# THE MASS OF THE $W$ BOSON

Revised March 2000 by C. Caso (Univ. of Genova) and A. Gurtu (Tata Inst.)

Till 1995 the production and study of the $W$ boson was the exclusive domain of the $\overline{p}p$ colliders at CERN and FNAL. $W$ production in these hadron colliders is tagged by a high $p_T$ lepton from $W$ decay. Owing to unknown parton–parton effective energy and missing energy in the longitudinal direction, the experiments reconstruct only the transverse mass of the $W$ and derive the $W$ mass from comparing the transverse mass distribution with Monte Carlo predictions as a function of $M_W$.

Beginning 1996 the energy of LEP increased to above 161 GeV, the threshold for $W$–pair production. A precise knowledge of the $e^+e^-$ centre of mass energy enables one to reconstruct the $W$ mass even if one of them decays leptonically. At LEP two methods have been used to obtain the $W$ mass. In the first method the measured $W$–pair production cross sections, $\sigma(e^+e^- \to W^+W^-)$, have been used to determine the $W$ mass using the predicted dependence of this cross section on $M_W$ (see Fig. 1). At 161 GeV, which is just above the $W$–pair production threshold, this dependence is a much more sensitive function of the $W$ mass than at the higher energies (172 to 202 GeV) at which LEP has run during 1996–99. In the second method, which is used at the higher energies, the $W$ mass has been determined by directly reconstructing the $W$ from its decay products.

Each LEP experiment has combined their own mass values properly taking into account the common systematic errors. In order to compute the LEP average $W$ mass each experiment has provided its measured $W$ mass for the $qqqq$ and $qq\ell\nu$ channels at each center-of-mass energy along with a detailed break-up of errors (statistical and uncorrelated, partially correlated and fully correlated systematics [1]). These have been properly combined to obtain a *preliminary* [2] LEP $W$ mass $= 80.401 \pm 0.048$ GeV. Errors due uncertainties in LEP energy (17 MeV) and possible effect of color reconnection (CR) and Bose–Einstein (BE) correlations between quarks from different $W$'s (18 MeV) are included. The mass difference between $qqqq$

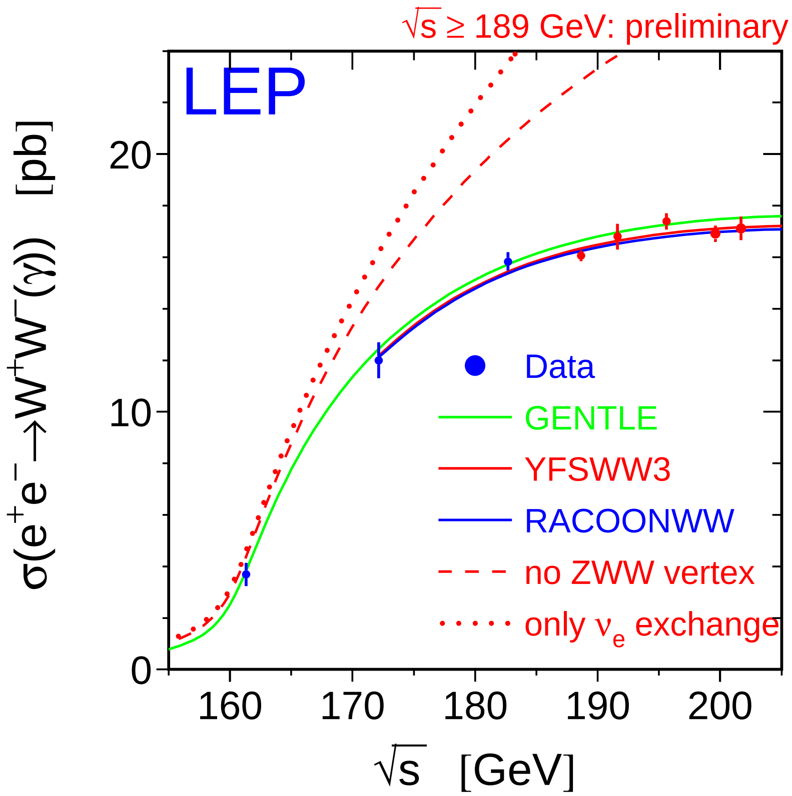


**Figure 1:** The $W$–pair cross section as a function of the center–of–mass energy. The data points are the LEP averages. The solid lines are predictions from different models of $WW$ production. For comparison the figure contains also the cross section if the ZWW coupling did not exist (dashed line), or if only the $t$–channel $\nu_e$ exchange diagram existed (dotted line).

and $qq\ell\nu$ final states (due to possible CR and BE effects) is 35±55 MeV.

The two Tevatron experiments have also carried out the exercise of identifying common systematic errors and averaging with CERN UA2 data obtain an average $W$ mass = 80.448±0.062 GeV.

Combining all the published and unpublished $p$–$\overline{p}$ Collider and LEP results (as of mid-March 2000) yields an average $W$–boson mass of 80.419±0.038 GeV assuming no common systematics between LEP and hadron collider measurements.

The Standard Model prediction from the electroweak fit, excluding the direct $W$ mass measurements from LEP and Tevatron, gives a $W$–boson mass of $80.382 \pm 0.026$ GeV.

OUR EVALUATION in the listing below is obtained by combining only published LEP and $p$–$\overline{p}$ Collider results using the same procedure as above.

## References

1. The LEP Collaborations: ALEPH, DELPHI, L3, OPAL, the LEP Electroweak Working Group, and the SLD Heavy Flavour and Electroweak Groups, CERN-EP-2000-016 (January 21, 2000).
2. A. Straessner and C. Sbarra, talks presented at the XXXV Rencontres de Moriond, "Electroweak Interactions and Unified Theories," (Les Arcs, France, 11–18 March 2000).