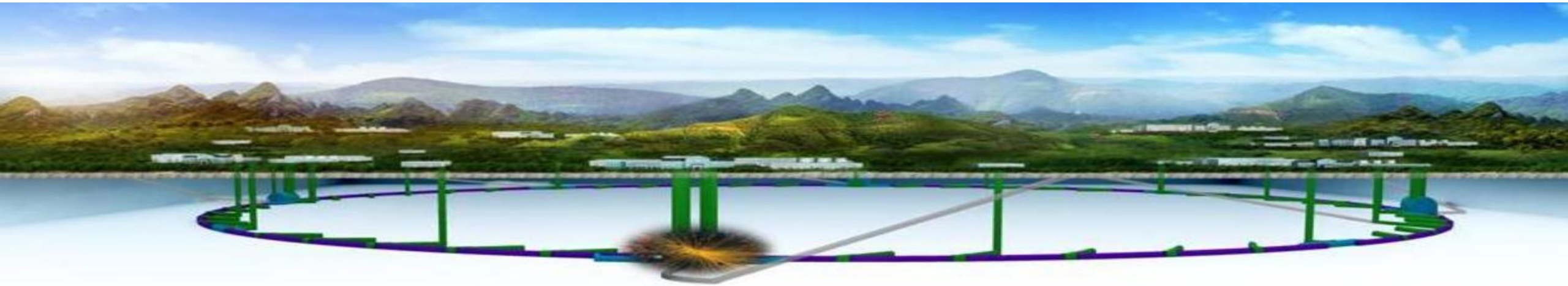
CEPC and the Future Plan of HEP in China

Yifang Wang

ICFA Seminar, Nov.5, 2026



CEPC： From Kick-off to TDR

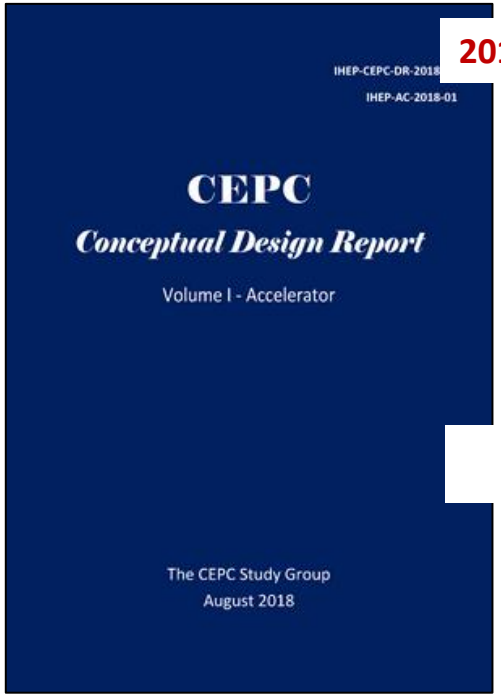


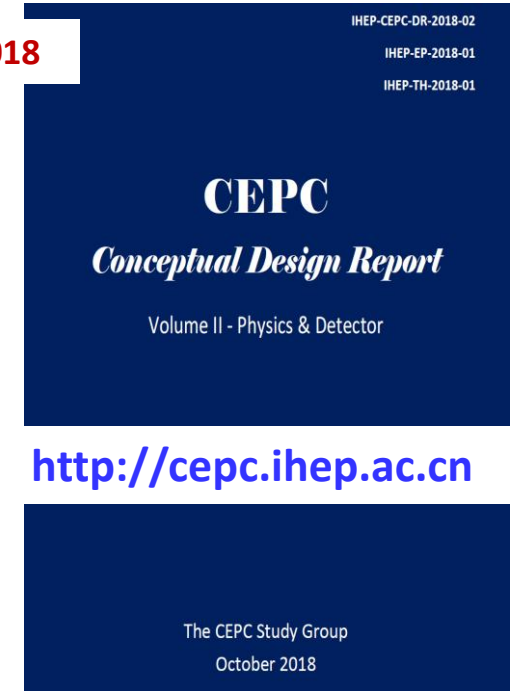




CEPC physics white papers:

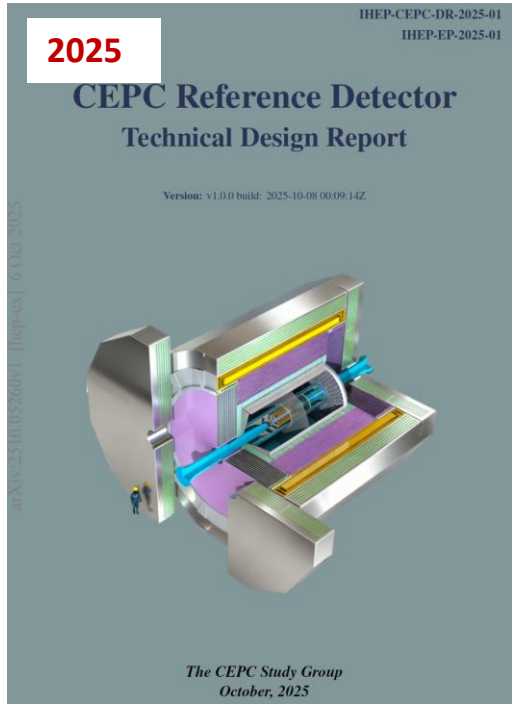
1. Higgs physics, arxiv:1810.09037
   Chin. Phys. C 43(2019) 043002
2. Flavor physics, arxiv:2412.19743
3. New Physics Search arXiv.2505.24810
4. Electroweak physics, to be published
5. QCD, to be published





http://cepc.ihep.ac.cn





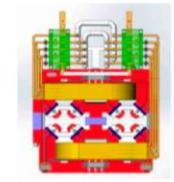
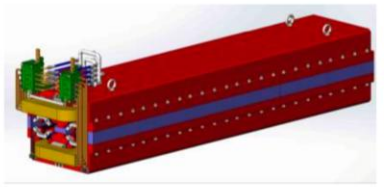
CEPC was not put into the 15th 5-yrs(2026-2030) plan

- A sad news but we will not stop pursuing HEP
- An IB meeting at the 2025 CEPC workshop concluded the following:
  - Continue CEPC while looking forward to be a major partner of FCC
    - Identify common interests and technologies, find a new way of collaboration
      - In contact with CERN/FCC
      - AGORA listed as one of the FCC detector concept
      - already in DRD
    - If FCC construction is not officially approved before 2030, we will propose again in China
  - Continue to explore the pp collider (~100 TeV) by working on Iron-based HTC superconducting materials (IBS) and magnet
    - Only IBS has potential to contribute significantly to the society: new, metal, cheap
  - Working for the high energy linear e+e- collider (1-10 TeV) and applications
    - Established a PWFA test facility based on BEPCII
    - Start to work on technologies, and applications for table-top light sources, injectors, FEL, etc.

CEPC Accelerator EDR

EDR tasks had 35 WGs, mostly common for CEPC & FCC_ee

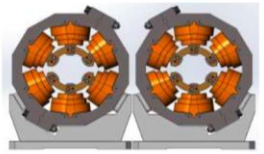
- Continue to optimize the design including MDI, polarization, backgrounds, etc.
- A full cryomodule with six 650 MHz 2-cell cavities
- Higher efficiency klystrons
- Automatic production line for magnets and NEG-coating vacuum chambers
- More prototypes of magnets
- C-band LINAC test band
- CCT type SC quadrupole magnet for final focusing
- Control and timing
- Alignment and installation plan
- Mockup for installation

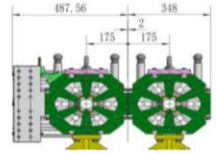
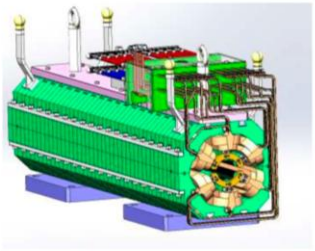



Dual aperture quadrupole: block iron core and new cooling and power line design in EDR



Correctors: mechanical design completed



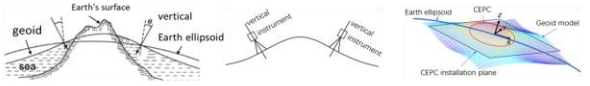



Sextupole magnets under design

- Alignment accuracy requirement

Component	Δx (mm)	Δy (mm)	$\Delta\theta_z$ (mrad)
Dipole	0.10	0.10	0.10
Arc Quadrupole	0.10	0.10	0.10
IR Quadrupole	0.10	0.10	0.10
Sextupole	0.10*	0.10*	0.10

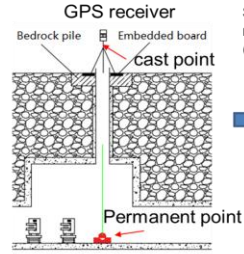
*implement beam-based alignment

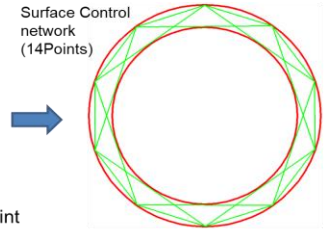


Component Pre-alignment




Wall Control Point

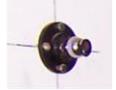




Backbone Control network
(short line:300m; long line 600m)



Tunnel Control network
(interval of 6 meters)



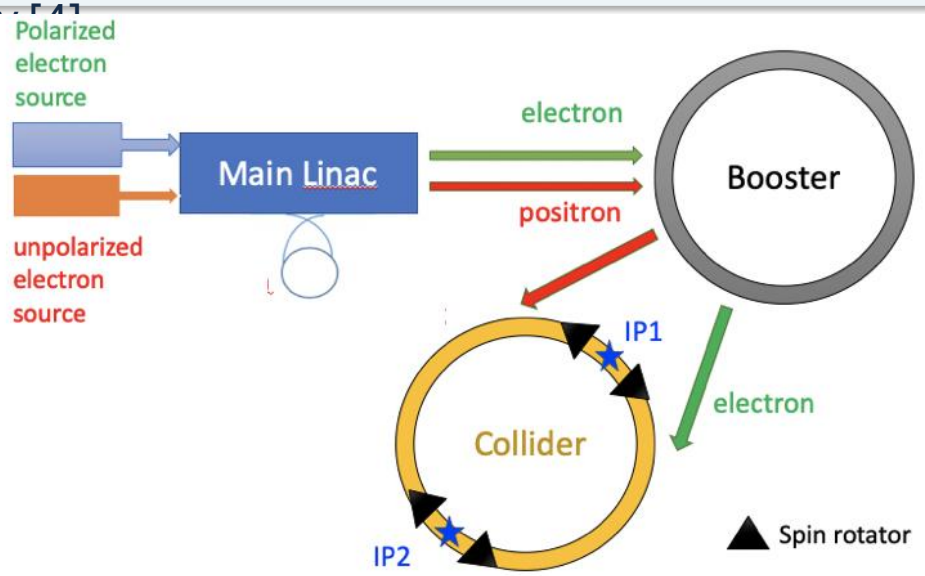
Ground Control Point



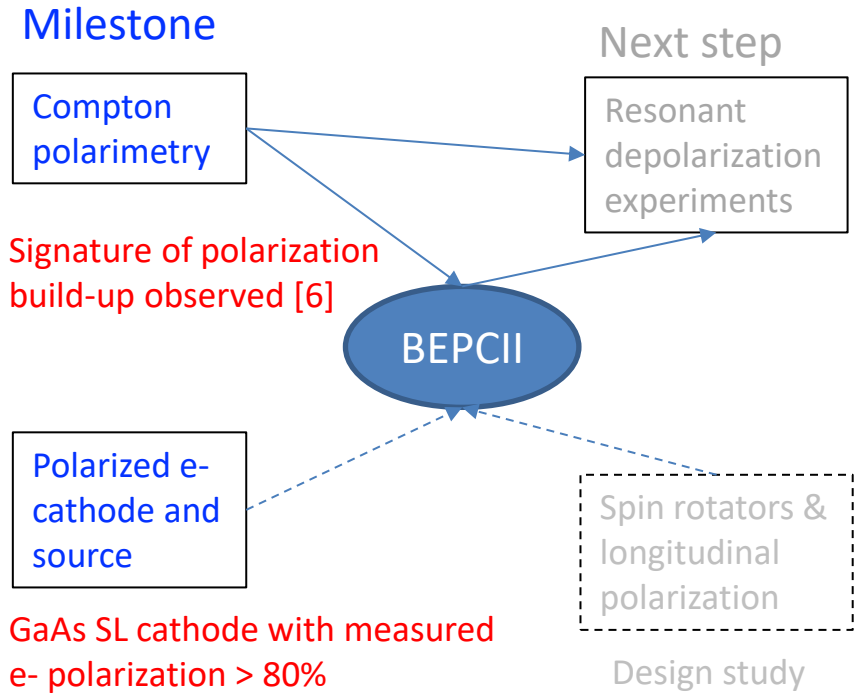
EDR example 1: Beam Polarization

Key achievements & Ongoing R&D:

- **Polarization preservation:** designed spin-resonance structure in booster enables polarization transmission to Z/W energies, without Siberian snakes [1].
- **Longitudinal polarization at Z-pole:** designed Solenoid-based spin rotators in the collider ring enables longitudinally polarized beams at the Z pole [2].
- **Radiative depolarization theory:** Identified the transition between correlated and uncorrelated regimes of spin diffusion [3], developed a unified theory based on spin-phase memo[4]



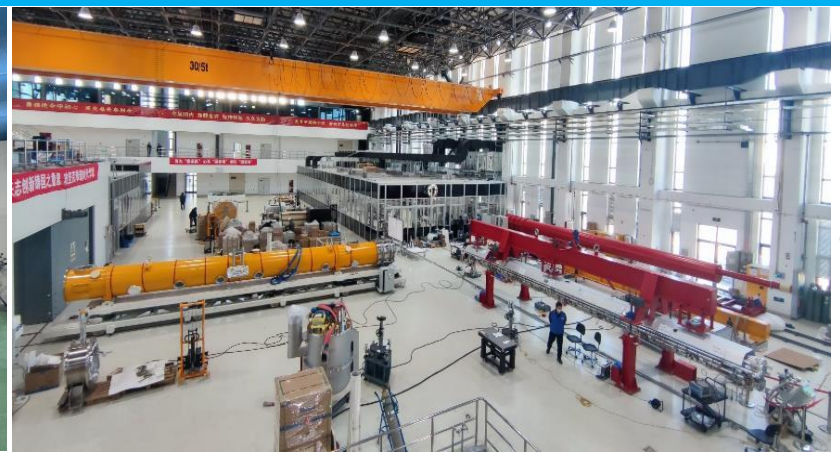
Key technology R&D and beam tests at BEPCII [5]
--- shared interests of future collider projects

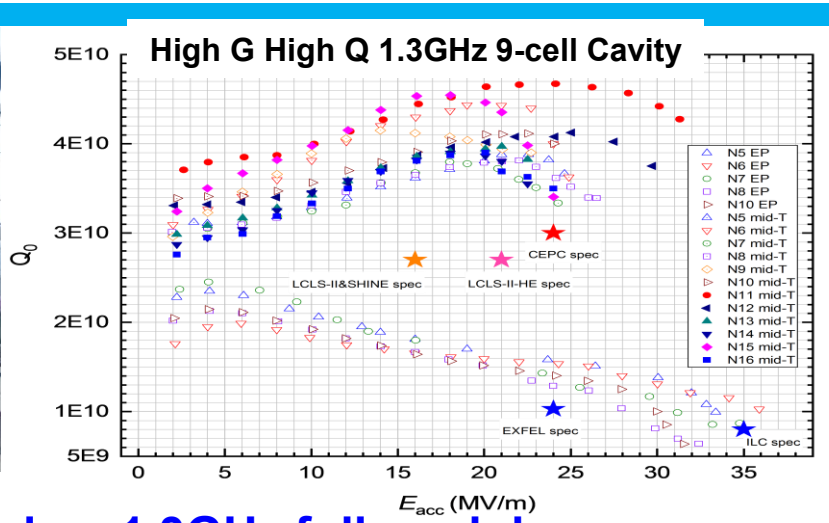


[1] T. Chen *et al.*, PRAB **26**, 051003 (2023).
[2] W. Xia *et al.*, RDTM **6**, 490 (2022).
[3] W. Xia *et al.*, PRAB **26**, 091001 (2023).
[4] Z. Duan, arXiv: 2610.18397 (2026).
[5] Z. Duan *et al.*, IJMPA **41**, 2641003 (2026).
[6] M. Su *et al.*, RDTM **10**, 736 (2026).

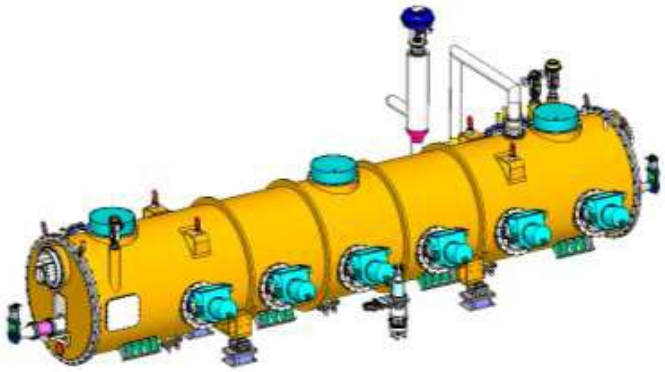
EDR Example 2: SRF Cavities and Modules

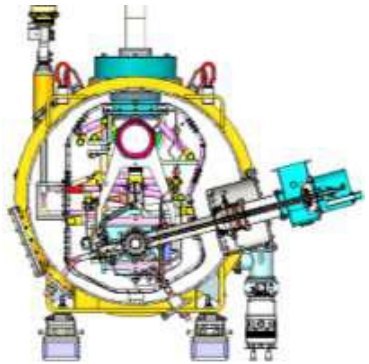


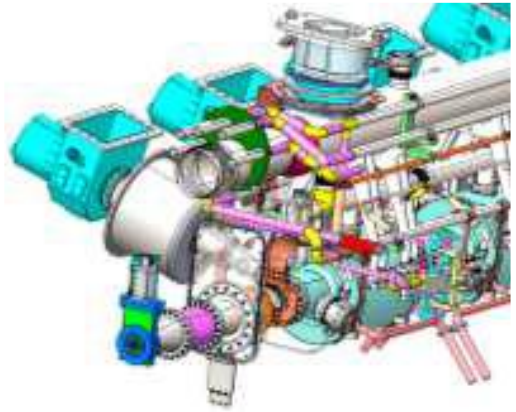




In TDR phase: successfully completed a 650MHz 2*cell short module and an 1.3GHz full module







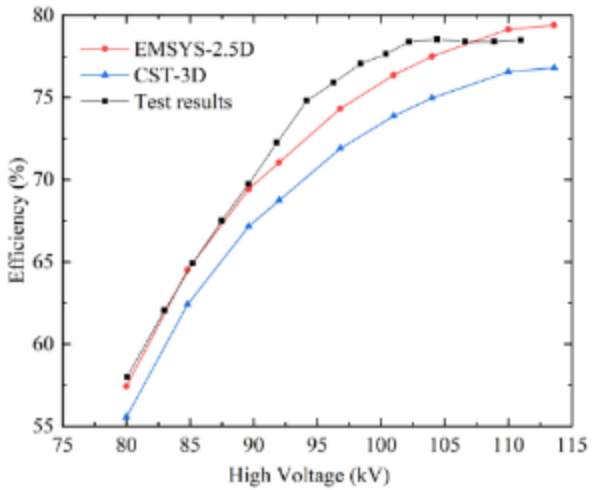


In EDR: a full 11 m-long module with six 650 MHz 2-cell cavities

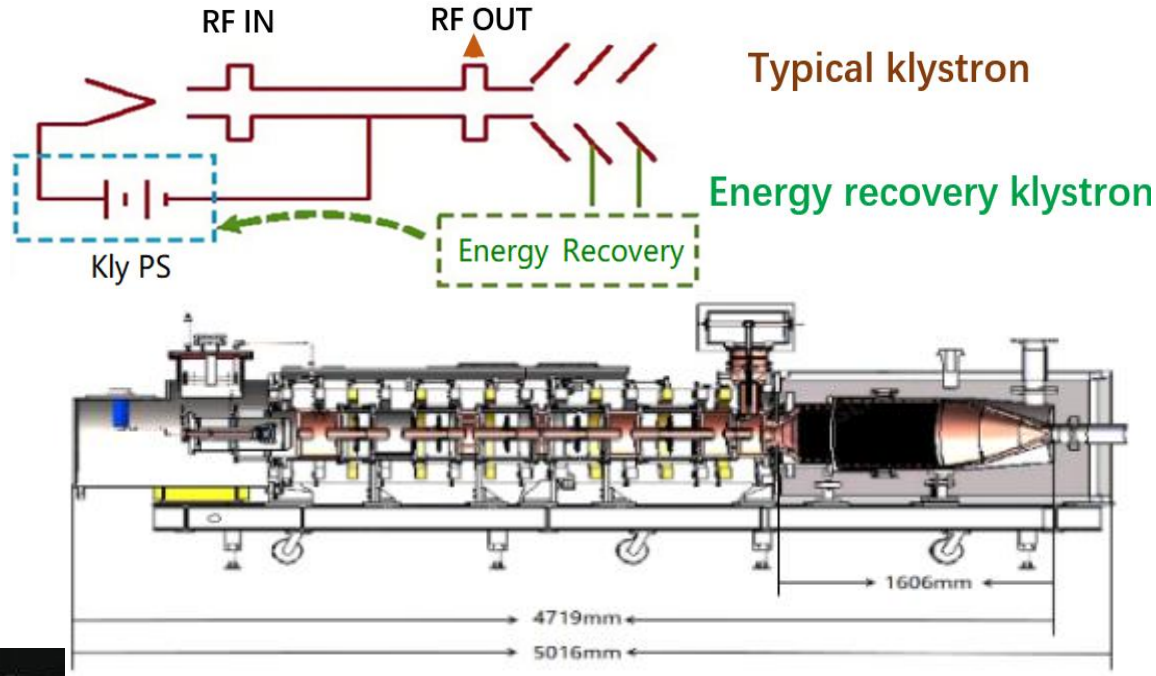
Status： construction in progress

EDR Example 3: Higher Efficiency Klystrons

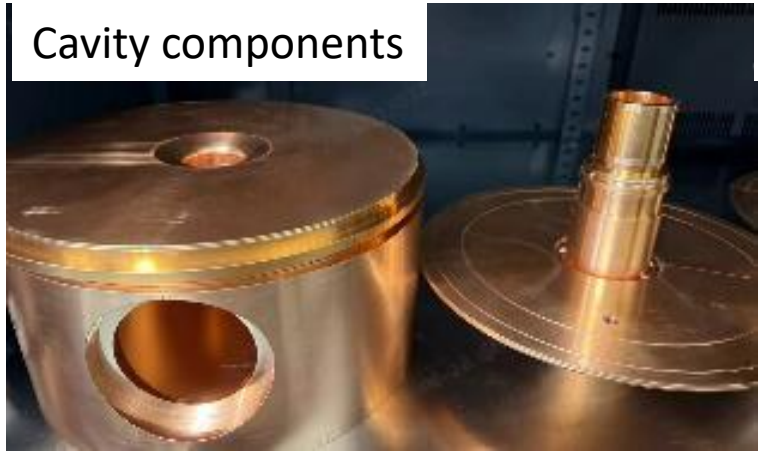




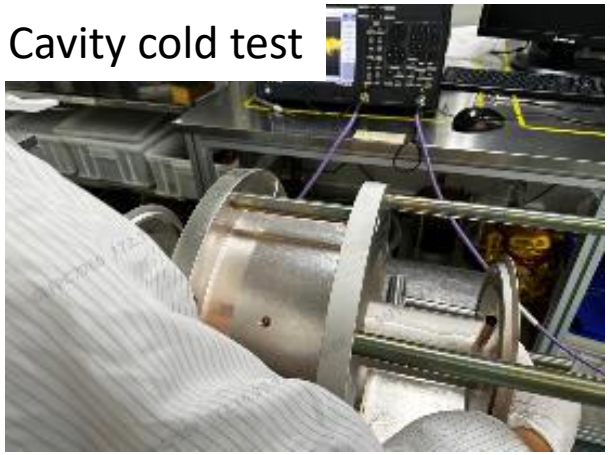
In TDR phase: CW 800 kW klystron reached effi. of ~78%



Cavity components



Cavity cold test



Parameter	Value
Frequency	650 MHz
Beam Voltage	113 kV
Output power	800 kW CW
Efficiency	**≥85%**

In EDR: An Energy Recovery Klystron (ERK) almost finished, to be tested next year

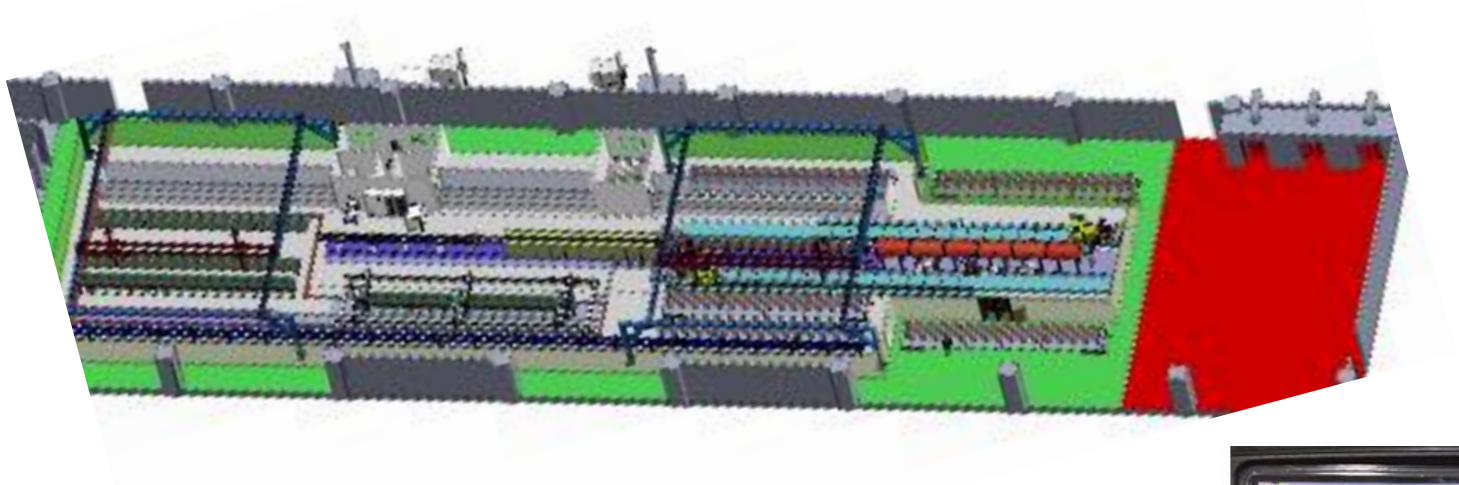
EDR Example 4: Automatic production line for magnet

- > 25% of total cost, saving can be significant
- Can work 24h/day, 7days/week, may reduce the cost by ~30-50%
- A prototype for booster dipole magnet: ~15000 magnets
- Status: 1/3 completed, commissioning in progress



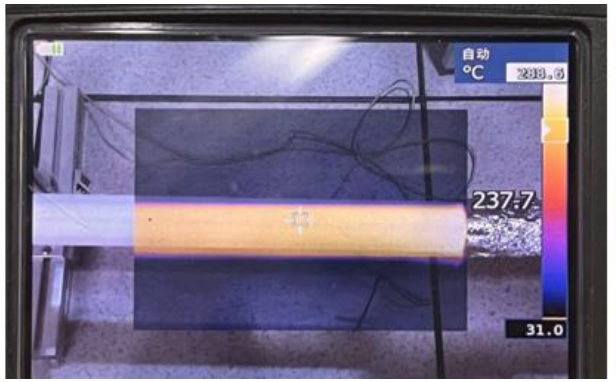
EDR Example 5: Automatic Production for NEG-Coating Vacuum Chamber

- A total of 200 km needed
- Can work 24h/day, 7days/week, may reduce the cost of coating by ~30-50%
- Key challenges: automatic sealing of CF flanges, coating under extreme conditions at a length-to-diameter ratio of ~200, and heating-layer implementation.





Assembly completed, undergoing system-level commissioning

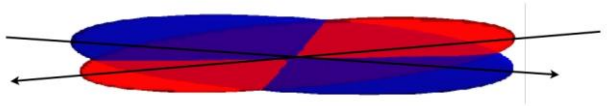




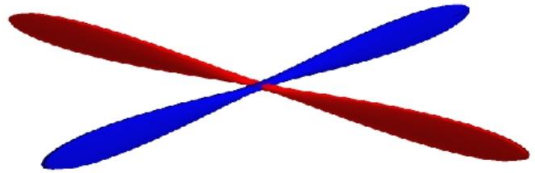
New： Testing the Crab Waist Scheme at BEPCII

Maintain the current machine and the BESIII detector unchanged

BEPCII/U



BEPCII crab waist



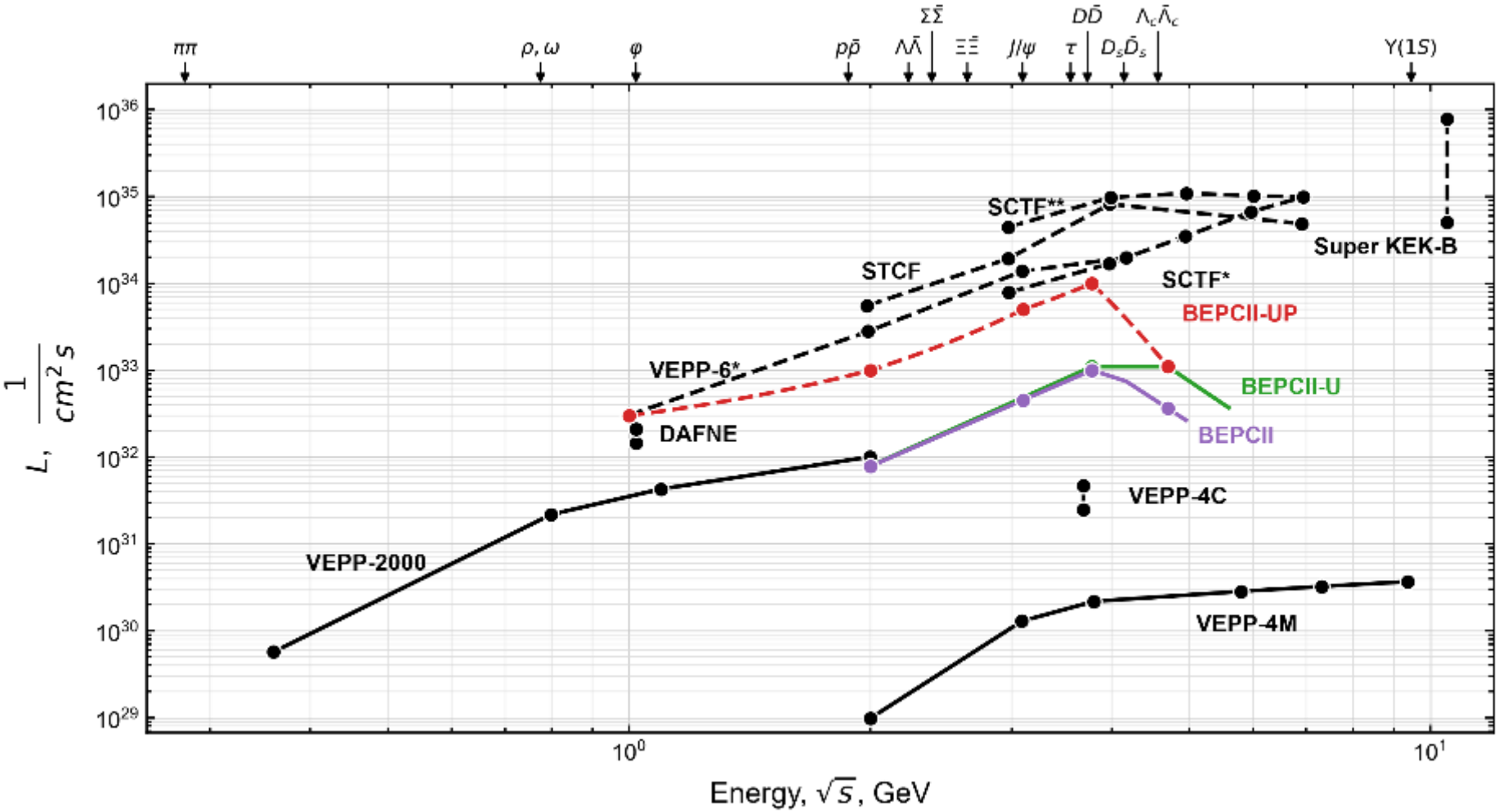
1. IR: crab waist collision

2. Inner ring Injection region: insert SC wigglers

3. Linac: a new compact damping ring



Higher Luminosity for Physics



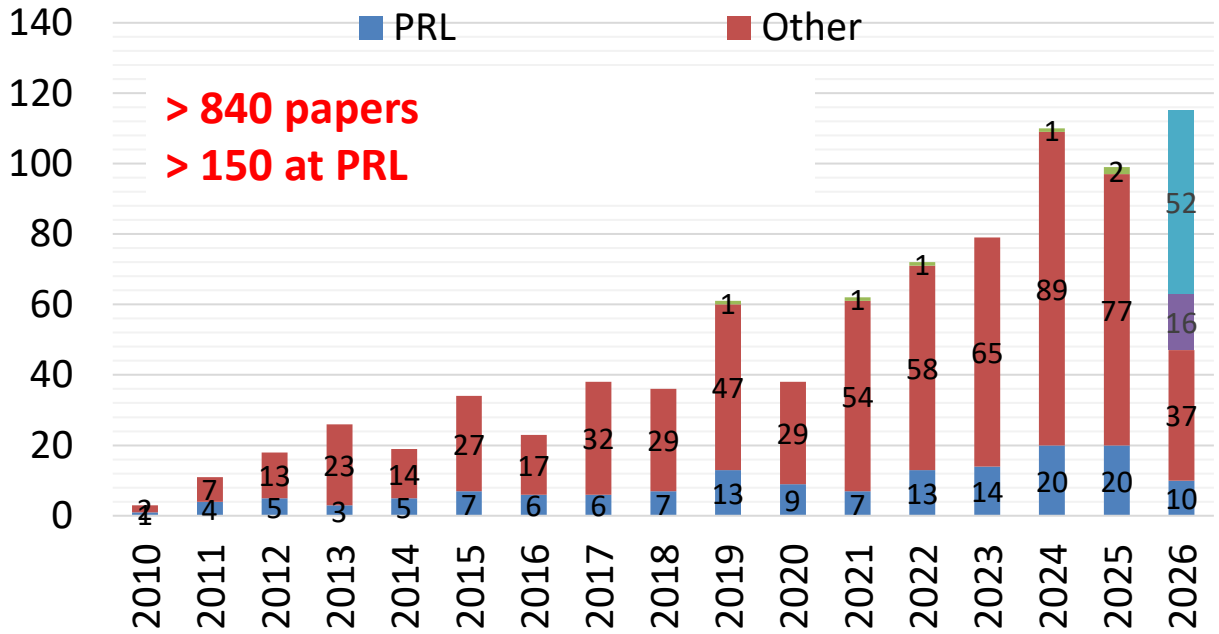
Main physics topics:

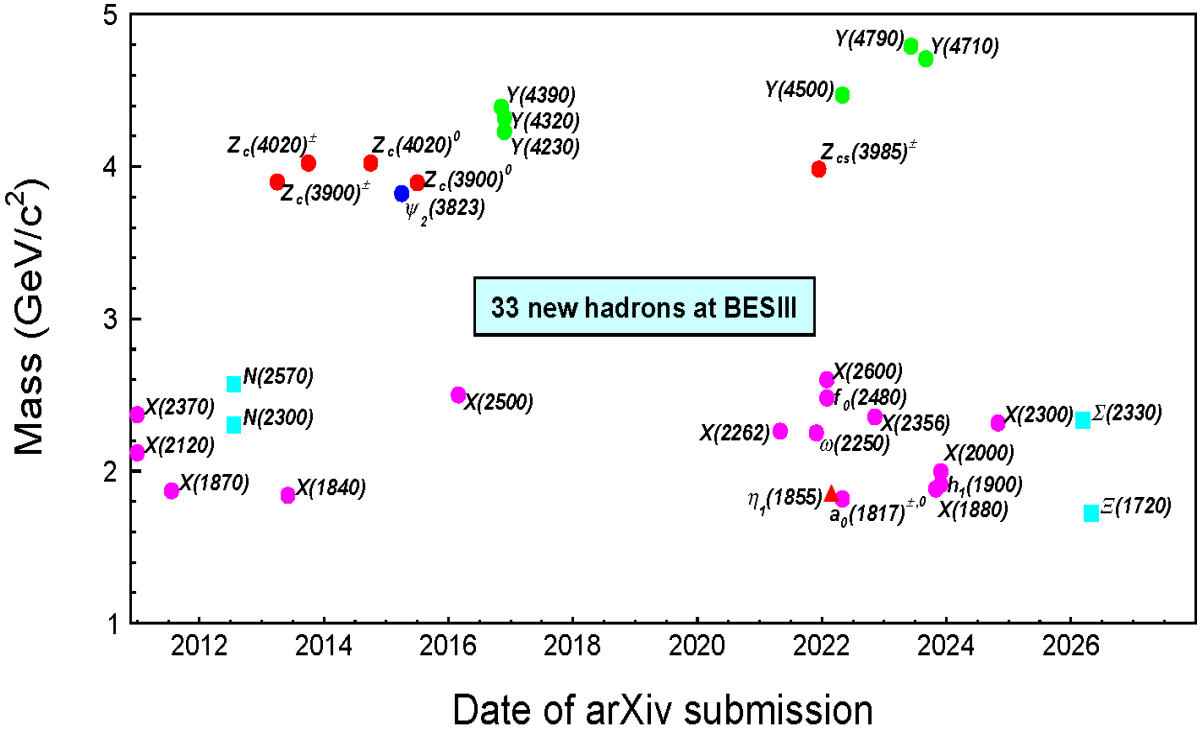
- XYZ and charmed baryons
- Search for more glueballs, multi-quark and hybrid states
- Precise R-value scan in 0.5-2.0 GeV
- Charmonium physics at ψ' and ψ(3770)
- Search for new physics

- Luminosity below 1.89GeV can increase by ×10
- Operation below 1GeV is enabled.

Data mostly from Ivan Logashenko @FTCF2025

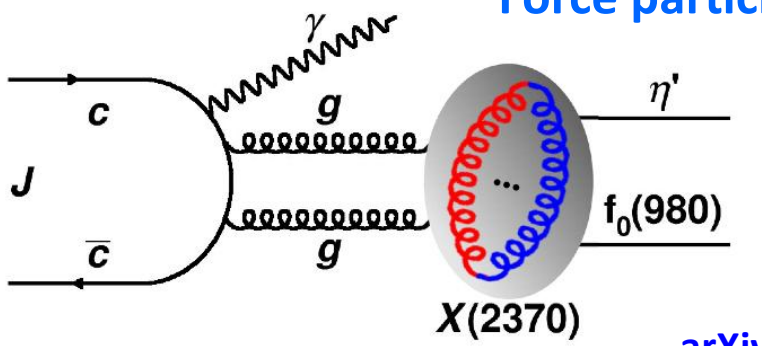
Continue the operation of BESIII up to > 2035





- **BESIII had been very successful since 2009**
  - Flavor and electroweak physics
  - QCD and hadron spectroscopy
  - Observation of glueballs, multiquarks and hybrids
  - New physics searches
- **Upgrade with much higher luminosity will bring us more**

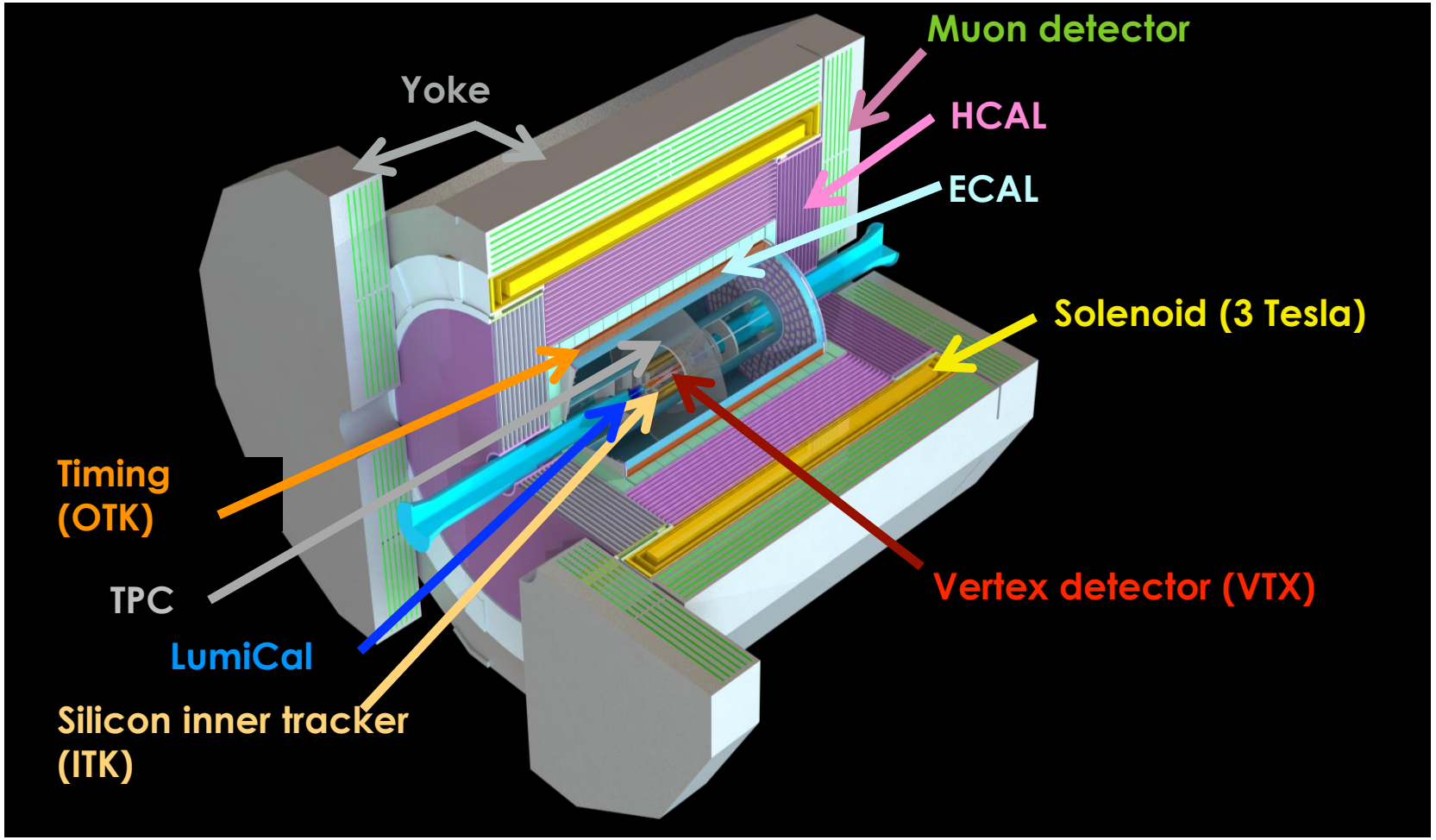
"Force particle" !



arXiv:2607.20366

Detector at CEPC/FCC_ee: AGORA

AGORA: Advanced Glass Optimized Research Apparatus



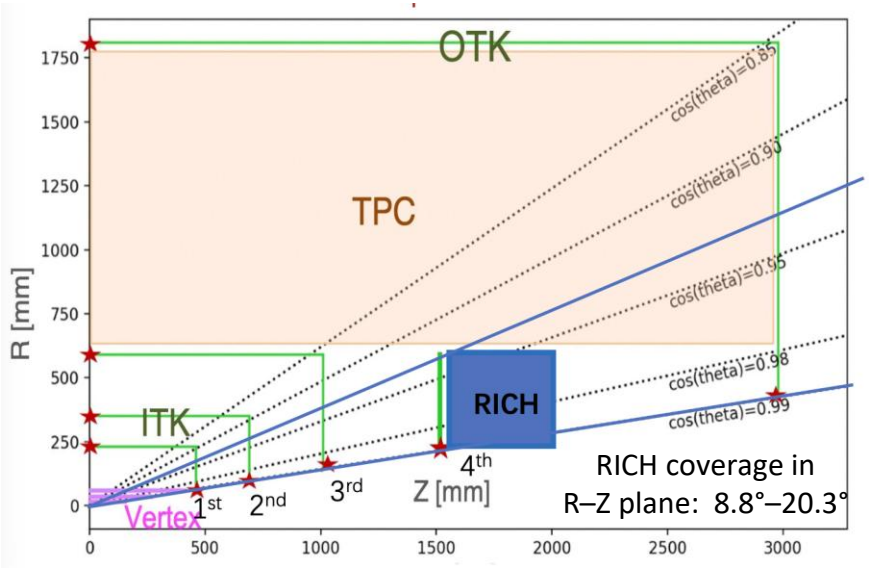
AGORA

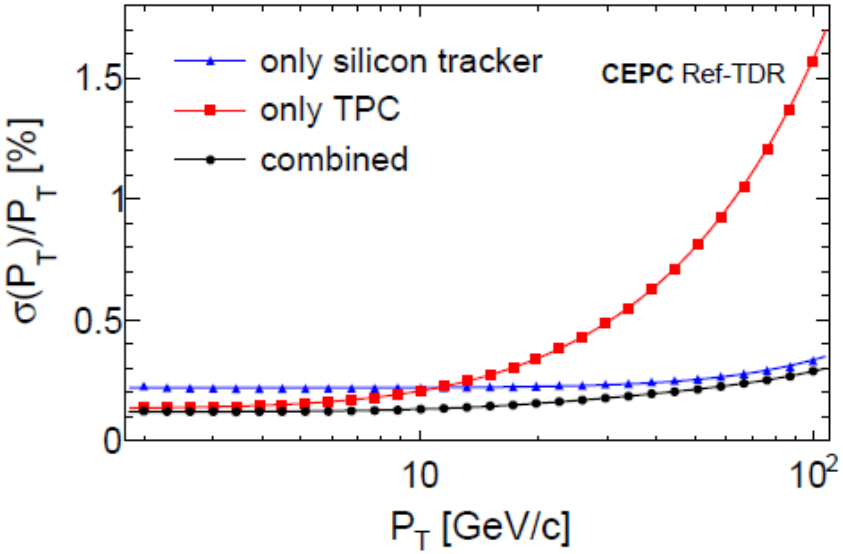
ADVANCED GLASS OPTIMIZED RESEARCH APPARATUS

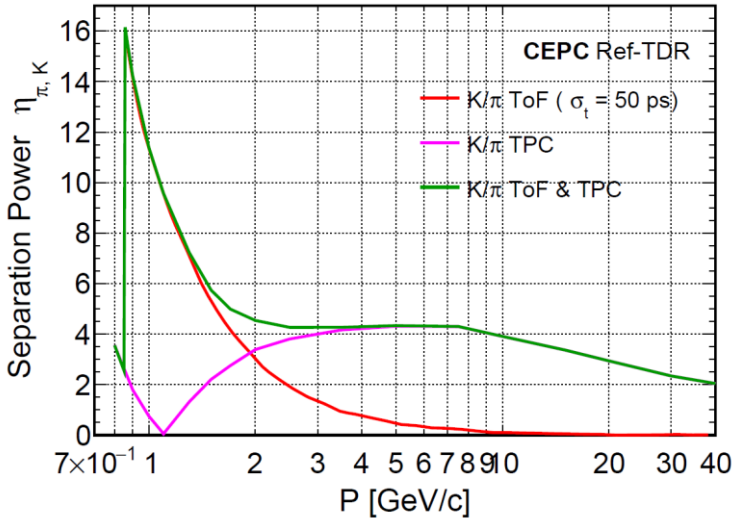
Detector: CDR → Ref-detector TDR → AGORA

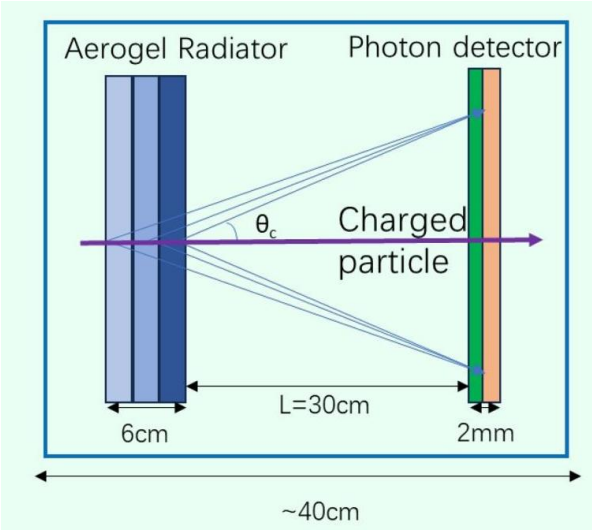
	ILD-like **CDR**	New concept **RefDet-TDR**	Newer concept **AGORA**
VTX	Inner radius of **16 mm**	Inner radius of **11 mm**	
	Material: 0.15%*6+ 0.14%(beampipe)=**1.05% X0**	Material: 0.06%*4(inner)+ 0.165%*2(outer)+0.2%(beampipe)=**0.77% X0**	
ITK	Silicon strips, **7 um**	Monolithic HV-CMOS pixel, **10 um**	
Gaseous Tracker	TPC with **1 mm* 6 mm** readout, tracking 100 um, **dE/dx ~ 6%**	TPC with **0.5 mm* 0.5 mm** readout, tracking 100 um, **dN/dx ~ 3%**	
ToF & OTK	Silicon strips, **7 um**	AC-LGAD, **50 ps** per MIP, 10 um	
Cerenkov	-	-	Aerogel + SiPM
ECAL	Si-W-ECAL: **17%**/√E ⊕ 1%	BGO Crystal: **<3%/√E ⊕ 0.7%**	Glass cubic: **<3%/√E ⊕ 1%**
HCAL	RPC-Iron: **60%**/√E ⊕ 2%	Glass-Steel: **<30%/√E ⊕ 6.5%**	Glass cubic: **<15%/√E ⊕ 4%**

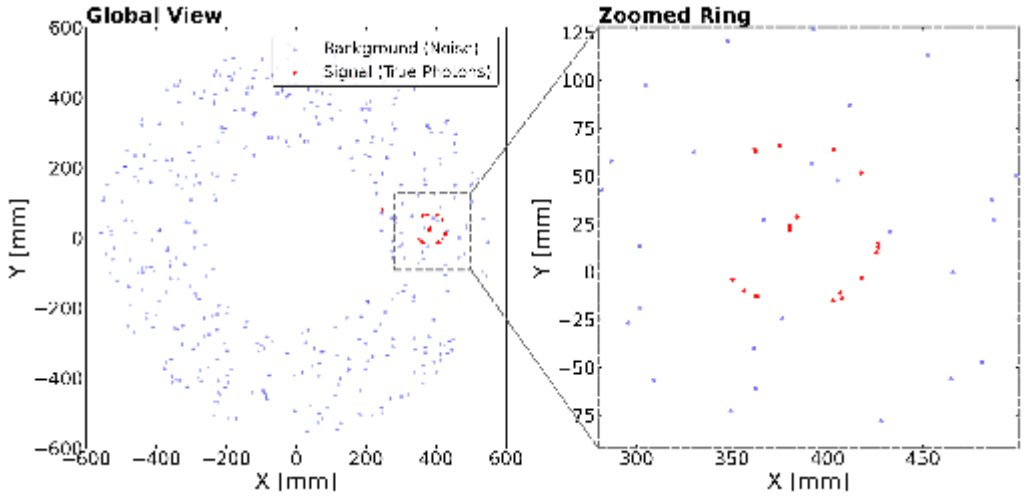
The Tracker and the Cherenkov Detector (RICH)

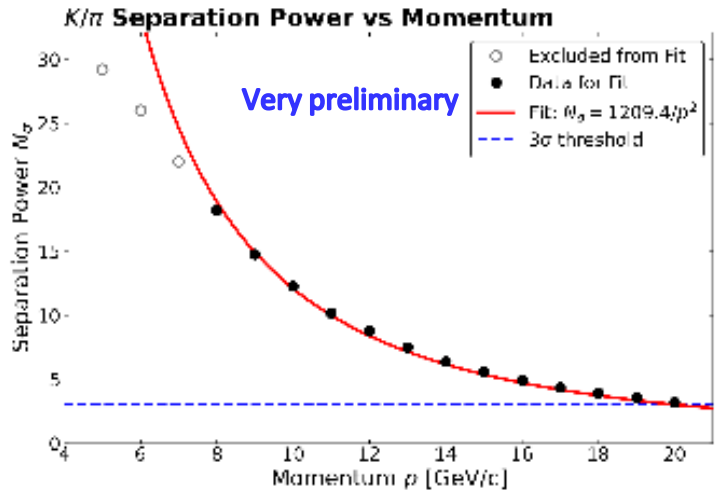








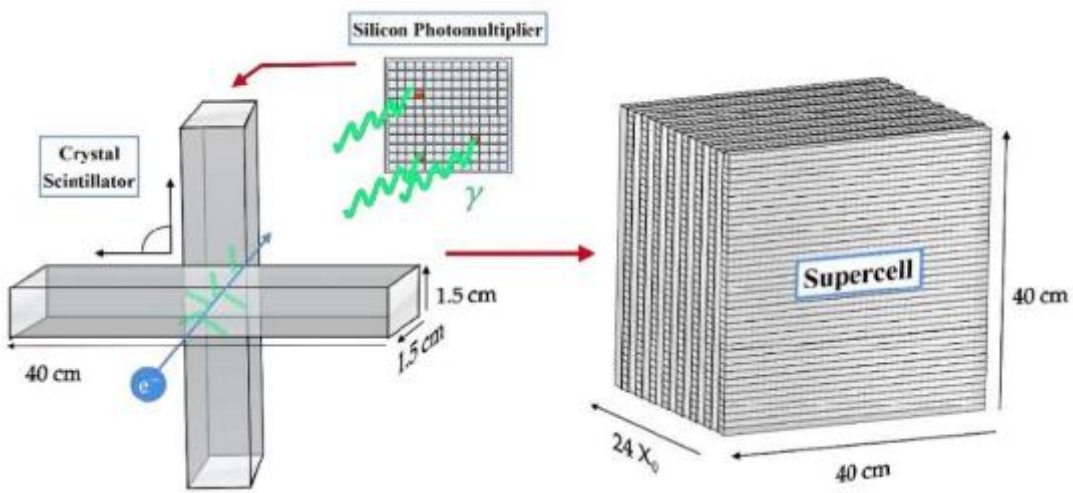




CEPC Reference Detector: Crystal ECAL

BGO bars (1.5 × 1.5 × ~40 cm³) alternate in x and y, with one 3 × 3 mm² SiPM at each end.

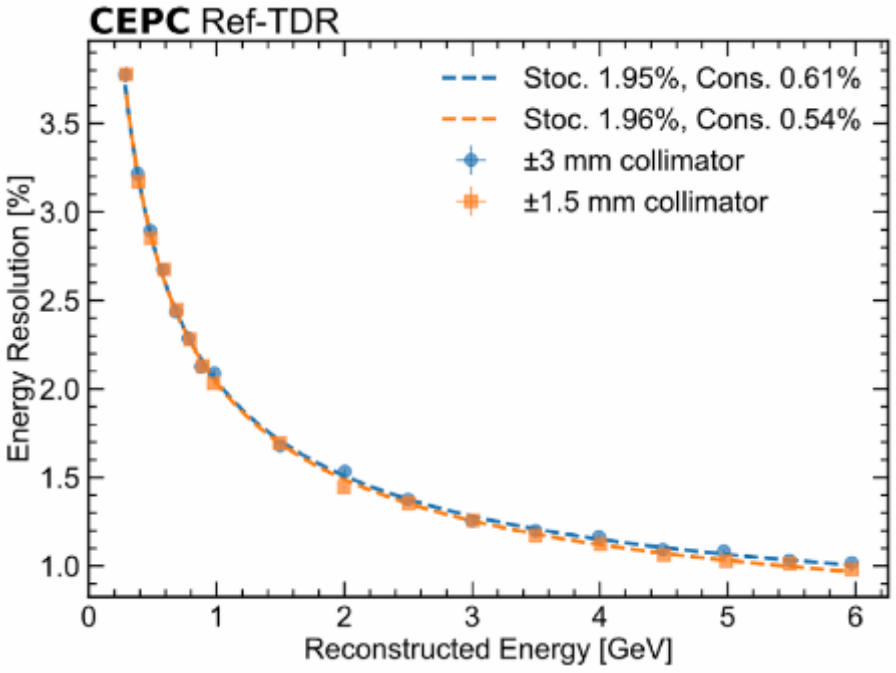
Crystal bar structure



Reference design: 18 layers, 24 X_0

Simulation: $\frac{1.14\%}{\sqrt{E(GeV)}} \oplus 0.44\%$

BGO prototype($2 \times 2 \times 12$ cm³) beam test results

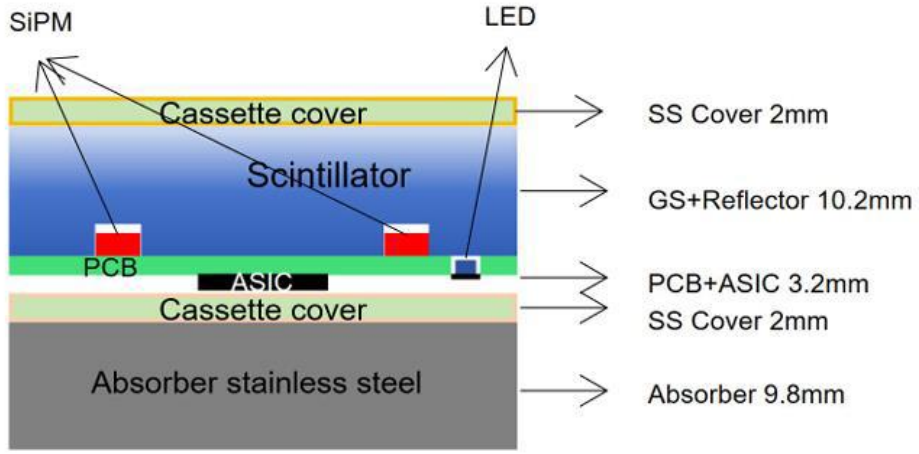


Beam test: $\frac{1.96\%}{\sqrt{E(GeV)}} \oplus 0.54\%$

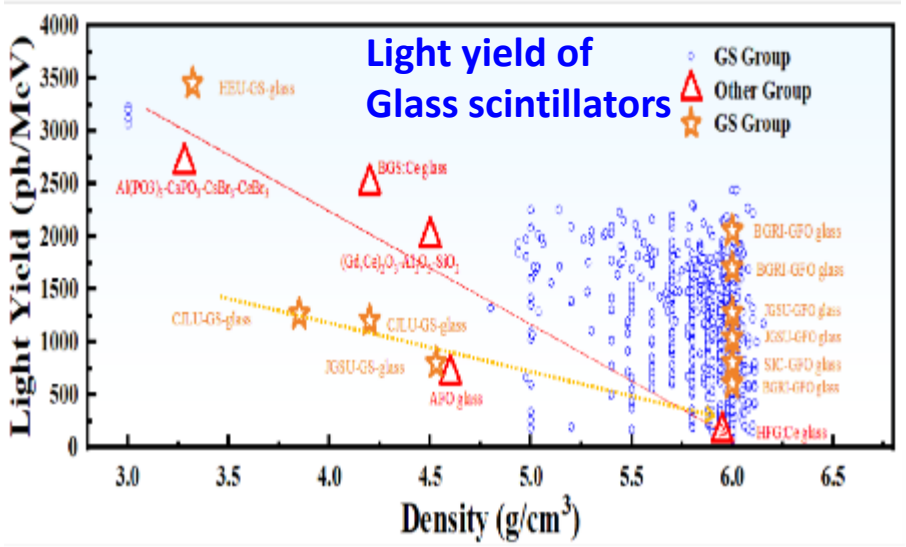
Beam energy spread not excluded

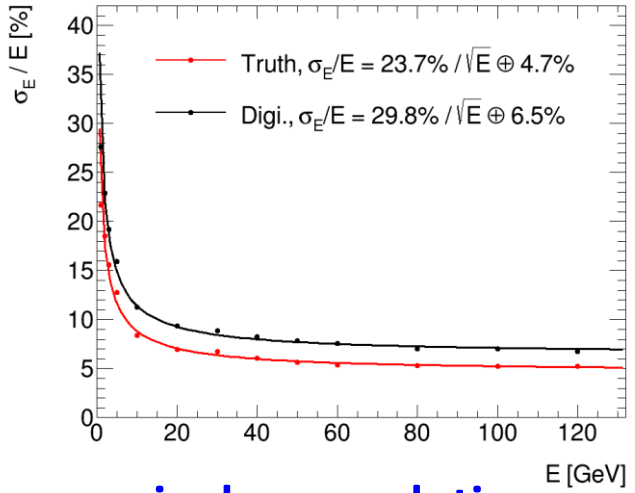
CEPC Reference Detector: Hadron Calorimeter

- High density glass scintillator for HCAL: much higher sampling ratio(~30%) but difficult to make it big
- Use small glass cubic: good for 3D shower reconstruction and PFA
- An R&D collaboration for scintillation glass was formed, including universities, research institutions and industries
- A novel Gadolinium Fluoro-Oxide glass was invented with following achieved specifications:
  - Density: ~6g/cm^3
  - Light yield: ~1500 ph/MeV
  - Decay time: 600 ns
  - Attenuation length ~ 6 cm
  - Cost: < 1$/cc



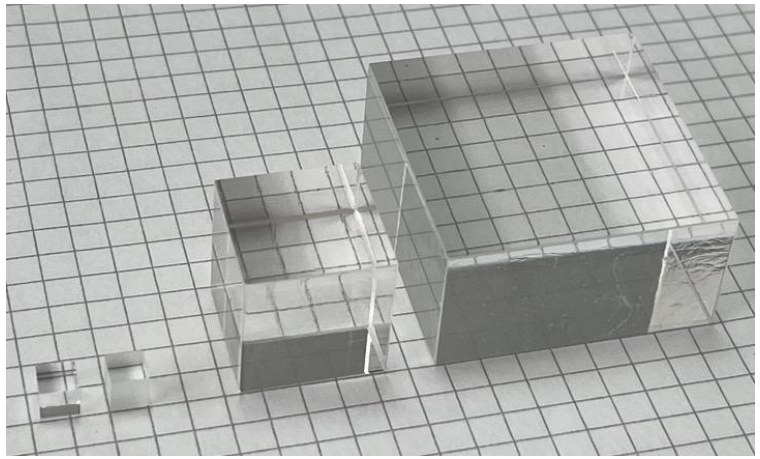
Glass Size: 40*40*10 mm^3



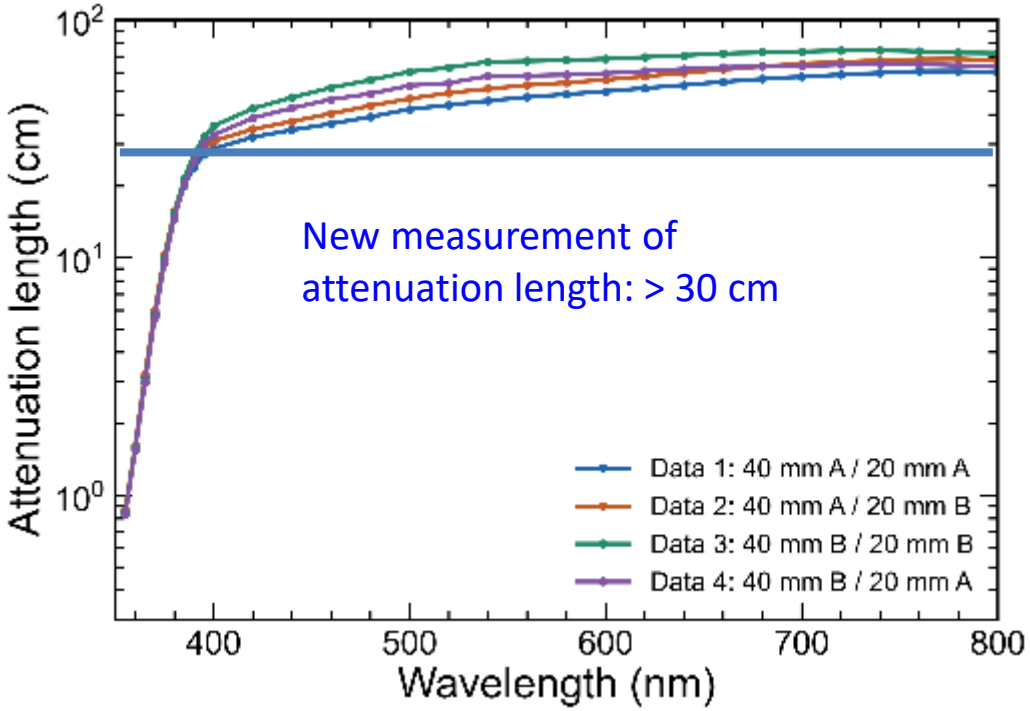


single π resolution:
< 30%/√E ⊕ 6.5%

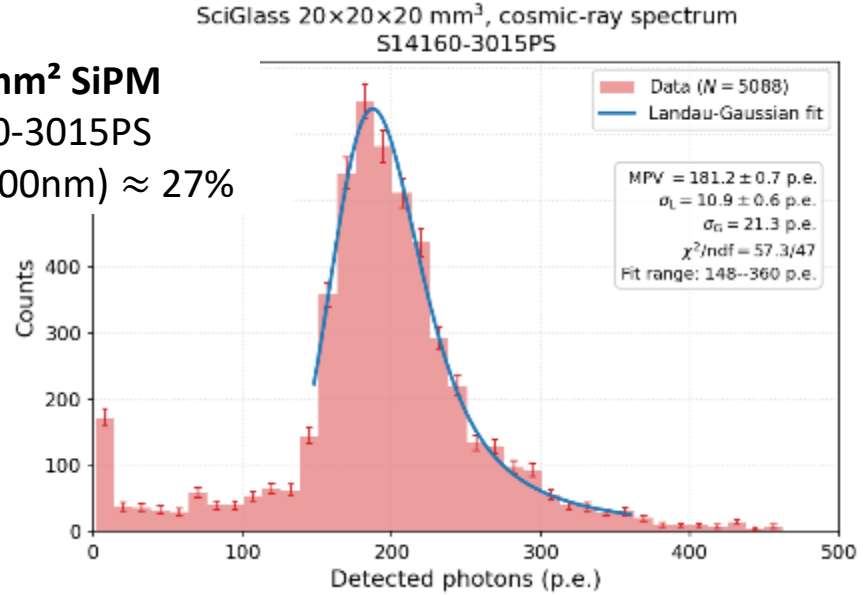
New Glass Samples and Cosmic-ray Test



5 × 5 × 5 mm³ cubes (×2)
20 × 20 × 20 mm³ cube (×1)
40 × 40 × 20 mm³ tile (×1)



3 × 3 mm² SiPM
S14160-3015PS
PDE (400nm) ≈ 27%



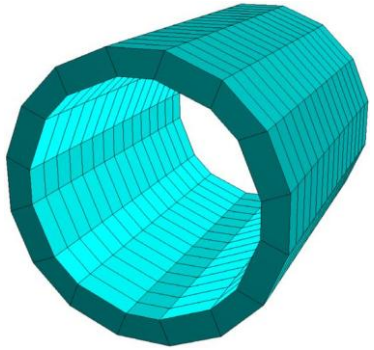
MPV: 181.6 ± 0.7 p.e.

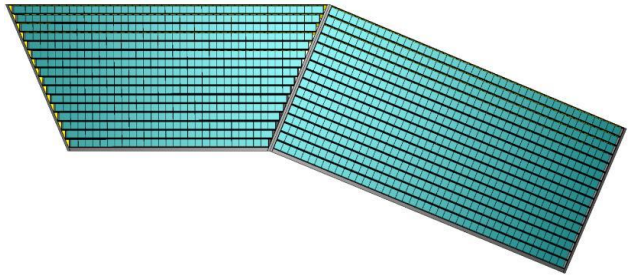
New:

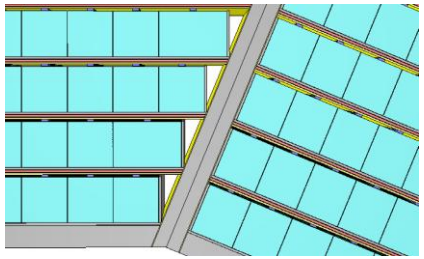
- Light yield can reach >1500 ph/MeV stably
- Attenuation length increased to >30 cm
- Can be used for EM calorimeter to replace crystals
- Money saved to build a full absorption HCAL

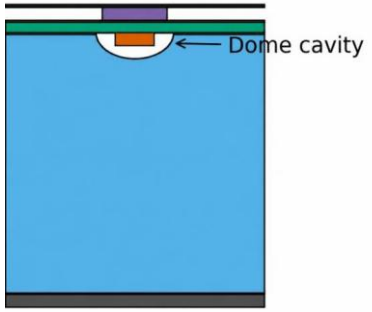
Full Glass ECAL and HCAL

ECAL

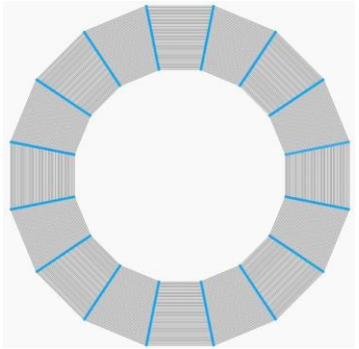


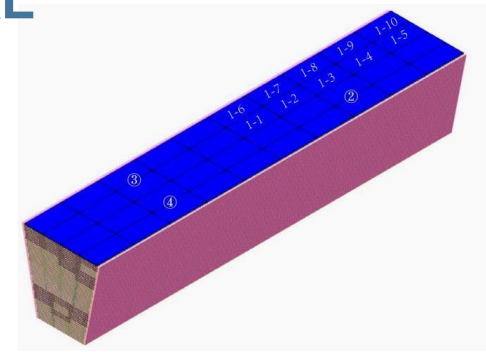


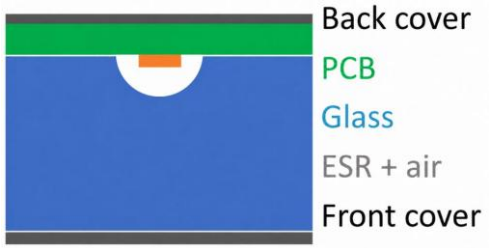




HCAL







Section	Layers	Glass cell size	Depth
ECAL	16	~2 × 2 × 2 cm³	32 cm ≈ 20 X_0 ≈ 1.3 λ_I
HCAL	33	4 × 4 × 3 cm³	~5 λ_I

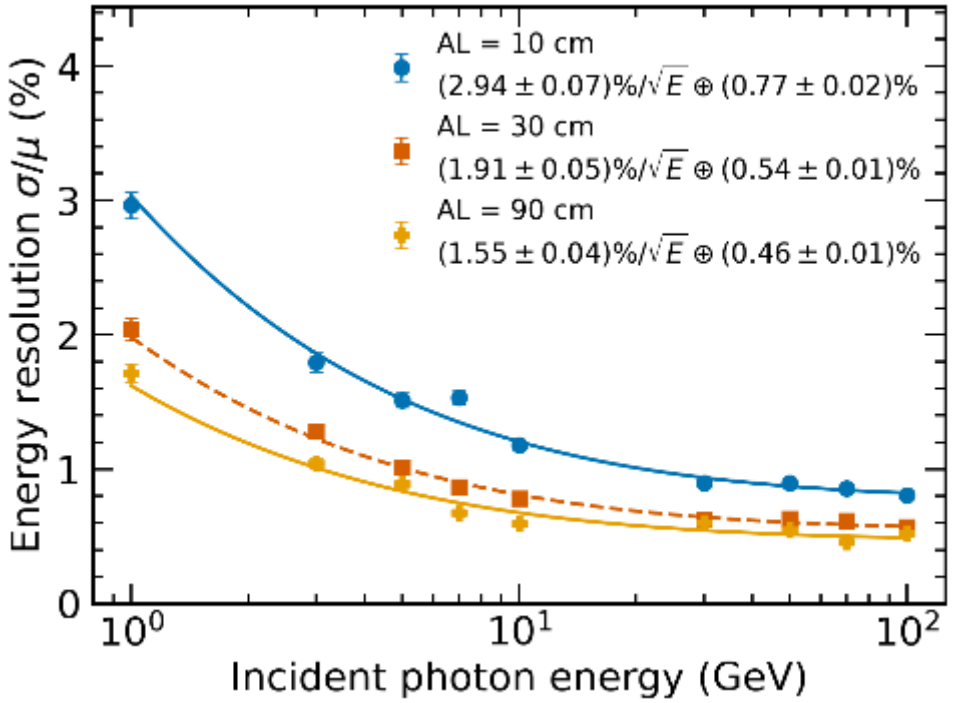
Dome cavities can improve light collection uniformity for each cell

Supports, SiPMs, PCBs and cooling are included in the detector model.

Energy Resolution for Single Particles

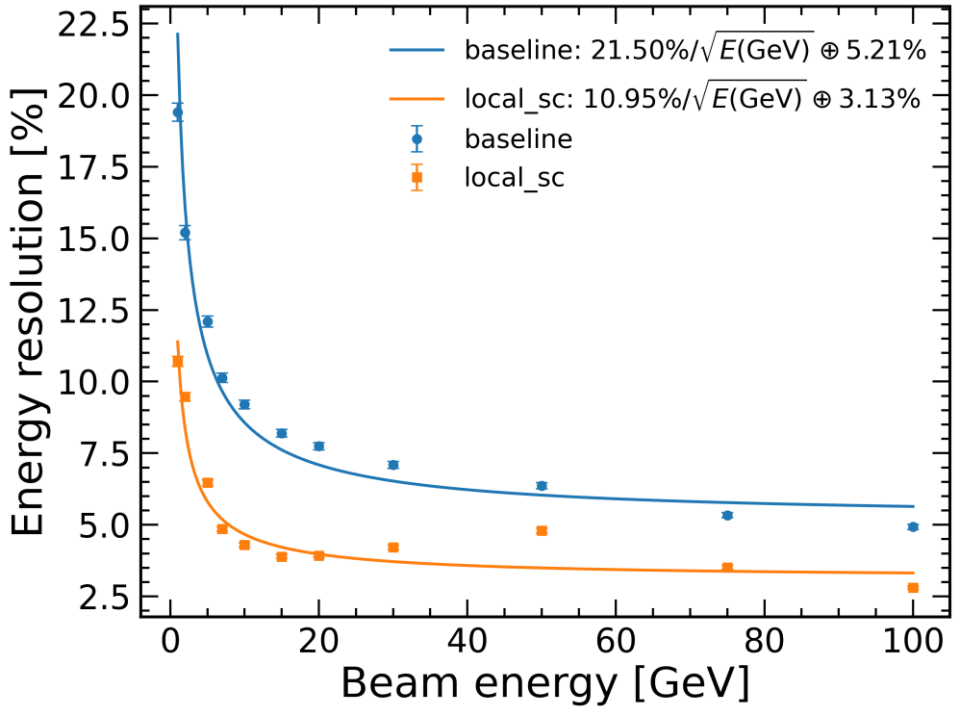
Preliminary results from simulation for AL=30 cm:

Single photons, 1–100 GeV, ECAL



1.9%/√E ⊕ 0.5%

Single charged pions, 1–100 GeV · ECAL + HCAL

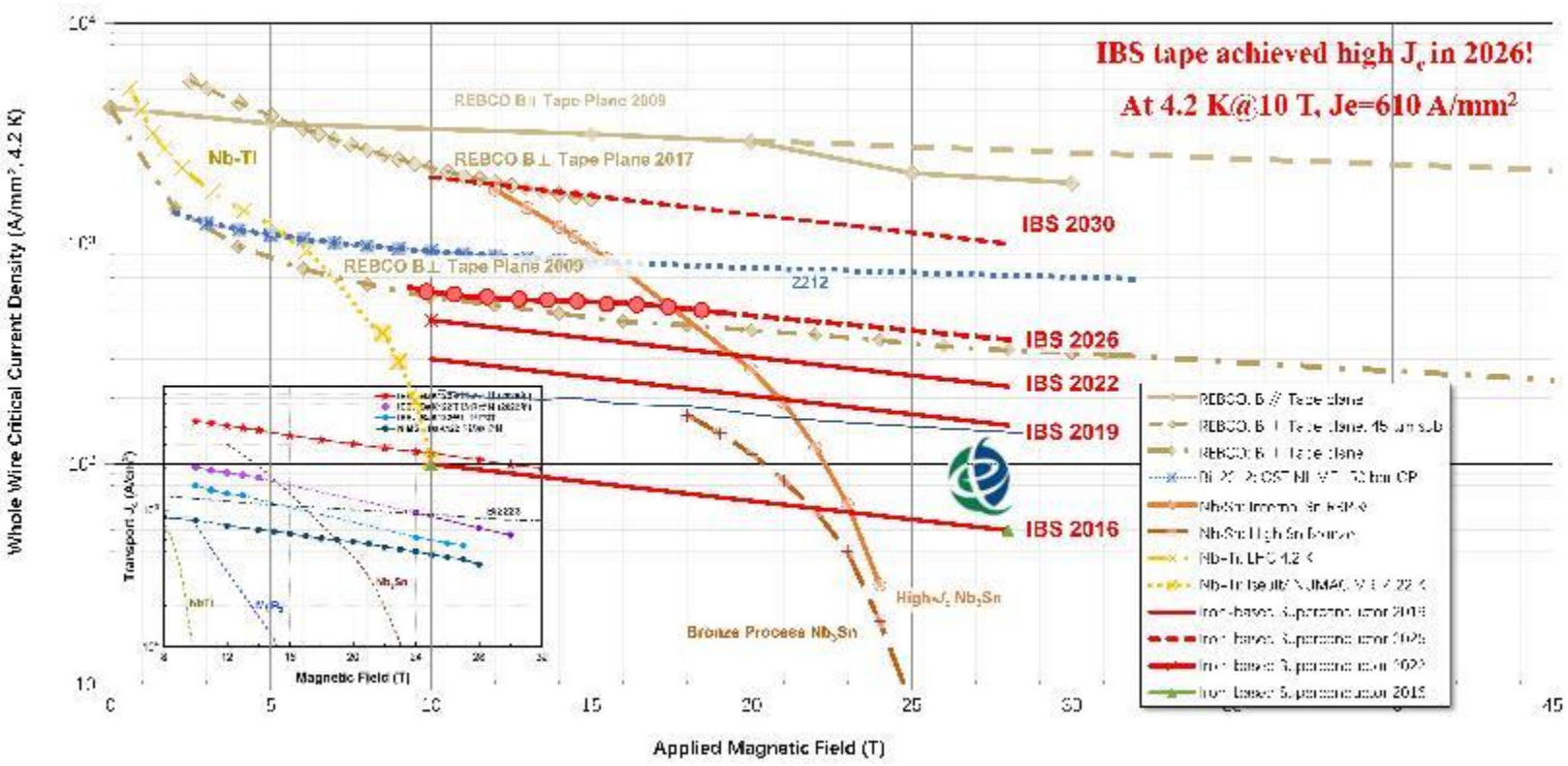


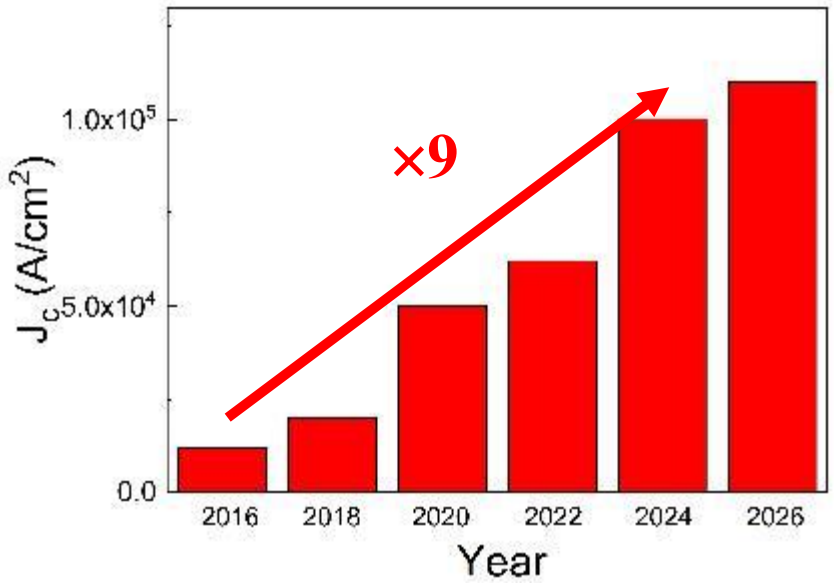
11.0%/√E ⊕ 3.1%
with local software compensation

Future Plan for the Glass Calorimeter

- Optimize structure design: mechanics, modules, cells, SiPM, electronics, cables, cooling, etc.
- Optimize Glass cells: size, shape, wrapping, glueing, …
- Glass R&D and production: attenuation length, uniformity, light yield, decay time, mass production yield, and cost
- Performance study: shower separation, jet reconstruction, AI enhanced algorithm, readout electronics, PSD for E/H correction, calibration, …
- Prototyping: EM 2027, HCAL 2028

R&D for Far Future 1: Iron-Based HTS Magnet





Plan

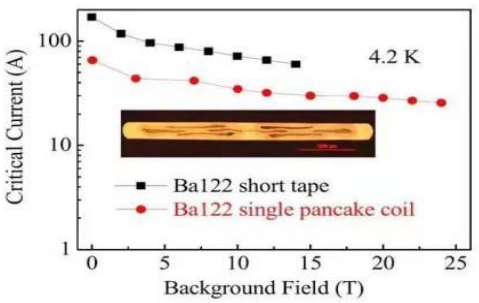
- Continue to improve Jc by × ~4
- Mid-scale cable production
- Test magnet

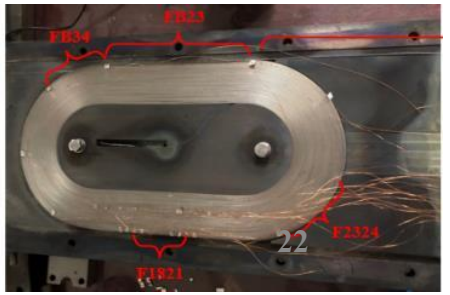
Advantages:

- "Metal", isotropic, …
- Cheap: material($Ba_{0.6}K_{0.4}Fe_2As_2$) and production(PIT, steel tube)

Status:

- Cable length >1000m with good Jc
- Small-scale cable production techniques understood
- Test coil successful





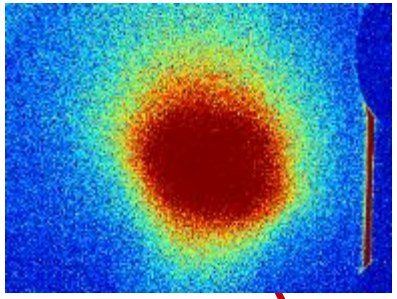
1st Iron-based Superconducting solenoid Coil at 24T

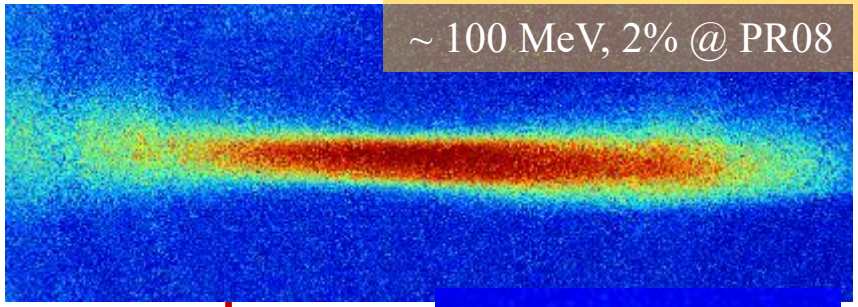
R&D for Far Future 2: Plasma accelerator

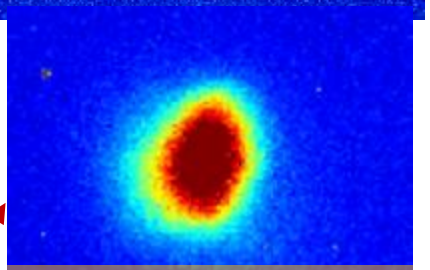
- Conceptual design for CEPC injector based on simulation: feasible
- A test facility based on the BEPCII LINAC has been constructed for
  - Cascading, positron acceleration, electron gun, laser, …
- Application for light sources, injectors, free electron laser, and 1-10 TeV e^+e^- Collider

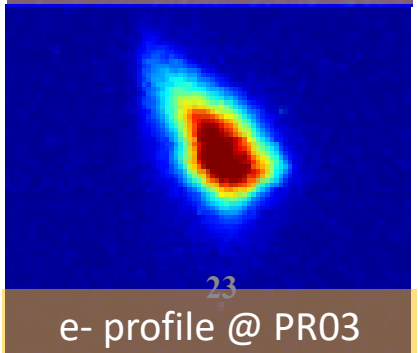


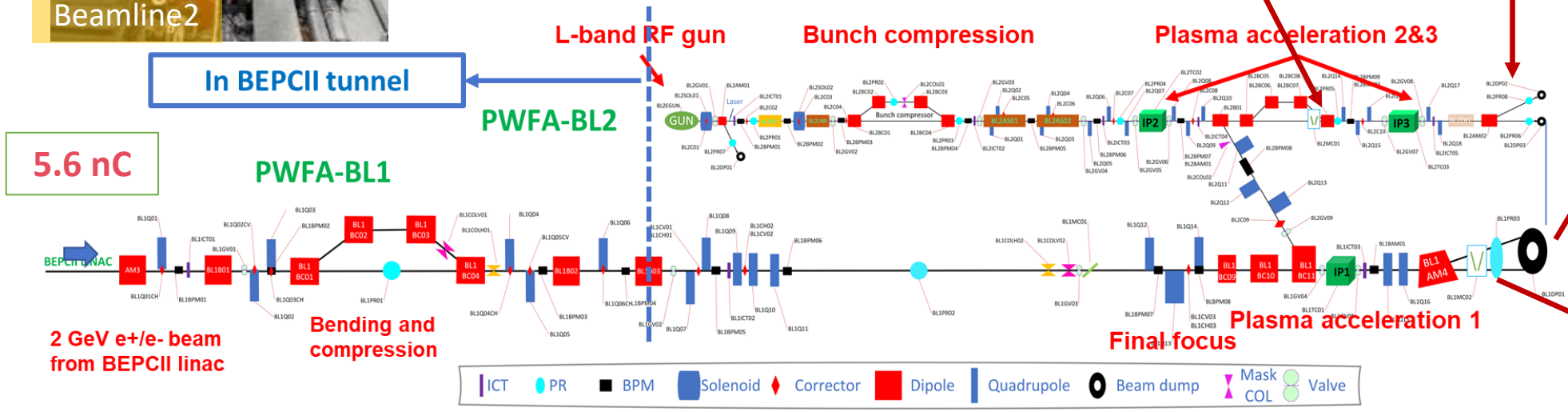












Summary

- Despite difficulties, we will continue to pursue High Energy Physics: road map is clear for us
- Accelerator design, R&D and EDR in progress, in exchange with FCC
- As an innovative concept, AGORA has been listed as a concept for FCC_ee: Glass scintillator is a very promising material, although a lot more R&D are needed
- Looking forward to (more) collaborations !