NODE=M222

$\psi(4230)$

$I^G(J^{PC}) = 0^-(1^{--})$

also known as $Y(4230)$; was $X(4230)$

The recent measurement of $e^+e^- \to J/\psi\pi\pi$ (ABLIKIM 17B) led to a downward shift in the mass of the $\psi(4260)$, also known as Y(4260), such that a distinction between the $\psi(4260)$ and $\psi(4230)$ no longer appears justified. Therefore, starting from this edition, we include the data of ABLIKIM 17B in this node and have listed the $\psi(4230)$ in the summary tables instead of the $\psi(4260)$. NODE=M222

$\psi(4230)$ MASS

NODE=M222M

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
4220 ±15 OUR ESTIMATE					→ UNCHECKED ←
4219.1± 1.7 OUR AVERAGE		Error includes scale factor of 1.1.			
4216.7± 8.9±4.1		[1] ABLIKIM	20AG	BES3	$e^+e^- \to \mu^+\mu^-$
4220.4± 2.4±2.3		[2] ABLIKIM	20N	BES3	$e^+e^- \to \pi^0\pi^0 J/\psi$
4218.6± 3.8±2.5		[2] ABLIKIM	20O	BES3	$e^+e^- \to \eta J/\psi$
4218.5± 1.6±4.0		[3] ABLIKIM	19AI	BES3	$e^+e^- \to \omega\chi_{c0}$
4228.6± 4.1±6.3		ABLIKIM	19R	BES3	$e^+e^- \to \pi^+ D^0 D^{*-}$ + c.c.
$4200.6^{+\ 7.9}_{-13.3}$±3.0		[4] ABLIKIM	19V	BES3	$e^+e^- \to \gamma\chi_{c1}(3872)$
4222.0± 3.1±1.4		[5] ABLIKIM	17B	BES3	$e^+e^- \to \pi^+\pi^- J/\psi$
$4218\ ^{+\ 5.5}_{-\ 4.5}$±0.9		ABLIKIM	17G	BES3	$e^+e^- \to \pi^+\pi^- h_c$
4209.5± 7.4±1.4		[6] ABLIKIM	17V	BES3	$e^+e^- \to \pi^+\pi^-\psi(2S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
4231.9± 5.3±4.9		ABLIKIM	20N	BES3	$e^+e^- \to \pi^0 Z_c(3900)^0$, $Z_c^0 \to \pi^0 J/\psi$ OCCUR=2
4230 ± 8 ±6	180	[7] ABLIKIM	15C	BES3	$e^+e^- \to \omega\chi_{c0}$

[1] Solution 1 of 8 with equal fit quality to the $e^+e^- \to \mu^+\mu^-$ cross section between 3.8 and 4.6 GeV to the coherent sum of four resonant amplitudes. Other solutions range from 4212.8 ± 7.2 ± 4.0 to 4219.4 ± 11.2 ± 4.1 MeV. NODE=M222M;LINKAGE=HP

[2] From a fit of the measured cross section in the range $\sqrt{s}$ = 3.808–4.600 GeV. NODE=M222M;LINKAGE=GP

[3] From a fit of the measured cross section from $\sqrt{s}$ = 4.178–4.278 GeV. Supersedes ABLIKIM 15C. NODE=M222M;LINKAGE=CP

[4] Simultaneous fit to $\chi_{c1} \to \omega J/\psi$ and $\chi_{c1} \to \pi^+\pi^- J/\psi$. NODE=M222M;LINKAGE=FP

[5] From a three-resonance fit. NODE=M222M;LINKAGE=EP

[6] From a fit to the cross section for $e^+e^- \to \pi^+\pi^-\psi(2S) \to 2(\pi^+\pi^-)\ell^+\ell^-$ obtained from 16 center-of-mass energies between 4.008 and 4.600 GeV and comprising 5.1 fb^{-1}. NODE=M222M;LINKAGE=BP

[7] From a 3-parameter fit of measured cross sections from $\sqrt{s}$ = 4.21–4.42 GeV to a phase-space modified Breit-Wigner function, using the decays $\chi_{c0} \to \pi^+\pi^-$, $\chi_{c0} \to K^+K^-$, and $\omega \to \pi^+\pi^-\pi^0$. NODE=M222M;LINKAGE=AP

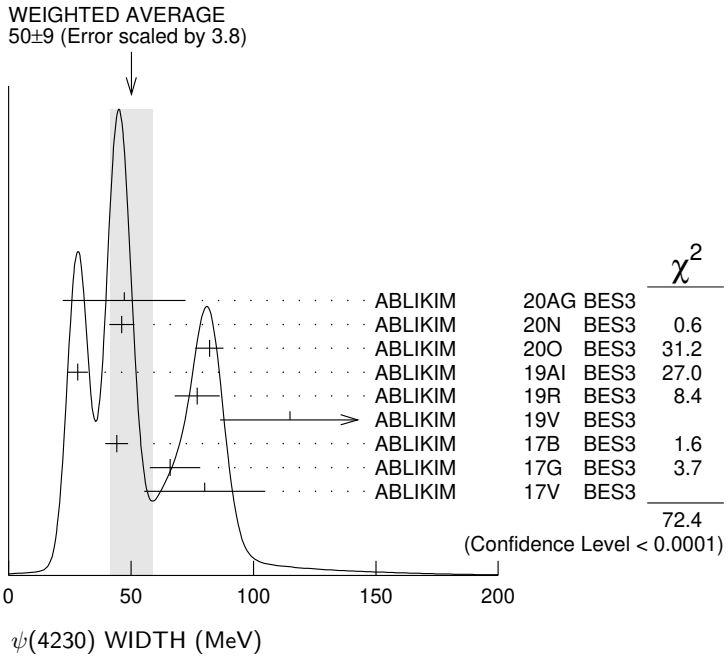
$\psi(4230)$ WIDTH

NODE=M222W

VALUE (MeV)	EVTS	DOCUMENT ID		TECN	COMMENT
20 to 100 OUR ESTIMATE					→ UNCHECKED ←
50 ± 9 OUR AVERAGE		Error includes scale factor of 3.8. See the ideogram below.			
47.2±22.8±10.5		[1] ABLIKIM	20AG	BES3	$e^+e^- \to \mu^+\mu^-$
46.2± 4.7± 2.1		[2] ABLIKIM	20N	BES3	$e^+e^- \to \pi^0\pi^0 J/\psi$
82.0± 5.7± 0.4		[2] ABLIKIM	20O	BES3	$e^+e^- \to \eta J/\psi$
28.2± 3.9± 1.6		[3] ABLIKIM	19AI	BES3	$e^+e^- \to \omega\chi_{c0}$
77.0± 6.8± 6.3		ABLIKIM	19R	BES3	$e^+e^- \to \pi^+ D^0 D^{*-}$ + c.c.
$115\ ^{+38}_{-26}$ ±12		[4] ABLIKIM	19V	BES3	$e^+e^- \to \gamma\chi_{c1}(3872)$
44.1± 4.3± 2.0		[5] ABLIKIM	17B	BES3	$e^+e^- \to \pi^+\pi^- J/\psi$
$66.0^{+12.3}_{-\ 8.3}$± 0.4		ABLIKIM	17G	BES3	$e^+e^- \to \pi^+\pi^- h_c$
80.1±24.6± 2.9		[6] ABLIKIM	17V	BES3	$e^+e^- \to \pi^+\pi^-\psi(2S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
41.2±16.0±16.4		ABLIKIM	20N	BES3	$e^+e^- \to \pi^0 Z_c(3900)^0$, $Z_c^0 \to \pi^0 J/\psi$ OCCUR=2
38 ±12 ± 2	180	[7] ABLIKIM	15C	BES3	$e^+e^- \to \omega\chi_{c0}$

[1] Solution 1 of 8 with equal fit quality to the $e^+e^- \to \mu^+\mu^-$ cross section between 3.8 and 4.6 GeV to the coherent sum of four resonant amplitudes. Other solutions range from 36.4 ± 16.8 ± 8.1 to 49.6 ± 22.6 ± 11.0 MeV.
[2] From a fit of the measured cross section in the range $\sqrt{s}$ = 3.808–4.600 GeV.
[3] From a fit of the measured cross section from $\sqrt{s}$ = 4.178–4.278 GeV. Supersedes ABLIKIM 15C.
[4] Simultaneous fit to $\chi_{c1} \to \omega J/\psi$ and $\chi_{c1} \to \pi^+\pi^- J/\psi$.
[5] From a three-resonance fit.
[6] From a fit to the cross section for $e^+e^- \to \pi^+\pi^-\psi(2S) \to 2(\pi^+\pi^-)\ell^+\ell^-$ obtained from 16 center-of-mass energies between 4.008 and 4.600 GeV and comprising 5.1 fb^{-1}.
[7] From a 3-parameter fit of measured cross sections from $\sqrt{s}$ = 4.21–4.42 GeV to a phase-space modified Breit-Wigner function, using the decays $\chi_{c0} \to \pi^+\pi^-$, $\chi_{c0} \to K^+K^-$, and $\omega \to \pi^+\pi^-\pi^0$.

NODE=M222W;LINKAGE=GP
NODE=M222W;LINKAGE=FP
NODE=M222W;LINKAGE=CP
NODE=M222W;LINKAGE=EP
NODE=M222W;LINKAGE=DP
NODE=M222W;LINKAGE=BP
NODE=M222W;LINKAGE=AP



ψ(4230) DECAY MODES

NODE=M222215;NODE=M222

	Mode	Fraction (Γ_i/Γ)	
Γ_1	e^+e^-		DESIG=1
Γ_2	$\mu^+\mu^-$		DESIG=15
Γ_3	$\omega\chi_{c0}$	seen	DESIG=2
Γ_4	$\pi^+\pi^- h_c$	seen	DESIG=3
Γ_5	$\pi^0\pi^0 J/\psi$	seen	DESIG=9
Γ_6	$\pi^+\pi^- J/\psi$	seen	DESIG=7
Γ_7	$\eta J/\psi$	seen	DESIG=10
Γ_8	$\pi^+\pi^-\psi(2S)$	seen	DESIG=4
Γ_9	$\pi^+ D^0 D^{*-}$ + c.c.	seen	DESIG=5
Γ_{10}	$\Xi^-\overline{\Xi}^+$		DESIG=6
Γ_{11}	$\gamma\chi_{c1}(3872)$	seen	DESIG=8
Γ_{12}	$\pi^+\pi^-\pi^0\eta_c$	seen	DESIG=11
Γ_{13}	$\pi^+\pi^-\eta_c$	not seen	DESIG=13
Γ_{14}	$\gamma\pi^0\eta_c$	not seen	DESIG=14
Γ_{15}	$p\overline{p}p\overline{p}$	not seen	DESIG=12

ψ(4230) PARTIAL WIDTHS

NODE=M222235

Γ(μ⁺μ⁻) Γ₂

NODE=M222W2
NODE=M222W2

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
1.53±1.26±0.54	[1,2] ABLIKIM	20AG	BES3	$e^+e^- \to \mu^+\mu^-$

[1] From a fit to the $e^+e^- \to \mu^+\mu^-$ cross section between 3.8 and 4.6 GeV to the coherent sum of four resonant amplitudes assuming $\Gamma(\mu^+\mu^-) = \Gamma(e^+e^-)$.
[2] From solution 1 of 8 with equal fit quality. Other solutions range from 1.09 ± 0.84 ± 0.39 to 1.53 ± 1.26 ± 0.54 keV.

NODE=M222W2;LINKAGE=A
NODE=M222W2;LINKAGE=B

$\psi(4230)$ $\Gamma(i)\Gamma(e^+e^-)/\Gamma(total)$

NODE=M222220

$\Gamma(\omega\chi_{c0}) \times \Gamma(e^+e^-)/\Gamma_{total}$ — $\Gamma_3\Gamma_1/\Gamma$

NODE=M222G01
NODE=M222G01

VALUE (eV)	EVTS	DOCUMENT ID		TECN	COMMENT
2.5±0.2±0.3		[1] ABLIKIM	19AI	BES3	$e^+e^- \to \omega\chi_{c0}$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
2.7±0.5±0.4	180	[2] ABLIKIM	15C	BES3	$e^+e^- \to \omega\chi_{c0}$

[1] From a fit of the measured cross section from $\sqrt{s}$ = 4.178–4.278 GeV. Supersedes ABLIKIM 15C.
NODE=M222G01;LINKAGE=B

[2] From a 3-parameter fit of measured cross sections from $\sqrt{s}$ = 4.21–4.42 GeV to a phase-space modified Breit-Wigner function, using the decays $\chi_{c0} \to \pi^+\pi^-$, $\chi_{c0} \to K^+K^-$, and $\omega \to \pi^+\pi^-\pi^0$.
NODE=M222G01;LINKAGE=A

$\Gamma(\eta J/\psi) \times \Gamma(e^+e^-)/\Gamma_{total}$ — $\Gamma_7\Gamma_1/\Gamma$

NODE=M222R10
NODE=M222R10

VALUE (eV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
8.0±1.7	[1] ABLIKIM	20O	BES3	$e^+e^- \to \eta J/\psi$
4.8±1.0	[2] ABLIKIM	20O	BES3	$e^+e^- \to \eta J/\psi$ OCCUR=2
7.0±1.5	[3] ABLIKIM	20O	BES3	$e^+e^- \to \eta J/\psi$ OCCUR=3

[1] Solution 1 of three equivalent fit solutions using three resonant structures.
NODE=M222R10;LINKAGE=A

[2] Solution 2 of three equivalent fit solutions using three resonant structures.
NODE=M222R10;LINKAGE=B

[3] Solution 3 of three equivalent fit solutions using three resonant structures.
NODE=M222R10;LINKAGE=C

$\Gamma(\pi^+\pi^-\psi(2S)) \times \Gamma(e^+e^-)/\Gamma_{total}$ — $\Gamma_8\Gamma_1/\Gamma$

NODE=M222R03
NODE=M222R03

VALUE (eV)	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.6±1.3	[1] ABLIKIM	19K	BES3	$e^+e^- \to \pi^+\pi^-\psi(2S)$
1.8±1.4	[2] ABLIKIM	19K	BES3	$e^+e^- \to \pi^+\pi^-\psi(2S)$ OCCUR=2

[1] Solution I of two equivalent solutions in a fit using two interfering resonances.
NODE=M222R03;LINKAGE=AA

[2] Solution II of two equivalent solutions in a fit using two interfering resonances.
NODE=M222R03;LINKAGE=BB

$\Gamma(\Xi^-\overline{\Xi}^+) \times \Gamma(e^+e^-)/\Gamma_{total}$ — $\Gamma_{10}\Gamma_1/\Gamma$

NODE=M222R05
NODE=M222R05

VALUE (eV)	CL%	DOCUMENT ID	TECN	COMMENT
$<3.3 \times 10^{-4}$	90	ABLIKIM	20C	BES3 $e^+e^- \to \Xi^-\overline{\Xi}^+$

$\psi(4230)$ BRANCHING RATIOS

NODE=M222225

$\Gamma(\omega\chi_{c0})/\Gamma_{total}$ — Γ_3/Γ

NODE=M222R01
NODE=M222R01

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
seen	180	[1] ABLIKIM	15C	BES3	$e^+e^- \to \omega\chi_{c0}$

[1] From a 3-parameter fit of measured cross sections from $\sqrt{s}$ = 4.21–4.42 GeV to a phase-space modified Breit-Wigner function, using the decays $\chi_{c0} \to \pi^+\pi^-$, $\chi_{c0} \to K^+K^-$, and $\omega \to \pi^+\pi^-\pi^0$.
NODE=M222R01;LINKAGE=A

$\Gamma(\pi^+\pi^- h_c)/\Gamma_{total}$ — Γ_4/Γ

NODE=M222R00
NODE=M222R00

VALUE	DOCUMENT ID		TECN	COMMENT
seen	ABLIKIM	17G	BES3	$e^+e^- \to \pi^+\pi^- h_c$

$\Gamma(\pi^0\pi^0 J/\psi)/\Gamma_{total}$ — Γ_5/Γ

NODE=M222R08
NODE=M222R08

VALUE	DOCUMENT ID		TECN	COMMENT
seen	[1] ABLIKIM	20N	BES3	$e^+e^- \to \pi^0\pi^0 J/\psi$

[1] From a fit to the cross section $e^+e^- \to \pi^0\pi^0 J/\psi$ at center-of-mass energies between 3.808 and 4.600 GeV.
NODE=M222R08;LINKAGE=A

$\Gamma(\pi^+\pi^- J/\psi)/\Gamma_{total}$ — Γ_6/Γ

NODE=M222R06
NODE=M222R06

VALUE	DOCUMENT ID		TECN	COMMENT
seen	ABLIKIM	17B	BES3	$e^+e^- \to \pi^+\pi^- J/\psi$

$\Gamma(\eta J/\psi)/\Gamma_{total}$ — Γ_7/Γ

NODE=M222R09
NODE=M222R09

VALUE	DOCUMENT ID		TECN	COMMENT
seen	ABLIKIM	20O	BES3	$e^+e^- \to \eta J/\psi$

$\Gamma(\pi^+\pi^-\psi(2S))/\Gamma_{total}$ Γ_8/Γ

NODE=M222R02
NODE=M222R02

VALUE	DOCUMENT ID		TECN	COMMENT
seen	[1] ABLIKIM	17V	BES3	$e^+e^- \to \pi^+\pi^-\psi(2S)$

[1] From a fit to the cross section for $e^+e^- \to \pi^+\pi^-\psi(2S) \to 2(\pi^+\pi^-)\ell^+\ell^-$ obtained from 16 center-of-mass energies between 4.008 and 4.600 GeV and comprising 5.1 fb^{-1}.

NODE=M222R02;LINKAGE=A

$\Gamma(\pi^+ D^0 D^{*-} + \text{c.c.})/\Gamma_{total}$ Γ_9/Γ

NODE=M222R04
NODE=M222R04

VALUE	DOCUMENT ID		TECN	COMMENT
seen	ABLIKIM	19R	BES3	$e^+e^- \to \pi^+ D^0 D^{*-}$ + c.c.

$\Gamma(\gamma\chi_{c1}(3872))/\Gamma_{total}$ Γ_{11}/Γ

NODE=M222R07
NODE=M222R07

VALUE	DOCUMENT ID		TECN	COMMENT
seen	ABLIKIM	19V	BES3	$e^+e^- \to \gamma\chi_{c1}(3872)$

$\Gamma(\pi^+\pi^-\pi^0\eta_c)/\Gamma_{total}$ Γ_{12}/Γ

NODE=M222R11
NODE=M222R11

VALUE	DOCUMENT ID		TECN	COMMENT
seen	[1] ABLIKIM	21B	BES3	$e^+e^- \to \pi^+\pi^-\pi^0\eta_c$

[1] Seen as a peak in the $e^+e^- \to \pi^+\pi^-\pi^0\eta_c$ cross section with a peak value of $46.1^{+9.5}_{-9.4} \pm 6.6$ pb at $\sqrt{s} = 4.226$ GeV.

NODE=M222R11;LINKAGE=A

$\Gamma(\pi^+\pi^-\eta_c)/\Gamma_{total}$ Γ_{13}/Γ

NODE=M222R13
NODE=M222R13

VALUE	DOCUMENT ID		TECN	COMMENT
not seen	[1] ABLIKIM	21B	BES3	$e^+e^- \to \pi^+\pi^-\eta_c$

[1] Not seen in $e^+e^- \to \pi^+\pi^-\eta_c$ at $\sqrt{s} = 4.226$ GeV with a 90% C.L. upper limit on the cross section of 16.8 pb.

NODE=M222R13;LINKAGE=A

$\Gamma(\gamma\pi^0\eta_c)/\Gamma_{total}$ Γ_{14}/Γ

NODE=M222R14
NODE=M222R14

VALUE	DOCUMENT ID		TECN	COMMENT
not seen	[1] ABLIKIM	21B	BES3	$e^+e^- \to \gamma\pi^0\eta_c$

[1] Not seen in $e^+e^- \to \gamma\pi^0\eta_c$ at $\sqrt{s} = 4.226$ GeV with a 90% C.L. upper limit on the cross section of 11.2 pb.

NODE=M222R14;LINKAGE=A

$\Gamma(p\bar{p}p\bar{p})/\Gamma_{total}$ Γ_{15}/Γ

NODE=M222R12
NODE=M222R12

VALUE	DOCUMENT ID		TECN	COMMENT
not seen	ABLIKIM	21D	BES3	4.0–4.6 $e^+e^- \to p\bar{p}p\bar{p}$

$\psi(4230)$ REFERENCES

NODE=M222

ABLIKIM	21B	PR D103 032006	M. Ablikim *et al.*	(BESIII Collab.)	REFID=61029
ABLIKIM	21D	PR D103 052003	M. Ablikim *et al.*	(BESIII Collab.)	REFID=61031
ABLIKIM	20AG	PR D102 112009	M. Ablikim *et al.*	(BESIII Collab.)	REFID=60744
ABLIKIM	20C	PRL 124 032002	M. Ablikim *et al.*	(BESIII Collab.)	REFID=60215
ABLIKIM	20N	PR D102 012009	M. Ablikim *et al.*	(BESIII Collab.)	REFID=60338
ABLIKIM	20O	PR D102 031101	M. Ablikim *et al.*	(BESIII Collab.)	REFID=60344
ABLIKIM	19AI	PR D99 091103	M. Ablikim *et al.*	(BESIII Collab.)	REFID=59871
ABLIKIM	19K	PR D99 019903 (errat.)	M. Ablikim *et al.*	(BESIII Collab.)	REFID=59611
ABLIKIM	19R	PRL 122 102002	M. Ablikim *et al.*	(BESIII Collab.)	REFID=59765
ABLIKIM	19V	PRL 122 232002	M. Ablikim *et al.*	(BESIII Collab.)	REFID=59796
ABLIKIM	17B	PRL 118 092001	M. Ablikim *et al.*	(BESIII Collab.)	REFID=57755
ABLIKIM	17G	PRL 118 092002	M. Ablikim *et al.*	(BESIII Collab.)	REFID=57915
ABLIKIM	17V	PR D96 032004	M. Ablikim *et al.*	(BESIII Collab.)	REFID=58029
Also		PR D99 019903 (errat.)	M. Ablikim *et al.*	(BESIII Collab.)	REFID=59611
ABLIKIM	15C	PRL 114 092003	M. Ablikim *et al.*	(BESIII Collab.)	REFID=56401