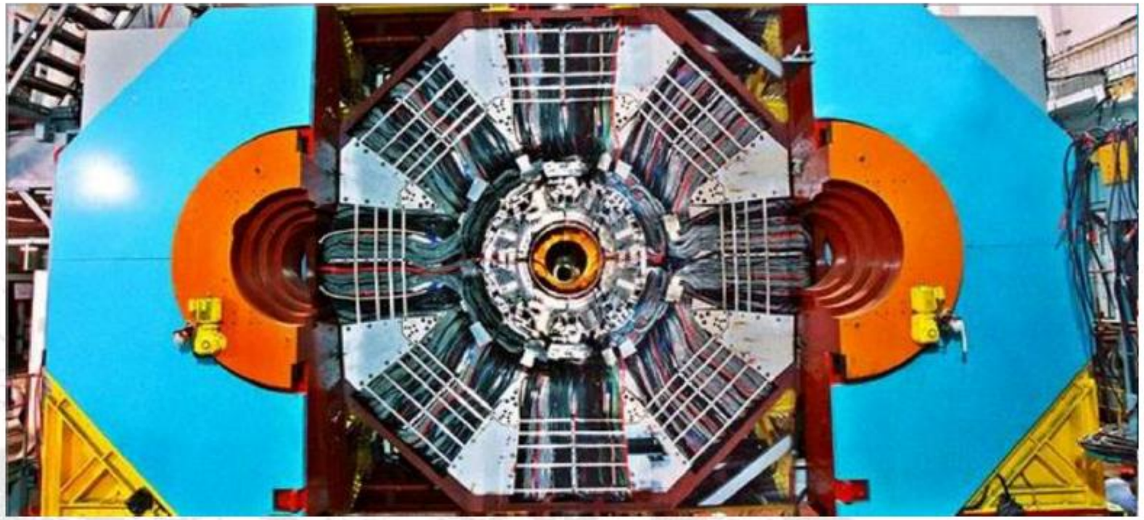
Recent Highlights at BESIII



Xiaoyan SHEN

On behalf of BESIII Collaboration

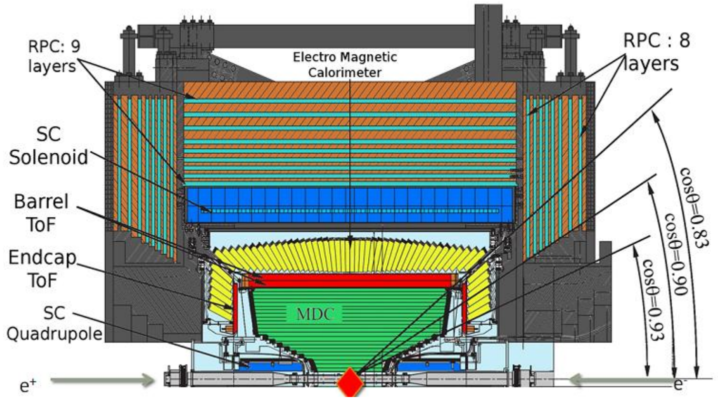
Institute of High Energy Physics, Chinese Academy of Sciences

Jan. 22, 2026, Bormio, Italy

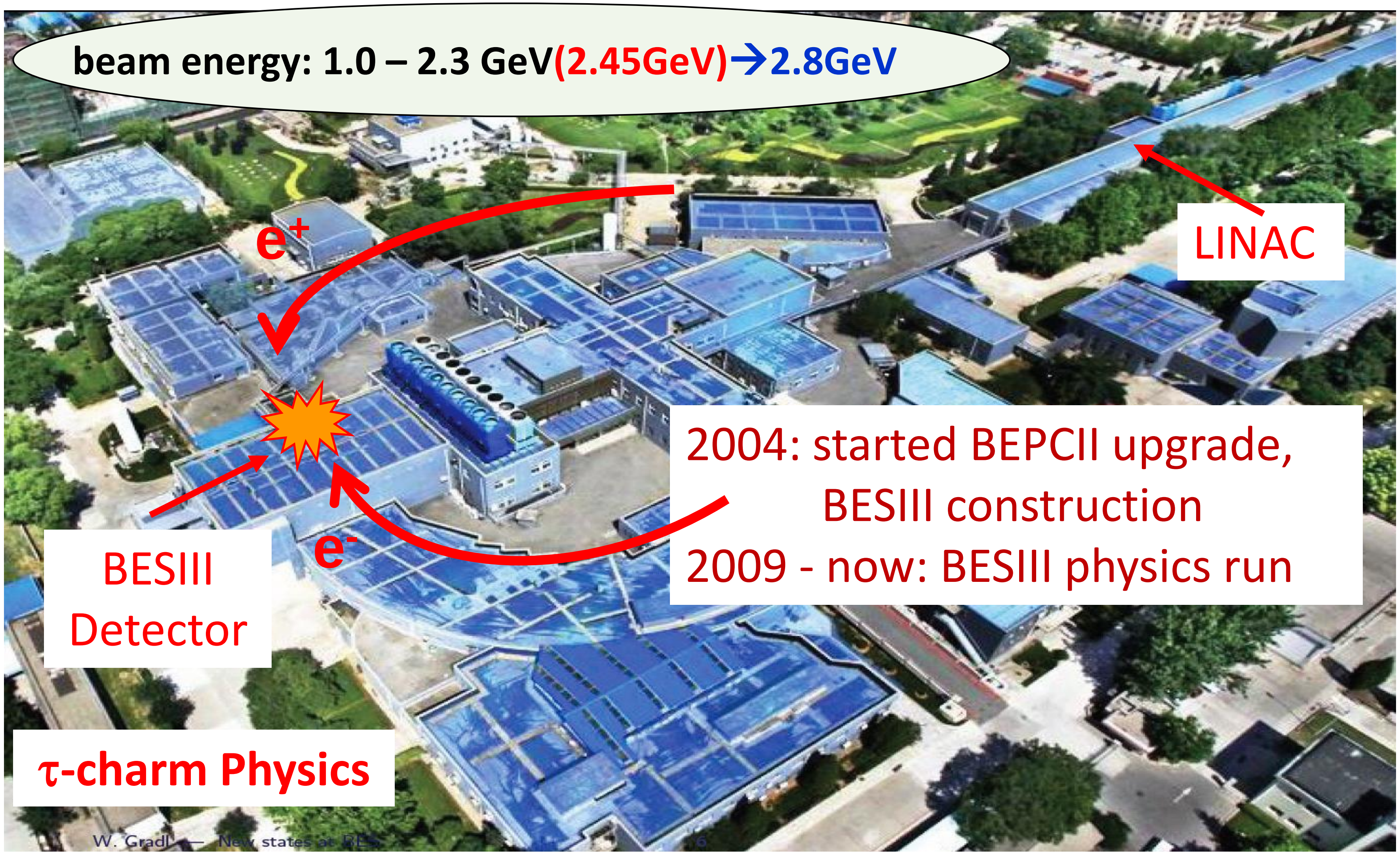
The 62nd International Winter Meeting on Nuclear Physics

BESIII @ Beijing Electron Positron Collider (BEPCII) - A τ-Charm Facility

- 1989-2004 (BEPC):
  L_{peak}=1.0x10^{31} /cm^{2}s
- 2009-now (BEPCII):
  L_{peak}= 1.0 x10^{33}/cm^2(2016)
  L_{peak}= 1.1 x10^{33}/cm^2(2023)



MDC: spatial reso. 115μm
dE/dx reso: 5%
EMC: energy reso.: 2.4%
BTOF: time reso.: 70 ps
ETOF: time reso.: 60 ps



Europe (19)

Germany(6): Bochum University, GSI Darmstadt, Helmholtz Institute Mainz, Johannes Gutenberg University of Mainz, Universitaet Giessen, University of Münster
Italy(3): Ferrara University, INFN, University of Turin,
Netherlands(1): KVI/University of Groningen
Russia(3): Budker Institute of Nuclear Physics, Dubna JINR, Lebedev Physical Institute
Sweden(1): Uppsala University
Turkey (1): Turkish Accelerator Center Particle Factory Group
UK(3): University of Manchester, University of Oxford, University of Bristol
Poland(1): National Centre for Nuclear Research

BESIII

~ 700 members
From 93 institutions
in 16 countries

USA(3)

Carnegie Mellon University
Indiana University
University of Hawaii

Mongolia(1)

Institute of Physics and Technology

Korea(1)

Chung-Ang University

Thailand(1)

Suranaree University of Technology

Pakistan(2)

Institute of Business Administration (IBA), Karachi
University of the Punjab

India(1)

Indian Institute of Technology madras

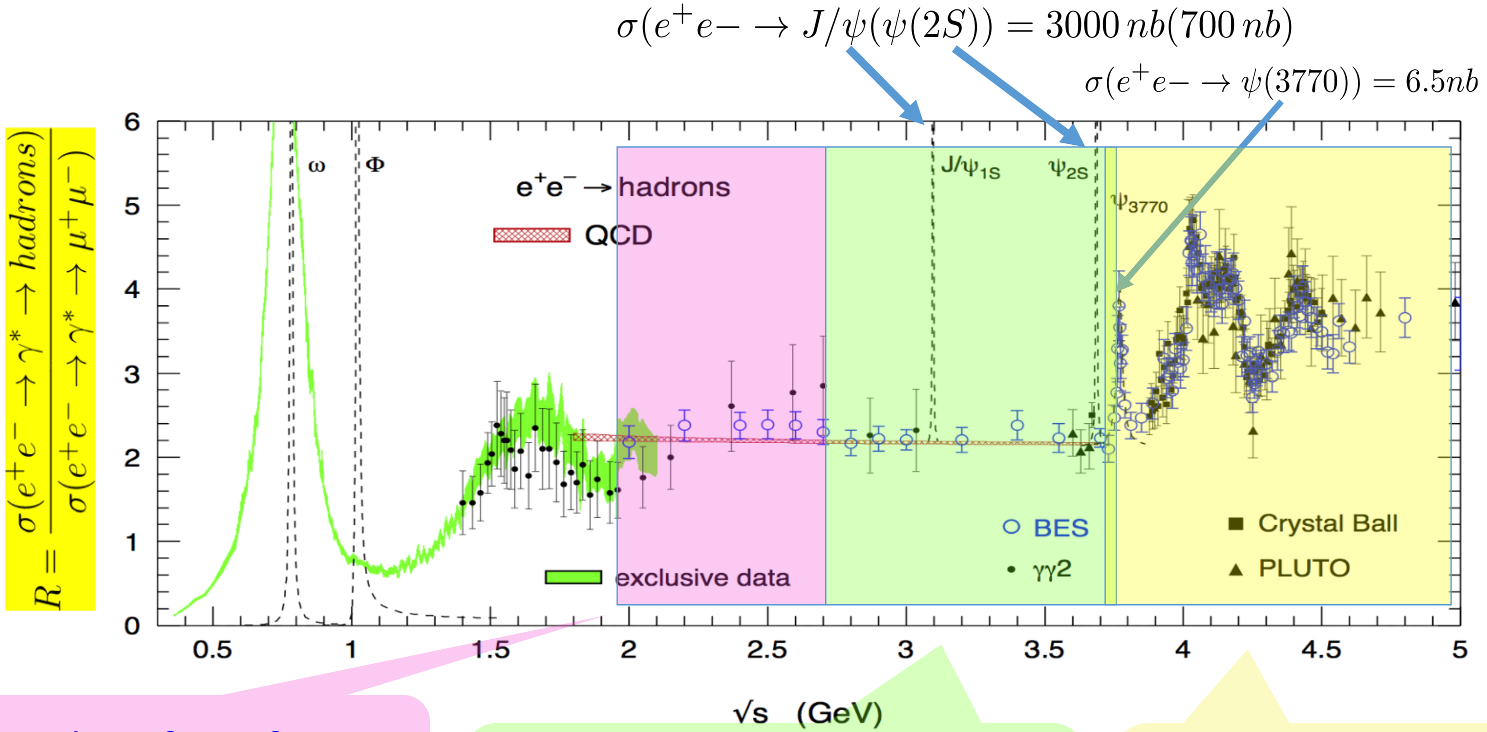
Chile(2)

University of Tarapaca
University of La Serena

China (63)

Beihang University, Central China Normal University, Central South University, Chengdu University of Technology , China Center of Advanced Science and Technology, China University of Geosciences, Fudan University, Guangxi Normal University, Guangxi University, Guangxi University of Science and Technology, Hangzhou Normal University, Hebei University, Henan University, Henan Normal University, Henan University of Science and Technology, Henan University of Technology, , Hengyang Normal University, Huangshan College, Hunan University, Hunan Normal University, Inner Mongolia University, Institute of High Energy Physics, Institute of Modern Physics, Jiangsu Ocean University , Jilin University, Lanzhou University, Liaoning Normal University, Liaoning University, Longyan University, Nanjing Normal University, Nanjing University, Nankai University, North China Electric Power University,Peking University, Qufu Normal University, Renmin University of China, Shaanxi Normal University, Shanxi University, Shanxi Normal University, Sichuan University, Shandong Management University , Shandong Normal University, Shandong University, Shandong University of Technology, Shanghai Jiao Tong University, Soochow University,South China Normal University, Southeast University, Southwest University of Science and Technology, Sun Yat-sen University, Tsinghua University, University of Chinese Academy of Sciences, University of Jinan, University of Science and Technology of China, University of Science and Technology Liaoning, University of South China, Wuhan University, Xi'an Jiaotong University, Xinyang Normal University, Yantai University , Yunnan University , Zhejiang University, Zhengzhou University

Rich physics program at BESIII



- Hadron form factors
- R values and QCD

- Light hadron spectroscopy
- Gluonic and exotic states
- Physics with τ lepton

- XYZ particles
- Charm mesons
- Charm baryons

✓ **Charm physics**
✓ **Hadron physics**
✓ **Charmonium physics + XYZ's**
✓ **…**

- **New observations**
- **Precise measurements**
- **> 700 publications**

BEPCII: ~2.0-5.0 GeV

- Rich of resonances: charmonia, charm mesons, charm baryons
- Transition between smooth and resonances, perturbative and non-perturbative QCD
- Energy location of the gluonic matters and XYZ's
- Threshold characteristics (pairs of τ, D, D_s, Λ_c…)
  Fixed initial and final states, low background

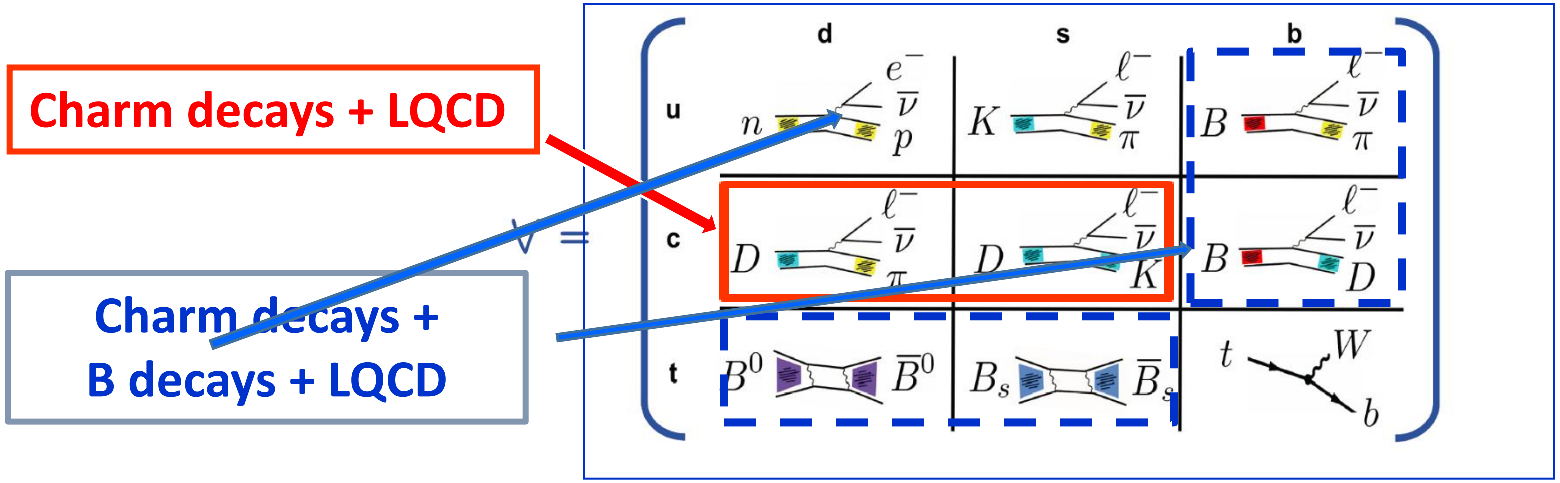
Recent highlights (selected) at BESIII

- **Charm physics** （CKM measurements）
- **Hadron physics**
  - Spectroscopy (light hadron spectroscopy)
  - Structure
    - Baryon Electromagnetic Form Factors
    - Fragmentation Functions
  - Interaction

    Hyperon-nucleon interaction
- **Λ EDM**
- **Prospects**

Precision measurement of CKM elements
-- verifying the unitarity of CKM to test EW theory

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



$$V_{\rm CKM}^{\rm PDG2024} = \begin{pmatrix} V_{ud} & V_{us} & V_{ub} \\ V_{cd} & V_{cs} & V_{cb} \\ V_{td} & V_{ts} & V_{tb} \end{pmatrix} = \begin{pmatrix} 0.97367 \pm 0.00032 & 0.22431 \pm 0.00085 & 0.00382 \pm 0.00020 \\ 0.221 \pm 0.004 & 0.975 \pm 0.006 & 0.0411 \pm 0.0012 \\ 0.0086 \pm 0.0002 & 0.0415 \pm 0.0009 & 1.010 \pm 0.027 \end{pmatrix}$$

$$|V_{ud}|^2 + |V_{us}|^2 + |V_{ub}|^2 = \mathbf{0.9984 \pm 0.0007} \qquad \sim 0.07\%$$

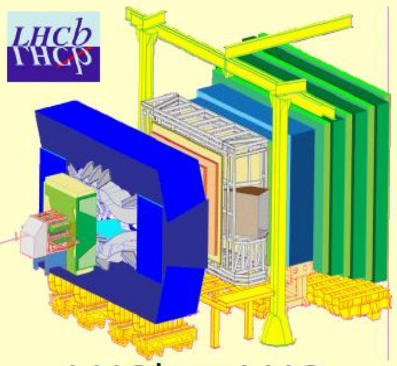
$$|V_{cd}|^2 + |V_{cs}|^2 + |V_{cb}|^2 = \mathbf{1.001 \pm 0.012} \qquad \sim 1.0\%$$

Precise measurement of $|V_{cd}|$ and $|V_{cs}|$ is crucial

Landscape of Charm Physics

B physics experiments are well suited for charm physics

hadron collider



LHCb at LHC

$\int_{run1} \mathcal{L} \approx 3 fb^{-1}$ $3.6 \cdot 10^{12}\ c\bar{c}$

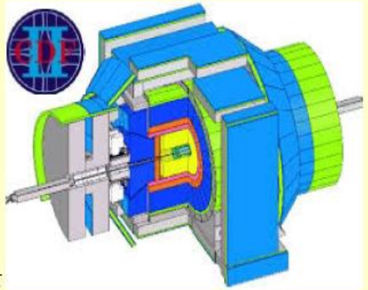
$\int_{run2} \mathcal{L} \approx 5.5 fb^{-1}$ $9.6 \cdot 10^{12}\ c\bar{c}$

world's largest c sample

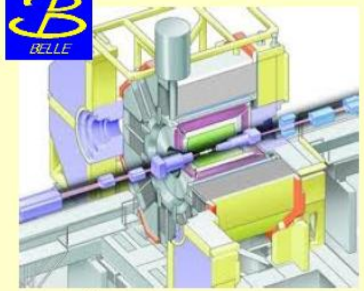
CDF at TEVATRON

$\int \mathcal{L} \approx 9.6 fb^{-1}$

$2.3 \cdot 10^{11}\ c\bar{c}$



e^+e^- collider



Belle at KEKB

$\int \mathcal{L} \approx 1 ab^{-1}$

$1.3 \cdot 10^{9}\ c\bar{c}$

Belle II

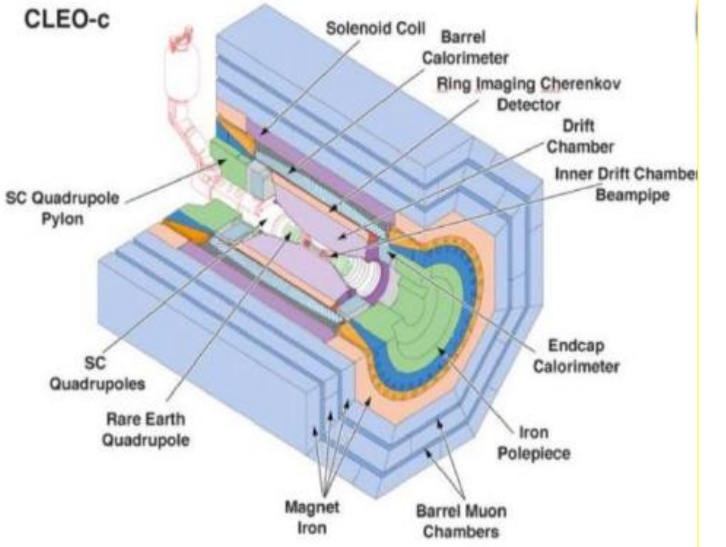
$\int \mathcal{L} \approx 6.5 fb^{-1}$

$8.5 \cdot 10^{6}\ c\bar{c}$

BABAR at PEPII

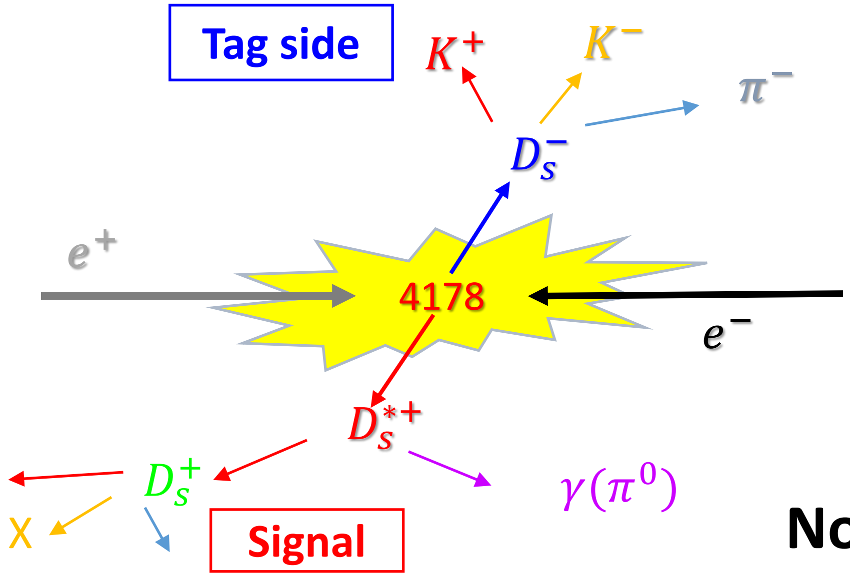
$\int \mathcal{L} \approx 550 fb^{-1}$

$7 \cdot 10^{8}\ c\bar{c}$



- **CLEOc exp. contributed much in early days.**
- **B factories: clean environment, good to detect neutral particles; lower boost, poorer lifetime resolution**
- **LHCb/hadron machine: huge production X-section, excellent lifetime resolution due to the boost; large combinatorial BG, difficult with neutral and missing particles**

Unique advantage at BESIII: BG free and Double tag method (DT)



Signal side: μ^+ is reconstructed, ν is reconstructed by MM^2

$$E_{\text{miss}} = E_{\text{beam}} - E_{\mu^+}, \quad \vec{p}_{\text{miss}} = -\vec{p}_{D^-} - \vec{p}_{\mu^+}$$

$$M^2_{\text{miss}} = E^2_{\text{miss}} - |\vec{p}_{\text{miss}}|^2, \quad U_{\text{miss}} = E_{\text{miss}} - |\vec{p}_{\text{miss}}|$$

Tag side: $K^+K^-\pi^-$ +…., very clean decay modes

Non-$D_s^{*+}D_s^-$ events can be suppressed by beam-constrained mass cut $M_{BC} \equiv \sqrt{\left(\frac{E_{CM}}{2}\right)^2 - |\vec{p}_{D_s^-}|^2}$

ST yield: $N^i_{\text{ST}} = 2 \times N_{D\bar{D}} \times B^i_{\text{ST}} \times \varepsilon^i_{\text{ST}}$

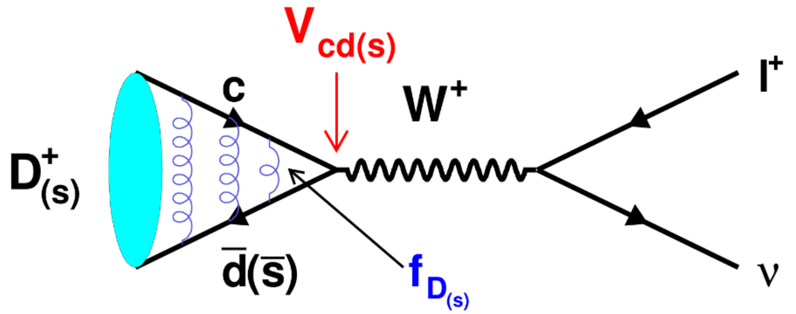
DT yield: $N^i_{\text{DT}} = 2 \times N_{D\bar{D}} \times B^i_{\text{ST}} \times B_{\text{sig}} \times \varepsilon^i_{\text{ST vs.sig}}$

Average eff.: $\bar{\varepsilon}_{\text{sig}} = \sum_{i=1}^{N} (N^i_{\text{ST}} \times \varepsilon^i_{\text{ST vs.sig}} / \varepsilon^i_{\text{ST}}) / \sum_{i=1}^{N} N^i_{\text{ST}}$

Absolute Br. $B_{\text{sig}} = \frac{N^{\text{tot}}_{\text{DT}}}{N^{\text{tot}}_{\text{ST}} \times \bar{\varepsilon}_{\text{sig}}}$

Advantages: almost background free, absolute Brs.

Charm Leptonic Decays $D_{(s)} \to \ell\,\nu$



- Charm leptonic decays involve both weak and strong interactions.
- The weak part is easy to be described as the annihilation of the quark-antiquark pair via the standard model W^+ boson.
- The strong interactions arise due to gluon exchanges between the charm quark and the light quark. These are parameterized in terms of the 'decay constant'.

Decay constant (LQCD)

Decay rate (Exp.)

$$\Gamma(D_{(s)} \to \ell\nu) = |V_{cd(s)}|^2 \times f^2_{D_{(s)}} \times \frac{G_F^2}{8\pi} m_\ell^2 m_{D_{(s)}} (1 - m_\ell^2/m^2_{D_{(s)}})^2$$

CKM matrix element

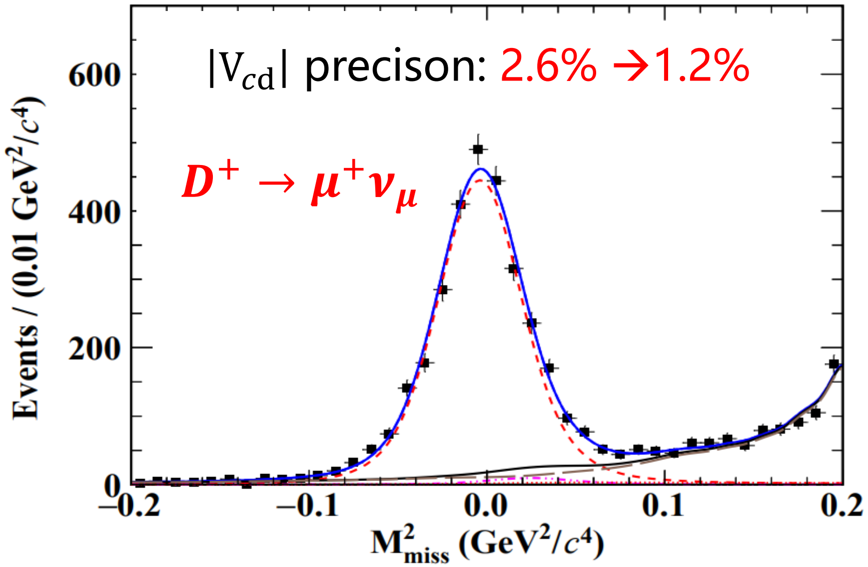
- **Exp. decay rate + $|V_{cs(d)}|^{\text{CKMfitter}}$ → calibrate LQCD @charm & extrapolate to Beauty**
- **Exp. decay rate + LQCD → CKM matrix elements**

$D^+ \to \mu^+ \upsilon_\mu$ BESIII $D^+ \to \tau^+ \upsilon_\tau$ via $\tau^+ \to \pi^+ \nu_\tau$

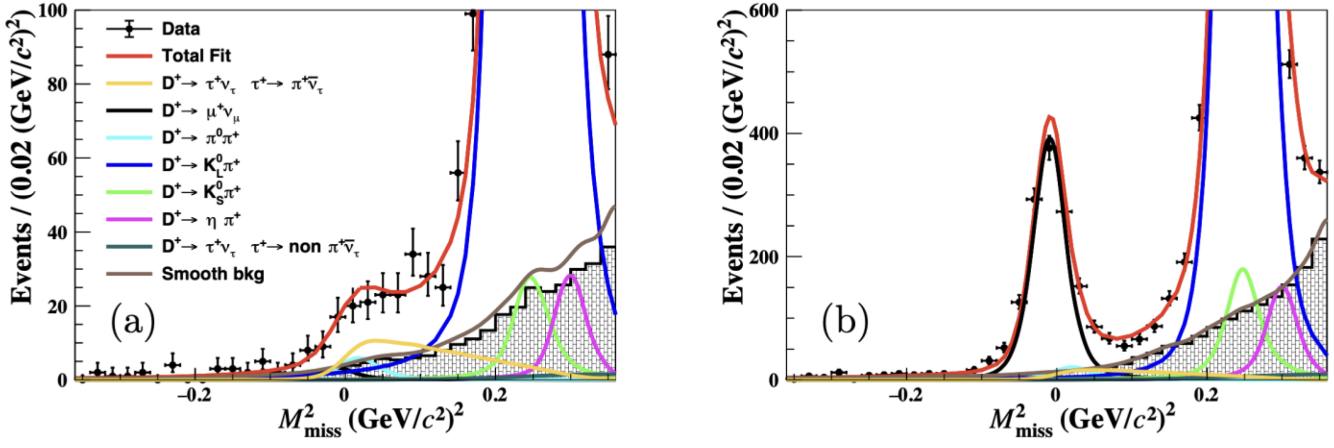
PRL 135, 061081 (2025)

JHEP 01 (2025) 089

20.3 fb^{-1}@E_{cm}=3.773 GeV



7.9 fb^{-1}@E_{cm}=3.773 GeV



LFU: $\frac{\Gamma_\tau}{\Gamma_\mu} = 2.45 \pm 0.31$ consistent with SM 2.66 ± 0.01

$$\mathcal{B}(D^+ \to \mu^+\nu_\mu) = (4.034 \pm 0.080 \pm 0.040) \times 10^{-4}$$

$$f_{D^+}|V_{cd}| = (48.02 \pm 0.48 \pm 0.24 \pm 0.12_{input} \pm 0.15_{EM})\ \text{MeV}$$

$$f_{D^+} = (213.5 \pm 2.1 \pm 1.1 \pm 0.8 \pm 0.7)\ \text{MeV (\sim1.2\%)}$$

$$|V_{cd}| = (0.2265 \pm 0.0023 \pm 0.0011 \pm 0.0009 \pm 0.0007)$$

Precision is improved by 2.4x, most precise result

$$\mathcal{B}(D^+ \to \tau^+\nu_\tau) = (9.9 \pm 1.1 \pm 0.5) \times 10^{-4}$$

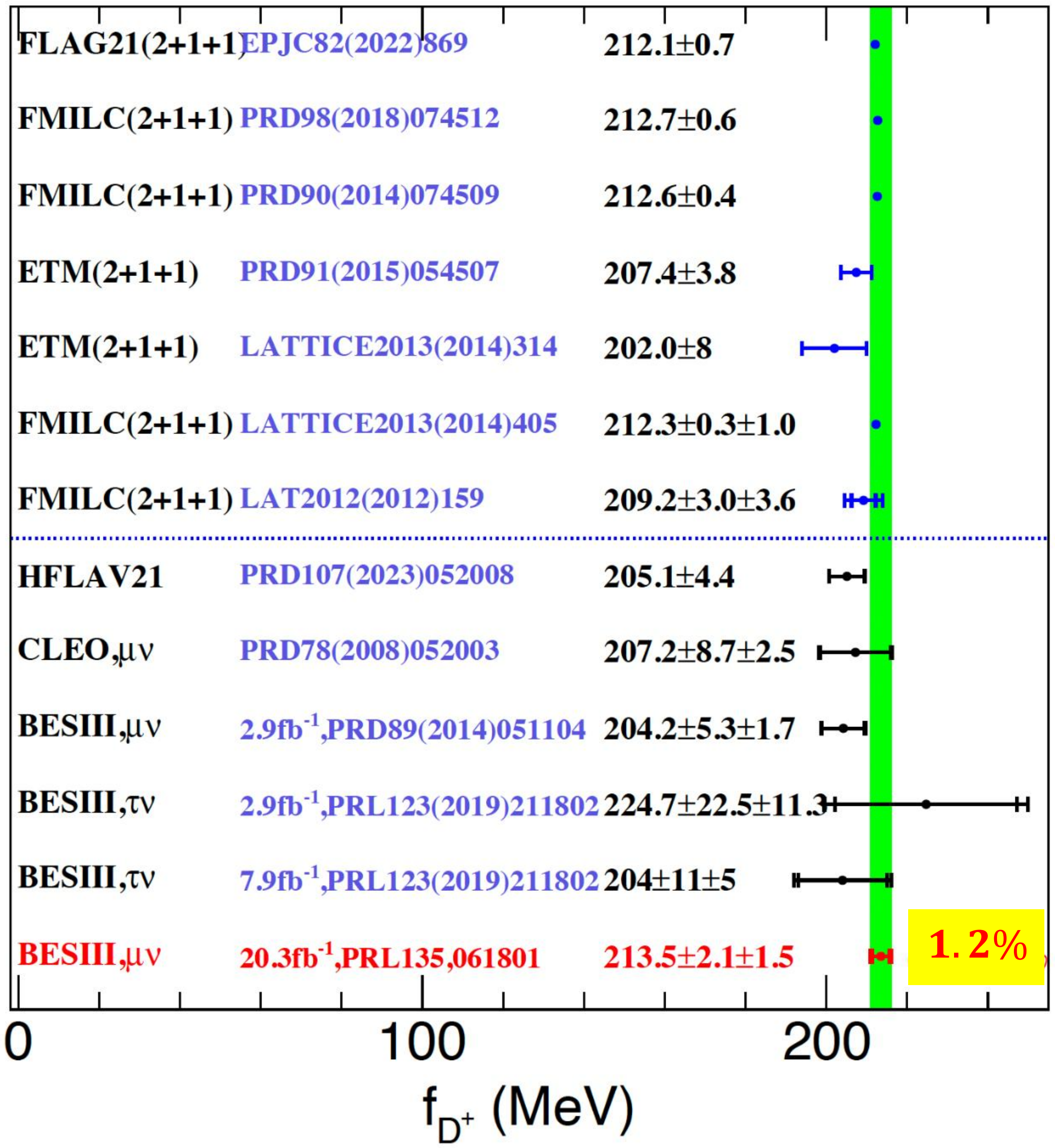
$$f_{D^+}|V_{cd}| = (45.9 \pm 2.5 \pm 1.2 \pm 0.1_{\text{input}})\ \text{MeV}$$

$$f_{D^+} = (204 \pm 11 \pm 5 \pm 1)\ \text{MeV (\sim5.9\%)}$$

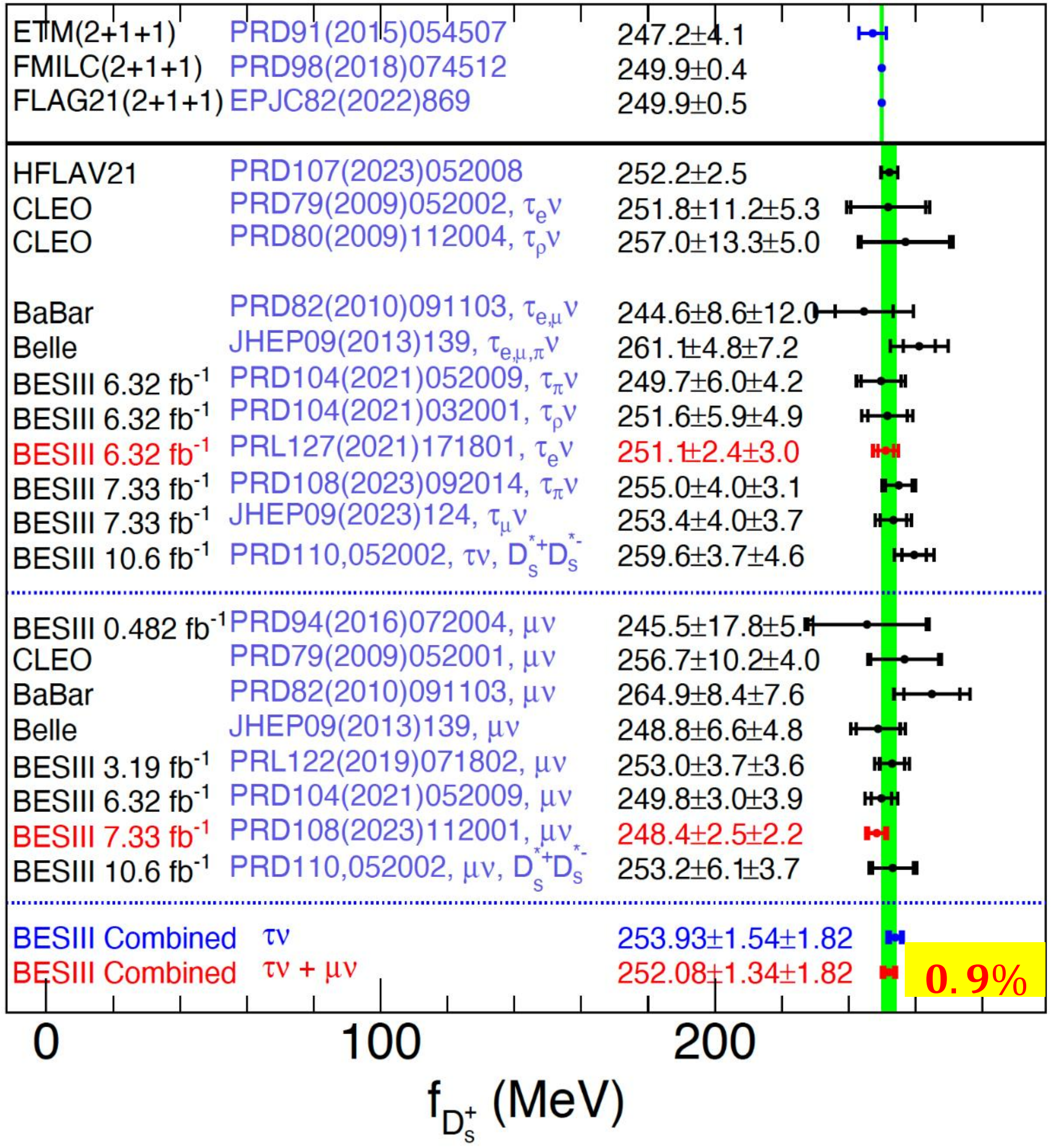
$$|V_{cd}| = 0.216 \pm 0.012 \pm 0.006 \pm 0.001\ \text{(\sim6.2\%)}$$

To be updated using the 20 fb^{-1} full dataset

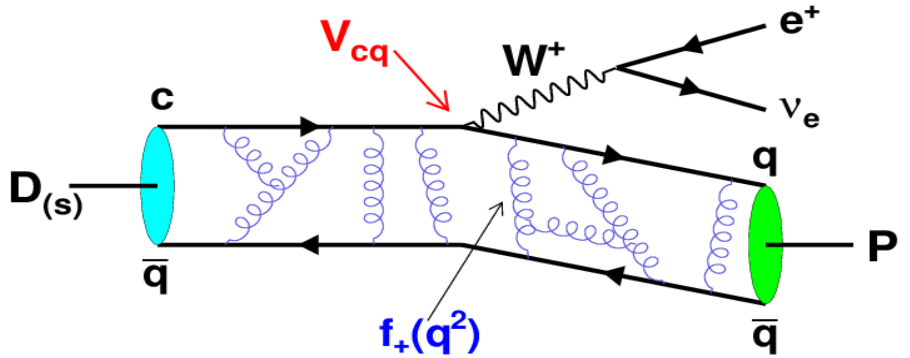
Comparison of f_{D^+}



Comparison of $f_{D_s^+}$



Charm semi-leptonic decays $D_{(s)} \to \pi(K)\ell\nu$



- The effects of the strong and weak interactions can be separated in semi-leptonic decays
- Good place to measure CKM matrix elements and study the weak decay mechanism of charm mesons; calibrate LQCD

At zero positron mass limit:

Differential rate (Exp.) — CKM matrix element — Form factor (LQCD)

$$\frac{d\Gamma(D_{(s)} \to K(\pi)\, l\nu)}{dq^2} = \frac{G_F^2 |V_{cs(d)}|^2 P_{K(\pi)}^3}{24\pi^3} |f_+(q^2)|^2$$

- **Analyze exp. partial decay rates → q^2 dependence of $f_+^{K(\pi)}(q^2)$**
- **FF parameterized in different form, extract $f_+^{K(\pi)}(0)$ with $|V_{cs(d)}|^{CKMfitter}$ as input – calibrate LQCD**
- **Exp. + LQCD calculation of $f_+^{K}(0)$ and $f_+^{\pi}(0)$ → $V_{cs(d)}$ – constrain CKM**

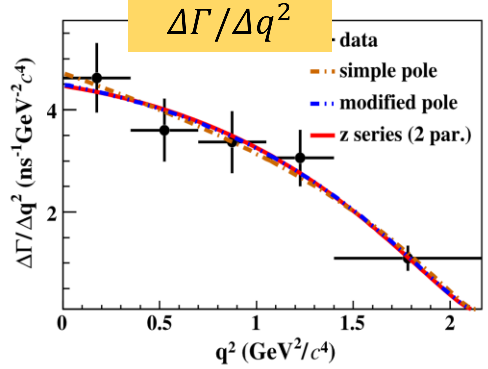
$D_s^+ \to K^0 e^+ \nu_e$

$D^+ \to \eta \ell^+ \nu_\ell (\ell = e, \mu)$

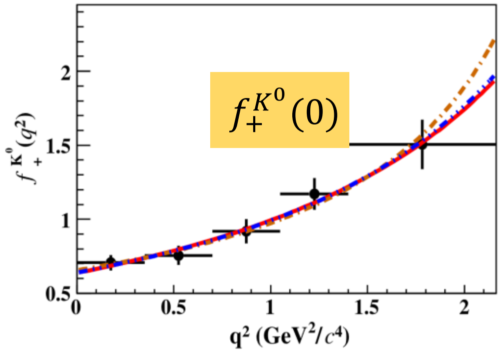
7.33fb^{-1}@E_{cm}=4.128-4.226 GeV ($e^+e^- \to D_s^{*\pm} D_s^{\mp}$)

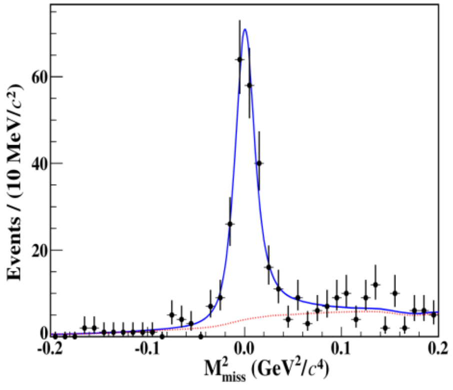
PRD 110, 052012 (2024)

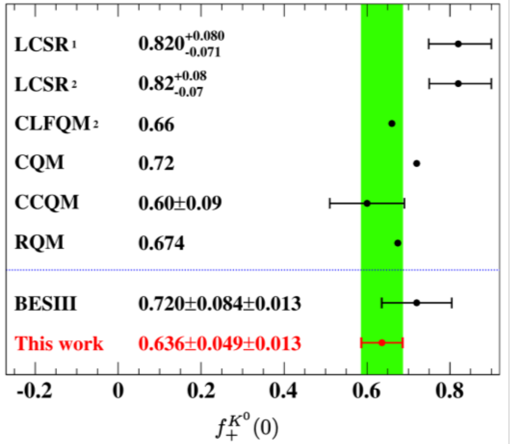
$\Delta\Gamma/\Delta q^2$



$f_+^{K^0}(0)$





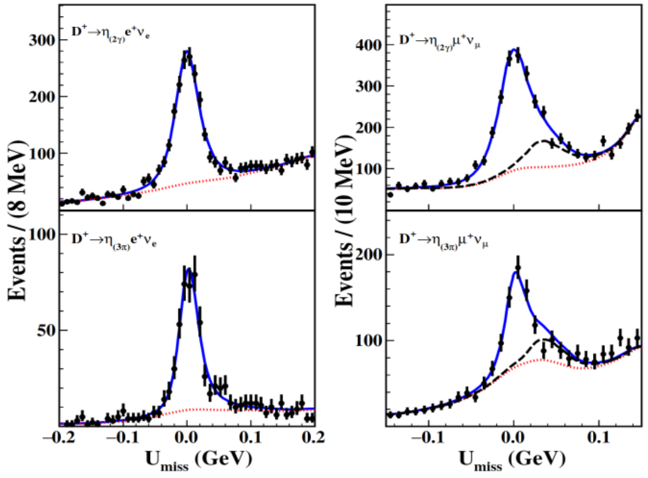


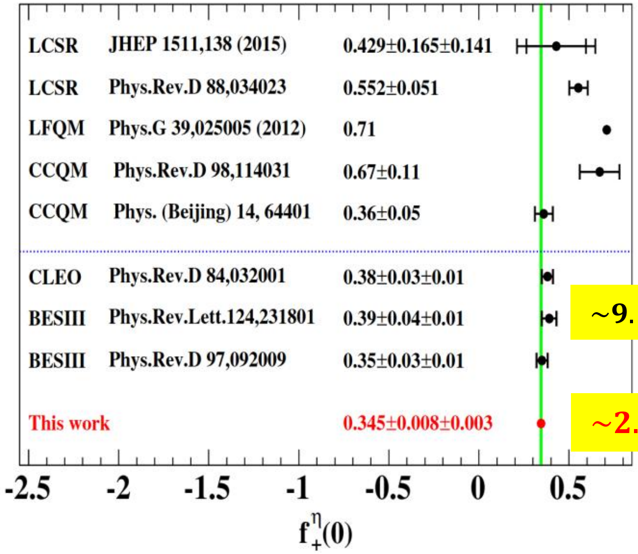
- $\mathcal{B}(D_s^+ \to K^0 e^+ \nu_e) = (0.298 \pm 0.023 \pm 0.012)\%$
- $f_+^{K^0}(0) = 0.636 \pm 0.049 \pm 0.013$

precision improved by 1.5 times

20.3fb^{-1}@E_{cm}=3.773 GeV

arXiv: 2506.02521, submitted to JHEP

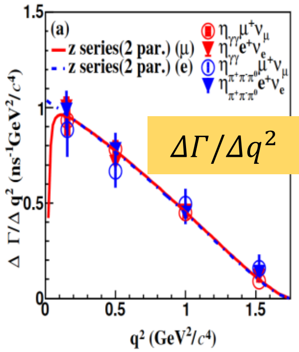




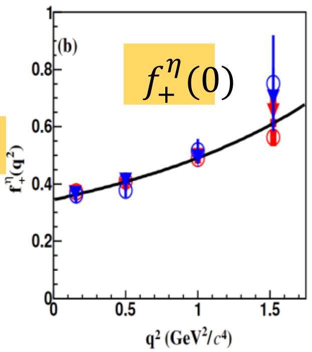
~9.0%

~2.5%

$\Delta\Gamma/\Delta q^2$



$f_+^\eta(0)$



$\mathcal{B}(D^+ \to \eta e^+ \nu_e) =$

$(9.75 \pm 0.29 \pm 0.28) \times 10^{-4}$

$\mathcal{B}(D^+ \to \eta \mu^+ \nu_\mu) =$

$(9.08 \pm 0.35 \pm 0.29) \times 10^{-4}$

LFU test :

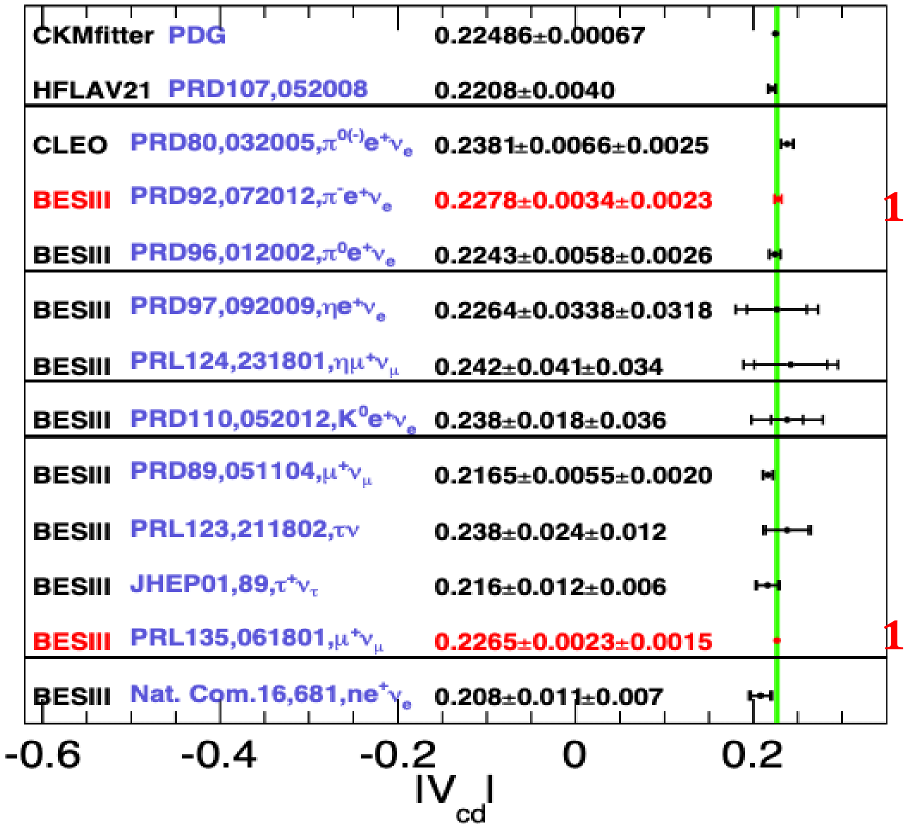
$\mathcal{R}_{\mu/e} = 0.93 \pm 0.05 \pm 0.02 (\sim 5.8\%)$

Form factor

$f_+^{D^+\to\eta}(0)$

$= 0.345 \pm 0.008 \pm 0.003 (\sim 2.5\%)$

Comparison of $|V_{cd}|$

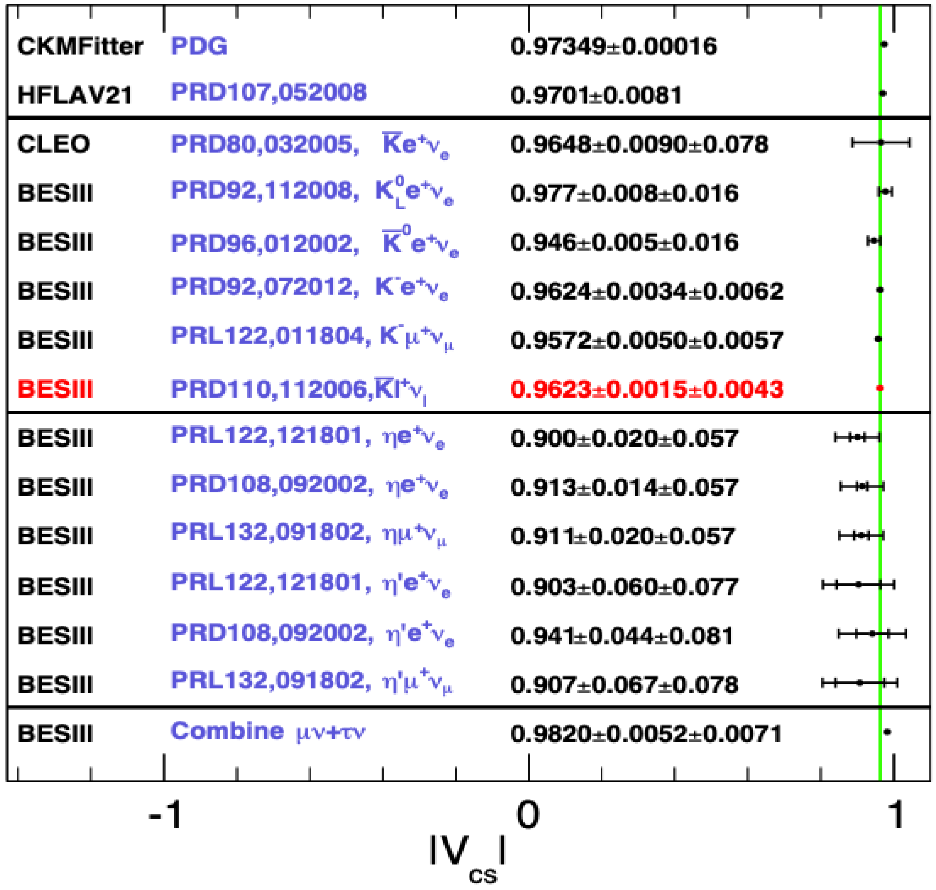


1.6%

1.2%

- The semi-leptonic decays have potential to yield better precision (Stat. Uncertainty < 0.5%) depending on the uncertainty from LQCD.
- The current best precision is from pure-leptonic decays.

Comparison of $|V_{cs}|$



0.5%

1.0%

- $\bar{K}\ell^+\nu_\ell$ simultaneous fit (stat. error ~ 0.2%)
- Main systematic uncertainty from the LQCD input $f_+^K(0)$)

CKM matrix

- **3X3 unitary complex matrix**
- **4 parameters**
- **3 mixing angles and 1 phase**

$$V_{ud}V_{ub}^{*}+V_{cd}V_{cb}^{*}+V_{td}V_{tb}^{*} = 0$$

$$\alpha = arg\left(-\frac{V_{td}V_{tb}^{*}}{V_{ud}V_{ub}^{*}}\right) \equiv \phi_2, \quad \alpha = (87.6^{+3.5}_{-3.3})^{\circ}$$

$$\beta = arg\left(-\frac{V_{cd}V_{cb}^{*}}{V_{td}V_{tb}^{*}}\right) \equiv \phi_1, \quad \sin 2\beta = 0.691 \pm 0.017$$

$$\gamma = arg\left(-\frac{V_{ud}V_{ub}^{*}}{V_{cd}V_{cb}^{*}}\right) \equiv \phi_3, \quad \gamma = (73.2^{+6.3}_{-7.0})^{\circ}$$

$$\begin{pmatrix} 1-\lambda^2/2 & \lambda & A\lambda^3(\rho-i\eta) \\ -\lambda & 1-\lambda^2/2 & A\lambda^2 \\ A\lambda^3[1-(\rho-i\eta)] & -A\lambda^2 & 1 \end{pmatrix} + O(\lambda^4)$$

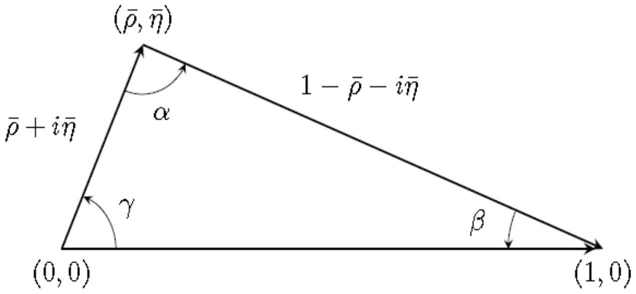
$$\lambda = \sin\theta_C$$

BESIII data @3770 MeV (20 fb^{-1})

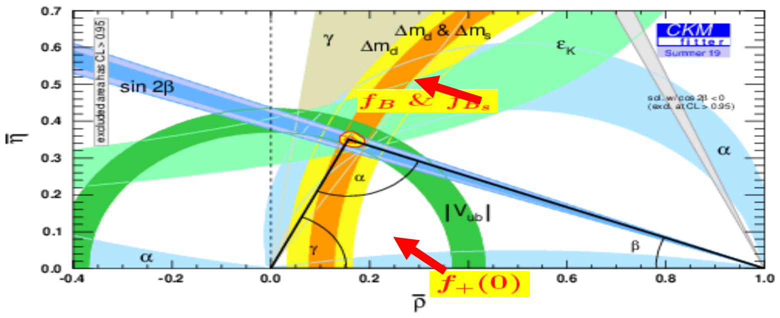
ψ(3770)→$D^0\overline{D^0}$ quantum correlation

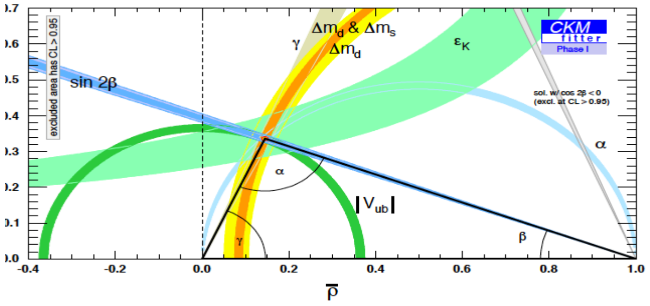
→strong phase parameters between D^0 and $\overline{D}^0$ decays

→inputs to LHCb/BelleII measurement of γ/ϕ_3



CP violation phase γ





Phase 1 (≃ 2025)
LHCb 27 fb^{-1}, CMS/ATLAS 300 fb^{-1}, Belle II 50 ab^{-1}

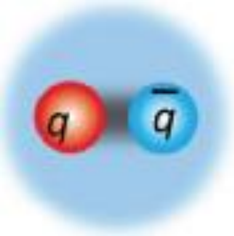
> year of 2030 (BESIII 20 fb^{-1} as inputs)

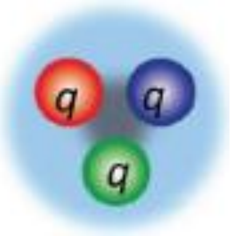
New forms of hadrons

- **Conventional hadrons consist of 2 or 3 quarks：**

Naive Quark Model：

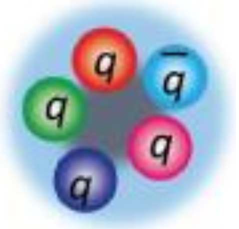
meson



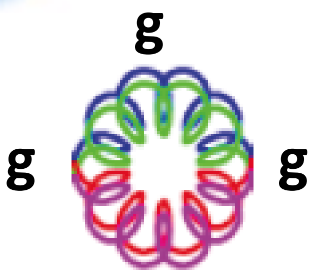


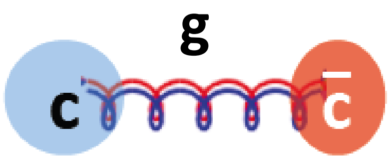
baryon

- **QCD predicts the new forms of hadrons:**
  - **Multi-quark states： Number of quarks >= 4**



  - **Hybrids： $q\bar{q}g$， qqqg …**
  - **Glueballs： gg， ggg …**

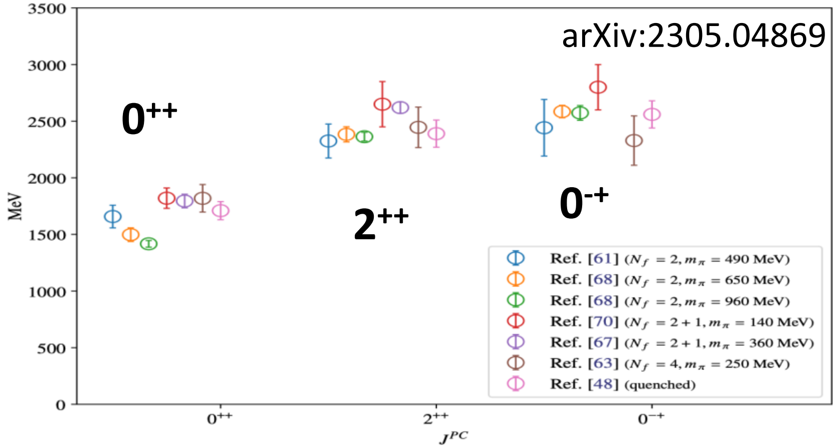




None of the new forms of hadrons is settled！

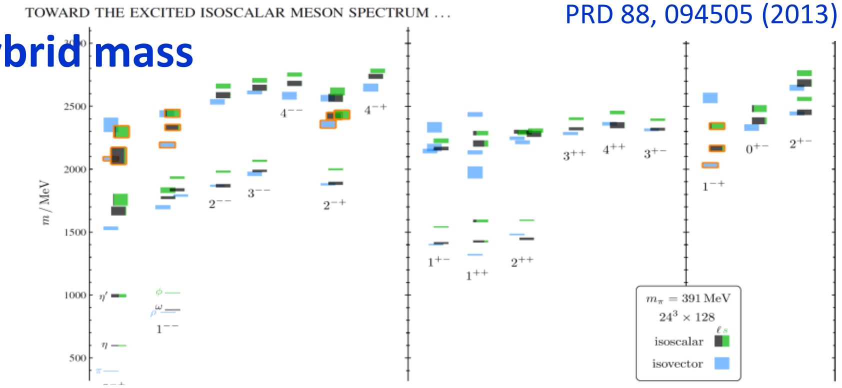
Glueball & Hybrid

Glueball mass in quenched and unquenched LQCD

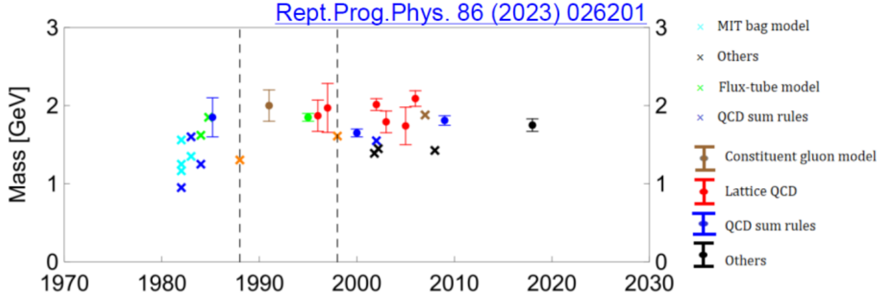


Hybrid mass

PRD 88, 094505 (2013)



Rept.Prog.Phys. 86 (2023) 026201

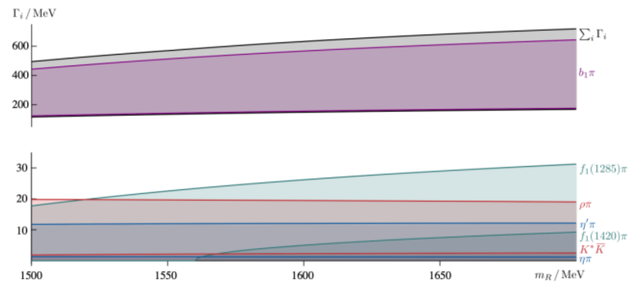


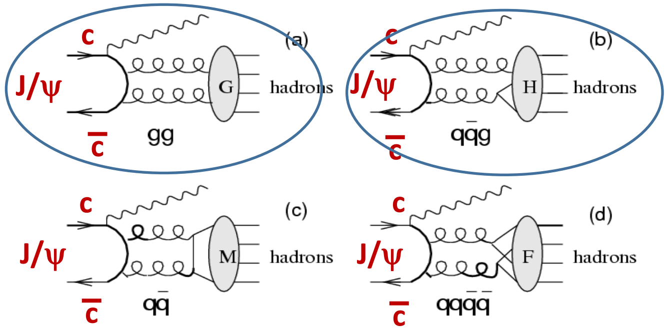
LQCD predicts:

- The mass for lowest 0^{++} glueball state is 1.5 – 1.7 GeV.
- The next lightest glueball is 2^{++}. The mass is around 2.3-2.4 GeV.
- The lightest 0^{-+} glueball mass is ~ 2.3-2.6 GeV

The mix of glueballs with ordinary $q\bar{q}$ mesons makes the situation more difficult.

1-+ hybrid decay width PRD 103, 054502 (2021)





$\Gamma(J/\psi \to \gamma G) \sim O(\alpha\alpha_s^2), \Gamma(J/\psi \to \gamma H) \sim O(\alpha\alpha_s^3),$

$\Gamma(J/\psi \to \gamma M) \sim O(\alpha\alpha_s^4), \Gamma(J/\psi \to \gamma F) \sim O(\alpha\alpha_s^4)$

Charmonium decays: gluon-rich processes

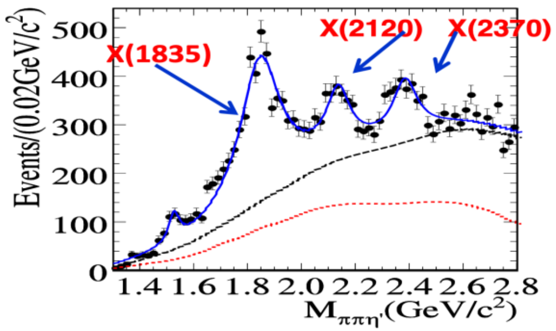
- well defined initial and final states
- low BG
- high cross section of J/ψ and ψ'

→ **Ideal lab for gluonic excitations**

X(2370): pseudoscalar glueball candidate (0^{-+})

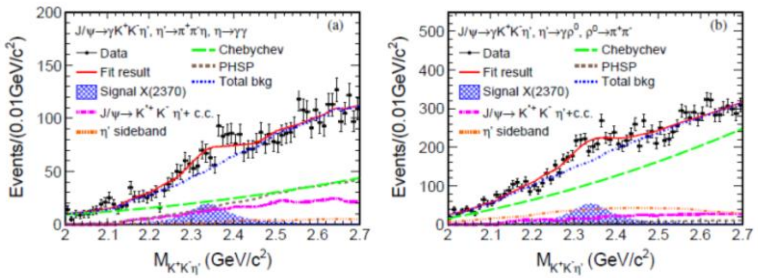
- Observed by BESIII in J/ψ→γη’π+π- in 2011
- Confirmed by BESIII in J/ψ→γη’π+π- and γη’KKbar
- Not seen in J/ψ→γη’ηη [BESIII: PRD 103, 012009(2021)], J/ψ→γγϕ[BESIII: PRD 111, 052011(2025)]. Upper limits of BFs are consistent with the predictions to 0-+ glueball
- Mass of X(2370) is consistent with LQCD prediction to 0-+ glueball
- Spin-parity determined to be 0-+ in J/ψ→γKsKsη

J/ψ→γη’π+π- ~225M J/ψ



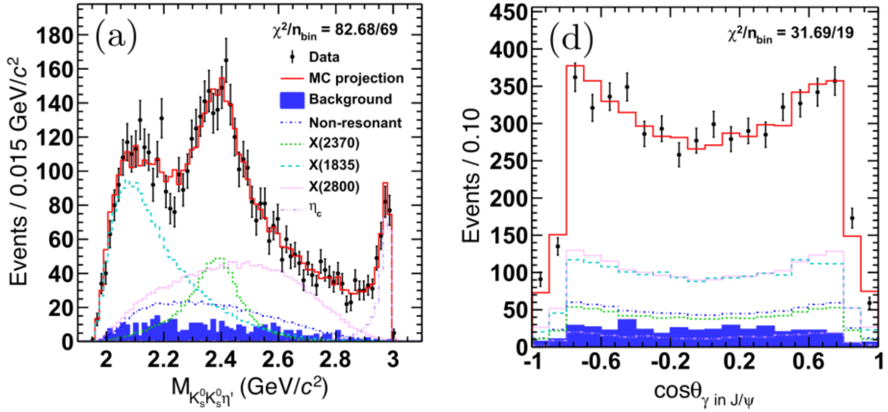
PRL 106, 072002 (2011)

~1300M J/ψ



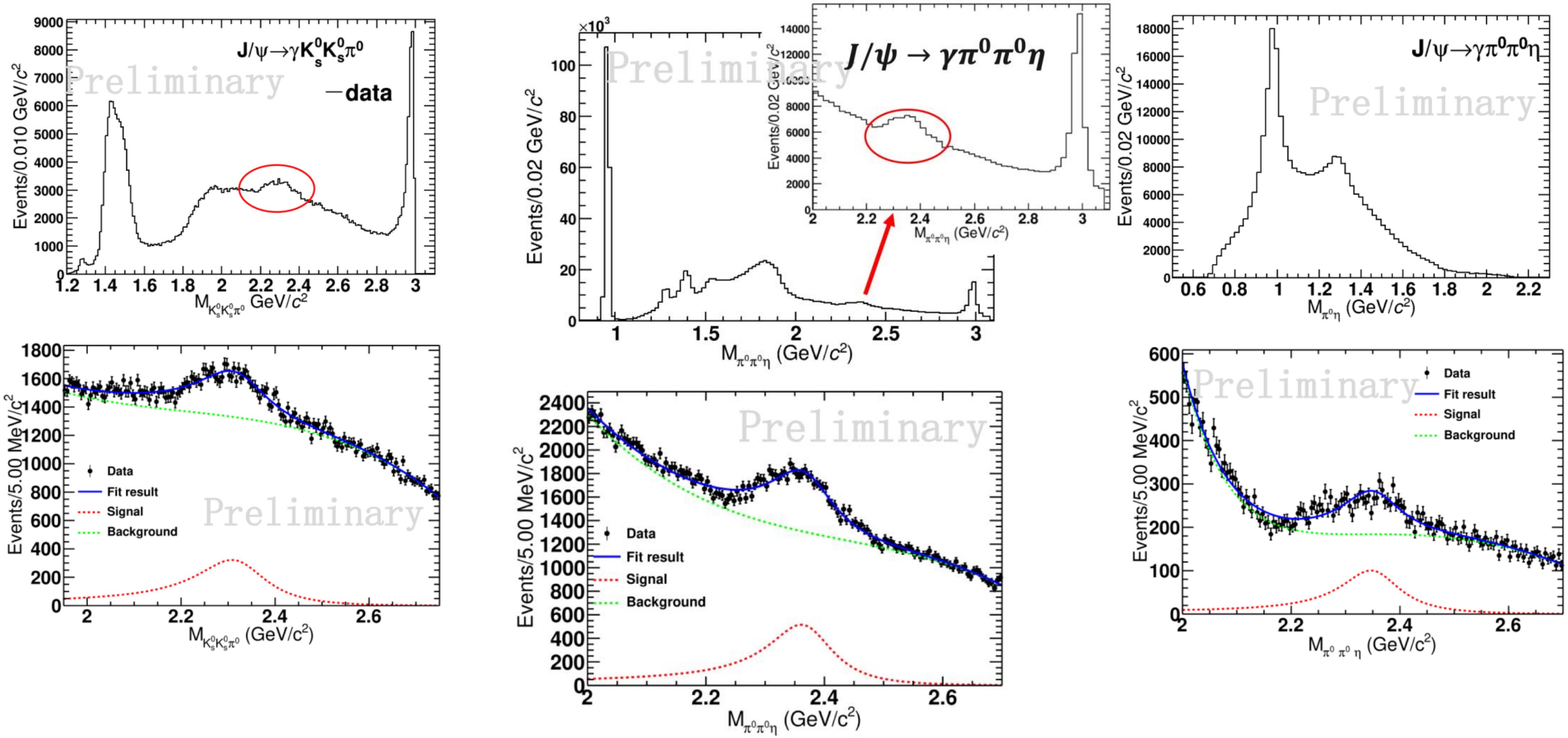
BESIII: PRL 132, 181901 (2024)

EPJC 80, 846, (2020)



$J^{PC} = 0^{-+}$ with significance >9.8σ
$M = 2395 \pm 11^{+26}_{-94}$ MeV
$\Gamma = 188^{+18}_{-17}{}^{+124}_{-33}$ MeV
$B(J/\psi\to\gamma X(2370))B(X(2370)\to f_0(980)\eta')B(f_0(980)\to K^0_S K^0_S)$
$= (1.31 \pm 0.22^{+2.85}_{-0.84})\times 10^{-5}$

New decay modes of the X(2370)



Observation of $X(2370) \rightarrow K_S^0 K_S^0 \pi^0$,$X(2370) \rightarrow \pi^0\pi^0\eta$ and $X(2370) \rightarrow a(980)\pi^0$with **significances >>** 5σ **and accompanied with** η_c

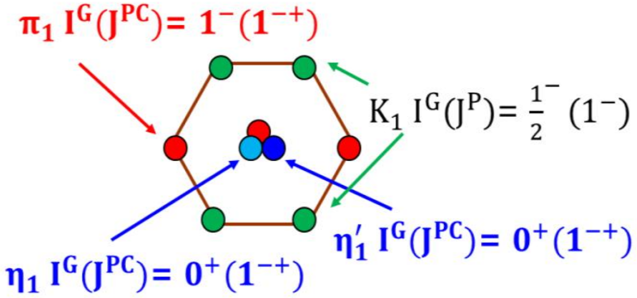
States with exotic quantum numbers

- $J^{PC} = 0^{--}$, even^{+-}, odd^{-+} are forbidden for $q\bar{q}$
- Light hadrons with exotic quantum numbers are unambiguously signatures of exotic states
- Three $1^{-}(1^{-+})$ isovector candidates:
  - ✓ $\pi_1(1400)$: seen in ηπ, ρπ
  - ✓ $\pi_1(1600)$: seen in ρπ, η'π, $b_1\pi$, $f_1\pi$
  - ✓ $\pi_1(2015)$ (needs confirmation): seen in $b_1\pi$, and $f_1\pi$

  $\pi_1(1400)$ and $\pi_1(1600)$ could be from one pole.

  PRL 122, 042002 (2019), EPJ C 81, 1056 (2021])

- Crucial to establish hybrid nonet.

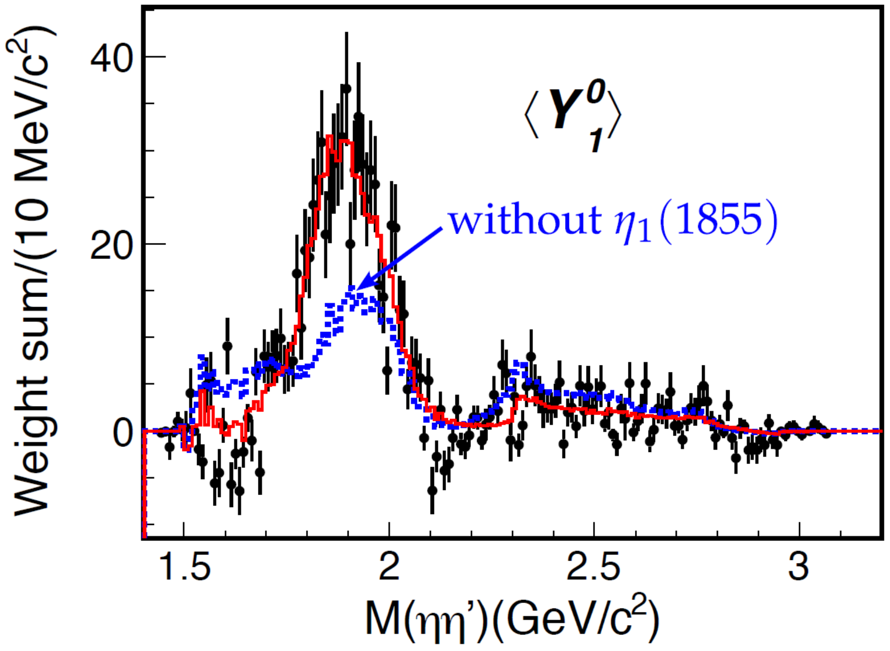


	Decay mode	Reaction	Experiment
$\pi_1(1400)$	$\eta\pi$	$\pi^-p \to \pi^-\eta p$ $\pi^-p \to \pi^0\eta n$ $\pi^-p \to \pi^-\eta p$ $\pi^-p \to \pi^0\eta n$ $\bar{p}n \to \pi^-\pi^0\eta$ $\bar{p}p \to \pi^0\pi^0\eta$	GAMS KEK E852 E852 CBAR CBAR
	$\rho\pi$	$\bar{p}p \to 2\pi^+2\pi^-$	Obelix
$\pi_1(1600)$	$\eta'\pi$	$\pi^-Be \to \eta'\pi^-\pi^0Be$ $\pi^-p \to \pi^-\eta' p$	VES E852
	$b_1\pi$	$\pi^-Be \to \omega\pi^-\pi^0Be$ $\bar{p}p \to \omega\pi^+\pi^-\pi^0$ $\pi^-p \to \omega\pi^-\pi^0 p$	VES CBAR E852
	$\rho\pi$	$\pi^-Pb \to \pi^+\pi^-\pi^-X$ $\pi^-p \to \pi^+\pi^-\pi^-p$	COMPASS E852
	$f_1\pi$	$\pi^-p \to p\eta\pi^+\pi^-\pi^-$ $\pi^-A \to \eta\pi^+\pi^-\pi^-A$	E852 VES
$\pi_1(2015)$	$f_1\pi$	$\pi^-p \to \omega\pi^-\pi^0 p$	E852
	$b_1\pi$	$\pi^-p \to p\eta\pi^+\pi^-\pi^-$	

Observation of $0^+(1^{-+})$ $\eta_1(1855)$ in $J/\psi\rightarrow\gamma\eta\eta'$ at BESIII

PRL 129 192002(2022) , PRD 106 072012(2022)

- **$J/\psi \rightarrow \gamma\eta\eta'$: 1^{-+} $\eta_1(1855)$, stat. sig. $>> 10\sigma$**
  - $M = (1855 \pm 9^{+6}_{-1})$ MeV/c^2, $\Gamma = (188 \pm 18^{+3}_{-8})$MeV
  - $B(J/\psi \rightarrow \gamma\eta_1(1855) \rightarrow \gamma\eta\eta') = (2.70 \pm 0.41^{+0.16}_{-0.35}) \times 10^{-6}$
- **The mass is consistent with LQCD expectation**
- **Stimulated theoretical discussions – Hybrid/$K\bar{K}_1$Molecule/Tetraquark**
- **Statistical significance for an additional η_1 ~4.6σ at ~ 2.15 GeV**



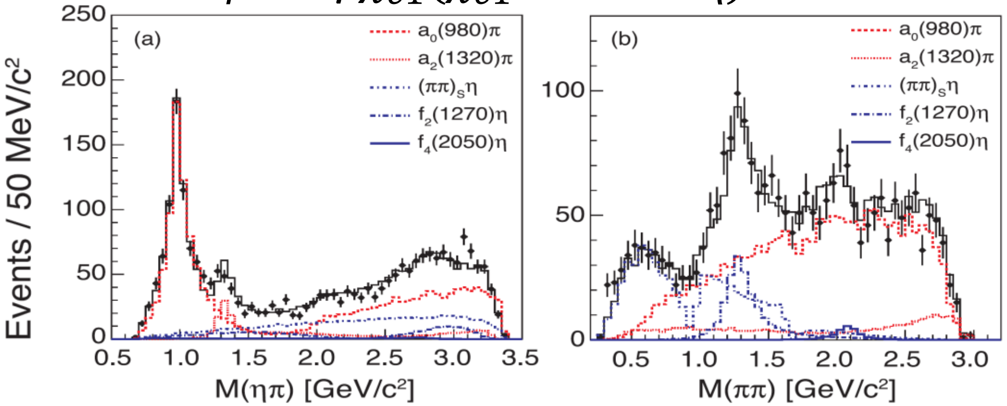
Exotic 1^{-+} Isovector state $\pi_1(1600)$

CLEO-c

2.6 X 10^7 ψ' @ CLEOc

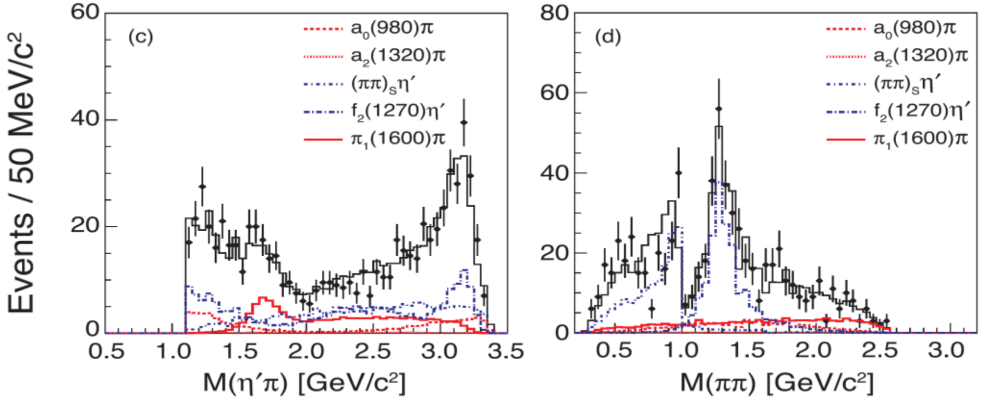
PRD 84, 112009 (2011)

$\psi' \to \gamma\chi_{c1}(\chi_{c1} \to \pi^+\pi^-\eta)$



No evidence of π_1 (1600)→ $\eta\pi$

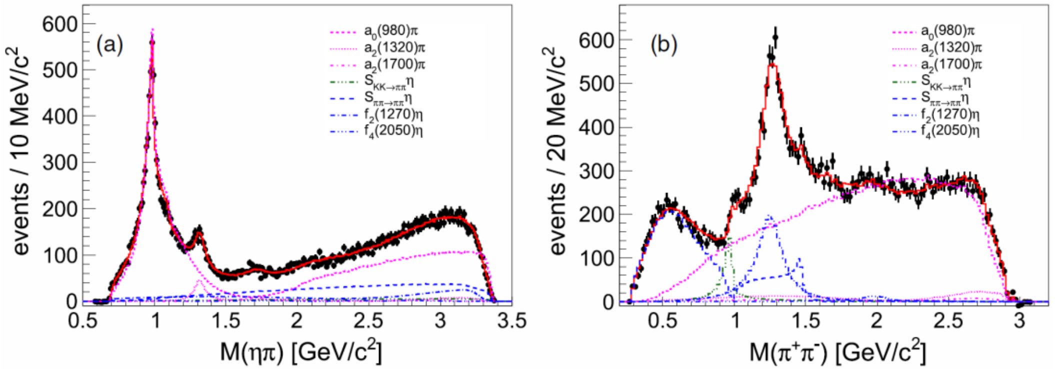
$\psi' \to \gamma\chi_{c1}(\chi_{c1} \to \pi^+\pi^-\eta')$



Evidence of π_1(1600)→ $\eta'\pi$ (4σ)
(without significant BW phase motion)

44.8 X 10^7 ψ' @ BESIII

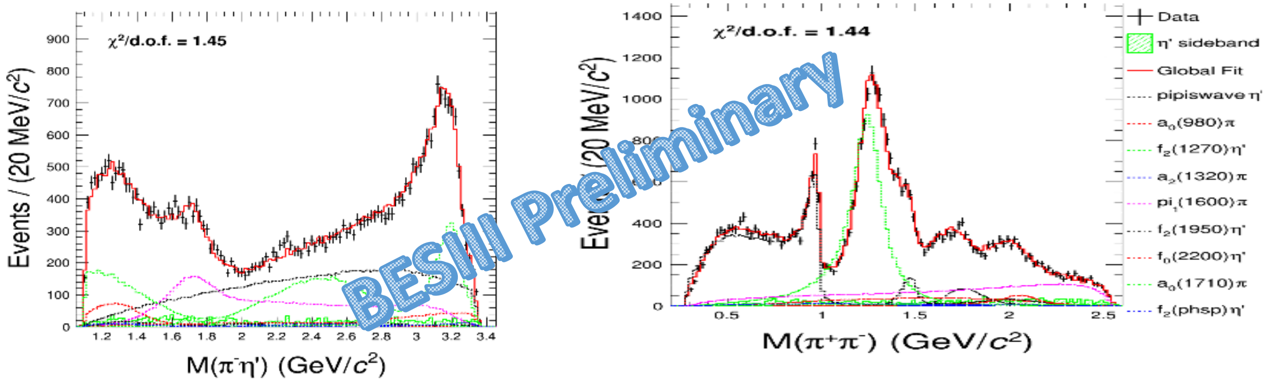
$\psi' \to \gamma\chi_{c1}(\chi_{c1} \to \pi^+\pi^-\eta)$ PRD 95, 032002 (2017)



No evidence of π_1(1600) → $\eta\pi$

270 X 10^7 ψ' @ BESIII (preliminary)

$\psi' \to \gamma\chi_{c1}(\chi_{c1} \to \pi^+\pi^-\eta')$

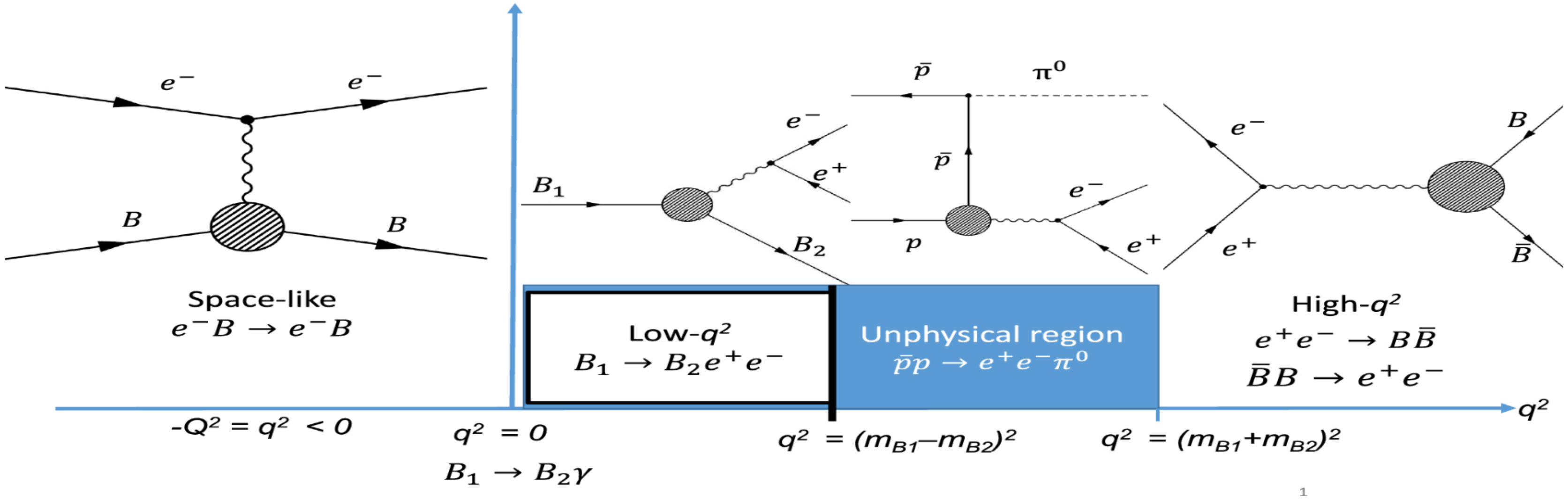


π_1(1600) → $\eta'\pi$ confirmed (>10σ)

Hadron structure

Quark confinement and non-perturbative feature in low-energy QCD region are big challenges

- Electromagnetic Form Factors (EMFFs) are fundamental properties of the baryon, describing the internal structure/shape of the non-point-like particle
  - ➢ Connected to charge, magnetization distribution
  - ➢ Crucial testing ground for models of the baryon internal structure
- EMFFs can be measured in space-like (SL) and time-like (TL) regions



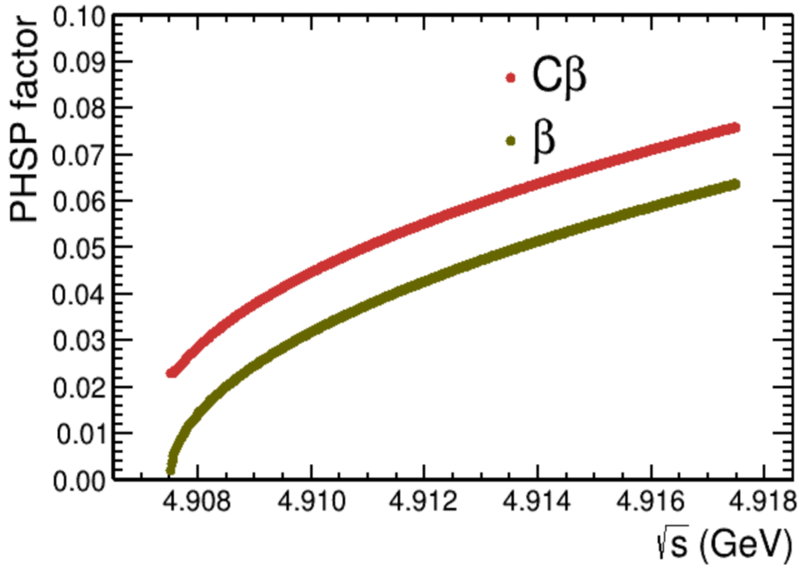
Dispersion theoretical analysis provides a coherent framework for the joint interpretation of SL and TL EMFFs over the entire physical range of q^2.

Time-like EMFFs

- Spin-$\frac{1}{2}$ baryons: two Form Factors (G_E and G_M)
- Assuming one γ exchange, $e^+e^- \to B\bar{B}$:

$$\frac{d\sigma_{B\bar{B}}}{d\cos\theta} = \frac{\pi\alpha^2 \boldsymbol{C}\beta}{2q^2}\left[(1+\cos^2\theta)|G_M|^2 + \frac{1}{\tau}|G_E|^2\sin^2\theta\right]$$

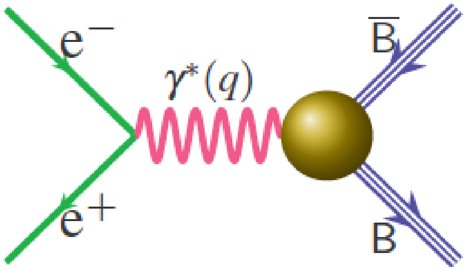
  - For charged baryon: $C=\frac{\pi\alpha}{\beta}\frac{1}{1-\exp(-\frac{\pi\alpha}{\beta})}$
  - For neutral baryon: C=1



- Or write in partial waves: $\sigma = 2\pi\alpha^2\beta\frac{4M^2}{(q^2)^2}[C|G_S(4M^2)|^2 + 2|G_D(q^2)^2|]$
- $G_S = \frac{2G_M\sqrt{\frac{q^2}{4M^2}}+G_E}{3}$ $\quad G_D = \frac{G_M\sqrt{\frac{q^2}{4M^2}}-G_E}{3}$
- **At threshold, S-wave only** $\Rightarrow$ $G_D(4M^2)=0$ $\Rightarrow$ $G_E(4M^2)=G_M(4M^2)$ $\Rightarrow$ $\frac{|G_E|}{|G_M|} = 1$

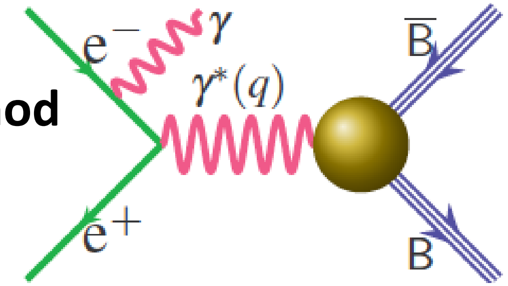
Time-like EMFFs

- **Energy scan method at discrete c.m. energies**



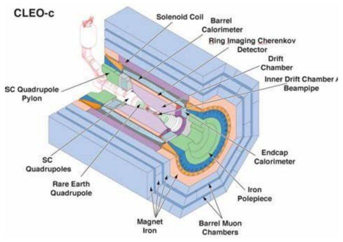
  - Well-defined c.m.energy, low background
  - Very good energy resolution
  - Discrete values, leaving gaps without information

- **Initial state radiation method at a fixed c.m. energy**

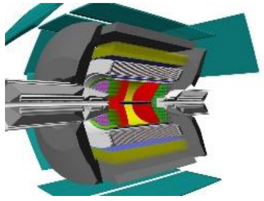


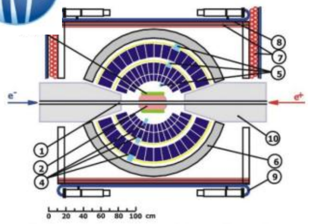
  - At a fixed c.m.energy $\sqrt{s}$, collecting events from threshold to $\sqrt{s}$
  - Systematic uncertainty in a coherent way
  - Large luminosity needed
  - Higher background

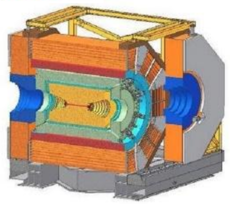
CLEO-c

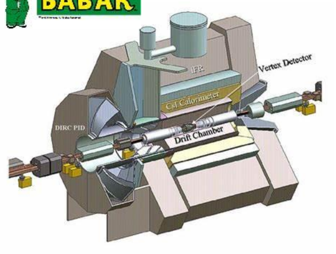


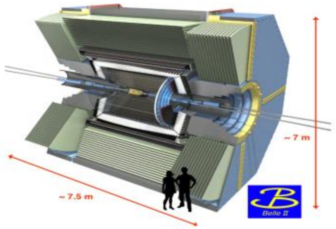
CMD-3

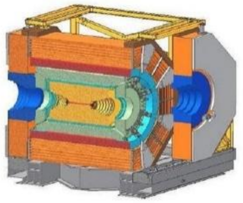








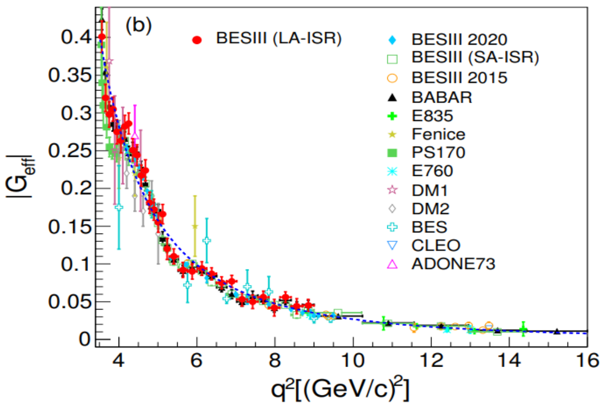


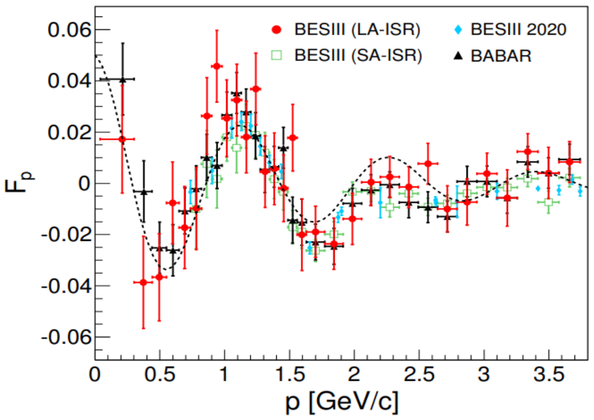


Both techniques can be used at BESIII.

Proton EMFFs

PLB 817, 136328 (2021)

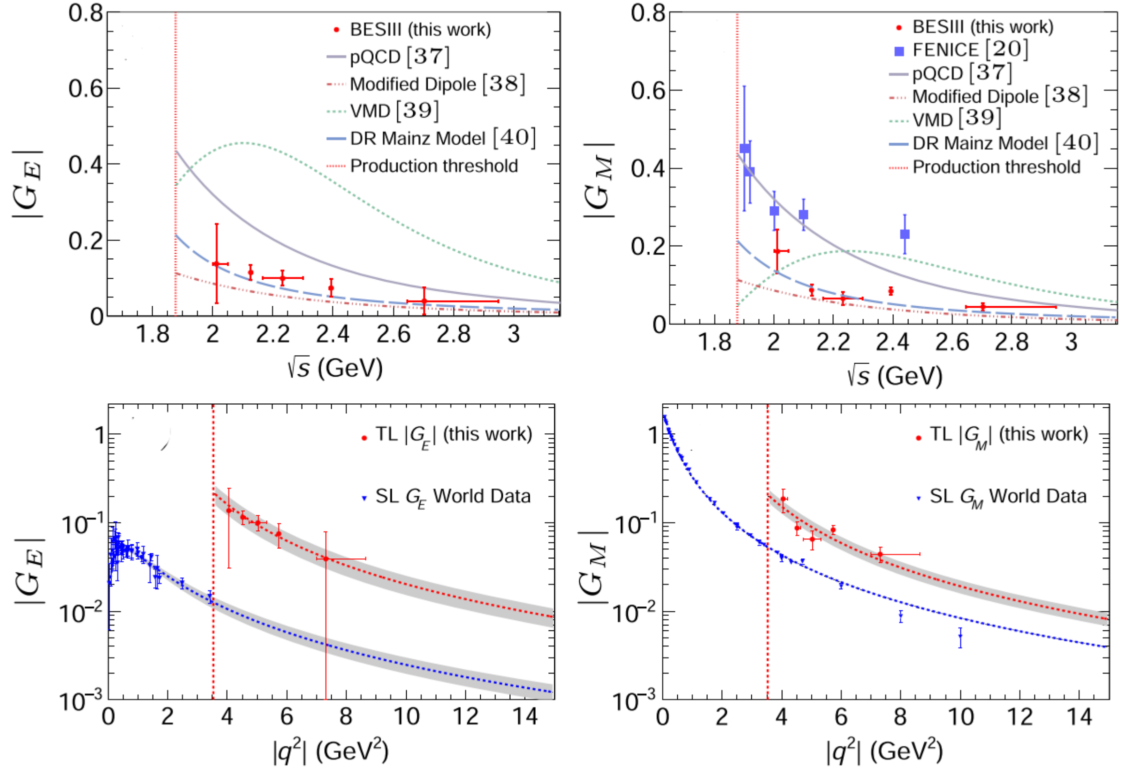




- $|G_E/G_M|$, $|G_M|$ are determined with **high accuracy**, comparable with data in SL.
- **Damped oscillation** distribution after subtracting the modified dipole.

Neutron EMFFs

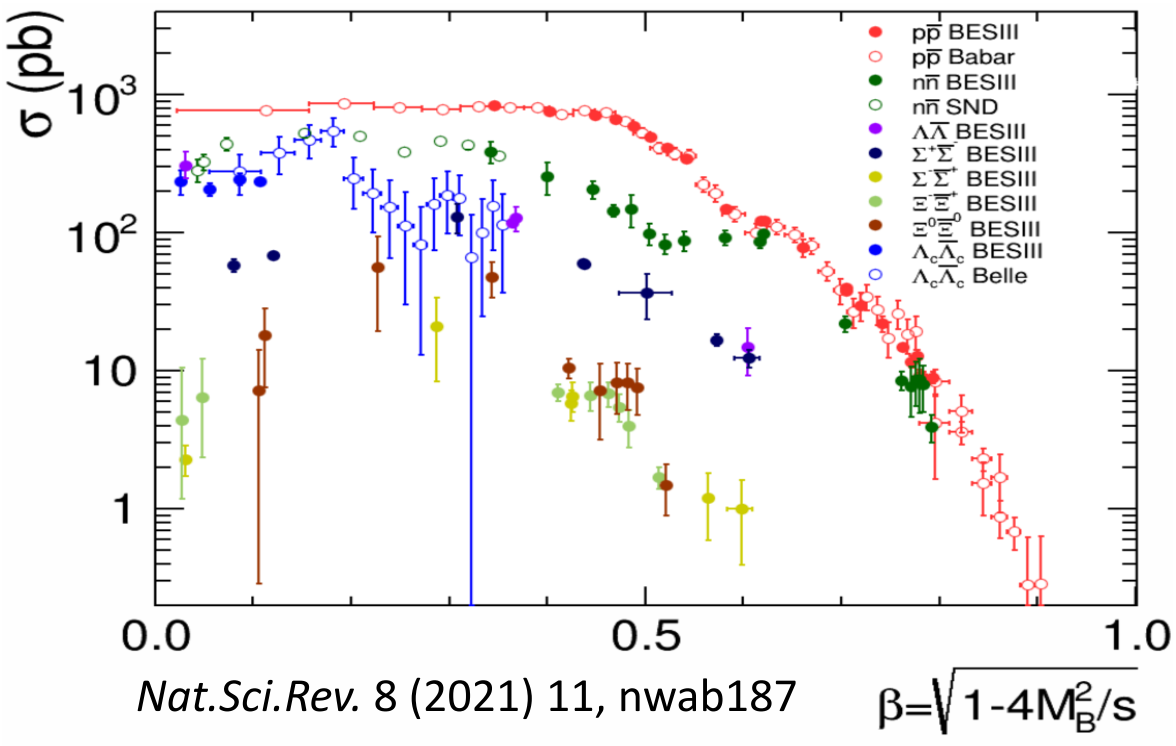
PRL 130, 151905 (2023)

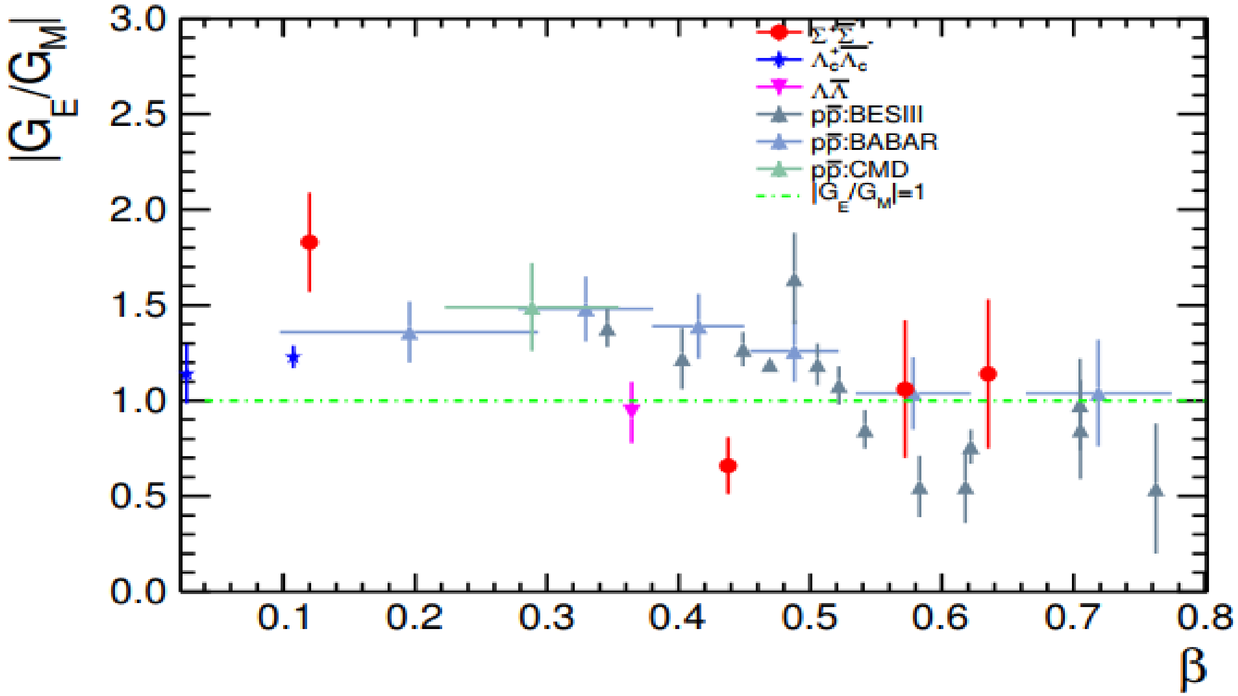


- Compared with FENICE results, the $|G_M|$ values are smaller by a factor of 2-3.
- The analyticity of neutron SL EMFFs and TL EMFFs: $\mathcal{R}^{E,M} \equiv |G^{TL}_{E,M}(q^2)/G^{SL}_{E,M}(-q^2)| \overset{|q^2|\to\infty}{\longrightarrow} 1$

$\mathcal{R}^E = 5.18 \pm 1.18$ $\quad\quad$ $\mathcal{R}^M = 1.72 \pm 0.14$

Results of EMFFs at BESIII





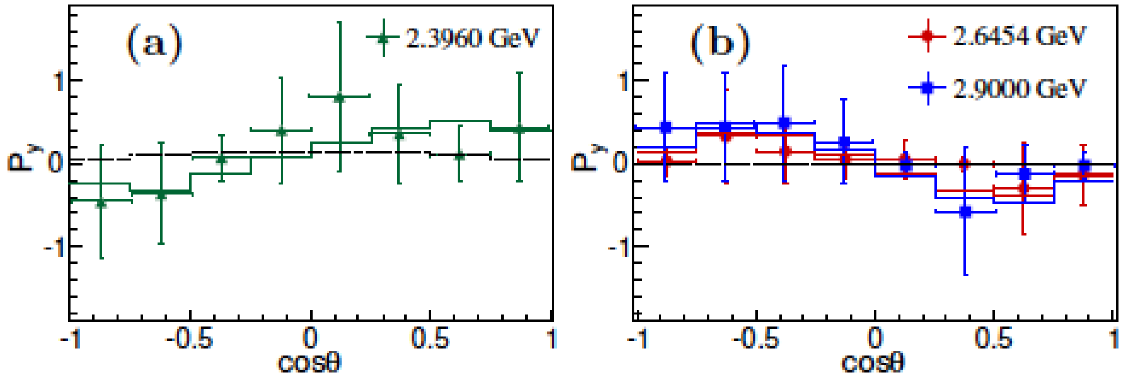
- $\triangleright$ Abnormal threshold effects observed in various baryon pair production: $p\bar{p}$, $\Lambda\bar{\Lambda}$, $\Lambda_c^+\bar{\Lambda}_c^-$ …
- $\triangleright$ Oscillation structures observed
- $\triangleright$ $|G_E/G_M|$ ratio significantly larger than 1 at low beta for p, Λ_c^+, Σ^+, indicating large D-wave near threshold
- $\triangleright$ Relative phase angle of form factor $\Delta\phi(\sin\Delta\phi)$ measured for Λ, Λ_c^+, etc

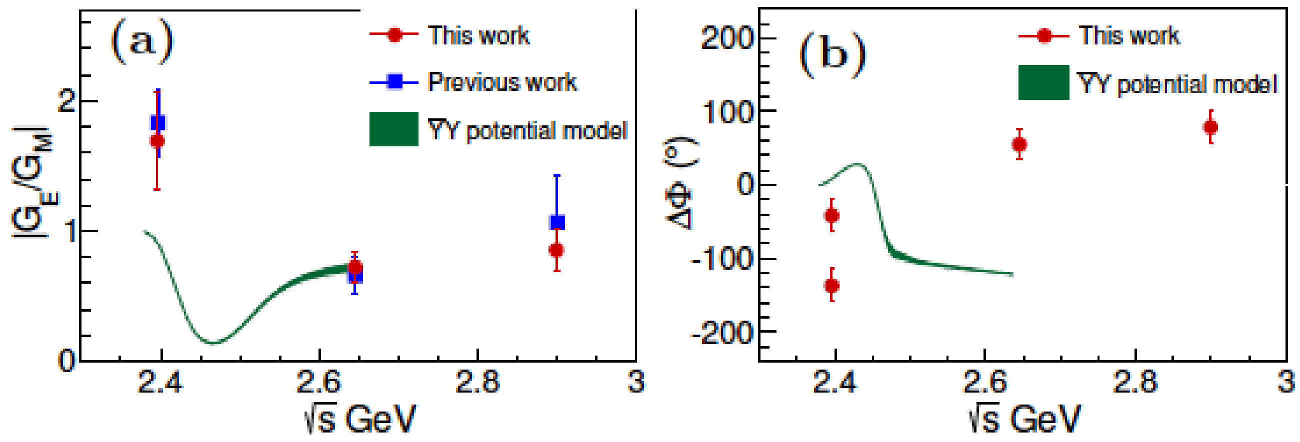
First complete measurement of Σ^+ EMFF

PRL 132 (2024) 081904

Polarization measurements at different center of mass energies

First measurement of the relative phase $\Delta\Phi$ between G_E and G_M form factors



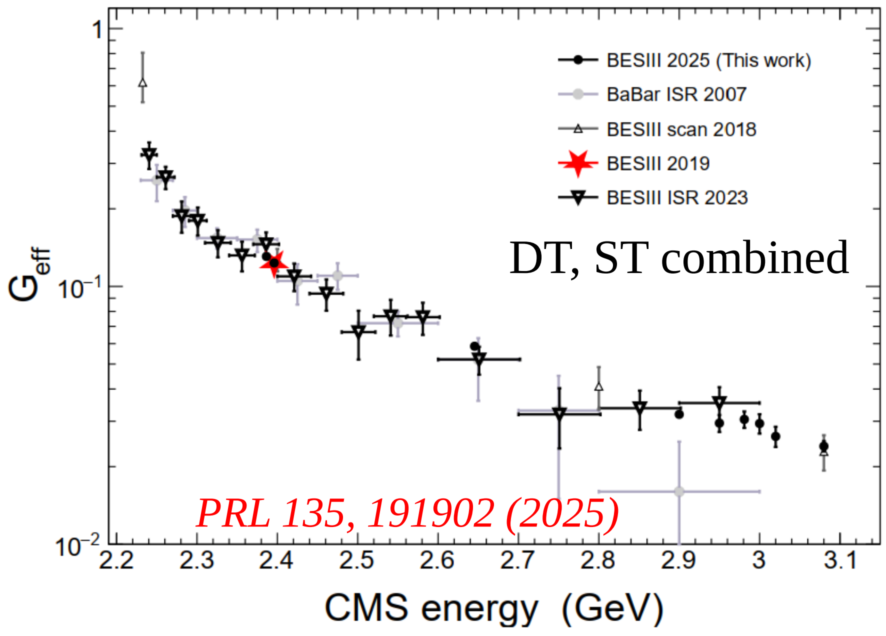


$\sqrt{s}$ (GeV)	2.3960	2.6454	2.9000
α	-0.47 ± 0.18 ± 0.09	0.41 ± 0.12 ± 0.06	0.35 ± 0.17 ± 0.15
$\Delta\Phi$ (°)	-42 ± 22 ± 14 (-138 ± 22 ± 14)	55 ± 19 ± 14	78 ± 22 ± 9
$\sin\Delta\Phi$	-0.67 ± 0.29 ± 0.18		
$\lvert G_E/G_M \rvert$	1.69 ± 0.38 ± 0.20	0.72 ± 0.11 ± 0.06	0.85 ± 0.16 ± 0.15

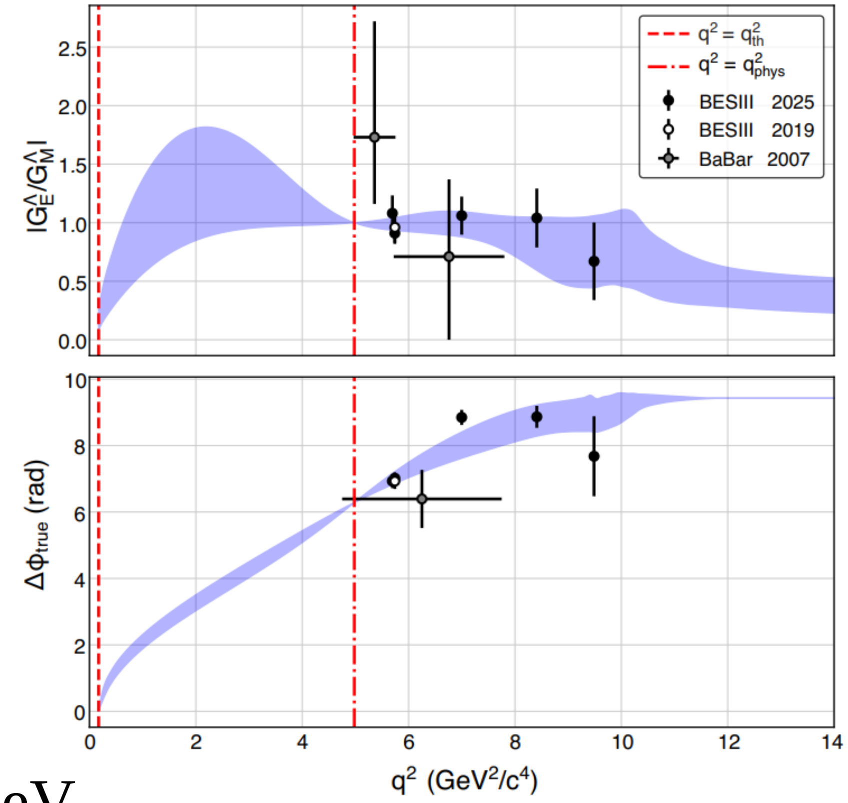
Such an evolution will be an important input for understanding its asymptotic behavior and the dynamics of baryons. Moreover, the fact that the relative phase is still increasing at 2.9 GeV indicates that the asymptotic threshold has not yet been reached. A. Mangoni, S. Pacetti, and E. Tomasi-Gustafsson, Phys. Rev. D 104, 116016 (2021).

Energy-dependent measurement of Λ EMFF from $e^+e^- \to \Lambda\bar{\Lambda}$ (2.396 - 3.08 GeV)

scan method



PRL 135, 191902 (2025)



- $R = |G_E(q^2)/G_M(q^2)|$ remains constant, while $\Delta\Phi$ changes by more than 90° between 2.396 and 2.6544 GeV.

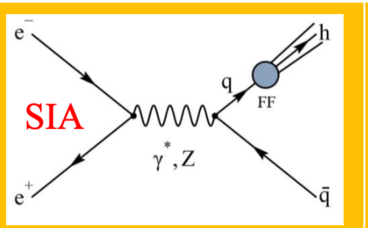
$$\langle r_E \rangle^2 = 6\mu \frac{dR(q^2)}{dq^2}\Bigg|_{q^2=0} = -0.076 \pm 0.043 \text{ fm}$$

an asymmetric charge distribution where the *ds* quark pair lies close to the center of the Λ hyperon.

Hadron structure

- Fragmentation function (FF), describing the processes of quarks/gluon hadronization, is non-perturbative process and challenging in theoretical calculation.
  - To extract Parton Distribution Functions (PDFs) accurately, precise knowledge on FFs are required.
  - Most of the information at high energy comes from SLAC, CERN, DESY, lack of data below 10 GeV.
  - The e+e- collider experiment provides the cleanest input for extracting FFs.
  - With **polarized** electron beam, polarized FFs can be studied.

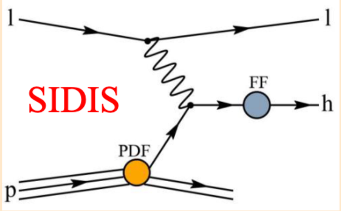
Single Inclusive Annihilation



e^+e^-: $\sigma = \sum_q \sigma(e^+e^- \to q\bar{q}) \otimes FF$

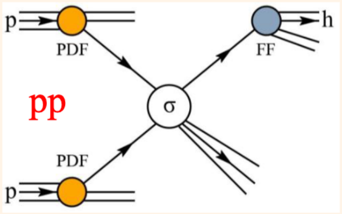
- No PDFs necessary
- Calculations know at NNLO
- Flavor structure not directly accessible

Semi - Inclusive
Deep Inelastic Scattering



SIDIS: $\sigma = \sum_q PDF \otimes \sigma(eq \to e'q') \otimes FF$

- Depend on unpolarized PDFs
- Flavor structure directly accessible
- FFs and PDFs



pp: $\sigma = \sum_q PDF \otimes PDF \otimes \sigma(q_1 q_1 \to q_1' q_2') \otimes FF$

- Depend on unpolarized PDFs
- Leading access to gluon FF
- Parton momenta not directly known

Experimental observable

$$\frac{1}{\sigma_{\text{had, tot}}} \frac{d\sigma_h}{dz}$$

Inclusive π^0 and K_S production in e^+e^- annihilations

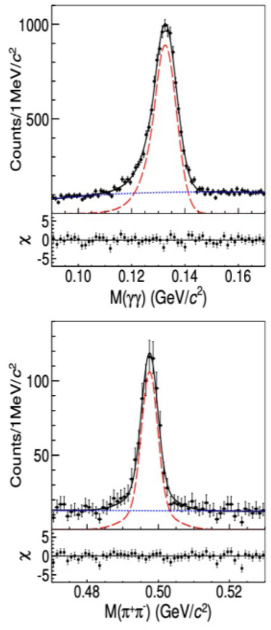
PRL130, 231901 (2023)

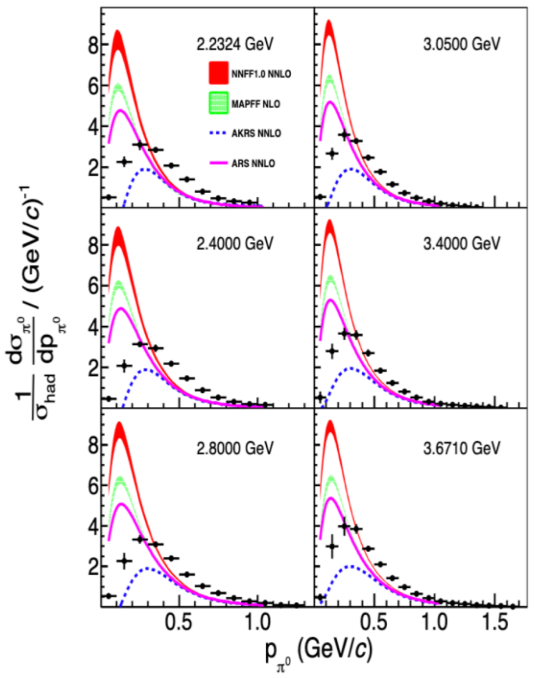
Differential inclusive production cross section of hadron *h* is:

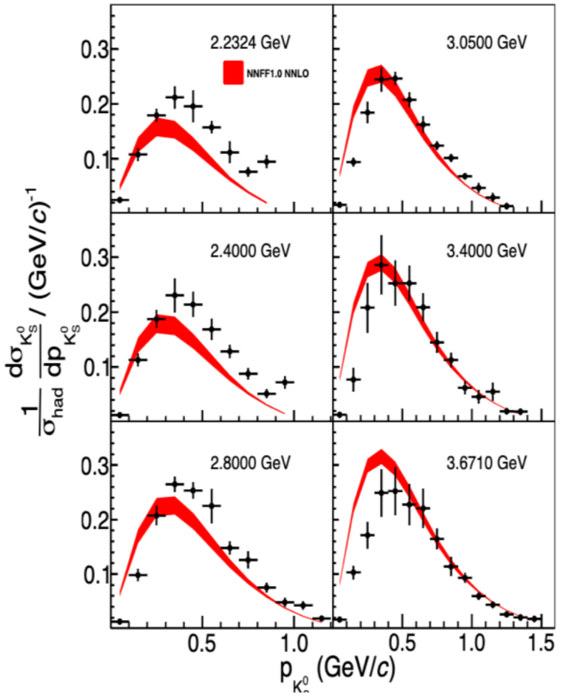
$$\frac{1}{\sigma_{\text{had}}}\frac{d\sigma\left(e^+e^- \to h+X\right)}{dp_h} = \frac{N_h}{N_{\text{had}}}\frac{1}{\Delta p_h} = \frac{N_h^{\text{obs}}}{N_{\text{had}}^{\text{obs}}}\frac{1}{\Delta p_h} f_h$$

Correction factor
- Reconstruction efficiency
- Radiative corrections
- Based on generator developed for R-Value measurements.

$$e^+e^- \to \pi^0/K_s^0+X \quad \Rightarrow \quad \frac{1}{\sigma(e^+e^- \to hadrons)}\frac{d\sigma(e^+e^- \to \pi^0/K_s^0+X)}{dp_{\pi^0/K_s^0}} = f\frac{N_{\pi^0/K_s^0+X}}{N_{had}}\frac{1}{\Delta p_{\pi^0/K_s^0}}$$





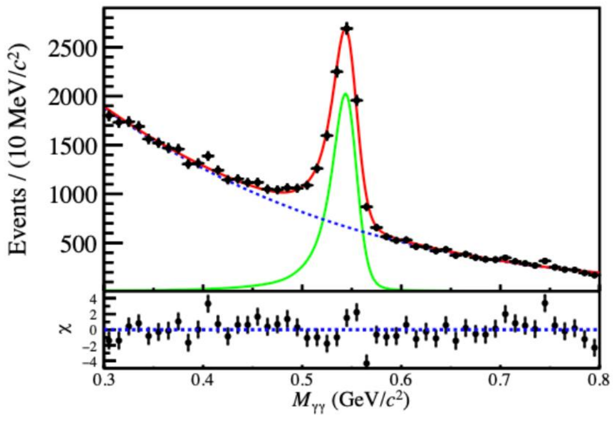


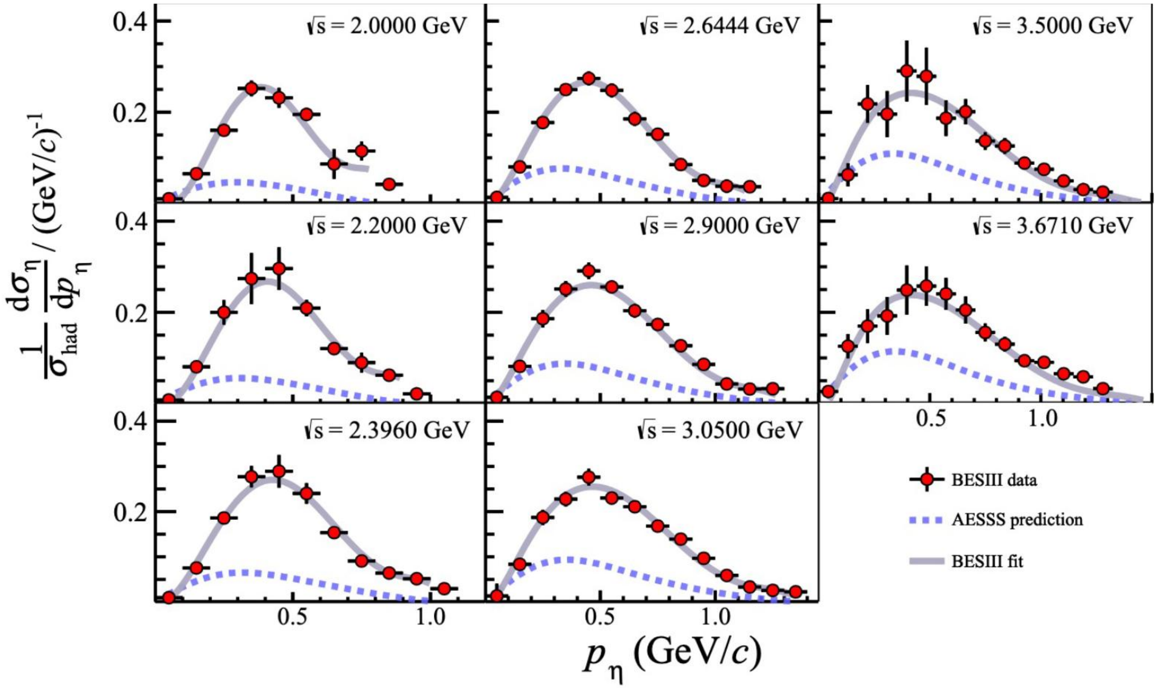
- broad z_h coverage from 0.1 to 0.9
- disagreement between data and theor. calculations based on the existing fragmentation functions
- provide brand new inputs in low-energy region to global fits of fragmentation function

Inclusive η production in e+e- annihilations

PRL133, 021901 (2024)

More information on the hadronization process since the η wave function contains all light quarks and antiquarks



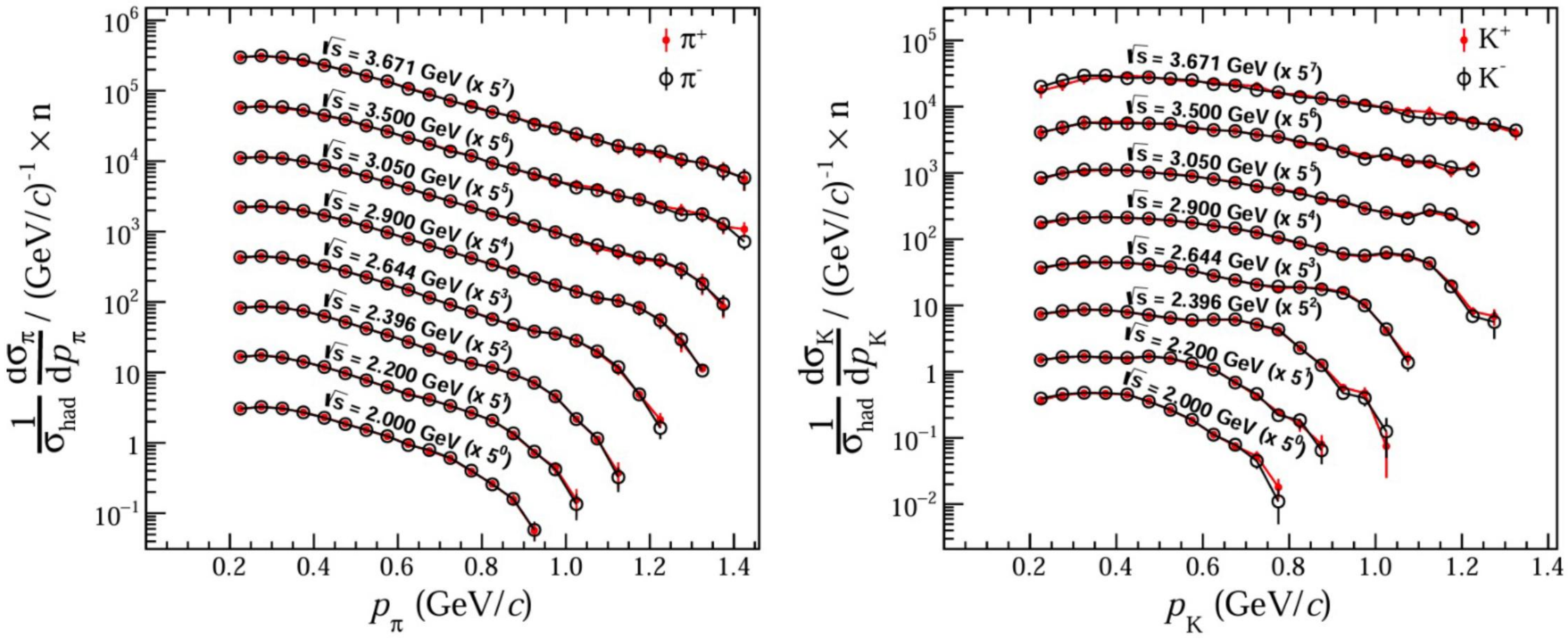


- Disagree with the AESSS fit [PRD83, 034002 (2011)]
- Agree with a new fit by Li, Anderle, Xing, Zhang [PRD111, 034030 (2025)]
  (includes NNLO accuracy, higher-twist effects and hadron mass correction)

Inclusive $K\pm/\pi\pm$ production in $e+e-$ annihilations

arXiv:2502.16084

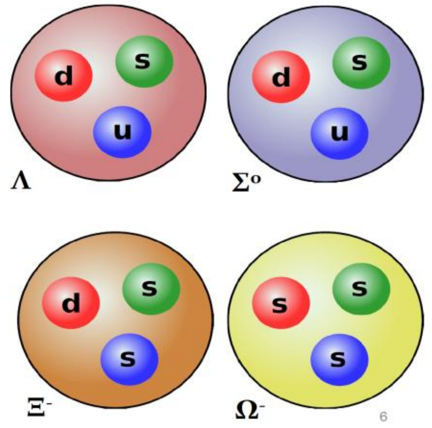
Normalized differential cross section of the inclusive process at 8 c.m. energy points from 2.00 GeV to 3.67 GeV



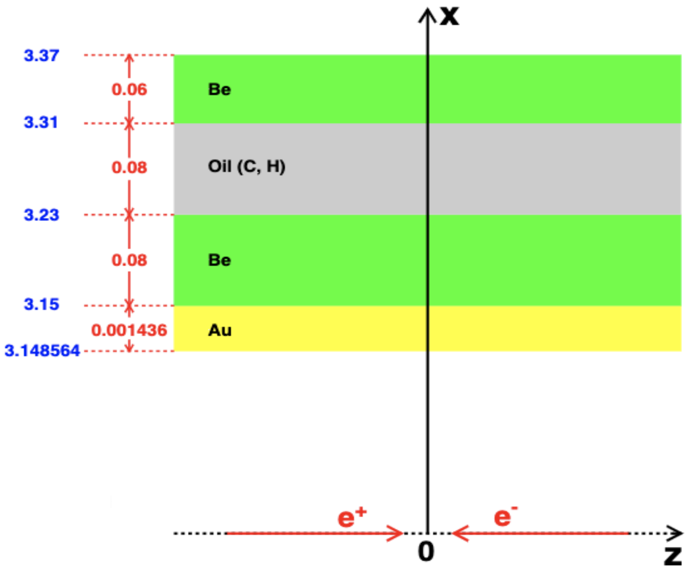
Inclusive hadron differential cross section data from e+e- collision experiments in the world (whole energy region) will be used to better extract fragmentation functions.

Hyperon-nucleon interaction

Hyperon is any baryon containing one or more *s* quarks, but no *c*, *b* or *t* quark.



Decay mode	$\mathcal{B}(\times 10^{-3})$	$N_B\ (\times 10^6)$	Detection Efficiency	Number of reconstructed
$J/\psi \to \Lambda\bar{\Lambda}$	1.61 ± 0.15	16.1 ± 1.5	40%	4500 X 10^3
$J/\psi \to \Sigma^0\bar{\Sigma}^0$	1.29 ± 0.09	12.9 ± 0.9	25%	600 X 10^3
$J/\psi \to \Sigma^+\bar{\Sigma}^-$	1.50 ± 0.24	15.0 ± 2.4	24%	640 X 10^3
$J/\psi \to \Sigma(1385)^-\bar{\Sigma}^+$ (or c.c.)	0.31 ± 0.05	3.1 ± 0.5		
$J/\psi \to \Sigma(1385)^-\bar{\Sigma}(1385)^+$ (or c.c.)	1.10 ± 0.12	11.0 ± 1.2		
$J/\psi \to \Xi^0\bar{\Xi}^0$	1.20 ± 0.24	12.0 ± 2.4	14%	670 X 10^3
$J/\psi \to \Xi^-\bar{\Xi}^+$	0.86 ± 0.11	8.6 ± 1.0	19%	810 X 10^3
$J/\psi \to \Xi(1530)^0\bar{\Xi}^0$	0.32 ± 0.14	3.2 ± 1.4		
$J/\psi \to \Xi(1530)^-\bar{\Xi}^+$	0.59 ± 0.15	5.9 ± 1.5		
$\psi(2S) \to \Omega^-\bar{\Omega}^+$	0.05 ± 0.01	0.15 ± 0.03		



Particle source: Hyperons from J/ψ decays
Target material: Beam pipe (Be)
Detector: BESIII detector

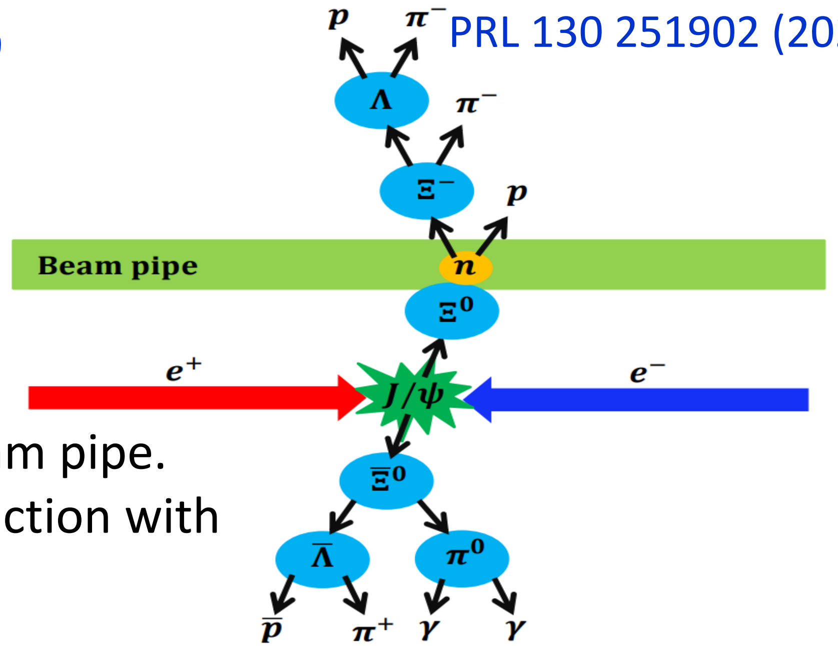
PRL 127, 012003 (2021), CPC 48, 073003 (2024)

Study of $\Xi^0 n \to \Xi^- p$

PRL 130 251902 (2023)

Reaction chain :

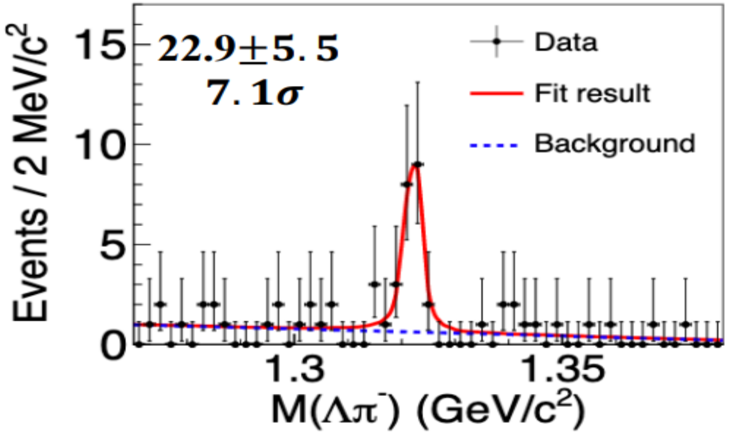
$$J/\psi \to \Xi^0\bar{\Xi}^0, \bar{\Xi}^0 \to \bar{\Lambda}\pi^0, \bar{\Lambda} \to \bar{p}\pi^+, \pi^0 \to \gamma\gamma,$$
$$\Xi^0 n \to \Xi^- p, \Xi^- \to \Lambda\pi^-, \Lambda \to p\pi^-.$$



The neutron is a component of the ^{9}Be, ^{12}C, and ^{197}Au nuclei in the beam pipe. Incident Ξ^0 has relatively high momentum(P_{Ξ^0} = 0.818 GeV/c), its interaction with atomic nuclei tends to be a direct nuclear reaction.

Analysis method (double-tag):

- Use $\bar{\Xi}^0$ to tag the event
- require the recoiling mass of $\bar{\Xi}^0$ in Ξ^0 region.
- Reconstruct Ξ^- and p in the signal side.



$$\sigma(\Xi^0 n \to \Xi^- p) = (7.4 \pm 1.8\text{stat} \pm 1.5\text{sys})\ mb$$

(assuming the effective number of reaction neutrons in ^{9}Be is 3 [PLB 633, 214 (2006)]

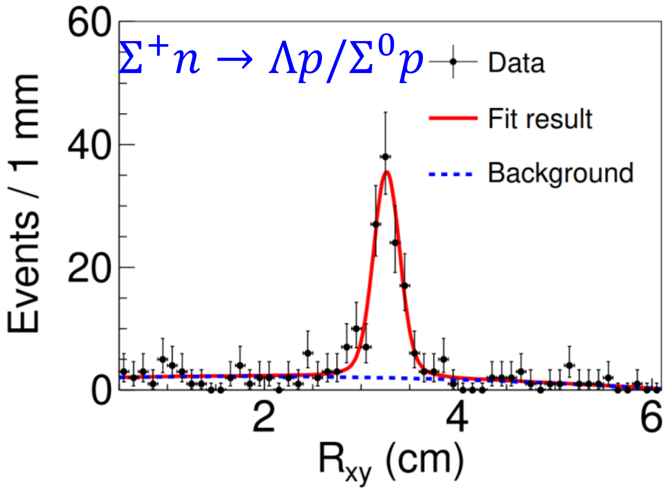
$\Xi^0 n \to \Xi^- p$ **is observed for the first time**

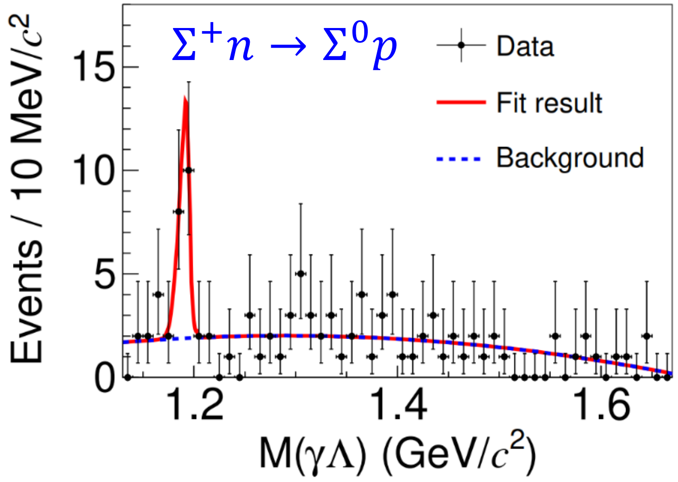
$$\sigma(\Xi^0 + {}^9\text{Be} \to \Xi^- + p + {}^8\text{Be}) = (22.1 \pm 5.3_{stat} \pm 4.5_{sys})\ mb$$

Study of $\Sigma^+ n \to \Lambda p$ and $\Sigma^+ n \to \Sigma^0 p$

arXiv: 2505.19907

R_{xy} is distance from reconstructed Λp vertex to z axis



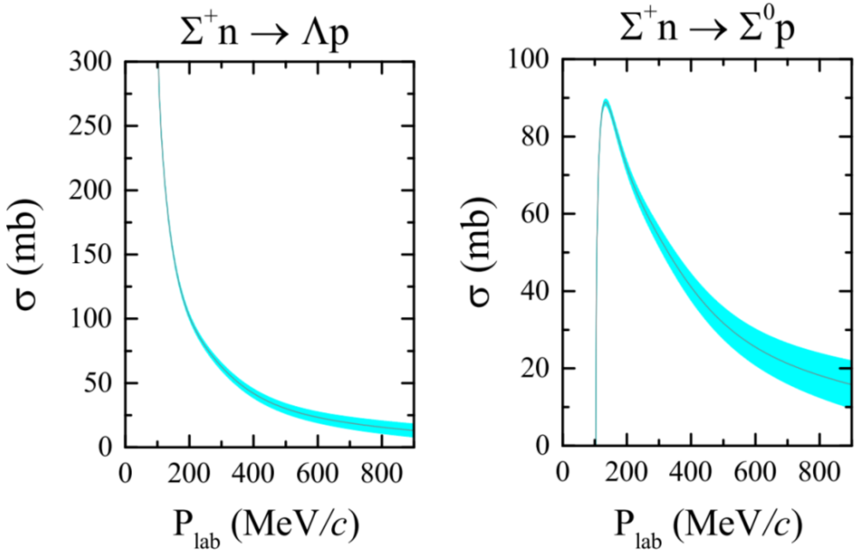


$N_\Lambda = 77.6 \pm 20.8$

$\varepsilon_\Lambda = 14.44\%$

$N_{\Sigma^0} = 14.1 \pm 4.6$

$\varepsilon_{\Sigma^0} = 3.98\%$



PRC 105, 035203 (2022)

For $P_{\Sigma^+} \approx 0.992$ GeV/c

Consistent with theoretical predictions

$\sigma(\Sigma^+ n \to \Lambda p) = (15.1 \pm 4.0_{\text{stat}} \pm 2.4_{\text{sys}})$ mb

$\sigma(\Sigma^+ n \to \Sigma^0 p) = (9.9 \pm 3.2_{\text{stat}} \pm 2.3_{\text{sys}})$ mb

$\sigma(\Sigma^+ + {}^9\text{Be} \to \Lambda + p + {}^8\text{Be}) = (45.2 \pm 12.1_{\text{stat}} \pm 7.2_{\text{sys}})$ mb

$\sigma(\Sigma^+ + {}^9\text{Be} \to \Sigma^0 + p + {}^8\text{Be}) = (29.8 \pm 9.7_{\text{stat}} \pm 6.9_{\text{sys}})$ mb

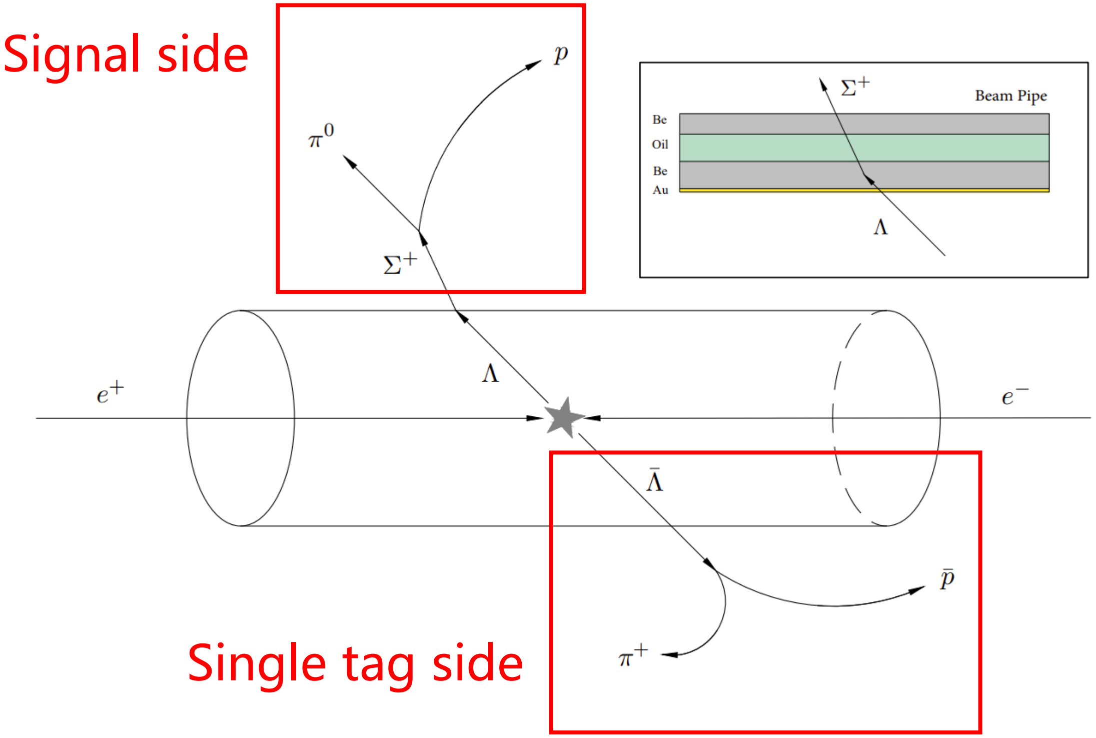
The first exploration of Σ-nucleon scattering at an electron-positron collider.
These results provide valuable constraints on ΛN-ΣN coupling, and help understanding the role of Σ-nucleon scattering in the neutron star.

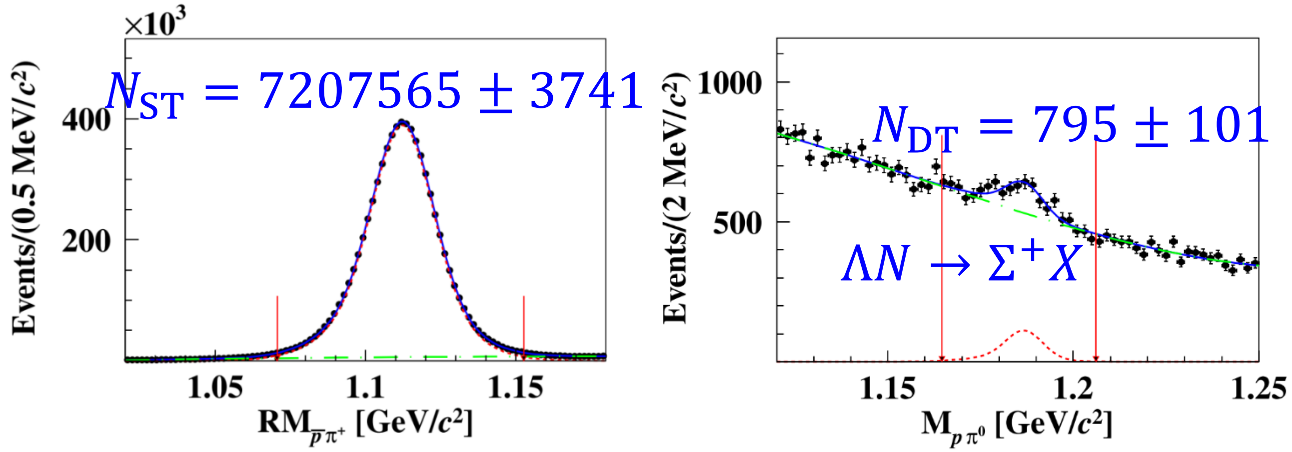
Study of $\Lambda N \to \Sigma^+ X$

PRC 109, L052201 (2024)

Reaction chain :

$J/\psi \to \Lambda\bar{\Lambda}$, $\bar{\Lambda} \to \bar{p}\pi^+$, $\Lambda + N(\text{nucleus}) \to \Sigma^+ + X(\text{anything})$, $\Sigma^+ \to p\pi^0$, $\pi^0 \to \gamma\gamma$.





For $P_\Lambda \approx 1.074$ GeV/c

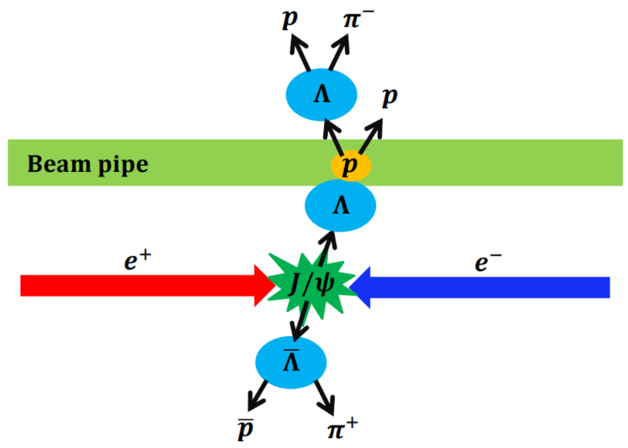
$\sigma(\Lambda + {}^9\text{Be} \to \Sigma^+ + X) = (37.3 \pm 4.7_{\text{stat}} \pm 3.5_{\text{sys}})$ mb

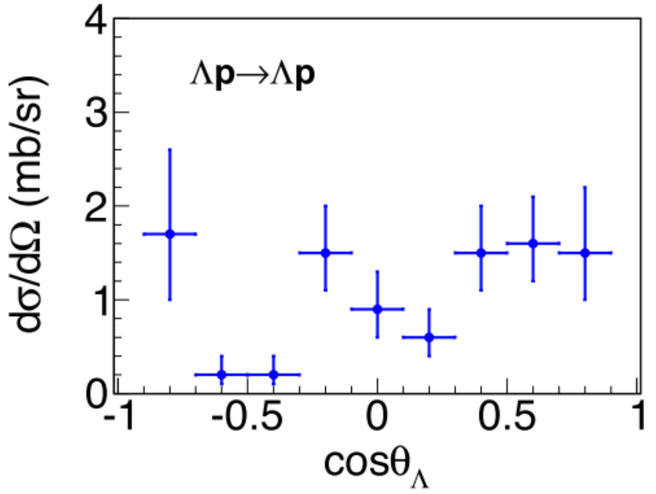
$\sigma(\Lambda p \to \Sigma^+ X) = (19.3 \pm 2.4_{\text{stat}} \pm 1.8_{\text{sys}})$ mb

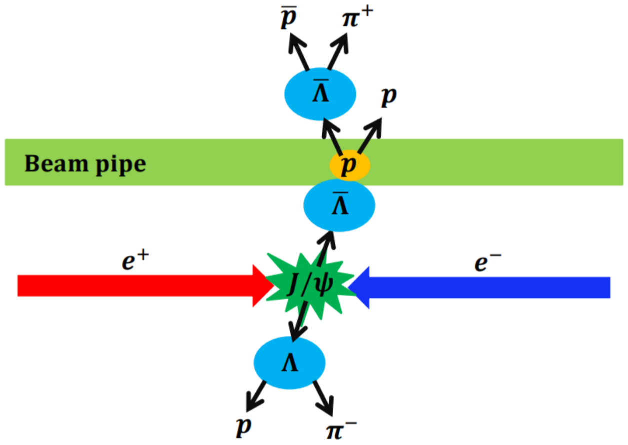
The first attempt to investigate Λ-nucleus interaction at an e^+e^- collider.

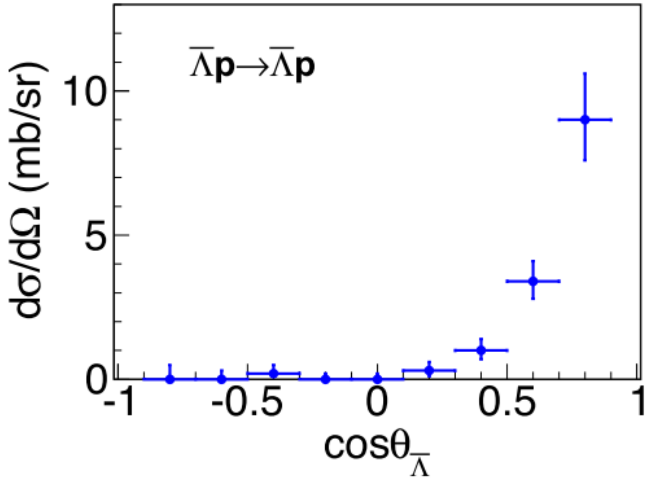
Study of $\Lambda p \to \Lambda p$ and $\bar{\Lambda} p \to \bar{\Lambda} p$

PRL 132, 231902 (2024)









$\cos\theta_{\Lambda/\bar{\Lambda}}$	$N_i^{\rm sig}$	ϵ_i (%)	$(d\sigma/d\Omega)$ (mb/sr)
$[-0.9, -0.7]$	$(5.0^{+2.6}_{-1.9}, 0.0^{+1.1}_{-0.0})$	(6.94,4.93)	$(1.7^{+0.9}_{-0.7}, 0.0^{+0.5}_{-0.0})$
$(-0.7, -0.5]$	$(1.0^{+1.4}_{-0.7}, 0.0^{+1.1}_{-0.0})$	(14.13,10.44)	$(0.2^{+0.2}_{-0.1}, 0.0^{+0.3}_{-0.0})$
$(-0.5, -0.3]$	$(1.0^{+1.4}_{-0.7}, 1.0^{+1.4}_{-0.7})$	(17.32,13.27)	$(0.2^{+0.2}_{-0.1}, 0.2^{+0.3}_{-0.1})$
$(-0.3, -0.1]$	$(11.0^{+3.7}_{-3.0}, 0.0^{+1.1}_{-0.0})$	(17.74,14.66)	$(1.5^{+0.5}_{-0.4}, 0.0^{+0.2}_{-0.0})$
$(-0.1, 0.1]$	$(6.9^{+3.0}_{-2.3}, 0.0^{+1.1}_{-0.0})$	(19.11,15.79)	$(0.9^{+0.4}_{-0.3}, 0.0^{+0.2}_{-0.0})$
$(0.1, 0.3]$	$(5.0^{+2.6}_{-1.9}, 2.0^{+1.8}_{-1.1})$	(19.53,16.82)	$(0.6^{+0.3}_{-0.2}, 0.3^{+0.3}_{-0.2})$
$(0.3, 0.5]$	$(12.0^{+3.8}_{-3.1}, 7.0^{+3.0}_{-2.3})$	(19.21,17.68)	$(1.5^{+0.5}_{-0.4}, 1.0^{+0.4}_{-0.3})$
$(0.5, 0.7]$	$(13.0^{+3.9}_{-3.3}, 25.0^{+5.3}_{-4.7})$	(19.71,17.60)	$(1.6^{+0.5}_{-0.4}, 3.4^{+0.7}_{-0.6})$
$(0.7, 0.9]$	$(6.0^{+2.8}_{-2.1}, 37.0^{+6.4}_{-5.8})$	(9.80,9.93)	$(1.5^{+0.7}_{-0.5}, 9.0^{+1.6}_{-1.4})$

Cross sections in $-0.9 \le \cos\theta_{\Lambda/\bar{\Lambda}} \le 0.9$ are measured to be
$\sigma(\Lambda p \to \Lambda p) = (12.2 \pm 1.6_{\rm stat} \pm 1.1_{\rm sys})$ mb and
$\sigma(\bar{\Lambda} p \to \bar{\Lambda} p) = (17.5 \pm 2.1_{\rm stat} \pm 1.6_{\rm stat})$ mb

Total cross sections are determined to be
$\sigma_t(\Lambda p \to \Lambda p) = (14.2 \pm 1.8_{\rm stat} \pm 1.3_{\rm sys})$ mb and
$\sigma_t(\bar{\Lambda} p \to \bar{\Lambda} p) = (27.4 \pm 3.2_{\rm stat} \pm 2.5_{\rm sys})$ mb

First measurement of antihyperon-nucleon scattering

Λ EDM via Quantum entanglement

Challenges in Hyperon EDM Measurement:

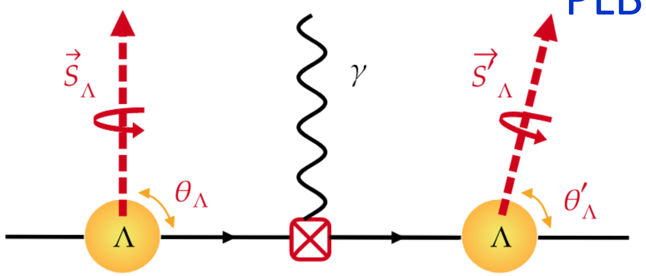
- Short lifetimes make traditional spin-precession measurements impractical
- Prior direct Λ EDM limit (Fermilab, 1981): $|\boldsymbol{d_\Lambda}| < \mathbf{1.5} \times \mathbf{10^{-16}}\boldsymbol{e} \cdot \mathbf{cm}$.

PRD 23, 814–816 (1981)

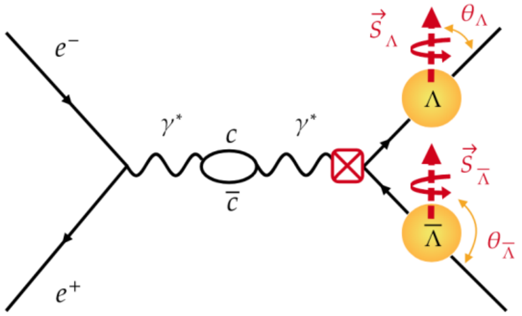
New Approach @ BESIII:

- Utilize **entangled $\boldsymbol{\Lambda}$– $\boldsymbol{\bar{\Lambda}}$ pairs** produced via $e^+e^- \to J/\psi \to \Lambda\bar{\Lambda}$
- Extract EDM from **CP-odd angular correlations** in decay distributions
- Angular variables sensitive to EDM via interference with CP-violating form factor H_T

PLB 839(2023)137834



Spin precession method



Extract EDM through CP-violating FF

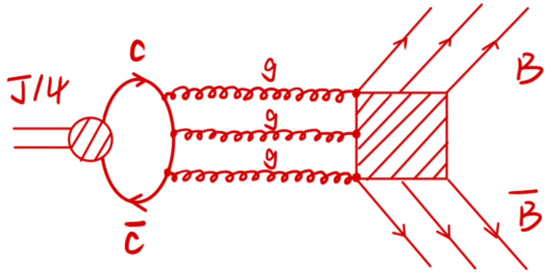
The interaction between the spin of a hyperon and an external electromagnetic field induces a precession effect, which can be used to directly measure the hyperon's EDM

Hyperon EDM at BESIII

X.G.He, J.P. Ma, PLB 839(2023)137834

Detailed dynamics in J/ψ decay to hyperon pair, have been studied:

$$\mathcal{A} = \epsilon_{\mu}(\lambda)\bar{u}(\lambda_1)\left(\boldsymbol{F_V}\gamma^{\mu} + \frac{i}{2M_{\Lambda}}\sigma^{\mu\nu}q_{\nu}\boldsymbol{H_{\sigma}} + \gamma^{\mu}\gamma^{5}\boldsymbol{F_A} + \sigma^{\mu\nu}\gamma^{5}q_{\nu}\boldsymbol{H_T}\right)v(\lambda_2)$$



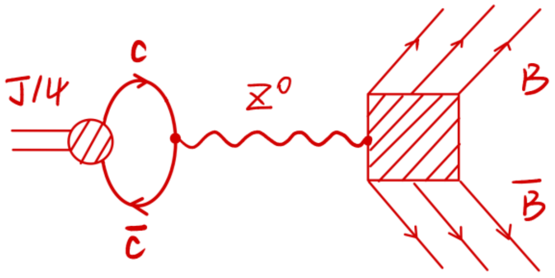
Dominant contribution

arXiv:hep-ph/0412158

Psionic form factor

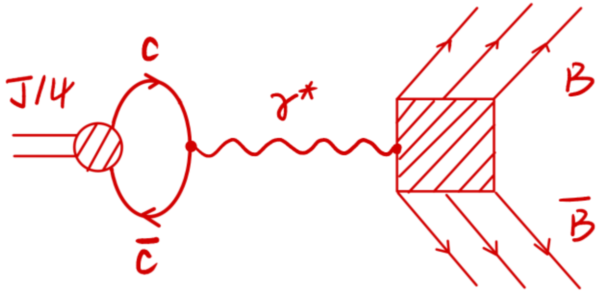
$\boldsymbol{F_V}$ and $\boldsymbol{H_{\sigma}}$

can also be represented as $\boldsymbol{G_1}$ and $\boldsymbol{G_2}$



P violation term

Complex form factor, $F_A \neq 0$ indicate P violation



$\boldsymbol{H_T}$ is included in this term

$$H_T(q^2) = \frac{2e}{3m_{J\psi}^2} g_V d_B(q^2)$$

Assuming $d_B(q^2) \equiv d_B(0)$

$d_B(q^2)$: electric dipole form factor

$d_B(0)$: electric dipole moment

Physics Letters B 551 (2003) 16–26

Measurement of Λ EDM at BESIII

BESIII: arXiv:2506.19180

- EDM extracted via **full angular analysis** of entangled decays:

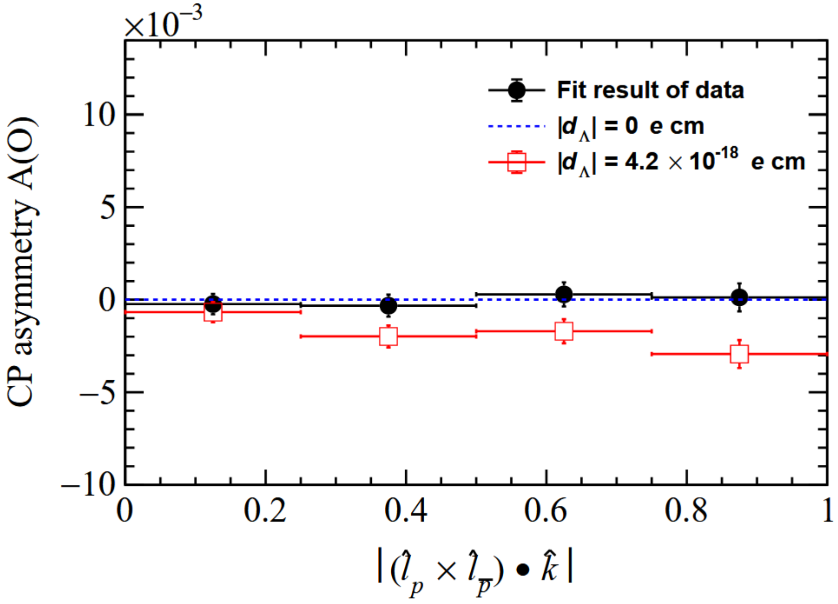
$$\mathrm{Re}(d_\Lambda) = (-3.1 \pm 3.2 \pm 0.5) \times 10^{-19}\ e \cdot \mathrm{cm}$$
$$\mathrm{Im}(d_\Lambda) = (2.9 \pm 2.6 \pm 0.6) \times 10^{-19}\ e \cdot \mathrm{cm}$$

which corresponds to an upper bound of:

$$|d_\Lambda| < 7.0 \times 10^{-19}\ e \cdot cm \quad (95\%\ CL)$$

$\boldsymbol{SM: 10^{-26}\ e \cdot cm}$

- Improves sensitivity by **3 orders of magnitude** over previous best.
- **First EDM constraint from strange quark system using quantum entanglement.**



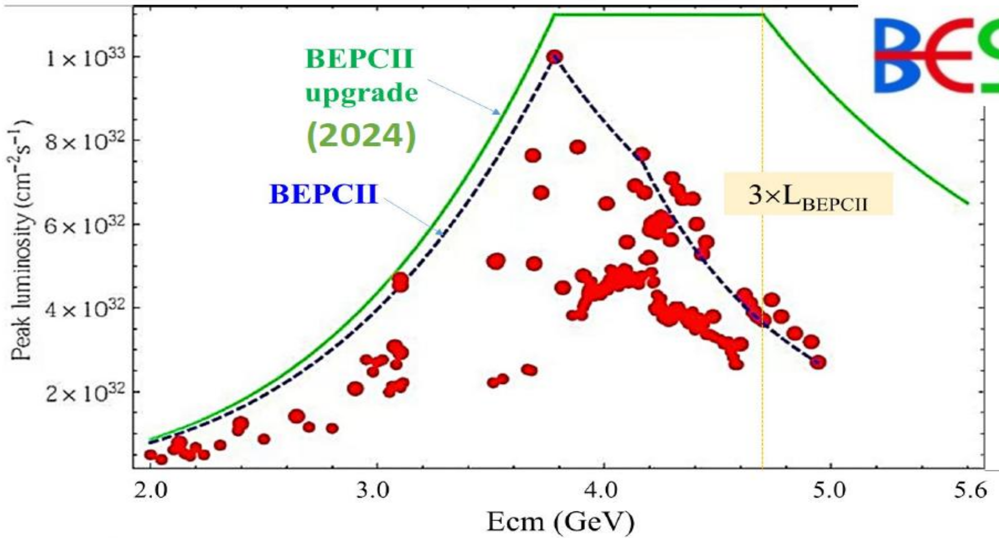
Triple-product asymmetry projection: EDM = 0 vs non-zero EDM hypothesis:

- Kinematic variable $O \equiv (\hat{l}_p \times \hat{l}_{\bar{p}}) \cdot \hat{k}$
- Triple-product asymmetry observable:

$$A(O) = \frac{N_{\mathrm{event}}(O > 0) - N_{\mathrm{event}}(O < 0)}{N_{\mathrm{event}}(O > 0) + N_{\mathrm{event}}(O < 0)}$$

- $\hat{l}_p(\hat{l}_{\bar{p}})$: unit momentum of $p(\bar{p})$ in $\Lambda(\bar{\Lambda})$ rest frame
- $\hat{k}$: unit momentum of Λ in J/ψ rest frame

Prospects of BESIII



BEPCII upgrade (2024 – 2028)

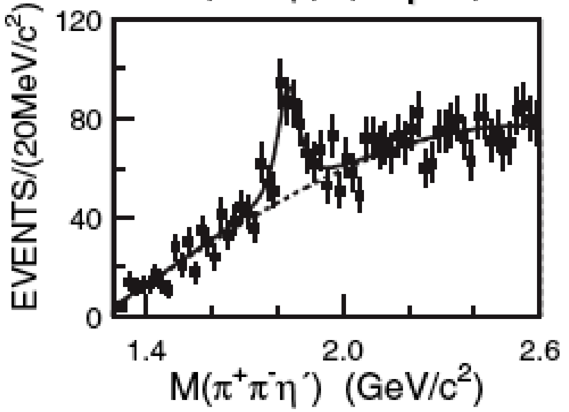
Highest beam energy: 2.8 GeV

Peak Lum.: 3.77 ~ 4.7 GeV : 1.2×10^{33} $cm^{-2}s^{-1}$

5.0 ~ 5.6 GeV: $(0.5\text{-}0.7)\times10^{33}$ $cm^{-2}s^{-1}$

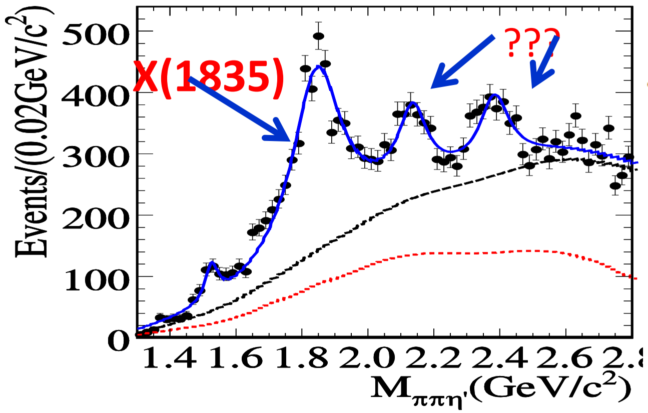
BESIII: CGEM successfully installed.

BESII: 58 M J/ψ events



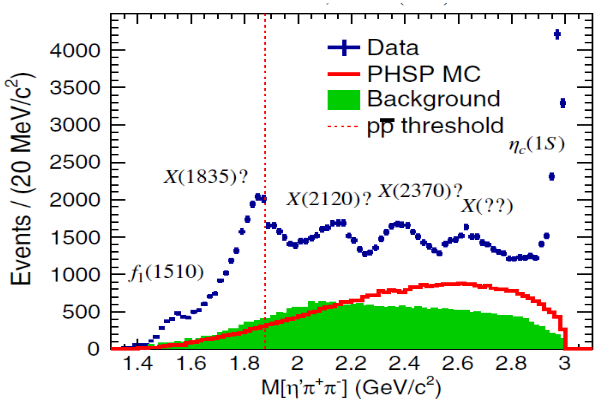
PRL 95,262001(2005)

BESIII: 225 M J/ψ events



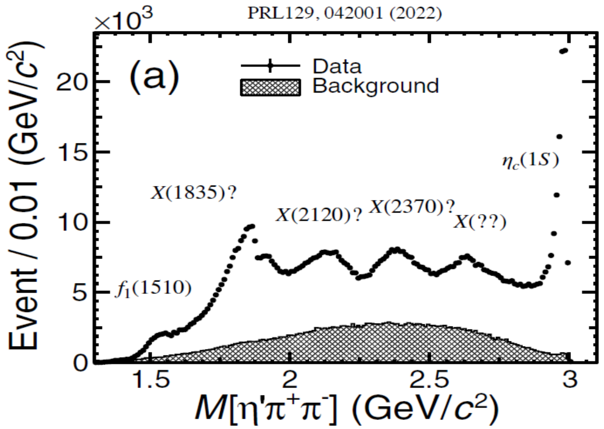
PRL 106, 072002 (2011)

BESIII: 1.1B J/ψ events



PRL 117, 042002 (2016)

BESIII: 10 B J/ψ events

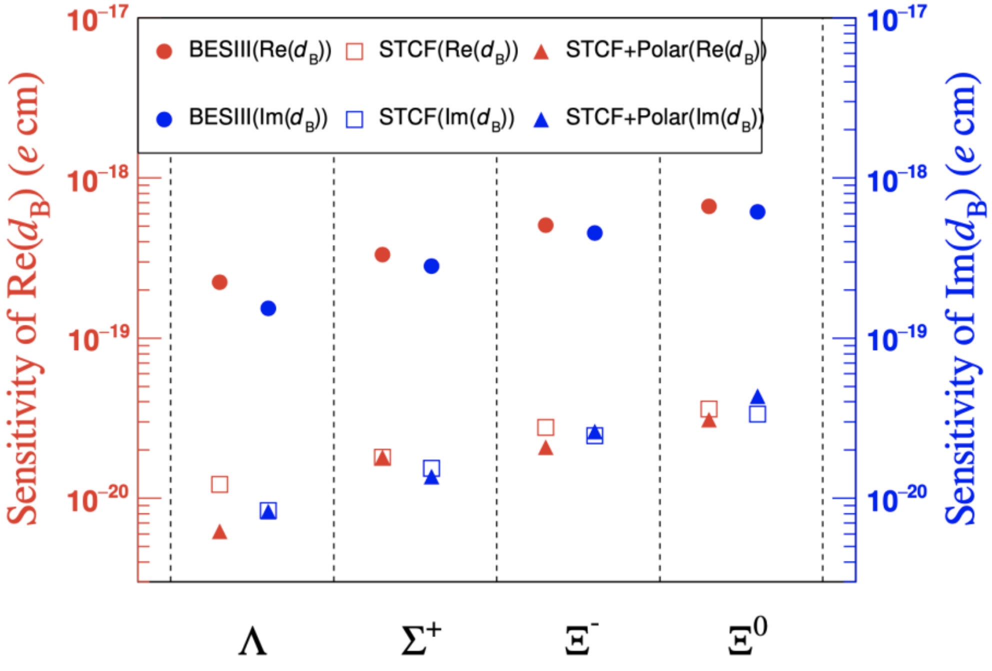


PRL 129, 042001 (2022)

High statistics data bring us more opportunities (surprises) and challenges.

Sensitivities of hyperon EDM at STCF

reminder: $H_T = \frac{2e}{3M_{J/\psi}^2} g_V d_B$



(a)Sensitivity of $Re(d_B)$ and $Im(d_B)$

SM: $\sim 10^{-26}$ e cm

BESIII: milestone for hyperon EDM measurement
Λ 10^{-19}e cm (FermiLab 10^{-16} e cm)
first achievement for Σ^+,Ξ^- and Ξ^0 at level of 10^{-19}e cm
a litmus test for new physics

STCF: improved by 2 order of magnitude

Jinlin Fu, Hai-Bo Li, Jianpeng Wang, Fusheng Yu, and Jianyu Zhang, arxiv: 2307.04364

Thanks for your attention

谢谢