# B-Quark Results and Prospects From D0

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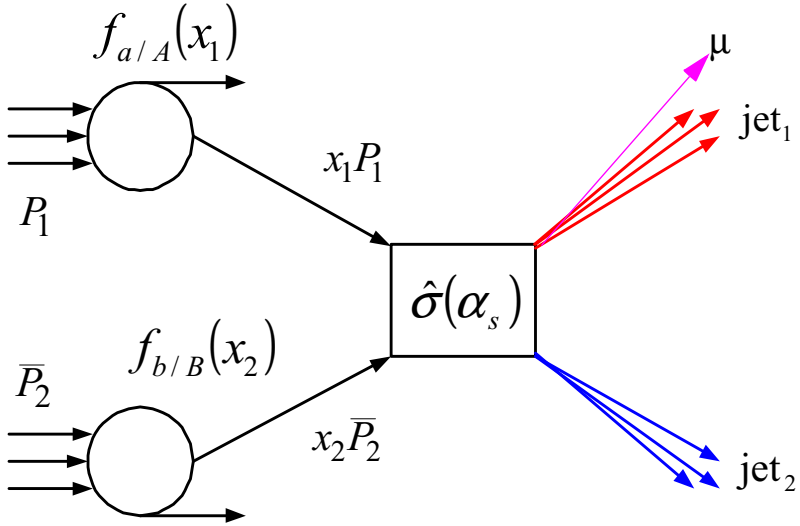
*Presented at FCP '01*

1. B Physics for QCD
2. B Detection at D0
3. B-Jet Cross Section
4. B-Quark Cross Section
5. Forward Cross Section
6. Open Questions and Directions

# B Physics for QCD

We see b-jets through their decay products

Quarks, gluons -> decay into jets of hadrons, semileptonic decay includes a muon




Compare distribution of muons and jets to theoretical models

# B Measurement

## Jet Measurement

Extract $\sigma^{bjet}$ from muon-tagged jet spectrum

Jets are directly observed

Muon used only as a tag

b-jet integrates fragmentation detail compared to b-quark

Jet counting compared to theory

$$\frac{\Delta\sigma^{bjet}}{\Delta E_T} = \frac{A(E_T)}{2(BR)}\frac{F_B(E_T)}{L\varepsilon}\frac{\Delta N^{\mu jet}}{\Delta E_T}$$

## Quark Measurement

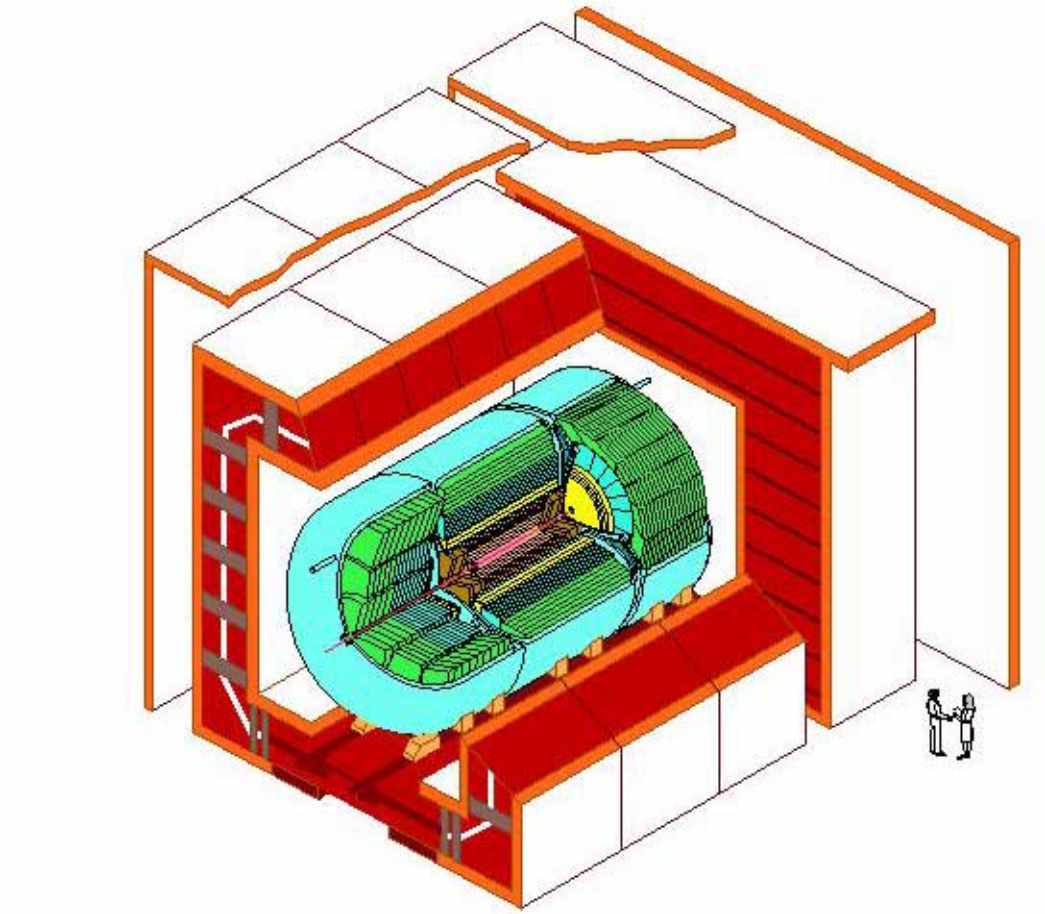
Extract $\sigma^{b}_{ptmin}$ from inclusive muon spectrum

b-fraction simpler than jet measurement

b-signal increases with $p_T^{\mu}$

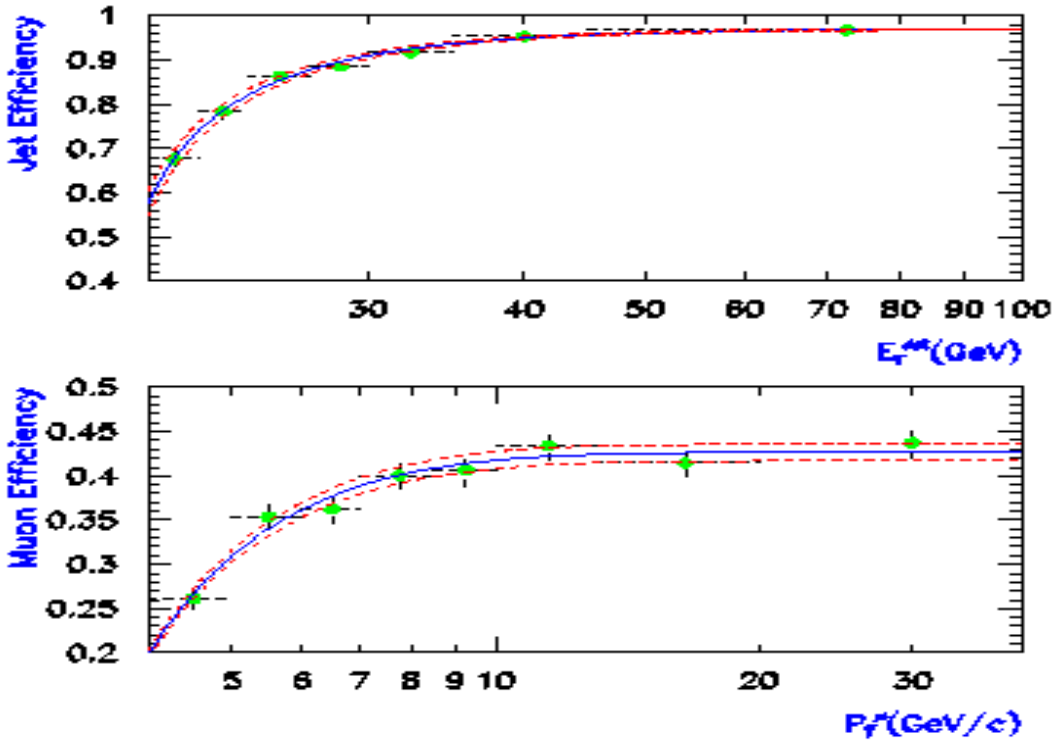
Errors dominated by kinematic relation between b-quark and muon spectra

# The D0 Detector



Muons in Run I : Iron Toroid Magnet 3 layers (10 planes) of Wire Chambers

# Detection Efficiency




Dominated by trigger and geometric muon efficiency

# Data Sample

Run IB (5.2 $pb^{-1}$)

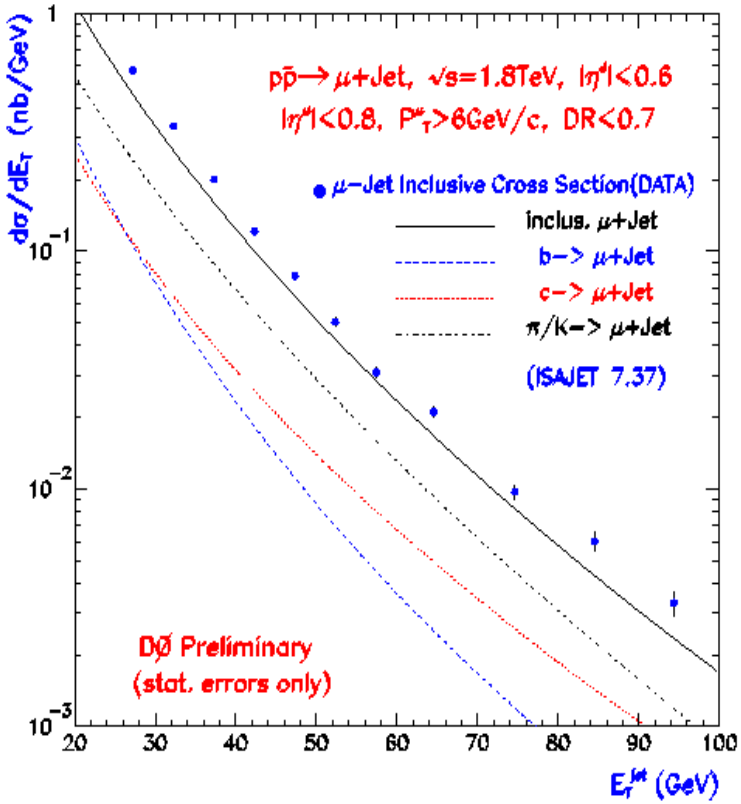
trigger $P_T^{\mu} > 4$ GeV/c

trigger $E_T^{j} > 3$ GeV

| Jet | Muon |
|---|---|
| $E_T > 25$ GeV | $P_T > 6$ GeV |
| $\|\eta\| < 0.6$ | $\|\eta\| < 0.8$ |
| $\Delta R = 0.7$ | $\Delta R < 0.7$ |

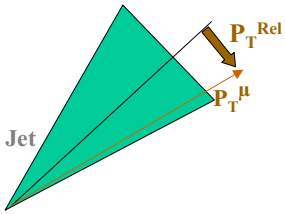
*Sample includes 30,000 events for B-jet, 40,000 for b-quark*

# Inclusive Spectrum



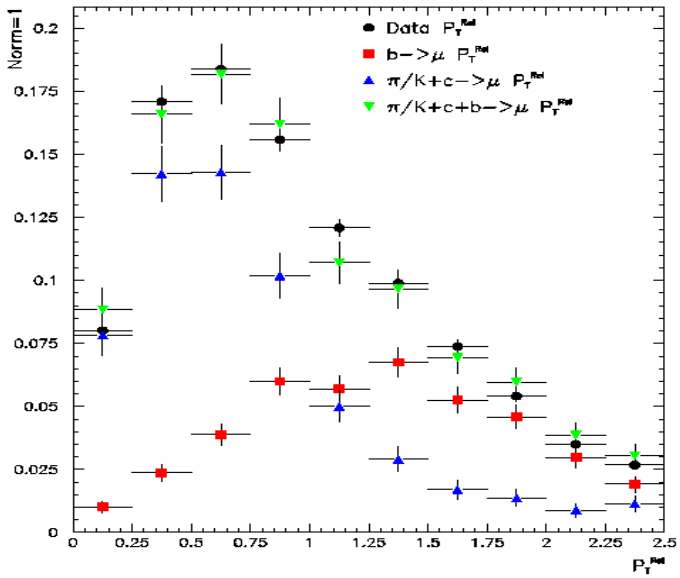

Estimate contributions from all μ+jet sources

# Relative Muon $P_T$



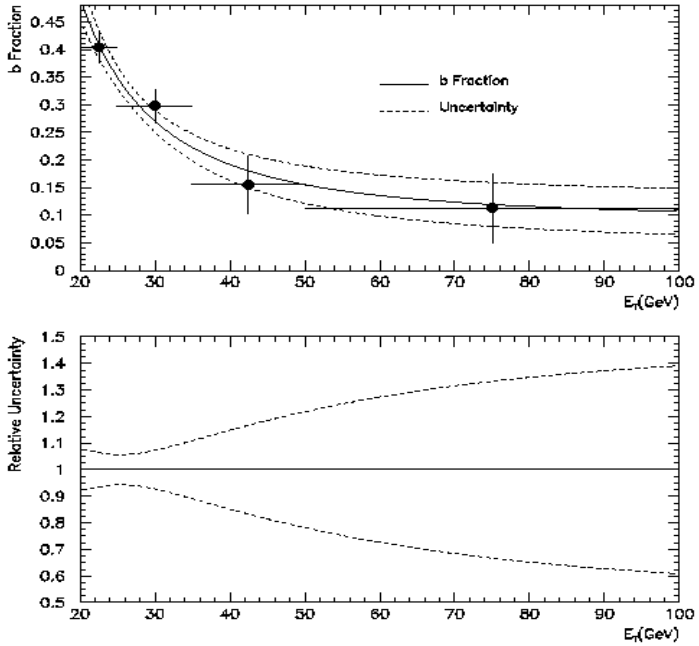

Measure $P_T^{\mu}$ relative to jet axis.

Fit to data (HMCMLL) at four $E_T$ ranges



# B Jet Extraction

Test closure and model dependence.




b-Fraction

Relative Uncertainty

$P_T^{rel}$ discrimination limits b-jet sample to $E_T < 100$ GeV.

# Tagging Acceptance

Corrections required to match data

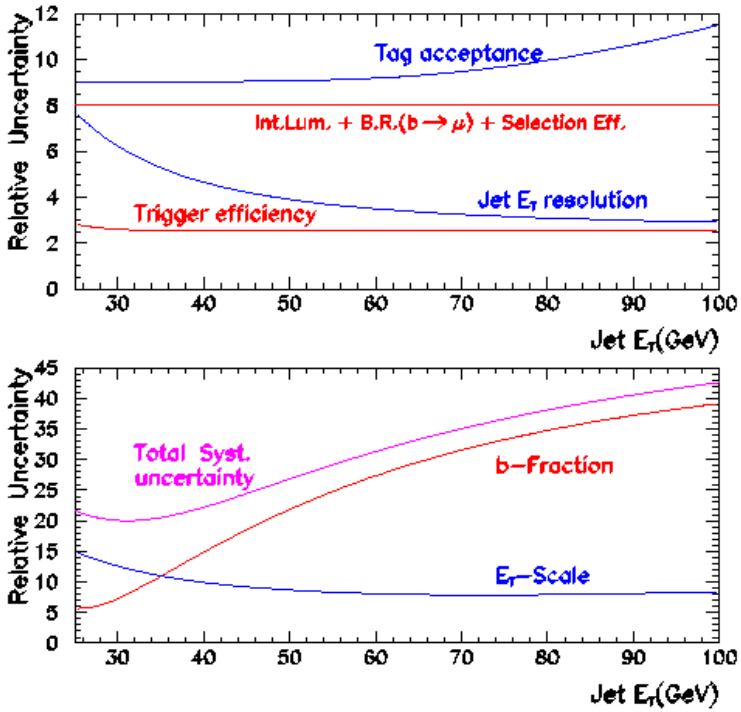
- Muon, jet η-range (central only)
- Muon $p_T$ threshold
- Jet cone size (R = 0.7)
- Missing jet $E_T$ from μ, ν
- Branching fractions

Acceptance as a function of $E_T$

$$A(E_T) = \frac{MC_{obs}(b \to \mu)}{MC_{parton}(b \to \mu)}$$

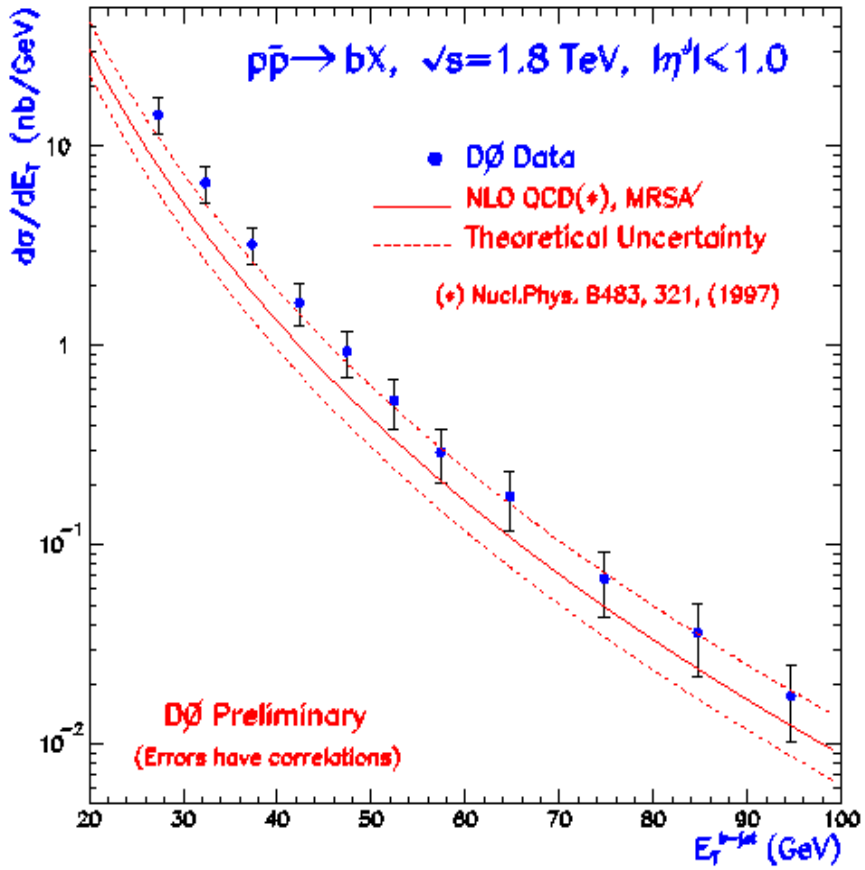
$MC_{obs}$ is the MC set to the observed data from analysis

# Systematic Uncertainty

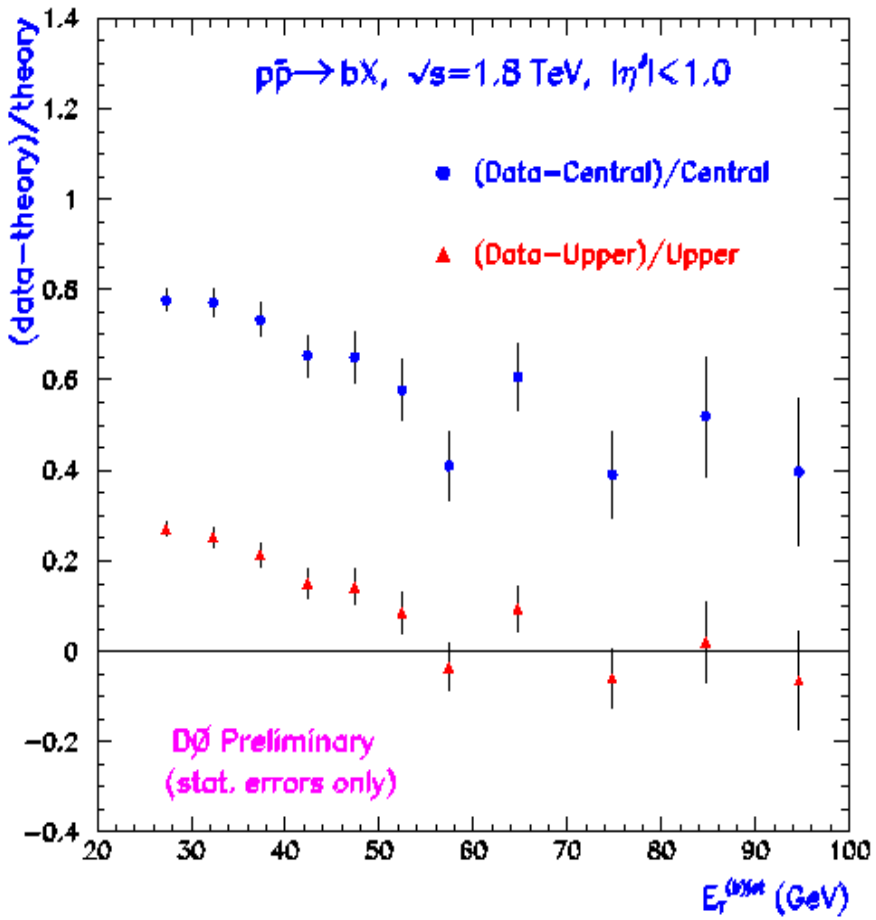



b-fraction dominates at high $E_T$

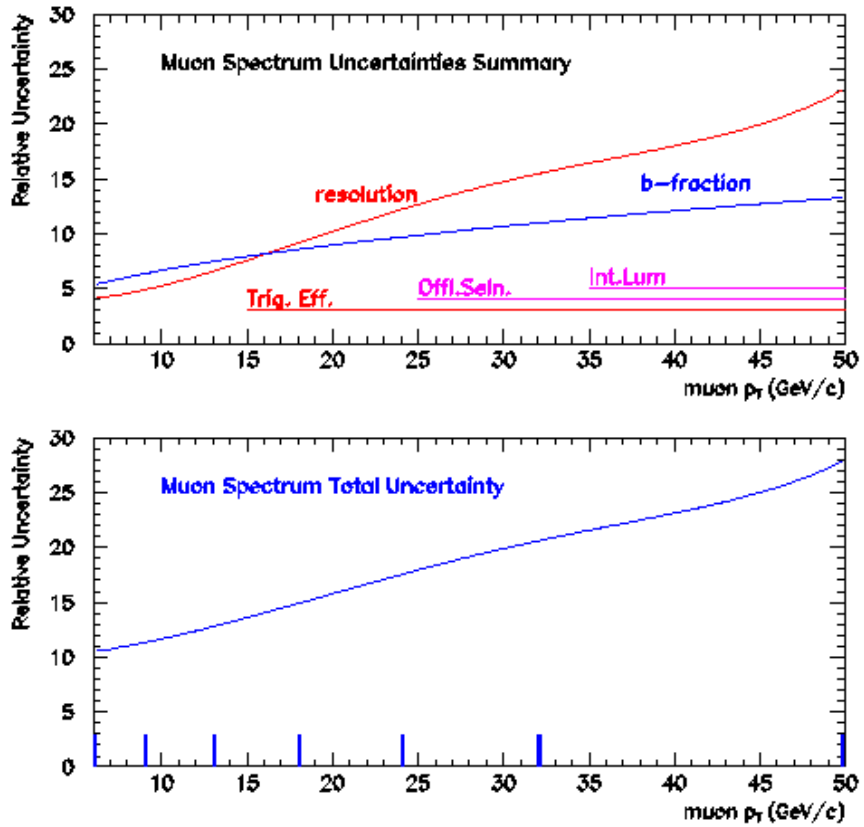
# B-Jet Cross Section



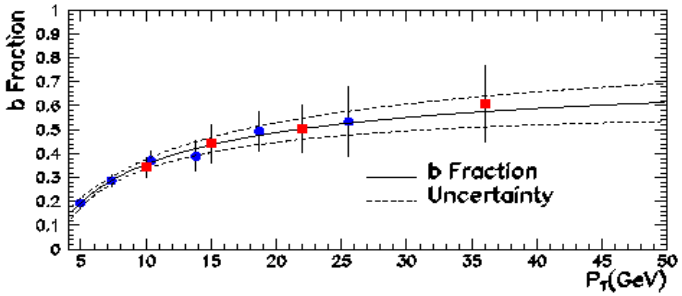
# B-Jet Cross Section Ratio

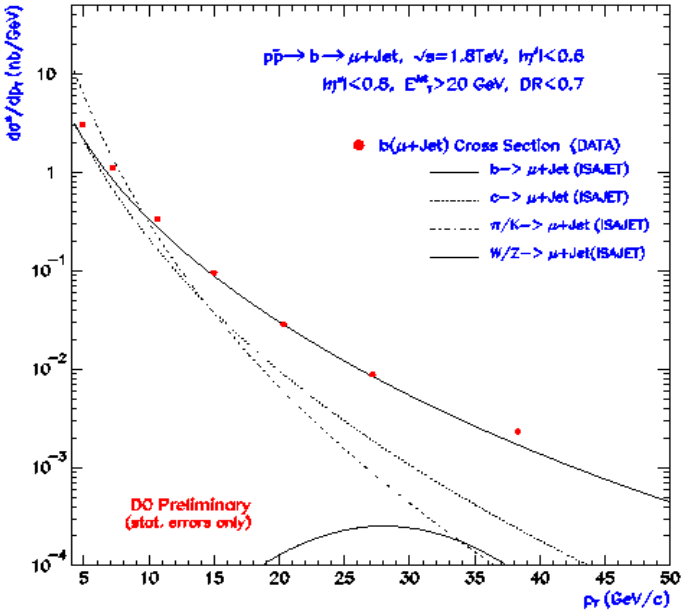


# B-Quark Uncertainties



# Muon Spectrum



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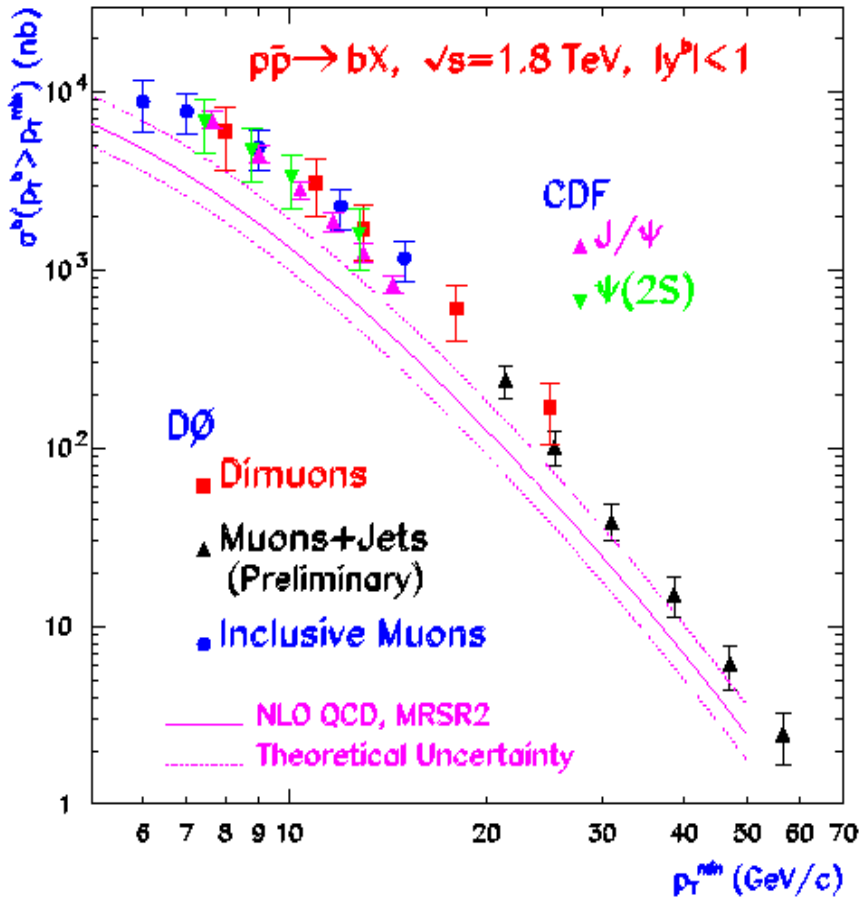
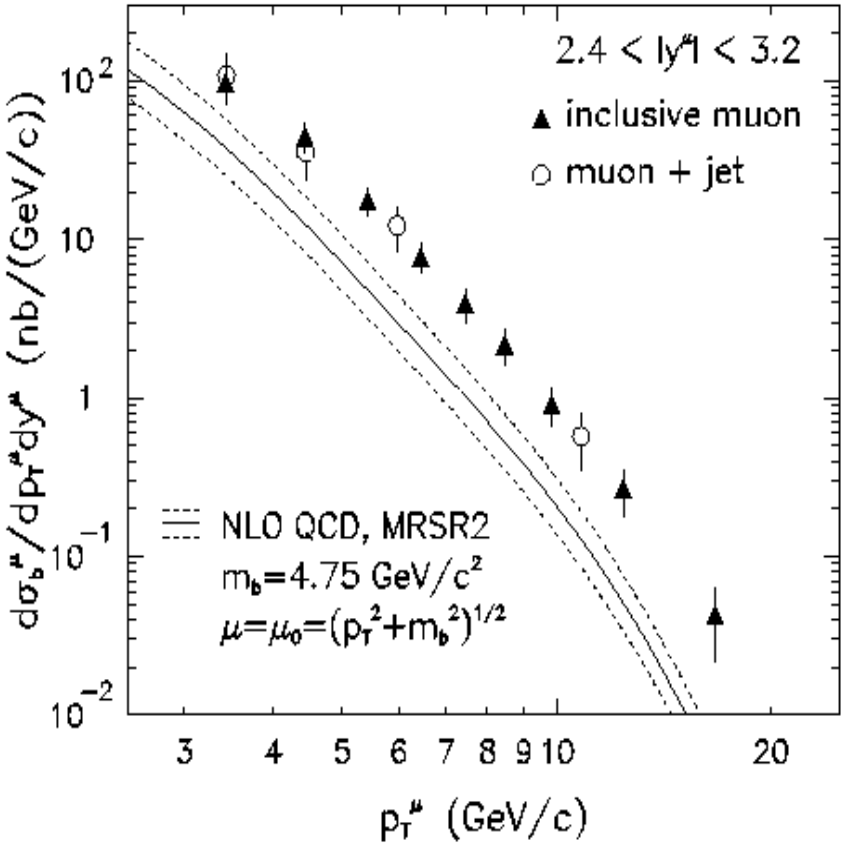


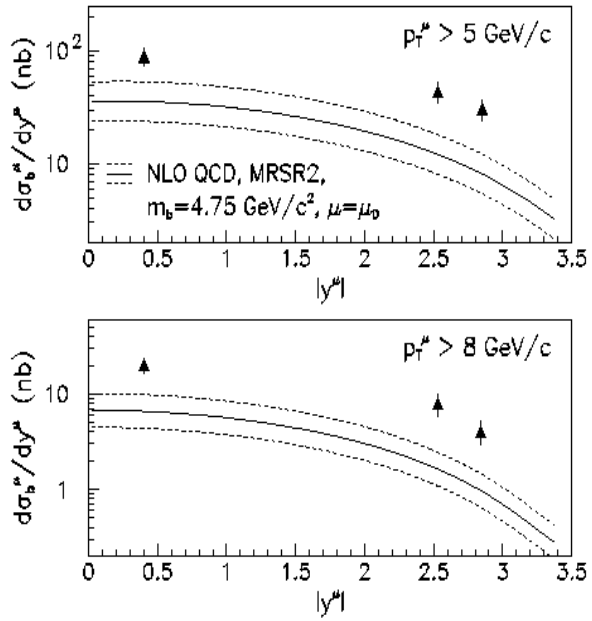
# Forward Muons

Forward cross section with 100 $nb^{-1}$



# Rapidity Dependence

Combine central and forward results, compare to NLO predictions




*Consistent discrepancy with theory: 2.5 at 5; 4 at 8*

# B Production Questions

- Data consistently is above the theory (factor of 2 to 4)
- Some data suggests convergence at highest pt
- b-jets favor $\mu_0/2$, b-quarks favor $\mu_0/4$

Both quantities derive from same underlying physics

# Possible Explanations

Higher orders needed in the expansion

- *R/F scale dependence is large*
- *Radiative corrections*
- *Coexistence of different scales ($S$, $P_T$, $M_b$)*

Non-perturbative effects needed

- *Fragmentation effects*
- *Incoming partons*

# Possible Directions

Remove model dependence

*Use b-jets to reduce fragmentation uncertainty*

Restrict kinematic ranges to reduce higher order contributions

*Optimize triggering and tagging*

Dijets

*Identify events with two tagged b's, look for correlations*

Ratio tests

*b-jet/c-jet to check scale dependence*

*b-jet/all jets to check $E_T$ dependence*

Run II is beginning with central field and SVX