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Combining W Mass Measurements

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We have agreed on a method for combining the different measurements of the W masses from different experiments. This method should work for upcoming measurements as well as the current ones. We apply this method to the current measurements to suggest the W mass to be used in the global electroweak fits.

The procedure to combine the measurements is to average recent measurements weighted by their uncorrelated uncertainties. The common uncertainty is included after the averaging. All uncertainties are propagated as if Gaussian. The correlated uncertainty is determined from the most recent CDF and D0 measurements. If the estimates of the correlated uncertainty differ, the larger is taken. For each measurement, the uncertainty quoted for the common effect is removed to determine the uncorrelated uncertainty. If the corresponding uncertainty for an old measurement becomes much larger than the common error, then that part of the uncertainty will not be removed for that measurement. Since there are a few points at which the various analyses differ slightly, rather than adjusting the measurements, the Particle Data Group's prescription for determining an S-factor [1] is followed for the uncorrelated parts of the measurement. If the S-factor is less than unity, no correction should be applied.

For example, currently the only correlated uncertainty for the most recent measurements at $\sqrt{s} = 1.8$ TeV is that due to proton structure. The assumptions behind the D0 and CDF event modelling are sufficiently different to treat the corresponding uncertainties as independent. CDF and D0 quote 100 MeV/c^2 and 70 MeV/c^2 (preliminary) structure function uncertainties, respectively. The larger of the two, 100 MeV/c^2 is taken as the common error.

In this note, we combine the following published and preliminary numbers according to this procedure:

Mass (GeV/c^2)	Experiment	Uncorrelated Uncert. (GeV/c^2)	Reference
79.91 ± 0.39	CDF-90	0.385	[2]
80.36 ± 0.37	UA2-92	0.360	[3]
79.86 ± 0.40	D0-93	0.394	[4]
80.38 ± 0.23	CDF-93/94	0.207	[5]

Combining these errors as stated gives 80.23 ± 0.18 GeV/c^2. The corresponding S-factor is 0.86 so no scaling of the final uncertainty is required. Note that if the numbers had been

combined without regard for correlations, the number would have been 80.21 ± 0.16 GeV/c^2, which differs insignificantly.

In summary, we recommend that the global electroweak fits use the value 80.23 ± 0.18 GeV/c^2 for the W mass.

References

[1] M. Aguilar-Benitez *et al.* (Particle Data Group), Phys. Rev. **D45**, Part 2 (1992).

[2] F. Abe *et al.* (CDF Collaboration), Phys. Rev. Lett. **65**, 2243 (1990).

[3] J. Alitti *et al.* (UA2 Collaboration), Phys. Lett., **B276**, 354 (1992). The W mass is calculated using the 1993 Lepton-Photon LEP Z mass of 91.187 ± 0.007 GeV/c^2.

[4] Q. Zhu (D0 Collaboration) at "The Ninth Topical Workshop on Proton-Antiproton Collider Physics", October 18-22, 1993.

[5] D. Saltzberg (CDF Collaboration) at "The Ninth Topical Workshop on Proton-Antiproton Collider Physics", October 18-22, 1993; Y. K. Kim (CDF Collaboration) at "Electroweak Interactions and Unified Theories," Meribel, Savoie, France, March 12-19, 1994.