$\Upsilon(10860)$

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

$\Upsilon(10860)$ MASS

VALUE (GeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
10.865±0.008 OUR AVERAGE	Error includes scale factor of 1.1.			
10.868±0.006±0.005	BESSON	85	CLEO	$e^+e^- \to$ hadrons
10.845±0.020	LOVELOCK	85	CUSB	$e^+e^- \to$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •				
10.876±0.002	[1] AUBERT	09E	BABR	$e^+e^- \to$ hadrons
10.869±0.002	[2] AUBERT	09E	BABR	$e^+e^- \to$ 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] 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.

$\Upsilon(10860)$ WIDTH

VALUE (MeV)	*DOCUMENT ID*		*TECN*	*COMMENT*
110±13 OUR AVERAGE				
112±17±23	BESSON	85	CLEO	$e^+e^- \to$ hadrons
110±15	LOVELOCK	85	CUSB	$e^+e^- \to$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •				
43± 4	[3] AUBERT	09E	BABR	$e^+e^- \to$ hadrons
74± 4	[4] AUBERT	09E	BABR	$e^+e^- \to$ hadrons

[3] 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.

[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.

$\Upsilon(10860)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Confidence level
Γ_1	e^+e^-	(2.8 ± 0.7) × 10^{-6}	
Γ_2	$B\overline{B}X$	(59 ±14) %	
Γ_3	$B\overline{B}$	< 13.8 %	90%
Γ_4	$B\overline{B}^* +$ c.c.	(14 ± 6) %	
Γ_5	$B^*\overline{B}^*$	(44 ±11) %	
Γ_6	$B\overline{B}^{(*)}\pi$	< 19.7 %	90%
Γ_7	$B\overline{B}\pi\pi$	< 8.9 %	90%

Γ_8	$B_s^{(*)}\overline{B}_s^{(*)}$	(19.3 ± 2.9) %
Γ_9	$B_s\overline{B}_s$	(5 ± 5) × 10^{-3}
Γ_{10}	$B_s\overline{B}_s^*$ + c.c.	(1.4 ± 0.6) %
Γ_{11}	$B_s^*\overline{B}_s^*$	(17.4 ± 2.7) %
Γ_{12}	$\Upsilon(1S)\pi^+\pi^-$	(5.3 ± 0.6) × 10^{-3}
Γ_{13}	$\Upsilon(2S)\pi^+\pi^-$	(7.8 ± 1.3) × 10^{-3}
Γ_{14}	$\Upsilon(3S)\pi^+\pi^-$	(4.8 $^{+\ 1.9}_{-\ 1.7}$) × 10^{-3}
Γ_{15}	$\Upsilon(1S)K^+K^-$	(6.1 ± 1.8) × 10^{-4}

Inclusive Decays.

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

Γ_{16}	ϕ anything	(13.8 $^{+\ 2.4}_{-\ 1.7}$) %
Γ_{17}	D^0 anything + c.c.	(108 ± 8) %
Γ_{18}	D_s anything + c.c.	(46 ± 6) %
Γ_{19}	J/ψ anything	(2.06± 0.21) %

$\Upsilon(10860)$ 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	*DOCUMENT ID*		*TECN*	*COMMENT*
0.589±0.100±0.092	[5] HUANG	07	CLEO	$\Upsilon(5S) \to$ hadrons

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

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<0.138	90	[5] 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*
0.143±0.053±0.027	[5] 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
0.436±0.083±0.072	[5] HUANG	07	CLEO	$\Upsilon(5S) \rightarrow$ 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	$\Upsilon(5S) \rightarrow$ hadrons

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

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

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

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

$\Gamma(B\overline{B}\pi\pi)/\Gamma(B\overline{B}X)$ Γ_7/Γ_2

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

$\Gamma(B_s^{(*)}\overline{B}_s^{(*)})/\Gamma_{total}$ $\Gamma_8/\Gamma = (\Gamma_9+\Gamma_{10}+\Gamma_{11})/\Gamma$

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	[6] DRUTSKOY	07	BELL	$\Upsilon(5S) \rightarrow D^0X$, D_sX
$0.21\ ^{+0.06}_{-0.03}$	[7] HUANG	07	CLEO	$\Upsilon(5S) \rightarrow D_sX$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.160±0.026±0.058	[8] ARTUSO	05B	CLEO	$e^+e^- \rightarrow D_xX$

$\Gamma(B_s^*\overline{B}_s^*)/\Gamma(B_s^{(*)}\overline{B}_s^{(*)})$ $\Gamma_{11}/\Gamma_8 = \Gamma_{11}/(\Gamma_9+\Gamma_{10}+\Gamma_{11})$

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

$\Gamma(B_s\overline{B}_s)/\Gamma(B_s^{(*)}\overline{B}_s^{(*)})$ $\Gamma_9/\Gamma_8 = \Gamma_9/(\Gamma_9+\Gamma_{10}+\Gamma_{11})$

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

$\Gamma(B_s\overline{B}_s)/\Gamma(B_s^*\overline{B}_s^*)$ Γ_9/Γ_{11}

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

$\Gamma(B_s\overline{B}_s^* + \text{c.c.})/\Gamma(B_s^{(*)}\overline{B}_s^{(*)})$ $\Gamma_{10}/\Gamma_8 = \Gamma_{10}/(\Gamma_9+\Gamma_{10}+\Gamma_{11})$

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_{10}/Γ_{11}

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

$\Gamma(\Upsilon(1S)\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_{12}/Γ

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

$\Gamma(\Upsilon(2S)\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_{13}/Γ

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

$\Gamma(\Upsilon(3S)\pi^+\pi^-)/\Gamma_{\text{total}}$ Γ_{14}/Γ

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

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

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

$\Gamma(\phi \text{ anything})/\Gamma_{\text{total}}$ Γ_{16}/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_{17}/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_{18}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.46 ±0.06 OUR AVERAGE				
0.472±0.024±0.072	[6] DRUTSKOY	07	BELL	$\Upsilon(5S) \to D_s X$
0.44 ±0.09 ±0.04	[11] ARTUSO	05B	CLE3	$e^+e^- \to D_x X$

$\Gamma(J/\psi \text{ anything})/\Gamma_{\text{total}}$ Γ_{19}/Γ

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

[5] Using measurements or limits from AQUINES 06.

[6] Using $B(D_s^+ \rightarrow \phi\pi^+) = (4.4 \pm 0.6)\%$ from PDG 06.

[7] Supersedes ARTUSO 05B. Combining inclusive ϕ, D_s, and B measurements. Using $B(D_s^+ \rightarrow \phi\pi^+) = 4.4 \pm 0.6\%$ from PDG 06.

[8] Uses a model-dependent estimate $B(B_s \rightarrow D_s X) = (92 \pm 11)\%$.

[9] From a measurement of $\sigma(e^+e^- \rightarrow B_s^* \overline{B}_s^*) / \sigma(e^+e^- \rightarrow B_s^{(*)} \overline{B}_s^{(*)})$ at $\sqrt{s} = 10.86$ GeV.

[10] Assuming that the observed events are solely due to the $\Upsilon(5S)$ resonance.

[11] ARTUSO 05B reports $[\Gamma(\Upsilon(10860) \rightarrow D_s \text{ anything } + \text{ c.c.})/\Gamma_{\text{total}}] \times [B(D_s^+ \rightarrow \phi\pi^+)] = 0.0198 \pm 0.0019 \pm 0.0038$ which we divide by our best value $B(D_s^+ \rightarrow \phi\pi^+) = (4.5 \pm 0.4) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Upsilon(10860)$ REFERENCES

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.)