W

$J = 1$

W MASS

The fit uses the W and Z mass, mass difference, and mass ratio measurements.

VALUE (GeV)	EVTS	DOCUMENT ID		TECN	COMMENT
80.33 ± 0.15 OUR FIT					
80.32 ± 0.19 OUR AVERAGE		Error includes scale factor of 1.2.			
80.410± 0.180	8986	[1] ABE	95P	CDF	$E_{cm}^{p\overline{p}}$= 1800 GeV
79.91 ± 0.39	1722	[2] ABE	90G	CDF	$E_{cm}^{p\overline{p}}$= 1800 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
80.84 ± 0.22 ±0.83	2065	[3] ALITTI	92B	UA2	See W/Z ratio below
80.79 ± 0.31 ±0.84		[4] ALITTI	90B	UA2	$E_{cm}^{p\overline{p}}$= 546,630 GeV
80.0 ± 3.3 ±2.4	22	[5] ABE	89I	CDF	$E_{cm}^{p\overline{p}}$= 1800 GeV
82.7 ± 1.0 ±2.7	149	[6] ALBAJAR	89	UA1	$E_{cm}^{p\overline{p}}$= 546,630 GeV
81.8 $^{+6.0}_{-5.3}$ ±2.6	46	[7] ALBAJAR	89	UA1	$E_{cm}^{p\overline{p}}$= 546,630 GeV
89 ± 3 ±6	32	[8] ALBAJAR	89	UA1	$E_{cm}^{p\overline{p}}$= 546,630 GeV
80.2 ± 0.6 ±1.4	251	[9] ANSARI	87	UA2	Repl. by ALITTI 90B
81.2 ± 1.0 ±1.4	119	[9] APPEL	86	UA2	Repl. by ANSARI 87
83.5 $^{+1.1}_{-1.0}$ ±2.7	86	[10] ARNISON	86	UA1	Repl. by ALBAJAR 89
81. $^{+6.}_{-7.}$	14	[11] ARNISON	84D	UA1	Repl. by ALBAJAR 89
83.1 ± 1.9 ±1.3	37	BAGNAIA	84	UA2	Repl. by ALITTI 90B
81. ± 5.	6	ARNISON	83	UA1	Repl. by ARNISON 83D
80.9 ± 2.9	27	ARNISON	83D	UA1	Repl. by ARNISON 86
81.0 ± 2.8		BAGNAIA	83	UA2	Repl. by BAGNAIA 84
80. $^{+10.}_{-6.}$	4	BANNER	83B	UA2	Repl. by ALITTI 90B

[1] ABE 95P use 3268 $W \to \mu\nu_\mu$ events to find M = 80.310 ± 0.205 ± 0.130 GeV and 5718 $W \to e\nu_e$ events to find M = 80.490 ± 0.145 ± 0.175 GeV. The result given here combines these while accounting for correlated uncertainties.

[2] ABE 90G result from $W \to e\nu$ is 79.91 ± 0.35 ± 0.24 ± 0.19(scale) GeV and from $W \to \mu\nu$ is 79.90 ± 0.53 ± 0.32 ± 0.08(scale) GeV.

[3] ALITTI 92B result has two contributions to the systematic error (±0.83); one (±0.81) cancels in m_W/m_Z and one (±0.17) is noncancelling. These were added in quadrature. We choose the ALITTI 92B value without using the LEP m_Z value, because we perform our own combined fit.

[4] There are two contributions to the systematic error (±0.84): one (±0.81) which cancels in m_W/m_Z and one (±0.21) which is non-cancelling. These were added in quadrature.

[5] ABE 89I systematic error dominated by the uncertainty in the absolute energy scale.

[6] ALBAJAR 89 result is from a total sample of 299 $W \to e\nu$ events.

[7] ALBAJAR 89 result is from a total sample of 67 $W \to \mu\nu$ events.

[8] ALBAJAR 89 result is from $W \to \tau\nu$ events.

[9] There are two contributions to the systematic error (±1.4): one (±1.3) which cancels in m_W/m_Z and one (±0.5) which is non-cancelling. These were added in quadrature.

[10] This is enhanced subsample of 172 total events.

[11] Using $W^\pm \to \mu^\pm\nu$.

W/Z MASS RATIO

The fit uses the W and Z mass, mass difference, and mass ratio measurements.

VALUE	EVTS	DOCUMENT ID		TECN	COMMENT
0.8810±0.0016 OUR FIT					
0.8813±0.0036±0.0019	156	[12] ALITTI	92B	UA2	$E_{cm}^{p\overline{p}}$= 630 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.8831±0.0048±0.0026		[12] ALITTI	90B	UA2	$E_{cm}^{p\overline{p}}$= 546,630 GeV

[12] Scale error cancels in this ratio.

$m_Z - m_W$

The fit uses the W and Z mass, mass difference, and mass ratio measurements.

VALUE (GeV)	DOCUMENT ID		TECN	COMMENT
10.85±0.15 OUR FIT				
10.4 ±1.4 ±0.8	ALBAJAR	89	UA1	$E_{\rm cm}^{p\overline{p}}$= 546,630 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •				
11.3 ±1.3 ±0.9	ANSARI	87	UA2	$E_{\rm cm}^{p\overline{p}}$= 546,630 GeV

$m_{W^+} - m_{W^-}$

VALUE (GeV)	EVTS	DOCUMENT ID		TECN	COMMENT
−0.19±0.58	1722	ABE	90G	CDF	$E_{\rm cm}^{p\overline{p}}$= 1800 GeV

W WIDTH

The widths labelled "extracted value" are obtained by measuring $R = \sigma(W \to e\nu)/\sigma(Z \to e^+e^-)$ which is equal to $[\sigma(W)/\sigma(Z)]$ $[\Gamma(W \to e\nu)/\Gamma(Z \to ee)]$ $\Gamma(Z)/\Gamma(W)$. The bracketed quantities can be calculated with plausible reliability. $\Gamma(W)$ is then extracted by using a value of $\Gamma(Z)$ measured at LEP. The Standard Model prediction is 2.067 ± 0.021 (ROSNER 94).

VALUE (GeV)	CL%	EVTS	DOCUMENT ID		TECN	COMMENT
2.08 ±0.07 OUR AVERAGE						
2.11 ±0.28 ±0.16		58	[13] ABE	95C	CDF	Direct meas.
2.064±0.061±0.059			[14] ABE	94B	CDF	Extracted value
$2.10\ ^{+0.14}_{-0.13}$ ±0.09		3559	[15] ALITTI	92	UA2	Extracted value
$2.18\ ^{+0.26}_{-0.24}$ ±0.04			[16] ALBAJAR	91	UA1	Extracted value
• • • We do not use the following data for averages, fits, limits, etc. • • •						
2.16 ±0.17			[17] ABE	92I	CDF	Repl. by ABE 94B
2.12 ±0.20			[18] ABE	90	CDF	Repl. by ABE 92I
2.30 ±0.19 ±0.06			[19] ALITTI	90C	UA2	Extracted value
<5.4	90	149	[20] ALBAJAR	89	UA1	$E_{\rm cm}^{p\overline{p}}$= 546,630 GeV
$2.8\ ^{+1.4}_{-1.5}$ ±1.3		149	[20] ALBAJAR	89	UA1	$E_{\rm cm}^{p\overline{p}}$= 546,630 GeV
<7	90	251	ANSARI	87	UA2	$E_{\rm cm}^{p\overline{p}}$= 546,630 GeV
<7	90	119	APPEL	86	UA2	$E_{\rm cm}^{p\overline{p}}$= 546,630 GeV
<6.5	90	86	[21] ARNISON	86	UA1	Repl. by ALBAJAR 89
<7	90	27	ARNISON	83D	UA1	Repl. by ARNISON 86

[13] ABE 95C use the tail of the transverse mass distribution of $W \to e\nu_e$ decays.

[14] ABE 94B measured $R = 10.90 \pm 0.32 \pm 0.29$. The values of $\sigma(Z)$ and $\sigma(W)$ come from $O(\alpha_s^2)$ calculations using $m_W = 80.24 \pm 0.10$ GeV, and $m_Z = 91.188 \pm 0.007$ GeV along with the corresponding value of $\sin^2\theta_W = 0.2325 \pm 0.005$. They use $\sigma(W)/\sigma(Z) = 3.33 \pm 0.03$, $\Gamma(Z) = 2.492 \pm 0.007$ GeV, and $\Gamma(W \to e\nu_e)/\Gamma(Z \to e^+e^-) = 2.710 \pm 0.018$.

[15] ALITTI 92 measured $R = 10.4\ ^{+0.7}_{-0.6} \pm 0.3$. The values of $\sigma(Z)$ and $\sigma(W)$ come from $O(\alpha_s^2)$ calculations using $m_W = 80.14 \pm 0.27$ GeV, and $m_Z = 91.175 \pm 0.021$ GeV along with the corresponding value of $\sin^2\theta_W = 0.2274$. They use $\sigma(W)/\sigma(Z) = 3.26 \pm 0.07 \pm 0.05$ and $\Gamma(Z) = 2.487 \pm 0.010$ GeV.

[16] ALBAJAR 91 measured $R = 9.5\ ^{+1.1}_{-1.0}$ (stat. + syst.). $\sigma(W)/\sigma(Z)$ is calculated in QCD at the parton level using $m_W = 80.18 \pm 0.28$ GeV and $m_Z = 91.172 \pm 0.031$ GeV along with $\sin^2\theta_W = 0.2322 \pm 0.0014$. They use $\sigma(W)/\sigma(Z) = 3.23 \pm 0.05$ and $\Gamma(Z) = 2.498 \pm 0.020$ GeV.

[17] ABE 92I report $1216 \pm 38\ ^{+27}_{-31}$ $W \to \mu\nu$ and $106 \pm 10\ ^{+0.2}_{-1}$ $Z \to \mu^+\mu^-$ events which are combined with 2426 $W \to e\nu$ events of ABE 91C to derive the ratio σ_W B($W \to \ell\nu$)/σ_Z B($Z \to \ell^+\ell^-$)= 10.0 ± 0.6 ± 0.4. Finally the value of $\Gamma(Z)$ measured by LEP 92 is used to extract $\Gamma(W)$.

[18] ABE 90 extract $\Gamma(W) = 2.19 \pm 0.20$ by using the value $\Gamma(Z) = 2.57 \pm 0.07$ GeV. However, in ABE 91C they update their analysis with a new LEP value $\Gamma(Z) = 2.496 \pm 0.016$; the value $\Gamma(W) = 2.12 \pm 0.20$ above reflects this update. They measured $R = 10.2 \pm$

0.8 ± 0.4, assumed $\sin^2\theta_W = 0.229 \pm 0.007$, and took predicted values $\sigma(W)/\sigma(Z) = 3.23 \pm 0.03$ and $\Gamma(W \to e\nu)/\Gamma(Z \to ee) = 2.70 \pm 0.02$. This yields $\Gamma(W)/\Gamma(Z) = 0.85 \pm 0.08$. The quoted error for $\Gamma(W)$ includes systematic uncertainties. $E_{\rm cm}^{p\overline{p}} = 1800$ GeV.

[19] ALITTI 90C used the same technique as described for ABE 90. They measured $R = 9.38^{+0.82}_{-0.72} \pm 0.25$, obtained $\Gamma(W)/\Gamma(Z) = 0.902 \pm 0.074 \pm 0.024$. Using $\Gamma(Z) = 2.546 \pm 0.032$ GeV, they obtained the $\Gamma(W)$ value quoted above and the limits $\Gamma(W) < 2.56$ (2.64) GeV at the 90% (95%) CL. $E_{\rm cm}^{p\overline{p}} = 546{,}630$ GeV.

[20] ALBAJAR 89 result is from a total sample of 299 $W \to e\nu$ events.

[21] If systematic error is neglected, result is $2.7^{+1.4}_{-1.5}$ GeV. This is enhanced subsample of 172 total events.

W ANOMALOUS MAGNETIC MOMENT ($\Delta\kappa$)

The full magnetic moment is given by $\mu_W = e(1+\kappa+\lambda)/2m_W$. In the Standard Model, at tree level, $\kappa = 1$ and $\lambda = 0$. Some papers have defined $\Delta\kappa = 1-\kappa$ and assume that $\lambda = 0$. Note that the electric quadrupole moment is given by $-e(\kappa-\lambda)/m_W^2$. A description of the parameterization of these moments and additional references can be found in HAGIWARA 87 and BAUR 88. The parameter Λ appearing in the theoretical limits below is a regularization cutoff which roughly corresponds to the energy scale where the structure of the W boson becomes manifest.

VALUE ($e/2m_W$)	*DOCUMENT ID*		*TECN*
• • • We do not use the following data for averages, fits, limits, etc. • • •			
	[22] ALITTI	92C	UA2
	[23] SAMUEL	92	THEO
	[24] SAMUEL	91	THEO
	[25] GRIFOLS	88	THEO
	[26] GROTCH	87	THEO
	[27] VANDERBIJ	87	THEO
	[28] GRAU	85	THEO
	[29] SUZUKI	85	THEO
	[30] HERZOG	84	THEO

[22] ALITTI 92C measure $\kappa = 1^{+2.6}_{-2.2}$ and $\lambda = 0^{+1.7}_{-1.8}$ in $p\overline{p} \to e\nu\gamma + X$ at $\sqrt{s} = 630$ GeV. At 95%CL they report $-3.5 < \kappa < 5.9$ and $-3.6 < \lambda < 3.5$.

[23] SAMUEL 92 use preliminary CDF and UA2 data and find $-2.4 < \kappa < 3.7$ at 96%CL and $-3.1 < \kappa < 4.2$ at 95%CL respectively. They use data for $W\gamma$ production and radiative W decay.

[24] SAMUEL 91 use preliminary CDF data for $p\overline{p} \to W\gamma X$ to obtain $-11.3 \leq \Delta\kappa \leq 10.9$. Note that their $\kappa = 1-\Delta\kappa$.

[25] GRIFOLS 88 uses deviation from ρ parameter to set limit $\Delta\kappa \lesssim 65\ (M_W^2/\Lambda^2)$.

[26] GROTCH 87 finds the limit $-37 < \Delta\kappa < 73.5$ (90% CL) from the experimental limits on $e^+e^- \to \nu\overline{\nu}\gamma$ assuming three neutrino generations and $-19.5 < \Delta\kappa < 56$ for four generations. Note their $\Delta\kappa$ has the opposite sign as our definition.

[27] VANDERBIJ 87 uses existing limits to the photon structure to obtain $|\Delta\kappa| < 33\ (m_W/\Lambda)$. In addition VANDERBIJ 87 discusses problems with using the ρ parameter of the Standard Model to determine $\Delta\kappa$.

[28] GRAU 85 uses the muon anomaly to derive a coupled limit on the anomalous magnetic dipole and electric quadrupole (λ) moments $1.05 > \Delta\kappa \ln(\Lambda/m_W) + \lambda/2 > -2.77$. In the Standard Model $\lambda = 0$.

[29] SUZUKI 85 uses partial-wave unitarity at high energies to obtain $|\Delta\kappa| \lesssim 190\,(m_W/\Lambda)^2$. From the anomalous magnetic moment of the muon, SUZUKI 85 obtains $|\Delta\kappa| \lesssim 2.2/\ln(\Lambda/m_W)$. Finally SUZUKI 85 uses deviations from the ρ parameter and obtains a very qualitative, order-of-magnitude limit $|\Delta\kappa| \lesssim 150\,(m_W/\Lambda)^4$ if $|\Delta\kappa| \ll 1$.

[30] HERZOG 84 consider the contribution of W-boson to muon magnetic moment including anomalous coupling of $WW\gamma$. Obtain a limit $-1 < \Delta\kappa < 3$ for $\Lambda \gtrsim 1$ TeV.

W$^+$ DECAY MODES

W^- modes are charge conjugates of the modes below.

	Mode		Fraction (Γ_i/Γ)		Confidence level
Γ_1	$\ell^+\nu$	[a]	(10.8±0.4) %		
Γ_2	$e^+\nu$		(10.8±0.4) %		
Γ_3	$\mu^+\nu$		(10.6±0.7) %		
Γ_4	$\tau^+\nu$		(10.8±1.0) %		
Γ_5	hadrons		(67.8±1.5) %		
Γ_6	$\pi^+\gamma$		< 5	$\times 10^{-4}$	95%

[a] ℓ indicates each type of lepton (e, μ, and τ), not sum over them.

CONSTRAINED FIT INFORMATION

An overall fit to 4 branching ratios uses 7 measurements and one constraint to determine 4 parameters. The overall fit has a $\chi^2 = 1.1$ for 4 degrees of freedom.

The following *off-diagonal* array elements are the correlation coefficients $\langle \delta x_i \delta x_j \rangle / (\delta x_i \cdot \delta x_j)$, in percent, from the fit to the branching fractions, $x_i \equiv \Gamma_i/\Gamma_{\text{total}}$. The fit constrains the x_i whose labels appear in this array to sum to one.

x_3	34		
x_4	43	15	
x_5	−70	−64	−82
	x_2	x_3	x_4

W BRANCHING RATIOS

$\Gamma(\ell^+\nu)/\Gamma_{\text{total}}$ 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	[31] ABE	92I	CDF	$E_{\text{cm}}^{p\overline{p}}$= 1.8 TeV

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

$\Gamma(e^+\nu)/\Gamma_{\text{total}}$ 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		[32] ABE	94B	CDF	$E_{\text{cm}}^{p\overline{p}}$= 1800 GeV
0.10 ±0.014 $^{+0.02}_{-0.03}$	248	[33] ANSARI	87C	UA2	$E_{\text{cm}}^{p\overline{p}}$= 546,630 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
0.106 ±0.0096	2426	[34] ABE	91C	CDF	Repl. by ABE 94B
seen	299	[35] ALBAJAR	89	UA1	$E_{\text{cm}}^{p\overline{p}}$= 546,630 GeV
seen	119	APPEL	86	UA2	$E_{\text{cm}}^{p\overline{p}}$= 546,630 GeV
seen	172	ARNISON	86	UA1	Repl. by ALBAJAR 89

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

[33] 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: $\sigma(546\text{ GeV}) = 4.7^{+1.4}_{-0.7}$ nb and $\sigma(630\text{ GeV}) = 5.8^{+1.8}_{-1.0}$ nb. See ALTARELLI 85B.

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

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

$\Gamma(\mu^+\nu)/\Gamma_{\text{total}}$ 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	[36] ABE	92I	CDF	$E_{\text{cm}}^{p\overline{p}}$= 1.8 TeV

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

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

VALUE	DOCUMENT ID
0.108±0.010 OUR FIT	

$\Gamma(\text{hadrons})/\Gamma_{\text{total}}$ 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	[37] ABE	92I	CDF	$E_{\text{cm}}^{p\overline{p}}$= 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	$E_{\text{cm}}^{p\overline{p}}$= 546,630 GeV
$1.24^{+0.6}_{-0.4}$	14	ARNISON	84D	UA1	Repl. by ALBAJAR 89

[37] ABE 92I obtain $\sigma_W \text{B}(W \to \mu\nu)$= 2.21 ± 0.07 ± 0.21 and combine with ABE 91C σ_W B($(W \to e\nu)$) 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	[38] ABE	92E	CDF	$E_{\text{cm}}^{p\overline{p}}$= 1.8 TeV
1.04 ±0.08 ±0.08	754	[39] ALITTI	92F	UA2	$E_{\text{cm}}^{p\overline{p}}$= 630 GeV
1.02 ±0.20 ±0.12	32	ALBAJAR	89	UA1	$E_{\text{cm}}^{p\overline{p}}$= 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

[38] ABE 92E use two procedures for selecting $W \to \tau\nu_\tau$ 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 $\sigma\text{B}(W \to \tau\nu) = 2.05 \pm 0.27$ nb. Combined with ABE 91C result on $\sigma\text{B}(W \to e\nu)$, ABE 92E quote a ratio of the couplings from which we derive this measurement.

[39] 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	$E_{\text{cm}}^{p\overline{p}}$= 1.8 TeV
$< 4.9 \times 10^{-3}$	95	[40] ALITTI	92D	UA2	$E_{\text{cm}}^{p\overline{p}}$= 630 GeV
$<58 \times 10^{-3}$	95	[41] ALBAJAR	90	UA1	$E_{\text{cm}}^{p\overline{p}}$= 546, 630 GeV

[40] ALITTI 92D limit is 3.8×10^{-3} at 90%CL.
[41] ALBAJAR 90 obtain < 0.048 at 90%CL.

W REFERENCES

ABE	95C	PRL 74 341	+Albrow, Amidei, Antos, Anway-Wiese+	(CDF Collab.)
ABE	95P	PRL to be publ.	+Albrow, Amidei, Antos, Anway-Wiese+	(CDF Collab.)
Fermilab-Pub-95/035-1995				
Also	95Q	PR D submitted	Abe, Albrow, Amidei, Antos, Anway-Wiese+	(CDF Collab.)
Fermilab-Pub-95/033-E				
ABE	94B	PRL 73 220	+Albrow, Amidei, Anway-Wiese+	(CDF Collab.)
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.)