Preview of new ZEUS results, + some considerations on theory

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- New ZEUS F_2^b measurement (HERA I)
- New ZEUS D^+ measurement (HERA I)

  (new preliminary results from HERA II hopefully in few weeks)
- Reminder of H1/ZEUS combined F^2_c
- Some considerations on theory

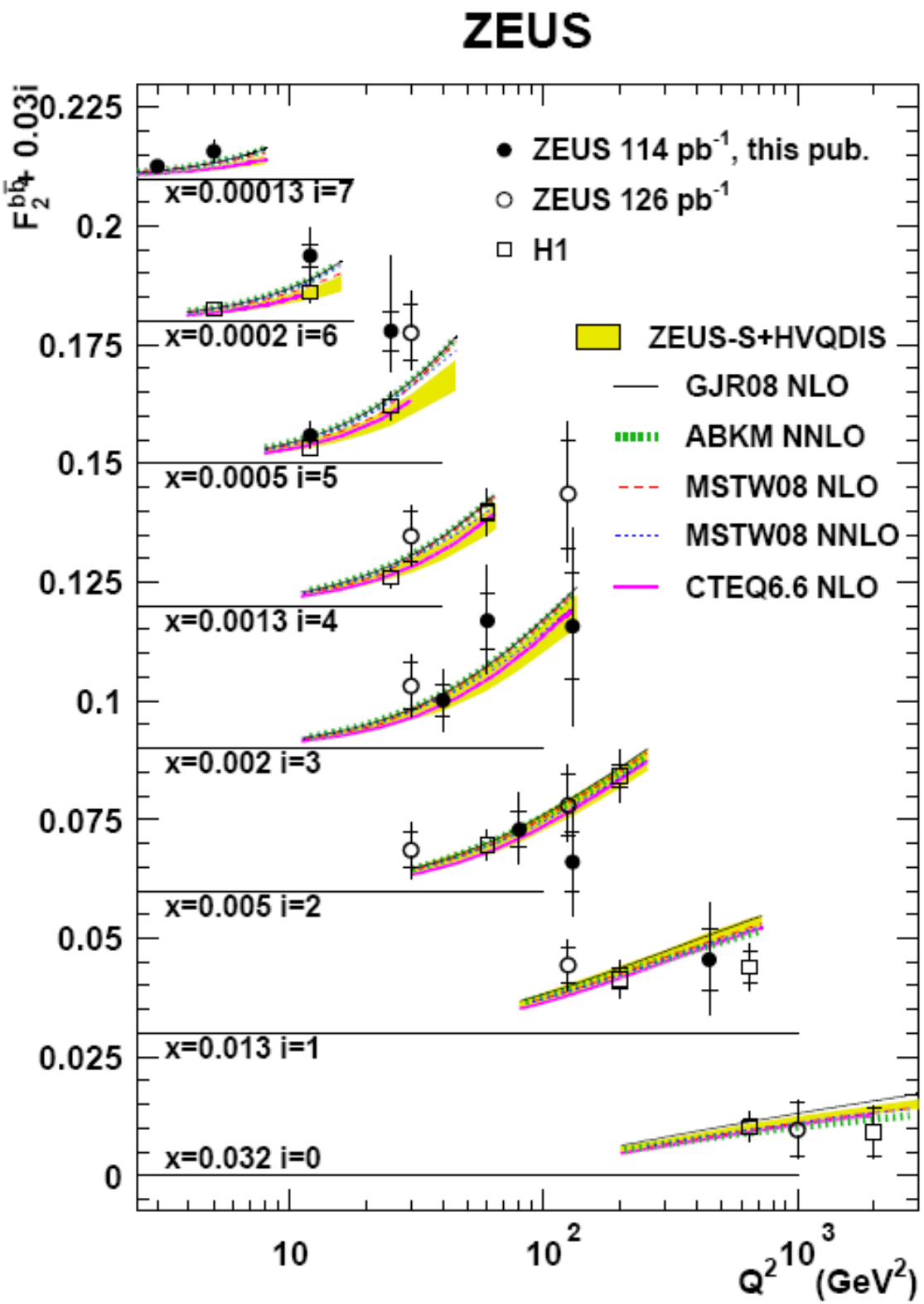
New ZEUS F_2^b measurement (HERA I)

- paper to appear soon
- beauty from semileptonic b decays
- similar to published ZEUS HERA II (126 pb^{-1}) measurement, but using p_{Trel} only, 114 pb^{-1}
- >=1 Jet E_T>5 GeV, -2<η<2.5
- >=1 μ p_T>1.5 GeV, η>-1.6 (from b decay), associated to jet
- Q^2>2 GeV^2, 0.05<y<0.7
- more details at DIS 2010 (this is just a preview)

F_2^b

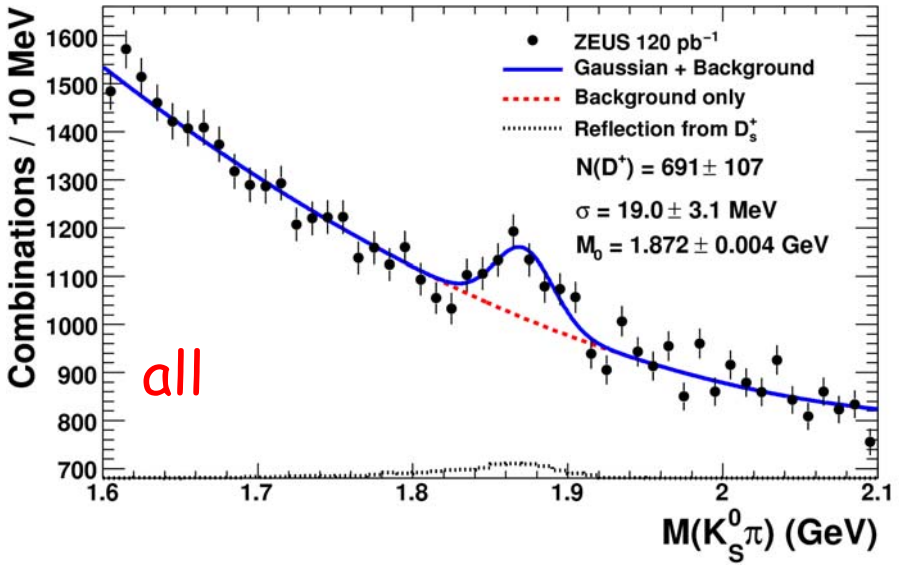
from F_2^b paper being published

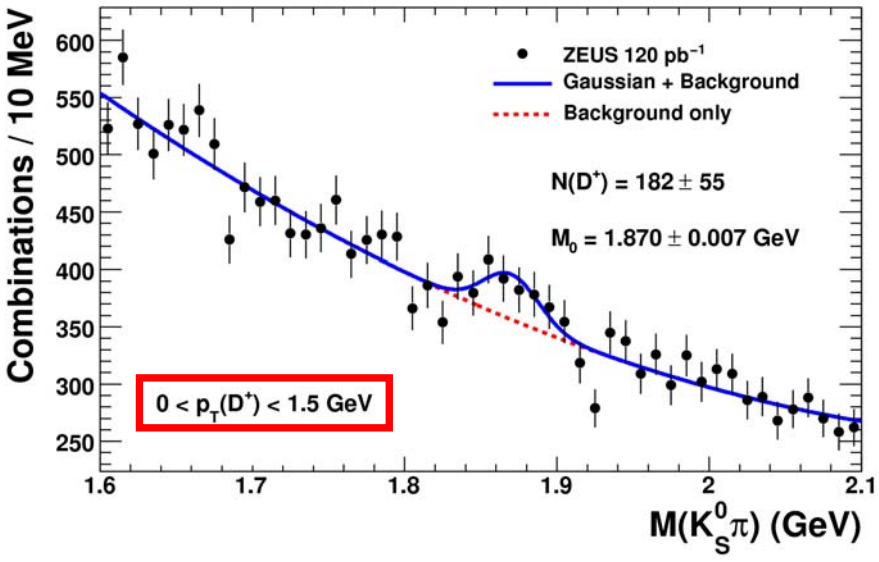
reasonable agreement with previous measurements and theory



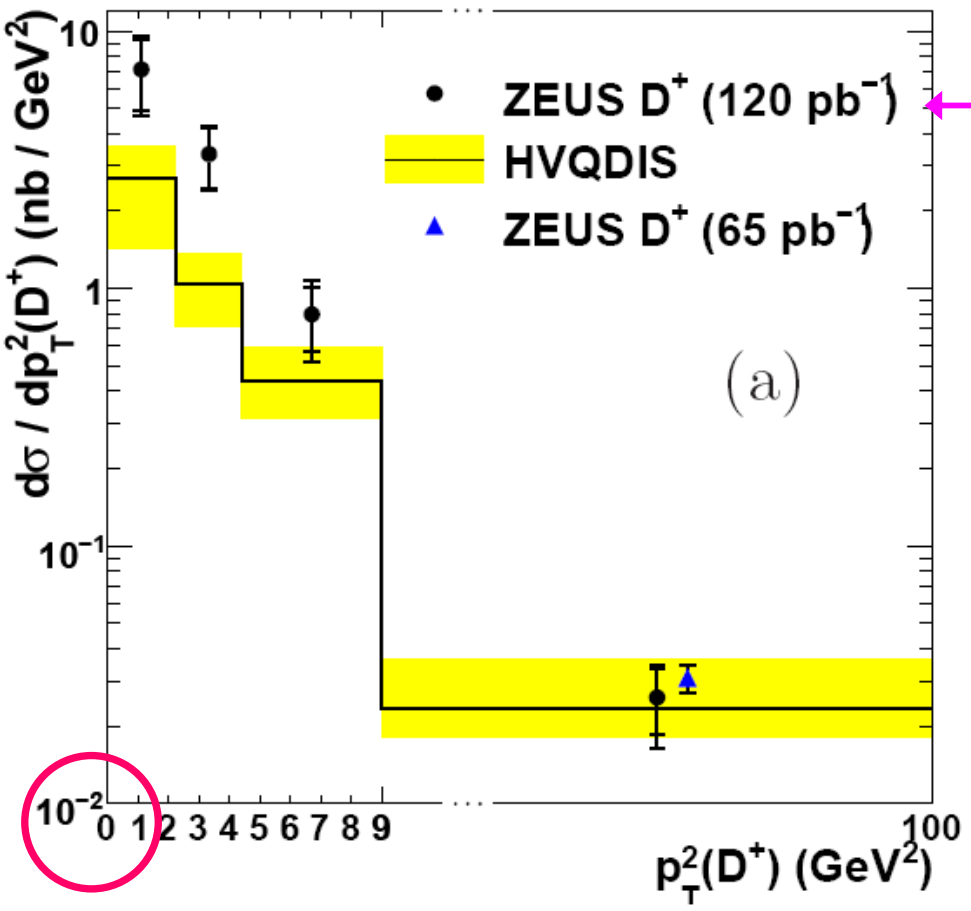
New ZEUS D^+ measurement (HERA I)

- paper to appear soon
- first HERA measurement using $D^+ \to K^0_s \pi^+$ decay channel
- low combinatorial background -> no cut on D^+ p_T !
- $0 < p_T(D^+) < 10$ GeV, $|\eta(D^+)| < 1.6$
- $Q^2 > 1.5$ GeV^2, $0.02<y<0.7$
- 120 pb^{-1} high Q^2, 17 pb^{-1} low Q^2 (trigger prescale)
- more details at DIS 2010 (this is just a preview)



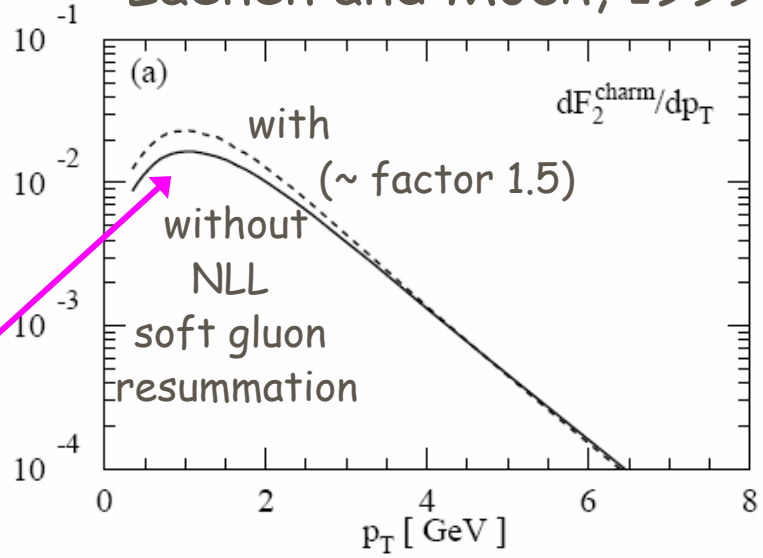


charm p_T spectrum



from D^+ paper being published

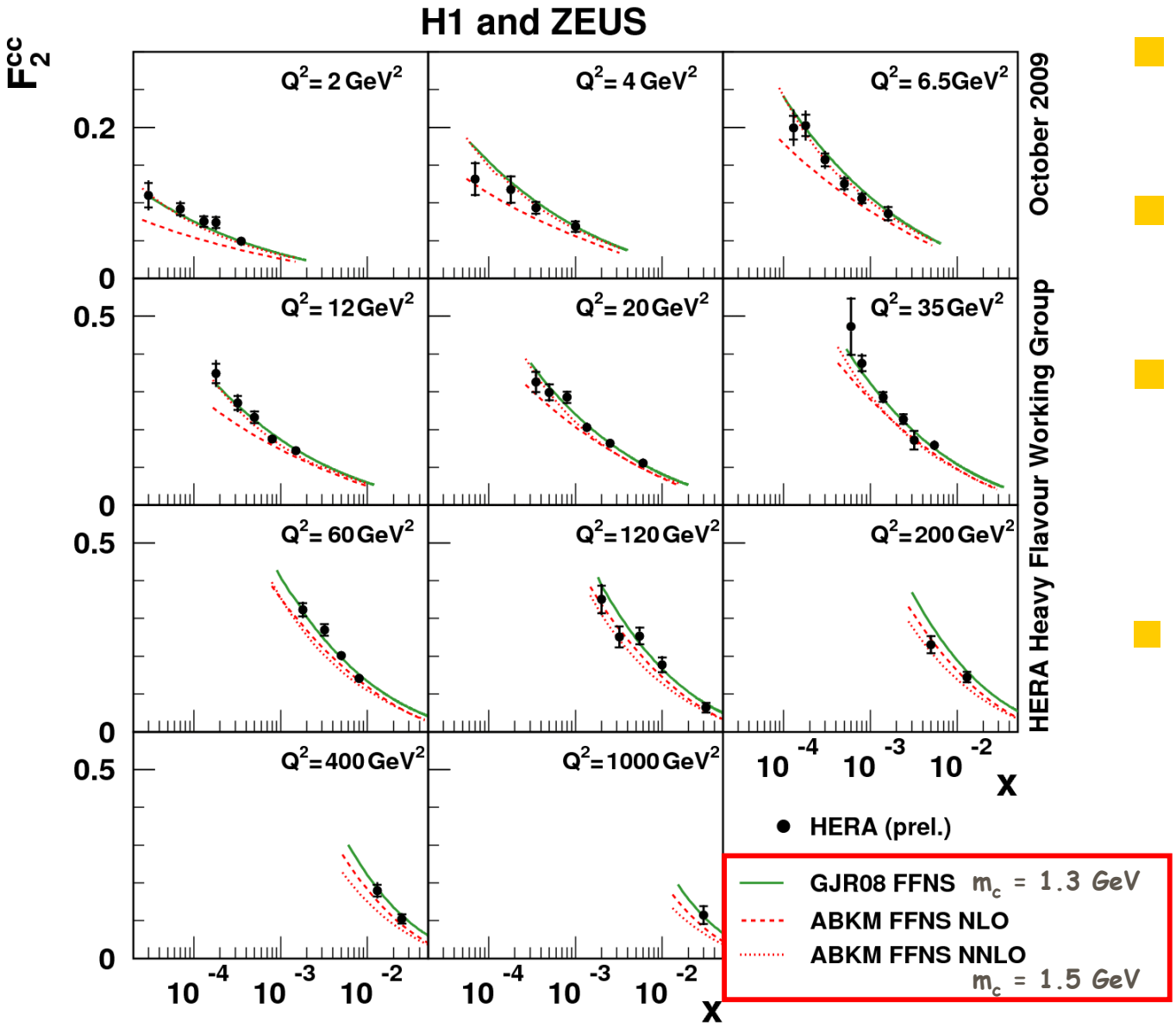
Laenen and Moch, 1999



NLL threshold resummation will make theory agree better!

Figure 17: (a): The differential distribution dF_2^c gluon PDF, $x = 0.01$, $m = 1.6\,\mathrm{GeV}$, $Q^2 = 10\,\mathrm{GeV}$

F^2_c and FFNS predictions: NNLO vs. NLO



- NNLO correction ("threshold resummation") large at low Q^2
- NNLO ABKM perfect close to threshold (low Q^2)
- too low far from threshold (high Q^2, missing NNLO constant term)

- GJR (NLO) compensate missing NNLO terms by choice of unphysically low charm mass

  does this make sense?

NNLO corrections vs. mass

choosing (unphysically) low m_c or m_b at NLO can mimick the effect of NNLO corrections (approximated by threshold resummation) at low/medium Q^2

(previous slide: GJR NLO very close to ABKM NNLO)

my conclusion: not a valid QCD approach

-> don't try to fit or choose low value of m_c to compensate for missing higher order corrections, rather use NNLO (wherever possible)

-> eagerly waiting for release of FFNS NNLO code for fits of F2c/F2b

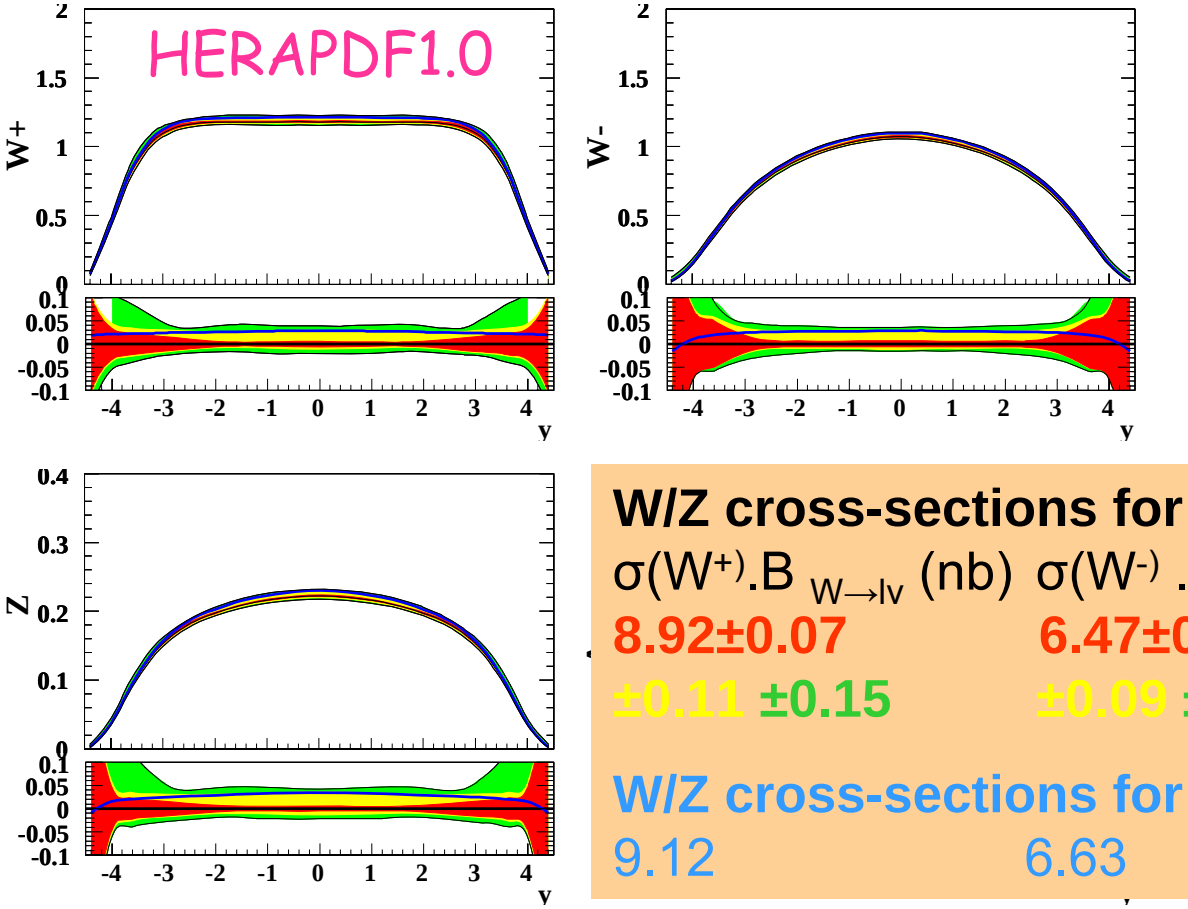
choice of m_c also cross-correlated to α_s and gluon:

reminder: influence on cross sections at LHC

Cooper-Sarkar
+my comments

And there is another important consequence of the choice of the charm mass – a higher charm mass choice raises W/Z cross-section predictions at the LHC by ~3%

W and Z rapidity distributions



10 TeV

larger m_c
-> more gluon, less c
-> more light quarks
-> larger W cross section

W/Z cross-sections for mc=1.4 GeV

$\sigma(W^{+}).B_{W\to l\nu}$ (nb)	$\sigma(W^{-}).B_{W\to l\nu}$ (nb)	$\sigma(Z).B_{Z\to ll}$ (nb)
8.92±0.07	6.47±0.03	1.43±0.01
±0.11 ±0.15	±0.09 ±0.12	±0.02 ±0.03

W/Z cross-sections for mc=1.65 GeV

9.12	6.63	1.47

Higher order uncertainties from scale variations?

- difference between NLO and NNLO predictions (factor ~1.5 at low Q^2) is not covered by scale variations of current predictions based e.g. on Riemersma et al./HVQDIS (typical variations: ~10%)

  my conclusion:
  current DIS NLO predictions for b,c tend to underestimate theoretical uncertainty (in contrast to PHP)

  plan to check scale variations by comparison with NLO predictions by Blümlein et al. during forthcoming months

summary of discussion on NNLO with ABKM authors

- Full massive NNLO calculation for F_2, F_2^c, F_2^b almost done.
  Only one term missing at low Q^2 (constant term for mass corrections)

  missing term will not get calculated soon, but can be safely interpolated between threshold resummation (exact at momentum threshold, ABKM prediction) and high Q^2 (exact massive NNLO calculation available, Blümlein et al.)

  -> could become available within this year

- Full massive NNLO calculation for differential distributions not in sight, but threshold resummation available for single differential heavy quark distributions (Moch 1999 !)

  -> reasonable approximation of NNLO effects at low Q^2

  -> can be used for extrapolation visible -> F_2^c

  Sven Moch will try to provide appropriate predictions within next few months

Discussion on FFNS schemes

- learned from recent discussions that there are not only several VFNS schemes, but also several FFNS schemes
- FFNS scheme by MSTW (e.g. MRST04FF, PLB 636 (2006) 259), CTEQ, and current FFNS HERAPDF attempts use $N_F=3$ evolution of α_s => no virtual heavy quark loops anywhere (somewhat unphysical)
- ABKM FFNS uses variable flavour α_s evolution
  => virtual quark loops in both PDF and coefficient functions
- some necessary related changes to HVQDIS and QCDNUM identified (thanks, Johannes !), but need FFNS ABKM PDF's in newest LHAPDF format in order to try this scheme consistently
  -> could you please provide this? ☺

Conclusions

for "best" comparison to/fit to F_2^c:

- showed preview of new final HERA I ZEUS results being published:

  - new measurement of F_2^b down to $Q^2>2$ GeV^2,

  - new measurement of charm (D^+) without p_T cut

  -> more details at DIS010. additional new HERA II preliminary results (not yet shown) expected by DIS010

- missing charm NNLO terms can be (partially) compensated/mimicked at low Q^2 by choosing unphysically low charm mass. Not a valid QCD approach -> beware of unwanted side effects at high Q^2 (e.g. LHC)

- ABKM FFNS NLO and NNLO predictions differ by up to factor 1.5
  -> threshold resummation important at low Q^2, unreliable at high Q^2?
  could be improved further by interpolation of missing NNLO constant term

- most uncertainties seem to be considerably reduced at NNLO (as they should)
  -> try to use ABKM (or RT) NNLO schemes for combined F_2/F_2^c fit
  -> try to use threshold resummation for NLO extrapolation visible -> F_2^c
  -> need publicly usable codes