HERAPDF2.5JETS progress to NNLO

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H1/ZEUS April 2018

Updating HERAPDF2.0Jets with new H1 lowQ2 jet data AND
Going to NNLO with the jets

Recall we have already established great agreement Mandy/Katyarzyna ie Oxford code/xFitter with all jets including the new H1 low Q2 jets at NLO..
The following is work in progress on NNLO

We got NNLO grids for the jet data from Daniel
All that were included in HERAPDF2.0Jets
----------**except** trijets
----------**except** ZEUS inclusive jets 96/97 (**which is underway- ANY NEWS?**)
----------**plus** the H1 2016 low q2 inclusive and dijets
These are as yet **unofficial—but there seems to be a way to make them official?**

The NNLO fits are done using AMCS 'ZEUS' code
There is no xFitter implementation yet? STILL TRUE?

Now compare NNLO and NLO both fits with alphas(M_Z^2)=0.118

NLO

Total chisq = 1806.5
Sumsq hera2 = 97.6
sumsqf2c= 45.9
sumsq old jets= 7.1, new h1jets= **70.0**
X/N CCEP = 39 44.0
X/N CCEM = 42 50.8
X/N NCEP 920= 377 429.0
X/N NCEP 820= 70 68.1
X/N NCEM= 159 222.5
newsigcharm = 47 43.6
newsigbeauty = 26 16.5
X/N NCEP 460 = 204 212.8
X/N NCEP 575 = 254 215.9
ZEUS di-jets = 16 **20.8**
H1 HERA1 highq2 = 24 16.8
H1 HERA1 lowq2 **= 22 19.8**
H1 2013 high q2 incl = 24 23.7
H1 2013 high q2 dijets = 24 37.8
H1 2016 low q2 incl = 48 99.8
H1 2016 low q2 dijet= 48 63.8

NNLO

Total chisq =1815.6
Sumsq hera2 = **121.4**
sumsqf2c= 46.3
sumsq old jets= **20.3 ,** new h1jets= **11.2**
X/N CCEP = 39 45.2
X/N CCEM = 42 53.2
X/N NCEP 920= 377 453.6
X/N NCEP 820= 70 71.3
X/N NCEM= 159 219.3
newsigcharm = 47 45.9
newsigbeauty = 26 18.5
X/N NCEP 460 = 204 208.7
X/N NCEP 575 = 254 217.9
ZEUS di-jets = 16 **15.2**
H1 HERA1 highq2 = 24 19.1
H1 HERA1 lowq2 **= 22 42.9**
H1 2013 high q2 incl = 24 36.1
H1 2013 high q2 dijets = 24 51.7
H1 2016 low q2 incl = 48 81.7
H1 2016 low q2 dijet= 48 35.8

Some jets better -new 2016 low q2 H1 jets and ZEUS dijets
Some jets worse—older 2013 high q2 H1 jets and HERA-1 H1 low q2 jets
The 2013 high q2 H1 jets also had worse chisq at NNLO for H1 jet analysis
Look in a bit more detail…

Compare chisq to H1 jets alphas fit (DESY-17-137)chisq

Don't expect complete agreement --H1 jets alphas fit is not done under all the same conditions

But should be in same 'ball park'

Inclusive	**ndp**	**chisq**	**From Daniel for H1 jets alphas fit**
H1 HERA1 lowq2 =	**22**	**42.9**	compare **22 17.5 -----NOT OKAY**
H1 HERA1 highq2 =	24	19.1	24 15.02

HERA-II lowq2 incl = 48 81.7 → 117.5 for 96 compare 31.42 for 63— **OK?**

HERA-II low q2 dijet= 48 35.8

Here data points are not the same because cuts on $\mu^2 = Q^2+pt^2$ are made in H1 fit

HERA-II high q2 incl = 24 36.1 → 87.8 for 48 compare 90.57 for 54 **OKAY**

HERA-II high q2 dijets= 24 51.7

Here data points are not the same because and extra low pt bin is added for the H1 fit

Need to investigate why H1 HERA-1 low q2 jets chisq differ so much could be because value of alphas I use-- 0.118 –is too high for them, they like 0.109

Need to investigate the effect of cuts.. And of fitting each data set alone..

Further work fit H1 new 2016 lowq2 ALONE- and applying cuts

Total chisq =1815.6
Sumsq hera2 = **121.4**
sumsqf2c= 46.3
sumsq old jets= **20.3 ,** new h1jets= **11.2**
X/N CCEP = 39 45.2
X/N CCEM = 42 53.2
X/N NCEP 920= 377 453.6
X/N NCEP 820= 70 71.3
X/N NCEM= 159 219.3
newsigcharm = 47 45.9
newsigbeauty = 26 18.5
X/N NCEP 460 = 204 208.7
X/N NCEP 575 = 254 217.9
ZEUS di-jets = 16 **15.2**
H1 HERA1 highq2 = 24 19.1
H1 HERA1 lowq2 **= 22 42.9**
H1 2013 high q2 incl = 24 36.1
H1 2013 high q2 dijets = 24 51.7
H1 2016 low q2 incl = 48 81.7
H1 2016 low q2 dijet= 48 35.8

Total chisq =1622 1544
Sumsq hera2 = **117.7 119.2**
sumsqf2c= 46.9 47.1
sumsq old jets= **,** new h1jets= **13.3, 14.1**
X/N CCEP = 39 44.6 43.8
X/N CCEM = 42 54.1 54.2
X/N NCEP 920= 377 442.3 438.7
X/N NCEP 820= 70 69.8 69.0
X/N NCEM= 159 218.5 218.7
newsigcharm = 47 46.4 46.6
newsigbeauty = 26 18.5 18.6
X/N NCEP 460 = 204 209.4 209.6
X/N NCEP 575 = 254 216.98 216.6

Fit alone without cuts—very similar
Fit alone with cuts—dramatic improvement

H1 2016 low q2 incl = 48 85.3 cut 31 32.2
H1 2016 low q2 dijet= 48 38.1 cut 31 15.6

Params not very different, slightly softer gluon
NOW apply cuts mu cut>14 and get 47.8 for 62 , more like Daniel
Params not so different after cuts.

Further work fit H1 HERA-1 lowq2 ALONE

Total chisq =1815.6
Sumsq hera2 = **121.4**
sumsqf2c= 46.3
sumsq old jets= **20.3 ,** new h1jets= **11.2**
X/N CCEP = 39 45.2
X/N CCEM = 42 53.2
X/N NCEP 920= 377 453.6
X/N NCEP 820= 70 71.3
X/N NCEM= 159 219.3
newsigcharm = 47 45.9
newsigbeauty = 26 18.5
X/N NCEP 460 = 204 208.7
X/N NCEP 575 = 254 217.9
ZEUS di-jets = 16 **15.2**
H1 HERA1 highq2 = 24 19.1
H1 HERA1 lowq2 **= 22 42.9**
H1 2013 high q2 incl = 24 36.1
H1 2013 high q2 dijets = 24 51.7
H1 2016 low q2 incl = 48 81.7
H1 2016 low q2 dijet= 48 35.8

Total chisq =1540.5 **alphas=0.109 1534.1**
Sumsq hera2 = **115.1** **100.8**
sumsqf2c= 45.7 44.3
sumsq old jets= **7.8 ,** new h1jets= **0,** **4.0**
X/N CCEP = 39 44.4 49.6
X/N CCEM = 42 54.3 52.8
X/N NCEP 920= 377 440.8 444.8
X/N NCEP 820= 70 69.4 68.6
X/N NCEM= 159 218.6 225.1
newsigcharm = 47 46.9 43.4
newsigbeauty = 26 18.6 17.8
X/N NCEP 460 = 204 210.5 213.7
X/N NCEP 575 = 254 217.7 220.3

H1 HERA1 lowq2 **= 22 48.9 alone, alphas=0.109 48.6!!**

Params not very different, slightly softer glue
And obvioulsy alphas=0.109 makes it softer still but it does NOT improve this jet data set chisq
The change is coming from HERA overall

So now look at cuts…

Could success simply be a matter of cuts?
Applying a mu cut of 14 to the H1 HERA-1 low q2 reduces 22 points to 15
I actually decided on mu cut 13.5 to make it 16 and I get

Total chisq =1513.8
Sumsq hera2 = **118.3**
sumsqf2c= 47.2
sumsq old jets= **8.0 ,** new h1jets= **0,**
X/N CCEP = 39 43.8
X/N CCEM = 42 54.3
X/N NCEP 920= 377 438.4
X/N NCEP 820= 70 69.0
X/N NCEM= 159 218.6
newsigcharm = 47 46.7
newsigbeauty = 26 18.6
X/N NCEP 460 = 204 210.0
X/N NCEP 575 = 254 216.8

H1 HERA1 lowq2 **= 16 23.9**

Params not very different, slightly softer glue

SO maybe try mu cut 13.5 on the whole lot?

Mu cut > 13.5 on everything—only affects lowq2 jets

Total chisq =1728.5
Sumsq hera2 = **123.7**
sumsqf2c= 45.8
sumsq old jets= **19.9 ,** new h1jets= **11.5**
X/N CCEP = 39 44.2
X/N CCEM = 42 53.5
X/N NCEP 920= 377 447.1
X/N NCEP 820= 70 70.2
X/N NCEM= 159 219.2
newsigcharm = 47 45.6
newsigbeauty = 26 18.4
X/N NCEP 460 = 204 208.3
X/N NCEP 575 = 254 217.1
ZEUS di-jets = 16 **167**
H1 HERA1 highq2 = 24 19.8
H1 HERA1 lowq2 **= 16 21.6**
H1 2013 high q2 incl = 24 36.8
H1 2013 high q2 dijets = 24 52.5
H1 2016 low q2 incl = 32 39.7
H1 2016 low q2 dijet= 32 16.7

Parameter check for Katarzyna

PARAM, 1 0.838 0.014
PARAM, 2 4.72 0.058
PARAM, 3 8.90 0.63
PARAM, 5 1.07 0.052
PARAM, 6 4.91 0.25

PARAM, 9 1.01 0.025
PARAM, 10 -0.107 0.0031
PARAM, 11 5.79 0.71
PARAM, 12 10.42 1.25
PARAM, 13 0.135 0.015
PARAM, 14 6.95 0.31
PARAM, 16 0.05 0.94
PARAM, 17 0.118 fixed

Success on getting chisq in reasonable agreement with Daniel

Now wait for ZEUS 96/97 and xFitter implemenmtation
AND then execute Iris' plan

Iris's suggested plan

Keep ALL settings as for HERAPDF2.0
[including mass parameters for NLO and NNLO, respectively]
Remove heavy flavor data
HERAPDF2.5NLO-Jets-only ==> compare HERAPDF2.5 Jets-only to HERAPDF2.0Jets at NLO- only message: it makes no difference (suggest apply mu cuts at this stage)

Produce the exactly same fit in NNLO --> HERAPDF2.5NNLO-Jets-only
==> MAJOR MESSAGE: What does NNLO do? How does alphas_s change?
Is the scale uncertainty less?

Then add all new jet data (subject to same mu cut) and produce:
HERAPDF3.0NLO-Jets-only HERAPDF3.0NNLO-Jets-only
Message: what do new low Q^2 jets do?

Do new mass parameter scans with new HF data and produce
HERAPDF3.5NLO-Jets-only HERAPDF3.5NNLO-Jets-only
==> message: mass parameters are insignificant at this level
Add the HF data to the fit and produce HERAPDF3.5NLO-Jets HERAPDF3.5NNLO-Jets
==> message: using the HF data expicitly doesn't do anything, everything's is consistent.

HERAPDF3.0NLO-Jets-only HERAPDF3.0NNLO-Jets-only
-- should have full error analysis, the rest could be treated with exp. unc. only and called consistent. (Why not JETS rather than JETS-only?)