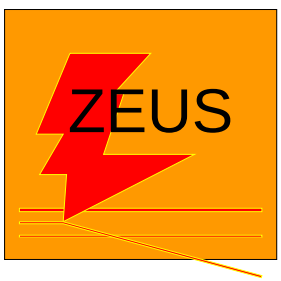
Final States in Diffraction at HERA

Mario Martínez
(DESY-ZEUS)



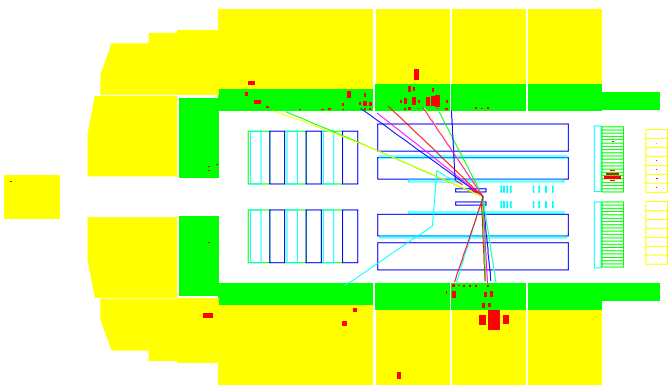
for the H1 and ZEUS Collaborations

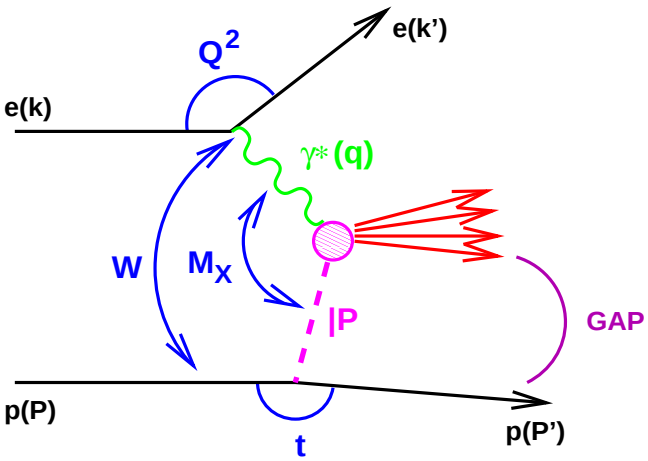
- Introduction
- Event Shapes
- Dijet Production
- Three-jet Production
- Conclusions

30th International Conference on High Energy Physics
Osaka, Japan, July 27th - August 2nd, 2000

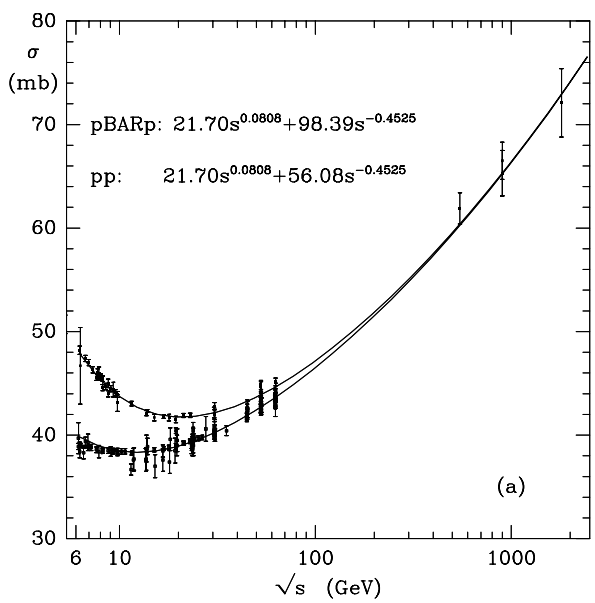
Introduction (I)

Events with no activity in the forward direction
⇒ Large Rapidity Gap events (LRG).





Exchange of colour singlet ⇒ $I\!P$ exchange



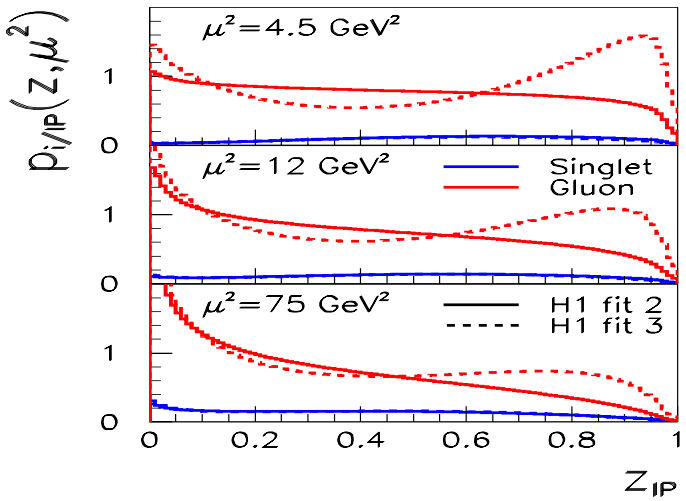
In hadron-hadron collisions the $I\!P$-trajectory describes the total cross section at high energies:

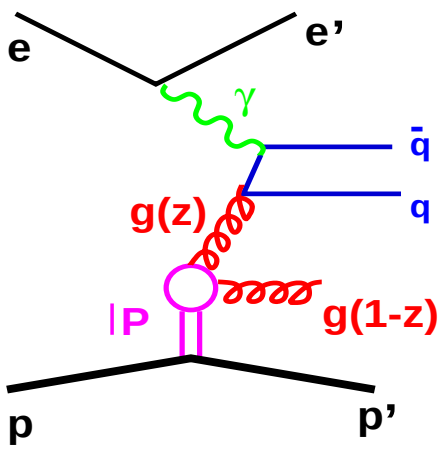
$$\sigma_{tot} \propto s^{\alpha_{I\!P}(0)-1}$$

⇒ The large γ-virtualities at HERA allow to study the $I\!P$-structure and formulate it in terms of QCD (quarks and gluons)

Introduction (II)

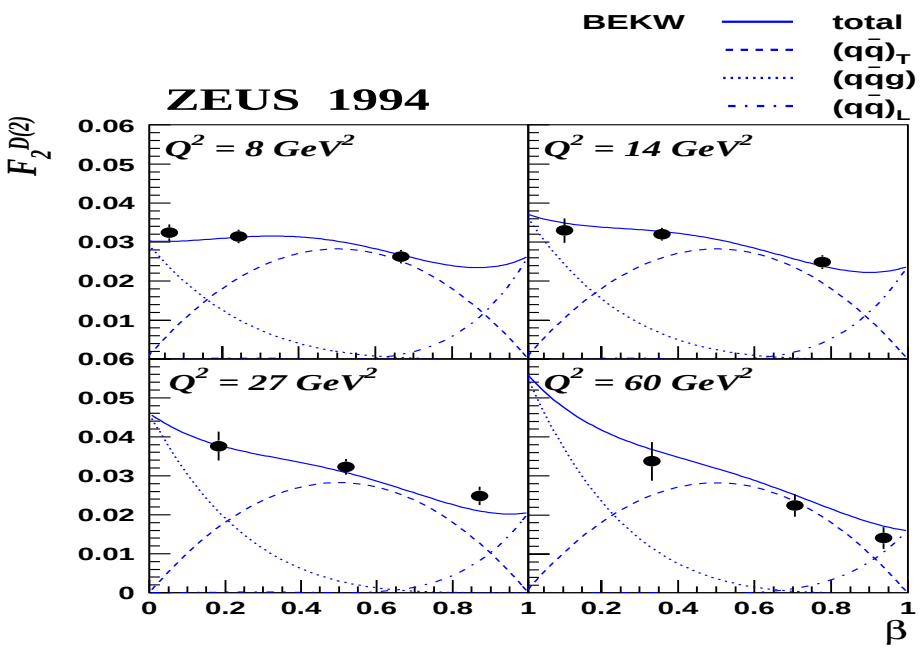
• Ingelman-Schlein factorisable model → Pomeron with partonic structure (quark and gluon densities)

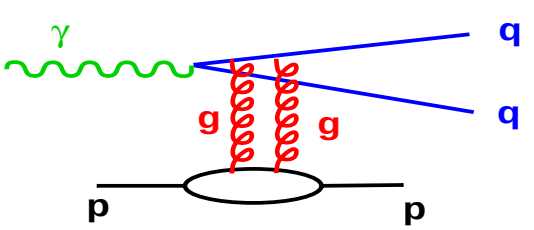


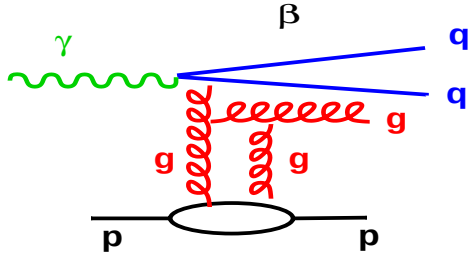


HERA data ⇒ Pomeron dominated by gluons.

• pQCD inspired models (γ-dissociation picture) → Pomeron described as two-gluons exchange



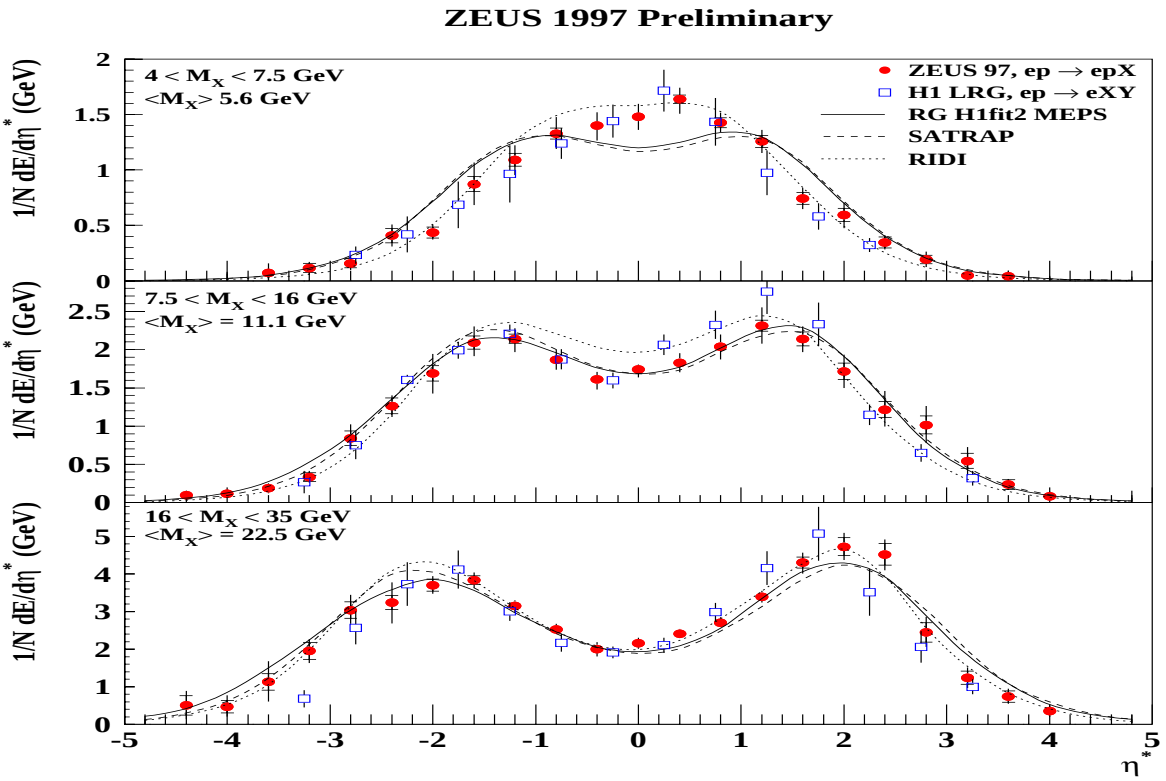


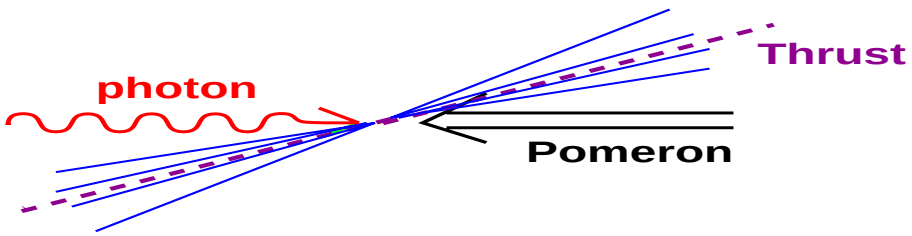


$q\bar{q}g$ contribution dominates at low-β ($\beta = \frac{Q^2}{Q^2+M_X^2}$).

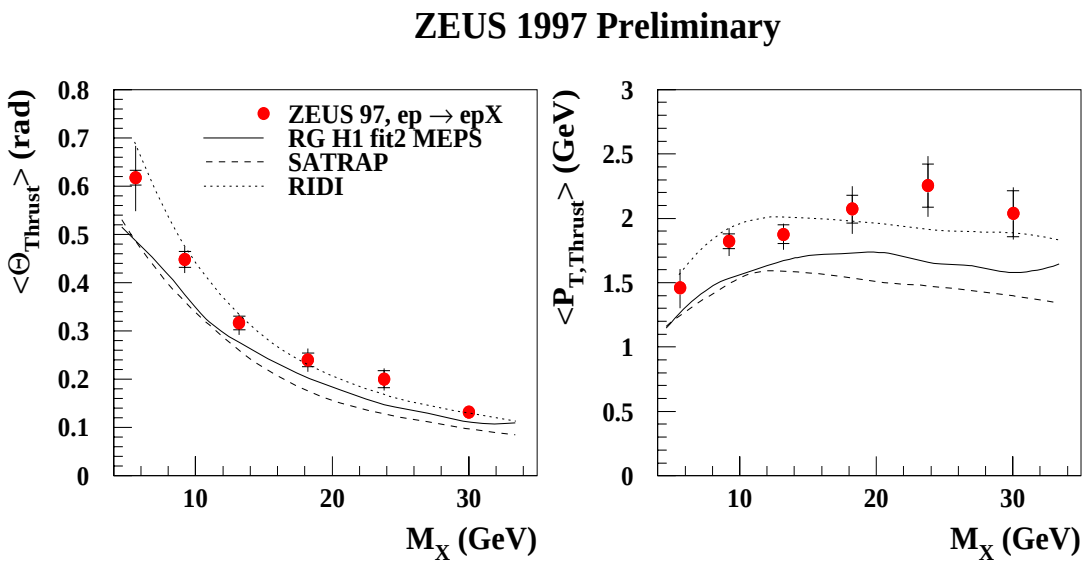
Event Shapes in Diffractive DIS

(ZEUS LPS : Contributed paper N^o 876)
(H1 LRG: Phys. Lett. B428 (1998) 206)





⇒ Clear dijet structure for $M_X \geq 8$ GeV.



⇒ Dominant aligned configurations w.r.t the $\gamma^* I\!P$ axis.

Event Shapes in Diffractive DIS

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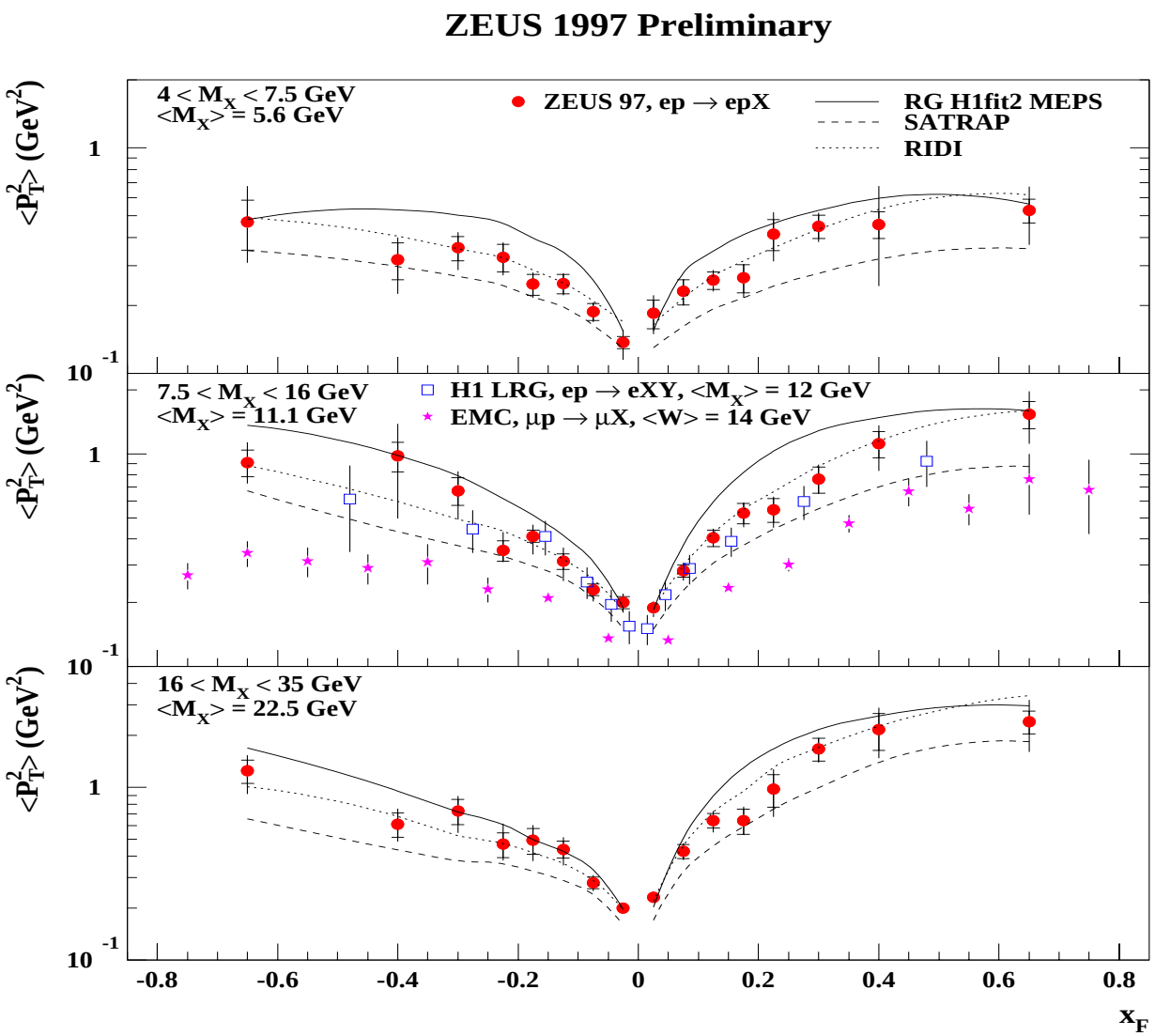
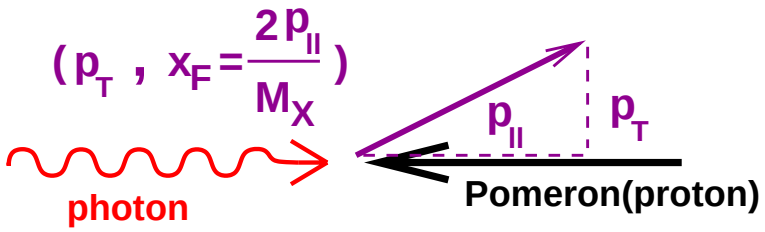
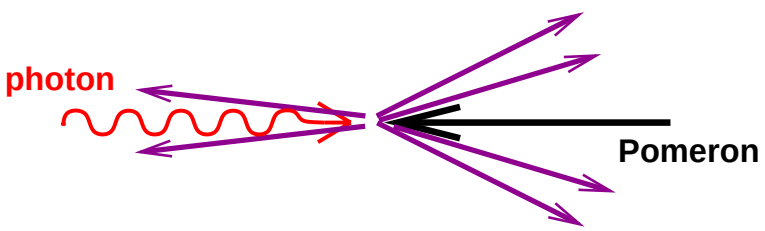




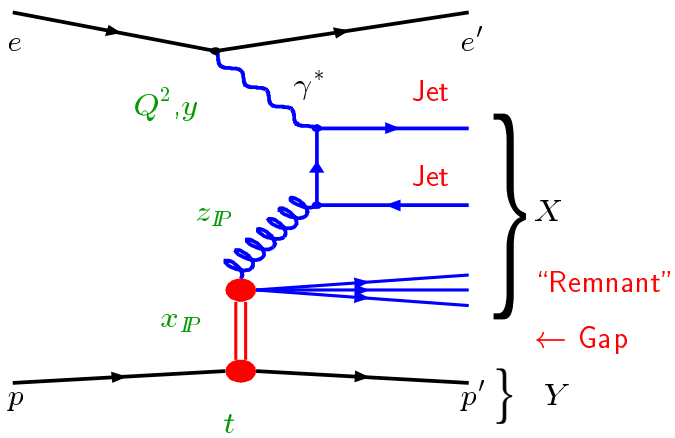
- P_t suppression ($I\!P$-side) smaller than in $\gamma^* P$ data.
- At high masses (> 16 GeV) $\rightarrow$ larger P_t in γ-side.



Dijet Production in Diffractive DIS

(H1 Collab., Contributed paper N^o 960)

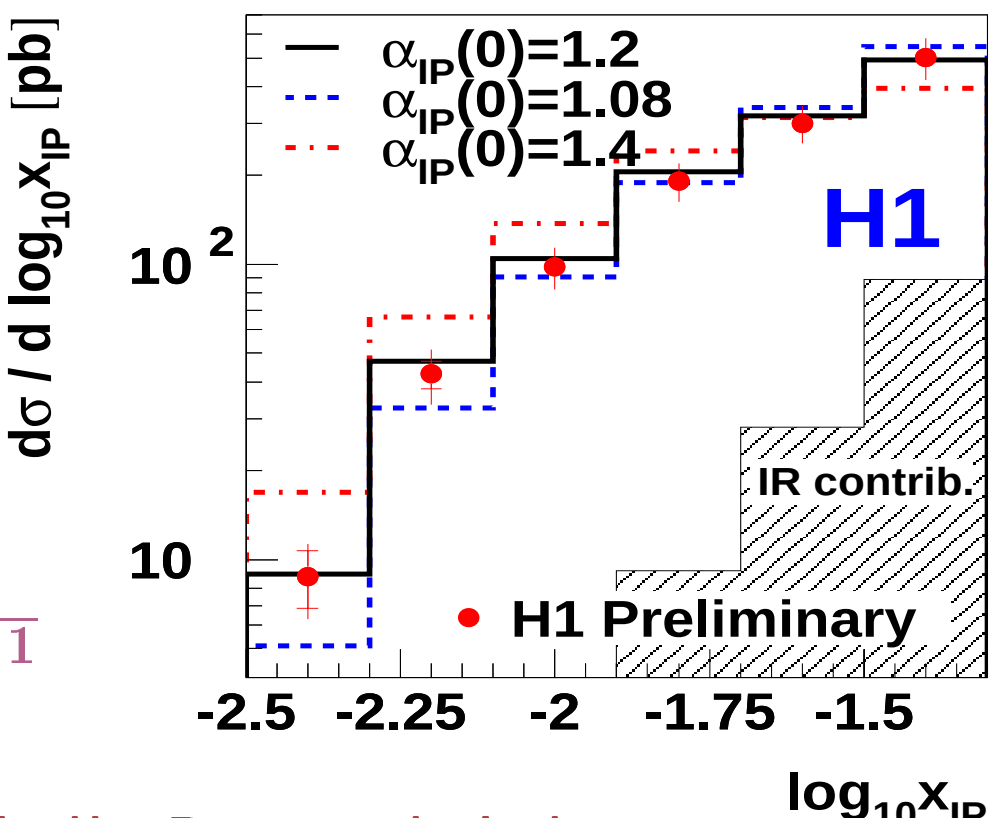
$4 < Q^2 < 80$ GeV^2
$0.1 < y < 0.7$
$x_{I\!P} < 0.05$
$M_Y < 1.6$ GeV
$|t| < 1.0$ GeV^2



Cone algorithm (R=1.0) in the $\gamma^* p$-CMS
$P^*_{T,jet} > 4$ GeV and $-3 < \eta^*_{jet} < 0$
($L = 17.9\text{pb}^{-1} \rightarrow \sim$ 2500 dijet events)

$$F_2^{D(3)}(\beta, Q^2; x_{I\!P}) = f_{I\!P/p}(x_{I\!P}) F_2^{D(2)}(\beta, Q^2) + \ldots$$

Diffractive Dijets



$$\frac{1}{x_{I\!P}^{2\cdot\alpha_{I\!P}(0)-1}}$$

- Sensitivity to the Pomeron trajectory.
- Dijet data prefers $\alpha_{I\!P}(0) \sim 1.2 \rightarrow$ ($F_2^{D(3)}$ analysis).

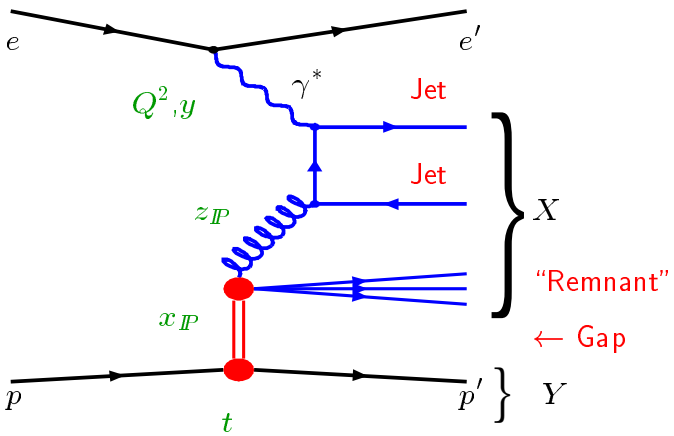
Dijet Production in Diffractive DIS

(H1 Collab., Contributed paper N^o 960)

Resolved $I\!P$ model:

$\rightarrow$ Dijets sensitive to gluon in $I\!P$ (from BGF)

$$z_{I\!P}^{jets} = \frac{Q^2+M_{12}^2}{Q^2+M_X^2}$$

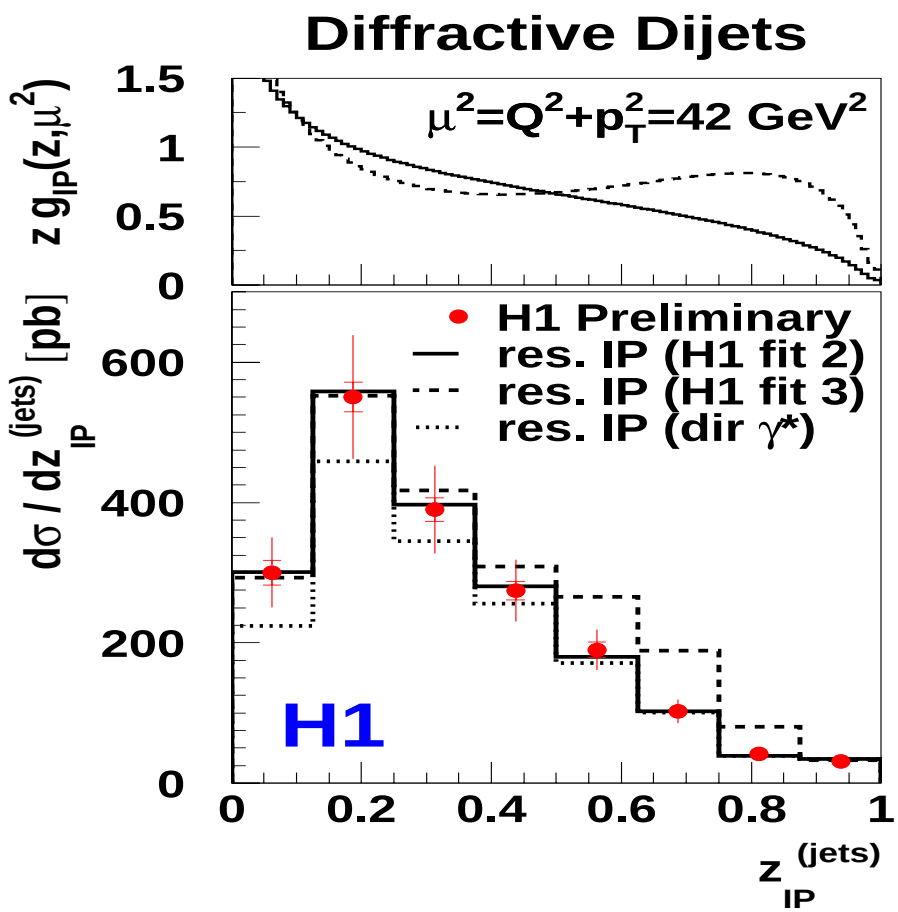


$$F_2^{I\!P} = \sum_i e_i^2 \; f_{q_i/I\!P}(z,\mu^2)$$

Gluon density:

$f_{g/I\!P}(z,\mu^2)$

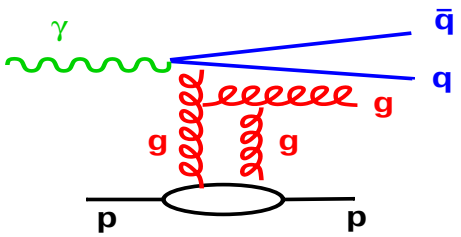
large-$z_{I\!P}$ region constrained by dijet data!

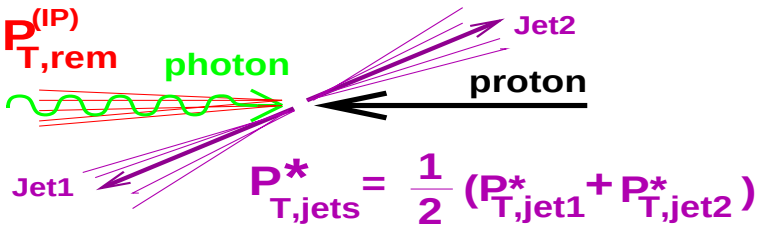


- Gluon-dominated Pomeron describes the data.
- Sensitivity to $f_{g/I\!P} \rightarrow$ flat distribution preferred.
- $z_{I\!P}^{jets}$ peaks at $\sim 0.2 \rightarrow$ large Pomeron remnant.

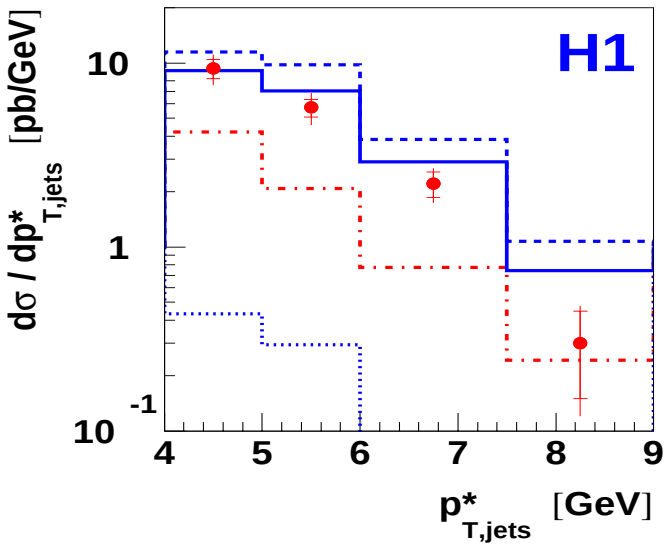
Dijet Production in Diffractive DIS

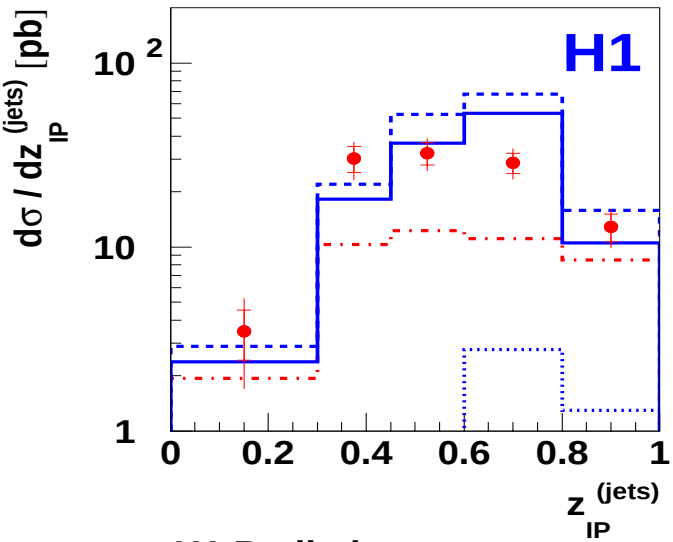
(H1 Collab., Contributed paper N^o 960)

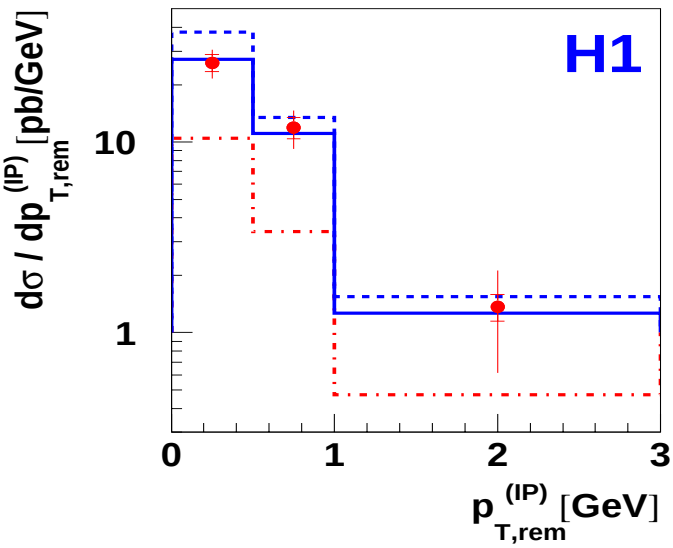




Diffractive Dijets - $x_{IP} < 0.01$







- H1 Preliminary
- Saturation model
- BJLW ($q\bar{q}$ only *5)
- BJLW ($p^2_{T,g} > 1.0$ GeV^2)
- BJLW ($p^2_{T,g} > 0.5$ GeV^2)

Dominant $q\bar{q}g$ contrib.

- Saturation Model $\rightarrow$ factor 2 too low.
(k_t ordering, gluon-distribution, t-dependence..?)

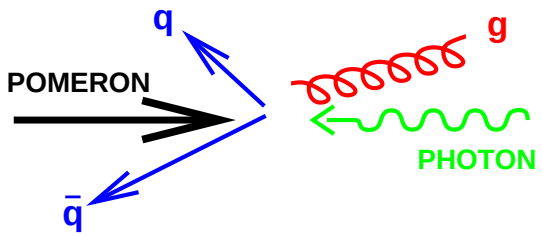
- Bartels, Jung, Lotter, Wüsthoff model $\rightarrow$ roughly describes the data with $p^2_{t,(cut)}(\text{gluon}) = 1.0$ GeV^2.

- for $p^2_{t,(cut)}(\text{gluon}) = 0.5$ GeV^2 $\rightarrow$ x-section overestimated
$\rightarrow$ suppression of low-p_t gluon radiation ?

3-Jet Production in Diffractive DIS

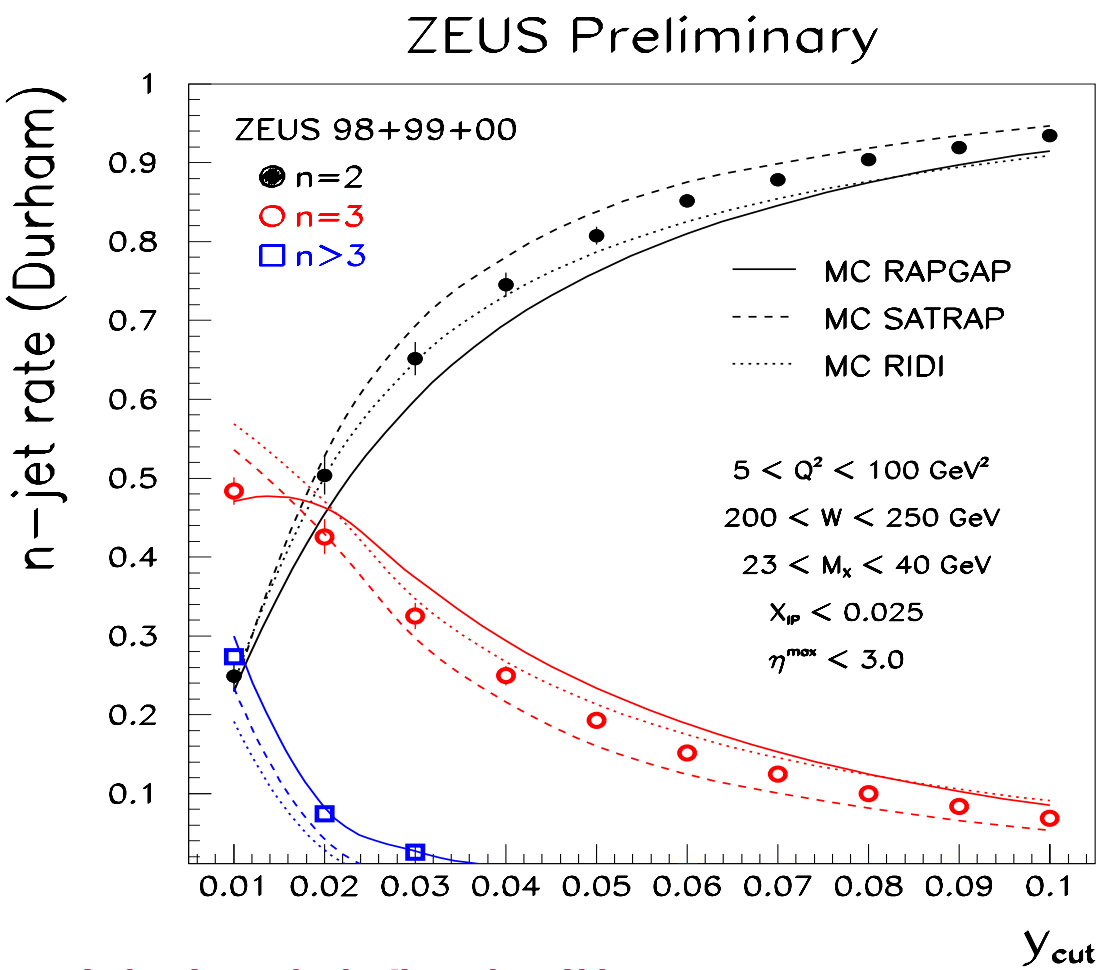
(ZEUS Collab., Contributed paper N^o 872)

$5 < Q^2 < 100$ GeV^2
$200 < W < 250$ GeV
$x_{I\!P} < 0.025$
$23 < M_X < 40$ GeV
$\eta^{\max}_{\text{hadron}} < 3.0$



In PETRA e^+e^- experiments $\Rightarrow$ three-jet production was observed for $\sqrt{s}$ in the range $29 \lesssim \sqrt{s} \lesssim 36$ GeV

Exclusive k_T algorithm in the $\gamma^* I\!P$-CMS (E-scheme)



- three-jet signal defined with $y_{\text{cut}} = 0.05$
(good parton-hadron correlation)
- RAPGAP (Resolved gluon-dominated $I\!P$)
- SATRAP (Saturation Model)
- RIDI (Ryskin pQCD approach)

3-Jet Production in Diffractive DIS

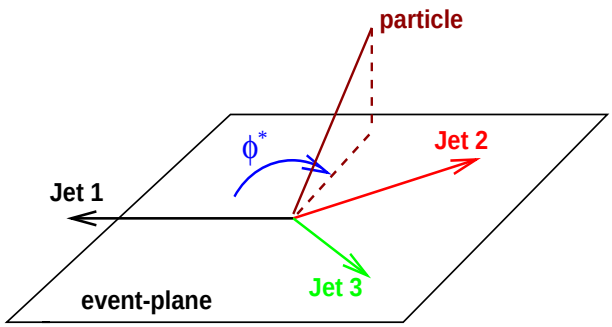
(ZEUS Collab., Contributed paper N^o 872)

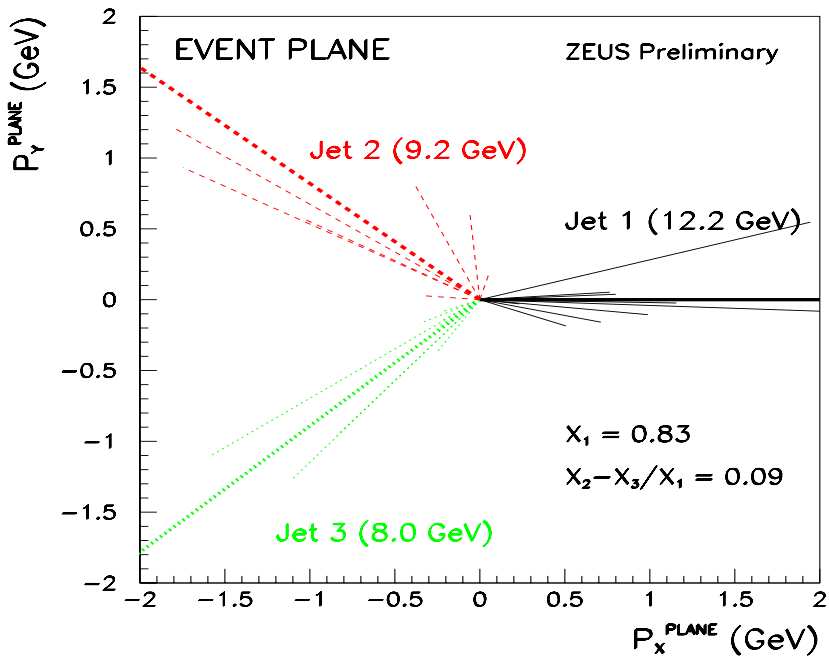
$23 < M_X < 40$ GeV

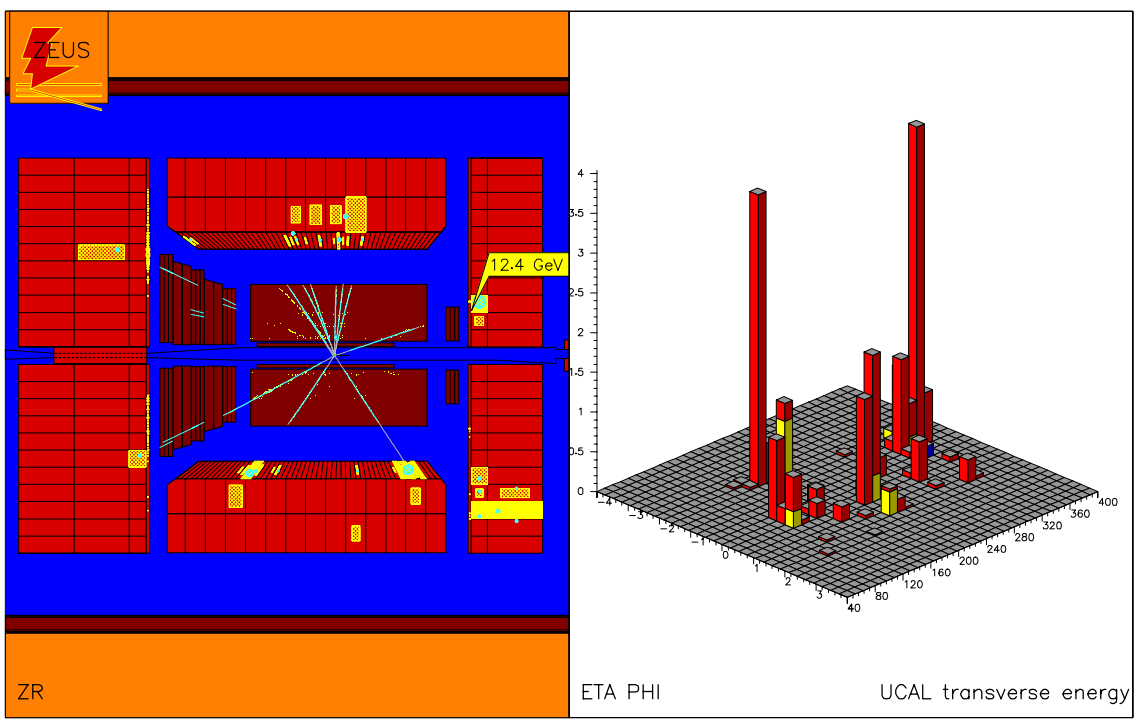
$N_{\rm jet} = 3$ $(y_{\rm cut} = 0.05)$

$-2.3 < \eta^{\rm jet}_{\rm lab} < 2.3$

$(L = 39{\rm pb}^{-1} \rightarrow$ 678 evts.)





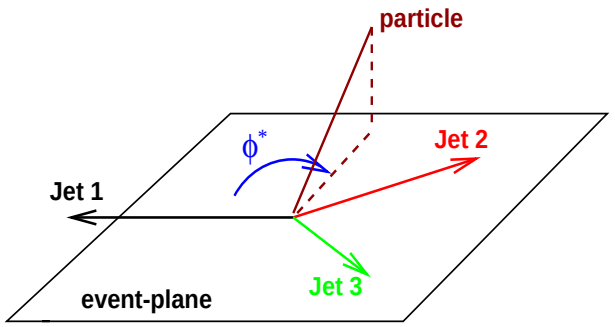


Evidence for three-jet production in LRG events!

3-Jet Production in Diffractive DIS

(ZEUS Collab., Contributed paper N^o 872)

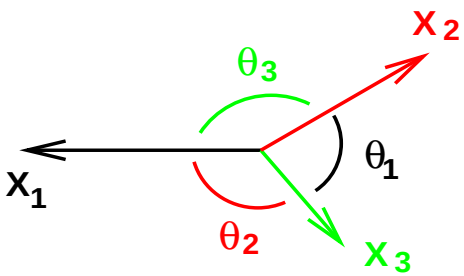
$23 < M_X < 40$ GeV
$N_{\rm jet} = 3$ $(y_{\rm cut} = 0.05)$
$-2.3 < \eta^{\rm jet}_{\rm lab} < 2.3$
$(L = 39 {\rm pb}^{-1} \rightarrow 678$ evts.)



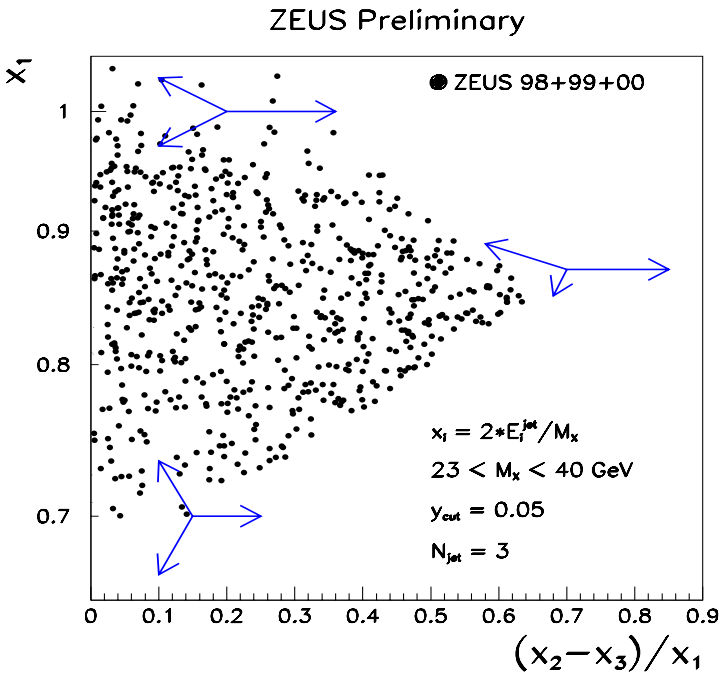
$$x_i = \frac{2 \cdot E_i^{\rm jet}}{M_X}$$

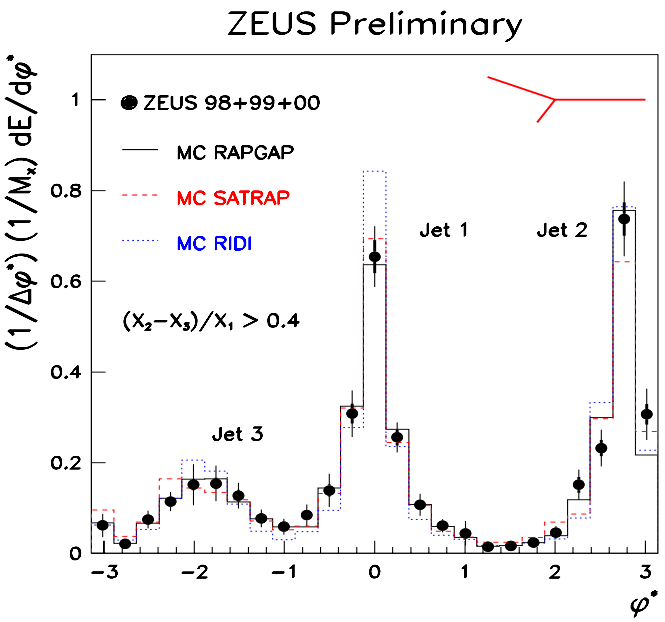
$$x_1 \geq x_2 \geq x_3$$

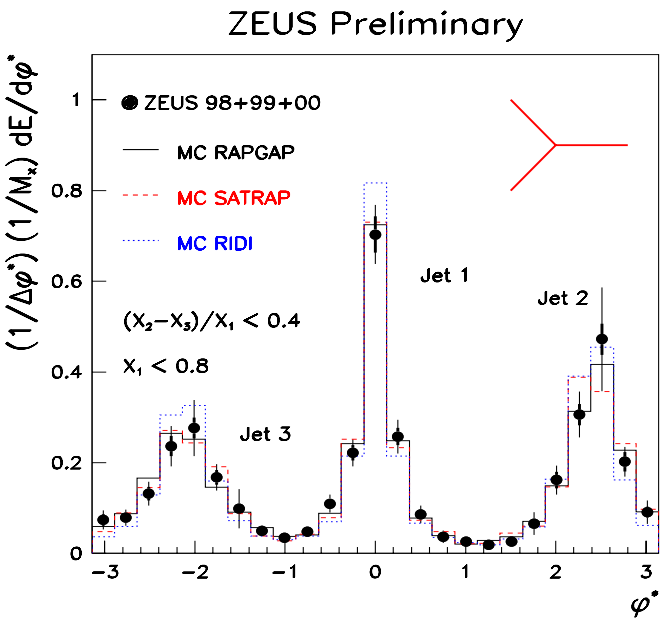
$$x_1 + x_2 + x_3 = 2$$



$$x_i \simeq \frac{2 \cdot sin\theta_i}{sin\theta_1 + sin\theta_2 + sin\theta_3}$$





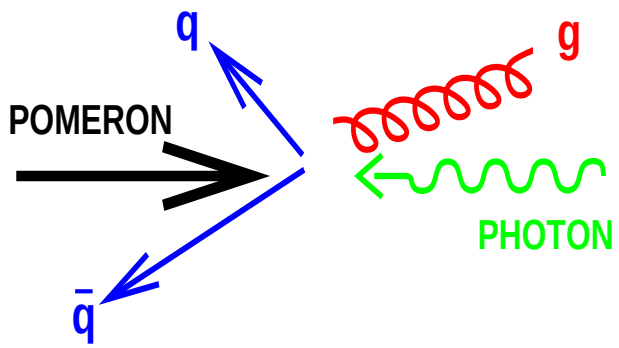


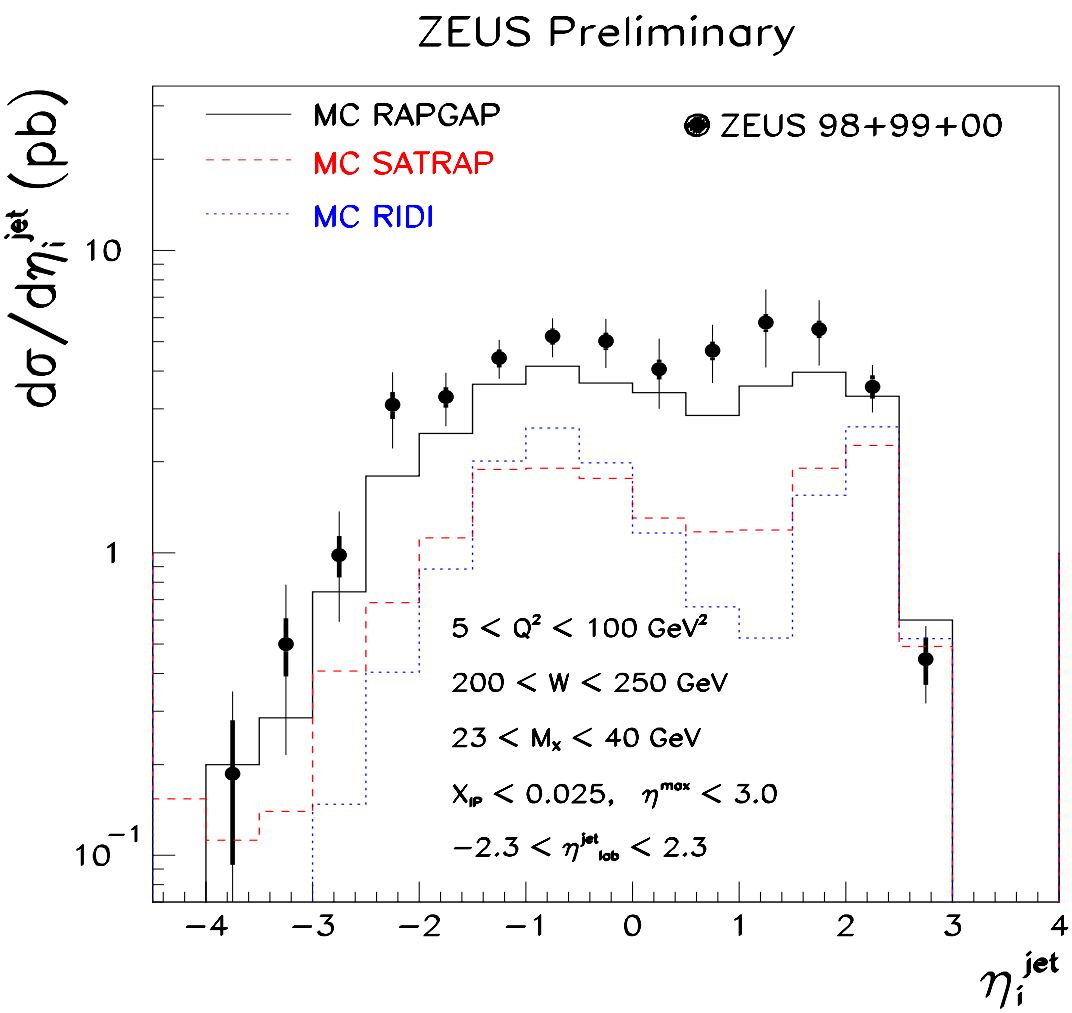
- Different three-jet topologies are observed in the data.

3-Jet Production in Diffractive DIS

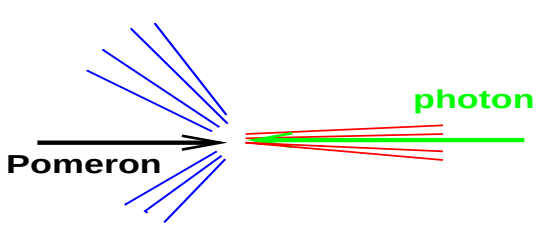
(ZEUS Collab., Contributed paper N^o 872)

$5 < Q^2 < 100$ GeV^2
$200 < W < 250$ GeV
$x_{I\!P} < 0.025$
$23 < M_X < 40$ GeV
$\eta^{\rm max}_{\rm hadron} < 3.0$
$-2.3 < \eta^{\rm jet}_{\rm lab} < 2.3$





- Gluon-dominated resolved $I\!P$ describes the data.
- Saturation Model and Ryskin's pQCD Model too low. (shape indicates that larger p_t(gluon) is needed)



Summary and Conclusions

- Event Shape:
  - Dominant aligned configurations w.r.t. $\gamma^* I\!P$ axis.
  - At high masses (> 16 GeV) larger $< p_t^2 >$ in γ-side.
- Jet Production:
  - Evidence for three-jet production ($\gamma I\!P$ cms).
  - Jet measurements well described by a factorisable model with a gluon-dominated Pomeron.
  - Dijet x-sections sensitive to $\alpha_{I\!P}(0)$ and $f_{g/I\!P}(z, \mu^2)$.
    - Same $\alpha_{I\!P}(0)$ for dijet and inclusive measurements.
    - Flat gluon distribution (no leading gluons!) preferred.
  - BJLW pQCD model with $p_{t,cut}^2(\text{gluon}) > 1$ GeV^2 roughly describes the measured dijet x-sections.
  - Saturation model and Ryskin's pQCD model do not describe the measured x-sections.
    $\Rightarrow$ larger p_t(gluon) is needed(?)
- Some new results not covered by this talk:
  - Open charm production in diffractive DIS
    (ZEUS Collab., Contributed paper N^o 874)
  - Energy flow between jets in γP
    (H1 Collab., Contributed paper N^o 962)