$\Upsilon(10860)$

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

$\Upsilon(10860)$ MASS

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
10876 ±11 OUR EVALUATION Weighted-average of Belle and BaBar results, but tripling the scaling *S*-factors applied to the uncertainties to account for model-dependence, handling of radiative corrections, and interference effects.				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
10879 ± 3	[1,2] CHEN	10	BELL	$e^+e^- \to$ hadrons
$10888.4^{+2.7}_{-2.6} \pm 1.2$	[3] CHEN	10	BELL	$e^+e^- \to \Upsilon(1S,2S,3S)\pi^+\pi^-$
10876 ± 2	[1] AUBERT	09E	BABR	$e^+e^- \to$ hadrons
10869 ± 2	[4] AUBERT	09E	BABR	$e^+e^- \to$ hadrons
10868 ± 6 ±5	[5] BESSON	85	CLEO	$e^+e^- \to$ hadrons
10845 ±20	[6] LOVELOCK	85	CUSB	$e^+e^- \to$ hadrons

[1] In a model where a flat non-resonant $b\overline{b}$-continuum is incoherently added to a second flat component interfering with two Breit-Wigner resonances. Systematic uncertainties not estimated.
[2] The parameters of the $\Upsilon(11020)$ are fixed to those in AUBERT 09E.
[3] In a model where a flat nonresonant $\Upsilon(1S,2S,3S)\pi^+\pi^-$ continuum interferes with a single Breit-Wigner resonance.
[4] In a model where a non-resonant $b\overline{b}$-continuum represented by a threshold function at $\sqrt{s}=2m_B$ is incoherently added to a flat component interfering with two Breit-Wigner resonances. Not independent of other AUBERT 09E results. Systematic uncertainties not estimated.
[5] Assuming four Gaussians with radiative tails and a single step in *R*.
[6] In a coupled-channel model with three resonances and a smooth step in *R*.

$\Upsilon(10860)$ WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
55 ±28 OUR EVALUATION Weighted-average of Belle and BaBar results, but tripling the scaling *S*-factors applied to the uncertainties to account for model-dependence, handling of radiative corrections, and interference effects.				
• • • We do not use the following data for averages, fits, limits, etc. • • •				
46^{+9}_{-7}	[7,8] CHEN	10	BELL	$e^+e^- \to$ hadrons
$30.7^{+8.3}_{-7.0} \pm 3.1$	[9] CHEN	10	BELL	$e^+e^- \to \Upsilon(1S,2S,3S)\pi^+\pi^-$
43 ± 4	[7] AUBERT	09E	BABR	$e^+e^- \to$ hadrons
74 ± 4	[10] AUBERT	09E	BABR	$e^+e^- \to$ hadrons
112 ±17 ±23	[11] BESSON	85	CLEO	$e^+e^- \to$ hadrons
110 ±15	[12] LOVELOCK	85	CUSB	$e^+e^- \to$ hadrons

[7] In a model where a flat non-resonant $b\overline{b}$-continuum is incoherently added to a second flat component interfering with two Breit-Wigner resonances. Systematic uncertainties not estimated.

[8] The parameters of the $\Upsilon(11020)$ are fixed to those in AUBERT 09E.

[9] In a model where a flat nonresonant $\Upsilon(1S, 2S, 3S)\pi^+\pi^-$ continuum interferes with a single Breit-Wigner resonance.

[10] In a model where a non-resonant $b\overline{b}$-continuum represented by a threshold function at $\sqrt{s}=2m_B$ is incoherently added to a flat component interfering with two Breit-Wigner resonances. Not independent of other AUBERT 09E results. Systematic uncertainties not estimated.

[11] Assuming four Gaussians with radiative tails and a single step in R.

[12] In a coupled-channel model with three resonances and a smooth step in R.

Υ(10860) DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Confidence level
Γ_1	e^+e^-	$(5.6 \pm 3.1) \times 10^{-6}$	
Γ_2	$B\overline{B}X$	(71 ± 6) %	
Γ_3	$B\overline{B}$	(5.5 ± 1.0) %	
Γ_4	$B\overline{B}^* +$ c.c.	(13.7 ± 1.6) %	
Γ_5	$B^*\overline{B}^*$	(38.1 ± 3.4) %	
Γ_6	$B\overline{B}^{(*)}\pi$	< 19.7 %	90%
Γ_7	$B\overline{B}\pi$	(0.0 ± 1.2) %	
Γ_8	$B^*\overline{B}\pi + B\overline{B}^*\pi$	(7.3 ± 2.3) %	
Γ_9	$B^*\overline{B}^*\pi$	(1.0 ± 1.4) %	
Γ_{10}	$B\overline{B}\pi\pi$	< 8.9 %	90%
Γ_{11}	$B_s^{(*)}\overline{B}_s^{(*)}$	(19.3 ± 2.9) %	
Γ_{12}	$B_s\overline{B}_s$	$(5 \pm 5) \times 10^{-3}$	
Γ_{13}	$B_s\overline{B}_s^* +$ c.c.	(1.4 ± 0.6) %	
Γ_{14}	$B_s^*\overline{B}_s^*$	(17.4 ± 2.7) %	
Γ_{15}	$\Upsilon(1S)\pi^+\pi^-$	$(5.3 \pm 0.6) \times 10^{-3}$	
Γ_{16}	$\Upsilon(2S)\pi^+\pi^-$	$(7.8 \pm 1.3) \times 10^{-3}$	
Γ_{17}	$\Upsilon(3S)\pi^+\pi^-$	$(4.8 {}^{+1.9}_{-1.7}) \times 10^{-3}$	
Γ_{18}	$\Upsilon(1S)K^+K^-$	$(6.1 \pm 1.8) \times 10^{-4}$	

Inclusive Decays.

These decay modes are submodes of one or more of the decay modes above.

	Mode	Fraction (Γ_i/Γ)	Confidence level
Γ_{19}	ϕ anything	$(13.8 {}^{+2.4}_{-1.7})$ %	
Γ_{20}	D^0 anything + c.c.	(108 ± 8) %	
Γ_{21}	D_s anything + c.c.	(46 ± 6) %	
Γ_{22}	J/ψ anything	(2.06 ± 0.21) %	
Γ_{23}	B^0 anything + c.c.	(77 ± 8) %	
Γ_{24}	B^+ anything + c.c.	(72 ± 6) %	

$\Upsilon(10860)$ PARTIAL WIDTHS

$\Gamma(e^+e^-)$ — Γ_1

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
0.31 ±0.07 OUR AVERAGE	Error includes scale factor of 1.3.			
0.22 ±0.05 ±0.07	BESSON	85	CLEO	$e^+e^- \to$ hadrons
0.365±0.070	LOVELOCK	85	CUSB	$e^+e^- \to$ hadrons

$\Upsilon(10860)$ BRANCHING RATIOS

$\Gamma(B\overline{B}X)/\Gamma_{total}$ — Γ_2/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.71 ±0.06 OUR AVERAGE					
0.737±0.032±0.051	1063	[13] DRUTSKOY	10	BELL	$\Upsilon(5S) \to B^+X,\ B^0X$
0.589±0.100±0.092		[14] HUANG	07	CLEO	$\Upsilon(5S) \to$ hadrons

$\Gamma(B\overline{B})/\Gamma_{total}$ — Γ_3/Γ

VALUE (units 10^{-2})	CL%	DOCUMENT ID		TECN	COMMENT
$\mathbf{5.5^{+1.0}_{-0.9}\pm0.4}$		[15] DRUTSKOY	10	BELL	$\Upsilon(5S) \to B^+X,\ B^0X$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<13.8	90	[14] HUANG	07	CLEO	$\Upsilon(5S) \to$ hadrons

$\Gamma(B\overline{B})/\Gamma(B\overline{B}X)$ — Γ_3/Γ_2

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.22	90	AQUINES	06	CLE3	$\Upsilon(5S) \to$ hadrons

$\Gamma(B\overline{B}^* + \text{c.c.})/\Gamma_{total}$ — Γ_4/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.137±0.016 OUR AVERAGE				
0.137±0.013±0.011	[15] DRUTSKOY	10	BELL	$\Upsilon(5S) \to B^+X,\ B^0X$
0.143±0.053±0.027	[14] HUANG	07	CLEO	$\Upsilon(5S) \to$ hadrons

$\Gamma(B\overline{B}^* + \text{c.c.})/\Gamma(B\overline{B}X)$ — Γ_4/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.24±0.09±0.03	10	AQUINES	06	CLE3	$\Upsilon(5S) \to$ hadrons

$\Gamma(B^*\overline{B}^*)/\Gamma_{total}$ — Γ_5/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.381±0.034 OUR AVERAGE				
$0.375^{+0.021}_{-0.019}\pm0.030$	[15] DRUTSKOY	10	BELL	$\Upsilon(5S) \to B^+X,\ B^0X$
0.436±0.083±0.072	[14] HUANG	07	CLEO	$\Upsilon(5S) \to$ hadrons

$\Gamma(B^*\overline{B}^*)/\Gamma(B\overline{B}X)$ — Γ_5/Γ_2

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.74±0.15±0.08	31	AQUINES	06	CLE3	$\Upsilon(5S) \to$ hadrons

$\Gamma(B\overline{B}^{(*)}\pi)/\Gamma_{total}$ — Γ_6/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.197	90	[14] HUANG	07	CLEO	$\Upsilon(5S) \to$ hadrons

$\Gamma(B\overline{B}^{(*)}\pi)/\Gamma(B\overline{B}X)$ — Γ_6/Γ_2

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.32	90	AQUINES	06	CLE3	$\Upsilon(5S) \to$ hadrons

$\Gamma(B\overline{B}\pi)/\Gamma_{total}$ — Γ_7/Γ

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
0.0±1.2±0.3	0	[15] DRUTSKOY	10	BELL	$\Upsilon(5S) \to B^{+,0}\pi^- X$

$[\Gamma(B^*\overline{B}\pi)+\Gamma(B\overline{B}^*\pi)]/\Gamma_{total}$ — Γ_8/Γ

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
$7.3^{+2.3}_{-2.1}\pm0.8$	38	[15] DRUTSKOY	10	BELL	$\Upsilon(5S) \to B^{+,0}\pi^- X$

$\Gamma(B^*\overline{B}^*\pi)/\Gamma_{total}$ — Γ_9/Γ

VALUE (units 10^{-2})	EVTS	DOCUMENT ID		TECN	COMMENT
$1.0^{+1.4}_{-1.3}\pm0.4$	5	[15] DRUTSKOY	10	BELL	$\Upsilon(5S) \to B^{+,0}\pi^- X$

$\Gamma(B\overline{B}\pi\pi)/\Gamma_{total}$ — Γ_{10}/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.089	90	[14] HUANG	07	CLEO	$\Upsilon(5S) \to$ hadrons

$\Gamma(B\overline{B}\pi\pi)/\Gamma(B\overline{B}X)$ — Γ_{10}/Γ_2

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.14	90	AQUINES	06	CLE3	$\Upsilon(5S) \to$ hadrons

$\Gamma(B_s^{(*)}\overline{B}_s^{(*)})/\Gamma_{total}$ — $\Gamma_{11}/\Gamma = (\Gamma_{12}+\Gamma_{13}+\Gamma_{14})/\Gamma$

VALUE	DOCUMENT ID		TECN	COMMENT
0.193±0.029 OUR EVALUATION	Taking into account common systematics.			
$0.195^{+0.030}_{-0.023}$ OUR AVERAGE				
0.180±0.013±0.032	[16] DRUTSKOY	07	BELL	$\Upsilon(5S) \to D^0 X$, $D_s X$
$0.21\ ^{+0.06}_{-0.03}$	[17] HUANG	07	CLEO	$\Upsilon(5S) \to D_s X$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.160±0.026±0.058	[18] ARTUSO	05B	CLEO	$e^+e^- \to D_X X$

$\Gamma(B_s^*\overline{B}_s^*)/\Gamma(B_s^{(*)}\overline{B}_s^{(*)})$ — $\Gamma_{14}/\Gamma_{11} = \Gamma_{14}/(\Gamma_{12}+\Gamma_{13}+\Gamma_{14})$

VALUE (units 10^{-2})	DOCUMENT ID		TECN	COMMENT
$90.1^{+3.8}_{-4.0}\pm0.2$	[19] LOUVOT	09	BELL	10.86 $e^+e^- \to B_s^{(*)}\overline{B}_s^{(*)}$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
$93\ ^{+7}_{-9}\ \pm1$	[19] DRUTSKOY	07A	BELL	Superseded by LOUVOT 09

$\Gamma(B_s\overline{B}_s)/\Gamma(B_s^{(*)}\overline{B}_s^{(*)})$ — $\Gamma_{12}/\Gamma_{11} = \Gamma_{12}/(\Gamma_{12}+\Gamma_{13}+\Gamma_{14})$

VALUE (units 10^{-2})	DOCUMENT ID		TECN	COMMENT
$2.6^{+2.6}_{-2.5}$	LOUVOT	09	BELL	10.86 $e^+e^- \to B_s^{(*)}\overline{B}_s^{(*)}$

$\Gamma(B_s\overline{B}_s)/\Gamma(B_s^*\overline{B}_s^*)$ — Γ_{12}/Γ_{14}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.16	90	BONVICINI	06	CLE3	e^+e^-

$\Gamma(B_s\overline{B}_s^* + \text{c.c.})/\Gamma(B_s^{(*)}\overline{B}_s^{(*)})$ — $\Gamma_{13}/\Gamma_{11} = \Gamma_{13}/(\Gamma_{12}+\Gamma_{13}+\Gamma_{14})$

VALUE (units 10^{-2})	DOCUMENT ID		TECN	COMMENT
$\mathbf{7.3^{+3.3}_{-3.0}\pm0.1}$	LOUVOT	09	BELL	10.86 $e^+e^- \to B_s^{(*)}\overline{B}_s^{(*)}$

$\Gamma(B_s\overline{B}_s^* + \text{c.c.})/\Gamma(B_s^*\overline{B}_s^*)$ — Γ_{13}/Γ_{14}

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.16	90	BONVICINI	06	CLE3	e^+e^-

$\Gamma(\Upsilon(1S)\pi^+\pi^-)/\Gamma_{\text{total}}$ — Γ_{15}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
5.3±0.3±0.5	325	[20] CHEN	08	BELL	10.87 $e^+e^- \to \Upsilon(1S)\pi^+\pi^-$

$\Gamma(\Upsilon(2S)\pi^+\pi^-)/\Gamma_{\text{total}}$ — Γ_{16}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
7.8±0.6±1.1	186	[20] CHEN	08	BELL	10.87 $e^+e^- \to \Upsilon(2S)\pi^+\pi^-$

$\Gamma(\Upsilon(3S)\pi^+\pi^-)/\Gamma_{\text{total}}$ — Γ_{17}/Γ

VALUE (units 10^{-3})	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{4.8^{+1.8}_{-1.5}\pm0.7}$	10	[20] CHEN	08	BELL	10.87 $e^+e^- \to \Upsilon(3S)\pi^+\pi^-$

$\Gamma(\Upsilon(1S)K^+K^-)/\Gamma_{\text{total}}$ — Γ_{18}/Γ

VALUE (units 10^{-4})	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{6.1^{+1.6}_{-1.4}\pm1.0}$	20	[20] CHEN	08	BELL	10.87 $e^+e^- \to \Upsilon(1S)K^+K^-$

$\Gamma(\phi\text{ anything})/\Gamma_{\text{total}}$ — Γ_{19}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
$\mathbf{0.138\pm0.007^{+0.023}_{-0.015}}$	HUANG	07	CLEO	$\Upsilon(5S) \to \phi X$

$\Gamma(D^0\text{ anything} + \text{c.c.})/\Gamma_{\text{total}}$ — Γ_{20}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
1.076±0.040±0.068	DRUTSKOY	07	BELL	$\Upsilon(5S) \to D^0 X$

$\Gamma(D_s\text{ anything} + \text{c.c.})/\Gamma_{\text{total}}$ — Γ_{21}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.46 ±0.06 OUR AVERAGE				
0.472±0.024±0.072	[16] DRUTSKOY	07	BELL	$\Upsilon(5S) \to D_s X$
0.44 ±0.09 ±0.04	[21] ARTUSO	05B	CLE3	$e^+e^- \to D_x X$

$\Gamma(J/\psi\text{ anything})/\Gamma_{\text{total}}$ — Γ_{22}/Γ

VALUE (units 10^{-2})	DOCUMENT ID		TECN	COMMENT
2.060±0.160±0.134	DRUTSKOY	07	BELL	$\Upsilon(5S) \to J/\psi X$

$\Gamma(B^0 \text{ anything} + \text{c.c.})/\Gamma_{\text{total}}$ Γ_{23}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{0.770^{+0.058}_{-0.056} \pm 0.061}$	352	DRUTSKOY	10	BELL	$\Upsilon(5S) \to B^0 X$

$\Gamma(B^+ \text{ anything} + \text{c.c.})/\Gamma_{\text{total}}$ Γ_{24}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
$\mathbf{0.721^{+0.039}_{-0.038} \pm 0.050}$	711	DRUTSKOY	10	BELL	$\Upsilon(5S) \to B^+ X$

[13] Not independent of DRUTSKOY 10 values for $\Upsilon(5S) \to B^{\pm,0}$ anything.
[14] Using measurements or limits from AQUINES 06.
[15] Assuming isospin conservation.
[16] Using $B(D_s^+ \to \phi\pi^+) = (4.4 \pm 0.6)\%$ from PDG 06.
[17] Supersedes ARTUSO 05B. Combining inclusive ϕ, D_s, and B measurements. Using $B(D_s^+ \to \phi\pi^+) = 4.4 \pm 0.6\%$ from PDG 06.
[18] Uses a model-dependent estimate $B(B_s \to D_s X) = (92 \pm 11)\%$.
[19] From a measurement of $\sigma(e^+ e^- \to B_s^* \overline{B}_s^*) / \sigma(e^+ e^- \to B_s^{(*)} \overline{B}_s^{(*)})$ at $\sqrt{s} = 10.86$ GeV.
[20] Assuming that the observed events are solely due to the $\Upsilon(5S)$ resonance.
[21] ARTUSO 05B reports $[\Gamma(\Upsilon(10860) \to D_s \text{ anything} + \text{c.c.})/\Gamma_{\text{total}}] \times [B(D_s^+ \to \phi\pi^+)] = 0.0198 \pm 0.0019 \pm 0.0038$ which we divide by our best value $B(D_s^+ \to \phi\pi^+) = (4.5 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Upsilon(10860)$ REFERENCES

CHEN	10	PR D82 091106R	K.-F. Chen *et al.*	(BELLE Collab.)
DRUTSKOY	10	PR D81 112003	A. Drutskoy *et al.*	(BELLE Collab.)
AUBERT	09E	PRL 102 012001	B. Aubert *et al.*	(BABAR Collab.)
LOUVOT	09	PRL 102 021801	R. Louvot *et al.*	(BELLE Collab.)
CHEN	08	PRL 100 112001	K.-F. Chen *et al.*	(BELLE Collab.)
DRUTSKOY	07	PRL 98 052001	A. Drutskoy *et al.*	(BELLE Collab.)
DRUTSKOY	07A	PR D76 012002	A. Drutskoy *et al.*	(BELLE Collab.)
HUANG	07	PR D75 012002	G.S. Huang *et al.*	(CLEO Collab.)
AQUINES	06	PRL 96 152001	O. Aquines *et al.*	(CLEO Collab.)
BONVICINI	06	PRL 96 022002	G. Bonvicini *et al.*	(CLEO Collab.)
PDG	06	JPG 33 1	W.-M. Yao *et al.*	(PDG Collab.)
ARTUSO	05B	PRL 95 261801	M. Artuso *et al.*	(CLEO Collab.)
BESSON	85	PRL 54 381	D. Besson *et al.*	(CLEO Collab.)
LOVELOCK	85	PRL 54 377	D.M.J. Lovelock *et al.*	(CUSB Collab.)