$\Upsilon(3S)$

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

$\Upsilon(3S)$ MASS

VALUE (GeV)	*DOCUMENT ID*	*TECN*	*COMMENT*
10.3552±0.0005	[1] ARTAMONOV 00	MD1	$e^+e^- \to$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •			
10.3553±0.0005	[2,3] BARU 86B	REDE	$e^+e^- \to$ hadrons

[1] Reanalysis of BARU 86B using new electron mass (COHEN 87).
[2] Reanalysis of ARTAMONOV 84.
[3] Superseded by ARTAMONOV 00.

$\Upsilon(3S)$ WIDTH

VALUE (keV)	*DOCUMENT ID*
26.3±3.5 OUR EVALUATION	See the Note on Width Determinations of the Υ states

$\Upsilon(3S)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Scale factor/ Confidence level
Γ_1	$\Upsilon(2S)$anything	(10.6 ±0.8) %	
Γ_2	$\Upsilon(2S)\pi^+\pi^-$	(2.8 ±0.6) %	S=2.2
Γ_3	$\Upsilon(2S)\pi^0\pi^0$	(2.00±0.32) %	
Γ_4	$\Upsilon(2S)\gamma\gamma$	(5.0 ±0.7) %	
Γ_5	$\Upsilon(1S)\pi^+\pi^-$	(4.48±0.21) %	
Γ_6	$\Upsilon(1S)\pi^0\pi^0$	(2.06±0.28) %	
Γ_7	$\Upsilon(1S)\eta$	$< 2.2 \times 10^{-3}$	CL=90%
Γ_8	$\mu^+\mu^-$	(1.81±0.17) %	
Γ_9	e^+e^-	seen	
	Radiative decays		
Γ_{10}	$\gamma\chi_{b2}(2P)$	(11.4 ±0.8) %	S=1.3
Γ_{11}	$\gamma\chi_{b1}(2P)$	(11.3 ±0.6) %	
Γ_{12}	$\gamma\chi_{b0}(2P)$	(5.4 ±0.6) %	S=1.1

$\Upsilon(3S)$ $\Gamma(i)\Gamma(e^+e^-)/\Gamma(\text{total})$

$\Gamma(\text{hadrons}) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ $\qquad$ $\Gamma_0\Gamma_9/\Gamma$

VALUE (keV)	*DOCUMENT ID*	*TECN*	*COMMENT*
0.45±0.03±0.03	[4] GILES 84B	CLEO	$e^+e^- \to$ hadrons

[4] Radiative corrections reevaluated by BUCHMUELLER 88 following KURAEV 85.

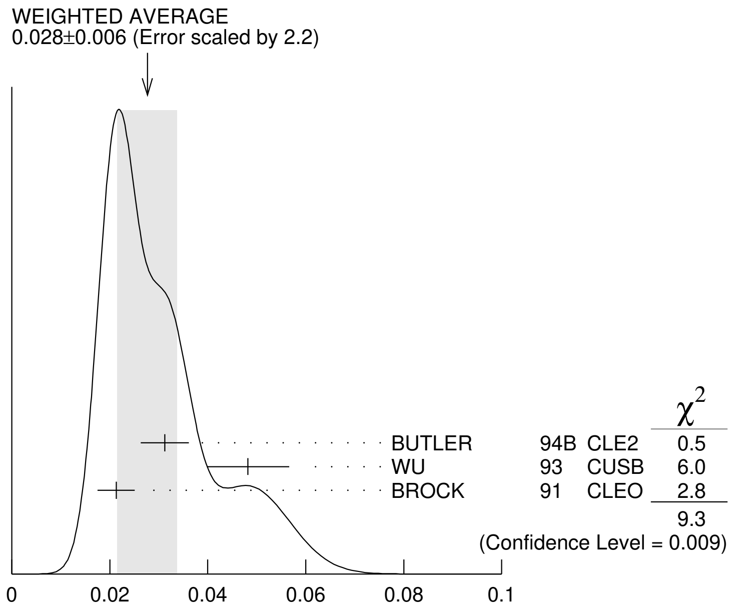
$\Upsilon(3S)$ BRANCHING RATIOS

$\Gamma(\Upsilon(2S)\text{anything})/\Gamma_{\text{total}}$ — Γ_1/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.106 ±0.008 OUR AVERAGE					
0.1023±0.0105	4625	[5,6,7] BUTLER	94B	CLE2	$e^+e^- \rightarrow \ell^+\ell^- X$
0.111 ±0.012	4891	[6,7,8] BROCK	91	CLEO	$e^+e^- \rightarrow \pi^+\pi^- X$, $\pi^+\pi^-\ell^+\ell^-$

$\Gamma(\Upsilon(2S)\pi^+\pi^-)/\Gamma_{\text{total}}$ — Γ_2/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.028 ±0.006 OUR AVERAGE Error includes scale factor of 2.2. See the ideogram below.					
0.0312±0.0049	980	[5,9] BUTLER	94B	CLE2	$e^+e^- \rightarrow \pi^+\pi^-\ell^+\ell^-$
0.0482±0.0065±0.0053	138	[8] WU	93	CUSB	$\Upsilon(3S) \rightarrow \pi^+\pi^-\ell^+\ell^-$
0.0213±0.0038	974	[8] BROCK	91	CLEO	$e^+e^- \rightarrow \pi^+\pi^- X$, $\pi^+\pi^-\ell^+\ell^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.031 ±0.020	5	MAGERAS	82	CUSB	$\Upsilon(3S) \rightarrow \pi^+\pi^-\ell^+\ell^-$



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

$\Gamma(\Upsilon(2S)\pi^0\pi^0)/\Gamma_{\text{total}}$ — Γ_3/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0200±0.0032 OUR AVERAGE					
0.0216±0.0039		[9,10] BUTLER	94B	CLE2	$e^+e^- \to \ell^+\ell^-\pi^0\pi^0$
0.017 ±0.005 ±0.002	10	[11] HEINTZ	92	CSB2	$e^+e^- \to \ell^+\ell^-\pi^0\pi^0$

$\Gamma(\Upsilon(2S)\gamma\gamma)/\Gamma_{\text{total}}$ — Γ_4/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.0502±0.0069	[9] BUTLER	94B	CLE2	$e^+e^- \to \ell^+\ell^- 2\gamma$

$\Gamma(\Upsilon(1S)\pi^+\pi^-)/\Gamma_{\text{total}}$ — Γ_5/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0448±0.0021 OUR AVERAGE					
0.0452±0.0035	11830	[6] BUTLER	94B	CLE2	$e^+e^- \to \pi^+\pi^- X$, $\pi^+\pi^-\ell^+\ell^-$
0.0446±0.0034±0.0050	451	[6] WU	93	CUSB	$\Upsilon(3S) \to \pi^+\pi^-\ell^+\ell^-$
0.0446±0.0030	11221	[6] BROCK	91	CLEO	$e^+e^- \to \pi^+\pi^- X$, $\pi^+\pi^-\ell^+\ell^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.049 ±0.010	22	GREEN	82	CLEO	$\Upsilon(3S) \to \pi^+\pi^-\ell^+\ell^-$
0.039 ±0.013	26	MAGERAS	82	CUSB	$\Upsilon(3S) \to \pi^+\pi^-\ell^+\ell^-$

$\Gamma(\Upsilon(1S)\pi^0\pi^0)/\Gamma_{\text{total}}$ — Γ_6/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0206±0.0028 OUR AVERAGE					
0.0199±0.0034	56	[6] BUTLER	94B	CLE2	$e^+e^- \to \ell^+\ell^-\pi^0\pi^0$
0.022 ±0.004 ±0.003	33	[12] HEINTZ	92	CSB2	$e^+e^- \to \ell^+\ell^-\pi^0\pi^0$

$\Gamma(\Upsilon(1S)\eta)/\Gamma_{\text{total}}$ — Γ_7/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.0022	90	BROCK	91	CLEO	$e^+e^- \to \pi^+\pi^-\pi^0\ell^+\ell^-$

$\Gamma(\mu^+\mu^-)/\Gamma_{\text{total}}$ — Γ_8/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.0181±0.0017 OUR AVERAGE					
0.0202±0.0019±0.0033		CHEN	89B	CLEO	$e^+e^- \to \mu^+\mu^-$
0.0173±0.0015±0.0011		KAARSBERG	89	CSB2	$e^+e^- \to \mu^+\mu^-$
0.033 ±0.013 ±0.007	1096	ANDREWS	83	CLEO	$e^+e^- \to \mu^+\mu^-$

$\Gamma(\gamma\chi_{b2}(2P))/\Gamma_{\text{total}}$ — Γ_{10}/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.114±0.008 OUR AVERAGE	Error includes scale factor of 1.3.				
0.111±0.005±0.004	10319	[13] HEINTZ	92	CSB2	$e^+e^- \to \gamma$
0.135±0.003±0.017	30741	MORRISON	91	CLE2	$e^+e^- \to \gamma X$

$\Gamma(\gamma\chi_{b1}(2P))/\Gamma_{\rm total}$ Γ_{11}/Γ

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.113±0.006 OUR AVERAGE					
$0.115\pm0.005\pm0.005$	11147	[13] HEINTZ	92	CSB2	$e^+e^- \to \gamma$
$0.105^{+0.003}_{-0.002}\pm0.013$	25759	MORRISON	91	CLE2	$e^+e^- \to \gamma X$

$\Gamma(\gamma\chi_{b0}(2P))/\Gamma_{\rm total}$ Γ_{12}/Γ

VALUE	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
0.054±0.006 OUR AVERAGE	Error includes scale factor of 1.1.				
$0.060\pm0.004\pm0.006$	4959	[13] HEINTZ	92	CSB2	$e^+e^- \to \gamma$
$0.049^{+0.003}_{-0.004}\pm0.006$	9903	MORRISON	91	CLE2	$e^+e^- \to \gamma X$

[5] Using B($\Upsilon(2S) \to \Upsilon(1S)\gamma\gamma$) = (0.038 ± 0.007)%, and B($\Upsilon(2S) \to \Upsilon(1S)\pi^0\pi^0$) = (1/2)B($\Upsilon(2S) \to \Upsilon(1S)\pi^+\pi^-$).

[6] Using B($\Upsilon(1S) \to \mu^+\mu^-$) = (2.48 ± 0.06)%. With the assumption of $e\mu$ universality.

[7] Using B($\Upsilon(2S) \to \Upsilon(1S)\pi^+\pi^-$) = (18.5 ± 0.8)%.

[8] Using B($\Upsilon(2S) \to \mu^+\mu^-$) = (1.31 ± 0.21)%, B($\Upsilon(2S) \to \Upsilon(1S)\gamma\gamma$)×2B($\Upsilon(1S) \to \mu^+\mu^-$) = (0.188 ± 0.035)%, and B($\Upsilon(2S) \to \Upsilon(1S)\pi^0\pi^0$)×2B($\Upsilon(1S) \to \mu^+\mu^-$) = (0.436 ± 0.056)%. With the assumption of $e\mu$ universality.

[9] From the exclusive mode.

[10] B($\Upsilon(2S) \to \mu^+\mu^-$) = (1.31 ± 0.21)% and assuming $e\mu$ universality.

[11] B($\Upsilon(2S) \to \mu^+\mu^-$) = (1.44 ± 0.10)% and assuming $e\mu$ universality. Supersedes HEINTZ 91.

[12] Using B($\Upsilon(1S) \to \mu^+\mu^-$) = (2.57 ± 0.07)% and assuming $e\mu$ universality. Supersedes HEINTZ 91.

[13] Supersedes NARAIN 91.

$\Upsilon(3S)$ REFERENCES

ARTAMONOV	00	PL B474 427	A.S. Artamonov *et al.*	
BUTLER	94B	PR D49 40	F. Butler *et al.*	(CLEO Collab.)
WU	93	PL B301 307	Q.W. Wu *et al.*	(CUSB Collab.)
HEINTZ	92	PR D46 1928	U. Heintz *et al.*	(CUSB II Collab.)
BROCK	91	PR D43 1448	I.C. Brock *et al.*	(CLEO Collab.)
HEINTZ	91	PRL 66 1563	U. Heintz *et al.*	(CUSB Collab.)
MORRISON	91	PRL 67 1696	R.J. Morrison *et al.*	(CLEO Collab.)
NARAIN	91	PRL 66 3113	M. Narain *et al.*	(CUSB Collab.)
CHEN	89B	PR D39 3528	W.Y. Chen *et al.*	(CLEO Collab.)
KAARSBERG	89	PRL 62 2077	T.M. Kaarsberg *et al.*	(CUSB Collab.)
BUCHMUEL...	88	HE e^+e^- Physics 412	W. Buchmueller, S. Cooper	(HANN, DESY, MIT)
		Editors: A. Ali and P. Soeding, World Scientific, Singapore		
COHEN	87	RMP 59 1121	E.R. Cohen, B.N. Taylor	(RISC, NBS)
BARU	86B	ZPHY C32 622	S.E. Baru *et al.*	(NOVO)
KURAEV	85	SJNP 41 466	E.A. Kuraev, V.S. Fadin	(NOVO)
		Translated from YAF 41 733.		
ARTAMONOV	84	PL 137B 272	A.S. Artamonov *et al.*	(NOVO)
GILES	84B	PR D29 1285	R. Giles *et al.*	(CLEO Collab.)
ANDREWS	83	PRL 50 807	D.E. Andrews *et al.*	(CLEO Collab.)
GREEN	82	PRL 49 617	J. Green *et al.*	(CLEO Collab.)
MAGERAS	82	PL 118B 453	G. Mageras *et al.*	(COLU, CORN, LSU+)

OTHER RELATED PAPERS

ALEXANDER	89	NP B320 45	J.P. Alexander *et al.*	(LBL, MICH, SLAC)
ARTAMONOV	84	PL 137B 272	A.S. Artamonov *et al.*	(NOVO)
GILES	84B	PR D29 1285	R. Giles *et al.*	(CLEO Collab.)
HAN	82	PRL 49 1612	K. Han *et al.*	(CUSB Collab.)
PETERSON	82	PL 114B 277	D. Peterson *et al.*	(CUSB Collab.)
KAPLAN	78	PRL 40 435	D.M. Kaplan *et al.*	(STON, FNAL, COLU)
YOH	78	PRL 41 684	J.K. Yoh *et al.*	(COLU, FNAL, STON)
COBB	77	PL 72B 273	J.H. Cobb *et al.*	(BNL, CERN, SYRA, YALE)
HERB	77	PRL 39 252	S.W. Herb *et al.*	(COLU, FNAL, STON)
INNES	77	PRL 39 1240	W.R. Innes *et al.*	(COLU, FNAL, STON)