STUDY OF THE FRAGMENTATION OF b QUARKS INTO B MESONS AT THE Z PEAK*

ALEPH Collaboration

CERN, CH-1211 Geneve 23, Switzerland
and University of Siegen, Germany

(Received July 7, 2000)

A study of the fragmentation of b quarks into B mesons is presented. The analysis makes use of the statistics collected by the ALEPH experiment around the Z peak during the years 1991–1995. A semi-exclusive reconstruction of $B \to l\nu D^{(*)}$ decays is performed, by combining lepton candidates with fully reconstructed $D^{(*)}$ mesons, while the neutrino energy is estimated from the missing energy of the event. The mean reduced energy of the weakly decaying and leading B meson is found to be $\langle x_b^{\rm wd} \rangle = 0.7198 \pm 0.0045(\text{stat}) \pm 0.0053(\text{syst})$ and $\langle x_b^{L} \rangle = 0.7394 \pm 0.0045(\text{stat}) \pm 0.0053(\text{syst})$ respectively.

PACS numbers: 14.65.Fy

1. Introduction

In high energy processes which involve strong interactions the quarks appear as jets of colourless hadrons. The process of hadron production is described as the convolution of a perturbative part and the non-perturbative fragmentation process itself. The latest is parametrised in terms of the variable z: $z = (E + p_{\|})_{\rm hadron}/(E + p)_{\rm quark}$, where $p_{\|}$ is the hadron momentum along the direction of the quark, and $(E + p)$ is the sum of the energy and momentum of the quark just before fragmentation. Unfortunately z is not accessible experimentally on an event by event basis. Instead, energy spectrum of b hadrons can be described in terms of the scaled mean energy $x^{\rm wd(L)} = E_{\rm wd(L)}/E_{\rm beam}$, where $E_{\rm wd(L)}$ denotes the energy of the weakly decaying (leading) b hadron. The main difference to the z variable is that $E_{\rm beam}$ does not unfold the effects of initial and final state radiation and hard gluon emission. In the analysis presented, the energy distribution

* Presented at the Meson 2000, Sixth International Workshop on Production, Properties and Interaction of Mesons, Cracow, Poland, May 19–23, 2000.

of the weakly decaying and the first (leading) b hadron after fragmentation process is reconstructed by investigating semileptonic decay of B^0 and B^{+-}: $B \to l\nu D^{(*)}$, pairing lepton with fully reconstructed D meson.

2. Events selection

The decays $B \to l\nu D^{(*)}$ are searched for events containing at least one lepton. The transverse momentum p_{T} of the lepton with respect to the jet to which it belongs, is required to be larger than 1 GeV/c. This helps rejecting fake leptons and leptons not coming from direct decay of b hadrons. Events are divided into two hemispheres using the thrust axis. In each hemisphere a D^* meson is reconstructed. For each lepton with a reconstructed D^*, at least two charged tracks from the D decay must have VDET hits, in order to ensure a good reconstruction of the D vertex position and reject combinatorial background. Tracks from the D decay are fitted to a common vertex. A combination of tracks is rejected if the χ^2/dof of the fit is too big. The purity of the selected events is calculated from the data, by fitting the reconstructed D^0 mass peak in a window between 1.7 and 2.0 GeV.

3. B energy reconstruction

The energy of the weakly decaying $B \to l\nu D^{(*)}$ is estimated as $x_b^{\mathrm{reco}} = (E_l + E_{D^*} + E_\nu)/E_{\mathrm{beam}}$. Both E_l and E_{D^*} are easily estimated using direct reconstruction methods. The neutrino energy E_ν can be evaluated as $E_\nu = E_{\mathrm{tot}}^{\mathrm{hemi}} - E_{\mathrm{vis}}^{\mathrm{hemi}}$ with $E_{\mathrm{tot}}^{\mathrm{hemi}} = E_{\mathrm{beam}} + (m_{\mathrm{same}}^2 - m_{\mathrm{oppo}}^2)/4E_{\mathrm{beam}}$, where the invariant masses m_{same} and m_{oppo} are computed using all the particles in the same and opposite hemispheres with respect to the lepton hemisphere.

4. Analysis

The raw reduced energy distribution for the weakly decaying B meson is reconstructed in 20 bins. In each of them the *non-*$b\bar{b}$ Monte Carlo estimated background is subtracted from the spectrum. With these events two different kind of analysis can be performed:

- A model-dependent analysis: fragmentation models present in literature are used; this analysis the shape of the probability of a B hadron to be generated with a given z, is imposed in the Monte Carlo generator. The reconstructed spectra obtained from the simulation are compared with x_b^{reco} spectra from the data using a χ^2 technique.

- A model-independent analysis, in which the shape of $x_b^{wl(L)}$ is reconstructed correcting the measured x_b^{reco} spectra for Monte Carlo estimated acceptance, detector resolution and missing particles.

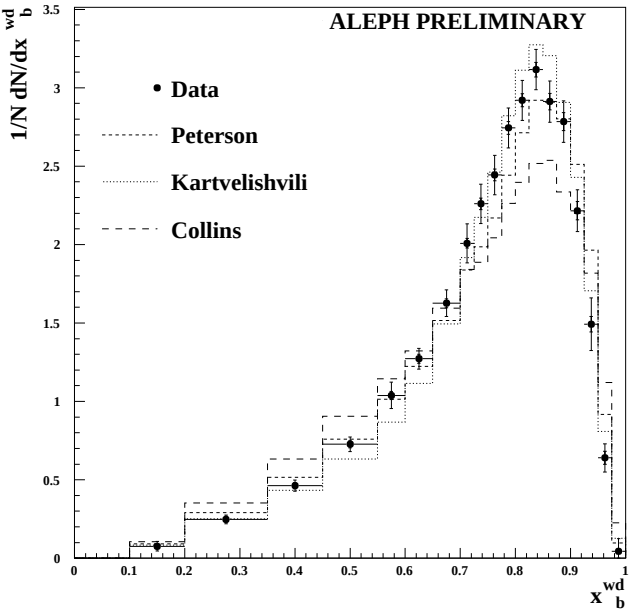

Fig. 1. Reduced energy of the weakly decaying B hadron, as reconstructed from data in comparison with fragmentation models.

5. Conclusion

Using the full LEP I statistics collected by the ALEPH experiment at the Z resonance, about 3000 semileptonic B^0 and $B^{\pm}$ decays were selected. The mean value of the reduced energy of the weakly decaying and leading B meson amounts to $\langle x_b^{\rm wd} \rangle = 0.7198 \pm 0.0045(\text{stat}) \pm 0.0053(\text{syst})$ and $\langle x_b^L \rangle = 0.7394 \pm 0.0045(\text{stat}) \pm 0.0053(\text{syst})$ respectively. The present result is compatible with the previous ALEPH analysis [1] and with the recent results from SLD [2]; it is about 2 sigma higher than the previously published results by OPAL [3] and DELPHI [4].

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