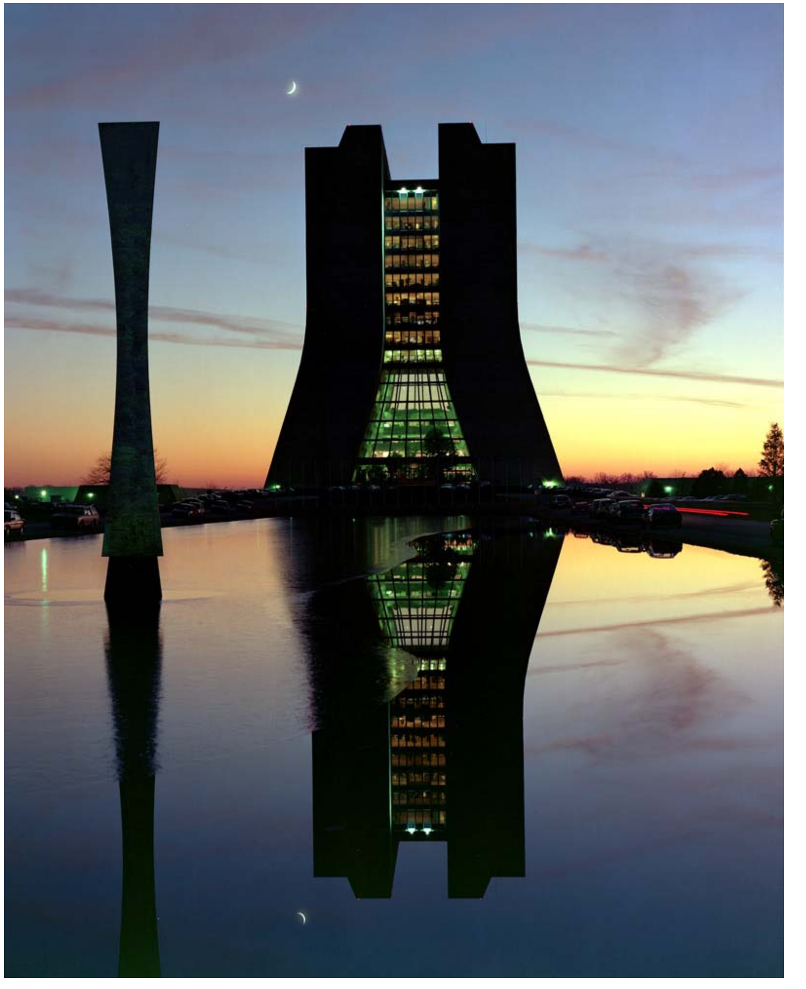
Constraints on PDFs from DØ



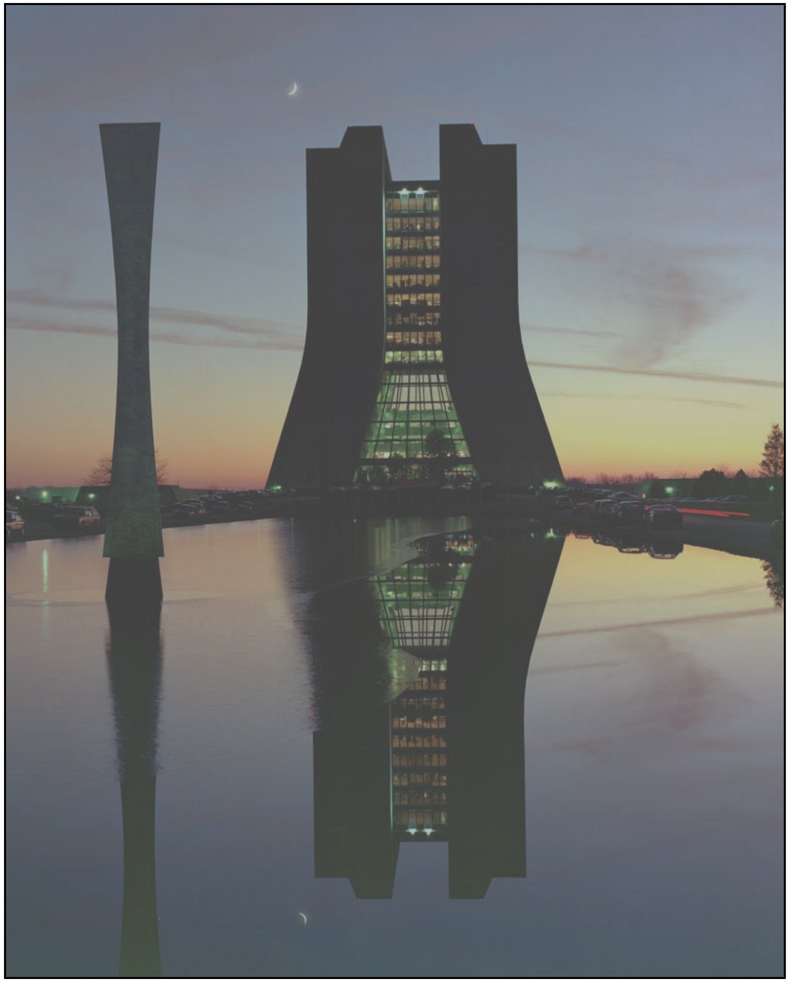
Jonathan Hays
Imperial College London
On Behalf of the DØ Collaboration

DIS 2008 UCL

Constraints on PDFs from DØ

Motivation

Recent Results and Future Prospects

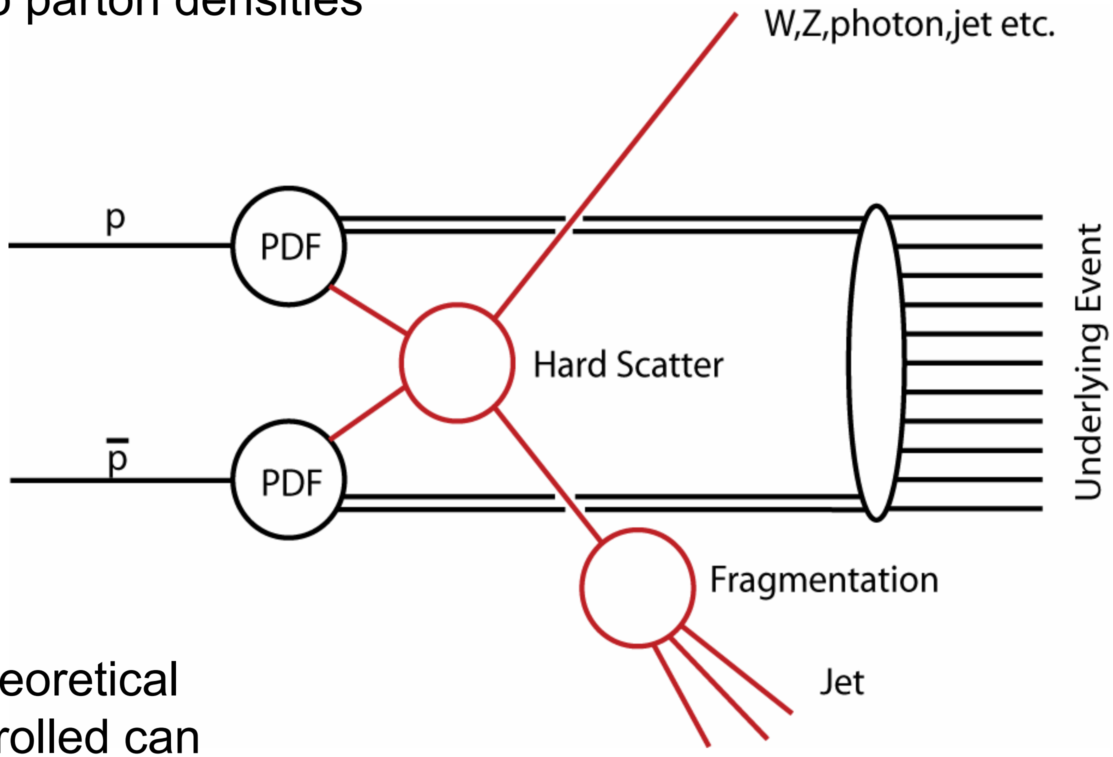


Jonathan Hays
Imperial College London
On Behalf of the D0 Collaboration

DIS 2008 UCL

Motivation

Many analyses sensitive to parton densities



When experimental and theoretical uncertainties are well controlled can provide constraints of PDFs

Feeds back into other results and for future analyses at LHC

Recent Results

Z rapidity (electrons)

W charge asymmetry (muons)

W charge asymmetry (electrons)*

} Leptons

Inclusive jets

Photon+jets

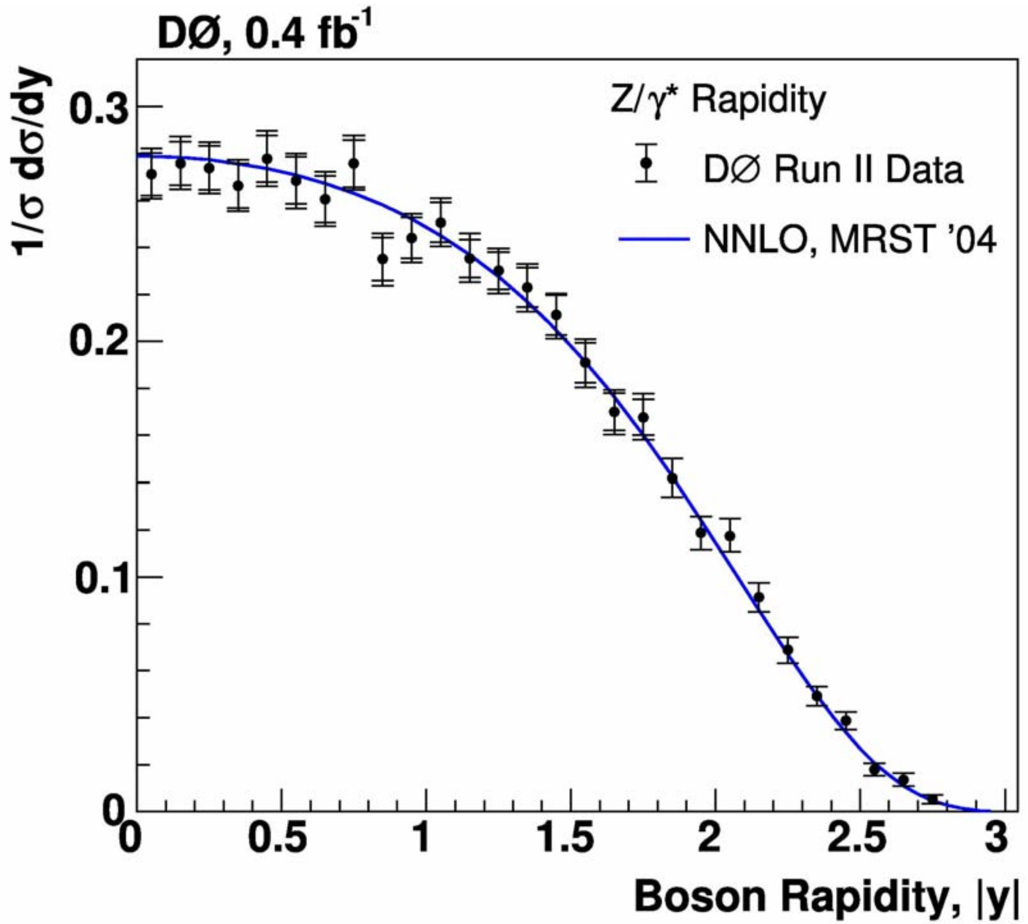
W+c/W+j

} Jets

* Not approved in time for DIS but coming soon!

Z Rapidity

Phys. Rev. D 76 0212003 (2007)



Shape of the Z rapidity distribution in electron channel

Statistics limited result

Systematics dominated by efficiencies and background determination – and PDFs for high y

Overlaps in (x,Q^2) with jet data but with different systematics

NNLO – Anastasiou et. al. PRD 69, 094008 (2004)

W Charge Asymmetry

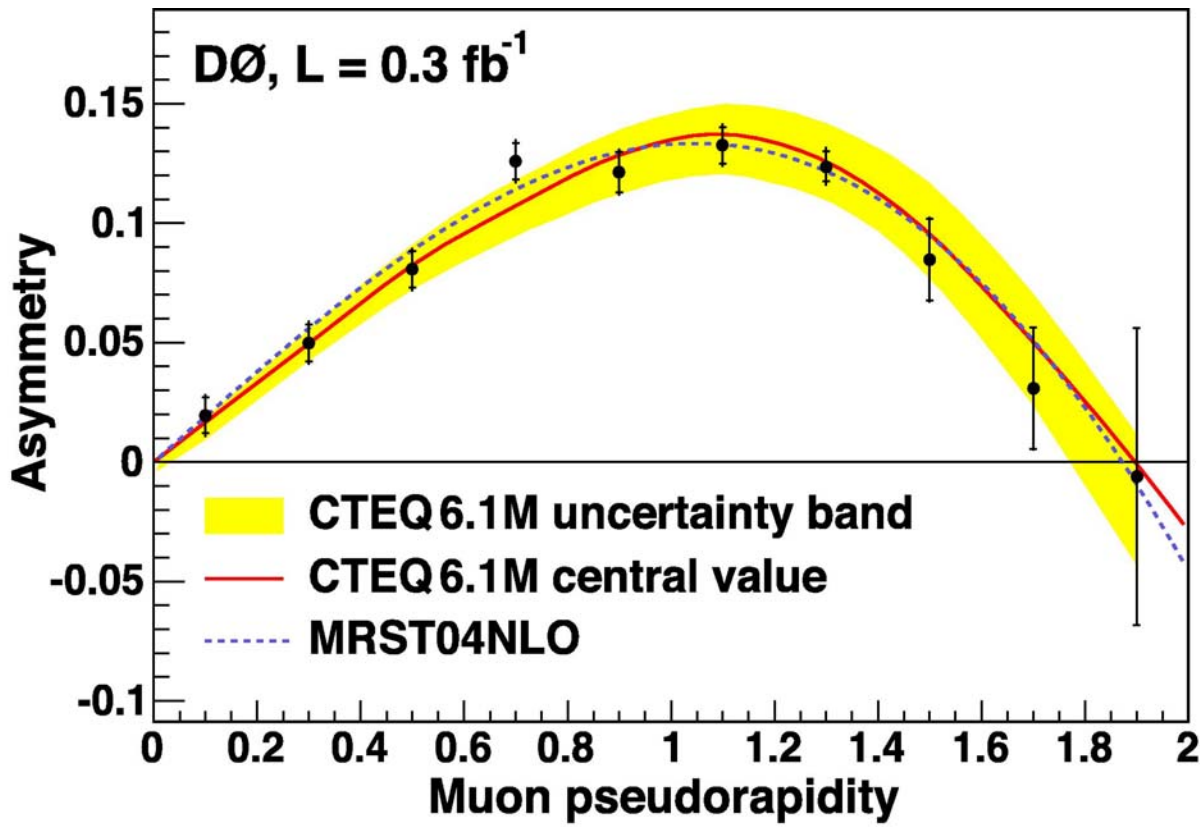
Phys. Rev. D 77 , 011106(R) (2008)

Sensitive to ratio of u and d quark PDFs

Neutrino complicates reconstruction of boson rapidity

Look at lepton asymmetry

Statistics limited result



Electron result with L=1fb^{-1} coming soon!

Jets

Defined by algorithm

Infer information about partons from calorimeter deposits

Run-II Jet mid-point algorithm

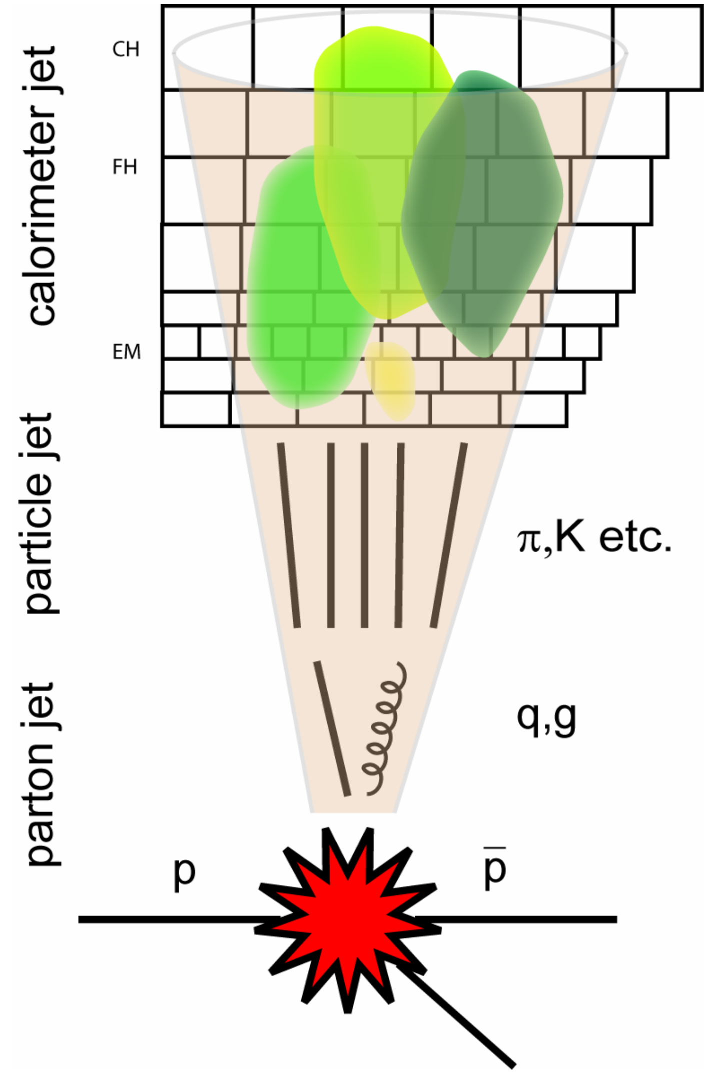
Improves on Run-I

Iterative process

use cone of $R = \sqrt{(\Delta y)^2 + (\Delta\phi)^2}$

Splitting and merging using mid-points

Better IR safety compared with Run-I



Jet Energy Scale

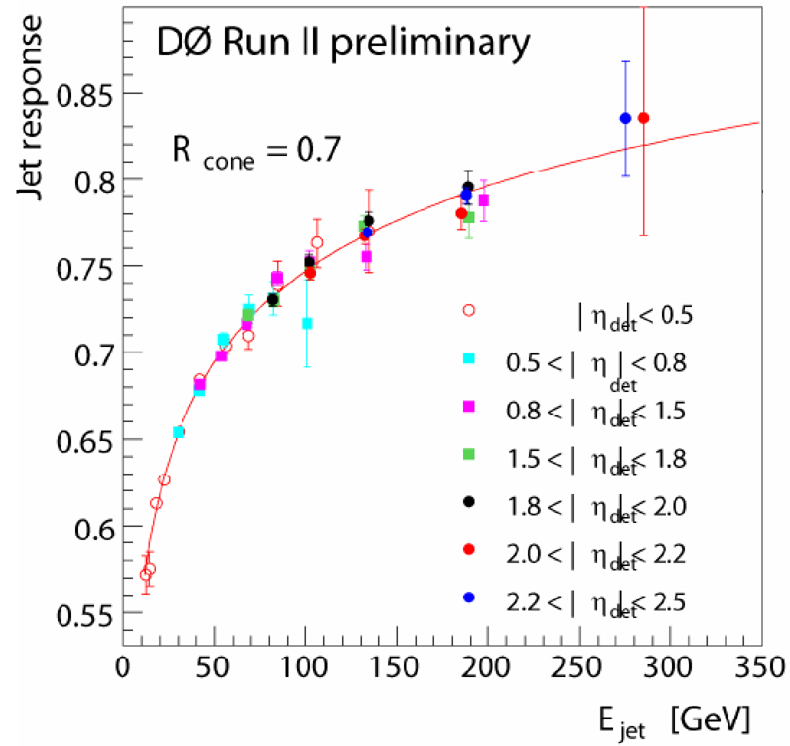
EM response calibrated using Z→ee

Hadronic response calibrated

- γ+jet for central rapidity jets
- Jet-jet combined with γ+jet with one central object - intercalibrates versus detector pseuduorapidity

Uncertainties vary between

- 1% and 1.5% for central cryostat
- 1.5% to 2% in forward cryostats



$$E_{jet}^{corr} = \frac{E_{jet}^{raw} - E_{offset}}{F_{\eta} \times R \times S}$$

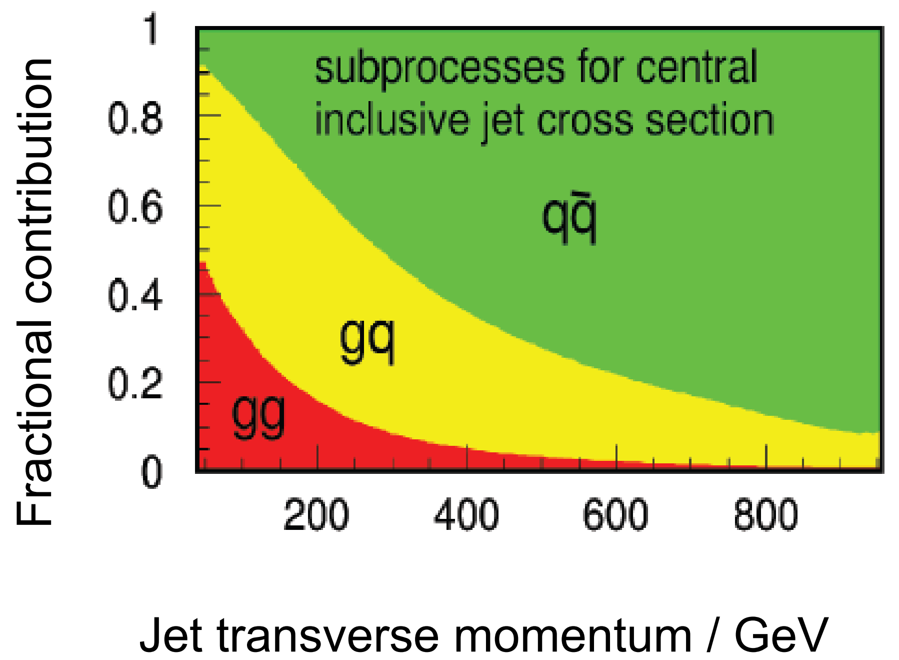
Inclusive Jet Cross-Section

Stringent test of pQCD and sensitive to physics beyond the SM

Could constrain gluon PDFs at high jet p_T

Improved uncertainties in JES imply sensitivity to gluon-quark jet variations

Estimated using MC tuned using single pion response +4% @50GeV, -2% @ 400 GeV for central jets

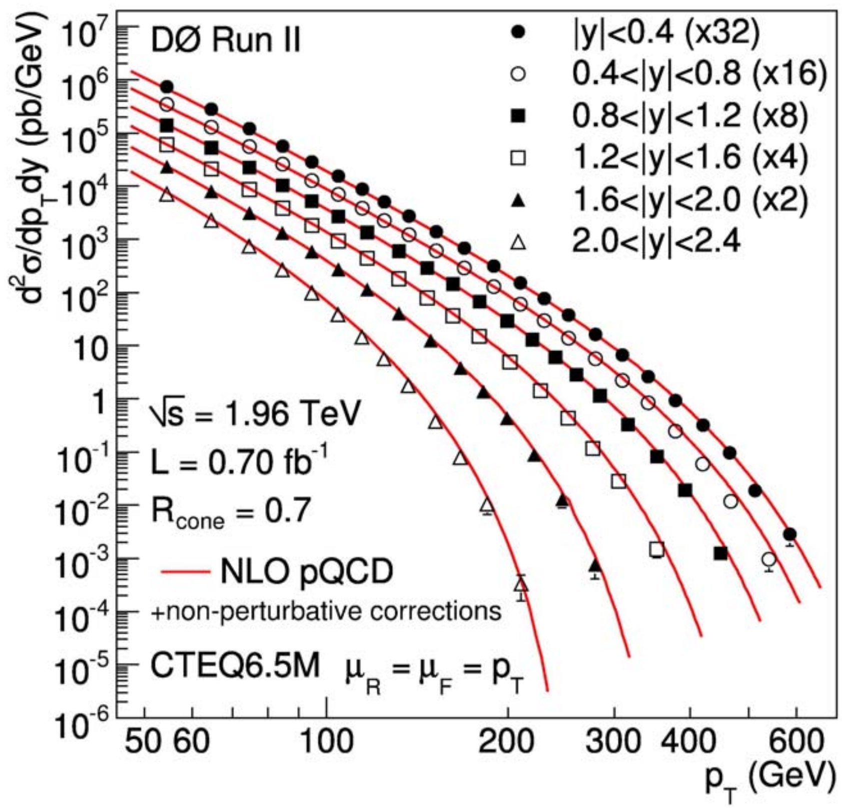


Inclusive Jets: Results

Measure double differential cross-section versus p_T in rapidity bins for jets R=0.7

Selection

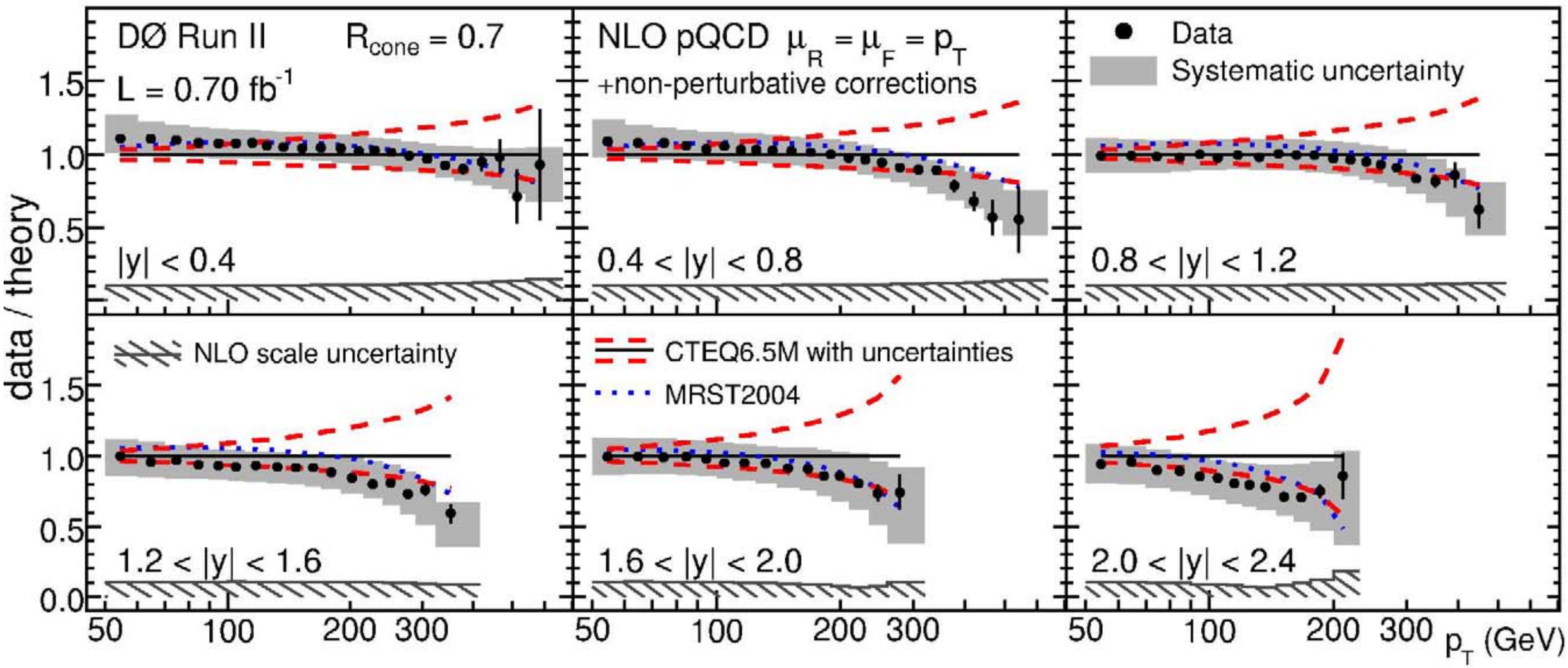
- jet pT > 50 GeV
- |y| < 2.4
- $|Vtx_z|$ < 50cm
  - efficiency ~ 93%
- $E_T^{miss} < 0.7\ p_T^{max}$ (p_T^{max} < 100)
- $E_T^{miss} < 0.5\ p_T^{max}$ (p_T^{max} > 100)
- cuts on shower shape
  - remove backgrounds from photons, electrons and noise
- Jet efficiency > 99% (above 50GeV)



hep-ex/0802.2400 submitted to PRL

Inclusive Jets: Data vs Theory

Data favours the lower edge of the CTEQ6.5M band at high jet pT



Good agreement in shape for MRST2004

Significantly reduced experimental uncertainties over previous results

See hep-ex/0802.2400 for data and errors with correlations

Photon + jet: Motivation

Direct photons

- probe the hard scattering directly
- energy calibration is better than jets

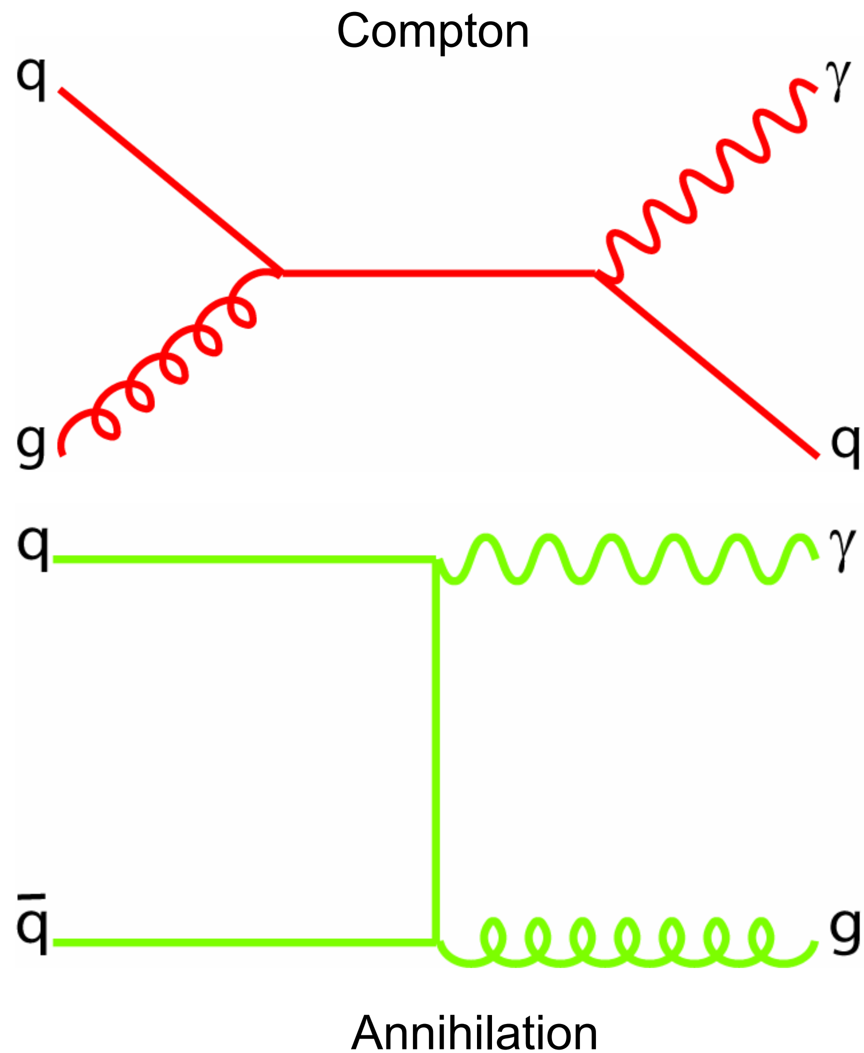
Compton dominates for low p_T^γ

- $p_T^\gamma < 120$ GeV

Probe PDFs at low x (x~0.007)

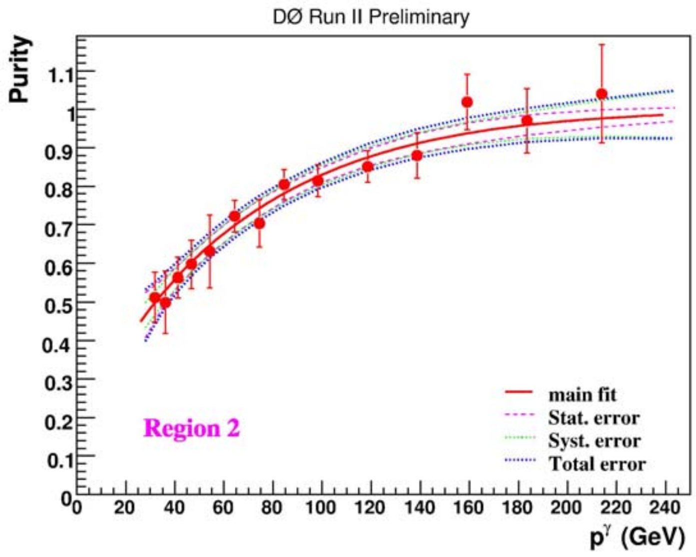
- Sensitive to gluon density

Tests of NLO pQCD



Also some contributions from fragmentation

Photon+jet: Photons



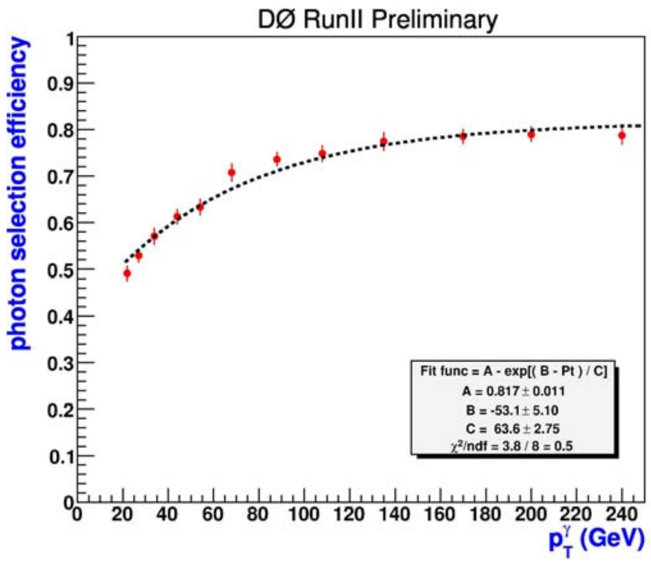
Require isolated EM shower in calorimeter

Shower profile consistent with e/gamma

No associated track

Isolated from jets

$\Delta R(\gamma,\mathrm{jet}) > 0.7$



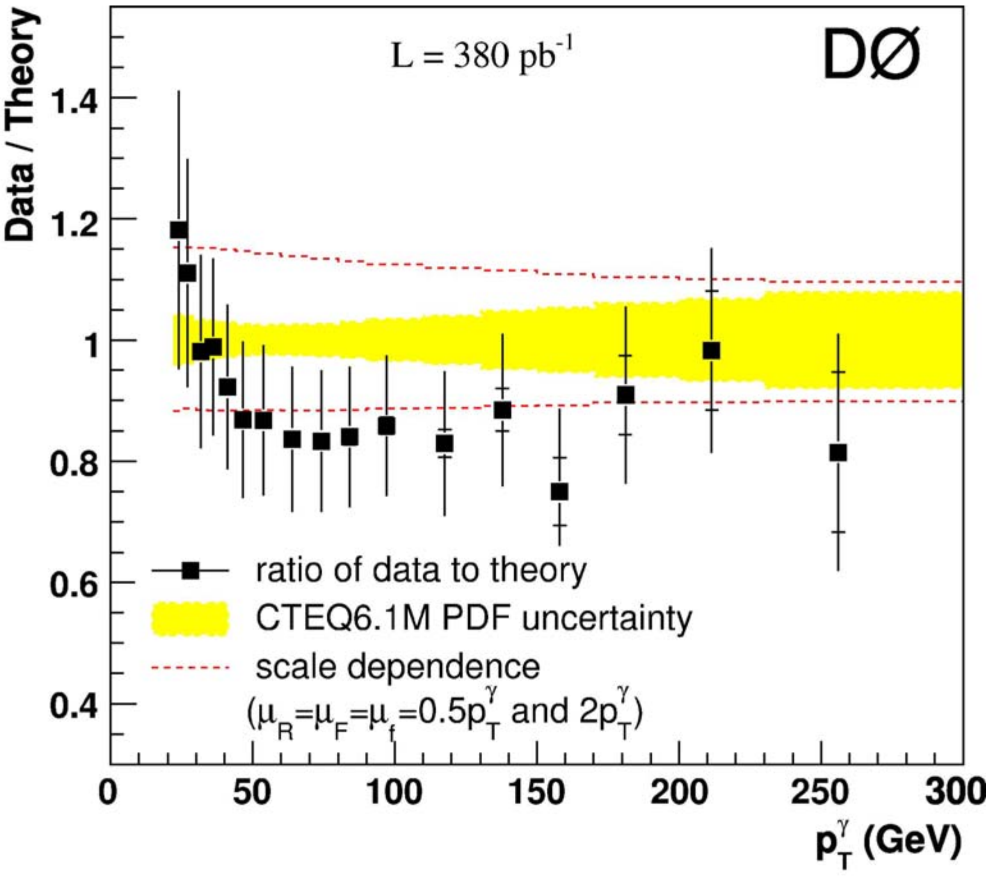
Backgrounds from: π^0,η, etc + mis-identified em-like jets

Suppressed using neural network

Reject cosmics and $W \rightarrow e\nu$ with sliding ET_{miss}< cut

Photon+jet : Previous Result

Phys. Lett. B 639, 151 (2006)



Data/theory consistent within errors but shape similar to former observations (UA2, CDF)

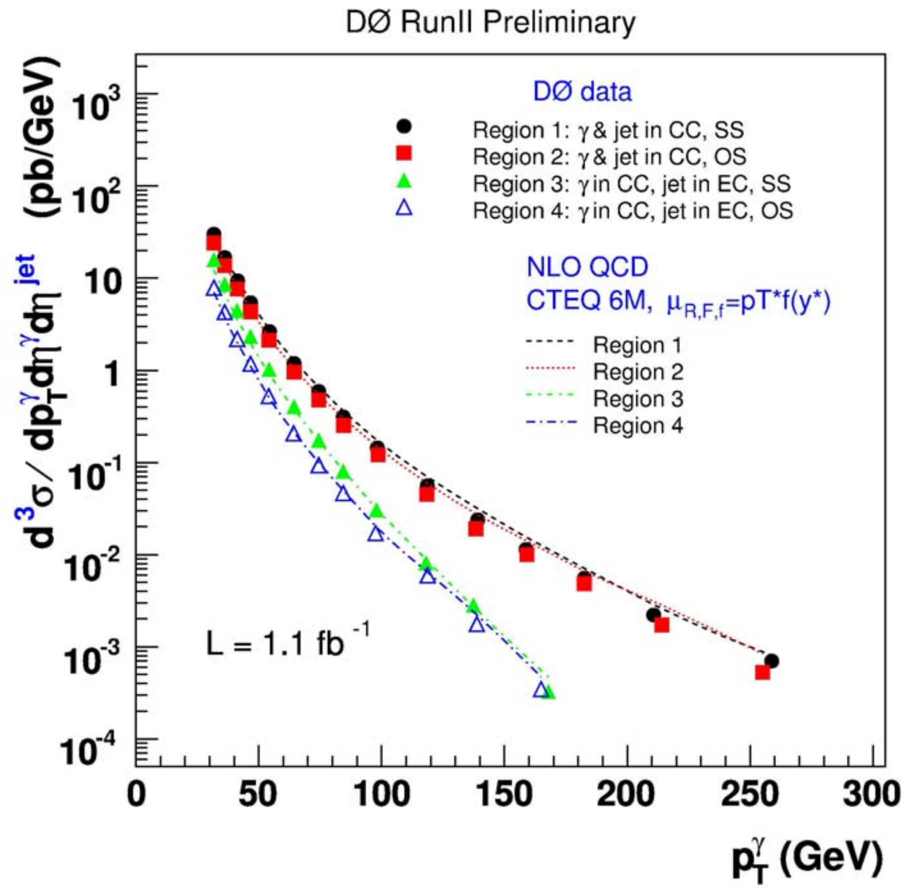
Triple Differential Cross-section

Data divided into 4 regions by pt and η

Total of 2.41M events

1. 34.4 % $0<\eta_\gamma<1$, $0<\eta_j<0.8$
2. 30.2% $0<\eta_\gamma<1$, $-0.8<\eta_j<0$
3. 20.1% $-1<\eta_\gamma<0$, $0<\eta_j<0.8$
4. 13.3 % $-1<\eta_\gamma<0$, $-0.8<\eta_j<0$

Analytical method used for unfolding of detector effects – resolution, E-scale etc.



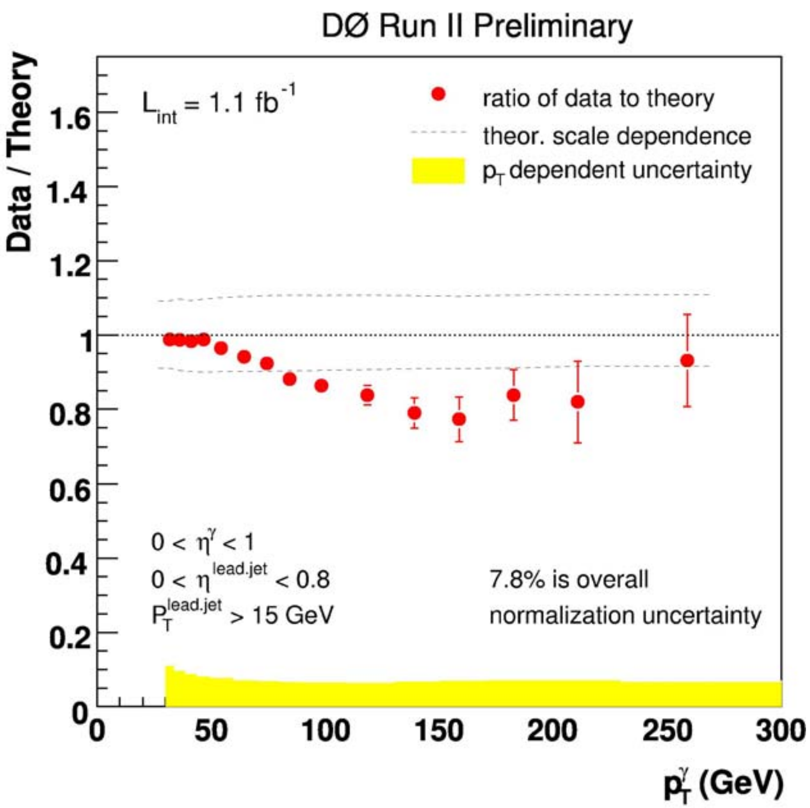
Statistical errors ~ 0.2% to 8% for R1 and R2 and ~ 20% for R3 and R4

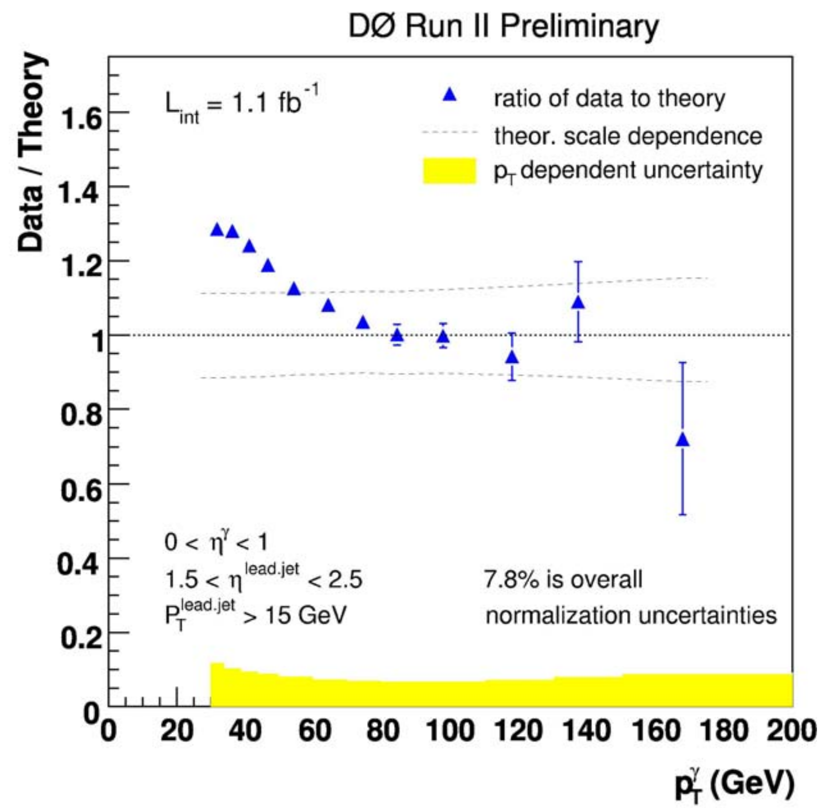
Systematics ~10-15%

NLO QCD curves from JetPhox with CTEQ6.1M PDFs

Photon+jet: theory vs data

Deviation from theory for p_T^γ > 100 GeV for central jets (SS)





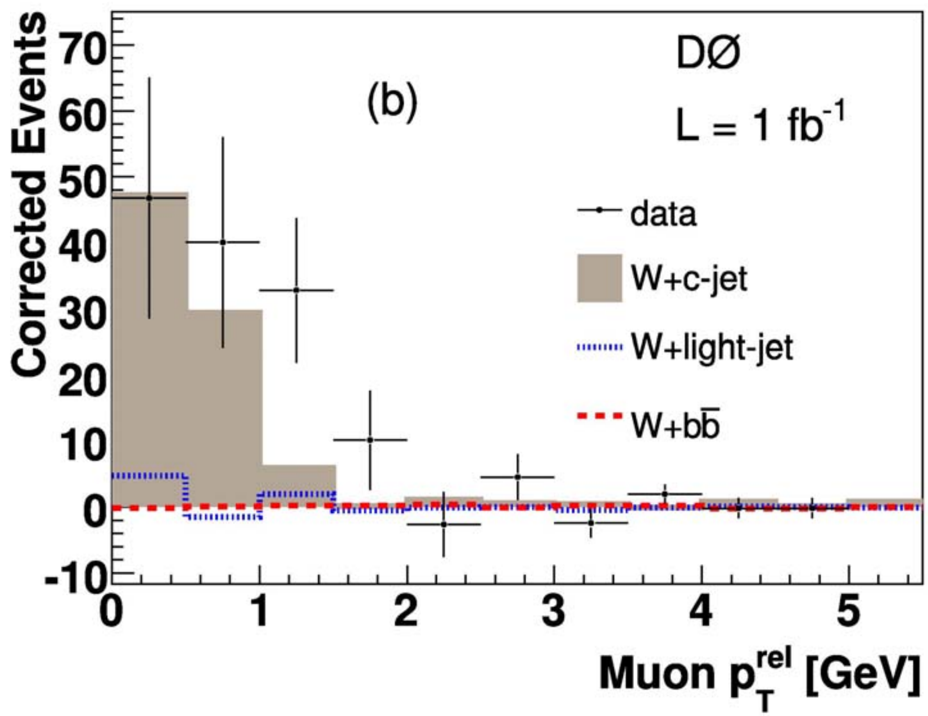
Deviation from theory for p_T^γ <50 GeV for forward jets (SS)

Cannot be accomodated simultaneously across all regions by scale variations

σ(W+charm) / σ(W+jets)

Provides direct sensitivity to strange quark PDF at high Q^2

Can also be sensitive to new physics beyond the SM



Measure ratio to inclusive W+jets:

Cancel many experimental and theoretical uncertainties

Luminosity, jet energy scale, efficiencies, renormalisation and factorisation scales

σ(W+charm) / σ(W+jets)

hep-ex/0803.2259 Submitted to PRL

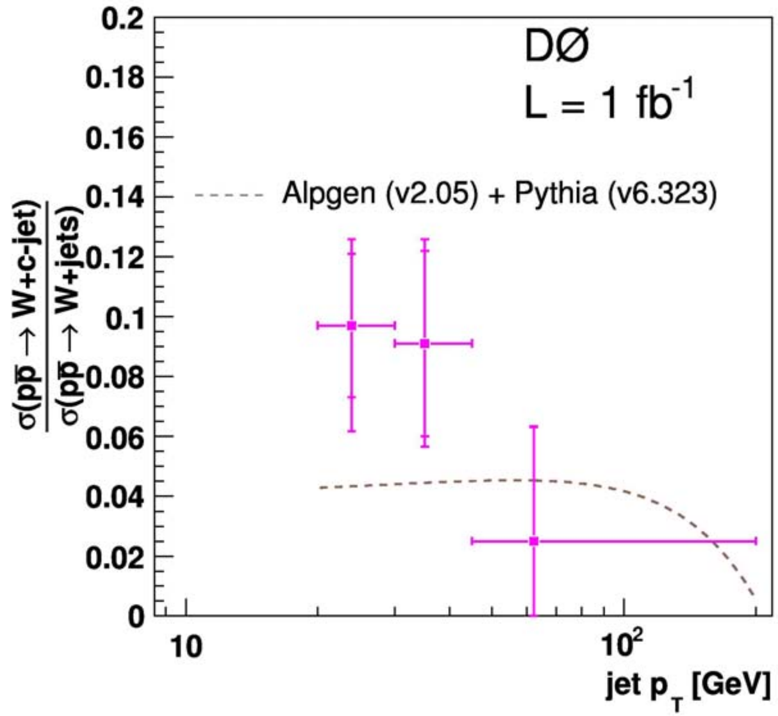
W selected by requiring

- high pt electron or muon
- large missing E_T

Jets from mid-point cone algorithm (R=0.5)

Charm candidates from muons in jets

- charge correlation between charm and W → estimate backgrounds



Measured W+c fraction in inclusive W+j sample: $0.074 \pm 0.019_{(stat)} + 0.012 - 0.014_{(syst)}$

Agrees with theoretical prediction and corresponds to 3.5σ significance

Summary

Results which can be used in global parton fits

- Z rapidity
- W Charge asymmetry
- Inclusive Jets

Example of two more results which could in the future provide PDF constraints

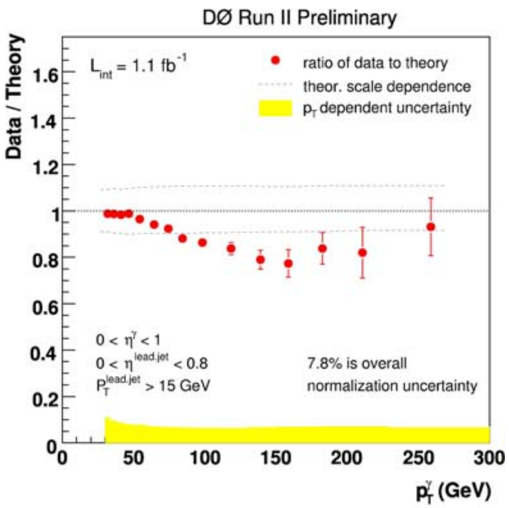
- Inclusive photon+jets
  - Once variation of theory from data is understood
- σ(W+charm) / σ(W+jets)
  - When further statistics allow improved results

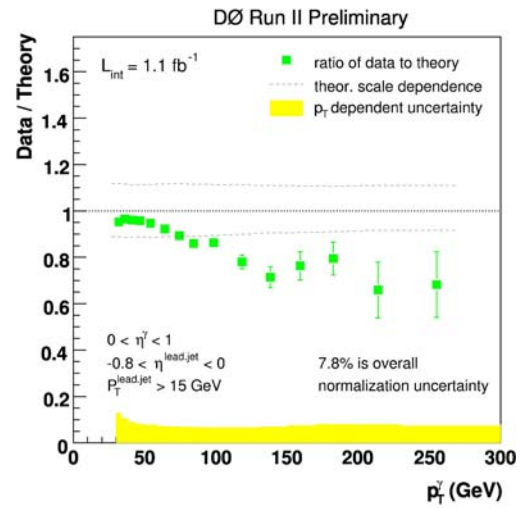
Results shown use between 0.3fb^{-1} and 1.1fb^{-1}

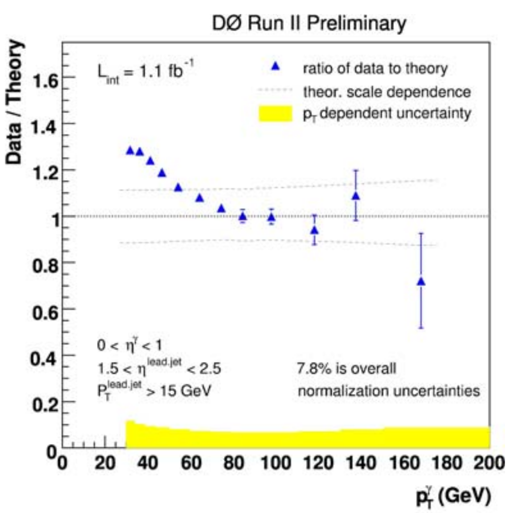
- >3fb^{-1} on tape
- Double that expected by end of Run-II

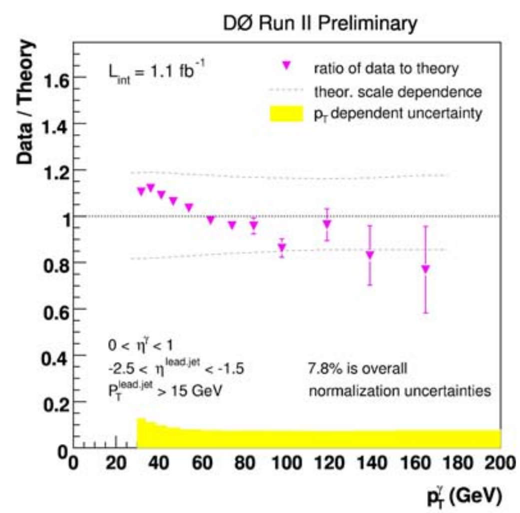
Plenty to come in the future

Backup slides


DØ Run II Preliminary
Data / Theory
L_{int} = 1.1 fb^{-1}
ratio of data to theory
theor. scale dependence
p_T dependent uncertainty
0 < η^{γ} < 1
0 < $\eta^{lead.jet}$ < 0.8
$P_T^{lead.jet}$ > 15 GeV
7.8% is overall
normalization uncertainty
p_T^{γ} (GeV)


DØ Run II Preliminary
Data / Theory
L_{int} = 1.1 fb^{-1}
ratio of data to theory
theor. scale dependence
p_T dependent uncertainty
0 < η^{γ} < 1
-0.8 < $\eta^{lead.jet}$ < 0
$P_T^{lead.jet}$ > 15 GeV
7.8% is overall
normalization uncertainty
p_T^{γ} (GeV)


DØ Run II Preliminary
Data / Theory
L_{int} = 1.1 fb^{-1}
ratio of data to theory
theor. scale dependence
p_T dependent uncertainty
0 < η^{γ} < 1
1.5 < $\eta^{lead.jet}$ < 2.5
$P_T^{lead.jet}$ > 15 GeV
7.8% is overall
normalization uncertainties
p_T^{γ} (GeV)


DØ Run II Preliminary
Data / Theory
L_{int} = 1.1 fb^{-1}
ratio of data to theory
theor. scale dependence
p_T dependent uncertainty
0 < η^{γ} < 1
-2.5 < $\eta^{lead.jet}$ < -1.5
$P_T^{lead.jet}$ > 15 GeV
7.8% is overall
normalization uncertainties
p_T^{γ} (GeV)