$$I(J^P) = \frac{1}{2}(0^-)$$

Quantum numbers not measured. Values shown are quark-model predictions.

See also the B^{\pm}/B^0 ADMIXTURE and $B^{\pm}/B^0/B_s^0/b$ -baryon AD-MIXTURE sections.

See the Note "Production and Decay of *b*-flavored Hadrons" at the beginning of the B^{\pm} Particle Listings and the Note on " $B^0-\overline{B}^0$ Mixing and *CP* Violation in *B* Decay" near the end of the B^0 Particle Listings.

B⁰ MASS

The fit uses m_{B^+} , $(m_{B^0}-m_{B^+}),$ and m_{B^0} to determine $m_{B^+},\ m_{B^0},$ and the mass difference.

VALUE (MeV)	EVTS	DOCUMENT ID	TECN	COMMENT
5279.4±0.5 OUR FIT				
5279.3±0.7 OUR AVE	RAGE			
$5279.1 {\pm} 0.7 {\pm} 0.3$	135	¹ CSORNA	00 CLE2	$e^+e^- ightarrow ~\Upsilon(4S)$
$5281.3 \pm 2.2 \pm 1.4$	51	ABE	96b CDF	<i>р р</i> at 1.8 ТеV
$\bullet \bullet \bullet$ We do not use the	ne followir	ig data for average	s, fits, limits,	etc. • • •
$5279.2\!\pm\!0.54\!\pm\!2.0$	340	ALAM	94 CLE2	$e^+e^- \rightarrow \Upsilon(4S)$
$5278.0 \pm 0.4 \pm 2.0$		BORTOLETT	O92 CLEO	$e^+e^- ightarrow ~\Upsilon(4S)$
$5279.6 \pm 0.7 \pm 2.0$	40	² ALBRECHT	90J ARG	$e^+e^- ightarrow ~\Upsilon(4S)$
$5278.2 \pm 1.0 \pm 3.0$	40	ALBRECHT	87c ARG	$e^+e^- ightarrow ~\Upsilon(4S)$
$5279.5 \pm 1.6 \pm 3.0$	7	³ ALBRECHT	87d ARG	$e^+e^- ightarrow ~\Upsilon(4S)$
$5280.6 \!\pm\! 0.8 \ \pm 2.0$		BEBEK	87 CLEO	$e^+e^- \rightarrow \Upsilon(4S)$
1		0	(l) 0	

¹CSORNA 00 uses fully reconstructed 135 $B^0 o J/\psi^{(\prime)} K^0_S$ events and invariant masses without beam constraint. $^2\rm ALBRECHT$ 90J assumes 10580 for $\Upsilon(4S)$ mass. Supersedes ALBRECHT 87C and

ALBRECHT 87D.

³Found using fully reconstructed decays with J/ψ . ALBRECHT 87D assume $m_{\Upsilon(4S)} =$ 10577 MeV.

$$m_{B^0} - m_{B^+}$$

VALUE (MeV)	DOCUMENT ID	TECN	COMMENT	
0.33±0.28 OUR FIT Error	includes scale factor of 1.2	1.		
0.34 ± 0.32 OUR AVERAGE	Error includes scale facto	or of 1.2.		
$0.41\!\pm\!0.25\!\pm\!0.19$	ALAM 94	CLE2	$e^+e^- \rightarrow \Upsilon(4S)$	
$-0.4 \ \pm 0.6 \ \pm 0.5$	BORTOLETTO92	CLEO	$e^+e^- \rightarrow \Upsilon(4S)$	
$-0.9 \ \pm 1.2 \ \pm 0.5$	ALBRECHT 90J	ARG	$e^+e^- \rightarrow \Upsilon(4S)$	
$2.0 \pm 1.1 \pm 0.3$	⁴ BEBEK 87	CLEO	$e^+e^- ightarrow ~\Upsilon(4S)$	
⁴ BEBEK 87 actually measure the difference between half of $E_{\rm cm}$ and the B^{\pm} or B^0 mass, so the $m_{B^0} - m_{B^{\pm}}$ is more accurate. Assume $m_{\Upsilon(4S)} = 10580$ MeV.				

$$m_{B_H^0} - m_{B_L^0}$$

See the B^0 - \overline{B}^0 MIXING PARAMETERS section near the end of these B^0 Listings.

B⁰ MEAN LIFE

See $B^{\pm}/B^0/B_s^0/b$ -baryon ADMIXTURE section for data on *B*-hadron mean life averaged over species of bottom particles.

"OUR EVALUATION" is an average of the data listed below performed by the LEP *B* Lifetimes Working Group as described in our review "Production and Decay of *b*-flavored Hadrons" in the B^{\pm} Section of the Listings. The averaging procedure takes into account correlations between the measurements and asymmetric lifetime errors.

<u>VALUE (10^{-12} s)</u>	EVTS	DOCUMENT ID	TECN	COMMENT
1.542 ± 0.016 OUR EV	ALUATION	N _		
$1.554\!\pm\!0.030\!\pm\!0.019$		⁵ ABE	02H BELL	$e^+e^- ightarrow ~\Upsilon(4S)$
$1.529\!\pm\!0.012\!\pm\!0.029$		⁶ AUBERT	02H BABR	$e^+e^- \rightarrow \Upsilon(4S)$
$1.546\!\pm\!0.032\!\pm\!0.022$		⁵ AUBERT	01F BABR	$e^+e^- \rightarrow \Upsilon(4S)$
$1.541\!\pm\!0.028\!\pm\!0.023$		⁶ ABBIENDI,G	00b OPAL	$e^+e^- \rightarrow Z$
$1.518\!\pm\!0.053\!\pm\!0.034$		⁷ BARATE	00r ALEP	$e^+e^- \rightarrow Z$
$1.523\!\pm\!0.057\!\pm\!0.053$		⁸ ABBIENDI	99j OPAL	$e^+e^- \rightarrow Z$
$1.58\ \pm 0.09\ \pm 0.02$		⁹ ABE	98b CDF	<i>р<mark>р</mark> at 1.8 ТеV</i>
$1.474 \!\pm\! 0.039 \!+\! 0.052 \\ -0.051$		⁷ ABE	98Q CDF	<i>рр</i> at 1.8 TeV
$1.52\ \pm 0.06\ \pm 0.04$		⁸ ACCIARRI	98s L3	$e^+e^- \rightarrow Z$
$1.64\ \pm 0.08\ \pm 0.08$		⁸ ABE	97j SLD	$e^+e^- \rightarrow Z$
$1.532\!\pm\!0.041\!\pm\!0.040$		¹⁰ ABREU	97f DLPH	$e^+e^- \rightarrow Z$
$1.25 \begin{array}{c} +0.15 \\ -0.13 \end{array} \pm 0.05$	121	⁹ BUSKULIC	96J ALEP	$e^+e^- \rightarrow Z$
$\begin{array}{rrrr} 1.49 & +0.17 & +0.08 \\ -0.15 & -0.06 \end{array}$		¹¹ BUSKULIC	96J ALEP	$e^+e^- \rightarrow Z$
$1.61 \begin{array}{c} +0.14 \\ -0.13 \end{array} \pm 0.08$	7	^{7,12} ABREU	95Q DLPH	$e^+e^- \rightarrow Z$
$1.63\ \pm 0.14\ \pm 0.13$		¹³ ADAM	95 DLPH	$e^+e^- \rightarrow Z$
$1.53\ \pm 0.12\ \pm 0.08$	7	^{′,14} AKERS	95⊤ OPAL	$e^+e^- \rightarrow Z$
$\bullet \bullet \bullet$ We do not use t	he followin	g data for averages	, fits, limits,	etc. • • •
$1.54\ \pm 0.08\ \pm 0.06$		⁷ ABE	96C CDF	Repl. by ABE 98Q
$1.55\ \pm 0.06\ \pm 0.03$		¹⁵ BUSKULIC	96J ALEP	$e^+e^- \rightarrow Z$
$1.61\ \pm 0.07\ \pm 0.04$		⁷ BUSKULIC	96J ALEP	Repl. by BARATE 00R
1.62 ± 0.12		¹⁶ ADAM	95 DLPH	$e^+e^- \rightarrow Z$
$1.57\ \pm 0.18\ \pm 0.08$	121	⁹ ABE	94d CDF	Repl. by ABE 98B
$1.17 \begin{array}{c} +0.29 \\ -0.23 \end{array} \pm 0.16$	96	⁷ ABREU	93D DLPH	Sup. by ABREU 95Q
$1.55\ \pm 0.25\ \pm 0.18$	76	¹³ ABREU	93G DLPH	Sup. by ADAM 95
$1.51 \begin{array}{c} +0.24 \\ -0.23 \end{array} \begin{array}{c} +0.12 \\ -0.14 \end{array}$	78	⁷ ACTON	93c OPAL	Sup. by AKERS 95⊤
$\begin{array}{rrrr} 1.52 & +0.20 & +0.07 \\ & -0.18 & -0.13 \end{array}$	77	⁷ BUSKULIC	93D ALEP	Sup. by BUSKULIC 96J
$\begin{array}{rrrr} 1.20 & +0.52 & +0.16 \\ & -0.36 & -0.14 \end{array}$	15	¹⁷ WAGNER	90 MRK2	$E_{\rm cm}^{ee}$ = 29 GeV
$0.82 \begin{array}{c} +0.57 \\ -0.37 \end{array} \pm 0.27$		¹⁸ AVERILL	89 HRS	E ^{ee} _{cm} = 29 GeV

⁵ Events are selected in which one B meson is fully reconstructed while the second B meson is reconstructed inclusively.

⁶ Data analyzed using partially reconsturcted $\overline{B}^0 \rightarrow D^{*+} \ell^- \overline{\nu}$ decays.

⁷ Data analyzed using $D/D^* \ell X$ event vertices.

- ⁸ Data analyzed using charge of secondary vertex.
- ⁹Measured mean life using fully reconstructed decays.
- ¹⁰ Data analyzed using inclusive $D/D^* \ell X$.
- 11 Measured mean life using partially reconstructed $D^{*-}\pi^+ X$ vertices.
- ¹²ABREU 95Q assumes $B(B^0 \rightarrow D^{**-} \ell^+ \nu_{\ell}) = 3.2 \pm 1.7\%$.
- 13 Data analyzed using vertex-charge technique to tag B charge.
- ¹⁴ AKERS 95T assumes $B(B^0 \rightarrow D_s^{(*)}D^{0(*)}) = 5.0 \pm 0.9\%$ to find B^+/B^0 yield.
- ¹⁵ Combined result of $D/D^* \ell x$ analysis, fully reconstructed B analysis, and partially reconstructed $D^{*-} \pi^+ X$ analysis.
- ¹⁶ Combined ABREU 95Q and ADAM 95 result.
- ¹⁷WAGNER 90 tagged B^0 mesons by their decays into $D^{*-}e^+\nu$ and $D^{*-}\mu^+\nu$ where the D^{*-} is tagged by its decay into $\pi^-\overline{D}^0$.
- ¹⁸ AVERILL 89 is an estimate of the B^0 mean lifetime assuming that $B^0 \rightarrow D^{*+} + X$ always.

MEAN LIFE RATIO τ_{B^+}/τ_{B^0}

τ_{B^+}/τ_{B^0} (direct measurements)

"OUR EVALUATION" is an average of the data listed below performed by the LEP B Lifetimes Working Group as described in our review "Production and Decay of b-flavored Hadrons" in the B^{\pm} Section of the Listings. The averaging procedure takes into account correlations between the measurements and asymmetric lifetime errors.

<u>VALUE</u> <u>EVTS</u> <u>DOCUMENT ID</u> <u>TECN</u> <u>COMMENT</u> The data in this block is included in the average printed for a previous datablock.

1.083 ± 0.017 OUR EVALUATION

$1.091 \!\pm\! 0.023 \!\pm\! 0.014$	¹⁹ ABE	02H BELL	$e^+e^- \rightarrow \Upsilon(4S)$
$1.082\!\pm\!0.026\!\pm\!0.012$	¹⁹ AUBERT	01F BABR	$e^+e^- \rightarrow \Upsilon(4S)$
$1.085 \!\pm\! 0.059 \!\pm\! 0.018$	²⁰ BARATE	00r ALEP	$e^+e^- \rightarrow Z$
$1.079 \!\pm\! 0.064 \!\pm\! 0.041$	²¹ ABBIENDI	99J OPAL	$e^+e^- \rightarrow Z$
$1.06\ \pm 0.07\ \pm 0.02$	²² ABE	98b CDF	<i>р</i> рат 1.8 ТеV
$1.110 \!\pm\! 0.056 \!+\! 0.033 \\ -\! 0.030$	²⁰ ABE	98Q CDF	<i>р</i> рат 1.8 ТеV
$1.09 \ \pm 0.07 \ \pm 0.03$	²¹ ACCIARRI	98s L3	$e^+e^- \rightarrow Z$
$1.01 \ \pm 0.07 \ \pm 0.06$	²¹ ABE	97j SLD	$e^+e^- \rightarrow Z$
$1.27 \begin{array}{r} +0.23 \\ -0.19 \end{array} \begin{array}{r} +0.03 \\ -0.02 \end{array}$	²² BUSKULIC	96J ALEP	$e^+e^- \rightarrow Z$
$1.00 \begin{array}{c} +0.17 \\ -0.15 \end{array} \pm 0.10$	^{20,23} ABREU	95Q DLPH	$e^+e^- \rightarrow Z$
$1.06 \begin{array}{c} +0.13 \\ -0.10 \end{array} \pm 0.10$	²⁴ ADAM	95 DLPH	$e^+e^- \rightarrow Z$
$0.99 \ \pm 0.14 \ \begin{array}{c} + \ 0.05 \\ - \ 0.04 \end{array}$	^{20,25} AKERS	95⊤ OPAL	$e^+e^- \rightarrow Z$

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

1.01	± 0.11	± 0.02		²⁰ ABE	96c CDF	Repl. by ABE 980
1.03	± 0.08	± 0.02		²⁶ BUSKULIC	96J ALEP	$e^+e^- \rightarrow Z$
0.98	± 0.08	± 0.03		²⁰ BUSKULIC	96J ALEP	Repl. by BARATE 00R
1.02	± 0.16	± 0.05	269	²² ABE	94d CDF	Repl. by ABE 98B
1.11	$^{\rm +0.51}_{\rm -0.39}$	± 0.11	188	²⁰ ABREU	93D DLPH	Sup. by ABREU 95Q
1.01	$^{\rm +0.29}_{\rm -0.22}$	± 0.12	253	²⁴ ABREU	93G DLPH	Sup. by ADAM 95
1.0	$^{\rm +0.33}_{\rm -0.25}$	± 0.08	130	ACTON	93c OPAL	Sup. by AKERS 95⊤
0.96	$^{\rm +0.19}_{\rm -0.15}$	$^{+0.18}_{-0.12}$	154	²⁰ BUSKULIC	93d ALEP	Sup. by BUSKULIC 96.

 19 Events are selected in which one B meson is fully reconstructed while the second B meson is reconstructed inclusively.

²⁰ Data analyzed using $D/D^* \ell X$ vertices.

²¹ Data analyzed using charge of secondary vertex.

²² Measured using fully reconstructed decays.

²³ABREU 95Q assumes $B(B^0 \rightarrow D^{**-}\ell^+\nu_\ell) = 3.2 \pm 1.7\%$.

²⁴ Data analyzed using vertex-charge technique to tag *B* charge. ²⁵ AKERS 95T assumes $B(B^0 \rightarrow D_s^{(*)}D^{0(*)}) = 5.0 \pm 0.9\%$ to find B^+/B^0 yield.

²⁶ Combined result of $D/D^* \ell X$ analysis and fully reconstructed B analysis.

τ_{B^+}/τ_{B^0} (inferred from branching fractions)

These measurements are inferred from the branching fractions for semileptonic decay or other spectator-dominated decays by assuming that the rates for such decays are equal for B^0 and B^+ . We do not use measurements which assume equal production of B^0 and B^+ because of the large uncertainty in the production ratio.

DOCUMENT ID TECN COMMENT <u>VALUE</u> <u>CL%</u>EVTS The data in this block is included in the average printed for a previous datablock.

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

$0.95^{+0.117}_{-0.080}{\pm}0.091$		²⁷ ARTUSO	97 CLE2	$e^+e^- ightarrow ~\Upsilon(4S)$
$1.15\!\pm\!0.17\ \pm0.06$		²⁸ JESSOP	97 CLE2	$e^+e^- \rightarrow \Upsilon(4S)$
$0.93 {\pm} 0.18 \ {\pm} 0.12$		²⁹ ATHANAS	94 CLE2	Sup. by AR-
$0.91 {\pm} 0.27 {\ \pm} 0.21$		³⁰ ALBRECHT	92c ARG	$ ext{TUSO 97} e^+e^- ightarrow extsf{7}(4S)$
1.0 ± 0.4		29 ^{30,31} ALBRECHT	92g ARG	$e^+e^- \rightarrow \Upsilon(4S)$
$0.89 \!\pm\! 0.19 \ \pm 0.13$		³⁰ FULTON	91 CLEO	$e^+e^- \rightarrow \Upsilon(4S)$
$1.00\!\pm\!0.23\ \pm0.14$		³⁰ ALBRECHT	89L ARG	$e^+e^- ightarrow ~\Upsilon(4S)$
0.49 to 2.3	90	³² BEAN	87b CLEO	$e^+e^- \rightarrow \Upsilon(4S)$

 27 ARTUSO 97 uses partial reconstruction of $B \rightarrow D^* \ell \nu_{\ell}$ and independent of B^0 and B^+ production fraction.

²⁸ Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.

²⁹ATHANAS 94 uses events tagged by fully reconstructed B^- decays and partially or fully reconstructed B^0 decays.

³⁰ Assumes equal production of B^0 and B^+ .

³¹ALBRECHT 92G data analyzed using $B \rightarrow D_s \overline{D}, D_s \overline{D}^*, D_s^* \overline{D}, D_s^* \overline{D}^*$ events.

³² BEAN 87B assume the fraction of $B^0 \overline{B}{}^0$ events at the $\Upsilon(4S)$ is 0.41.

 $\big| \Delta \Gamma_{B^0_d} \big| / \Gamma_{B^0_d}$

 $\Gamma_{B_d^0}$ and $|\Delta\Gamma_{B_d^0}|$ are the decay rate average and difference between two B_d^0 *CP* eigenstates.

VALUE	<u>CL%</u>	DOCUMENT ID	TECN	COMMENT
<0.80	95	33,34 BEHRENS 00	b CLE2	$e^+e^- \rightarrow \Upsilon(4S)$
33 BEHRENS 00B uses high-momentum lepton tags and partially reconstructed $\overline{B}{}^0$ $ o$				
$D^{*+}\pi^-$, ρ^- decays to determine the flavor of the <i>B</i> meson.				
⁵⁴ Assumes Δ_{md} =0.478 \pm 0.018 ps ⁻¹ and $ au_{B^0}$ =1.548 \pm 0.032 ps.				

B⁰ DECAY MODES

 \overline{B}^0 modes are charge conjugates of the modes below. Reactions indicate the weak decay vertex and do not include mixing. Modes which do not identify the charge state of the *B* are listed in the B^{\pm}/B^0 ADMIXTURE section.

The branching fractions listed below assume 50% $B^0 \overline{B}{}^0$ and 50% $B^+ B^-$ production at the $\Upsilon(4S)$. We have attempted to bring older measurements up to date by rescaling their assumed $\Upsilon(4S)$ production ratio to 50:50 and their assumed D, D_s , D^* , and ψ branching ratios to current values whenever this would affect our averages and best limits significantly.

Indentation is used to indicate a subchannel of a previous reaction. All resonant subchannels have been corrected for resonance branching fractions to the final state so the sum of the subchannel branching fractions can exceed that of the final state.

	Mode	F	Fraction (Γ _i /Γ)	Scale factor/ Confidence level
Γ ₁ Γ ₂ Γ ₃ Γ ₄ Γ ₅	$\ell^+ u_\ell$ anything $D^- \ell^+ u_\ell$ $D^* (2010)^- \ell^+ u_\ell$ $ ho^- \ell^+ u_\ell$ $\pi^- \ell^+ u_\ell$	[a] [a] [a] [a]	$(10.5 \pm 0.8) \%$ (2.11±0.17) % (4.60±0.21) % (2.6 $^{+0.6}_{-0.7}$) × 10 (1.8 ±0.6) × 10	4 4
Г ₆ Г ₇	$\begin{array}{l} {\rm Inclusive} \\ \pi^- \mu^+ \nu_\mu \\ {\rm K}^+ {\rm anything} \end{array}$	mode	es (78 ±8)%	

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 $D, D^*, \text{ or } D_s \text{ modes}$

Г ₈	$D^-\pi^+$	$(3.0 \pm 0.4$	1) $ imes$ 10 $^{-3}$	
Γg	$D^- ho^+$	(7.8 ± 1.4)	↓)×10 ⁻³	
Γ ₁₀	$D^{-}K^{*}(892)^{+}$	(3.7 ± 1.8)	3) $ imes$ 10 $^{-4}$	
Γ_{11}	$D^- \omega \pi^+$	(2.8 ± 0.6	5) $ imes$ 10 $^{-3}$	
Γ_{12}	D^-K^+	(2.0 ± 0.6	5) $ imes$ 10 $^{-4}$	
Γ ₁₃	$\overline{D}{}^{0}\pi^{+}\pi^{-}$	< 1.6	imes 10 ⁻³	CL=90%
Γ_{14}	$D^*(2010)^-\pi^+$	(2.76 ± 0.2)	$(21) \times 10^{-3}$	
Γ_{15}	$D^{-}\pi^{+}\pi^{+}\pi^{-}$	(8.0 ± 2.5	5) $\times 10^{-3}$	
Γ ₁₆	$(D^{-}\pi^{+}\pi^{+}\pi^{-})$ nonresonant	(3.9 ± 1.9	$) \times 10^{-3}$	
Γ ₁₇	$D^-\pi^+ ho^0$	($1.1~\pm1.0$)) $\times 10^{-3}$	
Γ ₁₈	$D^-a_1(1260)^+$	(6.0 ± 3.3)	3) $ imes$ 10 $^{-3}$	
Γ ₁₉	$D^*(2010)^- \pi^+ \pi^0$	(1.5 ± 0.5	5)%	
Γ ₂₀	$D^*(2010)^- ho^+$	(7.3 ± 1.5	5) × 10^{-3}	
Γ ₂₁	$D^*(2010)^- K^+$	(2.0 ± 0.5)	5) $\times 10^{-4}$	
Γ ₂₂	$D^{*}(2010)^{-}K^{*}(892)^{+}$	(3.8 ± 1.5	5) $\times 10^{-4}$	
Γ ₂₃	$D^*(2010)^-\pi^+\pi^+\pi^-$	(7.6 ± 1.8	$3) \times 10^{-3}$	S=1.4
Γ ₂₄	$(D^*(2010)^-\pi^+\pi^+\pi^-)$ non-	(0.0 ± 2.5)	5) × 10 ⁻³	
Г	resonant $D^*(2010) = \pi^+ a^0$		10-3	
г <u>25</u> Гас	$D^{*}(2010)^{-2} (1260)^{+}$	(5.7 ± 3.2)	$(2) \times 10^{-1}$	
г <u>26</u> Гат	$D^{*}(2010)^{-}\pi^{+}\pi^{+}\pi^{-}\pi^{0}$	(1.30 ± 0.2)	27) /0 07) %	
г 27 Гоо	$D^{*}(2010) + \pi^{+}\pi^{-}\pi^{-}\pi^{0}$	(1.70 ± 0.2)	7)%	
г <u>28</u> Гоо	$D^{*}(2010)^{-} p \overline{p} \pi^{+}$	(1.0 ± 0.7)	5×10^{-4}	
г <u>29</u> Гао	$D^{*}(2010)^{-} p \overline{p}$	(0.5 ± 0.4)	10^{-3}	
г 30 Гат	$\frac{D}{D^*}(2010)^- \omega \pi^+$	(29 ± 0.5)	5×10^{-3}	
· 31	$\frac{D}{D_{2}^{*}(2460)} \pi^{+}$	< 2.2	× 10 ⁻³	CI =90%
· 52	$\frac{D}{D^*}(2460) = a^+$	< 4.9	× 10 ⁻³	CI 90%
· 33	$D^{-}D^{+}$	< 9.4	× 10 ⁻⁴	CL 90%
י 34 Гог	$D^{-}D^{+}$	(80 +30	(10^{-3})	CL—9070
- 35 Fac	$D^{*}(2010)^{-}D^{+}$	(0.0 ± 0.0)	22) 0/	
130 Ea-	$D^{-}D^{*+}$		5) %	
г <u>37</u> Г.	$D^{*}(2010) - D^{*+}$	(1.0 ± 0.3)) /0 =) 0/	
г <u>38</u> Г	$D^{+} \pi^{-}$	(1.0 ±0.0) /0 v 10-4	
I 39	D_s^{*+}	< 2.8	$\times 10^{-4}$	CL=90%
I 40	$D_s \pi$	< 5	× 10 +	CL=90%
I ₄₁	$D_{s}^{\dagger}\rho^{-}$	< 7	× 10 ⁻⁴	CL=90%
I ₄₂	$D_{s}^{++}\rho^{-}$	< 8	$\times 10^{-4}$	CL=90%
Г ₄₃	$D_{s}^{+}a_{1}(1260)^{-}$	< 2.6	$\times 10^{-3}$	CL=90%
Г ₄₄	$D_s^{*+} a_1(1260)^-$	< 2.2	imes 10 ⁻³	CL=90%
Г ₄₅	$D_s^- K^+$	< 2.4	imes 10 ⁻⁴	CL=90%
Г ₄₆	$D_s^{*-}K^+$	< 1.7	imes 10 ⁻⁴	CL=90%
Γ ₄₇	$D_{s}^{-}K^{*}(892)^{+}$	< 9.9	imes 10 ⁻⁴	CL=90%

Г ₄₈	$D_{s}^{*-}K^{*}(892)^{+}$	< 1.1	imes 10 ⁻³	CL=90%
Г ₄₉	$D_{s}^{-}\pi^{+}K^{0}$	< 5	imes 10 ⁻³	CL=90%
Г ₅₀	$D_{s}^{*-}\pi^{+}K^{0}$	< 3.1	imes 10 ⁻³	CL=90%
Г ₅₁	$D_{s}^{-}\pi^{+}K^{*}(892)^{0}$	< 4	imes 10 ⁻³	CL=90%
Γ ₅₂	$D_{s}^{*-}\pi^{+}K^{*}(892)^{0}$	< 2.0	imes 10 ⁻³	CL=90%
Γ ₅₃	$\overline{D}^{0}\pi^{0}$	(2.9 ± 0.5)	5) $ imes$ 10 $^{-4}$	
Г ₅₄	$\overline{D}{}^0 ho^0$	< 3.9	imes 10 ⁻⁴	CL=90%
Γ ₅₅	$\overline{D}{}^{0}\eta$	(1.4 + 0.6)	\dot{b}) $ imes$ 10 $^{-4}$	
Γ ₅₆	$\overline{D}_{0}^{0}\eta'$	< 9.4	imes 10 ⁻⁴	CL=90%
Г ₅₇	$\overline{D}^{0}\omega$	(1.8 ± 0.6	5) × 10 ⁻⁴	
Γ ₅₈	$\frac{D^{*0}\gamma}{\overline{D}}$	< 5.0	$\times 10^{-5}$	CL=90%
Г ₅₉	$D^{*}(2007)^{0}\pi^{0}$	(2.5 ± 0.7)	$() \times 10^{-4}$	
I 60	$\frac{D^{*}(2007)^{\circ}}{D^{*}(2007)^{\circ}}$	< 5.6	$\times 10^{-4}$	CL=90%
l ₆₁	$\frac{D^{*}(2007)^{\circ}\eta}{D^{*}(2007)^{0}}$	< 2.6	$\times 10^{-4}$	CL=90%
Г ₆₂	$D^{*}(2007)^{\circ} \eta^{\circ}$	< 1.4	$\times 10^{-3}$	CL=90%
^т 63 Г.	$D^{*}(2007)^{0} \pi^{+} \pi^{+} \pi^{-} \pi^{-}$	< (.4)	$\times 10^{-3}$	CL=90%
• 64 _	$D(2007)$ $\pi \cdot \pi \cdot \pi \cdot \pi$	(3.0 ± 0.9)) × 10 -	
l ₆₅	$D^{*}(2010)^{+}D^{*}(2010)^{-}$	(9.9 + 3.5)	$(5) \times 10^{-4}$	
Г ₆₆	$D^{*}(2010)^{+}D^{-}$	< 6.3	imes 10 ⁻⁴	CL=90%
Г ₆₇	$D^{(*)0}D^{(*)0}$	< 2.7	%	CL=90%
	Charmon	ium modes		
Г ₆₈	$\eta_c K^0$	$(1.1 + 0.6 \\ -0.5)$	\dot{b}) $ imes$ 10 $^{-3}$	
Г ₆₉	$J/\psi(1S) K^0$	(8.7 ± 0.5)	5) $ imes$ 10 $^{-4}$	
Γ ₇₀	$J/\psi(1S)K^+\pi^-$	(1.2 ± 0.6	$5) imes 10^{-3}$	
Γ ₇₁	$J/\psi(1S){ m K}^{*}(892)^{0}$	(1.31 ± 0.0)	$(9) \times 10^{-3}$	
Γ ₇₂	$J/\psi(1S)\phiK^0$	(8.8 + 3.7)	$_{3}^{\prime}$) $ imes$ 10 $^{-5}$	
Г ₇₃	$J/\psi(1S) K(1270)^0$	(1.3 ± 0.5	5) $ imes$ 10 $^{-3}$	
Γ ₇₄	$J/\psi(1S)\pi^0$	(2.1 ± 0.5	5) $\times 10^{-5}$	
Γ ₇₅	$J/\psi(1S)\eta$	< 1.2	$ imes 10^{-3}$	CL=90%
Γ ₇₆	$J/\psi(1S) ho^0$	< 2.5	$\times 10^{-4}$	CL=90%
Г ₇₇	$J/\psi(1S)\omega$	< 2.7	$\times 10^{-4}$	CL=90%
I 78	$J/\psi(15) K^0 \pi^+ \pi^-$	(1.0 ± 0.4)	$(1) \times 10^{-3}$	
I 79	$J/\psi(1S) K^* \rho^*$	(5.4 ± 3.0)	$)) \times 10^{-4}$	
I 80 Г.	$J/\psi(1S) \wedge (\delta 92) + \pi$ $J/\psi(1S) \kappa^*(802)^0 - +$	(8 ± 4)	$) \times 10^{-7}$	
' 81 Гаг	$J/\psi(13)K(092)^{-\pi}/\pi$	(0.0 ± 2.2)	$(2) \times 10^{-4}$	
י 82 בפס	$\psi(25) K^{+} \pi^{-}$	(5.7 ±1.0	√ 10 ⁻³	CI _00%
• 83 Гел	$\psi(2S)K^*(892)^0$	(8.0 ±1.3	$^{-10}$ 3) × 10 ⁻⁴	CL—90/0
0-		· · · ·	,	

Г ₈₅	$\chi_{c0}(1P)K^0$	<	5.0	$ imes 10^{-4}$	CL=90%
Г ₈₆	$\chi_{c1}(1P)K^{0}$	($4.0 + 1.2 \\ 1.0 $	$ imes 10^{-4}$	
Γ07	$\gamma_{c1}(1P)K^*(892)^0$	(-1.0 $(4.1 + 1.5)$	$\times 10^{-4}$	
• 07	χει(1)). (002)	(
-	<i>v</i> + -	K or K* modes			
I 88	$K + \pi$	($1.74 \pm 0.15)$	× 10 ⁻⁵	
Г ₈₉	$K^0 \pi^0$	($1.07^{+0.27}_{-0.25}$	$\times 10^{-5}$	
Г ₉₀	$\eta' {\cal K}^0$	($5.8 \ ^{+1.4}_{-1.3}$)	imes 10 ⁻⁵	S=1.5
Γ ₉₁	η′ K*(892) ⁰	<	2.4	imes 10 ⁻⁵	CL=90%
Г ₉₂	η K*(892) ⁰	($1.4 \begin{array}{c} +0.6 \\ -0.5 \end{array}$	imes 10 ⁻⁵	
Γαз	ηK^0	<	9.3	imes 10 ⁻⁶	CL=90%
Г ₉₄	ωK^0	<	1.3	imes 10 ⁻⁵	CL=90%
Γ ₉₅	$K^0_S X^0$ (Familon)	<	5.3	imes 10 ⁻⁵	CL=90%
Γ ₉₆	$\omega K^{*}(892)^{0}$	<	2.3	imes 10 ⁻⁵	CL=90%
Γ ₉₇	$K^+ K^-$	<	1.9	imes 10 ⁻⁶	CL=90%
Г ₉₈	$K^0 \overline{K}^0$	<	1.7	imes 10 ⁻⁵	CL=90%
Г ₉₉	$K^+ \rho^-$	<	3.2	imes 10 ⁻⁵	CL=90%
Γ ₁₀₀	$K^0 \pi^+ \pi^-$			_	
Γ ₁₀₁	$K^0 \rho^0$	<	3.9	$\times 10^{-5}$	CL=90%
Γ ₁₀₂	$K^0 f_0(980)$	<	3.6	$\times 10^{-4}$	CL=90%
Γ ₁₀₃	$K^*(892)^+\pi^-$	<	7.2	$\times 10^{-5}$	CL=90%
Γ ₁₀₄	$K^{*}(892)^{0}\pi^{0}$	<	3.6	× 10 ⁻⁶	CL=90%
Γ ₁₀₅	$K_{2}^{*}(1430)^{+}\pi^{-}$	<	2.6	$\times 10^{-3}$	CL=90%
Γ ₁₀₆	$K^{0}K^{+}K^{-}$	<	1.3	$\times 10^{-3}$	CL=90%
Γ ₁₀₇	$\kappa^{0}\phi$	($8.1 \ +3.2 \ -2.6$)	imes 10 ⁻⁶	
Γ ₁₀₈	$K^{-}\pi^{+}\pi^{+}\pi^{-}$	[b] <	2.3	imes 10 ⁻⁴	CL=90%
Γ ₁₀₉	$K^*(892)^0 \pi^+ \pi^-$	<	1.4	imes 10 ⁻³	CL=90%
Γ ₁₁₀	$K^*(892)^0 ho^0$	<	3.4	imes 10 ⁻⁵	CL=90%
Γ_{111}	$K^*(892)^0 f_0(980)$	<	1.7	$\times 10^{-4}$	CL=90%
Γ ₁₁₂	$K_1(1400)^+ \pi^-$	<	1.1	$\times 10^{-3}$	CL=90%
Γ ₁₁₃	$K^{-}a_{1}(1260)^{+}$	[b] <	2.3	$\times 10^{-4}$	CL=90%
Γ ₁₁₄	K*(892) ⁰ K ⁺ K ⁻	<	6.1	imes 10 ⁻⁴	CL=90%
Γ_{115}	$K^*(892)^0\phi$	($9.5 \ {+2.4 \atop -2.0}$)	imes 10 ⁻⁶	
Γ ₁₁₆	$\overline{K}^{*}(892)^{0} K^{*}(892)^{0}$	<	2.2	imes 10 ⁻⁵	CL=90%
Γ ₁₁₇	K*(892) ⁰ K*(892) ⁰	<	3.7	imes 10 ⁻⁵	CL=90%
Γ ₁₁₈	$K^{*}(892)^{+}K^{*}(892)^{-}$	<	1.41	$ imes 10^{-4}$	CL=90%
Γ ₁₁₉	$K_1(1400)^0 \rho^0$	<	3.0	$\times 10^{-3}$	CL=90%
Γ ₁₂₀	$K_1(1400)^0 \phi$	<	5.0	imes 10 ⁻³	CL=90%
Γ_{121}	$K_2^*(1430)^0 \rho^0$	<	1.1	imes 10 ⁻³	CL=90%
Γ ₁₂₂	$K_2^*(1430)^0 \phi$	<	1.4	imes 10 ⁻³	CL=90%

Γ_{123}	$K^{*}(892)^{0}\gamma$	(4	.3 \pm 0.4) $ imes$ 10 $^{-5}$
Γ ₁₂₄	$K_1(1270)^0\gamma$	< 7	$.0 \times 10^{-3}$ CL=90%
Γ_{125}	$K_1(1400)^0\gamma$	< 4	$\times 10^{-3}$ CL=90%
Γ_{126}	$K_{2}^{*}(1430)^{0}\gamma$	< 4	$.0 \times 10^{-4} CL=90\%$
Γ ₁₂₇	$K^{*}(1680)^{0}\gamma$	< 2	$.0 \times 10^{-3}$ CL=90%
Γ ₁₂₈	$K_{2}^{*}(1780)^{0}\gamma$	< 1	.0 % CL=90%
Γ ₁₂₀	$K^{*}(2045)^{0}\gamma$	< 4	3×10^{-3} CL = 90%
• 129	14(2010)		
	-	Light unflavored meson m	odes
Γ ₁₃₀	$ ho^{0}\gamma$	< 1	.7 $\times 10^{-5}$ CL=90%
Γ ₁₃₁	$\omega \gamma$	< 9	$.2 \times 10^{-6}$ CL=90%
Γ ₁₃₂	$\phi\gamma$	< 3	$.3 \times 10^{-6}$ CL=90%
Γ ₁₃₃	$\pi^+\pi^-$	(4.	.4 ± 0.9) $ imes$ 10 $^{-6}$
Γ ₁₃₄	$\pi^0 \pi^0$	< 5	$.7 \times 10^{-6} CL=90\%$
Γ ₁₃₅	$\eta \pi^0$	< 2	$.9 10^{-6} CL=90\%$
Γ ₁₃₆	$\eta\eta$	< 1	$.8 \times 10^{-5} CL=90\%$
Γ ₁₃₇	$\eta' \pi^0$	< 5	$.7 \times 10^{-6} CL=90\%$
Γ ₁₃₈	$\eta' \eta'$	< 4	.7 $\times 10^{-5}$ CL=90%
Γ ₁₃₉	$\eta'\eta$	< 2	.7 $\times 10^{-5}$ CL=90%
Γ ₁₄₀	$\eta' \rho^0$	< 1	$.2 \times 10^{-5}$ CL=90%
Γ_{141}	ηho^{0}	< 1	$.0 \times 10^{-5} CL=90\%$
Γ ₁₄₂	$\omega \eta$	< 1	$.2 \times 10^{-5} CL=90\%$
Г ₁₄₃	$\omega \eta'$	< 6.	$.0 \times 10^{-5} CL=90\%$
Γ ₁₄₄	ωho^{0}	< 1	1×10^{-5} CL=90%
Γ ₁₄₅	$\omega \omega$	< 1	$.9 \times 10^{-5} CL=90\%$
Γ ₁₄₆	$\phi \pi^{0}$	< 5	$\times 10^{-6}$ CL=90%
Γ ₁₄₇	$\phi\eta$	< 9	$\times 10^{-6}$ CL=90%
Γ ₁₄₈	$\phi \eta'$	< 3	$.1 \times 10^{-5} CL=90\%$
Γ ₁₄₉	ϕho^{0}	< 1	$.3 \times 10^{-5} CL=90\%$
Γ ₁₅₀	$\phi \omega$	< 2	1×10^{-5} CL=90%
Γ ₁₅₁	$\phi \phi$	< 1	$.2 \times 10^{-5}$ CL=90%
Γ ₁₅₂	$\pi^+\pi^-\pi^0$	< 7.	$.2 \times 10^{-4}$ CL=90%
Γ ₁₅₃	$\rho^0 \pi^0$	< 5	.5
Г ₁₅₄	$ ho^{\mp}\pi^{\pm}$	[c] (2	.8 ± 0.9) $ imes 10^{-5}$
Γ ₁₅₅	$\pi^{+}\pi^{-}\pi^{+}\pi^{-}$	< 2	$.3 \times 10^{-4} CL=90\%$
Γ ₁₅₆	$ ho^{0} ho^{0}$	< 1	$.8 \times 10^{-5} CL=90\%$
Γ ₁₅₇	$a_1(1260)^{\mp}\pi^{\pm}$	[c] < 4	$.9 \times 10^{-4} CL=90\%$
Γ ₁₅₈	$a_2(1320)^{\mp}\pi^{\pm}$	[c] < 3	$.0 \times 10^{-4} CL=90\%$
Γ ₁₅₉	$\pi^{+}\pi^{-}\pi^{0}\pi^{0}$	< 3.	1×10^{-3} CL=90%
Γ ₁₆₀	$\rho^+ \rho^-$	< 2	$.2 \times 10^{-3}$ CL=90%
Г ₁₆₁	$a_1(1260)^0 \pi^0$	< 1	$.1 \times 10^{-3} CL=90\%$
Γ ₁₆₂	$\omega \pi^0$	< 3	$\times 10^{-6}$ CL=90%
Γ ₁₆₃	$\pi^{+}\pi^{+}\pi^{-}\pi^{-}\pi^{0}$	< 9	$.0 \times 10^{-3} CL=90\%$
Γ ₁₆₄	$a_1(1260)^+ ho^-$	< 3	.4 $\times 10^{-3}$ CL=90%

Γ ₁₆₅ Γ ₁₆₆ Γ ₁₆₇ Γ ₁₆₈	$\begin{array}{c} a_1(1260)^0 \rho^0 \\ \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \\ a_1(1260)^+ a_1(1260)^- \\ \pi^+ \pi^+ \pi^+ \pi^- \pi^- \pi^- \pi^0 \end{array}$	< < < <	2.4 3.0 2.8 1.1	$ \times 10^{-3} \ \times 10^{-3} \ \times 10^{-3} \ \times 10^{-3} \ \% $	CL=90% CL=90% CL=90% CL=90%
200		Barvon modes			
Γ160	n <u>n</u>		70	× 10 ⁻⁶	CI = 90%
Γ_{170}	$p\overline{p}\pi^{+}\pi^{-}$	<	2.5	$\times 10^{-4}$	CL=90%
Γ ₁₇₁	$p\overline{\Lambda}\pi^{-}$	<	1.3	$\times 10^{-5}$	CL=90%
Γ_{172}	$\frac{1}{\overline{\Lambda}}\Lambda$	<	3.9	imes 10 ⁻⁶	CL=90%
Γ_{173}	$\Delta^0 \overline{\Delta}{}^0$	<	1.5	imes 10 ⁻³	CL=90%
Γ ₁₇₄	${\it \Delta}^{++}{\it \Delta}^{}$	<	1.1	imes 10 ⁻⁴	CL=90%
Γ ₁₇₅	$\overline{\Sigma}_{c}^{}\Delta^{++}$	<	1.0	imes 10 ⁻³	CL=90%
Г ₁₇₆	$\overline{\Lambda}_{C}^{-} p \pi^{+} \pi^{-}$	(1.3 ± 0.6)	$\times 10^{-3}$	
Γ ₁₇₇	$\overline{\Lambda}_{c}^{-} p$	<	2.1	imes 10 ⁻⁴	CL=90%
Γ ₁₇₈	$\overline{\Lambda}_{c}^{c} p \pi^{0}$	<	5.9	$ imes 10^{-4}$	CL=90%
Γ ₁₇₉	$\overline{\Lambda}_{-}^{c} p \pi^{+} \pi^{-} \pi^{0}$	<	5.07	$\times 10^{-3}$	CL=90%
Γ ₁₈₀	$\overline{\Lambda}_{c}^{c} p \pi^{+} \pi^{-} \pi^{+} \pi^{-}$	<	2.74	$\times 10^{-3}$	CL=90%

Lepton Family number (*LF*) violating modes, or $\Delta B = 1$ weak neutral current (*B1*) modes

Γ_{181}	$\gamma \gamma$		< 1.7	imes 10 ⁻⁶	CL=90%
Γ ₁₈₂	$e^+ e^-$	B1	< 8.3	imes 10 ⁻⁷	CL=90%
Γ ₁₈₃	$\mu^+\mu^-$	B1	< 6.1	imes 10 ⁻⁷	CL=90%
Γ ₁₈₄	$K^0 e^+ e^-$	B1	< 2.7	imes 10 ⁻⁶	CL=90%
Γ ₁₈₅	$K^0 \mu^+ \mu^-$	B1	< 3.3	imes 10 ⁻⁶	CL=90%
Γ ₁₈₆	$K^{*}(892)^{0} e^{+} e^{-}$	B1	< 6.4	imes 10 ⁻⁶	CL=90%
Γ ₁₈₇	$K^{*}(892)^{0}\mu^{+}\mu^{-}$	B1	< 4.2	imes 10 ⁻⁶	CL=90%
Γ ₁₈₈	$K^*(892)^0 \nu \overline{ u}$	B1	< 1.0	imes 10 ⁻³	CL=90%
Γ ₁₈₉	$e^{\pm}\mu^{\mp}$	LF	[c] < 1.5	imes 10 ⁻⁶	CL=90%
Γ ₁₉₀	$e^{\pm} au^{\mp}$	LF	[c] < 5.3	imes 10 ⁻⁴	CL=90%
Г ₁₉₁	$\mu^{\pm} \tau^{\mp}$	LF	[c] < 8.3	imes 10 ⁻⁴	CL=90%

[a] An ℓ indicates an e or a μ mode, not a sum over these modes.

[b] B^0 and B^0_s contributions not separated. Limit is on weighted average of the two decay rates.

[c] The value is for the sum of the charge states or particle/antiparticle states indicated.

B⁰ BRANCHING RATIOS

For branching ratios in which the charge of the decaying B is not determined, see the B^{\pm} section.

$\Gamma(\ell^+ \nu_\ell \text{ anything}) / \Gamma_{\text{total}}$					Γ_1/Γ
VALUE	DOCUMENT ID		TECN	<u>COMMENT</u>	
0.105 ±0.008 OUR AVERAG	E				
$0.1078 \!\pm\! 0.0060 \!\pm\! 0.0069$	³⁵ ARTUSO	97	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$0.093 \ \pm 0.011 \ \pm 0.015$	ALBRECHT	94	ARG	$e^+ e^- \rightarrow$	$\Upsilon(4S)$
$0.099 \ \pm 0.030 \ \pm 0.009$	HENDERSON	92	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$\bullet~\bullet~\bullet$ We do not use the follow	ing data for average	s, fits	, limits,	etc. • • •	
$0.109 \ \pm 0.007 \ \pm 0.011$	ATHANAS	94	CLE2	Sup. by AF	RTUSO 97
³⁵ ARTUSO 97 uses partial r branching ratio from BARIS	reconstruction of B GH 96B (0.1049 \pm 0.0	\rightarrow 0017	$D^*\ell u_\ell \pm 0.004$	and inclusive 3).	e semileptonic
$ \Gamma(D^{-}\ell^{+}\nu_{\ell})/\Gamma_{\text{total}} \\ \ell \text{ denotes } e \text{ or } \mu, \text{ not the} $	sum.				Г ₂ /Г
VALUE	DOCUMENT ID		TECN	COMMENT	
0.0211 ± 0.0017 OUR AVERAG	E				
$0.0213\!\pm\!0.0012\!\pm\!0.0039$	ABE	02E	BELL	$e^+ e^- ightarrow$	$\Upsilon(4S)$
$0.0209 \pm 0.0013 \pm 0.0018$	³⁶ BARTELT	99	CLE2	_+ →	$\Upsilon(45)$

$0.0209 \pm 0.0013 \pm 0.0010$	DANTELT	99	CLLZ	$e e \rightarrow I(+3)$
$0.0235 \pm 0.0020 \pm 0.0044$	³⁷ BUSKULIC	97	ALEP	$e^+e^- \rightarrow Z$
$0.018\ \pm 0.006\ \pm 0.003$	³⁸ FULTON	91	CLEO	$e^+e^- \rightarrow \Upsilon(4S)$
$0.020 \ \pm 0.007 \ \pm 0.006$	³⁹ ALBRECHT	89J	ARG	$e^+e^- \rightarrow \Upsilon(4S)$
• • • We do not use the followin	g data for averages	, fits,	limits,	etc. • • •

⁴⁰ ATHANAS 97 CLE2 Repl. by BARTELT 99 $0.0187 \pm 0.0015 \pm 0.0032$

³⁶Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.

³⁷BUSKULIC 97 assumes fraction (B^+) = fraction (B^0) = $(37.8 \pm 2.2)\%$ and PDG 96 values for *B* lifetime and branching ratio of D^* and *D* decays.

³⁸ FULTON 91 assumes assuming equal production of B^0 and B^+ at the $\Upsilon(4S)$ and uses Mark III D and D^* branching ratios.

 39 ALBRECHT 89J reports 0.018 \pm 0.006 \pm 0.005. We rescale using the method described in STONE 94 but with the updated PDG 94 B($D^0 \rightarrow K^- \pi^+$).

 40 ATHANAS 97 uses missing energy and missing momentum to reconstruct neutrino.

$\Gamma(D^*(2010)^-\ell^+\nu_\ell)/\Gamma_{total}$					
VALUE	EVTS	DOCUMENT ID	TECN	<u>COMMENT</u>	
0.0460 ± 0.0021 OUR AVER	RAGE				
$0.0459 \!\pm\! 0.0023 \!\pm\! 0.0040$		⁴¹ ABE	02F BELL	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$0.0470 \!\pm\! 0.0013 \!+\! 0.0036 \\ -\! 0.0031$		⁴² ABREU	01H DLPH	$e^+e^- \rightarrow$	Ζ
$0.0526 \!\pm\! 0.0020 \!\pm\! 0.0046$		⁴³ ABBIENDI	00Q OPAL	$e^+e^- \rightarrow$	Ζ
$0.0553 \pm 0.0026 \pm 0.0052$		⁴⁴ BUSKULIC	97 ALEP	$e^+e^- \rightarrow$	Ζ
$0.0449 \!\pm\! 0.0032 \!\pm\! 0.0039$	376	⁴⁵ BARISH	95 CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$0.045 \ \pm 0.003 \ \pm 0.004$		⁴⁶ ALBRECHT	94 ARG	$e^+e^- ightarrow$	$\Upsilon(4S)$
$0.047 \ \pm 0.005 \ \pm 0.005$	235	⁴⁷ ALBRECHT	93 ARG	$e^+e^- ightarrow$	$\Upsilon(4S)$
$0.040\ \pm 0.004\ \pm 0.006$		⁴⁸ BORTOLETTO	D89B CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$

HTTP://PDG.LBL.GOV

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

$0.0508 \!\pm\! 0.0021 \!\pm\! 0.0066$		⁴⁹ ACKERSTAFF	97g OPAL	Repl. by ABBI-
$0.0552\!\pm\!0.0017\!\pm\!0.0068$		⁵⁰ ABREU	96p DLPH	ENDI 00Q Repl. by
$0.0518 \!\pm\! 0.0030 \!\pm\! 0.0062$	410	⁵¹ BUSKULIC	95N ALEP	ABREU 01H Sup. by
seen	398	⁵² SANGHERA	93 CLE2	$\begin{array}{c} \text{BUSKULIC 97}\\ e^+e^- \rightarrow \ \Upsilon(4S) \end{array}$
$0.070 \ \pm 0.018 \ \pm 0.014$		⁵³ ANTREASYAN	90B CBAL	$e^+e^- \rightarrow \Upsilon(4S)$
		⁵⁴ ALBRECHT	89c ARG	$e^+e^- \rightarrow \Upsilon(4S)$
$0.060\ \pm 0.010\ \pm 0.014$		⁵⁵ ALBRECHT	89J ARG	$e^+e^- \rightarrow \Upsilon(4S)$
$0.070 \ \pm 0.012 \ \pm 0.019$	47	⁵⁶ ALBRECHT	87J ARG	$e^+e^- \rightarrow \Upsilon(4S)$

⁴¹ Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.

⁴²ABREU 01H measured using about 5000 partial reconstructed D^* sample.

⁴³ABBIENDI 00Q assumes the fraction $B(b \rightarrow B^0) = (39.7 + 1.8)/(-2.2)\%$. This result is an average of two methods using exclusive and partial D^* reconstruction.

⁴⁴ BUSKULIC 97 assumes fraction (B^+) = fraction (B^0) = $(37.8 \pm 2.2)\%$ and PDG 96 values for *B* lifetime and D^* and *D* branching fractions.

⁴⁵ BARISH 95 use B($D^0 \rightarrow K^- \pi^+$) = (3.91 ± 0.08 ± 0.17)% and B($D^{*+} \rightarrow D^0 \pi^+$) = (68.1 ± 1.0 ± 1.3)%.

⁴⁶ ALBRECHT 94 assumes $B(D^{*+} \rightarrow D^0 \pi^+) = 68.1 \pm 1.0 \pm 1.3\%$. Uses partial reconstruction of D^{*+} and is independent of D^0 branching ratios.

- ⁴⁷ ALBRECHT 93 reports $0.052 \pm 0.005 \pm 0.006$. We rescale using the method described in STONE 94 but with the updated PDG 94 B($D^0 \rightarrow K^-\pi^+$). We have taken their average e and μ value. They also obtain $\alpha = 2*\Gamma^0/(\Gamma^-+\Gamma^+)-1 = 1.1 \pm 0.4 \pm 0.2$, $A_{AF} = 3/4*(\Gamma^--\Gamma^+)/\Gamma = 0.2 \pm 0.08 \pm 0.06$ and a value of $|V_{cb}| = 0.036-0.045$ depending on model assumptions.
- ⁴⁸We have taken average of the the BORTOLETTO 89B values for electrons and muons, 0.046 \pm 0.005 \pm 0.007. We rescale using the method described in STONE 94 but with the updated PDG 94 B($D^0 \rightarrow K^- \pi^+$). The measurement suggests a D^* polarization parameter value $\alpha = 0.65 \pm 0.66 \pm 0.25$.

⁴⁹ ACKERSTAFF 97G assumes fraction (B^+) = fraction $(B^0) = (37.8 \pm 2.2)\%$ and PDG 96 values for *B* lifetime and branching ratio of D^* and *D* decays.

⁵⁰ABREU 96P result is the average of two methods using exclusive and partial D^* reconstruction.

⁵¹ BUSKULIC 95N assumes fraction (B^+) = fraction (B^0) = 38.2 ± 1.3 ± 2.2% and τ_{B^0} = 1.58 ± 0.06 ps. $\Gamma(D^{*-}\ell^+\nu_{\ell})/\text{total}$ = [5.18 - 0.13(fraction(B^0)-38.2)-1.5(τ_{B^0} - 1.58)]%.

⁵² Combining $\overline{D}^{*0}\ell^+\nu_{\ell}$ and $\overline{D}^{*-}\ell^+\nu_{\ell}$ SANGHERA 93 test V-A structure and fit the decay angular distributions to obtain $A_{FB} = 3/4*(\Gamma^- - \Gamma^+)/\Gamma = 0.14 \pm 0.06 \pm 0.03$. Assuming a value of V_{cb} , they measure V, A_1 , and A_2 , the three form factors for the $D^*\ell\nu_{\ell}$ decay, where results are slightly dependent on model assumptions.

⁵³ANTREASYAN 90B is average over B and $\overline{D}^*(2010)$ charge states.

- ⁵⁴ The measurement of ALBRECHT 89C suggests a D^* polarization γ_L/γ_T of 0.85 ± 0.45. ____ or $\alpha = 0.7 \pm 0.9$.
- ⁵⁵ ALBRECHT 89J is ALBRECHT 87J value rescaled using $B(D^*(2010)^- \rightarrow D^0 \pi^-) = 0.57 \pm 0.04 \pm 0.04$. Superseded by ALBRECHT 93.
- ⁵⁶ ALBRECHT 87J assume μ -*e* universality, the B($\Upsilon(4S) \rightarrow B^0 \overline{B}{}^0$) = 0.45, the B($D^0 \rightarrow K^- \pi^+$) = (0.042 ± 0.004 ± 0.004), and the B($D^*(2010)^- \rightarrow D^0 \pi^-$) = 0.49 ± 0.08. Superseded by ALBRECHT 89J.

 $\Gamma(\rho^{-}\ell^{+}\nu_{\ell})/\Gamma_{\text{total}}$ Γ_4/Γ $\ell = e$ or μ , not sum over e and μ modes. VALUE (units 10^{-4}) DOCUMENT ID TECN COMMENT CL% $2.57 \pm 0.29 \substack{+0.53 \\ -0.62}$ 57 BEHRENS 00 CLE2 $e^+e^- \rightarrow \Upsilon(4S)$ • • • We do not use the following data for averages, fits, limits, etc. • • $2.69 \pm 0.41 \substack{+0.61 \\ -0.64}$ ⁵⁸ BEHRENS 00 CLE2 $e^+e^- \rightarrow \Upsilon(4S)$ $2.5 \pm 0.4 \begin{array}{c} +0.7 \\ -0.9 \end{array}$ ⁵⁹ ALEXANDER 96T CLE2 Repl. by BEHRENS 00 <4.1 90 ⁶⁰ BEAN 93B CLE2 $e^+e^- \rightarrow \Upsilon(4S)$ ⁵⁷ Averaging with ALEXANDER 96T results including experimental and theoretical correlations considered, BEHRENS 00 reports systematic errors $^{+0.33}_{-0.46}$ \pm 0.41, where the second error is theoretical model dependence. We combine these in quadrature. $^{58}\,\textsc{BEHRENS}$ 00 reports $^{+0.35}_{-0.40}\pm$ 0.50, where the second error is the theoretical model dependence. We combine these in quadrature. B^+ and B^0 decays combined using isospin symmetry: $\Gamma(B^0 \to \rho^- \ell^+ \nu) = 2\Gamma(B^+ \to \rho^0 \ell^+ \nu) \approx 2\Gamma(B^+ \to \omega \ell^+ \nu)$. No evidence for $\omega \ell \nu$ is reported. 59 ALEXANDER 96T reports $^{+0.5}_{-0.7}$ \pm 0.5 where the second error is the theoretical model dependence. We combine these in quadrature. B^+ and B^0 decays combined using isospin symmetry: $\Gamma(B^0 \to \rho^- \ell^+ \nu) = 2\Gamma(B^+ \to \rho^0 \ell^+ \nu) \approx 2\Gamma(B^+ \to \omega \ell^+ \nu)$. No evidence for $\omega \ell \nu$ is reported. 60 BEAN 93B limit set using ISGW Model. Using isospin and the quark model to combine $\Gamma(\rho^0 \ell^+ \nu_\ell)$ and $\Gamma(\omega \ell^+ \nu_\ell)$ with this result, they obtain a limit $\langle (1.6-2.7) \times 10^{-4}$ at 90% CL for $B^+ \to (\omega {
m or} \
ho^0) \ell^+
u_{\ell}$. The range corresponds to the ISGW, WSB, and KS models. An upper limit on $|V_{ub}/V_{cb}| < 0.08-0.13$ at 90% CL is derived as well. $\Gamma(\pi^{-}\ell^{+}\nu_{\ell})/\Gamma_{\rm total}$ Γ_5/Γ VALUE (units 10^{-4}) ⁶¹ ALEXANDER 96T CLE2 $e^+e^- \rightarrow \Upsilon(4S)$ $1.8 \pm 0.4 \pm 0.4$ 61 ALEXANDER 96T gives systematic errors $\pm 0.3 \pm 0.2$ where the second error reflects the estimated model dependence. We combine these in quadrature. Assumes isospin symmetry: $\Gamma(B^0 \rightarrow \pi^- \ell^+ \nu) = 2 \times \Gamma(B^+ \rightarrow \pi^0 \ell^+ \nu).$ $\Gamma(\pi^{-}\mu^{+}\nu_{\mu})/\Gamma_{\text{total}}$ Γ_6/Γ DOCUMENT ID TECN • We do not use the following data for averages, fits, limits, etc. • ⁶² ALBRECHT 91C ARG seen

 62 In ALBRECHT 91C, one event is fully reconstructed providing evidence for the $b \rightarrow u$ transition.

I (K ⁺ anything)/I total				ا/7 ا	l
VALUE	DOCUMENT ID	TECN	COMMENT		
0.78±0.08	⁶³ ALBRECHT	96d ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$	
63 .					

⁶³ Average multiplicity.

$\Gamma(D^{-}\pi^{+})/\Gamma_{total}$						Г ₈ /Г
VALUE EVT.	<u>s</u>	DOCUMENT ID		TECN	<u>COMMENT</u>	
$0.0030 \pm 0.0004 \text{ OUR AVERAGE}$						
$0.0029 \pm 0.0004 \pm 0.0002$ 83	1 64	ALAM	94	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$0.0027 \!\pm\! 0.0006 \!\pm\! 0.0005$	65	BORTOLETT	092	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$0.0048 \pm 0.0011 \pm 0.0011$ 22	2 66	ALBRECHT	9 0J	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$0.0051 \substack{+0.0028 + 0.0013 \\ -0.0025 - 0.0012}$	4 67	BEBEK	87	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
• • • We do not use the following	ng data	for averages, fi	its, lin	nits, etc.	• • •	
$0.0031 \pm 0.0013 \pm 0.0010$	7 66	ALBRECHT	88K	ARG	$e^+ e^- \rightarrow$	$\Upsilon(4S)$
⁶⁴ ALAM 94 reports $[B(B^0 - 0.000032 \pm 0.000023]$. We (9.1 ± 0.6) × 10 ⁻² . Our fi is the systematic error from u B^0 at the $\Upsilon(4S)$. ⁶⁵ BORTOLETTO 92 assumes Mark III branching fractions fi ⁶⁶ ALBRECHT 88K assumes B^0 BRECHT 90J which assumes	$\rightarrow D^{-}$ e divide irst error using ou equal p or the <i>L</i> $\partial \overline{B}^{0}:B^{+}$ 50:50.	π^+) × B(D^+ by our best or is their expect r best value. A production of B D. B^- production	⁻ → value srimen sssume 3 ⁺ ar on rati	$K^{-}\pi^{+}$ e B(D^{+} t's error es equal nd B^{0} a	$[\pi^{+})] = 0$ $\rightarrow K^{-}\pi$ π and our set production t the $\Upsilon(4S)$ 55. Superset	$000265 \pm \pi^+ \pi^+) =$ cond error of B^+ and) and uses ded by AL-
⁶⁷ BEBEK 87 value has been u noted for BORTOLETTO 92	ipdated	in BERKELM	AN 9	1 to use	e same assu	mptions as
$\Gamma(D^- ho^+)/\Gamma_{ ext{total}}$						٦/٩
VALUE EVT.	<u>'S</u>	DOCUMENT ID		TECN	<u>COMMENT</u>	
$0.0078 \pm 0.0013 \pm 0.0005$ 79 $0.009 \pm 0.005 \pm 0.003$ 9 • • • We do not use the following	9 68 9 69 ng data	ALAM ALBRECHT for averages, fi	94 90J its, lin	CLE2 ARG nits, etc.	$ \begin{array}{c} e^+e^- \rightarrow \\ e^+e^- \rightarrow \\ \bullet \bullet \bullet \\ \end{array} $	$\Upsilon(4S)$ $\Upsilon(4S)$
0.022 \pm 0.012 \pm 0.009 (6) ⁶⁸ ALAM 94 reports [B(B^0 – 0.000096 \pm 0.000070. We (9.1 \pm 0.6) \times 10 ⁻² . Our fi is the systematic error from u B^0 at the Υ (4 <i>S</i>). ⁶⁹ ALBRECHT 88K assumes B^0 BRECHT 90J which assumes	$b \rightarrow D^-$ $b \rightarrow D^-$ b = divide $dirst = error b = B^0: B^+50:50.$	ALBRECHT $ ho^+$) × B(D^+ by our best or is their expection r best value. A $^-B^-$ production	88K → value rimen ssume on rati	ARG $K^- \pi^+$ e B(D^+ t's error es equal to is 45:	$e^+e^- \rightarrow$ $(\pi^+)] = 0$ $\rightarrow K^-\pi$ r and our set production 55. Superset	$\Upsilon(4S)$.000704 \pm $\pi^+\pi^+$) = econd error of B^+ and ded by AL-
$\Gamma(D^{-}K^{*}(892)^{+})/\Gamma_{\text{total}}$						Г ₁₀ /Г
$\frac{VALUE}{(2,7,1,7,1,7,1,2,2,2,2,2,2,2,2,2,2,2,2,2,$	70		<u> </u>	<u>cn co</u>		(6)
$(3.7\pm1.5\pm1.0)\times10^{-4}$	⁷⁰ MA	AHAPATRA 02	2 CL	E2 e⊤	$e^- \rightarrow T($	45)
⁷⁰ Assumes equal production of	B ⁺ an	d B^0 at the $arTau$	(4 <i>S</i>).			
$\Gamma(D^-\omega\pi^+)/\Gamma_{\text{total}}$	DO	CUMENT ID	TF	CN CO	MMENT	Г ₁₁ /Г
$0.0028 \pm 0.0005 \pm 0.0004$	71 AI	EXANDER 0	<u>1</u> в СІ	E2 e ⁺	$e^- \rightarrow \gamma \ell$	4 <i>S</i>)
⁷¹ Assumes equal production of all observed $\omega \pi^+$ having pro-	B ⁺ ar	id B^0 at the η through the ${ ho'}^-$	 (4 <i>S</i>) + reso	. The si onance a	gnal is cons t mass 1349	istent with $\pm 25 \pm 10$

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$\Gamma(D^{-}\kappa^{+})/\Gamma_{\text{total}}$	DOCUMENT		Γ ₁₂ /Γ			
$(2.04\pm0.50\pm0.27)\times10^{-4}$	72 ABE	011 BELL	$e^+e^- \rightarrow \Upsilon(4S)$			
⁷² ABE 011 reports $B(B^0 \rightarrow D^- K^+)/B(B^0 \rightarrow D^- \pi^+) = 0.068 \pm 0.015 \pm 0.007$. We multiply by our best value $B(B^0 \rightarrow D^- \pi^+) = (3.0 \pm 0.4) \times 10^{-3}$. Our first error is their experiment's error and the second error is systematic error from using our best value.						
$\Gamma(\overline{D}^0\pi^+\pi^-)/\Gamma_{\text{total}}$			Γ ₁₃ /Γ			
VALUE <u>CL%</u> EVTS	<u>DOCUMENT</u>	<u>ID</u> <u>TECN</u>	COMMENT			
<0.0016 90	⁷³ ALAM	94 CLE2	$e^+e^- \rightarrow T(4S)$			
• • • We do not use the follow	wing data for aver	ages, fits, limits,	etc. • • •			
<0.007 90	⁷⁴ BORTOLE	TTO92 CLEO	$e^+e^- \rightarrow \Upsilon(4S)$			
<0.034 90	⁷⁵ BEBEK	87 CLEO	$e^+e^- \rightarrow \Upsilon(4S)$			
$0.07 \pm 0.05 5$	^{OBEHREND}	S 83 CLEO	$e^+e^- \rightarrow T(4S)$			
Mark III branching fraction followed by $D_0^*(2340) \rightarrow D_2^*(2460) \rightarrow D^0 \pi \text{ is } < 0$ 75 BEBEK 87 assume the Υ $K^- \pi^+) = (4.2 \pm 0.4 \pm 0.4$	s for the <i>D</i> . The $D^0 \pi$ is < 0.0001 .0004 at 90% CL. (4 <i>S</i>) decays 43% 0.4)% and B(D^0 assumptions: B D^0) = 50%. T π^-) = (0.39 ± 0.	product branchin at 90% CL and to $B^0 \overline{B}^0$. We $\rightarrow K^- \pi^+ \pi^+ \pi^-$ $(D^0 \rightarrow K^- \pi^-)$ he product branching 26) $\times 10^{-2}$.	g fraction into $D_0^*(2340) \pi$ into $D_2^*(2460)$ followed by rescale to 50%. $B(D^0 \rightarrow \pi^-) = (9.1 \pm 0.8 \pm 0.8)\%$ $\pi^+) = (0.042 \pm 0.006)$ nching ratio is $B(B^0 \rightarrow \pi^+)$			
$\Gamma(D^*(2010)^-\pi^+)/\Gamma_{\text{total}}$	VTS DOCUM	ENT ID TE	Г₁₄/Г			
0.00276±0.00021 OUR AVER	AGE					
$0.00281 \!\pm\! 0.00024 \!\pm\! 0.00005$	77 BRANI	DENB 98 CL	E2 $e^+e^- \rightarrow \Upsilon(4S)$			
$0.0026\ \pm 0.0003\ \pm 0.0004$	82 ⁷⁸ ALAM	94 CL	E2 $e^+e^- ightarrow ~\Upsilon(4S)$			
$0.00337 \pm 0.00096 \pm 0.00002$	⁷⁹ BORT	DLETTO92 CL	EO $e^+e^- \rightarrow \Upsilon(4S)$			
$0.00236 \pm 0.00088 \pm 0.00002$	12 ⁸⁰ ALBRE	CHT 90J AR	$G e^+e^- \rightarrow \Upsilon(4S)$			
$0.00236^{+0.00150}_{-0.00110} \pm 0.00002$	5 ⁸¹ BEBE	K 87 CL	EO $e^+e^- ightarrow \Upsilon(4S)$			
• • We do not use the follow	wing data for aver	ages, fits, limits,	etc. • • •			
$0.010 \pm 0.004 \pm 0.001$	8 ⁸² AKERS	5 94J OF	$PAL e^+e^- \rightarrow Z$			
$0.0027 \pm 0.0014 \pm 0.0010$	5 ⁸³ ALBRE	CHT 87C AR	$G e^+e^- \rightarrow \Upsilon(4S)$			
$0.0035 \pm 0.002 \pm 0.002$	⁸⁴ ALBRE	CHT 86F AR	$G e^+e^- \rightarrow \Upsilon(4S)$			
$0.017 \pm 0.005 \pm 0.005$	41 ⁸⁵ GILES	84 CL	EO $e^+e^- \rightarrow \Upsilon(4S)$			

⁷⁷ BRANDENBURG 98 assume equal production of B^+ and B^0 at $\Upsilon(4S)$ and use the D^* reconstruction technique. The first error is their experiment's error and the second error

is the systematic error from the PDG 96 value of $B(D^* \rightarrow D\pi)$. ⁷⁸ ALAM 94 assume equal production of B^+ and B^0 at the $\Upsilon(4S)$ and use the CLEO II $B(D^*(2010)^+ \rightarrow D^0\pi^+)$ and absolute $B(D^0 \rightarrow K^-\pi^+)$ and the PDG 1992 $B(D^0 \rightarrow K^-\pi^+\pi^0)/B(D^0 \rightarrow K^-\pi^+)$ and $B(D^0 \rightarrow K^-\pi^+\pi^+\pi^-)/B(D^0 \rightarrow K^-\pi^+)$.

⁷⁹BORTOLETTO 92 reports 0.0040 \pm 0.0010 \pm 0.0007 for B($D^*(2010)^+ \rightarrow D^0 \pi^+$) = 0.57 ± 0.06 . We rescale to our best value $B(D^*(2010)^+ \rightarrow D^0 \pi^+) = (67.7 \pm 0.5) \times D^0 \pi^+$ 10^{-2} . Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and uses Mark III branching fractions for the D.

⁸⁰ALBRECHT 90J reports 0.0028 \pm 0.0009 \pm 0.0006 for B($D^*(2010)^+ \rightarrow D^0 \pi^+$) = 0.57 ± 0.06 . We rescale to our best value B($D^*(2010)^+ \rightarrow D^0 \pi^+) = (67.7 \pm 0.5) \times 10^{-1}$ 10^{-2} . Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and uses Mark III branching fractions for the D.

⁸¹BEBEK 87 reports 0.0028 + 0.0015 + 0.0010 + 0.0010 for $B(D^*(2010)^+ \rightarrow D^0 \pi^+) = 0.57 \pm 0.0012 - 0.0000$ 0.06. We rescale to our best value $B(D^*(2010)^+ \rightarrow D^0 \pi^+) = (67.7 \pm 0.5) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Updated in BERKELMAN 91 to use same assumptions as noted for BORTOLETTO 92 and ALBRECHT 90J.

⁸²Assumes $B(Z \rightarrow b\overline{b}) = 0.217$ and 38% B_d production fraction.

 83 ALBRECHT 87C use PDG 86 branching ratios for D and D*(2010) and assume $B(\Upsilon(4S) \rightarrow B^+B^-) = 55\%$ and $B(\Upsilon(4S) \rightarrow B^0\overline{B}^0) = 45\%$. Superseded by AL-

BRECHT 90J. ⁸⁴ ALBRECHT 86F uses pseudomass that is independent of D^0 and D^+ branching ratios. ⁸⁵ Assumes B($D^*(2010)^+ \rightarrow D^0 \pi^+$) = 0.60 $^{+0.08}_{-0.15}$. Assumes B($\Upsilon(4S) \rightarrow B^0 \overline{B}^0$) = 0.40 ± 0.02 Does not depend on D branching ratios.

$\Gamma(D^{-}\pi^{+}\pi^{+}\pi^{-})/\Gamma_{\text{total}}$

VALUE	DOCUMENT ID	TECN	COMMENT	
0.0080±0.0021±0.0014	86 BORTOLETTO92	CLEO	$e^+e^- ightarrow ~\Upsilon(4S)$	

 86 BORTOLETTO 92 assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and uses Mark III branching fractions for the D.

$\Gamma((D^{-}\pi^{+}\pi^{+}\pi^{-}) \text{ nonresonant})/\Gamma_{\text{total}}$				
VALUE	DOCUMENT ID	TECN	COMMENT	
$0.0039 \pm 0.0014 \pm 0.0013$	87 BORTOLETTO92	CLEO	$e^+e^- \rightarrow \gamma$	r(4 <i>S</i>)
07		1	0	- 1

 87 BORTOLETTO 92 assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and uses Mark III branching fractions for the D.

$\Gamma(D^-\pi^+ ho^0)/\Gamma_{ m total}$				Г ₁₇ /Г
VALUE	DOCUMENT ID	TECN	<u>COMMENT</u>	
$0.0011 \pm 0.0009 \pm 0.0004$	88 BORTOLETTO92	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$

 88 BORTOLETTO 92 assumes equal production of B^+ and B^0 at the arphi(4S) and uses Mark III branching fractions for the D.

$\Gamma(D^-a_1(1260)^+)/\Gamma_{\text{total}}$					- ₁₈ /Г
VALUE	DOCUMENT ID	TECN	<u>COMMENT</u>		
$0.0060 \pm 0.0022 \pm 0.0024$	89 BORTOLETTO92	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$	

⁸⁹BORTOLETTO 92 assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and uses Mark III branching fractions for the *D*.

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$\Gamma(D^*(2010)^-\pi^+\pi^0)/\Gamma_0$	otal					Г ₁₉ /Г
VALUE	<u>EVTS</u>	DOCUMENT ID		TECN	COMMENT	
$0.0152 \pm 0.0052 \pm 0.0001$	51	⁹⁰ ALBRECHT	90J	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
• • • We do not use the fol	lowing	data for averages, fi	its, limi	its, etc.	• • •	
$0.015\ \pm 0.008\ \pm 0.008$	8	⁹¹ ALBRECHT	87C	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
⁹⁰ ALBRECHT 90J reports 0.06. We rescale to our Our first error is their e from using our best valu uses Mark III branching f ⁹¹ ALBRECHT 87C use F B($\Upsilon(4S) \rightarrow B^+B^-) =$ BRECHT 90J.	0.018 ± best va xperime e. Assu raction 2DG 86 = 55%	$\pm 0.004 \pm 0.005$ for l lue B($D^*(2010)^+$ - ent's error and our mes equal productions for the D . b branching ratios and B($\Upsilon(4S) \rightarrow D$)	$B(D^*)^{2} \rightarrow D^{0}$ second on of <i>E</i> for <i>D</i> $B^{0}\overline{B}^{0}$	$2010)^+$ $\pi^+) =$ $1 error i3^+ andand L0 = 45%$	$ \rightarrow D^{0}\pi^{+} $ (67.7 ± 0.9 is the system B^{0} at the $D^{*}(2010)$ and %. Supersec	$)=0.57\pm 5) imes 10^{-2}.$ matic error $\mathcal{T}(4S)$ and assume ded by AL-
$\Gamma(D^*(2010)^- ho^+)/\Gamma_{tota}$	I					Г ₂₀ /Г
VALUE	<u>EVTS</u>	DOCUMENT ID		TECN	COMMENT	
$\begin{array}{c} 0.0073 \pm 0.0013 \mbox{COR AVE} \\ 0.0074 \ \pm 0.0010 \ \pm 0.0014 \\ 0.0160 \ \pm 0.0113 \ \pm 0.0001 \\ 0.00589 \pm 0.00352 \pm 0.00004 \\ \bullet \ \bullet \ \ \ \ \ \ \ \ \ \ \ \ \ \ \ \$	76 76 19 lowing	^{92,93} ALAM ⁹⁴ BORTOLETT ⁹⁵ ALBRECHT data for averages, fi	94 092 90J its, limi	CLE2 CLEO ARG its, etc.	$e^+e^- \rightarrow e^+e^- \rightarrow e^+e^- \rightarrow \bullet \bullet \bullet$	$\Upsilon(4S)$ $\Upsilon(4S)$ $\Upsilon(4S)$
$\begin{array}{rrrr} 0.081 & \pm 0.029 & +0.059 \\ & -0.024 \end{array}$	19	⁹⁶ CHEN	85	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
⁹² ALAM 94 assume equal $B(D^*(2010)^+ \rightarrow D^0 \pi^-$ $K^- \pi^+ \pi^0)/B(D^0 \rightarrow H^-)^{93}$ This decay is nearly cor- expected from the factor contribution under the ρ ⁹⁴ BORTOLETTO 92 repor- 0.57 ± 0.06 . We rescale 10^{-2} . Our first error is error from using our best and uses Mark III branch ⁹⁵ ALBRECHT 90J reports 0.06. We rescale to our Our first error is their er- from using our best valu- uses Mark III branching f ⁹⁶ Uses $B(D^* \rightarrow D^0 \pi^+)$ = on <i>D</i> branching ratios.	produc $(-\pi^+)$ and a $(-\pi^+)$ npletely prization + is less prts 0.0 to our their ex- to our their ex- value. ing frac 0.007 \pm best va xperime e. Assu fraction $= 0.6 \pm$	tion of B^+ and B^0 absolute $B(D^0 \rightarrow K^-)$ and $B(D^0 \rightarrow K^-)$ and $B(D^0 \rightarrow K^-)$ and $B(D^0 \rightarrow K^-)$ and hypothesis (ROSI as than 9% at 90% at 19 \pm 0.008 \pm 0.012 best value $B(D^*(20)$ kperiment's error and Assumes equal productions for the D . $= 0.003 \pm 0.003$ for H^- lue $B(D^*(2010)^+)$ ent's error and our mes equal productions for the D . $= 0.15$ and $B(\Upsilon(4S))$	at the $\chi = \pi + \pi$	$e^{T}(4S)$ and the second for the) and use the PDG 199 $B(D^{0} \rightarrow K)$ $= (93 \pm 5)$ The nonresonance of the second sec	the CLEO II $2 \text{ B}(D^0 \rightarrow \tau^{\pm} \pi^{\pm})$. $\pm 5)\%$, as $\pi^{\pm} \pi^{0}$ $D^0 \pi^{\pm}) =$ $7 \pm 0.5) \times$ systematic the $\Upsilon(4S)$ $) = 0.57 \pm$ $5) \times 10^{-2}$. matic error $\Upsilon(4S)$ and not depend
$\Gamma(D^*(2010) - K^+) / \Gamma$						Гол /Г

$(D(2010) \Lambda^{+})/(total)$			· 21/·
VALUE	DOCUMENT ID	TECN COMMENT	
$(2.04 \pm 0.44 \pm 0.16) imes 10^{-4}$	⁹⁷ ABE	011 BELL $e^+e^- \rightarrow$	$\Upsilon(4S)$
97 ABE 011 reports B($B^0 \rightarrow$ 0.015 \pm 0.006. We multiply 0.21) \times 10 ⁻³ . Our first error atic error from using our best	$D^*(2010)^- K^+)/_V$ by our best value r is their experiment t value.	${}^{\prime}B(B^{0} \rightarrow D^{*}(2010)^{-}\pi)$ e $B(B^{0} \rightarrow D^{*}(2010)^{-}\pi)$ it's error and the second e	$^{+})=$ 0.074 \pm $^{+})=$ (2.76 \pm rror is system-

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Г(<i>D</i> *(2010) ⁻ К	*(892) ⁺)/Γ _{to}	tal				Г ₂₂ /Г
VALUE		DOG	CUMENT ID	TECN	COMMEN	IT
$(3.8 \pm 1.3 \pm 0.8) \times$	10 ⁴	⁹⁸ МА	HAPATRA 0	2 CLE2	e ⁺ e ⁻ -	$ ightarrow ~ \Upsilon(4S)$
⁹⁸ Assumes equal	production of B	+ and	d B^0 at the γ	(4S) and	an unpola	rized final state.
$\Gamma(D^*(2010)^-\pi^-)$	$(\pi^+\pi^-)/\Gamma_{tot}$	al				Г ₂₃ /Г
VALUE	<u>CL%</u>	EVTS	DOCUME	ENT ID	TECN	COMMENT
0.0076±0.0018	OUR AVERAGE	Erre	or includes sca	ale factor c	f 1.4. See	e the ideogram
0.0063±0.0010	± 0.0011	49 ⁹	^{9,100} ALAM	94	CLE2	$e^+e^- \rightarrow \Upsilon(4S)$
0.0134 ± 0.0036	± 0.0001		¹⁰¹ BORTC	LETTO92	CLEO	$e^+e^- \rightarrow \gamma(4S)$
0.0101 ± 0.0041	± 0.0001	26	¹⁰² ALBRE	CHT 90	J ARG	$e^+e^- \rightarrow \gamma$ $\gamma(4S)$
• • • We do not ι	ise the following	data	for averages, f	fits, limits,	etc. • •	•
0.033 ± 0.009 =	± 0.016	27	¹⁰³ ALBRE	CHT 87	c ARG	$e^+e^- \rightarrow \Upsilon(4S)$
<0.042	90		¹⁰⁴ BEBEK	87	CLEO	$e^+e^- \rightarrow \Upsilon(4S)$
00				0		

⁹⁹ALAM 94 assume equal production of B^+ and B^0 at the $\Upsilon(4S)$ and use the CLEO II B($D^*(2010)^+ \rightarrow D^0 \pi^+$) and absolute B($D^0 \rightarrow K^- \pi^+$) and the PDG 1992 B($D^0 \rightarrow K^- \pi^+ \pi^0$)/B($D^0 \rightarrow K^- \pi^+$) and B($D^0 \rightarrow K^- \pi^+ \pi^+ \pi^-$)/B($D^0 \rightarrow K^- \pi^+$).

¹⁰⁰ The three pion mass is required to be between 1.0 and 1.6 GeV consistent with an a_1 meson. (If this channel is dominated by a_1^+ , the branching ratio for $\overline{D}^{*-}a_1^+$ is twice that for $\overline{D}^{*-}\pi^+\pi^+\pi^-$.)

- ¹⁰¹ BORTOLETTO 92 reports $0.0159 \pm 0.0028 \pm 0.0037$ for $B(D^*(2010)^+ \rightarrow D^0 \pi^+) = 0.57 \pm 0.06$. We rescale to our best value $B(D^*(2010)^+ \rightarrow D^0 \pi^+) = (67.7 \pm 0.5) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and uses Mark III branching fractions for the D.
- ¹⁰² ALBRECHT 90J reports $0.012 \pm 0.003 \pm 0.004$ for $B(D^*(2010)^+ \rightarrow D^0 \pi^+) = 0.57 \pm 0.06$. We rescale to our best value $B(D^*(2010)^+ \rightarrow D^0 \pi^+) = (67.7 \pm 0.5) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and uses Mark III branching fractions for the D.
- ¹⁰³ ALBRECHT 87C use PDG 86 branching ratios for D and $D^*(2010)$ and assume $B(\Upsilon(4S) \rightarrow B^+B^-) = 55\%$ and $B(\Upsilon(4S) \rightarrow B^0\overline{B}^0) = 45\%$. Superseded by AL-BRECHT 90J.

¹⁰⁴ BEBEK 87 value has been updated in BERKELMAN 91 to use same assumptions as noted for BORTOLETTO 92.



$$\Gamma(D^*(2010)^- \pi^+ \pi^+ \pi^-) / \Gamma_{total}$$

$\Gamma((D^*(2010)^-\pi^+\pi^+\pi^-) \text{ nonresonant})/\Gamma_{\text{total}}$					
VALUE	DOCUMENT ID	TECN	<u>COMMENT</u>		
$0.0000 \pm 0.0019 \pm 0.0016$	¹⁰⁵ BORTOLETTO92	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$	

 $^{105}\,{\tt BORTOLETTO}$ 92 assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and uses Mark III branching fractions for the D and $D^*(2010)$.

$\Gamma(D^*(2010)^-\pi^+\rho^0)/\Gamma_{\text{total}}$	l			Г ₂₅ /Г
VALUE	DOCUMENT ID	TECN	COMMENT	
$0.00573 {\pm} 0.00317 {\pm} 0.00004$	¹⁰⁶ BORTOLETTO92	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
106 BORTOLETTO 92 reports ($0.57\pm0.06.$ We rescale to 0.57 ± 0.06 We rescale to $0.10^{-2}.$ Our first error is the error from using our best values Mark III branching	$0.0068 \pm 0.0032 \pm 0.002$ our best value $B(D^*(201))$ ir experiment's error and lue. Assumes equal produce fractions for the D .	1 for B(I 0) ⁺ \rightarrow our second uction of	$D^*(2010)^+$ $D^0\pi^+) = 0$ ond error is B^+ and B^0	$ \rightarrow D^0 \pi^+) = $ (67.7 ± 0.5) × the systematic at the $\Upsilon(4S)$
Γ(<i>D</i> *(2010) ⁻ <i>a</i> ₁ (1260) ⁺)/	Г _{total}			Г ₂₆ /Г
VALUE	DOCUMENT ID	TECN	<u>COMMENT</u>	
0.0130 ± 0.0027 OUR AVERAGE				
$0.0126 \pm 0.0020 \pm 0.0022$ 107	^{7,108} ALAM 94	CLE2	$e^+e^- ightarrow$	$\Upsilon(4S)$
$0.0152\!\pm\!0.0070\!\pm\!0.0001$	¹⁰⁹ BORTOLETTO92	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
¹⁰⁷ ALAM 94 value is twice the observation that the three n	neir $\Gamma(D^*(2010)^-\pi^+\pi^+)$	$(\pi^{-})/\Gamma_{t}$	otal value b	pased on their

observation that the three pions are dominantly in the $a_1(1260)$ mass range 1.0 to 1.6 GeV.

¹⁰⁸ ALAM 94 assume equal production of B^+ and B^0 at the $\Upsilon(4S)$ and use the CLEO II B($D^*(2010)^+ \rightarrow D^0 \pi^+$) and absolute B($D^0 \rightarrow K^- \pi^+$) and the PDG 1992 B($D^0 \rightarrow K^- \pi^+ \pi^0$)/B($D^0 \rightarrow K^- \pi^+$) and B($D^0 \rightarrow K^- \pi^+ \pi^- \pi^-$)/B($D^0 \rightarrow K^- \pi^+$).

¹⁰⁹ BORTOLETTO 92 reports $0.018 \pm 0.006 \pm 0.006$ for $B(D^*(2010)^+ \rightarrow D^0 \pi^+) = 0.57 \pm 0.06$. We rescale to our best value $B(D^*(2010)^+ \rightarrow D^0 \pi^+) = (67.7 \pm 0.5) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and uses Mark III branching fractions for the D.

$\Gamma(D^*(2010)^-\pi^+\pi^+\pi^-\pi^0)$	⁾)/Г _{total}			Г ₂₇ /Г
VALUE E	VTS DOCUMENT ID	TECN	COMMENT	
0.0176±0.0027 OUR AVERAG	Е			
$\begin{array}{c} 0.0172 \pm 0.0014 \pm 0.0024 \\ 0.0345 \pm 0.0181 \pm 0.0003 \end{array}$	¹¹⁰ ALEXANDER 28 ¹¹¹ ALBRECHT	01в CLE2 90J ARG	$e^+e^- \rightarrow e^+e^- \rightarrow$	$\Upsilon(4S)$ $\Upsilon(4S)$
¹¹⁰ Assumes equal production	of B^+ and B^0 at the γ (4 <i>S</i>). The	signal is consi	stent with
all observed $\omega \pi^+$ having p	proceeded through the $ ho'+$	resonance	at mass 1349	$\pm 25^{+10}_{5}$
MeV and width 547 \pm 86 $^{-}$	⊢46 45 MeV.			- 5
¹¹¹ ALBRECHT 90J reports 0.1	041 \pm 0.015 \pm 0.016 for B($(D^*(2010))$	$+ \rightarrow D^0 \pi^+$	$0 = 0.57 \pm$
0.06. We rescale to our be	st value B($D^*(2010)^+ \rightarrow$	$D^{0}\pi^{+})$	$= (67.7 \pm 0.5)$	$) \times 10^{-2}$.
Our first error is their exp	eriment's error and our se	econd erro	r is the system	natic error
from using our best value.	Assumes equal production	of B^+ and	nd B ⁰ at the ´	(4S) and
uses Mark III branching fra	ctions for the D.			
$\Gamma(D^*(2010)^- p \overline{p} \pi^+) / \Gamma_{tot}$	tal			Г ₂₉ /Г
VALUE (units 10^{-4})	DOCUMENT ID	TECN (COMMENT	
$6.5^{+1.3}_{-1.2}{\pm}1.0$	¹¹² ANDERSON 01	CLE2 e	$e^+e^- ightarrow ~\gamma(e^+e^-)$	4 <i>S</i>)
¹¹² Assumes equal production	of B^+ and B^0 at the $\Upsilon(4)$	<i>IS</i>).		
$\Gamma(D^*(2010)^- \rho \overline{n}) / \Gamma_{total}$				Г ₃₀ /Г
VALUE (units 10^{-4})	DOCUMENT ID	TECN C	COMMENT	
$14.5^{+3.4}_{-3.0}\pm 2.7$	¹¹³ ANDERSON 01	CLE2 e	$e^+e^- ightarrow~\gamma(4)$	45)
¹¹³ Assumes equal production	of B^+ and B^0 at the $\Upsilon(4)$	<i>IS</i>).		
$\Gamma(\overline{D}^{*}(0010) = +)/\Gamma$	· · · · · · · · · · · · · · · · · · ·	,		F /F
$(D'(2010) \omega \pi')/tota$		TECN	COMMENT	1 31/1
VALUE	114 ALEXANDED 010	$\frac{TECN}{CLE2}$	$2 - \frac{1}{2} - $	15)
11/ .			$e \cdot e \rightarrow I(e)$	+5)
Assumes equal production all observed $\omega \pi^+$ having p	of B^+ and B° at the $I($	45). The resonance	signal is consi at mass 1349	stent with $+25^{+10}$
MoV and width 547 ± 86^{-1}	⊢46 _{Mo} γ			5
	-45 ^{1016 V .}			
$\Gamma(\overline{D}_2^*(2460)^-\pi^+)/\Gamma_{total}$				Г ₃₂ /Г
VALUE CL%	DOCUMENT ID	<u>TECN</u>	COMMENT	
<0.0022 90	¹¹³ ALAM 94	CLE2 e	$e^+ e^- \rightarrow \Upsilon(4)$	4 <i>S</i>)
¹¹⁵ ALAM 94 assumes equal p absolute B($D^0 \rightarrow K^- \pi^+$	roduction of B^+ and B^0 ; `) and ${ m B}(D^*_2(2460)^+ o B^+_2)$	at the $ \Upsilon(4 D^0 \pi^+) =$	4 <i>S</i>) and use th 30%.	ne CLEO II

$\Gamma(\overline{D}_{2}^{*}(2460)^{-}\rho^{+})/\Gamma$	total					Г ₃₃ /Г
VALUE	<u>CL%</u>	DOCUMENT ID)	TECN	COMMENT	
<0.0049	90	¹¹⁶ ALAM	94	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
¹¹⁶ ALAM 94 assumesed absolute $B(D^0 \rightarrow R)$	qual properties $K^{-}\pi^{+}$	oduction of B^+ and) and B $(D_2^st(2460)^+)$	$ \stackrel{d}{\to} B^0 $	at the γ $D^0 \pi^+$)	(4 <i>S</i>) and us = 30%.	se the CLEO II
$\Gamma(D^-D^+)/\Gamma_{total}$						Г ₃₄ /Г
VALUE	<u>CL%</u>	DOCUMENT ID)	TECN	COMMENT	
<9.4 × 10 ⁻⁴	90	¹¹⁷ LIPELES	00	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
• • • We do not use th	e follow	ving data for averag	es, fits	s, limits,	etc. • • •	
$< 5.9 \times 10^{-3}$	90	BARATE	980	ALEP	$e^+e^- \rightarrow$	Ζ
$< 1.2 \times 10^{-3}$	90	ASNER	97	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
¹¹⁷ Assumes equal produ	uction o	of B^+ and B^0 at the	he $\Upsilon(4)$	4 <i>S</i>).		
$\Gamma(D^-D_s^+)/\Gamma_{\text{total}}$	51			TE		Г₃₅/Г
0.0080±0.0030 OUR A		<u>E</u>		<u></u>		
$0.0084 \pm 0.0030 + 0.0020$)	¹¹⁸ GIBAUT		96 CL	E2 e ⁺ e ⁻	$ ightarrow ~ \Upsilon(4S)$
-0.0021 0.013 +0.011 +0.003		119 AL BRECH	чт	926 AR	G+	$\rightarrow \Upsilon(4S)$
$0.007 \pm 0.004 \pm 0.002$		¹²⁰ BORTOL	FTTC	920 / II	EO e ⁺ e ⁻	$\rightarrow \gamma(4S)$
• • • We do not use th	e follov	ving data for averag	es, fits	s, limits,	etc. • • •	()
0.012 ±0.007		3 ¹²¹ BORTOL	ETTC	90 CL	EO e ⁺ e ⁻	$\rightarrow \gamma(4S)$
118 GIBALIT 96 reports	0 0087	$+ 0.0024 \pm 0.0020 \pm$	for B()	$D^+ \rightarrow D^+$	$(\phi \pi^+) = 0.0$	35 We rescale
to our best value E experiment's error ar ¹¹⁹ ALBRECHT 92G re	B(D ⁺ _s - nd our s ports 0	$\rightarrow \phi \pi^+) = (3.6 \pm 500)$ second error is the sy $.017 \pm 0.013 \pm 0.000$	± 0.9) ystema 006 foi	$\times 10^{-1}$ atic error r B(D^+	² . Our first from using $\rightarrow \phi \pi^+$)	t error is their our best value. = 0.027. We
rescale to our best v experiment's error ar Assumes PDG 1990 ¹²⁰ BORTOLETTO 92 0.011. We rescale to error is their experin our best value. Assu branching fractions f 121 BORTOLETTO 90	alue B(alue B(D^+ br reports o our bo nent's e mes eq for the assume	$D_s^+ \rightarrow \phi \pi^+) = (3)$ second error is the sy- anching ratios, e.g., $0.0080 \pm 0.0045 \pm$ est value $B(D_s^+ \rightarrow \phi)$ error and our second ual production of B^- D. $B(D_s \rightarrow \phi \pi^+) =$	3.6 ± 0 ystema $B(D^{-}$ 0.003 $\phi \pi^{+}$ d error $\phi \pi^{+}$ and 2%. S	$(3.9) \times 10^{-10}$ $(3.0) \times 10^{-10}$ $(3.0) \times 10^{-10} \times 10^{-10}$ $(3.0) \times 10^{-$	D^{-2} . Our fire from using $\pi + \pi^+$) = $(D_s^+ \rightarrow \phi \pi)$ $(5 \pm 0.9) \times 1$ hystematic en- the $\Upsilon(4S)$ and ded by BOR	st error is their our best value. = $7.7 \pm 1.0\%$. +) = $0.030 \pm$ 0^{-2} . Our first rror from using d uses Mark III TOLETTO 92.
$\Gamma(D^{*}(2010) - D^{+})/[$						Γ26/Γ
VALUE	EVTS	DOCUMENT ID		TECN	COMMENT	• 30/ •
0.0111±0.0033 OUR A	/ERAG	E <u></u>				
$0.0110 \pm 0.0021 + 0.0026$) ,	¹²² AHMED	00 B	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$0.010 \pm 0.008 \pm 0.003$		¹²³ ALBRECHT	92 G	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$0.013 \pm 0.008 \pm 0.003$		¹²⁴ BORTOLETT	092	CLEO	$e^+e^- \rightarrow$	$\dot{\Upsilon(4S)}$
• • • We do not use th	e follov	ving data for averag	es, fits	s, limits,	etc. • • •	
	,	125 GIRAUT	06		Popl by Al	
$0.0090 \pm 0.0027 \pm 0.0022$	-	010/101	50	ULEZ	Tepl. by Al	

¹²²AHMED 00B reports 0.0110 \pm 0.0018 \pm 0.0011 for B($D_s^+ \rightarrow \phi \pi^+$) = 0.036. We rescale to our best value B($D_s^+ \rightarrow \phi \pi^+$) = (3.6 \pm 0.9) \times 10⁻². Our first error is their experiment's error and our second error is the systematic error from using our best value.

¹²³ ALBRECHT 92G reports $0.014 \pm 0.010 \pm 0.003$ for $B(D_s^+ \rightarrow \phi \pi^+) = 0.027$. We rescale to our best value $B(D_s^+ \rightarrow \phi \pi^+) = (3.6 \pm 0.9) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes PDG 1990 D^+ and $D^*(2010)^+$ branching ratios, e.g., $B(D^0 \rightarrow K^- \pi^+) = 3.71 \pm 0.25\%$, $B(D^+ \rightarrow K^- \pi^+ \pi^+) = 7.1 \pm 1.0\%$, and $B(D^*(2010)^+ \rightarrow D^0 \pi^+) = 55 \pm 4\%$.

¹²⁴ BORTOLETTO 92 reports $0.016 \pm 0.009 \pm 0.006$ for $B(D_s^+ \to \phi \pi^+) = 0.030 \pm 0.011$. We rescale to our best value $B(D_s^+ \to \phi \pi^+) = (3.6 \pm 0.9) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and uses Mark III branching fractions for the D and $D^*(2010)$.

¹²⁵ GIBAUT 96 reports $0.0093 \pm 0.0023 \pm 0.0016$ for $B(D_s^+ \to \phi \pi^+) = 0.035$. We rescale to our best value $B(D_s^+ \to \phi \pi^+) = (3.6 \pm 0.9) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. ¹²⁶ BORTOLETTO 90 assume $B(D_s \to \phi \pi^+) = 2\%$. Superseded by BORTOLETTO 92.

			Г ₃₇ /I
DOCUMENT ID	TECN	COMMENT	
¹²⁷ GIBAUT	96 CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
¹²⁸ ALBRECHT	92g ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
	DOCUMENT ID 127 GIBAUT 128 ALBRECHT	DOCUMENT ID TECN 127 GIBAUT 96 CLE2 128 ALBRECHT 926 ARG	$\begin{array}{c cccc} \underline{DOCUMENT \ ID} & \underline{TECN} & \underline{COMMENT} \\ \hline 127 \ \text{GIBAUT} & 96 \ \text{CLE2} & e^+e^- \rightarrow \\ 128 \ \text{ALBRECHT} & 92G \ \text{ARG} & e^+e^- \rightarrow \end{array}$

¹²⁷ GIBAUT 96 reports $0.0100 \pm 0.0035 \pm 0.0022$ for $B(D_s^+ \to \phi \pi^+) = 0.035$. We rescale to our best value $B(D_s^+ \to \phi \pi^+) = (3.6 \pm 0.9) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. ¹²⁸ ALBRECHT 92G reports $0.027 \pm 0.017 \pm 0.009$ for $B(D_s^+ \to \phi \pi^+) = 0.027$. We rescale to our best value $B(D_s^+ \to \phi \pi^+) = (3.6 \pm 0.9) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes PDG 1990 D^+ branching ratios, e.g., $B(D^+ \to K^- \pi^+ \pi^+) = 7.7 \pm 1.0\%$.

$[\Gamma(D^*(2010)^- D_s^+)]$	(Г ₃₆ +Г ₃₈)/І			
VALUE (units 10^{-2})	EVTS	DOCUMENT ID	TECN	COMMENT
$4.15 \pm 1.11 \substack{+0.99 \\ -1.02}$	22	¹²⁹ BORTOLETTO90	CLEO	$e^+e^- \rightarrow \Upsilon(4S)$

¹²⁹BORTOLETTO 90 reports 7.5 ± 2.0 for $B(D_s^+ \rightarrow \phi \pi^+) = 0.02$. We rescale to our best value $B(D_s^+ \rightarrow \phi \pi^+) = (3.6 \pm 0.9) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(D^{*}(2010)^{-}D_{s}^{*+})/\Gamma_{total}$					Г ₃₈ /Г
VALUE	DOCUMENT ID		TECN	COMMENT	
0.018±0.006 OUR AVERAGE					
$0.018\!\pm\!0.004\!\pm\!0.004$	¹³⁰ AHMED	00 B	CLE2	$e^+e^- \rightarrow \Upsilon(4S)$)
$0.019\!\pm\!0.011\!\pm\!0.005$	¹³¹ ALBRECHT	9 2G	ARG	$e^+e^- \rightarrow \Upsilon(4S)$	·)
$\bullet~\bullet~\bullet$ We do not use the followi	ng data for averages	, fits,	limits,	etc. • • •	
$0.020\!\pm\!0.006\!\pm\!0.005$	¹³² GIBAUT	96	CLE2	Repl. by AHME	О 00 В

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¹³⁰ AHMED 00B reports 0.0182 \pm 0.0037 \pm 0.0025 for B($D_s^+ \rightarrow \phi \pi^+$) = 0.036. We rescale to our best value B($D_s^+ \rightarrow \phi \pi^+$) = (3.6 \pm 0.9) \times 10⁻². Our first error is their experiment's error and our second error is the systematic error from using our best value.

¹³¹ ALBRECHT 92G reports $0.026 \pm 0.014 \pm 0.006$ for $B(D_s^+ \rightarrow \phi \pi^+) = 0.027$. We rescale to our best value $B(D_s^+ \rightarrow \phi \pi^+) = (3.6 \pm 0.9) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes PDG 1990 D^+ and $D^*(2010)^+$ branching ratios, e.g., $B(D^0 \rightarrow K^- \pi^+) = 3.71 \pm 0.25\%$, $B(D^+ \rightarrow K^- \pi^+ \pi^+) = 7.1 \pm 1.0\%$, and $B(D^*(2010)^+ \rightarrow D^0 \pi^+) = 55 \pm 4\%$.

¹³²GIBAUT 96 reports $0.0203 \pm 0.0050 \pm 0.0036$ for $B(D_s^+ \rightarrow \phi \pi^+) = 0.035$. We rescale to our best value $B(D_s^+ \rightarrow \phi \pi^+) = (3.6 \pm 0.9) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

 $\Gamma(D_s^+\pi^-)/\Gamma_{\text{total}}$

Γ39/Γ

VALUECL%DOCUMENT IDTECNCOMMENT<0.00028</td>90133 ALEXANDER 93B CLE2 $e^+e^- \rightarrow \Upsilon(4S)$ • • We do not use the following data for averages, fits, limits, etc. • • •<0.0013</td>90134 BORTOLETTO90CLEO $e^+e^- \rightarrow \Upsilon(4S)$ 133 ALEXANDER 93B reports < 2.7×10^{-4} for $B(D_s^+ \rightarrow \phi \pi^+) = 0.037$. We rescale to our best value $B(D_s^+ \rightarrow \phi \pi^+) = 0.036$.134 POPTOLETTO OF TO 0 assume $B(D_s \rightarrow \phi \pi^+) = 0.036$.

¹³⁴ BORTOLETTO 90 assume B($D_s \rightarrow \phi \pi^+$) = 2%.



best value B($D_{s}^{+} \rightarrow \phi \pi^{+}$) = 0.036.

$\Gamma(D_s^+ \rho^-)/\Gamma_{\text{total}}$		DOCUMENT	TECN	COMMENT	Г ₄₁ /Г
<u>VALUE</u>	<u>00</u>	138 ALEXANDER 03B	$\frac{TECN}{CLE2}$		$\Upsilon(\Lambda S)$
• • • We do not use the	followi	ng data for averages, fits,	limits.	etc. $\bullet \bullet \bullet$	7 (43)
< 0.0016	90	¹³⁹ ALBRECHT 93F	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
138 ALEXANDER 03P KO	norte <	6.6×10^{-4} for B(D ⁺	·	(+) = 0.037	We rescale to
ALEXANDER 958 Te		(0.0×10) 101 D(D_s =	$\rightarrow \varphi \pi$) = 0.037.	we rescale to
139 ALPDECUT 035	$\rightarrow \varphi \eta$	$(1)^{-3} = 0.030.$	(_ +)	0.007 \\/	
ALBRECHT 93E repo	rts < 2	$.2 \times 10^{\circ}$ for $B(D_s^{\circ} \rightarrow 0)$	$\phi\pi$ '):	= 0.027. VV6	e rescale to our
best value $B(D_{s}^{+} \rightarrow$	$\phi\pi$ ')	= 0.036.			
$\Gamma(D_s^{*+} ho^-)/\Gamma_{ ext{total}}$	2 1.0/				Г ₄₂ /Г
<u>VALUE</u>	<u>CL%</u>	140 ALEXANDED 020		$\underline{COMMENT}$	$\mathcal{C}(AC)$
 	90 followi	ng data for averages, fits,	LE2	$e \cdot e \rightarrow$	1 (43)
<0.0019	90	141 ALBRECHT 93F	ARG	e ⁺ e [−] →	$\Upsilon(45)$
140 ALEXANDER 03P KO	norte <	7.4×10^{-4} for B(D ⁺	λ	(+) = 0.037	We rescale to
ALEXANDER 300 Te		$(D_s^+) = 0.036$	$\rightarrow \phi \pi$) = 0.037.	We rescale to
	$\rightarrow \varphi$	(-) = 0.030.	4 _+ \	0.007 \\/	
	rts < 2	$.5 \times 10^{-5}$ for $B(D_s^+ \to 0)$	$\varphi\pi$ ')	= 0.027. VV	e rescale to our
best value $B(D_s^+ \rightarrow s)$	$\phi\pi$ ')	= 0.036.			
$\Gamma(D_s^+a_1(1260)^-)/\Gamma_t$	otal				Г ₄₃ /Г
VALUE	<u>CL%</u>	142 AL DEFICIT	TECN	<u>COMMENT</u> + -	22(4.6)
<0.0020	90	ALBRECHI 93E	ARG	$e^+e^- \rightarrow$	7 (45)
¹⁴² ALBRECHT 93E repo	orts < 3	$.5 \times 10^{-3}$ for B($D_s^+ \rightarrow 0$	$\phi\pi^+$):	= 0.027. We	e rescale to our
best value B($D^+_{m{s}} ightarrow$	$\phi \pi^+)$	= 0.036.			
$\Gamma(D^{*+} = (1260)^{-})/\Gamma$					[44/]
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	• 44/ •
<0.0022	90	¹⁴³ ALBRECHT 93E	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
¹⁴³ ALBRECHT 93E repo	orts < 2	$.9 \times 10^{-3}$ for B($D^+ \rightarrow D$	$(\phi \pi^+)$	= 0.027. We	e rescale to our
best value $B(D^+_{s} o$	$\phi \pi^+)$	= 0.036.	,		
$\Gamma(D_s^-K^+)/\Gamma_{total}$					Г ₄₅ /Г
VALUE	<u>CL%</u>	DOCUMENT ID	TECN	COMMENT	
<0.00024	90	¹⁴⁴ ALEXANDER 93B	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
• • • We do not use the	followi	ng data for averages, fits,	limits,	etc. • • •	
<0.0013	90	¹⁴⁵ BORTOLETTO90	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$

¹⁴⁴ ALEXANDER 93B reports $\langle 2.3 \times 10^{-4} \text{ for } B(D_s^+ \rightarrow \phi \pi^+) = 0.037$. We rescale to our best value $B(D_s^+ \rightarrow \phi \pi^+) = 0.036$. ¹⁴⁵ BORTOLETTO 90 assume $B(D_s \rightarrow \phi \pi^+) = 2\%$.

$\Gamma(D_s^{*-}K^+)/\Gamma_{\text{total}}$							Г ₄₆ /Г
<u>VALUE</u>	<u>CL%</u>	146	DOCUMENT ID	030	<u>TECN</u>	$\frac{COMMENT}{a^+a^-}$	$\gamma(\Lambda S)$
146 ALEXANDER 03P ro	90	- 1 7	$\times 10^{-4}$ for B(פנפ +ח	CLL2	$\overline{e} = 0.037$	Me rescale to
our best value $B(D^+)$		、1.7 _+)	- 0.036	s	$\rightarrow \phi \pi$) = 0.057.	we rescale to
our best value D(Ds	$\rightarrow \phi$	()	- 0.030.				
$\frac{\Gamma(D_s^- K^*(892)^+)}{\Gamma_{ta}}$	otal <u>CL%</u>		DOCUMENT ID		<u>TECN</u>	<u>COMMENT</u>	Γ ₄₇ /Γ
<0.0010	90	147	ALEXANDER	93 B	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
• • We do not use the	followi	ng d	ata for averages	s, fits	, limits,	etc. • • •	
< 0.0034	90	140	ALBRECHT	93E _⊥	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
¹⁴ ALEXANDER 93B re	ports <	< 9.7	$\times 10^{-4}$ for B(D_{s}^{+}	$\rightarrow \phi \pi^{\neg}$	⁻) = 0.037.	We rescale to
our best value $B(D_s^{+})$	$\rightarrow \phi \tau$	π ⁺)	= 0.036.	_			
ALBRECHT 93E repo	orts < 4	.6×	10^{-5} for B(D_s	\rightarrow	$\phi\pi^{+}) =$	= 0.027. W€	e rescale to our
best value $B(D_{s}^{+} \rightarrow$	$\phi \pi^+$)	= 0	.036.				
$\Gamma(D_{e}^{*-}K^{*}(892)^{+})/\Gamma$	total						Г ₄₈ /Г
VALUE	<u>CL%</u>		DOCUMENT ID		TECN	COMMENT	
<0.0011	90	149	ALEXANDER	93 B	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
• • We do not use the	tollowi	ng d	ata for averages	s, tits	, limits,	etc. • • • • $+$	22(4.5)
	90	150		93E	ARG	$e \cdot e \rightarrow$	1 (45)
ALEXANDER 93B re	ports <	(11.0	0×10^{-4} for B((D_{s})	$\rightarrow \phi \pi$	() = 0.037.	We rescale to
our best value $B(D_s^+)$	$\rightarrow \phi \eta$	τ⊤) : ο	= 0.036.	_	(+)	0.007 144	
ALBRECHT 93E repo	rts < 5	0.8 ×	10° for $B(D_s)$	\rightarrow	$\phi\pi$ ') =	= 0.027. VVe	e rescale to our
best value $B(D_s^+ \rightarrow$	$\phi\pi$ ')	= 0	.030.				
$\Gamma(D_s^-\pi^+K^0)/\Gamma_{total}$							Г ₄₉ /Г
VALUE	<u>CL%</u>	1 - 1	DOCUMENT ID		TECN	COMMENT	
<0.005	90	151	ALBRECHT	93E	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
¹⁵¹ ALBRECHT 93E repo	orts < 7	′.3×	10^{-3} for B(D_s^+	\rightarrow	$\phi\pi^+) =$	= 0.027. We	e rescale to our
best value B($D^+_{m{s}} ightarrow$	$\phi \pi^+$)	= 0	.036.				
$\Gamma(D_{s}^{*-}\pi^{+}K^{0})/\Gamma_{\text{total}}$							Г ₅₀ /Г
<u>VALUE</u>	<u>CL%</u>	152	DOCUMENT ID	035	ARC	$\frac{COMMENT}{a^+a^-}$	$\gamma(\Lambda S)$
152 ALBRECHT 035 KORG	90	2~	10-3 for B(D ⁺	- ($4\pi^{\pm}$) -		rescale to our
host value $R(D^+)$	את בייג שמיילים א	0	10 101 D(<i>D</i>	\rightarrow	φπ ·) -	- 0.027. VVE	
Dest value $D(D_s \rightarrow s)$	$\varphi \pi \cdot \mathbf{j}$	= 0	.030.				
$\frac{\Gamma(D_s^-\pi^+K^*(892)^0)}{VALUE}$	Γ _{total}		DOCUMENT ID		TECN	<u>COMMENT</u>	Г ₅₁ /Г
<0.004	90	153	ALBRECHT	93E	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
¹⁵³ ALBRECHT 93E repo	orts < 5	$0.0 \times$	10^{-3} for B(D_s^+	$ \rightarrow$	$\phi \pi^+$) =	= 0.027. We	e rescale to our
best value $B(D^+_{s} ightarrow$	$\phi \pi^+$)	= 0	.036.				
HTTP://PDG.LBL.G	ίον		Page 25		Crea	ted: 12/2	/2002 16:13

$\Gamma(D_s^{*-}\pi^+K^*($	892) ⁰)/Г _{tot}	al			I <u>52</u> /I
VALUE	<u> </u>	154 AL DOCCUT	<u>) TECN</u>	$\frac{COMMENT}{2}$	
15/	90			$e \cdot e \rightarrow I$	(45)
¹³⁴ ALBRECHT	93E reports <	2.7×10^{-5} for B(L	$p_{s}^{+} \rightarrow \phi \pi^{+})$	= 0.027. We re	escale to our
best value B($D_{s}^{+} \rightarrow \phi \pi^{+}$) = 0.036.			
$\Gamma(\overline{D}^0\pi^0)/\Gamma_{\rm tota}$	al				Г ₅₃ /Г
VALUE (units 10^{-4})	<u>CL%</u>	DOCUMENT ID	D TECN	COMMENT	
$2.9 \pm 0.5 \text{ OU}$	RAVERAGE	155		+ - ~	
$3.1 \pm 0.4 \pm 0.1$	5	155 ABE	02J BELL	$e e \rightarrow I$	(45)
$2.74 + 0.30 \pm 0.00$	55	¹⁵⁵ COAN	02 CLE2	$e^+e^- \rightarrow \gamma$	(4 <i>S</i>)
• • • We do not	use the follow	ving data for averag	es, fits, limits,	etc. • • •	
<1.2	90	156 NEMATI	98 CLE2	Repl. by COA	AN 02
<4.8	90	¹⁵⁷ ALAM	94 CLE2	Repl. by NEM	/ATI 98
¹⁵⁰ NEMATI 98 a values for D ⁰ ¹⁵⁷ ALAM 94 ass absolute B(D	ssumes equal , D^{*0} , η , η' , sume equal properties $0 \rightarrow K^{-}\pi^{+}$)	production of B^+ a and ω branching fra- oduction of B^+ and and the PDG 1992	and B^0 at the actions. d B^0 at the γ B $(D^0 \rightarrow K^-)$	$\Upsilon(4S)$ and use $\Gamma(4S)$ and use $\pi^+ \pi^0)/{ m B}(D^0)$	the PDG 96 the CLEO II $\rightarrow K^{-}\pi^{+}$)
and B($D^0 ightarrow$	$K^-\pi^+\pi^+\tau$	$f)/B(D^{\circ} \rightarrow K)$	π^{+}).		
and $B(D^0 \rightarrow \Gamma(\overline{D^0} \rho^0) / \Gamma_{tota}$	$K = \pi^+ \pi^+ \tau$	$f)/B(D^{2} \rightarrow K)$	π ⁺).		Г ₅₄ /Г
and $B(D^0 \rightarrow \Gamma(\overline{D^0} \rho^0) / \Gamma_{tota}$ $\frac{VALUE}{< 0.00020}$	$K = \pi^+ \pi^+ \tau$	$\frac{DOCUMENT IE}{158 \text{ NEMATING}}$	π^{+}).	$\frac{COMMENT}{c^+ c^-} \sim \gamma$	Γ₅₄/Γ
and $B(D^0 \rightarrow \Gamma(\overline{D^0} \rho^0) / \Gamma_{tota}$ $\frac{VALUE}{< 0.00039}$	$K = \pi^+ \pi^+ \tau$ $\frac{CL\%}{90} = \frac{EVTS}{100}$ Use the follow	$DOCUMENT ID$ $\frac{DOCUMENT ID}{158 \text{ NEMATI}}$ $V_{\text{ing data for average}}$	π^+). <u>9</u> <u>TECN</u> 98 CLE2 res fits limits	$\frac{COMMENT}{e^+e^- \rightarrow \gamma}$	Γ₅₄/Γ
and $B(D^0 \rightarrow \Gamma(\overline{D^0} \rho^0) / \Gamma_{total}$ \overline{VALUE} < 0.00039 $\bullet \bullet \bullet$ We do not < 0.00055	$K = \pi + \pi + \tau$ $\frac{CL\%}{EVTS}$ 90 $use the follow$ 90	$DOCUMENT ID$ $\frac{DOCUMENT ID}{158 \text{ NEMATI}}$ V ing data for averag 159 ALAM	π ⁺⁺). <u>98</u> CLE2 ges, fits, limits, 94 CLE2	$\frac{COMMENT}{e^+e^- \rightarrow \gamma}$ etc. • • • Repl. by NEN	Γ₅₄/Γ (4 <i>5</i>) ΜΑΤΙ 98
and $B(D^0 \rightarrow \Gamma(\overline{D^0} \rho^0) / \Gamma_{tota}$ <u>VALUE</u> <0.00039 ••• We do not <0.00055 <0.0006	$K = \pi + \pi + \pi$	$(D^{0})/B(D^{0} \rightarrow K)$ $\frac{DOCUMENT E }{158}$ NEMATI ving data for averag 159 ALAM 160 BORTOLET	π ⁺⁺). 98 CLE2 es, fits, limits, 94 CLE2 TO92 CLEO	$rac{COMMENT}{e^+e^- ightarrow \ \gamma}$ etc. $\bullet \bullet \bullet$ Repl. by NEN $e^+e^- ightarrow \gamma$	Γ₅₄/Γ (4 <i>S</i>) ΜΑΤΙ 98 (4 <i>S</i>)
and $B(D^0 \rightarrow \Gamma(\overline{D^0} \rho^0) / \Gamma_{tota}$ \overline{VALUE} < 0.00039 $\bullet \bullet We do not$ < 0.00055 < 0.0006 < 0.0027 150	$K = \pi + \pi + \pi$	$\frac{DOCUMENT IE}{158 \text{ NEMATI}}$ <i>v</i> ing data for averag $\frac{159}{160} \text{ ALAM}$ $\frac{160}{161} \text{ ALBRECHT}$	 π⁺). <u>7ECN</u> 98 CLE2 ges, fits, limits, 94 CLE2 TO92 CLEO 88K ARG 	$\frac{COMMENT}{e^+e^- \rightarrow \gamma}$ etc. • • • Repl. by NEN $e^+e^- \rightarrow \gamma$ $e^+e^- \rightarrow \gamma$	Γ₅₄/Γ (4 <i>S</i>) (4 <i>S</i>) (4 <i>S</i>) (4 <i>S</i>)
and $B(D^0 \rightarrow \Gamma(D^0 \rho^0))/\Gamma_{total}$ <u>VALUE</u> <0.00039 ••• We do not <0.00055 <0.0006 <0.0027 ¹⁵⁸ NEMATI 98 a values for D^0 ¹⁵⁹ ALAM 94 ass absolute $B(D^0 \rightarrow$ and $B(D^0 \rightarrow$ ¹⁶⁰ BORTOLET Mark III brand ¹⁶¹ ALBRECHT We rescale to	$K^{-}\pi^{+}\pi^{+}\pi^{+}\pi^{-}\pi^{-}\pi^{-}\pi^{-}\pi^{-}\pi^{-}\pi^{-}\pi^{-$	$\frac{DOCUMENT E}{158 \text{ NEMATI}}$ $\frac{158 \text{ NEMATI}}{158 \text{ NEMATI}}$ $\frac{159 \text{ ALAM}}{160 \text{ BORTOLET}}$ $\frac{161 \text{ ALBRECHT}}{161 \text{ ALBRECHT}}$ $\frac{161 \text{ ALBRECHT}}{161 \text{ ALBRECHT}}$ $\frac{161 \text{ BORTOLET}}{161 \text{ ALBRECHT}}$ $\frac{160 \text{ BORTOLET}}{100 \text{ ALBRET}}$	π^+). p = TECN 98 CLE2 qes, fits, limits, 94 CLE2 TO92 CLEO 88K ARG $B(D^0 \rightarrow K^-)$ π^+). $of B^+$ and B^0 $B(B^0;B^+B^-)$	$\frac{COMMENT}{e^+e^- \rightarrow \gamma}$ etc. • • • Repl. by NEN $e^+e^- \rightarrow \gamma$ $e^+e^- \rightarrow \gamma$ $\gamma(4S)$ and use $\gamma(4S)$ and use $\pi^+\pi^0)/B(D^0)$ B^0 at the $\gamma(4.5)$ production rate	Γ_{54}/Γ (45) MATI 98 (45) (45) the PDG 96 the CLEO II $\rightarrow K^- \pi^+$) S) and uses tio is 45:55.
and $B(D^0 \rightarrow \Gamma(\overline{D^0} \rho^0))/\Gamma_{total}$ <u>VALUE</u> <0.00039 ••• We do not <0.00055 <0.0006 <0.0027 158 NEMATI 98 a values for D^0 159 ALAM 94 ass absolute $B(D^1 \rightarrow 160 \text{ BORTOLET})$ Mark III brand 161 ALBRECHT We rescale to $\Gamma(\overline{D^0} \eta)/\Gamma_{total}$	$K = \pi^{+}\pi^{+}\pi^{+}\pi^{+}\pi^{-}\pi^{+}\pi^{+}\pi^{-}\pi^{-}\pi^{-}\pi^{-}\pi^{-}\pi^{-}\pi^{-}\pi^{-$	$\frac{DOCUMENT \ IE}{158 \ NEMATI}$ $\frac{158 \ NEMATI}{160 \ BORTOLET}$ $\frac{160 \ BORTOLET}{161 \ ALBRECHT}$ $\frac{161 \ ALBRECHT}{161 \ ALBRECHT}$ $\frac{160 \ BORTOLET}{161 \ ALBRECHT}$ $\frac{160 \ B}{160 \ B}$ $\frac{160 \ B}{160 \ C}$	π^+). $p = \frac{TECN}{98}$ CLE2 res, fits, limits, 94 CLE2 TO92 CLEO 88K ARG and B^0 at the actions. d B^0 at the γ $B(D^0 \rightarrow K^{-1})$ π^+). of B^+ and B^0 $B^0:B^+B^-$	$\frac{COMMENT}{e^+e^- \rightarrow \gamma}$ etc. • • • Repl. by NEM $e^+e^- \rightarrow \gamma$ $e^+e^- \rightarrow \gamma$ $\gamma(4S)$ and use $\gamma(4S)$ and use $\pi^+\pi^0)/B(D^0)$ B^0 at the $\gamma(4.5)$ production rate	
and $B(D^0 \rightarrow \Gamma(\overline{D^0} \rho^0) / \Gamma_{total}$ <u>VALUE</u> <0.00039 ••• We do not <0.00055 <0.0006 <0.0027 ¹⁵⁸ NEMATI 98 a values for D^0 ¹⁵⁹ ALAM 94 ass absolute $B(D^0 \rightarrow$ ¹⁶⁰ BORTOLET Mark III brand ¹⁶¹ ALBRECHT We rescale to $\Gamma(\overline{D^0} \eta) / \Gamma_{total}$ <u>VALUE (units 10⁻⁴)</u>	$K = \pi + \pi + \pi$ $\frac{CL\%}{90} = EVTS$ 90 90 90 90 90 90 90 4 $ssumes equal pro- 0 \rightarrow K^{-}\pi^{+}) K^{-}\pi^{+}\pi^{+}\pi^{-}\pi^{-} FO 92 \text{ assume} 88K \text{ reports } < 50\%.$	$\frac{DOCUMENT \ IL}{158 \ NEMATI}$ $\frac{DOCUMENT \ IL}{158 \ NEMATI}$ $\frac{159 \ ALAM}{160 \ BORTOLET}$ $\frac{161 \ ALBRECHT}{161 \ ALBRECHT}$ $\frac{DOCUMENT \ IL}{160}$ $\frac{DOCUMENT \ IL}{160}$	π^+). p = TECN 98 CLE2 qes, fits, limits, 94 CLE2 TO92 CLEO 88K ARG $ad B^0$ at the TB $B(D^0 \rightarrow K^-)$ π^+). $of B^+$ and B^0 $B^0\overline{B}^0:B^+B^-$	$\frac{COMMENT}{e^+e^- \rightarrow \gamma}$ etc. • • • Repl. by NEM $e^+e^- \rightarrow \gamma$ $e^+e^- \rightarrow \gamma$ $\Upsilon(4S)$ and use $\pi^+\pi^0)/B(D^0)$ B^0 at the $\Upsilon(4.5)$ production rate $\Delta COMMENT$	$ \Gamma_{54}/\Gamma $ (45) MATI 98 (45) (45) the PDG 96 the CLEO II → $K^- \pi^+$) S) and uses tio is 45:55. Γ ₅₅ /Γ
and $B(D^0 \rightarrow \Gamma(\overline{D^0} \rho^0) / \Gamma_{tota}$ $\overline{\Gamma(\overline{D^0} \rho^0)} / \Gamma_{tota}$ $\overline{\Gamma(\overline{D^0} \rho^0)} / \Gamma_{tota}$ $\overline{\Gamma(\overline{D^0} \rho^0)} / \Gamma_{tota}$ $\overline{\Gamma(\overline{D^0} \eta)} / \Gamma_{tota}$	$K = \pi + \pi + \pi$ $\frac{CL\%}{90} = EVTS$ 90 use the follow 90 90 90 90 4 assumes equal $D^{*0}, \eta, \eta', \eta', \eta', \eta', \eta', \eta', \eta', \eta', \eta',$	$\frac{DOCUMENT IE}{158 \text{ NEMATI}}$ $\frac{DOCUMENT IE}{158 \text{ NEMATI}}$ $\frac{159 \text{ ALAM}}{160 \text{ BORTOLET}}$ $\frac{161 \text{ ALBRECHT}}{161 \text{ ALBRECHT}}$ $\frac{DOCUMENT IE}{162 \text{ ABE}}$	π^+). p <u>TECN</u> 98 CLE2 res, fits, limits, 94 CLE2 TO92 CLEO 88K ARG and B^0 at the 1 B($D^0 \rightarrow K^-$ π^+). of B^+ and E^0 $B^0_{}B^+$ π^+ $g^0_{}B^-$ π^+ $g^0_{}B^-$ π^- $g^0_{}B^-$ TECN 02J BELL	$\frac{COMMENT}{e^+e^- \rightarrow \gamma}$ etc. • • • Repl. by NEN $e^+e^- \rightarrow \gamma$ $e^+e^- \rightarrow \gamma$ γ γ (4S) and use γ (4S) and use $\pi^+\pi^0)/B(D^0)$ β^0 at the γ (4. production ration γ $\frac{COMMENT}{e^+e^- \rightarrow \gamma}$	
and $B(D^0 \rightarrow \Gamma(\overline{D^0} \rho^0))/\Gamma_{total}$ <u>VALUE</u> <0.00039 ••• We do not <0.00055 <0.0006 <0.0027 158 NEMATI 98 a values for D^0 159 ALAM 94 ass absolute $B(D^0 \rightarrow$ 160 BORTOLET Mark III brand 161 ALBRECHT We rescale to $\Gamma(\overline{D^0} \eta)/\Gamma_{total}$ <u>VALUE (units 10⁻⁴)</u> 1.4 + 0.5 ± 0.3 ••• We do not	$K = \pi + \pi + \pi$ $\frac{K}{2} = \frac{CL\%}{90} = \frac{EVTS}{90}$ use the follow 90 90 90 90 4 assumes equal $T, D^{*0}, \eta, \eta', \eta', \eta'$ sume equal pro $0 \rightarrow K^{-}\pi^{+}$ $K^{-}\pi^{+}\pi^{+}\pi^{+}\pi^{+}$ TO 92 assume ching fractions 88K reports < 50%. $CL\%$ use the follow	$\frac{DOCUMENT \ IL}{158 \ NEMATI}$ $\frac{158 \ NEMATI}{160 \ BORTOLET}$ $\frac{159 \ ALAM}{160 \ BORTOLET}$ $\frac{161 \ ALBRECHT}{161 \ ALBRECHT}$ $\frac{161 \ BORTOLET}{161 \ ALBRECHT}$ $\frac{160 \ BORTOLET}{161 \ ALBRECHT}$ $\frac{160 \ BORTOLET}{161 \ ALBRECHT}$ $\frac{160 \ BC}{162 \ ABE}$ $\frac{DOCUMENT \ IL}{162 \ ABE}$	π^+). 98 CLE2 98 CLE2 ges, fits, limits, 94 CLE2 TO92 CLEO 88K ARG and B^0 at the actions. d B^0 at the T $B(D^0 \rightarrow K^{-1})$ π^+). of B^+ and B^0 $B^0:B^+B^-$ $D = \frac{TECN}{02}$ ges, fits, limits,	$\frac{COMMENT}{e^+e^- \rightarrow \gamma}$ etc. • • • Repl. by NEM $e^+e^- \rightarrow \gamma$ $e^+e^- \rightarrow \gamma$ $\gamma(4S)$ and use $\pi^+\pi^0)/B(D^0)$ R^0 at the $\gamma(4.5)$ production rate $\frac{COMMENT}{e^+e^- \rightarrow \gamma}$ etc. • •	
and $B(D^0 \rightarrow \Gamma(\overline{D^0} \rho^0) / \Gamma_{total}$ <u>VALUE</u> <0.00039 ••• We do not <0.00055 <0.0006 <0.0027 ¹⁵⁸ NEMATI 98 a values for D^0 ¹⁵⁹ ALAM 94 ass absolute $B(D^0 \rightarrow$ and $B(D^0 \rightarrow$ ¹⁶⁰ BORTOLET Mark III brand ¹⁶¹ ALBRECHT We rescale to $\Gamma(\overline{D^0} \eta) / \Gamma_{total}$ <u>VALUE (units 10⁻⁴)</u> 1.4+0.5±0.3 ••• We do not <1.3	$K = \pi + \pi + \pi$ $\frac{CL\%}{PO} = \frac{EVTS}{PO}$ use the follow 90 90 90 90 90 90 4 issumes equal $T, D^{*0}, \eta, \eta', \pi$ sume equal pro $0 \rightarrow K^{-}\pi^{+})$ $K^{-}\pi^{+}\pi^{+}\pi^{+}\pi^{+}$ TO 92 assume ching fractions $88K \text{ reports } < 50\%.$ $CL\%$ use the follow 90	$\frac{DOCUMENT IE}{158 \text{ NEMATI}}$ $\frac{DOCUMENT IE}{158 \text{ NEMATI}}$ $\frac{159 \text{ ALAM}}{160 \text{ BORTOLET}}$ $\frac{161 \text{ ALBRECHT}}{161 \text{ ALBRECHT}}$ $\frac{161 \text{ ALBRECHT}}{161 \text{ ALBRECHT}}$ $\frac{161 \text{ ALBRECHT}}{161 \text{ ALBRECHT}}$ $\frac{100 \text{ BRTOLET}}{161 \text{ ALBRECHT}}$ $\frac{100 \text{ BRTOLET}}{100 \text{ ALBRECHT}}$ $\frac{162 \text{ ABE}}{163 \text{ NEMATI}}$	π^+). p <u>TECN</u> 98 CLE2 res, fits, limits, 94 CLE2 TO92 CLEO 88K ARG and B^0 at the actions. $d B^0$ at the TB $B(D^0 \rightarrow K^-)$ π^+). of B^+ and B^0 $B^0 \overline{B}^0 : B^+ B^-$ p <u>TECN</u> 02 BELL res, fits, limits, 98 CLE2	$\frac{COMMENT}{e^+e^- \rightarrow \gamma}$ etc. • • • Repl. by NEN $e^+e^- \rightarrow \gamma$ $e^+e^- \rightarrow \gamma$ $\gamma(4S)$ and use $\gamma(4S)$ and	Γ_{54}/Γ (45) MATI 98 (45) (45) the PDG 96 the CLEO II $\rightarrow K^- \pi^+$) S) and uses tio is 45:55. Γ_{55}/Γ

 162 Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$. 163 NEMATI 98 assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and use the PDG 96

values for D^0 , D^{*0} , η , η' , and ω branching fractions. ¹⁶⁴ ALAM 94 assume equal production of B^+ and B^0 at the $\Upsilon(4S)$ and use the CLEO II absolute $B(D^0 \rightarrow K^- \pi^+)$ and the PDG 1992 $B(D^0 \rightarrow K^- \pi^+ \pi^0)/B(D^0 \rightarrow K^- \pi^+)$ and $B(D^0 \rightarrow K^- \pi^+ \pi^+ \pi^-)/B(D^0 \rightarrow K^- \pi^+)$.

$\Gamma(\overline{D}^0\eta')/\Gamma_{total}$						Г ₅₆ /Г	
VALUE	<u>CL%</u>		DOCUMENT ID		TECN	COMMENT	
<0.00094	90	¹⁶⁵ NEMATI 98 CLE2 $e^+e^- ightarrow \gamma$ (45			$e^+e^- ightarrow ~\Upsilon(4S)$		
• • • We do not use the	followi	ng d	lata for averages	, fits	, limits,	etc. ● ● ●	
<0.00086	90	100	ALAM	94	CLE2	Repl. by NEMATI 98	
¹⁶⁵ NEMATI 98 assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and use the PDG 96 values for D^0 , D^{*0} , η , η' , and ω branching fractions. ¹⁶⁶ ALAM 94 assume equal production of B^+ and B^0 at the $\Upsilon(4S)$ and use the CLEO II absolute $B(D^0 \rightarrow K^- \pi^+)$ and the PDG 1992 $B(D^0 \rightarrow K^- \pi^+ \pi^0)/B(D^0 \rightarrow K^- \pi^+)$ and $B(D^0 \rightarrow K^- \pi^+ \pi^+ \pi^-)/B(D^0 \rightarrow K^- \pi^+)$.							
$\Gamma(\overline{D}{}^0\omega)/\Gamma_{ m total}$						Г ₅₇ /Г	
VALUE (units 10^{-4})	CL%		DOCUMENT ID		TECN	COMMENT	
$1.8 \pm 0.5 \substack{+0.4 \\ -0.3}$		167	ABE	02J	BELL	$e^+e^- \rightarrow \Upsilon(4S)$	
\bullet \bullet \bullet We do not use the	followi	ng d	lata for averages	, fits	, limits,	etc. • • •	
<5.1	90	168	NEMATI	98	CLE2	$e^+e^- \rightarrow \Upsilon(4S)$	
<6.3	90	169	ALAM	94	CLE2	Repl. by NEMATI 98	
¹⁶⁸ NEMATI 98 assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and use the PDG 96 values for D^0 , D^{*0} , η , η' , and ω branching fractions. ¹⁶⁹ ALAM 94 assume equal production of B^+ and B^0 at the $\Upsilon(4S)$ and use the CLEO II absolute $B(D^0 \to K^- \pi^+)$ and the PDG 1992 $B(D^0 \to K^- \pi^+ \pi^0)/B(D^0 \to K^- \pi^+)$ and $B(D^0 \to K^- \pi^+ \pi^+ \pi^-)/B(D^0 \to K^- \pi^+)$.							
$\Gamma(\overline{D}^{*0}\gamma)/\Gamma_{ ext{total}}$						Г ₅₈ /Г	
VALUE	<u>CL%</u>	170	DOCUMENT ID		<u>TECN</u>		
<5.0 × 10⁻⁵	90	170	ARTUSO	00	CLE2	$e^+e^- \rightarrow \Upsilon(4S)$	
Assumes equal produ	ction of	B^+	and B^{\cup} at the	Υ(4	·S).		
$\Gamma(\overline{D}^*(2007)^0\pi^0)/\Gamma_{to}$	tal					Г ₅₉ /Г	
VALUE (units 10 ⁻⁴) 2.5 ±0.7 OUR AVER	<u>CL%</u> RAGE		DOCUMENT ID		TECN	COMMENT	
$2.7 \begin{array}{c} +0.8 \\ -0.7 \end{array} \begin{array}{c} +0.5 \\ -0.6 \end{array}$		171	ABE	02J	BELL	$e^+e^- \rightarrow \Upsilon(4S)$	
$2.20^{+0.59}_{-0.52}{\pm}0.79$		171	COAN	02	CLE2	$e^+e^- \rightarrow \Upsilon(4S)$	
• • • We do not use the	followi	ng d	lata for averages	, fits	, limits,	etc. • • •	
<4.4 <9.7	90 90	172	^S NEMATI ³ ALAM	98 94	CLE2 CLE2	Repl. by COAN 02 Repl. by NEMATI 98	

¹⁷¹ Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.

¹⁷² NEMATI 98 assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and use the PDG 96 values for D^0 , D^{*0} , η , η' , and ω branching fractions.

¹⁷³ ALAM 94 assume equal production of B^+ and B^0 at the $\Upsilon(4S)$ and use the CLEO II B($D^*(2007)^0 \rightarrow D^0 \pi^0$) and absolute B($D^0 \rightarrow K^- \pi^+$) and the PDG 1992 B($D^0 \rightarrow K^- \pi^+ \pi^0$)/B($D^0 \rightarrow K^- \pi^+$) and B($D^0 \rightarrow K^- \pi^+ \pi^+ \pi^-$)/B($D^0 \rightarrow K^- \pi^+$).

$\Gamma(\overline{D}^*(2007)^0 \rho^0) / \Gamma_{\rm to}$	tal					Г ₆₀ /Г	
VALUE	<u>CL%</u>	<u>% DOCUMENT ID TE</u>		TECN	COMMENT		
<0.00056	90	¹⁷⁴ NEMATI	98	CLE2	$e^+e^- \rightarrow \Upsilon(4S)$	5)	
\bullet \bullet \bullet We do not use the	e followi	ng data for averages	, fits	, limits,	etc. • • •		
<0.00117	90	¹⁷⁵ ALAM	94	CLE2	Repl. by NEMA	TI 98	
¹⁷⁴ NEMATI 98 assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and use the PDG 96 values for D^0 , D^{*0} , η , η' , and ω branching fractions. ¹⁷⁵ ALAM 94 assume equal production of B^+ and B^0 at the $\Upsilon(4S)$ and use the CLEO II $B(D^*(2007)^0 \rightarrow D^0 \pi^0)$ and absolute $B(D^0 \rightarrow K^- \pi^+)$ and the PDG 1992 $B(D^0 \rightarrow K^- \pi^+ \pi^0)/B(D^0 \rightarrow K^- \pi^+)$ and $B(D^0 \rightarrow K^- \pi^+ \pi^+ \pi^-)/B(D^0 \rightarrow K^- \pi^+)$.							
$\Gamma(\overline{D}^*(2007)^0\eta)/\Gamma_{\rm tota}$	al					Г ₆₁ /Г	
VALUE	<u>CL%</u>	DOCUMENT ID		TECN	COMMENT		
<0.00026	90	176 NEMATI	98	CLE2	$e^+e^- \rightarrow \Upsilon(4S)$	5)	
• • • We do not use the	e followi	ng data for averages	, fits	, limits,	etc. ● ● ●		
<0.00046	90	177 ABE	02J	BELL	$e^+e^- \rightarrow \Upsilon(4S)$	5)	
<0.00069	90	178 ALAM	94	CLE2	Repl. by NEMA	TI 98	
¹⁷⁶ NEMATI 98 assumes values for D^0 , D^{*0} , ¹⁷⁷ Assumes equal produ ¹⁷⁸ ALAM 94 assume eq $B(D^*(2007)^0 \rightarrow D^0$ $K^- \pi^+ \pi^0)/B(D^0 - \pi^0)$	equal p η, η', a inction of ual prod $\eta^0 \pi^0$) an $\to K^- \pi$	roduction of B^+ and nd ω branching fract f B^+ and B^0 at the duction of B^+ and $D^0 \rightarrow$ nd absolute B($D^0 \rightarrow K^+$) and B($D^0 \rightarrow K^-$)	B^0 ions. $\Upsilon(4)$ B^0 a K^- $\chi^- \pi^-$	at the γ S). t the γ (π^+) an $+\pi^+\pi^-$	$\Gamma(4S)$ and use the $\Gamma(4S)$ and use the d the PDG 1992 $^-)/\mathrm{B}(D^0 \to K^-)$	CLEO II B($D^0 \rightarrow \pi^+$).	
$\Gamma(\overline{D}^*(2007)^0\eta')/\Gamma_{\rm tot}$	tal					Г ₆₂ /Г	

VALUE	CL%	DOCUMENT ID		TECN	COMMENT
<0.0014	90	BRANDENB	98	CLE2	$e^+e^- ightarrow ~\Upsilon(4S)$
$\bullet \bullet \bullet$ We do not use the	following o	lata for averages	, fits	, limits,	etc. • • •
<0.0019	90 179	⁹ NEMATI	98	CLE2	$e^+e^- ightarrow ~\Upsilon(4S)$
<0.0027	90 180	⁾ ALAM	94	CLE2	Repl. by NEMATI 98

¹⁷⁹ NEMATI 98 assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and use the PDG 96 values for D^0 , D^{*0} , η , η' , and ω branching fractions.

¹⁸⁰ ALAM 94 assume equal production of B^+ and B^0 at the $\Upsilon(4S)$ and use the CLEO II B($D^*(2007)^0 \rightarrow D^0 \pi^0$) and absolute B($D^0 \rightarrow K^- \pi^+$) and the PDG 1992 B($D^0 \rightarrow K^- \pi^+ \pi^0$)/B($D^0 \rightarrow K^- \pi^+$) and B($D^0 \rightarrow K^- \pi^+ \pi^- \pi^-$)/B($D^0 \rightarrow K^- \pi^+$).

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$\Gamma(\overline{D}^*(2007)^0\omega)/\Gamma_{to}$	tal				Г ₆₃ /Г
VALUE	CL%	DOCUMENT ID	TECN	COMMENT	
<0.00074	90	¹⁸¹ NEMATI	98 CLE2	$e^+e^- ightarrow$	$\Upsilon(4S)$
• • • We do not use th	e follow	ing data for average	s, fits, limits	, etc. • • •	
<0.00079 <0.0021	90 90	¹⁸² АВЕ 183 _{АГ АМ}	02J BELL 94 CLF2	$e^+e^- \rightarrow$ Repl by N	$\Upsilon(4S)$
 ¹⁸¹ NEMATI 98 assumes values for D⁰, D^{*0}, ¹⁸² Assumes equal prod 	s equal μ η, η', a uction o	production of B^+ and ω branching frac f B^+ and B^0 at the	d B^0 at the tions. e $\Upsilon(4S)$.	$\Upsilon(4S)$ and u	use the PDG 96
¹⁸³ ALAM 94 assume en B $(D^*(2007)^0 \to D$ $K^- \pi^+ \pi^0)/B(D^0 - D)$	qual pro $(\sqrt[4]{0}\pi^0)$ and $\rightarrow K^-$	oduction of B^+ and adsolute $B(D^0 o \pi^+)$ and $B(D^0 o \pi^+)$	$B^{0} \text{ at the} $ $K^{-}\pi^{+} \text{ at the} $ $K^{-}\pi^{+}\pi^{+}\pi^{+}\pi^{+}\pi^{+}\pi^{+}\pi^{+}\pi^{+$	$\Upsilon(4S)$ and using the PDG $T^{-})/B(D^{0}-T)$	se the CLEO II 1992 B($D^0 \rightarrow K^- \pi^+$).
$\Gamma(D^*(2007)^0\pi^+\pi^+)$	$\pi^-\pi^-$)/Γ _{total}			Г ₆₄ /Г
VALUE (units 10 ⁻³)		DOCUMENT ID	TECN	COMMENT	
3.0±0.7±0.6		¹⁸⁴ EDWARDS	02 CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
¹⁸⁴ Assumes equal prod	uction o	f B^+ and B^0 at the	r (4S).		
$\Gamma(D^*(2007)^0\pi^+\pi^+)$	$\pi^{-}\pi^{-}$)/Γ(D*(2010) ⁺ π	$+\pi^-\pi^-\pi$.0)	Γ ₆₄ /Γ ₂₈
0 17+0 04+0 02		185 EDWARDS	$\frac{1200}{1200}$		$\Upsilon(\Lambda S)$
185 Accuracy courses and and		EDVVARDS	$\gamma(AC)$	e e →	7 (43)
Assumes equal prod	uction o	TB' and B° at the	e 1 (45).		
Γ(D*(2010)⁺ D*(20 VALUE	10) ⁻),	/ F_{total <u>DOCUMENT I</u>}	<u>D</u>	N <u>COMMEN</u>	Г ₆₅ /Г
$(9.9^{+4.2}_{-3.3}\pm1.2) imes10^{-1}$	-4	¹⁸⁶ LIPELES	00 CLE	2 e ⁺ e ⁻ -	$ ightarrow ~ \Upsilon(4S)$
• • • We do not use th	e follow	ing data for averages	s, fits, limits	, etc. • • •	
$(6.2^{+4.0}_{-2.9}\pm1.0) imes10^{-1}$	-4	¹⁸⁷ ARTUSO	99 CLE	2 Repl. by	LIPELES 00
$< 6.1 \times 10^{-1}$ $< 2.2 \times 10^{-1}$	-3 ₉₀ -3 ₉₀	¹⁸⁸ BARATE ¹⁸⁹ ASNER	98Q ALE 97 CLE	EP e ⁺ e ⁻ - E2 Repl. by	$\rightarrow Z$ ARTUSO 99
 ¹⁸⁶ Assumes equal prod ¹⁸⁷ ARTUSO 99 uses B ¹⁸⁸ BARATE 98Q (ALE which corresponds to 	uction o $(\Upsilon(4S)$ PH) obs o a brar	f B^+ and B^0 at the $\rightarrow B^0 \overline{B}^0 = (48 \pm 100)$ verves 2 events with enching ratio of (2.3^+)	(45). (4)%. (1.9 ± 0.4)	background $\times 10^{-3}$.	of 0.10 \pm 0.03
¹⁸⁹ ASNER 97 at CLEC This correcsponds to) observ o a bran	es 1 event with an e ching ratio of (5.3 _	expected bac 7.1 3.7 ± 1.0) >	kground of $(\times 10^{-4})$.	$0.022 \pm 0.011.$
$\Gamma(D^*(2010)^+ D^-)/I$	total	DOCUMENT ID	TECN	COMMENT	Г ₆₆ /Г
<pre>////////////////////////////////////</pre>	00	190 LIDELES		<u></u>	$\Upsilon(\Lambda S)$
• • • We do not use th	e follow	ing data for average	s, fits, limits	, etc. • • •	((T J)
$< 5.6 imes 10^{-3}$	90	BARATE	98Q ALEP	$e^+e^- \rightarrow$	Ζ
$< 1.8 \times 10^{-3}$	90	ASNER	97 CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
¹⁹⁰ Assumes equal prod	uction o	f B^+ and B^0 at the	r (4S).		

$\Gamma(D^{(*)0}\overline{D}^{(*)0})/\Gamma_{t}$	otal				Г ₆₇ /Г
VALUE	<u>CL%</u>	DOCUMENT ID	TEC	CN COMMEN	Т
<0.027	90	BARATE	98Q AL	EP	→ Z
$\Gamma(\eta_c K^0) / \Gamma_{\text{total}}$					Г ₆₈ /Г
VALUE (units 10^{-3})		DOCUMENT ID	TEC	CN COMMEN	Г
$1.09^{+0.55}_{-0.42}\pm0.33$		¹⁹¹ EDWARDS	01 CL	E2 e ⁺ e ⁻ -	$\rightarrow \Upsilon(4S)$

 $^{191}\,{\sf EDWARDS}$ 01 assumes equal production of B^0 and B^+ at the $\varUpsilon(4S).$ The correlated uncertainties (28.3)% from B(J/ $\psi(1S) \rightarrow \gamma \eta_{c}$) in those modes have been accounted for.

$\Gamma(J/\psi(1S$) <i>K</i> ⁰),	/Γ _{total}

Γ₆₉/Γ

VALUE (units 10^{-4})	CL% EVTS	DOCUMENT ID	TECN	COMMENT
8.7±0.5 OUR AVI	ERAGE			
$8.3 {\pm} 0.4 {\pm} 0.5$		¹⁹² AUBERT	02 BABR	$e^+e^- \rightarrow \Upsilon(4S)$
$9.5 \pm 0.8 \pm 0.6$		¹⁹² AVERY	00 CLE2	$e^+e^- \rightarrow \Upsilon(4S)$
$11.5 \pm 2.3 \pm 1.7$		¹⁹³ ABE	96н CDF	<i>р р</i> ат 1.8 ТеV
$7.0 \pm 4.1 \pm 0.1$		¹⁹⁴ BORTOLETT	O92 CLEO	$e^+e^- ightarrow ~\Upsilon(4S)$
$9.3 \pm 7.3 \pm 0.2$	2	¹⁹⁵ ALBRECHT	90J ARG	$e^+e^- \rightarrow \Upsilon(4S)$
\bullet \bullet \bullet We do not use	the following da	ta for averages, fit	s, limits, etc.	• • •
$8.5^{+1.4}_{-1.2}{\pm}0.6$		¹⁹² JESSOP	97 CLE2	Repl. by AVERY 00
		10/		

$^{0.5}-1.2^{\pm0.0}$			JE2206	97	CLE2	Repl. by AVERT 00
$7.5 {\pm} 2.4 {\pm} 0.8$		10	¹⁹⁴ ALAM	94	CLE2	Sup. by JESSOP 97
<50	90		ALAM	86	CLEO	$e^+e^- ightarrow ~\Upsilon(4S)$
			_			

 192 Assumes equal production of B^+ and B^0 at the $\Upsilon(4S).$

¹⁹³ ABE 96H assumes that $B(B^+ \rightarrow J/\psi K^+) = (1.02 \pm 0.14) \times 10^{-3}$.

¹⁹⁴BORTOLETTO 92 reports $6 \pm 3 \pm 2$ for $B(J/\psi(1S) \rightarrow e^+e^-) = 0.069 \pm 0.009$. We rescale to our best value $B(J/\psi(1S) \rightarrow e^+e^-) = (5.93 \pm 0.10) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.

 195 ALBRECHT 90J reports 8 \pm 6 \pm 2 for B($J/\psi(1S) \rightarrow e^+e^-)=$ 0.069 \pm 0.009. We rescale to our best value $B(J/\psi(1S) \rightarrow e^+e^-) = (5.93 \pm 0.10) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.

$\Gamma(J/\psi(1S)K^+\pi^-)$	⁻)/Γ _{total}					Г;	70/F
VALUE (units 10^{-3})	CL% EV7	5	DOCUMENT ID		TECN	COMMENT	
$1.16 {\pm} 0.56 {\pm} 0.02$			¹⁹⁶ BORTOLETT	092	CLEO	$e^+e^- \rightarrow \Upsilon(4S)$	
$\bullet \bullet \bullet$ We do not use	the following da	ta	for averages, fits, lin	nits, e	etc. • •	•	
<1.3	90		¹⁹⁷ ALBRECHT	87 D	ARG	$e^+e^- \rightarrow \Upsilon(4S)$	
<6.3	90	2	GILES	84	CLEO	$e^+e^- \rightarrow \gamma(4S)$	

¹⁹⁶BORTOLETTO 92 reports $1.0 \pm 0.4 \pm 0.3$ for B($J/\psi(1S) \rightarrow e^+e^-$) = 0.069 ± 0.009. We rescale to our best value $B(J/\psi(1S) \rightarrow e^+e^-) = (5.93 \pm 0.10) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$. ¹⁹⁷ ALBRECHT 87D assume $B^+B^-/B^0\overline{B}^0$ ratio is 55/45. $K\pi$ system is specifically se-

lected as nonresonant.

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$\Gamma(J/\psi(1S)K^*(892)^0)/\Gamma_1$	otal			Г ₇₁ /Г
VALUE (units 10^{-3})	EVTS	DOCUMENT ID	TEC	N COMMENT
1.31 ± 0.09 OUR AVERAGE				
$1.24\!\pm\!0.05\!\pm\!0.09$		¹⁹⁸ AUBERT	02 BAI	BR $e^+e^- \rightarrow \Upsilon(4S)$
$1.74\!\pm\!0.20\!\pm\!0.18$		¹⁹⁹ ABE	980 CD	F <i>pp</i> 1.8 TeV
$1.32\!\pm\!0.17\!\pm\!0.17$		²⁰⁰ JESSOP	97 CLE	E2 $e^+e^- \rightarrow \Upsilon(4S)$
$1.28\!\pm\!0.66\!\pm\!0.02$		²⁰¹ BORTOLETTO	92 CLE	EO $e^+e^- ightarrow \Upsilon(4S)$
$1.28\!\pm\!0.60\!\pm\!0.02$	6	²⁰² ALBRECHT	90J AR	$G e^+e^- \rightarrow \Upsilon(4S)$
$4.1 \ \pm 1.8 \ \pm 0.1$	5	²⁰³ BEBEK	87 CLE	EO $e^+e^- \rightarrow \Upsilon(4S)$
\bullet \bullet \bullet We do not use the follow	owing o	lata for averages, fits,	, limits,	etc. ● ● ●
$1.36 \pm 0.27 \pm 0.22$		²⁰⁴ ABE	96н CD	F Sup. by ABE 980
$1.69\!\pm\!0.31\!\pm\!0.18$	29	²⁰⁵ ALAM	94 CLE	2 Sup. by JESSOP 97
		²⁰⁶ ALBRECHT	94g AR	$G e^+e^- \rightarrow \Upsilon(4S)$
4.0 ±0.30		²⁰⁷ ALBAJAR	91e UA	1 $E_{\rm cm}^{p\overline{p}} = 630 {\rm GeV}$
3.3 ±0.18	5	²⁰⁸ ALBRECHT	87D AR	$G e^+e^- \rightarrow \Upsilon(4S)$
$4.1 \hspace{0.1in} \pm 0.18$	5	²⁰⁹ ALAM	86 CLE	EO Repl. by BEBEK 87

¹⁹⁸Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.

¹⁹⁹ ABE 980 reports $[B(B^0 \rightarrow J/\psi(1S) K^*(892)^0)]/[B(B^+ \rightarrow J/\psi(1S) K^+)] = 1.76 \pm 0.14 \pm 0.15$. We multiply by our best value $B(B^+ \rightarrow J/\psi(1S) K^+) = (9.9 \pm 1.0) \times 10^{-4}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

 200 Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.

²⁰¹ BORTOLETTO 92 reports $1.1 \pm 0.5 \pm 0.3$ for $B(J/\psi(1S) \rightarrow e^+e^-) = 0.069 \pm 0.009$. We rescale to our best value $B(J/\psi(1S) \rightarrow e^+e^-) = (5.93 \pm 0.10) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.

- ²⁰² ALBRECHT 90J reports $1.1 \pm 0.5 \pm 0.2$ for $B(J/\psi(1S) \rightarrow e^+e^-) = 0.069 \pm 0.009$. We rescale to our best value $B(J/\psi(1S) \rightarrow e^+e^-) = (5.93 \pm 0.10) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.
- ²⁰³ BEBEK 87 reports $3.5 \pm 1.6 \pm 0.3$ for $B(J/\psi(1S) \rightarrow e^+e^-) = 0.069 \pm 0.009$. We rescale to our best value $B(J/\psi(1S) \rightarrow e^+e^-) = (5.93 \pm 0.10) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Updated in BORTOLETTO 92 to use the same assumptions.

²⁰⁴ ABE 96H assumes that B($B^+ \to J/\psi K^+$) = (1.02 \pm 0.14) imes 10⁻³.

- ²⁰⁵ The neutral and charged *B* events together are predominantly longitudinally polarized, $\Gamma_L/\Gamma = 0.080 \pm 0.08 \pm 0.05$. This can be compared with a prediction using HQET, 0.73 (KRAMER 92). This polarization indicates that the $B \rightarrow \psi K^*$ decay is dominated by the CP = -1 CP eigenstate. Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.
- ²⁰⁶ ALBRECHT 94G measures the polarization in the vector-vector decay to be predominantly longitudinal, $\Gamma_T/\Gamma = 0.03 \pm 0.16 \pm 0.15$ making the neutral decay a *CP* eigenstate when the K^{*0} decays through $K^0_S \pi^0$.
- ²⁰⁷ ALBAJAR 91E assumes B_d^{0} production fraction of 36%.

²⁰⁸ ALBRECHT 87D assume $B^+B^-/B^0\overline{B}^0$ ratio is 55/45. Superseded by ALBRECHT 90J. ²⁰⁹ ALAM 86 assumes B^\pm/B^0 ratio is 60/40. The observation of the decay $B^+ \rightarrow J/\psi K^*(892)^+$ (HAAS 85) has been retracted in this paper.

 $\Gamma(J/\psi(1S) K^{*}(892)^{0}) / \Gamma(J/\psi(1S) K^{0})$ Γ_{71}/Γ_{69} VALUE DOCUMENT ID TECN COMMENT 1.48 ± 0.12 OUR AVERAGE ²¹⁰ AUBERT 02 BABR $e^+e^- \rightarrow \Upsilon(4S)$ $1.49 \!\pm\! 0.10 \!\pm\! 0.08$ ABE 96Q CDF $1.39\!\pm\!0.36\!\pm\!0.10$ $p\overline{p}$ ²¹⁰ Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$. $\Gamma(J/\psi(1S)\phi K^0)/\Gamma_{\text{total}}$ Γ_{72}/Γ DOCUMENT ID VALUE TECN COMMENT $(8.8^{+3.5}_{-3.0}\pm1.3)\times10^{-5}$ ²¹¹ ANASTASSOV 00 CLE2 $e^+e^- \rightarrow \gamma(4S)$ 211 ANASTASSOV 00 finds 10 events on a background of 0.5 \pm 0.2. Assumes equal production of B^0 and B^+ at the $\Upsilon(4S)$, a uniform Dalitz plot distribution, isotropic $J/\psi(1S)$ and ϕ decays, and $B(B^+ \rightarrow J/\psi(1S)\phi K^+) = B(B^0 \rightarrow J/\psi(1S)\phi K^0)$. $\Gamma(J/\psi(1S)K(1270)^0)/\Gamma_{\text{total}}$ Γ₇₃/Γ VALUE (units 10^{-3}) DOCUMENT ID TECN COMMENT ²¹² ABE 01L BELL $e^+e^- \rightarrow \Upsilon(4S)$ $1.30 \pm 0.34 \pm 0.32$ 212 Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$ and uses the PDG value of $B(B^+ \rightarrow J/\psi(1S) K^+) = (1.00 \pm 0.10) \times 10^{-3}.$ $\Gamma(J/\psi(1S)\pi^0)/\Gamma_{\text{total}}$ Γ74/Γ VALUE (units 10^{-5}) CL% EVTS DOCUMENT ID TECN COMMENT 2.1 ± 0.5 OUR AVERAGE ²¹³ AUBERT 02 BABR $e^+e^- \rightarrow \Upsilon(4S)$ $2.0\!\pm\!0.6\!\pm\!0.2$ $2.5^{+1.1}_{-0.9}\pm0.2$ 213 AVERY 00 CLE2 $e^+e^- \rightarrow \Upsilon(4S)$ • • • We do not use the following data for averages, fits, limits, etc. • • • ²¹⁴ ACCIARRI 97C L3 < 32 90 96 CLE2 $e^+e^- \rightarrow \Upsilon(4S)$ 90 BISHAI < 5.8 ²¹⁵ ALEXANDER 95 CLE2 Sup. by BISHAI 96 90 <690 1 ²¹³Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$. ²¹⁴ ACCIARRI 97C assumes B^0 production fraction (39.5 ± 4.0%) and B_s (12.0 ± 3.0%). ²¹⁵ Assumes equal production of B^+B^- and $B^0\overline{B}^0$ on $\Upsilon(4S)$. $\Gamma(J/\psi(1S)\eta)/\Gamma_{\text{total}}$ Γ₇₅/Γ VALUE CL% DOCUMENT ID TECN ²¹⁶ ACCIARRI $< 1.2 \times 10^{-3}$ 90 97C L3 ²¹⁶ ACCIARRI 97C assumes B^0 production fraction (39.5 ± 4.0%) and B_s (12.0 ± 3.0%). $\Gamma(J/\psi(1S)\rho^0)/\Gamma_{\text{total}}$ Γ_{76}/Γ VALUE DOCUMENT ID <u>CL%</u> TECN COMMENT $e^+e^- \rightarrow \Upsilon(4S)$ $<2.5 \times 10^{-4}$ 90 96 CLE2 BISHAI $\Gamma(J/\psi(1S)\omega)/\Gamma_{\text{total}}$ Γ₇₇/Γ DOCUMENT ID TECN CL% COMMENT $e^+e^- \rightarrow \Upsilon(4S)$ <2.7 × 10 90 CLE2 BISHAI 96

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$\Gamma(J/\psi(1S)K^0\pi^+\pi)$	r [_])/Γ _{to}	tal					Г ₇₈ /Г
VALUE (units 10^{-4})			DOCUMENT ID		TECN	COMMENT	
10.3±3.3±1.5		217	AFFOLDER	0 2B	CDF	р <u>р</u> 1.8 Те\	/
²¹⁷ Uses $B^0 \rightarrow J/\psi(1)$	$(S) K_S^0 de$	ecay a	is a reference an	d B($B_0 \rightarrow 2$	$J/\psi(1S)K^0)$	$= 8.3 \times 10^{-4}$.
$\Gamma(J/\psi(1S)K^0 ho^0)/$	Γ _{total}						Г ₇₉ /Г
VALUE (units 10^{-4})			DOCUMENT ID		TECN	COMMENT	-
5.4±2.9±0.9		218	AFFOLDER	0 2B	CDF	р <u>р</u> 1.8 Те\	/
²¹⁸ Uses $B^0 \rightarrow J/\psi(1)$	$(S) K_S^0 de$	ecay a	is a reference an	d B($B_0 \rightarrow 2$	$J/\psi(1S)K^0)$	$= 8.3 \times 10^{-4}$.
$\Gamma(J/\psi(1S)K^*(892$	$()^{+}\pi^{-})/$	/Γ _{tot}	al				Г ₈₀ /Г
VALUE (units 10^{-4})			DOCUMENT ID		TECN	COMMENT	
7.7±4.1±1.3		219	AFFOLDER	0 2B	CDF	<i>р<mark>р</mark> 1.8 Те\</i>	/
²¹⁹ Uses $B^0 \rightarrow J/\psi(1)$	$(S) K_S^0 de$	ecay a	is a reference an	d B($B_0 \rightarrow $	$J/\psi(1S)K^0)$	$= 8.3 \times 10^{-4}$.
$\Gamma(J/\psi(1S)K^*(892))$	$)^{0}\pi^{+}\pi^{-}$	⁻)/Г	total				Г ₈₁ /Г
VALUE (units 10^{-4})	-		DOCUMENT ID		TECN	COMMENT	-
6.6±1.9±1.1		220	AFFOLDER	02в	CDF	р <u>р</u> 1.8 Те\	/
$ \begin{array}{r} 220 \text{ Uses } B^0 \rightarrow J/\psi \\ 12.4 \times 10^{-4}. \end{array} $	(1 <i>5</i>) <i>K</i> *(892) ⁽	⁾ decay as a re	feren	ce and	$B(B^0 \rightarrow)$	$J/\psi(1S) \kappa^0) =$
$\Gamma(\psi(2S)K^{o})/\Gamma_{tota}$	I						Г ₈₂ /Г
VALUE (units 10^{-4})	<u>CL%</u>		DOCUMENT ID		TECN	COMMENT	
5.7 \pm 1.0 OUR AVE	RAGE	221		00		+ -	$\mathcal{C}(AC)$
$0.9 \pm 1.1 \pm 1.1$		221		02		$e^+e^- \rightarrow$	T(4S)
$\bullet \bullet \bullet$ We do not use t	the follow	ving d	ata for average	s fits	LE2 limits	$e \cdot e \rightarrow$	1 (43)
2 8	00	222		04		a ⁺ a ⁻	$\Upsilon(\Lambda S)$
< 15	90	222		092	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
<28	90	222	ALBRECHT	90J	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
221 Assumes equal pro	duction c	of B^+	and B^0 at the	$\Upsilon(4)$	S).		. ,
Assumes equal pro	duction c	DT D'	and B° at the	. 1 (4	5).		
$\Gamma(\psi(2S) K^0) / \Gamma(J/$	$\psi(1S)$ k	۲ ⁰)	DOCUMENT ID		TECN	COMMENT	Г ₈₂ /Г ₆₉
$\frac{VALUE}{0.82\pm0.13\pm0.12}$		223		02	<u>TECN</u>	$\frac{COMMENT}{2}$	$\Upsilon(\Lambda S)$
223		с р +		02	C	e e —	7 (43)
Assumes equal pro	duction c	of B	and B° at the	e <i>I</i> (4	5).		_ /_
$\left(\psi(2S)K^{+}\pi^{-}\right)/\Gamma$	total <i>CL%</i>		DOCUMENT ID		TECN	COMMENT	I ₈₃ /Г
<0.001	90	224	ALBRECHT	90J	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
²²⁴ Assumes equal pro	duction a	of B^+	and B^0 at the	$\gamma(4$	5).		、 ,
· ····································				. ('	-)-		

I

I

$\Gamma(\psi(2S)K^*(892)^{0})$	^ν)/Γ _{total}					Г ₈₄ /Г
$VALUE$ (units 10^{-4})	<u>CL%</u>	DOCUMENT	ID	TECN	COMMENT	
8.0±1.3 OUR AV	ERAGE	225				
$7.6 \pm 1.1 \pm 1.0$		225 RICHICHI	01	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$9.0 \pm 2.2 \pm 0.9$	the followin	ZZO ABE	980 Jac fita l) CDF	<i>pp</i> 1.8 le	V
• • • we do not use			es, nts, i	ci co		
<19	90	227 DODTOUE	94	CLE2	Repl. by I	
$14 \pm 8 \pm 4$	00		TT 001		$e \cdot e \rightarrow a^+ a^-$	T(45) $\Upsilon(45)$
225	90		1 901		e e →	7 (43)
226 ABE 080 reports	oduction of	B' and B'' at tr	1e $I(45)$). + 、	$1/2/(15) K^{+}$)] _0 008 ⊥
0.101 ± 0.10 We	$\frac{D}{D} = \frac{D}{D}$	$\psi(25) = \pi (092)$)]/[D(D) ≥+	////(15)	$(13)^{(13)}$ $(13)^{(13)}$	$(1 0) \times 10^{-4}$
Our first error is t	heir experim	ent's error and ou	r second	error is	the systema	tic error from
using our best va	lue.				5	
²²⁷ Assumes equal pr	oduction of	B^+ and B^0 at the	he $\Upsilon(4S)$).		
$\Gamma(\gamma_{-0}(1P)K^0)/\Gamma_{-0}$	total					
VALUE	CL%	DOCUMENT ID) т	ECN	COMMENT	- 05/ -
<5.0 × 10 ⁻⁴	90	²²⁸ EDWARDS	01 C	CLE2	$e^+e^- \rightarrow \prime$	$\Gamma(4S)$
		I production of B	0 and B^{-1}	+ +	ο Υ(15) T	he correlated
uncertainties (28. for.	3)% from B	$S(J/\psi(1S) \rightarrow \gamma r)$	η_c) in the	ose mo	des have be	en accounted
$\Gamma(\chi_{c1}(1P)K^0)/\Gamma_{c1}$	total					Г ₈₆ /Г
	<u>CL%</u>	DOCUMENT ID) <u>7</u>	ECN	COMMENT	
VALUE (units 10 ⁻⁴)						
4.0 ^{+1.2} 4.0 ^{+1.2} OUR AV	/ERAGE					
4.0$^{+1.2}_{-1.0}$ OUR AV 4.7 \pm 1.5 \pm 0.5	/ERAGE	²²⁹ AUBERT	02 B	BABR	$e^+e^- \rightarrow $	$\Upsilon(4S)$
$\frac{4.0 + 1.2}{-1.0} \text{ OUR AV}$ $4.7 \pm 1.5 \pm 0.5$ $3.4 + 1.7 \pm 0.3$	/ERAGE	²²⁹ AUBERT ²³⁰ AVERY	02 B 00 C	BABR	$e^+e^- \rightarrow e^+e^- \rightarrow e^+e^+e^- \rightarrow e^+e^- \rightarrow e^- \rightarrow e^+e^- \rightarrow e^- $	Υ(4S) Υ(4S)
4.0 +1.2 OUR AV 4.7±1.5±0.5 $3.4^{+1.7}_{-1.2}$ ±0.3	FRAGE	²²⁹ AUBERT ²³⁰ AVERY	02 B 00 C es fits l	BABR CLE2	$e^+e^- \rightarrow e^+e^- \rightarrow e^+e^-$	r(45) r(45)
4.0 $^+$ 1.2 0.7 \pm 1.5 \pm 0.5 3.4 $^+$ 1.7 \pm 0.3 ••• We do not use	the followin	²²⁹ AUBERT ²³⁰ AVERY 19 data for averag 231 ALAM	02 B 00 C es, fits, l	BABR CLE2 imits, e	$e^{+}e^{-} \rightarrow e^{+}e^{-} \rightarrow e^{-}e^{-} \rightarrow e^{$	r(45) r(45)
4.0\pm1.2 OUR AV 4.7 \pm 1.5 \pm 0.5 3.4 \pm 1.7 \pm 0.3 • • We do not use <27	/ERAGE the followin 90	²²⁹ AUBERT ²³⁰ AVERY ²³¹ ALAM	02 E 00 C es, fits, l 94 C	BABR CLE2 imits, e CLE2	$e^+e^- \rightarrow e^+e^- \rightarrow e^- \rightarrow e^+e^- \rightarrow e^- \rightarrow e^+e^- \rightarrow e^- \rightarrow e$	r(45) r(45) r(45)
4.0 $^{+1.2}_{-1.0}$ OUR AV 4.7 $^{\pm}1.5\pm0.5$ 3.4 $^{+1.7}_{-1.2}\pm0.3$ • • We do not use <27 ²²⁹ AUBERT 02 repo	/ERAGE the followin 90 orts 5.4 ± 1 .	²²⁹ AUBERT ²³⁰ AVERY ²³¹ ALAM 4 ± 1.1 for B(χ_c	02 E 00 C es, fits, l 94 C 1(1P) -	BABR CLE2 imits, e CLE2 $\rightarrow \gamma J/v$	$e^+e^- \rightarrow e^+e^- \rightarrow e^+e^- \rightarrow e^+e^- \rightarrow e^+e^- \rightarrow e^+e^- \rightarrow e^+(1S)) = 0.$	r(45) r(45) r(45) $273 \pm 0.016.$
4.0 + 1.2 OUR AV 4.7 ±1.5±0.5 $3.4+1.7\pm0.3$ • • We do not use <27 ²²⁹ AUBERT 02 repo We rescale to our first error is their	/ERAGE the followin 90 orts 5.4 ± 1 . best value	²²⁹ AUBERT ²³⁰ AVERY ²³¹ ALAM 4 \pm 1.1 for B(χ_c B($\chi_{c1}(1P) \rightarrow \gamma$'s error and our s	02 E 00 C es, fits, l 94 C $\frac{1}{1/\psi}(1S)$	BABR CLE2 imits, e CLE2 $\rightarrow \gamma J/v$ ()) = (3	$e^+e^- \rightarrow e^+e^- \rightarrow e^+e^- \rightarrow e^+e^- \rightarrow e^+e^- \rightarrow e^+e^- \rightarrow e^+(1S)) = 0.$ $e^{\pm}(15) = 0.$	r(4S) r(4S) r(4S) $273 \pm 0.016.$ $< 10^{-2}$. Our
4.0 + 1.2 OUR AV 4.7 ± 1.5 ± 0.5 $3.4^{+1.7}_{-1.2}\pm 0.3$ • • We do not use <27 ²²⁹ AUBERT 02 repo We rescale to our first error is their using our best va	/ERAGE the followin 90 orts 5.4 ± 1 . best value experiment lue. Assume	²²⁹ AUBERT ²³⁰ AVERY ²³¹ ALAM ^{4 ± 1.1} for $B(\chi_c)$ $B(\chi_c1(1P) \rightarrow \gamma)$'s error and our s s equal productio	02 E 00 C es, fits, l 94 C $\frac{1(1P) - \frac{1}{\sqrt{J/\psi(1S)}}}{\frac{1}{\sqrt{U(1S)}}}$ second er n of B^+	BABR CLE2 imits, e CLE2 $\rightarrow \gamma J/v$ $\gamma J/v$ $\gamma = (3)$ rror is t and B^{0}	$e^+e^- \rightarrow e^+e^- \rightarrow e^+e^- \rightarrow e^+e^- \rightarrow e^+e^- \rightarrow e^+(1S)) = 0.$ $(1.6 \pm 3.2) > 0.$	$\Upsilon(4S)$ $\Upsilon(4S)$ $\Upsilon(4S)$ $\simeq 73 \pm 0.016.$ $\simeq 10^{-2}.$ Our ic error from (+S).
4.0 + 1.2 OUR AV 4.7 ± 1.5 ± 0.5 3.4 + 1.7 -1.2 ± 0.3 • • We do not use <27 ²²⁹ AUBERT 02 report We rescale to our first error is their using our best va ²³⁰ AVERY 00 report	/ERAGE the followin 90 orts 5.4 ± 1 . r best value experiment lue. Assume s $3.9^{+1.9}$ +	²²⁹ AUBERT ²³⁰ AVERY ²³¹ ALAM ⁴ ± 1.1 for B(χ_c B($\chi_{c1}(1P) \rightarrow \gamma$'s error and our s s equal productio = 0.4 for B($\chi_{c1}(1P)$	02 E 00 C es, fits, I 94 C $\frac{1}{2}J/\psi(1S)$ second er n of B^+ $P) \rightarrow \gamma$	BABR CLE2 imits, e CLE2 $\rightarrow \gamma J/\psi$)) = (3 rror is t and B ⁰ $J/\psi(1)$	$e^+ e^- \rightarrow$ $e^+ e^- \rightarrow$ $tc. \bullet \bullet$ $e^+ e^- \rightarrow$ $\psi(1S)) = 0.$ $(1.6 \pm 3.2) \Rightarrow$	T(4S) T(4S) T(4S) 273 ± 0.016 $< 10^{-2}$. Our 10^{-2} . Our
4.0 + 1.2 OUR AV 4.7 ± 1.5 ± 0.5 3.4 + 1.7 ± 0.3 • • We do not use <27 ²²⁹ AUBERT 02 report We rescale to our first error is their using our best va ²³⁰ AVERY 00 report	FRAGE the followin 90 orts 5.4 ± 1 . r best value experiment lue. Assume s $3.9^{+1.9}_{-1.3} \pm$	²²⁹ AUBERT ²³⁰ AVERY ²³¹ ALAM ⁴ \pm 1.1 for B(χ_c B($\chi_{c1}(1P) \rightarrow \gamma$'s error and our s s equal productio = 0.4 for B($\chi_{c1}(1P)$	02 E 00 C es, fits, I 94 C $\frac{1}{\sqrt{J/\psi(1S)}}$ second er n of B^+ $P) \rightarrow \gamma$ $\frac{1}{\sqrt{1S}}$	BABR CLE2 imits, e CLE2 $\gamma J/v$ $\gamma J/v$ and $B^{(1)}$ $J/\psi(12)$	$e^+e^- \rightarrow \\e^+e^- \rightarrow \\tc. \bullet \bullet \\e^+e^- \rightarrow \\\psi(1S)) = 0.\\tl.6 \pm 3.2) > \\the systemat \\0 at the \Upsilon(4)f(4) = 0.273f(5) = 0.273$	r(4S) r(4S) r(4S) 273 ± 0.016 $< 10^{-2}$. Out ic error from 4S). ± 0.016 . We -2 Out first

our best value. Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$. ²³¹Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$. $\Gamma(\chi_{c1}(1P) K^*(892)^0) / \Gamma_{total}$

 $\begin{array}{c|c} \Gamma(\chi_{c1}(1P) \ K^*(892)^0) / \Gamma_{total} & \Gamma_{87} / \Gamma \\ \hline \\ \hline \\ \underline{VALUE \ (units \ 10^{-4})}{4.1 \pm 1.4 \pm 0.4} & \underline{CL\%} & \underline{DOCUMENT \ ID} & \underline{TECN} & \underline{COMMENT} \\ \hline \\ \bullet \bullet \bullet \ We \ do \ not \ use \ the \ following \ data \ for \ averages, \ fits, \ limits, \ etc. \ \bullet \ \bullet \\ \hline \\ < 21 & 90 & \underline{233} \ ALAM & 94 \ CLE2 & e^+ e^- \rightarrow \ \Upsilon(4S) \end{array} \right)$

²³²AUBERT 02 reports 4.8 \pm 1.4 \pm 0.9 for B($\chi_{c1}(1P) \rightarrow \gamma J/\psi(1S)$) = 0.273 \pm 0.016. We rescale to our best value $B(\chi_{c1}(1P) \rightarrow \gamma J/\psi(1S)) = (31.6 \pm 3.2) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$. ²³³BORTOLETTO 92 assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.

$\Gamma(\chi_{c1}(1P)K^0)/\Gamma(J/\psi(1S))$	Г ₈₆ /Г ₆₉							
VALUE	DOCUMENT ID		TECN	COMMENT				
$0.57 {\pm} 0.17 {\pm} 0.06$	²³⁴ AUBERT	$e^+e^- \rightarrow$	$\Upsilon(4S)$					
²³⁴ AUBERT 02 reports $0.66 \pm 0.11 \pm 0.17$ for B($\chi_{c1}(1P) \rightarrow \gamma J/\psi(1S)$) = 0.273 ± 0.016.								
We rescale to our best value $B(\chi_{c1}(1P) \rightarrow \gamma J/\psi(1S)) = (31.6 \pm 3.2) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.								
$\Gamma(\chi_{c1}(1P)K^{*}(892)^{0})/\Gamma(\chi$	$\Gamma(\chi_{c1}(1P)K^*(892)^0)/\Gamma(\chi_{c1}(1P)K^0)$ Γ_{87}/Γ_{86}							

VALUE	DOCUMENT ID		TECN	<u>COMMENT</u>		
$0.89 {\pm} 0.34 {\pm} 0.17$	²³⁵ AUBERT	02	BABR	$e^+e^- \rightarrow$	$\Upsilon(4S)$	
235 Assumes equal production	of R^+ and R^0 at the	r((5)			

Assumes equal production of B^{\perp} and B° at the T(4S).

 $\Gamma(K^+\pi^-)/\Gamma_{\text{total}}$

Γ₈₈/Γ

<u>VALUE</u> (units 10 ⁻⁵)	CL%	DOCUMENT ID TECN COMMENT
1.74 ± 0.15 OUR AV	ERAGE	
$1.93 \substack{+0.34 + 0.15 \\ -0.32 - 0.06}$		²³⁶ ABE 01H BELL $e^+e^- \rightarrow \Upsilon(4S)$
$1.67\!\pm\!0.16\!\pm\!0.13$		236 AUBERT 01E BABR $e^+e^- ightarrow \Upsilon(4S)$
$1.72^{+0.25}_{-0.24}{\pm}0.12$		236 CRONIN-HEN00 CLE2 $e^+e^- \rightarrow \Upsilon(4S)$
$\bullet \bullet \bullet$ We do not use the	e followi	ing data for averages, fits, limits, etc. $ulletullet$
< 6.6	90	237 ABE 00C SLD $e^+e^- \rightarrow Z$
$1.5 \ {+0.5 \atop -0.4} \ \pm 0.14$		GODANG 98 CLE2 Repl. by CRONIN- HENNESSY 00
2.4 $^{+1.7}_{-1.1}$ ± 0.2		²³⁸ ADAM 96D DLPH $e^+e^- \rightarrow Z$
< 1.7	90	ASNER 96 CLE2 Sup. by ADAM 96D

< 3.0	90	²³⁹ BUSKULIC	96∨ ALEP	$e^+e^- \rightarrow Z$
< 9	90	²⁴⁰ ABREU	95N DLPH	Sup. by ADAM 96D
< 8.1	90	²⁴¹ AKERS	94l OPAL	$e^+e^- \rightarrow Z$
< 2.6	90	²⁴² BATTLE	93 CLE2	$e^+e^- ightarrow ~\Upsilon(4S)$
<18	90	ALBRECHT	91b ARG	$e^+e^- ightarrow ~\Upsilon(4S)$
< 9	90	²⁴³ AVERY	89b CLEO	$e^+e^- ightarrow ~\Upsilon(4S)$
<32	90	AVERY	87 CLEO	$e^+e^- \rightarrow \Upsilon(4S)$

 236 Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.

²³⁷ABE 00C assumes B($Z \rightarrow b\overline{b}$)=(21.7 ± 0.1)% and the *B* fractions $f_{B^0} = f_{B^+} =$ $(39.7^{+1.8}_{-2.2})\%$ and $f_{B_s} = (10.5^{+1.8}_{-2.2})\%$.

²³⁸ ADAM 96D assumes $f_{B^0} = f_{B^-} = 0.39$ and $f_{B_s} = 0.12$. Contributions from B^0 and B_s decays cannot be separated. Limits are given for the weighted average of the decay rates for the two neutral *B* mesons. ²³⁹ BUSKULIC 96V assumes PDG 96 production fractions for B^0 , B^+ , B_s , *b* baryons.

²⁴⁰ Assumes a B^0 , B^- production fraction of 0.39 and a B_s production fraction of 0.12. Contributions from B^0 and B_s^0 decays cannot be separated. Limits are given for the weighted average of the decay rates for the two neutral B mesons. ²⁴¹ Assumes B($Z \rightarrow b\overline{b}$) = 0.217 and B_d^0 (B_s^0) fraction 39.5% (12%). ²⁴² BATTLE 93 assumes equal production of $B^0\overline{B}^0$ and B^+B^- at $\Upsilon(4S)$. ²⁴³ Assumes the $\Upsilon(4S)$ decays 43% to $B^0\overline{B}^0$.

$\Gamma(K^+\pi^-)/\Gamma(K^0\pi^0)$						Г ₈₈ /Г ₈₉
VALUE	<u>D</u> (OCUMENT ID		TECN	COMMENT	
$1.20^{+0.50}_{-0.58}{}^{+0.22}_{-0.32}$	²⁴⁴ Al	ЗE	01H	BELL	$e^+e^- \rightarrow$	$\Upsilon(4S)$
²⁴⁴ Assumes equal production of	of B^+ a	nd B ⁰ at the	$\Upsilon(4)$	S).		
$\left[\Gamma(K^+\pi^-)+\Gamma(\pi^+\pi^-)\right]/$	Γ _{total}				(Г	88+Г ₁₃₃)/Г
VALUE (units 10^{-5}) EV	TS	DOCUMENT IL	D	TECN	COMMEN	IT
1.9 ± 0.6 OUR AVERAGE						
$2.8^{+1.5}_{-1.0}{\pm}2.0$	245	ADAM	96	6d DLP	H e^+e^- -	$\rightarrow Z$
$1.8^{+0.6}_{-0.5}^{+0.3}_{-0.4}$ 17	.2	ASNER	96	6 CLE2	2 e ⁺ e ⁻ -	$ ightarrow ~ \Upsilon(4S)$
$\bullet \bullet \bullet$ We do not use the follow	ving data	for averages	, fits,	limits,	etc. • • •	
$2.4^{+0.8}_{-0.7}\pm0.2$	246	BATTLE	93	3 CLE2	2 e ⁺ e ⁻ -	$ ightarrow ~ \Upsilon(4S)$

²⁴⁵ ADAM 96D assumes $f_{B^0} = f_{B^-} = 0.39$ and $f_{B_s} = 0.12$. Contributions from B^0 and B_s decays cannot be separated. Limits are given for the weighted average of the decay rates for the two neutral B mesons. 246 BATTLE 93 assumes equal production of $B^0 \overline{B}^0$ and $B^+ B^-$ at $\Upsilon(4S)$.

$\Gamma(K^0\pi^0)/\Gamma_{total}$						Г ₈₉ /Г
VALUE (units 10^{-5})	CL%		DOCUMENT ID		TECN	COMMENT
$1.07^{+0.27}_{-0.25}$ our ave	RAGE					
$1.60^{+0.72}_{-0.59}{}^{+0.25}_{-0.27}$		247	ABE	01H	BELL	$e^+e^- ightarrow ~\Upsilon(4S)$
$0.82^{+0.31}_{-0.27}{\pm}0.12$		247	AUBERT	01e	BABR	$e^+e^- ightarrow ~\Upsilon(4S)$
$1.46^{+0.59}_{-0.51}{}^{+0.24}_{-0.33}$		247	CRONIN-HEN.	.00	CLE2	$e^+e^- ightarrow ~\Upsilon(4S)$
$\bullet \bullet \bullet$ We do not use the	e followi	ng da	ata for averages	fits	limits,	etc. ● ● ●
<4.1	90		GODANG	98	CLE2	Repl. by CRONIN-
<4.0	90		ASNER	96	CLE2	Rep. by GODANG 98
²⁴⁷ Assumes equal produ	iction of	B+	and B^0 at the	$\Upsilon(4$	5).	


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VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT	
$1.38 \pm 0.55 \pm 0.16$		250 RICHICHI	00 0	CLE2		$\Upsilon(4S)$
-0.46 ± 0.10	the follow	ing data for average	c fite	limite		7(10)
			s, iits,	CLEO		
< 3.0	90		98 (CLE2	кері, ру к	
230 Assumes equal pr	oduction o	B^+ and B^0 at the	e 7 (45) .		
$\Gamma(\eta K^0)/\Gamma_{\text{total}}$						Гөз
VALUE (units 10^{-6})	CL%	DOCUMENT ID		TECN	COMMENT	
< 9.3	90	²⁵¹ RICHICHI	00 (CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$\bullet \bullet \bullet$ We do not use	the follow	ing data for average	s, fits,	limits,	etc. • • •	
<33	90	BEHRENS	98 (CLE2	Repl. by R	ICHICHI 0
²⁵¹ Assumes equal pr	oduction o	f B^+ and B^0 at the	e $\Upsilon(4S$	5).		
Г(,, к0) /Г						Га
	<u> </u>				COMMENT	· 94
<u>VALUE (units 10^{-3})</u>	<u>CL%</u>	252 AUDEET			$\underline{COMMENF}$	00(+ C)
<1.3	90 the follow	-32 AUBERT	01G l	BABR	$e^+e^- \rightarrow$	$\Gamma(4S)$
		252 IFCCOD	s, iits,	CLEO		$\Upsilon(AC)$
<2.1	90	252 BERCEELD	00 0	CLE2	$e \cdot e \rightarrow$	1 (45) ESSOP 00
252	90		90 0		Kepi. by J	
Assumes equal pr	oduction o	$f B'$ and B° at the	e / (45) .		
$\Gamma(K^0_{\alpha}X^0)$ (Familon))/[total					Г95
	/// LULAI					
VALUE (units 10^{-5})	CL%	DOCUMENT ID		TECN	COMMENT	
VALUE (units 10 ⁻⁵)	<u> </u>	253 <u>AMMAR</u>	01B (<i>TECN</i> CLE2	$\frac{COMMENT}{e^+e^-} \rightarrow$	$\gamma(4S)$
<u>VALUE (units 10⁻⁵)</u> <5.3 253 AMMAR 01D co	<u>CL%</u> 90	DOCUMENT ID 253 AMMAR	01B (TECN CLE2	$\frac{COMMENT}{e^+e^-} \rightarrow$	$\Upsilon(4S)$
VALUE (units 10 ⁻⁵) <5.3 ²⁵³ AMMAR 01B sea trail facility interpret	<u>CL%</u> 90 arched for	$\frac{DOCUMENT \ ID}{253}$ $\frac{253}{AMMAR}$ $\frac{1}{2}$ $\frac{1}{2}$	01B (ay of t	TECN CLE2 the Br	$\frac{COMMENT}{e^+e^-} \rightarrow$ meson to a	$\Upsilon(4S)$ massless r
 VALUE (units 10⁻⁵) <5.3 253 AMMAR 01B sea tral feebly-interac associated with a 	<u>CL%</u> 90 arched for cting partic sponateou	$\frac{DOCUMENT ID}{253}$ AMMAR the two-body deca cle X^0 such as the sly broken global fa	01B (ay of t familc milv sv	<u>TECN</u> CLE2 he <i>B</i> r on, the	$\frac{COMMENT}{e^+e^-} \rightarrow$ meson to a e Nambu-Go v.	$\Upsilon(4S)$ massless r Idstone bo
VALUE (units 10 ⁻⁵) <5.3 ²⁵³ AMMAR 01B sea tral feebly-interac associated with a	<u>CL%</u> 90 arched for cting partic sponateou	$\frac{DOCUMENT ID}{253}$ AMMAR the two-body decade X^0 such as the the sly broken global failed	01B (ay of t familo mily sy	<u>TECN</u> CLE2 the <i>B</i> r on, the mmetr	$\frac{COMMENT}{e^+e^-} \rightarrow$ meson to a e Nambu-Go y.	$\Upsilon(4S)$ massless r ldstone bc
VALUE (units 10 ⁻⁵) <5.3 ²⁵³ AMMAR 01B sea tral feebly-interac associated with a Γ(ω K*(892) ⁰)/Γ _t	<u>CL%</u> 90 arched for cting partic sponateou	$\frac{DOCUMENT ID}{253}$ AMMAR the two-body deca cle X^0 such as the sly broken global fa	01B (ay of t familo mily sy	TECN CLE2 the Br on, the mmetr	$\frac{COMMENT}{e^+e^-} \rightarrow$ meson to a e Nambu-Gc	$\Upsilon(4S)$ massless r ldstone bc
$\frac{VALUE \text{ (units } 10^{-5})}{<5.3}$ $\frac{253}{\text{AMMAR } 01B \text{ sea}}{\text{tral feebly-interac}}{\text{associated with a}}$ $\Gamma(\omega K^*(892)^0)/\Gamma_t$ $\frac{VALUE}{=}{}$	<u>CL%</u> 90 arched for cting partic sponateou otal	$\frac{DOCUMENT \ ID}{253}$ $\frac{253}{\text{AMMAR}}$ $\frac{1}{254} \text{ bold model}$ $\frac{DOCUMENT \ ID}{254}$	01B (ay of t familo mily sy	TECN CLE2 the Br on, the mmetr	$\frac{COMMENT}{e^+e^-} \rightarrow$ meson to a e Nambu-Go y.	$\Upsilon(4S)$ massless r ldstone bo
$\frac{VALUE \text{ (units } 10^{-5})}{<5.3}$ $\frac{253}{\text{AMMAR } 01B \text{ seat}}{\text{tral feebly-interact}}{\text{associated with a}}$ $\frac{\Gamma(\omega K^*(892)^0)}{\Gamma_t}/\Gamma_t$ $\frac{VALUE}{<2.3 \times 10^{-5}}$	<i>CL%</i> 90 arched for cting partic sponateou otal 90	<u>DOCUMENT ID</u> 253 AMMAR the two-body deca cle X ⁰ such as the sly broken global fai <u>DOCUMENT ID</u> 254 BERGFELD	01B (ay of t familo mily sy 98 (TECN CLE2 the B r con, the mmetr TECN CLE2	$\frac{COMMENT}{e^+e^-} \rightarrow$ neson to a e Nambu-Go y.	$\Upsilon(4S)$ massless r ldstone bc
$\frac{VALUE \text{ (units } 10^{-5})}{<5.3}$ $\frac{253}{\text{AMMAR } 01B \text{ sea}}{\text{tral feebly-interac}}{\text{associated with a}}$ $\frac{\Gamma(\omega K^* (892)^0)}{\Gamma_t}$ $\frac{VALUE}{<2.3 \times 10^{-5}}$ $\frac{254}{\text{Assumes equal product}}$	CL% 90 arched for cting partic sponateou otal <u>CL%</u> 90 oduction o	$\frac{DOCUMENT \ ID}{253}$ AMMAR the two-body deca cle X^0 such as the sly broken global fance $\frac{DOCUMENT \ ID}{254}$ BERGFELD f B^+ and B^0 at the	01B (ay of t familc mily sy 98 (e $\Upsilon(4S)$	TECN CLE2 the Br on, the mmetr TECN CLE2	$\frac{COMMENT}{e^+e^-} \rightarrow$ meson to a e Nambu-Go	$\Upsilon(4S)$ massless r ldstone bo
$\frac{VALUE \text{ (units } 10^{-5)}}{<5.3}$ $\frac{253}{\text{AMMAR } 01B \text{ seatral feebly-interaction}}$ $\frac{\Gamma(\omega K^*(892)^0)}{\Gamma_t}$ $\frac{VALUE}{<2.3 \times 10^{-5}}$ $\frac{254}{\text{Assumes equal product}}$ $\frac{\Gamma(K^+K^-)}{\Gamma_{total}}$	<i>CL%</i> 90 arched for cting partic sponateou otal <u>CL%</u> 90 oduction o	$\frac{DOCUMENT ID}{253}$ AMMAR the two-body deca cle X ⁰ such as the sly broken global factor $\frac{DOCUMENT ID}{254}$ BERGFELD f B ⁺ and B ⁰ at the	01B (ay of t familc mily sy 98 (e $\Upsilon(4S)$	TECN CLE2 the <i>B</i> r con, the mmetr TECN CLE2 5).	$\frac{COMMENT}{e^+e^-} \rightarrow$ meson to a e Nambu-Go	$\Upsilon(4S)$ massless r ldstone bo Fgg
$\frac{VALUE \text{ (units } 10^{-5})}{<5.3}$ $\frac{253}{\text{AMMAR } 01B \text{ seatral feebly-interact}}{<}$ $\frac{\Gamma(\omega K^* (892)^0)}{\Gamma_t}$ $\frac{VALUE}{<2.3 \times 10^{-5}}$ $\frac{254}{\text{Assumes equal pr}}{\Gamma(K^+ K^-)/\Gamma_{\text{total}}}$ $\frac{VALUE \text{ (units } 10^{-6})}{<}$	<i>CL%</i> <i>CL%</i> <i>CL%</i> <i>CL%</i> <i>CL%</i>	$\frac{DOCUMENT \ ID}{253}$ AMMAR the two-body deca cle X^0 such as the sly broken global fail $\frac{DOCUMENT \ ID}{254}$ BERGFELD f B^+ and B^0 at the $DOCUMENT \ ID$	01B (ay of t familo mily sy 98 (e $\Upsilon(4S)$	TECN CLE2 the B r on, the mmetr TECN CLE2 5).	$\frac{COMMENT}{e^+e^-} \rightarrow$ neson to a e Nambu-Go y.	$\Upsilon(4S)$ massless r ldstone bo Fgg
$\frac{VALUE \text{ (units } 10^{-5)}}{<5.3}$ $\frac{253}{\text{AMMAR } 01B \text{ seat}}{\text{tral feebly-interact}}{\text{associated with a}}$ $\frac{\Gamma(\omega K^* (892)^0) / \Gamma_t}{VALUE}$ $\frac{2.3 \times 10^{-5}}{^{254} \text{ Assumes equal pr}}{\Gamma(K^+ K^-) / \Gamma_{total}}$ $\frac{VALUE \text{ (units } 10^{-6)}}{< 1.9}$	<i>CL%</i> 90 arched for cting partic sponateou otal <u>CL%</u> 90 oduction o	$\frac{DOCUMENT \ ID}{253} \frac{DOCUMENT \ ID}{AMMAR}$ the two-body deca cle X^0 such as the sly broken global fail $\frac{DOCUMENT \ ID}{254} \frac{DOCUMENT \ ID}{BERGFELD}$ f B^+ and B^0 at the $\frac{DOCUMENT \ ID}{255} \frac{DOCUMENT \ ID}{CRONIN-HEN}$	$\frac{1}{01B}$	TECN CLE2 the B r on, the mmetr TECN CLE2 5). TECN CLE2	$\frac{COMMENT}{e^+e^-} \rightarrow$ meson to a a Nambu-Go y. $\frac{COMMENT}{e^+e^-} \rightarrow$	$\Upsilon(4S)$ massless r ldstone bo Fgg $\Upsilon(4S)$
$\frac{VALUE \text{ (units } 10^{-5)}}{<5.3}$ $\frac{253}{\text{AMMAR } 01B \text{ seatral feebly-interact}}{<}$ $\frac{\Gamma(\omega K^*(892)^0)}{\Gamma_t}$ $\frac{VALUE}{<2.3 \times 10^{-5}}$ $\frac{254}{\text{Assumes equal product}} \text{ r}(K^+K^-)/\Gamma_{\text{total}}$ $\frac{VALUE \text{ (units } 10^{-6})}{<} \text{ 1.9}$ ••• We do not use	<i>CL%</i> 90 arched for cting partic sponateou otal <u>CL%</u> 90 oduction o <u>CL%</u> 90 the follow	$\frac{DOCUMENT \ ID}{253}$ AMMAR the two-body deca cle X^0 such as the sly broken global fa $\frac{DOCUMENT \ ID}{254}$ BERGFELD f B^+ and B^0 at the $\frac{DOCUMENT \ ID}{255}$ CRONIN-HEN ing data for average	01B (ay of t familc mily sy 98 (e $\Upsilon(4S)$ 00 (s, fits.	TECN CLE2 the B r on, the mmetr TECN CLE2 5). TECN CLE2 limits.	$\frac{COMMENT}{e^+e^-} \rightarrow$ meson to a e Nambu-Go y. $\frac{COMMENT}{e^+e^-} \rightarrow$ etc. • • •	$\Upsilon(4S)$ massless r ldstone bc Fgg $\Upsilon(4S)$
$\frac{VALUE \text{ (units } 10^{-5)}}{<5.3}$ $\frac{253}{\text{AMMAR } 01B \text{ seatral feebly-interact}}{<}$ $\frac{\Gamma(\omega K^*(892)^0)}{\Gamma_t}$ $\frac{VALUE}{<2.3 \times 10^{-5}}$ $\frac{254}{\text{Assumes equal pr}}{\Gamma(K^+ K^-)/\Gamma_{\text{total}}}$ $\frac{VALUE \text{ (units } 10^{-6)}}{<}$ < 1.9 $\bullet \bullet \text{ We do not use}$ < 2.7	<i>CL%</i> 90 arched for cting partic sponateou otal <u>CL%</u> 90 oduction o <u>CL%</u> 90 the follow 90	$\frac{DOCUMENT \ ID}{253}$ AMMAR the two-body deca cle X^0 such as the asly broken global fail $\frac{DOCUMENT \ ID}{254}$ BERGFELD f B^+ and B^0 at the $\frac{DOCUMENT \ ID}{255}$ CRONIN-HEN ing data for average 255 ABE	01B (ay of t familo mily sy 98 (e $\Upsilon(4S)$ 00 (s, fits, 01H F	TECN CLE2 the B r on, the mmetr TECN CLE2 5). TECN CLE2 limits, BEI I	$\frac{COMMENT}{e^+e^- \rightarrow}$ meson to a e Nambu-Go y. $\frac{COMMENT}{e^+e^- \rightarrow}$ etc. • • • $e^+e^- \rightarrow$	$\Upsilon(4S)$ massless r ldstone bo Fgg $\Upsilon(4S)$
$\frac{VALUE (units 10^{-5})}{<5.3}$ $\frac{253}{AMMAR 01B seatral feebly-interactal sociated with a r(\omega K^*(892)^0)/\Gamma_t \frac{VALUE}{<2.3 \times 10^{-5}} \frac{254}{Assumes equal product of the seatral solution of the seatral feebly-interactal solution$	<i>CL%</i> 90 arched for cting partic sponateou otal <u>CL%</u> 90 oduction o <u>CL%</u> 90 the follow 90 90	$\frac{DOCUMENT \ ID}{253}$ $\frac{DOCUMENT \ ID}{AMMAR}$ $\frac{DOCUMENT \ ID}{254}$ $\frac{DOCUMENT \ ID}{BERGFELD}$ $\frac{DOCUMENT \ ID}{255}$ $\frac{DOCUMENT \ ID}{CRONIN-HEN}$ $\frac{DOCUMENT \ ID}{255}$	01B (ay of t familc mily sy 98 (e $\Upsilon(4S)$ 00 (s, fits, 01H H 01E H	TECN CLE2 the B r on, the mmetr TECN CLE2 5). TECN CLE2 limits, BELL BABR	$\frac{COMMENT}{e^+e^- \rightarrow}$ meson to a e Nambu-Go y. $\frac{COMMENT}{e^+e^- \rightarrow}$ etc. • • • $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ $e^+e^- \rightarrow$	$\Upsilon(4S)$ massless r Idstone bo Fgg $\Upsilon(4S)$ $\Upsilon(4S)$ $\Upsilon(4S)$
$\frac{VALUE (units 10^{-5})}{<5.3}$ 253 AMMAR 01B sea tral feebly-interace associated with a $\Gamma(\omega K^*(892)^0)/\Gamma_t$ <u>VALUE</u> $<2.3 \times 10^{-5}$ 254 Assumes equal pr $\Gamma(K^+K^-)/\Gamma_{total}$ <u>VALUE (units 10^{-6})</u> < 1.9 ••• We do not use < 2.7 < 2.5 < 66	<i>CL%</i> 90 arched for cting partic sponateou otal <u>CL%</u> 90 oduction o <u>CL%</u> 90 the follow 90 90 90	$\frac{DOCUMENT \ ID}{253}$ AMMAR the two-body deca cle X^0 such as the sly broken global fail $\frac{DOCUMENT \ ID}{254}$ BERGFELD f B^+ and B^0 at the $\frac{DOCUMENT \ ID}{255}$ CRONIN-HEN ing data for average 255 ABE 255 AUBERT 256 ABE	01B (ay of t familo mily sy 98 (e $\Upsilon(4S)$ 00 (s, fits, 01H H 01E H 00C S	TECN CLE2 the B r on, the mmetr TECN CLE2 5). TECN CLE2 limits, BELL BABR SLD	$\frac{COMMENT}{e^+e^- \rightarrow}$ meson to a e Nambu-Go y. $\frac{COMMENT}{e^+e^- \rightarrow}$ etc. • • • $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ $e^+e^- \rightarrow$	$\Upsilon(4S)$ massless r Idstone bo Fgg $\Upsilon(4S)$ $\Upsilon(4S)$ $\Upsilon(4S)$ $\Upsilon(4S)$ Z
VALUE (units 10^{-5}) <5.3	<i>CL%</i> 90 arched for cting partic sponateou otal <u>CL%</u> 90 oduction o <u>CL%</u> 90 the follow 90 90 90 90	$\frac{DOCUMENT \ ID}{253}$ AMMAR the two-body deca cle X^0 such as the asly broken global fail $\frac{DOCUMENT \ ID}{254}$ BERGFELD f B^+ and B^0 at the $\frac{DOCUMENT \ ID}{255}$ CRONIN-HEN ing data for average $\frac{255}{400}$ ABE $\frac{255}{400}$ CRONIN-HEN CODANG	01B (ay of t familo mily sy 98 (e $\Upsilon(4S)$ 00 (s, fits, 01E F 01E F 00C S 98 (TECN CLE2 che Br on, the mmetr TECN CLE2 c). TECN CLE2 limits, BELL BABR SLD CLE2	$\frac{COMMENT}{e^+e^- \rightarrow}$ meson to a e Nambu-Go y. $\frac{COMMENT}{e^+e^- \rightarrow}$ etc. • • • $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ Repl. by C	$\Upsilon(4S)$ massless r Idstone bo Γ_{97} Γ_{97} $\Upsilon(4S)$ $\Upsilon(4S)$ $\Upsilon(4S)$ $\chi(4S)$ Z RONIN-
$\frac{VALUE (units 10^{-5})}{<5.3}$ 253 AMMAR 01B seatral feebly-interact associated with a $\Gamma(\omega K^* (892)^0) / \Gamma_t$ VALUE $<2.3 \times 10^{-5}$ 254 Assumes equal pro $\Gamma(K^+ K^-) / \Gamma_{total}$ VALUE (units 10^{-6}) < 1.9 ••• We do not use < 2.7 < 2.5 < 66 < 4.3	<i>CL%</i> 90 arched for cting partic sponateou otal <u>CL%</u> 90 oduction o <u>CL%</u> 90 the follow 90 90 90 90	$\frac{DOCUMENT ID}{253}$ AMMAR the two-body deca cle X^0 such as the sly broken global fail $\frac{DOCUMENT ID}{254}$ BERGFELD f B^+ and B^0 at the $\frac{DOCUMENT ID}{255}$ CRONIN-HEN ing data for average 255 ABE 255 AUBERT 256 ABE GODANG 257 ADAM	01B (ay of t famile mily sy 98 (e $\Upsilon(4S)$ 00 (s, fits, 01H H 01E H 01C S 98 (06C S	TECN CLE2 the B r on, the mmetr TECN CLE2 5). TECN CLE2 limits, BELL BABR SLD CLE2	$\frac{COMMENT}{e^+e^- \rightarrow}$ meson to a a Nambu-Go y. $\frac{COMMENT}{e^+e^- \rightarrow}$ etc. • • • $e^+e^- \rightarrow$ $e^+e^- \rightarrow$	$\Upsilon(4S)$ massless r ldstone bo Γ_{97} $\Gamma(4S)$ $\Upsilon(4S)$ $\Upsilon(4S)$ Z RONIN- SSY 00 Z
$\frac{VALUE (units 10^{-5})}{<5.3}$ 253 AMMAR 01B seatral feebly-interact associated with a $\frac{\Gamma(\omega K^* (892)^0) / \Gamma_t}{VALUE}$ $\frac{VALUE}{<2.3 \times 10^{-5}}$ 254 Assumes equal pr $\frac{\Gamma(K^+ K^-) / \Gamma_{total}}{VALUE (units 10^{-6})}$ < 1.9 $• • We do not use$ < 2.7 < 2.5 < 66 < 4.3 < 46 < 4	<i>CL%</i> 90 arched for cting partic sponateou otal <u>CL%</u> 90 oduction o <u>CL%</u> 90 the follow 90 90 90 90 90	$\frac{DOCUMENT ID}{253}$ AMMAR the two-body deca cle X^0 such as the sly broken global fail $\frac{DOCUMENT ID}{254}$ BERGFELD f B^+ and B^0 at the $\frac{DOCUMENT ID}{255}$ CRONIN-HEN ing data for average $\frac{255}{255}$ ABE $\frac{255}{40}$ ABE GODANG $\frac{257}{40}$	01B (ay of t familo mily sy 98 (e $\Upsilon(4S)$ 00 (s, fits, 01H H 01E H 00C S 98 (98 (98 (98 (TECN CLE2 the B r on, the mmetr TECN CLE2 5). TECN CLE2 limits, BELL BABR SLD CLE2 DLPH CLE2	$\frac{COMMENT}{e^+e^- \rightarrow}$ meson to a e Nambu-Go y. $\frac{COMMENT}{e^+e^- \rightarrow}$ etc. • • • $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ Repl. by C HENNE $e^+e^- \rightarrow$	$\Upsilon(4S)$ massless r Idstone bo Γ_{97} $\Gamma(4S)$ $\Upsilon(4S)$ $\Upsilon(4S)$ $\chi(4S)$ Z RONIN- SSY 00 Z ODANC OD
$\frac{VALUE (units 10^{-5})}{<5.3}$ 253 AMMAR 01B sea tral feebly-interace associated with a $\Gamma(\omega K^*(892)^0)/\Gamma_t$ $\frac{VALUE}{<2.3 \times 10^{-5}}$ 254 Assumes equal properties $\Gamma(K^+ K^-)/\Gamma_{total}$ $\frac{VALUE (units 10^{-6})}{< 1.9}$ ••• We do not use < 2.7 < 2.5 < 66 < 4.3 < 46 < 4	<i>CL%</i> 90 arched for cting partic sponateou otal <u>CL%</u> 90 oduction o <u>CL%</u> 90 the follow 90 90 90 90 90	$\frac{DOCUMENT ID}{253}$ AMMAR the two-body deca cle X^0 such as the asly broken global far $\frac{DOCUMENT ID}{254}$ BERGFELD f B^+ and B^0 at the $\frac{DOCUMENT ID}{255}$ CRONIN-HEN ing data for average 255 ABE 255 ABE 255 ABE 255 ABE 255 ABE 255 ABE 257 ADAM ASNER 258 BUSKLUUC	01B (ay of t famile mily sy 98 (e $\Upsilon(4S)$ 00 (s, fits, 01H F 01E F 01E F 01C S 98 (98 (98 (98 (96)	TECN CLE2 the B r on, the mmetr TECN CLE2 5). TECN CLE2 limits, BELL BABR SLD CLE2 DLPH CLE2 ALEP	$\frac{COMMENT}{e^+e^-} \rightarrow \frac{e^+e^-}{e^+e^-}$ meson to a a Nambu-Go y. $\frac{COMMENT}{e^+e^-} \rightarrow \frac{e^+e^-}{e^+e^-} \rightarrow \frac{e^+e^-}{e^+e$	$\Upsilon(4S)$ massless r Idstone bo Γ_{97} $\Gamma(4S)$ $\Upsilon(4S)$ $\Upsilon(4S)$ $\Upsilon(4S)$ $\chi(4S)$
$\frac{VALUE (units 10^{-5})}{<5.3}$ $\frac{253}{AMMAR 01B seatral feebly-interactal sociated with a a sociated with a a sociated with a a f(\omega K^*(892)^0)/\Gamma_t \frac{VALUE}{<2.3 \times 10^{-5}} \frac{254}{Assumes equal pr} \frac{\Gamma(K^+ K^-)/\Gamma_{total}}{VALUE (units 10^{-6})} < 1.9 \bullet \bullet We do not use < 2.7 < 2.5 < 66 < 4.3 < 46 < 4 < 18 < 120$	<i>CL%</i> 90 arched for cting partic sponateou otal <u>CL%</u> 90 oduction o <u>CL%</u> 90 oduction o <u>CL%</u> 90 0 90 90 90 90 90 90 90 90	$\frac{DOCUMENT ID}{253}$ AMMAR the two-body deca cle X^0 such as the asly broken global fail $\frac{DOCUMENT ID}{254}$ BERGFELD f B^+ and B^0 at the $\frac{DOCUMENT ID}{255}$ CRONIN-HEN ing data for average 255 ABE 255 AUBERT 256 ABE GODANG 257 ADAM ASNER 258 BUSKULIC 259 ABEII	01B (ay of t familo mily sy 98 (e $\Upsilon(4S)$ 00 (s, fits, 01E F 01E F 01E F 01E F 01E F 01E F 01E F 01E F 01E (98 (98 (98 (96)	TECN CLE2 the B r on, the mmetr TECN CLE2 5). TECN CLE2 limits, BELL BABR SLD CLE2 DLPH CLE2 ALEP DLPH	$\frac{COMMENT}{e^+e^- \rightarrow}$ meson to a e Nambu-Go y. $\frac{COMMENT}{e^+e^- \rightarrow}$ etc. • • • $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ Repl. by C $e^+e^- \rightarrow$ Repl. by G $e^+e^- \rightarrow$ Sup by Al	$\Upsilon(4S)$ massless r Idstone bo Γ_{gr} Γ_{gr} $\Upsilon(4S)$ $\Upsilon(4S)$ $\Upsilon(4S)$ $\Upsilon(4S)$ χ RONIN- SSY 00 Z ODANG 96 Z
$\frac{VALUE (units 10^{-5})}{<5.3}$ $\frac{253}{AMMAR 01B seatral feebly-interactal sociated with a rail feebly-interactal feebly-interactal sociated with a f(\omega K^*(892)^0)/\Gamma_t\frac{VALUE}{<2.3 \times 10^{-5}} \frac{254}{Assumes equal product for the feet for the feet feet feet feet feet feet feet $	CL% 90 arched for for cting partid go otal	$\frac{DOCUMENT ID}{253}$ AMMAR the two-body deca cle X^0 such as the asly broken global fail $\frac{DOCUMENT ID}{254}$ BERGFELD f B^+ and B^0 at the $\frac{DOCUMENT ID}{255}$ CRONIN-HEN ing data for average 255 ABE 255 ABE 255 AUBERT 256 ABE GODANG 257 ADAM ASNER 258 BUSKULIC 259 ABREU 260 BATTI F	01B (ay of t famile mily sy 98 (e $\Upsilon(4S)$ 00 (s, fits, 01H I 01E I 01C S 98 (96D I 96 (96D I 96 (96D I 96 (96D I	TECN CLE2 the B r on, the mmetr TECN CLE2 5). TECN CLE2 limits, BELL BABR SLD CLE2 DLPH CLE2 ALEP DLPH CLE2	$\frac{COMMENT}{e^+e^- \rightarrow}$ meson to a e Nambu-Go y. $\frac{COMMENT}{e^+e^- \rightarrow}$ etc. • • • $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ Repl. by CO HENNE $e^+e^- \rightarrow$ Repl. by G $e^+e^- \rightarrow$ Sup. by Al $e^+e^- \rightarrow$	$\Upsilon(4S)$ massless r Idstone bo Γ_{97} $\Gamma(4S)$ $\Upsilon(4S)$ $\Upsilon(4S)$ Z RONIN- SSY 00 Z ODANG 98 Z DAM 96D $\Upsilon(4S)$

 255 Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.

- ²⁵⁶ ABE OOC assumes $B(Z \rightarrow b\overline{b}) = (21.7 \pm 0.1)\%$ and the *B* fractions $f_{B^0} = f_{B^+} = (39.7^{+1.8}_{-2.2})\%$ and $f_{B_s} = (10.5^{+1.8}_{-2.2})\%$.
- ²⁵⁷ ADAM 96D assumes $f_{B^0} = f_{B^-} = 0.39$ and $f_{B_s} = 0.12$. Contributions from B^0 and B_s decays cannot be separated. Limits are given for the weighted average of the decay rates for the two neutral *B* mesons.
- ²⁵⁸ BUSKULIC 96V assumes PDG 96 production fractions for B^0 , B^+ , B_s , b baryons.
- ²⁵⁹ Assumes a B^0 , B^- production fraction of 0.39 and a B_s production fraction of 0.12. Contributions from B^0 and B_s^0 decays cannot be separated. Limits are given for the weighted average of the decay rates for the two neutral *B* mesons. ²⁶⁰ BATTLE 93 assumes equal production of $B^0 \overline{B}^0$ and $B^+ B^-$ at $\Upsilon(4S)$.

 $\Gamma(K^0 \overline{K}^0) / \Gamma_{\text{total}}$ Γ98/Γ <u>CL%</u> DOCUMENT ID TECN COMMENT 98 CLE2 $e^+e^- \rightarrow \Upsilon(4S)$ $< 1.7 \times 10^{-1}$ 90 GODANG $\Gamma(K^+\rho^-)/\Gamma_{\text{total}}$ Γ₉₉/Γ <u>VAL</u>UE CL% TECN ²⁶¹ JESSOP $< 3.2 \times 10^{-5}$ 90 00 CLE2 $\Upsilon(4S)$ • • We do not use the following data for averages, fits, limits, etc. $< 3.5 \times 10^{-5}$ 90 ASNER 96 CLE2 Repl. by JESSOP 00 261 Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$. $\Gamma(\kappa^0 \pi^+ \pi^-)/\Gamma_{\text{total}}$ Γ_{100}/Γ CL% DOCUMENT ID VALUE TECN COMMENT • • • We do not use the following data for averages, fits, limits, etc. $< 4.4 \times 10^{-4}$ 91E ARG $e^+e^- \rightarrow \Upsilon(4S)$ 90 ALBRECHT $\Gamma(K^0 \rho^0) / \Gamma_{\text{total}}$ Γ_{101}/Γ CL% DOCUMENT ID TECN COMMENT VALUE × 10⁻⁵ ASNER 96 CLE2 $\Upsilon(4S)$ <3.9 90 e^+e^- • • • We do not use the following data for averages, fits, limits, etc. $< 3.2 \times 10^{-4}$ 91B ARG 90 $e^+e^- \rightarrow \Upsilon(4S)$ ALBRECHT ²⁶² AVERY $< 5.0 \times 10^{-4}$ 89B CLEO $e^+e^- \rightarrow \Upsilon(4S)$ 90 90 ²⁶³ AVERY 87 CLEO $e^+e^- \rightarrow \Upsilon(4S)$ < 0.064 $^{262}\,\text{AVERY}$ 89B reports < 5.8 \times 10 $^{-4}$ assuming the $\varUpsilon(4S)$ decays 43% to $B^0\,\overline{B}{}^0.$ We rescale to 50%. ²⁶³ AVERY 87 reports < 0.08 assuming the $\Upsilon(4S)$ decays 40% to $B^0 \overline{B}^0$. We rescale to 50%. $\Gamma(K^0 f_0(980))/\Gamma_{\text{total}}$ Γ_{102}/Γ

VALUE	<u>CL%</u>	DOCUMENT ID	TECN	<u>COMMENT</u>
<3.6 × 10 ⁻⁴	90	264 AVERY	89B CLEO	$e^+e^- \rightarrow \Upsilon(4S)$
264		10-1		

²⁶⁴ AVERY 89B reports $< 4.2 \times 10^{-4}$ assuming the $\Upsilon(4S)$ decays 43% to $B^0 \overline{B}^0$. We rescale to 50%.

$\Gamma(K^*(892)^+\pi^-)/$	Γ _{total}					Г ₁₀₃ /І
/ALUE	<u>CL%</u>	DOCUMENT ID		TECN	<u>COMMENT</u>	
<7.2 × 10 ⁻⁵	90	ASNER	96	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
<3.8 × 10 ⁻⁴	90	²⁶⁵ AVERY	89 B	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
• • We do not use	the following	ng data for averag	es, fits,	limits,	etc. • • •	
$< 6.2 \times 10^{-4}$	90	ALBRECHT	91 B	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$< 5.6 \times 10^{-4}$	90	²⁶⁶ AVERY	87	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
265 AVERY 80B repo	rts < 44	(10^{-4}) assuming	the γ	(45) de	acave 43% t	$R^{0}\overline{R}^{0}$ W
rescale to 50%. 266 AVERY 87 report to 50%.	$s < 7 \times 10^{-1}$	⁻⁴ assuming the 3	r(4 <i>S</i>) o	decays 4	40% to $B^0\overline{E}$	3 ⁰ . We rescal
Γ(<i>K</i> *(892) ⁰ π ⁰)/Γ	total			TECN	COMMENT	Г ₁₀₄ /I
ALUE	<u> </u>	190 JECCOR			\perp _	22(1.6)
$<3.6 \times 10^{-6}$	90	JESSOP	00	CLE2	$e^+e^- \rightarrow$	T(4S)
• • vve do not use	the following	ig data for averag	es, tits,	limits,	etc. ● ● ●	
$<2.8 \times 10^{-5}$	90	ASNER	96	CLE2	Repl. by J	ESSOP 00
- <i>(K</i> *(1/20)+)	/ Г .					F 107 //
		DOCUMENT IF		TECN	COMMENT	· 105/
10 C 10-3	<u> </u>		01-5		\pm –	22(4.6)
<2.6 × 10 °	90	ALBRECHT	9 1B	ARG	$e \cdot e \rightarrow$	<i>I</i> (4S)
$\Gamma(K^0K^+K^-)/\Gamma_{tc}$	stal					Γ ₁₀₆ /
ALUE	<u>CL%</u>	DOCUMENT ID		TECN	COMMENT	22 (- 2)
<1.3 × 10 ⁵	90	ALBRECHT	91E	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$\left(K^{0}\phi \right) / \Gamma_{\text{total}}$						Γ ₁₀₇ /
/ALUE (units 10 ⁻⁰)	<u>CL%</u>	DOCUMENT ID		TECN	COMMENT	
$8.1^{+3.1}_{-2.5}\pm0.8$		²⁶⁷ AUBERT	01 D	BABR	$e^+e^- \rightarrow$	$\Upsilon(4S)$
• • We do not use	the following	ng data for averag	es, fits,	limits,	etc. ● ● ●	
< 12.3	90	²⁶⁷ BRIERE	01	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
< 31	90	²⁰⁷ BERGFELD	98	CLE2	1	
< 88	90	ASNER	96	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
< 720	90	ALBRECHT	91B	ARG	e^+e^\to	T(4S)
< 420	90	200 AVERY	89B	CLEO	$e^+e^- \rightarrow _\perp$	T(4S)
<1000	90	AVERY	87	CLEO	$e^+e^- \rightarrow$	r(4S)
 ¹⁰⁷ Assumes equal pr ¹⁶⁸ AVERY 89B repo rescale to 50%. ⁶⁹ AVERY 87 reports to 50%. 	oduction of rts $<$ 4.9 $>$ s $<$ 1.3 $ imes$ 10	B^+ and B^0 at the 10 ⁻⁴ assuming 0^{-3} assuming the	the $arphi(4)$ the $arphi$ arphi(4S)	S). (4 <i>S</i>) de decays	ecays 43% t 40% to B ⁰ 7	o B ⁰ B ⁰ . W 3 ⁰ . We resca
$\frac{-(\kappa^{-}\pi^{+}\pi^{+}\pi^{-})}{(\kappa^{-}\pi^{+}\pi^{+}\pi^{-})}$	T _{total}	DOCUMENT IT		TECN		۲ ₁₀₈ /۱
2 2 10=4	00	270 ADAM	060		comment	7
	90	andata for averan	90D	ULPH limita	$e \cdot e \rightarrow$	۷
	THE TOHOW/I	ig uata for averag	es, fits,	nnnts,	elc. 🛡 🛡 🛡	
• • VVe do not use		071				

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²⁷⁰ ADAM 96D assumes $f_{B^0} = f_{B^-} = 0.39$ and $f_{B_s} = 0.12$. Contributions from B^0 and B_s decays cannot be separated. Limits are given for the weighted average of the decay rates for the two neutral *B* mesons. 271 Assumes a B^0 , B^- production fraction of 0.39 and a B_s production fraction of 0.12.

²⁷¹ Assumes a B^0 , B^- production fraction of 0.39 and a B_s production fraction of 0.12. Contributions from B^0 and B_s^0 decays cannot be separated. Limits are given for the weighted average of the decay rates for the two neutral B mesons.

$\Gamma(K^*(892)^0\pi^+\pi^-)/$	Г _{total}					Г ₁₀₉ /Г
VALUE	<u>CL%</u>	DOCUMENT ID		TECN	<u>COMMENT</u>	
<1.4 × 10 ⁻³	90	ALBRECHT	91E	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$\Gamma(K^*(892)^0 ho^0)/\Gamma_{ m tota}$	al					Г ₁₁₀ /Г
VALUE	<u>CL%</u>	DOCUMENT ID		TECN	COMMENT	
$<3.4 \times 10^{-5}$	90 27	² GODANG	02	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
• • • We do not use the	following o	data for average	s, fits	, limits,	etc. • • •	
$< 2.86 \times 10^{-4}$	90 27	³ ABE	00 C	SLD	$e^+e^- \rightarrow$	Ζ
$< 4.6 \times 10^{-4}$	90	ALBRECHT	91 B	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$< 5.8 \times 10^{-4}$	90 27	⁴ AVERY	89 B	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$< 9.6 \times 10^{-4}$	90 27	⁵ AVERY	87	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
272 Assumes a helicity 00 to 2.4×10^{-5} . 273 ABE 00C assumes B $(39.7^{+1.8}_{-2.2})\%$ and f_B 274 AVERY 89B reports rescale to 50%. 275 AVERY 87 reports < to 50%.	$\begin{array}{l} \text{O configurat}\\ \text{G}(Z \rightarrow E)\\ \text{G}_{s} = (10.5 \frac{+}{-2})\\ < 6.7 \times 10\\ 1.2 \times 10^{-3} \end{array}$	tion. For a helic \overline{b} = (21.7 \pm 0. 1.8 2.2)%. 0 ⁻⁴ assuming the 7 ³ assuming the 7	ity 11 1)% :he γ ^(4 <i>S</i>)	configu and the (4 <i>S</i>) de decays	uration, the B fraction ecays 43% t 40% to $B^0\overline{I}$	limit decreases ins $f_{B^0} = f_{B^+} =$ to $B^0 \overline{B}^0$. We \overline{B}^0 . We rescale
$\Gamma(K^*(892)^0 f_0(980)))$	/Γ _{total}					Γ ₁₁₁ /Γ
VALUE	<u>CL%</u> 27	DOCUMENT ID		<u>TECN</u>	COMMENT	
<1.7 × 10 ⁻⁴	90 27	^o AVERY	89 B	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
²⁷⁶ AVERY 89B reports rescale to 50%.	< 2.0 × 1	0^{-4} assuming t	he γ	~(4 <i>S</i>) de	ecays 43% t	to B ⁰ B ⁰ . We
$\Gamma(K_1(1400)^+\pi^-)/\Gamma_t$	otal CL%	DOCUMENT ID		TECN	COMMENT	Γ ₁₁₂ /Γ
<1.1 × 10 ⁻³	90	ALBRECHT	91 B	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$

$\Gamma(K^{-}a_{1}(1260)^{+})/\Gamma_{\text{total}}$								
VALUE	<u>CL%</u>	DOCUMENT ID	TECN	COMMENT				
<2.3 × 10 ⁻⁴	90	²⁷⁷ ADAM	96D DLPH	$e^+e^- \rightarrow Z$				
• • • We do not use t	he follow	ing data for averages	s, fits, limits,	etc. • • •				
$< 3.9 \times 10^{-4}$	90	²⁷⁸ ABREU	95N DLPH	Sup. by ADAM	96D			

²⁷⁷ ADAM 96D assumes $f_{B^0} = f_{B^-} = 0.39$ and $f_{B_s} = 0.12$. Contributions from B^0 and B_s decays cannot be separated. Limits are given for the weighted average of the decay rates for the two neutral B mesons.

rates for the two neutral B mesons. 278 Assumes a B^0 , B^- production fraction of 0.39 and a B_s production fraction of 0.12. Contributions from B^0 and B_s^0 decays cannot be separated. Limits are given for the weighted average of the decay rates for the two neutral B mesons.

$\Gamma(K^*(892)^0 K^+ K^-)$	⁻)/Γ _{tota}	I				Г ₁₁₄ /Г
VALUE	<u>CL%</u>	DOCUMENT ID		TECN	<u>COMMENT</u>	
<6.1 × 10 ⁻⁴	90	ALBRECHT	91E	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$\Gamma(K^*(892)^0\phi)/\Gamma_{to}$	tal					Г ₁₁₅ /Г
VALUE (units 10^{-6})	<u>CL%</u>	DOCUMENT ID		TECN	COMMENT	
9.5 <mark>+2.4</mark> OUR AV	ERAGE					
$8.7^{+2.5}_{-2.1}{\pm}1.1$		²⁷⁹ AUBERT	01 D	BABR	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$11.5^{+4.5}_{-3.7}{}^{+1.8}_{-1.7}$		²⁷⁹ BRIERE	01	CLE2	$e^+ e^- \rightarrow$	$\Upsilon(4S)$
• • • We do not use t	he follow	ing data for average	s, fits	, limits,	etc. • • •	
<384	90	²⁸⁰ ABE	00C	SLD	$e^+e^- \rightarrow$	Ζ
< 21	90	²⁷⁹ BERGFELD	98	CLE2		
< 43	90	ASNER	96	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
<320	90	ALBRECHT	91 B	ARG	$e^+e^- \rightarrow$	$\hat{\Upsilon(4S)}$
<380	90	²⁸¹ AVERY	89B	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
<380	90	²⁸² AVERY	87	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
 ²⁸¹ AVERY 89B report rescale to 50%. ²⁸² AVERY 87 reports to 50%. 	ts < 4.4 < 4.7×1	$ imes 10^{-4}$ assuming t 0^{-4} assuming the 7	the Υ $\Upsilon(4S)$	(4 <i>S</i>) de	ecays 43% t 40% to B ⁰ I	o <i>B⁰ B</i> ⁰ . We 3 ⁰ . We rescale
	2) ²)/ ¹ to			TECN	COMMENT	· 116/ ·
<pre>////////////////////////////////////</pre>	00	283 CODANC	02		$\frac{COMMENT}{2}$	$\Upsilon(\Lambda S)$
• • • We do not use t	90 he follow	ing data for average	s, fits	, limits,	etc. • • •	7 (43)
$< 4.69 imes 10^{-4}$	90	²⁸⁴ ABE	00 C	SLD	$e^+ e^- \rightarrow$	Ζ
283 Assumes a helicity to 1.9×10^{-5} .	00 config	guration. For a helic	ity 11	configu	iration, the	limit decreases
²⁸⁴ ABE 00C assumes	s B(Z →	$\rightarrow b\overline{b} = (21.7 \pm 0.1)$	1)%	and the	e B fraction	is $f_{B^0} = f_{B^+} =$
$(39.7^{+1.0}_{-2.2})\%$ and	$f_{B_s} = (10.$	$(5^{+1.6}_{-2.2})\%$				
Γ(K*(892) ⁰ K*(892)	2) ⁰)/Γ _{tc}	otal				Г ₁₁₇ /Г
VALUE		DOCUMENT ID		TECN	COMMENT	
<3.7 × 10 ⁻⁵	90	²⁸⁵ GODANG	02	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
285 Assumes a helicity to $2.9\times10^{-5}.$	00 config	guration. For a helic	ity 11	configu	iration, the	limit decreases
Г(<i>K</i> *(892) ⁺ <i>K</i> *(89	2) [_])/Г	total				Г ₁₁₈ /Г
VALUE	<u>CL%</u>	DOCUMENT ID		TECN	COMMENT	
<1.41 × 10 ⁻⁴	90	²⁸⁶ GODANG	02	CLE2	$e^+ e^- \rightarrow$	$\Upsilon(4S)$
$\begin{array}{c} 286 \text{ Assumes a helicity} \\ \text{to } 8.9 \times 10^{-5}. \end{array}$	00 config	guration. For a helic	ity 11	configu	iration, the	limit decreases

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$\Gamma(K_1(1400)^0\rho^0)/\Gamma_{\rm tc}$	otal							Γ ₁	₁₁₉ /Г
VALUE	<u>CL%</u>	<u>D0</u>	CUMENT ID		TECN	COMME	ΝT		
<3.0 × 10 ⁻³	90	AL	BRECHT	91 B	ARG	e ⁺ e ⁻	\rightarrow	$\Upsilon(4S)$	
$\Gamma(K_1(1400)^0\phi)/\Gamma_{\text{tot}}$		00			TECN	COMM		۲	₁₂₀ /Г
VALUE	<u> </u>			010		<u>-+</u>		$\mathcal{C}(AC)$	
<5.0 × 10 °	90	AL	BRECHI	9 1B	ARG	e'e	\rightarrow	1 (45)	
$\Gamma(K_2^*(1430)^0\rho^0)/\Gamma_{\rm tr}$	otal							Γ	₁₂₁ /Г
VALUE	<u>CL%</u>	<u>D0</u>	CUMENT ID		TECN	COMME	INT		
$<1.1 \times 10^{-3}$	90	AL	BRECHT	91 B	ARG	e ⁺ e ⁻	\rightarrow	$\Upsilon(4S)$	
$\Gamma(\kappa_2^*(1430)^0\phi)/\Gamma_{to}$	tal							Г	₁₂₂ /Г
VALUE	<u>CL%</u>	<u>D0</u>	CUMENT ID		TECN	<u>COMME</u>	ΝT		
$<1.4 \times 10^{-3}$	90	AL	BRECHT	91 B	ARG	e ⁺ e ⁻	\rightarrow	$\Upsilon(4S)$	
$\Gamma(K^*(892)^0\gamma)/\Gamma_{tota}$	al							Γ	₁₂₃ /Г
VALUE (units 10^{-5})	CL%	EVTS	DOCU	MENT	ID	TECN	<u>C</u> 0	MMENT	
4.3 \pm 0.4 OUR A	VERAGE		207						
4.23±0.40±0.22			²⁸⁷ AUBE	RT	02C	BABR	e^+	$e^{-} \xrightarrow{\rightarrow} \Upsilon(4S)$	
$4.55^{+0.72}_{-0.68}{\pm}0.34$			²⁸⁸ COAN	١	00	CLE2	e^+	$e^{-} \rightarrow \Upsilon(4S)$	
• • • We do not use th	e followi	ng data	for average	es, fits	, limits,	etc. •	•	(-)	
< 21	90		289 ADAN	Л	96 D	DIPH	+م	-e- →	7
$4.0 \pm 1.7 \pm 0.8$	50	8	²⁹⁰ AMM	AR	93	CLE2	Re	epl. by	-
< 42	90		ALBR	ECHI	F 89g	ARG	e^+	COAN ($e^{-} \rightarrow$ $\Upsilon(AS)$	00
< 24	90		²⁹¹ AVER	Y	89 B	CLEO	e^+	$e^{-} \rightarrow \gamma(4S)$	
<210	90		AVER	Y	87	CLEO	e^+	$e^{-} \rightarrow \gamma$ $\Upsilon(4S)$	
²⁸⁷ Assumes equal prod ²⁸⁸ Assumes equal prod $K\pi\gamma$ contamination ²⁸⁹ ADAM 96D assumes	uction of uction of was see $f_{B^0} =$	FB^+ and FB^+ and FB^+ and $FB^-=0$	d B ⁰ at the d B ⁰ at the entral value D.39 and f _E	e $\Upsilon(4)$ e $\Upsilon(4)$ e assur $g_s=0$	S). S). No e mes no c).12.	evidence contami	e for natio	a nonres	sonant
²⁹⁰ AMMAR 93 observe ²⁹¹ AVERY 89B reports rescale to 50%.	ed 6.6 \pm 5 < 2.8 \times	2.8 ever × 10 ⁻⁴	nts above b assuming	ackgro $the~\gamma$	ound. `(4 <i>S</i>) de	cays 43	% t	o B ⁰ B ⁰). We
$\Gamma(K_{1270})_{0}/\Gamma$								Г	/ Г

$\Gamma(K_1(1270)^0\gamma)/\Gamma$	total				Г ₁₂₄ /Г
VALUE	<u>CL%</u>	DOCUMENT ID	TECN	<u>COMMENT</u>	
<0.0070	90	²⁹² ALBRECHT	89g ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
000					• •

 $^{292}\,{\sf ALBRECHT}$ 89G reports < 0.0078 assuming the $\varUpsilon(4S)$ decays 45% to $B^0\,\overline{B}{}^0.$ We rescale to 50%.

$\Gamma(K_1(1400)^0\gamma)/\Gamma_1$	total						Γ ₁₂₅ /Γ
VALUE	<u>CL%</u>		DOCUMENT ID		TECN	COMMENT	
<0.0043	90	293	ALBRECHT	89 G	ARG	$e^+ e^- \rightarrow$	$\Upsilon(4S)$
²⁹³ ALBRECHT 89G rescale to 50%.	reports $<$	0.00)48 assuming tl	he γ	(4 <i>S</i>) de	ecays 45% to	o B ⁰ B ⁰ . We
$\Gamma(K_2^*(1430)^0\gamma)/\Gamma_1$	total						Г ₁₂₆ /Г
VALUE	<u> </u>	204	DOCUMENT ID		<u>TECN</u>	COMMENT	
<4.0 × 10	90	294	ALBRECHT	89 G	ARG	$e^{-}e^{-} \rightarrow$	T(4S)
²⁹⁴ ALBRECHT 89G r rescale to 50%.	reports < 4	4.4 ×	10 ⁻⁴ assuming	g the	$\Upsilon(4S)$	decays 45%	to <i>B⁰ B⁰.</i> We
$\Gamma(K^*(1680)^0\gamma)/\Gamma_0$	total						Г ₁₂₇ /Г
VALUE	<u>CL%</u>	205	DOCUMENT ID		TECN	COMMENT	
<0.0020	90	295	ALBRECHT	89 G	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
²⁹⁵ ALBRECHT 89G rescale to 50%.	reports <	0.00)22 assuming tl	he γ	(4 <i>S</i>) de	ecays 45% to	o <i>B⁰ B</i> ⁰ . We
$\Gamma(K_3^*(1780)^0\gamma)/\Gamma_1$	total						Г ₁₂₈ /Г
VALUE	<u>CL%</u>	206	DOCUMENT ID		<u>TECN</u>	COMMENT	
<0.010	90	290	ALBRECHT	89 G	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
²⁹⁶ ALBRECHT 89G r to 50%.	eports < 0	0.011	assuming the γ	^(4 <i>S</i>)	decays	45% to <i>B⁰ E</i>	³⁰ . We rescale
$\Gamma(K_4^*(2045)^0\gamma)/\Gamma_1$	total				TECN	COMMENT	Г ₁₂₉ /Г
<u>VALUE</u>	00	297		800		$\frac{COMMENT}{2}$	$\Upsilon(\Lambda S)$
²⁹⁷ ALBRECHT 89G rescale to 50%.	90 reports <	0.00	ALBRECHT)48 assuming th	he Υ	(4 <i>S</i>) de	ere \rightarrow ecays 45% to	$B^0 \overline{B}^0$. We
$\Gamma(ho^0\gamma)/\Gamma_{ m total}$							Г ₁₃₀ /Г
<u>VALUE</u>	<u> </u>	208	DOCUMENT ID		<u>TECN</u>	COMMENT	
<1.7 × 10 ⁻⁵	90	290	COAN	00	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
²⁹⁸ Assumes equal pro	oduction o	f <i>B</i> +	and B^0 at the	Υ(4	·S).		
$\Gamma(\omega\gamma)/\Gamma_{total}$							Г ₁₃₁ /Г
VALUE	<u>CL%</u>	• • • •	DOCUMENT ID		TECN	COMMENT	
<0.92 × 10 ⁻⁵	90	299	COAN	00	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
²⁹⁹ Assumes equal pro	oduction o	f <i>B</i> +	and B^0 at the	$\Upsilon(4$	<i>S</i>).		
$\Gamma(\phi\gamma)/\Gamma_{total}$					TECH	601.41 FNT	Г ₁₃₂ /Г
<u>value</u>	<u> </u>	300	DOCUMENT ID	00		$\underline{COMMENT}$	$\mathcal{C}(AC)$
< U.35 X 10	90			00	CLE2	$e \cdot e \rightarrow$	1 (45)
Assumes equal pro	oduction o	f <i>B</i> +	and B [∪] at the	Υ(4	5).		

 $\Gamma(\pi^+\pi^-)/\Gamma_{\rm total}$ Γ_{133}/Γ VALUE (units 10^{-6}) CL% EVTS COMMENT TECN 4.4±0.9 OUR AVERAGE $5.6^{+2.3}_{-2.0}{}^{+0.4}_{-0.5}$ ³⁰¹ ABE 01H BELL $e^+e^- \rightarrow \Upsilon(4S)$ ³⁰¹ AUBERT 01E BABR $e^+e^- \rightarrow \Upsilon(4S)$ $4.1\!\pm\!1.0\!\pm\!0.7$ $4.3^{+1.6}_{-1.4}{\pm}0.5$ ³⁰¹ CRONIN-HEN..00 CLE2 $e^+e^- \rightarrow \Upsilon(4S)$ • • We do not use the following data for averages, fits, limits, etc. • ³⁰² ABE 90 00C SLD $e^+e^- \rightarrow Z$ < 67 Repl. by CRONIN-< 1590 GODANG 98 CLE2 HENNESSY 00 ³⁰³ ADAM < 45 90 96D DLPH $e^+e^- \rightarrow Z$ 96 CLE2 Repl. by GO-< 20 90 ASNER DANG 98 ³⁰⁴ BUSKULIC 96V ALEP < 41 90 $e^+e^- \rightarrow Z$ ³⁰⁵ ABREU < 55 90 95N DLPH Sup. by ADAM 96D ³⁰⁶ AKERS 94L OPAL $e^+e^- \rightarrow Z$ < 47 90 ³⁰⁷ BATTLE < 29 90 93 CLE2 $e^+e^- \rightarrow \Upsilon(4S)$ ³⁰⁷ ALBRECHT 90B ARG $e^+e^- \rightarrow \Upsilon(4S)$ <130 90 ³⁰⁸ BORTOLETTO89 CLEO < 77 90 $e^+e^ \rightarrow \Upsilon(4S)$ 308 BEBEK CLEO $e^+e^- \rightarrow \Upsilon(4S)$ 90 87 <260 90 4 GILES 84 CLEO $e^+e^- \rightarrow$ $\Upsilon(4S)$ < 500 301 Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$. 302 ABE 00C assumes B(Z $\rightarrow b\overline{b}$)=(21.7 \pm 0.1)% and the B fractions $f_{B^0} = f_{B^+} =$ $(39.7^{+1.8}_{-2.2})\%$ and $f_{B_e} = (10.5^{+1.8}_{-2.2})\%$. 303 ADAM 96D assumes $f_{B^0} = f_{B^-} = 0.39$ and $f_{B_s} = 0.12$. ³⁰⁴ BUSKULIC 96V assumes PDG 96 production fractions for B^0 , B^+ , B_s , b baryons. 305 Assumes a B^0 , B^- production fraction of 0.39 and a B_s production fraction of 0.12. ³⁰⁶ Assumes B($Z \rightarrow b\overline{b}$) = 0.217 and B_d^0 (B_s^0) fraction 39.5% (12%). ³⁰⁷ Assumes equal production of $B^0 \overline{B}{}^0$ and $B^+ B^-$ at $\Upsilon(4S)$. ³⁰⁸ Paper assumes the $\Upsilon(4S)$ decays 43% to $B^0\overline{B}^0$. We rescale to 50%. $\Gamma(\pi^+\pi^-)/\Gamma(K^+\pi^-)$ Γ_{133}/Γ_{88} <u>VAL</u>UE TECN COMMENT DOCUMENT ID $0.29\substack{+0.13 + 0.01 \\ -0.12 - 0.02}$ ³⁰⁹ ABE 01H BELL $e^+e^- \rightarrow \Upsilon(4S)$ 309 Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$. $\Gamma(\pi^0\pi^0)/\Gamma_{\rm total}$ Γ_{134}/Γ <u>V</u>ALUF CL% DOCUMENT ID TECN COMMENT $< 5.7 \times 10^{-6}$ ³¹⁰ ASNER 90 02 CLE2 $\rightarrow \Upsilon(4S)$ e^+ • • • We do not use the following data for averages, fits, limits, etc. $< 9.3 \times 10^{-6}$ 90 GODANG 98 CLE2 Repl. by ASNER 02 $< 0.91 \times 10^{-5}$ 90 ASNER 96 CLE2 Repl. by GODANG 98 $< 6.0 \times 10^{-5}$ ³¹¹ ACCIARRI 90 95H L3 $e^+e^- \rightarrow Z$ ³¹⁰ Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$. 311 ACCIARRI 95H assumes $f_{B^0}=$ 39.5 \pm 4.0 and $f_{B_s}=$ 12.0 \pm 3.0%. HTTP://PDG.LBL.GOV

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$\Gamma(\eta \pi^0) / \Gamma_{ ext{total}}$						Г ₁₃₅ /Г
VALUE E	<u>CL%</u>	DOCUMENT ID		TECN	COMMENT	
<2.9 × 10 ⁻⁰	90	³¹² RICHICHI	00	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
• • We do not use	the followir	ng data for average	s, fits	, limits,	, etc. ● ● ●	
$< 8 \times 10^{-6}$	90	BEHRENS	98	CLE2	Repl. by R	RICHICHI 00
$<2.5 \times 10^{-4}$	90	³¹³ ACCIARRI	95H	L3	$e^+e^- \rightarrow$	Ζ
$< 1.8 \times 10^{-3}$	90	³¹⁴ ALBRECHT	90 B	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
⁵¹² Assumes equal pro 5 ¹³ ACCIARRI 95н ass	oduction of sumes f _R 0	B^+ and B^0 at the = 39.5 \pm 4.0 and	e	<i>S</i>). = 12.0 <u>-</u>	± 3.0%.	
¹⁴ ALBRECHT 90в I	imit assum	es equal productio	n of B	0 <u> </u>	nd B^+B^- a	at $\Upsilon(4S)$.
$(\eta \eta) / \Gamma_{\text{total}}$						Г ₁₃₆ /Г
ALUE	<u>CL%</u>	DOCUMENT ID		TECN	COMMENT	•
<1.8 × 10 ⁻⁵	90	BEHRENS	98	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
• • We do not use	the followir	ng data for average	es, fits	, limits,	etc. • • •	()
$< 4.1 \times 10^{-4}$	90	315 ACCIARRI	95н	13	_+_− →	7
	50		ر د	10.0		Z
- ACCIARRI 95H as	sumes $^{T}B^{0}$	$= 39.5 \pm 4.0$ and	$B_s =$	= 12.0 =	± 3.0%.	
$(\eta' \pi^0) / \Gamma_{\text{total}}$						Г ₁₃₇ /Г
ALUE	<u>CL%</u>	DOCUMENT ID		<u>TECN</u>	<u>COMMENT</u>	
	00	³¹⁶ RICHICHI	00	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
<5.7 × 10 ^{—6}	90					
< 5.7 × 10⁻⁶ • • We do not use t	90 the followir	ng data for average	s, fits	, limits,	, etc. • • •	
<5.7 × 10⁻⁶ ••• We do not use $< 1.1 \times 10^{-5}$	90 the followir 90	ng data for average BEHRENS	s, fits 98	, limits, CLE2	, etc. ● ● ● Repl. by R	RICHICHI 00
<5.7 × 10⁻⁶ • • We do not use $< <1.1 \times 10^{-5}$	the followir 90	ng data for average BEHRENS B^+ and B^0 at the	es, fits 98 • 7(4	, limits, CLE2 S)	, etc. ● ● ● Repl. by R	RICHICHI 00
<5.7 × 10⁻⁶ • • We do not use $< 1.1 \times 10^{-5}$ $<^{16}$ Assumes equal pro-	90 the followir 90 oduction of	ng data for average BEHRENS B ⁺ and B ⁰ at the	es, fits 98 e γ(4	, limits, CLE2 <i>S</i>).	, etc. ● ● ● Repl. by R	RICHICHI 00
<5.7 × 10 ⁻⁶ • • We do not use $1 < 1.1 \times 10^{-5}$ 1^{16} Assumes equal prot $\Gamma(\eta'\eta')/\Gamma_{total}$	the followir 90 oduction of	ng data for average BEHRENS B ⁺ and B ⁰ at the	es, fits 98 e Υ(4	, limits, CLE2 <i>S</i>).	, etc. ● ● ● Repl. by R	аснісні 00 Г ₁₃₈ /Г
<5.7 × 10 ⁻⁶ • • We do not use 1.1×10^{-5} ¹⁶ Assumes equal pro $(\eta' \eta') / \Gamma_{total}$	90 the followir 90 oduction of <u>CL%</u>	ng data for average BEHRENS B ⁺ and B ⁰ at the <u>DOCUMENT ID</u>	es, fits 98 e Υ(4	, limits, CLE2 <i>S</i>). <u>TECN</u>	Repl. by R	пснісні 00 Г ₁₃₈ /Г
<5.7 × 10 ⁻⁶ • We do not use 1.1×10^{-5} ¹⁶ Assumes equal prot $(\eta' \eta') / \Gamma_{\text{total}}$ ALUE <4.7 × 10 ⁻⁵	the followir 90 oduction of <u>CL%</u> 90	ng data for average BEHRENS B ⁺ and B ⁰ at the <u>DOCUMENT ID</u> BEHRENS	es, fits 98 e Υ(4 98	, limits, CLE2 <i>S</i>). <u><i>TECN</i> CLE2</u>	Repl. by R $\frac{COMMENT}{e^+e^-} \rightarrow \frac{c}{e^+e^-} \rightarrow \frac{c}{e^+e^+} \rightarrow \frac{c}{e^+} \rightarrow \frac{c}$	Γ <mark>138</mark> /Γ Γ138
<5.7 × 10 ⁻⁶ • • We do not use γ <1.1 × 10 ⁻⁵ ³¹⁶ Assumes equal pro $\Gamma(\eta'\eta')/\Gamma_{total}$ ×4.7 × 10 ⁻⁵ $\Gamma(\eta'\eta)/\Gamma_{total}$	90 the followir 90 oduction of <u>CL%</u> 90	ng data for average BEHRENS B ⁺ and B ⁰ at the <u>DOCUMENT ID</u> BEHRENS	es, fits 98 e Υ(4 	, limits, CLE2 <i>S</i>). <u>TECN</u> CLE2	Repl. by R COMMENT $e^+e^- \rightarrow$	аснісні 00 Γ₁₃₈/Γ <i>Υ</i> (4 <i>S</i>) Γ₁₃₉/Γ
$ < 5.7 \times 10^{-6} $ • We do not use f $ < 1.1 \times 10^{-5} $ $ 316 Assumes equal product $ $ < (\eta' \eta') / \Gamma_{total} $ $ < 4.7 \times 10^{-5} $ $ < (\eta' \eta) / \Gamma_{total} $ $ < 4.7 \times 10^{-5} $ $ < (\eta' \eta) / \Gamma_{total} $ $ < 4.7 \times 10^{-5} $	90 the followir 90 oduction of <u>CL%</u> 90	ng data for average BEHRENS B ⁺ and B ⁰ at the <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u>	es, fits 98 e Υ(4 98	, limits, CLE2 S). <u>TECN</u> CLE2 <u>TECN</u>	etc. • • • Repl. by R COMMENT $e^+e^- \rightarrow$ COMMENT	richichi 00 Γ ₁₃₈ /Γ ^γ (4 <i>S</i>) Γ ₁₃₉ /Γ
<5.7 × 10 ⁻⁶ • • We do not use γ <1.1 × 10 ⁻⁵ ¹⁶ Assumes equal pro $(\eta' \eta') / \Gamma_{total}$ <u>ALUE</u> <4.7 × 10 ⁻⁵ $(\eta' \eta) / \Gamma_{total}$ <u>ALUE</u> <2.7 × 10 ⁻⁵	90 the followir 90 oduction of <u>CL%</u> 90 <u>CL%</u> 90	ng data for average BEHRENS B ⁺ and B ⁰ at the <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> BEHRENS	es, fits 98 e Υ(4 98 98 98	, limits, CLE2 <i>S</i>). <u><i>TECN</i></u> CLE2 <u><i>TECN</i></u> CLE2	etc. • • • Repl. by R $\frac{COMMENT}{e^+e^-} \rightarrow \frac{COMMENT}{e^+e^-} \rightarrow \frac{COMENT}{e^+e^-} \rightarrow \frac{COMENT}{e^+$	ειςμιςμι 00 Γ ₁₃₈ /Γ Γ ₁₃₉ /Γ Γ ₁₃₉ /Γ
<5.7 × 10 ⁻⁶ • • We do not use η <1.1 × 10 ⁻⁵ ¹⁶ Assumes equal pro- $(\eta'\eta')/\Gamma_{total}$ ×4.7 × 10 ⁻⁵ $(\eta'\eta)/\Gamma_{total}$ ×4.0E <2.7 × 10 ⁻⁵	90 the followir 90 oduction of <u>CL%</u> 90 <u>CL%</u> 90	ng data for average BEHRENS B^+ and B^0 at the <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> BEHRENS	es, fits 98 e $\Upsilon(4)$ 98 98 98	, limits, CLE2 <i>S</i>). <u><i>TECN</i></u> CLE2 <u><i>TECN</i></u> CLE2	retc. • • • Repl. by R $\frac{COMMENT}{e^+e^-} \rightarrow \frac{COMMENT}{e^+e^-} \rightarrow \frac{COMMENT}{e^+e^-} \rightarrow \frac{COMMENT}{e^+e^-}$	αιςμιςμι ου Γ <mark>138</mark> /Γ Υ(4 <i>S</i>) Γ 139 /Γ Υ(4 <i>S</i>)
<5.7 × 10 ⁻⁶ • • We do not use γ <1.1 × 10 ⁻⁵ ¹⁶ Assumes equal pro- $(\eta'\eta')/\Gamma_{total}$ ($\eta'\eta')/\Gamma_{total}$ <4.7 × 10 ⁻⁵ $(\eta'\eta)/\Gamma_{total}$ <2.7 × 10 ⁻⁵ $(\eta'\rho^0)/\Gamma_{total}$	90 the followir 90 oduction of <u>CL%</u> 90 <u>CL%</u> 90	ng data for average BEHRENS B^+ and B^0 at the <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> BEHRENS	es, fits 98 e $\Upsilon(4)989898$, limits, CLE2 S). <u>TECN</u> CLE2 <u>TECN</u> CLE2	etc. • • • Repl. by R $\frac{COMMENT}{e^+ e^- \rightarrow}$ $\frac{COMMENT}{e^+ e^- \rightarrow}$	RICHICHI 00 Γ₁₃₈/Γ <i>Υ</i> (4 <i>S</i>) Γ₁₃₉/Γ <i>Υ</i> (4 <i>S</i>) Γ₁₄₀/Γ
<5.7 × 10 ⁻⁶ • • We do not use γ <1.1 × 10 ⁻⁵ ¹⁶ Assumes equal pro- $(\eta' \eta') / \Gamma_{\text{total}}$ ($\eta' \eta) / \Gamma_{\text{total}}$ ($\eta' \eta) / \Gamma_{\text{total}}$ ($\eta' \rho^0) / \Gamma_{\text{total}}$	90 the followir 90 oduction of <u>CL%</u> 90 <u>CL%</u>	ng data for average BEHRENS B^+ and B^0 at the <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> BEHRENS	es, fits 98 e Υ(4 98 98 98	, limits, CLE2 S). <u>TECN</u> CLE2 <u>TECN</u> CLE2 <u>TECN</u>	etc. • • • Repl. by R COMMENT $e^+e^- \rightarrow$ COMMENT $e^+e^- \rightarrow$	RICHICHI 00 Γ₁₃₈/Γ <i>Υ</i> (4 <i>S</i>) Γ₁₃₉/Γ <i>Υ</i> (4 <i>S</i>) Γ₁₄₀/Γ
<5.7 × 10 ⁻⁶ • We do not use $\gamma^{(1.1 \times 10^{-5})}$ ¹⁶ Assumes equal pro- ($\eta' \eta'$)/ Γ_{total} <u>ALUE</u> <4.7 × 10 ⁻⁵ $(\eta' \rho)/\Gamma_{total}$ <u>ALUE</u> <2.7 × 10 ⁻⁵ $(\eta' \rho^0)/\Gamma_{total}$ <u>ALUE</u> <1.2 × 10 ⁻⁵	90 the followir 90 oduction of <u>CL%</u> 90 <u>CL%</u> 90 <u>CL%</u> 90	ng data for average BEHRENS B ⁺ and B ⁰ at the <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> 317 RICHICHI	es, fits 98 e $\Upsilon(4)$ 98 98 98 00	, limits, CLE2 S). <u>TECN</u> CLE2 <u>TECN</u> CLE2 <u>TECN</u> CLE2	retc. • • • Repl. by R $e^+e^- \rightarrow$ $\frac{COMMENT}{e^+e^- \rightarrow}$ $\frac{COMMENT}{e^+e^- \rightarrow}$	RICHICHI 00 Γ ₁₃₈ /Γ Υ(4S) Γ ₁₃₉ /Γ Υ(4S) Γ ₁₄₀ /Γ Υ(4S)
<5.7 × 10 ⁻⁶ • We do not use f <1.1 × 10 ⁻⁵ ¹⁶ Assumes equal pro- $(\eta'\eta')/\Gamma_{total}$ <u>ALUE</u> <4.7 × 10 ⁻⁵ $(\eta'\eta)/\Gamma_{total}$ <u>ALUE</u> <2.7 × 10 ⁻⁵ $(\eta'\rho^0)/\Gamma_{total}$ <u>ALUE</u> <1.2 × 10 ⁻⁵ • We do not use f	the followir 90 oduction of <u>CL%</u> 90 <u>CL%</u> 90 <u>CL%</u> 90 the followir	ng data for average BEHRENS B ⁺ and B ⁰ at the <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> 317 RICHICHI ng data for average	es, fits 98 e $\Upsilon(4)$ 98 98 98 98 00 es, fits	, limits, CLE2 S). <u>TECN</u> CLE2 <u>TECN</u> CLE2 <u>TECN</u> CLE2 , limits,	retc. • • • Repl. by R $\frac{COMMENT}{e^+e^-} \rightarrow \frac{COMMENT}{e^+e^-} \rightarrow \frac{COMENT}{e^+e^-} \rightarrow \frac{COMENT}{$	RICHICHI 00 Γ₁₃₈/Γ <i>Υ</i> (4 <i>S</i>) Γ₁₃₉/Γ <i>Υ</i> (4 <i>S</i>) Γ₁₄₀/Γ <i>Υ</i> (4 <i>S</i>)
<5.7 × 10 ⁻⁶ • • We do not use γ <1.1 × 10 ⁻⁵ ¹⁶ Assumes equal pro- ($\eta' \eta'$)/ Γ_{total} ($\eta' \eta$)/ Γ_{total} ($\eta' \eta$)/ Γ_{total} ($\eta' \rho^0$)/ Γ_{total}	90 the followir 90 oduction of <u>CL%</u> 90 <u>CL%</u> 90 the followir 90	ng data for average BEHRENS B ⁺ and B ⁰ at the <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> BEHRENS 317 RICHICHI ng data for average BEHRENS	es, fits 98 e $\Upsilon(4)$ 98 98 98 00 es, fits 98	, limits, CLE2 S). <u>TECN</u> CLE2 <u>TECN</u> CLE2 <u>TECN</u> CLE2 , limits, CLE2	etc. • • • Repl. by R $\frac{COMMENT}{e^+e^-} \rightarrow$ $\frac{COMMENT}{e^+e^-} \rightarrow$ etc. • • • Repl. by R	RICHICHI 00 Γ₁₃₈/Γ <i>Υ</i> (4 <i>S</i>) Γ₁₃₉/Γ <i>Υ</i> (4 <i>S</i>) Γ₁₄₀/Γ <i>Υ</i> (4 <i>S</i>) RICHICHI 00
<5.7 × 10 ⁻⁶ • • We do not use f <1.1 × 10 ⁻⁵ ¹⁶ Assumes equal pro- $(\eta' \eta')/\Gamma_{total}$ $(\eta' \eta)/\Gamma_{total}$ $(\eta' \rho)/\Gamma_{total}$ $(\eta' \rho^0)/\Gamma_{total}$ $(\eta' \rho^0)/\Gamma_{total}$	the followir 90 oduction of <u>CL%</u> 90 <u>CL%</u> 90 <u>CL%</u> 90 the followir 90	ng data for average BEHRENS B ⁺ and B ⁰ at the <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> BEHRENS <u>317 RICHICHI</u> ng data for average BEHRENS B ⁺ and B ⁰ at th	es, fits 98 $e \Upsilon(4)$ 98 98 98 98 00 e, fits 98 $e \Upsilon(4)$, limits, CLE2 S). <u>TECN</u> CLE2 <u>TECN</u> CLE2 , limits, CLE2 S)	retc. • • • Repl. by R $\frac{COMMENT}{e^+e^-} \rightarrow$ $\frac{COMMENT}{e^+e^-} \rightarrow$ $\frac{COMMENT}{e^+e^-} \rightarrow$ retc. • • • Repl. by R	RICHICHI 00 Γ₁₃₈/Γ <i>τ</i> (4 <i>S</i>) Γ₁₃₉/Γ <i>τ</i> (4 <i>S</i>) Γ₁₄₀/Γ <i>τ</i> (4 <i>S</i>) RICHICHI 00
<5.7 × 10 ⁻⁶ • • We do not use γ <1.1 × 10 ⁻⁵ ¹⁶ Assumes equal pro- $(\eta'\eta')/\Gamma_{total}$ <u>ALUE</u> <4.7 × 10 ⁻⁵ $(\eta'\eta)/\Gamma_{total}$ <u>ALUE</u> <2.7 × 10 ⁻⁵ $(\eta'\rho^0)/\Gamma_{total}$ <u>ALUE</u> <1.2 × 10 ⁻⁵ • • We do not use γ <2.3 × 10 ⁻⁵ ¹⁷ Assumes equal pro-	the followir 90 oduction of <u>CL%</u> 90 <u>CL%</u> 90 <u>CL%</u> 90 the followir 90 oduction of	ng data for average BEHRENS B^+ and B^0 at the <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> 317 RICHICHI ng data for average BEHRENS B^+ and B^0 at the	es, fits 98 $e \Upsilon(4)$ 98 98 98 98 00 $e \Upsilon(4)$, limits, CLE2 S). <u>TECN</u> CLE2 <u>TECN</u> CLE2 , limits, CLE2 S).	retc. • • • Repl. by R $\frac{COMMENT}{e^+e^-} \rightarrow$ $\frac{COMMENT}{e^+e^-} \rightarrow$ $\frac{COMMENT}{e^+e^-} \rightarrow$ retc. • • • Repl. by R	RICHICHI 00 Γ₁₃₈/Γ <i>Υ</i> (4 <i>S</i>) Γ₁₃₉/Γ <i>Υ</i> (4 <i>S</i>) Γ₁₄₀/Γ <i>Υ</i> (4 <i>S</i>) RICHICHI 00
<5.7 × 10 ⁻⁶ • • We do not use f <1.1 × 10 ⁻⁵ ³¹⁶ Assumes equal pro- $(\eta' \eta')/\Gamma_{total}$ (ALUE) <4.7 × 10 ⁻⁵ $(\eta' \rho^0)/\Gamma_{total}$ (ALUE) <2.7 × 10 ⁻⁵ $(\eta' \rho^0)/\Gamma_{total}$ (ALUE) <2.3 × 10 ⁻⁵ • • We do not use f <2.3 × 10 ⁻⁵ ³¹⁷ Assumes equal pro- $(\eta \rho^0)/\Gamma_{total}$	the followir 90 oduction of <u>CL%</u> 90 <u>CL%</u> 90 <u>CL%</u> 90 the followir 90 oduction of	ng data for average BEHRENS B ⁺ and B ⁰ at the <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> 317 RICHICHI ng data for average BEHRENS B ⁺ and B ⁰ at the	es, fits 98 $rac{}{}$ $\gamma(4)$ 98 98 98 00 rs, fits 98 $rac{}{}$ $\gamma(4)$, limits, CLE2 <i>S</i>). <u>TECN</u> CLE2 <u>TECN</u> CLE2 , limits, CLE2 <i>S</i>).	retc. • • • Repl. by R $\frac{COMMENT}{e^+e^-} \rightarrow$ $\frac{COMMENT}{e^+e^-} \rightarrow$ $\frac{COMMENT}{e^+e^-} \rightarrow$ retc. • • • Repl. by R	RICHICHI 00 Γ₁₃₈/Γ <i>τ</i> (4 <i>S</i>) Γ₁₃₉/Γ <i>τ</i> (4 <i>S</i>) Γ₁₄₀/Γ <i>τ</i> (4 <i>S</i>) RICHICHI 00 Γ₁₄₁/Γ
<5.7 × 10 ⁻⁶ • • We do not use f <1.1 × 10 ⁻⁵ ³¹⁶ Assumes equal pro- $(\eta' \eta')/\Gamma_{total}$ ALUE <4.7 × 10 ⁻⁵ $(\eta' \eta)/\Gamma_{total}$ ALUE <2.7 × 10 ⁻⁵ $(\eta' \rho^0)/\Gamma_{total}$ <u>ALUE</u> <1.2 × 10 ⁻⁵ • • We do not use f <2.3 × 10 ⁻⁵ ³¹⁷ Assumes equal pro- $(\eta \rho^0)/\Gamma_{total}$ <i>ALUE</i>	90 the followir 90 oduction of <u>CL%</u> 90 <u>CL%</u> 90 the followir 90 oduction of <u>CL%</u>	ng data for average BEHRENS B ⁺ and B ⁰ at the <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> 317 RICHICHI ng data for average BEHRENS B ⁺ and B ⁰ at the <u>DOCUMENT ID</u>	es, fits 98 r (4 98 98 98 98 00 es, fits 98 e Υ (4	, limits, CLE2 <i>S</i>). <u><i>TECN</i></u> CLE2 <u><i>TECN</i></u> CLE2 , limits, CLE2 <i>S</i>). <u><i>TECN</i></u>	retc. • • • Repl. by R $\frac{COMMENT}{e^+e^-} \rightarrow$ $\frac{COMMENT}{e^+e^-} \rightarrow$ $\frac{COMMENT}{e^+e^-} \rightarrow$ retc. • • • Repl. by R $\frac{COMMENT}{e^+e^-} \rightarrow$	RICHICHI 00 Γ₁₃₈/Γ <i>Υ</i> (4 <i>S</i>) Γ₁₃₉/Γ <i>Υ</i> (4 <i>S</i>) Γ₁₄₀/Γ <i>Υ</i> (4 <i>S</i>) RICHICHI 00 Γ₁₄₁/Γ
$ < 5.7 \times 10^{-6} $ • We do not use f $ < 1.1 \times 10^{-5} $ $ < 1.1 \times 10^{-5} $ $ < 16 Assumes equal product of the second prod$	the followir 90 90 90 90 90 <u>CL%</u> 90 <u>CL%</u> 90 the followir 90 90 90 90 90 90 90 10 10 10 10 10 10 10 10 10 1	ng data for average BEHRENS B ⁺ and B ⁰ at the <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> 317 RICHICHI ng data for average BEHRENS B ⁺ and B ⁰ at the <u>DOCUMENT ID</u> 318 RICHICHI	es, fits 98 $e \Upsilon(4)$ 98 98 98 98 98 00 es, fits 98 $e \Upsilon(4)$ 00	, limits, CLE2 <i>S</i>). <u>TECN</u> CLE2 <u>TECN</u> CLE2 , limits, CLE2 <i>S</i>). <u>TECN</u> CLE2	retc. • • • Repl. by R $\frac{COMMENT}{e^+e^-} \rightarrow \frac{COMMENT}{e^+e^-} \rightarrow \frac{COMENT}{e^+e^-} \rightarrow \frac{COMENT}{e^+e^-}$	RICHICHI 00 Γ_{138}/Γ $\tau(45)$ Γ_{139}/Γ $\tau(45)$ Γ_{140}/Γ $\tau(45)$ RICHICHI 00 Γ_{141}/Γ $\tau(45)$
$ < 5.7 \times 10^{-6} $ • We do not use f $ < 1.1 \times 10^{-5} $ $ S16 Assumes equal products a sequence of the sequence of the$	the followir 90 pduction of CL% 90 CL% 90 CL% 90 the followir 90 pduction of CL% 90 the followir 90 pduction of CL% 90 the followir	ng data for average BEHRENS B ⁺ and B ⁰ at the <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> 317 RICHICHI ng data for average BEHRENS B ⁺ and B ⁰ at the <u>DOCUMENT ID</u> 318 RICHICHI ng data for average	es, fits 98 $e \Upsilon(4)$ 98 98 98 98 98 00 es, fits 98 $e \Upsilon(4)$ 00 es, fits 98 $e \Upsilon(4)$, limits, CLE2 <i>S</i>). <u>TECN</u> CLE2 <u>TECN</u> CLE2 , limits, CLE2 <i>S</i>). <u>TECN</u> CLE2 <i>S</i>).	retc. • • • Repl. by R $\frac{COMMENT}{e^+e^-} \rightarrow$ $\frac{COMMENT}{e^+e^-} \rightarrow$ retc. • • • Repl. by R $\frac{COMMENT}{e^+e^-} \rightarrow$ retc. • • •	RICHICHI 00 Γ_{138}/Γ $\tau(45)$ Γ_{139}/Γ $\tau(45)$ Γ_{140}/Γ $\tau(45)$ RICHICHI 00 Γ_{141}/Γ $\tau(45)$
<5.7 × 10 ⁻⁶ ••• We do not use f <1.1 × 10 ⁻⁵ ³¹⁶ Assumes equal pro- $(\eta' \eta')/\Gamma_{total}$ ALUE <4.7 × 10 ⁻⁵ $(\eta' \rho)/\Gamma_{total}$ ALUE <2.7 × 10 ⁻⁵ $(\eta' \rho^0)/\Gamma_{total}$ ALUE <1.2 × 10 ⁻⁵ •• We do not use f <2.3 × 10 ⁻⁵ ³¹⁷ Assumes equal pro- $(\eta \rho^0)/\Gamma_{total}$ <u>ALUE</u> <1.0 × 10 ⁻⁵ •• We do not use f <1.3 × 10 ⁻⁵	the followir 90 pduction of CL% 90 CL% 90 CL% 90 CL% 90 the followir 90 pduction of CL% 90 pduction of CL% 90 pduction of 0	ng data for average BEHRENS B^+ and B^0 at the <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> BEHRENS <u>DOCUMENT ID</u> 317 RICHICHI ng data for average BEHRENS B^+ and B^0 at the <u>DOCUMENT ID</u> 318 RICHICHI ng data for average BEHRENS	es, fits 98 $e \Upsilon(4)$ 98 98 98 98 98 98 $e \Upsilon(4)$ 00 $e \Upsilon(4)$ 00 $e \Upsilon(4)$ 00 rs, fits 98	, limits, CLE2 <i>S</i>). <u><i>TECN</i></u> CLE2 <u><i>TECN</i></u> CLE2 , limits, CLE2 <i>S</i>). <u><i>TECN</i></u> CLE2 <i>S</i>). <i>TECN</i> CLE2 <i>S</i>).	retc. • • • Repl. by R COMMENT $e^+e^- \rightarrow$ COMMENT $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ retc. • • • Repl. by R COMMENT $e^+e^- \rightarrow$ retc. • • • Repl. by R	RICHICHI 00 Γ_{138}/Γ $\tau(4S)$ Γ_{139}/Γ $\tau(4S)$ Γ_{140}/Γ $\tau(4S)$ RICHICHI 00 Γ_{141}/Γ $\tau(4S)$ RICHICHI 00

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$\Gamma(\omega\eta)/\Gamma_{\rm total}$							Г ₁₄₂ /Г
VALUE	<u>CL%</u>		DOCUMENT ID		TECN		•
<1.2 × 10 ⁻⁵	90	319	BERGFELD	98	CLE2		
³¹⁹ Assumes equal prod	uction o	f <i>B</i> +	and B^0 at the	e Υ(4	1 <i>5</i>).		
$\Gamma(\omega\eta')/\Gamma_{ m total}$							Г ₁₄₃ /Г
VALUE	<u>CL%</u>		DOCUMENT ID		TECN		
<6.0 × 10 ⁻⁵	90	320	BERGFELD	98	CLE2		
³²⁰ Assumes equal prod	uction o	f <i>B</i> +	and B^0 at the	e Υ(4	4 <i>5</i>).		
$\Gamma(\omega ho^0) / \Gamma_{ m total}$							Г ₁₄₄ /Г
VALUE	<u>CL%</u>		DOCUMENT ID		TECN		
<1.1 × 10 ⁻⁵	90	321	BERGFELD	98	CLE2		
³²¹ Assumes equal prod	uction o	f <i>B</i> +	and B^0 at the	e Υ(4	4 <i>5</i>).		
$\Gamma(\omega\omega)/\Gamma_{total}$							Г ₁₄₅ /Г
VALUE	<u>CL%</u>		DOCUMENT ID		TECN		
<1.9 × 10 ⁻⁵	90	322	BERGFELD	98	CLE2		
³²² Assumes equal prod	uction o	f <i>B</i> +	and B^0 at the	e Υ(4	1 <i>5</i>).		
$\Gamma(\phi \pi^0) / \Gamma_{total}$							Г ₁₄₆ /Г
VALUE	<u>CL%</u>		DOCUMENT ID		TECN		
<0.5 × 10 ⁻⁵	90	323	BERGFELD	98	CLE2		
³²³ Assumes equal prod	uction o	f <i>B</i> +	and B^0 at the	e Υ(4	1 <i>5</i>).		
$\Gamma(\phi\eta)/\Gamma_{total}$							Г ₁₄₇ /Г
VALUE _	<u>CL%</u>		DOCUMENT ID		TECN		
<0.9 × 10 ^{—5}	90	324	BERGFELD	98	CLE2		
³²⁴ Assumes equal prod	uction o	f <i>B</i> +	and B^0 at the	e Υ(4	1 <i>5</i>).		
$\Gamma(\phi\eta')/\Gamma_{ ext{total}}$							Г ₁₄₈ /Г
VALUE	<u>CL%</u>		DOCUMENT ID		TECN		
<3.1 × 10 ⁻⁵	90	325	BERGFELD	98	CLE2		
³²⁵ Assumes equal prod	uction o	f <i>B</i> +	and B^0 at the	e Υ(4	1 <i>5</i>).		
$\Gamma(\phi ho^0) / \Gamma_{ m total}$							Г ₁₄₉ /Г
VALUE	<u>CL%</u>		DOCUMENT ID		TECN	COMMENT	
$<1.3 \times 10^{-5}$	90 s fallowi	326 ing d	BERGFELD	98	CLE2		
• • • vve do not use th $(1 - 4)$		111g a 327	ata ior average	s, rits	s, mnits,		
<1.50 × 10	90	521	ABE	UUC	. SLD	$e \cdot e \rightarrow Z$	
³²⁰ Assumes equal prod	uction o	f <i>B</i> +	and B^0 at the	e Υ(4	1 <i>S</i>).		
ABE 00C assumes	$B(Z \rightarrow$	· b	$b)=(21.7 \pm 0.0)$	1)%	and the	e <i>B</i> fractions <i>f</i>	$B^{0}=f_{B^{+}}=$
$(39.7^{+1.8}_{-2.2})\%$ and f_{1}	$B_s = (10.$	5^{+1}_{-2}	⁸)%.				

$\Gamma(\phi\omega)/\Gamma_{ ext{total}}$						Γ ₁₅₀ /	Γ
VALUE	<u>CL%</u>		DOCUMENT ID		TECN		
<2.1 × 10 ⁻⁵	90	328	BERGFELD	98	CLE2		
³²⁸ Assumes equal produc	ction of	B+	and B^0 at the	Υ(4	S).		
$\Gamma(\phi\phi)/\Gamma_{ m total}$						Γ ₁₅₁ /	Γ
VALUE	<u>CL%</u>		DOCUMENT ID		TECN	COMMENT	_
$<1.2 \times 10^{-5}$	90	329	BERGFELD	98	CLE2		
• • • We do not use the	followi	ng d	ata for averages	, fits,	limits,	etc. • • •	_
$<3.21 \times 10^{-4}$	90	330	ABE	00 C	SLD	$e^+e^- \rightarrow Z$	
$< 3.9 \times 10^{-5}$	90		ASNER	96	CLE2	$e^+e^- ightarrow ~\Upsilon(4S)$	
³²⁹ Assumes equal produc	ction of	B+	and B^0 at the	$\Upsilon(4)$	<i>S</i>).		
³³⁰ ABE 00C assumes E	$B(Z \rightarrow$	b	$\overline{b}){=}(21.7 \pm 0.1$.)% :	and the	B fractions $f_{R0} = f_{R+}$	=
$(39.7^{+1.8}_{-2.2})\%$ and f_B	_=(10.5	5^{+1}_{-2}	. ⁸ 2)%.				
	5	2	• –			_	- -
$ (\pi^+\pi^-\pi^0)/ _{total}$						l ₁₅₂ /	
VALUE	<u>CL%</u>	221	DOCUMENT ID		TECN	COMMENT	_
<7.2 × 10 ⁻⁴	90	331	ALBRECHT	90 B	ARG	$e^+e^- ightarrow ~\Upsilon(4S)$	
³³¹ ALBRECHT 90B limi	t assum	es e	qual production	of B	0 <u> </u>	d $B^+ B^-$ at $\Upsilon(4S)$.	
$\Gamma(ho^0 \pi^0) / \Gamma_{ m total}$						Γ ₁₅₃ /	Γ
VALUE	<u>CL%</u>		DOCUMENT ID		TECN	COMMENT	_
<5.5 × 10 ⁻⁶	90	186	JESSOP	00	CLE2	$e^+e^- ightarrow ~\Upsilon(4S)$	
\bullet \bullet \bullet We do not use the	followi	ng d	ata for averages	, fits,	limits,	etc. • • •	
$< 2.4 imes 10^{-5}$	90		ASNER	96	CLE2	Repl. by JESSOP 00	
$< 4.0 \times 10^{-4}$	90	332	ALBRECHT	90 B	ARG	$e^+e^- \rightarrow \Upsilon(4S)$	
332 ALBRECHT 90B limit	t assum	es e	qual production	of B	$0\overline{B}^0$ and	d $B^+ B^-$ at $\Upsilon(4S)$.	
$\Gamma(ho^{\mp}\pi^{\pm})/\Gamma_{total}$						Г ₁₅₄ /	Γ
VALUE (units 10^{-5})	CL%		DOCUMENT IL)	TECN	COMMENT	
$2.76^{+0.84}_{-0.74}\pm 0.42$	_	3	³³ JESSOP	00) CLE2	$\frac{1}{2} e^+e^- \rightarrow \Upsilon(4S)$	
• • • We do not use the	followi	ng d	ata for averages	, fits,	limits,	etc. ● ● ●	
< 8.8	90		ASNER	96	5 CLE2	Repl. by JESSOP 00	1
< 52	90	3	³⁴ ALBRECHT	90)b ARG	$e^+e^- \rightarrow \Upsilon(4S)$	
<520	90	3	³⁵ BEBEK	87	7 CLE	$D e^+e^- \rightarrow \Upsilon(4S)$	
333 Assumes equal produc	ction of	B+	and B^0 at the	$\gamma(4$	S).	× /	
³³⁴ ALBRECHT 90B limit	t assum	es e	qual production	of B	0 <u>7</u> 0 an	d B^+B^- at $\Upsilon(4S)$.	
³³⁵ BEBEK 87 reports <	6.1×10^{-10})-3	assuming the γ	(4 <i>S</i>)	decays	43% to $B^0 \overline{B}^0$. We resca	le

to 50%.

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$\Gamma(\pi^+\pi^-\pi^+\pi^-)/\Gamma_{\text{tot}}$	al _{CL%}	DOCUMENT	ID	TECN	COMMENT	Г ₁₅₅ /Г
<2.3 × 10 ⁻⁴	90	336 ADAM	96 D	DLPH	$e^+e^- \rightarrow$	Z
• • We do not use the	followin	ng data for avera	ages, fits	, limits,	etc. • • •	_
$< 2.8 \times 10^{-4}$	90	³³⁷ ABREU	95N	DLPH	Sup. bv A[DAM 96D
$< 6.7 \times 10^{-4}$	90	338 ALBRECH	Г 90в	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
336 ADAM 96D assumes	$f_{\mathbf{D}0} = \mathbf{f}$	$f_{\rm D} = 0.39$ and	$f_{P} = 0$).12.		
$337 \Delta_{\text{ssumes a}} B^0 B^-$ n	B ⁰ roducti	B^-	0 ₅ 30 and a	B pro	duction frac	tion of 0.12
³³⁸ ALBRECHT 90B limit	t assum	es equal product	tion of B	$B^0 \overline{B}^0$ ar	and B^+B^- a	t $\Upsilon(4S)$.
$\Gamma(\rho^0 \rho^0) / \Gamma_{\text{total}}$						Г ₁₅₆ /Г
VALUE	<u>CL%</u>	<u>DOCUMENT</u>	ID	TECN	COMMENT	
<1.8 × 10 ⁻⁵	90	³³⁹ GODANG	02	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$\bullet \bullet \bullet$ We do not use the	followin	ng data for avera	ages, fits	, limits,	etc. • • •	
${<}1.36\times10^{-4}$	90	³⁴⁰ ABE	00 C	SLD	$e^+e^- \rightarrow$	Ζ
$< 2.8 \times 10^{-4}$	90	³⁴¹ ALBRECHT	Г 90 в	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$<2.9 \times 10^{-4}$	90	342 BORTOLE	TTO89	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$<4.3 \times 10^{-4}$	90	³⁴² BEBEK	87	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
³³⁹ Assumes a helicity 00 to 1.4×10^{-5} .	configu	uration. For a he	elicity 11	configu	iration, the l	imit decreases
³⁴⁰ ABE 00C assumes E $(39.7^{+1.8}_{-2.2})\%$ and f_B	$B(Z \rightarrow = (10.5)$	$b\overline{b})=(21.7 \pm 5^{+1.8})\%.$	0.1)%	and the	B fraction	s $f_{B^0} = f_{B^+} =$
341 ALBRECHT 90B limit	s t assum	es equal product	tion of B	$0 \overline{B}^0$ ar	nd B^+B^- a	t $\Upsilon(4S)$.
342 Paper assumes the γ	(4 <i>S</i>) de	ecays 43% to B^0	\overline{B}^0 . We	rescale	to 50%.	
$\Gamma(a_1(1260)^{\mp}\pi^{\pm})/\Gamma_{to}$	tal	DOCUMENT		TECN	COMMENT	Г ₁₅₇ /Г
$\frac{VALUE}{40 \times 10^{-4}}$	<u>CL%</u>	343 PODTOLE				$\Upsilon(AC)$
• • • We do not use the	followin	ng data for avera	ages, fits	, limits,	$e \cdot e \rightarrow$ etc. • • •	1 (43)
$< 6.3 \times 10^{-4}$	90	344 ALBRECHT	С 90 _В	ARG	_+	$\Upsilon(45)$
$< 0.5 \times 10^{-3}$	90	³⁴³ BEBEK	87	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
343 Paper assumes the γ	(15) da	$A_{20} = -2.1$		rescale	to 50%	()
³⁴⁴ ALBRECHT 90B limit	t assum	es equal product	tion of B	$10^{10} B^{0}$ ar	$d B^+ B^- a$	t $\Upsilon(4S)$.
$\Gamma(a_2(1320)^{\mp}\pi^{\pm})/\Gamma_{to}$	tal					Г ₁₅₈ /Г
VALUE	<u>CL%</u>	DOCUMENT	ID	TECN	COMMENT	
<3.0 × 10 ⁻⁴	90	345 BORTOLE	TTO89	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
• • • vve do not use the	TOHOWI	ng data for avera	ages, fits	, limits,	etc. • • •	
$<1.4 \times 10^{-3}$	90	³⁴⁵ BEBEK	87	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
345 Paper assumes the $ \Upsilon$	(4 <i>S</i>) de	ecays 43% to B^0	\overline{B}^0 . We	rescale	to 50%.	
$\Gamma(\pi^+\pi^-\pi^0\pi^0)/\Gamma_{\rm tota}$	I					Г ₁₅₉ /Г
VALUE	<u>CL%</u>	DOCUMENT	ID	TECN	COMMENT	
$<3.1 \times 10^{-5}$	90	³⁴⁰ ALBRECH	Г 90 В	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
346 ALBRECHT 90B limit	t assum	es equal product	tion of <i>B</i>	r ⁰ B ⁰ ar	nd B^+B^- a	t $\Upsilon(4S)$.

 $\Gamma(\rho^+\rho^-)/\Gamma_{\text{total}}$ Γ_{160}/Γ TECN COMMENT $< 2.2 \times 10^{-3}$ 347 ALBRECHT 90 90B ARG $e^+e^- \rightarrow \Upsilon(4S)$ ³⁴⁷ ALBRECHT 90B limit assumes equal production of $B^0 \overline{B}{}^0$ and $B^+ B^-$ at $\Upsilon(4S)$. $\Gamma(a_1(1260)^0 \pi^0) / \Gamma_{\text{total}}$ Γ_{161}/Γ VALUE TECN COMMENT $< 1.1 \times 10^{-3}$ 348 ALBRECHT 90 90B ARG $e^+e^- \rightarrow \Upsilon(4S)$ ³⁴⁸ ALBRECHT 90B limit assumes equal production of $B^0 \overline{B}{}^0$ and $B^+ B^-$ at $\Upsilon(4S)$. $\Gamma(\omega \pi^0) / \Gamma_{\text{total}}$ Γ_{162}/Γ VALUE DOCUMENT ID CL% TECN COMMENT ³⁴⁹ AUBERT $<3 \times 10^{-6}$ 01G BABR $e^+e^- \rightarrow \Upsilon(4S)$ 90 • • • We do not use the following data for averages, fits, limits, etc. • • • ³⁴⁹ JESSOP 00 CLE2 $< 5.5 \times 10^{-6}$ 90 $e^+e^- \rightarrow \Upsilon(4S)$ ³⁴⁹ BERGFELD $< 1.4 \times 10^{-5}$ 90 98 CLE2 Repl. by JESSOP 00 $< 4.6 \times 10^{-4}$ ³⁵⁰ ALBRECHT 90 90B ARG $e^+e^- \rightarrow \Upsilon(4S)$ 349 Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$. 350 ALBRECHT 90B limit assumes equal production of $B^0 \overline{B}{}^0$ and $B^+ B^-$ at $\Upsilon(4S)$. $\Gamma(\pi^+\pi^+\pi^-\pi^-\pi^0)/\Gamma_{\rm total}$ Γ_{163}/Γ VALUE DOCUMENT ID TECN COMMENT ³⁵¹ ALBRECHT $< 9.0 \times 10^{-3}$ 90 90B ARG $e^+e^- \rightarrow \Upsilon(4S)$ ³⁵¹ALBRECHT 90B limit assumes equal production of $B^0 \overline{B}{}^0$ and $B^+ B^-$ at $\Upsilon(4S)$. $\Gamma(a_1(1260)^+\rho^-)/\Gamma_{\text{total}}$ Γ_{164}/Γ TECN COMMENT VALUE DOCUMENT ID $<3.4 \times 10^{-3}$ ³⁵² ALBRECHT 90b ARG 90 $e^+e^- \rightarrow \Upsilon(4S)$ ³⁵²ALBRECHT 90B limit assumes equal production of $B^0 \overline{B}{}^0$ and $B^+ B^-$ at $\Upsilon(4S)$. $\Gamma(a_1(1260)^0 \rho^0) / \Gamma_{\text{total}}$ Γ_{165}/Γ VALUE TECN COMMENT DOCUMENT ID $< 2.4 \times 10^{-3}$ ³⁵³ ALBRECHT $e^+e^- \rightarrow \Upsilon(4S)$ 90 90b ARG ³⁵³ALBRECHT 90B limit assumes equal production of $B^0 \overline{B}{}^0$ and $B^+ B^-$ at $\Upsilon(4S)$. $\Gamma(\pi^+\pi^+\pi^+\pi^-\pi^-\pi^-)/\Gamma_{\text{total}}$ Γ_{166}/Γ DOCUMENT ID TECN COMMENT VALUE ³⁵⁴ ALBRECHT $e^+e^- \rightarrow \Upsilon(4S)$ $< 3.0 \times 10^{-3}$ 90 90B ARG ³⁵⁴ ALBRECHT 90B limit assumes equal production of $B^0 \overline{B}{}^0$ and $B^+ B^-$ at $\Upsilon(4S)$. $\Gamma(a_1(1260)^+ a_1(1260)^-) / \Gamma_{\text{total}}$ Γ_{167}/Γ VALUE DOCUMENT ID TECN COMMENT CL% $< 2.8 \times 10^{-3}$ ³⁵⁵ BORTOLETTO89 CLEO $e^+e^- \rightarrow \Upsilon(4S)$ 90 • • • We do not use the following data for averages, fits, limits, etc. • • • ³⁵⁶ ALBRECHT $< 6.0 \times 10^{-3}$ 90 90b ARG $e^+e^- \rightarrow \Upsilon(4S)$ ³⁵⁵BORTOLETTO 89 reports $< 3.2 \times 10^{-3}$ assuming the $\Upsilon(4S)$ decays 43% to $B^0 \overline{B}^0$. We rescale to 50%. ³⁵⁶ ALBRECHT 90B limit assumes equal production of $B^0 \overline{B}{}^0$ and $B^+ B^-$ at $\Upsilon(4S)$. HTTP://PDG.LBL.GOV Page 50 Created: 12/2/2002 16:13

$\Gamma(\pi^+\pi^+\pi^+\pi^-\pi^-)$	$(-\pi^{-}\pi^{0})/$	ΊΓ _{total}			Г ₁₆₈ /Г
VALUE	<u>CL%</u>	DOCUMENT ID	TECN	COMMENT	
<1.1 × 10 ⁻²	90	³⁵⁷ ALBRECHT	90b ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
357 ALBRECHT 90B	limit assun	nes equal production	of $B^0 \overline{B}{}^0$ ar	nd B^+B^- a	t $\Upsilon(4S)$.

$\Gamma(p\overline{p})/\Gamma_{total}$						Г ₁₆₉ /Г
VALUE	<u>CL%</u>	DOCUMENT ID		TECN	COMMENT	
<7.0 × 10 ⁻⁶	90	³⁵⁸ COAN	99	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
\bullet \bullet \bullet We do not use the	followi	ng data for averages,	fits,	limits,	etc. • • •	
$< 1.8 imes 10^{-5}$	90	³⁵⁹ BUSKULIC	96v	ALEP	$e^+e^- \rightarrow$	Ζ
$< 3.5 \times 10^{-4}$	90	³⁶⁰ ABREU	95N	DLPH	Sup. by AE	DAM 96D
$< 3.4 \times 10^{-5}$	90	361 BORTOLETTO	89	CLEO	$e^+ e^- \rightarrow$	$\Upsilon(4S)$
$< 1.2 \times 10^{-4}$	90	³⁶² ALBRECHT	88F	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$< 1.7 \times 10^{-4}$	90	³⁶¹ BEBEK	87	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$

³⁵⁸ Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$.

 359 BUSKULIC 96V assumes PDG 96 production fractions for B^0 , B^+ , B_s , b baryons.

³⁶⁰ Assumes a B^0 , B^- production fraction of 0.39 and a B_s production fraction of 0.12.

³⁶¹ Paper assumes the $\Upsilon(4S)$ decays 43% to $B^0\overline{B}^0$. We rescale to 50%. ³⁶² ALBRECHT 88F reports $< 1.3 \times 10^{-4}$ assuming the $\Upsilon(4S)$ decays 45% to $B^0\overline{B}^0$. We rescale to 50%.

$\Gamma(p\overline{p}\pi^+\pi^-)/\Gamma_{\text{total}}$

Γ₁₇₀/Γ

VALUE (units 10^{-4})	CL%	DOCUMENT ID		TECN	COMMENT
<2.5	90	363 BEBEK	89	CLEO	$e^+e^- \rightarrow \Upsilon(4S)$
$\bullet \bullet \bullet$ We do not use the	followi	ng data for averages	, fits	, limits,	etc. • • •
<9.5	90	³⁶⁴ ABREU	95N	DLPH	Sup. by ADAM 96D
$5.4 \pm 1.8 \pm 2.0$		³⁶⁵ ALBRECHT	88F	ARG	$e^+e^- ightarrow ~\Upsilon(4S)$
262		4			0-0

 363 BEBEK 89 reports $< 2.9 \times 10^{-4}$ assuming the $\Upsilon(4S)$ decays 43% to $B^0 \overline{B}^0$. We rescale to 50%. 364 Assumes a B^0 , B^- production fraction of 0.39 and a B_s production fraction of 0.12.

 365 ALBRECHT 88F reports 6.0 \pm 2.0 \pm 2.2 assuming the $\Upsilon(4S)$ decays 45% to $B^0\overline{B}^0$. We rescale to 50%.

$\Gamma(p\overline{\Lambda}\pi^{-})/\Gamma_{\text{total}}$

 Γ_{171}/Γ

(.)/						=.=/
VALUE	CL%	DOCUMENT ID		TECN	<u>COMMENT</u>	
<1.3 × 10 ⁻⁵	90	³⁶⁶ COAN	99	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
• • • We do not use the	follow	ing data for averages	, fits,	limits,	etc. • • •	
$< 1.8 \times 10^{-4}$	90	³⁶⁷ ALBRECHT	88F	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
³⁶⁶ Assumes equal produ	ction o	f B^+ and B^0 at the	$\Upsilon(4)$	<i>S</i>).		
267			. (-).		0-0

 367 ALBRECHT 88F reports $< 2.0 imes 10^{-4}$ assuming the $\Upsilon(4S)$ decays 45% to $B^0 \overline{B}^0$. We rescale to 50%.

$\Gamma(\overline{\Lambda}\Lambda)/\Gamma_{\text{total}}$						Г ₁₇₂ /Г
VALUE	<u>CL%</u>	DOCUMENT ID		TECN	<u>COMMENT</u>	
<3.9 × 10 ⁻⁶	90	³⁶⁸ COAN	99	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
³⁶⁸ Assumes equal pr	oduction o	f B^+ and B^0 at the	r(4	<i>S</i>).		

						Г ₁₇₃ /Г
<u>CL%</u>	<u>1</u>	DOCUMENT ID		TECN	COMMENT	
90	369	BORTOLETT	089	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
eports -	< 0.00	18 assuming γ	^(4 <i>S</i>)	decays	43% to B ⁰ I	3 ⁰ . We rescale
CI 9/		DOCUMENT ID		TECN	COMMENT	Г ₁₇₄ /Г
00	370 -		000		$\frac{COMMENT}{a^+a^-}$	$\Upsilon(AC)$
90	. 1 0				$e \cdot e \rightarrow$	(43)
eports	< 1.3	× 10 · assum	ning	7 (45) c	lecays 43%	to B° B°. We
				TECN	COMMENT	Г ₁₇₅ /Г
<u>CL%</u>	371	DOCUMENT ID	04		$\frac{COMMENT}{2}$	$\gamma(AC)$
90			94		$e \cdot e \rightarrow$	7 (43)
ts < 0	.0012	for $B(\Lambda_{c}^{+} \rightarrow$	pK⁻	$(\pi^{+}) =$	0.043. We	rescale to our
pK ⁻	π ⁺) =	= 0.050.				
I						Г ₁₇₆ /Г
	<u>-</u>	DOCUMENT ID		TECN	COMMENT	
	372	FU	97	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
values	of Λ_c	branching frac	tion.			
						Г ₁₇₇ /Г
<u>CL%</u>	<u>.</u>	DOCUMENT ID		TECN	COMMENT	,
90	373	FU	97	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
values	of Λ_c	branching ratio	Э.			
						Г ₁₇₈ /Г
<u>CL%</u>	<u></u>	DOCUMENT ID		TECN	COMMENT	
90	374	FU	97	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
values	of Λ_c	branching ratio	Э.			
otal						Г ₁₇₉ /Г
<u>CL%</u>		DOCUMENT ID		TECN	<u>COMMENT</u>	
90	375	FU	97	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
values	of Λ_c	branching ratio	э.			
)/Γ _{tot}	al					Г ₁₈₀ /Г
<u>CL%</u>	276	DOCUMENT ID		<u>TECN</u>	COMMENT	
90	5/0	FU	97	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
values	of Λ_c	branching ratio	э.			
	$\frac{CL\%}{90}$ $\frac{CL\%}{90}$ eports $\frac{CL\%}{90}$ eports $\frac{CL\%}{90}$ $\frac{CL\%}{90}$ values	$\frac{CL\%}{90} = 369$ $\frac{90}{369}$ $\frac{90}{369}$ $\frac{6}{369}$ $\frac{6}{369}$ $\frac{6}{369}$ $\frac{6}{369}$ $\frac{6}{369}$ $\frac{6}{370}$ $\frac{6}{90} = 370$ $\frac{6}{90} = 373$ $\frac{6}{90} = 374$ $\frac{6}{90} = 374$ $\frac{6}{90} = 375$ $\frac{6}{90} = 376$	$\frac{CL\%}{90} \frac{DOCUMENT ID}{369} \frac{DOCUMENT ID}{BORTOLETTO}$ $\frac{CL\%}{90} \frac{DOCUMENT ID}{370} \frac{DOCUMENT ID}{BORTOLETTO}$ $\frac{CL\%}{90} \frac{DOCUMENT ID}{371} \frac{DOCUMENT ID}{PROCARIO}$ $\frac{CL\%}{90} \frac{T}{371} \frac{DOCUMENT ID}{PROCARIO}$ $\frac{DOCUMENT ID}{372} \frac{T}{FU}$ values of Λ_c branching frace $\frac{CL\%}{90} \frac{DOCUMENT ID}{373} \frac{DOCUMENT ID}{FU}$ values of Λ_c branching ratio $\frac{CL\%}{90} \frac{T}{375} \frac{DOCUMENT ID}{FU}$ values of Λ_c branching ratio $\frac{CL\%}{90} \frac{T}{375} \frac{DOCUMENT ID}{FU}$ values of Λ_c branching 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\frac{DOCUMENT ID}{373 \text{ FU} 97}$ $\frac{CL\%}{90} \frac{DOCUMENT ID}{374 \text{ FU} 97}$ $\frac{OCUMENT ID}{90} \frac{374 \text{ FU} 97}{7}$ $\frac{OCUMENT ID}{90} \frac{375 \text{ FU} 97}{7}$ $\frac{OCUMENT ID}{90} \frac{375 \text{ FU} 97}{7}$ $\frac{OCUMENT ID}{90} \frac{OCUMENT ID}{375 \text{ FU} 97}$ $\frac{OCUMENT ID}{90} \frac{OCUMENT ID}{375 \text{ FU} 97}$ $\frac{OCUMENT ID}{90} \frac{OCUMENT ID}{375 \text{ FU} 97}$ $\frac{OCUMENT ID}{90} \frac{OCUMENT ID}{90$	$\frac{CL\%}{90} \frac{DOCUMENT ID}{369} \frac{TECN}{\text{BORTOLETTO89} CLEO}$ $\frac{CL\%}{90} \frac{DOCUMENT ID}{370} \frac{TECN}{\text{BORTOLETTO89} CLEO}$ $\frac{CL\%}{90} \frac{DOCUMENT ID}{370} \frac{TECN}{\text{BORTOLETTO89} CLEO}$ $\frac{CL\%}{90} \frac{DOCUMENT ID}{371} \frac{TECN}{\text{PROCARIO} 94} CLE2$ $\frac{CL\%}{90} \frac{371}{97} \frac{DOCUMENT ID}{\text{PROCARIO} 94} \frac{TECN}{\text{CLE2}}$ $\frac{CL\%}{372} FU \qquad 97 \text{ CLE2}$ $\frac{CL\%}{90} \frac{DOCUMENT ID}{373} \frac{TECN}{FU} \qquad 97 \text{ CLE2}$ $\frac{CL\%}{90} \frac{DOCUMENT ID}{374} \frac{TECN}{FU} \qquad 97 \text{ CLE2}$ $\frac{CL\%}{90} \frac{DOCUMENT ID}{374} \frac{TECN}{FU} \qquad 97 \text{ CLE2}$ $\frac{CL\%}{90} \frac{374}{75} \frac{DOCUMENT ID}{FU} \qquad 7ECN}{90} \frac{TECN}{75} \frac{DOCUMENT ID}{70} \frac{TECN}{\text{CLE2}}$ $\frac{CL\%}{90} \frac{374}{375} \frac{DOCUMENT ID}{FU} \qquad 97 \text{ CLE2}$ $\frac{CL\%}{90} \frac{375}{75} \frac{DOCUMENT ID}{75} \frac{TECN}{70} \frac{TECN}{70} \frac{10}{70} \frac{TECN}{70}$ $\frac{CL\%}{90} \frac{376}{75} \frac{DOCUMENT ID}{70} \frac{TECN}{70} \frac{7ECN}{70} \frac{10}{70} \frac{7ECN}{70}$ $\frac{CL}{10} \frac{10}{90} \frac{TECN}{75} \frac{10}{70} \frac{97}{70} \frac{7ECN}{70} \frac{10}{70} \frac{10}{70} \frac{7ECN}{70} \frac{10}{70} 10$	$\begin{array}{cccc} \underline{CL\%} & \underline{DOCUMENT \ ID} & \underline{TECN} & \underline{COMMENT} \\ 90 & 369 & \text{BORTOLETTO89} & \text{CLEO} & e^+e^- \rightarrow \\ \text{eports} < 0.0018 & \text{assuming} \ \mathcal{T}(4S) & \text{decays} \ 43\% & \text{to} \ B^0 \overline{R} \\ \hline \underline{CL\%} & \underline{DOCUMENT \ ID} & \underline{TECN} & \underline{COMMENT} \\ 90 & 370 & \text{BORTOLETTO89} & \text{CLEO} & e^+e^- \rightarrow \\ \text{eports} < 1.3 \times 10^{-4} & \text{assuming} \ \mathcal{T}(4S) & \text{decays} \ 43\% \\ \hline \underline{CL\%} & \underline{DOCUMENT \ ID} & \underline{TECN} & \underline{COMMENT} \\ 90 & 371 & \text{PROCARIO} & 94 & \text{CLE2} & e^+e^- \rightarrow \\ \text{ts} < 0.0012 & \text{for} \ B(\Lambda_c^+ \rightarrow pK^-\pi^+) = 0.043. \ \text{We} \\ pK^-\pi^+) = 0.050. \\ \hline \underline{DOCUMENT \ ID} & \underline{TECN} & \underline{COMMENT} \\ \hline \underline{OOCUMENT \ ID} & \underline{TECN} & \underline{COMMENT} \\ 372 & \text{FU} & 97 & \text{CLE2} & e^+e^- \rightarrow \\ \text{values of} \ \Lambda_c \ \text{branching fraction.} \\ \hline \underline{CL\%} & \underline{DOCUMENT \ ID} & \underline{TECN} & \underline{COMMENT} \\ 90 & 373 & \text{FU} & 97 & \text{CLE2} & e^+e^- \rightarrow \\ \text{values of} \ \Lambda_c \ \text{branching ratio.} \\ \hline \underline{CL\%} & \underline{DOCUMENT \ ID} & \underline{TECN} & \underline{COMMENT} \\ 90 & 374 & \text{FU} & 97 & \text{CLE2} & e^+e^- \rightarrow \\ \text{values of} \ \Lambda_c \ \text{branching ratio.} \\ \hline \underline{CL\%} & \underline{DOCUMENT \ ID} & \underline{TECN} & \underline{COMMENT} \\ 90 & 375 & \text{FU} & 97 & \text{CLE2} & e^+e^- \rightarrow \\ \text{values of} \ \Lambda_c \ \text{branching ratio.} \\ \hline \underline{OCUMENT \ ID} & \underline{TECN} & \underline{COMMENT} \\ 90 & 375 & \text{FU} & 97 & \text{CLE2} & e^+e^- \rightarrow \\ \text{values of} \ \Lambda_c \ \text{branching ratio.} \\ \hline \underline{O\Gamma} \ \underline{DOCUMENT \ ID} & \underline{TECN} & \underline{COMMENT} \\ 90 & 376 & \text{FU} & 97 & \text{CLE2} & e^+e^- \rightarrow \\ \text{values of} \ \Lambda_c \ \text{branching ratio.} \\ \hline \underline{O\Gamma} \ \underline{OCUMENT \ ID} & \underline{TECN} & \underline{COMMENT} \\ 90 & 376 & \text{FU} & 97 & \text{CLE2} & e^+e^- \rightarrow \\ \text{values of} \ \Lambda_c \ \text{branching ratio.} \\ \hline \underline{O\Gamma} \ \underline{OCUMENT \ ID} & \underline{TECN} & \underline{COMMENT} \\ \underline{OOCUMENT \ ID} & \underline{OOCUMENT \ ID} & \underline{TCN} & \underline{COMMENT} \\ \underline{OOCUMENT \ ID} & \underline{OCUMENT \ ID} &$

$(\gamma\gamma)/\Gamma_{total}$							Г ₁₈₁ /Г
ALUE	<u>CL%</u>	07 -	DOCUMENT ID		TECN	COMMENT	
(1.7 × 10 ^{—6}	90	377	AUBERT	011	BABR	$e^+e^- \rightarrow$	$\Upsilon(4S)$
• • We do not use t	the follow	ing da	ata for average	s, fits	, limits,	etc. • • •	
(3.9×10^{-5})	90	378	ACCIARRI	95ı	L3	$e^+e^- \rightarrow$	Ζ
⁷⁷ Assumes equal pro	duction o	f <i>B</i> +	and B^0 at the	$\gamma(4$	<i>S</i>).		
⁷⁸ ACCIARRI 951 assi	umes f _B 0	= 39	$0.5~\pm$ 4.0 and f	$B_s =$	12.0 ±	3.0%.	
$(e^+e^-)/\Gamma_{\text{total}}$	1 weak ne	eutral	current. Allow	/ed by	higher	-order electr	F₁₈₂/F
tions.	CI %			j	TECN	COMMENT	
<u>10-</u> 7	00	379		000			$\gamma(\Lambda S)$
• • We do not use t	90 the follow	ing da	ata for average	s, fits	, limits,	etc. • • •	1 (43)
(1.4×10^{-5})	90	380	ACCIARRI	97 B	13	$e^+e^- \rightarrow$	7
(5.9×10^{-6})	90		AMMAR	94	CLE2	Repl. by	-
	00	381		005		BERGF	ELD 00B
(2.6×10^{-5})	90	382	AVERY	89B		$e^+e^- \rightarrow e^+e^-$	T(4S)
(7.0×10^{-5})	90	383		01U 07		$e^+e^- \rightarrow$	T(45)
(0.4×10^{-1})	90			01 0л		$e \cdot e \rightarrow$	1 (43)
	90		GILES	04	CLEO	Repl. by P	
(3 × 10 ⁻⁺ ⁷⁹ Assumes equal pro ³⁰ ACCIARRI 97B ass ³¹ AVERY 89B report to 50%	oduction o sume PDC ss < 3 × 10	f B+ 5 96 p 0 ⁻⁵ a	and B^0 at the production fractors γ	$\Upsilon(4)$ tions $\Gamma(4S)$	S). for B ⁺ , decays	B ⁰ , B _s , ar 43% to B ⁰ I	nd A _b . 3 ⁰ . We rescale
 × 10⁻⁺ Assumes equal prc ACCIARRI 97B ass AVERY 89B report to 50%. ALBRECHT 87D r rescale to 50%. AVERY 87 reports to 50%. 	oduction o sume PDC ss $< 3 \times 10^{10}$ reports $< 5 < 8 \times 10^{10}$	$f B^+$ 3 96 p $0^{-5} a$ $8.5 \times 10^{-5} a$	and B^0 at the production fract assuming the γ 10^{-5} assuming ssuming the γ	$rac{}{2} \Upsilon(4)$ tions $\Gamma(4S)$ g the (4S)	S). for B^+ , decays γ $\Upsilon(4S)$ decays γ	B ⁰ , B _s , ar 43% to B ⁰ 7 decays 45% 40% to B ⁰⁷	ad Λ_b . \overline{B}^0 . We rescale to $B^0 \overline{B}^0$. We \overline{B}^0 . We rescale
⁽³ × 10 ⁻⁺ ⁷⁹ Assumes equal pro ³⁰ ACCIARRI 97B ass ³¹ AVERY 89B report to 50%. ³² ALBRECHT 87D r rescale to 50%. ³³ AVERY 87 reports to 50%. $(\mu^+\mu^-)/\Gamma_{total}$ Test for $\Delta B =$ tions.	oduction of sume PDC $r < 3 \times 10^{\circ}$ reports $< 3 \times 10^{\circ}$ $r < 8 \times 10^{\circ}$ 1 weak ne	f B^+ G 96 p 0^{-5} 8.5 × 1^{-5} a eutral	and B^0 at the production fract assuming the γ 10^{-5} assuming ssuming the γ current. Allow	$refree \Upsilon(4)$ tions $refree \Upsilon(4S)$ g the $(4S)$	S). for B^+ , decays $\Upsilon(4S)$ decays higher	B^0 , B_s , ar 43% to $B^0\overline{D}$ decays 45% 40% to $B^0\overline{D}$ -order electr	Ind Λ_b . \overline{B}^0 . We rescale to $B^0 \overline{B}^0$. We \overline{B}^0 . We rescale Γ_{183}/Γ roweak interac-
(3 × 10 ⁻⁺ ⁷⁹ Assumes equal pro ³⁰ ACCIARRI 97B as: ³¹ AVERY 89B report to 50%. ³² ALBRECHT 87D r rescale to 50%. ³³ AVERY 87 reports to 50%. $(\mu^+\mu^-)/\Gamma_{total}$ Test for $\Delta B =$ tions. <u>NUUE</u>	bduction o sume PDC $cs < 3 \times 10^{\circ}$ reports $< -3 \times 10^{\circ}$ $cs < 8 \times 10^{\circ}$ 1 weak no $cc = -\frac{CL\%}{200}$	f B^+ $5 96 \text{ p}_{0}^{-5}$ $8.5 \times \text{p}^{-5}$ p^{-5} a eutral 384	and B^0 at the production fract assuming the γ 10^{-5} assuming ssuming the γ current. Allow <u>DOCUMENT ID</u>	$rac{2}{2} \Upsilon(4$ tions $rac{2}{2}$ (4S) g the $(4S)$ wed by $rac{2}{2}$	S). for B^+ , decays $\Upsilon(4S)$ decays higher <u>TECN</u>	B^{0} , B_{s} , ar 43% to $B^{0}\overline{D}$ decays 45% 40% to $B^{0}\overline{D}$ -order electr <u>COMMENT</u>	Ind Λ_b . \overline{B}^0 . We rescale to $B^0\overline{B}^0$. We \overline{B}^0 . We rescale Γ_{183}/Γ roweak interac-
(3 × 10 ⁻⁺ ⁷⁹ Assumes equal pro ³⁰ ACCIARRI 97B as: ³¹ AVERY 89B report to 50%. ³² ALBRECHT 87D r rescale to 50%. ³³ AVERY 87 reports to 50%. $(\mu^+\mu^-)/\Gamma_{total}$ Test for $\Delta B =$ tions. <u>NUUE</u> (6.1 × 10 ⁻⁷ • We do not use to the set of	boduction of sume PDC is $< 3 \times 10^{10}$ reports $< 3 \times 10^{10}$ $3 < 8 \times 10^{10}$ 1 weak not 1 weak not 90^{10}	$\begin{array}{c} f B^+ \\ 5 96 \\ p \\ 0^{-5} \\ a \\ a \\ b \\$	and B^0 at the production fract assuming the γ 10^{-5} assuming ssuming the γ current. Allow <u>DOCUMENT ID</u> BERGFELD	$rac{}{} r(4$ tions $rac{}{}$ (4S) g the (4S) (4S) ved by ued by ued by	S). for B^+ , decays $\Upsilon(4S)$ decays higher <u>TECN</u> CLE2 limits	B^{0} , B_{s} , ar 43% to $B^{0}\overline{B}$ decays 45% 40% to $B^{0}\overline{B}$ -order electr $\underline{COMMENT}$ $e^{+}e^{-} \rightarrow$	and Λ_b . \overline{B}^0 . We rescale to $B^0 \overline{B}^0$. We \overline{B}^0 . We rescale Γ_{183}/Γ roweak interac- $\widehat{T}(4S)$
(3 × 10 ⁻⁺ ⁷⁹ Assumes equal pro ³⁰ ACCIARRI 97B ass ³¹ AVERY 89B report to 50%. ³² ALBRECHT 87D r rescale to 50%. ³³ AVERY 87 reports to 50%. $(\mu^+\mu^-)/\Gamma_{total}$ Test for $\Delta B =$ tions. <u>AVER</u> (6.1 × 10 ⁻⁷ • We do not use for the formation of the for	bduction o sume PDC $cs < 3 \times 10^{-10}$ reports $< -10^{-10}$ $cs < 8 \times 10^{-10}$ 1 weak no -10^{-10} g_0 the follow	f B^+ $5 96 \text{ g}_0^-5$ $8.5 \times$ 9^-5 a_0^-5 eutral 384 ing da	and B^0 at the production fract assuming the γ 10^{-5} assuming ssuming the γ current. Allow <u>DOCUMENT ID</u> BERGFELD ata for averages	$e \Upsilon(4 \\ \text{tions})$ $f(4S)$ $g \text{ the}$ $(4S)$ $/ed \text{ by}$ $00B$ s, fits	S). for B^+ , decays $\Upsilon(4S)$ decays decays $\frac{TECN}{CLE2}$, limits,	B^{0}, B_{s}, ar $43\% \text{ to } B^{0}\overline{B}$ $decays 45\%$ $40\% \text{ to } B^{0}\overline{B}$ $-order electric \frac{COMMENT}{e^{+}e^{-}} \rightarrow etc. \bullet \bullet$	Ind Λ_b . \overline{B}^0 . We rescale to $B^0 \overline{B}^0$. We \overline{B}^0 . We rescale Γ_{183}/Γ roweak interac- $\Upsilon(4S)$
(3 × 10 ⁻⁺ ⁷⁹ Assumes equal pro ³⁰ ACCIARRI 97B ass ³¹ AVERY 89B report to 50%. ³² ALBRECHT 87D r rescale to 50%. ³³ AVERY 87 reports to 50%. $(\mu^+\mu^-)/\Gamma_{total}$ Test for $\Delta B =$ tions. <u>AUUE</u> 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50 50	boduction of sume PDC is $< 3 \times 10^{10}$ eports $< 3 \times 10^{10}$ $< 8 \times 10^{10}$ 1 weak not $= \frac{CL\%}{90}$ the follow 90 00^{10}	$f B^+$ $5 96 r$ $0^{-5} a^{-5}$ $1^{-5} a^{-5}$ 384 384 384 385	and B^0 at the production fract assuming the γ 10^{-5} assuming ssuming the γ current. Allow <u>DOCUMENT ID</u> BERGFELD ata for averages ABBOTT	$e \Upsilon(4)$ tions $\Upsilon(4S)$ g the (4S) $(4S)$ $(4S)$ $00B$ s, fits 98B	S). for B^+ , decays $\Upsilon(4S)$ decays decays $\frac{TECN}{CLE2}$, limits, D0	$B^{0}, B_{s}, \text{ ar}$ $43\% \text{ to } B^{0}\overline{B}$ $decays 45\%$ $40\% \text{ to } B^{0}\overline{B}$ $eorder \text{ electric}$ $\frac{COMMENT}{e^{+}e^{-}} \rightarrow$ $etc. \bullet \bullet$ $p\overline{p} 1.8 \text{ Te}$	and Λ_b . $\overline{B^0}$. We rescale to $B^0 \overline{B^0}$. We $\overline{B^0}$. We rescale Γ_{183}/Γ roweak interac- $\Upsilon(4S)$
(3 × 10 ⁻⁺ ⁷⁹ Assumes equal pro ³⁰ ACCIARRI 97B ass ³¹ AVERY 89B report to 50%. ³² ALBRECHT 87D r rescale to 50%. ³³ AVERY 87 reports to 50%. ($\mu^+\mu^-$)/ Γ_{total} Test for $\Delta B =$ tions. <u>AUUE</u> (6.1 × 10 ⁻⁷ • We do not use for (4.0 × 10 ⁻⁵ (6.8 × 10 ⁻⁷ 1.0 × 10 ⁻⁵	boduction of sume PDC is $< 3 \times 10^{10}$ reports $< 3 \times 10^{10}$ $3 < 8 \times 10^{10}$ 1 weak ne $2 = \frac{CL\%}{90}$ the follow 90 90 90 90	f B^+ 5 96 r 0^{-5} 8.5 × 1^{-5} a eutral 384 ing da 385 386	and B^0 at the production fract assuming the γ 10^{-5} assuming ssuming the γ current. Allow <u>DOCUMENT ID</u> BERGFELD ata for averages ABBOTT ABE	r (4) $r (4S)$	S). for B^+ , decays $T(4S)$ decays $T(4S)$ decays $T(4S)$ decays $T(4S)$ decays $T(4S)$ decays $T(4S)$ decays $T(4S)$ decays $T(4S)$ decays $T(4S)$	B^{0} , B_{s} , ar 43% to $B^{0}\overline{P}$ decays 45% 40% to $B^{0}\overline{P}$ -order electr COMMENT $e^{+}e^{-} \rightarrow$ etc. • • • $p\overline{p}$ 1.8 Te ³ $p\overline{p}$ at 1.8 $e^{+}e^{-}$	and Λ_b . $\overline{B^0}$. We rescale to $B^0 \overline{B^0}$. We $\overline{B^0}$. We rescale Γ_{183}/Γ roweak interac- $\Upsilon(4S)$ V TeV Z
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(3 × 10 ⁻⁺ ⁷⁹ Assumes equal pro ⁸⁰ ACCIARRI 97B ass ⁸¹ AVERY 89B report to 50%. ⁸² ALBRECHT 87D r rescale to 50%. ⁸³ AVERY 87 reports to 50%. $(\mu^+\mu^-)/\Gamma_{total}$ Test for $\Delta B =$ tions. <u>AUE</u> (6.1 × 10 ⁻⁷ • We do not use for the form th	boduction of sume PDC is $< 3 \times 10^{10}$ eports $< 3 \times 10^{10}$ $< 8 \times 10^{10}$ 1 weak ne 20×10^{10} 90 90 90 90 90 90 90 90 90 90 90 90 90	f B^+ 5 96 p 0^{-5} 8.5 × 1^{-5} a eutral 384 ing da 385 386 387	and B^0 at the production fract assuming the γ 10^{-5} assuming ssuming the γ current. Allow <u>DOCUMENT ID</u> BERGFELD ata for averages ABBOTT ABE ACCIARRI ABE AMMAR	$e \Upsilon(4$ tions \uparrow (4S) g the (4S) \prime ed by 	S). for B^+ , decays $\Upsilon(4S)$ decays decays $\frac{TECN}{CLE2}$, limits, D0 CDF L3 CDF L3 CDF	B^{0} , B_{s} , ar 43% to $B^{0}\overline{B}$ decays 45% 40% to $B^{0}\overline{B}$ corder electric $\underline{COMMENT}$ $e^{+}e^{-} \rightarrow$ etc. • • • $p\overline{p}$ 1.8 Te ¹ $p\overline{p}$ at 1.8 $e^{+}e^{-} \rightarrow$ Repl. by A $e^{+}e^{-} \rightarrow$	and Λ_b . $\overline{B^0}$. We rescale to $B^0 \overline{B^0}$. We $\overline{B^0}$. We rescale Γ_{183}/Γ roweak interac- $\overline{\Upsilon(4S)}$ V TeV Z NBE 98 $\Upsilon(4S)$
(3 × 10 ⁻⁺ ⁷⁹ Assumes equal pro ³⁰ ACCIARRI 97B ass ³¹ AVERY 89B report to 50%. ³² ALBRECHT 87D r rescale to 50%. ³³ AVERY 87 reports to 50%. ($\mu^+\mu^-$)/ Γ_{total} Test for $\Delta B =$ tions. <u>AUUE</u> (6.1 × 10 ⁻⁷ • We do not use for the form	boduction of sume PDC is $< 3 \times 10^{10}$ reports $< 3 \times 10^{10}$ is $< 8 \times 10^{10}$ 1 weak ne $\frac{CL\%}{90}$ the follow 90^{10} 90^{10	f B^+ 5 96 r 0^{-5} 8.5 × 1^{-5} a eutral 384 ing da 385 386 387 388	and B^0 at the production fract assuming the γ 10^{-5} assuming ssuming the γ current. Allow <u>DOCUMENT ID</u> BERGFELD ata for averages ABBOTT ABE ACCIARRI ABE AMMAR	$e \Upsilon(4$ tions $\Upsilon(4S)$ g the (4S) wed by ued by ued by ued by ued by ued by ued by ued by ued by ued	S). for B^+ , decays $T(4S)$ decays $T(4S)$ decay	B ⁰ , B _s , ar 43% to B ⁰ I decays 45% 40% to B ⁰ I e-order electr <u>COMMENT</u> $e^+e^- \rightarrow$ etc. • • • $p\overline{p}$ 1.8 Te ¹ $p\overline{p}$ at 1.8 $e^+e^- \rightarrow$ Repl. by A $e^+e^- \rightarrow$ $E^{p\overline{p}} - 636$	and Λ_b . $\overline{B^0}$. We rescale to $B^0 \overline{B^0}$. We $\overline{B^0}$. We rescale Γ_{183}/Γ roweak interac- $\overline{\Upsilon(4S)}$ V TeV Z NBE 98 $\Upsilon(4S)$ Ω CeV
(3 × 10 ⁻⁺ ⁷⁹ Assumes equal pro ³⁰ ACCIARRI 97B ass ³¹ AVERY 89B report to 50%. ³² ALBRECHT 87D r rescale to 50%. ³³ AVERY 87 reports to 50%. $(\mu^+\mu^-)/\Gamma_{total}$ Test for $\Delta B =$ tions. <u>AUE</u> 5.1 × 10 ⁻⁷ • We do not use for (4.0×10^{-5}) 5.8 × 10 ⁻⁷ 5.9 × 10 ⁻⁶ 5.9 × 10 ⁻⁶ 5.9 × 10 ⁻⁶ 5.9 × 10 ⁻⁵ 5.9 × 10 ⁻⁵ 5.9 × 10 ⁻⁶ 5.9 × 10 ⁻⁵ 5.9 × 10 ⁻⁵ 5.1 × 10 ⁻⁵	boduction of sume PDC is $< 3 \times 10^{10}$ reports $<$ $< 8 \times 100^{10}$ 1 weak ne $\frac{CL\%}{90}$ the follow 90^{0} 90^{0	f B^+ 5 96 r 0^{-5} $8.5 \times$ 1^{-5} a eutral 384 ing da 385 386 387 388 388 388	and B^0 at the production fract assuming the γ 10^{-5} assuming ssuming the γ current. Allow <u>DOCUMENT ID</u> BERGFELD ata for averages ABBOTT ABE ACCIARRI ABE AMMAR ALBAJAR	$e \Upsilon(4$ tions (4S) g the (4S) (4S) (4S) (4S) (4S) (4S) (4S) (4S)	S). for B^+ , decays $T(4S)$ decays $T(4S)$ decays $TECN$ CLE2 , limits, D0 CDF L3 CDF L3 CDF CLE2 UA1	B^{0} , B_{s} , ar 43% to $B^{0}\overline{B}$ decays 45% 40% to $B^{0}\overline{B}$ -order electr conder electr $e^{+}e^{-} \rightarrow$ etc. • • • $p\overline{p}$ 1.8 Te ¹ $p\overline{p}$ at 1.8 $e^{+}e^{-} \rightarrow$ Repl. by A $e^{+}e^{-} \rightarrow$ $E^{p\overline{p}}_{cm} = 630$ $E^{p\overline{p}}_{cm} = 630$	and Λ_b . $\overline{B^0}$. We rescale to $B^0 \overline{B^0}$. We $\overline{B^0}$. We rescale Γ_{183}/Γ roweak interac- T(4S) V TeV Z BE 98 T(4S) 0 GeV C = V
(3 × 10 ⁻⁺ ⁷⁹ Assumes equal pro ³⁰ ACCIARRI 97B ass ³¹ AVERY 89B report to 50%. ³² ALBRECHT 87D r rescale to 50%. ³³ AVERY 87 reports to 50%. $(\mu^+\mu^-)/\Gamma_{total}$ Test for $\Delta B =$ tions. <u>AUUE</u> 5.1 × 10 ⁻⁷ • We do not use for (4.0 × 10 ⁻⁵) (5.8 × 10 ⁻⁷) (1.0 × 10 ⁻⁶) (5.9 × 10 ⁻⁶) (3.3 × 10 ⁻⁶) (1.2 × 10 ⁻⁵) (4.2 × 10 ⁻⁵)	boduction of sume PDC is $< 3 \times 10^{10}$ reports $< 3 \times 10^{10}$ $< 8 \times 100^{10}$ 1 weak ne 200^{10} 90 90 90 90 90 90 90 90 90 90 90 90 90	f B^+ 5 96 r 0^{-5} 8.5 × 1^{-5} a eutral 384 ing da 385 386 387 388 389 300	and B^0 at the production fract assuming the γ 10^{-5} assuming ssuming the γ current. Allow <u>DOCUMENT ID</u> BERGFELD ata for averages ABBOTT ABE ACCIARRI ABE ACMMAR ALBAJAR ALBAJAR	$rac{}{}$ $\Upsilon(4$ tions $\Upsilon(4S)$ g the (4S) \prime ed by 	S). for B^+ , decays $T(4S)$ decays $T(4S)$ decay	B^{0}, B_{s}, ar $43\% \text{ to } B^{0}\overline{B}$ $decays 45\%$ $40\% \text{ to } B^{0}\overline{B}$ $decays 45\%$ $40\% \text{ to } B^{0}\overline{B}$ $e^{-}e^{-} \rightarrow$ $P\overline{p} 1.8 \text{ Te}^{-}$ $P\overline{p} 1.8 \text{ Te}^{-} \rightarrow$ $Repl. \text{ by } A$ $e^{+}e^{-} \rightarrow$ $E^{P\overline{p}}_{cm} = 630$ $E^{P\overline{p}}_{cm} = 630$	and Λ_b . $\overline{B^0}$. We rescale to $B^0 \overline{B^0}$. We $\overline{B^0}$. We rescale Γ_{183}/Γ roweak interac- $\overline{\Upsilon(4S)}$ V TeV Z NBE 98 $\Upsilon(4S)$ 0 GeV 0 GeV
(3 × 10 ⁻⁺ ⁷⁹ Assumes equal pro ³⁰ ACCIARRI 97B ass ³¹ AVERY 89B report to 50%. ³² ALBRECHT 87D r rescale to 50%. ³³ AVERY 87 reports to 50%. ($\mu^+\mu^-$)/ Γ_{total} Test for $\Delta B =$ tions. <u>AUUE</u> (6.1 × 10 ⁻⁷ • We do not use for the second s	boduction of sume PDC is $< 3 \times 10^{10}$ reports $< 3 \times 10^{10}$ is $< 8 \times 10^{10}$ 1 weak ne $\frac{CL\%}{90}$ 90 90 90 90 90 90 90 90 90 90 90 90 90	f B^+ 5 96 r 0^{-5} a 8.5 × 1^{-5} a eutral 384 ing da 385 386 387 388 389 390 301	and B^0 at the production fract assuming the γ 10^{-5} assuming ssuming the γ current. Allow <u>DOCUMENT ID</u> BERGFELD ata for averages ABBOTT ABE ACCIARRI ABE AMMAR ALBAJAR ALBAJAR AVERY	$rac{2}{2} \Upsilon(4$ tions $\Upsilon(4S)$ g the (4S) $rac{2}{2}$	S). for B^+ , decays T(4S) decays decays TECN CLE2 , limits, D0 CDF L3 CDF L3 CDF CLE2 UA1 UA1 CLE0	B^{0}, B_{s}, ar $43\% \text{ to } B^{0}\overline{P}$ $decays 45\%$ $40\% \text{ to } B^{0}\overline{P}$ $decays 45\%$ $40\% \text{ to } B^{0}\overline{P}$ $ecode constant cons$	and Λ_b . $\overline{B^0}$. We rescale to $B^0 \overline{B^0}$. We $\overline{B^0}$. We rescale Γ_{183}/Γ roweak interac- T(4S) V TeV Z BE 98 T(4S) 0 GeV T(4S) TeV Z TeV TeV Z TeV Z TeV
(3 × 10 ⁻⁺ ⁷⁹ Assumes equal pro ³⁰ ACCIARRI 97B as: ³¹ AVERY 89B report to 50%. ³² ALBRECHT 87D r rescale to 50%. ³³ AVERY 87 reports to 50%. ($\mu^+\mu^-$)/ Γ_{total} Test for $\Delta B =$ tions. 4.0 × 10⁻⁵ (4.0×10^{-5} (1.6×10^{-6} (1.2×10^{-5} (1.5×10^{-5}	boduction of sume PDC is $< 3 \times 10^{10}$ reports $<$ is $< 8 \times 10^{10}$ 1 weak ne $\frac{CL\%}{90}$ the follow 90 90 90 90 90 90 90 90 90 90 90 90 90	f B^+ 5 96 r 0^{-5} 8.5 × 1^{-5} a eutral 384 ing da 385 386 387 388 389 390 391 302	and B^0 at the production fract assuming the γ 10^{-5} assuming ssuming the γ current. Allow <u>DOCUMENT ID</u> BERGFELD ata for averages ABBOTT ABE ACCIARRI ABE AMMAR ALBAJAR ALBAJAR ALBAJAR ALBAJAR ALBAJAR	$rac{}{}$ $\Upsilon(4$ tions $\Upsilon(4S)$ g the (4S) $ ac{}{}$ ved by $ ac{}{}$ $ ac{$	S). for B^+ , decays T(4S) decays decays TECN CLE2 , limits, D0 CDF L3 CDF L3 CDF CLE2 UA1 UA1 CLE0 ARG CLE0	B ⁰ , B _s , ar 43% to B ⁰ R decays 45% 40% to B ⁰ R -order electr $\frac{COMMENT}{e^+e^-}$ etc. • • • $p\overline{p}$ 1.8 Te ¹ $p\overline{p}$ at 1.8 $e^+e^- \rightarrow$ Repl. by A $e^+e^- \rightarrow$ $E^{D\overline{p}}_{C\overline{m}} = 630$ $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ $e^+e^- \rightarrow$ $e^+e^- \rightarrow$	and Λ_b . $\overline{B^0}$. We rescale to $B^0 \overline{B^0}$. We $\overline{B^0}$. We rescale Γ_{183}/Γ roweak interac- T(4S) V TeV Z NBE 98 T(4S) 0 GeV T(4S) T(4
(3 × 10 ⁻⁺ ⁷⁹ Assumes equal pro ⁸⁰ ACCIARRI 97B ass ⁸¹ AVERY 89B report to 50%. ⁸² ALBRECHT 87D r rescale to 50%. ⁸³ AVERY 87 reports to 50%. $(\mu^+\mu^-)/\Gamma_{total}$ Test for $\Delta B =$ tions. <u>84.0 × 10⁻⁵</u> (6.1 × 10 ⁻⁷ • We do not use for the second s	$\begin{array}{c} \text{bold uction of sume PDG} \\ \text{sume PDG} \\ \text{s < 3 × 1} \\ \text{reports < } \\ \text{s < 8 × 10} \\ 1 \text{ weak ne} \\ \hline \\ 6 < 8 × 10 \\ 1 \text{ weak ne} \\ \hline \\ 90 \\ 90 \\ 90 \\ 90 \\ 90 \\ 90 \\ 90 $	f B^+ 5 96 p 0^{-5} a 8.5 × 1^{-5} a eutral 384 385 386 387 388 389 390 391 392	and B ⁰ at the production fract assuming the Υ 10 ⁻⁵ assuming ssuming the Υ current. Allow <u>DOCUMENT ID</u> BERGFELD ata for averages ABBOTT ABE ACCIARRI ABE ACCIARRI ABE ALBAJAR ALBAJAR ALBAJAR ALBAJAR ALBAJAR ALBAJAR ALBAJAR	$e \Upsilon(4$ tions (4S) g the (4S) (4S) (4S) (4S) (4S) (4S) (4S) (4S)	S). for B^+ , decays T(4S) decays decays TECN CLE2 , limits, D0 CDF L3 CDF L3 CDF CLE2 UA1 UA1 CLE0 ARG CLE0 CLE0	B^{0} , B_{s} , ar 43% to $B^{0}\overline{B}$ decays 45% 40% to $B^{0}\overline{B}$ -order electr $\overline{COMMENT}$ $e^{+}e^{-} \rightarrow$ etc. • • • $p\overline{p}$ 1.8 Te ¹ $p\overline{p}$ at 1.8 $e^{+}e^{-} \rightarrow$ Repl. by A $e^{+}e^{-} \rightarrow$ Repl. by A $e^{+}e^{-} \rightarrow$ $E^{\overline{p}\overline{p}}_{cm} = 630$ $e^{+}e^{-} \rightarrow$ $e^{+}e^{-} \rightarrow$ $e^{+}e^{-} \rightarrow$ $e^{+}e^{-} \rightarrow$ $e^{+}e^{-} \rightarrow$ $e^{+}e^{-} \rightarrow$	and Λ_b . $\overline{B^0}$. We rescale to $B^0 \overline{B^0}$. We $\overline{B^0}$. We rescale Γ_{183}/Γ roweak interac- T(4S) V TeV Z BE 98 T(4S) 0 GeV T(4S) T(5)

³⁸⁴ Assumes equal production of B^+ and B^0 at the $\Upsilon(4S)$. ³⁸⁵ ABE 98 assumes production of $\sigma(B^0) = \sigma(B^+)$ and $\sigma(B_s)/\sigma(B^0) = 1/3$. They normalize to their measured $\sigma(B^0, p_T(B) > 6, |y| < 1.0) = 2.39 \pm 0.32 \pm 0.44 \,\mu\text{b}.$

 386 ACCIARRI 97B assume PDG 96 production fractions for $B^+,~B^0,~B_s,$ and $\Lambda_b.$

 387 ABE 96L assumes equal B^0 and B^+ production. They normalize to their measured $\sigma(B^+, \ p_T(B) > 6 \ {
m GeV}/c, \ |y| < 1) = 2.39 \pm 0.54 \ \mu{
m b}.$

- $^{388}B^0$ and $^{9}B_s$ are not separated. 389 Obtained from unseparated $^{9}B^0$ and $^{9}B_s$ measurement by assuming a $^{9}B^0$; $^{9}B^0$ ratio 2:1. 390 AVERY 89B reports $< 5 \times 10^{-3}$ assuming the $\Upsilon(4S)$ decays 43% to $^{80}B^0$. We rescale to 50%.
- 391 ALBRECHT 87D reports $< 5 \times 10^{-5}$ assuming the $\Upsilon(4S)$ decays 45% to $B^0 \overline{B}^0$. We rescale to 50%.
- 392 AVERY 87 reports $< 9 \times 10^{-5}$ assuming the $\Upsilon(4S)$ decays 40% to $B^0 \overline{B}^0$. We rescale to 50%.

$\Gamma(K^0 e^+ e^-)/\Gamma_{total}$

 Γ_{184}/Γ

Test for $\Delta B = 1$ weak neutral current. Allowed by higher-order electroweak interactions.

VALUE	<u>CL%</u>		DOCUMENT ID		TECN	<u>COMMENT</u>	
<2.7 × 10 ⁻⁶	90	393	ABE	02	BELL	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$\bullet \bullet \bullet$ We do not use the	e followi	ng d	ata for averages	, fits	limits,	etc. • • •	
$< 8.45 imes 10^{-6}$	90	394	ANDERSON	01 B	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$< 3.0 \times 10^{-4}$	90		ALBRECHT	91E	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$< 5.2 \times 10^{-4}$	90	395	AVERY	87	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
 ³⁹³ Assumes equal produces ³⁹⁴ The result is for di-lete ³⁹⁵ AVERY 87 reports < to 50%. 	epton of 6.5 × 10	B ⁺ asses)-4	and B^0 at the above 0.5 GeV assuming the γ	Υ(4 (4 <i>S</i>)	S). decays	40% to B ⁰ E	3 ⁰ . We rescale
$\Gamma(\kappa^{0}\mu^{+}\mu^{-})/\Gamma_{\text{total}}$ Test for $\Delta B = 1$ tions	weak ne	utra	l current. Allowe	ed by	, higher	-order electr	F₁₈₅/F oweak interac-
VALUE	<u>CL%</u>		DOCUMENT ID		TECN	COMMENT	
$<3.3 \times 10^{-6}$	90	396	ABE	02	BELL	$e^+ e^- \rightarrow$	$\Upsilon(4S)$
$\bullet \bullet \bullet$ We do not use the	e followi	ng d	ata for averages	, fits	limits,	etc. • • •	
$< 6.64 imes 10^{-6}$	90	397	ANDERSON	01 B	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$< 5.2 \times 10^{-4}$	90		ALBRECHT	91E	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$< 3.6 \times 10^{-4}$	90	398	AVERY	87	CLEO	$e^+e^- \rightarrow$	$\Upsilon(4S)$
 ³⁹⁶ Assumes equal produces ³⁹⁷ The result is for di-leteration of the second s	iction of pton ma 4.5 × 10	B ⁺ asses -4	and B^0 at the above 0.5 GeV assuming the γ	Υ(4 (4 <i>S</i>)	S). decays	40% to B ⁰ Ē	3 ⁰ . We rescale
$\Gamma(\kappa^*(892)^0 e^+ e^-)/Test \text{ for } \Delta B = 1$	F_{total} weak new	utra	l current. Allowe	ed by	, higher	-order electr	F₁₈₆/F oweak interac-
VALUE	<u>CL%</u>		DOCUMENT ID		TECN	COMMENT	
<6.4 × 10 ⁻⁶	90	399	ABE	02	BELL	$e^+e^- \rightarrow$	$\Upsilon(4S)$
$\bullet \bullet \bullet$ We do not use the	e followi	ng d	ata for averages	, fits	limits,	etc. • • •	
${<}2.9 imes10^{-4}$	90		ALBRECHT	91E	ARG	$e^+e^- \rightarrow$	$\Upsilon(4S)$
³⁹⁹ Assumes equal produ	iction of	B+	and B^0 at the	$\Upsilon(4$	5).		

$\Gamma(\kappa^*(892)^0\mu^+\mu^-)/\Gamma_{total}$

Test for $\Delta B = 1$ weak neutral current. Allowed by higher-order electroweak interactions.

VALUE	<u>CL%</u>	DOCUMENT ID		TECN	COMMENT
<4.2 × 10 ⁻⁶	90	⁴⁰⁰ ABE	02	BELL	$e^+e^- \rightarrow \Upsilon(4S)$
$\bullet \bullet \bullet$ We do not use the	followi	ng data for averages	, fits,	limits,	etc. ● ● ●
$< 4.0 \times 10^{-6}$	90	⁴⁰¹ AFFOLDER	99 B	CDF	<i>р<mark>р</mark> at 1.8 TeV</i>
$< 2.5 \times 10^{-5}$	90	⁴⁰² ABE	96L	CDF	Repl. by AF-
$<\!\!2.3 imes 10^{-5}$	90	⁴⁰³ ALBAJAR	91 C	UA1	$\frac{FOLDER 99B}{E_{cm}^{pp}} = 630 \text{ GeV}$
$< 3.4 \times 10^{-4}$	90	ALBRECHT	91E	ARG	$e^+e^- ightarrow ~\Upsilon(4S)$
		-			

 400 Assumes equal production of B^+ and B^0_- at the $\Upsilon(4S)$.

⁴⁰¹ AFFOLDER 99B measured relative to $B^0 \rightarrow J/\psi(1S) K^*(892)^0$. ⁴⁰² ABE 96L measured relative to $B^0 \rightarrow J/\psi(1S) K^*(892)^0$ using PDG 94 branching ratios. ⁴⁰³ ALBAJAR 91C assumes 36% of \overline{b} quarks give B^0 mesons.

$\Gamma(K^*(892)^0 \nu \overline{\nu}) / \Gamma_{\text{total}}$

 Γ_{188}/Γ

 Γ_{187}/Γ

41.0.	10-3			404		0		-+	7
VALUE			CL9	6	DOCUMEN	NT ID	TECN	COMMENT	
ti	ons.								
Ť	est for	$\Delta B =$	1 weak	neutral	current.	Allowed	by higher	-order electr	oweak interac

 $^{404}\,\mathrm{ADAM}$ 96D assumes $f_{B^0}=f_{B^-}=0.39$ and $f_{B_{\mathrm{s}}}=0.12.$

$\Gamma(e^{\pm}\mu^{\mp})/\Gamma_{\text{total}}$

Γ_{189}/Γ

Test of lepton family number conservation. Allowed by higher-order electroweak interactions.

VALUE	<u>CL%</u>	<u>DOCUMENT ID</u>	TECN	COMMENT	_
<15 × 10 ⁻⁷	90	⁴⁰⁵ BERGFELD	00B CLE2	$e^+e^- ightarrow ~\Upsilon(4S)$	
• • • We do not use	the follow	ing data for average	s, fits, limits	s, etc. ● ● ●	
< 3.5 $ imes$ 10 ⁻⁶	90	ABE	98v CDF	<i>р<mark>р</mark> at 1.8 Те</i> V	
$<$ 1.6 $ imes$ 10 $^{-5}$	90	⁴⁰⁶ ACCIARRI	97B L3	$e^+e^- \rightarrow Z$	
$< 5.9 imes 10^{-6}$	90	AMMAR	94 CLE2	$e^+e^- ightarrow ~\Upsilon(4S)$	
$< 3.4 \times 10^{-5}$	90	⁴⁰⁷ AVERY	89B CLEC) $e^+e^- \rightarrow \Upsilon(4S)$	
$< 4.5 \times 10^{-5}$	90	⁴⁰⁸ ALBRECHT	87d ARG	$e^+ e^- ightarrow ~\Upsilon(4S)$	
$< 7.7 \times 10^{-5}$	90	⁴⁰⁹ AVERY	87 CLEC) $e^+e^- \rightarrow \Upsilon(4S)$	
$< 3 \times 10^{-4}$	90	GILES	84 CLEC	Repl. by AVERY 87	
⁴⁰⁵ Assumes equal pr	oduction o	of B^+ and B^0 at the	$\gamma(4S).$		
406 ACCIARRI 97B a	ssume PD0	G 96 production frac	tions for B^+	$$, B^0 , B_s , and Λ_h .	
⁴⁰⁷ Paper assumes th	ne $\Upsilon(4S)$ d	lecays 43% to $B^0 \overline{B}^0$). We resca	le to 50%.	
408 ALBRECHT 87D	reports <	5×10^{-5} assuming	the $\Upsilon(4S)$	decays 45% to $B^0 \overline{B}^0$. We	
rescale to 50%.	·	F		0-0	
409 AVERY 87 report	s < 9 imes 10) $^{-5}$ assuming the γ	f(4S) decays	540% to B^0B^0 . We rescale	:
to 50%.					
$\Gamma(e^{\pm}\tau^{\mp})/\Gamma_{\text{total}}$				Г ₁₉₀ /Г	•

 $|(e^{\pm}\tau^{\pm})/|$ total Test of lepton family number conservation. Allowed by higher-order electroweak interactions.

VALUE	<u>CL%</u>	DOCUMENT ID		TECN	<u>COMMENT</u>
<5.3 × 10 ⁻⁴	90	AMMAR	94	CLE2	$e^+e^- ightarrow ~\Upsilon(4S)$

actions.	CI %			TECN	COMMENT
<8.3 × 10 ⁻⁴	90	AMMAR	94	CLE2	$e^+e^- \rightarrow \Upsilon(4S)$
	POL	ARIZATION IN	B⁰ D	ECAY	
Γ_L/Γ in $B^0 \to J/$	′ψ(1S) K	*(892) ⁰			
$\Gamma_L/\Gamma = 1$ would be a set of the set of th	ld indicate	that $B^0 \rightarrow J/\psi(1)$	LS) K'	*(892) ⁰	followed by $K^*(892)^0$ –
$K_S^0 \pi^0$ is a pure	e <i>CP</i> eigen	state with $CP = -1$	1.		
VALUE	<u>EVTS</u>	DOCUMENT ID		TECN	COMMENT
0.590±0.028 OUR A	VERAGE	410	01		$+$ $ \infty(4c)$
$0.597 \pm 0.028 \pm 0.024$			01H	BABR	$e \cdot e \rightarrow I(4S)$
$0.59 \pm 0.00 \pm 0.01$		412 JESSOD	001		pp at 1.0 TeV $a^+a^- \rightarrow \gamma(AS)$
$1.52 \pm 0.07 \pm 0.04$	65	ABE	97	CLE2	$e^+e^- \rightarrow I(43)$
$1.05 \pm 0.10 \pm 0.04$	12	413 AL RECUT	952		$\rho p at 1.0 \text{ rev}$ $a^+ a^- \gamma \gamma(\Lambda S)$
$\bullet \bullet We do not use$	the followi	ng data for average	94G s fits	limite	$e^+e^- \rightarrow I(43)$
	the followi	ng uata ioi average	5, 1115	, mmus,	
$0.80 \pm 0.08 \pm 0.05$	42	⁴¹³ ALAM	94	CLE2	Sup. by JESSOP 97
$0.80 \pm 0.08 \pm 0.05$ 410 Averaged over an	42 admixture	413 ALAM	94	CLE2	Sup. by JESSOP 97
$0.80 \pm 0.08 \pm 0.05$ 410 Averaged over an 3.2 ± 1.4 $\times 10^{-10}$	42 admixture 2	413 ALAM of B^0 and B^- de	94 cays a	CLE2 nd the	Sup. by JESSOP 97 P wave fraction is (16.0 \pm
$0.80 \pm 0.08 \pm 0.05$ 410 Averaged over an $3.2 \pm 1.4) \times 10^{-10}$ 411 AFFOLDER 00N sample of 89 pb ⁻¹	42 admixture 2 _. measureme 1. The <i>P</i> -v	413 ALAM of B^0 and B^- depends are based on 19 wave fraction is four	94 cays a 90 <i>B</i> ^C nd to	CLE2 and the candid be 0.13	Sup. by JESSOP 97 <i>P</i> wave fraction is (16.0 \pm lates obtained from a data $\pm 0.12 + 0.06$.
$0.80 \pm 0.08 \pm 0.05$ 410 Averaged over an $3.2 \pm 1.4) \times 10^{-1}$ 411 AFFOLDER 00N sample of 89 pb ⁻¹ 412 JESSOR 07 is the	42 admixture ² . measureme ¹ . The <i>P</i> -v	413 ALAM a of B^0 and B^- depends are based on 19 wave fraction is four	94 cays a 90 <i>B</i> ^C nd to	CLE2 and the candid be 0.13	Sup. by JESSOP 97 <i>P</i> wave fraction is (16.0 \pm lates obtained from a data $\pm 0.12 \pm 0.06$. cover The <i>P</i> wave fraction
$0.80 \pm 0.08 \pm 0.05$ 410 Averaged over an $3.2 \pm 1.4) \times 10^{-1}$ 411 AFFOLDER 00N sample of 89 pb ⁻¹ 412 JESSOP 97 is the is found to be 0.1	42 admixture 2. 1. The <i>P</i> -v e average c 6 + 0.08 + 1	⁴¹³ ALAM a of B^0 and B^- depents are based on 1 th wave fraction is four over a mixture of B^0 + 0.04.	94 cays a 90 <i>B</i> ^C nd to ⁰ and	CLE2 and the candid be 0.13 B ⁺ de	Sup. by JESSOP 97 P wave fraction is (16.0 \pm lates obtained from a data $\pm 0.12 \pm 0.06$. -0.9 ± 0.06 . cays. The <i>P</i> -wave fraction
$0.80 \pm 0.08 \pm 0.05$ 410 Averaged over an $3.2 \pm 1.4) \times 10^{-1}$ 411 AFFOLDER 00N sample of 89 pb ⁻¹ 412 JESSOP 97 is the is found to be 0.1 413 Averaged over an	42 admixture 2. measureme 1. The <i>P</i> -v e average o $6 \pm 0.08 \pm$ admixture	⁴¹³ ALAM a of B^0 and B^- depends are based on 19 wave fraction is four over a mixture of B^0 ± 0.04 . of B^0 and B^+ dec	94 cays a 90 <i>B</i> ^C nd to ⁰ and :ays.	CLE2 and the candid be 0.13 <i>B</i> ⁺ de	Sup. by JESSOP 97 P wave fraction is (16.0 \pm lates obtained from a data $+0.12 \pm 0.06$. -0.9 ± 0.06 . cays. The <i>P</i> -wave fraction
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$B^0 - \overline{B}{}^0$ MIXING

Written March 2000 and revised March 2002 by O. Schneider (University of Lausanne).

Formalism in quantum mechanics

There are two neutral $B^0-\overline{B}^0$ meson systems, $B^0_d-\overline{B}^0_d$ and $B^0_s-\overline{B}^0_s$ (generically denoted $B^0_q-\overline{B}^0_q$, q = s, d), which exhibit the phenomenon of particle-antiparticle mixing [1]. Such a system is produced in one of its two possible states of well-defined flavor: $|B^0\rangle$ ($\overline{b}q$) or $|\overline{B}^0\rangle$ ($b\overline{q}$). Due to flavor-changing interactions, this initial state evolves into a time-dependent quantum superposition of the two flavor states, $a(t)|B^0\rangle + b(t)|\overline{B}^0\rangle$, satisfying the equation

$$i\frac{\partial}{\partial t} \begin{pmatrix} a(t) \\ b(t) \end{pmatrix} = \left(\mathbf{M} - \frac{i}{2}\mathbf{\Gamma} \right) \begin{pmatrix} a(t) \\ b(t) \end{pmatrix}, \tag{1}$$

where **M** and Γ , known as the mass and decay matrices, describe the dispersive and absorptive parts of $B^0 - \overline{B}^0$ mixing. These matrices are hermitian, and CPT invariance requires $M_{11} = M_{22} \equiv M$ and $\Gamma_{11} = \Gamma_{22} \equiv \Gamma$

The two eigenstates of the effective Hamiltonian matrix $(\mathbf{M} - \frac{i}{2}\mathbf{\Gamma})$ are given by

$$|B_{\pm}\rangle = p|B^0\rangle \pm q|\overline{B}{}^0\rangle, \qquad (2)$$

and correspond to the eigenvalues

$$\lambda_{\pm} = \left(M - \frac{i}{2}\Gamma\right) \pm \frac{q}{p}\left(M_{12} - \frac{i}{2}\Gamma_{12}\right), \qquad (3)$$

where

$$\frac{q}{p} = \sqrt{\frac{M_{12}^* - \frac{i}{2}\Gamma_{12}^*}{M_{12} - \frac{i}{2}\Gamma_{12}}}.$$
(4)

We choose a convention where $\operatorname{Re}(q/p) > 0$ and $CP|B^0\rangle = |\overline{B}^0\rangle$.

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An alternative notation is

$$|B_{\pm}\rangle = \frac{(1+\epsilon)|B^0\rangle \pm (1-\epsilon)|\overline{B}^0\rangle}{\sqrt{2(1+|\epsilon|^2)}} \quad \text{with} \quad \frac{1-\epsilon}{1+\epsilon} = \frac{q}{p}.$$
 (5)

The time dependence of these eigenstates of well-defined masses $M_{\pm} = \operatorname{Re}(\lambda_{\pm})$ and decay widths $\Gamma_{\pm} = -2 \operatorname{Im}(\lambda_{\pm})$ is given by the phases $e^{-i\lambda_{\pm}t} = e^{-iM_{\pm}t}e^{-\frac{1}{2}\Gamma_{\pm}t}$: the evolution of a pure $|B^0\rangle$ or $|\overline{B}^0\rangle$ state at t = 0 is thus given by

$$|B^{0}(t)\rangle = g_{+}(t)|B^{0}\rangle + \frac{q}{p}g_{-}(t)|\overline{B}^{0}\rangle, \qquad (6)$$

$$|\overline{B}^{0}(t)\rangle = g_{+}(t) |\overline{B}^{0}\rangle + \frac{p}{q}g_{-}(t) |B^{0}\rangle, \qquad (7)$$

where

$$g_{\pm}(t) = \frac{1}{2} \left(e^{-i\lambda_{\pm}t} \pm e^{-i\lambda_{\pm}t} \right) \,. \tag{8}$$

This means that the flavor states remain unchanged (+) or oscillate into each other (-) with time-dependent probabilities proportional to

$$|g_{\pm}(t)|^2 = \frac{e^{-\Gamma t}}{2} \left[\cosh\left(\frac{\Delta\Gamma}{2}t\right) \pm \cos(\Delta m t) \right], \qquad (9)$$

where

$$\Delta m = |M_{+} - M_{-}|, \quad \Delta \Gamma = |\Gamma_{+} - \Gamma_{-}|.$$
 (10)

Time-integrated mixing probabilities are only well defined when considering decays to flavor-specific final states, *i.e.* final states f such that the instantaneous decay amplitudes $A_{\overline{f}} = \langle \overline{f} | H | B^0 \rangle$ and $\overline{A}_f = \langle f | H | \overline{B}^0 \rangle$, where H is the weak interaction Hamiltonian, are both zero. Due to mixing, a produced B^0 can decay to the final state \overline{f} (mixed event) in addition to the final state

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f (unmixed event). Restricting the sample to these two decay channels, the time-integrated mixing probability is given by

$$\chi_{f}^{B^{0} \to \overline{B}^{0}} = \frac{\int_{0}^{\infty} |\langle \overline{f} | H | B^{0}(t) \rangle|^{2} dt}{\int_{0}^{\infty} |\langle \overline{f} | H | B^{0}(t) \rangle|^{2} dt + \int_{0}^{\infty} |\langle f | H | B^{0}(t) \rangle|^{2} dt}$$
$$= \frac{|\xi_{f}|^{2} (x^{2} + y^{2})}{|\xi_{f}|^{2} (x^{2} + y^{2}) + 2 + x^{2} - y^{2}},$$
(11)

where we have defined $\xi_f = \frac{q}{p} \frac{A_{\overline{f}}}{A_f}$ and

$$x = \frac{\Delta m}{\Gamma}, \quad y = \frac{\Delta \Gamma}{2\Gamma}.$$
 (12)

The mixing probability $\chi_f^{\overline{B}^0 \to B^0}$ for the case of a produced \overline{B}^0 is obtained by replacing ξ_f with $1/\xi_f$ in Eq. (11). It is different from $\chi_f^{B^0 \to \overline{B}^0}$ if $|\xi_f|^2 \neq 1$, a condition reflecting non-invariance under the CP transformation. CP violation in decay amplitudes is discussed elsewhere [2] and we assume $|\overline{A}_{\overline{f}}| = |A_f|$ from now on. The deviation of $|q/p|^2$ from 1, namely the quantity

$$1 - \left|\frac{q}{p}\right|^2 = \frac{4\operatorname{Re}(\epsilon)}{1 + |\epsilon|^2} + \mathcal{O}\left(\left(\frac{\operatorname{Re}(\epsilon)}{1 + |\epsilon|^2}\right)^2\right), \quad (13)$$

describes CP violation in $B^0 - \overline{B}{}^0$ mixing. As can be seen from Eq. (4), this can occur only if $M_{12} \neq 0$, $\Gamma_{12} \neq 0$ and if the phase difference between M_{12} and Γ_{12} is different from 0 or π .

In the absence of CP violation, $|q/p|^2 = 1$, $\text{Re}(\epsilon) = 0$, the mass eigenstates are also CP eigenstates,

$$CP |B_{\pm}\rangle = \pm |B_{\pm}\rangle,$$
 (14)

the phases $\varphi_{M_{12}} = \arg(M_{12})$ and $\varphi_{\Gamma_{12}} = \arg(\Gamma_{12})$ satisfy

$$\sin(\varphi_{M_{12}} - \varphi_{\Gamma_{12}}) = 0, \qquad (15)$$

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Figure 1: Dominant box diagrams for the $B_q^0 \rightarrow \overline{B}_q^0$ transitions (q = d or s). Similar diagrams exist where one or both t quarks are replaced with c or u quarks.

the mass and decay width differences reduce to

$$\Delta m = 2 |M_{12}|, \quad \Delta \Gamma = 2 |\Gamma_{12}|, \quad (16)$$

and the time-integrated mixing probabilities $\chi_f^{B^0\to\overline{B}^0}$ and $\chi_f^{\overline{B}^0\to B^0}$ become both equal to

$$\chi = \frac{x^2 + y^2}{2(x^2 + 1)} \,. \tag{17}$$

Standard Model predictions and phenomenology

In the Standard Model, the transitions $B_q^0 \to \overline{B}_q^0$ and $\overline{B}_q^0 \to B_q^0$ are due to the weak interaction. They are described, at the lowest order, by box diagrams involving two W bosons and two up-type quarks (see Fig. **@Fg.box@**), as is the case for $K^0 - \overline{K}^0$ mixing. However, the long range interactions arising from intermediate virtual states are negligible for the neutral B meson systems, because the large B mass is off the region of hadronic resonances. The calculation of the dispersive and absorptive parts of the box diagrams yields the following predictions for the off-diagonal element of the mass and decay matrices [3],

$$M_{12} = -\frac{G_F^2 m_W^2 \eta_B m_{Bq} B_{Bq} f_{Bq}^2}{12\pi^2} S_0(m_t^2/m_W^2) (V_{tq}^* V_{tb})^2 \qquad (18)$$

$$\Gamma_{12} = \frac{G_F^2 m_b^2 \eta_B' m_{Bq} B_{Bq} f_{Bq}^2}{8\pi}$$

$$\times \left[(V_{tq}^* V_{tb})^2 + V_{tq}^* V_{tb} V_{cq}^* V_{cb} \mathcal{O}\left(\frac{m_c^2}{m_b^2}\right) + (V_{cq}^* V_{cb})^2 \mathcal{O}\left(\frac{m_c^4}{m_b^4}\right) \right] \qquad (19)$$

where G_F is the Fermi constant, m_W the W boson mass, m_i the mass of quark *i*, and $m_{B_q} = M$, f_{B_q} and B_{B_q} are the B_q^0 mass, weak decay constant and bag parameter, respectively. The known function $S_0(x_t)$ can be approximated very well with $0.784 x_t^{0.76}$ [4] and V_{ij} are the elements of the CKM matrix [5]. The QCD corrections η_B and η'_B are of order unity. The only non negligible contributions to M_{12} are from box diagrams involving two top quarks. The phases of M_{12} and Γ_{12} satisfy

$$\varphi_{M_{12}} - \varphi_{\Gamma_{12}} = \pi + \mathcal{O}\left(\frac{m_c^2}{m_b^2}\right) \tag{20}$$

implying that the mass eigenstates have mass and width differences of opposite signs. This means that, like in the $K^{0}-\overline{K}^{0}$ system, the "heavy" state with mass $M_{\text{heavy}} = \max(M_{+}, M_{-})$ has a smaller decay width than that of the "light" state with mass $M_{\text{light}} = \min(M_{+}, M_{-})$. We thus redefine

$$\Delta m = M_{\text{heavy}} - M_{\text{light}}, \qquad \Delta \Gamma = \Gamma_{\text{light}} - \Gamma_{\text{heavy}}, \qquad (21)$$

where Δm is positive by definition and $\Delta \Gamma$ is expected to be positive in the Standard Model.

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Furthermore, the quantity

$$\left|\frac{\Gamma_{12}}{M_{12}}\right| \simeq \frac{3\pi}{2} \frac{m_b^2}{m_W^2} \frac{1}{S_0(m_t^2/m_W^2)} \sim \mathcal{O}\left(\frac{m_b^2}{m_t^2}\right)$$
(22)

is small, and a power expansion of $|q/p|^2$ yields

$$\left|\frac{q}{p}\right|^2 = 1 + \left|\frac{\Gamma_{12}}{M_{12}}\right|\sin(\varphi_{M_{12}} - \varphi_{\Gamma_{12}}) + \mathcal{O}\left(\left|\frac{\Gamma_{12}}{M_{12}}\right|^2\right).$$
(23)

Therefore, considering both Eqs. (20) and (22), the CP-violating parameter

$$1 - \left|\frac{q}{p}\right|^2 \simeq \operatorname{Im}\left(\frac{\Gamma_{12}}{M_{12}}\right) \tag{24}$$

is expected to be very small: ~ $\mathcal{O}(10^{-3})$ for the $B_d^0 - \overline{B}_d^0$ system and $\leq \mathcal{O}(10^{-4})$ for the $B_s^0 - \overline{B}_s^0$ system [6].

In the approximation of negligible CP violation in mixing, the ratio $\Delta\Gamma/\Delta m$ is equal to the small quantity $|\Gamma_{12}/M_{12}|$ of Eq. (22); it is hence independent of CKM matrix elements, *i.e.* the same for the $B_d^0 - \overline{B}_d^0$ and $B_s^0 - \overline{B}_s^0$ systems. It can be calculated with lattice QCD techniques; typical results are $\sim 5 \times 10^{-3}$ with quoted uncertainties of $\sim 30\%$. Given the current experimental knowledge (discussed below) on the mixing parameter x,

$$\begin{cases} x_d = 0.755 \pm 0.015 & (B_d^0 - \overline{B}_d^0 \text{ system}) \\ x_s > 19.0 \text{ at } 95\% \text{ CL} & (B_s^0 - \overline{B}_s^0 \text{ system}) \end{cases}, \quad (25)$$

the Standard Model thus predicts that $\Delta\Gamma/\Gamma$ is very small for the $B_d^0-\overline{B}_d^0$ system (below 1%), but considerably larger for the $B_s^0-\overline{B}_s^0$ system (~ 10%). This width difference is caused by the existence of final states to which both the B_q^0 and \overline{B}_q^0 mesons can decay. Such decays involve $b \rightarrow c\overline{c}q$ quarklevel transitions, which are Cabibbo-suppressed if q = d and

Cabibbo-allowed if q = s. If the final states common to B_s^0 and \overline{B}_s^0 are predominantly *CP*-even as discussed in Ref. 7, then the $B_s^0 - \overline{B}_s^0$ mass eigenstate with the largest decay width corresponds to the *CP*-even eigenstate. Taking Eq. (21) into account, one thus expects $\Gamma_{\text{light}} = \Gamma_+$ and

$$\Delta m_s = M_- - M_+ > 0, \qquad \Delta \Gamma_s = \Gamma_+ - \Gamma_- > 0.$$
 (26)

Experimental issues and methods for oscillation analyses

Time-integrated measurements of $B^0 - \overline{B}{}^0$ mixing were published for the first time in 1987 by UA1 [8] and ARGUS [9], and since then by many other experiments. These measurements are typically based on counting same-sign and opposite-sign lepton pairs from the semileptonic decay of the produced $b\overline{b}$ pairs. Such analyses cannot easily separate the contributions from the different *b*-hadron species, therefore the clean environment of $\Upsilon(4S)$ machines (where only B_d^0 and charged B_u mesons are produced) is in principle best suited to measure χ_d .

However, better sensitivity is obtained from time-dependent analyses aimed at the direct measurement of the oscillation frequencies Δm_d and Δm_s , from the proper time distributions of B_d^0 or B_s^0 candidates identified through their decay in (mostly) flavor-specific modes and suitably tagged as mixed or unmixed. (This is particularly true for the $B_s^0 - \overline{B}_s^0$ system where the large value of x_s implies maximal mixing, *i.e.* $\chi_s \simeq 1/2$.) In such analyses the B_d^0 or B_s^0 mesons are either fully reconstructed, partially reconstructed from a charm meson, selected from a lepton with the characteristics of a $b \rightarrow \ell^-$ decay, or selected from a reconstructed displaced vertex. At high-energy colliders (LEP, SLC, Tevatron), the proper time $t = \frac{m_B}{p}L$ is measured from the distance L between the production vertex and

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the *B* decay vertex, and from an estimate of the *B* momentum *p*. At asymmetric *B* factories (KEKB, PEP-II), producing $e^+e^- \rightarrow \Upsilon(4S) \rightarrow B^0_d \overline{B}^0_d$ events with a boost $\beta\gamma$ (= 0.425, 0.55), the proper time difference between the two *B* candidates is estimated as $\Delta t \simeq \frac{\Delta z}{\beta\gamma c}$, where Δz is the spatial separation between the two *B* decay vertices along the boost direction. In all cases, the good resolution needed on the vertex positions is obtained with silicon detectors.

The statistical significance ${\cal S}$ of a B^0_d or B^0_s oscillation signal can be approximated as [10]

$$S \approx \sqrt{N/2} f_{\text{sig}} \left(1 - 2\eta\right) e^{-(\Delta m \,\sigma_t)^2/2}, \qquad (27)$$

where N and $f_{\rm sig}$ are the number of candidates and the fraction of signal in the selected sample, η is the total mistag probability, and σ_t is the resolution on proper time (or proper time difference). The quantity S decreases very quickly as Δm increases; this dependence is controlled by σ_t , which is therefore a critical parameter for Δm_s analyses. At high-energy colliders, the proper time resolution $\sigma_t \sim \frac{m_B}{\langle p \rangle} \sigma_L \oplus t \frac{\sigma_p}{p}$ includes a constant contribution due to the decay length resolution σ_L (typically 0.05-0.3 ps), and a term due to the relative momentum resolution σ_p/p (typically 10–20% for partially reconstructed decays) which increases with proper time. At *B* factories, the *B* momentum is reconstructed and/or estimated from the beam energy constraint, and the term due to the spatial resolution dominates (typically 1–1.5 ps because of the much smaller *B* boost).

In order to tag a B candidate as mixed or unmixed, it is necessary to determine its flavor both in the initial state and in the final state. The initial and final state mistag probabilities, η_i and η_f , degrade S by a total factor $(1-2\eta) = (1-2\eta_i)(1-2\eta_f)$. In lepton-based analyses, the final state is tagged by the charge

of the lepton from $b \to \ell^-$ decays; the biggest contribution to η_f is then due to $\overline{b} \to \overline{c} \to \ell^-$ decays. Alternatively, the charge of a reconstructed charm meson $(D^{*-} \text{ from } B^0_d \text{ or } D^-_s \text{ from } B^0_s)$, or that of a kaon thought to come from a $b \to c \to s$ decay [11], can be used. For fully inclusive analyses based on topological vertexing, final state tagging techniques include jet charge [12] and charge dipole [13,14] methods.

At high-energy colliders, the methods to tag the initial state (i.e. the state at production), can be divided in two groups: the ones that tag the initial charge of the \overline{b} quark contained in the B candidate itself (same-side tag), and the ones that tag the initial charge of the other b quark produced in the event (opposite-side tag). On the same side, the charge of a track from the primary vertex is correlated with the production state of the B if that track is a decay product of a B^{**} state or the first particle in the fragmentation chain [15,16]. Jet- and vertex-charge techniques work on both sides and on the opposite side, respectively. Finally, the charge of a lepton from $b \to \ell^$ or of a kaon from $b \to c \to s$ can be used as opposite side tags, keeping in mind that their performance is degraded due to integrated mixing. At SLC, the beam polarization produced a sizeable forward-backward asymmetry in the $Z \to b \overline{b}$ decays and provided another very interesting and effective initial state tag based on the polar angle of the B candidate [11]. Initial state tags have also been combined to reach $\eta_i \sim 26\%$ at LEP [16,17], or even 22% at SLD [13] with full efficiency. The equivalent figure at CDF (Tevatron Run I) is $\sim 40\%$ [18].

At *B* factories, the flavor of a B_d^0 meson at production cannot be determined, since the two neutral *B* mesons produced in a $\Upsilon(4S)$ decay evolve in a coherent *P*-wave state where they keep opposite flavors at any time. However, as soon as one

of them decays, the other follows a time-evolution given by Eqs. (6) or (7), where t is replaced with Δt . Hence, the "initial state" tag of a B can be taken as the final state tag of the other B. Effective mistag probabilities of $\eta_i \sim 24\%$ for full efficiency (corresponding to effective tagging efficiencies of ~ 27% for perfect tagging) are achieved by BABAR and Belle [19], using different techniques including $b \to \ell^-$ and $b \to c \to s$ tags. It is interesting to note that, in this case, mixing of this other B (i.e. the coherent mixing occurring before the first B decay) does not contribute to the mistag probability.

In the absence of experimental evidence for a width difference, oscillation analyses typically neglect $\Delta\Gamma$ and describe the data with the physics functions $\Gamma e^{-\Gamma t} (1 \pm \cos(\Delta m t))/2$ (highenergy colliders) or $\Gamma e^{-\Gamma |\Delta t|} (1 \pm \cos(\Delta m \Delta t))/4$ (asymmetric $\Upsilon(4S)$ machines). As can be seen from Eq. (9), a non-zero value of $\Delta\Gamma$ would effectively reduce the oscillation amplitude with a small time-dependent factor that would be very difficult to distinguish from time resolution effects. Whereas measurements of Δm_d are usually extracted from the data using a maximum likelihood fit, no significant $B_s^0 - \overline{B}_s^0$ oscillations have been seen so far. To extract information useful to set lower limits on Δm_s , B_s^0 analyses follow a method [10] in which a B_s^0 oscillation amplitude \mathcal{A} is measured as a function of a fixed test value of Δm_s , using a maximum likelihood fit based on the functions $\Gamma_s e^{-\Gamma_s t} (1 \pm \mathcal{A} \cos(\Delta m_s t))/2$. To a very good approximation, the statistical uncertainty on \mathcal{A} is Gaussian and equal to $1/\mathcal{S}$ [10]. If $\Delta m_s = \Delta m_s^{\text{true}}$, one expects $\mathcal{A} = 1$ within the total uncertainty $\sigma_{\mathcal{A}}$; however, if Δm_s is (far) below its true value, a measurement consistent with $\mathcal{A} = 0$ is expected. A value of Δm_s can be excluded at 95% CL if $\mathcal{A} + 1.645 \sigma_{\mathcal{A}} \leq 1$. If Δm_s^{true} is very large, one expects $\mathcal{A} = 0$, and all values of Δm_s such that

 $1.645 \sigma_{\mathcal{A}}(\Delta m_s) < 1$ are expected to be excluded at 95% CL. Because of the proper time resolution, the quantity $\sigma_{\mathcal{A}}(\Delta m_s)$ is an increasing function of Δm_s and one therefore expects to be able to exclude individual Δm_s values up to Δm_s^{sens} , where Δm_s^{sens} , called here the sensitivity of the analysis, is defined by $1.645 \sigma_{\mathcal{A}}(\Delta m_s^{\text{sens}}) = 1.$

B^0_d mixing studies

Many $B^0_d - \overline{B}^0_d$ oscillations analyses have been performed by the ALEPH [12,20], BABAR [21], Belle [22,23], CDF [15,24], DELPHI [14,25], L3 [26], OPAL [27] and SLD [11] collaborations. Although a variety of different techniques have been used, the individual Δm_d results obtained at high-energy colliders have remarkably similar precision. Their average is compatible with the recent and more precise measurements from asymmetric B factories. The systematic uncertainties are not negligible; they are often dominated by sample composition, mistag probability, or b-hadron lifetime contributions. Before being combined, the measurements are adjusted on the basis of a common set of input values, including the *b*-hadron lifetimes and fractions published in this *Review*. Some measurements are statistically correlated. Systematic correlations arise both from common physics sources (fragmentation fractions, lifetimes, branching ratios of b hadrons), and from purely experimental or algorithmic effects (efficiency, resolution, tagging, background description). Combining all published measurements [15,20–22,25–27] and accounting for all identified correlations as described in Ref. 28 yields $\Delta m_d = 0.489 \pm 0.005 (\text{stat}) \pm 0.007 (\text{syst}) \text{ ps}^{-1}$.

On the other hand, ARGUS and CLEO have published time-integrated measurements [29–31], which average to $\chi_d = 0.182 \pm 0.015$. Following Ref. 31, the width difference $\Delta \Gamma_d$ could in principle be extracted from the measured value of Γ_d

and the above averages for Δm_d and χ_d (see Eqs. (12) and (17)), provided that $\Delta \Gamma_d$ has a negligible impact on the Δm_d measurements. However, a stronger constraint, $\Delta \Gamma_d / \Gamma_d < 20\%$ at 90% CL, has been obtained by DELPHI from a direct timedependent study [14]. Assuming $\Delta \Gamma_d = 0$ and no CP violation in mixing, and using the measured B_d^0 lifetime, the Δm_d and χ_d results are combined to yield the world average

$$\Delta m_d = 0.489 \pm 0.008 \ \mathrm{ps}^{-1} \tag{28}$$

or, equivalently,

$$\chi_d = 0.181 \pm 0.004 \,. \tag{29}$$

Evidence for CP violation in B_d^0 mixing has been searched for, both with flavor-specific and inclusive B_d^0 decays, in samples where the initial flavor state is tagged. In the case of semileptonic (or other flavor-specific) decays, where the final state tag is also available, the following asymmetry

$$\frac{N(\overline{B}_{d}^{0}(t) \to \ell^{+}\nu_{\ell}X) - N(B_{d}^{0}(t) \to \ell^{-}\overline{\nu}_{\ell}X)}{N(\overline{B}_{d}^{0}(t) \to \ell^{+}\nu_{\ell}X) + N(B_{d}^{0}(t) \to \ell^{-}\overline{\nu}_{\ell}X)} = a_{CP} \simeq 1 - |q/p|_{d}^{2} \simeq \frac{4\text{Re}(\epsilon_{d})}{1 + |\epsilon_{d}|^{2}}$$
(30)

has been measured, either in time-integrated analyses at CLEO [30–32] and CDF [33], or in time-dependent analyses at LEP [34–36] and BABAR [37]. In the inclusive case, also investigated at LEP [35,36,38], no final state tag is used, and the asymmetry [39]

$$\frac{N(B_d^0(t) \to \text{all}) - N(\overline{B}_d^0(t) \to \text{all})}{N(B_d^0(t) \to \text{all}) + N(\overline{B}_d^0(t) \to \text{all})} \\
\simeq a_{CP} \left[\frac{x_d}{2} \sin(\Delta m_d t) - \sin^2 \left(\frac{\Delta m_d t}{2} \right) \right]$$
(31)

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must be measured as a function of the proper time to extract information on CP violation. In all cases asymmetries compatible with zero have been found, with a precision limited by the available statistics. A simple average of all published and preliminary results [30–38] neglecting small possible statistical correlations and assuming half of the systematics to be correlated between measurements performed at the same energy, is $a_{CP} = -0.002 \pm 0.009(\text{stat}) \pm 0.008(\text{syst})$, a result which does not yet constrain the Standard Model.

The Δm_d result of Eq. (28) provides an estimate of $|M_{12}|$ and can be used, together with Eqs. (16) and (18), to extract the magnitude of the CKM matrix element V_{td} within the Standard Model [40]. The main experimental uncertainties on the resulting estimate of $|V_{td}|$ come from m_t and Δm_d ; however, the extraction is at present completely dominated by the uncertainty on the hadronic matrix element $f_{B_d}\sqrt{B_{B_d}} = 230 \pm 40$ MeV obtained from lattice QCD calculations [41].

B_s^0 mixing studies

 $B_s^0-\overline{B}_s^0$ oscillations have been the subject of many studies from ALEPH [16,42], CDF [43], DELPHI [14,17,44,45], OPAL [46] and SLD [13,47]. No oscillation signal has been found so far. The most sensitive analyses appear to be the ones based on inclusive lepton samples at LEP. Because of their better proper time resolution, the small data samples analyzed inclusively at SLD, as well as the few fully reconstructed B_s decays at LEP, turn out to be also very useful to explore the high Δm_s region.

All results are limited by the available statistics. They can easily be combined, since all experiments provide measurements of the B_s^0 oscillation amplitude. The latter are averaged using the procedure of Ref. 28 to yield the combined amplitudes

 \mathcal{A} shown in Fig. **@Fg.amplitude@** as a function of Δm_s . The individual results have been adjusted to common physics inputs, and all known correlations have been accounted for; the sensitivities of the inclusive analyses, which depend directly through Eq. (27) on the assumed fraction f_s of B_s^0 mesons in an unbiased sample of weakly-decaying b hadrons, have also been rescaled to a common preliminary average of $f_s = 0.097 \pm 0.011$. The combined sensitivity for 95% CL exclusion of Δm_s values is found to be 19.3 ps⁻¹. All values of Δm_s below 14.9 ps⁻¹ are excluded at 95% CL. The values between 14.9 and 22.4 ps⁻¹ cannot be excluded, because the data is compatible with a signal in this region. However, no deviation from $\mathcal{A} = 0$ is seen in Fig. **@Fg.amplitude@** that would indicate the observation of a signal.

Some Δm_s analyses are still unpublished [13,14,42,45,47]. Using only published results, the combined Δm_s result is

$$\Delta m_s > 13.1 \text{ ps}^{-1}$$
 at 95% CL, (32)

with a sensitivity of 13.3 ps^{-1} .

The information on $|V_{ts}|$ obtained, in the framework of the Standard Model, from the combined amplitude spectrum is hampered by the hadronic uncertainty, as in the B_d^0 case. However, many uncertainties cancel in the frequency ratio

$$\frac{\Delta m_s}{\Delta m_d} = \frac{m_{B_s}}{m_{B_d}} \xi^2 \left| \frac{V_{ts}}{V_{td}} \right|^2 \,, \tag{33}$$

where $\xi = (f_{B_s}\sqrt{B_{B_s}})/(f_{B_d}\sqrt{B_{B_d}}) = 1.16 \pm 0.05$ is an SU(3) flavor-symmetry breaking factor obtained from lattice QCD calculations [41]. The CKM matrix can be constrained using the experimental results on Δm_d , Δm_s , $|V_{ub}/V_{cb}|$, ϵ_K and $\sin(2\beta)$ together with theoretical inputs and unitarity conditions [40,49].

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Figure 2: Combined measurements of the B_s^0 oscillation amplitude as a function of Δm_s , including all preliminary results available at the time of the winter 2002 conferences [48]. The measurements are dominated by statistical uncertainties. Neighboring points are statistically correlated.

Given all measurements other than Δm_d and Δm_s , the constraint from our knowledge on the ratio $\Delta m_d / \Delta m_s$ is presently more effective in limiting the position of the apex of the CKM unitarity triangle than the one obtained from the Δm_d measurements alone, due to the reduced hadronic uncertainty in Eq. (33). We note also that it would be difficult for the Standard Model to accommodate values of Δm_s above ~ 25 ps⁻¹ [49].

Information on $\Delta\Gamma_s$ can be obtained by studying the proper time distribution of untagged data samples enriched in B_s^0

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mesons [50]. In the case of an inclusive B_s^0 selection [51] or a semileptonic B_s^0 decay selection [17,52], both the short- and long-lived components are present, and the proper time distribution is a superposition of two exponentials with decay constants $\Gamma_s \pm \Delta \Gamma_s/2$. In principle, this provides sensitivity to both Γ_s and $(\Delta \Gamma_s / \Gamma_s)^2$. Ignoring $\Delta \Gamma_s$ and fitting for a single exponential leads to an estimate of Γ_s with a relative bias proportional to $(\Delta \Gamma_s / \Gamma_s)^2$. An alternative approach, which is directly sensitive to first order in $\Delta\Gamma_s/\Gamma_s$, is to determine the lifetime of B_s^0 candidates decaying to CP eigenstates; measurements exist for $B_s^0 \to J/\psi \phi$ [53] and $B_s^0 \to D_s^{(*)+} D_s^{(*)-}$ [54], which are mostly *CP*-even states [7]. An estimate of $\Delta \Gamma_s / \Gamma_s$ has also been obtained directly from a measurement of the $B_s^0 \to D_s^{(*)+} D_s^{(*)-}$ branching ratio [54], under the assumption that these decays practically account for all the CP-even final states.

Present data is not precise enough to efficiently constrain both Γ_s and $\Delta\Gamma_s/\Gamma_s$; since the B_s^0 and B_d^0 lifetimes are predicted to be equal within less than a percent [55], an expectation compatible with the current experimental data [56], the constraint $\Gamma_s = \Gamma_d$ can also be used to improve the extraction of $\Delta\Gamma_s/\Gamma_s$. Applying the combination procedure of Ref. 28 on the published results [17,52–54,57] yields

$$\Delta \Gamma_s / \Gamma_s < 0.52$$
 at 95% CL (34)

without external constraint, or

$$\Delta \Gamma_s / \Gamma_s < 0.31 \quad \text{at } 95\% \text{ CL}$$
 (35)

when constraining $1/\Gamma_s$ to the measured B_d^0 lifetime. These results are not yet precise enough to test Standard Model predictions.

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Average b-hadron mixing and b-hadron production fractions at high energy

Let f_u , f_d , f_s and f_{baryon} be the B_u , B_d^0 , B_s^0 and bbaryon fractions composing an unbiased sample of weaklydecaying b hadrons produced in high-energy colliders. LEP experiments have measured $f_s \times \text{BR}(B_s^0 \to D_s^- \ell^+ \nu_\ell X)$ [58], $\text{BR}(b \to \Lambda_b^0) \times \text{BR}(\Lambda_b^0 \to \Lambda_c^+ \ell^- \overline{\nu}_\ell X)$ [59] and $\text{BR}(b \to \Xi_b^-) \times$ $\text{BR}(\Xi_b^- \to \Xi^- \ell^- \overline{\nu}_\ell X)$ [60] from partially reconstructed final states including a lepton, f_{baryon} from protons identified in bevents [61], and the production rate of charged b hadrons [62]. The various b-hadron fractions have also been measured at CDF from electron-charm final states [63]. All the published results have been combined following the procedure and assumptions described in Ref. 28, to yield $f_u = f_d = (37.3 \pm 2.0)\%$, $f_s =$ $(13.9 \pm 3.8)\%$ and $f_{\text{baryon}} = (11.5 \pm 2.0)\%$ under the constraints

$$f_u = f_d$$
 and $f_u + f_d + f_s + f_{\text{baryon}} = 1$. (36)

Time-integrated mixing analyses performed with lepton pairs from $b\overline{b}$ events produced at high-energy colliders measure the quantity

$$\overline{\chi} = f'_d \,\chi_d + f'_s \,\chi_s \,, \tag{37}$$

where f'_d and f'_s are the fractions of B^0_d and B^0_s hadrons in a sample of semileptonic *b*-hadron decays. Assuming that all *b* hadrons have the same semileptonic decay width implies $f'_q = f_q/(\Gamma_q \tau_b)$ (q = s, d), where τ_b is the average *b*-hadron lifetime. Hence $\overline{\chi}$ measurements can be used to improve our knowledge on the fractions f_u , f_d , f_s and f_{baryon} .

Combining the above estimates of these fractions with the average $\overline{\chi} = 0.1184 \pm 0.0045$ (published in this *Review*), χ_d from

Eq. (29) and $\chi_s = 1/2$ yields, under the constraints of Eq. (36),

$$f_u = f_d = (38.8 \pm 1.3)\%, \qquad (38)$$

$$f_s = (10.6 \pm 1.3)\%, \tag{39}$$

$$f_{\text{baryon}} = (11.8 \pm 2.0)\%,$$
 (40)

showing that mixing information substantially reduces the uncertainty on f_s . These results and the averages quoted in Eqs. (28) and (29) for χ_d and Δm_d have been obtained in a consistent way by the *B* oscillations working group [28], taking into account the fact that many individual measurements of Δm_d depend on the assumed values for the *b*-hadron fractions.

Summary and prospects

 $B^0-\overline{B}^0$ mixing has been and still is a field of intense study. The mass difference in the $B_d^0-\overline{B}_d^0$ system is very well measured (with an accuracy of 1.7%) but, despite an impressive theoretical effort, the hadronic uncertainty still limits the precision of the extracted estimate of $|V_{td}|$. The mass difference in the $B_s^0-\overline{B}_s^0$ system is much larger and still unmeasured. However, the current experimental lower limit on Δm_s already provides, together with Δm_d , a significant constraint on the CKM matrix within the Standard Model. No strong experimental evidence exists yet for the rather large decay width difference expected in the $B_s^0-\overline{B}_s^0$ system. It is interesting to recall that the ratio $\Delta\Gamma_s/\Delta m_s$ does not depend on CKM matrix elements in the Standard Model (see Eq. (22)), and that a measurement of either Δm_s or $\Delta\Gamma_s$ could be turned into a Standard Model prediction of the other one.

The LEP and SLD experiments have still not finalized all their B_s^0 oscillation analyses, but a first measurement of Δm_s from data collected at the Z pole is now very unlikely. In the

near future, the most promising prospects for B_s^0 mixing are from Run II at the Tevatron, where both Δm_s and $\Delta \Gamma_s$ are expected to be measured with fully reconstructed B_s^0 decays; for example, with 2 fb⁻¹ of data, CDF expects to observe B_s^0 oscillations for values of Δm_s up to ~ 40 – 50 ps⁻¹ (depending on event yields and signal-to-background ratios) [64], well above the current Standard Model prediction.

CP violation in B mixing, which has not been seen yet, as well as the phases involved in B mixing, will be further investigated with the large statistics that will become available both at the B factories and at the Tevatron.

B mixing may not have delivered all its secrets yet, because it is one of the phenomena where new physics might very well reveal itself (for example new particles involved in the box diagrams). Theoretical calculations in lattice QCD are becoming more reliable and further progress in reducing hadronic uncertainties is expected. In the long term, a stringent check of the consistency, within the Standard Model, of the B_d^0 and B_s^0 mixing measurements with all other measured observables in B physics (including CP asymmetries in B decays) will be possible, allowing to place limits on new physics or, better, discover new physics.

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$B^0 - \overline{B}^0$ MIXING PARAMETERS

For a discussion of $B^0-\overline{B}^0$ mixing see the note on " $B^0-\overline{B}^0$ Mixing" in the B^0 Particle Listings above.

 χ_d is a measure of the time-integrated $B^0_-\overline{B}^0$ mixing probability that a produced $B^0(\overline{B}^0)$ decays as a $\overline{B}^0(B^0)$. Mixing violates $\Delta B \neq 2$ rule.

$$\begin{split} \chi_d &= \frac{x_d^2}{2(1\!+\!x_d^2)} \\ x_d &= \frac{\Delta m_{B^0}}{\Gamma_{B^0}} = (m_{B^0_H} - m_{B^0_L}) \; \tau_{B^0} \; , \end{split}$$

where *H*, *L* stand for heavy and light states of two B^0 *CP* eigenstates and $\tau_{B^0} = \frac{1}{0.5(\Gamma_{B^0_H} + \Gamma_{B^0_L})}$.

χd

This $B^0 - \overline{B}{}^0$ mixing parameter is the probability (integrated over time) that a produced B^0 (or $\overline{B}{}^0$) decays as a $\overline{B}{}^0$ (or B^0), e.g. for inclusive lepton decays

$$\begin{split} \chi_{d} &= \Gamma(B^{0} \to \ell^{-} X \text{ (via } \overline{B}^{0})) / \Gamma(B^{0} \to \ell^{\pm} X) \\ &= \Gamma(\overline{B}^{0} \to \ell^{+} X \text{ (via } B^{0})) / \Gamma(\overline{B}^{0} \to \ell^{\pm} X) \end{split}$$

Where experiments have measured the parameter $r = \chi/(1-\chi)$, we have converted to χ . Mixing violates the $\Delta B \neq 2$ rule.

Note that the measurement of χ at energies higher than the $\Upsilon(4S)$ have not separated χ_d from χ_s where the subscripts indicate $B^0(\overline{b}d)$ or $B^0_s(\overline{b}s)$. They are listed in the $B_{s}^{0}-\overline{B}_{s}^{0}$ MIXING section.

The experiments at $\Upsilon(4S)$ make an assumption about the $B^0 \overline{B}{}^0$ fraction and about the ratio of the B^{\pm} and B^{0} semileptonic branching ratios (usually that it equals one).

OUR EVALUATION, provided by the LEP B Oscillation Working Group, includes χ_{d} calculated from Δm_{B^0} and τ_{B^0} .

VALUE	<u>CL%</u>	DOCUMENT ID	TECN	COMMENT	_
0.181 ± 0.004 OUR E	VALUATIO	N			
0.182 ± 0.015 OUR A	VERAGE				
$0.198\!\pm\!0.013\!\pm\!0.014$		⁴¹⁵ BEHRENS	00B CLE2	$e^+e^- ightarrow ~\Upsilon(4S)$	
$0.16\ \pm 0.04\ \pm 0.04$		⁴¹⁶ ALBRECHT	94 ARG	$e^+e^- ightarrow ~\Upsilon(4S)$	
$0.149\!\pm\!0.023\!\pm\!0.022$		⁴¹⁷ BARTELT	93 CLE2	$e^+e^- ightarrow ~\Upsilon(4S)$	
0.171 ± 0.048		⁴¹⁸ ALBRECHT	92L ARG	$e^+e^- ightarrow ~\Upsilon(4S)$	
\bullet \bullet \bullet We do not use the	ne following	g data for averages,	fits, limits, et	ic. ● ● ●	
$0.20\ \pm 0.13\ \pm 0.12$		⁴¹⁹ ALBRECHT	96d ARG	$e^+e^- \rightarrow \Upsilon(4S)$	
$0.19\ \pm 0.07\ \pm 0.09$		⁴²⁰ ALBRECHT	96d ARG	$e^+e^- ightarrow ~\Upsilon(4S)$	
$0.24\ \pm 0.12$		⁴²¹ ELSEN	90 JADE	e^+e^- 35–44 GeV	
$0.158 \substack{+ 0.052 \\ - 0.059}$		ARTUSO	89 CLEO	$e^+e^- ightarrow ~\Upsilon(4S)$	
$0.17\ \pm 0.05$		⁴²² ALBRECHT	871 ARG	$e^+e^- ightarrow ~\Upsilon(4S)$	
<0.19	90	⁴²³ BEAN	87b CLEO	$e^+e^- \rightarrow \Upsilon(4S)$	
<0.27	90	⁴²⁴ AVERY	84 CLEO	$e^+e^- \rightarrow \Upsilon(4S)$	
115					

 415 BEHRENS 00B uses high-momentum lepton tags and partially reconstructed \overline{B} $D^{*+}\pi^{-}$, ρ^{-} decays to determine the flavor of the *B* meson.

 416 ALBRECHT 94 reports r=0.194 \pm 0.062 \pm 0.054. We convert to χ for comparison. Uses tagged events (lepton + pion from D^*).

- 417 BARTELT 93 analysis performed using tagged events (lepton+pion from D^*). Using dilepton events they obtain 0.157 \pm 0.016 $\substack{+0.033\\-0.028}$
- ⁴¹⁸ ALBRECHT 92L is a combined measurement employing several lepton-based techniques. It uses all previous ARGUS data in addition to new data and therefore supersedes AL-BRECHT 871. A value of $r = 20.6 \pm 7.0\%$ is directly measured. The value can be used to measure x = $\Delta M/\Gamma$ = 0.72 \pm 0.15 for the B_d meson. Assumes f_{+-}/f_0 = 1.0 \pm 0.05 and uses $\tau_{B^{\pm}}/\tau_{B^{0}} = (0.95 \pm 0.14) (f_{+-}/f_{0})$.

⁴¹⁹ Uses $D^{*+}K^{\pm}$ correlations. ⁴²⁰ Uses $(D^{*+}\ell^{-})K^{\pm}$ correlations.

 421 These experiments see a combination of B_s and B_d mesons.

 422 ALBRECHT 871 is inclusive measurement with like-sign dileptons, with tagged B decays plus leptons, and one fully reconstructed event. Measures $r=0.21\pm0.08$. We convert to χ for comparison. Superseded by ALBRECHT 92L.

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 $^{423}\,{\rm BEAN}$ 87B measured r $<\,$ 0.24; we converted to $\chi.$

 424 Same-sign dilepton events. Limit assumes semileptonic BR for B^+ and B^0 equal. If B^0/B^{\pm} ratio <0.58, no limit exists. The limit was corrected in BEAN 87B from r < 0.30 to r < 0.37. We converted this limit to χ .

$\Delta m_{B^0} = m_{B^0_H} - m_{B^0_L}$

 $\Delta m_{B_{-}^{0}}$ is a measure of 2π times the $B^{0}-\overline{B}^{0}$ oscillation frequency in time-dependent mixing experiments.

The second "OUR EVALUATION" (0.489 \pm 0.009) is an average of the data listed below performed by the LEP B Oscillation Working Group as described in our "Review of $B-\overline{B}$ Mixing" in the B^0 Section of these Listings. The averaging procedure takes into account correlations between the measurements.

The first "OUR EVALUATION" (0.489 \pm 0.008), also provided by the LEP B Oscillation Working Group, includes Δm_d calculated from χ_d measured at $\Upsilon(4S)$.

VALUE $(10^{12} h s^{-1})$	EVTS	DOCUMENT ID	TECN	COMMENT
0.489±0.008 OUR EVAL	JATION			
0.489±0.009 OUR EVAL	JATION			
$0.516\!\pm\!0.016\!\pm\!0.010$	425	AUBERT	021 BABR	$e^+e^- ightarrow ~\Upsilon(4S)$
$0.493\!\pm\!0.012\!\pm\!0.009$	426	AUBERT	02J BABR	$e^+e^- \rightarrow \Upsilon(4S)$
$0.463\!\pm\!0.008\!\pm\!0.016$	426	ABE	01D BELL	$e^+e^- \rightarrow \Upsilon(4S)$
$0.497\!\pm\!0.024\!\pm\!0.025$	427	ABBIENDI,G	00b OPAL	$e^+e^- \rightarrow Z$
$0.503\!\pm\!0.064\!\pm\!0.071$	428	ABE	99k CDF	<i>р</i> рат 1.8 ТеV
$0.500\!\pm\!0.052\!\pm\!0.043$	429	ABE	99Q CDF	<i>р</i> рат 1.8 ТеV
$0.516 {\pm} 0.099 {+} 0.029 \\ {-} 0.035$	430	AFFOLDER	99C CDF	<i>р</i> р ат 1.8 ТеV
$0.471 \substack{+ 0.078 + 0.033 \\ - 0.068 - 0.034}$	431	ABE	98C CDF	<i>р</i> р at 1.8 ТеV
$0.458\!\pm\!0.046\!\pm\!0.032$	432	ACCIARRI	98d L3	$e^+e^- \rightarrow Z$
$0.437 \!\pm\! 0.043 \!\pm\! 0.044$	433	ACCIARRI	98d L3	$e^+e^- \rightarrow Z$
$0.472\!\pm\!0.049\!\pm\!0.053$	434	ACCIARRI	98d L3	$e^+e^- \rightarrow Z$
$0.523\!\pm\!0.072\!\pm\!0.043$	435	ABREU	97N DLPH	$e^+e^- \rightarrow Z$
$0.493\!\pm\!0.042\!\pm\!0.027$	433	ABREU	97N DLPH	$e^+e^- \rightarrow Z$
$0.499\!\pm\!0.053\!\pm\!0.015$	436	ABREU	97N DLPH	$e^+e^- \rightarrow Z$
$0.480\!\pm\!0.040\!\pm\!0.051$	432	ABREU	97N DLPH	$e^+e^- \rightarrow Z$
$0.444 \!\pm\! 0.029 \!+\! 0.020 \\ -0.017$	433	ACKERSTAFF	97∪ OPAL	$e^+e^- \rightarrow Z$
$0.430 \!\pm\! 0.043 \!+\! 0.028 \\ -0.030$	432	ACKERSTAFF	97V OPAL	$e^+e^- \rightarrow Z$
$0.482\!\pm\!0.044\!\pm\!0.024$	437	BUSKULIC	97d ALEP	$e^+e^- \rightarrow Z$
$0.404 \!\pm\! 0.045 \!\pm\! 0.027$	433	BUSKULIC	97d ALEP	$e^+e^- \rightarrow Z$
$0.452\!\pm\!0.039\!\pm\!0.044$	432	BUSKULIC	97d ALEP	$e^+e^- \rightarrow Z$
$0.539 \!\pm\! 0.060 \!\pm\! 0.024$	438	ALEXANDER	96v OPAL	$e^+e^- \rightarrow Z$
$0.567 \!\pm\! 0.089 \!+\! 0.029 \\ -0.023$	439	ALEXANDER	96∨ OPAL	$e^+e^- \rightarrow Z$

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

$0.444 \pm 0.028 \pm 0.028$ 0.497 ± 0.035		⁴⁴⁰ ACCIARRI ⁴⁴¹ ABREU	98d L3 97n DLPH	$e^+e^- \rightarrow Z$ $e^+e^- \rightarrow Z$
$0.467 \pm 0.022 {+0.017 \atop -0.015}$		⁴⁴² ACKERSTAFF	97∨ OPAL	$e^+e^- \rightarrow Z$
0.446±0.032		⁴⁴³ BUSKULIC	97d ALEP	$e^+e^- \rightarrow Z$
$0.531^{+0.050}_{-0.046} \pm 0.078$		⁴⁴⁴ ABREU	96Q DLPH	Sup. by ABREU 97N
$0.496^{+0.055}_{-0.051}{\pm}0.043$		⁴³² ACCIARRI	96E L3	Repl. by ACCIARRI 98D
$0.548 \!\pm\! 0.050 \!+\! 0.023 \\ -\! 0.019$		⁴⁴⁵ ALEXANDER	96∨ OPAL	$e^+e^- \rightarrow Z$
0.496 ± 0.046		⁴⁴⁶ AKERS	95J OPAL	Repl. by ACKER- STAFE 97V
$0.462 \substack{+ 0.040 + 0.052 \\ - 0.053 - 0.035}$		⁴³² AKERS	95J OPAL	Repl. by ACKER-
$0.50 \ \pm 0.12 \ \pm 0.06$		⁴³⁵ ABREU	94м DLPH	Sup. by ABREU 97N
$0.508\!\pm\!0.075\!\pm\!0.025$		⁴³⁸ AKERS	94C OPAL	Repl. by ALEXAN-
$0.57\ \pm 0.11\ \pm 0.02$	153	⁴³⁹ AKERS	94h OPAL	DER 96V Repl. by ALEXAN- DER 96V
$\begin{array}{rrr} 0.50 & +0.07 & +0.11 \\ & -0.06 & -0.10 \end{array}$		⁴³² BUSKULIC	94b ALEP	Sup. by BUSKULIC 97D
$\begin{array}{rrrr} 0.52 & +0.10 & +0.04 \\ & -0.11 & -0.03 \end{array}$		⁴³⁹ BUSKULIC	93к ALEP	Sup. by BUSKULIC 97D

⁴²⁵Uses a tagged sample of fully-reconstructed neutral B decays at $\Upsilon(4S)$.

⁴²⁶ Measured based on the time evolution of dilepton events in $\Upsilon(4S)$ decays.

⁴²⁷ Data analyzed using partially reconsturcted $\overline{B}^0 \to D^{*+} \ell^- \overline{\nu}$ decay and a combination of flavor tags from the rest of the event.

428 Uses di-muon events.

⁴²⁹ Uses jet-charge and lepton-flavor tagging.

430 Uses $\ell^- D^{*+} - \ell$ events.

431 Uses π -B in the same side.

432 Uses *ℓ*-*ℓ*.

433 Uses ℓ - Q_{hem} .

 434 Uses ℓ - ℓ with impact parameters.

435 Uses $D^{\pm}-Q_{\text{hem}}$.

⁴³⁶Uses $\pi_s^{\pm}\ell$ - Q_{hem} .

- 437 Uses $D^{*\pm} \ell/Q_{\text{hem}}$.
- 438 Uses $D^{\pm}\ell$ - Q_{hem} .
- ⁴³⁹Uses $D^{\pm}-\ell$.

440 ACCIARRI 98D combines results from $\ell - \ell$, $\ell - Q_{hem}$, and $\ell - \ell$ with impact parameters. 441 ABREU 97N combines results from $D^{\pm} - Q_{hem}$, $\ell - Q_{hem}$, $\pi_s^{\pm} \ell - Q_{hem}$, and $\ell - \ell$. 442 ACKERSTAFF 97V combines results from $\ell - \ell$, $\ell - Q_{hem}$, $D^{\pm} - \ell$, and $D^{\pm} - Q_{hem}$. 443 BUSKULIC 97D combines results from $D^{\pm} - \ell / Q_{hem}$, $\ell - Q_{hem}$, and $\ell - \ell$.

444 ABREU 96Q analysis performed using lepton, kaon, and jet-charge tags.

445 ALEXANDER 96V combines results from $D^{\pm}-\ell$ and $D^{\pm}\ell$ - Q_{hem} .

⁴⁴⁶ AKERS 95J combines results fromt charge measurement, $D^{*\pm}\ell$ - Q_{hem} and ℓ - ℓ .

0.755±0.015 OUR EVALUATION

 $\mathbf{x_d} = \frac{\Delta m_{B^0} / \Gamma_{B^0}}{\text{The second "OUR EVALUATION"}} (0.755 \pm 0.015) \text{ is an average of the data listed}$ in Δm_{B^0} section performed by the LEP B Oscillation Working Group as described

in our "Review of $B-\overline{B}$ Mixing" in the B^0 Section of these Listings. The averaging procedure takes into account correlations between the measurements.

The first "OUR EVALUATION" (0.755 \pm 0.015), also provided by the LEP B Oscillation Working Group, includes χ_d measured at $\Upsilon(4S)$.

VALUE 0.755±0.015 OUR EVALUATION DOCUMENT ID

DECAY -CP VIOLATION IN B **STANDARD** MODEL PREDICTIONS

Revised January 2002 by H. Quinn (SLAC) and A.I. Sanda (Nagoya University).

With the commissioning of the asymmetric B Factories at KEKB and PEP II, and of CESR III and with the completion of the main ring injector at Fermilab, we are headed into an exciting time for the study of *CP* violation in *B* meson decays. This review outlines the basic ideas of such studies. For the most part, we follow the discussions given in Refs. [1-3].

Time evolution of neutral B meson states

Neutral B mesons, like neutral K mesons, have mass eigenstates which are not flavor eigenstates. This subject is reviewed separately [4]. Here we give some formulae to establish the notation used in this review. The mass eigenstates are given by:

$$|B_1\rangle = p|B^0\rangle + q|\overline{B}^0\rangle ,$$

$$|B_2\rangle = p|B^0\rangle - q|\overline{B}^0\rangle ,$$
(1)

where B^0 and \overline{B}^0 are flavor eigenstates containing the \overline{b} and bquarks respectively. The ratio

$$\frac{q}{p} = +\sqrt{\frac{M_{12}^* - \frac{i}{2}\Gamma_{12}^*}{M_{12} - \frac{i}{2}\Gamma_{12}}}.$$
(2)

HTTP://PDG.LBL.GOV Page 83 Created: 12/2/2002 16:13 Here, the *CP* operator is defined so that $CP|B^0\rangle = |\overline{B}^0\rangle$, and *CPT* symmetry is assumed. We define $M_{12} = \overline{M}_{12}e^{i\xi}$, where the phase ξ is restricted to $-\frac{1}{2}\pi < \xi < \frac{1}{2}\pi$, and \overline{M}_{12} is taken to be real but not necessarily positive; and similarly (with a different phase) for Γ_{12} . The convention used here is that the real part of q/p is positive.

The differences in the eigenvalues $\Delta M = M_2 - M_1$ and $\Delta \Gamma = \Gamma_1 - \Gamma_2$ are given by

$$\Delta M = -2\operatorname{Re}\left(\frac{q}{p}(M_{12} - \frac{i}{2}\Gamma_{12})\right)$$
$$\simeq -2\overline{M}_{12}$$
$$\Delta \Gamma = -4\operatorname{Im}\left(\frac{q}{p}(M_{12} - \frac{i}{2}\Gamma_{12})\right)$$
$$\simeq 2\overline{\Gamma}_{12}\cos\zeta . \tag{3}$$

Here we denoted $\frac{\Gamma_{12}}{M_{12}} = re^{i\zeta}$. As we expect $r \sim 10^{-3}$ in the Standard Model for B_d , we kept only the leading order term in r. In the Standard Model, with these conventions and given that all models give a positive value for the parameter B_B , ΔM is positive, so that B_2 is heavier than B_1 ; this is unlikely to be tested soon. (Note that a common alternative convention is to name the two states B_L and B_H for light and heavy respectively; then the sign of q/p becomes the quantity to be tested.)

This review focuses on the B_d system, but also mentions some possibly interesting studies for CP violation in B_s decays, which may be pursued at hadron colliders. Much of the discussion here can be applied directly for B_s decays with the appropriate replacement of the spectator quark type.

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The time evolution of states starting out at time t = 0 as pure B^0 or \overline{B}^0 is given by:

$$|B^{0}(t)\rangle = g_{+}(t)|B^{0}\rangle + \frac{q}{p}g_{-}(t)|\overline{B}^{0}\rangle$$

$$|\overline{B}^{0}(t)\rangle = g_{+}(t)|\overline{B}^{0}\rangle + \frac{p}{q}g_{-}(t)|B^{0}\rangle, \qquad (4)$$

where

$$g_{\pm}(t) = \frac{1}{2}e^{-iM_{1}t}e^{-\frac{1}{2}\Gamma_{1}t}\left[1 \pm e^{-i\Delta Mt}e^{\frac{1}{2}\Delta\Gamma t}\right] .$$
 (5)

We define

$$A(f) = \langle f | H | B^0 \rangle ,$$

$$\overline{A}(f) = \langle f | H | \overline{B}^0 \rangle ,$$

$$\overline{\rho}(f) = \frac{\overline{A}(f)}{\overline{A}(f)} = \rho(f)^{-1} ,$$
(6)

where f is a final state that is possible for both B^0 and \overline{B}^0 decays. The time-dependent decay rates are thus given by

$$\Gamma(B^{0}(t) \to f)$$

$$\propto e^{-\Gamma_{1}t} |A(f)|^{2} \left[K_{+}(t) + K_{-}(t) \left| \frac{q}{p} \right|^{2} |\overline{\rho}(f)|^{2} + 2\operatorname{Re} \left[L^{*}(t) \left(\frac{q}{p} \right) \overline{\rho}(f) \right] \right], \qquad (7)$$

$$\Gamma(\overline{B}^{0}(t) \to f)$$

$$\propto e^{-\Gamma_{1}t} |\overline{A}(f)|^{2} \left[K_{+}(t) + K_{-}(t) \left| \frac{p}{q} \right|^{2} |\rho(f)|^{2} \right]$$

$$+ 2\operatorname{Re}\left[L^*(t)\left(\frac{p}{q}\right)\rho(f)\right]\Big],\tag{8}$$

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where

$$|g_{\pm}(t)|^{2} = \frac{1}{4}e^{-\Gamma_{1}t}K_{\pm}(t) ,$$

$$g_{-}(t)g_{+}^{*}(t) = \frac{1}{4}e^{-\Gamma_{1}t}L^{*}(t) ,$$

$$K_{\pm}(t) = 1 + e^{\Delta\Gamma t} \pm 2e^{\frac{1}{2}\Delta\Gamma t}\cos\Delta Mt ,$$

$$L^{*}(t) = 1 - e^{\Delta\Gamma t} + 2ie^{\frac{1}{2}\Delta\Gamma t}\sin\Delta Mt .$$
(9)

For the case of B_d decays the quantity $\Delta\Gamma/\Gamma$ is small and is usually dropped, for B_s decays it may be significant [6] and hence is retained in Eqs. 4–8.

Three classes of CP violation in B decays

When two amplitudes with different phase-structure contribute to a *B* decay, they may interfere and produce *CP*violating effects [5]. There are three distinct types of *CP* violation: (1) *CP* violation from nonvanishing relative phase between the mass and the width parts of the mixing matrix which gives $|q/p| \neq 1$, often called "indirect;" (2) Direct *CP* violation, which is any effect that indicates two decay amplitudes have different weak phases (those arising from Lagrangian couplings), in particular it occurs whenever $|\rho(f)| \neq 1$; (3) Interference between a decays with and without mixing which can occur for decays to *CP* eigenstates whenever $\operatorname{Arg}((q/p)\overline{\rho}(f)) \neq 0$. This can occur even for modes where both the other types do not, *i.e.* |q/p|, $|\rho(f)| = 1$.

(1) Indirect CP violation

In the next few years, experiments will accumulate a large number of semileptonic B decays. Any asymmetry in the wrong-sign semileptonic decays (or in any other wrong-flavor decays) is a clean sign of indirect CP violation.

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The semileptonic asymmetry for the wrong sign B_q decay, where q = d or s, is given by

$$a_{SL}(B_q) = \frac{\Gamma(\overline{B}_q(t) \to \ell^+ X) - \Gamma(B_q(t) \to \ell^- X)}{\Gamma(\overline{B}_q(t) \to \ell^+ X) + \Gamma(B_q(t) \to \ell^- X)}$$
$$= \frac{|p/q|^2 - |q/p|^2}{|p/q|^2 + |q/p|^2} = r_{B_q} \sin \zeta_{B_q} , \qquad (10)$$

where we kept only the leading order term in r_{Bq} . Within the context of the Standard Model, if hadronic rescattering effects are small then $\sin \zeta_{Bq}$ is small because M_{12} and Γ_{12} acquire their phases from the same combination of CKM matrix elements. Since this asymmetry is tiny in the Standard Model, this may be a fruitful area to search for physics beyond the Standard Model.

(2) Direct CP violation

Direct CP violation is the name given to CP violation that arises because there is a difference between the weak phases of any two decay amplitudes for a single decay. Weak phases are those that arise because of a complex coupling constant in the Lagrangian. Note that a single weak phase from a complex coupling constant is never physically meaningful because it can generally be removed by redefining some field by a phase. Only the differences between the phases of couplings which cannot be changed by such redefinitions are physically meaningful. The strong and electromagnetic couplings can always be defined to be real but, as Kobayashi and Maskawa first observed, in the three generation Standard Model one cannot remove all the phases from the CKM matrix by any choice of field redefinitions [7].

There are two distinct ways to observe direct CP-violation effects in B decays:

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• $|\overline{A}_{\overline{f}}/A_f| \neq 1$ leading to rate asymmetries for *CP*-conjugate decays. Here, two amplitudes with different weak phases must contribute to the same decay; they must also have different strong phases, that is, the phases that arise because of absorptive parts (often called final-state interaction effects). When the final state f has different flavor content than its *CP* conjugate, this gives a rate asymmetry that is directly observable. The asymmetry is given by

$$a = \frac{2A_1A_2\sin(\xi_1 - \xi_2)\sin(\delta_1 - \delta_2)}{A_1^2 + A_2^2 + 2A_1A_2\cos(\xi_1 - \xi_2)\cos(\delta_1 - \delta_2)}, \qquad (11)$$

where the A_i are the magnitudes, the ξ_i are the weak phases, and the δ_i are the strong phases of the two amplitudes contributing to A_f . The impact of direct CP violation of this type in decays of neutral B's to flavor eigenstates is discussed below.

• Any difference (other than an overall sign) between the CP asymmetries for decays of B_d mesons to flavor eigenstates, or between those of neutral B_s mesons, is an evidence of direct CP violation. As is shown below, such asymmetries arise whenever the decay weak phase is not canceled by the mixing weak phase, hence any two different results imply that there is a difference between the weak phases of the amplitudes for the two decays. Only if the asymmetries are the same can one choose a phase convention which ascribes all CP-violating phases to the mixing amplitude. For example, the expected asymmetries for the $B \rightarrow J/\psi K_S$ and $B \rightarrow \pi\pi$ decays are different (whether or not penguin graphs add additional direct CP-violating effects of the type $|\overline{A}_{\overline{f}}/A_f| \neq 1$ in the latter channel) because the dominant decay amplitudes have different weak phases in the Standard Model.

(3) Decays of B^0 and \overline{B}^0 to CP eigenstates

In decays to CP eigenstates, the time-dependent asymmetry is given by

$$a_f(t) = \frac{\Gamma(\overline{B}^0(t) \to f) - \Gamma(B^0(t) \to f)}{\Gamma(\overline{B}^0(t) \to f) + \Gamma(B^0(t) \to f)} .$$
(12)

Asymmetry is generated if: (i) both $A(B \to f)$ and $A(\overline{B} \to f)$ are nonzero; and (ii) the mixing weak phase in $\frac{q}{p}$ is different from the weak decay phase in $\overline{\rho}(f)$. To the leading order in r, the Standard Model predicts

$$q/p = \frac{V_{tb}^* V_{td}}{V_{tb} V_{td}^*} = e^{-i2\phi_{\text{mixing}}} .$$
 (13)

If there is only one amplitude (or two with the same weak phase) contributing to $A(B \to f)$ and $A(\overline{B} \to f)$ then $|\overline{\rho}(f)| = 1$ and the relationship between the measured asymmetry and the Kobayshi-Maskawa phases is cleanly predicted by

$$a_f(t) = \operatorname{Im}\left(\frac{q}{p}\overline{\rho}(f)\right) \sin \Delta M t$$

= $-\eta_f \sin 2(\phi_{\text{mixing}} + \phi_{\text{decay}}) \sin \Delta M t$. (14)

Here we have used the fact that in such cases we can write $\overline{\rho}(f) = \eta_f e^{-i2\phi_{\text{decay}}}$ where $\eta_f = \pm$ is the *CP* eigenvalue of the state f. The weak phases ϕ_{mixing} and ϕ_{decay} are parameterization dependent quantities, but the combination $\phi_{\text{mixing}} + \phi_{\text{decay}}$ is parameterization independent. This is *CP* violation due to the interference between decays with and without mixing. Note that a single measurement of $\sin(2\phi)$ yields four ambiguous solutions for ϕ .

When more than one amplitude with different weak phases contribute to a decay to a CP eigenstate there can also be direct

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CP violation effects $|\lambda_f=(q/p)\,\rho(f)|\neq 1$ and the asymmetry takes the more complicated form

$$a_f(t) = \frac{(|\lambda_f|^2 - 1)\cos(\Delta M t) + 2\mathrm{Im}\lambda_f\sin(\Delta M t)}{(1 + |\lambda_f|^2)} .$$
(15)

The quantity λ_f involves the ratio of the two amplitudes that contribute to A_f as well as their relative strong phases and hence introduces the uncertainties of hadronic physics into the relationship between the measured asymmetry and the K–M phases. However in certain cases such channels can be useful in resolving the ambiguities mentioned above. If $\cos(2\phi)$ can be measured as well as $\sin(\phi)$ only a two-fold ambiguity remains. This can be resolved only by knowledge of the sign of certain strong phase shifts [8].

When a B meson decays to a CP self-conjugate set of quarks the final state is in general a mixture of CP even and CP odd states, which contribute opposite sign and hence partially canceling asymmetries. In two special cases, namely the decay to two spin zero particles, or one spin zero and one non-zero spin particle there is a unique CP eigenvalue because there is only one possible relative angular momentum between the two final state particles. Quasi-two-body modes involving two particles with non-zero spin can sometimes be resolved into contributions of definite CP by angular analysis of the decays of the "final-state" particles [9].

There can also be a direct CP violation in these channels from the interference of two contributions to the same decay amplitude, $|\rho(f)| \neq 1$. This introduces dependence on the relative strengths of the two amplitude contributions and on their relative strong phases. Since these cannot be reliably calculated at present, this complicates the attempt to relate the measured asymmetry to the phases of CKM matrix elements.

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$Standard \ Model \ predictions \ for \ CP-violating \ asymmetries$

• Unitarity Triangles

The requirement that the CKM matrix be unitary leads to a number of relationships among its entries. The constraints that the product of row i with the complex conjugate of row j is zero are generically referred to as "unitarity triangles" because they each take the form of a sum of three complex numbers equal to zero and hence can be represented by triangles in the complex plane. There are six such relationships, (see for example Ref. 10); the most commonly studied is that with all angles of the same order of magnitude, given by the relationship

$$V_{ud}V_{ub}^* + V_{cd}V_{cb}^* + V_{td}V_{tb}^* = 0.$$
 (16)

This relation can be represented as a triangle on the complex plane, as shown in Fig. **@Fg.unitangle@**, where the signs of all three angles are also defined. When the sides are scaled by $|V_{cd}V_{cb}^*|$, the apex of the triangle is the point ρ, η , where these parameters are defined by the Wolfenstein parameterization of the CKM matrix [11]. If $\eta = 0$, the CKM matrix is real and there is no *CP* violation in the Standard Model.

The angles of the triangle are

$$\phi_{1} = \pi - \arg\left(\frac{-\mathbf{V}_{tb}^{*}V_{td}}{-V_{cb}^{*}V_{cd}}\right) = \beta ,$$

$$\phi_{2} = \arg\left(\frac{V_{tb}^{*}V_{td}}{-V_{ub}^{*}V_{ud}}\right) = \alpha ,$$

$$\phi_{3} = \arg\left(\frac{V_{ub}^{*}V_{ud}}{-V_{cb}^{*}V_{cd}}\right) = \gamma .$$
(17)

Two naming conventions for these angles are commonly used in the literature [12,13]; we provide the translation dictionary



Figure 1: Angles of the unitarity triangle are related to the Kobayashi-Maskawa phases of the CKM matrix. The right-hand rule gives the positive direction of the angle between two vectors. This figure was reproduced from Ref. 1 with permission from Cambridge University Press.

in Eq. (17), but use the ϕ_i notation in the remainder of this review, where ϕ_i is the angle opposite the side $V_{ib}^*V_{id}$ of the unitarity triangle and *i* represents the *i*-th up-type quark. As defined here, for consistency with the measured value of ϵ_K , these angles are all positive in the Standard Model, thus a determination of the sign of these angles constitutes a test of the Standard Model [14].

There are two other independent angles of the Standard Model which appear in other triangles. These are denoted

$$\chi = \arg\left(\frac{-V_{cs}^* V_{cb}}{V_{ts}^* V_{tb}}\right) = \beta_s$$

$$\chi' = \arg\left(\frac{-V_{ud}^* V_{us}}{V_{cd}^* V_{cs}}\right) = -\beta_K .$$
(18)

Again there are two naming conventions in common usage so we give both. These angles are of order λ^2 and λ^4 respectively [15], where $\lambda = V_{us}$. The first of them is the phase of the B_s mixing

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and thus is in principle measurable, though it will not be easy to achieve a result significantly different from zero for such a small angle. The angle χ' will be even more difficult to measure. Meaningful standard model tests can be defined which use the measured value of λ coupled with χ and any two of the three ϕ_i [16].

A major aim of CP-violation studies of B decays is to make enough independent measurements of the sides and angles that this unitarity triangle is overdetermined, and thereby check the validity of the Standard Model predictions that relate various measurements to aspects of this triangle. Constraints can be made on the basis of present data on the *B*-meson mixing and lifetime, and on the ratio of charmless decays to decays with charm (V_{ub}/V_{cb}) , and on ϵ in K decays [17]. These constraints have been discussed in many places in the literature; for a recent summary of the measurements involved, see Ref. [18]. Note, however, that any given "Standard Model allowed range" cannot be interpreted as a statistically-based error range. The ranges of allowed values depend on matrix element estimates. Improved methods to calculate such quantities, and understand the uncertainties in them, are needed to further sharpen tests of the Standard Model. Recent progress in lattice simulation using dynamical fermions seems encouraging [19]. It can be hoped that reliable computations of f_B , B_B , and B_K will be completed in the next few years. This will reduce the theoretical uncertainties in the relationships between measured mixing effects and the magnitudes of CKM parameters.

In the Standard Model there are only two independent phases in this triangle since, by definition, the three angles add up to π . The literature often discusses tests of whether the angles add up to π ; but this really means tests of whether relationships

between different measurements, predicted in terms of the two independent parameters in the Standard Model, hold true. For example, many models that go beyond the Standard Model predict an additional contribution to the mixing matrix. Any change in phase of M_{12} will change the measured asymmetries so that ϕ_1 (measured) $\rightarrow \phi_1 - \phi_{\text{new}}$ and ϕ_2 (measured) $\rightarrow \phi_2 + \phi_{\text{new}}$. Thus the requirement that the sum of the three angles must add up to π is not sensitive to ϕ_{new} [20]. However, the angles as determined from the sides of the triangle would, in general, no longer coincide with those measured from asymmetries. It is equally important to check the asymmetries in channels for which the Standard model predicts very small or vanishing asymmetries. A new mixing contribution which changes the phase of M_{12} will generate significant asymmetries in such channels. In the Standard Model the CKM matrix must be unitary, this leads to relationships among its entries.

• Standard Model decay amplitudes

In the Standard Model, there are two classes of quark-level diagrams that contribute to hadronic B decays, as shown in Fig. **@Fg.penguin@**. Tree diagrams are those where the W produces an additional quark-antiquark pair. Penguin diagrams are loop diagrams where the W reconnects to the same quark line. Penguin diagrams can further be classified by the nature of the particle emitted from the loop: gluonic or QCD penguins if it is a gluon, and electroweak penguins if it is a photon or a Z boson. In addition, one can label penguin diagrams by the flavor of the up-type quark in the loop; for any process all three flavor types contribute. For some processes, there are additional annihilation-type diagrams; these always contribute to the same CKM structure as the corresponding trees. For a detailed discussion of the status of calculations based on these

diagrams, or rather on the more complete operator product approach which also includes higher order QCD corrections see, for example, Ref. 21. Note that the distinction between tree and penguin contributions is a heuristic one, the separation of contributions by the operator that enters is more precise.



Figure 2: Quark level processes for the example of $b \rightarrow c\overline{c}s$. (a) Tree diagram; (b) Penguin diagram. In the case of electroweak penguin contributions, the gluon is replaced by a Z or a γ .

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To explore possible CP violations, it is useful to tabulate all possible decays by the CKM structure of the various amplitudes. Let us first consider decays $b \rightarrow q\overline{q}'s$. The CKM factors for the diagrams for such decays are given in Table 1. Here we have used the fact that, for all such decays, the contribution to the amplitude from penguin graphs has the structure

$$A_P(q\bar{q}s) = V_{tb}V_{ts}^*P_t + V_{cb}V_{cs}^*P_c + V_{ub}V_{us}^*P_u , \qquad (19)$$

where the P_i quantities are the amplitudes described by the loop diagram with a flavor *i* quark apart from the explicitly shown CKM factor (*i.e.*, including strong phases). These are actually divergent quantities, so it is convenient to use a Standard Model unitarity relationship, $V_{tb}V_{ts}^* + V_{cb}V_{cs}^* + V_{ub}V_{us}^* = 0$, to regroup them in the following way

$$A_P(q\overline{q}s) = V_{cb}V_{cs}^*(P_c - P_t) + V_{ub}V_{us}^*(P_u - P_t) , \qquad (20)$$

or, equivalently,

$$A_P(q\bar{q}s) = V_{tb}V_{ts}^*(P_t - P_c) + V_{ub}V_{us}^*(P_u - P_c) .$$
(21)

The first term is of order λ^2 , whereas the second is of order λ^4 , and can be ignored in most instances. For modes with $q' \neq q$, there are no penguin contributions. Note also that for the $q\overline{q} = u\overline{u}, d\overline{d}$ cases, the QCD penguin graphs contribute only to the isospin zero combinations, whereas tree graphs contribute only for $u\overline{u}$ and hence have both $\Delta I = 0$ and $\Delta I = 1$ parts, as do electroweak penguins.

The CKM coefficients for $b \to q\overline{q}'d$ are listed in Table 2. A similar exercise to that described above for the penguins yields

$$A_P(q\overline{q}d) = V_{tb}V_{td}^*(P_t - P_c) + V_{ub}V_{ud}^*(P_u - P_c) .$$
 (22)

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Here the two CKM contributions are of the same order of magnitude λ^3 , so both must be considered. This grouping is generally preferred over the alternative, because the second term here is somewhat smaller than the first term; it has no top-quark contribution and would vanish if the up and charm quarks were degenerate. In early literature it was often dropped, but, particularly for modes where there is no tree contribution, its effect in generating direct CP violation may be important [22]. Here the $q\bar{q} = u\bar{u}, d\bar{d}$ cases in the penguin graph contribute only to the isospin zero combinations, yielding $\Delta I = 1/2$ for the three-quark combination, whereas tree graphs and electroweak penguins have both $\Delta I = 1/2$ and $\Delta I = 3/2$ parts. For $q\bar{q} = c\bar{c}$, isospin does not distinguish between tree and penguin contributions.

Modes with direct CP violation

The largest direct CP violation is expected when there are two comparable magnitude contributions with different weak phases. Modes where the tree graphs are Cabibbo suppressed, compared to the penguins or modes with two comparable penguin contributions, are thus the best candidates. As can be seen from the tables and expressions for penguin contributions above, there are many possible modes to study. Because strong phases cannot usually be predicted, there is no clean prediction as to which modes will show the largest direct CP-violation effects. One interesting suggestion is to study three-body modes with more than one resonance in the same kinematic region. Then the different amplitudes can have very different, possibly known, strong phase structure because of the resonance (Breit-Wigner) phases [23].

Over the past two years, new information has become available from the CLEO Collaboration which suggests that

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penguin contributions, at least for some modes, are larger than initial estimates suggested. This is seen by using SU(3)and comparing $B \to K\pi$ and $B \to \pi\pi$ decays. To get an order of magnitude picture, we ignore such details as Clebsch-Gordan coefficients and assume that top penguins dominate the penguin contributions. Thus, we identify the tree and penguin contributions, minus their CKM coefficients, as T and P, the same for both modes. Writing $A_{T,P}(K\pi)$ for the tree and penguin contributions to the $K\pi$ amplitude, and similarly for $\pi\pi$ from the Tables, we see that $|A^T(K\pi)/A^T(\pi\pi)| = \mathcal{O}(\lambda)$. Thus, if the tree graph matrix elements were to dominate both decays, we would expect $\operatorname{Br}(B \to K\pi)/\operatorname{Br}(B \to \pi\pi) \sim \mathcal{O}(\lambda^2)$. Naively, this was expected, since the ratio of tree to penguin contribution was estimated to be $\frac{P}{T} = \frac{\alpha_S}{12\pi} \log \frac{m_t^2}{m_t^2} \sim \mathcal{O}(0.02).$ Experimentally, this is not so [24]; in fact, the $K\pi$ branching ratio is larger. This indicates that $A^P(K\pi) \sim A^T(\pi\pi)$, which suggests that $\frac{P}{T} = \mathcal{O}(\lambda)$ or larger, considerably bigger than expected. Note that this is one way that new physics could be hidden in modes with $|\rho(f)| \neq 1$; any new physics contribution can always be written as a sum of two terms with the weak phases of the two Standard Model terms (for example in Eq. (22), and thus, when added to the Standard Model contributions, appears only as a change in the sizes of P and Tfrom that expected in the Standard Model. However, we cannot calculate these relative sizes well enough to identify such an effect with confidence.

From the point of view of looking for direct CP-violation effects, a large P/T is good news. The largest asymmetry is expected when the interfering amplitudes have comparable magnitudes. This may be so in $B \to K\pi$ decay (or the penguin

contribution may even be larger than the tree). There is no reason for the strong phases to be equal (although they could both be small). Therefore, $B^{\pm} \to K^{\pm}\pi$ is a likely hunting ground for direct CP violation. (Note there is no gluonic penguin contribution to charged $B \to \pi\pi$, and hence, no significant CP violation expected in the Standard Model.) However, as we will see below, a large P/T complicates the relationship between the measured asymmetry in neutral B decays to $\pi^+\pi^-$ and KM phases.

$Studies \ of CP \ eigenstates$

• $f=J/\psi K_S$

The asymmetry in the "golden mode" $B \rightarrow J/\psi K_S$ has now been measured by both the BaBar and Belle experiments [25]. The Standard Model prediction for this mode is very clean. Since, using Eq. (20), the dominant penguin contribution has the same weak phase as the tree graph, and the remaining term is tiny, there is effectively only one weak phase in the decay amplitude. Hence, in the asymmetry, all dependence on the amplitudes cancel. With about 1% uncertainty,

$$\frac{q}{p}\overline{\rho}(J/\psi K_S) \simeq -\frac{V_{tb}^* V_{td}}{V_{tb} V_{td}^*} \cdot \frac{V_{cb} V_{cs}^*}{V_{cb}^* V_{cs}} \cdot \frac{V_{cs} V_{cd}^*}{V_{cs}^* V_{cd}} \equiv -e^{-2i\phi_1} , \quad (23)$$

where the last factor arises from the $K^0 - \overline{K}^0$ mixing amplitude and appears because of the K_S in the final state. The asymmetry is thus given by

$$a_{J/\psi K_S} = \sin(2\phi_1) \sin \Delta M t , \qquad (24)$$

where the angle ϕ_1 is defined in Fig. 1. The result is consistent within errors with the prediction from the Standard Model, which strongly suggests that the KM ansatz for CP violation is at least one of the sources of this interesting phenomenon.

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ullet $B^0 o \pi^+\pi^-$

The tree and penguin terms appear at the same order in λ (see Eq. (22) and Table 2.) If penguin decays were negligible the asymmetry would directly measure $\sin(2\phi_2)$. Given the enhanced penguin contribution seen from comparing $\pi\pi$ and $K\pi$ decays, the penguins cannot be ignored, and a treatment that does not assume $|\rho(f)| = 1$ must be made.

If all six modes of $B^+ \to \pi^+ \pi^0$, $B^0 \to \pi^+ \pi^-$, $B^0 \to \pi^0 \pi^0$ and their charge conjugates can be measured with sufficient accuracy, ϕ_2 can be extracted using an isospin analysis [26], up to small corrections from electroweak penguins. However, the branching ratio for the charged modes is less than 10^{-5} [24], and that for the more difficult to measure $B^0 \to \pi^0 \pi^0$ is expected to be even smaller. Therefore, further ingenuity is needed to get at this angle cleanly. A future possibility is to study the Dalitz plot of $B \to 3\pi$ decays [27].

To date only upper limits on CP-violating asymmetries in this mode have been reported [25].

Further Measurements

As Tables 1 and 2 suggest there are many more CPeigenstate modes that are interesting to study, both for B_d and similarly for B_s decays. The latter states are not accessible for the *B* factories operating at the $\Upsilon(4S)$ resonance, but may be studied at hadronic colliders. The CDF result on the asymmetry in the $J/\psi K_S$ mode is an indication of the capabilities of such facilities for *B* physics [29]. Upgrades of the Fermilab detectors are in progress and proposals for new detectors with the capability to achieve fast triggers for a larger variety of purely hadronic modes are under development, promising some future improvement in this capability.

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In addition to CP-eigenstate modes there are many additional modes for which particular studies have been proposed, in particular those focussed on extracting ϕ_3 (γ). Modes such as DK, DK^* and D^*K where the D mesons decay to CP eigenstates provide theoretically clean extraction of this parameter but have small branching ratios [30]. Other approaches involve the more copious $K\pi$ modes but rely on the use of isospin and SU(3) (U-spin) symmetries, so have larger theoretical uncertainties [31]. This is an active area of current theoretical work.

For a recent review of how predictions for CP-violating effects are affected by Beyond Standard Model effects see Ref. 28. There are also many ways to search for new physics effects in B decays that do not involve just the CP-violation effects. For example searches for isospin breaking effects in $K\pi$ modes have recently been suggested as a likely method to isolate such effects [32].

Table 1:	B -	$\rightarrow q\overline{q}s$	decay	modes
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Quark process	Leading term	Secondary term	Sample B_d modes	B_d angle	Sample B_s modes	B_s angle
$b \to c\overline{c}s$	$V_{cb}V_{cs}^* = A\lambda^2$ tree + penguin $(c - t)$	$V_{ub}V_{us}^* = A\lambda^4(\rho - i\eta)$ penguin only $(u - t)$	$J/\psi \ K_S$	eta	$J/\psi\eta \ D_s\overline{D}_s$	0
$b \rightarrow s\overline{s}s$	$V_{cb}V_{cs}^* = A\lambda^2$ penguin only $(c-t)$	$V_{ub}V_{us}^* = A\lambda^4(\rho - i\eta)$ penguin only $(u - t)$	ϕK_S	eta	$\phi\eta^\prime$	0
$b ightarrow u\overline{u}s$ $b ightarrow d\overline{d}s$	$V_{cb}V_{cs}^* = A\lambda^2$ penguin only $(c-t)$	$V_{ub}V_{us}^* = A\lambda^4(\rho - i\eta)$ tree + penguin(u - t)	$\pi^0 K_S$ ρK_S	competing terms	$\phi \pi^0 \ K_S \overline{K}_S$	competing terms

Table 2: $B \rightarrow q\overline{q}d$ decay modes

Quark process	Leading term	Secondary term	Sample B_d modes	B_d angle	Sample B_s modes
$b \to c\overline{c}d$	$V_{cb}V_{cd}^* = -A\lambda^3$ tree + penguin(c - u)	$V_{tb}V_{td}^* = A\lambda^3(1-\rho+i\eta)$ penguin only $(t-u)$	$D^{+}D^{-}$	*eta	$J/\psi K_S$
$b \rightarrow s\overline{s}d$	$V_{tb}V_{td}^* = A\lambda^3(1-\rho+i\eta)$ penguin only $(t-u)$	$V_{cb}V_{cd}^* = A\lambda^3$ penguin only $(c-u)$	$\phi\pi K_S\overline{K}_S$	competing terms	ϕK_S
$b \to u \overline{u} d$ $b \to d \overline{d} d$	$V_{ub}V_{ud}^* = A\lambda^3(\rho - i\eta)$ tree + penguin(u - c)	$V_{tb}V_{td}^* = A\lambda^3(1-\rho+i\eta)$ penguin only $(t-c)$	$\pi\pi; \pi ho \ \pi a_1$	*α	$\frac{\pi^0 K_S}{\rho^0 K_S}$
$b \to c \overline{u} d$	$V_{cb}V_{ud}^* = A\lambda^2$	0	$D^0 \pi^0, \ D^0 \rho^0$ $ _ \longrightarrow C D^0 \rho^0$	β P eigenstate	$ \begin{array}{c} D^0 K_S \\ $

*Leading terms only, large secondary terms shift asymmetry.

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CP VIOLATION PARAMETERS

$\operatorname{Re}(\epsilon_{B^0})/(1+|\epsilon_{B^0}|^2)$

CP impurity in B_d^0 system. It is obtained from either $a_{\ell\ell}$, the charge asymmetry in like-sign dilepton events or a_{cp} , the time-dependent asymmetry of inclusive B^0 and \overline{B}^0 decays.

VALUE (units 10^{-3})	DOCUMENT ID		TECN	COMMENT
0 ± 4 OUR AVERAGE				
-3 ± 7	⁴⁴⁷ BARATE	01 D	ALEP	$e^+e^- \rightarrow Z$
$3.5\!\pm\!10.3\!\pm\!1.5$	⁴⁴⁸ JAFFE	01	CLE2	$e^+ e^- ightarrow ~ \Upsilon(4S)$
1 ± 14 ± 3	⁴⁴⁹ ABBIENDI	99 J	OPAL	$e^+e^- \rightarrow Z$
$2 \pm 7 \pm 3$	⁴⁵⁰ ACKERSTAFF	97 U	OPAL	$e^+e^- \rightarrow Z$
$\bullet \bullet \bullet$ We do not use the following	ng data for averages	, fits,	limits,	etc. ● ● ●
$4 \pm 18 \pm 3$	⁴⁵¹ BEHRENS	00 B	CLE2	Repl. by JAFFE 01
< 45	⁴⁵² BARTELT	93	CLE2	$e^+e^- ightarrow ~\Upsilon(4S)$

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- ⁴⁴⁷BARATE 01D measured by investigating time-dependent asymmetries in semileptonic and fully inclusive B_d^0 decays.
- 448 JAFFE 01 finds $a_{\ell\ell}=0.013\pm0.050\pm0.005$ and combines with the previous BEHRENS 00B independent measurement.
- ⁴⁴⁹ Data analyzed using the time-dependent asymmetry of inclusive B^0 decay. The production flavor of B^0 mesons is determined using both the jet charge and the charge of secondary vertex in the opposite hemisphere.
- 450 ACKERSTAFF 97U assumes *CPT* and is based on measuring the charge asymmetry in a sample of B^0 decays defined by lepton and Q_{hem} tags. If CPT is not invoked, $\text{Re}(\epsilon_B) = -0.006 \pm 0.010 \pm 0.006$ is found. The indirect CPT violation parameter is determined to $Im(\delta B) = -0.020 \pm 0.016 \pm 0.006$.
- 451 BEHRENS 00B uses high-momentum lepton tags and partially reconstructed $\overline{B}^0 \rightarrow$ $D^{*+}\pi^-$, ρ^- decays to determine the flavor of the B meson.
- 452 BARTELT 93 finds $a_{\ell\ell}=0.031\pm0.096\pm0.032$ which corresponds to $|a_{\ell\ell}|<0.18$, which yields the above $|\text{Re}(\epsilon_{B^0})/(1+|\epsilon_{B^0}|^2|$.

 $A_{CP} (B^0 \rightarrow K^+ \pi^-)$ A_{CP} is defined as

$$\frac{B(\overline{B}^0 \to \overline{f}) - B(B^0 \to f)}{B(\overline{B}^0 \to \overline{f}) + B(B^0 \to f)}$$

the *CP*-violation charge asymmetry of inclusive B^0 and \overline{B}^0 decay. DOCUMENT ID VALUE TECN COMMENT

-0.09 ±0.06 OUR AVER	AGE		
$-0.07 \pm 0.08 \pm 0.02$	⁴⁵³ AUBERT	02D BABR	$e^+e^- \rightarrow \Upsilon(4S)$
$0.044 \substack{+0.186+0.018\\-0.167-0.021}$	⁴⁵⁴ ABE	01ĸ BELL	$e^+e^- \rightarrow \Upsilon(4S)$
$-0.19 \pm 0.10 \pm 0.03$	⁴⁵⁵ AUBERT	01e BABR	$e^+e^- \rightarrow \Upsilon(4S)$
-0.04 ± 0.16	⁴⁵⁶ CHEN	00 CLE2	$e^+e^- \rightarrow \Upsilon(4S)$

 453 Corresponds to 90% confidence range $-0.21 < A_{CP} < 0.07$.

 454 Corresponds to 90% confidence range $-0.25 < A_{CP} < 0.37$.

 455 Corresponds to 90% confidence range $-0.35 < A_{CP} < -0.03$

 456 Corresponds to 90% confidence range $-0.30 < A_{CP} < 0.22$.

$$A_{CP}(B^0 \rightarrow \phi K^*(892)^0)$$

VALUE	DOCUMENT ID	TECN	COMMENT
0.00±0.27±0.03	457 AUBERT	02E BABR	$e^+e^- ightarrow ~\Upsilon(4S)$
457			

 457 Corresponds to 90% confidence range $-0.44 < A_{CP} < 0.44$.

 $C_{\pi\pi} (B^0 \rightarrow \pi^+ \pi^-)$

 $C_{\pi\pi}$ is defined as $(1-|\lambda|^2)/(1+|\lambda|^2)$, where the quantity $\lambda=(q/p)
ho$, involves the ratio of the two amplitudes with different phases that contribute to a deceay to a CP eigenstate. For details, see the note on "CP Violation in B Decay Standard Model Predictions" in the B^0 Particle Listings above.

VALUE	DOCUMENT ID	TECN	COMMENT	
$-0.25^{+0.45}_{-0.47}\pm0.14$	458 AUBERT	02D BABR	$e^+e^- \rightarrow$	$\Upsilon(4S)$

 458 Corresponds to 90% confidence range $-1.0 < C_{\pi \pi} < 0.47$.

$$S_{\pi\pi} (B^{0} \rightarrow \pi^{+}\pi^{-})$$

$$S_{\pi\pi} = 2 \text{Im}\lambda/(1+|\lambda|^{2}), \text{ see the note in the } C_{\pi\pi} \text{ datablock above.}$$

$$VALUE \qquad DOCUMENT ID \qquad TECN \quad COMMENT$$

$$0.03^{+0.52}_{-0.56} \pm 0.11 \qquad 459 \text{ AUBERT} \qquad 02D \text{ BABR } e^{+}e^{-} \rightarrow \Upsilon(4S)$$

 459 Corresponds to 90% confidence range $-0.89 < \! S_{\!\pi\,\pi} < 0.85$

$sin(2\beta)$

For a discussion of CP violation, see the note on "CP Violation in B Decay Standard Model Predictions" in the B^0 Particle Listings above. $sin(2\beta)$ is a measure of the *CP*-violating amplitude in the $B_d^0 \rightarrow J/\psi(1S) K_S^0$.

VALUE	DOCUMENT ID	TECN	COMMENT
0.79 ± 0.14 OUR AVERAGE	Error includes scale fac	tor of 1.3.	See the ideogram below.
$0.99\!\pm\!0.14\!\pm\!0.06$	⁴⁶⁰ ABE	01G BELL	$e^+e^- \rightarrow \Upsilon(4S)$
$0.59\!\pm\!0.14\!\pm\!0.05$	⁴⁶⁰ AUBERT	01B BABR	$e^+e^- \rightarrow \Upsilon(4S)$
$0.79 \substack{+0.41 \\ -0.44}$	⁴⁶¹ AFFOLDER	00c CDF	<i>р</i> р at 1.8 ТеV
$0.84^{+0.82}_{-1.04}{\pm}0.16$	⁴⁶² BARATE	00Q ALEP	$e^+e^- \rightarrow Z$
$3.2 \ {}^{+1.8}_{-2.0} \ {}^{\pm 0.5}$	⁴⁶³ ACKERSTAFF	98z OPAL	$e^+e^- \rightarrow Z$
\bullet \bullet We do not use the following	owing data for averages	, fits, limits,	etc. • • •
$a = -0.32 \pm 0.09$			

0.58 - 0.34 - 0.10	ABASHIAN	01 BELL	Repl. by ABE 01G
$0.34\!\pm\!0.20\!\pm\!0.05$	AUBERT	01 BABR	Repl. by AUBERT 01B
$1.8 \pm 1.1 \pm 0.3$	⁴⁶⁴ ABE	98∪ CDF	Repl. by AF-
			FOLDER 00C

⁴⁶⁰ First observation of *CP* violation in B^0 meson system. ⁴⁶¹ AFFOLDER 00C uses about 400 $B^0 \rightarrow J/\psi(1S) \kappa_S^0$ events. The production flavor of

 B0 was determined using three tagging algorithms: a same-side tag, a jet-charge tag, and a soft-lepton tag.

 462 BARATE 00Q uses 23 candidates for $B^0 \rightarrow J/\psi(1S) K_S^0$ decays. A combination of jet-charge, vertex-charge, and same-side tagging techniques were used to determine the B^0 production flavor.

⁴⁶³ ACKERSTAFF 98Z uses 24 candidates for $B_d^0 \rightarrow J/\psi(1S) \kappa_S^0$ decay. A combination of jet-charge and vertex-charge techniques were used to tag the B_d^0 production flavor.

⁴⁶⁴ ABE 98U uses 198 \pm 17 $B_d^0 \rightarrow J/\psi(1S) K^0$ events. The production flavor of B^0 was determined using the same side tagging technique.



 $sin(2\beta)$

$B^0 \rightarrow D^{*-} \ell^+ \nu_\ell$ FORM FACTORS

R_1 (form factor ratio \sim	$V/A_1)$							
VALUE	DOCUMENT ID TECN		TECN	COMMENT				
$1.18 \pm 0.30 \pm 0.12$	DUBOSCQ	96	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$			
R_2 (form factor ratio $\sim A_2/A_1$)								
VALUE	DOCUMENT ID		TECN	<u>COMMENT</u>				
$0.71 \pm 0.22 \pm 0.07$	DUBOSCQ	96	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$			
$ ho_{oldsymbol{A}_1}^2$ (form factor slope)								
VALUE	DOCUMENT ID		TECN	COMMENT				
$0.91 {\pm} 0.15 {\pm} 0.06$	DUBOSCQ	96	CLE2	$e^+e^- \rightarrow$	$\Upsilon(4S)$			

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ABE	02H	PRL 88 171801	K. Abe <i>et al.</i>	(BELLE	Collab.)
ABE	02J	PRL 88 052002	K. Abe <i>et al.</i>	BELLE	Collab.)
AFFOLDER	02B	PRL 88 071801	T. Affolder <i>et al.</i>	CDF	Collab.)
ASNER	02	PR D65 031103R	D.M. Asner <i>et al.</i>	(ĊLEO	Collab.)
AUBERT	02	PR D65 032001	B. Aubert <i>et al.</i>	(BaBar	Collab.)
AUBERT	02C	PRL 88 101805	B. Aubert <i>et al.</i>	(BaBar	Collab.)
AUBERT	02D	PR D65 051502	B. Aubert <i>et al.</i>	(BaBar	Collab.)
AUBERT	02E	PR D65 051101R	B. Aubert <i>et al.</i>	(BaBar	Collab.)
AUBERT	02H	PRL (to be publ.)	B. Aubert <i>et al.</i>	(Babar	Collab.)
hep-ex/0202	2005				

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ABE	01K	PR D64 071101	K. Abe <i>et al.</i>	(Belle Collab.)
ABE	01L	PRL 87 161601	K. Abe <i>et al.</i>	(Belle Collab.)
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	01H 01R	PE D510 55 PR D64 092001	P. Abreu el al. I P. Alevander et al	(CLEO Collab.)
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PDG PROCARIO STONE	94 94 94	PR D50 1173 PRL 73 1472 HEPSY 93-11	L. Montanet <i>et al.</i> M. Procario <i>et al.</i> S. Stone	(CERN, LBL, BOST+) (CLEO Collab.)
Published ir ABREU ABREU ACTON ALBRECHT ALBRECHT ALEXANDER AMMAR	93D 93G 93G 93C 93 93E 93B 93B 93	ecays, 2nd Edition, World ZPHY C57 181 PL B312 253 PL B307 247 ZPHY C57 533 ZPHY C60 11 PL B319 365 PRL 71 674	Scientific, Singapore P. Abreu <i>et al.</i> P. Abreu <i>et al.</i> P.D. Acton <i>et al.</i> H. Albrecht <i>et al.</i> H. Albrecht <i>et al.</i> J. Alexander <i>et al.</i> R. Ammar <i>et al.</i>	(DELPHI Collab.) (DELPHI Collab.) (OPAL Collab.) (ARGUS Collab.) (ARGUS Collab.) (CLEO Collab.) (CLEO Collab.)
BARTELT	93	PRL 71 1680	J.E. Bartelt <i>et al.</i>	(CLEO Collab.)
BATTLE	93	PRL 71 3922	M. Battle <i>et al.</i>	(CLEO Collab.)
BEAN	93B	PRL 70 2681	A. Bean <i>et al.</i>	(CLEO Collab.)
BUSKULIC	93D	PL B307 194	 D. Buskulic <i>et al.</i> D. Buskulic <i>et al.</i> D. Buskulic <i>et al.</i> S. Sanghera <i>et al.</i> 	(ALEPH Collab.)
Also	94H	PL B325 537 (errata)		(ALEPH Collab.)
BUSKULIC	93K	PL B313 498		(ALEPH Collab.)
SANGHERA	93	PR D47 791		(CLEO Collab.)
ALBRECHT	92C	PL B275 195	H. Albrecht <i>et al.</i>	(ÀRGUS Collab.)
ALBRECHT	92G	ZPHY C54 1	H. Albrecht <i>et al.</i>	(ARGUS Collab.)
ALBRECHT	92L	ZPHY C55 357	H. Albrecht <i>et al.</i>	(ARGUS Collab.)
BORTOLETTO	92	PR D45 21	D. Bortoletto, <i>et al.</i>	(CLEQ Collab.)
HENDERSON	92	PR D45 2212	S. Henderson <i>et al.</i>	(CLEO Collab.)
KRAMER	92	PL B279 181	G. Kramer, W.F. Palmer	(HAMB, OSU)
ALBAJAR	91C	PL B262 163	C. Albajar <i>et al.</i>	(UA1 Collab.)
ALBAJAR	91E	PL B273 540	 C. Albajar <i>et al.</i> H. Albrecht <i>et al.</i> H. Albrecht <i>et al.</i> H. Albrecht <i>et al.</i> 	(UAI Collab.)
ALBRECHT	91B	PL B254 288		(ARGUS Collab.)
ALBRECHT	91C	PL B255 297		(ARGUS Collab.)
ALBRECHT	91E	PL B262 148		(ARGUS Collab.)
BERKELMAN "Decays of FULTON	91 <i>B</i> Me 91	ARNPS 41 1 sons" PR D43 651	K. Berkelman, S. Stone R. Fulton <i>et al.</i>	(CORN, SYRA)
ALBRECHT	90B	PL B241 278	 H. Albrecht <i>et al.</i> H. Albrecht <i>et al.</i> D. Antreasyan <i>et al.</i> D. Bortoletto <i>et al.</i> 	(ARGUS Collab.)
ALBRECHT	90J	ZPHY C48 543		(ARGUS Collab.)
ANTREASYAN	90B	ZPHY C48 553		(Crystal Ball Collab.)
BORTOLETTO	90	PRL 64 2117		(CLEO Collab.)
ELSEN ROSNER WAGNER	90 90 90	ZPHY C46 349 PR D42 3732 PRL 64 1095	E. Elsen <i>et al.</i> J.L. Rosner S.R. Wagner <i>et al.</i>	(JADE Collab.) (Mark II Collab.)
ALBRECHT	89C	PL B219 121	 H. Albrecht <i>et al.</i> H. Albrecht <i>et al.</i> H. Albrecht <i>et al.</i> H. Albrecht <i>et al.</i> 	(ARGUS Collab.)
ALBRECHT	89G	PL B229 304		(ARGUS Collab.)
ALBRECHT	89J	PL B229 175		(ARGUS Collab.)
ALBRECHT	89J	Pl B232 554		(ARGUS Collab.)
ARTUSO	89	PRL 62 2233	M. Artuso <i>et al.</i>	(CLEO Collab.)
AVERILL	89	PR D39 123	D.A. Averill <i>et al.</i>	(HRS Collab.)
AVERY	89B	PL B223 470	P. Avery <i>et al.</i>	(CLEO Collab.)
BEBEK	89	PRL 62 8	 C. Bebek <i>et al.</i> D. Bortoletto <i>et al.</i> D. Bortoletto <i>et al.</i> H. Albrecht <i>et al.</i> 	(CLEO Collab.)
BORTOLETTO	89	PRL 62 2436		(CLEO Collab.)
BORTOLETTO	89B	PRL 63 1667		(CLEO Collab.)
ALBRECHT	88F	PL B209 119		(ARGUS Collab.)
ALBRECHT	88K	PL B215 424	 H. Albrecht <i>et al.</i> H. Albrecht <i>et al.</i> H. Albrecht <i>et al.</i> H. Albrecht <i>et al.</i> 	(ARGUS Collab.)
ALBRECHT	87C	PL B185 218		(ARGUS Collab.)
ALBRECHT	87D	PL B199 451		(ARGUS Collab.)
ALBRECHT	87I	PL B192 245		(ARGUS Collab.)
ALBRECHT	87J	PL B197 452	 H. Albrecht <i>et al.</i> P. Avery <i>et al.</i> A. Bean <i>et al.</i> C. Bebek <i>et al.</i> 	(ARGUS Collab.)
AVERY	87	PL B183 429		(CLEO Collab.)
BEAN	87B	PRL 58 183		(CLEO Collab.)
BEBEK	87	PR D36 1289		(CLEO Collab.)
ALAM	86	PR D34 3279	M.S. Alam <i>et al.</i>	(CLEO Collab.)
ALBRECHT	86F	PL B182 95	H. Albrecht <i>et al.</i>	(ARGUS Collab.)
PDG	86	PL 170B	M. Aguilar-Benitez <i>et al.</i>	(CERN, CIT+)
CHEN	85	PR D31 2386	A. Chen <i>et al.</i>	(CLEO, Collab.)
HAAS	85	PRL 55 1248	J. Haas et al.	(CLEO Collab.)
AVERY	84	PRL 53 1309	P. Avery et al.	(CLEO Collab.)
GILES	84	PR D30 2279	R. Giles et al.	(CLEO Collab.)
BEHRENDS	83	PRI 50 881	S. Behrends et al.	(CLEO Collab.)
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