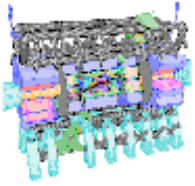


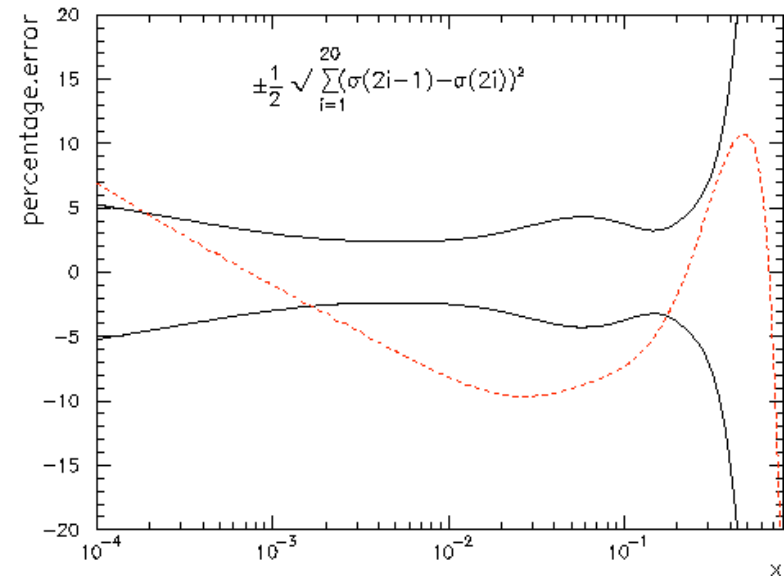
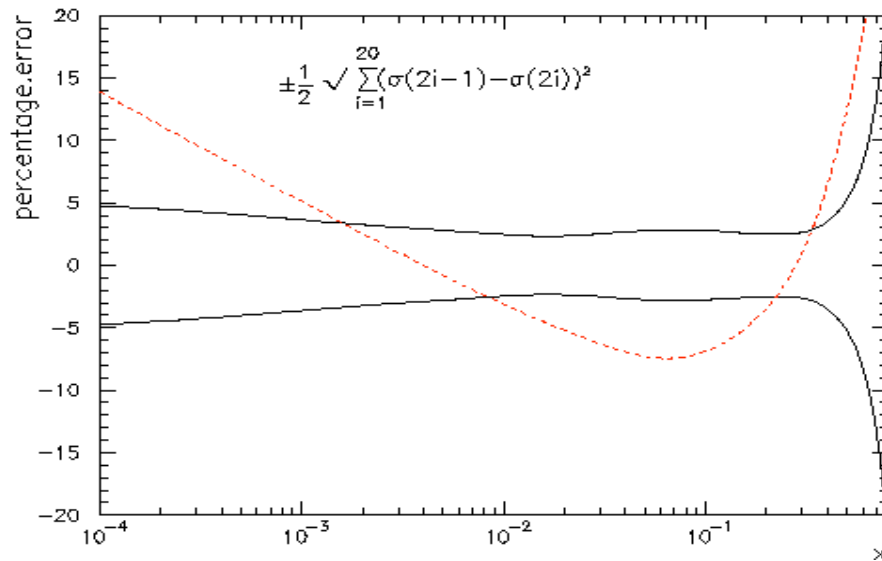
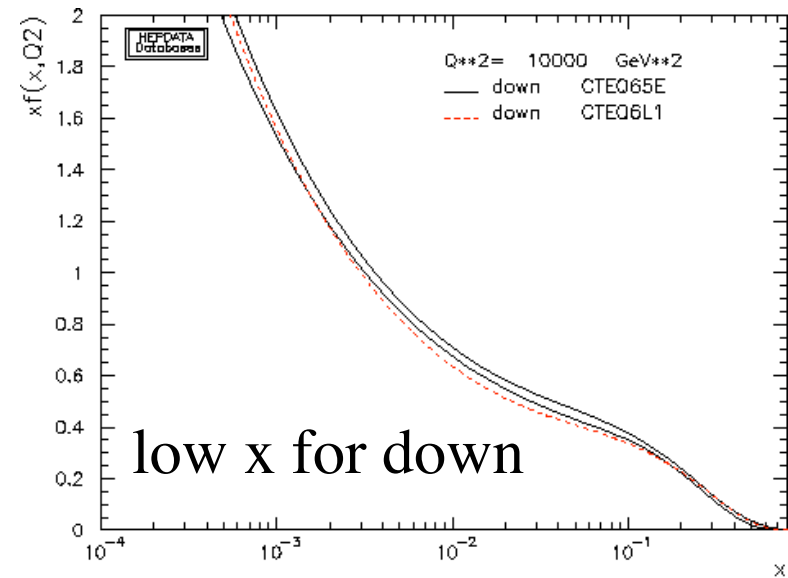
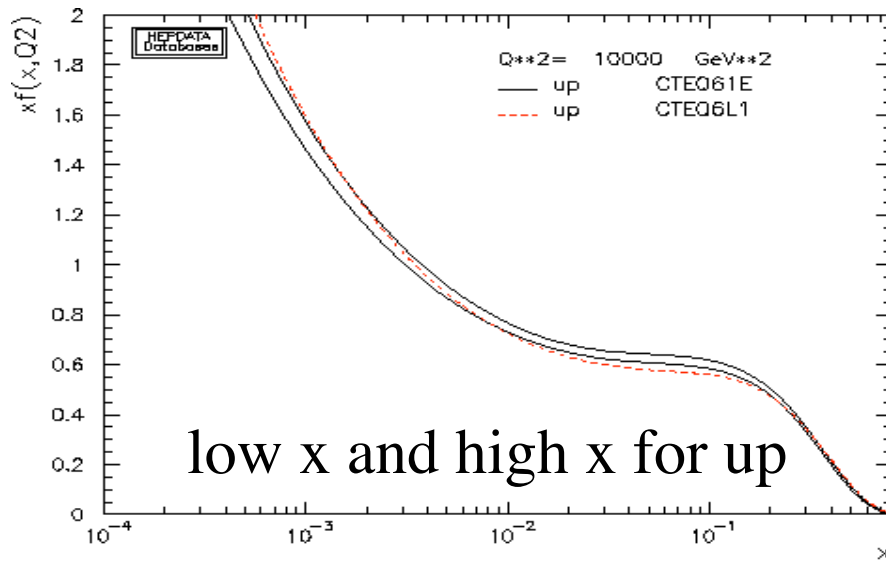
# LO vs NLO pdf's for parton shower MC's

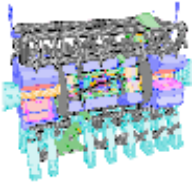


- For NLO calculations, use NLO pdf's (duh)
- What about for parton shower Monte Carlos?
  - ◆ somewhat arbitrary assumptions (for example fixing Drell-Yan normalization) have to be made in LO pdf fits
  - ◆ DIS data in global fits affect LO pdf's in ways that may not directly transfer to LO hadron collider predictions
  - ◆ LO pdf's for the most part are outside the NLO pdf error band
  - ◆ experimenters use the NLO error pdf's in combination with the central LO pdf even with this mis-match
  - ◆ LO matrix elements for many of the processes that we want to calculate are not so different from NLO matrix elements
  - ◆ by adding parton showers, we are partway towards NLO anyway
  - ◆ any error is formally of NLO
- (my recommendation) use NLO pdf's
  - ◆ pdf's must be + definite in regions of application (CTEQ is so by def'n)
- Note that this has implications for MC tuning, i.e. Tune A uses CTEQ5L
  - ◆ need tunes for NLO pdf's

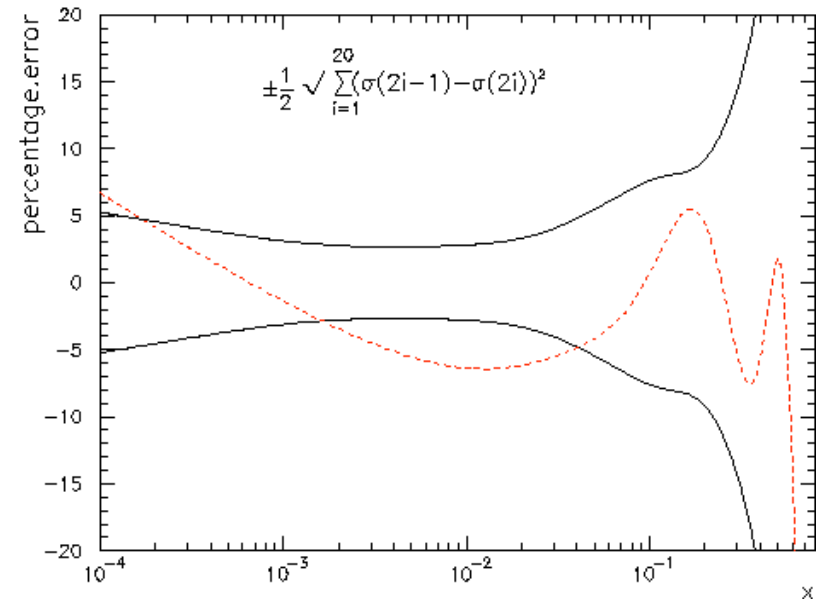
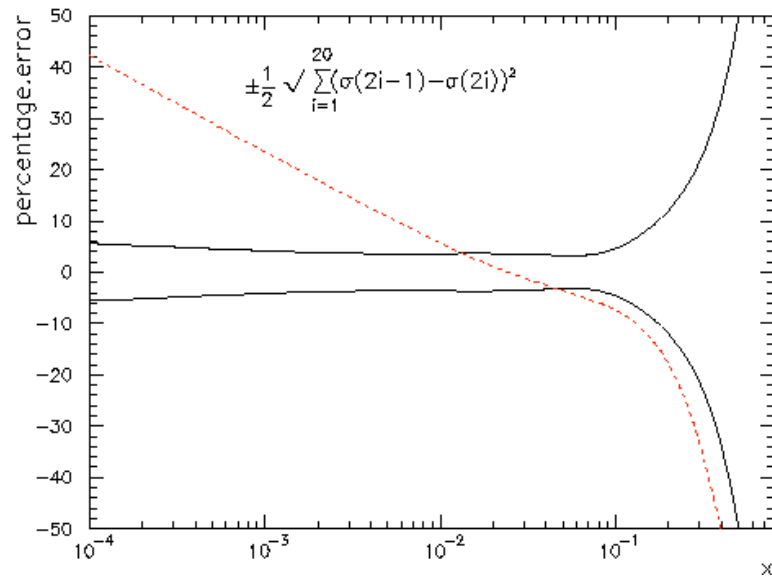
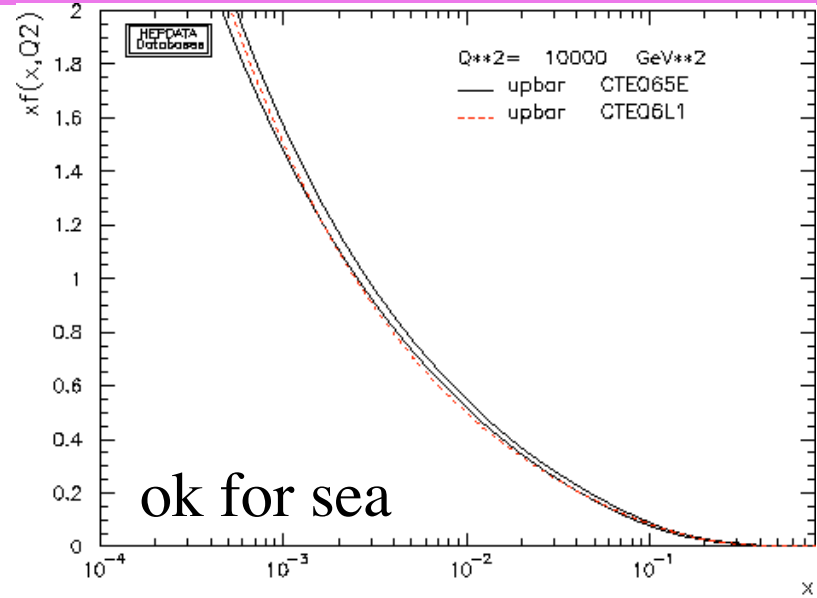
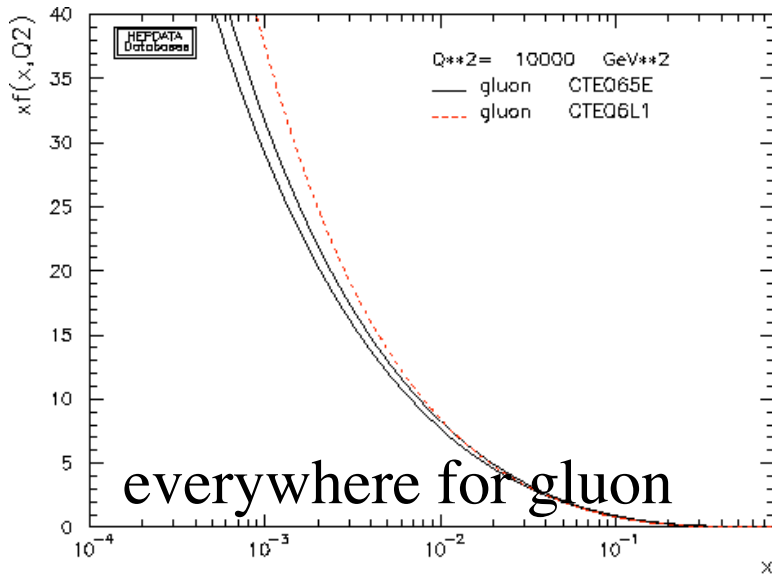


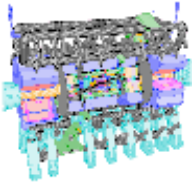
# Where are the differences?





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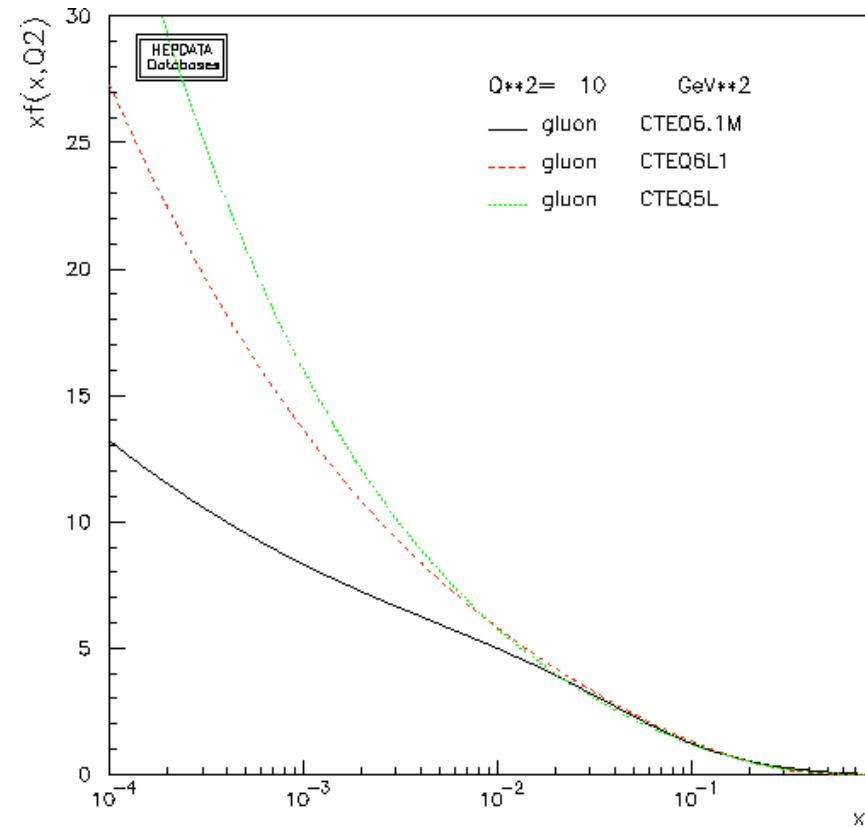
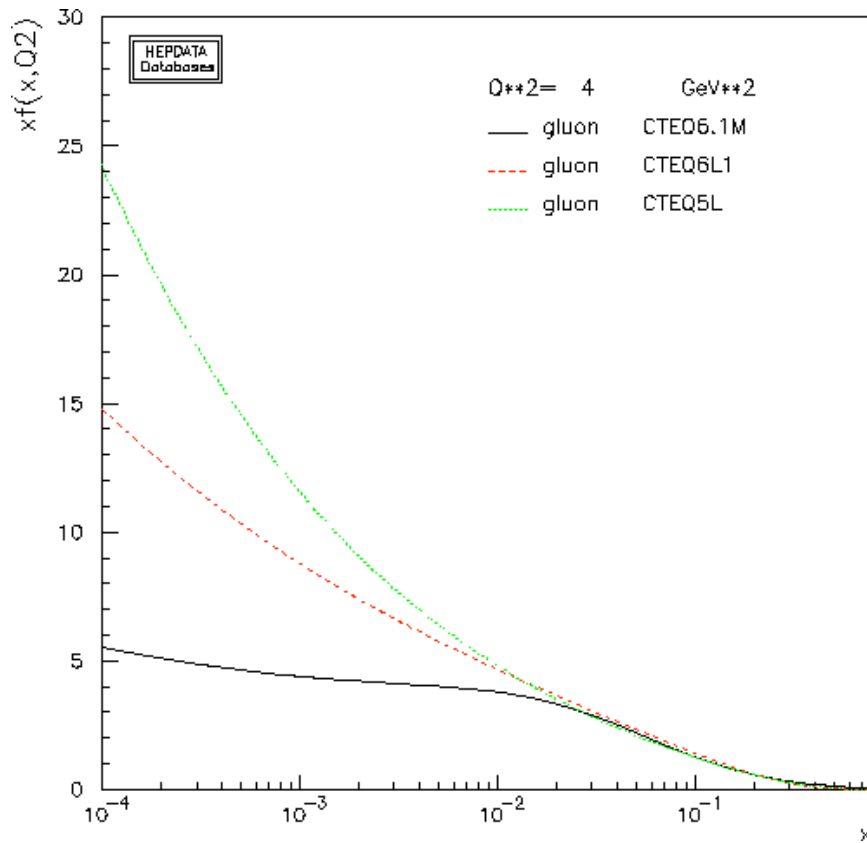


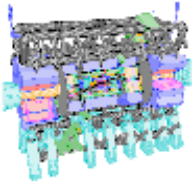


# Impact on UE tunes



- 5L significantly steeper at low  $x$  and  $Q^2$
- Rick Field has produced a tune based on CTEQ6.1





# Rick's tune



## CTEQ6.1 Tune

PYTHIA 6.2 CTEQ6.1

**UE Parameters**

Parameter	Tune Q	Tune QW
MSTP(81)	1	1
MSTP(82)	4	4
PARP(82)	1.2 GeV	1.2 GeV
PARP(83)	0.5	0.5
PARP(84)	0.4	0.4
PARP(85)	0.9	0.9
PARP(86)	0.95	0.95
PARP(89)	1.8 TeV	1.8 TeV

**ISR Parameters**

PARP(90)	0.25	0.25
PARP(62)	1.0	1.25
PARP(64)	1.0	0.2
PARP(67)	4.0	4.0

**Intrinsic KT**

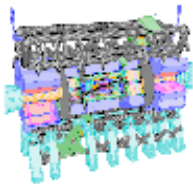
MSTP(91)	1	1
PARP(91)	1.0	2.1
PARP(92)	5.0	15.0

I used **LHAPDF!** See the next talk by Craig Group!

The top plot shows the 'Transverse' Charged Particle Density  $dN/d\eta d\phi$  vs  $PT(\text{particle jet\#1})$  (GeV/c) for charged particles ( $|\eta| < 1.0, PT > 0.5$  GeV/c) at 1.96 TeV. It compares the 'generator level' (black solid line), 'PY Tune Q CTEQ6.1' (red solid line), and 'PY Tune A CTEQ6.1' (red dashed line). The bottom plot shows the 'Transverse' PTsum Density  $dPT/d\eta d\phi$  (GeV/c) vs  $PT(\text{particle jet\#1})$  (GeV/c) for the same conditions and tunes.

...discussed in detail in TeV4LHC writeup

# Study



- We are carrying out a systematic study of the impact of the use of NLO pdf's for LO parton shower predictions

Torbjorn Sjostrand

The proof of the pudding . . .

Assume the best description of physics is obtained with (a)  $\hat{\sigma}(\text{NLO}) \otimes \text{PDF}(\text{NLO})$ .

Interesting comparisons would then be with the scenarios:

(b)  $\hat{\sigma}(\text{LO}) \otimes \text{PDF}(\text{LO})$ .

(c)  $\hat{\sigma}(\text{LO}) \otimes \text{PDF}(\text{LO}) \otimes \text{showers}$ .

(d)  $\hat{\sigma}(\text{LO}) \otimes \text{PDF}(\text{NLO})$ .

(e)  $\hat{\sigma}(\text{LO}) \otimes \text{PDF}(\text{NLO}) \otimes \text{showers}$ .

Only if (e) is a better approximation to (a) than is (c) would the use of NLO PDF's be motivated in a general-purpose generator.

Technical aside:

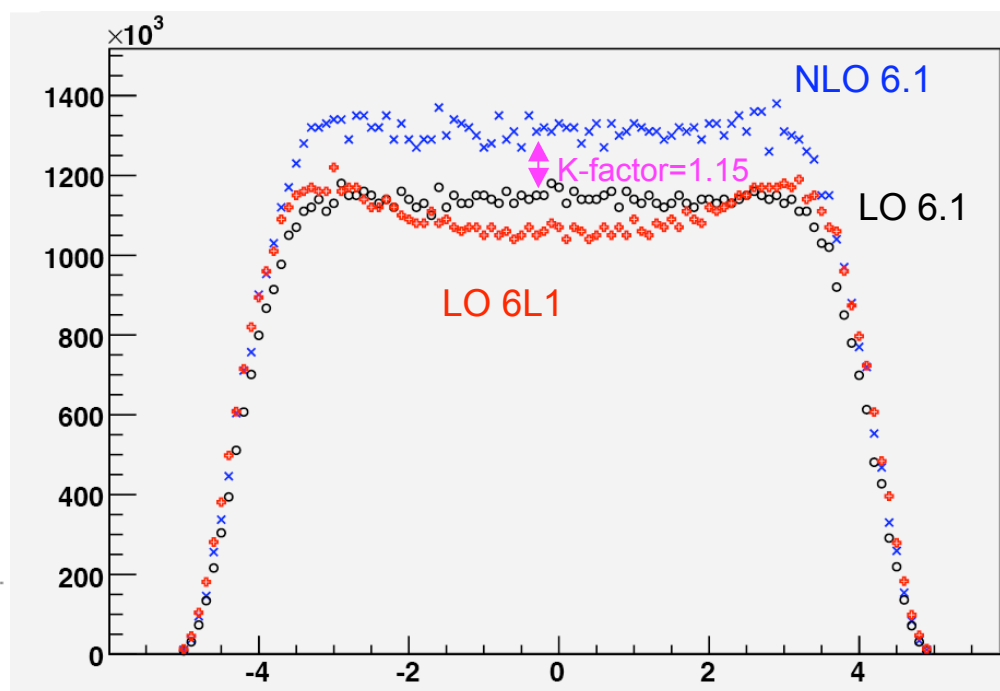
(a) = external NLO program.

(c), (e) = PYTHIA/HERWIG/ . . . without primordial  $k_{\perp}$ , MI or hadronization.

(b), (d) = ditto, also without ISR and FSR showers.

- One possibility
  - ♦ use CTEQ5L for UE but NLO pdf's for matrix element evaluation

$W^+$  rapidity distribution at LHC



$y_{W^+}$

For example, the shape of the  $W^+$  rapidity distribution is significantly different than the NLO result if the LO pdf is used, but very similar if the NLO pdf is used.



# Discussion



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- Torbjorn is uncomfortable with the idea of using a NLO pdf with Pythia (even though experimenters are doing worse, mixing LO and NLO pdf's)
- Can we think of a hybrid pdf for use in Monte Carlos?
- Wu Ki suggested using NLO evolution in the LO fit
- I've heard that Robert Thorne is trying to relax the sum rule constraints for LO fits
- Can we try to limit the low- $x$  and high- $x$  differences which are due not to evolution effects, I believe, but to the LO matrix elements used in fitting the DIS data?