Recent Results of BESIII Experiment

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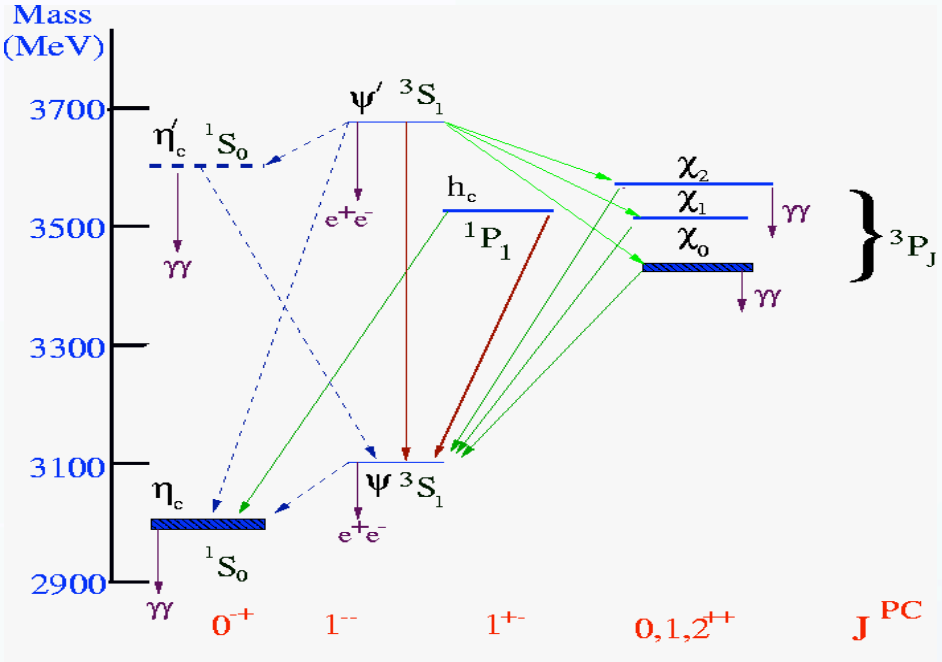
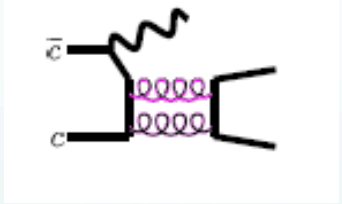
OUTLINE

- Introduction
- Beijing Electron Positron Collider II and Beijing Spectrometer III (BEPCII/BESIII)
- Physics results
  - χ_{cJ}
  - $\psi(2S) \rightarrow \gamma\gamma J/\psi$
  - h_c
  - X(1860) & X(1835)
  - $f_0(980) - a_0(980)$ mixing
  - Charm physics
  - Summary

Physics of tau – charm region (2~5GeV)

- **Light hadron spectroscopy.**
- **Charmonium:** J/ψ, ψ', ψ'', $\eta_C(1S)$, $\chi_{c\{0,1,2\}}$, $\eta_c(2S)$, $h_c(^1P_1)$, etc.
- **New Charmonium states above open charm threshold (X, Y, Z).**
- **In J/ψ and $\psi(2S)$ hadronic decays:**
  - **Exotics : hybrids, glueballs, and other exotics.**
  - **Baryons and excited baryons.**
  - **Mesons and mixing of quarks and gluons.**
- **Electromagnetic form factors and precise R values.**
- **High precision tau and charm physics near threshold. Tau mass.**

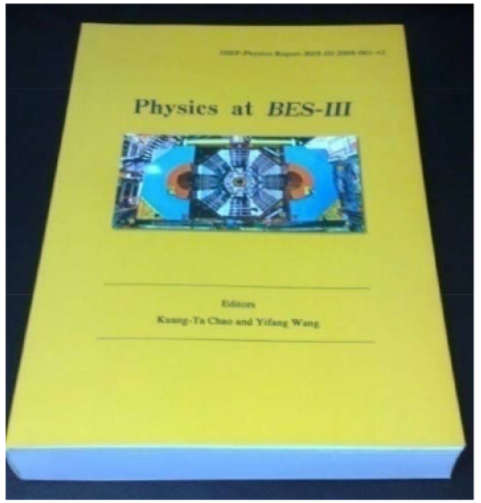




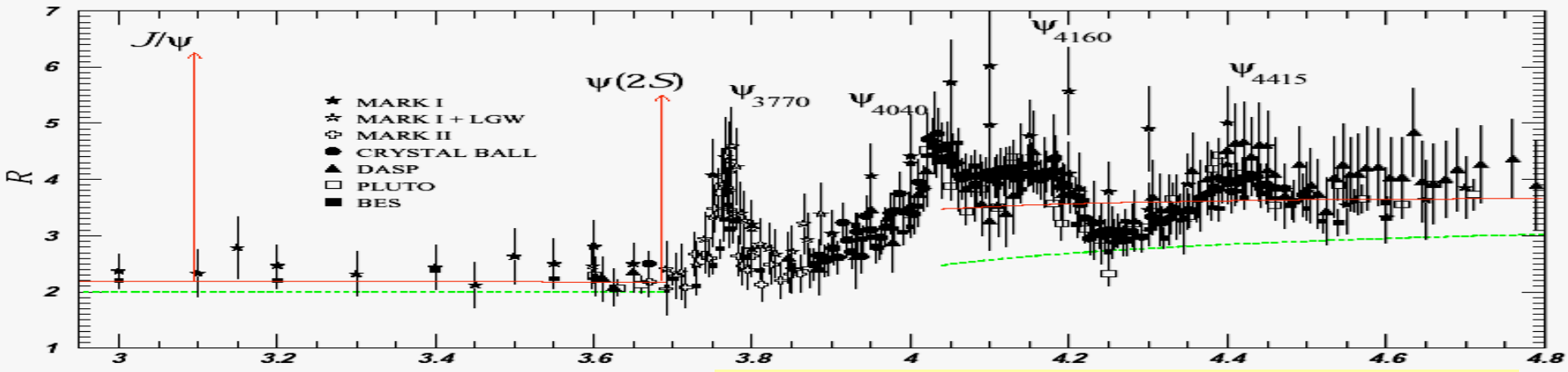
$$\begin{pmatrix} e & \mu & \tau \\ \nu_e & \nu_\mu & \nu_\tau \end{pmatrix} \qquad \begin{pmatrix} u & c & t \\ d & s & b \end{pmatrix}$$

Physics of tau – charm region

- **Open charm factory :**
  - Absolute BR measurements of D and D_S decays
  - Rare D decay
  - D^0 - D^0bar mixing
  - Quantum correlations (ψ")
  - CP violation, strong phase.
  - f_{D+}, f_{Ds}, form factors in leptonic D decays
  - Can provide calibrations and tests of lattice QCD.
  - precise measurement (~1.6%) of CKM (Vcd, Vcs)
  - light meson spectroscopy in D^0 and D^+ Dalitz plot analyses.
- **Search for new physics.**



arXiv: 0809.1869



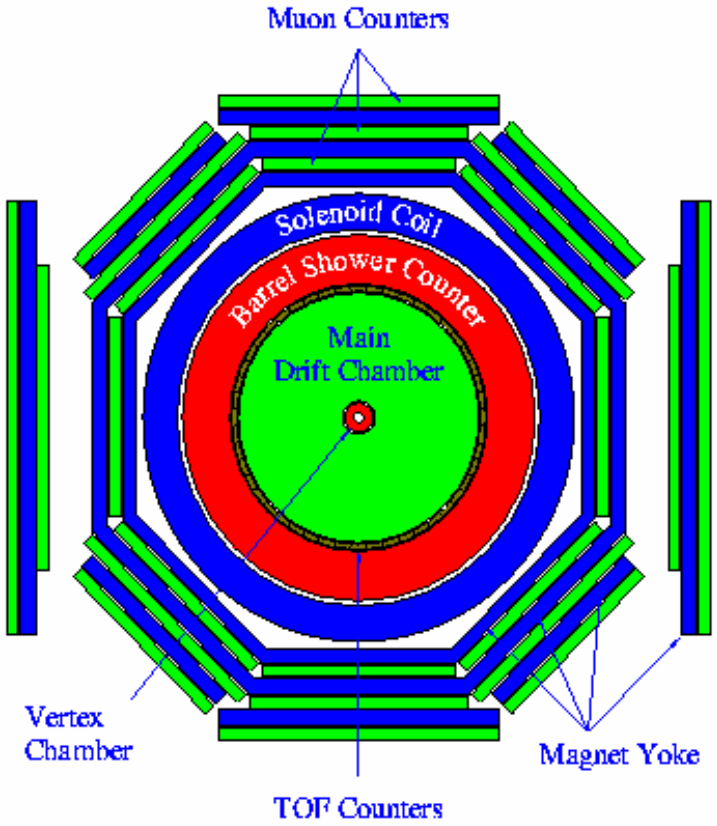
Very rich and interesting energy region.

The Beijing Electron Positron Collider (BEPC)

BEPC/BESII
– Predecessor of BEPCII/BESIII

CM Energy ranges from 2 to 5 GeV

Luminosity at J/ψ ~ 5 x 10^{30} cm^{-2} s^{-1}

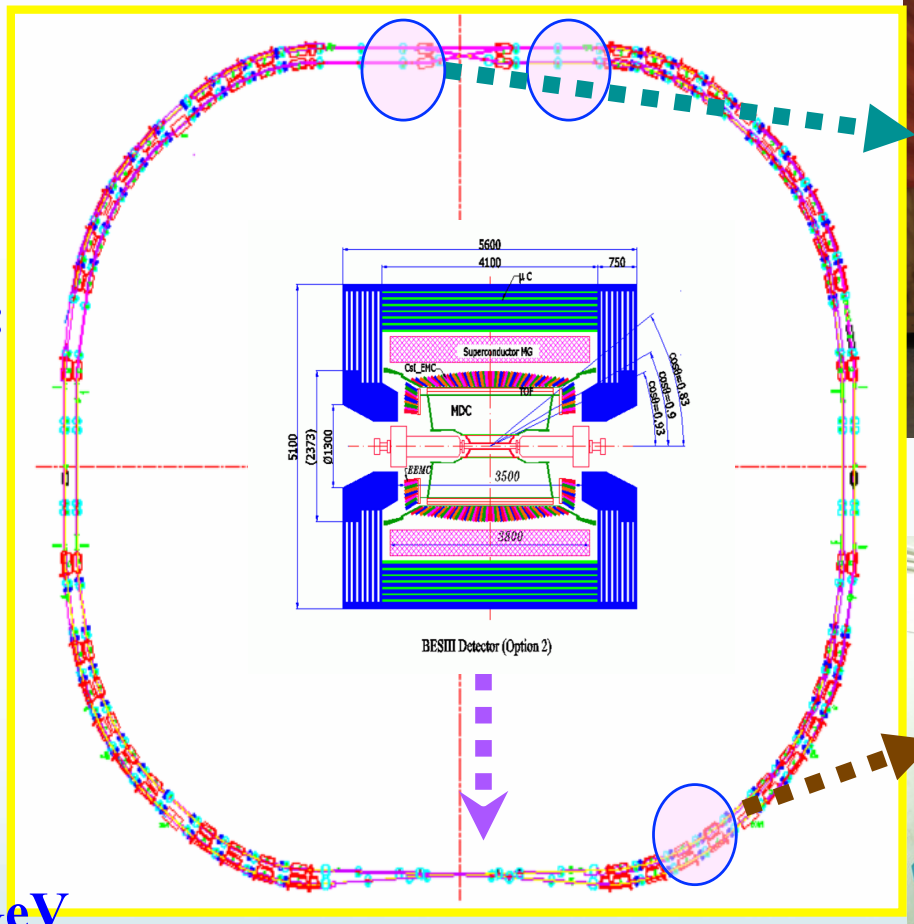


BESII detector was removed in 2004.

BEPCII: a high luminosity double–ring collider

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

22 mrad crossing angle

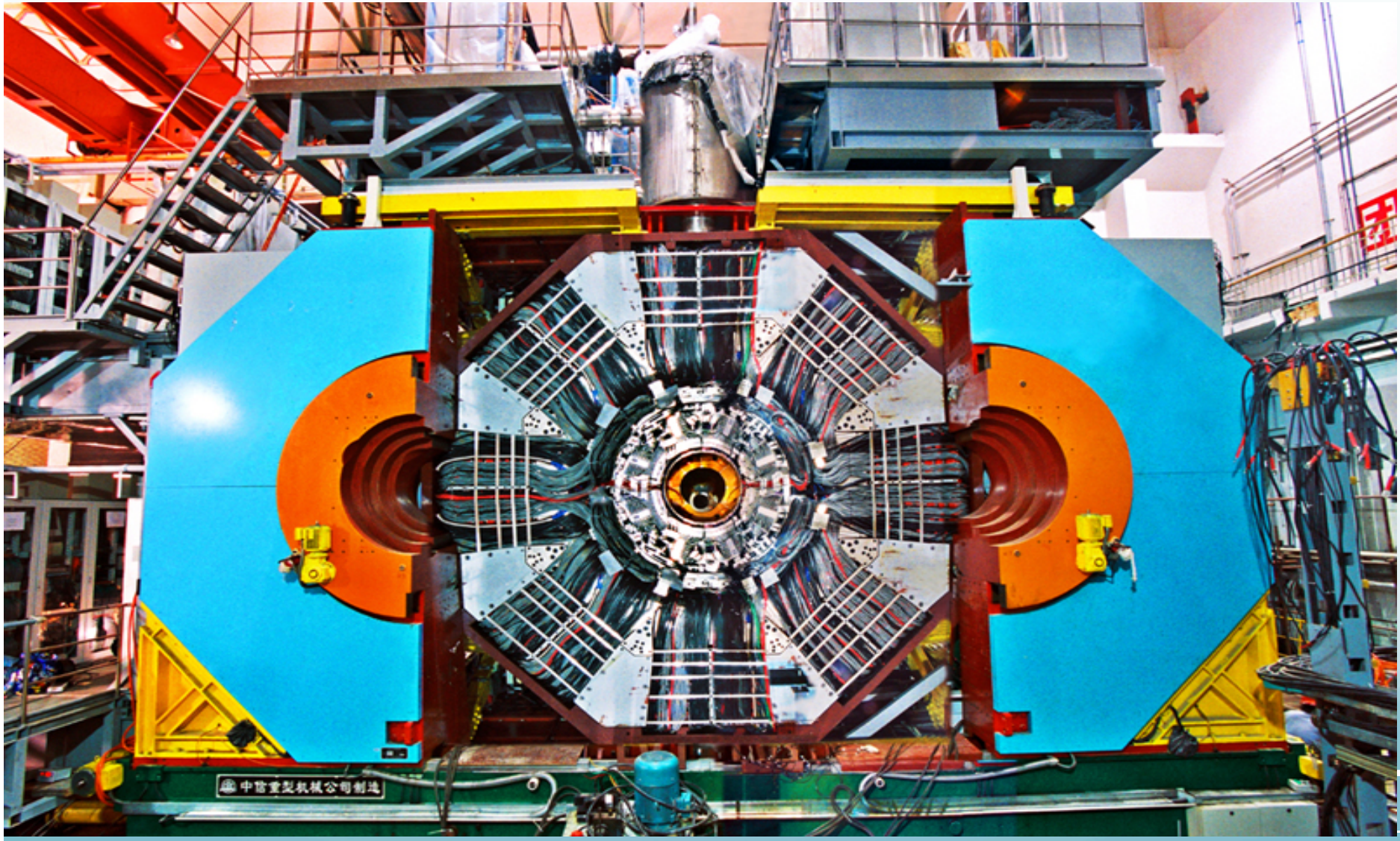


SC RF

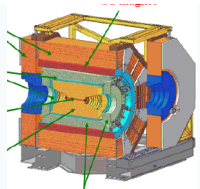
Beam magnets

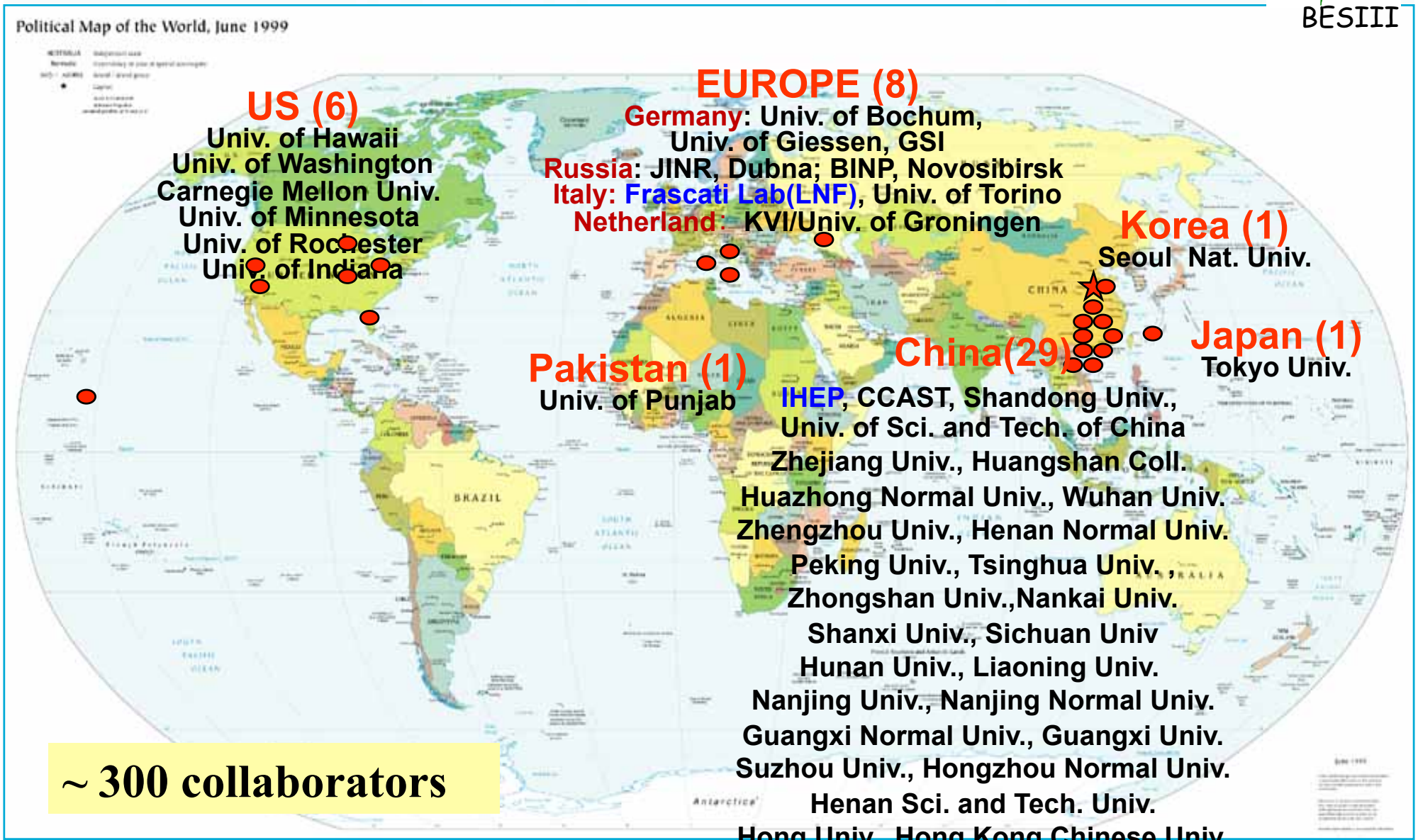
Use many bunches and SC mini-beta.

Beijing Spectrometer III (BESIII): April 2008 - Installation complete



BESIII collaboration: 46 Institutes





US (6)
Univ. of Hawaii
Univ. of Washington
Carnegie Mellon Univ.
Univ. of Minnesota
Univ. of Rochester
Univ. of Indiana

EUROPE (8)
Germany: Univ. of Bochum,
Univ. of Giessen, GSI
Russia: JINR, Dubna; BINP, Novosibirsk
Italy: Frascati Lab(LNF), Univ. of Torino
Netherland: KVI/Univ. of Groningen

Korea (1)
Seoul Nat. Univ.

Japan (1)
Tokyo Univ.

Pakistan (1)
Univ. of Punjab

China(29)
IHEP, CCAST, 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.
Shanxi Univ., Sichuan Univ
Hunan Univ., Liaoning Univ.
Nanjing Univ., Nanjing Normal Univ.
Guangxi Normal Univ., Guangxi Univ.
Suzhou Univ., Hongzhou Normal Univ.
Henan Sci. and Tech. Univ.
Hong Univ., Hong Kong Chinese Univ.

~ 300 collaborators

BEPCII/BESIII Milestones

Beginning of 2004, construction starts

Mar. 2008: Collisions at 500 mA × 500 mA, Lum.: 1 ×10^{32} $cm^{-2}s^{-1}$

Apr. 30, 2008: Move BESIII to IP

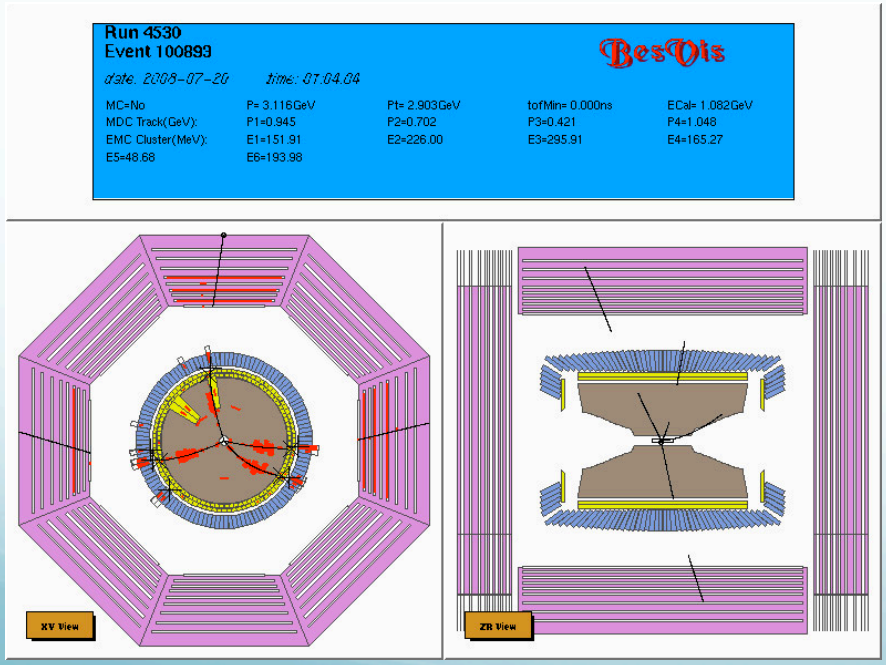
July 18, 2008: First e^+e^- collision event in BESIII

Apr. 14, 2009 ~106 M ψ(2S) events (42.3pb^{-1} at 3.65GeV)

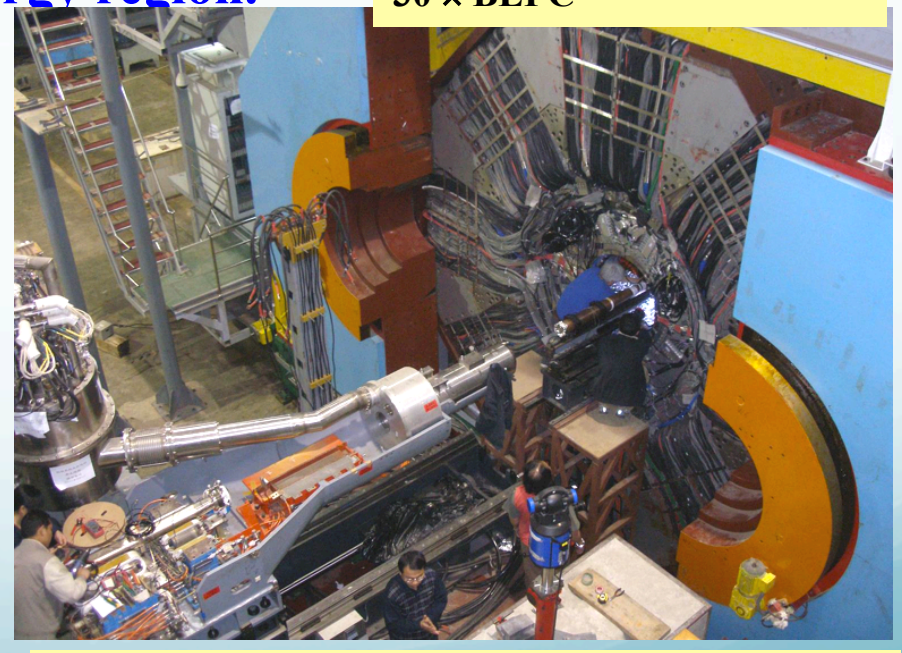
July 28, 2009 ~226 M J/ψ events

June 27, 2010 ~930 pb^{-1} at ψ(3770), with ~70pb^{-1} scanning in ψ(3770) energy region.

Record Luminosity
3.2 X $10^{32}cm^{-2}s^{-1}$ or
5 × CESRc
30 × BEPC



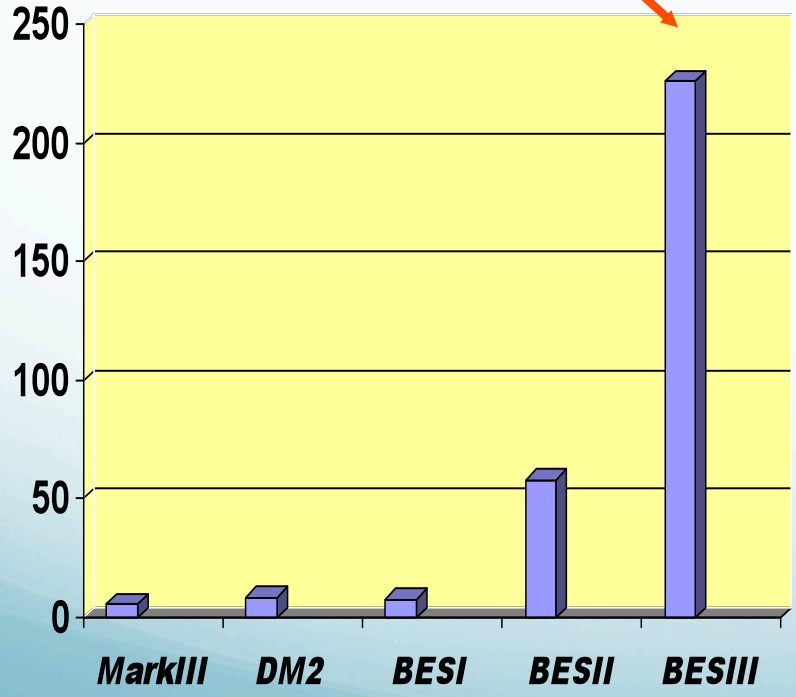
First collision event

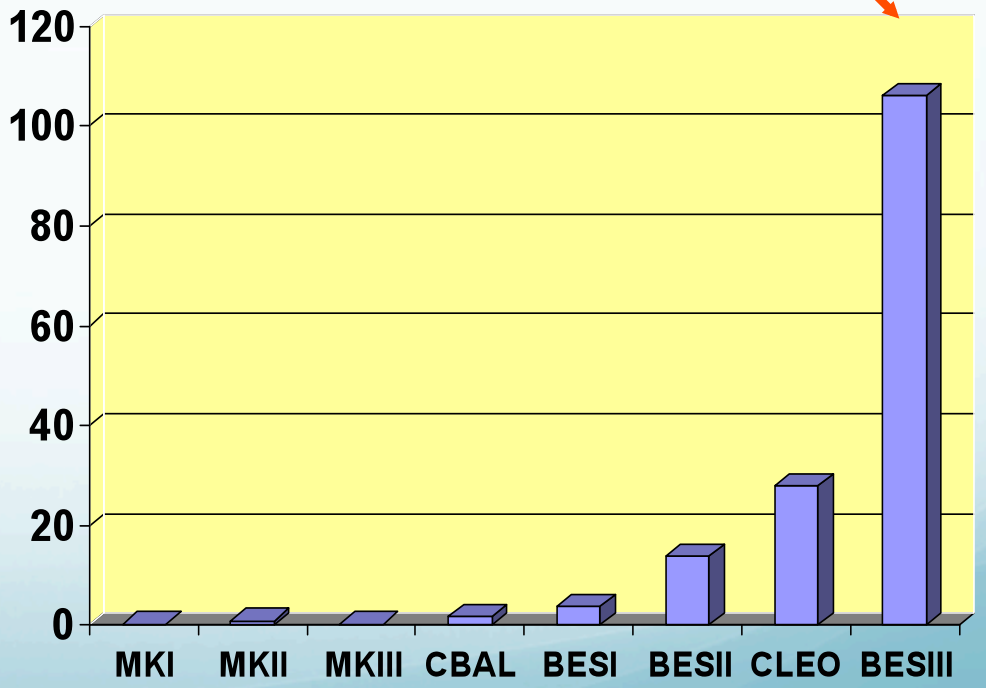


May 15, 2008: detector at IP; installing SC quads and beam pipe.

World Largest J/ψ and ψ(2S) Samples (×10^6)

BESIII: J/ψ 2009 – ~226M ψ(2S) 2009 – 106M





BESII: J/ψ 58M ψ(2S) 14M

BESIII

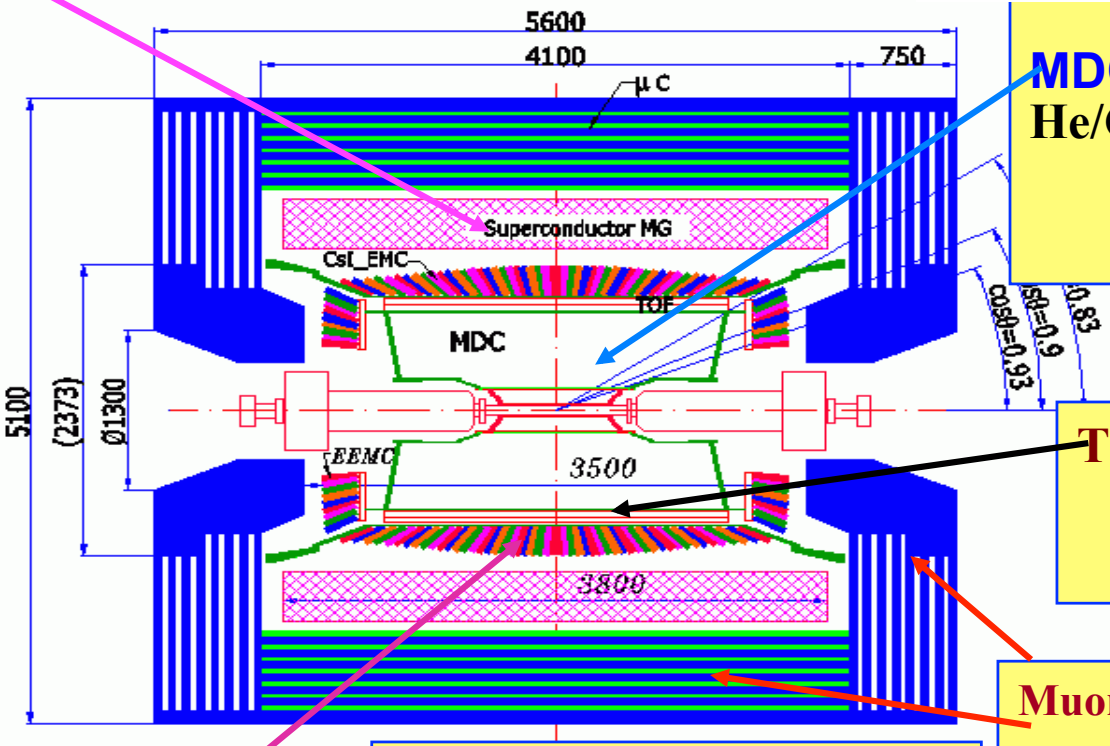
BESIII detector: all new !

CsI calorimeter

Precision tracking

Time-of-flight + dE/dx PID

Magnet: 1 T Super conducting



MDC: small cell & Gas:
He/C_3H_8 (60/40), 43 layers
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

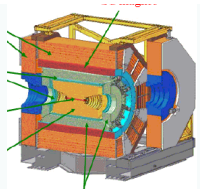
EMC: CsI crystal, 28 cm
ΔE/E = 2.5% @1 GeV
σz = 0.6 cm/√E

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

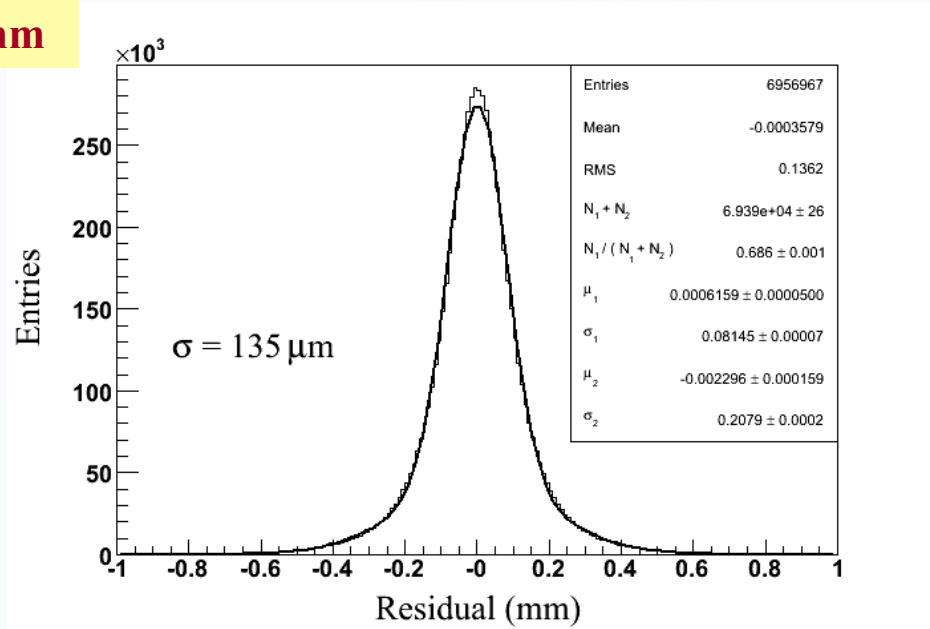
The detector is hermetic for neutral and charged particle with excellent resolution, PID, and large coverage.

Detector performance

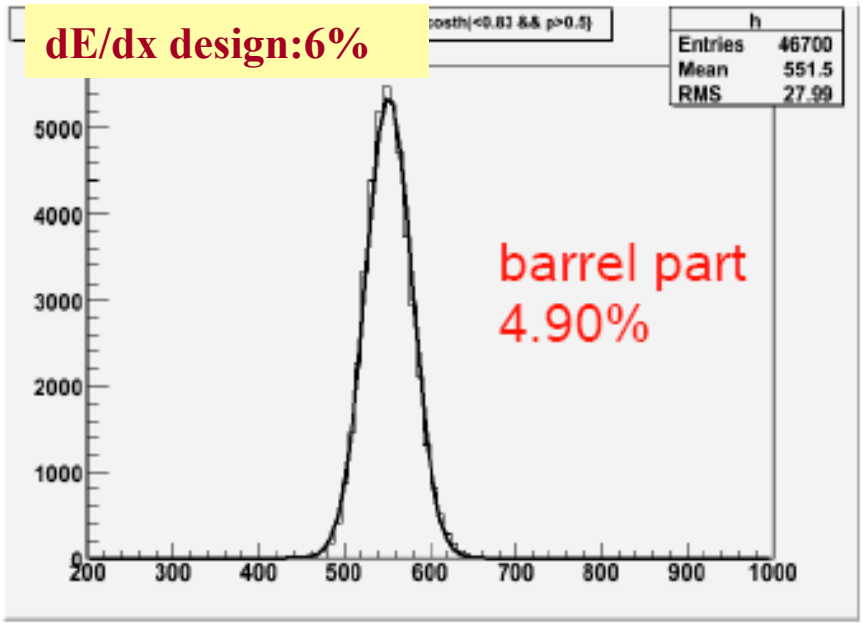
MDC



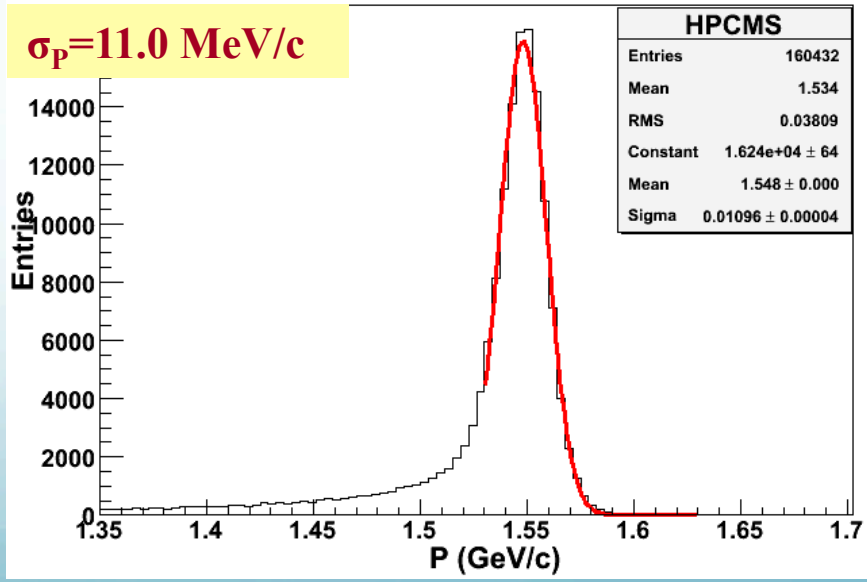
Wire reso. design：130mm



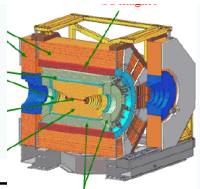
dE/dx design:6%

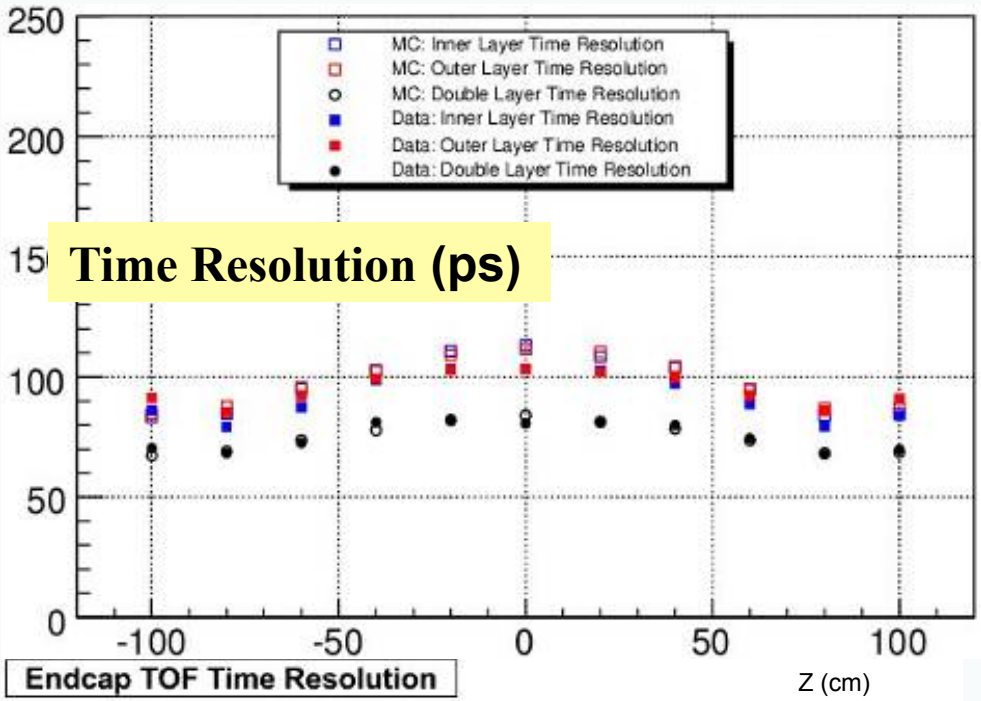


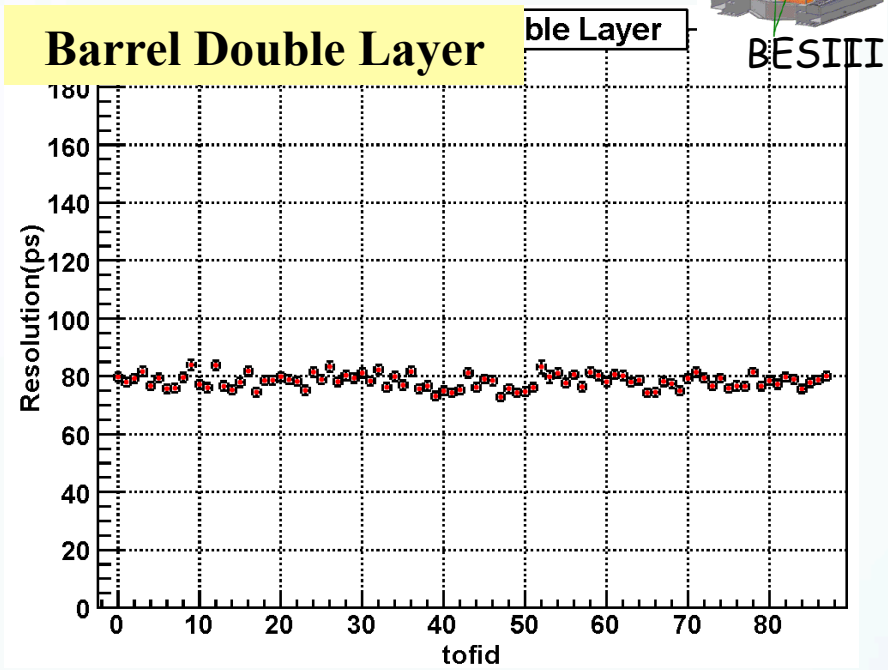
σ_P=11.0 MeV/c

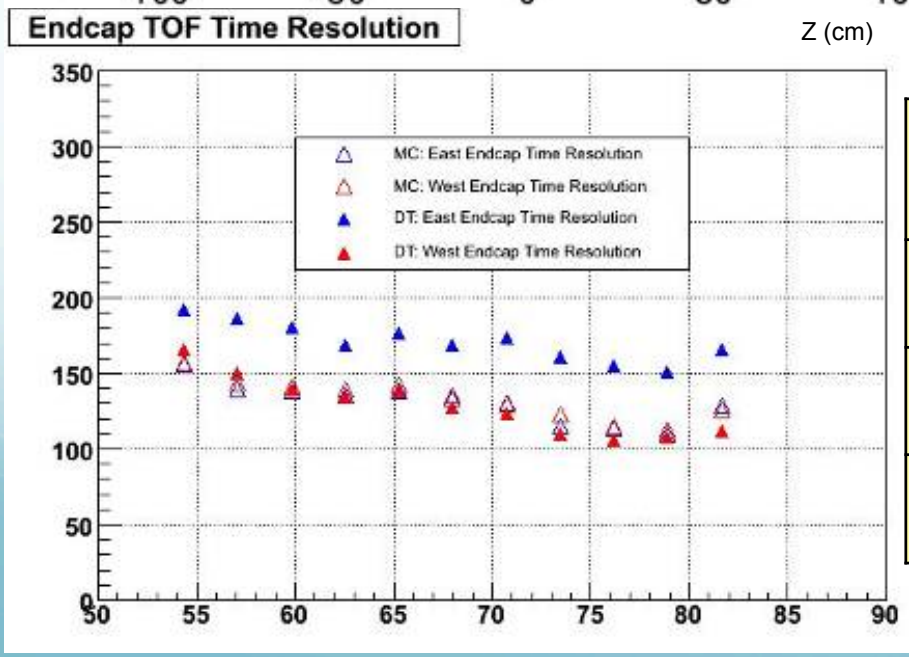


TOF, Top time resolution



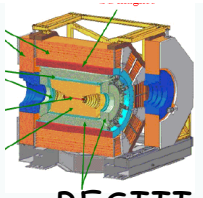




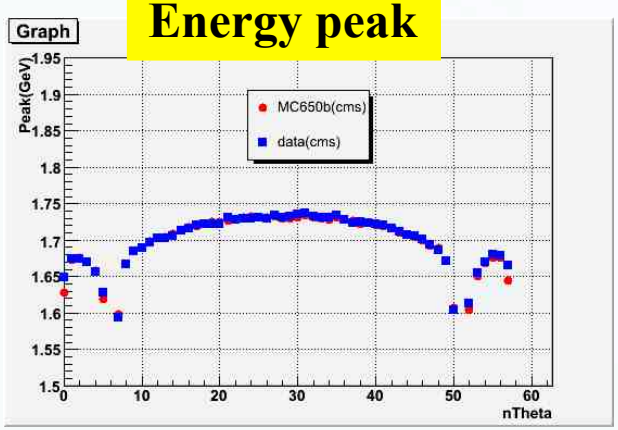


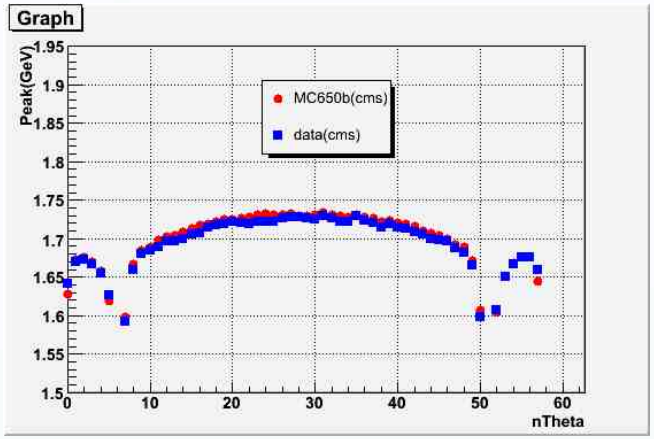
Time Resolution (ps)	Design Target	Bhabha	Dimu
Barrel Single Layer	100~110	98.0	95.3
Barrel Double Layer	80~90	78.9	76.3
Endcap	110~120	136.4	95.0

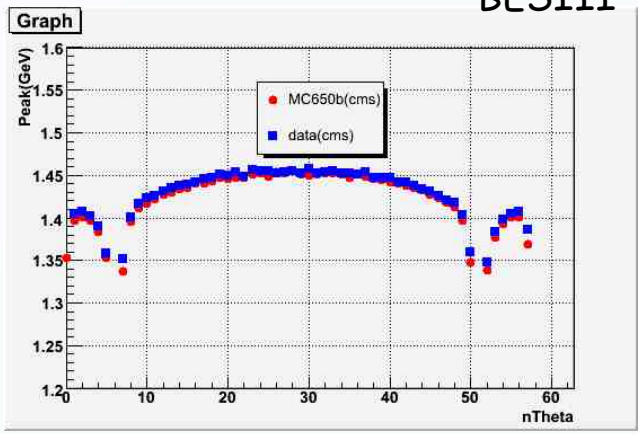
Energy peak and resolution in CMS in different runs



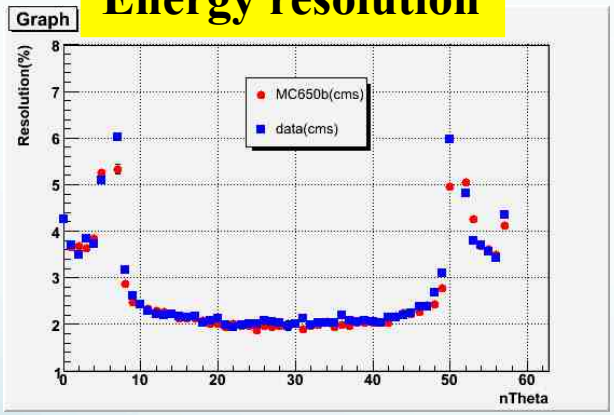
Energy peak

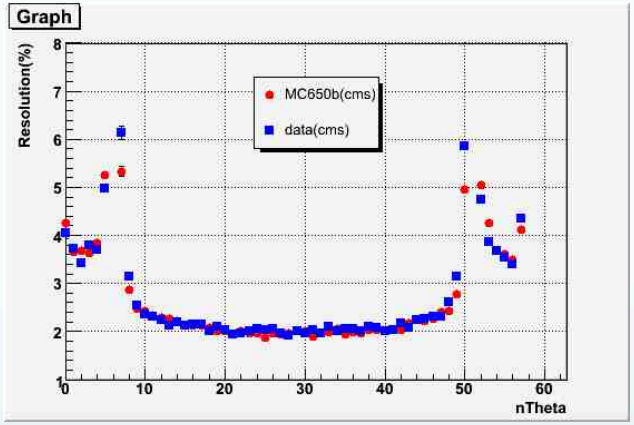


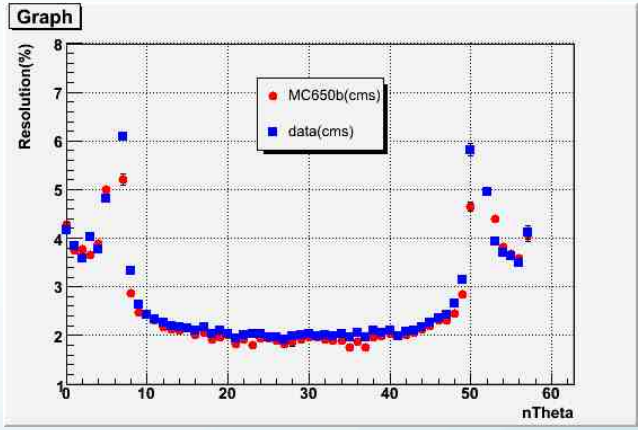




Energy resolution







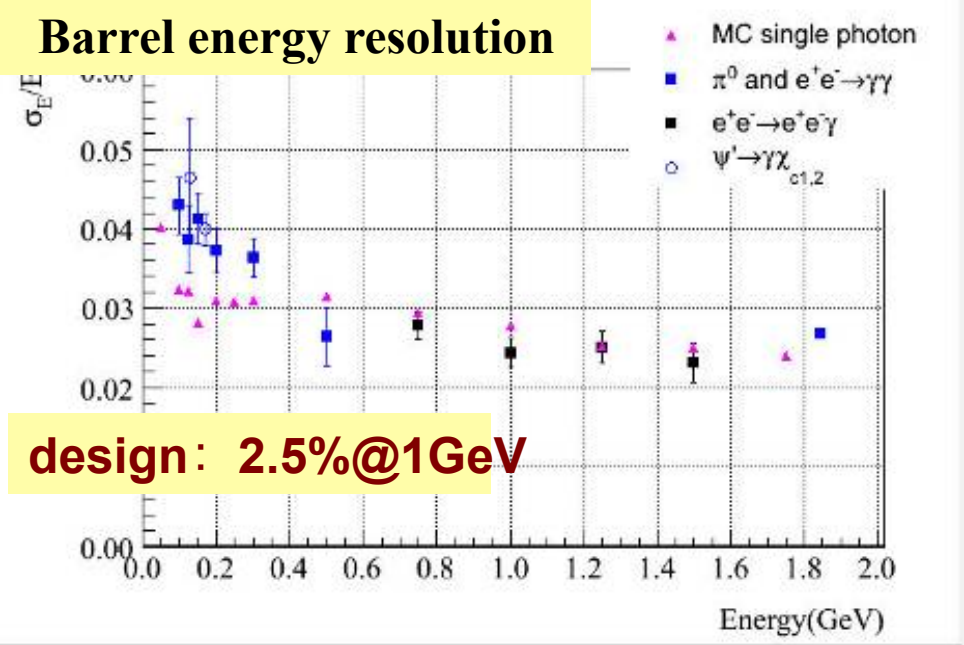
8447(3.686GeV) 9680(3.65GeV) 10138(3.097GeV)

DATA and MC consist very well for Bhabha events,

after the calibration with Bhabha

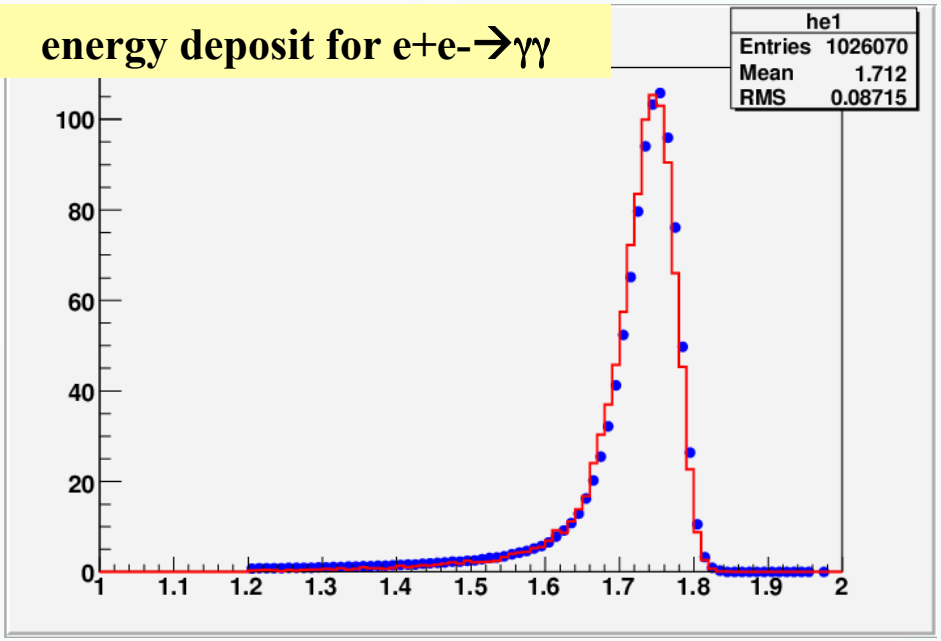
EMC Performance reach/exceed design

Barrel energy resolution



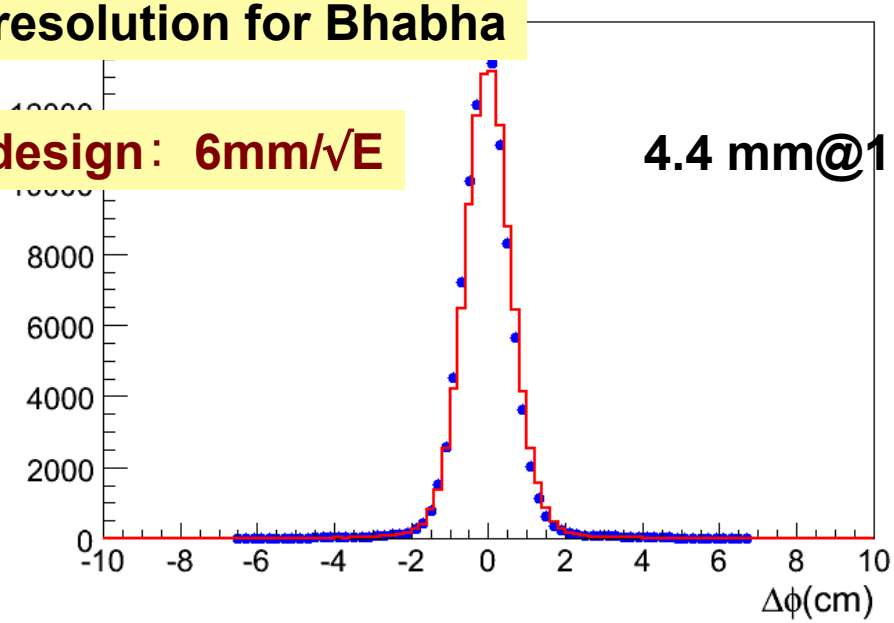
design：2.5%@1GeV

energy deposit for e+e-→γγ



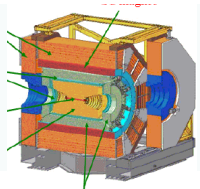
Position resolution for Bhabha

design：6mm/√E

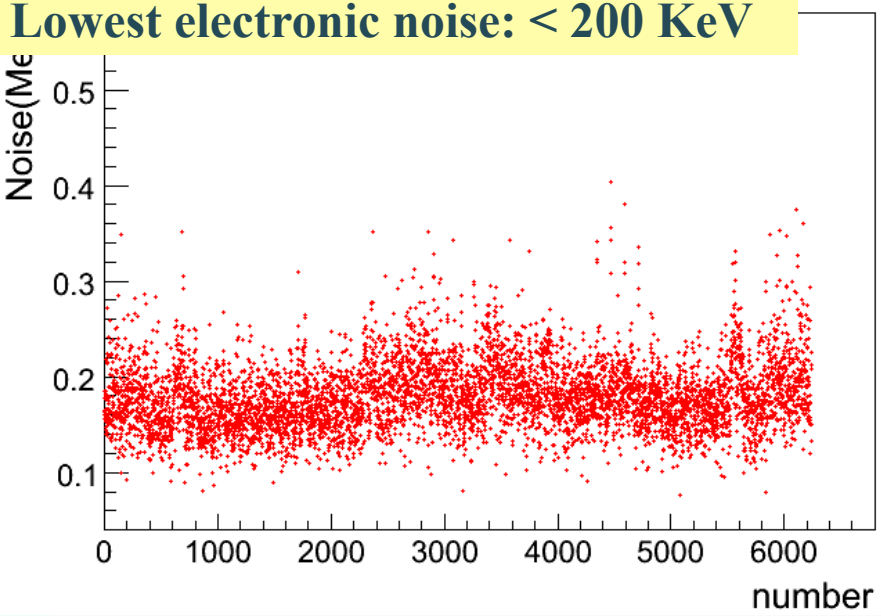


4.4 mm@1.89 GeV

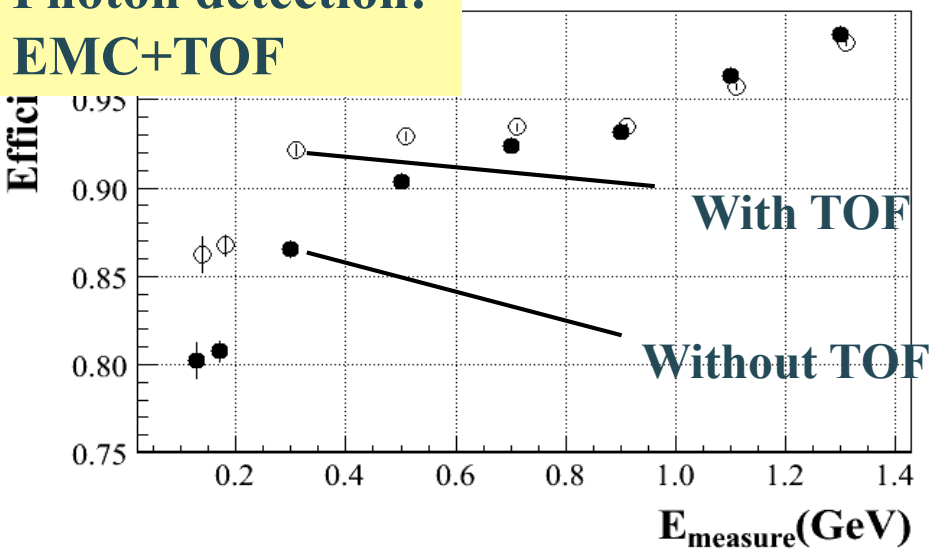
Nice features of BESIII EMC



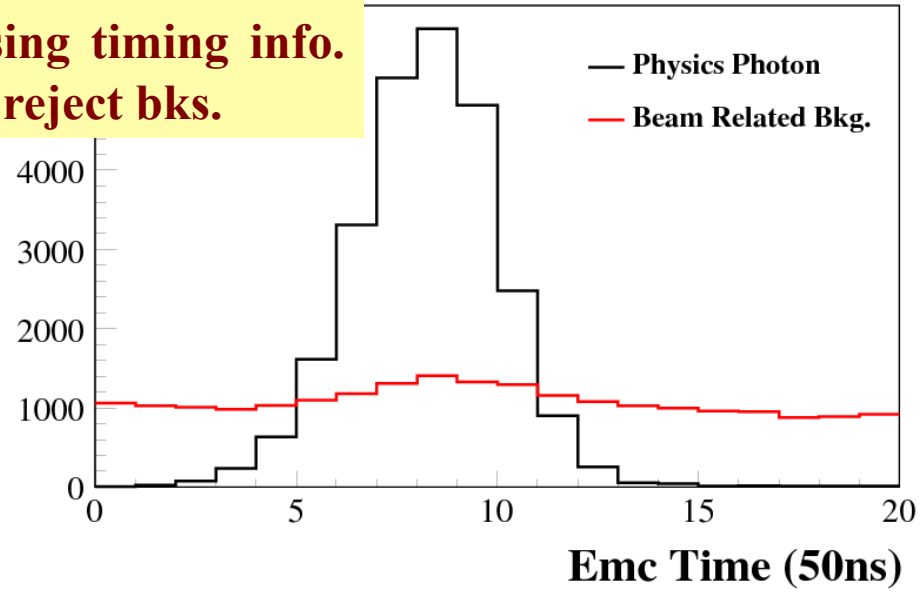
Lowest electronic noise: < 200 KeV

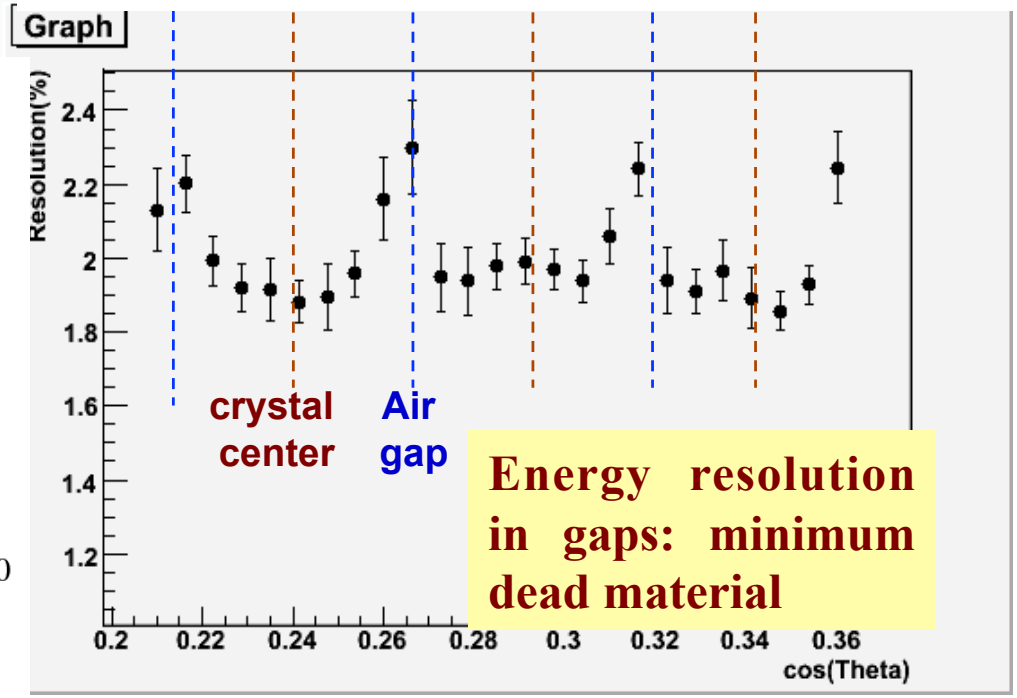


Photon detection: EMC+TOF



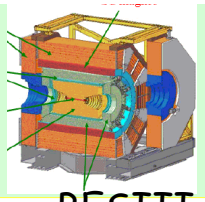
Using timing info. to reject bks.





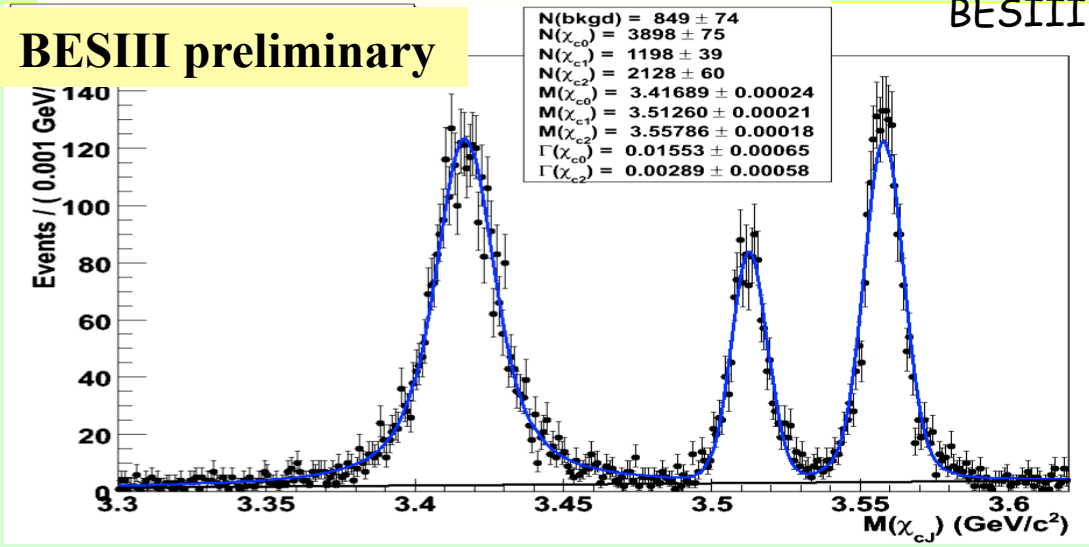
Energy resolution in gaps: minimum dead material

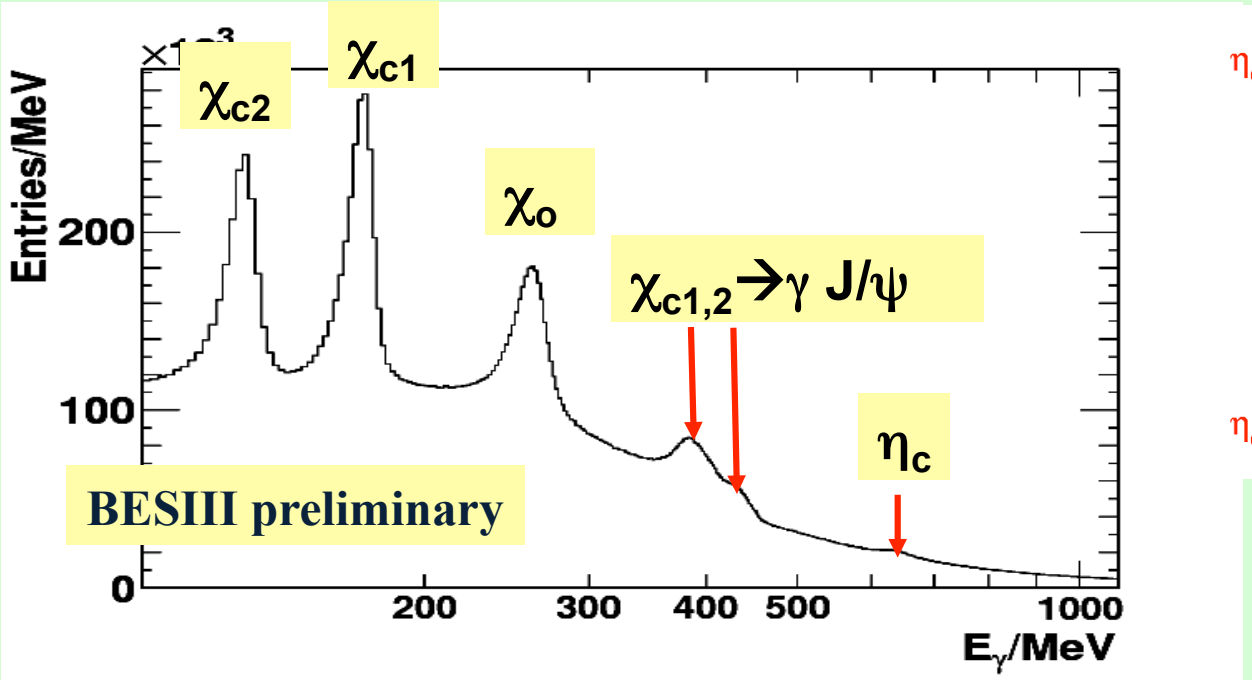
Performance check using ψ(2S)→γX

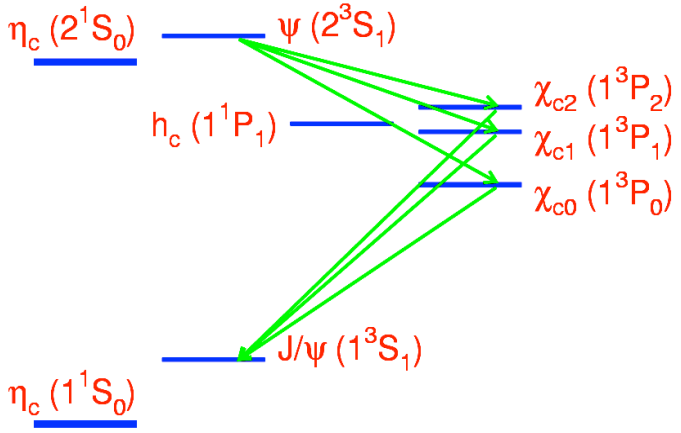


- Clean exclusive signal
- High statistics
- Clear inclusive photon spectrum
- Excellent photon resolution

$$\psi(2S) \to \gamma\chi_{cJ} \to \gamma 2\pi^+ 2\pi^-$$







χ_{cJ} decays

- Good place to study gluonium: $\chi_c \rightarrow gg \rightarrow (q\bar{q})(q\bar{q})$.

  C. Amsler and F. E. Close,Phys. Rev. D 53, 295 (1996).

- Color octet mechanism can be tested.

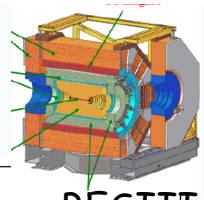
  G. T. Bodwin *et al.*, Phys Rev. Lett. **D51**, 1125 (1995).

  H.-W. Huang and K.-T. Chao, Phys. Rev. **D54**, 6850 (1996).

  J. Bolz *et al.*, Eur. Phys. J. C **2**, 705 (1998).

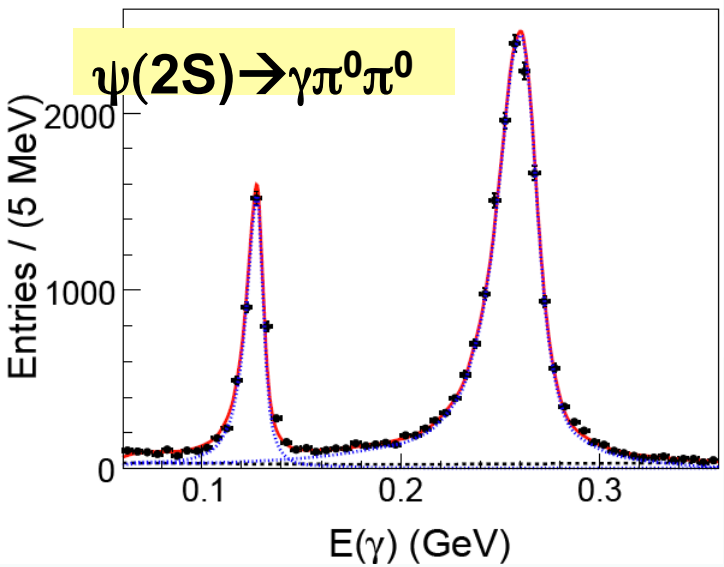
- **Improved measurement of $\chi_{cJ} \rightarrow \pi^0\pi^0, \eta\eta$**
- **Measurement of $\chi_{cJ} \rightarrow$ VV**
- **First measurement of $\chi_{cJ} \rightarrow \gamma\phi$**

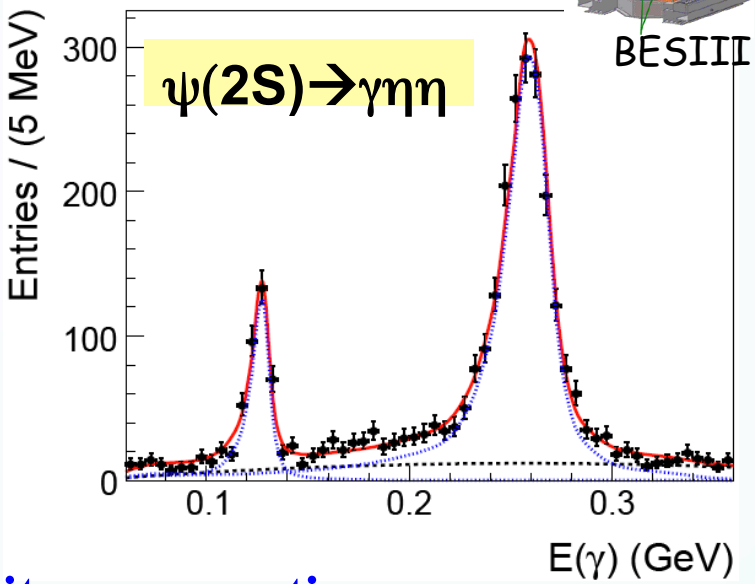
Study of $\psi(2S) \to \gamma\chi_{cJ}$; $\chi_{cJ} \to \pi^0\pi^0$, $\eta\eta$



(η, $\pi^0 \to \gamma\gamma$)

BESIII:
PRD 81, 052005 (2010).





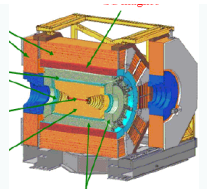
$\chi_{c1} \to \pi\pi$, $\eta\eta$ not allowed by parity conservation.

Decay mode		χ_{c0} (10^{-3})	χ_{c2} (10^{-3})
$\pi^0\pi^0$	BESIII	**3.23±0.03±0.23±0.14**	**0.88±0.02±0.06±0.04**
	PDG08	2.43±0.20	0.71±0.08
	CLEOc	2.94±0.07±0.32±0.15	0.68±0.03±0.07±0.04
$\eta\eta$	BESIII	**3.44±0.10±0.24±0.20**	**0.65±0.04±0.05±0.03**
	PDG08	2.4±0.4	< 0.5
	CLEOc	3.18±0.13±0.31±0.16	0.51±0.05±0.05±0.03

CLEOc:
PRD 79, 072007 (2009).

CLEOc used their own branching ratios for $\psi' \to \gamma\chi_{cJ}$.

$\chi_{cJ} \to 4\pi^0$ from $\psi(2S) \to \gamma\chi_{cJ}$ decays



- **Branching fraction excluding Ks → $\pi^0\pi^0$**

$Br(\chi_{c0} \to 4\pi^0) = 3.42\pm0.07 \pm0.45)\times10^{-3}$

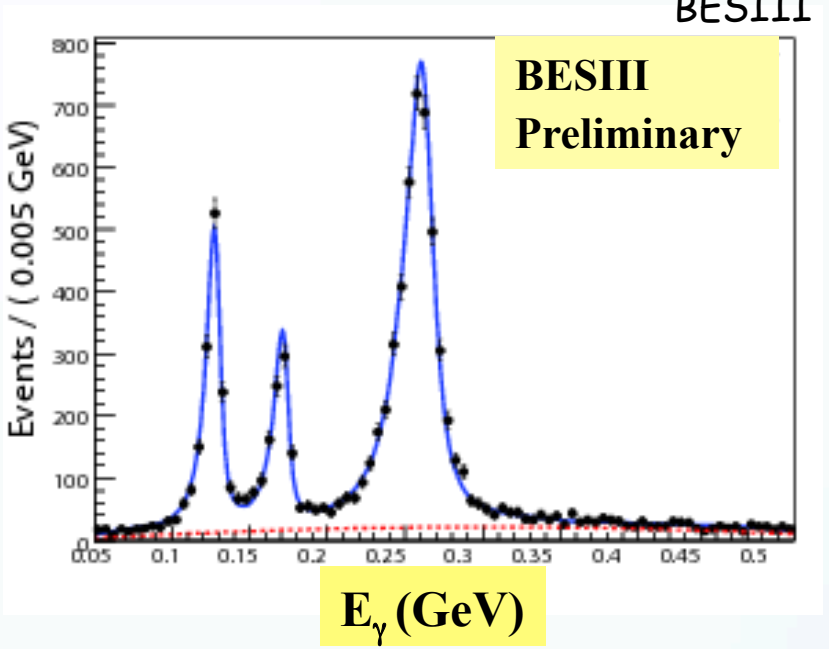
$Br(\chi_{c1} \to 4\pi^0) = 0.60\pm0.03 \pm0.09)\times10^{-3}$

$Br(\chi_{c2} \to 4\pi^0) = 1.13\pm0.04 \pm0.15)\times10^{-3}$

- **Branching fraction for $\chi_{cJ} \to$ KsKs**

$Br(\chi_{c0} \to K_SK_S) = 4.1\pm0.4(stat.))\times10^{-3}$

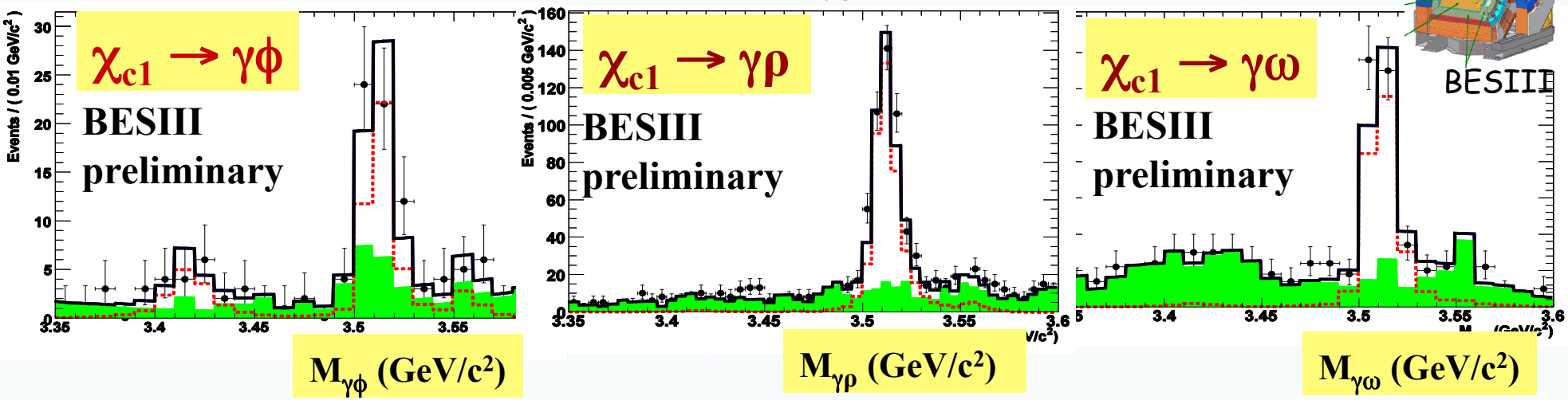
$Br(\chi_{c2} \to K_SK_S) = 0.6\pm0.2(stat.))\times10^{-3}$



$B(\chi_{c0} \to K_SK_S)$	χ_{c0} (10^{-3})	χ_{c2} (10^{-3})
BESIII	$4.1 \pm 0.4_{stat}$	$0.6 \pm 0.2_{stat}$
PDG08	2.82 ± 0.28	0.65 ± 0.08
CLEOc	3.49 ± 0.08 ± 0.18 ± 0.17	0.53 ± 0.03 ± 0.03 ± 0.03

CLEO Collaboration, Phys. Rev. D79: 072007 (2009).

Measurements of $\chi_{cJ} \to \gamma V$, V=ϕ,ρ,ω



B (10^{-6})	BESIII	CLEOc	pQCD
$\chi_{c0} \to \gamma\phi$	< 14.8	< 6.4	0.46
$\chi_{c1} \to \gamma\phi$	$27.3 \pm 5.5_{stat}$	< 26	3.6
$\chi_{c2} \to \gamma\phi$	< 7.8	< 13	1.1
$\chi_{c0} \to \gamma\rho^0$	< 9.5	< 9.6	1.2
$\chi_{c1} \to \gamma\rho^0$	$241 \pm 14_{stat}$	243 ± 19 ± 22	14
$\chi_{c2} \to \gamma\rho^0$	< 19.7	< 50	4.4
$\chi_{c0} \to \gamma\omega$	< 11.7	< 8.8	0.13
$\chi_{c1} \to \gamma\omega$	$73.5 \pm 7.6_{stat}$	83 ± 15 ± 12	1.6
$\chi_{c2} \to \gamma\omega$	< 5.8	< 7.0	0.5

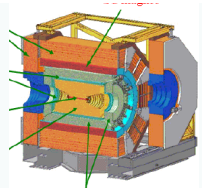
- $\chi_{c1} \to \gamma\phi$ observed for first time.
- pQCD predictions are too low.
- Difference may be explained by non-perturbative QCD "loop corrections". D.Y Chen *et al*, arXiv:1005.0066v2[hep-ph].

CLEOc: PRL 101, 151801 (2008)

pQCD: Y.J. Gao et al., hep-ph/0701009

BESIII: Only statistical errors are shown

Measurements of $\chi_{cJ} \to \gamma V$, V=ϕ,ρ,ω



Helicity angle θ is the angle between the vector meson direction in the χ_{c1} rest frame and a daughter meson in the vector meson rest frame (ρ and ϕ) or the normal to the decay plane in the ω rest frame.

Longitudinal polarization (transverse) exhibits a $\cos^2\theta$ ($\sin^2\theta$) dependence.

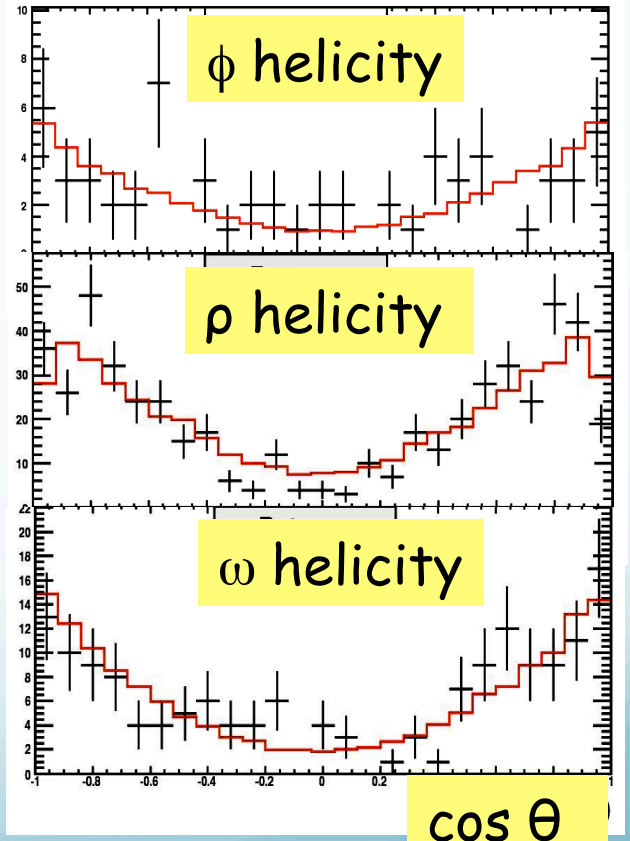
Longitudinal polarization dominant in $\chi_{c1} \to \gamma\rho$ decays. (parallel to $f_1(1285) \to \gamma\rho$)

CLEO-c determines ratio of transverse to longitudinal polarization (f_T) :

$$f_T = 0.078^{+0.048+0.002}_{-0.036-0.022} \quad \text{for } \chi_{c1} \to \gamma\rho$$

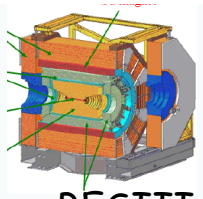
$$f_T = 0.47^{+0.37+0.11}_{-0.24-0.23} \quad \text{for } \chi_{c1} \to \gamma\omega$$

CLEOc: PRL 101, 151801 (2008)



BESIII preliminary

Study of $\chi_{cJ} \to VV$, V = ω,ϕ



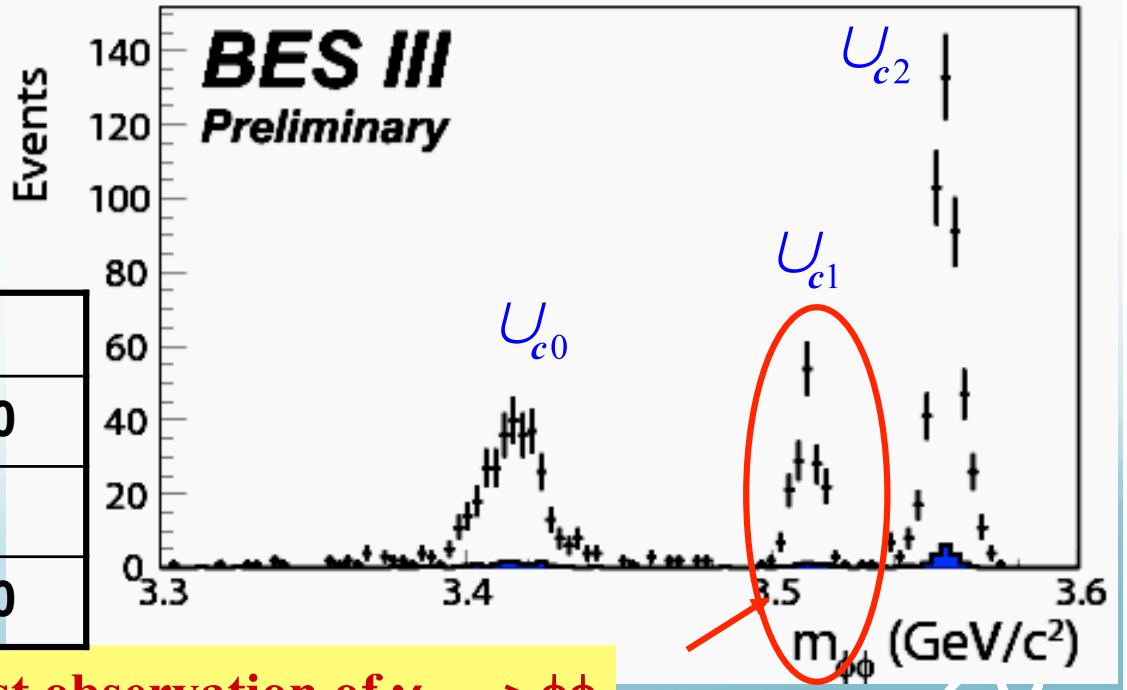
- Previous measurements from BESII.
- They do not show expected helicity suppression.

BR (10^{-3})	χ_{c0}	χ_{c2}
$\to \phi\phi$	0.94±0.21±0.13	1.70±0.30±0.25
$\to \omega\omega$	2.29±0.58±0.41	1.77±0.47±0.36

BESII, PLB 642, 197 (2006)

BESII, PLB 630, 7 (2005)

BESIII sees clear $\chi_{cJ} \to \phi\phi$ → 4K signals

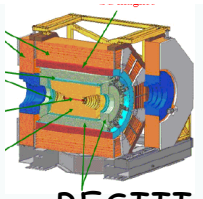


BR(10^{-3})	BESIII	PDG08
$\chi_{c0} \to \phi\phi$	0.80 ± 0.04	0.93 ± 0.20
$\chi_{c1} \to \phi\phi$	0.42 ± 0.03	----
$\chi_{c2} \to \phi\phi$	1.15 ± 0.04	1.54 ± 0.30

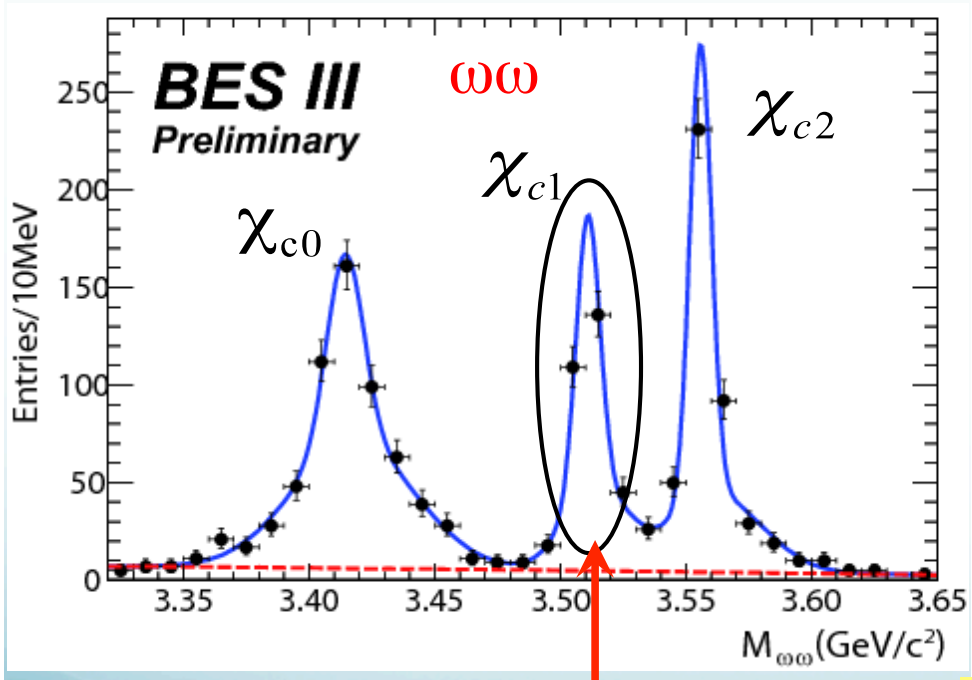
Errors statistical only.

First observation of $\chi_{c1} \to \phi\phi$

Study of $\chi_{cJ} \to VV$, V = ω,ϕ

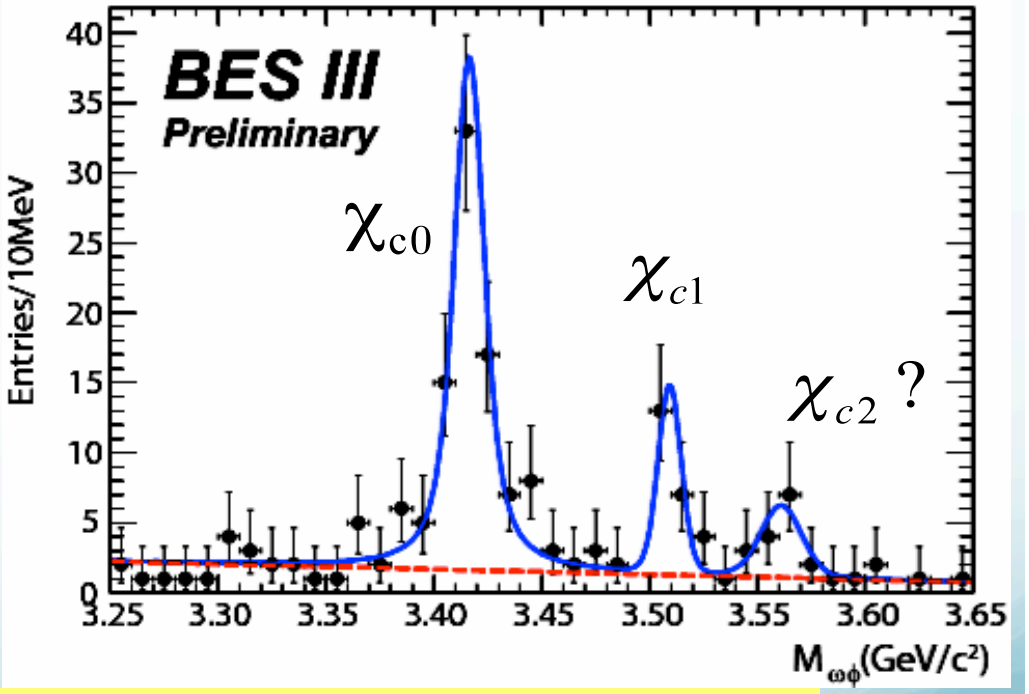


And clear $\chi_{cJ} \to \omega\omega$
$\to 2(\pi^+\pi^-\pi^0)$



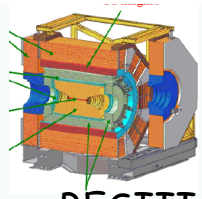
First observation of $\chi_{c1} \to \omega\omega$.

And clear $\chi_{cJ} \to \omega\phi$
$\to (\pi^+\pi^-\pi^0)(KK)$



Doubly OZI suppressed $\chi_{cJ} \to \omega\phi$ signals are observed for the first time.

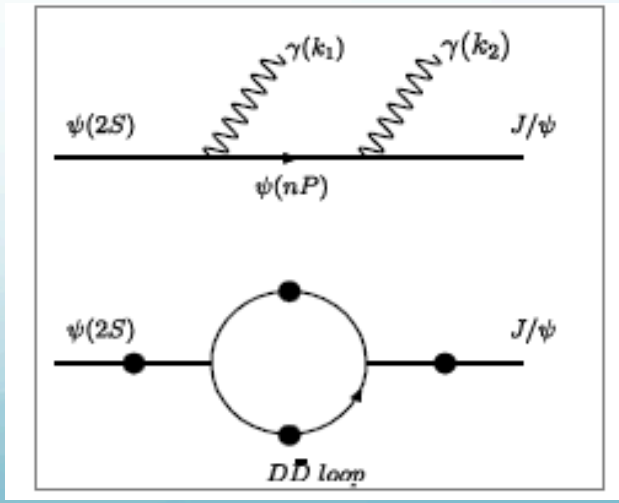
First observation of $\psi' \rightarrow \gamma\gamma J/\psi$



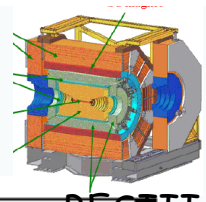
- Two photon transitions are well known in excitations of molecules, atomic hydrogen, and positronium.
  - A. Quattropani **etal**, PRA **25**, 3079 (1982).
  - F. Bassani **etal**, PRL **39**, 1070 (1977).
  - A. Quattropani **etal**, PRL **50**, 1258 (1983).
- CLEO observed two photon transitions in Y(3S)→Y(2S).
  - F. Butler **etal**, PRD **49**, 40 (1994).
- Never been observed in the charmonium system.
- Observation helpful to understanding QCD.

Theoretically:

- potential models give discrete spectra ($\psi(2S) \rightarrow \gamma\chi_{cJ}, \chi_{cJ} \rightarrow \gamma J/\psi$)
- coupled channel models can give continuous spectra.
- theoretical work ongoing.

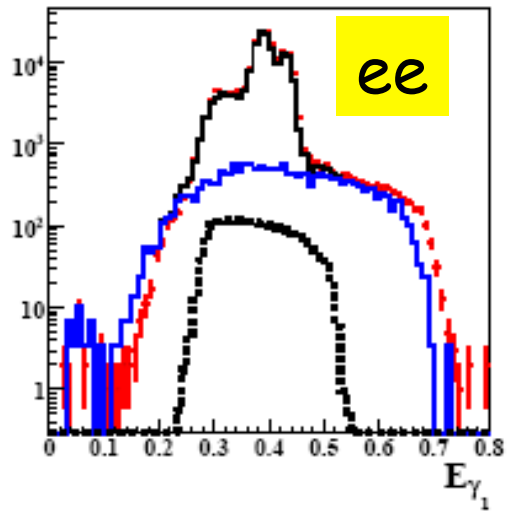


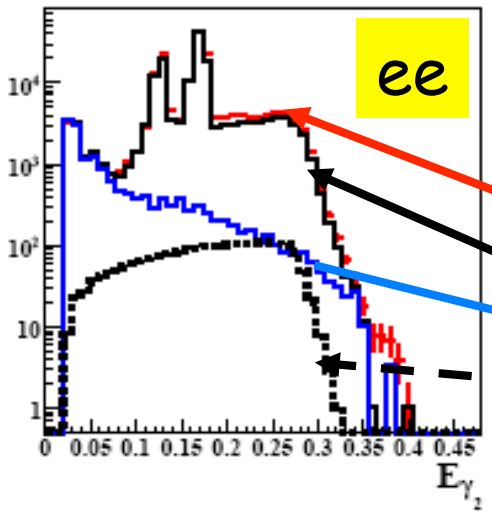
First observation of $\psi(2S) \rightarrow \gamma\gamma J/\psi$



- select $\psi(2S) \rightarrow \gamma\gamma J/\psi$, $J/\psi \rightarrow l^+l^-$ events.
- $J/\psi \rightarrow$ ee channel ($\mu\mu$ similar):

γ_1 - high energy gamma, γ_2 - low energy gamma



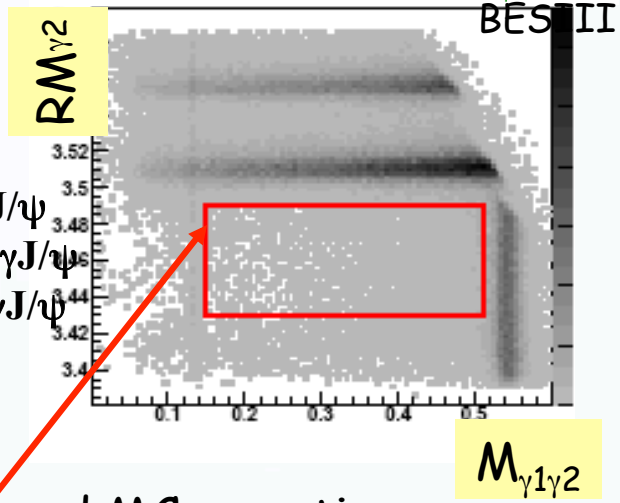


Side band of

$\psi' \rightarrow \gamma\chi_{cJ} \rightarrow \gamma\gamma J/\psi$

$\psi' \rightarrow \pi^0 J/\psi \rightarrow \gamma\gamma J/\psi$

$\psi' \rightarrow \eta J/\psi \rightarrow \gamma\gamma J/\psi$



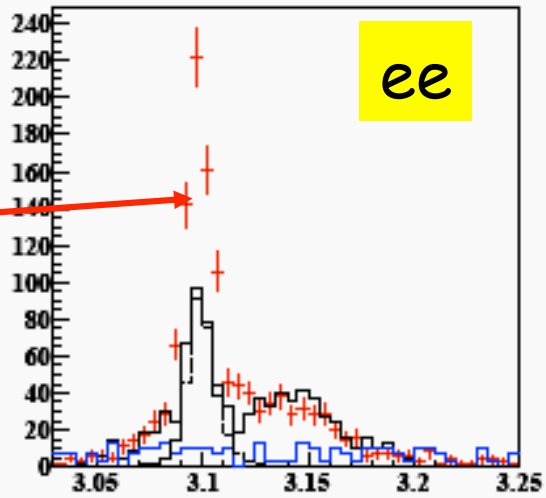
data

background MC + continuum

continuum only

signal (phase space; BR = 1×10^{-3})

- select events in box to enhance signal.
- see clear excess over BG + continuum in $M_{J/\psi}$ distribution. Significance > 10σ



$B(\psi(2S) \rightarrow \gamma\gamma J/\psi)$ [both ee and $\mu\mu$]

$= (1.02 \pm 0.05\ ^{+0.19}_{-0.20}) \times 10^{-3}$

preliminary

$h_c(^1P_1)$

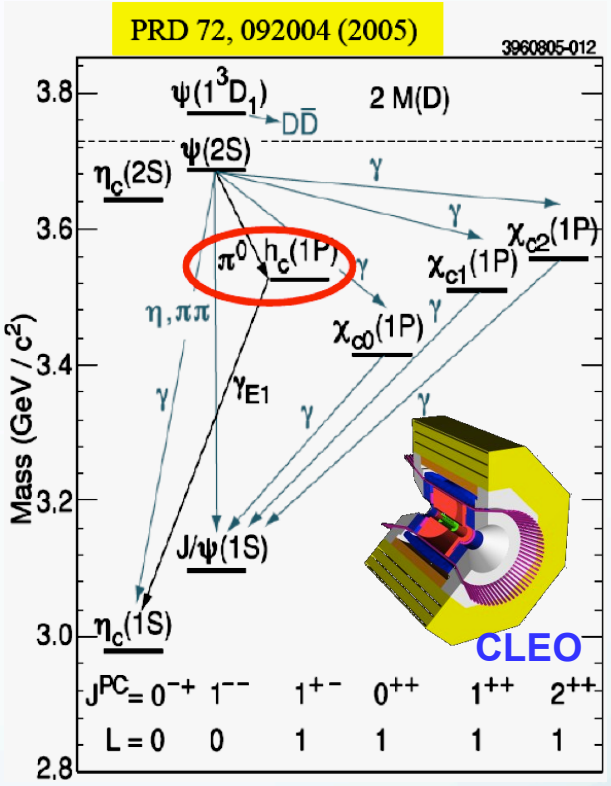
$M(h_c)$ important to learn about hyperfine (spin-spin) interaction of P wave states.

Hyperfine or triplet-singlet splitting determined by spin-spin term in QCD potential models.

h_c: 1st seen by E835 and CLEO in 2005

- E835: Evidence in $pp \rightarrow h_c \rightarrow \gamma\eta_c$
- CLEO: Observation in $\psi(2S) \rightarrow \pi^o h_c$; $h_c \rightarrow \gamma\eta_c$

- CLEOc in 2008: 25 M $\psi(2S)$ events



Combining with earlier CLEO results:

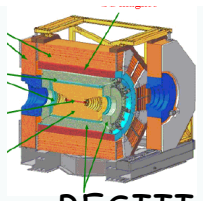
$$M(h_c)_{AVG} = 3525.20 \pm 0.18 \pm 0.12 \text{ MeV}/c^2$$
$$(B_1 \times B_2)_{AVG} = (4.16 \pm 0.30 \pm 0.37) \times 10^{-4}$$

Using the spin weighted centroid of ^3P_J states, $\langle M(^3P_J)\rangle$, to represent $M(^3P_J)$: $\Delta M_{hf}(1P) = \langle M(^3P_J)\rangle - M(^1P_1) = 0.08 \pm 0.18 \pm 0.12$ MeV

Consistent with lowest order expectation of 0.

PRL 101, 182003 (2008).

BESIII h_c: Tagged $\psi(2S)\rightarrow\pi^0 h_c$, $h_c\rightarrow\gamma\eta_c$



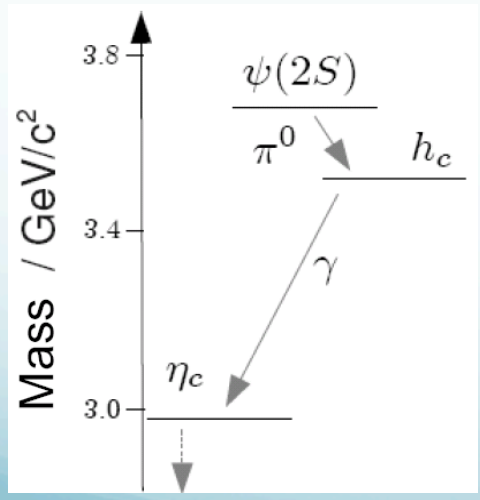
- Select events with E1-photon to tag $h_c \rightarrow \gamma\ \eta_c$
- Plot mass recoiling from inclusive π^0 ($\psi(2S) \rightarrow \pi^0 h_c$)
- Fit with double-Gaussian signal x BW + sideband bkg:

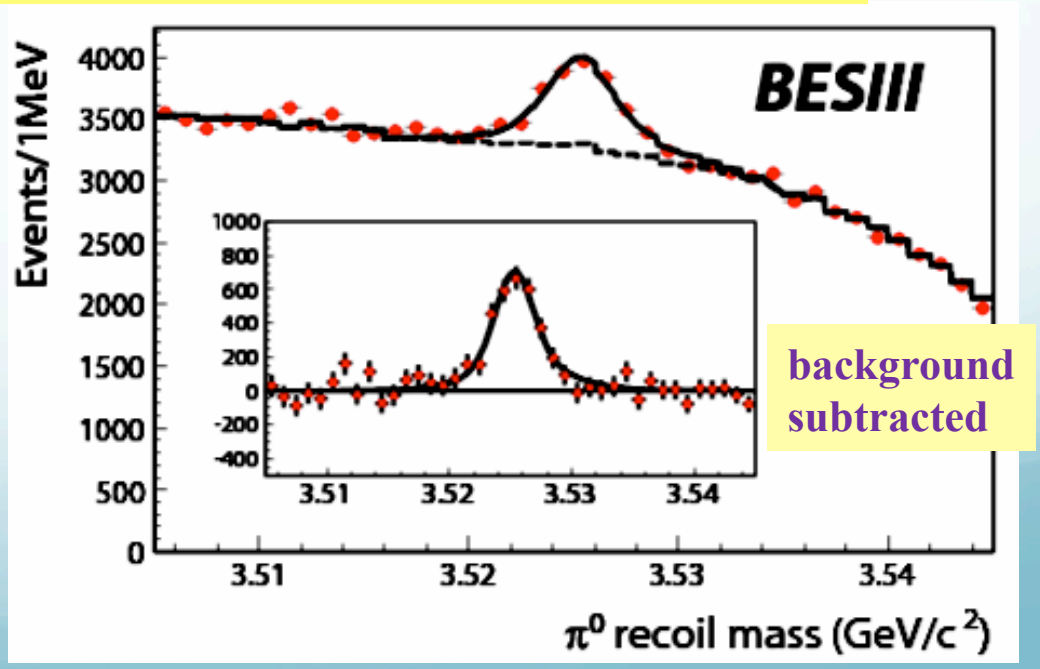
$M(h_c) = 3525.40 \pm 0.13 \pm 0.18$ MeV/c^2

$\Gamma(h_c) = 0.73 \pm 0.45 \pm 0.28$ MeV/c^2 (< 1.44 MeV/c^2 @ 90% CL)

(First measurement)

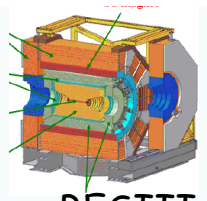
$Br(\psi(2S)\rightarrow\pi^0 h_c)\times Br(h_c\rightarrow\gamma\eta_c) = (4.58 \pm 0.40 \pm 0.50) \times 10^{-4}$





BES Collab., PRL 104, 132002 (2010)

BESIII h_c : Inclusive $\psi(2S) \rightarrow \pi^0 h_c$

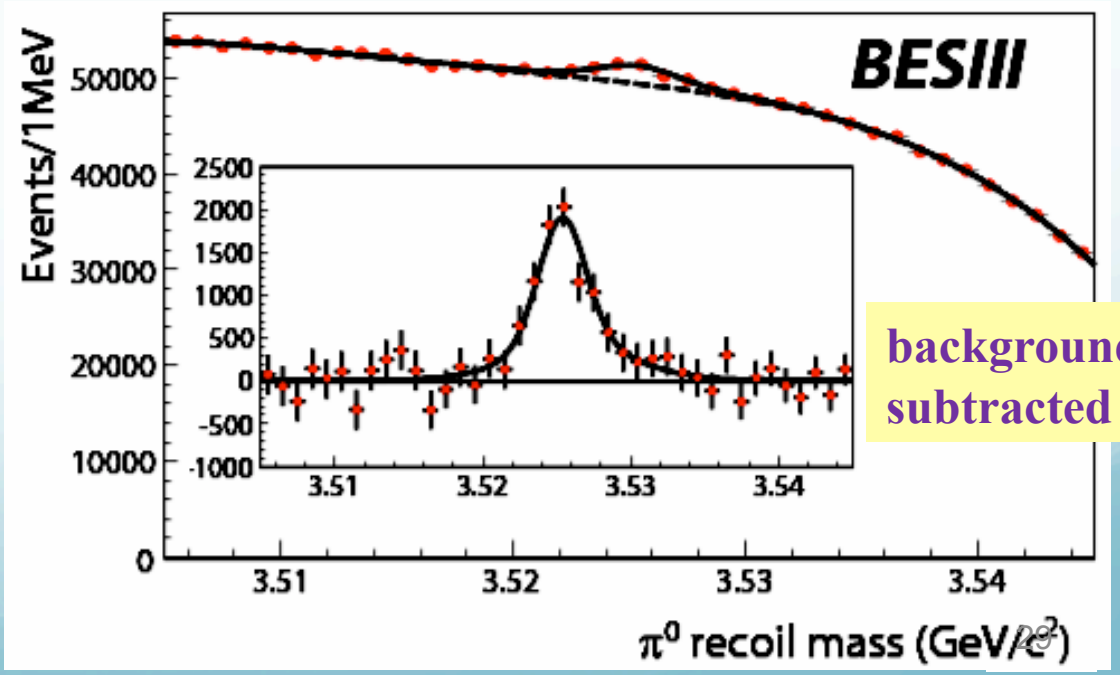


- Select inclusive π^0 (untagged)
- Plot mass recoiling against π^0
- Fit with double-Gaussian x BW signal + 4th Poly. bkg
  (mass and width fixed to tagged values)
- Combine with tagged results to determine:

$Br(\psi(2S) \rightarrow \pi^0 h_c) = (8.4 \pm 1.3 \pm 1.0) \times 10^{-4}$ (First measurement)

$Br(h_c \rightarrow \gamma \eta_c) = (54.3 \pm 6.7 \pm 5.2)\ \%$ (First measurement)

BES Collaboration, PRL 104, 132002 (2010)



h_c : analysis summary

BES Collaboration, PRL 104, 132002 (2010)

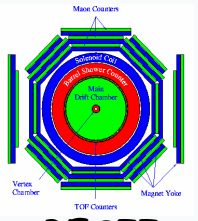
	BESIII	CLEOc	Th(Kuang)
$Br(\psi(2S)\to \pi^0 h_c) \times Br(h_c\to\gamma\eta_c)$ $[10^{-4}]$	4.58±0.40±0.50	4.16±0.30±0.37	
M [MeV/c^2]	3525.40 ±0.13±0.18	3525.20 ±0.18±0.12	
Γ [MeV]	0.73±0.45±0.28 < 1.44 @ 90%CL		1.1 (NRQCD) 0.51 (PQCD)
$\Delta M_{hf}(1P)$ [MeV/c^2]	0.10±0.13±0.18	0.08±0.18±0.12	

CLEO-c Collaboration, PRL 101, 182003 (2008)

	BESIII	theoretical predictions
$Br(\psi'\to \pi^0 h_{c)}$ $[10^{-4}]$	8.4±1.3±1.0	4 – 13 Kuang
$Br(h_c\to\gamma\eta_c)$ [%]	54.3±6.7±5.2	41 (NRQCD) Kuang 88 (PQCD) Kuang 38 Godfrey, Rosner

Theoretical predictions: Kuang, PRD65, 094024 (2002),
Godfrey & Rosner, PRD 66, 014012 (2002).

Threshold enhancement in $J/\psi \to \gamma p\bar{p}$

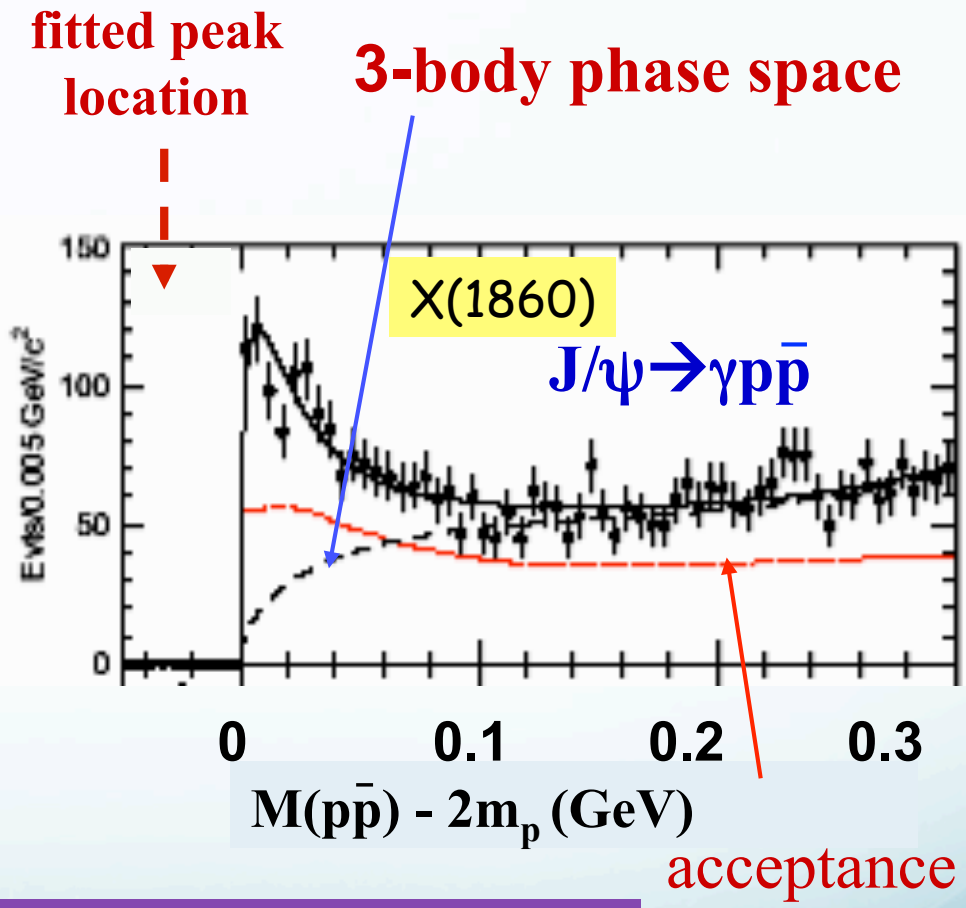


- **BESII**: enhancement seen near threshold in M_{pp} in $J/\psi \to \gamma\, p\, \bar{p}$.

- **If fitted with an *S* -wave resonance:**

$$M = 1859^{+3}_{-10}{}^{+5}_{-25}\ \text{MeV}/c^2$$

$$\Gamma < 30\ \text{MeV}/c^2\ (90\%\ \text{CL})$$



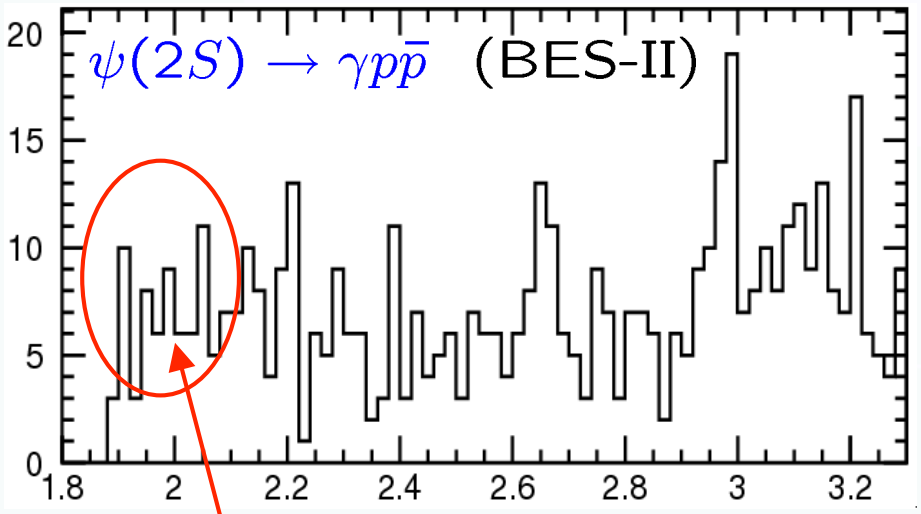
Phys. Rev. Lett. 91, 022001 (2003)
162 citations

"The BES Particle"
Klempt: Glueballs, Hybrids, and Pentaquarks

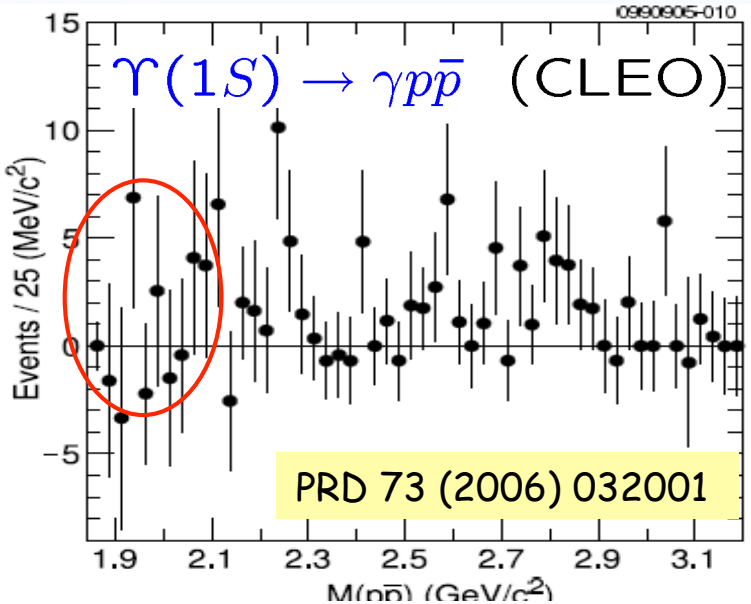
$p\bar{p}$ threshold enhancement

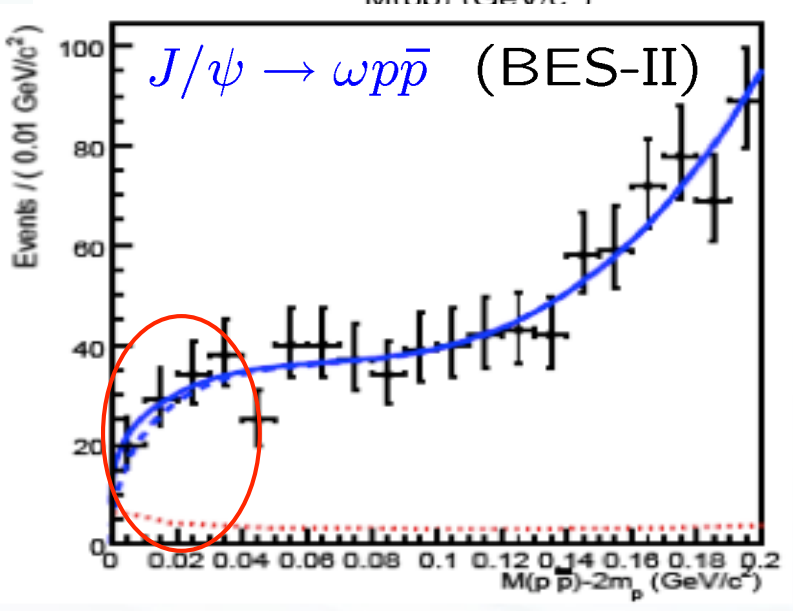
Several *non*-observations...

PRL 99 (2007) 011802



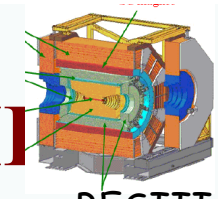
No significant signal of X(1860) found (only 2σ significance)

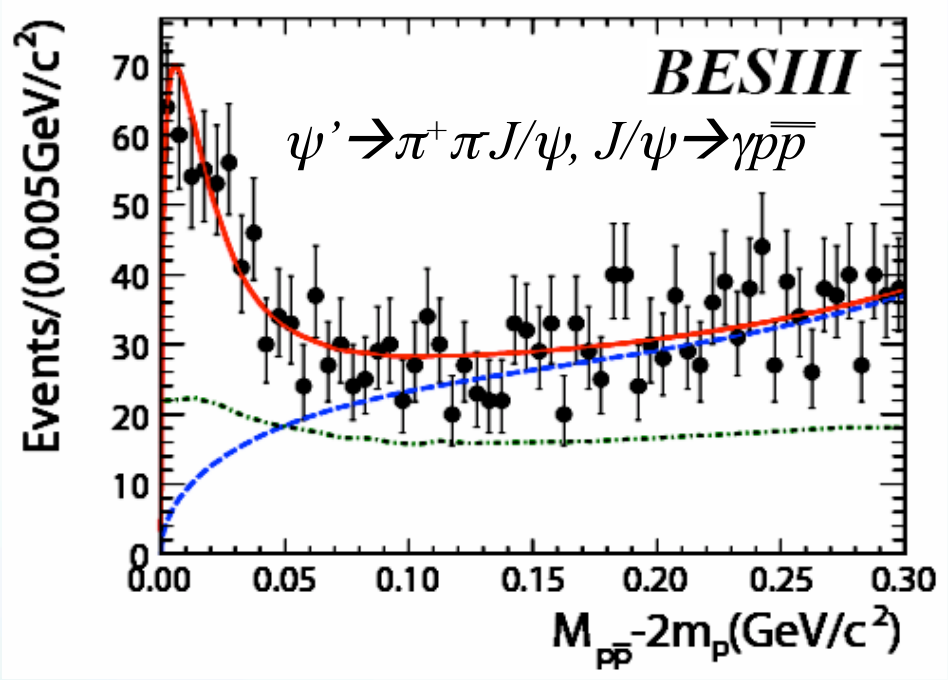


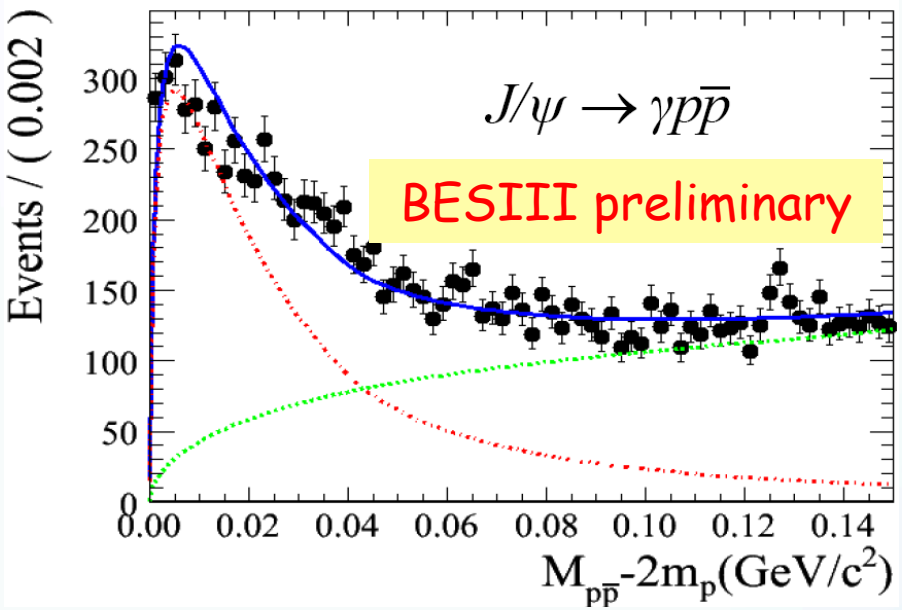


EPJ C53 (2008) 15

$p\bar{p}$ threshold enhancement @ BESIII







$M = 1861\ ^{+6}_{-13}\ ^{+7}_{-26}$ MeV/c^2

$\Gamma < 38$ MeV/c^2 (90% CL)

$M = 1861.6 \pm 0.8$ MeV/c^2

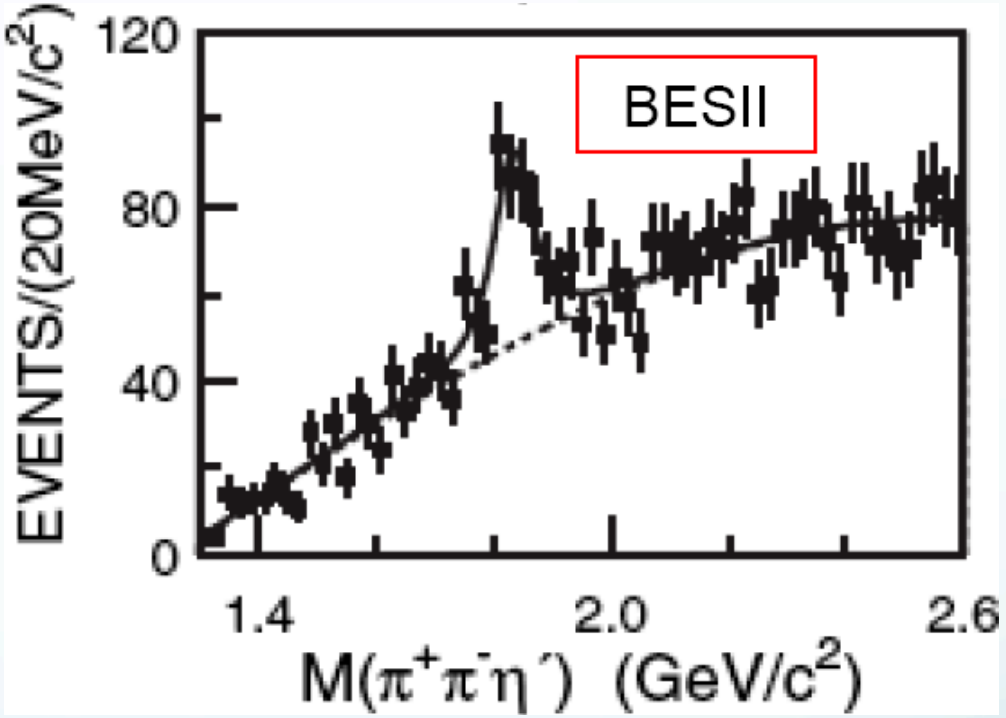
$\Gamma < 8$ MeV/c^2 (90% CL)

Published in
Chinese Physics C 34, 421 (2010)

Consistent observation by BESIII !

X(1835) at BESII

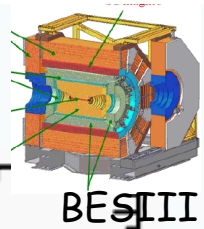
- The X(1860) should be detected in other decay modes.
- G.J. Ding and M.L. Yan suggest η'ππ to be a favorable mode. (Hep-ph/0502127)
  - there is gluon content in $p\bar{p}$
  - η' has strong coupling to gluons
- Confirmation of X(1835) is necessary with BESIII 226M J/ψ data sample

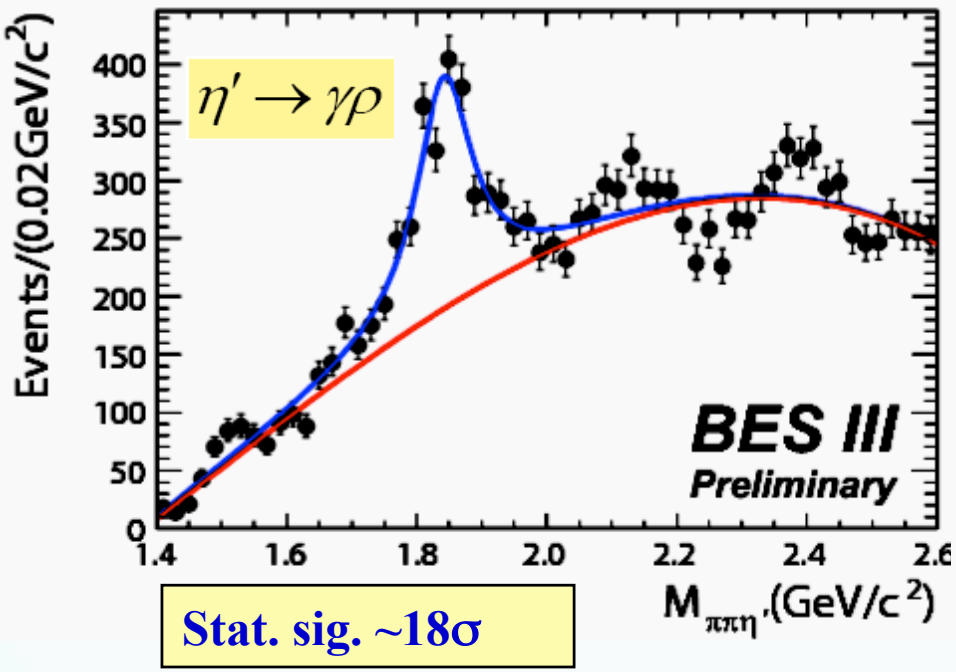


The $\pi^+\pi^-\eta'$ mass spectrum for η' decaying into $\eta' \to \pi^+\pi^-\eta$ and $\eta' \to \gamma\rho$ in $J/\psi \to \gamma\pi^+\pi^-\eta'$

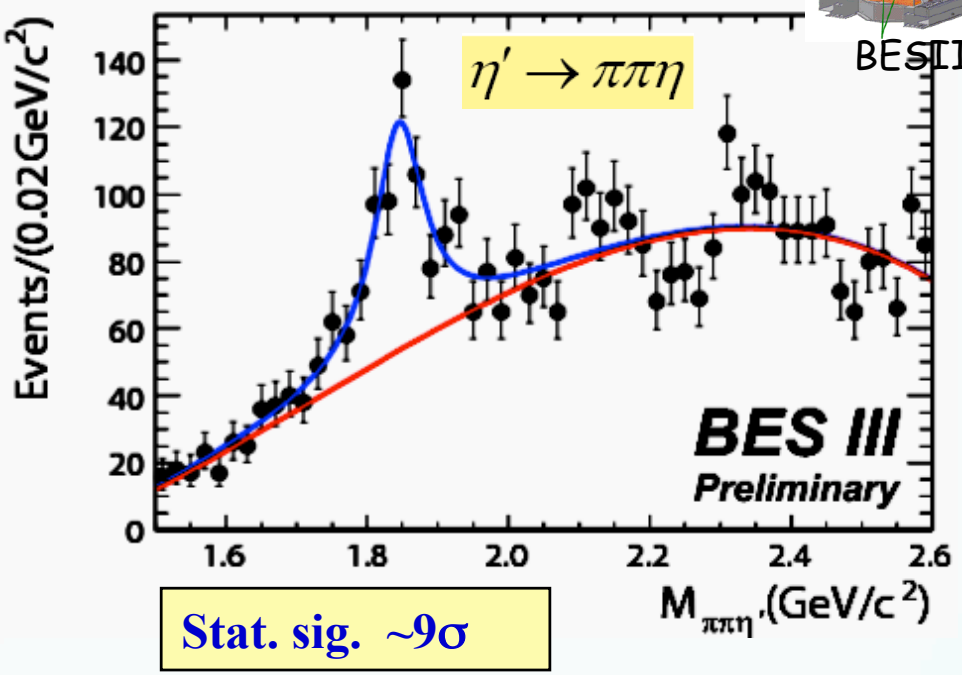
PRL 95, 262001 (2005)

X(1835) at BESIII

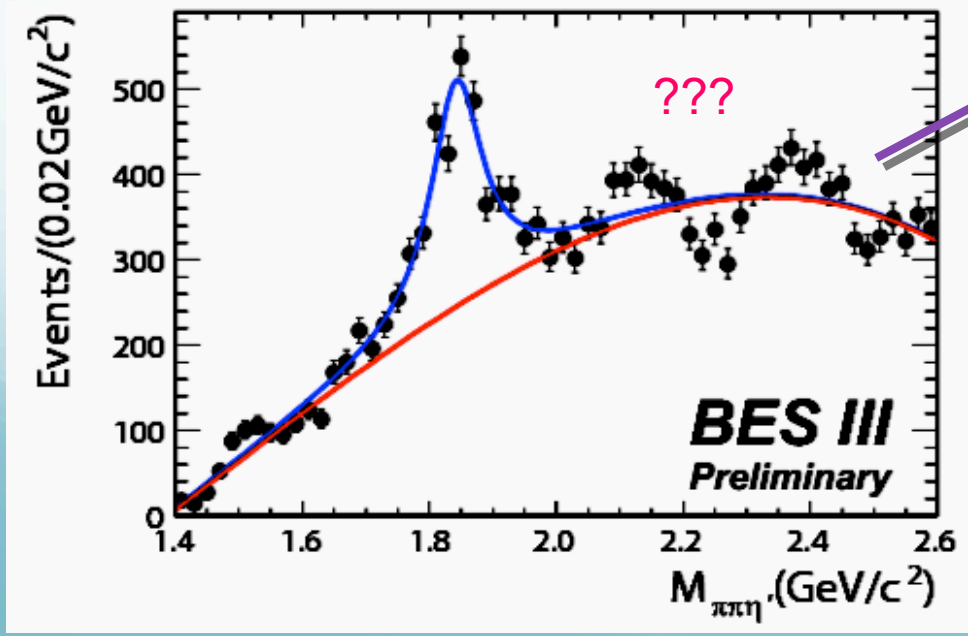




Stat. sig. ~18σ



Stat. sig. ~9σ



The possibility that there are two new resonances is under further study.

$Fit\ result(\text{Statistic significant}\sim 21\sigma):$

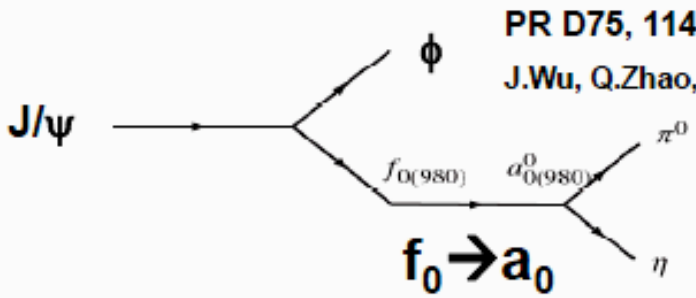
$M = 1842.4 \pm 2.8(stat)MeV$

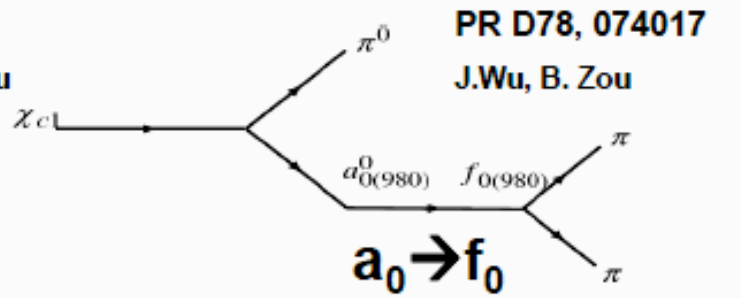
$\Gamma = 99.2 \pm 9.2(stat)MeV$

X(1835) confirmed by BESIII

$a_0(980)$ – $f_0(980)$ mixing

- Light scalar mesons f_0 and a_0 are still controversial.
- Described as quark-antiquarks, four quarks, KK-bar molecule, qq-bar g hybrids, etc.
- Study of mixing is important to clarify their nature.





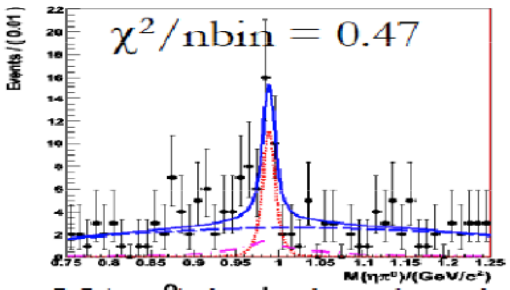
$$\xi_{fa}(s) = \frac{d\Gamma_{X\to Yf_0(980)\to Ya_0^0(980)\to Y\pi^0\eta(s)}}{d\Gamma_{X\to Yf_0(980)\to Y\pi\pi(s)}} = \left|\frac{g_{a_0^0K^+K^-}g_{f_0K^+K^-}}{g_{a_0^0\pi^0\eta}g_{f_0\pi^0\pi^0}}\right|^2 \frac{|\rho_{K^+K^-}(s)-\rho_{K^0\bar{K}^0}(s)|^2}{3\rho_{\pi\pi}(s)\rho_{\pi\eta}(s)} \times \frac{1}{\left|\frac{m_a^2-s}{\Gamma^a_{\pi\eta}\sqrt{s}} - i\left[\left|\frac{g_{a_0^0K^+K^-}}{g_{a_0^0\pi^0\eta}}\right|^2\left(\frac{\rho_{K^+K^-}(s)}{\rho_{\pi\eta(s)}}+\frac{\rho_{K^0\bar{K}^0}}{\rho_{\pi\eta}}\right)+1\right]\right|^2}$$

$$\xi_{af}(s) = \frac{d\Gamma_{X\to Ya_0^0(980)\to Yf_0(980)\to Y\pi\pi(s)}}{d\Gamma_{X\to Ya_0^0(980)\to Y\pi^0\eta(s)}} = \left|\frac{g_{a_0^0K^+K^-}g_{f_0K^+K^-}}{g_{a_0^0\pi^0\eta}g_{f_0\pi^0\pi^0}}\right|^2 \frac{|\rho_{K^+K^-}(s)-\rho_{K^0\bar{K}^0}(s)|^2}{3\rho_{\pi\pi}(s)\rho_{\pi\eta}(s)} \times \frac{1}{\left|\frac{m_f^2-s}{\Gamma^f_{\pi\pi}\sqrt{s}} - i\left[\left|\frac{g_{f_0K^+K^-}}{g_{f_0\pi^0\pi^0}}\right|^2\left(\frac{\rho_{K^+K^-}(s)}{3\rho_{\pi\pi(s)}}+\frac{\rho_{K^0\bar{K}^0(s)}}{3\rho_{\pi\pi(s)}}\right)+1\right]\right|^2}$$

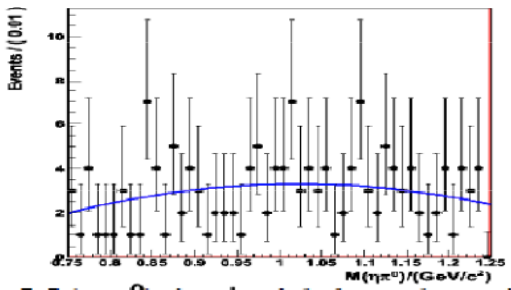
$a_0(980) - f_0(980)$ mixing

Mixing peaks expected at ~991 MeV/c^2 with 8 MeV/c^2 width.

$J/\psi \to \phi f_0 \to \phi a_0$



$M(\eta\pi^0)$ in ϕ signal region



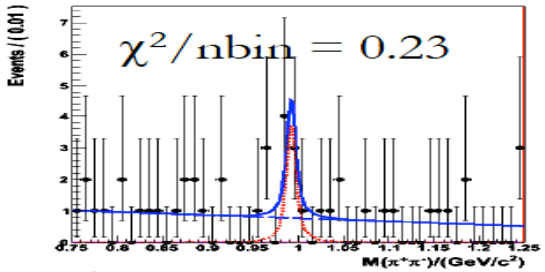
$M(\eta\pi^0)$ in ϕ sideband region

- $N(\text{mixing}) = 24.7 \pm 8.6$ (< 36.7 @ 90% C.L.), $S = 3.3\ \sigma$;

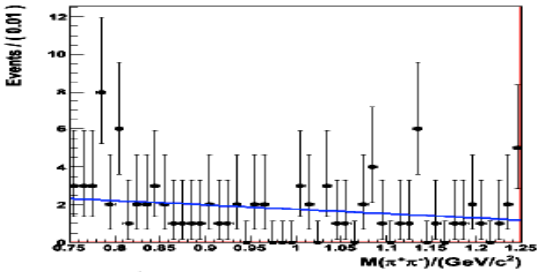
Mixing intensity

$\xi_{fa} = Br(J/\psi \to \phi f_0(980) \to \phi a_0(980) \to \phi\eta\pi^0) / Br(J/\psi \to \phi f_0(980) \to \phi\pi\pi) =$ $(0.6 \pm 0.2(\text{stat.}) \pm 0.2(\text{sys.}))\%$ ($< 1.1\%$ @ 90% C. L.)

$\chi_{c1} \to a_0\pi^0 \to f_0\pi^0$



$M(\pi^+\pi^-)$ in χ_{c1} signal region



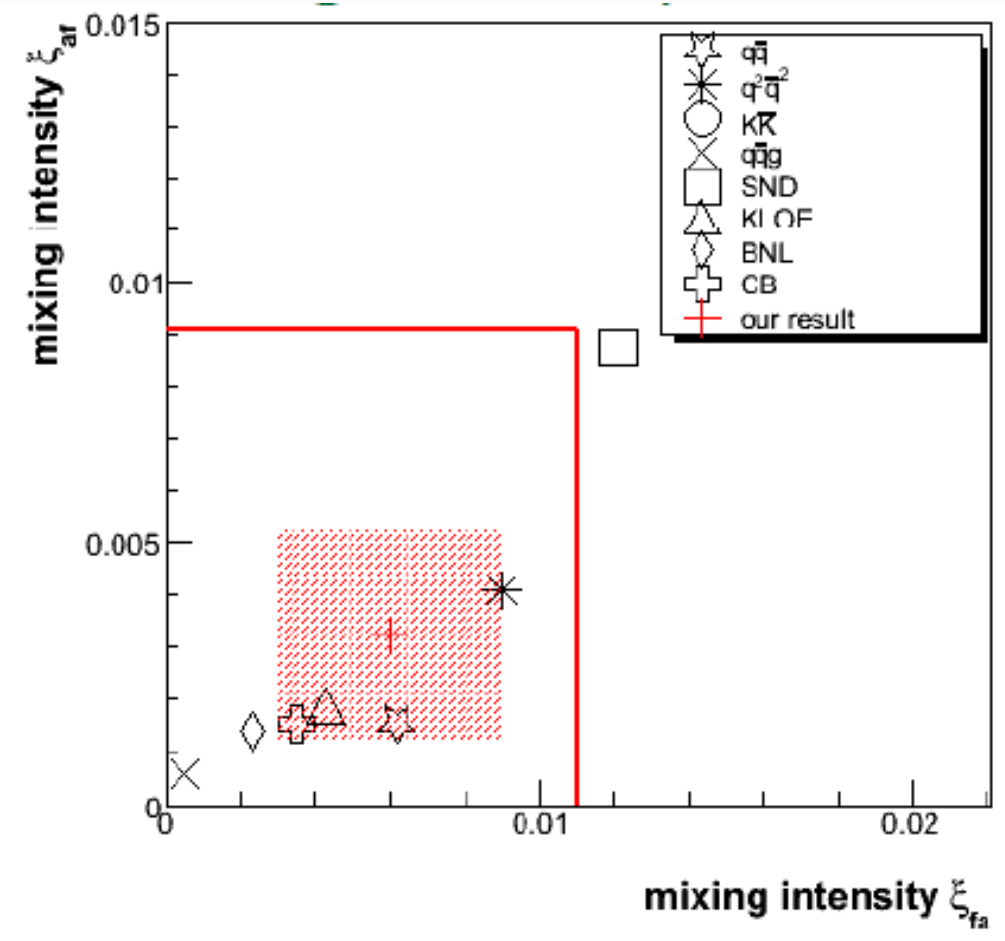
$M(\pi^+\pi^-)$ in χ_{c1} sideband region

- $N(\text{mixing}) = 6.5 \pm 3.2$ (< 12.1 @ 90% C.L.), $S = 2.0\ \sigma$;

$\xi_{af} = (0.32 \pm 0.16(\text{stat.}) \pm 0.12$ $(\text{sys.}))\%$ ($< 0.91\%$ @ 90% C. L.)

$a_0(980) - f_0(980)$ mixing

Mixing intensity ξ_{fa} and ξ_{af}



Shaded region: Our measurement

Red line:

Upper limit

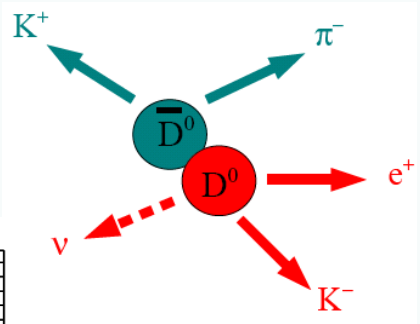
BESIII Preliminary

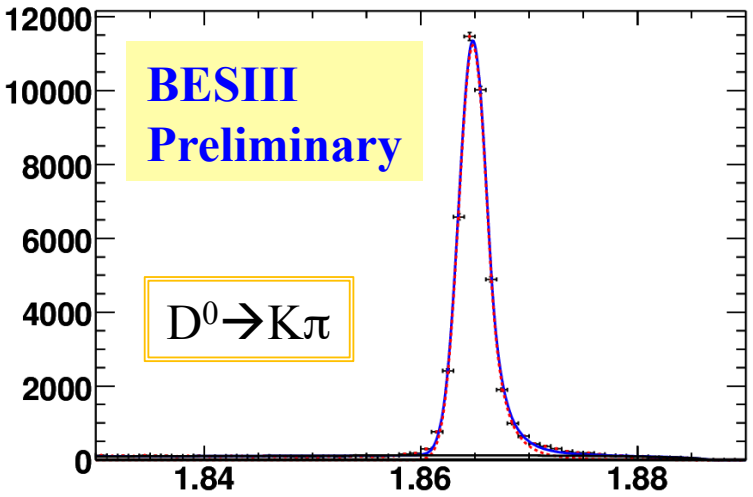
Charm meson production

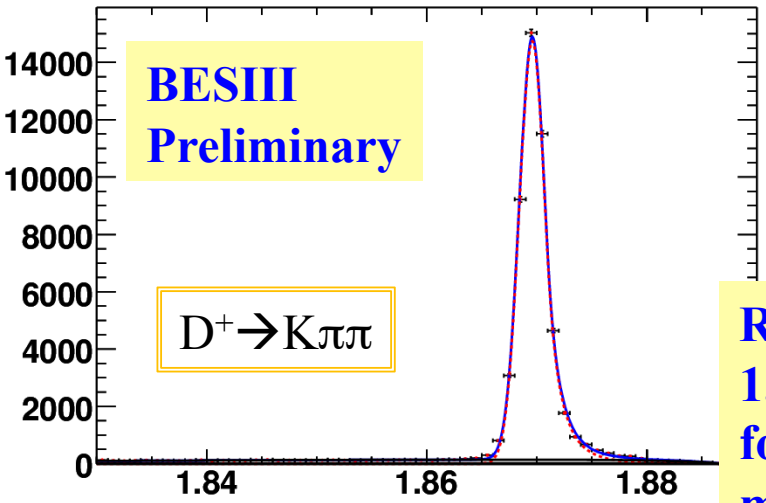
- Threshold productions at 3.773, 4.03, 4.17 GeV
- Quantum Coherent of $D\overline{D}$ meson pair
- Development of Double Tag techniques: (partial-) reconstruct both D mesons
- Charm events at threshold are very clean

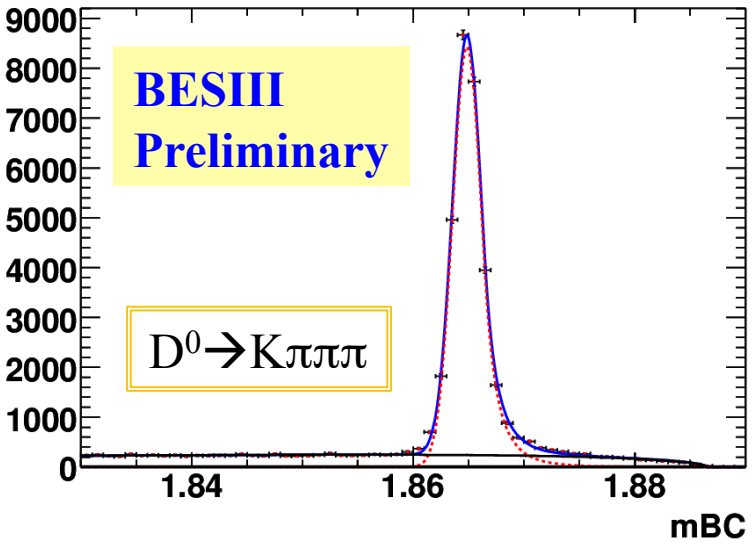
Clean single tag at BESIII

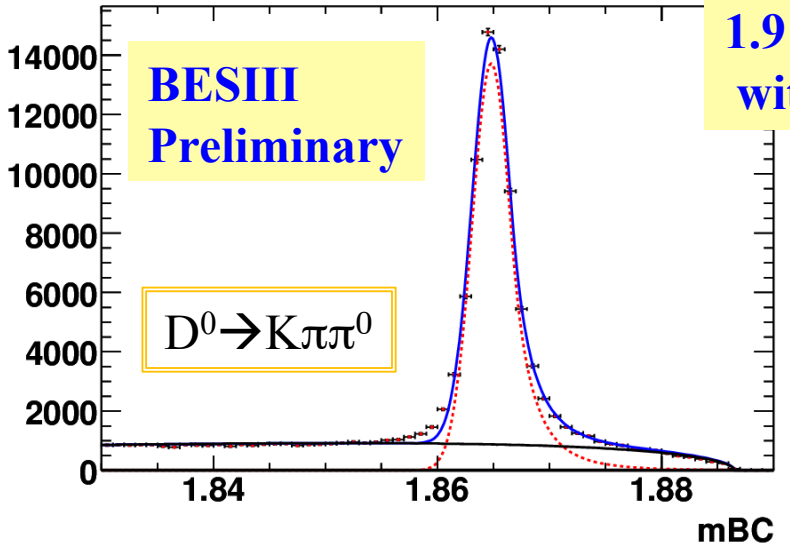
@ψ(3770) with 420pb^{-1} first clean single tagging sample:











Resolution:
1.3 MeV for pure charged modes;
1.9 MeV for modes with one π^0.

Scan data around ψ”

- About 70 pb^{-1} of data were taken at 65 energy points in the energy region from 3.65 to 3.89 GeV.
- Three ψ(3686) energy scan data samples were collected for BEPC-II energy calibration, …
- Separated beam data were taken for three hours, which will be used to study the beam associated background.

➢ To more precisely measure the line shape of cross sections for e^+e^- → hadrons in the energy range from 3.72 to 3.89 GeV

➢ To measure B[ψ(3770)→non-DD] and B[ψ(3770)→LH]

➢ To measure line-shape for σ(e^+e^- →DD) and σ(e^+e^- →LH)

➢ To measure ψ(3770) resonance parameters precisely

➢ To measure inclusive decay of ψ(3770) to K^0, K^{0*}, ϕ, J/ψ, etc.

to understand the nature of ψ”

Summary

- **BEPCII/BESIII completed successfully:**
  - **Peak Luminosity of $3.2*10^{32}$ achieved.**
  - **106 M $\psi(2S)$ and ~226 M J/ψ events obtained in 2009.**
  - **~930 pb^{-1} at $\psi(3770)$ so far in 2010, with some energy scan data.**

- **Some nice results are obtained with the data: χ_{cJ}, h_c, light hadron spectroscopy**

- **More results will come soon**

Thanks!

Backup

Anomalous Line Shape of the Cross Section e+e-→Hadrons Nearby ψ(3770) BESII, PRL 101,102004(2008)