Exclusive Dijet Production in Diffractive Deep Inelastic Scattering at HERA

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The only lepton-proton collider

HERA II(2003-2007)

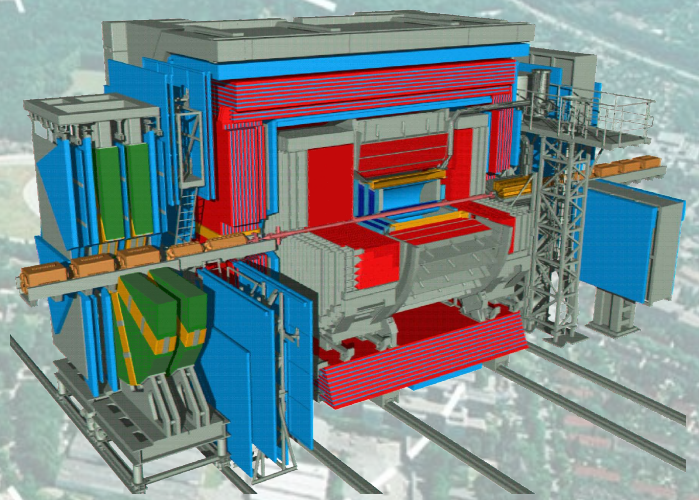
$L = 372\,pb^{-1}$

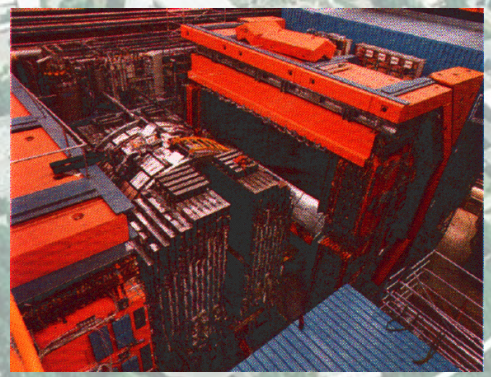
$E_{lepton} = 27.5\,GeV$

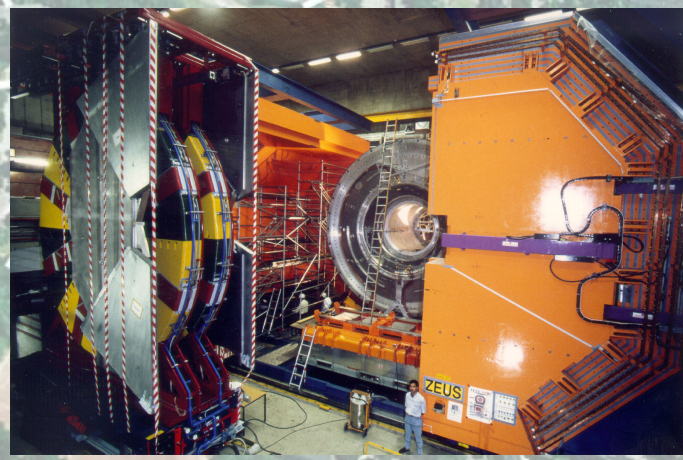
$E_{proton} = 920\,GeV$

$\Downarrow$

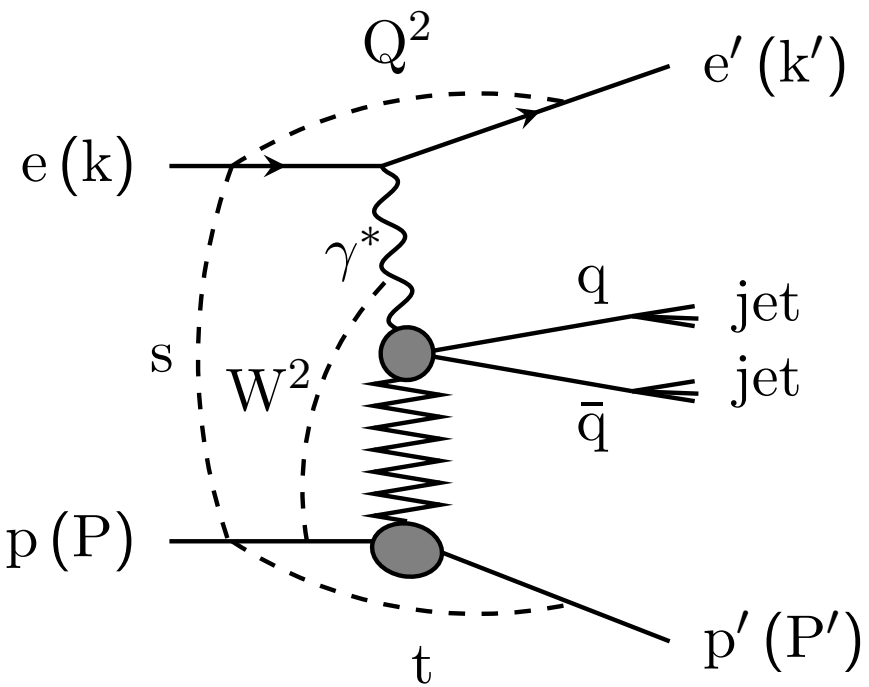
$\sqrt{s} = 318\,GeV$







Kinematic variables



DIS

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

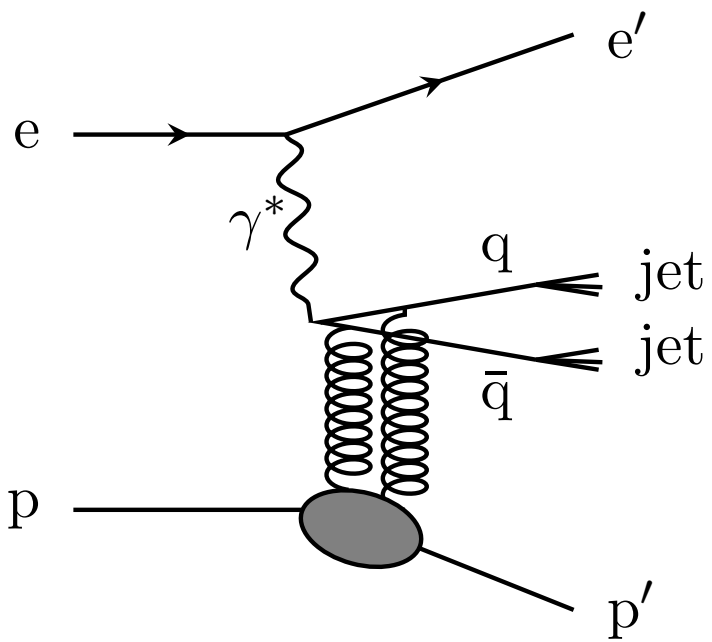
Diffraction

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

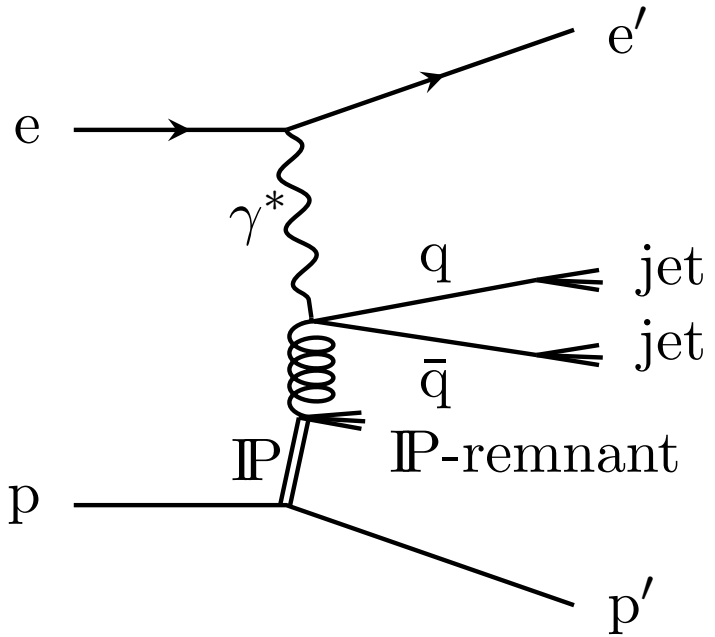
Diffractive Dijet Production Mechanisms

Phys. Lett. B386 (1996) 389-396

2-gluon exchange



Boson-Gluon Fusion

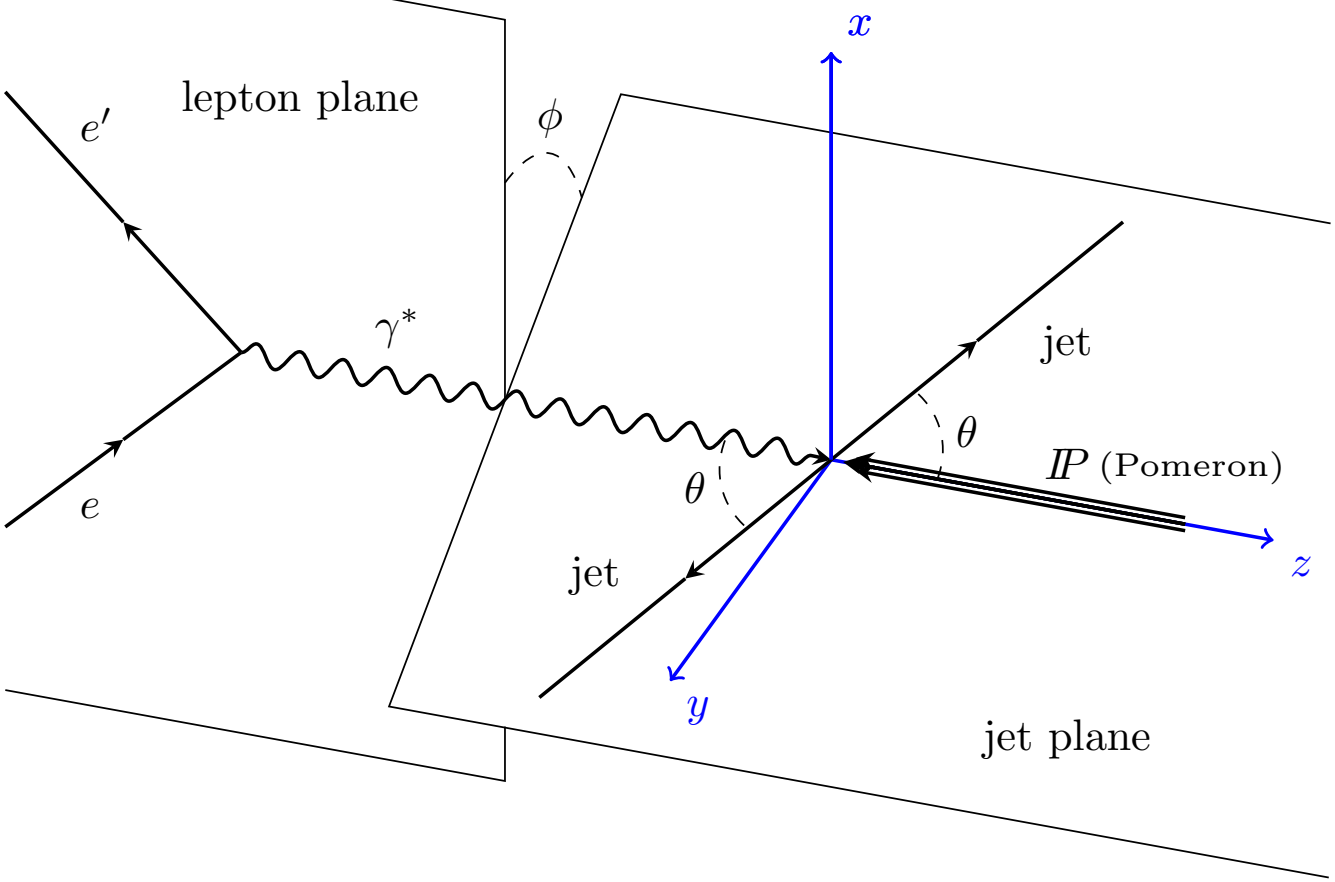


fully perturbative calculations based on proton PDF

calculations based on pomeron structure functions

Diffractive Dijet Production in $\gamma^* - \mathbb{P}$ CMS

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



- ϕ - angle between lepton and jet planes
- θ - polar angle of a jet

Parton Level Azimuthal Angular Distribution

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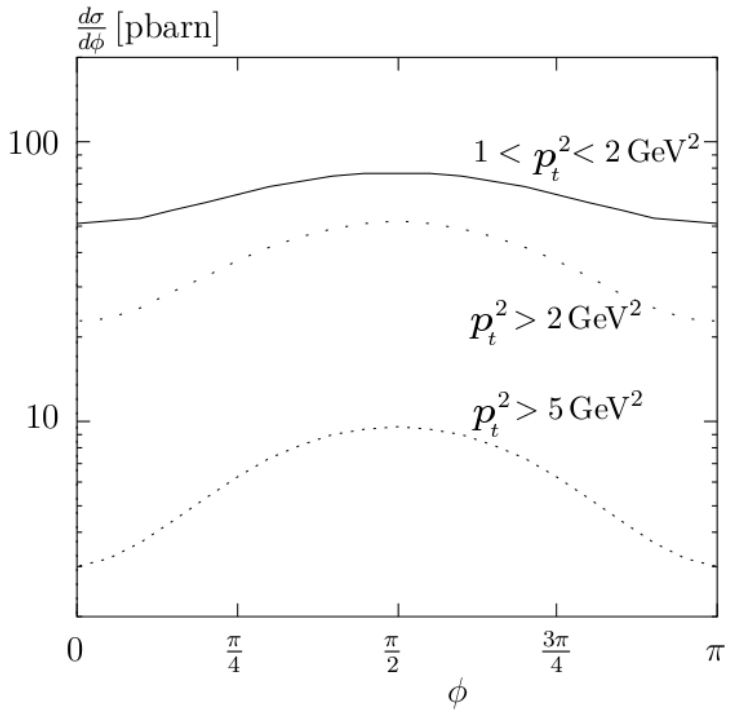
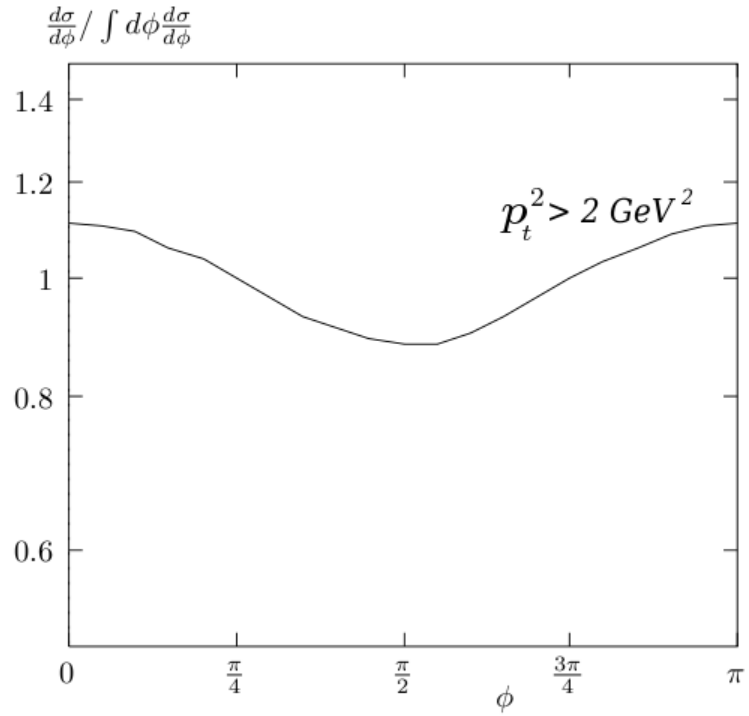
2-gluon exchange



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 ϕ distributions of the dijet sample required hadron level reweighting

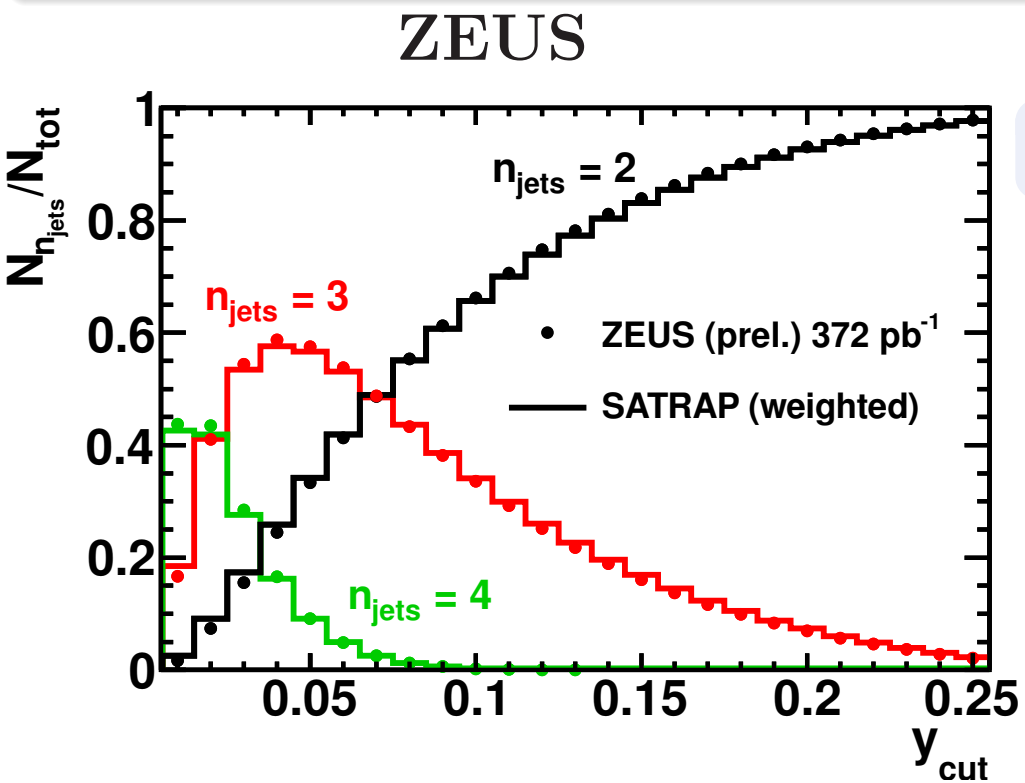
Hadron Level Predictions

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

Durham Exclusive k_t Jet Algorithm (FastJet)

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

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



$y_{cut} = 0.15$

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

Transverse Energy Flows

γ^* – IP CMS

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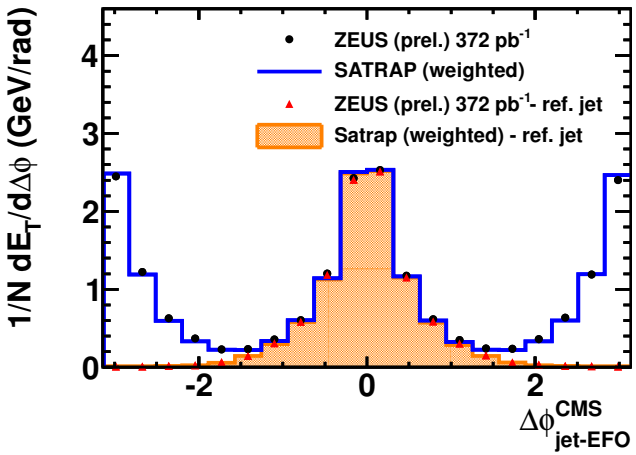
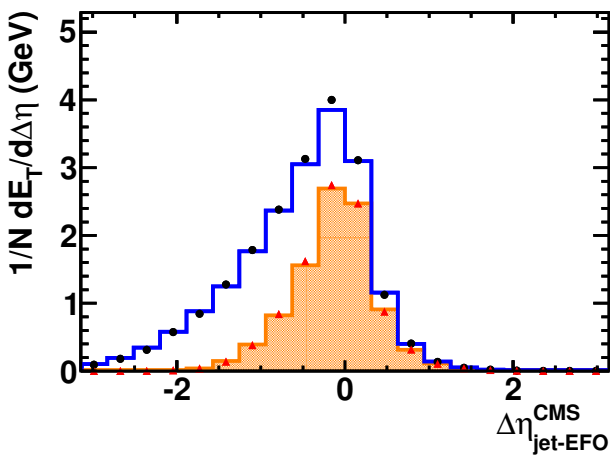
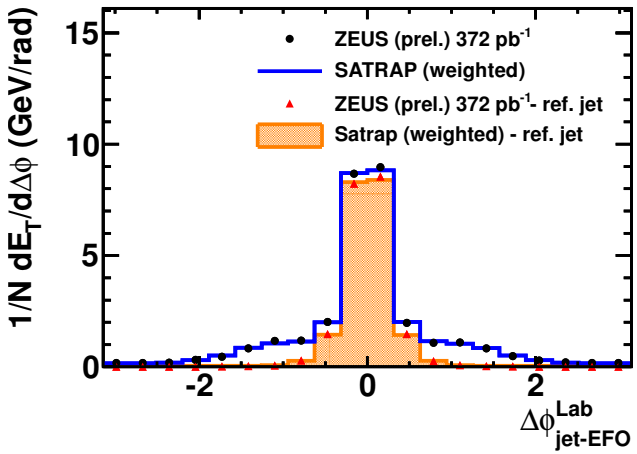
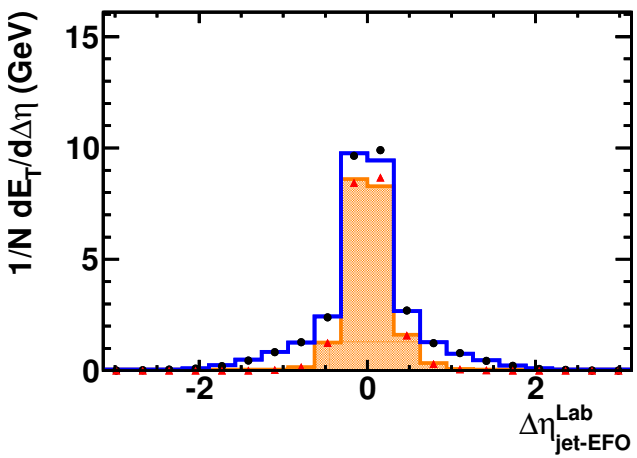




Laboratory Frame

ZEUS





ref. jet
i.e. jet with higher p_T in lab. frame

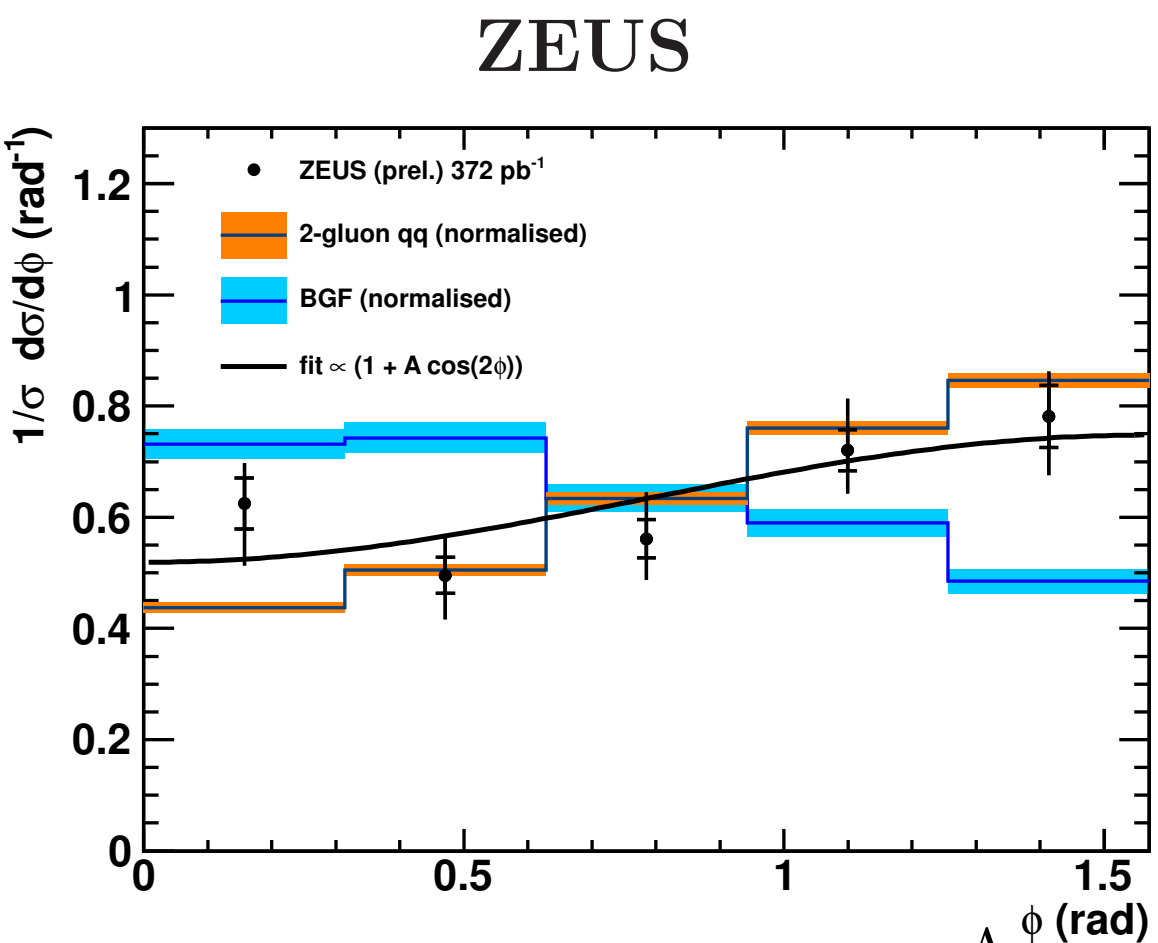
Weighted SATRAP describes the jet shape of exclusive dijet sample in both CMS and laboratory frames

Kinematic range to which data are unfolded

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

Unfolding and Regularisation

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



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

negative A coefficient favours 2-gluon exchange model

	A	χ^2/NDF
fit	$-0.18 \pm 0.06(\text{stat.})^{+0.06}_{-0.09}(\text{sys.})$	4.11/3
2-gluon(qq) MC	$-0.34 \pm 0.01(\text{stat.})$	
BGF MC	$0.21 \pm 0.02(\text{stat.})$	

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!