W BRANCHING RATIOS

$\Gamma(\ell^+\nu)/\Gamma_{total}$ — Γ_1/Γ

ℓ indicates average over e, μ, and τ modes, not sum over modes.

Currently only e and μ data enter this average because there are no absolute τ data, only the τ/e ratio.

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
0.108±0.004 OUR AVERAGE		Includes data from the 2 datablocks that follow this one.		
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.104±0.008	3642	[29] ABE 92I	CDF	$E_{cm}^{p\overline{p}}$= 1.8 TeV

[29] 1216 ± 38^{+27}_{-31} $W \rightarrow \mu\nu$ events from ABE 92I and 2426$W \rightarrow e\nu$ events of ABE 91C. ABE 92I give the inverse quantity as 9.6 ± 0.7 and we have inverted.

$\Gamma(e^+\nu)/\Gamma_{total}$ — Γ_2/Γ

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
The data in this block is included in the average printed for a previous datablock.				
0.108 ±0.004 OUR FIT				
0.109 ±0.004 OUR AVERAGE				
0.1094±0.0033±0.0031		[30] ABE 94B	CDF	$E_{cm}^{p\overline{p}}$= 1800 GeV
0.10 ±0.014 $^{+0.02}_{-0.03}$	248	[31] ANSARI 87C	UA2	$E_{cm}^{p\overline{p}}$= 546,630 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.106 ±0.0096	2426	[32] ABE 91C	CDF	Repl. by ABE 94B
seen	299	[33] ALBAJAR 89	UA1	$E_{cm}^{p\overline{p}}$= 546,630 GeV
seen	119	APPEL 86	UA2	$E_{cm}^{p\overline{p}}$= 546,630 GeV
seen	172	ARNISON 86	UA1	Repl. by ALBAJAR 89

[30] ABE 94B result is from a measurement of $\sigma B(W \rightarrow e\nu)/\sigma B(Z \rightarrow e^+e^-)$ = 10.90 ± 0.32 ± 0.29, the theoretical prediction for the cross section ratio, the experimental knowledge of $\Gamma(Z \rightarrow e^+e^-)$ = 83.33 ± 0.30 MeV, and $\Gamma(Z)$ = 2.492 ± 0.007.

[31] The first error was obtained by adding the statistical and systematic experimental uncertainties in quadrature. The second error reflects the dependence on theoretical prediction of total W cross section: σ(546 GeV) = $4.7^{+1.4}_{-0.7}$ nb and σ(630 GeV) = $5.8^{+1.8}_{-1.0}$ nb. See ALTARELLI 85B.

[32] ABE 91C result is from a measurement of $\sigma B(W \rightarrow e\nu)/\sigma B(Z \rightarrow e^+e^-)$, the theoretical prediction for the cross section ratio, and the experimental knowledge of $\Gamma(Z \rightarrow e^+e^-)/\Gamma(Z \rightarrow \text{all})$.

[33] ALBAJAR 89 experiment determines values of branching ratio times production cross section.

$\Gamma(\mu^+\nu)/\Gamma_{total}$ — Γ_3/Γ

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
The data in this block is included in the average printed for a previous datablock.				
0.106±0.007 OUR FIT				
0.10 ±0.01	1216	[34] ABE 92I	CDF	$E_{cm}^{p\overline{p}}$= 1.8 TeV

[34] ABE 92I quote the inverse quantity as 9.9 ± 1.2 which we have inverted.

$\Gamma(\tau^+\nu)/\Gamma_{total}$ — Γ_4/Γ

VALUE	DOCUMENT ID
0.108±0.010 OUR FIT	

$\Gamma(\text{hadrons})/\Gamma_{total}$ — Γ_5/Γ

VALUE	DOCUMENT ID
0.678±0.016 OUR FIT	

$\Gamma(\mu^+\nu)/\Gamma(e^+\nu)$ — Γ_3/Γ_2

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
0.98±0.06 OUR FIT				
1.02±0.08	1216	[35] ABE 92I	CDF	$E_{cm}^{p\overline{p}}$= 1.8 TeV
• • • We do not use the following data for averages, fits, limits, etc. • • •				
1.00±0.14±0.08	67	ALBAJAR 89	UA1	$E_{cm}^{p\overline{p}}$= 546,630 GeV
$1.24^{+0.6}_{-0.4}$	14	ARNISON 84D	UA1	Repl. by ALBAJAR 89

[35] ABE 92I obtain $\sigma_W B(W \rightarrow \mu\nu)$= 2.21 ± 0.07 ± 0.21 and combine with ABE 91C σ_W B(($W \rightarrow e\nu$)) to give a ratio of the couplings from which we derive this measurement.

$\Gamma(\tau^+\nu)/\Gamma(e^+\nu)$ — Γ_4/Γ_2

VALUE	EVTS	DOCUMENT ID	TECN	COMMENT
1.00 ±0.08 OUR FIT				
1.00 ±0.08 OUR AVERAGE				
0.94 ±0.14	179	[36] ABE 92E	CDF	$E_{cm}^{p\overline{p}}$= 1.8 TeV
1.04 ±0.08 ±0.08	754	[37] ALITTI 92F	UA2	$E_{cm}^{p\overline{p}}$= 630 GeV
1.02 ±0.20 ±0.12	32	ALBAJAR 89	UA1	$E_{cm}^{p\overline{p}}$= 546,630 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •				
0.995±0.112±0.083	198	ALITTI 91C	UA2	Repl. by ALITTI 92F
1.02 ±0.20 ±0.10	32	ALBAJAR 87	UA1	Repl. by ALBAJAR 89

[36] ABE 92E use two procedures for selecting $W \rightarrow \tau\nu_\tau$ events. The missing E_T trigger leads to 132 ± 14 ± 8 events and the τ trigger to 47 ± 9 ± 4 events. Proper statistical and systematic correlations are taken into account to arrive at $\sigma B(W \rightarrow \tau\nu)$ = 2.05 ± 0.27 nb. Combined with ABE 91C result on $\sigma B(W \rightarrow e\nu)$, ABE 92E quote a ratio of the couplings from which we derive this measurement.

[37] This measurement is derived by us from the ratio of the couplings of ALITTI 92F.

$\Gamma(\pi^+\gamma)/\Gamma(e^+\nu)$ — Γ_6/Γ_2

VALUE	CL%	DOCUMENT ID	TECN	COMMENT
$< 7.5 \times 10^{-3}$	95	ABE 92K	CDF	$E_{cm}^{p\overline{p}}$= 1.8 TeV
$\mathbf{< 4.9 \times 10^{-3}}$	95	[38] ALITTI 92D	UA2	$E_{cm}^{p\overline{p}}$= 630 GeV
$<58 \times 10^{-3}$	95	[39] ALBAJAR 90	UA1	$E_{cm}^{p\overline{p}}$= 546, 630 GeV

[38] ALITTI 92D limit is 3.8×10^{-3} at 90%CL.

[39] ALBAJAR 90 obtain < 0.048 at 90%CL.

W REFERENCES

ABE	94B	PRL (to be pub.)	+Albrow, Amidei, Anway-Wiese+	(CDF Collab.)
Fermilab-PUB-94-051-E				
ROSNER	94	PR D49 1363	+Worah, Takeuchi	(EFI, FNAL)
ABE	92E	PRL 68 3398	+Amidei, Apollinari, Atac+	(CDF Collab.)
ABE	92I	PRL 69 28	+Amidei, Apollinari, Atac, Auchincloss+	(CDF Collab.)
ABE	92K	PRL 69 2160	+Amidei, Anway-Weiss+	(CDF Collab.)
ALITTI	92	PL B276 365	+Ambrosini, Ansari, Autiero, Bareyre+	(UA2 Collab.)
ALITTI	92B	PL B276 354	+Ambrosini, Ansari, Autiero, Bareyre+	(UA2 Collab.)
ALITTI	92C	PL B277 194	+Ambrosini, Ansari, Autiero, Bareyre+	(UA2 Collab.)
ALITTI	92D	PL B277 203	+Ambrosini, Ansari, Autiero, Bareyre+	(UA2 Collab.)
ALITTI	92F	PL B280 137	+Ambrosini, Ansari, Autiero, Bareyre+	(UA2 Collab.)
LEP	92	PL B276 247	+ALEPH, DELPHI, L3, OPAL	(LEP Collabs.)
SAMUEL	92	PL B280 124	+Li, Sinha, Sinha, Sundaresan	(OKSU, CARL)
ABE	91C	PR D44 29	+Amidei, Apollinari, Atac, Auchincloss+	(CDF Collab.)
ALBAJAR	91	PL B253 503	+Albrow, Allkofer, Ankoviak, Apsimon+	(UA1 Collab.)
ALITTI	91C	ZPHY C52 209	+Ambrosini, Ansari, Autiero+	(UA2 Collab.)
SAMUEL	91	PRL 67 9	+Li, Sinha, Sinha, Sundaresan	(OKSU, CARL)
Also	91C	PRL 67 2920 erratum		
ABE	90	PRL 64 152	+Amidei, Apollinari, Atac, Auchincloss+	(CDF Collab.)
Also	91C	PR D44 29	Abe, Amidei, Apollinari, Atac, Auchincloss+	(CDF Collab.)
ABE	90G	PRL 65 2243	+Amidei, Apollinari, Atac+	(CDF Collab.)
Also	91B	PR D43 2070	Abe, Amidei, Apollinari, Atac, Auchincloss+	(CDF Collab.)
ALBAJAR	90	PL B241 283	+Albrow, Allkofer+	(UA1 Collab.)
ALITTI	90B	PL B241 150	+Ansari, Ansorge, Autiero+	(UA2 Collab.)
ALITTI	90C	ZPHY C47 11	+Ansari, Ansorge, Bagnaia+	(UA2 Collab.)
ABE	89I	PRL 62 1005	+Amidei, Apollinari, Ascoli, Atac+	(CDF Collab.)
ALBAJAR	89	ZPHY C44 15	+Albrow, Allkofer, Arnison, Astbury+	(UA1 Collab.)
BAUR	88	NP B308 127	+Zeppenfeld	(FSU, WISC)
GRIFOLS	88	IJMP A3 225	+Peris, Sola	(BARC, DESY)
Also	87	PL B197 437	Grifols, Peris, Sola	(BARC, DESY)
ALBAJAR	87	PL B185 233	+Albrow, Allkofer, Arnison, Astbury+	(UA1 Collab.)
ANSARI	87	PL B186 440	+Bagnaia, Banner, Battiston+	(UA2 Collab.)
ANSARI	87C	PL B194 158	+Bagnaia, Banner, Battiston+	(UA2 Collab.)
GROTCH	87	PR D36 2153	+Robinett	(PSU)
HAGIWARA	87	NP B282 253	+Peccei, Zeppenfeld, Hikasa	(KEK, UCLA, FSU)
VANDERBIJ	87	PR D35 1088	van der Bij	(FNAL)
APPEL	86	ZPHY C30 1	+Bagnaia, Banner, Battiston+	(UA2 Collab.)
ARNISON	86	PL 166B 484	+Albrow, Allkofer, Astbury+	(UA1 Collab.) J
ALTARELLI	85B	ZPHY C27 617	+Ellis, Martinelli	(CERN, FNAL, FRAS)
GRAU	85	PL 154B 283	+Grifols	(BARC)
SUZUKI	85	PL 153B 289		(LBL)
ARNISON	84D	PL 134B 469	+Astbury, Aubert, Bacci+	(UA1 Collab.)
BAGNAIA	84	ZPHY C24 1	+Banner, Battiston, Blech+	(UA2 Collab.)
HERZOG	84	PL 148B 355		(WISC)
Also	84B	PL 155B 468 erratum	Herzog	(WISC)
ARNISON	83	PL 122B 103	+Astbury, Aubert, Bacci+	(UA1 Collab.)
ARNISON	83D	PL 129B 273	+Astbury, Aubert, Bacci+	(UA1 Collab.)
BAGNAIA	83	PL 129B 130	+Banner, Battiston, Bloch+	(UA2 Collab.)
BANNER	83B	PL 122B 476	+Battiston, Bloch, Bonaudi+	(UA2 Collab.)

$\boxed{Z}$

$J = 1$

NOTE ON THE Z BOSON

Precision measurements at the Z-boson resonance using electron-positron colliding beams began in 1989 at the SLC and at LEP. During 1989–93, the four CERN experiments have made high-statistics studies of the Z. The availability of longitudinally polarized electron beams at the SLC in 1993 has enabled a precision determination of the effective electroweak mixing angle $\sin^2\overline{\theta}_W$ that is competitive with the CERN results on this parameter.

The Z-boson properties reported in this section may broadly be categorized as:

- The standard 'lineshape' parameters of the Z consisting of its mass, M_Z, its total width, Γ_Z, and its partial decay widths, Γ(hadrons) and $\Gamma(\ell\overline{\ell})$ where $\ell = e, \mu, \tau, \nu$;
- The b- and c-quark-related partial widths and charge asymmetries which require special techniques;
- Determination of rare Z decay modes and the search for modes that violate known conservation laws.