ZEUS results on large rapidity gap events in NC and CC DIS at high Q^2

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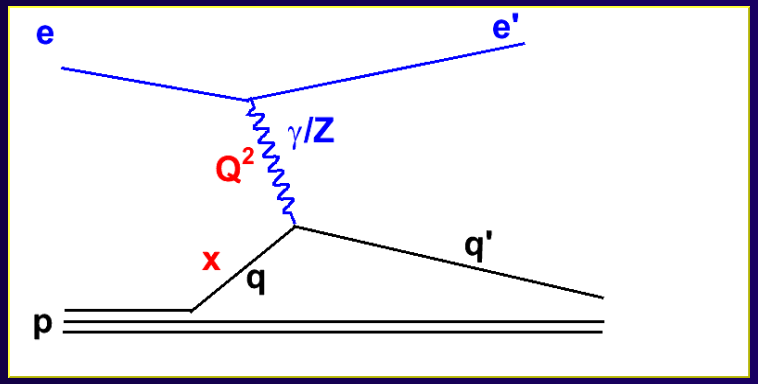
On behalf of the
ZEUS Collaboration

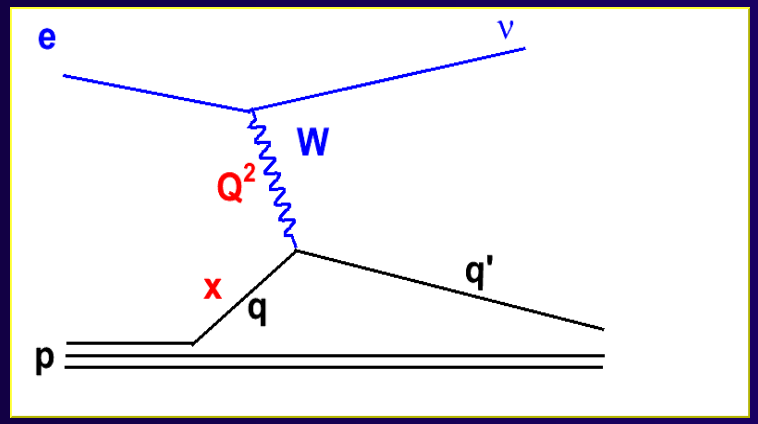
- Motivation
- MC models
- LRG selection
- Results

High Q^2 DIS

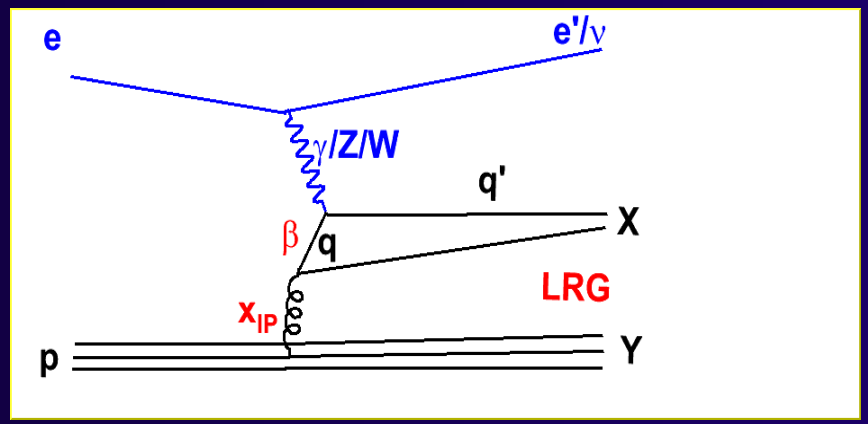
Neutral current



Charged current



Large Rapidity Gap events



Event topology

- NC
  electron with large transverse momentum in central detector
- CC
  neutrino carries away large transverse momentum

Kinematic variable:

- Q^2 – virtuality of the boson
- x – fraction of proton momentum carried by struck quark
- x_{IP} – fraction of proton momentum caried by diffractive exchange
- β – momentum fraction of the exchange carried by struck quark

Relation $x = x_{IP}\ \beta$

$$\sigma^{dif} = \sum_a \int \sigma^{\gamma/Z/W\ a} \otimes f_a^{dif}$$

Motivation

$$\sigma^{tot} = \sum_a \int \sigma^{\gamma/Z/W\ a} \otimes f_a$$

- Measure diffractive parton density functions (dPDF) of the proton at large scale ($200 < Q^2 < 2000\ GeV^2$). Important for predictions of diffractive production of large mass states in proton–proton collisions. For example diffractive Higgs (need dPDF at scale up to M_H^2)
- Compare NC and CC diffraction to test factorisation in hard diffractive scattering

NC	⇔	CC
mainly EM exchange	⇔	purely weak exchange
symmetric target $\gamma(u\bar{u}, d\bar{d}, s\bar{s})$	⇔	asymmetric target $W^+(u\bar{d}, c\bar{s})$

- Ratio $\sigma^{dif}/\sigma^{tot}$ sensitive to dPDF/PDF
  Is it independent of the target (NC vs. CC) ?

MC models

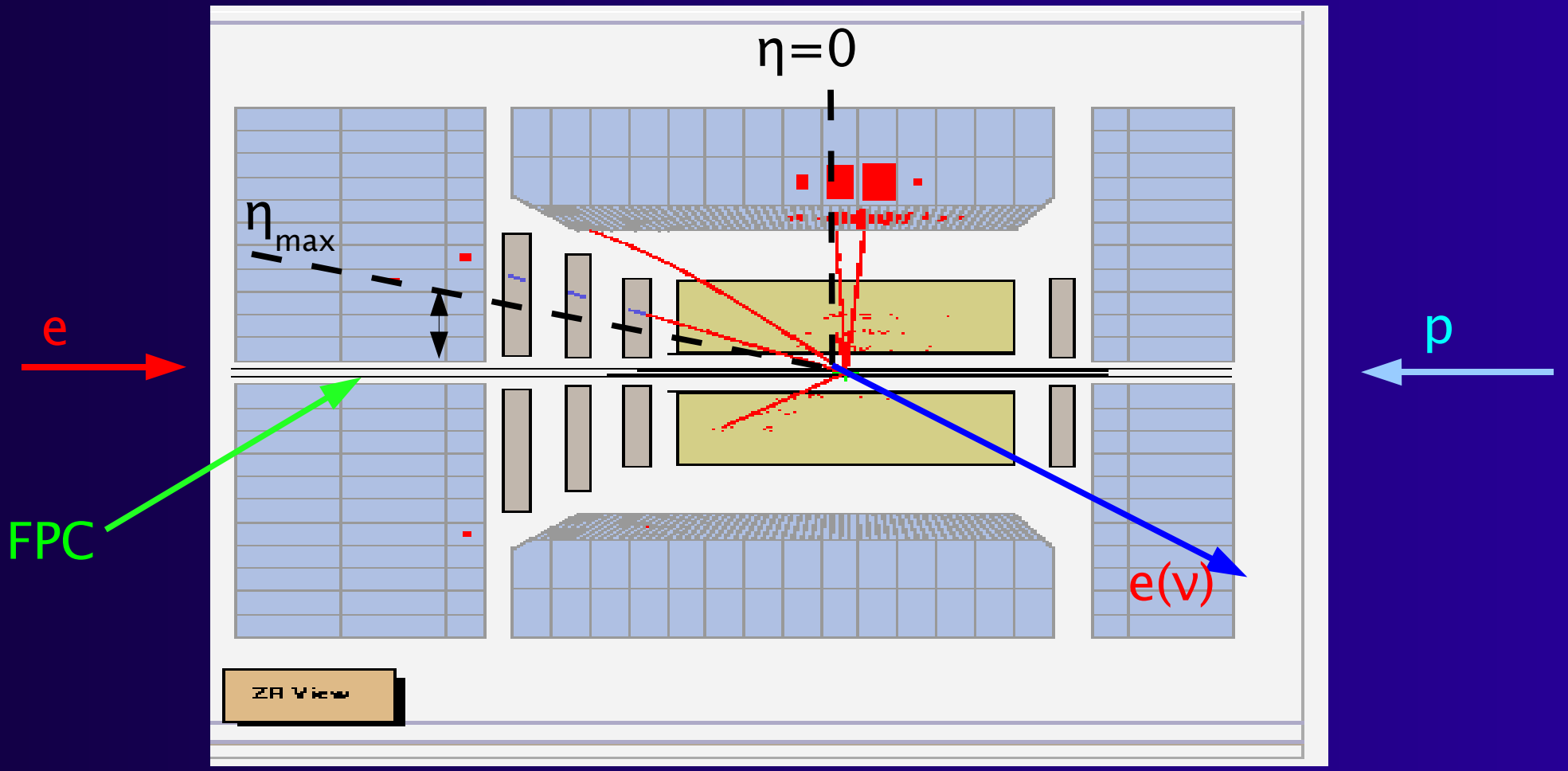
1. Mixture of DJANGOH interfaced with ARIADNE
   (colour dipole model) $e^+p \rightarrow e^+(\nu)\, X$
   and RAPGAP diffractive MC with H1 fit 2
   dPDF of the Pomeron $e^+p \rightarrow e^+(\nu)\, X\, p$

2. MEPS (parton shower) with SCI (soft colour interaction) mechanism. Alternative model to produce LRG topology.

LRG selection

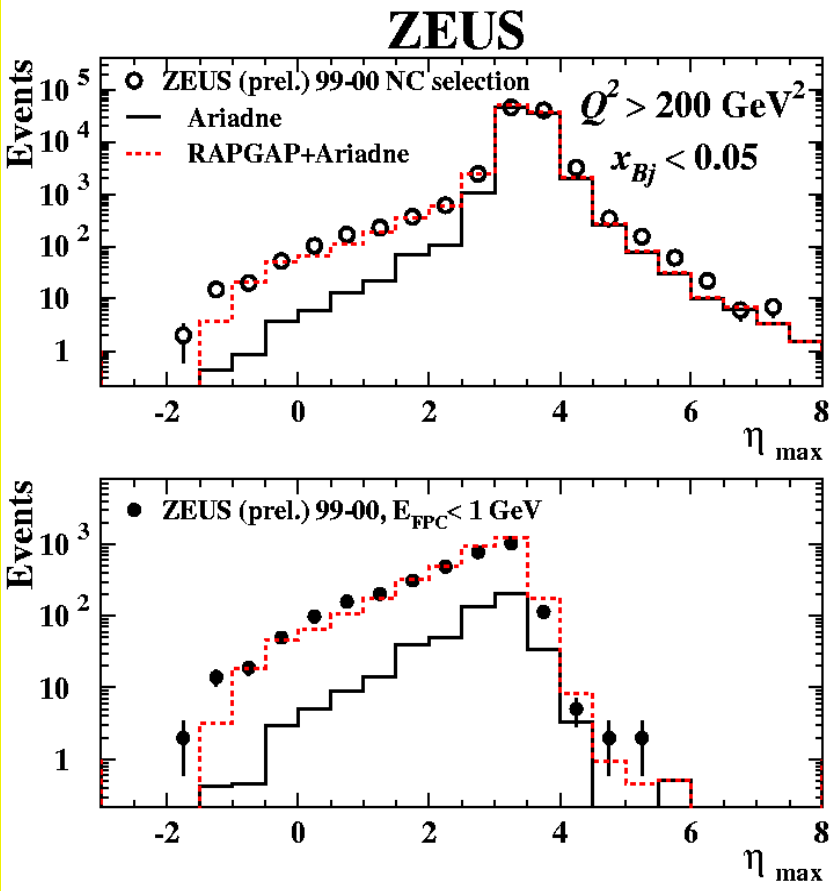
η_{max} – rapidity of most forward energy deposition in central detector $\eta<4$

Forward Plugin Calorimiter $4<\eta<5$



Rapidity gap: at least $4-\eta_{max}$ or with FPC veto $5-\eta_{max}$

NC



ARIADNE not sufficient to describe η_{max} distribution

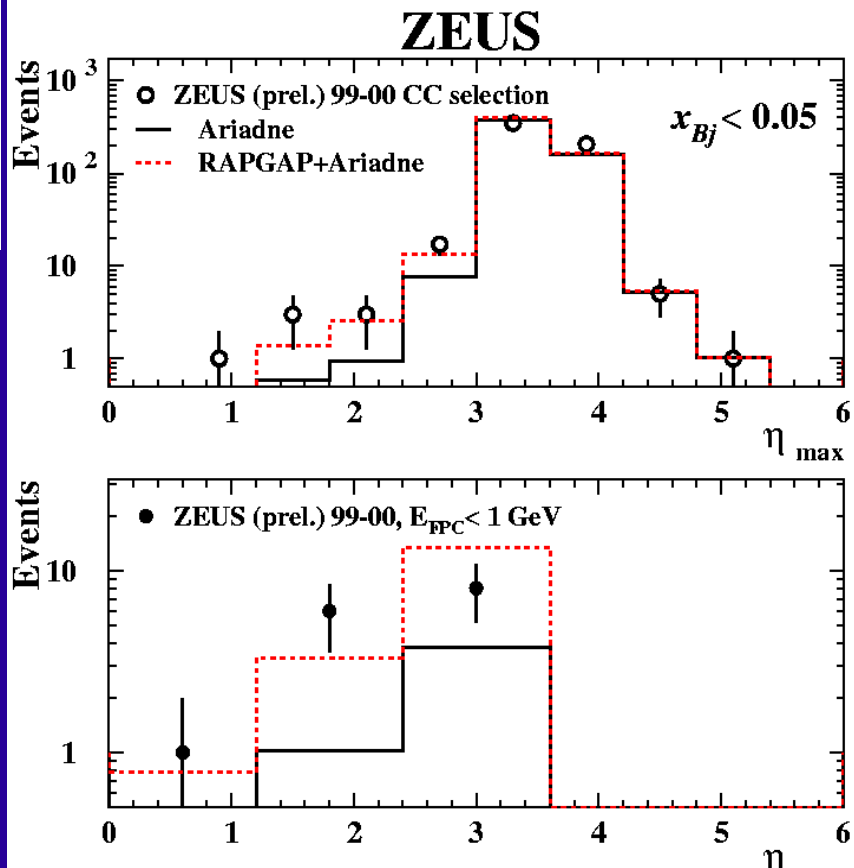
Use $E_{FPC} < 1$ GeV to suppress non-diffractive contribution

Good description of data using ARIADNE + RAPGAP

$\eta_{max} < 2.9$ && $E_{FPC} < 1$ GeV

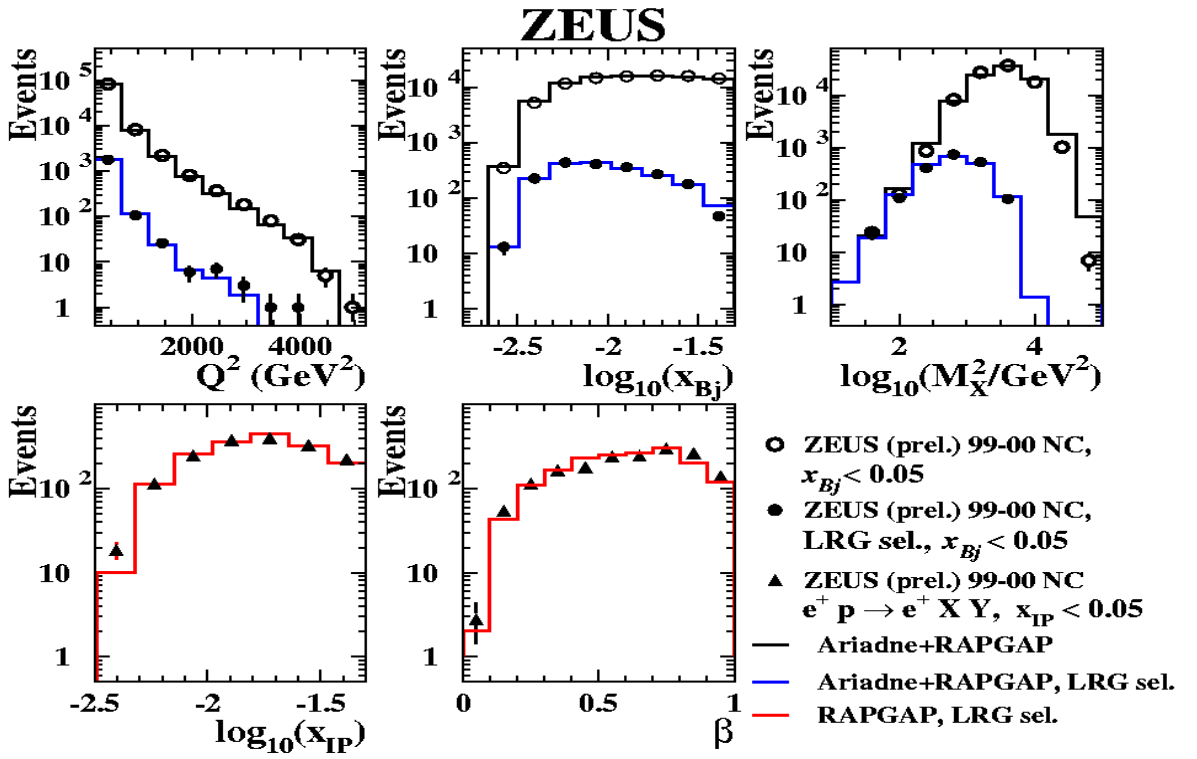
⇓

rapidity gap of at least 2 units (LRG selection)



CC

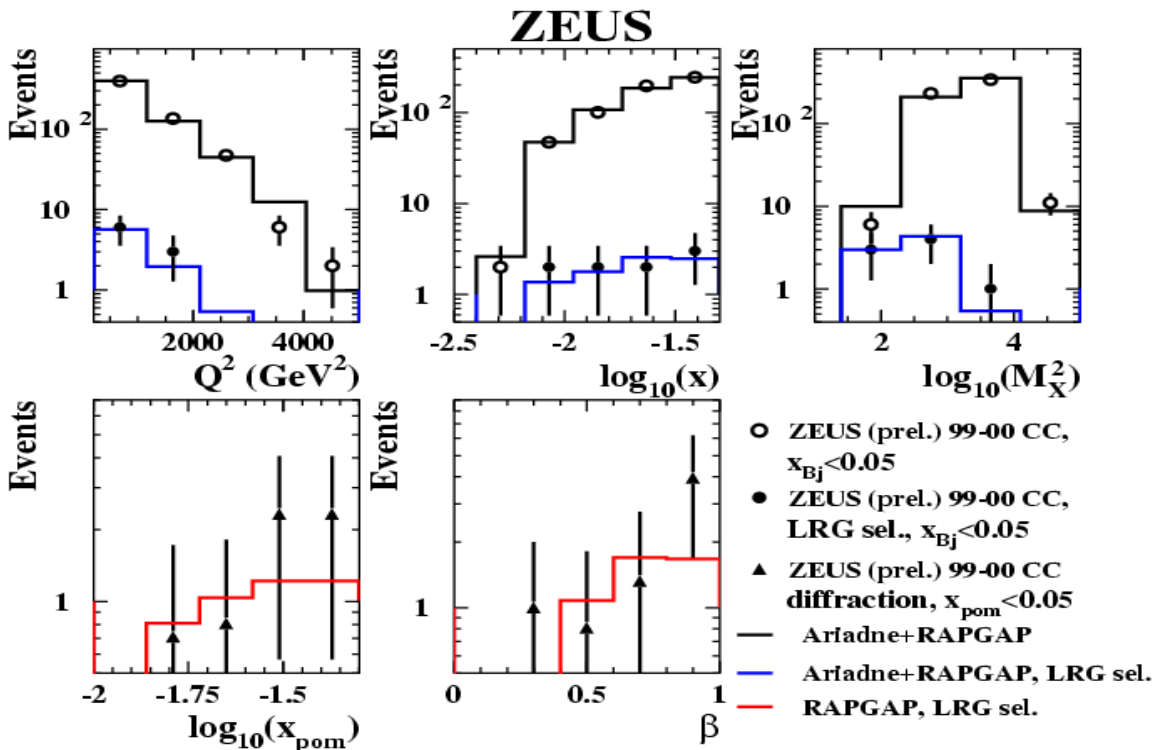
NC



ARIADNE + RAPGAP describes inclusive and LRG data well

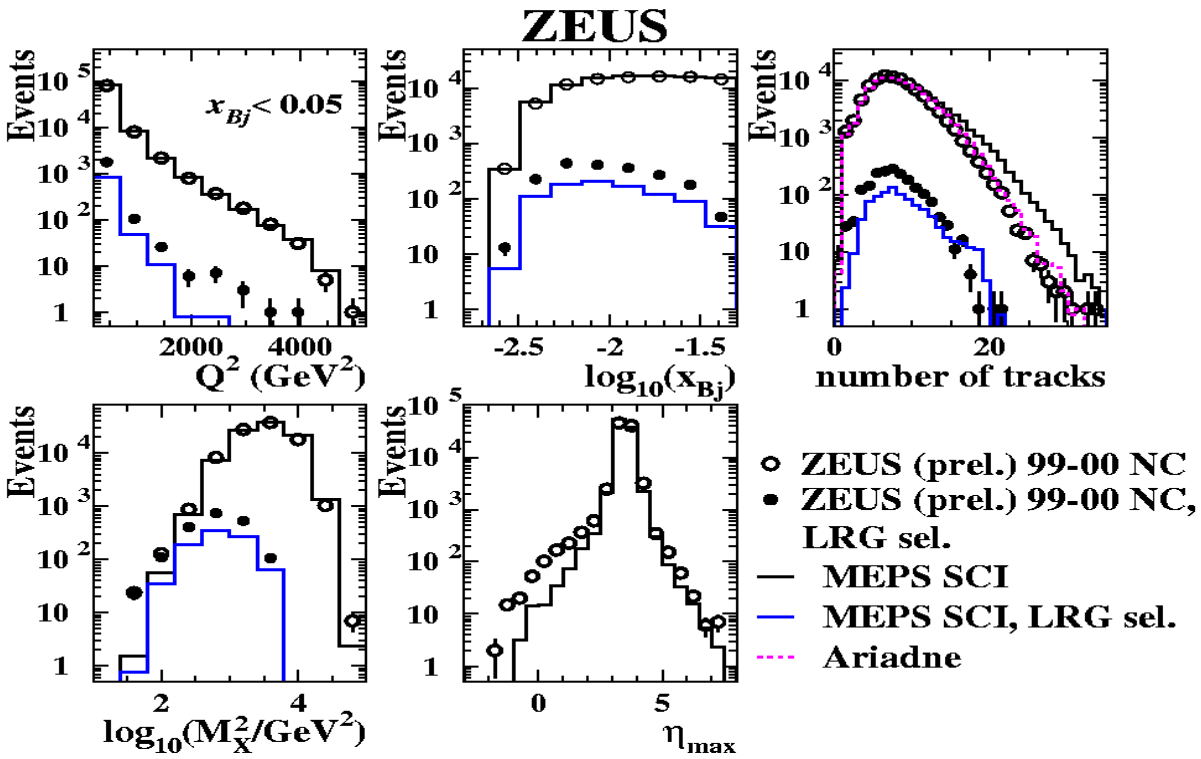
$e^+p \to e^+(\nu) X Y$ signal

obtained by subtracting non-diffractive ARIADNE & other bkg contributions



CC

NC



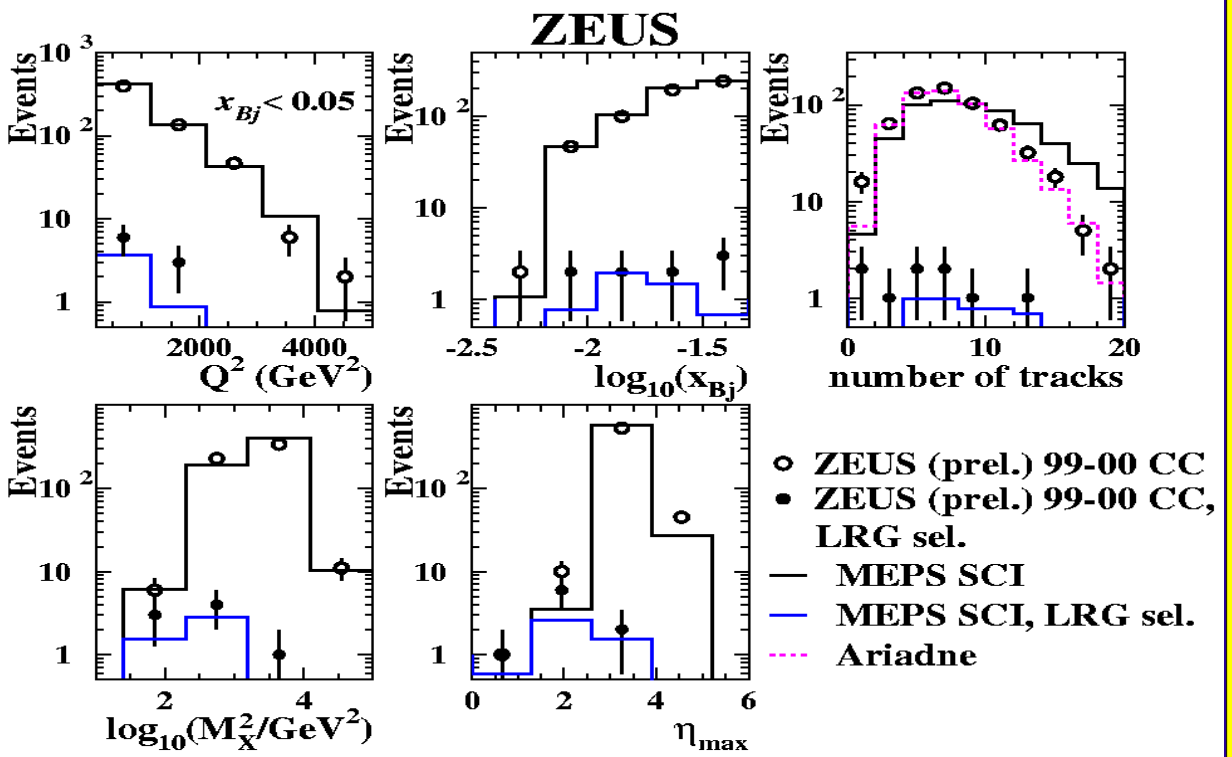
SCI model does not describe η_{max} and charged-track multiplicity in inclusive sample

NC LRG data exceeds SCI prediction by factor of 2

Indication of similar effect in CC:

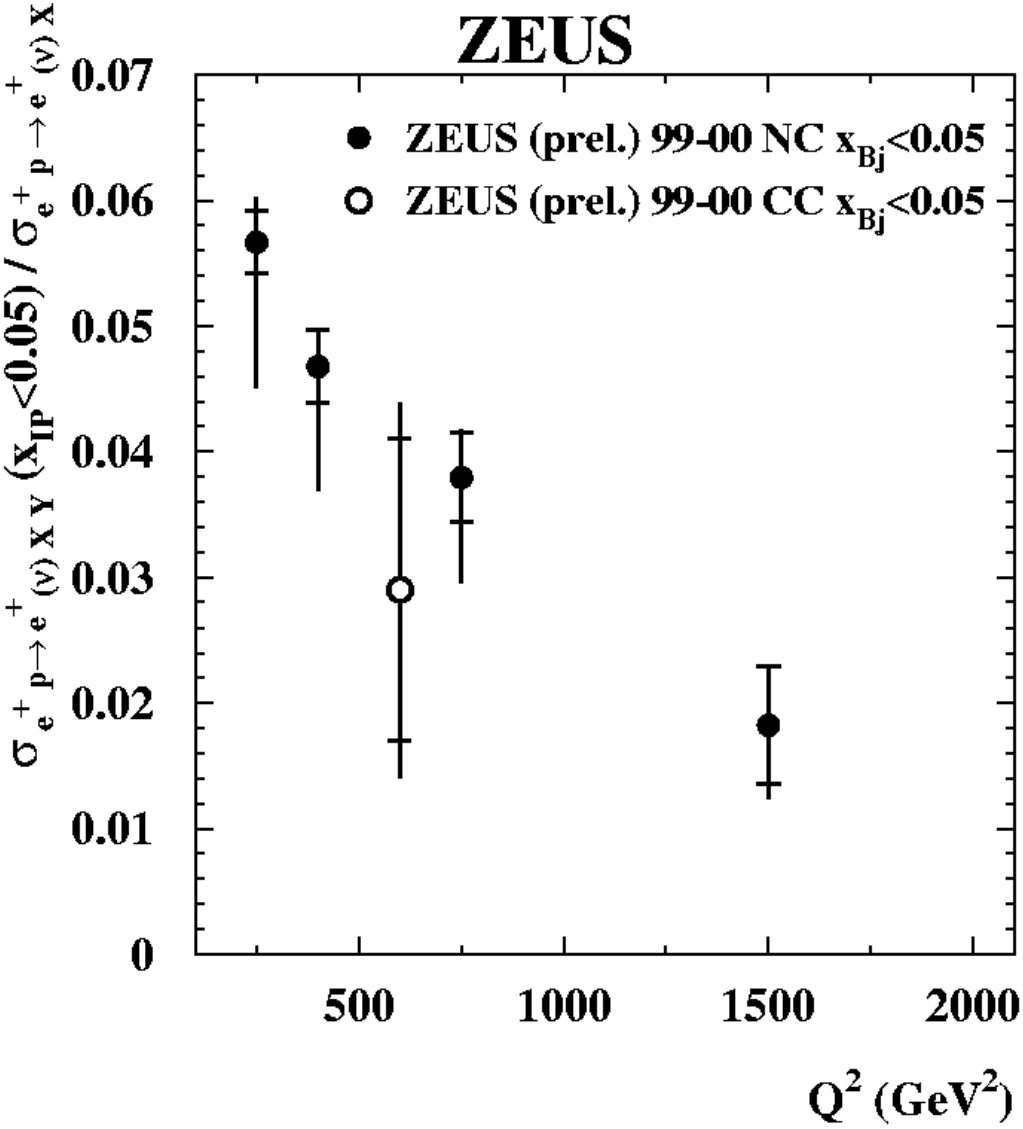
9 CC LRG data events

$3.9\ ^{+1}_{-0.7}$ SCI prediction



CC

Ratio $\sigma_{e^+p \to e^+(\nu) X Y}(x_{IP}<0.05) / \sigma_{e^+p \to e^+(\nu) X}(x_{Bj}<0.05)$ vs. Q^2



Ratio of cross sections calculated using RAPGAP and ARIADNE for acceptance corrections

NC ratio decreases with increasing Q^2

CC and NC ratio compatible

Summary

- LRG events observed in CC and NC DIS at $Q^2 > 200\ GeV^2$
- CC and NC inclusive and LRG samples well described by mixture of ARIADNE and RAPGAP samples
- SCI model does not describe NC data, indication of similar effect in CC
- Ratio $\sigma_{e^+p \to e^+(\nu) X Y}(x_{IP}<0.05) / \sigma_{e^+p \to e^+(\nu) X}(x_{Bj}<0.05)$ in CC process consistent with that in NC process