Status of BES-III Experiment

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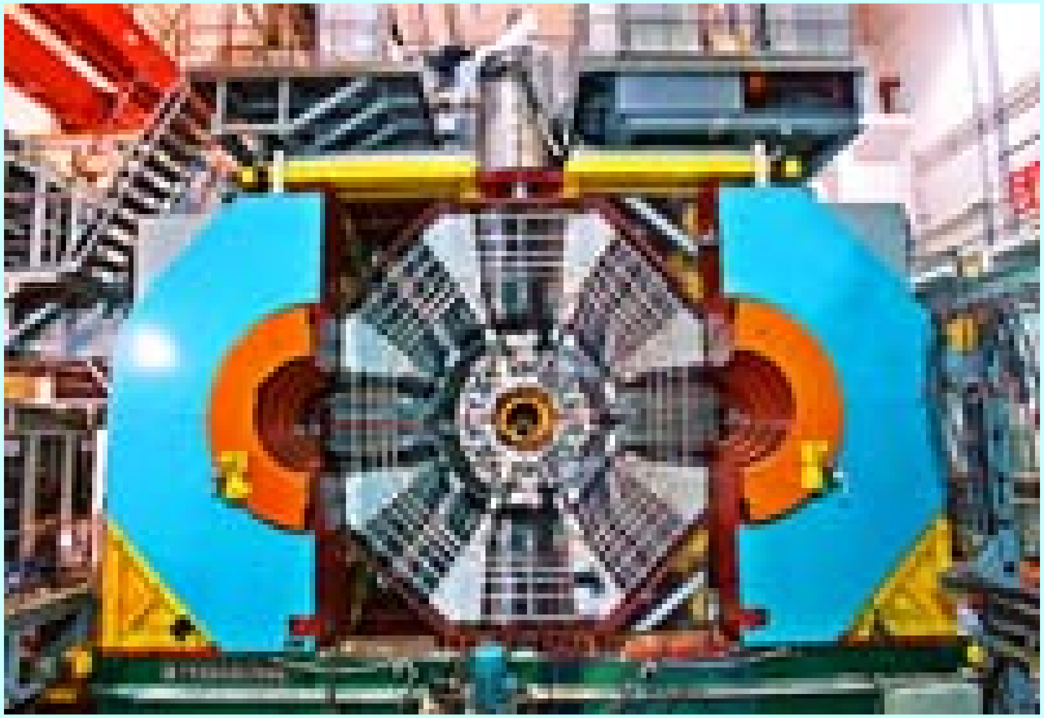
for BES-III Collaboration
IHEP, Beijing

Heavy Quarks and Leptons,
5 June-9 June 2008
School of Physics,
The University of Melbourne
Australia

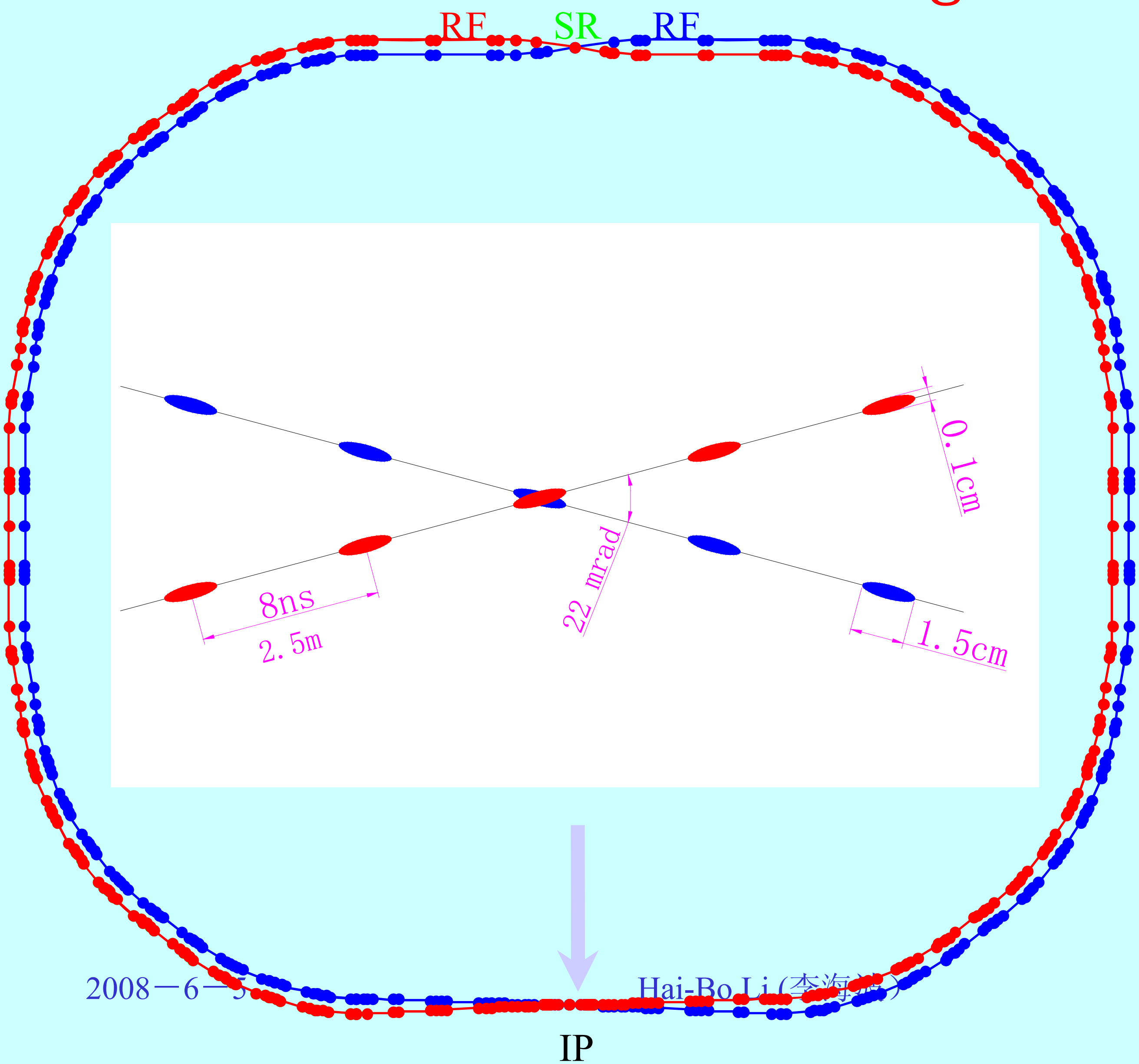


Outline

- BEPC-II/BES-III detectors
- Physics program at BESIII
- Summary

Status of BEPC-II and BES-III

BEPC II Storage ring: Large angle, double-ring



Beam energy:
1.0-2.3 GeV
Luminosity:
1×10^{33} $cm^{-2}s^{-1}$
Optimum beam energy:
1.89 GeV
Energy spread:
5.16×10^{-4}
No. of bunches:
93
Bunch length:
1.5 cm
Total current:
0.91 A
SR mode:
0.25A @ 2.5 GeV

Milestone of BEPCII storage ring commissioning

Nov. 2006 Beam stored in the storage ring

Dec. 2006 Start to provide SR beams for users

Mar. 2007 First e^+e^- collision, Lumi ~ 10^{30} cm^{-2} s^{-1}

June 2007 Provide SR beams for users at 2.5GeV, 200 mA with a lifetime of 5.5 hr

Aug. 2007 Beam current reached 500 mA

Sep. 2007 SCQ moved to the interaction region

Jan. 2008 BEPCII: collision with 500mA×500mA and 93 bunches in each ring the luminosity is about $1*10^{32}cm^{-2}s^{-1}$

June 20 2008 First physics collision

Charm productions per year at BEPCII

Average Lum: $\mathcal{L}$ = 0.5×Peak Lum.; One year data taking time: T = 10^7s

$$\sigma_{exp}(W) = \int_0^\infty dW' \sigma_{r.c.}(W') G(W', W)$$

N_{event}/year = $\sigma_{exp} \times L \times T$

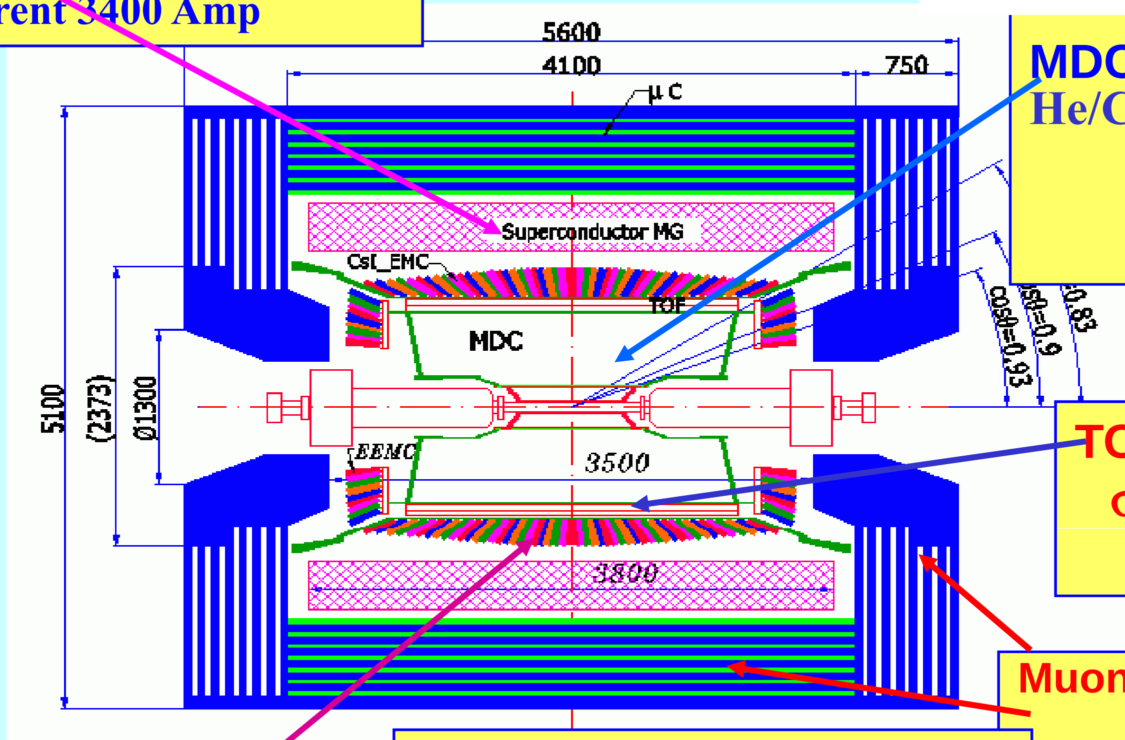
Resonance	Mass(GeV) CMS	Peak Lum. ($10^{33}cm^{-2}s^{-1}$)	Physics Cross Section (nb)	#Nevents/year
J/ψ	3.097	0.6	3400	10×10^9
$\tau^+\tau^-$	3.670	1.0	2.4	12×10^6
$\psi(2S)$	3.686	1.0	640	3.2×10^9
D^0D^0bar	**3.770**	**1.0**	**3.6**	**18×10^6**
D^+D^-	**3.770**	**1.0**	**2.8**	**14×10^6**
DsDs	**4.030**	**0.6**	**0.32**	**1.0×10^6**
DsDs	**4.170**	**0.6**	**1.0**	**2.0×10^6**

BES-III

BESIII detector: all new !

CsI calorimeter
Precision tracking
Time-of-flight + dE/dx PID

Magnet: 1 T Super conducting current 3400 Amp



MDC: small cell & Gas: He/C3H8 (60/40)
σ_{xy}=130 μm
σ_p/p = 0.5% @1GeV
dE/dx=6%

TOF:
σ_T = 100 ps Barrel
110 ps Endcap

Muon ID: 9 layers RPC
8 layers for endcap

EMC: CsI crystal
ΔE/E = 2.5% @1 GeV
σz = 0.6 cm/√E

Data Acquisition:
Event rate = 4 kHz
Total data volume ~ 50 MB/s

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

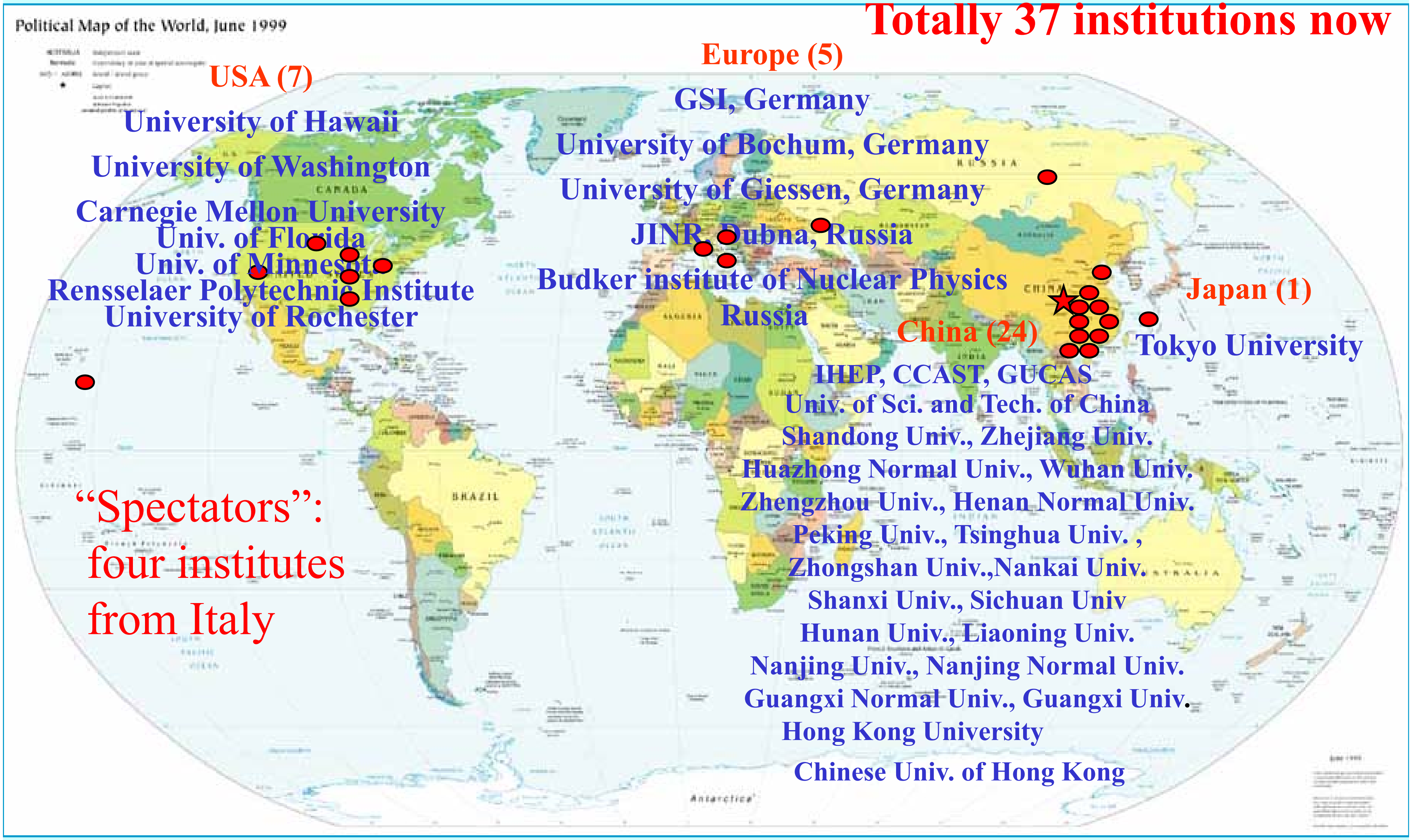
Detector properties

Subdetector	BESIII	BESII	CLEOc
MDC	σ_{xy} = 130 um	250 um	90 um
	ΔP/P = 0.5% @ 1GeV	2.4%@1GeV	0.5% @ 1GeV
	dE/dx resolution 6-7 %	8.5%	6 %
EMC	ΔE/E = 2.5% @ 1 GeV Δ θ ~5mrad @ 1 GeV	20%@1GeV 25mrad @1GeV	2%
TOF	σ_T: barrel:100 ps end-cap:110 ps	180 ps barrel 350 ps endcap	RICH
Muon Identifier	9 layers	3 layers	----
Magnet	1.0 Tl	0.4 Tl	1.0 Tl

BESIII Status

- ✓ **Finish the installation of all the detector components.**
  Beam pipe, MDC, Barrel and endcap TOF, barrel and endcap EMC, all muon chambers.
- ✓ **Cosmic ray data from Dec. 2007 to March 15 2008, with DAQ, Trigger, and Slow control, fixing problems.**
- ✓ **BESIII detector into beam-line on May 6, 2008**
- ✓ **Starting another cosmic run on May 28, 2008**
- ✓ **Physics run on July 20, 2008**
- ✓ **Luminosity of BEPCII is expected to reach ~**
  3 x $10^{32}cm^{-2}s^{-1}$ in the end of 2008.
  [The design Lum is 1 x $10^{33}cm^{-2}s^{-1}$]
- ✓ **Software and physics preparation in good shape.**

BESIII collaboration



Hot physics topics at BES-III

Hot topics at BES-III

- Light hadron spectroscopy:
  meson, baryon, hybrid, glueball and other exotics in J/ψ and $\psi(2S)$ decays.
- Charmonium states: $\eta_c(1S)$, $\eta_c(2S)$, J/ψ, $\psi(2S)$, χ_c, h_c, $\psi(3770)$, new ccbar states above 4.0 GeV

- Energy scan: R values, new resonances …
- Tau physics: precision tau mass
- Charm physics: D, Ds mesons

Leptonic Charm Decays $D \to l + \nu$

Semileptonic decay rates & form-factors

Charm Dalitz Decays, ……

Charm Mixing. CP Violation and Rare charm decays …

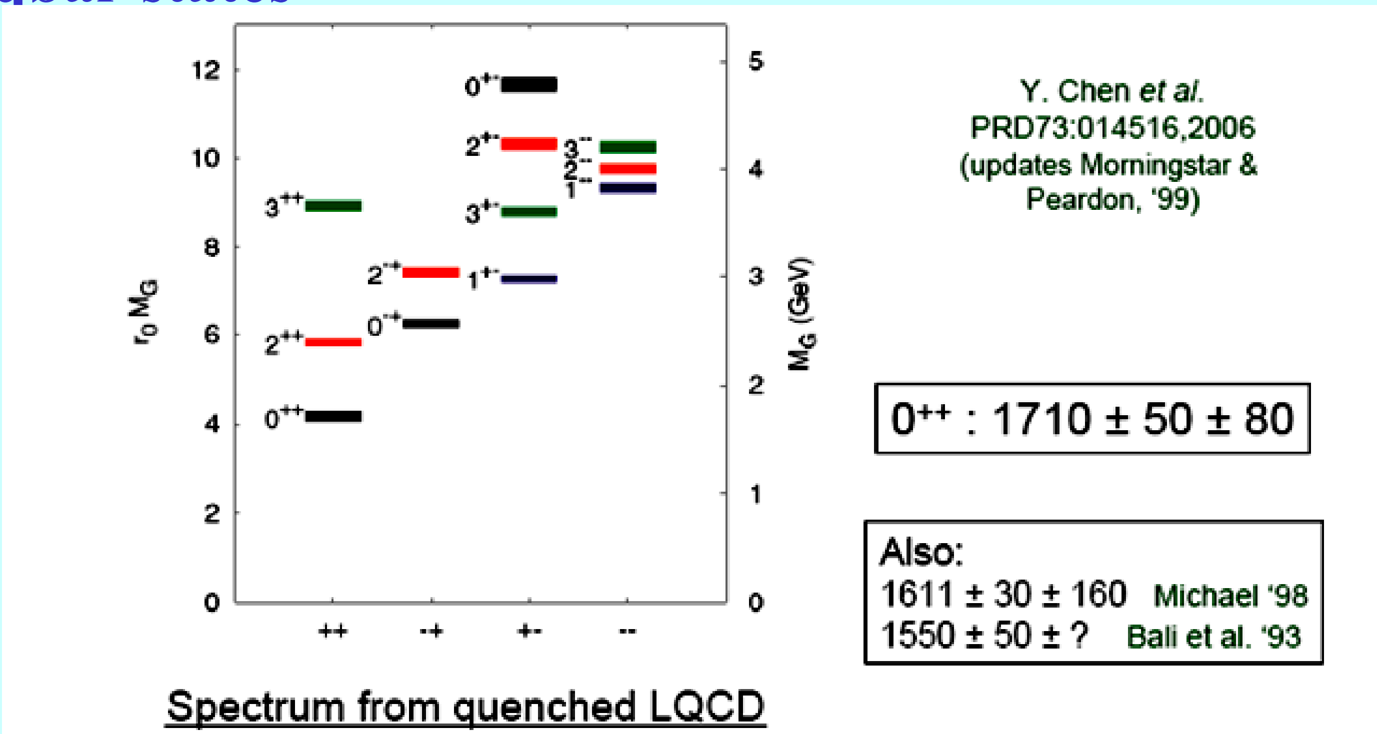
- **Rare charmonium decays:**

LFV, invisible decays , …… many more unexpected innovations

Light hadron spectroscopy

With 10^{10} J/ψ events with the state of art detector, we expect to learn more on:

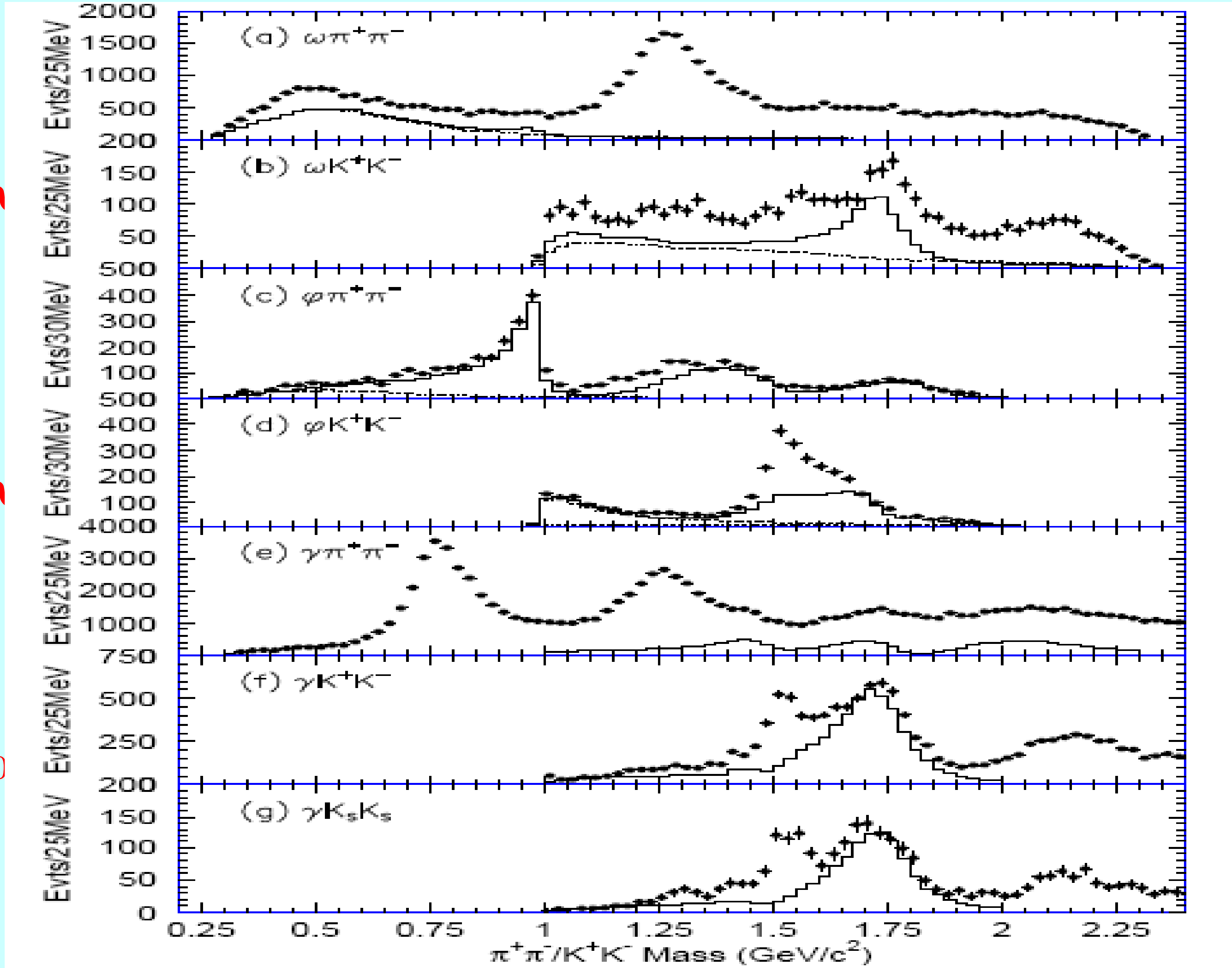
- **Baryon spectroscopy**
- **Glueballs**
- **Non-qqbar states**



Spectrum of glueballs from LQCD

0^{++} resonances at BESIII

J/



J/

χ_{c0}

States with Exotic quantum number

Hybrid mesons and glueballs are always mixing with normal mesons with the same quantum numbers.
It is hard to us to separate them from normal mesons.

Quantum numbers of fermion-antifermion

$^{2s+1}L_J$	J^{PC}	Meson
$^1S_0$	0^{-+}	π
$^3S_1$	1^{--}	ρ
$^1P_1$	1^{+-}	b_1
$^3P_0$	0^{++}	a_0
$^3P_1$	1^{++}	a_1
$^3P_2$	2^{++}	a_2

1^{-+}:

$\pi\eta$ (s-wave)	a_0
$\pi\eta$ (p-wave)	π_1
$\pi\eta$ (d-wave)	a_2
$\pi\rho$ (p-wave)	π_1
πf_1 (s-wave)	π_1
πb_1 (s-wave)	π_1

Exotic quantum numbers

J^{PC}
0^{+-}
0^{--}
→ 1^{-+}
2^{+-}
3^{-+}

Example

X(1835) at BESIII via $J/\psi \to \gamma\eta'\pi^+\pi^-, \eta' \to \eta\pi^+\pi^-$

58M J/ψ data

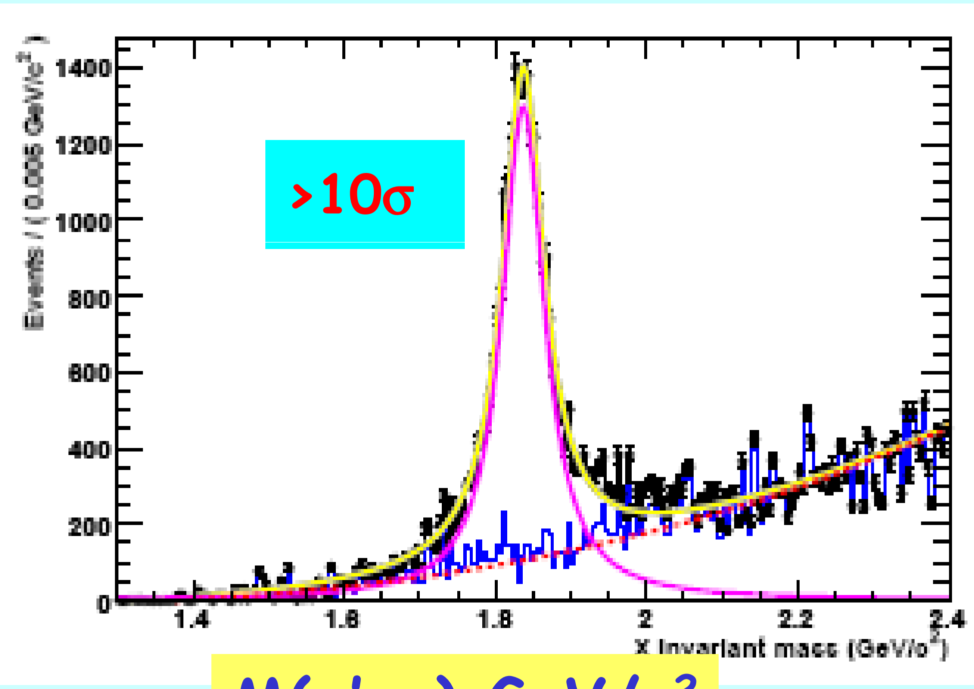
Phys.Rev.Lett.95:262001,2005

at BESIII

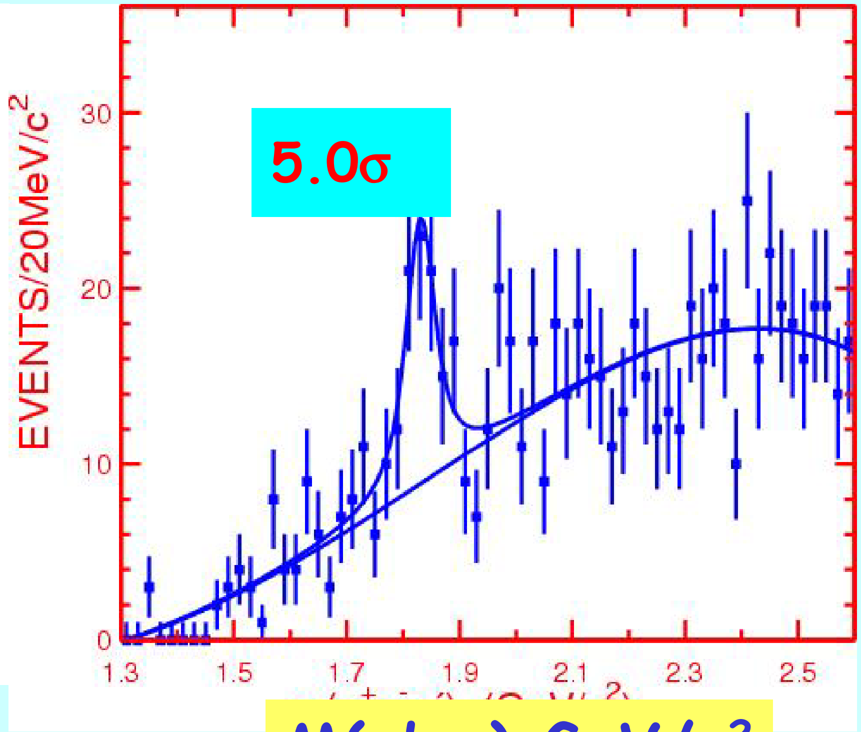
3×10^9 J/psi events (50 times of BESII)

at BESII

2 years' data taking



M(η'ππ) GeV/c²



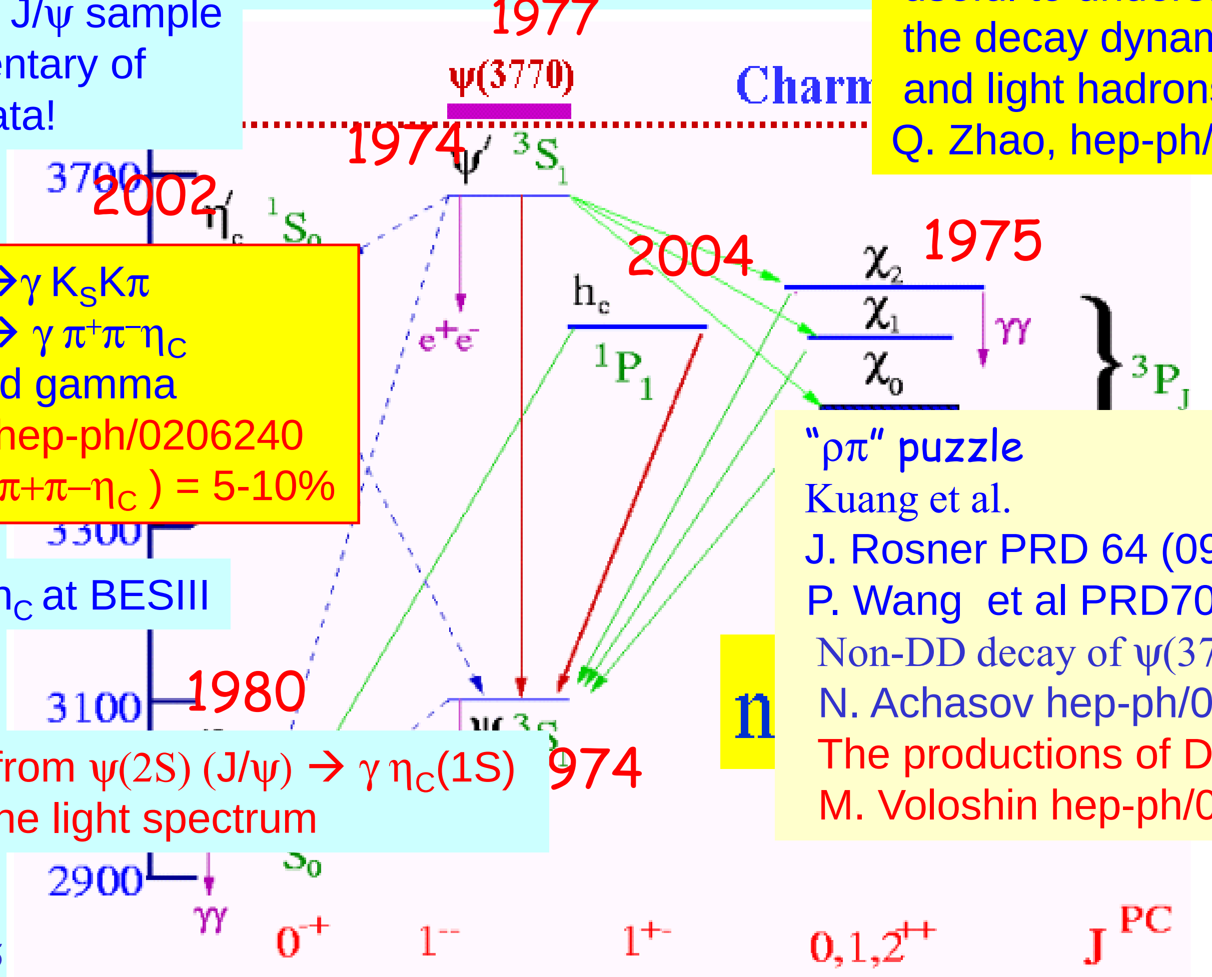
M(η'ππ) GeV/c²

Charmonium states below open charm

What can we do with 3 billion $\psi(2S)$?

$\Psi(2S) \rightarrow \pi^+\pi^- J/\psi$ (31%)
really "pure" J/ψ sample
a complementary of
J/ψ peak data!

$\chi_{c,0,1,2}$ sample
useful to understand
the decay dynamics of ccbar
and light hadrons
Q. Zhao, hep-ph/0508086



η_c' in $\psi(2S) \rightarrow \gamma K_S K\pi$
$\psi(2S) \rightarrow \gamma\, \pi^+\pi^- \eta_C$
with untagged gamma
M. Voloshin hep-ph/0206240
$B(\eta_C(2S) \rightarrow \pi^+\pi^-\eta_C) = 5\text{-}10\%$

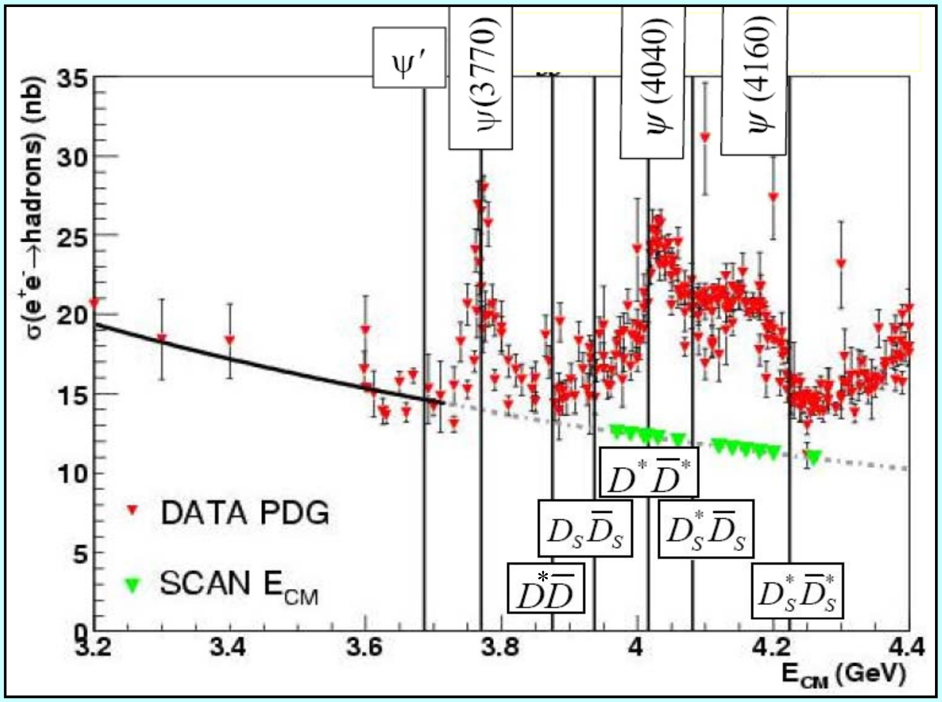
Detail study of h_C at BESIII

"ρπ" puzzle
Kuang et al.
J. Rosner PRD 64 (094002) 2001
P. Wang et al PRD70(114014)2004
Non-DD decay of $\psi(3770)$:
N. Achasov hep-ph/0505146
The productions of D^0D^0, D^+D^-
M. Voloshin hep-ph/0402171

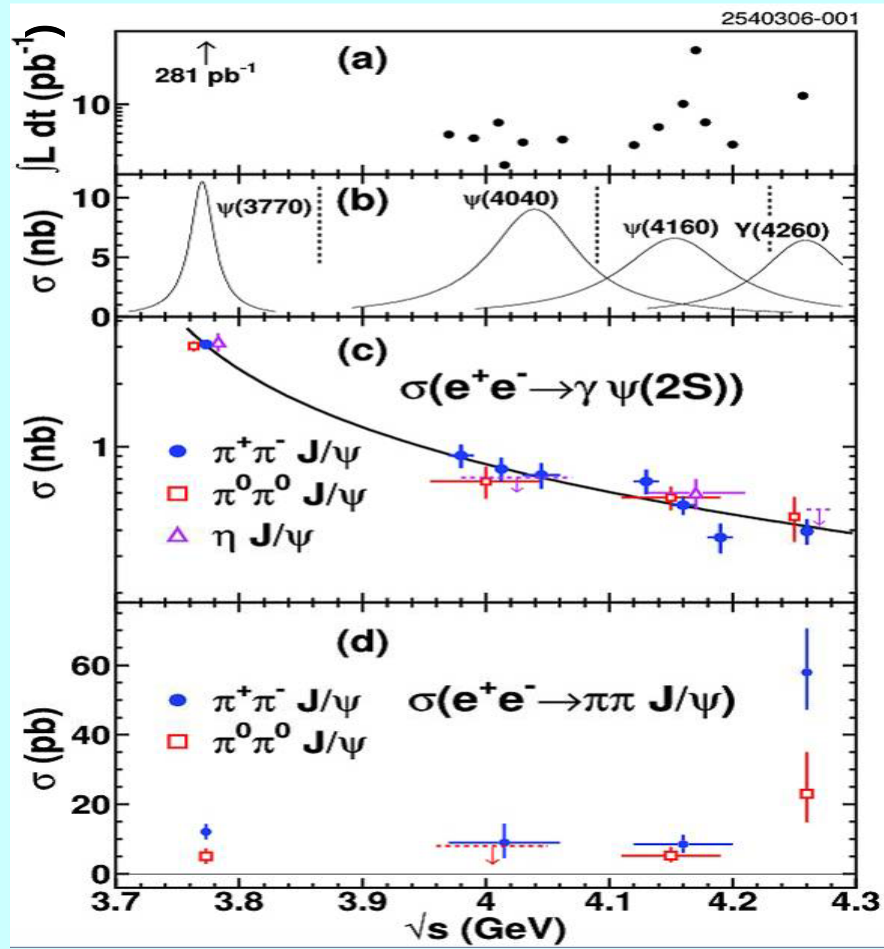
$\eta_C(1S)$ sample from $\psi(2S)$ (J/ψ) $\rightarrow \gamma\, \eta_C(1S)$
used to study the light spectrum

Scan will be crucial at BES-III: E_{CM} = 3773-4600 MeV

Opportunity at BESIII to look for new states above the open charm region.



CLEO-c Preliminary
Ron Poling talk at Charm2006



CLEO-c PRL 96, 162003 (2006)

Rare and forbidden quarkonium decays

No any evidence beyond SM is found on the accelerators.
No any indication beyond SM in Quarkonium decays.

Rare and forbidden Charmonium decays :

(1) Lepton Flavor/baryon number violating decays;

(2) Invisible decays .

Lepton flavor violating processes in J/ψ decays

Lepton flavor violating (LFV) processes are strongly suppressed in the Standard Model by power of (small) neutrino masses. Such decays signal new physics.

PRD63, 016003, S. Nussinov, R.D. Peccei and X.M. Zhang

BESII upper limit

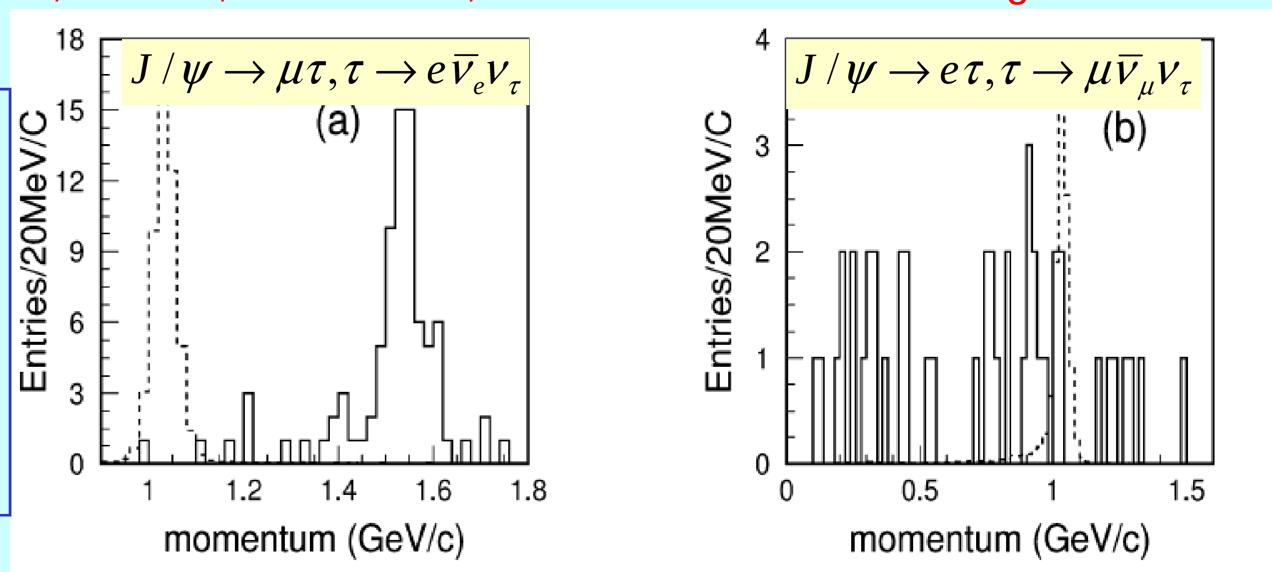
BR(J/ψ → eμ) < 1.1×10^{-6}

BR(J/ψ → eτ) < 8.3×10^{-6}

BR(J/ψ → μτ) < 2.0×10^{-6}

with 58M J/ ψ sample

BESII
PLB561, 49 (2003)
PLB598, 172(2004)



μ momentum distribution

J/ψ → eμ, eτ, τμ, the sensitivity can be 10^{-8} – 10^{-9} at BES-III with 10^{10} J/ψ events per year

J/ψ → e^- proton +c.c, J/ψ → μ^- proton +c.c can also be searched for.

Invisible quarkonium decays

With in SM, the invisible quarkonium decays are predicted by:
hep-ph/9806487, L.N Chang, O.Lebedlev and J. N. Ng

$$\frac{\Gamma\left(\Upsilon \to \nu\bar{\nu}\right)}{\Gamma\left(\Upsilon \to e^+e^-\right)} = \frac{27G^2M_\Upsilon^4}{64\pi^2\alpha^2}(-1+\frac{4}{3}\sin^2\theta_W)^2$$
$$= 4.14 \times 10^{-4} \,,$$
$$\frac{\Gamma(J/\Psi \to \nu\bar{\nu}))}{\Gamma(J/\Psi \to e^+e^-)} = \frac{27G^2M_{J/\Psi}^4}{256\pi^2\alpha^2}(1-\frac{8}{3}\sin^2\theta_W)^2 \,,$$
$$= 4.54 \times 10^{-7} \,,$$

With 2-3% uncertainty!

One get:

$Br(Y(1S) \to \nu\bar{\nu}) = 1.0\times10^{-5}$

$Br(J/\psi \to \nu\bar{\nu}) = 2.69 \times10^{-8}$

Theoretical clean process can be used to test model and probe new physics!

New physics may enhance the production rate of the invisible decays of quarkonia. For example, MeV dark matter candidates.

hep-ph/0506151 **Bob McElrath**

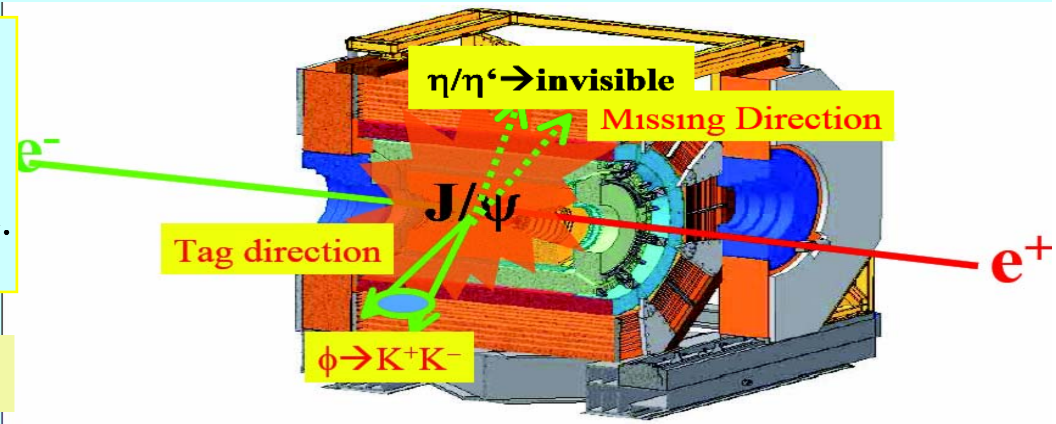
Invisible decays of mesons

- **Search for η/η' → Invisible Decays in J/ψ → φη/η'** **58 million J/ψ**

$$\frac{BR(\eta \to invisible)}{BR(\eta \to \gamma\gamma)} < 1.65\times10^{-3} \ @90\%C.L.$$

$$\frac{BR(\eta' \to invisible)}{BR(\eta' \to \gamma\gamma)} < 6.69\times10^{-2} \ @90\%C.L.$$

BES, Phys.Rev.Lett.97:202002,2006

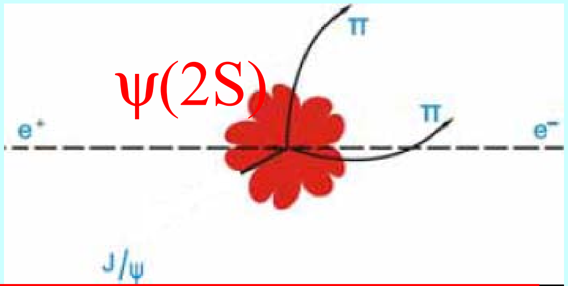


- **Search for J/ψ Invisible Decays** by using **ψ(2S)→π⁺π⁻ J/ψ^invisible**

14 million ψ(2S)

$$\frac{B(J/\psi \to invisible)}{B(J/\psi \to \mu^+\mu^-)} < 1.0\times10^{-2} \ @90\%C.L.$$

BES, Phys. Rev. Lett. 100: (2008)

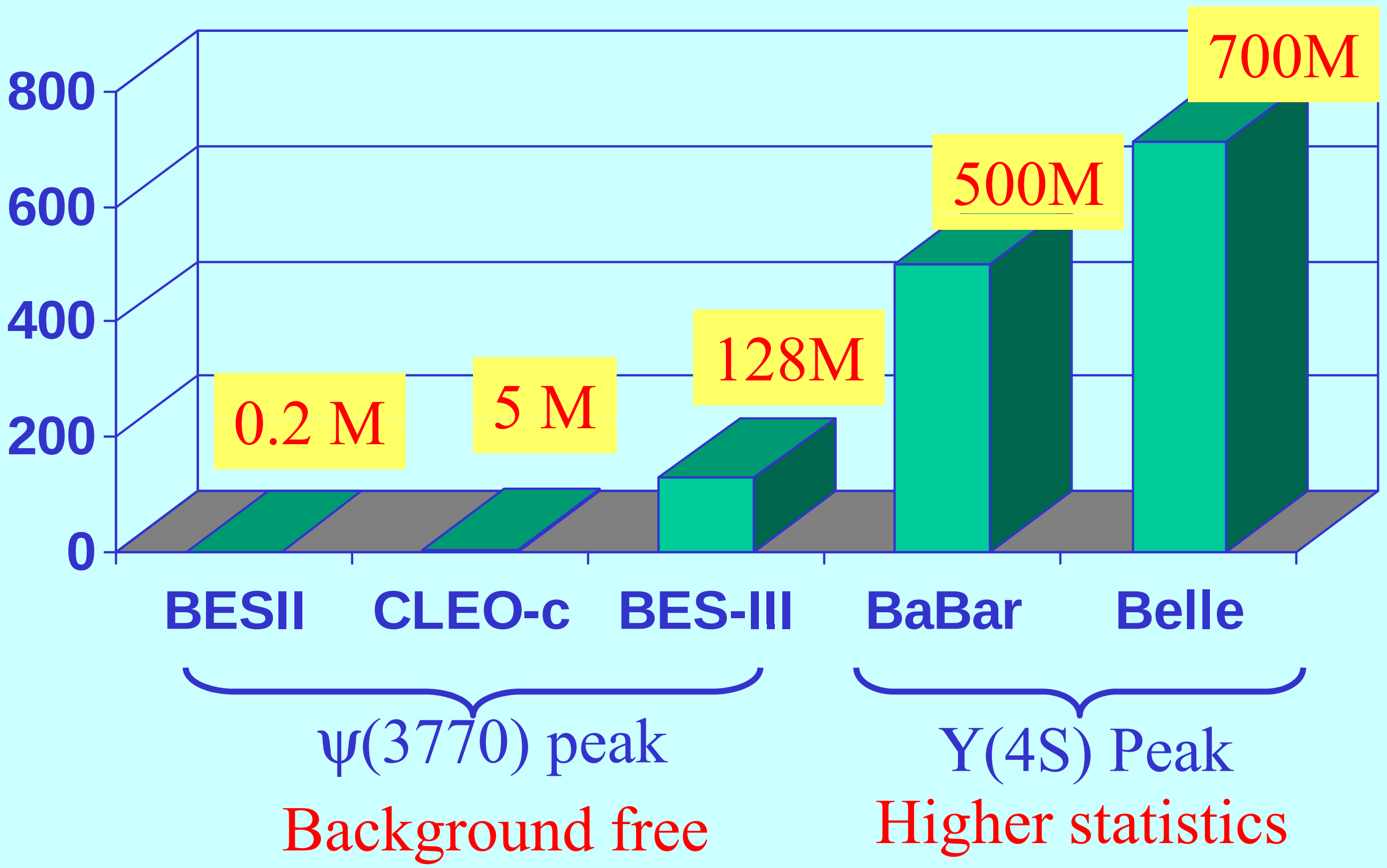


The sensitivity at BESIII will be 10^{-6} – 10^{-7} for J/ψ, χ_C , η_C η, η'→ Invisible

Charm physics at BES-III

$D\overline{D}$ Pairs at different Experiments

128 M is expected at BES-III with 4 years' luminosity.
5 M is expected at CLEO-c until 2008.

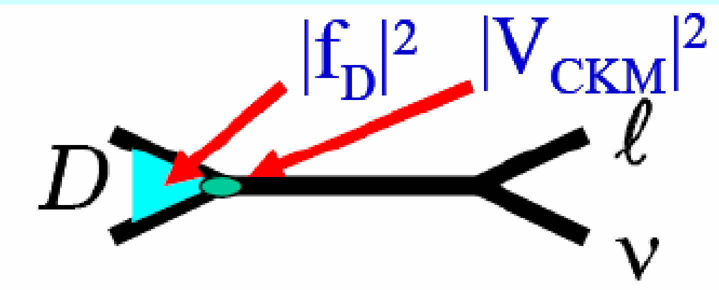


Impact of Charm Physics

- **Precision CKM**
  - **Leptonic Charm Decays $D\to\ell^+\nu$**
  - **Semileptonic decay rates & form-factors**
  - **Hadronic Charm Decays - $B\to$Charm is dominant**
- **Possible New Physics in Charm Sector**
  - **Rare Charm Decays**

    (Heavily GIM suppressed: BF($c\to ull$)~10^{-8})
  - **Charm Mixing.**
  - **CP Violation**

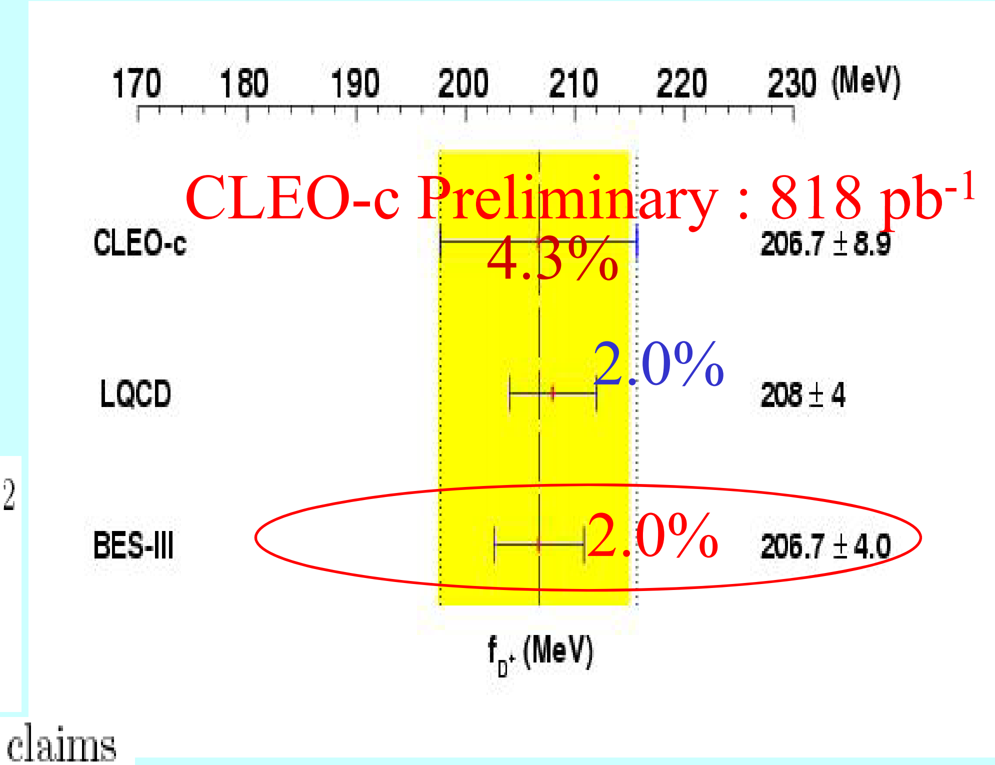
f_{D+} and challenge of QCD



$$\Gamma(D_s^+ \to l^+\nu) = \frac{G_F^2 m_{D_s^+} m_l^2 f_{D_s^+}^2}{8\pi} |V_{cs}|^2 \left(1 - \frac{m_l^2}{m_{D_s^+}^2}\right)^2$$

Recently, the HPQCD+UKQCD collaboration claims better than 2% precision for their unquenched calculations [11] **PRL 100, 062002(2008)**

$$(f_{D+})_{QCD} = (208 \pm 4)\mathrm{MeV},$$
$$(f_{D_s^+})_{QCD} = (241 \pm 3)\mathrm{MeV}, \qquad (7)$$

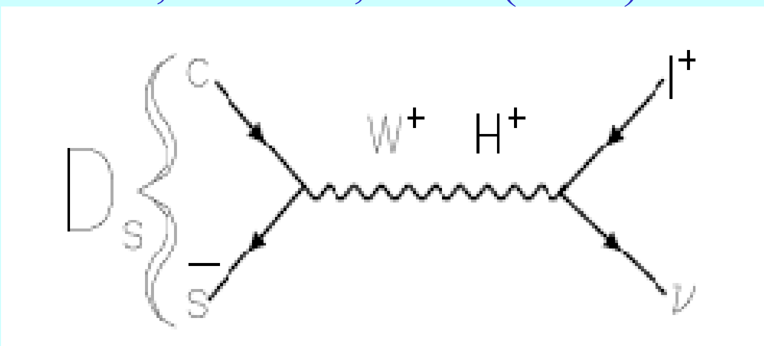


BES-III reaches 2% with 20 fb^{-1} data @ psi(3770).

Precise determination of f_{D_s} –challenge LQCD

H.B.Li ,J.H.Zou arXiv:0804.1822

See Hewett [hep-ph/9505246] & Hou, PRD 48, 2342 (1993).



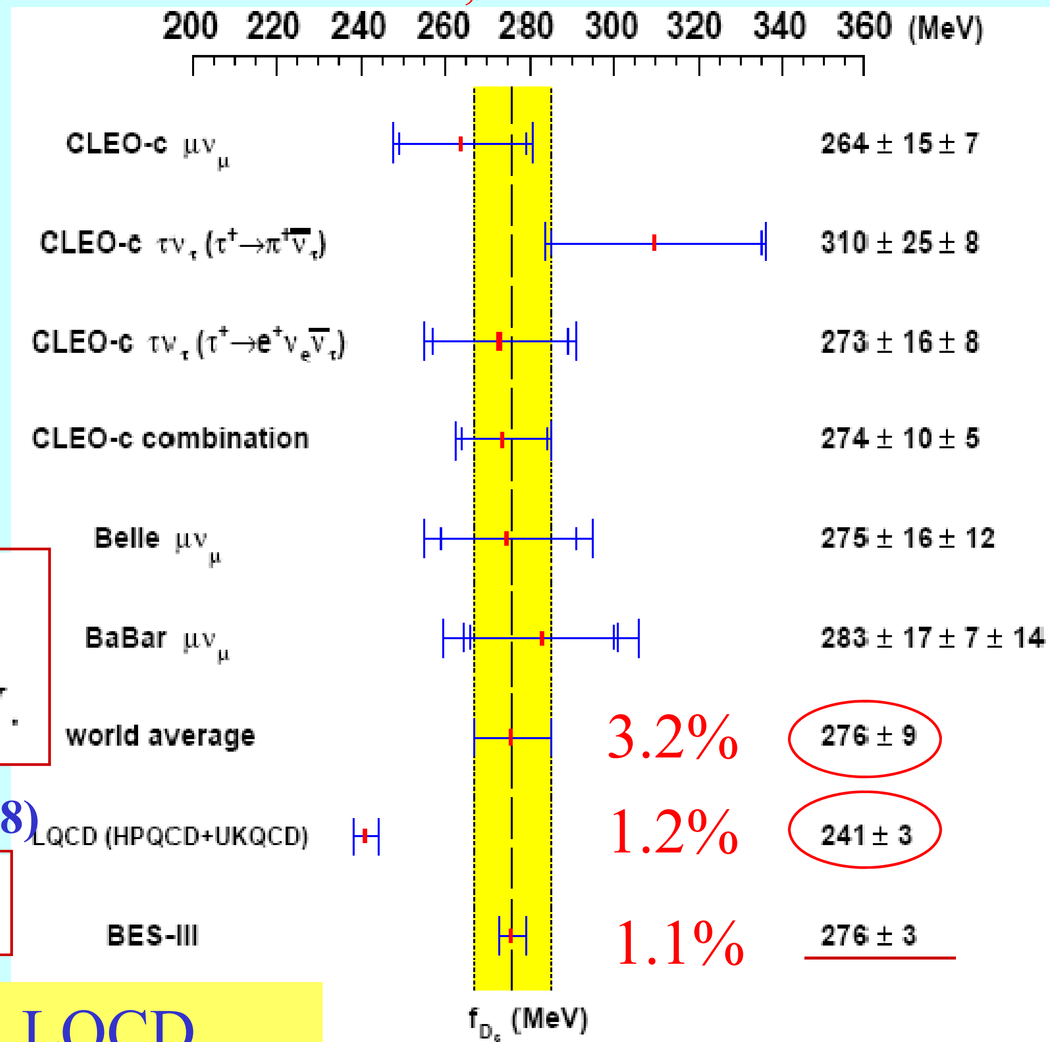
CLEO-c, Belle and BaBar:

The average of $\tau\nu_\tau$ and $\mu\nu_\mu$ values is

$$(f_{D_s^+})_{exp} = (276 \pm 9)\,\mathrm{MeV}.$$

HPQCD+UKQCD PRL 100, 062002(2008)

$$(f_{D_s^+})_{QCD} = (241 \pm 3)\mathrm{MeV},$$



4.0 sigma discrepancy between LQCD and experimental determination in the SM.

Probing new physics in leptonic decays

In the Standard model:

$$\mathcal{R}_\mu \equiv \frac{\mathcal{BR}(D_s^+ \to \mu^+\nu)}{\mathcal{BR}(D^+ \to \mu^+\nu)} = \left|\frac{f_{D_s^+}}{f_{D^+}}\right|^2 \left|\frac{V_{cs}}{V_{cd}}\right|^2 \frac{m_{D_s^+}}{m_{D^+}} \times \left(\frac{1-m_\mu^2/m_{D_s^+}^2}{1-m_\mu^2/m_{D^+}^2}\right) \times \frac{\tau_{D_s^+}}{\tau_{D^+}}.$$

$$r_s = \left[1 - m_{D_s^+}^2 \frac{\tan^2\beta}{m_{H^\pm}^2}\left(\frac{m_s}{m_c+m_S}\right)\right]^2 = \left[1 - m_{D_s^+}^2 R^2 \left(\frac{m_s}{m_c+m_s}\right)\right]^2,$$

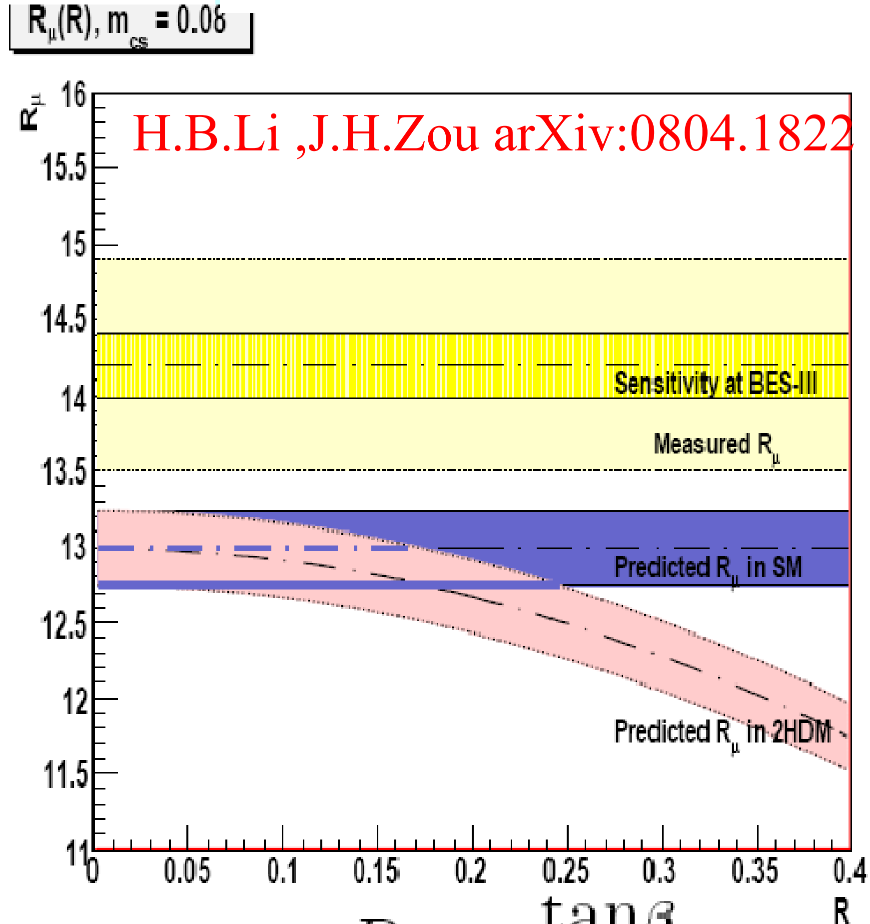
CLEO-c determination:

$$r_{D_s^+/D^+} \equiv \frac{f_{D_s^-}}{f_{D^-}} = 1.23 \pm 0.10,$$

HPQCD+UKQCD: **PRL 100, 062002(2008)**

$$f_{D_s^+}/f_{D^+} = 1.164 \pm 0.011,$$

At BES-III, $\mathcal{R}_\mu$: 2.0% with 20fb^{-1} data at 4170 MeV.



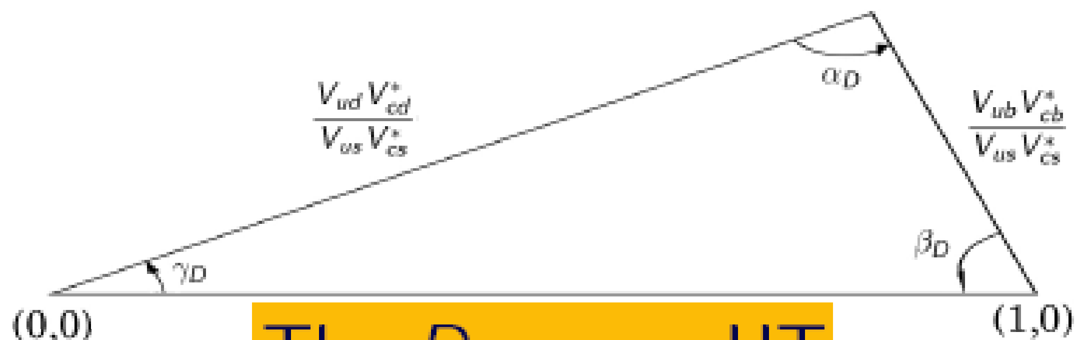
$$R = \frac{\tan\beta}{m_{H^\pm}}$$

The D-meson Unitarity triangle

Many unitarity relations, related to four hadrons (top excluded)

- B_d meson : $V_{ud}V_{ub}^* + V_{cd}V_{cb}^* + V_{td}V_{tb}^* = 0$ $(\lambda^3, \lambda^3, \lambda^3)$
- B_s meson : $V_{us}V_{ub}^* + V_{cs}V_{cb}^* + V_{ts}V_{tb}^* = 0$ $(\lambda^4, \lambda^2, \lambda^2)$
- K meson : $V_{ud}V_{us}^* + V_{cd}V_{cs}^* + V_{td}V_{ts}^* = 0$ $(\lambda, \lambda, \lambda^5)$
- D meson : $V_{ud}V_{cd}^* + V_{us}V_{cs}^* + V_{ub}V_{cb}^* = 0$ $(\lambda, \lambda, \lambda^5)$

$$\frac{V_{ud}V_{cd}^*}{V_{us}V_{cs}^*} + 1 + \frac{V_{ub}V_{cb}^*}{V_{us}V_{cs}^*} = 0$$

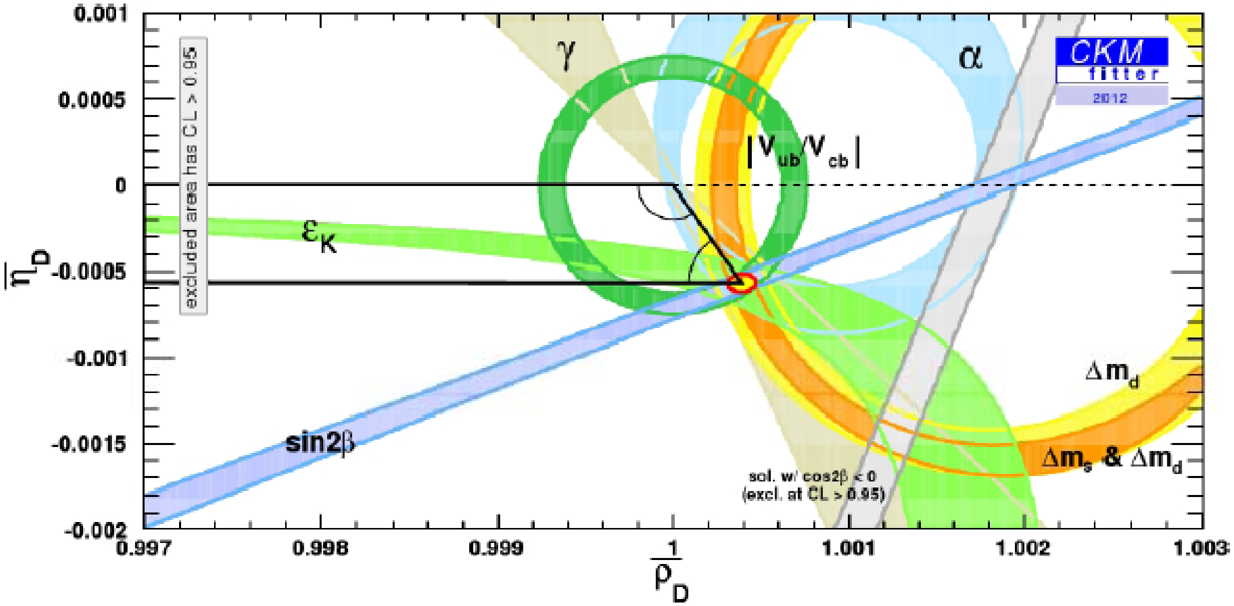


The D-meson UT

can be used to define a (squashed) D-meson unitarity triangle

- $\bar{\rho}_D + i\bar{\eta}_D = -\frac{V_{ud}V_{cd}^*}{V_{us}V_{cs}^*}$
- $\alpha_D = \arg\left(-\frac{V_{ub}V_{cb}^*}{V_{ud}V_{cd}^*}\right) = \arg\left(-\frac{V_{ub}V_{ud}^*}{V_{cb}V_{cd}^*}\right) = -\gamma$
- $\gamma_D = \arg\left(-\frac{V_{ud}V_{cd}^*}{V_{us}V_{cs}^*}\right) = O(\lambda^4)$
- $\beta_D = \arg\left(-\frac{V_{us}V_{cs}^*}{V_{ub}V_{cb}^*}\right) = \pi - \alpha_D - \gamma_D = \pi + \gamma + O(\lambda^4)$

Precise test of CKM in D decays



BES accuracy

- For leptonic D decays

$$\sigma(|V_{cd}|)/(|V_{cd}|) = 2.3\%$$
$$\sigma(|V_{cs}|)/|V_{cs}| = 1.7\%$$
$$\frac{\sigma(|V_{cd}|/|V_{cs}|)}{|V_{cd}|/|V_{cs}|} = 1.3\%$$

- For semileptonic D decays ($D_s \to K$ and $D_s \to \phi$):

$$\sigma(|V_{cd}|)/(|V_{cd}|) = 2.4\%$$
$$\sigma(|V_{cs}|)/|V_{cs}| = 1.3\%$$

Observable	CKM	QCD	Lattice	Exp meas	Exp err
$Br(D \to \ell\nu)$	$\|V_{cd}\|$	f_D	2%	$f_D\|V_{cd}\|$	1.1%
$Br(D_s \to \ell\nu)$	$\|V_{cs}\|$	f_{Ds}	1.5%	$f_{Ds}\|V_{cs}\|$	0.7%
$\frac{Br(D_s\to\ell\nu)}{Br(D\to\ell\nu)}$	$\left\|\frac{V_{cs}}{V_{cd}}\right\|$	$\frac{f_{Ds}}{f_D}$	1%	$\left\|\frac{V_{cs}f_{Ds}}{V_{cd}f_D}\right\|$	0.8%
$d\Gamma(D^0 \to \pi^-)$	$\|V_{cd}\|$	$F_{D\to\pi}(0)$	4%	$\|V_{cd}\|F_{D\to\pi}(0)$	0.6%
$d\Gamma(D^0 \to K^-)$	$\|V_{cs}\|$	$F_{D\to K}(0)$	3%	$\|V_{cs}\|F_{D\to K}(0)$	0.5%
$d\Gamma(D_s \to K)$	$\|V_{cd}\|$	$F_{D_s\to K}(0)$	2%	$\|V_{cd}\|F_{D_s\to K}(0)$	1.2%
$d\Gamma(D_s \to \phi)$	$\|V_{cs}\|$	$F_{D_s\to\phi}(0)$	1%	$\|V_{cs}\|F_{D_s\to\phi}(0)$	0.8%

Quantum Correlation

At BES-III:

$D\overline{D}$ pair with L =1 must be in anti-asymmetric state

$$|D^0\overline{D}^0\rangle^{C=-1} = \frac{1}{\sqrt{2}}\left[|D^0\rangle|\overline{D}^0\rangle - |\overline{D}^0\rangle|D^0\rangle\right]$$

the interference comes for free:

$$M_{ij}^2 = \left|\langle i|D^0\rangle\langle j|\overline{D^0}\rangle - \langle j|D^0\rangle\langle i|\overline{D^0}\rangle\right|^2$$

PRD 73, 034024 (2006) Asner and Sun
I.I.Bigi SLAC report-33, 1989 page 169

(C=–1) $e^+e^- \to \psi(3770) \to$	D	$\overline{D}$
Forbidden if no mixing	$K^-\pi^+$	$K^-\pi^+$
Forbidden if no mixing	$K^-l^+\nu$	$K^-l^+\nu$
Forbidden by CP conservation	CP+	CP+
Forbidden by CP Conservation	CP–	CP–
Interference of CF with DCS	$K^-\pi^+$	CP±

Special menu at BES-III:

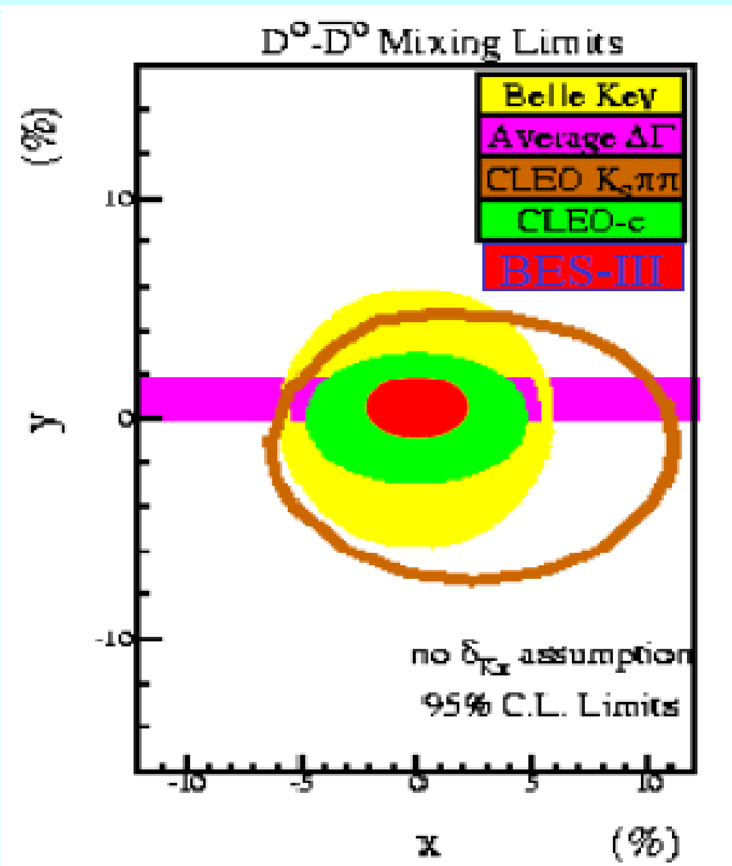
- The mixing rate R_M can be measured at the first order;
- Strong phase $\delta_{K\pi}$ is from CP tagged $D\to K\pi$;
- CP violation is measured in a production rate.

Mixing rate R_M from

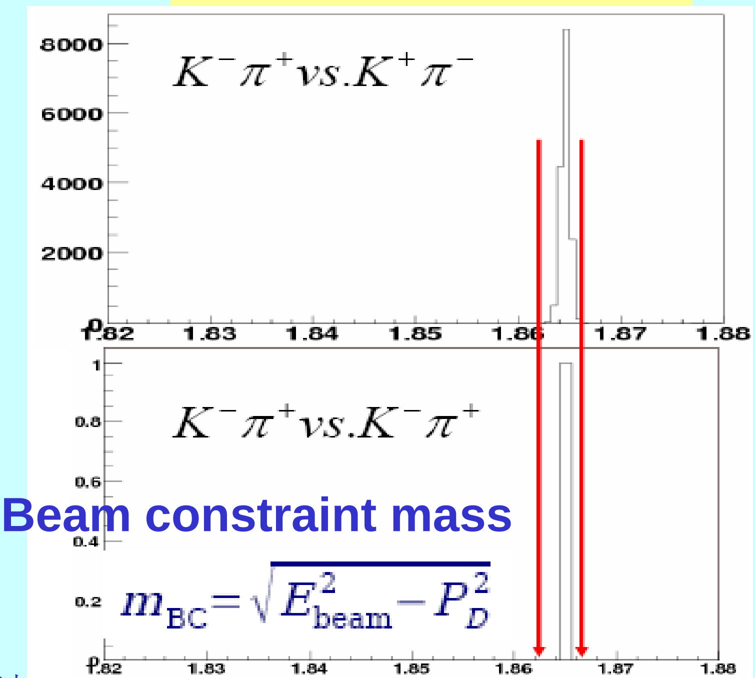
$\psi(3770) \to D^0\overline{D}^0 \to (K^-\pi^+)(K^-\pi^+)$

$$R_M = \frac{x^2 + y^2}{2} = \frac{N[(K^\pm\pi^\mp)(K^\pm\pi^\mp)]}{N[(K^\pm\pi^\mp)(K^\mp\pi^\pm)]}$$

Sensitivity in 20 fb^{-1} data at BES-III: $R_M < 1.5 \times 10^{-4}$



2 events in the signal region due to mis-ID. (the mis-ID rate for pi as a Kaon is 1%).



Beam constraint mass

$$m_{BC} = \sqrt{E_{beam}^2 - P_D^2}$$

The first order sensitivity to strong phase

CP even:

$$D_1 = \frac{1}{\sqrt{2}}\left(D^0 + \overline{D}^0\right)$$

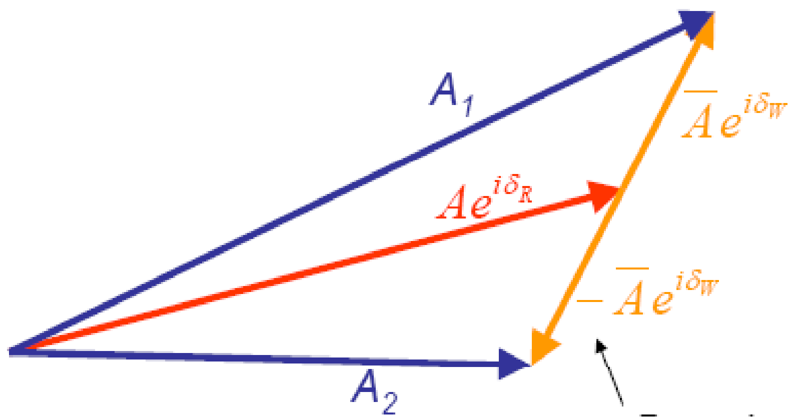
CP odd :

$$D_2 = \frac{1}{\sqrt{2}}\left(D^0 - \overline{D}^0\right)$$

Consider the amplitudes for these mass eigenstates decaying to $K^-\pi^+$:

$$A_1 = \langle K^-\pi^+ | D_1 \rangle = \frac{1}{\sqrt{2}}\left(\langle K^-\pi^+ | D^0 \rangle + \langle K^-\pi^+ | \overline{D}^0 \rangle\right) \equiv \frac{1}{\sqrt{2}}\left(Ae^{i\delta_R} + \overline{A}e^{i\delta_W}\right)$$

$$A_2 = \langle K^-\pi^+ | D_2 \rangle = \frac{1}{\sqrt{2}}\left(\langle K^-\pi^+ | D^0 \rangle - \langle K^-\pi^+ | \overline{D}^0 \rangle\right) \equiv \frac{1}{\sqrt{2}}\left(Ae^{i\delta_R} - \overline{A}e^{i\delta_W}\right)$$



i.e. the CP even & CP odd rates to a specific final state will not be the same !

$$r = \frac{\overline{A}}{A}, \quad \delta = \delta_R - \delta_W$$

CP tagged $K\pi$ decay:

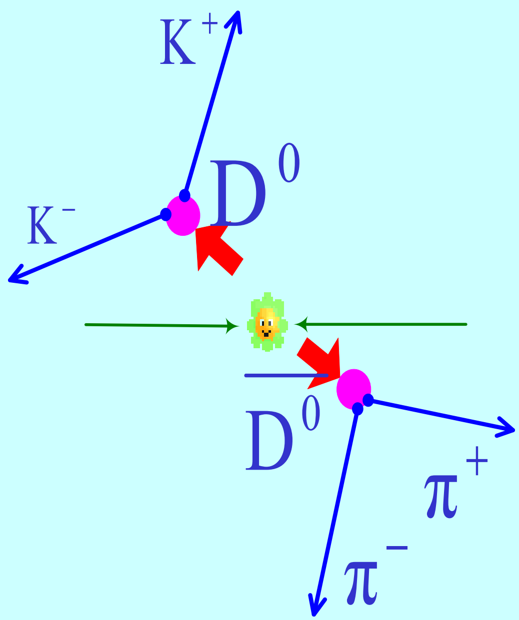
$$\frac{B(D_{CP+} \to K^-\pi^+) - B(D_{CP-} \to K^-\pi^+)}{B(D_{CP+} \to K^-\pi^+) + B(D_{CP-} \to K^-\pi^+)} = 2r\cos(\delta)$$

$\Delta\cos\delta_{K\pi} < 0.06$

The model independent strong phase determination is useful for γ/ϕ_3

A. Bondar, A.Poluektov, Eur. Phys. J. C47 347-353 (2006), hep-ph/0510246].

CP Violation at ψ(3770) at BESIII



CP violating asymmetries can be measured by searching for events with two CP odd or two CP even final states:

$\pi^+\pi^-$, K^+K^-, $\pi^0\pi^0$, $K_s\pi^0$,

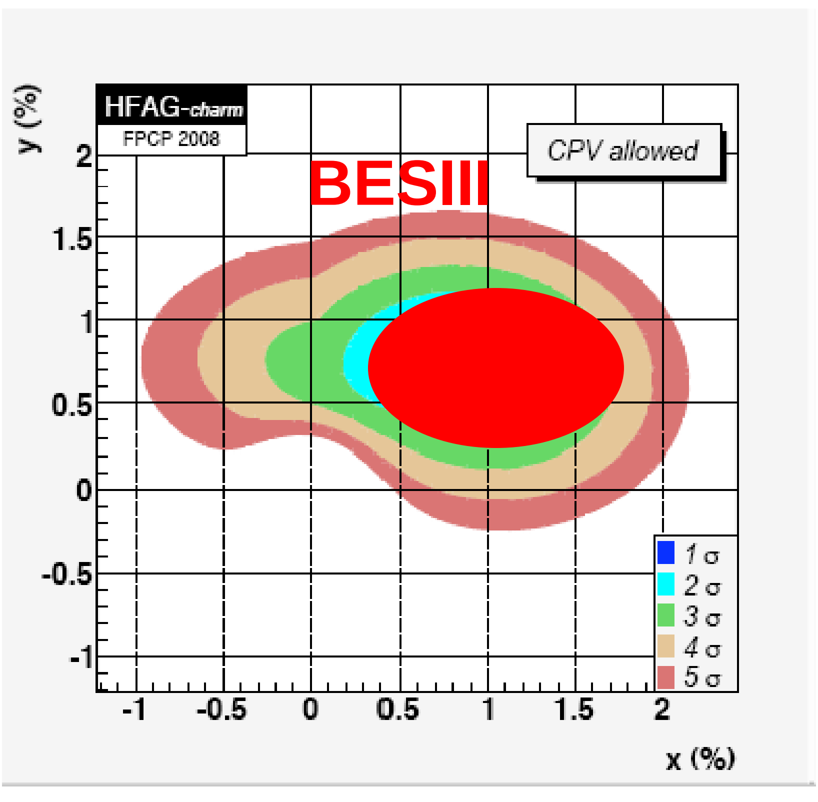
for the decay of $\psi'' \to f_1 f_2$

$$CP(f_1 f_2) = CP(f_1)\cdot CP(f_2)\cdot(-1)^L = -$$
$$CP(\psi'') = +$$

A_{CP} sensitivity : $\Delta A \sim 10^{-3}$

Sensitivities (20 fb^{-1} at psi(3770) peak)

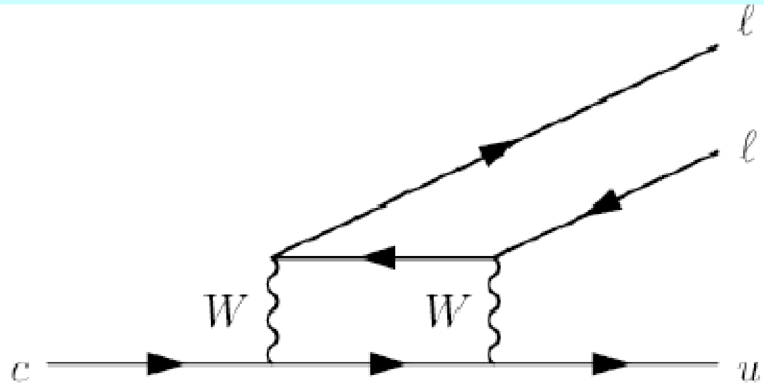
- Mixing parameters
  - $R_M=(x^2+y^2)/2 < 10^{-4}$ in $K\pi$ and $Ke\nu$ channels
  - Probe y: $\Delta y_{CP} < 0.7\%$,
  - $\Delta\cos\delta_{K\pi} < 0.06$
- CP Violation
  - $\Delta A_{CP} \sim 10^{-3}$ in D^+ decays (direct CPV),
- Improvement to ϕ_3/γ measurement in $B \rightarrow D^{(*)}K < 2^o$ (CLEO-c: $\sim 5^o$)



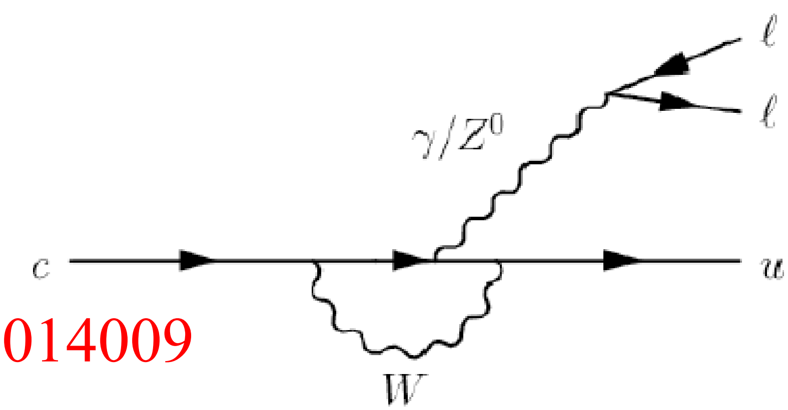
Rare and forbidden Charm Decays

Charm FCNC decays heavily GIM suppressed in SM:

$BF(c \to ull) \sim 10^{-8}$



Burdman et. al., PRD66(2002)014009



New Physics can contribute in loop, which is different from the cases in B and Kaon mesons.

Lepton decays: $D^0 \to l^+l^-$ ($l = e,\mu$);

GIM suppressed decays: $D^{0(\pm)} \to M^{0(\pm)} l^+l^-$ (M is meson allowed);

LFV decays: $D^0 \to e^+ \mu^-$, $D^{0(\pm)} \to M^{0(\pm)} e^+ \mu^-$;

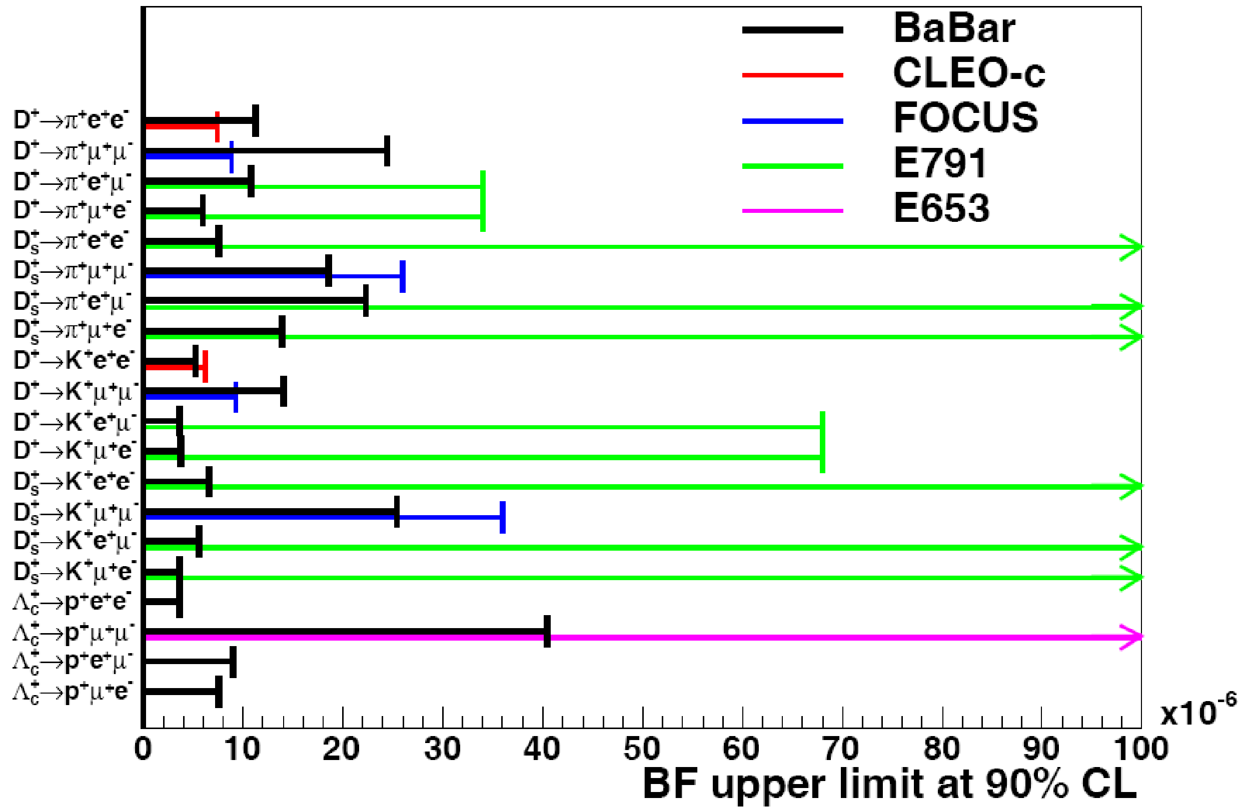
LNV decays: $D^\pm \to M^\pm l^+ l^+$ ($l = e, \mu$; the same signed-di-lepton) ;

$D \to hl^+l^-$ Like Rare Decays

BaBar Input
ICHEP06
288 fb^{-1} @Y(4S)

CLEO-c
0.8 M (0.281 fb^{-1})

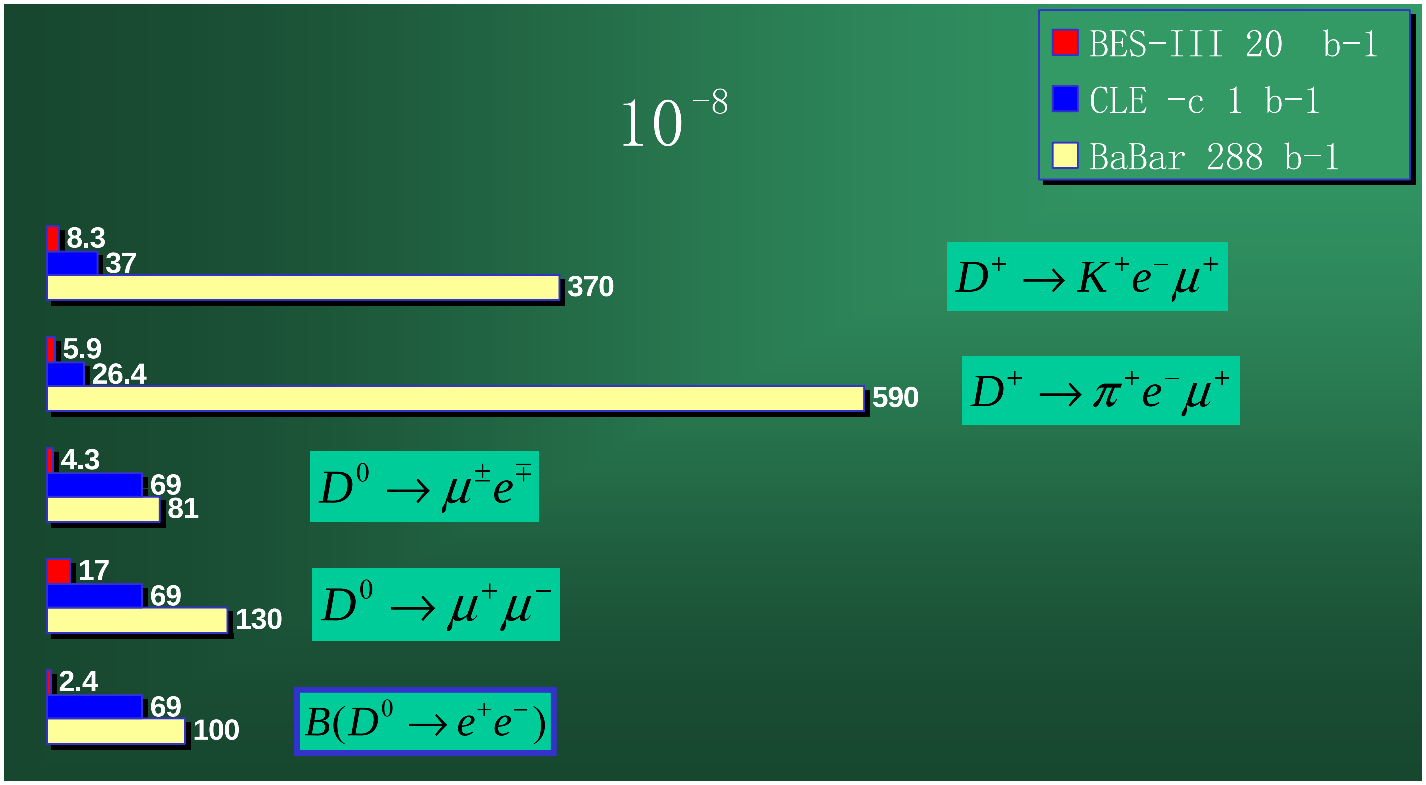
$$\frac{L_{BaBar}}{L_{CLEO-c}} = \frac{288}{0.3} = 960$$



Background free at a charm factory @psi(3770) peak!

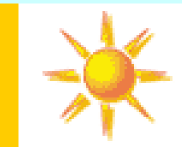
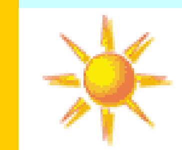
Sensitivity of LFV

Improve the limits by more than order magnitude!



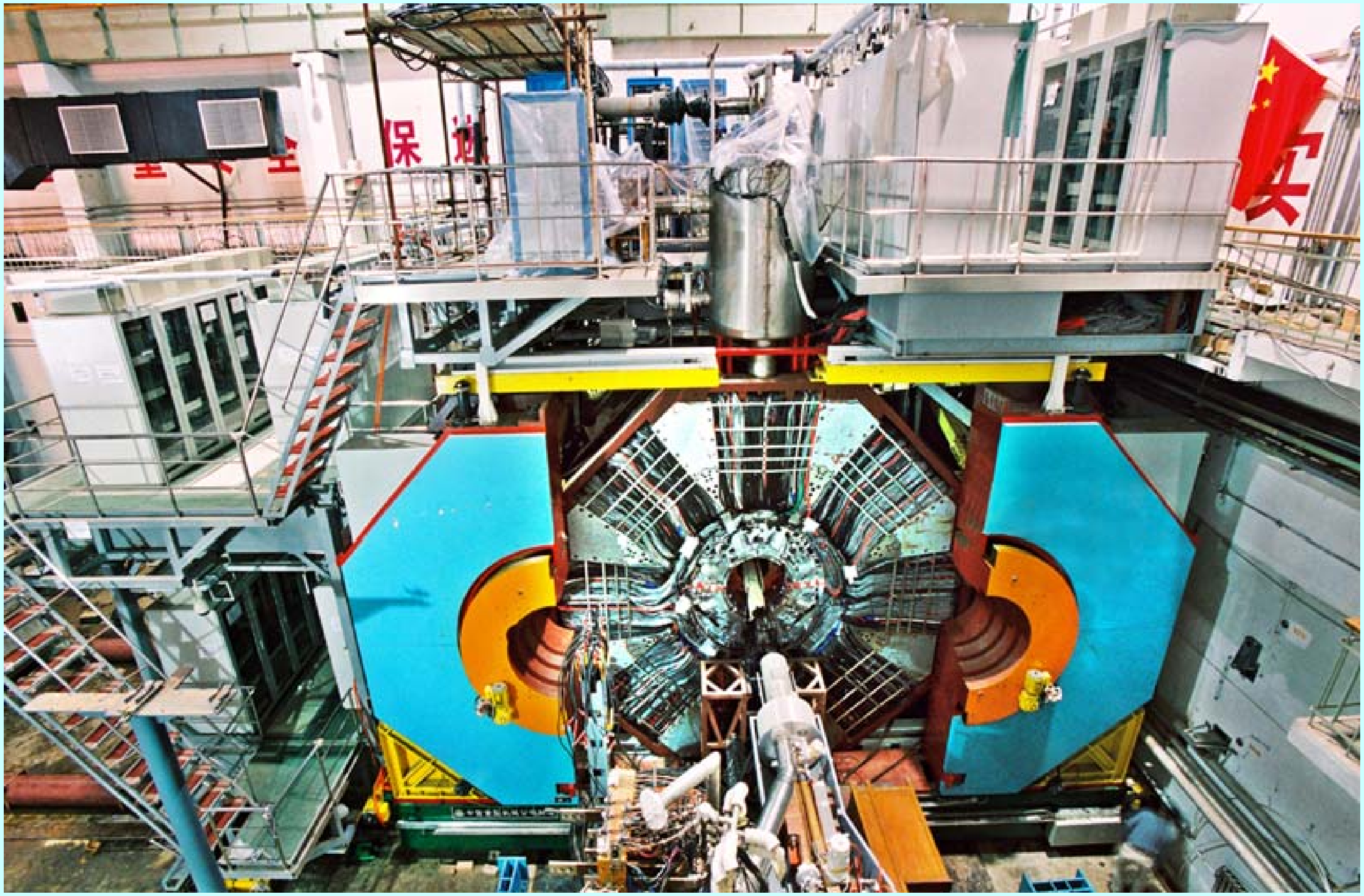
LFV and LNV are "smoking gun", any indication of deviation from zero will indicate New Physics (NP).

Summary

- ✓ Tests of QCD at low energy in various way: light hadron spectrum, charmonium decays and spectrum, light hadron decays, decay constants; 
- ➢ Precise measurements: test of SM (R values, tau mass); 
- ➢ New Physics probe at BES-III:
  - (0) Rare and forbidden decays of quarkonia 
  - (1) Rare decays of Charm meson
  - (2) D^0-D^0bar mixing 
  - (3) CP violation in D meson decays
  - (4) Lepton Flavor/baryon number violated decays 

We expect to locate the search of tiny contributions from new physics at heavy flavor sector after anything new can be found at LHC!

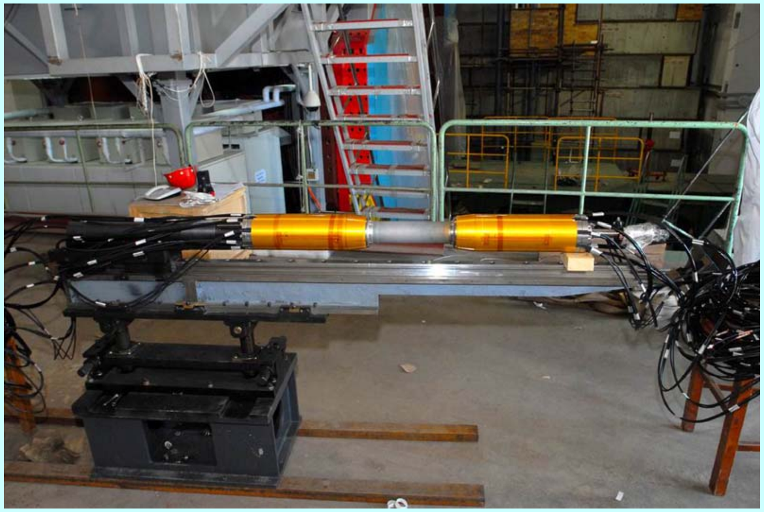
Thank you!

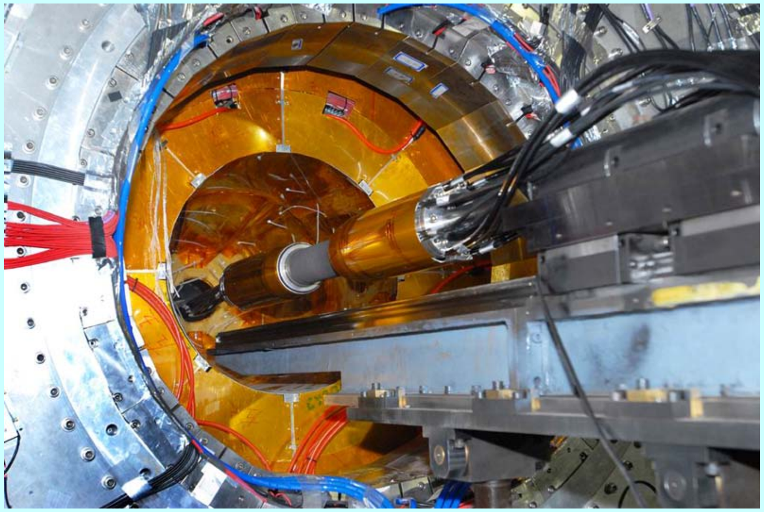


BESIII in beam line!

Back up

Be beam pipe





- Two Be cylinders (0.8 mm and 0.5 mm thick, 0.8mm gap), cold by paraffine-1
- 14.6 μm gold at the inner surface.
- The beam pipe was put in the place on March 27, 2008, it is the last component of the BES-III detectors.

Drift chamber

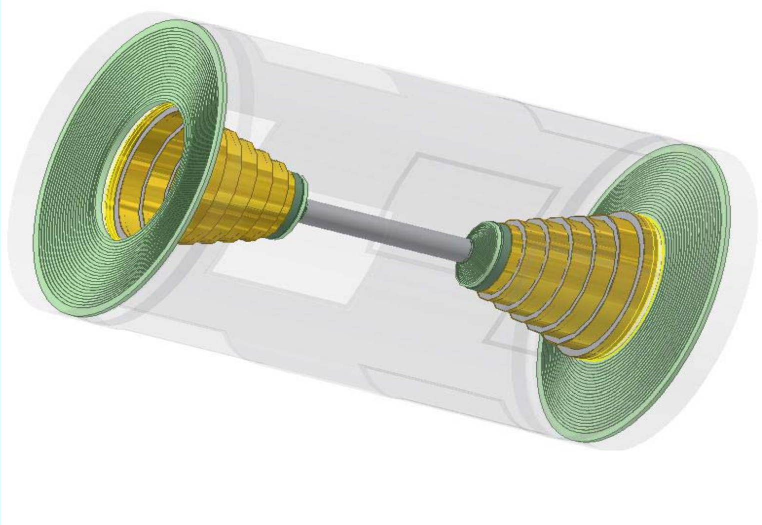
- To measure the momentum of charged particles
- Design spec.: Single wire reso. dE/dx reso.

	Single wire reso.	dE/dx reso.
CLEO:	~110μm,	5.7%
Babar:	~110μm,	6.2%
Belle:	~130μm,	5.7%
BESIII	~120μm	6 %

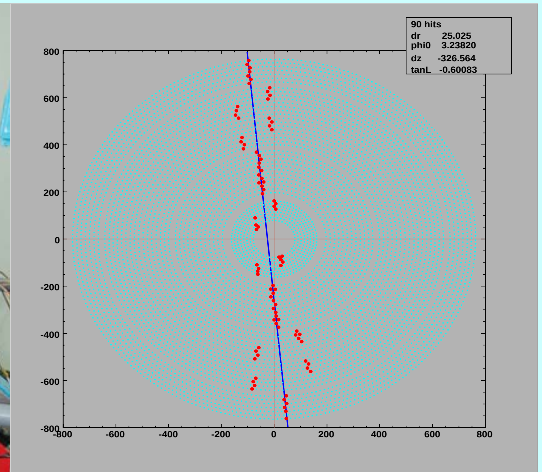
- R_{in} = 63mm; R_{out} = 810mm; length = 2400 mm
- 7000 Signal wires: 25(3% Rhenium) μm gold-plated tungsten
- 22000 Field wires: 110 μm Al
- Gas: He + C_3H_8 (60/40)
- Momentum resolution@1GeV:

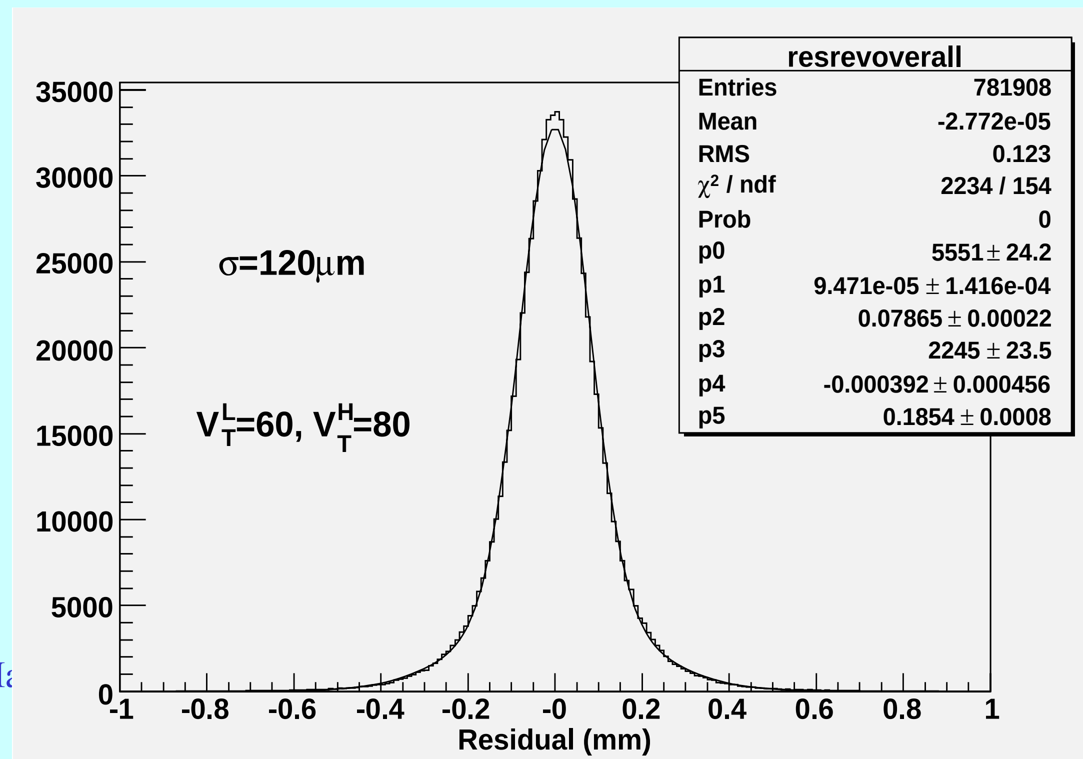
0.5%

$$\frac{\sigma_{P_t}}{P_t} = 0.32\% \oplus 0.37\%$$



Separate cosmic ray test　meet design





U3

BESIII CsI(Tl) crystal calorimeter

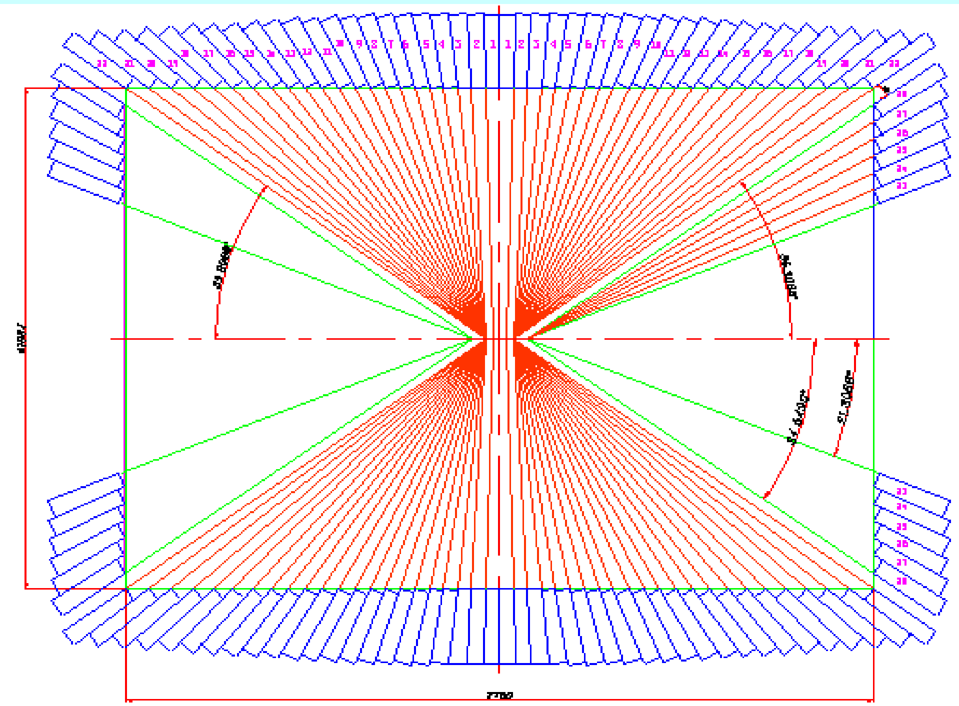
- To measure the energy of electromagnetic particles
- Barrel: 5280 crystals Endcap: 960 crystals
- Crystal: (5.2x 5.2 – 6.4 x 6.4) x $28cm^3$
- Readout: ~13000 Photodiodes, 1cm×2cm,
- Energy range 20MeV – 2 GeV
- position resolution: 6 mm@1GeV
- Tiled angle: theta ~ 1-3^o, phi ~ 1.5^o

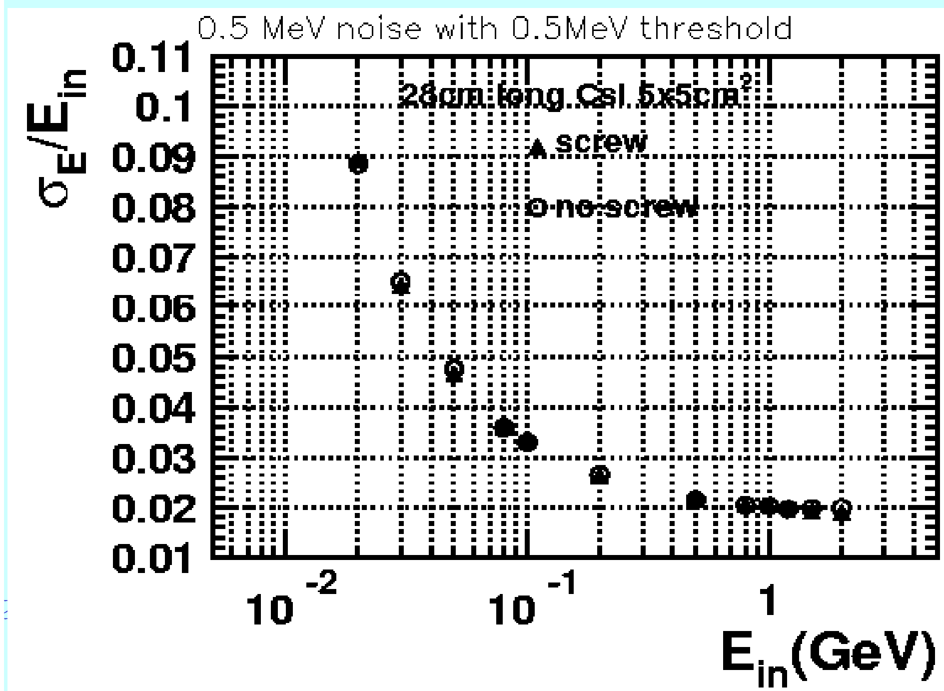
Babar: 2.67% @1GeV

BELLE: 2.2% @1GeV

CLEO: 2.2% @1GeV

BESIII: 2.5%@1GeV





U3

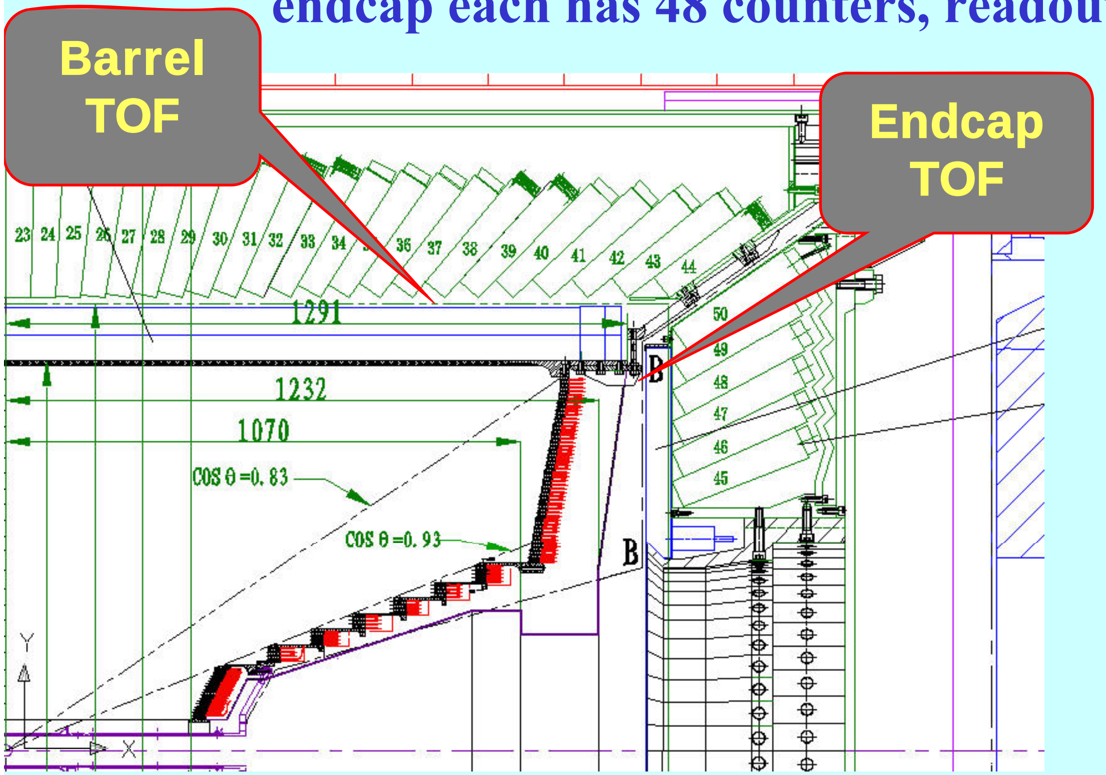
250rad/year
28 cm long
electronic noise less than 200keV
0.5 MeV noise.
User, 5/30/2008

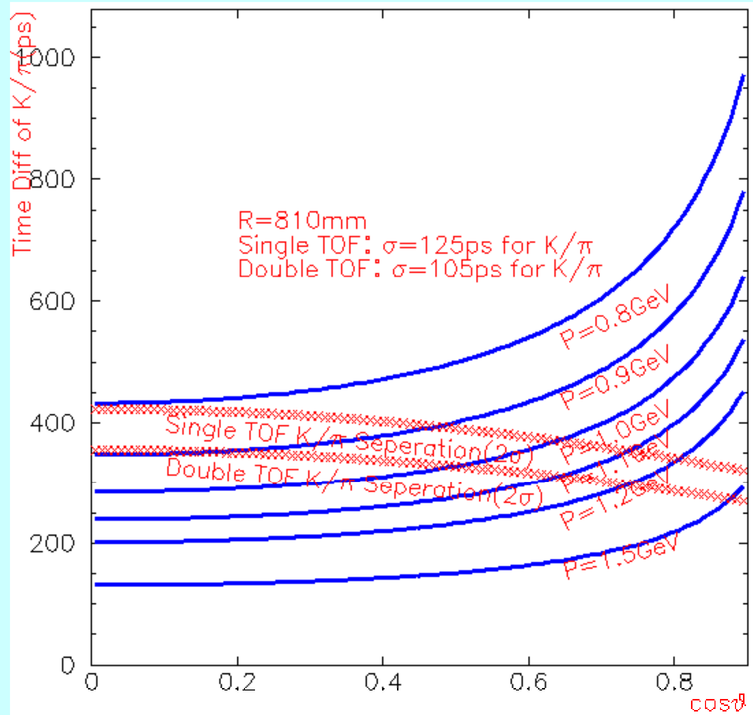
Installation of barrel and endcap EMC

Crystal calorimeter without supporting wall between crystals

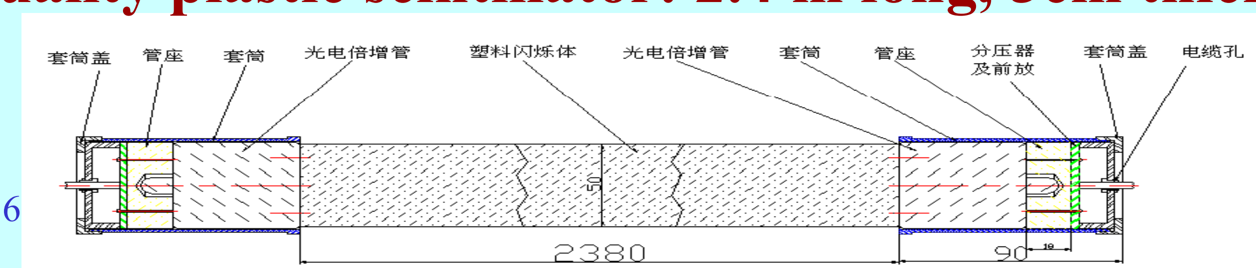
PID: Time-Of-Flight counters

- Double layers at barrel of 88 counters/layer, readout at both ends, endcap each has 48 counters, readout at the inner end.





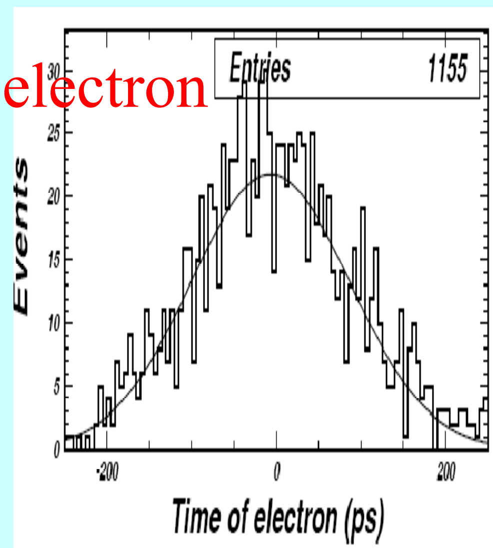
High quality plastic scintillator: 2.4 m long, 5cm thick



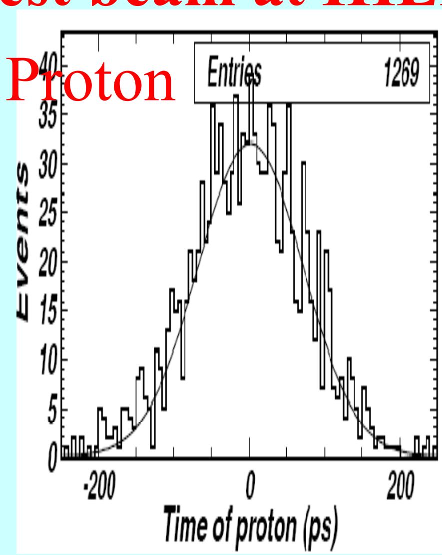
TOF

- All scintillator bars arrived from Bicron. BC408 at barrel, BC404 at endcap, PMT:R5924;
- Laser light monitor system;
- All counters are assembled, tested and installed.
- Cosmic ray test shows the system works.

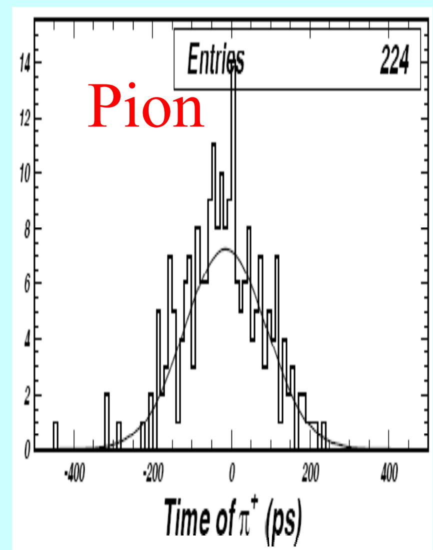
Test beam at IHEP



(94   3) ps



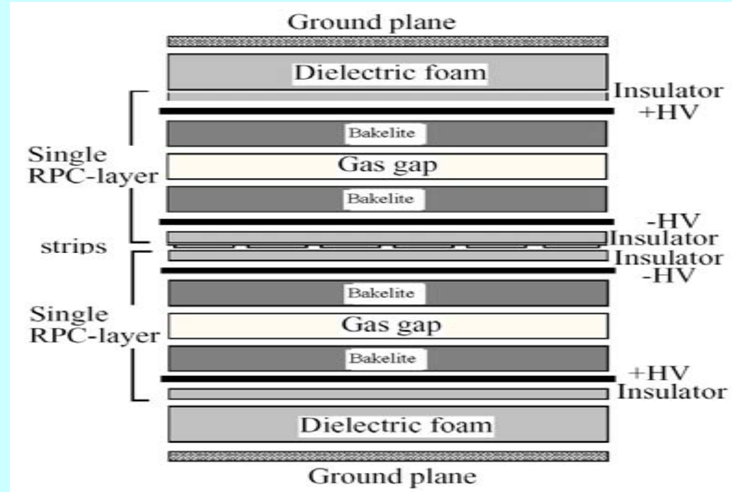
(70   2) ps

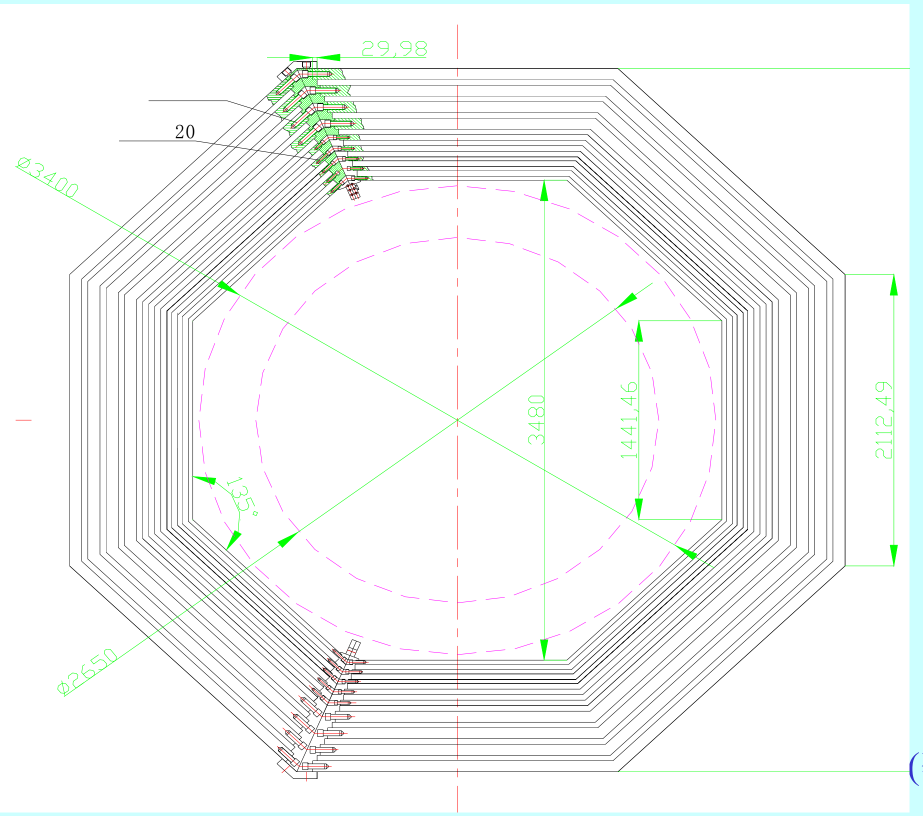


(104   11) ps

μ system : RPC

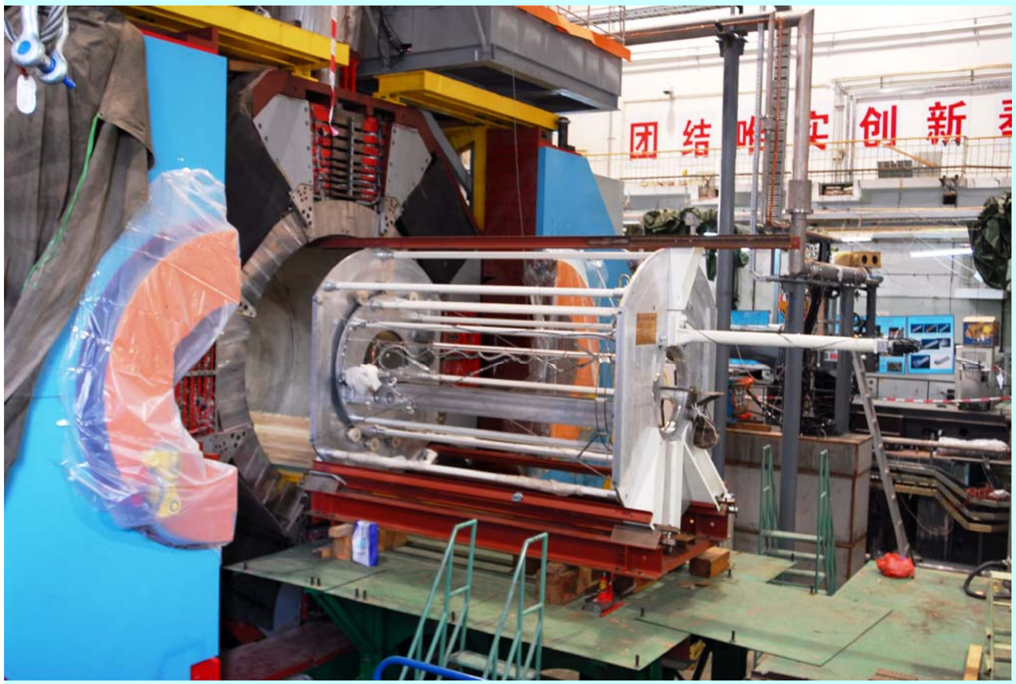
- 9 layer, 2000 m^2
- Special bakelite plate w/o linseed oil
- 4cm strips, ~10000 channels
- Noise less than 0.1 Hz/cm^2

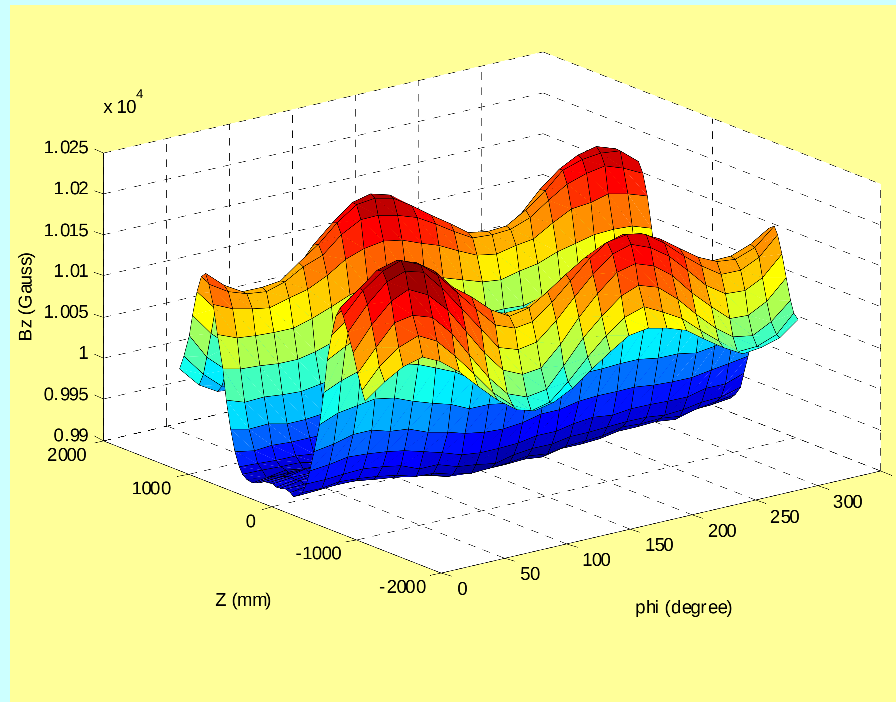




U4

Magnet reached 1 tesla 3364A）, sep. of 2006. Mapped the field with machine magnet together Aug. of 2007





Slide 50

U4 The maximum fluctuation is about 1.5%.
User, 5/30/2008