PDF4MC – charm fits

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- PDF4MC

  why special PDFs for MCs are needed, necessary and important

  - Strategy:

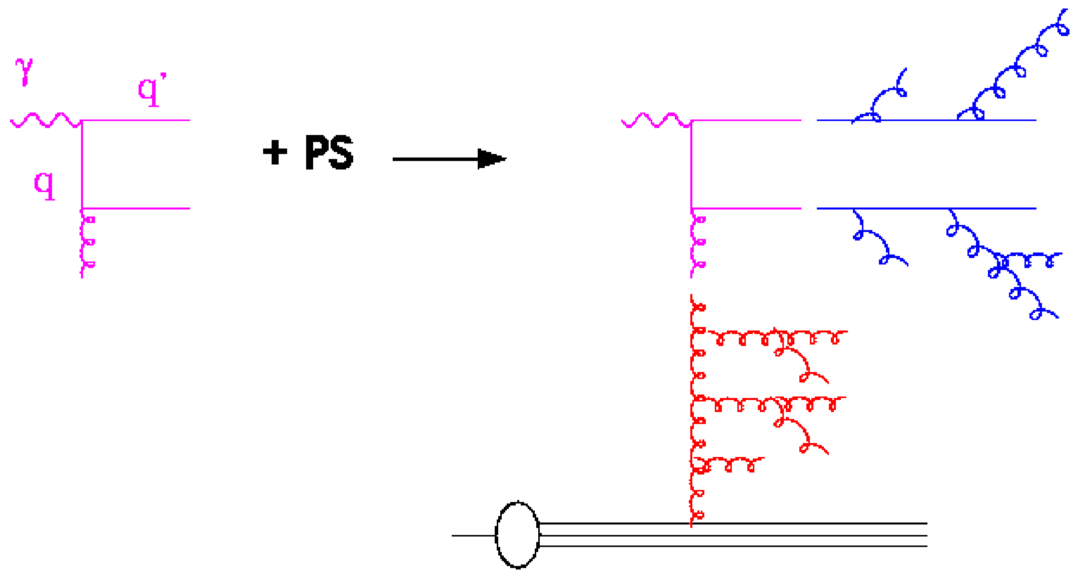
    HOWTO obtain PDF4MC

  - which data to use for fits

    final states from HERA

- Resume on charm fits

Motivation: example from HERA



- **Collinear approach:** incoming/outgoing partons are on mass shell

  $(\gamma+q)^2 = q'^{\,2}\,,\ -Q^2 + x\,y\,s = 0 \rightarrow\ x = Q^2/(ys)$
- **BUT** final state radiation:

  $(\gamma+q)^2 = q'^{\,2}\,,\ -Q^2 + x\,y\,s = m^2 \rightarrow\ x = (Q^2+m^2)/(ys)$
- **AND** initial state radiation:

  $(\gamma+q)^2 = q'^{\,2}\,,\ -Q^2 + x\,y\,s + q^2 = 0 \rightarrow\ x = (Q^2-q^2)/(ys)$
- **Collinear approach: $q'^{\,2} = q^2 = 0$, order by order ....**
- Well known.... since years....
- NLO corrections... better treatment of kinematics... but still not all....

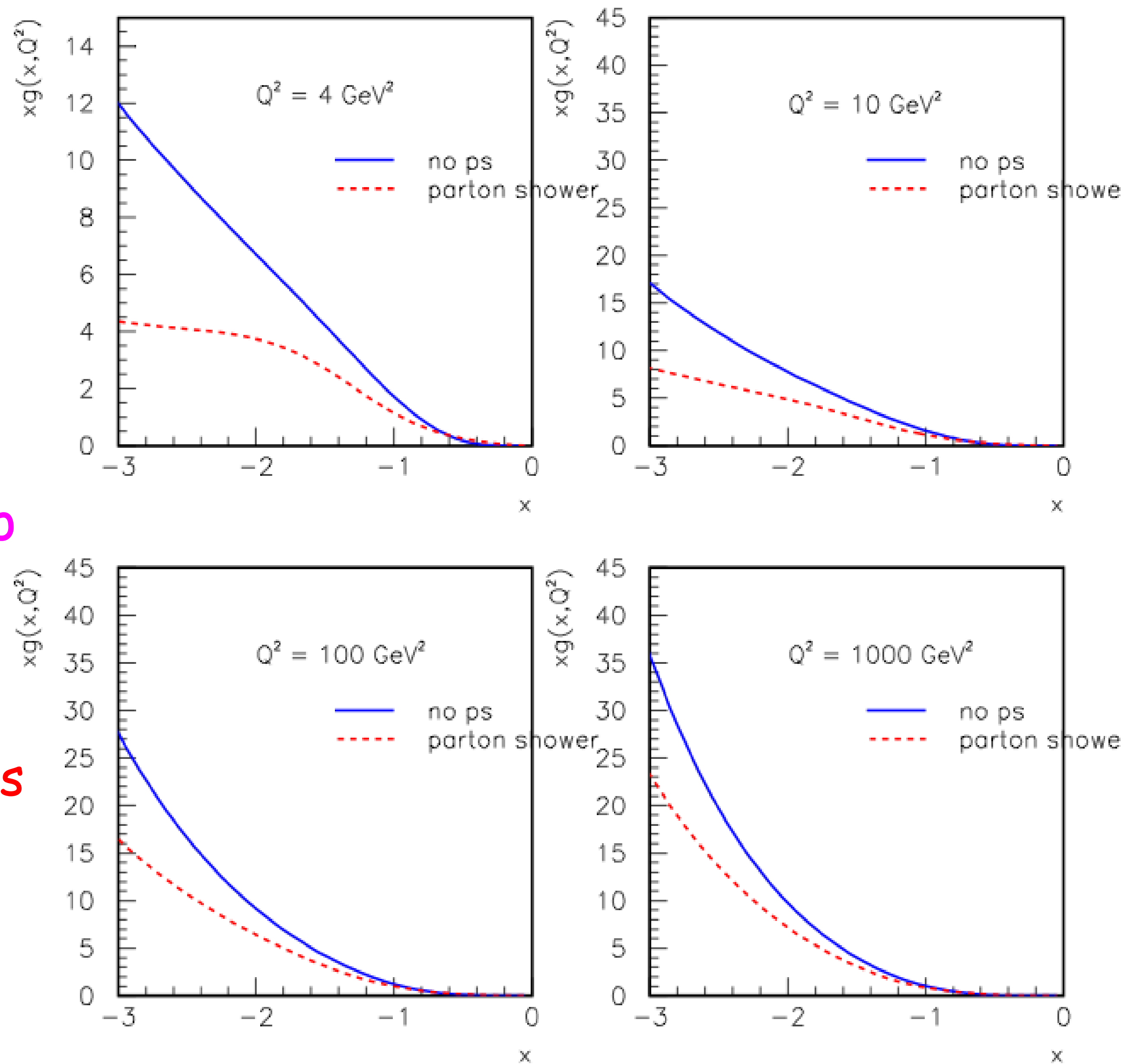
gluon from F_2

- F_2 described by PYTHIA with reasonable χ^2
- significant difference from including initial state parton showers
- gluon much less steep !!!!

➔ change of kinematics

➔ better treat kinematics from beginning

- special machinery in DIS needed....



PDF4MC – why ?

- MC generators include not only LO ME – calculations, but include resummation to all orders via parton showers
- as resummations are now included in PDF determiantions, parton showers should also
- "factorization scheme" in MC event generators is not DIS, nor MSbar, but a MC specific factorization scheme
- in a global analysis, PDF and also parton shower parameters can be simultaneously determined ...
- kinematic effects of including transverse momenta can be important for PDFs

Strategy

- fully consistent approach would require doubly uPDFs and appropriate factorization theorem, which will include collinear factorization and kt-factorization as asymptotic limits...
- branch 1: use uPDFs and k_t-factorization as done with CCFM and CASCADE (see talks at HERA-LHC WS 2008 by F. Hautmann, A. Knutsson and CASCADE)
- branch 2: use standard MCEG like PYTHIA/HERWIG/RAPGAP but also ALPGEN/SHERPA etc and obtain PDFs from fits to F_2 and TeVatron data, as done in global analyses
  - neither LO or NLO is appropriate
  - define MC-PDFs, depend on generator, parton showers etc
    - **MC-factorization scheme.... instead of MS bar**
  - include proper treatment of parton showers in initial and final state
  - include all kinematics from full simulation, no approximations

Strategy (cont'd)

- use LHAPDF library for parton evolution and alphas
  - use any distribution and evolution code
  - evolve for every call (fast enough, can be improved if necessary...)
  - massive/massless treatment
- use HZTool/RIVET for comparison of MC prediction with measurements
  - HERA H1/ZEUS: F_2, F_2^c, D*, jets etc....
  - and at a later stage ....
    - TeVatron CDF/D0: jets, W/Z x section as fct of pt
- use general fit program (PROFFIT A. Bacchetta,A. Knutsson, K. Kutak)
  - easy to extend for other MC generators and also NLO programs
  - Improvements for fits (in progress: A. Knutsson, K.Kutak, H. Hoeth)

➔ calculation in grid points

➔ parametrization

➔ fit to data (including uncertainties)

Where to start ... ?

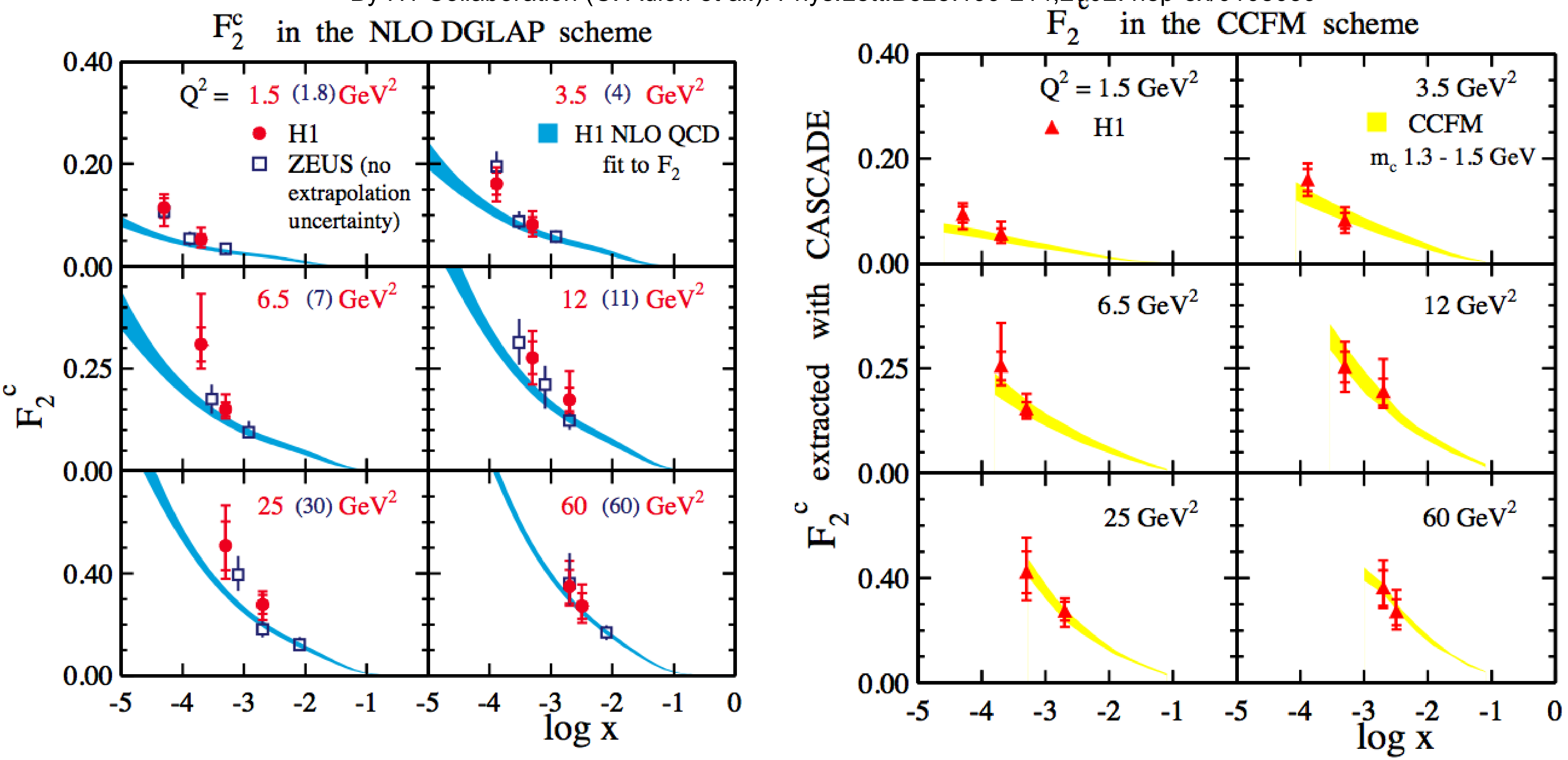
- determination of gluon distribution
- use CTEQ 6L as starting distribution (evolution code is fast)
  - with NLO α_s
  - with heavy quark PDF ....
- evolve starting distribution for every event

Which data to use for PDF4MC fit ?

- inclusive structure function measurements:
  - F_2 from HERA (not used here)
- heavy quark measurements at HERA:
  - F_2^c, D* in DIS, D* + dijets in DIS

The problem with charm

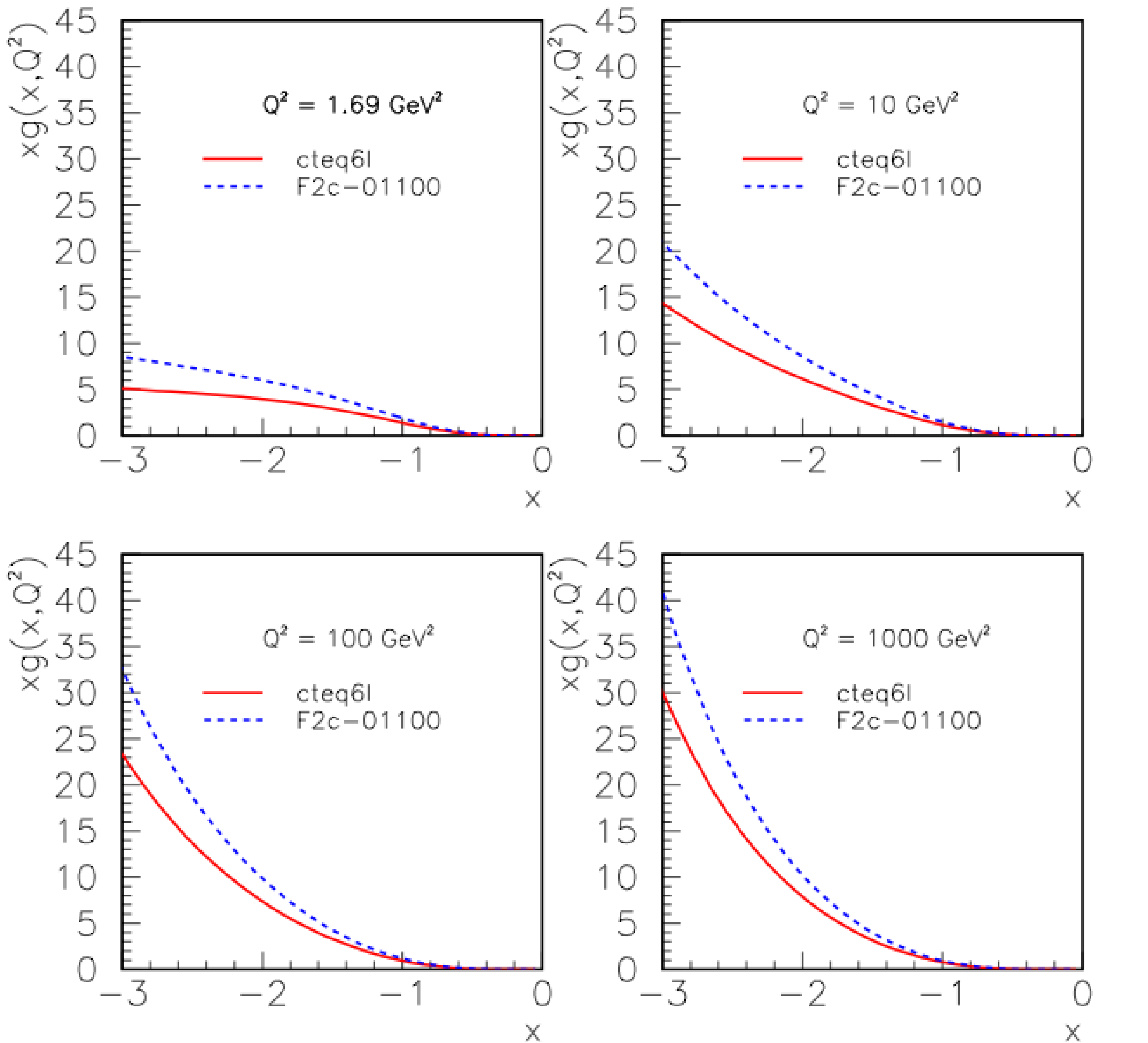
Measurement of D*+- meson production and F2(c) in deep inelastic scattering at HERA.
By H1 Collaboration (C. Adloff et al.). Phys.Lett.B528:199-214,2002. hep-ex/0108039



- F_2^c depends on assumption for extraction ....
- large extrapolation factors
- more results at ICHEP 08 .....

The gluon from F_2^c ...

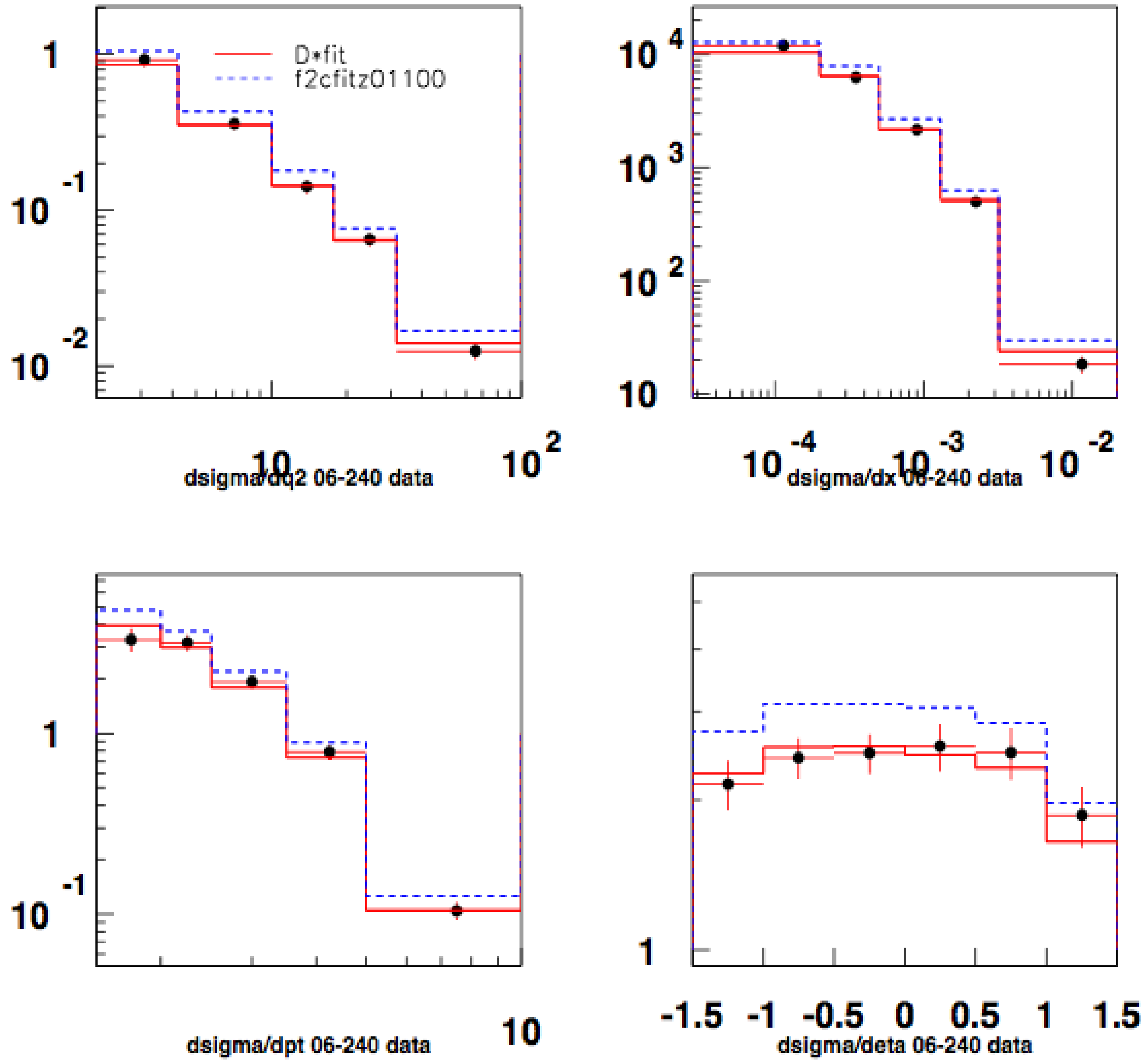
- Fit DGLAP F2c to obtain gluon
- use RAPGAP with massive MEs in LO + PS
- steep gluon obtained ...
- is this a problem of the way F_2^c is "measured" ?



Fits to D* cross section

- use measured xsection of D*
- fit Q^2, x, p_t, η
- improve χ^2 by 6 units compared to starting values
- much improved χ^2 compared to F2c fit

Production of D*+- Mesons with Dijets in Deep-Inelastic Scattering at HERA.
H1 Collaboration (A. Aktas et al) Eur.Phys.J.C51:271-287,2007.hep-ex/0701023



Gluon from D* with jets

- only slightly changed parameters
- BUT further constraints due to different kinematic regions
- Gluon can be well determined from visible charm x-section

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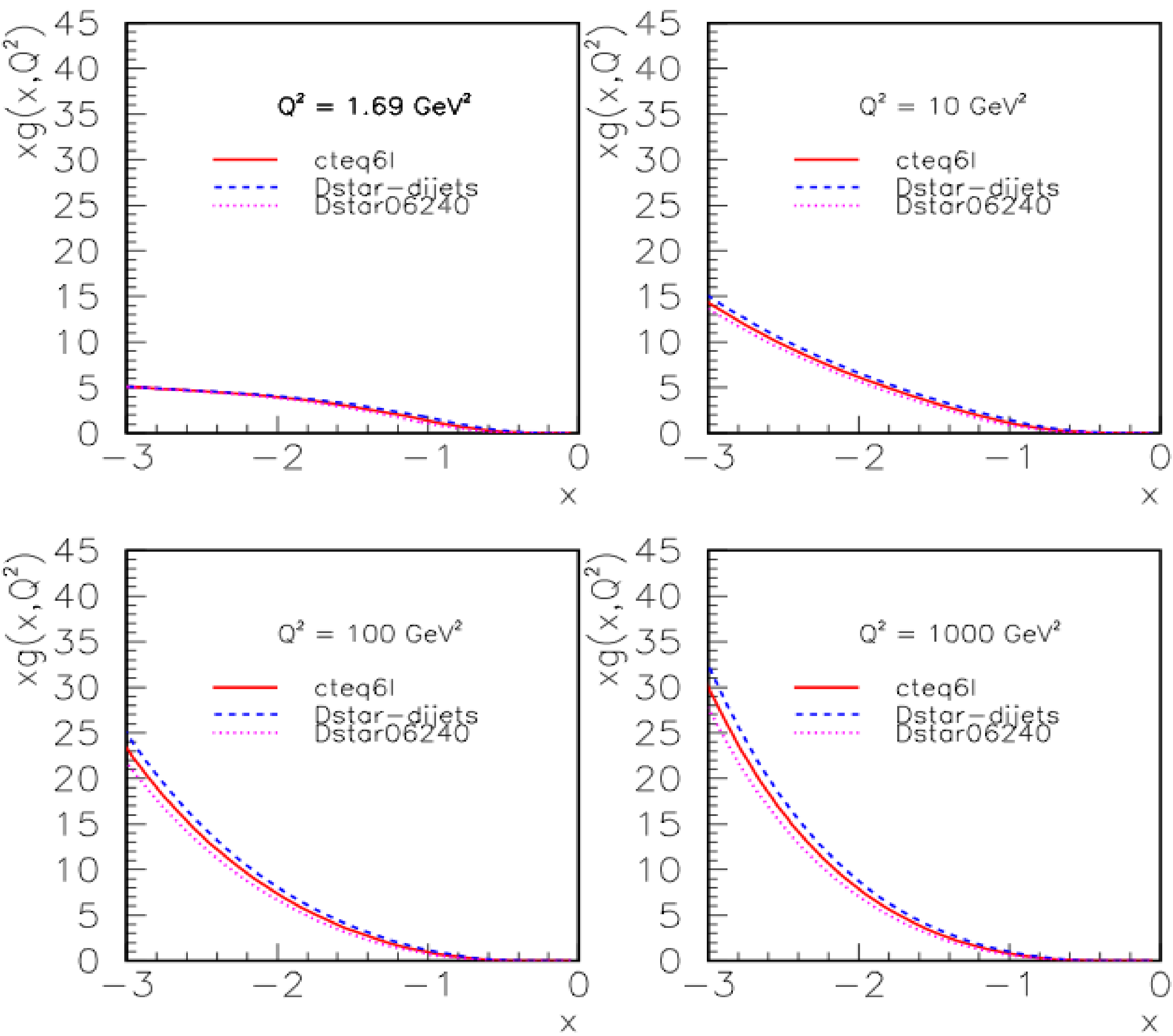

Resume from heavy quarks

- use only visible cross sections,
  - at least for MC fits.... extrapolations to total x-section highly model dependent
  - D* and D*+jet measurements give consistent results for gluon
  - result is nearly identical to CTEQ6l
    - BUT pdf in massless scheme, and ME massive ...
    - NLO alphas in pdf, BUT LO alphas in ME
    - need to check consistency on mass parameters etc