

Introduction

- This afternoon session is mainly targeting the extracting PDF information from LHC measurements (present and future)
- This is a follow-up of a discussion that started in December, following a request from the LPCC-chair.

From last meeting...

It is time to think of a coordinated effort aiming at laying out a possible plan for key measurements to be done in the future, in order to **reduce PDF systematics with LHC data**, using present experience.

Michelangelo suggested having, for example, a small document, that could stimulate the experiments to give higher priority to the relevant QCD and EW measurements.

The PDF4LHC steering fully agrees with this goal and will take Initiative in this direction. We would make this the main theme for our next meeting. But we can start now.

People or groups that are interested in contributing/participating should contact us (eg deroeck@mail.cern.ch)

-> We will put up a twiki page with the input received for discussion.

PDF Info from LHC

- Twiki page with information/all are invited to contribute with results (experiments) and with ideas for new measurements, relevant TH discussion etc.,...
- Do we need special runs or special conditions (triggers, pile-up,...) to reduce systematics?
- Note: should be also a useful exercise for FCC or alike studies...

PDF information from LHC-data

- Input has been accumulated on a twiki
<https://twiki.cern.ch/twiki/bin/view/PDF4LHC/WebHome>
- People that would like access/add info should contact Juan.Rojo@physics.ox.ac.uk

Welcome to the PDF4LHC web page for collecting information on PDF relevant processes at the LHC

- See also: [Public PDF4LHC webpage](#) for general [PDF4LHC](#) information (Hosted at UCL)

The motivation for this [PDF4LHC](#) Twiki is to collect relevant information on available and future measurements for PDF studies, as well as the theoretical developments that are most pressing to make the most of LHC data. The plan, as briefly presented at the [PDF4LHC](#) meeting on December 13th is given on [PDF4LHC charge](#) and will be used as the basis of a public document that will summarise the status of PDF studies at the LHC. Right now we should collect the data.

The main charge is aiming at laying out a possible plan for key measurements to be done in the future, in order to reduce PDF systematics with LHC data, using present experience. In the last weeks it became also important that important to think on the precise measurements on the boundaries of the LHC kinematic phase space to help reducing the extrapolations needed for PDFs for eg FCC studies in the next years, so suggestions tailored to this question are also welcome.

People should feel free to add information to this web page following the format given below. The plan is to spend the next [PDF4LHC](#) meeting end of March on an in depth discussion and organise eventual additional studies and the editing of the document.

This Twiki is divided into three main sections: LHC data for PDF studies, theoretical calculations and tools, and methodological issues in PDF fits.

LHC Results

LHC data from Run I - Public results		
Process	Data	Theory
Inclusive W, Z production	ATLAS 2010 data arXiv:1109.5141	Differential predictions at NNLO QCD
	WZinclusiveData	WZinclusiveTheory
Inclusive W,Z production	LHCb 7 TeV 37pb-1 (mu) arXiv:1204.1620	
Inclusive Z production	LHCb 7 TeV 940pb-1 (e) arXiv:1212.4620	
Inclusive WZ production	CMS 8 TeV 19pb-1 (e/mu) arXiv:1402.0923	Inclusive cross section at NNLO
	CMS 7 TeV 36pb-1 (e/mu) arXiv:1107.4789	
W lepton charge asymmetry	CMS 7 TeV 840pb-1 (e) arXiv:1206.2598	
W lepton charge asymmetry	CMS 7 TeV 5fb-1 (mu) arXiv:1312.6283	
Top quark pair production	ATLAS 7 TeV 5fb-1 ATL-PHYS-PUB-2013-056	
Top quark pair production	ATLAS 7 TeV and 8 TeV data	Inclusive cross-sections at NNLO
	CMS 7 and 8 TeV data	Differential distributions at NLO+NNLL, full NNLO in progress
	TTbarData	TTbarTheory
Isolated photon production	ATLAS 7 TeV data from 2011 run arXiv:1311.1440	Differential distributions at NLO
	DirectPhotonData	DirectPhotonTheory
Isolated photon production	CMS 7 TeV 36pb-1 arXiv:1108.2044	
Isolated photon + jet	CMS 7 TeV 2.1fb-1 arXiv:1311.6141	
W production in association with charm	ATLAS 2011 data arXiv:1402.6263	
W production in association with charm	CMS 7 TeV 5fb-1 arXiv:1310.1138	
Z production in association with charm	LHCb 7 TeV 1fb-1 arXiv:1401.3245	
Z rapidity and transverse momentum	CMS 7 TeV 36pb-1 arXiv:1110.4973	
Z transverse momentum	ATLAS 7 TeV 4fb-1 arXiv:1211.6899	
Inclusive jet production	ATLAS 2011 2.76 data arXiv:1304.4739	
Dijet production	ATLAS 2011 data arXiv:1312.3524	
Inclusive jet and dijet production	CMS 7 TeV 5fb-1 arXiv:1212.6660	
3/2 jets ratio	CMS 7 TeV 5fb-1 arXiv:1304.7498	
Z + jets	LHCb 7 TeV 1fb-1 arXiv:1310.8197	
Z + jets	ATLAS 7 TeV 4fb-1 arXiv:1304.7098	
Single top production		
Low-mass Drell-Yan	ATLAS 2011 and 2010 data arXiv:1404.1212	
High-mass Drell-Yan	ATLAS 2011 data arXiv:1305.4192	
Drell-Yan	CMS 7 TeV 5fb-1 arXiv:1310.7291	
Exclusive J/psi	LHCb 7 TeV 1fb-1 arXiv:1401.3288	

LHC Results/Theory

LHC data from Run I - Results not yet available (preliminary only)		
Process	Data	Theory
Inclusive W, Z production	ATLAS 2011 and 2012 data	Differential predictions at NNLO QCD
	WZinclusiveData	WZinclusiveTheory
Z high-pT and Y	CMS 8 TeV 20fb-1: SMP-13-013	
Inclusive jets	CMS 8 TeV 20fb-1: SMP-12-012	
3-jets mass	CMS 7 TeV 5fb-1: SMP-12-027	

WZinclusiveData

The inclusive production of W and Z boson is directly sensitive to the quark/antiquark flavor separation. The measurement of the rapidity distributions of the final state leptons provides a handle on quarks and antiquarks in a broad range of x. Data for this process is available from ATLAS, CMS and LHCb

TTbarData

DirectPhotonData

Direct photon production at the LHC probes the gluon PDF via the QCD Compton Scattering

Theoretical Calculations

WZinclusiveTheory

Fully differential predictions for W and Z production at hadron colliders are available in NNLO QCD in tools like [FEWZ](#) and [DYNLO](#)

Inclusive Jets, Di-jets, Tri-jets

Fully differential predictions at hadron colliders are available only in NLO QCD NLO predictions can be interfaced to APPLgrid either via MCFM or to [FastNLO](#) via NLOJet++

TTbarTheory

The NNLO calculation of inclusive top quark pair production cross-sections was presented in [arXiv:1303.6254](#). This calculation was used to study the constraints on g(x,Q) from the most updated top quark pair cross-section data from ATLAS and CMS in [arXiv:1303.7215](#)

DirectPhotonTheory

For isolated photon production the theory is available at NLO in QCD. For the direct component (not the fragmentation) NLO predictions can be interfaced to APPLgrid either via MCFM or aMCatNLO.

The constraints on the gluon PDF from LHC direct photon data were quantified in [arXiv:1202.1762](#). Since this publication however many new data have become public. Also one needs to study the impact of theoretical uncertainties.

PDF from LHC Data

- Aim for a write-up as requested by the LPCC chair on the LHC PDF data experience/anticipated precision etc by **fall 2014** Aim for a first draft in September... Volunteers for editorial work?
- The whole community is **invited to join** this project
- We want to foster discussion among the PDF fitters and the experiments regarding the **presentation of the systematic errors** in such a manner that the data can be of greatest use in the PDF fits, especially with data sets for the same processes at different energies; and discussion among the PDF fitters and the experiments regarding **data sets for the same process from different experiments** that may lead to different conclusions regarding specific PDF determinations
- The W+c data channel --being discussed among the experiments now-- could be a first good case to prepare & try combination of ATLAS+CMS data...
- APPLGrid files of the experimental data? Aim for public web pages with that information

Pre-announcement

- Revisiting the PDF4LHC recommendations: we foresee two steps:
- De facto the published recommendation is used with the original PDFs replaced by the more recent incarnations. We have turned this now into a recommendation on the PDF4LHC web page that can be referred to, as of today. There will be no separate note on it. This should be useful for eg the Higgs cross section group...
- At the same time we plan to move towards using metaPDFs and have an envelope of a number of input PDF family uncertainty bands and prepare for a new recommendation & paper at the time scale of end of the year. Given that in a few months we expect updated PDFs by essentially all the groups, these would naturally be based on these new sets.
- This would become then the recommendation as of 2015 for the upcoming new data analyses. These envelopes can in principle have more sets than what we use now, where sensible.
- **Discussion on this at the next PDF4LHC meeting (end of summer)**