Highlights of CEPC2022

International Workshop on Accelerator

(24-27, October 2022)

Yuhui Li (IHEP)

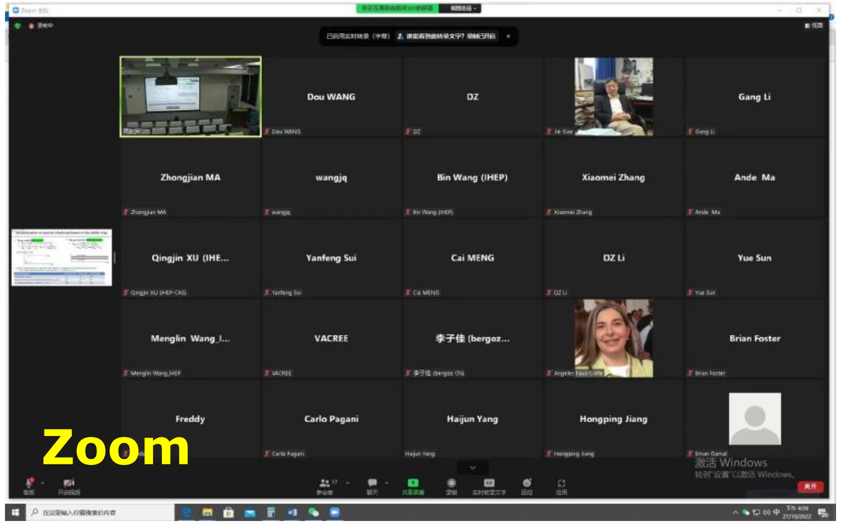
October 28th, 2022

CEPC 2022 International Workshop

- Annual meeting, hybrid on-line and in-person meeting
- Mon-Thu, 4 days, 12 sessions, **60 talks**
- **13** foreign, **6** other domestic, 41 IHEP
  - 8 FCCee/CERN
  - 2 Japan (KEK)
  - 1 Italy(INFN)
  - 1 Korea (PAL)
  - 1 Russia (BINP)
  - 2 Tsinghua
  - 1 Beijing Uni.
  - 1 Huhan Uni.
  - 2 Huanghe Co.

	Convener	Topic Focus
1	Jie Gao	KEKB, lattice, BB, DR
2	Wenhui Huang	Timing, Impe., HOM, BeamLoad
3	Angeles F. Golfe	eeFACT, TDR, Error, Booster
4	Younguk Sohn	SRF, Klystron, LLRF, Cryogenic
5	Anton Bongomyagkov	Mag., Inje./Extr. Power, Deflector.
6	Maria E. Biagini	Mag., Vac., Instr.

	Convener	Topic Focus
7	Eiji Kako	Linac,Contr.,FB
8	Wenhui Huang	SupTauC,Mech., MPS, Dump
9	Makoto Tobiyama	BII-U, Collimation, MDI,
10	Xueqing Yan	Gun, Plasma, Polarimeter
11	Yuhui Li	Installation, Siting, SR Utility
12	Carlo Pagani	Vibration, Polari., SppC



Highlights of Highlights

Highlights of
TTC2022 meeting at Aomori
(11-14, October 2022')

Eiji Kako (KEK, Japan)
TTC Chair

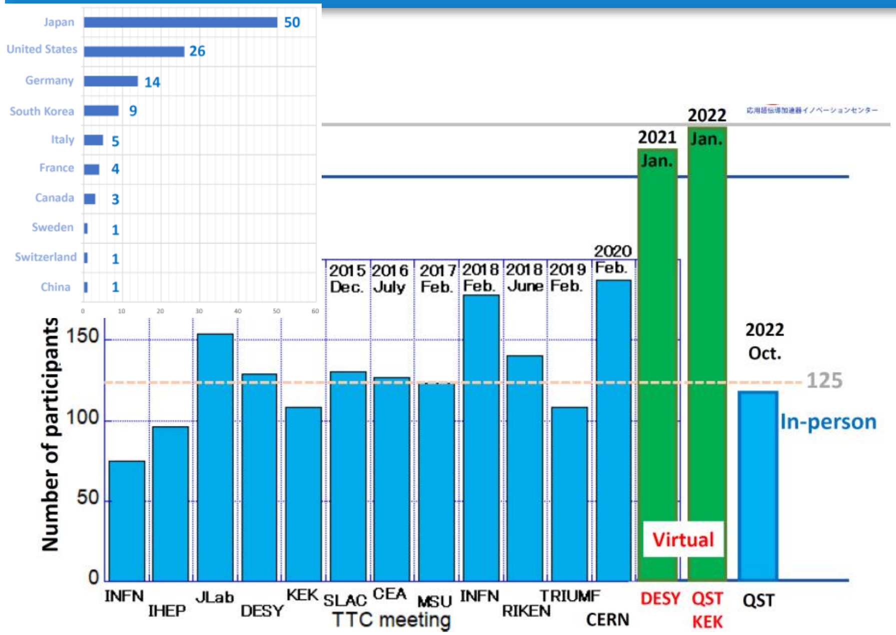
October 25th , 2022

https://www.ttc2022aomori.org/event/2/

https://agenda.infn.it/event/21199/timetable/?view=standard

In-person accelerator international workshop/conference restart

Highlights TTC2022@Aomori



WG-1: Progress of High Q and High Gradient activities

WG-2: Low beta machine commissioning and operational experience

WG-3: Applications and cooling schemes for Nb3Sn- cavities

WG-4: Availability and operability of existing accelerators compared to their design goals

"SRF activities discusses within Snowmass and European HEP strategy process" by S. Belomestnykh (FNAL) and H. Weise (DESY)

"Summary report of TTC Thin Film WG and Thin Film WS" by A.M. Valente (JLab)
"Summary report of ERL2022 Workshop at Cornell" by H. Sakai (KEK)

Highlights of eeFACT2022 (ICFA 65th Beam Dynamics workshop)

WG1	Levichev/Biagini	Overview of colliders (including muon & e-ion colliders)
WG2	Branchini/Dam	Physics & Detector
WG3	Oide/Gao	Optics & Beam Dynamics
WG4	Zobov/Zimmermann	Beam-beam & Instabilities
WG5	Boscolo/Sullivan	Interaction Region & MDI & Backgrounds
WG6	Seeman/Furukawa	Injection
WG7	Ikeda/Wendt	Instrumentation
WG8	Bogomyagkov/Gianfelice	Polarization and energy calibration
WG9	Kersevan/Shibata	Vacuum
WG10	Parker/Koop/Li	Magnets
WG11	Brunner/Rimmer	RF
WG12	Qin/Funakoshi	Infrastructures, Cryogenics, Commissioning & Operation
WG13	Faus-Golfe/Wenninger	Monochromatization

- Mixed format presence (55%)+remote (45%), 96 talks, 112 registered participants
- Most of talks related to the huge on-going effort for FCCee and CEPC (with some glimpse to EIC). Congratulations! (22 FCCee, 15 CEPC)
- SuperKEKB experience presented extensively (very useful for the present work on future colliders)
- 2 EXTRA sessions at the end, focused on "Power issues for future colliders", lead by F. Zimmerman. Please go to Indico for slides
- Summarizing here just a few highlights (mostly from SuperKEKB)

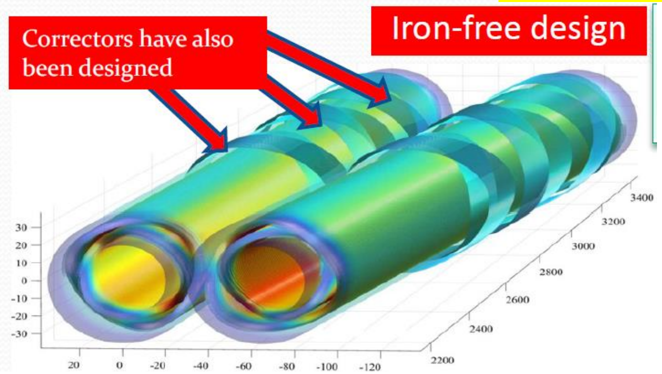
SuperKEKB Experience: **Y. Onishi**

- 4.65 (4.71) x 10^{34} $cm^{-2}s^{-1}$
- "Sudden beam loss"
- "Beam blowup in LER"
- "BPM accur. needed"
- "Beamline deform. (SR) as a function of current"
- "High & Low current operation different"
- "Short life time (CrabW on/off)"

Lessons from ESRF: **P. Raimondi**

- RF extremely reliable (redundant design)
- Power Supplies failure negligible
- Vacuum level better than expected
- Beam stability 5 times better than old machine
- In-principle study prior construction

FCCee IR CCT: **M. Koratzinos**

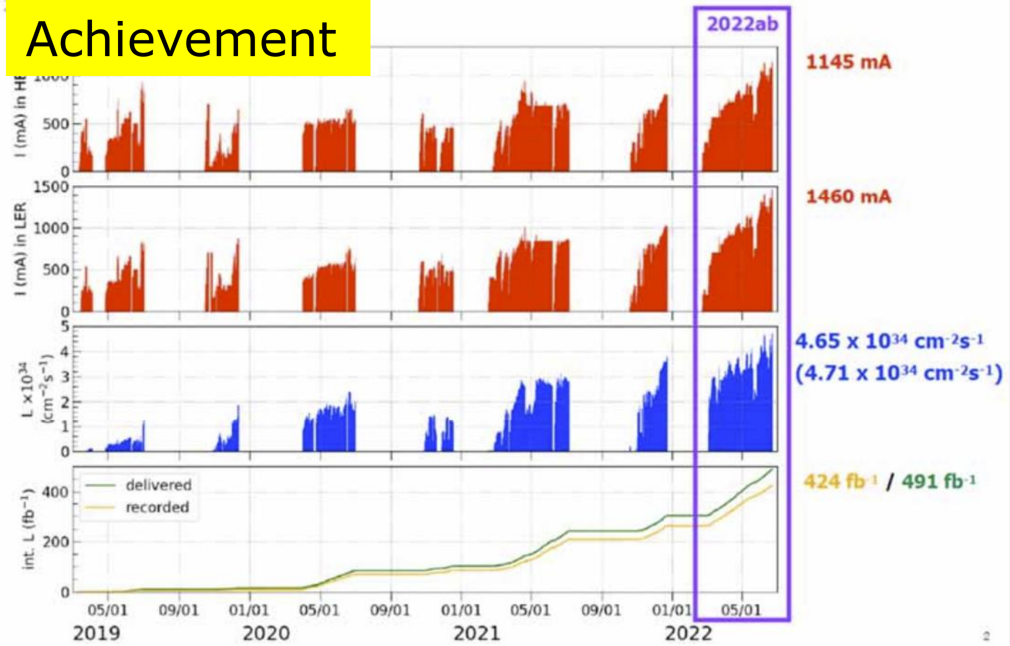


Status of SuperKEKB Collider

Status of SuperKEKB collider

Makoto Tobiyama

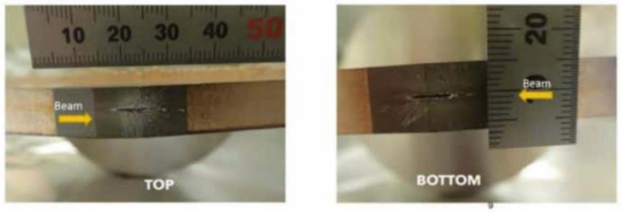
Achievement



- βy*: 1 mm (0.8 mm) << bunch length ~6 mm -> proof of the nano-beam
- Crab waist scheme has been applied (80 % in the LER, 40 % in the HER).
- Bunch-by-bunch FB tuning (gain, noise reduction) in the HER
- Bunch-by-bunch FB tuning (number of taps) in the LER ->suppress single bunch blowup, luminosity improvements
- Chromatic X-Y coupling correction with rotatable sextupoles in the LER
- Long-term drift of QCS magnetic field (beta-beat)

Challenges:

- IR Optics (by*) modulation due to stored current (HER)
  - Betatron tune shift due to resistive wall current on racetrack vacuum chamber (HER)
  - Horizontal orbit deviation around strong sextupoles, especially around local chromaticity correction sections.
- Beam-beam interaction
  - Lower beam current in the HER tends to cause beam blowup.
  - This means that the HER beam size is easier to blow-up when the beam current of the HER decreases.
  - Therefore, the beam current of the HER is larger than the energy ratio (4 GeV / 7 GeV).
- Chromatic X-Y coupling
  - QC1s of LER have no magnetic shields nor anti-solenoid to cancel strong solenoidal field from Belle II detector.
  - Beam-beam simulations suggest the induced chromatic X-Y coupling could introduce large vertical beam blowup
  - Rotatable sextupole magnets around IR to correct chromatic coupling.
- Sudden beam loss (within 1-2 turns), damage of vertical collimator heads.



Overview of the FCCee Collider Design

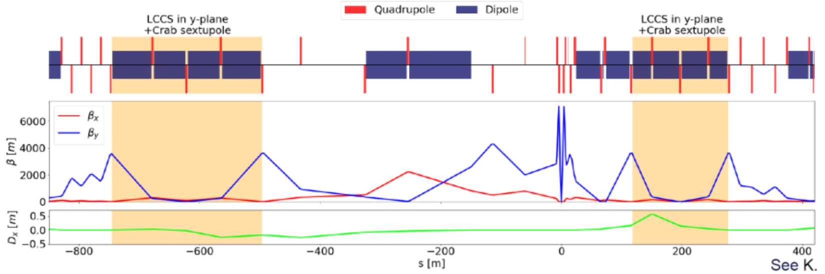
Parameter [4 IPs, 91.1 km, T_{rev}=0.3 ms]	Z	WW	H (ZH)	ttbar	CEPC-Higgs_2 IP (50MW upgrade)
beam energy [GeV]	45	80	120	182.5	120
beam current [mA]	1280	135	26.7	5.0	27.8
number bunches/beam	10000	880	248	40	447
bunch intensity [10^{11}]	2.43	2.91	2.04	2.37	1.3
SR energy loss / turn [GeV]	0.0391	0.37	1.869	10.0	1.8
total RF voltage 400 / 800 MHz [GV]	0.120 / 0	1.0 / 0	2.08 / 0	2.5 / 8.8	2.2 (650MHz)
long. damping time [turns]	1170	216	64.5	18.5	71.5
horizontal beta* [m]	0.1	0.2	0.3	1	0.3
vertical beta* [mm]	0.8	1	1	1.6	1
horizontal geometric emittance [nm]	0.71	2.17	0.64	1.49	0.64
vertical geom. emittance [pm]	1.42	4.34	1.29	2.98	1.3
horizontal rms IP spot size [μm]	8	21	14	39	14
vertical rms IP spot size [nm]	34	66	36	69	36
beam-beam parameter ξ_x / ξ_y	0.004 / 0.159	0.011 / 0.111	0.0187 / 0.129	0.093 / 0.140	0.015/0.11
rms bunch length with SR / BS [mm]	4.38 / 14.5	3.55 / 8.01	3.34 / 6.0	1.95 / 2.75	2.3/4.1
luminosity per IP [10^{34} cm^{-2}s^{-1}]	182	19.4	7.26	1.25	8.3
total integrated luminosity / year [ab^{-1}/yr]	87	9.3	3.5	0.65	2.2
beam lifetime rad Bhabha + BS [min]	19	18	6	9	18

Experimental IR

Common IR layout for all working points

- L* of 2.2 m and horizontal crossing angle of 30 mrad
- Weak bending of dipoles upstream of IP to keep SR E_{crit} < 100 keV
- Detector solenoid with 2 T locally compensated by anti-solenoids
- Local chromaticity correction in vertical plane, combined with crab sextupo

Operation mode	β_x^* [mm]	β_y^* [mm]
Z	100	0.8
W	200	1
H	300	1
$t\bar{t}$	1000	1.6

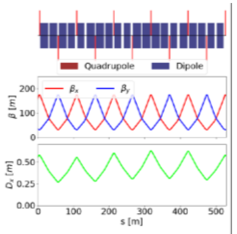


See K.

Arc cell optics

- FODO cell is used in the arcs due to high packing factor
  - Large momentum compaction at Z and W required for mitigation of collective instabilities and low ϵ_x for H and $t\bar{t}$ operation
  - In current lattice, variable cell length implemented
    - For Z and W, cell length of ~100m
    - Reduce cell length for H and $t\bar{t}$ to 50m by installing quadrupoles in the gaps between dipoles

Z



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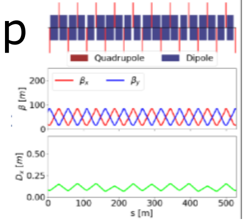


Machine Detector Interface

- Complex integration of different elements (SC quadrupoles, LumiCal, shielding, diagnostics, ..)
  - Mechanical integration, thermal analysis, and discussion on alignment strategy ongoing

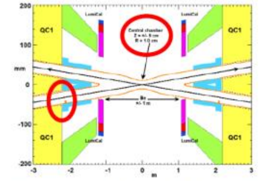
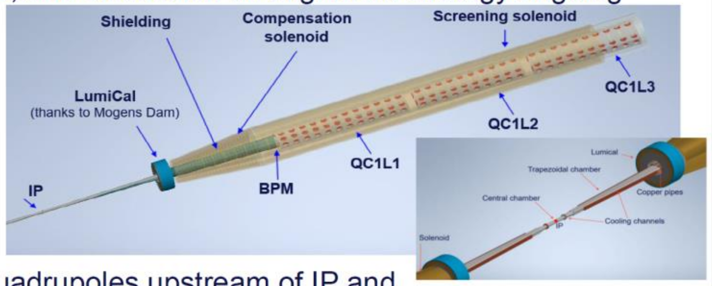


Figure 1: IR layout with 10 mm radius of the central pipe.

From arXiv:2105.09698

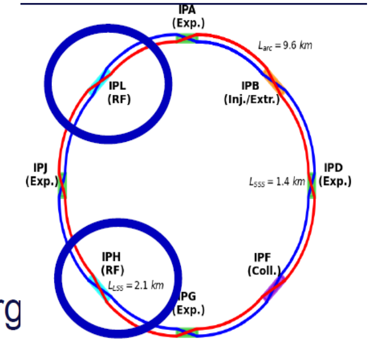


- SR background from last dipoles and quadrupoles upstream of IP and location for SR collimators under study
- Beamstrahlung radiation to require a photon dump downstream of IP
- Studies on vibration tolerances ongoing

Overview of the FCCee Collider Design

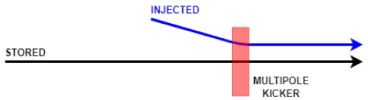
RF insertions

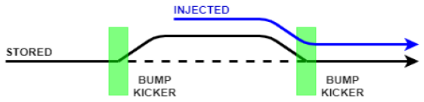
- After preliminary survey of surface sites, recommendation is to place RF in points H and L
  - To reduce the uncertainty on center-of-mass energ RF located in a single place for Z and W operation
  - In $t\bar{t}$ operation, RF cavities distributed between points H and L



Top-up injection

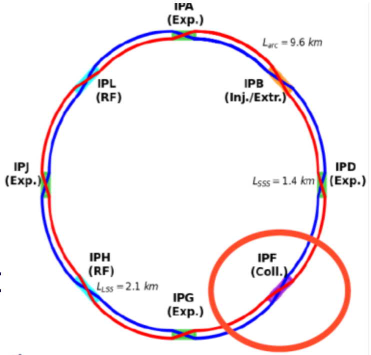
- Top-up injection essential ingredient to maximize integrat
- Four feasible injection schemes have been identified
  - Multipole kicker injection using a special kicker with zero on-axis field
  - Orbit bump injection using a one turn bump
  - Both schemes also work off-momentum



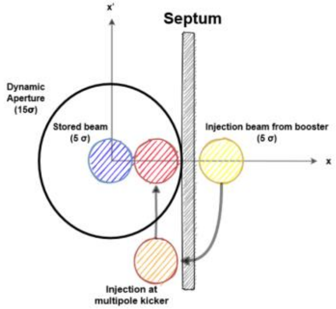


Collimation

- Stored beam energy in FCC-ee reaches 20.7 MJ, similar to heavy ion operation in LHC
  - A halo collimation system is being developed to protect equipment (e.g. SC final focus quadrupoles) from unavoidable loss
- One straight section to host both betatron and momentum collimation



Sextupoles and DA optimiza



- For on-momentum top-up injection, a dynamic aperture of more than 15σ is required
  - For off-momentum injection, DA > 5σ for chosen setting of ${}^{\Delta p}/_{p}$
- Target for momentum acceptance based on beam lifetime in the presence of large energy spread due to beamstrahlung
- Chromaticity correction by families of non-interleaved sextupole pairs, with –I transform between sextupoles

FCC-ee optics tuning Working Group
J. Keintzel and R. Tomas
for the FCC-ee optics tuning team

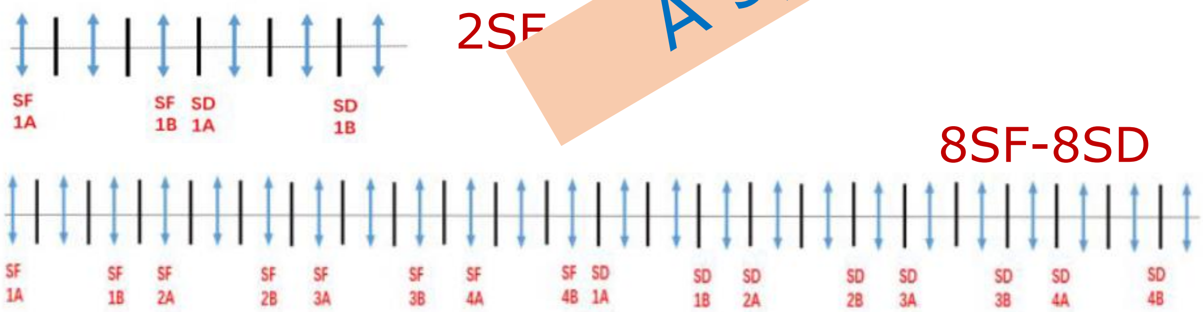
How does CEPC reach successful tuning results for linear optics and DA?

Yiewi Wang's slides   Tessa Charles's slides

	CEPC	FCC-ee
Number of IPs	2	4
Sextupole rms misalignment [µm]	100→10	140
Arc quad. rms misalignment [µm]	100	170
IR quads. and sexts. strength errors	No	Ye
Arc chromaticity correction	8SF-8SD	

Note the 10 µm specification for sextupole mi… …of CEPC is assumed after beam-based alignment.

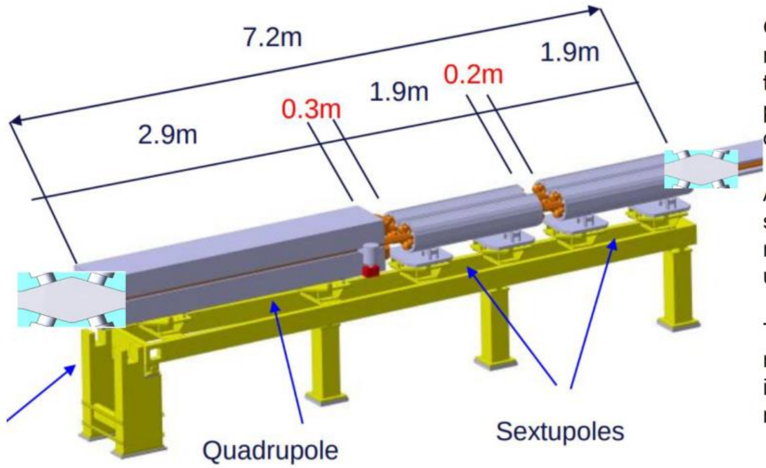
A synergy between CEPC & FCCee



Extrapolating from SuperKEKB HER to FCC-ee?

	SKEKB, HER	FCC-ee, Z
Number of IPs	1	4
IR sext. offset for	10	3
Targ… …] …s)	10	3/√4 = **1.5 ?**
…R sextupoles	4	16
β^* [mm]	1	0.8
…RC sext. offset for DQy=0.005 [µm]	200	250
Number of ARC sextupoles	100	832
Target orbit control [µm] (at ARC sextupoles)	-	250/√832 = **10 ?**

How to reach 10 µm sextupole-to-beam offset in physics



Girder and magnets will likely move by 10s of µms due to temperature changes between pilot and high intensity operation.

Attaching BPMs to quads and sexts could determine magnet-to-beam offsets. Then use movers?

Turn-by-turn optics measurements at high intensity could relax the 10 µm requirement.

Accelerator magnet: Collider Dipole

Status of Collider and Booster Magnets for FCC-ee

J. Bauche, C. Eriksson, *et al.*, CEPC Workshop 2022, 25th October 2022

CEPC Magnet Design and R & D in Booster Ring

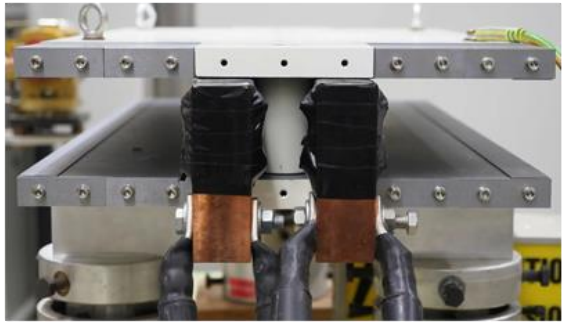
Wen Kang

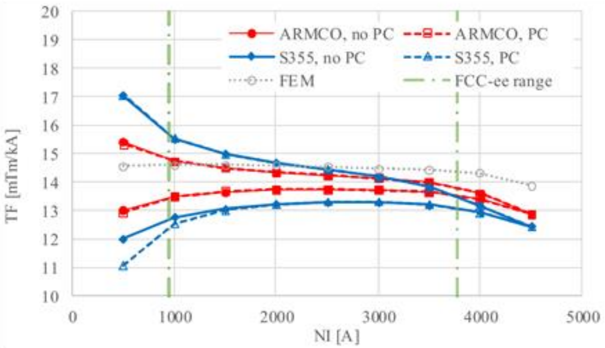
CEPC Magnet Design and R&D Status in Collider Ring

Mei Yang, Fusan Chen, Xianjing Sun

Dipole magnetic design

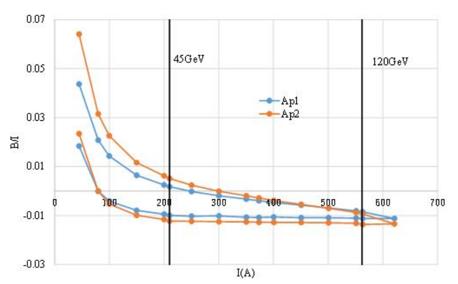
- Twin aperture design, magnetically coupled
- Simple, pure, **cost effective**
- **Low power consumption** (50% w.r.t. separate magnets)
- **300 mm inter-beam distance** shared between vacuum chamber, SR absorbers, busbars and yoke return leg
- DC operation, compatible with solid iron yoke construction, but alternatives are possible
- Twin air-cooled aluminium busbar considered in CDR





Prototype 1m-long, single busbar "coil", field quality conforms to specifications

- First short prototype of 1m
  - Dual aperture dipole with sextupole component
  - Simple, pure solid iron, worked at DC mode
  - Same field strength in two apertures with trim coils(±1.5%)
  - Low field range from 145Gs to 540Gs
  - Aluminum busbar coils of 4 turns (compatible with PS)
  - 350mm beam separation, determined by vacuum chamber, synchrotron absorbers, lead blocks, clearance, and excited coils.



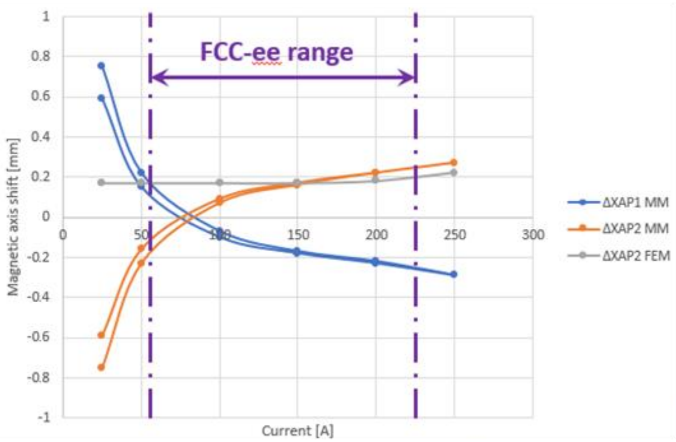
Accelerator magnet: Collider Quadrupole

Quadrupole magnetic axis shift

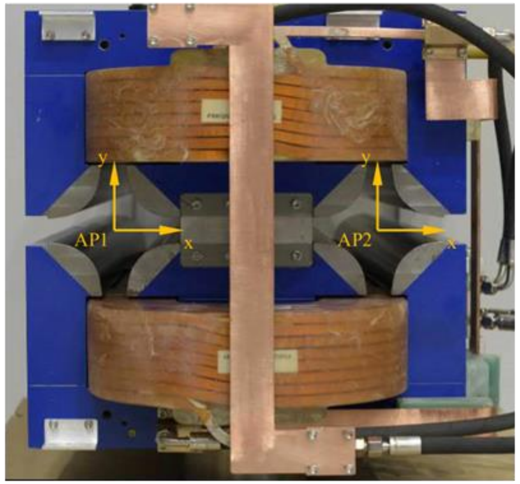
Magnetic measurements performed on 1-m prototype

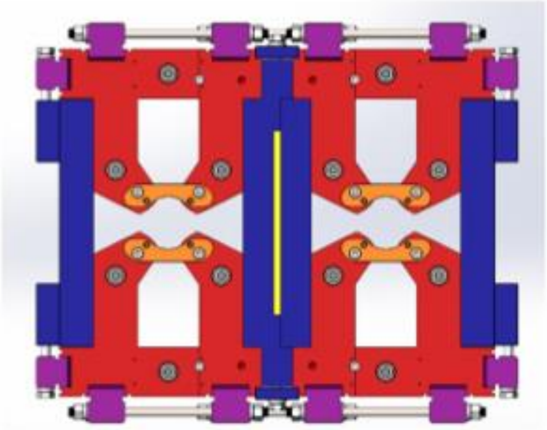
- ~0.4 mm shift for each aperture between low and high fields
- Mismatch MM vs. FEM (3D) at low fields not completely explained

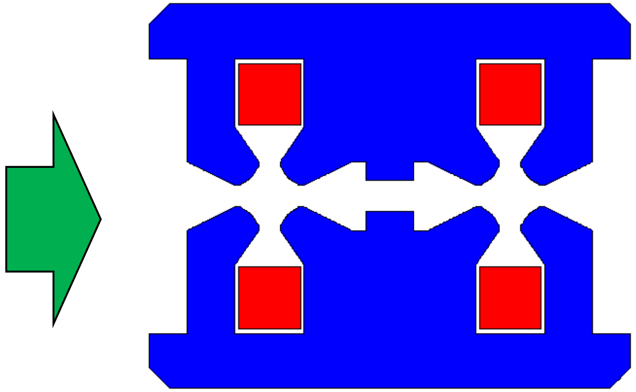
➔ **Under investigation**

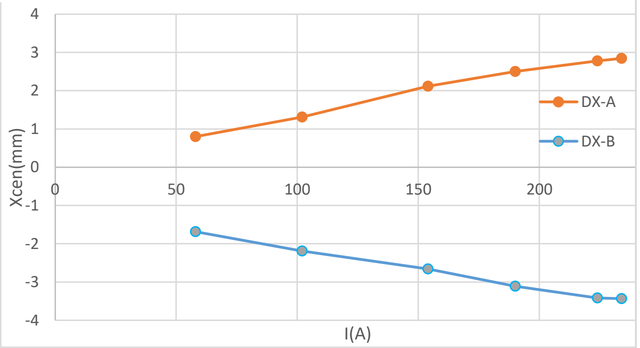


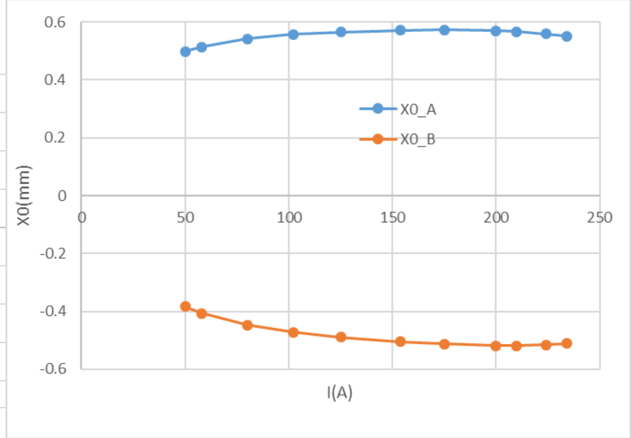
Magnetic axis shift











Axis shift by current heavily reduced (2mm->0.1mm)

Accelerator magnet: Booster Dipole (FCCee)

Magnet specifications and challenges

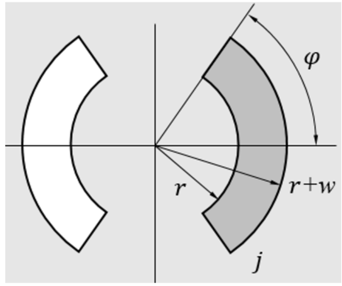
- **Aperture Ø 50 mm**, GFR over 2/3 aperture, **dB/B < 1.0E-4**
- **Challenging dipole field at injection**, only ~150 x B_{earth}

The injection energy for the booster is determined by the field quality and reproducibility of the magnetic field in the dipole magnets of the arc sections. The current design features an energy of 20 GeV, corresponding to a magnetic field of $B = 6\,\mathrm{mT}$.

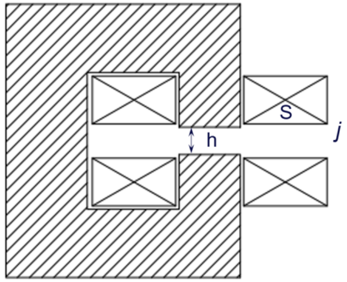
- **Main considerations for design**
  - ***Performance***: *field quality, reproducibility, and limited sensitivity to perturbations (@ injection)*
  - ***Cost optimization***: *large scale manufacturing, power consumption and energy storage*
  - ***Size***: *integration in same tunnel as collider*

- **Design options**

→ ***Coil dominated*** *magnet or* ***iron dominated*** *magnet?*

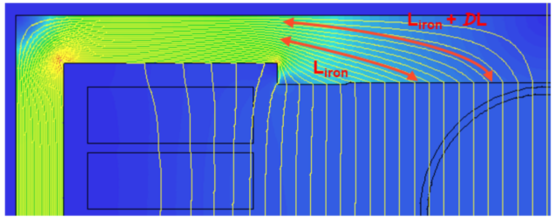


$$B = \frac{2\mu_0 \sin\varphi\, j\, w}{\pi}$$



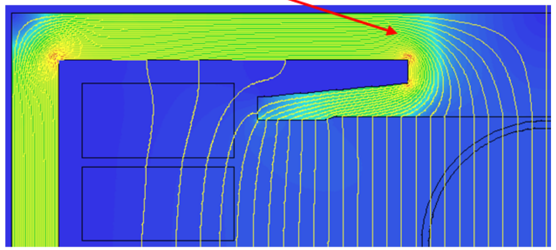
$$B = \frac{2\mu_0\, j\, S}{h}$$

Ampere-turns >5x larger for ironless magnet for same aperture



O-shape magnet

Flux lines path length increased



"Anvil" pole shape magnet

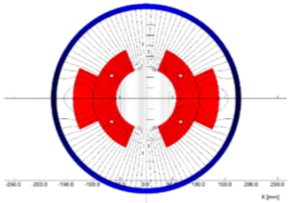
- ***Normal conducting*** *mode for both options*
- *Required* ***ampere-turns much larger*** *for* ***coil dominated****, even with iron shell (power consumption, capital cost, size)*
- ***Ironless*** *magnet does not shield the* ***earth magnetic field*** *(B_{earth} ≈ 70 units of B_{inj})* → *not acceptable*
- ***Strong sensitivity*** *of field quality to* ***coil positioning*** *for* ***coil dominated***
- *Required* ***conductor shape not commercially available*** *for* ***coil dominated***
  } → *costly for large scale manufacturing*
- *Effect of iron* ***coercivity*** *on low field performance larger for* ***iron dominated*** *magnet*

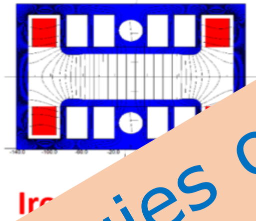
→ iron dominated magnet considered…

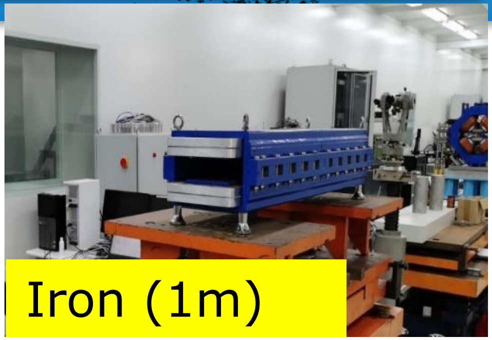
Accelerator magnet: Booster Dipole (CEPC)

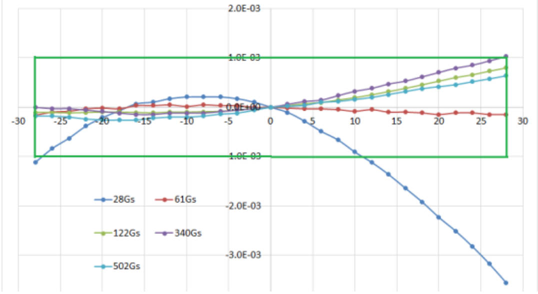
Field quality of two subscale prototype dipole magnets

	CT coil dipole	Iron-core dipole
Gap (mm)	63	63
Magnetic Length (mm)	1400	1400
Good field region (mm)	55	55
Field uniformity @28Gs	7.6E-4(√)	3.6E-3(×)
Field uniformity @56Gs	4.5E-4(√)	5.3E-4(√)







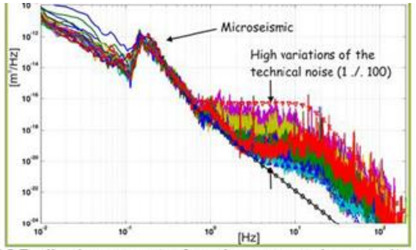


Potential synergies on magnet technology

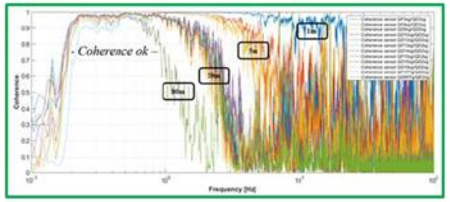
Full length (5m) prototype assembly

Ground vibrations for FCCee

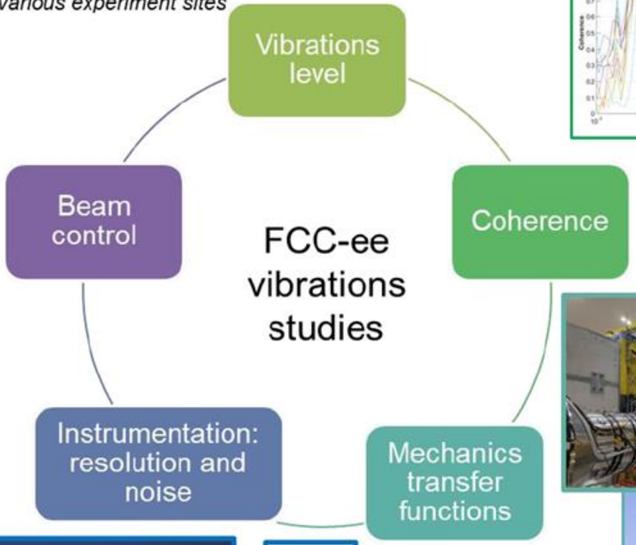
IP is the most sensitive region to vibration

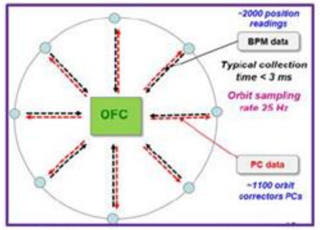


PSD displacement of various experiment sites

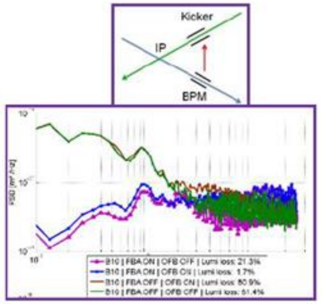


ATF2 coherence





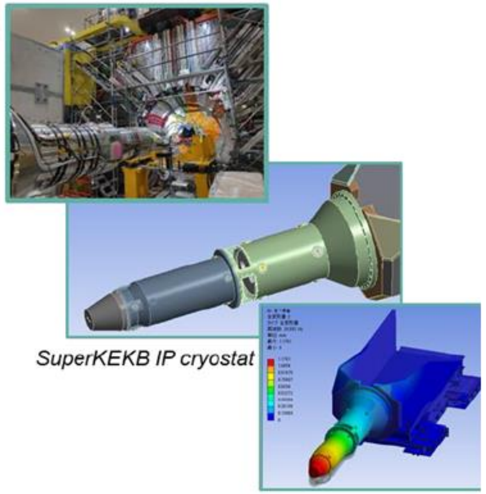
LHC Feedback controller design



CLIC post IP BPM feedback


LHC Beam Position Monitor


Vibration sensor

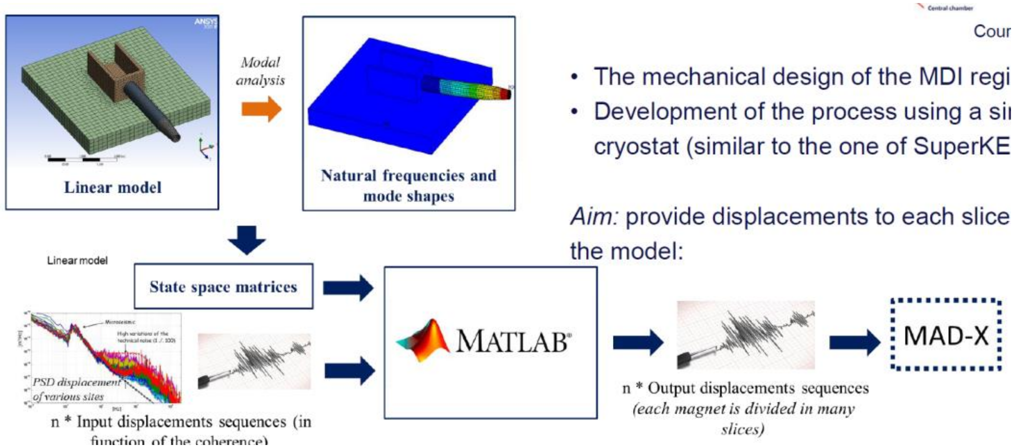

SuperKEKB IP cryostat

STUDIES OF THE GROUND MOTION INDUCED VIBRATIONS IN FCC-EE Z MODE

B. Aimard, G. Balik, L. Brunetti, J.P. Baud, A. Dominjon, S. Grabon, G. Lamanna, E. Montbarbon, F. Poirier

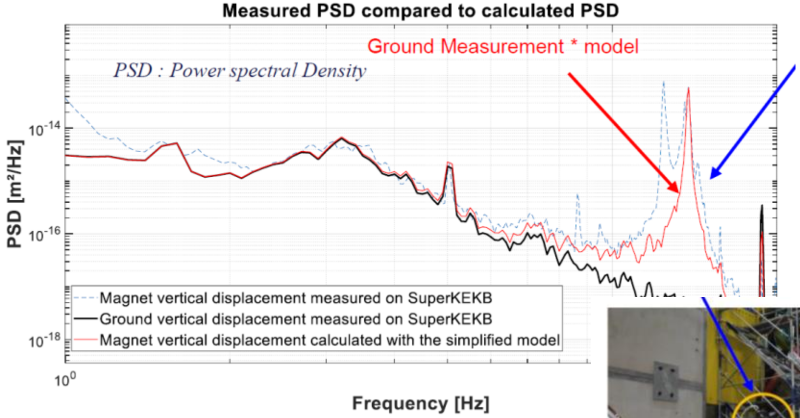
F.Poirier on behalf of E.Montbarbon

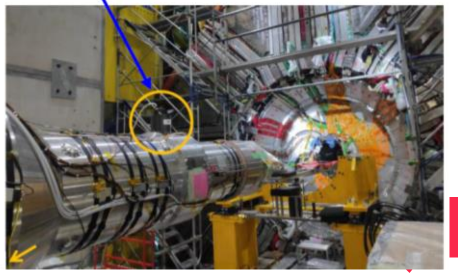
Simplified model and validation
(Ground move → QUAD Vibration)



- The mechanical design of the MDI regi
- Development of the process using a si cryostat (similar to the one of SuperKE

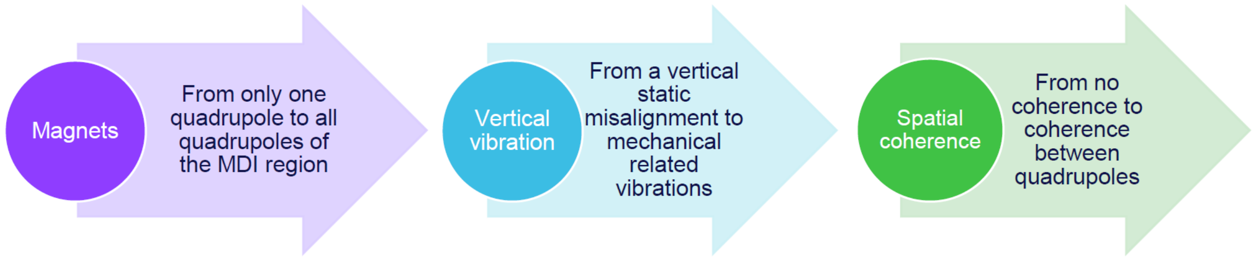
Aim: provide displacements to each slice the model:

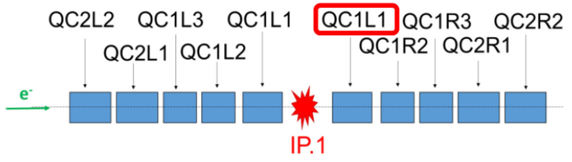




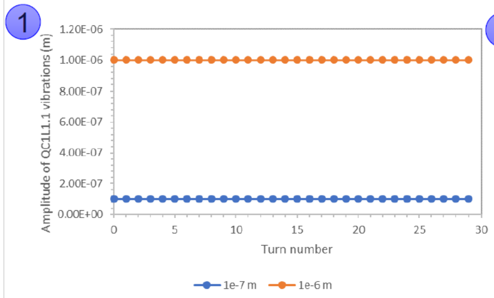
Ground vibrations for FCCee

Gradual complexification of the simulations:

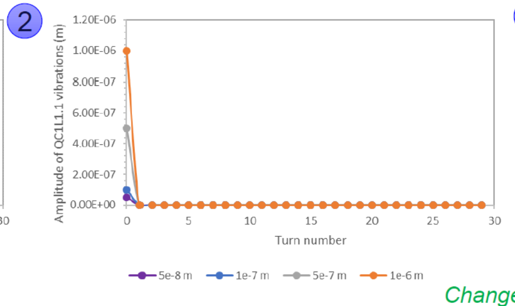




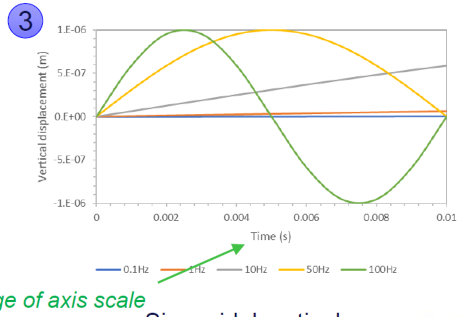
- Only one quadrupole, QC1L1.1, is concerned by vertical displacements/vibrations
- Bunch of 200 electrons are tracked
- 30 turns, i.e. 0.01 s *(not much, only to assess the behaviour of the machine…)*
- Three cases, from static to sinusoidal displacement:



Static vertical displacement



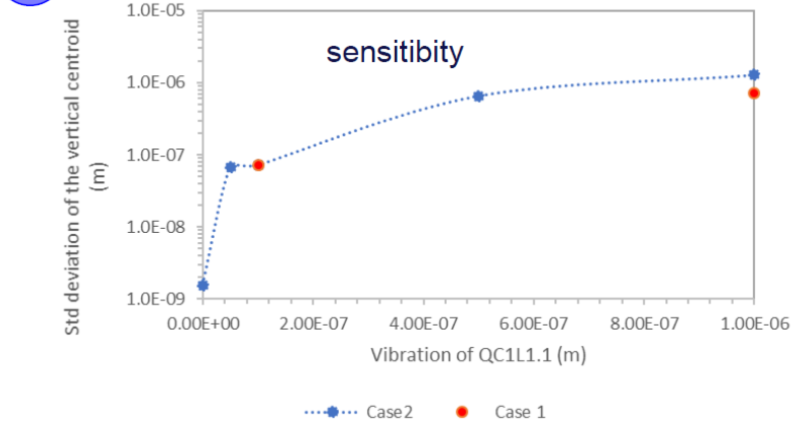
"Bump" like vertical displacement

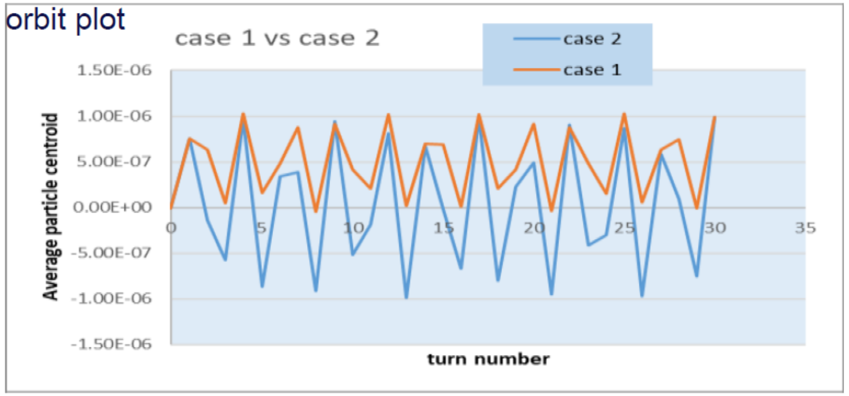


Sinusoidal vertical displacement (different frequencies)

1 Case 1: static vertical displacement

2 Case 2: « bump » like displacement





Tools are set up to simulate more and more realistically the vibrations in the MDI region:

- MAD-X Tracking module adapted to time-dependent vertical displacements of quadrupoles
- Automatization of data processing
- Crosscheck and validate the process with simple study cases *(not realistic yet…)*

Studies ongoing

Accelerator in Korea

Accelerator Activities in Korea

Younguk Sohn, Garam Han (PAL, POSTECH)
Myun Kwon (RISP)
Pilsoo Lee (KOMAC)

Multipurpose Synchrotron Radiation Construction Project (4GSR)
Korean Basic Science Institute (KBSI) & PAL

PAL XFEL:
10GeV, S-band
1^{st} lasing in 2016

O'Chang (KBSI, PAL)
- 4GSR (synchrotron)

Dajeon (RISP - IBS)
- RAON (Rare isotope accelerator)

Pohang (PAL - POSTECH)
- PLS-II (synchrotron)
- PAL-XFEL
- PAL-EUV (synchrotron)

Kyungju (KAERI)
- **KOMAC** (Proton linac)

Busan (DIRAMS, KIRAMS)
- 6 MeV C-band LINAC (radiotherapy-electron)
- 50MeV e-FLASH Radiotherapy

Accelerator in Korea

PAL-EUV is a new Low Energy Synchrotron Light Source, fully funded from Korean Government
To provide diffraction-limited radiation at EUV range
Application mainly for semiconductor R&D

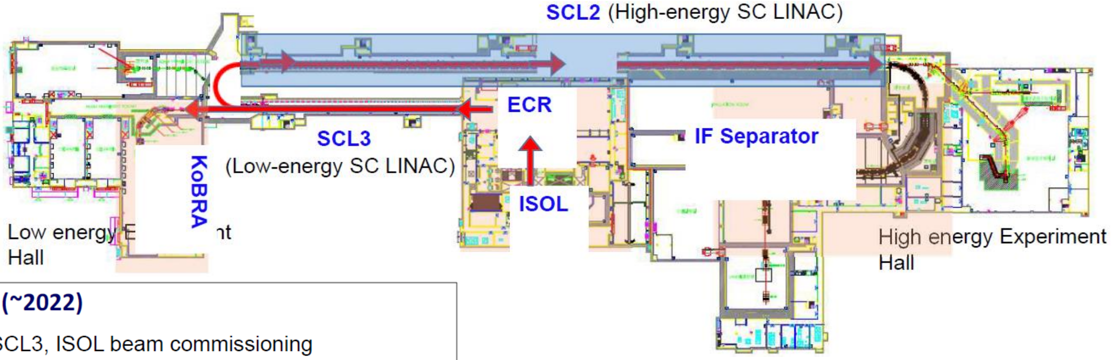
- Injector Linac (to 20 MeV)
  - Photocathode gun + 3 m accelerator column
  - 10 MW S-band klystron + solid state modulator
- Booster Ring (400 MeV)
  - 2 straights for injection/extraction
  - 500 MHz PLS cavity (reuse)
  - Storage Ring (400 MeV)
- 4 straights for injection and three IDs
  - 140 mA beam with 500 MHz NC cavity
  - 1500 MHz harmonic cavity

- Tunnel will be closed and beam commissioning will start in late November, 2022.
- Beam commissioning until summer 2023
- Beamline research with high-harmonic generation EUV source
- EUV beam service from 3rd Quator 2023
- Second ID beamline will start in 2023.
- For second ID, permanent magnet undulator with cryogenic temperature

RISP

- **Goal:** To build **a heavy ion accelerator complex RAON**, for **rare isotope science** research in Korea.

  * RAON - Rare isotope Accelerator complex for ON-line experiments
- **Budget: KRW 522.8 billion (US$ 420 million)**
  for accelerators and experimental apparatus
- **Period: 2011.12 ~ 2022.12 (1st Phase)**



❖ **Phase 1 (~2022)**
- Injector, SCL3, ISOL beam commissioning
- All experimental systems including IF separator system to be installed and machine commissioned

❖ **Phase 2 (~2029)**
- High energy Linac, SCL2
- Prototyping R&D until 2025

SCL3 → installation done on 2021
& atarting commissioning on Oct 2022

Accelerator in Korea

❖ **Multipurpose Synchrotron Radiation Construction Project**

- Period: 2021 July to 2027 June (6yrs)
- Budget: 1.0454 Trillion KRW (≈ USD 750M)
- Land: 540,000 ㎡ / Building: 69,400 ㎡
- Location: Ochang, Chungcheongbuk-do

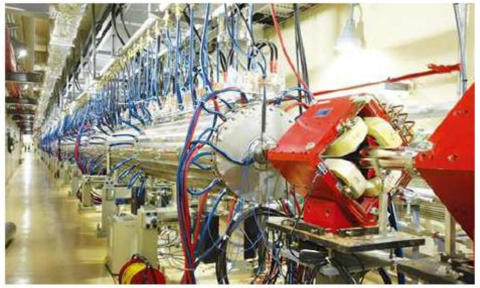
❖ **Specifications**

- Beam Energy: 4 GeV
- Beam Emittance: less than 100 pm·rad (CDR: 58 pm·rad)
- Circumference: 800m
- Beamlines : more than 40
- Accelerator: Gun, Injector LINAC, 4 GeV Booster
- Lattice: MBA-7 Bend Achromat

KOMAC

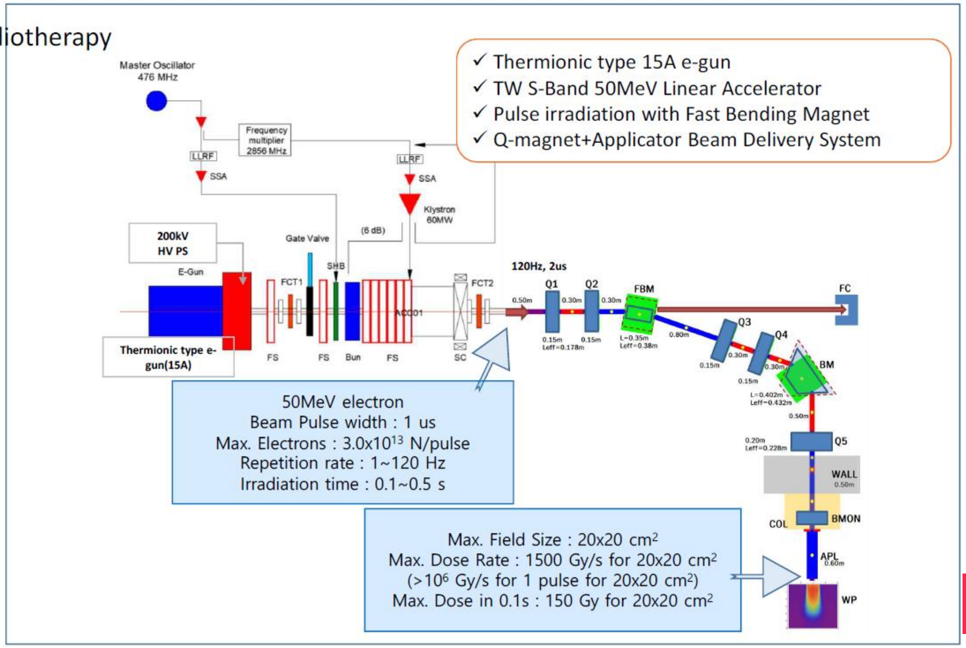
Construction -	2002.7~2012.12 Proton Engineering Frontier Project (PEFP)
Budget -	~$300M (Government: $180M, Gyeongju: $110M, Industry: $10M)
Specification -	**High Current (20 mA) Proton Linear Accelerator**
Applications -	Atmospheric/Space Radiation Effects, RI Production, Bio, Basic sciences, Secondary Particle Productions

- In last 5 years, supported 489 projects of 1,967 users from 188 institutions



50MeV e-FLASH Radiotherapy System of KIRAMS

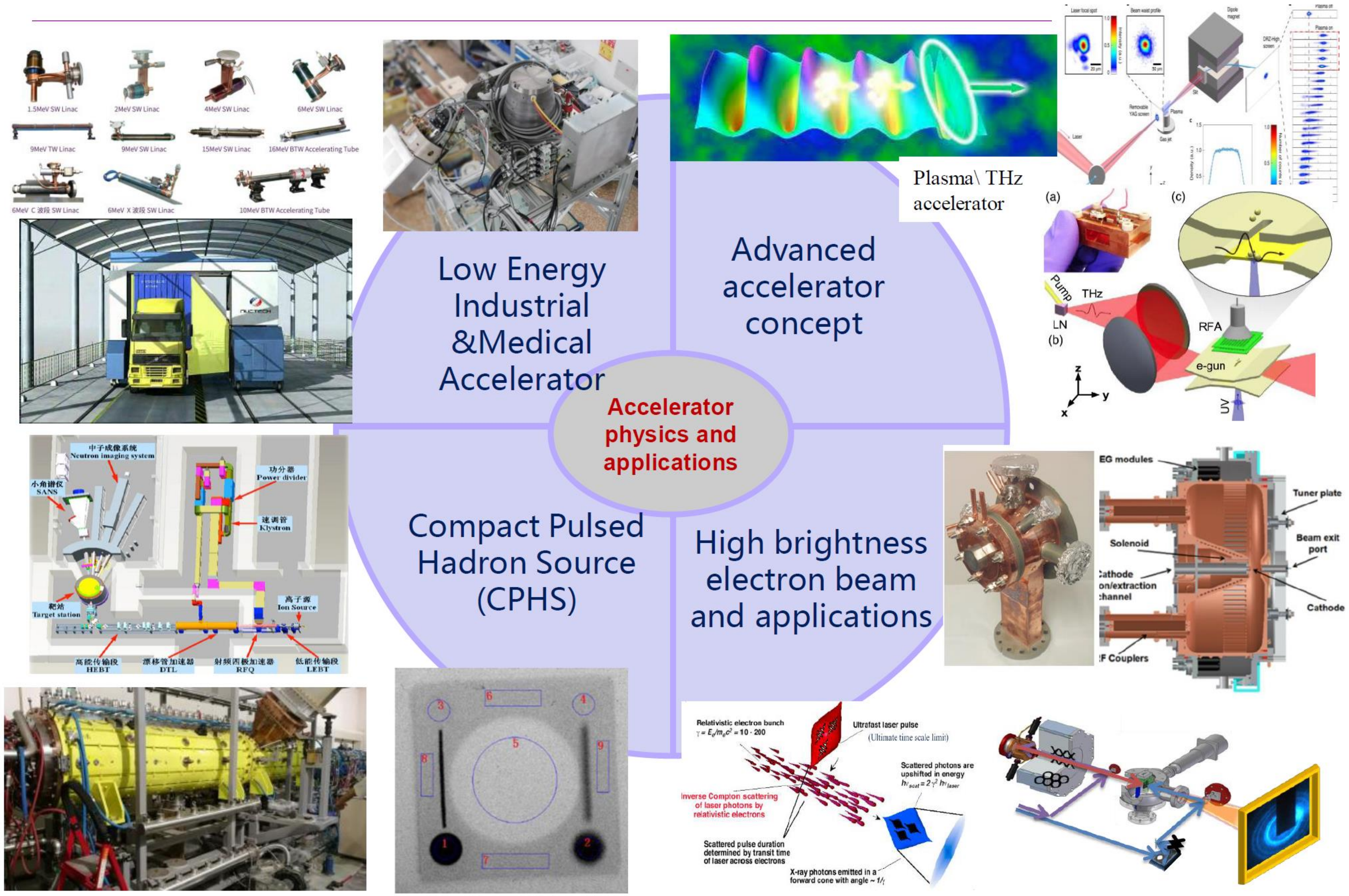
50MeV electron Flash Radiotherapy System
- 1 step : 2021 – 2023
- 2 step : 2024 - 2025



Acc. Activities at Tsinghua

Accelerator Activities at Tsinghua University

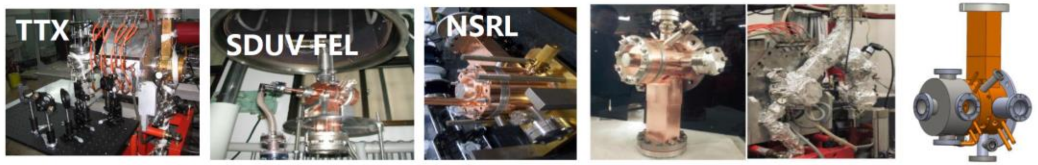
Yingchao Du



Acc. Activities at Tsinghua

Photo RF Gun

- The history of S-band photocathode RF gun study at THU

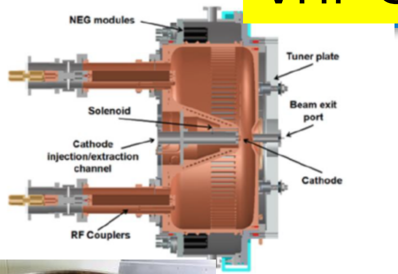


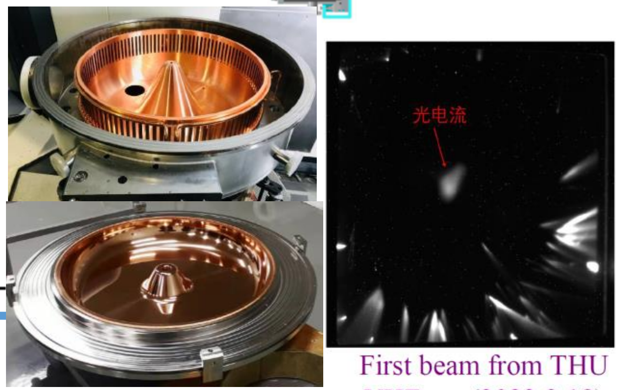
2001-2006, 1st	2006-2009, 2nd	2009-2020, 3rd
Modified BNL-type gun Silver brazing Heavy dark current ~70MeV/m	Collaboration with BNL BNL-type gun Gold brazing Low dark current 80-110MeV/m	Incorporate design gun Gold brazing Very low dark current Low RF breakdown 100-120MeV/m

SHINE facility's requirements for CW electron gun:

parameters	value	unit
Gun operation mode	CW	
Gun cathode gradient	>25	MV/m
voltage	≥750	kV
Bunch charge	10-300	pC
Repetition rate	1	MHz
Emittance	<0.4 @	um
Dark current	<400	nA
Vacuum in the gun	$<2\times10^{-9}$	Torr

VHF Gun





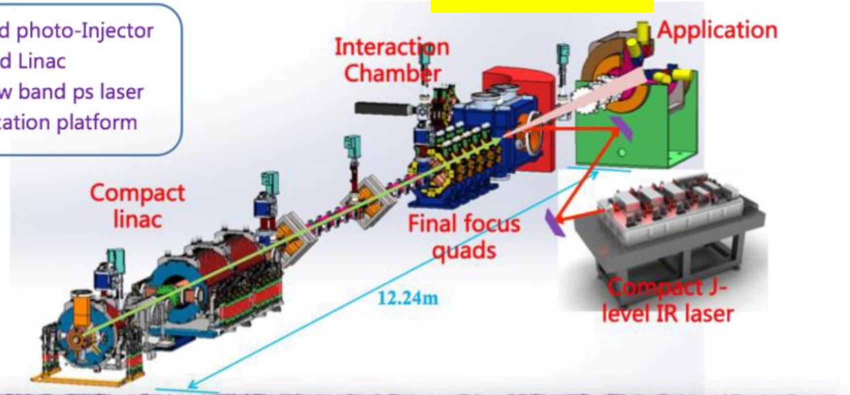
First beam from THU VHF gun(2022.8.18)

- Emittance optimization
  - 10pC: ~0.25 umrad@1mm rms
  - 50pC: ~0.55 umrad@ 1mm rms
  - 100pC: ~1.20 umrad@ 1mm rms
- The gun will be delivered to SHINE in early 2023.

VIGAS

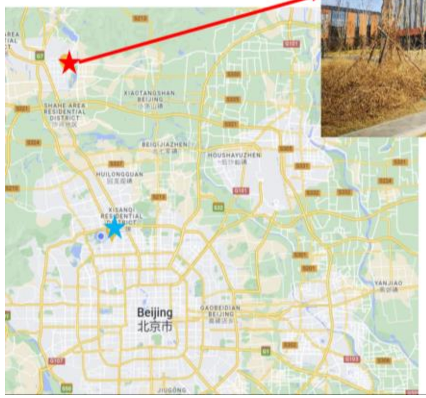
- Funded by NSFC, 2021-2025
- The first compact MeV ICS γ-ray source

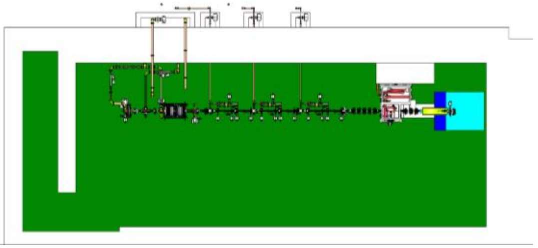
◆ S-band photo-Injector
◆ X-band Linac
◆ Narrow band ps laser
◆ Application platform



γ-ray energy: 0.2-4.8MeV
Bandwidth with collimator : <1.5%
Total photon flux(ph/s): $>4\times10^{8}$@0.2-2.4MeV; $>1\times10^{8}$@2.4-4.8MeV
Photon flux with 1.5% Bandwidth(ph/s): $>4\times10^{6}$@0.2-2.4MeV; $>1\times10^{6}$@2.4-4.8MeV
controllable polarization from linear to circle

Building area ~ 4800m^2
Bunker for VIGAS accelerator:
21m × 10 m



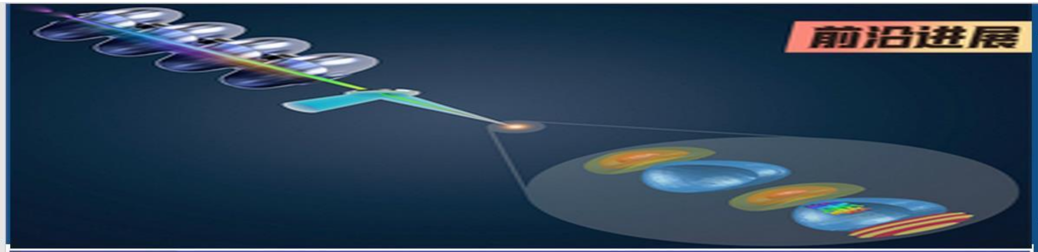


Laser develop. & Plasma Acc @Tsinghua

Progress on advanced laser development and plasma based accelerator applications in Tsinghua and BAQIS

Wei Lu

Tsinghua University/BAQIS



nature physics

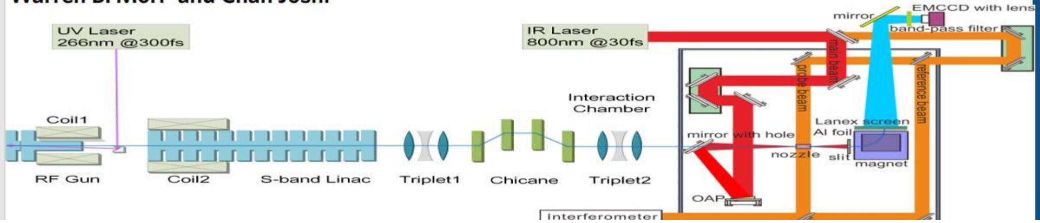
LETTERS

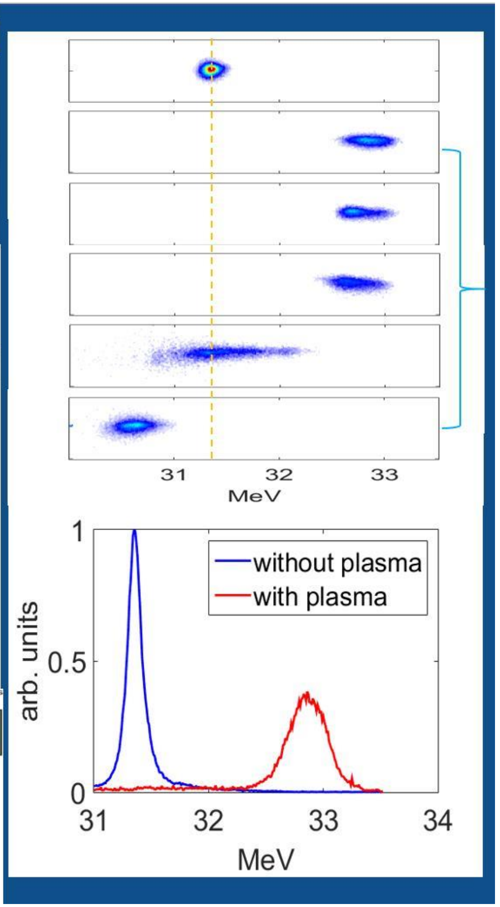
https://doi.org/10.1038/s41567-021-01202-6

Check for updates

High-throughput injection–acceleration of electron bunches from a linear accelerator to a laser wakefield accelerator

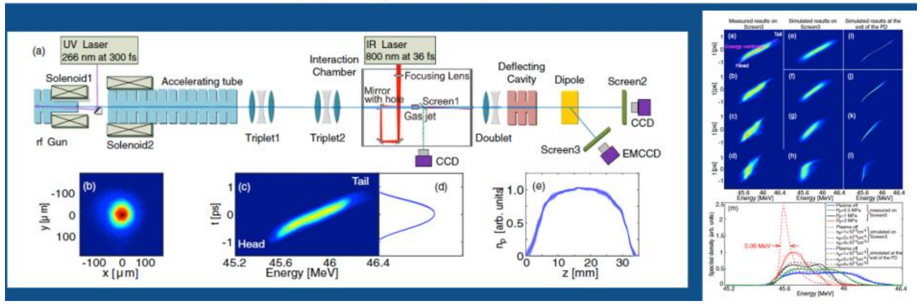
Yipeng Wu[1,2], Jianfei Hua[1]✉, Zheng Zhou[1], Jie Zhang[1], Shuang Liu[1], Bo Peng[1], Yu Fang[1], Xiaonan Ning[1], Zan Nie[2], Fei Li[2], Chaojie Zhang[2], Chih-Hao Pai[1], Yingchao Du[1]✉, Wei Lu[1]✉, Warren B. Mori[2] and Chan Joshi[2]





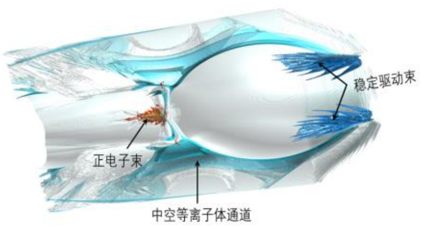
Phase Space Dynamics of a Plasma Wakefield Dechirper for Energy Spread Reduction

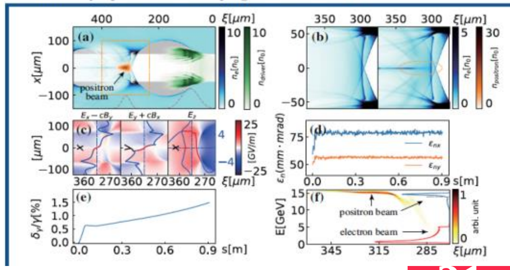
Y. P. Wu,[1] J. F. Hua,[1,*] Z. Zhou,[1] J. Zhang,[1] S. Liu,[1] B. Peng,[1] Y. Fang,[1] Z. Nie,[1] X. N. Ning,[1] C.-H. Pai,[1] Y. C. Du,[1] W. Lu,[1,†] C. J. Zhang,[2] W. B. Mori,[2] and C. Joshi[2]
[1]*Department of Engineering Physics, Tsinghua University, Beijing 100084, China*
[2]*University of Los Angeles, Los Angeles, California 90095, USA*



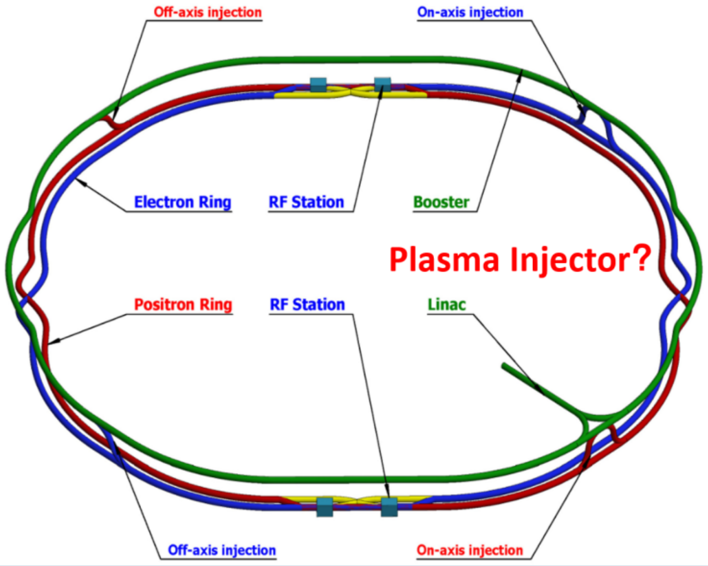
High Efficiency Uniform Wakefield Acceleration of a Positron Beam Using Stable Asymmetric Mode in a Hollow Channel Plasma

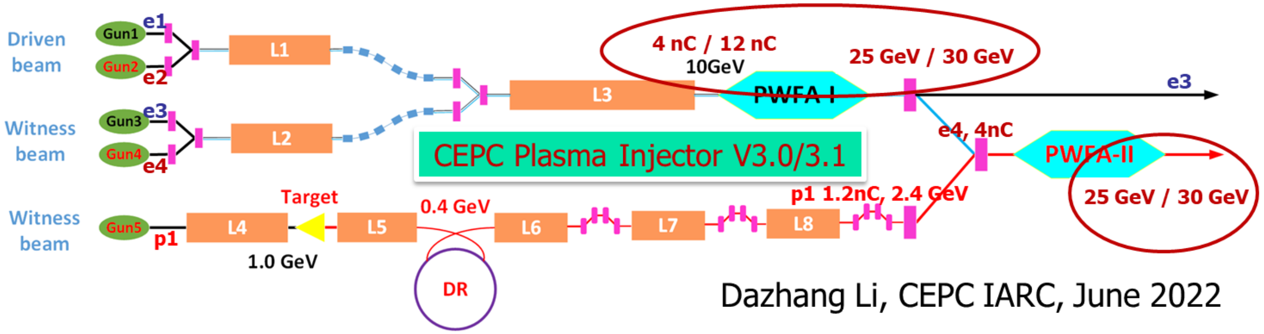
Shiyu Zhou,[1] Jianfei Hua,[1] Weiming An,[2] Warren B. Mori,[3] Chan Joshi,[3] Jie Gao,[5] and Wei Lu[1,4,*]
[1]*Department of Engineering Physics, Tsinghua University, Beijing 100084, China*
[2]*Beijing Normal University, Beijing 100875, China*
[3]*University of California Los Angeles, Los Angeles, California 90095, USA*
[4]*Beijing Academy of Quantum Information Sciences, Beijing 100193, China*
[5]*Institute of High Energy Physics, Chinese Academy of Sciences, Beijing 100049, China*



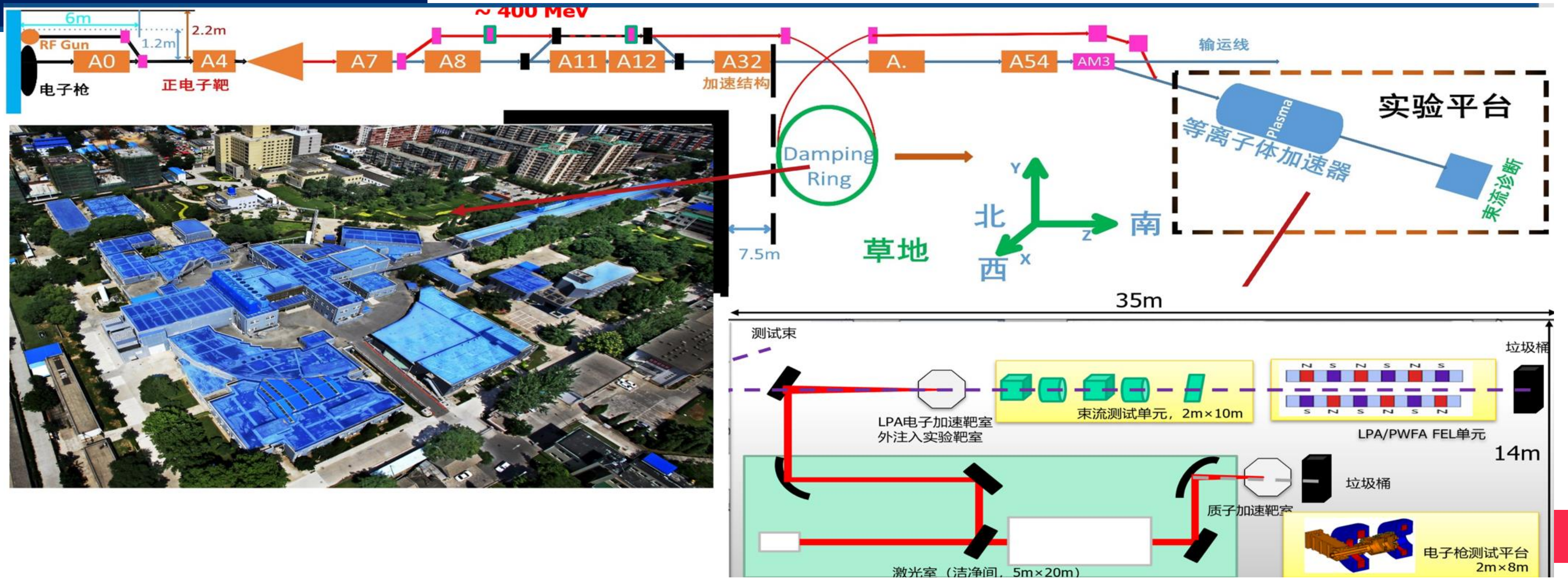


IHEP Collaborations

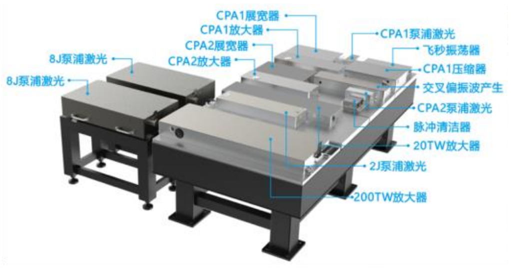


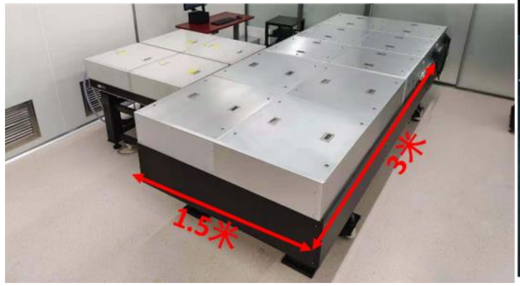


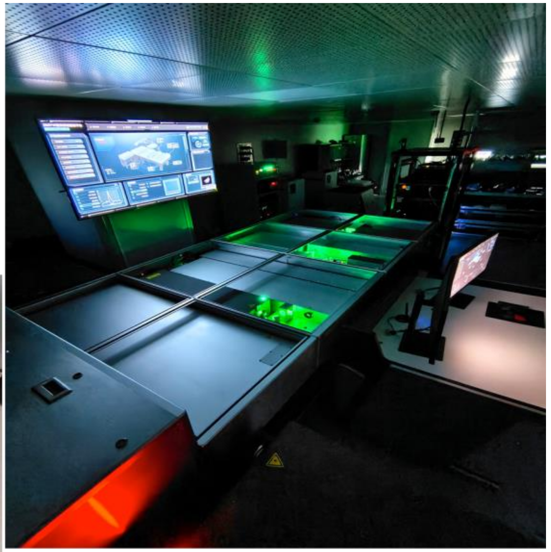
Dazhang Li, CEPC IARC, June 2022



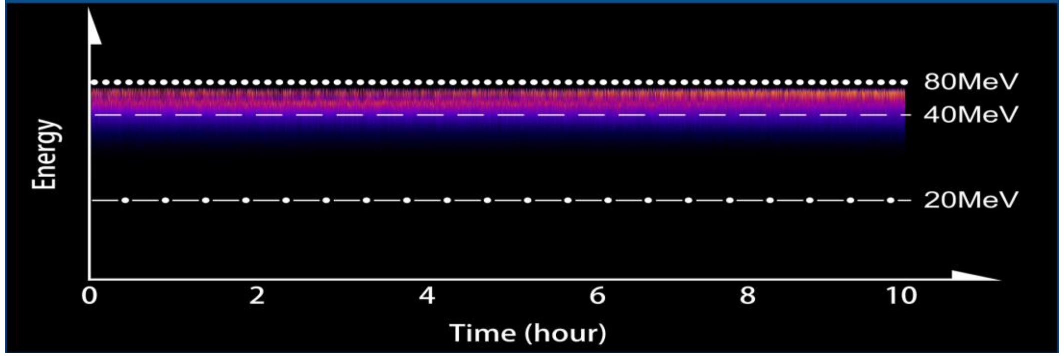
Stable laser and tabletop MeV electron beams







10 hours stable electron beam



The first demonstration of table top MeV UED driven by LWFA

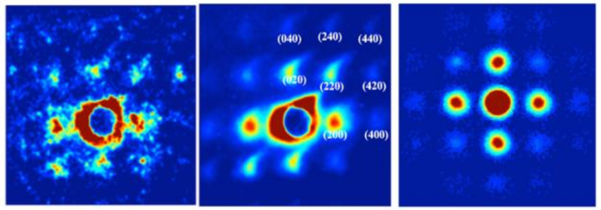


Fig.5 Diffraction images of single-shot(a), multi-shot (100 shots) (b) and simulation(c) results of single-crystalline gold.

arXiv:2210.12093 [physics.acc-ph]

Pre-bunched Plasma Acc. beam

Generation of pre-bunched electron beams from plasma wakefield accelerators and their applications in light sources

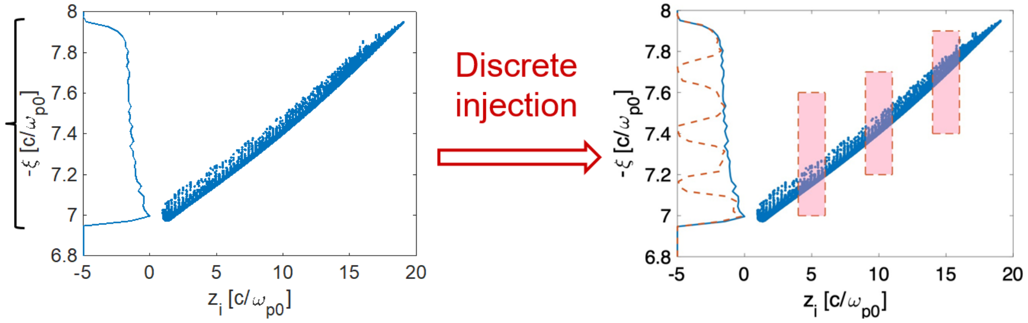
Xinlu Xu

Physics School, Peking University

Longitudinal mapping

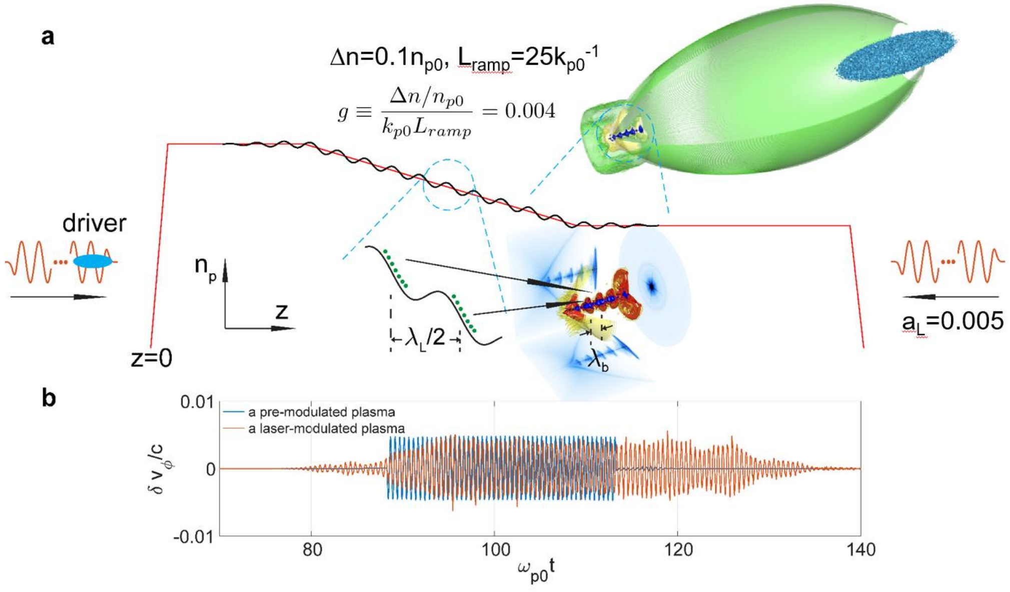
Beam duration:0.1~1 c/ω_p

Turn the injection on and off periodically

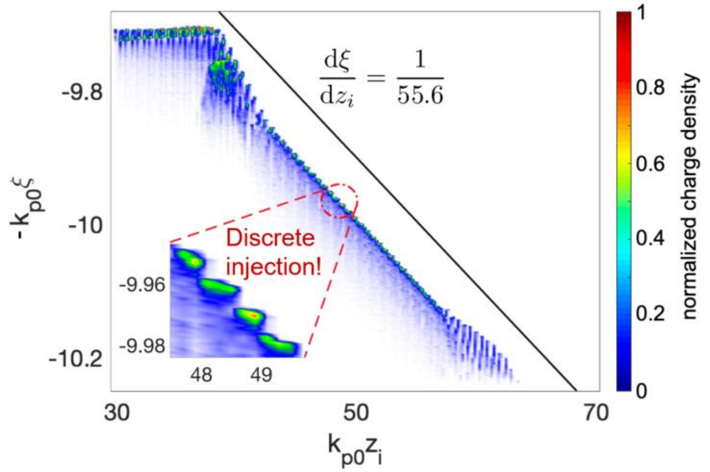


L_{ramp}~10s of c/ω_p

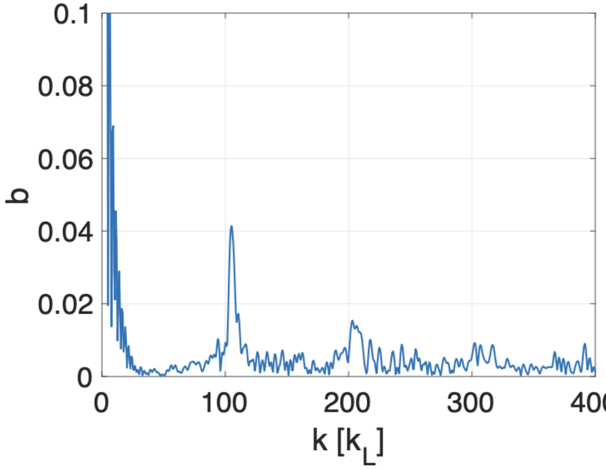
The period is significantly compressed.

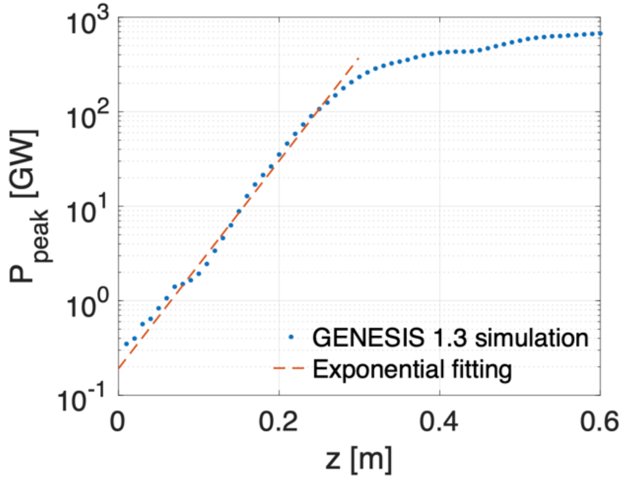


$$g \equiv \frac{\Delta n / n_{p0}}{k_{p0} L_{ramp}} = 0.004$$



$$\frac{d\xi}{dz_i} = \frac{1}{55.6}$$





FEL simulation results:

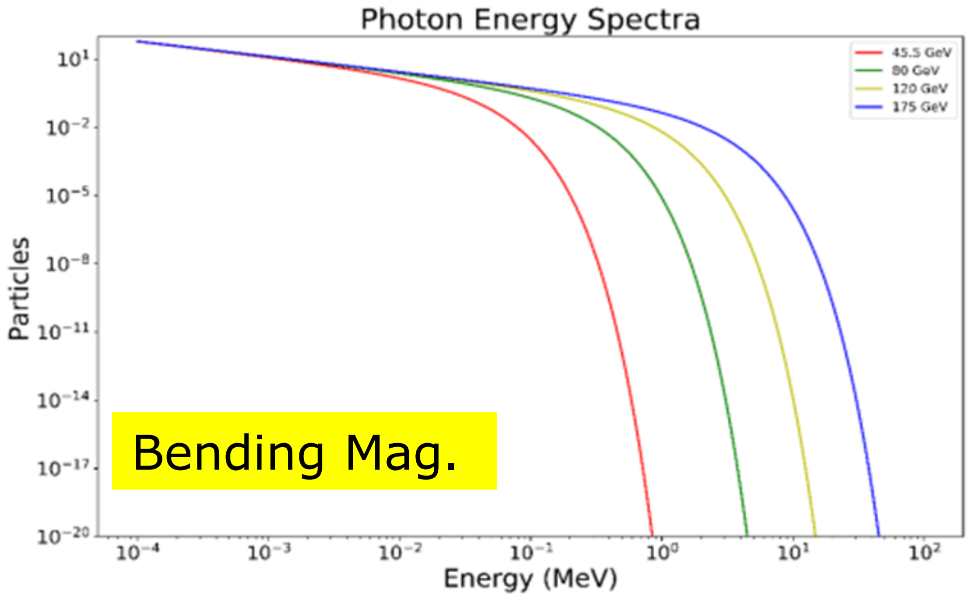
λ_r=3.6nm

$\rho \approx 0.01$

$L_{gain} \approx$ 4cm

P=234 GW at z=0.3 m

Flash Radiotherapy @ CEPC



Synchrotron radiation spectrum

Flash Radiotherapy with CEPC Synchrotron Radiation

Junyu Zhang, Pengyuan Qi
Adviser: Jike Wang

- Average energy of the photons in front of the target.
  - Average energy without filters: 134 keV
  - Average energy with filters: 307 keV

	CEPC without filter	CEPC with filter	ESRF ID17
Instantaneous dose rate (Gy/s)	1.06×10^7	6.13×10^6	1.2×10^4

1. CEPC can work as a powerful and excellent synchrotron light source, which can generate high-quality synchrotron radiation. The beam with a high instantaneous dose rate and higher energy has potential advantages in the medical field.

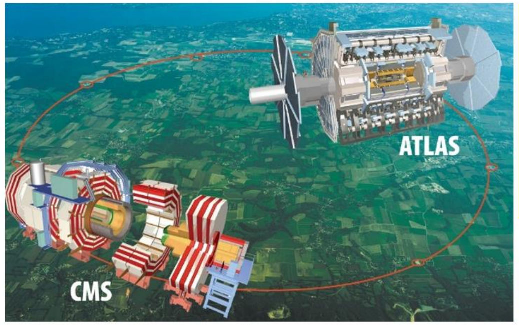
2. The prediction model shows that CEPC synchrotron radiation beam is one of the best beams for FLASH radiotherapy.

Superconducting Magnet

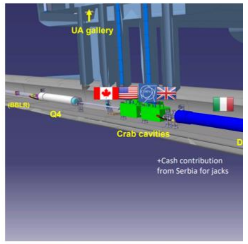
Progress of the High Field Magnet Technology for the Future High-energy Particle Accelerators

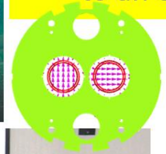
Qingjin Xu

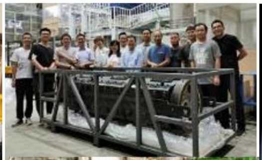
China provides 13 units CCT twin-aperture dipole magnets for HL-LHC

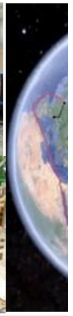


- To be installed in the ATLAS & CMS interaction regions, help to raise the luminosity by 5 times
- The 1st time CCT type magnets applied to an operating accelerator.

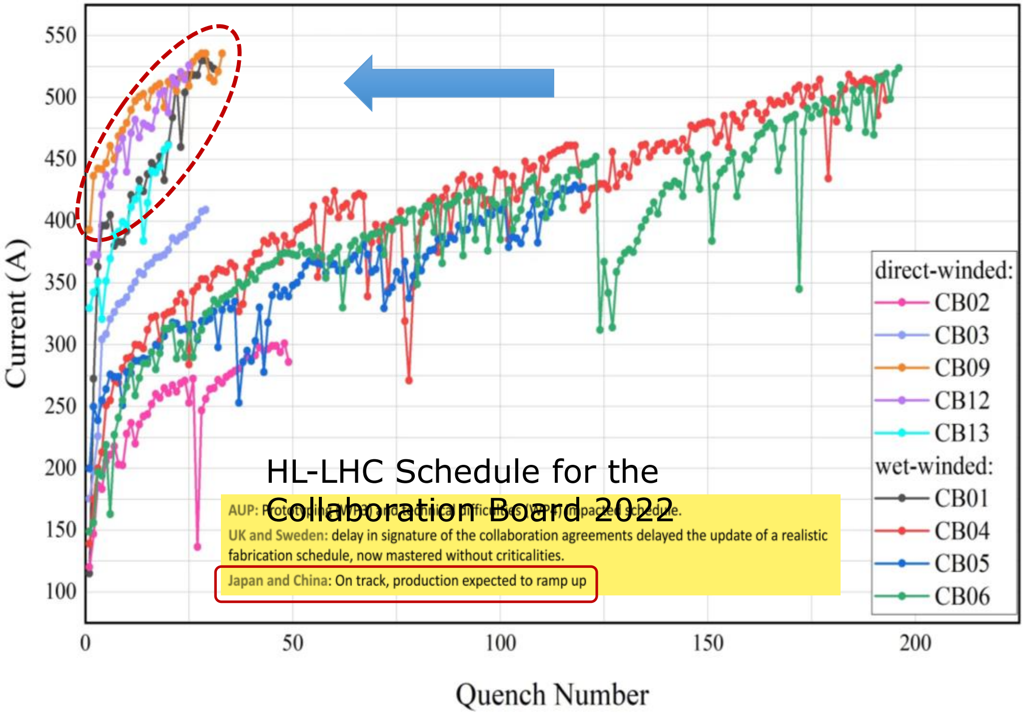






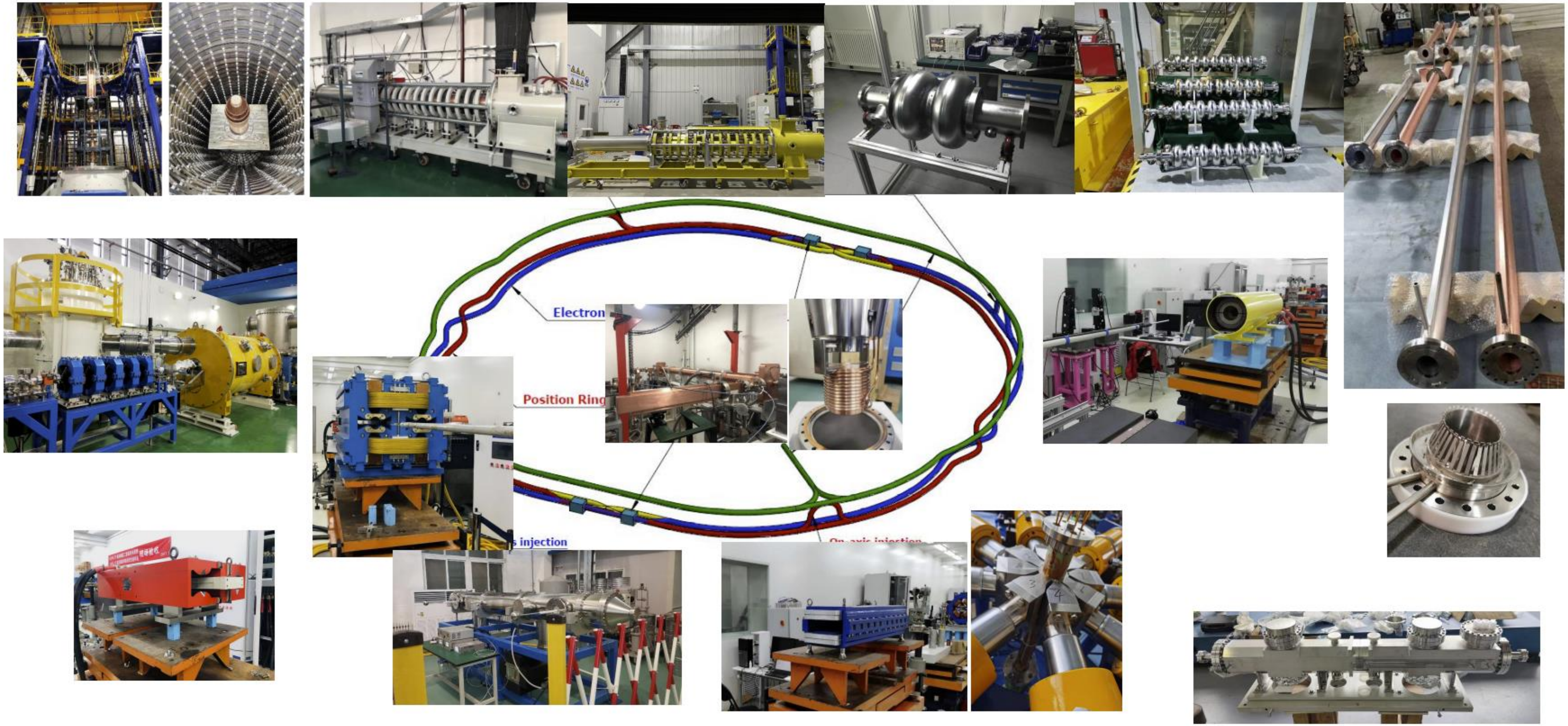


Training History of the HL-LHC CCT Coils



- AP1(CB12，25 quenches 526A) reached ±422A after 11 quenches.
- AP2(CB09, 33 quenches 530A; after thermal cycle >500A) reached ±422A without any quenches.

CEPC Talks



Summary

- Many foreign/domestic institutes and universities have participated in the lecture
- Synergy on design & technology R&D between FCCee and CEPC is ongoing.
- Researche on various topics is presented beyond collider