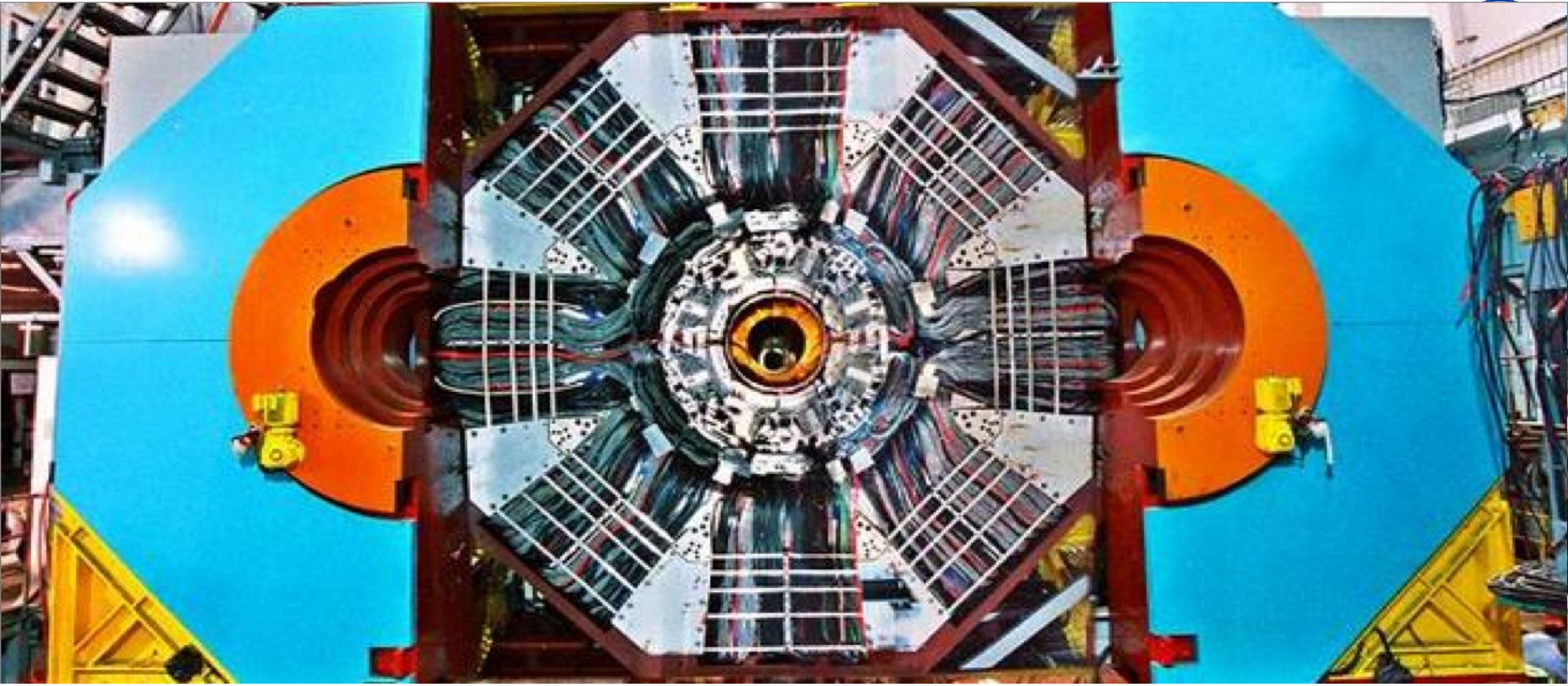


Studying QCD/EW Phenomena at BESIII

Xiao-Rui Lyu （吕晓睿）
University of Chinese Academy of Sciences (UCAS), Beijing
中国科学院大学
(On behalf of the BESIII collaboration)

Outline

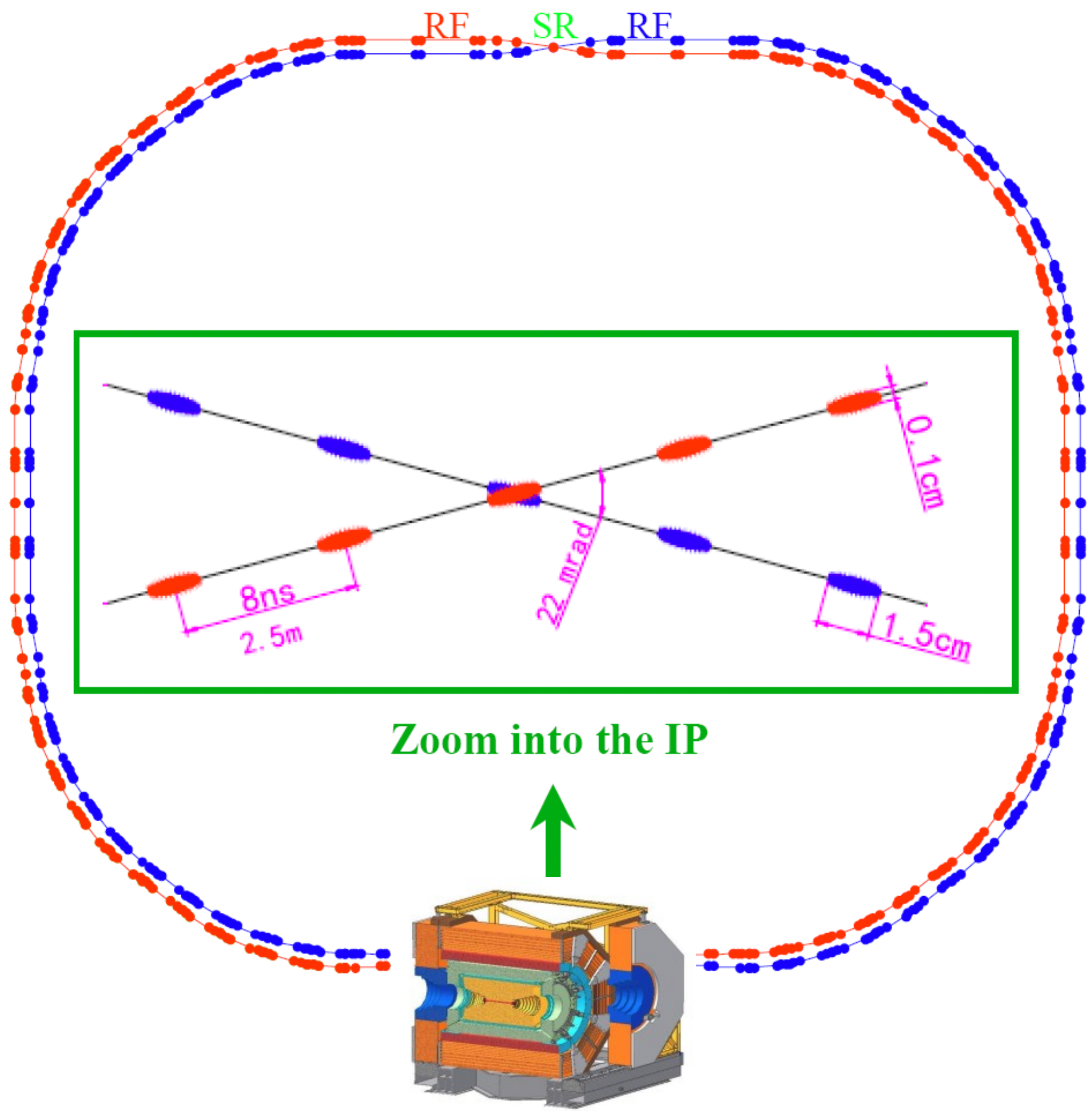
- ✓ **Introduction to the BESIII experiment**
- ✓ **Collins Fragmentation Function**
  fundamental test on QCD
- ✓ **Studies of the Zc states**
  search for tetraquark in QCD
- ✓ **Charmed meson decays at threshold**
  D^0–$\underline{D}^0$ mixing parameter y_{CP}, Ds hadronic decays
- ✓ **Charmed baryon Λ_c decays at threshold**
  Λ_c hadronic and semi-leptonic decays
- ✓ **Summary**

The BEPCII Collider

Beam energy: 1.0 – 2.3 GeV
Peak Luminosity:
    Design: $1 \times 10^{33}\ cm^{-2}s^{-1}$
    ***Achieved:* 0.85 × $10^{33}\ cm^{-2}s^{-1}$**

Optimum energy: 1.89 GeV
Energy spread: 5.16×10^{-4}

Circumference: 237 m



In 2015, BEPCII made successful test with top-up mode!

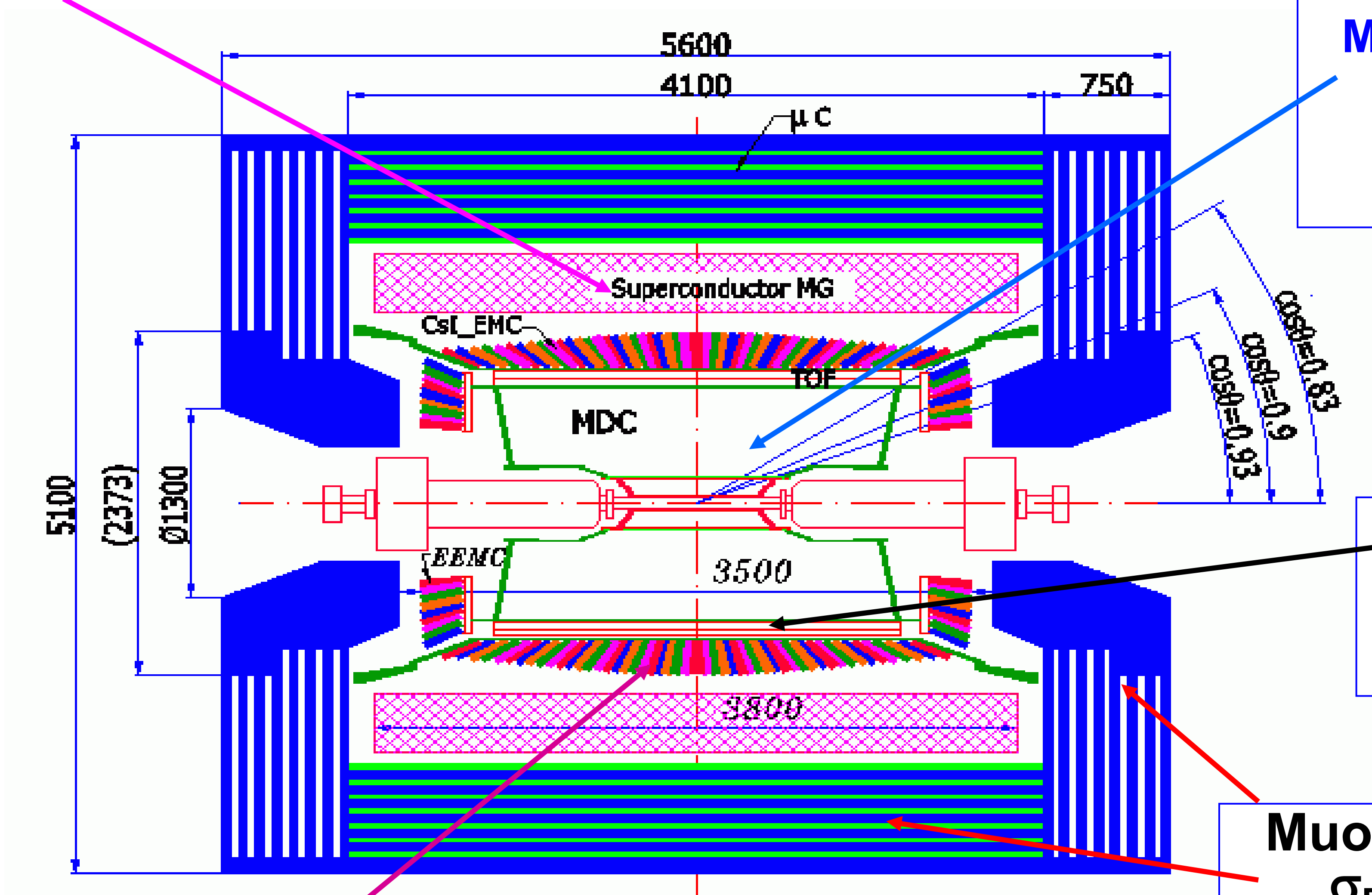
Beam energy measurement: Using Compton backscattering technique. Accuracy up to **5×10^{-5}**

The BESIII Detector

NIM A614, 345 (2010)

Magnet: 1 T Super conducting

MDC: small cell & He gas
σ_{xy}=130 μm
s_p/p = 0.5% @1GeV
dE/dx=6%



TOF:
σ_T = 90 ps Barrel
110 ps Endcap

Muon ID: 8~9 layer RPC
$\sigma_{R\Phi}$=1.4 cm~1.7 cm

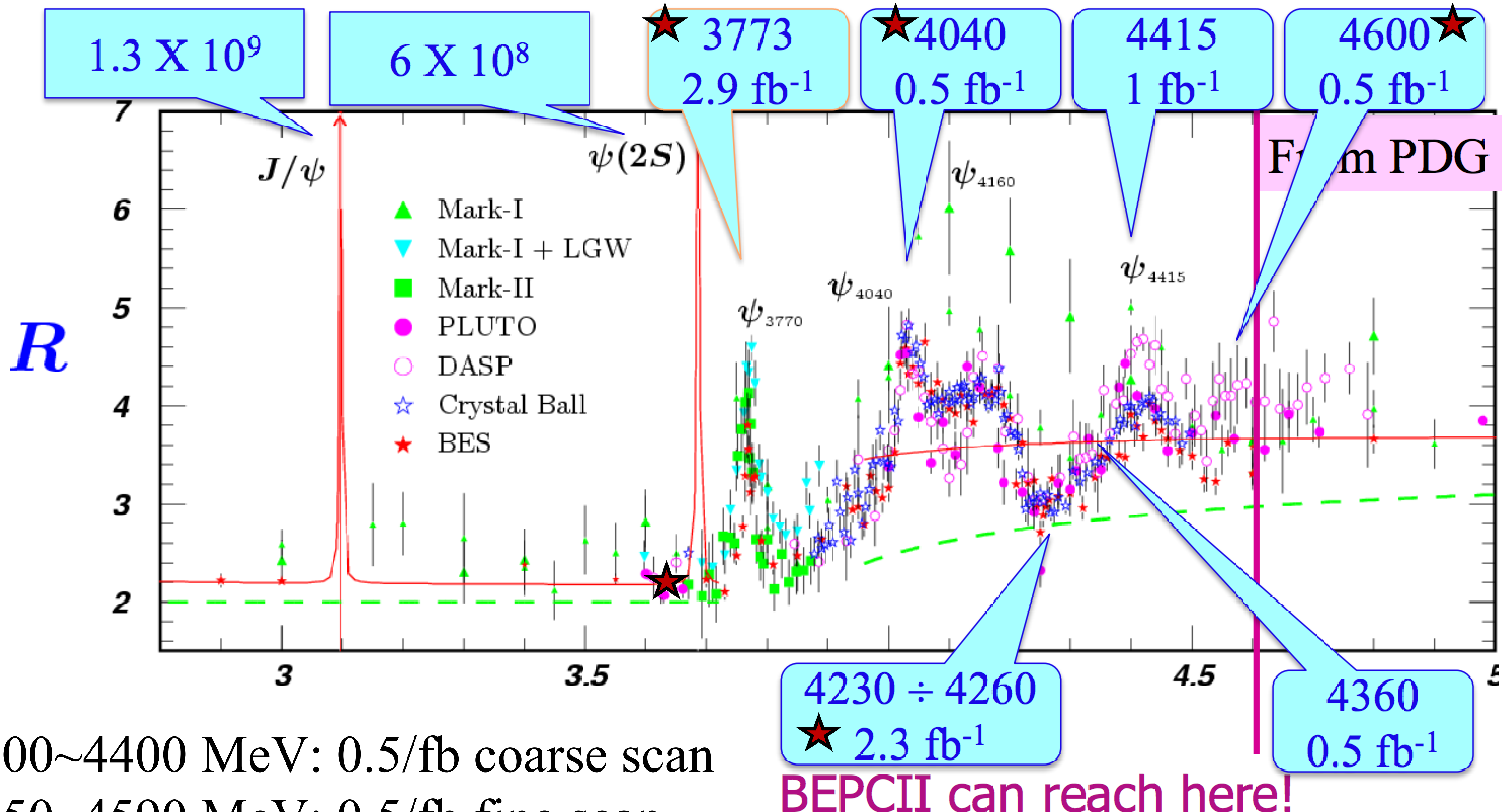
EMCAL: CsI crystal
$\Delta E/E$ = 2.5% @1 GeV
$\sigma_{\varphi,z}$ = 0.5~0.7 cm/$\sqrt{E}$

Data Acquisition:
Event rate = 3 kHz
Throughput ~ 50 MB/s

Trigger: Tracks & Showers
Pipelined; Latency = 6.4 μs

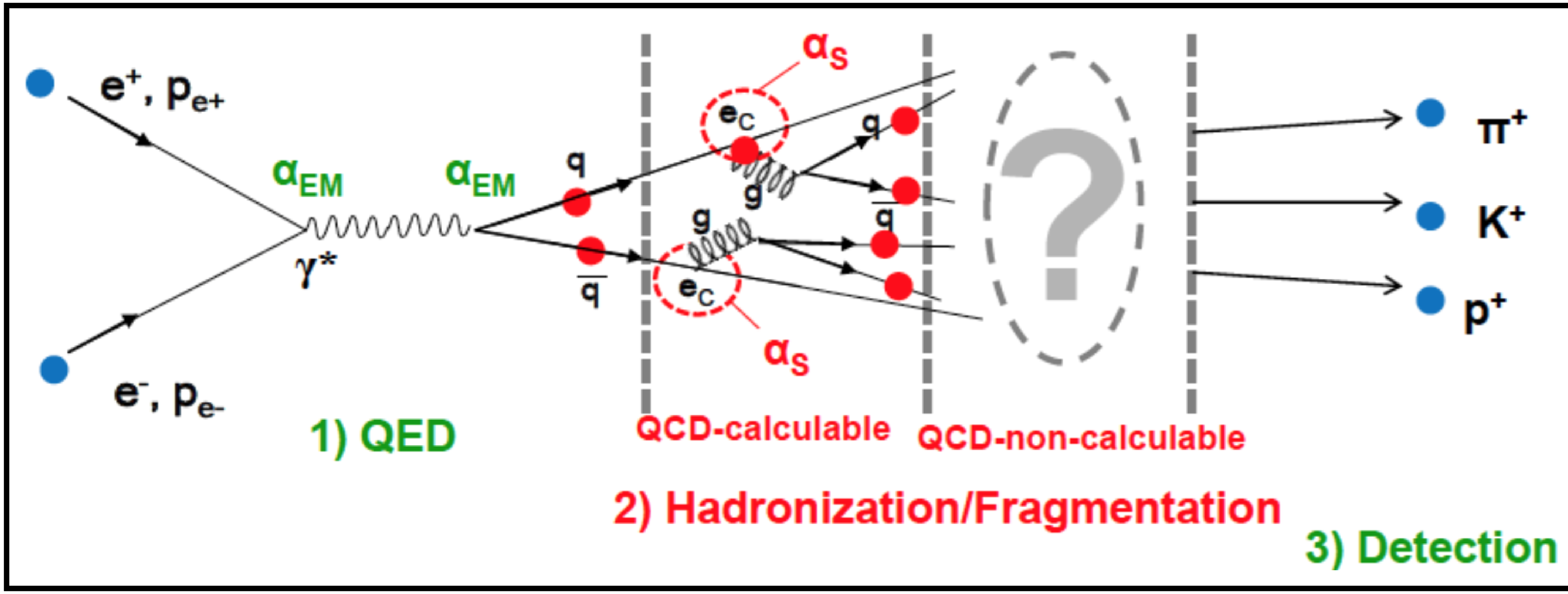
The new BESIII detector is hermetic for neutral and charged particle with excellent resolution, PID, and large coverage.

Data Samples at BESIII



- 4100~4400 MeV: 0.5/fb coarse scan
- 3850~4590 MeV: 0.5/fb fine scan
- In 2015, we finished energy scan at 2000~3000 MeV
- In 2016, we will take 3/fb Ds data about 4170 MeV (*about 5 times of CLEO-c data*)

Machine luminosity is optimal near ψ" peak

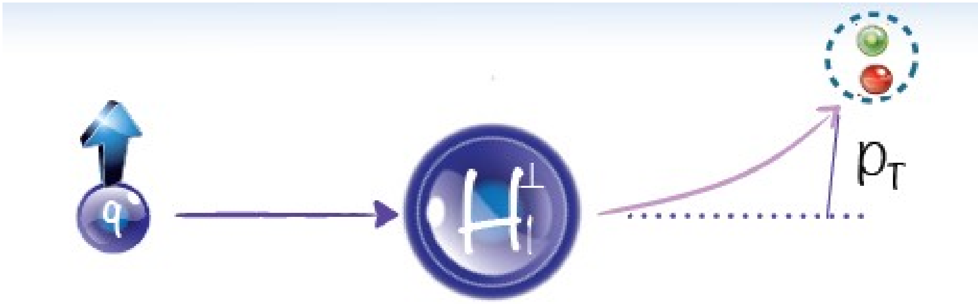


Collins Fragmentation Function

Fundamental test on QCD

BESIII Collins Fragmentation Function

The perturbative QCD fragmentation function (FF) is an important probe in experiment to test and calibrate QCD theory.



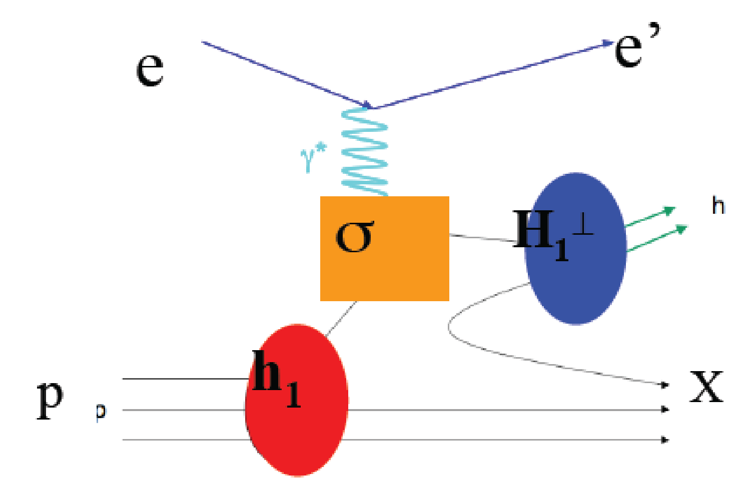
J. C. Collins, Nucl.Phys. B396, 161 (1993)

$$D_{hq^\uparrow}(z, P_{h\perp}) = D_1^q(z, P_{h\perp}^2) + H_1^{\perp q}(z, P_{h\perp}^2)\frac{(\hat{\mathbf{k}} \times \mathbf{P}_{h\perp}) \cdot \mathbf{S}_q}{zM_h},$$

D_1: the unpolarized FF
H_1: the Collins FF
→describes the fragmentation of a transversely polarized quark into a spinless hadron *h*.
→depends on $z = 2E_h/\sqrt{s}$, $\mathbf{P}_{h\perp}$
→leads to an azimuthal modulation of hadrons around the quark momentum.

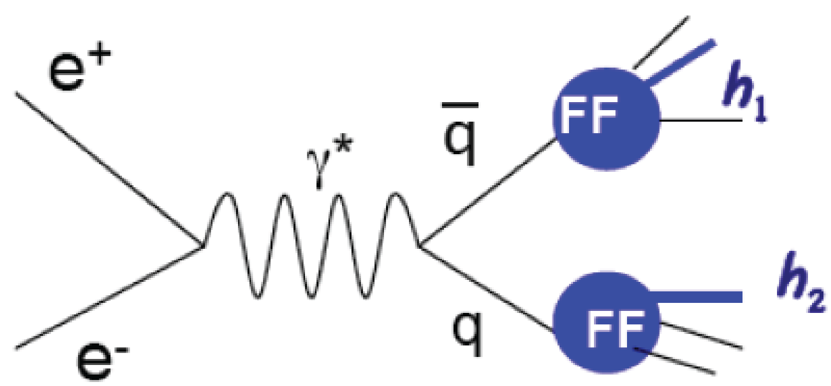
SIDIS

Transversity ⊗ Collins FF



e+ e-

Collins FF ⊗ Collins FF



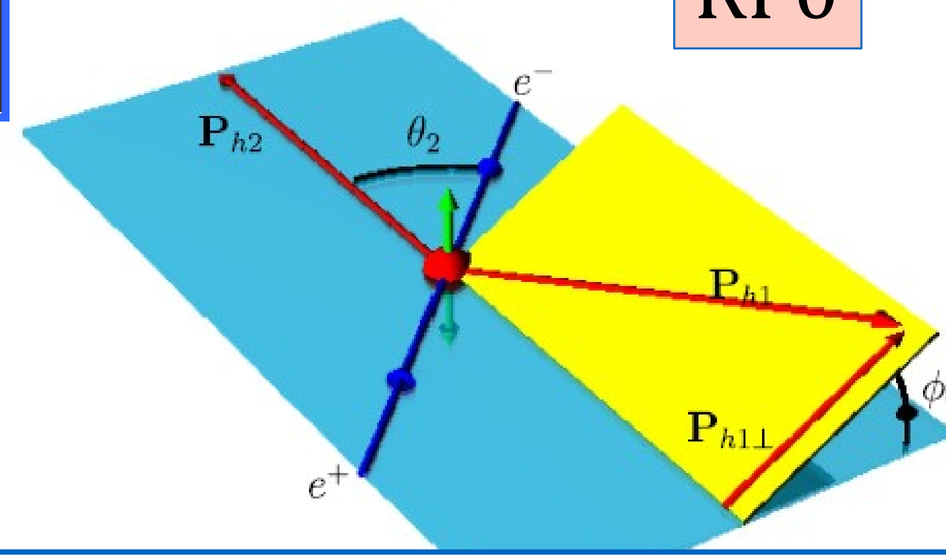
Probes of Collins Effect in e^+e^- Machine

- **Collins effect:** cosine modulation.

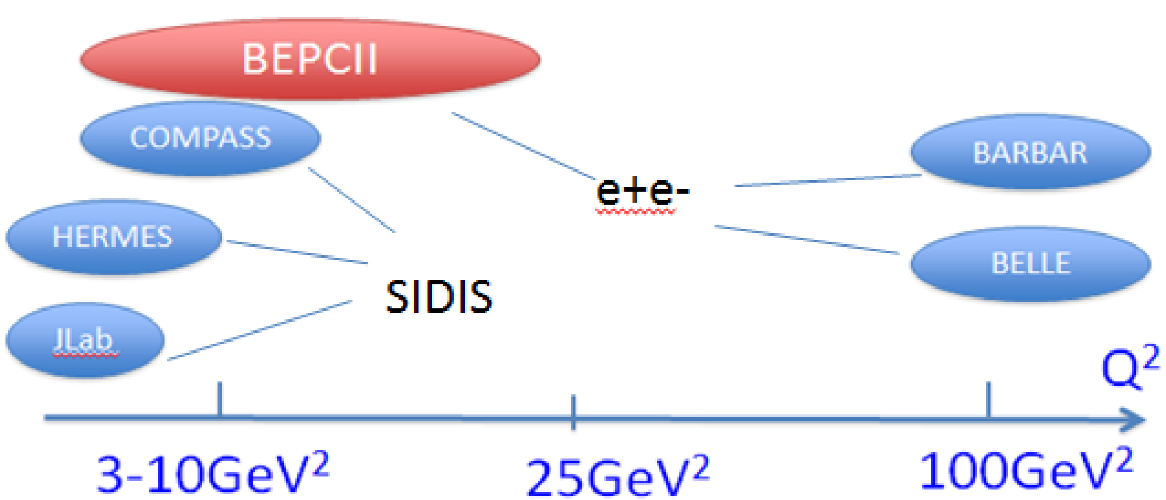
$$e^+e^- \to q\,\bar{q} \to h_1\,h_2\,X$$

RF0

$$\sigma \sim 1 + \frac{\sin^2\theta_2}{1+\cos^2\theta_2}\cos(2\phi_0)\mathcal{F}\left[\frac{H_1^\perp(z_1)\bar{H}_1^\perp(z_2)}{D_1(z_1)\bar{D}_1(z_2)}\right]$$



- **The Q^2 evolution of Collins FFs has not been validated.**
- **Low Q^2 data from e^+e^- collider is useful.**
- **BEPCII: similar Q^2 coverage with SIDIS**



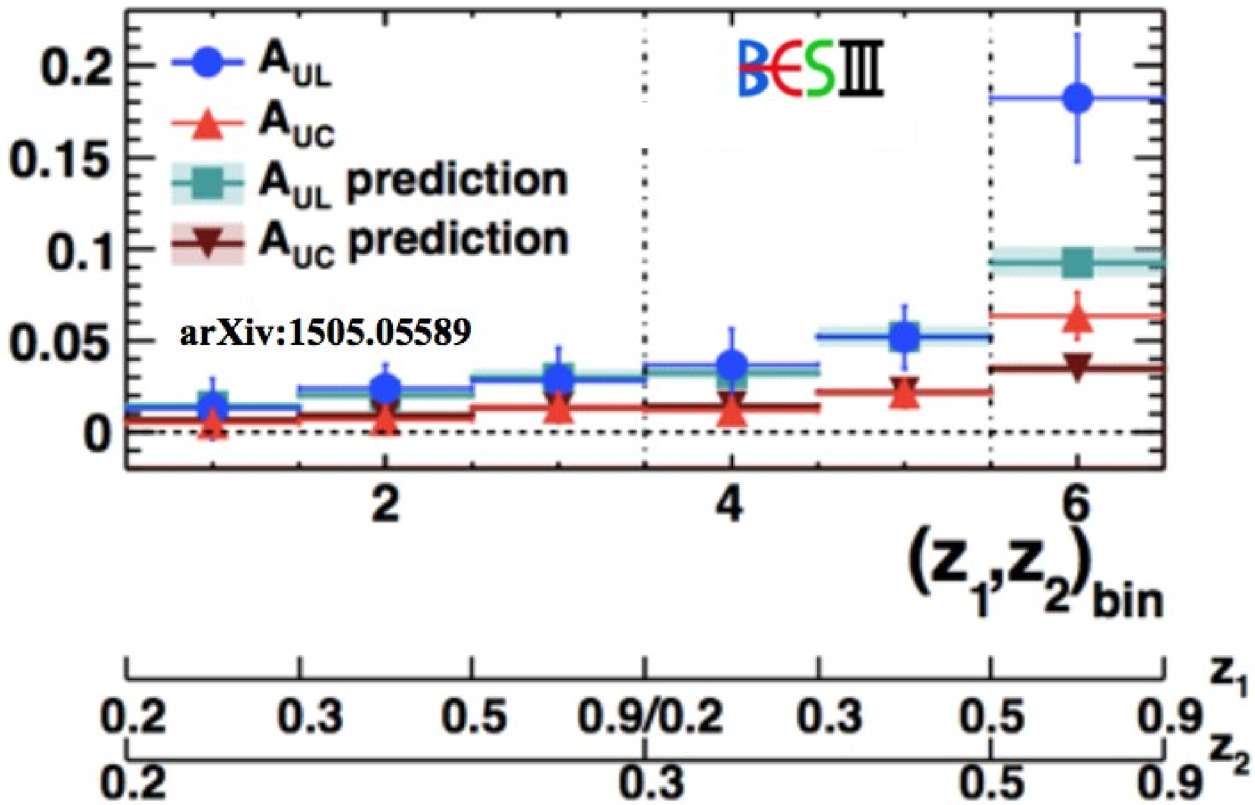
- **62 pb^{-1} @3.65GeV:** continuum region in-between the J/ψ and ψ(2S) peaks
- Back-to-back charged pion pairs:
  - **Unlike-sign pairs ($\pi^+\pi^-$)**
  - **Like-sign pairs ($\pi^+\pi^+$ & $\pi^-\pi^-$)**
  - **All Charged pairs ($\pi\,\pi$)**
- Take their ratios to cancel acceptance effect

$$\frac{R^U}{R^{L(C)}} \sim 1 + A_{UL(C)}\cos(2\Phi_0)$$

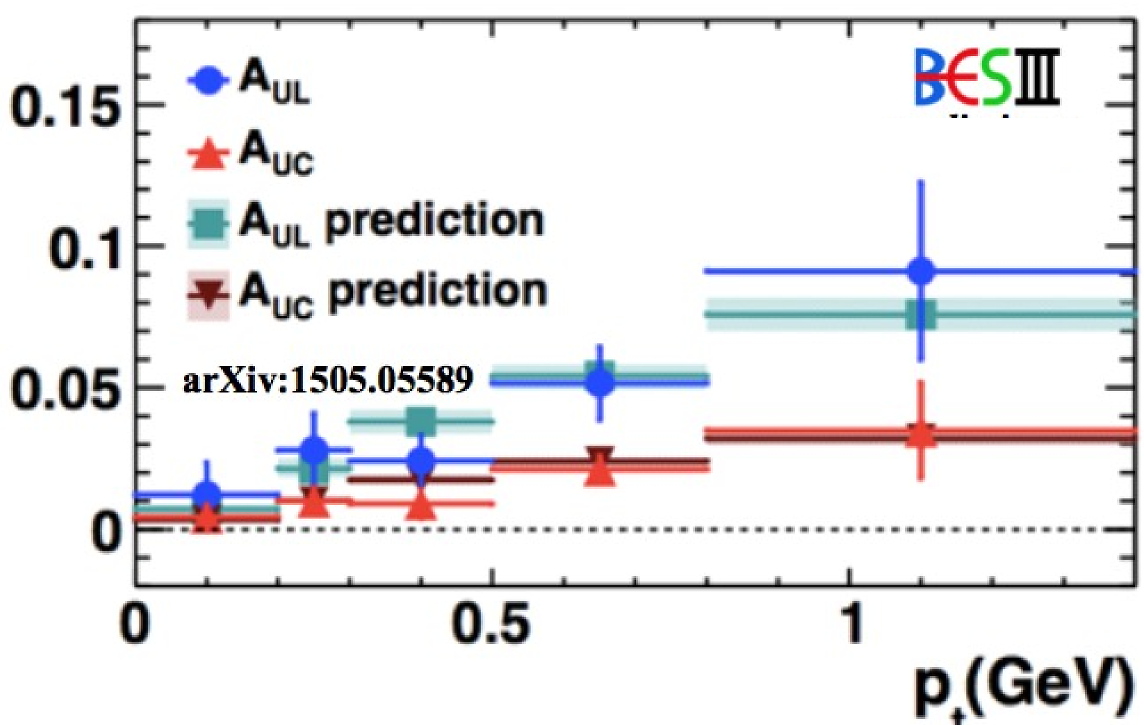
Measurement of the Asymmetries

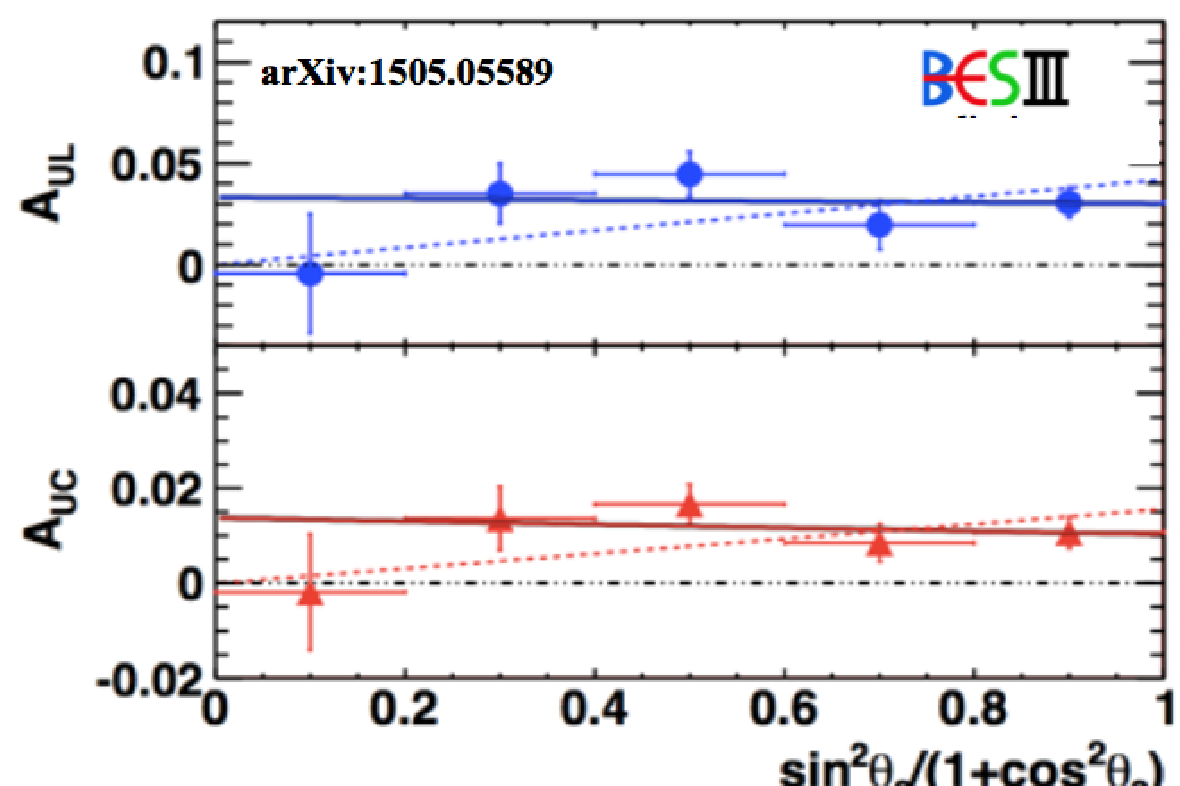
62 pb^{-1} @3.65GeV

arXiv:1507.06824
submitted to PRL



- Collins effect studied as a function of several kinematic variables
- Nonzero Collins asymmetries are observed.
- First measurement at medium energy, which is closer to SIDIS experiments
- It helps to understand the energy evolution of hadronization➔QCD

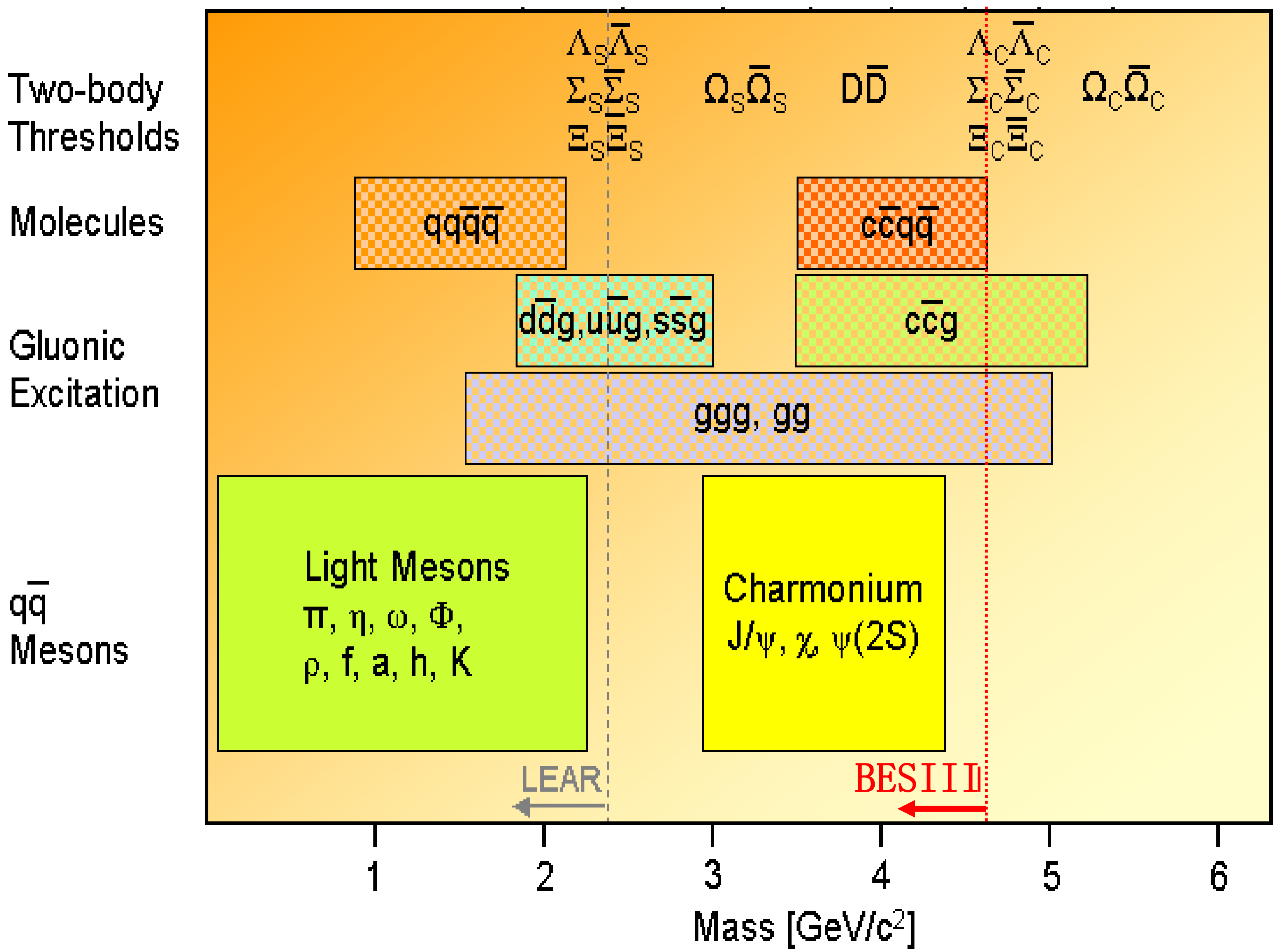




Studies of the Zc states

Search for tetraquark in QCD

Hadron Landscape



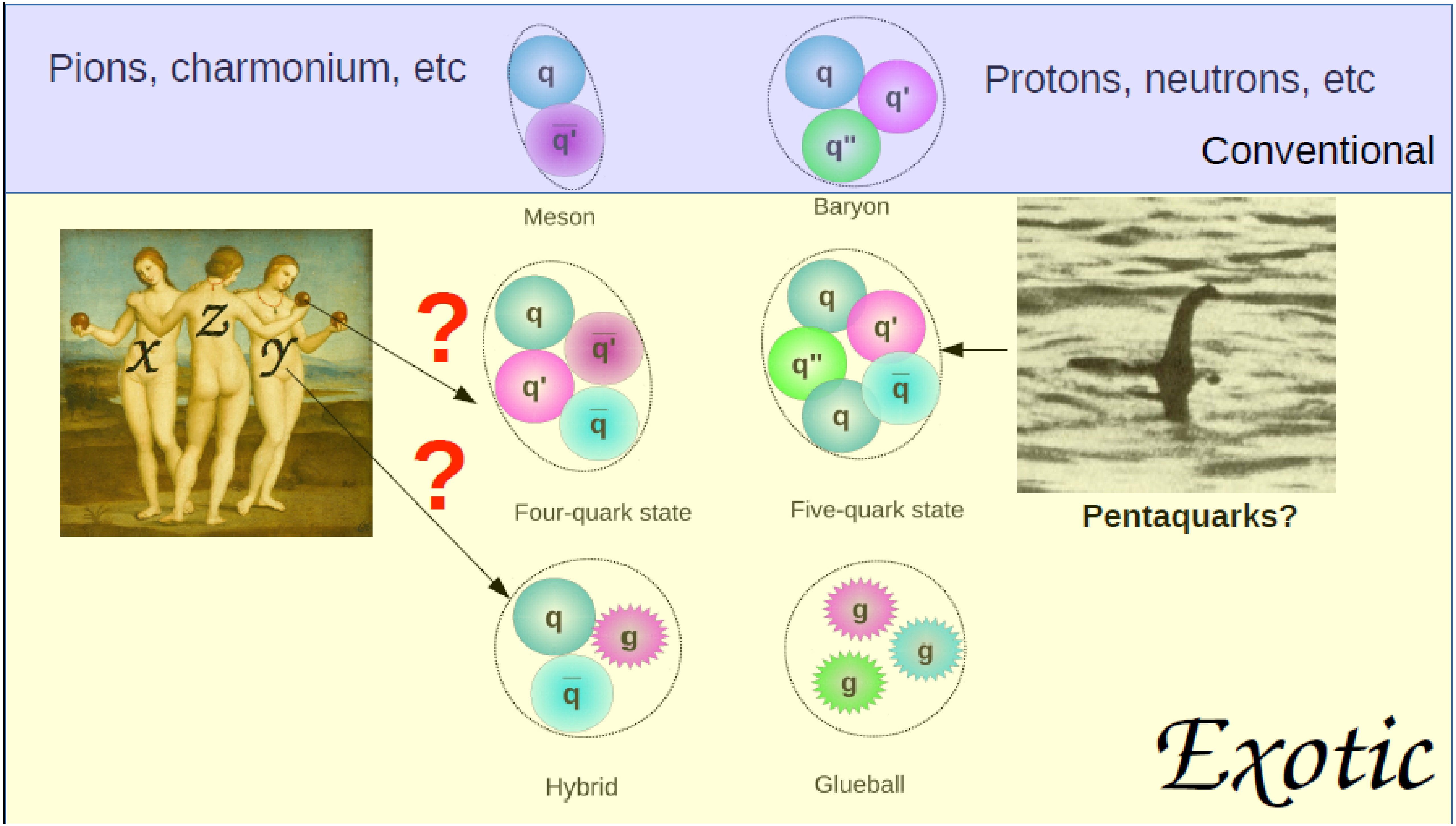
Hadron-physics challenges:

- Understanding of established states: precision spectroscopy
- Nature of exotic states: search and spectroscopy of unexpected states

At BESIII, two golden measures to study hadron spectroscopy, *esp*., to search for exotics

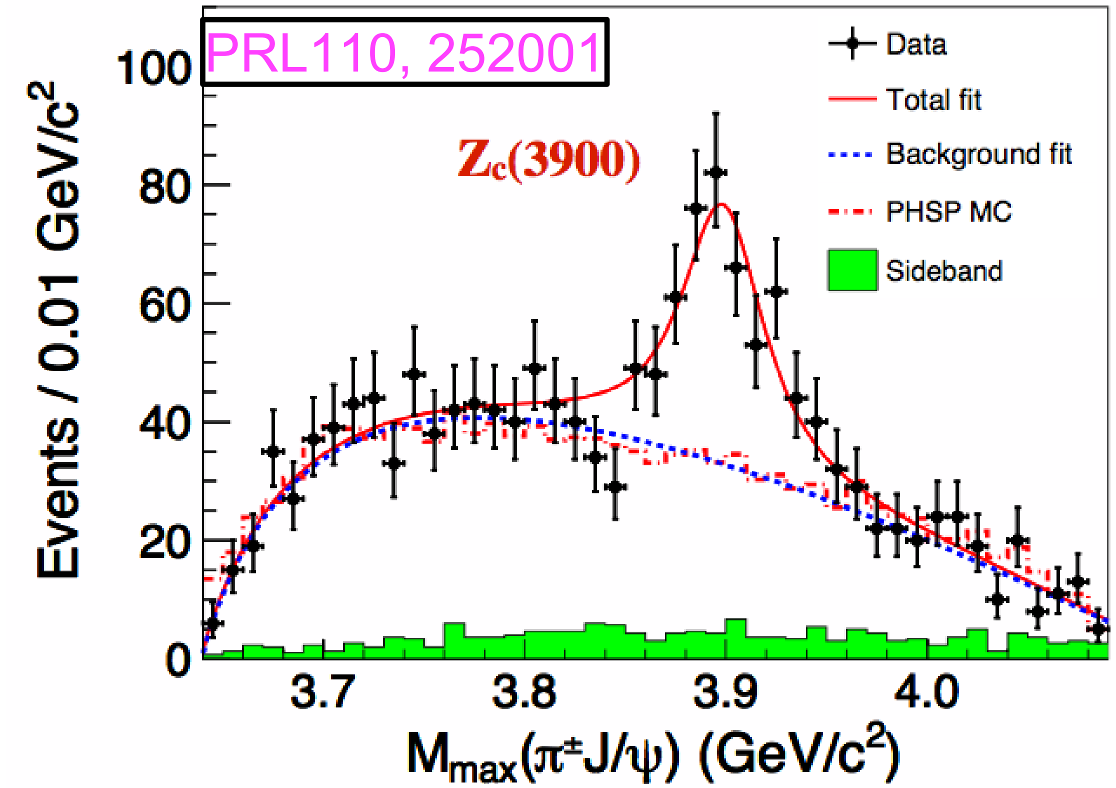
- Light hadrons: charmonium radiative decays (act as spin filter)
- Heavy hadrons: direct production, radiative and hadronic transitions

QCD predicted states

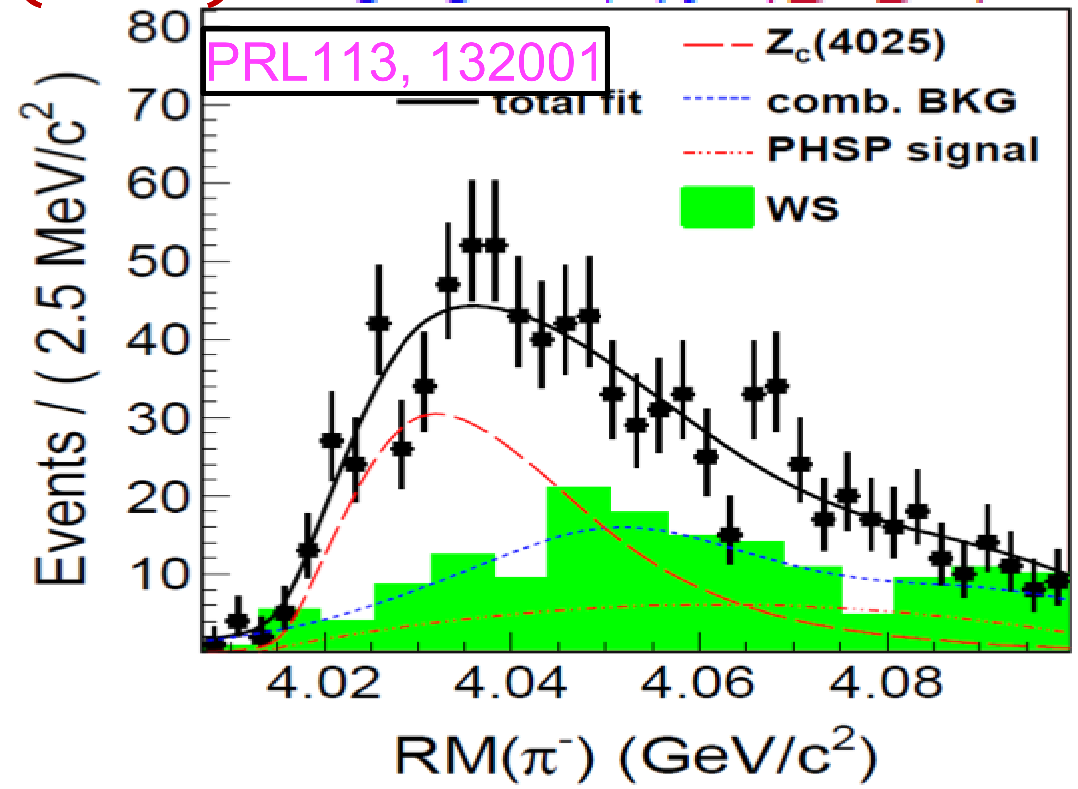


Discoveries of the charged $Z_c^{\pm}$'s

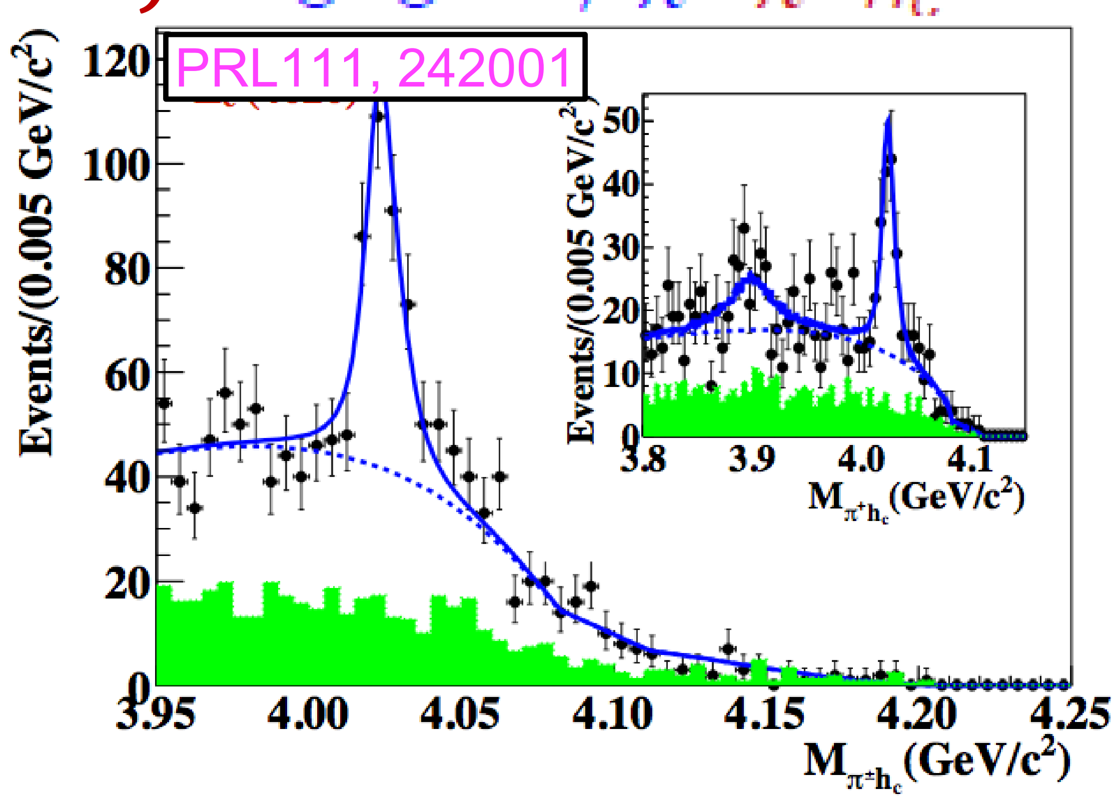
Zc(3900)+ $e^+e^- \to \pi^-\pi^+ J/\psi$



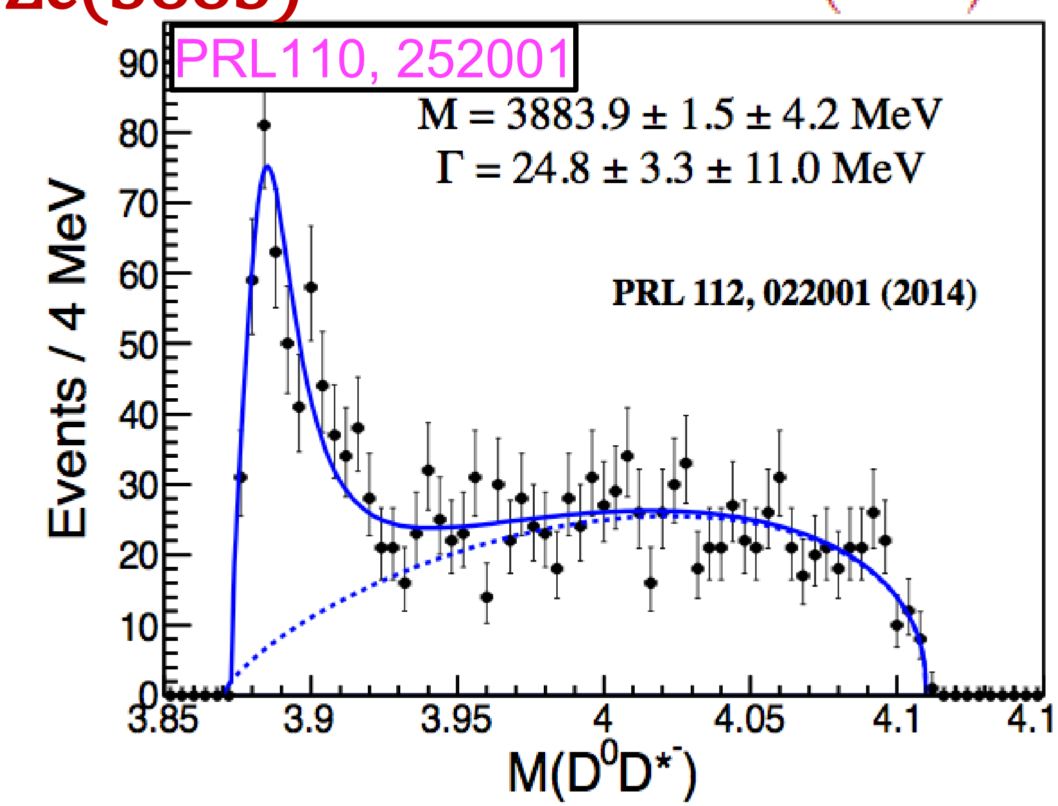
Zc(4025)+ $e^+e^- \to \pi^-(D^*\bar{D}^*)^+$



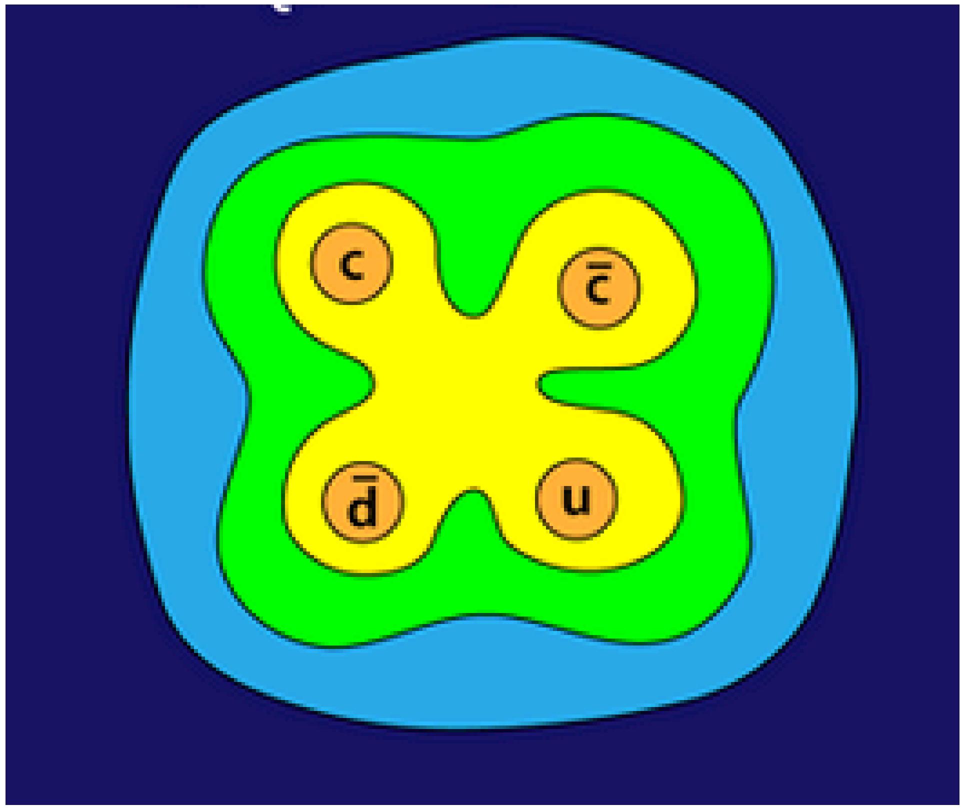
Zc(4020)+ $e^+e^- \to \pi^-\pi^+ h_c$

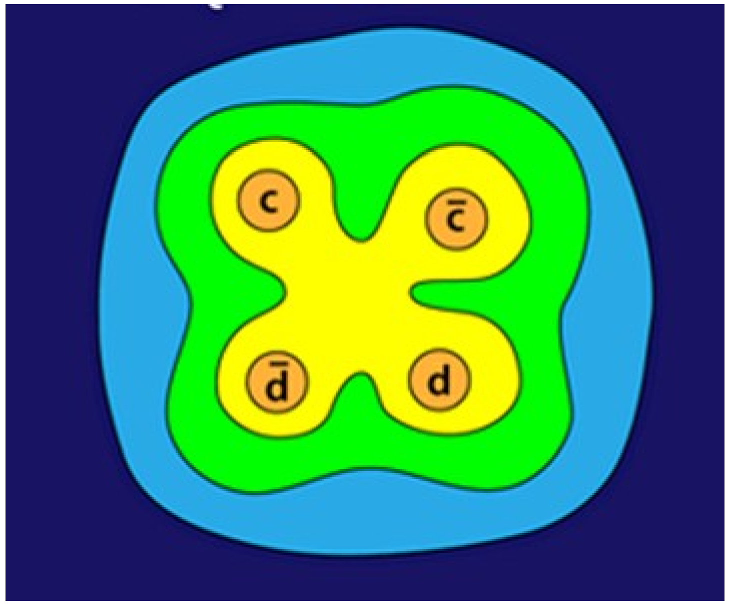


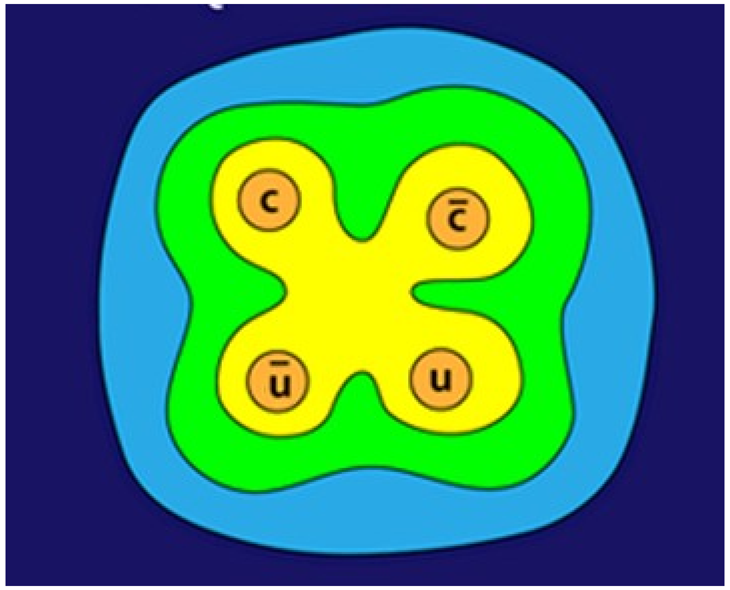
Zc(3885)+ $e^+e^- \to \pi^-(D\bar{D}^*)^+$



Neutral partners of the exotic Zc ?







- Search for isospin partners for the charged $Zc(3885)^+$ and $Zc(4025)^+$ states in open-charm decays
  - ✓ $e^+e^- \rightarrow \pi^0 (D^0\bar{D}^{*0} + D^+D^{*-})$?
  - ✓ $e^+e^- \rightarrow \pi^0 (D^{*0}\bar{D}^{*0} + D^{*+}D^{*-})$?

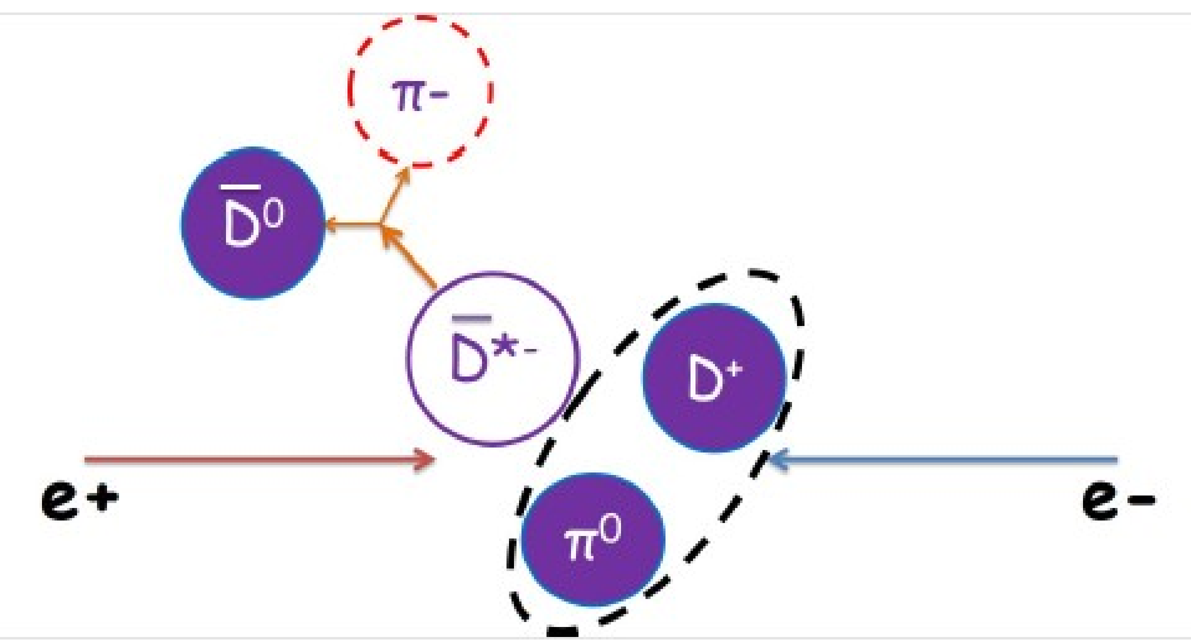
BESIII Search in $e^+e^- \to \pi^0 (D\bar{D}^*)^0$

Compared to the analysis of the charged $Z_c(3885)^+$, backgrounds are high due to π^0 detection.

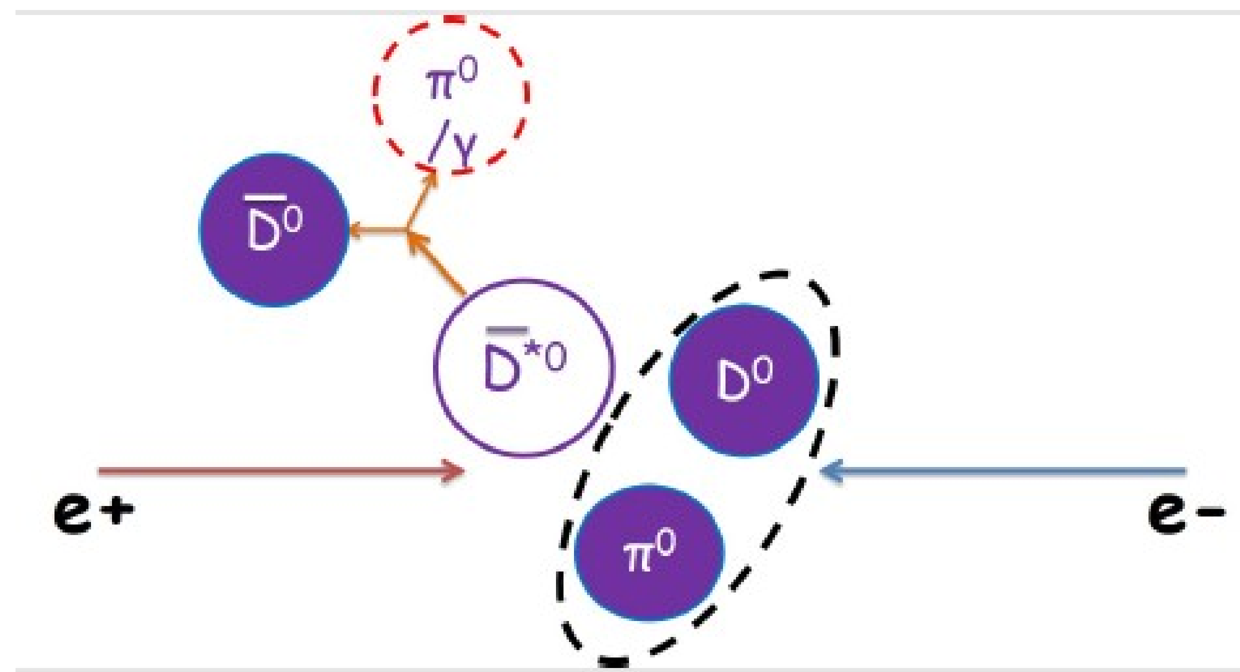
We shall reconstruct the two *D* in the final states:

➔ Lower signal efficiency: one thirds of the charged mode

- Combine the two isospin channels



+



$e^+e^- \to D^+D^{*-}\pi^0 \to D^+\bar{D}^0\pi^-\pi^0$

$e^+e^- \to D^0\bar{D}^{*0}\pi^0 \to D^0\bar{D}^0\pi^0\pi^0$

$D^+ \to K^-\pi^+\pi^+$, $K^-\pi^+\pi^+\pi^0$, $K_S\pi^+$, $K_S\pi^+\pi^0$, $K_S\pi^+\pi^+\pi^-$

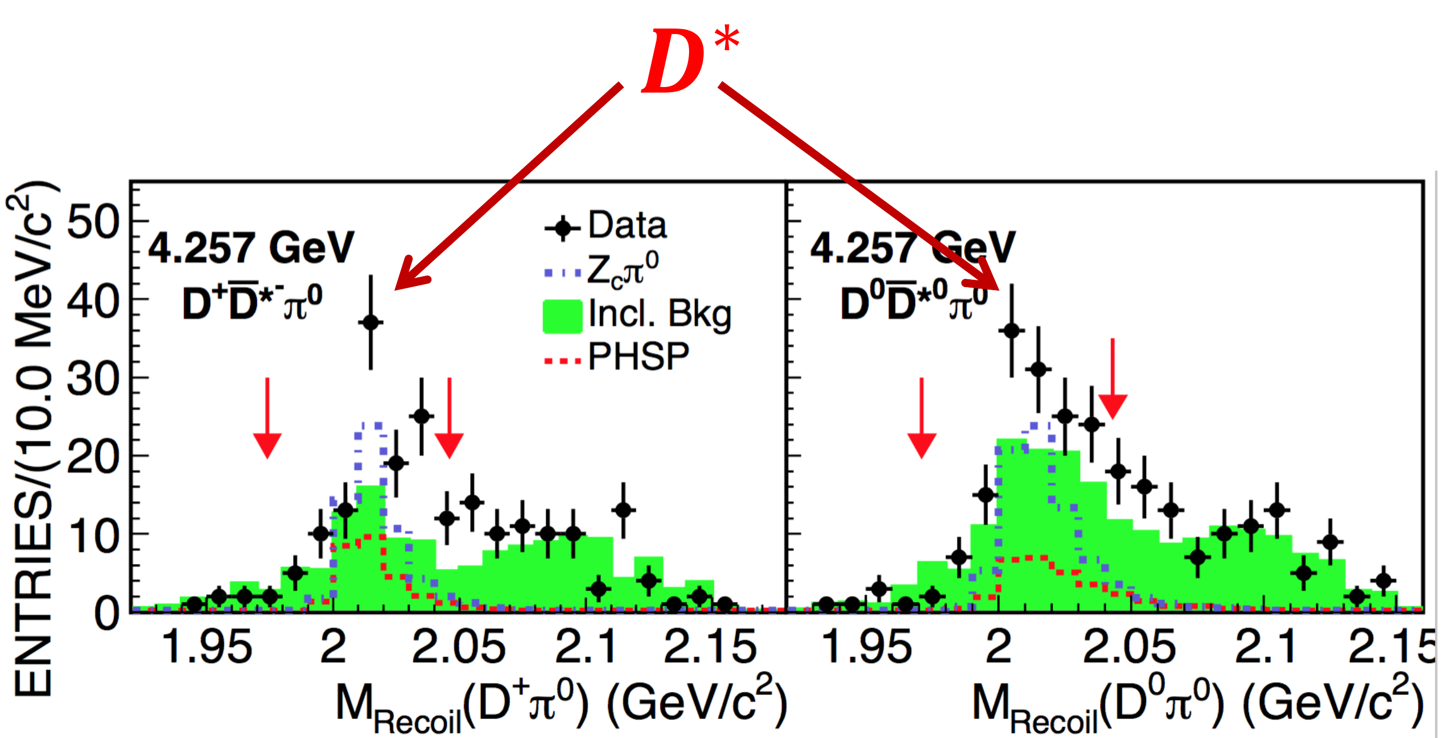
$D^0 \to K^-\pi^+$, $K^-\pi^+\pi^0$, $K^-\pi^-\pi^+\pi^+$

In total, 39 channels are analyzed!

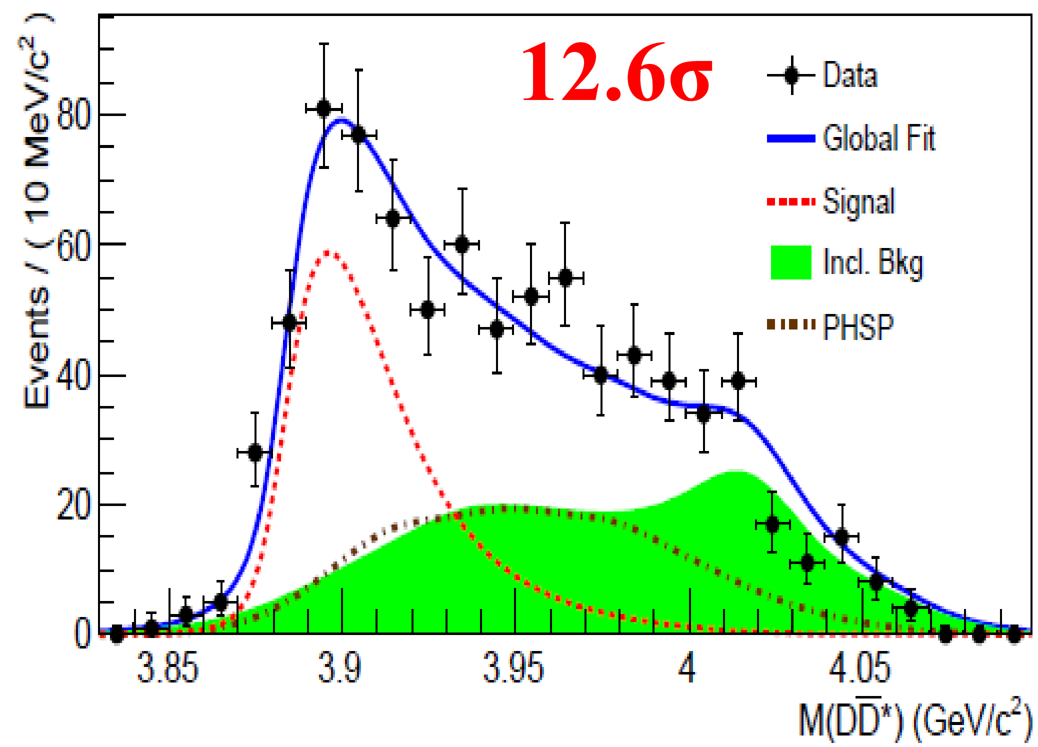
Observation of the $Z_c(3885)^0$ in $e^+e^- \to \pi^0(D\bar{D}^*)^0$

arXiv:1509.05620 accepted by PRL

- $\pi^0(D\bar{D}^*)^0$ signals are evident
- MC simulated backgrounds agree with data well



summed over data at two energy points 1.9/fb @ (4.23&4.26 GeV)



$m_{pole} = (3885.7^{+4.3}_{-5.7} \pm 8.4)$ MeV/c^2

$\Gamma_{pole} = (35^{+11}_{-12} \pm 15)$ MeV

An isospin triplet is established

$Z_c(3885)^{\pm/0}$

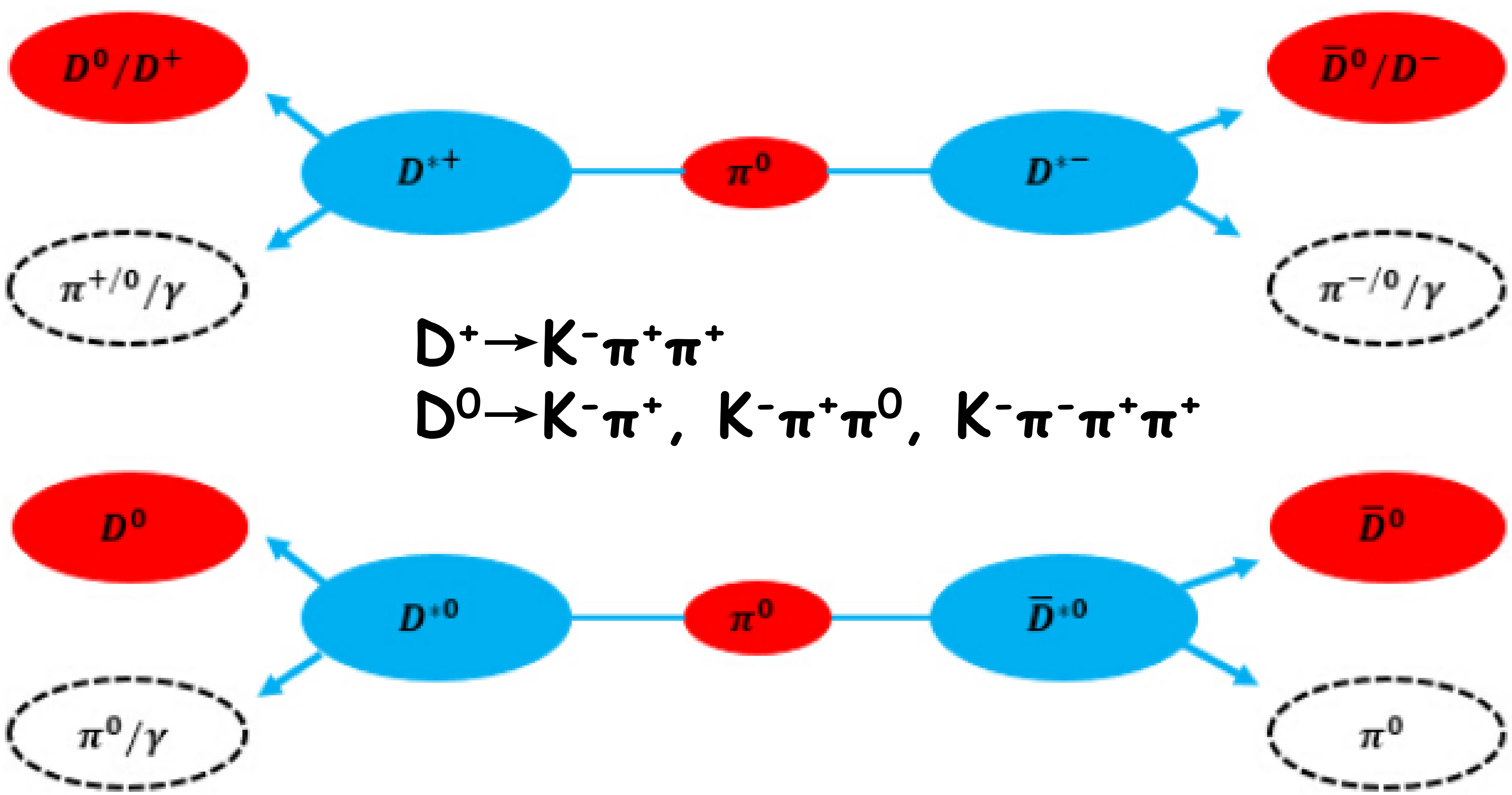
Search in $e^+e^- \to \pi^0(D^*\bar{D}^*)^0$

This process is more challenging: huger backgrounds and lower yields

We decide to:

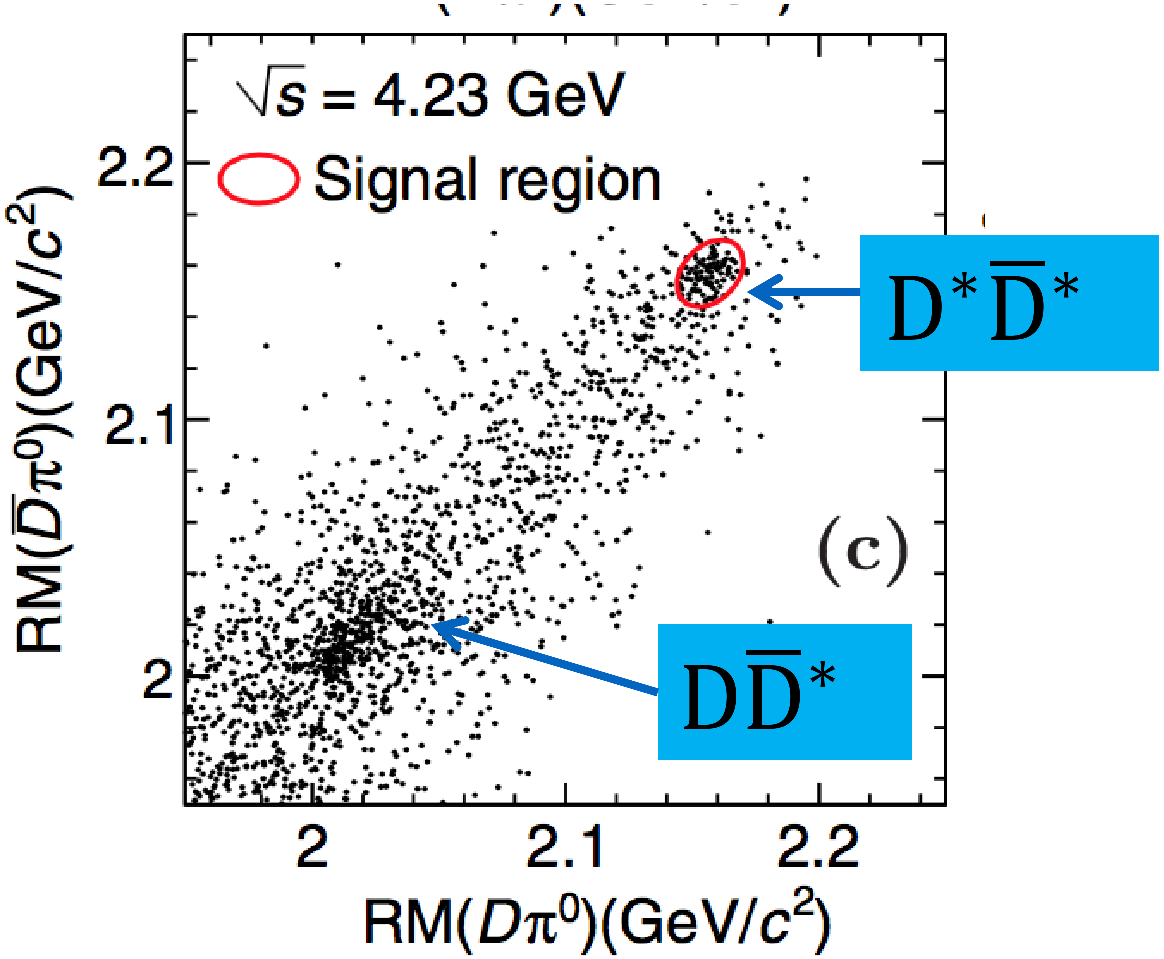
- detect the two D in final states
  ➔ Low signal efficiency
- choose the clean mode $D^+ \to K^-\pi^+\pi^+$
- combine the two isospin channels

In total, 16 decay channels are analyzed!



Observation of the $Z_c(4025)^0$ in $e^+e^- \to \pi^0(D^*\bar{D}^*)^0$

PRL115, 182002 (2015)

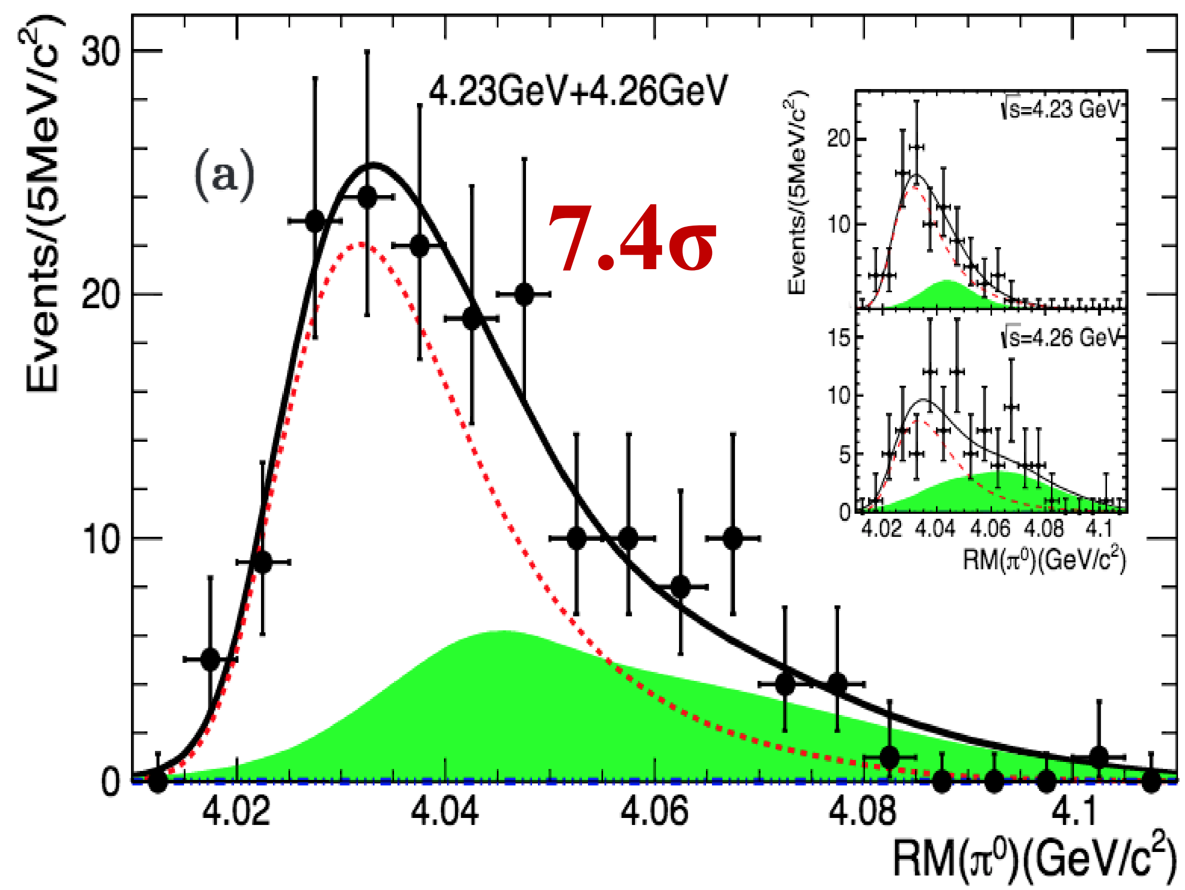


- The upper–left accumulation lies around $m(D^*)+m(\pi)$, because of missing a soft π from D* decays

$$\pi^0 D^* D^* \to D, \quad D^* \to \pi_{soft}$$

- $\pi^0(D^*\bar{D}^*)^0$ signals are evident

MC simulated backgrounds validated



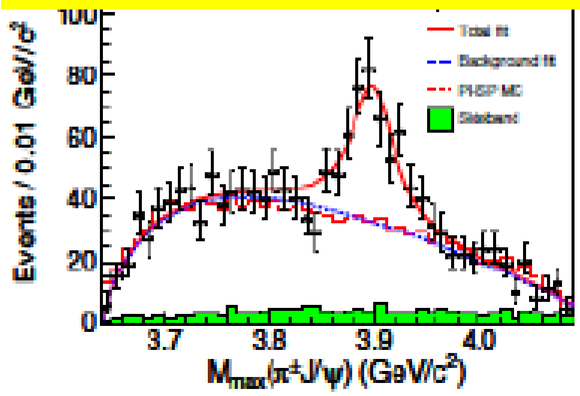
$m_{pole} = (4025.5^{+2.0}_{-4.7} \pm 3.1)$ MeV/c²
$\Gamma_{pole} = (23.0 \pm 6.0 \pm 1.0)$ MeV

Another isospin triplet is established: $Z_c(4025)^{\pm/0}$

The Zc Family at BESIII

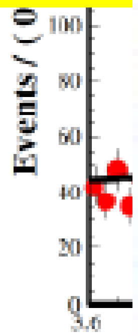
Zc(3900)$^+$?

PRL 110, 252001 (2013)

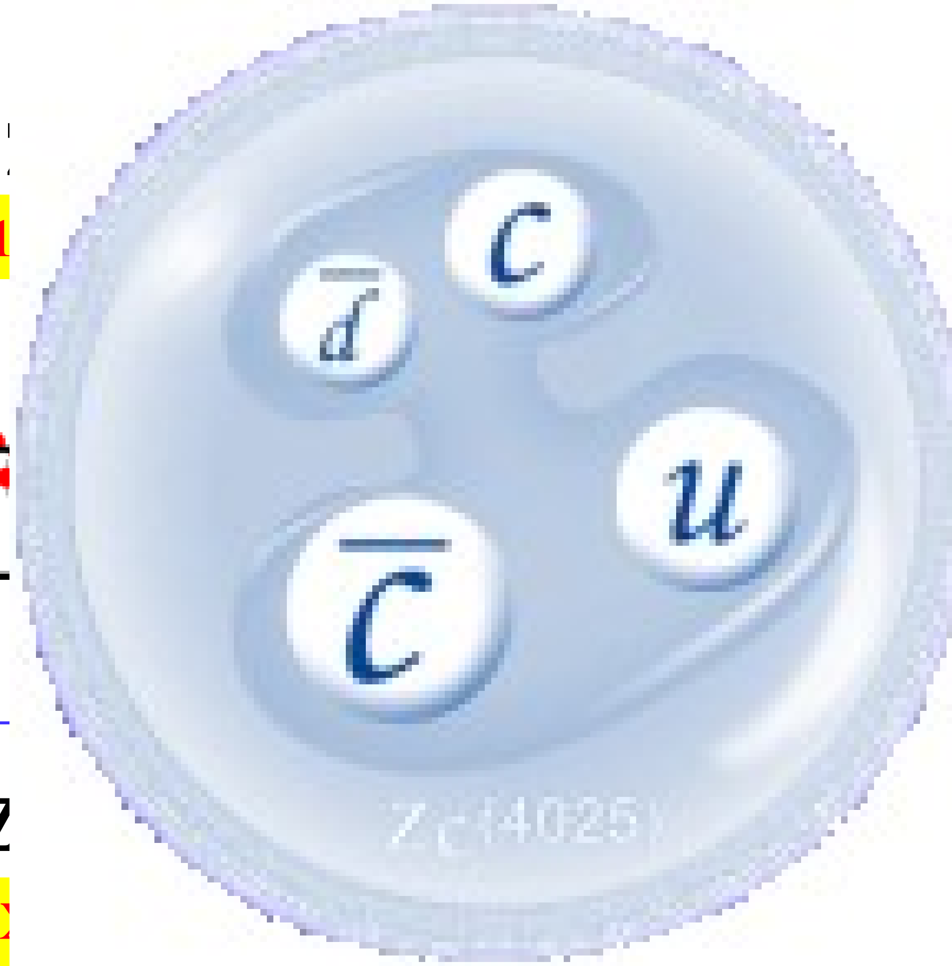


$e^+e^- \to \pi^-\pi^+J/\psi$

PRL 11



e^+e^-



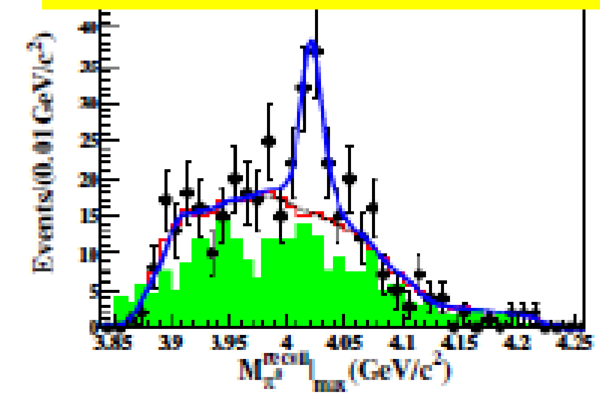
+?

013)

h_c

Zc(4020)^0?

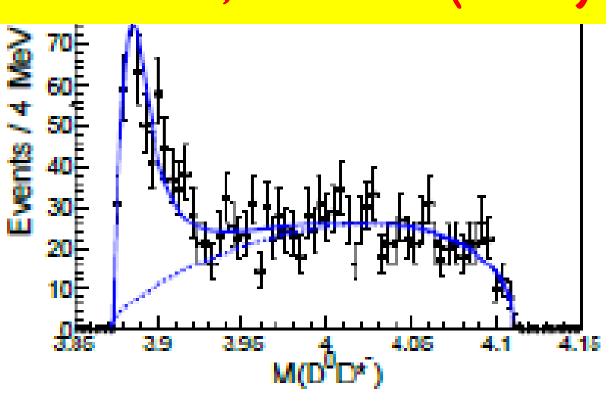
PRL113,212002 (2014)



$e^+e^- \to \pi^0\pi^0 h_c$

Zc(3885)$^+$?

ST: PRL 112, 022001(2014)
DT: PRD92, 092006 (2015)

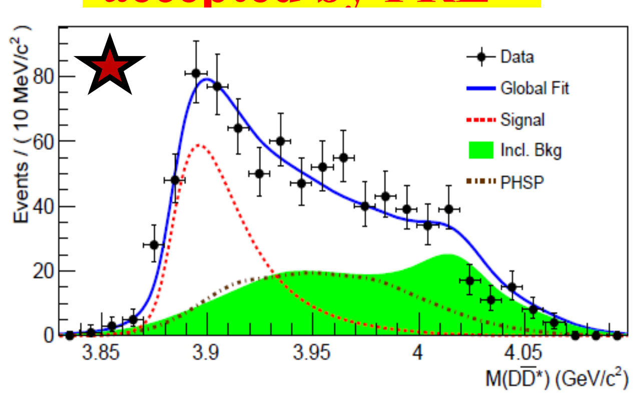


$e^+e^- \to \pi^-(D\bar{D}^*)^+$

Z

ar

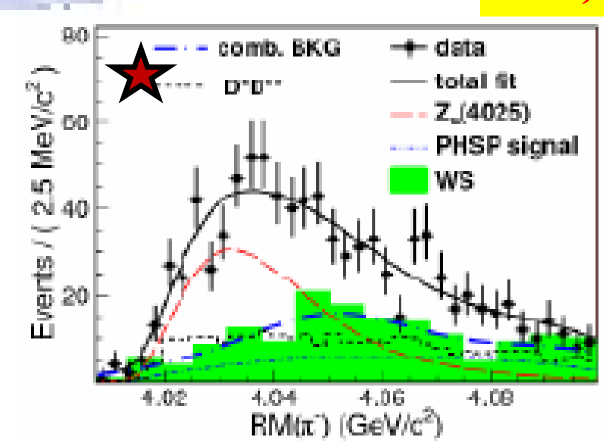
accepted by PRL



$e^+e^- \to \pi^0(D^*\bar{D})^0$

+?

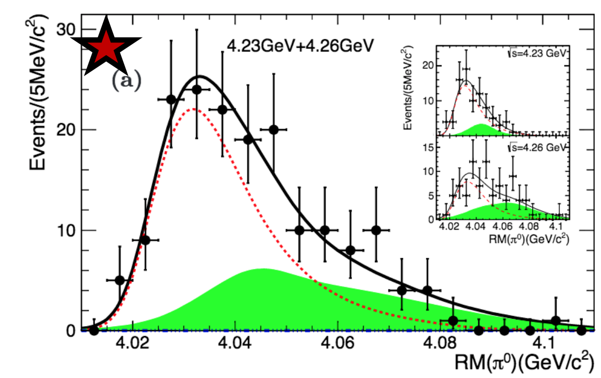
2014)



$e^+e^- \to \pi^-(D^*\bar{D}^*)^+$

Zc(4025)^0?

PRL115, 182002 (2015)



$e^+e^- \to \pi^0(D^*\bar{D}^*)^0$

Which is the nature of these states?

Different decay channels of the same observed states? Other decay modes?

Future experimental efforts to understand these new findings?

at BESIII

- Search for more decay modes : $\pi\psi'$, $D^{(*)}D^{**}$, light hadrons ...
- PWA of the found charged Zc states: signal statistics is desired.
- Coupled channel analysis if we want to identify whether they are the same state
  - e.g., **Zc → $\pi J/\psi$, DD***; **Z'c → πh_c, D*D***

at other experiments

- It will provide very valuable knowledge if we do searches in *B* decays

Charmed meson decays at threshold

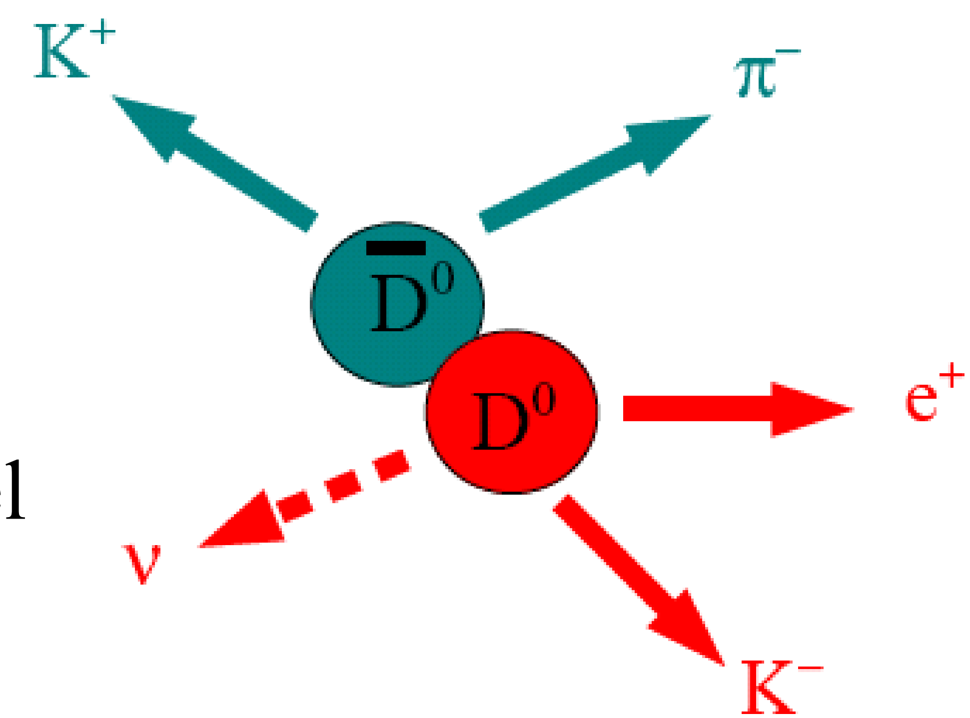
D^0-$\underline{D}^0$ mixing parameter y_{CP}, Ds hadronic decays

Charmed Hadron at Threshold

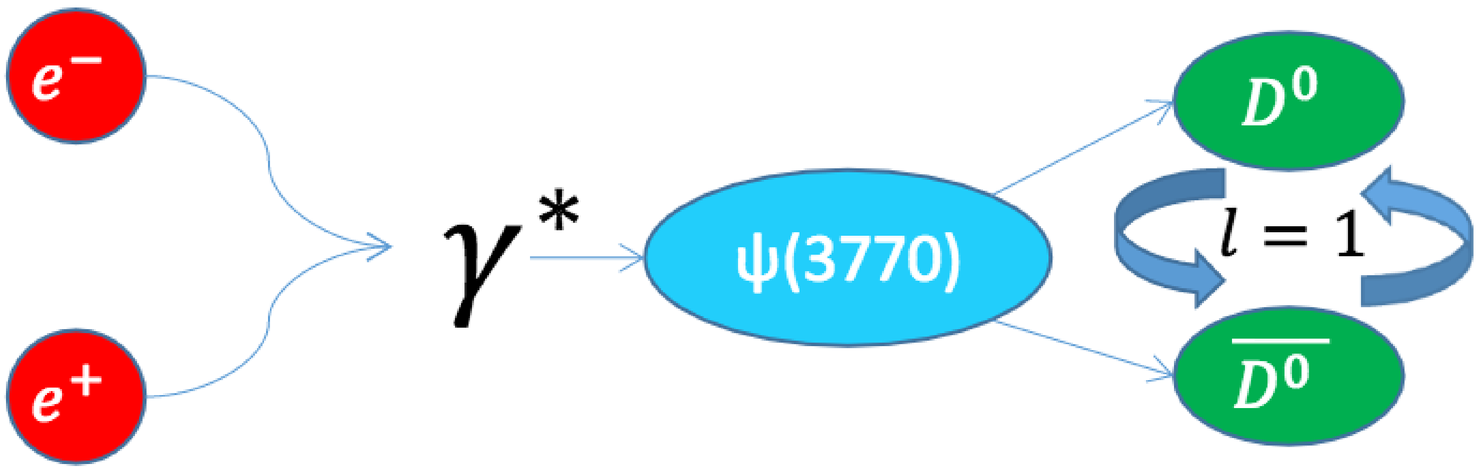
- **Threshold production at 3.773, 4.01, 4.17 GeV, 4.6GeV**

$$e^+e^- \to D\overline{D}, D_sD_s, D_sD_s^*, \Lambda_c^+\Lambda_c^-$$

- **Double Tag (DT) techniques: (partial-)reconstruct both D/Λ_c mesons**
- **Charm events at threshold**
  - Only the hadron pairs, no extra CM energy for pions: clean backgrounds
  - Ratio of signal to background is optimum
  - Lots of systematic uncertainties cancel while applying double tag method



BESIII Quantum Correlation near Threshold



If D^0 in CP eigenstate, $\overline{D^0}$ must be in opposite CP eigenstate

Quantum Correlations (QC) and CP-tagging are unique

Taking advantage the QC of $D\overline{D}$ pairs, we can study the D mixing and CPV in a unique way

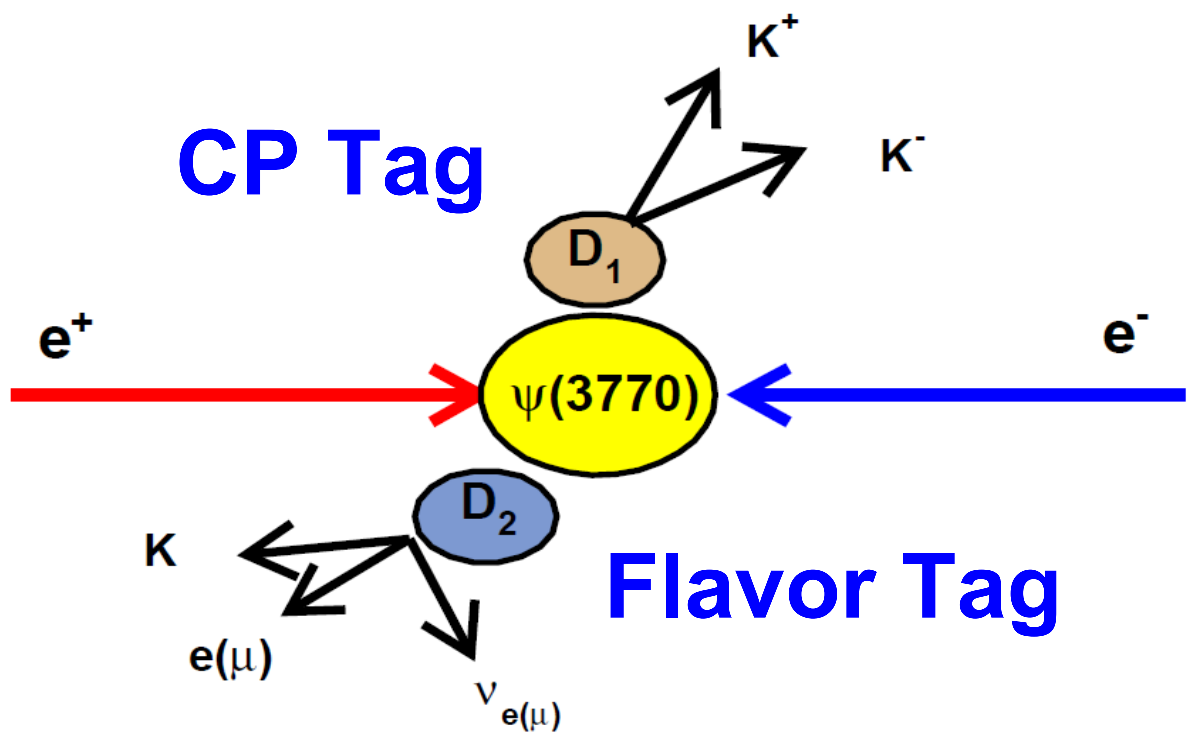
- *strong phase in D decays : Kπ strong phase* [PLB734, 227 (2014)]
- *D^0-$\overline{D^0}$ mixing parameters: y_{CP} measurement*
- *…*

y_{CP} measurement

PLB744, 339 (2015)
(BESIII: 2.93 fb^{-1})

y_{CP} reflects the life-time difference between D in CP-eigenstate and *D* in flavor-eigenstate

We measure the y_{CP} using CP-tagged semi-leptonic D decays, which allows to access CP asymmetry in mixing and decays.



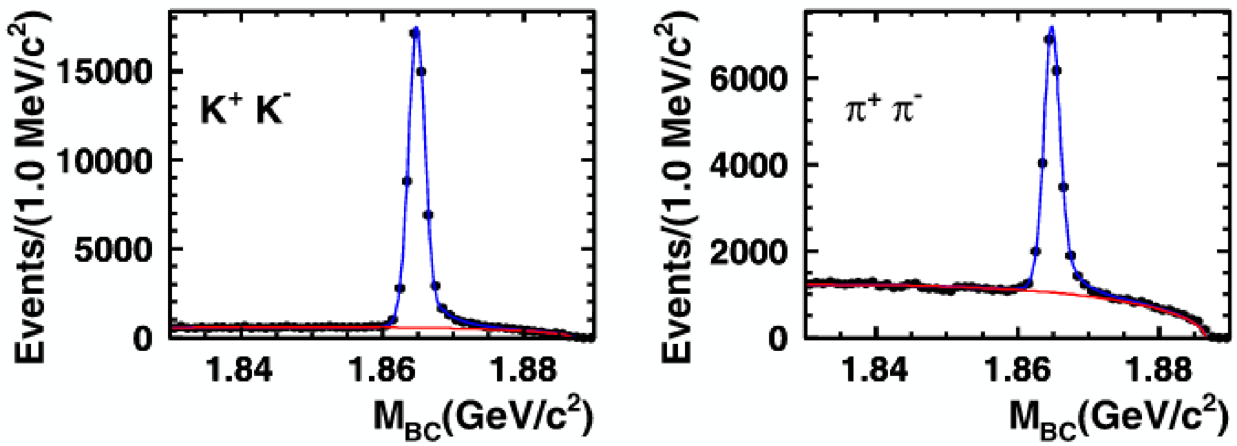
- **Single Tag decay rate (CP tags)**
  - $\Gamma_{CP\pm} \propto 2|A_{CP\pm}|^2(1 \mp y)$
- **Double Tag decay rate (Flavor tags + CP tags)**
  - $\Gamma_{l;CP\pm} \propto |A_l|^2 |A_{CP\pm}|^2$
- **Neglect term y^2 or higher order**
  - $y_{CP} \approx \frac{1}{4}\left(\frac{\Gamma_{l;CP+}\Gamma_{CP-}}{\Gamma_{l;CP-}\Gamma_{CP+}} - \frac{\Gamma_{l;CP-}\Gamma_{CP+}}{\Gamma_{l;CP+}\Gamma_{CP-}}\right)$

- **Reconstructed modes:**
  - Flavor tags: $Ke\nu_e$, $K\mu\nu_\mu$
  - CP+ tags (3 modes): K^-K^+, $\pi^+\pi^-$, $K^0_S\pi^0\pi^0$,
  - CP- tags (3 modes): $K^0_S\pi^0$, $K^0_S\eta$, $K^0_S\omega$

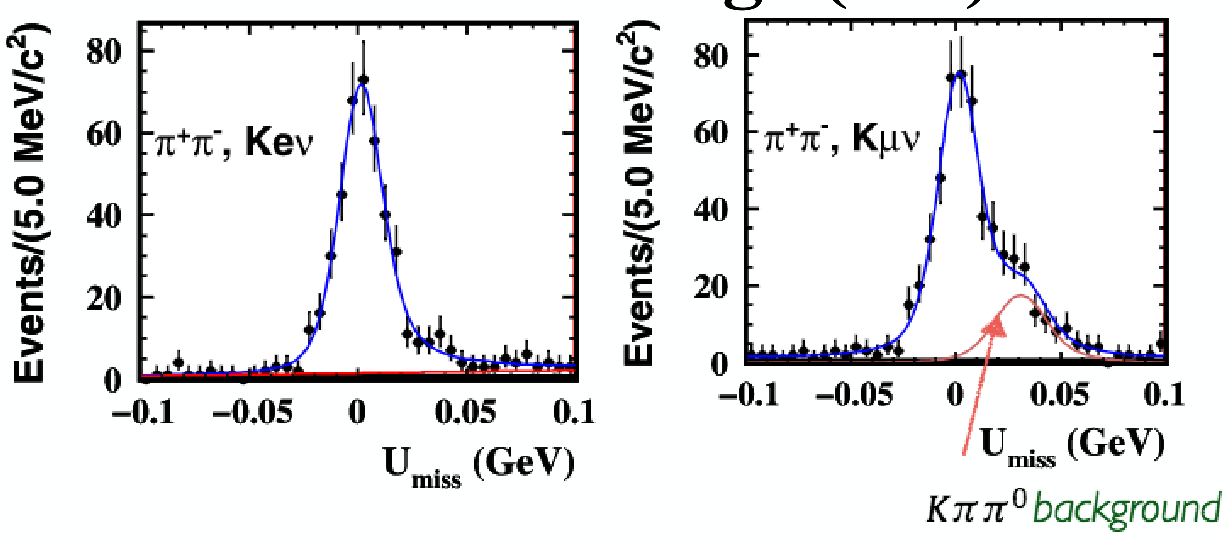
y_{CP} measurement

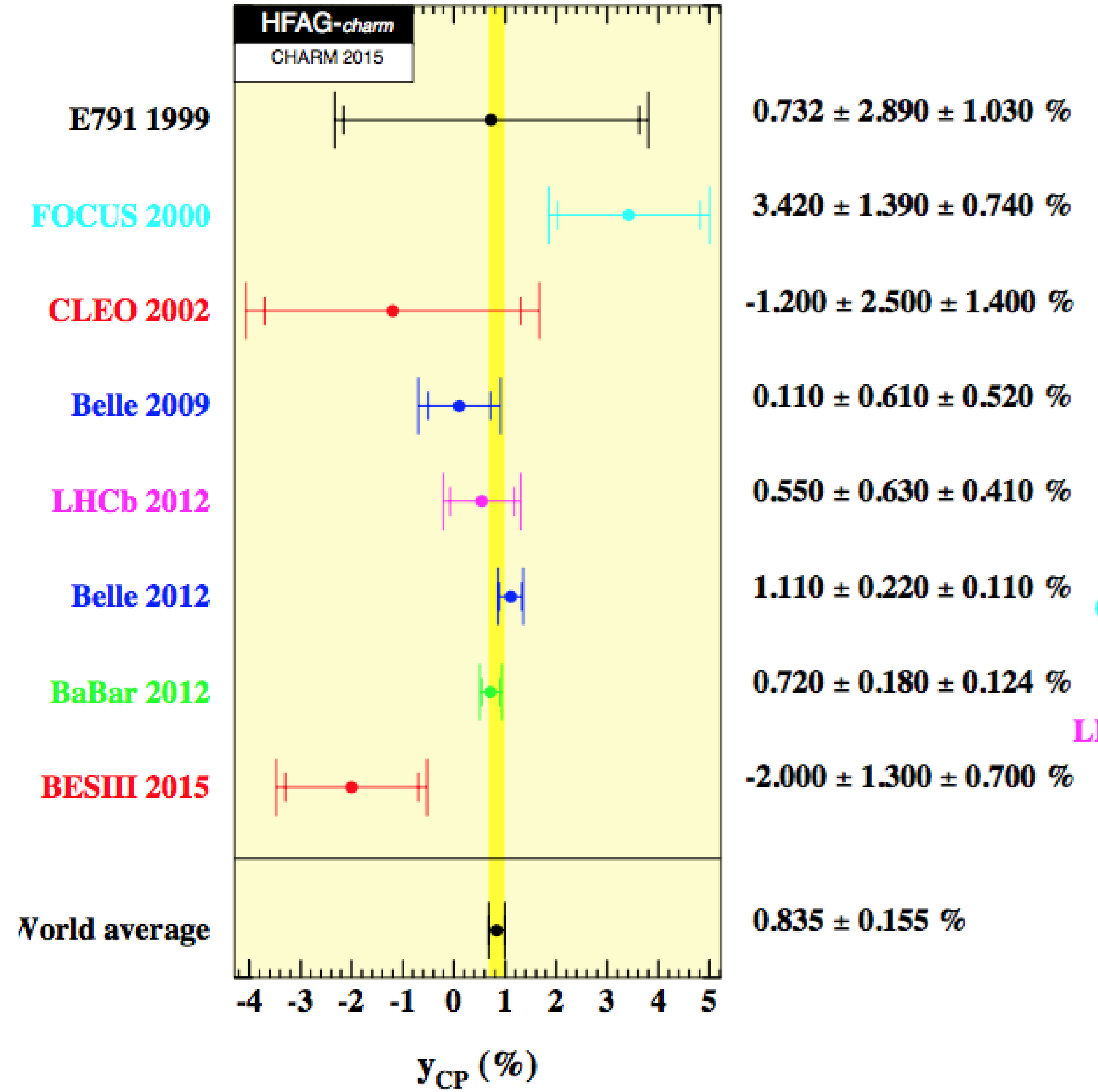
PLB 744, 339 (2015)

Single Tags (ST)



Double Tags (DT)





BESIII result:

$$y_{CP} = (-2.0 \pm 1.3 \pm 0.7)\%$$

- **Most precise measurement with QC charm mesons**
- **In the limit of no CP violation: $y_{CP} = y$**

$D_s^+ \to \eta' X$ and $D_s^+ \to \eta' \rho^+$

To provide more experimental data in Ds hadronic decays.

PLB750, 466 (2015)

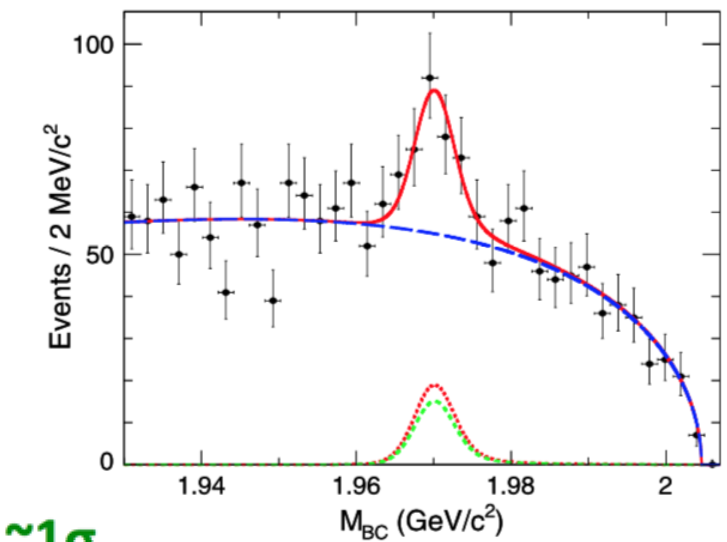
482/pb@4009MeV

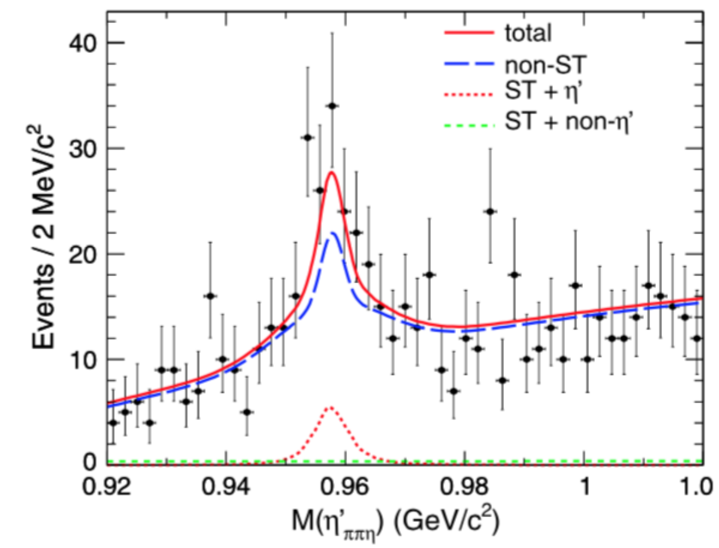
DT method for $\mathcal{B}(D_s^+ \to \eta' X)$

- 9 ST modes
- Fit to a 2D: $M(\pi\pi\eta)$ vs M_{BC}(ST)

BF($D_s^+ \to \eta' X$) = (8.8±1.8±0.5)%,

consistent with PDG = (11.7±1.7±0.7)% within ~1σ.

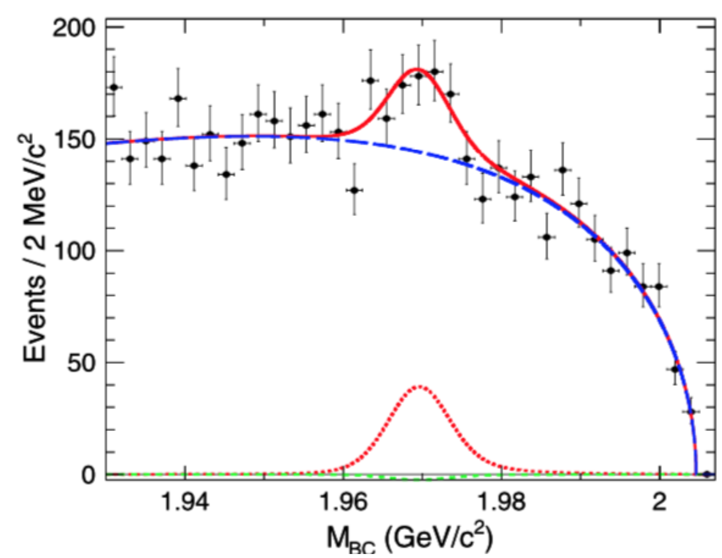


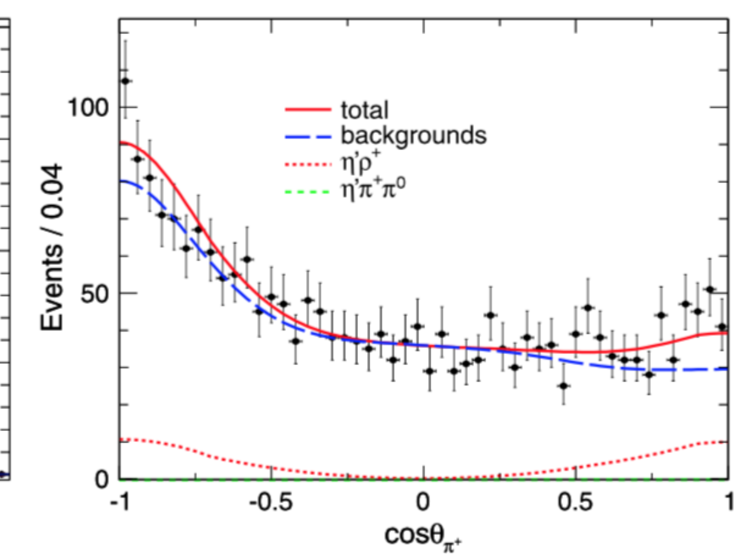


ST method for $\mathcal{B}(D_s^+ \to \eta' \rho^+)$

- Relative to $\mathcal{B}(K^-K^+\pi^+)$
- 2D fit : M_{BC}(ST) vs helicity angle (ρ^+ decays)

BF($D_s^+ \to \eta' \rho^+$) = (5.8±1.4±0.4)%





First Ds publication at BESIII!

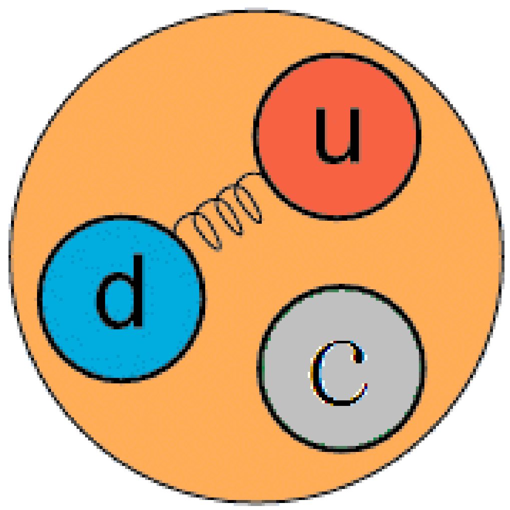
IHEP, SDU, UCAS

Charmed baryon Λ_c decays at threshold

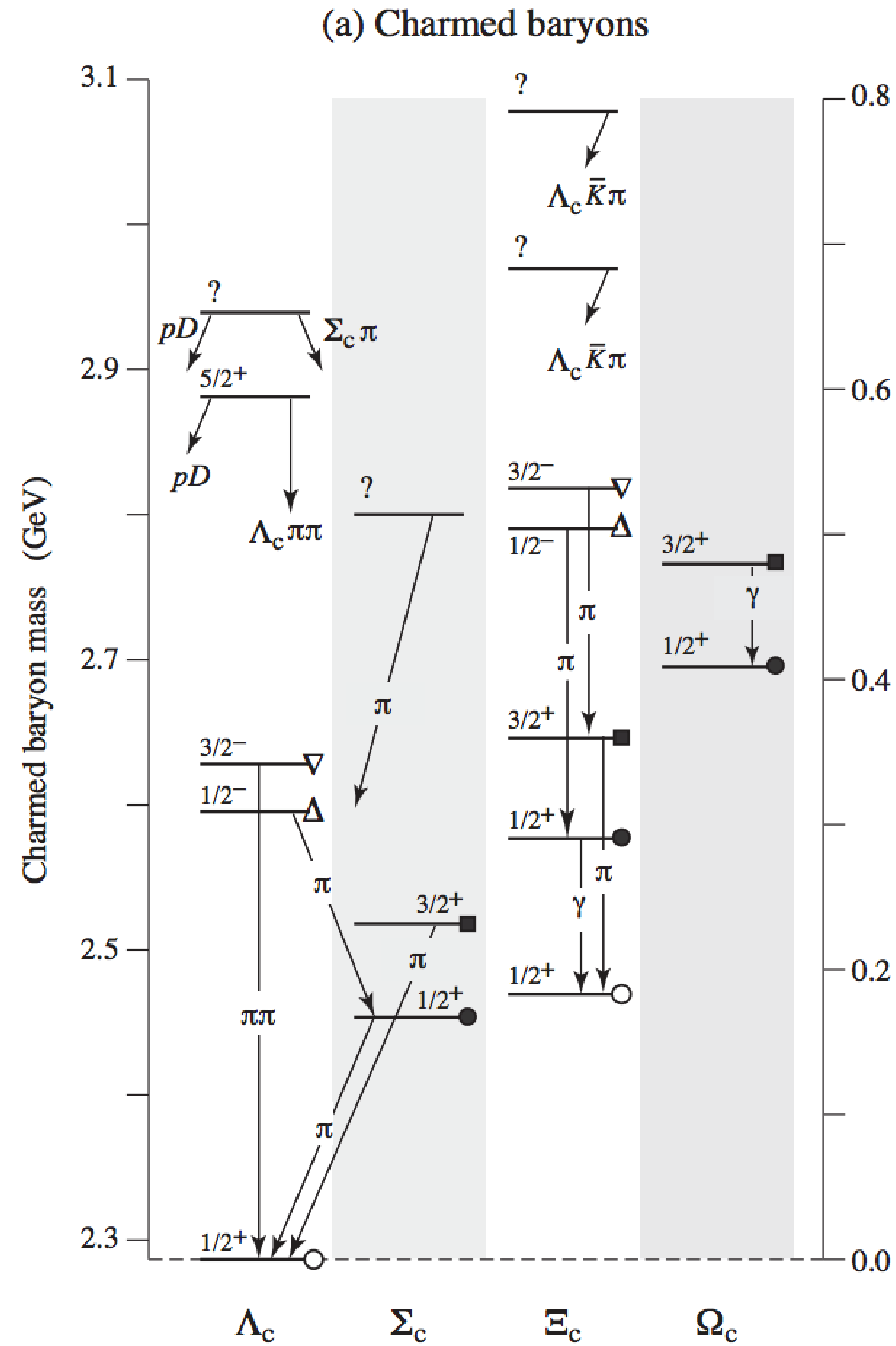
Λ_c hadronic and semi-leptonic decays

Λ_c^+ : cornerstone of charmed baryon spectroscopy

Quark model picture:
a heavy quark (c) with a unexcited spin-zero diquark (u-d)



Heavy Quark Effective Theory:
more reliable prediction of heavy-light quark transition without dealing with light degrees of freedom that have net spin or isospin.



Λ_c^+ provides more powerful test than D/Ds does !
But experimental data is very insufficient.

BESIII data taken

In 2014, BESIII took data above Λ_c pair threshold and run machine at 4.6GeV with excellent performance!
This is a **marvelous achievement of BEPCII**

available data set at BESIII

Energy(GeV)	lum.(1/pb)
4.575	~48
4.580	~8.5
4.590	~8.1
4.600	~567

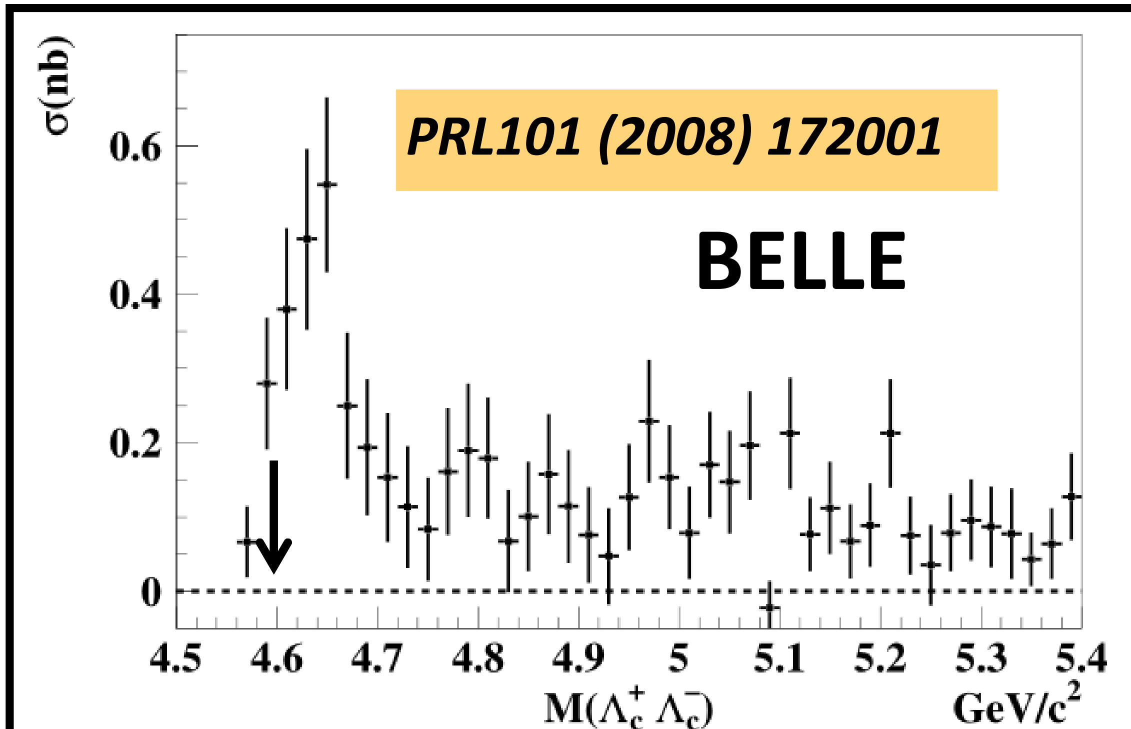


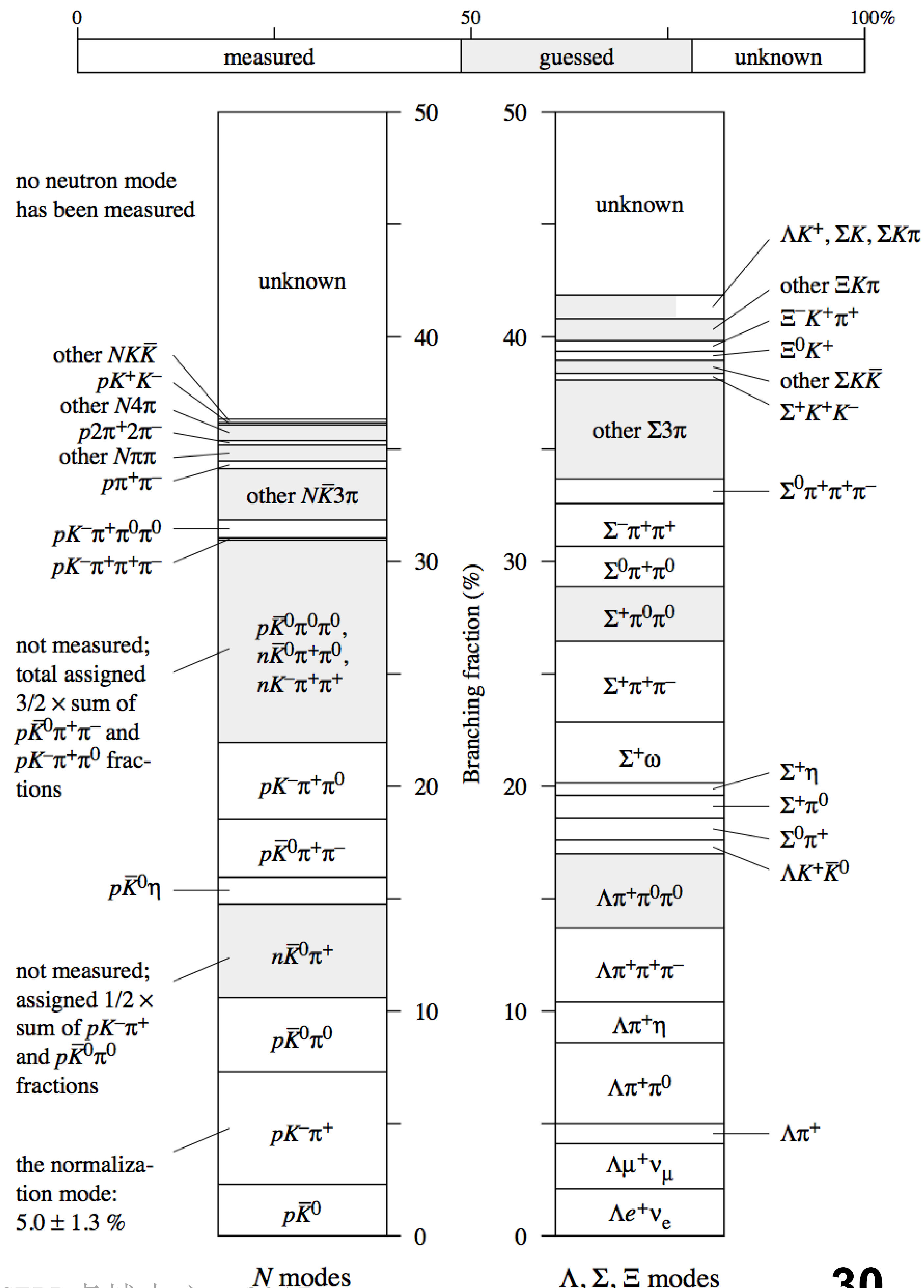
FIG. 4: The cross section for the exclusive process $e^+e^- \to \Lambda_c^+\Lambda_c^-$.

First time to systematically study charmed baryon at threshold!

Λ_c^+ decay rates

- Absolute branching fractions (BF) has large uncertainties
- semi-leptonic decay modes have not been fully explored; The only measured $B(\Lambda_c \to \Lambda l^+ \nu_l)$ has large uncertainties of $\delta B/B$~16%
- no neutron modes have been measured

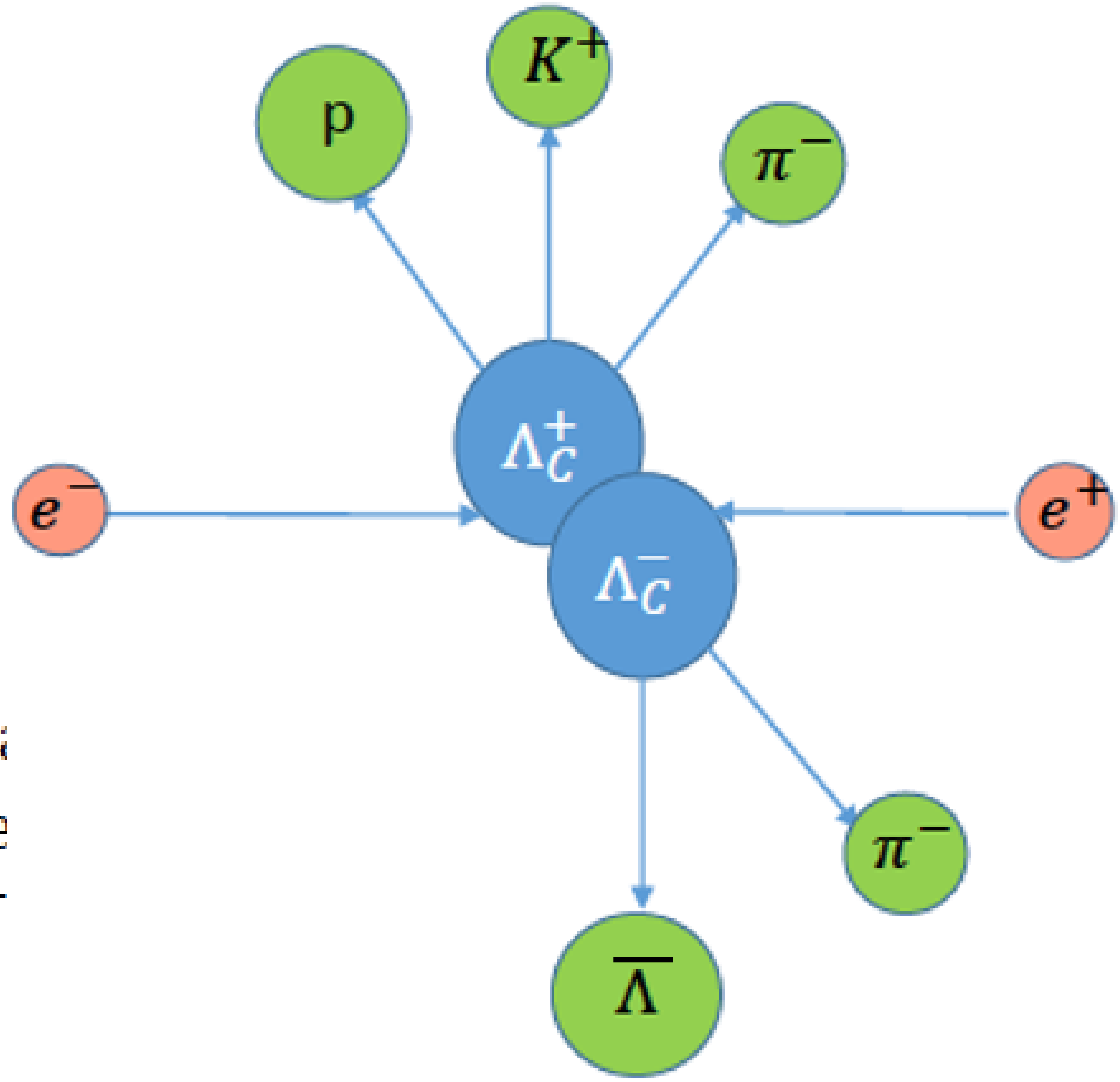
Thorough exploration of different decay modes and their precise measurements are important to test theoretical models!



Absolute BFs of Λ_c^+ hadronic decays

- Absolute branching fractions (BF) of Λ_c^+ decays are still not well determined since its discovery 30 years ago
  - BFs of all the decay modes (~85%) are measured relative to $\Lambda_c^+ \to pK^-\pi^+$
  - Charm counting ➔ test SM
  - However, no completely model-independent measurements of the absolute BF of $\Lambda_c^+ \to pK^-\pi^+$ (from Argus and CLEO very old results)
    uncertainties of BFs of Λ_c^+ decays are 25%~40% in PDG2014
- Until Belle's first "model-independent" measurement:
  $B(\Lambda_c^+ \to pK^-\pi^+) = (6.84 \pm 0.24^{+0.21}_{-0.27})\%$ [PRL113(2014)042002]
  precision reaches to 4.7%
- However, measurement using the threshold pair-productions via e^+e^- annihilations is unique:
  the most simple and straightforward

Detection of Λ_c pairs



12 modes

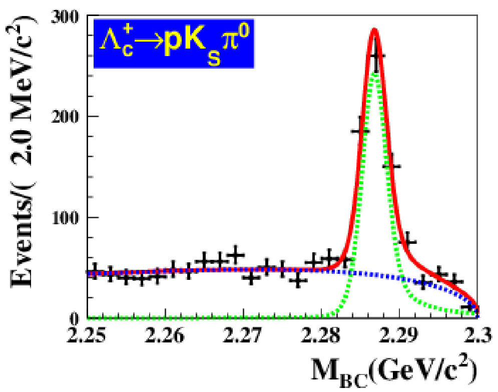
pK_S
$pK^-\pi^+$
$pK_S\pi^0$
$pK_S\pi^+\pi^-$
$pK^-\pi^+\pi^0$
$\Lambda\pi^+$
$\Lambda\pi^+\pi^0$
$\Lambda\pi^+\pi^-\pi^+$
$\Sigma^0\pi^+$
$\Sigma^+\pi^0$
$\Sigma^+\pi^+\pi^-$
$\Sigma^+\omega$

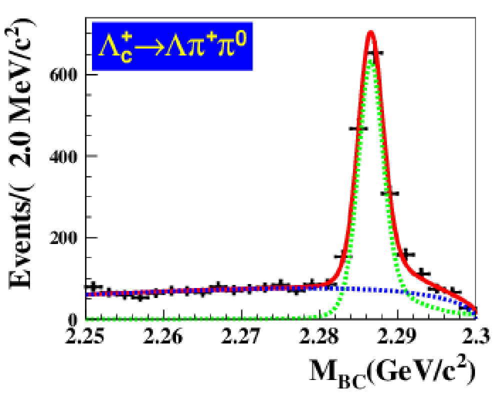
Constructing pa
from final state

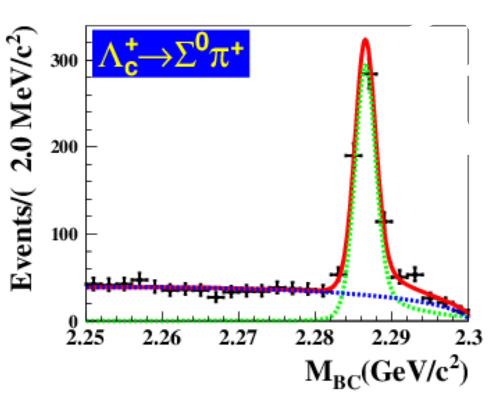
- $K_S \to \pi^+\pi^-$
- $\pi^0 \to \gamma\gamma$
- $\Lambda \to p\pi^-$
- $\Sigma^0 \to \Lambda\gamma$
- $\Sigma^+ \to p\pi^0$
- $\omega \to \pi^+\pi^-\pi^0$

$\Lambda_c^{\pm}$ ST and DT yields in data

567/pb @ 4.6 GeV

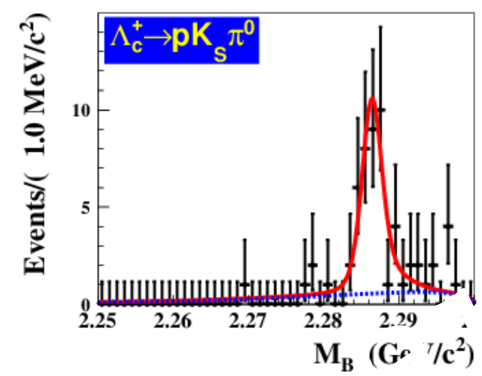


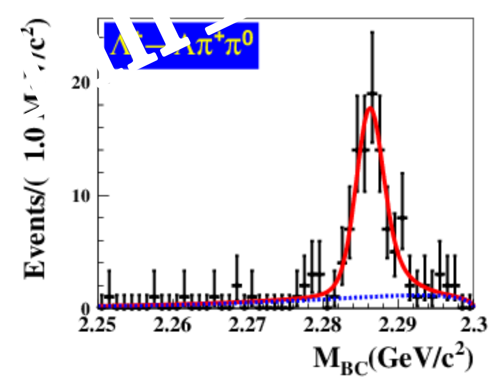


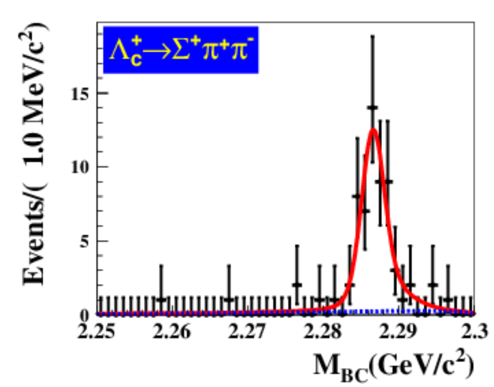


Single tags

modes	N_i^{ST}
pK_S	1243 ± 37
$pK^-\pi^+$	6308 ± 88
$pK_S\pi^0$	558 ± 33
$pK_S\pi^+\pi^-$	454 ± 28
$pK^-\pi^+\pi^0$	1849 ± 71
$\Lambda\pi^+$	706 ± 27
$\Lambda\pi^+\pi^0$	1497 ± 52
$\Lambda\pi^+\pi^-\pi^+$	609 ± 3[illegible]
$\Sigma^0\pi^+$	[illegible]36 ± 32
$\Sigma^+\pi^0$	271 ± 25
$\Sigma^+\pi^+\pi^-$	836 ± 43
$\Sigma^+\omega$	157 ± 22







Double tags

Decay modes	N_{-j}^{DT}
pK_S	89 ± 10
$pK^-\pi^+$	390 ± 21
$pK_S\pi^0$	40 ± 7
$pK_S\pi^+\pi^-$	29 ± 6
$pK^-\pi^+\pi^0$	148 ± 14
$\Lambda\pi^+$	59 ± 8
$\Lambda\pi^+\pi^0$	89 ± 11
$\Lambda\pi^+\pi^-\pi^+$	53 ± 7
$\Sigma^0\pi^+$	39 ± 6
$\Sigma^+\pi^0$	20 ± 5
$\Sigma^+\pi^+\pi^-$	56 ± 8
$\Sigma^+\omega$	13 ± 3

Very clean backgrounds

Hadronic branching fraction results

- **12 hadronic decay modes are being measured at the same time based on a global least square fit** [Chin. Phys. C37(2013)106201]: simultaneous fit to the all tag modes while constraining the total Λ_c pair number, taking into account the correlations

BESIII prel.

to be submitted to PRL soon

Decay modes	global fit $\mathcal{B}$	PDG $\mathcal{B}$	Belle $\mathcal{B}$
pK_S	1.48 ± 0.08	1.15 ± 0.30	
$pK^-\pi^+$	5.77 ± 0.27	5.0 ± 1.3	$6.84 \pm 0.24^{+0.21}_{-0.27}$
$pK_S\pi^0$	1.77 ± 0.12	1.65 ± 0.50	
$pK_S\pi^+\pi^-$	1.43 ± 0.10	1.30 ± 0.35	
$pK^-\pi^+\pi^0$	4.25 ± 0.22	3.4 ± 1.0	
$\Lambda\pi^+$	1.20 ± 0.07	1.07 ± 0.28	
$\Lambda\pi^+\pi^0$	6.70 ± 0.35	3.6 ± 1.3	
$\Lambda\pi^+\pi^-\pi^+$	3.67 ± 0.23	2.6 ± 0.7	
$\Sigma^0\pi^+$	1.28 ± 0.08	1.05 ± 0.28	
$\Sigma^+\pi^0$	1.18 ± 0.11	1.00 ± 0.34	
$\Sigma^+\pi^+\pi^-$	3.58 ± 0.22	3.6 ± 1.0	
$\Sigma^+\omega$	1.47 ± 0.18	2.7 ± 1.0	

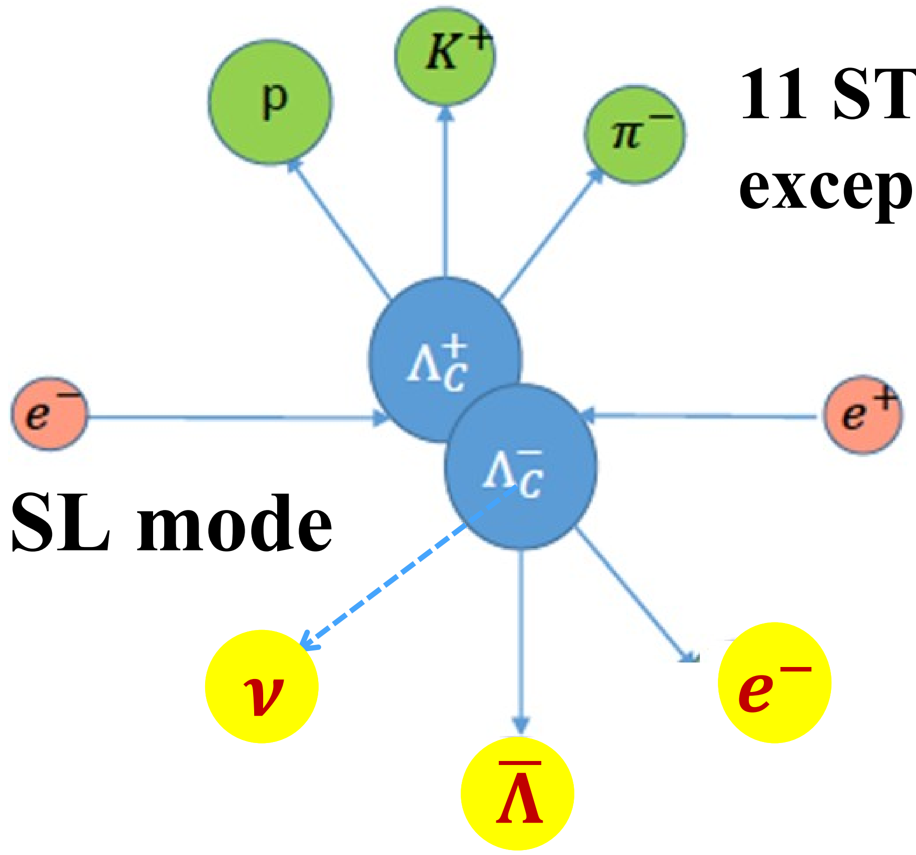
only stat. errors

- ✓ **$B(pK^-\pi^+)$: BESIII precision comparable with Belle's result**
- ✓ **BESIII rate $B(pK^-\pi^+)$ is smaller**
- ✓ **Improved precisions of the other 11 modes significantly**

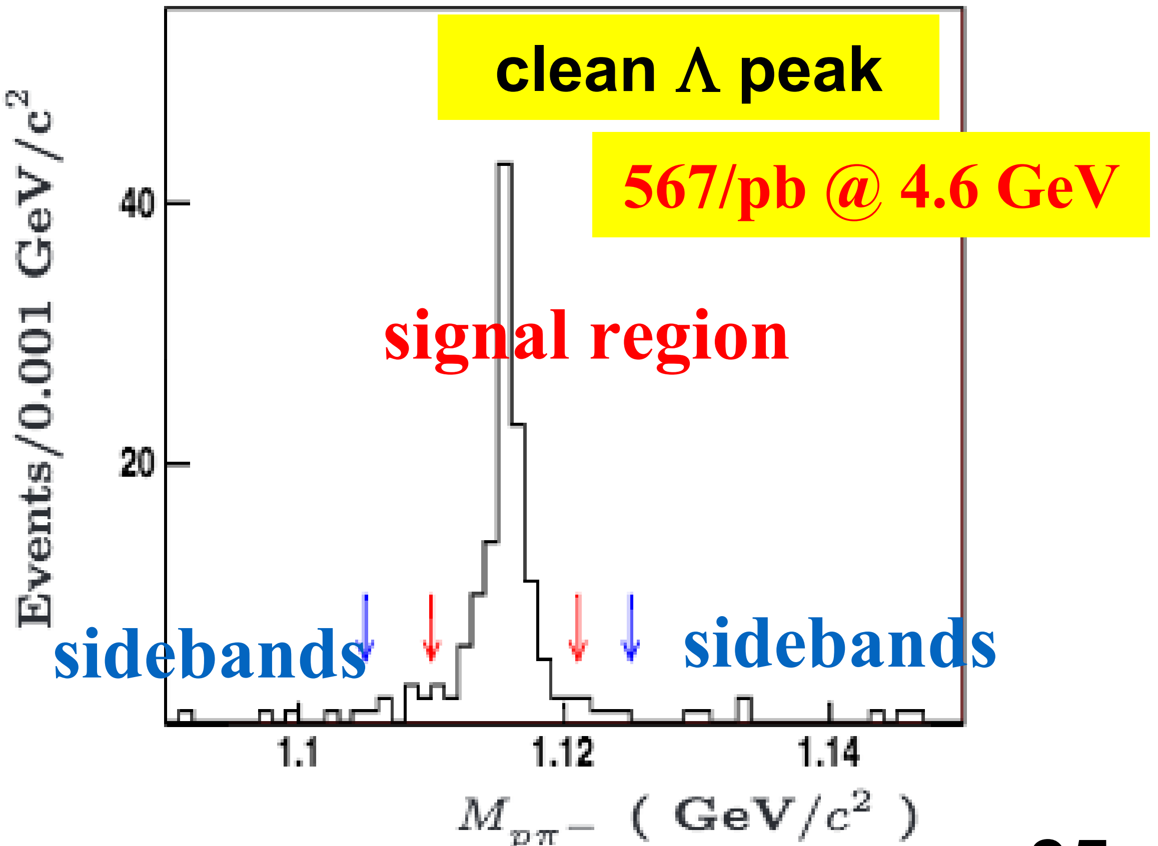
IHEP, SDU, UCAS

BF of $\Lambda_c^+ \to \Lambda e^+ \nu_e$

- $\Lambda_c^+ \to \Lambda e^+ \nu_e$ is a $c \to s l^+ \nu_l$ dominated process.
- Urgently needed for LQCD calculations.
- Thus, measuring $\mathcal{B}(\Lambda_c^+ \to \Lambda e^+ \nu_e)$ will provide very important experimental information for
  1) testing the theoretical predications for $\mathcal{B}(\Lambda_c^+ \to \Lambda e^+ \nu_e)$.
  2) calibrating the LQCD calculations.
  3) addition information for determining CKM elements.

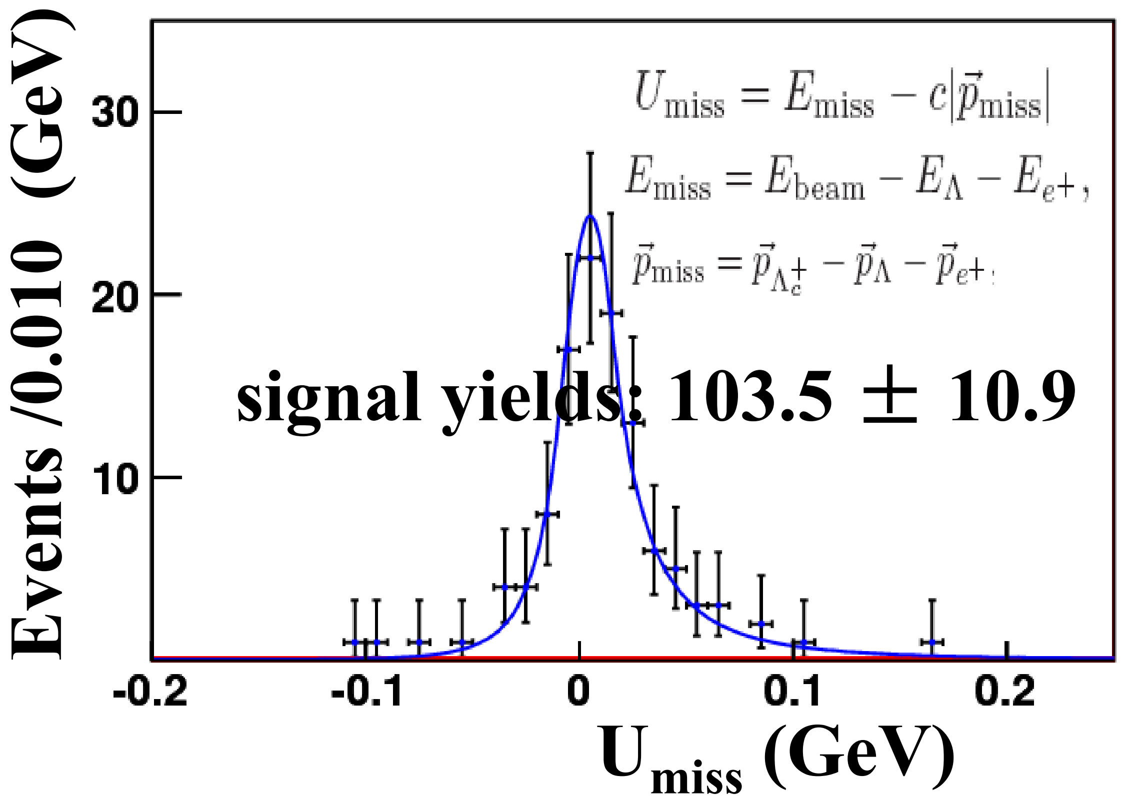


11 ST modes, except $\Sigma^+\omega$



Candidate Events for $\Lambda_c^+ \to \Lambda e^+ \nu_e$

arXiv: 1510.02610
accepted by PRL



- First absolute measurement!
- Best precision to date
- Reject several theoretical predictions.

First Λ_c^+ publication at BESIII!

	$\mathcal{B}(\Lambda_c^+ \to \Lambda e^+ \nu_e)$
MBM [5]	1.9%
NRQM [5]	2.6%
SU(4)-symmetry limit [6]	9.2%
RSQM [11]	4.4%
QCM [7]	5.62%
SQM [8]	1.96%
NRQM2 [9]	2.15%
NRQM3 [10]	1.42%
QCD SR1 [12]	$(3.0 \pm 0.9)\%$
QCD SR2 [13]	$(2.6 \pm 0.4)\%$
QCD SR3 [13]	$(5.8 \pm 1.5)\%$
STSR [14]	2.22% for $\Lambda_c^+ \to \Lambda l^+ \nu_l$
STNR [14]	1.58% for $\Lambda_c^+ \to \Lambda l^+ \nu_l$
HOSR [14]	4.72% for $\Lambda_c^+ \to \Lambda l^+ \nu_l$
HONR [14]	4.2% for $\Lambda_c^+ \to \Lambda l^+ \nu_l$
LCSRs [15]	$(3.0 \pm 0.3)\%$ for $\Lambda_c^+ \to \Lambda l^+ \nu_l$ (CZ-type)
PDG [2]	$(2.1 \pm 0.6)\%$
BESIII	$(3.63 \pm 0.38 \pm 0.20)\%$

(Reference No. in the BESIII paper)

BIPT, TSU, UCAS

Experimental precision reaches of charmed hadrons

	golden mode	δB/B	SL	δB/B
D0	B(Kπ)=(3.88±0.05)%	1.3%	B(Kev)=(3.55±0.05)%	1.4%
D+	B(Kππ)=(9.13±0.19)%	2.1%	B(K^0ev)=(8.83±0.22)%	2.5%
Ds	B(Kkπ)=(5.39±0.21)%	3.9%	B(Φev)=(2.49±0.14)%	5.6%
Λ_c	B(pKπ)=(5.0±1.3)%(PDG2014) =(6.8±0.36)% (BELLE) =(5.77±0.27±??)% (BESIII)	26% 5.3% 5~6%	B(Λev)=(2.1±0.6)%(PDG2014) =(3.63±0.43)% (BESIII)	29% 12%

- **BESIII Λ_c data correspond to 567/pb taken in 2014**
- **We have chance to improve the precisions of Λ_c decay rates to the levels of charmed mesons!**

More Λ_c data set ?

A combined data taking proposal of studying Λ_c^+

Proposal of precise study of the charmed baryon Λ_c^+ decays

Hai-Bo Li, Peirong Li, Lei Li, Xiao-Rui Lyu,
Haiping Peng, Yangheng Zheng

Analyticity Violation in $e^+e^- \to \Lambda_c \bar{\Lambda}_c$?
A request for
additional integrated luminosity at threshold

Rinaldo Baldini, Marco Maggiora, Guangshun Huang, RongGang Ping, Weimin Song, Weiping Wang, Liang Yan, Zhengguo Zhao, Xiaorong Zhou, Kai Zhu,
and the BESIII Italian Collaboration Team

BESIII collaboration meeting at SJTU 2015.6.14

We propose one year dedicated data taking at Λ_c threshold.

Summary

Collins Effects at BESIII:

- **First measurement at lower-Q^2 region** close to SIDIS experiments
  important to understand energy evolution in QCD

Tetraquark states studies: to understand QCD

- **Observation of the neutral Z_c states:**
  $Z_c(3885)^{\pm/0}$ and $Z_c(4025)^{\pm/0}$ at BESIII are established
- **More efforts** are needed from both theorists and experimenters

Precise study of charmed meson D/Ds decays

- **D^0-$\underline{D}^0$ at threshold:** QC and CP-tagging are unique
  a unique way to access D^0-$\underline{D}^0$ mixing parameter: y_{CP}
- **First Ds publication:** Ds hadronic decays involving η'

Precise study of Λ_c decays

- **For the first time, BES is able to study its decays at threshold**
  Absolute measurement!
- **BESIII released two world-best results:**
  hadronic branching fractions; $B(\Lambda_c^+ \rightarrow \Lambda e^+ \nu_e)$
- **We are proposing a one-year data taking;**
  a golden opportunity to thoroughly improve our knowledge on Λ_c decays

More exciting results at BESIII are expected.

BESIII

2014年度卓越中心考评

- 正在开展一系列相关的物理分析工作
  - 新强子态: (1) $Zc^0(3885) \rightarrow (DD^*)^0$; (2) $Zc^0(4025) \rightarrow (D^*D^*)^0$
  - D介子混合参数y_{CP}
  - Λc重子绝对分支比 → 即将发表
  - $D_{(s)}$介子衰变: $Ds \rightarrow \eta' X$ → memo审核
  - 极化依赖的Collins碎裂函数 → 撰写memo
  - $D_{(s)}$介子高激发态研究 (2 + 1)
- 预期未来一年有更丰富的成果

2015年度卓越中心考评

- $Zc(3885)^0 \rightarrow (DD^*)^0$ → accepted by PRL [arXiv:1509.05620]
- $Zc(4025)^0 \rightarrow (D^*D^*)^0$ → PRL115, 182002 (2015)
- D介子混合参数y_{CP} → PLB744, 339 (2015)
- Λc强子衰变分支比 → to be submitted to PRL soon
  $\Lambda c \rightarrow \Lambda e^+ \nu_e$分支比 → accepted by PRL [arXiv: 1510.02610]
- $Ds \rightarrow \eta' X$ → PLB750, 466 (2015)
- Collins碎裂函数 → submitted to PRL [arXiv:1507.06824]

2015年度工作，3篇PRL已发表或接受，2篇PLB，2篇在投PRL

Thank you!

谢谢！