Status of pseudo-experiments generation for PDF correlation studies

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Introduction

- Aim to determine correlations among the different PDFs of the new generation global PDF fits
  - Without knowing these correlations, we cannot "average" measurements over different PDF sets and therefore cannot scientifically produce a result for mW or s2w which accounts fully for PDF uncertainties
  - Correlations to be measured using pseudo-experiments generated for the full datasets used by the PDF fitters

- Proposal first presented by Daniel at the PDF4LHC last December (link) and further discussed in Durham (link)
  - Dedicated technical discussion last month (link)
  - xFitter identified as the tool to produce and validate the toys production
- Contact persons identified for each PDF group and experiment
  - F. Giuli (ATLAS & NNPDF) E. Lipka (CMS & CT),
    S. Amoroso (ATLAS & MMHT), O. Zenaiev (CMS & ABMP), M. Pili (LHCb)

Introduction

* Strategy for toys production using xFitter discussed by S. Glazov (link) and agreed upon at the last meeting

Proposed strategy

- Use Gaussian errors
- Use symmetrized uncertainties
- Develop scripts for toy generation/monitoring.
- Store tools in a common repository
- Apart from generated toys, keep steering cards/validation results for reproducibility
- Validate setup on selected data sample.
- Review data sets used by the fitting groups, check if they are present in xFitter, add missing.
- Validate matching of toys to files used by the fitting groups.

Toys from xFitter datasets

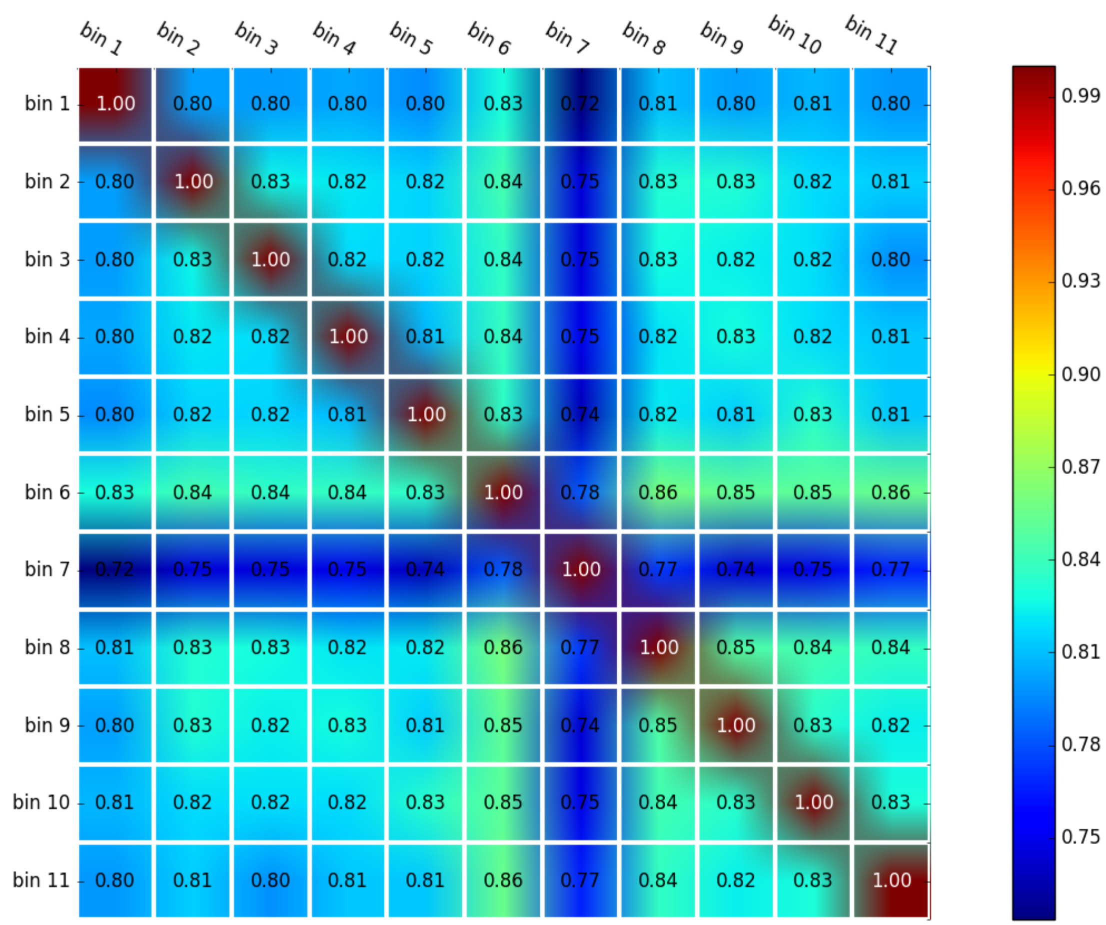
- Code for toys production and their validation developed in the past month by S. Mikhalcov and V. Novik
  - Available at https://gitlab.cern.ch/smikhalc/test

- Can generate multiple pseudo-experiments for any dataset in xFitter format
  - Code is fast enough to produce o(1000 toys)/day
- Validation scripts able to compare the covariance matrix as built from the data with the one obtained by the toys
  - What is the level of accuracy we should aim for?
- Result of the toys stored in the same format as the input datasets
  - Should be close to what PDF groups use as input

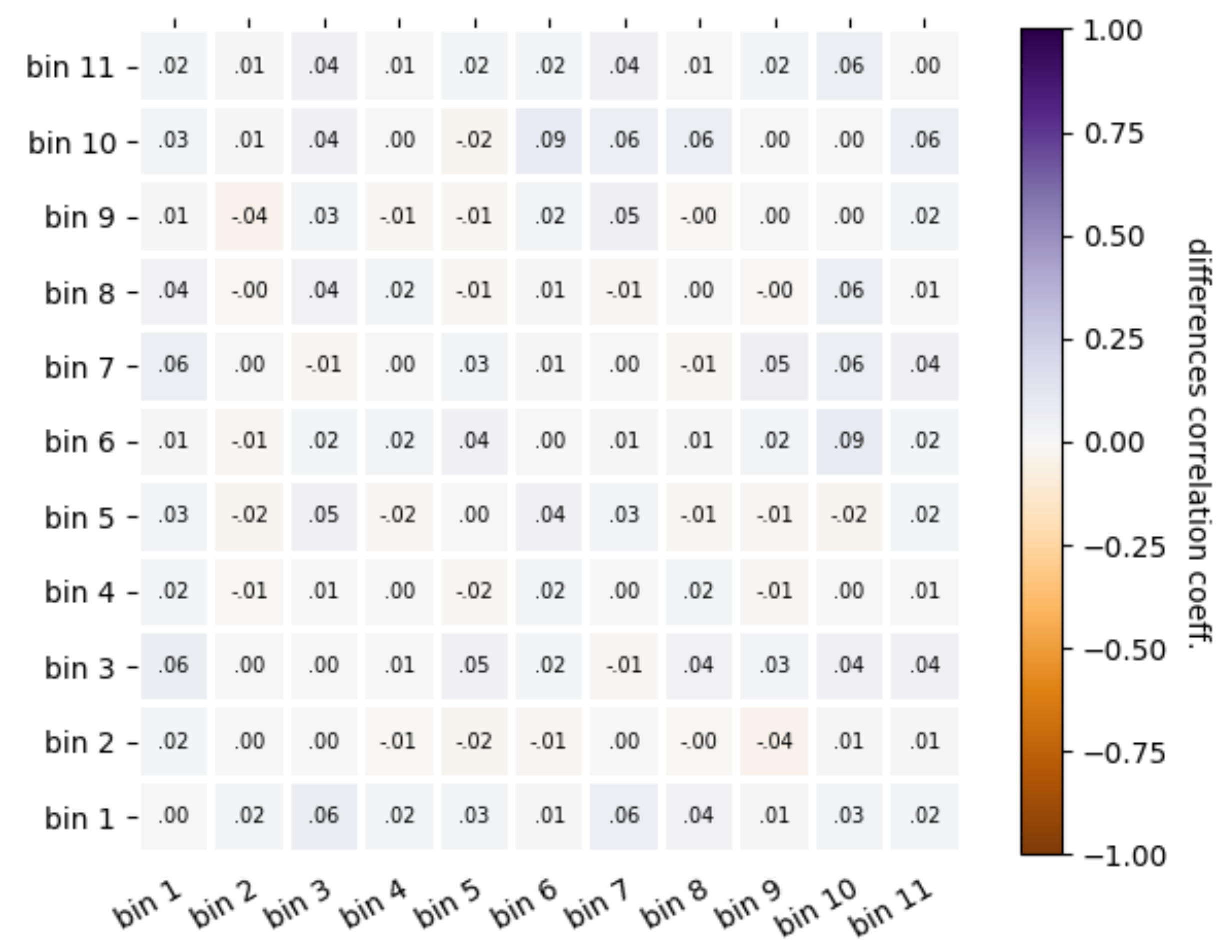
Validation of the toys

From ATLAS 1612.03016

Covariance matrix from the toys



Difference covariances from the data uncertainties and as built from the toys



Datasets in xFitter

- Not all of the datasets used by the global PDF fits are present in xFitter
- At the last meeting went through the datasets currently available in the latest xFitter release (2.0.1)
  - https://cernbox.cern.ch/index.php/s/CX4DmTT33fhOoNf
- Compared this with the datasets used in last PDF fits
  - CT14 - 1506.07443
  - MMHT14 - 1412.3989
  - NNPDF31 - 1706.00428
  - ABMP16 - 1701.05838
- Some general conclusions
  - HERA datasets are all present (some still privately available
  - Tevatron data mostly available
  - Neutrino experiments are missing
  - All but the newest ATLAS and CMS datasets are present, but missing most of the LHCb ones

Input to PDF fitters

- Pseudo-experiments for the already existing datasets could already be produced
  - What is the preferred format and location to share them across the groups?
  - Are the xFitter input datasets format good enough? Iterations ongoing with CT to provide inputs closer to their native format; if needed could do the same for other groups

- Quite a number of missing datasets would need to be implemented in xFitter; not hard if available in HepData
  - Will provide a list of what's missing; should/will the experiment contacts do this work?
- And I would consider useful to distribute o(1000) toys for the HERA2 dataset to start getting feedback from PDF groups
  - Both on the format, and on the results of fitting them

Backup

Datasets in xFitter-2.0.1

- E866 0103030
- CDF/dy 0901.2169, 0908.3914
- CDF/jets 0807.2204
- CDFandD0/top 1309/7570
- D0/jets 0802.2400
- D0/dy 1309.2591, 1312.2895, 1412.2862, 0702025
- BCDMS/dis cern-ep-89-06
- ATLAS/dy 1305.4192, 1404.1212,1203.4051,1612.03016
- ATLAS/jets 1112.6297,1304.4739
- CMS/jets 1212.6660,1609.05331
- CMS/dy 1110.4973,1206.2598,1310.1138,1312.6283,1603.01803
- H1/jets 0706.3722, 0707.4057, 0904.3870, 0911.5678, 1406.4789
- H1/dis 1012.4355
- ZEUS/jets 1010.6167, 0208037, 0608048
- HERA/dis 0911.0884,1506.06042
- HERA/charmbeauty 1211.1182,

ABMP16

- From https://arxiv.org/pdf/1701.05838.pdf

HERA I+II Eur. Phys. J. C 75, 580 (2015) arXiv:1506.06042.

BCDMS Phys. Lett. B223, 485 (1989).

NMC Nucl. Phys. B483, 3 (1997), hep-ph/9610231

SLAC Phys. Rev. D20, 1471 (1979), Phys. Rev. D27, 285 (1983) , Phys. Lett. B250, 193 (1990)

HERA charm Eur. Phys. J. C73, 2311 (2013), arXiv:1211.1182.

H1 bottom Eur. Phys. J. C65, 89 (2010), arXiv:0907.2643

ZEUS bottom JHEP 09, 127 (2014), arXiv:1405.6915.

CCFR Phys. Rev. D64, 112006 (2001), hep-ex/0102049.

CHORUS New J. Phys. 13, 093002 (2011), arXiv:1107.0613

NOMAD Nucl. Phys. B876, 339 (2013), arXiv:1308.4750

NuTeV Phys. Rev. D64, 112006 (2001), hep-ex/0102049.

ATLAS W/Z 7TeV Phys. Rev. D85, 072004 (2012), arXiv:1109.5141.

ATLAS W/Z 13TeV Phys. Lett. B759, 601 (2016), arXiv:1603.09222.

CMS W 7TeV Phys. Rev. D90, 032004 (2014), arXiv: 1312.6283.

CMS W 8TeV Eur. Phys. J. C76, 469 (2016), arXiv: 1603.01803.

D0 W->munu Phys. Rev. D88, 091102 (2013), arXiv: 1309.2591.

D0 W->enu Phys. Rev. D91, 032007 (2015), arXiv: 1412.2862

LHCB W/Z 7TeV JHEP 08, 039 (2015), arXiv: 1505.07024.

LHCB W 8TeV JHEP 01, 155 (2016), arXiv: 1511.08039.

LHCB Z 8TeV JHEP 05, 109 (2015), arXiv: 1503.00963.

FNAL-605 Phys. Rev. D43, 2815 (1991)

FNAL-866 Phys. Rev. D64, 052002 (2001), hep-ex/ 0103030

Used in MMHT14

- From https://arxiv.org/pdf/1412.3989.pdf

———— Neutrino ————

NuTeV νN F_2 [Phys.Rev. D74, 012008 (2006), hep-ex/0509010]

CHORUS νN F_2 [Phys.Lett. B632, 65 (2006)]

NuTeV νN xF_3 [Phys.Rev. D74, 012008 (2006), hep-ex/0509010]

CHORUS νN xF_3 [Phys.Lett. B632, 65 (2006)]

CCFR νN → μμX [Phys.Rev. D64, 112006 (2001), hep- ex/0102049.]

NuTeV νN → μμX [Phys.Rev. D64, 112006 (2001), hep- ex/0102049.]

———— NuSea ————

E866/NuSea pp DY [hep-ex/0301031.]

E866/NuSea pd/pp DY [Phys.Rev. D64, 052002 (2001), hep-ex/0103030]

———— HERA ————

HERA e^+p NC 820 GeV[JHEP 1001, 109 (2010), 0911.0884]

HERA e^+p NC 920 GeV[JHEP 1001, 109 (2010), 0911.0884]

HERA e^-p NC 920 GeV [JHEP 1001, 109 (2010), 0911.0884]

HERA e^+p CC [JHEP 1001, 109 (2010), 0911.0884]

HERA e^-p CC [JHEP 1001, 109 (2010), 0911.0884]

HERA ep F^{charm} [Eur.Phys.J. C73, 2311 (2013), 1211.1182]

H1 99–00 e^+p incl. jets [Phys.Lett. B653, 134 (2007), 0706.3722]

ZEUS incl. jets [Nucl.Phys. B765, 1 (2007), hep-ex/0608048 , Phys.Lett. B547, 164 (2002), hep-ex/0208037]

Used in MMHT14

———— Tevatron ————

DØ II $p\bar{p}$ incl. jets Phys.Rev. D85, 052006 (2012), 1110.3771.

CDF II $p\bar{p}$ incl. jets Phys.Rev. D75, 092006 (2007), hep-ex/0701051.

CDF II W asym Phys.Rev.Lett. 102, 181801 (2009), 0901.2169

DØ II $W \rightarrow \nu e$ asym. Phys.Rev.Lett. 101, 211801 (2008), 0807.3367

DØ II $W \rightarrow \nu\mu$ asym Phys.Rev. D88, 091102 (2013), 1309.2591

DØ II Z rap. Phys.Rev. D76, 012003 (2007), hep-ex/0702025

CDF II Z rap. Phys.Lett. B692, 232 (2010), 0908.3914

———— LHC ————

ATLAS W^+,W^-,Z [Phys.Rev. D85, 072004 (2012), 1109.5141]

CMS W asymm $p_T > 35$ GeV [Phys.Rev.Lett. 109, 111806 (2012), 1206.2598]

CMS asymm $p_T > 25$ GeV, 30 GeV[JHEP 1104, 050 (2011), 1103.3470]

LHCb $Z \rightarrow e^+e^-$[JHEP 1302, 106 (2013), 1212.4620]

LHCb W asymm $p_T > 20$ GeV[JHEP 1206, 058 (2012), 1204.1620]

CMS $Z \rightarrow e^+e^-$ [Phys.Rev. D85, 032002 (2012), 1110.4973]

ATLAS high-mass Drell-Yan [Phys.Lett. B725, 223 (2013), 1305.4192]

CMS double diff. Drell-Yan [JHEP 1312, 030 (2013), 1310.7291]

Tevatron,ATLAS,CMS $\sigma_{t\bar{t}}$[91]–[97]

ATLAS jets (2.76 TeV+7 TeV)[Eur.Phys.J. C73, 2509 (2013), 1304.4739 , Phys.Rev. D86, 014022 (2012), 1112.6297]

CMS jets (7 TeV) [Phys.Rev. D87, 112002 (2013), 1212.6660]

Used in CT14

- From https://arxiv.org/pdf/1506.07443.pdf

———— NuSea ————

E605 Drell-Yan process [Phys. Rev. D 43, 2815 (1991)]

E866 Drell-Yan process, $\sigma_{pd}/(2\sigma_{pp})$ [Phys.Rev. D64, 052002 (2001), hep-ex/0103030]

E866 Drell-Yan process, $Q^3 d^2\sigma_{pp}/(dQdx_F)$ hep-ex/0302019

———— Tevatron ————

CDF Run-1 electron A_{ch}, $p_{Tl} > 25$ GeV [Phys.Rev.Lett. 77, 2616 (1996)]

CDF Run-2 electron A_{ch}, $p_{Tl} > 25$ GeV [Phys. Rev. D71, 051104 (2005)]

DØ Run-2 muon A_{ch}, $p_{Tl} > 20$ GeV [Phys.Rev. D77, 011106 (2008), 0709.4254]

DØ Run-2 Z rapidity [Phys.Lett. B658, 112 (2008), hep-ex/0608052]

CDF Run-2 Z rapidity [Phys.Lett. B692, 232 (2010), 0908.3914.]

DØ Run-2 9.7 fb^{-1} electron A_{ch}, $p_{Tl} > 25$ GeV [Phys. Rev. D91, 032007 (2015) 1412.2862]

CDF Run-2 inclusive jet production [Phys. Rev. D78, 052006 (2008)]

DØ Run-2 inclusive jet production [Phys.Rev.Lett. 101, 062001 (2008), 0802.2400.]

———— LHC ————

CMS 7 TeV 4.7 fb^{-1}, muon A_{ch}, $p_{Tl} > 35$ GeV [Phys.Rev. D90, 032004 (2014), 1312.6283]

CMS 7 TeV 840 pb^{-1}, electron A_{ch}, $p_{Tl} > 35$ GeV [Phys.Rev.Lett. 109, 111806 (2012), 1206.2598]

ATLAS 7 TeV 35 pb^{-1} W/Z cross sec., A_{ch} [Phys.Rev. D85, 072004 (2012), 1109.5141]

ATLAS 7 TeV 35 pb^{-1} incl. jet production [Phys.Rev. D86, 014022 (2012), 1112.6297]

CMS 7 TeV 5 fb^{-1} incl. jet production [Phys.Rev. D87, 112002 (2013), 1212.6660]

LHCb 7 TeV 35 pb^{-1} W/Z $d\sigma/dy_l$ [JHEP 1206, 058 (2012), 1204.1620]

LHCb 7 TeV 35 pb^{-1} A_{ch}, $p_{Tl} > 20$ GeV [JHEP 1206, 058 (2012), 1204.1620.]

———— Neutrino ————

BCDMS F_2^p [Phys. Lett. B 223, 485 (1989)]

BCDMS F_2^d [Phys. Lett. B 237, 592 (1990)]

NMC F_2^d/F_2^p [Nucl. Phys. B 483, 3 (1997) [hep-ph/9610231].]

NMC σ^p [Nucl. Phys. B 483, 3 (1997) [hep-ph/9610231].]

CDHSW F_2^p [Z. Phys. C 49, 187 (1991)]

CDHSW F_3^p [Z. Phys. C 49, 187 (1991)]

C C F R F_2^p [Phys. Rev. Lett. 86, 2742 (2001) [hep-ex/0009041]]

CCFR xF_3^p [Phys. Rev. Lett. 79, 1213 (1997) [hep-ex/9701017]

NuTeV $\nu\mu\mu$ SIDIS [FERMILAB-THESIS-2006-01]

NuTeV $\bar{\nu}\mu\mu$ SIDIS [FERMILAB-THESIS-2006-01]

CCFR $\nu\mu\mu$ SIDIS [Phys. Rev. D 64, 112006 (2001) [hep-ex/0102049]]

CCFR $\bar{\nu}\mu\mu$ SIDIS [Phys. Rev. D 64, 112006 (2001) [hep-ex/0102049].]

———— HERA ————

H 1 σ_r^b [Eur. Phys. J. C 40, 349 (2005) [hep-ex/0411046]

Combined HERA charm production [Eur.Phys.J. C73, 2311 (2013), 1211.1182.]

HERA1 Combined NC and CC DIS [JHEP 1001, 109 (2010), 0911.0884]

H1 F_L [.Eur.Phys.J. C71, 1579 (2011), 1012.4355]

Used in NNPDF31

* From https://arxiv.org/pdf/1706.00428.pdf

ATLAS W,Z 2010 Phys.Rev. D85 (2012) 072004, [arXiv:1109.5141].

ATLAS W, Z 2011 (*) arXiv:1612.03016

ATLAS high-mass DY 2011 Phys.Lett. B725 (2013) 223 [arXiv:1305.4192]

ATLAS low-mass DY 2011 (*) JHEP 06 (2014) 112, [arXiv:1404.1212].

ATLAS [ZpT 7TeV (*) JHEP 09 (2014) 145, [arXiv:1406.3660].

ATLAS ZpT 8TeV (*) Eur. Phys. J. C76 (2016), no. 5 291, [arXiv:1512.02192].

ATLAS 7 TeV jets 2010. Phys. Rev. D86 (2012) 014022, [arXiv:1112.6297].

ATLAS 2.76 TeV jets Eur.Phys.J. C73 (2013) 2509, [arXiv:1304.4739]

ATLAS 7 TeV jets 2011 (*) JHEP 02 (2015) 153, [arXiv:1410.8857]

ATLAS top 74,75 73

CMS W electron asy Phys.Rev.Lett. 109 (2012) 111806 arxiv:1206.2598

CMS W muon asy Phys.Rev. D90 (2014) 032004, [arXiv:1312.6283].

CMS W + c JHEP 02 (2014) 013, arXiv:1310.1138

CMS 2D DY 2011 7 TeV JHEP 1312 (2013) 030 [arXiv:1310.7291]

CMS 2D DY 2012 8 TeV Eur.Phys.J C75 (2015) 4, 147 arXiv:1412.1115

CMS $W^{\pm}$ rap 8 TeV (*) Eur.Phys. J. C76 (2016), no. 8 469, [arXiv:1603.01803].

CMS ZpT 8TeV(*) Phys. Lett. B749 (2015) 187–209, [arXiv:1504.03511].

CMS 7 TeV jets 2011 Phys.Rev. D87 (2013) 112002 [arXiv:1212.6660]

CMS 2.76 TeV jets (*) Eur. Phys. J. C76 (2016), no. 5 265, [arXiv:1512.06212]

CMS top 82,88, 81

LHCb Z rapidity 940 pb JHEP 1206 (2012) 058 [arXiv:1204.1620]

LHCb $Z \to ee$ rapidity 2 fb JHEP 1302 (2013) 106, [arXiv:1212.4620]

LHCb W, $Z \to \mu$ 7 TeV (*) JHEP 08 (2015) 039, [arXiv:1505.07024]

LHCb W, $Z \to \mu$ 8 TeV (*) JHEP 01 (2016) 155, [arXiv:1511.08039]

Used in NNPDF31

E866 Phys. Rev. D64 (2001) 052002, [hep-ex/0103030] , hep-ex/0302019.

E605 Phys. Rev. D43 (1991) 2815-2836

CDF Z rap Phys. Lett. B692 (2010) 232–239, [arXiv:0908.3914].

CDF incl jets Phys. Rev. D75 (2007) 092006 [hep-ex/0701051]

D0 Z rap Phys. Rev. D76 (2007) 012003, [hep-ex/0702025].

D0 W electron asy (*) Phys. Rev. D91 (2015), no. 3 032007, [arXiv:1412.2862].

D0 W muon asy (*) Phys.Rev. D88 (2013) 091102, [arXiv:1309.2591]

NMC F_2^d/F_2^p Nucl. Phys. B487 (1997) 3–26, [hep-ex/9611022] , Nucl. Phys. B483 (1997) 3–43, [hep-ph/9610231]

SLAC F_2^d Phys. Lett. B282 (1992) 475–482.

BCDMS F_2^p Phys. Lett. B223 (1989) 485

BCDMS F_2^d Phys. Lett. B237 (1990) 592.

CHORUS Phys. Lett. B632 (2006) 65–75.

NuTeV Phys. Rev. D64 (2001) 112006, [hep-ex/0102049], FERMILAB-THESIS-2006-01

HERA Eur. Phys. J. C65 (2010) 89–109, [arXiv:0907.2643], JHEP 09 (2014) 127, [arXiv:1405.6915], Eur.Phys.J. C73 (2013) 2311, [arXiv:1211.1182],Eur. Phys. J. C75 (2015), no. 12 580, [arXiv:1506.06042].

EMC Nucl. Phys. B213 (1983) 31–64.