$\psi(4230)$

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

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 $\psi(4260)$.

$\psi(4230)$ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
4220 ±15 OUR ESTIMATE					
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.
$4200.6^{+\ 7.9}_{-13.3}\pm3.0$		[4] ABLIKIM	19V	BES3	$e^+e^- \to \gamma\chi_{c1}(3872)$
4222.0± 3.1±1.4		[5] ABLIKIM	17B	BES3	$e^+e^- \to \pi^+\pi^- J/\psi$
$4218\ ^{+\ 5.5}_{-\ 4.5}\pm0.9$		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	$e^+e^- \to \pi^0 Z_c(3900)^0$, $Z_c^0 \to \pi^0 J/\psi$
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.

[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 $\chi_{c1} \to \pi^+\pi^- J/\psi$.

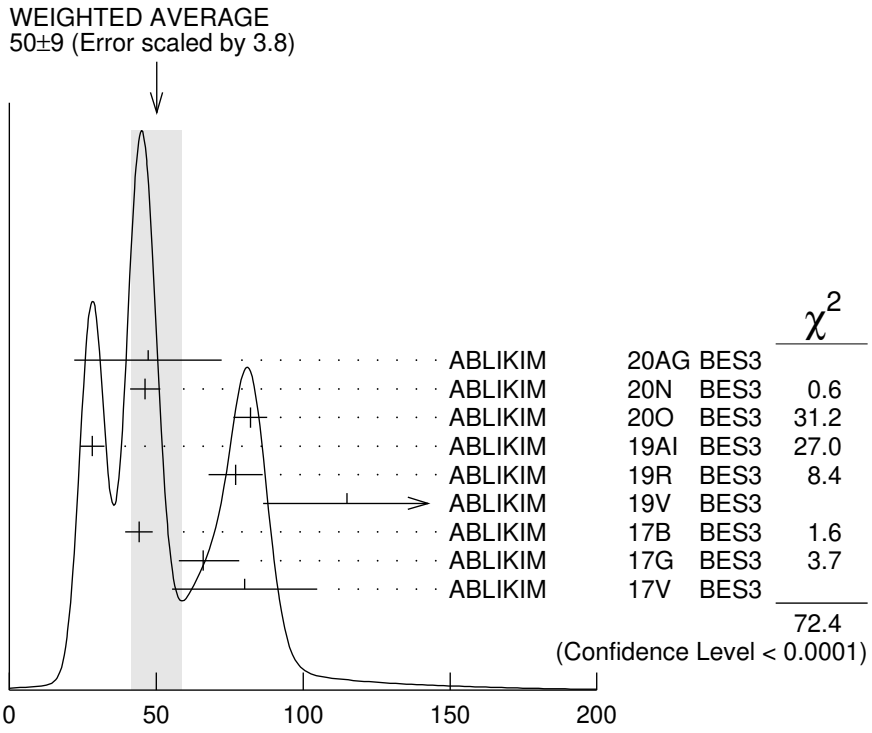
[5] From a three-resonance fit.

[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 $\omega \to \pi^+\pi^-\pi^0$.

$\psi(4230)$ WIDTH

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
20 to 100 OUR ESTIMATE					
50 ± 9 OUR AVERAGE		Error includes scale factor of 3.8. See the ideogram below.			
$47.2 \pm 22.8 \pm 10.5$		[1] ABLIKIM	20AG	BES3	$e^+e^- \to \mu^+\mu^-$
$46.2 \pm 4.7 \pm 2.1$		[2] ABLIKIM	20N	BES3	$e^+e^- \to \pi^0\pi^0 J/\psi$
$82.0 \pm 5.7 \pm 0.4$		[2] ABLIKIM	20O	BES3	$e^+e^- \to \eta J/\psi$
$28.2 \pm 3.9 \pm 1.6$		[3] ABLIKIM	19AI	BES3	$e^+e^- \to \omega\chi_{c0}$
$77.0 \pm 6.8 \pm 6.3$		ABLIKIM	19R	BES3	$e^+e^- \to \pi^+ D^0 D^{*-}$ + c.c.
$115\ ^{+38}_{-26} \pm 12$		[4] ABLIKIM	19V	BES3	$e^+e^- \to \gamma\chi_{c1}(3872)$
$44.1 \pm 4.3 \pm 2.0$		[5] ABLIKIM	17B	BES3	$e^+e^- \to \pi^+\pi^- J/\psi$
$66.0\ ^{+12.3}_{-8.3} \pm 0.4$		ABLIKIM	17G	BES3	$e^+e^- \to \pi^+\pi^- h_c$
$80.1 \pm 24.6 \pm 2.9$		[6] ABLIKIM	17V	BES3	$e^+e^- \to \pi^+\pi^-\psi(2S)$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$41.2 \pm 16.0 \pm 16.4$		ABLIKIM	20N	BES3	$e^+e^- \to \pi^0 Z_c(3900)^0$, $Z_c^0 \to \pi^0 J/\psi$
$38 \pm 12 \pm 2$	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 $36.4 \pm 16.8 \pm 8.1$ to $49.6 \pm 22.6 \pm 11.0$ 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 $\omega \to \pi^+\pi^-\pi^0$.

$\psi(4230)$ DECAY MODES

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

$\psi(4230)$ PARTIAL WIDTHS

$\Gamma(\mu^+\mu^-)$ Γ_2

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.

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

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

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.

[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 $\omega \to \pi^+\pi^-\pi^0$.

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

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	$e^+e^- \to \eta J/\psi$
7.0±1.5	[3] ABLIKIM	20O	BES3	$e^+e^- \to \eta J/\psi$

[1] Solution 1 of three equivalent fit solutions using three resonant structures.
[2] Solution 2 of three equivalent fit solutions using three resonant structures.
[3] Solution 3 of three equivalent fit solutions using three resonant structures.

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

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	$e^+e^- \to \pi^+\pi^-\psi(2S)$

[1] Solution I of two equivalent solutions in a fit using two interfering resonances.
[2] Solution II of two equivalent solutions in a fit using two interfering resonances.

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

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

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

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 $\omega \to \pi^+\pi^-\pi^0$.

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

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

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.

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

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

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

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

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

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}.

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

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

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

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

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

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.

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

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.

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

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.

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

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

$\psi(4230)$ REFERENCES

ABLIKIM	21B	PR D103 032006	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	21D	PR D103 052003	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	20AG	PR D102 112009	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	20C	PRL 124 032002	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	20N	PR D102 012009	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	20O	PR D102 031101	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	19AI	PR D99 091103	M. Ablikim *et al.*	(BESIII Collab.)

ABLIKIM	19K	PR D99 019903 (errat.)	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	19R	PRL 122 102002	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	19V	PRL 122 232002	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	17B	PRL 118 092001	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	17G	PRL 118 092002	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	17V	PR D96 032004	M. Ablikim *et al.*	(BESIII Collab.)
Also		PR D99 019903 (errat.)	M. Ablikim *et al.*	(BESIII Collab.)
ABLIKIM	15C	PRL 114 092003	M. Ablikim *et al.*	(BESIII Collab.)