Part 1

Updfs

Part 2

PDF4MC

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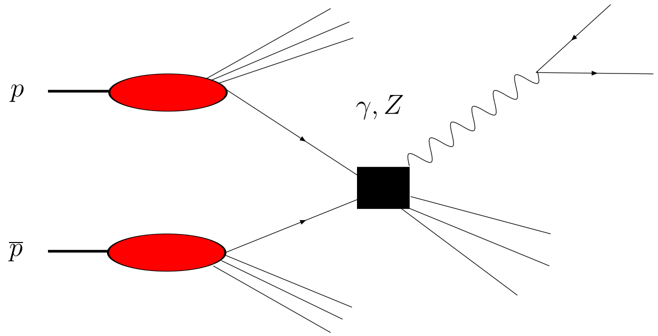
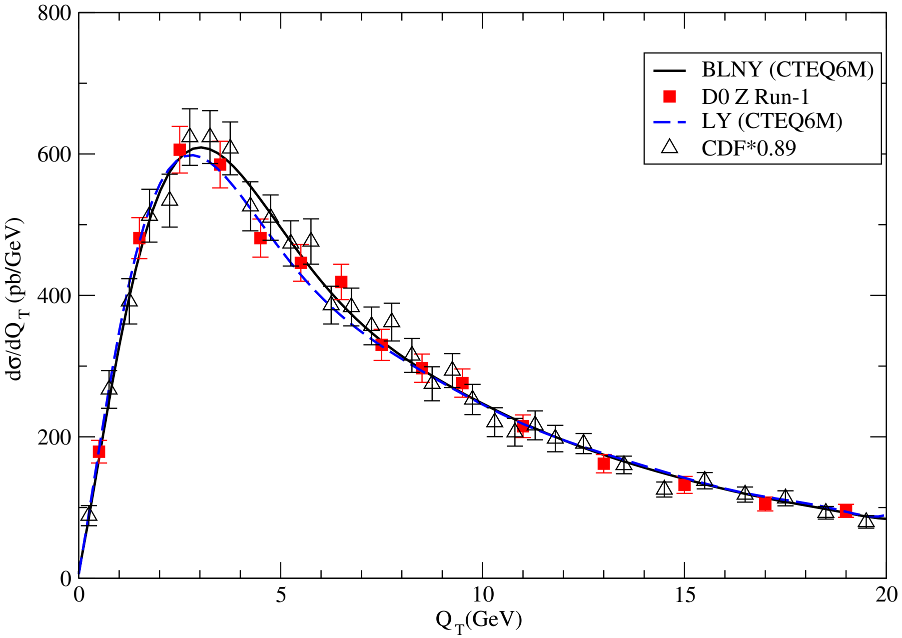
Why uPDFs are needed.

Appeared in the discussion of the Drell-Yan process (D. Soper).

Z_0 x-sec hep-ph/0212159 Brock, Landry, Nadolsky ↘

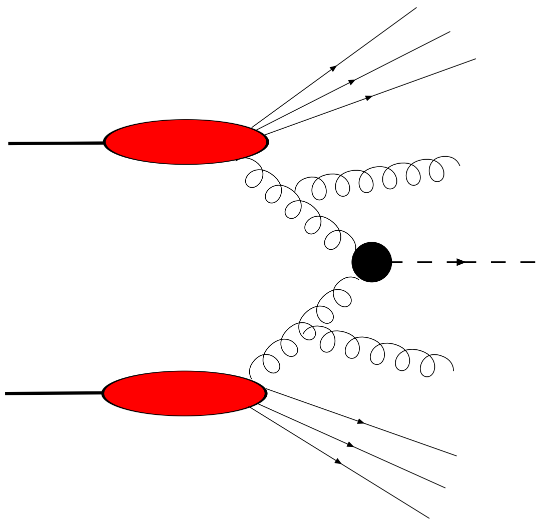


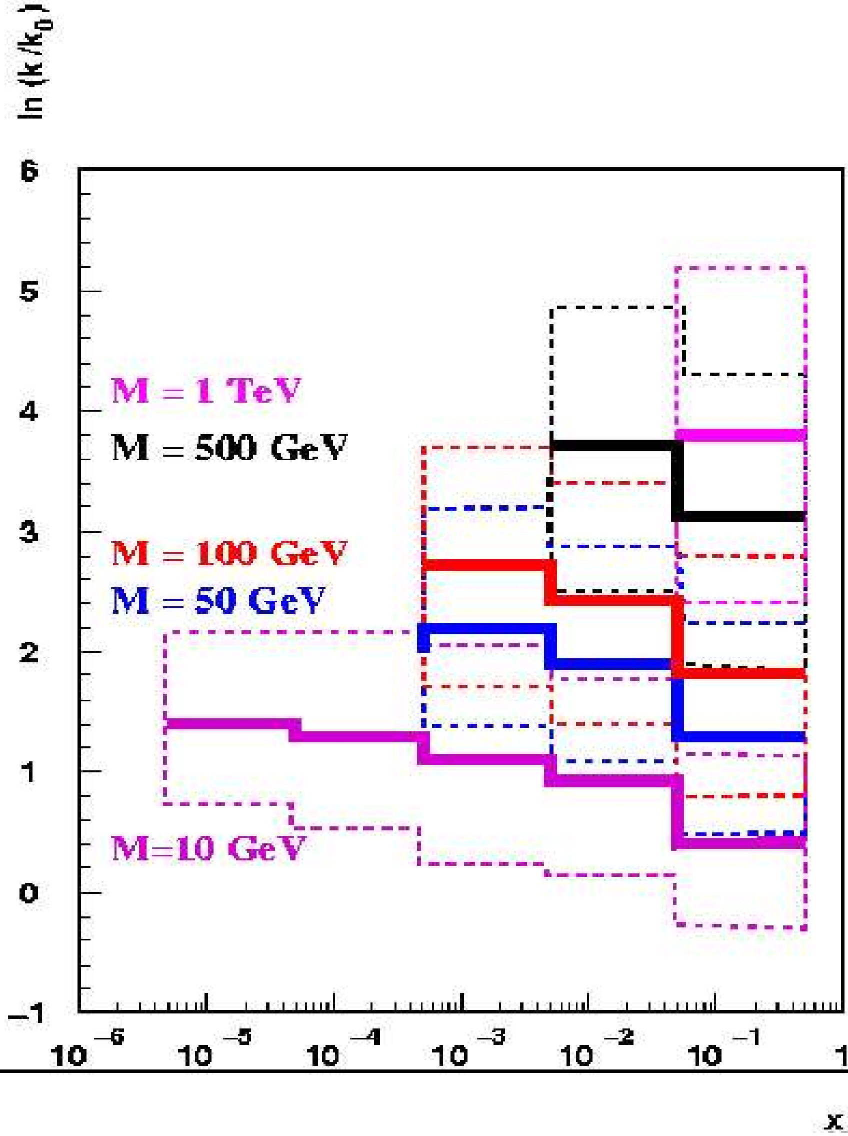


Why uPDFs are needed

Gluons can have sizable k_t

$\longrightarrow$ Higgs can have sizable k_t





Why uPDFs are needed

- at low x updfs appear naturally $\longrightarrow$ BFKL, BK, CCFM...
- one can consistently address problems of unitarization and saturation of the cross sections
- kinematics is treated more correctly

Why uPDFs are needed

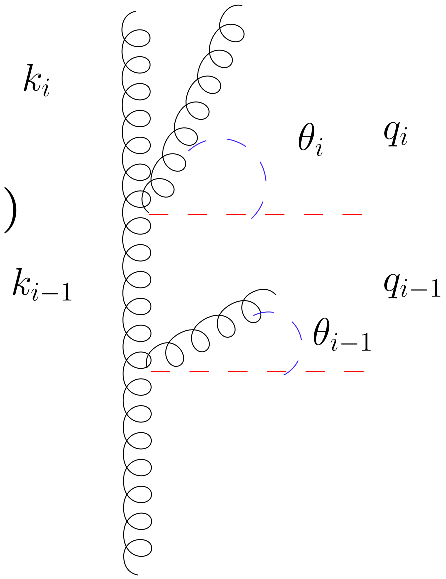
Here we focus on the CCFM equation. Strong ordering in angle of emission of gluons: $\theta_i \gg \theta_{i-1}$

Integral equation:

$$xA(x, k_T, q) = xA_0(x, k_T, q) + K \otimes xA(x, k_T, q)$$

Starting distribution to be determined by fit:

$$xA_0 = Nx^{-Bx}(1-x)^4 exp(-(k-\mu)^2/\sigma^2)$$

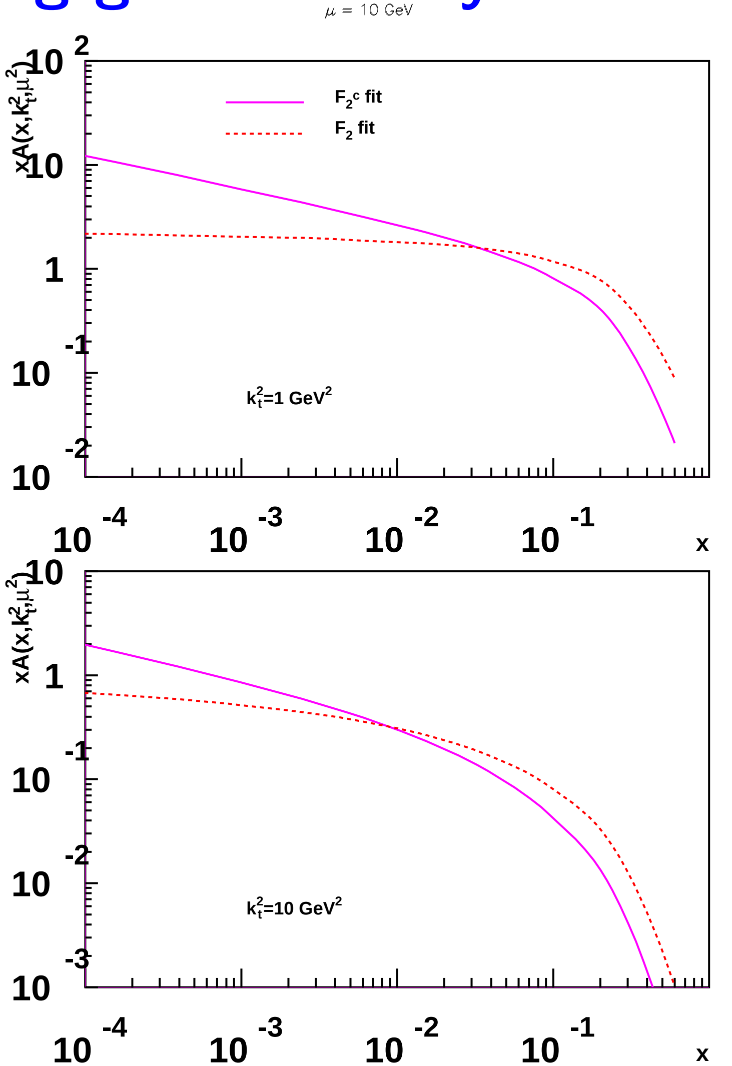


Constraining gluon density

Independent fits to F_2 and F_2^c give different gluon

↑

unsolved puzzle (Jung, Kotikov, Lipatov, Zotov)



Hint to include additional processes in CASCADE?

Total cross-section(hard subprocess ($p_t > 10GeV$))

ARIADNE: 9.45 mb
PYTHIA: 9.46 mb
CASCADE: 0.27 mb

Only gluon-gluon induced processes (and MI turned off)

Total cross-section(hard subprocess ($p_t > 10GeV$))

ARIADNE: 0.19 mb
PYTHIA: 0.19 mb
CASCADE: 0.27 mb

Comparison has been done by Albert Knutsson.

Together with Michal Deak we are working on including large x physics in CASCADE.

Fitting gluon density

Traditional MINUIT fitting takes too long time
to solve the puzzles one needs something else...
Together with Albert Knutsson and Alessandro Baccetta inspired by Hendrik Hoeth's talk at MC school at Durham we developed program for fast fitting

- Observable $\longrightarrow$ parton density$\longrightarrow$ initial parameters $\longrightarrow$ choice of a tuning interval for the parameters
- Build up a grid of points in parameter space with very high statistics$\longrightarrow$ only once
- Interpolation between grid points using formula which accounts for correlations
- Fit polynomial to the data by tuning parameters

Procedure

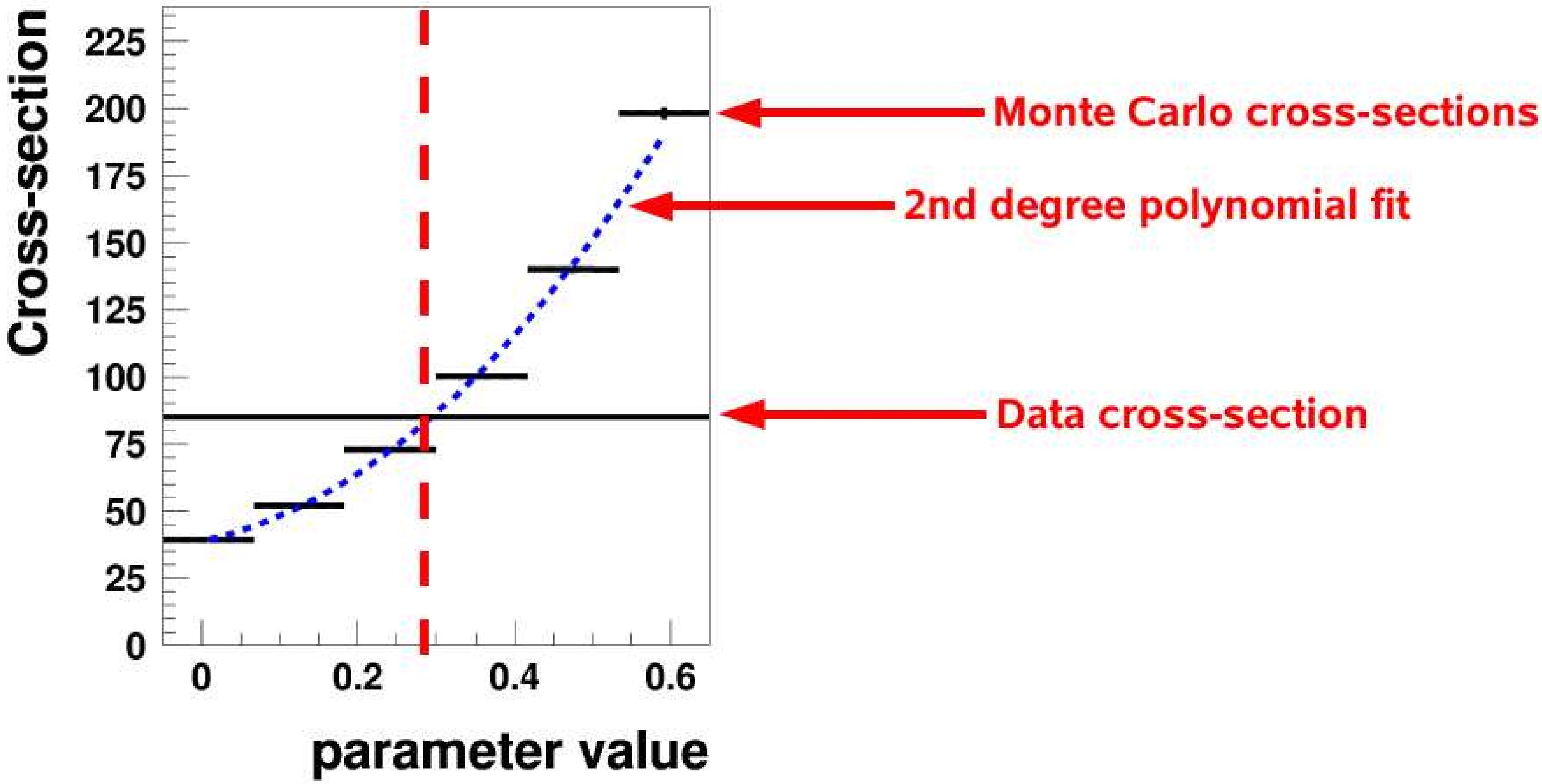
The interpolation formula accounting for correlations:

$$X(p_1, p_2, .., p_n) = A_0 + \sum_{i=1}^{n} B_i p_i + \sum_{i=1}^{n} C_i p_i^2 + \sum_{i=1}^{n-1} \sum_{j=i+i}^{n} D_{ij} p_i p_j + ...$$

- $p_i \longrightarrow$ free parameter $\longleftarrow$ grid
- $X \longrightarrow$ observable at grid points
- Run code to determine $A_0, B_1, ...$
  - MINUIT or use linear algebra (Singular Value Decomposition)$\longrightarrow$ both implemented
- The resulting prediction is then adjusted(MINUIT) to the data $\longrightarrow$ seconds!
- The traditional way $\longrightarrow$ days...

Simple Example

1 parameter, 1 data cross-section

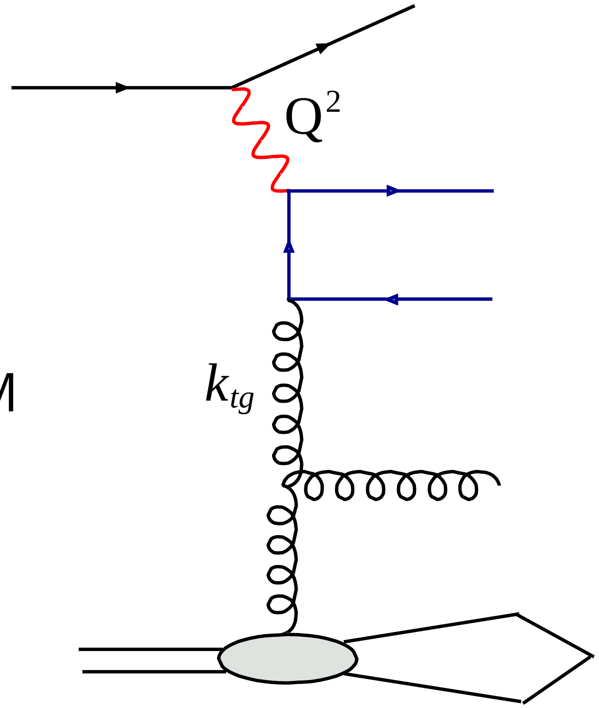


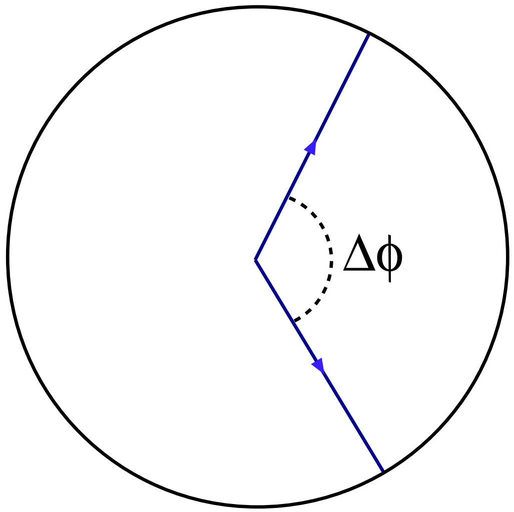
Data-azimuthal decorelation of dijets

M. Hansson(see talk DIS 2006). Generation of events → CASCADE

- Kinematic range
  $5GeV^2 < Q^2 < 100GeV^2$
  $0.1 < y < 0.7$
- Dijet selection $5GeV < E_T$

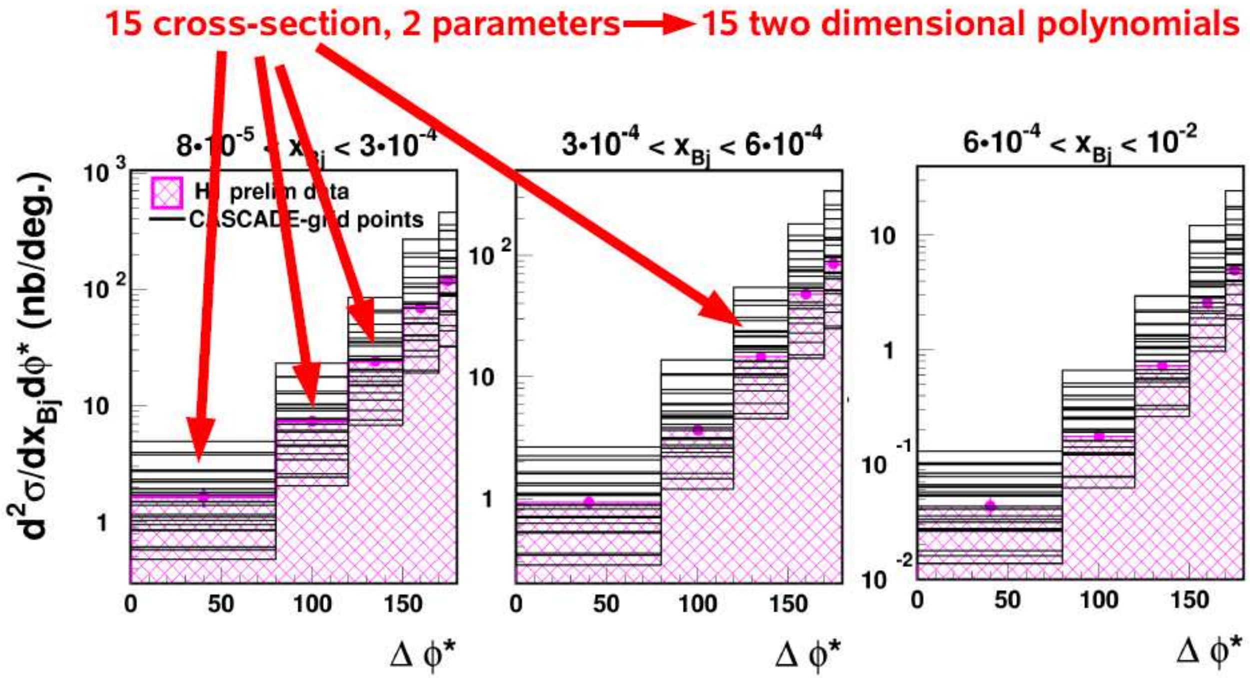
Sensitive to gluons →CCFM



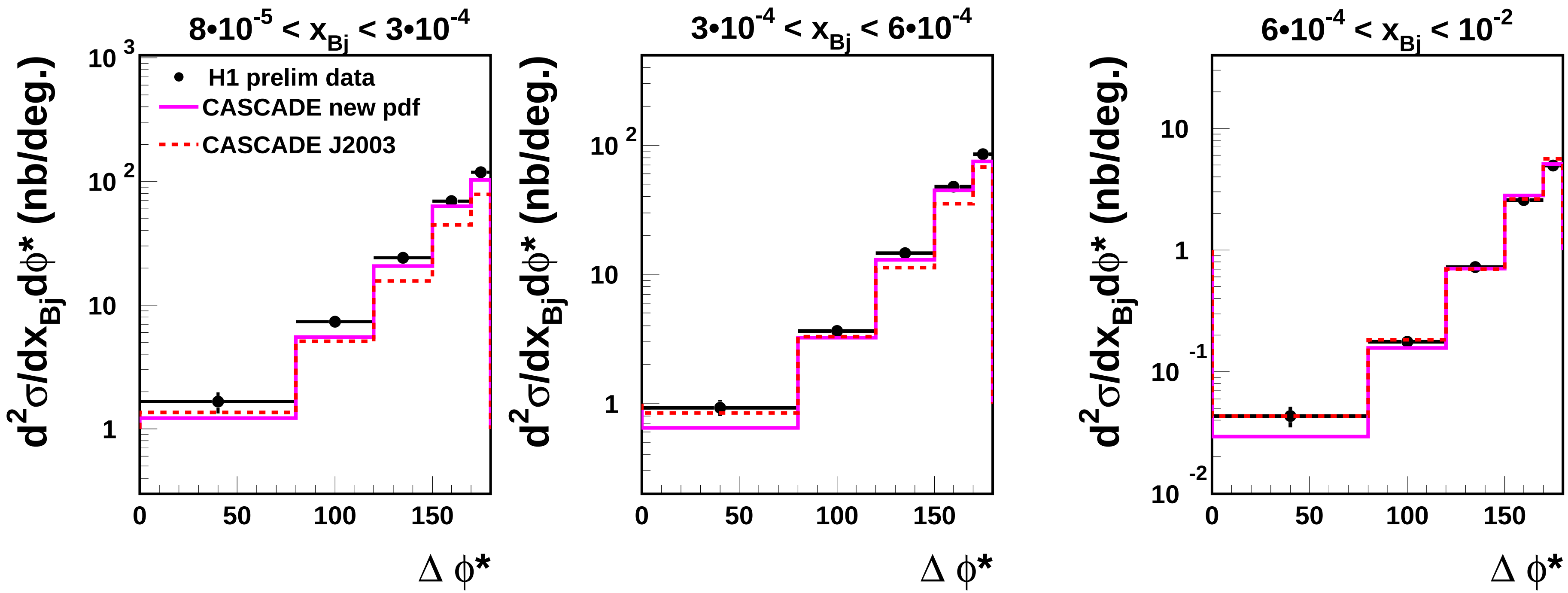


Grid

Example in 2 dimensions...



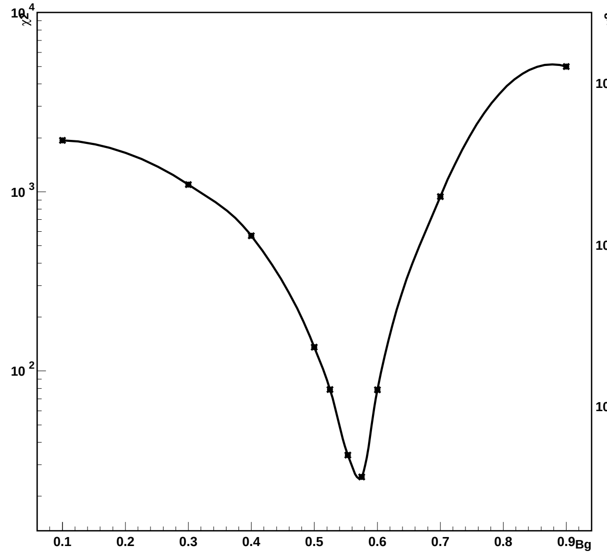
Preliminary results



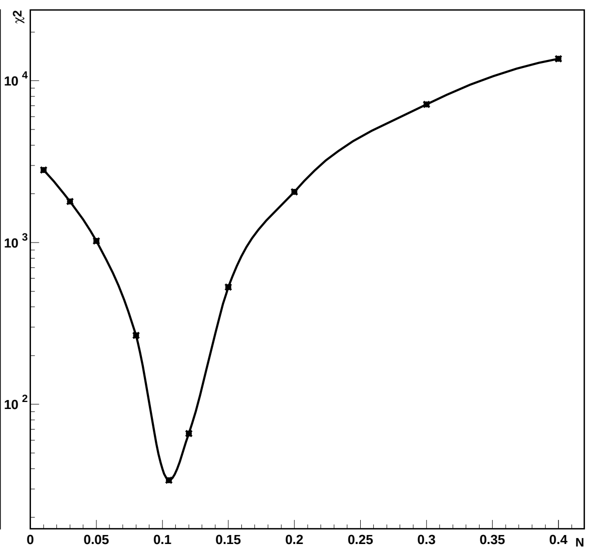
At present $\rightarrow$ $\chi^2 = 2.25,\ N = 0.11,\ B = 0.55,\ \sigma = 1.5,\ \mu = 3.0$

Preliminary results

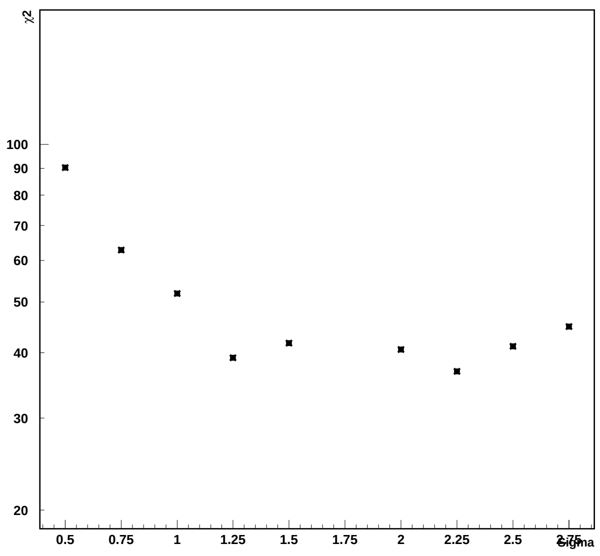
χ2 as a function of bg



χ2 as a function of n



χ2 as a function of sigma



End of part 1

Future developments and outlook

- Application $\longrightarrow$ other MC generators
- Applications to fitting programs based on NLO calculations
- F_2, F_2^c

PDF4MC

Arguments by T. Sjostrand.
Which PDFs to be used in Monte Carlos?
General purpose event generators provide:

$$\sigma(LO) \otimes PDF(LO) \otimes showers$$

Some difficulties:

- LO PDF fits are bad
- no uncertainty for LO PDFs
- PDFs are not obs. $\longrightarrow$ not necessarily positive

Proposed solutions:

- determine new LO PDF by relaxing momentum sum rule (R. Thorne)
- use NLO PDFs for hard process, and LO PDFS for showering
- determine special PDFs: PDF4MC

Strategy

- Fully consistent approach would require doubly unintegrated updfs, limit $\rightarrow k_t$ factorisation, collinear factorisation
- define MCPDFS, depend on generator, parton showers,...
- include all kinematics
- use general fit program

First attempts$\rightarrow$...

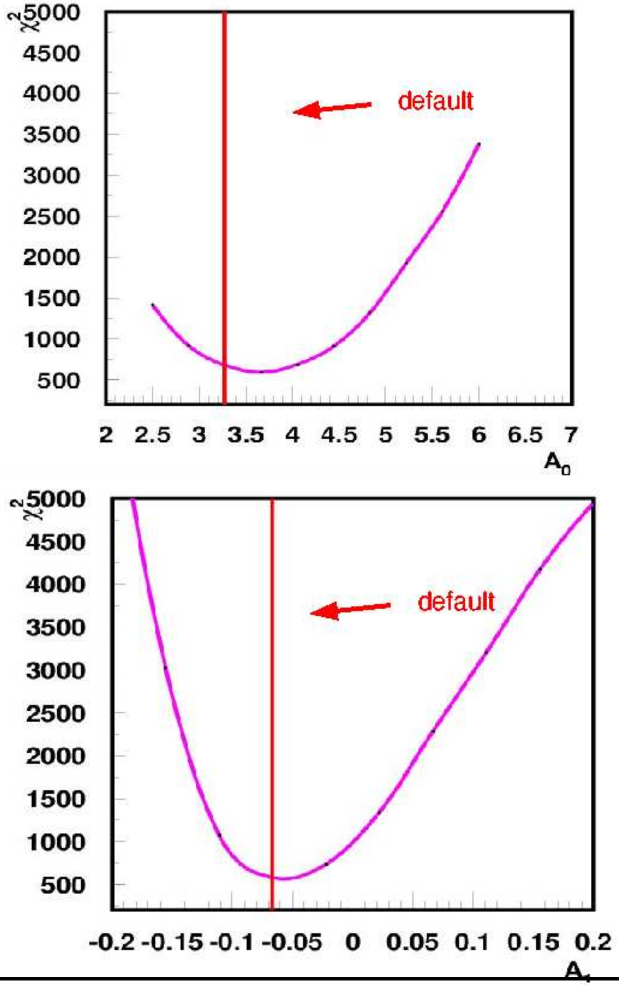
Proof of Concept

- Let us "ask" PYTHIA about optimal parameters for F_2 fit.
- Use CTEQ6L as starting distribution
- Scan different parameters

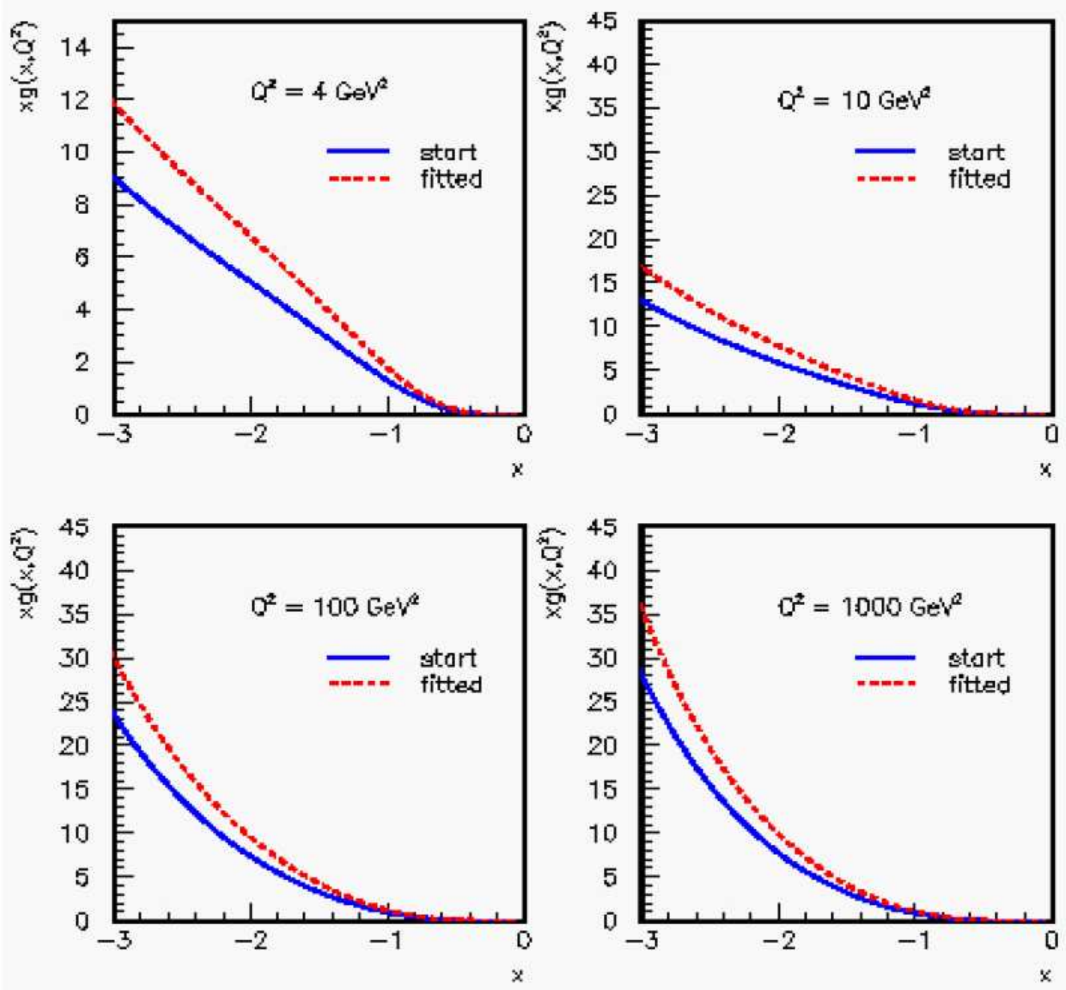
$$xg(x, \mu) \simeq A_0 x^{A_1}$$

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

Prepared by H. Jung$\longrightarrow$



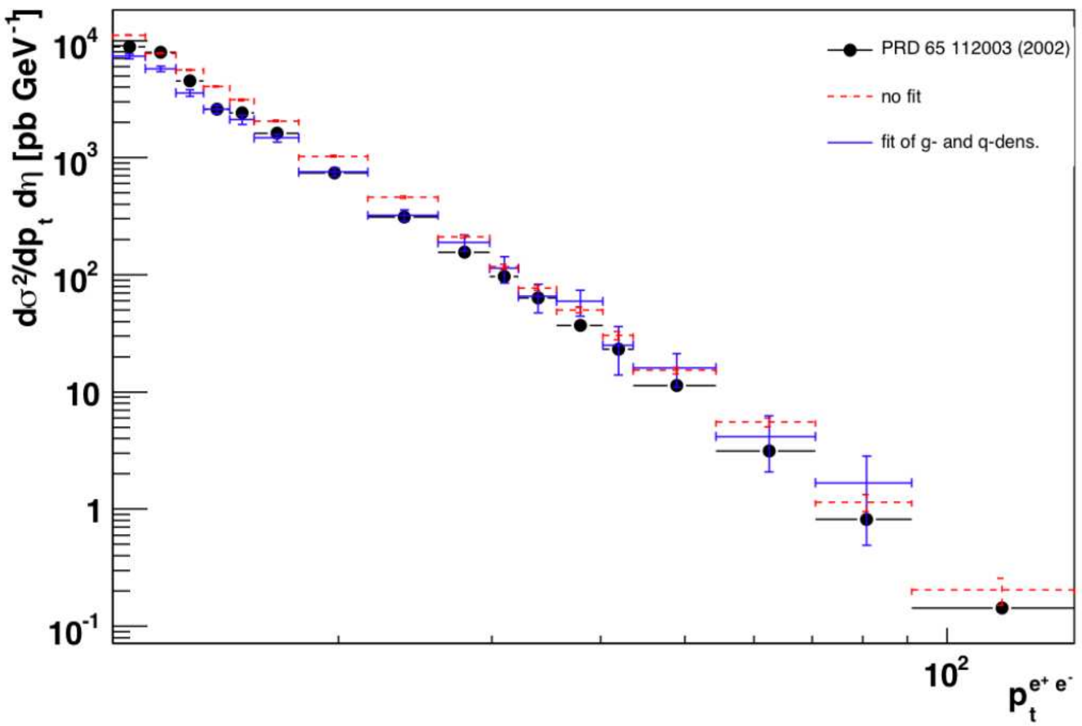
The gluon after fitting



Prompt photon at the Tevatron

Work done by

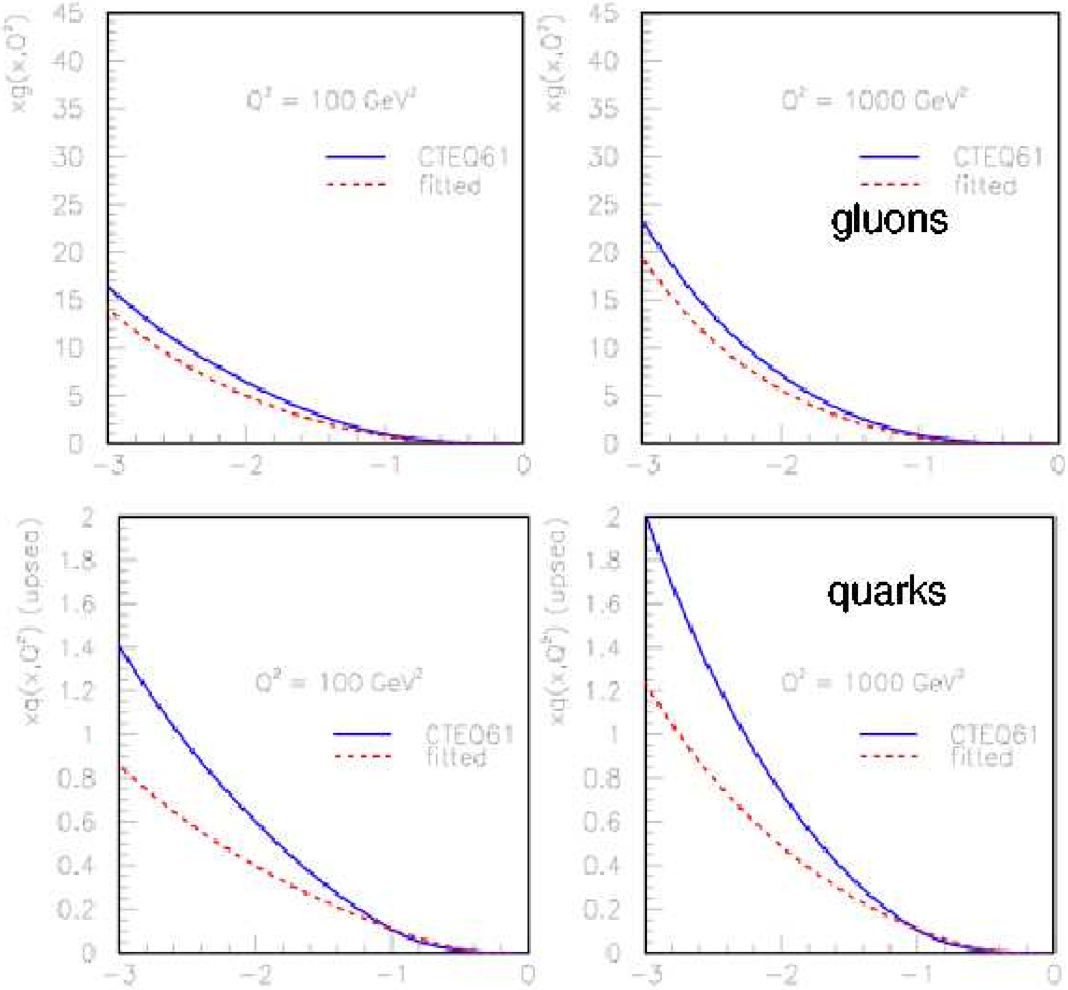
Federico von Samson-Himmelstjerna



PDF from fitting quarks and gluons

PDF from fitting sea quarks and gluons

Work done by Federico von Samson-Himmelstjerna →

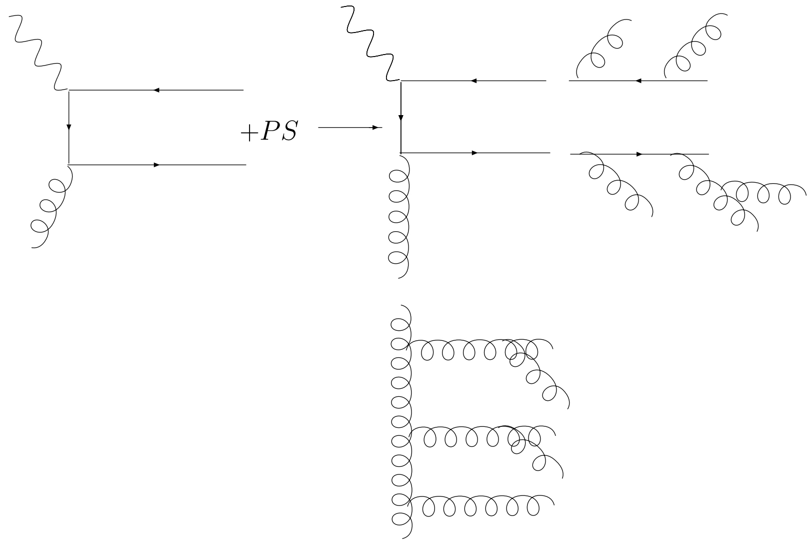


End of part 2

Use of PDF4MC helps to:

- simulate detector better
- includes kinematic effects
- allows to use all order predictions $\longrightarrow$ parton showers
- treat consistently of parton showers
- treat consistently pt cutoffs and other parameters

Backup, kinematic



- incoming/outgoing partons are on mass shell
  $$(\gamma + q)^2 = q'^2$$
  $$-Q^2 + xys = 0 \rightarrow x = Q^2/(ys)$$
- when we take final state radiation into account
  $$(\gamma + q)^2 = q'^2$$
  $$-Q^2 + xys = m^2 \rightarrow x = (Q^2 + m^2)/(ys)$$
- when we take initial state radiation into account
  $$(\gamma + q)^2 = q'^2$$
  $$-Q^2 + xys = q^2 \rightarrow x = (Q^2 - q^2)/(ys)$$

  In LO collinear factorisation it is assumed $q'^2 = q^2$