

b-baryon ADMIXTURE (Λ_b , Ξ_b , Σ_b , Ω_b)

b-baryon ADMIXTURE MEAN LIFE

Each measurement of the b -baryon mean life is an average over an admixture of various b baryons which decay weakly. Different techniques emphasize different admixtures of produced particles, which could result in a different b -baryon mean life. More b -baryon flavor specific channels are not included in the measurement.

“OUR EVALUATION” is an average of the data listed below performed by the Heavy Flavor Averaging Group (HFAG) as described in our review “Production and Decay of b -flavored Hadrons” in the B^\pm Section of these Listings. The averaging procedure takes into account correlations between the measurements and asymmetric lifetime errors.

VALUE (10^{-12} s)	EVTS	DOCUMENT ID	TECN	COMMENT
1.208 ± 0.051 OUR EVALUATION				
1.16 ± 0.20 ± 0.08		¹ ABREU	99W DLPH	$e^+ e^- \rightarrow Z$
1.19 ± 0.14 ± 0.07		² ABREU	99W DLPH	$e^+ e^- \rightarrow Z$
1.20 ± 0.08 ± 0.06		³ BARATE	98D ALEP	$e^+ e^- \rightarrow Z$
1.10 $\begin{smallmatrix} +0.19 \\ -0.17 \end{smallmatrix}$ ± 0.09		ABREU	96D DLPH	Excess $\Lambda\mu^-$ impact parameters
1.16 ± 0.11 ± 0.06		AKERS	96 OPAL	Excess $\Lambda\ell^-$, decay lengths and impact parameters
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.14 ± 0.08 ± 0.04		⁴ ABREU	99W DLPH	$e^+ e^- \rightarrow Z$
1.46 $\begin{smallmatrix} +0.22 \\ -0.21 \end{smallmatrix}$ ± 0.07		ABREU	96D DLPH	Repl. by ABREU 99W
1.27 $\begin{smallmatrix} +0.35 \\ -0.29 \end{smallmatrix}$ ± 0.09		ABREU	95S DLPH	Repl. by ABREU 99W
1.05 $\begin{smallmatrix} +0.12 \\ -0.11 \end{smallmatrix}$ ± 0.09	290	BUSKULIC	95L ALEP	Repl. by BARATE 98D
1.04 $\begin{smallmatrix} +0.48 \\ -0.38 \end{smallmatrix}$ ± 0.10	11	⁵ ABREU	93F DLPH	Excess $\Lambda\mu^-$, decay lengths
1.05 $\begin{smallmatrix} +0.23 \\ -0.20 \end{smallmatrix}$ ± 0.08	157	⁶ AKERS	93 OPAL	Excess $\Lambda\ell^-$, decay lengths
1.12 $\begin{smallmatrix} +0.32 \\ -0.29 \end{smallmatrix}$ ± 0.16	101	⁷ BUSKULIC	92I ALEP	Excess $\Lambda\ell^-$, impact parameters

¹ Measured using $\Lambda\ell^-$ decay length.

² Measured using $p\ell^-$ decay length.

³ Measured using the excess of $\Lambda\ell^-$, lepton impact parameter.

⁴ This ABREU 99W result is the combined result of the $\Lambda\ell^-$, $p\ell^-$, and excess $\Lambda\mu^-$ impact parameter measurements.

⁵ ABREU 93F superseded by ABREU 96D.

⁶ AKERS 93 superseded by AKERS 96.

⁷ BUSKULIC 92I superseded by BUSKULIC 95L.

b -baryon ADMIXTURE DECAY MODES ($\Lambda_b, \Xi_b, \Sigma_b, \Omega_b$)

These branching fractions are actually an average over weakly decaying b -baryons weighted by their production rates in Z decay (or high-energy $p\bar{p}$), branching ratios, and detection efficiencies. They scale with the LEP b -baryon production fraction $B(b \rightarrow b\text{-baryon})$ and are evaluated for our value $B(b \rightarrow b\text{-baryon}) = (11.8 \pm 2.1)\%$.

The branching fractions $B(b\text{-baryon} \rightarrow \Lambda \ell^- \bar{\nu}_\ell \text{ anything})$ and $B(\Lambda_b^0 \rightarrow \Lambda_c^+ \ell^- \bar{\nu}_\ell \text{ anything})$ are not pure measurements because the underlying measured products of these with $B(b \rightarrow b\text{-baryon})$ were used to determine $B(b \rightarrow b\text{-baryon})$, as described in the note "Production and Decay of b -Flavored Hadrons."

Mode	Fraction (Γ_i/Γ)
Γ_1 $p\mu^- \bar{\nu}$ anything	$(4.2^{+1.7}_{-1.5})\%$
Γ_2 $p\ell\bar{\nu}_\ell$ anything	$(4.0 \pm 1.0)\%$
Γ_3 p anything	$(50 \pm 17)\%$
Γ_4 $\Lambda\ell^- \bar{\nu}_\ell$ anything	$(2.7 \pm 0.5)\%$
Γ_5 $\Lambda\ell^+ \nu_\ell$ anything	
Γ_6 Λ anything	
Γ_7 $\Lambda_c^+ \ell^- \bar{\nu}_\ell$ anything	
Γ_8 $\Lambda/\bar{\Lambda}$ anything	$(28 \pm 6)\%$
Γ_9 $\Xi^- \ell^- \bar{\nu}_\ell$ anything	$(4.7 \pm 1.3) \times 10^{-3}$

b -baryon ADMIXTURE ($\Lambda_b, \Xi_b, \Sigma_b, \Omega_b$) BRANCHING RATIOS

$\Gamma(p\mu^- \bar{\nu} \text{ anything})/\Gamma_{\text{total}}$					Γ_1/Γ
VALUE	EVTS	DOCUMENT ID	TECN	COMMENT	
$0.042^{+0.016}_{-0.013} \pm 0.007$	125	⁸ ABREU	95S DLPH	$e^+e^- \rightarrow Z$	

⁸ ABREU 95S reports $[B(b\text{-baryon} \rightarrow p\mu^- \bar{\nu} \text{ anything}) \times B(\bar{b} \rightarrow b\text{-baryon})] = 0.0049 \pm 0.0011^{+0.0015}_{-0.0011}$. We divide by our best value $B(\bar{b} \rightarrow b\text{-baryon}) = (11.8 \pm 2.1) \times 10^{-2}$.

Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(p\ell\bar{\nu}_\ell \text{ anything})/\Gamma_{\text{total}}$					Γ_2/Γ
VALUE	DOCUMENT ID	TECN	COMMENT		
0.040 ± 0.010 OUR NEW AVERAGE	$[0.040^{+0.010}_{-0.009}]$			OUR 2002 AVERAGE	
$0.040 \pm 0.007 \pm 0.007$	⁹ BARATE	98V ALEP	$e^+e^- \rightarrow Z$		

⁹ BARATE 98V reports $[B(b\text{-baryon} \rightarrow p\ell\bar{\nu}_\ell \text{ anything}) \times B(\bar{b} \rightarrow b\text{-baryon})] = (4.72 \pm 0.66 \pm 0.44) \times 10^{-3}$. We divide by our best value $B(\bar{b} \rightarrow b\text{-baryon}) = (11.8 \pm 2.1) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(\rho\ell\bar{\nu}_\ell\text{anything})/\Gamma(\rho\text{anything})$

Γ_2/Γ_3

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.080±0.012±0.014	BARATE	98V ALEP	$e^+e^- \rightarrow Z$

$\Gamma(\Lambda\ell^-\bar{\nu}_\ell\text{anything})/\Gamma_{\text{total}}$

Γ_4/Γ

The values and averages in this section serve only to show what values result if one assumes our $B(b \rightarrow b\text{-baryon})$. They cannot be thought of as measurements since the underlying product branching fractions were also used to determine $B(b \rightarrow b\text{-baryon})$ as described in the note on "Production and Decay of b -Flavored Hadrons."

<u>VALUE</u>	<u>EVS</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.027±0.005 OUR AVERAGE				
0.028±0.004±0.005		¹⁰ BARATE	98D ALEP	$e^+e^- \rightarrow Z$
0.025±0.003±0.004		¹¹ AKERS	96 OPAL	Excess of $\Lambda\ell^-$ over $\Lambda\ell^+$
0.025±0.006±0.005	262	¹² ABREU	95S DLPH	Excess of $\Lambda\ell^-$ over $\Lambda\ell^+$
0.052±0.010±0.009	290	¹³ BUSKULIC	95L ALEP	Excess of $\Lambda\ell^-$ over $\Lambda\ell^+$
• • • We do not use the following data for averages, fits, limits, etc. • • •				
seen	157	¹⁴ AKERS	93 OPAL	Excess of $\Lambda\ell^-$ over $\Lambda\ell^+$
0.059±0.017±0.011	101	¹⁵ BUSKULIC	92I ALEP	Excess of $\Lambda\ell^-$ over $\Lambda\ell^+$

¹⁰ BARATE 98D reports $[B(b\text{-baryon} \rightarrow \Lambda\ell^-\bar{\nu}_\ell\text{anything}) \times B(\bar{b} \rightarrow b\text{-baryon})] = 0.00326 \pm 0.00016 \pm 0.00039$. We divide by our best value $B(\bar{b} \rightarrow b\text{-baryon}) = (11.8 \pm 2.1) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Measured using the excess of $\Lambda\ell^-$, lepton impact parameter.

¹¹ AKERS 96 reports $[B(b\text{-baryon} \rightarrow \Lambda\ell^-\bar{\nu}_\ell\text{anything}) \times B(\bar{b} \rightarrow b\text{-baryon})] = 0.00291 \pm 0.00023 \pm 0.00025$. We divide by our best value $B(\bar{b} \rightarrow b\text{-baryon}) = (11.8 \pm 2.1) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

¹² ABREU 95S reports $[B(b\text{-baryon} \rightarrow \Lambda\ell^-\bar{\nu}_\ell\text{anything}) \times B(\bar{b} \rightarrow b\text{-baryon})] = 0.0030 \pm 0.0006 \pm 0.0004$. We divide by our best value $B(\bar{b} \rightarrow b\text{-baryon}) = (11.8 \pm 2.1) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

¹³ BUSKULIC 95L reports $[B(b\text{-baryon} \rightarrow \Lambda\ell^-\bar{\nu}_\ell\text{anything}) \times B(\bar{b} \rightarrow b\text{-baryon})] = 0.0061 \pm 0.0006 \pm 0.0010$. We divide by our best value $B(\bar{b} \rightarrow b\text{-baryon}) = (11.8 \pm 2.1) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

¹⁴ AKERS 93 superseded by AKERS 96.

¹⁵ BUSKULIC 92I reports $[B(b\text{-baryon} \rightarrow \Lambda\ell^-\bar{\nu}_\ell\text{anything}) \times B(\bar{b} \rightarrow b\text{-baryon})] = 0.0070 \pm 0.0010 \pm 0.0018$. We divide by our best value $B(\bar{b} \rightarrow b\text{-baryon}) = (11.8 \pm 2.1) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value. Superseded by BUSKULIC 95L.

$\Gamma(\Lambda\ell^+\nu_\ell\text{anything})/\Gamma(\Lambda\text{anything})$

Γ_5/Γ_6

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.080±0.012±0.008	ABBIENDI	99L OPAL	$e^+e^- \rightarrow Z$

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

0.070±0.012±0.007	ACKERSTAFF	97N OPAL	Repl. by ABBIENDI 99L
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$\Gamma(\Lambda/\bar{\Lambda}\text{anything})/\Gamma_{\text{total}}$ Γ_8/Γ

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.28±0.06 OUR AVERAGE			
0.30±0.04±0.05	¹⁶ ABBIENDI	99L OPAL	$e^+e^- \rightarrow Z$
0.19 ^{+0.11} _{-0.07} ±0.03	¹⁷ ABREU	95C DLPH	$e^+e^- \rightarrow Z$

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

- 0.33±0.05±0.06 ¹⁸ ACKERSTAFF 97N OPAL Repl. by ABBIENDI 99L
- ¹⁶ ABBIENDI 99L reports $[B(b\text{-baryon} \rightarrow \Lambda/\bar{\Lambda}\text{anything}) \times B(\bar{b} \rightarrow b\text{-baryon})] = 0.035 \pm 0.0032 \pm 0.0035$. We divide by our best value $B(\bar{b} \rightarrow b\text{-baryon}) = (11.8 \pm 2.1) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.
- ¹⁷ ABREU 95C reports $0.28^{+0.17}_{-0.12}$ for $B(\bar{b} \rightarrow b\text{-baryon}) = 0.08 \pm 0.02$. We rescale to our best value $B(\bar{b} \rightarrow b\text{-baryon}) = (11.8 \pm 2.1) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.
- ¹⁸ ACKERSTAFF 97N reports $[B(b\text{-baryon} \rightarrow \Lambda/\bar{\Lambda}\text{anything}) \times B(\bar{b} \rightarrow b\text{-baryon})] = 0.0393 \pm 0.0046 \pm 0.0037$. We divide by our best value $B(\bar{b} \rightarrow b\text{-baryon}) = (11.8 \pm 2.1) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

$\Gamma(\Xi^- \ell^- \bar{\nu}_\ell \text{anything})/\Gamma_{\text{total}}$ Γ_9/Γ

<u>VALUE</u>	<u>DOCUMENT ID</u>	<u>TECN</u>	<u>COMMENT</u>
0.0047±0.0013 OUR AVERAGE			
0.0046±0.0012±0.0008	¹⁹ BUSKULIC	96T ALEP	Excess $\Xi^- \ell^-$ over $\Xi^- \ell^+$
0.0050±0.0020±0.0009	²⁰ ABREU	95V DLPH	Excess $\Xi^- \ell^-$ over $\Xi^- \ell^+$

- ¹⁹ BUSKULIC 96T reports $[B(b\text{-baryon} \rightarrow \Xi^- \ell^- \bar{\nu}_\ell \text{anything}) \times B(\bar{b} \rightarrow b\text{-baryon})] = 0.00054 \pm 0.00011 \pm 0.00008$. We divide by our best value $B(\bar{b} \rightarrow b\text{-baryon}) = (11.8 \pm 2.1) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.
- ²⁰ ABREU 95V reports $[B(b\text{-baryon} \rightarrow \Xi^- \ell^- \bar{\nu}_\ell \text{anything}) \times B(\bar{b} \rightarrow b\text{-baryon})] = 0.00059 \pm 0.00021 \pm 0.0001$. We divide by our best value $B(\bar{b} \rightarrow b\text{-baryon}) = (11.8 \pm 2.1) \times 10^{-2}$. Our first error is their experiment's error and our second error is the systematic error from using our best value.

b -baryon ADMIXTURE ($\Lambda_b, \Xi_b, \Sigma_b, \Omega_b$) REFERENCES

ABBIENDI	99L	EPJ C9 1	G. Abbiendi <i>et al.</i>	(OPAL Collab.)
ABREU	99W	EPJ C10 185	P. Abreu <i>et al.</i>	(DELPHI Collab.)
BARATE	98D	EPJ C2 197	R. Barate <i>et al.</i>	(ALEPH Collab.)
BARATE	98V	EPJ C5 205	R. Barate <i>et al.</i>	(ALEPH Collab.)
ACKERSTAFF	97N	ZPHY C74 423	K. Ackerstaff <i>et al.</i>	(OPAL Collab.)
ABREU	96D	ZPHY C71 199	P. Abreu <i>et al.</i>	(DELPHI Collab.)
AKERS	96	ZPHY C69 195	R. Akers <i>et al.</i>	(OPAL Collab.)
BUSKULIC	96T	PL B384 449	D. Buskulic <i>et al.</i>	(ALEPH Collab.)
ABREU	95C	PL B347 447	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ABREU	95S	ZPHY C68 375	P. Abreu <i>et al.</i>	(DELPHI Collab.)
ABREU	95V	ZPHY C68 541	P. Abreu <i>et al.</i>	(DELPHI Collab.)
BUSKULIC	95L	PL B357 685	D. Buskulic <i>et al.</i>	(ALEPH Collab.)
ABREU	93F	PL B311 379	P. Abreu <i>et al.</i>	(DELPHI Collab.)
AKERS	93	PL B316 435	R. Akers <i>et al.</i>	(OPAL Collab.)
BUSKULIC	92I	PL B297 449	D. Buskulic <i>et al.</i>	(ALEPH Collab.)