Study of the Electromagnetic Dalitz decay of $J/\psi \rightarrow e^+e^-\pi^0$

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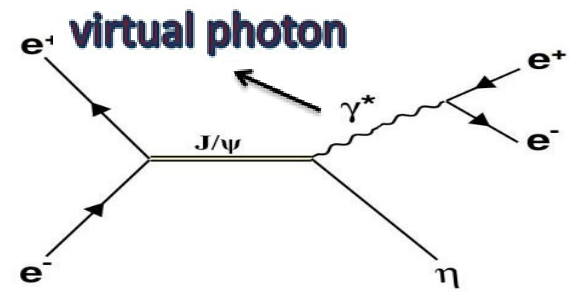
Motivation

- The study of Electromagnetic Dalitz decays of $V \to Pe^+e^-$ is important to reveal the structure of hadrons and the transition form factor (TFF), $|F_{VP}(m^2_{l^+l^-})|^2$, at the transition vertex.



- $q^2 = m_{e^+e^-}$ dependent decay rate:

$$\frac{d\Gamma(V\to Pe^+e^-)}{dq} = \Gamma(V\to P\gamma)\frac{\alpha}{3\pi}|F_{J/\psi P}(q^2)|^2\frac{2}{q}\left(1-\frac{4m_e^2}{q^2}\right)^{1/2}\left(1+\frac{2m_e^2}{q^2}\right)\times\left[\left(1+\frac{q^2}{m^2_{J/\psi}-m^2_P}\right)^2-\frac{4m_V^2q^2}{(m_V^2-m_P^2)^2}\right]^{3/2}$$

***

$$= \quad |F_{VP}(q^2)|^2\times[QED(q^2)]$$

[Phys.Rep.128,301(1985)]

- **Vector meson dominance model (VMD):** $|F_{VP}(m^2_{l^+l^-})|^2$ is mainly governed by the coupling of the γ^* to the V meson via an intermediate vector (V') meson in the timelike region

$$F_{VP}(q^2) = N\sum_{V'}A_{V'}\frac{m^2_{V'}}{m^2_{V'}-q^2-i\Gamma_{V'}m_{V'}}$$

[JETP Lett. **29**, 398 (1979)]

simple pole approximation:

$$F_{VP}(q^2) = \frac{1}{1-q^2/\Lambda^2}$$

where Λ is an effective pole mass of the virtual vector meson and its inverse square value (Λ^{-2}) reflects the slope of the $|F_{VP}(m^2_{l^+l^-})|^2$ at $m_{l^+l^-}=0$.

Motivation

$J/\psi \to Pe^+e^-$ (225M J/ψ data) **[Phys. Rev. D 89 092008 (2014)]**

Experimental result agrees well with theoretical predication for η and η'.

Mode	Branching fraction	Combined result	Theoretical prediction
$J/\psi \to \eta' e^+e^-(\eta' \to \gamma\pi^+\pi^-)$	$(6.01 \pm 0.20 \pm 0.34) \times 10^{-5}$		
$J/\psi \to \eta' e^+e^-(\eta' \to \pi^+\pi^-\eta)$	$(5.51 \pm 0.29 \pm 0.32) \times 10^{-5}$	$(5.81 \pm 0.16 \pm 0.31) \times 10^{-5}$	$(5.66 \pm 0.16) \times 10^{-5}$
$J/\psi \to \eta e^+e^-(\eta \to \pi^+\pi^-\pi^0)$	$(1.12 \pm 0.13 \pm 0.06) \times 10^{-5}$		
$J/\psi \to \eta e^+e^-(\eta \to \gamma\gamma)$	$(1.17 \pm 0.08 \pm 0.06) \times 10^{-5}$	$(1.16 \pm 0.07 \pm 0.06) \times 10^{-5}$	$(1.21 \pm 0.04) \times 10^{-5}$
$J/\psi \to \pi^0 e^+e^-(\pi^0 \to \gamma\gamma)$	$(7.56 \pm 1.32 \pm 0.50) \times 10^{-7}$	$(7.56 \pm 1.32 \pm 0.50) \times 10^{-7}$	$(3.89^{+0.37}_{-0.33}) \times 10^{-7}$

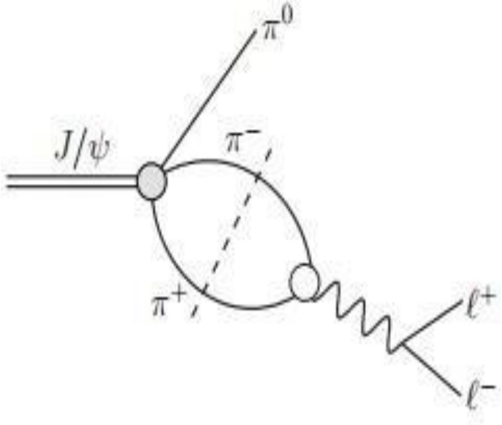
- Large discrepancy between experimental and theoretical results in $J/\psi \to e^+e^-\pi^0$ decay.

- New models, based on effective Lagrangian and dispersion theories, update the branching fraction of $J/\psi \to e^+e^-\eta(')\pi^0$ decays once again while taking into account to the contributions of light vector mesons and $\pi\pi$ intermediate states. **[arXiv:1412.5385 [hep-ph] (2015)]**

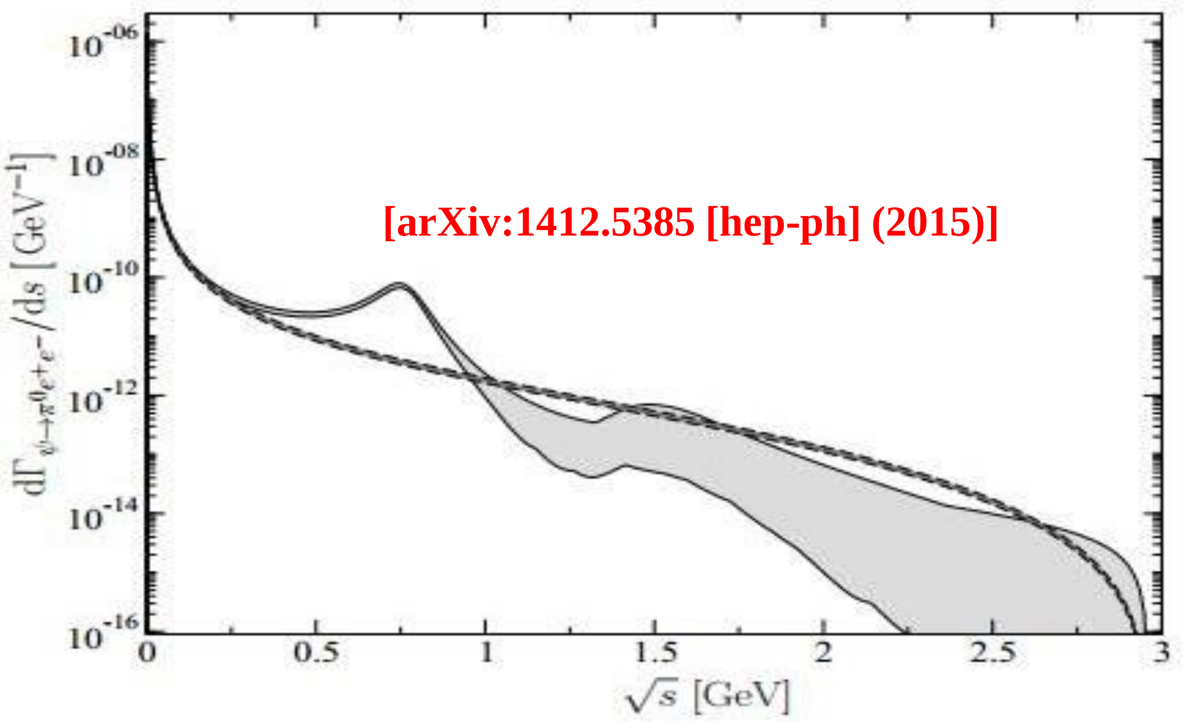
	Exp. data	this work	VMD prediction [13]
$\psi \to \pi^0 e^+e^-$	0.0756 ± 0.0141	0.1191 ± 0.0138	$0.0389^{+0.0037}_{-0.0033}$
$\psi \to \eta e^+e^-$	1.16 ± 0.09	1.16 ± 0.08	1.21 ± 0.04
$\psi \to \eta' e^+e^-$	5.81 ± 0.35	5.76 ± 0.16	5.66 ± 0.16

[arXiv:1411.1159 [hep-ph] (2014)]

Motivation



The objective of this analysis is to measure the branching fraction of $J/\psi \to e^+e^-\pi^0$ in the full $m_{e^+e^-}$-range using 1.31 billion J/ψ events collected by the BESIII detector.



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[arXiv:1411.1159 [hep-ph] (2014)]

Data-sets

- We use 1310.6 million J/psi data-set collected by BEESIII experiment during 2009-2012.
- Also use 1225 million events of inclusive J/ψ Monte Carlo (MC) sample for background study.
- Generate the signal MC for $J/\psi \to e^+e^-\pi^0$ using the formula of Equation *** shown in slide no 1 with TFF=1 GeV/c^2 to optimize the event selection criteria.
- Generate the exclusive MC events for the following decay processes to study the backgrounds:

$e^+e^- \to \gamma\mu^+\mu^-$	(Phokhara)	10 million
$e^+e- \to \gamma\pi+\pi-$	(Phokhara)	5 million
$e+e^- \to \gamma\pi^+\pi^-\pi^0$	(Phokhara)	20 million
$e^+e^- \to \gamma e^+e^-$	(Babayaga)	11 million
$J/\psi \to \gamma\pi^+\pi^-\pi^0$	(EvtGen)	74.1 million
$J/\psi \to V\pi^0$, $V(=\rho,\omega) \to e^+e^-$	(EvtGen)	120000 for each V decays
$J/\psi \to V\,\pi^0\pi^0$, $\omega \to e^+e^-$	(EvtGen)	120000

- Use BOSS V 664 to produce the ntuples.

Event reconstruction and selection

- Select the events of interests with exactly two charged tracks and at least two photons.

Good charged tracks

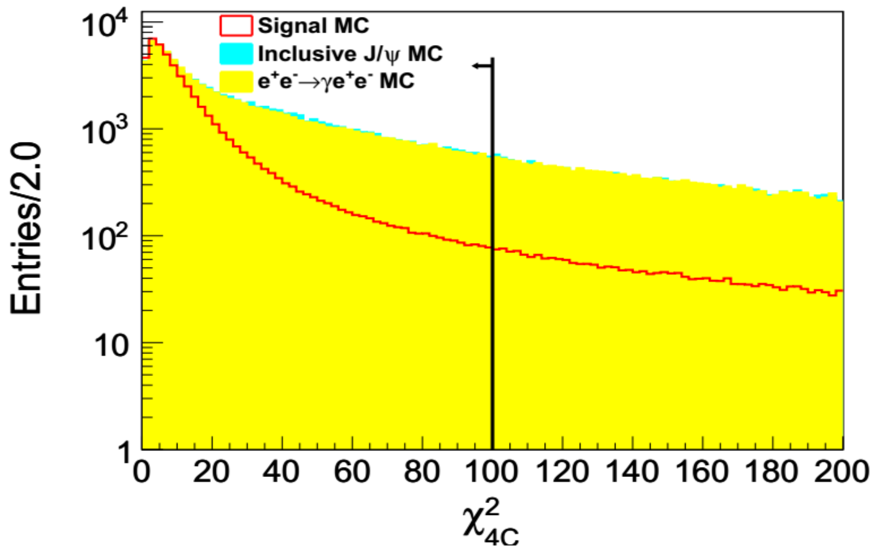
$|V_r| < 1.0$ cm, $|V_z| < 10$ cm and $|\cos\theta| \leq 0.93$

Good photons

Barrel region ($\cos\theta_\gamma < 0.8$): $E_\gamma > 25$ MeV
End-cap region ($0.86 < \cos\theta_\gamma < 0.92$): $E_\gamma > 50$ MeV
EMC timing: [0,14]×(50) ns, $\theta_{\gamma,x^\pm} > 10$ degrees.

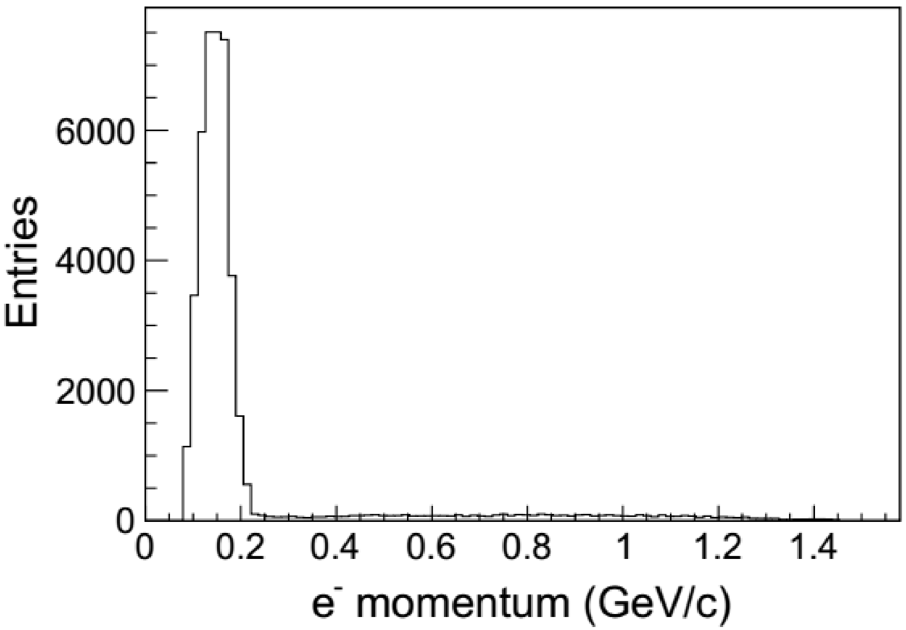
- Perform a 4C kinematic fit with two charged tracks and at least two good photon candidates.

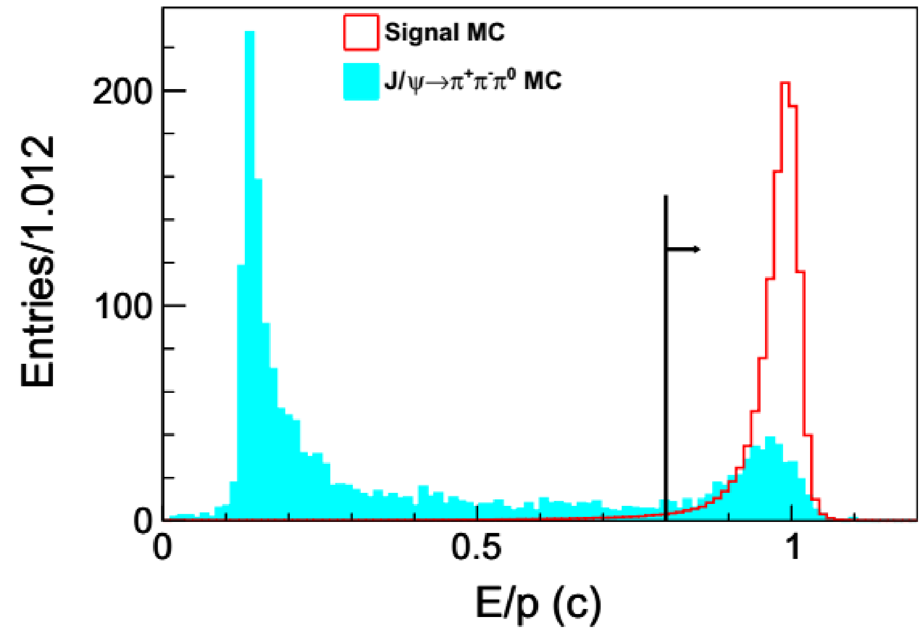
- The χ^2 from 4C kinematic fit is required to be less than 100.



Particle identification

- The two charged tracks are required to be identified as electrons using the PID based on dE/dx, TOF and EMC
  - prob of e^- > prob of π^-
  - Prob of e^- > prob of K^-
- E/p > 0.8 if $e^\pm$ momentums are larger than 0.25 GeV/c.

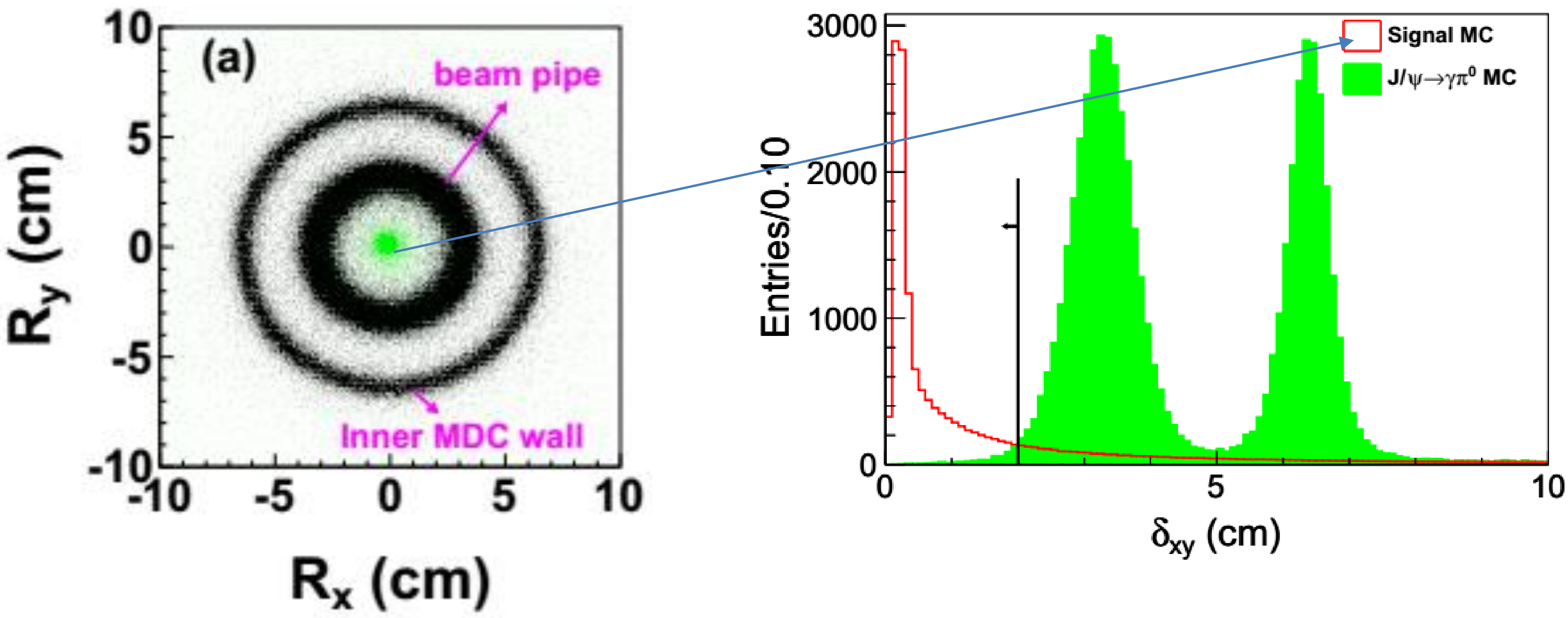




Veto of gamma conversion events

Use a photon conversion finder package to veto the gamma conversion events

$\delta_{xy} = \sqrt{R_x^2 + R_y^2}$ The distance from the conversion vertex point to the origin in the $x - y$ plane

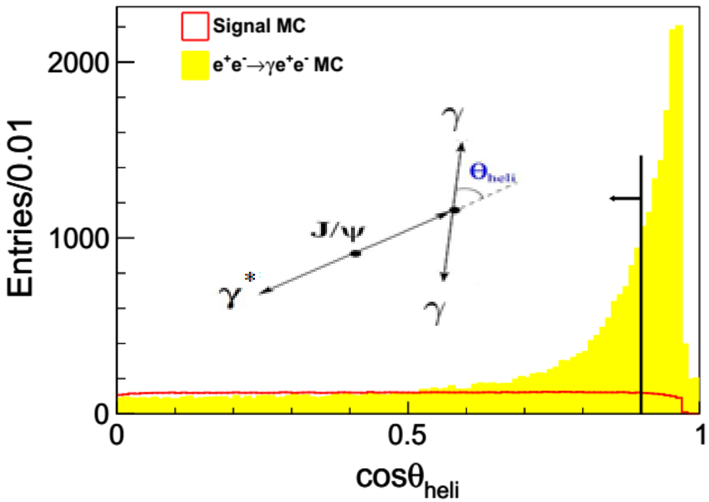


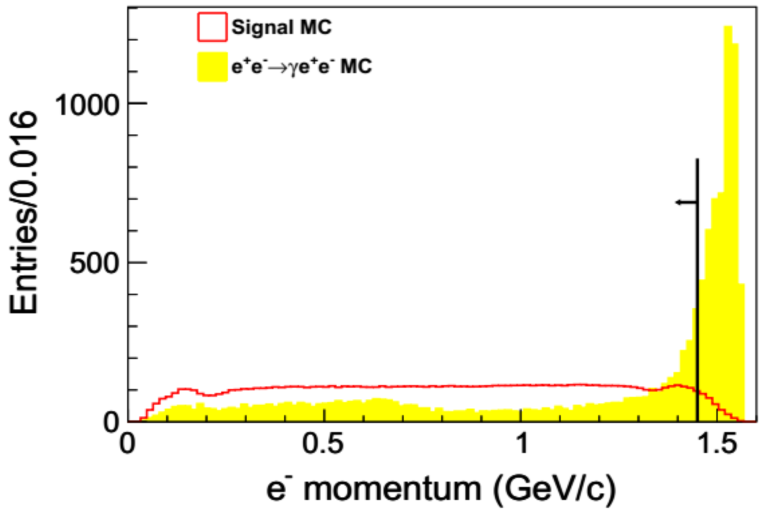
[Chin. Phys. C 36, 742 (2012)]

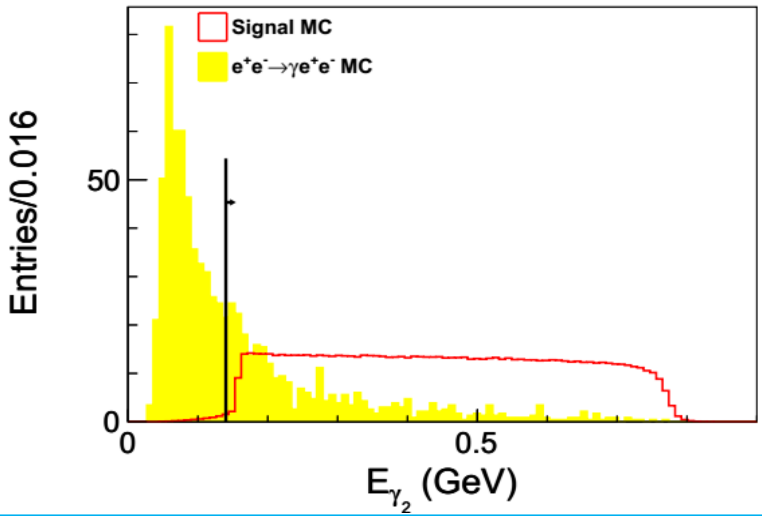
Veto of radiative Bhabha events

Cosine of photon helicity angle

- $|\cos\theta_{heli}| < 0.9$
- The momentum of both the e tracks is required to be 1.45 Gev/c
- The energy of the low energetic photon used for $\pi^0 \to \gamma\gamma$ reconstruction is required to be larger than 0.14 GeV







Remaining sources of backgrounds

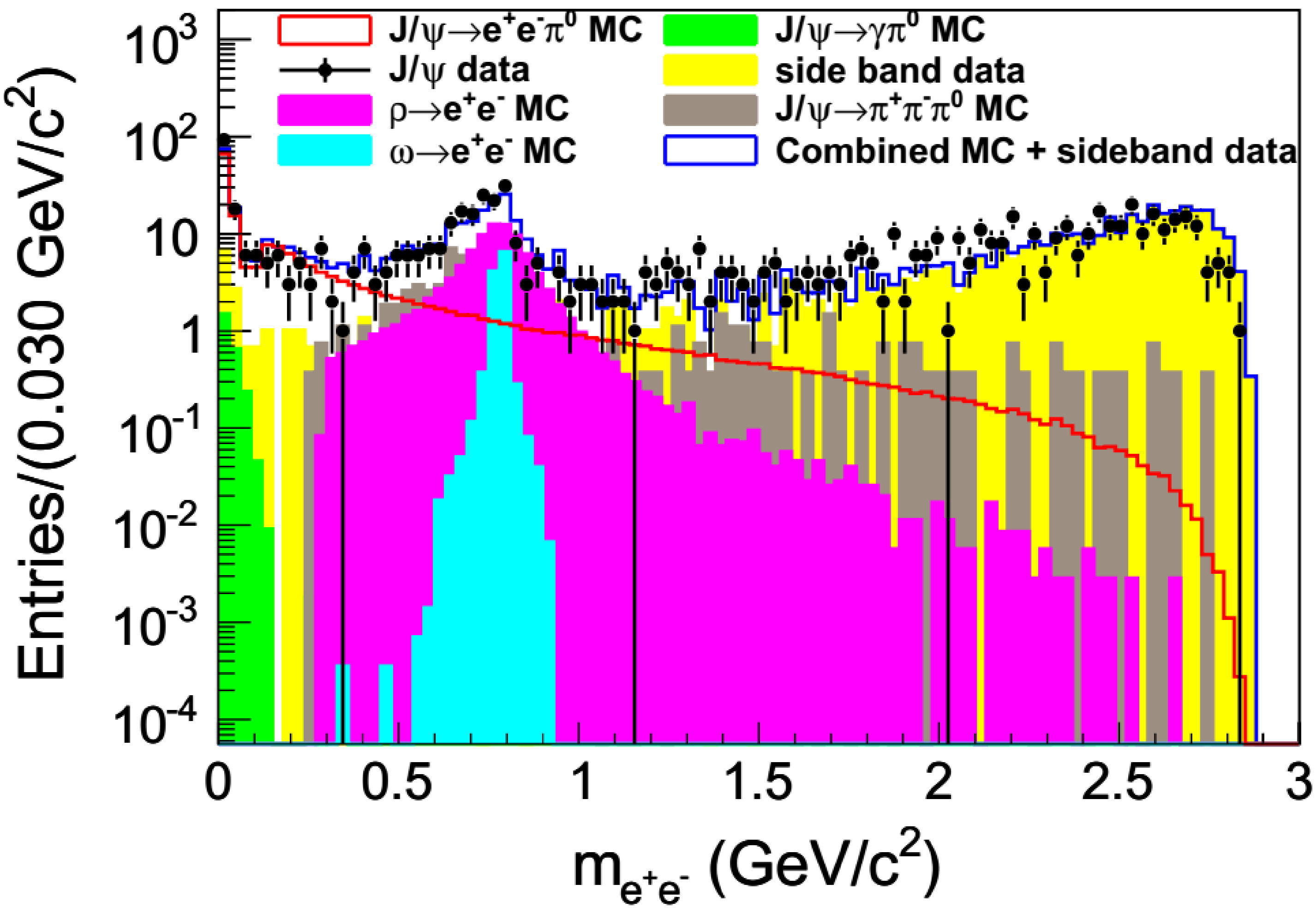
Remaining backgrounds in the inclusive J/ψ MC sample:

No.	decay chain	final states	iTopo	nEvt	nTot
0	$J/\psi \to e^- e^+$	$J/\psi \to e^+ e^-$	0	69	69
1	$J/\psi \to \pi^0 \rho^0,\ \rho^0 \to \pi^- \pi^+$	$J/\psi \to \pi^+ \pi^0 \pi^-$	2	9	78
2	$J/\psi \to \pi^- \pi^0 \pi^+$	$J/\psi \to \pi^+ \pi^0 \pi^-$	1	4	82
3	$J/\psi \to \pi^- \rho^+,\ \rho^+ \to \pi^0 \pi^+$	$J/\psi \to \pi^+ \pi^0 \pi^-$	3	2	84
4	$J/\psi \to \gamma f_4(2050),\ f_4(2050) \to \pi^0 \pi^0$	$J/\psi \to \gamma \pi^0 \pi^0$	4	1	85
5	$J/\psi \to \rho^- \pi^+,\ \rho^- \to \pi^- \pi^0$	$J/\psi \to \pi^+ \pi^0 \pi^-$	5	1	86

Exclusive MC study for the remaining sources of the backgrounds:

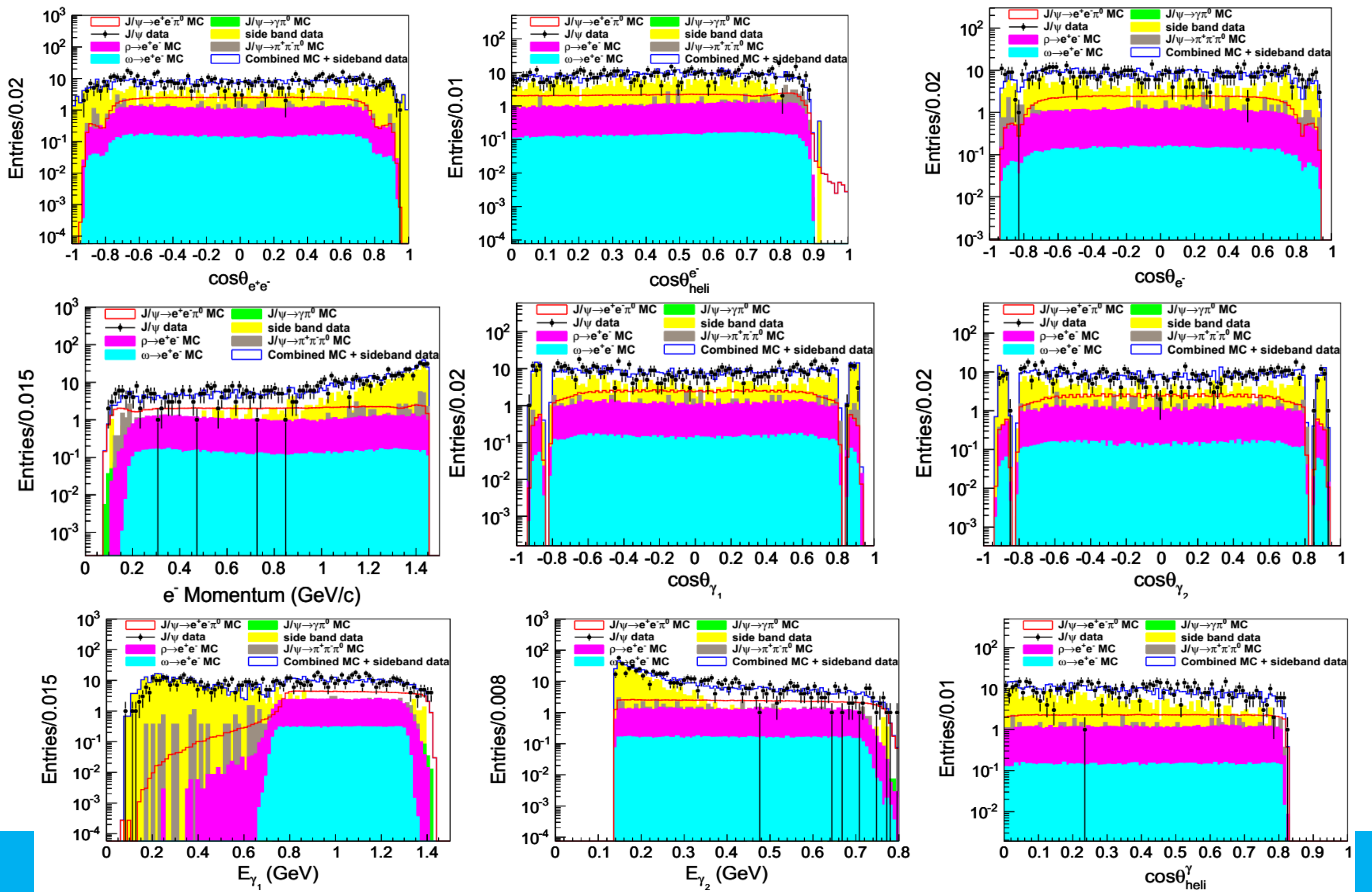
Decay channel	Generated	Survival	Expt Evt (PDG)	Norm. Evt
$J/\psi \to \gamma \pi^0$	25.0M	1352	45201.58 ± 241.43	2.45 ± 0.013
$J/\psi \to \pi^+ \pi^- \pi^0$	74.0M	218	$27328176.42 \pm 145961.57$	80.51 ± 0.430
$J/\psi \to \omega \pi^0,\ \omega \to \pi^+ \pi^-$	5.0M	39	9023.48 ± 48.20	0.072 ± 0.00
$J/\psi \to \omega \pi^0,\ \omega \to e^+ e^-$	0.12M	32978	42.43 ± 0.25	11.66 ± 0.07
$J/\psi \to \rho \pi^0,\ \rho \to e^+ e^-$	0.12M	33099	342.34 ± 1.83	94.43 ± 0.51
$J/\psi \to \omega \pi^0 \pi^0,\ \omega \to e^+ e^-$	0.12M	19	316.81 ± 1.69	0.05 ± 0.00

Di-electron invariant mass distribution: Data vs. MC



Need to generate the signal MC while including the resonant and non-resonant contribution in $J/\psi \rightarrow e^+e^-\pi^0$

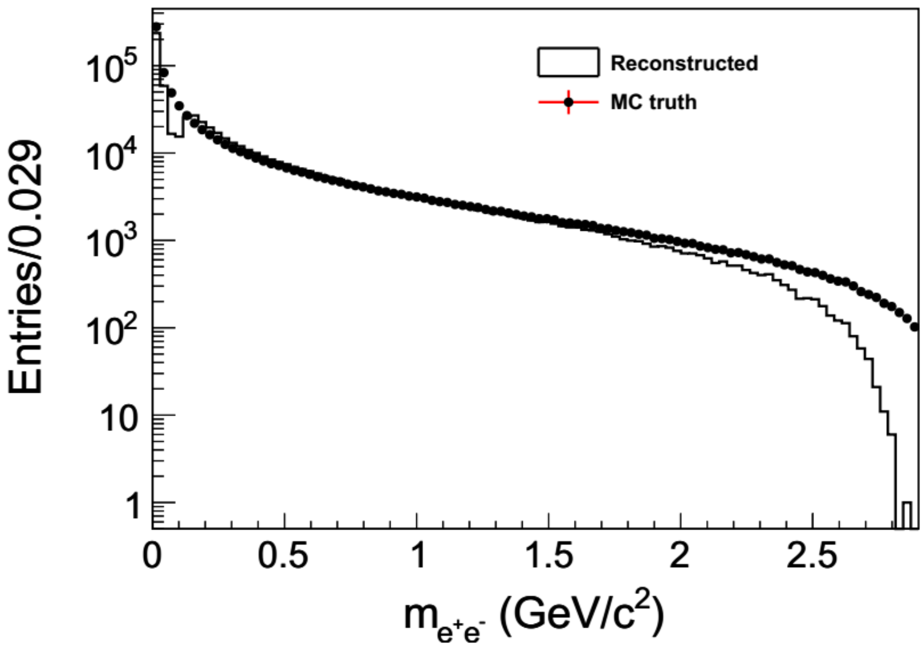
Data vs. MC

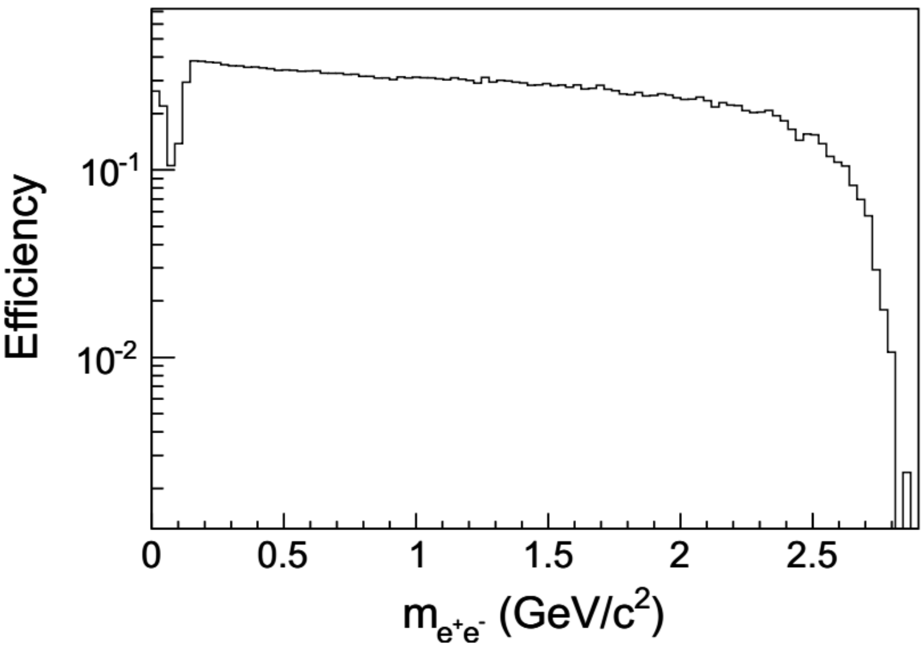


$J/\psi \to e^+e^-\pi^0$ MC
J/ψ data
$\rho \to e^+e^-$ MC
$\omega \to e^+e^-$ MC
$J/\psi \to \gamma\pi^0$ MC
side band data
$J/\psi \to \pi^+\pi^-\pi^0$ MC
Combined MC + sideband data
Entries/0.02
$\cos\theta_{e^+e^-}$
Entries/0.01
$\cos\theta^{e^-}_{heli}$
Entries/0.02
$\cos\theta_{e^-}$
Entries/0.015
e^- Momentum (GeV/c)
Entries/0.02
$\cos\theta_{\gamma_1}$
Entries/0.02
$\cos\theta_{\gamma_2}$
Entries/0.015
E_{γ_1} (GeV)
Entries/0.008
E_{γ_2} (GeV)
Entries/0.01
$\cos\theta^{\gamma}_{heli}$

Di-electron invariant mass dependent Signal efficiency

In order to study the $m_{e^+e^-}$ dependent TFF, we generate the signal MC using formula of Eq. *** with TFF = 1.

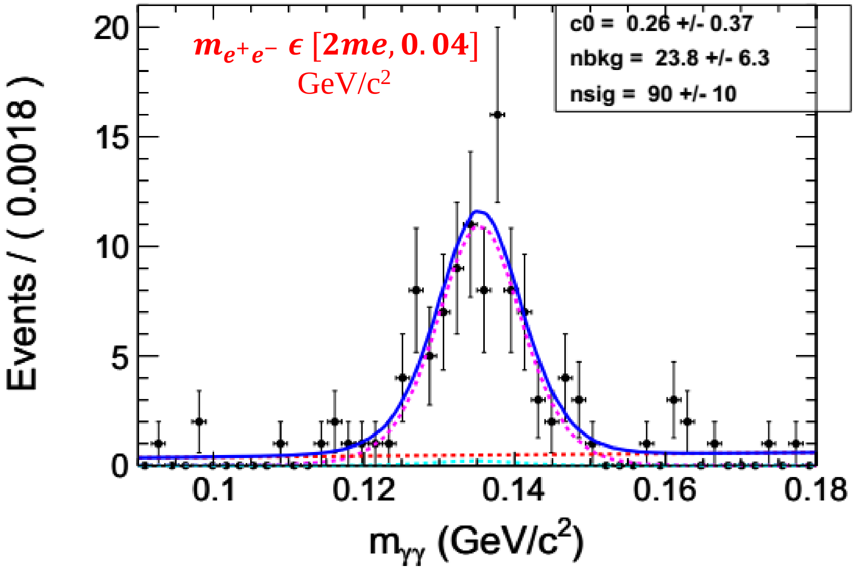


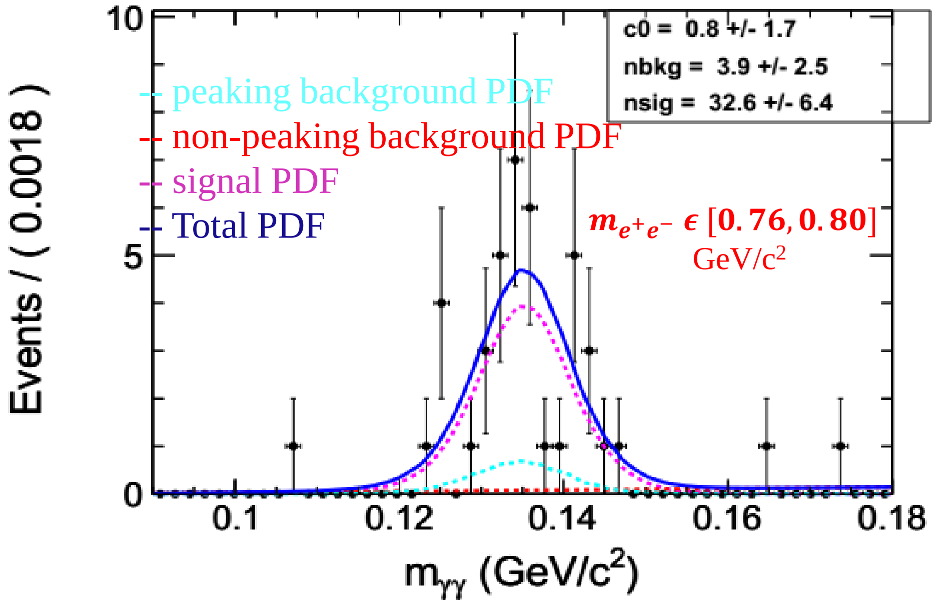


$$Efficiency = \frac{N_{sigMC}^{Reconstructed}}{N_{sigMC}^{MC-truth}}$$

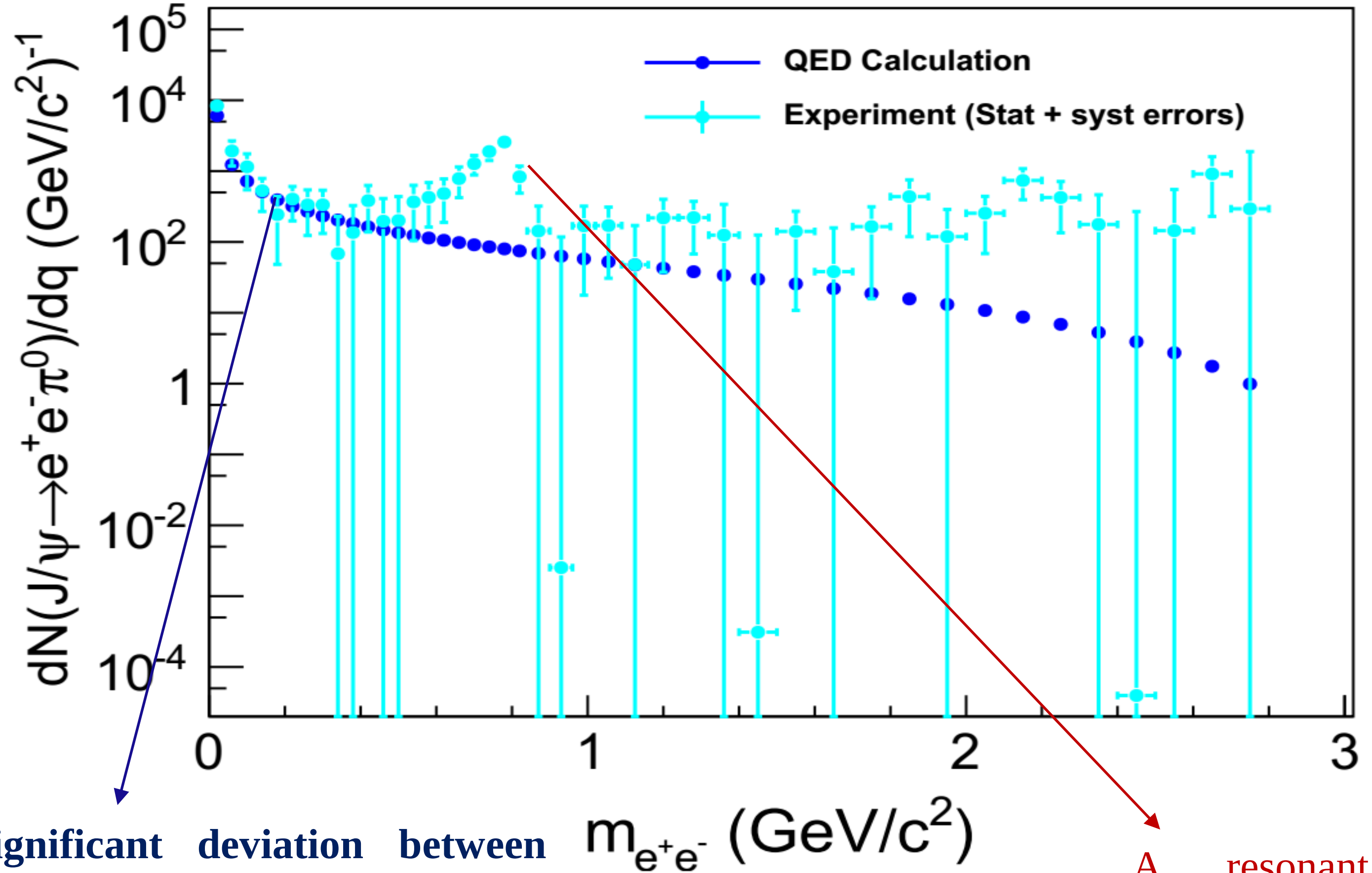
Maximum likelihood fit: Di-electron invariant mass dependent signal yield

- Perform the $m_{e^+e^-}$-dependent maximum likelihood fit to the $m_{\gamma\gamma}$ distribution.
- The signal PDF is described by the signal MC convoluted with a Gaussian function.
- Non-peaking background PDF is described by a 1st order Chebyshev polynomial function.
- Peaking background PDF is described by the histogram of the exclusive MC sample of the peaking background contribution.
- The peaking background is dominated by $J/\psi \to \gamma\pi^0$ in the low-mass region, and by $J/\psi \to \pi^+\pi^-\pi^0$ in the higher mass region.





Efficiency corrected signal yield



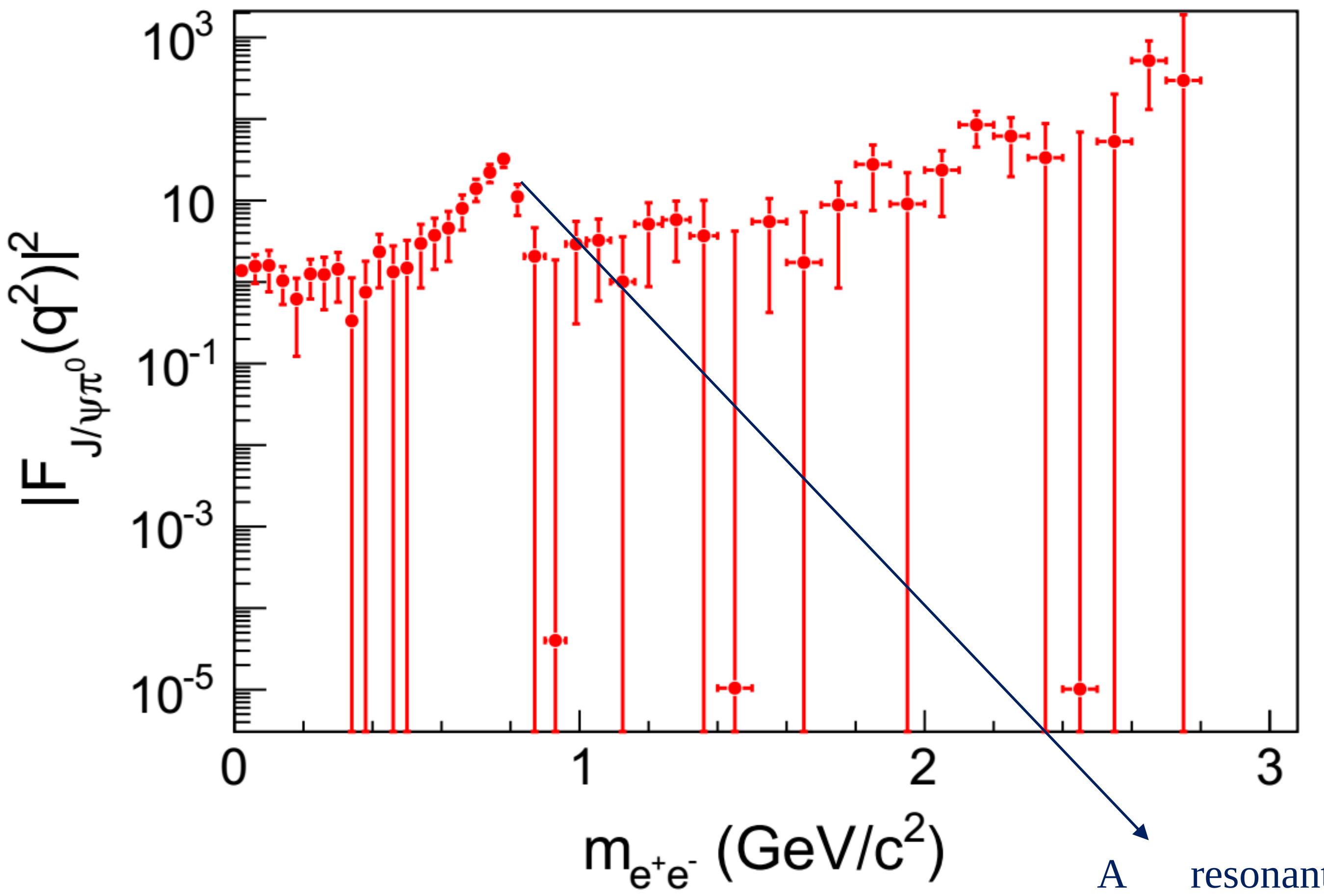
No any significant deviation between experimental and theoretical prediction is seen for $m_{e^+e^-} < 0.4$ GeV/c^2 as seen **by previous BESIII measurement** based on 2009 J/ψ data-set.

[Phys. Rev. D 89 092008 (2014)]

A resonant structure corresponding to ρ/ω mass position is seen.

TFF vs. m_{e+e-} data

TFF is the ratio of experimentally measured $m_{e^+e^-}$ dependent differential decay rate of $J/\psi \rightarrow e^+e^-\pi^0$ to its standard QED point-like prediction defined by the formula of Eq.*** mentioned in page 2.



A resonant structure corresponding to ρ/ω mass position is seen.

TFF vs. m_{e+e-} data

Fit to ρ/ω peak of the TFF curve

$$F_{J/\psi\pi^0}(q^2) = \frac{BW^{\rm GS}_{\rho}(q^2, m_\rho, \Gamma_\rho)\frac{1+c_\omega BW^{\rm KS}_{\omega}(q^2,m_\omega,\Gamma_\omega)}{1+c_\omega} + c_{\rho'} BW^{\rm GS}_{\rho'}(q^2, m_{\rho'}, \Gamma_{\rho'}) + c_{\rho''} BW^{\rm GS}_{\rho''}(q^2, m_{\rho''}, \Gamma_{\rho'''}) + ..}{1 + c_{\rho'} + c_{\rho''} + ..}, \quad (6)$$

where, the amplitudes of the Breit-Wigner (BW) functions are complex: $c_\omega = |c_\omega| e^{i\phi_\omega}$, $c_{\rho'} = |c_{\rho'}| e^{i\phi_{\rho'}}$ and $c_{\rho''} = |c_{\rho''}| e^{i\phi_{\rho''}}$. The BW of the ω is defined as:

$$BW^{\rm KS}_{\omega}(q^2, m, \Gamma) = \frac{m^2}{m^2 - q^2 - im\Gamma}. \quad (7)$$

The wide ρ, ρ' and ρ'' resonances are described by the Gounaris-Sakurai (GS) model [30], which takes into account the variation of their width with energy:

$$BW^{\rm GS}(q^2, m, \Gamma) = \frac{m^2(1 + d(m)\Gamma/m)}{m^2 - q^2 + f(q^2, m, \Gamma) - im\Gamma(q^2, m, \Gamma)}, \quad (8)$$

with

$$\Gamma(q^2, m, \Gamma) = \Gamma \frac{q^2}{m^2}\left(\frac{\beta_e(q^2)}{\beta_e(m^2)}\right)^3, \quad (9)$$

where $\beta_\pi(q^2) = \sqrt{1 - 4m_e^2/q^2}$.

The auxiliary functions used in the GS model are:

$$d(m) = \frac{3}{\pi}\frac{m_e^2}{k^2(m^2)} \ln\left(\frac{m + 2k(m^2)}{2m_e}\right) + \frac{m}{2\pi k(m^2)} - \frac{m_e^2 m}{\pi k^3(m^2)}, \quad (10)$$

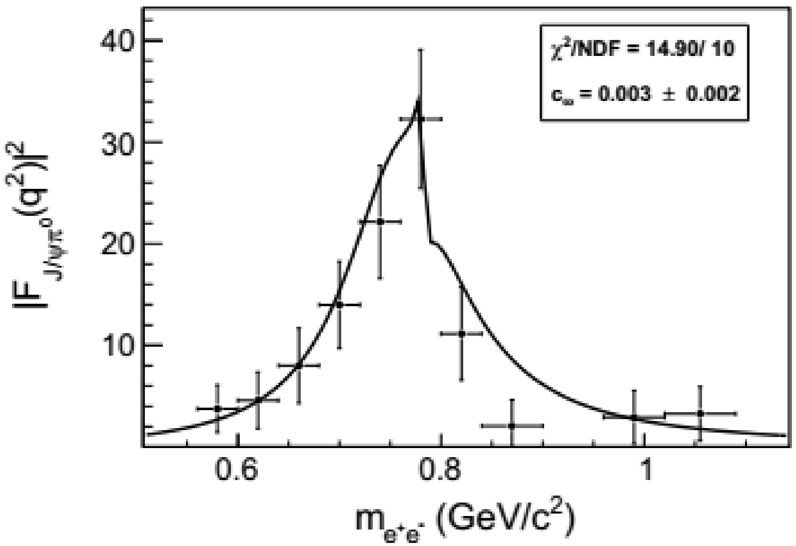
$$f(q^2, m, \Gamma) = \frac{\Gamma m^2}{k^3(m^2)}\left[k^2(q^2)(h(q^2) - h(m^2)) + (m^2 - q^2)k^2(m^2)h'(m^2)\right], \quad (11)$$

where

$$k(q^2) = \frac{1}{2}\sqrt{q^2}\beta_\pi(q^2), \quad (12)$$

$$h(q^2) = \frac{2}{\pi}\frac{k(q^2)}{\sqrt{q^2}} \ln\left(\frac{\sqrt{q^2} + 2k(q^2)}{2m_e}\right). \quad (13)$$

and $h'(q^2)$ is the derivative of $h(q^2)$.



Ignore the excited states of the ρ resonances (such as ρ´, ρ´´ etc.) from the fit.

Mass and widths of ρ and ω resonances are fixed to their PDG values.

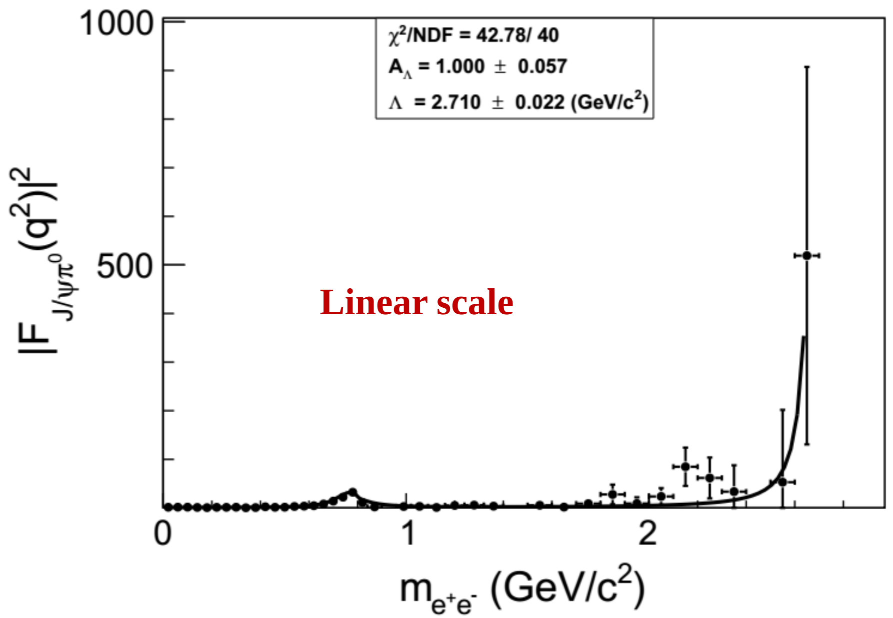
The value of the phase ϕ_ω of the $\rho - \omega$ interference is fixed to be 0.182 rad [Phys. Lett. B **648**, 28 (2007)]

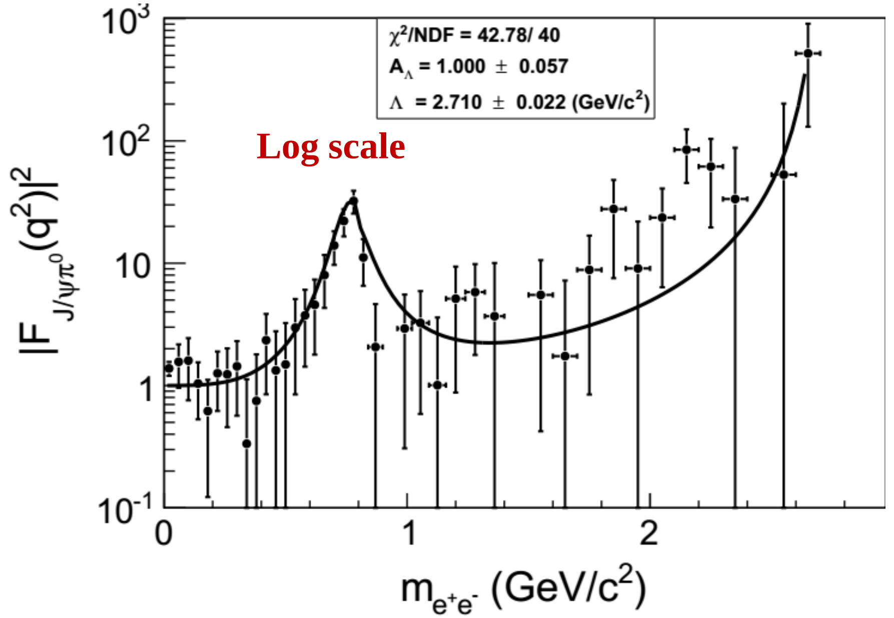
Measured c_ω value is consistent with the Benedikt results with the statistical uncertainty. [Phys. Lett. B **753**, 629 (2016)]

TFF vs. $m_{e^+e^-}$ data

We then perform the fit to TFF vs. $m_{e^+e^-}$ data in the full $m_{e^+e^-}$ range using the following formula:

$$|F_{J/\psi\pi^0}(q^2)|^2 = |BW_\rho^{GS}(q^2, m_\rho, \Gamma_\rho)\frac{1 + c_\omega BW_\omega^{KS}(q^2, m_\omega, \Gamma_\omega)}{1 + c_\omega}|^2 + A_\Lambda|\frac{1}{1 - q^2/\Lambda^2}|^2 \qquad ****$$

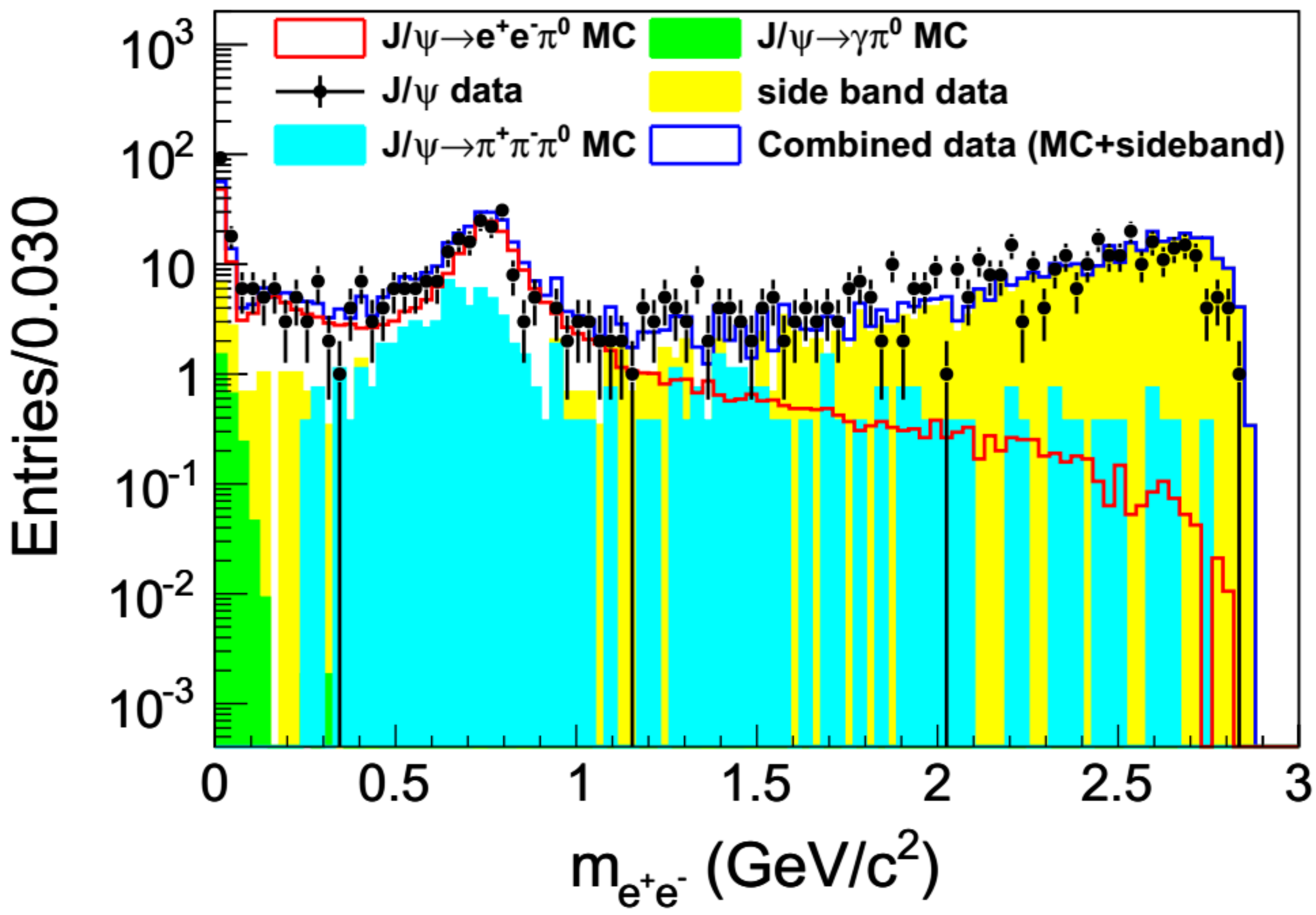




The Λ value is observed to be $\Lambda = 0.271 \pm 0.022$ GeV/c^2, which seems not to be correct due to its value is lower than $m_{J/\psi} - m_{\pi^0}$ threshold, that might be due to the contributions of massive ρ resonances in the high mass region.

Generate the signal MC for $J/\psi \to e^+e^-\pi^0$ using the TFF function of Eq. **** with Λ = 3.686 GeV/c^2.

Data vs. MC: di-electron invariant mass spectrum



- Systematic uncertainty due to the TFF is evaluated while generating the signal MCs with Λ=3.10, 3.686 and 4.0 GeV/c^2.

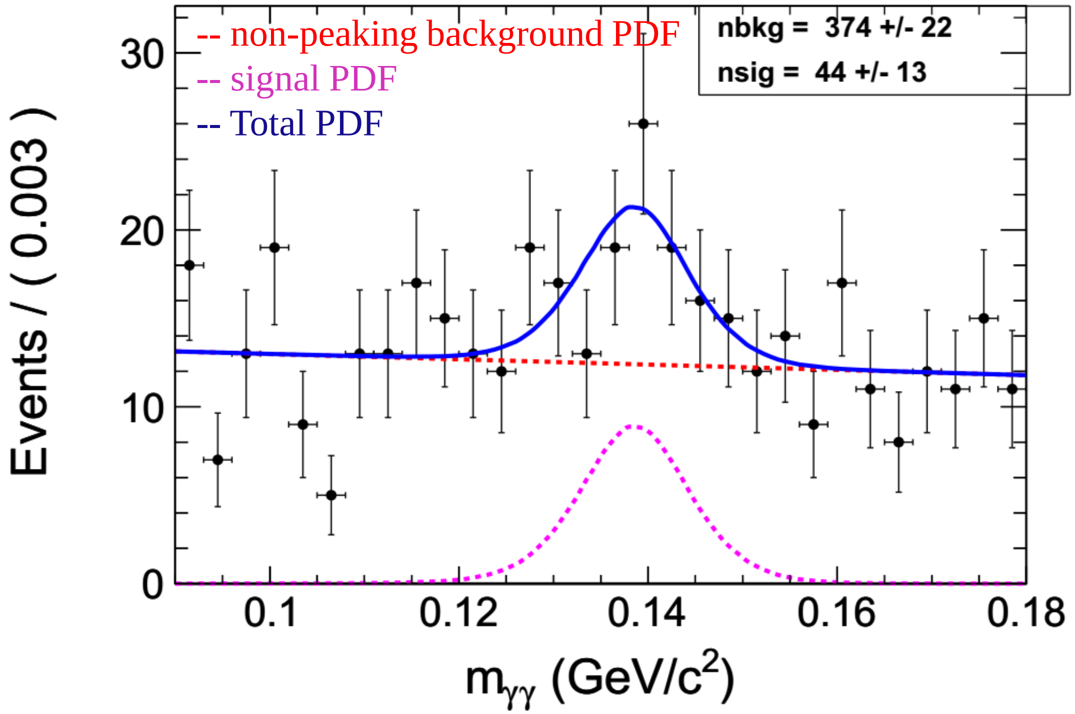
Background study: Two photon process of $e^+e^-\to e^+e^-\pi^0$@ J/ψ

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

830.8 ± 0.8 pb @ 3.773 GeV

729.4±0.9 pb @ 3.0969 GeV

Many thanks to Dr. Christoph Redmer for providing these numbers.

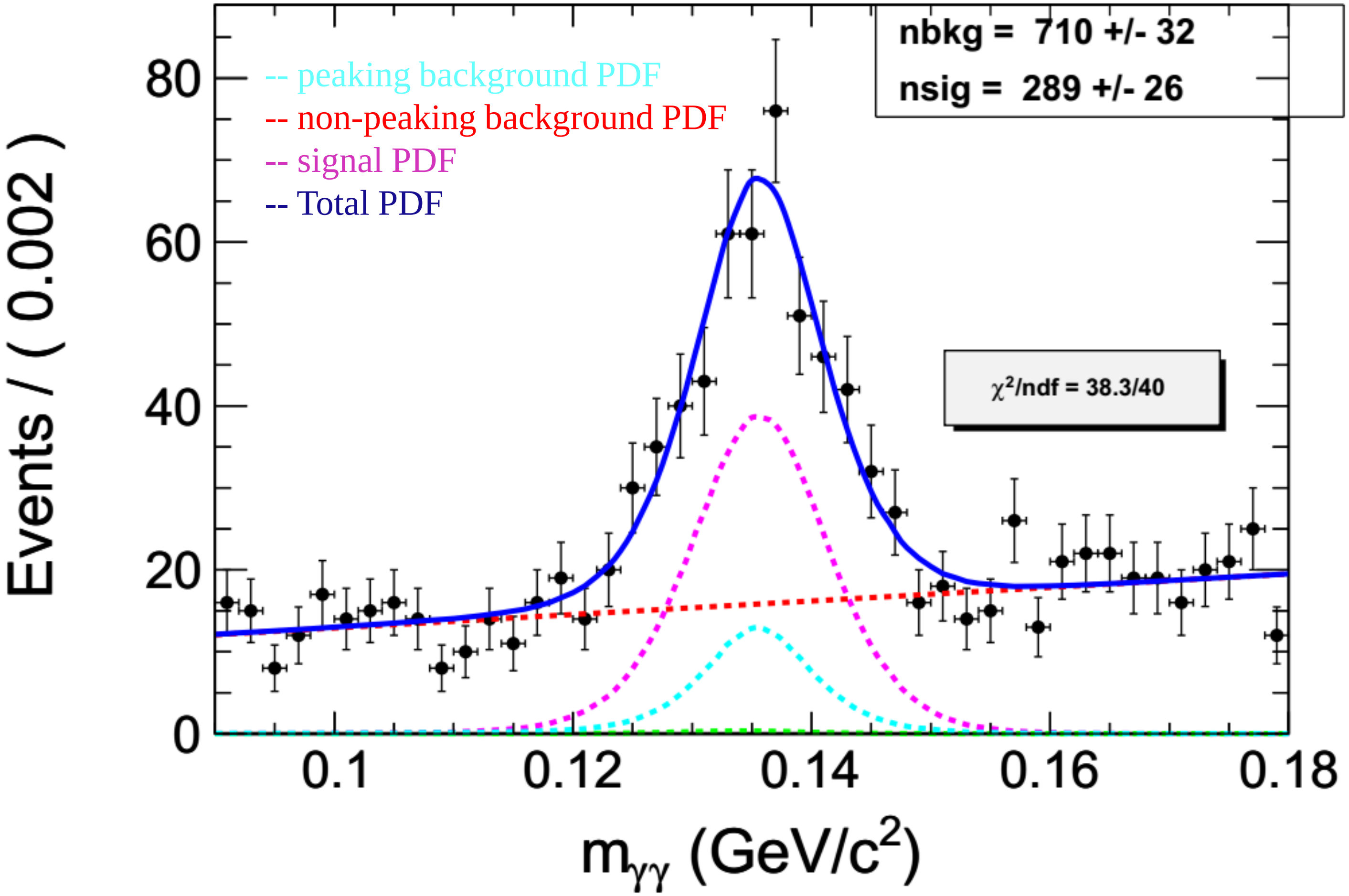


$$\frac{d\sigma^{(0)}}{ds\,d\Gamma} = 2\left(\frac{\alpha}{\pi}\right)^2 \frac{1}{s}\ln^2\frac{E}{m_e} f\left(\frac{\sqrt{s}}{2E}\right)\frac{d\sigma_{\gamma\gamma\to X(s)}}{d\Gamma},$$
$$f(\gamma) = -(2+\gamma^2)^2\ln\gamma - (1-\gamma^2)(3+\gamma^2),$$

$$f = \frac{N_{J/\psi}}{N_{\psi(3770)}} = \frac{L_{J/\psi}}{L_{\psi(3770)}} \cdot \frac{\sigma^{J/\psi}_{(e^+e^-\to e^+e^-\pi^0)}}{\sigma^{\psi(3770)}_{(e^+e^-\to e^+e^-\pi^0)}} \approx 0.14$$

- The normalized two photon $e^+e^-\to e^+e^-\pi^0$ peaking background contribution in J/ψ data is: **(44 ±13)×0.14=6.16±1.82 events**

Projection plot (in the full di-electron invariant mass spectrum region)



N_{sig} (after subtracting the background from the two photon process) = **282.64 ± 26.22** events

Systematic uncertainty

Source	Uncertainty (for EM Dalitz decay)	uncertainty (for TFF)
Additive systematic uncertainties (events)		
Fixed PDFs	2.38	0 – 4.7
Fit Bias	1.78	1.78
Background modelling	15.00	...
Total	15.29	1.78 – 5.03
Multiplicative systematic uncertainties (%)		
$\mathrm{Cos}\theta_{\gamma}^{hel}$	1.81	1.81
Charged tracks	2.40	2.40
Photon detection efficiency	2.00	2.00
χ^2_{4C}	0.96	0.96
e^- PID	1.20	1.20
J/ψ counting	0.50	0.50
π^0 reconstruction	1.00	1.00
Form factor	2.06	...
Veto of gamma conversion	1.00	1.00
$P_{e^\pm}$ and E_{γ_2}	3.88	3.88
Total	6.08	5.72

Most of the systematic numbers are taken from BAM-0266 (recently released for the CWR).

Branching fraction

$$\mathcal{B}(J/\psi \to e^+e^-\pi^0) = \frac{N_{sig}}{eff \cdot \mathcal{B}(\pi^0 \to \gamma\gamma) \cdot N_{J/\psi}}$$

Where,

$eff = 28.86\%$

$B(\pi \to \gamma\gamma) = 0.98823$

$NJ/\psi = 1310.6 \times 10^6$

$N_{sig} = 282.64 \pm 26.22$ events

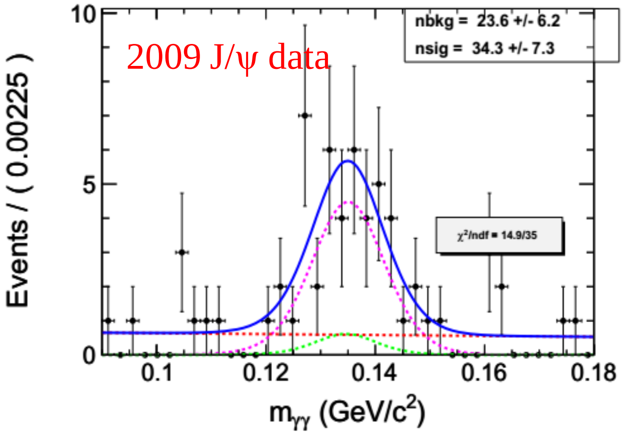
$B(J/\psi \to e^+e^-\pi^0) = (7.56 \pm 0.70(stat) \pm 0.62(syst)) \times 10^{-7}$

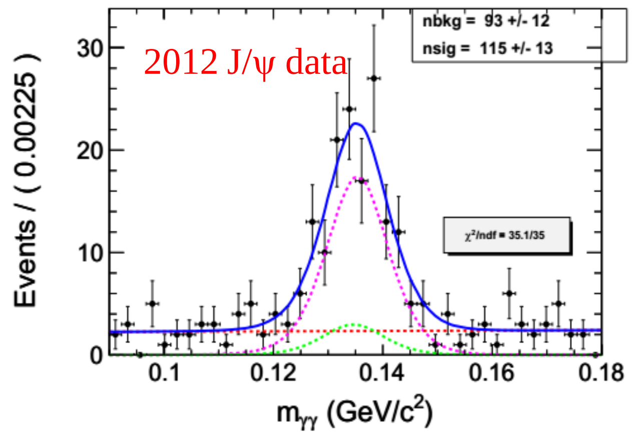
The accuracy of the measured branching fraction is improved by a factor of 2 over the previous BESIII measurement.

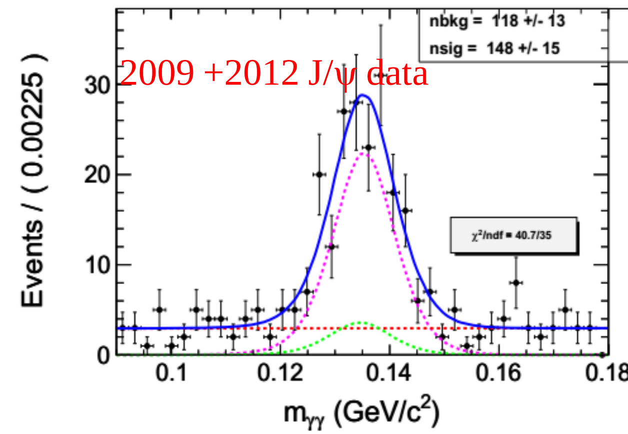
[Phys. Rev. D 89 092008 (2014)]

The branching fraction of $J/\psi \to e^+e^-\pi^0$ for $m_{e^+e^-} < 0.4\ \mathrm{GeV}/c^2$

- Generate 2000 Signal MC events in the same way as produced by previous BESIII measurement.







data-set	N^{back}_{peak}	$N^{back}_{non-peak}$	N_{sig}	significance	efficiency	BR (10^{-7})
2009 J/ψ	4.07 ± 0.02	23.64 ± 6.21	34.31 ± 7.30	6.98	0.256 ± 0.003	6.03 ± 1.28
2012 J/ψ	19.64 ± 0.09	93.44 ± 11.80	114.97 ± 13.40	13.76	0.256 ± 0.003	4.18 ± 0.49
combined	23.71 ± 0.09	118.24 ± 13.3	148.0 ± 15.22	15.4	0.256 ± 0.003	4.46 ± 0.46
BESII old [15]	1.1 ± 0.1	20.4 ± 5.3	39.4 ± 6.9	—	0.234	7.56 ± 1.32

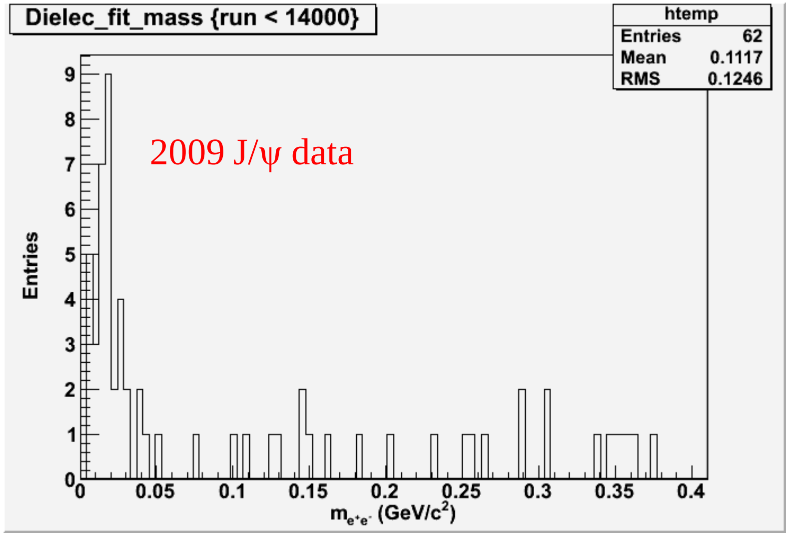
The peaking background is dominated by $J/\psi \to \pi^+\pi^-\pi^0$ decay.

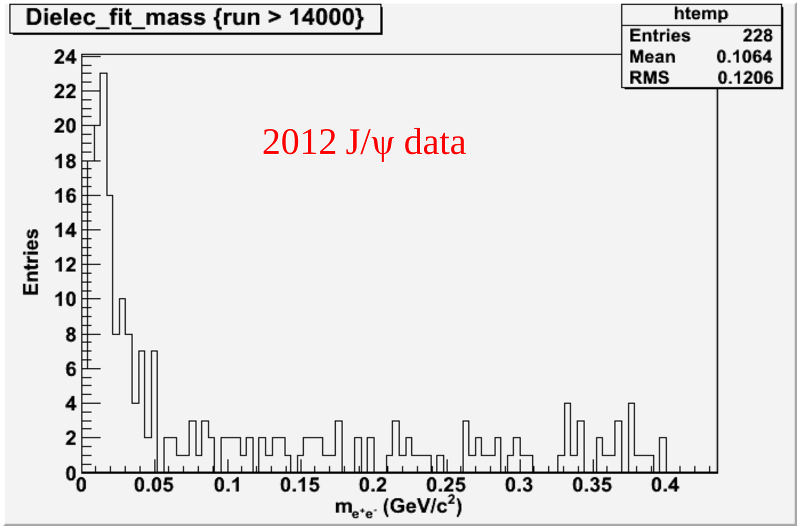
This peaking background in previous BESIII measurement seems to be not properly evaluated due to generating the MC sample of $J/\psi \to \pi^+\pi^-\pi^0$ using the helicity amplitude model only.

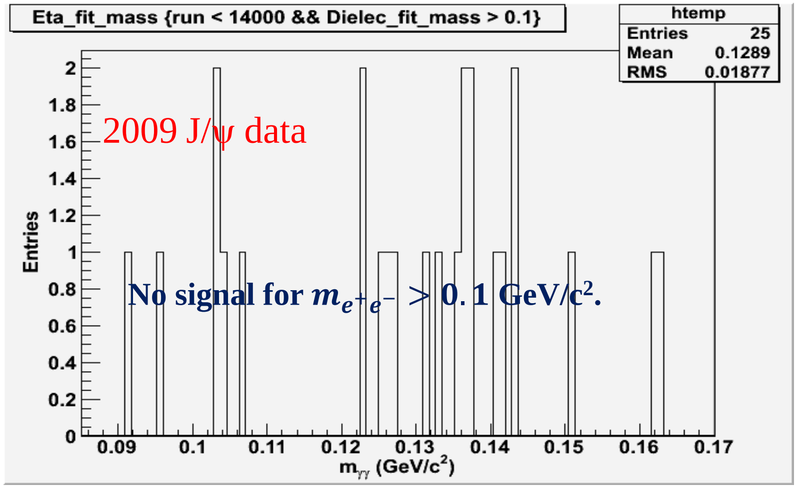
[Phys. Rev. D 89 092008 (2014)]

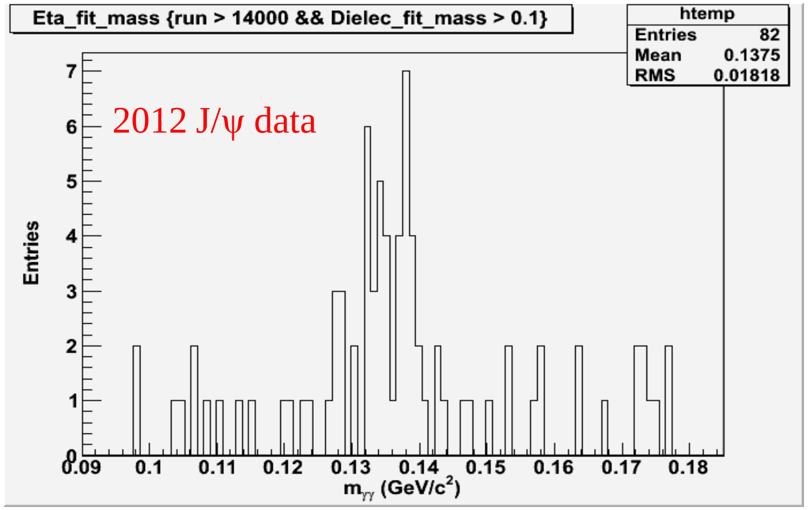
The branching fraction of $J/\psi \to e^+e^-\pi^0$ for $m_{e^+e^-} < 0.4$ GeV/c^2

2009 vs. 2012 J/ψ data









Summary and conclusion

- We perform the study of the electromagnetic Dalitz decay of $J/\psi \to e^+e^-\pi^0$ using 1.31 billion J/ψ events collected by the BESIII experiment.

- The di-electron dependent TFF curve is studied for the first time.

- **No any significant deviation between experimental and theoretical prediction** is seen for $m_{e^+e^-} < 0.4$ GeV/c^2 as **seen by previous BESIII measurement** based on 2009 J/ψ data-set. **[Phys. Rev. D 89 092008 (2014)]**

- The branching fraction of $J/\psi \to e^+e^-\pi^0$ in $m_{e^+e^-}$ range is measured to be **$B(J/\psi \to e^+e^-\pi^0) = (7.56 \pm 0.70(stat) \pm 0.62(syst)) \times 10^{-7}$,** which precision is improved by **a factor of 2** over the **previous BESIII measurement**.

- Future BESIII J/ψ data will be utilized to measure the branching fraction and TFF of $J/\psi \to e^+e^-\pi^0$ precisely.

- Memo is ready for a review.

BESIII

Memo version 1.0

BESIII Analysis Memo

BAM-XXX

November 15, 2017

Study of the electromagnetic Dalitz decay of $J/\psi \rightarrow e^+e^-\pi^0$

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Internal Referee Committee

XX (Chair)[e], XX[f], and XX[g]

[e]*XX*
[f]*XX*
[g]*XX*

HN : http://hnbes3.ihep.ac.cn/HyperNews/get/paperXXX.html

Abstract

We study the electromagnetic Dalitz decay of $J/\psi \rightarrow e^+e^-\pi^0$ using a data sample of $(1310.6 \pm 7.0) \times 10^6$ J/ψ events collected by the BESIII detector. The transition form factor of this decay process is studied as a function of di-electron mass spectrum. A significant peaking structure corresponding to the ρ/ω mass position is observed. While taking into account of the contribution of this resonant structure, the branching fraction $\mathcal{B}(J/\psi \rightarrow e^+e^-\pi^0)$ is observed to be $\mathcal{B}(J/\psi \rightarrow e^+e^-\pi^0) = (7.56 \pm 0.70(stat) \pm 0.62(syst)) \times 10^{-7}$, where the first uncertainty is the statistical and the second the systematic uncertainty. The precision of this new measurement is improved by a factor of two over the previous BESIII measurement.

Thanks!

Back slide

Decay file of $J/\psi \rightarrow e^+e^-\pi^0$

```
*************************************************
        Decay Options:
Decay J/psi
0.18358    pi+ pi- pi0      OMEGA_DALITZ;
0.27214    rho0 pi0        HELAMP 1.0 0.0 0.0 0.0 -1.0 0.0;
0.27214    rho+ pi-        HELAMP 1.0 0.0 0.0 0.0 -1.0 0.0;
0.27214    rho- pi+        HELAMP 1.0 0.0 0.0 0.0 -1.0 0.0;
Enddecay
Decay rho0
 1.000    pi+ pi-                  VSS;
Enddecay
Decay rho+
 1.000    pi+ pi0                  VSS;
Enddecay
Decay rho-
 1.000    pi- pi0                  VSS;
Enddecay
Decay pi0
 1.000    gamma gamma                   PHSP;
Enddecay
End

*************************************************
```