Early Results & Future Prospects for BESIII

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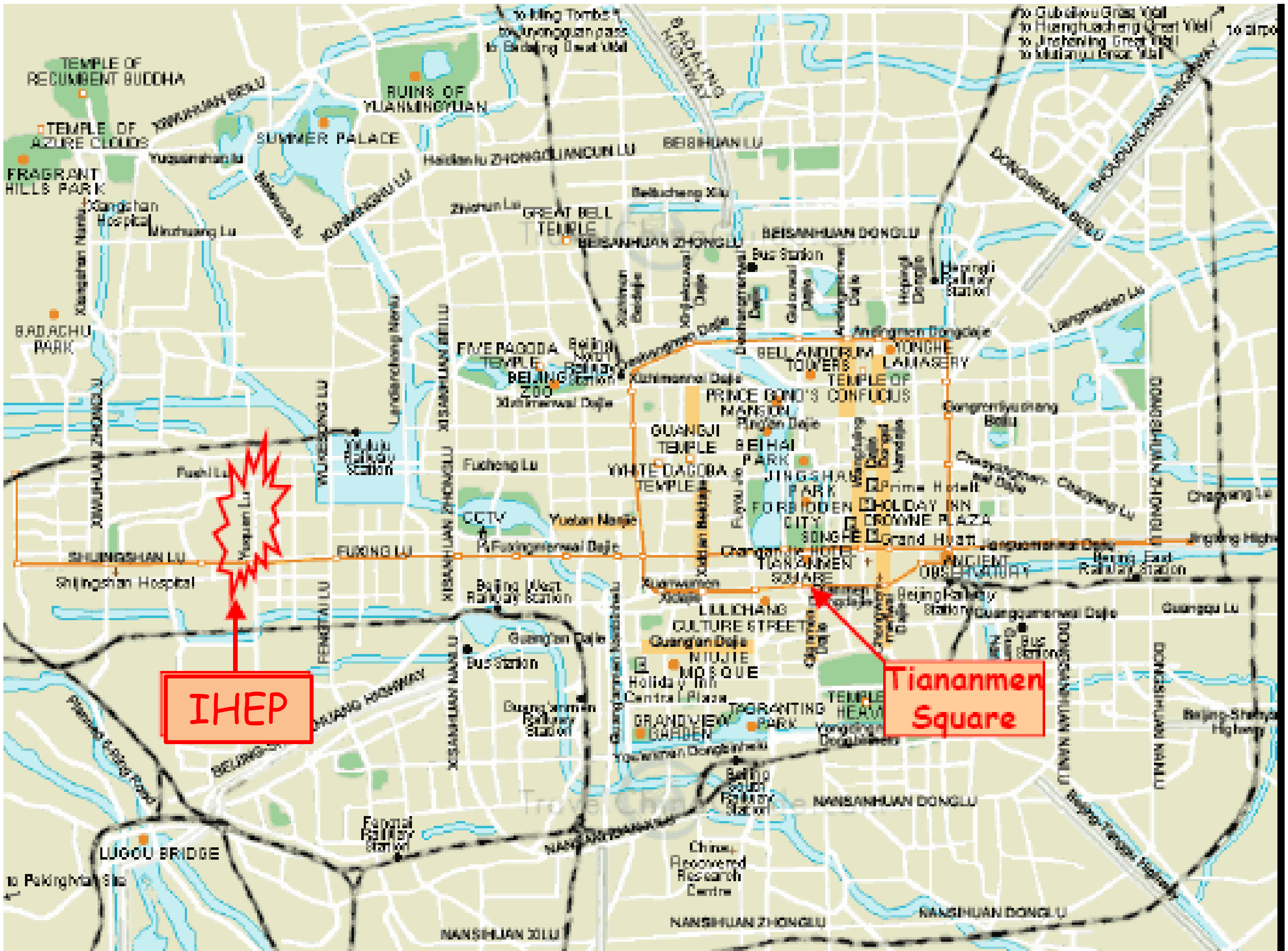
YongPyong-2012 Feb 19-23 Gangwon-do Korea

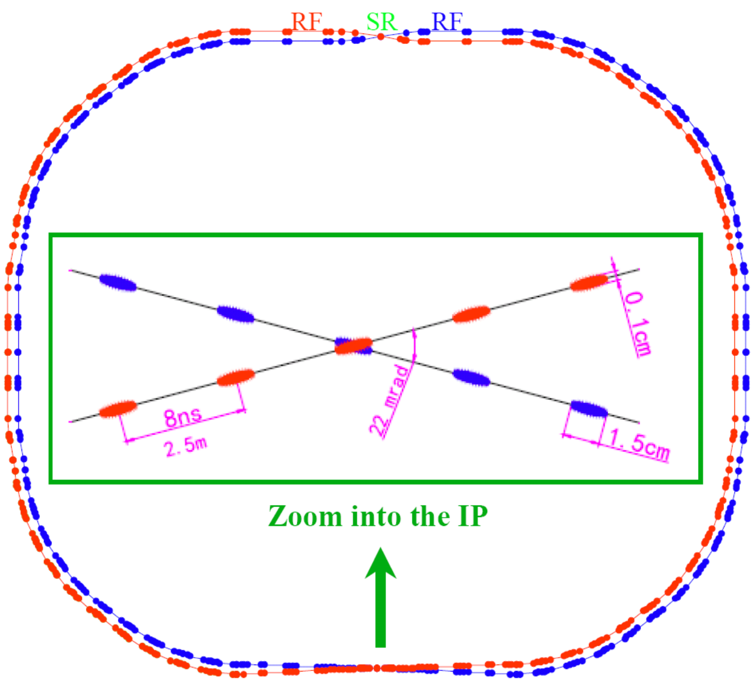
Institute of High Energy Physics
-- Beijing --



The Beijing Electron Positron Collider (BEPCII)

To Tiananmen Square (~10 km)

BEPCII storage rings



Beam energy: 1.0 − 2.3 GeV

Peak Luminosity:

Design: 1×10^{33} cm^{-2}s^{-1}

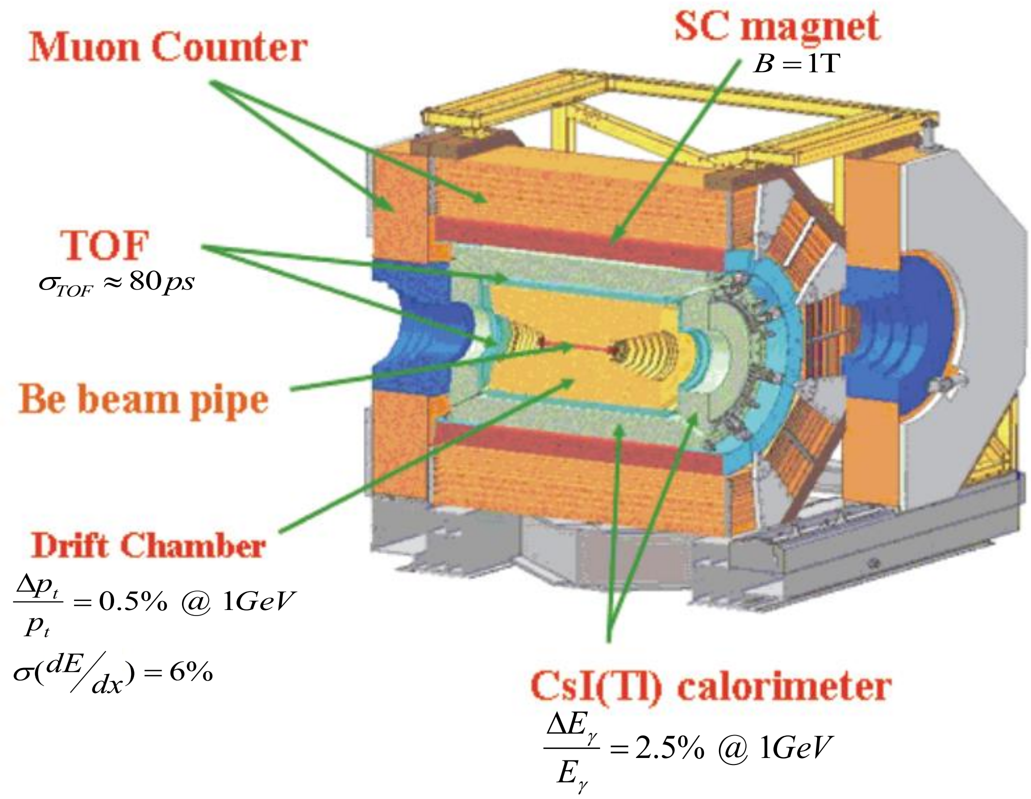
Achieved: 0.65×10^{33} cm^{-2}s^{-1}

Beam energy measurement: Using Compton backscattering technique.

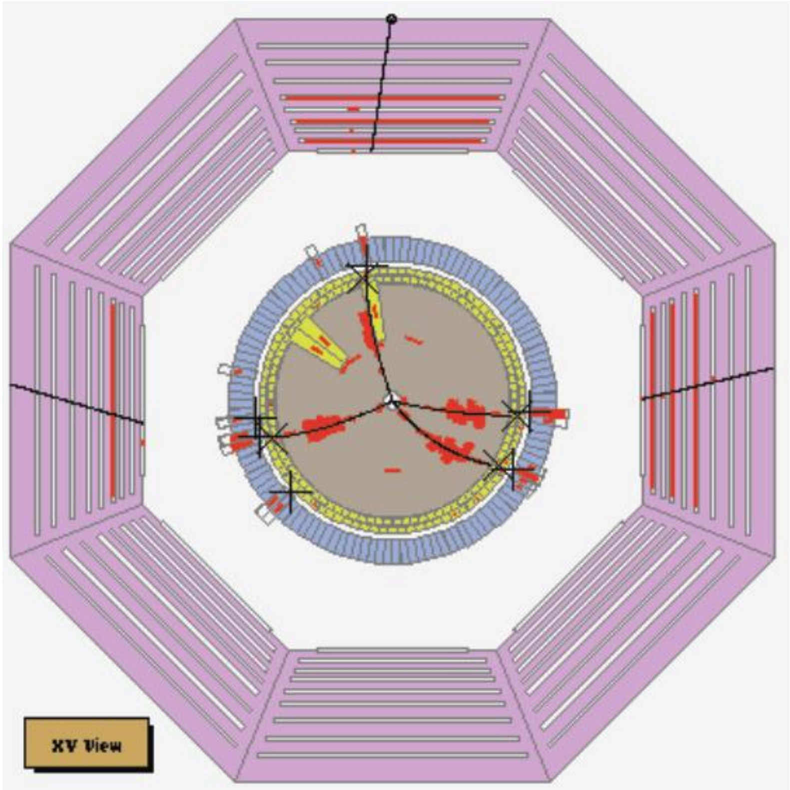
Accuracy: $\delta E_{beam}/E_{beam} \approx 5\times 10^{-5}$

➔ $\delta E_{beam} \approx 50$ KeV @$E_{beam} \approx m_{\tau}$

The BESIII Detector



BESIII's 1st event



BESIII Collaboration

Data

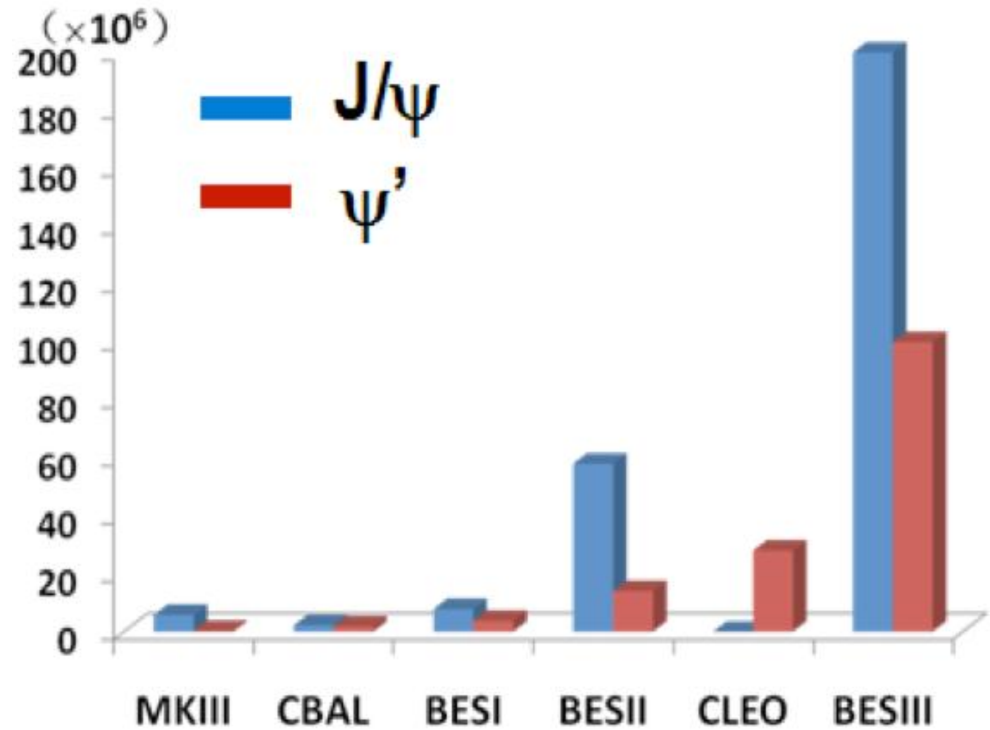
Data samples collected:

– 225 M J/ψ

– 106 M ψ'

– 2.9 fb^{-1} $\psi(3770)$

– 0.5 fb^{-1} @4010 MeV



This year: τ mass scan

~500M ψ' events

~1 B J/ψ events

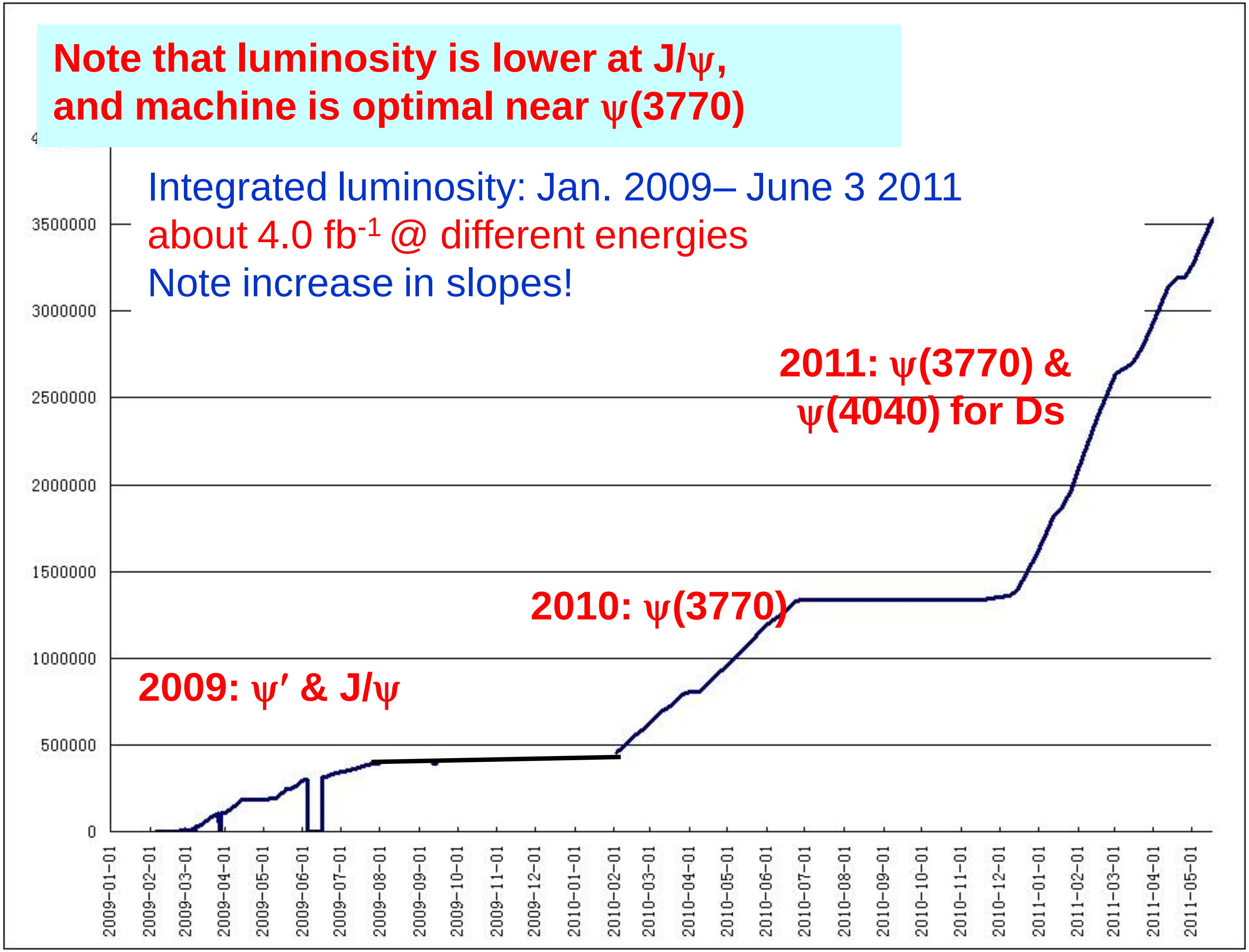
Tentative future running plans:

2013: E_{cm}=4170 MeV: D_s physics + R scan (E_{cm} > 4 GeV)

2014: ψ'/τ /R scan (E_{cm} > 4 GeV)

2015: $\psi(3770)$: 5-10 fb^{-1} for $D\bar{D}$ physics

luminosity since startup



Physics program @ BESIII

Light hardron physics

- -meson & baryon spectroscopy
- -multiquark states
- -threshold effects
- -glueballs & hybrids
- -two-photon physics
- -form-factors

Charmonium physics:

- precision spectroscopy
- transitions and decays

QCD & τ -physics:

- precision R-measurement
- τ decays

Charm physics:

- semi-leptonic form factors
- f_D & f_{D_s} decay consts.
- CKM matrix: V_{cd}, V_{cs}
- D^0-D^0 mixing and CPV
- strong phases

Precision mass measurements:

- τ mass
- D^0 mass

XYZ meson physics:

-$Y(4260) \rightarrow \pi\pi h_c$ decays

…,

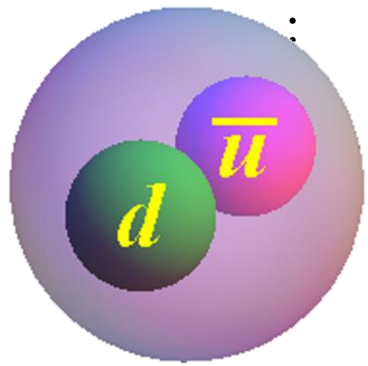
Light hadron physics

threshold effects and mixing in the
$a_0(890)$ – $f_0(980)$ light scalar meson system

"standard" hadrons

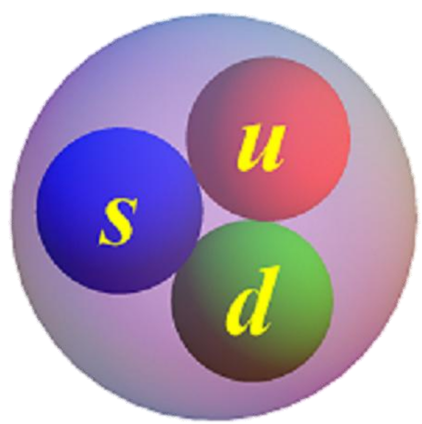
-- ABC's (hangeul?) of particle physics --

<u>mesons</u>: bound states of a of quark and anti-quark



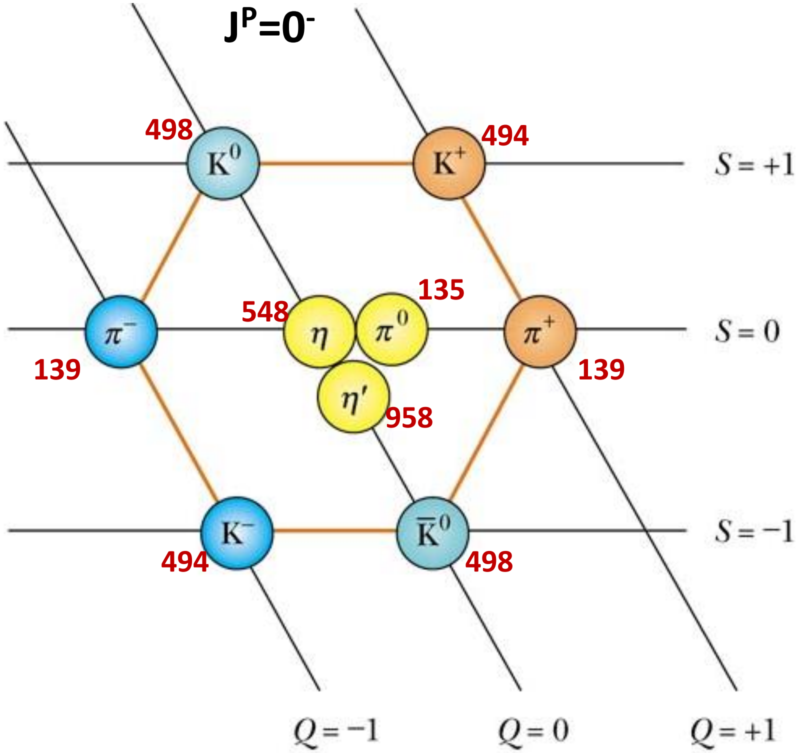
$$\pi^- = (d\bar{u})$$

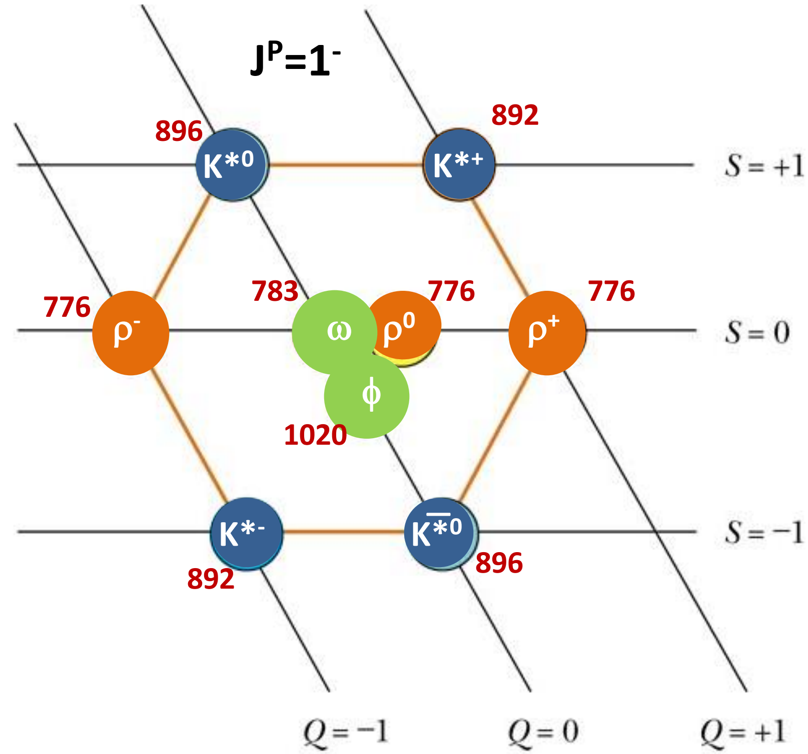
<u>baryons:</u> bound state of 3 quarks



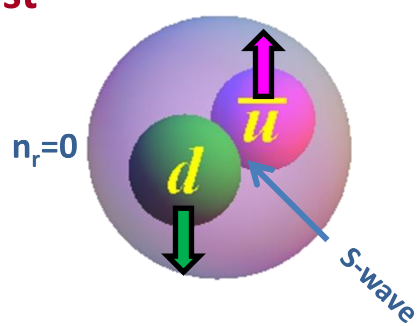
$$\Lambda = (uds)$$

mesons come in nonets

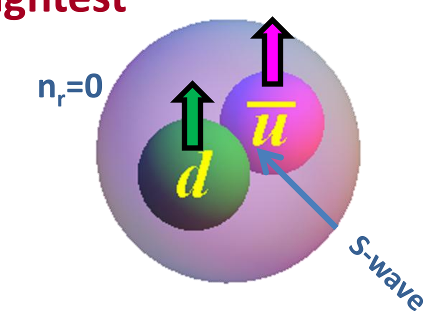




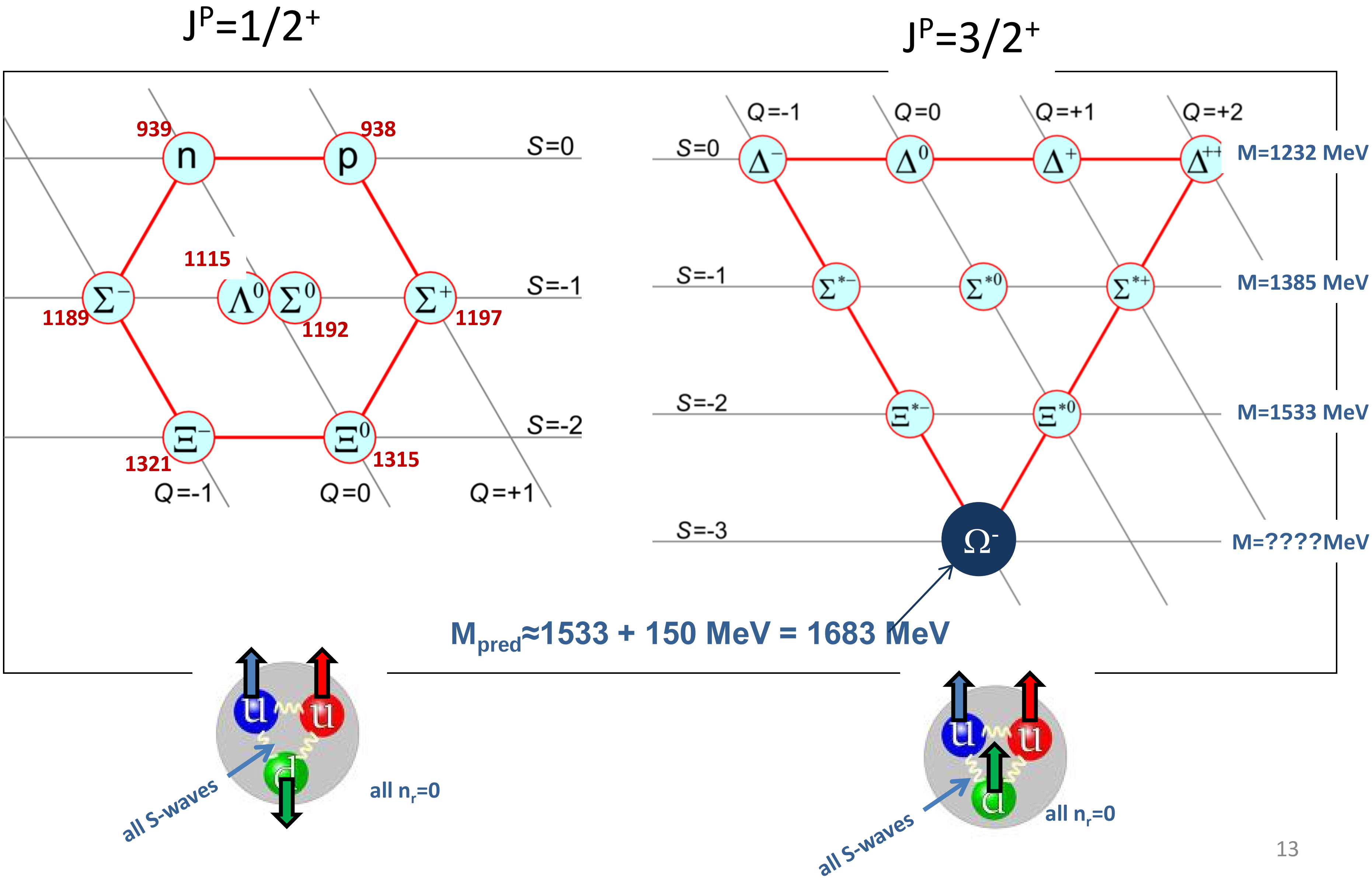
(π^+,π^0,π^-)=lightest



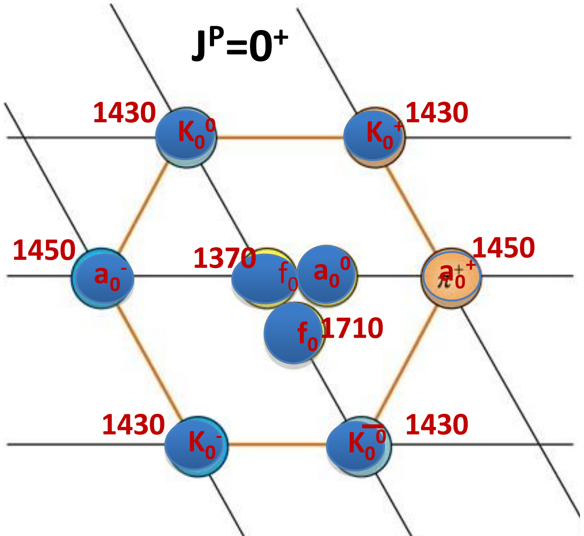
(ρ^+,ρ^0,ρ^-)=lightest

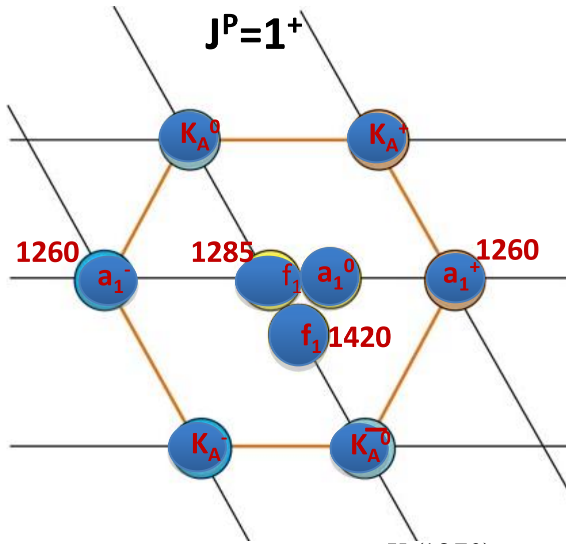


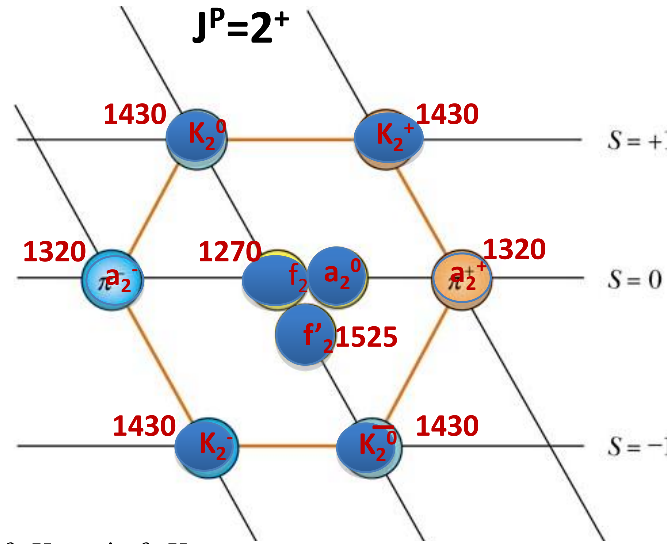
baryons come in octets & decuplets



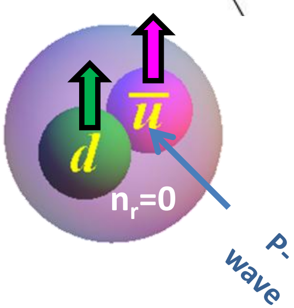
P-wave meson nonets

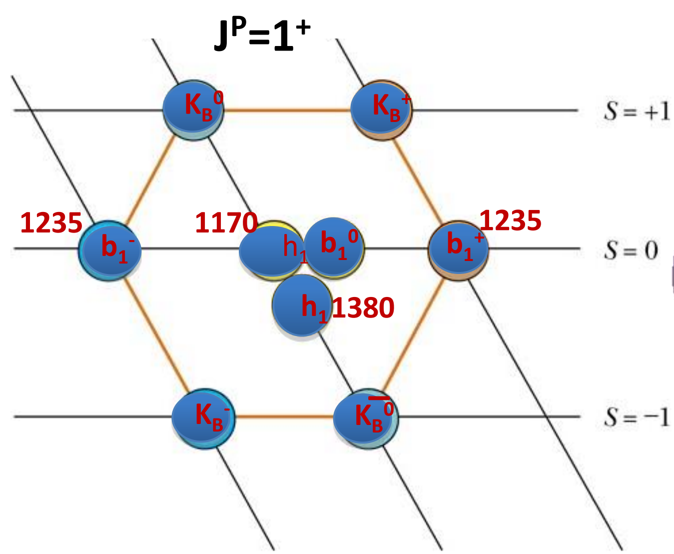


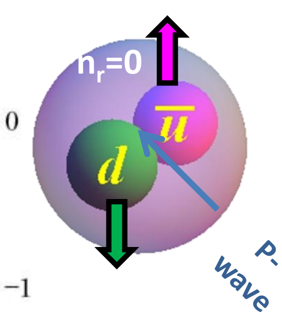




$$K_1(1270) = \cos\theta_K K_A + \sin\theta_K K_B$$
$$K_1(1400) = -\sin\theta_K K_A + \cos\theta_K K_B$$



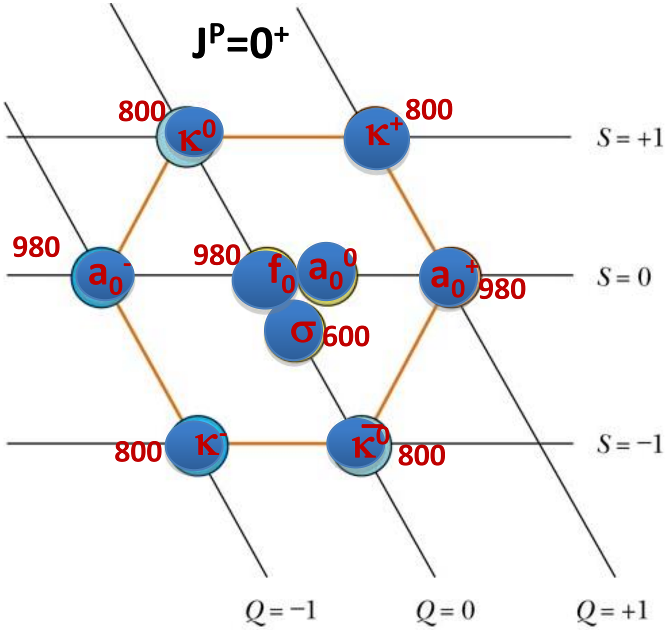




PDG assignments

The "light" scalar mesons

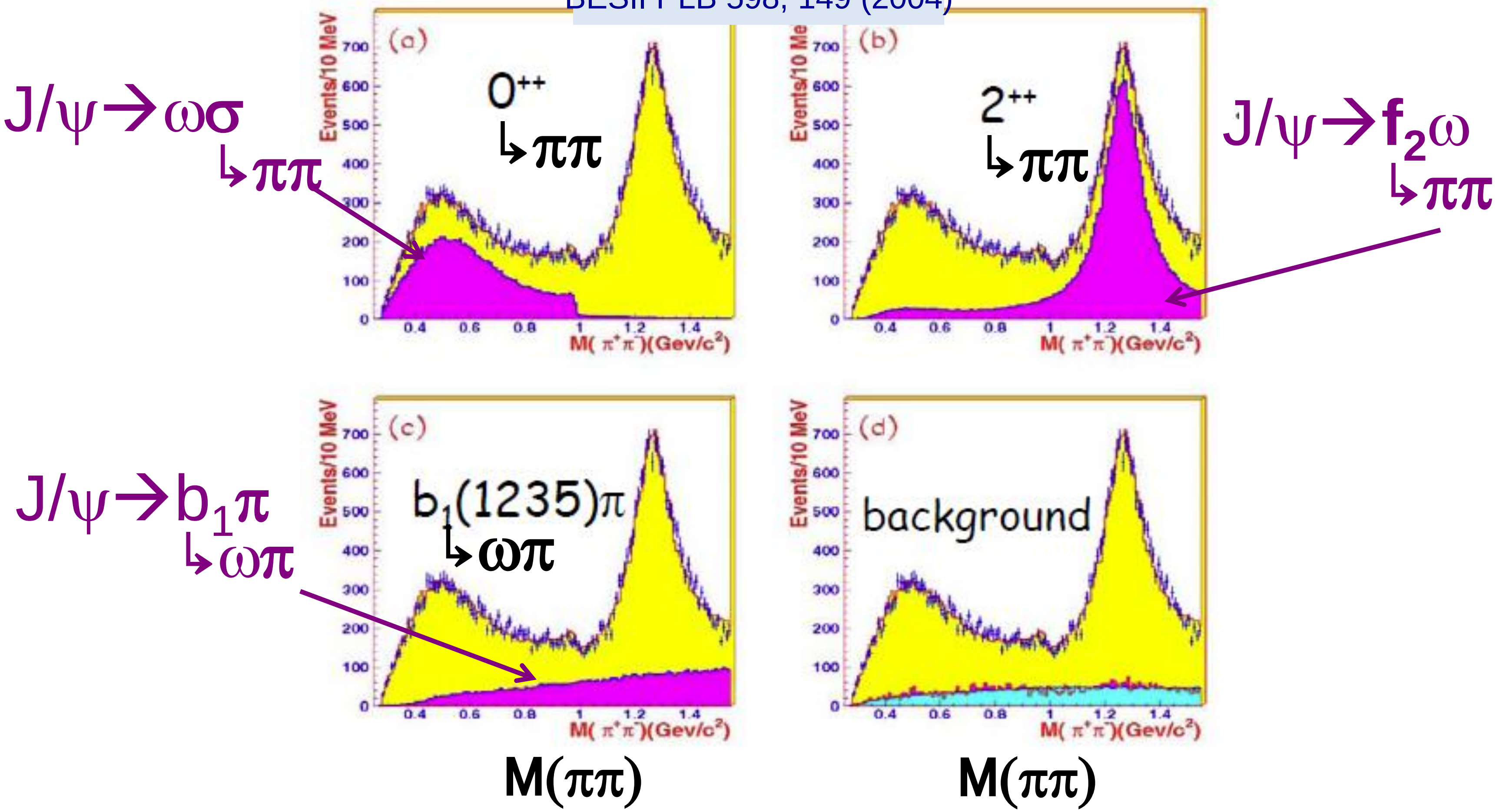
another scalar nonet?



The $f_0(600)$ (the "σ")

From a Partial Wave Analysis of $J/\psi \to \omega\pi^+\pi^-$

BESII PLB 598, 149 (2004)

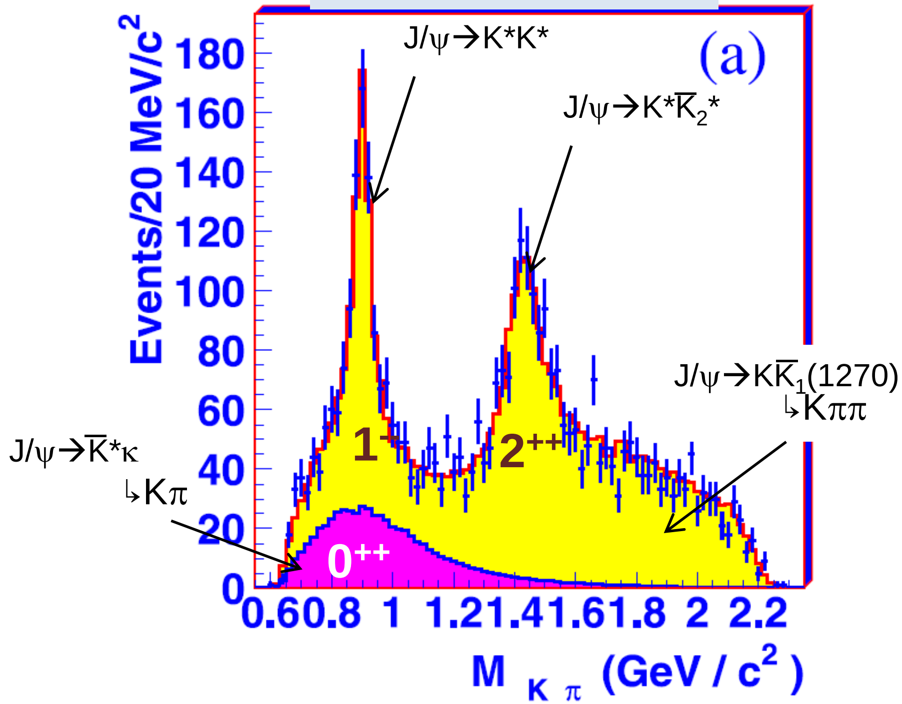


σ pole position: $(541\pm39) - i(252\pm42)$ MeV

$K_0(800)^{\pm}$ (the "$\kappa^{\pm}$")

From a Partial Wave Analysis of $J/\psi \to K^+\pi^0 K_S\pi^-$
with either $M(K^+\pi^0)$ or $M(K_S\pi^-) = M(K^{*\pm}) \pm 80$ MeV

BESII PLB 693, 88 (2010)



κ pole position: $(849 \pm 77^{+18}_{-14}) - i(256 \pm 40^{+46}_{-22})$ MeV

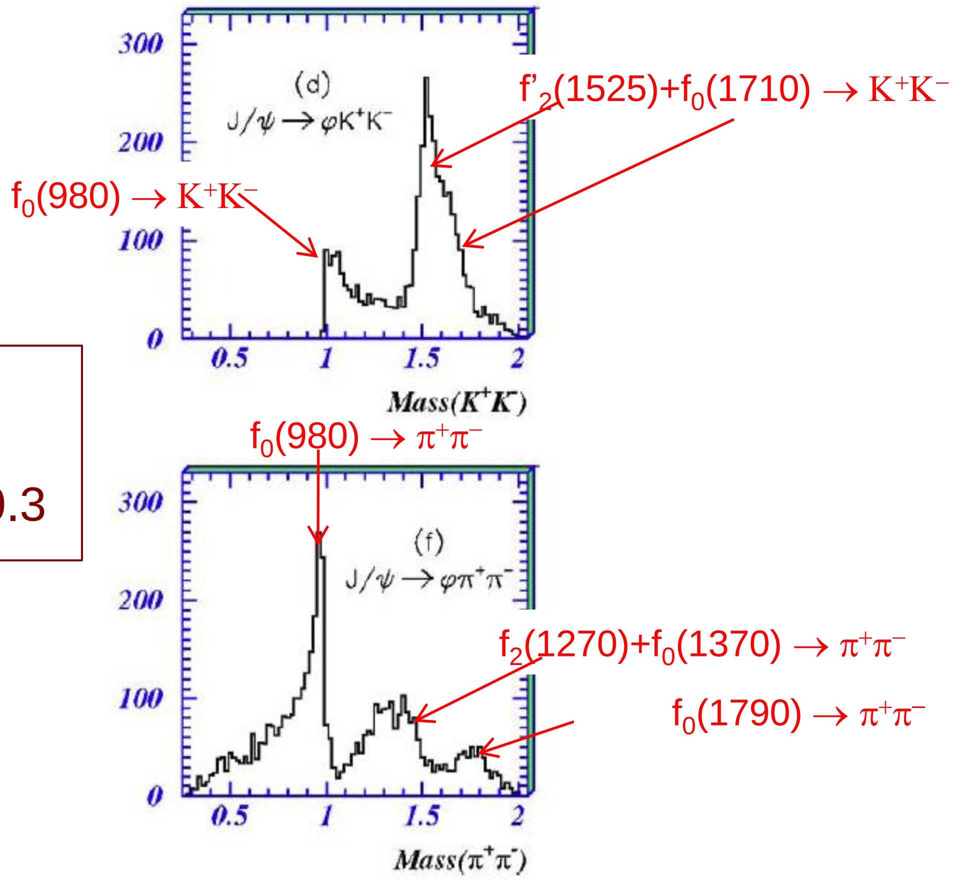
Signals for $f_0(980) \to \pi\pi$ & $\to K^+K^-$

Resonances in $J/\psi \to \phi\pi^+\pi^-$ and ϕK^+K^-

BESII PLB 607, 243 (2005)

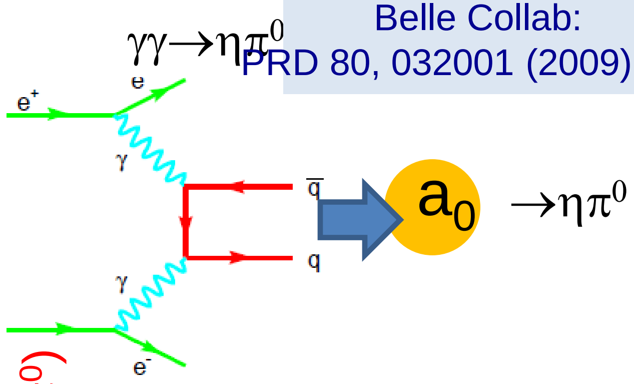
strong $f_0(980)$ coupling to $K\bar{K}$

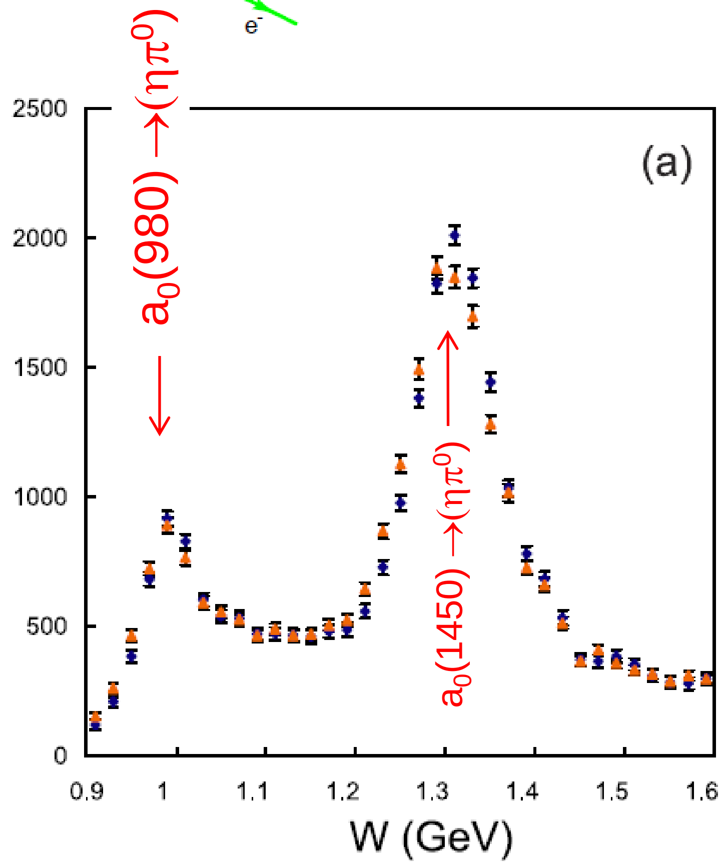
$$\frac{g_{KK}}{g_{\pi\pi}} = 4.2 \pm 0.3$$



Signal for $a_0(980) \to \eta\pi$

Belle Collab:
PRD 80, 032001 (2009)



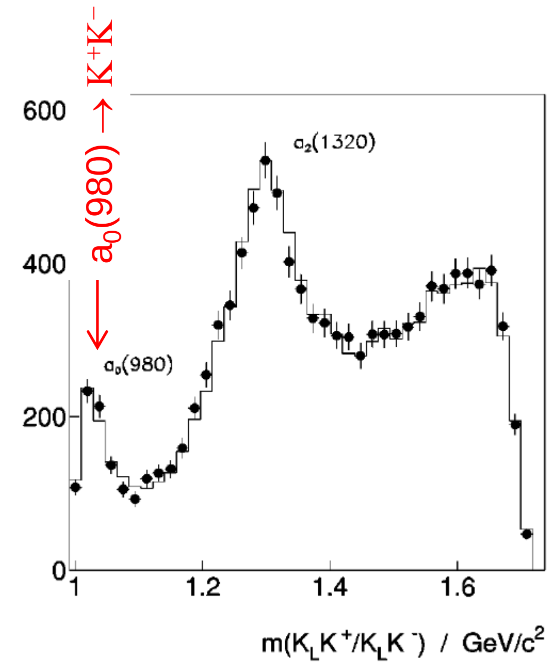


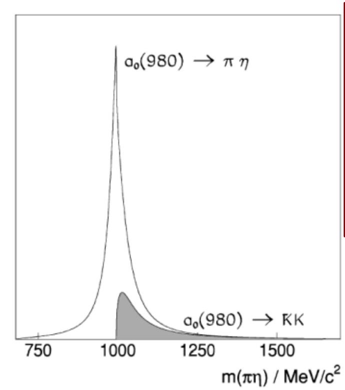
PHYSICAL REVIEW D **80,** 032001 (2009)

Signal for $a_0(980) \to K^+K^-$

$\bar{p}p$ ANNIHILATION AT REST INTO $K_L K^{\pm} \pi^{\mp}$

Crystal Barrel Collab: PRD 57, 3860 (1998)



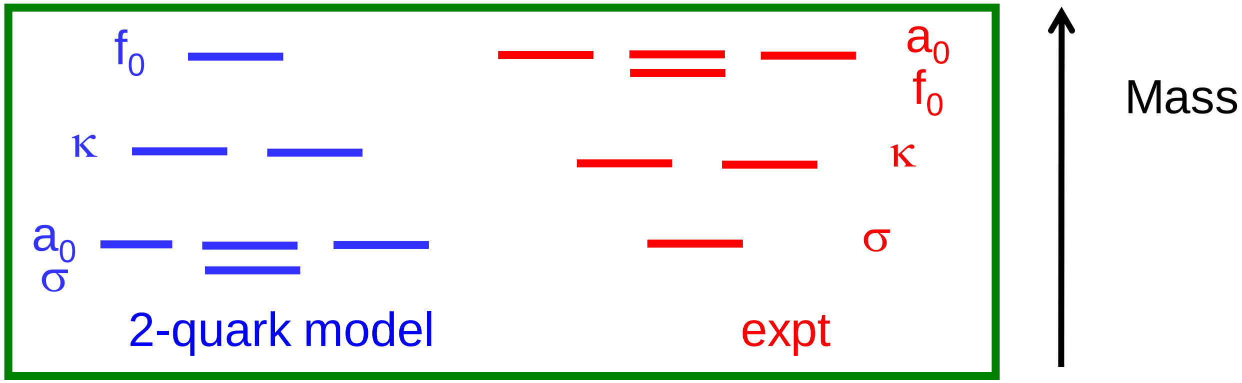


strong $a_0(980)$ coupling to KK

$$\frac{g_{KK}}{g_{\pi\eta}} = 1.03 \pm 0.14$$

Problems with $q\bar{q}$ assignment for the light scalar meson nonet

- Inverted mass spectrum



Also:

- In $q\bar{q}$ meson nonets, the I=1 state (here the $a_0(980)$) has no s-quarks
- $m(f_0(980)) \approx m(a_0(980))$ ➔ "ideal" mixing & ***small*** s-quark content in $f_0(980)$

  strong $a_0(980)$ & $f_0(980)$ couplings to $K\bar{K}$ indicate strong OZI-rule violations

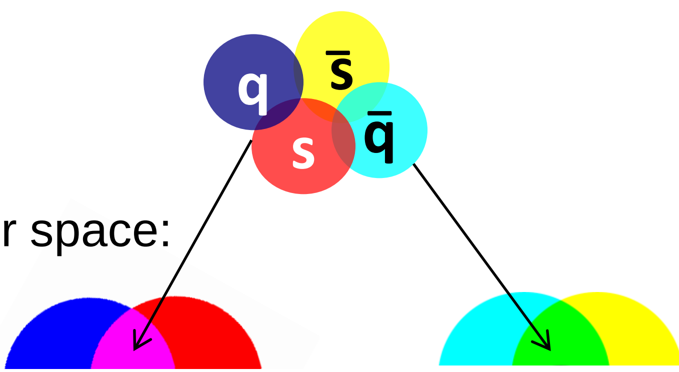
- No "light" $J^P=1^+$ and 2^{++} partner nonets in the same mass range

If not $q\bar{q}$, then what?

Possibilities that have been suggested:

tightly bound
diquark-diantiquark

In color space:



red+blue=magenta
(antigreen)

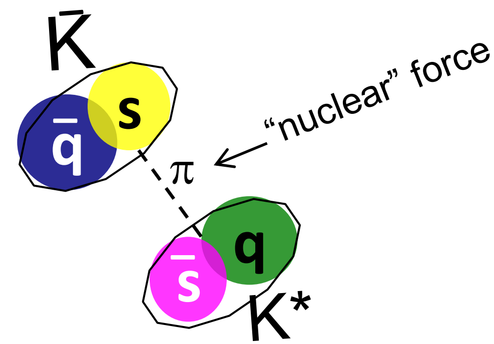
cyan+yellow=green
(antimagenta)

A colored diquark
is like a antiquark

A colored diantiquark
is like a quark

R.L.Jaffe PRD 15, 267 (1977)

loosely bound
meson-antimeson
“molecule”

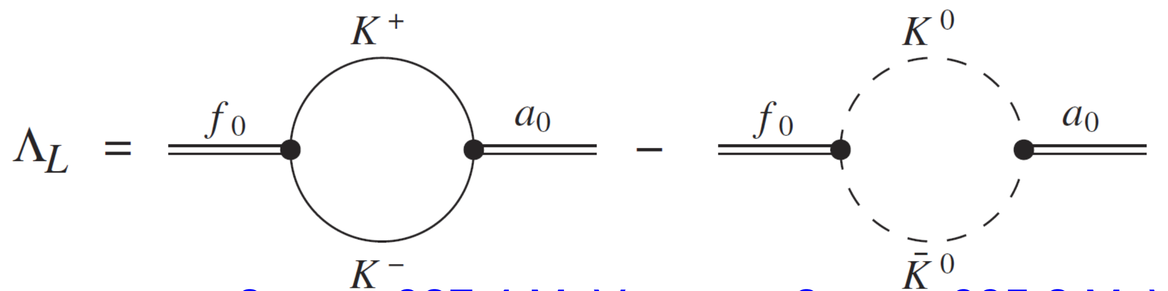


J.D.Weinstein & N.Isgur PRD 27, 588 (1983)

KK: enhanced $a_0(980)^0 \leftrightarrow f_0(980)$ mixing

isospin violation enhanced by $K^0 - K^+$ mass difference

C. Hanhart, B. Kubis, and J.R. Pelaez, Phys. Rev. D **76**, 074028 (2007)

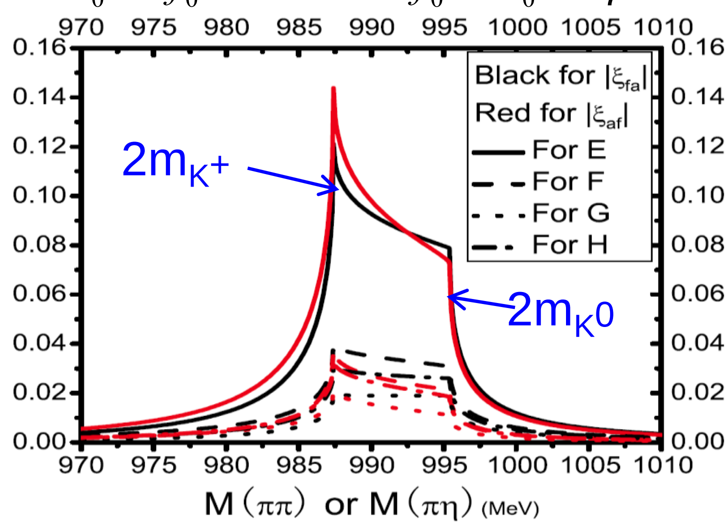


$2m_{K^+} = 987.4$ MeV $\quad 2m_{K^0} = 995.2$ MeV

expect a narrow line shape:

$\Gamma \approx 2(m_{K^0} - m_{K^+}) = 7.8$ MeV

$a_0^0 \to f_0 \to \pi^+\pi^-$ or $f_0 \to a_0^0 \to \eta\pi^0$



J.J. Wu and B.S. Zou, Phys. Rev. D **78**, 074017 (2007)

PDG2010:

$M_{f_0} = 980 \pm 10$ MeV

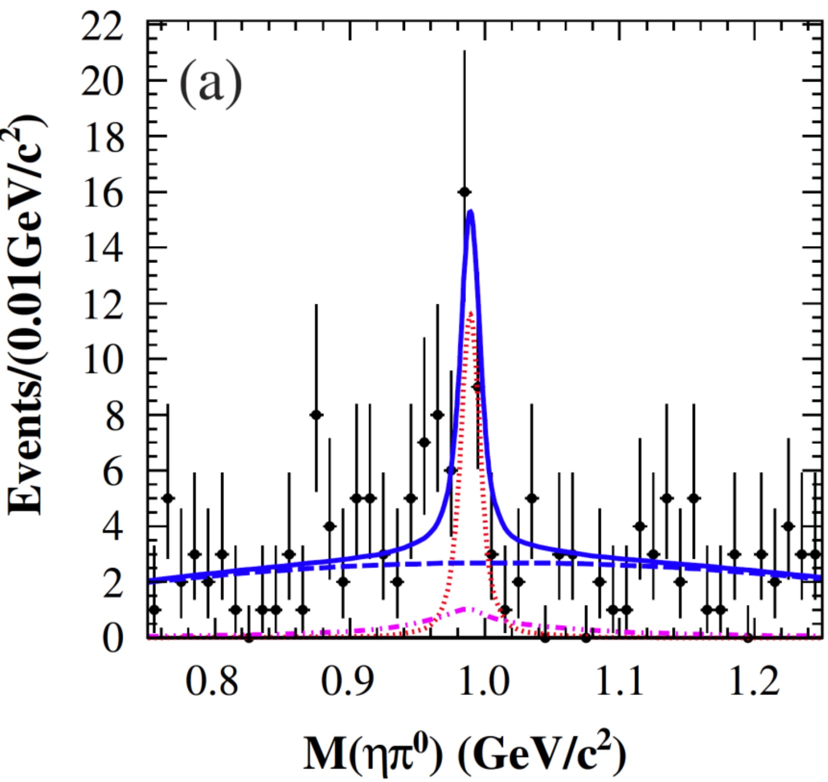
$\Gamma_{f_0} = 40 \sim 100$ MeV

$M_{a_0} = 980 \pm 20$ MeV

$\Gamma_{a_0} = 50 \sim 100$ MeV

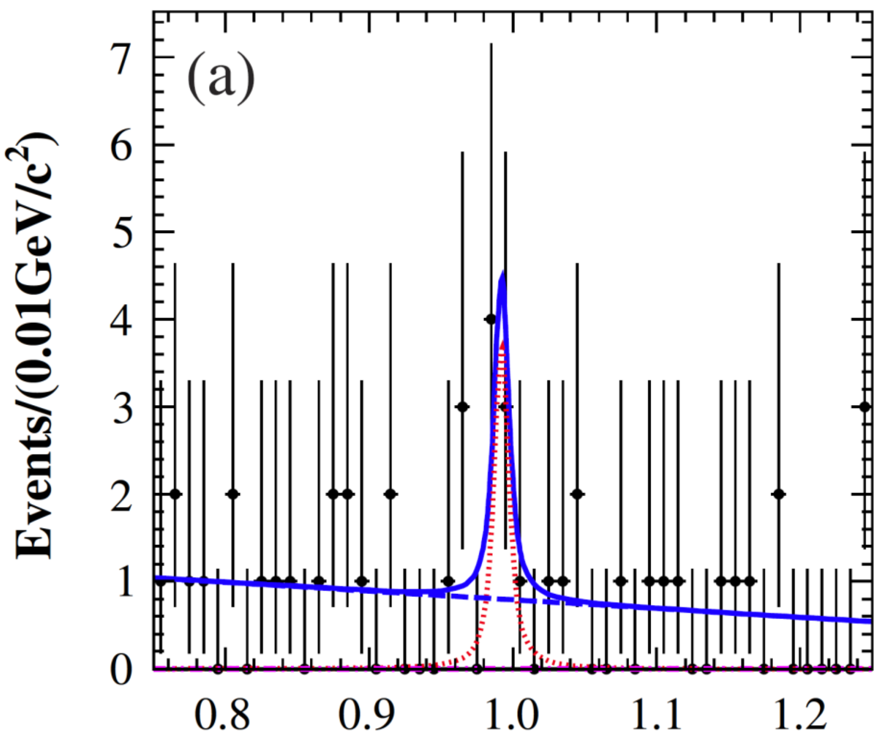
BESIII study of $a_0(980)^0 \longleftrightarrow f_0(980)$ mixing

$J/\psi \to \phi f_0 \to \varphi a_0^0 \to K^+K^-\eta\pi^0$



$\xi_{fa} = (0.60 \pm 0.20(\text{stat})) \pm 0.12(\text{sys}) \pm 0.26(\text{para})\%$

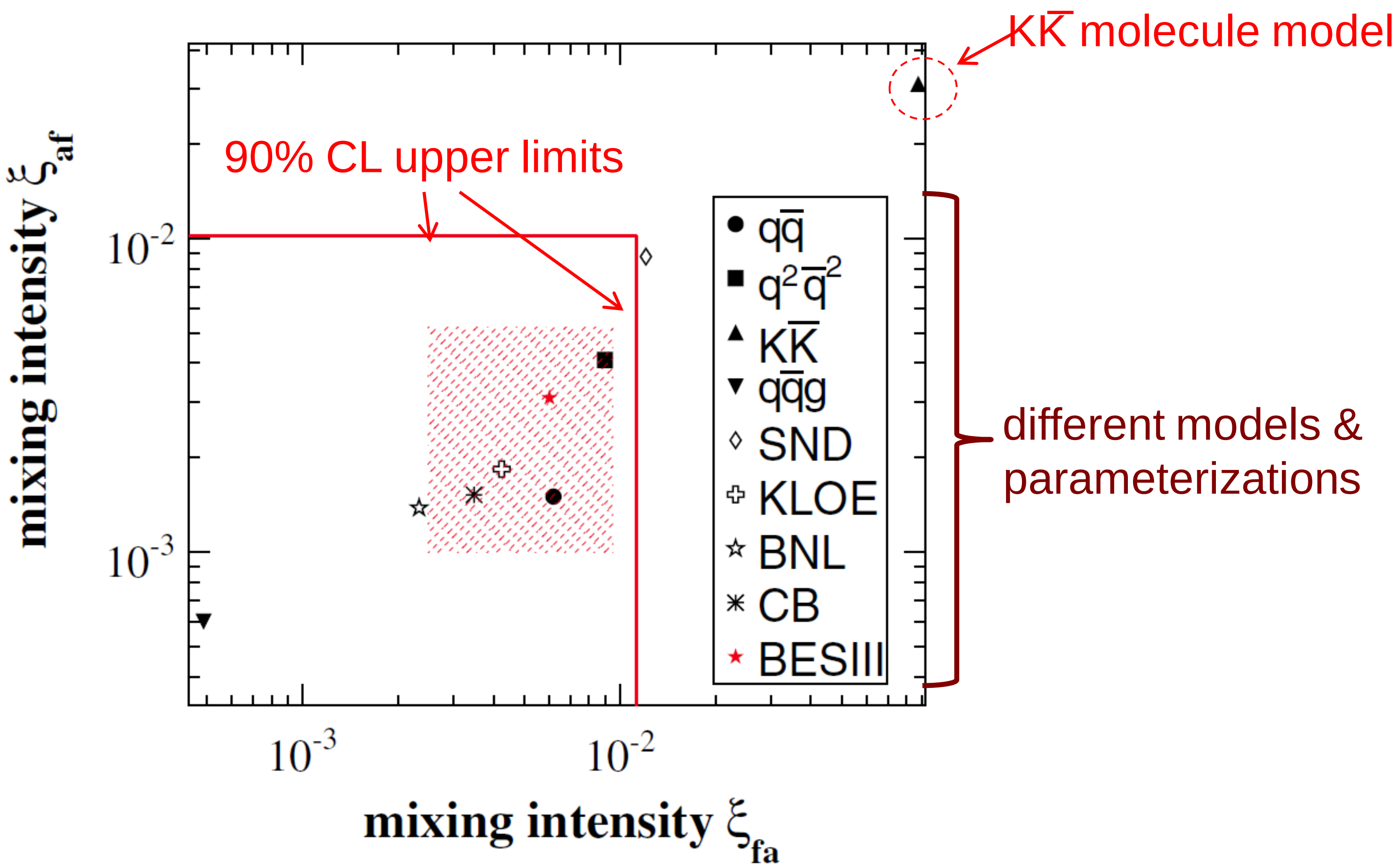
$\psi' \to \gamma\chi_{c1} \to \gamma\pi^0 a_0^0 \to \gamma\pi^0 f_0 \to \gamma\pi^0\pi^+\pi^-$



$\xi_{af} = (0.31 \pm 0.16(\text{stat}) \pm 0.14(\text{sys}) \pm 0.03(\text{para}))\%$

BESIII PRD 83, 032003 (2011)

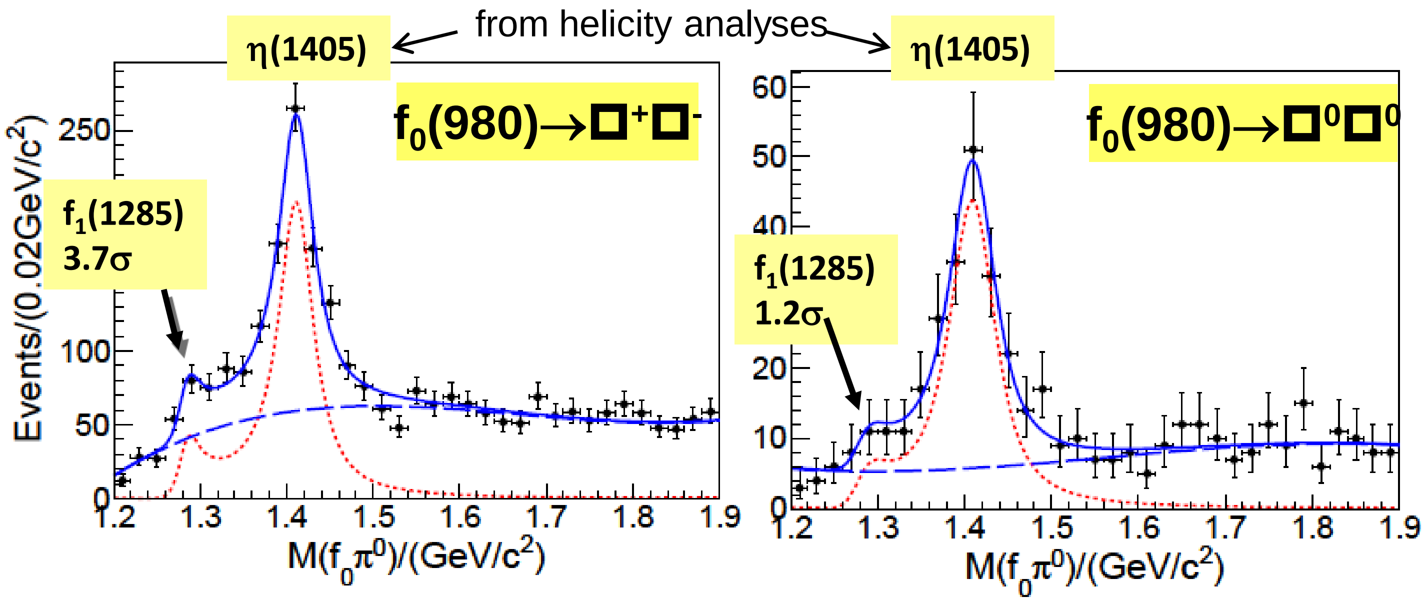
$a_0(980)^0 \longleftrightarrow f_0(980)$ mixing results



Statistics limited, but we should have lots more data soon

$J/\psi \to \gamma f_0(980)\pi^0, f_0(980) \to \pi\pi$

BESIII arXiv:1201:2737 (→PRL) ← last month!



1st observations: **$\eta(1405) \to f_0(980)\pi^0$**

&

$J/\psi \to \gamma f_0(980)\pi^0$

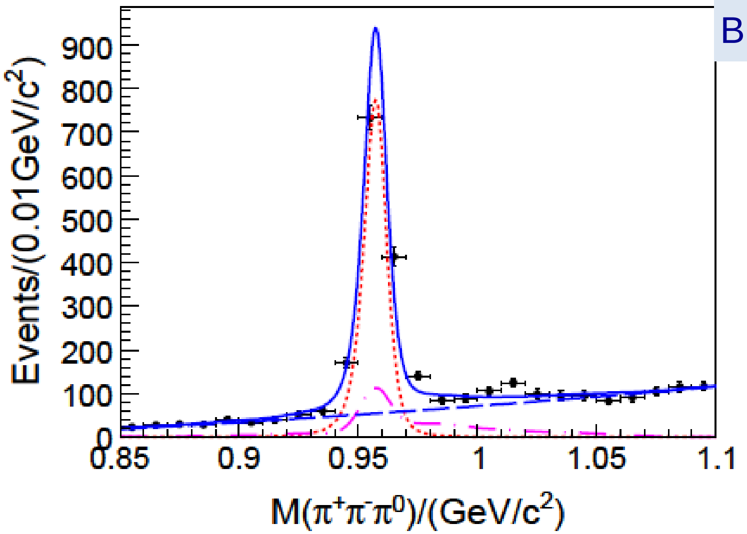
$$Bf(J/\psi \to \gamma\eta(1405) \to \gamma\pi^0 f_0 \to \gamma\pi^0\pi^+\pi^-)$$
$$= (1.50 \pm 0.11(stat.) \pm 0.11(syst.)) \times 10^{-5}$$
$$Bf(J/\psi \to \gamma\eta(1405) \to \gamma\pi^0 f_0 \to \gamma\pi^0\pi^0\pi^0)$$
$$= (7.10 \pm 0.82(stat.) \pm 0.72(syst.)) \times 10^{-6}$$

Large Isospin violations:

$$\frac{BR(\eta(1405) \to f_0(980)(\pi^+\pi^-)\pi^0)}{BR(\eta(1405) \to \pi^+\pi^-\eta)} \approx 7.5\%, \quad \frac{BR(\eta(1405) \to f_0(980)\pi^0)}{BR(\eta(1405) \to a_0(980)\pi^0)} \approx 25\%$$

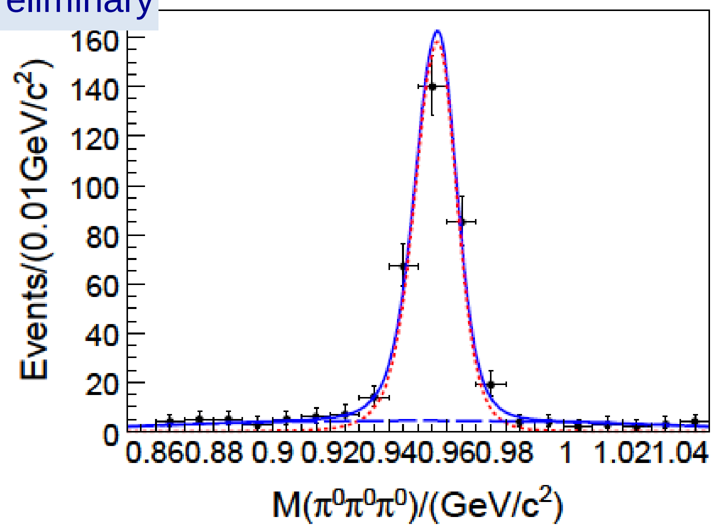
comparison: Isospin violations in η'→πππ

$J/\psi \to \gamma\eta' \to \pi^+\pi^-\pi^0$



BESIII preliminary

$J/\psi \to \gamma\eta' \to \pi^0\pi^0\pi^0$



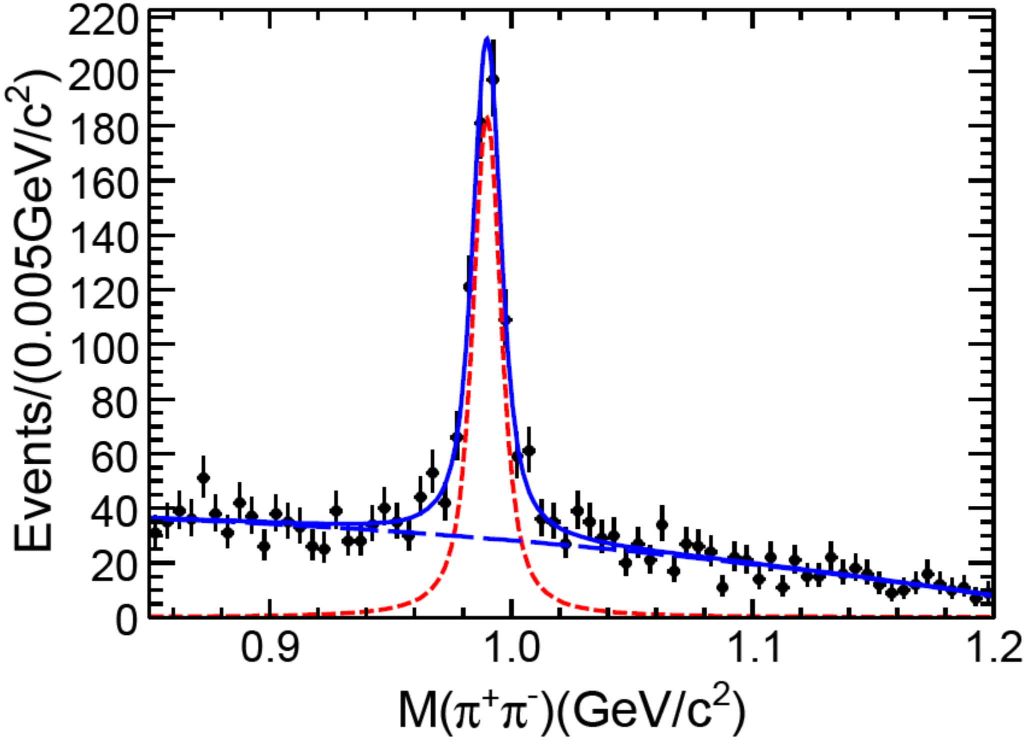
$$Br(\eta' \to \pi^+\pi^-\pi^0) = (3.83 \pm 0.15(stat.) \pm 0.39(sys.)) \times 10^{-3}$$

$$Br(\eta' \to 3\pi^0) = (3.56 \pm 0.22(stat.) \pm 0.34(sys.)) \times 10^{-3}$$

$$\frac{BR(\eta' \to \pi^+\pi^-\pi^0)}{BR(\eta' \to \pi^+\pi^-\eta)} \approx 0.9\%, \quad \frac{BR(\eta' \to \pi^0\pi^0\pi^0)}{BR(\eta' \to \pi^0\pi^0\eta)} \approx 1.6\%$$

Anomalous $f_0(980)$ lineshape in $\eta(1405) \rightarrow f_0(980)\pi^0$

BESIII arXiv:1201:2737



Fitted mass:

$M_{"f_0"}$ = 989.9 $\pm$ 0.4 MeV

$\Gamma_{"f_0"}$ = 9.5 $\pm$ 1.1 MeV

The peak is midway between $2m_{K^0}$ & $2m_{K^+}$ & width ≈ $2(m_{K^0} - m_{K^+})$

PDG2010:

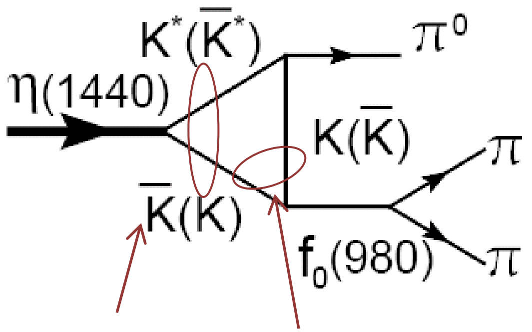
M_{f_0}= 980 $\pm$ 10 MeV

Γ_{f_0}=40 ~ 100 MeV

Effect of Triangle Singularity?

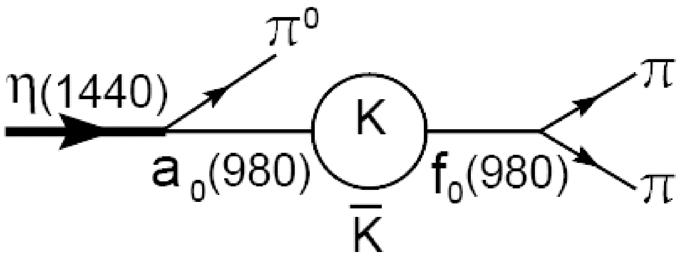
J.J.Wu et al,
arXiv:1108.3772

Triangle Singularity (TS)



$K^*\bar{K}$ and $K\bar{K}$ are on shell enhancing TS contribution and isospin violation

a_0—f_0 mixing



a_0—f_0 mixing is too small to explain anomaly by itself

Physics program @ BESIII

Light hardron physics

-meson & baryon spectroscopy
-multiquark states
-threshold effects
-glueballs & hybrids
-two-photon physics
-form-factors

Charmonium physics:

- precision spectroscopy
- transitions and decays

QCD & τ -physics:

- precision *R*-measurement
- τ decays

Charm physics:

- semi-leptonic form factors
- f_D & f_{D_s} decay consts.
- CKM matrix: V_{cd}, V_{cs}
- D^0-D^0 mixing and *CPV*
- strong phases

Precision mass measurements:

- τ mass
- D^0 mass

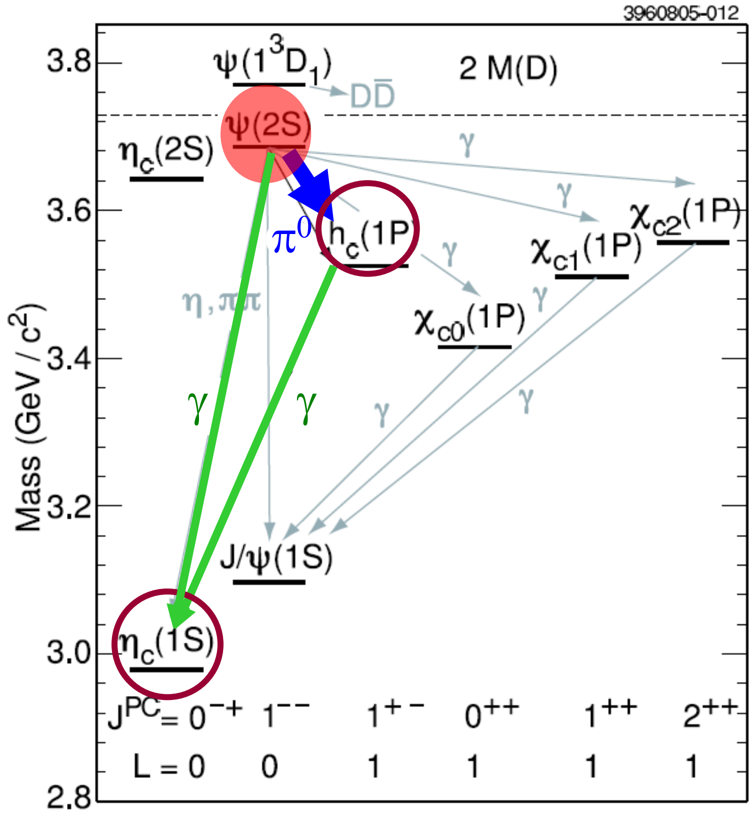
XYZ meson physics:

-$Y(4260) \rightarrow \pi\pi h_c$ decays

…,

Precision charmonium

- mass of the η_c ← charmonium ground state
- properties of the h_c ← most recently discovered charmonium state

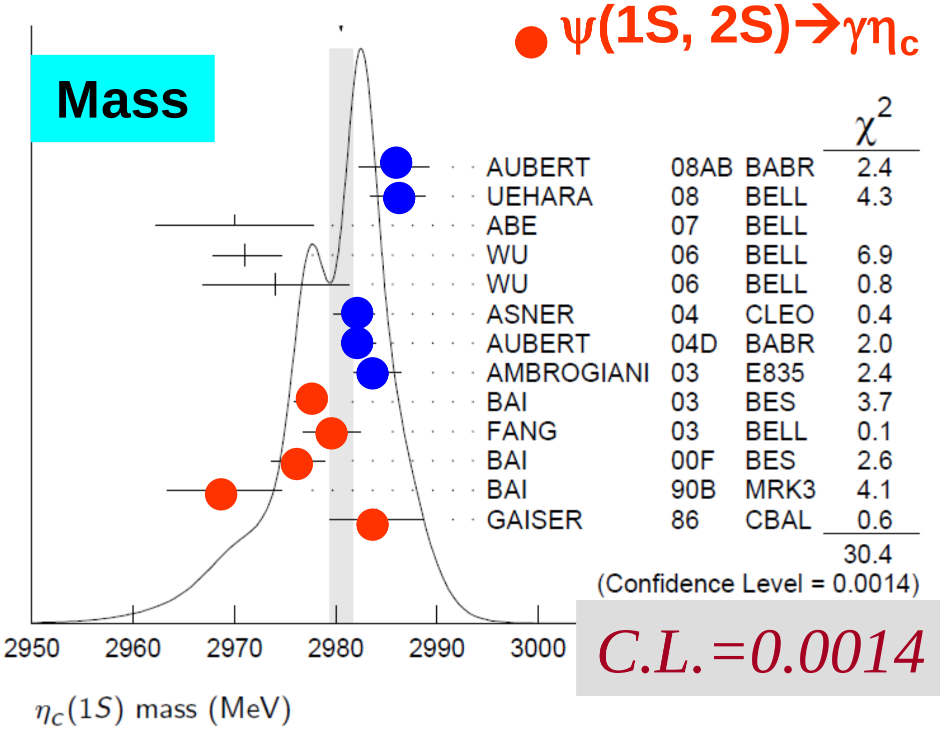


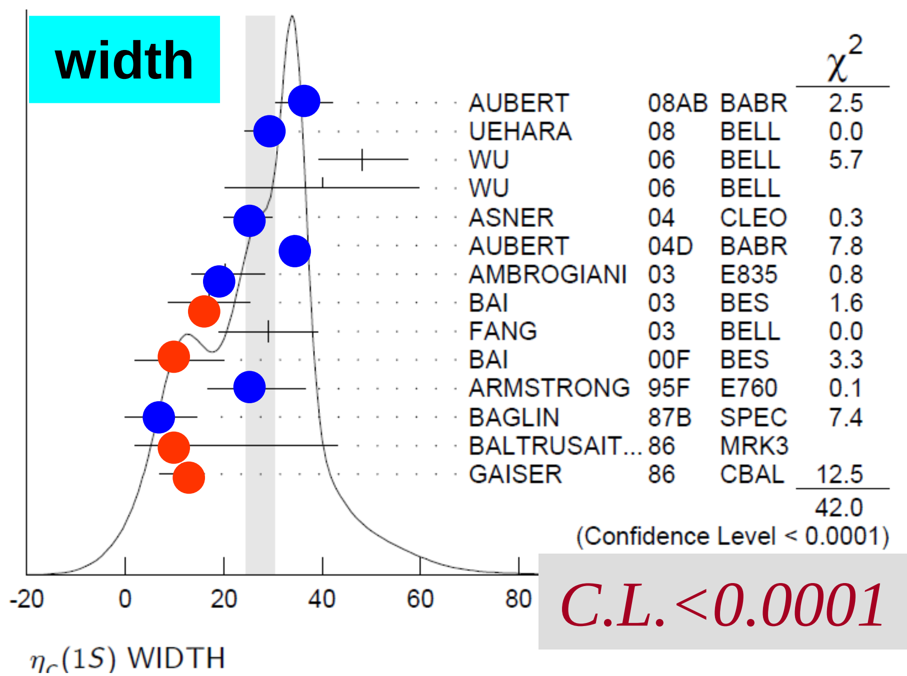
$\eta_c(1S)$

- The S-wave spin-singlet charmonium ground state, found in 1980
- M & Γ measurements:
  - -J/ψ radiative transitions: M ~ 2978.0 MeV, Γ ~ 10 MeV
  - -γγ processes / B→Kη_c: M = 2983.1±1.0 MeV/, Γ = 31.3±1.9 MeV

● γγ, $p\bar{p}$, B decay

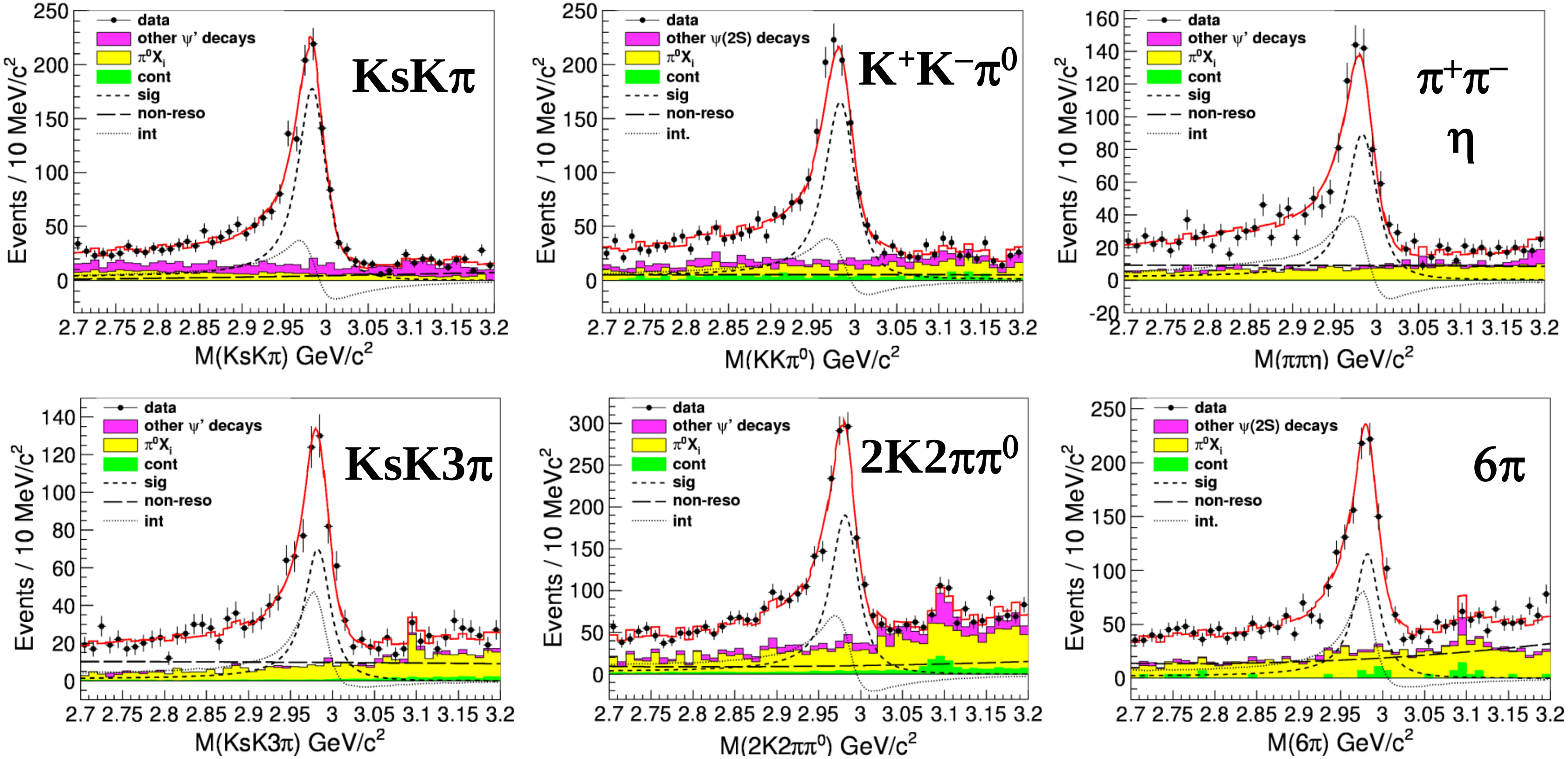
● $\psi(1S, 2S) \to \gamma\eta_c$





$\psi' \rightarrow \gamma\eta_c$, $\eta_c \rightarrow$ *exclusive* decays

interference with non-resonant background is significant!!



Relative phase ϕ values from each mode are consistent within 3σ,

➔ use a common phase value in the simultaneous fit.

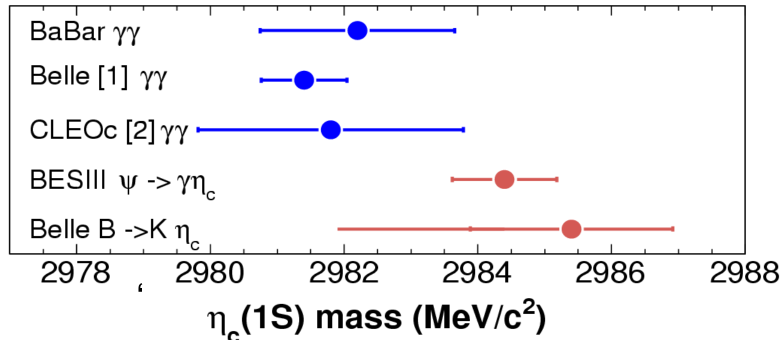
M: **2984.4 ± 0.5 ± 0.6** MeV

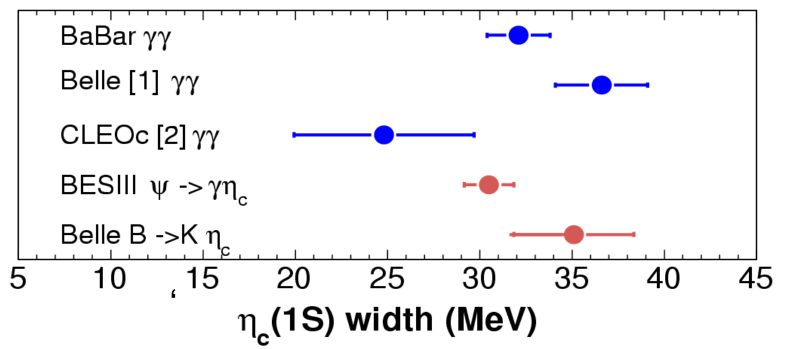
Γ: **30.5 ± 1.0 ± 0.9** MeV

ϕ: **2.35 ± 0.05 ± 0.04** rad

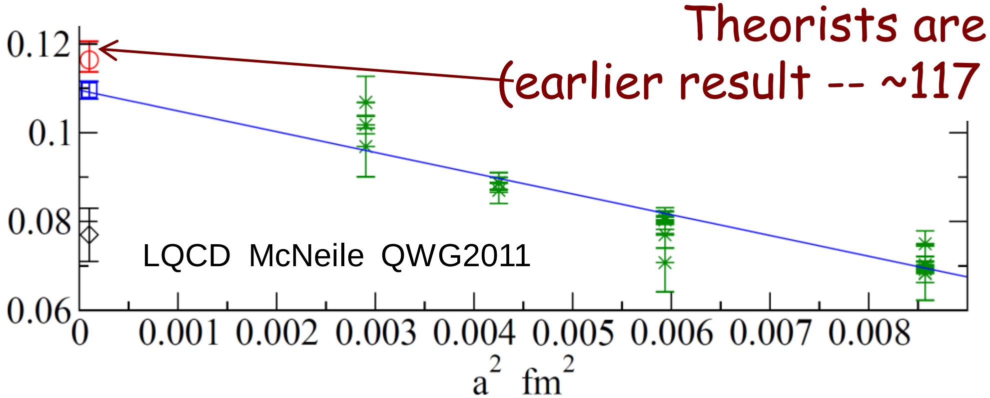
BESIII arXiv:1111:0398 →PRL

Summary of recent η_c results





Hyperfine splitting: $\Delta M(1S)$ = **112.5 ± 0.8** MeV



Theorists are happier with this value
(earlier result -- ~117 MeV -- was too large for them)

$h_c(^1P_1)$

- Spin singlet *P* wave (S=0, L=1)

- Potential model: if non-zero *P*-wave spin-spin interaction,

  $\Delta M_{hf}(1P) = M(h_c) - \langle m(1\ ^3P_J)\rangle \neq 0$

  where $\langle m(1\ ^3P_J)\rangle = [(M(\chi_{c0}) + 3M(\chi_{c1}) + 5M(\chi_{c2})]/9$,

- CLEOc 1st observed h_c in $ee \to \psi' \to \pi^0 h_c$, $h_c \to \gamma\eta_c$

  $\Delta M_{hf}(1P) = 0.08 \pm 0.18 \pm 0.12$ MeV/c^2

  Consistent with 1P hyperfine splitting = 0.

Theoretical prediction:

$BF(\psi(2S) \to \pi^0 h_c) = (0.4\text{-}1.3) \times 10^{-4}$

$BF(h_c \to \gamma\eta_c) = 48\%$ (NRQCD)

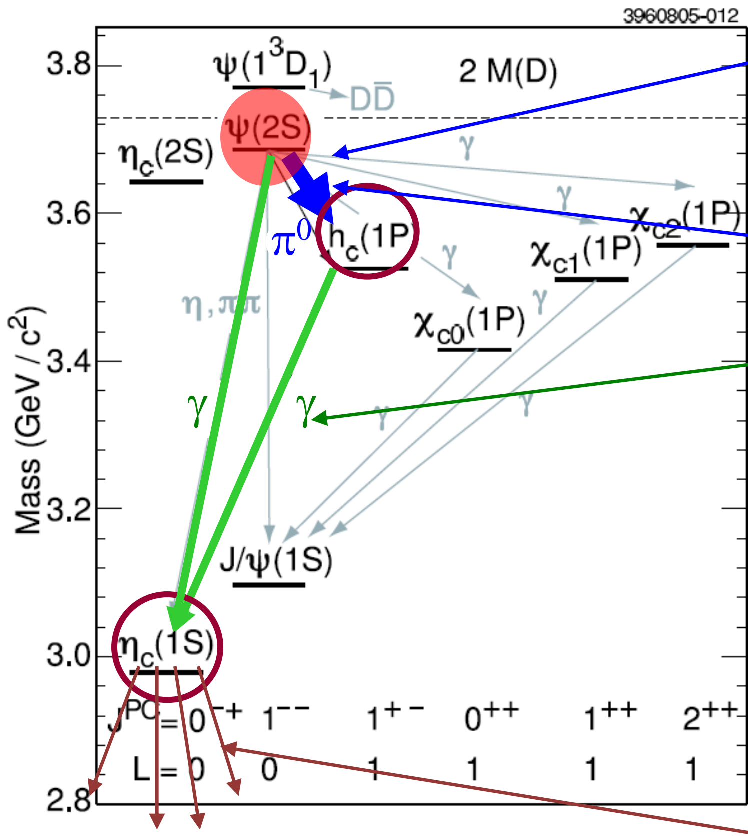
$BF(h_c \to \gamma\eta_c) = 88\%$ (PQCD)

Kuang, PR D65 094024 (2002)

$BF(h_c \to \gamma\eta_c) = 38\%$

Godfrey and Rosner, PR D66 014012(2002)

methods for studying the h_c



hadrons

only detect the π^0 → "inclusive"
(compute M_{h_c} from kinematics)

$$Rate \propto Bf(\psi' \to \pi^0 h_c)$$

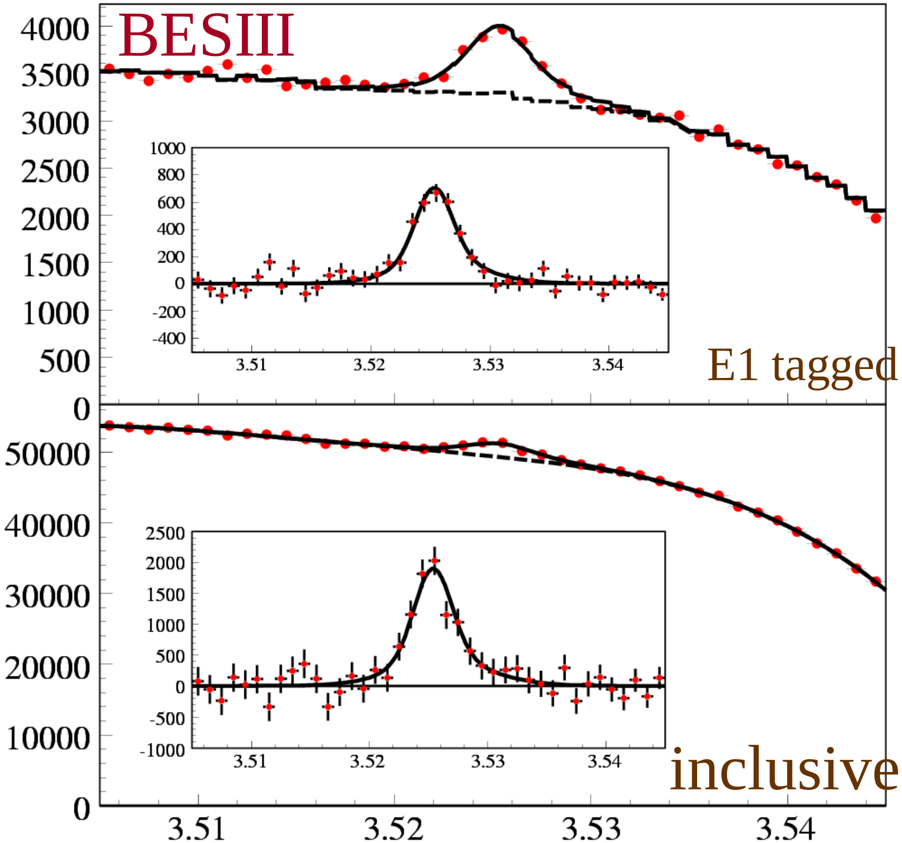
detect the π^0 & γ → "E_1-tagged"
(compute M_{h_c} from kinematics)

$$Rate \propto Bf(\psi' \to \pi^0 h_c) \times Bf(h_c \to \gamma \eta_c)$$

detect the π^0 , γ & *all* η_c → X_i decay products → "exclusive"
(compute M_{h_c} from 4-C kinematic fit)

$$Rate \propto Bf(\psi' \to \pi^0 h_c) \times Bf(h_c \to \gamma \eta_c) \times Bf(\eta_c \to X_i)$$

$\psi' \rightarrow \pi^0 h_c$, $h_c \rightarrow \gamma \eta_c$



BESIII: PRL 104 132002 (2010)

Mass = **3525.40 ± 0.13 ± 0.18** MeV/c^2

Width = **0.73 ± 0.45 ± 0.28** MeV

<1.44 MeV @90%

CLEOc: PRL 101 182003 (2008)

Mass = **3525.28 ± 0.19 ± 0.12** MeV

Width: fixed at 0.9 MeV

Hyperfine mass splitting

$\Delta M_{hf}(1^1P) = M(h_c) - \langle m(1^3P_J) \rangle$

BESIII: ***0.10 ± 0.13 ± 0.18*** MeV/c^2

CLEOc: ***0.02 ± 0.19 ± 0.13* MeV/*c*²**

By combining inclusive results with E1-photon tagged results

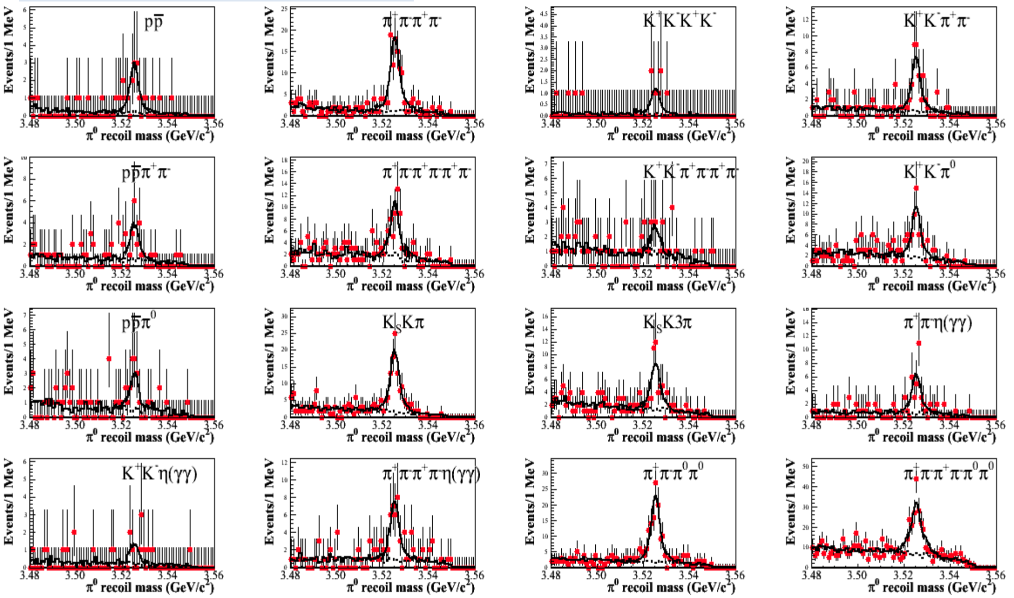
BF($\psi' \rightarrow \pi^0 h_c$) = **(8.4 ± 1.3 ± 1.0) × 10⁻⁴**

BF($h_c \rightarrow \gamma \eta_c$) = **(54.3 ± 6.7 ± 5.2)%**

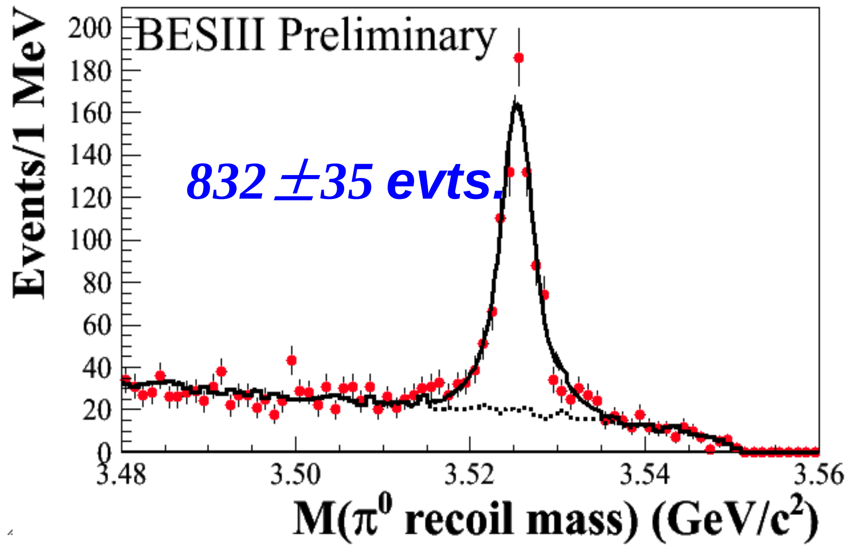
Agrees with prediction from Kuang, Godfrey, Dude et al.

$\psi' \rightarrow \pi^0 h_c$, $h_c \rightarrow \gamma\eta_c$, η_c *exclusive* decays

BESIII Preliminary



Summed distribution



16 different η_c decay channels

Simultaneous fit to π^0 recoiling mass

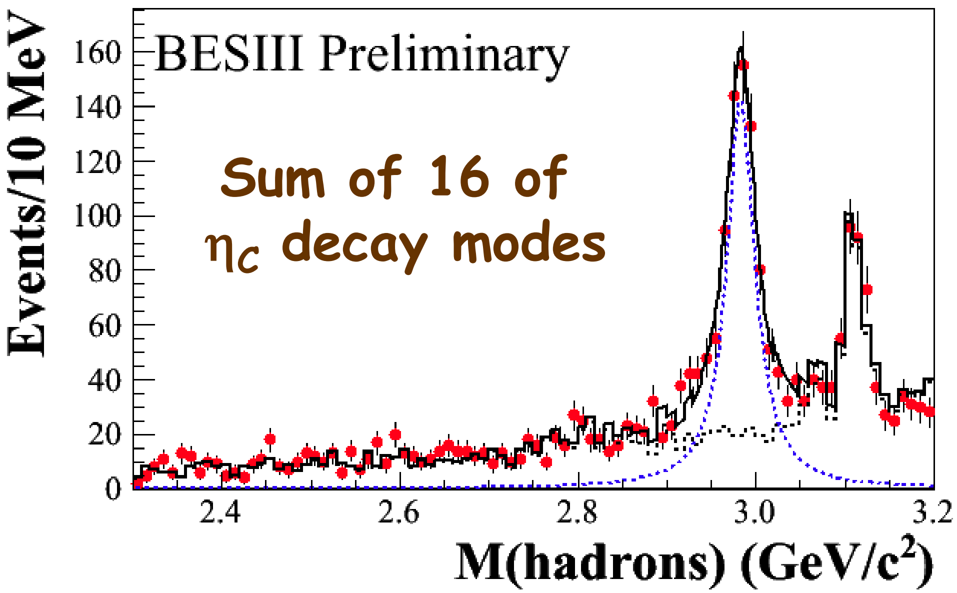
χ^2/d.o.f. = 32/46

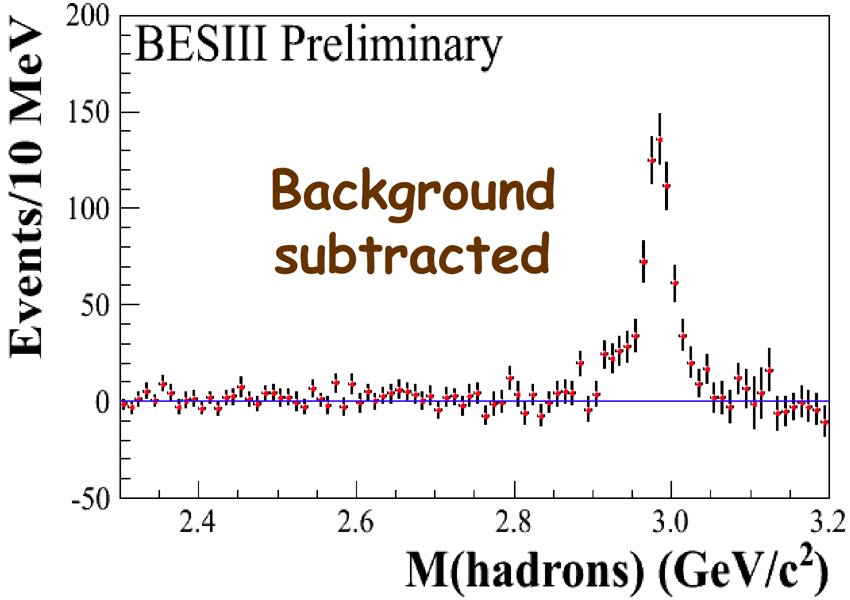
Mass = **3525.31 ± 0.11 ± 0.15** MeV/c^2

Width = **0.70 ± 0.28 ± 0.25** MeV

consistent with BESIII E_1-tagged results

η_c lineshape from $\psi' \to \pi^0 h_c$, $h_c \to \gamma\eta_c$





The η_c lineshape in $h_c \to \gamma\eta_c$ is not as distorted as in $\psi' \to \gamma\eta_c$ decays; the non-resonant interfering bkg is small (non-existent?). Ultimately, this channel will be best suited to determine η_c resonance parameters.

yesterday's search → today's discovery → tomorrow's calibration

Physics program @ BESIII

Light hardron physics

-meson & baryon spectroscopy

-multiquark states

-threshold effects

-glueballs & hybrids

-two-photon physics

-form-factors

Charmonium physics:

- precision spectroscopy
- transitions and decays

QCD & τ -physics:

- precision R-measurement
- τ decays

Charm physics:

- semi-leptonic form factors
- f_D & f_{D_s} decay consts.
- CKM matrix: V_{cd}, V_{cs}
- D^0-D^0 mixing and CPV
- strong phases

Precision mass measurements:

- τ mass
- D^0 mass

XYZ meson physics:

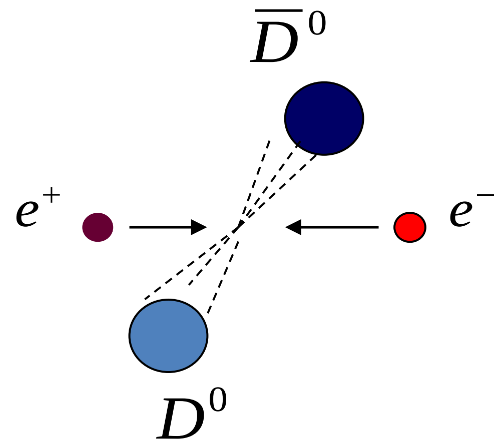
-$Y(4260) \rightarrow \pi\pi h_c$ decays

…,

Charmed meson physics at BESIII

coherent process:

$$e^+e^- \to \psi'' \to D^0\overline{D}^0$$



The initial state C=-1:

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

$$\hat{C}\left|D^0\right\rangle = \left|\overline{D}^0\right\rangle$$
$$\hat{C}\left|\overline{D}^0\right\rangle = \left|D^0\right\rangle$$

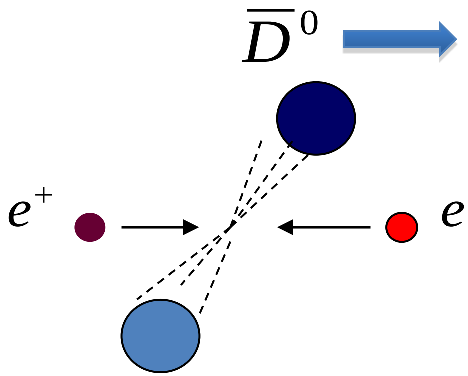
coherent amplitudes:

$$\Gamma_{ij}^2 = \left|\left\langle i \mid D^0\right\rangle\left\langle j \mid \overline{D^0}\right\rangle \mp \left\langle j \mid D^0\right\rangle\left\langle i \mid \overline{D^0}\right\rangle\right|^2$$

input to B-factory ϕ_3 & D^0-D^0 mixing measurements

$$\frac{\left\langle f \middle| \overline{D}^0\right\rangle^{DCS}}{\left\langle f \middle| D^0\right\rangle^{CF}} = r_D e^{-i\delta_D}$$

CP-tagged D decays

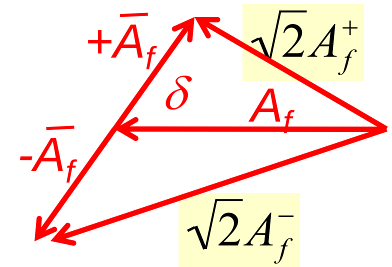


CP=$\pm$1 eigenstate

CP=+1	CP=-1
K^+K^- (~0.4%)	$K_s\pi^0$ (~1.2%)
$\pi^+\pi^-$ (~0.1%)	$K_s\eta$ (~0.4%)
$K_s\pi^0\pi^0$ (~0.8%)	$K_s\omega$ (~1%)

$$D^0 \Rightarrow D^{CP=\mathrm{m}} = \tfrac{1}{\sqrt{2}}\left(D^0\ \mathrm{m}\overline{D}^0\right) \Rightarrow f$$

$$A_f^{\mathrm{m}} = A(D^{CP\mathrm{m}} \to f) = \tfrac{1}{\sqrt{2}}\left(\langle f|D^0\rangle\ \mathrm{m}\langle f|\overline{D}^0\rangle\right) = \tfrac{1}{\sqrt{2}}(A_f\ \mathrm{m}\overline{A}_f)$$

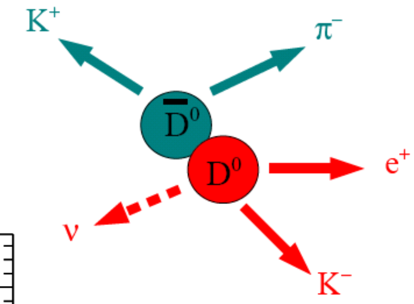


$$2\sqrt{R_f}\cos\delta \approx \frac{|A_f^+|^2 - |A_f^-|^2}{|A_f^+|^2 + |A_f^-|^2} = \frac{Br(D^{CP+} \to f) - Br(D^{CP-} \to f)}{Br(D^{CP+} \to f) + Br(D^{CP-} \to f)}$$

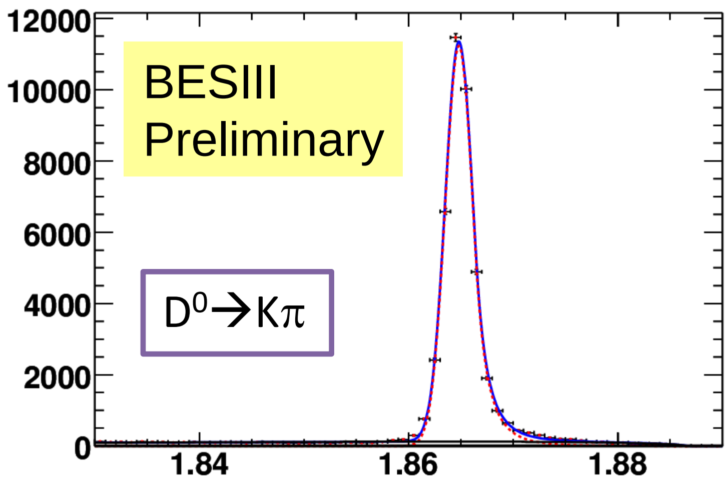
BESIII now has 10x more data

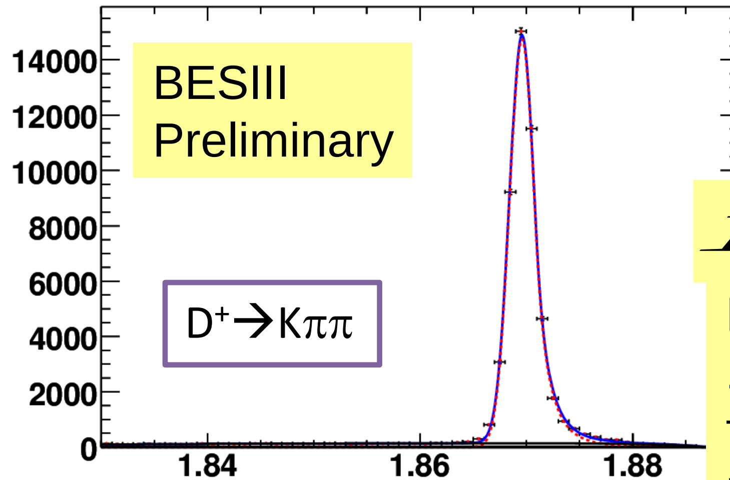
for f=$K^+\pi^-$ CLEOc finds $\cos\delta_{K\pi}$ = 22$^o\pm$16^o with 281 pb^{-1} PRD 78 012001

BESIII “single tags” at ψ”(3770)

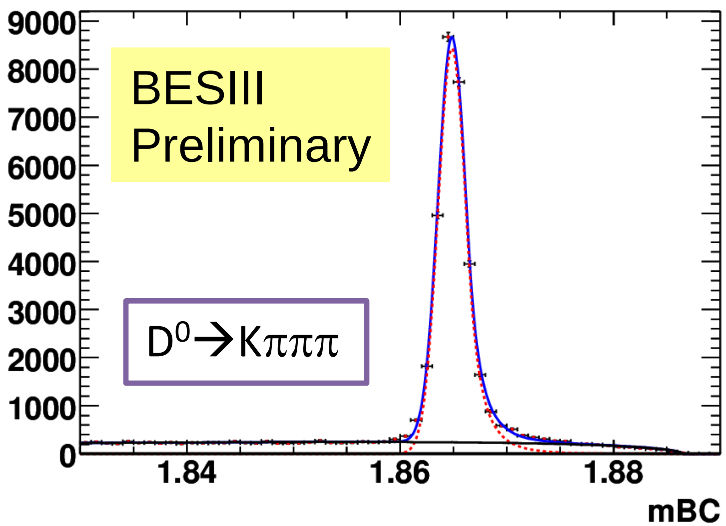


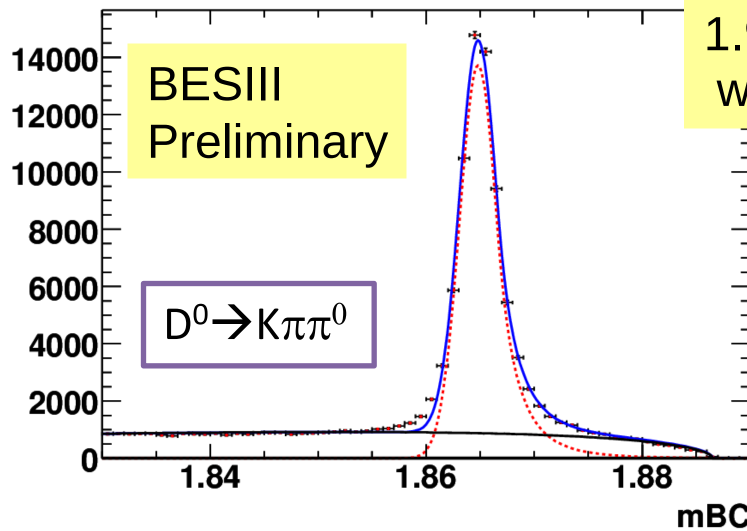
420pb^{-1}:





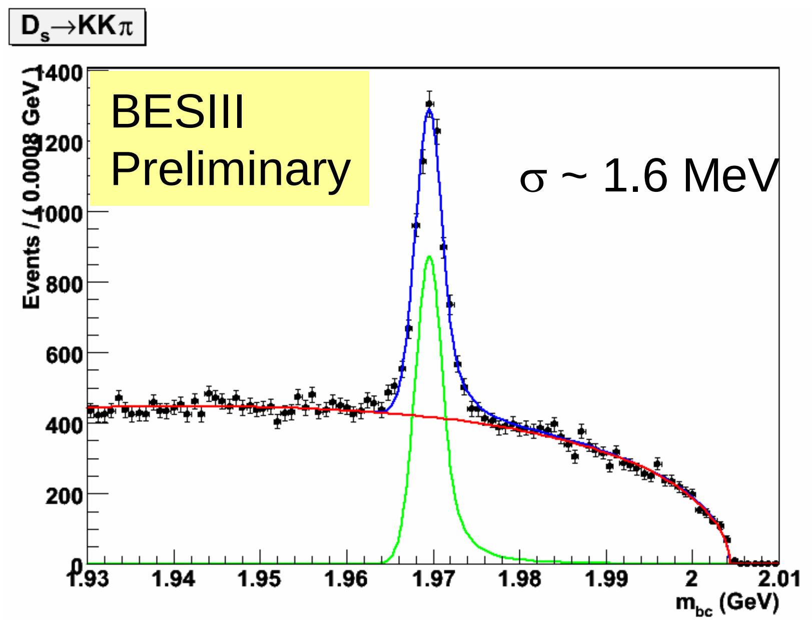
Resolution:
1.3 MeV
for pure charged modes;
1.9 MeV for modes with one π^0.

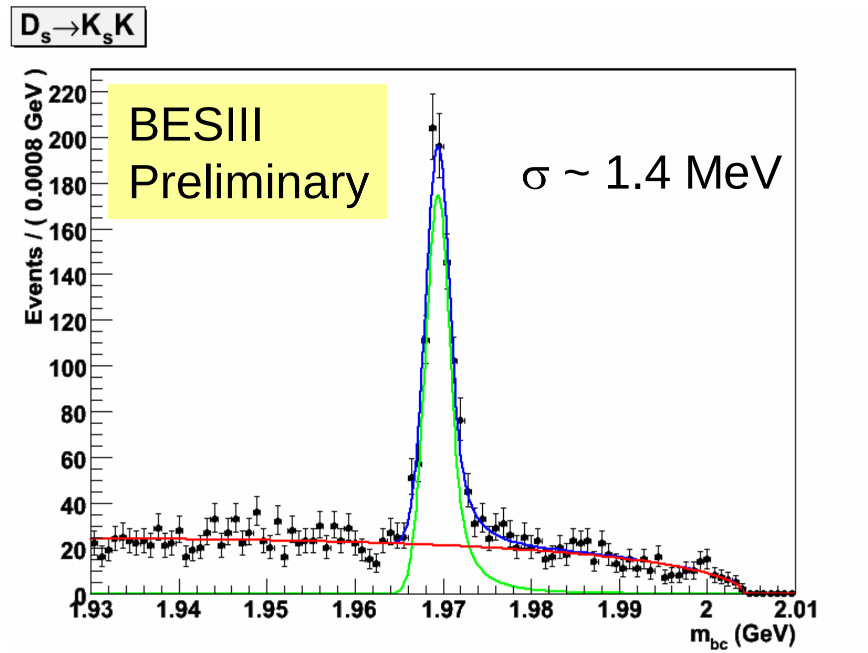




m_{BC} of D_s Single Tag

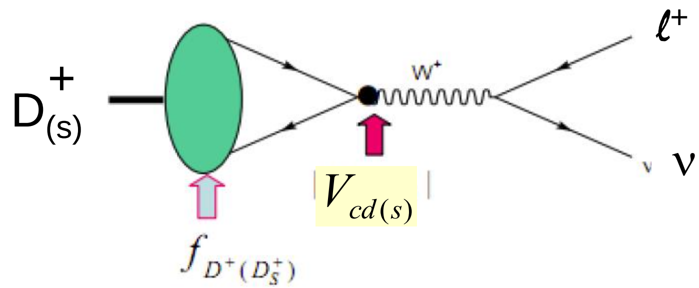
part of data @ 4010 MeV





D analyses currently in progress I

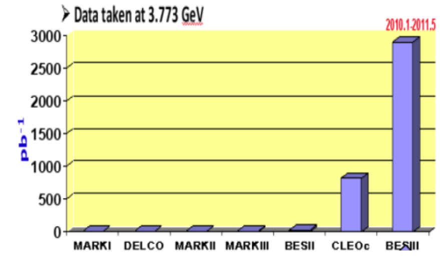
1) Purely leptonic decays:

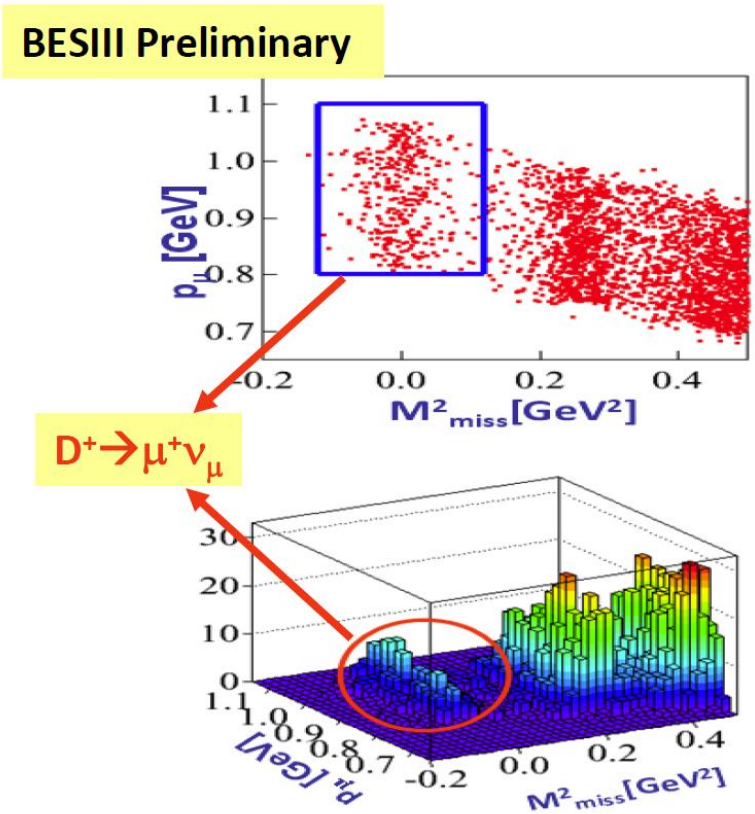


$$\Gamma(D^+ \to l^+ \upsilon_l) = \frac{G_F^2 f_{D^+}^2}{8\pi} |V_{cd}|^2 m_l^2 m_{D^+} (1 - \frac{m_l^2}{m_{D^+}^2})^2$$

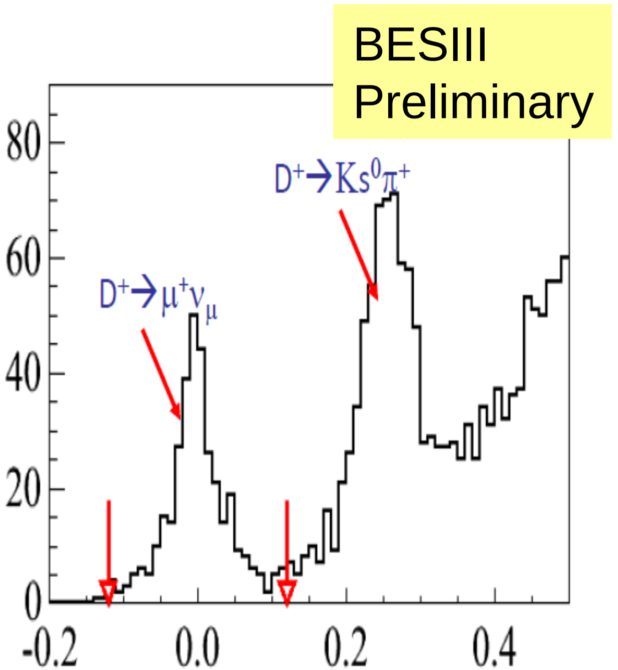
All quantities well measured except f_{D+}.
Use W.A. $|V_{cd}|$ & compare f_{D+} to LQCD.

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





$$M^2_{miss} = E^2_{miss} - P^2_{miss}$$



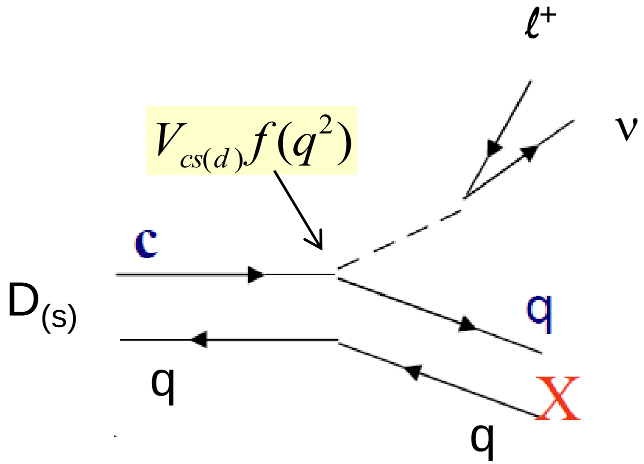
M^2_{miss} Distribution (part of data)

Expectations for f_D (with existing data)

EXP or Theory	f_{D+} (MeV)
BESIII expectation [2.9 fb^{-1}]	**~2.8% (stat.)**
CLEO-c **(818 pb^{-1})**	206 ± 9 **[4.4%]**
Lattice[1]	208 ± 4
Lattice[2]	217 ± 10
PQL	197 ± 9
QL(QCDSF)	206 ± 23
QS(Taiwan)	235 ± 16
QL(UKQCD)	210 ± 20
QL	211 ± 18
QCD Sum Rules[1]	177 ± 21
QCD Sum Rules[2]	203 ± 20
Field Correlators	210 ± 10
Light Front	206

D analyses currently in progress II

2) semi-leptonic decays:



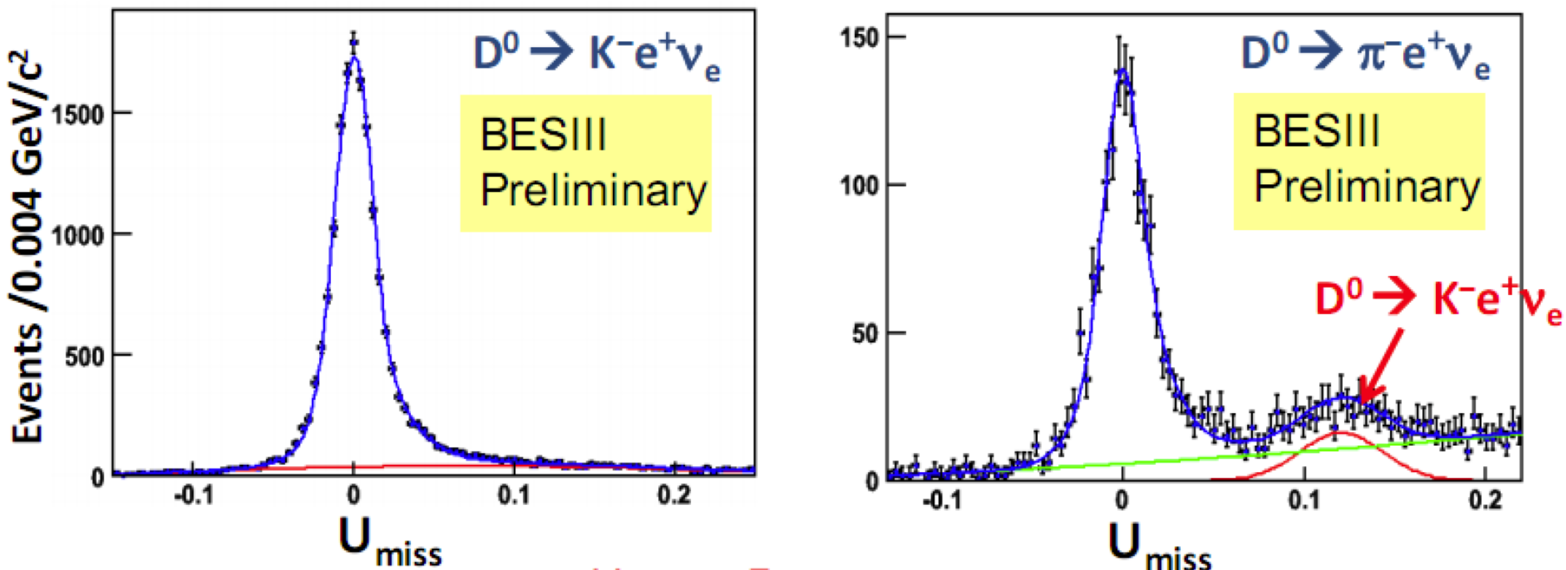
$$\Gamma(D^0 \to K^- e^+ \nu_e) = 1.53 \times |V_{cs}|^2 \times |f_+^K(0)|^2 \times 10^{11} s^{-1}$$

$$\Gamma(D^0 \to \pi^- e^+ \nu_e) = 3.01 \times |V_{cd}|^2 \times |f_+^\pi(0)|^2 \times 10^{11} s^{-1}$$

if X=*K* or π, only 1 form-factor

$D^0 \to K^-/\pi^- e^+ \nu$ Measurement

Candidate events for $D^0 \to K^- e^+ \nu_e$, $\pi^- e^+ \nu_e$



$U_{miss} = E_{miss} - p_{miss}$.

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-multiquark states
-threshold effects
-glueballs & hybrids
-two-photon physics
-form-factors

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- strong phases

Precision mass measurements:

- τ mass
– D^0 mass

XYZ meson physics:

-$Y(4260) \rightarrow \pi\pi h_c$ decays

…,

Precision mass measurements

m_τ

Particle	Mass, MeV	σ_m/m
e	$0.510998910 \pm 0.000000013$	$2.5 \cdot 10^{-8}$
μ	$105.6583668 \pm 0.0000038$	$3.6 \cdot 10^{-8}$
τ	1776.82 ± 0.16	$9.0 \cdot 10^{-5}$

factor of ~3000 disparity

lepton universality: $r = \left(\frac{G_\tau}{G_\mu}\right)^2 = \left(\frac{G(\tau^- \to e^- \nu_\tau \bar{\nu}_e)}{G(\mu^- \to e^- \nu_\mu \bar{\nu}_e)}\right)^2 = \left(\frac{m_\mu}{m_\tau}\right)^5 \left(\frac{t_\mu}{t_\tau}\right) \mathcal{B}(\tau \to e \nu_\tau \bar{\nu}_e) \frac{F_{\rm cor}(m_\mu, m_e)}{F_{\rm cor}(m_\tau, m_e)}$

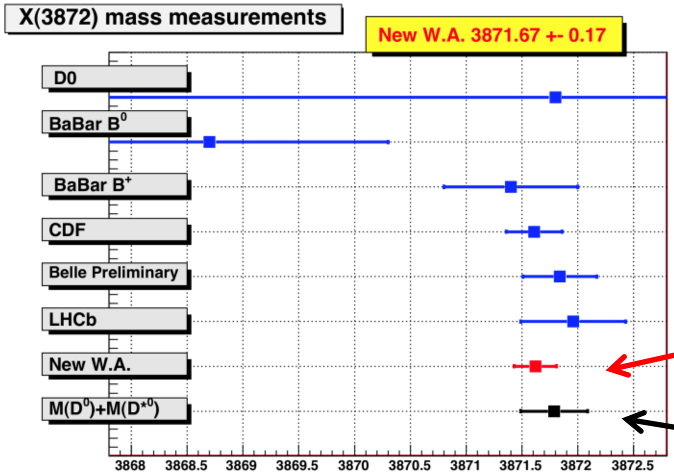
Koide's formula:
PRD 28, 252 (1983)

$$\frac{(\sqrt{m_e} + \sqrt{m_\mu} + \sqrt{m_\tau})^2}{(m_e + m_\mu + m_\tau)} = 1.4999973^{+0.0000395}_{-0.0000304}$$

numerology?

m_{D^0}

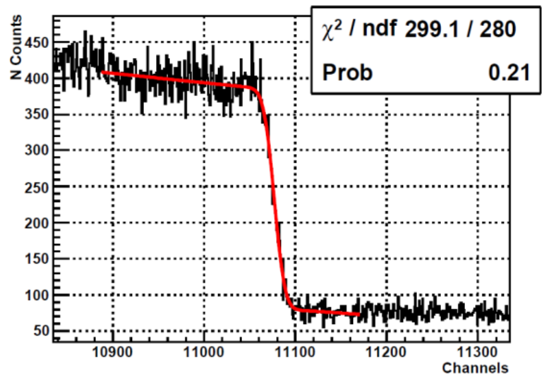
is $M_{X(3872)}$ above or below $m_{D^0}+m_{D^{*0}}$?



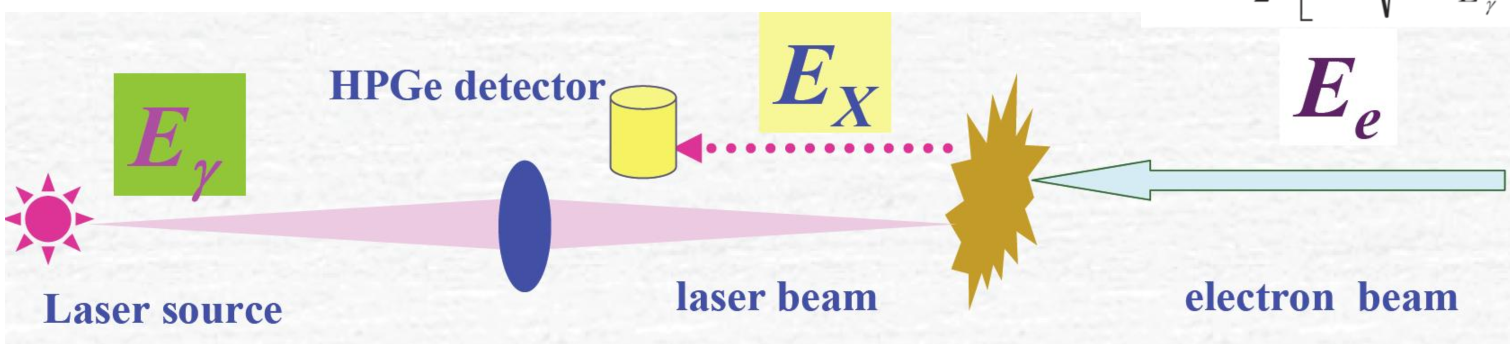
$M_{X(3872)}$

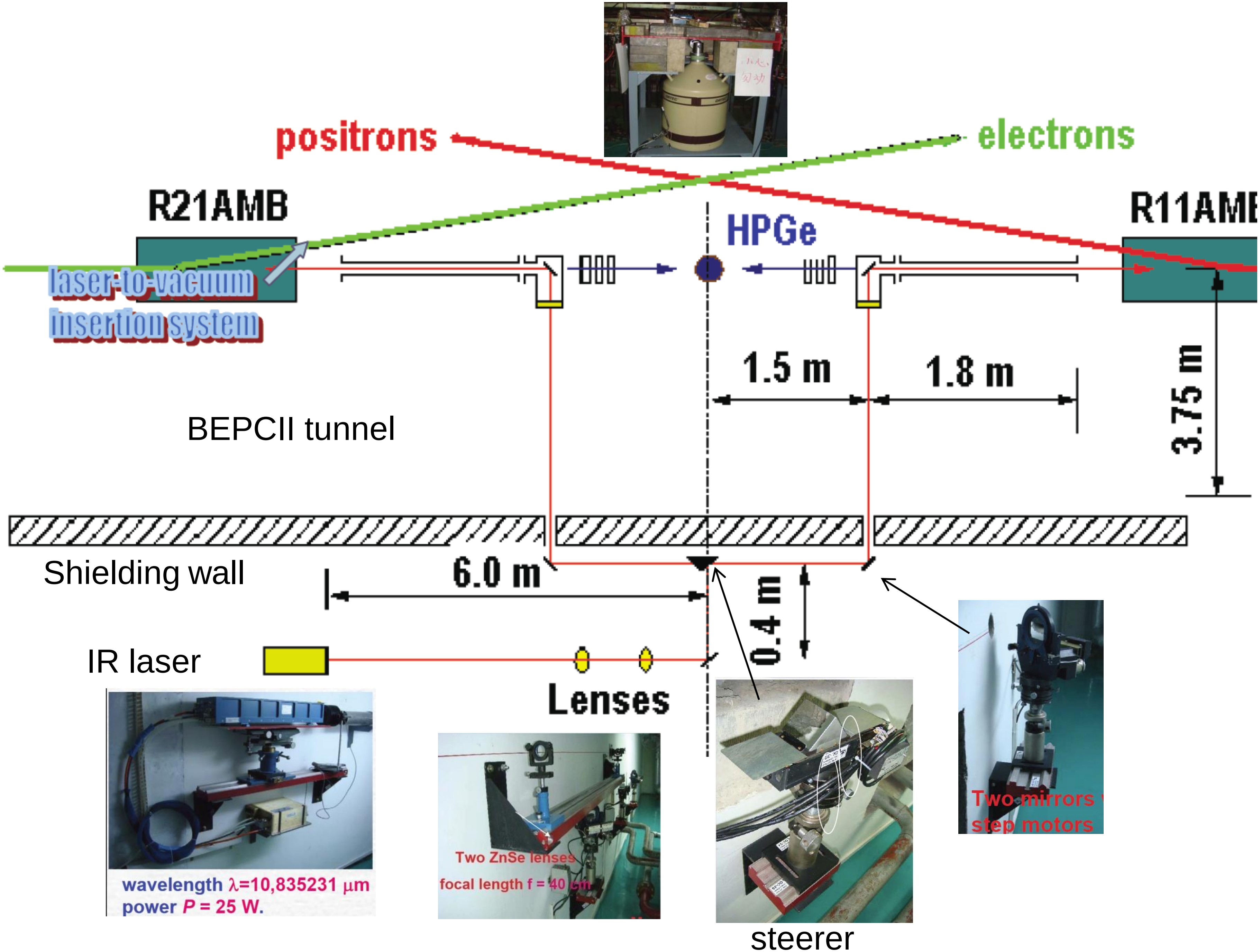
$m_{D^0} + m_{D^{*0}}$

BEPCII beam energy monitor



$$E_e = \frac{E_X}{2}\left[1 + \sqrt{1 + \frac{m_e^2}{E_\gamma E_X}}\right]$$

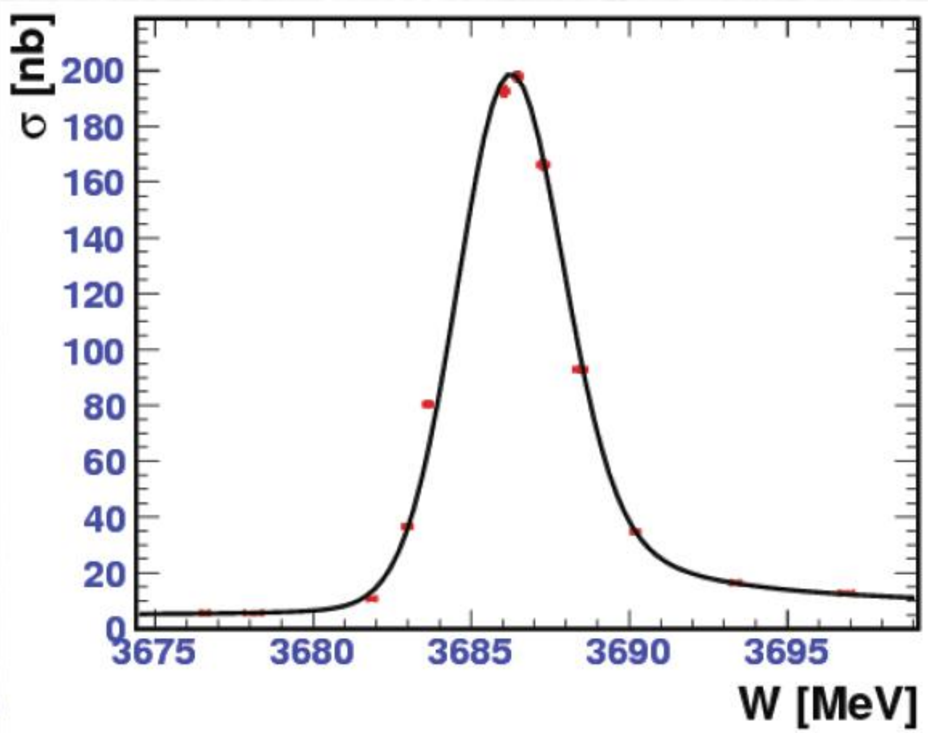




positrons
electrons
R21AMB
R11AMB
HPGe
laser-to-vacuum
insertion system
1.5 m
1.8 m
3.75 m
BEPCII tunnel
Shielding wall
6.0 m
0.4 m
IR laser
Lenses
wavelength λ=10,835231 μm
power P = 25 W.
Two ZnSe lenses
focal length f = 40 cm
steerer
Two mirrors
step motors

Validate at the ψ' peak

The accuracy of beam energy measurement was studied by comparison of ψ(2s) resonance mass 3686.09 ± 0.040 MeV, with its value obtained using the energy obtained using BEMS data.



Two scans of ψ(2s) with integrated luminosity about 4 pb^{-1}.

Mass difference:

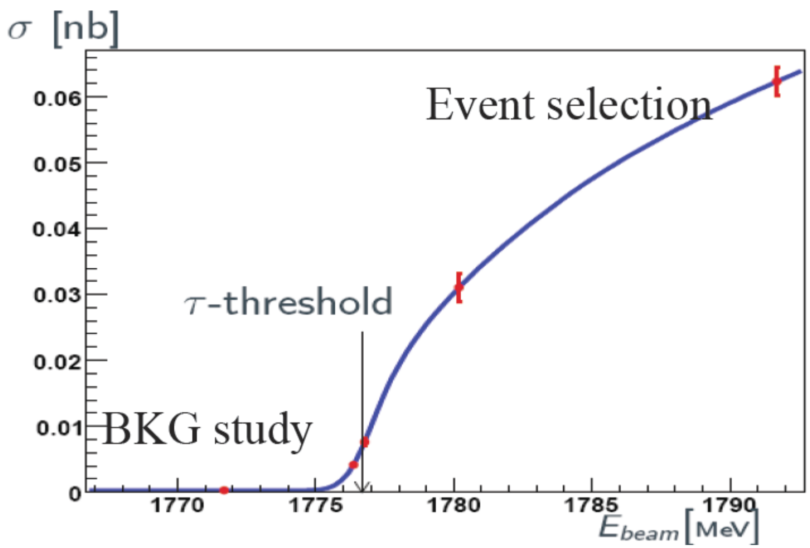
$$\Delta m = m - m_{\psi} = 0.02 \pm 0.05 MeV$$

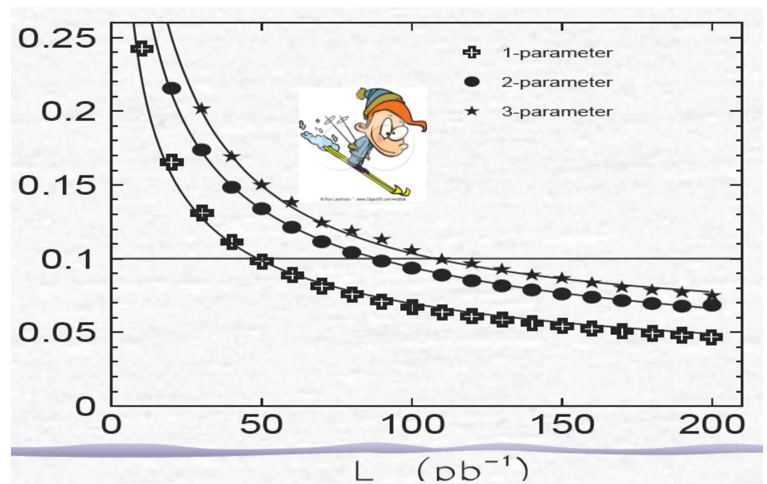
Deviation of the measured beam energy of the beam from true value:

$$\delta\varepsilon = \frac{\Delta m}{2} = 0.01 \pm 0.03$$

Accuracy of the BEMS: **δε/ε** ~ 2×10^{-5}

expected precision on m_τ





Concluding remarks

- BEPCII is operating near design luminosity & BESIII is performing at state-of-art levels
- Clear evidence for the influence of the $K\bar{K}$ threshold on the $a_0(980)$-$f_0(980)$ system
  - probably not pure $K\bar{K}$ molecules, but dynamical effects are strong
- Precision measurements of η_c and h_c charmonium-state properties are made
  - interference with non-resonant bkg is significant
- World's largest sample ever of ψ"→ $D\bar{D}$ decays already collected
  - precision measurements of f_D, $|V_{cs}|$ and $|V_{cd}|$ & strong phases in progress
- Plan for order-of-mag. increases in J/ψ & ψ' samples soon, then a large D_s sample
  - precision R scan, τ-mass measurement, Y(4260) studies…. also planned.

감사합니다

Thank you