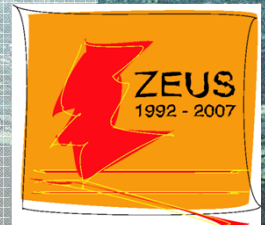


Charm production in DIS (and γp) at HERA

Achim Geiser, DESY Hamburg

36th International Conference for
High Energy Physics
Melbourne, Australia, July 4-11, 2012

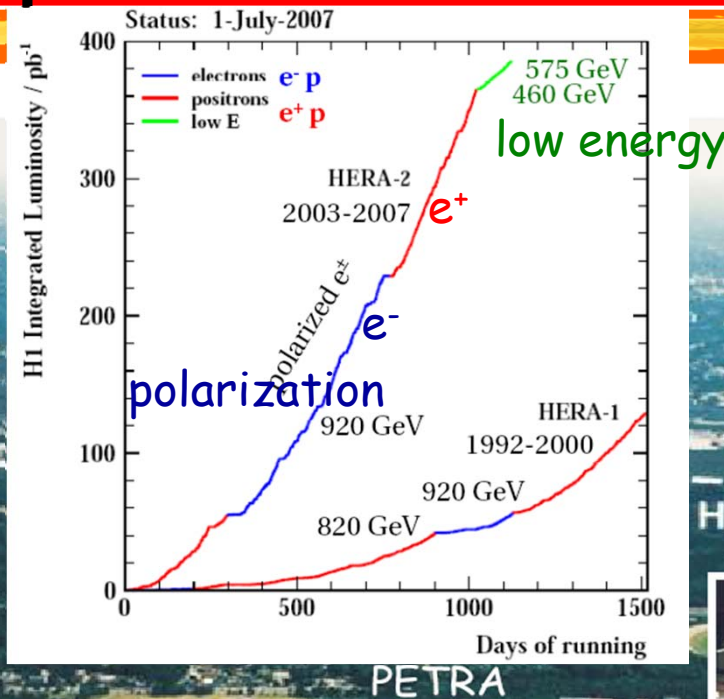
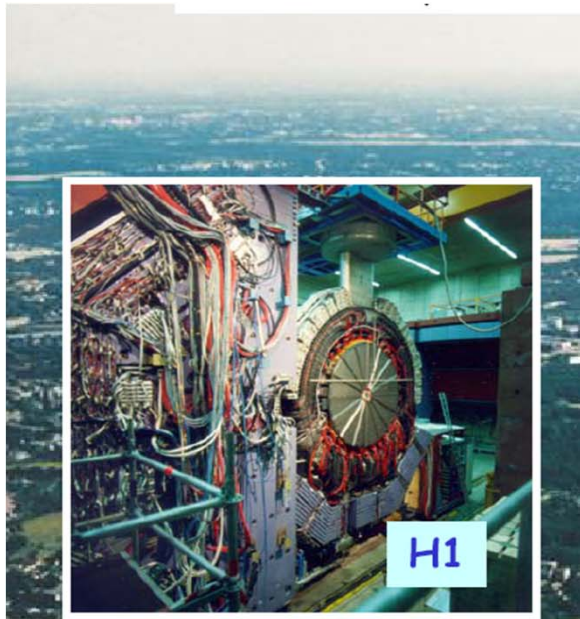


- Introduction
- D^* production in DIS
- Inclusive charm production in DIS
- Charm fragmentation fractions (γp)
- Conclusions

selection
of recent
results

PETRA

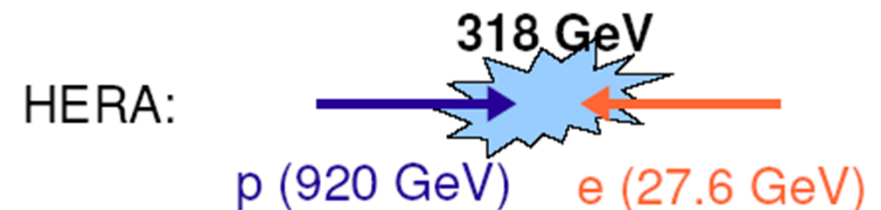
The HERA ep collider and experiments



HERA I: $\sim 130 \text{ pb}^{-1}$ (physics)

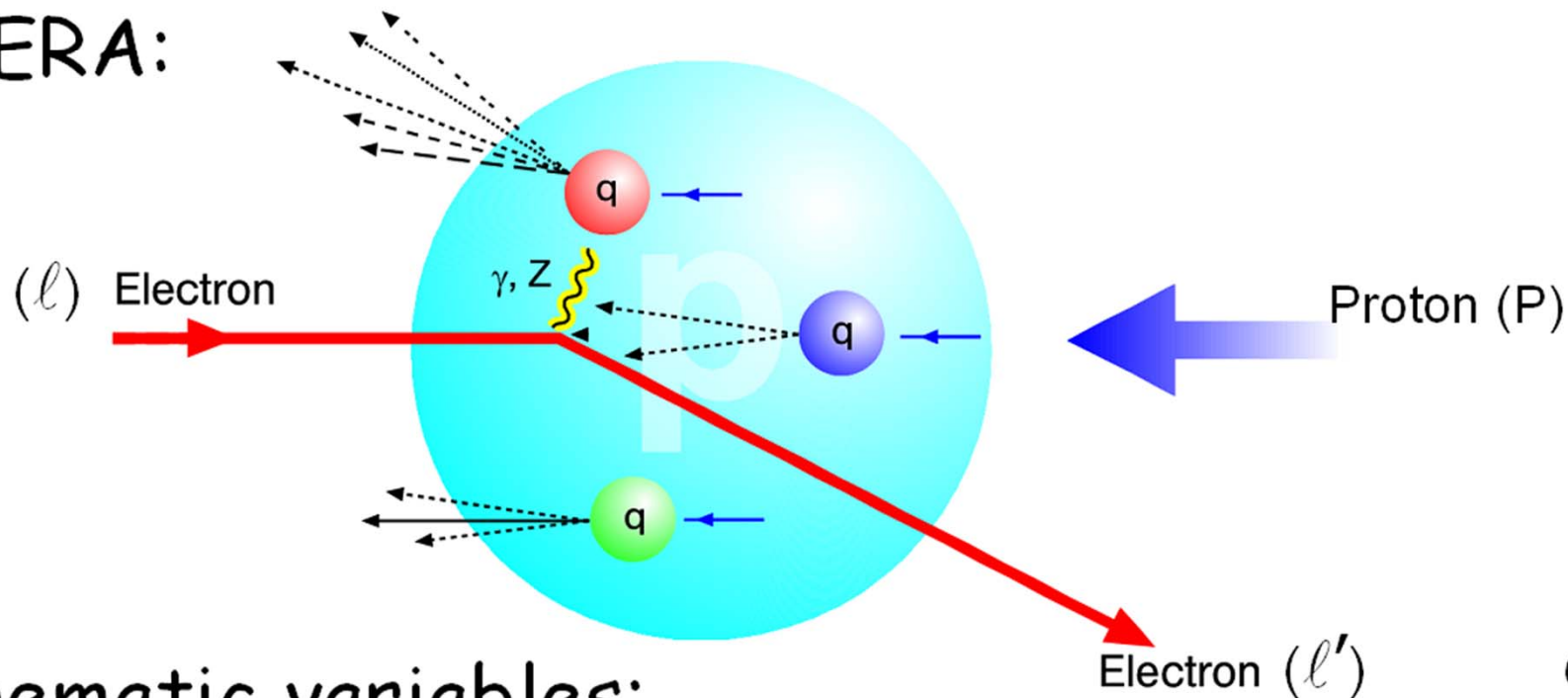
HERA II: $\sim 380 \text{ pb}^{-1}$ (physics)

combined: $\sim 2 \times 0.5 \text{ fb}^{-1}$



Kinematics of Deep Inelastic Scattering (DIS)

HERA:



kinematic variables:

$Q^2 = -q^2$	photon (or Z) virtuality, squared momentum transfer
$x = \frac{Q^2}{2Pq}$	Bjorken scaling variable, for $Q^2 \gg (2m_q)^2$: momentum fraction of p constituent
$y = \frac{qP}{lP}$	inelasticity, γ momentum fraction (of e)

$$Q^2 \lesssim 1 \text{ GeV}^2:$$

photoproduction

$$Q^2 \gtrsim 1 \text{ GeV}^2:$$

DIS

Why are heavy flavours important?

- charm contribution to DIS data up to 40%!

- kinematic effect of mass

- competing scales for perturbative expansion

e.g. m , Q^2 , p_T \rightarrow terms $\log Q^2/m^2$
 $\log p_T^2/m^2$ etc.

\Rightarrow “massless” treatment allows resummation, but fails near
“mass threshold” \rightarrow avoid !

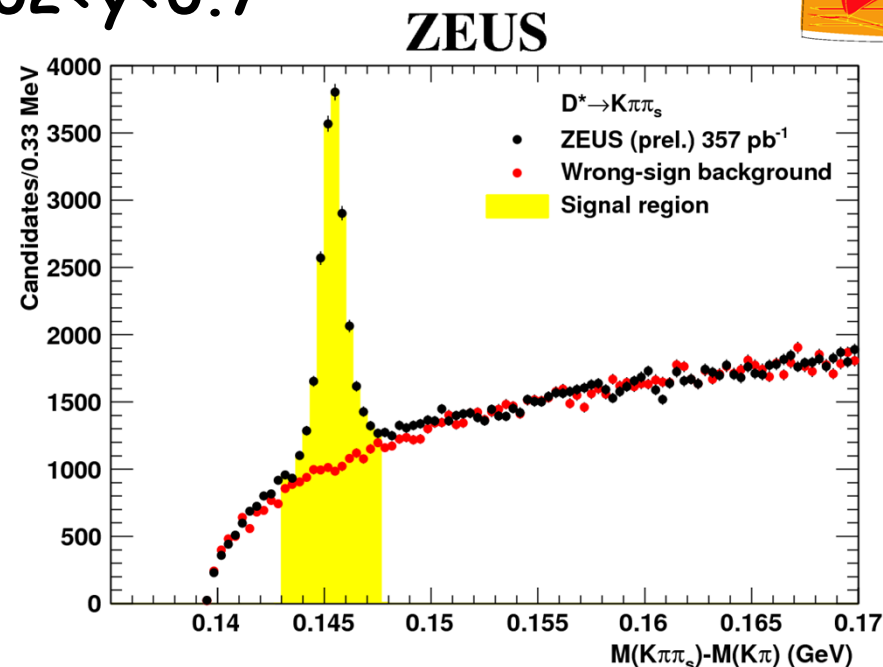
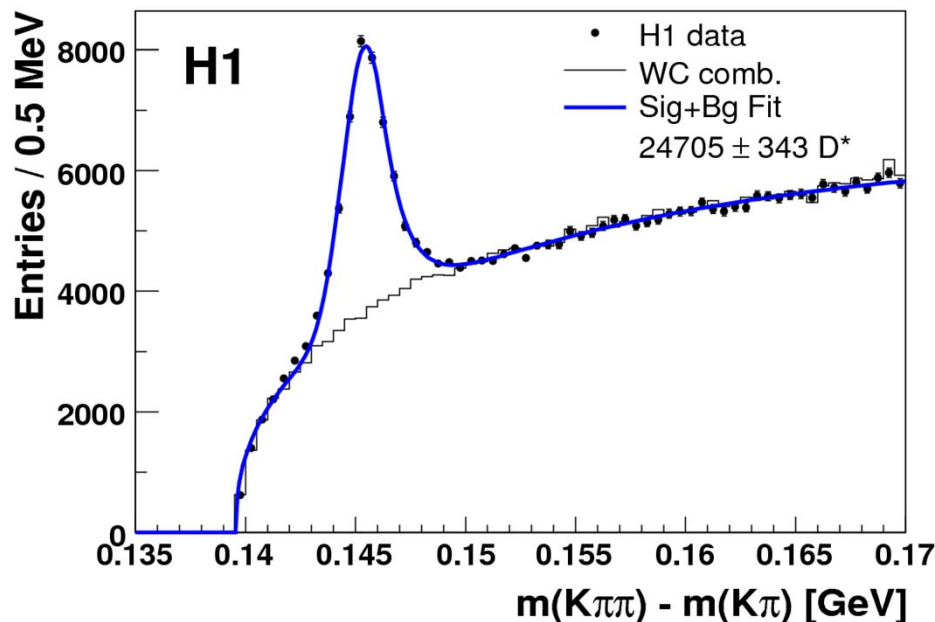
\Rightarrow “massive” treatment gets kinematics right,
but does not allow resummation (fixed flavour number schemes)
or induces ambiguities in QCD corrections near flavour threshold
(variable flavour number schemes)

check different schemes against HERA data

D* production in DIS



$Q^2 > 5 \text{ GeV}^2, \quad 0.02 < \gamma < 0.7$



$|\eta(\text{D}^*)| < 1.8$
 $p_T(\text{D}^*) > 1.25 \text{ GeV}$

large statistics!

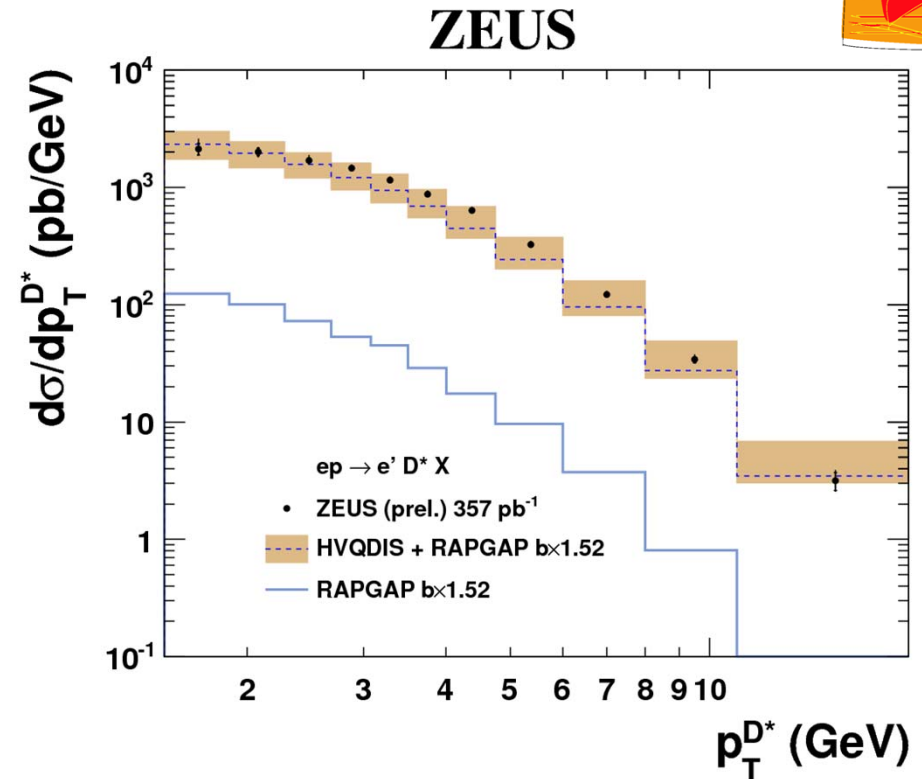
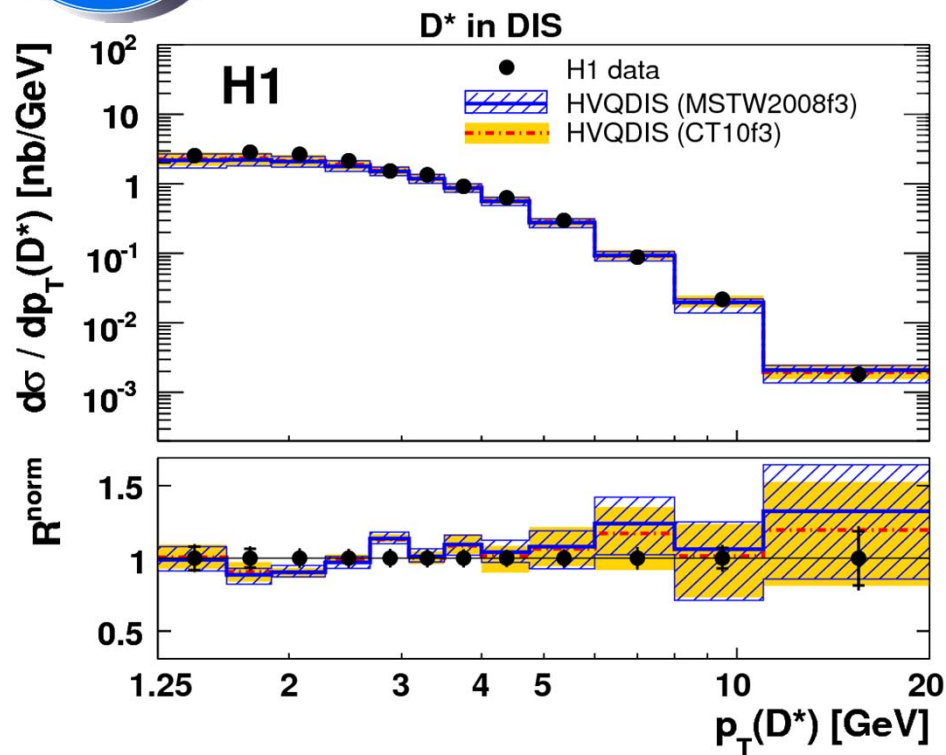
Eur.Phys.J.
C71 (2011) 1769,
Phys.Lett.
B686 (2010) 91-100

H1 slightly larger phase space

ZEUS slightly better mass resolution

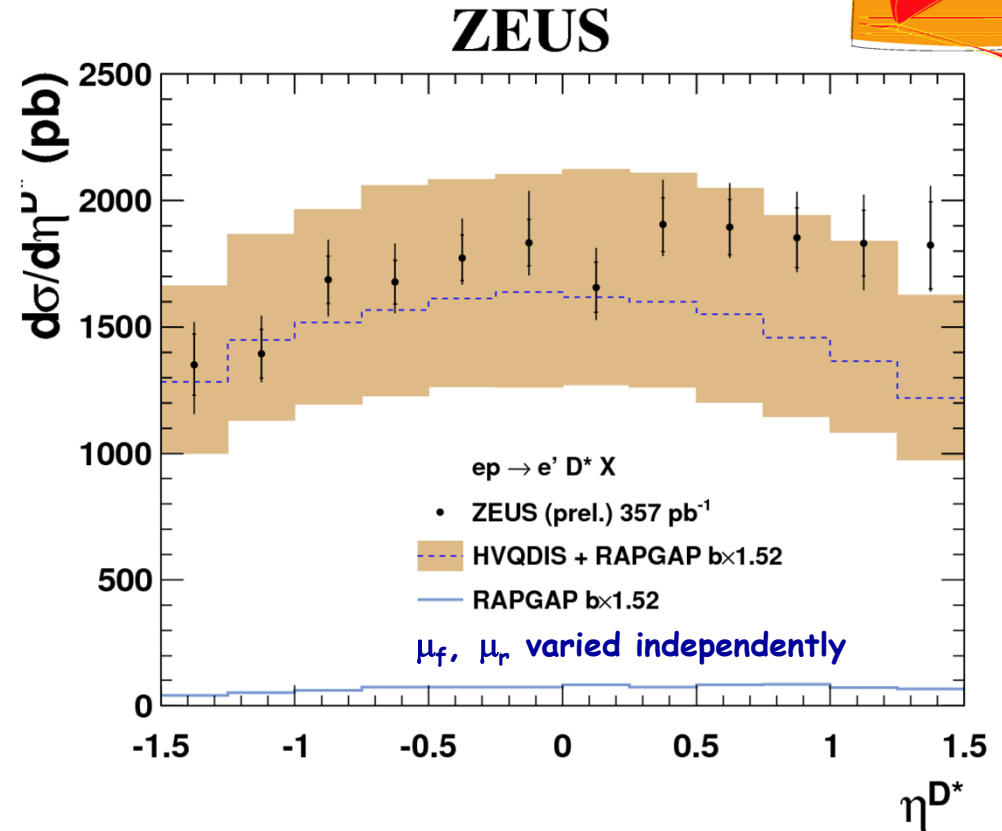
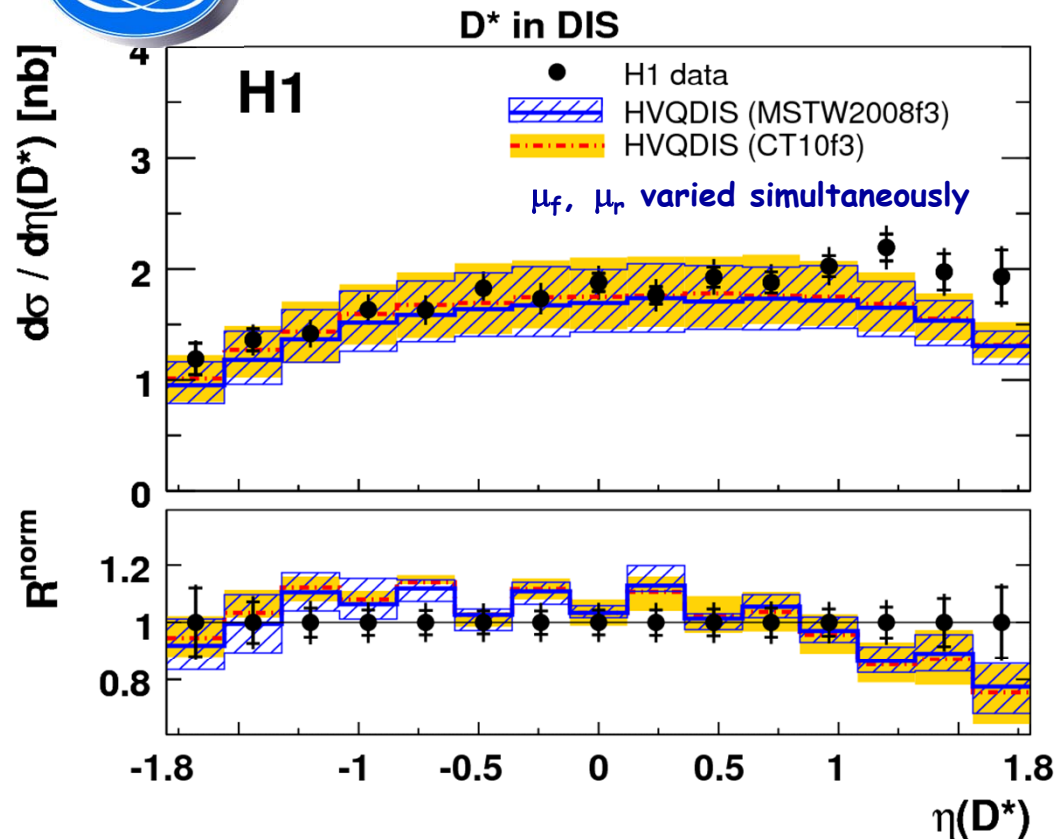
$|\eta(\text{D}^*)| < 1.5$
 $p_T(\text{D}^*) > 1.5 \text{ GeV}$
ZEUS-prel-11-012

D* cross section vs. p_T



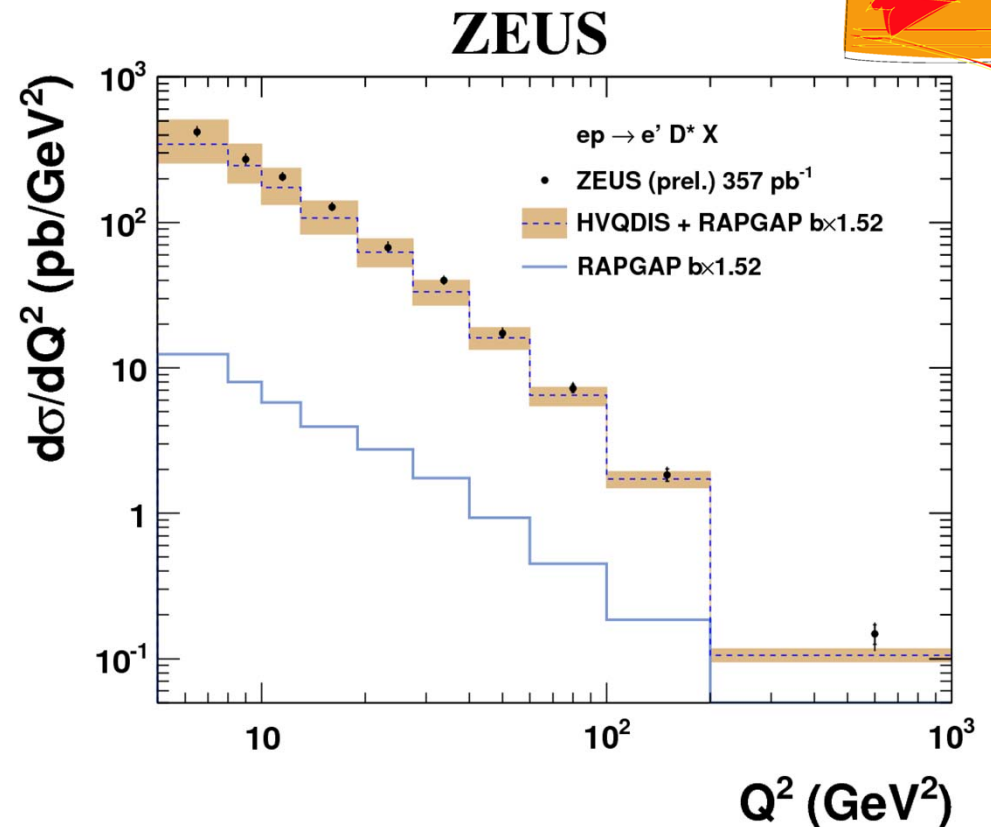
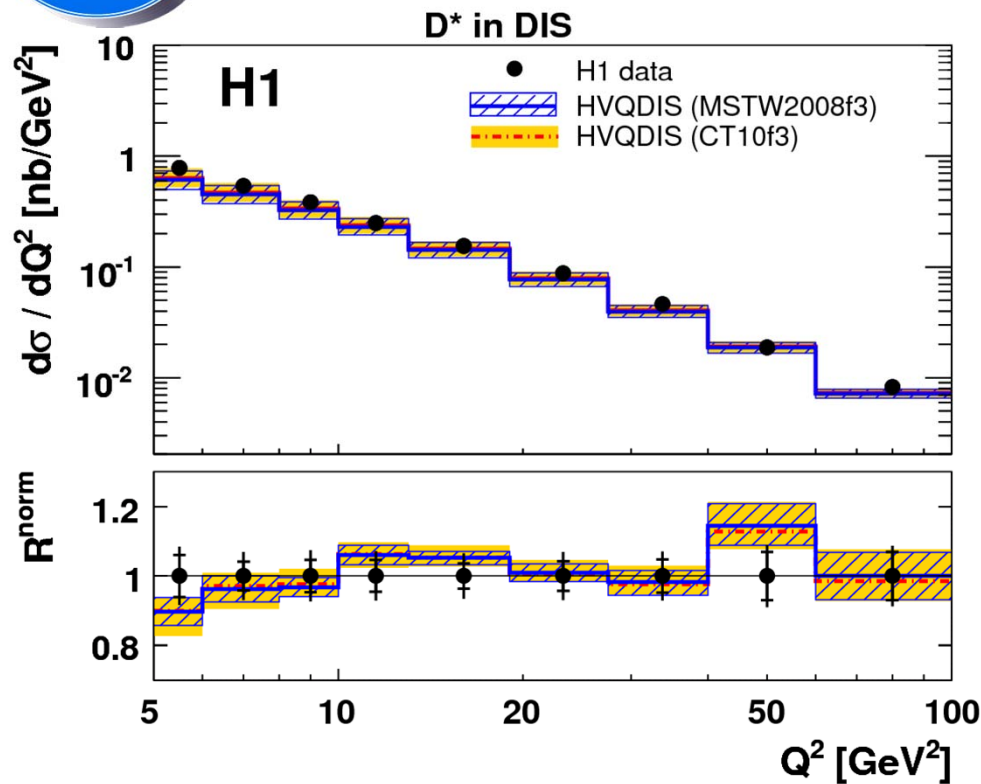
- good agreement between H1 and ZEUS and with NLO QCD (massive differential predictions only available in fixed flavour number scheme)

D* cross section vs. pseudorapidity η



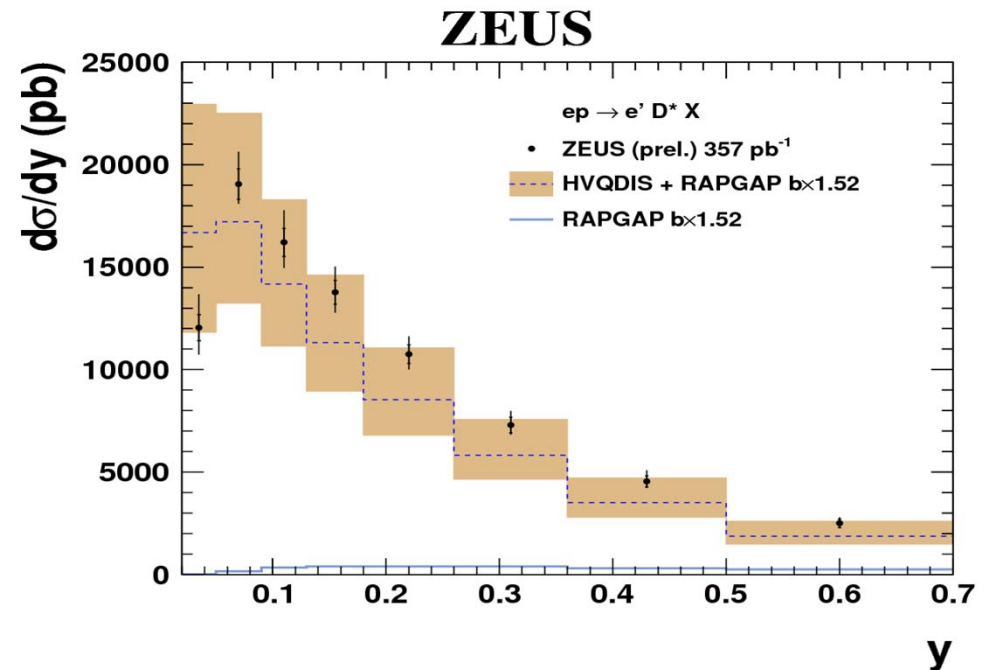
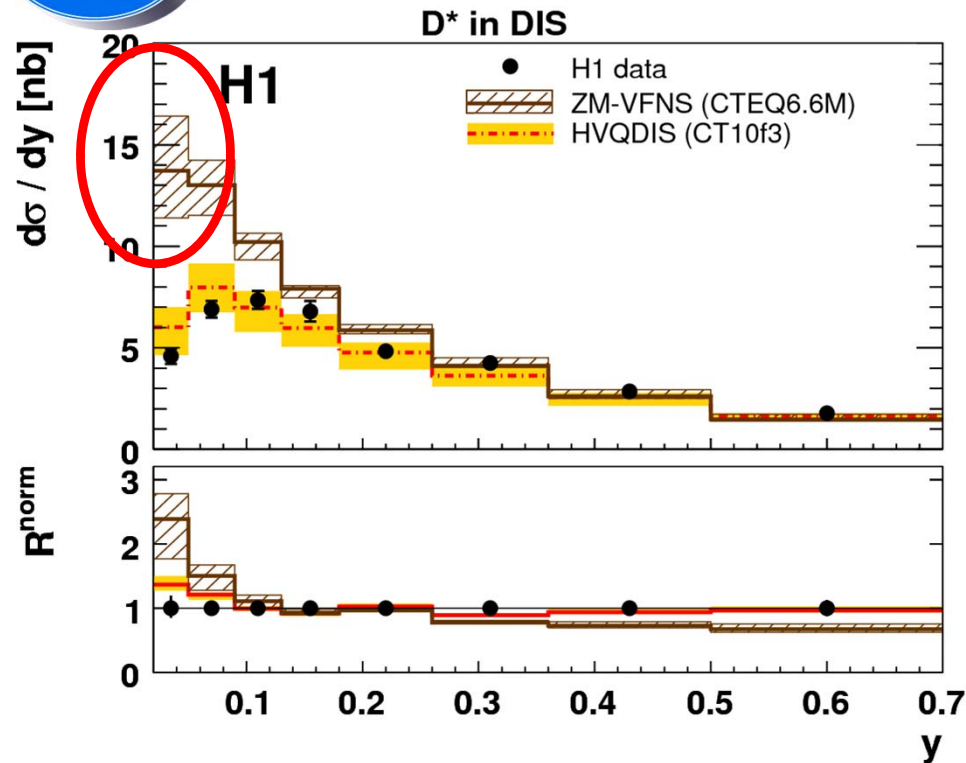
- good agreement between experiments
- tendency for somewhat more forward D*s than NLO QCD predicts?

D* cross section vs. Q^2



- good agreement between experiments and with NLO QCD

D* cross section vs. inelasticity y

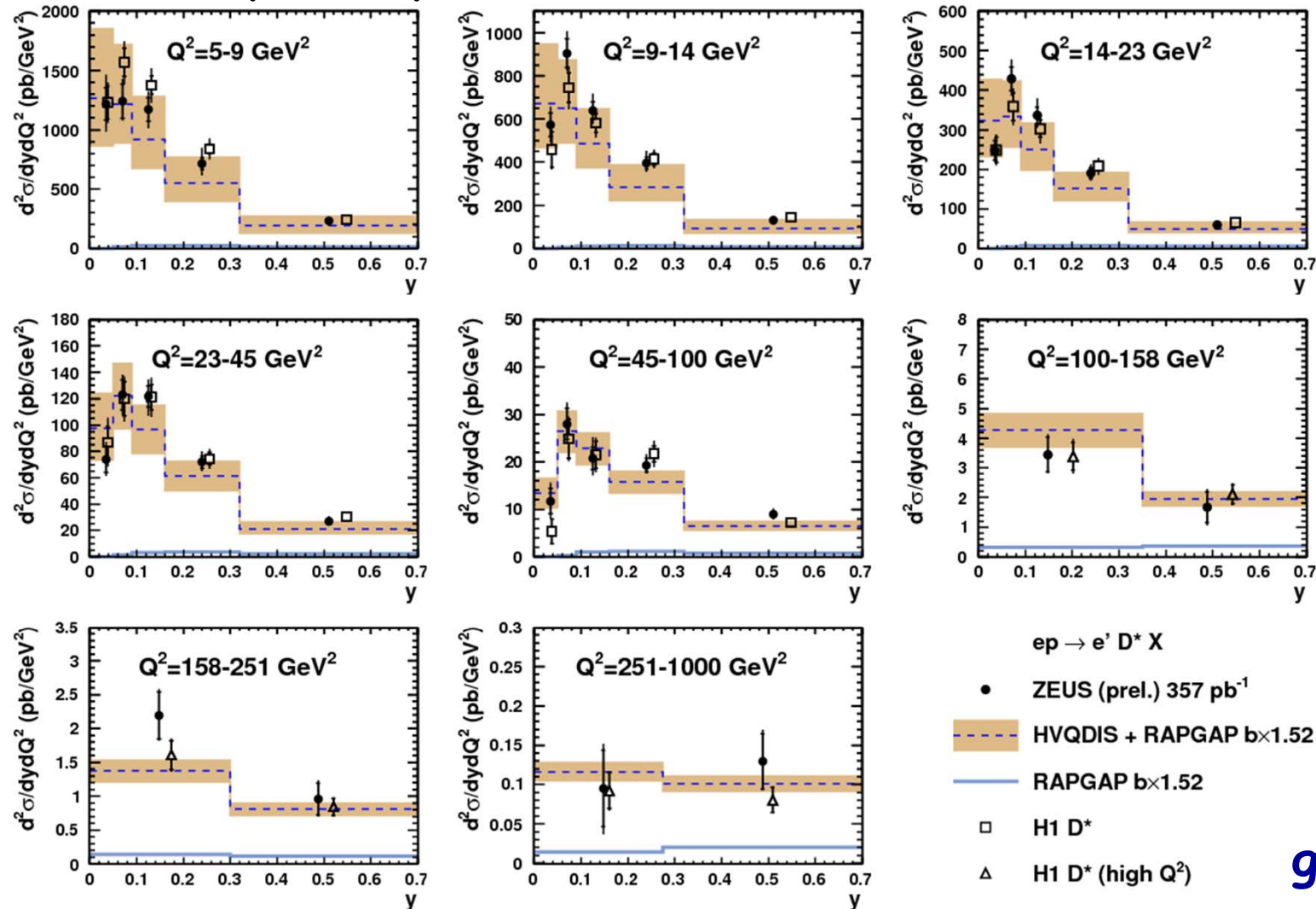


- good agreement between experiments and with massive NLO QCD calculations
- massless NLO calculation (ZM-VFNS) fails at low y

D* double differential cross sections



now H1 in same phase space as ZEUS



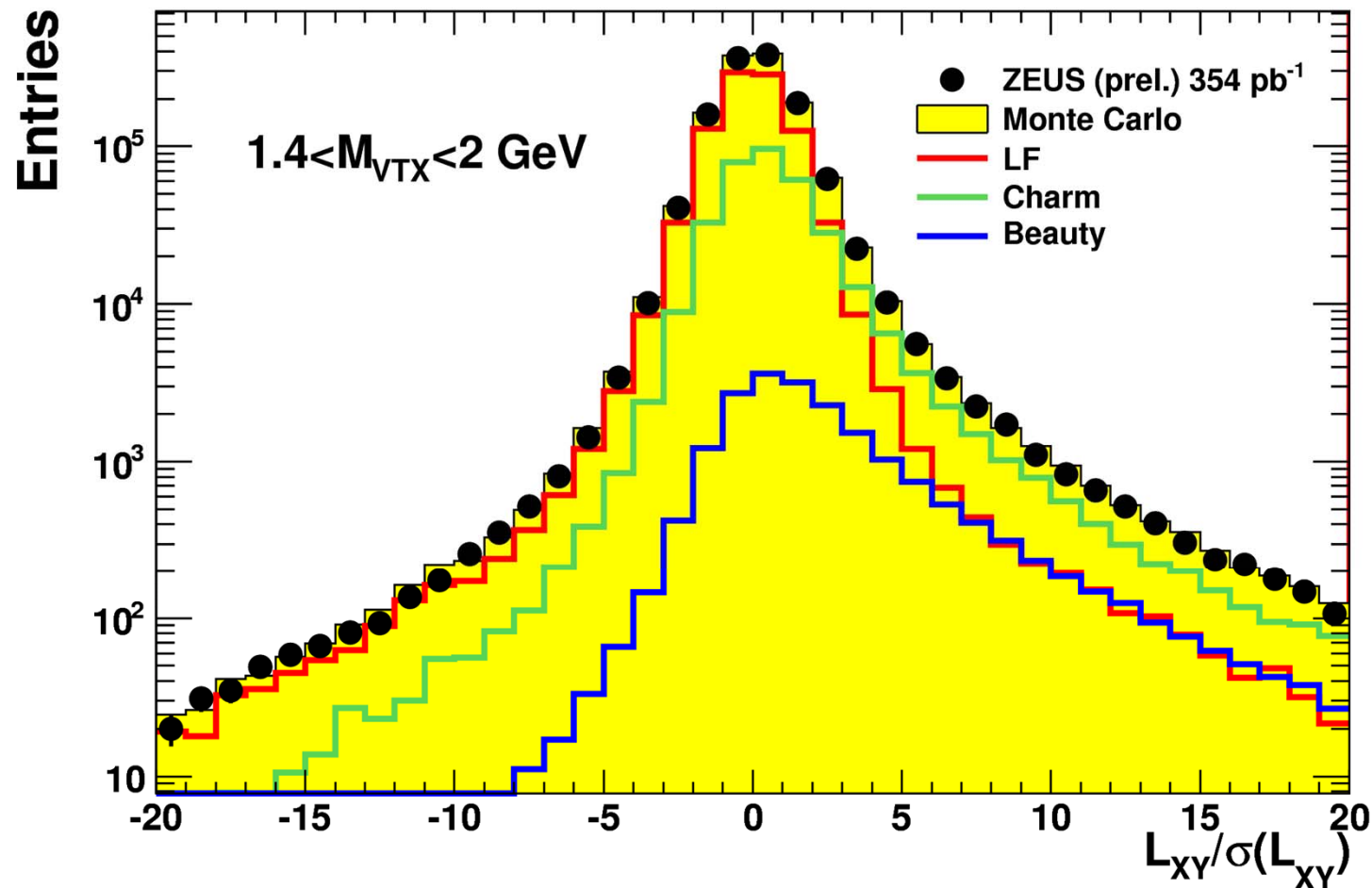
good agreement!

Charm in DIS from inclusive secondary vertices



ZEUS

ZEUS-prel-12-002

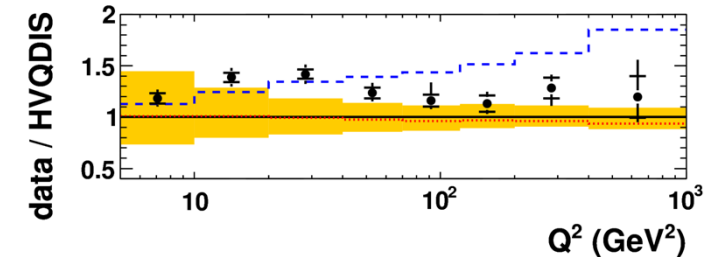
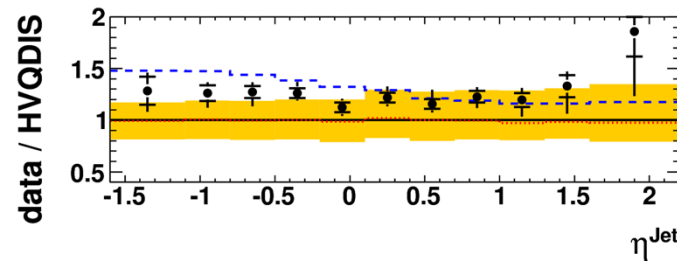
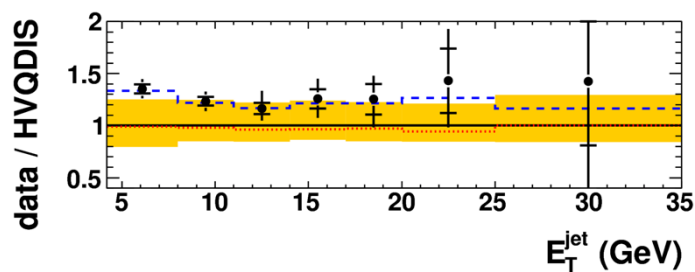
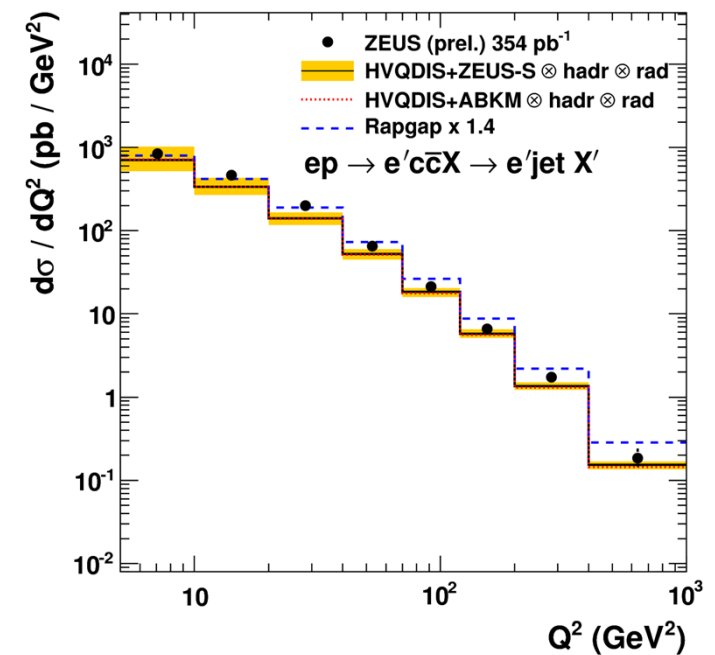
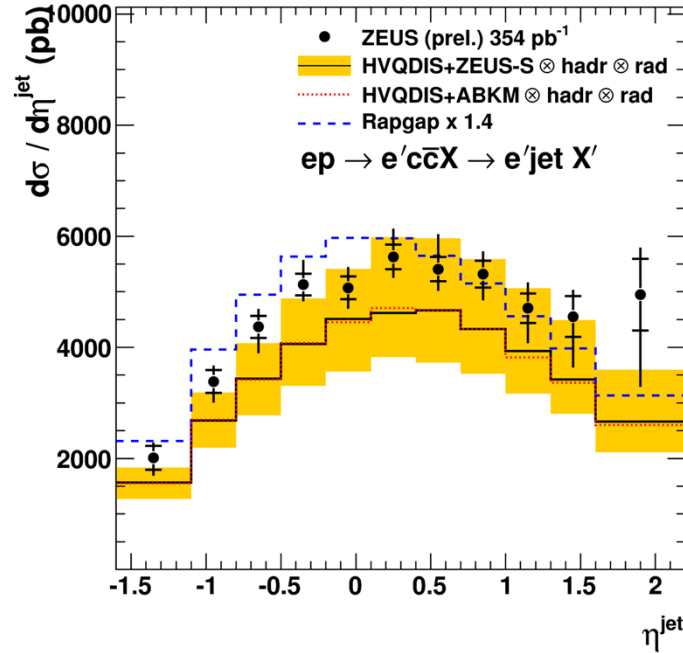
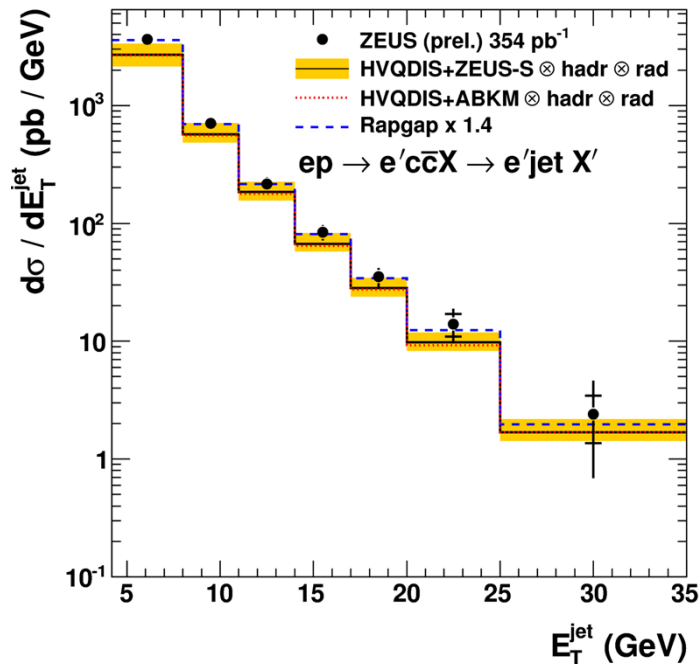


asymmetry of vertex significance distribution well described

Charm cross section, incl. sec. vtx

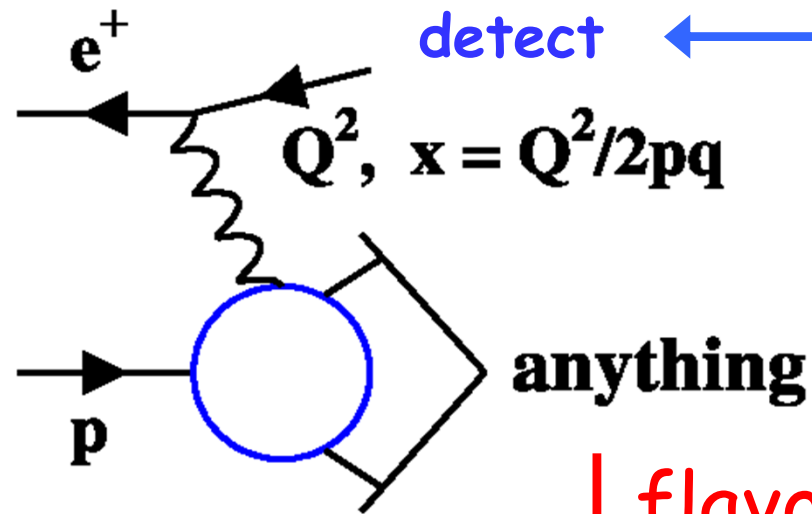
ZEUS

ZEUS-prel-12-002



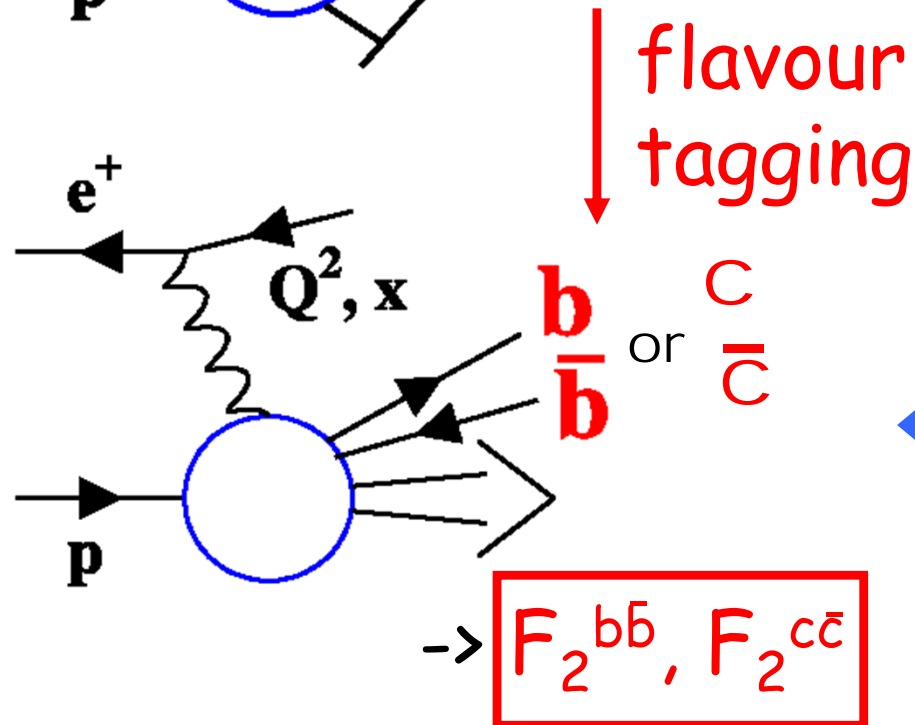
access higher p_T , η , and Q^2 : same conclusions as from D* data

Heavy flavour contributions to F_2

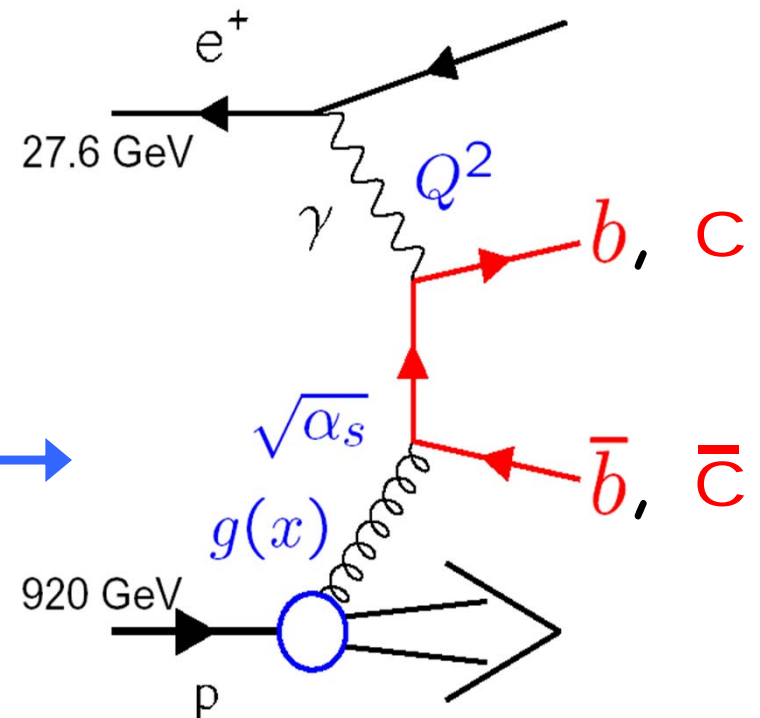


Measure cross section

$$\frac{d^2\sigma}{dx dQ^2} \cong \frac{2\pi\alpha^2}{Q^4 x} \left\{ \left[1 + (1-y)^2 \right] F_2(x, Q^2) \right\}$$



\longleftrightarrow QCD \longleftrightarrow



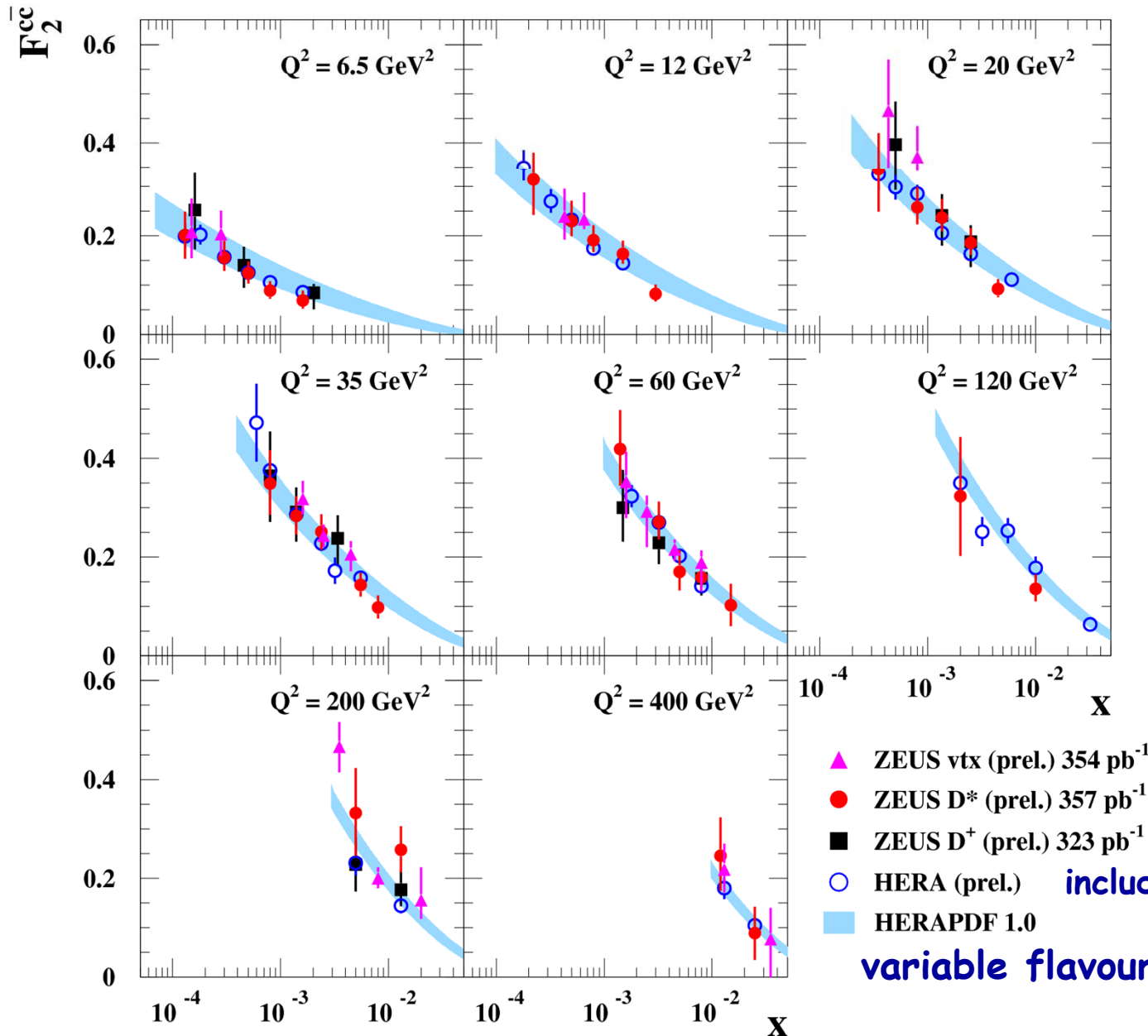


ZEUS

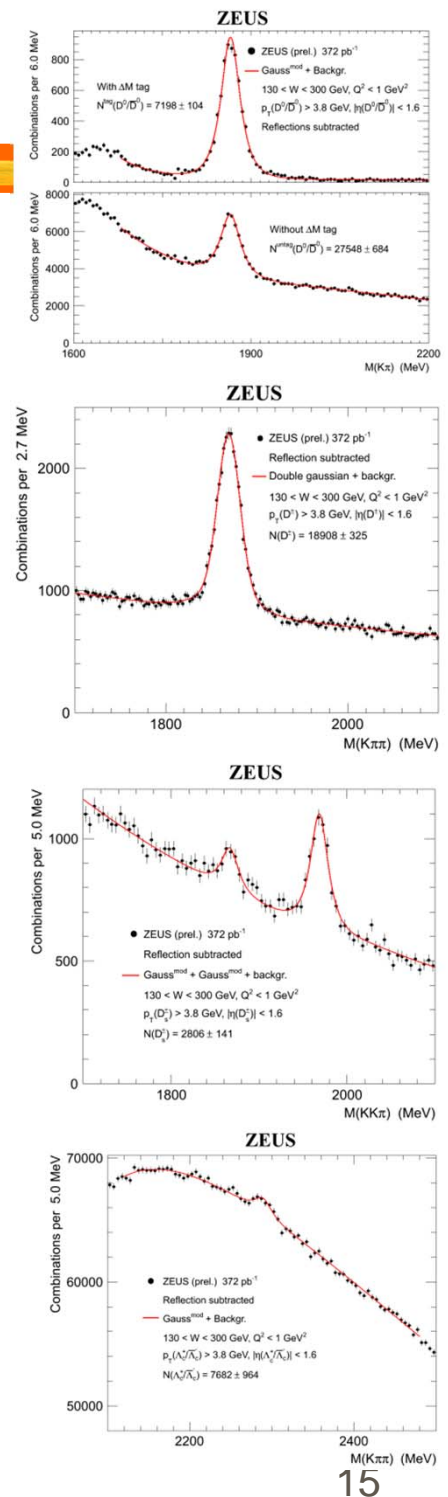
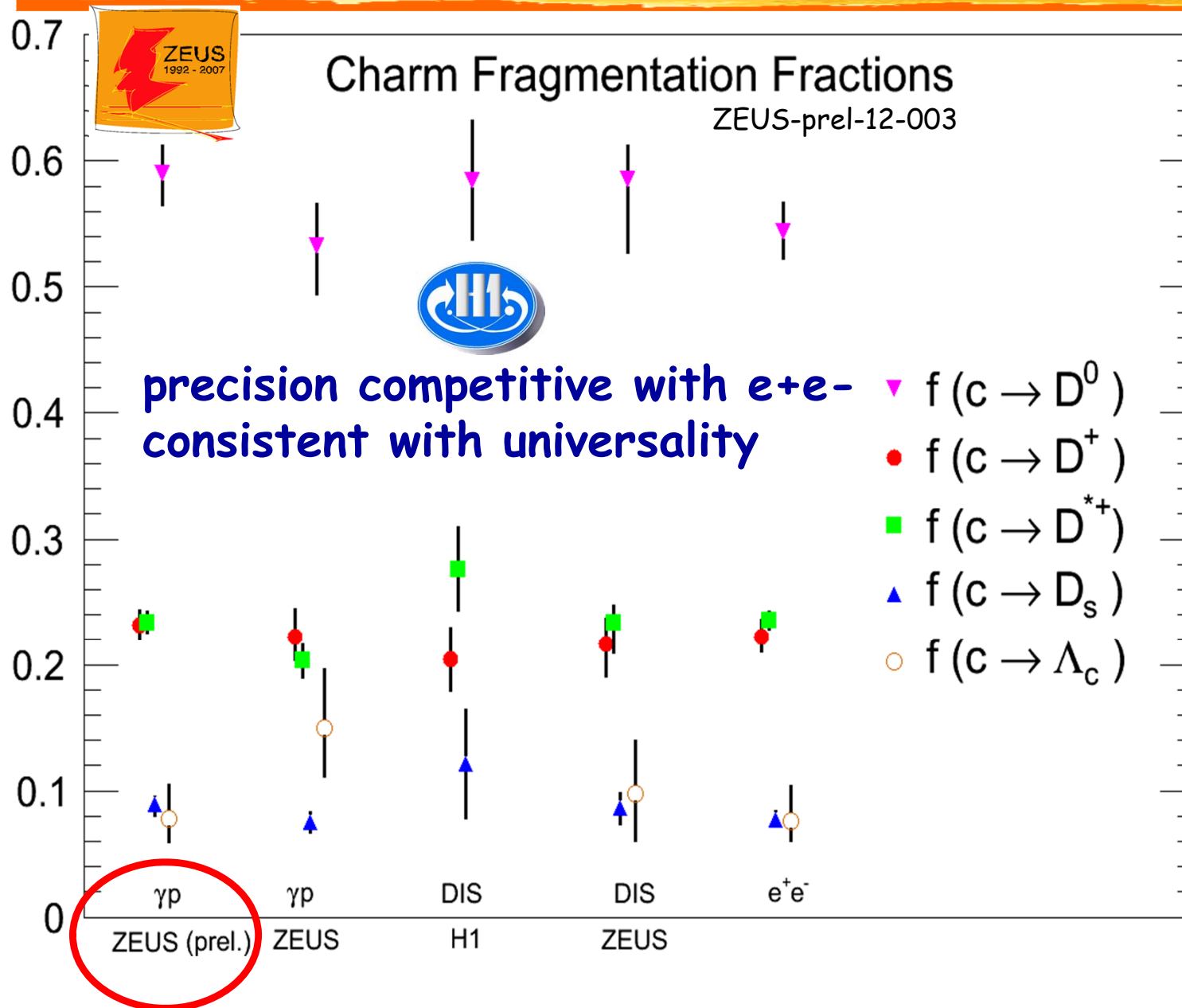


good agreement
between all data
sets, and with
theory

use to constrain
PDFs and to
measure the
charm mass
(in preparation)



charm fragmentation fractions



Summary and conclusions

- different measurements of charm production in DIS yield good agreement with each other and with NLO theory
 - > allows to further constrain PDFs and measure charm mass (ongoing work, see also talk R. Plačakytė)
 - > better predictions for processes at HERA, Tevatron, and LHC
- recent measurement of charm fragmentation fractions in charm photoproduction competitive with e^+e^- and consistent with universality
- most HERA results now available with full HERA statistics, but final results, in particular H1-ZEUS combinations, still to come.