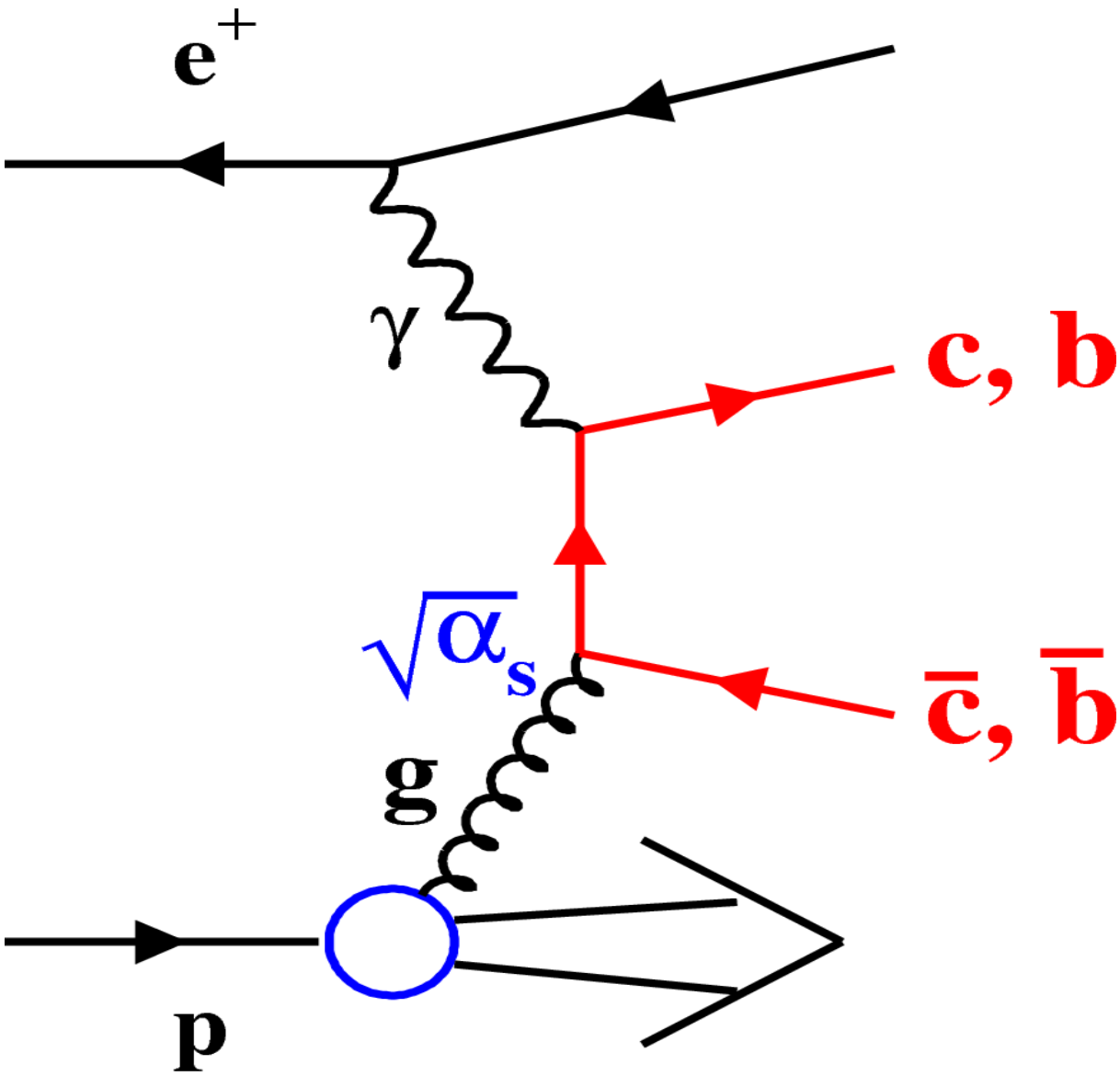
★ Charm and Beauty ★
DIS cross sections at the LHeC

Olaf Behnke (DESY) LHeC workshop, Divonne, 2. Sep 2008

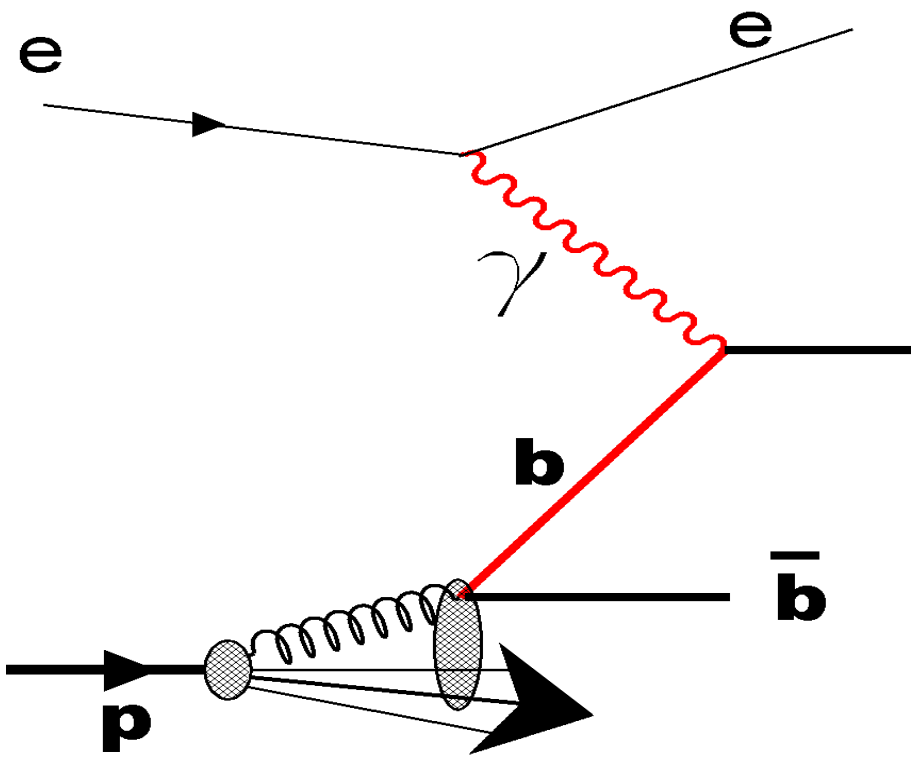
2. Part: Jets in DIS at the LHeC
on behalf of
Thomas Schörner-Sadenius, Uni Hamburg

Reminder of dominant c,b production process in DIS

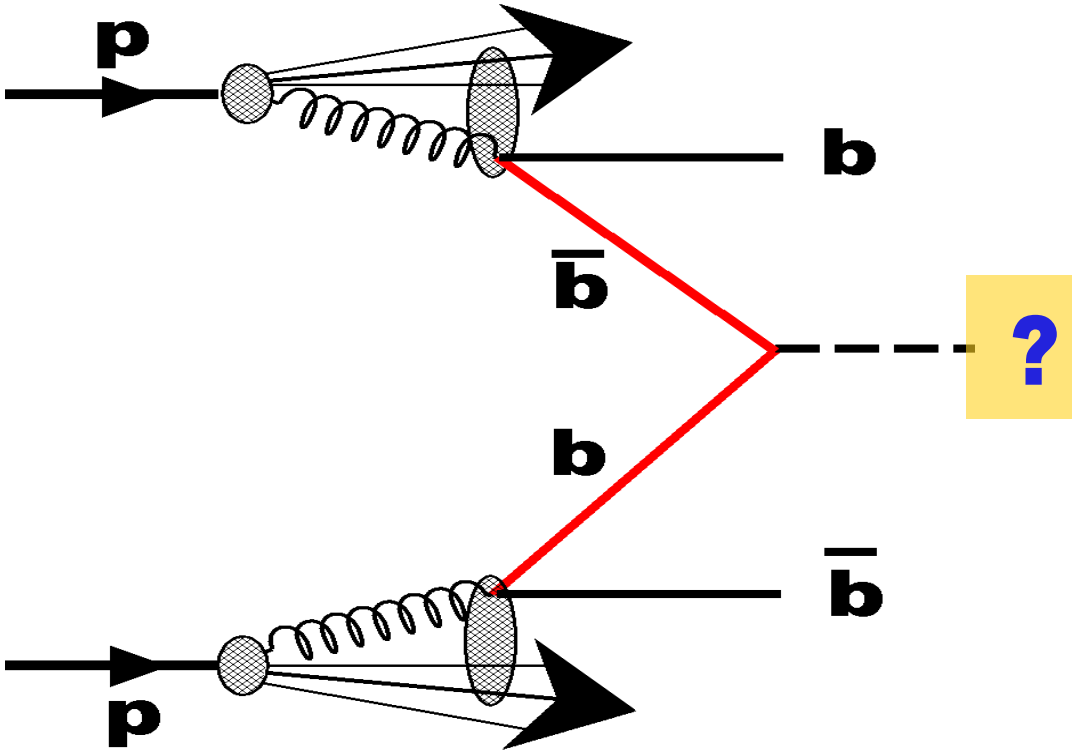


One Motivation: Determine effective b-density in p!

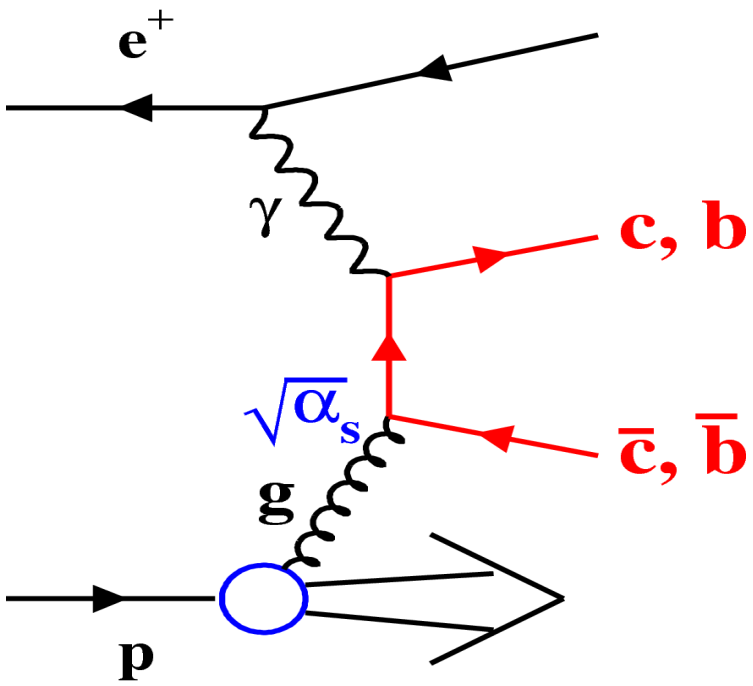
LHeC



LHC



Used tool for LHec (and HERA) predictions



Rapgap 31 + hztool

LO BGF + ps

PDF CTEQ5l

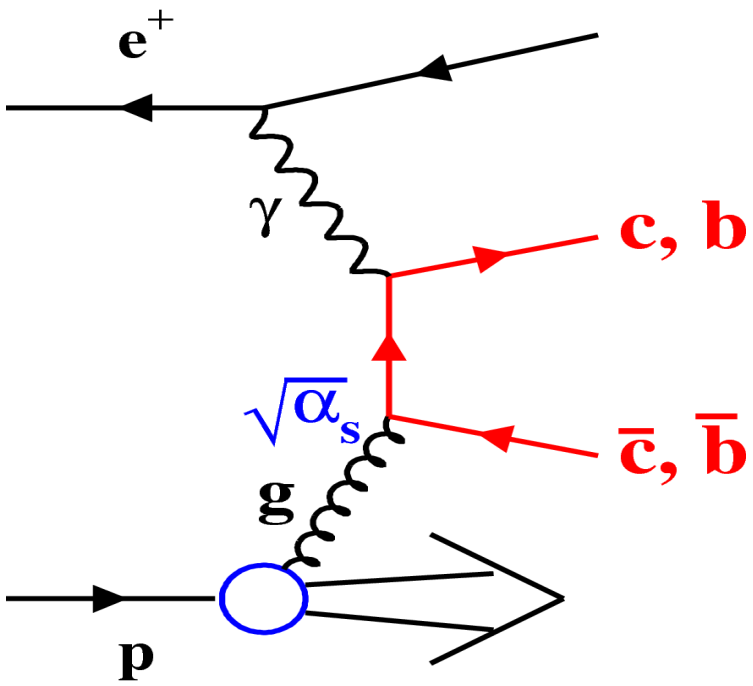
mc = 1.5 GeV

mb = 4.75 GeV

ipro=14 (eg ->QQ)

applied y-cut: 0.01-0.95

Used tool for LHeC (and HERA) predictions

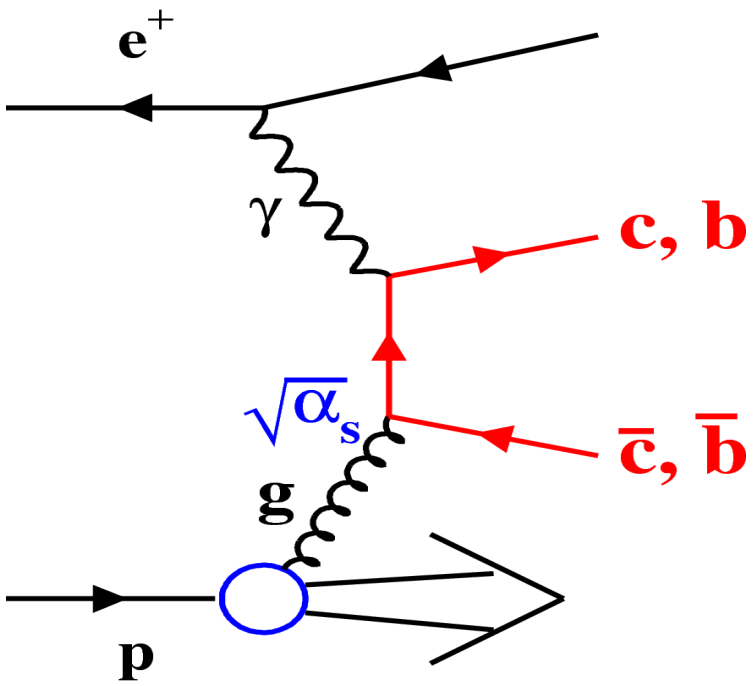


Parton Level Cross-sections

Cuts on pt and rapidity of charm (or beauty) quark

Assume certain c- and b- tagging efficiencies

Used tool for LHec (and HERA) predictions



Calculate expected number of tagged events in bins of Q2 and x:

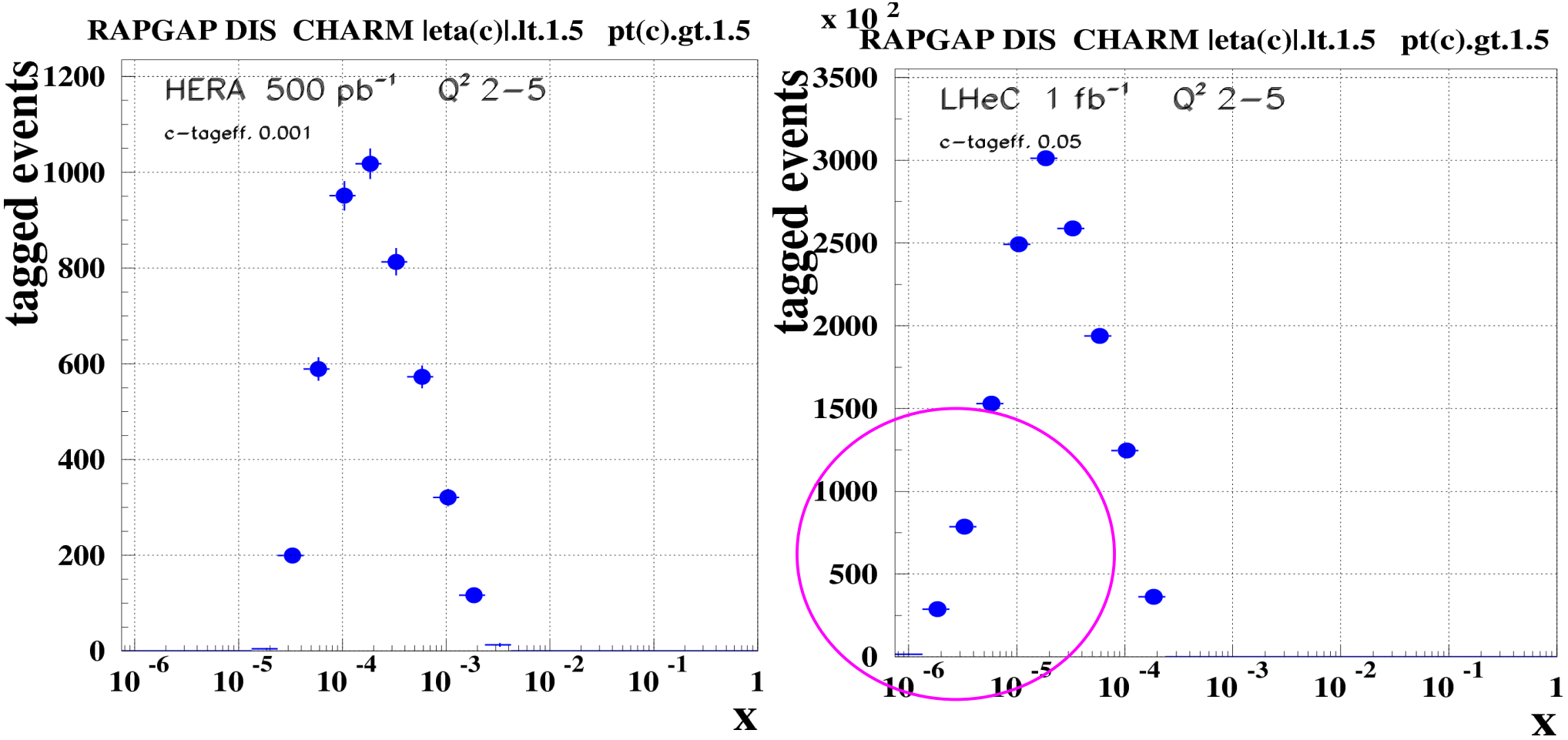
N = $\mathcal{L}$ *dσ/dlogx * Δlogx * tageff

σ(**n**) = **sqrt(N)**, - ***background free assumption*** -

Results: Charm Q^2: [2-5 GeV^2]; pt_c>1.5, |η_c|<1.5

HERA with typical effective c-tageff~ 0.001 (D*)

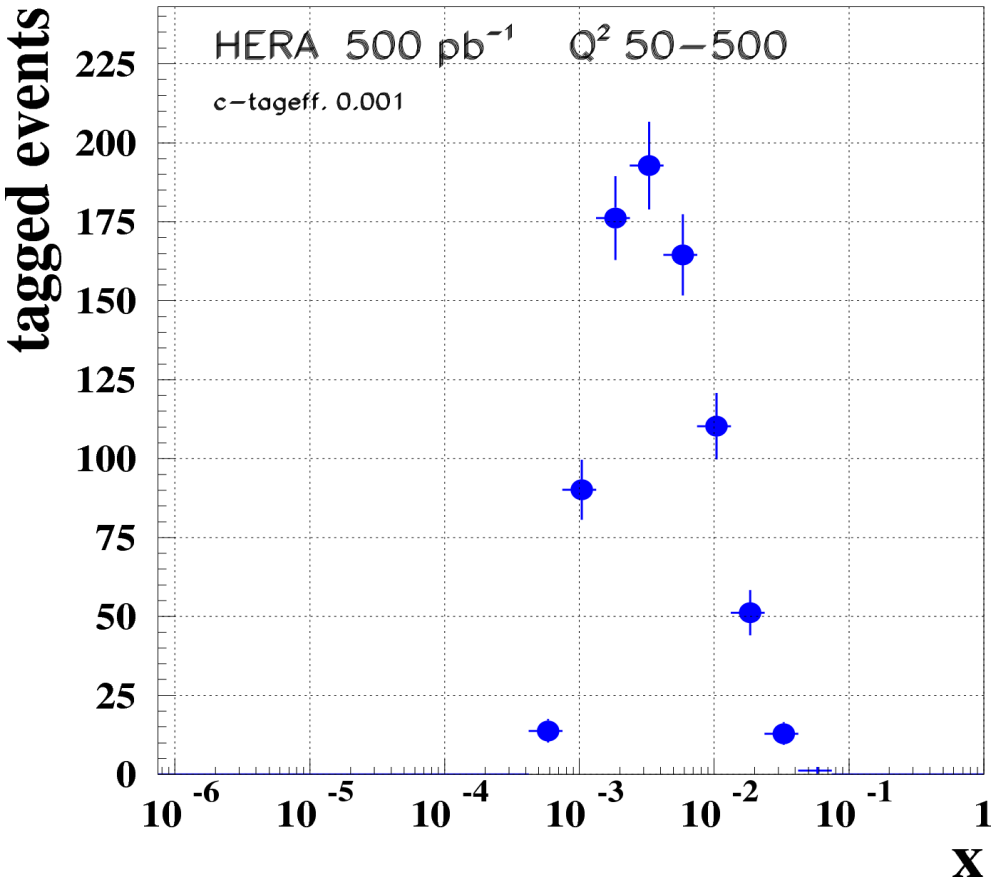
LHeC assume improved c-tageff~0.05 (lifetime+mass)



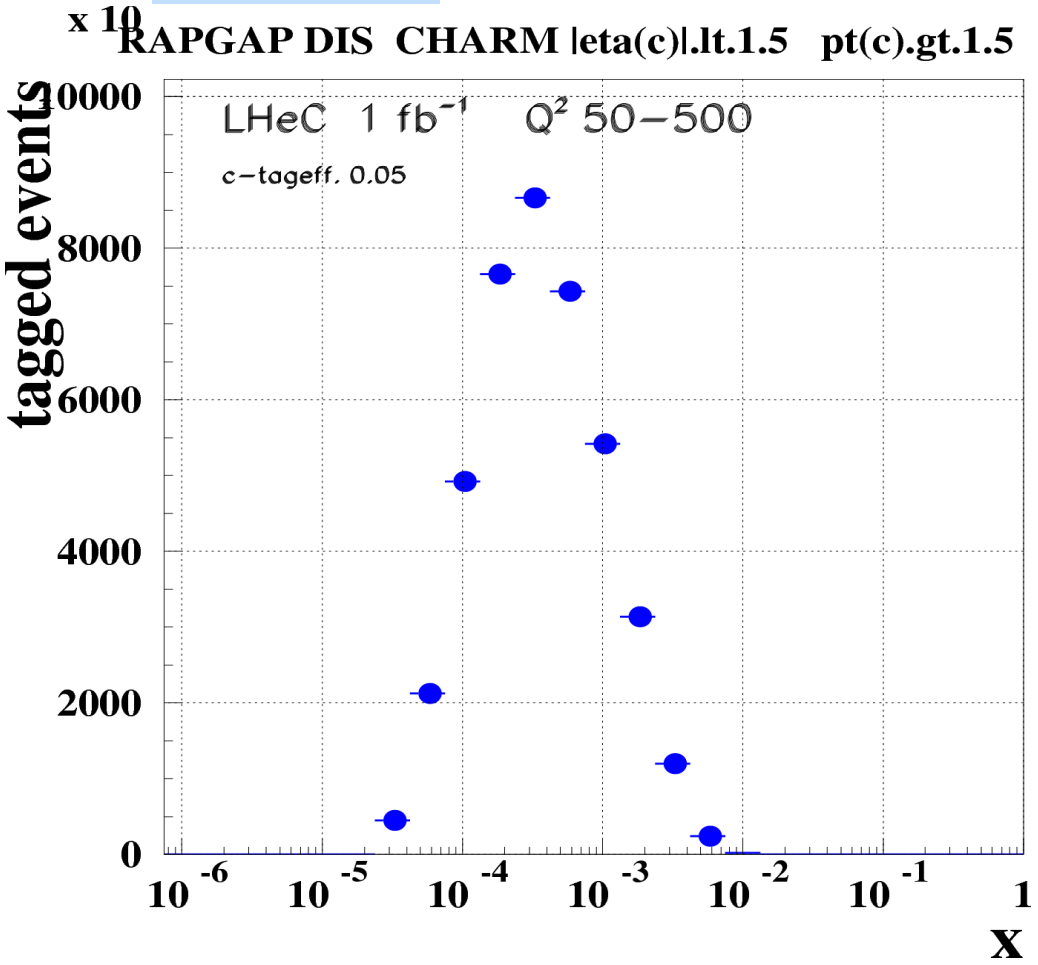
➔ Would probably add very valuable information on low x gluon density

Results: Charm Q^2: [50-500 GeV^2]

HERA



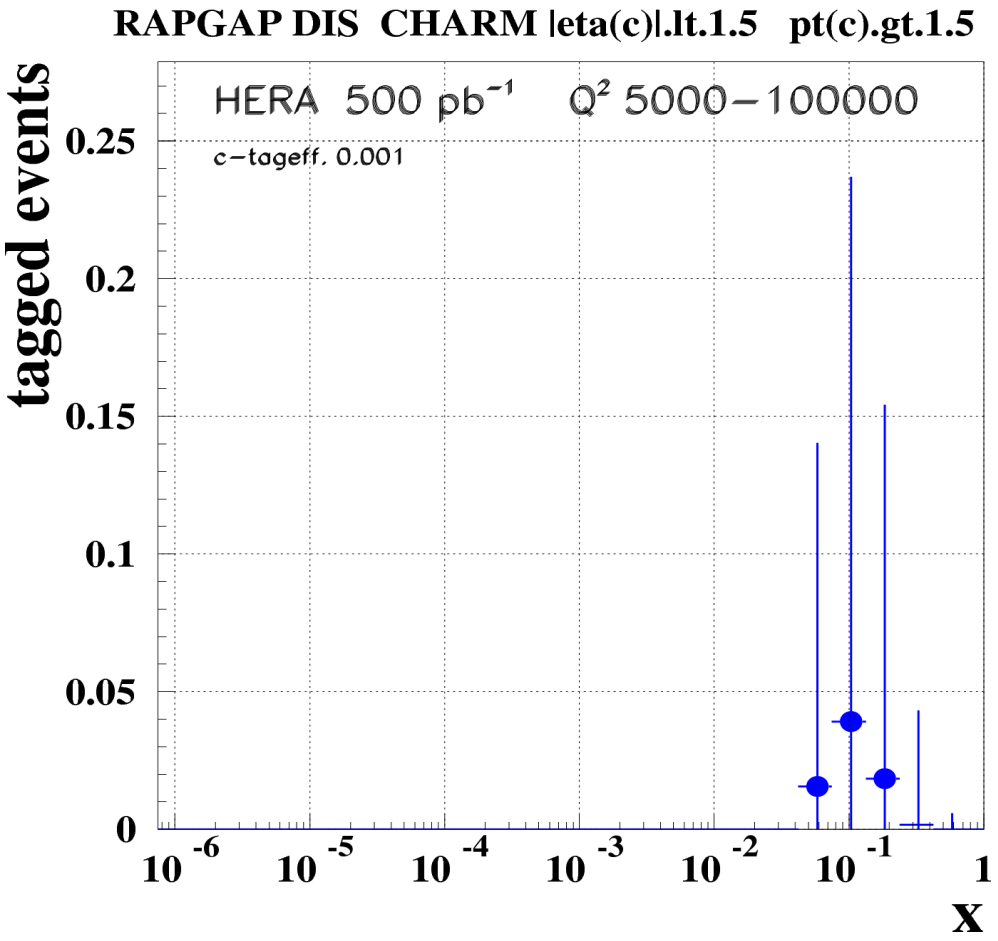
LHeC



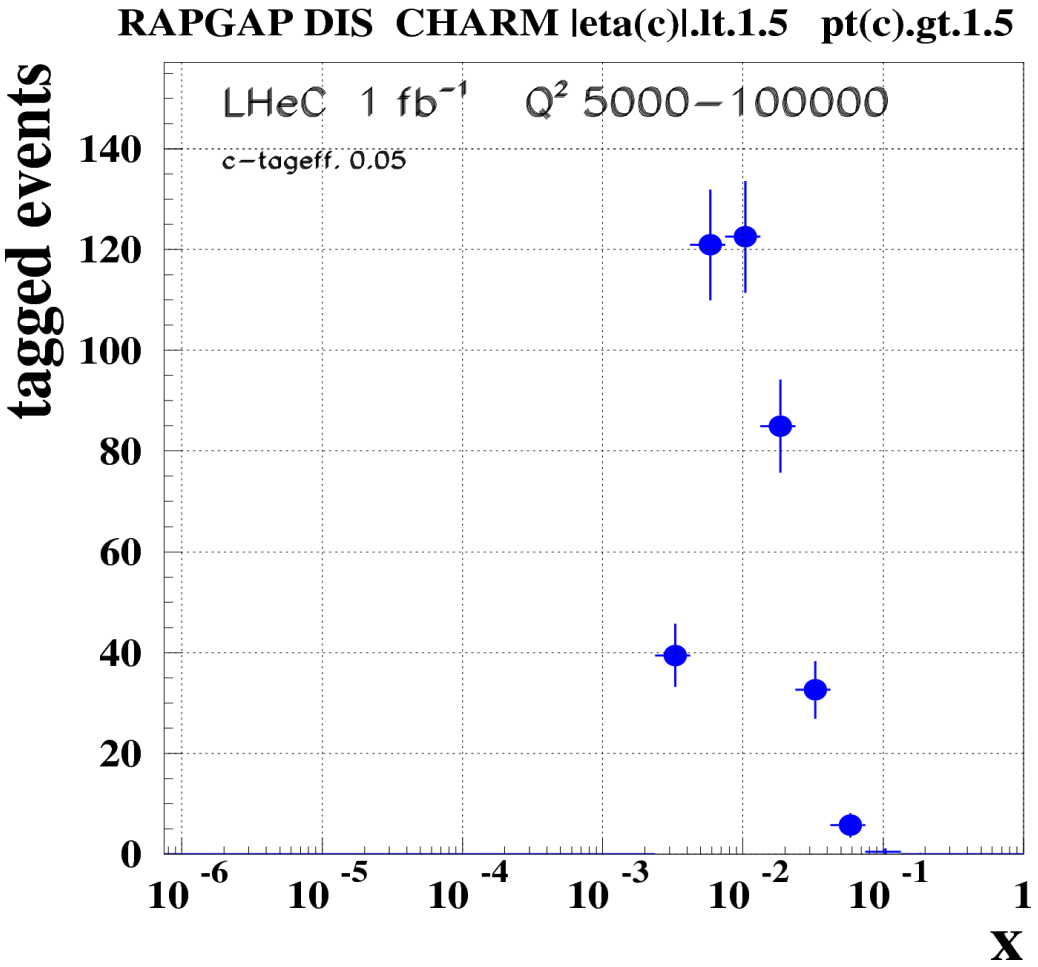
➔ 400 times more data (2*L, 50*eff, 4*xsec) at LHeC

Results: Charm Q^2: [5000-100000 GeV^2]

HERA



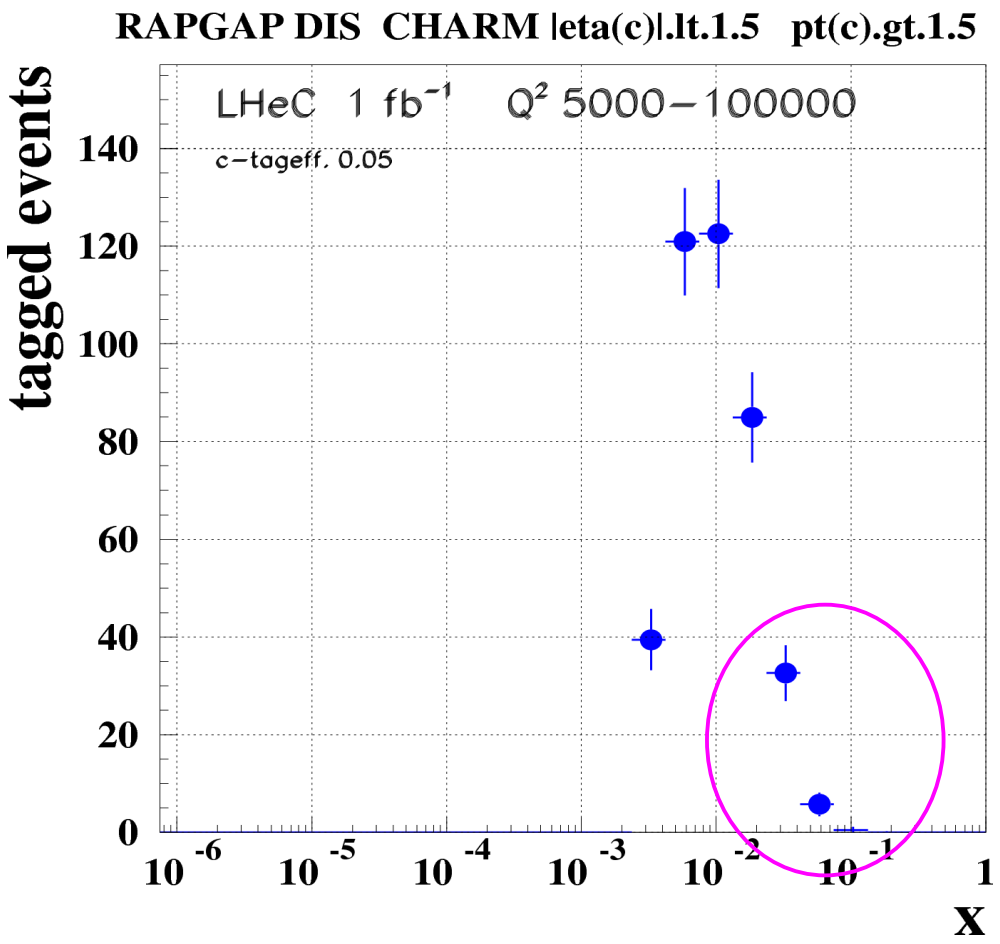
LHeC



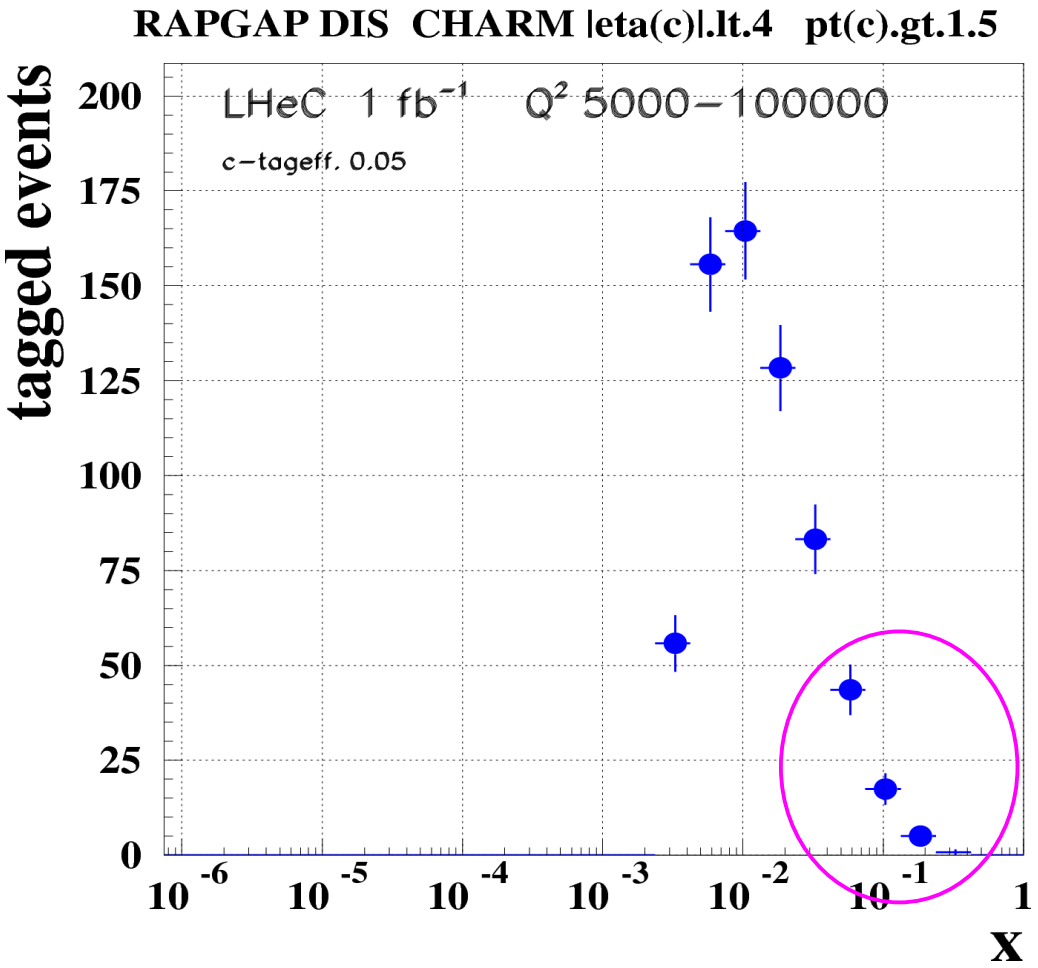
➔ For the first time...

Results: Charm Q^2: [5000-100000 GeV^2]

LHeC |eta_c|<1.5



LHeC |eta_c|<4

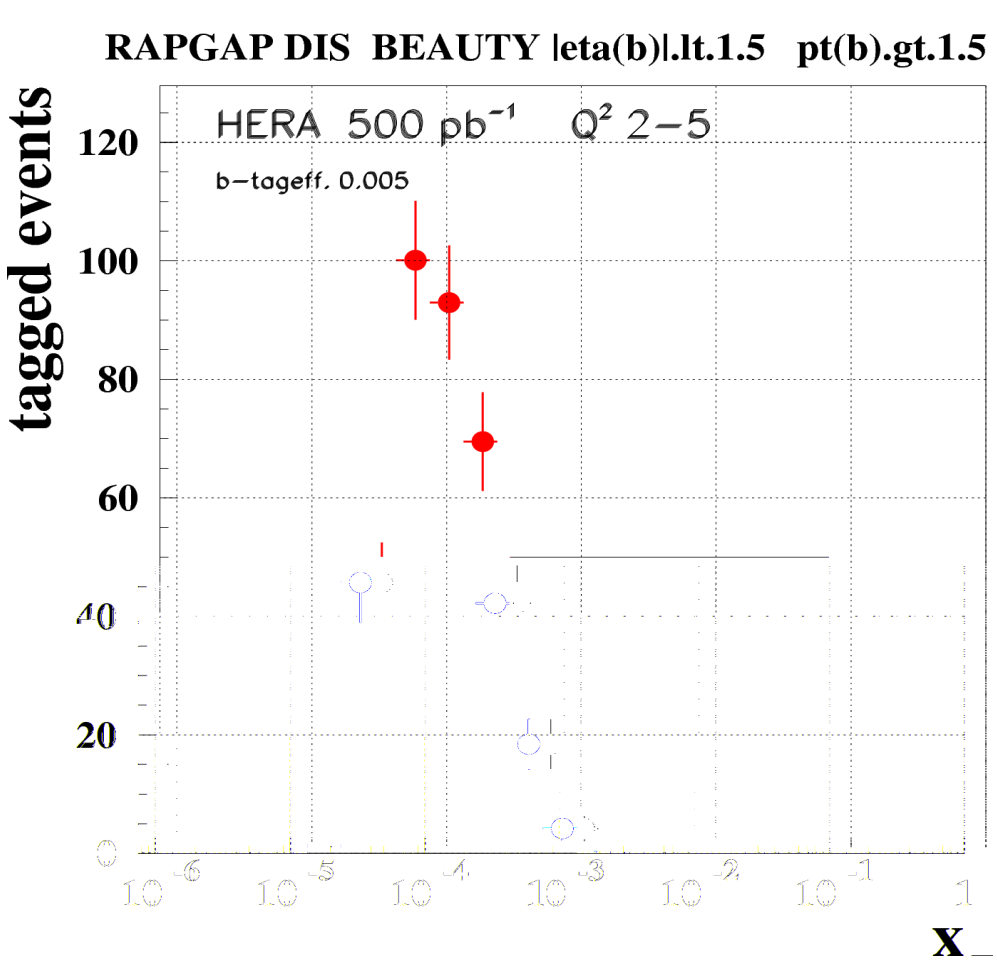


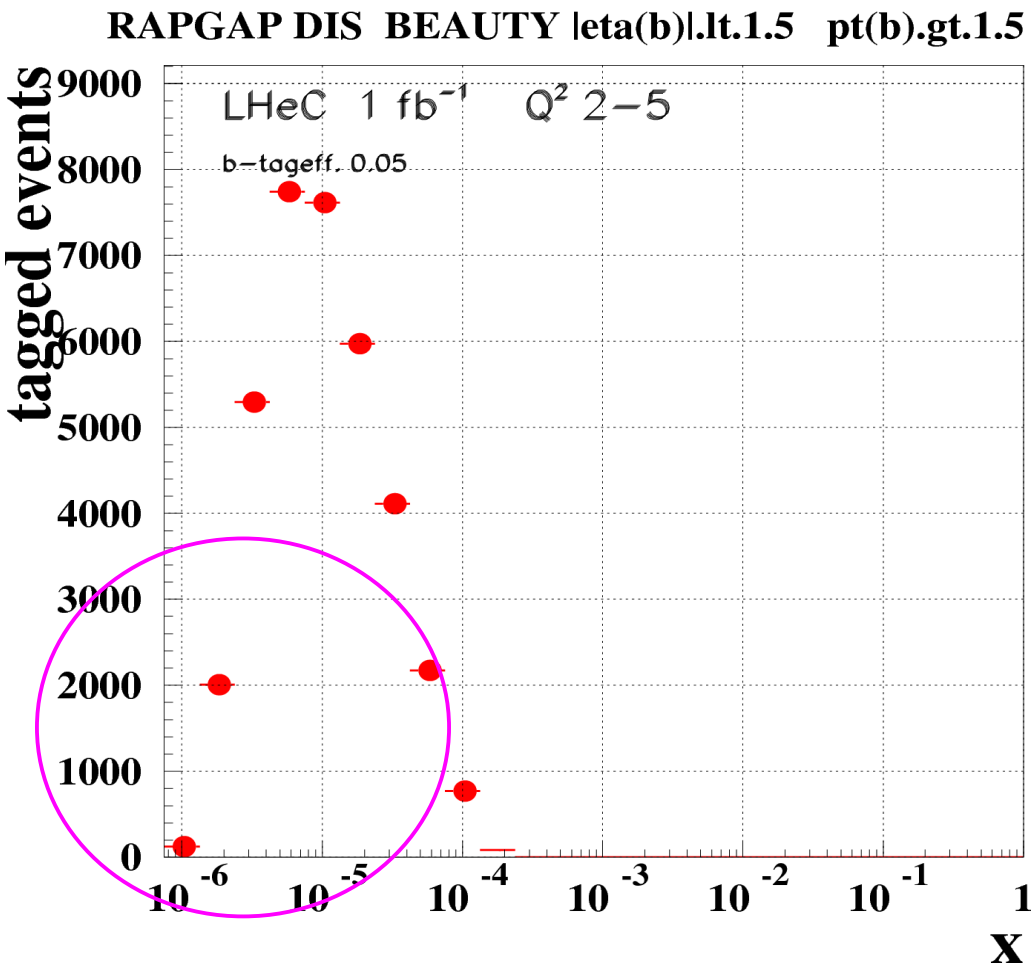
➔ Intrinsic charm (x>~0.1) will be difficult (again)

Results: Beauty Q^2: [2-5 GeV^2]

HERA with typical effective b-tageff~ 0.005 (μ)

LHeC assume improved b-tageff~0.05 (lifetime+mass)

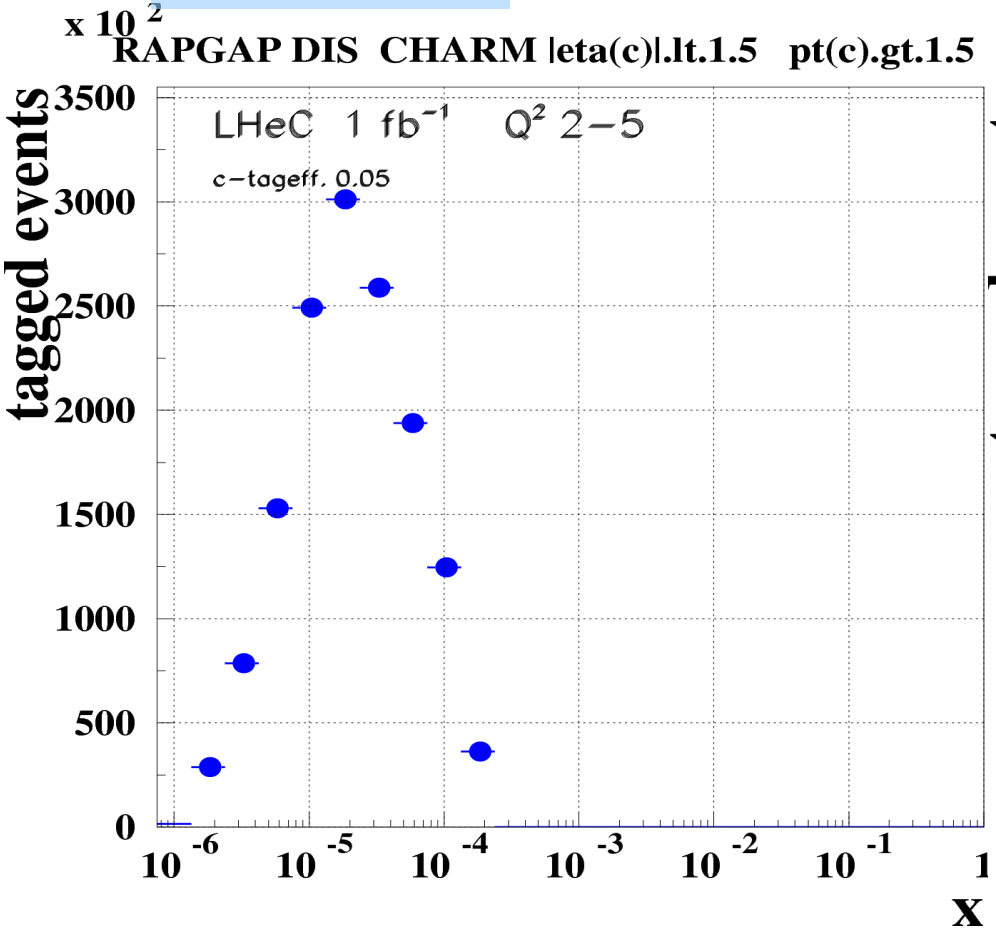




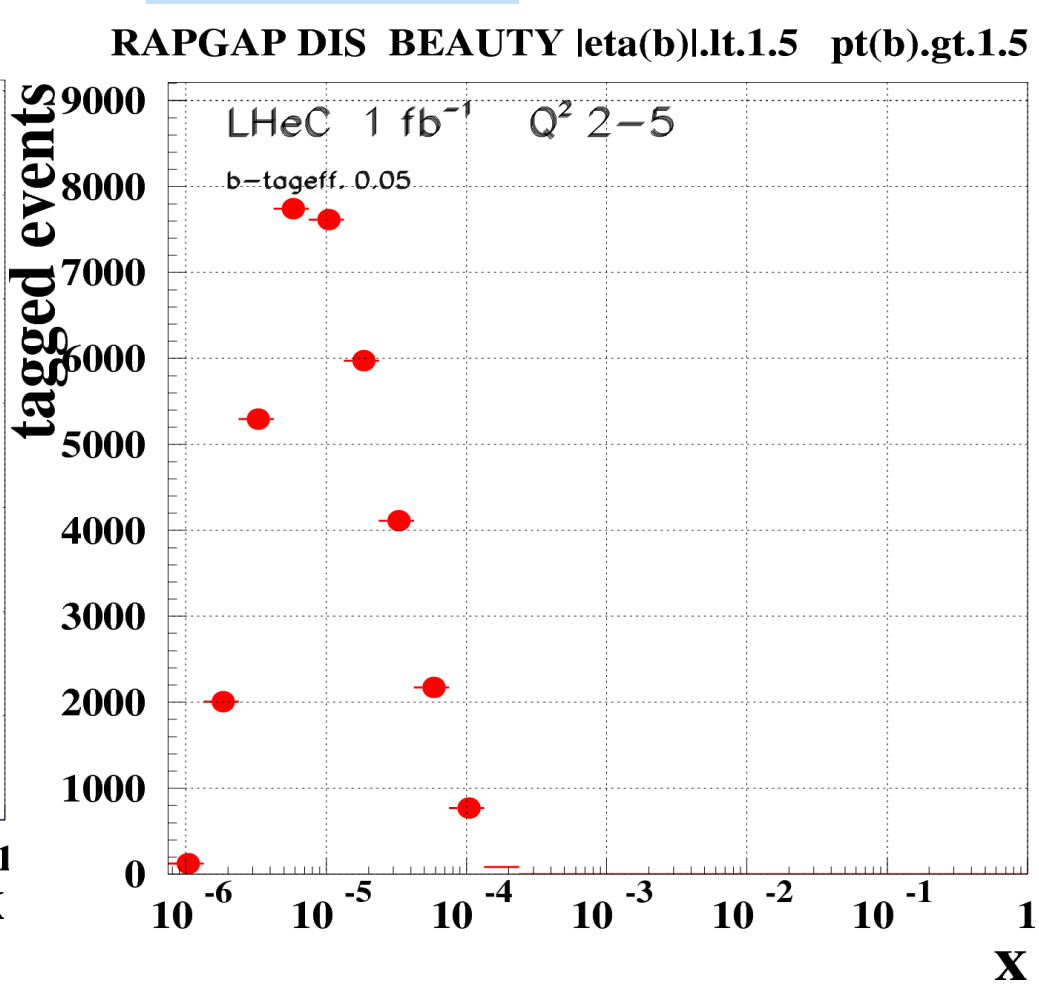
➔ again reach to 20 times lower x at LHeC… (as expected)

Results: Charm vs Beauty Q^2: [2-5 GeV^2]

LHeC charm



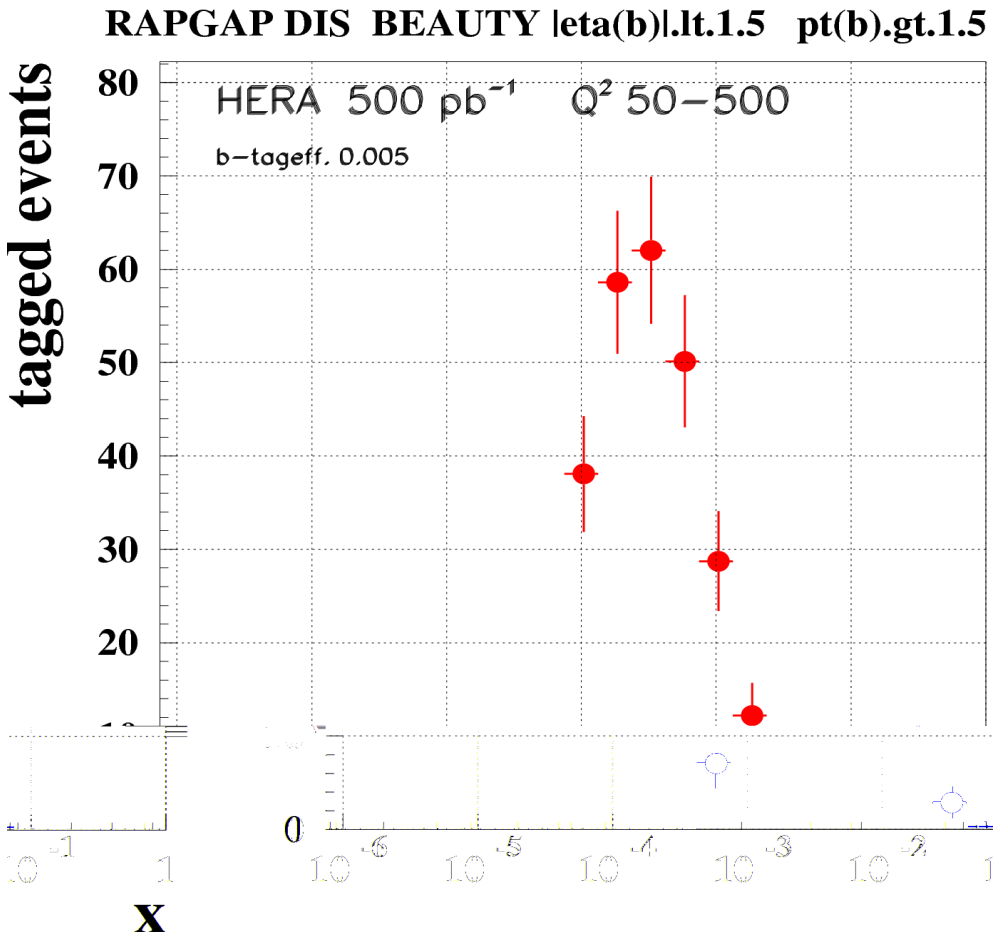
LHeC beauty



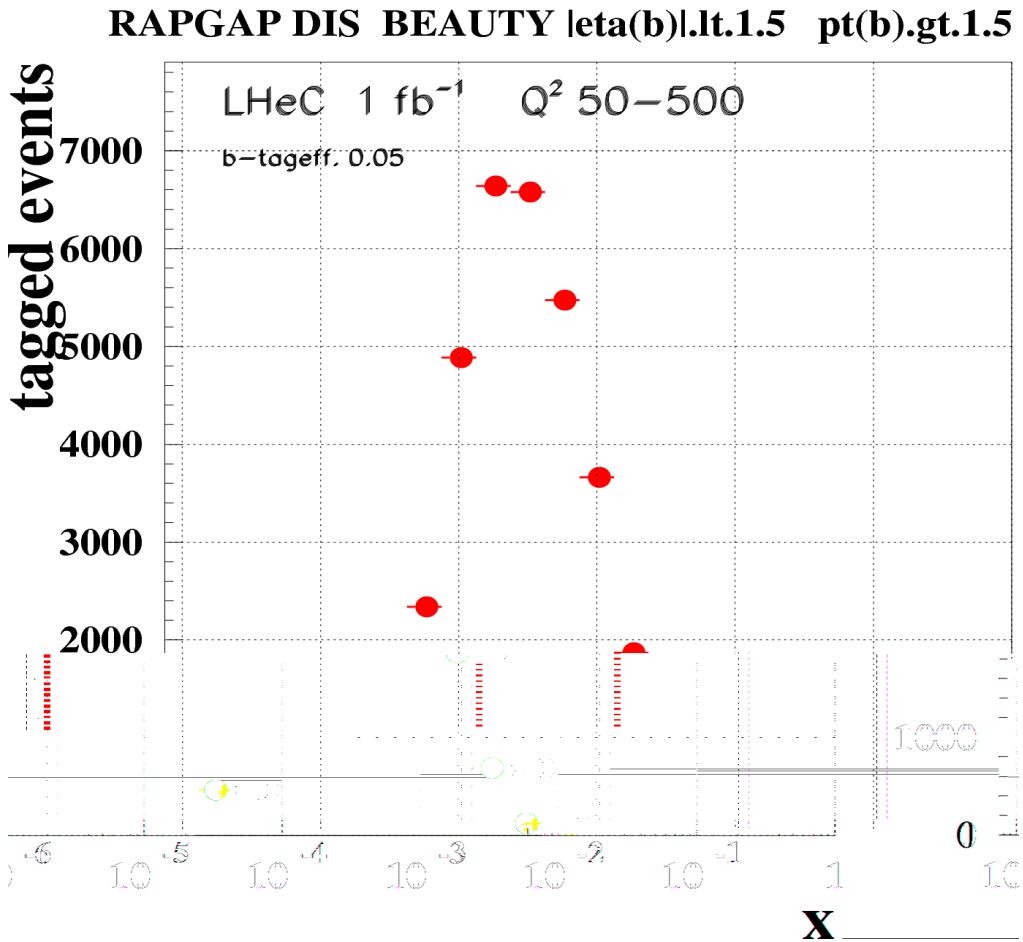
➔ Beauty shifted to lower x (= x_bjorken) than charm (can it be?)

Results: Beauty Q^2: [50-500 GeV^2]

HERA



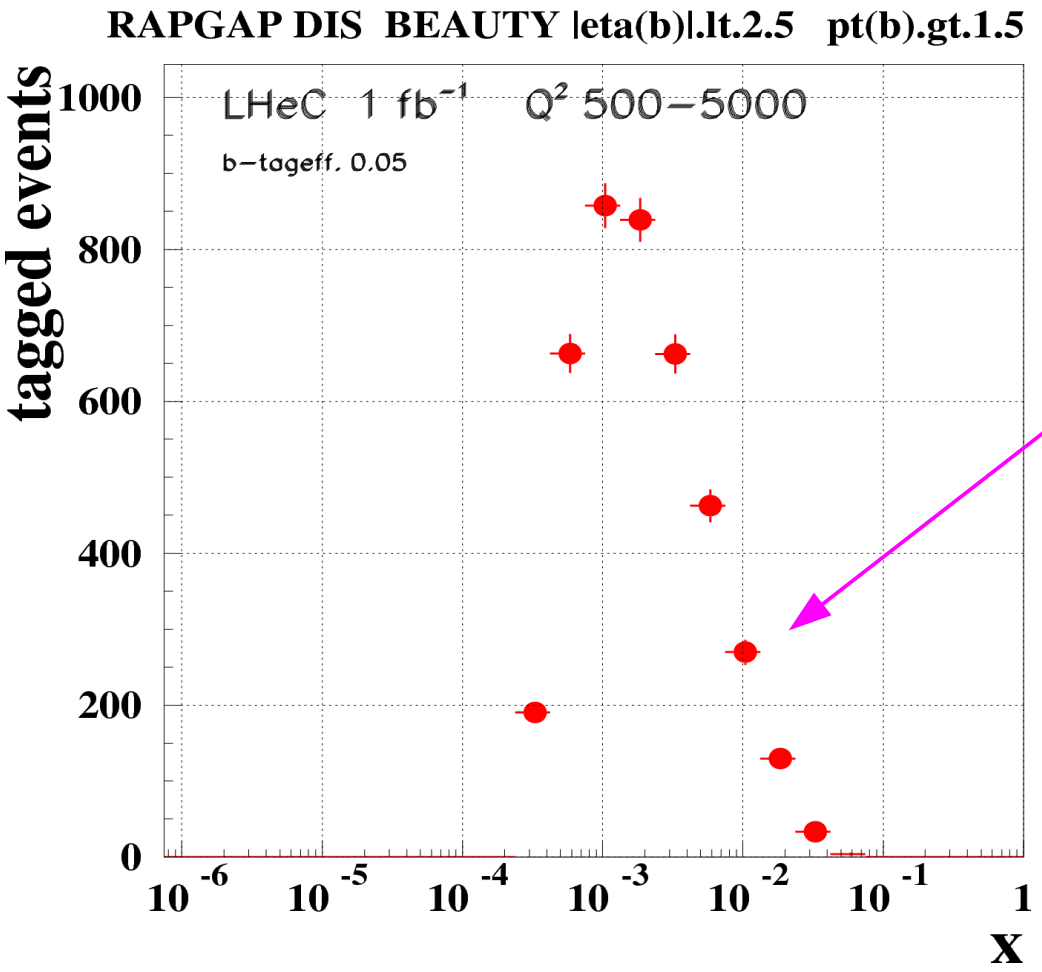
LheC



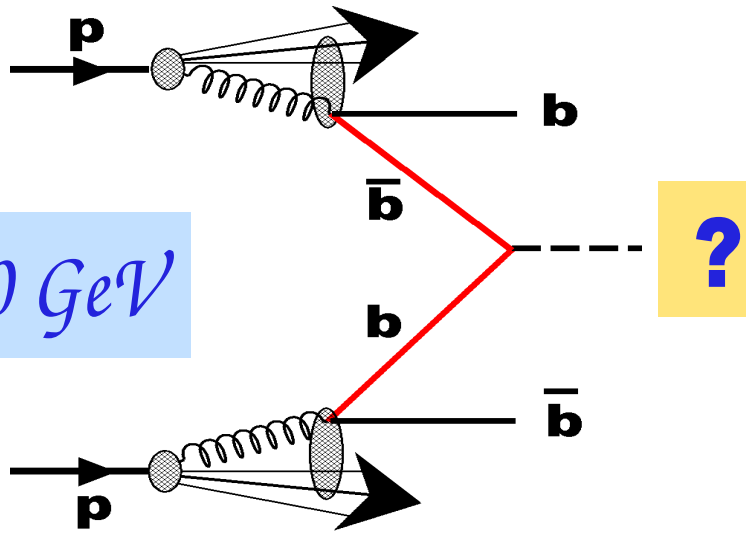
➔ 100 times more data (2*L, 10*eff, 5*xsec) at LHeC

Results: Beauty Q^2: [500-5000 GeV^2]

LHeC |eta_b|<2.5



LhC

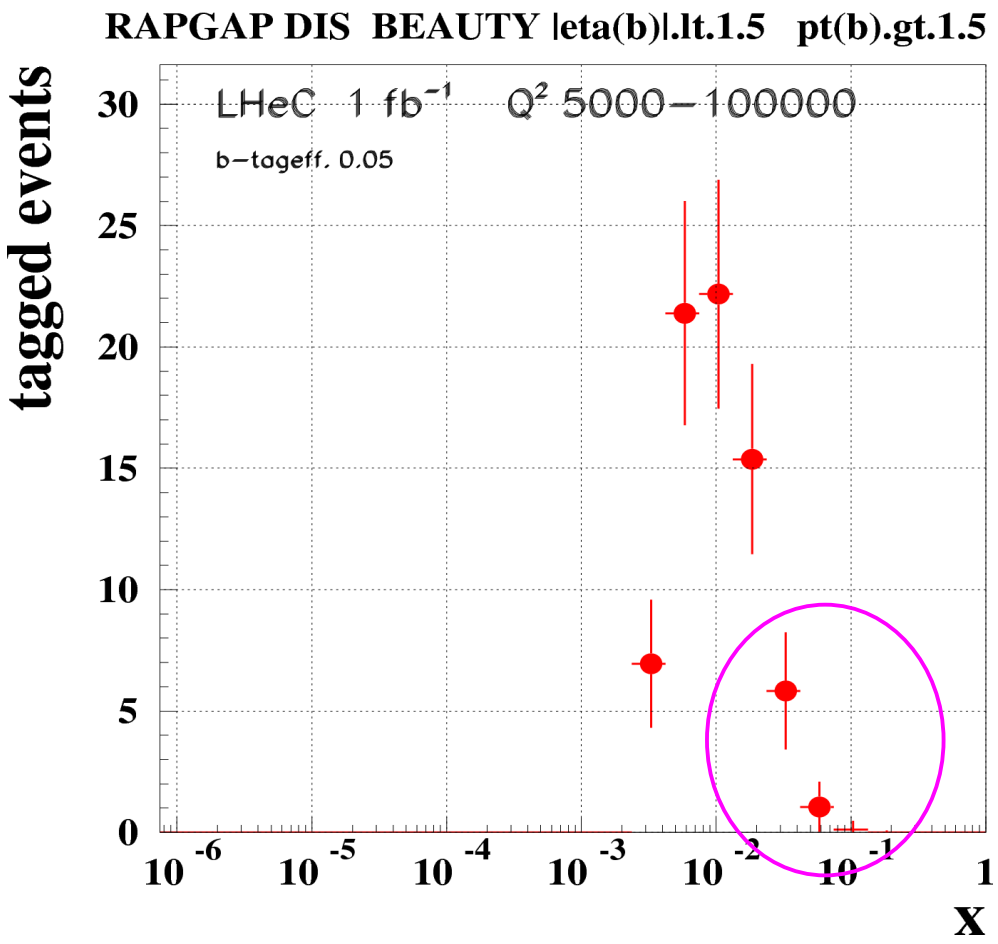


70 GeV

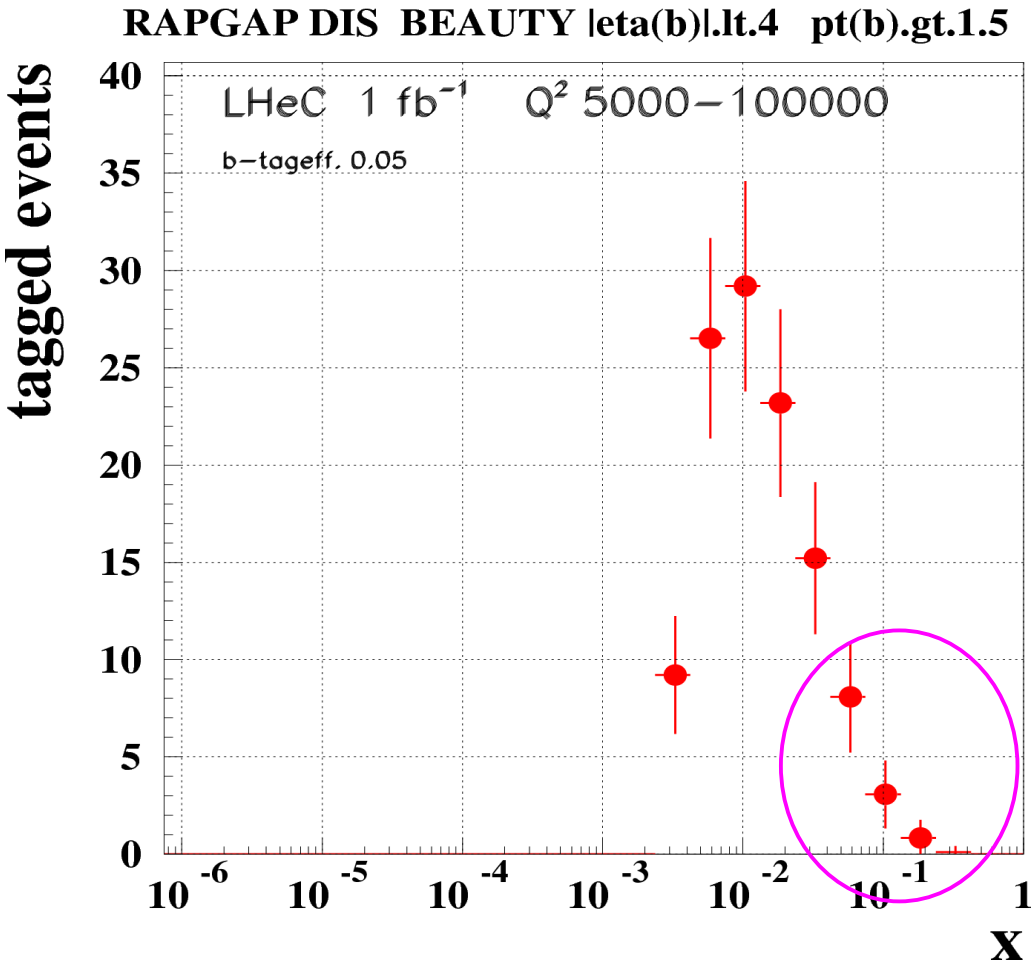
➔ “Reasonable” b-density precision up to some hard scales…

Results: Beauty Q^2: [5000-100000 GeV^2]

LHeC |eta_b|<1.5



LHeC |eta_b|<4



➔ Stan, how much intrinsic beauty is one to expect in the proton?

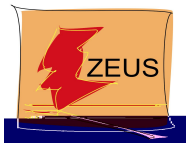
Conclusions

- ✔ Charm and beauty in DIS at LheC vs HERA: Main effects are
  - ✔ reaching down to 20 times smaller x (10^{-6})
  - ✔ Typically 100-400 more statistics due to
    - ➢ **1. rising gluon density, less phase space suppression**
    - ➢ **2. Twice the lumi and 10-50 better (expected) tagging eff.**
- ✔ Coverage up to x=0.1 but not higher

Preliminary Jet Study for the LHeC

… and comparison to ZEUS data

Thomas Schörner-Sadenius
Hamburg University



JETS AT HERA AND LHeC

Typical selection in high-Q^2 DIS at HERA

Event selection:
- $125 < Q^2 < 10.000\ \text{GeV}^2$.
- $0.2 < y < 0.6$ or cut on $\cos\gamma_{had}$.

Jet selection (inclusive jets):
- $E_{T,Breit} > 8$ GeV,
- $-2 < \eta_{Breit} < 1.8$ or $-1 < \eta_{lab} < 2.5$

Jet selection (dijets)
- $E_{T,1} > 12$ GeV, $E_{T,2} > 8$ GeV
- similar pseudorapidity cuts as above.

Toy selection for LHeC

Event selection:
- $100 < Q^2 < 500.000\ \text{GeV}^2$.
- $0.2 < y < 0.6$.

Jet selection (inclusive jets):
- $E_{T,Breit} > 20$ GeV,
- $-2 < \eta_{lab} < 3$.

Jet selection (dijets)
- $E_{T,1} > 30$ GeV, $E_{T,2} > 20$ GeV
- similar pseudorapidity cuts as above.

Common features for jet analyses:
– Analysis performed in Breit frame.
– kT clustering algorithm

RESULTS AND PREDICTIONS

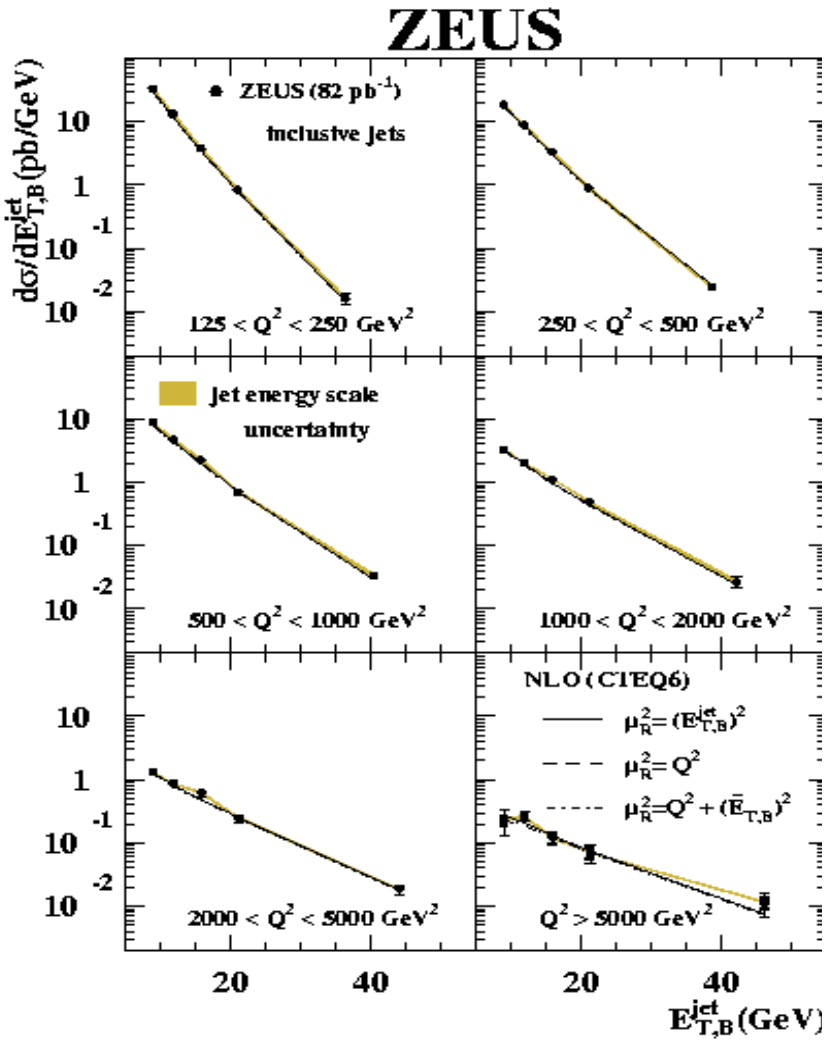
Shown are published results from ZEUS

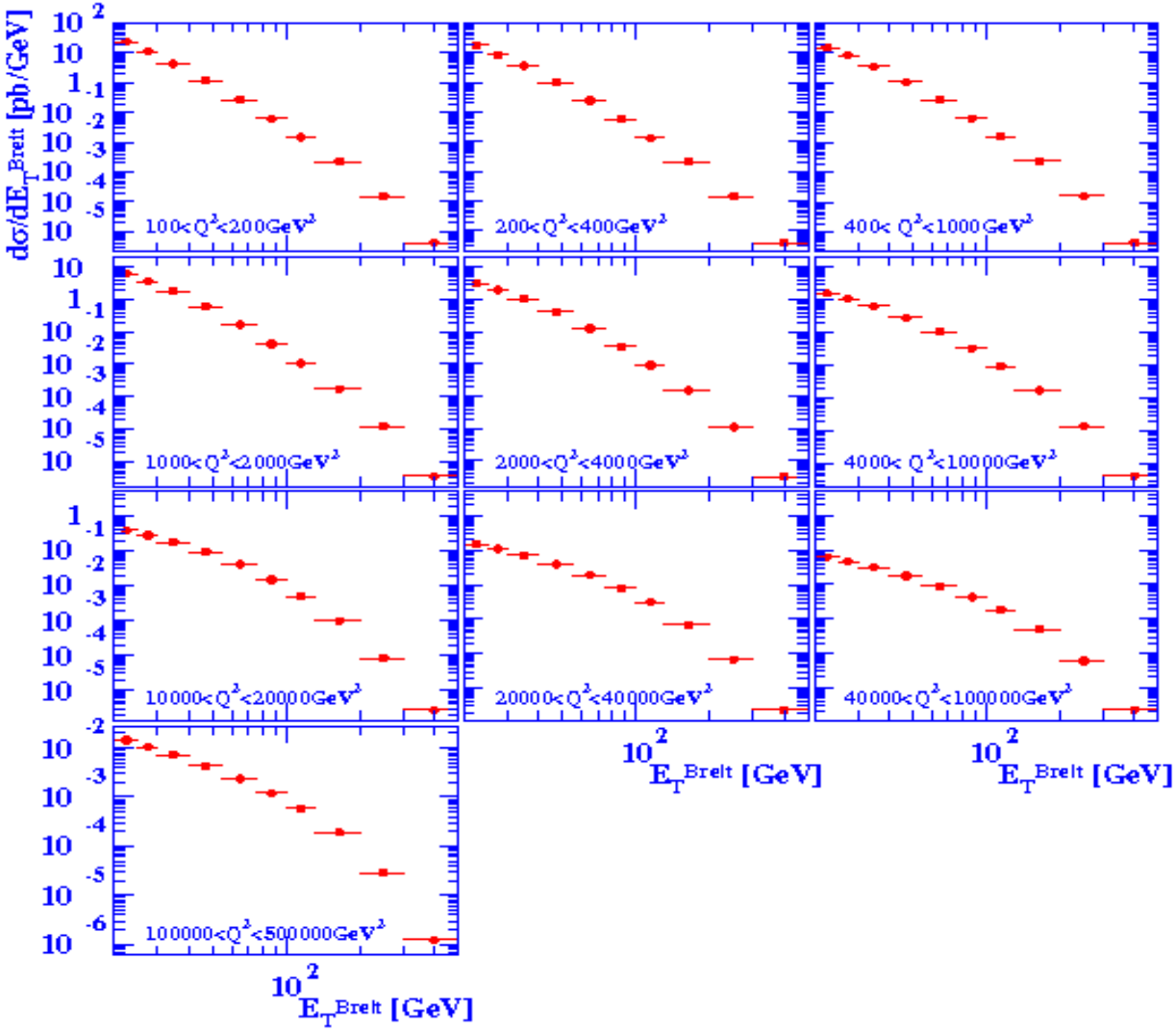
Inclusive-jet and dijet cross sections at high Q^2:
- DESY-06-128 (phase space see page before).

Theoretical predictions for LHeC derived with DISENT (NLO QCD)

Rather standard settings:
- Phase space see page before.
- PDF sets: CTEQ 6.1.
- renormalisation scale: $0.25*(Q^2+E_T^2)$
- factorisation scale: Q^2.
- 100M events (split into two samples at lower and higher values of Q^2)

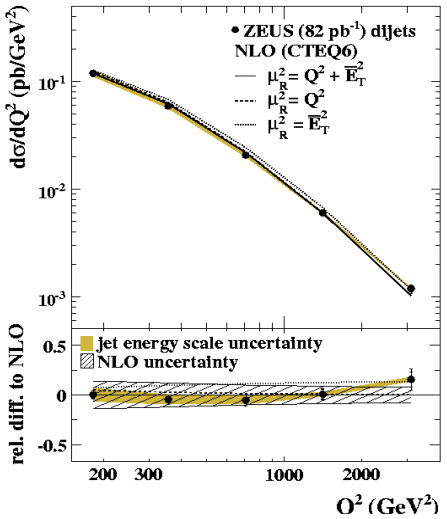
INCLUSIVE JETS: DOUBLE-DIFFERENTIAL

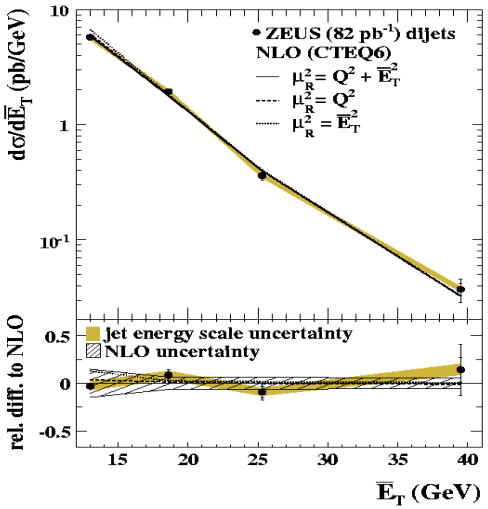


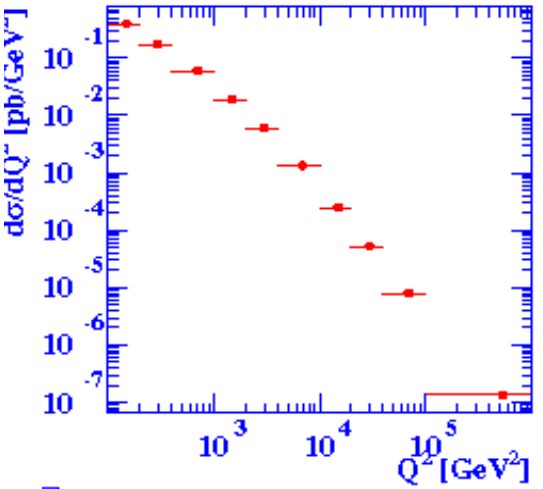


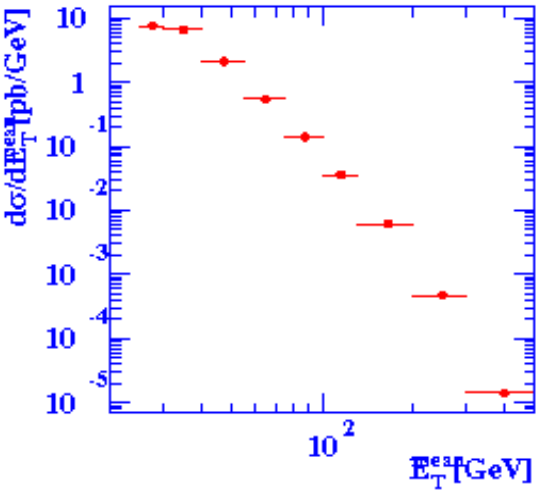
Plenty of jets with transverse energies of up to or more than 200 GeV at LHeC!

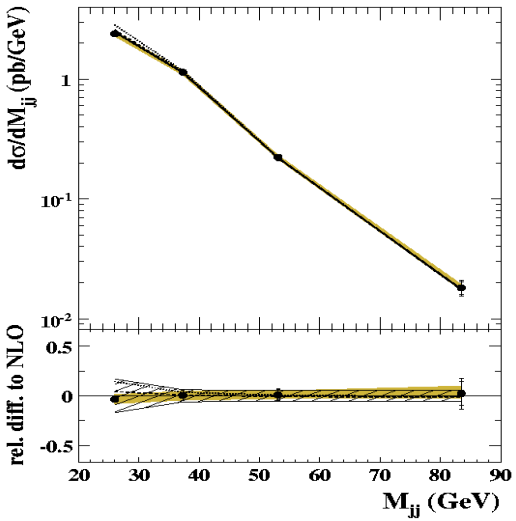
DIJETS: SINGLE-DIFFERENTIAL

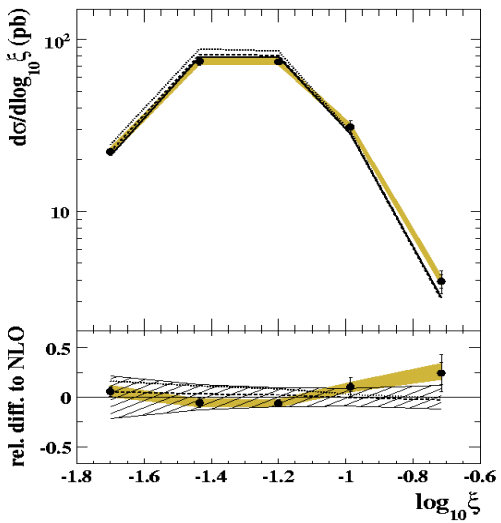


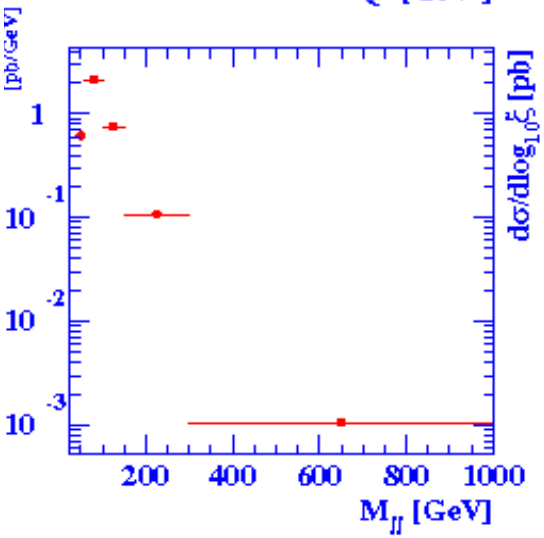


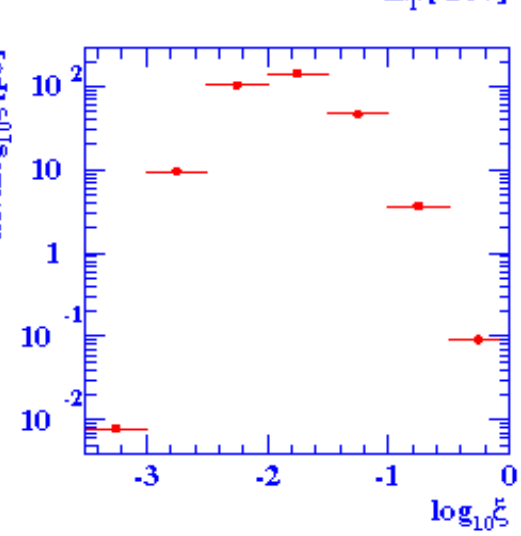






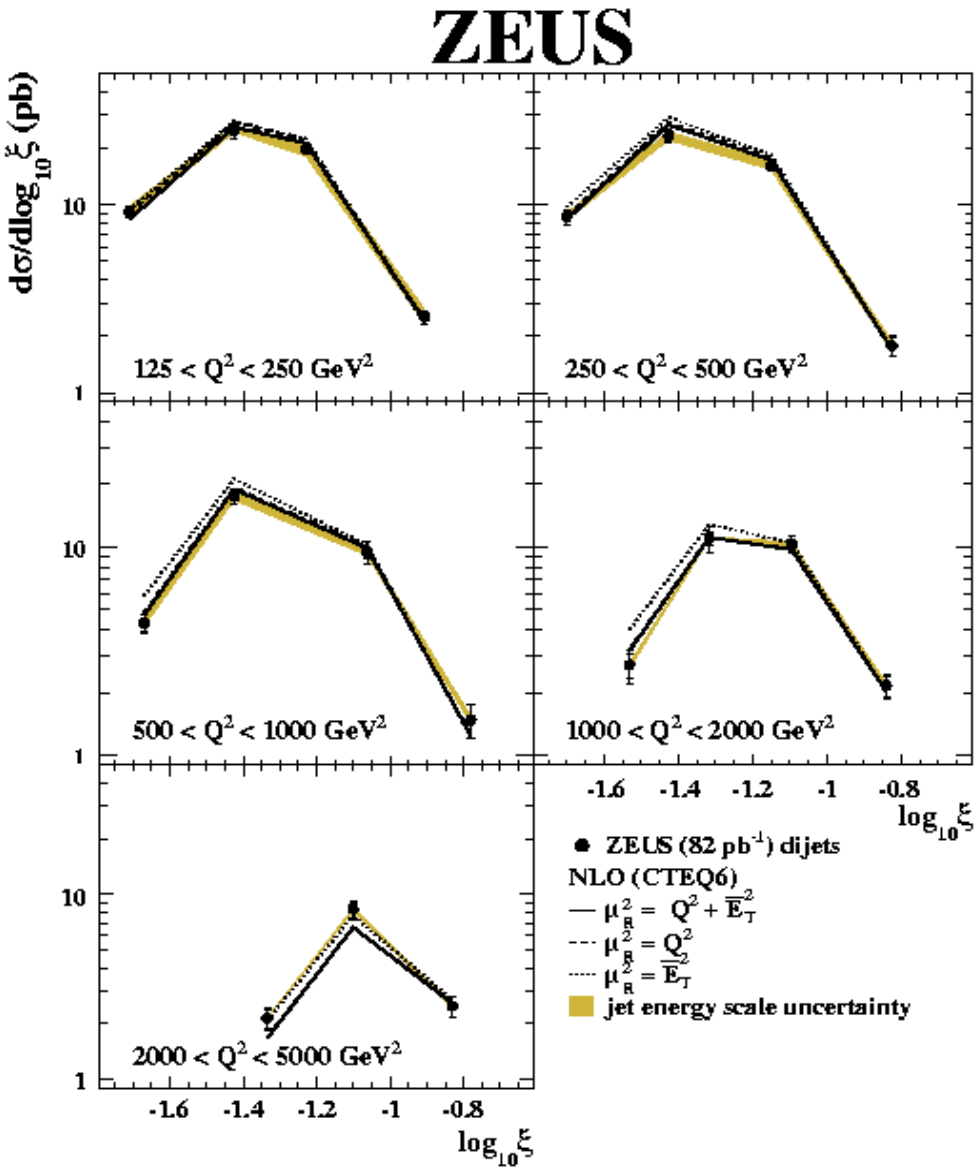


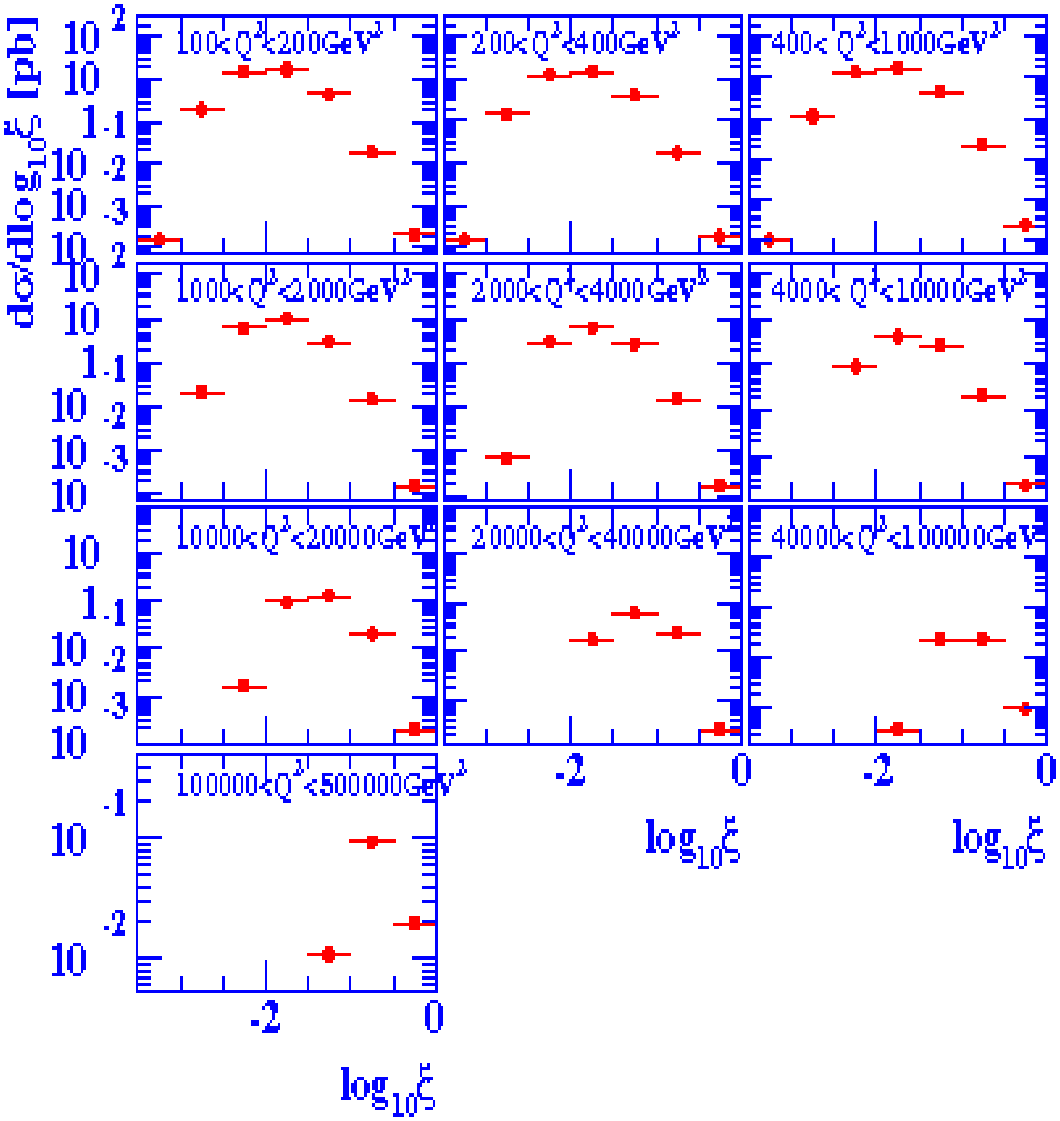




Dijet cross-sections at LHeC about 10-100 times larger than at HERA.

DIJETS: DOUBLE-DIFFERENTIAL





INTERPRETATION: TO BE DONE

To be done: Investigation of theoretical uncertainties and sensitivity to the PDFs
(in principle very simple, just requires some time …).