PDF4LHC-selected slides

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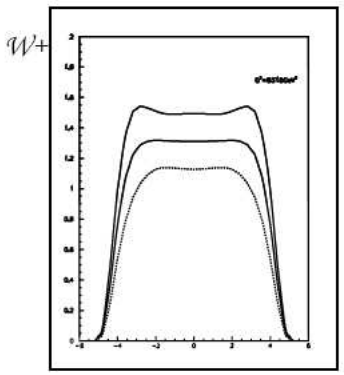
Agenda

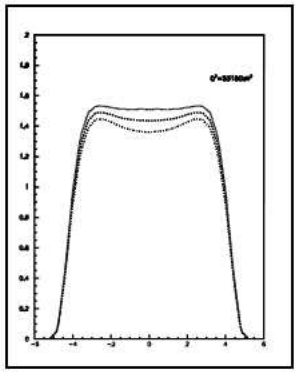
- Needs for and input from first data of the LHC to PDF Determination
- PDF Uncertainties
- PDFs for MC generators

Needs for and input from first data of the LHC to PDF Determination

What do we think is well known: W/Z cross-sections?

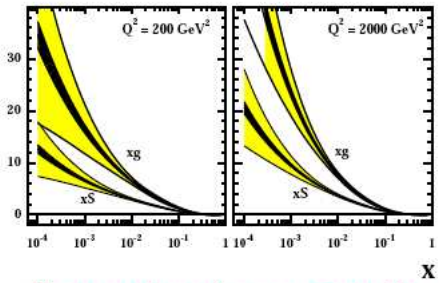


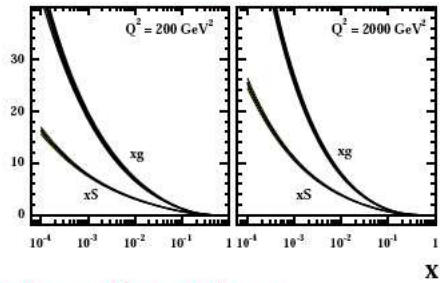
Thanks to HERA they have become better known



Pre-HERA W+/W-/Z rapidity spectra ~ ± 15% uncertainties

Post-HERA W+/W-/Z rapidity spectra ~ ± 5% uncertainties





Tremendous improvement in our knowledge of the low-x glue and sea

At the LHC W/Z are formed by sea-sea parton interactions at low-x

And for Q2~MZ2 the sea is driven by the gluon

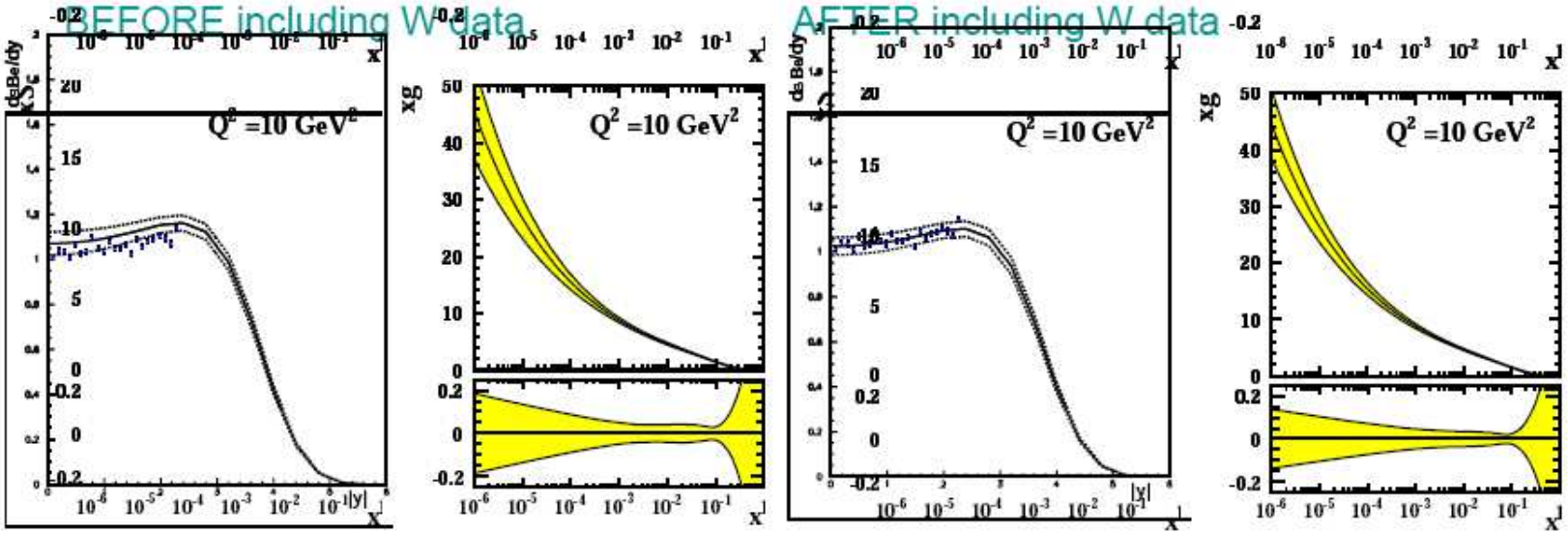
Different predictions from different PDF sets

PDF set	$\sigma_{W+} B_{W\to l\nu}$ (nb)	$\sigma_{W-} B_{W\to l\nu}$ (nb)	$\sigma_{Z} B_{Z\to ll}$ (nb)	
ZEUS-2005	11.87±0.45	8.74±0.31	1.97±0.06	MSTW08?
MRST01	11.61±0.23	8.62±0.16	1.95±0.04	Massive heavy quark treatment
MRST04	11.74	8.71	1.97	
CTEQ65	12.44±0.47	9.12±0.36	2.05±0.08	
CTEQ61	11.61±0.55	8.53±0.43	1.92±0.09	Massless heavy quark treatment
H1 PDF2000	11.98±0.22	8.74±0.15	1.98±0.04	

And what consequences might this have?

Such PDF uncertainties in the jet cross sections compromise the LHC potential for discovery of any new physics which can written as a contact interaction
E.G. Dijet cross section has potential sensitivity to compactification scale of extra dimensions (M_c)

LHC will help to reduce uncertainty



e+ rapidity spectrum and gluon PDF BEFORE these data are included in the PDF fit

e+ rapidity spectrum and gluon PDF AFTER these pseudodata are included in the PDF fit

Gluon PDF uncertainties are reduced

Neural network

Initial scale parametrization of PDFs

Standard Approach

- Introduce a simple functional form with enough (but not too many) free parameters

$$q(x, Q^2) = x^{\alpha}(1-x)^{\beta} P(x; \lambda_1, ..., \lambda_n).$$

- Fit parameters minimizing χ^2.

Open problem:

- Theoretical bias due to the chosen parametrization is difficult to assess.

Neural network

How to avoid Overlearning

Stopping criterion based on Training-Validation separation

- Divide the data in two sets: Training and Validation
- Minimize the χ^2 of the data in the Training set
- Compute the χ^2 for the data in the Validation set
- When validation χ^2 stops decreasing, **STOP** the fit

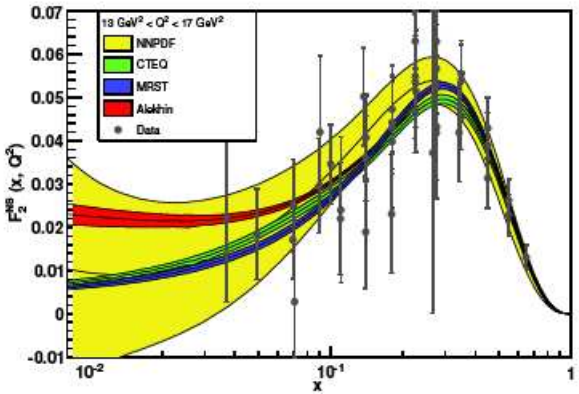
Neural network

Introduction

Might Neural MC methods improve the situation?

Example: F_2^{NS} determination

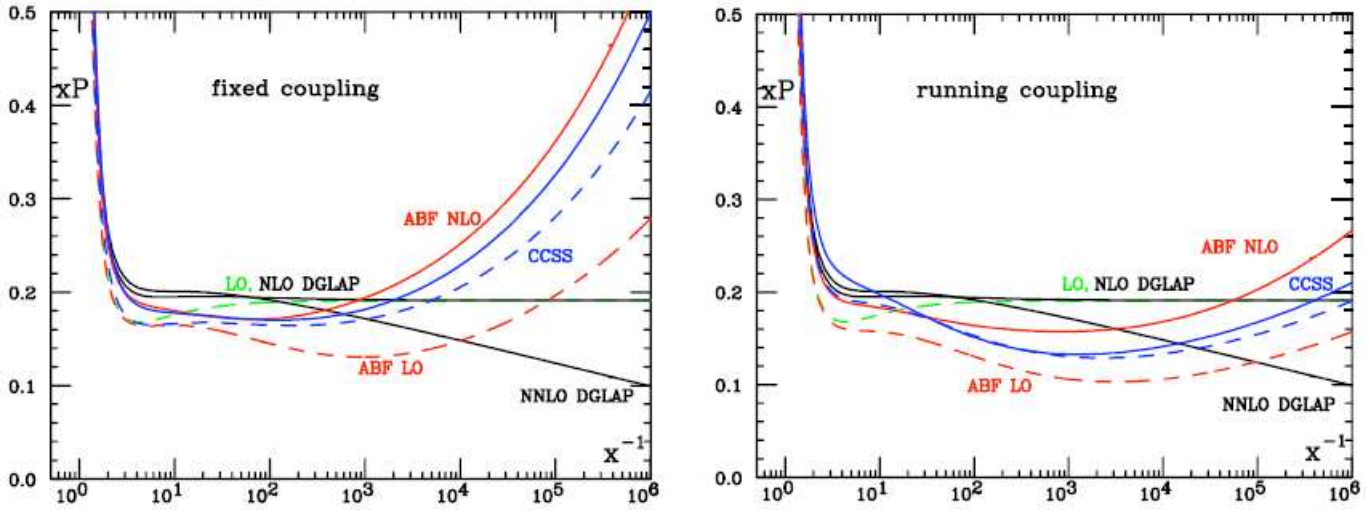
[L. Del Debbio et al., hep-ph/0701127]



- Compatible with results from other PDF determinations (even when they are not in agreement)
- Lager uncertainties both in the
  - Data region (MC error estimation)
  - Extrapolation region (functional form bias)

Small x Resummation

- Gluon splitting function: results are converging



ABF: Altarelli, Ball, Forte

CCSS: Ciafaloni, Colferai, Salam, Stasto

[also Thorne & White]

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

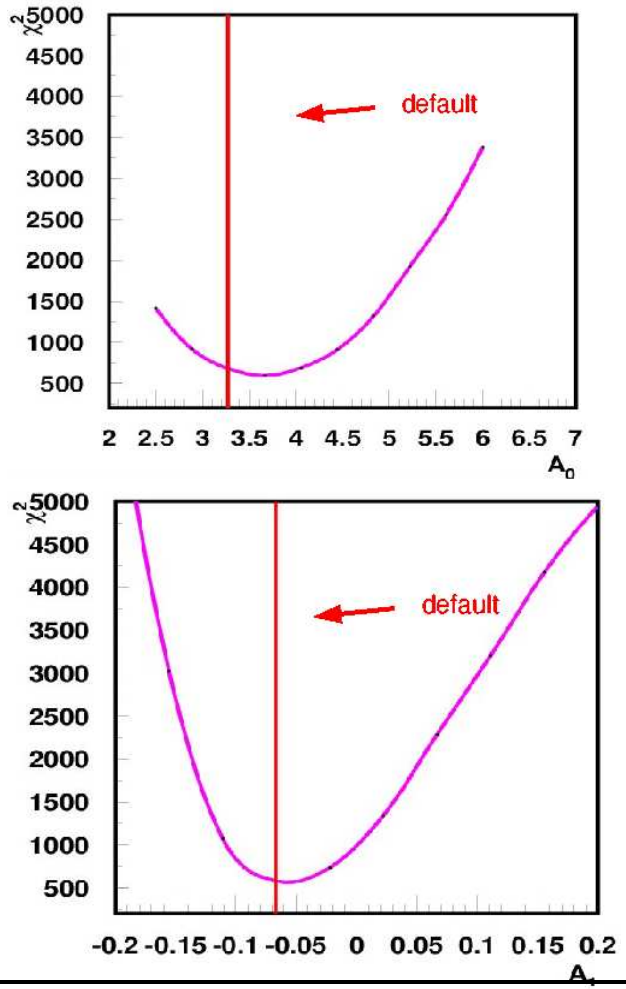
Proof of Concept

- 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→



Doubly-unintegrated PDFs

G.W., Martin, Ryskin [hep-ph/0306169, hep-ph/0309096]

Type of PDF	PDF integrated over	Incoming momentum
Integrated	k^-, $\mathbf{k_t}$	$k = (k^+, 0, \mathbf{0})$
Unintegrated	k^-	$k = (k^+, 0, \mathbf{k_t})$
Doubly-unintegrated	Nothing!	$k = (k^+, k^-, \mathbf{k_t})$

- Doubly-unintegrated PDFs in terms of integrated PDFs from last step of LO DGLAP evolution:

$$f_a(k, \mu^2) \equiv f_a(x, z, k_t^2, \mu^2)$$
$$= T_a(k_t^2, \mu^2) \frac{\alpha_S(k_t^2)}{2\pi} \sum_{b=q,g} P_{ab}(z) \frac{x}{z} b\left(\frac{x}{z}, k_t^2\right)$$
$$+ \text{angular-ordering constraints}$$

- Take input integrated PDFs $b(x/z, k_t^2)$ from MRST 2001 LO.

Comments

- Many more interesting talks
- The address is:
  http://indico.cern.ch/conferenceDisplay.py?confId=27439