The Partonic Structure of Quasi-Real Photons

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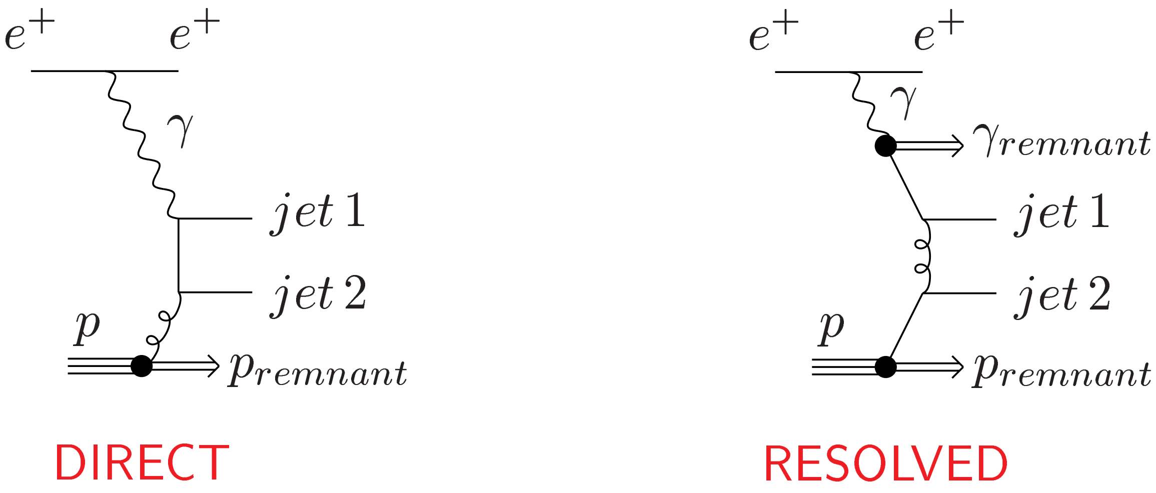
On behalf of ZEUS and H1.

Dijet photo production (leading order picture):



$$\sigma^{\gamma p}_{resolved} \sim \sum_{ij} f_i^{\gamma}(x_\gamma, \mu_F^2)\, |M_{ij}|^2\, f_j^p(x_p, \mu_F^2)$$

(ij stands for: gg, gq, qq)

$$y \approx \frac{E_\gamma}{E_e} \quad (W_{\gamma p} = \sqrt{ys})$$

$$E_T^{jet} \;\&\; \eta^{jet} \quad (\eta \equiv -ln(tan\frac{\theta}{2}))$$

$$x_\gamma^{obs} (= x_\gamma^{jets}) = \frac{E_{T1} e^{-\eta_1} + E_{T2} e^{-\eta_2}}{2yE_e}$$

H1 dijet measurement: The gluon density in the photon

Single Effective Subprocess approximation
(Combridge & Maxwell Nucl. Phys. B239(1984)429):

gg, gq, qq scattering dominated by t-channel gluon exchange

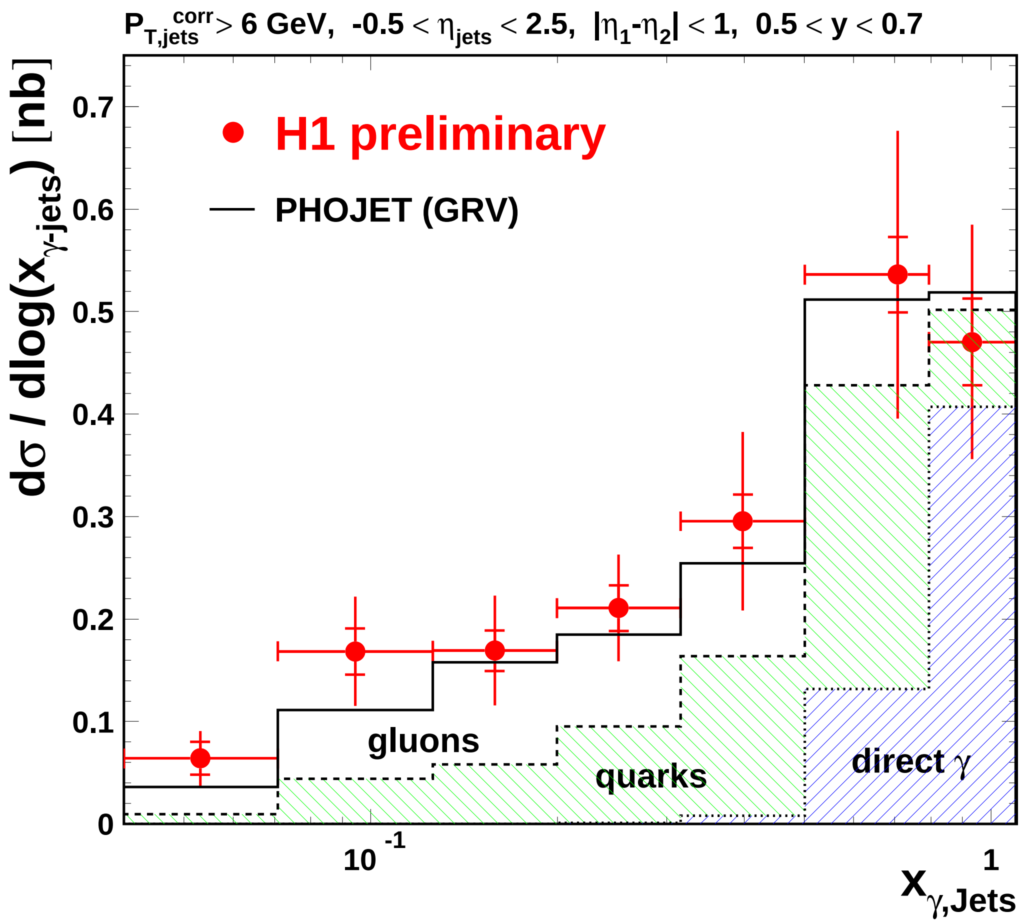
$\sigma^{\gamma p}_{resolved} \sim f^{\gamma}_{SES}(x_\gamma, \mu_F^2)\,|M_{SES}|^2\, f^{p}_{SES}(x_p, \mu_F^2)$

where:

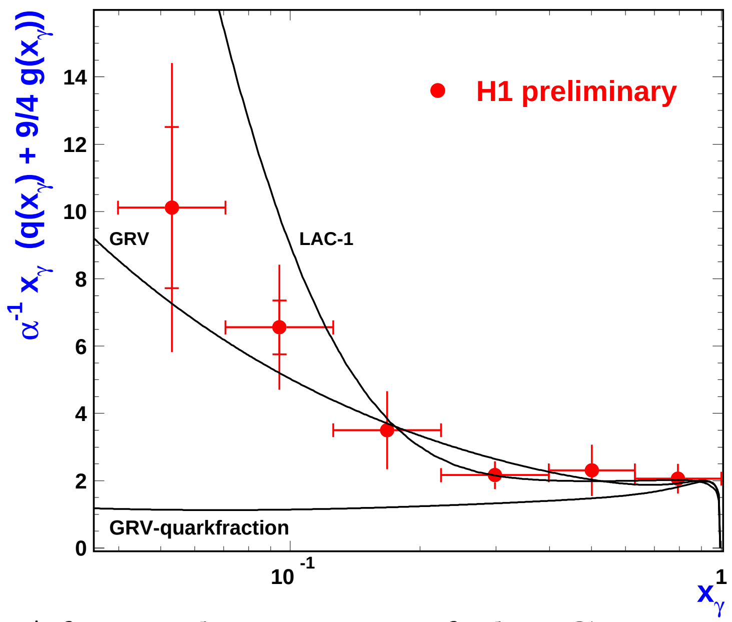
$f_{SES} = \sum_{i=1}^{N_f}(q_i + \bar{q}_i) + \frac{9}{4}g$

H1 dijet measurement: $\frac{d\sigma(ep \to 2\, jets + X)}{dx_\gamma}$

Jets are determined with a cone algorithm ($R = 0.7$). and jet pedestals are subtracted.



Unfolding the gluon density



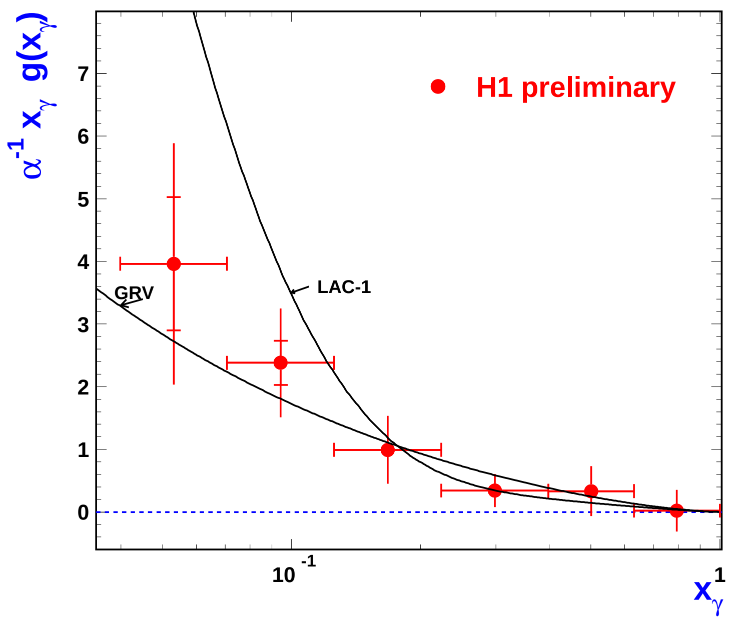
$f^\gamma_{SES}(x_\gamma)$

$(= \sum_{i=1}^{N_f}(q_i + \bar{q}_i) + \frac{9}{4}g)$

LAC1: very high gluon

GRV: low gluon

After subtraction of the GRV quarks, that agree with LEP data within 30%, one obtains the gluon density.



$g^\gamma(x_\gamma)$

GRV gluon density

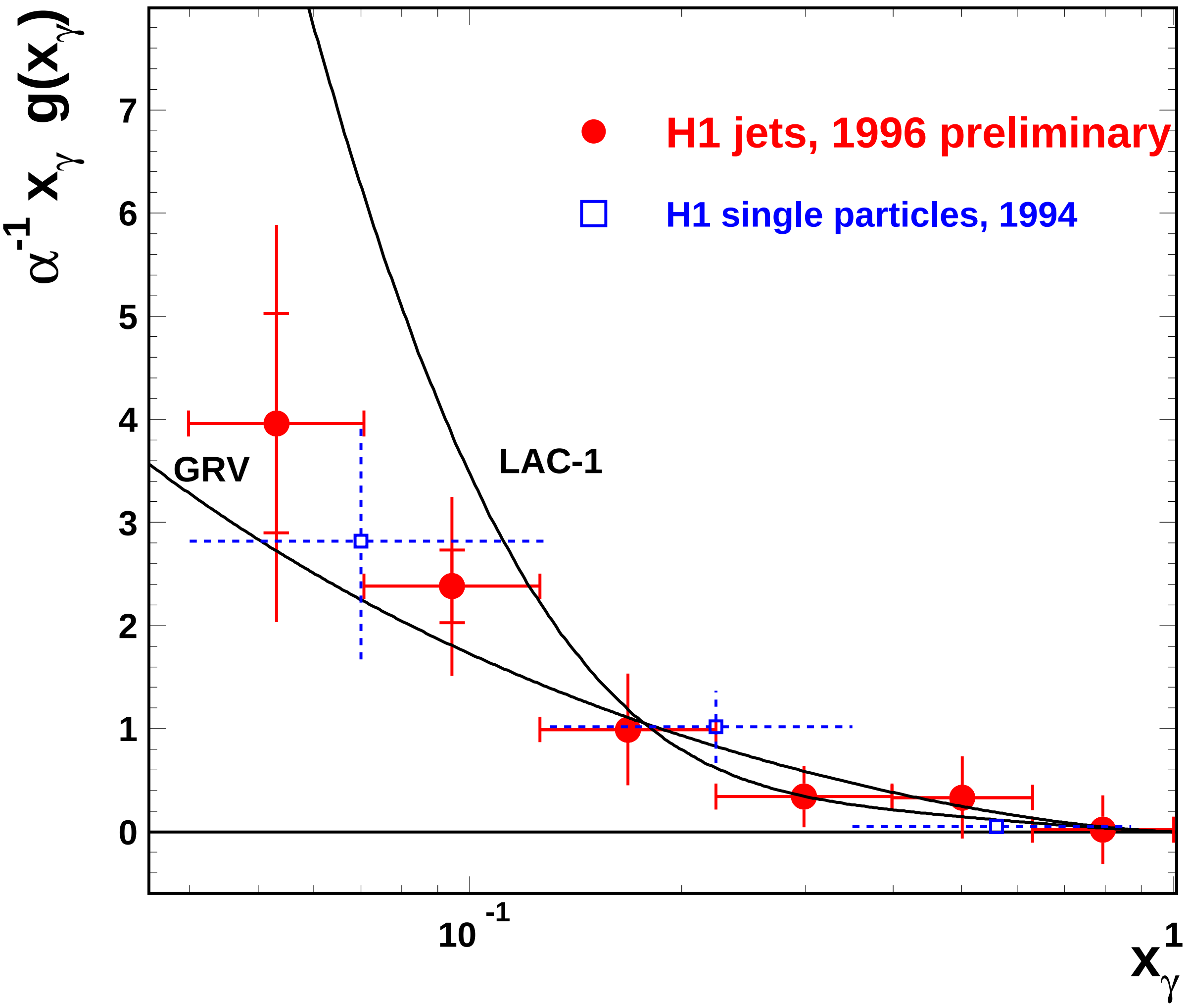
is favoured

Charged particle cross section: $\frac{d\sigma}{dx_\gamma}$

(Published in DESY-98-148)

At least one track with: $P_T > 2.6$ GeV

$$x_\gamma^{rec} = \frac{\sum P_T e^{-\eta}}{E_\gamma} (sum\, over\, all\, tracks\, with\, P_T > 2\, GeV)$$



ZEUS dijet measurement: $\frac{d\sigma(ep \to 2\,jets + X)}{dE_{T_{leading}}^{jet}\, d\eta_1^{jet}\, d\eta_2^{jet}}$

Quantitative comparison to NLO-QCD
sensitive to $q_\gamma(x_\gamma)$ at high x_γ

≥ 2 jets:

$$-1 < \eta^{jet} < 2$$

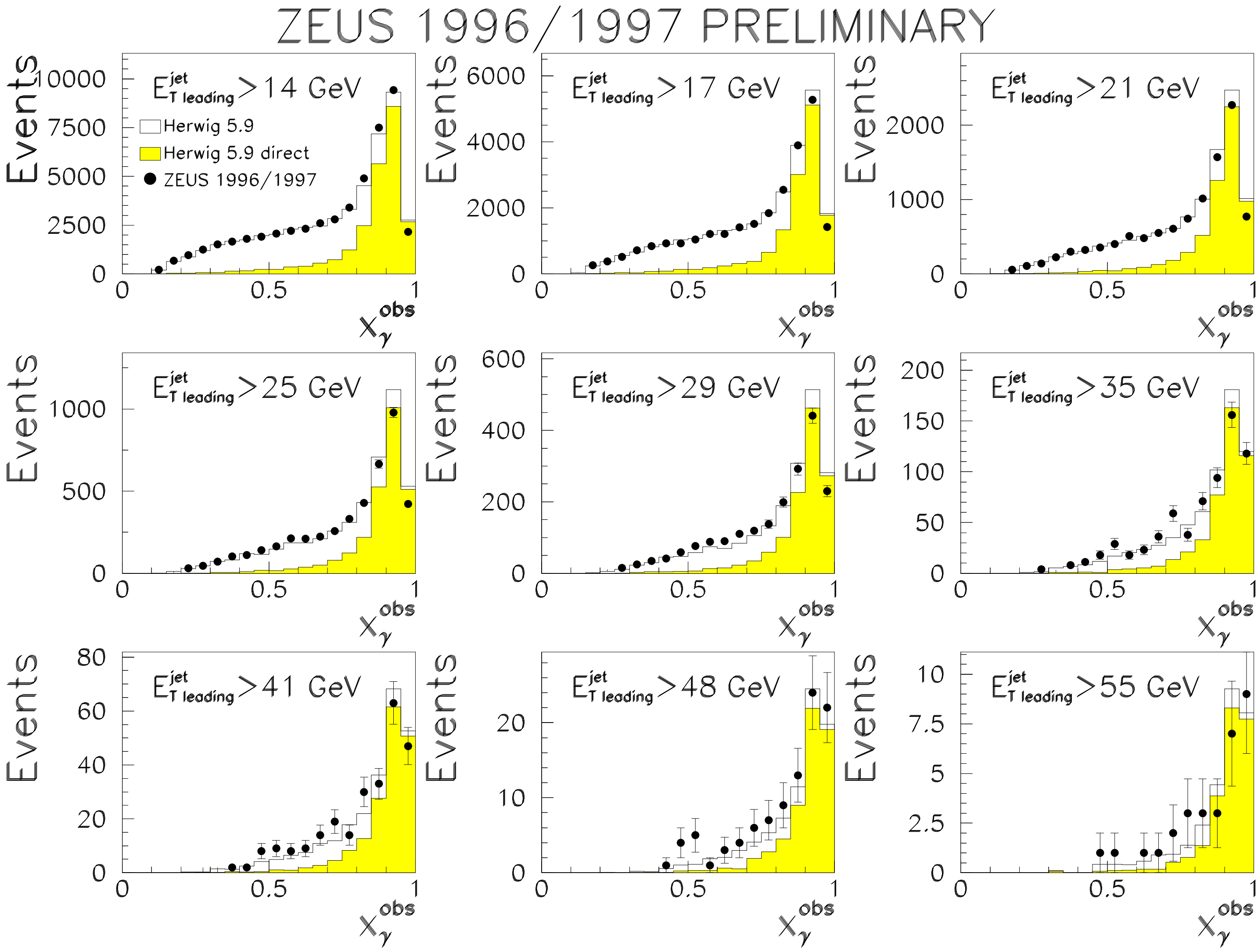
$$E_T^{leading\,jet} > 14\,GeV$$

$$E_T^{second\,jet} > 11\,GeV$$

$$0.20 < y < 0.85$$

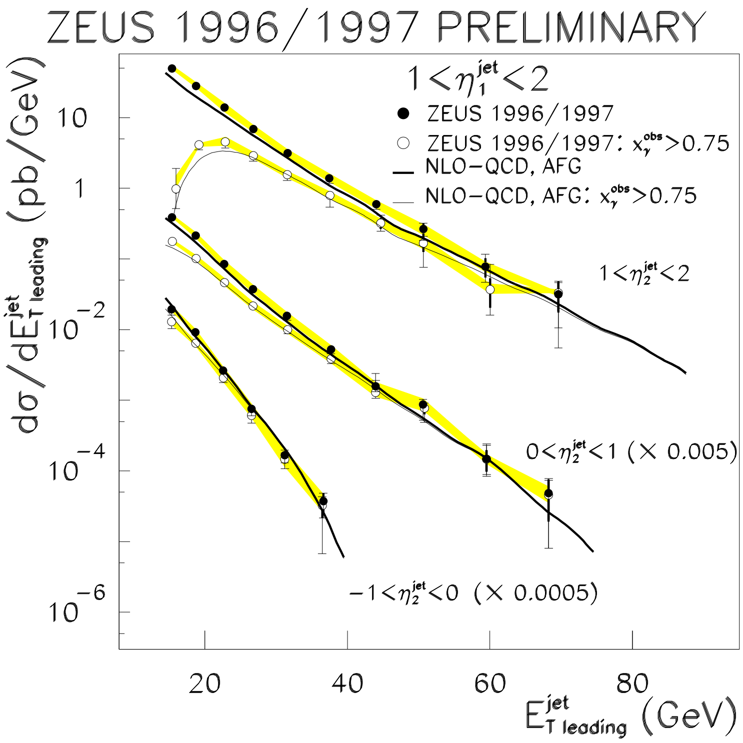
$$Q^2 < 1 \text{ GeV}^2$$

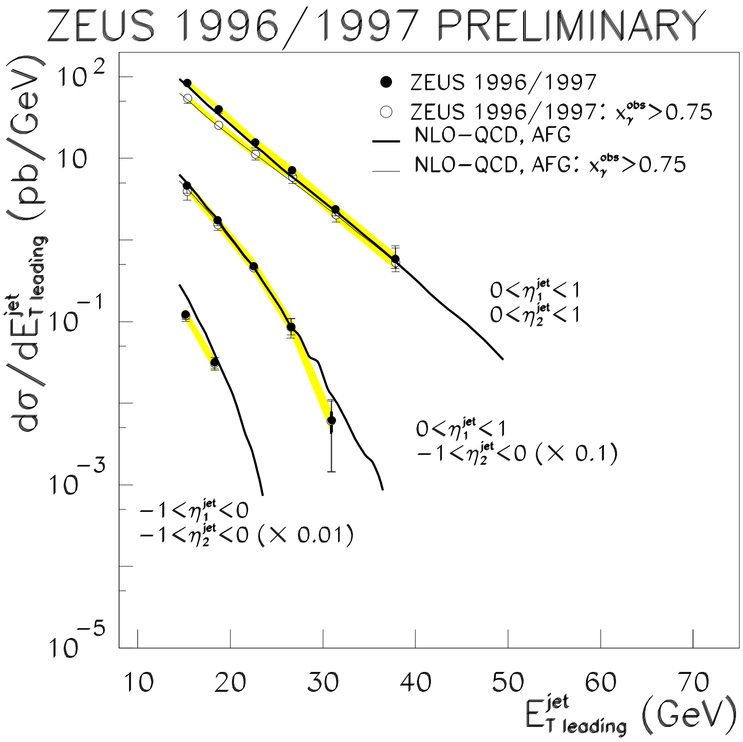
x_γ^{obs} distributions



⟹ MC: HERWIG 5.9 (without multiple interactions)

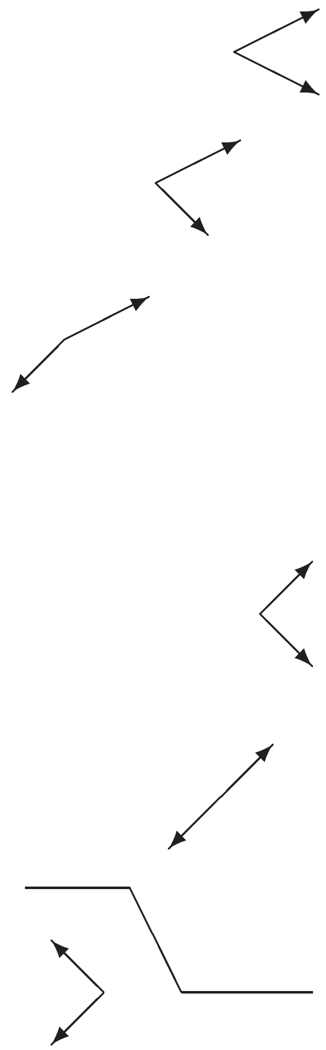
- no sensitivity to multiple interaction effects.
- direct dominates at high E_T^{jet}, but resolved is still needed.





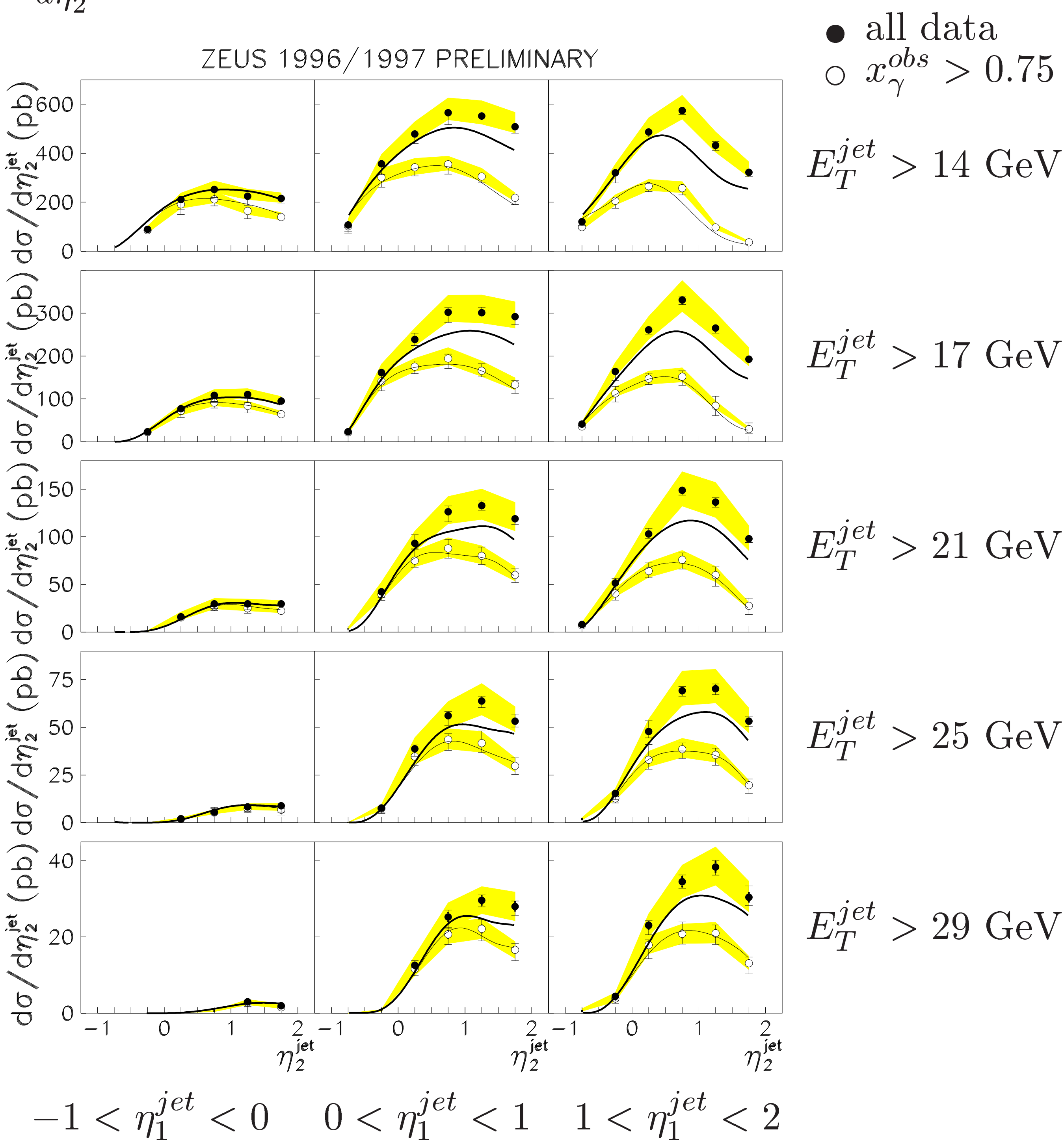
$$\frac{d\sigma}{dE_{T\,leading}^{jet}}$$

$\Longrightarrow$ proton direction

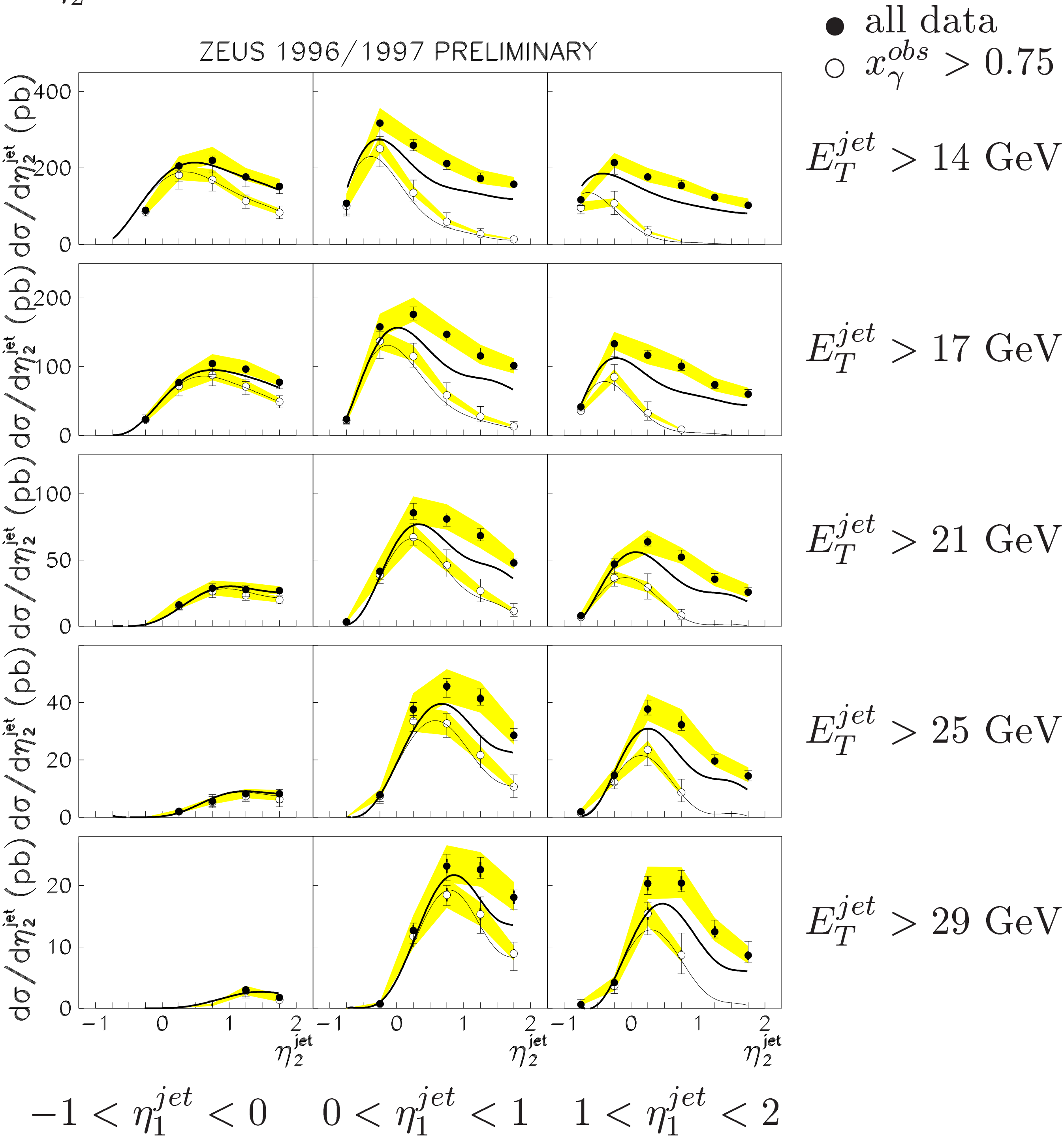


Good agreement except at forward η^{jets}

$\frac{d\sigma}{d\eta_2^{jet}}$: $E_{T\,leading}^{jet} > 14, 17, 21, 25\&29$ GeV, $0.20 < y < 0.85$.



$\frac{d\sigma}{d\eta_2^{jet}}$: $E_{T\,leading}^{jet} > 14, 17, 21, 25, 29$ GeV, $0.50 < y < 0.85$.



Summary

- ZEUS: $\frac{d\sigma(2\,jets)}{dE_{T_{leading}}d\eta_1 d\eta_2}$.
  Up to $E_T^{jet} > 29$ GeV the cross section is above NLO-QCD in a kinematic region where theoretical uncertainties are small. This suggests that quark densities are too low at relatively high x_γ and at a high scale.

- H1 $\frac{d\sigma(2\,jets)}{dx_\gamma}$ and $\frac{d\sigma(charged\ particles)}{dx_\gamma}$.
  $g^\gamma(x_\gamma)$ is unfolded for $0.04 < x_\gamma < 1$. The results favour the gluon density of GRV over LAC1.

- New HERA results provide information on the photon structure complementary to F_2^γ measurements in e^+e^- experiments. These results should be included in LO/NLO QCD fits used to determine PDF's for the photon, to improve the parametrisations of the photon structure and to test consistency between these data and available F_2^γ data.