HEAVY FLAVOUR PHYSICS AT HERA

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CONTENTS OF TALK

(1) D^* production

(2) J/ψ production

(3) Beauty production

in each case in photoproduction and DIS.

Theoretical Issues

— QCD description: LO, NLO

— Presence of >1 QCD scale

— Mass of charm quark

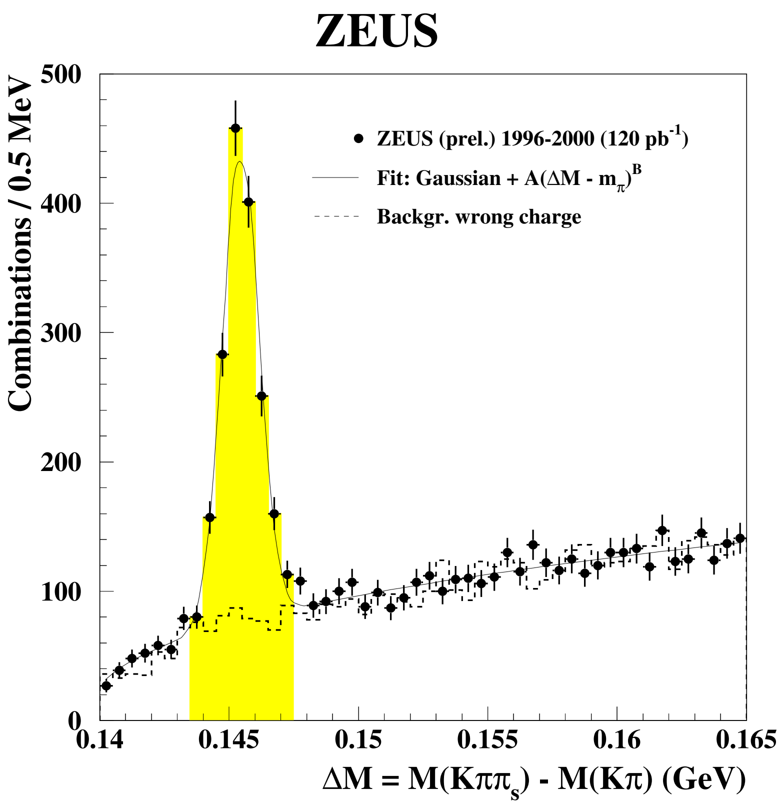
— Fragmentation effects

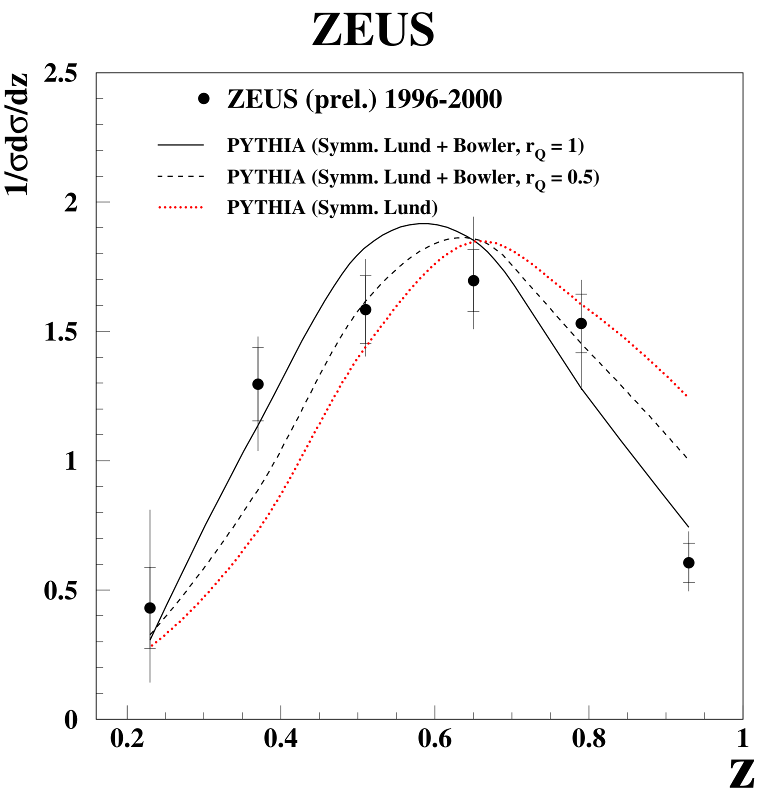
— J/ψ production through Colour Singlet (CS) – i.e. colour neutral – exchange or more complex Colour Octet (CO) exchange mechanisms

— Understanding the beauty cross section

OPEN CHARM IN PHOTOPRODUCTION

$K\pi\pi$ – $K\pi$ mass difference: D^* – D peak identifies charm signal



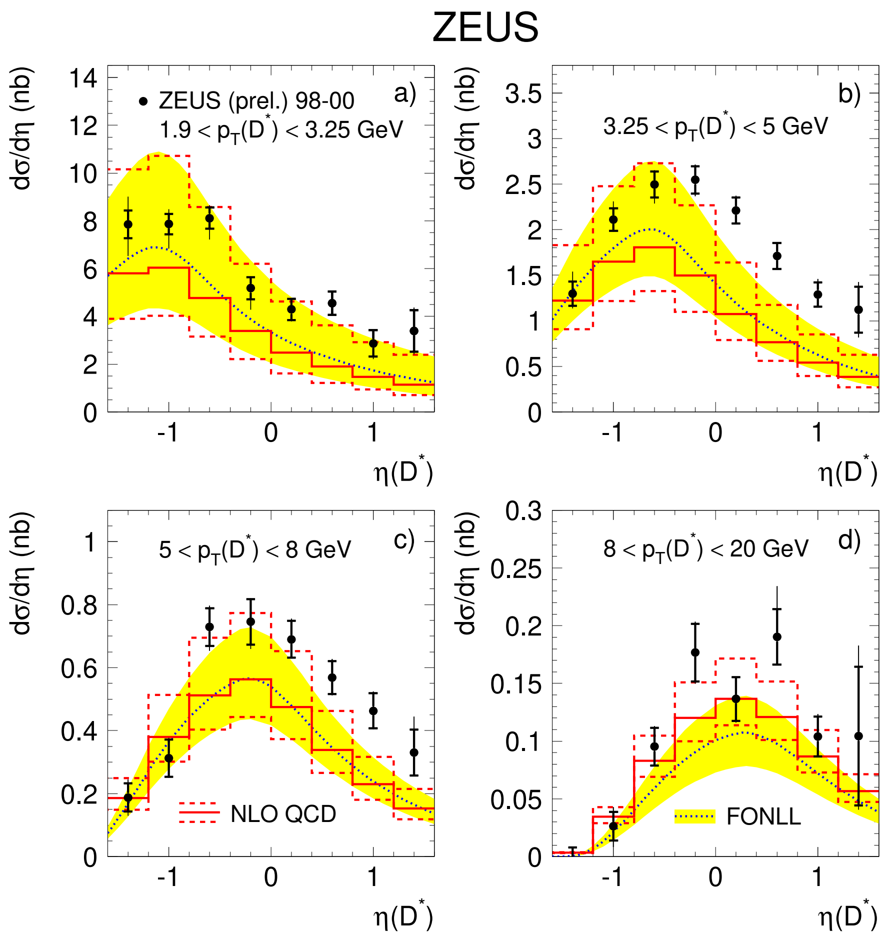


Charm fragmentation in jets $(E_T > 9$ GeV)

$$z = \frac{E+p_{||}^{D^*}}{E+p_{||}^{\text{jet}}}$$

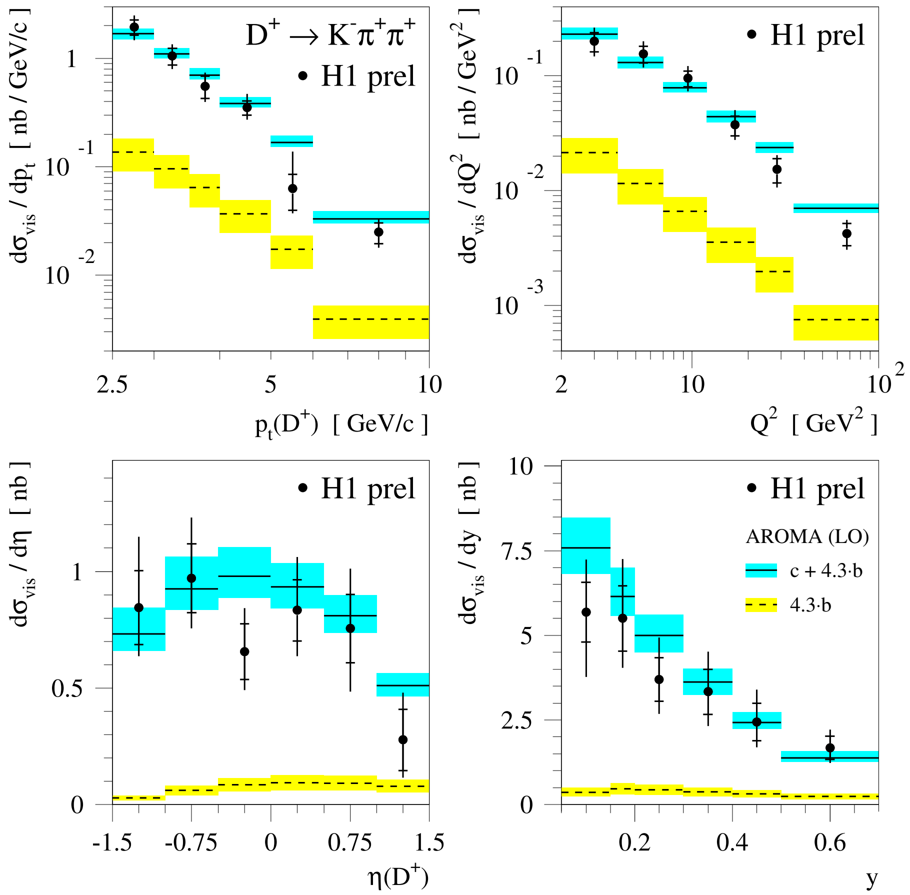
Compare with models. PYTHIA favoured, Peterson parameter $\epsilon = 0.064$

OPEN CHARM IN PHOTOPRODUCTION



Inclusive $D^{*\pm}$
tests NLO predictions from Frixione et al
and FONLL (Cacciari et al) (fixed order + n/ldg log)
Theory errors represent uncertainties on renormalisation scale and charm quark mass: 1.3–1.7 GeV.
Agreement still somewhat poor.

OPEN CHARM in DIS



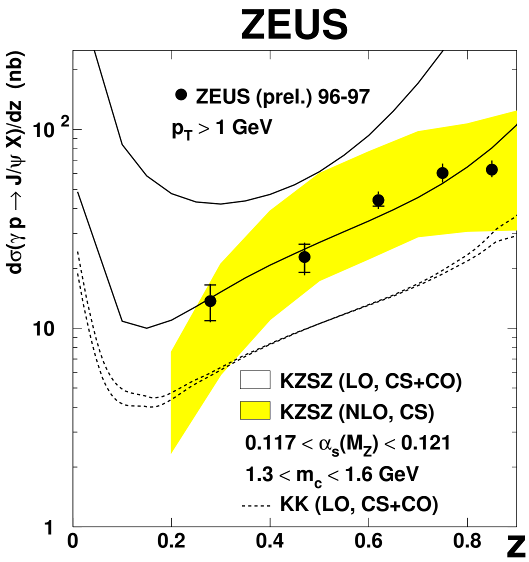
H1 (+ Si detector) $K\pi, K2\pi, K3\pi$ channels used.
First D^+ at HERA.
Xsecs agree with LO (AROMA).
(Ingelman et al.)
Beauty contribution included.

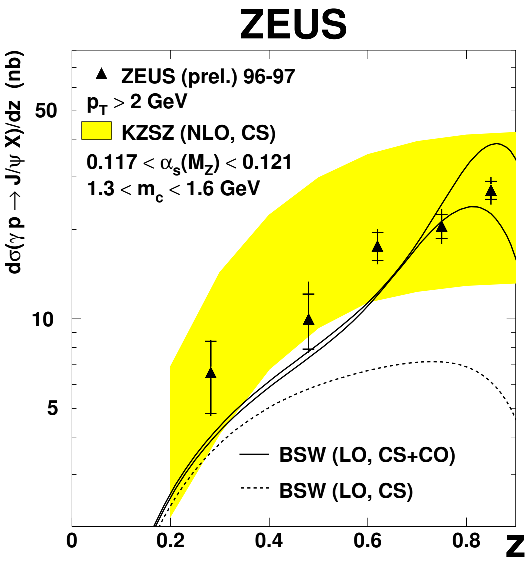
Fragmentation parameters measured $\longrightarrow$ agree with world averages.

H1 also measure events with $D^* + \mu$.

$\longrightarrow$ charm and beauty Xsecs consistent with other measurements.

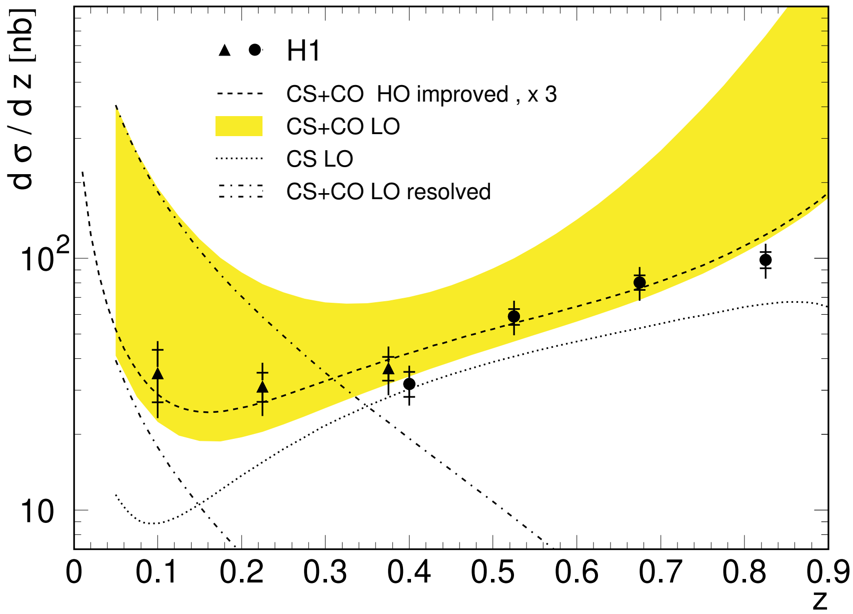
J/ψ in PHOTOPRODUCTION





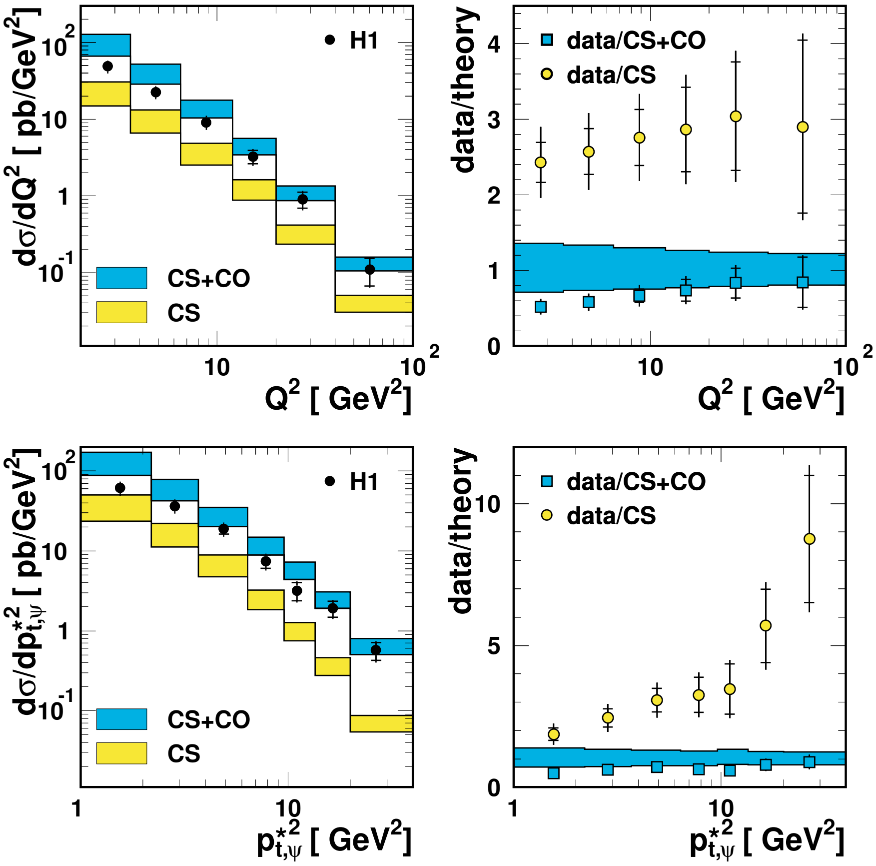
$$z = \frac{p_\psi \cdot p_p}{q_\gamma \cdot p_p}$$

Theory: Krämer et al (KZSZ); Beneke et al (BSW); Kniehl & Krämer (KK) NRQCD
LO and QCD calculations. CS only or CS + CO.
NLO CS probably best. No real evidence for CO



Krämer (shaded)
KK (dots).
Similar concs.
LO CS not OK.

J/ψ in DIS



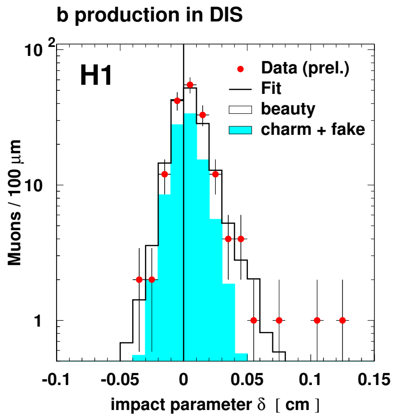
Theory: Kniehl & Zwirner NRQCD

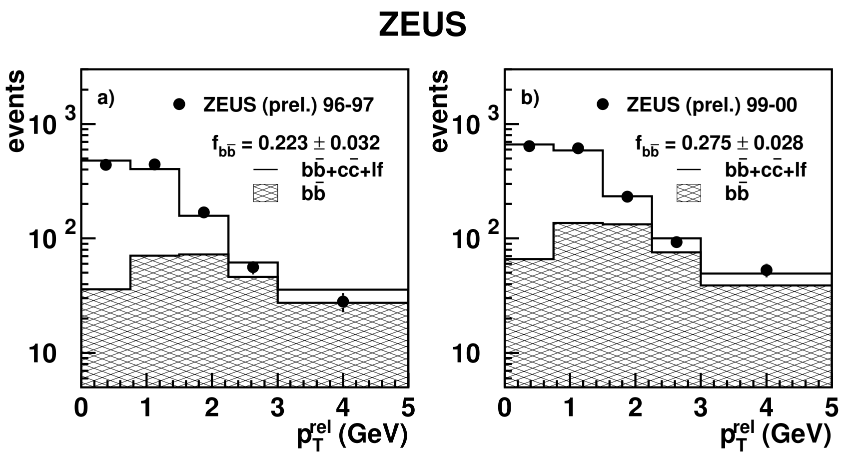
CS + CO theory preferred in most plots (however not z – not shown)

But this is not a full NLO calculation.

Better agreement at high p_T

BEAUTY in PHOTOPRODUCTION and DIS



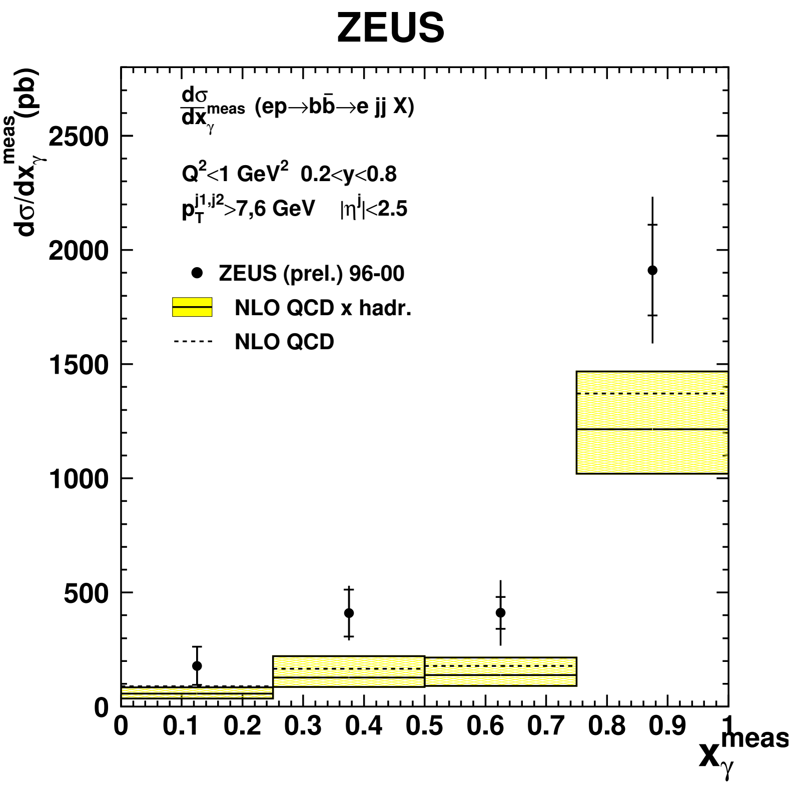


B measured through semileptonic decays

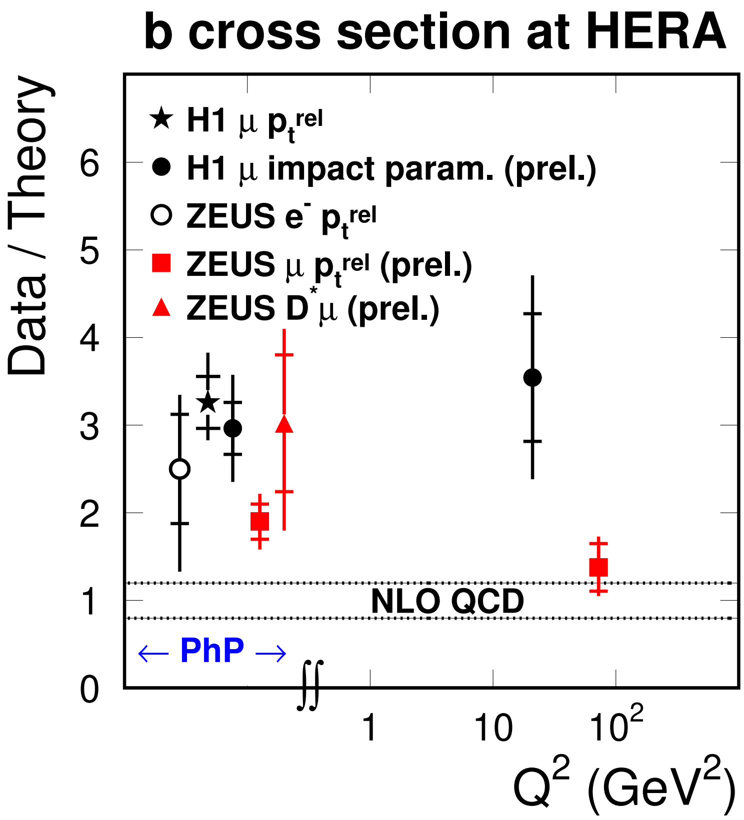
Signal separated from **charm** through impact parameter or lateral momentum of lepton wrt jet.

Photoproduction: strong direct signal

Data seem to lie above theory (Frixione NLO)



BEAUTY in PHOTOPRODUCTION and DIS



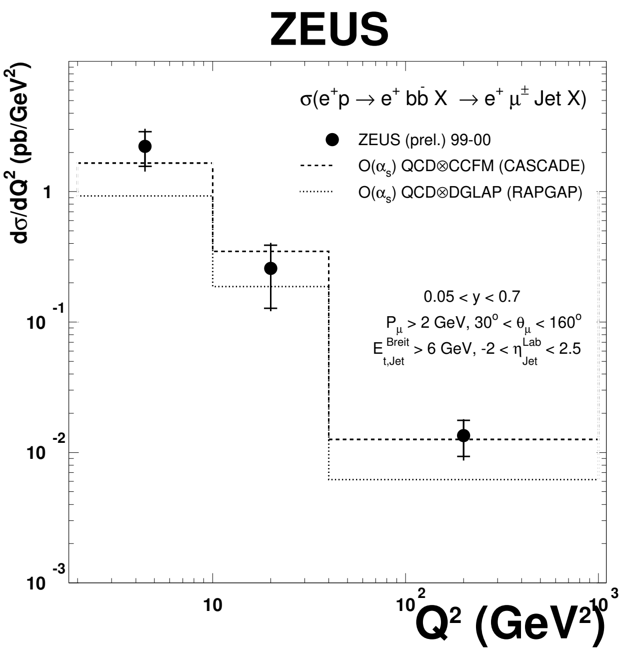
SUMMARY

— Photoproduction results consistently above NLO QCD

— ZEUS p_T^{rel} method still high in γp , OK in DIS

— Experimental situation needs resolution!

There are other models
RAPGAP (LO+had) low.
CASCADE agrees with ZEUS DIS but not H1.



CONCLUSIONS

Many aspects of charm and beauty physics have been studied at HERA, complementing those at other laboratories.

— Despite uncertainties (c quark mass, renormalisation scale) theory still does not well explain open charm production!

— J/ψ provides detailed test of LO/NLO QCD with colour singlet and octet models.

— Beauty production contains interesting disagreements between experiments and theory!

— Must have good high luminosity running to continue studies!