

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

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

### $\Upsilon(4S)$ MASS

VALUE (GeV)	DOCUMENT ID	TECN	COMMENT
<b>10.5800 ± 0.0035</b>	<sup>1</sup> BEBEK	87 CLEO	$e^+e^- \rightarrow$ hadrons
● ● ● We do not use the following data for averages, fits, limits, etc. ● ● ●			
10.5774 ± 0.0010	<sup>2</sup> LOVELOCK	85 CUSB	$e^+e^- \rightarrow$ hadrons
<sup>1</sup> Reanalysis of BESSON 85.			
<sup>2</sup> No systematic error given.			

### $\Upsilon(4S)$ WIDTH

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT
<b>14 ± 5 OUR AVERAGE</b>	Error includes scale factor of 1.7.		
10.0 ± 2.8 ± 2.7	<sup>3</sup> ALBRECHT	95E ARG	$e^+e^- \rightarrow$ hadrons
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
<sup>3</sup> Using LEYAQUANC 77 parametrization of $\Gamma(s)$ .			

### $\Upsilon(4S)$ DECAY MODES

Mode	Fraction ( $\Gamma_i/\Gamma$ )	Confidence level
$\Gamma_1$ $B\bar{B}$	> 96 %	95%
$\Gamma_2$ $B^+B^-$		
$\Gamma_3$ $B^0\bar{B}^0$		
$\Gamma_4$ non- $B\bar{B}$	< 4 %	95%
$\Gamma_5$ $e^+e^-$	$(2.8 \pm 0.7) \times 10^{-5}$	
$\Gamma_6$ $J/\psi(1S)$ anything	< 1.9 $\times 10^{-4}$	95%
$\Gamma_7$ $D^{*+}$ anything + c.c.	< 7.4 %	90%
$\Gamma_8$ $\phi$ anything	< 2.3 $\times 10^{-3}$	90%
$\Gamma_9$ $\Upsilon(1S)$ anything	< 4 $\times 10^{-3}$	90%
$\Gamma_{10}$ $\Upsilon(1S)\pi^+\pi^-$	< 1.2 $\times 10^{-4}$	90%
$\Gamma_{11}$ $\Upsilon(2S)\pi^+\pi^-$	< 3.9 $\times 10^{-4}$	90%

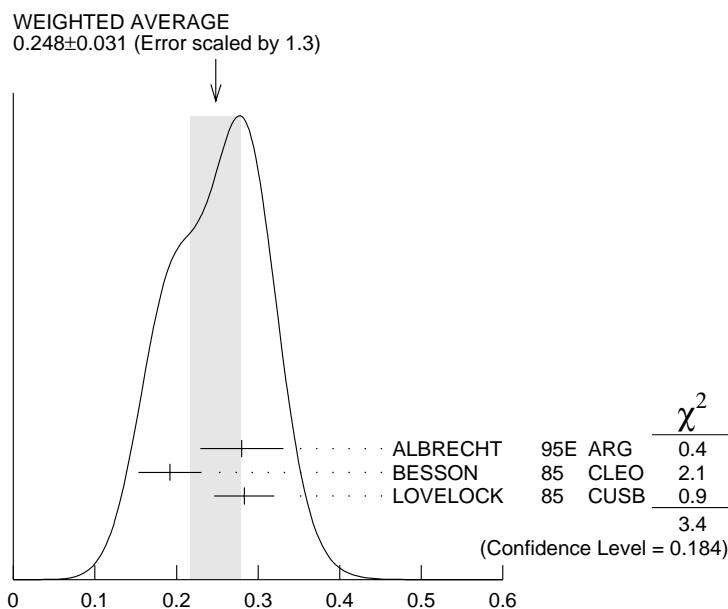
## $\Upsilon(4S)$ PARTIAL WIDTHS

$\Gamma(e^+e^-)$

$\Gamma_5$

VALUE (keV)	DOCUMENT ID	TECN	COMMENT
<b>0.248 ± 0.031 OUR AVERAGE</b>	Error includes scale factor of 1.3. See the ideogram below.		
0.28 ± 0.05 ± 0.01	<sup>4</sup> ALBRECHT	95E ARG	$e^+e^- \rightarrow$ hadrons
0.192 ± 0.007 ± 0.038	BESSION	85 CLEO	$e^+e^- \rightarrow$ hadrons
0.283 ± 0.037	LOVELOCK	85 CUSB	$e^+e^- \rightarrow$ hadrons

<sup>4</sup> Using LEYAOUANC 77 parametrization of  $\Gamma(s)$ .



$\Gamma(e^+e^-)$  (keV)

## $\Upsilon(4S)$ BRANCHING RATIOS

$\Gamma(B^+B^-)/\Gamma(B^0\bar{B}^0)$

$\Gamma_2/\Gamma_3$

VALUE	DOCUMENT ID	TECN	COMMENT
<b>1.04 ± 0.07 OUR NEW AVERAGE</b>	[1.02 ± 0.14 OUR 2002 AVERAGE]		
<b>1.041 ± 0.054 ± 0.050</b>	<sup>5</sup> ATHAR	02 CLEO	$e^+e^- \rightarrow B\bar{B}$
1.02 ± 0.14	<sup>6</sup> ALEXANDER	01 CLEO	$e^+e^- \rightarrow B\bar{B}$

• • • We do not use the following data for averages, fits, limits, etc. • • •

<sup>5</sup> Using also results from ALEXANDER 01 and assuming  $\tau_{B^+}/\tau_{B^0} = 1.074 \pm 0.028$ .

<sup>6</sup> Assuming isospin conservation with  $(\tau_{B^+})/(\tau_{B^0}) = 1.09^{+0.11}_{-0.10} \pm 0.08$ . Superseded by ATHAR 02;

**$\Gamma(e^+e^-)/\Gamma_{\text{total}}$**   **$\Gamma_5/\Gamma$**

<u>VALUE (units <math>10^{-5}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>2.77 \pm 0.50 \pm 0.49</math></b>		<sup>7</sup> ALBRECHT	95E ARG	$e^+e^- \rightarrow \text{hadrons}$

<sup>7</sup> Using LEYAOUANC 77 parametrization of  $\Gamma(s)$ .

**$[\Gamma(D^{*+} \text{ anything}) + \Gamma(\text{c.c.})]/\Gamma_{\text{total}}$**   **$\Gamma_7/\Gamma$**

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>&lt;0.074</math></b>	90	<sup>8</sup> ALEXANDER	90C CLEO	$e^+e^-$

<sup>8</sup> For  $x > 0.473$ .

**$\Gamma(\phi \text{ anything})/\Gamma_{\text{total}}$**   **$\Gamma_8/\Gamma$**

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>&lt;0.0023</math></b>	90	<sup>9</sup> ALEXANDER	90C CLEO	$e^+e^-$

<sup>9</sup> For  $x > 0.52$ .

**$\Gamma(J/\psi(1S) \text{ anything})/\Gamma_{\text{total}}$**   **$\Gamma_6/\Gamma$**

<u>VALUE (units <math>10^{-4}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>&lt;1.9</math></b>	95	<sup>10</sup> ABE	02D BELL	$e^+e^- \rightarrow J/\psi X \rightarrow \ell^+ \ell^- X$

• • • We do not use the following data for averages, fits, limits, etc. • • •

$<4.7$	90	<sup>10</sup> AUBERT	01C BABR	$e^+e^- \rightarrow J/\psi X \rightarrow \ell^+ \ell^- X$
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<sup>10</sup> Uses  $B(J/\psi \rightarrow e^+e^-) = 0.0593 \pm 0.0010$  and  $B(J/\psi \rightarrow \mu^+\mu^-) = 0.0588 \pm 0.0010$ .

**$\Gamma(\Upsilon(1S) \text{ anything})/\Gamma_{\text{total}}$**   **$\Gamma_9/\Gamma$**

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>&lt;0.004</math></b>	90	ALEXANDER	90C CLEO	$e^+e^-$

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

<u>VALUE (units <math>10^{-4}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>&lt;1.2</math></b>	90	GLENN	99 CLE2	$e^+e^-$

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

<u>VALUE (units <math>10^{-4}</math>)</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>&lt;3.9</math></b>	90	GLENN	99 CLE2	$e^+e^-$

**$\Gamma(\text{non-}B\bar{B})/\Gamma_{\text{total}}$**   **$\Gamma_4/\Gamma$**

<u>VALUE</u>	<u>CL%</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
<b><math>&lt;0.04</math></b>	95	BARISH	96B CLEO	$e^+e^-$

## $\Upsilon(4S)$ REFERENCES

ABE	02D	PRL 88 052001	K. Abe <i>et al.</i>	(BELLE Collab.)
ATHAR	02	PR D66 052003	S.B. Athar <i>et al.</i>	(CLEO Collab.)
ALEXANDER	01	PRL 86 2737	J.P. Alexander <i>et al.</i>	(CLEO Collab.)
AUBERT	01C	PRL 87 162002	B. Aubert <i>et al.</i>	(BaBar Collab.)
GLENN	99	PR D59 052003	S. Glenn <i>et al.</i>	
BARISH	96B	PRL 76 1570	B.C. Barish <i>et al.</i>	(CLEO Collab.)
ALBRECHT	95E	ZPHY C65 619	H. Albrecht <i>et al.</i>	(ARGUS Collab.)
ALEXANDER	90C	PRL 64 2226	J. Alexander <i>et al.</i>	(CLEO Collab.)
BEBEK	87	PR D36 1289	C. Bebek <i>et al.</i>	(CLEO Collab.)
BESSON	85	PRL 54 381	D. Besson <i>et al.</i>	(CLEO Collab.)
LOVELOCK	85	PRL 54 377	D.M.J. Lovelock <i>et al.</i>	(CUSB Collab.)
LEYAOUANC	77	PL B71 397	A. Le Yaouanc <i>et al.</i>	(ORSAY)

## OTHER RELATED PAPERS

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