

W mass and PDF: an experimental view

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On behalf of the CMS and ATLAS

W mass working groups

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Outline

- 1) PDF and W mass at W mass workshop
- 2) Rhetorical questions about PDF and W mass
- 3) PDF and parton showers/resummation
- 4) non-PQCD effects and TMD PDF

LHC measurements and PDF fits

- Lots of measurement from LHC suitable for PDF fits, many already included in NNPDF 3.0

NNPDF3.0: New data

As compared to NNPDF2.3, in NNPDF3.0 we have included **more than 1000 new data points** from recent measurements from HERA and the LHC:

- HERA structure function data:** HERA-II structure functions from H1 and ZEUS, combined HERA F_{2c} cross-sections (**to be updated if HERA-II combined data released soon**)
- LHC jet data:** CMS 7 TeV **inclusive jets** from 2011, ATLAS 7 TeV **inclusive jets** from 2010, ATLAS 2.76 TeV **jets** including their correlation with 7 TeV data
- LHC electroweak data:** ATLAS **W, Z** from 2010, CMS **electron and muon asymmetries** from 2011, LHCb **W distributions** from 2010 and **Z rapidity distributions** from 2011, CMS **W+charm** production data, ATLAS and CMS **Drell-Yan production**, ATLAS **W p_T** distributions
- LHC top quark pair production data**

All these data are already reasonably well described by NNPDF2.3

Moderate impact in global fit, much more substantial in collider-only fit

Experiment	Dataset	DOF
NMC	NMCPD	356
	NMC	132
	NMC	224
SLAC	SLACP	74
	SLACP	37
	SLACD	37
BCDMS	BCDMS	581
	BCDMS	333
	BCDMS	248
CHORUS	CHORUS	862
	CHORUS	431
	CHORUS	431
NTVDM	NTVDM	79
	NTVDM	41
	NTVDM	38
HERA1A	HERA1A	592
	HERA1A	379
	HERA1A	145
	HERA1A	34
	HERA1A	34
ZEUSHERA2	ZEUSHERA2	252
	ZEUSHERA2	90
	ZEUSHERA2	37
	ZEUSHERA2	90
	ZEUSHERA2	35
H1HERA2	H1HERA2	511
	H1HERA2	139
	H1HERA2	138
	H1HERA2	29
	H1HERA2	29
	H1HERA2	124
HERAF2CHARM	HERAF2CHARM	47
	HERAF2CHARM	199
DYE86	DYE86	15
	DYE86	184
DYE605	DYE605	119
	DYE605	105
CDF	CDF	29
	CDF	76
DO	DO	138
	DO	28
ATLAS	ATLAS	110
	ATLAS	179
	ATLAS	30
CMS	CMS	30
	CMS	90
	CMS	59
	CMS	95
	CMS	11
LHCb	LHCb	11
	LHCb	11
	LHCb	63
	LHCb	5
	LHCb	5
	LHCb	5
	LHCb	132
TOP	TOP	19
	TOP	10
Total (exps)	TOP	9
	TOP	6
Total (exps)		4214

PDF during W mass @ LHC workshop(s)

ATLAS+CMS+TH on Mw

20-21 October 2014
Galileo Galilei Institute
Europe/Rome timezone

Search

<https://indico.cern.ch/event/340393>

Overview

Scientific Programme

Timetable

Contribution List

Author List

My Conference

... My Contributions

Registration

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Participant List

Video Services

Indications on how to reach GGI:
<http://www.ggi.fi.infn.it/index.php?p=info.inc>

Starts 20 Oct 2014 14:00
Ends 21 Oct 2014 18:00
Europe/Rome

Perrozzi, Luca
Montagna, Guido
Piccinini, Fulvio
Boonekamp, Maarten
Vicini, Alessandro
Prof. Wackerroth, Doreen

Galileo Galilei Institute
Largo Enrico Fermi,2 I-50125 FIRENZE
(Italy)

No material yet

- 30 participants among ATLAS, CMS and theorists

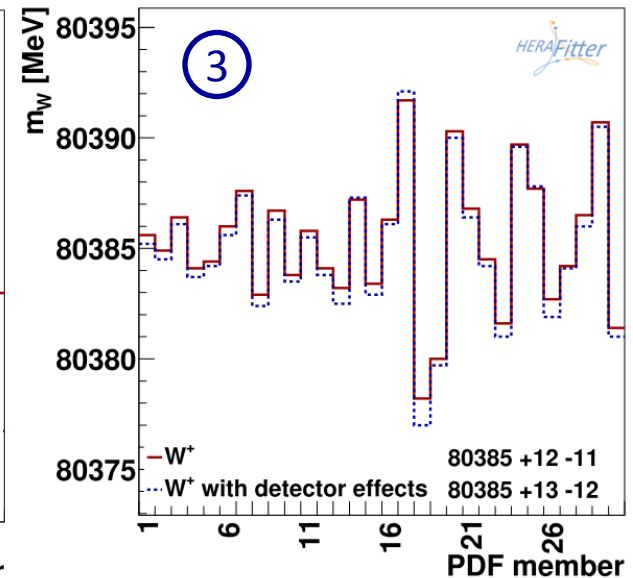
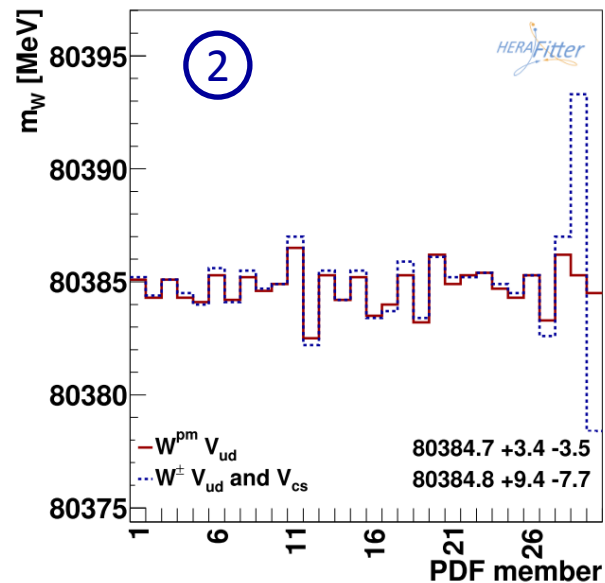
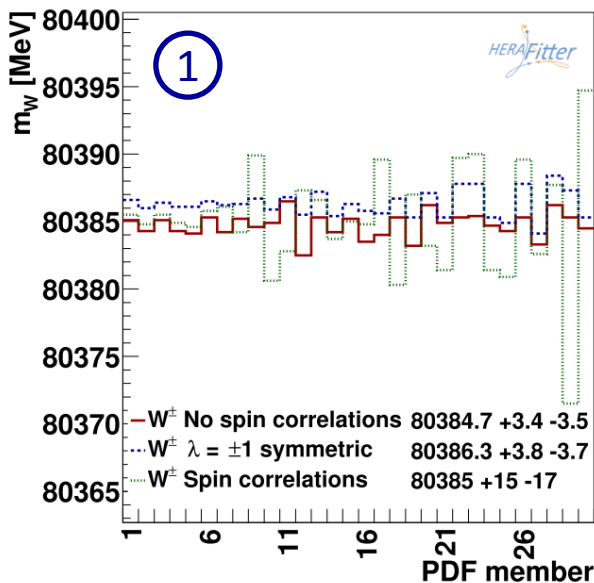
PDF uncertainties (discussion)	<i>Alessandro VICINI</i>
<i>Galileo Galilei Institute</i> https://indico.cern.ch/event/340393/contribution/5/material/slides/0.pdf	17:00 - 17:20
PDF uncertainty estimates	<i>Stefano CAMARDA</i>
<i>Galileo Galilei Institute</i> https://indico.cern.ch/event/340393/contribution/7/material/slides/0.pdf	09:30 - 09:50

- **Next workshop to be held Feb. 23rd-24th at CERN**
<https://indico.cern.ch/event/367442/>

If interested, subscribe to the mailing list lhc-ewwg-wmass@cern.ch through <http://egroups.cern.ch>

PDF studies for W mass: the ATLAS case

- Studies also shown at the last PDF4LHC
 - Public document available for details [ATL-PHYS-PUB-2014-015](#)
- Fitting m_W with lepton p_T the study uses a custo HERA PDF to addresses mainly:
 - 1) u and d PDF uncertainties on the average W polarisation
 - 2) strange PDF uncertainty on the charm-initiated W -production
 - 3) Impact of the muon momentum resolution on the PDF uncertainties



PDF studies for W mass: the ATLAS case

- Summary of PDF uncertainties

	MW-NLO	CT10nlo	MSTW2008CPdeutnlo	NNPDF30_nlo_as_118
W^+	+13 -12	+18 -22	+11 -10	+8 -10
W^-	+22 -22	+18 -23	+11 -10	+8 -9
W^\pm	+11 -11	+14 -18	+7 -7	+6 -5

NB: CT10nlo scaled to 68% C.L.

- Summary of biases among different PDF sets

	MW-NLO	CT10nlo	MSTW2008CPdeutnlo	NNPDF30_nlo_as_118
W^+	-9	-0.1	-20	-1.2
W^-	+48	+0.2	+13	+12
W^\pm	+16	0.0	-6	+5

Question time

Rhetorical questions on W mass and PDF

Fairly rhetorical but still unanswered or partially answered questions

a) Which flavours contribute the most in the pdf uncertainty of the w mass?

- Which is the most reliable method to be used for this scope? (bayesian reweighting and similar tools, pdf correlations, ATLAS approach...)

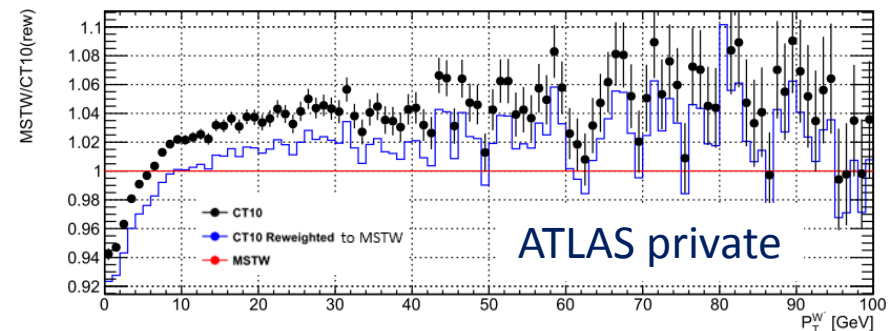
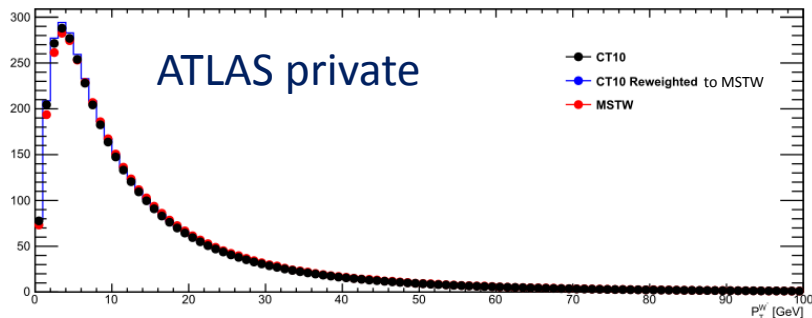
b) How to quote the pdf uncertainty for the W mass?

- Single set(s) 'a la Tevatron? Envelope of more sets? Which ones? PDF4LHC? **Meta-PDF?**
- NNPDF and CT10 uncertainties seem to be quite different: is it clear why?
- Are there correlations to take into account when PDF sets include the same dataset of the analysis?
 - For instance W charge asymmetry and W mass at the same energy
- Related to the point a): which measurements would have the major impact in the uncertainty reduction

Rhetorical questions on W mass and PDF

c) Reweighting tools: which are the most reliable?

- LHAPDF reweighting tool vs matrix element reweighting (in POWHEG, aMC@NLO, Sherpa, ...)
- How to probe the reliability of these tools?
- Example: PDF variations induce changes in the p_T distribution (cfr CT10 vs MSTW shown below), hence need a combined treatment of PDF and PS/resummation
- PDF reweighting incorporating properly the p_T effects would be an enormous benefit to avoid stat. noise which comes in if every set has to be generated explicitly
 - (POWHEG authors working on this)



PDF and parton showers/resummation

- Different PDFs predict different boson p_T shapes
 - This is particularly important for m_W since the W p_T spectrum is critical for the measurement
- Can we propagate PDF and PS (or resummed calculation) uncertainties separately?
 - Probably not
 - Shall we use a dedicated parton shower tune for each PDF, when propagating PDF uncertainties, to ensure agreement with p_T measurements at any time?
- How uncertain is the boson p_T spectrum for a given flavour?
 - Part of the PDF-induced p_T shape uncertainties come from heavy quark mass effects
 - Heavier initial quarks give harder p_T spectrum, changing the initial quark fractions affects the inclusive p_T distribution
- What is the timescale for combined PDF + PS/resummation fits?

non-PQCD effects and TMD PDF

- Recent studies performed with **Resbos (arXiv:1309.1393)** include **non-PQCD parameter** to properly fit $Z \text{ } \phi^*$ spectrum
 - What is the relation between primordial k_t , non-pQCD parametrisation in resummed calculations, and TMD PDF?
 - How to assign systematics?
- **What is the status of TMD PDF?**
 - Will they become important for the ultimate level of precision we are aiming for?

Summary

- The quest for a W mass measurement below the 10 MeV level requires a coordinated effort of several communities with complementary expertises
 - Experiments, MC builders, PDF fitters, ...
- The ultimate precision of W mass at LHC is likely to be dominated by the PDF uncertainty
- Is important to stimulate the discussions on the subject among the different communities
 - To develop tools and to agree on standard procedures to ensure reliability of the results
- We are organizing a series of workshops to discuss the specific points regarding W mass
 - Next workshop to be held Feb. 23rd-24th at CERN <https://indico.cern.ch/event/367442/>
 - You are very welcome to join → subscribe to the mailing list lhc-ewwg-wmass@cern.ch through <http://egroups.cern.ch>