Pions from Different W's in $e^+e^- \to W^+W^-$ Events

The DELPHI Collaboration

Amiran Tomaradze
Universitaire Instelling Antwerpen, Wilrijk, Belgium
e-mail amiran.tomaradze@cern.ch

ABSTRACT

Correlations between pions from different Ws in $e^+e^- \to W^+W^-$ events are studied using data collected by the DELPHI detector at LEP running at a centre-of-mass energy of 172 GeV in 1996. At the present level of statistics, no enhancement of the correlation function above that expected from a pair of uncorrelated Ws is observed at small values of the four-momentum difference of the pions.

1. Introduction

For a pair of identical bosons, the quantum mechanical wave-function must be symmetric under particle exchange, which leads to an enhancement in the production of pairs of bosons of the same charge and similar momenta. Such effects are observed in a variety of processes and are attributed to this Bose-Einstein(BE) symmetrization. Since a symmetrization of amplitudes is absent in probabilistic descriptions, a crucial question is whether or not BE correlations can be considered to be a small correction to the probabilistic approach to the hadronization processes. If not, models formulated along a probabilistic approach and such way of understanding of multiparticle production would be far from reality.

There are clear indications that BE effects play an increasingly large role with increasing centre-of-mass energy and it is becoming difficult to perform detailed analyses of multiparticle production without a better understanding of this effect. Recently, it has also been conjectured that the measurement of the W mass at LEP2 by reconstructing W pairs giving 4 jets is likely to be affected by BE correlations[1] between pions from different Ws. A study of the correlations between pions originating from different Ws presents a unique possibility of measuring, in a clean way, the Bose-Einstein effect between particles from different, well-understood, sources. Such measurements may help to provide a better understanding of the Bose-Einstein phenomenon and, correspondingly, lead to improvement of existing models or the need for new models to describe multiparticle production.

This analysis describes an investigation of BE correlations between pions from different Ws in $e^+e^- \to W^+W^-$ events at a centre-of-mass energy of 172 GeV, using data collected with the DELPHI detector at LEP in 1996, corresponding to an integrated luminosity of 10 pb^{-1}.

2. Results

The Q distributions of pion pairs from different Ws, both for like-sign and for unlike-sign combinations, were obtained statistically, as the difference between (a) the distribution for all combinations in fully hadronically decaying WW (four jet) events and (b) the appropriately normalized distribution for events where one of the Ws decays leptonically (two jet, lepton, neutrino events). The distribution of the fitted W-mass for these events are shown in Fig. 1 together with the Monte-Carlo expectations for the signal and background. The ratio of like-sign to unlike-sign pairs,

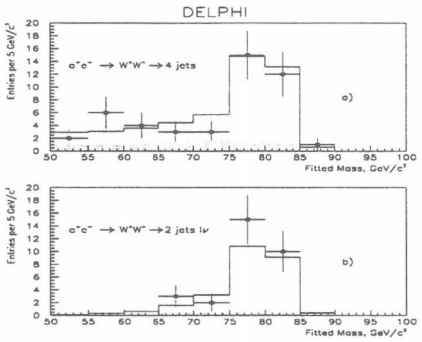

Figure 1: Fitted mass for WW four jet(a) and mixed decay channels(b).

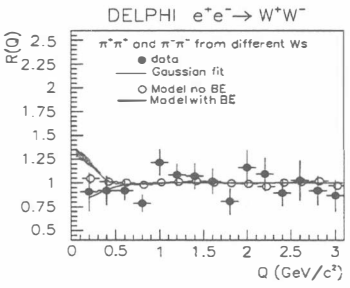

Figure 2: The correlation function $R(Q)$ for pions from different Ws.

$R(Q)$, is shown in Fig. 2. Fixing the value of the radius r at 0.5 fm, the Bose-Einstein correlation strength is found to be

$$\lambda = -0.20 \pm 0.22 \text{ (stat)} \pm 0.08 \text{ (syst)}. \quad (1)$$

Fig. 2 also shows $R(Q)$ distributions predicted using WW generated events with and without BE correlations included. The $R(Q)$ distribution for data in the low-Q region is in a better agreement with prediction of the model without BE effect included.

3. Conclusions

The first measurement of the correlation function for like-sign particles arising from *different* Ws is reported, using unlike-sign particles as a reference. At the present level of statistical precision, no enhancement of the correlation function is observed at small Q values.

References

1. L. Lönnblad and T. Sjöstrand, Phys. Lett. **B351** (1995) 293.