Determination of the W mass in the leptonic channel at OPAL

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We present an analysis performed for the data recorded in 1998 at $\sqrt{s}$ = 189 GeV with the OPAL detector at LEP.
In purely leptonic events, each W boson decays to a lepton and a neutrino after its creation. In spite of the small rate of these events (10% of all W decays, 5% without considering τ events, in comparison with 40% for semileptonic or 50% for hadronic events), the leptonic decay modes give the cleanest signal of the W-pair production process [1]. An example of a leptonic event is shown in fig. 1.

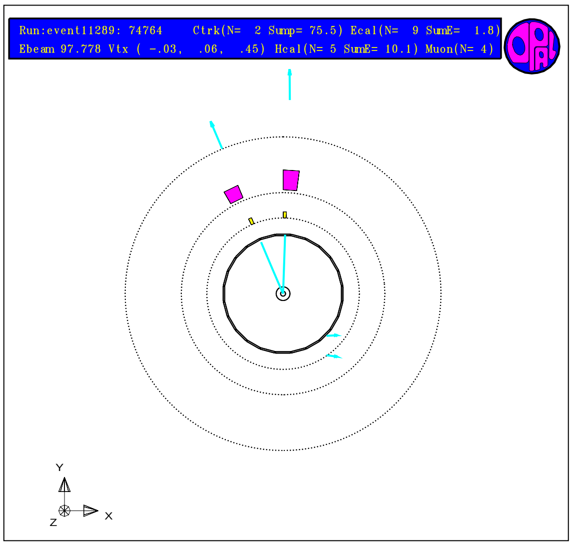

Fig. 1: Muon-Muon event at 189 GeV.

The standard method for the W mass determination, the full reconstruction of the final state can not be applied in this channel. Due to the presence of two unobserved neutrinos, there are not enough contraints for a kinematic fit. Therefore alternative methods must be used to determinate the mass.
We have studied two sensitive variables, the leptonic energy and the pseudomass.
The pseudomass is obtained from an approximative reconstruction of the events, assuming both unobserved neutrinos in the same plane as the charged leptons [2]. The two variables are shown in fig. 2.
To maximize the sensitivity of the measurement, the different energy resolutions for electrons and muons must be taken into account. Electrons are best measured in the electromagnetic calorimeter with a resolution of 3%, while the resolution of the charged momentum measurement for muons ranges from 5-8%. Therefore we define different classes of events. For the pseudomass analysis we use three classes: events with two electrons, with two muons and mixed electron-muon events. For the leptonic energy two classes are used to separate electrons and muons. For each class an individual likelihood function is constructed and the W mass and its error are obtained from the combination of these.

A further complication arises for events with $W \to \tau\nu_\tau$ decays. Due to the additional neutrinos in the subsequent τ decay, the energy of the τ cannot be reconstructed. Such events must be rejected for the pseudomass. For mixed events ($W^+W^- \to \tau\nu \;\; e/\mu \;\; \nu$) the non-$\tau$ decay can still be used for the leptonic energy.

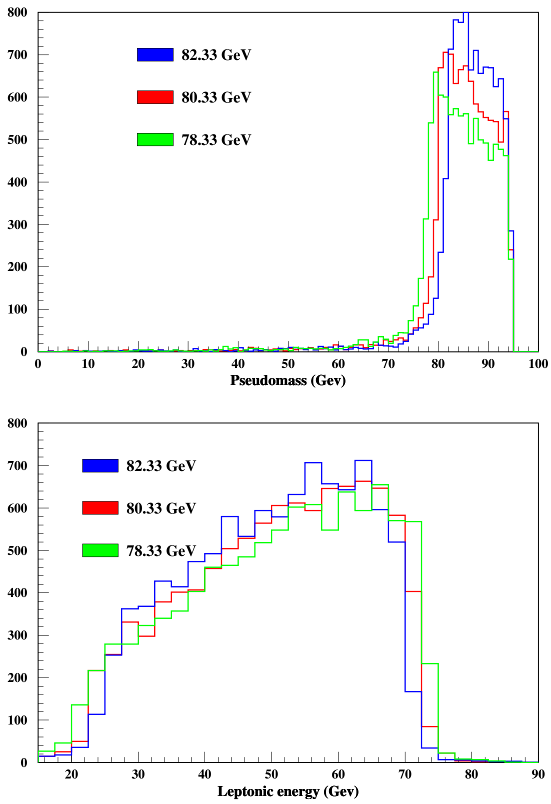

Fig. 2: Comparison of the sensitive variables spectra for different generated Monte Carlo masses without detector effects. Upper: Pseudomass spectra. Lower: Leptonic energy spectra.

In order to obtain the mass from the spectra of these variables a reweighting method is used. The basic idea of this method is to fit spectra of Monte Carlo events with different W masses to the data sample. These Monte Carlo spectra include also background events. The W mass together with its error are obtained from the shape of the log-likelihood contour.
For the pseudomass we obtain a resolution of 1.174 GeV and for the leptonic energy, where also mixed events contribute, we get 1.052 GeV.

References

[1] Ed: G. Altarelli, T. Sjöstrand and F. Zwirner Physics at LEP2, CERN 96-01, 1996, Vol.1
[2] K. Hagiwara, R. D. Peccei, D. Zeppenfeld and K. Hikasa Nucl. Phys. **B282** (1987) 253