Inclusive jets in photoproduction

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ZEUS

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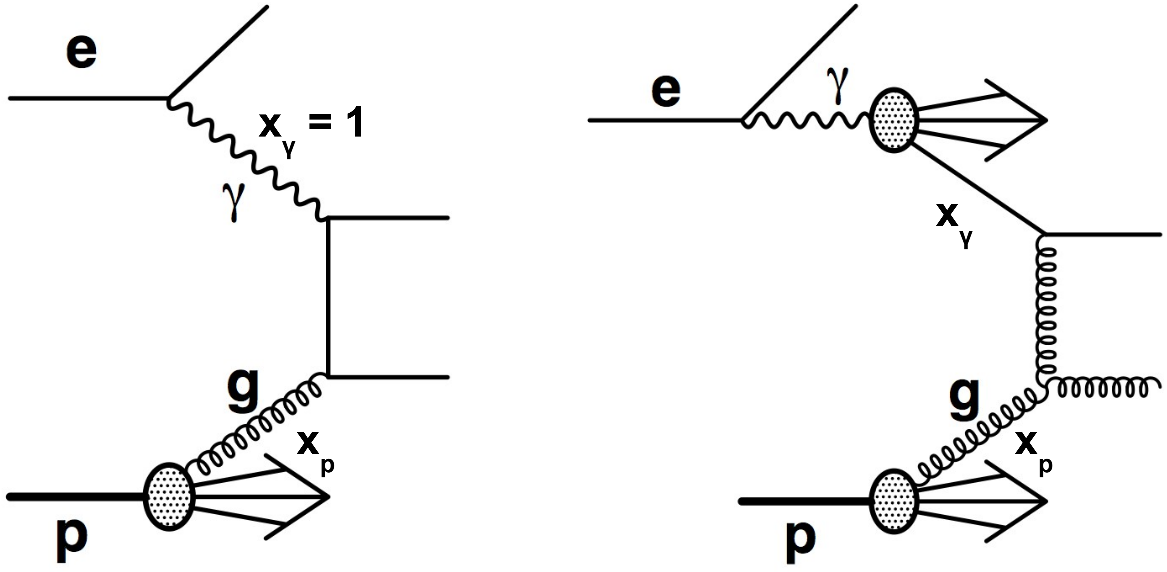
Jets in photoproduction at HERA

Jet production in photoproduction at $O(\alpha_s)$:



direct

resolved

$Q^2 \approx 0$ GeV^2: γ virtuality
W: γp centre-of-mass energy
y: inelasticity
$x_{\gamma(p)}$: parton momentum fraction of γ(p)

- Large statistics for tests of pQCD, single hard scale E_T^{jet}
- Direct sensitivity to proton and photon PDFs
- Extraction of α_s and its energy dependence

Jet algorithms

k_T cluster algorithm in the longitudinally invariant inclusive mode (Catani, Ellis, Soper)**:**

- Infrared and collinear safe cross sections at any order of pQCD
- Extensively tested at HERA: small theoretical uncertainties / hadronisation corrections in ep collisions

→ *New measurement in photoproduction presented in the following*

New infrared and collinear safe jet algorithms:

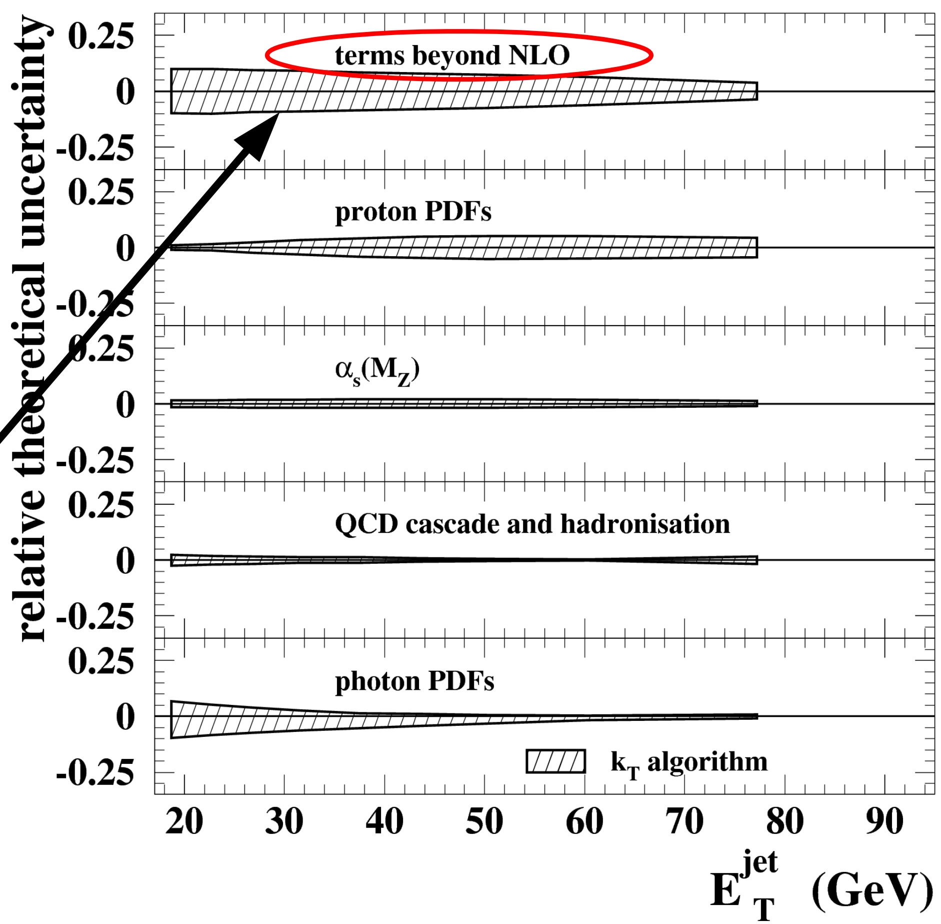
- Anti-k_T (Cacciari, Salam, Soyez)
- SIScone (Salam, Soyez)

→ *Test of their performance in a well-understood hadron-induced reaction: photoproduction at HERA*

Cross sections and NLO QCD predictions

NLO predictions (Klasen et al.)**:**

- $\mu_R = \mu_F = E_T^{jet}$
- ZEUS-S for proton PDFs, GRV-HO for photon PDFs (unless explicitly stated otherwise)
- Hadronisation corrections from PYTHIA and HERWIG
- PYTHIA including multi-parton interactions (PYTHIA-MI) for comparisons



Missing terms beyond NLO are the dominating uncertainty of the predictions (for all jet algorithms)

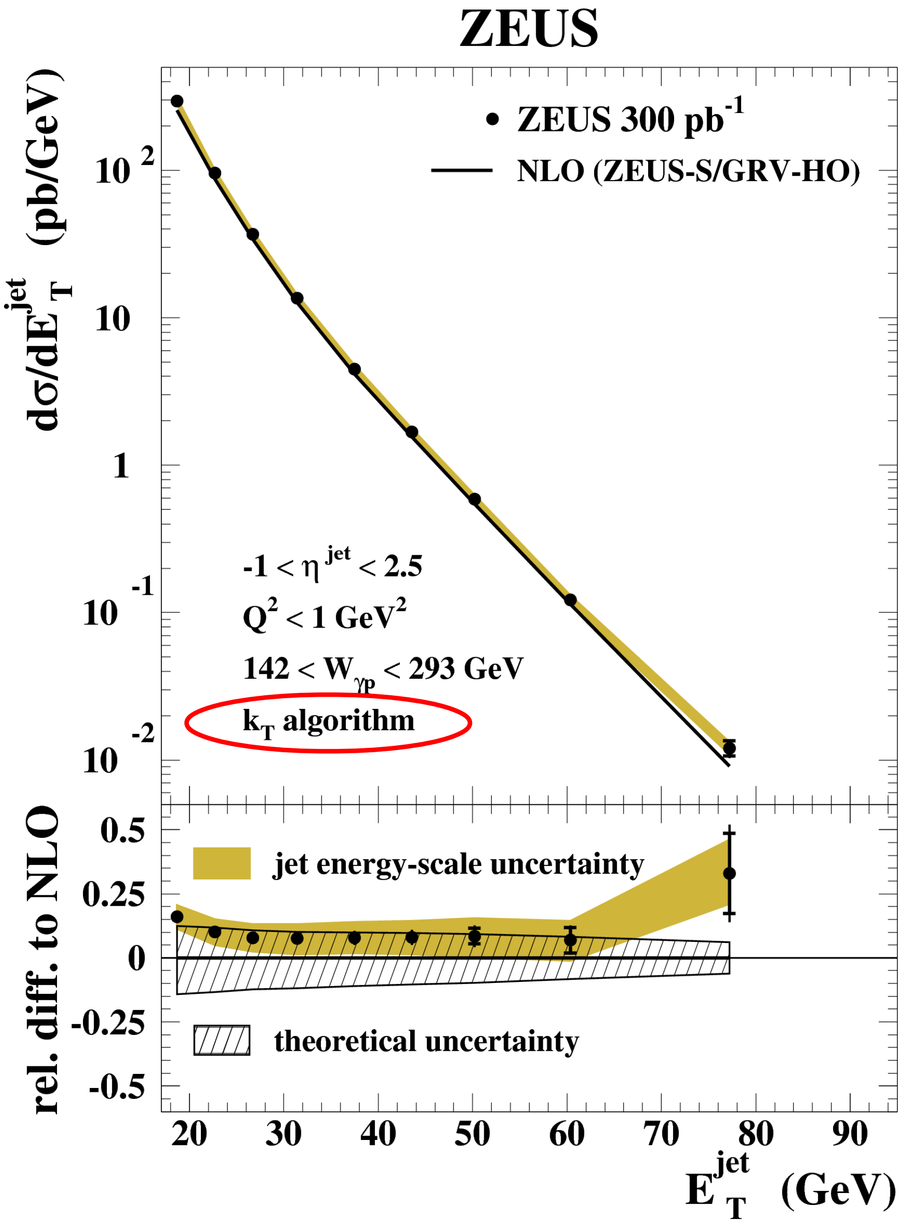
Single-differential cross sections: $d\sigma / dE_T^{jet}$

ep → e + jet + X:

- $142 < W_{\gamma p} < 293$ GeV
- $Q^2 < 1$ GeV^2
- Cross sections include every jet with $E_T^{jet} > 17$ GeV, $-1 < \eta^{jet} < 2.5$
- $L_{int} = 300$ pb^{-1} (2005 – 2007)

Energy scale: ±1%
→ ±5% uncertainty on cross section at low E_T^{jet}, ±10% at high E_T^{jet}

The data are well described by NLO QCD



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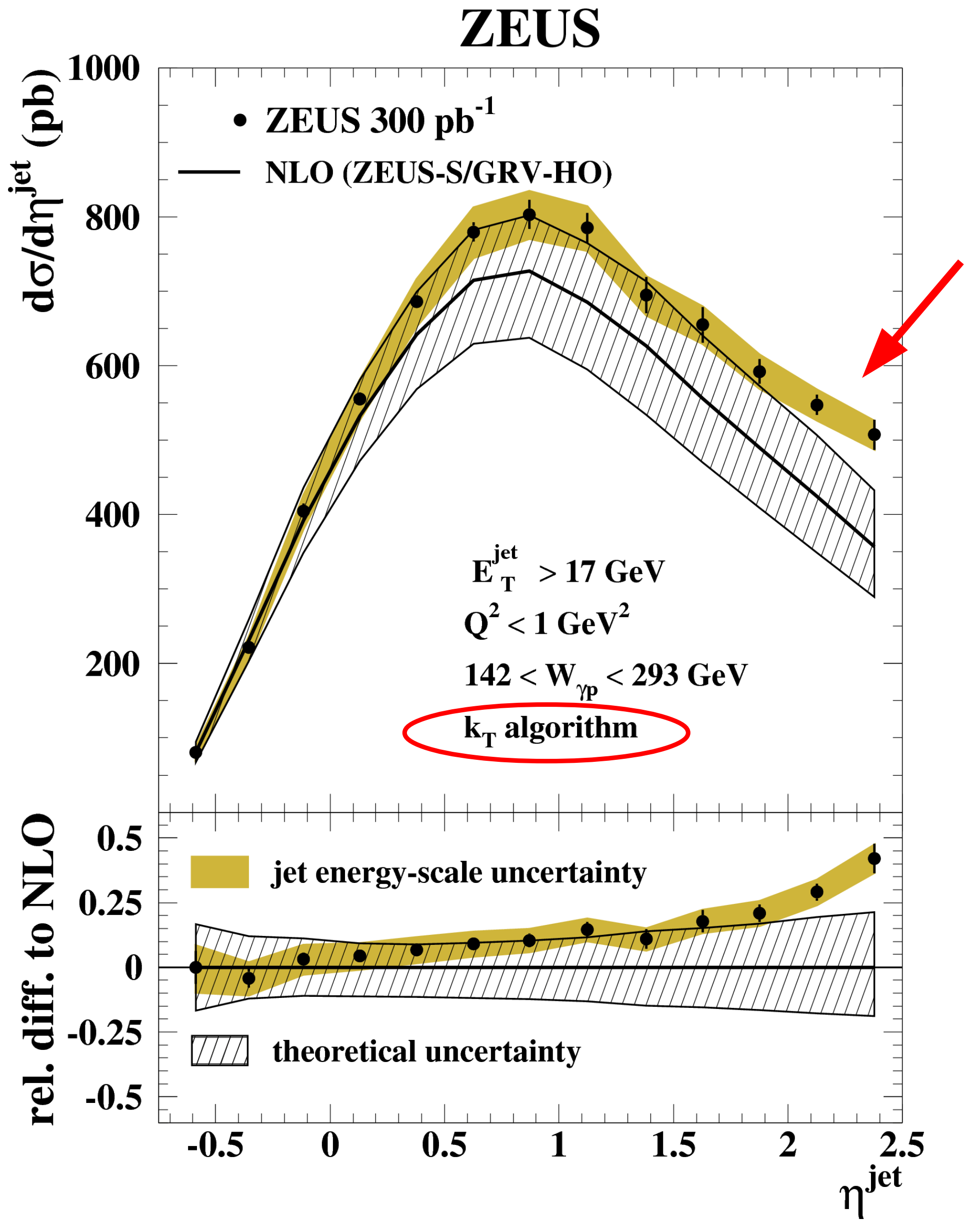
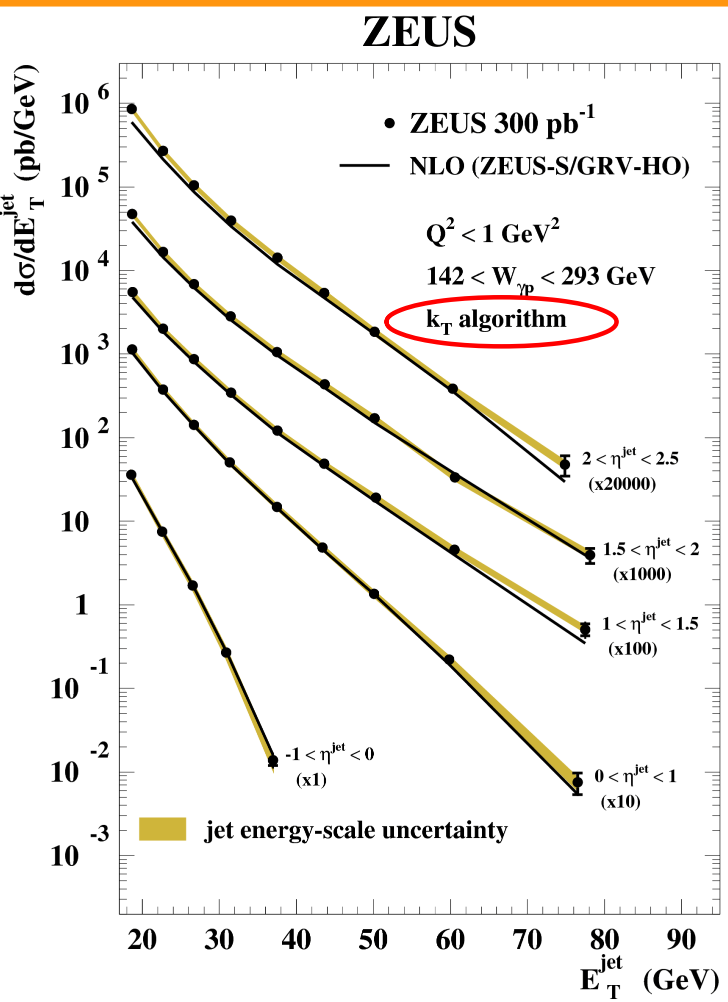
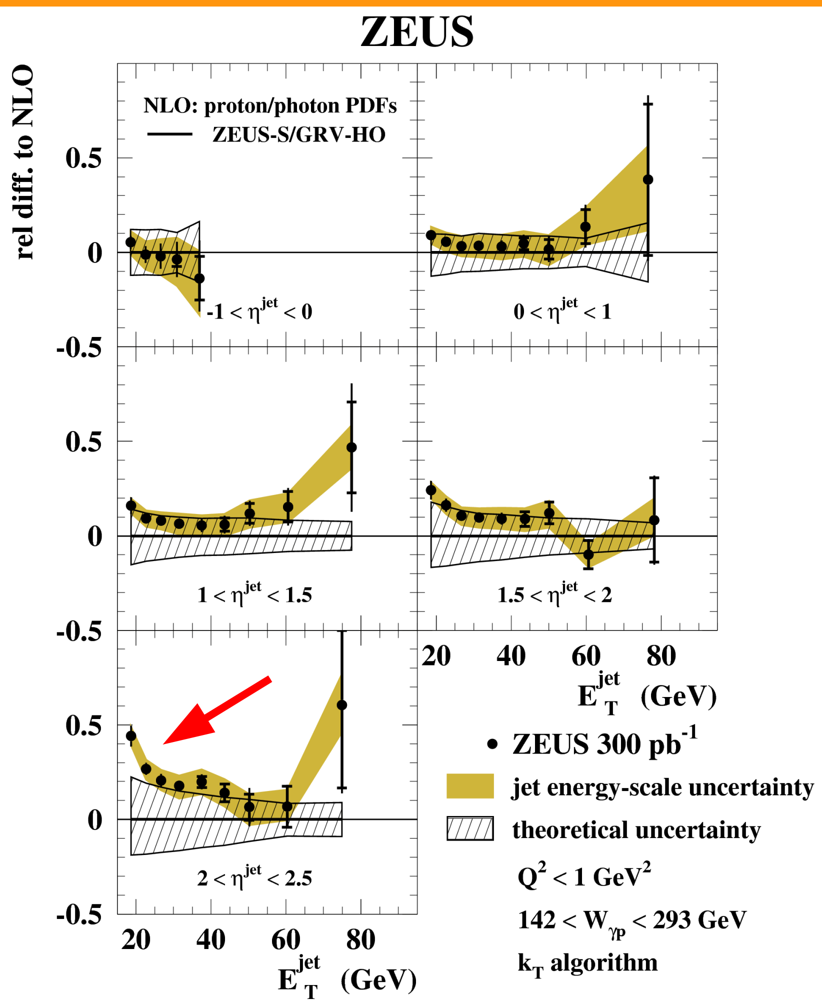
The data are well described by NLO QCD for $\eta^{jet} < 2$
(disagreement disappears for $E_T^{jet} > 21$ GeV)



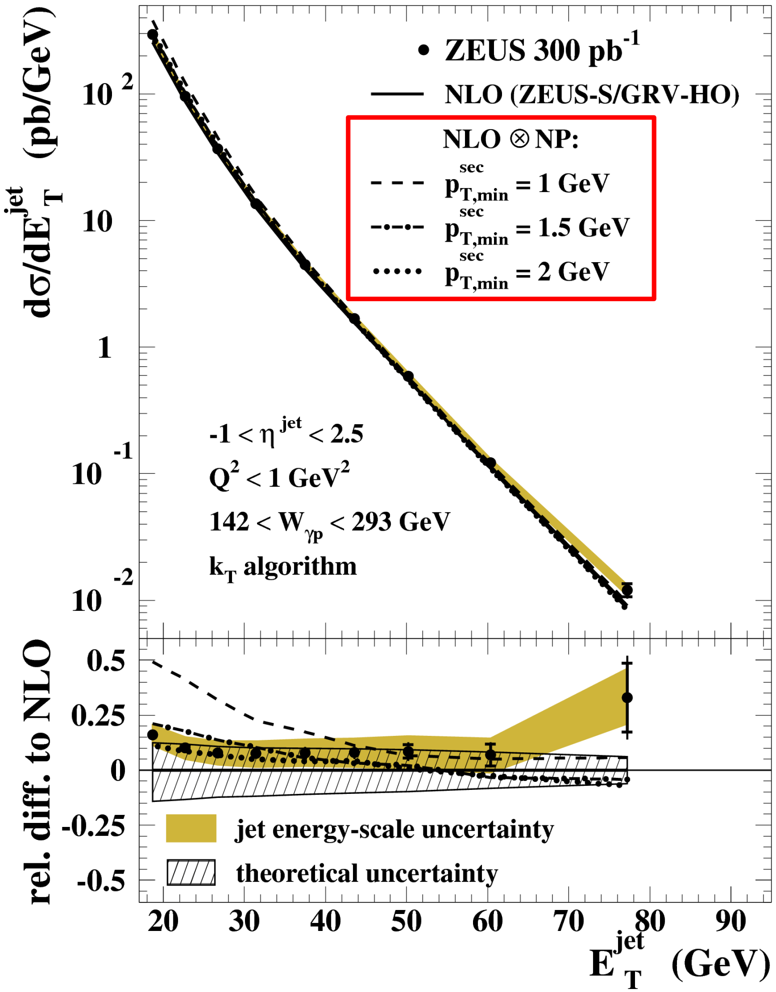
Double-differential cross sections

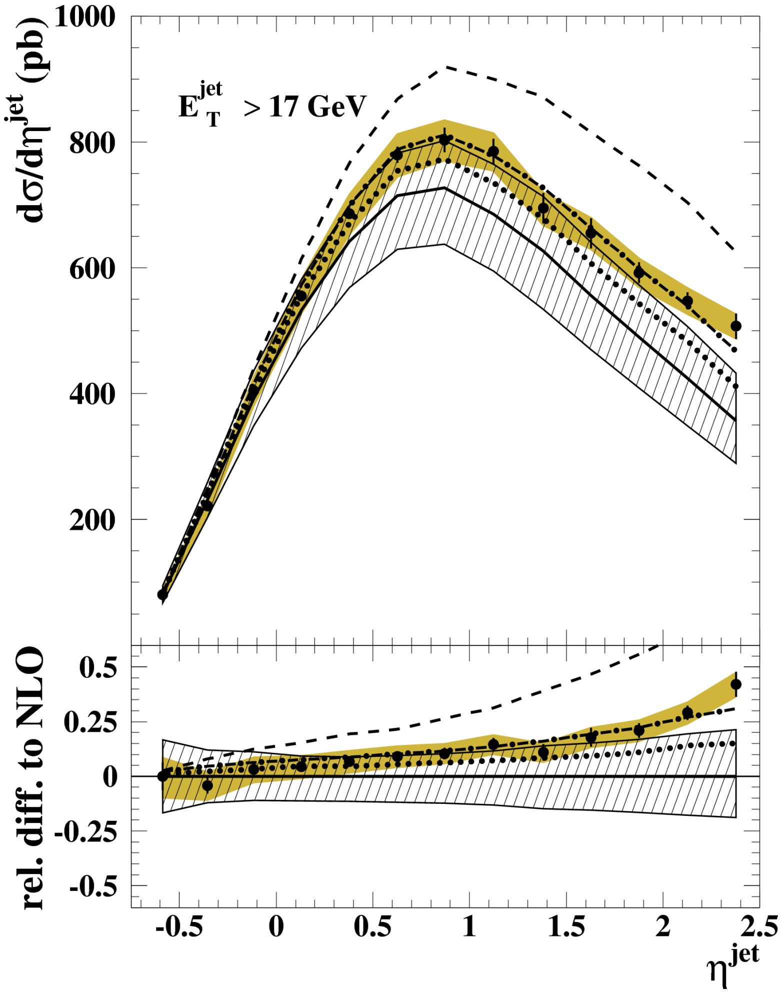


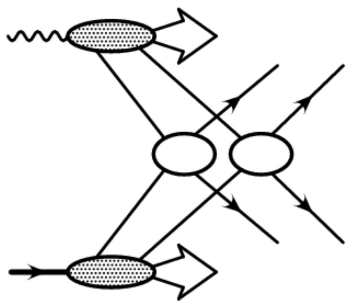


The data are well described by NLO QCD except at $E_T^{jet} < 21$ GeV for $\eta^{jet} > 2$

Impact of multi-parton interactions



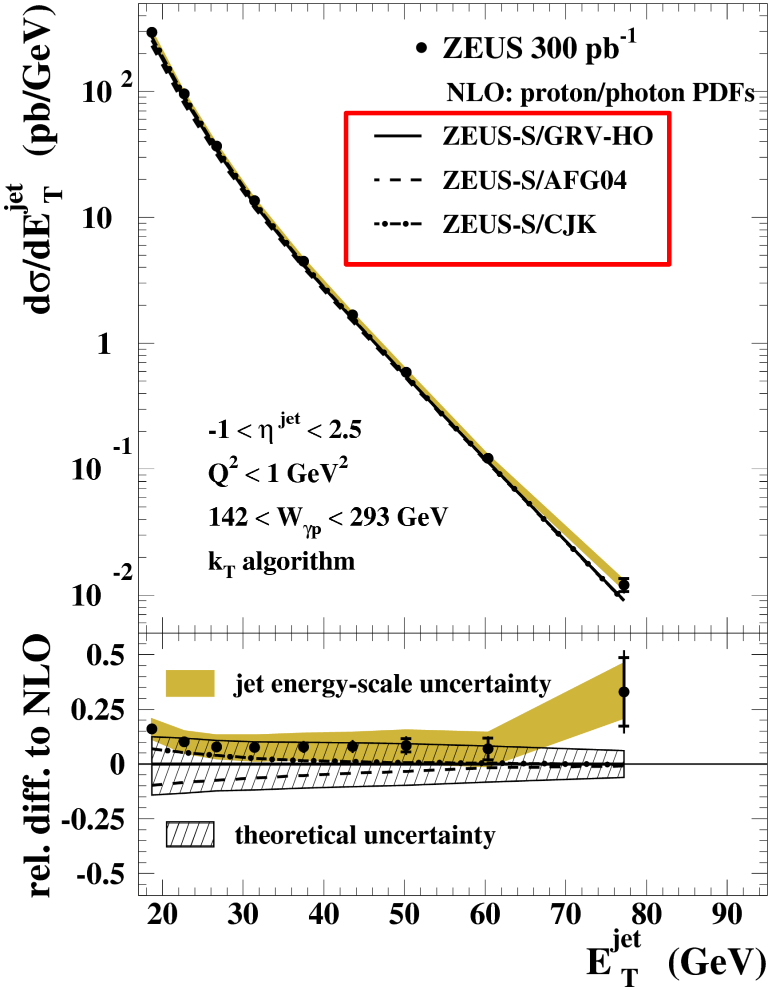


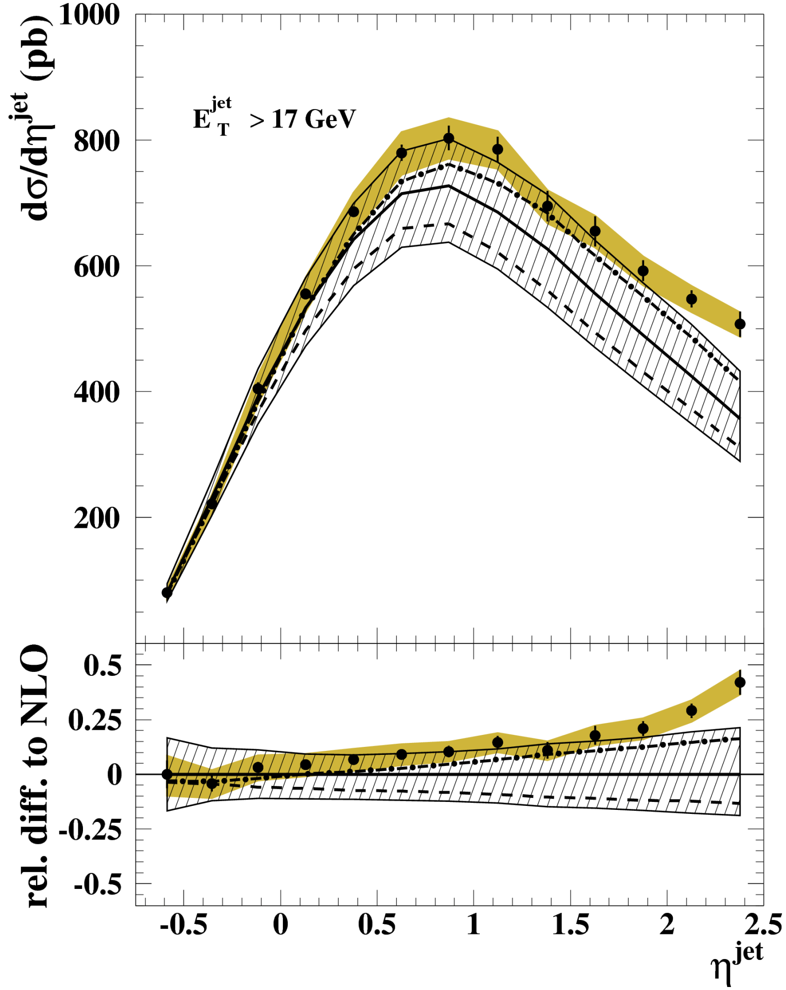


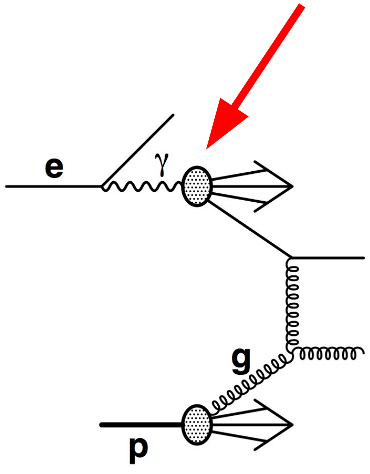
Not included on NLO QCD calculations, correction factors obtained using PYTHIA(-MI)

- Multi-parton interactions increase the predictions at low E_T^{jet} and large η^{jet}
- Best description of the data for $p_{T,min}^{sec} = 1.5$ GeV

Impact of photon PDFs



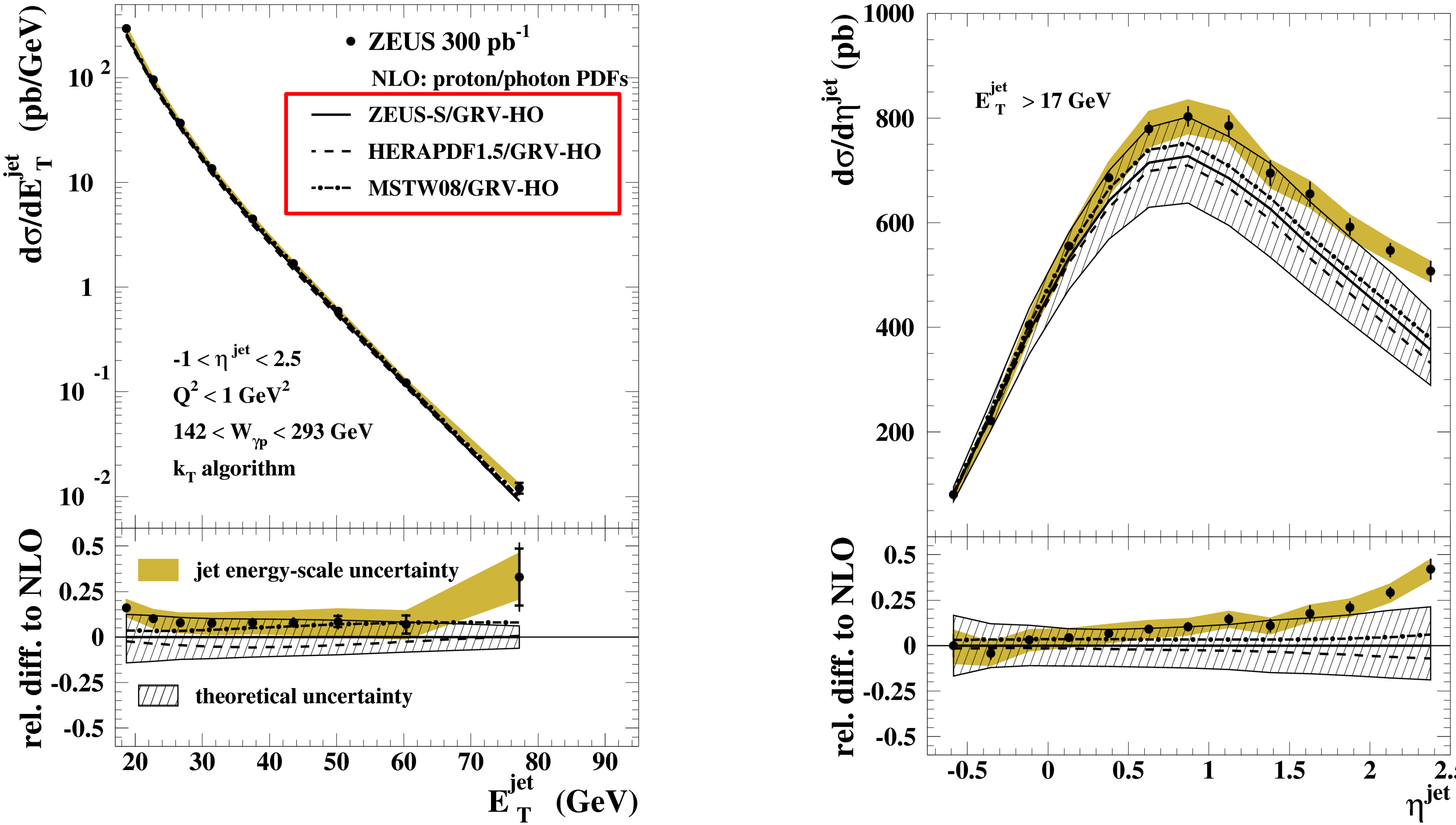




- Comparing predictions based on GRV-HO, AFG04 and CJK
- Some difference between the predictions, especially at low E_T^{jet} high large η^{jet}

→ Measurements have the potential to constrain photon PDFs

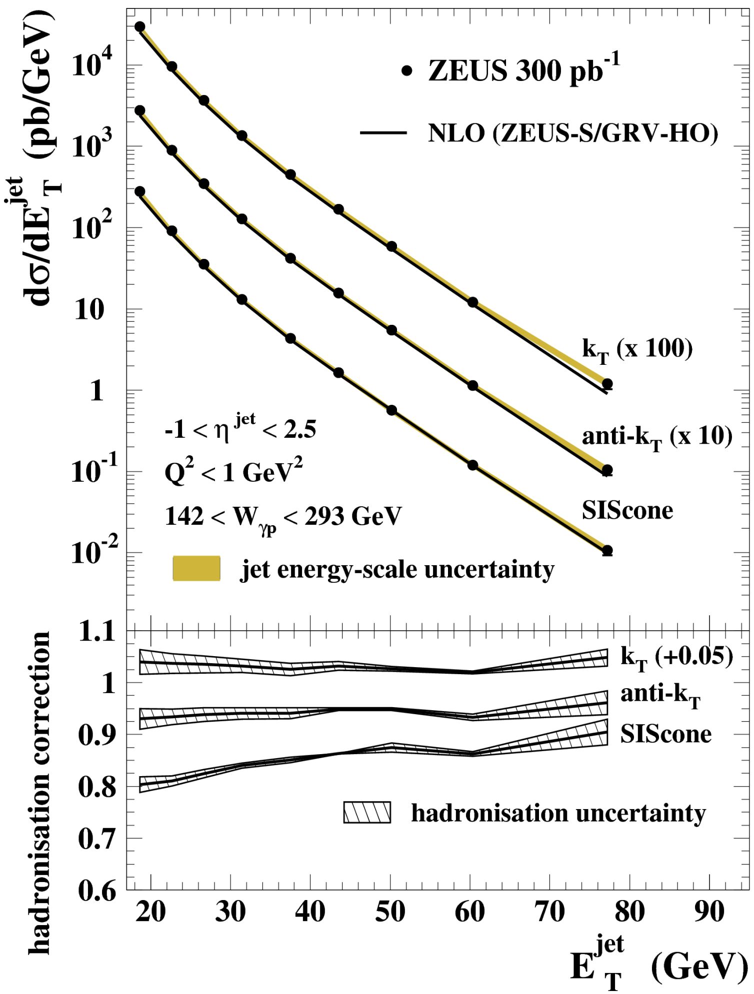
Impact of proton PDFs

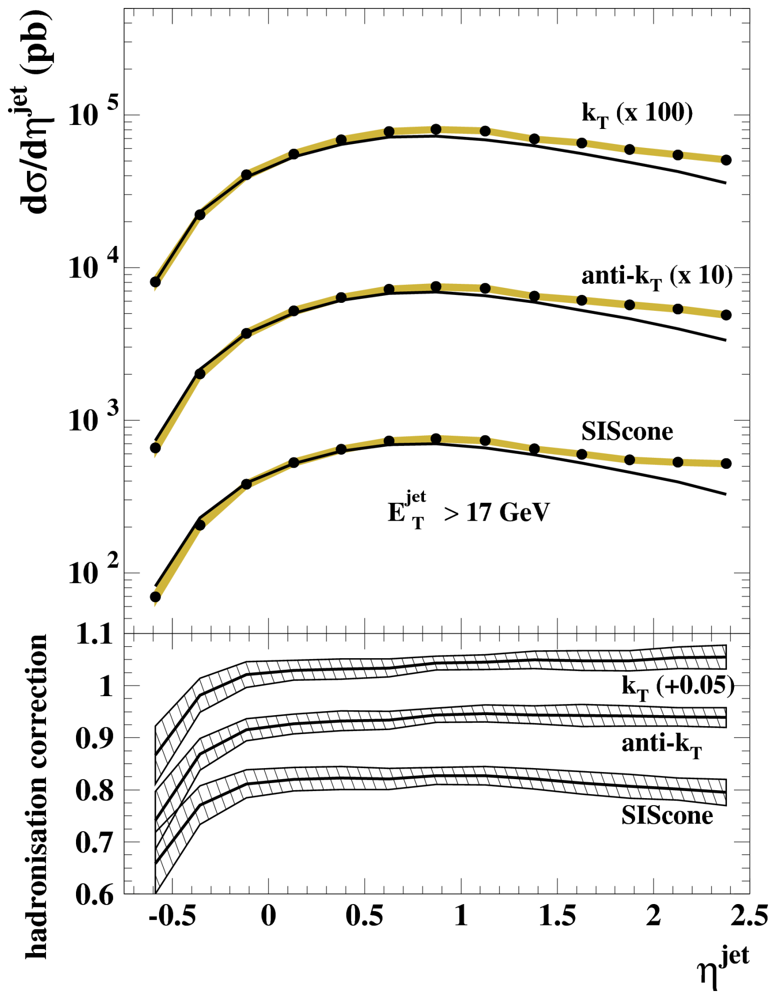


- Comparing predictions based on ZEUS-S, HERAPDF1.5 and MSTW08
- HERAPDF1.5 mostly lower than ZEUS-S, MSTW08 higher at high E_T^{jet}

→ Measurements have the potential to constrain proton PDFs

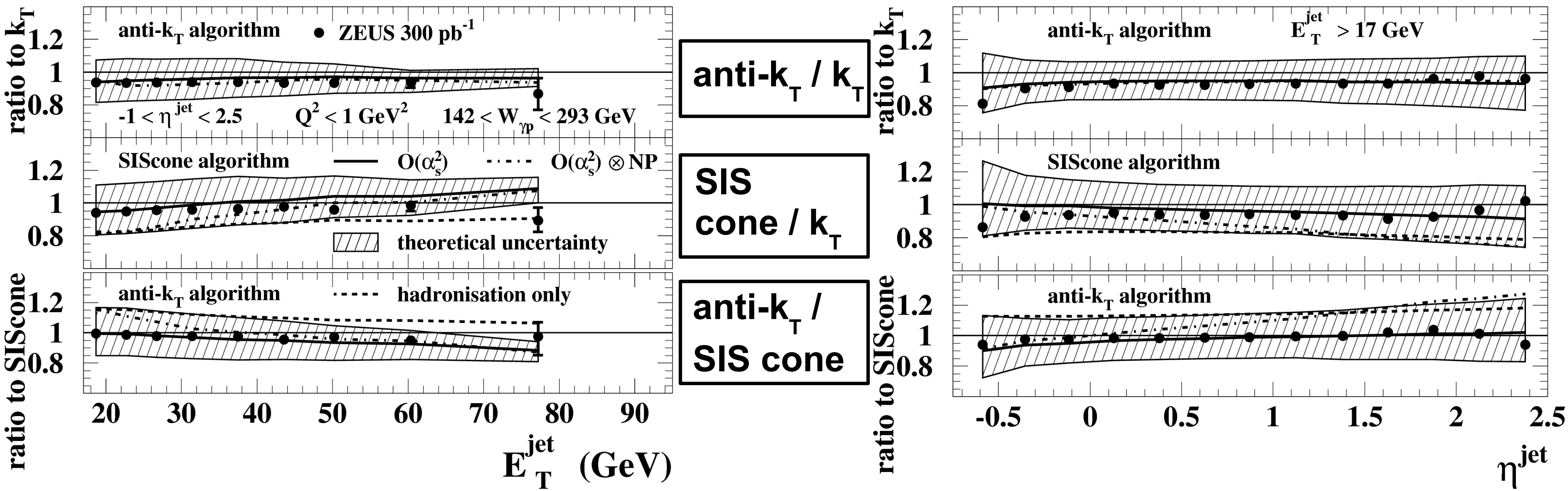
Comparison of the jet algorithms





- The hadronisation corrections are largest for SISCone, similar corrections for k_T and anti-k_T
- The measurements are well described by NLO QCD except at large η^{jet}

Cross section ratios



- The cross sections for anti-k_T have the same shape as those for k_T, but are about 6% smaller
- SISCone has a slightly different shape than k_T or anti-k_T
- The QCD calculations with up to three partons in the final state describe the measured ratios

Determination of α_s

- Fit of NLO QCD to single-differential cross sections $d\sigma / dE_T^{jet}$ for $21 < E_T^{jet} < 71$ GeV (Phys. Lett. **B 547** (2002) 164)

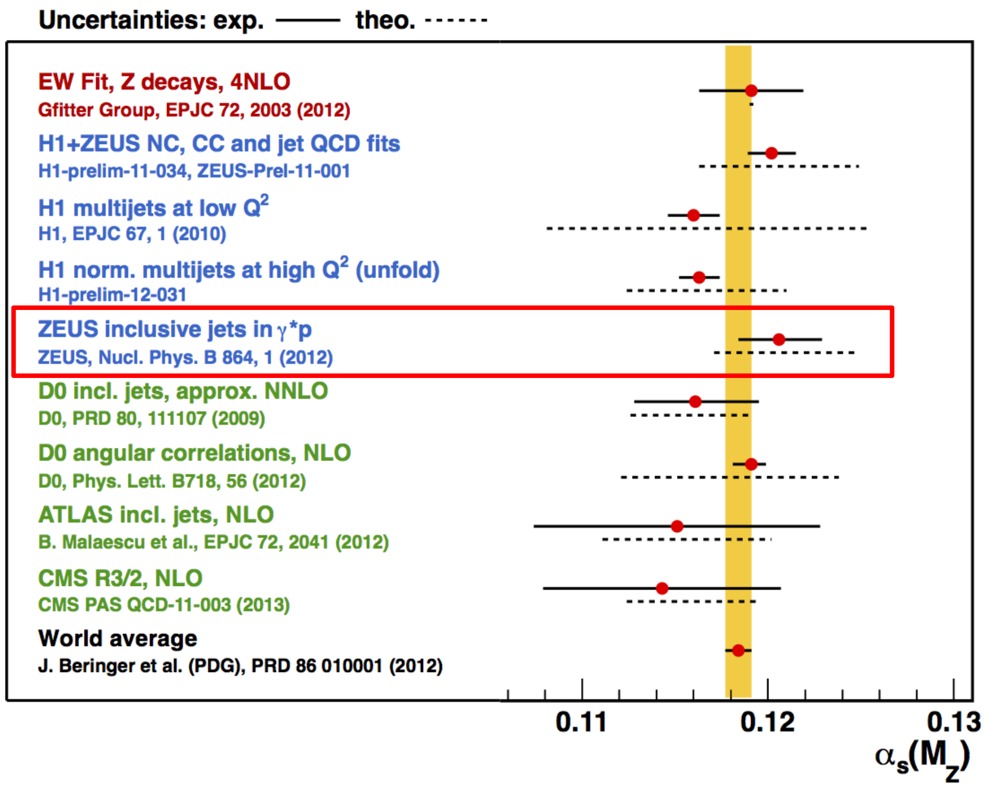
- Consistent results observed for all three jet algorithms

- The results are in agreement with other determinations of α_s

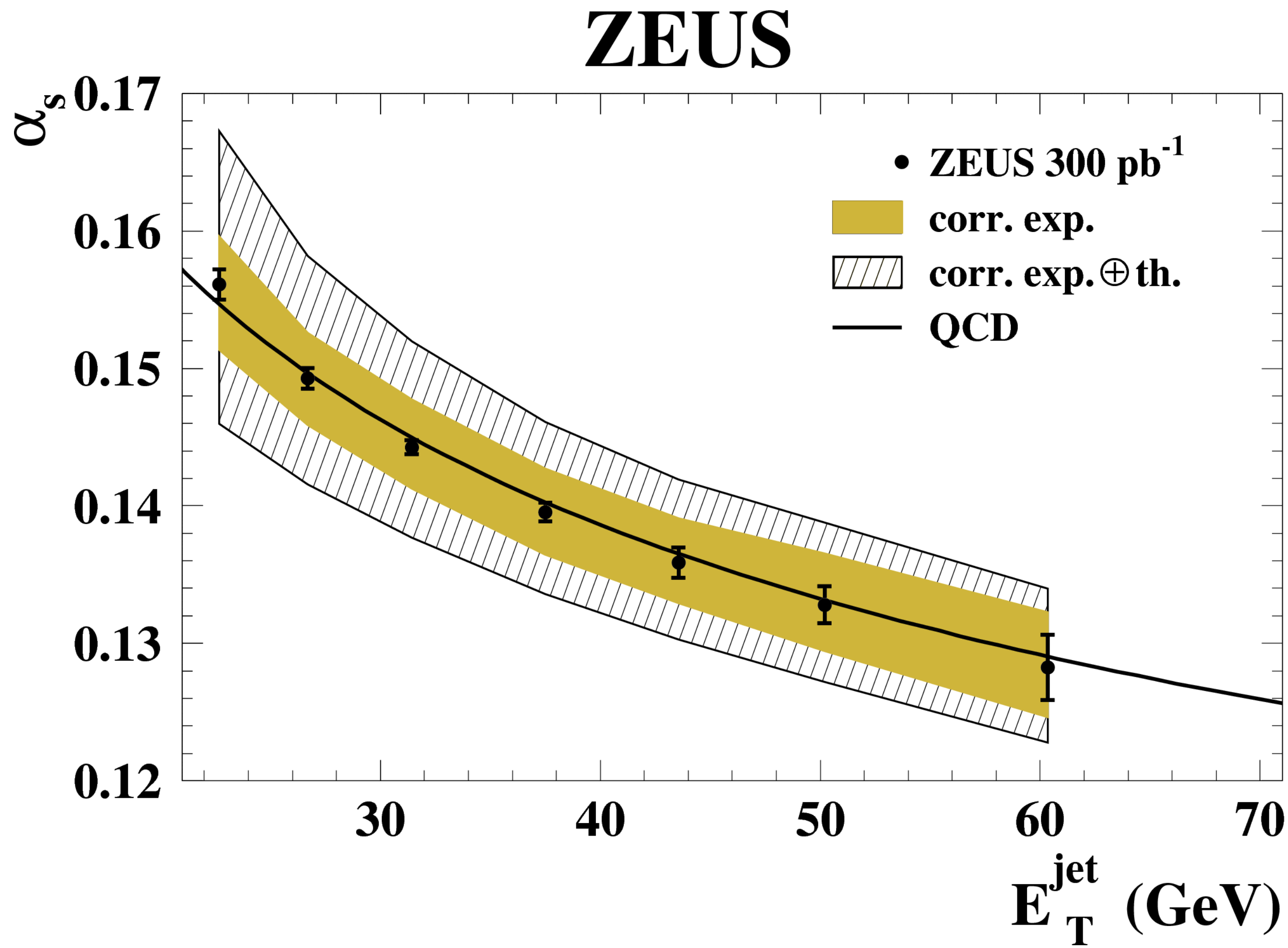
$$\alpha_s(M_Z)|_{k_T} = 0.1206\,^{+0.0023}_{-0.0022}\,(\text{exp.})\,^{+0.0042}_{-0.0035}\,(\text{th.})$$

$$\alpha_s(M_Z)|_{\text{anti-}k_T} = 0.1198\,^{+0.0023}_{-0.0022}\,(\text{exp.})\,^{+0.0041}_{-0.0034}\,(\text{th.})$$

$$\alpha_s(M_Z)|_{\text{SIScone}} = 0.1196\,^{+0.0022}_{-0.0021}\,(\text{exp.})\,^{+0.0046}_{-0.0043}\,(\text{th.})$$



Energy-scale dependence of α_s



- This measurement confirms the running of α_s over a wide range of E_T^{jet}
- The running is in good agreement with the two-loop QCD prediction

Summary

- Inclusive jet cross sections in PhP were measured using the ZEUS detector

- The data are generally well described by NLO QCD predictions

- The inclusion of multi-parton interactions improves the predictions at low E_T^{jet} and large η^{jet}

- The presented measurements have the potential to improve the photon and proton PDFs in future QCD fits

- The strong coupling constant was extracted at the Z mass with competitive precision compared to other measurements and over a wide E_T^{jet} range