Issues with large-x / large-Q^2 systematics

Nothing really new or surprising, just a few
awareness raising observations

PDF4LHC meeting
March 7 2017
CERN

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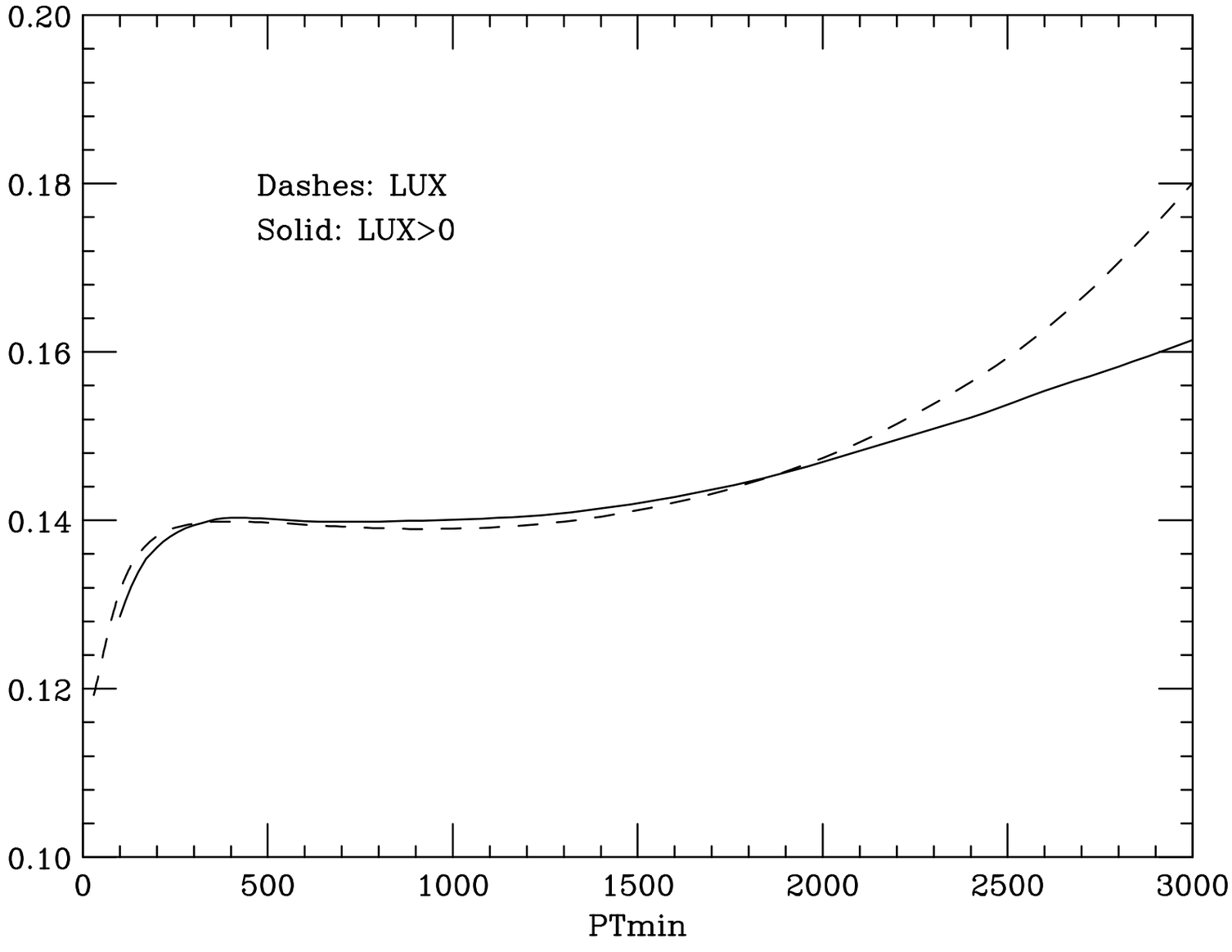
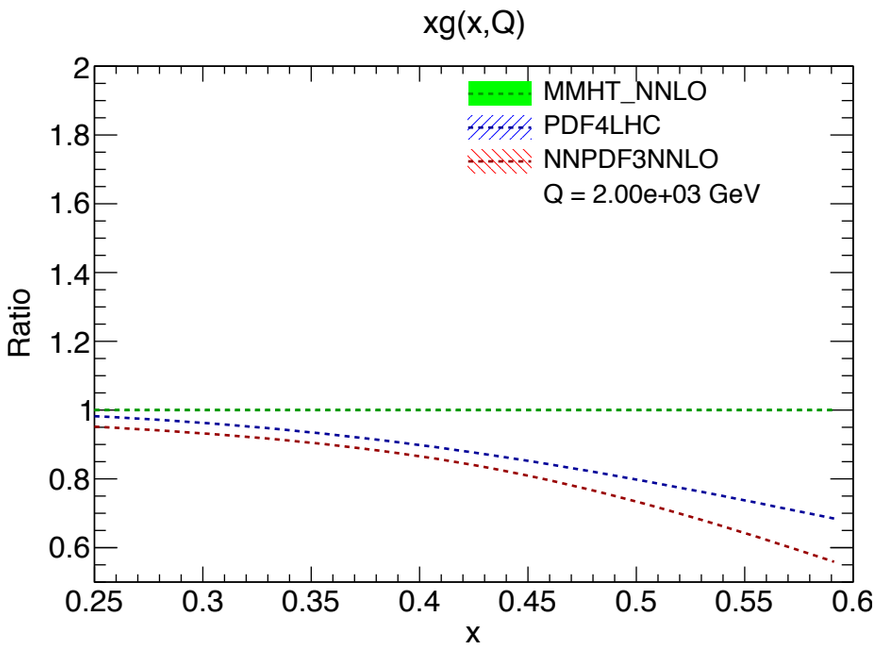
TH Department, CERN

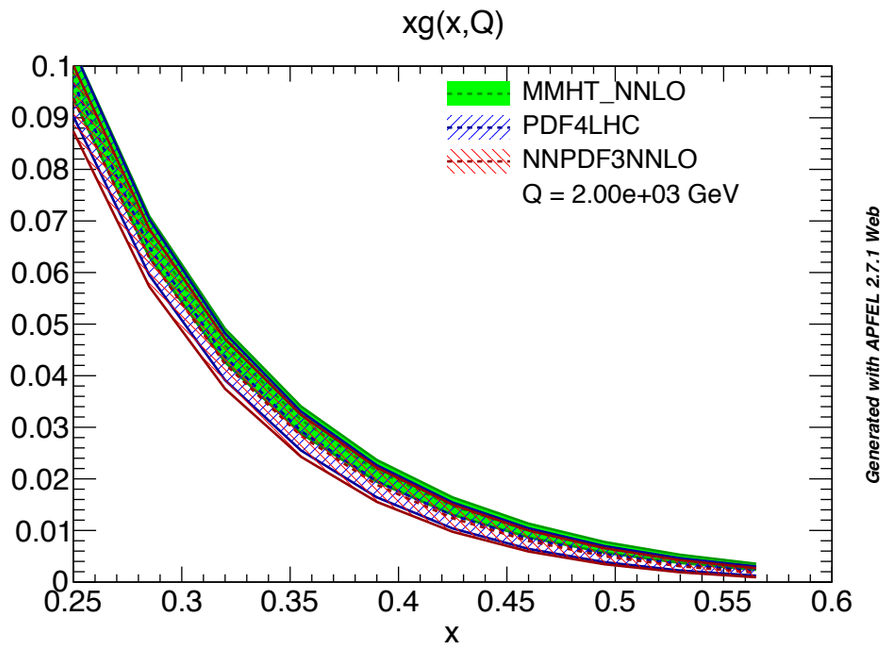
Ratio of Z/W production rates at large pT

$$\sigma(Z,\ p_T > P_{Tmin}) \ / \ \sigma(W,\ p_T > P_{Tmin})$$

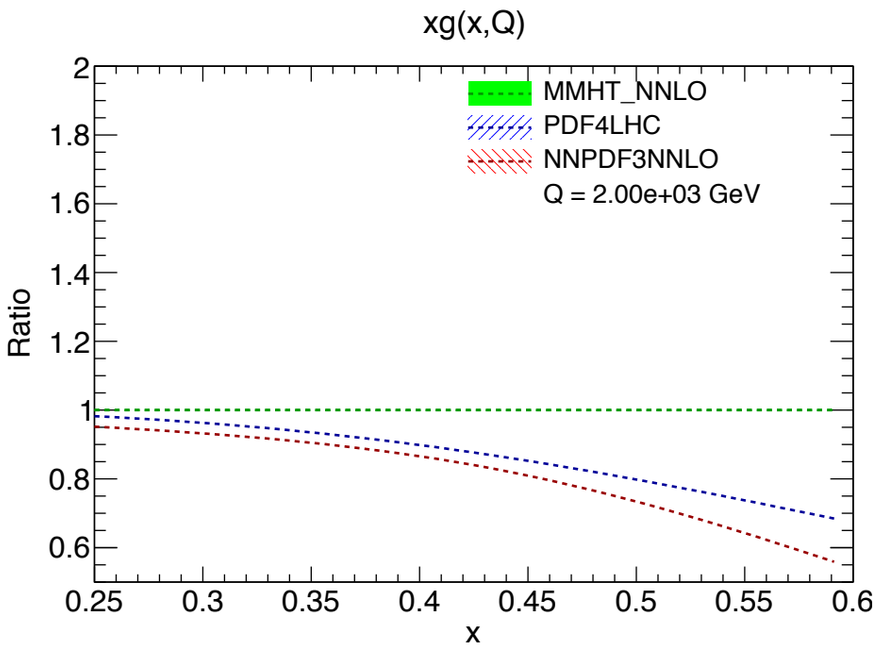


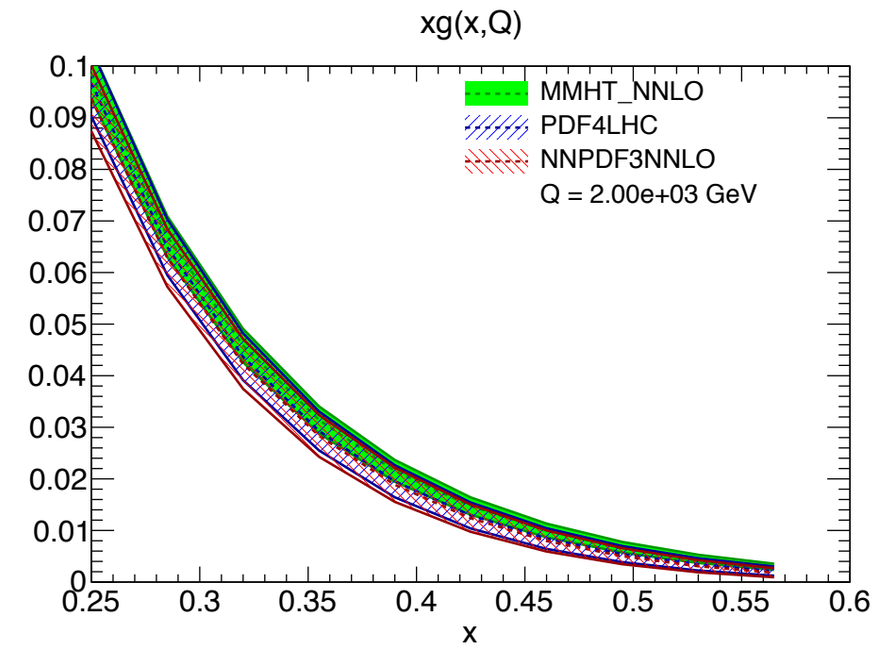
The solid line is obtained by setting to 0 individual flavours when their PDF turns negative (this is what I label, here and later, LUX>0). All plots here and in the following at LO





The gluon density is rather well behaved. It stays positive in the range shown here, and there is a mild difference between MMHT and NNPDF (PDF4LHC combines these two plus CT14, and it's always located in between MMHT and NNPDF)





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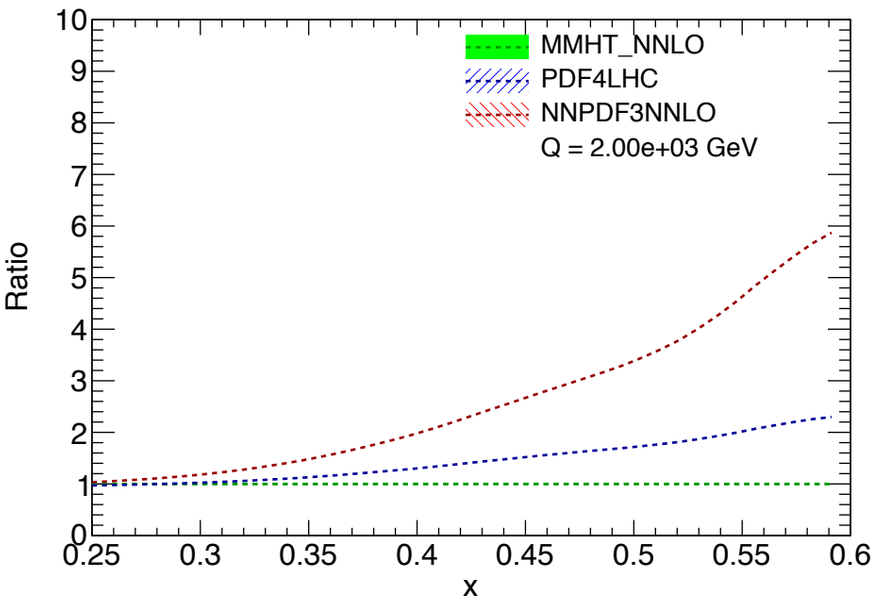
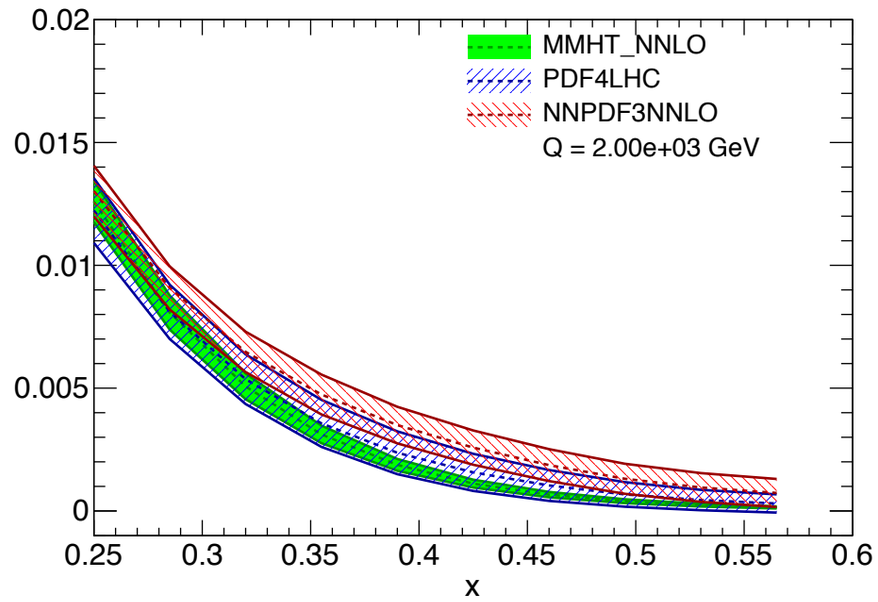
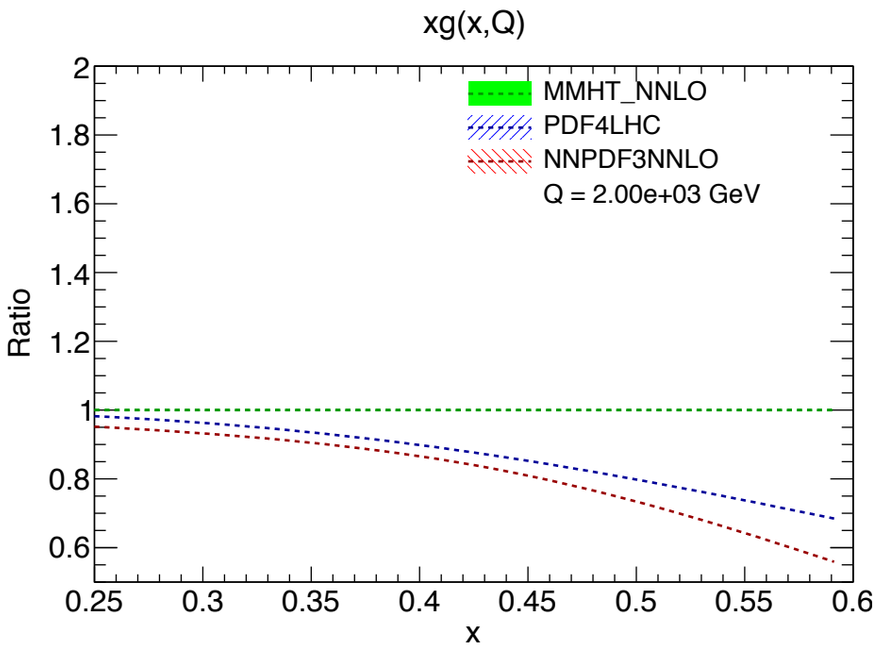
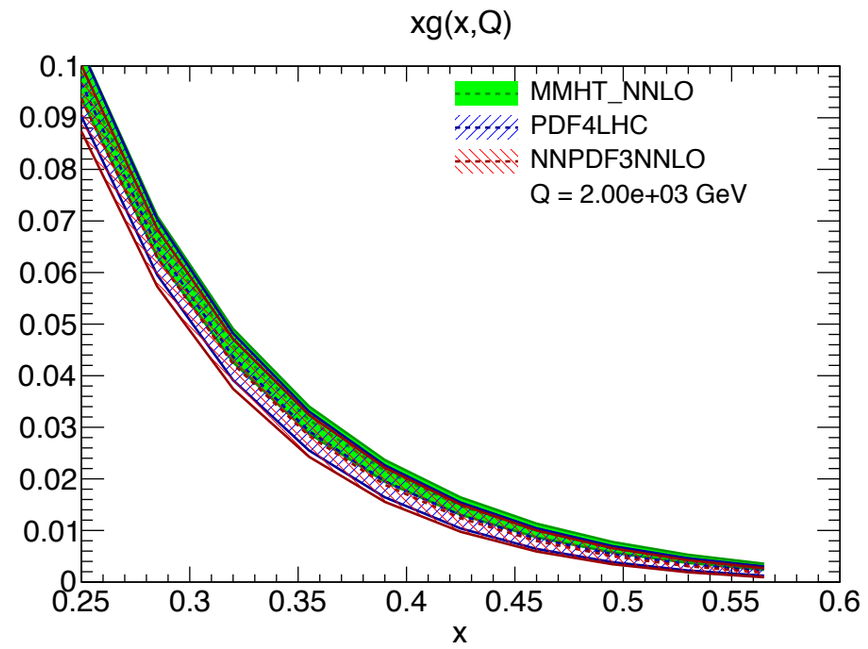




ubar is also positive, but it's much more uncertain, with the ratio between NNPDF and MMHT reaching 5 at x=0.5. Notice there is ~ a factor of 10 between ubar and g (ubar/g~0.1), as expected





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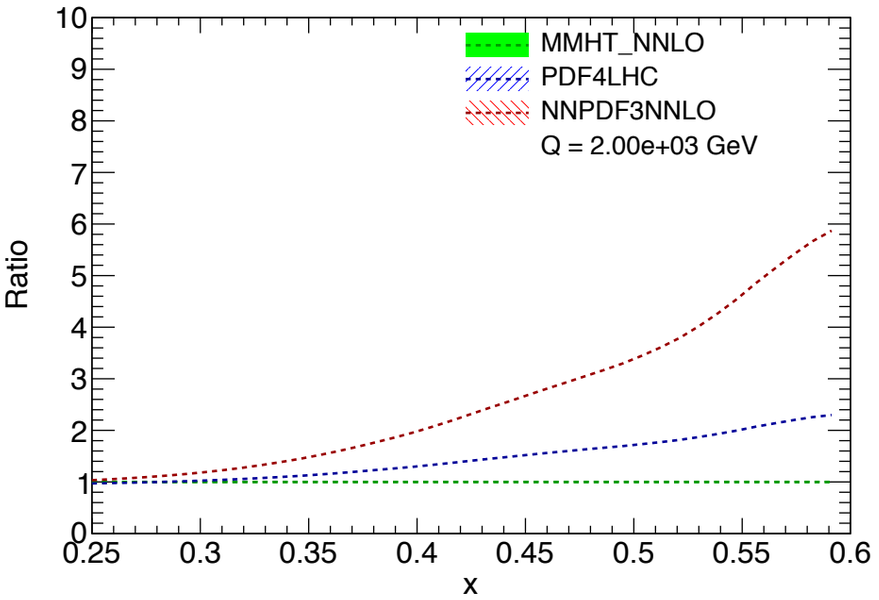

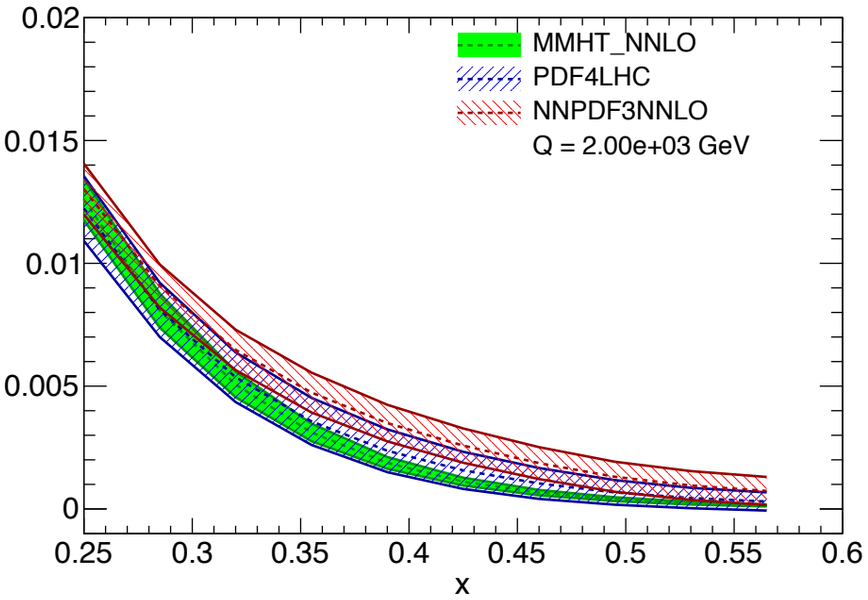

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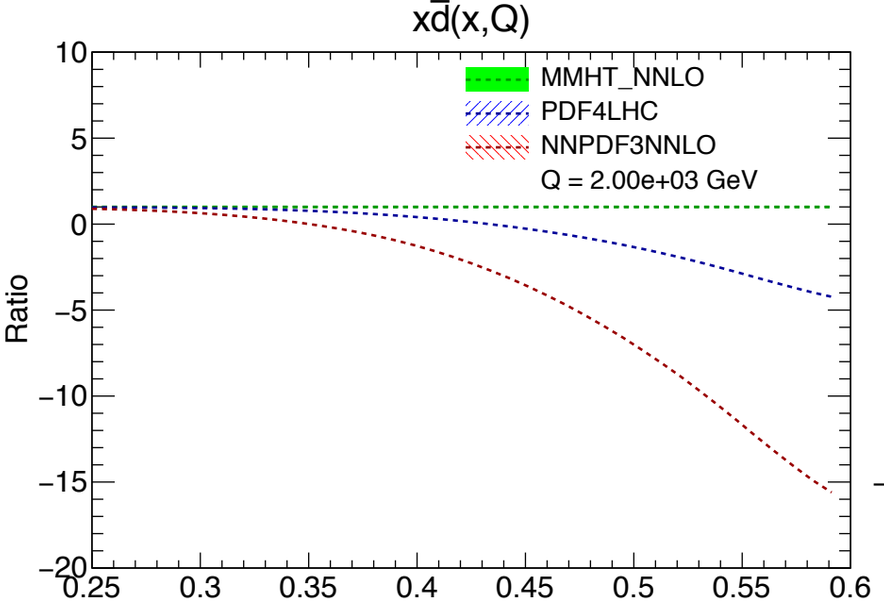
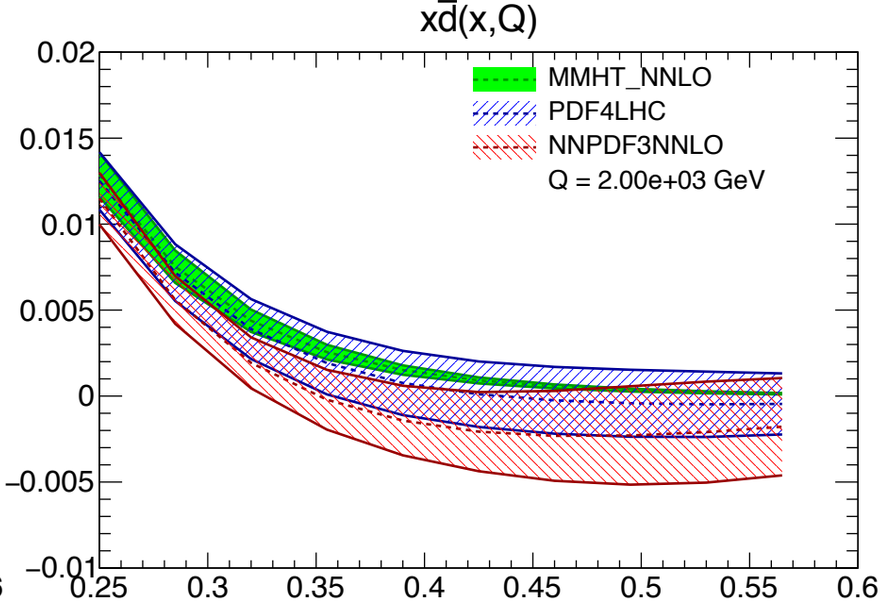
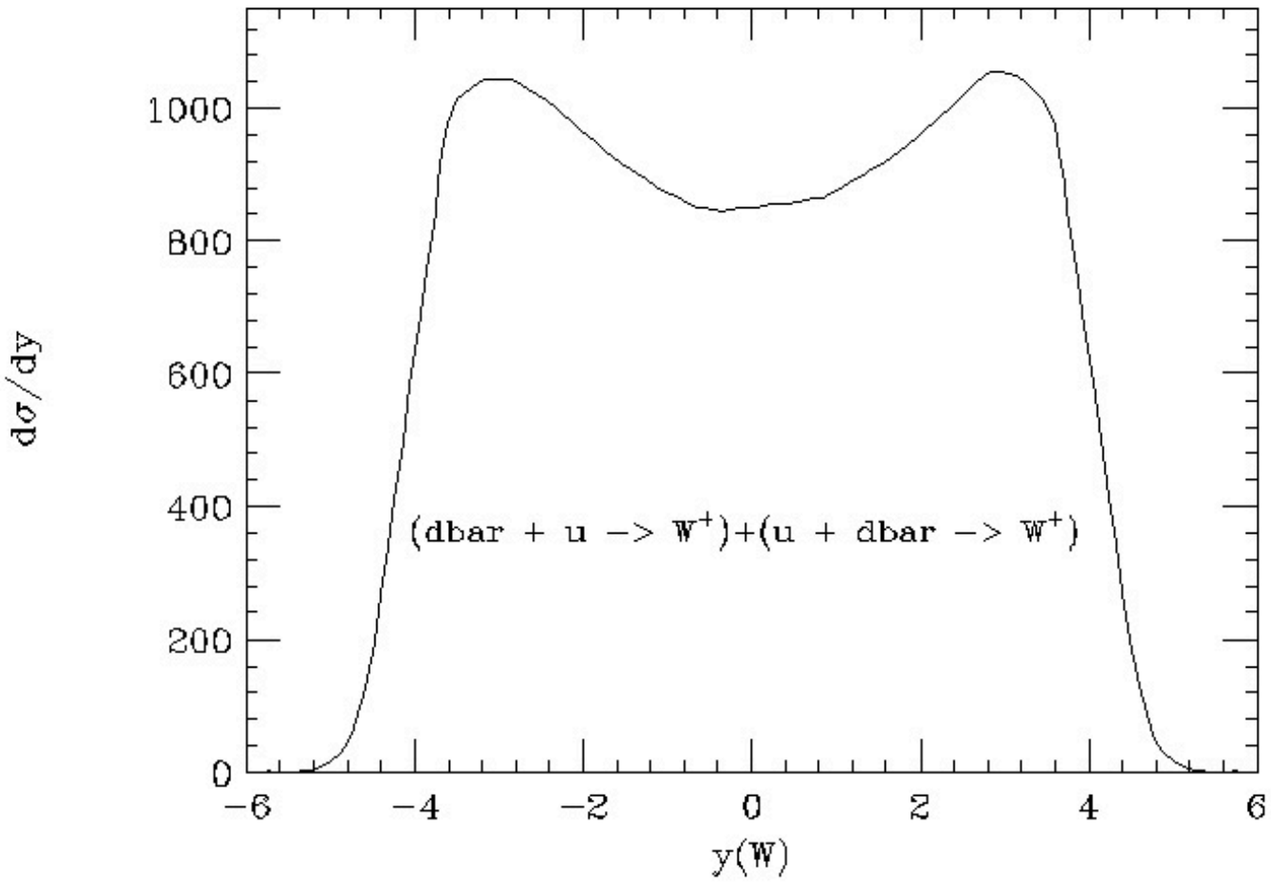
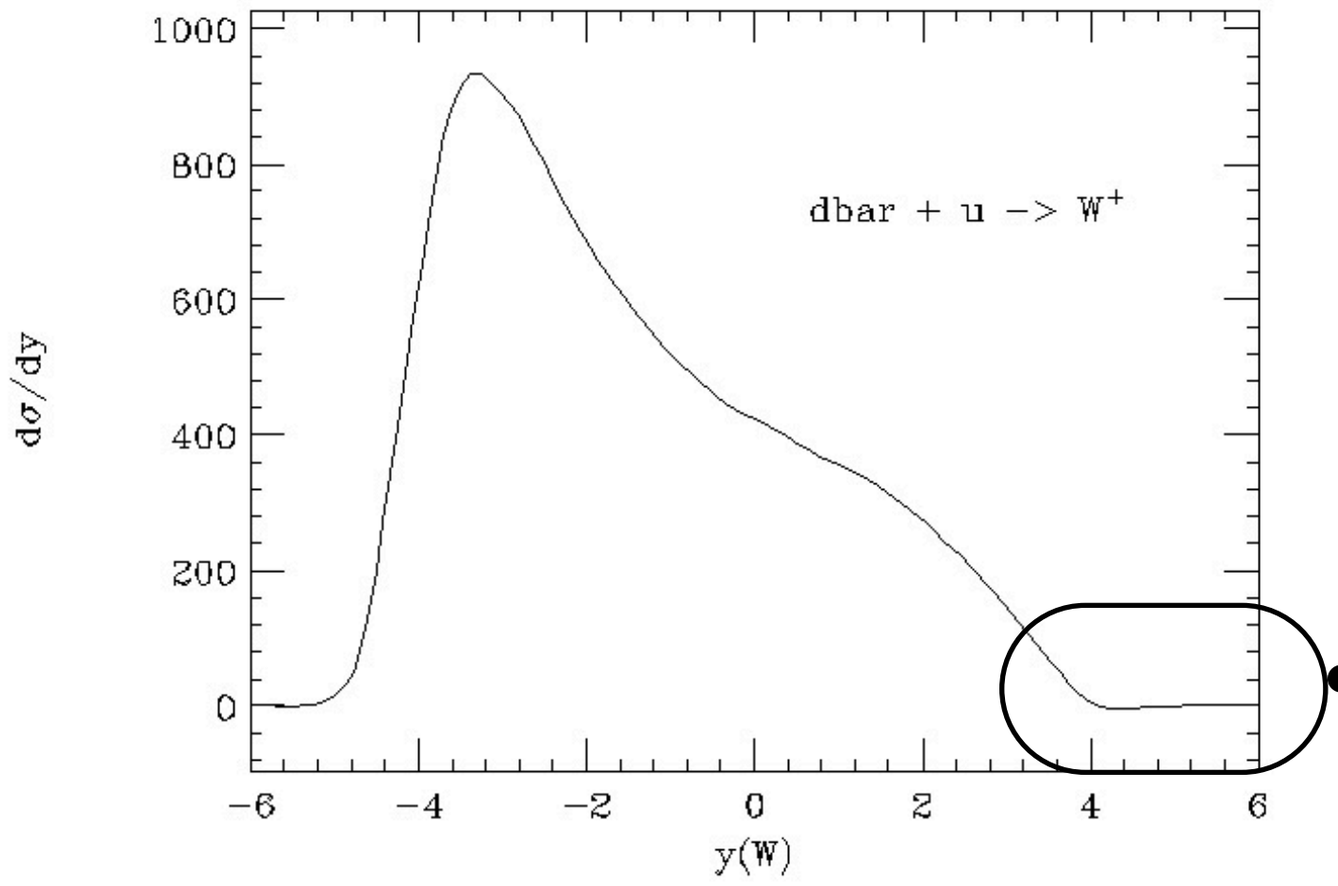




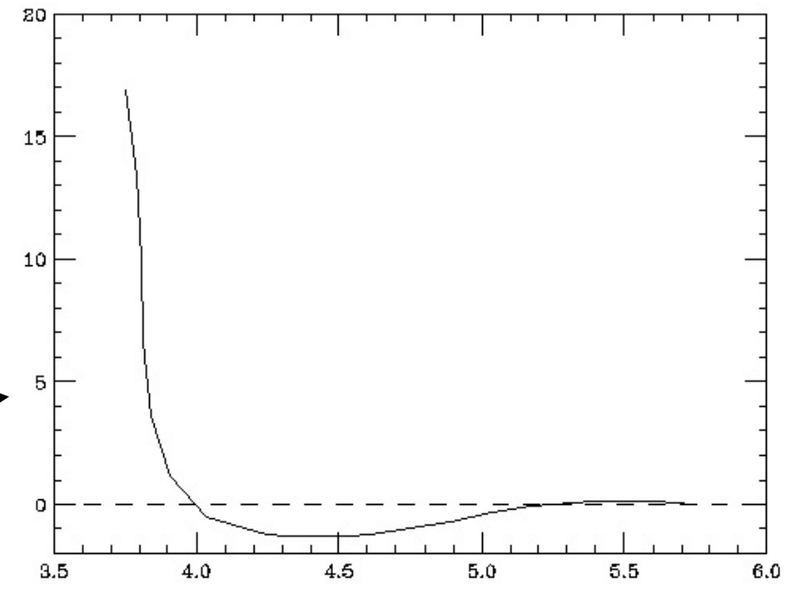
dbar becomes negative for NNPDF above x~0.35. Its absolute value remains almost constant, and therefore the ratio NNPDF/MMHT grows large at large x. PDF4LHC reflects this behavior. Close inspection shows that within the uncertainty band |dbar(x)| can be > g(x)

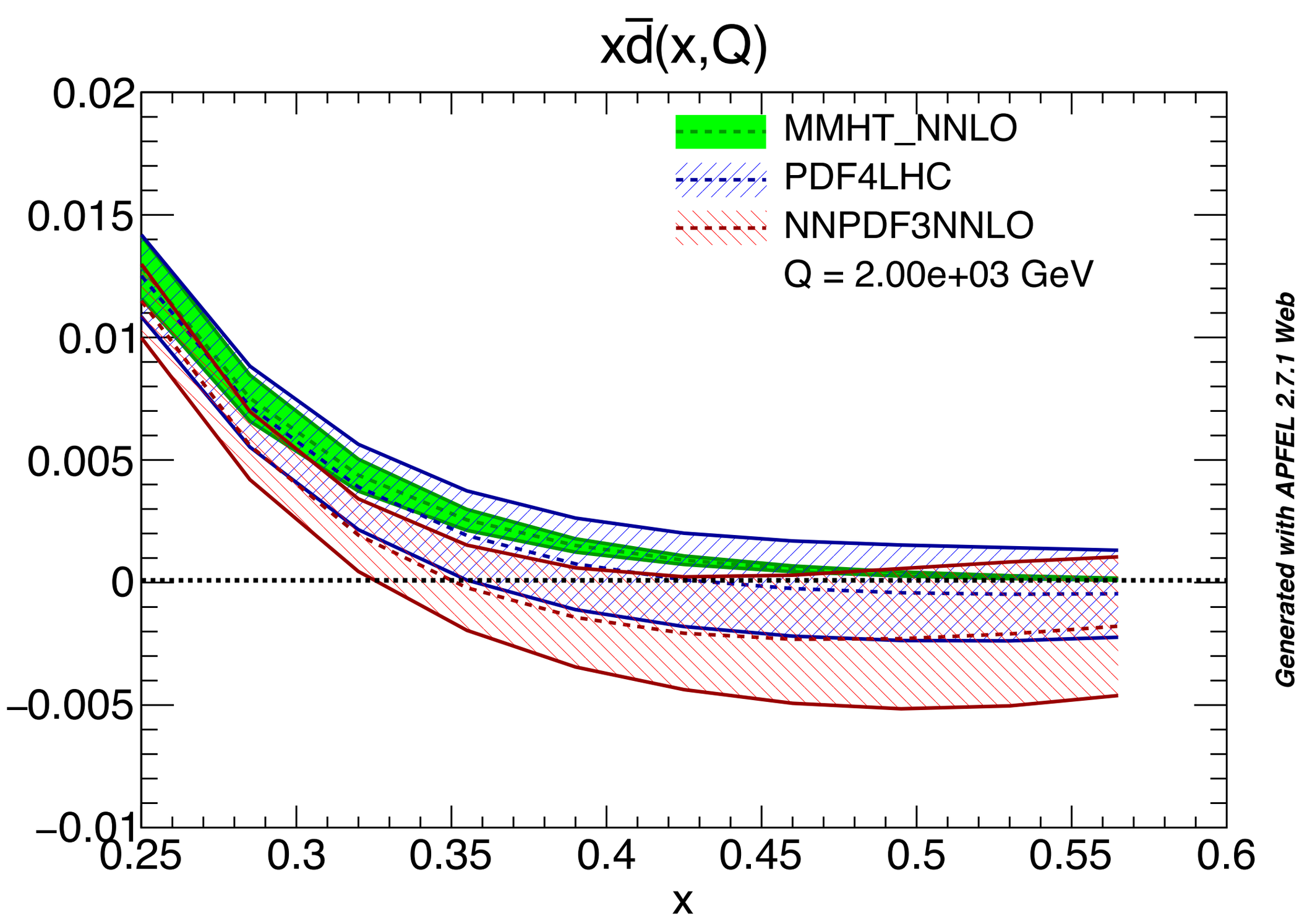


impact of negative PDF not evident from inclusive W spectra….



….but is present in the distributions of specific subprocesses




$x\bar{d}(x,Q)$
MMHT_NNLO
PDF4LHC
NNPDF3NNLO
Q = 2.00e+03 GeV
0.02
0.015
0.01
0.005
0
−0.005
−0.01
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
x
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xg(x,Q), r{d}(x,Q)

xd(x,Q)

MMHT_NNLO
NNPDF3NNLO
PDF4LHC

NNPDF3NNLO
Q = 2.00e+03 GeV
Q = 2.00e+03 GeV

g(x)

0.02
0.015
0.01
0.005
0
−0.005
−0.01

0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6

x

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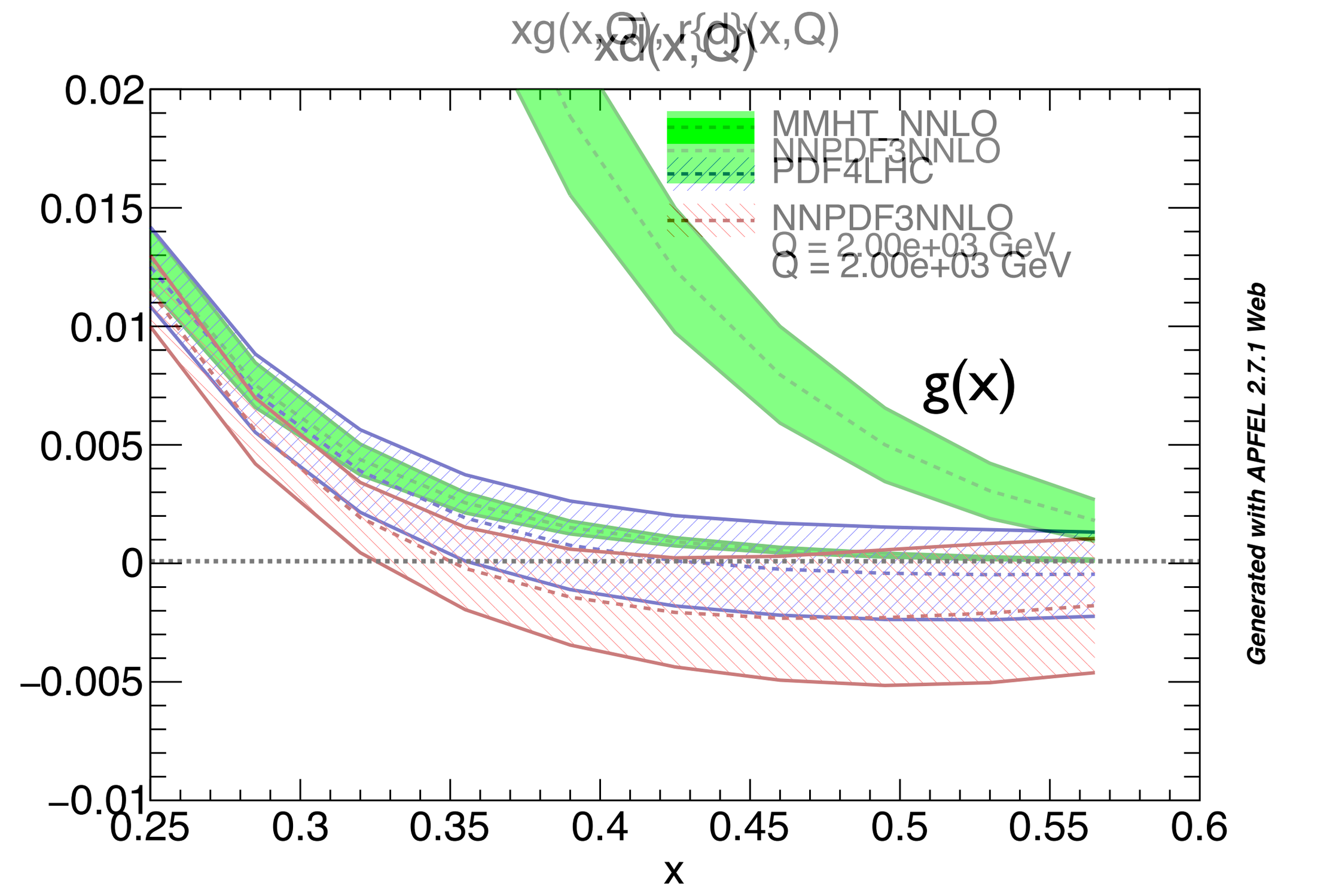
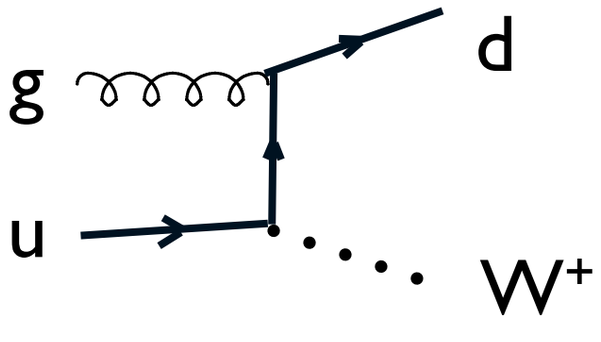
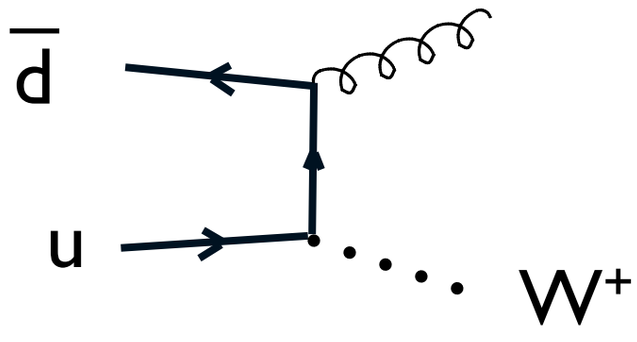
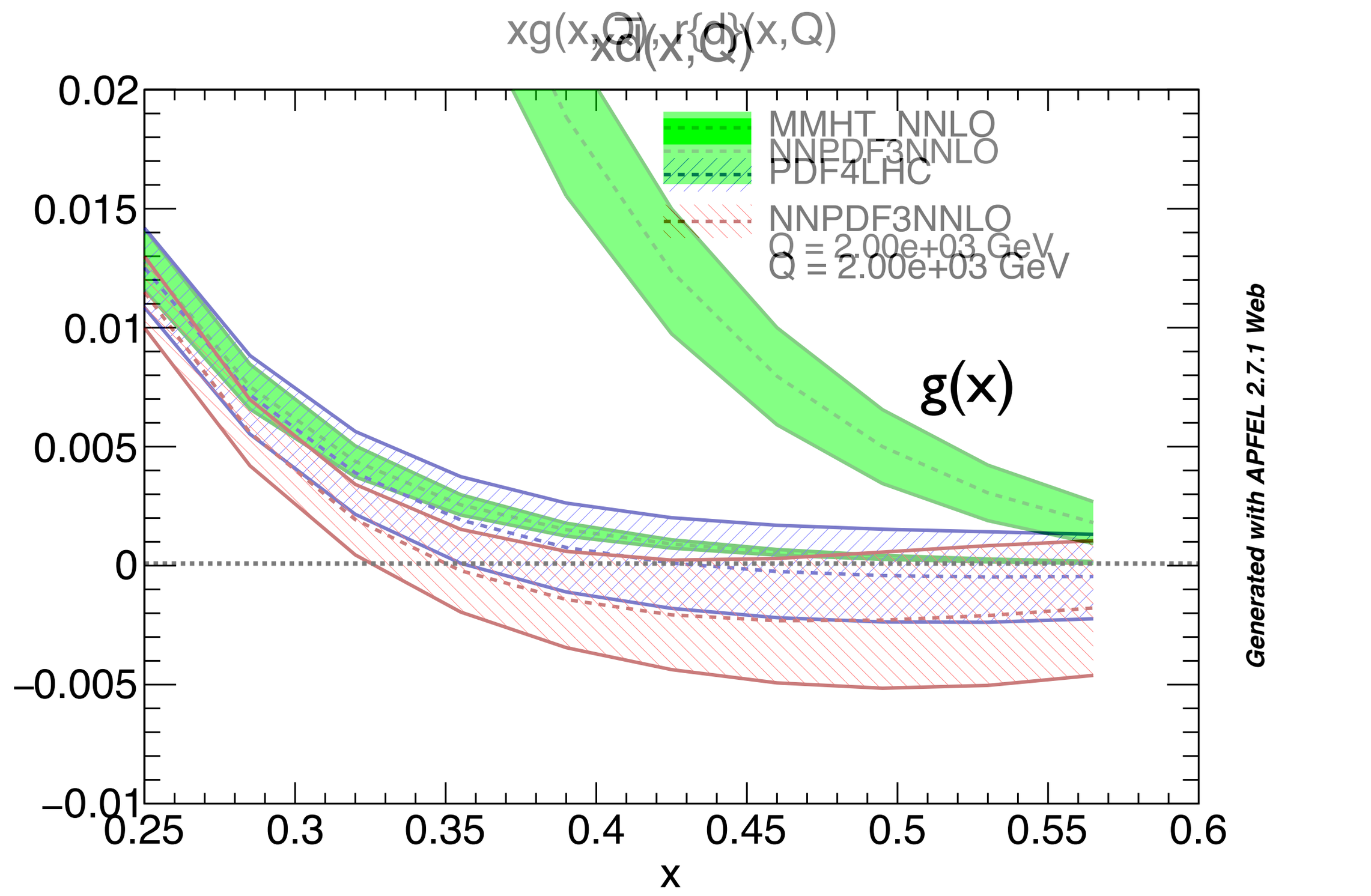
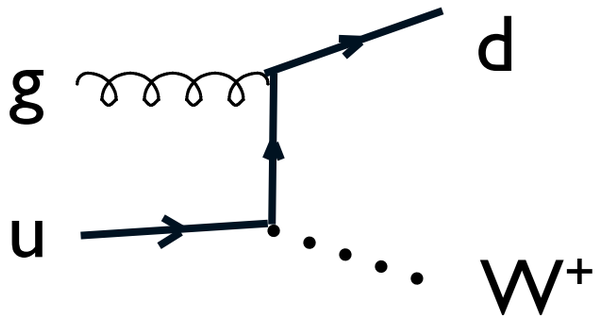


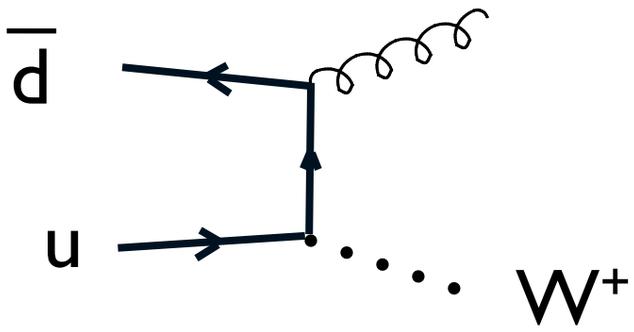




$$\sim f_u * [\, f_g + f_{\bar{d}} \,]$$

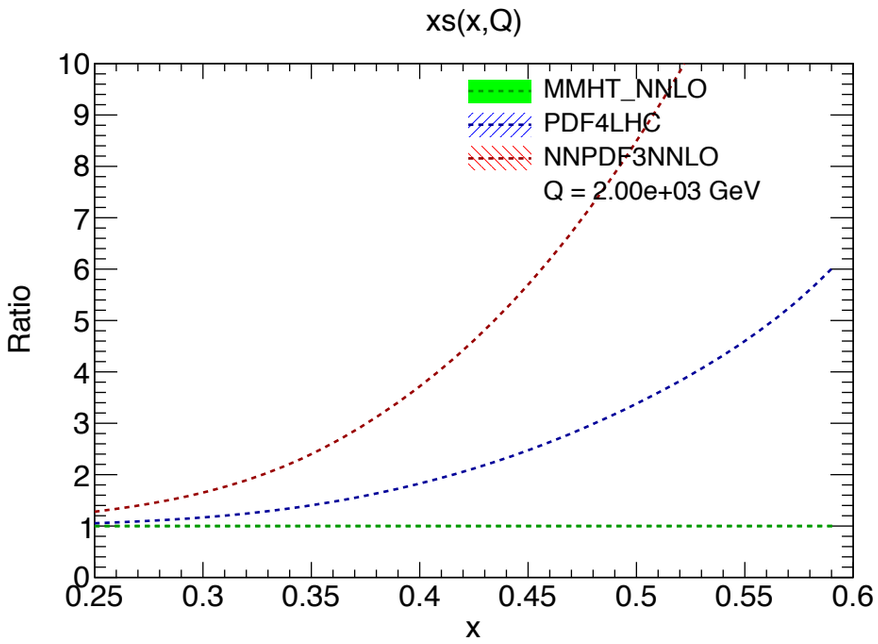


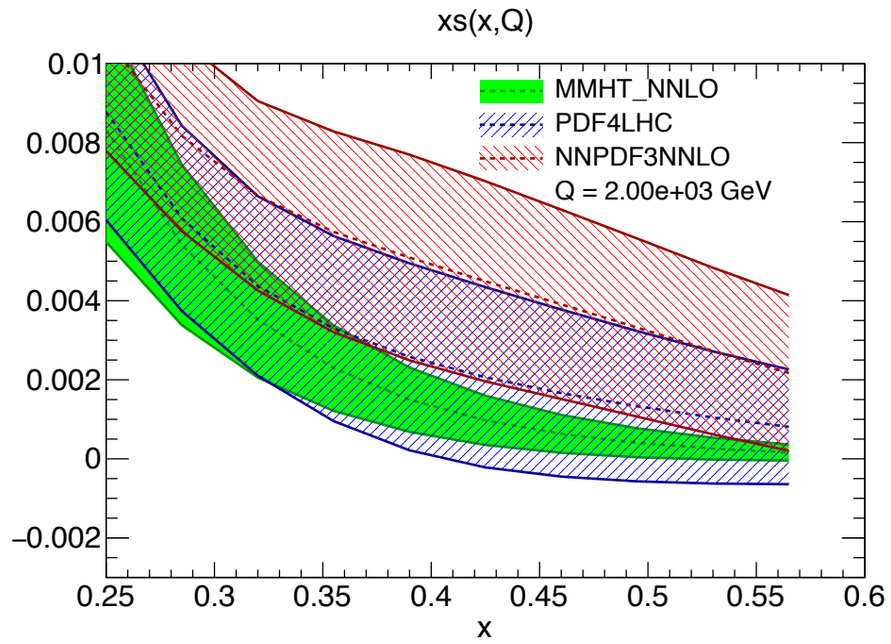




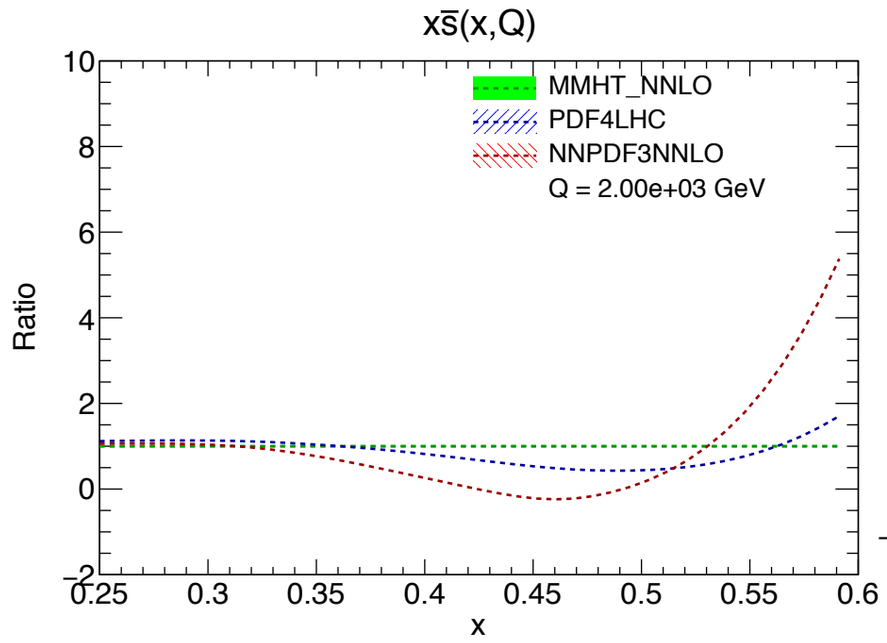
$$\sim f_u * [\, f_g + f_{\bar{d}} \,]$$

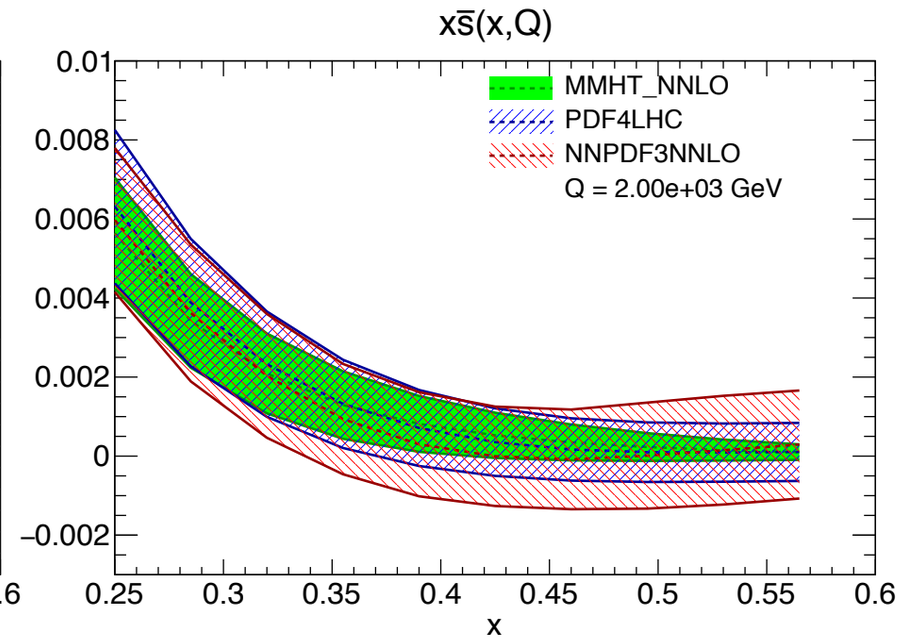
< 0 at large pt !!



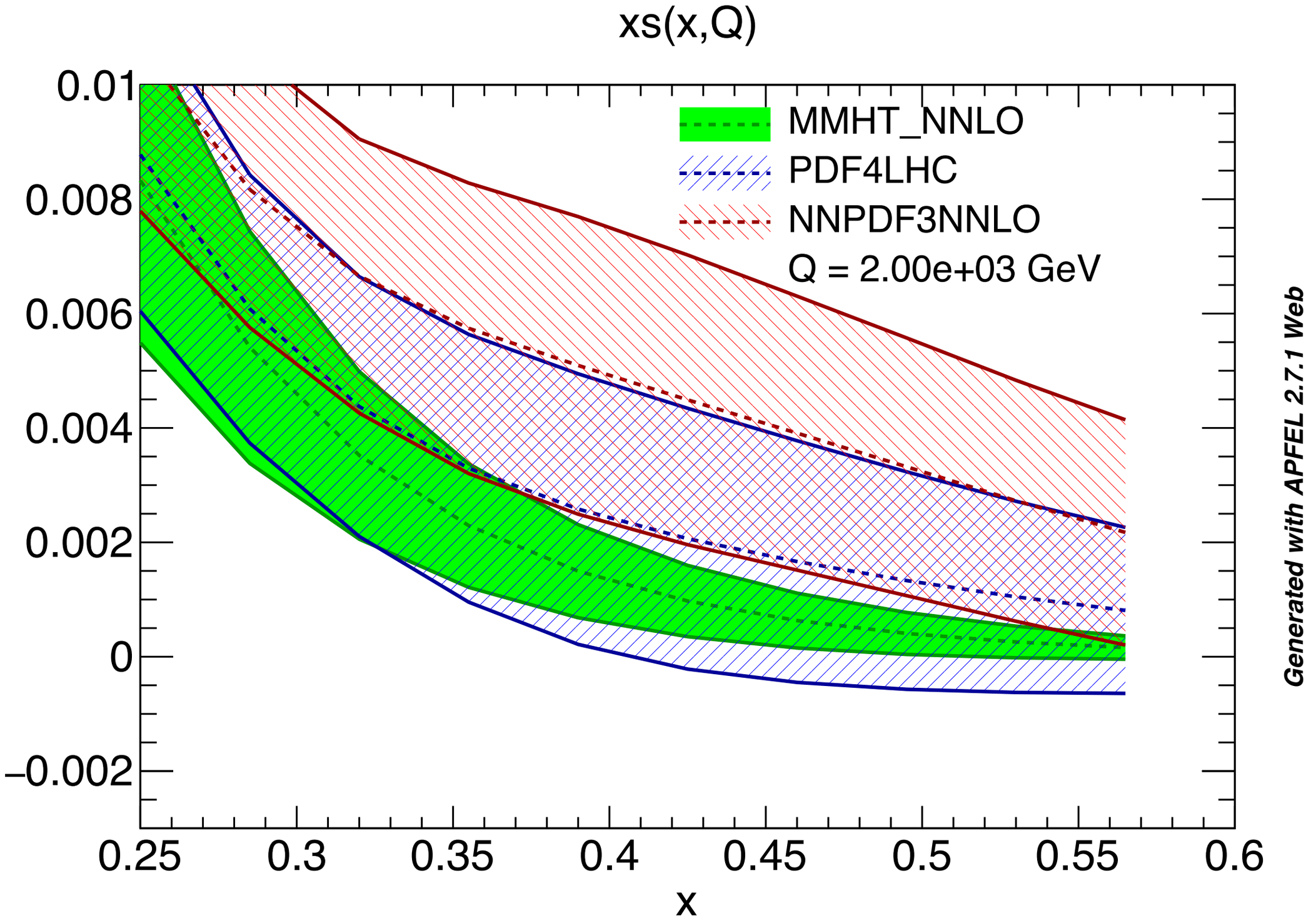


The strange behaves like the ubar. It's positive, but NNPDF (and as a consequence PDF4LHC) grows a lot and has a huge uncertainty





The antistrange of MMHT is very similar to the strange. For NNPDF it's totally different, and goes negative. Overall there isn't really a justification for this behaviour


xs(x,Q)
MMHT_NNLO
PDF4LHC
NNPDF3NNLO
Q = 2.00e+03 GeV
0.01
0.008
0.006
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0
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x
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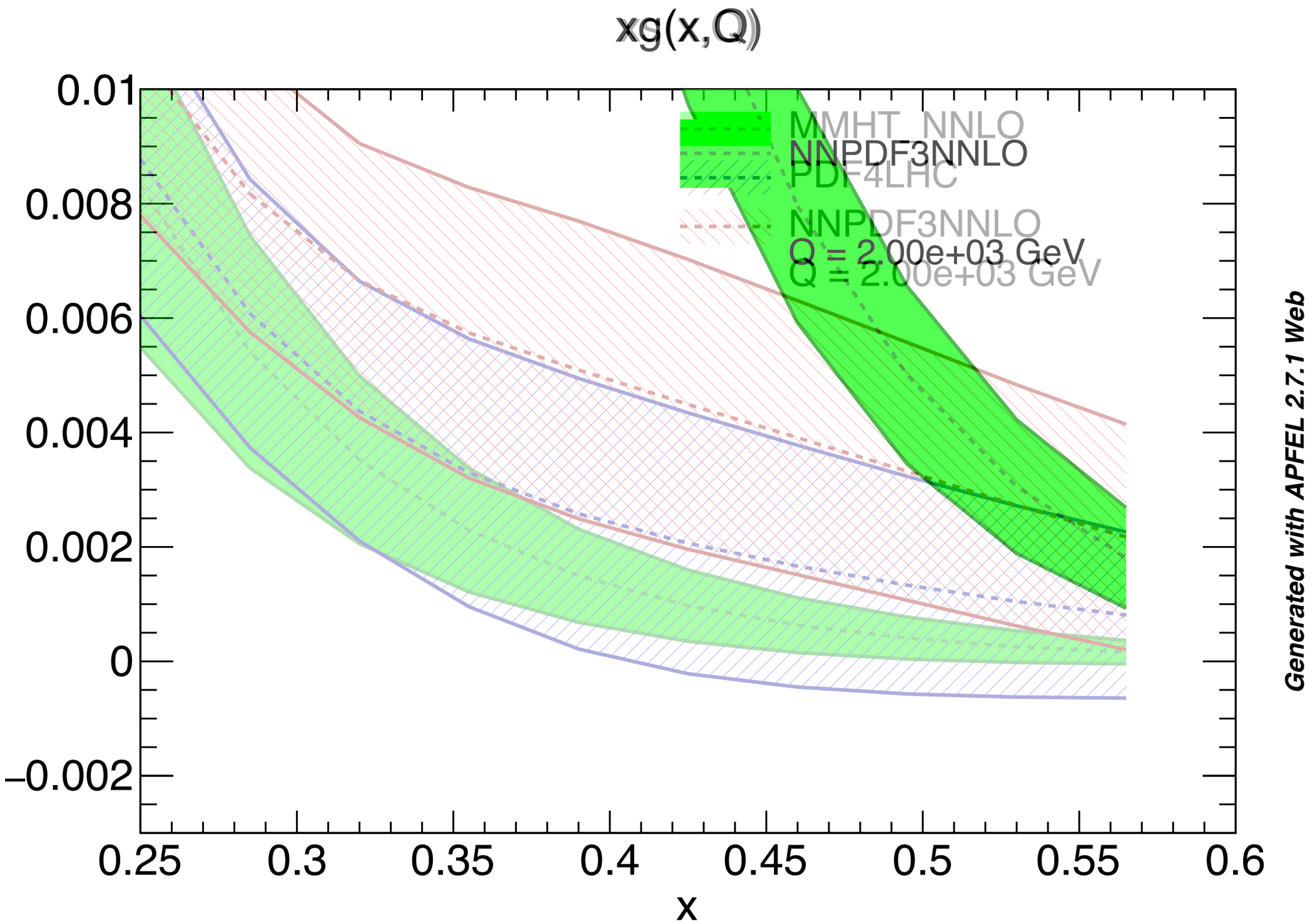
xg(x,Q)
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0
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0.25
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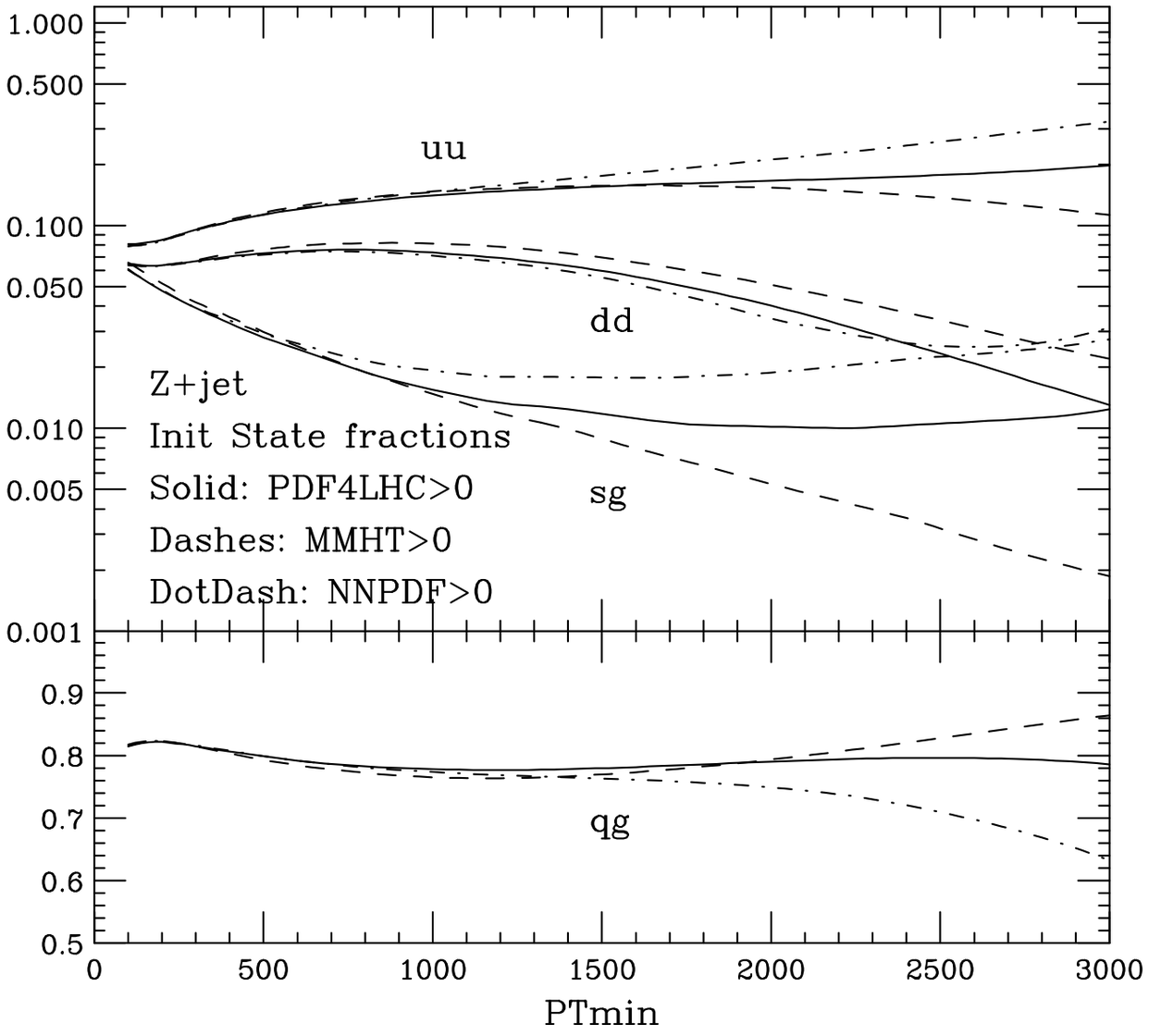
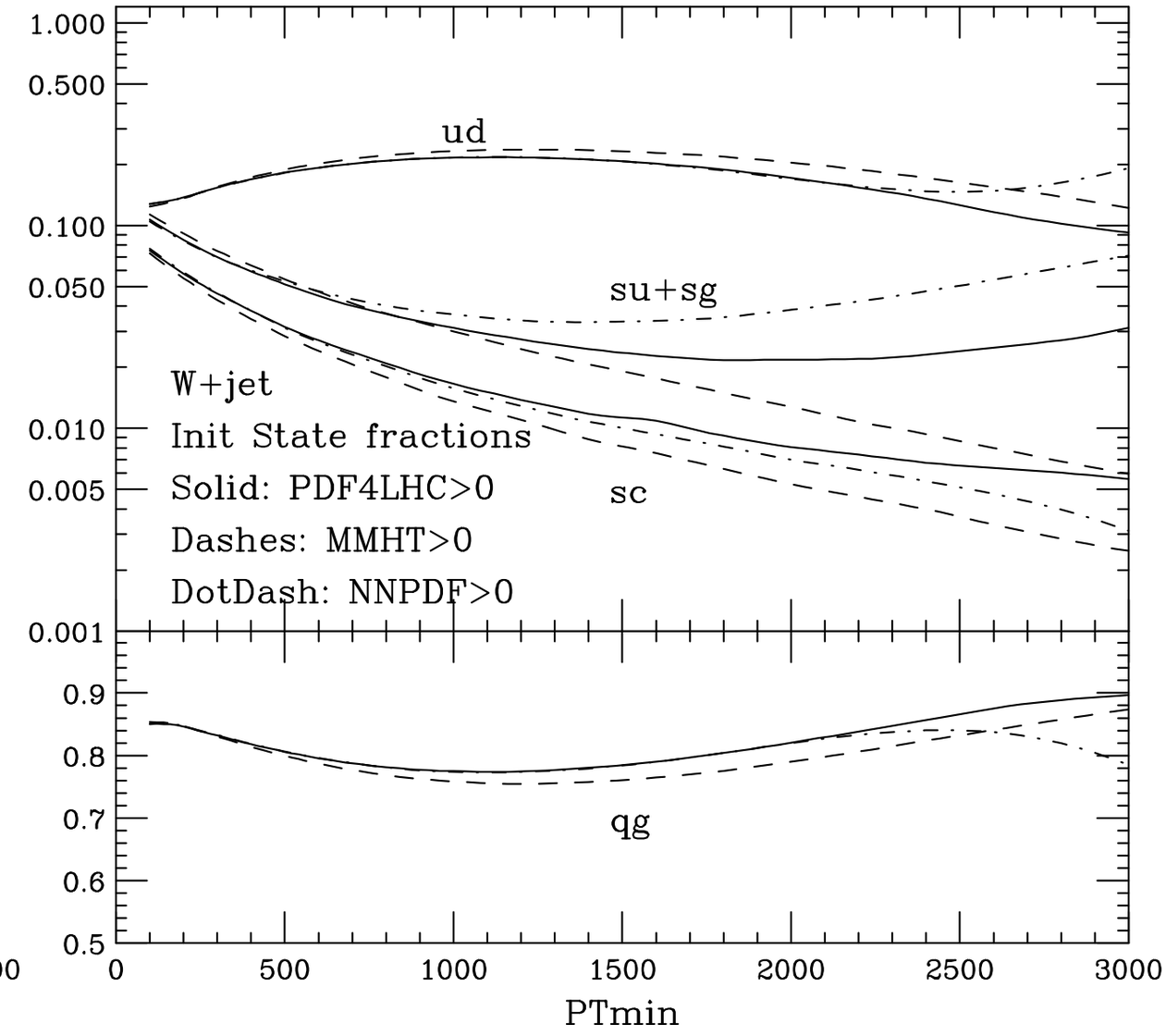
x
Generated with APFEL 2.7.1 Web

s(x) > g(x) for x>~ 0.5

Fractional contributions of different initial states, for different PDF sets (LO and positive PDFs)





Notice the different shapes of the qg contribution for Z and W spectra.

Notice also the big PDF dependence of these fractions. In particular the huge spread of the processes involving a strange quark, which at large pt can vary between few permille (MMHT) and several percent (NNPDF). PDF4LHC is in between, but it's likely to be greatly pulled by NNPDF

Differences would be enhanced allowing for negative PDFs

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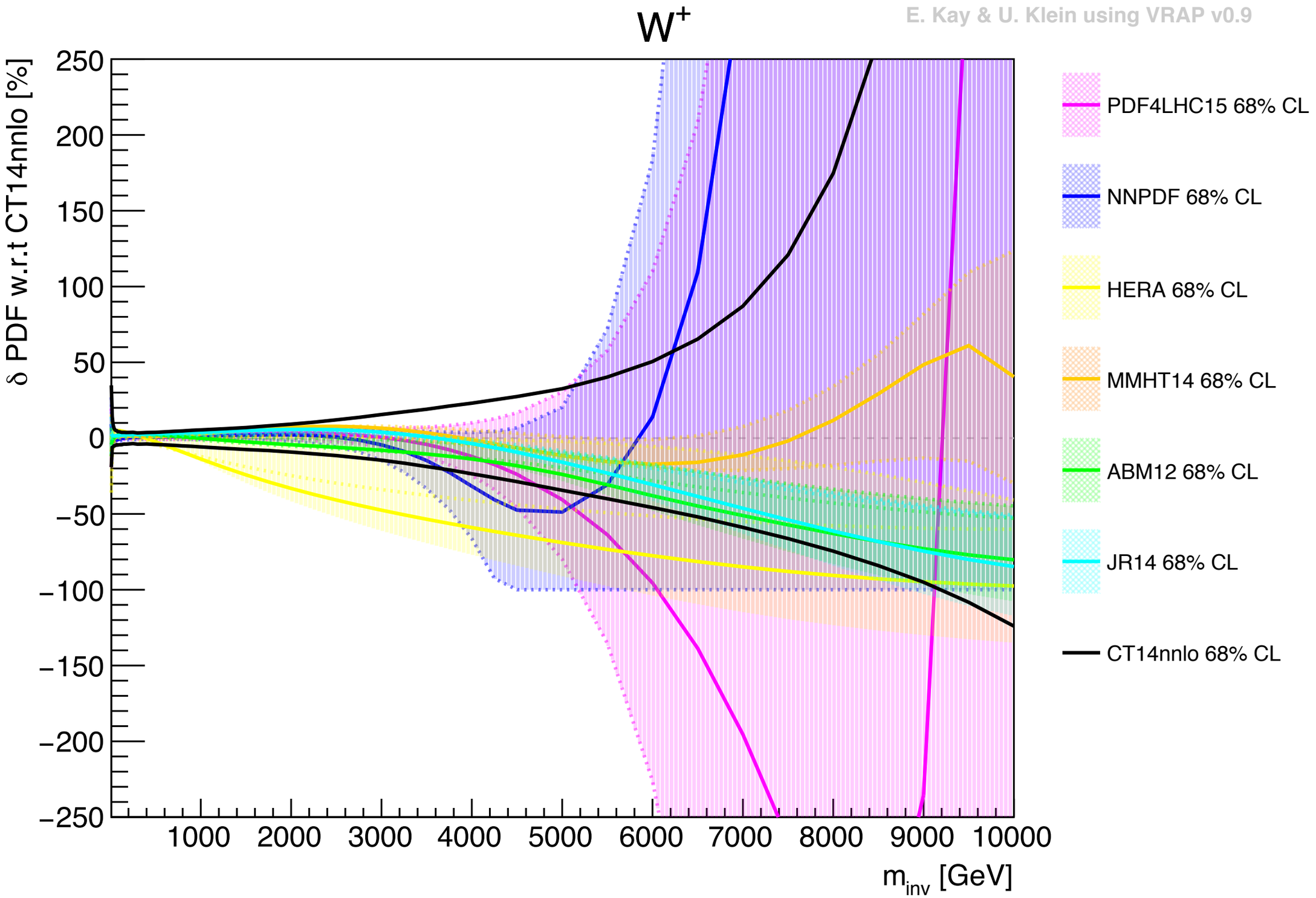
from Uta Klein



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- Are there general criteria that can be added? E.g.
  - gluon > sea?
  - s vs sbar?