$\Upsilon(4S)$ or $\Upsilon(10580)$

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

$\Upsilon(4S)$ MASS

VALUE (GeV)	DOCUMENT ID		TECN	COMMENT
10.5800±0.0035	[1] BEBEK	87	CLEO	$e^+e^- \rightarrow$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •				
10.5774±0.0010	[2] LOVELOCK	85	CUSB	$e^+e^- \rightarrow$ hadrons

[1] Reanalysis of BESSON 85.
[2] No systematic error given.

$\Upsilon(4S)$ WIDTH

VALUE (MeV)	DOCUMENT ID		TECN	COMMENT
20±2 ±4	BESSON	85	CLEO	$e^+e^- \rightarrow$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •				
25±2.5	LOVELOCK	85	CUSB	$e^+e^- \rightarrow$ hadrons

$\Upsilon(4S)$ DECAY MODES

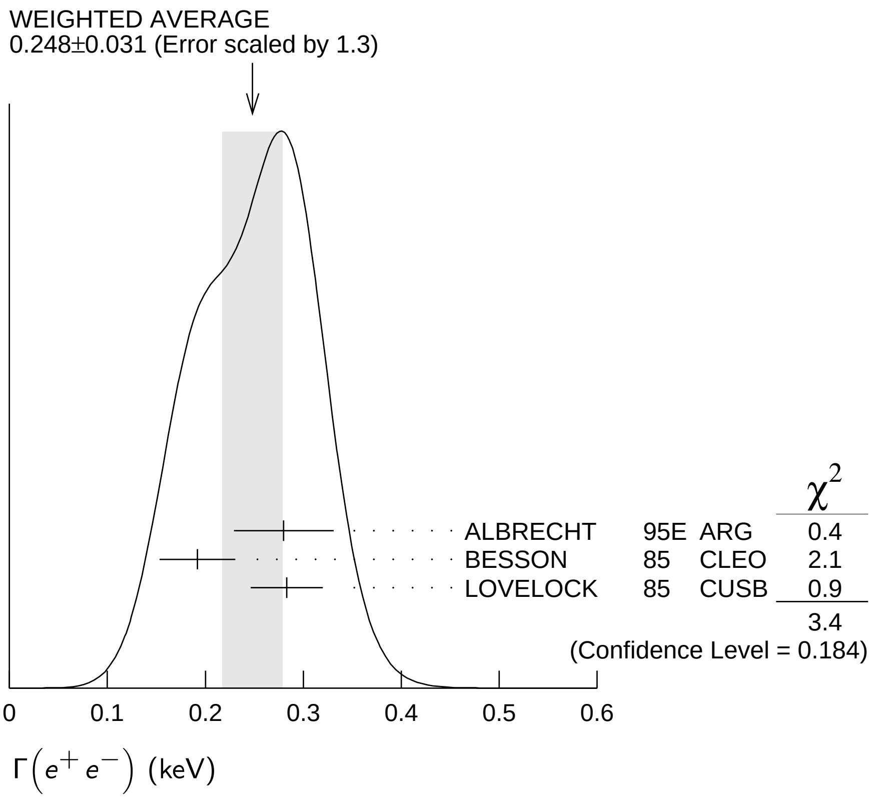
	Mode	Fraction (Γ_i/Γ)	Confidence level
Γ_1	$B\overline{B}$	> 96 %	95%
Γ_2	B^+B^-	(50.7±0.8) %	
Γ_3	$B^0\overline{B}^0$	(49.3±0.8) %	
Γ_4	non-$B\overline{B}$	< 4 %	95%
Γ_5	e^+e^-	(2.8±0.7) $\times 10^{-5}$	
Γ_6	$J/\psi(1S)$anything	< 1.9 $\times 10^{-4}$	95%
Γ_7	D^{*+}anything + c.c.	< 7.4 %	90%
Γ_8	ϕanything	< 2.3 $\times 10^{-3}$	90%
Γ_9	$\Upsilon(1S)$anything	< 4 $\times 10^{-3}$	90%
Γ_{10}	$\Upsilon(1S)\pi^+\pi^-$	< 1.2 $\times 10^{-4}$	90%
Γ_{11}	$\Upsilon(2S)\pi^+\pi^-$	< 3.9 $\times 10^{-4}$	90%

$\Upsilon(4S)$ PARTIAL WIDTHS

$\Gamma(e^+e^-)$ Γ_5

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
0.248±0.031 OUR AVERAGE	Error includes scale factor of 1.3. See the ideogram below.			
0.28 ±0.05 ±0.01	[3] ALBRECHT	95E	ARG	$e^+e^- \rightarrow$ hadrons
0.192±0.007±0.038	BESSON	85	CLEO	$e^+e^- \rightarrow$ hadrons
0.283±0.037	LOVELOCK	85	CUSB	$e^+e^- \rightarrow$ hadrons

[3] Using LEYAOUANC 77 parametrization of $\Gamma(s)$.



$\Upsilon(4S)$ BRANCHING RATIOS

—— $B\overline{B}$ DECAYS ——

The ratio of branching fraction to charged and neutral B mesons is often derived assuming isospin invariance in the decays, and relies on the knowledge of the B^+/B^0 lifetime ratio. "OUR EVALUATION" is obtained based on averages of rescaled data listed below. The average and rescaling were performed by the Heavy Flavor Averaging Group (HFAG) and are described at http://www.slac.stanford.edu/xorg/hfag/. The averaging/rescaling procedure takes into account the common dependence of the measurement on the value of the lifetime ratio.

$\Gamma(B^+B^-)/\Gamma(B^0\overline{B}^0)$ — Γ_2/Γ_3

VALUE	DOCUMENT ID		TECN	COMMENT
1.029±0.035 OUR EVALUATION				
1.006±0.036±0.031	[4] AUBERT	04F	BABR	$\Upsilon(4S) \to B\overline{B} \to J/\psi K$
1.01 ±0.03 ±0.09	[4] HASTINGS	03	BELL	$\Upsilon(4S) \to B\overline{B} \to$ dileptons
1.058±0.084±0.136	[5] ATHAR	02	CLEO	$\Upsilon(4S) \to B\overline{B} \to D^* \ell \nu$
1.10 ±0.06 ±0.05	[6] AUBERT	02	BABR	$\Upsilon(4S) \to B\overline{B} \to (c\overline{c})K^*$
1.04 ±0.07 ±0.04	[7] ALEXANDER	01	CLEO	$\Upsilon(4S) \to B\overline{B} \to J/\psi K^*$

[4] HASTINGS 03 and AUBERT 04F assume $\tau(B^+)$ / $\tau(B^0) = 1.083 \pm 0.017$.
[5] ATHAR 02 assumes $\tau(B^+)$ / $\tau(B^0) = 1.074 \pm 0.028$. Supersedes BARISH 95.
[6] AUBERT 02 assumes $\tau(B^+)$ / $\tau(B^0) = 1.062 \pm 0.029$.
[7] ALEXANDER 01 assumes $\tau(B^+)$ / $\tau(B^0) = 1.066 \pm 0.024$.

$\Gamma(B^+ B^-)/\Gamma_{total}$ Γ_2/Γ

VALUE	DOCUMENT ID
0.507±0.008 OUR EVALUATION	Assuming B($\Upsilon(4S) \to B\overline{B}$) = 1

$\Gamma(B^0 \overline{B}^0)/\Gamma_{total}$ Γ_3/Γ

VALUE	DOCUMENT ID
0.493±0.008 OUR EVALUATION	Assuming B($\Upsilon(4S) \to B\overline{B}$) = 1

non-$B\overline{B}$ DECAYS

$\Gamma(e^+ e^-)/\Gamma_{total}$ Γ_5/Γ

VALUE (units 10^{-5})	DOCUMENT ID		TECN	COMMENT
2.77±0.50±0.49	[8] ALBRECHT	95E	ARG	$e^+ e^- \to$ hadrons

[8] Using LEYAOUANC 77 parametrization of $\Gamma(s)$.

$[\Gamma(D^{*+}\text{anything}) + \Gamma(\text{c.c.})]/\Gamma_{total}$ Γ_7/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.074	90	[9] ALEXANDER	90C	CLEO	$e^+ e^-$

[9] For $x >$ 0.473.

$\Gamma(\phi\text{anything})/\Gamma_{total}$ Γ_8/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.0023	90	[10] ALEXANDER	90C	CLEO	$e^+ e^-$

[10] For $x >$ 0.52.

$\Gamma(J/\psi(1S)\text{anything})/\Gamma_{total}$ Γ_6/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<1.9	95	[11] ABE	02D	BELL	$e^+ e^- \to J/\psi X \to \ell^+ \ell^- X$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<4.7	90	[11] AUBERT	01C	BABR	$e^+ e^- \to J/\psi X \to \ell^+ \ell^- X$

[11] Uses B($J/\psi \to e^+ e^-$) = 0.0593 ± 0.0010 and B($J/\psi \to \mu^+ \mu^-$) = 0.0588 ± 0.0010.

$\Gamma(\Upsilon(1S)\text{anything})/\Gamma_{total}$ Γ_9/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.004	90	ALEXANDER	90C	CLEO	$e^+ e^-$

$\Gamma(\Upsilon(1S)\pi^+\pi^-)/\Gamma_{total}$ Γ_{10}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<1.2	90	GLENN	99	CLE2	$e^+ e^-$

$\Gamma(\Upsilon(2S)\pi^+\pi^-)/\Gamma_{total}$ Γ_{11}/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<3.9	90	GLENN	99	CLE2	$e^+ e^-$

$\Gamma(\text{non-}B\overline{B})/\Gamma_{\text{total}}$ Γ_4/Γ

VALUE	*CL%*	*DOCUMENT ID*		*TECN*	*COMMENT*
<0.04	95	BARISH	96B	CLEO	$e^+ e^-$

$\Upsilon(4S)$ REFERENCES

AUBERT	04F	PR D69 071101	B.Aubert *et al.*	
HASTINGS	03	PR D67 052004	N.C. Hastings *et al.*	(BELLE Collab.)
ABE	02D	PRL 88 052001	K. Abe *et al.*	(BELLE Collab.)
ATHAR	02	PR D66 052003	S.B. Athar *et al.*	(CLEO Collab.)
AUBERT	02	PR D65 032001	B. Aubert *et al.*	(BaBar Collab.)
ALEXANDER	01	PRL 86 2737	J.P. Alexander *et al.*	(CLEO Collab.)
AUBERT	01C	PRL 87 162002	B. Aubert *et al.*	(BaBar Collab.)
GLENN	99	PR D59 052003	S. Glenn *et al.*	
BARISH	96B	PRL 76 1570	B.C. Barish *et al.*	(CLEO Collab.)
ALBRECHT	95E	ZPHY C65 619	H. Albrecht *et al.*	(ARGUS Collab.)
BARISH	95	PR D51 1014	B.C. Barish *et al.*	(CLEO Collab.)
ALEXANDER	90C	PRL 64 2226	J. Alexander *et al.*	(CLEO Collab.)
BEBEK	87	PR D36 1289	C. Bebek *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.)
LEYAOUANC	77	PL B71 397	A. Le Yaouanc *et al.*	(ORSAY)

OTHER RELATED PAPERS

ABE	01J	PR D64 072001	K. Abe *et al.*	(BELLE Collab.)
HENDERSON	92	PR D45 2212	S. Henderson *et al.*	(CLEO Collab.)
ANDREWS	80B	PRL 45 219	D. Andrews *et al.*	(CLEO Collab.)
FINOCCHI...	80	PRL 45 222	G. Finocchiaro *et al.*	(CUSB Collab.)