

Studies of the Mass Resolution of $b\bar{b}$ Dijets

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ABSTRACT

The mass resolution in the DØ detector of reconstructed $b\bar{b}$ dijets originating from electroweak resonances with masses of about 100 GeV is summarized.

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The increased luminosity available with the Main Injector at Fermilab will allow searches for the Higgs particle for masses between about 90 and 140 GeV. For these masses, the dominant decay mode is to $b\bar{b}$ pairs. Separating Higgs decay from other sources of $b\bar{b}$ pairs will strongly depend on the mass resolution of the reconstructed b-jet pair. This note summarizes a series of studies on the anticipated mass resolution of the DØ detector.[1]

Z events and Higgs events, with $m_H = 120$ and 140 GeV, decaying to $b\bar{b}$ were generated using either ISAJET or PYTHIA. They were then processed using full DØGEANT for detector simulation, and the complete offline reconstruction. Run I versions of DØGEANT and reconstruction were used, but as calorimeter effects dominate the mass resolution, this should be very similar to Run II results. Jets were reconstructed using either a cone algorithm with dR of 0.3, 0.5, or 0.7, or a kT algorithm with separation distances of 0.4 or 1.0. Detected muons were included in determining each jet momentum vector.

Many different techniques were tried. To a first approximation, all give the same result. The mass resolution using a kT algorithm was slightly better (10-15%) than cone algorithms, and the results in this note use the available DØ kT algorithm with separation 0.4.

Neutrinos play an important role in the $b\bar{b}$ mass resolution. The number of electrons and muons indicate how many neutrinos are present. Corrections can be made so that the average reconstructed mass for events with neutrinos is the same as for those with none. However, the correlation between the muon or electron energy and the neutrino energy in a given event is poor, so events with neutrinos will have degraded mass resolution. Fig. 1 shows the reconstructed mass for dijets from Z decay where each jet has an associated muon. The dijet mass is shown uncorrected for the neutrino energy and with the neutrino energy taken directly from the ISAJET information. The effect both on the amount of missing energy, and on the degradation in mass resolution can be seen.

For simplicity, Gaussian fits were made. Almost identical values of σ/M were found for Z and Higgs masses between 91 and 140 GeV. There are three factors which determine the dijet mass resolution. Each neutrino in an event contributes about 7%. The inherent detector energy resolution for measuring individual particles (electrons, muons, pions, photons) adds about 6%. The largest contribution, 10%, is from “jet” effects, meaning items such as out-of-cone energy, the underlying event, or quark brehmstrahlung. Adding these factors give σ/M of 12% if there are no neutrinos (i.e. no electrons or muons), and 14% or 15% for one or two neutrino events.

Simple attempts were made to recognize events that had poorer mass resolution. Items such as jet width, the presence of a nearby jet, or the angular difference between the b-direction and the jet direction, in principle can flag events where a gluon was radiated by a b-quark. Minor improvements (10-20%) in the dijet mass resolution were found but with losses of one-third or more of the events. However more sophisticated algorithms may obtain a somewhat improved mass resolution with better efficiency.

II. REFERENCES

- [1] Studies of jet-jet masses with two b-tagged jets with the DØ detector, D. Hedin, et al., DØ Note 2951, May, 1996; Studies of $Z \rightarrow b\bar{b}$ mass resolution, D. Hedin, DØ Note 2968, July 1996.

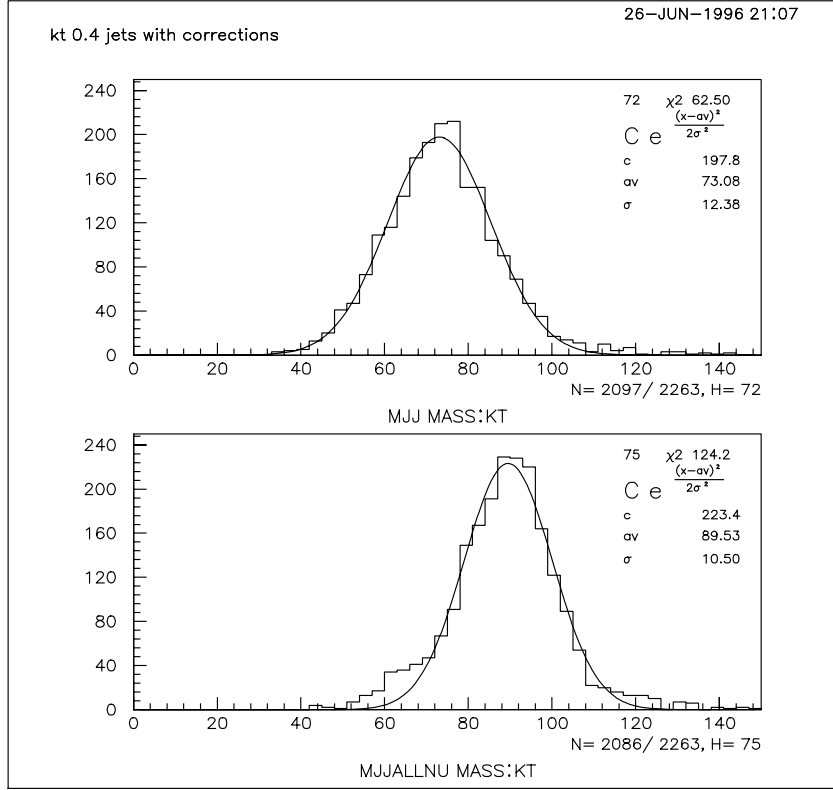


Figure 1: Dijet invariant mass (GeV) for $Z \rightarrow b\bar{b}$ events decaying to two muons using a kT algorithm with separation distance of 0.4. The bottom figure includes neutrinos from the ISAJET banks.