Highlight of Charm Physics at BESIII

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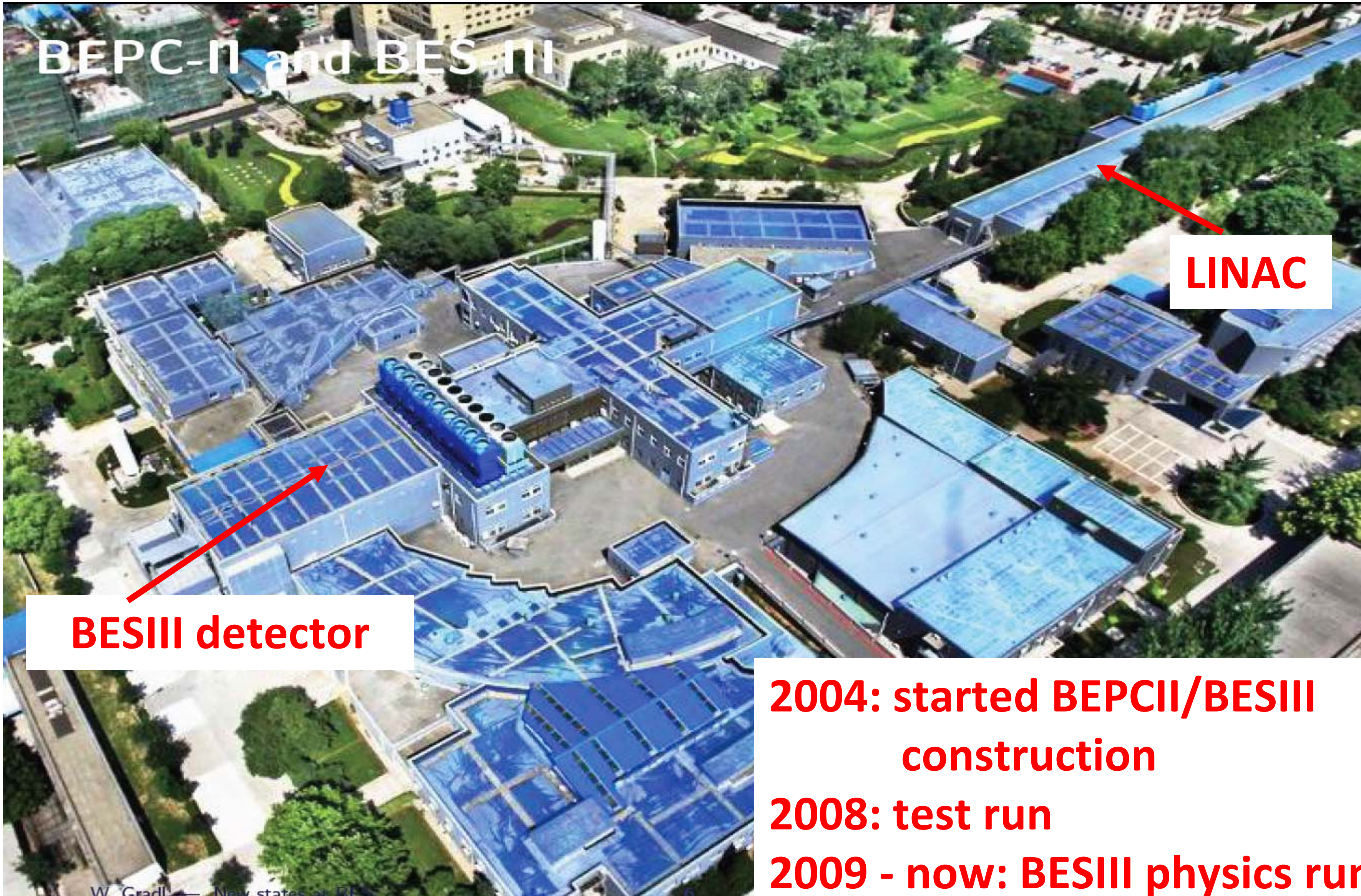
Outline

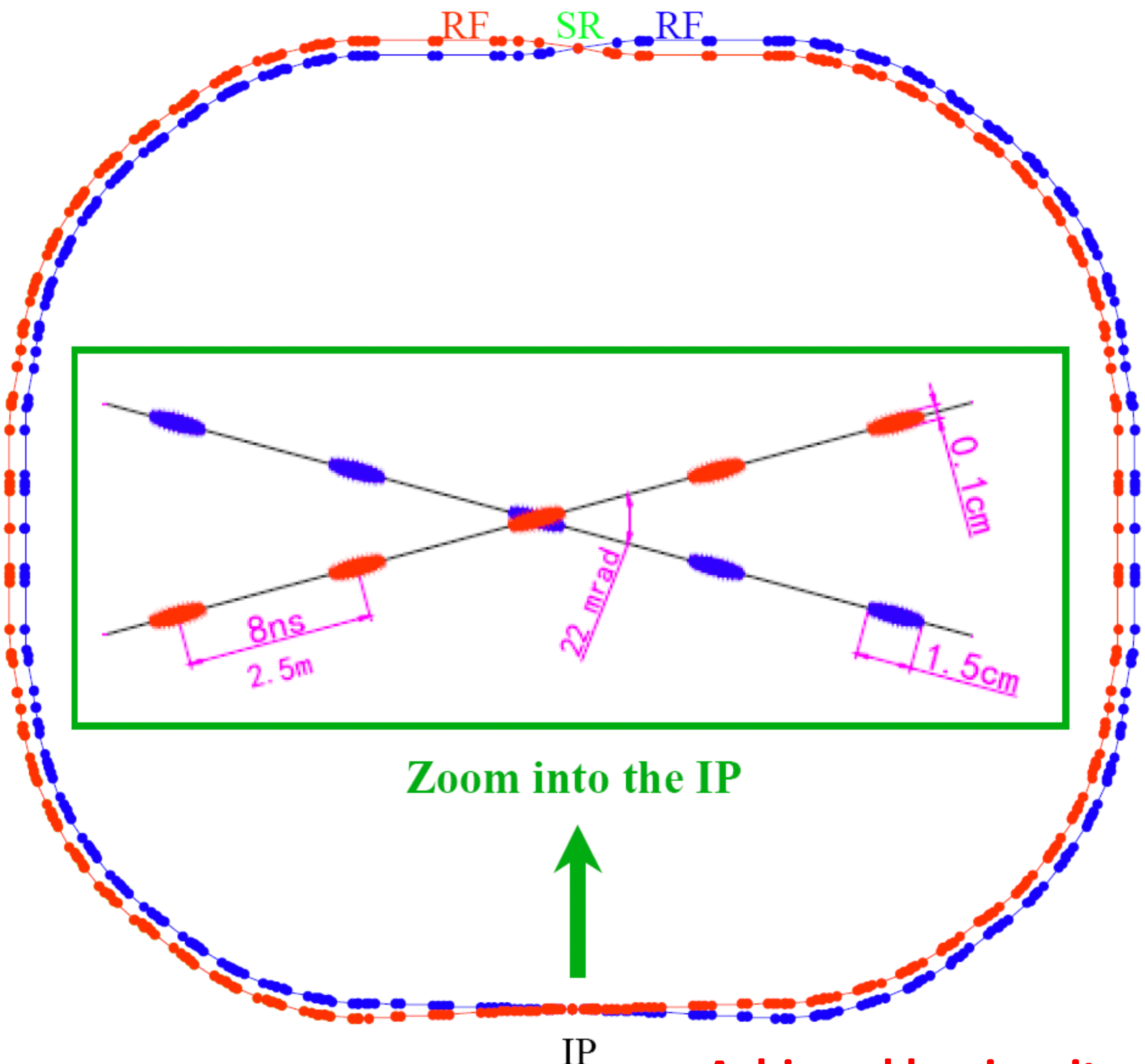
- Introduction
- BESIII data sets
- Open charm physics
- Summary

Beijing Electron Positron Collider-II (BEPCII)



2004: started BEPCII/BESIII construction
2008: test run
2009 - now: BESIII physics run

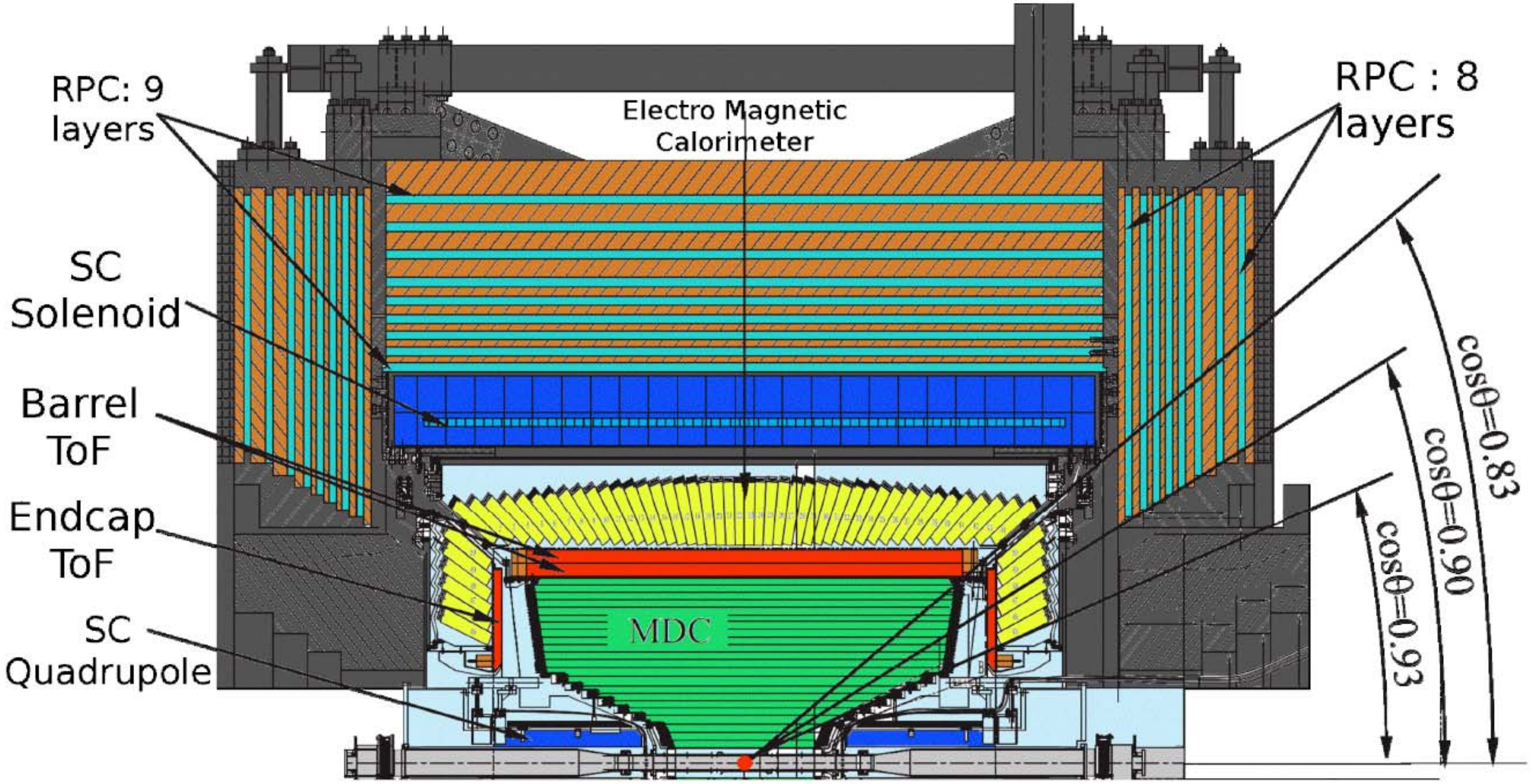
BEPCII storage rings



Beam energy:
1.0-2.3 GeV
Design Luminosity:
1×10^{33} $cm^{-2}s^{-1}$
Optimum energy:
1.89 GeV
Energy spread:
5.16×10^{-4}
No. of bunches:
93
Bunch length:
1.5 cm
Total current:
0.91 A
Circumference：
237m

Achieved luminosity: 0.7×10^{33} $cm^{-2}s^{-1}$@3770MeV

BESIII detector



Wire tracker (no Si); **TOF** + **dE/dx** for PID; **CsI Ecal** ; **RPC muon**

The BESIII Collaboration

US (6)

Univ. of Hawaii
Univ. of Washington
Carnegie Mellon Univ.
Univ. of Minnesota
Univ. of Rochester
Univ. of Indiana

Europe (13)

Germany: Univ. of Bochum, Univ. of Giessen, GSI
Univ. of Johannes Gutenberg
Helmholtz Ins. In Mainz
Russia: JINR Dubna; BINP Novosibirsk
Italy: Univ. of Torino, Frascati Lab, Ferrara Univ.
Univ. of Perugia, Univ. of Eastern Piedmont
Netherland: KVI/Univ. of Groningen
Sweden: Uppsala Univ.
Turkey: Turkey Accelerator Center

Korea (1)

Seoul Nat. Univ.

Japan (1)

Tokyo Univ.

Pakistan (2)

Univ. of Punjab
COMSAT CIIT

China(29)

IHEP, CCAST, GUCAS, Shandong Univ.,
Univ. of Sci. and Tech. of China
Zhejiang Univ., Huangshan Coll.
Huazhong Normal Univ., Wuhan Univ.
Zhengzhou Univ., Henan Normal Univ.
Peking Univ., Tsinghua Univ. ,
Zhongshan Univ.,Nankai Univ., Beihang Univ.
Shanxi Univ., Sichuan Univ., Univ. of South China
Hunan Univ., Liaoning Univ.
Nanjing Univ., Nanjing Normal Univ.
Guangxi Normal Univ., Guangxi Univ.
Suzhou Univ., Hangzhou Normal Univ.
Lanzhou Univ., Henan Sci. and Tech. Univ.

~350 members
52 institutions from 11 countries

BESIII data taking status

	Previous data	BESIII present	Goal
J/ψ	BESII: 58M	1.2 B 20* BESII	10 B
ψ'	CLEO: 28 M	0.5 B 20* CLEOc	3B
ψ"	CLEO: 0.8/fb	2.9/fb 3.5*CLEOc	20/fb
4040/4160/4260 /4360 MeV	CLEO: 0.6/fb @ ψ(4160)	2011: 0.5/fb @ ψ(4040) 2013: 2/fb@4260, 0.5/fb 4360 50-60/pb 3.81-4.42 GeV 2014: 0.5 fb^{-1} @4.60 GeV for XYZ	5-10/fb
R scan	BESII	2012: R @2.23,2.4,2.8,3.4GeV 25/pb tau threshold 2013-2014: 100 points scan 3.85—4.59 GeV 5 –10 MeV steps 6–8 pb^{-1} per point	

Breath of physics

63 published /accepted papers + 6 advanced drafts since 2010 :

8 new low-energy resonances
8 η, η' , (a_0-f_0) decays

5 XYZ states
3 ψ(3770), ψ(4040) decays

20 J/ψ, ψ(2S), χ_{cJ}, hadronic decays
12 J/ψ, ψ(2S), χ_{cJ}, radiative/2-photon/rare decays
6 h_c, η_c, η_c(2S), decays /parameters
2 ψ(2S) $\rightarrow$ J/ψ, hadronic transitions

2 D Physics
3 Measurements of luminosity & # of J/ψ and ψ(2S)

D physics @ $\psi(3770)$

At $\psi(3770)$ peak : $\sigma(e^+e^- \to DDbar) \approx 6.6$ nb
Only D pars: no phase space for even one extra pion

Reconstruction one D in a set of hadronic "tag" modes:
Reduce backgrounds,
Find the other D's direction: produce a "tagged D beam"
→ can be used to reconstruct a neutrino 4-vector

Tag variables: conservation of momentum and energy:

$$M_{bc} = (E_{beam}{}^2 - p_{cand}{}^2)^{1/2} \qquad \Delta E = E_{cand} - E_{beam}$$

Absolute BR measurement:
Tag-side efficiency mostly cancels;
tag systematics cancel.

$$BR = \frac{N_{tag+signal}\varepsilon_{tag}}{N_{tag}\varepsilon_{tag+signal}} \approx \frac{N_{tag+signal}}{N_{tag}\varepsilon_{signal}}$$

Flavor Physics Connection

Tests of Lattice QCD

Leptonic, decay constant
B mixing
Semieptonic, form factors
B pi l nu

Indirect access to the CKM via B decay
Direct access to two more in charm decays

Strong Phases

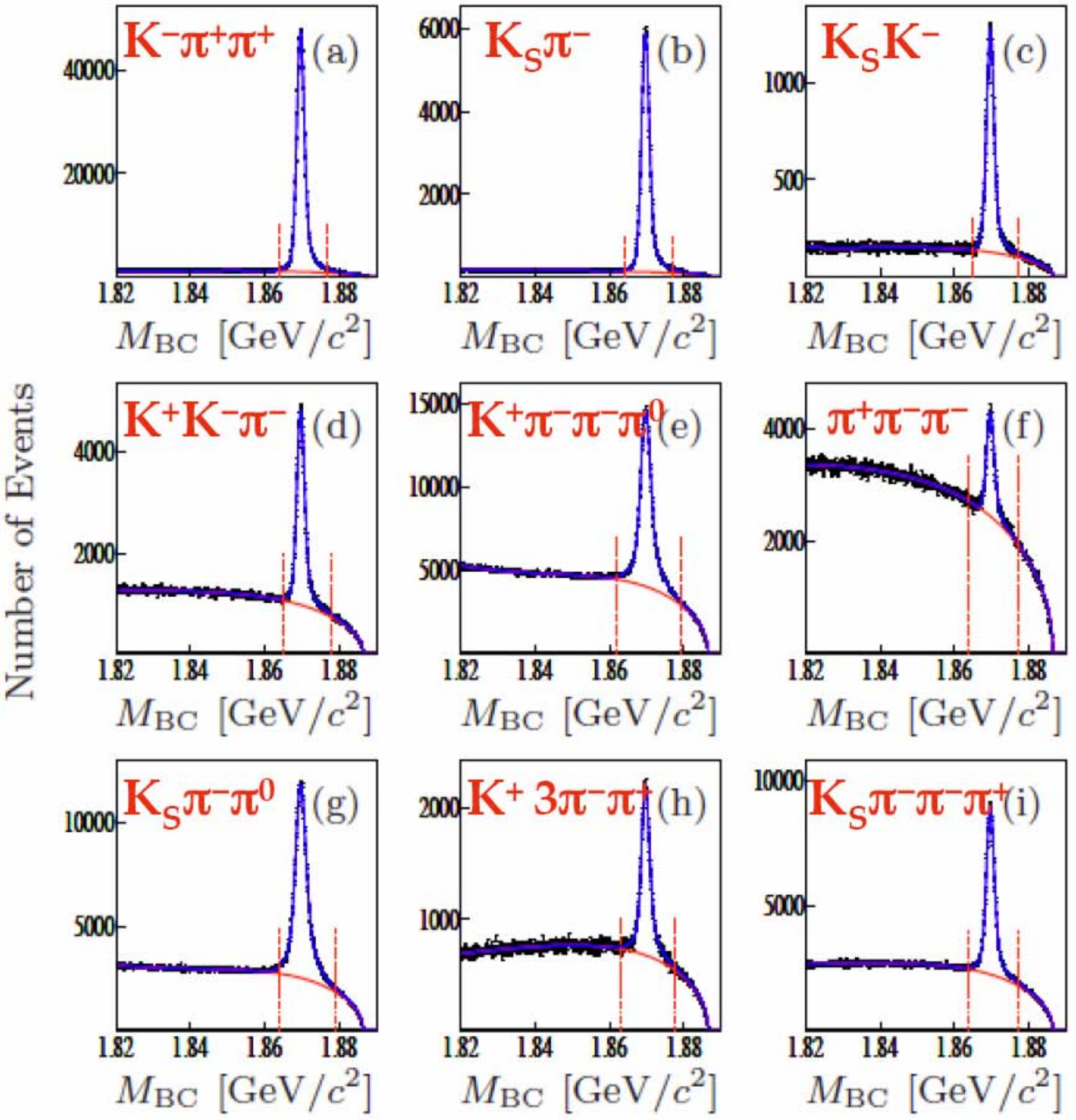
Accessible due to quantum-correlations
Affect CKM gamma/phi3 extraction

D0 D+ Ds+ golden mode BF

Normalize heavy flavor physics
Systematics limited after CLEO-c; lower priority to check…

$D^+ \to \mu^+\nu$

BESIII 2.9 fb^{-1}
arXiv:1312.0374
Accepted by PRD



Uses 9 tag modes

Signal side: ONE track !

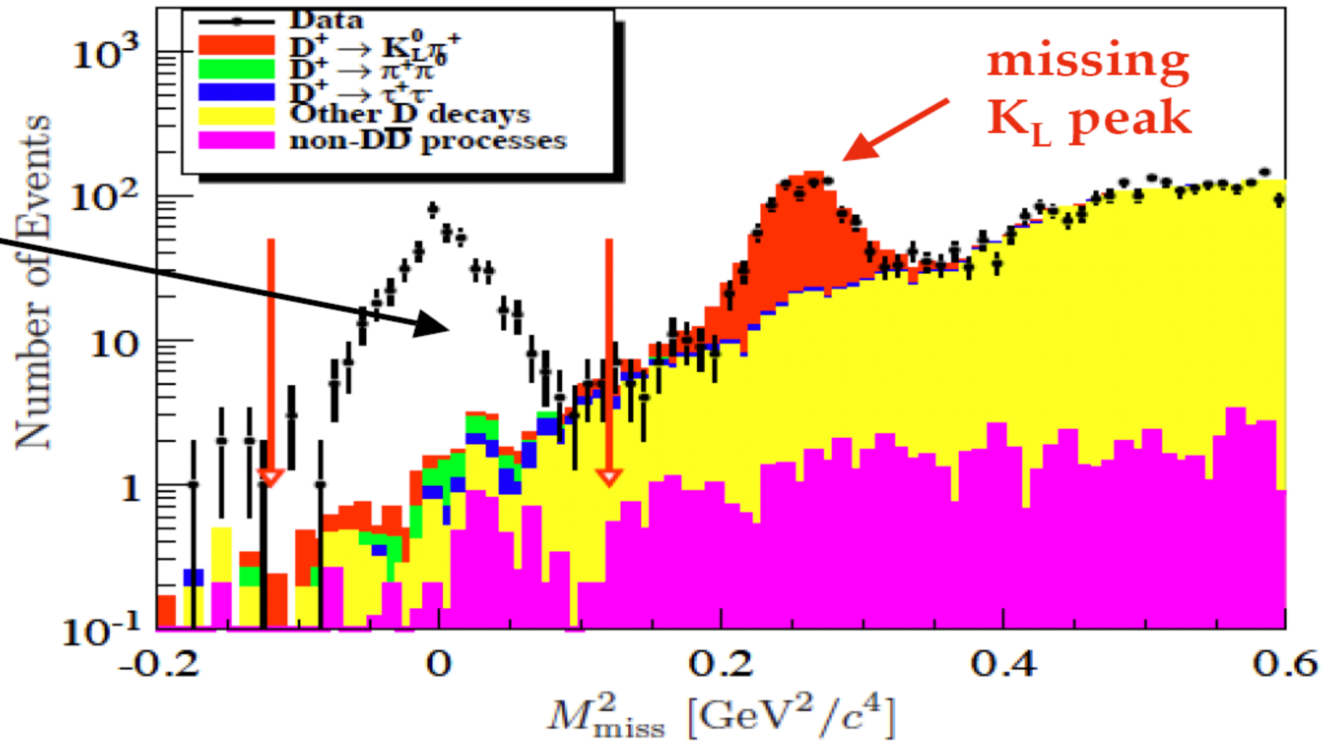
Veto on extra tracks,
and un-matched showers
with E > 300 MeV

Reconstruct " MM^2 "
= (missing-mass)^2

presumably just a neutrino:
signal peaks at 0

$D^+ \to \mu^+\nu$

BESIII 2.9 fb^{-1}
arXiv:1312.0374



Result:

377.3 ± 20.6 ± 2.6 events above background

$B(D^+ \to \mu\nu) = (3.71 \pm 0.19 \pm 0.06) \times 10^{-4}$

Combining with V_{cd}, G_F, τ_D, m_D :

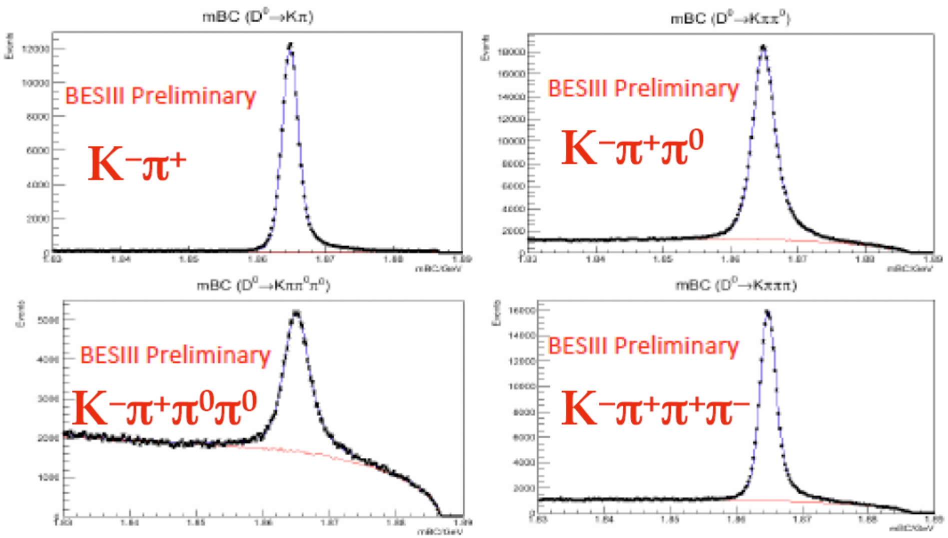
$f_D = (203.2 \pm 5.3 \pm 1.8)$ MeV (± 2.6 ± 0.9)% *most precise !*

previous best: CLEO-c : (205.8 ± 8.5 ± 2.5) MeV **(± 4.1 ± 1.2)%**

$D^0 \to Ke\nu$, $\pi e\nu$

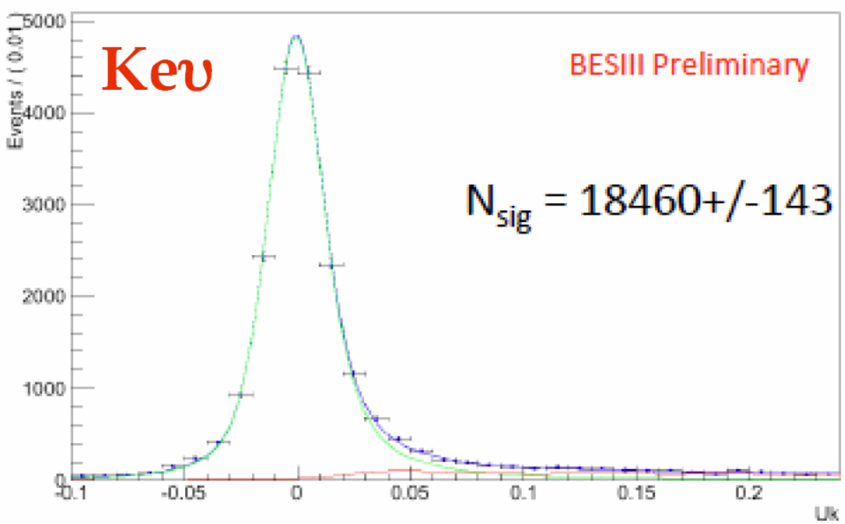
BESIII 0.9 fb^{-1} CHARM2012
arXiv:1207.1171

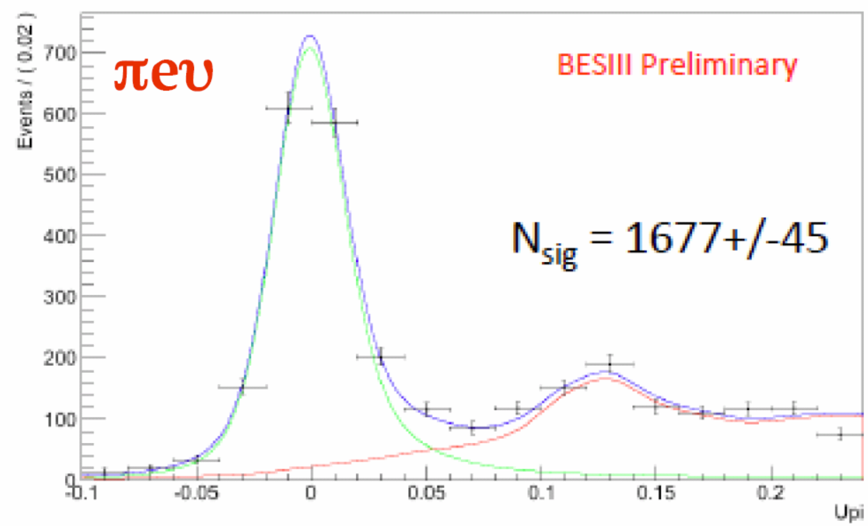
Use 4 hadronic tag modes



Signal side:
two tracks, e & K/π

Signal variable:
$U = E_{miss} - p_{miss}$
(peaks @ zero, similar to MM^2)

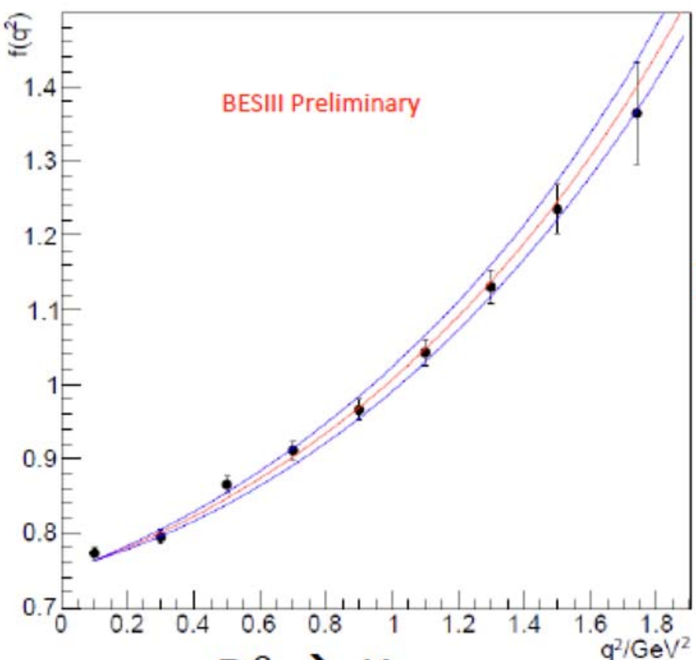




$D^0 \to K e \nu$, $\pi e \nu$

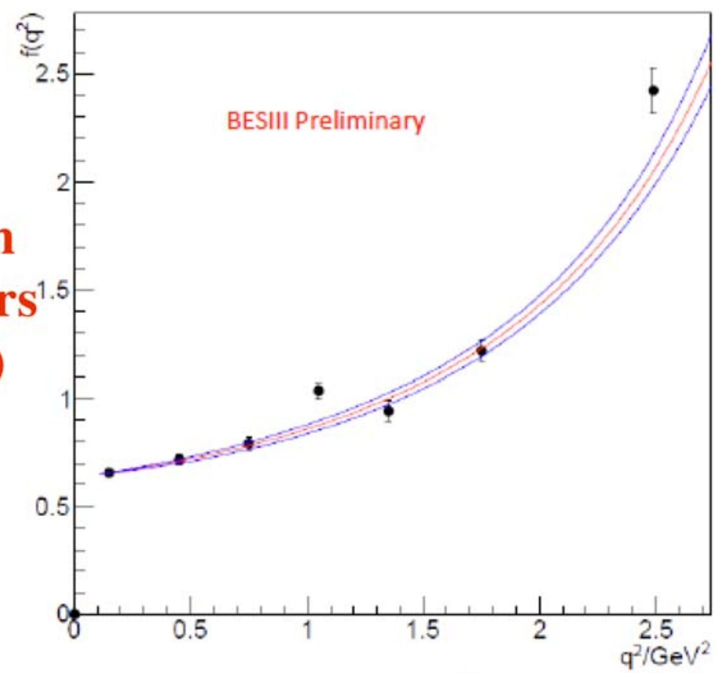
- Points: data with stat. error only
- Curves: from Fermilab-MILC within one stat. error, preliminary, **arXiv:1111.5471** (XXIX International Symposium on Lattice Field Theory);
- Other theoretical work: HPQCD, arXiv:1111.0225
- Comparing shape only here ($f_+(0)$ not known)

BESIII 0.9 fb^{-1}
CHARM2012
arXiv: 1207.1171



$D^0 \to K e \nu$

Form Factors $f(q^2)$



$D^0 \to \pi e \nu$

$D^0 \to Kev$, πev: numerical results 0.9fb^{-1} data

BESIII Preliminary

Mode	measured branching fraction(%)	PDG	CLEOc
$\bar{D}^0 \to K^+e^-\bar{\nu}$	3.542 ±0.030±0.067	3.55 ±0.04	3.50 ±0.03 ±0.04
$\bar{D}^0 \to \pi^+e^-\bar{\nu}$	0.288 ±0.008±0.005	0.289 ±0.008	0.288 ±0.008±0.003

BESIII Preliminary

Simple Pole	$f_+(0)\|V_{cd(s)}\|$	m_{pole}	
$D^0 \to Ke\nu$	0.729±0.005±0.007	1.943±0.025±0.003	
$D^0 \to \pi e\nu$	0.142±0.003±0.001	1.876±0.023±0.004	
Modified Pole	$f_+(0)\|V_{cd(s)}\|$	α	
$D^0 \to Ke\nu$	0.725±0.006±0.007	0.265±0.045±0.006	
$D^0 \to \pi e\nu$	0.140±0.003±0.002	0.315±0.071±0.012	
2 par. series	$f_+(0)\|V_{cd(s)}\|$	r_1	
$D^0 \to Ke\nu$	0.726±0.006±0.007	−2.034±0.196±0.022	
$D^0 \to \pi e\nu$	0.140±0.004±0.002	−2.117±0.163±0.027	
3 par. series	$f_+(0)\|V_{cd(s)}\|$	r_1	r_2
$D^0 \to Ke\nu$	0.729±0.008±0.007	−2.179±0.355±0.053	4.539±8.927±1.103
$D^0 \to \pi e\nu$	0.144±0.005±0.002	−2.728±0.482±0.076	4.194±3.122±0.448

1/3 of the total data@ψ(3770)

BESIII

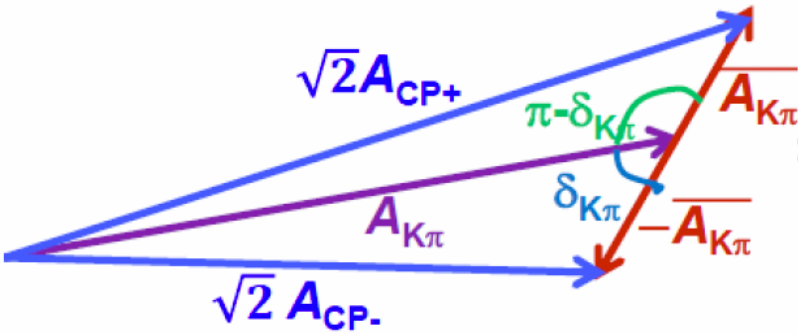
Strong phase $\delta_{K\pi}$

BESIII 2.9 fb^{-1}
Preliminary

Strong phase: $\dfrac{\langle K^-\pi^+ | \overline{D}^0 \rangle^{DCS}}{\langle K^-\pi^+ | D^0 \rangle^{CF}} \equiv -r_{K\pi} e^{-i\delta_{K\pi}}$

Quantum correlation → Interference → access strong phase!

$$\langle K\pi | D_{CP\pm}\rangle = (\langle K\pi | D^0\rangle \pm \langle K\pi | \overline{D^0}\rangle)/\sqrt{2} \Rightarrow \sqrt{2}A_{CP\pm} = A_{K\pi} \pm \overline{A}_{K\pi}$$



$$\Rightarrow 2r_{K\pi}\cdot\cos\delta_{K\pi} \approx A_{CP\to K\pi} \equiv \frac{|A_{CP-}|^2 - |A_{CP+}|^2}{|A_{CP-}|^2 + |A_{CP+}|^2}$$

$$= \frac{Br(D_{CP-}\to K\pi) - Br(D_{CP+}\to K\pi)}{Br(D_{CP-}\to K\pi) + Br(D_{CP+}\to K\pi)}$$

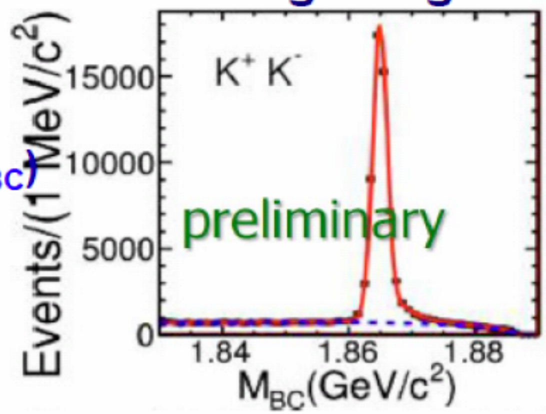
- Measuring $\delta_{K\pi}$ from rate differences if using external $r_{K\pi}$
- Reconstructed modes:
  - Flavor tags: $K^-\pi^+$, $K^+\pi^-$
  - CP+ tags (5 modes): K^-K^+, $\pi^+\pi^-$, $K^0_S\pi^0\pi^0$, $\pi^0\pi^0$, $\rho^0\pi^0$
  - CP- tags (3 modes): $K^0_S\pi^0$, $K^0_S\eta$, $K^0_S\omega$

Strong phase $\delta_{K\pi}$

BESIII 2.9 fb[-1]
Preliminary

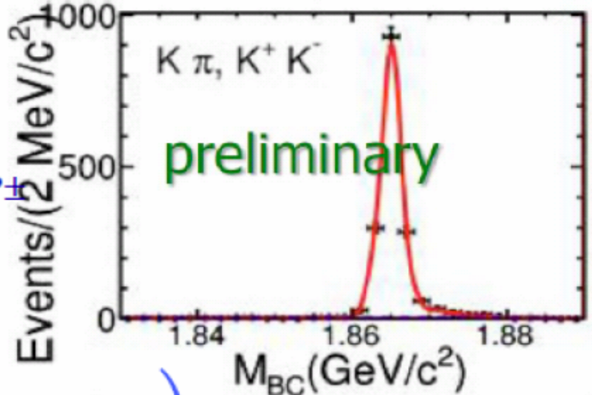
- **Signal reconstruction:**
  - **Single Tag (ST): CP tags**
  - **Double Tag (DT) : Kπ + CP Tag**
  - **Kinematic variable: Beam Constrained Mass (M_{BC})**
  - **Singal shape: σ⊗MC-truth**
  - **Background shape: ARGUS function**

Single Tags



- $$Br(D_{CP\pm} \to K\pi) = \frac{n_{K\pi,CP\pm}}{n_{CP\pm}} \cdot \frac{\varepsilon_{CP\pm}}{\varepsilon_{K\pi,CP\pm}}$$
  - $n_{K\pi,CP\pm}$ **and** $n_{CP\pm}$ **are event yields for DT and ST from M_{BC} fit**
  - $\varepsilon_{K\pi,CP\pm}$**and** $\varepsilon_{CP\pm}$ **are detection efficiencies of DT and ST from MC simulation**
  - **Most systematics cancelled for ratio** $\varepsilon_{CP\pm}/\ \varepsilon_{K\pi,CP\pm}$

Double Tags



BES III preliminary:

$$A_{CP\to K\pi} = \left(12.77 \pm 1.31(\mathrm{Stat.})\ {}^{+0.33}_{-0.31}(\mathrm{sys.})\right)\%$$

Strong phase $\delta_{K\pi}$

BESIII 2.9 fb^{-1}
Preliminary

- If we don't ignore the mixing effect
- $2r_{K\pi}\cos\delta_{K\pi} + y = (1 + R_{WS}) \cdot A_{CP\to K\pi}$
  - $R_{WS} \equiv \frac{\Gamma(D^0\to K^+\pi^-)}{\Gamma(D^0\to K^-\pi^+)} = r_{K\pi}^2 + r_{K\pi}y' + \frac{(x^2+y^2)}{2}$
- External inputs from HFAG2013 and PDG
  - $r_{K\pi}^2 = 0.347 \pm 0.006\%$,
  - $y = 0.66 \pm 0.09\%$,
  - $R_{WS} = 0.380 \pm 0.005\%$
- BESIII preliminary results:

$$\cos\delta_{K\pi} = 1.03 \pm 0.12 \pm 0.04 \pm 0.01$$

(Uncertainty is dominated by the statistical error.)

$\delta_{K\pi}$ slides courtesy of Yangheng Zheng, CHARM2013

Other Quantum Correlation work

Coherence factors: feed into CKM γ/ϕ_3 with B's

$K_S\,\pi^+\pi^-$ most advanced: binned analysis ("CLEO-style")

$K^-\pi^+\pi^0$, $\pi^+\pi^-\pi^0$ } likely to pursue both model-ind't analyses, and also detailed Dalitz analyses

+ other modes e.g., $K^-\pi^+\pi^+\pi^-$ & $K_SK^+\pi^-$ have been done by CLEO-c)

Mixing analyes: statistics-limited at $\psi(3770)$

Luminosity x cross-section much higher @ B factories, LHCb

But… We do have a y_{CP} analysis in the works

DP model independent approach

- **Initially proposed for γ measurement in $B^+ \to DK^+$**

- **Divide DP into symmetrical bins:**

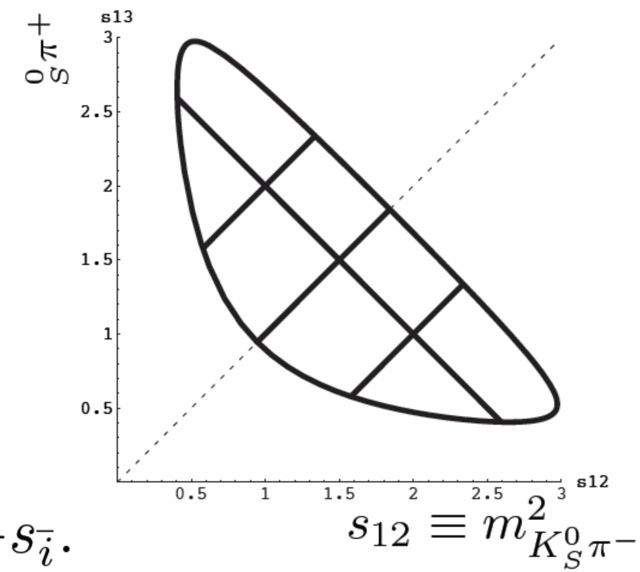
$$c_i \equiv \int_i dp\, A_{12,13}\, A_{13,12}\, \cos(\delta_{12,13} - \delta_{13,12}),$$

$$s_i \equiv \int_i dp\, A_{12,13}\, A_{13,12} \sin(\delta_{12,13} - \delta_{13,12}),$$

$$T_i \equiv \int_i dp\, A^2_{12,13},$$

$$A_{1j,1k} \equiv A(s_{1j}, s_{1k})$$
$$\delta_{1j,1k} \equiv \delta(s_{1j}, s_{1k})$$

For mirror bins, i and $\bar{i}$: $c_i = c_{\bar{i}},\ s_i = -s_{\bar{i}}$.



- **With mixing, the number of events in bin i at time t is:**

$$T'_i(t) \propto e^{-\Gamma t}[T_i + \sqrt{T_i T_{\bar{i}}}(c_i y_D + s_i x_D)\Gamma t + \mathcal{O}((x_D^2 + y_D^2)(\Gamma t)^2)]$$

[Bondar et al, PRD82, 034033 (2010)]

- **One can fit all bins simultaneously to extract (x_D, y_D), if s_i, c_i are: Known**

Model independent approach

Modified optimal binning: 8 bins

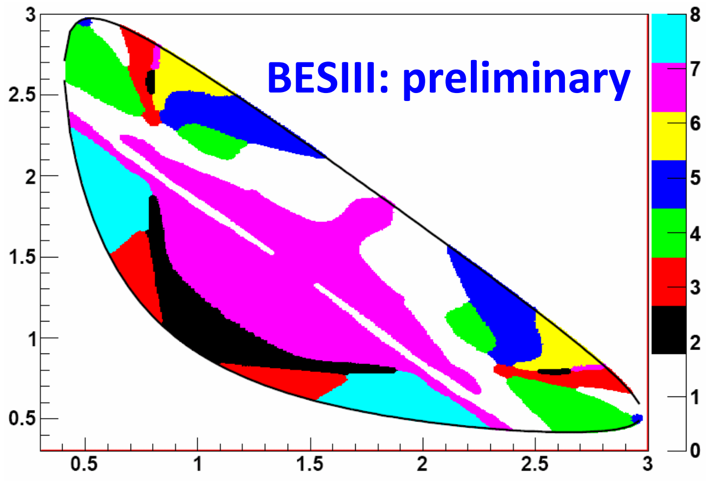
CLEO-c: 0.818 fb^{-1}

uncertainty on γ reduced to 1.7° to 3.9°

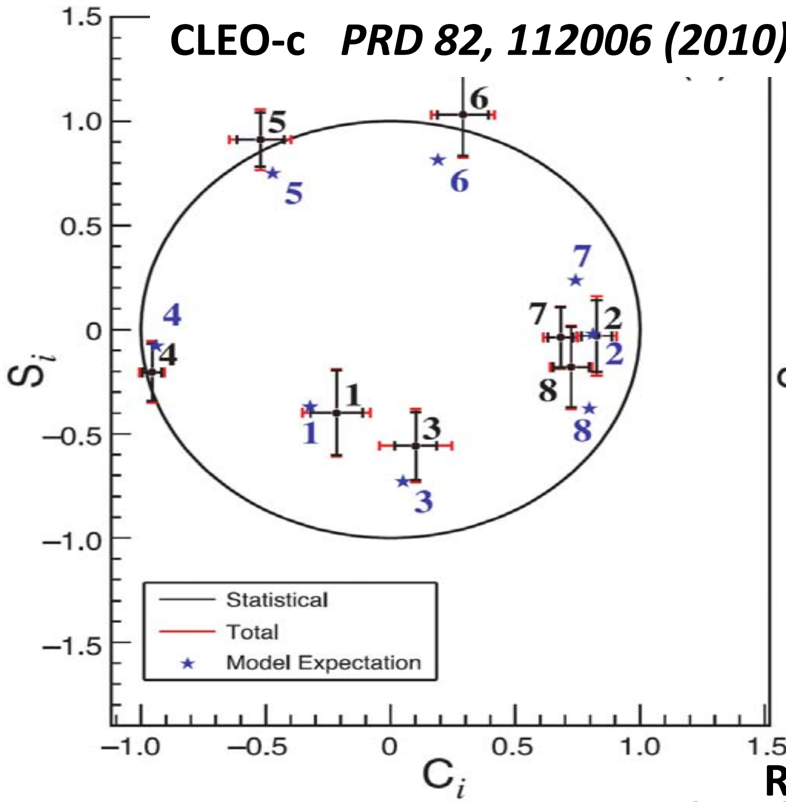
BESIII: 2.9fb^{-1}

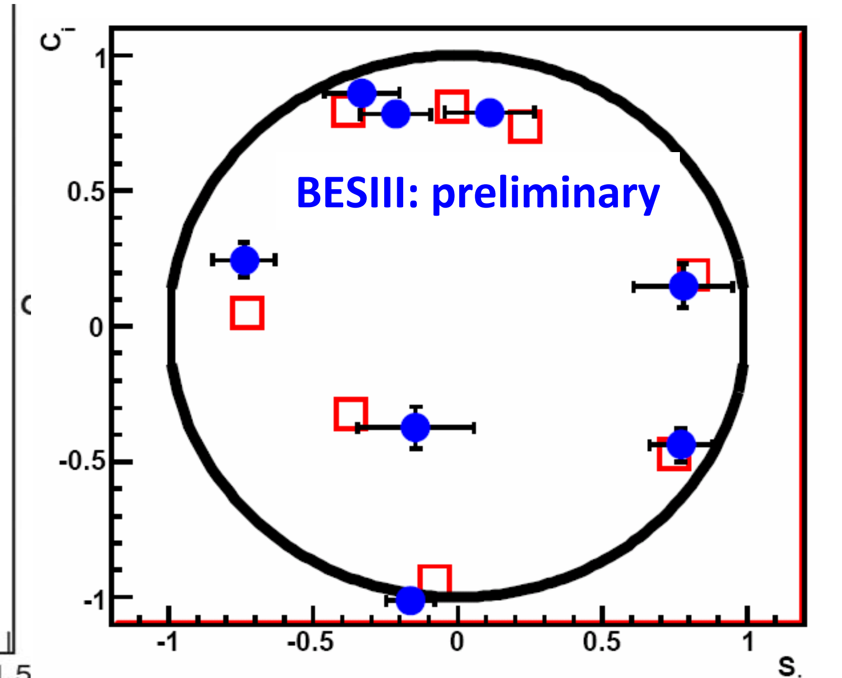
Uncertainty on γ reduced to 0.9° to 2.0°

depend on the binning methods.



CLEO-c *PRD 82, 112006 (2010),*

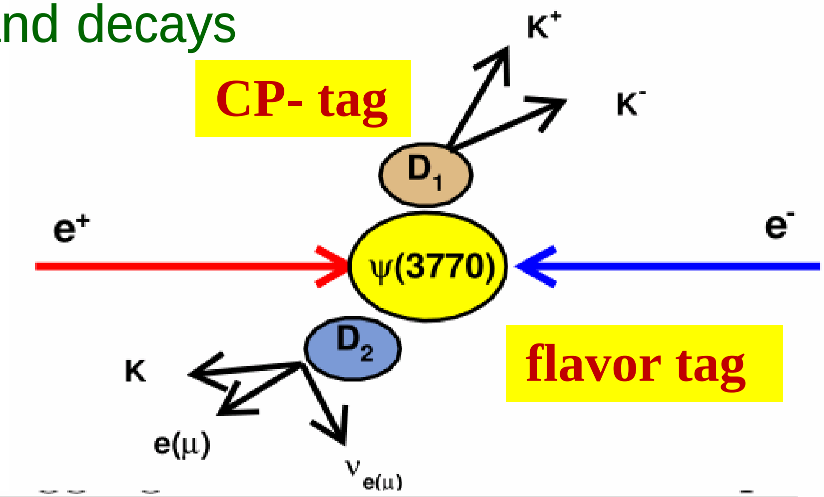




Results will appear at APS meeting 2014

y_{CP}: CP tagged semileptonic D decays

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



Type	Modes
CP^+	K^+K^-, $\pi^+\pi^-$, $K_S\pi^0\pi^0$
CP^-	$K_S^0\pi^0$, $K_S^0\omega$, $K_S^0\eta$
$l^\pm$	$Ke\nu$, $K\mu\nu$

For D decay to CP eigenstates:

$$R_{CP\pm} \propto |A_{CP\pm}|^2(1 \mp y_{CP})$$

$$y_{CP} = \frac{1}{2}[y\cos\phi(|\frac{q}{p}| + |\frac{p}{q}|) - x\sin\phi(|\frac{q}{p}| - |\frac{p}{q}|)]$$

For CP tagged semileptonic D decays:

$$R_{l,CP\pm} \propto |A_l|^2|A_{CP\pm}|^2$$

$$y_{CP} \approx \frac{1}{4}(\frac{R_{l;CP+}R_{CP-}}{R_{l;CP-}R_{CP+}} - \frac{R_{l;CP-}R_{CP+}}{R_{l;CP+}R_{CP-}})$$

Modes	N_{tag}	$N_{tag,Ke\nu}$	$N_{tag,K\mu\nu}$
K^+K^-	54307 ± 252	1216 ± 40	1093 ± 37
$\pi^+\pi^-$	19996 ± 177	427 ± 28	400 ± 23
$K_S^0\pi^0\pi^0$	24369 ± 231	560 ± 28	558 ± 28
$K_S^0\pi^0$	71419 ± 286	1699 ± 47	1475 ± 43
$K_S^0\omega$	21249 ± 157	473 ± 25	501 ± 26
$K_S^0\eta$	9843 ± 117	242 ± 17	237 ± 18

preliminary

$$y_{CP} = -1.6\% \pm 1.3\%(\text{stat.}) \pm 0.6\%(\text{syst.})$$

CLEOc *[PRD 86 (2012) 112001]:*
$y_{CP}=(4.2\pm2.0\pm1.0)\%$

Running: Now & Later

So far this run (2014) :

About 100 points for R values "scan":

3.85-4.59 GeV, 5 or 10 MeV steps, ~6 – 8 pb^{-1} per point

500 pb^{-1} @ 4.60 GeV for XYZ states;

Current: working on the 500 pb @ 4.420 GeV for XYZ states.

Future runs (no particular order)

- **Ds data @ 4.170 GeV**
- **more $\psi(3770)$ for D physics**
- **More "XYZ", J/ψ, ψ'**

Easy to fill MANY years !

Conclusions

Precision D Physics begun

New states very active

- **the XYZ**
- **also many *other* analyses completed on new low-energy hadronic resonances**

Thanks

Backup

e^+e^- for τ-charm: physics goals

✓Hadron spectroscopy and test of QCD at low energy:
Light meson and baryon
Glueball: direct test of QCD at low energy
Hybrid/exotics states/multiquark states/molecular states…
Charmonium(-like) spectroscopy and decays / Charmed baryon decays

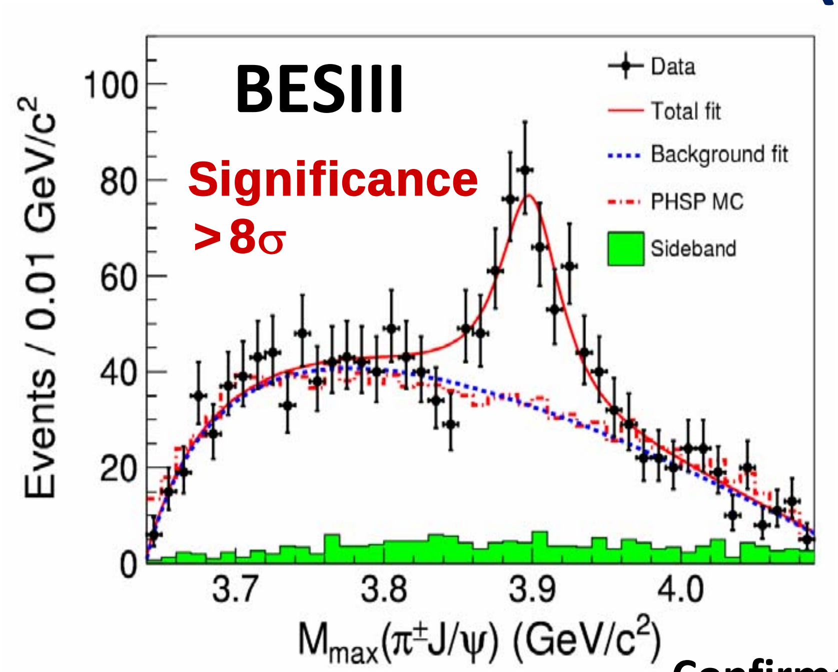
✓Precise test of the Standard Model:
R values, tau mass and tau decays, CKM matrix, lepton universality test…
Decay constants and form factors (in D meson decays)

✓ New physics searches at low energy (tiny/forbidden in SM):
Rare charmonium decays: weak decays, LFV, LNV, BNV …
Rare charm and tau decays: FCNC, LFV, LNV, invisible decays
Rare light meson decays: $\eta/\eta'/\omega/\phi$ rare decays
Neutral D mixing
CP violation in tau and charm: tiny in SM
CP violation in baryon /charmed baryon weak decays

✓ Exotic physics:
Light dark matter candidates, Dark photon, light Higgs boson(a_0),
New interactions…

BESIII is statistical limited

Observation of Zc(3900) in $e^+e^- \rightarrow \pi^+\pi^- J/\psi$



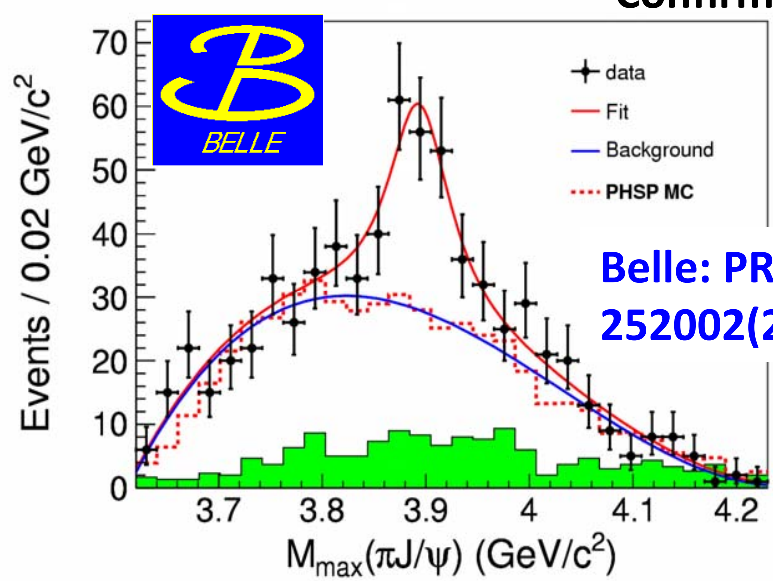
BESIII: PRL110, 252001 (2013)

- $M = 3899.0 \pm 3.6 \pm 4.9$ MeV
- $\Gamma = 46 \pm 10 \pm 20$ MeV
- 307 ± 48 events

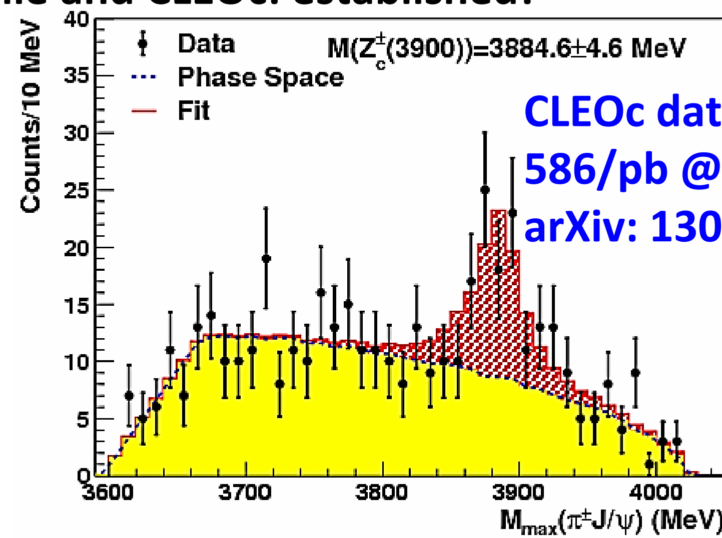
The mass position is 24 MeV away from DD* threshold!

A Partial wave analysis is on going!

Confirmed by Belle and CLEOc: established!



Belle: PRL 110, 252002(2013)

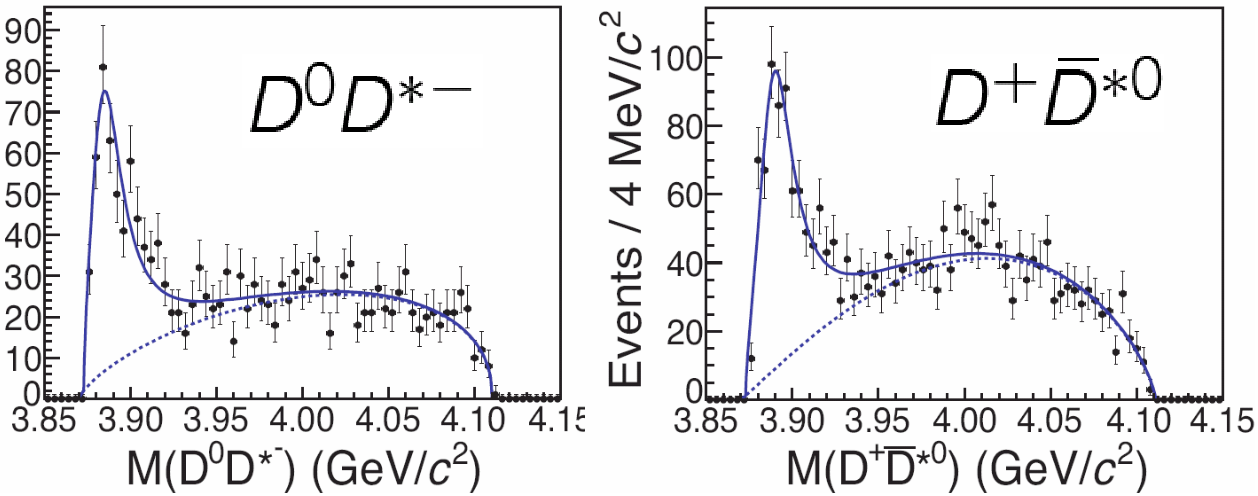


CLEOc data
586/pb @4.17GeV
arXiv: 1304.3036

$e^+e^- \to \pi^\pm(D\bar{D}^*)^\mp - Z_c(3885)$ with 525/pb @4.26 GeV

Partial reconstruct: reconstruct "bachelor" π
reconstruct $D^0 \to K\pi$ and $D^+ \to K\pi$
looking at the recoiling mass of π

BESIII: arXiv:1310.1163
Submitted to PRL



Fit with mass-dependent BW with phase space factor and efficiency correction.

	$Z_c(3885) \to D\bar{D}^*$	$Z_c(3900) \to \pi J/\psi$
Mass (MeV/c^2)	$3883.9 \pm 1.5 \pm 4.2$	$3899 \pm 3.6 \pm 4.9$
Γ (MeV)	$24.8 \pm 3.3 \pm 11.0$	$46 \pm 10 \pm 20$
$\sigma \times \mathcal{B}$ (pb)	$83.5 \pm 6.6 \pm 22.0$	$13.5 \pm 2.1 \pm 4.8$

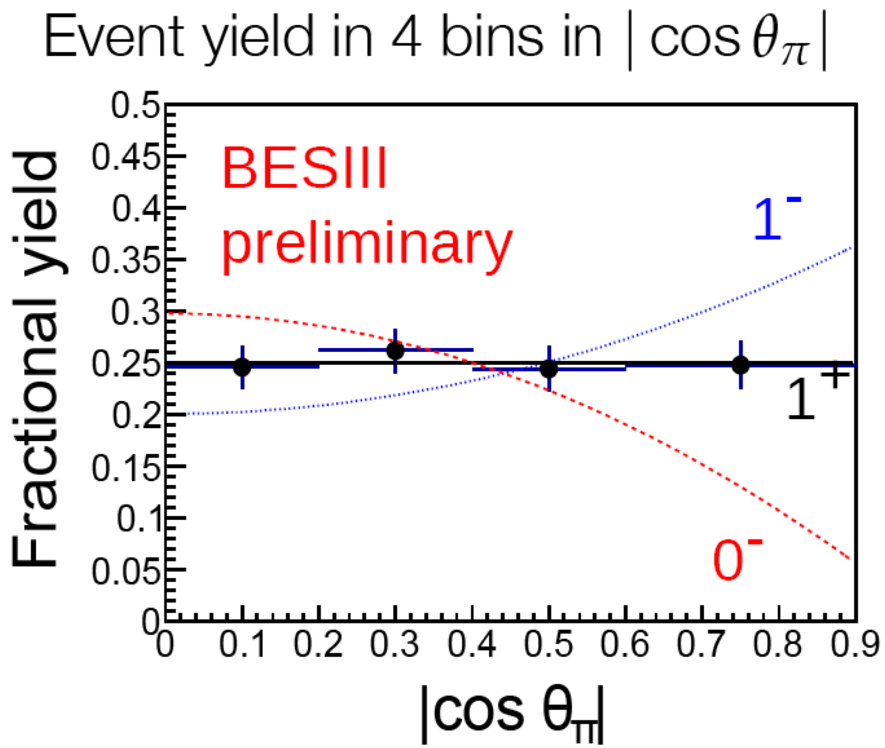
The pole mass and width are reported for Zc(3885).

Assuming the Zc(3885) is due to Zc(3900):

$$\frac{\Gamma(Z_c(3885)\to D\bar{D}^*)}{\Gamma(Z_c(3900)\to \pi J/\psi)} = 6.2 \pm 1.1 \pm 2.7$$

Strange behavior of Y(4260)–Zc(3900)! Large non-DD coupling!

Quantum number of Zc(3885)



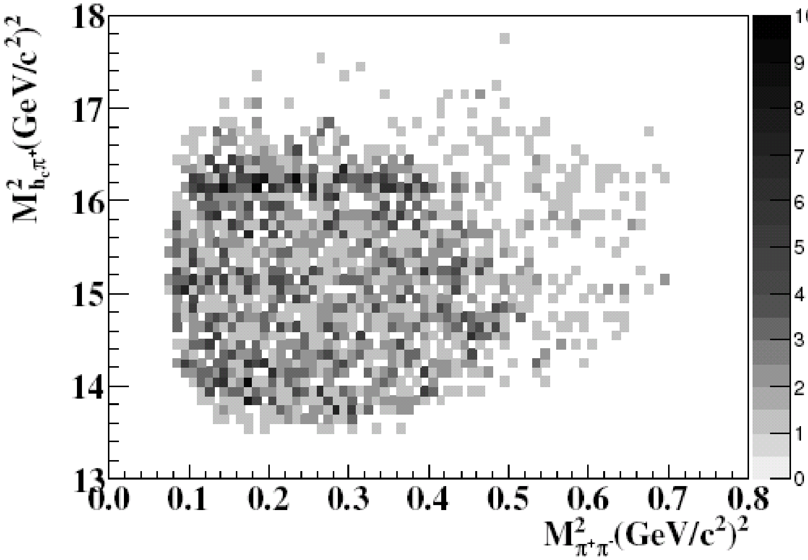
BESIII: arXiv:1310.1163
Accepted by PRL

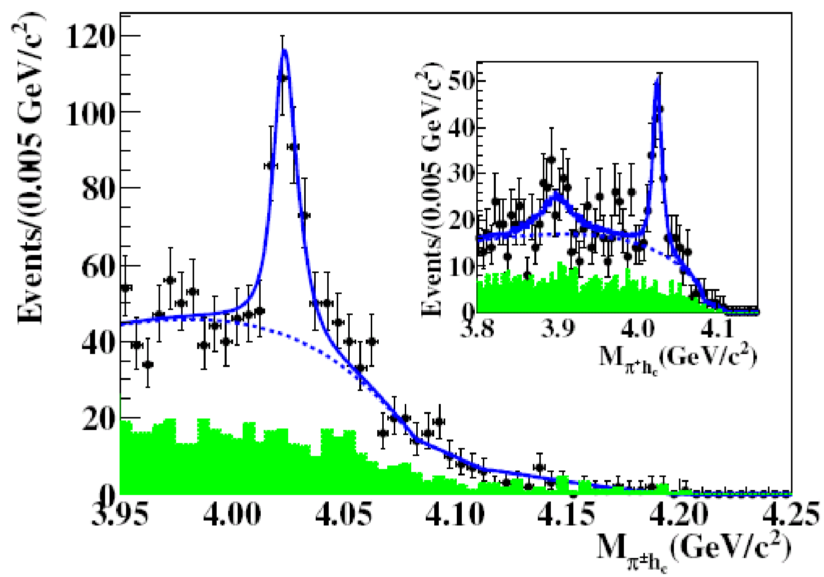
data clearly favour $J^P = 1^+$ for $D\bar{D}^*$ structure

first measurement of J^P for one of the Z_c

$Z^{\pm}_c(4020)$ in $e^+e^- \to \pi^+\pi^- h_c(1P)$

- Using data taken at 4.23 GeV, 4.26 GeV 4.36 GeV (total 2.4 fb^{-1})
- See structure in $h_c\pi^{\pm}$ spectrum, close to $D^*\bar{D}^*$ threshold :





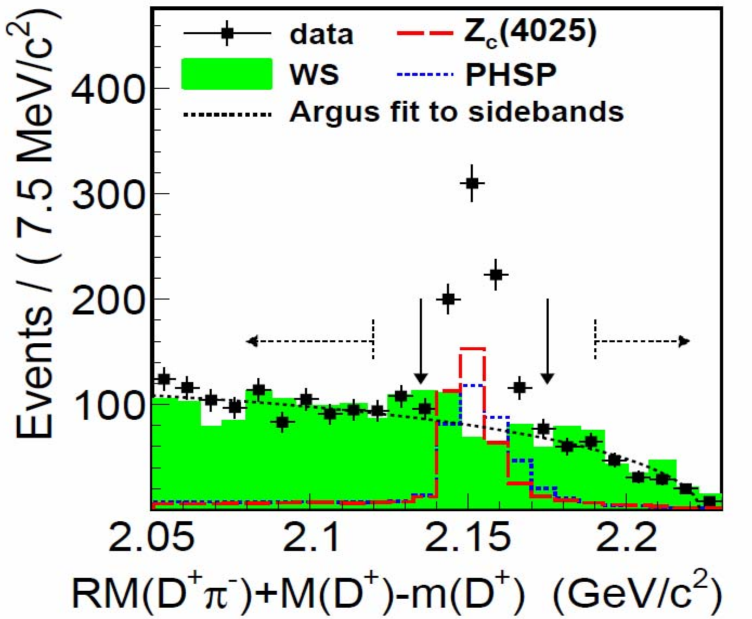
$$M(Z_c(4020)) = 4022.9 \pm 0.8 \pm 2.7\,\text{MeV}/c^2$$
$$\Gamma(Z_c(4020)) = 7.9 \pm 2.7 \pm 2.6\,\text{MeV}$$

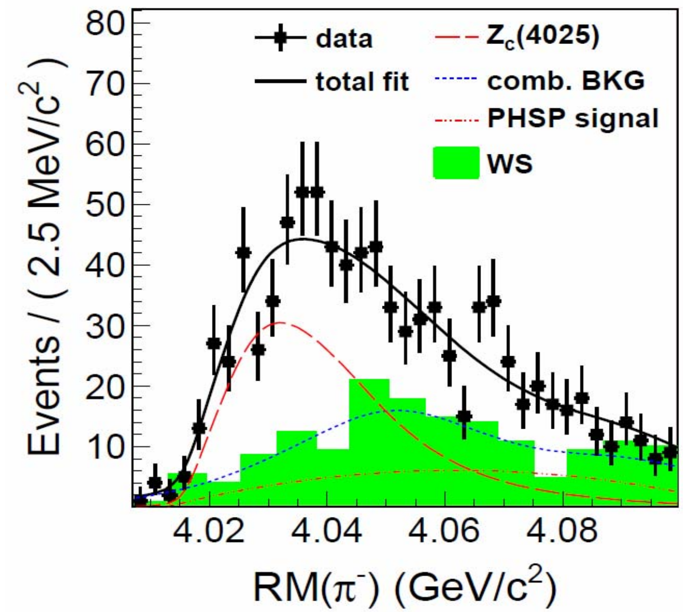
arXiv:1309.1896
submitted to PRL

No significant signal $Z_c(3900) \to h_c\pi^+$ seen **: less than 2.1 σ**

Zc(4025) in $e^+e^- \to \pi^- (D^*\underline{D}^*)^+$+c.c. @4.26 GeV

Partial reconstruction technique: reconstruct D^+ from D^{*+} decay, bachelor π^-, and at least one soft π0 from $D^* \to D^0 \pi$or $D^{*+} \to D^+\pi^0$ decays .





Fit to $\pi^\pm$ recoil mass yields 401±47 Z_c(4025) events. **>10σ**

The pole mass and with:

$M(Z_c(4025)) = 4026.3 \pm 2.6 \pm 3.7$ MeV; $\Gamma(Z_c(4025)) = 24.8 \pm 5.7 \pm 7.7$ MeV

$$\sigma(e^+e^- \to \pi^\pm (D^*\overline{D}^*)^\mp) = (137 \pm 9 \pm 15)\ \text{pb}$$

$$R = \frac{\sigma(e^+e^- \to \pi^\pm Z_c^\mp \to \pi^\pm (D^*\overline{D}^*)^\mp)}{\sigma(e^+e^- \to \pi^\pm (D^*\overline{D}^*)^\mp)} = (65 \pm 9 \pm 6)\ \%$$

arXiv:1308.2760 submitted to PRL

Summary of Z states

Channel	Mass [MeV/c^2]	Width [MeV]
$J/\psi\,\pi^+$	$3899.0 \pm 3.6 \pm 4.9$	$46 \pm 10 \pm 20$
$(D\bar{D}^*)^+$	$3883.9 \pm 1.5 \pm 4.2$	$24.8 \pm 3.3 \pm 11.0$
$h_c\pi^+$	$4022.9 \pm 0.8 \pm 2.7$	$7.9 \pm 2.7 \pm 2.6$
$(D^*\bar{D}^*)^+$	$4026.3 \pm 2.6 \pm 3.7$	$24. \pm 5.6 \pm 7.7$

Close to D*D* threshold=3875 MeV

Close to D*D* threshold=4017 MeV

With electric charge thus has two more light quarks! ➔ Nquark ≥ 4 !

Clear **signature of exotic state**

Nature of these states?

- Tetraquark L. Maiani, A. Ali et al.
- Hadronic molecule U.-G. Meissner, F.K. Guo et al.
- Hadro-charmonium M. B. Voloshin
- Meson loop Q. Zhao et al.
- ISPE model X. Liu et al.
- …

Charm physics at BESIII

Advantage of open charm at threshold

e^+e^- colliders@threshold:

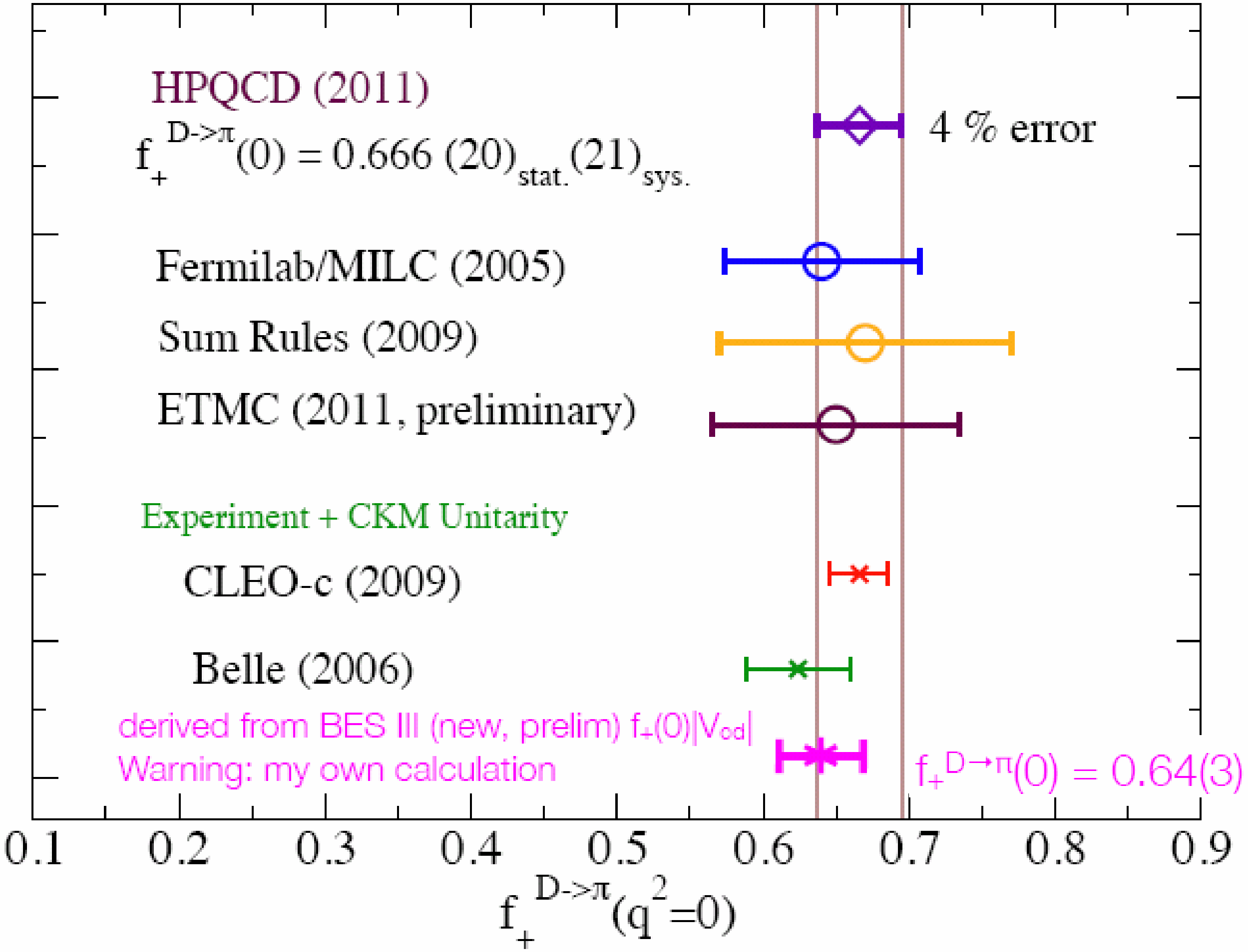
$$e^+e^- \to \psi(3770) \to D^0\bar{D}^0 \quad [C=-1] \quad \text{OR} \quad e^+e^- \to \gamma^* \to D^0\bar{D}^0\gamma \quad [C=+1]$$

Good for charm flavor physics:

- Threshold production: clean
- Known initial energy and quantum numbers
- Both D and Dbar fully reconstructed (double tag)
- Absolute measurements
- Quantum correlation allow to determine the relative phase / CP violation in D decays/mixing parameters

$f_+^{D\to\pi}(0)$ from experiment and theory

Taken from Na, Davies, Follana, Koponen, Lepage and Shigemitsu, Phys.Rev. D84 (2011) 114505 and modified (added BES III)

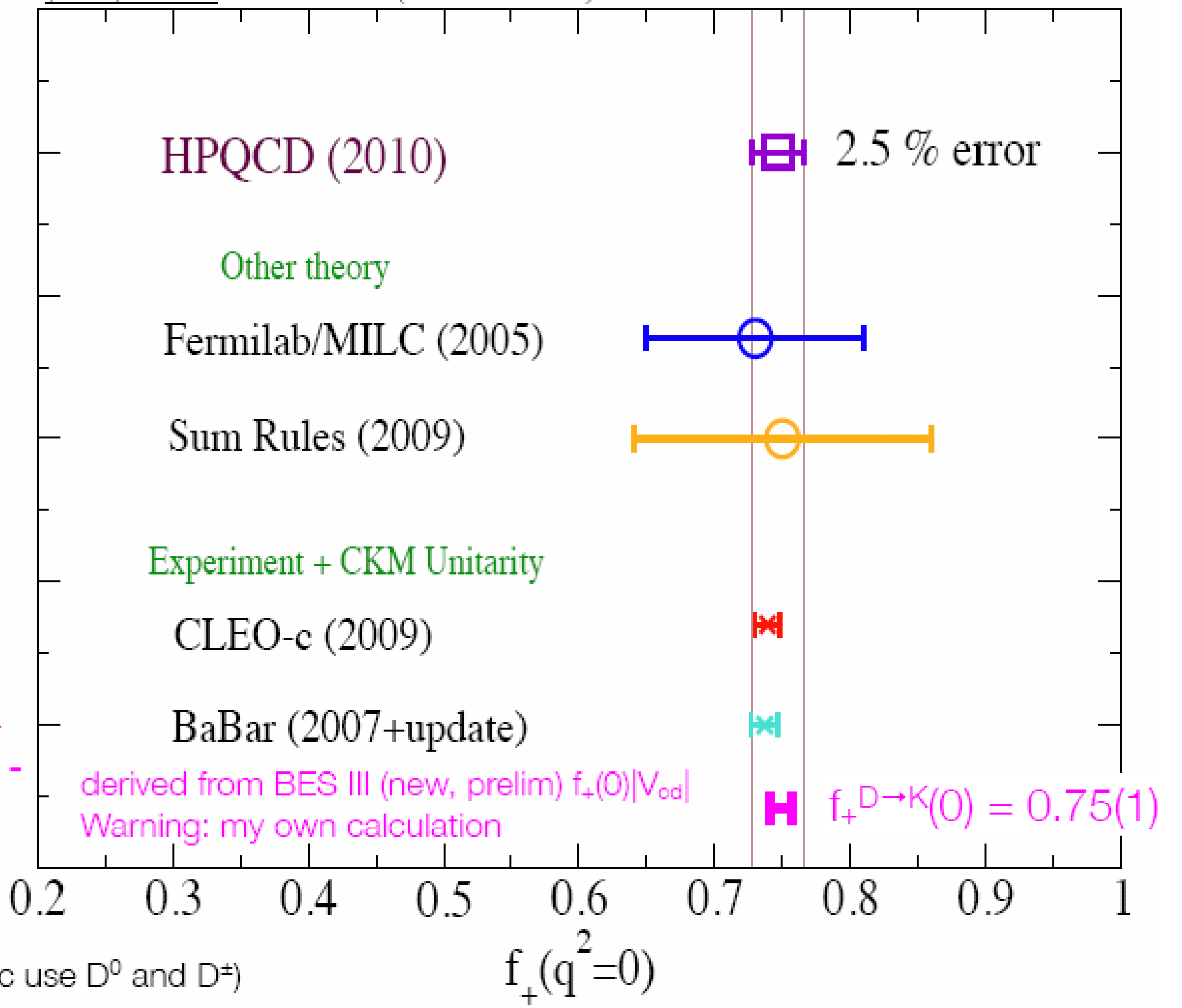


With $|V_{cd}| = 0.2252 \pm 0.0007$, I get from BES III new result (3 par series - as used by CLEO-c):

(note: BES III result from D^0 only, CLEO-c use D^0 and $D^\pm$)

$f_+^{D\to K}(0)$ from experiment and theory

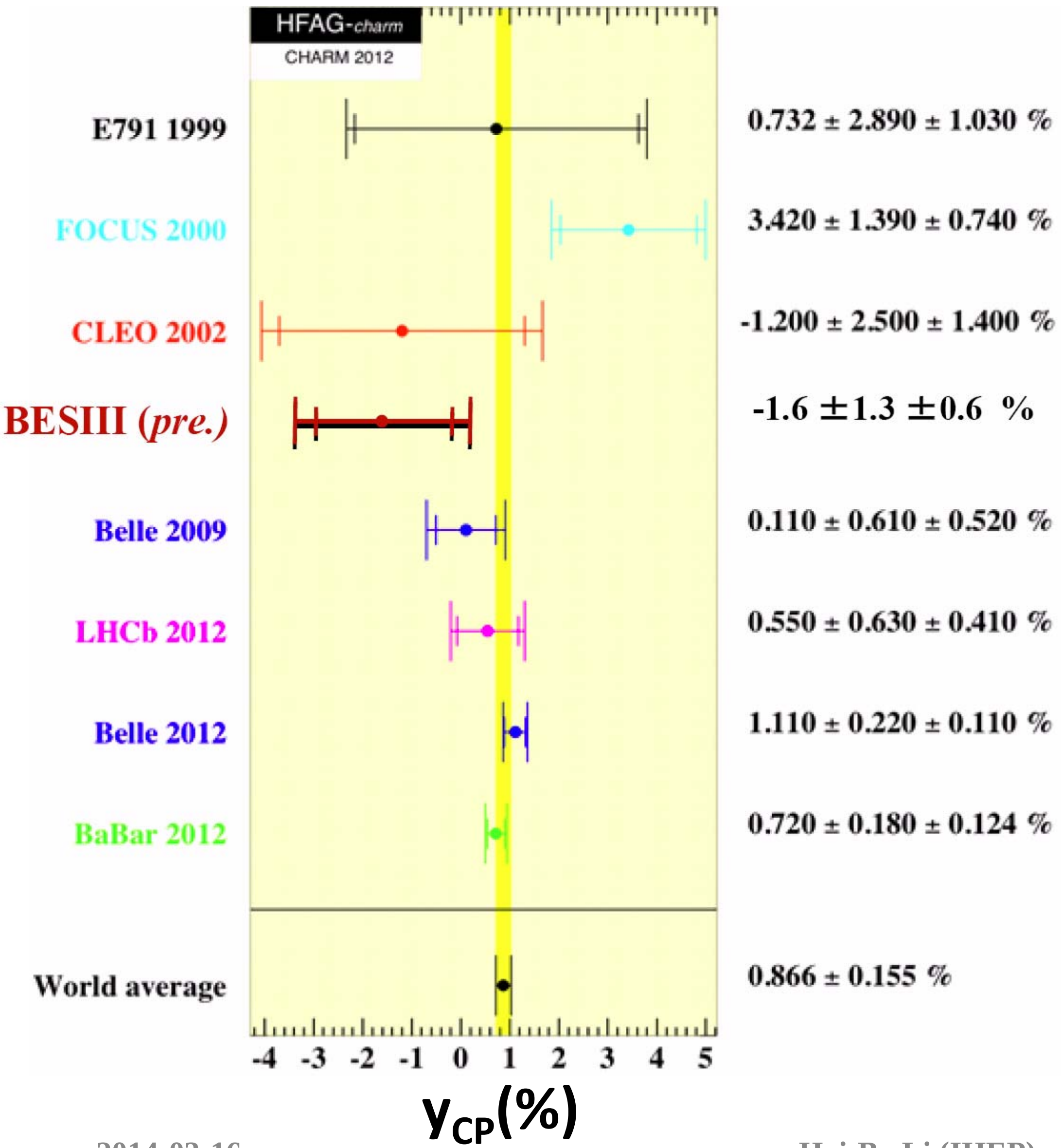
Taken from Na, Davies, Follana, Koponen, Lepage and Shigemitsu, Phys.Rev. D82 (2010) 114506 and modified (added BES III)



With $|V_{cs}| = 0.97345$, I get from BES III new result (3 par series - as used by CLEO-c):

(note: BES III result from D^0 only, CLEO-c use D^0 and $D^\pm$)

Comparison with world measurement

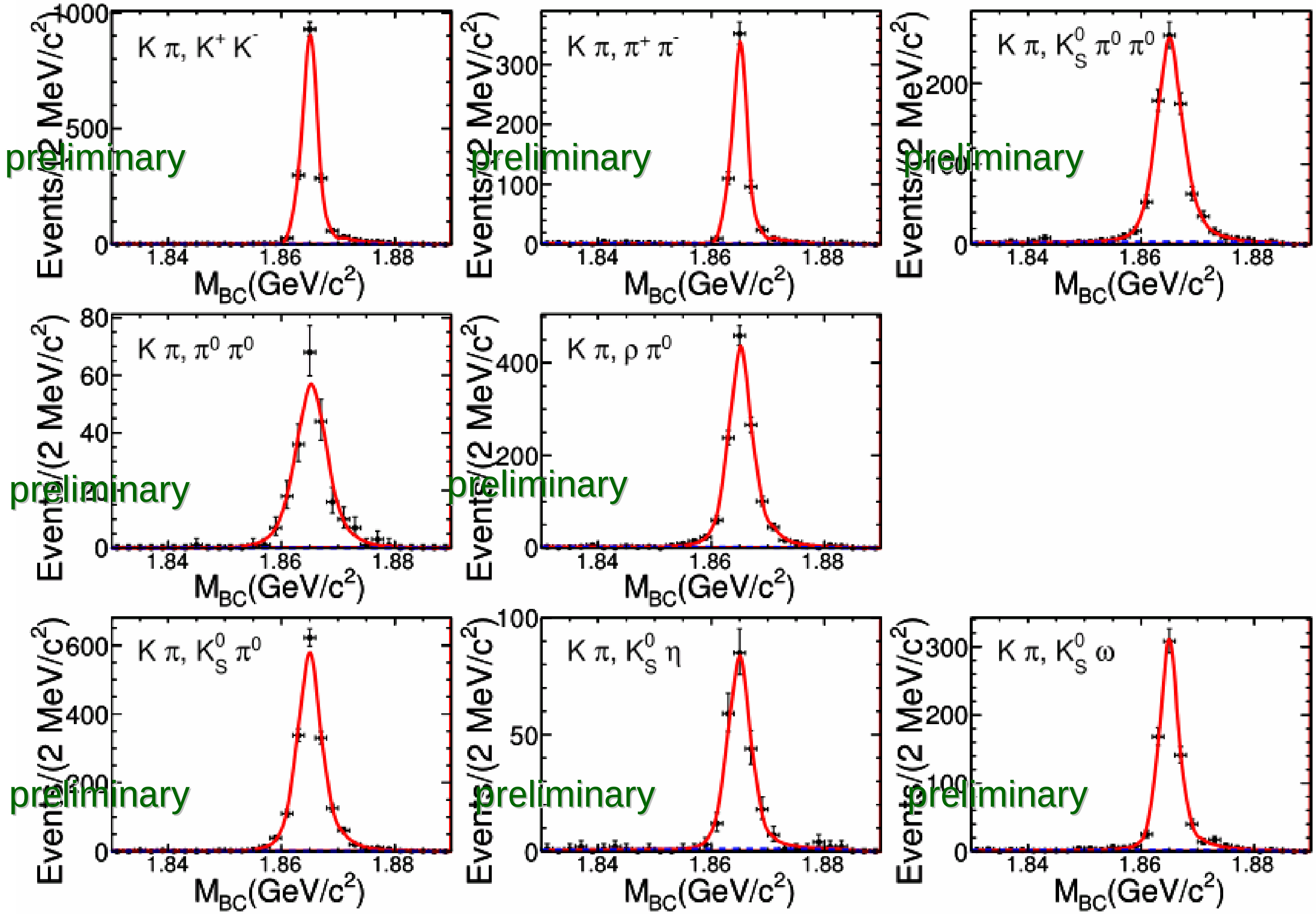


compatible with
world average results

CLEOc 2012:
[PRD 86 (2012) 112001]
y_{CP}=(4.2±2.0 ±1.0)%

best precision in Charm factory

Double tags of (CP, $K\pi$) modes



arXiv:1304.6170

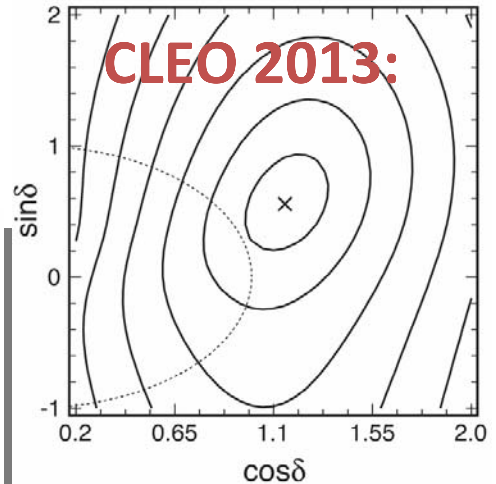
Sensitivity of the global fit at BESIII

- MC study corresponds to 3.0 / fb data
- input of the central values of the world average in 2012:
- with the external constrains of :

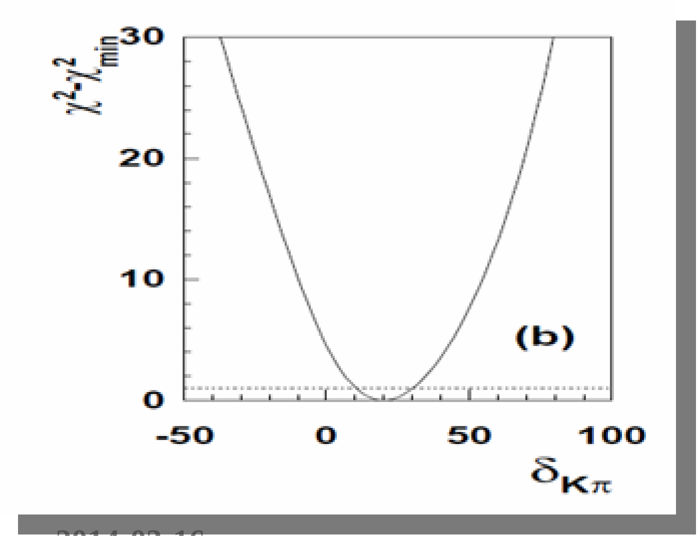
$$\delta_{K\pi} = 22.1^{+9.7}_{-11.1}(^o),\ y_D = 0.75 \pm 0.12(\%)$$

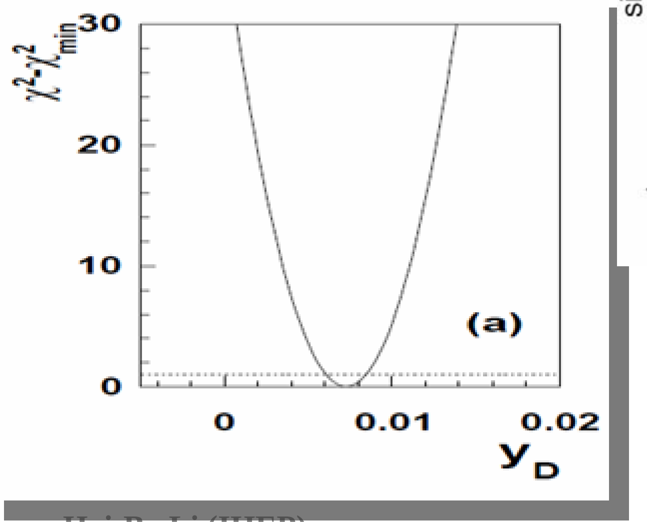
- output:

$$\delta_{K\pi} :\ \pm 8.3(^o),\ y_D :\ \pm 0.10(\%)$$



$$\delta = (18^{+11}_{-17})^{\circ}$$





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