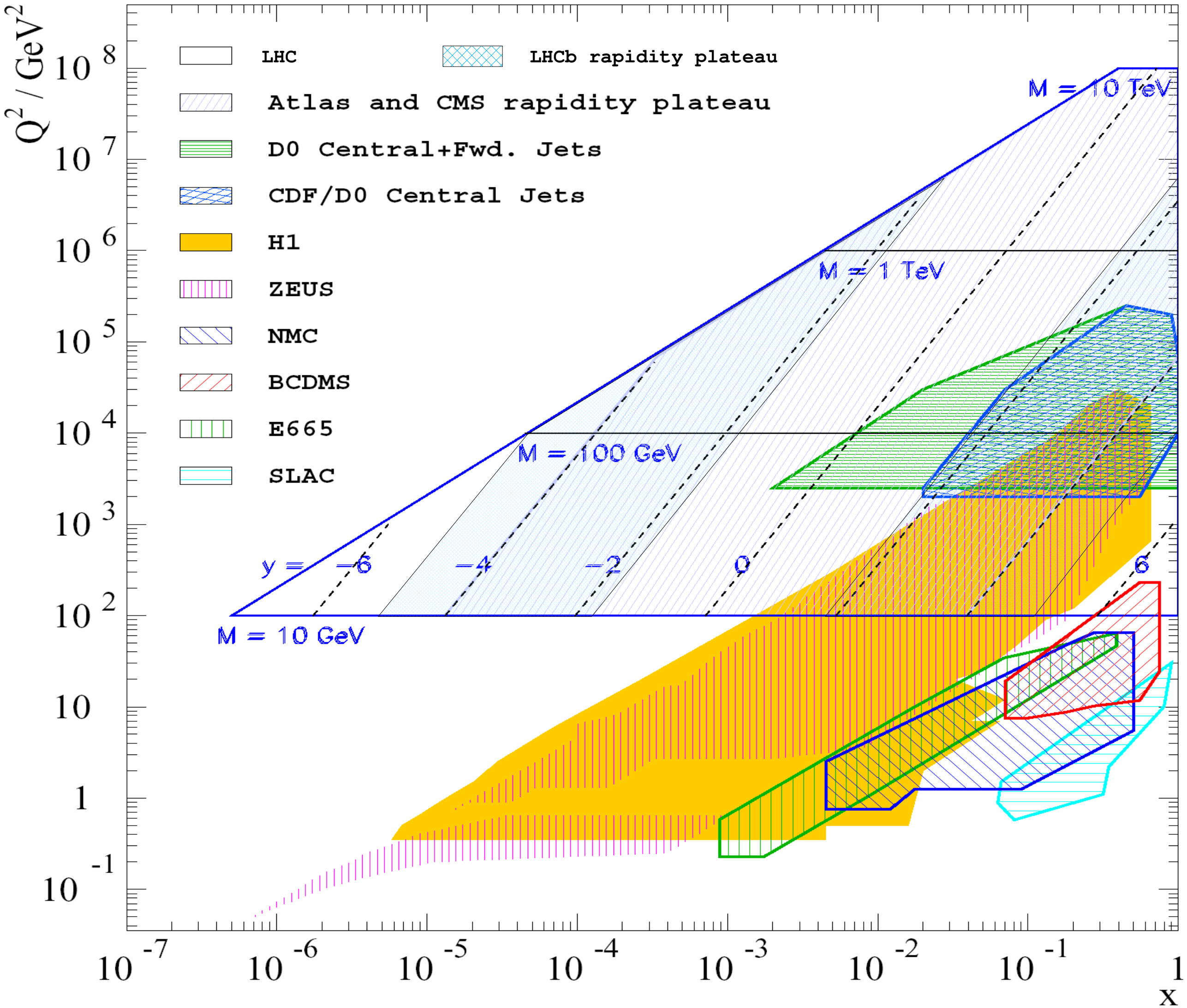
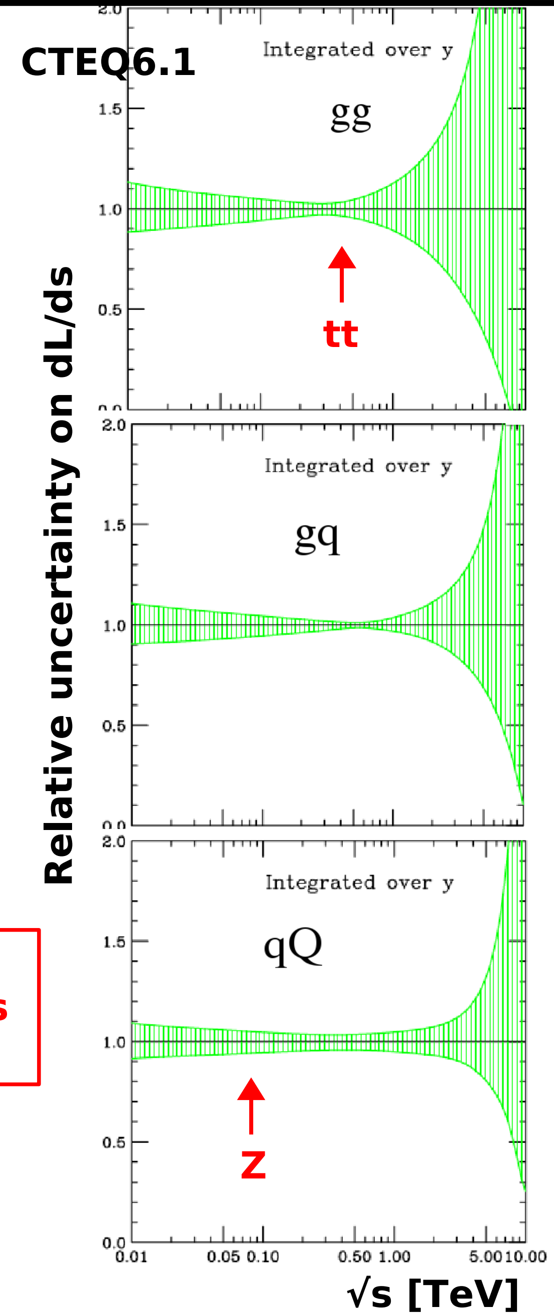


PDF can be constrained by LHC measurements using :
- → Cross-sections and shape of EW or QCD processes
- → Ratios of cross-sections or direct fits of PDF

PDF uncertainties at the LHC

- *Large PDF uncertainties at low & high Q^2*
  dσ/σ > 10 %
- *Error is small for SM processes*
  dσ/σ ~ 5% for W, Z, tt

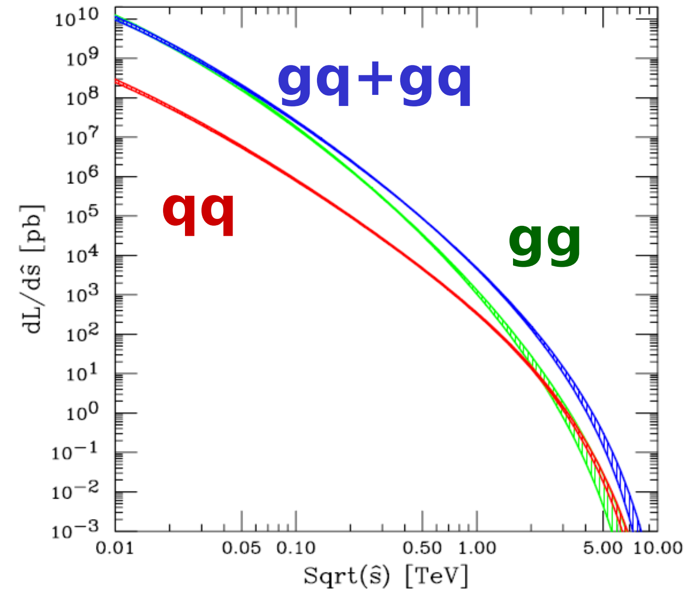
⇨ A high level of precision is needed for theoretical partonic cross-sections and for LHC measurements before starting constraining PDF

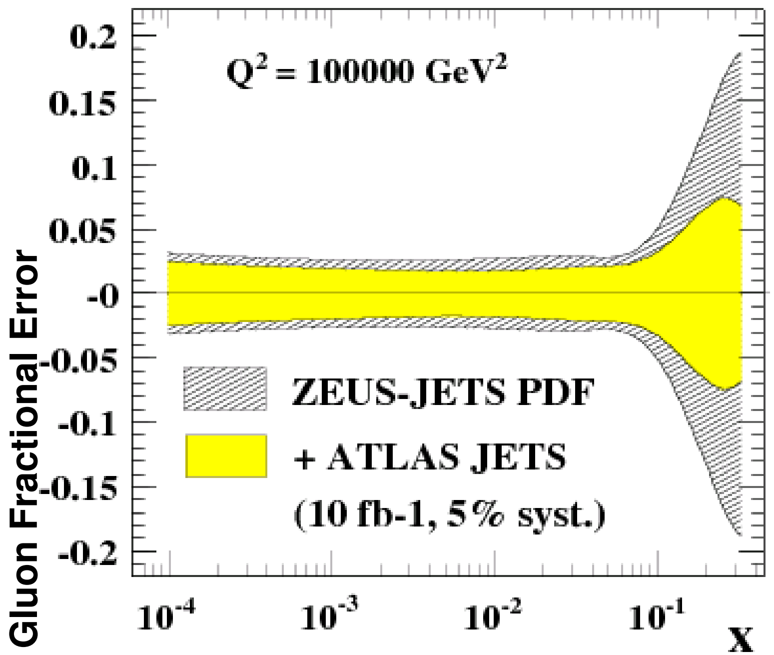


Motivations
- *High cross-section*
  dσ/σ = 1% (stat) @ pT = 2 TeV with 100 fb-1
- *LHC will probe unexplored (x, Q^2) domains*
- *Non-DGLAP evolution sensitivity*
  Forward di-jets

Main issues
- *Minimum-bias and the underlying event*
  Dominated by soft processes
- *Precise jet calibration*
  Δ JES ~ 1% @ 1 TeV

PDF fitting using pseudo-data
- *Assess the potential of LHC data*
  Generate 10 fb^{-1} of di-jet events
  → 1 year at low luminosity
- *Preliminary results*
  LHC data can constrain the high x-gluon
  Small improvement if increasing statistics





PDF constraints with W pseudo-data

Goal

- *Assess the gain in precision of PDF*

  Constrain low-x gluon PDF with LHC data

  Use normalized dσ/dη(l)

  → lower systematics

Simulate real experimental conditions

- *Generate W events*

  500 pb^{-1} → 10^6 events

  Simulate detector & reconstruction effects

- *Measure dσ/dη(l)*

  Add 4% uncertainty for systematics

- *include this data in the global ZEUS PDF fit*

Results on $xg(x) = x^{-\lambda}$

- *Low-x gluon shape parameter λ*

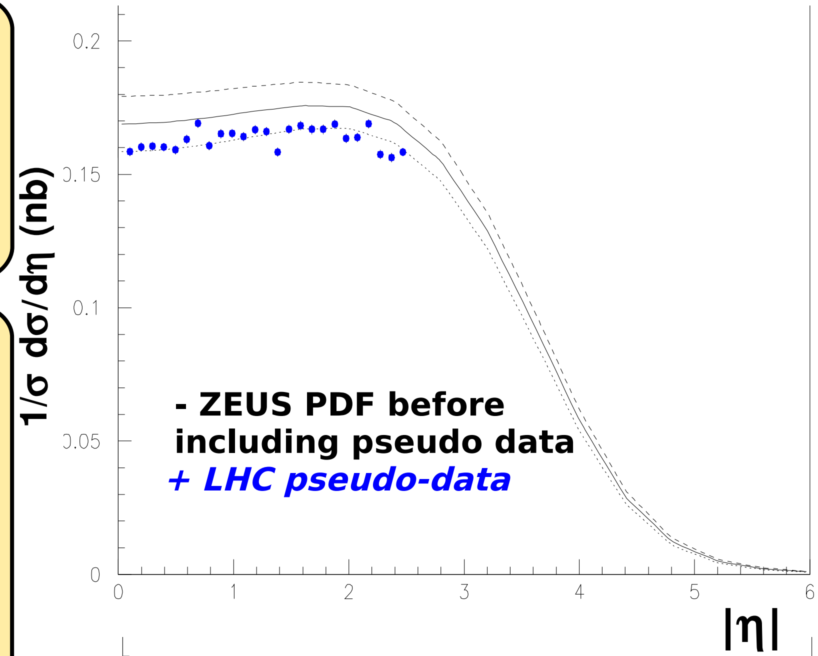
  $\lambda = -0.200\ (46) \rightarrow \lambda = -0.181\ (30)$

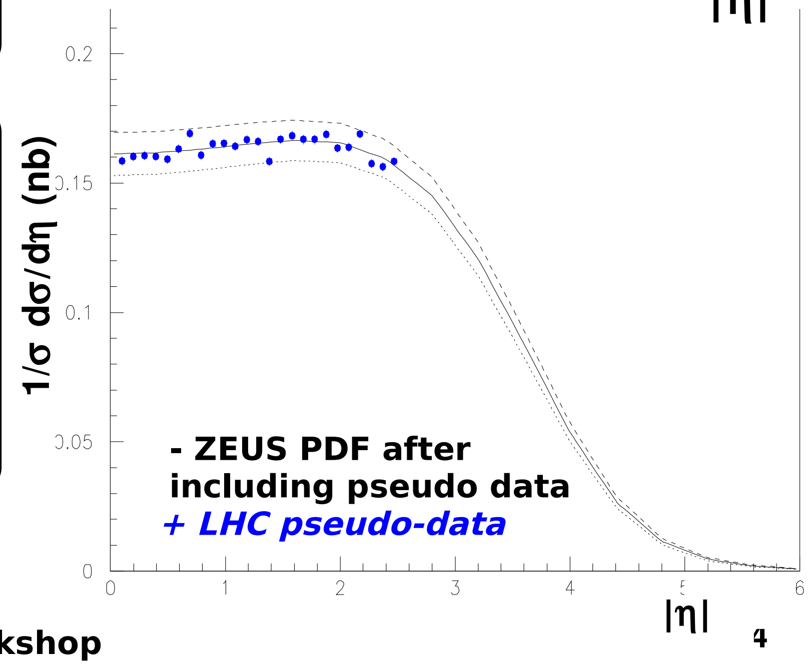
  Mean value is shifted

  Uncertainty is reduced by -41%

- *New PDF uncertainties on dσ/dη(l)*

  Still much larger than experimental errors

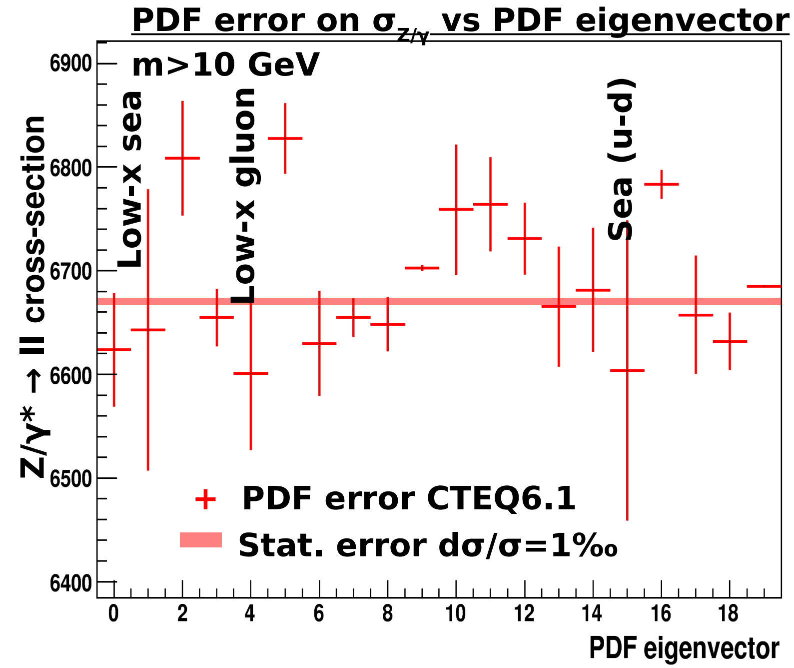




PDF constraints with Z cross-section

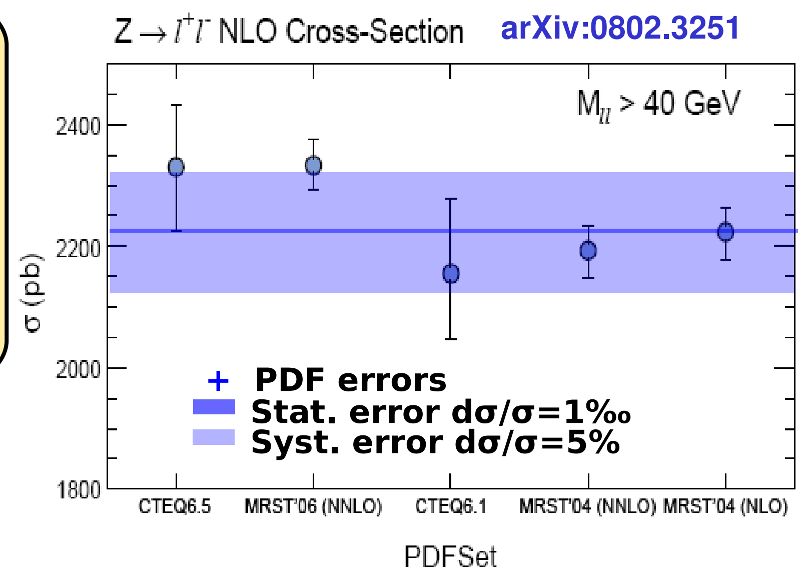
LHC will explore low-x partons

- *(x, Q^2) parameters covered with 1 fb^{-1}*
  - $10 < Q \lesssim 300$ GeV
  - $\rightarrow 3.10^{-4} < x < 0.1$
- *Main contributions of PDF uncertainties at LO*
  - Low-x sea quarks
  - Low-x gluon
  - Difference between sea u & d quarks



PDF constraints with Z data

- *Constraints within models*
  - Sea & gluon free parameters in PDFs
- *Constraints between different PDF modelling*
  - Low-Q^2 functionnal form
  - Evolution of PDF with scale



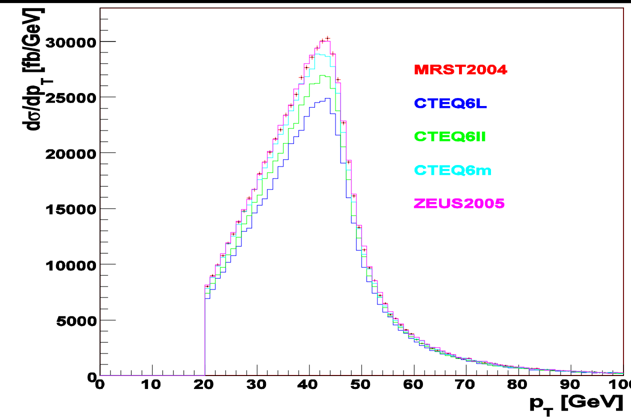
Reduction of acceptance uncertainties on Z cross-section with prior PDF constraints

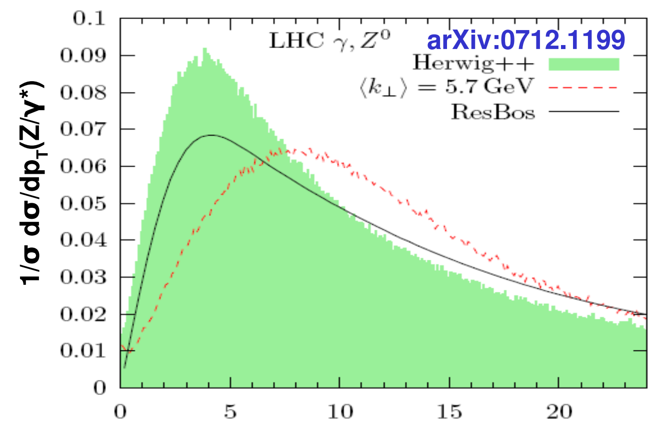
Reduction of acceptance uncertainties

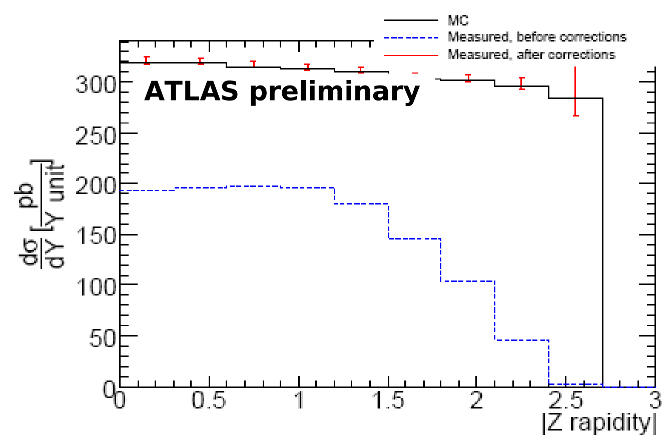
- ***p_T (l) measurements***
  Sensitivity to PDFs diluted
- ***p_T (Z/γ^*) measurements***
  Helps to constrain universal model of non-perturbative soft gluon radiation
  → sensitivity to PDFs
- ***y(Z/γ^*) measurements***
  Sensitivity in the high-y region (high & low x)
  → sensitivity to PDFs
  Limitations by detector acceptance

Other measurements that constrain PDF

- ***$d\sigma/dM(Z/\gamma^*)$***
  Sensitivity to low-x & $Q^2 < 200^2 GeV^2$ regions
  $Q^2 < 200^2$ GeV^2 → x<0.1
- ***Asymmetry A_{FB}***
  Need to estimate the quark & antiquark directions
  Experimental systematic errors are reduced







Cross-normalizing experiments

Problematics

- *Reduction of experimental uncertainties*

$$\sigma^{exp} = \frac{N}{L\,.\,\varepsilon} \qquad \frac{d\sigma}{\sigma} = \frac{dN}{N} \oplus \frac{dL}{L} \oplus \frac{d\varepsilon}{\varepsilon}$$

Statistical errors

Luminosity measurement

Acceptance & selection efficiencies

Measurement of ratios

- *Correlated uncertainties cancel*

$$R = \frac{\sigma}{\sigma^{ref}} = \frac{N}{L\,.\,\varepsilon} / \frac{N^{ref}}{L\,.\,\varepsilon^{ref}} \qquad \frac{dR}{R} = \frac{dN}{N} \oplus \frac{dN^{ref}}{N^{ref}} \oplus 0 \oplus \frac{d(\varepsilon/\varepsilon^{ref})}{\varepsilon/\varepsilon^{ref}}$$

No luminosity uncertainty

Additionnal terms from the reference measurement

→ larger uncertainty if uncorrelated systematics

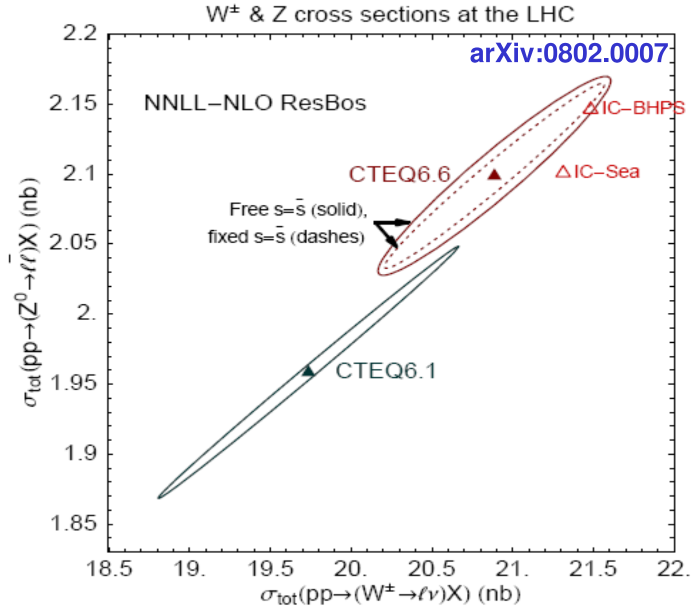
Global variables

- *Shape of distributions (mean values, RMS, ...)*
- *Fits of distributions*

PDF constraints with σ_W/σ_Z

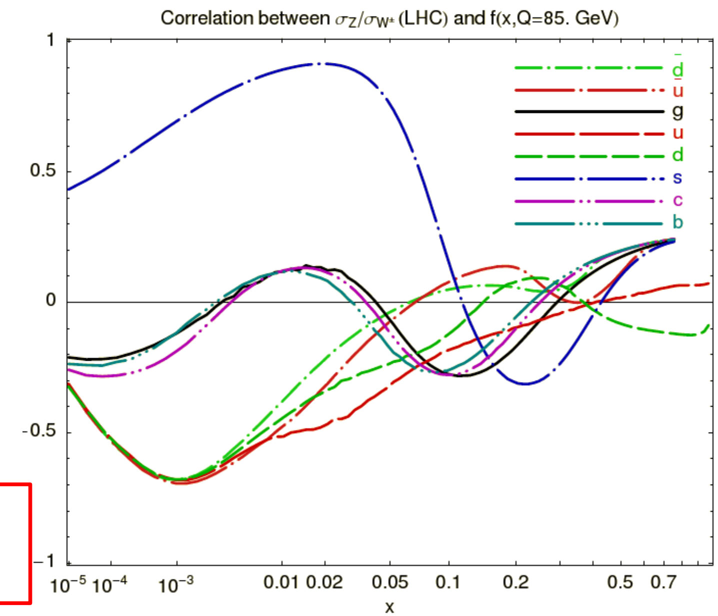
Motivations

- ***Similar selection procedure***
  - **1, 2 isolated leptons**
  - **~ Same pT range**
  - **Can be selected using same trigger**
- ***LO partonic process***
  - **Quark initial state; singlet final state**
  - **Similar QCD corrections**
- ***Behave similarly under PDF variations***
  - **~ Same x, Q^2**
  - **Initial partons mainly from sea**

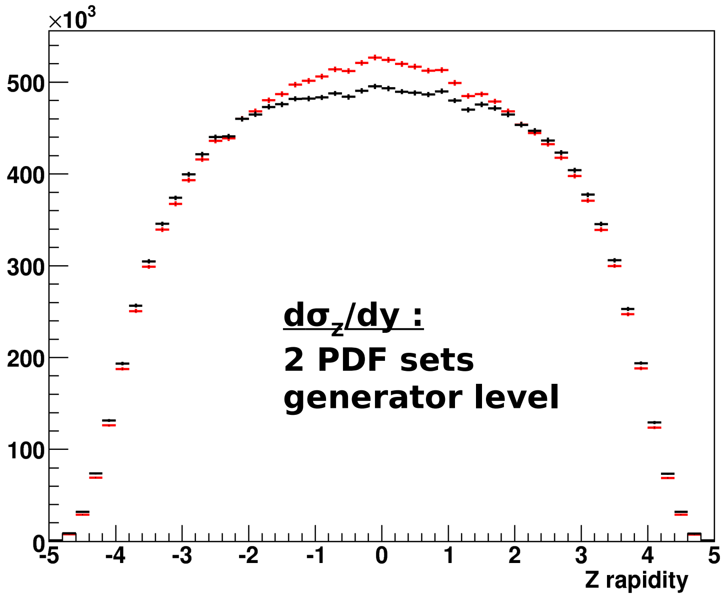


Remaining PDF uncertainties

- ***Mostly due to strange PDF***
  - **increases x3 compared to CTEQ6.1 as a result of free strangeness in CTEQ6.6**



Measurements of σ_W/σ_Z imposes strong constraints on strange quark parametrisation



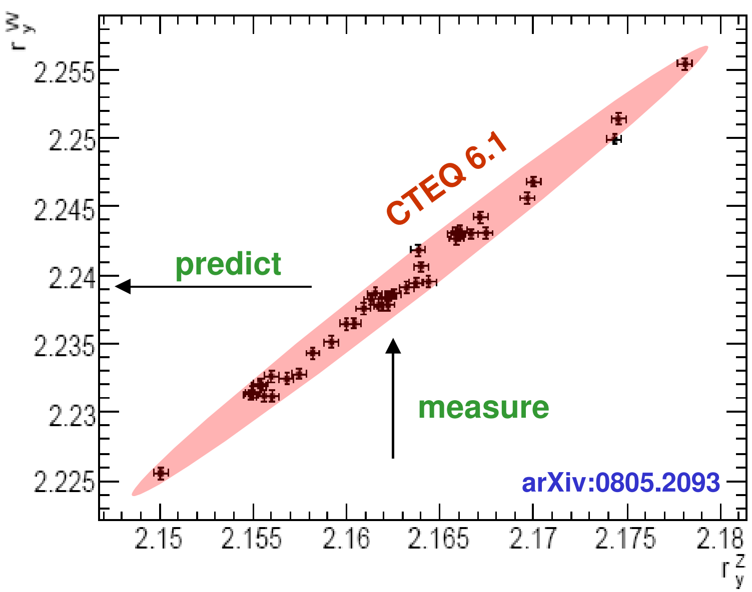
W & Z rapidity distributions

- ***Estimate the width with RMS ($y_{W,Z}$)***

- ***Strong correlation***

  Compare RMS (y_W) and RMS (y_Z)

  → Make ratios RMS(y_W)/RMS (y_Z)



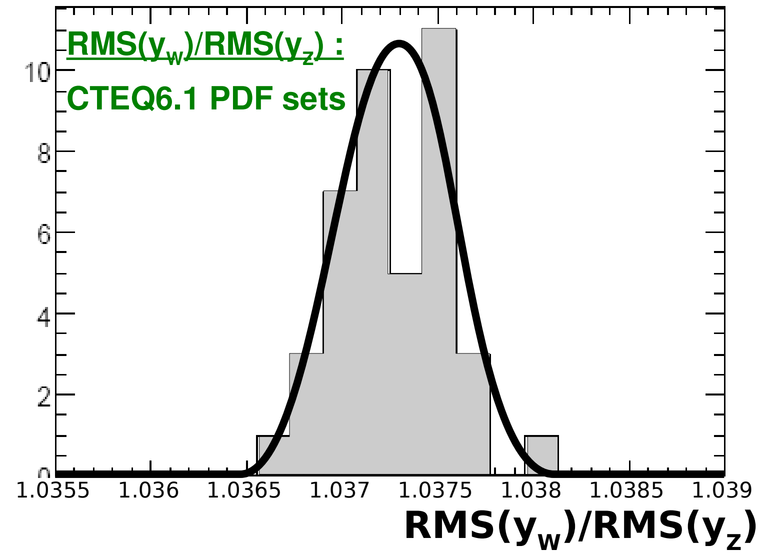
PDF constraints with RMS of $d\sigma_z/dy$

RMS ratios

- ***Precise prediction***

  Spread of RMS : 7.10^{-3}

  Spread of RMS ratio : 7.10^{-4}



Comparisons between different PDF sets

- ***Different theoretical frameworks***

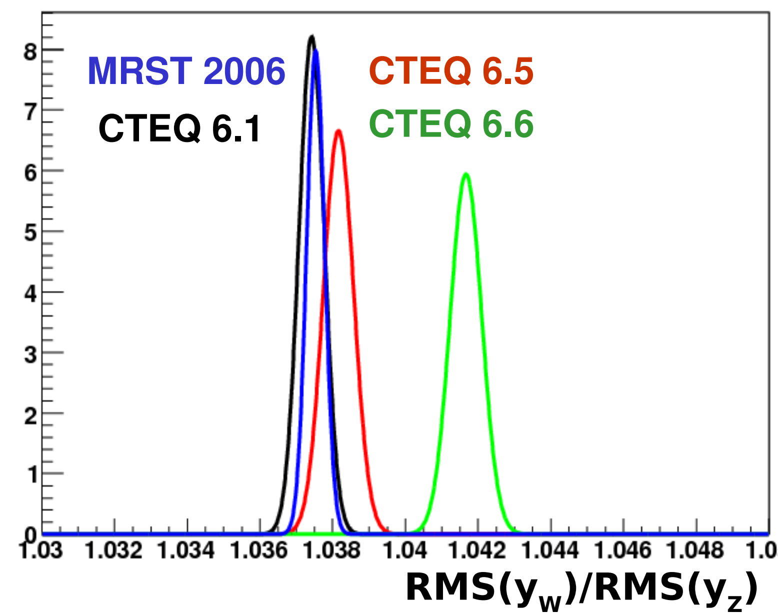
  LO, NLO or heavy quarks treatment

  → compatible predictions

- ***Different starting assumptions***

  Parametrization on s(x)

  → uncompatible predictions



⇒ **What is the validity of underlying hypotheses on PDF parametrizations ?**