The progress of Super Tau Charm Facility in CHINA

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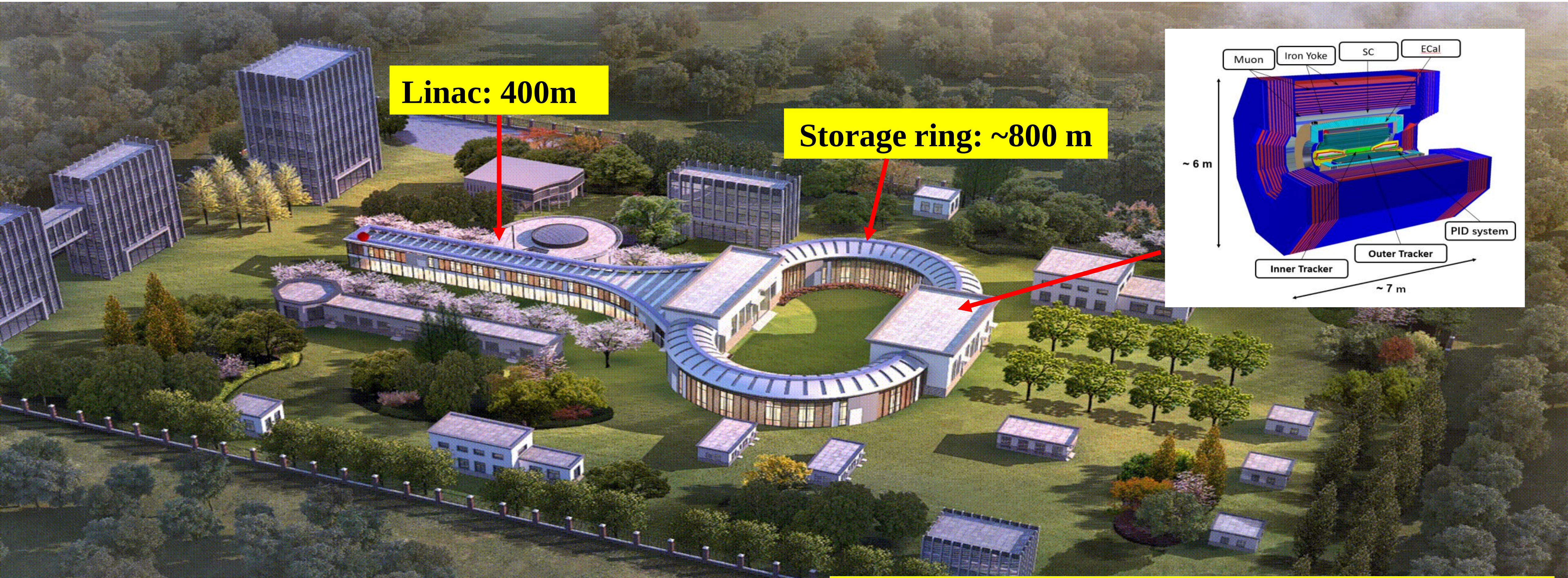
Outline

- STCF project in China
- Physics in STCF
- Accelerator design consideration
- Detector conceptual design and R&D
- Summary and outlook

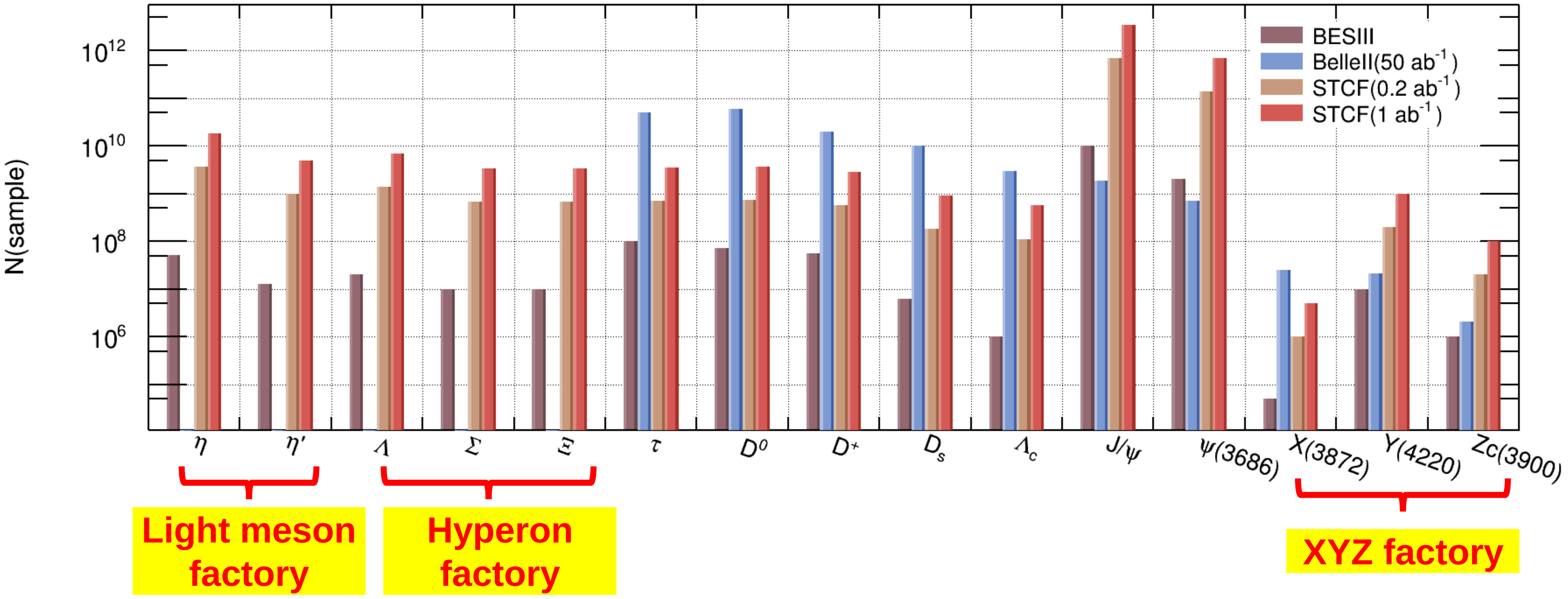
Super tau-charm facility (STCF) in China



- Peak luminosity $>0.5\times10^{35}$ $cm^{-2}s^{-1}$ at 4 GeV
- Energy range E_{cm} = 2-7 GeV
- Potential to increase luminosity & realize beam polarization
- Total cost: 4.5B RMB

- 1 ab^{-1} data expected per year
- Rich of physics program, unique for physics with *c* quark and τ leptons,
- Important playground for study of QCD, exotic hadrons, flavor physics and search for new physics.

Expected data samples at STCF



- STCF is expected to have higher detection efficiency and low bkg. for productions at threshold
- STCF has excellent resolution, kinematic constraining
- Opportunities at 5-7 GeV which is experimentally blank before

Physics program of STCF

STCF CDR: Volume 1 -- Physics & Detector

arXiv:2303.15790

- **Physics at STCF**
  - **QCD and hadronic physics**
    - **XYZ Properties:** e+e-→Y→γX,ηX,ϕX; e+e-→Y→πZc, KZcs
    - **Hadron Spectroscopy:** Excited ccbar and their transition, Charmed hadron spectroscopy, Light hadron spectroscopy
    - **R value:** e+e-→inclusive; τ mass: e+e-→τ+τ-
    - **Nucleon Form Factors:** e+e-→BBbar from threshold
    - **Pentaquarks:** e+e-→J/ψppbar, Λc Dbar pbar, Σc Dbar pbar
      Di-charmonium: e+e-→J/ψηc, J/ψhc
    - **Muon g-2:** e+e-→π+ π-, π+ π- π0, 4π, K+ K-, γγ→π0, η(′),π+ π-
    - **Fragmentation functions:** e+e-→(π,K,p,Λ,D)+X, e+e-→(ππ,KK,πK)+X
  - **Flavor Physics and CP Violation**
    - **CKM matrix (Vcd, Vcs):** D_(s)+→l+v, D→P l+ v
    - **Charm hadron decay:** Λc+, Σc, Ξc, Ωc decay
    - **CPV in Hyperons:** J/ψ→ΛΛbar, ΣΣbar, Ξ- Ξ+bar, Ξ0 Ξ0bar
    - **D0-D0bar mixing:** ψ(3770)→(D0 D0bar)(CP=-), ψ(4140)→π0 (D0 D0bar)(CP=-) or γ(D0 D0bar)(CP=+)
    - **CPV in τ:** τ→Ks πv, EDM of τ, τ→π/K π0 v for polarized e- beam
    - **CPV in Charm:** D0→K+K-/π+π-, Λc→pK-π+π0/Λπ+π+π-/pKs π+π-
    - **γ/ϕ3 measurement:** D0→K(s/L) π+ π-, K(s/L) K+ K-,K3π, 4π
    - **γ polarization:** D0→K1 e+ v_e
  - **Forbidden/Rare decay and New Particle**
    - **LNV, BNV:** D(s)+→l+ l+ X-, J/ψ→Λc e-, B→Bbar…
    - **Symmetry violation:** η(′)→llπ0, η′→ηll…
    - **FLV decays:** τ→γl, lll,l P1 P2 , J/ψ→ll′, D0→ll′ (l′≠l)…
    - **FCNC:** D→γV, D0→l+ l-, e+e-→D⋆ , Σ+→pl+ l-…
    - **Dark photon:** e+e-→γA′(→l+ l-), J/ψ→e+e-A′…
      Millicharged: e+e-→χχ γ…

- Leading role
- In Competition with Belle II/LHCb
- Synergy with BelleII/LHCb/Eic/EicC

*Due to time constraints, only one or two types will be briefly introduced
For specific details, please refer to the CDR

Hadrons Spectrum

❖ Experiments at particle accelerators in last fifties and sixties created more than 100 hadrons

➔ "hadronic zoo"

❖ Quark model established order in the hadronic zoo

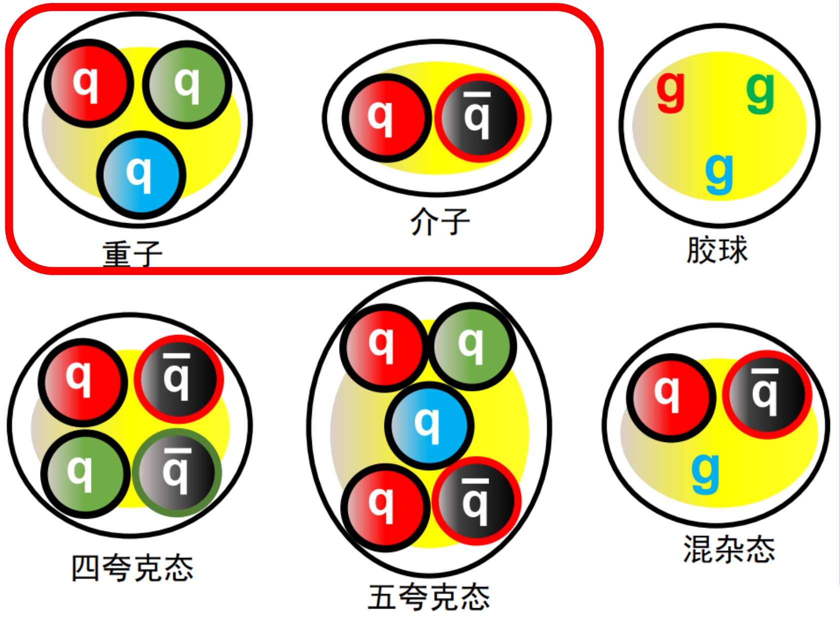
M. Gell-Mann, A schematic model of baryons and mesons: Phys.Lett. 8 (1964) 214-215

"Baryons can now be constructed from quarks by using the combinations (qqq), $(qqqq\bar{q})$, etc., while mesons are made out of $(q\bar{q})$, $(qq\bar{q}\bar{q})$, etc".

G. Zweig, An SU(3) model for strong interaction symmetry and its breaking. CERN-TH-401

"In general, we would expect that baryons are built not only from the product of these aces, AAA, but also from $\bar{A}AAAA$, $\bar{A}\bar{A}AAAAA$, etc., where $\bar{A}$ denotes an anti-ace. Similarly, mesons could be formed from $\bar{A}A$, $\bar{A}\bar{A}AA$, etc".

- Suggested by self-coupling of gluons of QCD, glueballs and hybrids exist.
- Experimental searches for exotic hadrons have a long history
- Recent high-quality data samples from several experiments allow us study the properties of established mesons, and search for new states.



Heavy “nonstandard” hadron candidates

- Large amount of experimental activity on the “nonstandard” heavy sector
  - e^+e^- direct production: BESIII, Belle, BaBar
  - $pp/p\bar{p}$ promote production: LHCb, CMS, ALTAS…
  - Quarkonia decay: BESIII, Belle, BaBar
  - B, Λ_b decays: Belle, Babar, LHCb

2003-
X(3872)

2005-
X(3915)
Y(4260)
$Y_b(10860)$

2007-
X(3940)
X(4160)
Y(4360)
Y(4660)
X(4050)
X(4250)
Z(4430)

2009-
X(4140)
X(4350)

2011-
$Z_b(10610)$
$Z_b(10650)$

2013-
$Z_c(3900)$
$Z_c(4020)$
Z(4200)

2015-
$P_c(4380)$
$P_c(4450)$

2017-
X(4274)
X(4500)
X(4700)
Y(4220)
Y(4390)

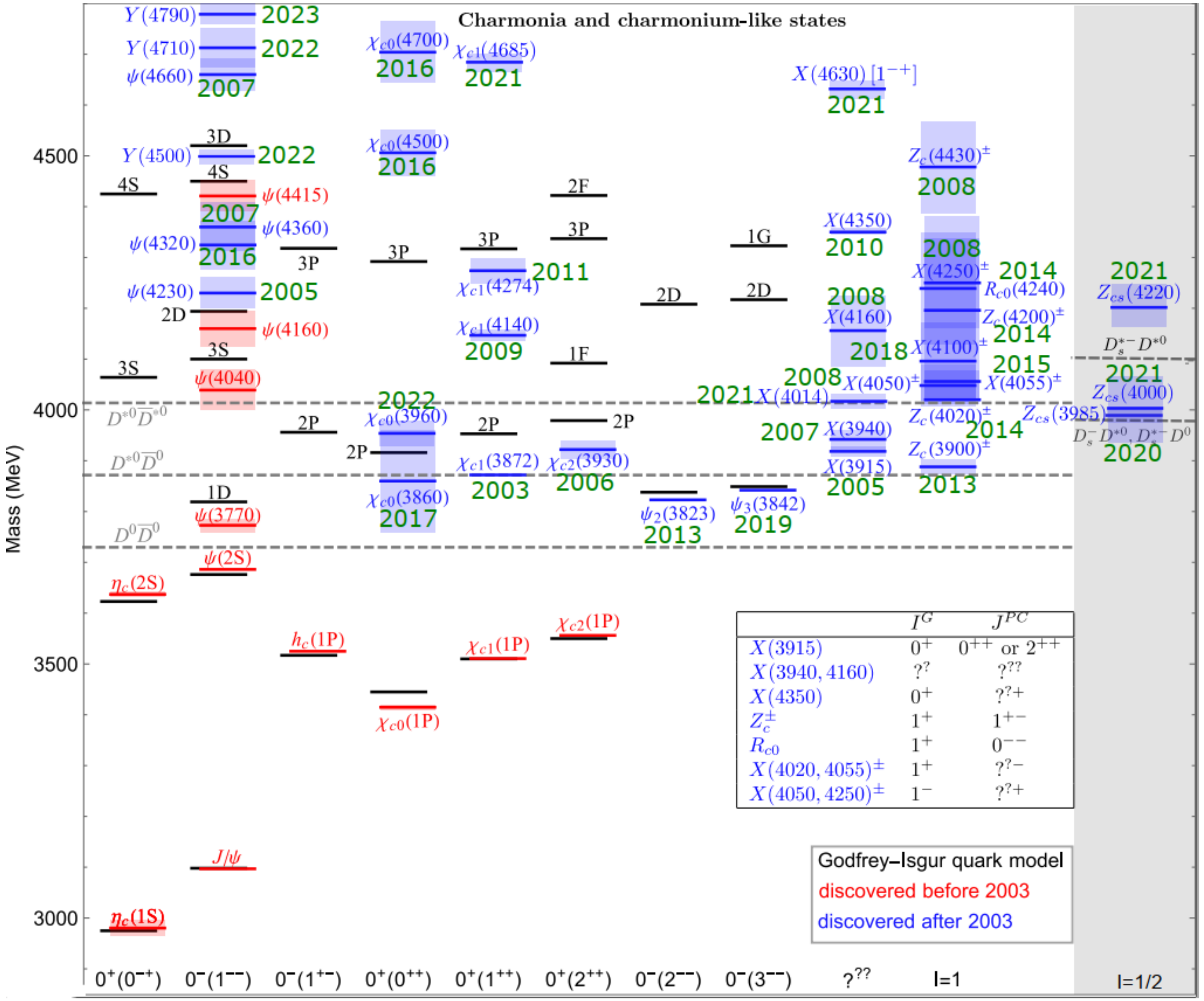
2019-
$P_c(4457)$
$P_c(4440)$
$P_c(4312)$
X(3842)
X(6900)
$X_0(2900)$
$X_1(2900)$

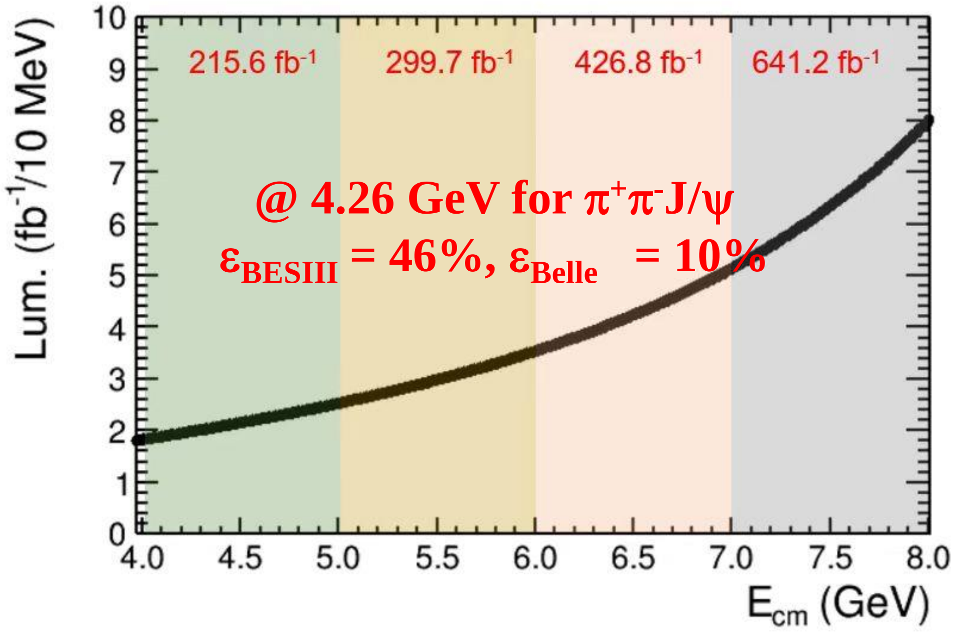
2021-
X(4685)
X(4630)
Z (3985)

- Most of them are with masses in 4-7 GeV.
- However, their properties are still poorly known.

Before 2003, it was thought that charmonium states, being bound states of a charm and an anticharm quark, should be well described by nonrelativistic potential quark models. However, since the discovery of the X(3872) by Belle in 2003, a large number of new resonance(-like) structures have been observed in the charmonium mass region by various experiments, including BESIII, BaBar, Belle, CDF, D0, ATLAS, CMS and LHCb.

Charmonium (Like) states at STCF





- **Belle II :** ISR approach; B meson decay ($m_R <$ 4.8 GeV)
- **LHCb:** B/Λ_b decay; Prompt production
- **STCF:** Scan with 10 MeV/step, every point has 10 fb^{-1}/year, 3 ab^{-1} in 4-7 GeV

arXiv: 2203.07141

Charm physics

- **LHCb:** **huge x-sec, boost, 9 fb^{-1} now (×40 current B factories)**
- **B-factories (Belle(-II), BaBar): more kinematic constrains, clean environment, ~100% trigger efficiency**
- **τ-charm factory : Low backgrounds and high efficiency, Quantum correlations and CP-tagging are unique**
- STCF :
  - 4×10^9 pairs of $D^{\pm,0}$ and 10^8 D_s pairs per year
    - 10^{10} charm from Belle II/year
  - Highlighted Physics programs
    - Precise measurement of (semi-)leptonic decay (f_D, f_{Ds}, CKM matrix…)
    - D decay strong phase (Determination of $\gamma/\phi3$ angle)
    - $D^0-\bar{D}^0$ mixing, CPV
    - Rare decay (FCNC, LFV, LNV….)
    - Excite charm meson states D_J, D_{sJ} (mass, width, J^{PC}, decay modes)
    - Charmed baryons (J^{PC}, Decay modes, absolute BF)

	STCF	Belle II	LHCb
Production yields	★★	★★★★	★★★★★
Background level	★★★★★	★★★	★★
Systematic error	★★★★★	★★★	★★
Completeness	★★★★★	★★★	★
(Semi)-Leptonic mode	★★★★★	★★★★	★★
Neutron/K_L mode	★★★★★	★★★☆☆	☆
Photon-involved	★★★★★	★★★★	★☆☆
Absolute measurement	★★★★★	★★★	☆

arXiv:2203.03211

Precision measurements of CKM elements

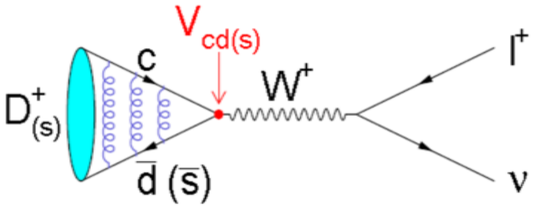
CKM matrix elements are fundamental SM parameters that describe the mixing of quark fields due to weak interaction.

$$\begin{pmatrix} d' \\ s' \\ b' \end{pmatrix} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} \begin{pmatrix} d \\ s \\ b \end{pmatrix}$$

Leptonic and semileptonic decays of charmed hadrons (D^0, D^+, D_s^+, Λ_c^+) provide ideal testbeds to explore weak and strong interactions

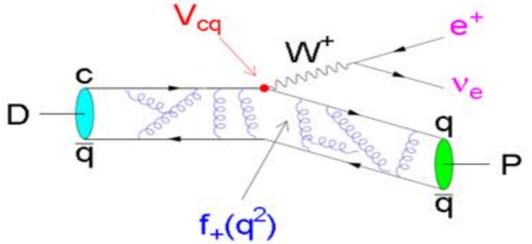
1. $|V_{cs(d)}|$: better test on CKM matrix unitarity
2. (Semi-)leptonic D(s) decays allow for LFU tests
3. $f_{D(s)^+}$, $f^{+K(\pi)}(0)$: test of LQCD

Purely Leptonic:



$$\Gamma(D^+_{(s)} \to \ell^+\nu_\ell) = \frac{G_F^2 f^2_{D^+_{(s)}}}{8\pi} |V_{cd(s)}|^2 m_\ell^2 m_{D^+_{(s)}} \left(1 - \frac{m_\ell^2}{m^2_{D^+_{(s)}}}\right)^2$$

Semi-Leptonic:



$$\frac{d\Gamma}{dq^2} = \frac{G_F^2}{24\pi^3} |V_{cs(d)}|^2 p^3_{K(\pi)} |f_+^{K(\pi)}(q^2)|^2$$

Probe CP violation at tau-charm factory

Billions hyperon pairs from J/ψ decay, clean topology, background free

Transversely polarized, spin correlation

Sensitivity: $A_{CP}\sim10^{-4}$, $\xi\sim0.05^{\circ}$

Peak cross section in $\sqrt{s}$ =4-5 GeV, $\sigma_{\tau\tau}\approx$ 3.5 nb, 10 ab^{-1} data in total

Sensitivity of τ decay with 1ab^{-1} @ 4.26 GeV $\sim9.7\times10^{-4}$

CP in hyperon decay

CP in tau decay/production

CP in charm mixing

CPT in kaon mixing

Billions $D^0/\bar{D}^0$, threshold production, quantum coherence with $(D^0\bar{D}^0)_{\mathrm{CP}=-}$ or $(D^0\bar{D}^0)_{\mathrm{CP}=+}$

Sensitivity: $x\sim0.035\%$, y$\sim0.023\%$, $r_{CP}\sim0.017$, $\alpha_{CP}\sim1.3^{\circ}$

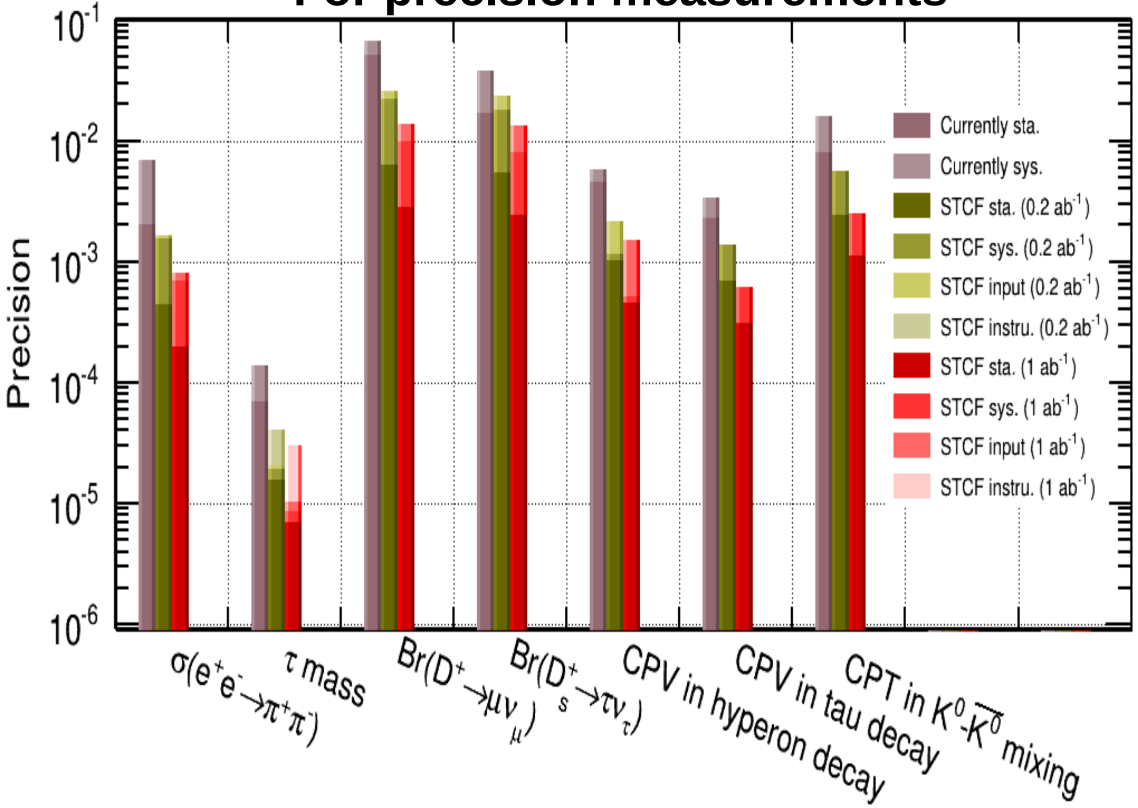
CP tagging and flavor tagging of $K^0/\bar{K}^0$ available from J/ψ decay

CP variables determined with time-dependent decay rate

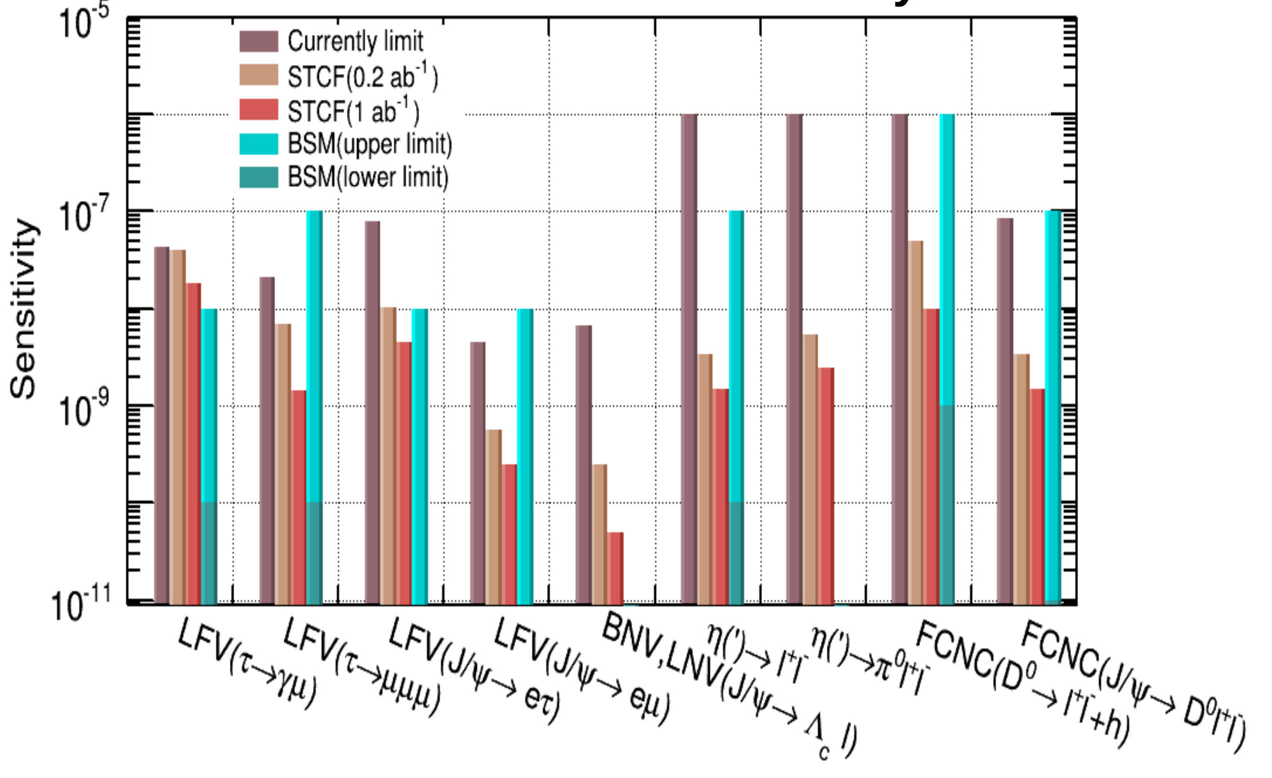
CPT Sensitivity: $\eta_{\pm}\sim10^{-3}$, $\Delta\phi_{\pm}\sim0.05^{\circ}$

Sensitivity study

For precision measurements



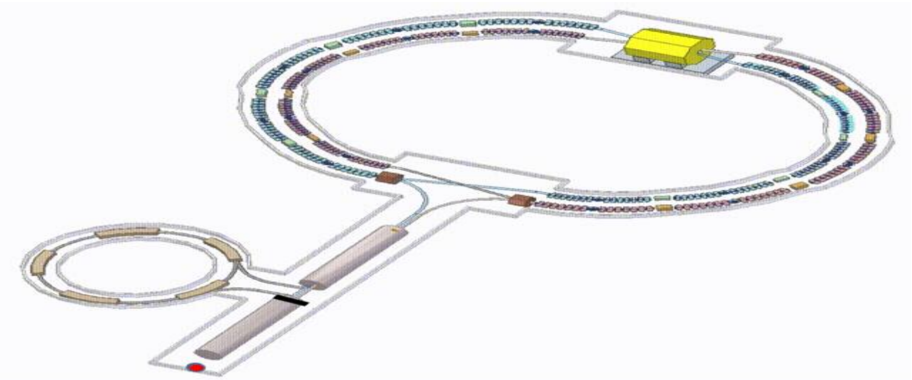
For rare/forbidden decays



- Precision frontier for testing of SM parameters, uncertainties from reducible (selection-based), and irreducible sources (theoretical input, instrument effect).

- Sensitivity of various rare/forbidden decays from STCF measurements are compared with various BSM models. The excellent precision from STCF can be used to distinguish from various BSM models.

STCF accelerator

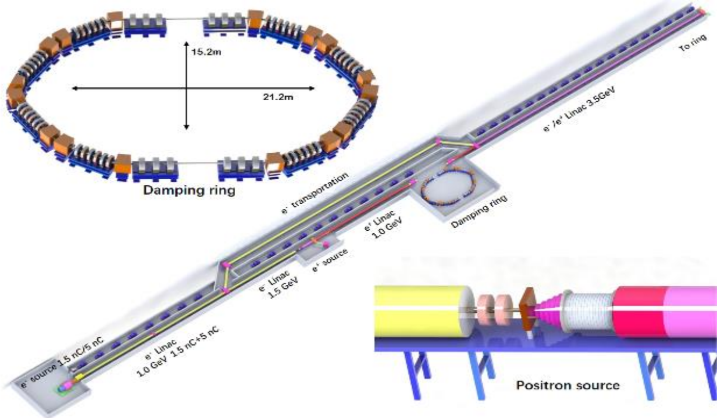


Challenge： realize luminosity of >0.5x10[35] cm[-2] s[-1]

$$L(cm^{-2}s^{-1}) = \frac{\gamma\, n_b\, I_b}{2\, e\, r_e \beta_y^*} H\, \xi_y$$

Interaction Region: Large Piwinski Angle Collision + Crabbed Wais

Parameters	Phase1	Phase2
Circumference/m	600~800	600~800
Optimized Beam Energy/GeV	2.0	2.0
Beam Energy Range/GeV	1-3.5	1-3.5
Current/A	1.5	2.0
Emittance $(\varepsilon_x/\varepsilon_y)$/nm·rad	6/0.06	5/0.05
β Function @IP (β_x^*/β_y^*)/mm	60/0.6	50/0.5(estimated)
Full Collision Angle 2θ/mrad	60	60
Tune Shift ξy	0.06	0.08
Hourglass Factor	0.8	0.8
Aperture and Lifetime	15σ, 1000s	15σ, 1000s
Luminosity @Optimized Energy/ $\times 10^{35}$cm^{-2}s^{-1}	~0.5	~1.0



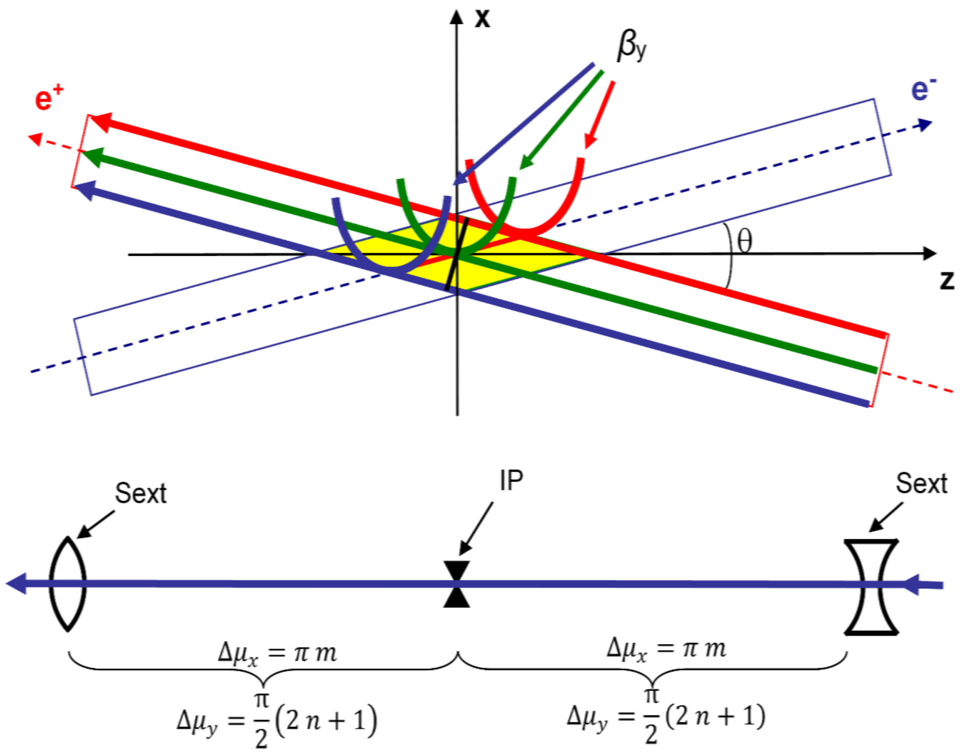
Injector:

- Length: 400m
- e^+, a convertor, a linac and a damping ring, 0.5 GeV
- e^-, a polarized e- source, accelerated to 0.5 GeV
- No booster, 0.5 GeV→1~3.5 GeV

Challenges for future tau-charm accelerators

Large Piwinski Angle + Crab Waist

(P. Raimondi 2006)

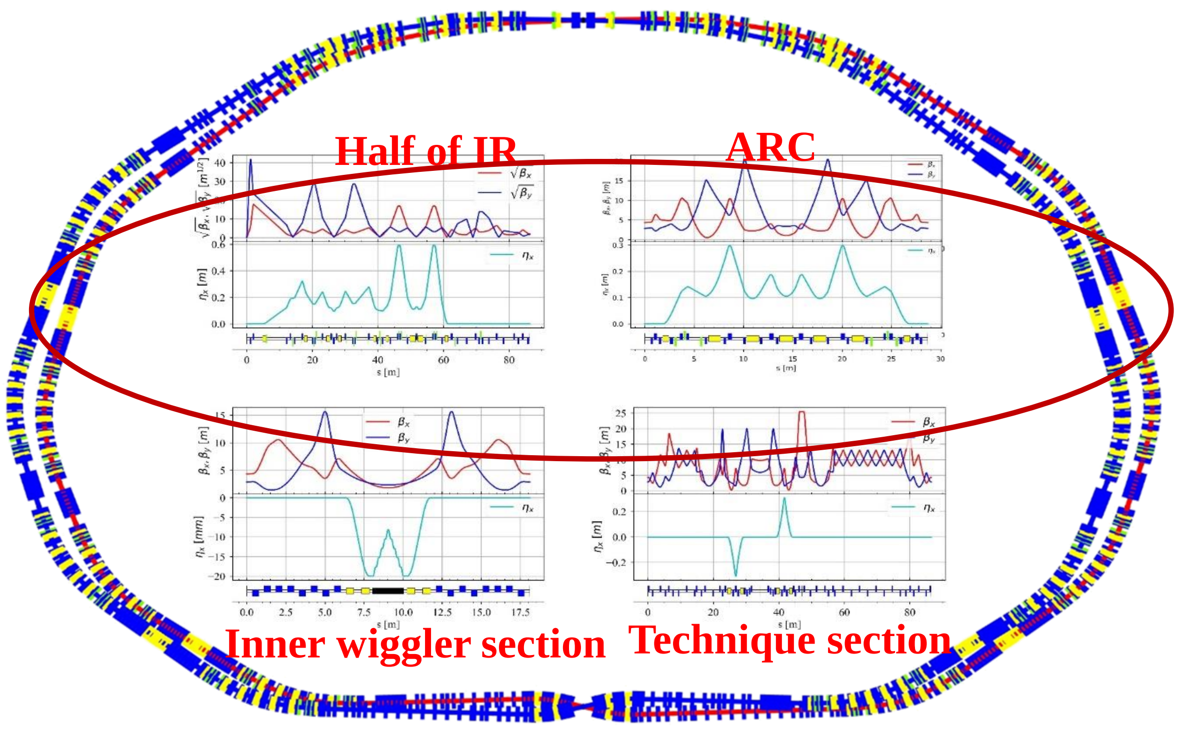


K. Hirata PRL 1995

Test of "Crab-Waist" Collisions at the DAΦNE Φ Factory, PRL 2010

- **Accelerator physics**
  - **High current** and **small bunches** at IP → **Collective** effects and **Instability** increased
  - **Strong Focusing**→Negative chromaticity → Chromatic correcting sextupoles + crab waist sextupoles → more **non-linearity**
  - Smaller **dynamic aperture** and **energy aperture**, also much **shorter Touschek lifetime**
- **Key Technologies**
  - **high peak luminosity** : Interaction Region Misc
  - **high integrated luminosity** : Beam instrumentations and so on
  - **Beam sources and injection** : high current and quality electron and positron source; on-axis injection may be necessary

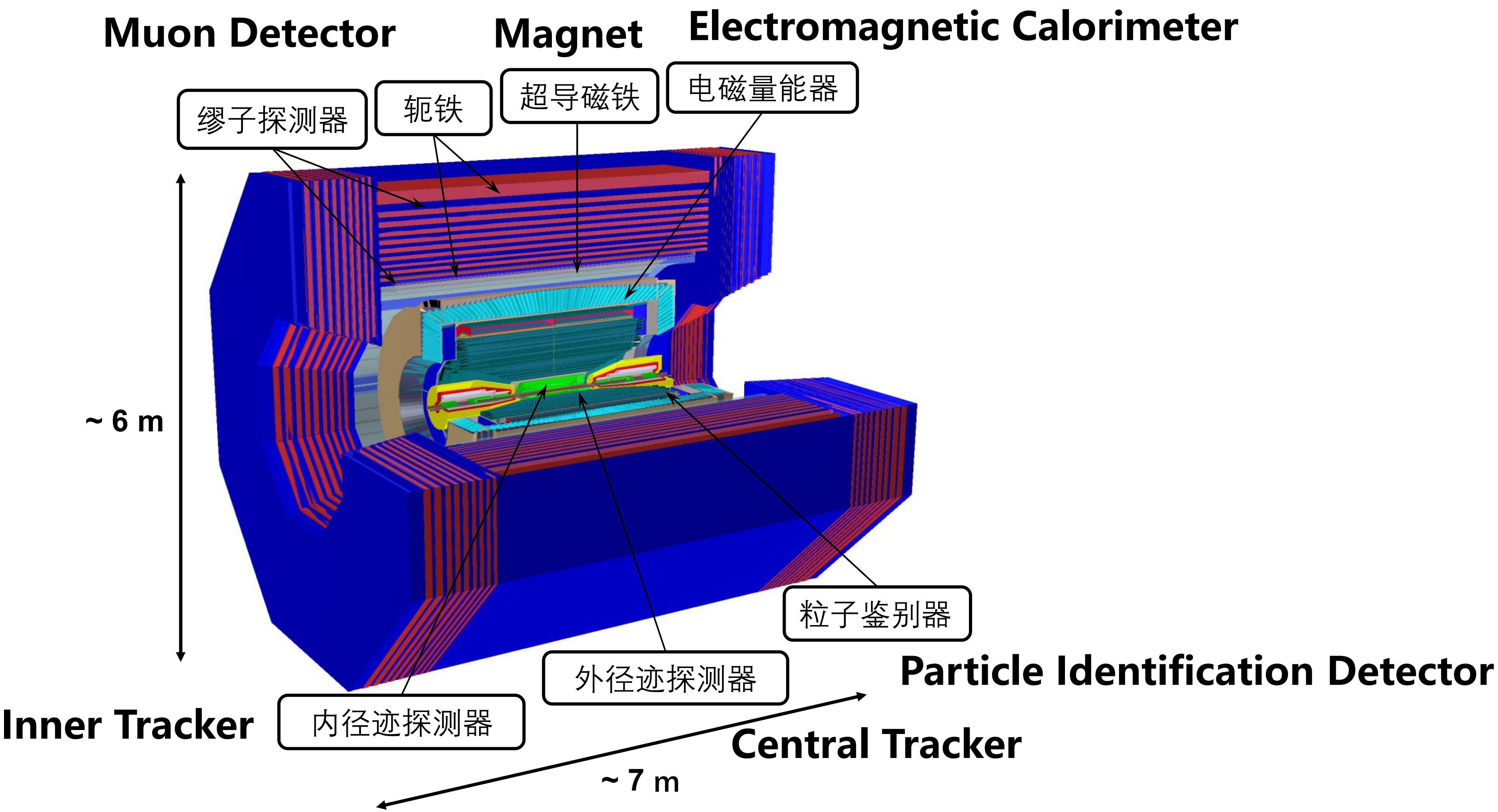
Ring lattice design



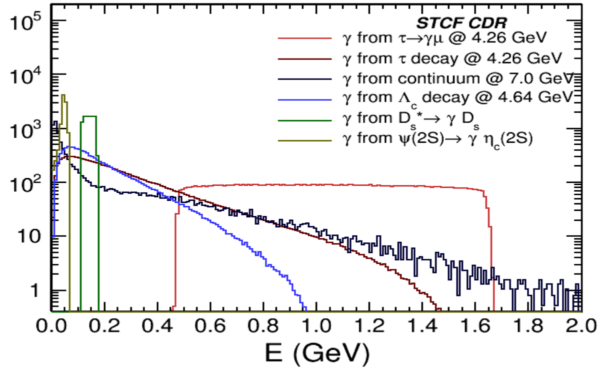
Parameters	Units	STCF-v0.2 (no wiggler)	STCF-v0.2 (wiggler)	STCF-v0.2 (wiggler+IBS)
Optimal beam energy, E	GeV	2	2	2
Circumference, C	m	616.76	616.76	616.76
Crossing angle, 2θ	mrad	60	60	60
Relative gamma		3913.9	3913.9	3913.9
Revolution period, T_0	ms	2.057	2.057	2.057
Revolution frequency, f_0	kHz	486.08	486.08	486.08
Horizontal emittance, ε_x	nm	5.40	3.12	4.47
Coupling, k		0.50%	0.50%	0.50%
Vertical emittance, ε_y	pm	27	15.6	22.35
Hor. beta function at IP, β_x	mm	40	40	40
Ver. beta function at IP, β_y	mm	0.6	0.6	0.6
Hor. beam size at IP, σ_x	μm	14.70	11.17	13.37
Ver. beam size at IP, σ_y	μm	0.127	0.097	0.116
Betatron tune, ν_x/ν_y		31.552/24.572	31.552/24.572	31.552/24.572
Momentum compaction factor, α_p	10^{-4}	10.29	10.27	10.27
Energy spread, σ_e	10^{-4}	5.17	7.88	8.77
Beam current, I	A	2	2	2
Number of bunches, n_b		512	512	512
Single-bunch current, I_b	mA	3.91	3.91	3.91
Particles per bunch, N_b	10^{10}	5.02	5.02	5.02
Single-bunch charge	nC	8.04	8.04	8.04
Energy loss per turn, U_0	keV	135.87	273	273
Hor. damping time, τ_x	ms	60.57	30.14	30.14
Ver. damping time, τ_y	ms	60.57	30.14	30.14
Long. damping time, τ_z	ms	30.28	15.07	15.07
RF frequency, f_{RF}	MHz	497.5	497.5	497.5
Harmonic number, h		1024	1024	1024
RF voltage, V_{RF}	MV	1.2	1.2	1.2
Synchronous phase, f_s	deg	173	167	167
Synchrotron tune, ν_z		0.0100	0.0099	0.0099
Natural bunch length, σ_z	mm	5.22	8.04	8.94
RF bucket height, $(\Delta E/E)_{max}$	%	1.73	1.56	1.56
Piwinski angle, ϕ_{Piw}	rad	10.66	21.58	20.06
Hor. beam-beam parameter, ξ_x		0.0094	0.0040	0.0032
Ver. beam-beam parameter, ξ_y		0.173	0.148	0.111
Equivalent bunch length, σ_{z_e}	mm	0.49	0.37	0.45
Hour-glass factor, F_h		0.8932	0.9287	0.9066
Luminosity, L	$cm^{-2}s^{-1}$	2.23E+35	1.98E+35	1.45E+35

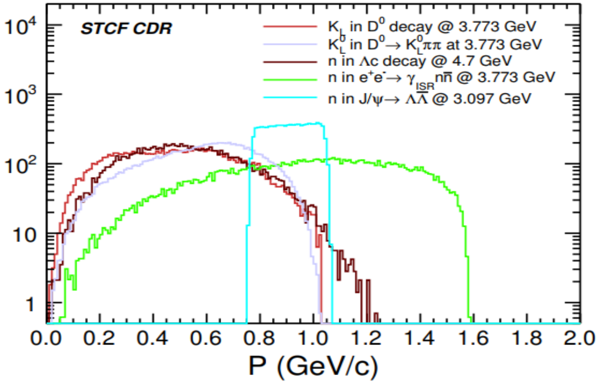
- **Beam-beam simulation, collective effective simulation are considered**
- $\sigma_z = 8.04$ mm(w/o IBS), $\xi_x = 0.0040 \rightarrow \nu_z = 2.5\,\xi_x$
- $\sigma_z = 8.94$ mm(wi IBS), $\xi_x = 0.0032 \rightarrow \nu_z = 3.1\,\xi_x$
- w/o IBS: $\xi_y = 0.148,\ L = 1.98 \times 10^{35}\ cm^{-2}s^{-1}$
- w/ IBS: $\xi_y = 0.111,\ L = 1.45 \times 10^{35}\ cm^{-2}s^{-1}$
- **Touschek Lifetime ~100s**

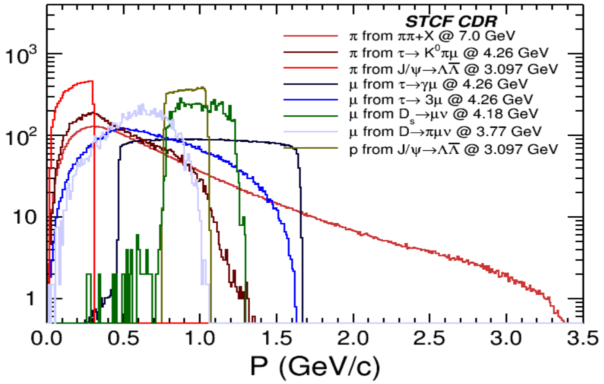
STCF Detector Conceptual design

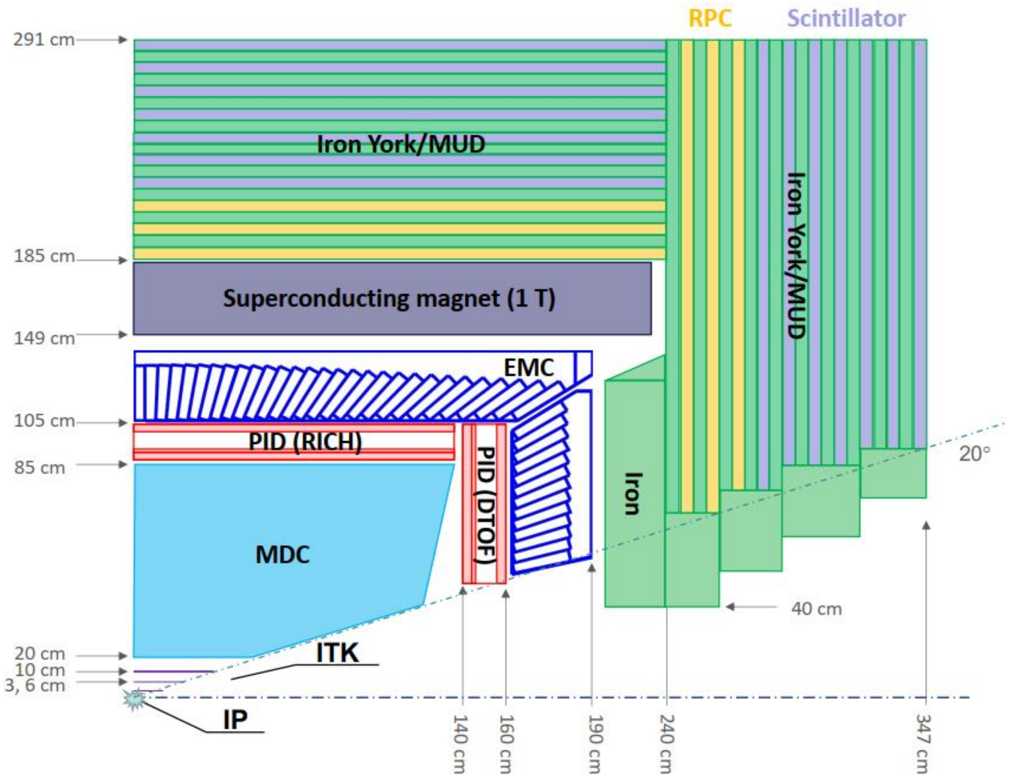


STCF detector









Requirement:

- High detection efficiency and good resolution
- Superior PID ability
- Tolerance to high rate/background environment

ITK

<0.25%X0 / layer

σ_{xy}< 100 μm

MDC

σ_{xy}< 130 μm

$\sigma p/p$ ~ 0.5% @ 1 GeV

PID

π/K (and K/p): 3-4σ separation up to 2GeV/c

EMC

E range: 0.025-3.5 GeV

σ_E @ 1 GeV: 2 .5% in barrel, 4% at endcaps

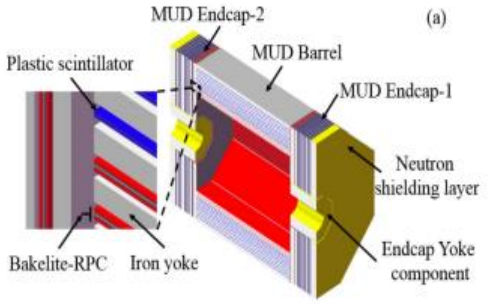
Pos. Res. : ~ 4 mm

MUD

0.4 - 1.8 GeV

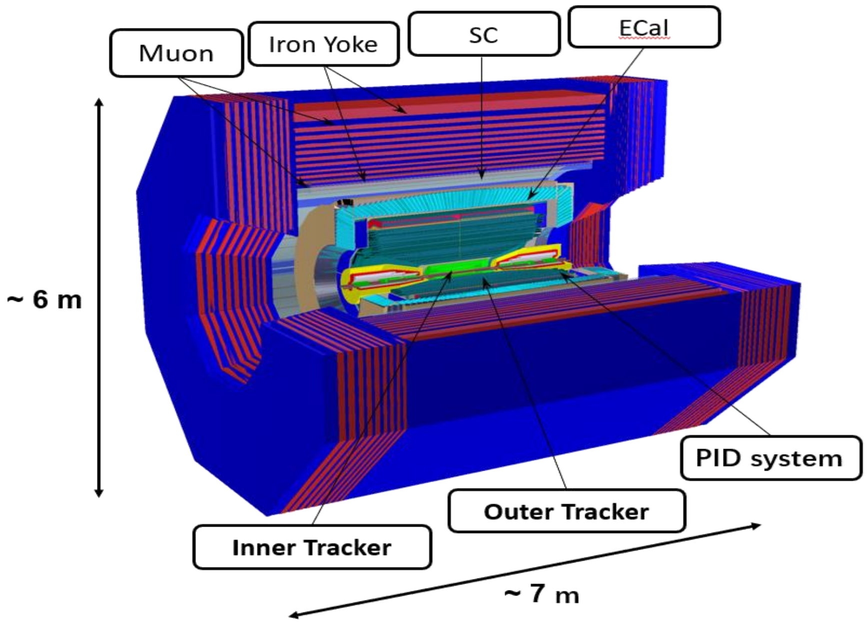
π suppression >30

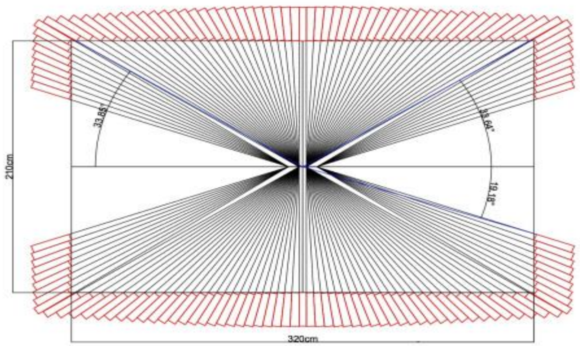
Detector options



Muon detector

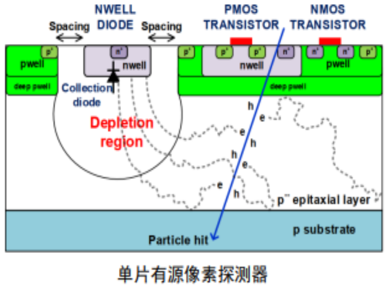
- Bakelite RPC + Scintillator strips

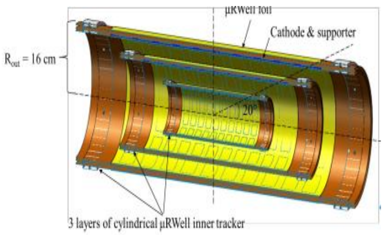




EM calorimeter

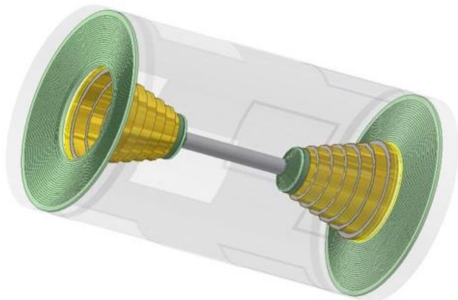
- Pure CsI crystal + APD





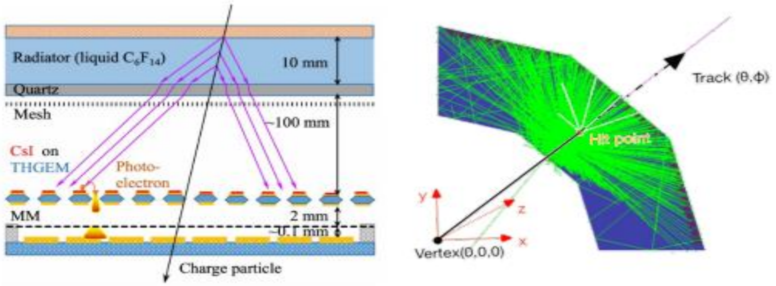
Inner Tracker

- MPGD: Cylindrical µRWELL
  - Silicon: CMOS MAPS



Central Tracker

- Drift Chamber with extra-low mass and small cell

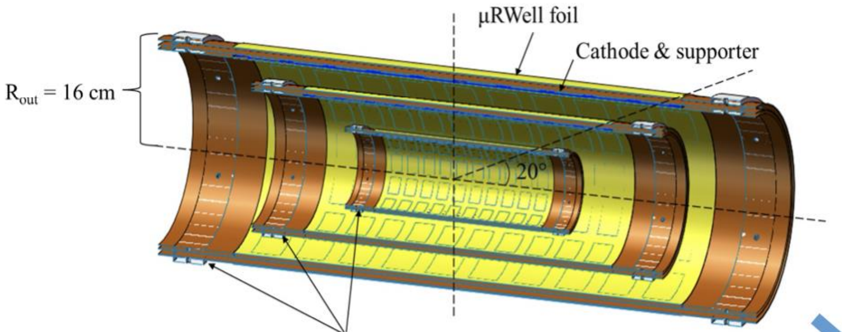


Particle Identification

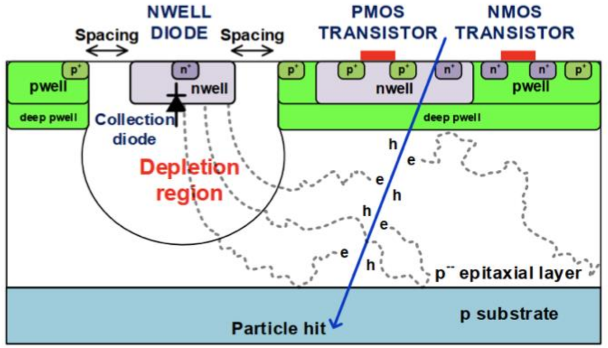
- Barrel: RICH
- EndCap: DIRC-Like TOF

Tracking system: inner tracker + drift chamber

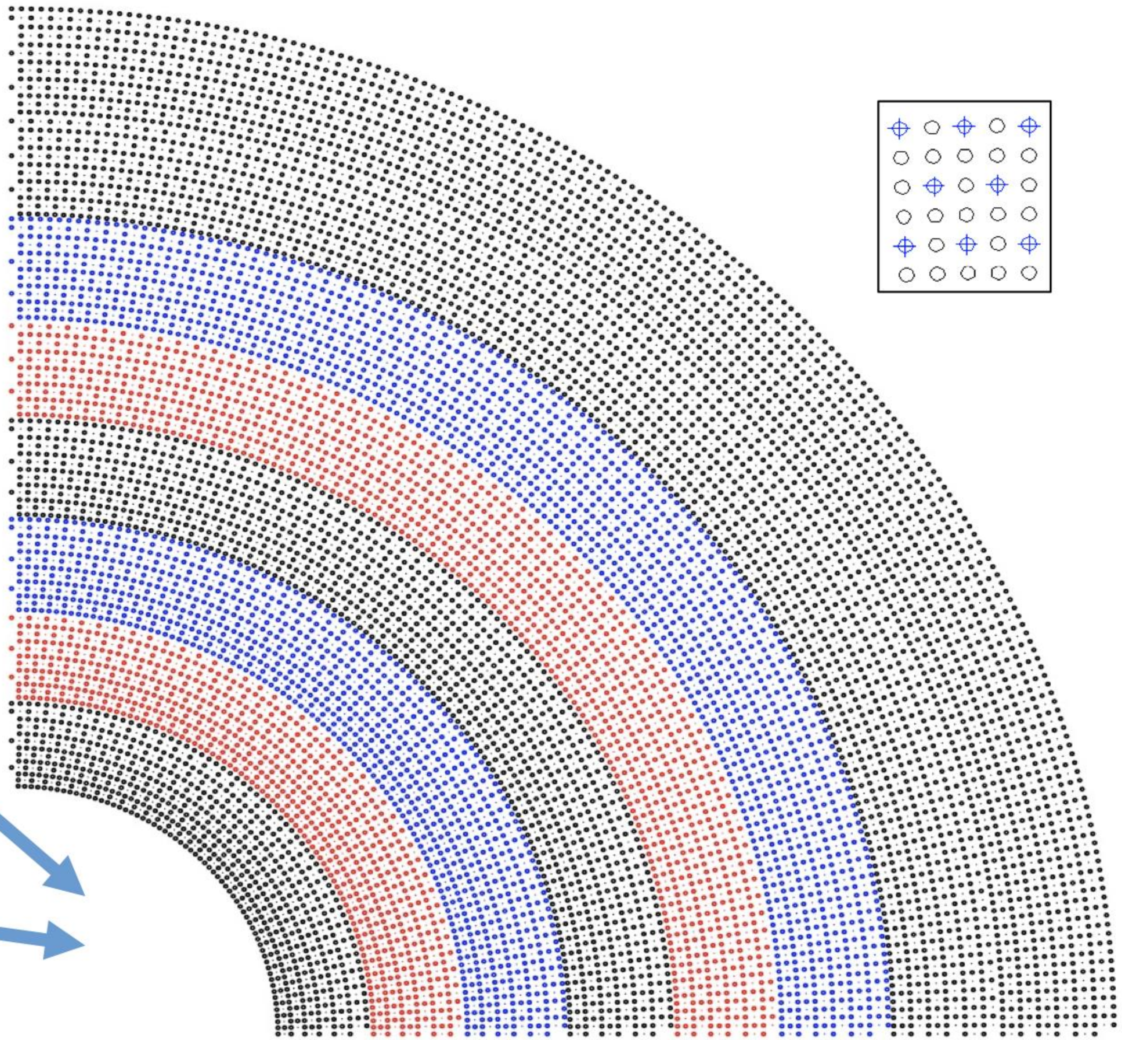
MPGD option: uRWELL



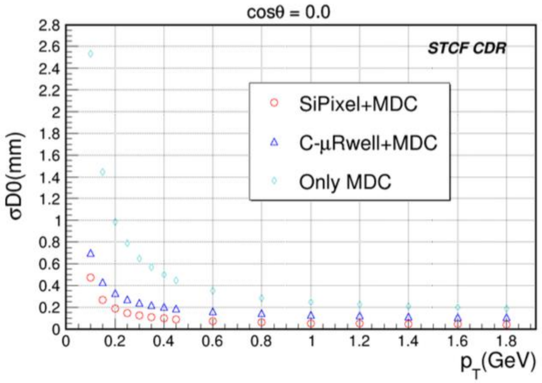
Silicon option: CMOS MAPS



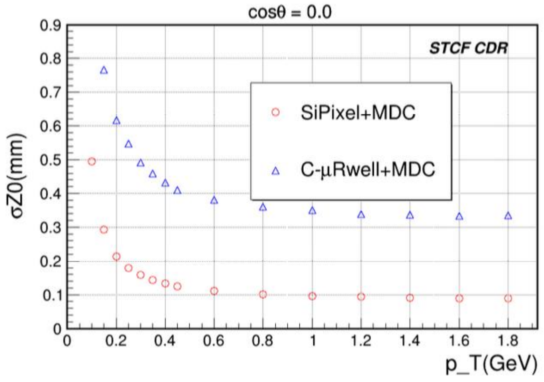
单片有源像素探测器



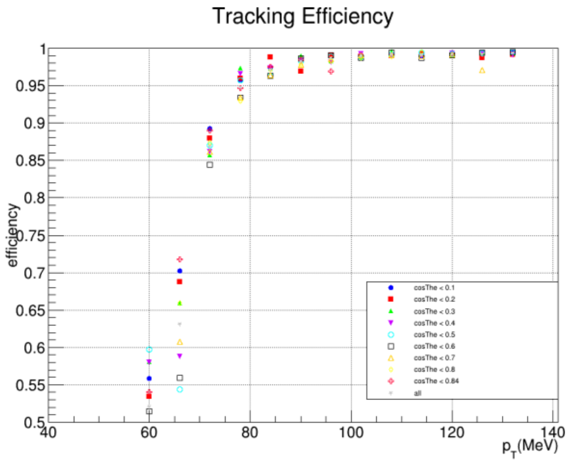
Expected Performance of the tracking system

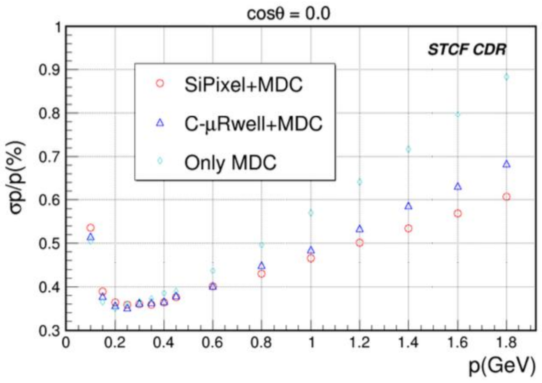


(a)



(b)





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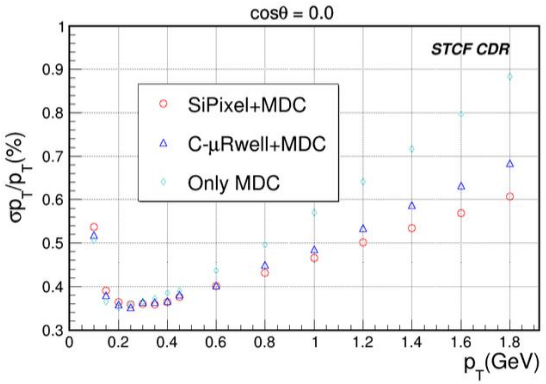
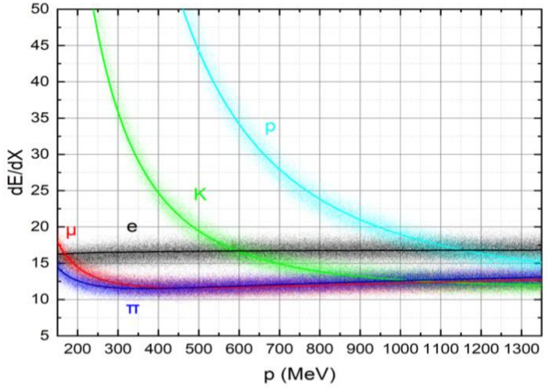
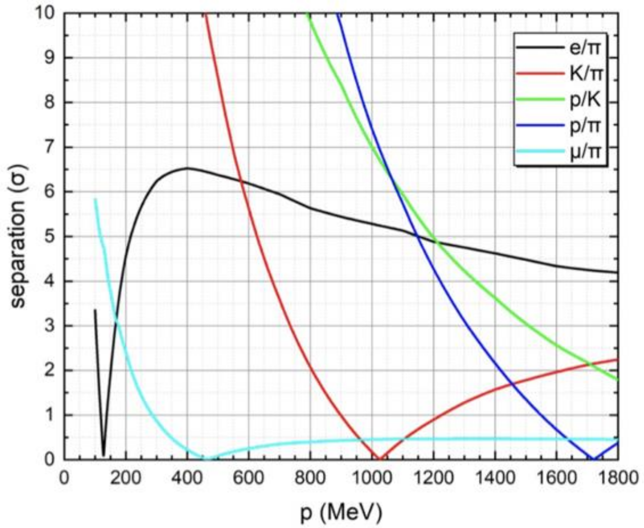


(d)

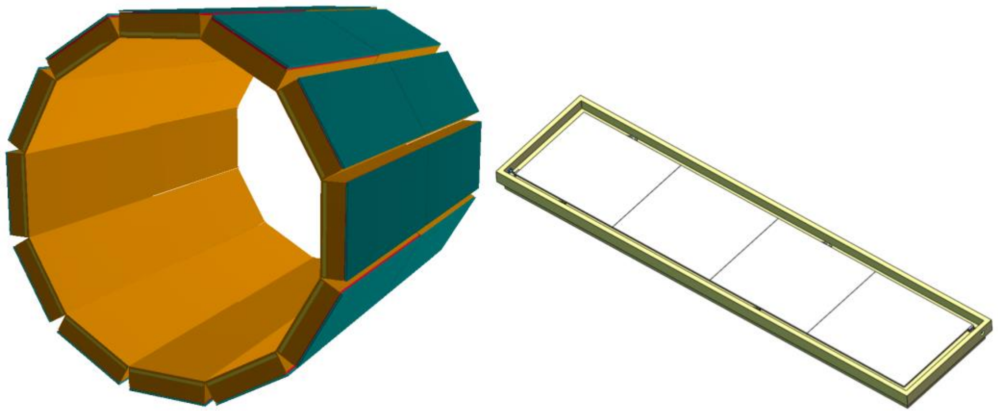


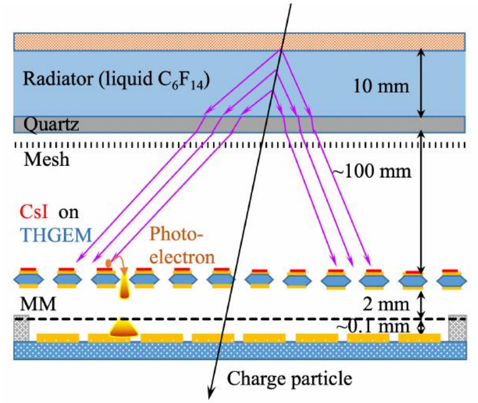


Optimization campaign of the inner tracker layout has been recently launched, particularly targeting low momentum tracking performance.

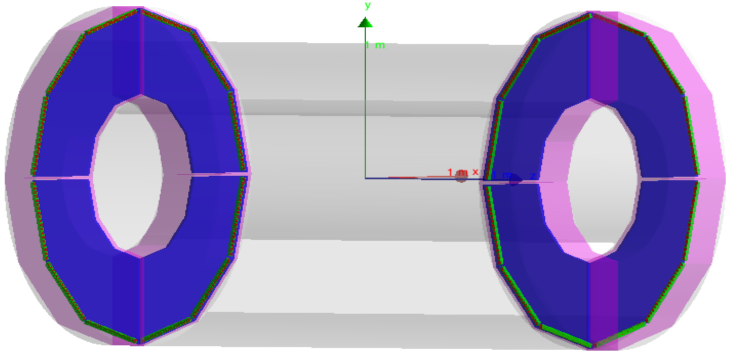
Particle Identification

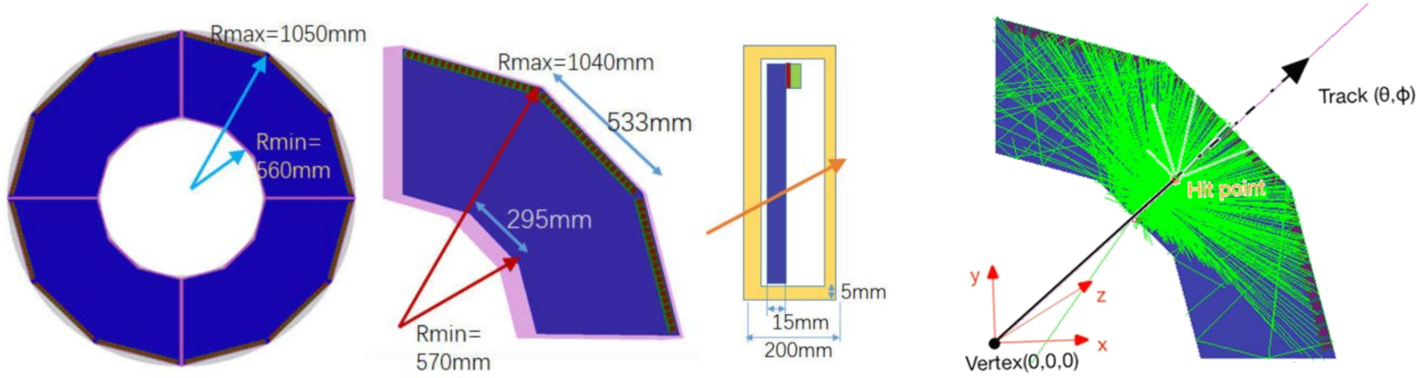
- ❖ **Barrel : A RICH detector using MPGD for photon detection (TOF technology no longer feasible for PID up to 2 GeV due to short distance of flight)**





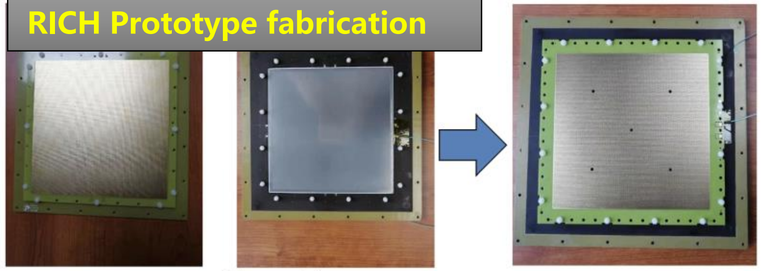
- ❖ **Endcaps : A DIRC-like high-resolution TOF detector is proposed (TOF option is possible thanks to the longer distance of flight) .**



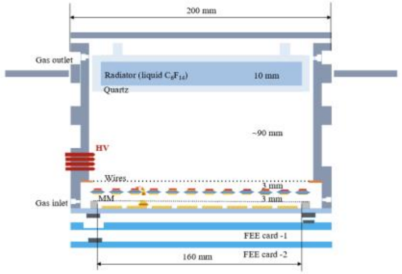


Development of a RICH Prototype with C6F14

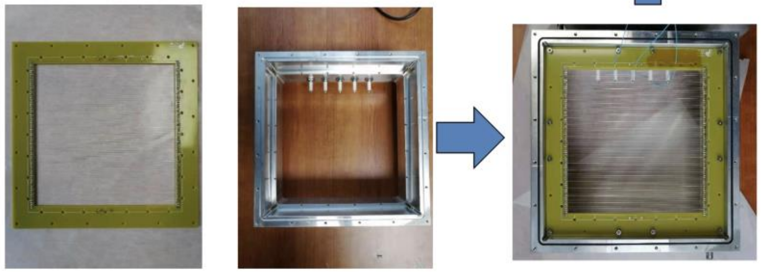
RICH Prototype fabrication



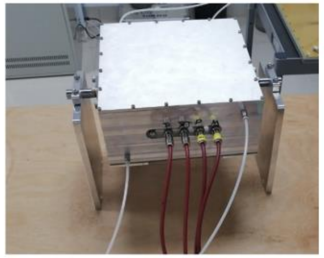
THGEM　热压接Micromegas



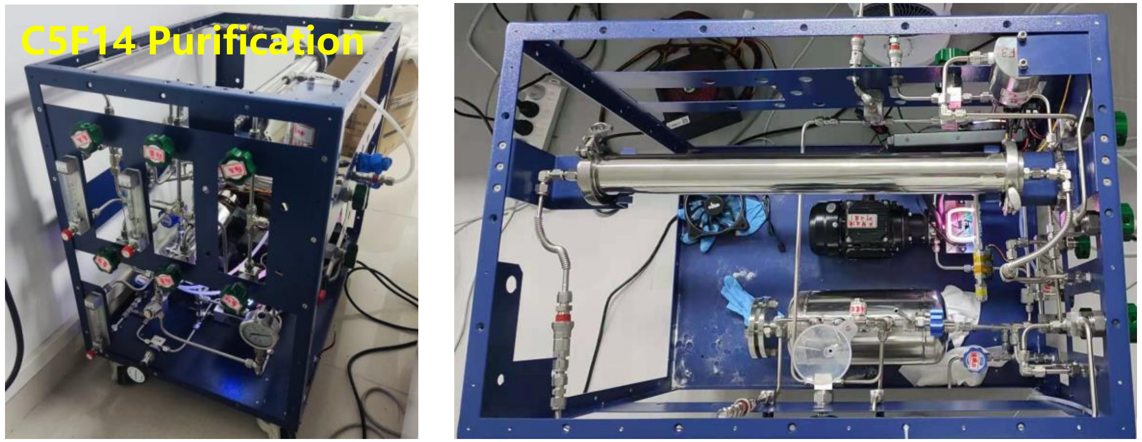
设计图及样机实物



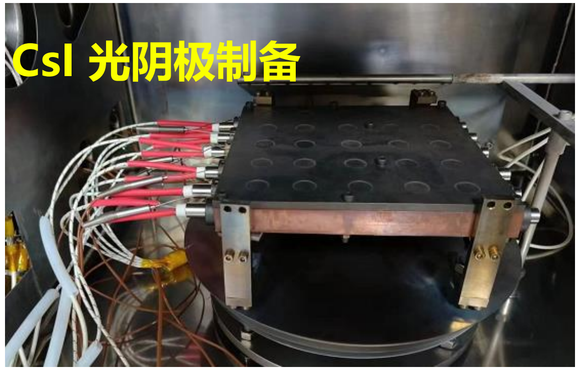
丝型漂移阴极　气体腔室

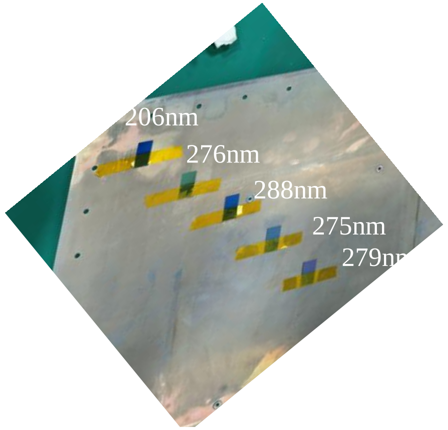


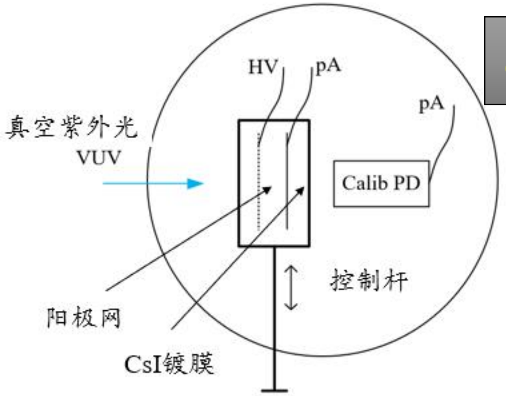
C5F14 Purification



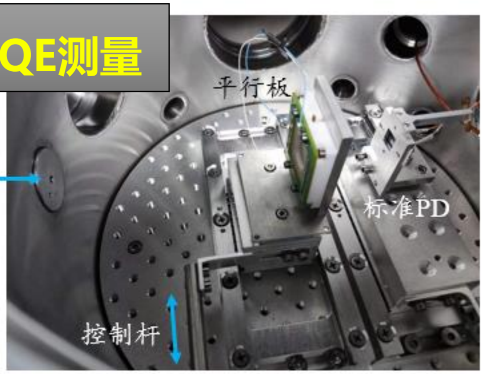
CsI 光阴极制备

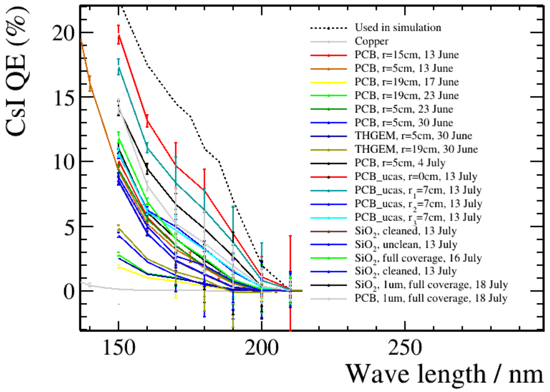


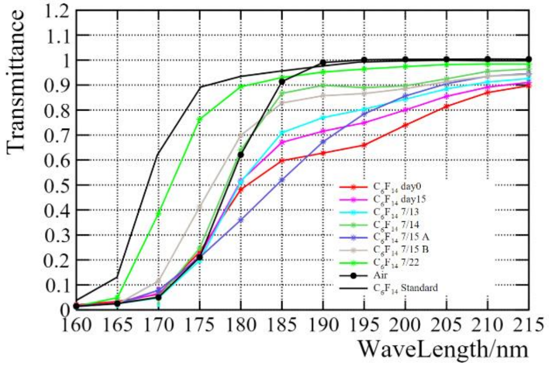




CsI QE测量

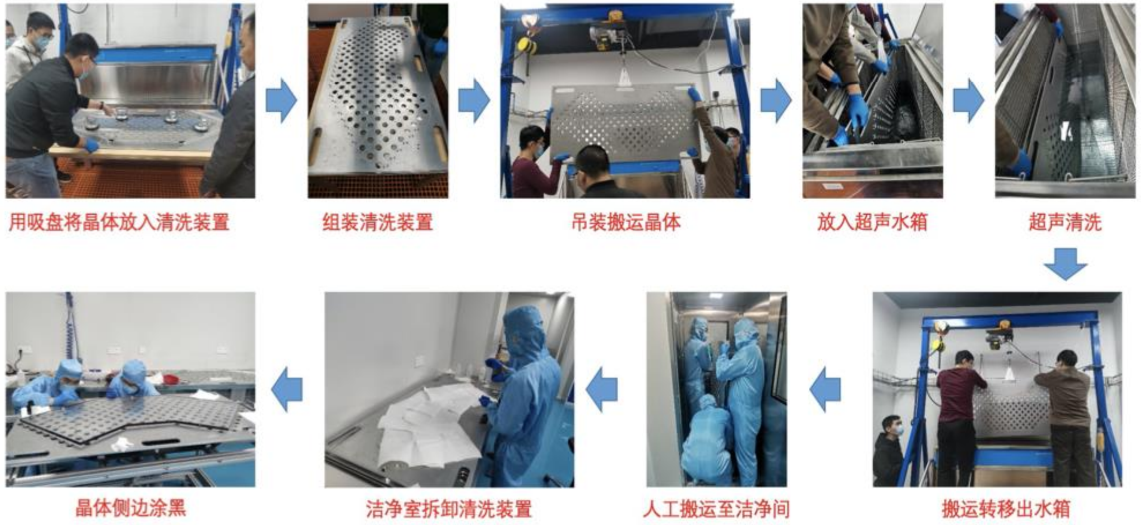




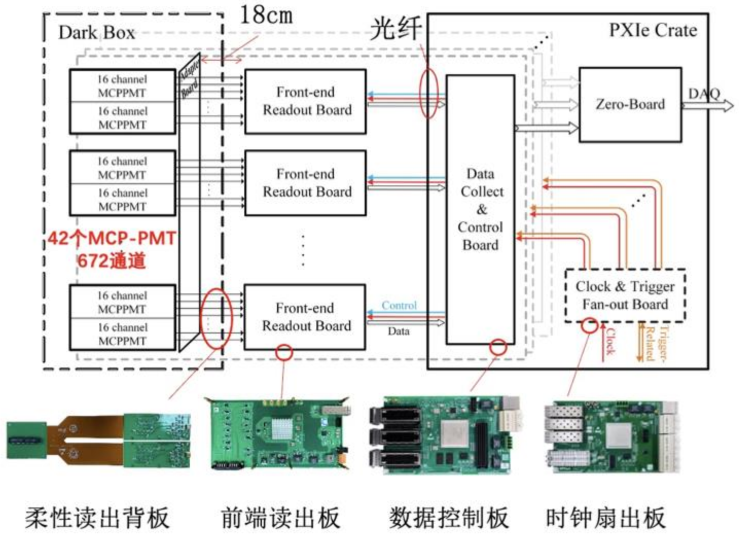


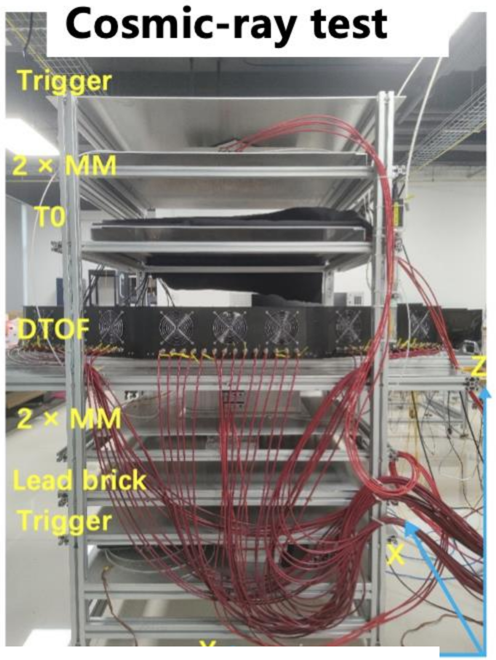
Full size DTOF prototype and readout electronics

Quartz radiator cleaning and mounting

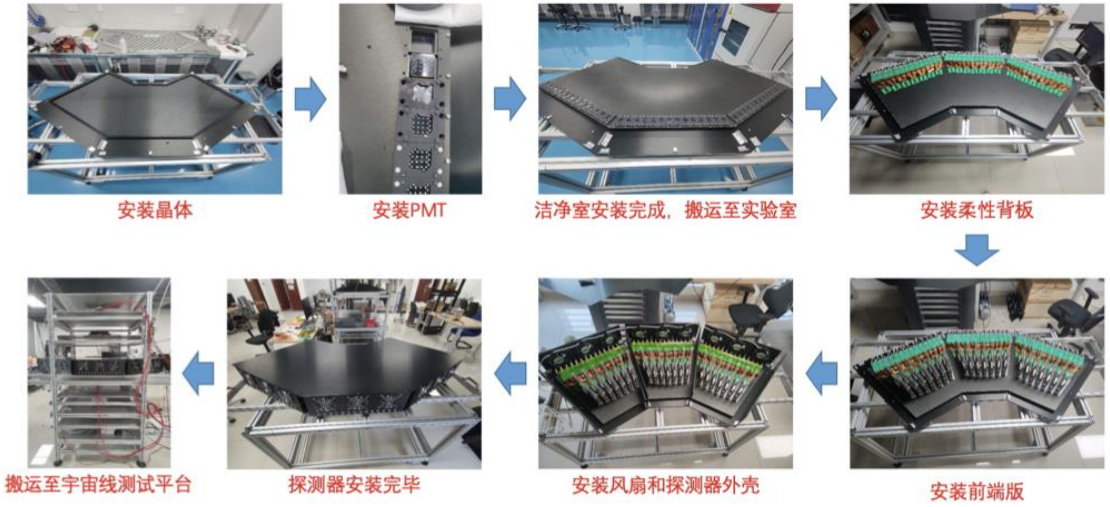


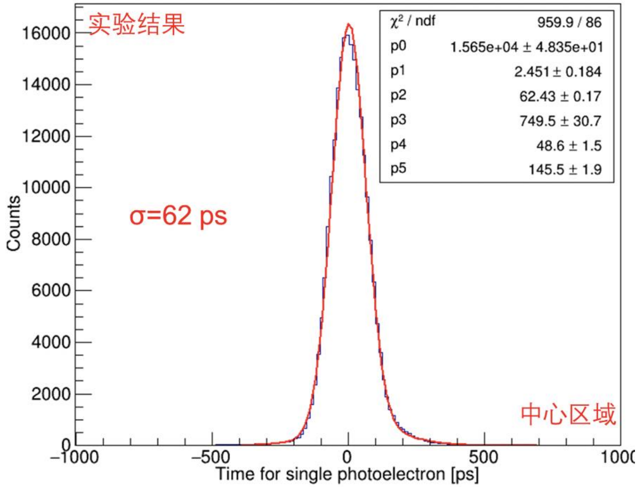
Readout electronics development



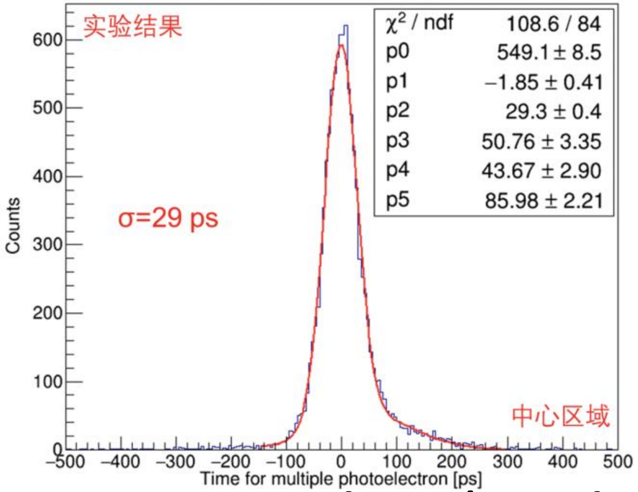


Detector assembling





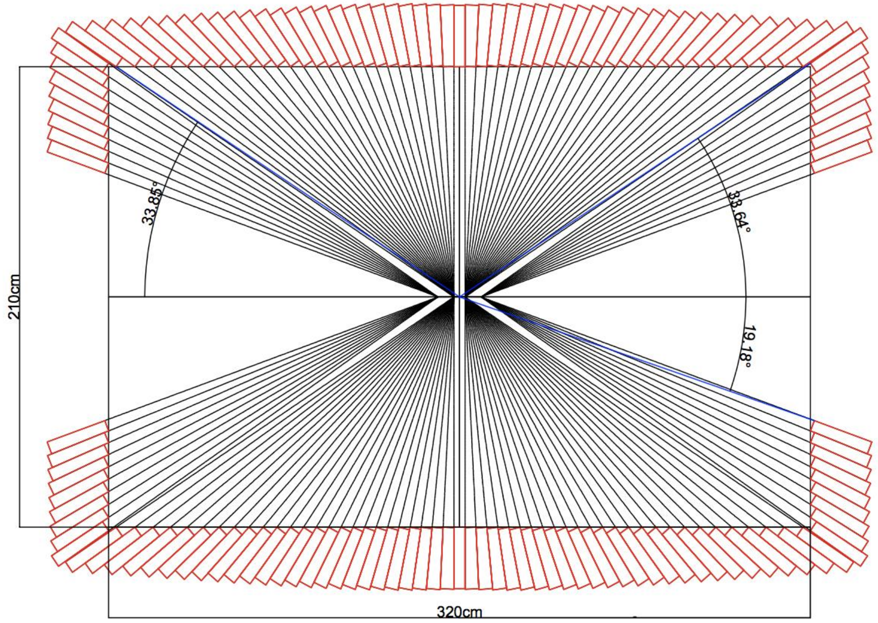
Single photon time resolution



DTOF time resolution(T0 included)

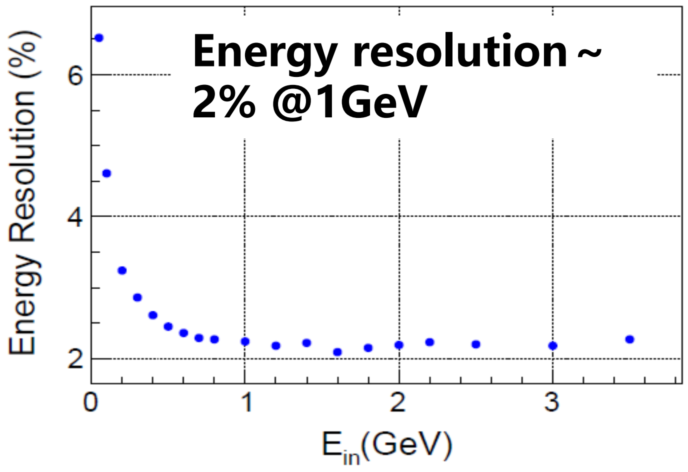
Electromagnetic Calorimeter

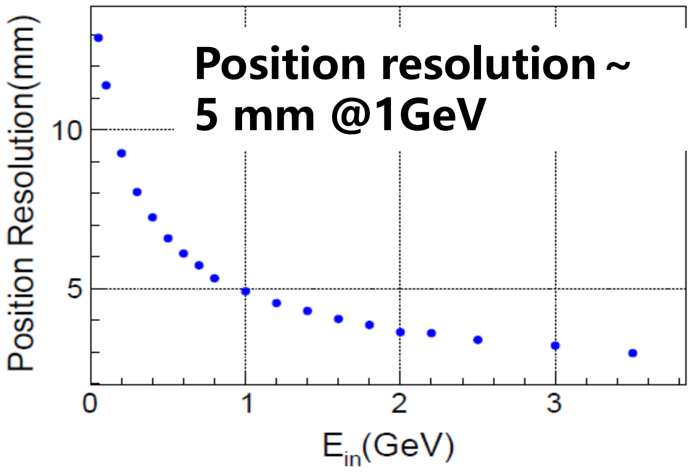
- A crystal calorimeter using pCsI (short decay time of 30ns) to tackle the high background rate (~ 1 MHz/crystal)
  - crystal size： 28cm (15X_0), 5×5cm^2
  - defocused layout： 6732 crystals in barrel， 1938 crystals in endcaps
  - 4 large area APDs to address low light yield: 4×(1×1cm^2)



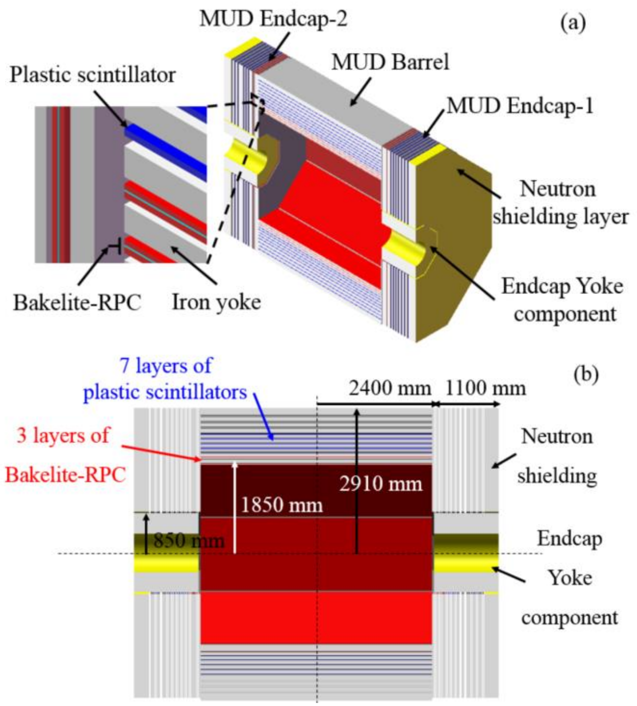
pCsI has a very low light yield of 3.6% → a major R&D task : enhance light yield

Simulation assuming a light yield of 100pe/MeV



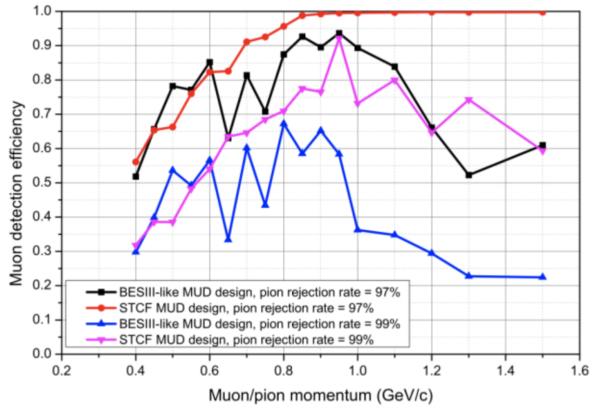


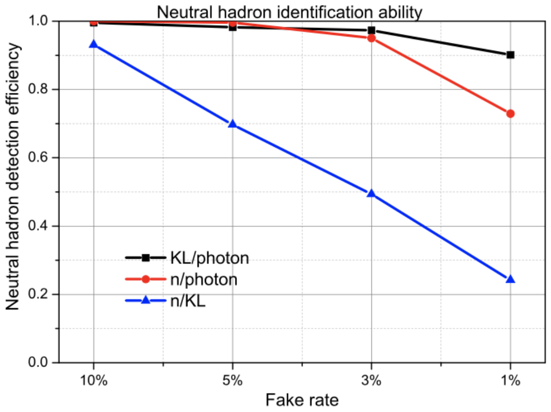
The Muon Detector



Parameter	Baseline design
R_{in} [cm]	185
R_{out} [cm]	291
R_e [cm]	85
L_{Barrel} [cm]	480
T_{Endcap} [cm]	107
Segmentation in ϕ	8
Number of detector layers	10
Iron yoke thickness [cm]	4/4/4.5/4.5/6/6/6/8/8 cm
(λ=16.77 cm)	Total: 51 cm, 3.04λ
Solid angle	79.2%×4π in barrel 14.8%×4π in endcap 94%×4π in total
Total area [m^2]	Barrel ~717 Endcap ~520 Total ~1237

- A hybrid design with Bakelite RPC and scintillator strips for optimal overall performance
  - RPC for inner layers : not sensitive to background
  - Scintillator for outer layers: sensitive to hadrons
- Key design parameters have been optimized based on simulation of muon identification performance
  - Inner 3 RPC layers + outer 7 scintillator layers
  - Taking neutral hadron identification into account





Using BDT combining the muon detector and EMC

Tentative plan of STCF

	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032-2042	2043-2046
Form collaboration																
Conception design CDR																
R&D (TDR)																
Construction																
Operation																
Upgrade																

STCF kickoff meeting in 08/25/2023

超级陶粲装置关键技术攻关项目战略发展研讨会暨项目启动会
Project Launch Meeting for Key Technology Research and Development of STCF

Summary & Outlook

FRONTIERS OF PHYSICS
f p REPORT
Volume 19 / Issue 1 / 14701 / 2024

STCF conceptual design report (Volume 1):
Physics & detector

M. Achasov[3], X. C. Ai[82], R. Aliberti[38], Q. An[63,72], X. Z. Bai[63,72], Y. Bai[62], O. Bakina[39], A. Barnyakov[3,50],
V. Blinov[3,50,51], V. Bobrovnikov[3,51], D. Bodrov[23,60], A. Bogomyagkov[3], A. Bondar[3], I. Boyko[39],
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K. T. Chao[54], D. Y. Chen[62], H. Chen[81], H. X. Chen[62], J. F. Chen[58], K. Chen[6], L. L. Chen[20],
P. Chen[78], S. L. Chen[6], S. M. Chen[66], S. Chen[69], S. P. Chen[69], W. Chen[64], X. Chen[74], X. F. Chen[58],
X. R. Chen[33], Y. Chen[32], Y. Q. Chen[36], H. Y. Cheng[34], J. Cheng[48], S. Cheng[28], T. G. Cheng[2],
J. P. Dai[80], L. Y. Dai[28], X. C. Dai[54], D. Dedovich[39], A. Denig[19,38], I. Denisenko[39], J. M. Dias[4],
D. Z. Ding[58], L. Y. Dong[32], W. H. Dong[63,72], V. Druzhinin[3], D. S. Du[63,72], Y. J. Du[77], Z. G. Du[41],
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F. K. Guo[4,69,2], J. C. Guo[63,72], J. Guo[59], Y. P. Guo[11], Z. H. Guo[16], A. Guskov[39], K. L. Han[69], L. Han[63,72],
M. Han[63,72], X. Q. Hao[20], J. B. He[69], S. Q. He[63,72], X. G. He[59], Y. L. He[20], Z. B. He[33], Z. X. Heng[20],
B. L. Hou[63,72], T. J. Hou[74], Y. R. Hou[69], C. Y. Hu[74], H. M. Hu[32], K. Hu[57], R. J. Hu[33], X. H. Hu[9], Y. C. Hu[49],
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Z. K. Jia[63,72], H. B. Jiang[77], J. Jiang[57], S. Z. Jiang[14], J. B. Jiao[57], Z. Jiao[24], H. J. Jing[69], X. L. Kang[8],
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R. H. Li[30], S. Li[59], T. Li[57], W. J. Li[20], X. Li[33], X. H. Li[74], X. Q. Li[6], X. H. Li[63,72], Y. Li[79], Y. Y. Li[72], Z. J. Li[33],
H. Liang[63,72], J. H. Liang[61], Y. T. Liang[33], G. R. Liao[13], L. Z. Liao[25], Y. Liao[61], C. X. Lin[69], D. X. Lin[33],
X. S. Lin[63,72], B. J. Liu[32], C. W. Liu[15], D. Liu[63,72], F. Liu[6], G. M. Liu[61], H. B. Liu[14], J. Liu[54], J. J. Liu[74],
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H. J. Lyu[24], X. R. Lyu[69], J. P. Ma[35], P. Ma[33], Y. Ma[15], Y. M. Ma[33], F. Maas[19,38], S. Malde[71], D. Matvienko[3],
Z. X. Meng[70], R. Mitchell[29], A. Nefediev[40], Y. Nefedov[39], S. L. Olsen[22,53], Q. Ouyang[32,63], P. Pakhlov[23],
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X. Y. Peng[8], X. J. Peng[41], K. Peters[12], S. Pivovarov[3], E. Pyata[3], B. B. Qi[63,72], Y. Q. Qi[63,72], W. B. Qian[69],
Y. Qian[33], C. F. Qiao[69], J. J. Qin[74], J. J. Qin[63,72], L. Q. Qin[13], X. S. Qin[57], T. L. Qiu[33], J. Rademacker[68],
C. F. Redmer[38], H. Y. Sang[63,72], M. Saur[54], W. Shan[26], X. Y. Shan[63,72], L. L. Shang[20], M. Shao[63,72],
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J. S. Tian[78], Y. Tian[33], Y. Tikhonov[3], K. Todyshev[3,51], T. Uglov[52], V. Vorobyev[3], B. D. Wan[15],
B. L. Wang[69], B. Wang[63,72], D. Y. Wang[54], G. Y. Wang[21], G. L. Wang[17], H. L. Wang[61], J. Wang[49],
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W. P. Wang[63,72], X. C. Wang[20], X. D. Wang[74], X. L. Wang[63,72], X. L. Wang[20], X. P. Wang[2], X. F. Wang[41],

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https://doi.org/10.1007/s11467-023-1333-z

- **STCF is a super tau-charm facility proposed by the Chinese HEP community as one of the post-BEPCII HEP projects in China.**
  - $E_{cm} = 2 – 7$ GeV, $L > 0.5\times10^{35}$ $cm^{-2}s^{-1}$@4 GeV
- **Many new R&D efforts have launched, the CDR for physics and detector was published recently.**
- **A full-scale R&D program funded by local governments and USTC**
- **Still lots of room for design optimization, particularly global optimization**

Thanks for your attention!