Chapter 8

Conclusion

This work has established the feasibility of studying oribtally excited states of B mesons through semileptonic B decays in the complex environment of a hadron collider.

The most important building blocks of this analysis were:

- extracting a large sample of B events by using many partially reconstructed signatures of decays with large branching fractions, instead of using a much smaller sample of fully reconstructed mesons;

- looking for the excess in the mass difference between the partially reconstructed B meson and its composite with a pion, instead of looking for a B^{**} mass peak; using a corrected B momentum to improve the resolution on this mass difference;

- decomposing the prompt background into several components, and separating the components according to the type of their correlation with the B meson;

- deriving the magnitude of flavor mixing from measured quantities;

- recognizing that the signal can be distinguished from the b hadonization background by the different charge-flavor correlation with the B meson;

- constructing the procedure for simultaneous fitting of the signal and the hadronization background, which reduces the dependence on the parameters of the hadronization model and thereby diminishes the systematic uncertainty.

The most important (and the least plausible) assumptions we had to make in order to carry out the measurement are:

- the region of space between $\Delta\phi = 1$ and $\Delta\phi = 2$ with respect to the B meson direction is populated only with the underlying event tracks, which are not correlated with the properties of the meson;
- the B^{**} meson hadronizes in the same way as its ground state;
- the shape of the hadronization background is the same around neutral and charged mesons (but the normalizations and the asymmetries may be different).

The measured production fraction and mass of B^{**} mesons are summarized in table 8.1. The probability that the backgrounds fluctuated to fake the measured fraction is estimated at less than 10^{-6}.

Model	EHQ	EGF
m(B_1) (J= 1, $J_q = \frac{3}{2}$)	$5732 \pm 22\,\mathrm{MeV/c^2}$	$5709 \pm 20\,\mathrm{MeV/c^2}$
h^{**}	$0.287^{+0.053}_{-0.057} stat ^{+0.040}_{-0.034} syst$	$0.278^{+0.054}_{-0.057} stat ^{+0.031}_{-0.027} syst$

Table 8.1: Summary of the measured B^{**} properties.

Besides improved measurements of the production fractions and masses, probably the most important goal of the future B^{**} and D^{**} analyses is the observation of the still unobserved broad states, *i.e.* resolving the four resonances. The intrinsic limitations on the B^{**} mass resolution in the semileptonic B samples make them an unlikely candidate for such an observation. Fortunately, the fully reconstructed B samples offer an order of magnitude better mass resolution, and will grow significantly in the near future.

It is obvious from this work that study of excited B mesons relies heavily on understanding the non-perturbative process of hadronization of b quarks, and *vice versa*. While we have treated the latter as a background, it is likely that significant further improvements lie in understanding exactly the interplay between these two sources of prompt tracks. This is especially important for the construction of better B flavor taggers, where the goal is to find the quantity with the maximal correlation with the B flavor.