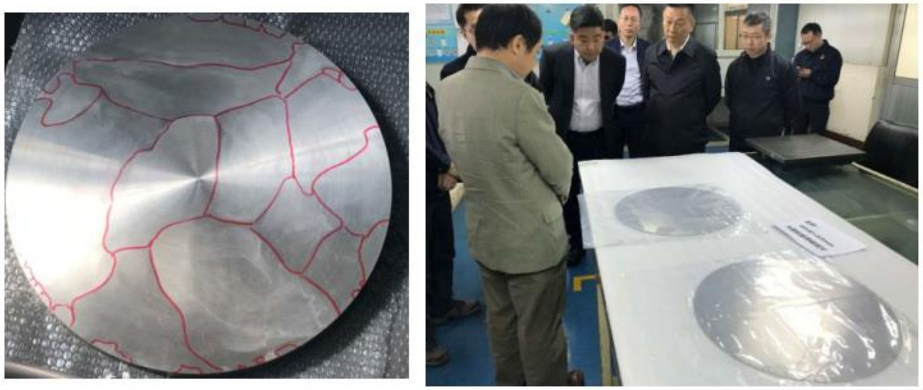


Off-resonance excitation of 1.3 GHz power at 2 K

CEPC R&D

650 MHz 1-Cell Cavity (Large Grain)

- 650 MHz 1-cell cavity (large grain) is favorable for HL-Z, which have higher Q and gradient than fine grain.
- Target of Vertical test: **5E10 @ 42MV/m at 2.0 K**.
- Four cavities are under fabrication now, which will be tested in the middle 2019.



Large grain Nb sheets made by OTIC

Jie GAO

CEPC Infrastructure

IHEP New SC Lab under Construction （Status August 2019）

Jie GAO

Xinchou Lou

The LCLS-II Challenge from SRF2019 *(Marc Ross)*

CEBAF (94) → LEP2 (99) → LCLS-II (2021) → HE (2026)

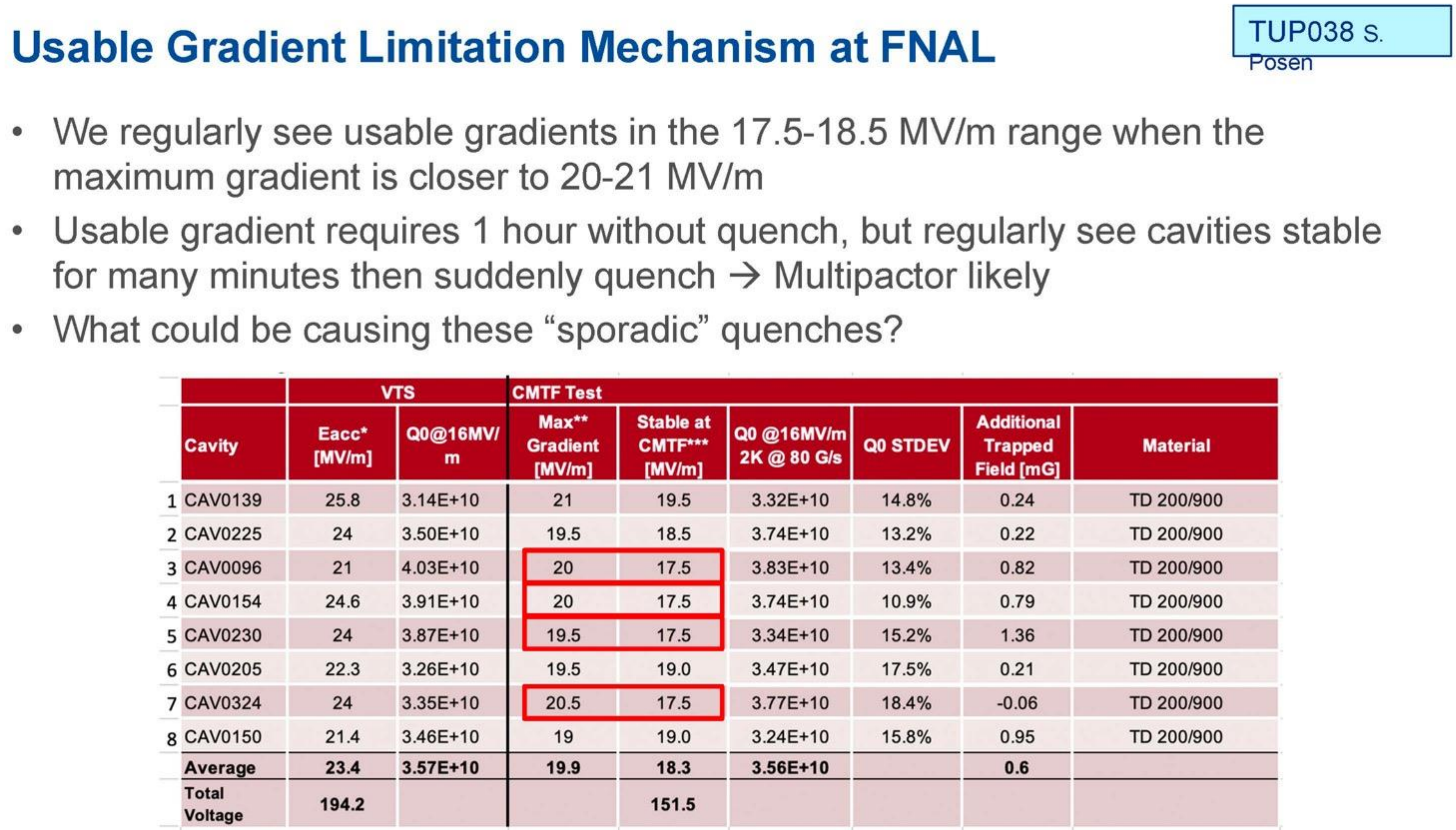
Three large CW Superconducting

Parameter	CEBAF 1994	LEP2 1999	LCLS-II 2021	LCLS-II-HE 2026
N_cav	338	288	280	440
E_acc (MV/m)	7.5	7.2	18.5	20.8
Meters of SRF	169	490	296	466
E_tot (GeV)	1.2	3.6	4.6	8.6
<Q0>	4.0e9	3.2e9	2.7e10	2.7e10
f (MHz)	1497	352	1300	1300
Temp (K)	2.08	4.5	2.0	2.0
Heat Load (kW)	5	53	3.7	7.3
Heat Load kW/GeV	4.2	14.7*	0.8	0.8
* @4.5K. Divide by 3.5 to convert to equivalent load at 2 K, (4.2 for LEP2)				

Substantial investment in CW SRF

Carlo Pagani

Some open Questions



Usable Gradient Limitation Mechanism at FNAL

TUP038 S. Posen

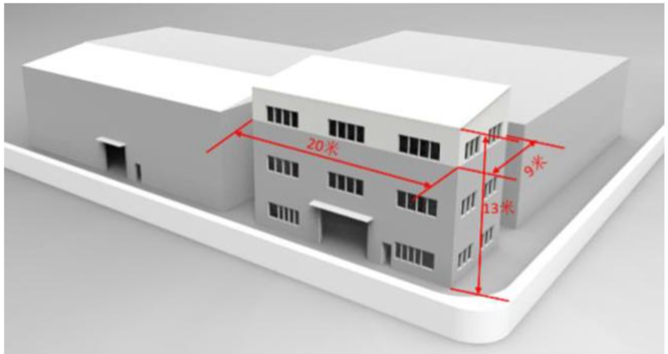
- We regularly see usable gradients in the 17.5-18.5 MV/m range when the maximum gradient is closer to 20-21 MV/m
- Usable gradient requires 1 hour without quench, but regularly see cavities stable for many minutes then suddenly quench → Multipactor likely
- What could be causing these “sporadic” quenches?

		VTS		CMTF Test					
	Cavity	**Eacc* [MV/m]**	**Q0@16MV/m**	**Max** Gradient [MV/m]**	**Stable at CMTF*** [MV/m]**	**Q0 @16MV/m 2K @ 80 G/s**	**Q0 STDEV**	**Additional Trapped Field [mG]**	**Material**
1	CAV0139	25.8	3.14E+10	21	19.5	3.32E+10	14.8%	0.24	TD 200/900
2	CAV0225	24	3.50E+10	19.5	18.5	3.74E+10	13.2%	0.22	TD 200/900
3	CAV0096	21	4.03E+10	20	17.5	3.83E+10	13.4%	0.82	TD 200/900
4	CAV0154	24.6	3.91E+10	20	17.5	3.74E+10	10.9%	0.79	TD 200/900
5	CAV0230	24	3.87E+10	19.5	17.5	3.34E+10	15.2%	1.36	TD 200/900
6	CAV0205	22.3	3.26E+10	19.5	19.0	3.47E+10	17.5%	0.21	TD 200/900
7	CAV0324	24	3.35E+10	20.5	17.5	3.77E+10	18.4%	-0.06	TD 200/900
8	CAV0150	21.4	3.46E+10	19	19.0	3.24E+10	15.8%	0.95	TD 200/900
	Average	**23.4**	**3.57E+10**	**19.9**	**18.3**	**3.56E+10**		**0.6**	
	Total Voltage	**194.2**			**151.5**				

Marc Ross @ SRF2019

1st 650Mhz Klystron Prototype Manufacture Facility

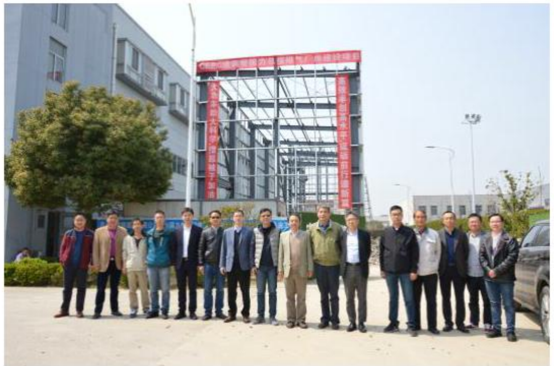
② Infrastructure preparation



Plant

2018.12

2019.1



2019.3

2019.5

2019.5

Jie Gao

CEPC R&D

1st CEPC 650MHz Klystron Prototype Manufacture

① Components

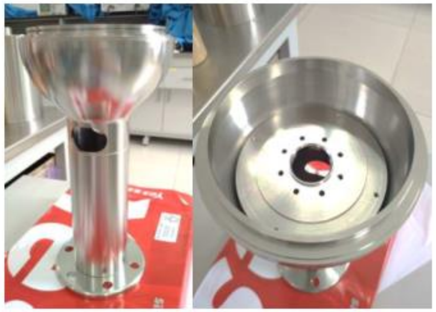
De-gassing
facility

Modulator anode

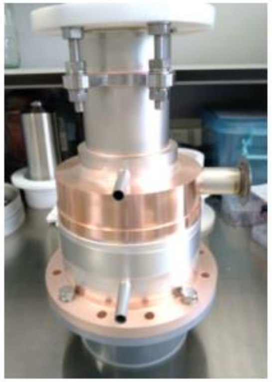
Pumping out pipe

Input coupler

Cavity



Focusing electrode



Output window

Cathode

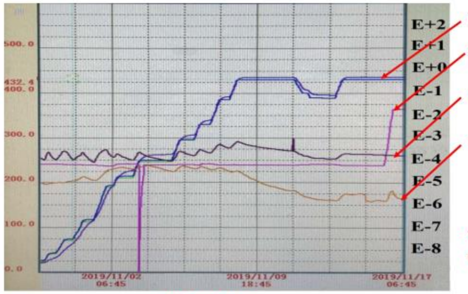
Gun support

Jie GAO

Xinchou Lou

1st 650Mhz Klystron Prototype Manufacture

② Klystron facbrication



Tube temperature(430° C)

Filament current(30A)

Vessel pressure(-4Pa)

Tube Pressure(-6Pa)

The bake-out will end on next week

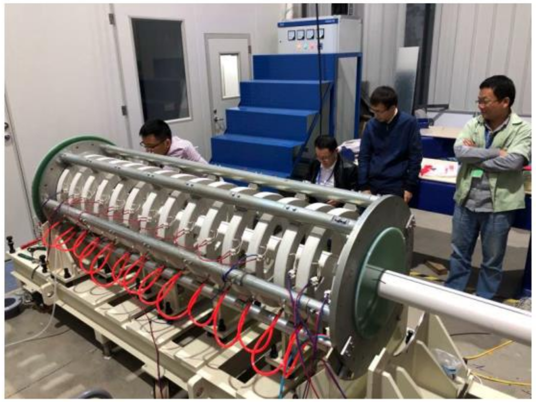
More than 15 days

Baking temperature curve

Klystron welding completed on Oct. 20, 2019

Into baking furnace on Oct. 28, 2019

Baking



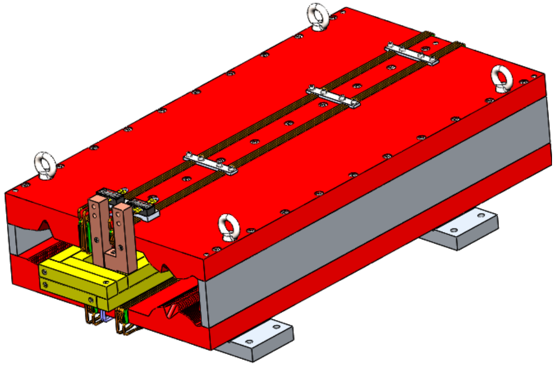
Focusing coil test

Jie Gao

Mei Yang

Mechanical design of DAD prototype

- Liron=1m, solid yoke , three parts;
- Main coils: aluminum bus bars, 4 turns, air cooled, interconnect by screw;
- Trim coils: copper wire, 4 turns per pole, air cooled;
- Two stainless steel supporters to increase rigidity of the overall structure.



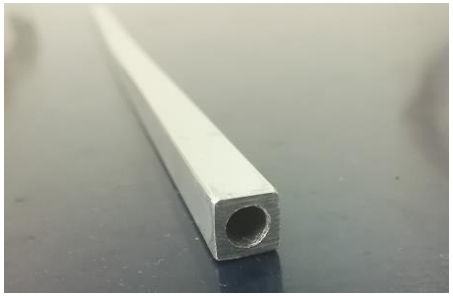
CAD model of dual aperture dipole

Dual aperture dipole prototype

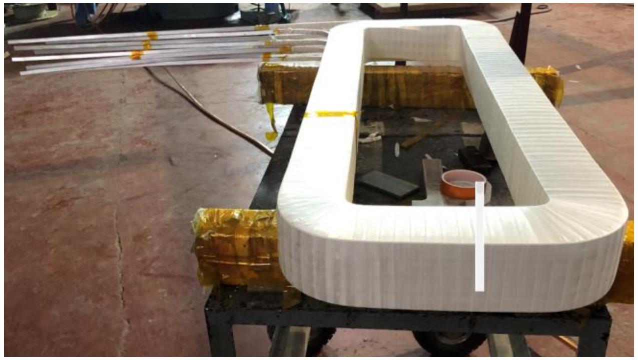
Magnetic strength [T]		0.0373
Aperture [mm]		70
Main coil	Turns	4
	Material	Aluminum
	Current [A]	563
	Current density [A/mm2]	0.7
	Power consumption [kW]	0.12
Trim coil	Turns	1×4
	Material	Copper
	Current [A]	16.7
	Current density [A/mm2]	0.093
	Power consumption [kW]	0.0005
Tot cross section(mm)		535*200
Iron length (mm)		1000
Iron weight(kg)		510
Al weight(kg)		22
Cu weight(kg)		0.3

Dual aperture quadrupole prototype

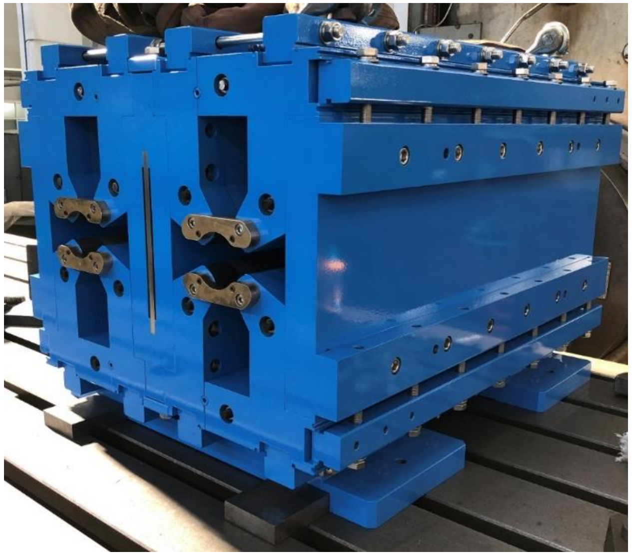
- The DAQ prototype has been finished and will be measured later.



Hollow aluminum wire



Main coil



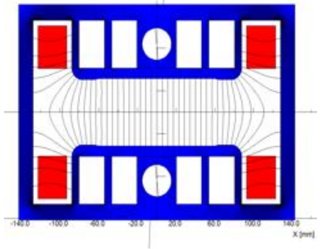
Iron of dual aperture quadrupole

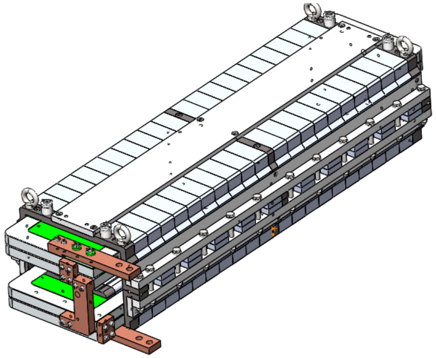
Dual aperture quadrupole prototype

Designs of the booster dipole magnets

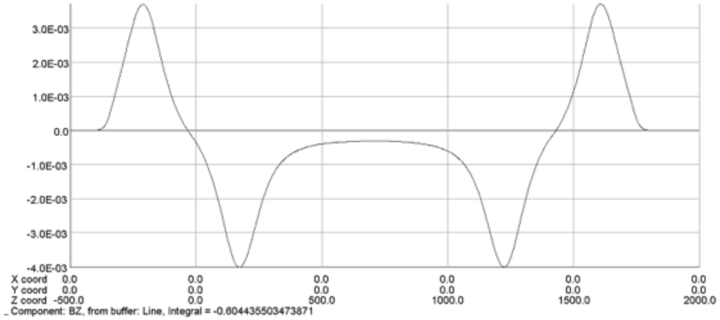
Carlo Pagani,
Wen Kang

1) The dipole magnet with diluted iron core

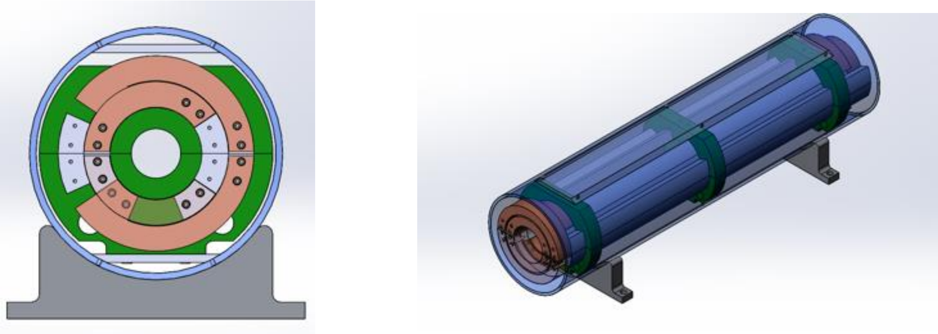




2) CCT dipole magnet without iron core



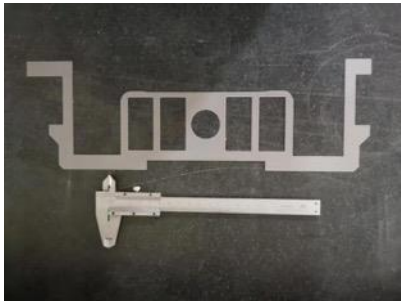
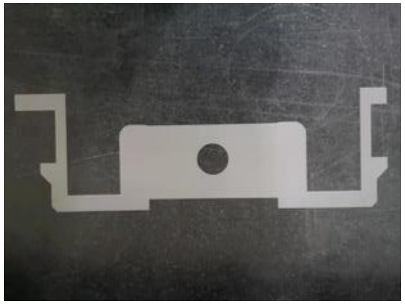
3) CT dipole magnet without iron core



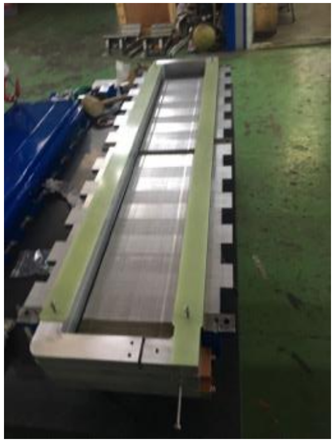
Wen Kang

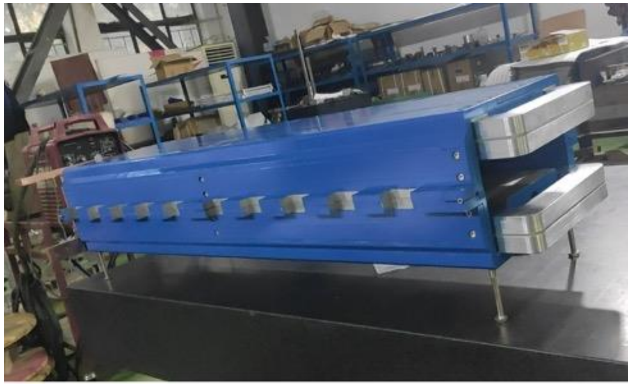
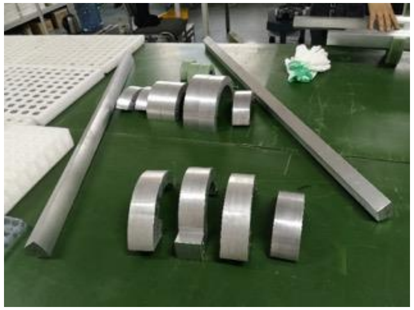
Parts of the booster magnet prototyp

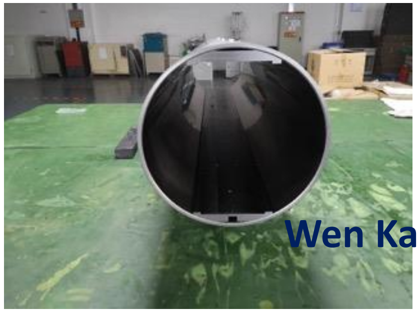
Carlo Pagani,
Wen Kang


Wen Kang





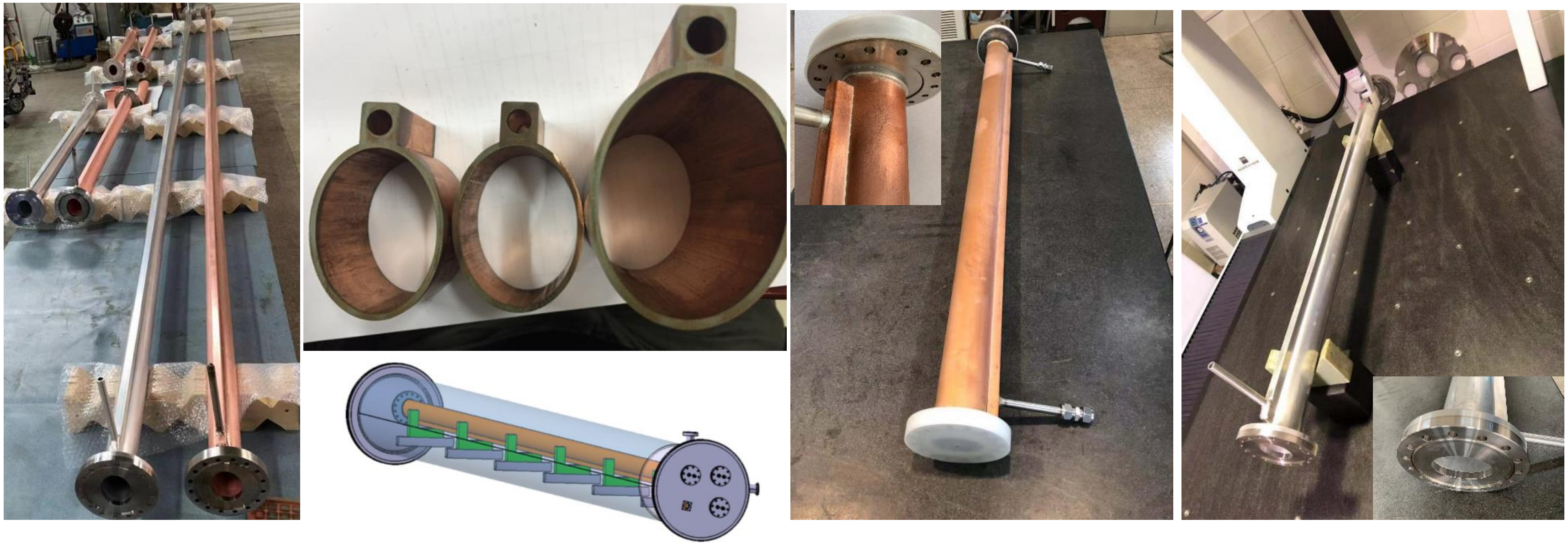
Wen Kang

Vacuum chamber

- The synchrotron radiation power deposited on the chamber walls would entail using a water-cooled high thermal conductivity chamber material (aluminum or copper);
- Copper is preferred in the CEPC dipole chamber design because of its naturally lower molecular yields, lower secondary electron yields, lower electrical resistance, higher thermal conductivity, good radiation self-shielding, and resistant to deformation for the NEG activation temperature of 200 °C;
- Considering the cost of manufacture, the dipole vacuum chambers of the electron ring will be fabricated from the aluminum alloy.

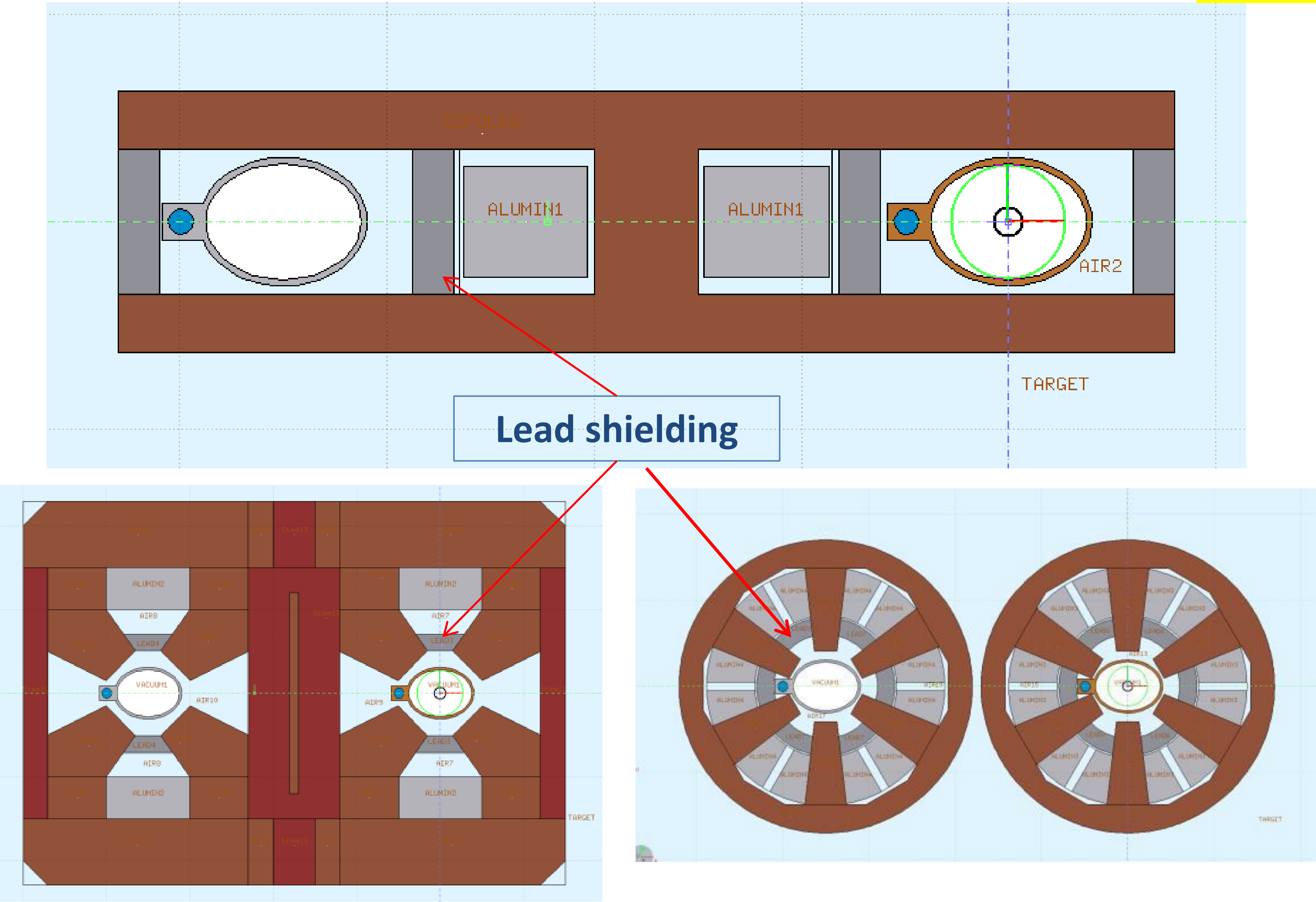
Dong Haiyi

Cu and Al vacuum chamber prototypes



- A 6 m long simple vacuum furnace is fabricated, which is used to weld the water cooling channels of Cu chambers through low temperature brazing solder.
- The welding seams are checked by wire-electrode cutting. The welding joints are smooth and have good contacting.
- The prototypes of copper & aluminum vacuum chambers with a length of 6 m have been fabricated and tested, which meet the engineering requirements.

Dong Haiyi



Lead shielding

Synchrotron Radiation Shielding

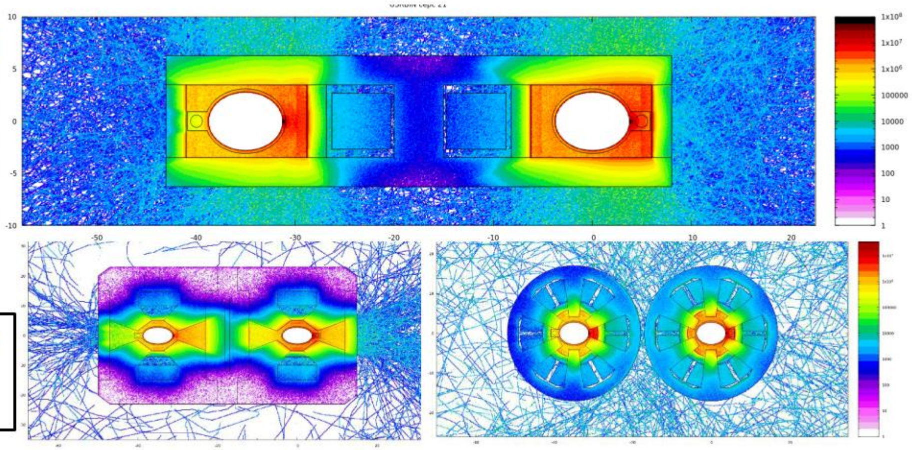
Synchrotron radiation _ design updates

- First designed for 10 years machine operation in condition of 30MW&120GeV
- Operation scenario changed: 10 years running @ 50MW&120GeV and 3 years running @ 50MW&175GeV
- The person in charge of this issue is transferred from Haoyu Shi and Yadong Ding to Guangyi Tang.

Parameters	Symbols	Values		Units
Beam energy	E	120	175	GeV
Beam current	I	17.8	3.95	mA
Bending radius	ρ	10.7	10.7	km
Power per unit length	P	453.9	455.6	W/m
Critical Energy	Ec	0.358	1.111	MeV

Parameters of synchrotron radiation

CDR: 2cm lead was added to shield the Synchrotron Radiation to make sure the accumulated dose on the magnet coil well below the dose limit in operation of 120GeV@30MW

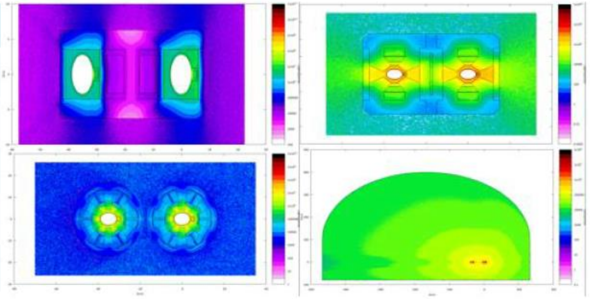


Zhongjian Ma

Synchrotron radiation _ design updates

- Re-calculated the absorber dose of insulators of coil: Ethylene Oxide (Oxirane) the results were consistent with CDR
- Optimization was conducted through:
  - Detailed analyze the spectrum of SR, divided and weighted the high energy part to study the radioactive characteristics of the beam pipe
  - Iterative optimization of the lead thickness according to different machine operation modes for the whole lifetime

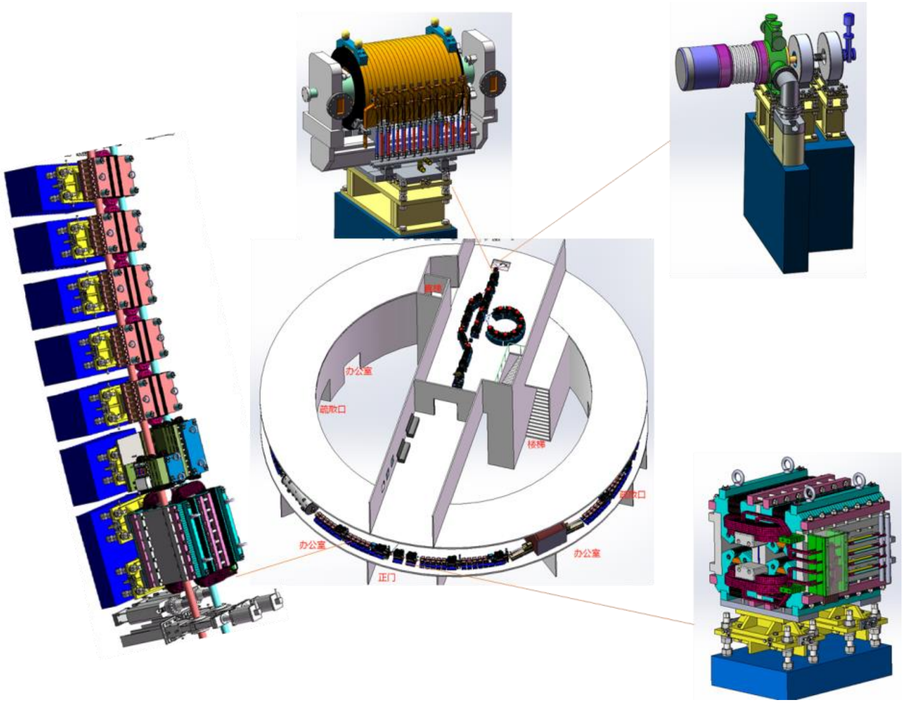
Magnets	Dose/(Gy/Ah)			
	120GeV		175GeV	
	average	maximum	average	maximum
Dipole	$(2.6 \pm 0.2) \times 10^4$	$(3.5 \pm 0.2) \times 10^4$	$(2.7 \pm 0.1) \times 10^4$	$(4.0 \pm 0.2) \times 10^4$
Quadrupole	$(4.0 \pm 0.5) \times 10^4$	$(10 \pm 5) \times 10^4$	$(2.6 \pm 0.5) \times 10^4$	$(9 \pm 5) \times 10^4$
Sextupole	$(9.0 \pm 1.6) \times 10^4$	$(13 \pm 1) \times 10^4$	$(12 \pm 3) \times 10^4$	$(23 \pm 13) \times 10^4$

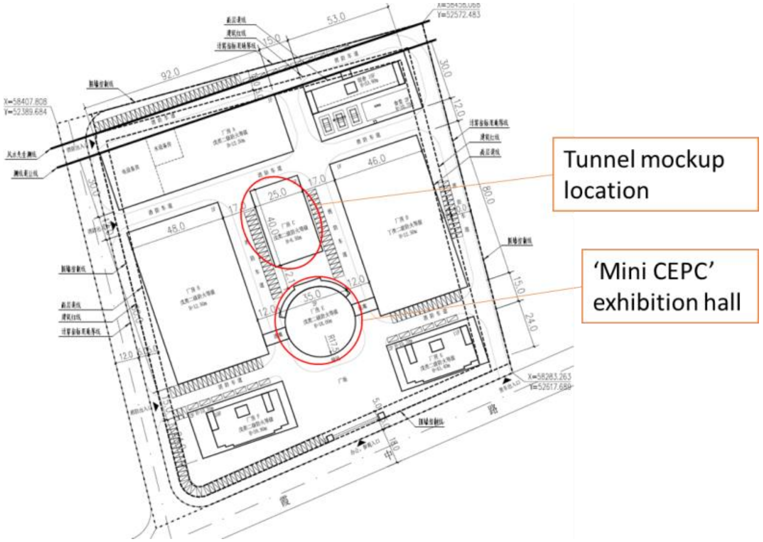


Haijing Wang

“Mini CEPC” model

- The “Mini CEPC” is a 100 meters long, anamorphic model of CEPC, which will be used for popularization of CEPC.
- The Booster of “Mini CEPC” is under design.
- The “Mini CEPC” is assumed at the same site as Tunnel mockup.





** Cooperate with Zhong Ke High Energy Science and Technology Ltd,. Co*

	Higgs (CDR)	*Higgs (high)*	
Number of IPs	2	2	
Beam energy (GeV)	120	120	
Circumference (km)	100	100	
Synchrotron radiation loss/turn (GeV)	1.73	1.68	The filling factor of bends should be increased to get a even lower SR with smaller emiitance.
Crossing angle at IP (mrad)	16.5×2	16.5×2	
Piwinski angle	3.48	3.78	
Number of particles/bunch N_e (10^{10})	15.0	17.0	single bunch charge increased thus larger momentum acceptance required
Bunch number (bunch spacing)	242 (0.68μs)	218 (0.76μs)	
Beam current (mA)	17.4	17.8	
Synchrotron radiation power /beam (MW)	30	30	
Bending radius (km)	10.7	10.7	
Momentum compact (10^{-5})	1.11	0.91	
β function at IP β_x^* / β_y^* (m)	0.36/0.0015	0.33/0.001	much larger natural chromaticity
Emittance $\varepsilon_x/\varepsilon_y$ (nm)	1.21/0.0024	0.89/0.0018	
Beam size at IP σ_x/σ_y (μm)	20.9/0.06	17.1/0.042	
Beam-beam parameters ξ_x/ξ_y	0.018/0.109	0.024/0.113	
RF voltage V_{RF} (GV)	2.17	2.4	
RF frequency f_{RF} (MHz) (harmonic)	650 (216816)	650 (216816)	
Natural bunch length σ_z (mm)	2.72	2.2	
Bunch length σ_z (mm)	4.4	3.93	
HOM power/cavity (2 cell) (kw)	0.46	0.58	
Energy spread (%)	0.134	0.19	
Energy acceptance requirement (%)	1.35	1.7	larger momentum acceptance required
Energy acceptance by RF (%)	2.06	3.0	
Photon number due to beamstrahlung	0.082	0.104	
Beamstruhlung lifetime /quantum lifetime* (min)	80/80	30/50	
Lifetime (hour)	0.43	0.22	
F (hour glass)	0.89	0.85	
Luminosity/IP *L* (10^{34}cm^{-2}s^{-1})	2.93	5.2	

D. Wang et al

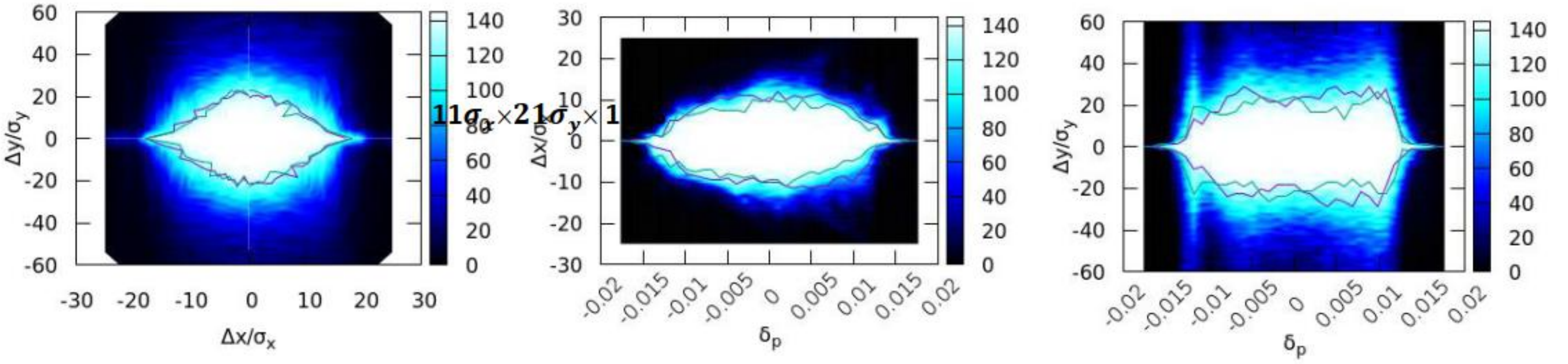
Yiwei Wang

Xinchou Lou

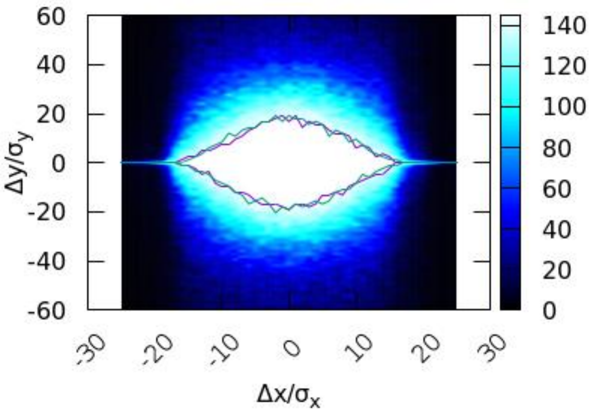
CEPC design enhancement

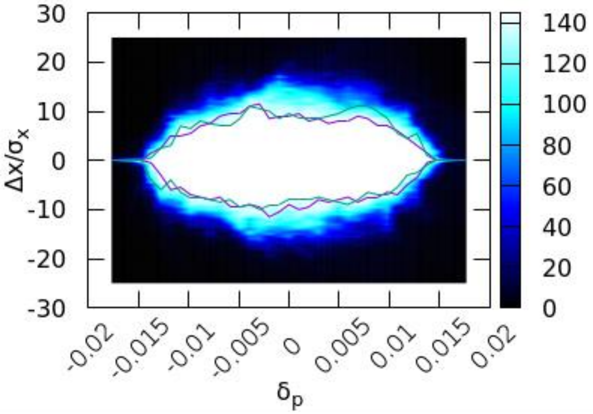
Dynamic aperture optimization

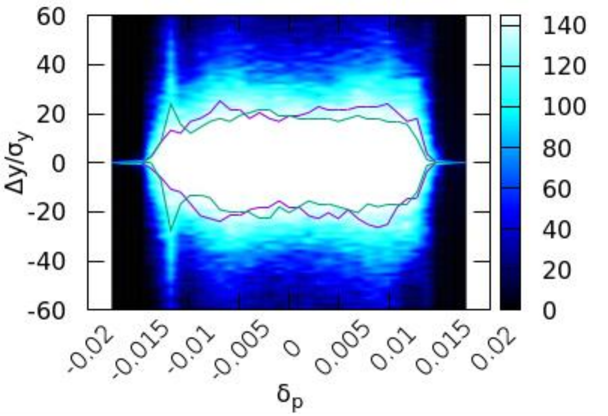
- Dynamic aperture optimized with the new lattice aiming at luminosity of $5 \times 10^{34}/cm^2/s$.
  - Effects of nonlinearity in lattice, synchrotron radiation, beam-beam interaction are included.
  - Multi-Object Deferential Evolution (MODE) algorithm used to make global optimization.
  - DA goal $8\sigma_x \times 15\sigma_y \times 1.7\%$
- More efforts will be made to enlarge the momentum acceptance.
- The goal will be adjusted with further beam lifetime study which is under going.

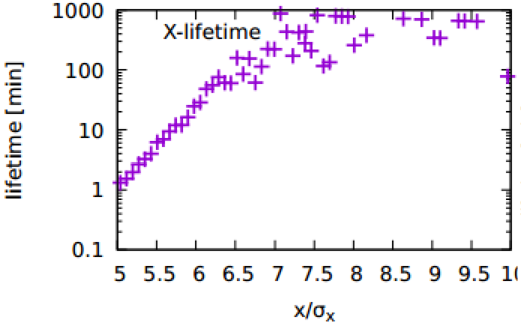


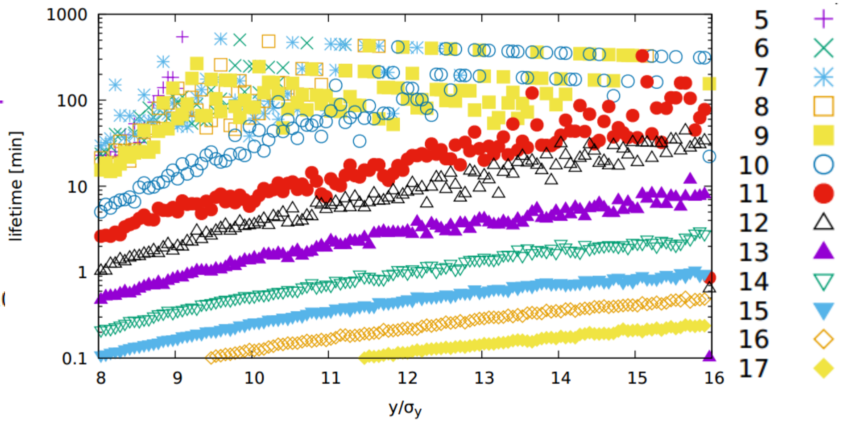
Dynamic aperture optimization for the *β_y^* =1mm* @ Higgs

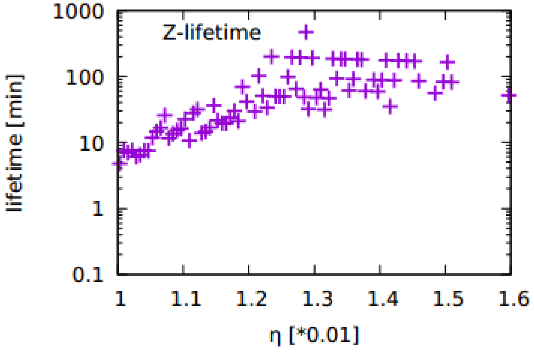












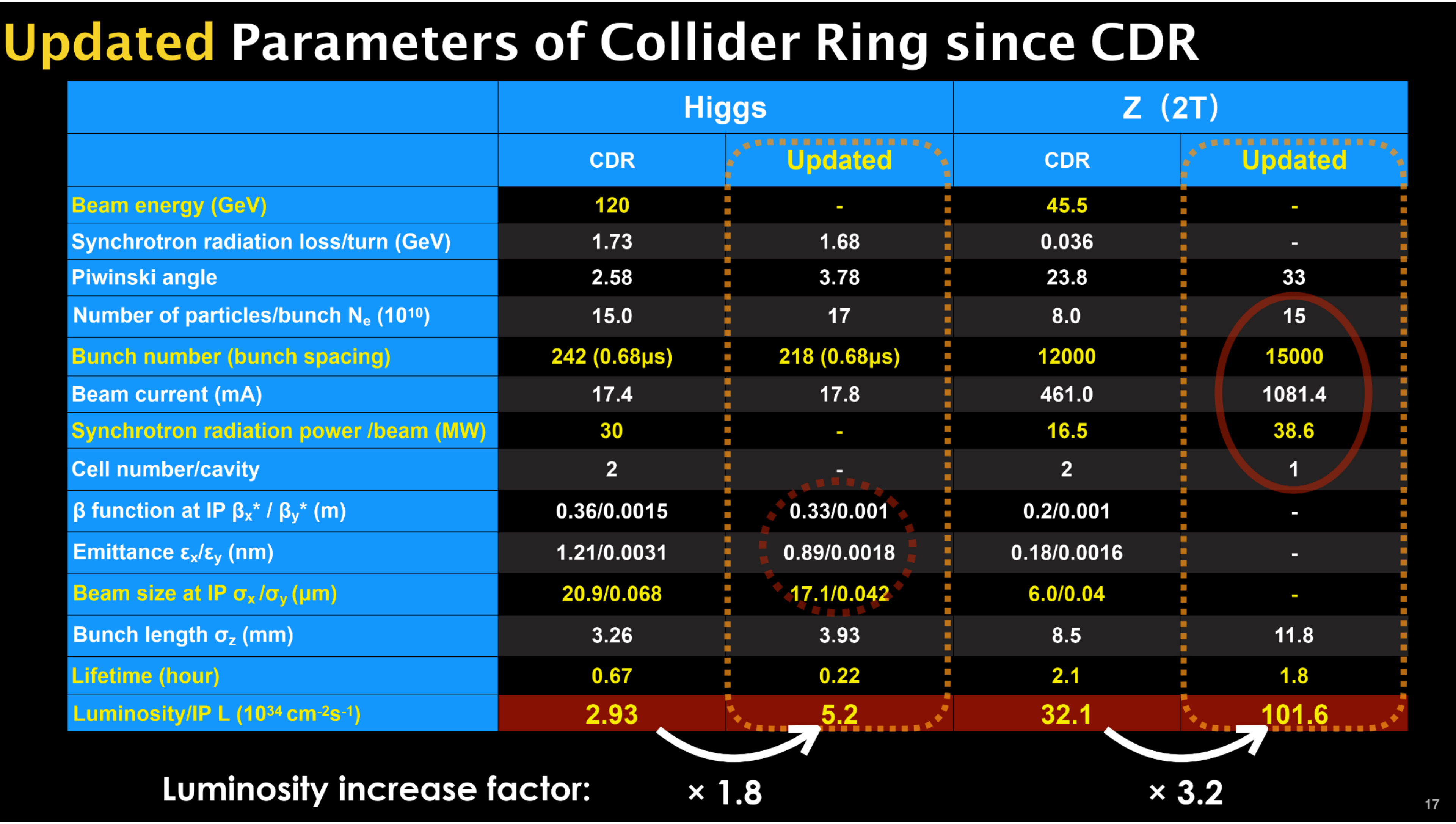
$15\sigma_x \times 20\sigma_y \times 1.5\%$

Strong limitation @ NP=11E10

- **Good for the injected beam**
- **Worse for the circulating beam**

Chenghui Yu

João Guimarães da Costa

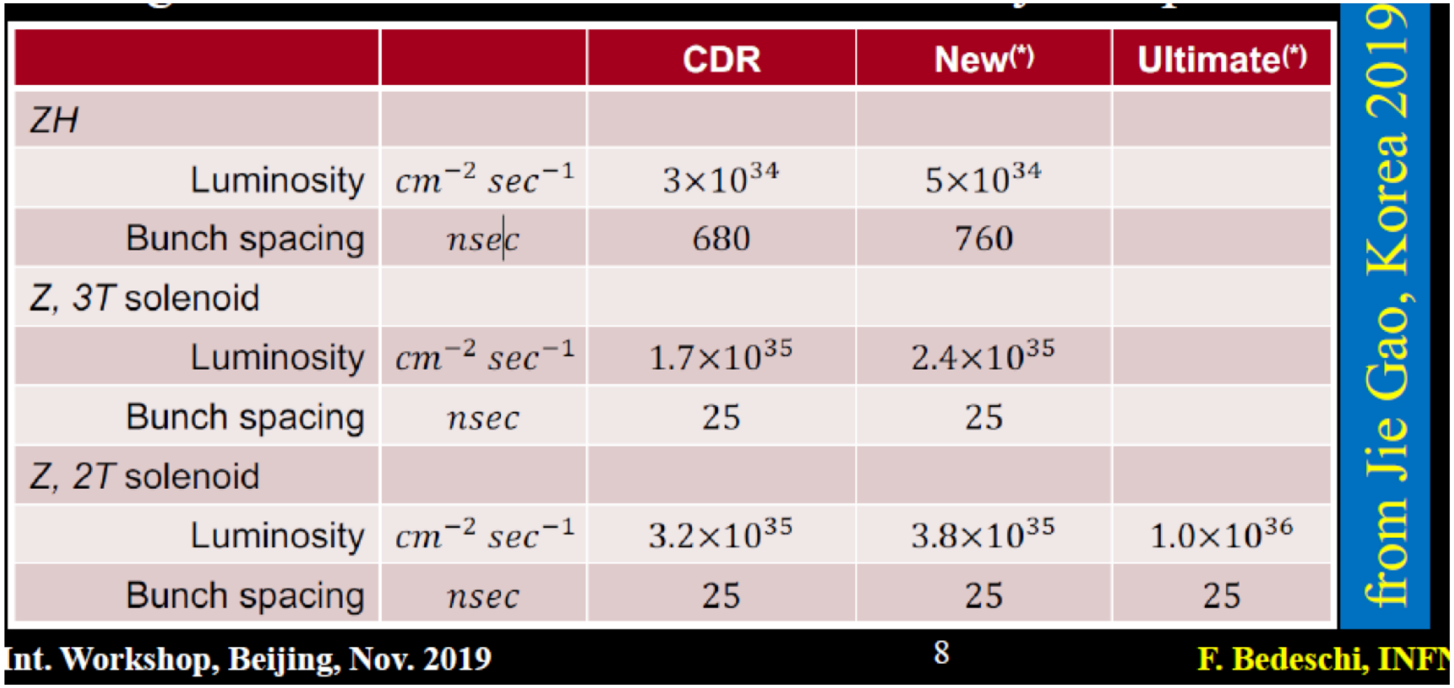


Updated Parameters of Collider Ring since CDR

	Higgs		Z (2T)	
	CDR	Updated	CDR	Updated
Beam energy (GeV)	120	-	45.5	-
Synchrotron radiation loss/turn (GeV)	1.73	1.68	0.036	-
Piwinski angle	2.58	3.78	23.8	33
Number of particles/bunch N_e (10^{10})	15.0	17	8.0	15
Bunch number (bunch spacing)	242 (0.68μs)	218 (0.68μs)	12000	15000
Beam current (mA)	17.4	17.8	461.0	1081.4
Synchrotron radiation power /beam (MW)	30	-	16.5	38.6
Cell number/cavity	2	-	2	1
β function at IP β_x^* / β_y^* (m)	0.36/0.0015	0.33/0.001	0.2/0.001	-
Emittance $\varepsilon_x/\varepsilon_y$ (nm)	1.21/0.0031	0.89/0.0018	0.18/0.0016	-
Beam size at IP σ_x/σ_y (μm)	20.9/0.068	17.1/0.042	6.0/0.04	-
Bunch length σ_z (mm)	3.26	3.93	8.5	11.8
Lifetime (hour)	0.67	0.22	2.1	1.8
Luminosity/IP L (10^{34} $cm^{-2}s^{-1}$)	2.93	5.2	32.1	101.6

Luminosity increase factor: × 1.8 × 3.2

Challenges at Z



		CDR	**New(*)**	**Ultimate(*)**
ZH				
Luminosity	$cm^{-2}\ sec^{-1}$	3×10^{34}	5×10^{34}	
Bunch spacing	$nsec$	680	760	
Z, 3T solenoid				
Luminosity	$cm^{-2}\ sec^{-1}$	1.7×10^{35}	2.4×10^{35}	
Bunch spacing	$nsec$	25	25	
Z, 2T solenoid				
Luminosity	$cm^{-2}\ sec^{-1}$	3.2×10^{35}	3.8×10^{35}	1.0×10^{36}
Bunch spacing	$nsec$	25	25	25

from Jie Gao, Korea 2019

Int. Workshop, Beijing, Nov. 2019 8 F. Bedeschi, INFN

The ability to run on the Z is a very appealing feature of the circular machines. It is also a place where CEPC cannot stand on the giant shoulders of the work for ILC

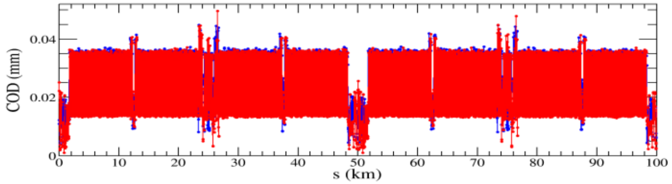
Correction of misalignment, main field errors

- with by*=1.5mm lattice

Component	Δx (μm)	Δy (μm)	$\Delta\theta_z$ (μrad)
Arc quadrupole	100	100	100
IR Quadrupole	50 (30 for FF)	50 (30 for FF)	50 (30 for FF)
Sextupole	100	100	100

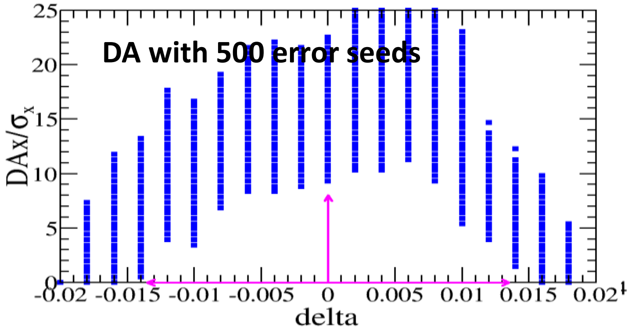
Component	Field error
Dipole	0.01%
Quadrupole	0.02%

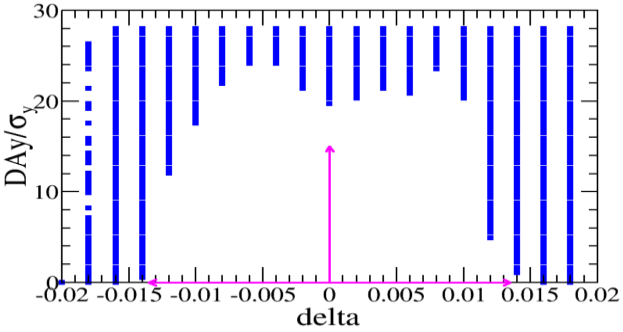
Bin Wang,
Yuanyuan Wei



COD correction: $RMS_{COD} < 0.05\ mm$

Observable	Before correction	After correction
Hori. disp.	30.0 mm	2.9 mm
Vert. disp.	77.0 mm	0.5 mm
Hori. Beta-beating	5.7%	0.8%
Hori. Beta-beating	6.8%	0.5%





Out of 1000 seeds, 831 converged

ex = 1.217±0.005 nm

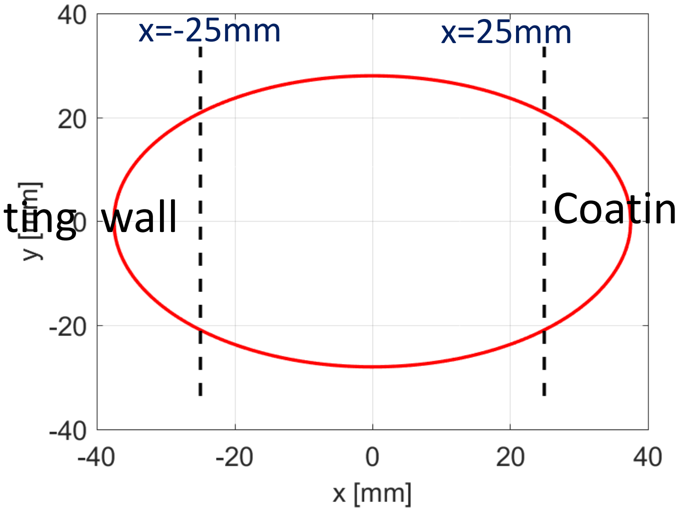
ey = 0.043 ± 0.002 pm

ey/ex = (0.0035 ± 0.0002)%

Yiwei Wang

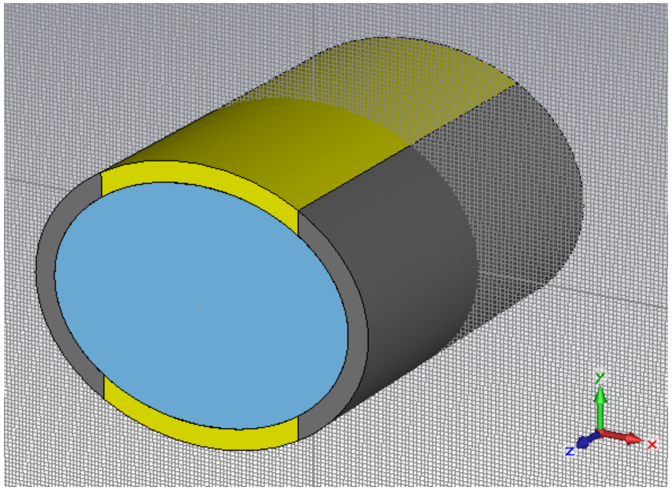
Yudong Liu

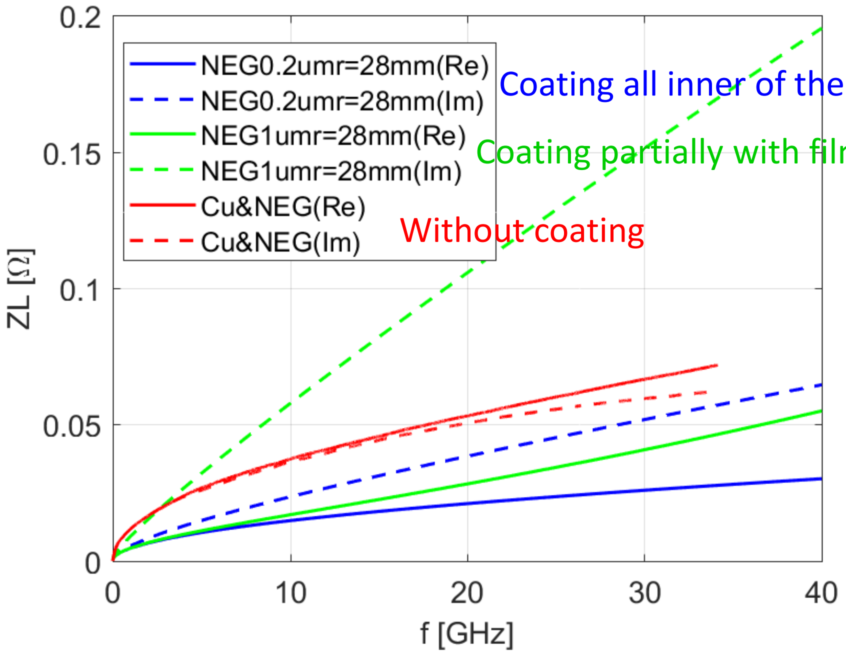
Resistive wall Impedance of the NEG coating in part of the chamber wall



Coating wall

Coating wall





Coating all inner of the wall with film thickness 0.2um

Coating partially with film thickness 1um

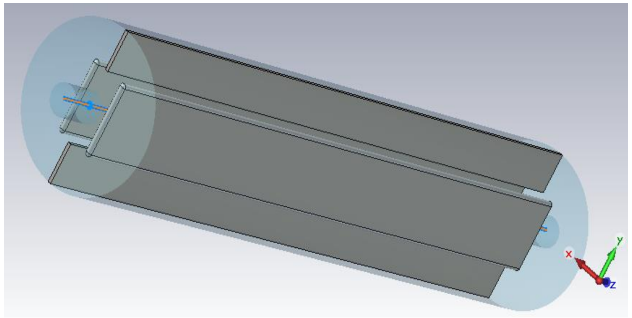
Without coating

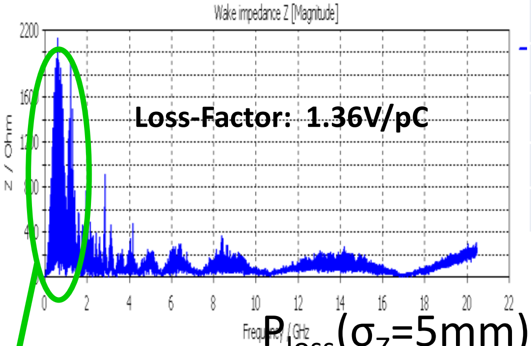
Partial coating with 1um NEG is not deterioration for wall impedance.

Electrostatic separator impedance and optimization

Yudong Liu

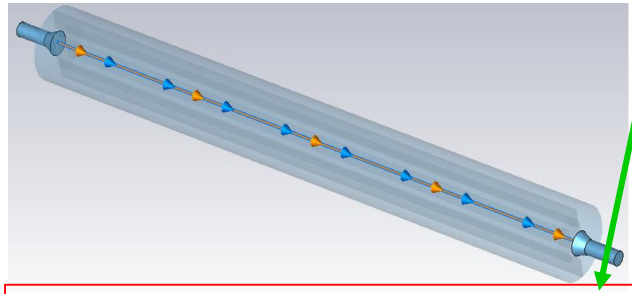
Separator tank length	**4060mm**
Inner diameter of separator tank	**460mm**
Electrode height	**220mm**
Electrode gap	**90mm**
Electrode thickness	**20mm**
Transition pipe length	**220mm**
Transition pipe diameter	**90mm**
Ground plate length	**4000mm**
Ground plate height	**120mm**
Ground plate thickness	**10mm**

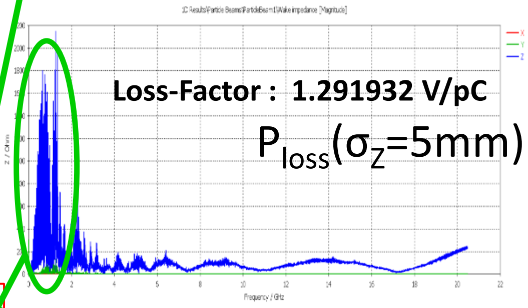




Loss-Factor: 1.36V/pC

$P_{loss}(\sigma_Z=5mm)$: 573w(Higgs)/2.32kw(W)/8.12kw(Z)

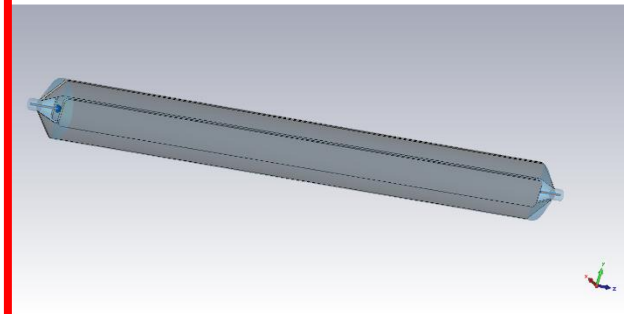


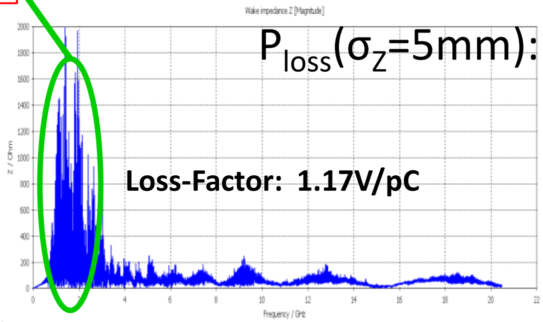


Loss-Factor : 1.291932 V/pC

$P_{loss}(\sigma_Z=5mm)$: 542w(Higgs)/2.19kw(W)/7.63kw(Z)

HOM absorber for these mode





$P_{loss}(\sigma_Z=5mm)$: 495w(Higgs)/1.98kw(W)/6.91kw(Z)

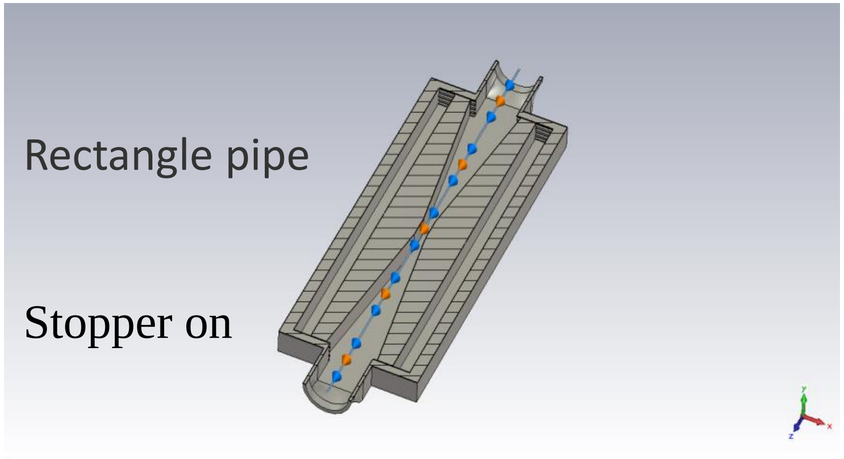
Loss-Factor: 1.17V/pC

Separator tank length	4000mm
Inner diameter of separator tank	380mm
Electrode height	180mm
Electrode gap	75mm
Electrode thickness	20mm
Transition pipe length	150mm
Transition pipe diameter	75mm
Ground plate length	4300mm
Ground plate height	100mm
Ground plate thickness	10mm

This structure is chosen as the prototype for TDR

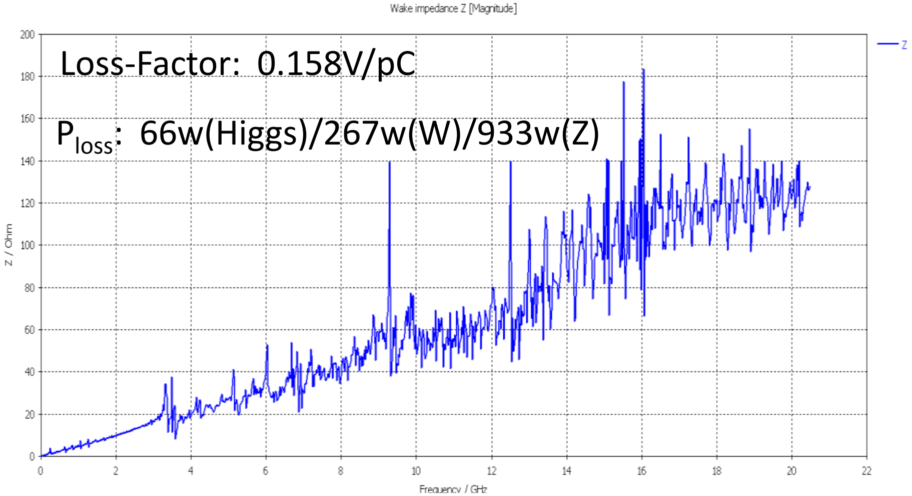
Collimator impedance and optimization

Yudong Liu



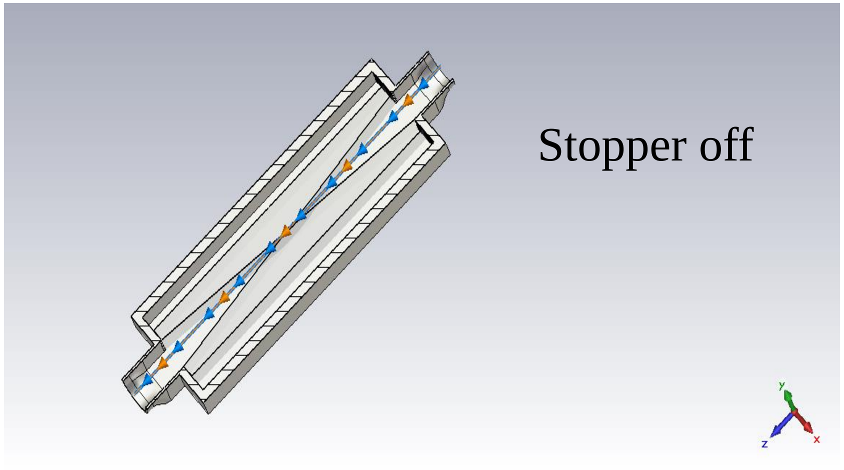
Rectangle pipe

Stopper on

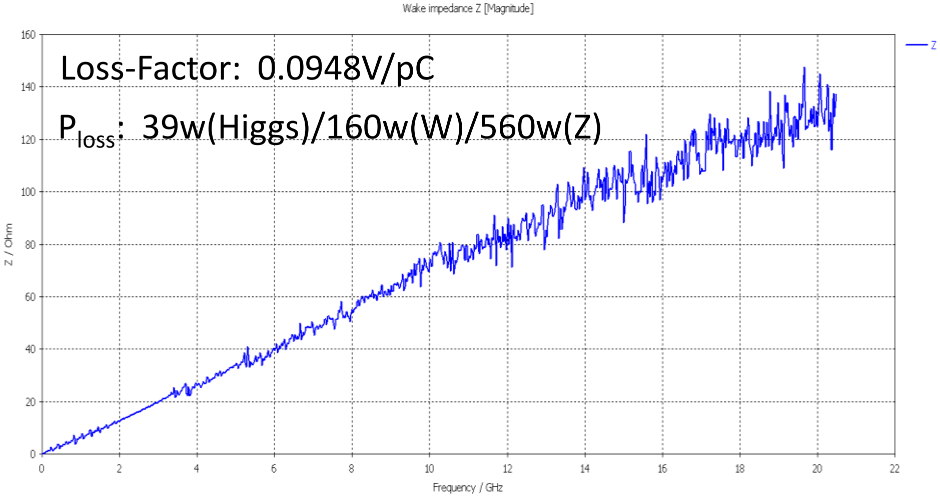


Loss-Factor: 0.158V/pC

P_{loss}: 66w(Higgs)/267w(W)/933w(Z)



Stopper off



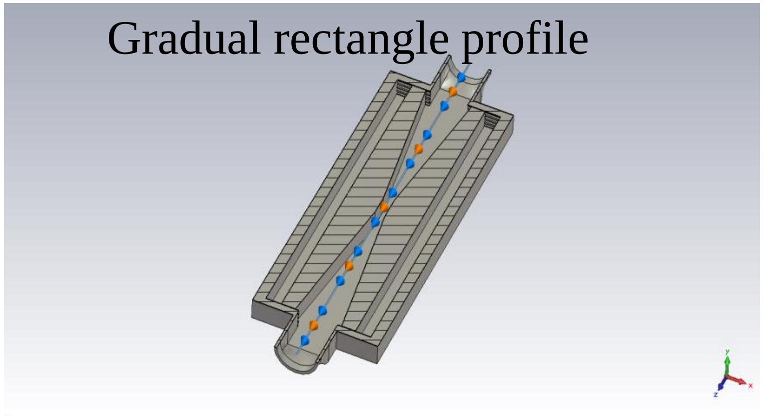
Loss-Factor: 0.0948V/pC

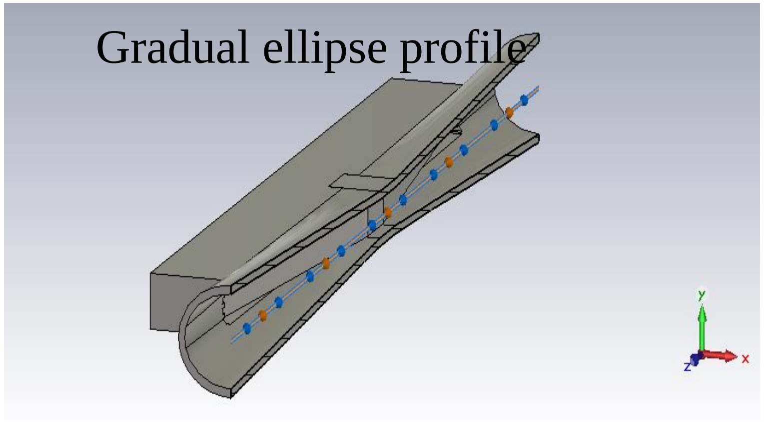
P_{loss}: 39w(Higgs)/160w(W)/560w(Z)

Haijing Wang

Movable collimators

- Two inner profiles are designed, gradual rectangle and gradual ellipse with movable stoppers in them.
- RF fingers are at the edges of the stoppers to decrease impedance.





		Energy loss (no RF fingers) (W)		
		Higgs	W	Z
Gradual rectangle profile	Stopper open	66	267	933
	Stopper closed	39	160	560
Gradual ellipse profile	Stopper open	8	32	112
	Stopper closed	19	76	266

** From Y Liu et al., Impedance and Collective Instabilities for Collider, Booster and damping ring in CEPC, this workshop*

Discussion on model

- The model demonstrates, although slow, but convergence. The asymptotic value of the beam length, found as the average over the 'saw-tooth-like' sequence, is self-consistent and is 9 mm. It is easily verified by its substitution into the system of used equations

- PWD, which lengthens the bunch, does not give rise to the energy spread growth. Instead, in collision it leads to a decrease of 30% in the resulting energy spread due to a decrease in the total diffusion rate (BS + SR). At the same time, the bunch length increases by a factor 1.5

So far, this model only indicates that the interaction between various factors, such as the beam of the beam and impedance, in this case can lead to a change in the parameters of the beam.

By and large, a self-consistent iterative (on beam current) approach is needed, since
a) the length of the bunch depends on the current, impedance and BS, but in turn
b) and effective impedance and BS depend on the length of the bunch.

	SR	**SR+PW**	**SR+BS**	**SR+BS+PW**	**(SR+BS+PW)/(SR+BS)**
Energy spread	0.00038	0.00038	0.001	0.00069	0.69
Beam length	2.42mm	5.1mm	6.33mm	9mm	1.5

Bunch lengthening due to the beam coupling impedance results in energy spread reduction in colliding beams!

Conclusions:

1) Shift of average energy (measured by RD) relative to the energy at IP due to the **lack of mirror symmetry of magnetic structure** is negligible at energy 45.5 GeV. But **at energy 80 GeV this value $4.8285 \cdot 10^{-6}$ of systematic error far exceeds the accuracy of the experiment 10^{-6}.**

2) The contribution of additional radiation losses due to the error of magnetic field manufacture is negligible at both energies (45.5 and 80 GeV). The contribution of BS is negligible in this case.

3) The energy shift of the center of mass due to non-zero angle of the beams intersection is negligible without and with BS at both energies.

4) BS significantly affects the energy spread of the center of mass. But at energy of Z-boson, this effect can be neglected due to the large width of the resonance ($\Gamma \approx 2$ GeV).

5) Our **analytic-based approach** allows us to determine the corresponding energy loss and also the BS contribution to the diffusion rate without using beam-beam simulation codes

Dou Wang

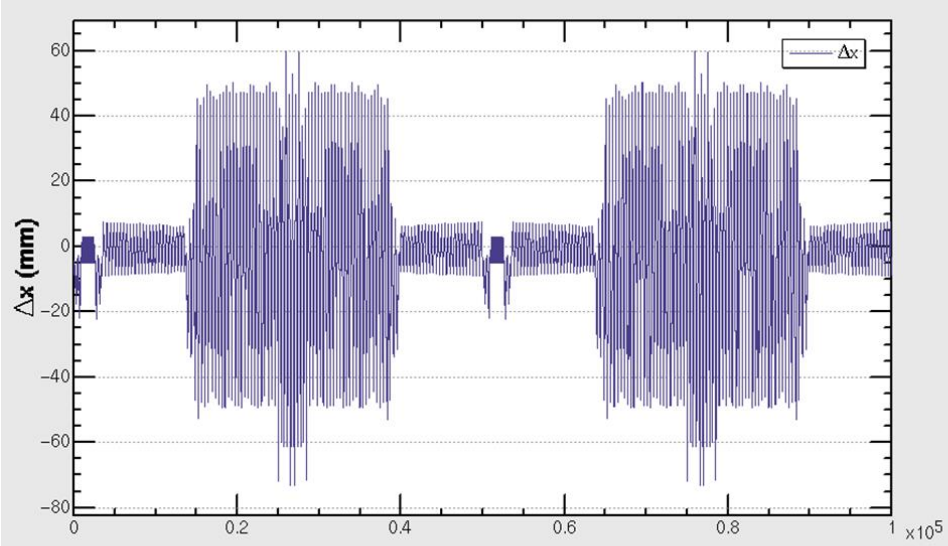
Effect of earthfield @10GeV

- ~20% vacuum pipe (drift) is exposed in earthfield directly.
- treat drifts as week dipole to simulate the effect of earthfield
- Assume earthfield: ~0.6 gauss, no solution for the close orbit, optics unstable

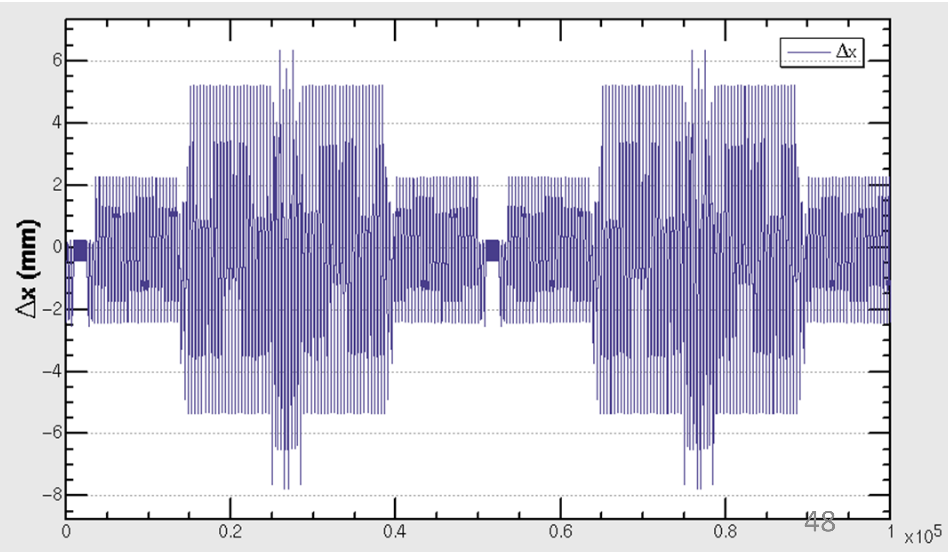
$$(263.204,\ 261.210) \rightarrow (262.717,\ 260.727)$$

- Without shielding to the bare pipe, the earthfield effect is intolerable.
- Global COD correction will be tested.

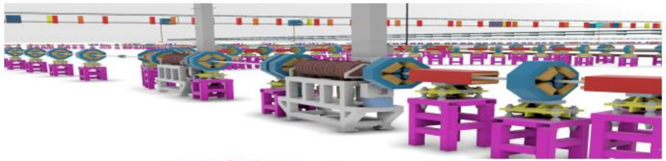
0.6 gauss

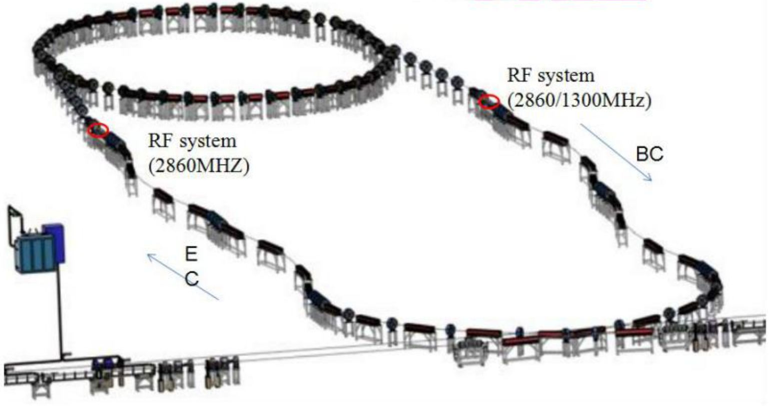


0.06 gauss



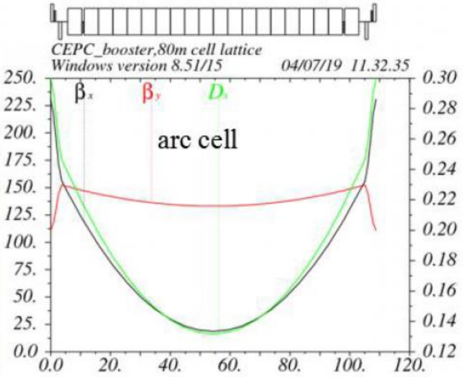
Design of Damping Ring System

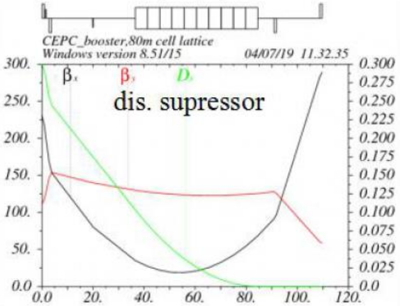


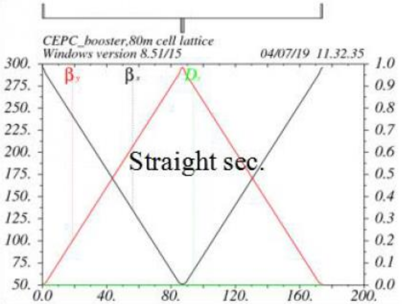


parameters	damping ring for SuperKEKB	damping ring for CEPC
Energy	1.1Gev	1.1Gev
circumference	135.5	75.4
Beta tune	8.24/7.265	3.84/4.81
Bunch lenght	11.12mm	5mm
Bunch number	4	2
synchtron tune	0.0153	0.062
Beam current	70 mA	10 mA

- emittance=**1.29nm** @120GeV
- TME lattice
- Cell length: 110m
- Interleave sextupole scheme







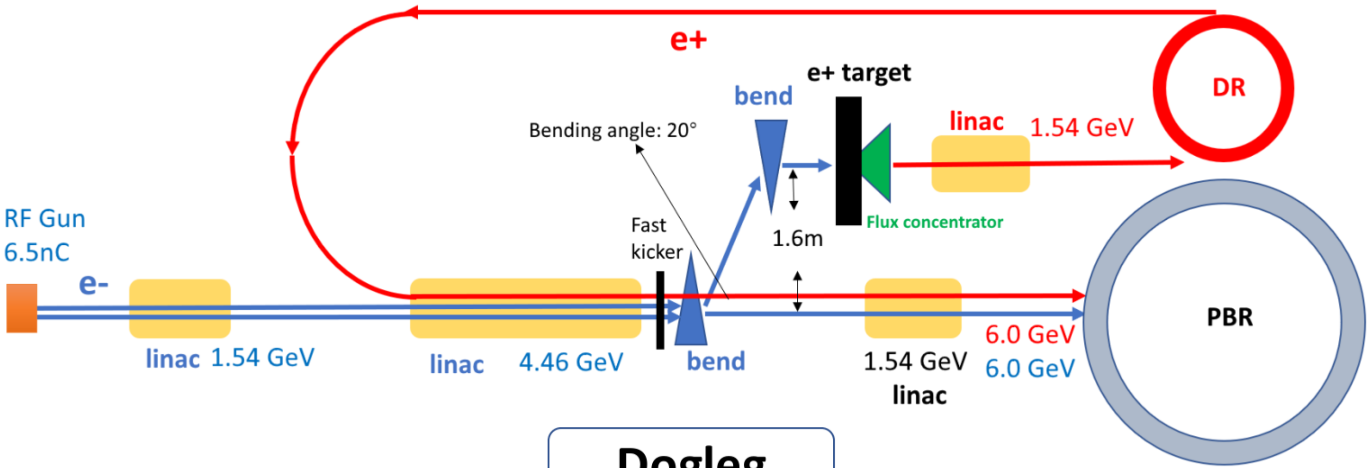
Jie Gao

Angeles Faus-Golfe

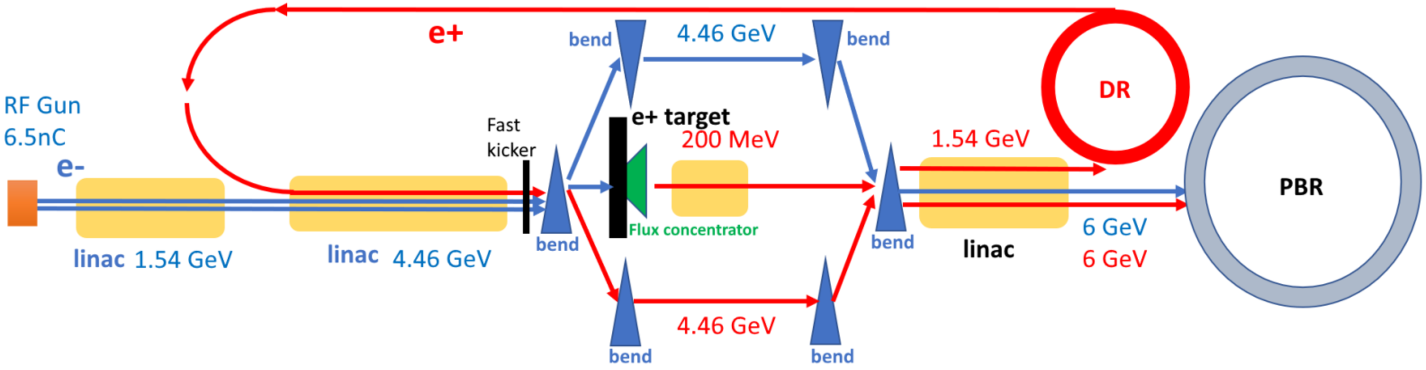
FCC-ee Positron Injector (bypass)

Schemes with the bypass under consideration

Preliminary



Dogleg



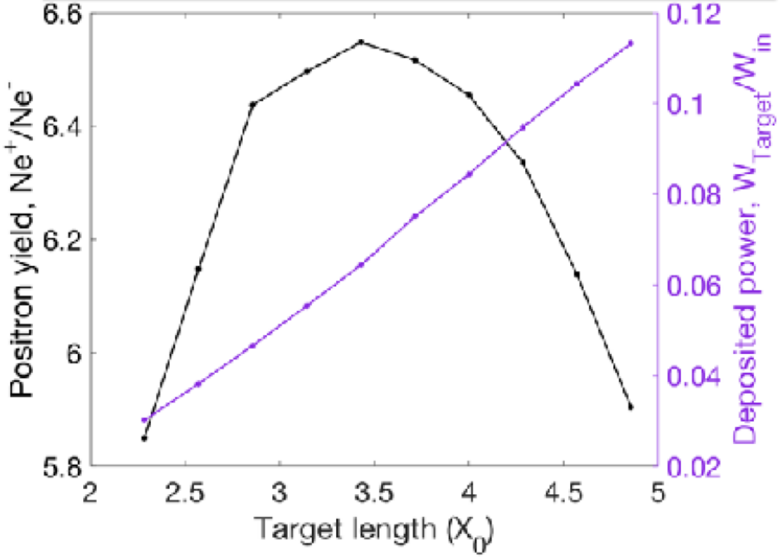
Chicane

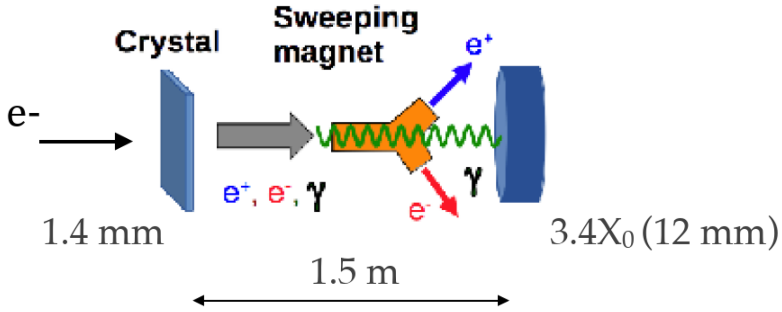
B. Bai

Angeles Faus-Golfe

Production Target

Hybrid scheme 1 (target-converter)



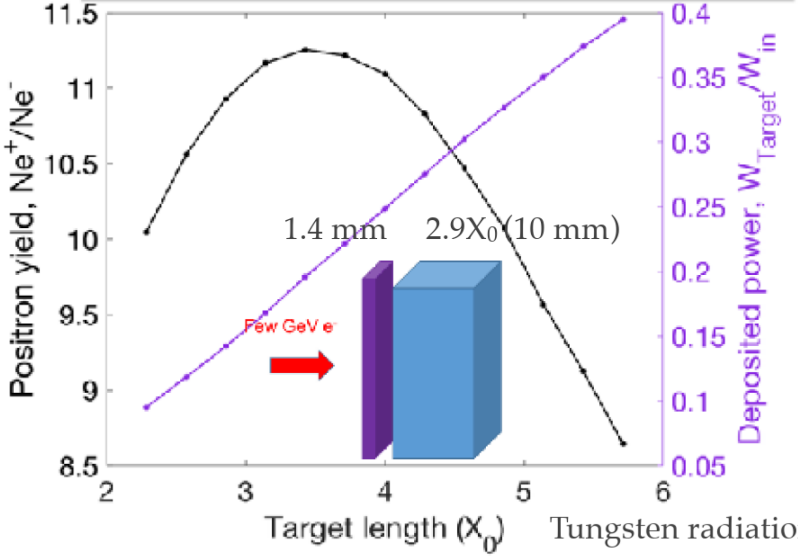


1.4 mm

3.4X₀ (12 mm)

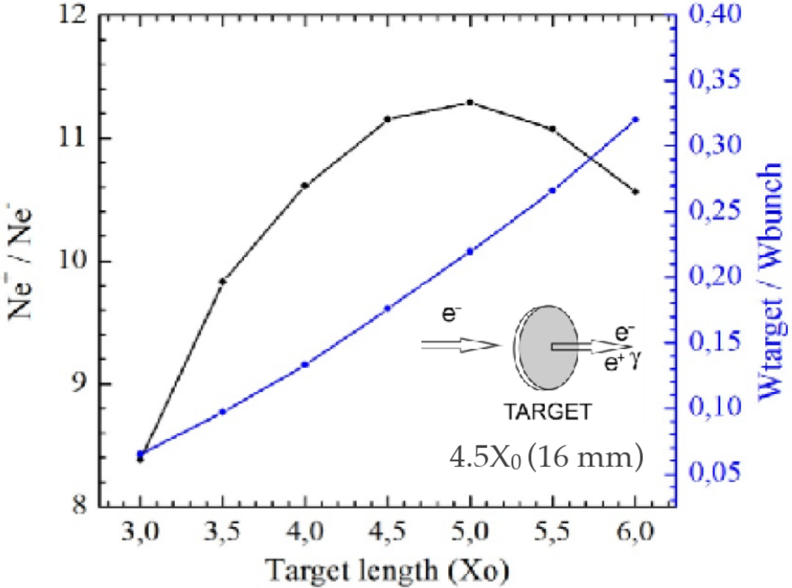
1.5 m

Hybrid scheme 2 (target-converter)



1.4 mm 2.9X₀ (10 mm)

Conventional scheme



4.5X₀ (16 mm)

Tungsten radiation length X_0 is 0.35 cm.

Angeles Faus-Golfe

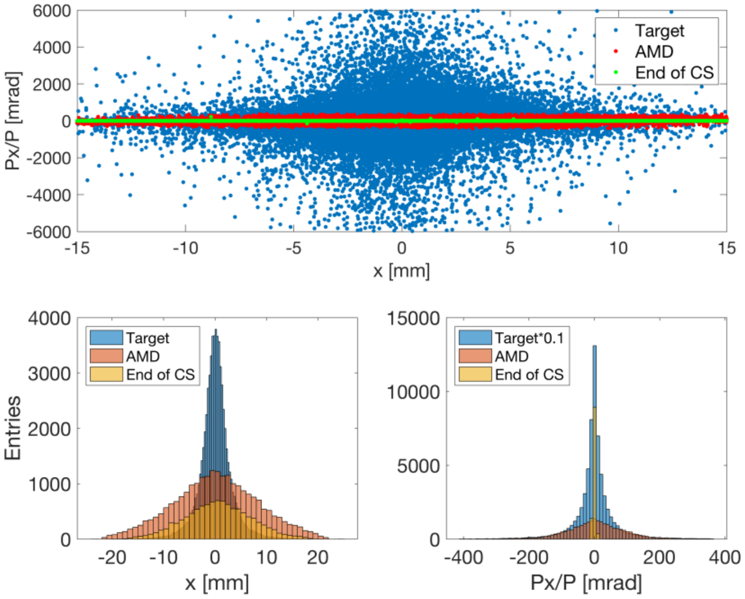
Capture and Primary Acceleration

The capture linac is encapsulated inside a solenoid with the axial magnetic field of 0.5-0.7 T.

☞ **Hybrid scheme:** 1.5 meter long 17 MV/m, 2 GHz L-band structures.

☞ **Conventional scheme:** 3 meter long 20 MV/m 2856 MHz large aperture S-band structures.

Positron emittance at the exit of the target, the AMD and the capture section at 200 MeV (uniform DC solenoid field)



Beam Parameter	Convention	Hybrid 1	Hybrid 2
B_{max} = 5 T, B_{DC} = 0.5 T			
Mean Energy	190 MeV	197 MeV	235 MeV
Accepted yield	1.1 N_{e+}/N_{e-}	0.7 N_{e+}/N_{e-}	~1.4 N_{e+}/N_{e-}
Emittance h/v	17 μm (1σ)	14 μm (2σ)	10 μm (3σ)
B_{max} = 7 T, B_{DC} = 0.7 T			
Mean Energy	190 MeV	198 MeV	226 MeV
Accepted yield	1.3 N_{e+}/N_{e-}	~0.9 N_{e+}/N_{e-}	~2 N_{e+}/N_{e-}
Emittance h/v	21μm (1σ)	16 μm (2σ)	11 μm (3σ)

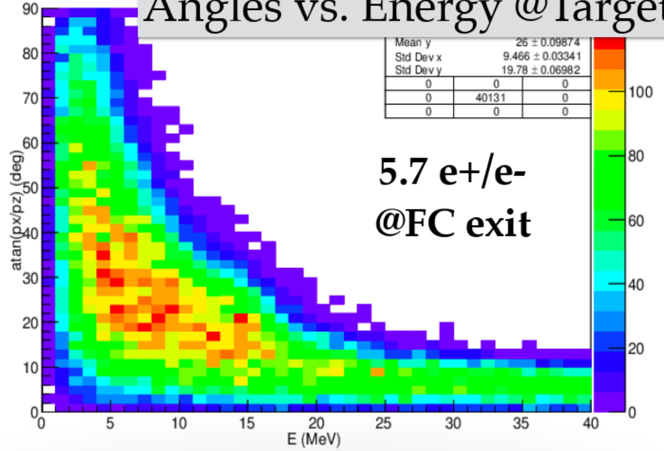
B_{DC} up to 0.7 - 0.8 T and FC B_{max} ~ 7-8 T

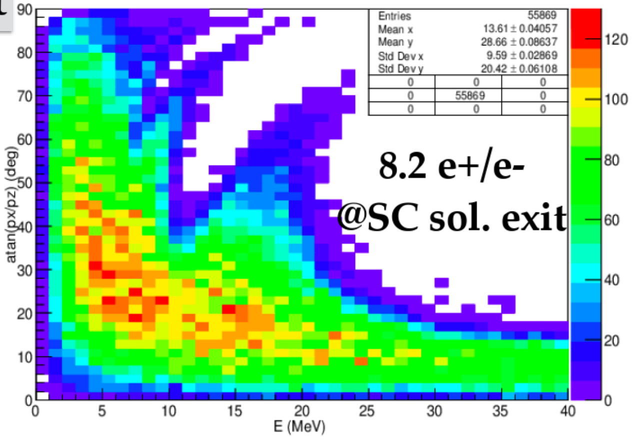
Assuming [optimization x transport until 1.54 GeV x DR injection efficiency] e+ yield ≳ 1 N_{e+}/N_{e-} but the realistic simulations are needed + safety factor.

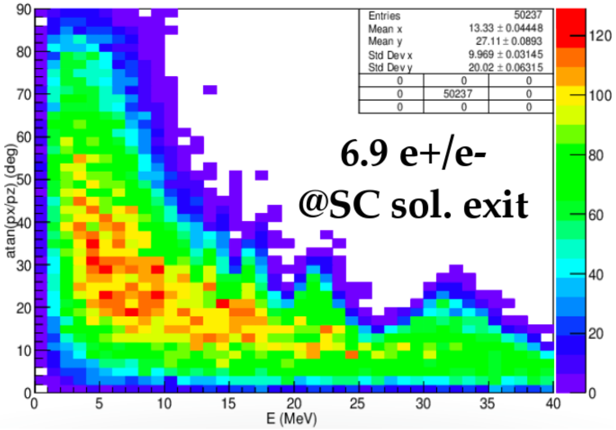
Positron capture @Target/AMD

Angeles Faus-Golfe

Angles vs. Energy @Target





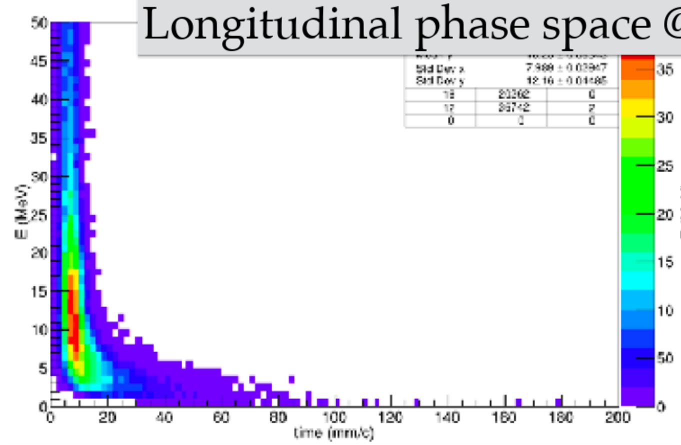


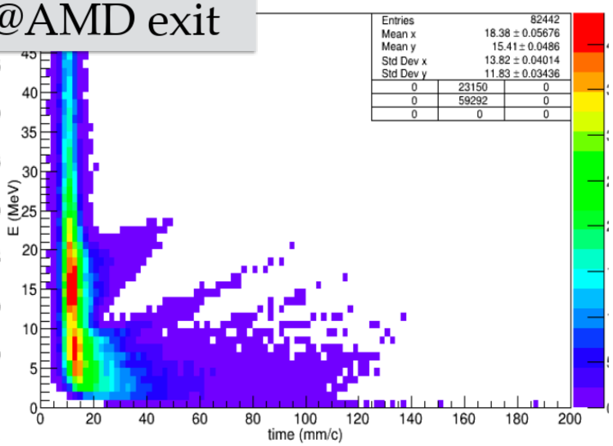
FC L = 10 cm

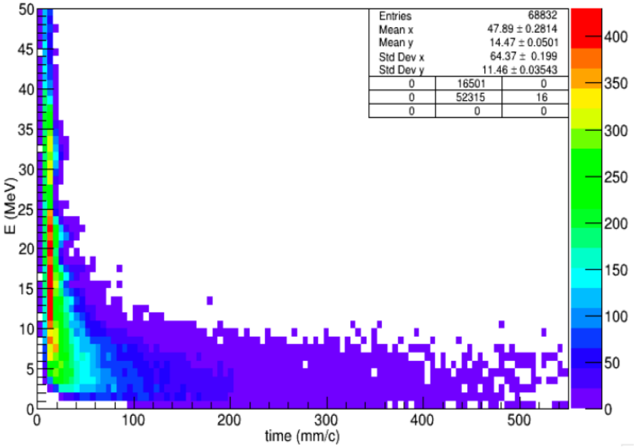
SC solenoid L = 10 cm

SC solenoid L = 50 cm

Longitudinal phase space @AMD exit







Primary Acceleration with SC solenoid

The simulations are done for the hybrid 2 scheme with the SC solenoid (B_{max} = 8 T, B_{end} = 0.7 T, different length) and FC (B_{max} = 7 T, B_{DC} = 0.7 T) as the AMD.

SC solenoid: B_{TARGET} = 8 T
FC: B_{TARGET} = 3 T

Preliminary

	Yield @ AMD	Total Yield @ 200 MeV	Acc. Yield @ 200 MeV (30 MeV & 40 degrees RF)
FC	5.7	2.3	1.5
SC – 10 cm	8.2	3.0	2.0
SC – 25 cm	7.5	3.4	1.8
SC – 50 cm	6.9	3.4	1.0

Positron capture to be optimized (RF phase, gradient) + global optimization of the capture section

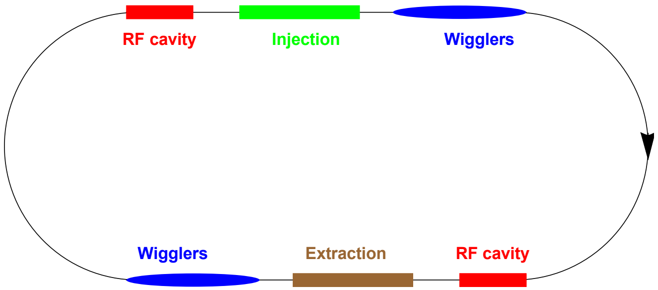
Achieving > 50% average polarization for polarized colliding beams

Scenario 2: polarized injected beam

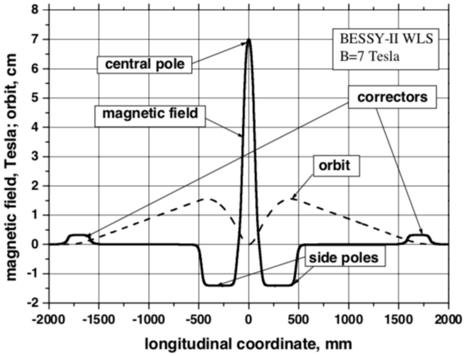
- $P_{\text{avg}} = \frac{P_{\text{ens,DK}}}{1+\tau_{\text{DK}}/\tau_{\text{b}}} + \frac{P_0}{1+\tau_{\text{b}}/\tau_{\text{DK}}} \approx P_0$, given that $\tau_{\text{DK}} \gg \tau_{\text{b}}$
- A high average beam polarization is not in direct contradiction to a high luminosity!
- Tasks:
  - Preparation of polarized beam in the injector (example: AGS, RHIC)
  - Design of spin rotators in the collider rings (example: LEP, HERA, SuperB, SuperT-C, RHIC)
  - Ensure $\tau_{\text{DK}} \gg \tau_{\text{b}}$ via spin matching (example: HERA, LEP)
  - Does high luminosity hurts beam polarization? (open question)

Zhe Duan

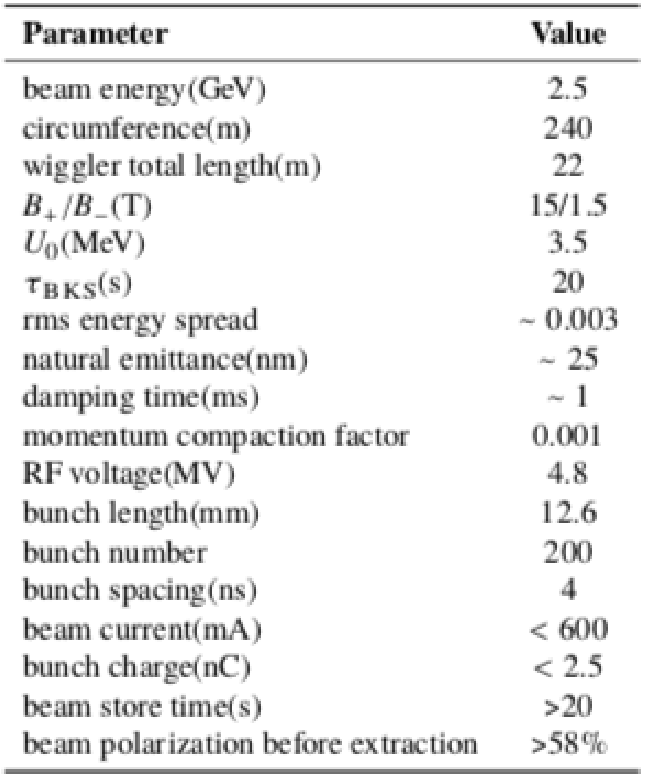
Positron polarizing ring



An asymmetric wiggler @BESSY-II as WLS,
A. M. Batrakov, et al., APAC 2001, pp251-253.



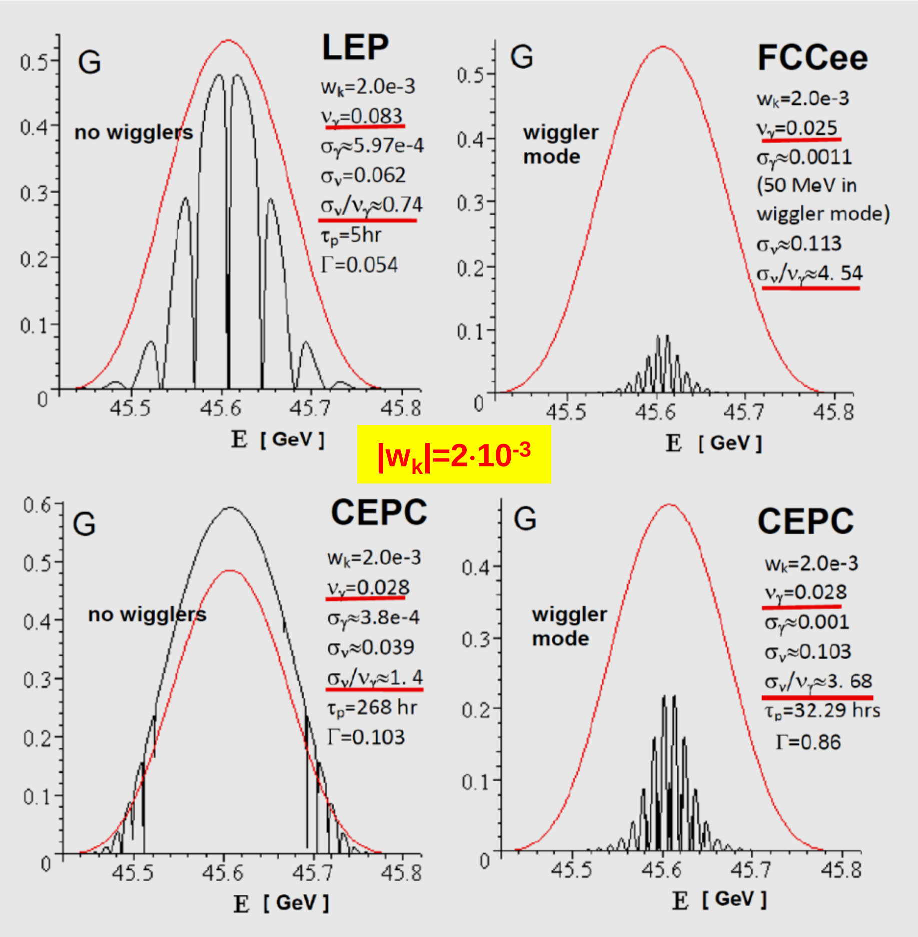
Tentative parameters



Parameter	Value
beam energy(GeV)	2.5
circumference(m)	240
wiggler total length(m)	22
B_+/B_-(T)	15/1.5
U_0(MeV)	3.5
τ_{BKS}(s)	20
rms energy spread	~ 0.003
natural emittance(nm)	~ 25
damping time(ms)	~ 1
momentum compaction factor	0.001
RF voltage(MV)	4.8
bunch length(mm)	12.6
bunch number	200
bunch spacing(ns)	4
beam current(mA)	< 600
bunch charge(nC)	< 2.5
beam store time(s)	>20
beam polarization before extraction	>58%

- Using superconducting asymmetric wigglers to boost self-polarization to ~ 20 second
- e+ beam stays in the ring for ~ 20 second to gain > 50% beam polarization before extraction
- Key hardware challenge: 15 Tesla dipole magnet, in line with R&D efforts for SppC
- Key physics issues: low-emittance lattice design w/ very strong wigglers, electron cloud, etc.

Comparison of CEPC, FCCee and LEP at 45 GeV



In given wiggler mode examples, FCCee loses to CEPC due to higher spin tune spread (**.113** vs **.103**) as well as modulation index (**4.54** vs. **3.68**). Index=spread/synchrotron tune. FCCee has lower synchrotron tune (**0.025** vs **0.028**).

The lower the modulation index, the higher the degree of equilibrium polarization!
Therefore,
a higher synchrotron tune and a lower energy spread are beneficial

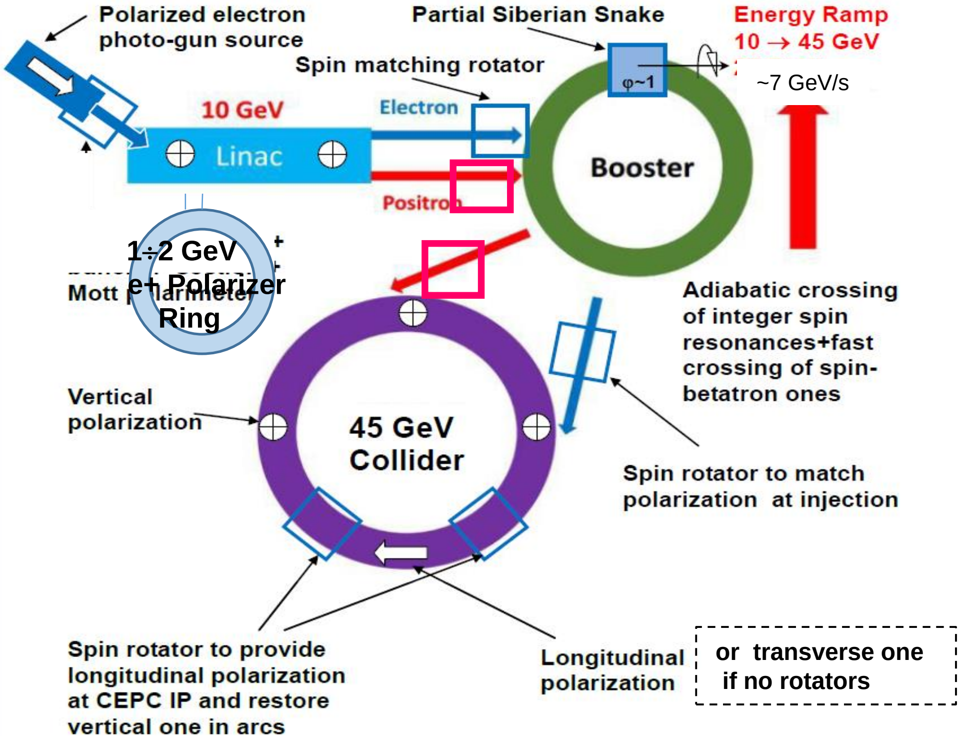
Sergei Nikitin

Acceleration of polarized beam in CEPC booster

electrons and positrons

Maintaining of polarization in Booster using Partial Siberian Snake just as at proton machines
Adiabatic crossing of energy values corresponding to integer spin resonances:
$\varphi^2 >> 4\pi^2\varepsilon' \;\to\; \varphi \sim 1$, spin rotation angle around velocity, at $\varepsilon' \approx 2\cdot 10^{-3}$, rate of detuning change. In presence of such perturbation equilibrium polarization vector is not vertical and changes with energy. By this reason, it is required to match polarization vectors at injection as well as at ejection.
Adiabatic mode is needed to keep particle polarization oriented along that vector.
Owing to snake, detuning from integer resonances does not become zero anywhere.
Worth to be considered!

Proposed in: S.Nikitin, Talk at IAS Program on HEP, Jan. 2018, Hong Kong; IJMP A, Vol. 34 No. 13n14, 1940004 (2019)



High energy ramping rate + large machine size → huge rate of change of detuning are basis of proposal!

Introduction

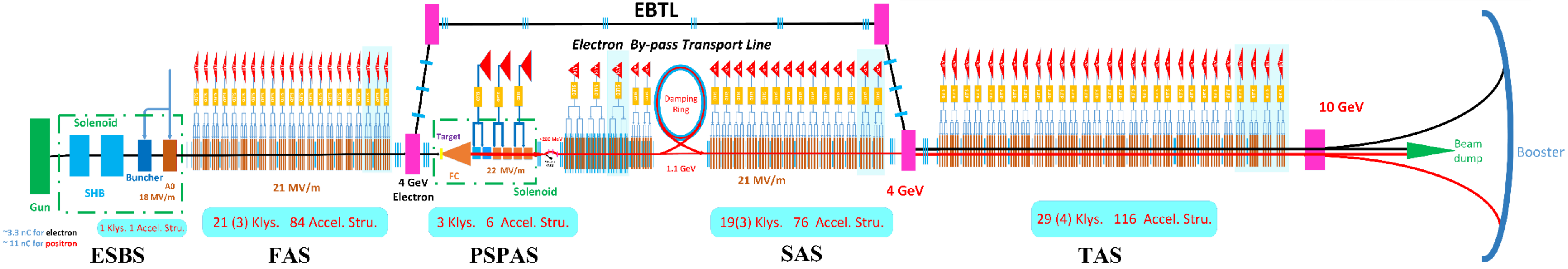
Linac baseline design

Cai Meng

➢ Baseline design principles and consideration

- Meet the requirements of the Booster injection
- High availability and simplicity
  - ✓ About 15% backups for Klystrons and accelerating structures (**Redundancy**)
- More potential
  - ✓ Have potential to provide electron/positron beam with bunch charge larger than 3nC

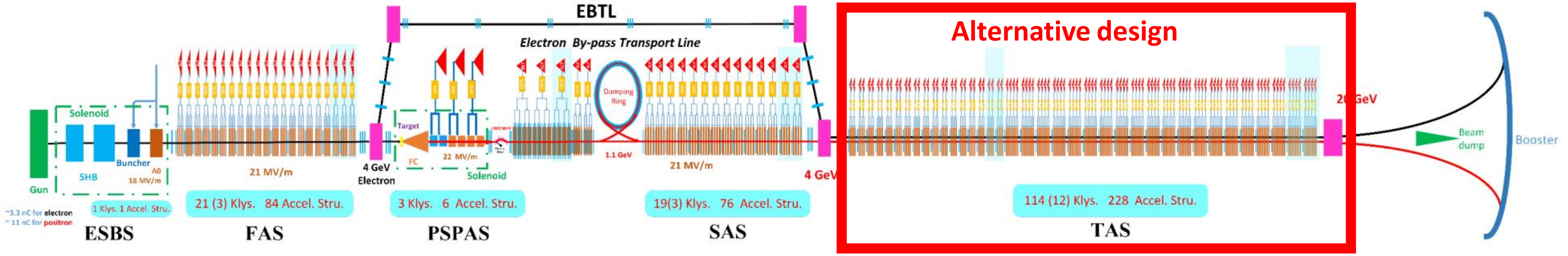
Parameter	Symbol	Unit	Value
e^-/e^+ beam energy	E_{e-}/E_{e+}	GeV	10
Repetition rate	f_{rep}	Hz	100
e^-/e^+ bunch population	$Ne-/Ne+$	nC	>1.5(3)
Energy spread (e^-/e^+)	σ_E		$<2\times10^{-3}$
Emittance (e^-/e^+)	ε_r	nm	40
e^- beam energy on Target		GeV	4
e^- bunch charge on Target		nC	10



Layout

Cai Meng

- Alternative Linac design
  - Linac exit energy: 10GeV → 20GeV



S-band Accelerating structure

C-band Accelerating structure

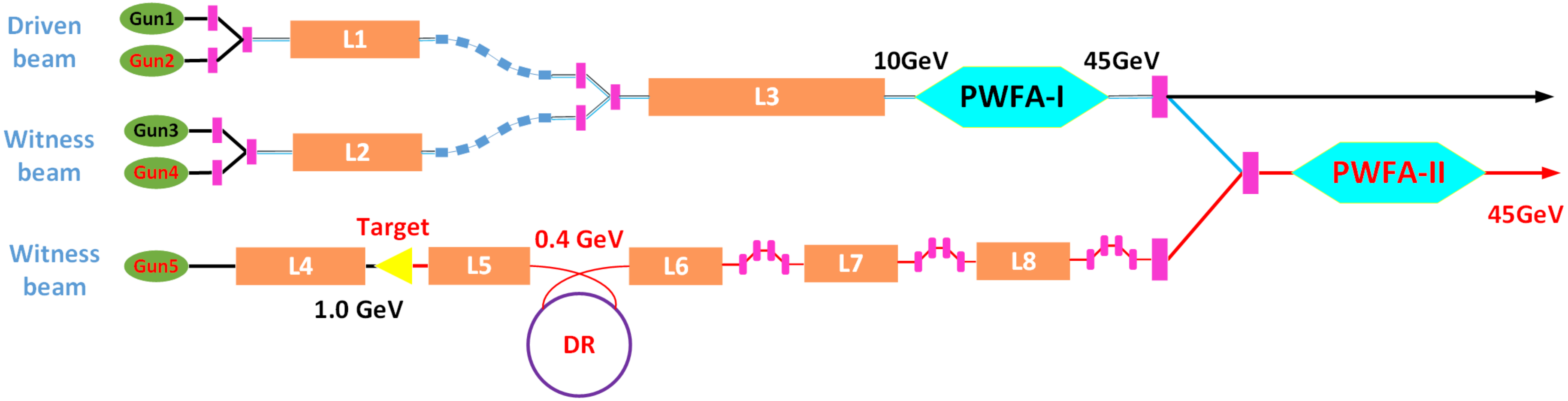
- **C-band: start energy~ 4GeV**
- Transverse focusing: Triplet
- One klystron drive 2 accelerating structure

C-band: 4GeV → 20GeV

12% redundancy of accelerating unit

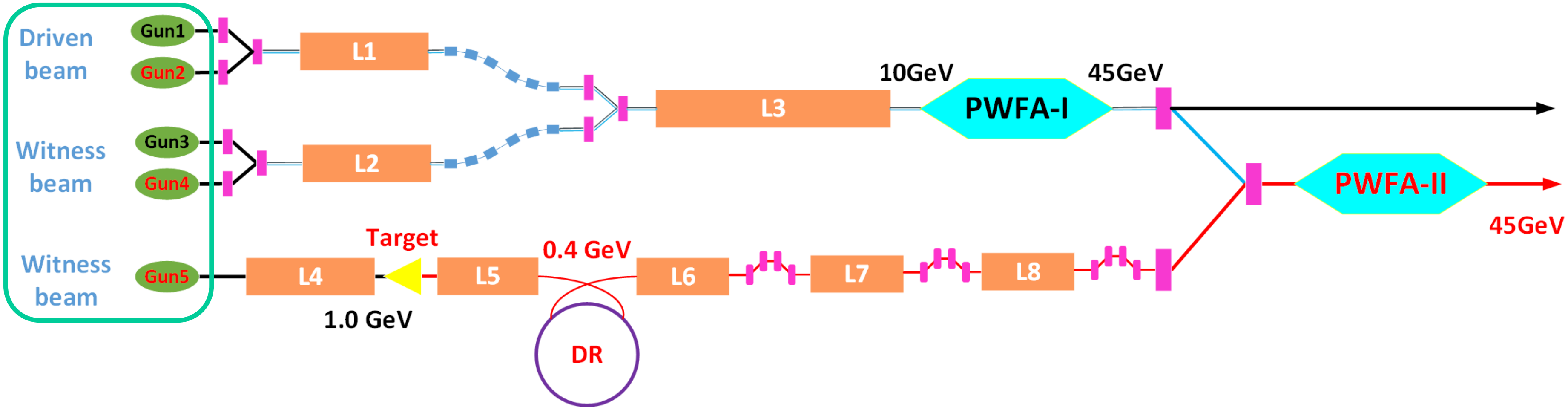
Wei Lu, Tsinghua

CEPC plasma injector concept design （V2.0）



Parameter	Symbol	Unit	Requirement	Achieved(in sim.)
Energy	E_e	GeV	45.5	45.3(e-) / 45.2(+)
Energy Spread	σ_e		< 0.2%	0.2%(e-) / 0.14%(e+)
Frequency	f_{rep}	Hz	100	100
Bunch Charge	N_e	nC	> 1.0	1
Emittance	ε_r	nm·rad	< 30	1.89(e-) / 1.0(e+)
Bunch Length	σ_l	mm	< 3	0.3(e-) / 0.3(e+)
Energy Stability			< 0.2%	
Longitudinal Stability		mm	< 2	
Orbit Stability		mm	< 5(H) / 3(V)	

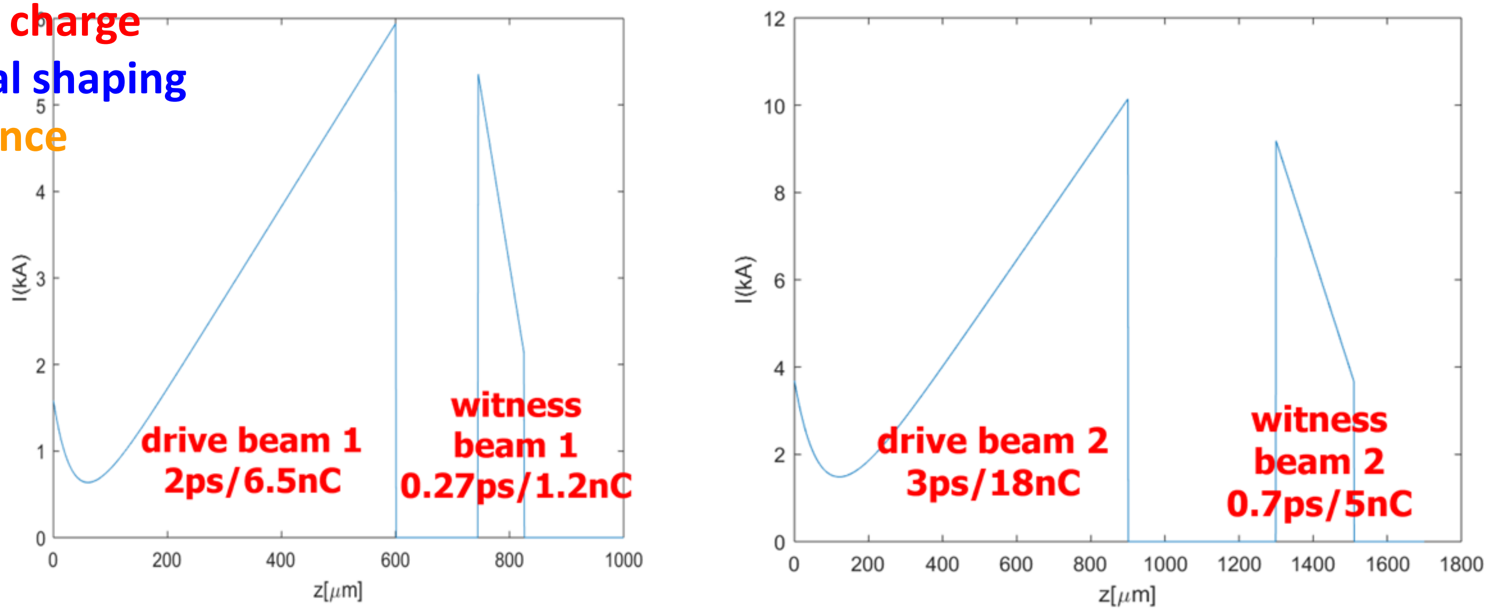
Waiting for PWFA



e- Gun Main Factor:

- High bunch charge
- Longitudinal shaping
- Low emittance

Plasma Injector beam requirements

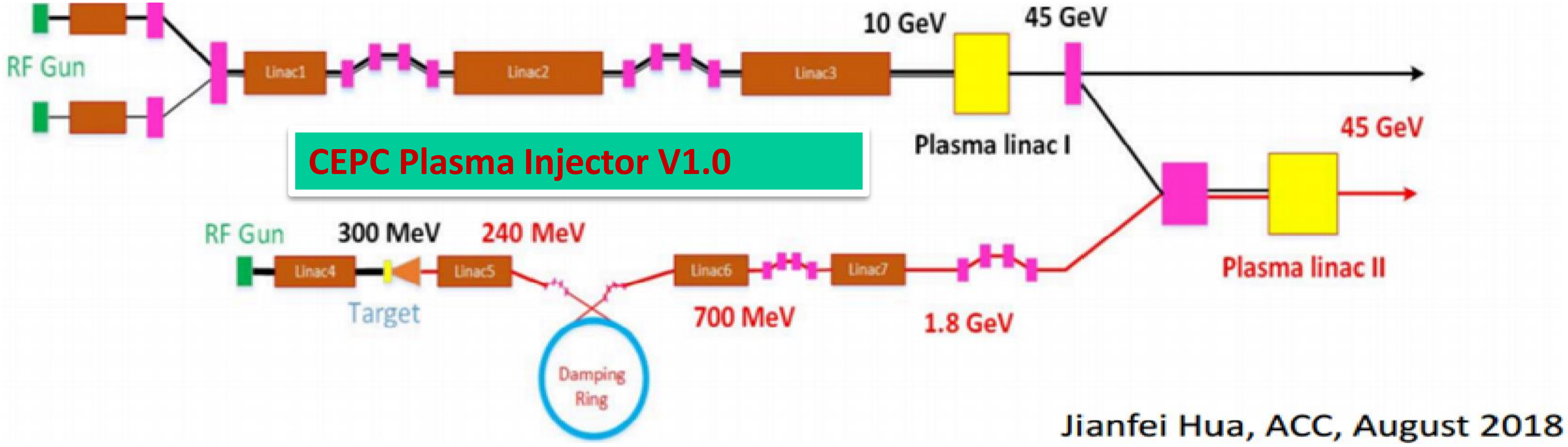


Carlo Pagani

CEPC plasma injector & THU-IHEP AARG

IHEP-THU joint group on Advanced Accelerator Research

- Foundation：March 2017
- THU Member：Wei Lu, Jianfei Hua, Shiyu Zhou, Yue Ma, Shuang Liu, Bo Peng, ……
- IHEP Member：Jie Gao, Dazhang Li, Guan Shu, Cai Meng, Dou Wang, Jingru Zhang, Xiaoning Wang ……



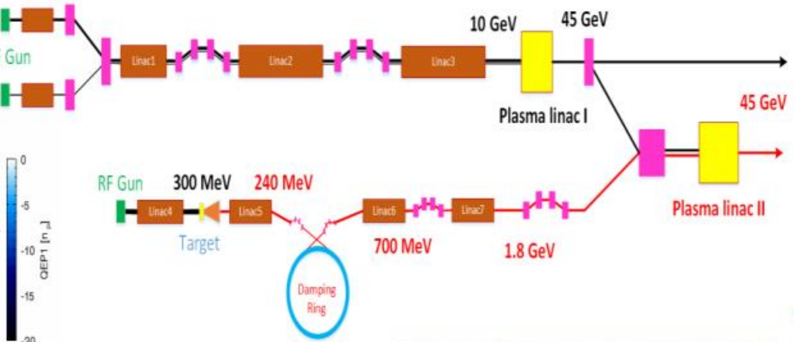
CEPC Plasma Injector V1.0

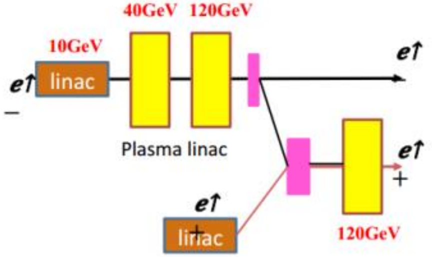
Jianfei Hua, ACC, August 2018

CEPC design enhancement

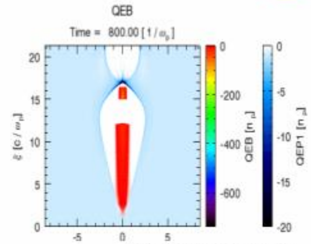
Experimental Verification Planfor CEPC Plasma Injector Scheme

A dedicated budget of 8Million has been alocated by IHEP



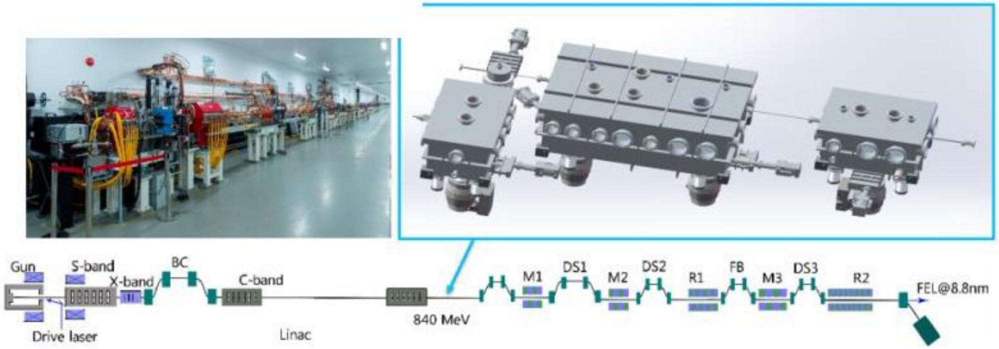


Technical design review has been done (August 22,2019)



Plasma density $n_0(cm^{-3})$	5.15×10^{16}
Driver charge $Q_d(nC)$	6.47
Driver energy $E_d(GeV)$	10
Driver length $L_d(\mu m)$	285
Driver RMS size $\sigma_d(\mu m)$	10
Driver normalized emittance $\epsilon_{nd}(mm\ mrad)$	10
Trailor charge $Q_t(nC)$	1.25
Trailor energy $E_t(GeV)$	10
Trailor length $L_t(\mu m)$	35
Trailor RMS size $\sigma_t(\mu m)$	5
Trailor normalized emittance $\epsilon_{nt}(mm\ mrad)$	100

Trailor energy $E_t(GeV)$	45.5
Trailor normalized emittance $\epsilon_{nt}(mm\ mrad)$	98.9
TR	3.55
Energy spread $\delta_E(\%)$	0.7
Efficiency (driver -> trailor)	68.6%

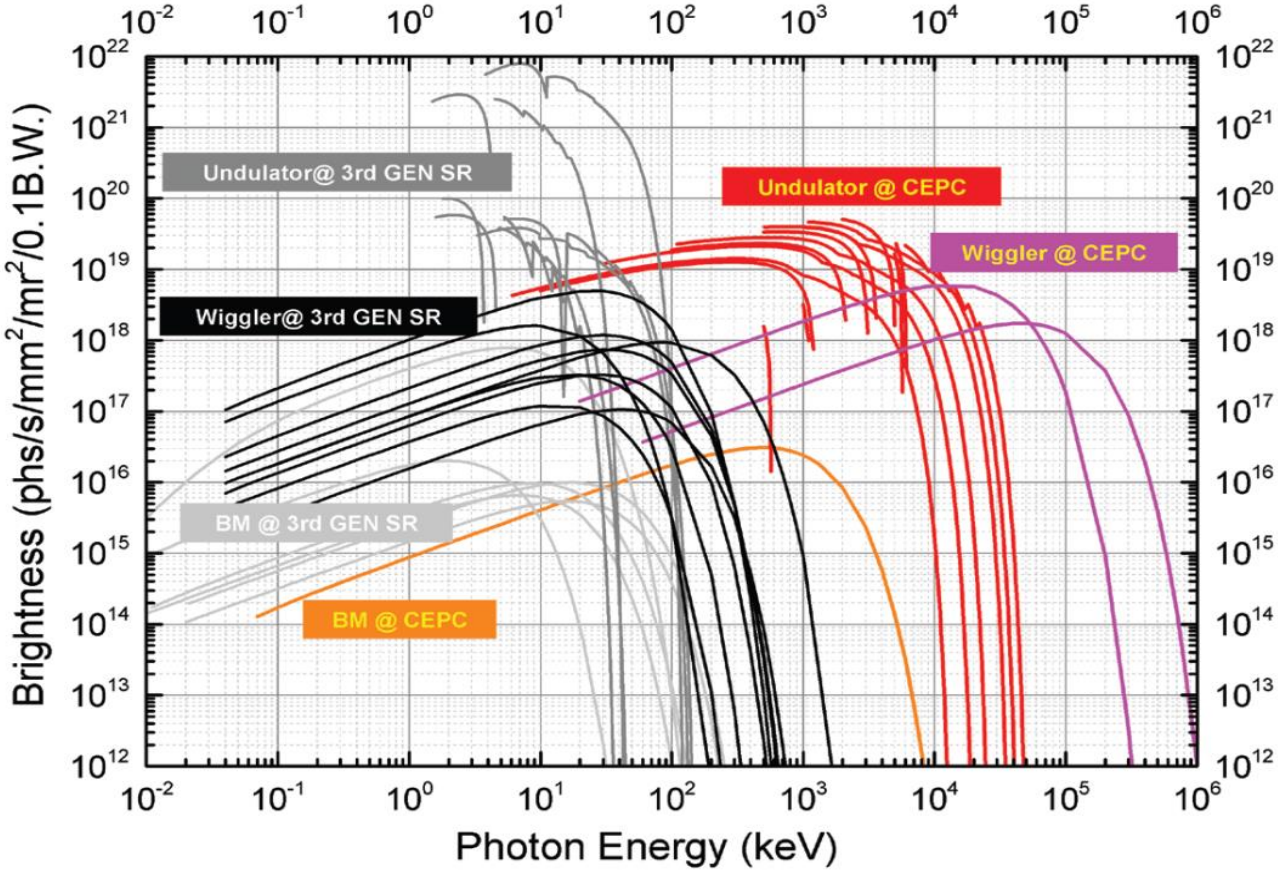


- **Electron plasma acceleration will be tested in Shanghai's Soft XFEL Facility**
- **Positron plasma acceleration scheme will be tested at FACET-II at SLAC**

Jie GAO

Xinchou Lou

Yongsheng Huang



Brightness of the SR from bent iron, torsion, oscillator and low-K undulators in future high-energy particle colliders(CEPC-CDR)

The torsion pendulum has a characteristic gamma energy of 19.2 MeV and a high flux radiant energy of 300 MeV. The gamma light energy produced by the undulator can reach 20 MeV at high flux. Moreover, in the energy region greater than 100 keV, the brightness and flux of the future high energy particle collider synchrotron source are higher than those of the third generation synchrotron radiation source.

Yongsheng Huang

Central intensity of Synchrotron radiation,[photon/s/mrad2/0.1%b.w.]

$$\left.\frac{d^2F_{bm}}{d\theta d\psi}\right|_{\psi=0} = 1.327\times10^{13}E^2[GeV]I(A)H_2(y)$$

F_{bm} , flux; I, the curent of the ring, $\mathrm{H}_2(\mathrm{y}) = \mathrm{y}^2\mathrm{K}^2_{\frac{2}{3}}(\mathrm{y}/2)$, K, the second Bessel function;

$\mathrm{y} = \epsilon/\epsilon_c$, ϵ,the photon energy, $\epsilon_c = 0.665E^2[GeV]B[T] = 358.2\mathrm{keV}$.

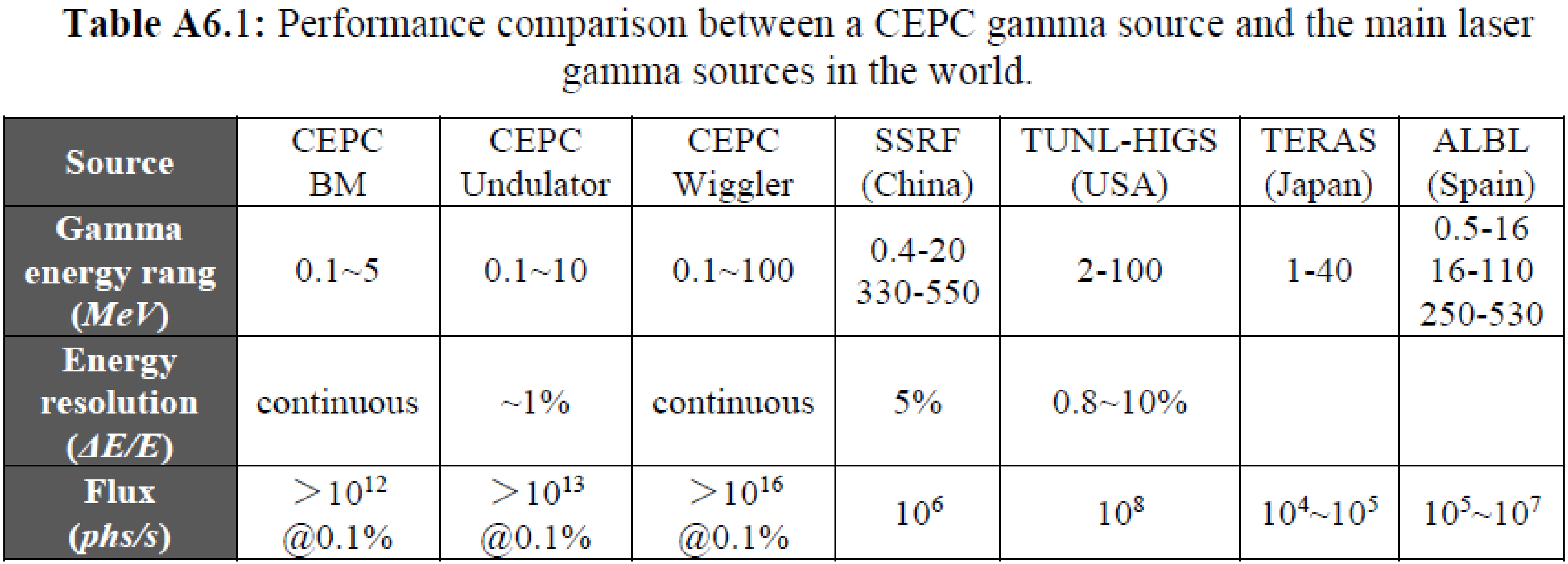
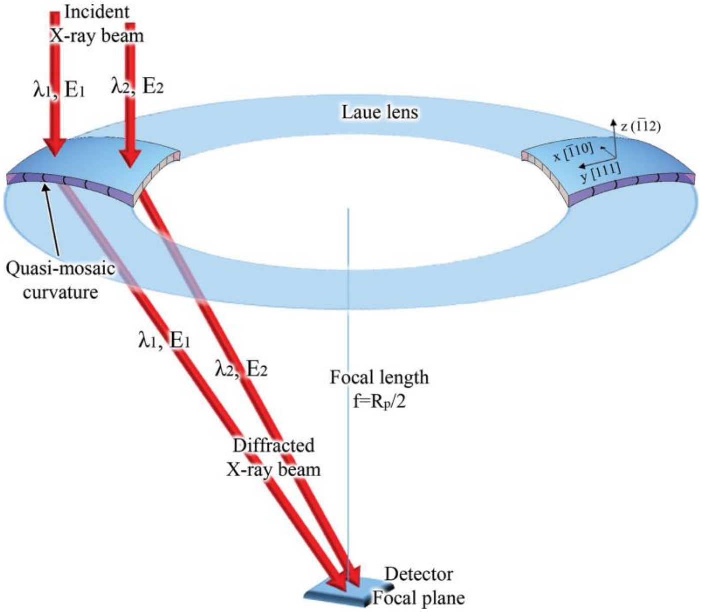


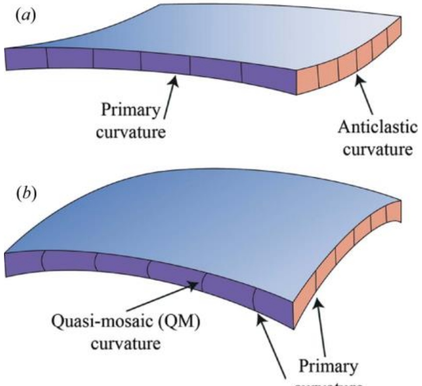
Table A6.1: Performance comparison between a CEPC gamma source and the main laser gamma sources in the world.

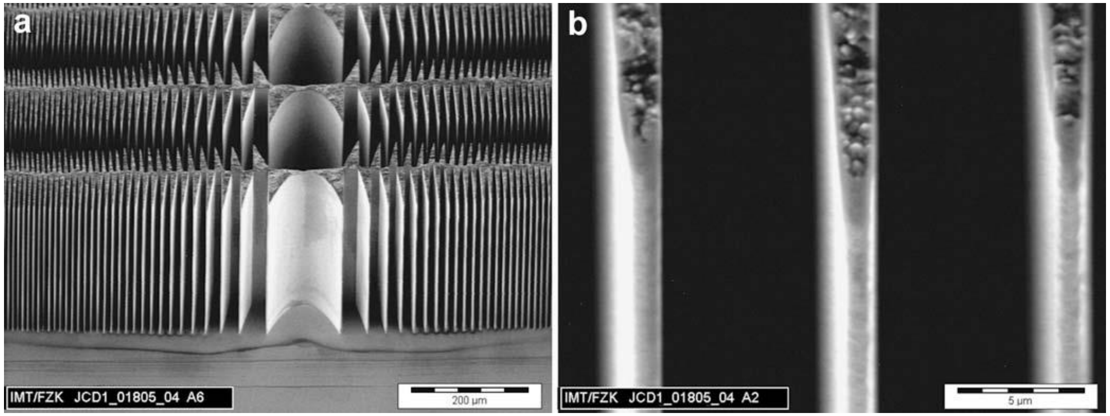
Source	CEPC BM	CEPC Undulator	CEPC Wiggler	SSRF (China)	TUNL-HIGS (USA)	TERAS (Japan)	ALBL (Spain)
Gamma energy rang *(MeV)*	0.1~5	0.1~10	0.1~100	0.4-20 330-550	2-100	1-40	0.5-16 16-110 250-530
Energy resolution *(ΔE/E)*	continuous	~1%	continuous	5%	0.8~10%		
Flux *(phs/s)*	$>10^{12}$ @0.1%	$>10^{13}$ @0.1%	$>10^{16}$ @0.1%	10^6	10^8	10^4~10^5	10^5~10^7

The focalization of hard x-ray And soft gamma-ray 100keV-1MeV, 1MeV still problem?

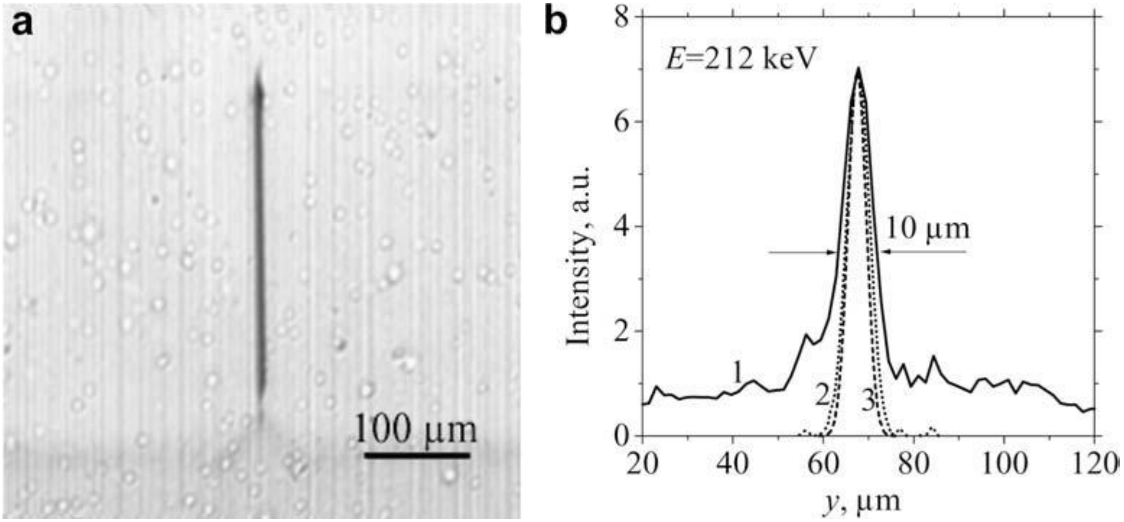


Schematic representation of a Laue lens based on QM crystals. J. Appl. Cryst. (2015). 48, 977–989





LIGA fabrication of X-ray Nickel lenses 100keV-1MeV : Microsystem Technologies 11 (2005) 292–297



Yiwei Wang

Geometry compatibility of CEPC collider, CEPC booster and SPPC

- CEPC booster will locate upside of CEPC collider (d=2.4m) except the IP1 and IP3
- CEPC booster will also bypass the CEPC detector at IP1 and IP3 thus can share the part of SPPC tunnel at IP1 and IP3.
  - Straight section of CEPC booster at IP1 and IP3 is 1.25km

Tunnel in the ARC

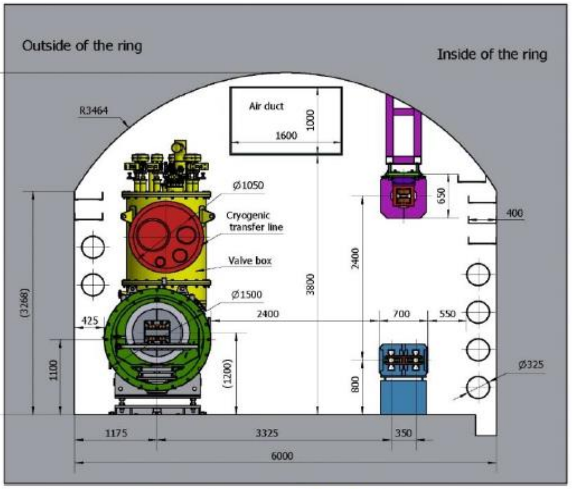
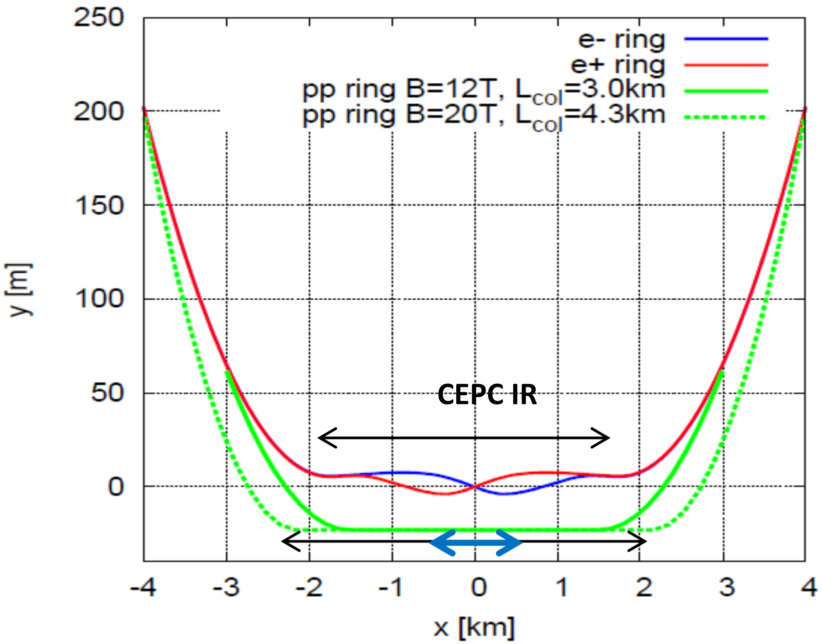


Figure 2.1: Tunnel cross section in the arc region

solutions of two schemes



CEPC booster

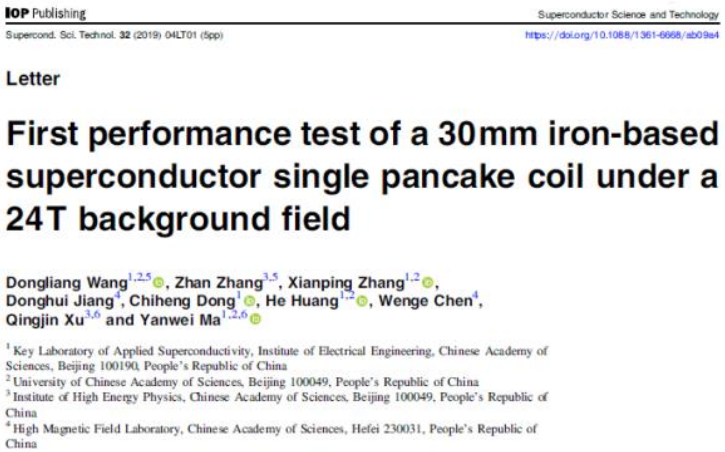
SPPC collimation

Jingyu Tang

Details in Qingjin Xu's talk

Fabrication and test of the 1st IBS solenoid coil at 24T

The 1st solenoid coil with IBS tape fabricated and tested with up to 24T background field. Performance is more than expected.



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Superconductor Science and Technology

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https://doi.org/10.1088/1361-6668/ab09a4

Letter

First performance test of a 30 mm iron-based superconductor single pancake coil under a 24 T background field

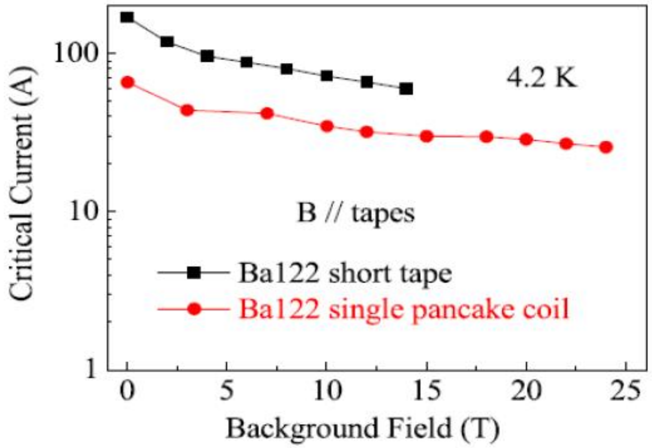
Dongliang Wang[1,2,5], Zhan Zhang[3,5], Xianping Zhang[1,2], Donghui Jiang[4], Chiheng Dong[1], He Huang[1,2], Wenge Chen[4], Qingjin Xu[3,6] and Yanwei Ma[1,2,6]

[1] Key Laboratory of Applied Superconductivity, Institute of Electrical Engineering, Chinese Academy of Sciences, Beijing 100190, People's Republic of China

[2] University of Chinese Academy of Sciences, Beijing 100049, People's Republic of China

[3] Institute of High Energy Physics, Chinese Academy of Sciences, Beijing 100049, People's Republic of China

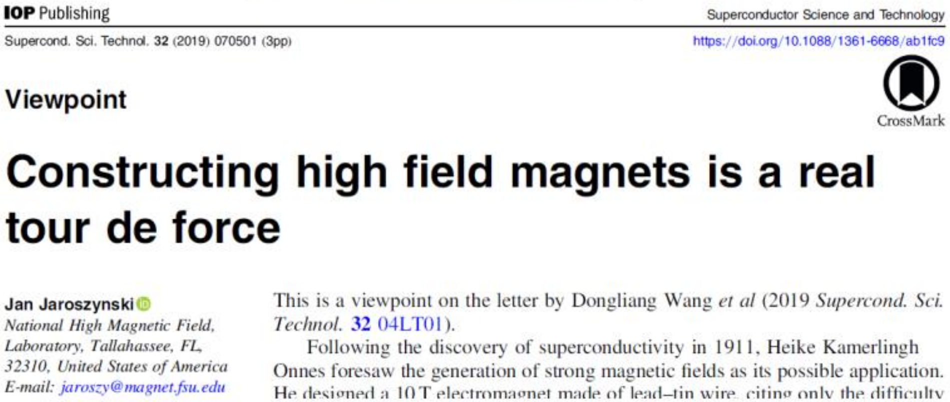
[4] High Magnetic Field Laboratory, Chinese Academy of Sciences, Hefei 230031, People's Republic of China



Viewpoint by NHMFL

'From a practical point of view, **IBS are ideal candidates for applications**. Indeed, some of them have quite a **high critical current density, even in strong magnetic fields**, and a low superconducting anisotropy.

Moreover, **the cost of IBS wire can be four to five times lower than that of Nb_3Sn**……



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https://doi.org/10.1088/1361-6668/ab1fc9

Viewpoint

CrossMark

Constructing high field magnets is a real tour de force

Jan Jaroszynski
National High Magnetic Field, Laboratory, Tallahassee, FL, 32310, United States of America
E-mail: jaroszy@magnet.fsu.edu

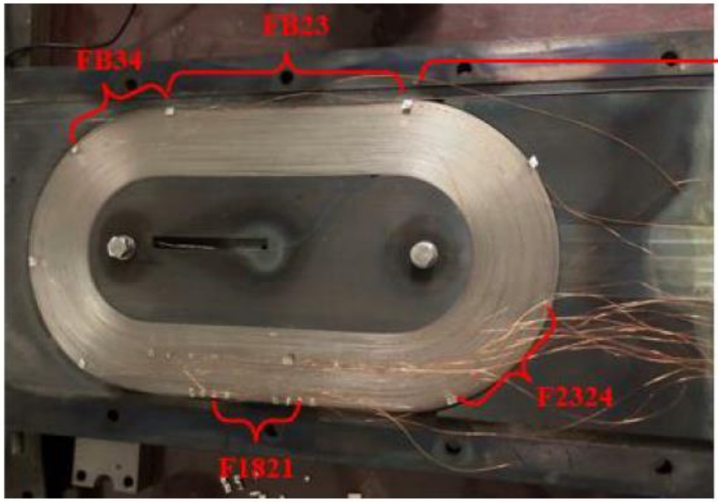
This is a viewpoint on the letter by Dongliang Wang *et al* (2019 *Supercond. Sci. Technol.* **32** 04LT01).

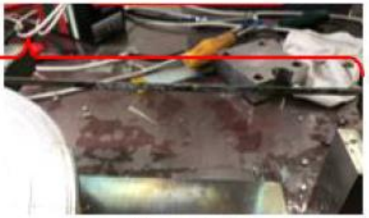
Following the discovery of superconductivity in 1911, Heike Kamerlingh Onnes foresaw the generation of strong magnetic fields as its possible application. He designed a 10 T electromagnet made of lead–tin wire, citing only the difficulty

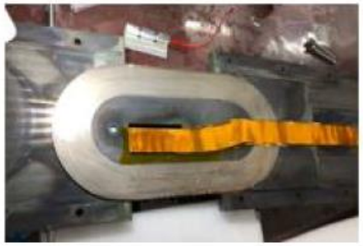
Jingyu Tang

Fabrication and test of the 1st IBS racetrack coil at 8T

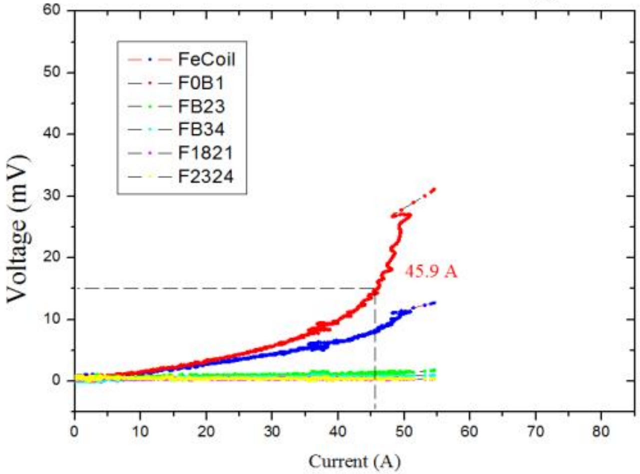
- The 1st racetrack coil with 100m long IBS tape fabricated and tested with up to 8T background field. Performance limited by unsatisfying joints.
- The 2nd IBS racerack coil has been fabricated and to be tested at 10-12T.



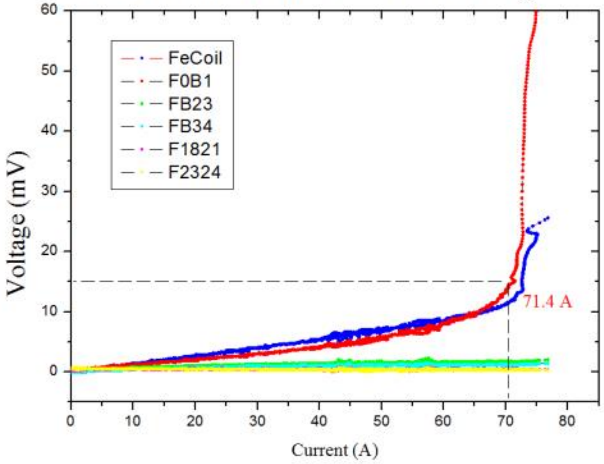

Outer Joint



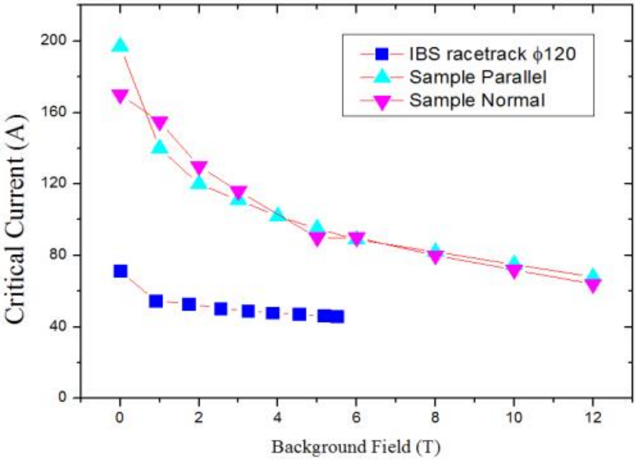
I-V Curveof IBS 100 m Racetrack Coil @ 7.5T



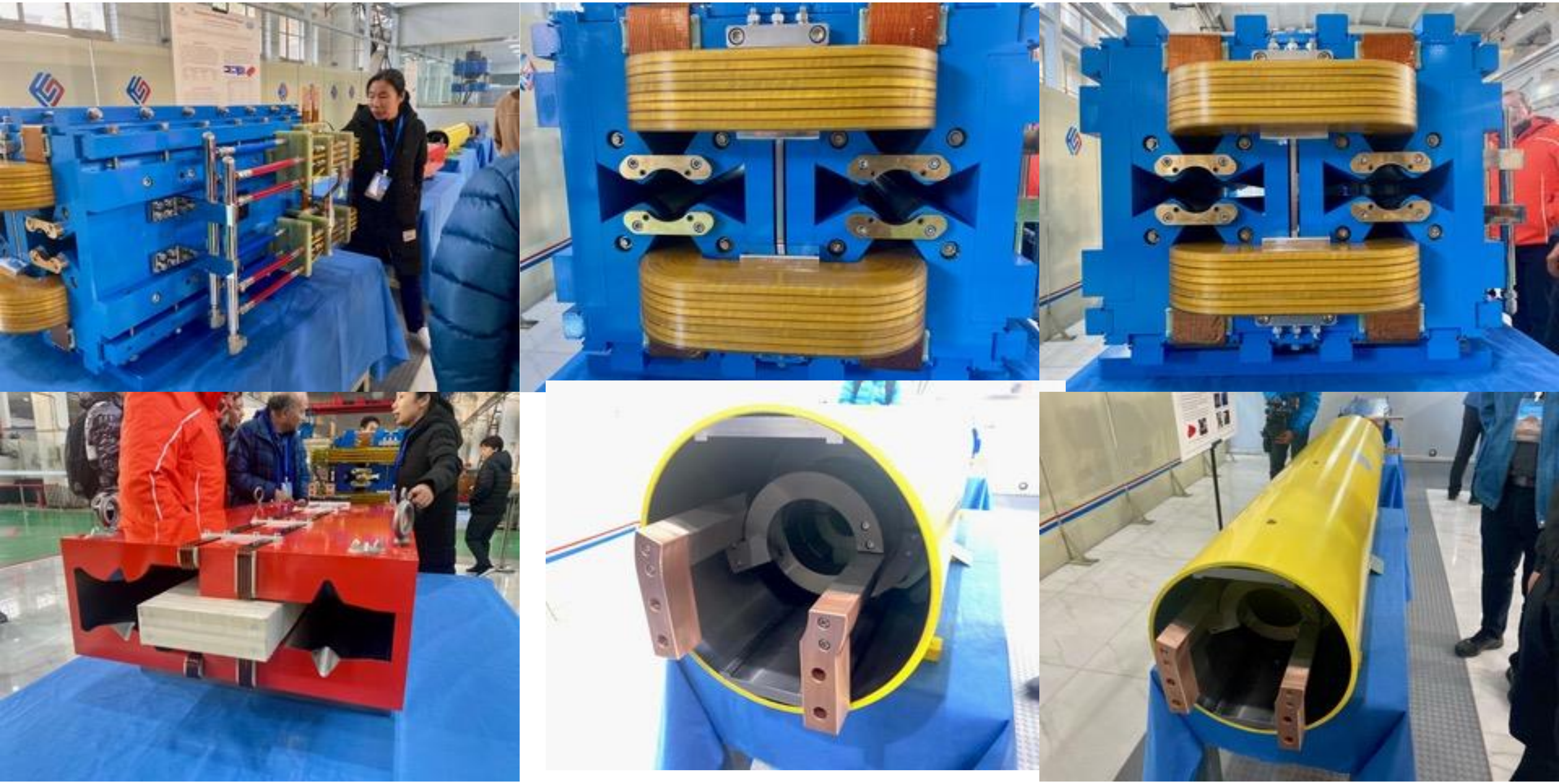
I-V Curveof IBS 100 m Racetrack Coil @ 0T



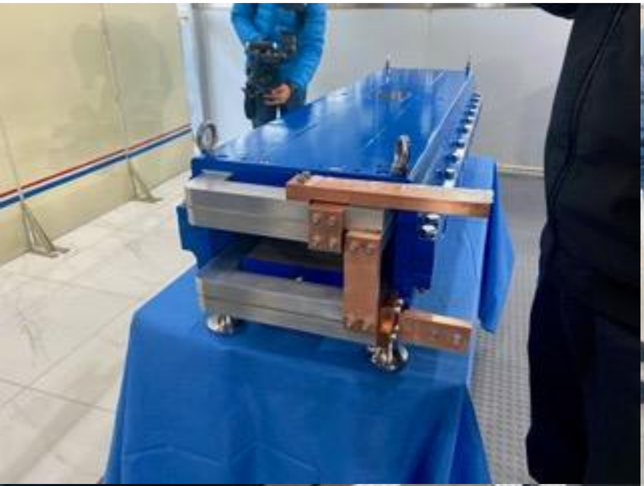
Critical Current w.r.t Background Field of 100 m IBS Racetrack

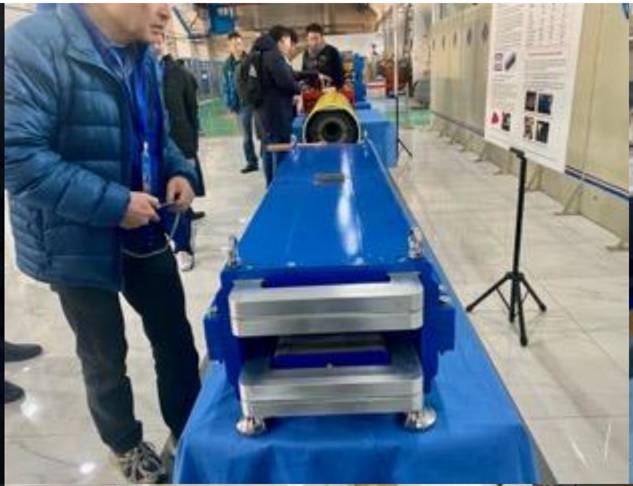


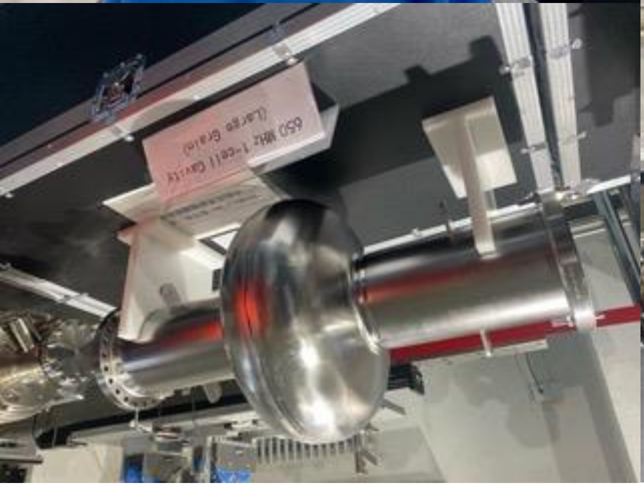
photos from CEPC workshop tour by Katsunobu Oide

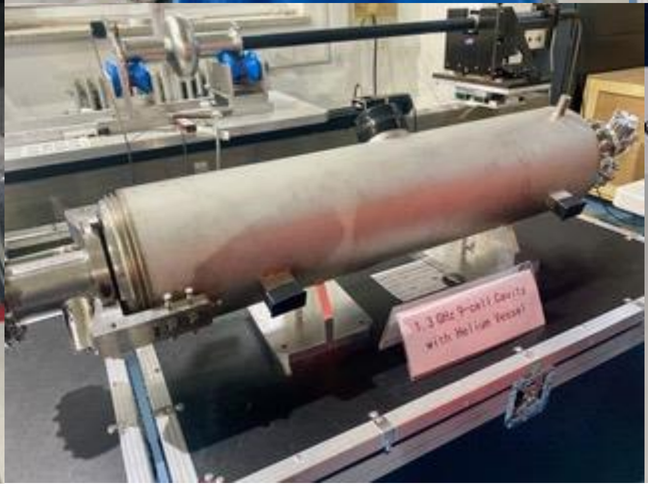


photos from CEPC workshop tour by Katsunobu Oide ct’d









Paolo Giacomelli

CEPC current situation

- We are currently in the post-CDR phase
- CEPC project is well established in the International Physics community
- Endorsed by ICFA
- Hope CEPC is mentioned in the European Strategy Update
- Hope CEPC gets selected in the list of 3-5 International programs supported by China in 2020
- **Green** light towards the end of **2022**?
- Need to prepare for the period bringing up to the TDR (**2023-24**?)
  - Intense R&D program on detectors essential
  - Will need adequate resources and funding up to the TDR
  - Up to the TDR CEPC will be one common International Collaboration
  - After the TDR, two International Collaborations will naturally form around the two selected detectors

Paolo Giacomelli

Towards an International Collaboration

- Need to agree on, and later endorse, the procedures that will lead to the formation of the International Collaboration
- First easy thing to do: prepare an e-mail list with 1-2 representatives of each Institute interested in participating to CEPC
- This list will define the International Board (IB) of Institutes
- Define a first simple, non-binding, Memorandum of Understanding (MoU)
  - Will show and later circulate a first draft of a possible MoU
- The IB will then become the body that endorses the most important decisions of the collaboration
  - Work in close connection with the Project Leader and endorse together the important CEPC decisions

João Guimarães da Costa

CEPC International Detector R&D Review Committee (IDRC)

Committee proposed by CEPC IAC

Detector R&D Committee that reviews and endorses the **Detector R&D proposals** from the **international community**, such that the international participants could apply for funds from their funding agencies and make effective and sustained contributions.

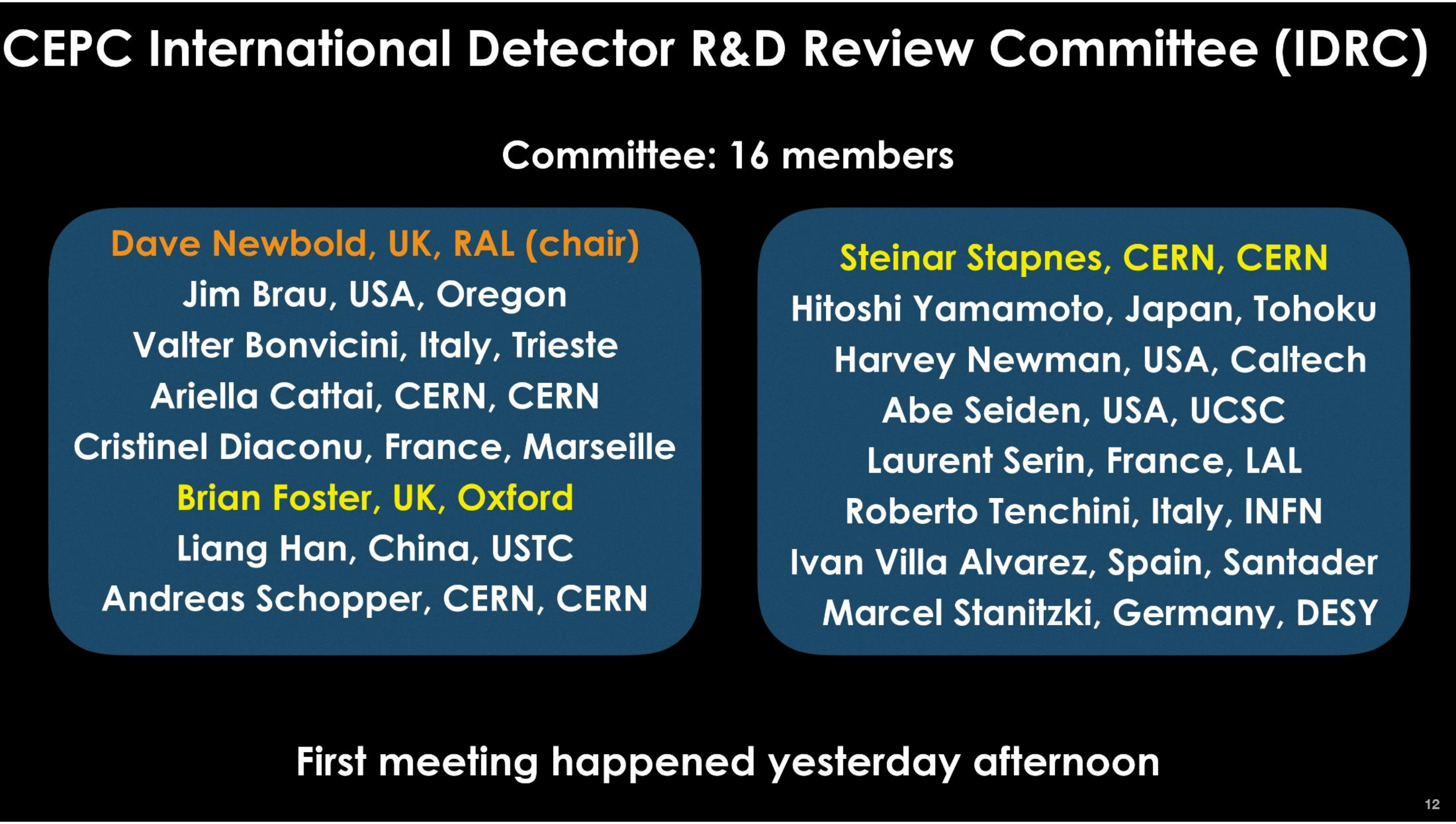
Later, this committee is expected to evolve to

evaluate the Letters of Intent for the CEPC Detectors

submitted by the proponents of the International Detector Collaborations

(Expected timescale 2022-23)

João Guimarães da Costa



CEPC International Detector R&D Review Committee (IDRC)

Committee: 16 members

Dave Newbold, UK, RAL (chair)
Jim Brau, USA, Oregon
Valter Bonvicini, Italy, Trieste
Ariella Cattai, CERN, CERN
Cristinel Diaconu, France, Marseille
Brian Foster, UK, Oxford
Liang Han, China, USTC
Andreas Schopper, CERN, CERN

Steinar Stapnes, CERN, CERN
Hitoshi Yamamoto, Japan, Tohoku
Harvey Newman, USA, Caltech
Abe Seiden, USA, UCSC
Laurent Serin, France, LAL
Roberto Tenchini, Italy, INFN
Ivan Villa Alvarez, Spain, Santander
Marcel Stanitzki, Germany, DESY

First meeting happened yesterday afternoon

Nathaniel Craig

Conclusions

- The physics case for CEPC is robust and compelling; time for great ambition now that details are converging.
- Big questions: fundamental identity of Higgs, origin & nature of EWSB, identity of dark matter, existence of dark sectors, origin of flavor
- Benchmark analyses continually evolving, new directions beckon: **Higgs form factor**, **tests of QFT** (dimension-8 operators & positivity), **dark matter** (Higgs portal @ threshold; millicharge), **dark sectors** (prompt & long-lived exotic decays), **flavor**…
- …and this is only the beginning.

Thank you!

Sarah Eno

Future thoughts

The detector needs of an e^+e^- Higgs factory has been pondered since at least 1886, when the JLC was proposed as a next step for the KEK program. When I got my Ph.D. on AMY in 1989, and I moved on to the Tevatron, some of my fellow postdocs/students moved on to work on JLC. There is probably also even older history. Thinking about the "next steps" is therefore daunting.

Any future e+e- collider has a deep debt of gratitude to ILC (including the ILC itself)

But we still have time before the final design and construction of the detectors begins. Physics is always moving, and it is important to reassess and challenge conventional wisdom on the design needs.

workshop extremely inspiring !

somewhat different complementary community attending

having two similar, great projects speeds up design progress and increases likelihood that one (or both) of them will be realized