

Diffraction in Charged Current



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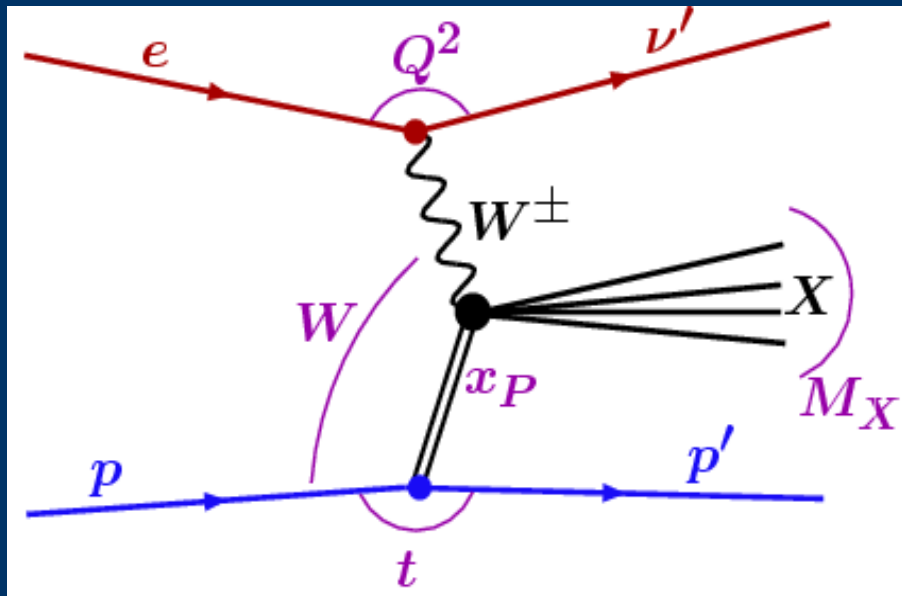
on behalf of the
ZEUS Collaboration



Diffraction 2004
18. - 23. September, Cala Gonone

- Motivation
- CC & LRG selection
- MC simulation
- Results

HERA kinematic for inclusive diffraction



Deep inelastic scattering of electrons (27 GeV) on protons (920 GeV) at $\sqrt{s} = 319$ GeV

Q^2 : virtuality of the boson

M_X : mass of the hadronic system X

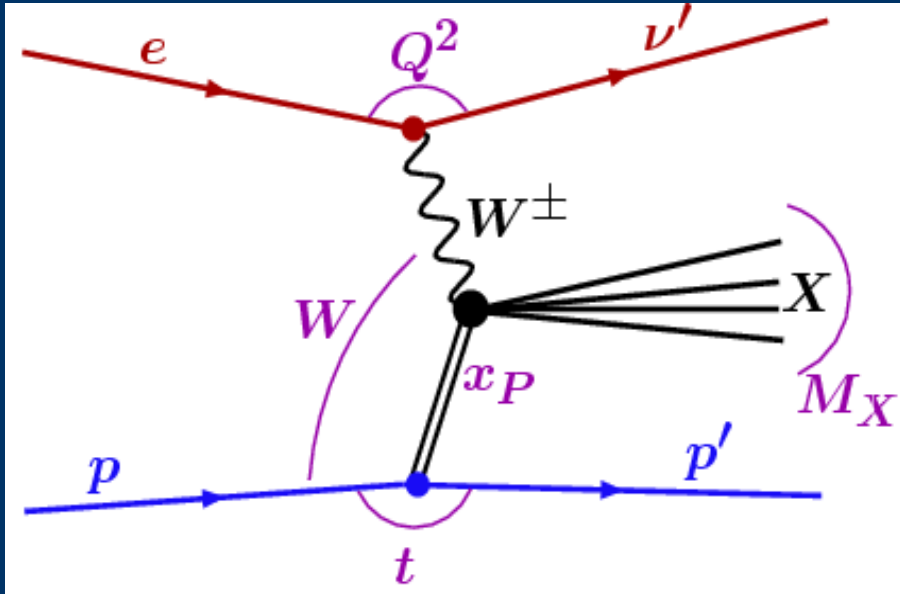
x_P : fraction of proton-momentum carried by pomeron

β : fraction of pomeron-momentum carried by struck quark

$$x_P = \frac{q \cdot (p - p')}{q \cdot p} \simeq \frac{M_X^2 + Q^2 - t}{W^2 + Q^2 + M_P^2}$$

$$\beta = \frac{x}{x_P} = \frac{Q^2}{2q \cdot (p - p')} \simeq \frac{Q^2}{M_X^2 + Q^2 - t}$$

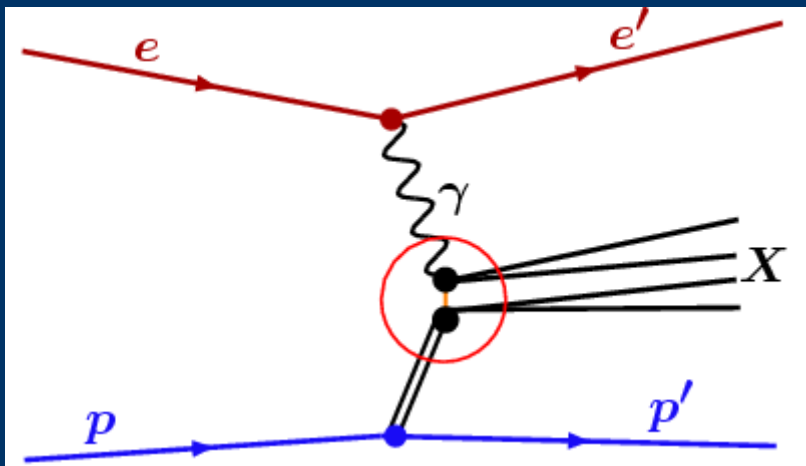
Motivation



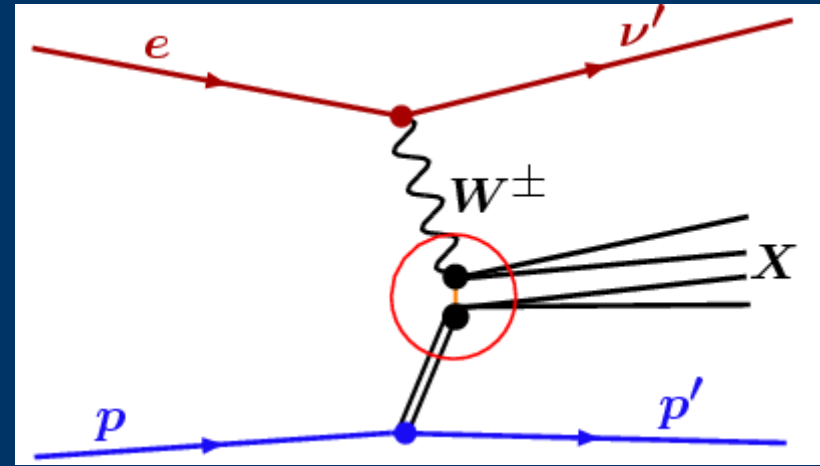
- Diffractive reactions in purely weak exchange - not yet measured
- Measure diffractive parton density functions (dPDF) of the proton at large scale $100 < Q^2 < 2000 \text{ GeV}^2$ (\Rightarrow higher x_{pom} ; $x_{pom} > 0.001$)
- Signature similar to diffractive Higgs production

Universality of diffractive PDFs

- Test diffractive PDFs obtained from NC (EM)



in CC (weak).



- Does factorization hold?
- lepton-charge invariant? flavor symmetry?

Charged Current event-selection

- Principle signature:
 - Initial state has no transverse momentum, $P_t^{in} = 0$
 - but** neutrino escapes detection
 - no energy-deposit in calorimeter from neutrino
 - transverse momentum in the final state, $P_t^{fin} > 0$

ep background:

ep-signature (tracking-vertex),
but no P_t or very small cross-section

- ◆ Photoproduction
- ◆ NC
- ◆ Di-lepton & W production

Non-*ep* background:

true P_t ,
but no *ep*-signature (tracking-vertex)

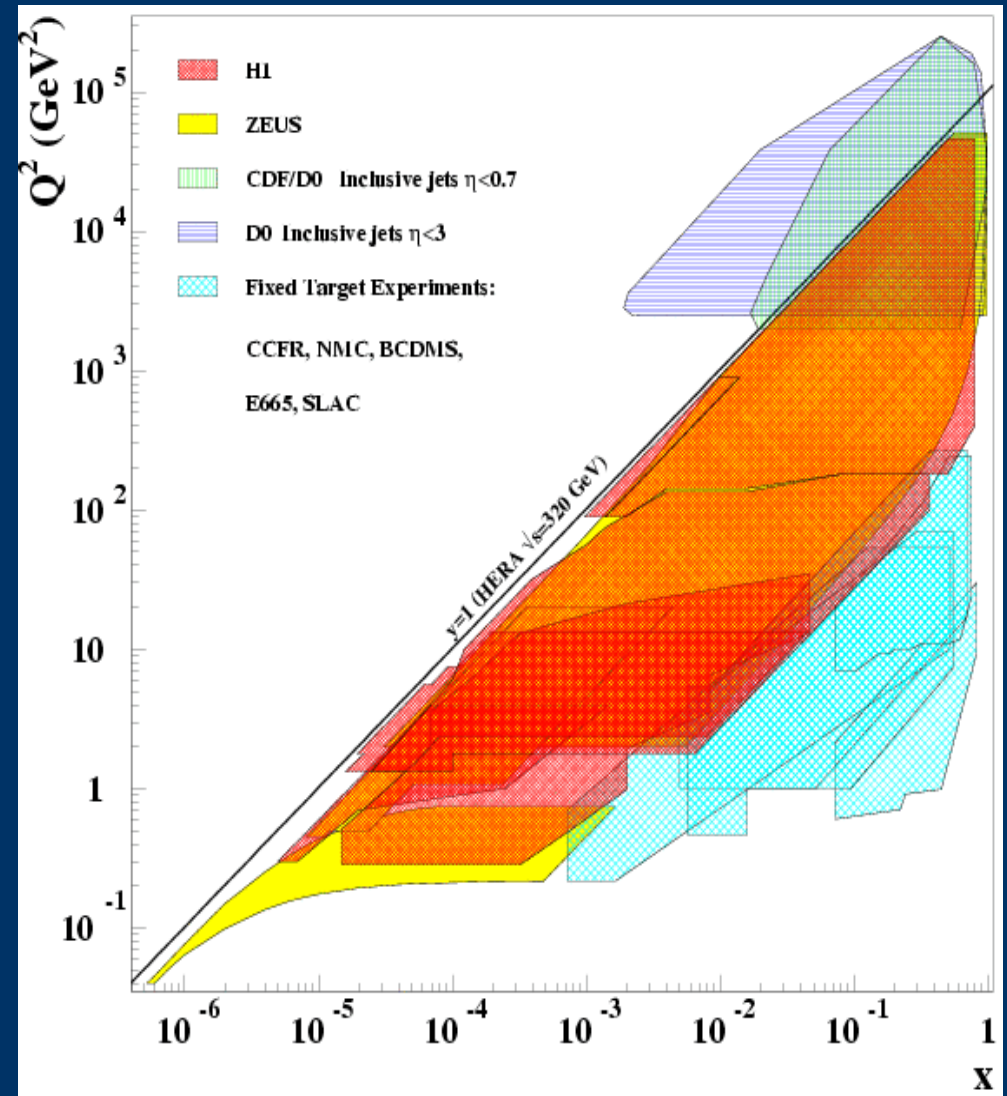
- ◆ beam-gas-interactions
- ◆ halo-muons
- ◆ cosmic muons

Kinematic region

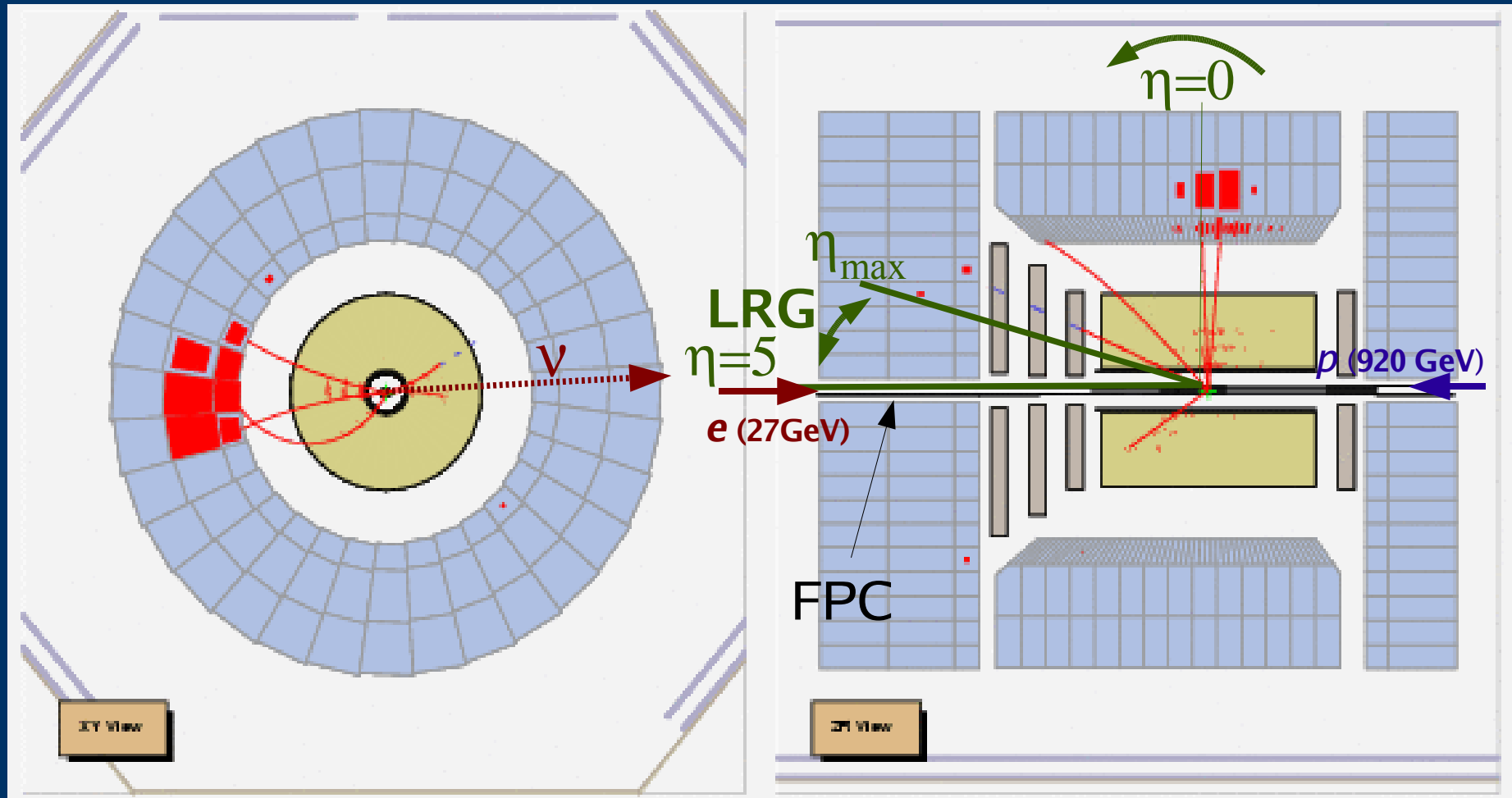
Background contribution drops fast with increasing P_t , but P_t strictly correlated with Q^2 and x

$$Q^2 = P_t^2 / (1-y)$$

→ limit of kinematic region
 $Q^2 > 200 \text{ GeV}^2$
 $\Rightarrow x_{pom} > 0.001$



ZEUS LRG-Event



LRG-selection:

$\eta_{\max} < 2.9$ and $E_{\text{FPC}} < 1 \text{ GeV}^2 \Rightarrow$ rapidity gap of at least 2 units!

Data-Samples

Data:

- ZEUS 1999/2000
- $e^+(27\text{GeV}) p(920\text{GeV})$
- $\sqrt{s} = 319 \text{ GeV}$
- Integrated Luminosity 61 pb^{-1}

CC-inclusive MC:

- Djangoh with **Ariadne**
(Color dipol model)
- **MEPS** (parton shower) with SCI
(soft color interactions) potential LRG

CC-diffractive MC:

- **Rapgap**
- Assuming factorization
- Diffractive H1 fit 2 PDFs (NC)
- Pomeron – light quarks (uds) and gluons
- Diffractive cross-section: 1.2 pb for $Q^2 > 200 \text{ GeV}^2$

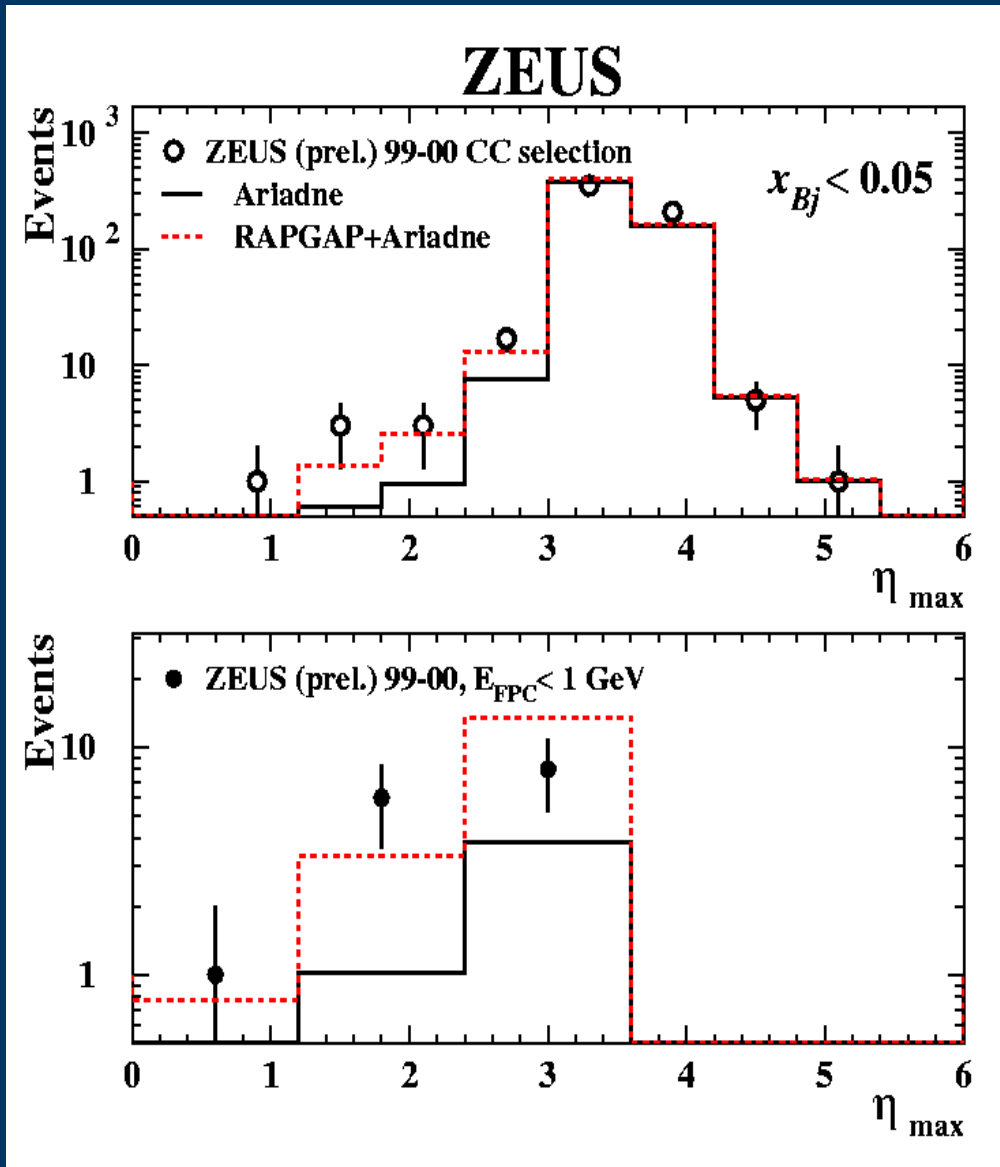
... + ep -background MCs

Is inclusive MC sufficient? \Rightarrow **Ariadne**

Or do we need a diffractive contribution? \Rightarrow **Ariadne+Rapgap**

Can it be described by alternative MC? \Rightarrow **MEPS SCI only**

LRG selected CC



To enhance diffractive contribution:

$$x_{pom} < 0.05 \text{ (diff.)}$$

$$\text{or } x_{Bj} < 0.05 \text{ (inkl.)}$$

(applied from here on)

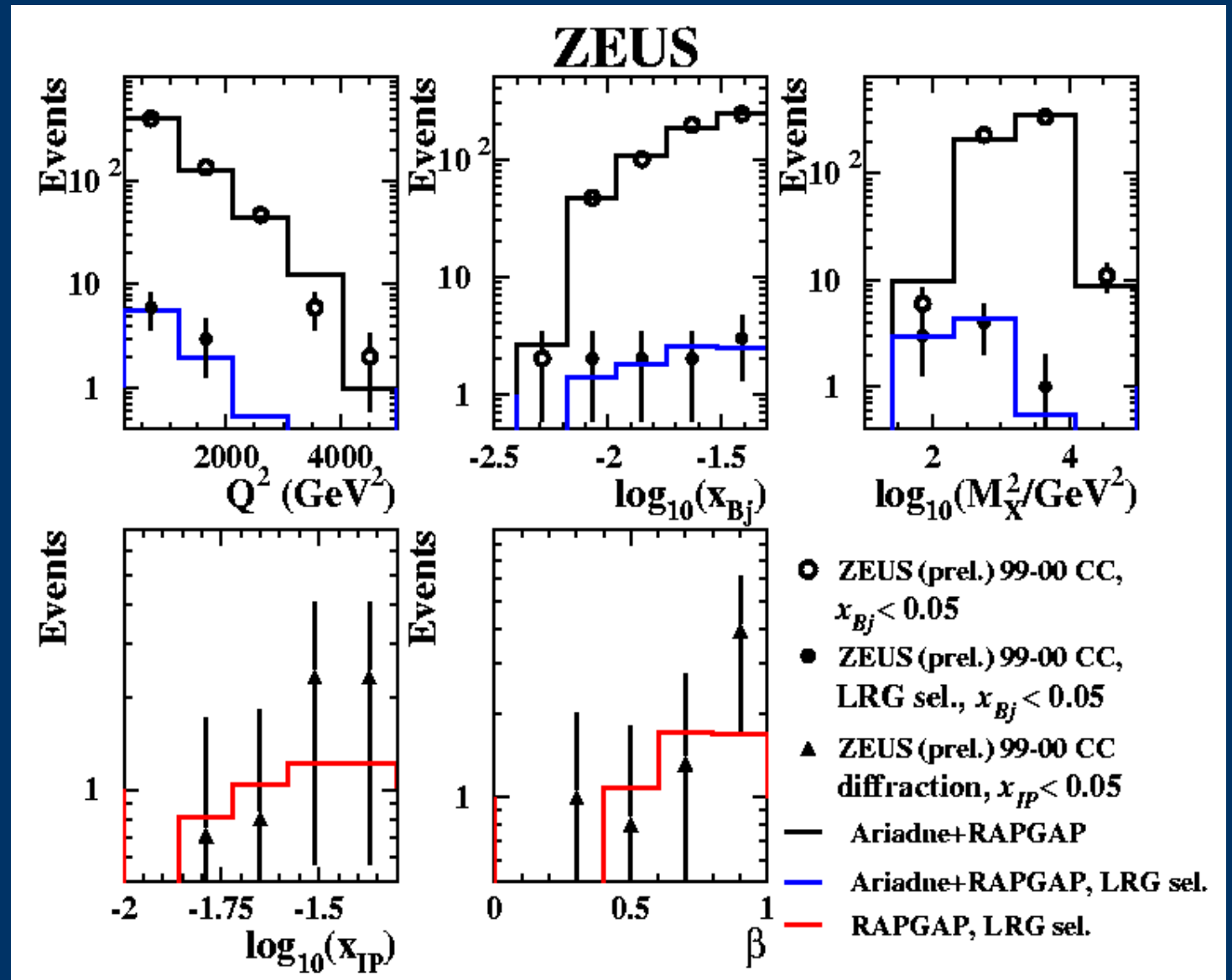
Better description of data using Ariadne + Rapgap

Extraction of diffractive signal

Ariadne + Rapgap
describes
LRG selected
Data well

used for
acceptance
correction

Diffractive signal
obtained by
statistically
subtracting
incl. CC and
background



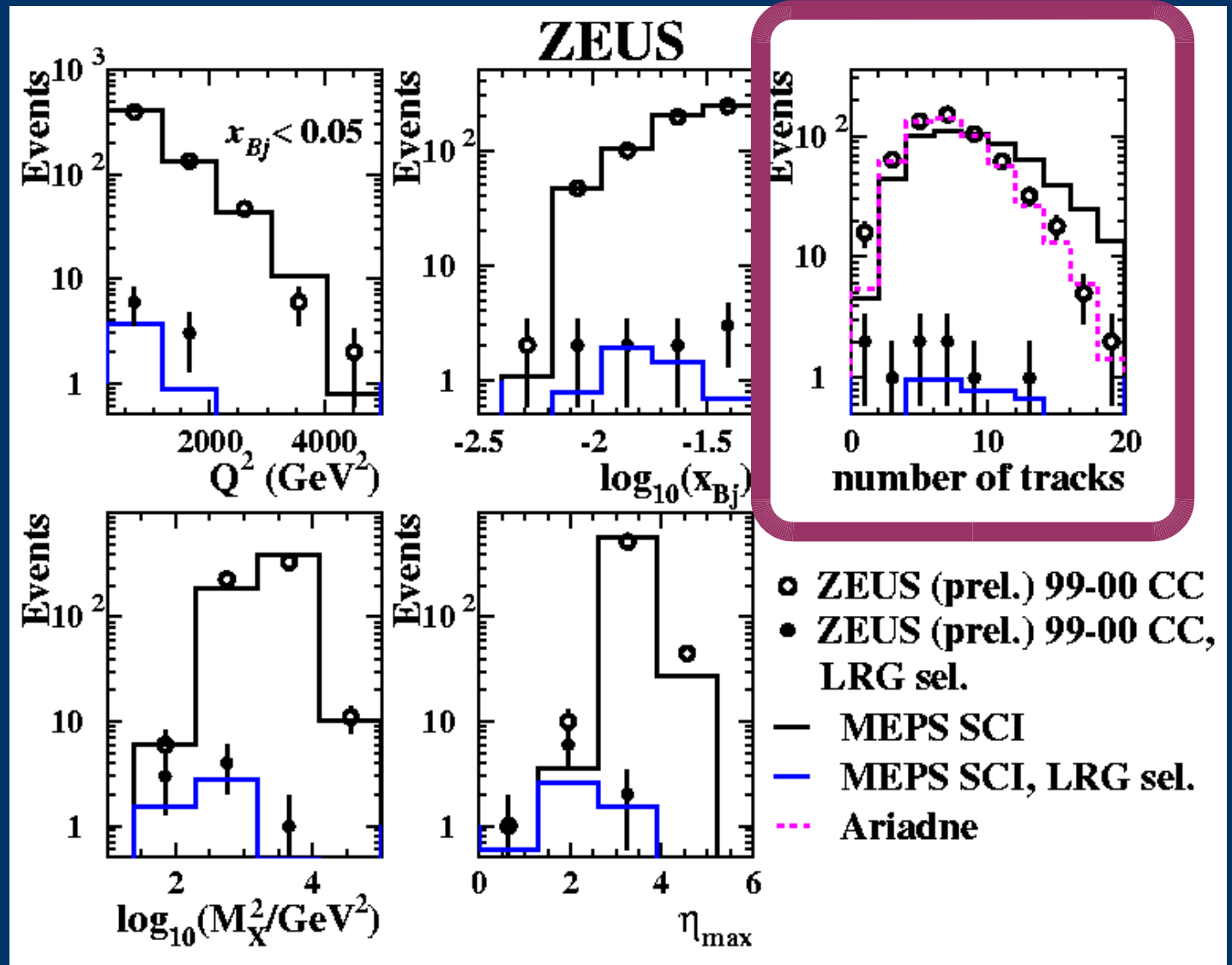
MEPS SCI vs Ariadne

Inclusive CC:

Charged-track multiplicity much better described by Ariadne than by MEPS SCI

LRG sel. CC:

data might exceed MEPS SCI prediction



Diffraction cross section

- 9 events with LRG selected
- Rapgap predicts 5.6 ± 0.7 events
- Ariadne + BG predict 2.1 ± 0.4 events
- MEPS SCI predicts $3.9^{+1.0}_{-0.7}$ events

Assuming diffractive signal described by Rapgap:

Cross section: $\sigma^{\text{CC-diff}} (Q^2 > 200 \text{ GeV}^2, x_{\text{pom}} < 0.05) = 0.49 \pm 0.20 \text{ (stat.)} \pm 0.13 \text{ (syst.) pb}$

Ratio: $r_{\text{diff}}^{\text{CC}} = \frac{\sigma^{\text{CC-diff.}} (Q^2 > 200 \text{ GeV}^2, x_{\text{pom}} < 0.05)}{\sigma^{\text{CC-incl.}} (Q^2 > 200 \text{ GeV}^2, x_{\text{bj}} < 0.05)} = 2.9 \pm 1.2 \text{ (stat.)} \pm 0.8 \text{ (syst.) \%}$

Summary

- ★ 9 CC-events with LRG selected in the 1999/2000 ZEUS data, corresponding to 61 pb^{-1} .
- ★ Signal well described using diffractive MC.
- ★ Measurement of CC diffractive cross section assuming diffractive signal described by Rapgap:
 $\sigma^{\text{CC-diff}} (Q^2 > 200 \text{ GeV}^2, x_{\text{pom}} < 0.05) = 0.49 \pm 0.20 \text{ (stat.)} \pm 0.13 \text{ (syst.) pb}$
and CC diffractive ratio

$$r_{\text{diff}}^{\text{CC}} = 2.9 \pm 1.2 \text{ (stat.)} \pm 0.8 \text{ (syst.) \%}$$

Expectation from HERA II data:

- more luminosity, more events,
- differential CC-diff cross-section?
- e^- data to test flavor symmetry