Impact of the PDF uncertainties on the eXtra-Dimensions sensitivity using di-jets cross section at LHC

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- Introduction: motivation from eXtra-Dimensions
- Sensitivity to the XD model
- Dijets cross section uncertainties calculation
- Standard Model prediction zone
- PDF uncertainties ingredients
- Impact of the PDF uncertainties
- Conclusion

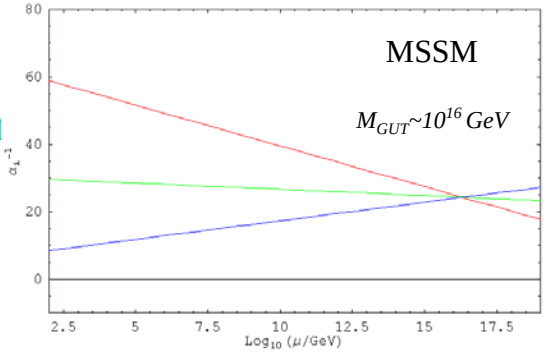
Introduction: motivations from eXtra-Dimensions (XD)

Hierarchy problem:

- EW symmetry breaking scale ~ 10^2 GeV
- GUT scale ~ 10^{16} GeV
- Planck scale ~ 10^{19} GeV

Alternative:

1 fondamental scale: ~ few tens TeV and 1+3+δ time-space structu

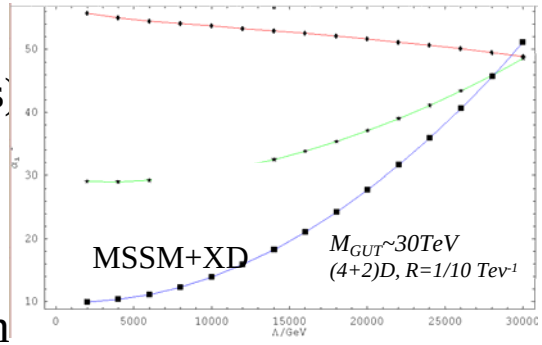


Parameters: number of extra-dimensions δ
(large?) compactification scale Mc

Phenomenological aspects;

- Possibility to produce Gravitons at LHC: (low Planck scale)
- Kaluza Klein (KK)excitations: (δ compactified extra dimensions)
- *Violation of the expected (MS)SM evolution behavior of* $\alpha_{em,w,s}$

(E. Dudas, R. Dienes, T. Ghergetta, hep/ph9803466 and hep/ph9807522)

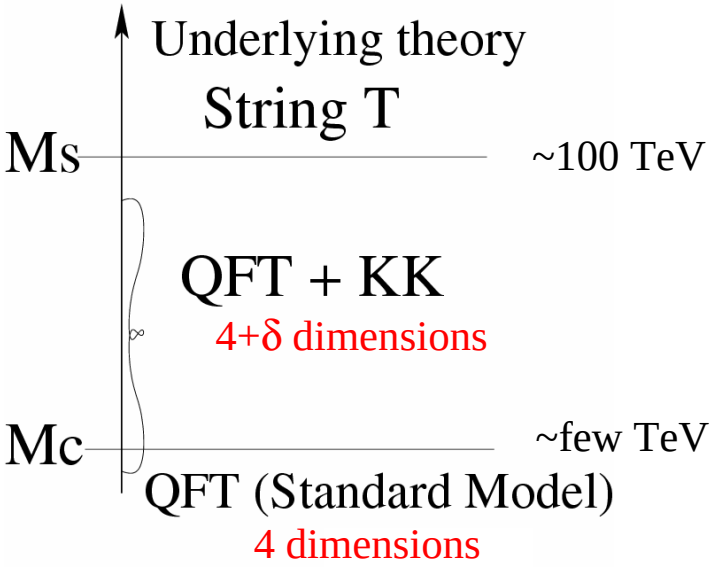


Our Analysis, Evolution of α_s by measuring di-jets cross section on a large energy range

Introduction: eXtra-Dimensions model

Theoritical calculation of cross section:

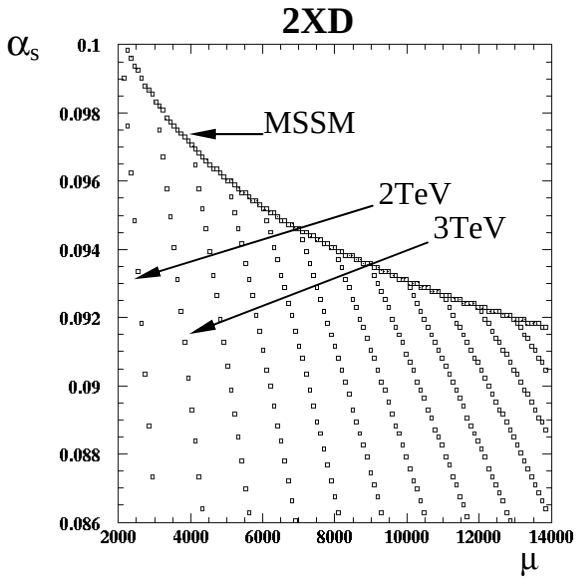
- all the fondamental scales are close to EW scale
- underlying theory approached by a QFT
- KK excitations included only in α_s running
- running of α_s in given by E. Dudas *et al*



Hypothesis;

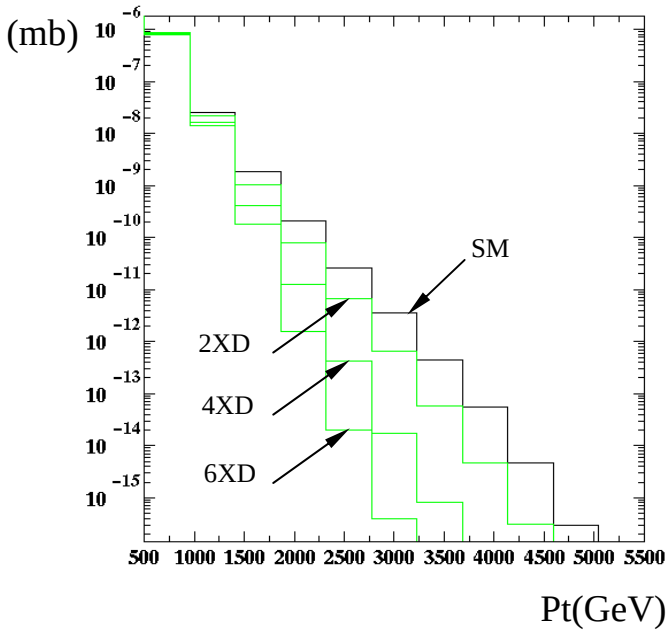
di-jets cross section in the XD regime is a continuity of the Standard Model one with new αs running:

$$\frac{d\sigma^{XD}}{dM_{JJ}} = \frac{d\sigma}{dM_{JJ}}\left(\alpha_S^{XD}\right)$$

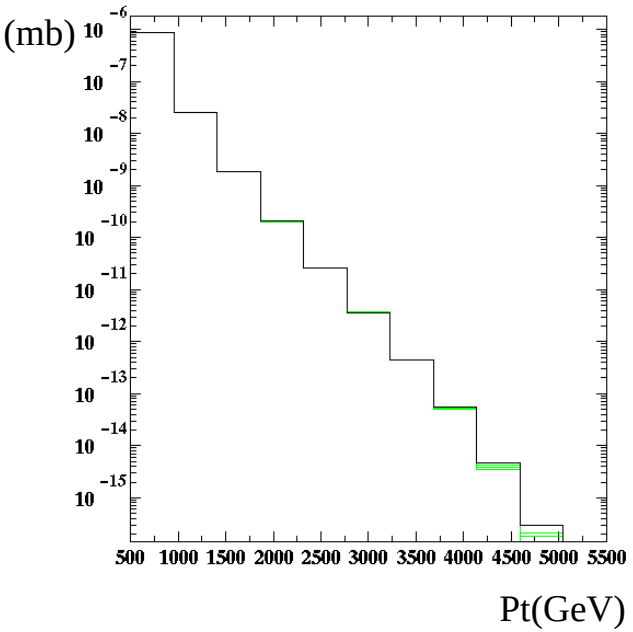


Sensitivity to eXtra-Dimensions

Mc= 2 TeV



Mc= 8 TeV



Sensitivity to XD at LHC

C.Balazs, B. Laforge [Phys. Lett. B 525 (2002) 219-224]

$$S = \frac{NSM - NXD}{\sqrt{NSM}}$$

Sensitivity to XD until 5 TeV in compactification scale (fixed at 5σ)

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Dijets cross section uncertainties calculation

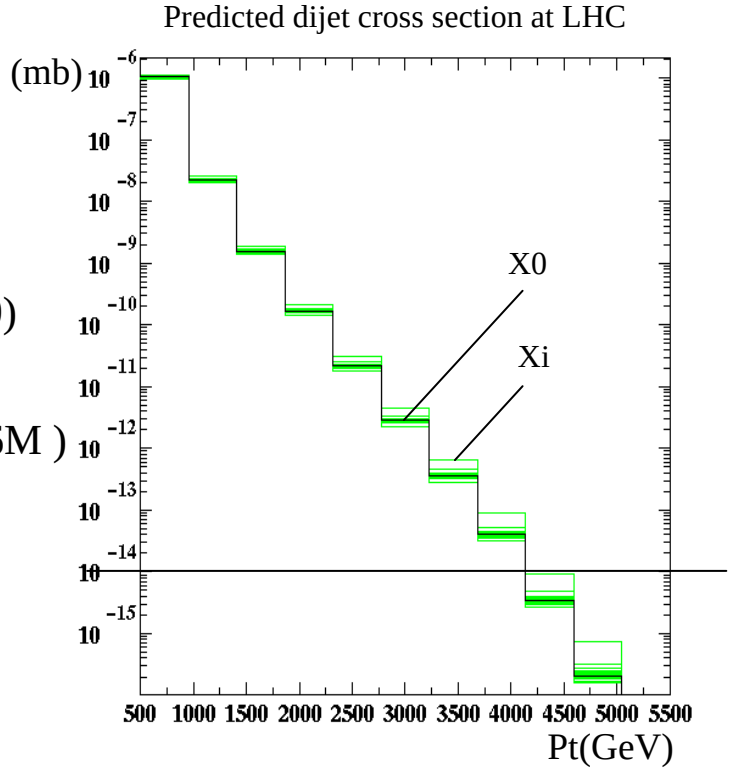
- CTEQ6M is used with 40 other *error* PDFs to compute di-jets uncertainties
- CTEQ6M and error PDFs are fixed as follow:

  - fit data with 20 PDF parameters and built nominal PDF CTEQ6M for the central values

$$\chi^2/N = 1954/1811$$

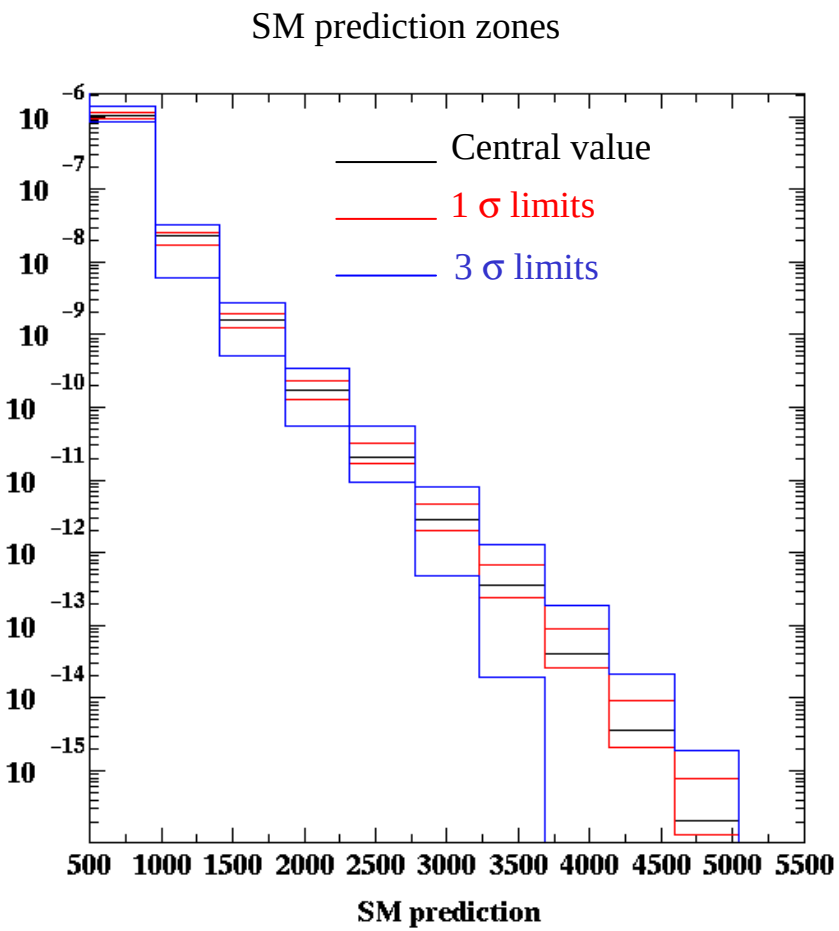
  - Increase the global χ^2 by 100 for the 1811 data point and get the error matrix
  - Diagonalization of the matrix error to obtain 20 eigenvector parameters
  - excursion, up and down, for every eigenvector. 40 sets of parameters
  - for every set of new parameters, built an error PDF (40 error PDFs)

S_i: error PDF (corresponding to int(i/2) eigenvector, i=1 to 40)
$X(S_i)$: error PDF dependant dijet cross section
X_0: predicted dijet cross section (computed with CTEQ6M)
$\Delta X_i = X_i - X_0$



PDF uncertainties: Standard Model prediction zone

Quadratic summation

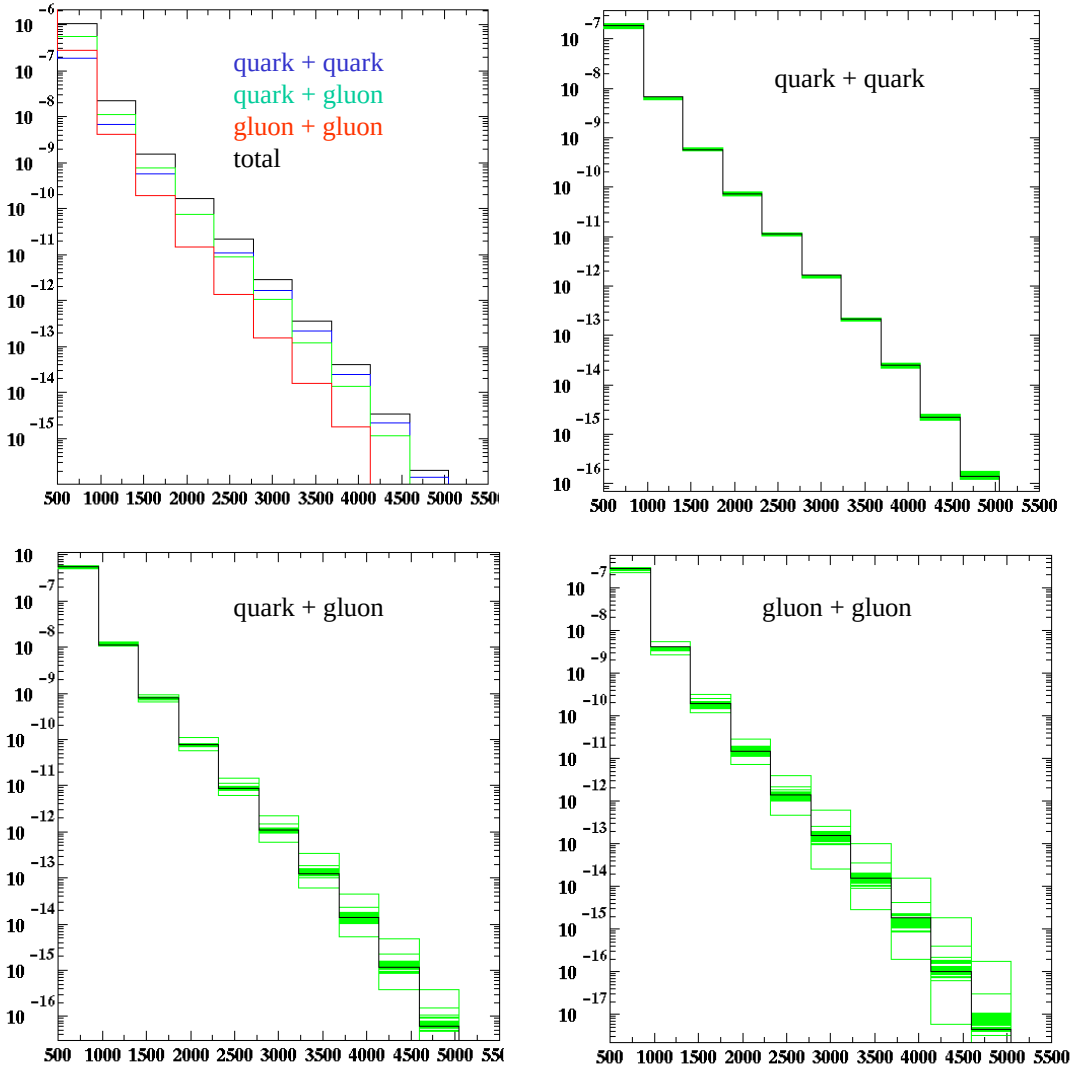


Standard Model prediction zone:

zone where every measured cross section can be explained by a PDF fit, and *every power of discovering new physics is killed and absorbed by the PDF fit*

PDF uncertainties: quarks and gluon PDFs uncertanties

Parton + parton to di-jets cross sections



➔ Gluon PDF is responsible of big uncertainty of cross section prediction

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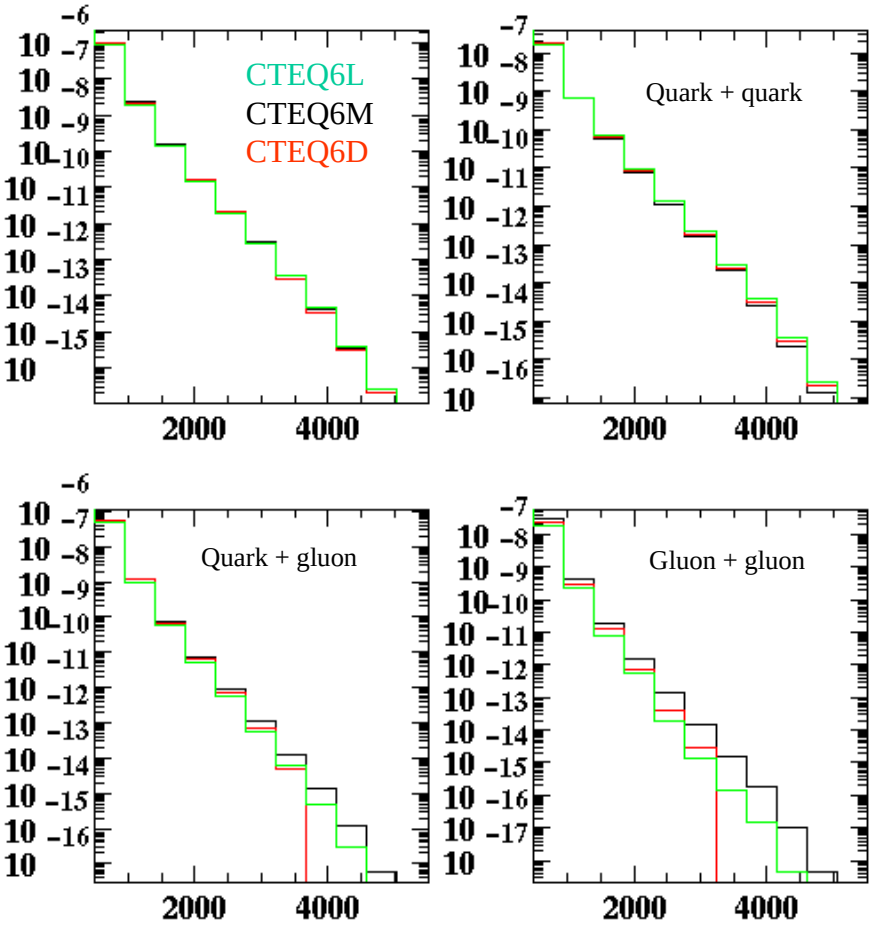
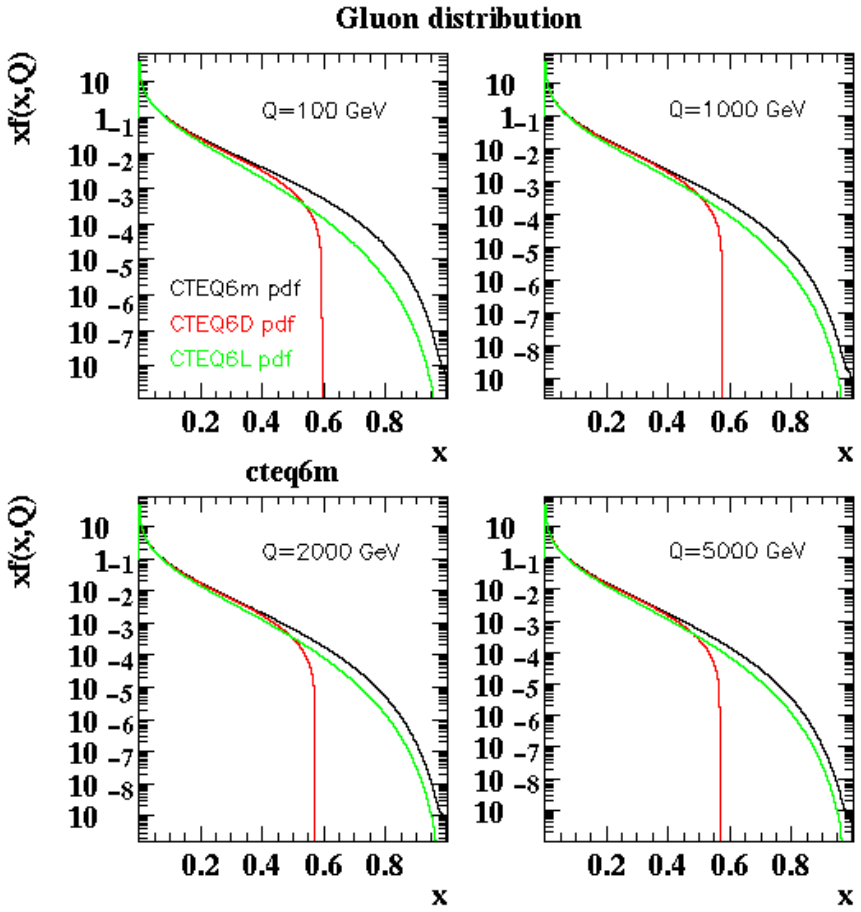
PDF uncertainties: LO, NLO and DIS cross section predictions



- CTEQ6L predictions:
  - Lower gluon at high x than CTEQ6M
  - higher quark at high x than CTEQ6M
  - same total cross section
- CTEQ6L within CTEQ6M errors
- CTEQ6D:
  no gluon prediction at high x

➔Gluon PDF uncertainties are also seen trough CTEQ6 L, M and D desagreement

PDF uncertainties: Gluon density function

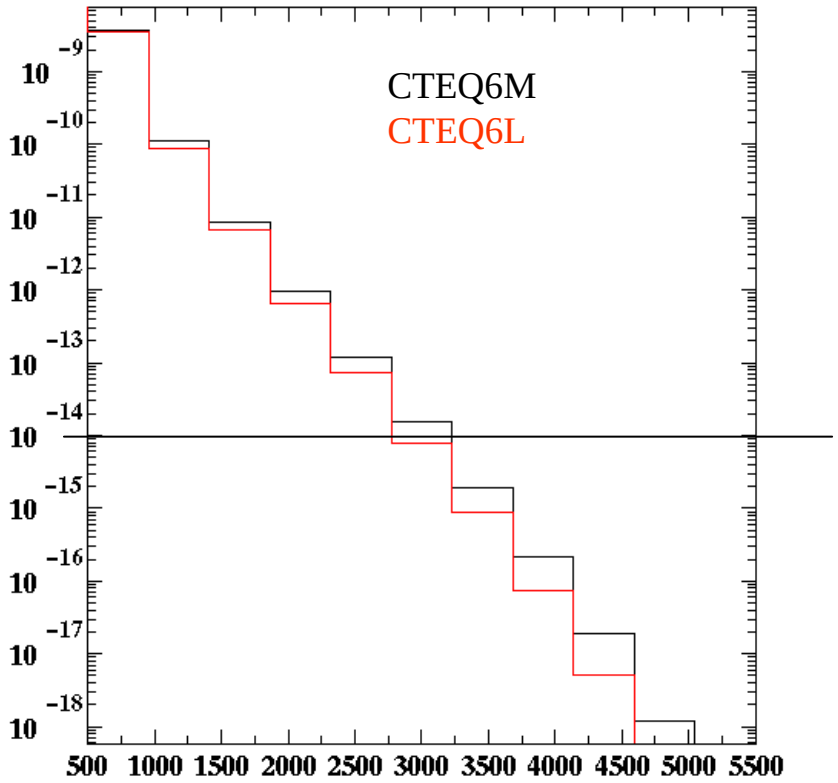


- L gluon is smaller than the M gluon at high x
- D high x gluon is poorly determined quantity. It is not used in following

➔ **Gluon high x distribution is not quite constrained in the PDF fits**

PDF uncertainties: exemple of data to constrain gluon PDF

Boson + jet cross section



To investigate:

➔We can reduce gluon uncertainties by measuring

gluon+quark ---> boson + jet cross section at LHC

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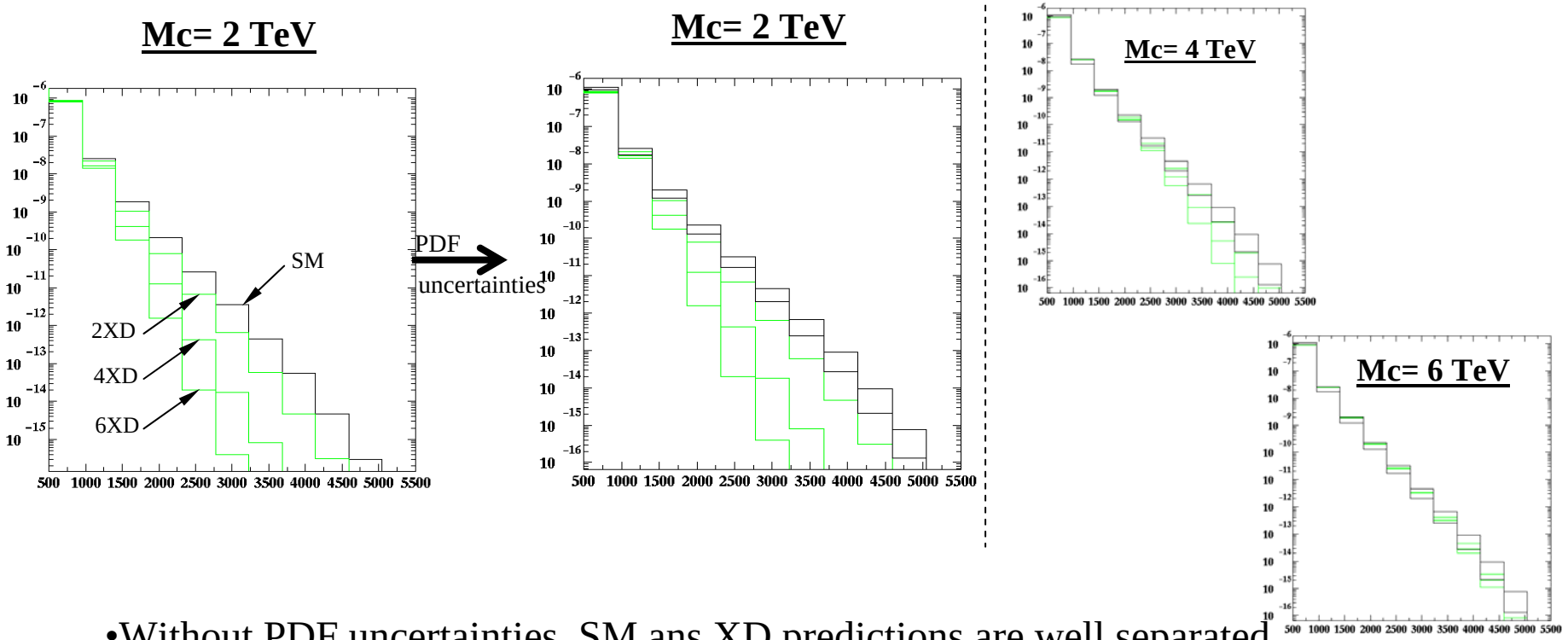
Impact of PDF uncertainties (I)

- XD parameters: N_{XD} and M_C (number of XD and compactification scale)



- Without PDF uncertainties, SM ans XD predictions are well separated
- With PDF uncertainties Standard Model prediction become band
- By increasing Mc, some of the XD predictions fall into the SM band
- Predictions of XD model are absorbed in the SM zone by new PDF fit

Discovery power is cancelled by PDF uncertainties above Mc=4TeV

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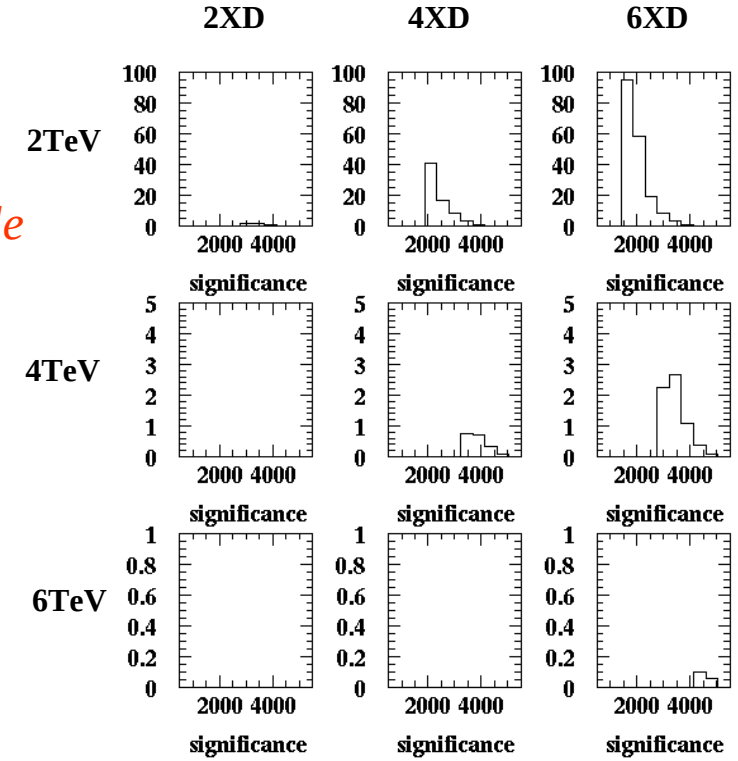
Impact of PDF uncertainties (II)

- Without PDF uncertainties:

  Sensitivity to XD at LHC+Tevatron

  C.Balazs, B. Laforge [Phys. Lett. B 525 (2002) 219-224]

  Sensitivity until 5 TeV in compactification scale



- With PDF uncertainties:

  Significane is estimated comparing to the lower limit of the SM prediction zone

$$S = \frac{NSM - NXD}{\sqrt{NSM}}$$

Sensitivity is low than 2 (or 3 in 6 XDs)TeV in compactification scale

➔ XD are masked by pdf uncertainties

Conclusion

- Di-jets cross section is sensitive to the PDF uncertainties
- high x gluon is responsible of the big PDF uncertainties
- PDF uncertainties decrease discovery reach for XD from

  5 TeV to < 2 TeV

- Understand old physics to discover new physics