Jet production at HERA

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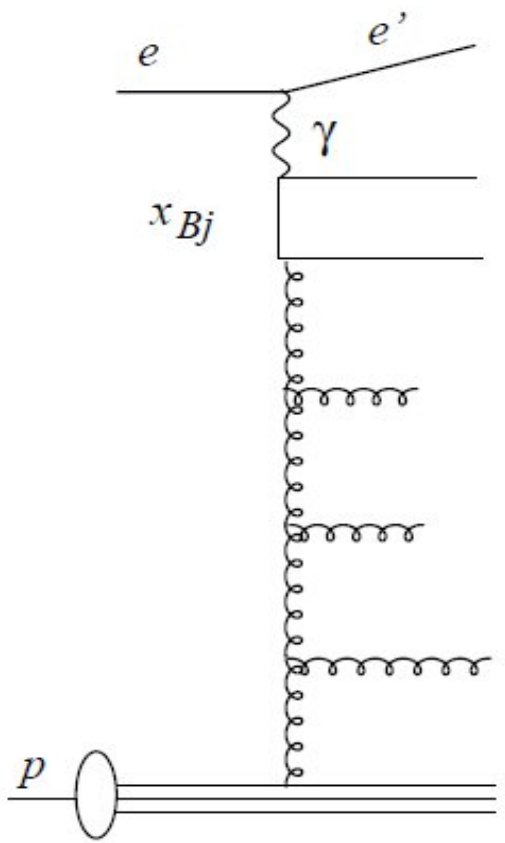
Forward Jets in DIS at HERA

Forward jets are studied in deep inelastic ep collisions at HERA for different Q^2, p_T^2 and x.



The Deep Inelastic Scattering (DIS) consists of the deflection of a lepton that collides against a nucleon.

Forward jets are emitted close to the proton original direction.

All the analyses were performed with Rivet, a C++ tool for validation of Monte Carlo event generator.

Then the results were compared with HZTool (Fortran based system) validation plots found in literature.

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Investigating BFKL effect in ranges of E^2/Q^2 and x-bj with RAPGAP and ARIADNE

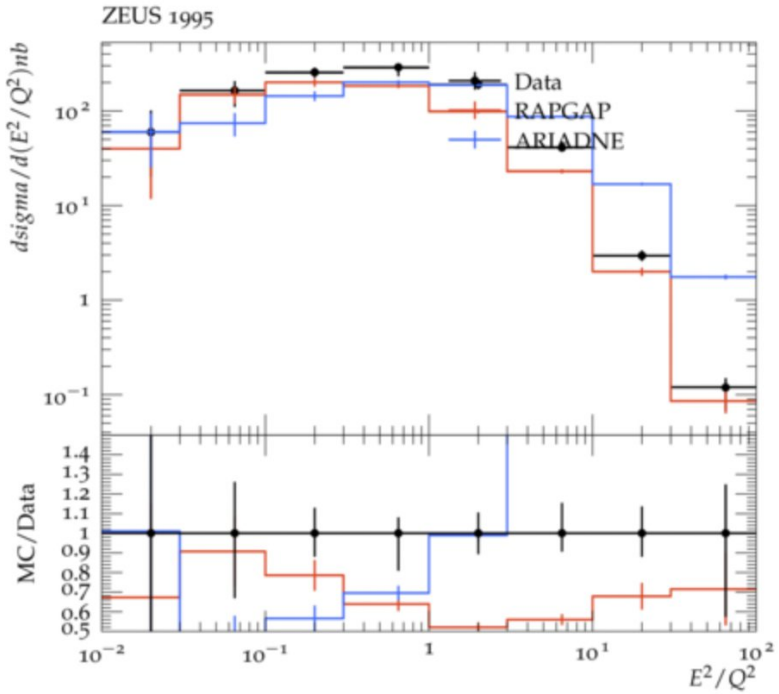
	DGLAP	BFKL
Ordering	Strong order in k_T	Strong order in x
Leading terms	$ln(Q^2)$	$\ln(\frac{1}{x})$
Dominant region	$Q^2 \gg p_T^2$	$Q^2 \approx p_T^2$, $x_{jet} \gg x_{bj}$

$$E_{e'} > 10 \text{ GeV}$$
$$y > 0.1$$
$$\eta_{Jet} < 2.6$$
$$E_{T,Jet} > 5 \text{ GeV}$$
$$x_{Jet} > 0.036$$
$$0.5 < E_{T,Jet}^2/Q^2 < 2$$
$$p_{Z,Jet}(Breit) > 0$$
$$4.5 \cdot 10^{-4} < x < 4.5 \cdot 10^{-2}$$

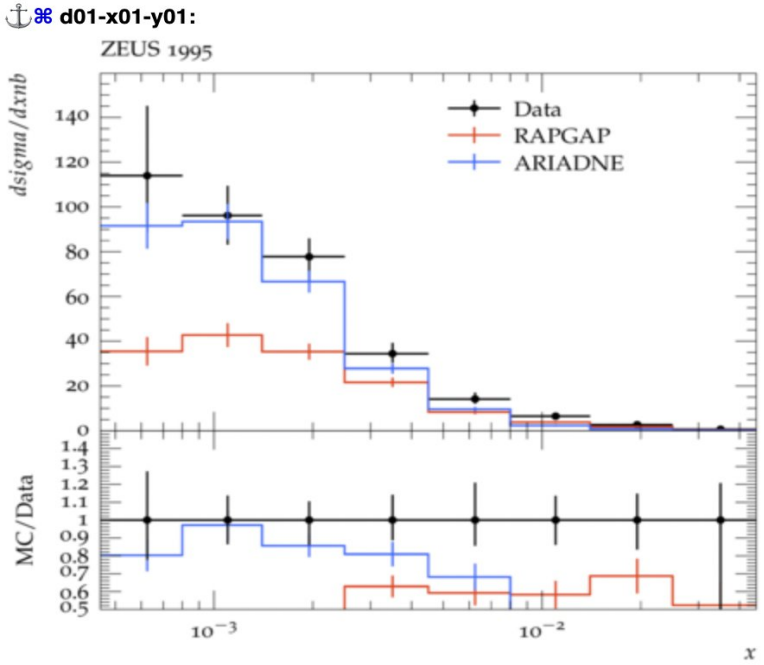
(Only applied for x-bj)

Source: https://inspirehep.net/literature/470499

Validation plots from Rivet plug-in



$0.5 < E^2_{T,Jet}/Q^2 < 2$



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Low $\frac{E^2}{Q^2}$ -- DGLAP

$\frac{E^2}{Q^2} \approx 1$ -- BFKL

$\frac{E^2}{Q^2} \gg 1$ -- no mechanism fit -- photoproduction

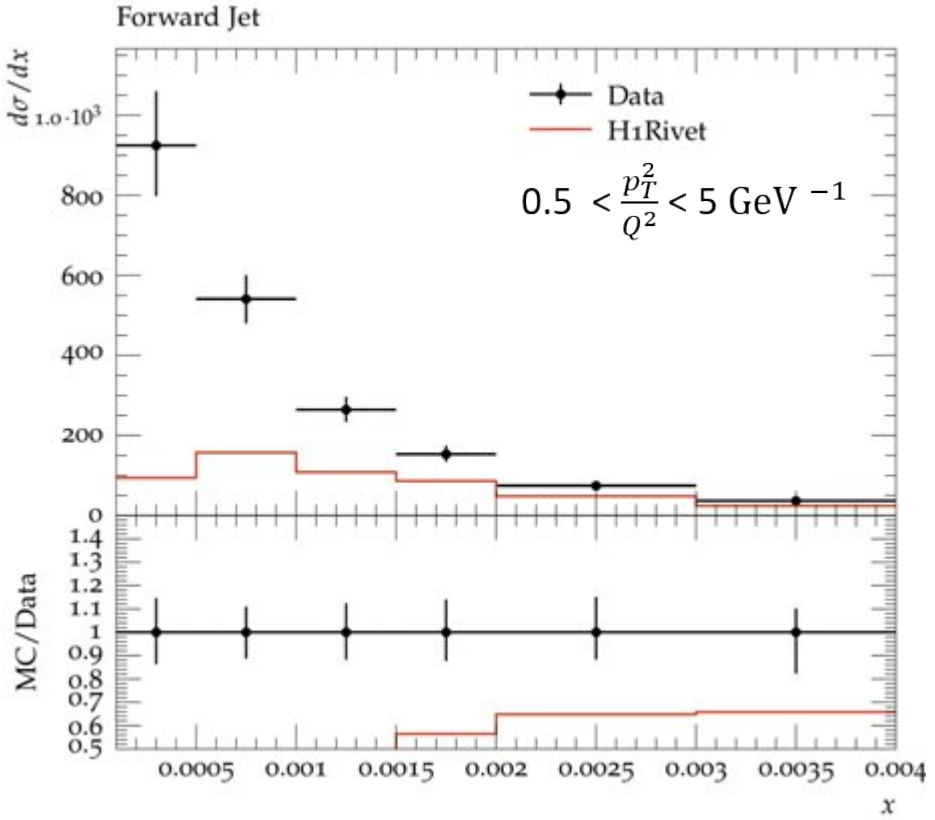
Experiment shows higher cross-section at low xbj --BFKL

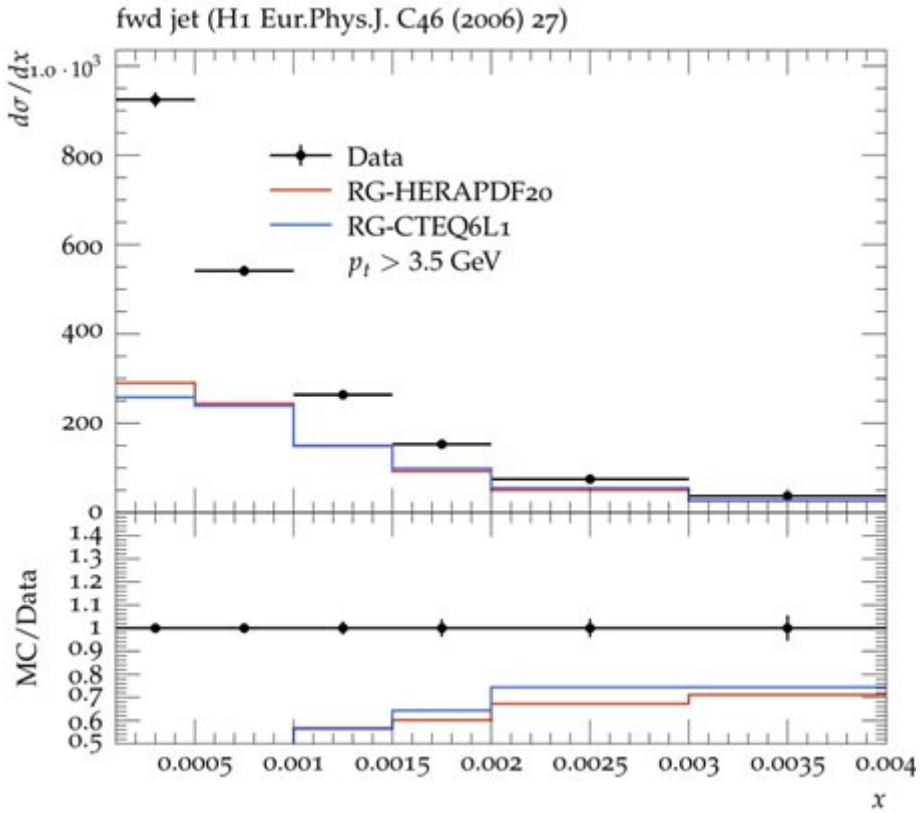
Single Differential Cross Section at low x & Validations

H1 detector and beam properties:

- Integrated luminosity: 13,7 pb^{-1}
- Proton energy: 820 GeV
- Positron energy: 27.6 GeV
- Centre-of-mass energy: 300 GeV

Scattered electron	DIS variables	Forward Jet
$E'_e > 10$ GeV	$5\ \mathrm{GeV}^2 < Q^2 < 85\ \mathrm{GeV}^2$	$p_{t,jet} > 3.5\ GeV$
$156° < \theta_e < 175°$	$0.0001 < x_{bj} < 0.004$	$x_{jet} > 0.035$
	$0.1 < y < 0.7$	$7° < \theta_{jet} < 20°$





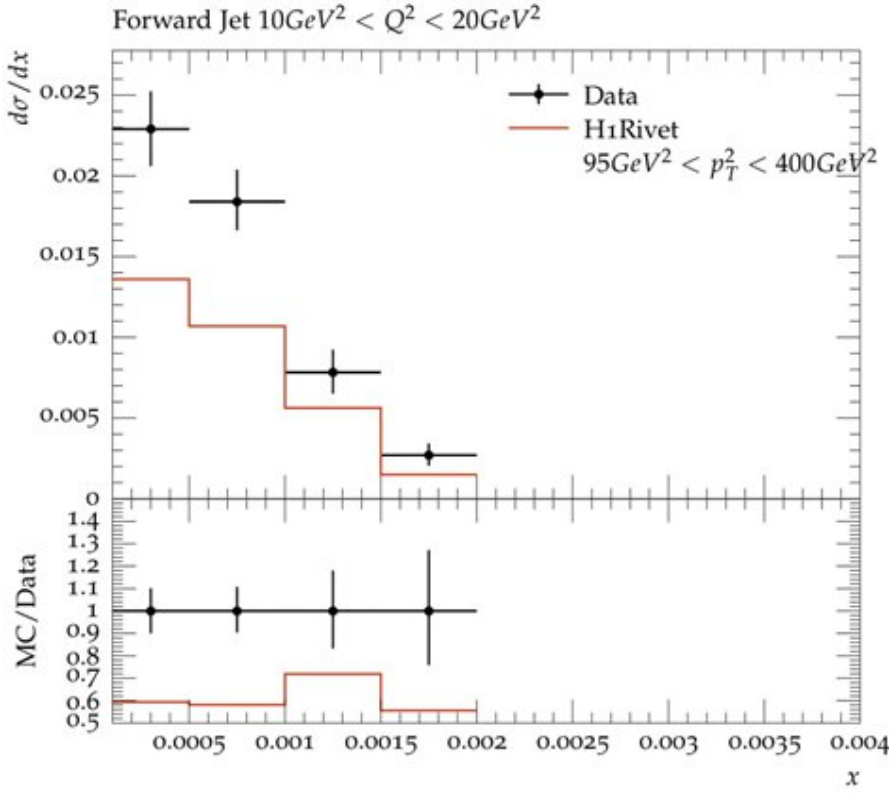
Source: https://inspirehep.net/literature/690939

Triple Differential Cross Section at low x & Validations

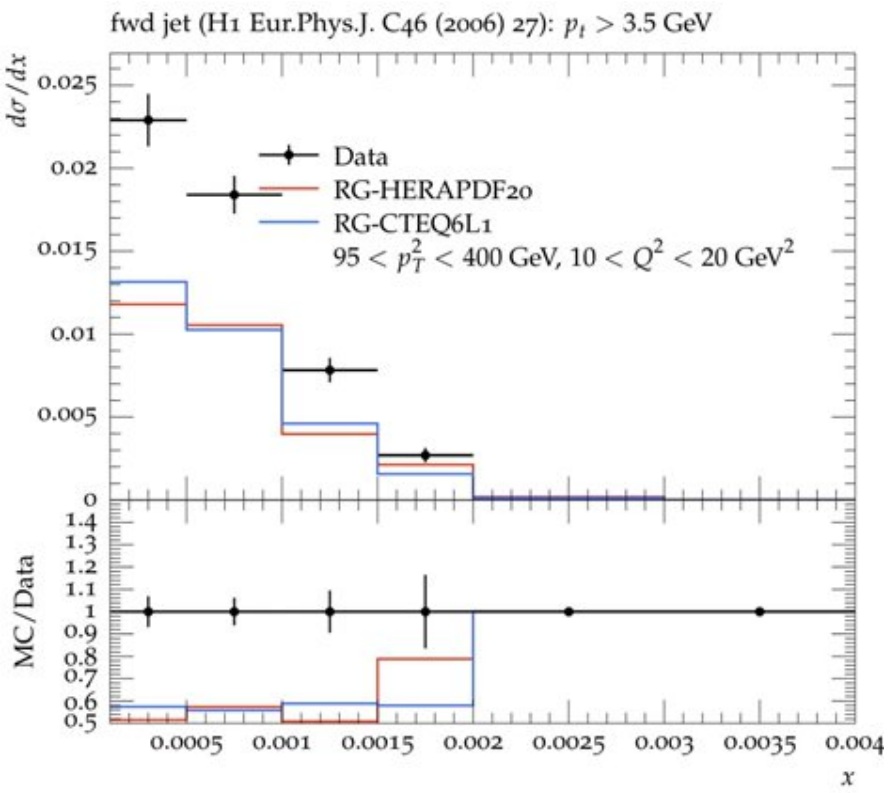
Triple differential cross section as function of x, in bins of Q^2 and p_T^2 in 3 different kinematic regions.

- $Q^2 >> p_T^2$ DGLAP model
- $Q^2 \sim p_T^2$ BFKL model
- $Q^2 >> p_T^2$DGLAP + Resolved models

Results obtained with Rivet



Results obtained with HZTool Analysis



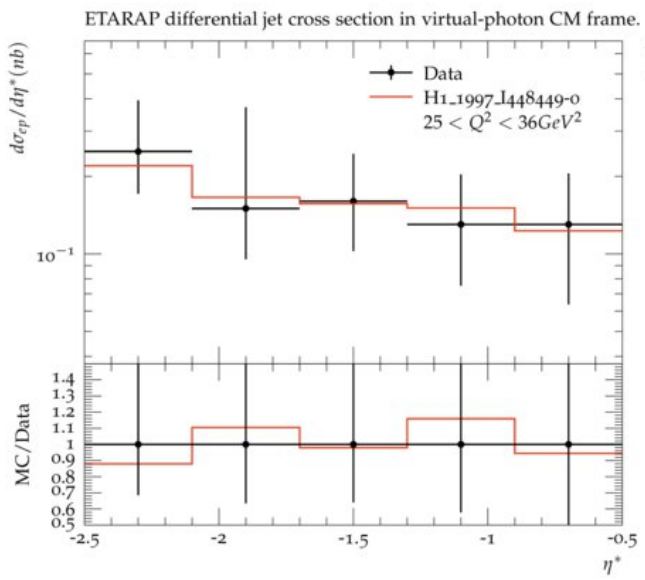
The cross sections predicted by the DGLAP direct model are consistently too low.

Low Q^2 jet production at HERA and virtual photon structure

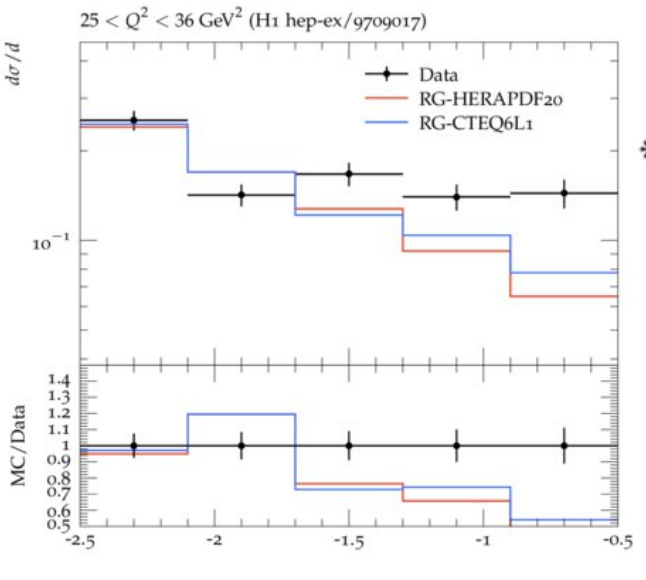
Condition	
Q^2	0.65 to 49 GeV^2
y	0.3 to 0.6
E_t^*	>5 GeV (only for Eta* plot)
η^*	-2.5 to 0.5
Frame	HCM frame

The η^* differential jet cross section in the virtual-photon CM frame

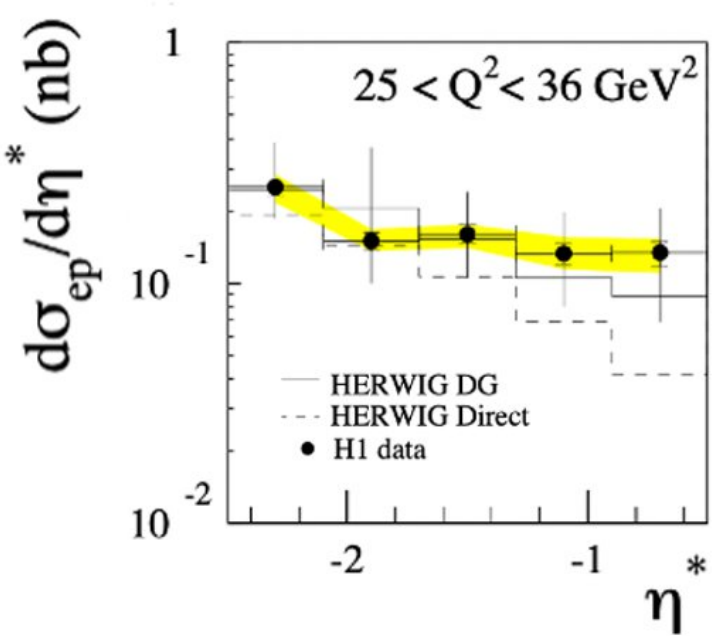
Result obtained from Rivet



Result obtained from HZToolAnalysis



Result in paper

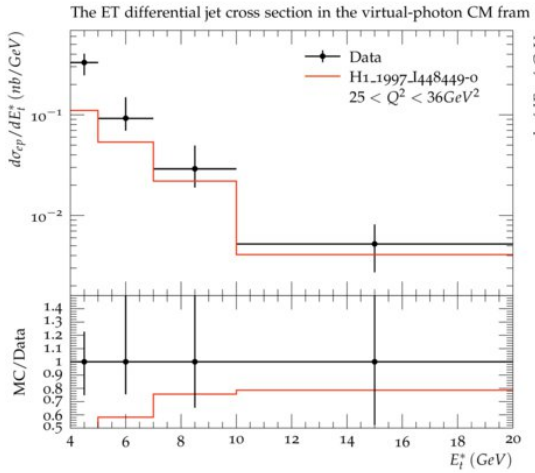


- Result is good agreement with the data at high Q^2.

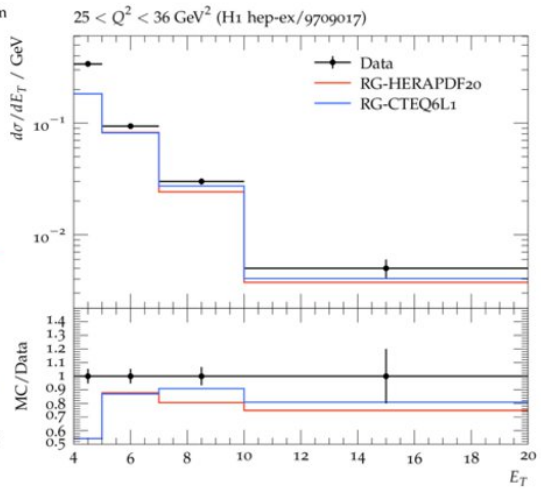
Low Q^2 jet production at HERA and virtual photon structure

The E_t^* differential jet cross section in the virtual-photon CM frame

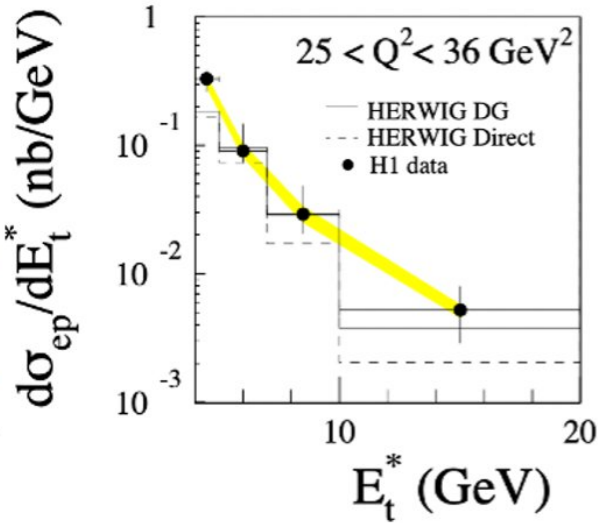
Result obtained from Rivet



Result obtained from HZToolAnalysis



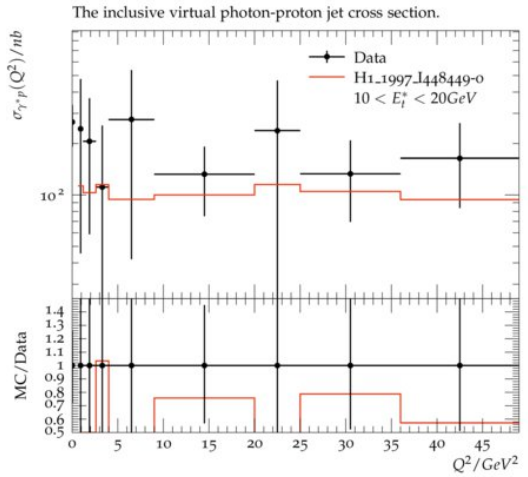
Result in paper



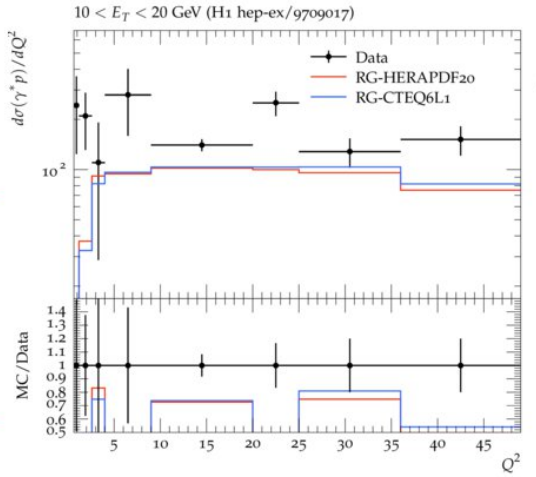
- Result is in good agreement with the data at high E_t^*.

The inclusive γ^*p jet cross-section $\sigma_{\gamma^*p}(Q^2)$

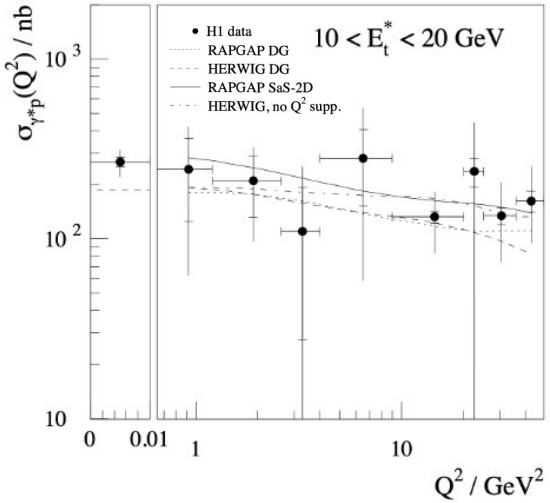
Result obtained from Rivet



Result obtained from HZToolAnalysis



Result in paper



Forward Π^0 meson production at HERA

Theory and previous results

Particle type	Event type	Event selection cuts	Kinematic cuts
High transverse momentum Π^0 mesons measured with the H1 detector at HERA.	Deep-inelastic ep scattering events at low Bjorken-x, down to x ≈ 4·10−5	• $0.1 < y < 0.6$, • $2 < Q^2 < 70$ GeV^2	• pt > 2.5 GeV • 5º< θ<25º(lab) • x > 0.001

Previous result:

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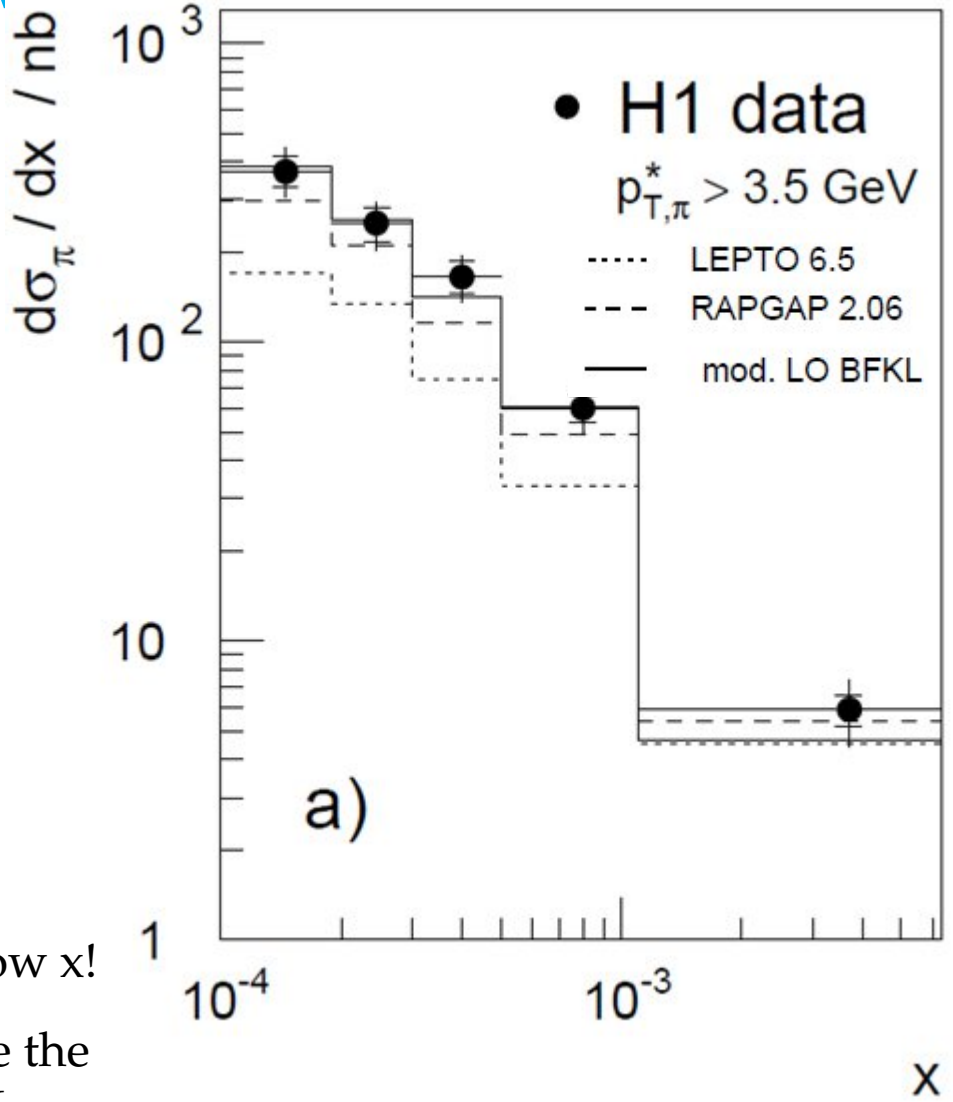
o The DGLAP prediction for point like virtual photon scattering (including parton showers): LEPTO6.5 -> far from an agreement at low x!

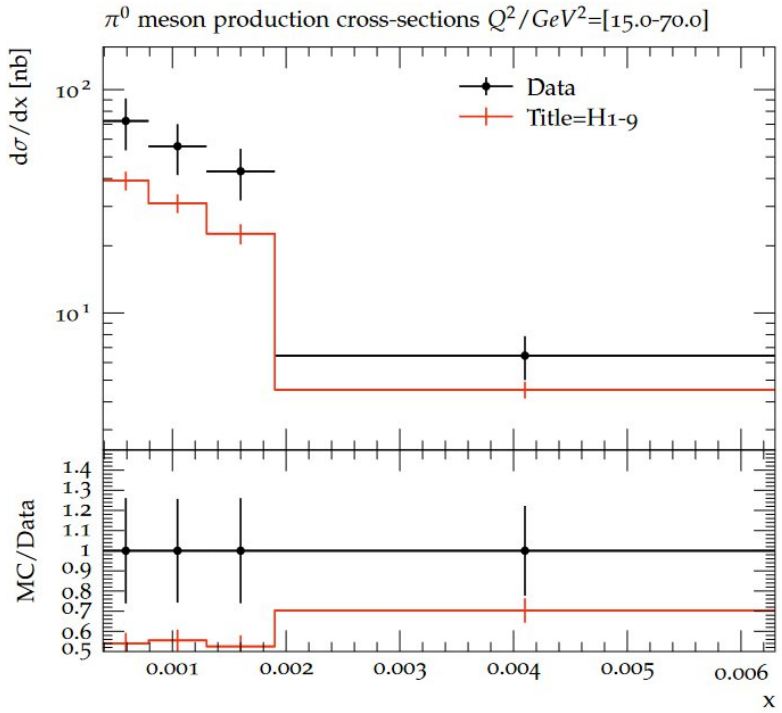
o A considerable improvement including additional processes where the virtual photon entering the scattering process is resolved -> BFKL calculations needed



Source: [PhysicsLettersB 462, (1999) H1 Collab., C. Adloffet al](#).

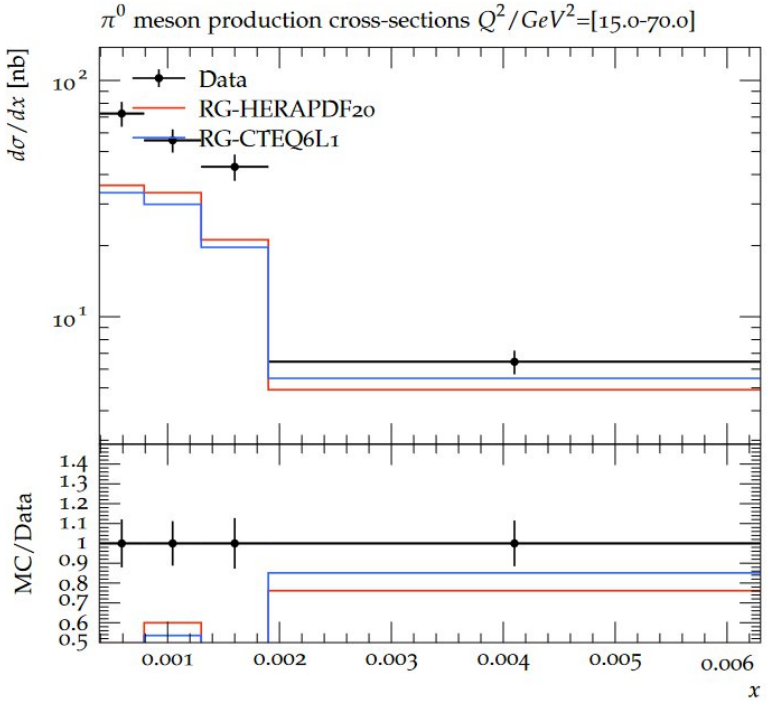
Forward Π^0 meson production at HERA

Validation results



Result obtained using Rivet

Experimental manifestation of leading ln 1/x (pQCD evolution)

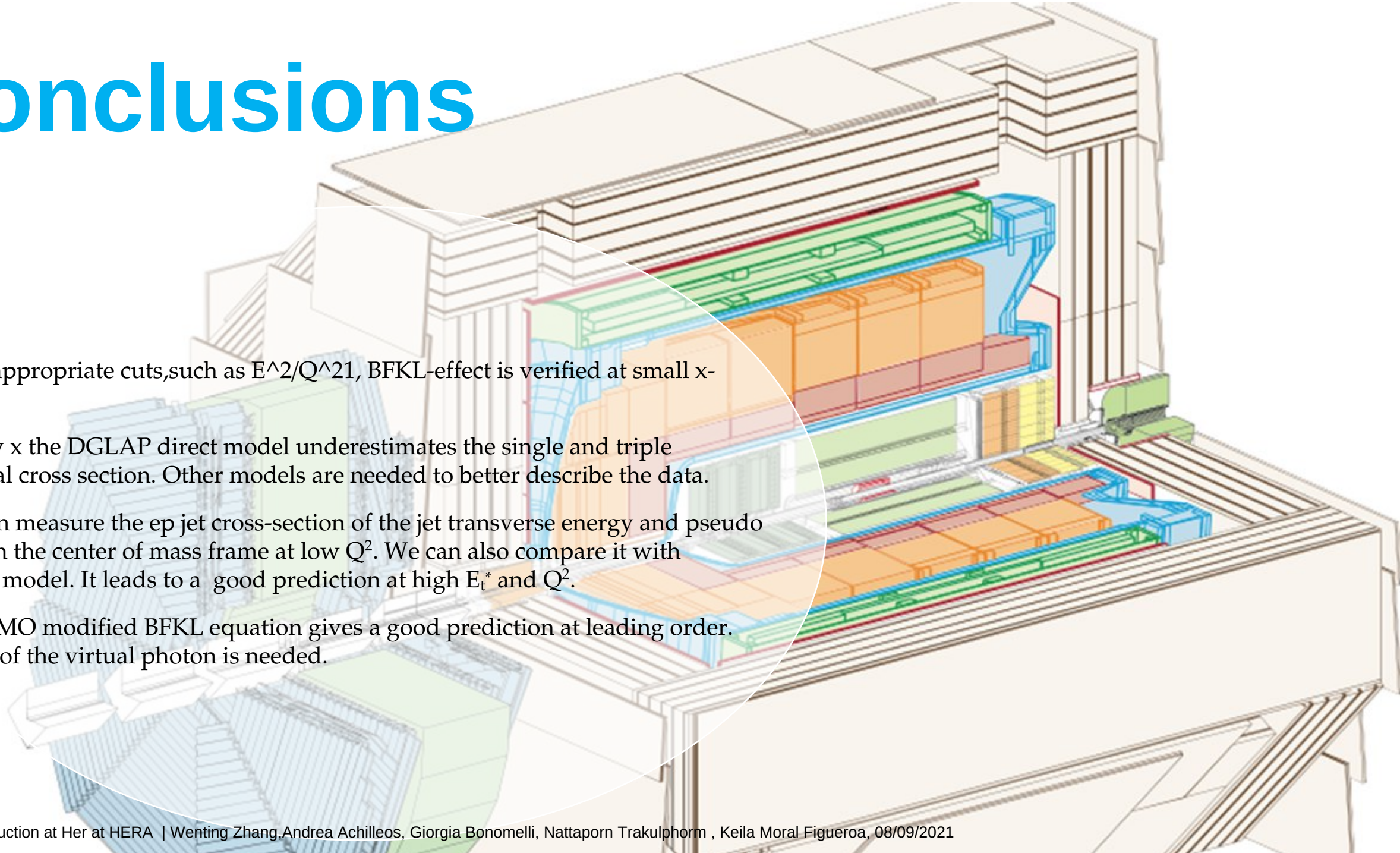


Result obtained with HZToolAnalysis

Validation result:

o The prediction given by Rivet is in agreement with the validation result but there is a factor of approx. 0.5 between the data and the prediction

Conclusions



•1. With appropriate cuts,such as E^2/Q^21, BFKL-effect is verified at small x-Bjorken.

•2. At low x the DGLAP direct model underestimates the single and triple differential cross section. Other models are needed to better describe the data.

•3. We can measure the ep jet cross-section of the jet transverse energy and pseudo rapidity in the center of mass frame at low Q^2. We can also compare it with HERWIG model. It leads to a good prediction at high E_t^* and Q^2.

•4. The KMO modified BFKL equation gives a good prediction at leading order. Inclusion of the virtual photon is needed.

Thank you

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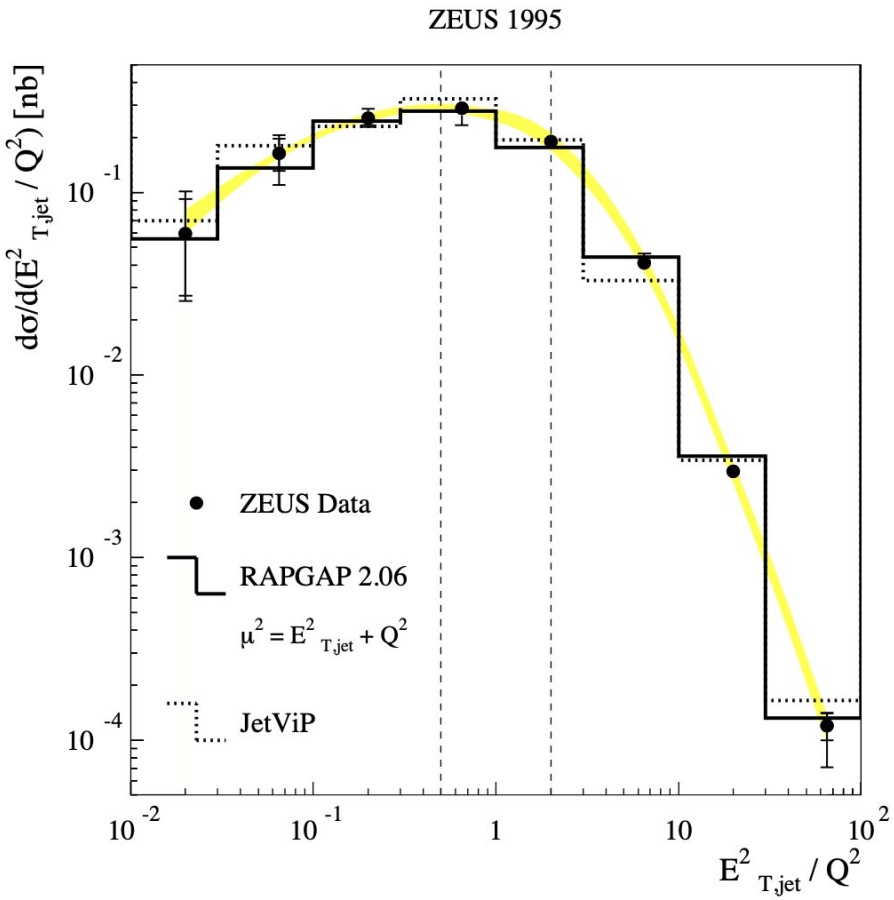
Backup

DESY.



Source: https://inspirehep.net/literature/470499

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DESY.

Forward Π^0 meson production at HERA

Why single particles instead of jets?
- Not jet algorithm is needed
- Smaller angles
- Direct comparison with the theory

Why high transverse momentum?
- Greater sensitivity to hard parton emission in the QCD cascade.
- Reduces the influence of soft hadronization

At high Q^2 & high Bjorken-x	At high Q^2 & low Bjorken-x
$\alpha_s \ln(Q^2/Q_o^2)$ terms -> DGLAP equation	leading ln 1/x terms becomes important -> BFKL equation.

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