THE MASS OF THE *W* BOSON

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Until 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 in 1996, the energy of LEP increased to above 161 GeV, the threshold for W–pair production. A precise knowledge of the e^+e^- center-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 209 GeV) at which LEP ran 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 $q\overline{q}q\overline{q}$ and $q\overline{q}\ell\overline{\nu_\ell}$ 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 = 80.376±0.033 GeV, which includes W mass determination from W-pair producton cross section variation at threshold. Errors due to uncertainties in LEP energy (9 MeV), and possible effect of color reconnection (CR) and Bose–Einstein correlations

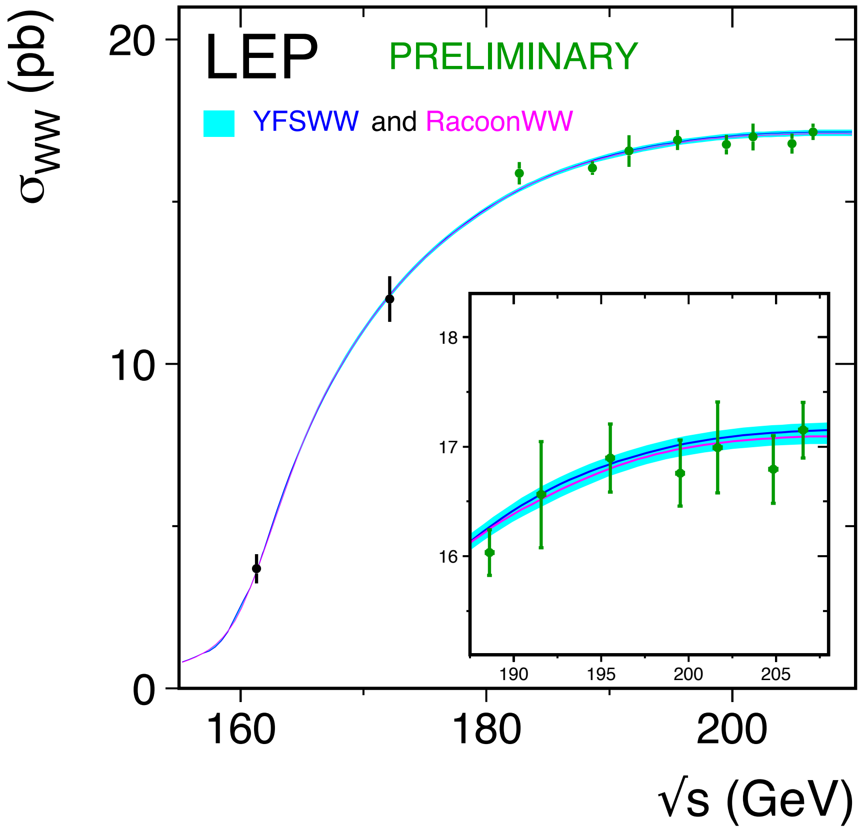

Figure 1: Measurement of the W-pair production cross section as a function of the center–of–mass energy [1], compared to the predictions of RACOONWW [2] and YFSWW [3]. The shaded area represents the uncertainty on the theoretical predictions, estimated to be ±2% for $\sqrt{s} < 170$ GeV and ranging from 0.7 to 0.4% above 170 GeV.

(BEC) between quarks from different W's (8 MeV) are included. The mass difference between $q\overline{q}q\overline{q}$ and $q\overline{q}\ell\overline{\nu_\ell}$ final states (due to possible CR and BEC effects) is -12 ± 45 MeV.

For completeness we give here also the *preliminary* LEP value for the W width: $\Gamma(W) = 2.196 \pm 0.083$ GeV [1].

For Run I data, 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 [4] $= 80.454 \pm 0.059$ GeV. The CDF Collaboration has reported its preliminary W mass measurement using Run II data as 80.413±0.048 GeV [5].

Combining the above W mass values from LEP and hadron colliders, which are based on all published and unpublished results, and assuming no common systematics between them, yields a *preliminary* average W mass of 80.399 ± 0.025 GeV.

Finally, a fit to this directly determined W mass together with measurements on the ratio of W to Z mass (M_W/M_Z) and on their mass difference ($M_Z - M_W$) yields a world average W-boson mass of 80.400 ± 0.024 GeV.

The Standard Model prediction from the electroweak fit, using Z–pole data plus m_{top} measurement, gives a W–boson mass of 80.361 ± 0.020 GeV [1].

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

References

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