## THE MASS OF THE $W$ BOSON

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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, $\sigma(e^+e^- \rightarrow W^+W^-)$, 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 208 GeV) at which LEP has run during 1996–2000. 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* LEP $W$ mass = 80.446±0.040 GeV [2]. 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 (40 MeV and 25 MeV respectively) are included. The mass difference between $qqqq$ and $qq\ell\nu$ final states (due to possible CR and BE effects) is $+18 \pm 46$ MeV.

The two Tevatron experiments have also carried out the exercise of identifying common systematic errors and averag-

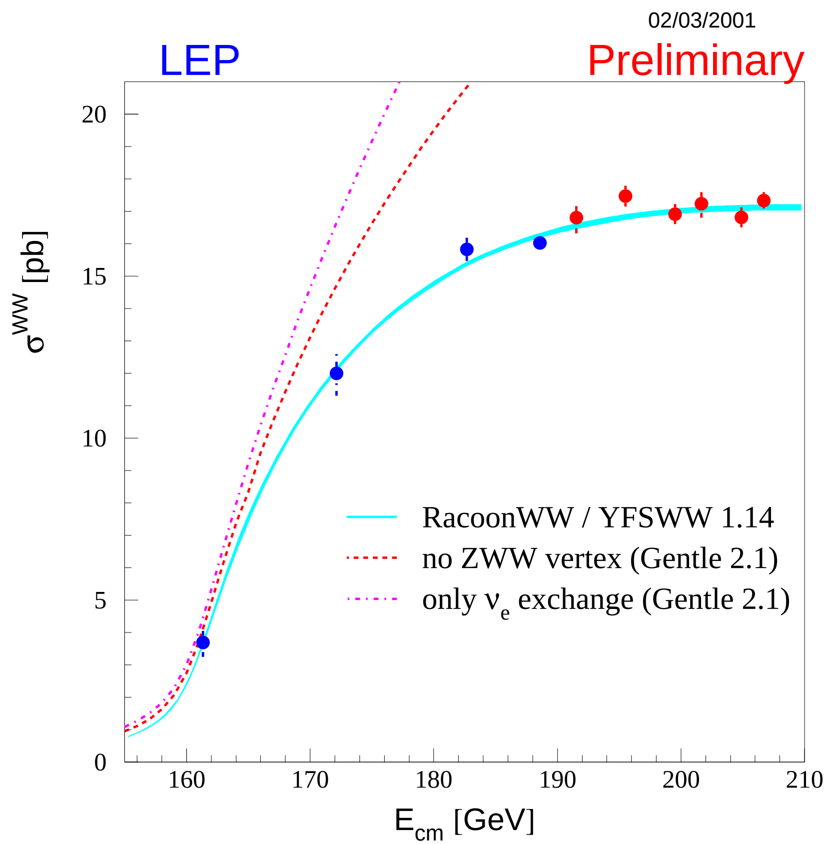


**Figure 1:** The $W$–pair cross section as a function of the center–of–mass energy. The data points are the LEP averages. The solid lines are predictions from different models of $WW$ production. For comparison the figure contains also the cross section if the ZWW coupling did not exist (dashed line), or if only the $t$–channel $\nu_e$ exchange diagram existed (dotted-dashed line). (Figure from `http://lepewwg.web.cern.ch/LEPEWWG/plots/winter2001/m01_sww_no_tgc.eps`)

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-2001-021, hep-ex/0103048 (March 2001).
2. N. Watson, "$W$ mass and $W^+W^-$ final state interactions," *XXXVI Rencontres de Moriond, "ElectroWeak Interactions and Unified Theories"*, Les Arcs, France (10–17 March 2001).
3. http://www-cdf.fnal.gov/physics/ewk/wmass_new.html.