LO PDF discussion

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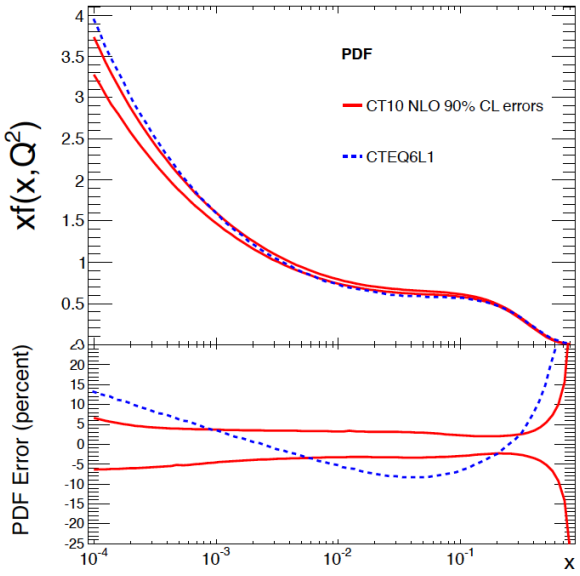
The story so far

- There has been a great deal of progress in adding processes at NLO to ME+PS programs
- Such programs automatically require NLO PDFs, and the uncertainties are given by the NLO PDF uncertainty bands
- However, there is still substantial use of LO MC programs such as Pythia, especially for exotic processes
- Such programs have substantially greater theoretical uncertainties associated with them
- In the past, it has been canonical wisdom to use LO PDFs with such programs
- …but there are significant differences between LO and NLO PDFs driven not by matrix element differences for collider processes, but by matrix differences for DIS production
- So from the perspective of LHC physics, LO PDFs are poorly defined
- LO PDF uncertainties are (poorly defined)^2

…for example

- NLO uncertainty bands for up quark and gluon PDFs are reasonably small, as would be expected
- …and entirely unlike the behavior of the corresponding LO PDFs
- Can the uncertainty bands for LO PDFs adequately reflect the fact that the LO PDFs for the most part are just wrong?



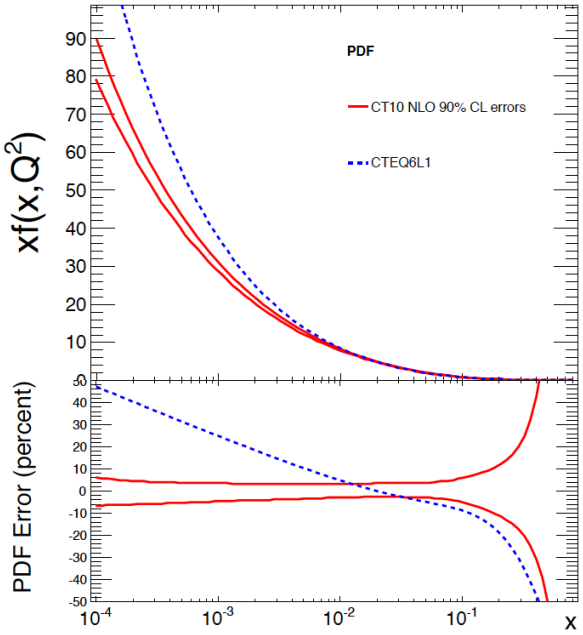
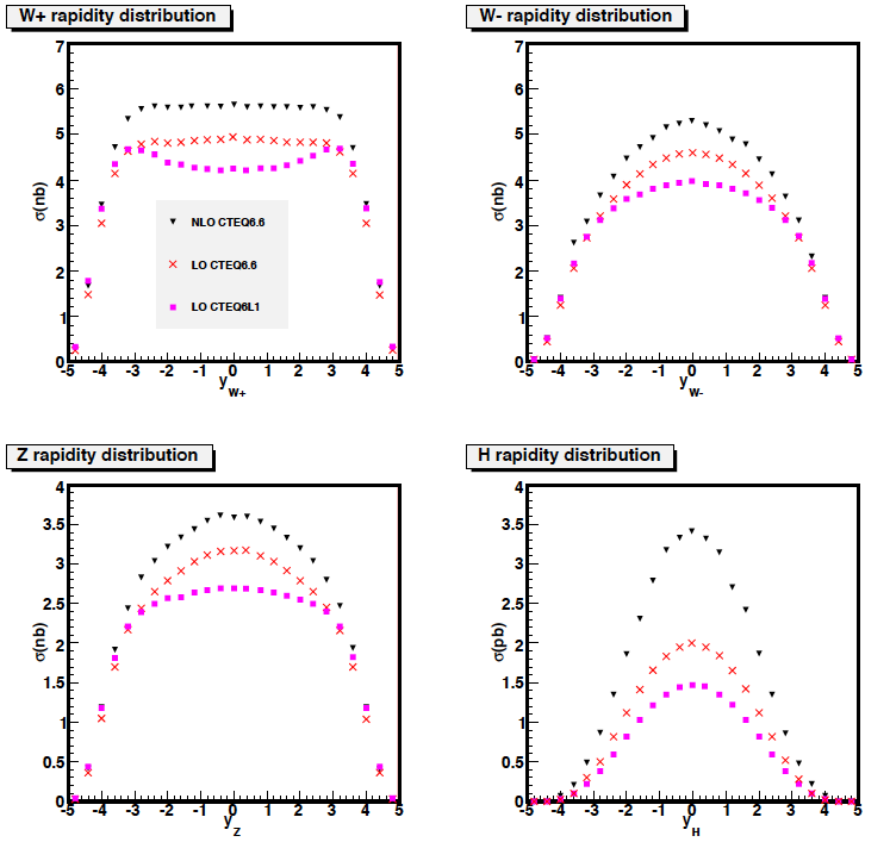


Fig. 1.24 The CTEQ6L1 up quark and gluon PDFs, evaluated at $Q^2 = 10^4\ GeV^2$ compared to the CT10 NLO pdf error bands for the same.

NLO PDFs

- For many processes, using NLO PDFs with LO ME's produces the right shape (if not normalization)



There are some situations where the use of NLO PDFs leads to predictions that are worse…but not as many.

Modified LO PDFs were developed to try to remove the worst of the LO PDF problems, but they have their own problems, and have basically disappeared from the scene.

Fig. 1.25 A comparison of NLO predictions for SM boson rapidity distributions to LO predictions for the same, using CTEQ6.6 and CTEQ6L1 pdfs, respectively.

Torbjorn doesn't like NLO PDFs

- The underlying event at the LHC probes small x and Q^2 values, where the NLO gluon distribution can (for some parametrizations) become negative
  - not all PDFs allow this
- This creates a problem for the MC programs
- It's possible in Pythia to separate the functions of the UE (LO PDFs) and of the matrix element evaluation (NLO PDFS with their uncertainty bands)
- If one wants to use NLO PDFs, this is Torbjorn's suggestion

This is the start of the discussion.