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Inclusive Single Muons at DØ

Kamel A. Bazizi
for the DØ Collaboration

Fermi National Accelerator Laboratory
P.O. Box 500, Batavia, Illinois 60510

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Kamel A. Basisi, for the DØ Collaboration
University of California, Riverside
Riverside, CA 92521, USA

ABSTRACT

We report preliminary results on b-quark production in $p\bar{p}$ collisions at $\sqrt{s} = 1.8$ TeV from the current Run 1a of the Tevatron collider. Using an inclusive muon data sample which corresponds to an integrated luminosity of 50–70 nb^{-1} and by further requiring the muon to be accompanied by a jet we obtain an almost background free sample of muons consistent with $b\bar{b} \rightarrow \mu X$ decay. A preliminary p_T^{μ} spectrum and some characteristics of this decay, compared to the Monte Carlo expectations, are presented.

1. The DØ Detector

The DØ detector consists of a tracking system, a calorimeter and a muon detection system. The central tracking chambers play an important role in muon identification. The calorimeter is utilized to measure jet energies and the minimum ionizing energy along the muon track which also aids in muon identification. The muon system, which includes proportional drift tubes and toroidal magnets, is used to reconstruct muon tracks and determine the corresponding momenta. The properties and performance parameters of the DØ detector are described in references [1] and [2].

2. The Muon Trigger

A description of the DØ trigger system can be found in a paper submitted to these proceedings [3]. The muon trigger, [4], consists of two hardware triggers, a coarse centroid trigger (level 1.0) and a fine centroid trigger (level 1.5), and one software trigger (level 2.0). The centroids are based on patterns of hits from discriminated and latched cathode pad signals. Centroid combinations consistent with tracks pointing to the interaction region are programmed into the trigger logic. The effective p_T threshold for the level 1.0 trigger is currently 5 GeV and is expected to be lowered to 3 GeV, (for level 1.5 it is about 7 GeV). At level 2.0 the muon track is reconstructed and selection cuts can be applied on the track quality and transverse momentum p_T. The data considered in this analysis was collected with a single muon trigger inside of a pseudo rapidity range of $|\eta| <1.7$ with a prescaling factor of 5 and a p_T minimum of 7 GeV at level 2.0.

3. Offline Event Selection

The offline muon identification consists of a full reconstruction of the muon track and a selection on the quality of the fit parameters. The track is required to include hits in all three layers of muon chambers and have good fits. The track must extrapolate to within 15 cm of the vertex and match with at least one track in the central detector.

Backgrounds for muons include hadron punchthrough, decay in flight of pions and kaons, and cosmic rays. The calorimeter and toroids are about 13 to 20 interaction lengths deep. Therefore punchthrough background is small. Decay in flight probability is reduced considerably by the small decay path in the central detector. To eliminate any residual background from cosmic ray and in flight decay muons the muon track is required to have an associated jet within $\Delta R = 0.6$. The jet reconstruction uses a fixed cone algorithm ($R = 0.7$) and a minimum transverse jet energy of 8 GeV.

4. Preliminary Results

The muon p_T spectrum for the final sample, in the range $7\,GeV < P_T^\mu < 20\,GeV$, where the best momentum resolution is currently achieved, is shown in Fig. 1. The shape of the spectrum is consistent with monte carlo expectations for $b\bar{b}$ and $c\bar{c}$ decays.

Fig. 2 shows the distribution of the separation of the muon and the accompanying jet ($\Delta R = \sqrt{\Delta\eta^2 + \Delta\phi^2}$). The data agrees with the monte carlo model for $b\bar{b} \to \mu X$ decay. This is an indication that the data sample consists largely of b decay muons. The dominance of b decays with a $P_T^\mu > 7\,GeV$ is expected [5].

Fig. 3 shows the distribution of the muon transverse momentum with respect to the jet axis (p_T^{rel}) which is also consistent with the monte carlo prediction (ISAJET) for b decays. This distribution is sensitive to the fragmentation of the parent quark. Since b quarks have a higher Q value than c quarks, this parameter can be used on a statistical basis to remove any residual c quark decay background [5].

5. Conclusions

Based on a very small sample of muon data, DØ has observed muons in association with hadronic jets with characteristics consistent with $b\bar{b}$ decays. By extending the muon trigger coverage out to the region $1.7 < |\eta| < 3.4$ and by lowering the p_T threshold, the DØ experiment, in the course of Tevatron collider Runs 1a and 1b, is expected to collect high statistics data for the study of many aspects of b Physics.

6. References

1. DØ Design Report Fermilab (1984)
2. C. Brown, et al., *Nucl. Instrum. and Meth.* **A279** (1989) 331.
3. J.T. Linneman, *Triggering the DØ Detector*, these proceedings.
4. M. Fortner , et al., *Nucl. IEEE Transactions on Nuclear Science,* **38** (1991) 480.
5. C.Albajar, et al., *Phys. Lett. B,* **256** (1991) 121.

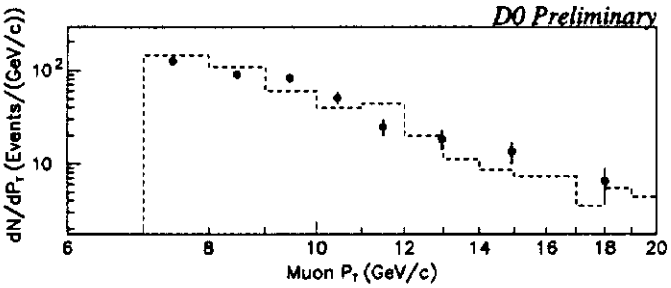

Figure 1: The muon p_T spectrum where the points are the data and the histogram represents the Monte Carlo (ISAJET) model for $b\bar{b} + c\bar{c} \to \mu X$ decays.

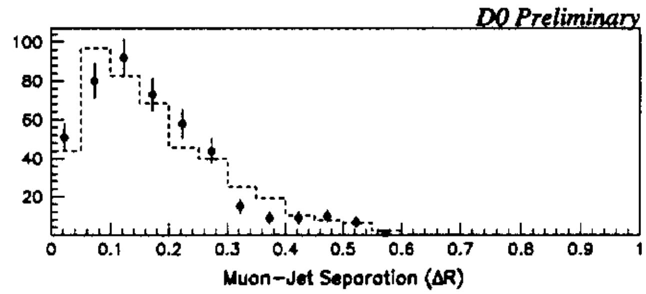

Figure 2: The distribution of the muon-jet separation $\Delta R = \sqrt{\Delta\eta^2 + \Delta\phi^2}$. The points are the data and the histogram represents ISAJET prediction for $b\bar{b} \to \mu X$ decay.

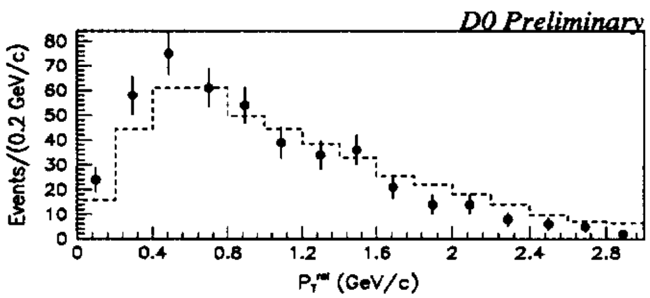

Figure 3: The muon transverse momentum with respect to the jet axis, $P_T^{rel} = P^{\mu} \sin\theta^{rel}$, where θ^{rel} is the muon-jet angle. The points are the data and the histogram represents ISAJET prediction for $b\bar{b} \to \mu X$ decay.