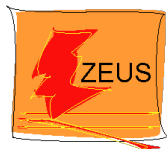


# *Measurement of Exclusive Dijet Production in Diffractive DIS with the ZEUS Detector at HERA*

Grzegorz Gach  
(on behalf of the ZEUS Collaboration)

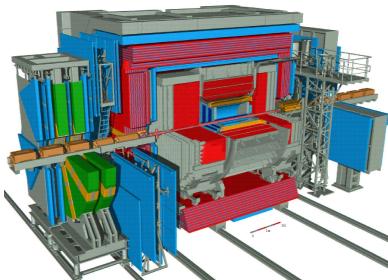


AGH University of Science and Technology

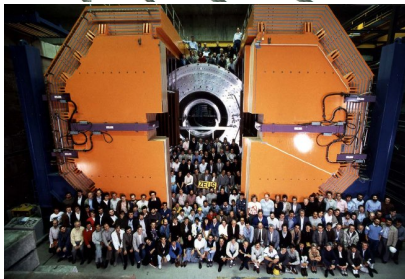
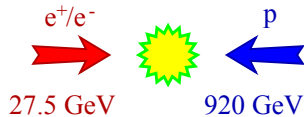


11 September 2014

# HERA II and ZEUS



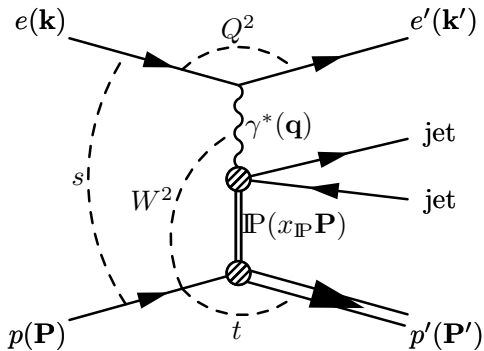
DESY, Hamburg  
2003-2007



$$\sqrt{s} = 318 \text{ GeV}$$

$$\int L dt \approx 370 \text{ pb}^{-1}$$

# Kinematic Variables



## DIS

- $\mathbf{q} = \mathbf{k} - \mathbf{k}'$
- $Q^2 = -\mathbf{q}^2 > 1 \text{ GeV}^2 \Rightarrow \text{DIS}$
- $W^2 = (\mathbf{P} + \mathbf{q})^2$
- $s = (\mathbf{P} + \mathbf{k})^2$
- $x = \frac{Q^2}{2\mathbf{P} \cdot \mathbf{q}}$

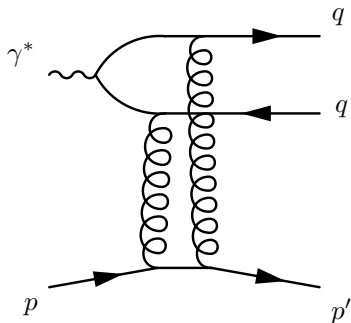
## Diffraction

- $x_{\mathbb{P}} = \frac{(\mathbf{P} - \mathbf{P}') \cdot \mathbf{q}}{\mathbf{P} \cdot \mathbf{q}}$
- $\beta = x/x_{\mathbb{P}}$

# Diffractive Dijet Production Mechanisms

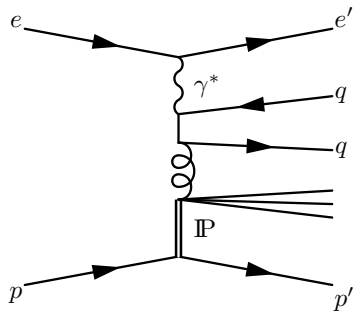
*Phys. Lett. B386 (1996) 389-396*

2-gluon exchange



fully perturbative  
calculations based on  
proton PDF

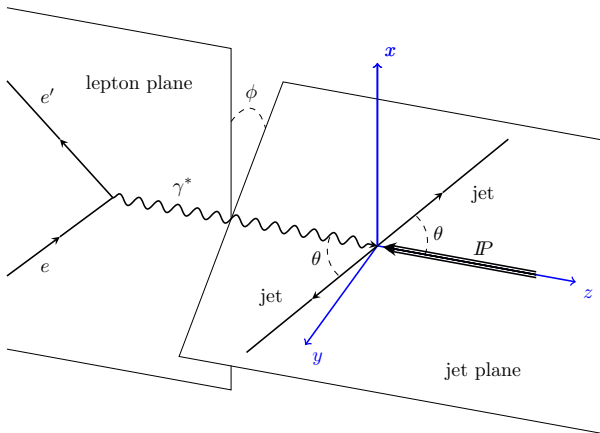
Boson-Gluon Fusion



calculations based on  
pomeron structure  
functions

# Diffractive Dijet Production in $\gamma^*$ – IP CMS

$$e + p \rightarrow e' + p' + \text{jet} + \text{jet}$$

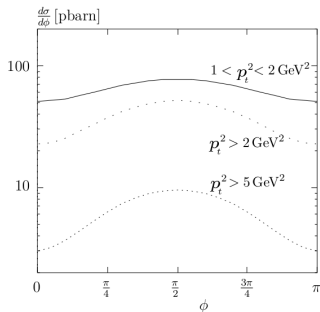


- $\phi$  - angle between lepton and jet planes
- $\theta$  - polar angle of a jet

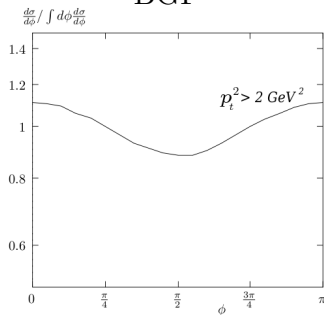
# Parton Level Azimuthal Angular Distribution

*Phys. Lett. B386 (1996) 389-396*

## 2-gluon exchange



## BGF



$$d\sigma/d\phi \propto 1 + A \cos(2\phi)$$

- $d\sigma/d\phi$  described by the same function in both mechanisms
- two-gluon exchange mechanism predicts negative  $A$
- boson-gluon fusion mechanism predicts positive  $A$

# Monte Carlo

## MC Generator

RAPGAP 3.01/26 + JETSET(hadronisation)

## Detector Level MC

SATRAP - RapGap 3.01/26 + HERACLES 4.6.3(radiation)

- color dipole model with saturation
- $q\bar{q}$  and  $q\bar{q}g$  in a final state
- description of  $p_T$  and  $\phi$  distributions of the dijet sample required hadron level reweighting

## Hadron Level Predictions

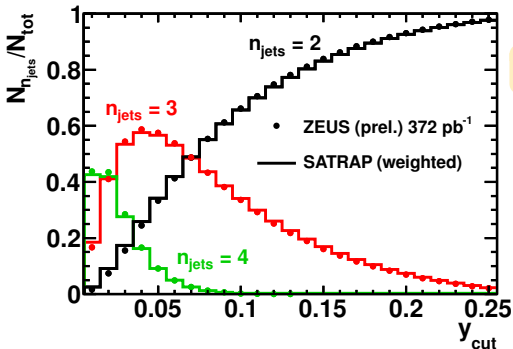
- 2-gluon exchange model - RapGap 3.01/26
- BGF (resolved Pomeron) - RapGap 3.01/26

# Durham Exclusive $k_t$ Jet Algorithm (FastJet)

$$y_{ij} = 2 \frac{\min(E_i^2, E_j^2)}{M_X^2} (1 - \cos \theta_{ij})$$

$\theta_{ij}$  is the angle between objects  $(i, j)$  and  $M_X$  is the total mass of hadronic system.

ZEUS



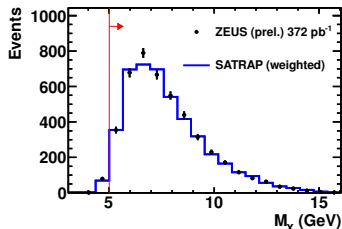
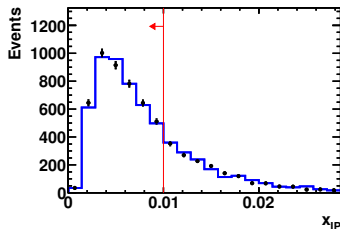
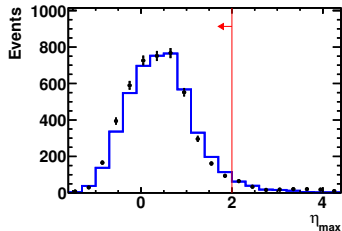
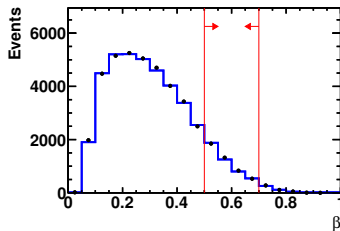
$$y_{cut} = 0.15$$

- if  $y_{ij} < y_{cut}$  then  $i$  and  $j$  are merged
- every particle must be clustered into a jet



# *Diffractive Control Distributions*

## ZEUS

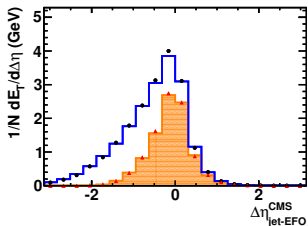
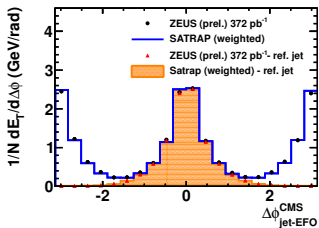


good description of data by MC

# Transverse Energy Flows

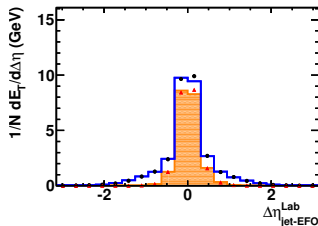
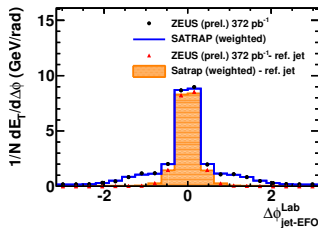
$\gamma^*$  – IP CMS

ZEUS



Laboratory Frame

ZEUS



Weighted SATRAP describes the jet shape of exclusive dijets

# Hadron Level

*Kinematic range to which data are unfolded*

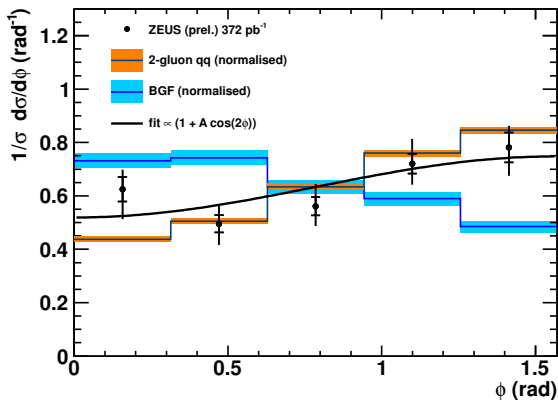
$$\begin{aligned} 90 \text{ GeV} < W < 250 \text{ GeV} \\ 25 \text{ GeV}^2 < Q^2 \\ x_{\mathcal{P}} < 0.01 \\ 0.5 < \beta < 0.7 \\ n_{jets} = 2 \\ 2 \text{ GeV} < p_{T \text{ jet}} \end{aligned}$$

*Unfolding and Regularisation*

- TSVDunfold (Nucl. Instrum. Meth. A372 (1996) 469-481)  
Singular Value Decomposition with Regularisation

# Results

## ZEUS



$$d\sigma \propto 1 + A \cos(2\phi)$$

negative  $A$  coefficient  
favours 2-gluon exchange  
model

$$A = -0.18 \pm 0.06(\text{stat.})_{-0.09}^{+0.06}(\text{sys.})$$

# Summary

- transverse energy flows as functions of pseudorapidity and azimuthal angle have been measured
- the shape of the azimuthal angular distribution of exclusive dijets in diffractive DIS has been measured for the first time at HERA
- the data favour 2-gluon exchange model of quark anti-quark production over BGF

*Thank You for Your Attention!*