DØ QCD Results and Prospects

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For the DØ Collaboration

Outline

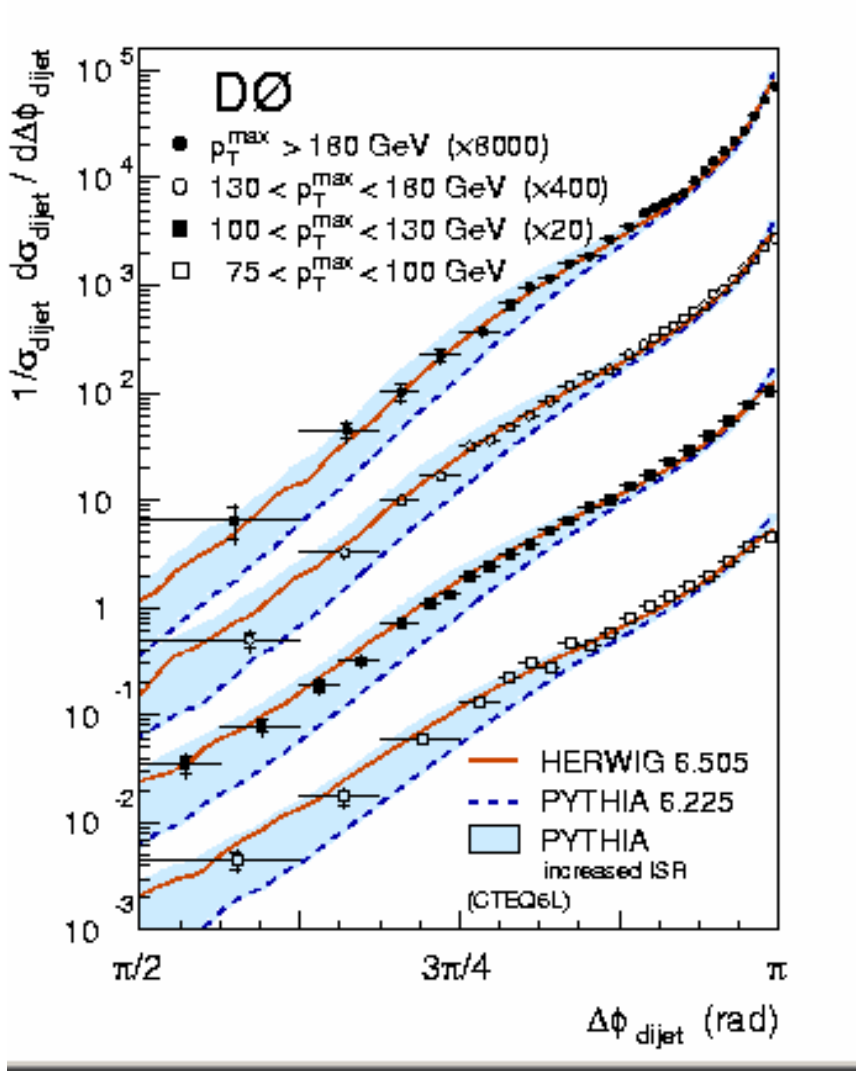
- Motivation
- Recent results
  - Azimuthal decorrelation
  - Inclusive jets
  - Inclusive μ-tagged jets
  - Direct photon
  - Z rapidity
  - Z + n jets
- Results we expect soon
  - Diffractive
    - J/ψ studies
    - Z analysis
    - Di-jets
  - Dijet mass
  - SVX-tagged jets
  - W + c jet
  - γ + b/c jet
  - W charge Asymmetry

Motivation

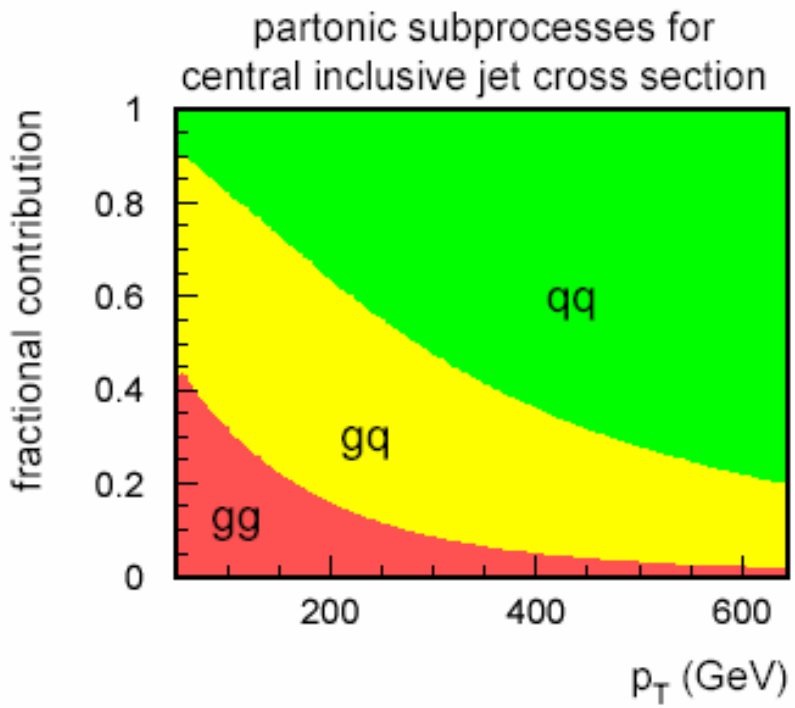
- QCD: It's not just for backgrounds anymore
  - "Need good QCD for our **** search at the LHC"
- QCD is the strongest force
  - Access to the highest energy collisions
  - Searches for new sources of energy are here
- It's the next force to be added on the road to TOE
- When the public asks "What do you do?"
  - Look at what's inside the proton
    - It's all QCD
- Precision measurement over 7 orders of magnitude
  - Where else does precision mean 30% errors.

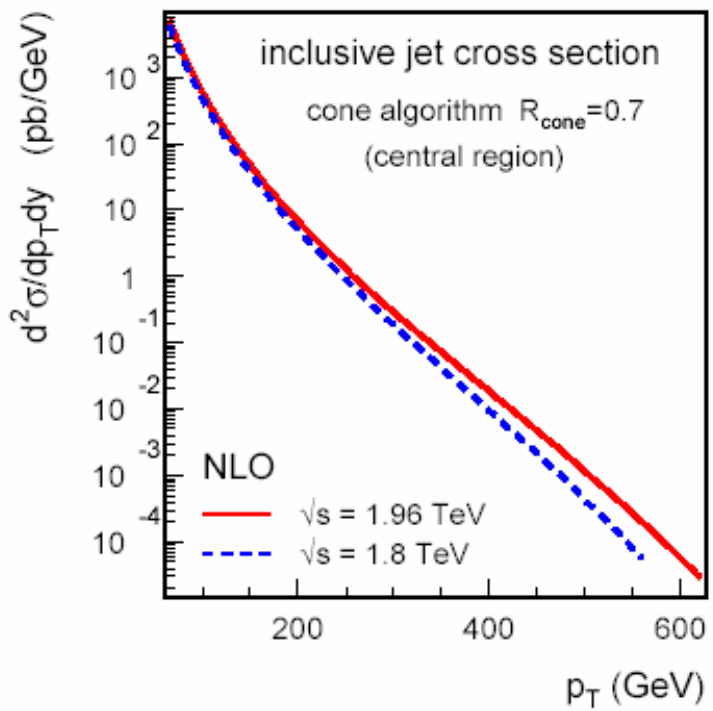
Azimuthal Decorrelation

- Recall last years results on azimuthal decorrelation
  - Azimuthal separation between two highest pt jets in the event
- Sensitive to multi-parton radiation
- Quite consistent with Herwig, but requires tuning for Pythia.



Inclusive Jet

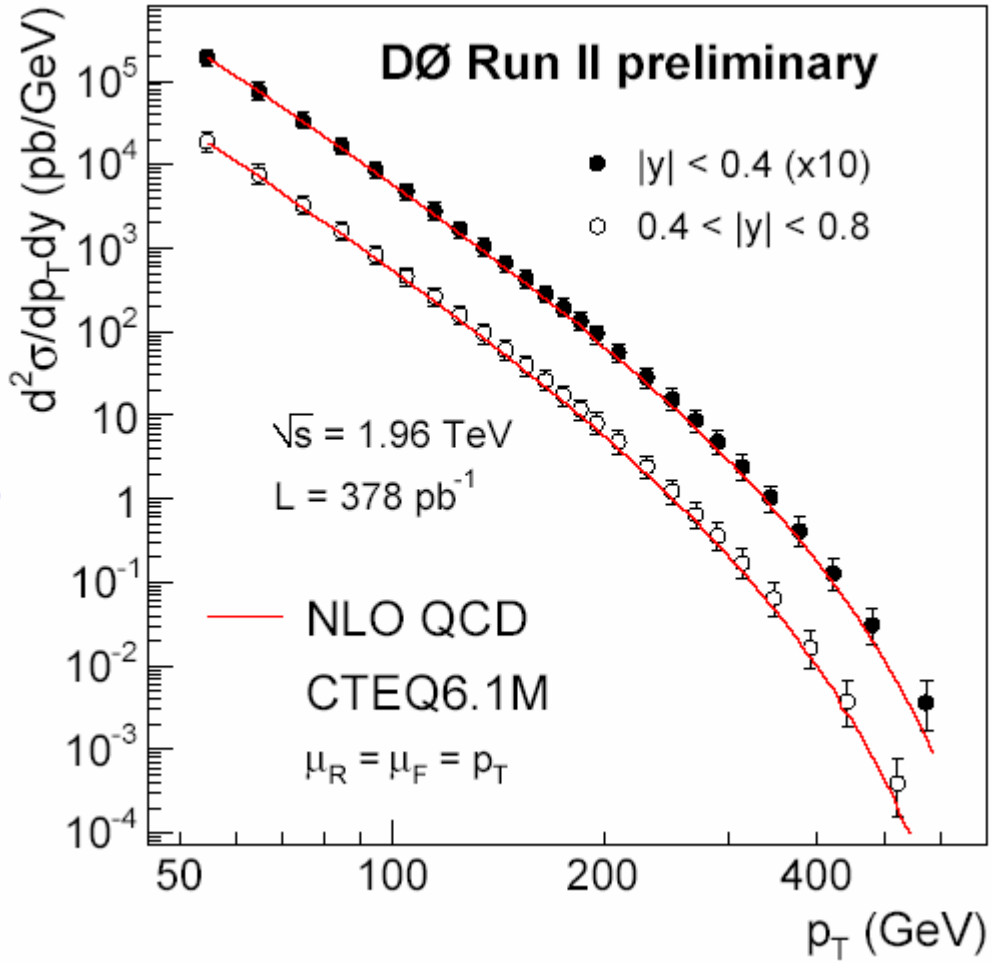




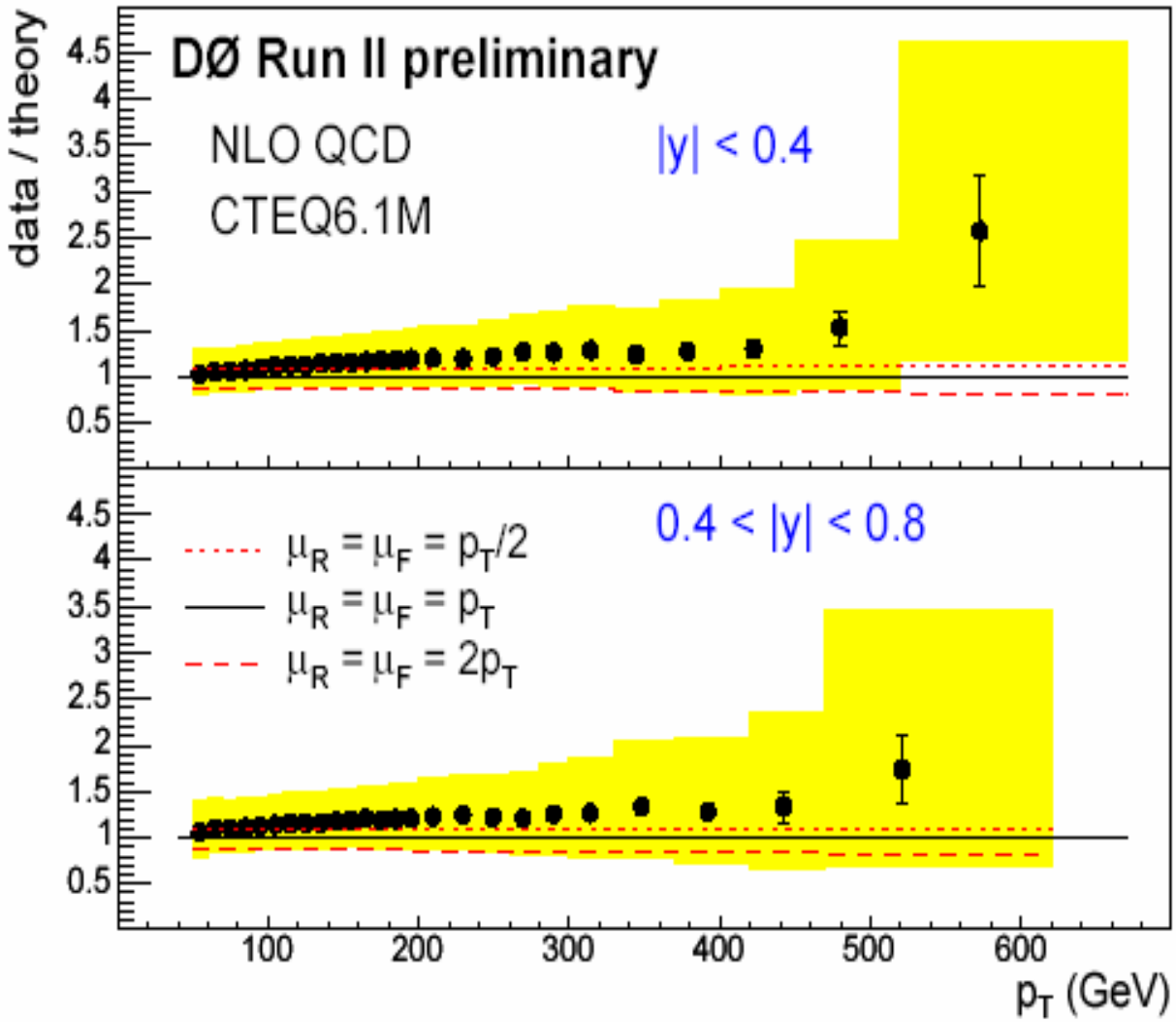
- **Sensitive to many different processes**
  - **α_s, PDF's, new physics @ edge of the Tevatrons reach**
- **Substantial increase in high pt region due to increased center of mass. (3x as high @ 500 GeV)**

Inclusive Jet Cross-section

- Uses Run II Cone algorithm
  - Radius of 0.7
- Int $\mathcal{L}$=380pb^{-1}
- Only two rapidity bins
- Highest Pt jet is 630 GeV…E_{cm} of 1.2 TeV
- Note the ~9 orders of magnitude

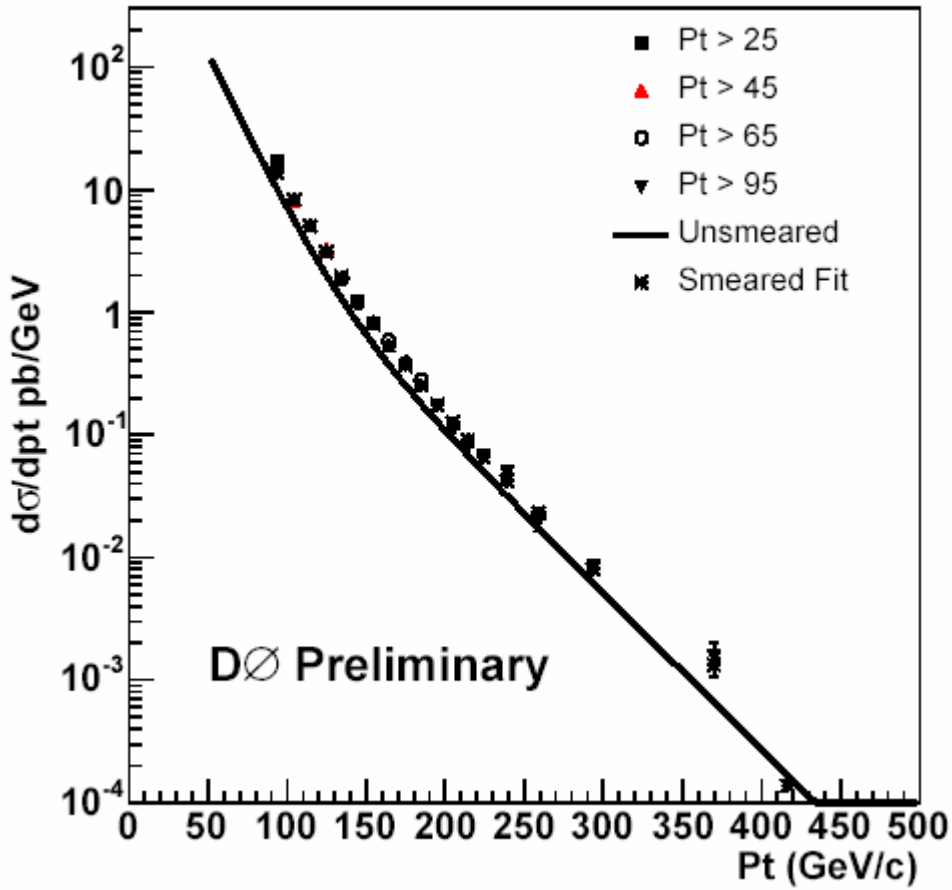


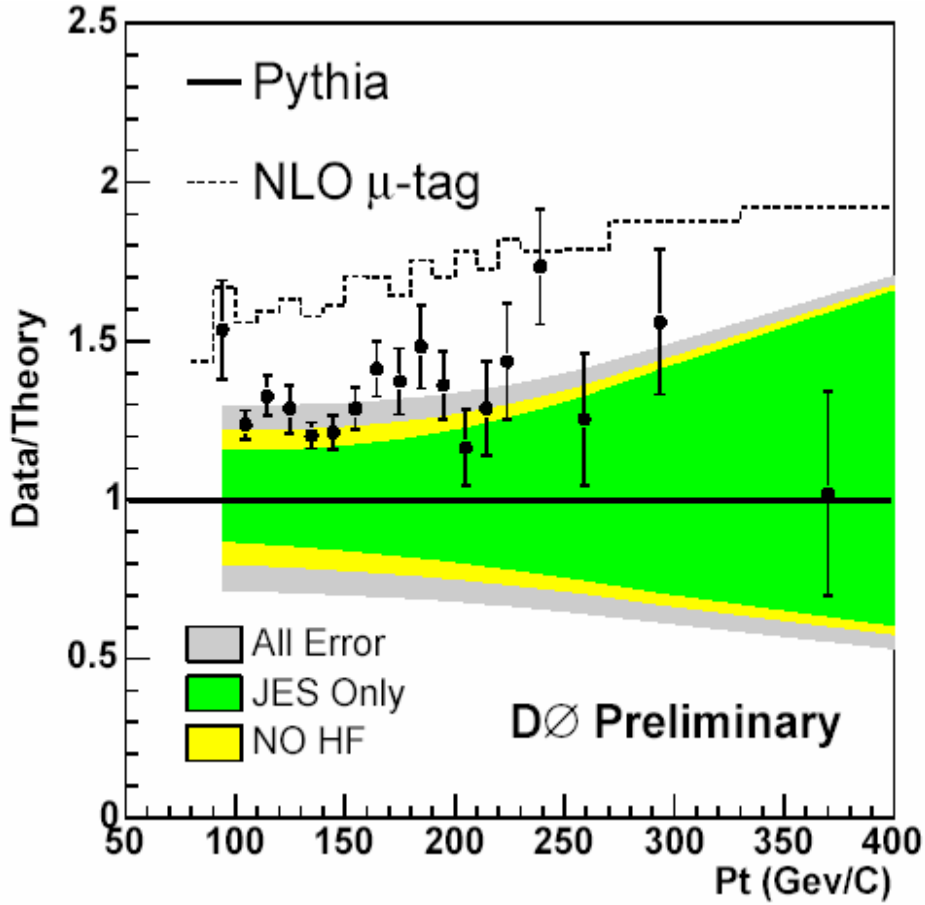
- **Errors of 30% 'good', 200% bad.**
- **Jet energy determination is dominate error (JES)**
- **Jet energy uncertainty is being improved**

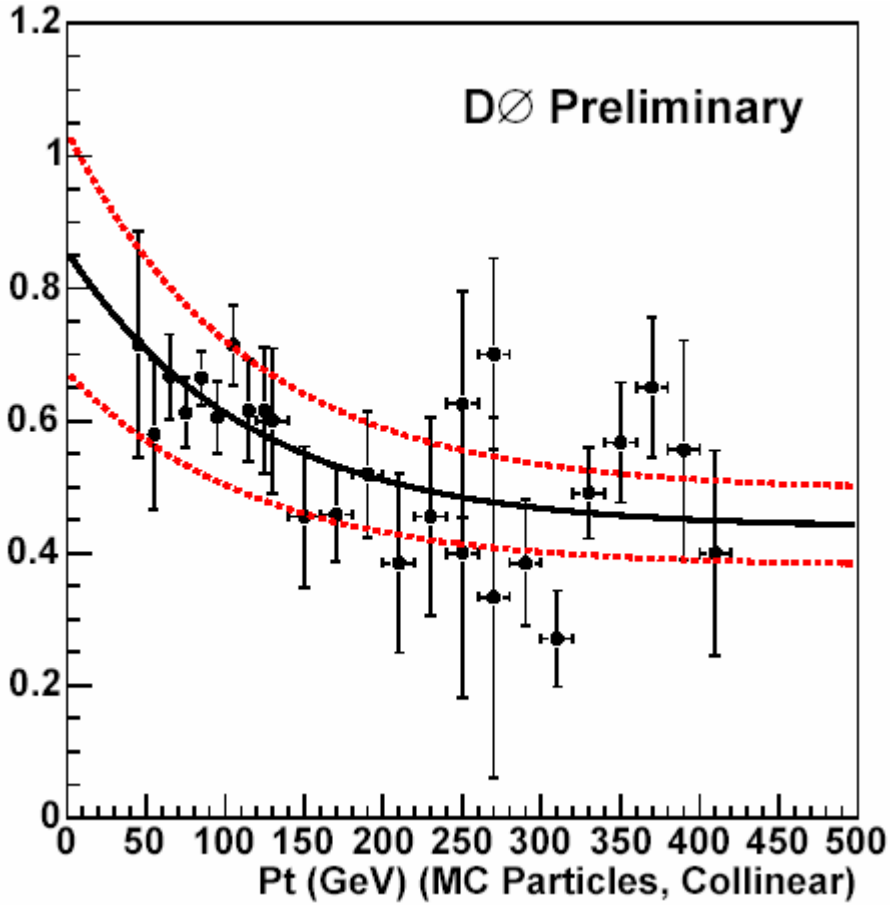


μ-Tagged Jets

- Uses Run II Cone algorithm
  - Radius of 0.5
  - Requires muon in 0.5
- Int $\mathcal{L}$=300pb^{-1}
- |y|<0.5
- Highest Pt jet is 416 GeV
- 'Only' ~5 orders of magnitude



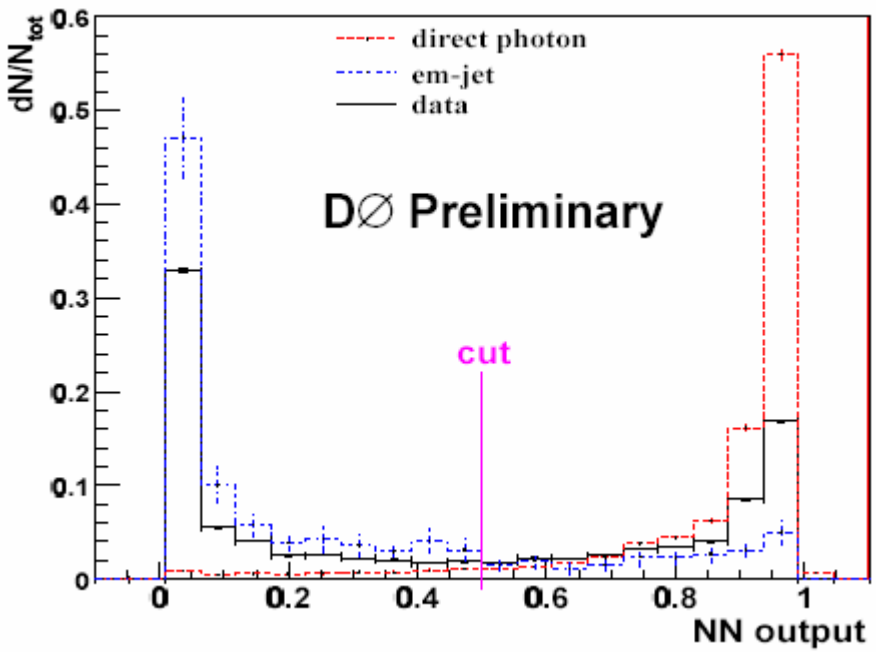


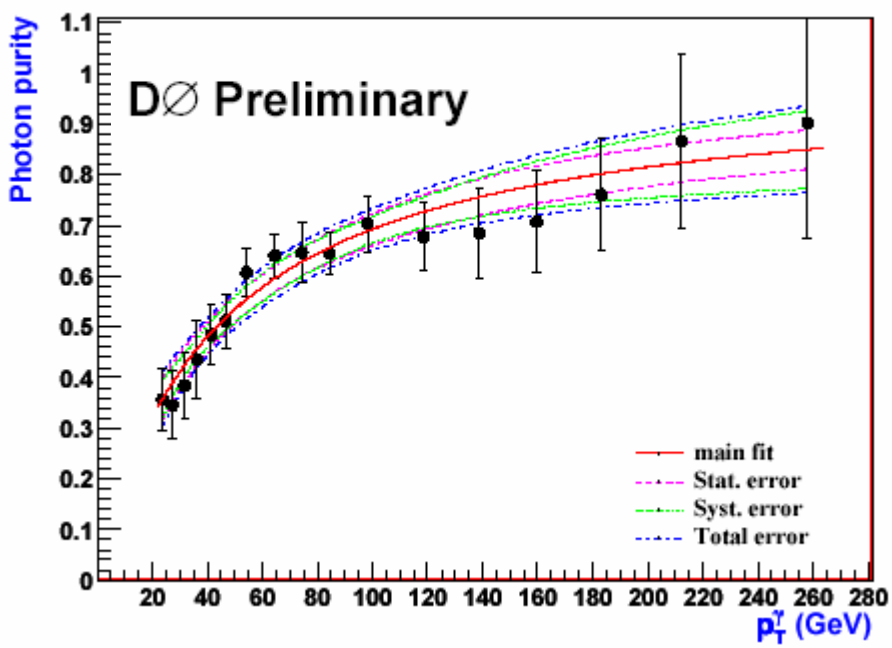


- **Again JES dominate error and errors ~30%**

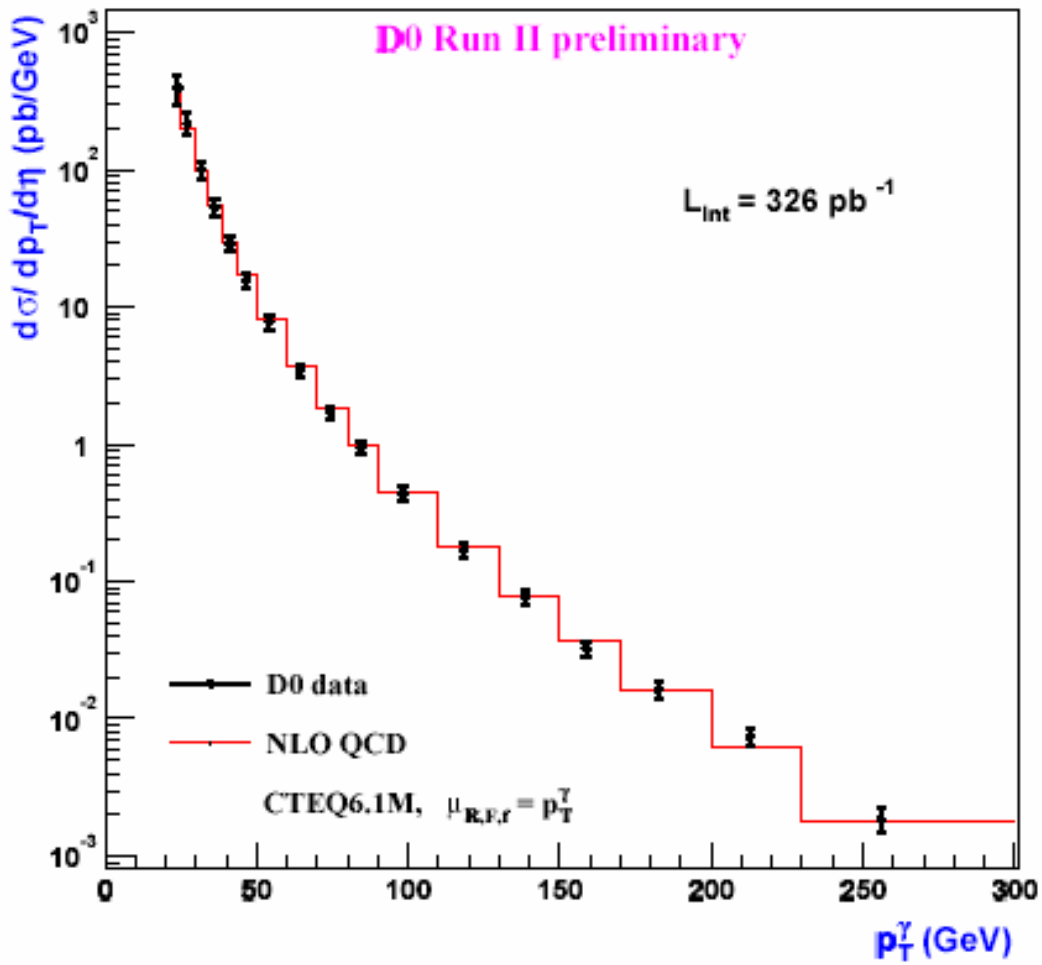
Direct Photons

- Sensitive to gluon PDF and hard scatter dynamics
- Separating photons from jet backgrounds is hard
- Use neural net (NN).
  - Track isolation, and calorimeter shower shape varriables

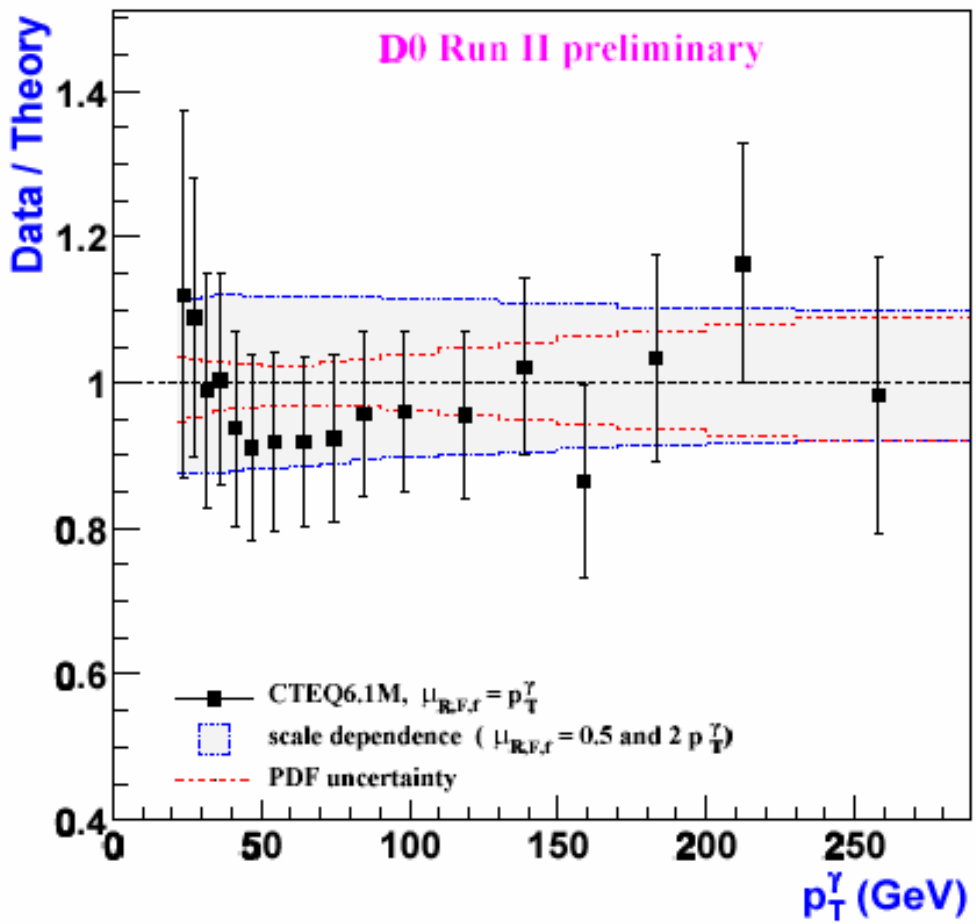




- Int $\mathcal{L}$=330pb^{-1}
- |y|<0.9
- Highest Pt γ is 442 GeV (3 events above 300 not used)
- Six orders of magnitude

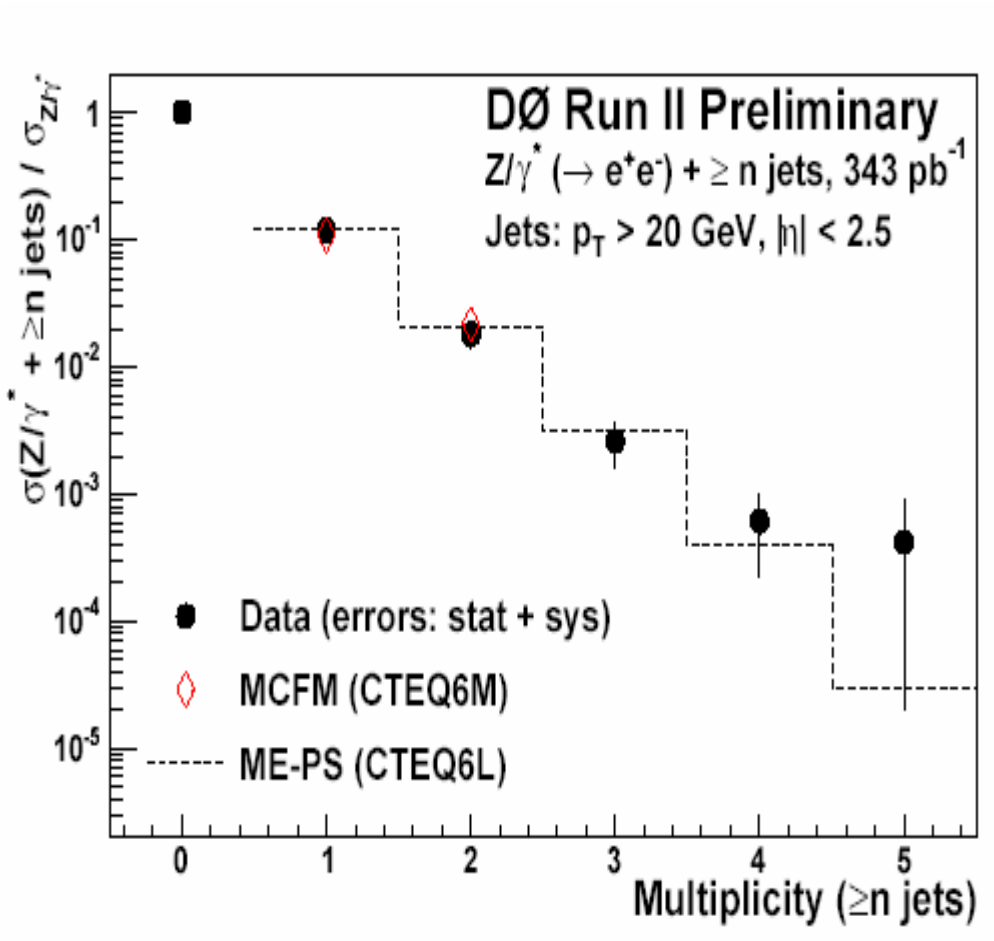


- No JES error…purity dominates
- Errors ~20%
- Need NNLO for sensitivity to PDF effects?

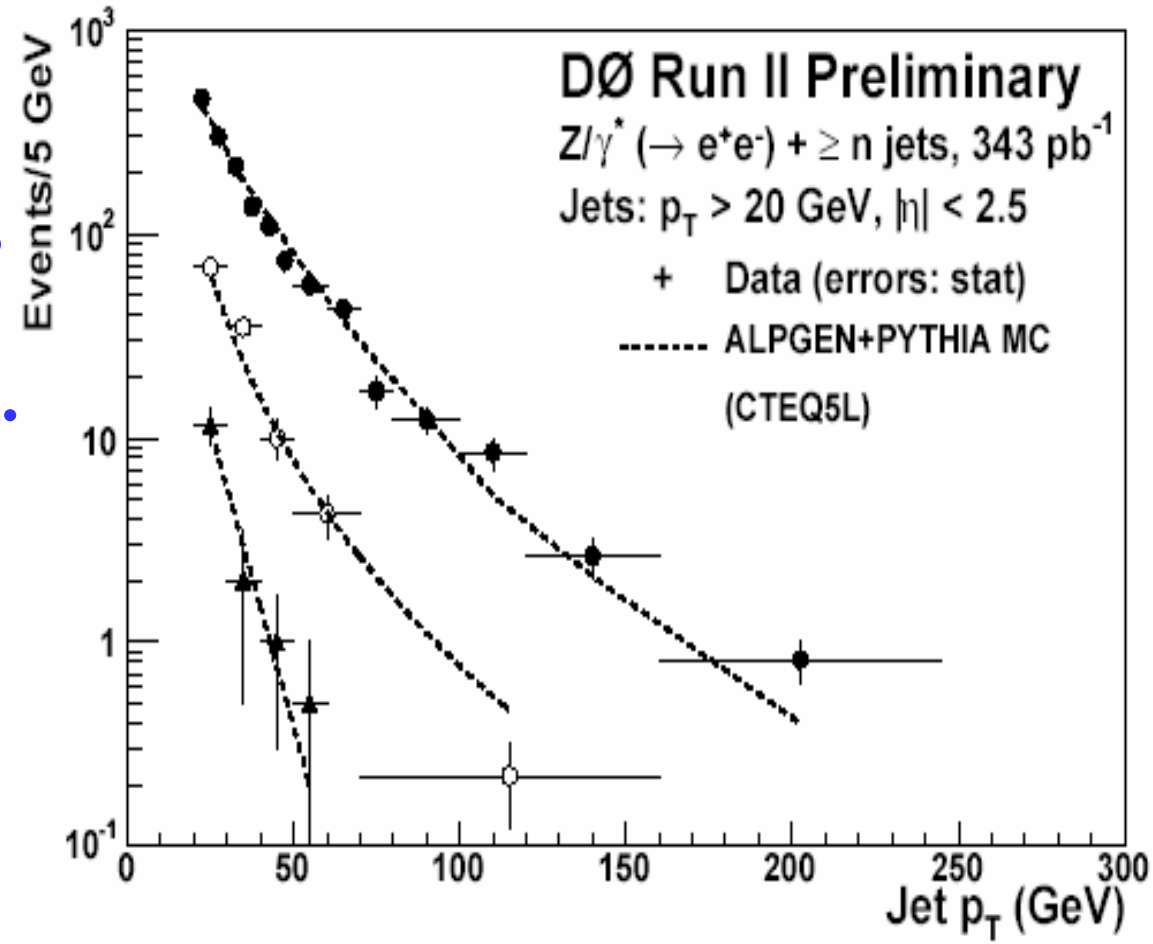


Z + n jets

- About 14,000 Z→ee candidates
  - Two EM objects $|\eta_{det}|<1.1$
  - At least 1 track match
  - Di-EM mass 75-105
- Uses Run II Cone algorithm
  - Radius of 0.5
  - $|\eta_{det}|<2.5$
- Int $\mathcal{L}$=340pb^{-1}
- Normalized 0 jets.

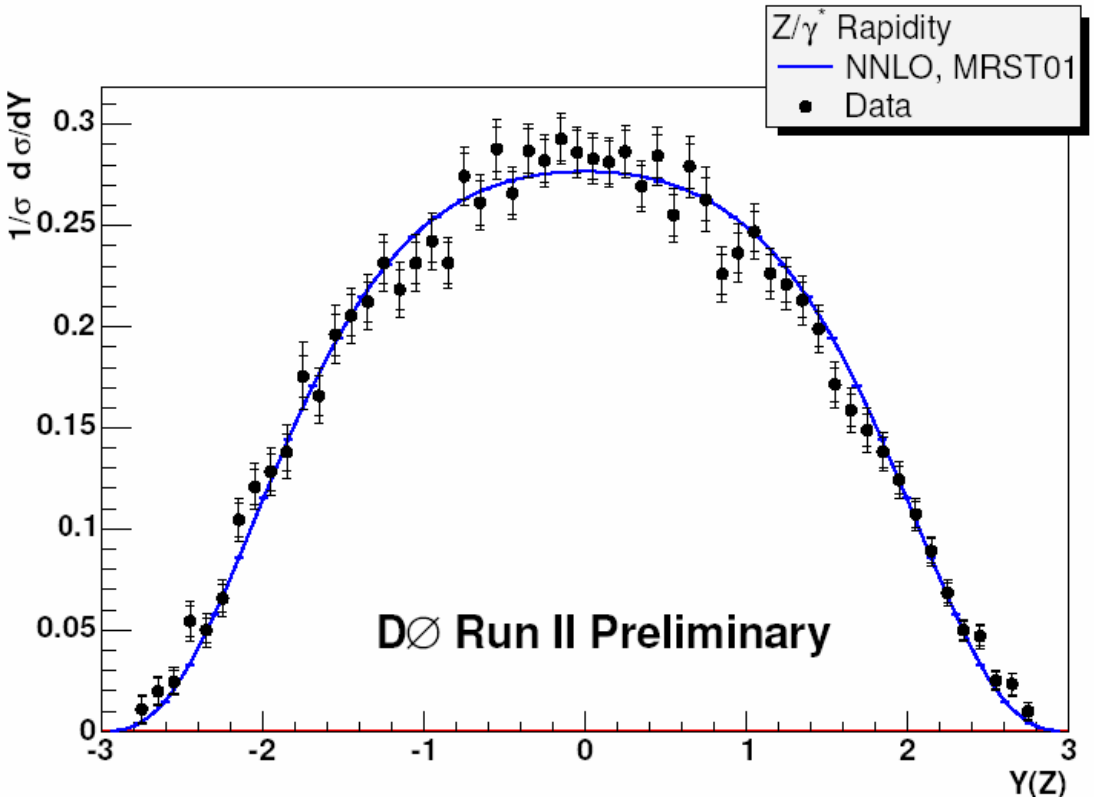


- **No Syst. Error (JES)**
- **Only comparing shape… MC is area normalized.**



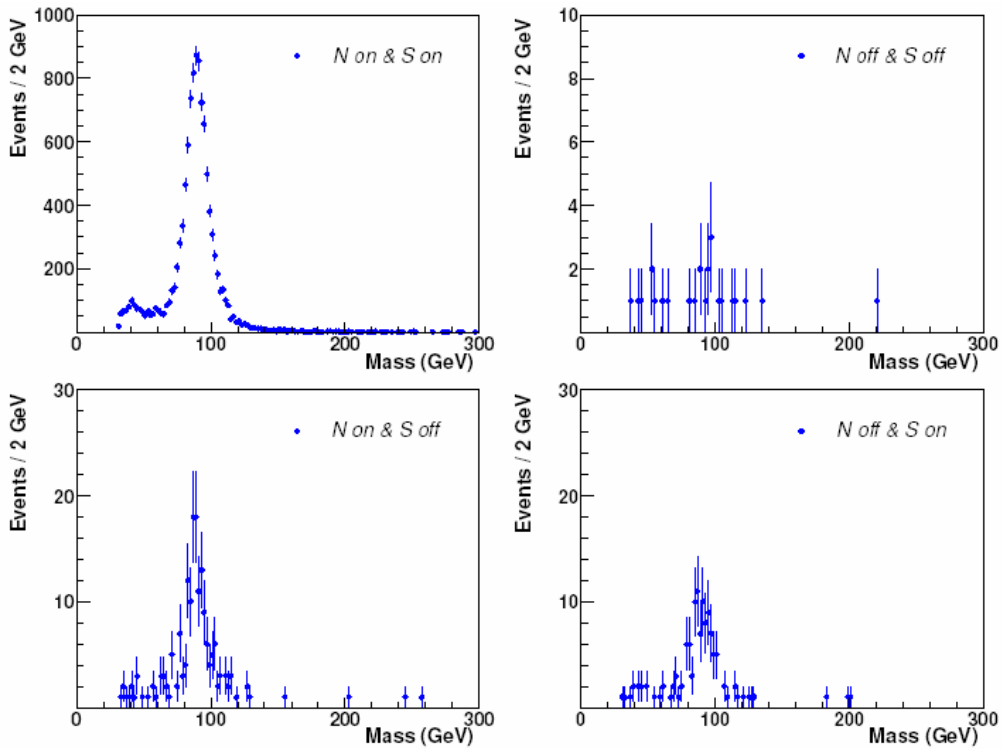
Z Rapidity

- About 14,000 Z→ee candidates
  - Two EM objects $|\eta_{det}|<1.1$ or 1.5-3.2
  - At least 1 track match
  - Di-EM mass 75-105
- Int $\mathcal{L}$=340pb^{-1}
- Sensitive to PDFs



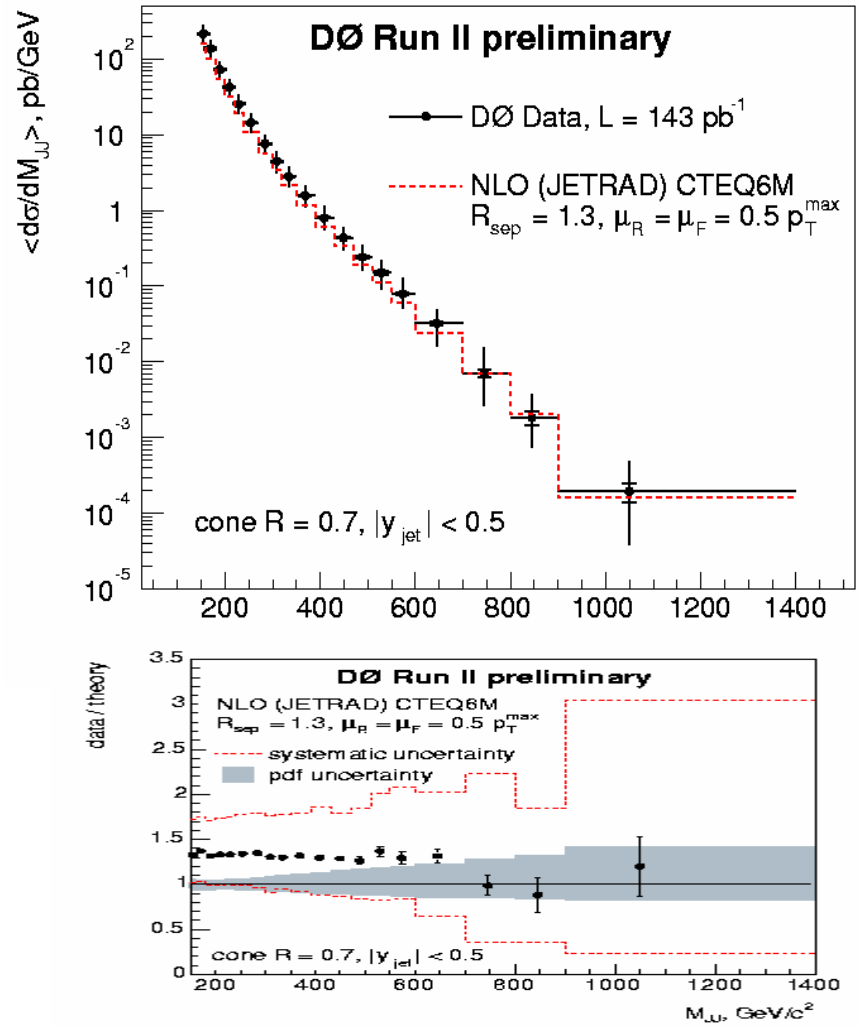
Diffractive Physics

- Diffractive events are events which have a ‘quite region’ in the detector known as a rapidity gap.
  - This implies that no color has left the proton
- We’ve already had a preliminary Diff Z
  - Expect final results
- Expect a preliminary diff J/ψ soon
- And results on Diff. Di-jet



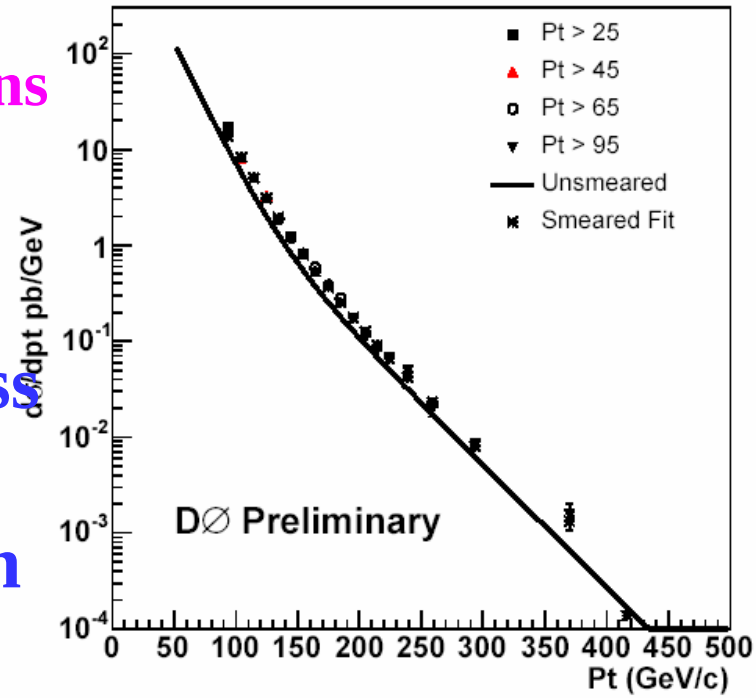
Update of Di-jet Mass

- We expect an update to the di-jet mass analysis in the winter.



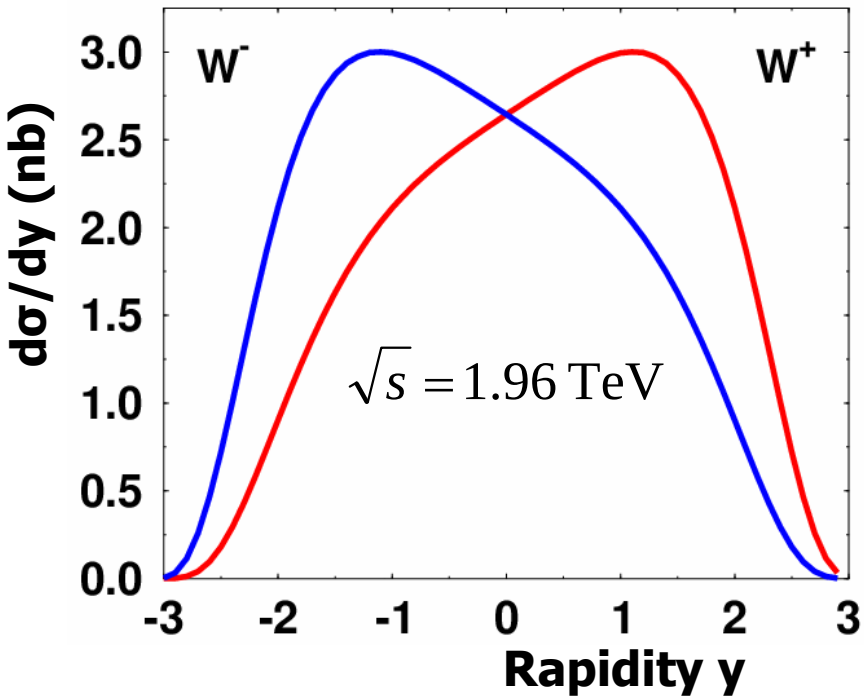
SVX Tagged Jets

- The μ-tagged jet cross section leads us to a secondary vertex tagged cross section.
  - Data driven heavy flavor fractions
- Both inclusive jet cross section and di-jet mass.
- In addition the di-SVX-jet mass should be sensitive to compositeness models if we can reduce the JES error.



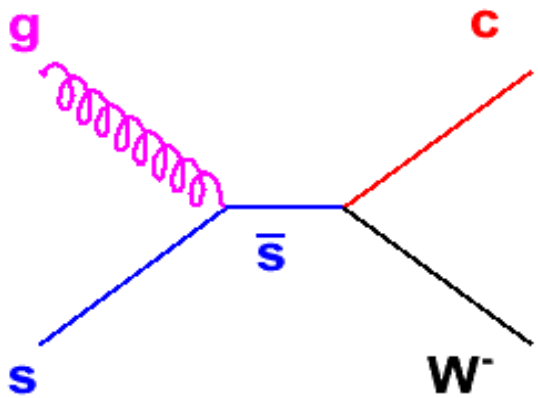
W Charge Asymmetry

- Studying the charge asymmetry in W rapidity is sensitive to u(x) – d(x).
- This asymmetry also manifests itself in the lepton rapidity
- This analysis is very advanced…almost approved but a thesis "got in the way"



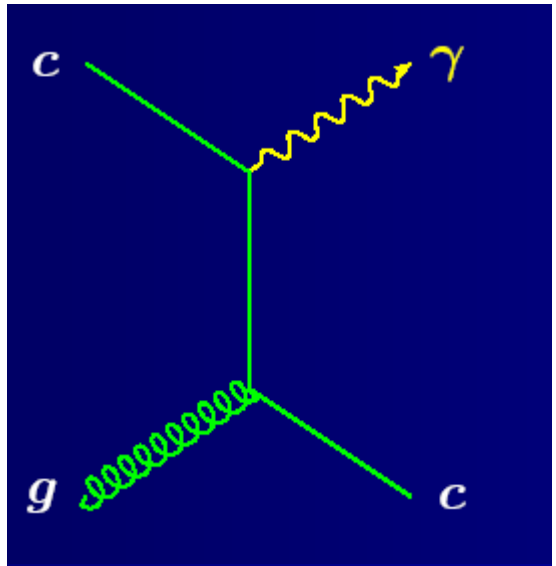
W + Charm Jet

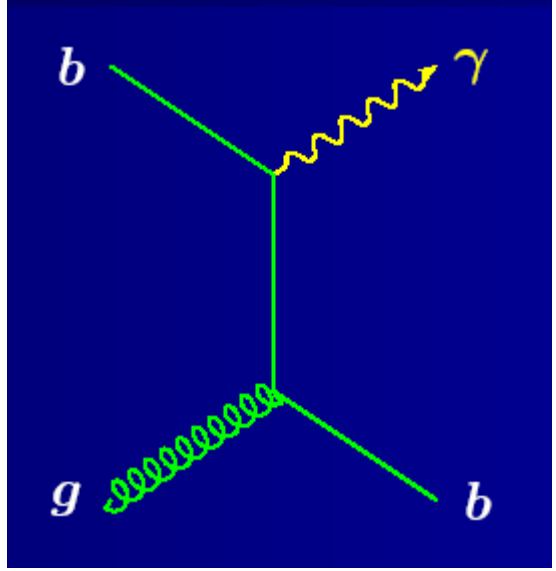
- This analysis began about 6 months ago
- We hope to see preliminary results in about 6 months.
- Sensitive to the strange sea
- Can study $s(x)\ \bar{s}(x)$ differences
  - 'NuTeV Anomaly'
- Charm tagging…challenging



Photon plus heavy

- Sensitive to the charm and bottom sea.
- Challenges of photon purity and lifetime tagging.
- Hope to produce a triple-differential cross-section
  - pt-g y_γ y_j





Summary

- I've shown that QCD can be an interesting field
- I've shared our preliminary results and our plans.
  - Hope that others will let us know if they are interested in specific distributions, or would like minor changes.