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Direct measurement of the W boson mass in $e^+ e^-\$ collisions at LEP
Mulders, M.P.

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Citation for published version (APA):
Mulders, M. P. (2001). Direct measurement of the W boson mass in $e^+ e^-\$ collisions at LEP

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Chapter 8

Results and Conclusion

The previous chapters described the analysis used and the systematic errors associated with the measurement. Here an overview of the measurement results is given, together with its interpretation and a comparison with other existing measurements.

8.1 W mass

Fully-hadronic results

The 2D Ideogram analysis as presented in chapter 6 was not only applied to the 189 GeV data, but also used to update the 172 and 183 GeV results that were already published before. In figure 8.1 the new results are compared to the published results. The agreement is good. At 189 GeV, the only difference in mass comes from a slightly different treatment of the systematic corrections. The published versions of the Ideogram analysis at lower energies differ from the ‘final’ analysis in quite a number of points (chapter 5). Main differences are the cut at 25% purity, the 4C approximation while at 183 GeV still the full 6C 2D Ideograms were used, and the event-by-event ISR treatment. Considering these changes in the analysis, the difference in measured mass at 183 GeV is not surprising.

To appreciate the development of the $q\bar{q}q\bar{q}$ analysis it is illustrative to compare the expected statistical sensitivity on MC, and the development of the quoted systematic errors, as shown in Table 8.1

<table>
<thead>
<tr>
<th></th>
<th>$m_W$ q$q\bar{q}\bar{q}$ channel (MeV/c$^2$)</th>
<th>Expected statistical error</th>
<th>Quoted systematic error</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>‘New’ Ideogram</td>
<td>Published</td>
</tr>
<tr>
<td>172 GeV</td>
<td>510</td>
<td>520</td>
<td>33</td>
</tr>
<tr>
<td>183 GeV</td>
<td>189</td>
<td>193</td>
<td>23</td>
</tr>
<tr>
<td>189 GeV</td>
<td>104</td>
<td>104</td>
<td>27</td>
</tr>
</tbody>
</table>

Table 8.1: Comparison of the expected statistical errors and quoted systematic errors (excluding the systematic error due to the LEP beam energy scale, and FSI).
In spite of the fact that more possible sources of systematic errors have been studied and are included, the overall systematic uncertainties have decreased compared to the published numbers. It is clear that the understanding of the systematic has improved considerably. The improvement on the expected statistical errors is small, which is no surprise because the 172 GeV analysis already took into account 5-jet topologies, the event purity and event resolution.

The overall combination of the $q\bar{q}q\bar{q}$ results obtained at 172, 183 and 189 GeV gives:

$$m_W^{q\bar{q}q\bar{q}} = 80.395 \pm 91\text{ (stat)} \pm 25\text{ (syst)} \pm 47\text{ (FSI)} \pm 17\text{ (LEP)}\text{ MeV}/c^2$$

This result is shown together with the published results from the 4 LEP experiments for the 172-189 GeV data sets in Figure 8.2. The L3 result has not been published, but is based on the numbers used by the LEP EW working group in the Summer 2000 EW fit.

![Compatibility of $q\bar{q}q\bar{q}$ results 172-189 GeV](image)

Figure 8.1: $W$ mass measurement results obtained with the final 2D ideogram analysis (from Table 6.8, with the corrections listed in Table 7.12), compared to the published DELPHI results. Only the statistical errors are shown

### Semi-leptonic results

The $q\ell\nu$ results obtained with the 2D Ideogram analysis are compared to the DELPHI published numbers in Figure 8.3. The analyses are independent, but they were applied to the same data sets. Thus the Ideogram results can be considered as an independent cross-check. At 183 and 172 GeV the agreement is excellent. At 189 GeV, however, both the results of the $q\ell\mu\nu$ and the $q\ell\nu\nu$ channels deviate more than expected. To quantify the statistical significance of the observed differences would require more work, taking into account the correlations between the analyses. The largest deviation is seen in the $q\ell\nu\nu$ channel, where the reconstructed equal-mass spectrum (Figure 6.11) already showed a deficit of events exactly at the peak. This deficit can also be
seen in the corresponding mass spectrum for the main DELPHI $q\bar{q}\ell\nu$ analysis [3], however. At that time the unexpected peak structure inspired an intensified cross-check of possible systematic problems in the electron channel at 189 GeV, but nothing was found that could explain the effect. It therefore had to be interpreted as a statistical fluctuation. In addition to this hitherto unexplained effect, another possible source of a systematic bias may be an incomplete simulation of the backgrounds in the Ideogram analysis. The plots in Figure 6.6 show some indication that a few background events not included in the MC simulation (probably Bhabha events) are selected in the $q\bar{q}\ell\nu$ channel. The possible effects of such a background have not been studied. A detailed systematic investigation was considered to be beyond the scope of the $q\bar{q}\ell\nu$ Ideogram study.

The principal aim of the $q\bar{q}\ell\nu$ project reported here, was to investigate the statistical sensitivity of the Ideogram analysis in the $q\bar{q}\ell\nu$ channel. From Table 8.2, it is clear that the Ideogram study can match the statistical sensitivity of the main DELPHI $q\bar{q}\ell\nu$ analysis, despite its preliminary character.

The overall combination of the $q\bar{q}\ell\nu$ results obtained at 172, 183 and 189 GeV gives:

$$m_{W}^{q\bar{q}\ell\nu} = 80.239 \pm 124 \text{ (stat)} \pm 60 \text{ (syst)} \pm 18 \text{ (LEP) } \text{MeV}/c^2$$

This result is shown together with the published results from the 4 LEP experiments for the 172-189 GeV data sets in Figure 8.4. The L3 number is based on the numbers (up to 189 GeV) used by the LEP EW working group in the Summer 2000 EW fit.
Compatibility of q\(\ell\)\(\nu\) results 172-189 GeV

<table>
<thead>
<tr>
<th></th>
<th>This thesis 172 GeV</th>
<th>DELPHI 172 GeV</th>
<th>172 GeV q(\ell)(\nu)</th>
<th>183 GeV q(\ell)(\nu)</th>
<th>189 GeV q(\ell)(\nu)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>80.454 ± 0.506 (stat)</td>
<td>80.510 ± 0.570 (stat)</td>
<td>80.056 ± 0.213 (stat)</td>
<td>80.128 ± 0.290 (stat)</td>
<td>80.086 ± 0.332 (stat)</td>
</tr>
<tr>
<td></td>
<td>80.554 ± 0.232 (stat)</td>
<td>80.520 ± 0.267 (stat)</td>
<td>80.195 ± 0.213 (stat)</td>
<td>80.478 ± 0.291 (stat)</td>
<td>80.114 ± 0.319 (stat)</td>
</tr>
<tr>
<td></td>
<td>80.081 ± 0.153 (stat)</td>
<td>80.253 ± 0.151 (stat)</td>
<td>80.114 ± 0.319 (stat)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 8.3: \(W\) mass measurement results obtained with the final 2D ideogram analysis (from Table 6.8, with the corrections listed in Table 7.12), compared to the published DELPHI results. Only the statistical errors are shown.

<table>
<thead>
<tr>
<th>(m_W) q(\ell)(\nu) channel (MeV/c(^2))</th>
<th>Expected statistical error</th>
<th>'New' Ideogram</th>
<th>Published</th>
</tr>
</thead>
<tbody>
<tr>
<td>172 GeV q(\ell)(\nu)</td>
<td>592</td>
<td>623*</td>
<td></td>
</tr>
<tr>
<td>183 GeV q(\ell)(\nu)</td>
<td>235</td>
<td>259*</td>
<td></td>
</tr>
<tr>
<td>189 GeV q(\ell)(\nu)</td>
<td>142</td>
<td>143</td>
<td></td>
</tr>
</tbody>
</table>

* The DELPHI published q\(\ell\)\(\nu\) measurements at energies below 189 GeV did not include the q\(\ell\)\(\tau\)\(\nu\) channel.

Table 8.2: Comparison of expected statistical errors in the q\(\ell\)\(\nu\) channel.

**Overall combination and interpretation of the W mass result**

Combination of the q\(\ell\)\(\nu\) and qqq\(\bar{q}\) channel gives the following overall measurement of the W boson mass:

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Comparison of $q\bar{q}l\nu$ results 172-189 GeV

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Result (GeV/c²)</th>
<th>Stat. Error</th>
<th>Syst. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>This thesis</td>
<td>80.239 ± 0.124</td>
<td>± 0.060</td>
<td></td>
</tr>
<tr>
<td>DELPHI</td>
<td>80.327 ± 0.128</td>
<td>± 0.045</td>
<td></td>
</tr>
<tr>
<td>ALEPH</td>
<td>80.335 ± 0.084</td>
<td>± 0.034</td>
<td></td>
</tr>
<tr>
<td>L3</td>
<td>80.216 ± 0.117</td>
<td>± 0.050</td>
<td></td>
</tr>
<tr>
<td>OPAL</td>
<td>80.441 ± 0.086</td>
<td>± 0.045</td>
<td></td>
</tr>
</tbody>
</table>

Figure 8.4: Comparison of the $q\bar{q}l\nu$ result obtained in this thesis with the published results of the LEP experiments used in the LEP EW combination. The systematic errors shown do not include the error due to the LEP beam energy scale.

$[m_W] = 80.339 ± 73$ (stat) ± 32 (syst) ± 30 (FSI) ± 18 (LEP) MeV/c²

This result is in excellent agreement with the standard model expectation (equation (1.34)): $m_W = 80.373 ± 0.024$ GeV/c², and also with the combined direct measurement of LEP (Summer 2000, including energies up to 202 GeV [75]): $m_W = 80.428 ± 0.047$ GeV/c². The good agreement of the measured W mass also means that the corresponding value of $\Delta r$:

\[ \Delta r = 0.0377 ± 0.0052 \] (8.3)

agrees with the SM prediction [11] $\Delta r = 0.0357 ± 0.0014$. Subtracting the term due to the running of $\alpha$, $\Delta \alpha = 0.0664 ± 0.0002$ (equation (1.32)), the result is:

\[ \Delta r_W = -0.0287 ± 0.0052 \] (8.4)

which demonstrates the existence of purely EW radiative corrections (of the type discussed in chapter 1) by 5.5 standard deviations. These quantum fluctuations cause the measured value of the $\rho$ parameter to deviate from unity:

\[ \rho = 1.0096 ± 0.0022 \] (8.5)
but taking into account the effect from radiative corrections on $\rho$ predicted by the SM (as in equation (1.39)), one obtains the following measurement of $\rho_0$:

$$\rho_0 = 0.9989 \pm 0.0022$$  \hspace{1cm} (8.6)

The agreement of the measured value of $\rho_0$ with unity reflects the compatibility of the measurement with the assumption that the Higgs field is limited to the SM Higgs doublet.

This agreement has been confirmed already with better precision by the combination of the LEP and Tevatron results. It is therefore interesting to use the above assumption and predict the Higgs mass indirectly from a SM fit. The results of this world combined EW fit are shown in Figure 8.5 (and Figure 8.9 at the end of this chapter). As an illustration the direct W mass measurement presented in this thesis is superimposed $^1$ on the plots.

---

Figure 8.5: Prediction of the SM Higgs boson mass as a function of the W mass. Based on a Summer 2000 EW working group plot [75].

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$^1$The result of this thesis is correlated to the overall direct $m_W$ measurement shown, through the DELPHI $m_W$ results already included in the world average.
Results and Conclusion

Figure 8.6: Comparison of the \( \Gamma_W \) results obtained in this thesis with the 183 and 189 GeV results published by DELPHI. Only the statistical errors are shown.

8.2 W width

Combination of results

W width results have also been published by DELPHI before, but only for 183 and 189 GeV data. The updated Ideogram results show an excellent agreement with the published DELPHI results, as shown in Figure 8.6. Again the 189 GeV numbers are shown separately for the different qqlv channels. Both in the qqlv Ideogram study and in the main DELPHI analysis the measured width in the qqlv channel is high compared to the other results. This is consistent with the deficit of events seen in the mass peak, as discussed in relation with the \( m_W \) measurement in the previous section.

The combination of the different semi-leptonic channels was done at the level of the likelihood
Comparison of $\Gamma_W$ results 172-189 GeV

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Measured Width (GeV/c$^2$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This thesis</td>
<td>$2.29 \pm 0.17$ (stat) ± 0.08 (syst)</td>
</tr>
<tr>
<td>DELPHI</td>
<td>$2.29 \pm 0.18$ (stat) ± 0.08 (syst)</td>
</tr>
<tr>
<td>ALEPH</td>
<td>$2.24 \pm 0.20$ (stat) ± 0.13 (syst)</td>
</tr>
<tr>
<td>L3</td>
<td>$2.12 \pm 0.18$ (stat) ± 0.18 (syst)</td>
</tr>
<tr>
<td>OPAL</td>
<td>$2.04 \pm 0.16$ (stat) ± 0.09 (syst)</td>
</tr>
</tbody>
</table>

Figure 8.7: Comparison of the $\Gamma_W$ results obtained in this thesis with the 172-189 GeV results made available to the EW working group (and partly published) by the 4 LEP experiments. The systematic errors include the uncertainty due to CR, BEC and LEP.

The overall ideogram result for $\Gamma_W$ is equal to:

$$\Gamma_W = 2.295^{+1.73}_{-1.64} \text{ (stat) } \pm 64 \text{ (syst) } \pm 44 \text{ (FSI) MeV/c}^2$$

where the systematic uncertainties related to LEP are included in the ‘syst’ error quoted. This result is compared to the published results of the 4 LEP experiments in Figure 8.7.

**Interpretation**

The good agreement of the measured value in the $q\bar{q}q\bar{q}$ channel with the SM prediction of $\Gamma_W$ can be interpreted as a confirmation of our understanding of the detector resolution, and the correct propagation of errors in the 2D Ideogram analysis.
As mentioned already in the qq\ell\nu channel the agreement is not so good. In this case the results presented here provide an independent cross-check for the main DELPHI analysis confirming that the effects are really in the DELPHI data and are not restricted to a specific analysis.

The overall LEP summer 2000 combined result [75]:

\[ \Gamma_{W}^{\text{LEP}} = 2.120 \pm 80 \text{(stat)} \pm 70 \text{(syst)} \text{ MeV/c}^2 \]  

(8.9)
is in good agreement with the Standard Model and currently is the most precise direct measurement of \( \Gamma_{W} \). The final LEP2 combined measurement will be slightly more precise, but can certainly not match the precision of the indirect SM prediction (better than 0.003 GeV/c\(^2\) [11]).

### 8.3 \( m_{W^+} - m_{W^-} \) results

**Result and discussion**

The measured differences between the \( W^+ \) and \( W^- \) boson masses are shown in Figure 8.8. All results are compatible with a zero mass difference, except the \( q\bar{q}\ell\nu \) measurement at 189 GeV. This result is 3.1 sigma away from zero. This discrepancy calls for a detailed investigation. However, given the considerable effort already spent by the DELPHI \( q\bar{q}\ell\nu \) mass group to understand the observed deviations in the \( m_{W} \) and the \( \Gamma_{W} \) measurement on the same data sample, this is not expected to be a simple task.

The possibility that this mass difference of 6.66 GeV/c\(^2\) is due to a systematic effect is extremely unlikely as well. It cannot be explained by a wrong calibration slope. A forward-backward asymmetry of the electron reconstruction could in principle lead to such an effect, but would be required to be anomalously large.

The effects on \( \Delta m_{W^+W^-} \) of possible backgrounds like electrons from Bhabha scattering have not been investigated. Again it would require not only a significant background, but also a detector-related forward-backward asymmetry.

In view of the above, and in line with the approach followed in the DELPHI 189 GeV publication, the effect is taken as a so far unexplained, possibly statistical, fluctuation. Therefore the \( q\bar{q}\ell\nu \) number is included in the combined result:

\[
\frac{m_{W^+} - m_{W^-}}{m_{W}} = -0.013 \pm 0.011 \text{(stat)} \pm 0.002 \text{(syst)}
\]

The measurement is statistically dominated. The precision in the \( q\bar{q}\ell\nu \) channel is better than in the \( q\bar{q}q\bar{q} \) channel thanks to the easy separation between the \( W^+ \) and \( W^- \) provided by the lepton. In the \( q\bar{q}q\bar{q} \) channel resolution is lost due to non-perfect jet clustering, jet pairing, and limited separating power that can be achieved using jet charge information.

**Discussion**

It is interesting to see how much better one can measure the average \( W \) mass than the difference of the \( W^+ \) and \( W^- \) mass. This is due to the nature of the kinematic constraints available at LEP, which cause \( m_{W^+} \) and \( m_{W^-} \) (in one event) to be anti-correlated in the constrained fit. This effect is visible as the elongated ellipses along the \( m_{W^+} - m_{W^-} \) axis in the Ideograms (see e.g. Figures 5.5 and 6.14), and is strongest near the kinematical limit.
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Figure 8.8: *Difference of $W^+$ and $W^-$ boson mass measured with the 2D ideogram analysis.*

From a physics point of view the result is not surprising. As discussed in section 1.2 the masses of a particle and its anti-particle have to be equal in a relativistic quantum field theory. Since this fundamental prediction so far has only been experimentally tested in the Weak vector boson sector by the CDF collaboration [18], an additional independent measurement is worthwhile. Especially since it is possible to perform this measurement at LEP, with only a small change in the existing $W$ mass analyses.
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$m_{W^+} - m_{W^-}$ outlook

It will be hard to improve the Ideogram measurement in the qqqq channel, unlike the qqlν measurement which can certainly be developed further. With some further improvements and the full LEP2 statistics DELPHI alone could probably obtain a final precision of the order of 0.50 GeV/c² on $\Delta m_{W^+ W^-}$, and the LEP combination would allow a 0.3% measurement.

8.4 Conclusion and Outlook

The main result of the thesis research presented here is the development of the Ideogram analysis for the measurement of the W mass at LEP. As can be seen from the results presented in this chapter, the statistical performance and the control of the systematic uncertainties (both of crucial importance for the LEP W mass measurement) of the analysis have achieved an excellent level.

The main focus was on the W mass measurement in the qqqq channel. But also in the qqlν channel and the measurement of $\Gamma_W$ the statistical sensitivity of the Ideogram approach was demonstrated.

The W mass, width and $m_{W^+} - m_{W^-}$ results presented were all in agreement with the current world averages and Standard Model expectations. The 172, 183 and 189 GeV data samples analysed correspond to approximately 1/3 of the LEP2 data taken by DELPHI. A final analysis of the full LEP2 data set is currently ongoing in DELPHI and the other LEP experiments.

Outlook Ideogram analysis and DELPHI W mass

The qqqq Ideogram analysis is in good shape. Small improvements in the statistical sensitivity are still possible, but are not expected to make a big difference.

It is probably important to improve the description and understanding of the jet energy flow response (at least the part that is not covered by MLBZs); especially because some of these effects were found to increase for higher values of $\sqrt{s}$.

The qqlν Ideogram framework is ready to be used. To turn it into a full-fledged analysis, a further development of the event selection would be the first requirement. An improved identification of tau leptons and maybe an ISR treatment as used in the main DELPHI qqlν analysis could also help to further improve the statistical sensitivity.

LEP W mass and systematics

The combination of the W mass results of the 4 LEP experiments brings the overall statistical error down to a level where the understanding of the systematics becomes crucial. A detailed and careful study of systematics was presented in chapter 7. It is worthwhile to consider the three main sources of systematics in the LEP combination, and the prospects for possible improvements:

Jet fragmentation In the summer 2000 LEP combination the largest systematic uncertainty was quoted for fragmentation modelling. As argued in this thesis (chapter 7 and Appendix A), the true systematic effect is probably much smaller than that. Using the MLBZ method to compare the DELPHI fragmentation modelling directly with the data, possible systematic discrepancies were searched for with a high level of detail and statistical precision.
further development of the MLBZ method and use by the other experiments would lead to an improved understanding of this systematic effect and help to reduce the fragmentation uncertainty, possibly to a negligible level.

**Final state cross-talk** Only affecting the \( q\bar{q}q\bar{q} \) channel, the FSI error reduced the weight of the \( q\bar{q}q\bar{q} \) channel in the summer 2000 LEP combination to 27%, even though the statistical sensitivity for this channel is superior to that of the \( q\bar{q}\nu \) channel. Thus the quoted systematic error for FSI was smaller, while its effective impact on the final precision of the W mass combination was actually bigger than the fragmentation error. A better understanding of this systematic effect will have to come from direct measurements constraining the available FSI models.

- Colour reconnection: So far the strongest experimental constraint on the size of the CR shift comes from the measured difference in \( m_W \) between the \( q\bar{q}q\bar{q} \) and the \( q\bar{q}\nu \) channel. The LEP summer 2000 combination gave the following (preliminary) value: \( \Delta m_W(q\bar{q}q\bar{q} - q\bar{q}\nu) = +5 \pm 51 \text{ MeV/c}^2 \). This result is model-independent and does not contradict the quoted systematic uncertainty. When all LEP2 data will be included the error may be reduced to to \( \sim 42 \text{ MeV/c}^2 \).

For obvious reasons an independent and more precise experimental confirmation is wanted. But it turns out to be difficult to find observables more sensitive to CR than the W mass. A promising candidate is the measurement of the particle flow of low momentum particles in between jets (the ‘string effect’) using the L3 method [45]. It is hoped that this type of measurements can be used to constrain the available CR models (a factor ~ 2) better than the W mass. These constrained models can then be used to address the effect on \( m_W \).

Another viable option would be to trade statistical sensitivity for systematics, for example by ignoring low-momentum particles or discarding events that are expected to be most sensitive to CR reconnection, thus increasing the statistical error but reducing CR systematics. The danger of this approach is that it will certainly increase the statistical error, while it is not sure how much it might reduce the unknown CR effects.

A more elegant way to sacrifice statistical sensitivity would be to perform a simultaneous measurement of W mass and CR shift (in the framework of the different models).

Finally, the question needs to be answered whether the current estimation of the CR error is consistent with the way the other errors are quoted. While most of the other systematic errors are quoted as ‘1 sigma’-like two-sided uncertainties, the current quoted CR effect covers the full range of observed shifts, and its one-sided numerical value is quoted among two-sided numbers. Effectively, this leads to a factor \( 2^2 \) extra weight of the CR uncertainty with respect to the other errors. It might eventually be more consistent to perform 3 different LEP combinations: a conservative one, a ‘best estimate’, and a combination assuming only CR at the perturbative level (\( \sim 5 \text{ MeV/c}^2 \)).

- **BEC**: As argued in chapter 7 the effect of BEC is probably smaller than 10 MeV/c\(^2\).

To come to a final estimation of systematics related to BEC it is important that the LEP experiments continue to pursue a direct measurement using an event-mixing
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... technique, where the reference sample is produced by mixing the hadronic parts of \( qq\ell\nu \) events, to reduce model dependences in the analyses.

It is up to the W-mass measurement community to find a (preferably model-independent) way to translate the observed reduction of inter-W correlations in an uncertainty on the mass and width measurements.

**LEP beam energy scale** As discussed in chapter 3, several independent methods are being pursued to further cross-check and reduce the uncertainty on the extrapolation of the LEP energy scale. It is not yet clear whether the aim of 10 MeV will eventually be reached.

Extrapolating the currently available LEP results to the full LEP2 data set, the fully-hadronic channel is expected to achieve a statistical sensitivity of \( \sim 28 \text{ MeV}/c^2 \) compared to \( \sim 30 \text{ MeV}/c^2 \) for the semi-leptonic channel. Depending on the impact of the final estimation of the FSI errors, the combined statistical precision will be in the range from 21-24 MeV/c^2. Thus, in an optimistic scenario where the fragmentation error is strongly reduced and the FSI error reaches a level of 25 MeV/c^2 (qqqqq channel only), the final error on the LEP2 W mass could become better than 30 MeV/c^2; close to the uncertainty on the indirect prediction of the W mass.

**Outlook \( m_W \) and the Standard Model**

LEP finished data taking in 2000. The final analysis of the LEP2 data and subsequent combination is likely to take at least until 2003. The final LEP W mass result will set the standard for the nearby future.

The Tevatron collider recently started a new data taking period (RUN2) which will enable an improved, high statistics measurement of \( m_W \) using the transverse momentum spectrum of leptonically decaying W's. But Tevatron and LHC (its start foreseen in 2006) will certainly need a few years of running to achieve the level of understanding of the systematics required to reach a similar or better precision.

Another important next step in the EW precision measurements for the coming years is the expected improvement in the direct measurement of the mass of the top quark. A detailed study of the top quark which will be one of the main topics at the Tevatron. In Figure 8.9 the relation between the top mass, W mass and the prediction for the SM Higgs mass is illustrated. The improved knowledge of the W boson and top quark masses will further restrict the allowed region for the SM Higgs boson mass — and thus be a key ingredient in solving the mystery of mass generation in the Standard Model.
Figure 8.9: The indirect SM prediction of the $W$ mass and top quark mass (based on LEP1, SLD and neutrino scattering data), compared to different sets of direct measurements. The plot is based on the summer 2000 Standard Model fit performed by the LEP EW working group [75]. The final $W$ mass result presented in this thesis is superimposed, both as a single measurement and in combination with the direct measurement of the top quark mass.