

PDF4MC

H. Jung (DESY)

- PDF4MC

why special PDFs for MCs are needed, necessary and important

- Strategy:

HOWTO obtain PDF4MC

connection to uPDFs and collinear PDFs

- 1st attempts

F_2

di-jets in DIS

Z_0 at TeVatron

- Conclusions

Motivation

CP. Yuan, DIS2007

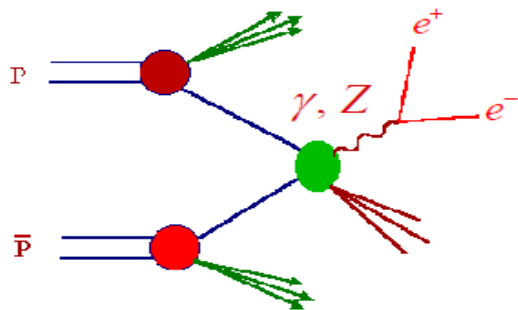
New from
DIS07

New Task of Global Analysis

Include Transverse Momentum p_T distributions

- New Data: include not only rapidity (y) but also

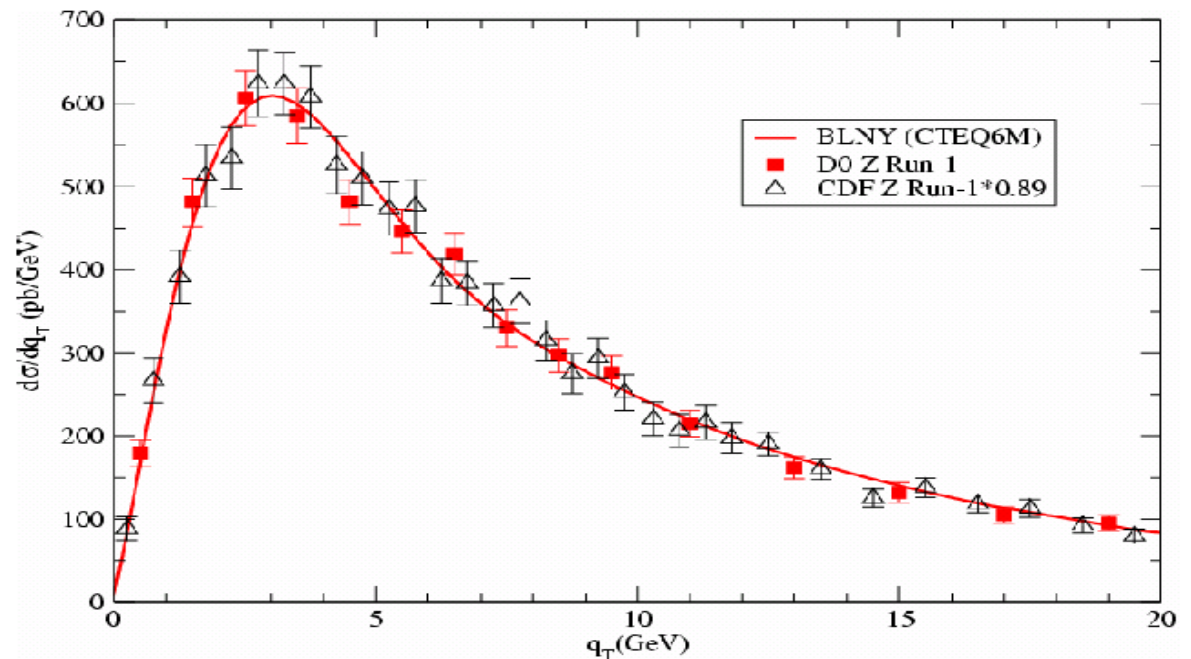
p_T of Drell-Yan pairs and Z bosons



QCD P_T Resummation
Global Analysis

hep-ph/0212159

Brock, Landry, Nadolsky, CPY



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 determinations, **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

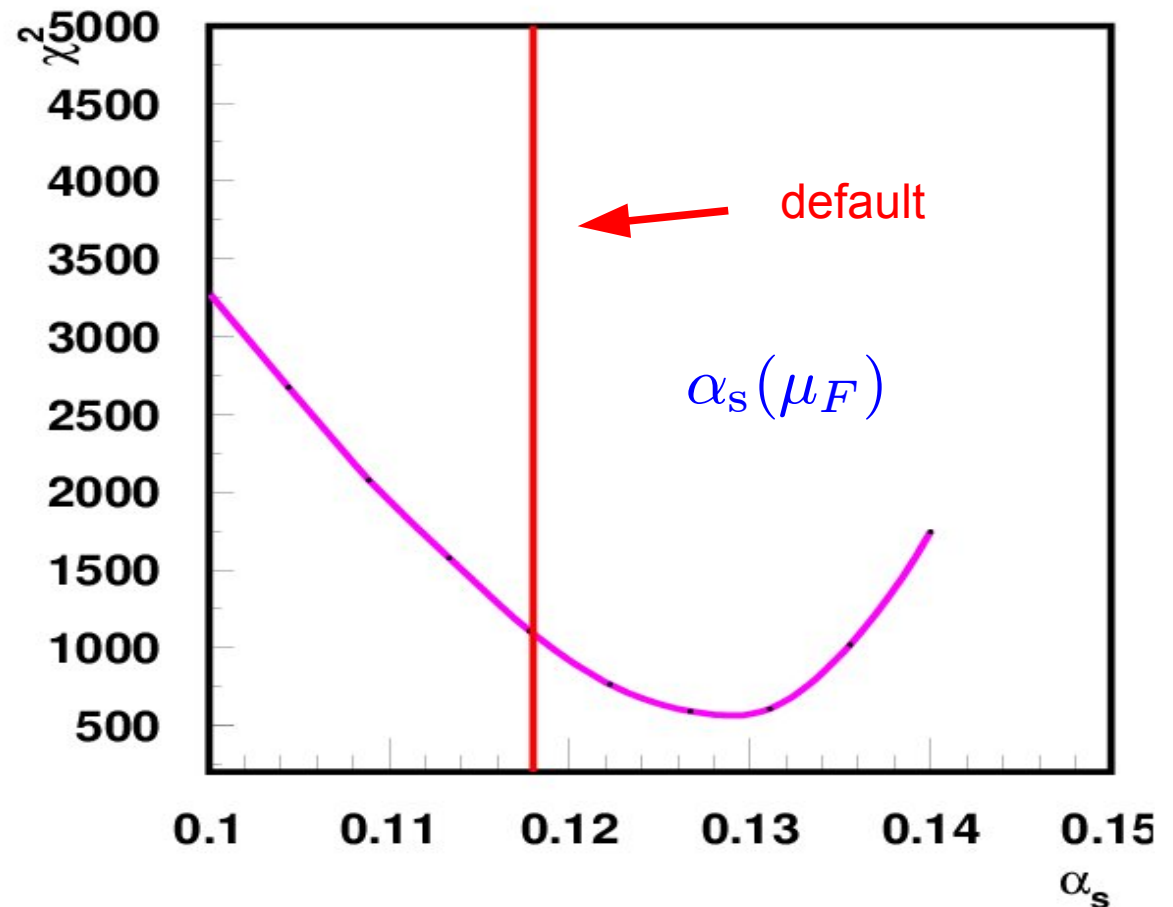
- fully consistent approach would require doubly uPDFs and appropriate factorization theorem, which will include collinear factorization and kt-factorization as asymptotic limits...
- branch 1: use uPDFs and k_{\perp} -factorization as done with CCFM and CASCADE (see talk by F. Hautmann, A. Knutsson 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 \overline{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 , jets etc....
 - TeVatron CDF/D0: jets, W/Z x section as fct of pt
 - (CTEQ also wants to do this.....)
- use general fit program (PROFFIT or PROFESSOR)
 - easily extendable 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)

1st attempts: F_2

- fit F_2 with PYTHIA
- use CTEQ6L as starting distribution
- scan different parameters

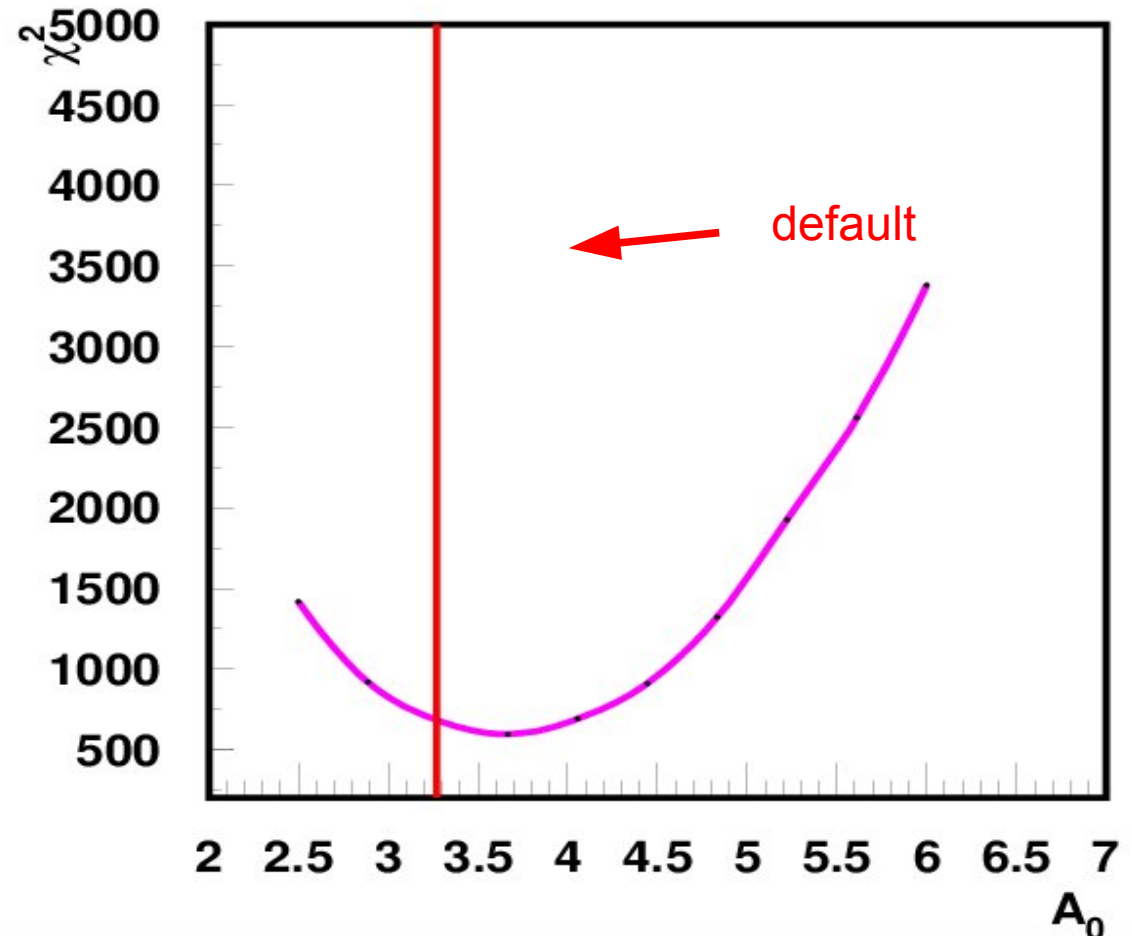


1st attempts: F_2

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$$xG(x, \mu_0) \sim A_0 x^{A_1} \dots$$

→ normalization changed

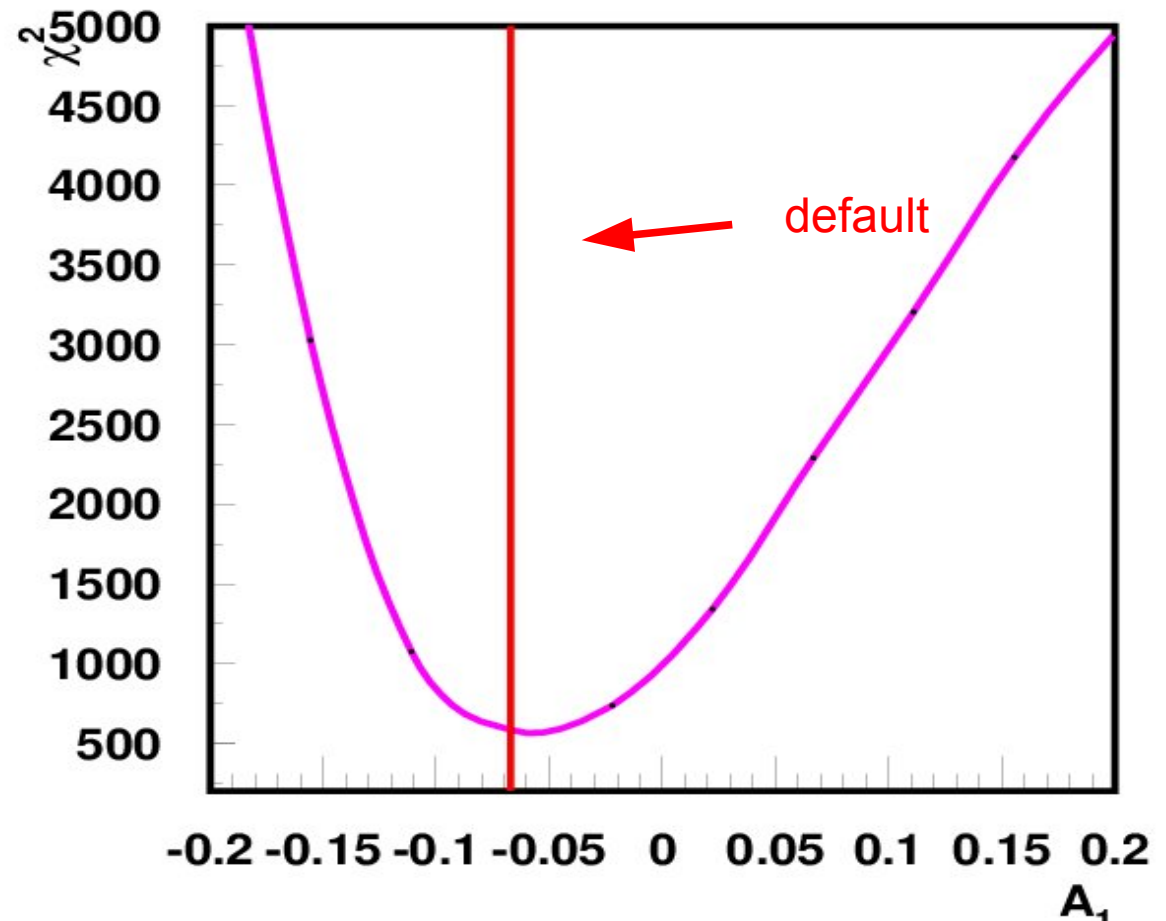


1st attempts: F_2

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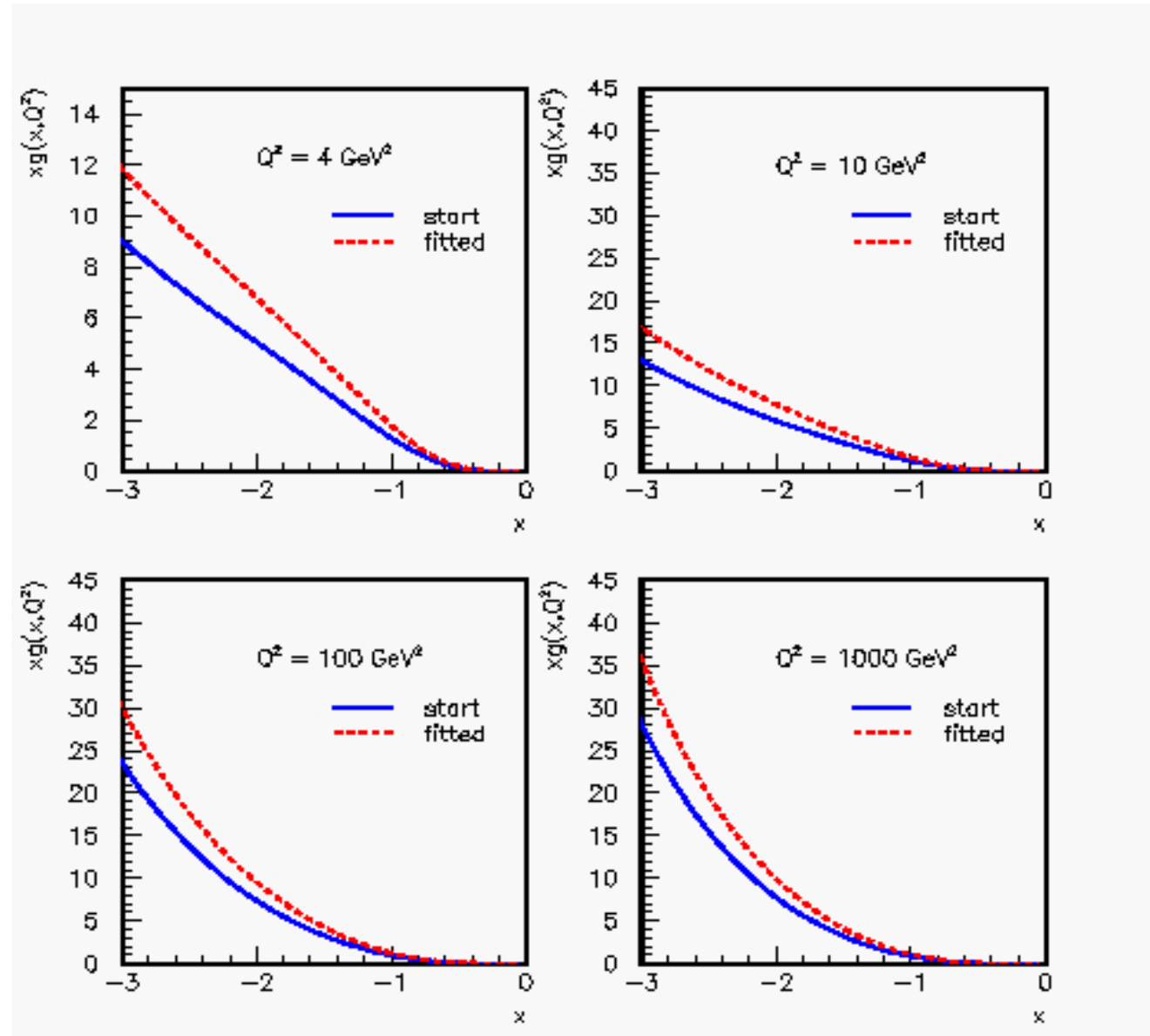
$$xG(x, \mu_0) \sim A_0 x^{A_1} \dots$$

- normalization changed
- small x -dependence of gluon changes slightly !!!

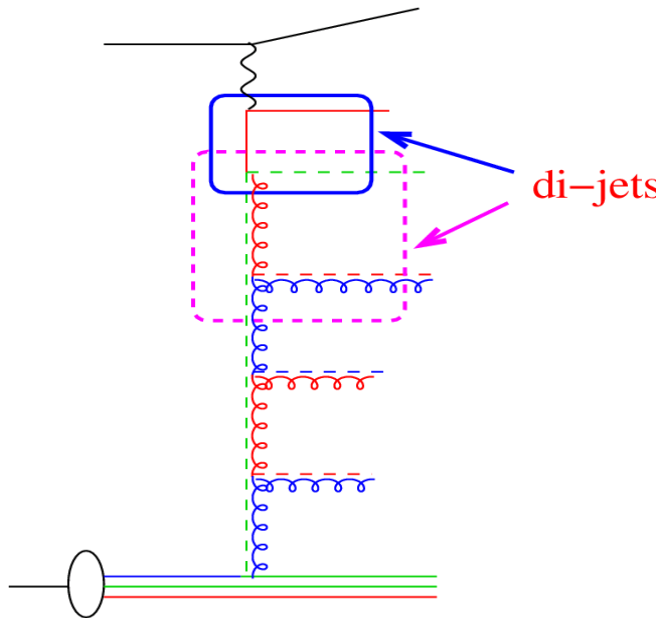


The gluon after fitting F_2

- Use LO fit....
- Fit F_2 by varying
 $yg(x, \mu) = A_0 x^{A_1} \dots$
and $\alpha_s(\mu)$
- Fit changes
normalization and
slope of gluon ... as
seen in the scan....
- χ^2/ndf
improves...., but can
still be better....
- ➔ Not yet the final
answer...



Jets in DIS



- Using PYTHIA for jets in DIS
NEW !!!
- gives reasonable results...
- for E_+ distributions gives

$$\frac{\chi^2}{ndf} = \frac{66}{36} = 1.8$$

- Using H1 jet measurements

(H1 EPJC 33 (2004) 477)

$$5 < Q^2 < 100 \text{ GeV}^2$$

$$-1 < \eta < 2.5$$

$$E_T > 5 \text{ GeV}$$

- investigate x dependence of starting distribution

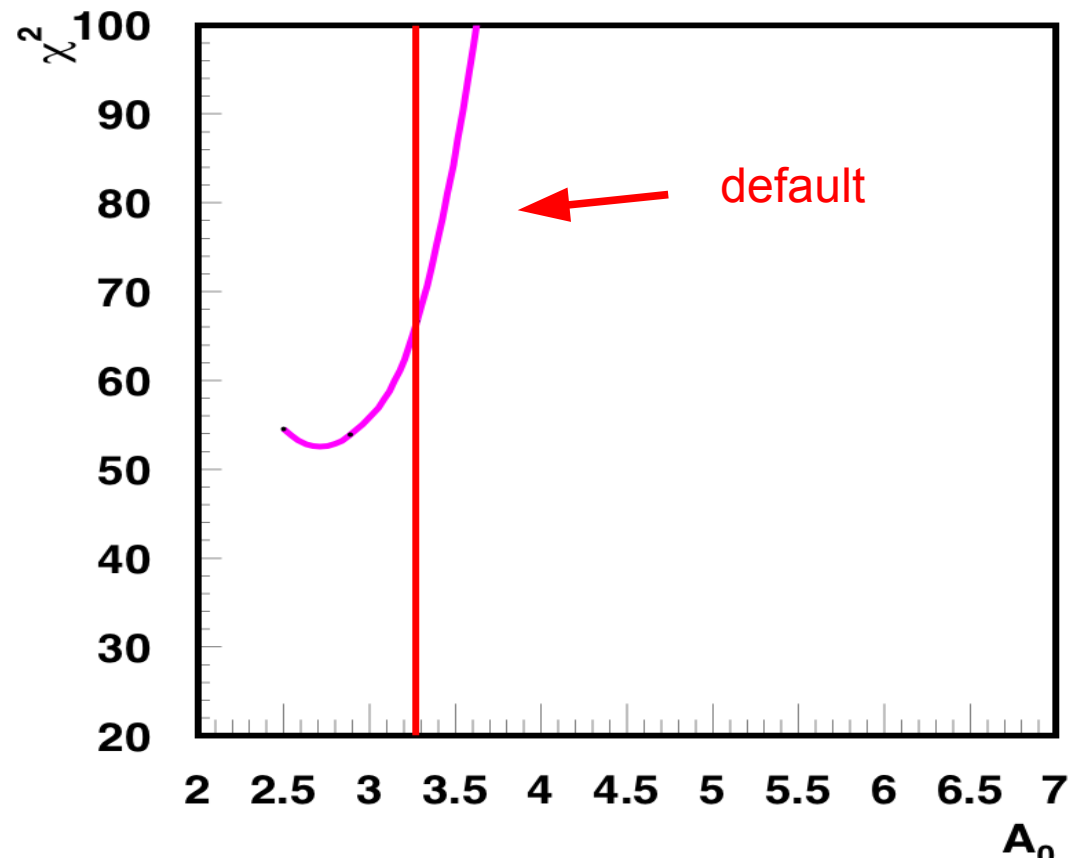
with CTEQ6L

Gluon after Jet fit

- fit DIS dijets with PYTHIA
- use CTEQ6L as starting distribution
- scan different parameters

$$xG(x, \mu_0) \sim A_0 x^{A_1} \dots$$

- normalization changed
- and as a consequence
also the quark
distributions...



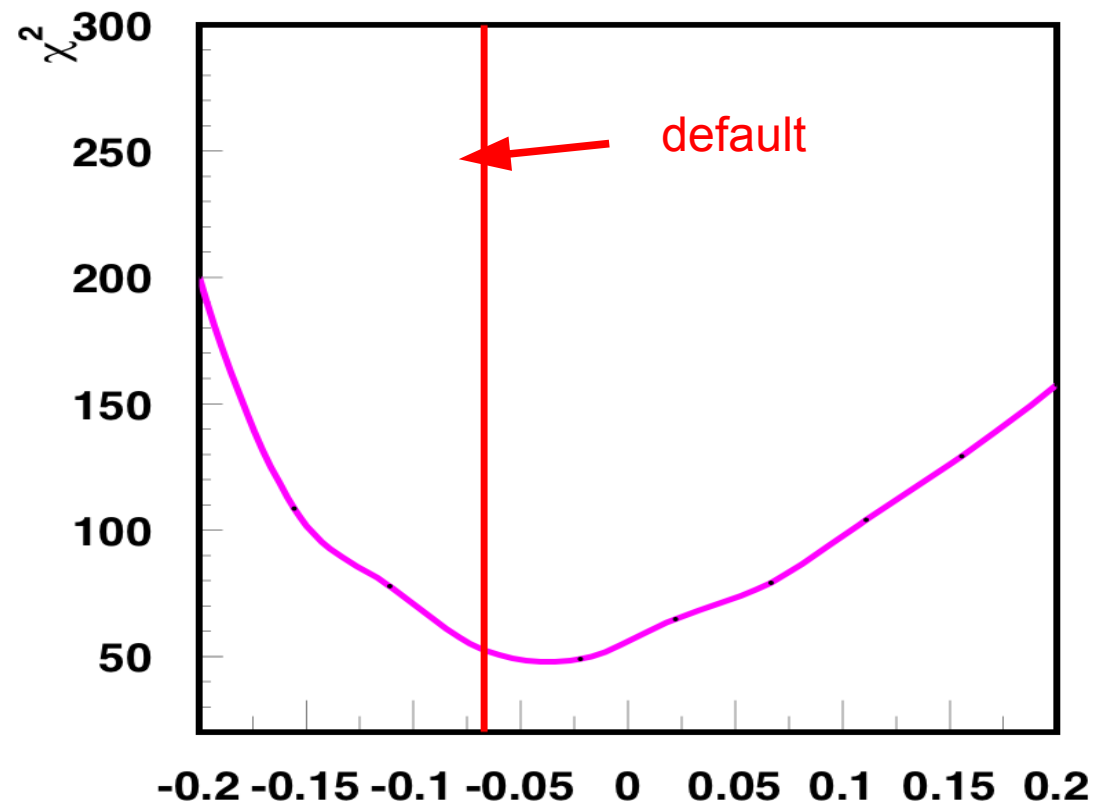
Gluon after Jet fit

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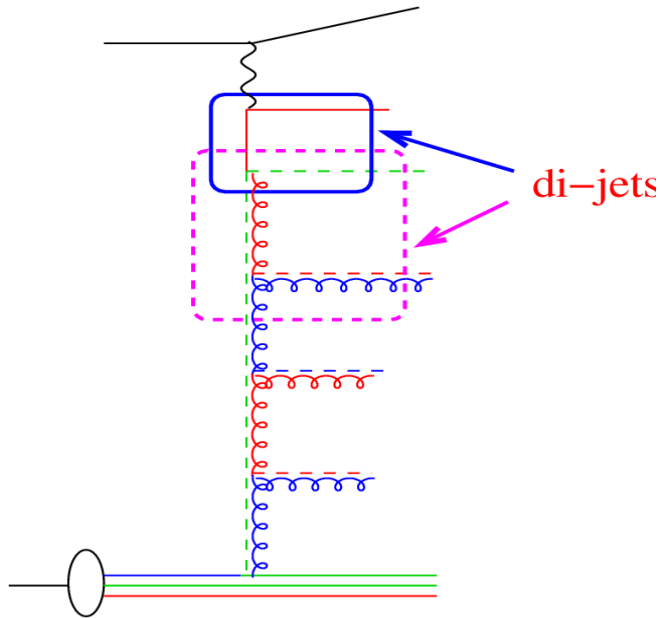
$$xG(x, \mu_0) \sim A_0 x^{A_1} \dots$$

- normalization changed
- small x-dependence of gluon does not change much
- overall χ^2 improves by 10 units
- **NOTE:** changing the gluon changes also the quarks via mom.sum rule

Consistent result is obtained



Jets in DIS... after fit ...



- Using H1 jet measurements

(H1 EPJC 33 (2004) 477)

$$5 < Q^2 < 100 \text{ GeV}^2$$

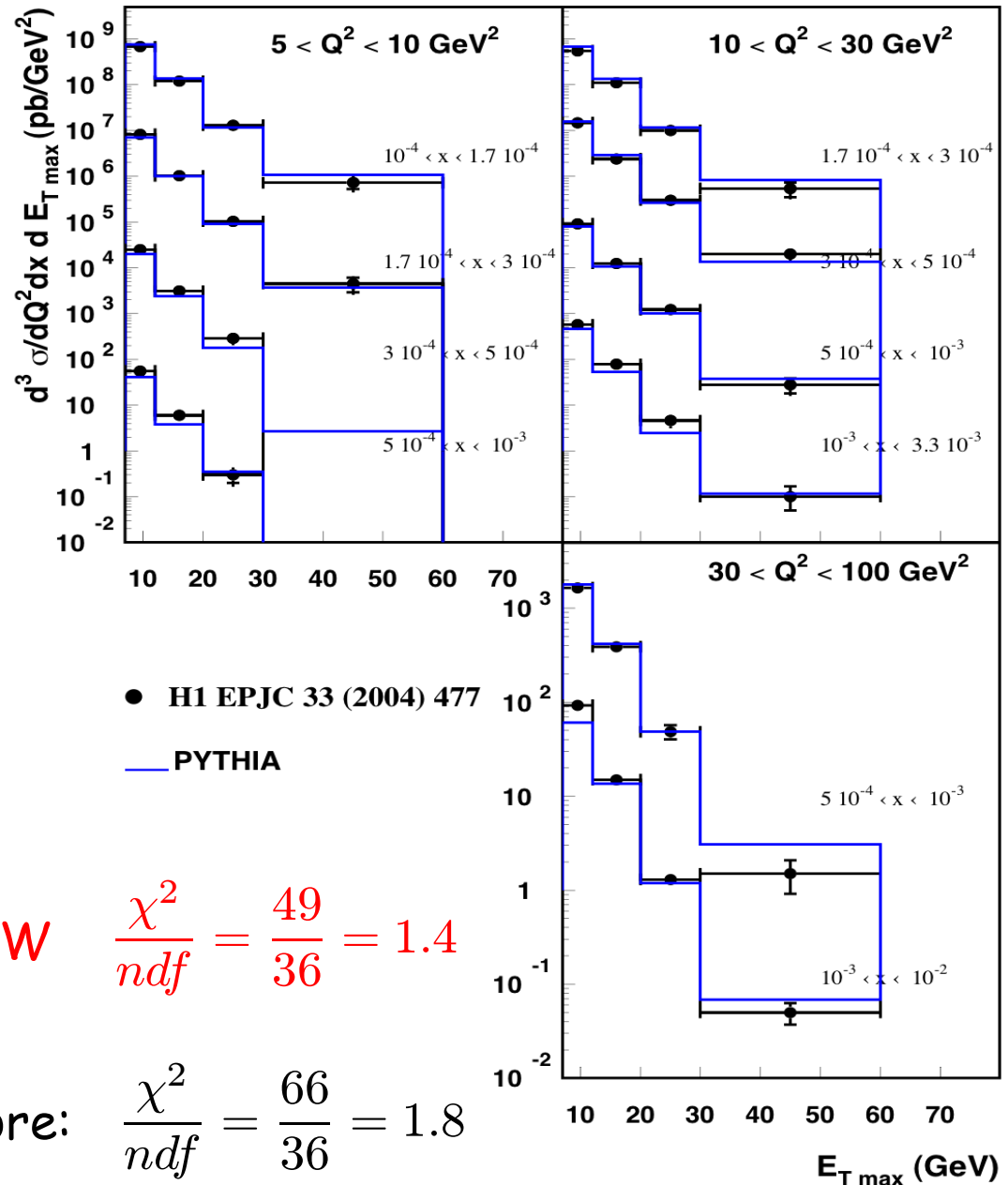
$$-1 < \eta < 2.5$$

$$E_T > 5 \text{ GeV}$$

NEW

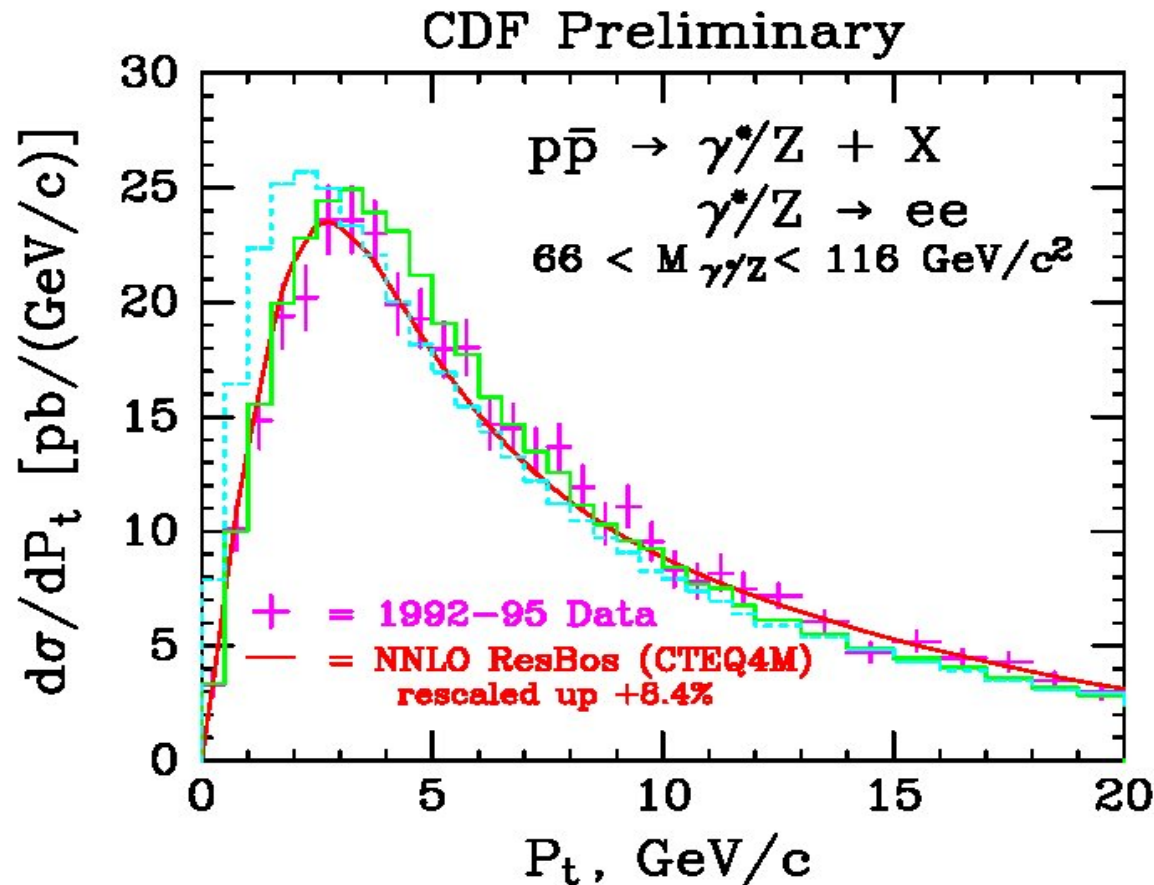
$$\frac{\chi^2}{ndf} = \frac{49}{36} = 1.4$$

compared to before: $\frac{\chi^2}{ndf} = \frac{66}{36} = 1.8$



steps toward global fit: Z at pp

Campbell, Huston Stirling
Rep.Prog.Phys 70 (2007) 89



to produce Z, need:
 $x \sim 0.05 \dots E \sim 45 \text{ GeV}$

transverse momentum
is ca 10 %

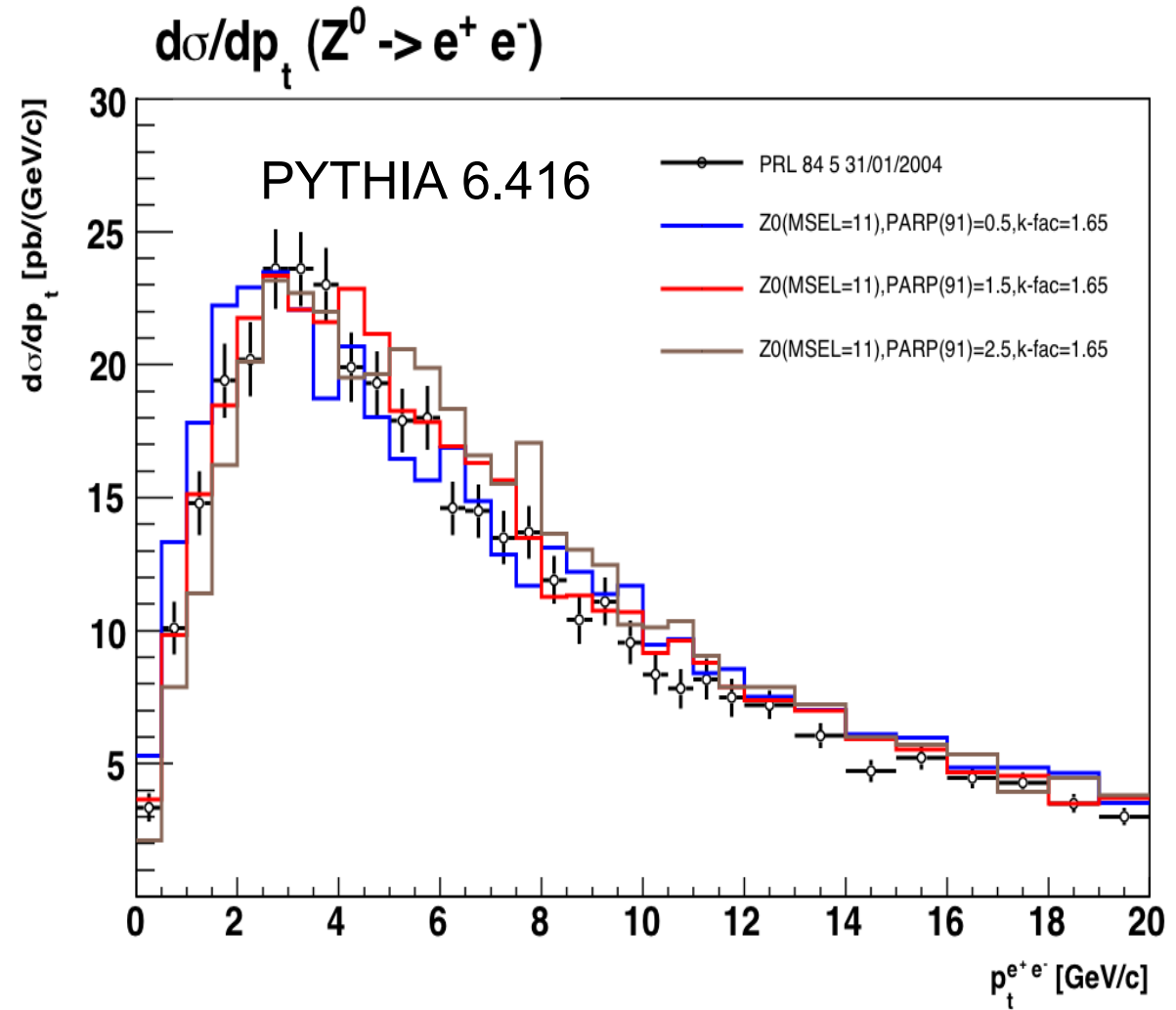
can have effect on $x \dots$

Figure 40. The transverse momentum distribution (low p_T) for $Z \rightarrow e^+e^-$ from CDF in Run 1, along with comparisons to predictions from PYTHIA and ResBos. The dashed blue curve is the default PYTHIA prediction. The PYTHIA solid-green curve has had an additional 2 GeV of k_T added to the parton shower.

Z_0 in pp with PYTHIA

from Federico Samson-Himmelstjerna (DESY)

- 1st studies on p_t spectrum of Z at Tevatron
- reasonable description after adjusting intrinsic k_t ... ~ 2 GeV ...
- What is the effect on PDFs ?
- What is the effect on HERA measurements ?
- Perform a global fit including also other HERA measurements !!!



Next steps ...

- tools are available ...
- start with fits: (Federico Samson-Himmelstjerna, DESY)
 - HERA inclusive data (F2c, F2 (?), DIS jets, photoprod jets and charm)
 - determine gluon, sea quarks
 - perform fits to parton shower parameters (together with pdfs)
- perform global fits
 - include Tevatron Z for intrinsic kt and IPS
 - study quark pdfs, etc ..
 - collaborate with tuning at Tevatron/LHC including multiple interactions etc ...
- PDF4MC is one of the activities of MC group of Terascale Analysis Center at DESY (see presentation tomorrow)

Conclusions

- using PDF4MC helps to improve description of data by MCs
 - will improve model dependence of hadron level correction
 - smaller systematic uncertainty
- concept of PDF4MC works
 - to be extended for a global fit of HERA and other data using PROFFIT
- use of PDF4MC is important to
 - include kinematic effects
 - use all order resummed predictions (from PS MCs)
 - is the **only** consistent way to use PDFs in MC generators