

ATLAS REPORT ON PDFS.

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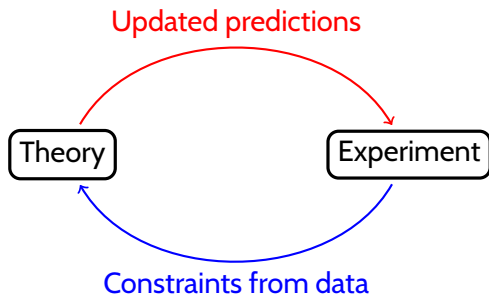
on behalf of the ATLAS Collaboration

¹DESY

PDF4LHC meeting, 27th October 2015

Introduction

- > New ATLAS measurements to constrain PDFs
- > Use of PDFs for ATLAS measurements



PDFs are a critical part of the interface between experiment and theory

Increasing number of **precision** ATLAS measurements

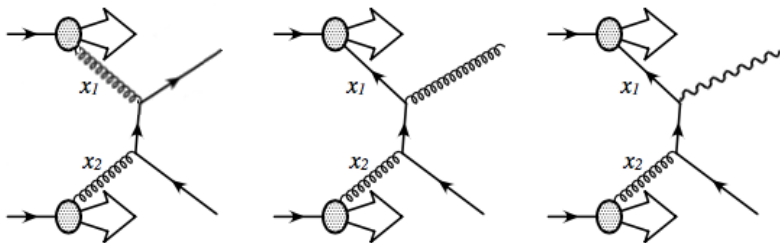
Recent measurements

- > Jet/dijet/trijet production [7 TeV]
- > High-mass Drell-Yan [7 TeV]
- > Vector-boson cross sections [13 TeV]
- > $t\bar{t}$ production [13 TeV]

...all in addition to previously published 7 TeV and 2.76 TeV results

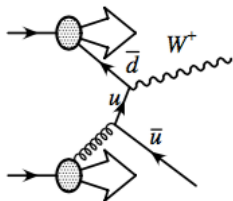
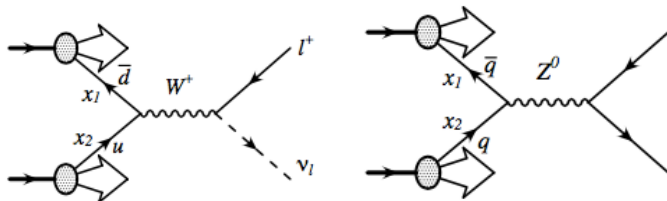


- > Different final states provide different information

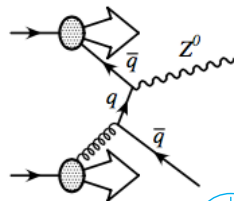


- > Inclusive jet, dijet, $t\bar{t}$, γ directly sensitive to **gluon** PDF
- > At higher p_T also sensitive to **valence quarks**

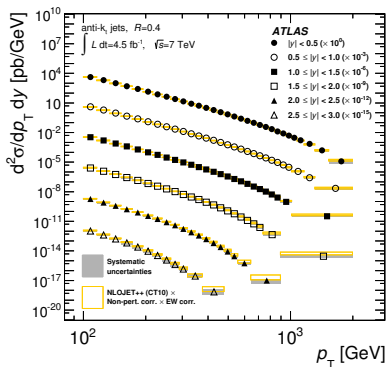
ATLAS PDF sensitivities



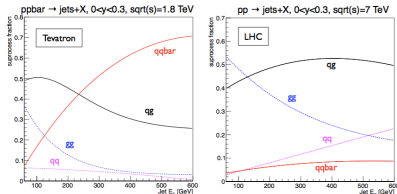
- > EW bosons sensitive to **valence** and **sea** quarks
- > With jets also sensitive to **gluon** PDF



ATLAS JET MEASUREMENTS

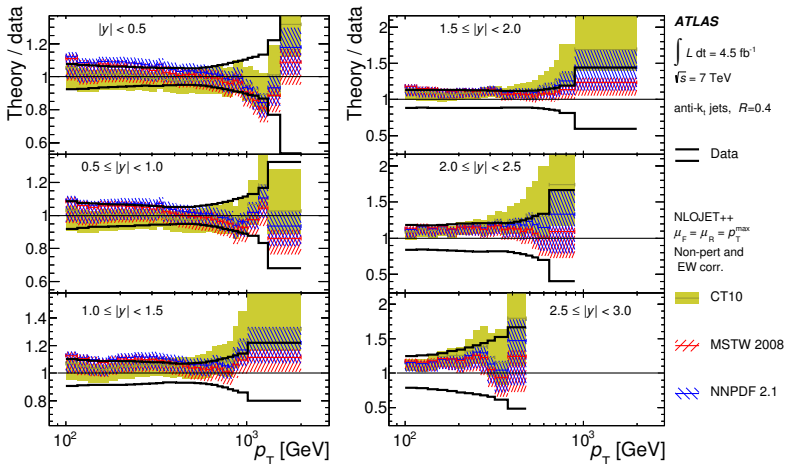


- High- p_T jets from lower x partons than at Tevatron



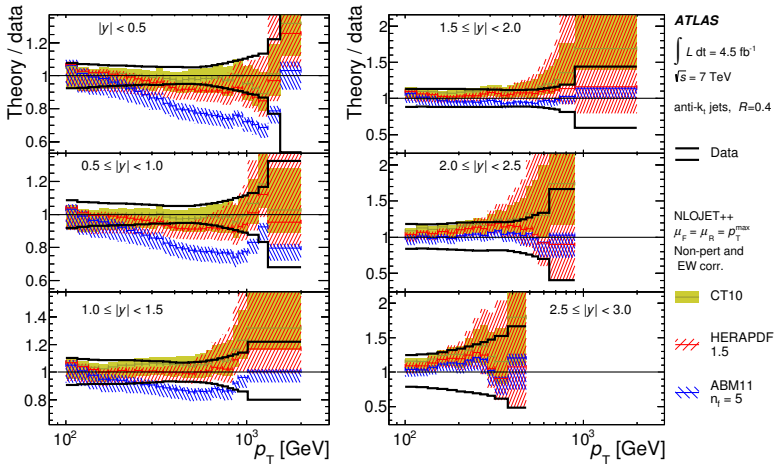
- Importance of **gluon** PDF
- More phase space for ISR

- p_T range covers **five** orders of magnitude in cross section



- > Major success for perturbative QCD
- > **MSTW** and **NNPDF** agree well across p_T and $|y|$ range

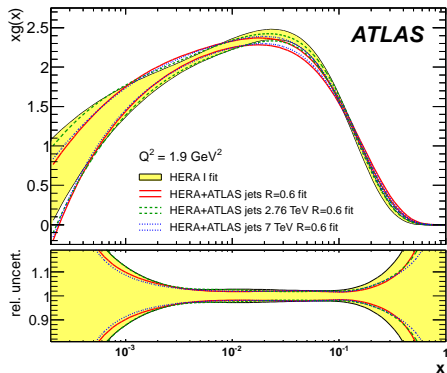




- > **ABM11** shows deviations from data at low $|\eta|$
- > Impressive agreement without fitting to jet data



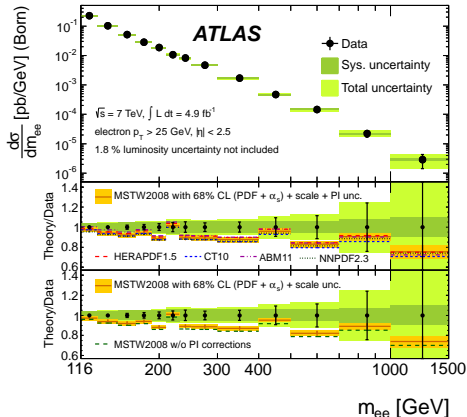
ATLAS also has dijet (HEP05(2014)059) and trijet (EPJC(2015)75) cross sections



- Currently studying combination of ATLAS jet and HERA DIS data
- Also combine jet data from different \sqrt{s} → 2.76 TeV and 7 TeV
- Potential to improve constraints on xg

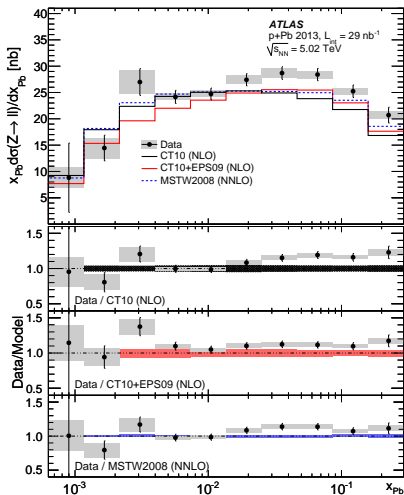
Work in progress, may also combine with 8 TeV data

ATLAS ELECTROWEAK MEASUREMENTS

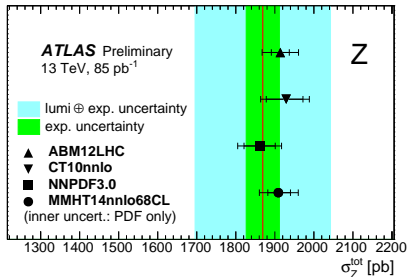
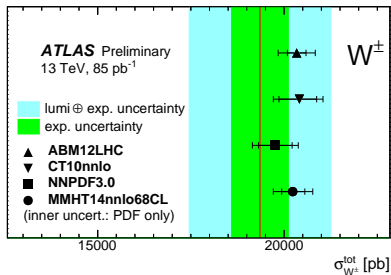


- Measurement covers five orders of magnitude in cross section
- Photon-induced contribution rises with M_{ll}
- Percent-level effects becoming important
- 8 TeV result on the way...

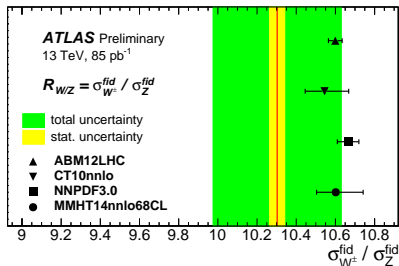
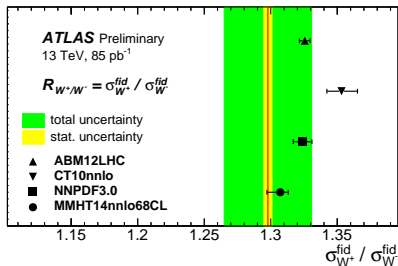




- > Sensitive to **nPDFs** and to nuclear corrections
- > Consistent with **pQCD** + binding effects from EPS09
- > Q^2 evolution washes out differences in x -shape by M_Z^2
 \rightarrow difficult to constrain PDFs

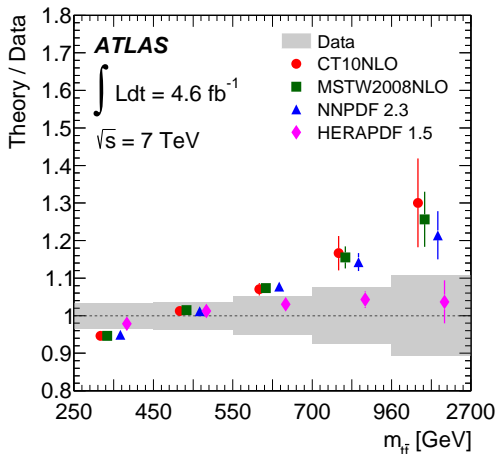


- > Consistency between modern PDF sets and first 13 TeV data



- > Many uncertainties **cancel** in ratio (eg. luminosity)
- > W^+ / W^- most sensitive to u/d **valence** PDFs
- > W/Z to **strange** (some existing tension between PDF sets)

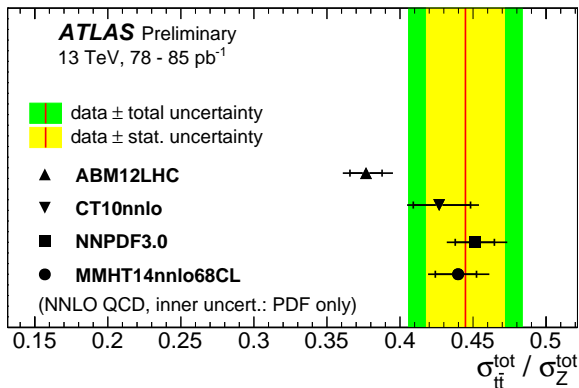
OTHER ATLAS MEASUREMENTS



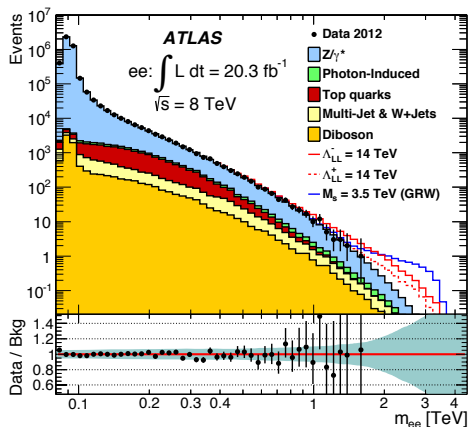
- > Sensitive to ISR/FSR and gluon PDF
- > Disagreements in high $m_{t\bar{t}}$ tail
- > Also seems to be present at 8 TeV
- > NNLO QCD and EW corrections could be important [Czakon, Fiedler,

Heymes, Mitov]

Scan across mass of di-top system



- > Updates to these results will have reduced uncertainties
→ limited by statistics of top sample at the moment
- > $t\bar{t}/Z$ sensitive to **gluon** PDF and **low-x sea**



- Large uncertainties in **high-x** PDFs limit new physics searches
- Many interesting processes are **gluon-gluon** initiated (top, Higgs, BSM gluino pairs...)
- Understanding of high-x partons crucial for HL-LHC

- > pQCD (and PDFs derived from HERA data) very successful
 - > Agreement with ATLAS data across many orders of magnitude
-
- > precision measurements (such as W, Z) provide **direct** constraints
 - > top, jet and γ measurements also interesting in PDF context
 - > Higgs physics increasingly **sensitive** to PDF uncertainties
 - > High-mass searches at large x_{Bj} \rightarrow large PDF uncertainties
 \rightarrow PDF treatment important for limits/discoveries/high- x QCD
 - > First ATLAS measurements sensitive to **nuclear PDFs**
 - > PDFs also important in context of tuning/matching etc.

Many reasons for ATLAS to maintain connections with PDF4LHC!



BACKUP

Choice of PDF set varies from generator to generator

- 1 NLO generators many use **CT10** (SHERPA:NNPDF3.0(NNLO))
→ MMHT and CT14 not available in time for testing
- 2 Shower MC mostly use **NNPDF2.3LO** (PYTHIA 6:CTEQ6L1)
→ used in Monash and A14 tunes

Essentially decision comes down to

- > Using tried-and-tested set up from Run I
- > Using appropriate PDF for desired tune



Precision analysis increasingly sensitive to PDF uncertainties

- > Uncertainty treatment depends on the problem under study
 - 1 Consider uncertainties from a **single** PDF error set
 - 2 Take **full envelope** of several PDF sets
 - 3 Combination following **PDF4LHC 2011** recommendation
- > Updated **PDF4LHC 2015** recommendations under discussion
- > ATLAS working on internal recommendations and clear recipes

