中国物理学会高能物理分会第十二届全国会员代表大会暨学术年会 广州 2026年7月15日

高能量前沿及探测器进展

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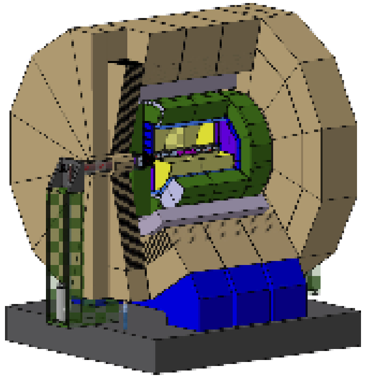
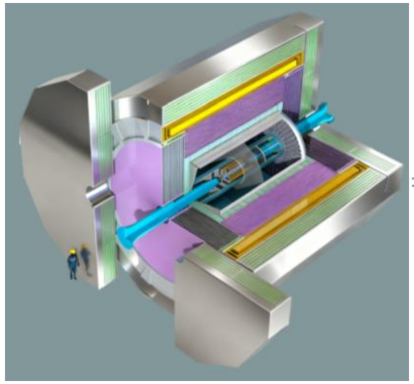
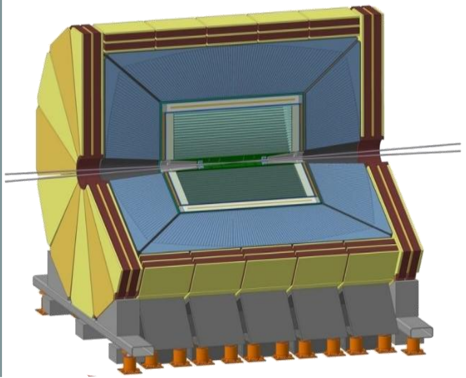
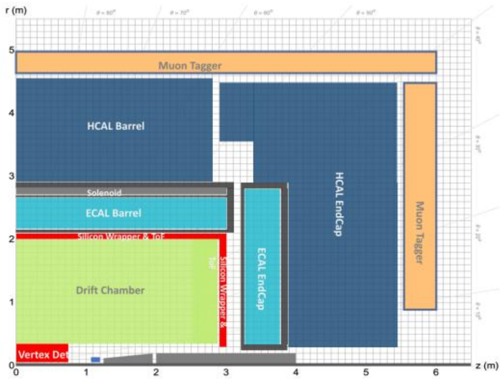
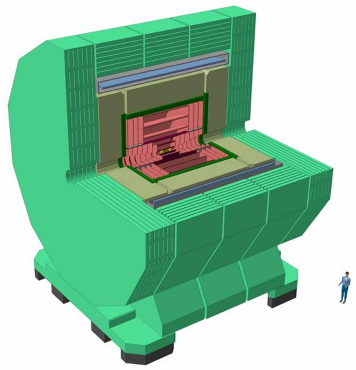
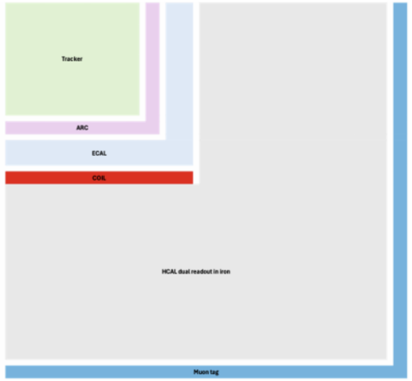
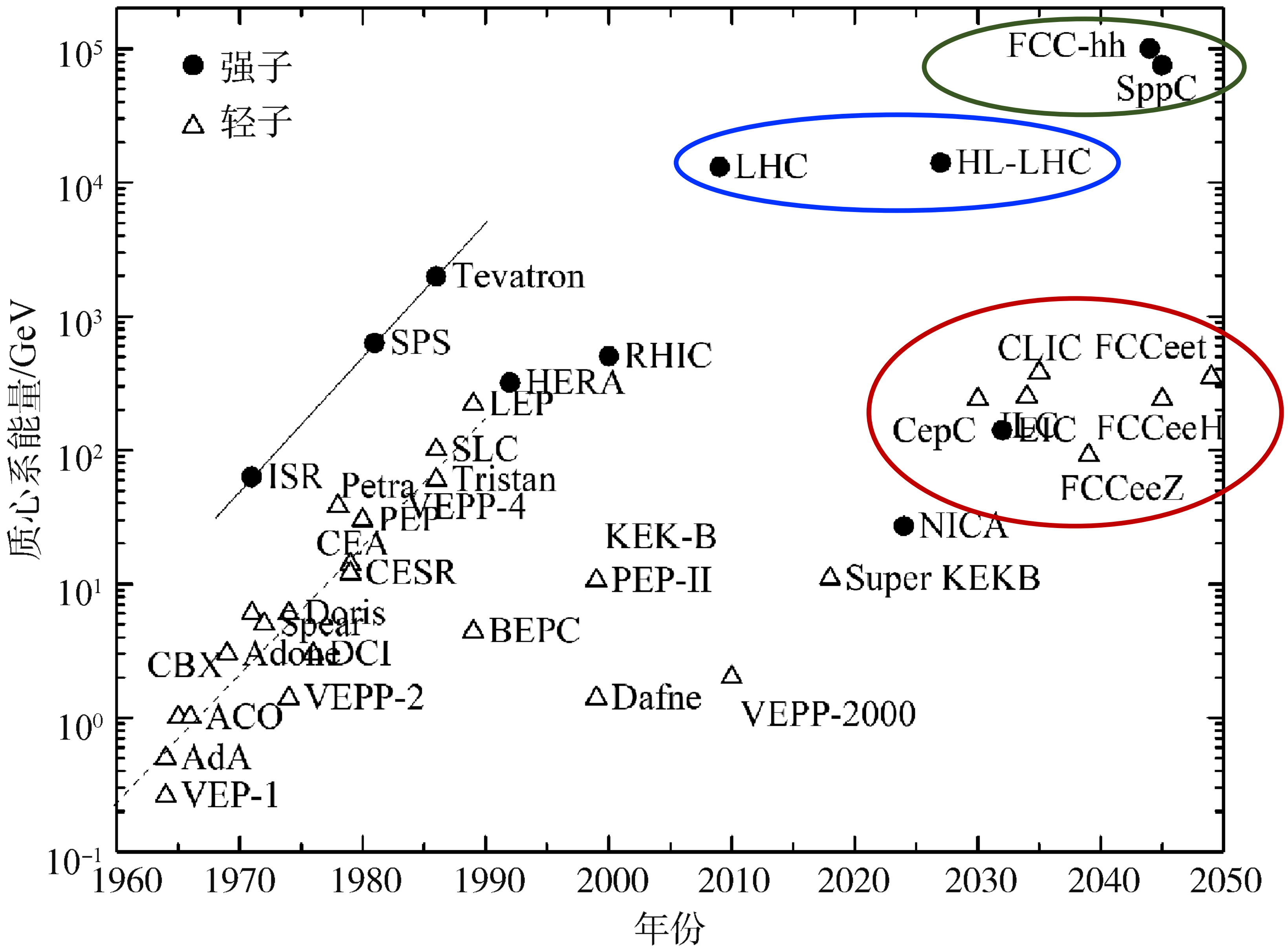
Chinese Academy of Sciences

国际高能量前沿对撞机



未来强子对撞机
(100 TeV量级)

强子对撞机
(10 TeV量级)

未来正负电子对撞机
(100 GeV量级)

对撞机建造时间与质心系能量之间的关系图

杨海军，王逗，高杰
[《物理》54卷 (2025年) 8 期]

LHC停机升级

CERN bids farewell to the LHC and enters Long Shutdown 3

The Large Hadron Collider is embarking on its most ambitious upgrade yet

–

29 June, 2026

https://home.cern/cern-bids-farewell-to-the-lhc-and-enters-long-shutdown-3/

- 2026年6月29日，LHC结束最后一个物理run，开始为期四年的长停机
- 基于铌三锡超导技术，升级加速器为High-Luminosity LHC，对撞亮度提高6倍，事例堆积、辐照剂量、数据率等均提高一个量级
- 升级ATLAS和CMS探测器和触发系统，制定LHCb和ALICE的升级计划

Mark Thomson
Director-General of CERN
Talk at FCC week in June, 2026

Maintaining this schedule is the highest priority for CERN
- essential to maintain the momentum for CERN's current flagship collider
- and essential for the transition to the next long-term project

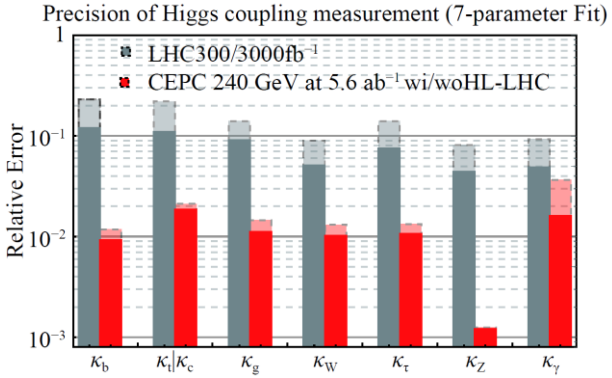
下一代高能对撞机：希格斯工厂

中国 欧盟 European Strategy Update ICFA 国际未来加速器委员会 美国 Community Summer Study SNOWMASS July 17-26 2022, Seattle Seattle Snowmass Summer Meeting 2022

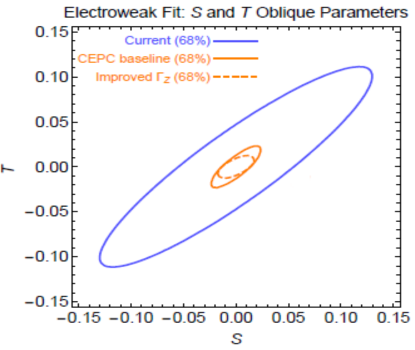
建设希格斯工厂是国内外共识

以CEPC为例，
与HL-LHC对比

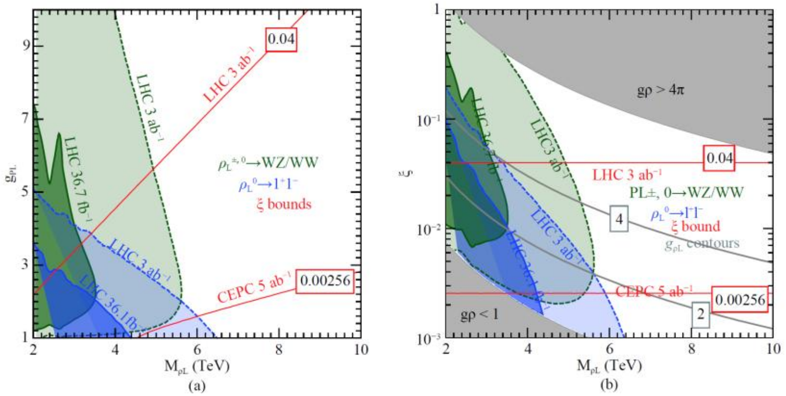
希格斯测量精度提高1个数量级



电弱测量精度提高 1-2个数量级



可探测新物理至10 TeV能区，提升大约一个量级



The CERN Council decided to update the European Strategy for Particle Physics

22 May, 2026

2026年5月，CERN更新了《欧洲粒子物理战略》

https://home.cern/the-cern-council-decided-to-update-the-european-strategy-for-particle-physics/

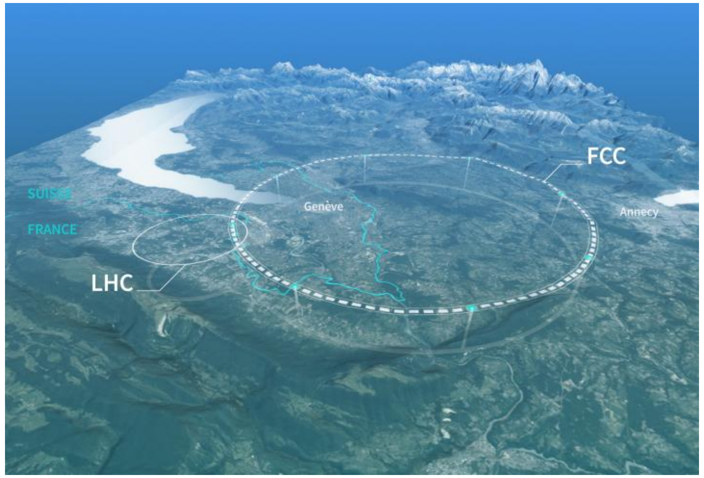
Artistic representation of the Future Circular Collider (FCC-ee) (Image: CERN)

欧洲未来首选方案：FCC-ee

- 首选方案: **FCC-ee**
  (91公里，91-365 GeV，50 MW，4个探测器)
- 备选方案: **Descoped FCC-ee**
  (91-240 GeV，30 MW，2个探测器)

Paris Sphicas
chair of ECFA
[Talk at FCC week in June, 2026]

At this stage, without knowing the reasons for which the FCC-ee would not be feasible, the other alternative options are not ranked.

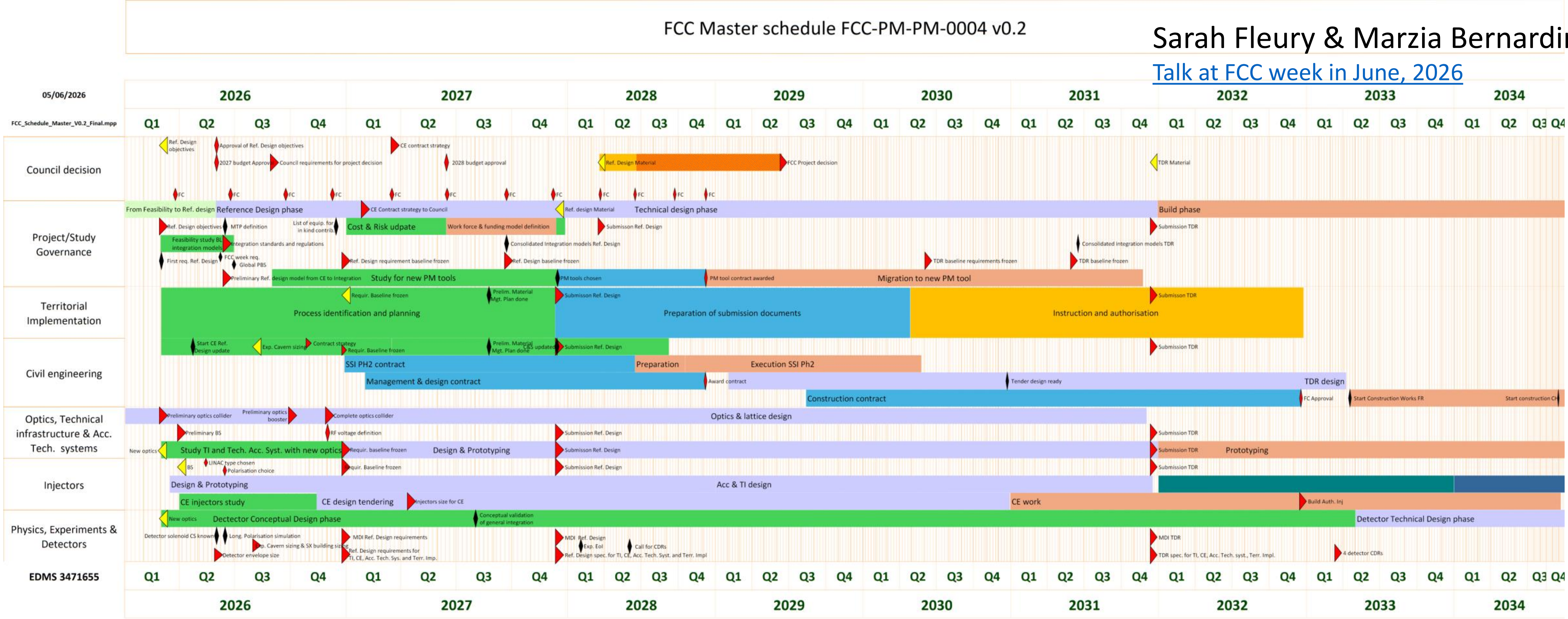


Machine	Precision Physics	BSM physics	Physics vs CEPC	Technical readiness	Constr. cost (BCHF)	Time scale	Path to ≥10 TeV
FCC-ee	22	23			15.3	2046-2060	
Descoped FCC-ee	15	17			12.9	2046-2055	
LCF550	15	17			14.8	2045-2065	
CLIC1500	14	18			14.6	2045-2066	
LCF250	10	16			9.4	2045-2053	
CLIC380	10	16			7.5	2045-2054	
LEP3	15	17			4.1	2047-2062	
LHeC	8	7			2.1	2044-2051	

Plan A

Plan B

FCC时间线



Sarah Fleury & Marzia Bernardini

[Talk at FCC week in June, 2026]

- CERN管理层在未来两年提交年度报告。
- 理事会计划在2028-2029年做决定。
- 2032年开建，2046年运行。

Procure
Study
Design
Build
Instruction
Production
Installation
Decision point
Requirements
Milestones
Output
Input

BL: Baseline
BS: Bunch Spacing
C&S: Cost and Schedule
CS: Compensation scheme
PM: Project Management
RF: Radiofrequency
SSI: Sub-surface Site Investigation
TDR: Technical design report

美国和日本的规划

美国对希格斯工厂的规划

Dec. 2023 P5 Report: "An offshore Higgs factory, realized in collaboration with international partners, in order to reveal the secrets of the Higgs boson. The current designs of FCC-ee and ILC meet our scientific requirements." — Agnostic

May 2024 CERN-US Joint Statement: "Should the CERN Member States determine the FCC-ee is likely to be CERN's next world-leading research facility following the high-luminosity Large Hadron Collider, the United States intends to collaborate on its construction and physics exploitation, subject to appropriate domestic approvals." — FCC

Aug. 2024 US HFCC: Charge letter mentions both FCC and ILC. — Agnostic

Mar. 2025 HFCC ESPP Input: "We strongly support FCC-ee as the next major flagship project at CERN." — FCC

Jun. 2025 NAS Report: "The United States should participate in the international Future Circular Collider Higgs factory currently under study at CERN to unravel the physics of the Higgs boson." — FCC

Aug. 2025 US HF FCC: Decision by DOE to reorganize the Higgs Factory Coordination Consortium into the Higgs Factory Circular Collider Organization (HFCC -> HF FCC). — FCC

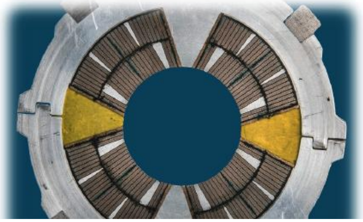
Spencer Gessner, SLAC
Linear Collider@CERN Workshop, Jan. 2026
https://indico.cern.ch/event/1602105/contributions/6836106/

2023年P5 report同时提到FCC-ee和ILC → 2025年确定支持FCC-ee

美国对未来10TeV对撞机的规划

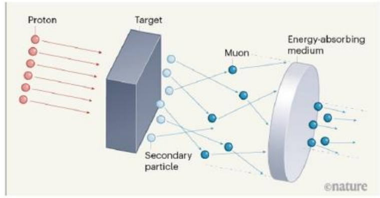
The P5 Report Recommends vigorous R&D toward a cost-effective 10 TeV pCM collider based on proton, muon, or possible wakefield technologies.

Proton-Proton Collisions at 100 TeV



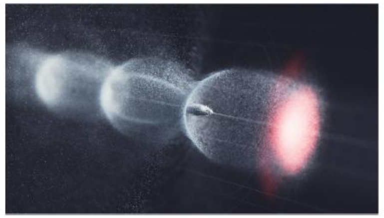
支持力度加大 ↗

The Muon Collider



支持力度加大 ↑

Wakefield Acceleration



支持力度减小 ↘

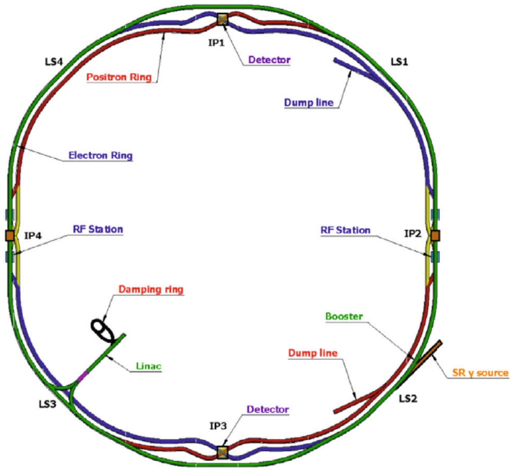
日本对ILC的规划

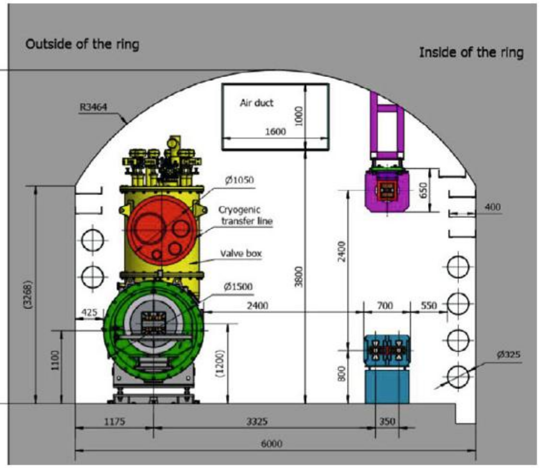
Shoji Asai
Director-General of KEK
Talk at Open Symposium on the European Strategy for Particle Physics in June, 2025

单一实验室无力独立承建未来对撞机项目。……未来对撞机有赖各国及区域实验室开展全球合作，整合全球各类资源，包括人力资源。

CEPC

- **2012年提出，正负电子对撞，质心能量91-240 GeV，可以产生海量的希格斯、Z和W粒子。升级到360 GeV后产生$t\bar{t}$。**
- **设计方案：** CEPC加速器主体由直线段、增强器、储存环组成；有两个对撞点容纳探测器
- **共享隧道:** CEPC增强器、对撞环及未来SppC共用同一隧道（早于FCC的概念）
- **100km周长:** 性价比最优的选择
- **能量灵活切换:** 原创性Higgs，W，Z 等多能量模式运行（被FCC采用）





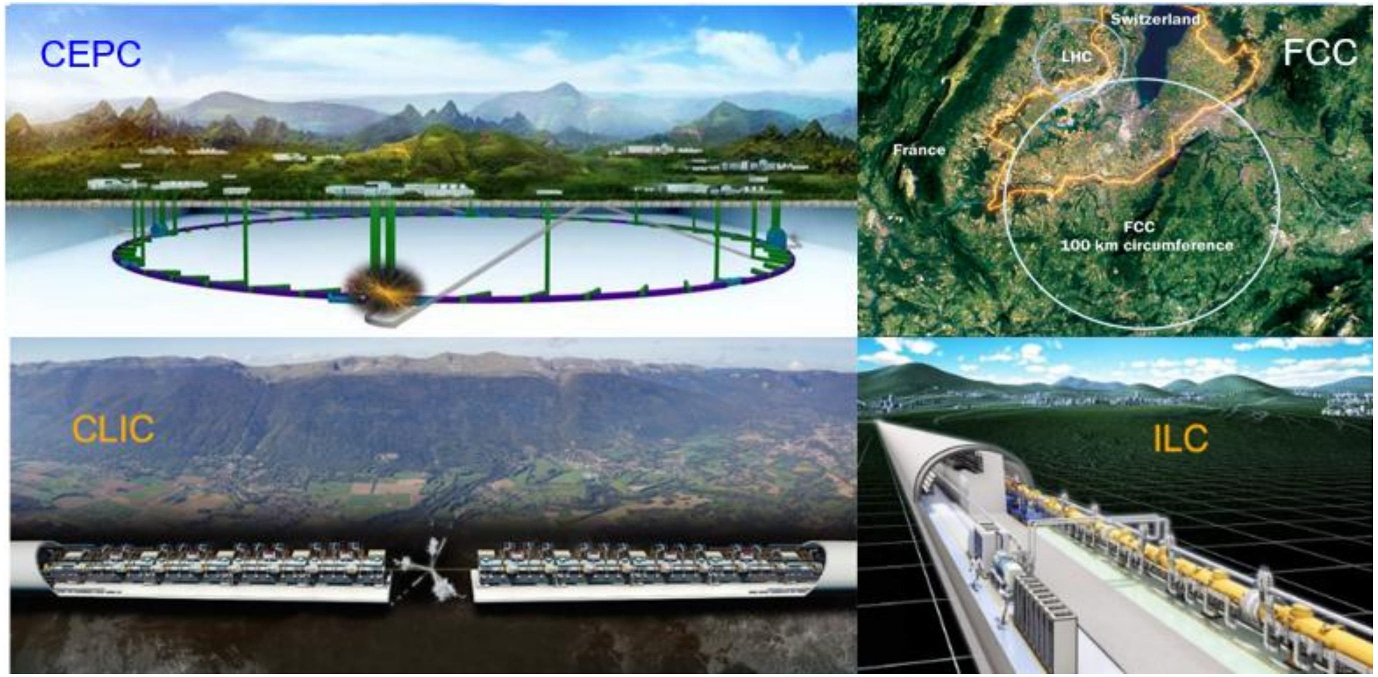
基本运行方案

Operation mode	$\sqrt{s}$ (GeV)	SR power (MW)	$\mathcal{L}$ (10^{34} cm^{-2}s^{-1})	$\int \mathcal{L}$/year (ab^{-1})	Years	Total $\int \mathcal{L}$ (ab^{-1})	Event yields
H	240	30	5	0.65	15	10	2.0×10^6
Z	91	12.1	26(*)	3.2	4	13	5.6×10^{11}
W^+W^-	155-170	30	16	1.2	1	1.2	1.0×10^7(†)

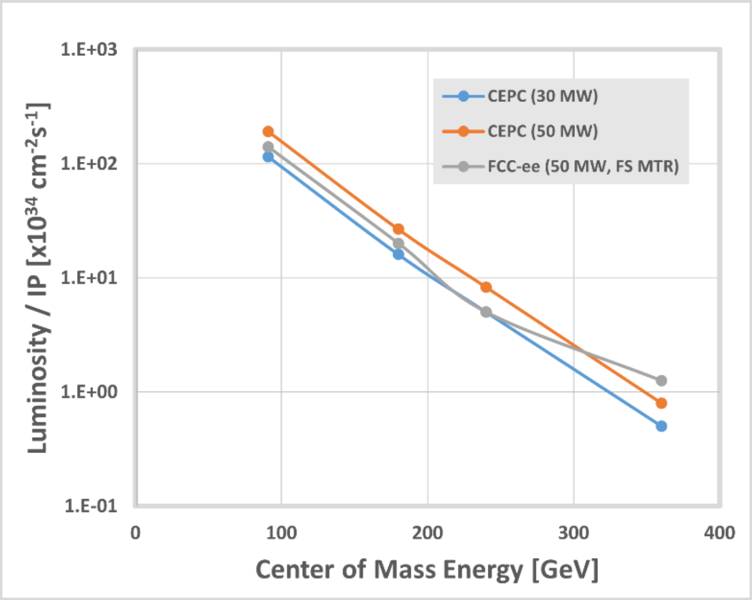
获得国际贡献后的升级运行方案：提高功率和能量

Operation mode	$\sqrt{s}$ (GeV)	SR power (MW)	$\mathcal{L}$ (10^{34} cm^{-2}s^{-1})	$\int \mathcal{L}$/year (ab^{-1}, 2 IPs)	Years	Total $\int \mathcal{L}$ (ab^{-1}, 2 IPs)	Event yields
H	240	50	8.3	2.2	10	21.6	4.3×10^6
Z	91	50	192(*)	50	2	100	4.1×10^{12}
W^+W^-	155-170	50	26.7	6.9	1	6.9	5.5×10^7
$t\bar{t}$	360	50	0.8	0.2	5	1.0	0.6×10^6

国际希格斯工厂比较



对撞亮度 / IP (CEPC vs FCC-ee)



直线希格斯工厂无优势，CEPC 在环形方案中有明显优势（共识：FCC/CEPC只建一个）

相比欧洲 FCC-ee
- 性能略好，使用灵活
- 建造成本低，时间短，性价比高

相比日本ILC和欧洲CLIC
- 性能好5-10倍
- 覆盖至90GeV能区（Z）
- 隧道可为质子对撞机复用

	CEPC	FCC	ILC	CLIC
计划开建时间	2032	2032	2030	2035
亮度($10^{34}cm^{-2}s^{-1}$)	5-8	5-8	~1	~1
造价(亿人民币)	380	1200	500	522

CEPC未来规划

- CEPC IB会议讨论结论 （2025年11月8日）
  - ➢继续在国内推进CEPC预研和立项
  - ➢加强和Cern的合作建设未来正负电子对撞机希格斯工厂

- 高能所“十五五”规划
  - ➢继续推进高能量前沿粒子物理研究和技术发展
  - ➢CEPC加速器与探测器作为前沿方向与未来技术之一
  - ➢深挖CEPC物理潜力，完成加速器工程设计报告，开展探测器关键技术研发

- CEPC下一步计划和目标
  - ➢如果FCC-ee在2030年以前立项，则放弃CEPC，加入FCC-ee
  - ➢如果FCC-ee在2030年以前未立项，则继续申请CEPC在“十六五”立项

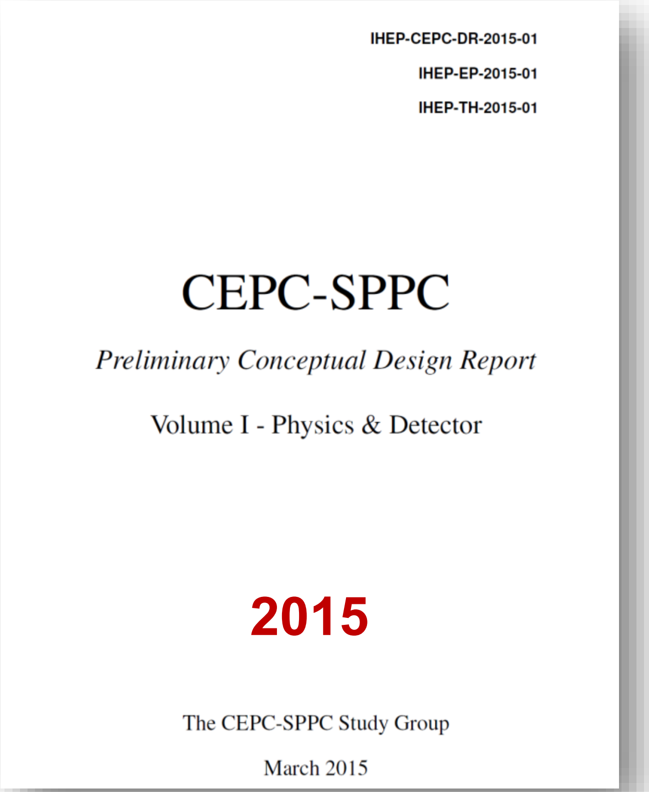
Xinchou Lou

Talk at CEPC workshop in Lisbon in April, 2026

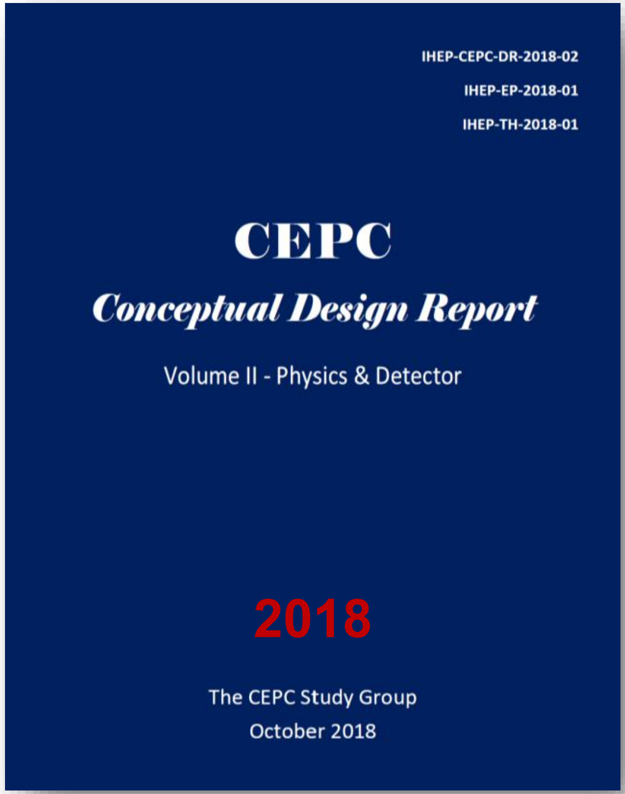
Build synergetic scientific collaboration to ensure that a future Higgs+Z+W boson factory will be realized, and that Chinese HEP community will be at the forefront of the particle physics programs

CEPC基准探测器 （Reference Detector）

- **2025年10月6日发布技术设计报告 (TDR)**
- 19章（含ILD、IDEA各1章），669页
- 来自**43**个国家或地区、**383**个单位的**1474**位作者



初步概念设计报告



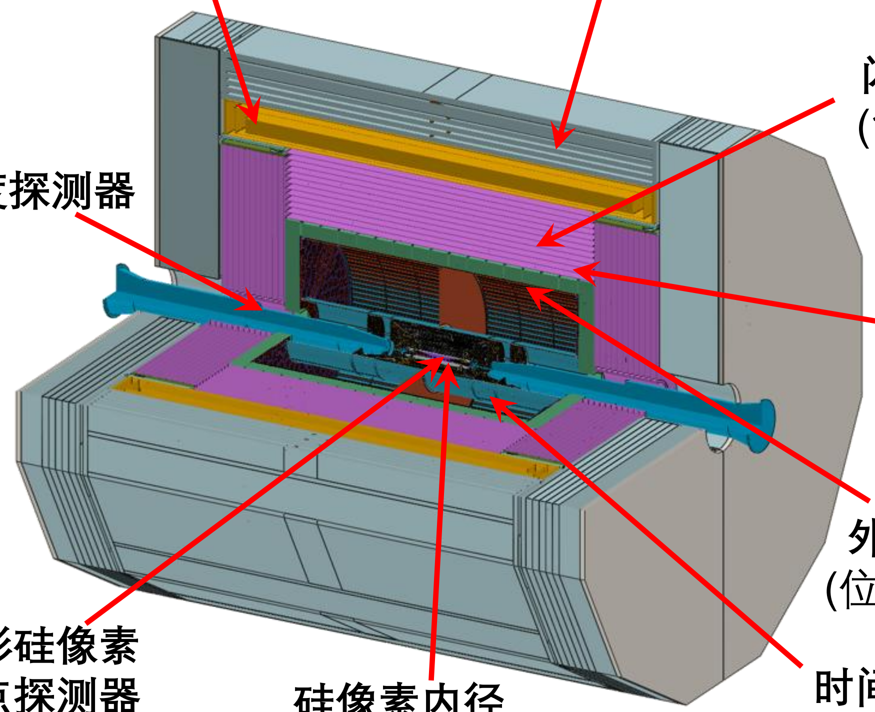
概念设计报告

技术设计报告

探测器整体设计

Sub-system	Technologies
Beam pipe	Beryllium, ϕ 20 mm
LumiCal	Silicon tracker + LYSO crystals
Vertex	Si Pixels: CMOS MAPS+stitching
Inner tracker (ITK)	Si Pixels: CMOS MAPS 55-nm
Gas detector	TPC with high granularity
Outer tracker (OTK)	AC-LGAD → TOF
ECAL	4D transverse crystal bars
HCal	Glass scintillator, SiPM + Fe
Magnet	LTS Solenoid
Muon	Plastic scintillator bars, SiPM
TDAQ	Conventional
Back-end electronics	Common

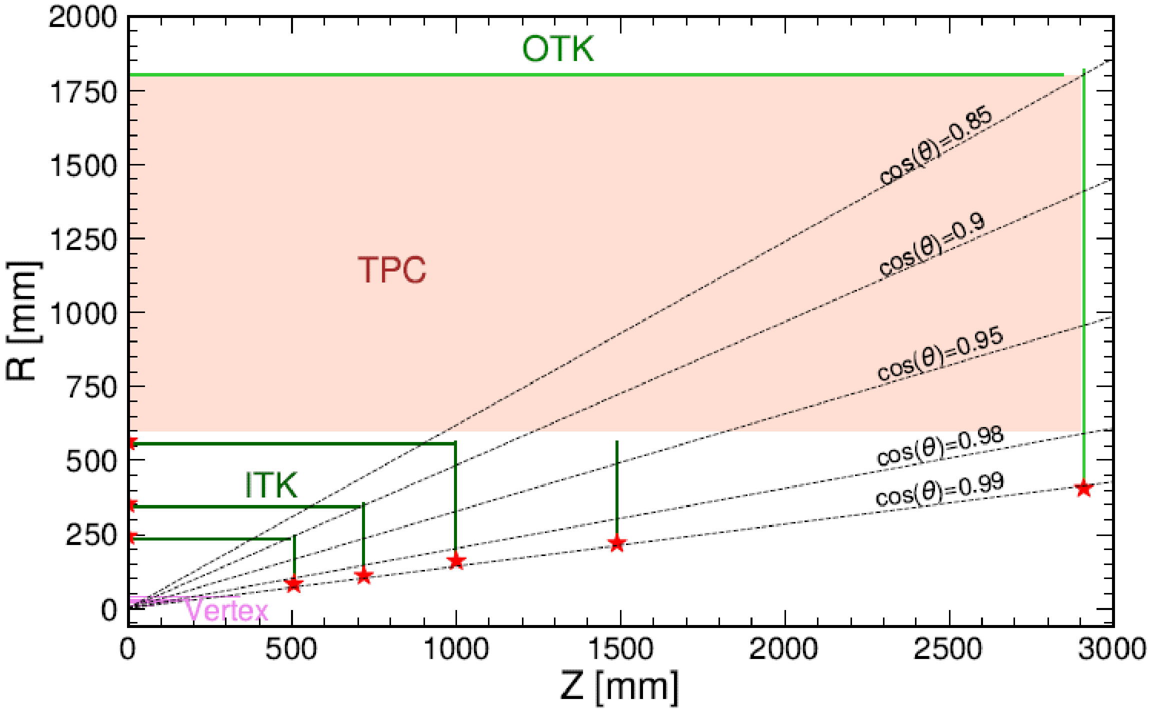
10×10×12 米^3, ~5000吨



顶点和径迹探测系统

硅探测器
- 顶点探测器 Vertex
- 内径迹探测器 inner tracker
- 外径迹探测器 outer tracker

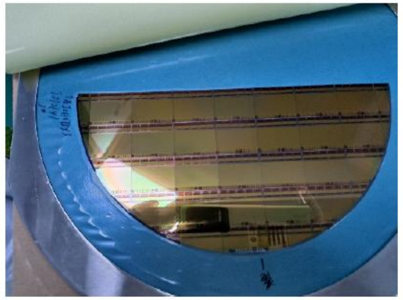
气体探测器
- 时间投影室TPC

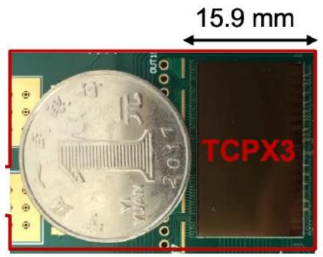


- 主要性能指标
  - 动量分辨 $\delta p/p$~0.3%@100GeV，精确测量希格斯玻色子衰变等电弱过程的性质
  - 径迹位置精度好于10μm，提供精确的径迹分辨能力
  - 电离能损分辨3%，外层时间测量50ps，在20GeV以下π/K/p粒子类型鉴别达到3σ水平

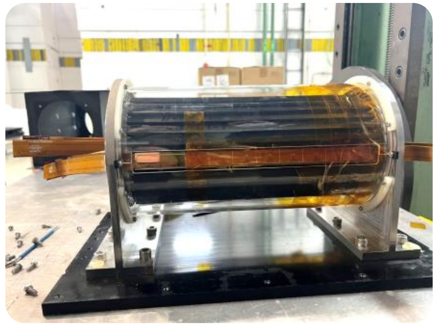
硅探测器核心技术

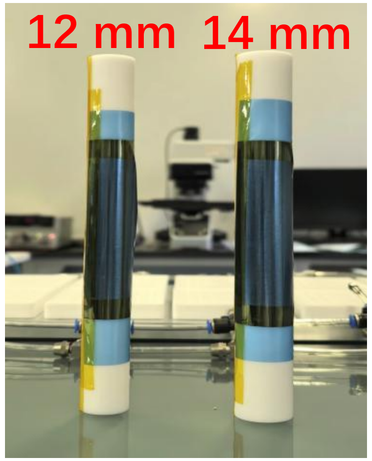
- **顶点探测器:** 弯曲的**MAPS** (Monolithic Active Pixel CMOS), 低物质量 (0.8%X_0) 、低功耗，位置分辨5 μm





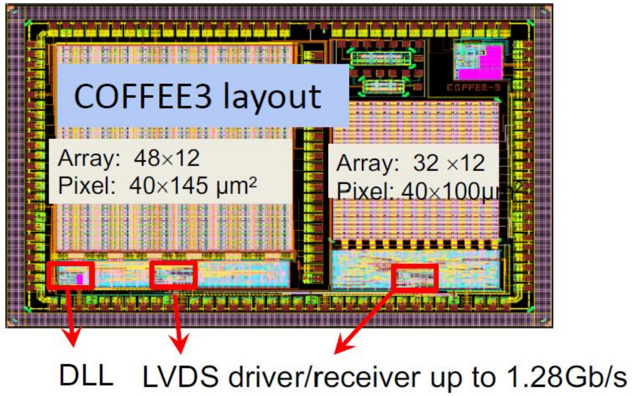
TaichuPix-3 chip vs. coin

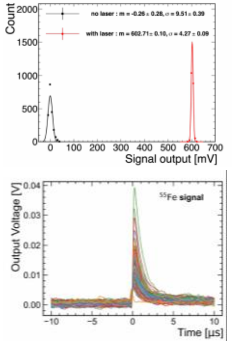




顶点探测器样机
(平面芯片)

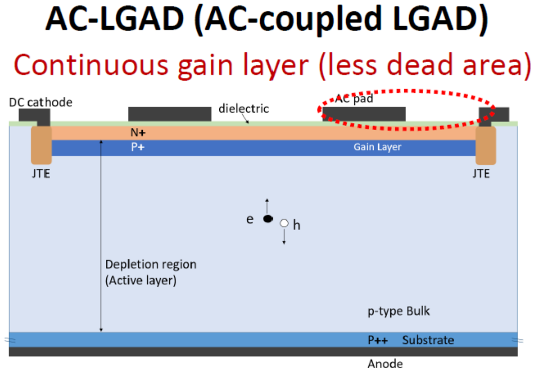
- **内径迹探测器:** 20 m² **HV-CMOS** MAPS硅像素，**55 nm** 工艺，位置分辨8 μm

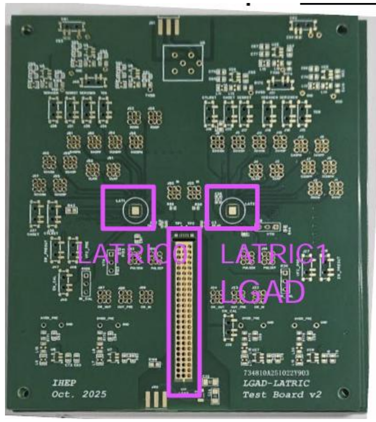




利用激光和放射源测试
COFFEE芯片性能

- **外径迹探测器:** 85 m² **AC-LGAD**硅微条，空间分辨10 μm，时间分辨50 ps

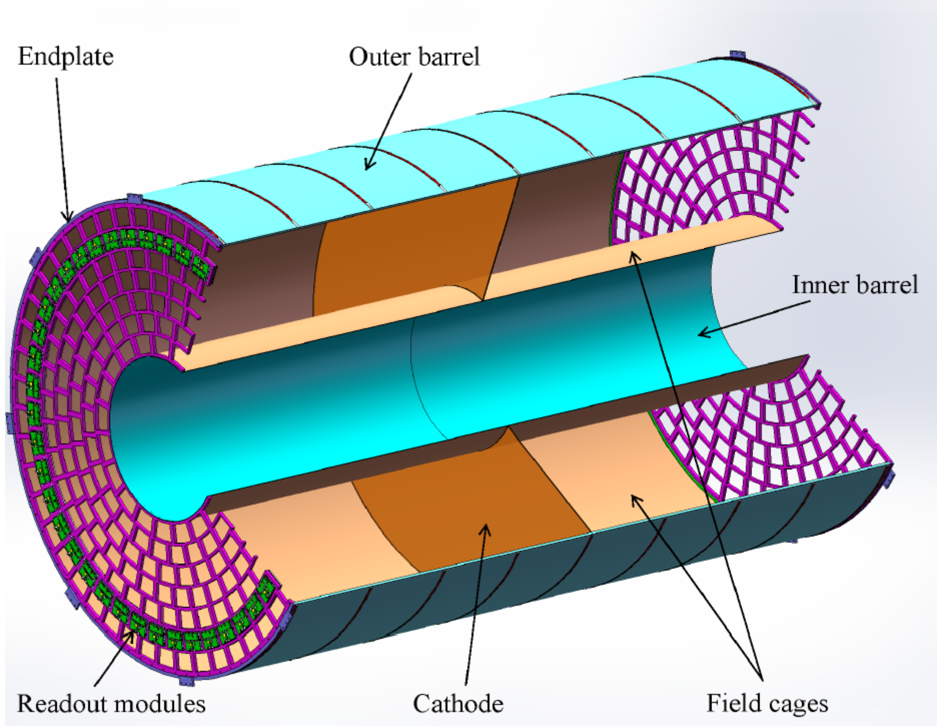




AC-LGAD传感器及专用读出
芯片LATRIC联合测试

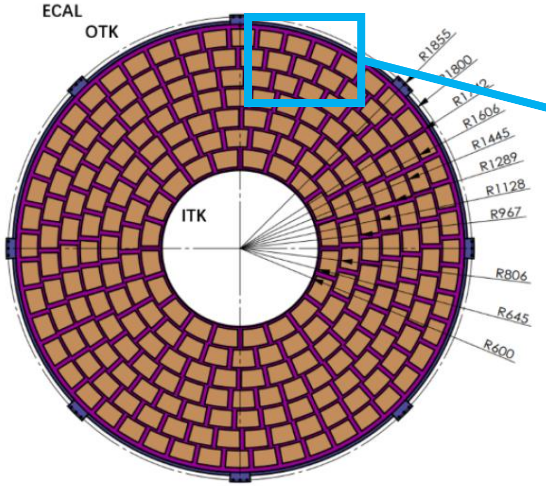
时间投影室 (TPC)

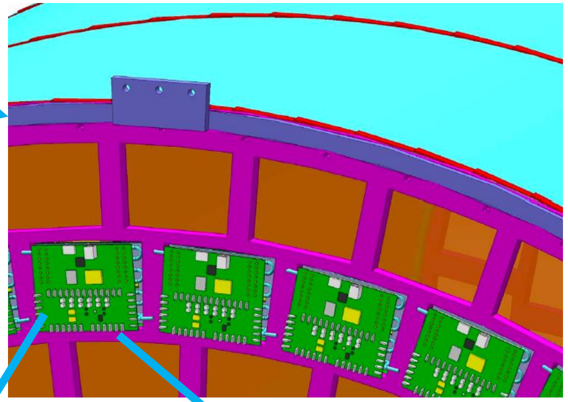
- 内外两个碳纤维复合材料圆桶，表面分布铜条形成电场笼，两边端盖，工作气体$Ar/CF_4/iC_4H_{10}$ = 95/3/2, 低横向扩散和高漂移速度。

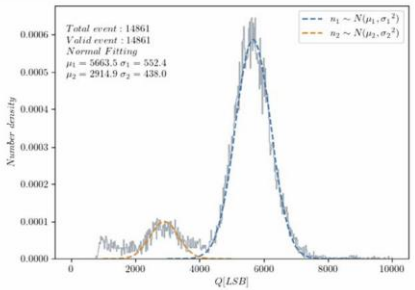


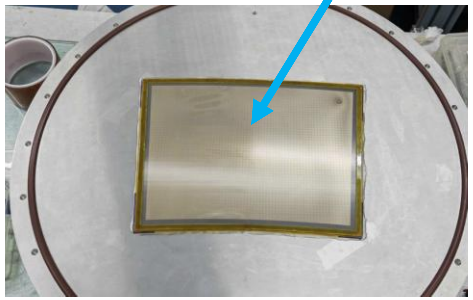
Length: 5.8 m, R extension: 0.6-1.8 m.

- 微结构气体探测器（MicroMegas）读出像素大小500×500 μm²，实现100 μm径迹重建精度和3%的dN/dx









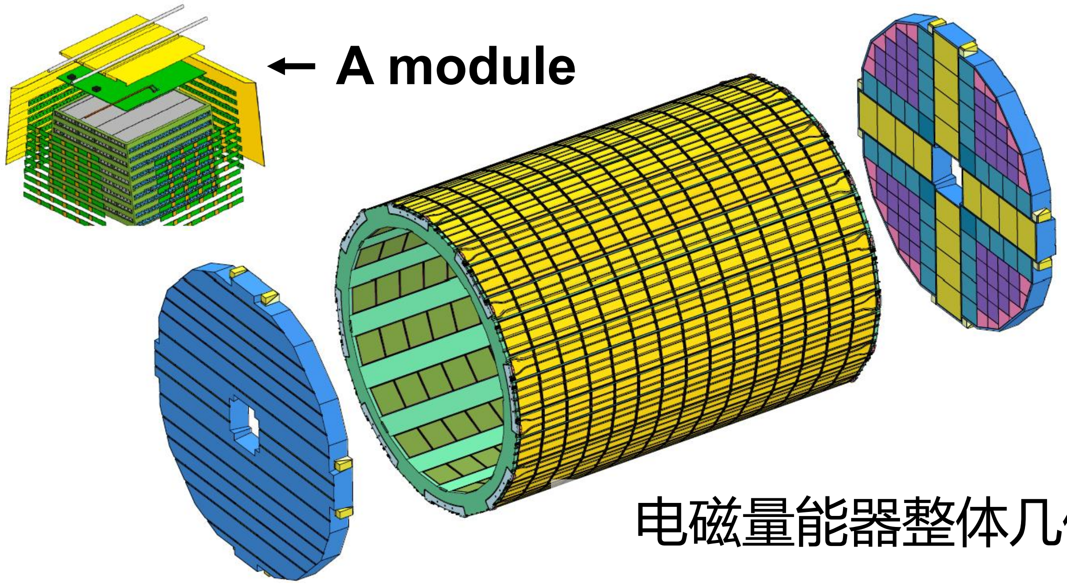
TPC小模型加micromegas读出，与TEPIX联合测试进行中

TEPIX: 低功耗专用读出芯片 (<100 mW/cm²)

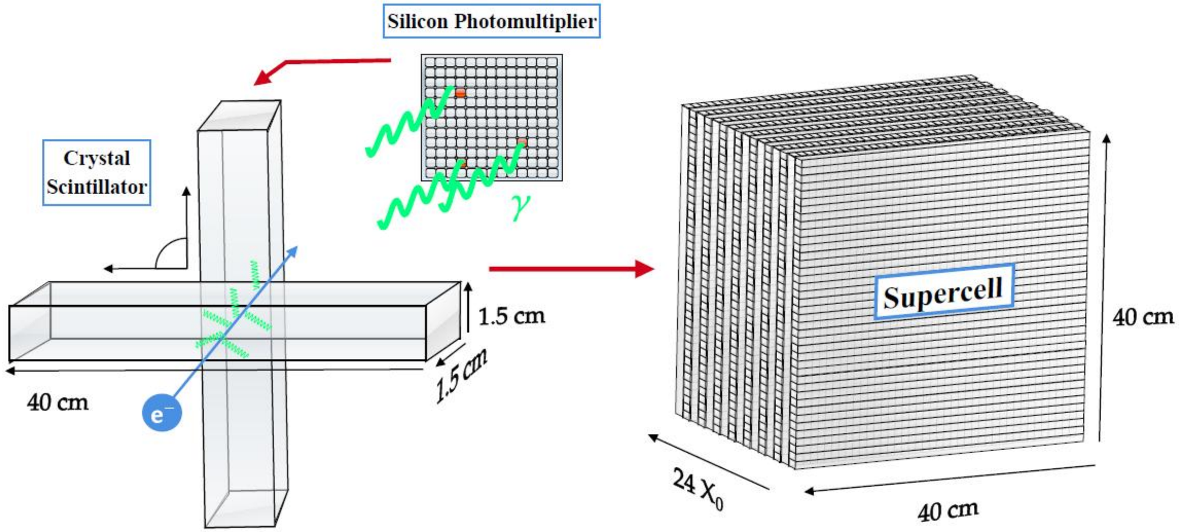
全吸收型电磁量能器

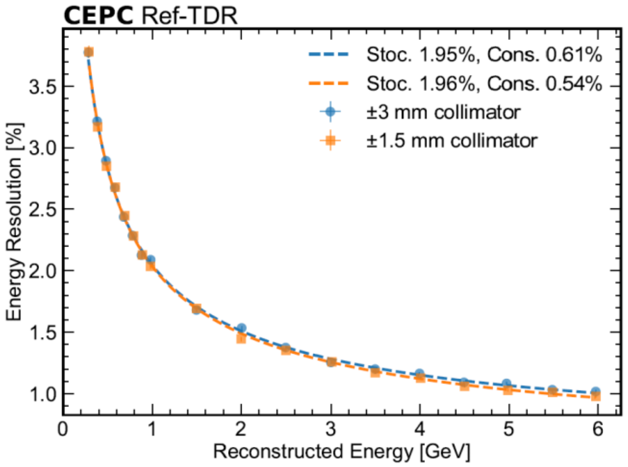
- 18层**BGO**晶体（24 m³），单元尺寸1.5×1.5×40 cm³，垂直于束流方向正交排列，双端硅光电倍增器（SiPM）读出（570,000 路），通过特殊的粒子流软件算法实现高颗粒度
- 极佳的电磁能量分辨率（2025年束流测试结果）：

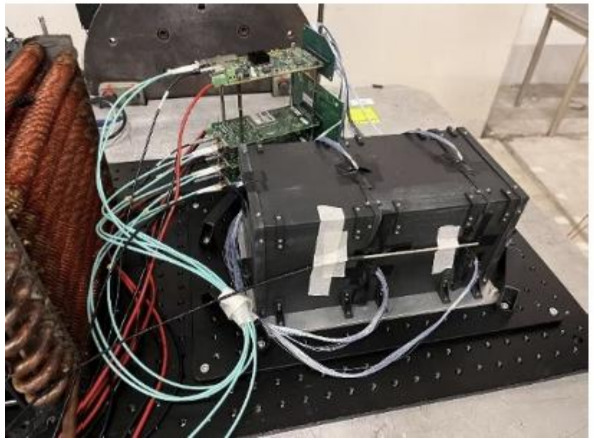
$$1.96\,\%/\sqrt{E(\mathrm{GeV})} \oplus 0.54\,\%$$



电磁量能器整体几何



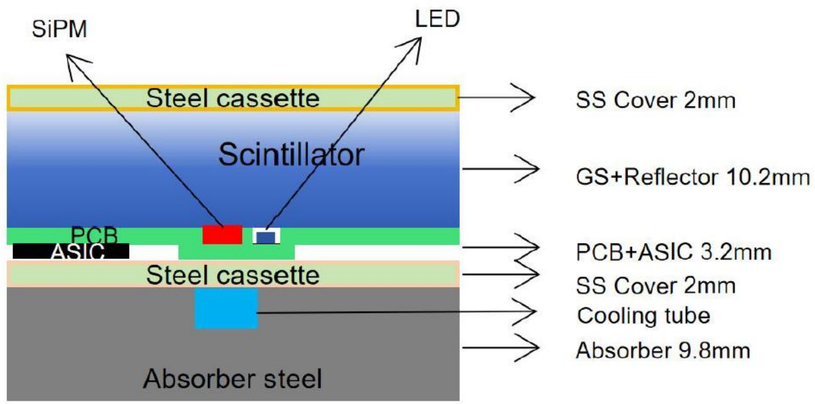




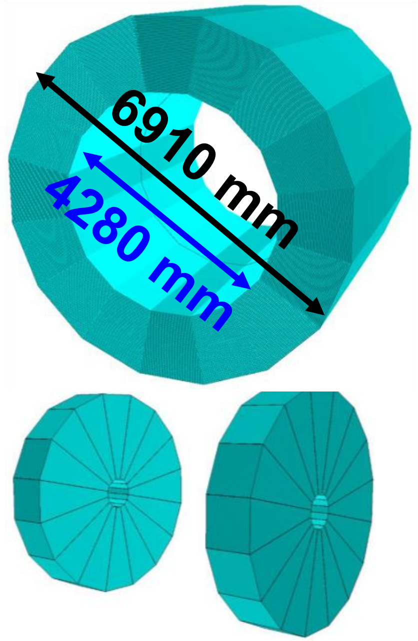
电磁量能器样机及束流测试: 72 BGO + 12 BSO晶体阵列12×12×28 cm³ (24.9 X_0)

基于闪烁玻璃的取样型强子量能器

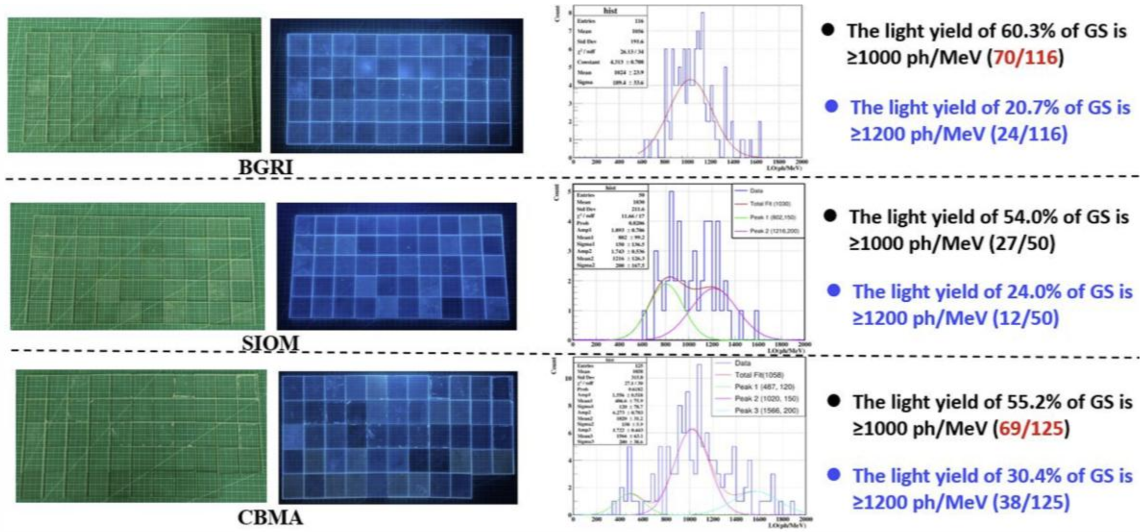
- 48层闪烁玻璃 (85 m³)和吸收铁，总厚度6λ_I，采样率30%，强子能量分辨~30%/$\sqrt{E}$
- 单片玻璃尺寸4×4×1 cm³，>5百万路SiPM读出
- 关键技术：高密度（6 g/cm³）、高光产额 (1500 ph/MeV) **闪烁玻璃**



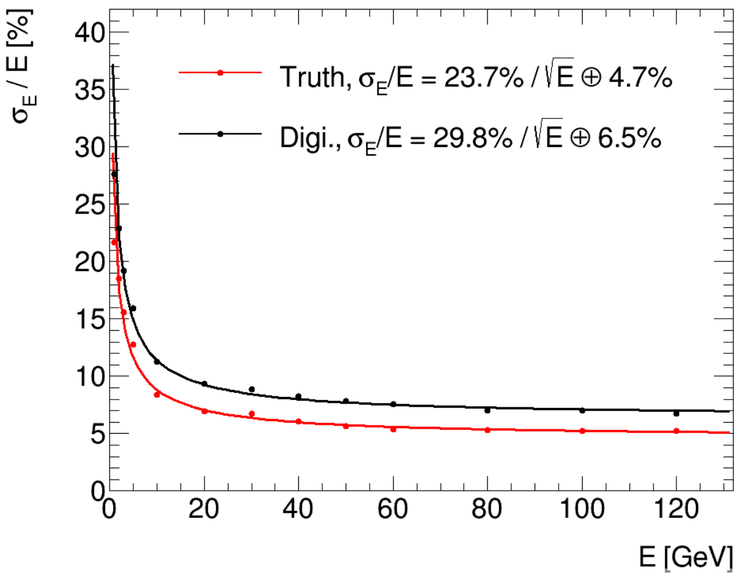
探测单元结构图



强子量能器整体几何



闪烁玻璃样品



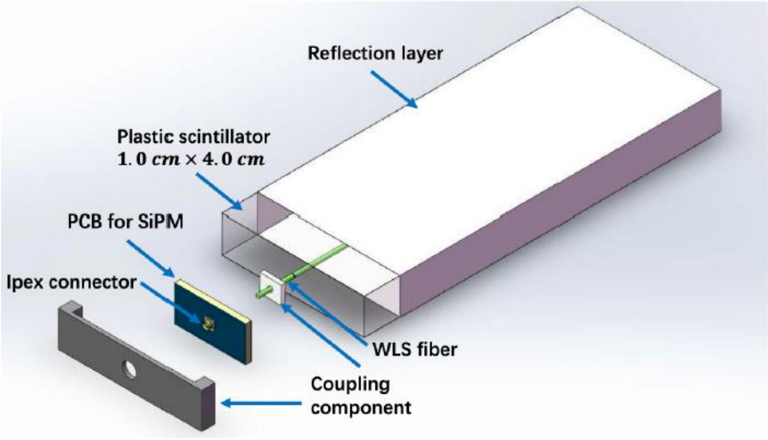
模拟得到的能量分辨率

缪子探测器

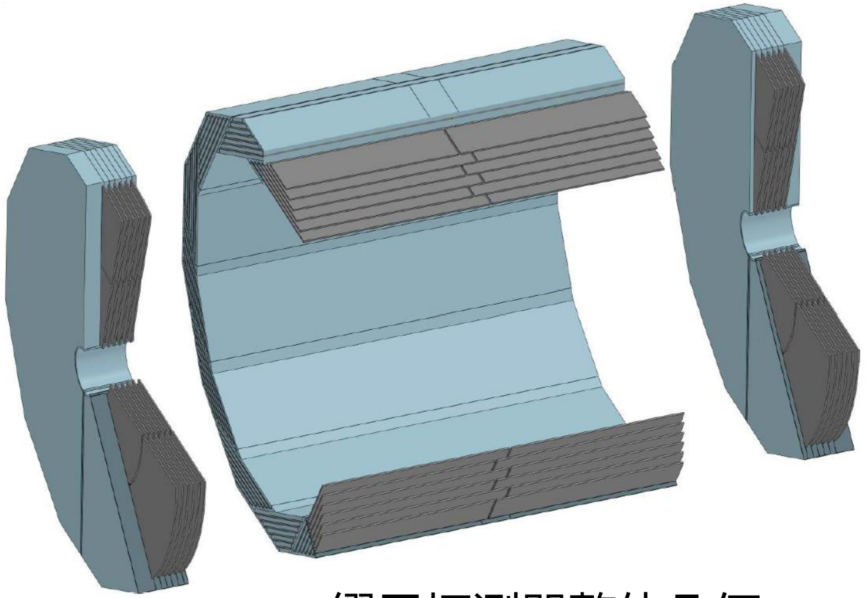
6 层塑料闪烁体与轭铁交错排列

- 覆盖立体角: > 98% × 4π
- μ 鉴别效率: > 95%
- $\pi \rightarrow \mu$ 误判率: <1%
- 空间分辨: ~1 cm
- 时间分辨: ~1 ns
- 最高事例率: 50 Hz/cm^2

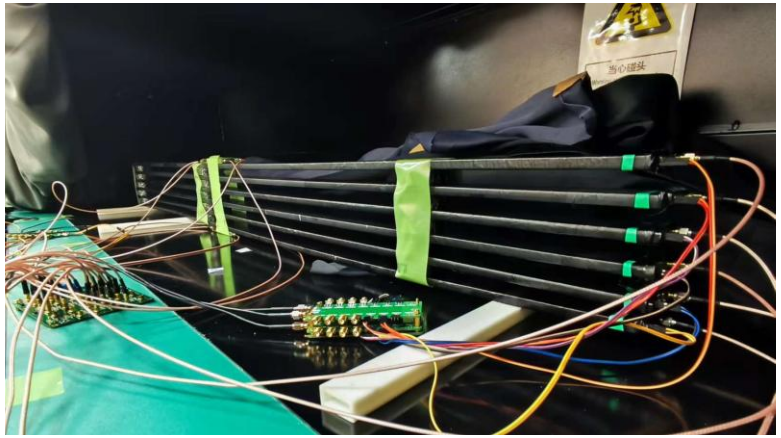
关键技术：长条塑料闪烁体加波移光纤，SiPM和读出电子学



读出单元设计



缪子探测器整体几何



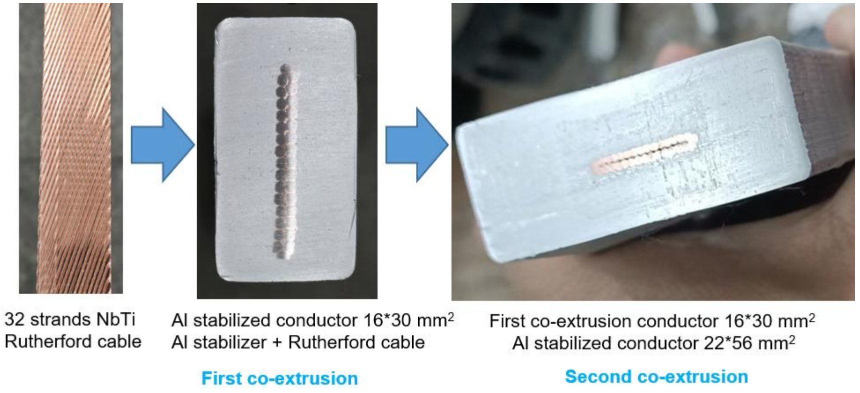
6层探测器模型

5米长塑料闪烁体样品

探测器磁体

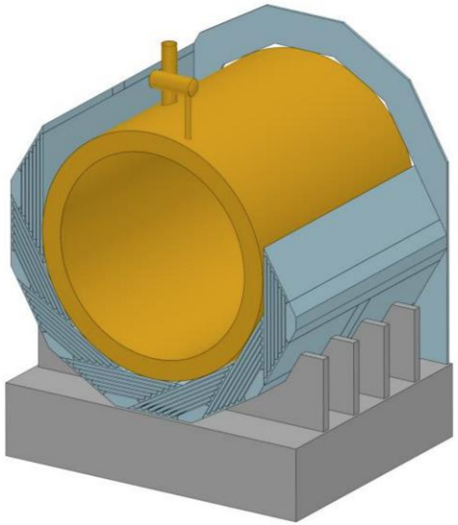
- 基于低温(4.5K)超导铌钛合金(NbTi)的螺线管磁体方案
- 32芯NbTi卢瑟福电缆，绞制工艺验证通过
- 双层共挤出Box-type：内层纯铝稳定体，外层铝合金加强

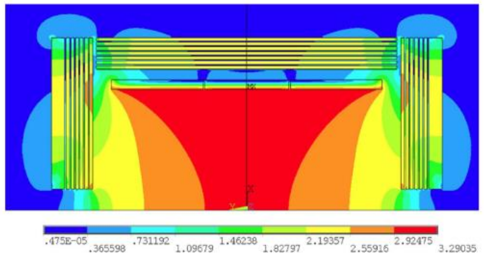
完成50米32芯NbTi卢瑟福电缆



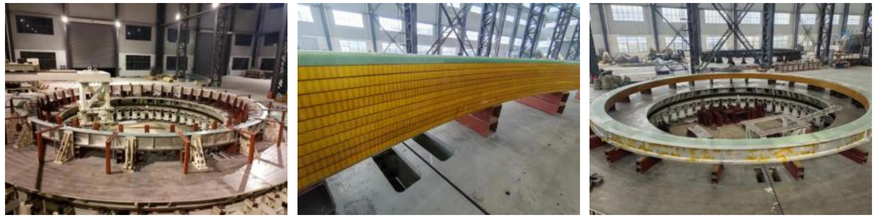
完成50厘米-5米双层共挤出全尺寸截面电缆

中心场强	3 T
内径	7.07 米
外径	8.47 米
厚度	0.7 米
长度	9.05 米
轭铁重量	2960 吨
磁体重量	250 吨





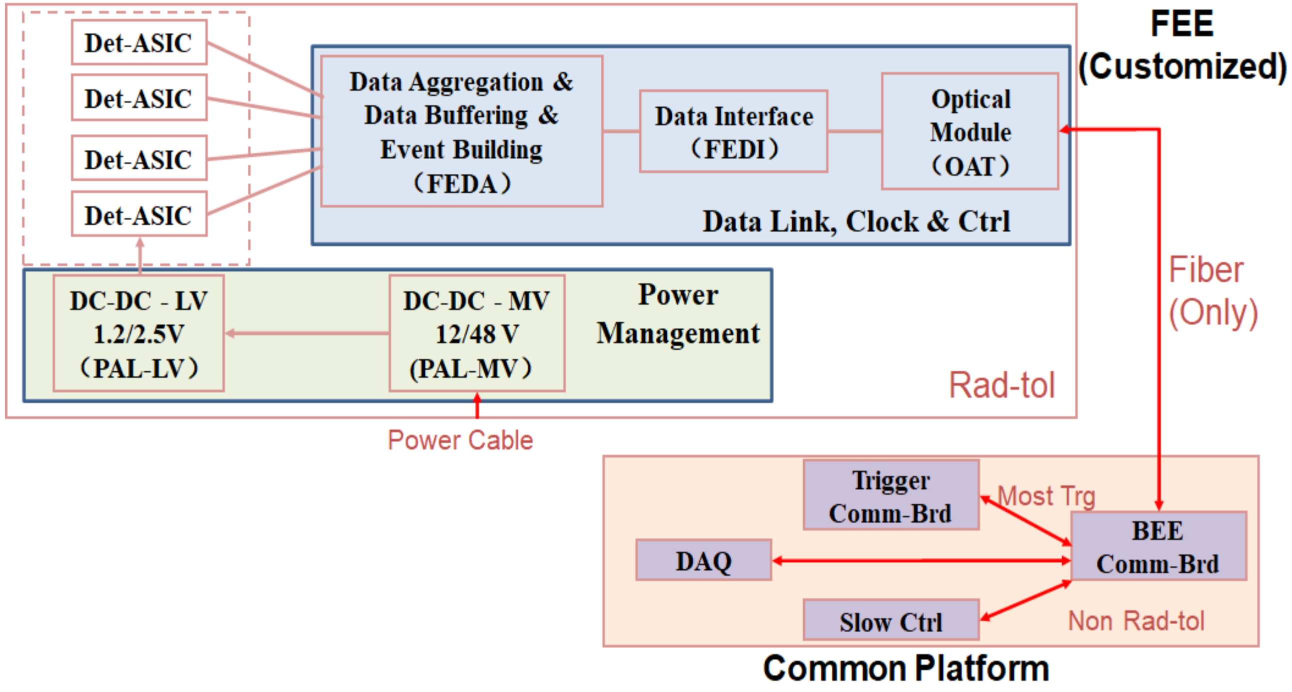
磁场分布，最大非均匀性7%



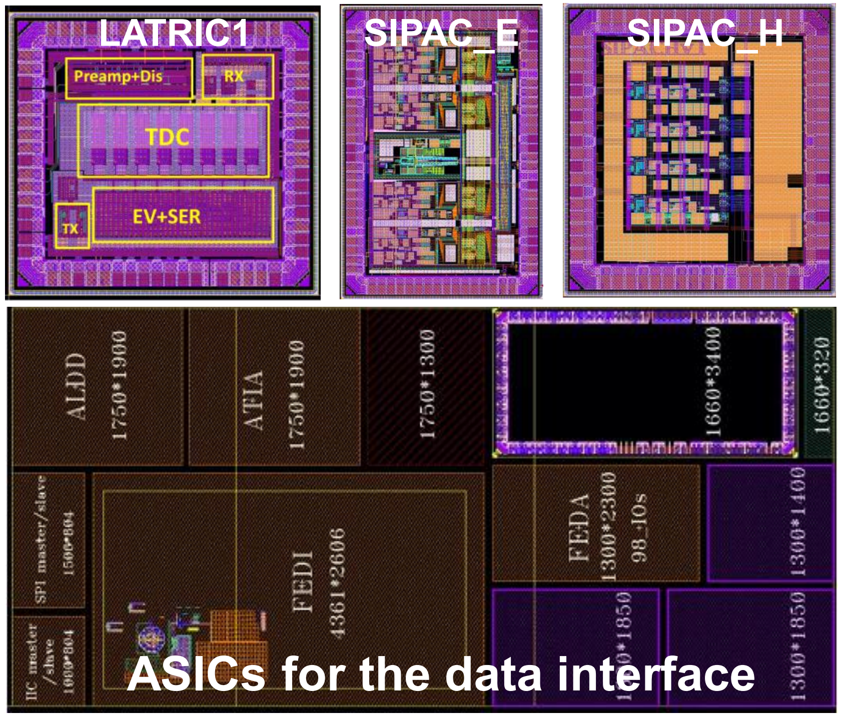
大型超导磁体绕制平台和全尺寸模型线圈

统一的电子学和数据读出方案

- 数据读出总体策略：全数据传输
  - 保留探索新物理的最大可能性
  - 简化专用集成电路（ASIC）设计
  - 最大化了电子学系统设计的通用性
  - 足够的容量和灵活的升级空间
- 触发和数据获取
  - 系统需要从TBytes/s量级的探测器原始数据中，通过软硬件快速实时并行处理，挑选出更多的候选物理事例，并压缩到至数个GBytes/s量级保存。



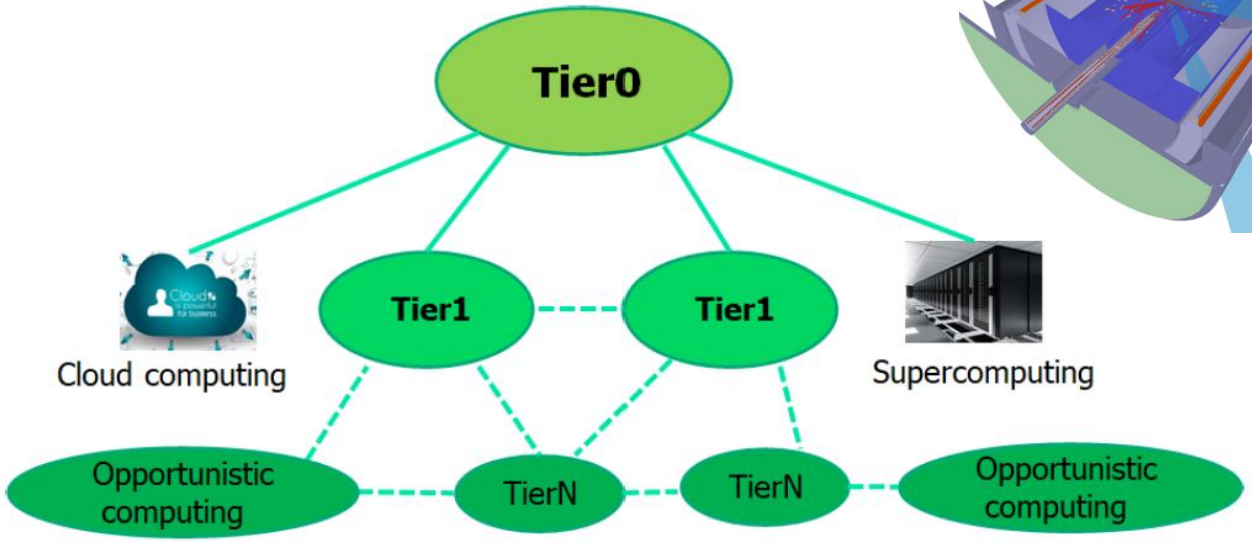
通用电子学和数据读出框架

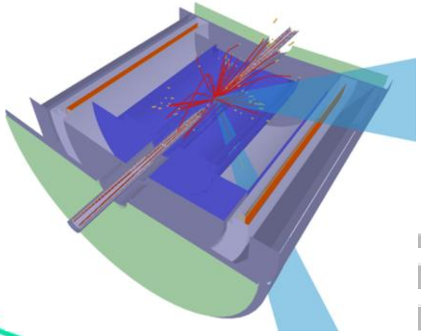


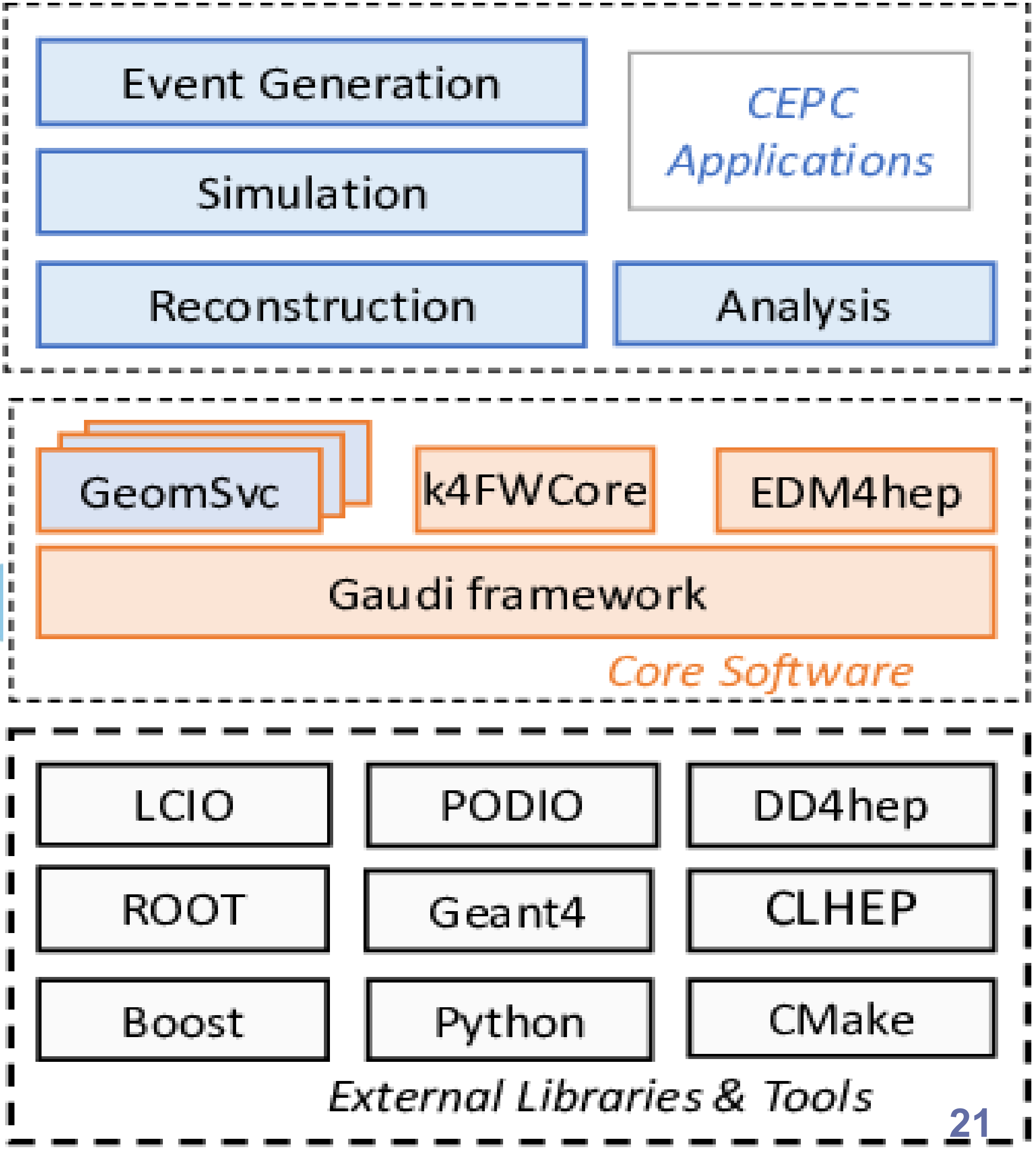
一系列55nm专用集成电路

软件和计算

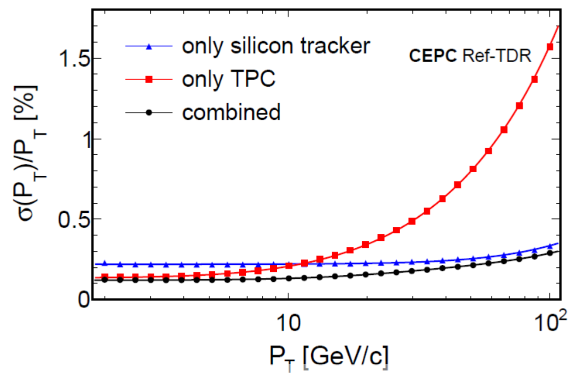
- 基于通用高能物理软件库，开发CEPC离线数据处理和分析的核心软件，集成到Key4hep，可接入FCC软件框架
- 研发探测器模拟、事例重建和分析工具软件，支持探测器优化和物理研究
- 开展机器学习和量子计算算法研究，应对未来海量数据处理的挑战
- 利用DIRAC中间件，连接多个数据中心，构建分布式计算平台



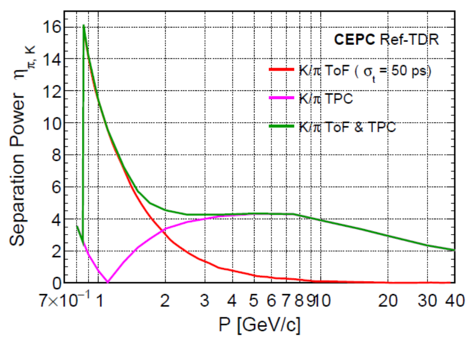




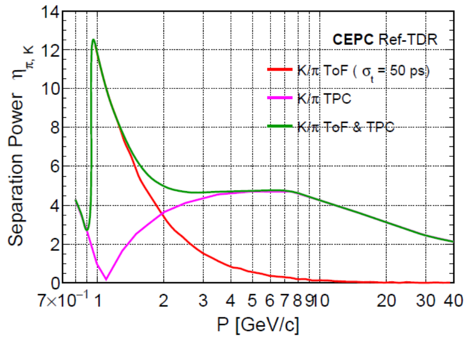
探测器关键性能



P_T resolution at 85°

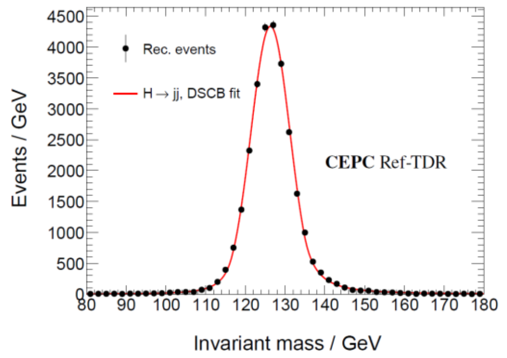


(a) $\theta = 85°$

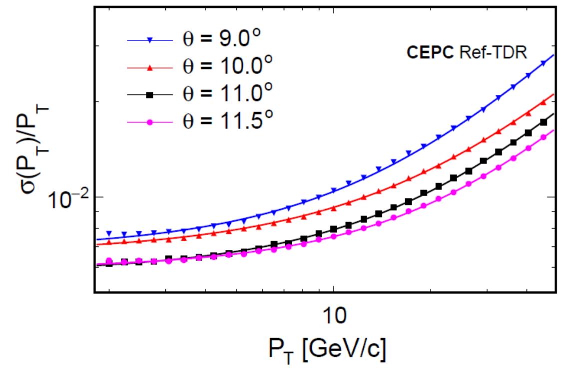


(b) $\theta = 60°$

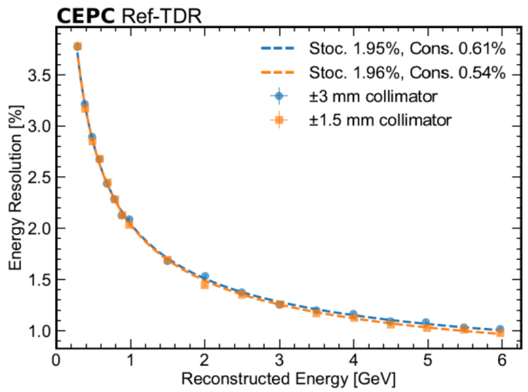
K/π separation power



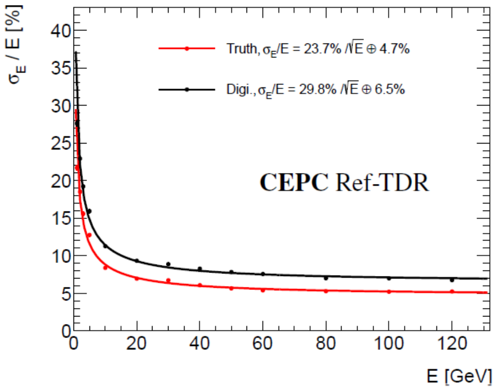
H→jj resolution



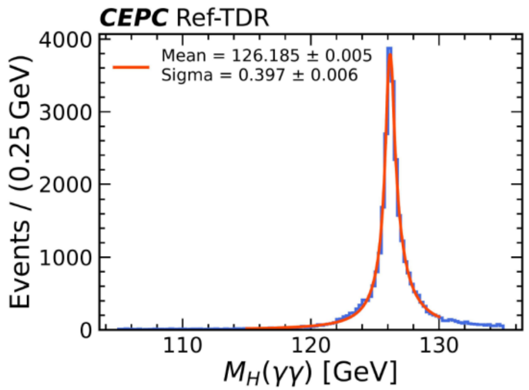
P_T resolution at different angles



EM resolution from beam test



Simulated Hadron resolution

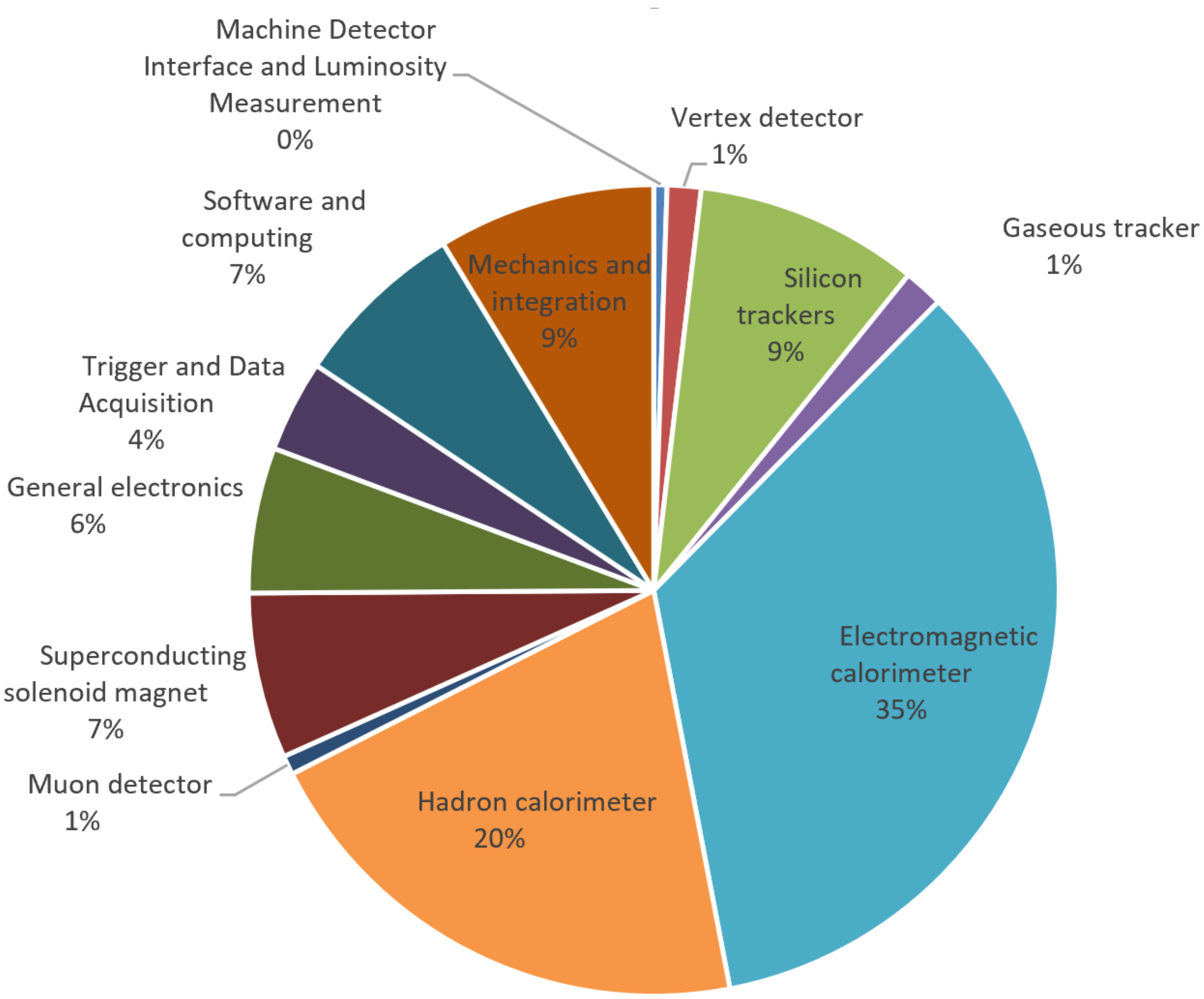


H→γγ resolution

Tracking efficiency	Tracking σ_{pT}	Vertexing $\sigma_{x,y,z}$	π-k separation	EM resolution	BMR
>99.7% (for p>1 GeV)	**~0.1%** for majority	**< 3.5 μm**	**3σ** (1-20 GeV)	**$2\%/\sqrt{E} \oplus 0.5\%$**	**3.87%** (H->gg)

探测器造价：26.7亿元

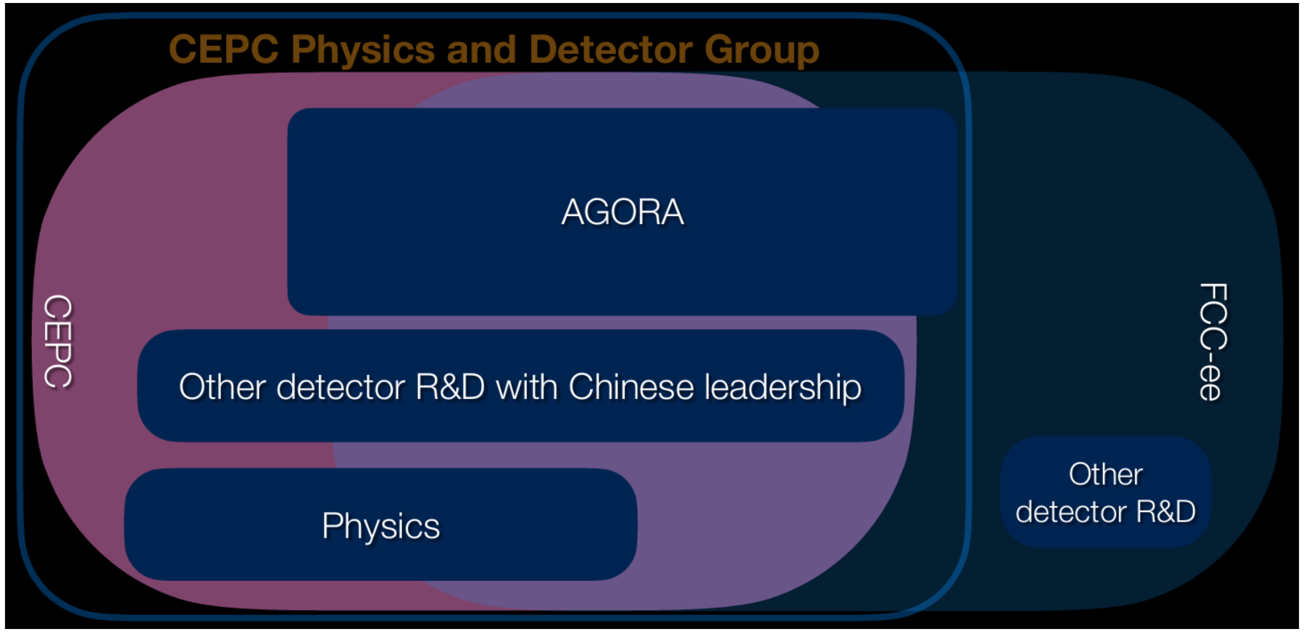
系统	造价（万元）	比例
探测器与加速器结合部和亮度测量	1,403	0.5%
顶点探测器	3,599	1.3%
硅径迹探测器	23,756	8.9%
气体径迹探测器	4,943	1.9%
电磁量能器	91,974	34.5%
强子量能器	54,613	20.5%
缪子探测器	2,020	0.8%
探测器磁体	17,573	6.6%
电子学系统	15,417	5.8%
触发与数据获取系统	9,741	3.7%
软件与计算系统	18,480	6.9%
探测器总体机械与安装	23,095	8.7%
合计	**266,620**	**100.0%**



从CEPC Reference Detector到AGORA

AGORA: **A**dvanced **G**lass **O**ptimized **R**esearch **A**pparatus

- AGORA面向下一代正负电子对撞机实验 (CEPC/FCC)
- 体现CEPC探测器的最大特色：基于闪烁玻璃的量能器
- AGORA在英文中是“聚集”的意思，体现国际和国内合作
- AGORA基于CEPC基准探测器并不断发展



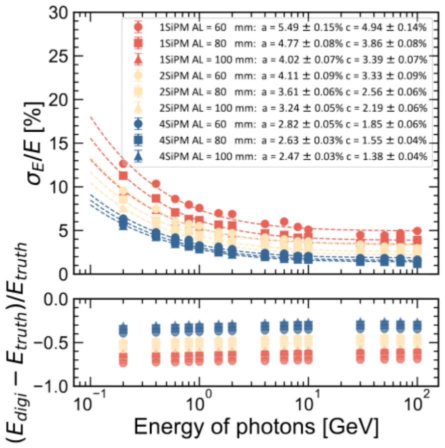
AGORA

ADVANCED GLASS OPTIMIZED RESEARCH APPARATUS

AGORA中的新方案

基于闪烁玻璃的一体化电磁和强子量能器：平衡探测器性能与造价

- 闪烁玻璃电磁量能器: 闪烁材料价格远低于BGO，通道数×7，需要进一步提高玻璃光产额和透光率
- 闪烁玻璃强子量能器: 优化采样率提高强子能量分辨率



Energy solution of GS-ECAL can reach 3%-4%

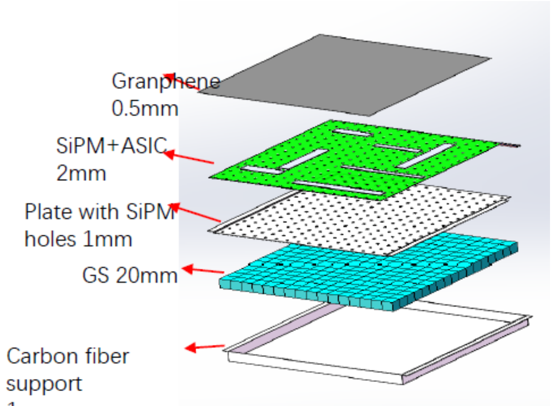


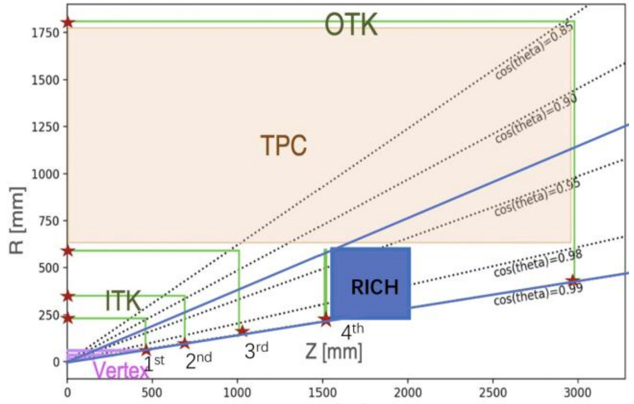
Fig. Unit composition

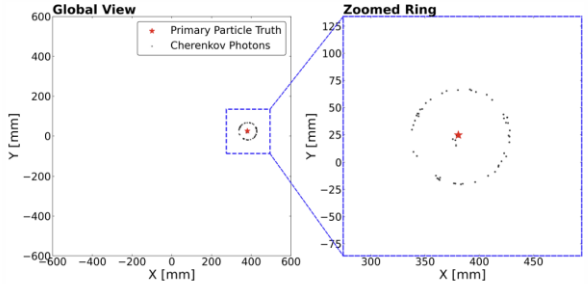
Preliminary design of a unit of GS-ECAL

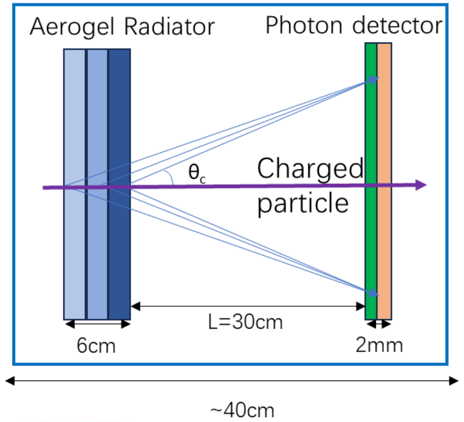
Reference (talk at CEPC workshop in Lisbon, April 2026):
https://indico.cern.ch/event/1598929/contributions/7012849/

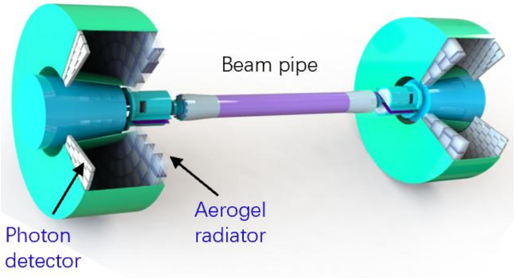
端盖环成像切伦科夫探测器 (RICH)

- 提高端盖区域的K/π分辨能力
- 关键技术：低折射率气凝胶和抗辐照、低噪声SiPM









Reference (talk at CEPC workshop in Lisbon, April 2026):
https://indico.cern.ch/event/1598929/contributions/7014479/

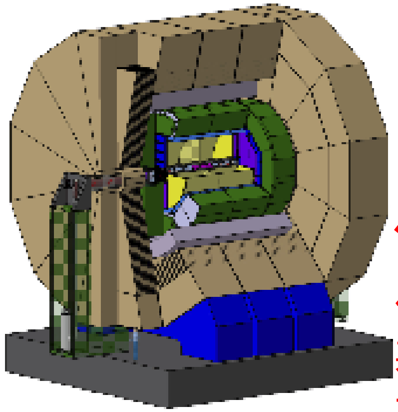
高能量前沿探测器概念汇总

FCC Detector Concepts

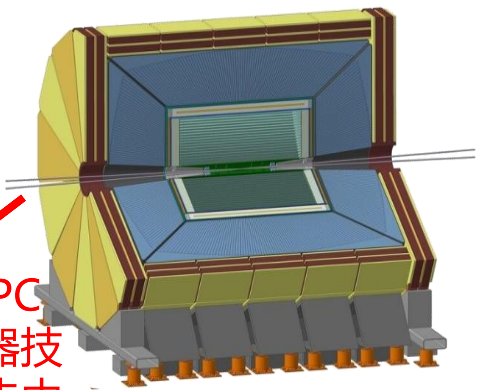
https://indico.cern.ch/category/20285/

- AGORA
- ALFA
- ALLEGRO
- CLD
- IDEA
- ILD

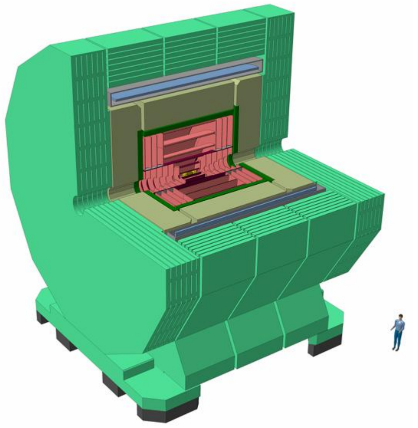
ILD:
TPC 气体主径迹
+ 硅钨高粒度量能器



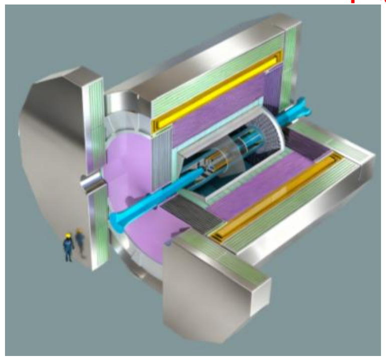
IDEA:
轻质氦漂移室
+ 双读出量能器



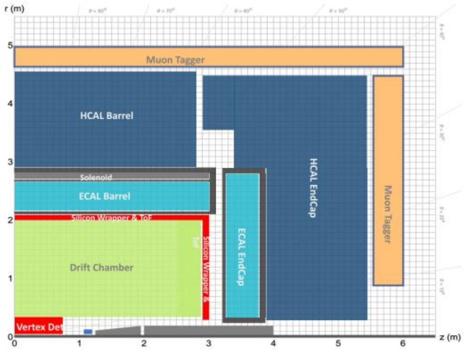
CLD:
全硅多层径迹 + 超高粒度硅钨电磁量能器



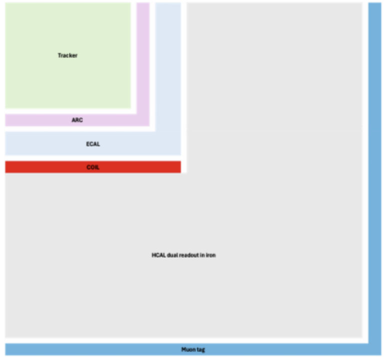
包含在CEPC基准探测器技术设计报告中



AGORA :
大型TPC+全吸收型电磁量能器+基于闪烁玻璃的强子量能器



ALLEGRO:
液氩电磁量能器
+波长位移光纤闪烁体强子量能器



ALFA:
紧凑型低成本全硅径迹+简化颗粒度硅钨量能器兼磁轭

探测器研发的国际合作

- 加入欧洲探测器发展规划（DRD）合作组、Key4hep等，开展探测器、电子学、软件等技术合作

7月13日DRD相关自由讨论

Sub-system	DRD	Sub-system	DRD	Sub-system	DRD
Pixel Vertex Detector	3	Electromagnetic Calorimeter	6	Superconducting Solenoid	
Inner Silicon Tracker	3	Hadron Calorimeter	4, 6	Mechanical and Integration	8
Outer Silicon Tracker	3	Machine Detector Interface	8	General Electronics	**7**
Gas Tracker (TPC / DC)	1	Luminosity Calorimeter		Trigger and DAQ	**7**
Muon Detector	1 (RPC)	Fast Luminosity Monitor	3	Offline Software	Key4hep

总结

- 2026年6月，LHC停止运行，开始HL-LHC升级，预计2030年开始运行
- 国际高能量前沿聚焦于正负电子对撞机希格斯工厂
- 国际上面向希格斯工厂提出多个探测器概念，致力于半导体探测、闪烁探测、气体探测、电子学、磁铁、机械集成、软件等先进技术的研发。
- CEPC发布基准探测器技术设计报告，通过国际评审，下一阶段将继续进行核心技术验证、子探测器模型和新方案探索等。

让我们AGORA（聚集），共同推进下一代高能量前沿粒子探测器的研发

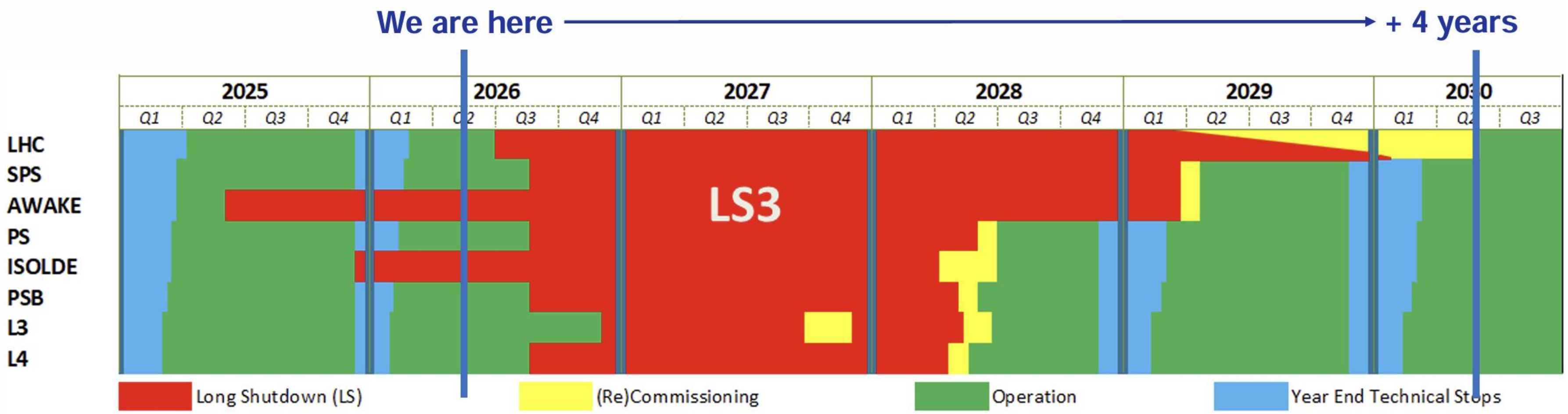
欢迎参加CEPC workshop！

10月22-26日，上海

https://indico.ihep.ac.cn/event/28911/

LHC升级→HL-LHC

Mark Thomson
Director-General of CERN
[Talk at FCC week in June, 2026]



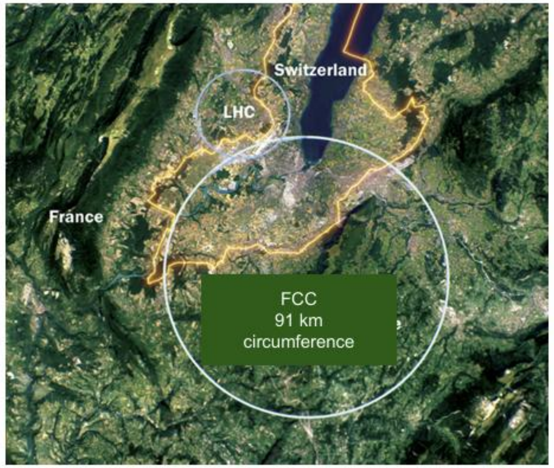
Maintaining this schedule is the highest priority for CERN
- essential to maintain the momentum for CERN's current flagship collider
- and essential for the transition to the next long-term project

- 基于铌三锡超导技术，升级加速器为High-Luminosity LHC，提供6倍于LHC的数据量
- 升级ATLAS和CMS探测器和触发系统，指定LHCb和ALICE的升级计划
- AI技术的广泛使用，培养新一代科学家……
- 2030年完成升级开始运行HL-LHC

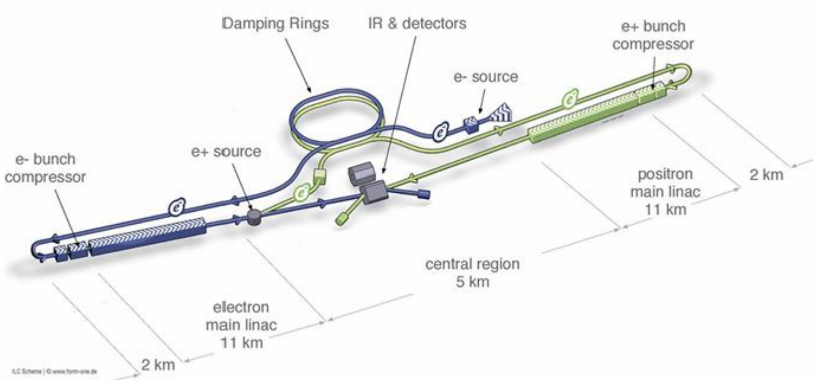
HL-LHC探测器升级

e^+e^- colliders
("Higgs, Electroweak, Top and Flavor Factories factories")

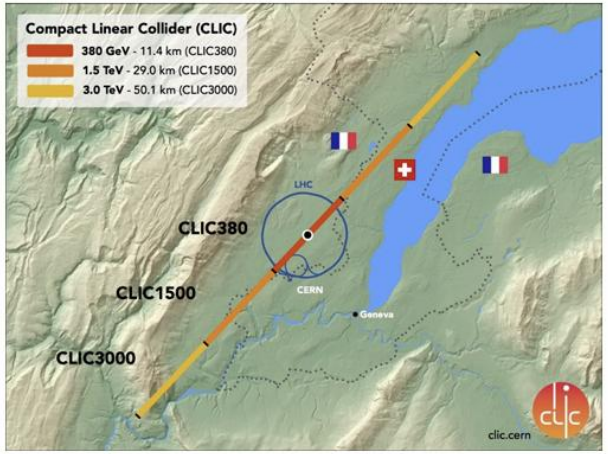
FCC-ee (e^+e^-, circular, 91 – 365 GeV)



LCF (e^+e^-, linear, 91 – 240, 550 GeV)



CLIC (e^+e^-, linear, 380 GeV, 1.5 TeV)

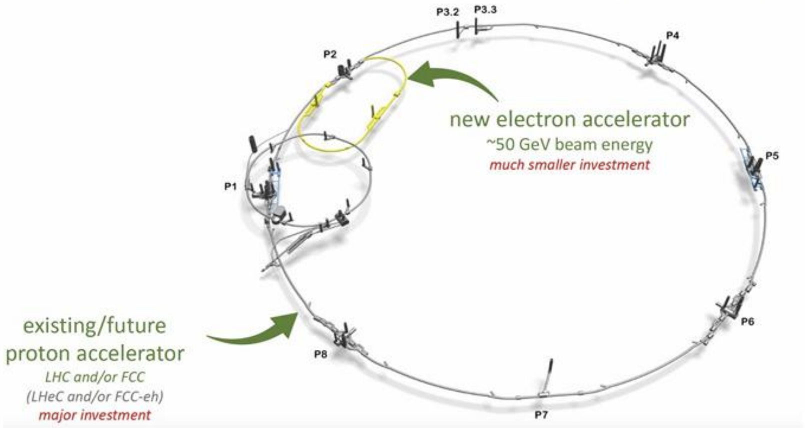


Intermediate projects

(Leave room (time, budget, resources) for further development of THE machine that can probe directly the energy frontier at the 10++ TeV parton center-of-mass scale)

LEP3 (e^+e^-, circular, 91 – 230 GeV)

LHeC (ep, circular, electron ERL, 50 GeV e^-, > 1 TeV ep collisions)



美国对希格斯工厂的规划

Dec. 2023 P5 Report: "An offshore Higgs factory, realized in collaboration with international partners, in order to reveal the secrets of the Higgs boson. The current designs of FCC-ee and ILC meet our scientific requirements."

Agnostic

May 2024 CERN-US Joint Statement: "Should the CERN Member States determine the FCC-ee is likely to be CERN's next world-leading research facility following the high-luminosity Large Hadron Collider, the United States intends to collaborate on its construction and physics exploitation, subject to appropriate domestic approvals."

FCC

Aug. 2024 US HFCC: Charge letter mentions both FCC and ILC.

Agnostic

Mar. 2025 HFCC ESPP Input: "We strongly support FCC-ee as the next major flagship project at CERN."

FCC

Jun. 2025 NAS Report: "The United States should participate in the international Future Circular Collider Higgs factory currently under study at CERN to unravel the physics of the Higgs boson."

FCC

Aug. 2025 US HF FCC: Decision by DOE to reorganize the Higgs Factory Coordination Consortium into the Higgs Factory Circular Collider Organization (HFCC -> HF FCC).

FCC

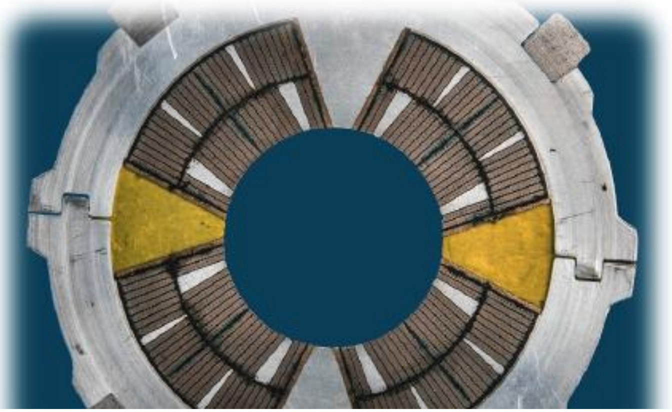
2023年P5 report同时提到FCC-ee和ILC → 2025年确定支持FCC-ee

Spencer Gessner, SLAC
Linear Collider@CERN Workshop, Jan. 2026
https://indico.cern.ch/event/1602105/contributions/6836106/

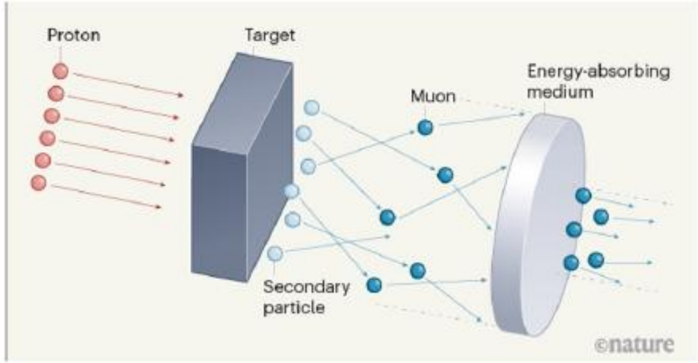
美国对未来10TeV对撞机的规划

The P5 Report Recommends vigorous R&D toward a cost-effective 10 TeV pCM collider based on proton, muon, or possible wakefield technologies.

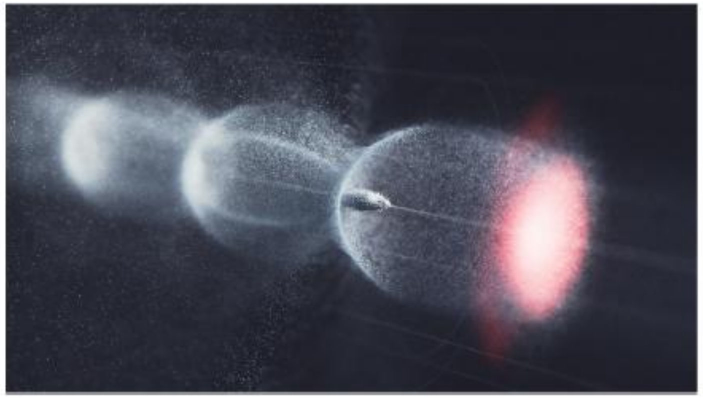
Proton-Proton Collisions at 100 TeV



The Muon Collider



Wakefield Acceleration



The US continues to support the high field magnet program.

- Support continues under the US Magnet Development Program (MDP)

US support for the Muon Collider is increasing.

- Limited financial support for FY26 ($150k).
- Formation of US National Lab Accelerator Study Group for a Muon Collider.
- Healthy and increasing collaboration between USMCC and IMCC.

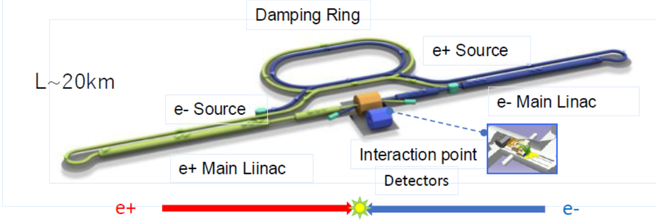
Dramatic reductions in store for AAC (wakefield) program.

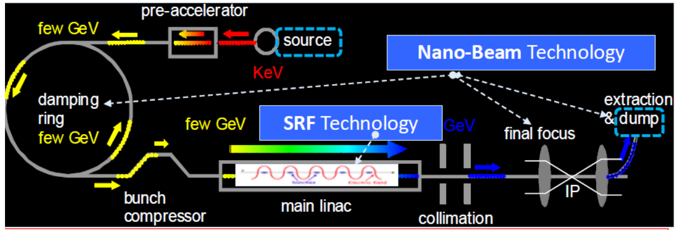
- FACET-II and BELLA will end operations unless non-HEP sponsors step up support.
- AWA at Argonne will continue operations.
- The 10 TeV Wakefield Collider Design Study is making progress, but the only way to maintain the momentum is by increasing collaboration with Europe.

Spencer Gessner, SLAC
Linear Collider@CERN Workshop, Jan. 2026
https://indico.cern.ch/event/1602105/contributions/6836106/

日本对ILC的规划

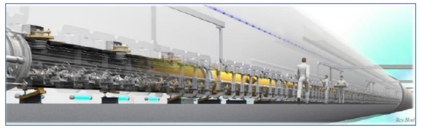
3. Future Project: ILC Higgs Factory





(ILC key technologies)
1. SRF cavities of 9000 numbers
2. Nanobeam production and stability。
3. Huge electron and positron production

IDT + KEK + ILC-Japan(JAHEP) collaborate from 2021



Parameters	Value
Beam Energy	125 + 125 GeV
Luminosity	1.35 x 10^{34} cm^2/s [2.7 x 10^{34} cm^2/s]
Beam rep. rate	5 Hz
Pulse duration	0.73 ms [0.961 ms]
# bunch / pulse	1312 [2625]
Beam Current	5.8 mA [8.8 mA]
Beam size (y) at FF	7.7 nm
SRF Field gradient	< 31.5 > MV/m (+/-20%) Q_0 = $1x10^{10}$
#SRF 9-cell cavities (CM)	~ 8,000 (~ 900)
AC-plug Power	111 MW [138 MW]

* Black is basic & green is written in snowmass

Shoji Asai
Director-General of KEK
[Talk at Open Symposium on the European Strategy for Particle Physics in June, 2025]

单一实验室无力独立承建未来对撞机项目。……未来对撞机有赖各国及区域实验室开展全球合作，整合全球各类资源，包括人力资源。

R&D for Key technologies are on-going

Work packages at ILC Technology Network (ITN)

ITN is the global collaboration program.
https://linearcollider.org/documents/idt-docs/idt-eb-docs/
https://linearcollider.org/wp-content/uploads/2023/09/IDT-EB-2023-002.pdf

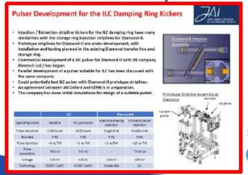
MEXT Development of key element technologies to improve the performance of future accelerators Program
advanced Accelerator element Technology Development (MEXT-ATD)

Budget 0.7BJYEN/year from MEXT + KEK internal

- •Creating particles — *Sources*
  - •polarized elections / positrons
- •High quality beams — *Damping ring*
  - •Low emittance beams
    - •Small beam size (small beam spread)
    - •Parallel beam (small momentum spread)
- •Acceleration — *Main linac*
  - •superconducting radio frequency (SRF)
- •Getting them collided — *Final focus*
  - •nano-meter beams
- •Go to *Beam dumps*

SRF
e-, e+ Sources
Nano-Beam

WPP	1	Cavity production
WPP	2	CM design
WPP	3	Crab cavity
WPP	4	E- source
WPP	6	Undulator target
WPP	7	Undulator focusing
WPP	8	E-driven target
WPP	9	E-driven focusing
WPP	10	E-driven capture
WPP	11	Target replacement
WPP	12	DR System design
WPP	14	DR Injection/extraction
WPP	15	Final focus
WPP	16	Final doublet
WPP	17	Main dump



Interesting trials in many European counties

Insight through Accelerators KEK 25

ILC Technology Network starts:

This shows Labs/Univ.s join to IDT WG2 :

My opinion : Future collider is not affordable in one Lab.
Too big budget is necessary
Missing Diversity in Science
Risk: Large HR is used in Long Priode.

Future collider will require global collaboration among national and regional labs to bring in global resources, including human resources.

The ITN could serve as a miniature model case

CERN, German, UK, France, Italy, Spain

KEK, Korea Australia

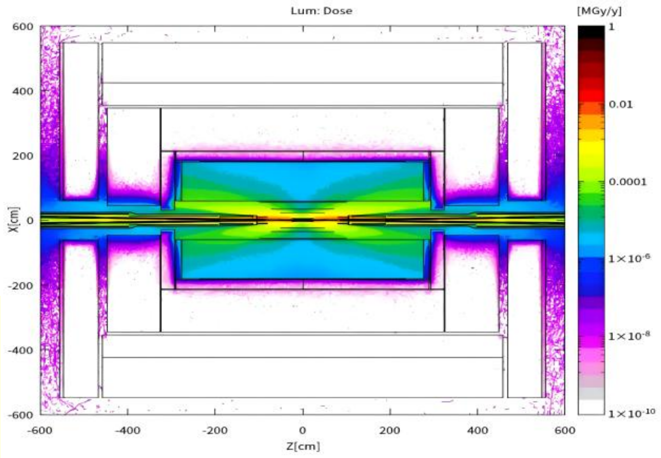
P5 recommendation: MEXT-DOE discussion: US Labs. join using Japan-US funding. 27

Insight through Accelerators. KEK

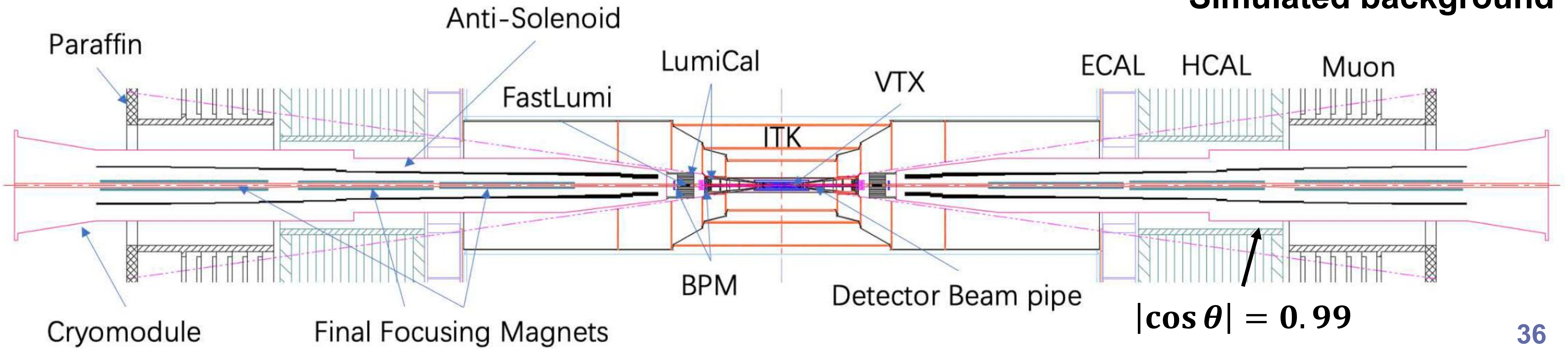
Machine detector interface

- **Beam pipe:** Φ_{inner} 20 mm, double-layer Beryllium, 0.454% X_0, water or paraffin cooling
- **Beam-induced background:** background simulation and optimization of shielding
- **Luminosity measurement:**
  - ✓ Luminosity Calorimeter: silicon detectors + LYSO calorimeters
  - ✓ Fast Luminosity monitor: diamond slab + SiC detectors
  - ✓ Beam position monitor: σ ≈ 1 μm

Deliver the maximum luminosity without affecting detector performance. Most challenging component.



Simulated background



探测器技术设计国际评审 (IDRC)

- International Committee composed of 19 experts in detector & physics, chaired by Daniela Bortoletto
- **Three review meetings** were held from October 2024 to September 2025
- **Final report outcome:** In summary, the CEPC detector programme is entering a decisive stage. A significant portion of the technical groundwork is complete, but the coming years must consolidate the design through focused R&D, integrated prototyping, and system validation.
- **Readiness for construction after R&D and engineering preparations:** With sector/module demonstrators, thermal and mechanical mock-ups, full DAQ chains, and formal design/production reviews (FDR/PRR), the project can credibly achieve production readiness… remaining work is system-level validation and final down-selection on an agreed schedule.

Table 2.2: Key technologies and parameters of the CEPC reference detector, the dimensions listed in the table are for the sensitive parts.

Detector	Technology	In (mm)	Out (mm)	Comment
Vertex	Silicon pixel	$r_{in} = 11.1$	$r_{out} = 47.9$	4 single, 2 double layers
ITK (barrel)	Silicon pixel	$r_{in} = 235.0$	$r_{out} = 555.6$	3 layers
ITK (endcap)	Silicon pixel	$\|z_{in}\| = 505.0$	$\|z_{out}\| = 1489$	4 disks
LumiCAL (front)	Silicon pixel	$r_{in} = 12$	$r_{out} = 42$	1 double layer disk
		$\|z\| = 560$		
LumiCAL (back)	Silicon pixel	$r_{in} = 12$	$r_{out} = 51$	1 double layer disk
		$\|z\| = 640$		
OTK (barrel)	Silicon microstrip	$r = 1800$		1 layer
		$\|z\| \leq 2840$		
OTK (endcap)	Silicon microstrip	$r_{in} = 406$	$r_{out} = 1816$	1 disk
		$\|z\| = 2910$		
TPC	Gaseous tracking	$r_{in} = 600$	$r_{out} = 1800$	MPGD high-granularity readout
		$\|z\| \leq 2900$		
ECAL (barrel)	Crystal + SiPM	$r_{in} = 1830$	$r_{out} = 2130$	18 layers, 32 sectors
		$\|z\| \leq 2900$		
ECAL (endcap)	Crystal + SiPM	$r_{in} = 350$	$r_{out} = 2130$	$1.5 \times 1.5 \times 3$ cm^3 3D granularity
		$\|z_{in}\| = 2930$	$\|z_{out}\| = 3230$	18 layers, 24 X_0, 1.2 λ_I
LumiCAL (front)	LYSO + SiPM	$r_{in} = 12$	$r_{out} = 56$	14 layers
		$\|z_{in}\| = 647$	$\|z_{out}\| = 670$	2 X_0
LumiCAL (back)	LYSO + SiPM	$r_{in} = 12$	$r_{out} = 110$	10 layers
		$\|z_{in}\| = 800$	$\|z_{out}\| = 950$	13.4 X_0
HCAL (barrel)	Glass scintillator + SiPM	$r_{in} = 2140$	$r_{out} = 3455$	48 layers, 16 sectors
		$\|z\| \leq 3230$		
HCAL (endcap)	Glass scintillator + SiPM	$r_{in} = 400$	$r_{out} = 3385$	$4 \times 4 \times 1$ cm^3 pixel
		$\|z_{in}\| = 3260$	$\|z_{out}\| = 4575$	48 layers, 6 λ_I
Muon (barrel)	Plastic scintillator + SiPM	$r_{in} = 4245$	$r_{out} = 5185$	6 layers, 12 sectors
		$\|z\| \leq 4475$		
Muon (endcap)	Plastic scintillator + SiPM	$r_{in} = 550$	$r_{out} = 5085$	
		$\|z_{in}\| = 4635$	$\|z_{out}\| = 5875$	