Table 2: Average fit χ^2 contribution of τ branching ratio measurements grouped by decay mode category.

Category	Data entries	$\langle\chi^2\rangle$ per datum
All modes	116	1.17
1-prong 0 neutrals	51	0.74
1-prong ≥ 1 neutrals	28	1.87
Not 1-prong modes	37	1.23

The fact that the fit has to spread the branching fraction corresponding to the 1-prong deficit between many relatively well-measured basis modes means that the *average* values for some branching fractions (*i.e.*, B_e and B_μ) may be slightly more accurate than the *fit* values. In this edition, the method of calculating averages has been improved. In previous editions, individual branching fraction measurements were either used for both the fit and averages, or they were excluded from both the fit and averages. Many data must be excluded from the fit because they are highly correlated to other data which are used in the fit. Thus, many data were not used in averages even though there was no other reason to exclude them. With the new change, data not used in the fit may be used in averages. For branching ratios which contain some data which are to be used only in the average, a new column has been added to the Listings to indicate which data are used both for fits and averages ("f&a") and which are flagged for use only for averages ("avg").

Experimental measurements of the charged-prong topological branching fractions† and $B(h^-h^-h^+\nu_\tau)$ also exhibit some internal inconsistency. Refer to the scale factors and ideograms given in the Full Listings for further information.

Conclusions: Experimental measurements of τ branching fractions contain internal inconsistencies. Measurements have become sufficiently precise that the constrained fit to branching ratio data now has an improbably large χ^2. Much of the inconsistency is contained in decay modes of the type $\tau^- \to h^- + (\geq)n\pi^0\nu_\tau$ for $n = 1,\ 2,$ and 3, although the charged-prong topological branching fractions and $B(h^-h^-h^+\nu_\tau)$ also show signs of problems. Future precise measurements at LEP should resolve the problems in the charged-prong topological branching fractions. Additional measurements with small, well-understood systematic errors are needed to sort out the confusion in the other modes.

Notes and References

* Because of the way we have grouped the modes, the number of degrees of freedom (dof) is not available except for the "all modes" category. While not as well defined as χ^2 per dof, the number provides a useful measure of the source of the dominant χ^2 contributions.

† We have slightly generalized the idea of topological branching fractions to include $(\geq)n\pi^0$'s. These are *topological*, in the sense that they classify what is observed, rather than *physical*, which would classify modes at the top of the decay chain: e, μ, π, K, ρ, $K^*(892)$, *etc.*

1. T.N. Troung, Phys. Rev. **D30**, 1509 (1984).
2. F.J. Gilman and S.H. Rhie, Phys. Rev. **D31**, 1066 (1985); F.J. Gilman, Phys. Rev. **D35**, 3541 (1987).
3. See for example M.A. Samuel, Mod. Phys. Lett. **A8**, 2491 (1993).
4. R. Akers *et al.*, Phys. Lett. B (to be published).
5. M. Artuso *et al.*, Phys. Rev. Lett. (to be published).
6. M. Procario *et al.*, Phys. Rev. Lett. **70**, 1207 (1993).

τ MASS

VALUE (MeV)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
$1777.1^{+0.4}_{-0.5}$ OUR AVERAGE					
$1777.8 \pm 0.7 \pm 1.7$	35k	[1] BALEST	93	CLEO	$E^{ee}_{cm} = 10.6$ GeV
$1776.3 \pm 2.4 \pm 1.4$	11k	[2] ALBRECHT	92M	ARG	$E^{ee}_{cm} = 9.4$–10.6 GeV
$1776.9^{+0.4}_{-0.5} \pm 0.2$	14	[3] BAI	92	BES	$E^{ee}_{cm} = 3.55$–3.60 GeV
1787 ± 10		BLOCKER	80	MRK2	$E^{ee}_{cm} = 3.5$–6.7 GeV
1783^{+3}_{-4}	692	[4] BACINO	78B	DLCO	$E^{ee}_{cm} = 3.1$–7.4 GeV
1787^{+10}_{-18}	299	[5] BARTEL	78	SPEC	$E^{ee}_{cm} = 3.6$–4.4 GeV
1807 ± 20		BRANDELIK	78	DASP	$E^{ee}_{cm} = 3.1$–5.2 GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
1803 ± 16	1138	BLOCKER	82D	MRK2	Incl. in BLOCKER 80

[1] BALEST 93 fit spectra of minimum kinematically allowed τ mass in events of the type $e^+e^- \to \tau^+\tau^- \to (\pi^+ n\pi^0\nu_\tau)(\pi^- m\pi^0\nu_\tau)$ $n \leq 2$, $m \leq 2$, $1 \leq n+m \leq 3$. If $m_{\nu_\tau} \neq 0$, result increases by $(m^2_{\nu_\tau}/1100\ \text{MeV})$.

[2] ALBRECHT 92M fit τ pseudomass spectrum in $\tau^- \to 2\pi^-\pi^+\nu_\tau$ decays. Result assumes $m_{\nu_\tau}=0$.

[3] BAI 92 fit $\sigma(e^+e^- \to \tau^+\tau^-)$ near threshold using $e\mu$ events.

[4] BACINO 78B value comes from $e^\pm X^\mp$ threshold. Published mass 1782 MeV increased by 1 MeV using the high precision $\psi(2S)$ mass measurement of ZHOLENTZ 80 to eliminate the absolute SPEAR energy calibration uncertainty.

[5] BARTEL 78 fits energy dependence of cross section for $e^\pm$ and $\mu^\pm$ events. Mass value not dependent on whether $V-A$ or $V+A$ decay assumed.

τ MEAN LIFE

The downward revision of the τ mass to 1777.1 MeV (see the τ mass above) results in a downward correction of some of the older lifetime measurements, with the net result that the average should be reduced by 0.2 fs. WASSERBAECH 93 shows that additional systematic biases are not consistently taken into account by the experimenters. When the appropriate corrections are applied, the average is decreased by an additional 0.8 fs. "OUR EVALUATION" reflects these changes.

VALUE (10^{-15} s)	*EVTS*	*DOCUMENT ID*		*TECN*	*COMMENT*
295.6 ± 3.1 OUR EVALUATION					
296.6 ± 3.1 OUR AVERAGE					
298 ± 7		ABREU	93E	DLPH	$E^{ee}_{cm} = 88.5$–93.7 GeV
$291.9 \pm 5.1 \pm 3.1$	28k	ACTON	93J	OPAL	$E^{ee}_{cm} = 88$–94 GeV
$293 \pm 9 \pm 12$	5743	ADRIANI	93M	L3	1991 LEP run
$304 \pm 14 \pm 7$	4100	BATTLE	92	CLEO	$E^{ee}_{cm} = 10.6$ GeV
$294.7 \pm 5.4 \pm 3.0$	11.8k	BUSKULIC	92H	ALEP	$E^{ee}_{cm} = 88.5$–93.7 GeV
$314 \pm 23 \pm 9$		ABREU	91D	DLPH	$E^{ee}_{cm} = 88$–94 GeV
$309 \pm 23 \pm 30$	2817	ADEVA	91F	L3	1990 LEP run
301 ± 29	3780	KLEINWORT	89	JADE	$E^{ee}_{cm} = 35$–46 GeV
$288 \pm 16 \pm 17$	807	AMIDEI	88	MRK2	$E^{ee}_{cm} = 29$ GeV
$306 \pm 20 \pm 14$	695	BRAUNSCH...	88C	TASS	$E^{ee}_{cm} = 36$ GeV
$299 \pm 15 \pm 10$	1311	ABACHI	87C	HRS	$E^{ee}_{cm} = 29$ GeV
$295 \pm 14 \pm 11$	5696	ALBRECHT	87P	ARG	$E^{ee}_{cm} = 9.3$–10.6 GeV
$309 \pm 17 \pm 7$	3788	BAND	87B	MAC	$E^{ee}_{cm} = 29$ GeV
$325 \pm 14 \pm 18$	8470	BEBEK	87C	CLEO	$E^{ee}_{cm} = 10.5$ GeV
• • • We do not use the following data for averages, fits, limits, etc. • • •					
$291 \pm 13 \pm 6$	6621	DECAMP	92E	ALEP	Repl. by BUSKULIC 92H
308 ± 13		ACTON	91C	OPAL	Repl. by ACTON 93J
$315 \pm 36 \pm 40$	10k	FERNANDEZ	85	MAC	$E^{ee}_{cm} = 29$ GeV
318^{+81}_{-94}	50	ALTHOFF	84D	TASS	Repl. by BRAUNSCHWEIG 88C
320 ± 54	156	JAROS	83	MRK2	Repl. by AMIDEI 88