New Standard Model results @ ICHEP14.

Misha Lisovyi

LHC physics discussion @ DESY

28/07/2014

Slides from J.Berryhill,
C. Roda and P. Nason

HELMHOLTZ GEMEINSCHAFT

DESY

New Standard Model results @ ICHEP14: QCD & EW.

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Very personal/incomplete/biased selection!

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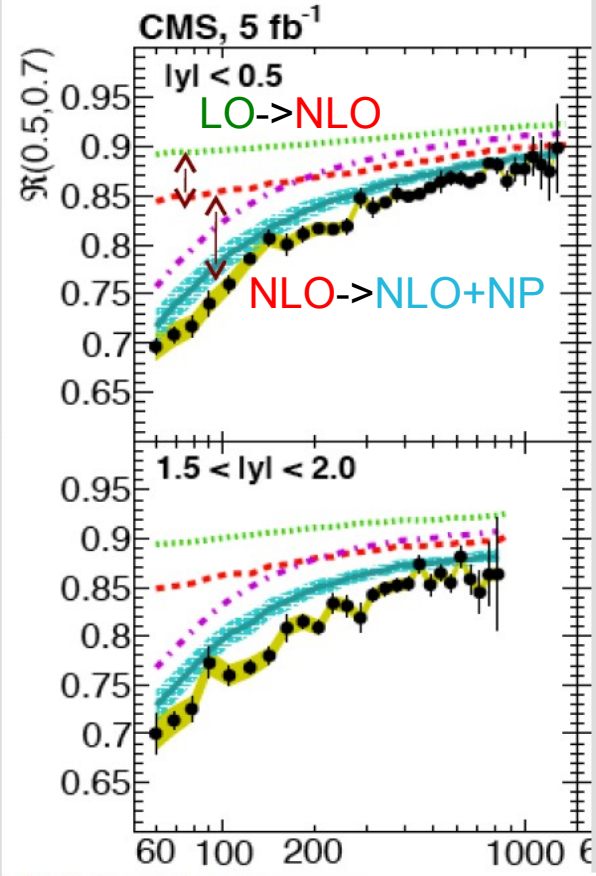
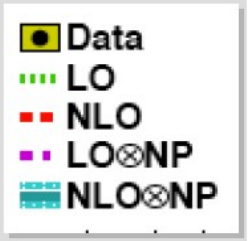
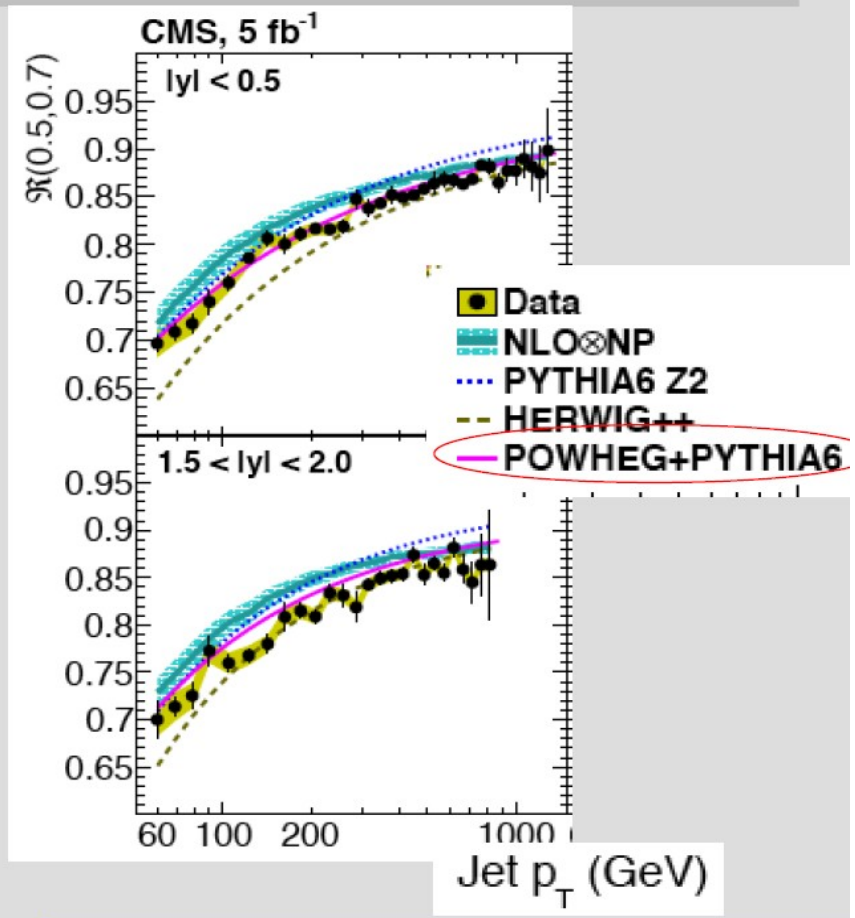
arXiv:1406;0324

Jet with different sizes … what we learn

$R(0.5,0.7) = [d\sigma(0.5)/dp_T]/[d\sigma(0.7)/dp_T]$







Best description need NLO and parton shower are needed to describe correctly the ratio …

ICHEP-2014 2-9 July Valencia

Sensitive to the hadronisation, UE, parton radiation

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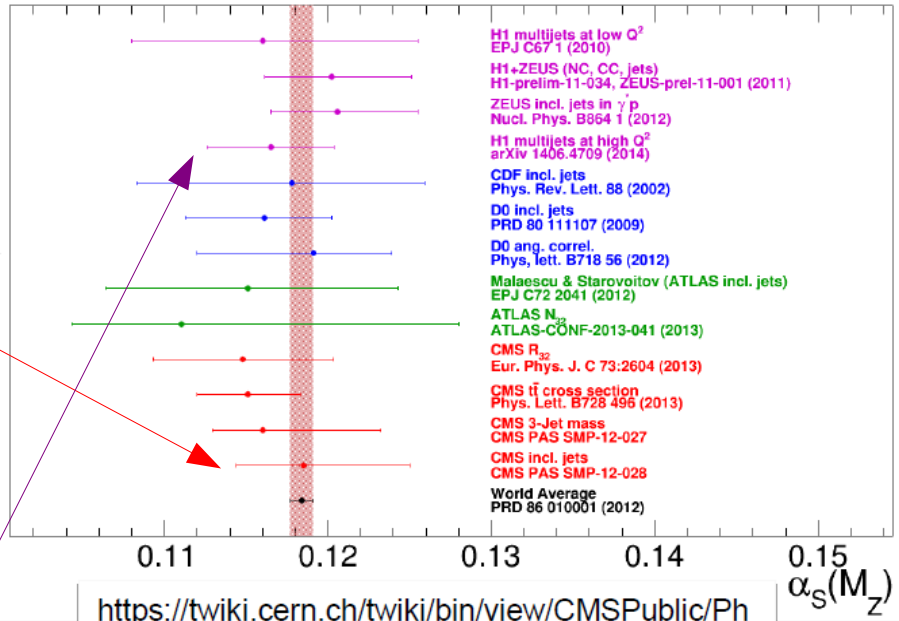
CMS-PAS-SMP-12-028 CMS-PAS-SMP-12-027 arXiv 1406:470

α_s measurement

World average (2014)
$\alpha_s(M_Z) = 0.1185 \pm 0.0006$ (0.5%)

CMS Most recent: inclusive jet (5%)

$$\alpha_s(M_Z) = 0.1185 \pm 0.0019(\text{exp}) \pm 0.0028(PDF)$$
$$\pm 0.0004(NP) \pm^{0.0055}_{0.0022} (scale)$$



https://twiki.cern.ch/twiki/bin/view/CMSPublic/PhysicsResultsSMP

H1 most recent α_s extraction from inclusive and multjet cross-section. Best precision is reached from fit to normalised multijet cross sections:

$$\alpha_s = 0.1165 \pm 0.0008(\text{exp}) \pm 0.0038(PDF, theo)$$

exp. unc.0.7%

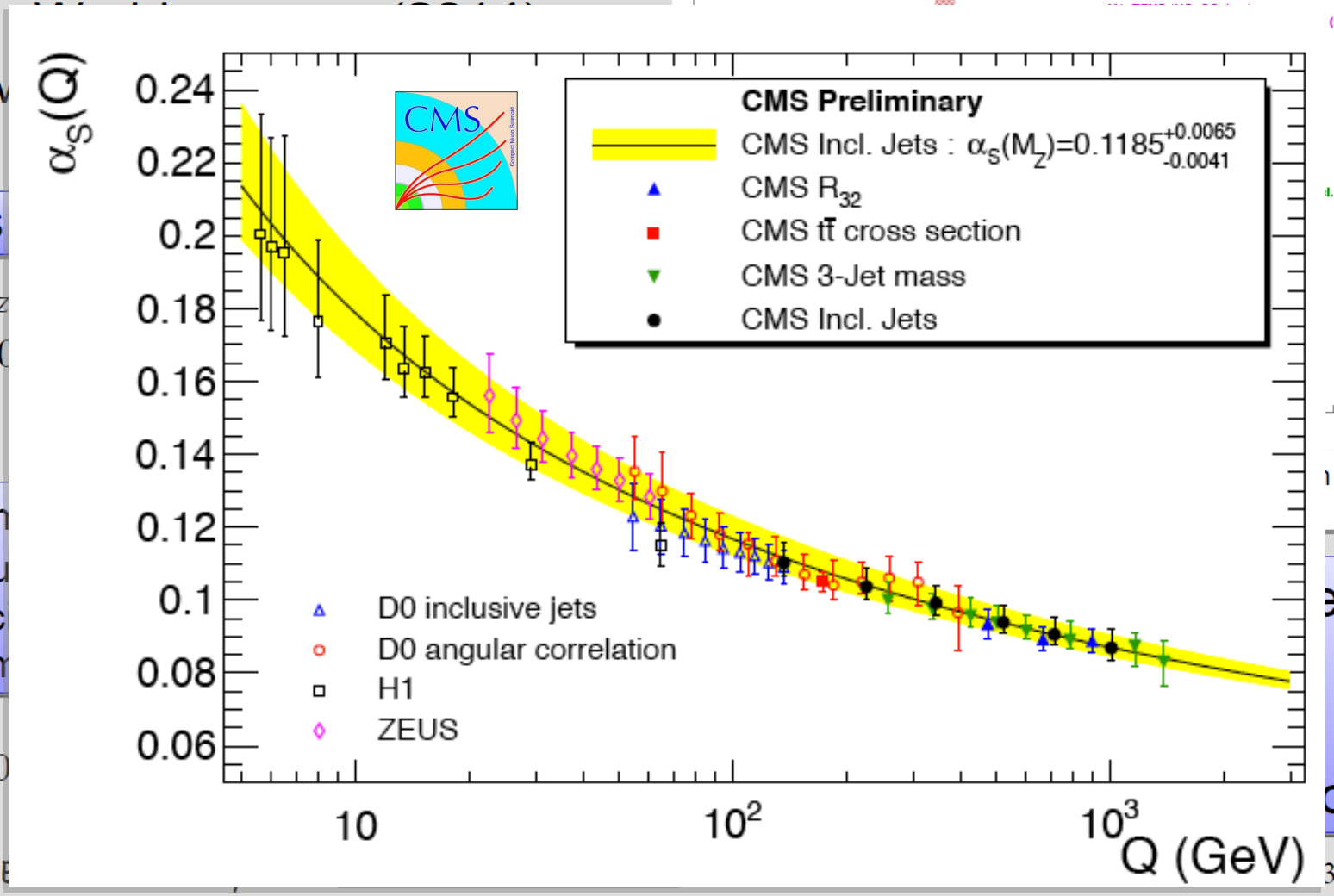
All measurements consistent with world average
Fantastic proof of $\alpha_s(Q)$ running up to the TeV region

α_s from jets from HERA is still somewhat more precise

DESY

CMS-PAS-SMP-12-028 CMS-PAS-SMP-12-027 arXiv 1406:470

α_s measurement



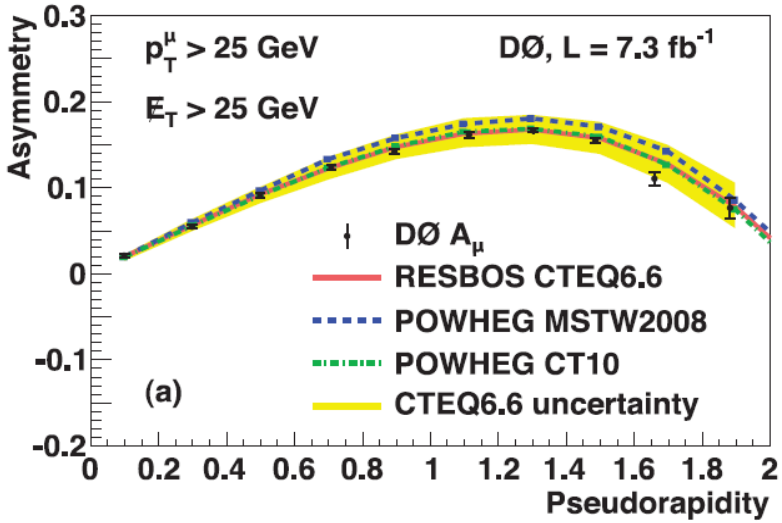
α_s running over a few orders of magnitude in Q

W charge asymmetry.

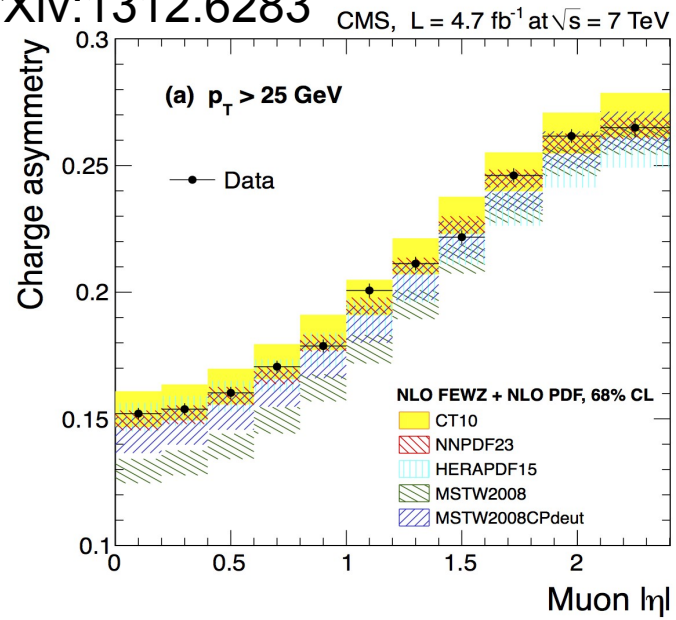
$$\mathcal{A}(\eta) = \frac{\frac{d\sigma}{d\eta}(W^+ \to \ell^+\nu) - \frac{d\sigma}{d\eta}(W^- \to \ell^-\bar{\nu})}{\frac{d\sigma}{d\eta}(W^+ \to \ell^+\nu) + \frac{d\sigma}{d\eta}(W^- \to \ell^-\bar{\nu})}$$

- CMS measured the asymmetry to 0.1% absolute per bin.
- The charge asymmetry has clear constraining power
- DØ W rapidity asymmetry uses electron and MET to estimate W rapidity directly

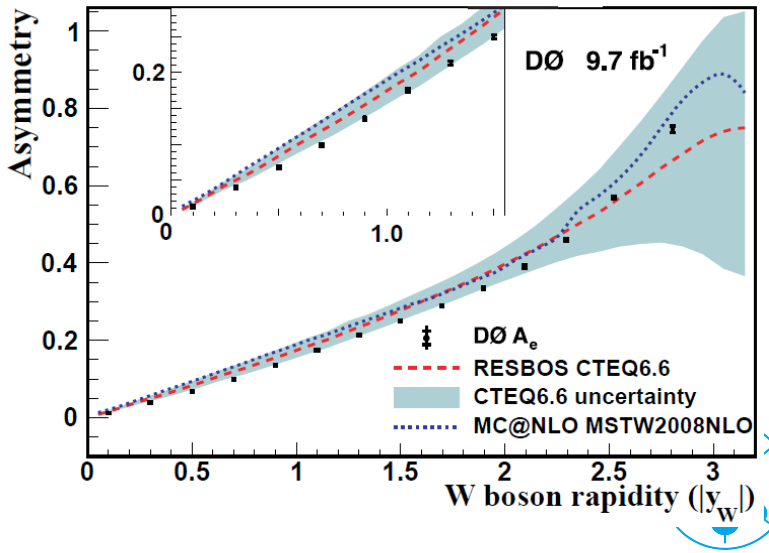
PRD 88 (2013) 091102



arXiv:1312.6283



PRL 112 (2014) 151803

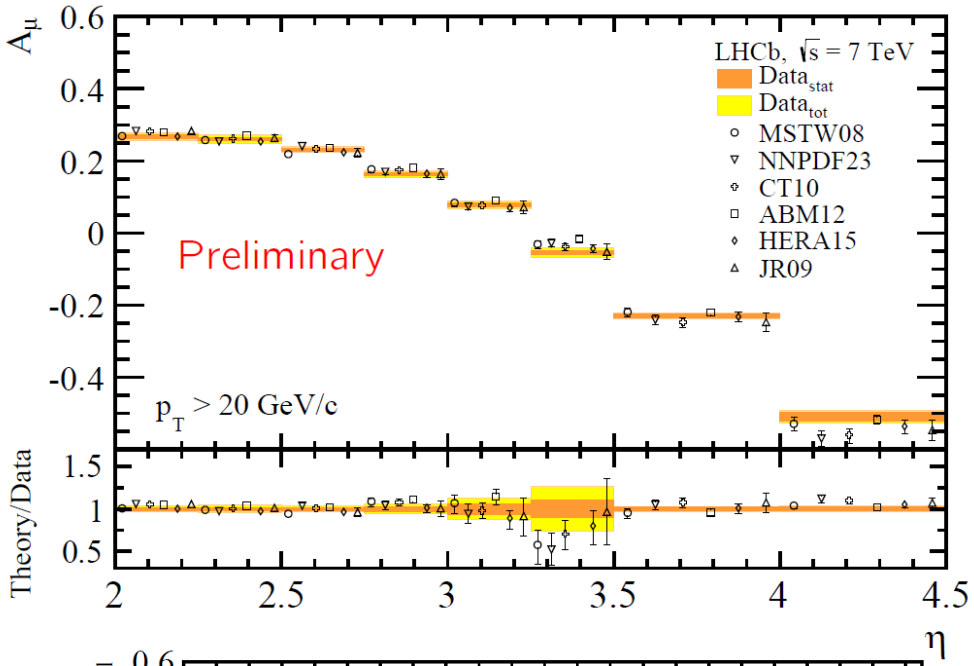


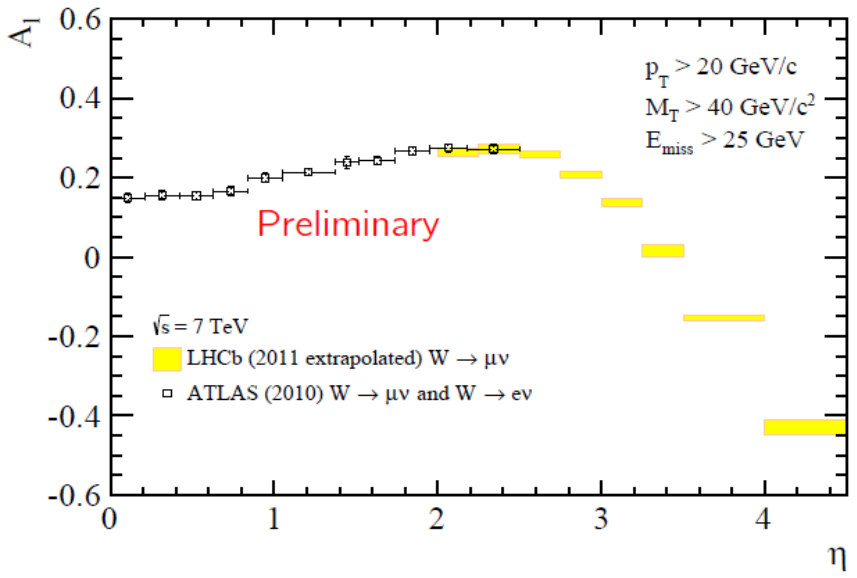
W charge asymmetry.

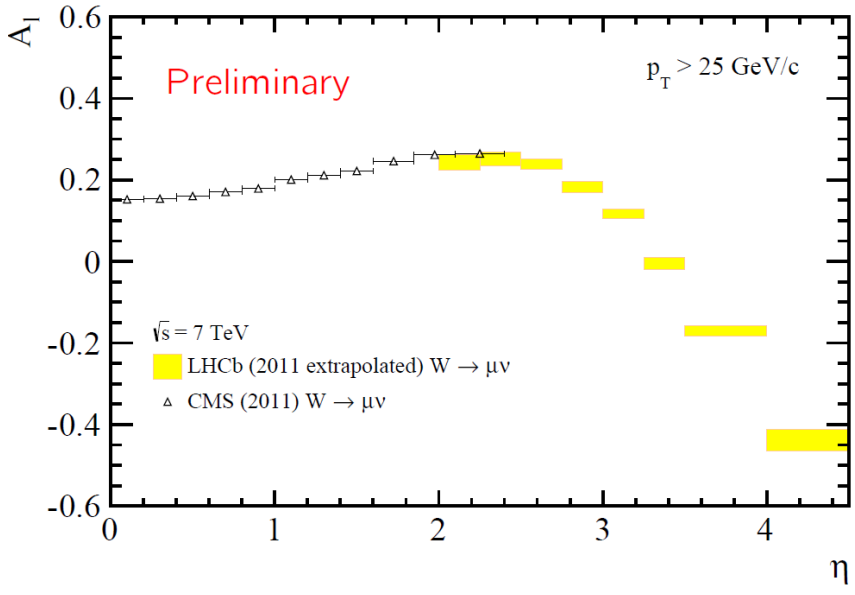
LHCb-PAPER-2014-033

NEW for ICHEP14

- LHCb has unique access to high rapidity leptons ($2 < \eta < 4.5$)
- New 1/fb W asymmetry constrains PDFs at lower x
- In agreement with CMS/ATLAS in overlap region (2-2.4)







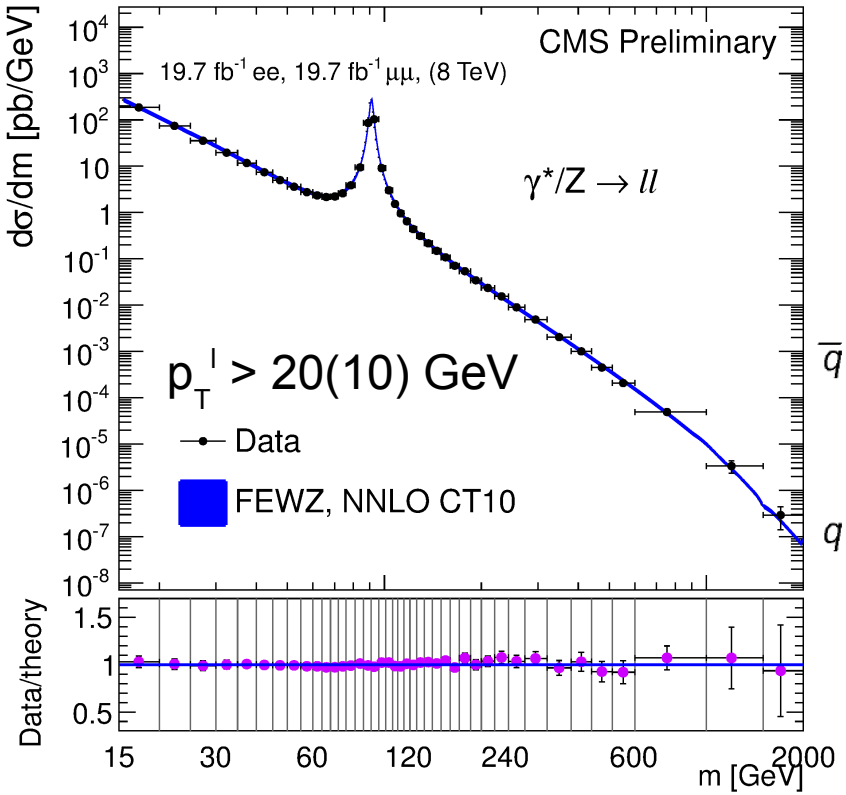
Drell Yan cross section @ 8 TeV.

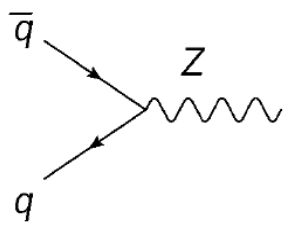
NEW for ICHEP14

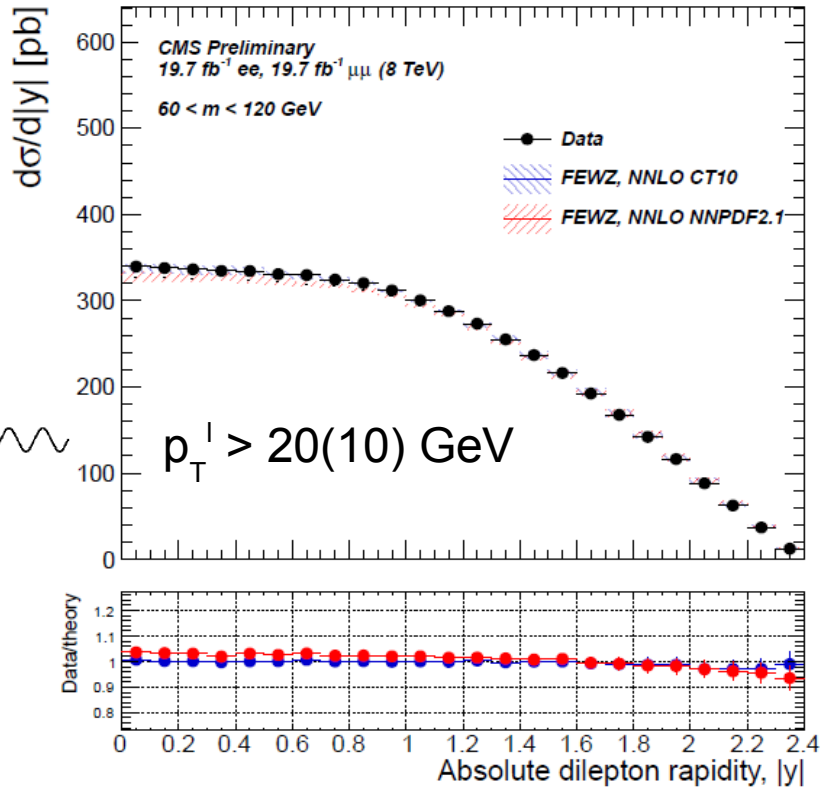
CMS-PAS-SMP-14-003

- Cross section vs. dilepton mass now measured at 8 TeV, from **15-2000 GeV in mass**.

- **Double-differential absolute cross sections** as a function of y_Z in 6 mass bins for 20<M<1500 GeV. => Constraints on PDFs!



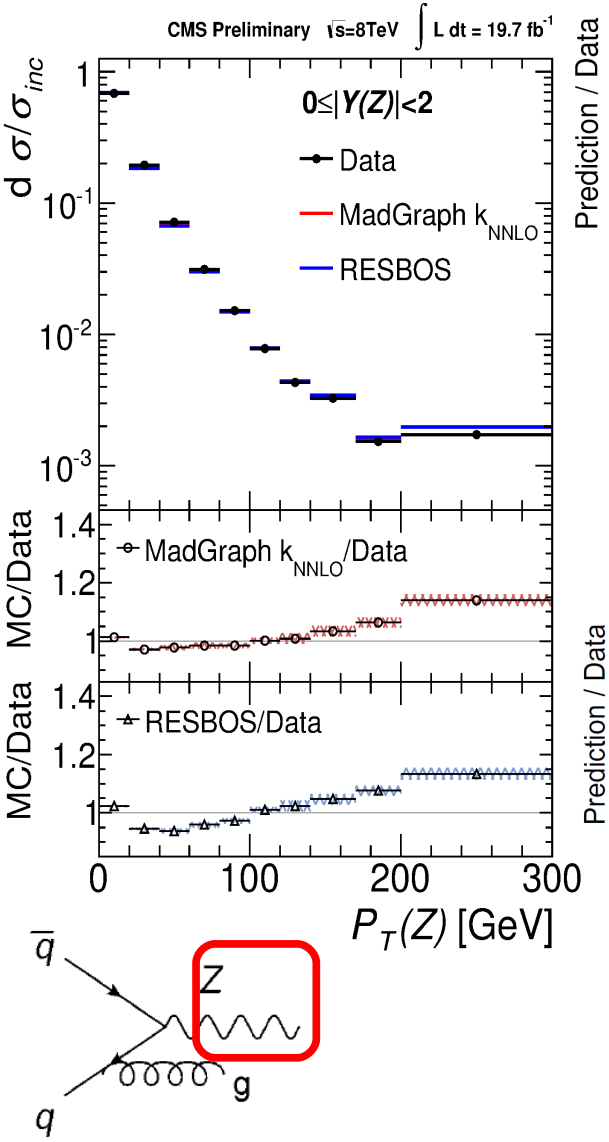




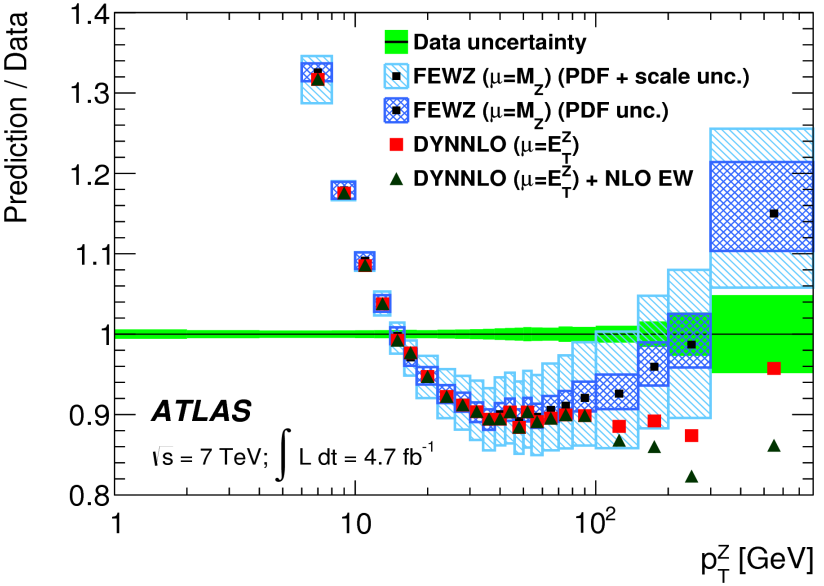
Z transverse momentum.

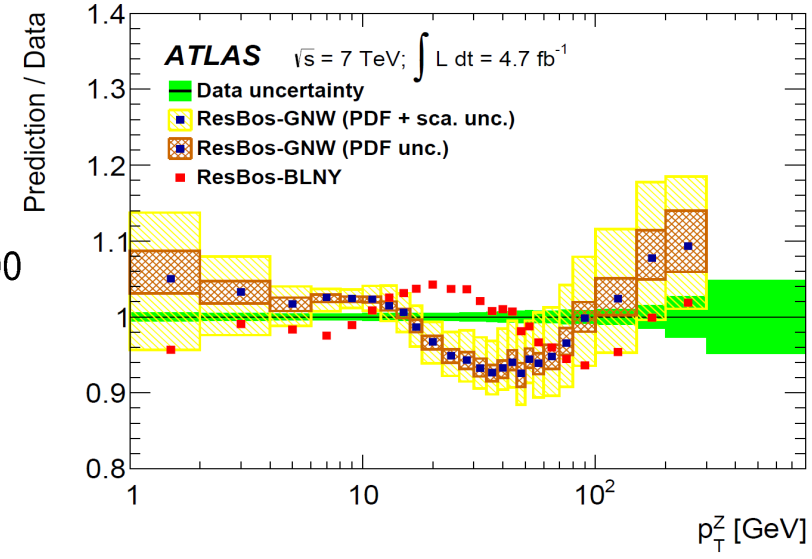
- **Z PT** measured and compared with predictions
- **Now measured at 7 (ATLAS) and 8 TeV (CMS)** doubly differentially
- **Large NNLO V+jet corrections, large EW corrections at high pT**
- Resummed calculation describes the data well

CMS-PAS-SMP-13-013



arXiv:1406.3660

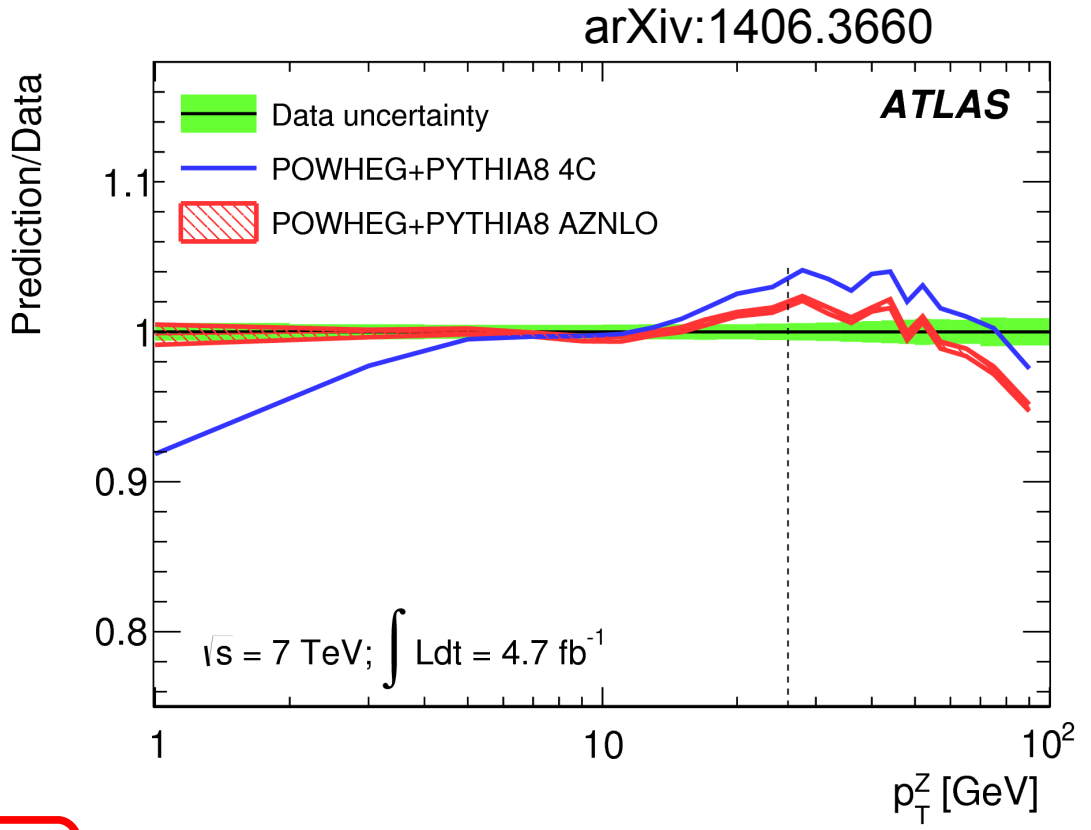


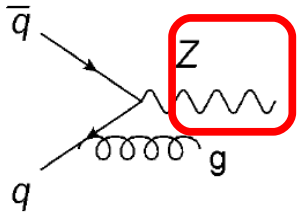


Z transverse momentum.

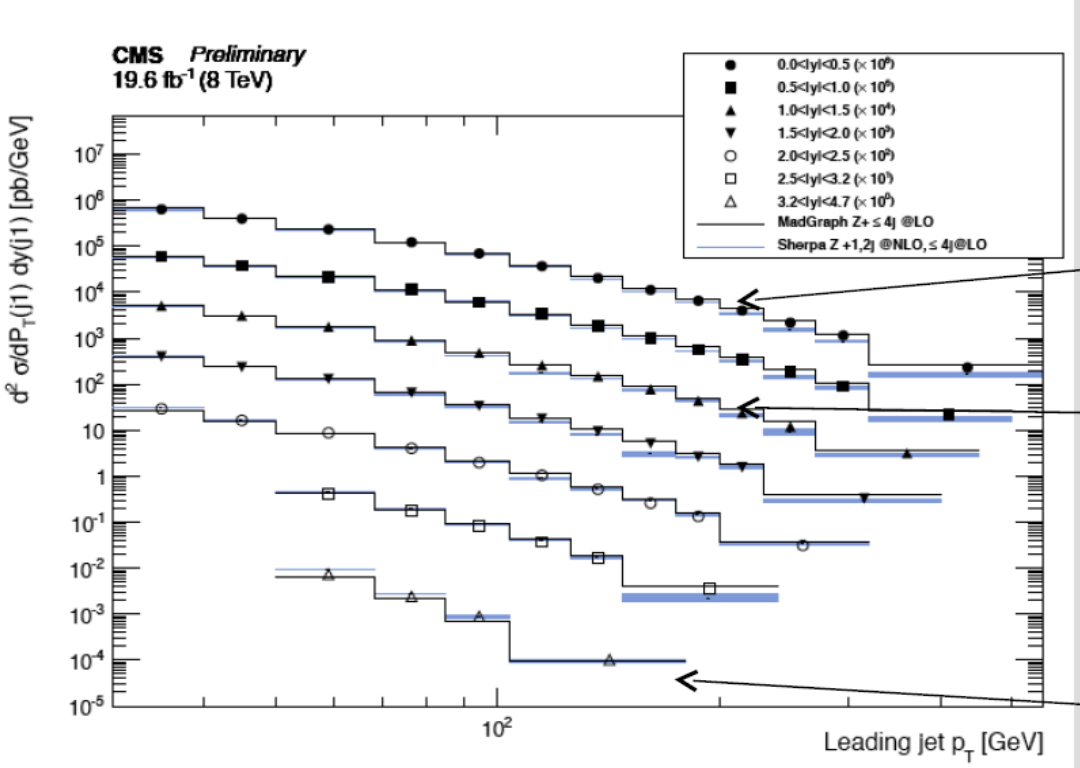
- **PDFs and UE models can improve upon tuning to this data**

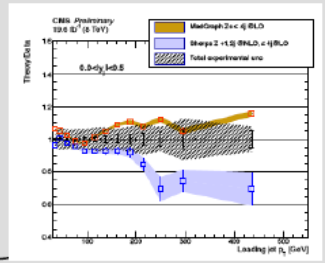
- ATLAS has a new tune for PYTHIA8 and PYTHIA8+POWHEG "AZ" and "AZNLO" **which flattens disagreement at the percent level at low PT up to ~30 GeV**
- High PT Z data could potentially constrain the **gluon PDF**

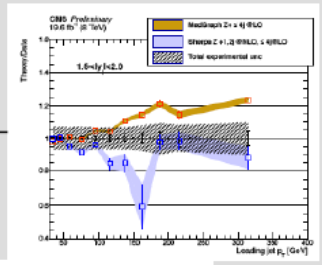


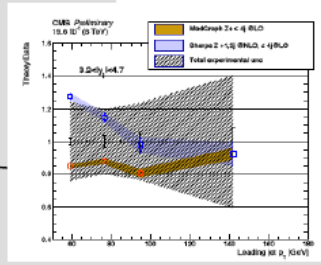


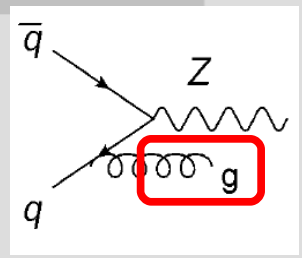
Double differential Z+jet @ 8 TeV









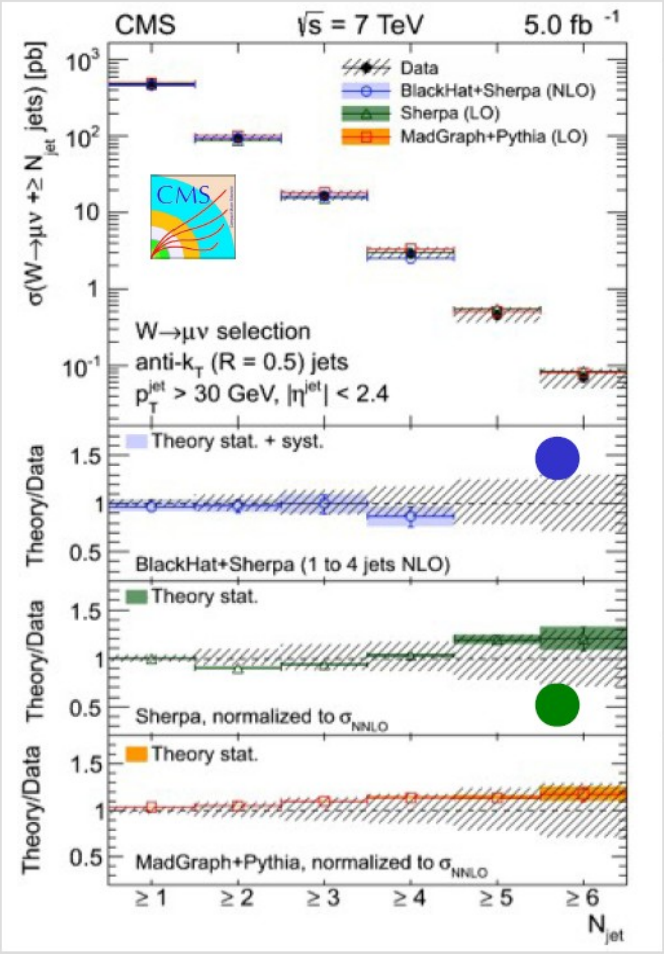


First double differential measurement Z+jet
Jet up to $|\eta|<4.7$ – $30 < p_T < 550$ GeV
Largest experimental uncertainty JES
Predictions: MadGraph norm.NNLO / Sherpa2 (NLO 1j,2j /LO<=4j)

MadGraph overshoot for $p_T$jet > 100 GeV
Reasonable description from Sherpa2, some regions to investigate

A deep look at W+jet – ATLAS & CMS

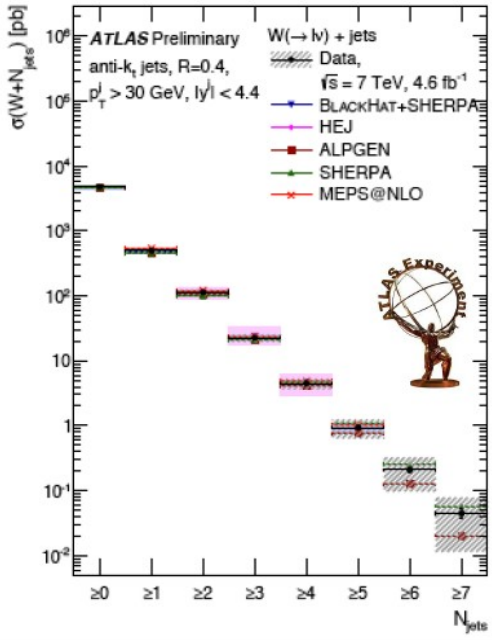
arXiv.1406.7533

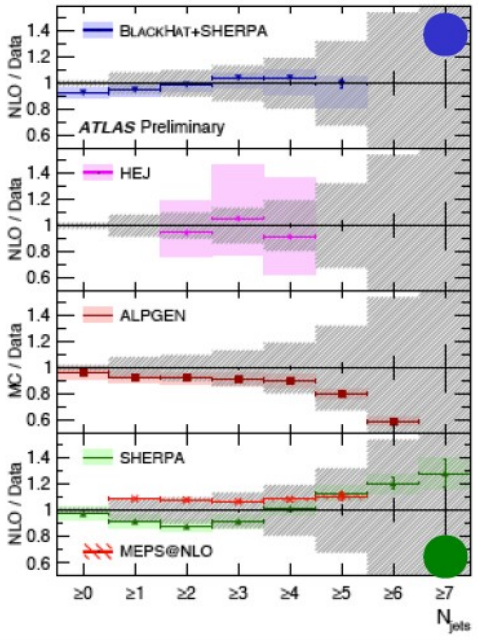


A detailed comparison on a high statistics sample and in a large kinematics range → precious information to validate/tune the predictions.

Predictions: NLO calculations, resummation calculations, MC generators NLO,LO + PS

Jet multiplicity



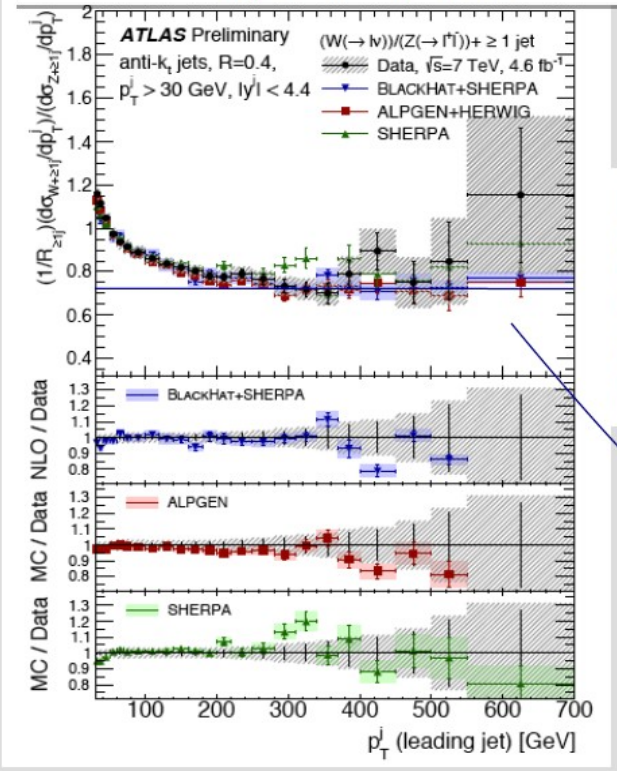


Jet multiplicity well reproduced up to ≥7 jets on 5 order of magnitudes !
Best overall description NLO+PS (BlackHat+Sherpa) with some exception for high H_T, S_T distributions.

Boson+jets production ratios

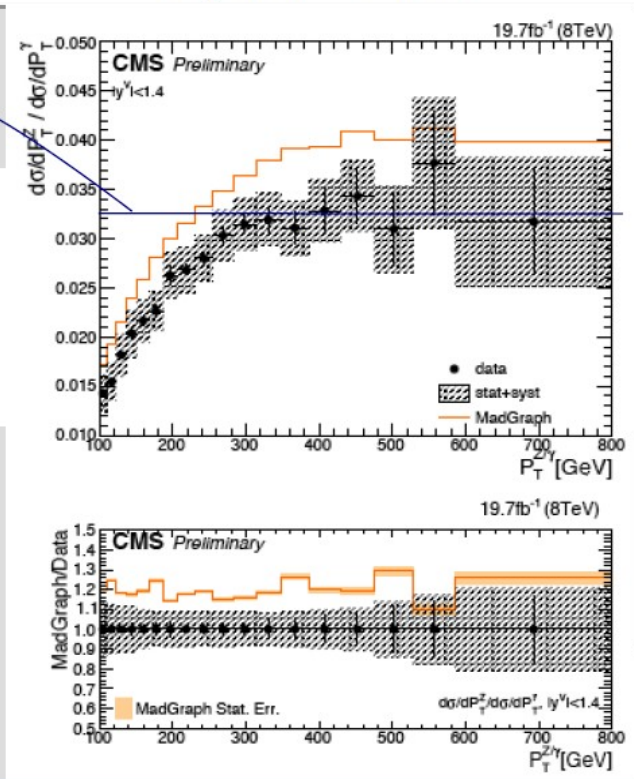
Ratios allows to reduce experimental systematic uncertainties
Ratio is studied in inclusive and exclusive distributions of N_{jet}=3

W+jet/Z+jet vs p_T jet leading
Njet≥1 - 7 TeV



Flattens at high transferred transverse momentum

Z+jet/γ+jet vs p_T boson
Njet≥1 - 8 TeV



LO prediction 10% off in norm / good in shape

Detailed test of ratios with respect to NLO/LO predictions

DESY

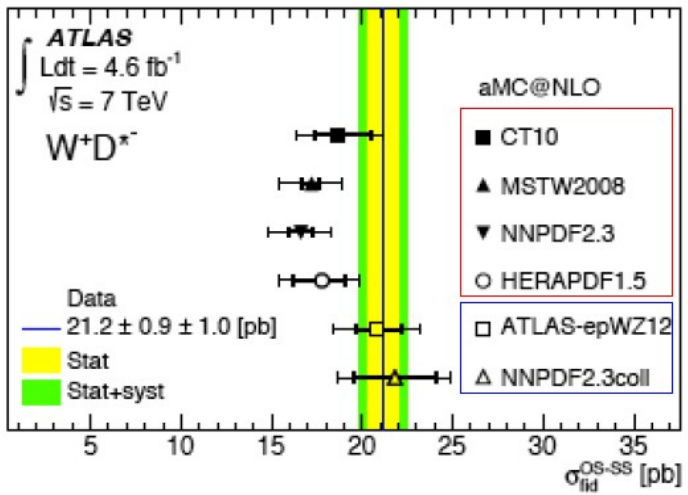
JHEP05(2014)068 arXiv:1402.6263 arXiv:1312.6283

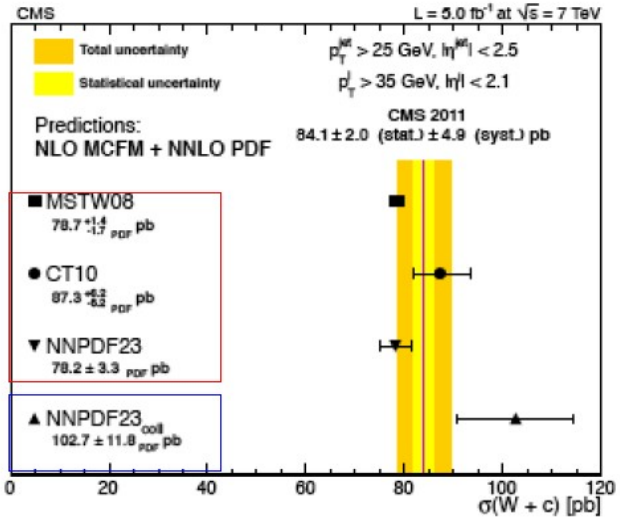
W+c – LHC

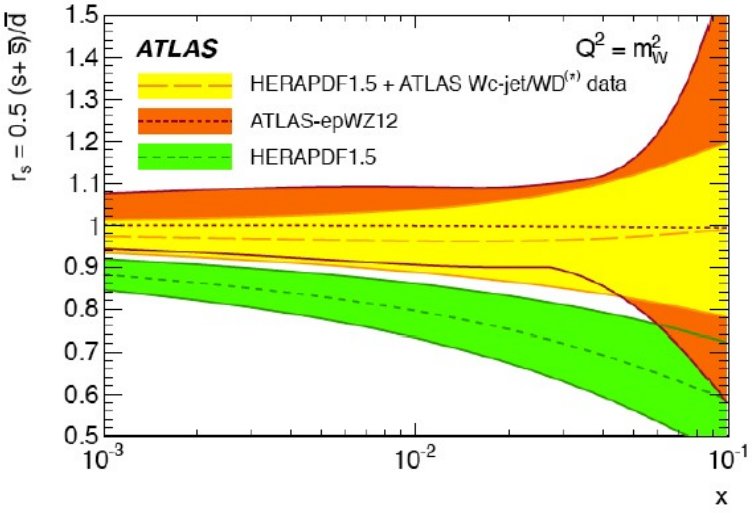
ATLAS → no s-sea suppression w.r. to light flavour sea

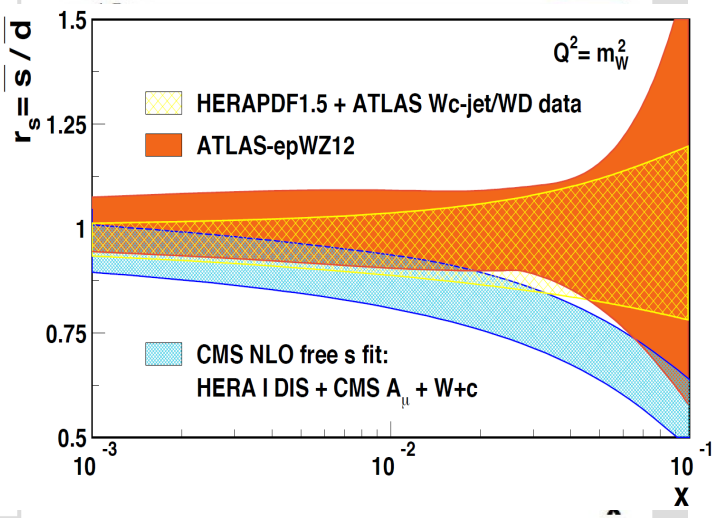
CMS → consistent with s-sea suppression

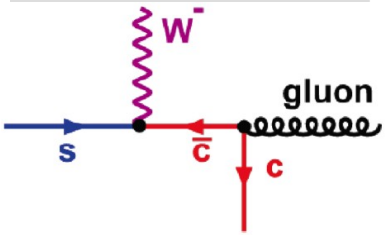
Fit s-quark PDF: HERAPDF including W+c data











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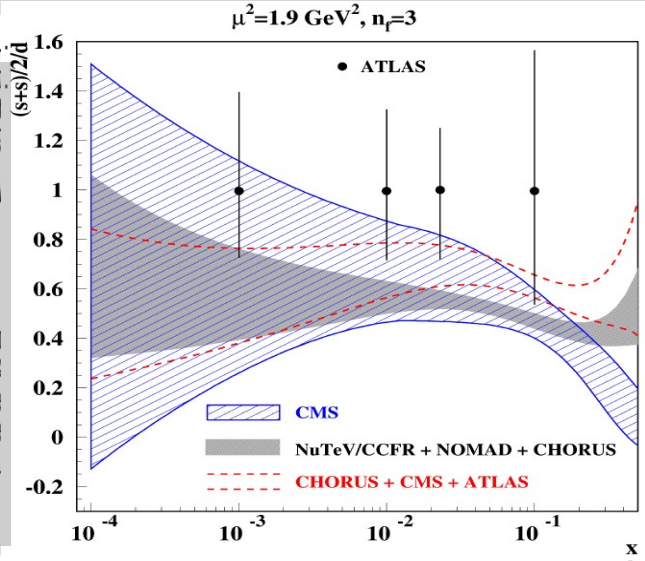
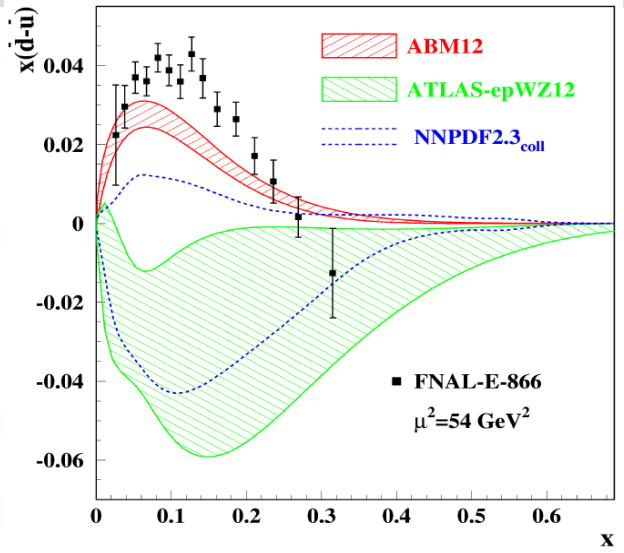
JHEP05(2014)068 arXiv:1402.6263 arXiv:1312.6283

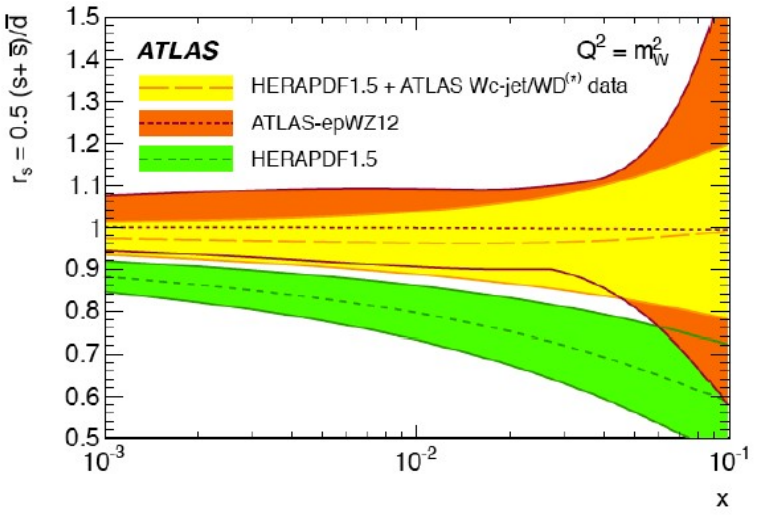
W+c – LHC

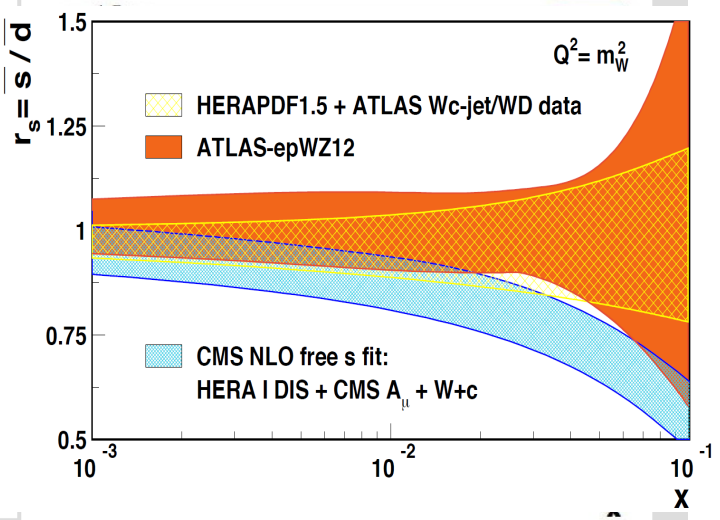
Fit s-quark PDF: also ABM et al. find suppressed strange driven by ν fixed-target data (neg. d-u for collider-only fits). Can fit all data simultaneously.

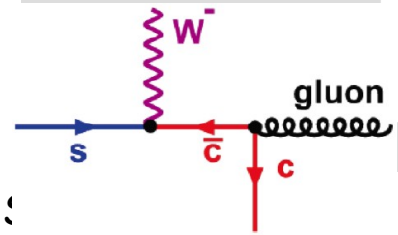




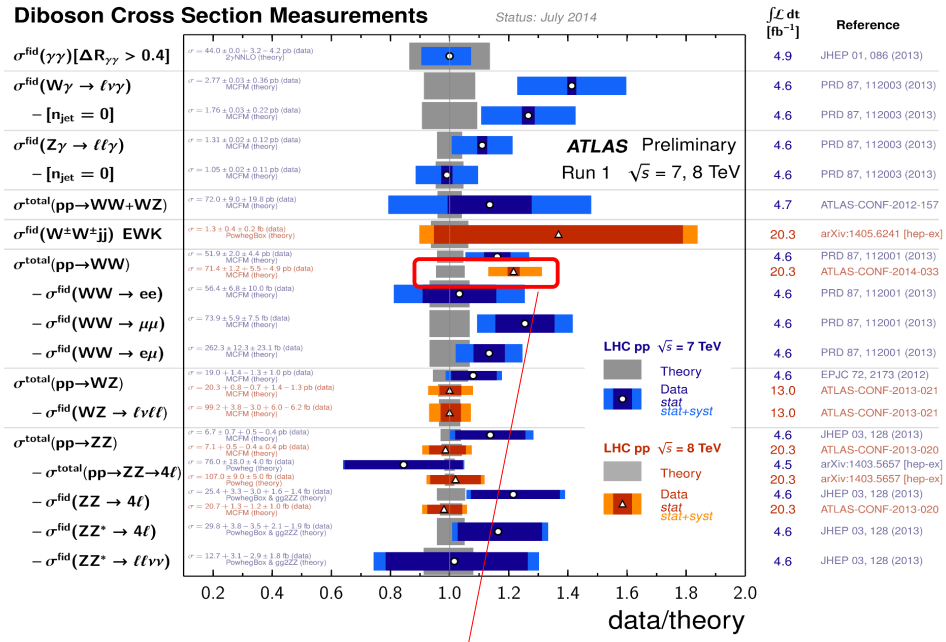
Fit s-quark PDF: HERAPDF including W+c data

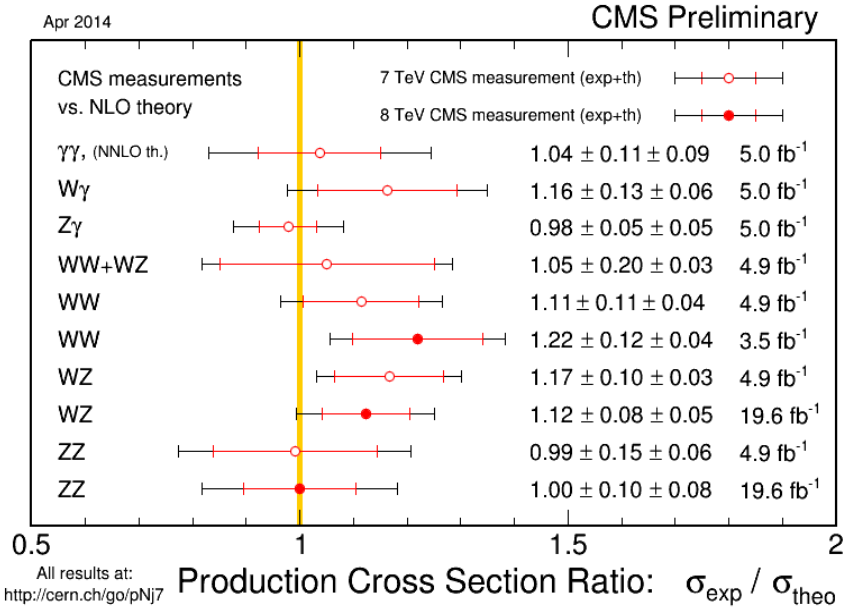


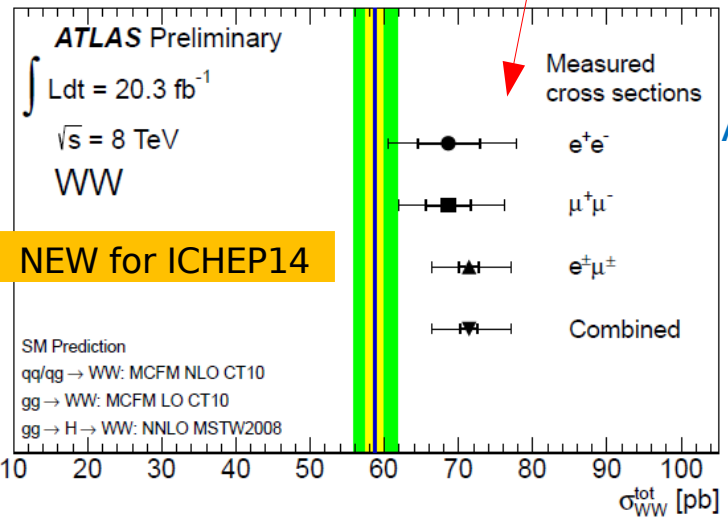




Di-boson production.







NEW for ICHEP14

CMS 69.9±2.8 (stat.)±5.6 (syst.)±3.1 (lum.) pb (1.8σ)

ATLAS 71.4±1.2 (stat.)±5.0 (syst.)±2.2 (lum.) pb (2.1σ)

MCFM 58.7±3.0 (syst.) pb
=qq,qg 53.2 MCFM NLO
+gg 1.4 MCFM LO
+HWW 4.1 NNLO+NNLL

Higher order/other≈ +3-4pb?

- **Also recent Wγ, Zγ, WZ, ZZ data**
- **WW is still ~2σ above predictions**: theory calculation being actively studied (jet vetoes, NNLO)

DESY

P.Nason

Theory status

QCD is currently undergoing enormous progress, in fixed order calculations, soft gluon resummation and Shower algorithms, mostly dedicated to collider (LHC) physics. Highlights:

- NNLO is coming! $2 \to 2$ processes have become calculable at NNLO, with several results for important (complex) processes already available.
  ZZ, Wγ, Zγ, single-t (t-channel)
- NNLO improved parton shower generator are feasible; available for some simple processes of interest. Several tecniques are being studied.
  NNLO+PS: H, DY
- Not all QCD progress means very involved multiloop calculations. Novel results in the analytic understanding of jet substructure.

XXX

DESY

Summary.

- Many new results: some presented here, much more not covered (also Tevatron, HERA, ...).
- http://indico.ific.uv.es/indico/conferenceTimeTable.py?confId=2025

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Backup