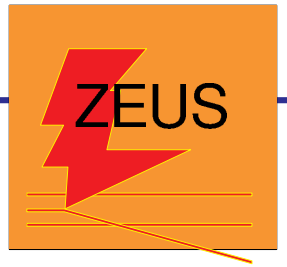
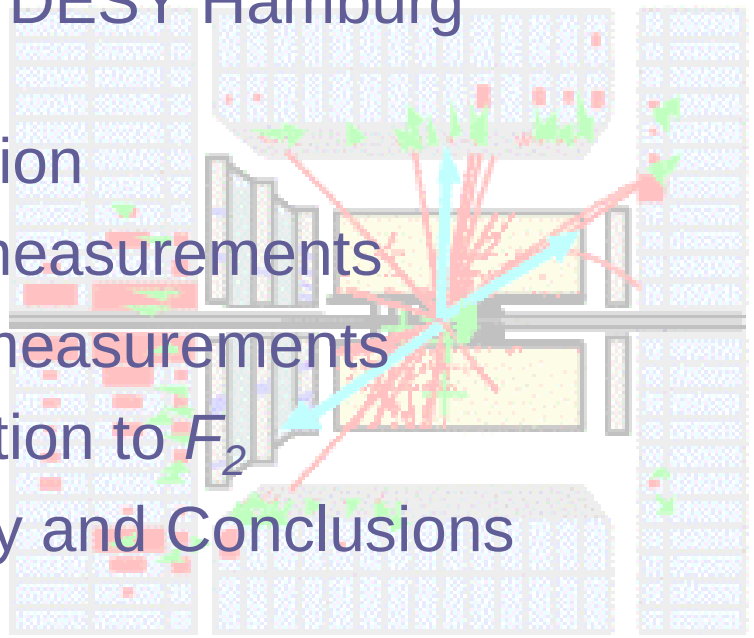


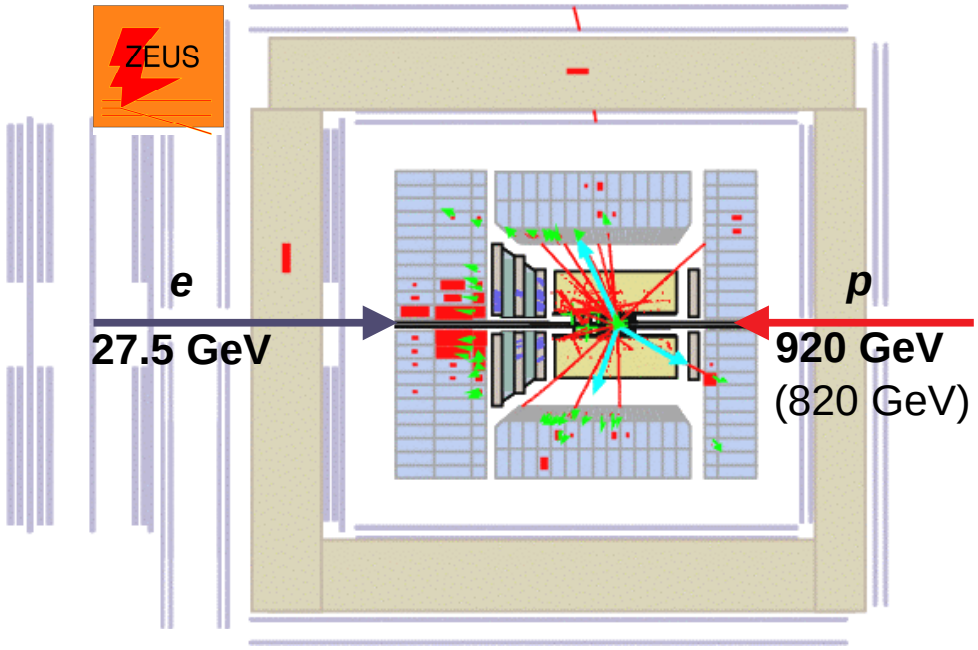
First results on Heavy Flavour production at HERA II

B. Kahle, DESY Hamburg

- Introduction
- Charm measurements
- Beauty measurements
- Contribution to F_2
- Summary and Conclusions



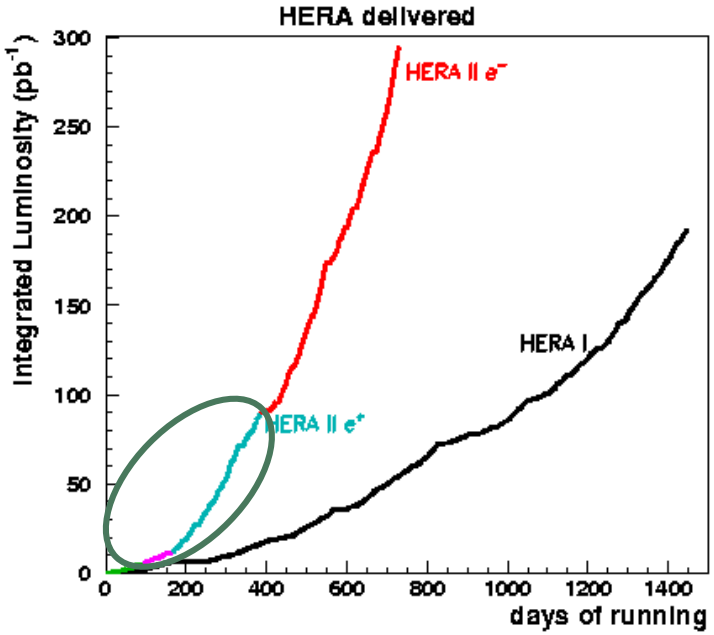
HERA: *ep*-collisions at H1 and ZEUS



ep center-of-mass energy:	
1992 - 97:	300 GeV
98 - 2005:	318 GeV

Integrated Luminosity (e.g. ZEUS physics):

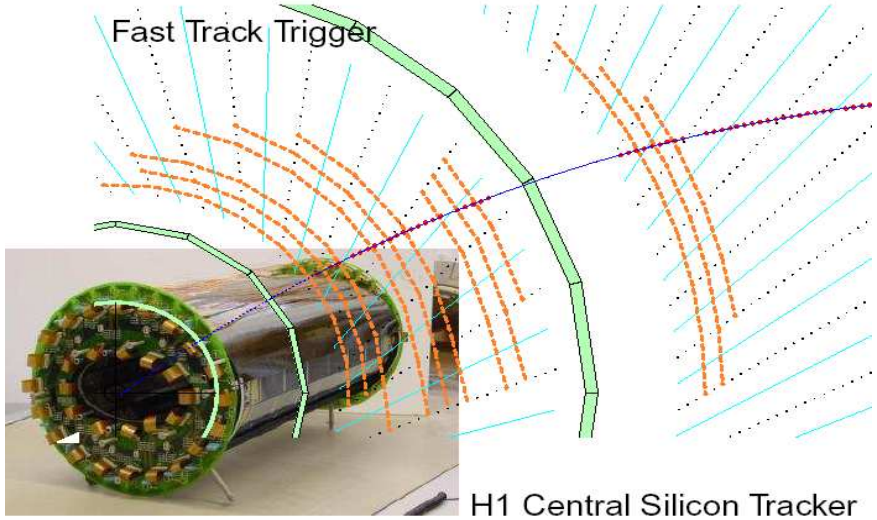
Year	e^+p	e^-p
96-00 (HERA I)	105 pb^{-1}	17 pb^{-1}
03-05 (HERA II)	41 pb^{-1}	152 pb^{-1}
06-07 (expected)	about factor 2 more	



Detector upgrades for HERA II

upgrades most relevant for heavy flavour production:

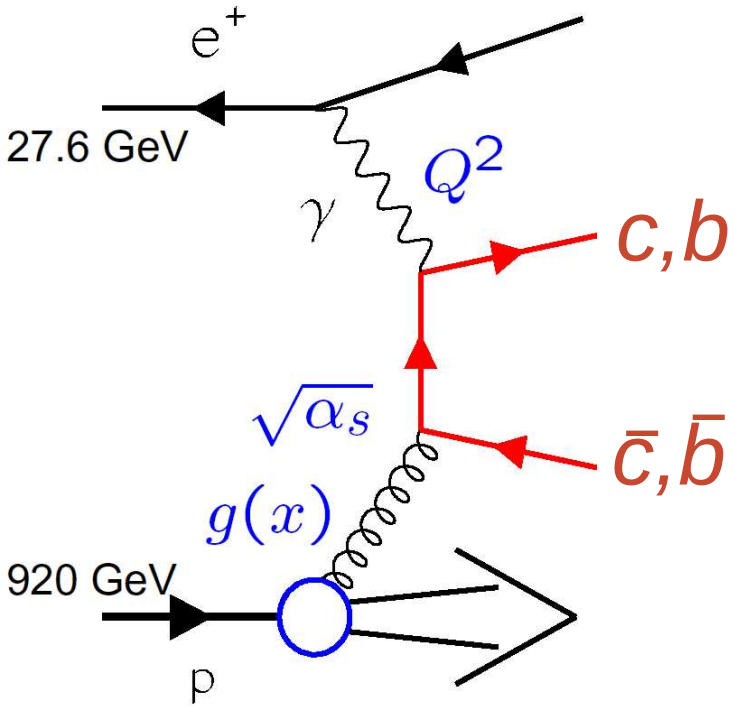
- H1 Fast Track Trigger



- ZEUS Micro-Vertex Detector (MVD)

Heavy Flavour production mechanism

Dominant process in *ep*-collisions: **Boson-Gluon-Fusion**



Kinematic variables:

$Q^2 = -q^2$ photon virtuality, squared momentum transfer

$x = \frac{Q^2}{2Pq}$ Bjorken scaling variable, for $Q^2 >> (2m_Q)^2$: momentum fraction of p constituent

Two kinematic regimes:

- Photoproduction (γp): γ quasi-real $Q^2 < 1$ GeV^2
- Deep inelastic scattering (DIS): $Q^2 > 1$GeV^2

Multiple scales:

$m_{c,b}$ ~ 1.5/5 GeV

$p_t^{c,b}$ ~ typically few GeV

Q^2 $\gtrsim$ 1 GeV^2 in DIS

→ different pQCD approaches

good testing ground for pQCD

Charm tags

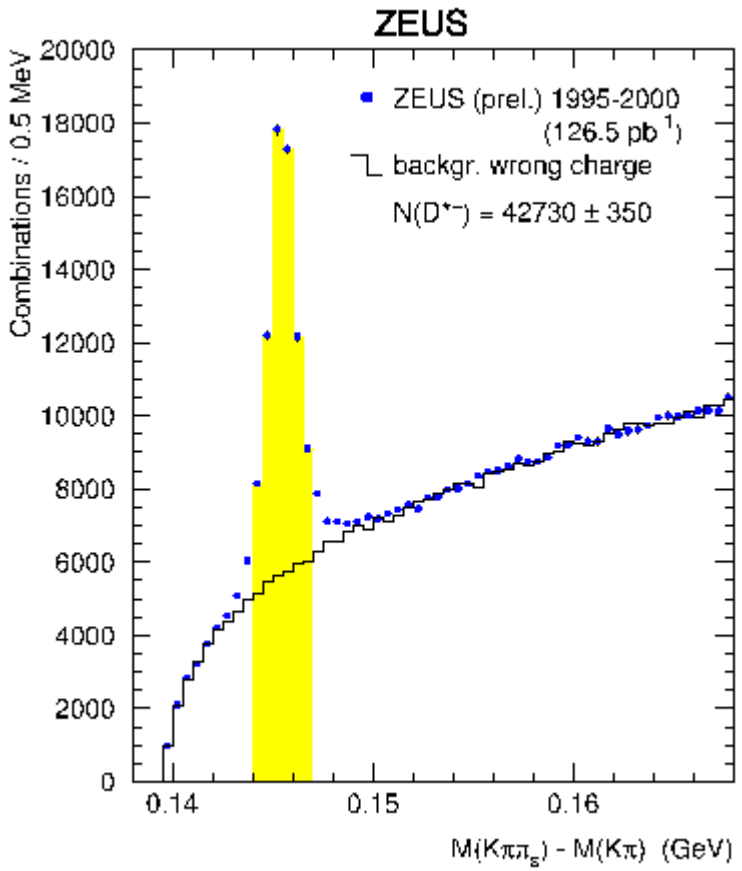
$\sigma_{uds} : \sigma_{charm} : \sigma_{beauty}$

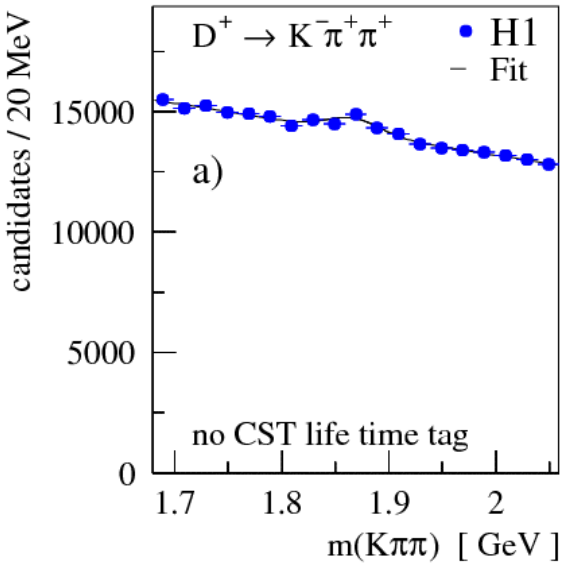
~2000 : 200 : 1

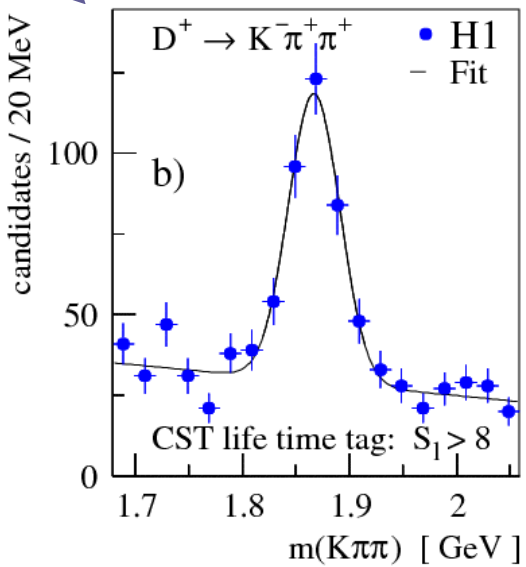
↳ HERA is a charm factory

Measurements using:

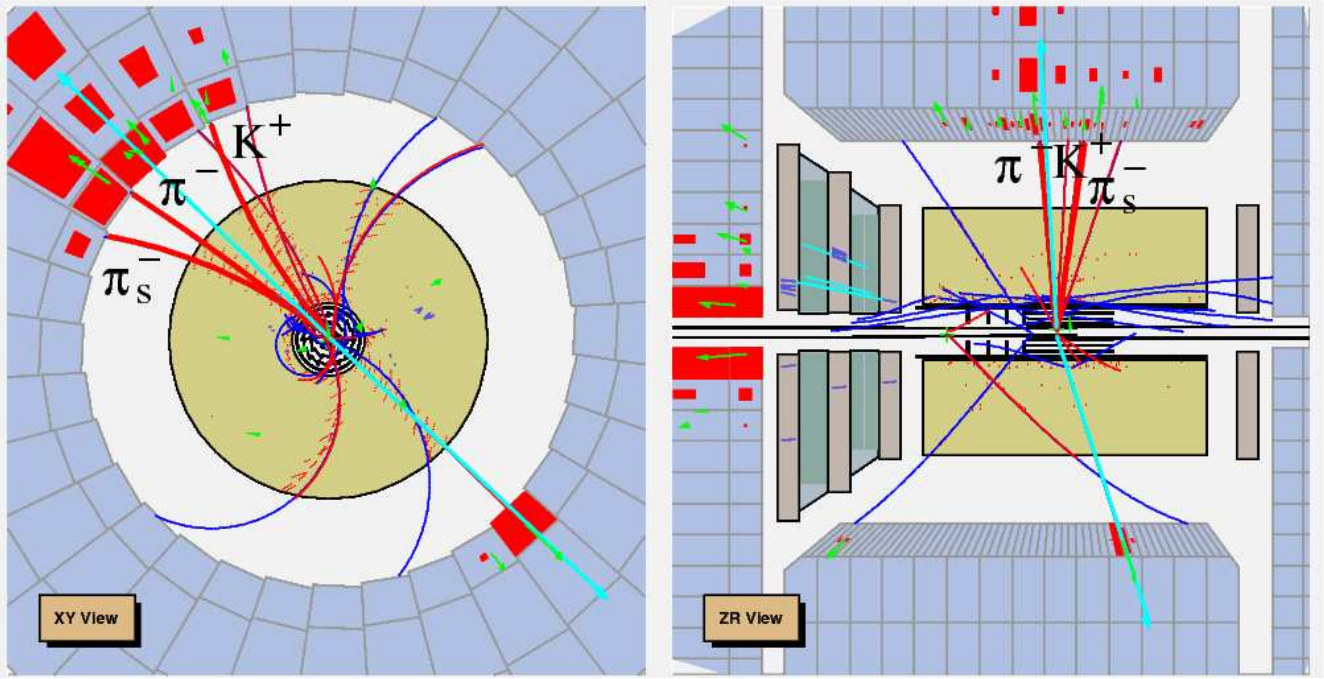
- meson tag, e.g. D*-> K π π →
- lifetime tag, e.g. D^+ (or inclusive)







D* candidate at ZEUS



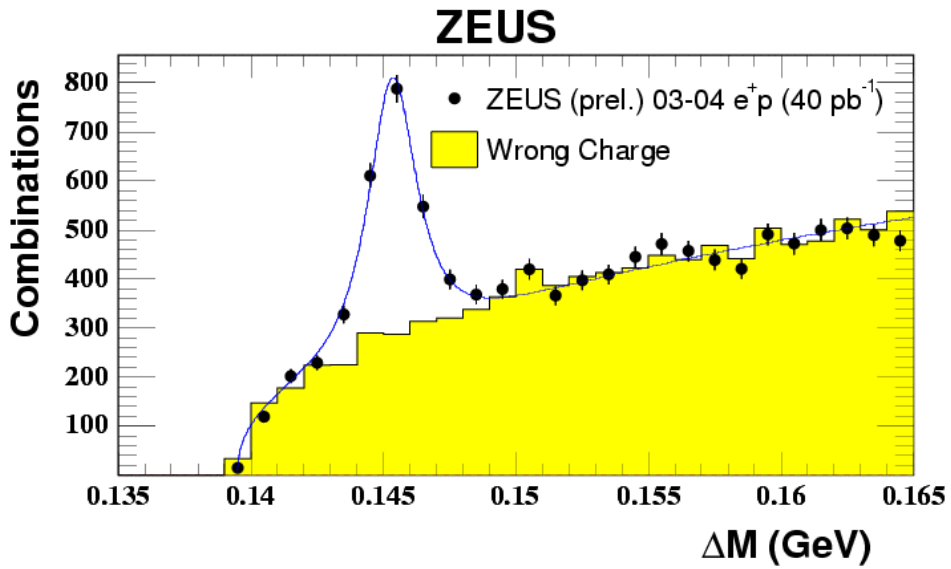
- date: 2-06-2004
- $Q^2 = 918\,GeV^2$
- $y = 0.39$
- $p_T(D^*) = 10.3\,GeV$
- $\eta(D^{*-}) = 0.06$

Charm in HERA II data

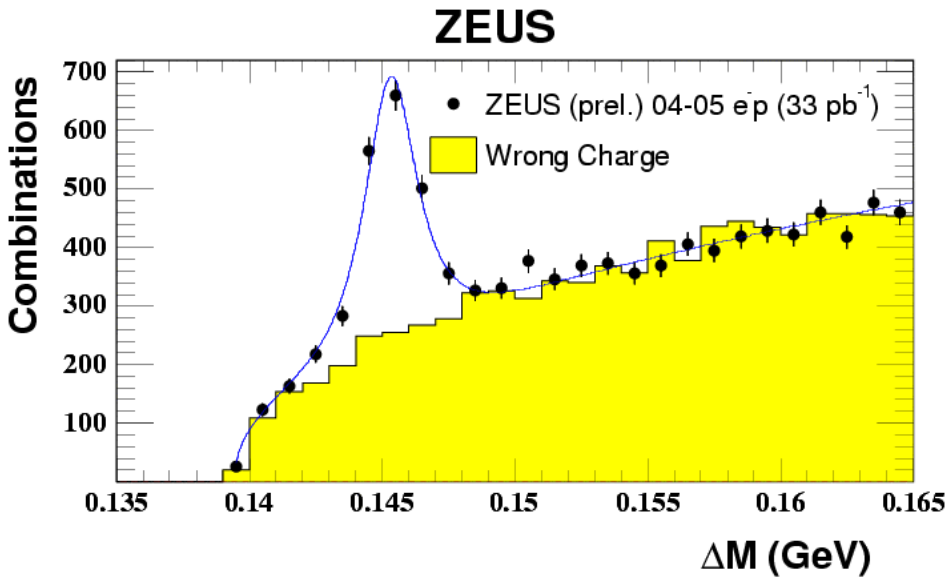
first HERA II charm data

$e^{\pm}p \rightarrow D^{*\pm} + X$

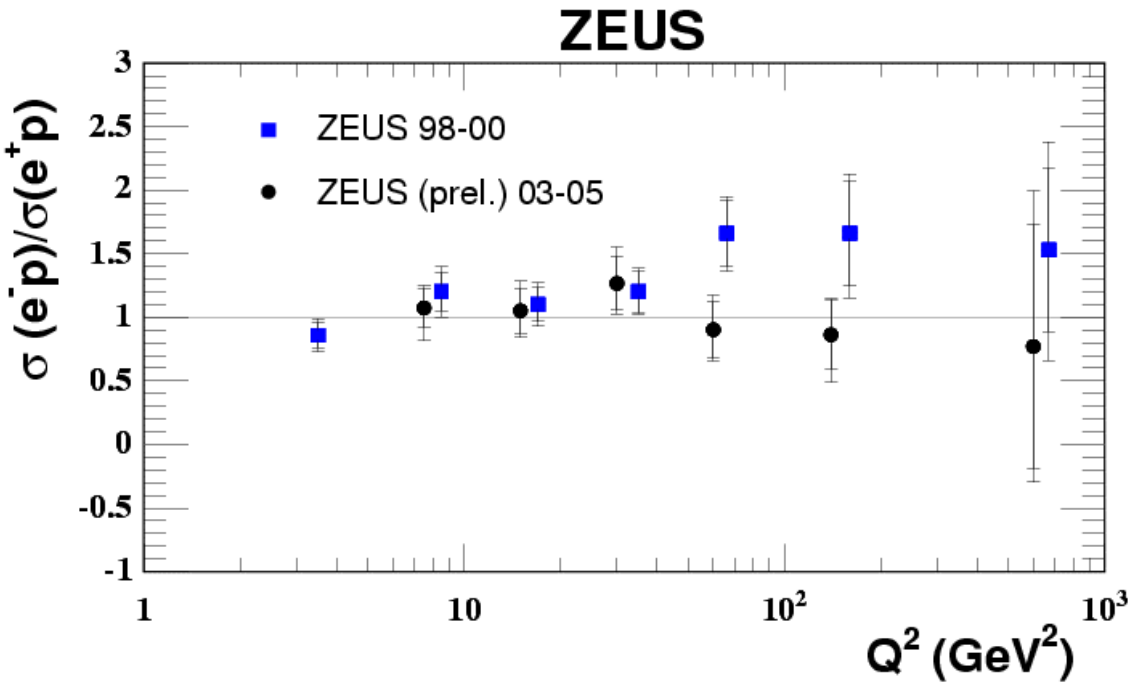
D* ($e^{+}p$)



D* ($e^{-}p$)

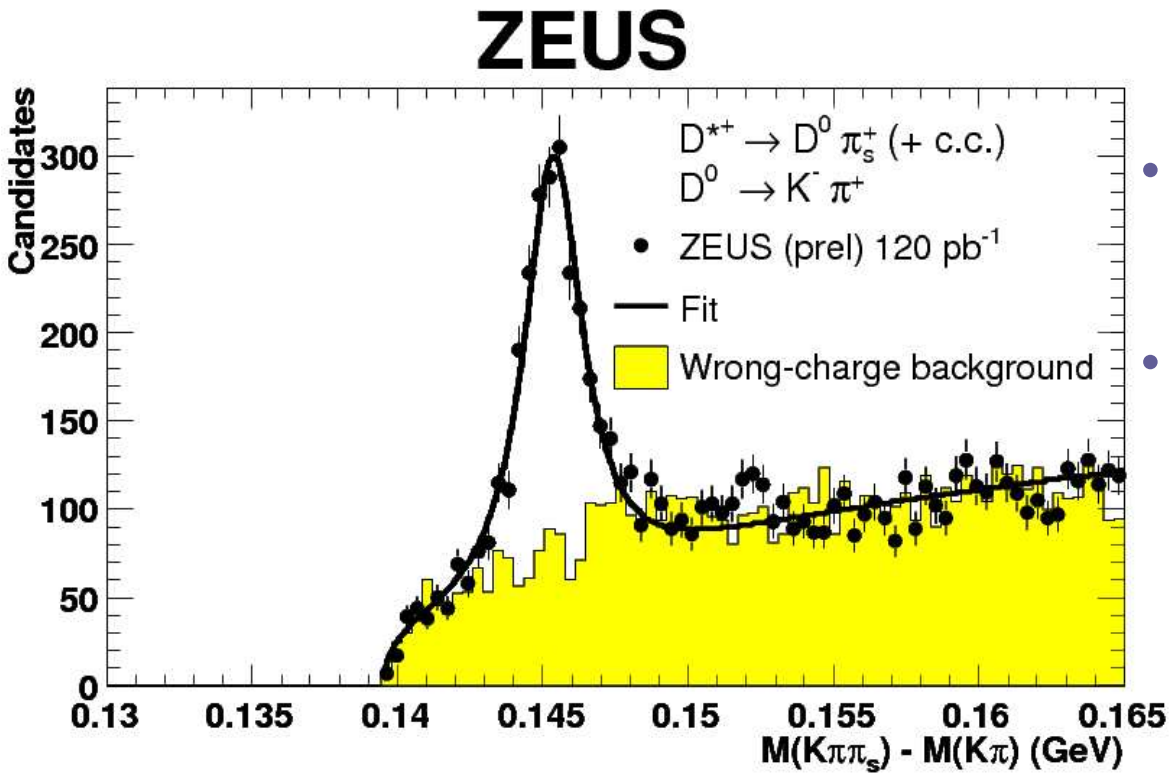


Charm in HERA II data



HERA I "excess" in charm e^-p/e^+p cross section at high Q^2 was statistical fluctuation (as expected)

More data…

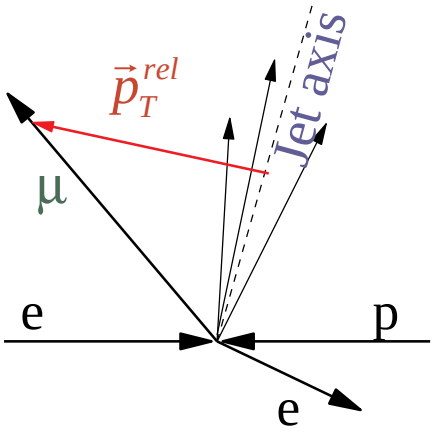


- data of 2005 added
  - ↳ $(e^{-}p) = 120pb^{-1}$
- signal width improved from 2 MeV to 1.8 MeV using improved track fits

Beauty identification

Semileptonic beauty decay

Method 1: p_t^{rel}

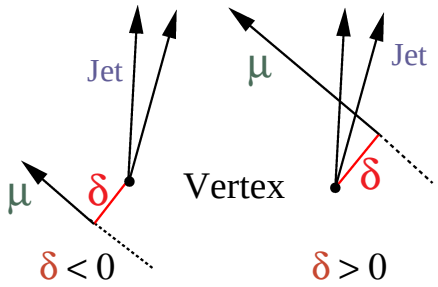


p_T^{rel} is the relative momentum of the muon to the jet axis (including the muon).

Large *b* mass → p_T^{rel} spectrum is harder for ***b*** than for ***c***.

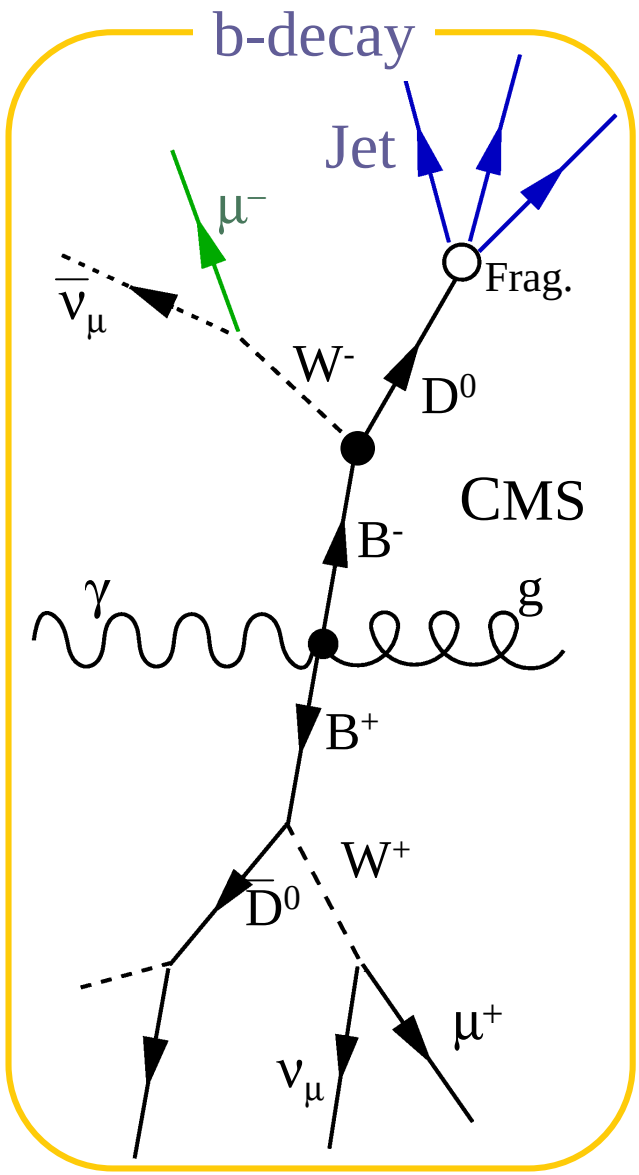
→ statistical separation using MC-distributions.

Method 2: Impact-parameter



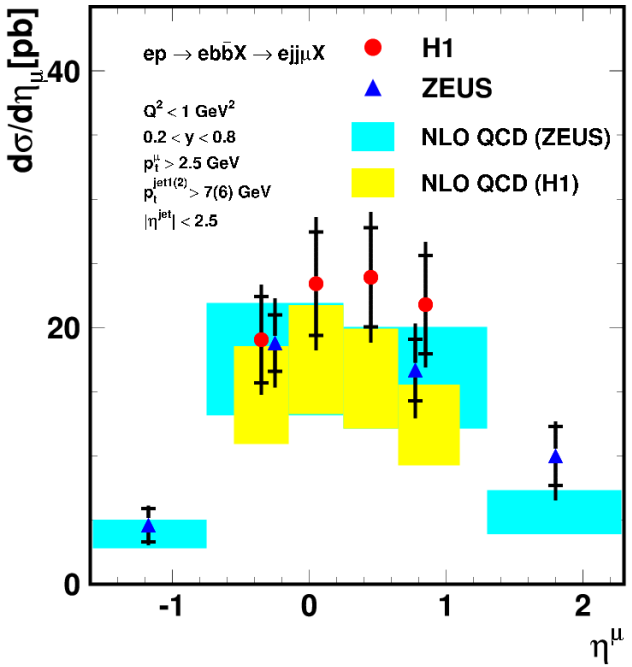
Shortest distance δ between the primary vertex and a track (here the μ).

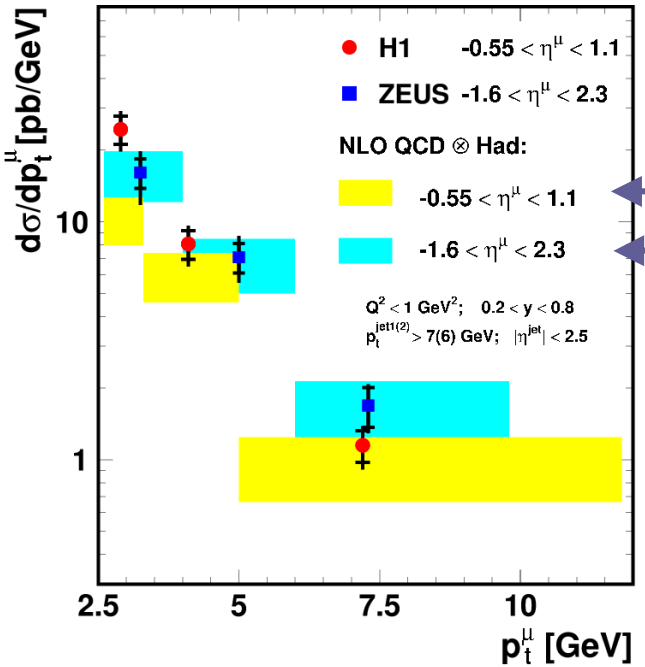
Long lifetime → δ large (positive)



Beauty in photoproduction and DIS

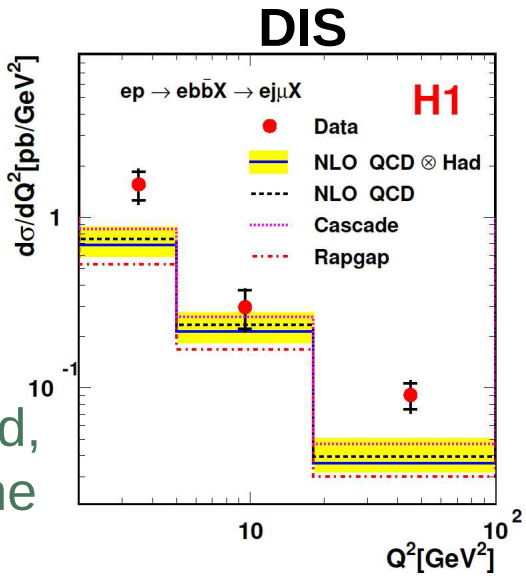
previous measurements





γp

diff. kin. regions!



Reasonable description of H1 and ZEUS data by NLO

H1 data above prediction at low p_t^μ

Q^2 shape is described, data slightly above the NLO prediction

Beauty in DIS at HERA II

Preliminary results for ep -> eb$\bar{b}$X -> e μ jet X'
in DIS at HERA II

- first 30 pb^{-1} of HERA II data
- p_t^{rel} method to determine beauty fraction
- data compared to MC (NLO calculations not yet ready)

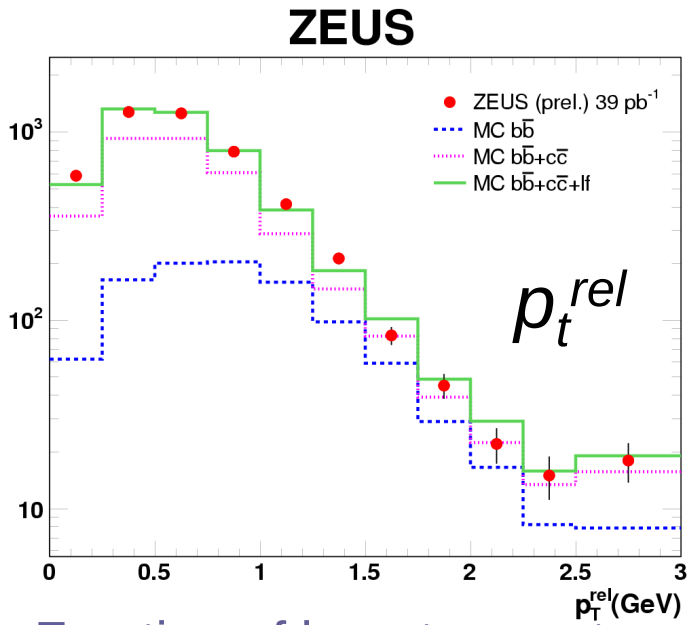
Kinematic region:

$Q^2 > 4$ GeV^2 $\quad 0.05 < y < 0.7$

$E_t^{jet} > 5$ GeV $\quad p_t^{\mu} > 1.5$ GeV

$-2 > \eta^{jet} > 2.5$ $\quad \eta^{\mu} > -1.6$

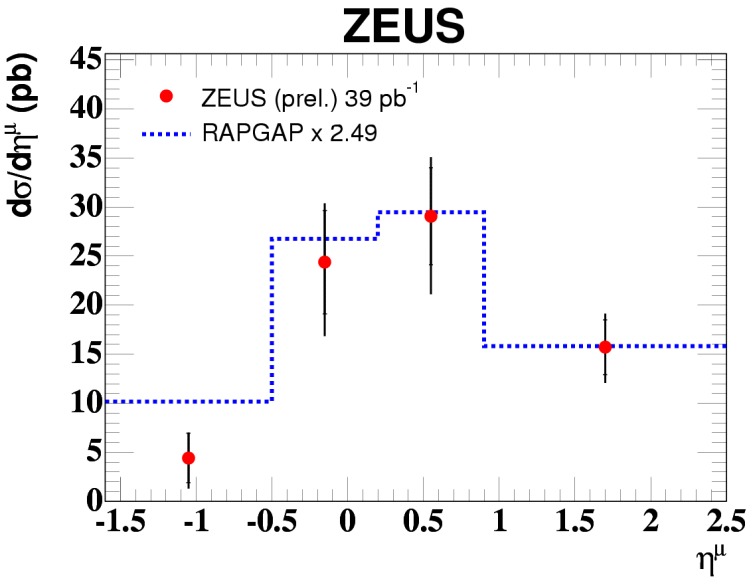
$\sigma_{b\bar{b}} = 77.1 \pm 7.8\,(stat.)^{+9.6}_{-14.9}\,(syst.)$ pb

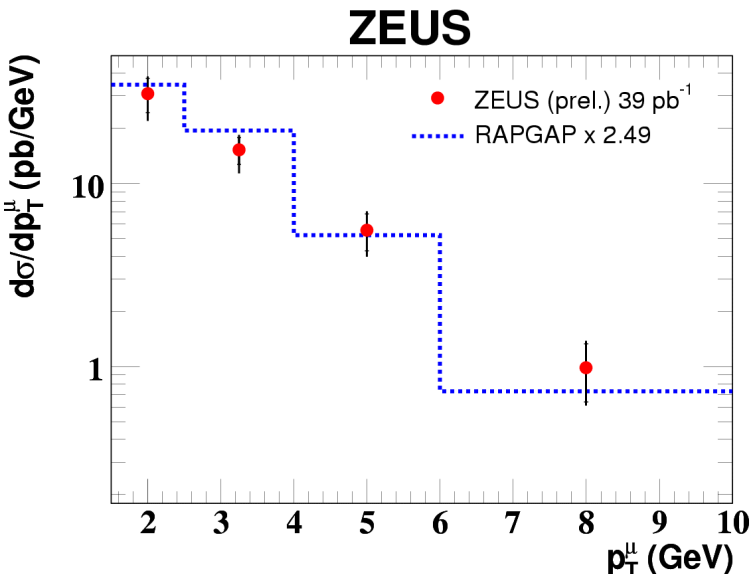


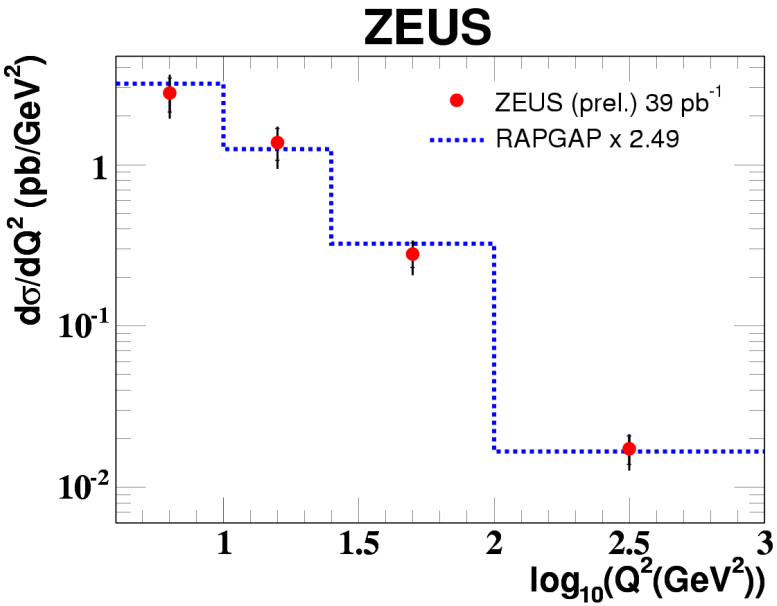
Fraction of beauty events:
21,4% ± 2.1%(stat.)

Beauty MC scaled by a factor of 2.49

Beauty in DIS at HERA II







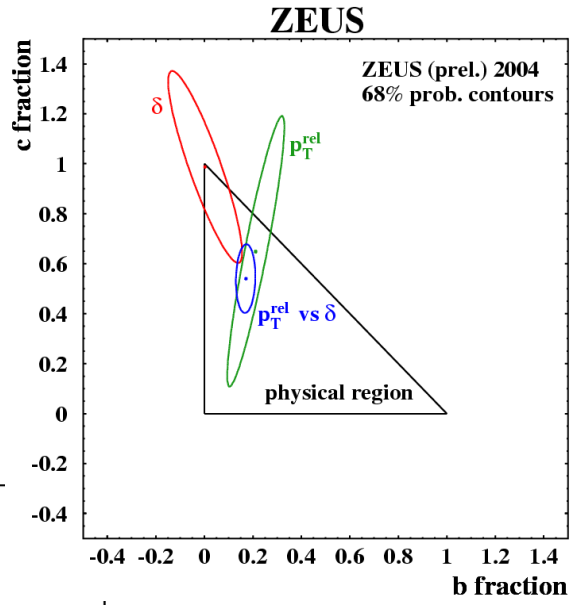
Good agreement between data and scaled MC

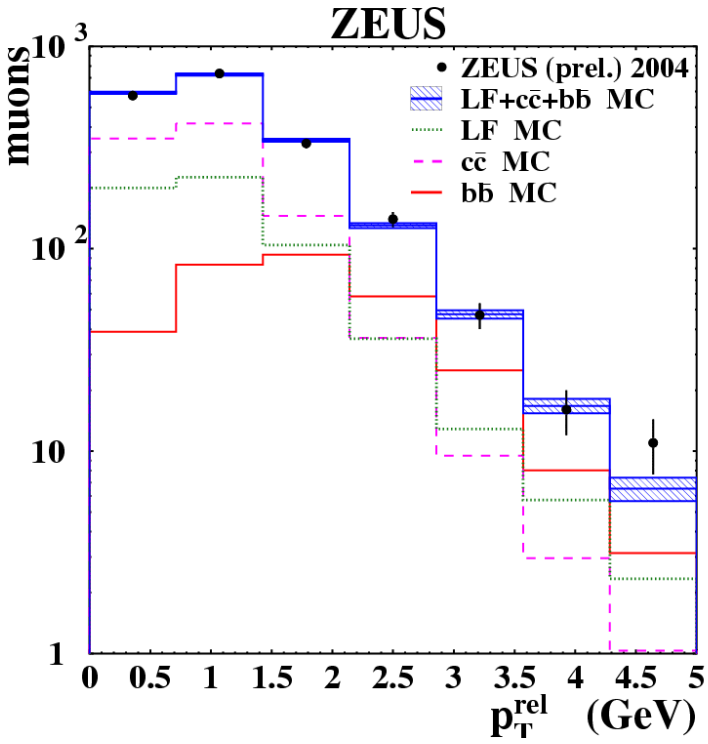
No significant disagreement at low p_t^{μ} or large η^{μ}

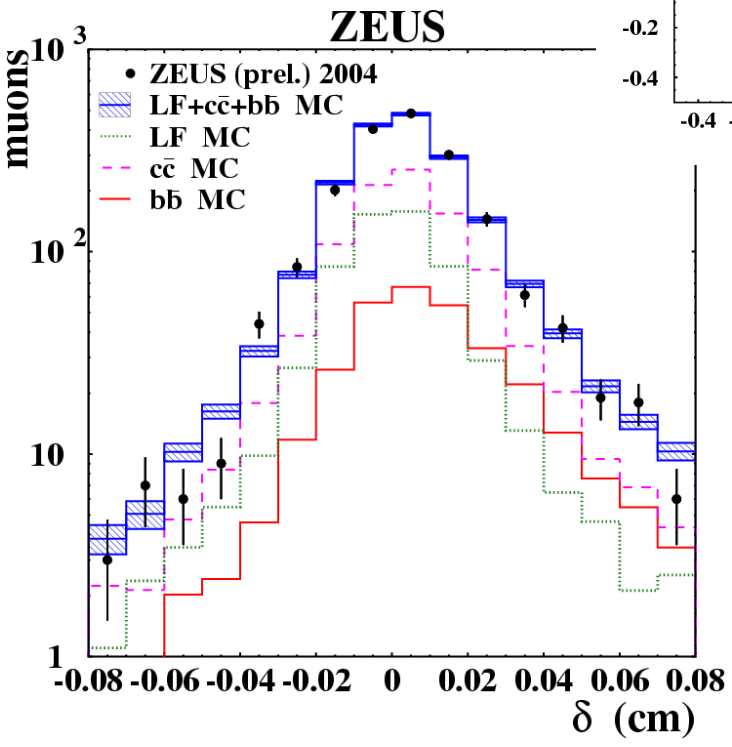
Beauty in HERA II data

First preliminary results using new ZEUS MVD:

- first 30 pb^{-1} of HERA II data
- combine muon p_t^{rel} with impact parameter (μ+dijet events)







f(b): 16.7% ± 2.6%

f(c): 52% ± 10%

Beauty in HERA II data

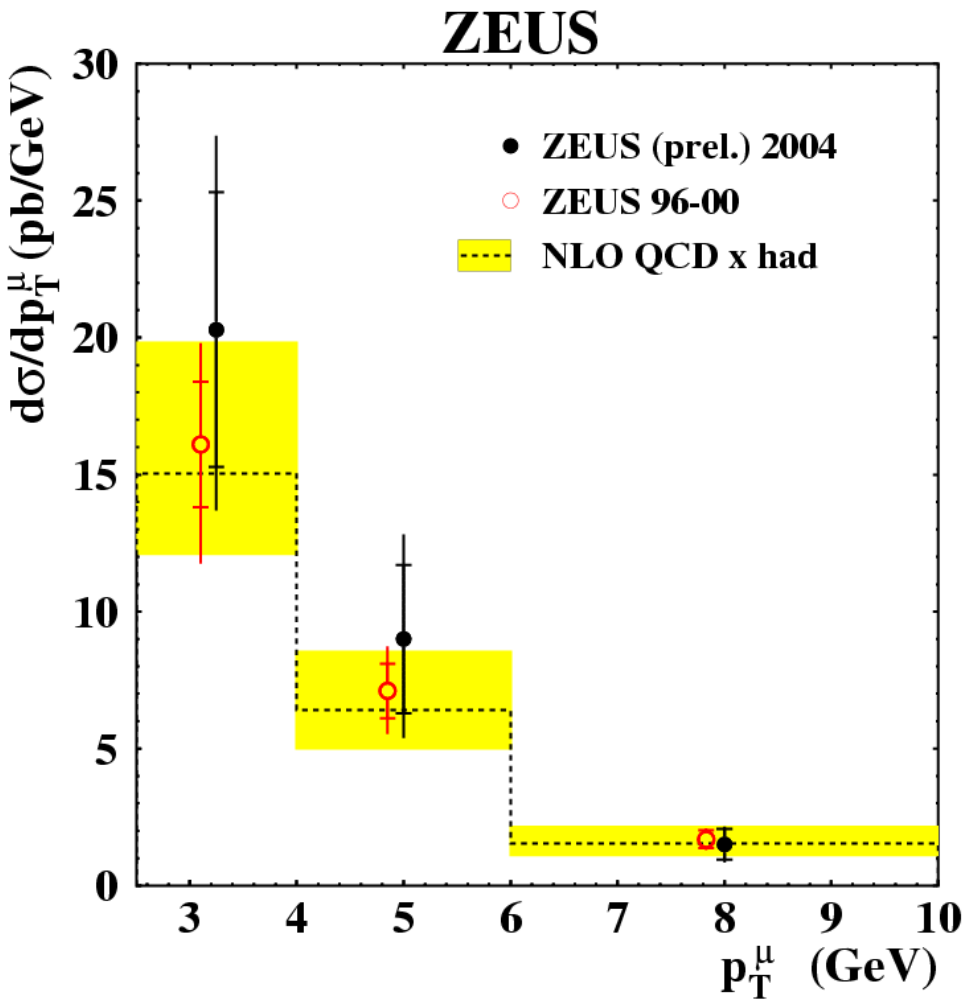
Kinematic region:

$Q^2 < 1$ GeV^2 $\quad 0.2 < y < 0.8$

$p_t^{jet} > 7(6)$ GeV $\quad p_t^{\mu} > 2.5$ GeV

$|\eta^{jet}| < 2.5$ $\quad -1.6 < \eta^{\mu} < 2.3$

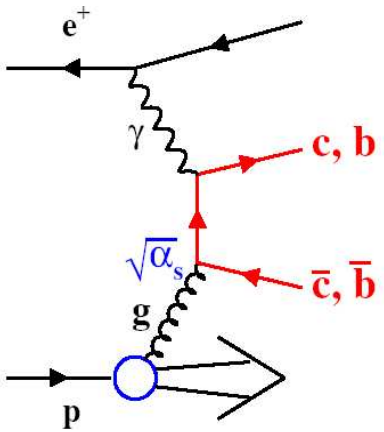
HERA II data agree with NLO prediction (FMNR) and with HERA I data



Charm contribution to F_2

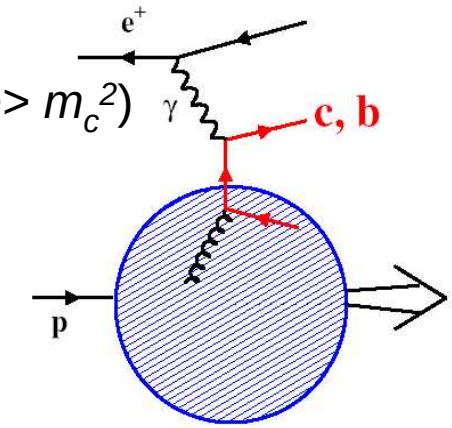
$$\frac{d^2\sigma^{ep\to c\bar{c}X}}{dxdQ^2} = \frac{2\pi\alpha^2}{Q^4 x}\left\{\left[1+(1-y)^2\right]F_2^{c\bar{c}}(x,Q^2)+\ldots\right\}$$

test/constrain gluon density

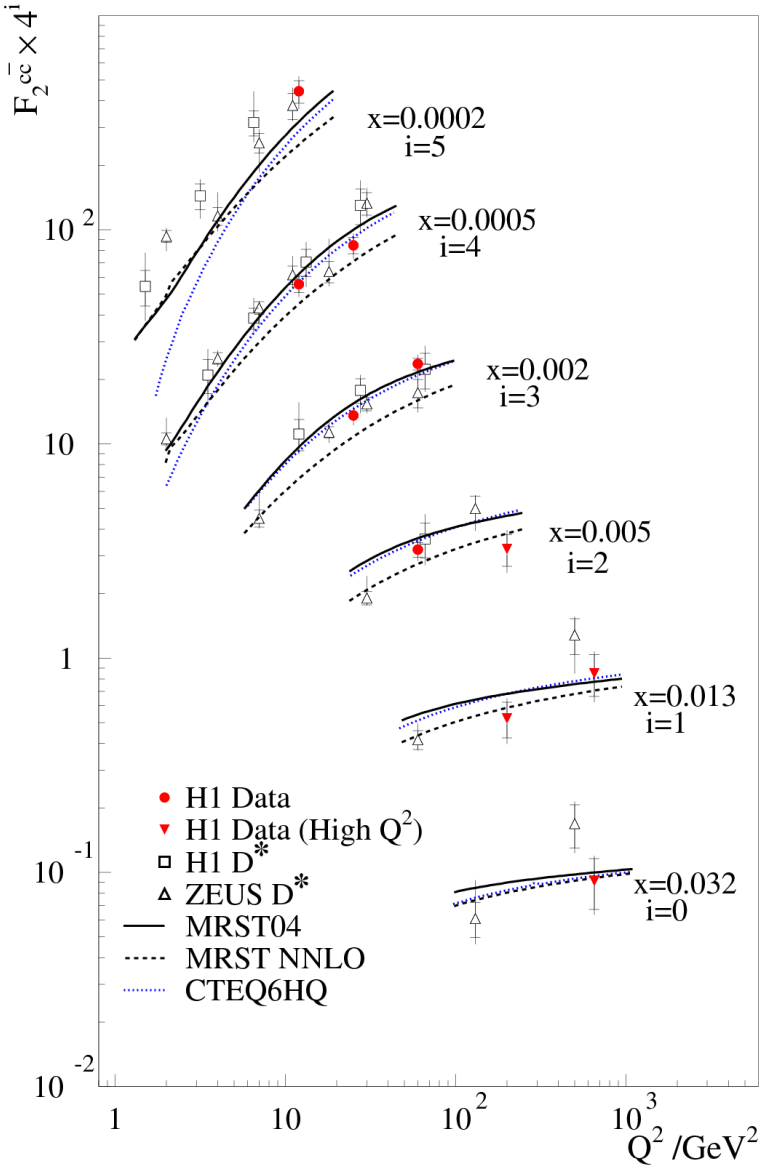


or

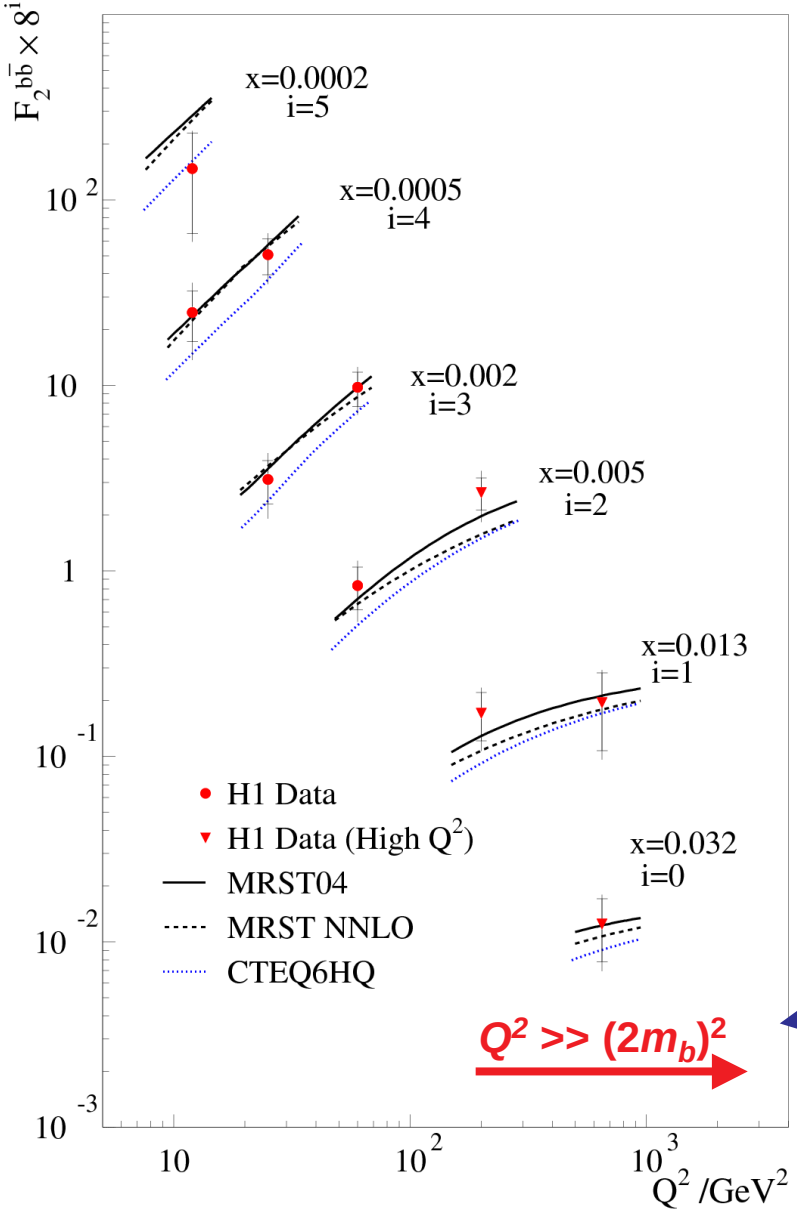
$(Q^2 >> m_c^2)$



obtain virtual charm content (PDF) of proton

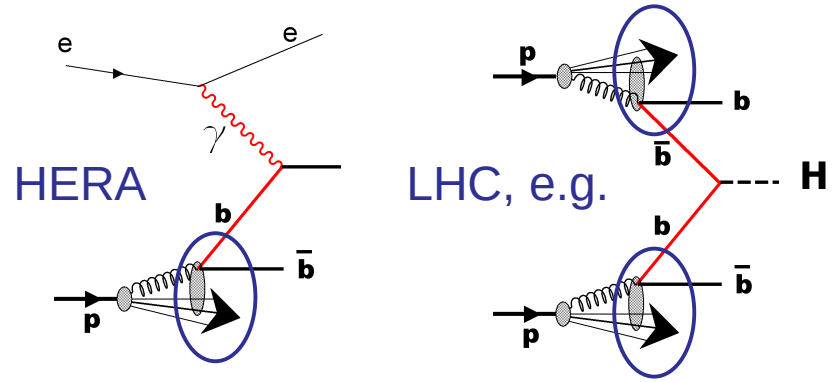


Beauty contribution to F_2

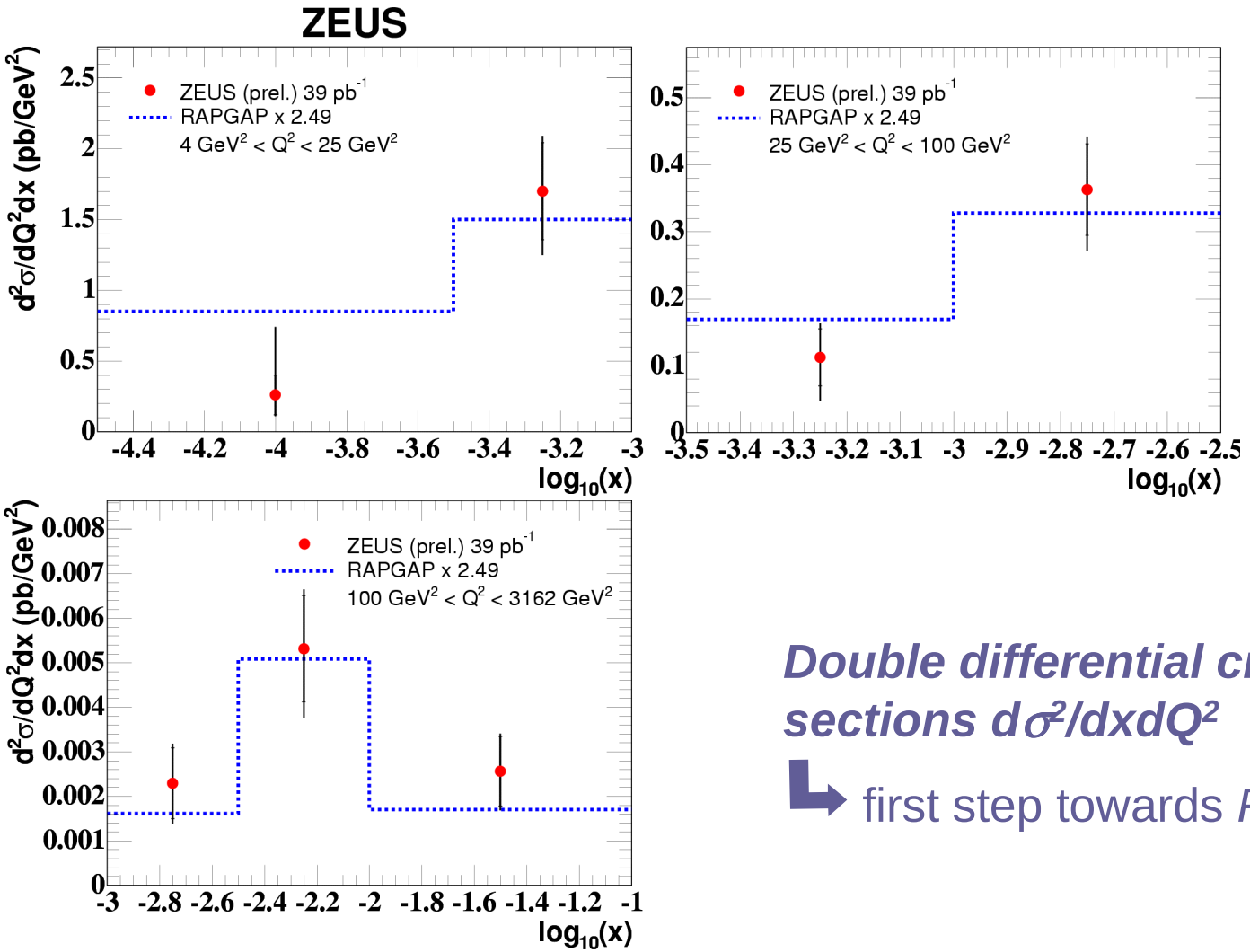


$F_2^{b\bar{b}}(x,Q^2)$

- first measurement
- rise with the gluon density (towards smaller x and larger Q^2)
- data are well described by calculations



Beauty contribution to $F_2^{b\bar{b}}$ at HERA II



Data are described within the uncertainties by the MC

Double differential cross sections $d\sigma^2/dxdQ^2$

↳ first step towards $F_2^{b\bar{b}}(x,Q^2)$

Summary and Conclusions

- Heavy Flavour production in *ep*-collisions remains interesting testing ground for perturbative QCD
- charm production:
  - HERA II confirms small “deviation” in HERA I $\sigma e^{-}p / \sigma e^{+}p$ was statistical fluctuation
- beauty production:
  - Photoproduction results of measurement using p_t^{rel} and impact parameter consistent with NLO calculations and with HERA I data
  - in DIS p_t^{rel} results consistent with LO+PS MC, NLO calculations in progress
- Structure Functions ($F_2^{c\bar{c}}$, $F_2^{b\bar{b}}$):
  - both charm and beauty well described by HERA I data
  - looking forward to improved measurement of $F_2^{b\bar{b}}$ in HERA II
- HERA II performing well and most data are expected to come. Expect improved results soon!