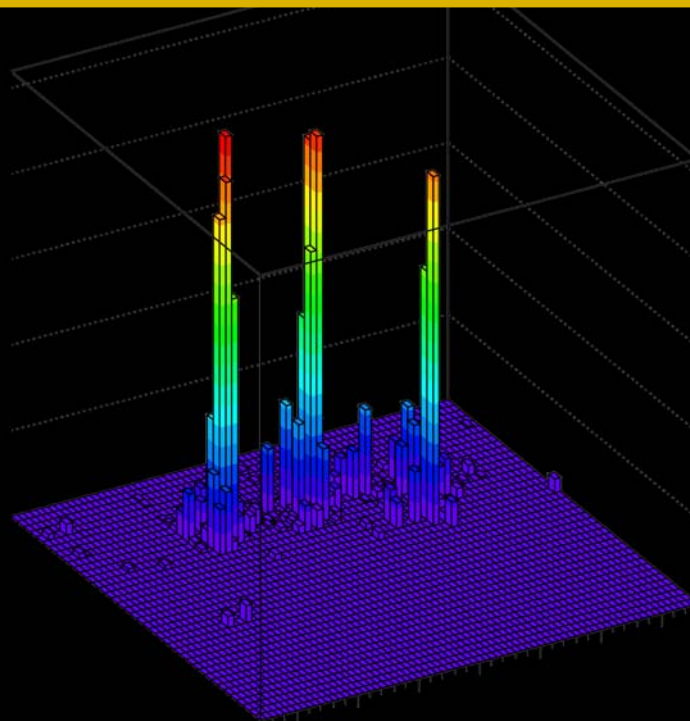
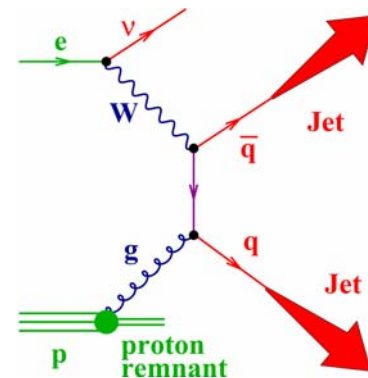
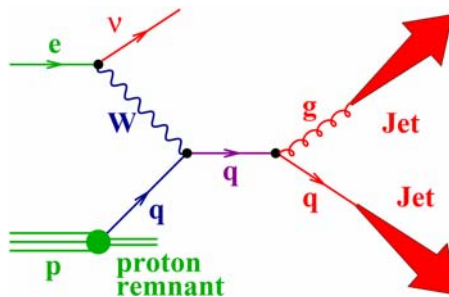
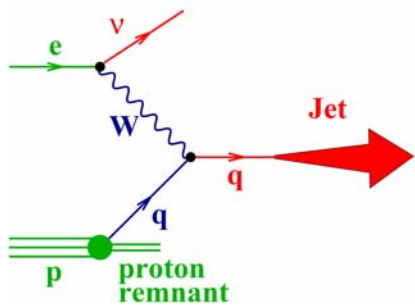


Multijet Production in CC ep Scattering With ZEUS at HERAII



**H. Wolfe, University of Wisconsin
on behalf of the ZEUS Collaboration
DIS07 17 April, 2007**

- **Jet production in CC DIS provides a testing ground for QCD and for the electroweak sector of the Standard Model, with statistics at high Q^2 and x comparable to NC DIS.**



- **CC Processes have previously been observed with ZEUS, both inclusively, and with jet production.**
 - α_s extracted from subjet multiplicity
 - W^{+-} boson mass
 - previous studies limited by statistics
- **This is the first time three-jet and four-jet events in CC observed!**

- **180pb⁻¹ HERAII e⁻p DATA**

- ($P_e = .27:106\text{pb}^{-1}$, $P_e = -.3:74\text{pb}^{-1}$)

- **Selection of CC events based on large p_T signature**

- **Phase space**

- $Q^2 > 200 \text{ GeV}^2$

- $y < .9$

- $E_T^{\text{jet}1} > 14\text{GeV}$ ($E_T^{\text{jet}2,3} > 5 \text{ GeV}$)

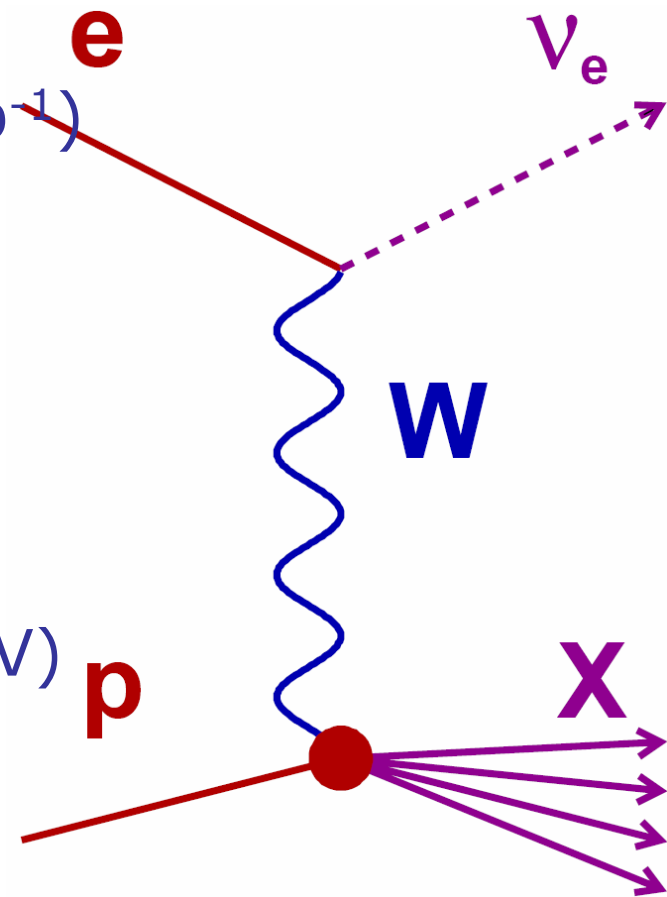
- $-1 < \eta_{\text{lab}} < 2.5$

- **Selected events**

- ~ 6000 Inclusive jet events

- ~ 900 Dijet events

- ~ 100 Three-jet events



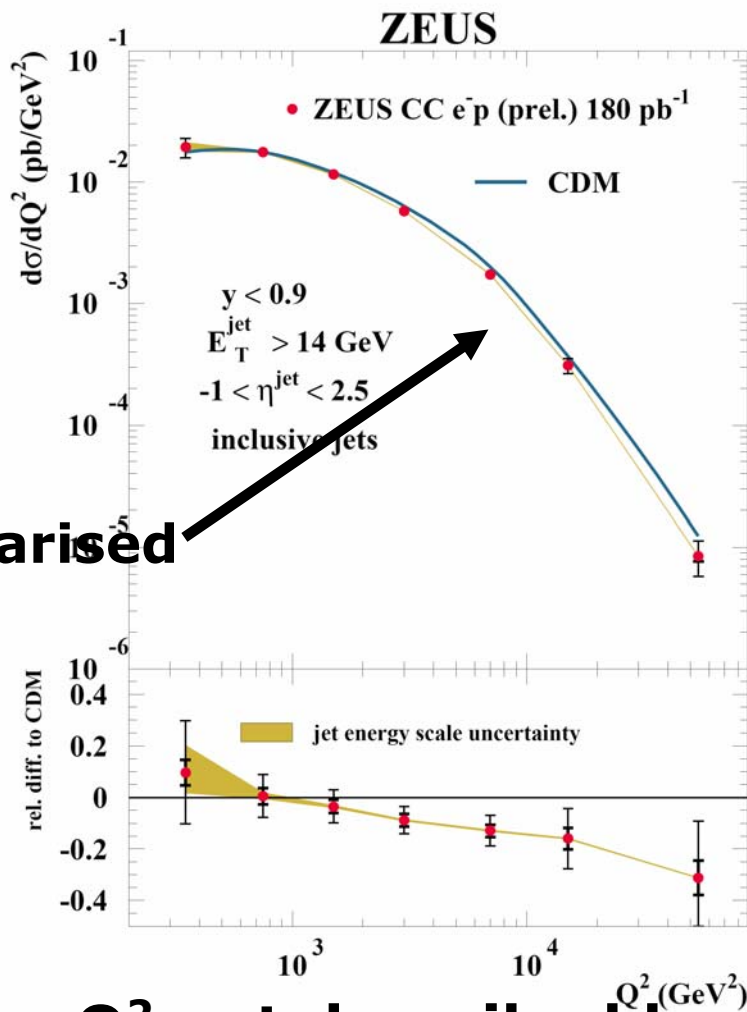
Interpolation to unpolarized:

$$(1-p) \sigma_0(e^-p) = \sigma_p(e^-p)$$

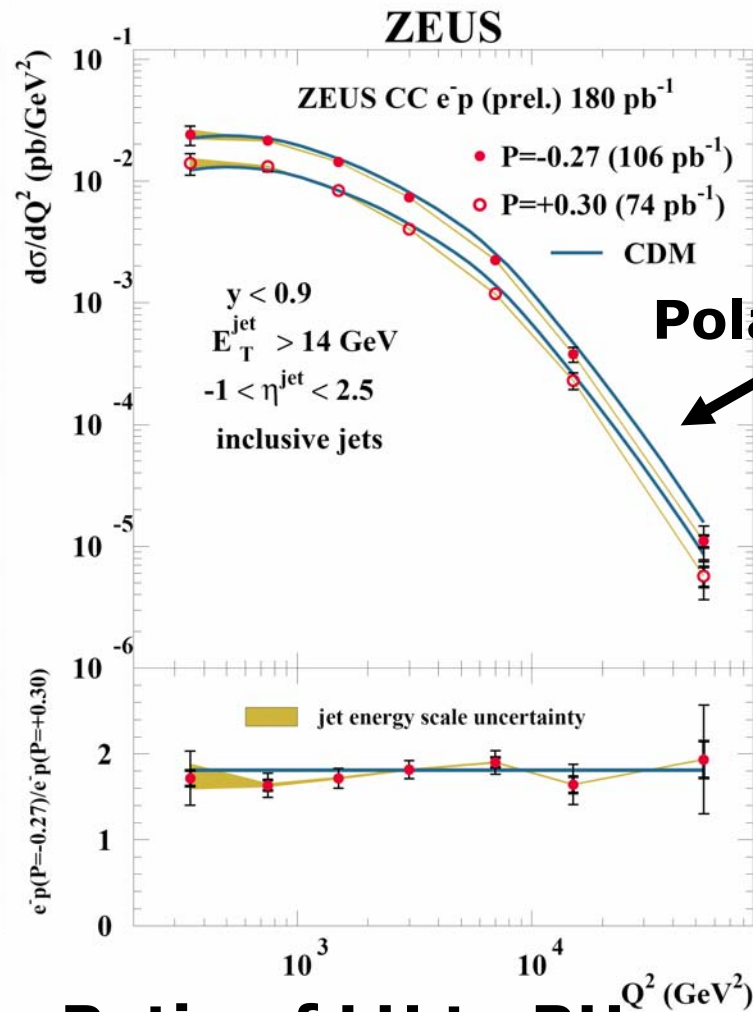
- **Monte Carlo (MC)**
 - CDM: ARIADNE
 - Color dipole model
 - Matrix elements leading order (LO) in α_s .
 - Three-jet events only from parton shower
 - Predicted di & three-jet cross sections low.
 - Luminosity: 6812.5pb^{-1} (unpolarised)
- **Systematic Errors**
 - Main sources of systematic error
 - Jet energy scale
 - Calorimeter energy scale
 - Photoproduction background
 - Systematic error effects on differential cross sections are smaller than statistical errors.



Inclusive Unpolarised and Polarised Q^2



Q^2 not described by LO MC above 2000 GeV^2

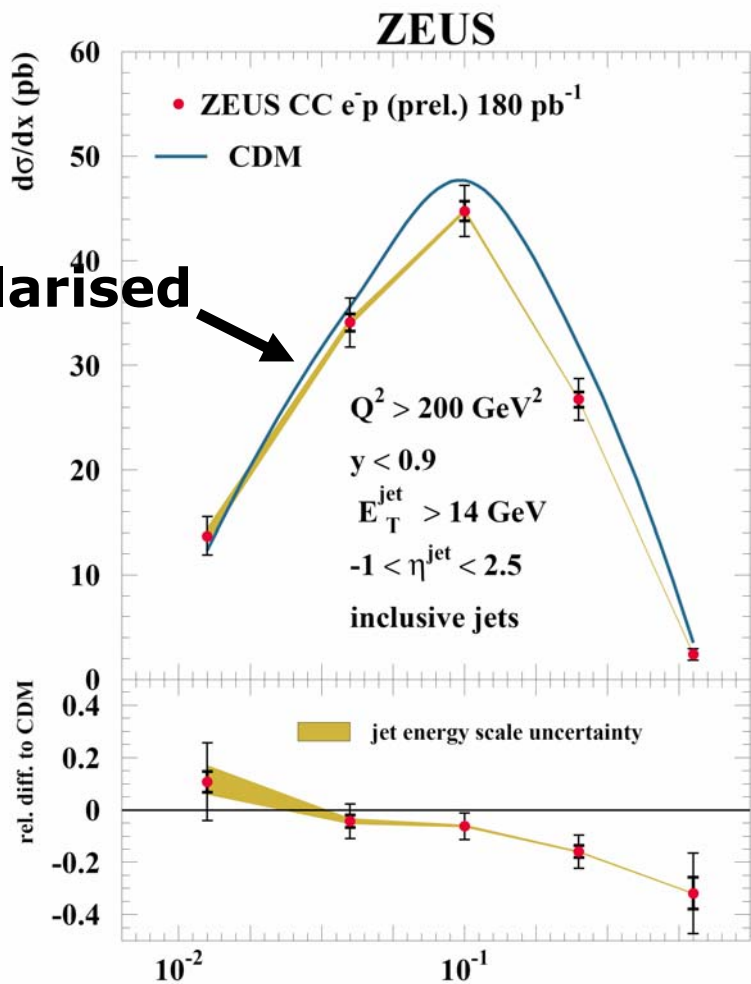


Ratio of LH to RH polarised cross sections agrees with SM



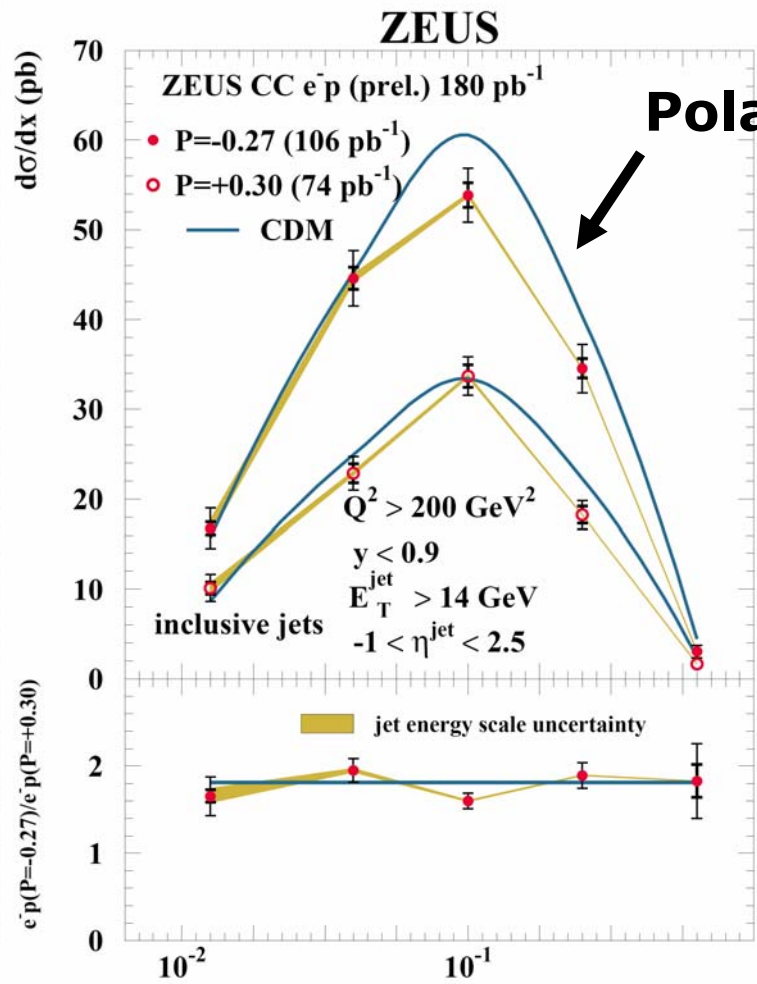
Inclusive Unpolarised and Polarised x_{JB}

Unpolarised



x not described by LO MC above .1

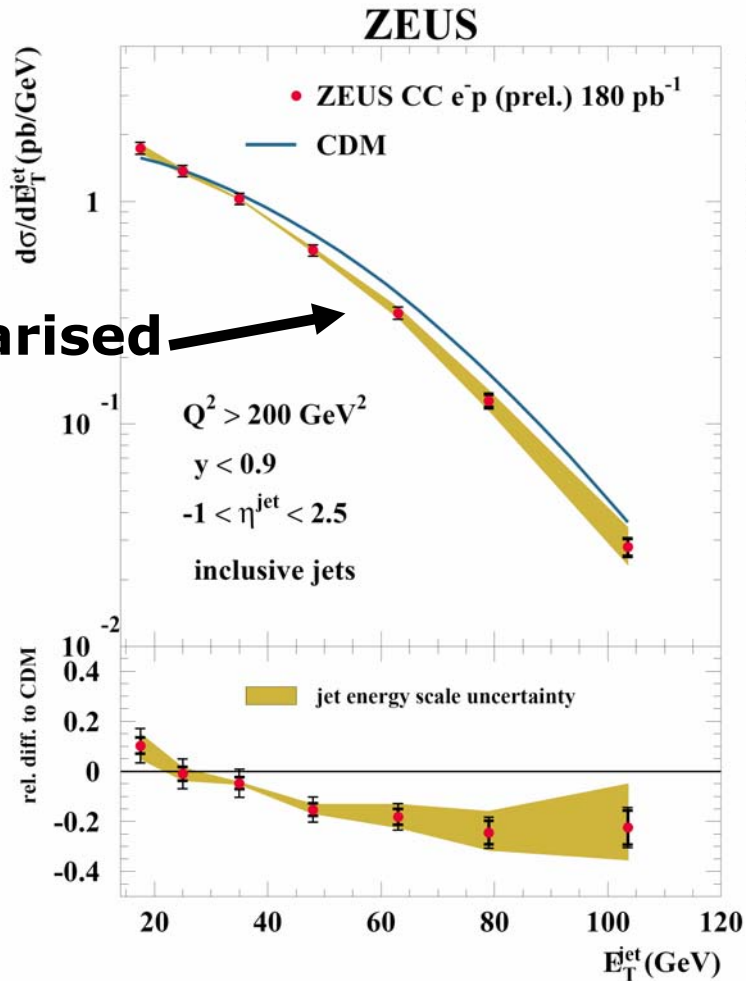
Polarised



Ratio of LH to RH polarised cross sections agrees with SM

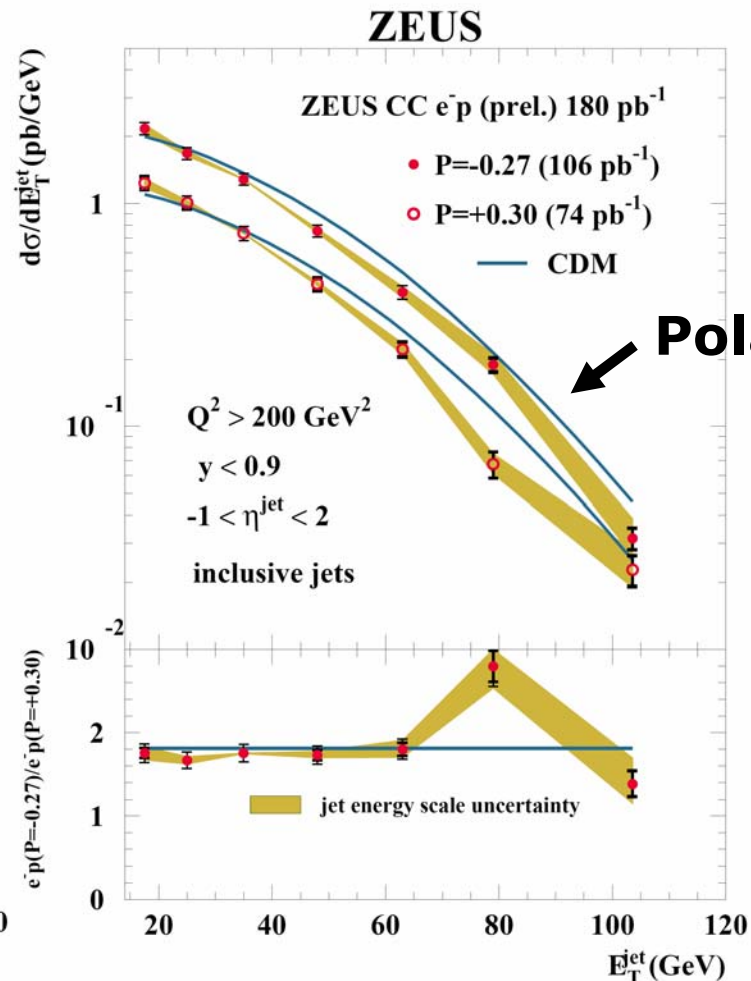


Inclusive Jet Unpolarised and Polarised Jet E_T



Unpolarised →

Slope of E_T not described by LO MC

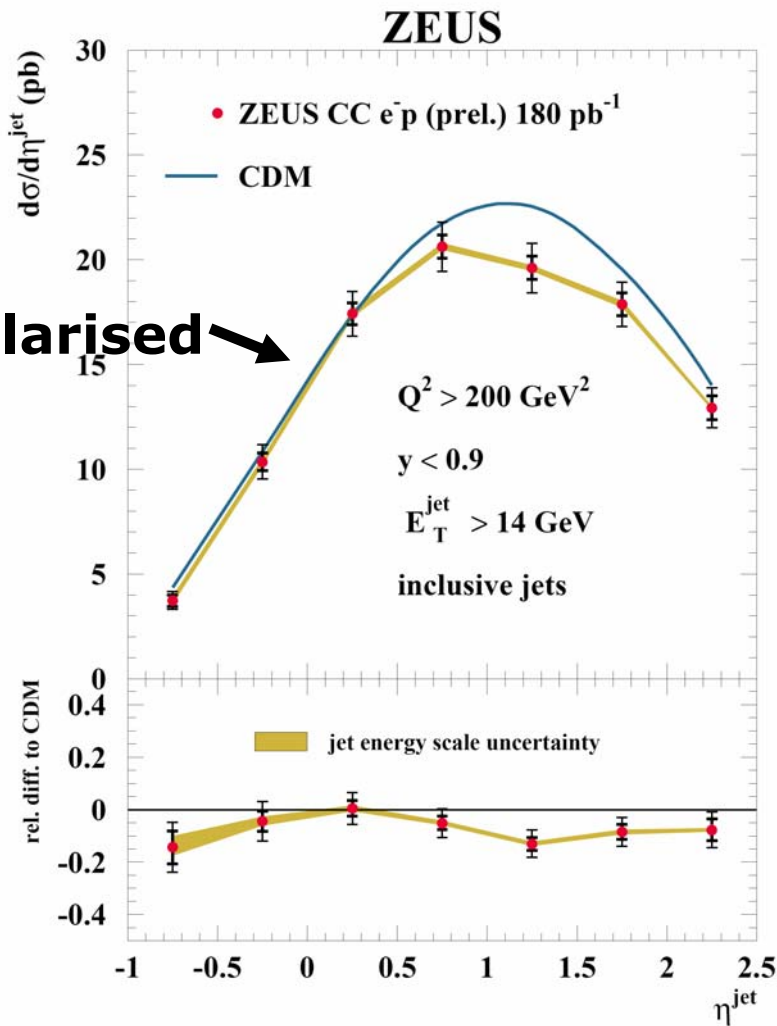


← **Polarised**

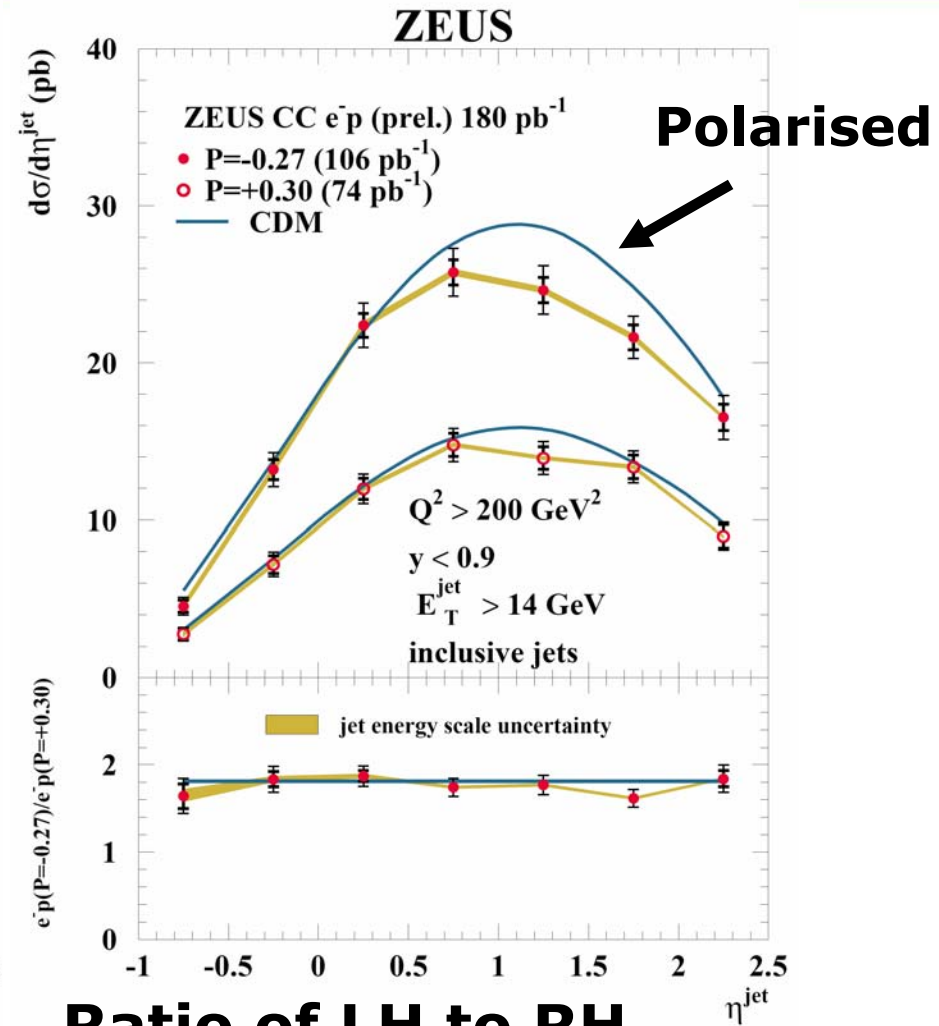
Ratio of LH to RH polarised cross sections agrees with SM



Inclusive Unpolarised and Polarised Jet η



Shape of η adequately described by LO MC.



Ratio of LH to RH polarised cross sections agrees with SM

Total Polarised Jet Cross Sections

$$Q^2 > 200 \text{ GeV}^2, y < .9, E_T > 14 \text{ GeV}, -1 < \eta_{\text{lab}} < 2.5$$

- Left Handed Polarisation

$$\begin{aligned}
 - \sigma_{\text{jets}}(P_e = -0.27) &= 64.42 \quad +/\text{-} 0.96 \text{ (stat.)} \\
 &\quad +/\text{-} 3.32 \text{ (syst.)} \\
 &\quad -0.55 \text{ } +0.62 \text{ (E}_{\text{scale}}) \text{ pb}
 \end{aligned}$$

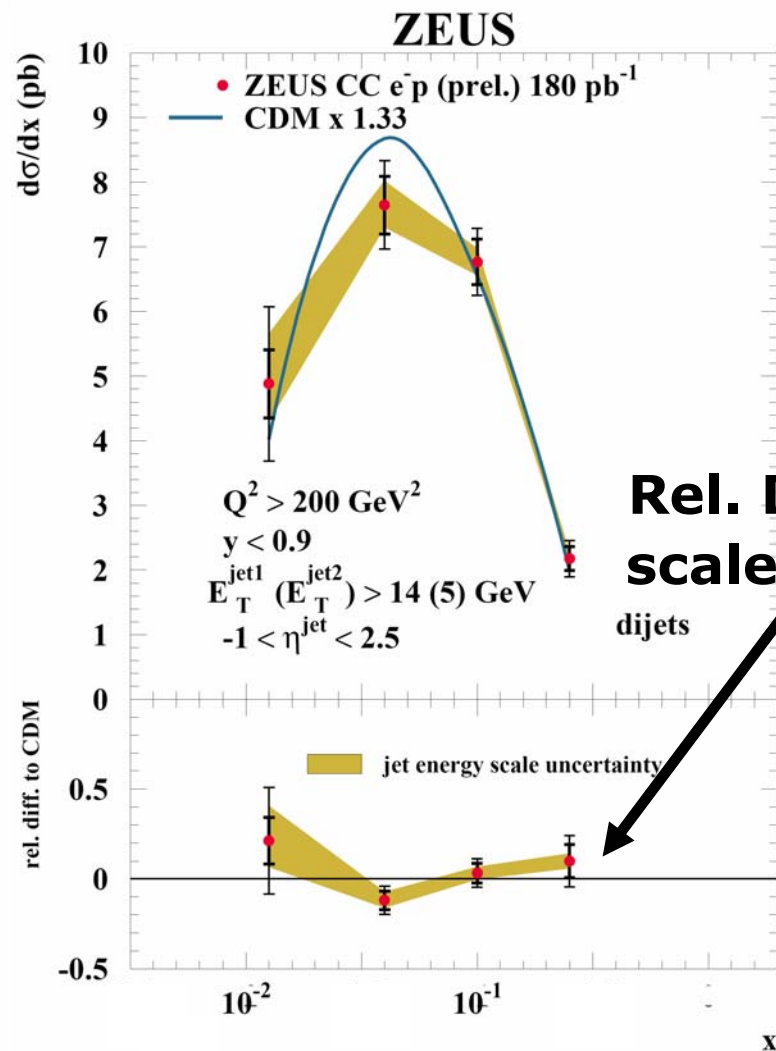
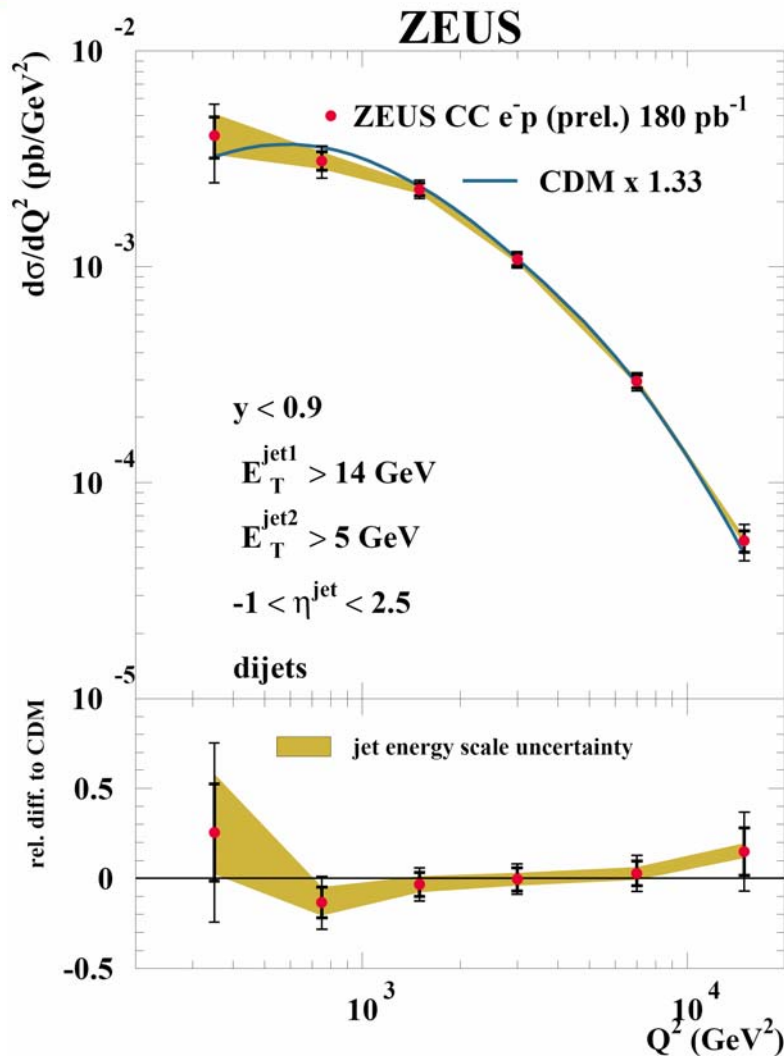
- Right Handed Polarisation

$$\begin{aligned}
 - \sigma_{\text{jets}}(P_e = +0.30) &= 36.58 \quad +/\text{-} 0.87 \text{ (stat.)} \\
 &\quad +/\text{-} 1.92 \text{ (syst.)} \\
 &\quad -0.31 \text{ } +0.35 \text{ (E}_{\text{scale}}) \text{ pb}
 \end{aligned}$$

- CDM predictions:

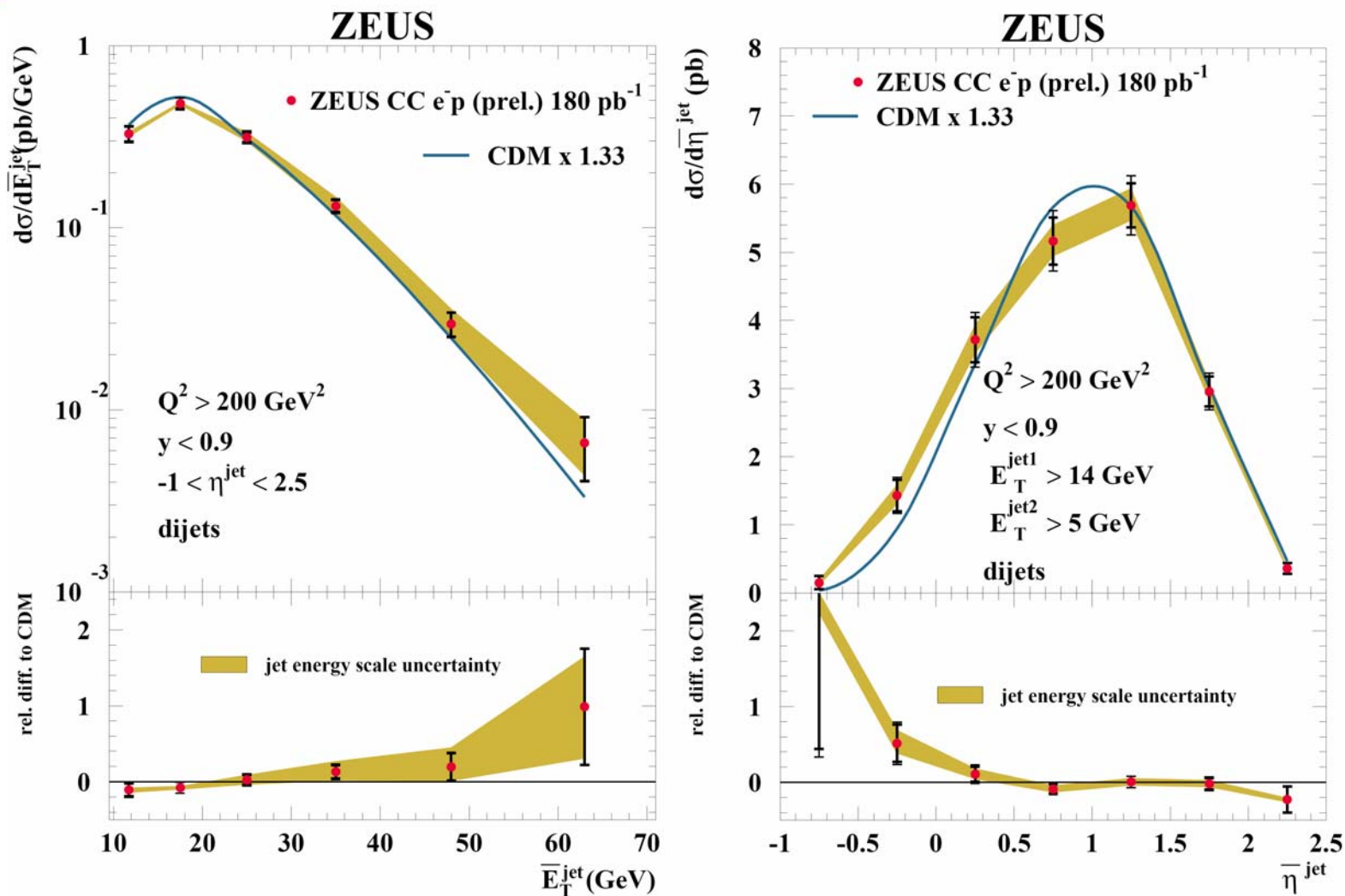
$$\begin{aligned}
 - \sigma_{\text{jets}}(P_e = -0.27) &= 70 \text{ pb} \\
 - \sigma_{\text{jets}}(P_e = +0.30) &= 39 \text{ pb}
 \end{aligned}$$

Measured total polarized inclusive jet cross sections agree with SM predictions.

Dijet Unpolarised Q^2 and x_{JB} 

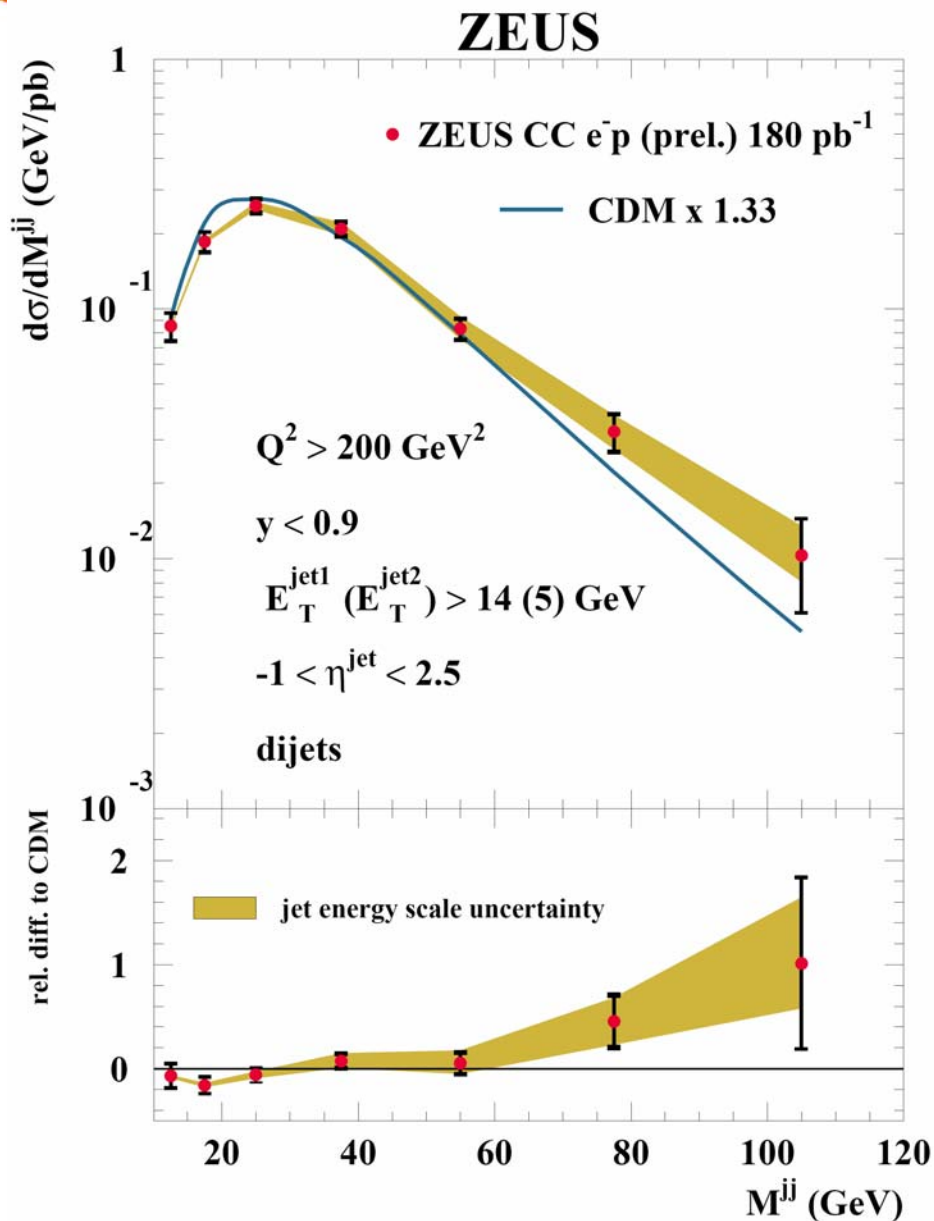
**CDM scaled by factor of 1.33 to total dijet data cross section.
 Differential cross sections are described by scaled LO MC.**

Dijet Unpolarised Mean Jet E_T and Mean Jet η



**CDM scaled by factor of 1.33 to total dijet data cross section.
 Differential cross sections are not described by LO MC.**

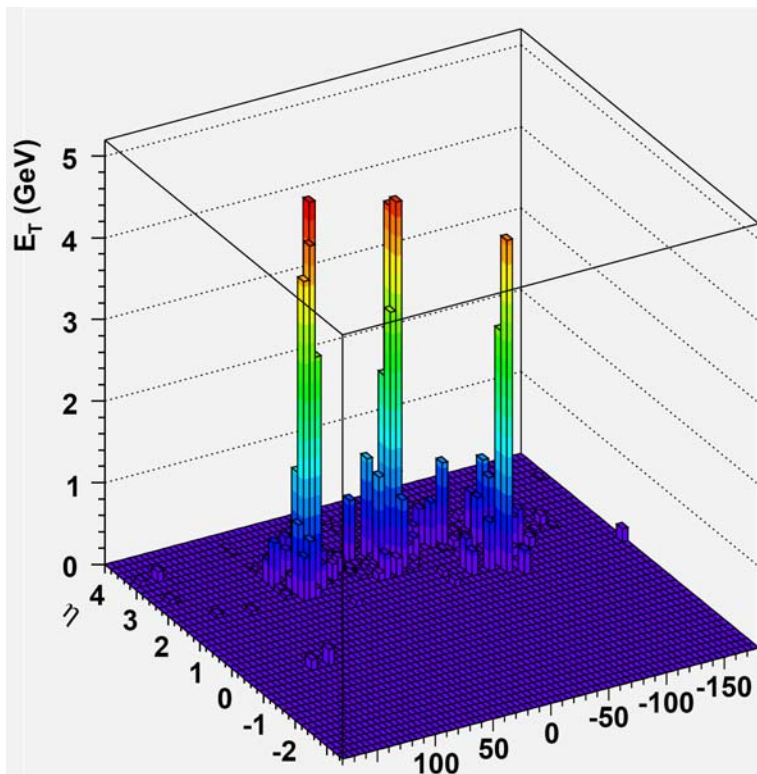
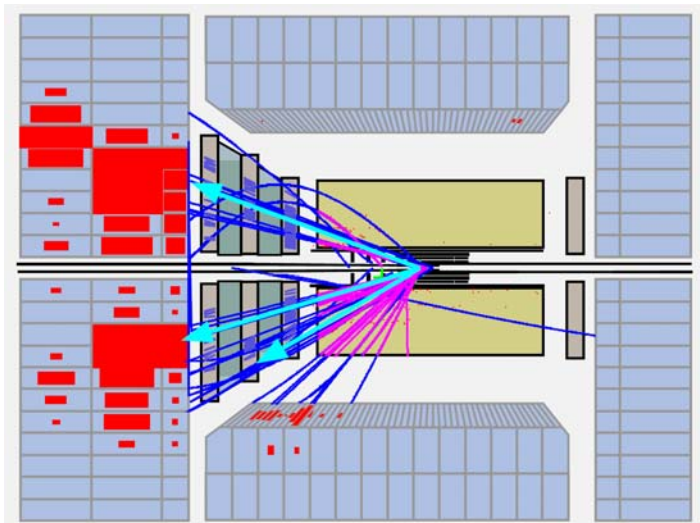
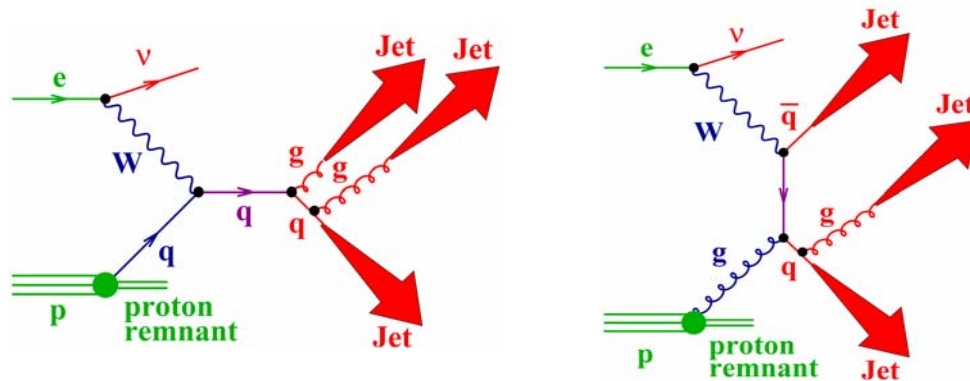
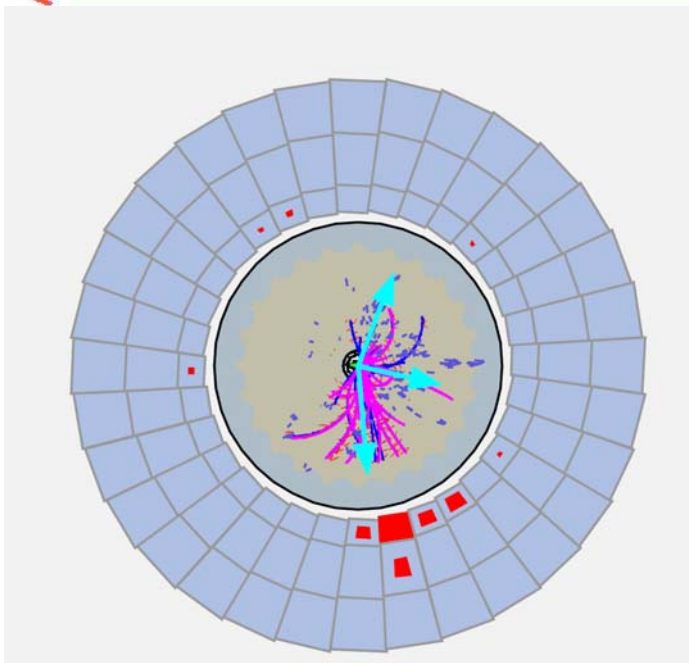
Dijet Unpolarised Invariant Jet Mass



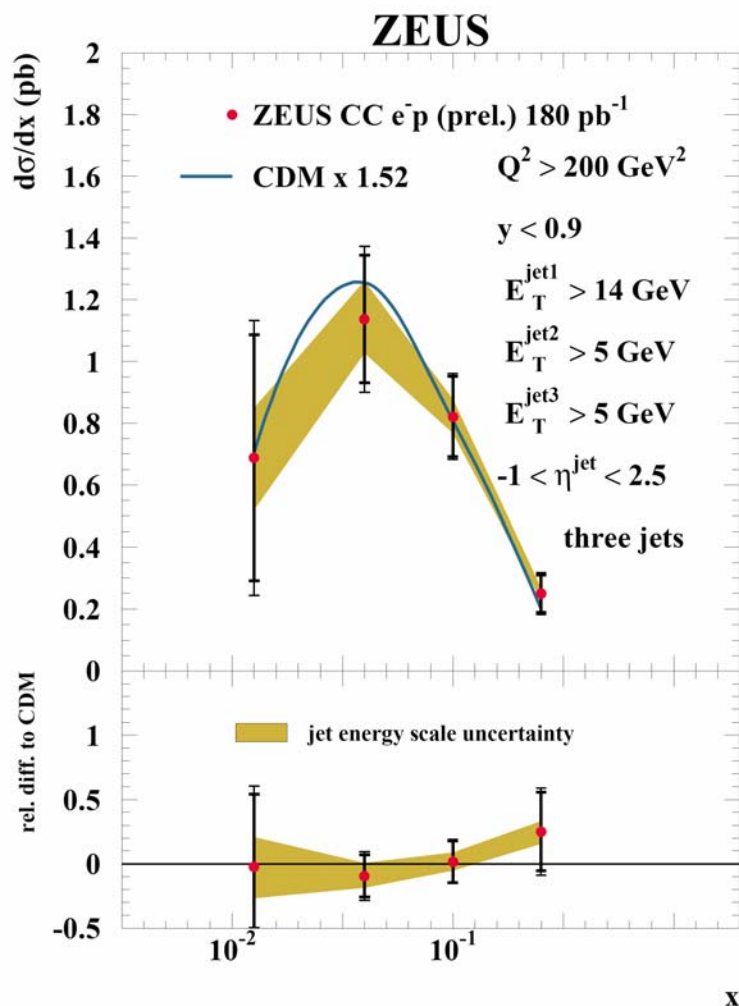
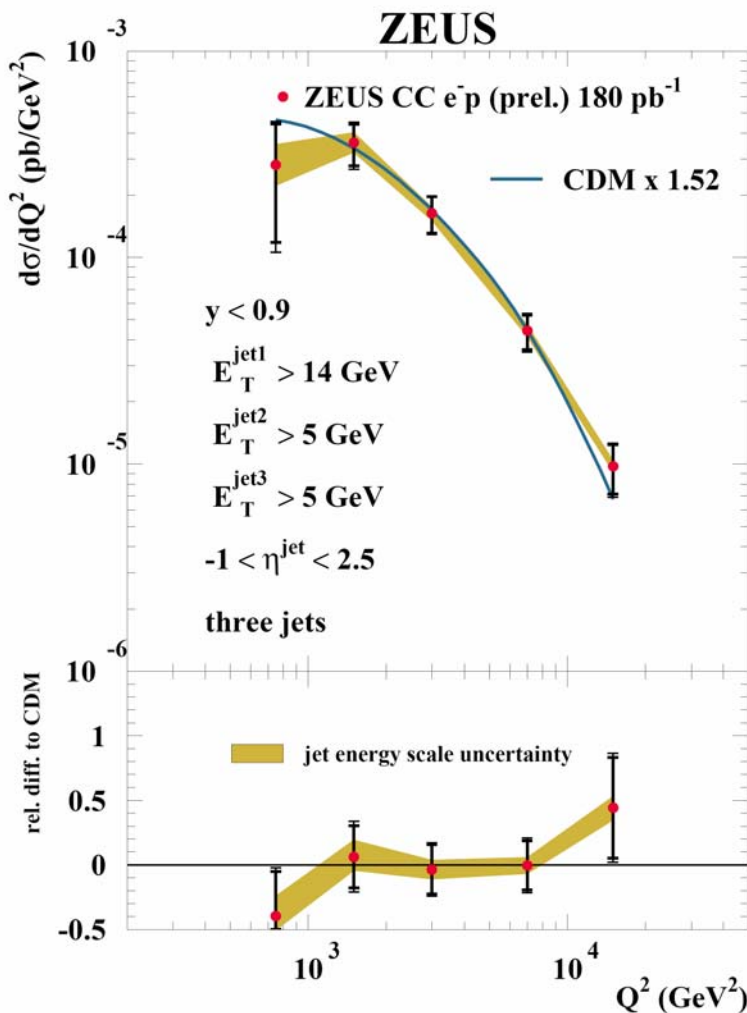
CDM scaled by factor of 1.33 to total dijet data cross section.

LO MC shows tendency to be below Data at large invariant mass

A First Look at CC Three-Jet Events!

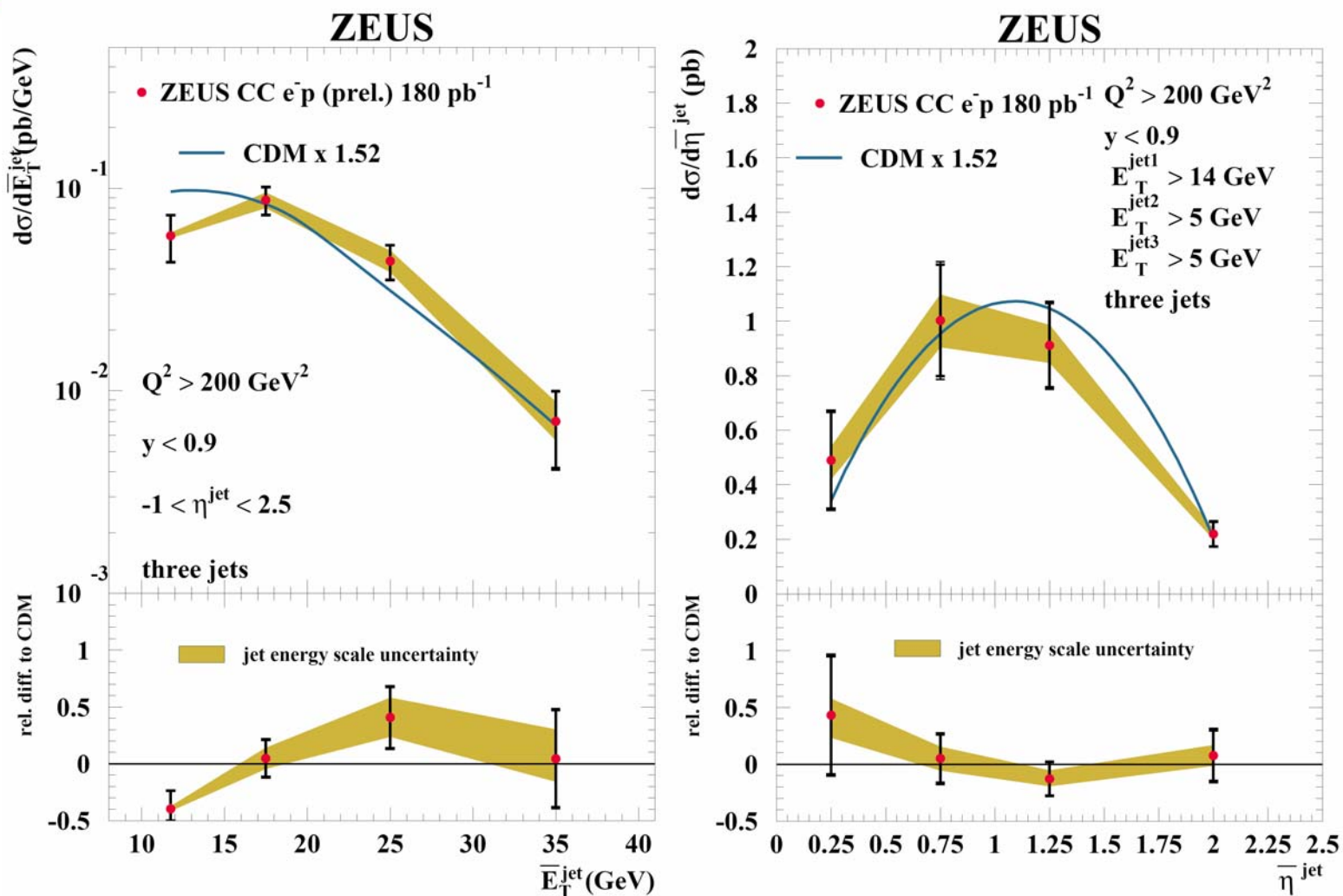


Three-jet Unpolarised Q^2 , x_{JB}



CDM scaled by factor of 1.52 to total three-jet data cross section. Shape described by LO MC.

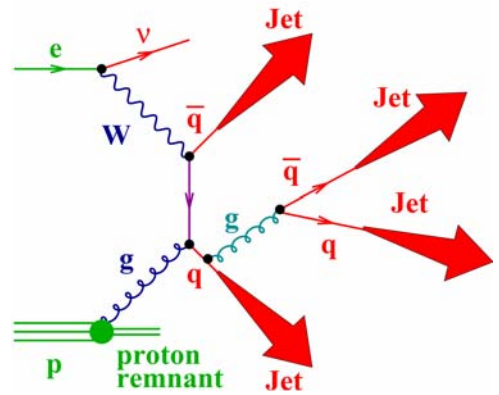
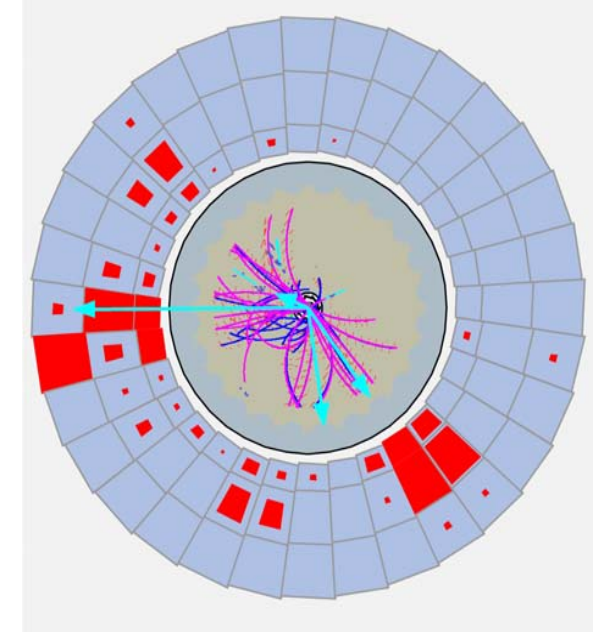
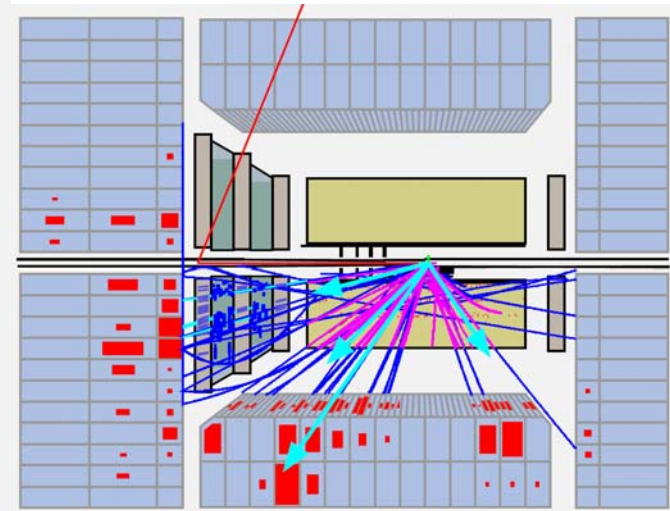
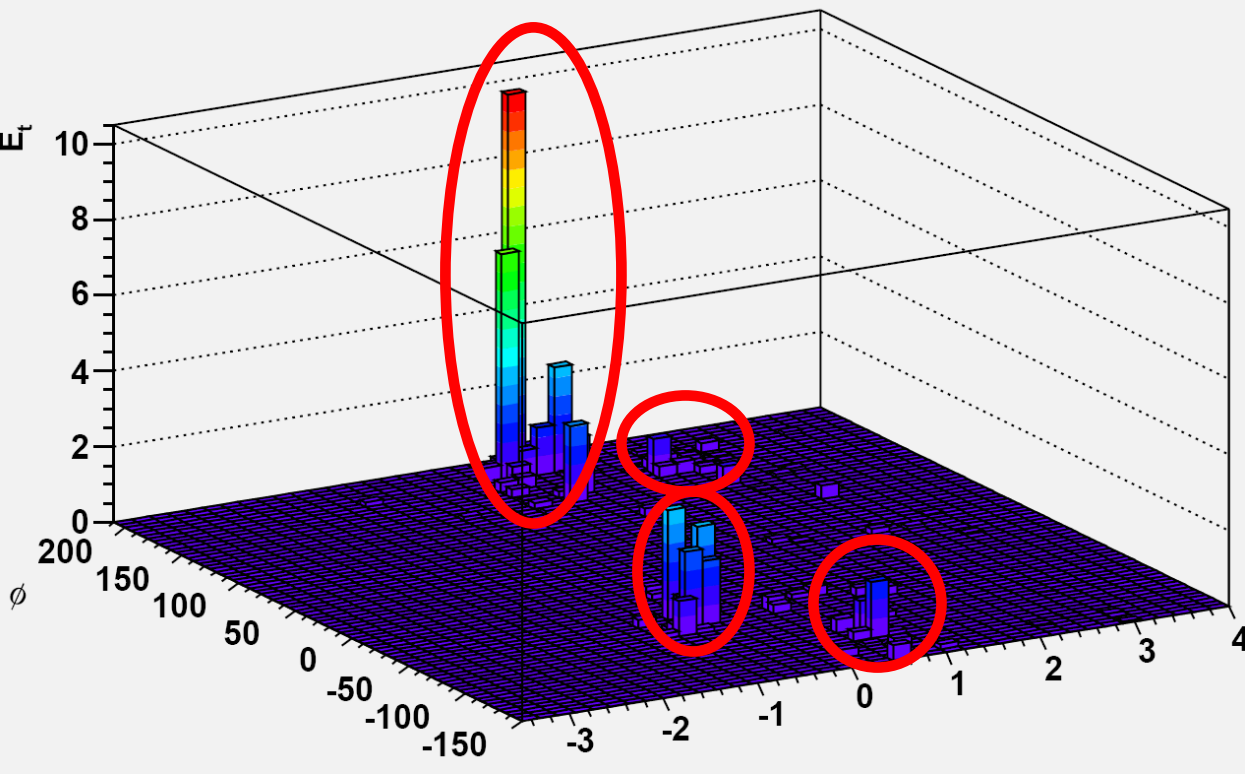
Three-jet Unpolarised Mean Jet E_T and Mean Jet η



CDM scaled by factor of 1.52 to total three-jet data cross section. Shape described by LO MC.



A First Look at CC FOUR-Jet Events!



Sample contains
6 CC four-jet
candidates!

- First CC e-p jet analysis of HERAII data at ZEUS, and the first observation of three-jet and four-jet events in CC DIS at HERA.
- Multijet cross sections measured for $Q^2 > 200 \text{ GeV}^2$, $y < .9$, $-1 < \eta_{\text{lab}} < 2.5$, where
 - $E_{\text{T}}^{\text{jet}} > 14 \text{ GeV}$ for inclusive jets
 - $E_{\text{T}}^{\text{jet}1} > 14 \text{ GeV}$, $E_{\text{T}}^{\text{jet}2} > 5 \text{ GeV}$ for dijets
 - $E_{\text{T}}^{\text{jet}1} > 14 \text{ GeV}$, $E_{\text{T}}^{\text{jet}2,3} > 5 \text{ GeV}$ for three-jets
- Measurements:
 - Total polarized inclusive jet cross sections agree with SM.
 - inclusive jets differential: shape not described by CDM
 - Seen in previous publications
 - dijets, three-jets differential: shape described by CDM, not normalisation
 - NLO is needed to describe normalisation of dijets and three-jets. Work on MEPJET is ongoing.