$\Upsilon(2S)$

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

$\Upsilon(2S)$ MASS

VALUE (GeV)	DOCUMENT ID		TECN	COMMENT
10.02326±0.00031 OUR AVERAGE				
10.0235 ±0.0005	[1] ARTAMONOV	00	MD1	$e^+ e^- \to$ hadrons
10.0231 ±0.0004	BARBER	84	REDE	$e^+ e^- \to$ hadrons
• • • We do not use the following data for averages, fits, limits, etc. • • •				
10.0236 ±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[3] Superseded by ARTAMONOV 00.

$\Upsilon(2S)$ WIDTH

VALUE (keV)	DOCUMENT ID
44±7 OUR EVALUATION	See the Note on Width Determinations of the Υ states

$\Upsilon(2S)$ DECAY MODES

	Mode	Fraction (Γ_i/Γ)	Confidence level
Γ_1	$\Upsilon(1S)\pi^+\pi^-$	(18.8 ±0.6) %	
Γ_2	$\Upsilon(1S)\pi^0\pi^0$	(9.0 ±0.8) %	
Γ_3	$\tau^+\tau^-$	(1.7 ±1.6) %	
Γ_4	$\mu^+\mu^-$	(1.31±0.21) %	
Γ_5	e^+e^-	(1.18±0.20) %	
Γ_6	$\Upsilon(1S)\pi^0$	$< 1.1 \times 10^{-3}$	90%
Γ_7	$\Upsilon(1S)\eta$	$< 2 \times 10^{-3}$	90%
Γ_8	$J/\psi(1S)$anything	$< 6 \times 10^{-3}$	90%
	Radiative decays		
Γ_9	$\gamma\chi_{b1}(1P)$	(6.8 ±0.7) %	
Γ_{10}	$\gamma\chi_{b2}(1P)$	(7.0 ±0.6) %	
Γ_{11}	$\gamma\chi_{b0}(1P)$	(3.8 ±0.6) %	
Γ_{12}	$\gamma f_0(1710)$	$< 5.9 \times 10^{-4}$	90%
Γ_{13}	$\gamma f'_2(1525)$	$< 5.3 \times 10^{-4}$	90%
Γ_{14}	$\gamma f_2(1270)$	$< 2.41 \times 10^{-4}$	90%
Γ_{15}	$\gamma f_J(2220)$		

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

$\Gamma(e^+e^-) \times \Gamma(\mu^+\mu^-)/\Gamma_{total}$ — $\Gamma_5\Gamma_4/\Gamma$

VALUE (eV)	DOCUMENT ID		TECN	COMMENT
6.5±1.5±1.0	KOBEL	92	CBAL	$e^+e^- \to \mu^+\mu^-$

$\Gamma(\text{hadrons}) \times \Gamma(e^+e^-)/\Gamma_{\text{total}}$ — $\Gamma_0\Gamma_5/\Gamma$

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
0.553±0.023 OUR AVERAGE				
0.552±0.031±0.017	[4] BARU	96	MD1	$e^+e^- \to$ hadrons
0.54 ±0.04 ±0.02	[4] JAKUBOWSKI	88	CBAL	$e^+e^- \to$ hadrons
0.58 ±0.03 ±0.04	[5] GILES	84B	CLEO	$e^+e^- \to$ hadrons
0.60 ±0.12 ±0.07	[5] ALBRECHT	82	DASP	$e^+e^- \to$ hadrons
0.54 ±0.07 $^{+0.09}_{-0.05}$	[5] NICZYPORUK	81C	LENA	$e^+e^- \to$ hadrons
0.41 ±0.18	[5] BOCK	80	CNTR	$e^+e^- \to$ hadrons

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

$\Upsilon(2S)$ PARTIAL WIDTHS

$\Gamma(e^+e^-)$ — Γ_5

VALUE (keV)	DOCUMENT ID		TECN	COMMENT
0.52 ±0.03 ±0.01	[6] ALBRECHT	95E	ARG	$e^+e^- \to$ hadrons

[6] Applying the formula of Kuraev and Fadin.

$\Upsilon(2S)$ BRANCHING RATIOS

$\Gamma(J/\psi(1S)\text{anything})/\Gamma_{\text{total}}$ — Γ_8/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.006	90	MASCHMANN	90	CBAL	$e^+e^- \to$ hadrons

$\Gamma(\Upsilon(1S)\pi^+\pi^-)/\Gamma_{\text{total}}$ — Γ_1/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.188±0.006 OUR AVERAGE					
0.192±0.002±0.010	52.6k	[7] ALEXANDER	98	CLE2	$\pi^+\pi^-\ell^+\ell^-$, $\pi^+\pi^-$ MM
0.181±0.005±0.010	11.6k	ALBRECHT	87	ARG	$e^+e^- \to \pi^+\pi^-$ MM
0.169±0.040		GELPHMAN	85	CBAL	$e^+e^- \to e^+e^-\pi^+\pi^-$
0.191±0.012±0.006		BESSON	84	CLEO	$\pi^+\pi^-$ MM
0.189±0.026		FONSECA	84	CUSB	$e^+e^- \to \ell^+\ell^-\pi^+\pi^-$
0.21 ±0.07	7	NICZYPORUK	81B	LENA	$e^+e^- \to \ell^+\ell^-\pi^+\pi^-$

[7] Using $B(\Upsilon(1S) \to e^+e^-) = (2.52 \pm 0.17)\%$ and $B(\Upsilon(1S) \to \mu^+\mu^-) = (2.48 \pm 0.07)\%$.

$\Gamma(\Upsilon(1S)\pi^0\pi^0)/\Gamma_{\text{total}}$ — Γ_2/Γ

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.090±0.008 OUR AVERAGE					
0.092±0.006±0.008	275	[8] ALEXANDER	98	CLE2	$e^+e^- \to \ell^+\ell^-\pi^0\pi^0$
0.095±0.019±0.019	25	ALBRECHT	87	ARG	$e^+e^- \to \pi^0\pi^0\ell^+\ell^-$
0.080±0.015		GELPHMAN	85	CBAL	$e^+e^- \to \ell^+\ell^-\pi^0\pi^0$
0.103±0.023		FONSECA	84	CUSB	$e^+e^- \to \ell^+\ell^-\pi^0\pi^0$

[8] Using $B(\Upsilon(1S) \to e^+e^-) = (2.52 \pm 0.17)\%$ and $B(\Upsilon(1S) \to \mu^+\mu^-) = (2.48 \pm 0.07)\%$.

$\Gamma(\tau^+\tau^-)/\Gamma_{total}$ — Γ_3/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.017±0.015±0.006	HAAS	84B	CLEO	$e^+e^- \rightarrow \tau^+\tau^-$

$\Gamma(\mu^+\mu^-)/\Gamma_{total}$ — Γ_4/Γ

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
0.0131±0.0021 OUR AVERAGE					
0.0122±0.0028±0.0019		[9] KOBEL	92	CBAL	$e^+e^- \rightarrow \mu^+\mu^-$
0.0138±0.0025±0.0015		KAARSBERG	89	CSB2	$e^+e^- \rightarrow \mu^+\mu^-$
0.009 ±0.006 ±0.006		[10] ALBRECHT	85	ARG	$e^+e^- \rightarrow \mu^+\mu^-$
0.018 ±0.008 ±0.005		HAAS	84B	CLEO	$e^+e^- \rightarrow \mu^+\mu^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.038	90	NICZYPORUK	81C	LENA	$e^+e^- \rightarrow \mu^+\mu^-$

[9] Taking into account interference between the resonance and continuum.
[10] Re-evaluated using B($\Upsilon(1S) \rightarrow \mu^+\mu^-$) = 0.026.

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

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.0011	90	ALEXANDER	98	CLE2	$e^+e^- \rightarrow \ell^+\ell^-\gamma\gamma$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.008	90	LURZ	87	CBAL	$e^+e^- \rightarrow \ell^+\ell^-\gamma\gamma$

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

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.002	90	FONSECA	84	CUSB	
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<0.0028	90	ALEXANDER	98	CLE2	$e^+e^- \rightarrow \ell^+\ell^-\eta$
<0.005	90	ALBRECHT	87	ARG	$e^+e^- \rightarrow \pi^+\pi^-\ell^+\ell^-$ MM
<0.007	90	LURZ	87	CBAL	$e^+e^- \rightarrow \ell^+\ell^-(\gamma\gamma, 3\pi^0)$
<0.010	90	BESSON	84	CLEO	

$\Gamma(\gamma\chi_{b1}(1P))/\Gamma_{total}$ — Γ_9/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.068±0.007 OUR AVERAGE				
0.069±0.005±0.009	EDWARDS	99	CLE2	$\Upsilon(2S) \rightarrow \gamma\chi(1P)$
0.091±0.018±0.022	ALBRECHT	85E	ARG	$e^+e^- \rightarrow \gamma$conv. X
0.065±0.007±0.012	NERNST	85	CBAL	$e^+e^- \rightarrow \gamma$X
0.080±0.017±0.016	HAAS	84	CLEO	$e^+e^- \rightarrow \gamma$conv. X
0.059±0.014	KLOPFEN...	83	CUSB	$e^+e^- \rightarrow \gamma$X

$\Gamma(\gamma\chi_{b2}(1P))/\Gamma_{total}$ — Γ_{10}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.070±0.006 OUR AVERAGE				
0.074±0.005±0.008	EDWARDS	99	CLE2	$\Upsilon(2S) \rightarrow \gamma\chi(1P)$
0.098±0.021±0.024	ALBRECHT	85E	ARG	$e^+e^- \rightarrow \gamma$conv. X
0.058±0.007±0.010	NERNST	85	CBAL	$e^+e^- \rightarrow \gamma$X
0.102±0.018±0.021	HAAS	84	CLEO	$e^+e^- \rightarrow \gamma$conv. X
0.061±0.014	KLOPFEN...	83	CUSB	$e^+e^- \rightarrow \gamma$X

$\Gamma(\gamma \chi_{b0}(1P))/\Gamma_{total}$ — Γ_{11}/Γ

VALUE	DOCUMENT ID		TECN	COMMENT
0.038±0.006 OUR AVERAGE				
0.034±0.005±0.006	EDWARDS	99	CLE2	$\Upsilon(2S) \to \gamma \chi(1P)$
0.064±0.014±0.016	ALBRECHT	85E	ARG	$e^+ e^- \to \gamma$conv. X
0.036±0.008±0.009	NERNST	85	CBAL	$e^+ e^- \to \gamma$X
0.044±0.023±0.009	HAAS	84	CLEO	$e^+ e^- \to \gamma$conv. X
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.035±0.014	KLOPFEN...	83	CUSB	$e^+ e^- \to \gamma$X

$\Gamma(\gamma f_0(1710))/\Gamma_{total}$ — Γ_{12}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
<59	90	[11] ALBRECHT	89	ARG	$\Upsilon(2S) \to \gamma K^+ K^-$
• • • We do not use the following data for averages, fits, limits, etc. • • •					
< 5.9	90	[12] ALBRECHT	89	ARG	$\Upsilon(2S) \to \gamma \pi^+ \pi^-$

[11] Re-evaluated assuming B($f_0(1710) \to K^+ K^-$) = 0.19.
[12] Includes unknown branching ratio of $f_0(1710) \to \pi^+ \pi^-$.

$\Gamma(\gamma f'_2(1525))/\Gamma_{total}$ — Γ_{13}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
<53	90	[13] ALBRECHT	89	ARG	$\Upsilon(2S) \to \gamma K^+ K^-$

[13] Re-evaluated assuming B($f'_2(1525) \to K\overline{K}$) = 0.71.

$\Gamma(\gamma f_2(1270))/\Gamma_{total}$ — Γ_{14}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
<24.1	90	[14] ALBRECHT	89	ARG	$\Upsilon(2S) \to \gamma \pi^+ \pi^-$

[14] Using B($f_2(1270) \to \pi\pi$) = 0.84.

$\Gamma(\gamma f_J(2220))/\Gamma_{total}$ — Γ_{15}/Γ

VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT
• • • We do not use the following data for averages, fits, limits, etc. • • •					
<6.8	90	[15] ALBRECHT	89	ARG	$\Upsilon(2S) \to \gamma K^+ K^-$

[15] Includes unknown branching ratio of $f_J(2220) \to K^+ K^-$.

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