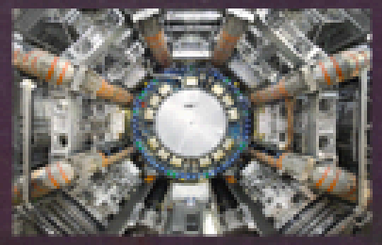
LHC
after one year of operation
Symposium

November 29, 2010
Lisboa - Portugal
location: IST Auditorium


cms


LHC


atlas


The LHC after one year: what have we learned?

Agenda

JOÃO VARELA - Chairperson of the Symposium

GUSTAVO CASTELO BRANCO
GASPAR BARREIRA
Welcome
15:00 - 15:15

LYN EVANS
The Large Hadron Collider
15:15 - 15:45

PETER JENNI
The ATLAS experiment
15:45 - 16:15

JIM VIRDEE
The CMS experiment
16:15 - 16:45

MICHELANGELO MANGANO
Theory and Prospects
16:45 - 17:15

Sponsored by

LIP
Laboratório de Instrumentação e Física Experimental de Partículas

IST
Instituto Superior Técnico

FCT
Fundação para a Ciência e Tecnologia

Contacts

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João Pedro Santos

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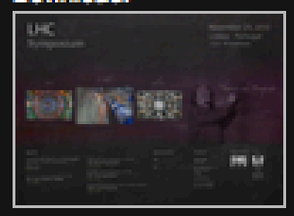
Poster

Download:



Michelangelo L. Mangano, CERN PH-TH

The LHC after one year: what have we learned?

Introduction

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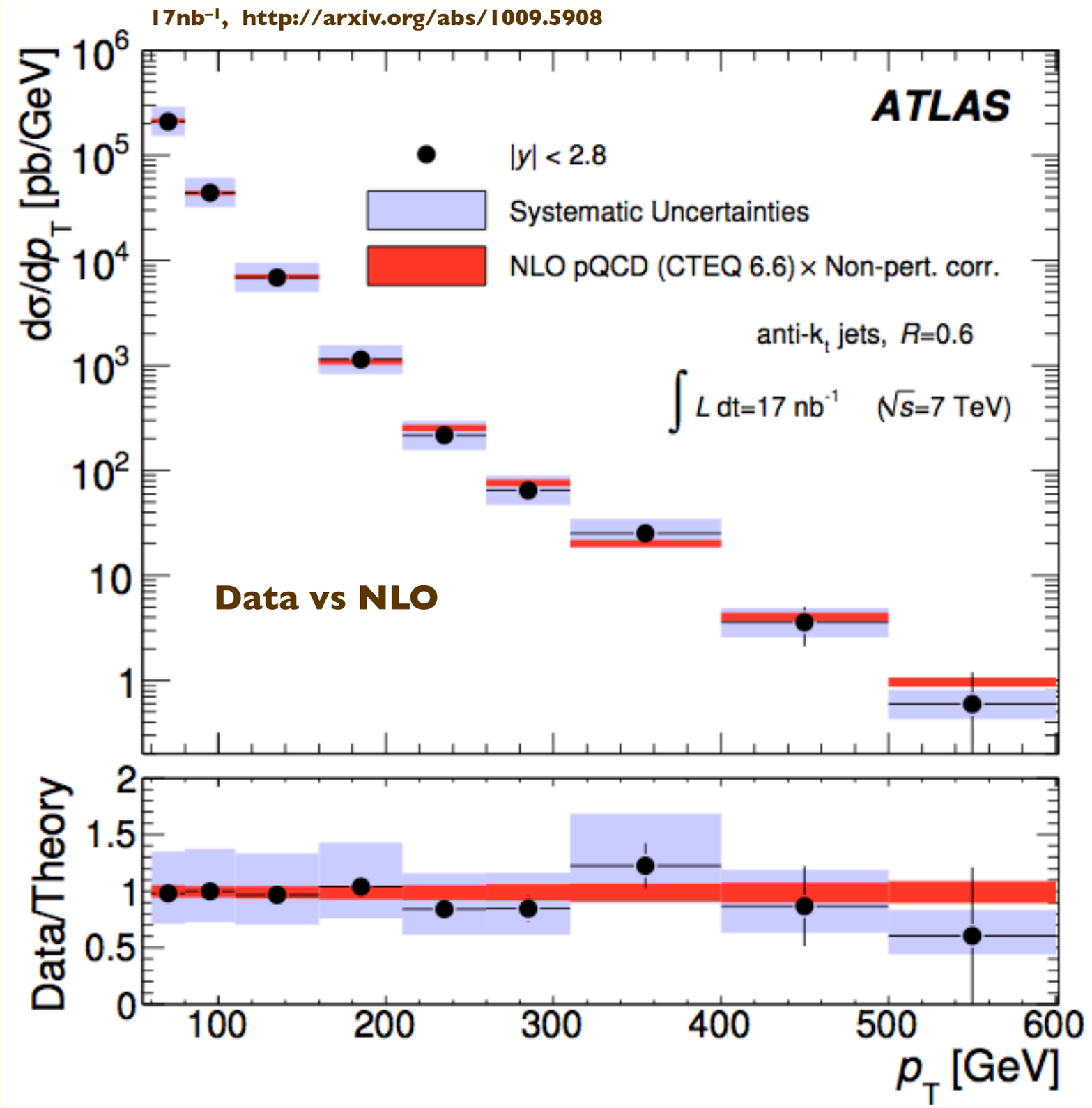
  - Nothing that should have worked and didn't!

Jets

Inclusive jet E_T spectrum



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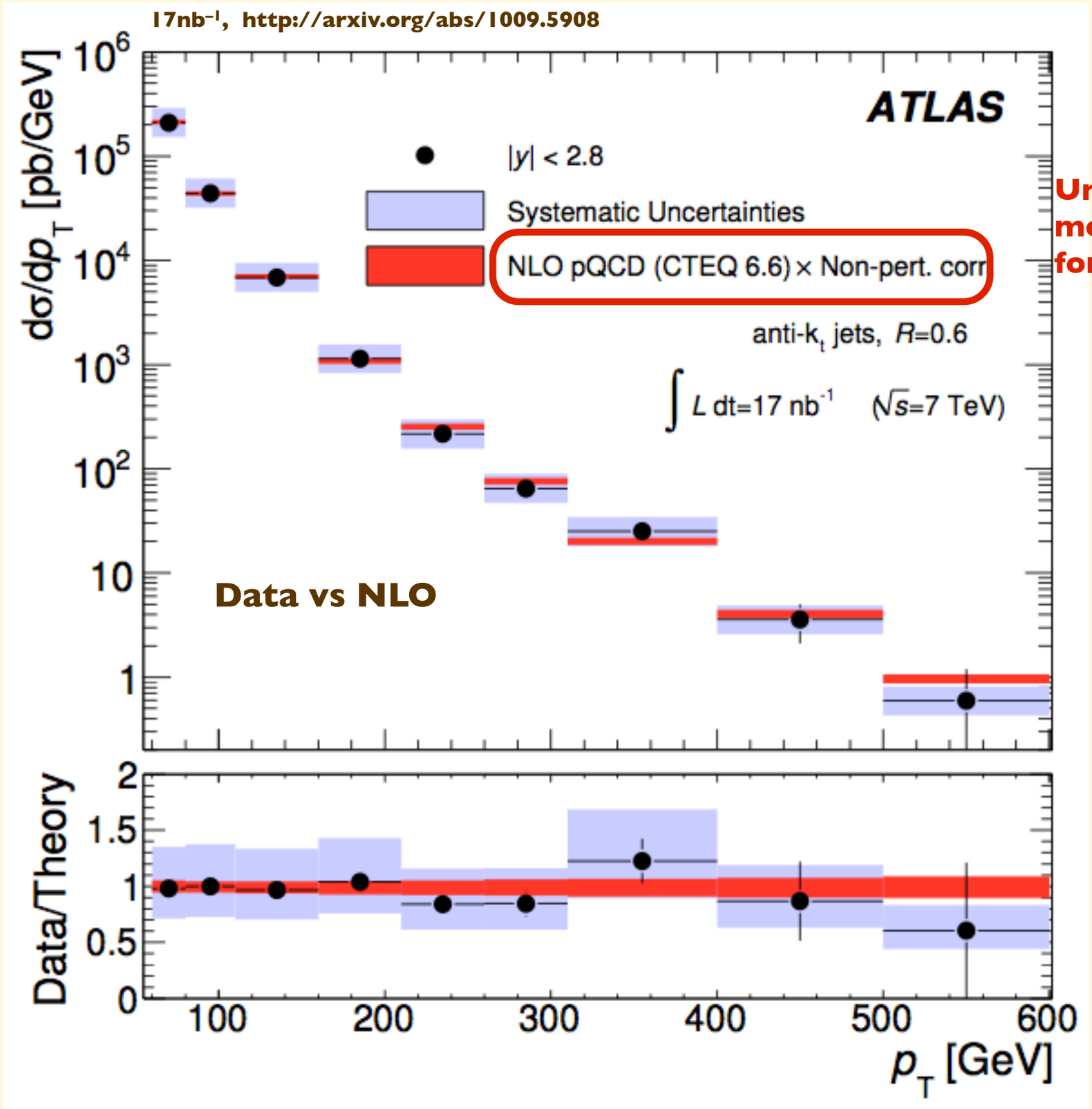

Unfolded cross-section measurement, suitable for comparison with NLO

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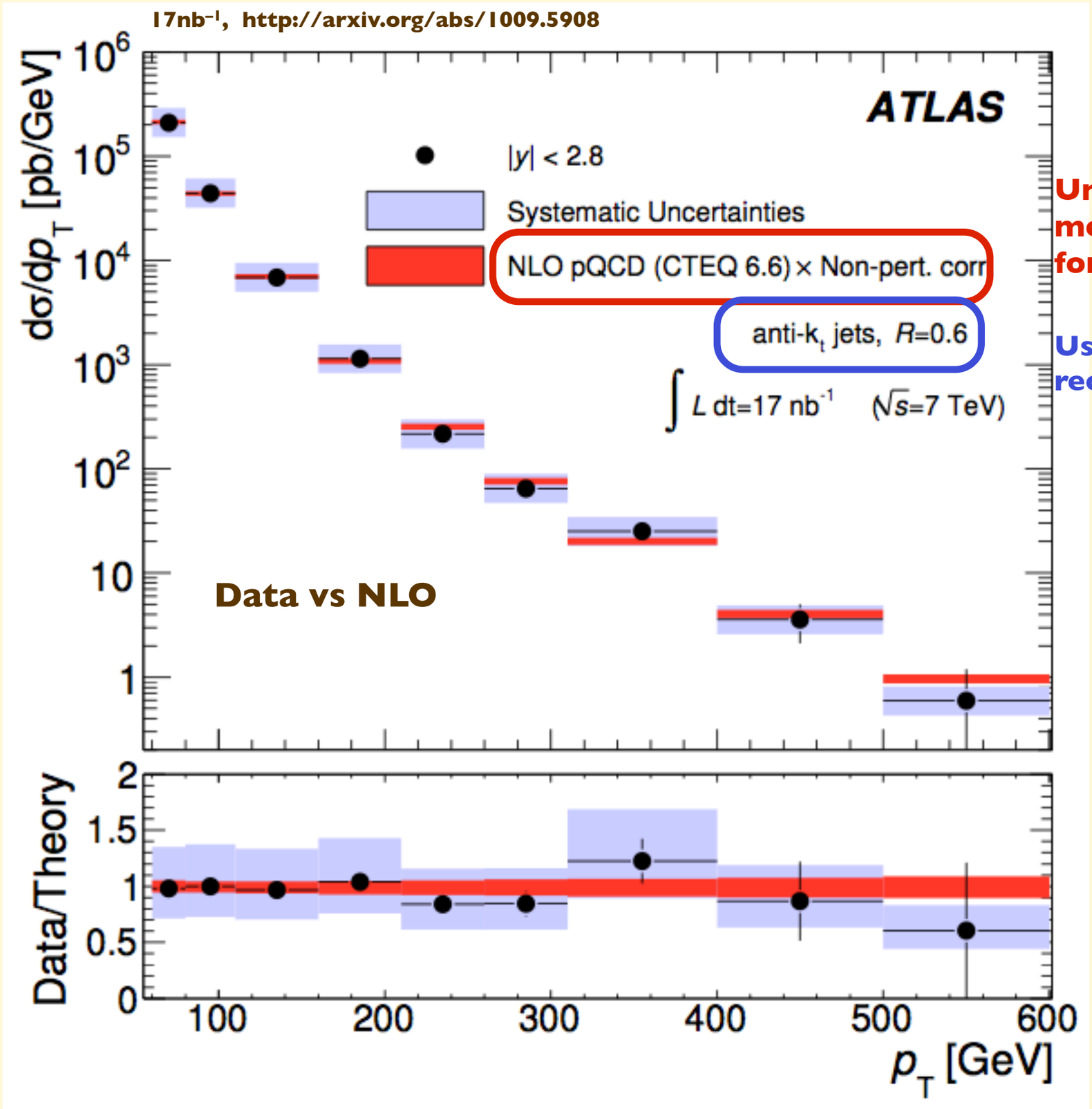
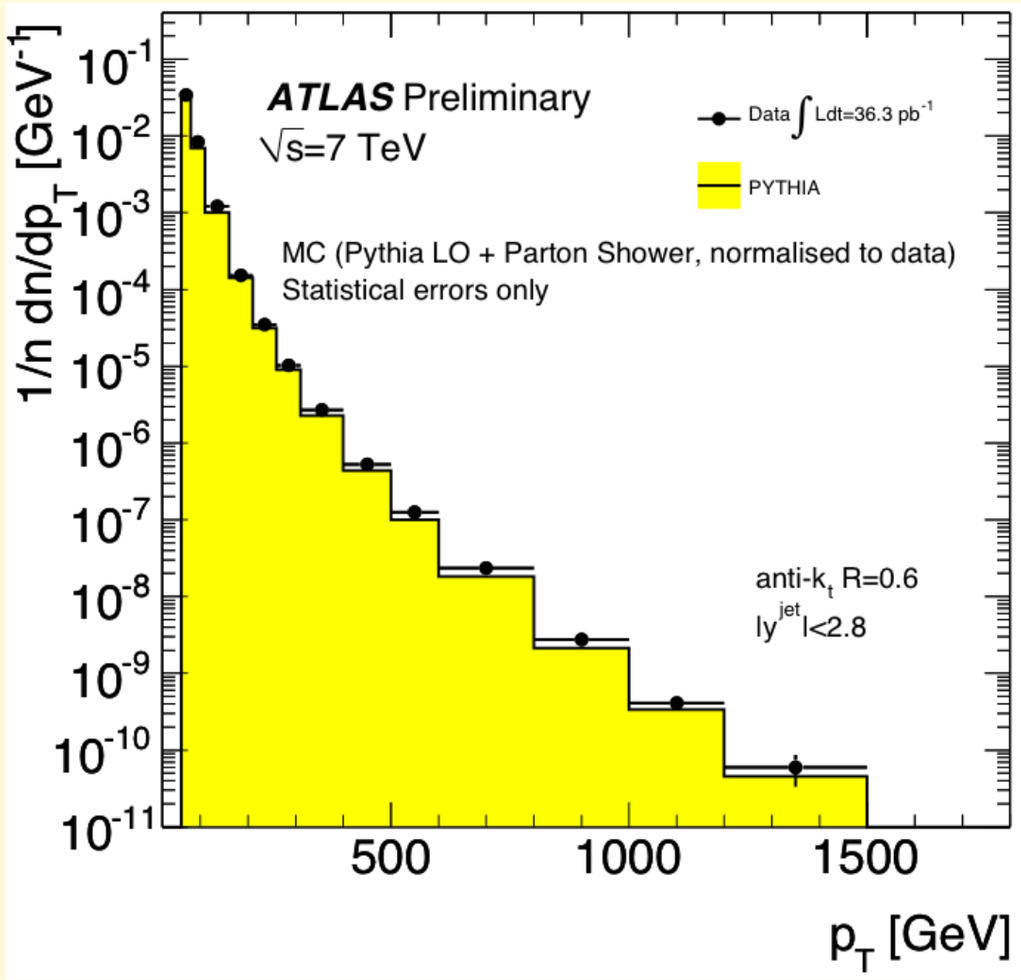
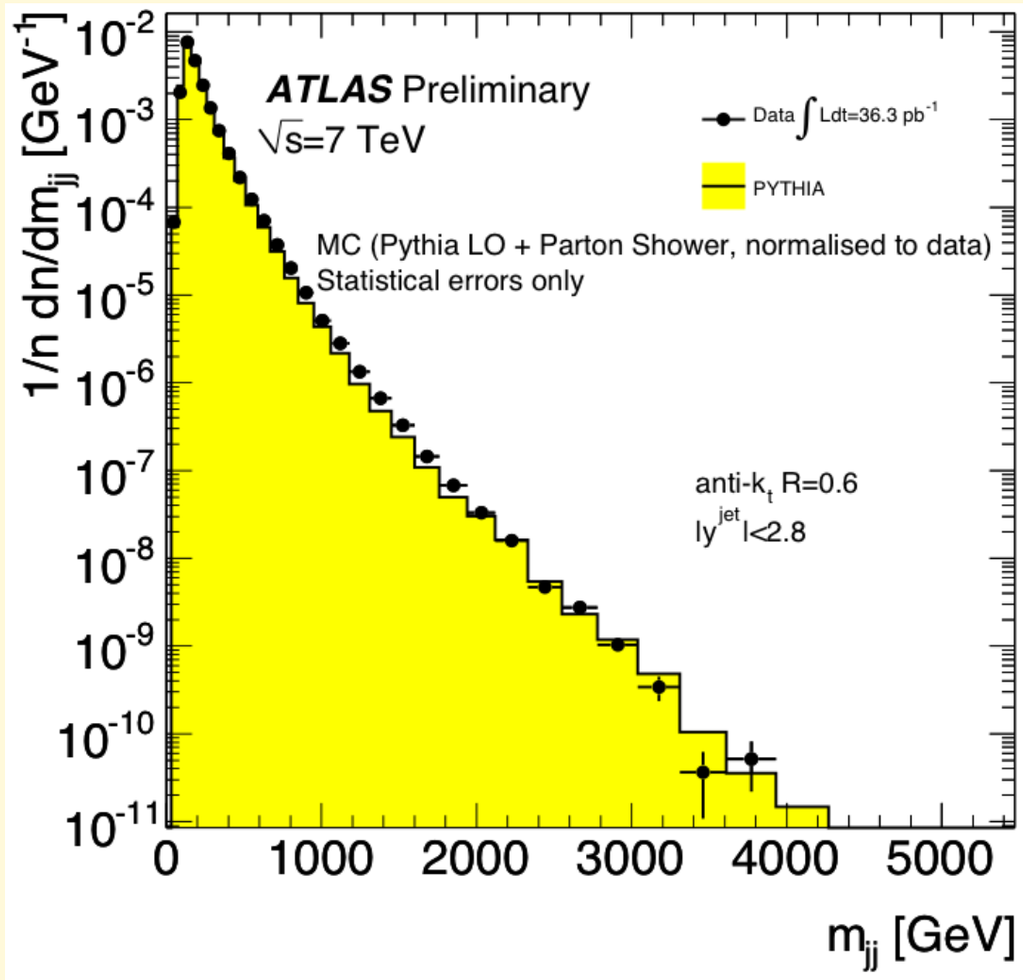


Unfolded cross-section measurement, suitable for comparison with NLO

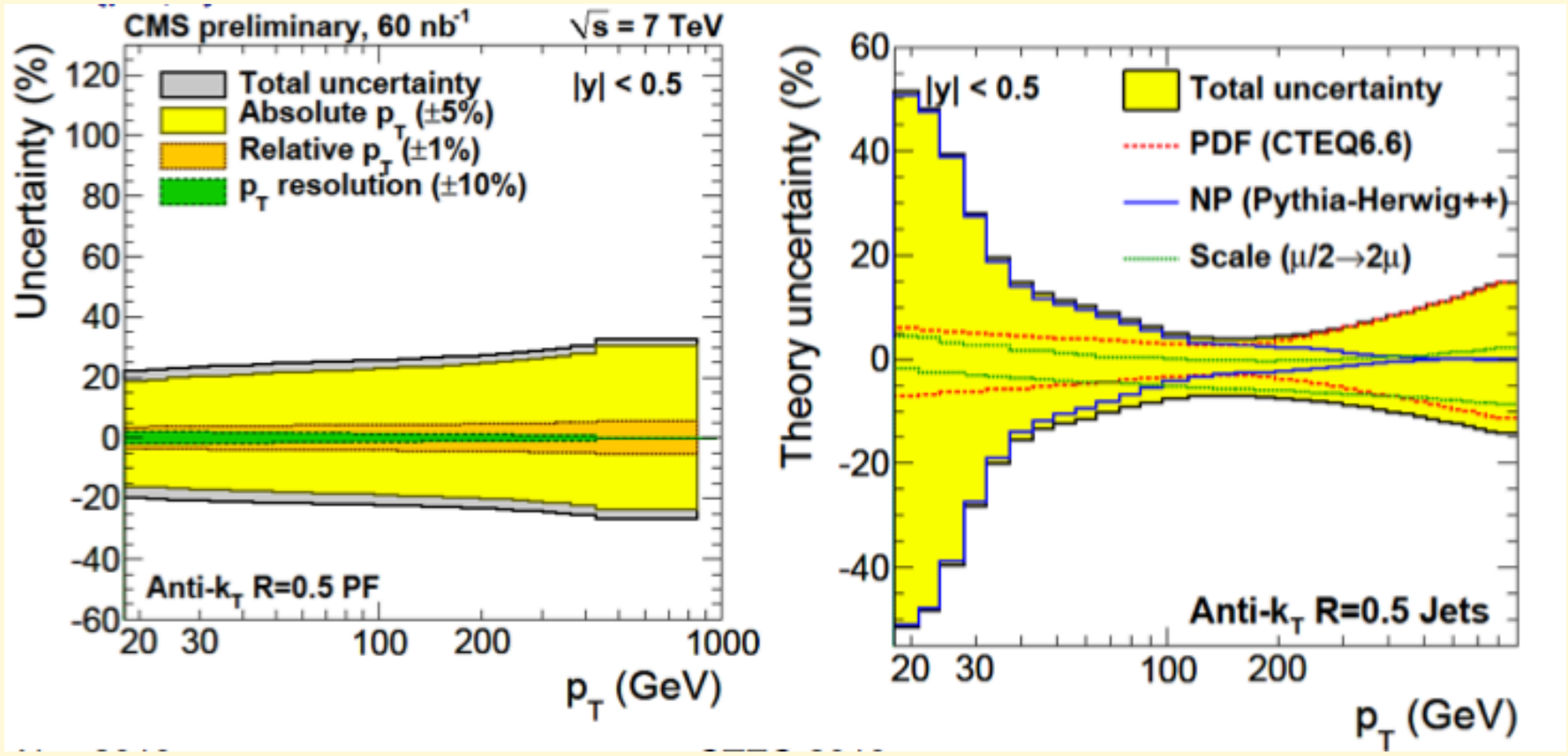
Use of modern jet reconstruction tools

Full 2010 luminosity update:

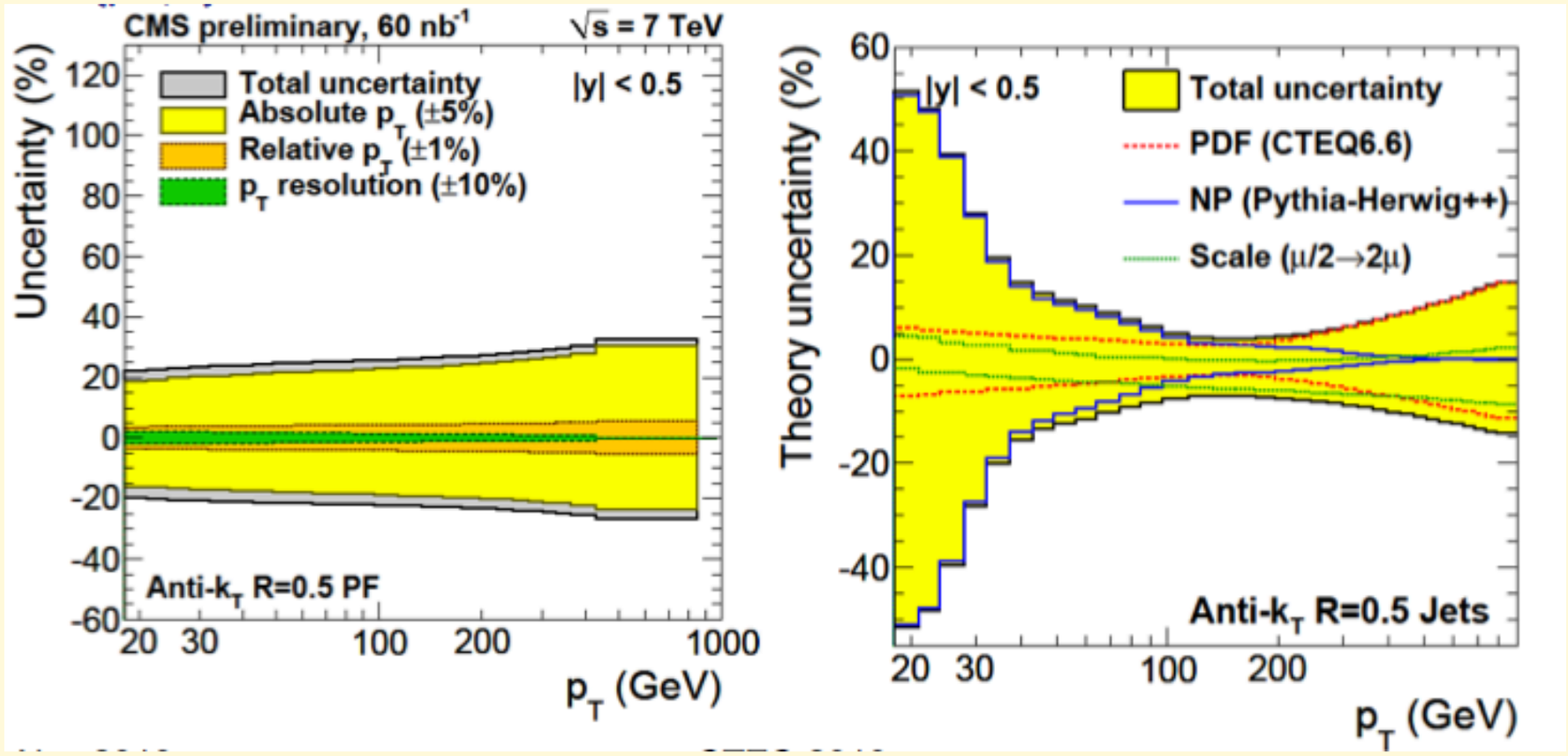




See P. Wells, for the ATLAS collab., 104th LHCC session, http://indico.cern.ch/conferenceDisplay.py?confId=112439



PDF will be dominant source of theoretical systematics at large E_T



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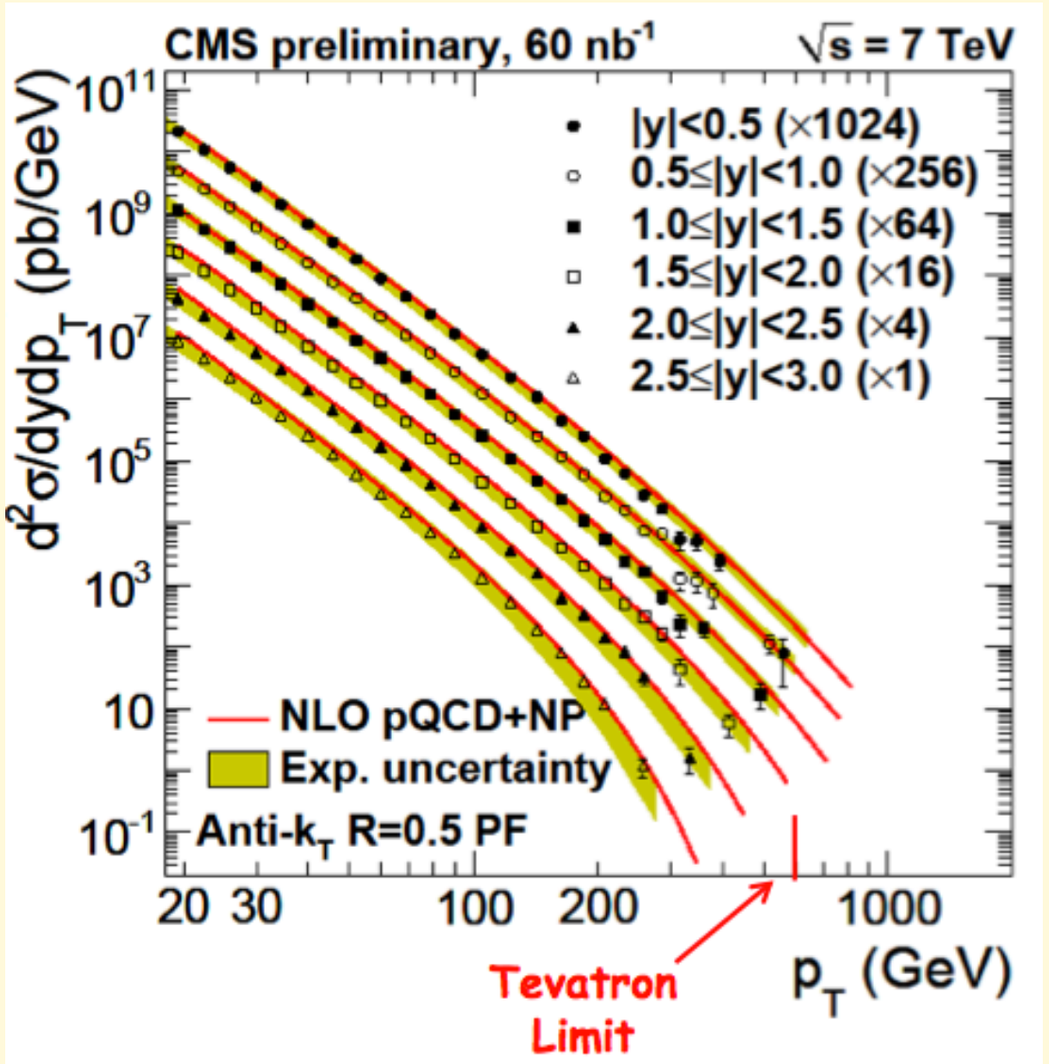
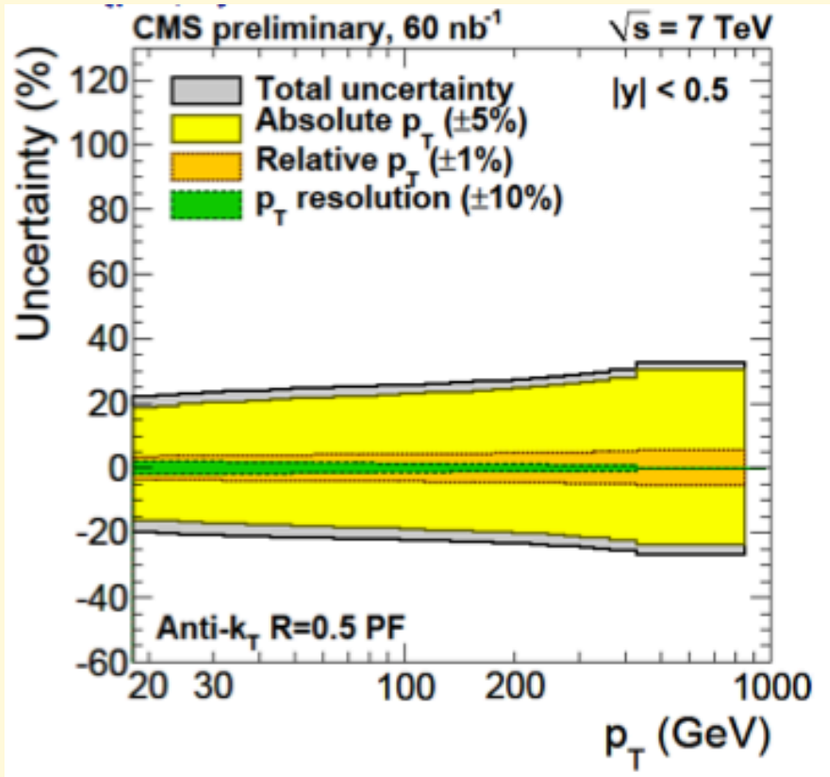
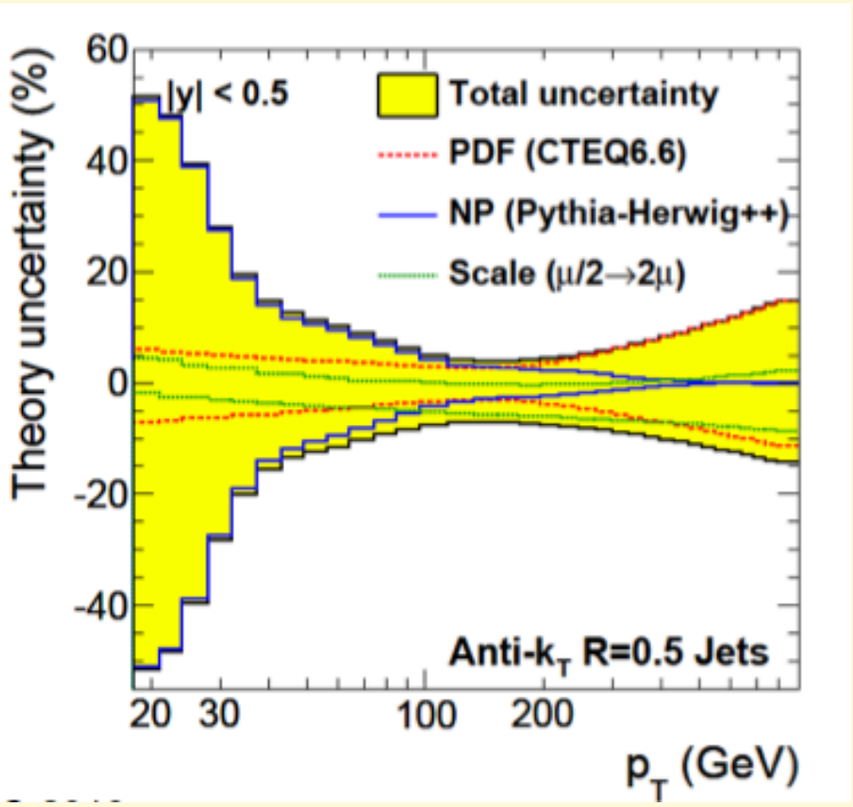
How powerful will be the jet data at large η in reducing this systematics?







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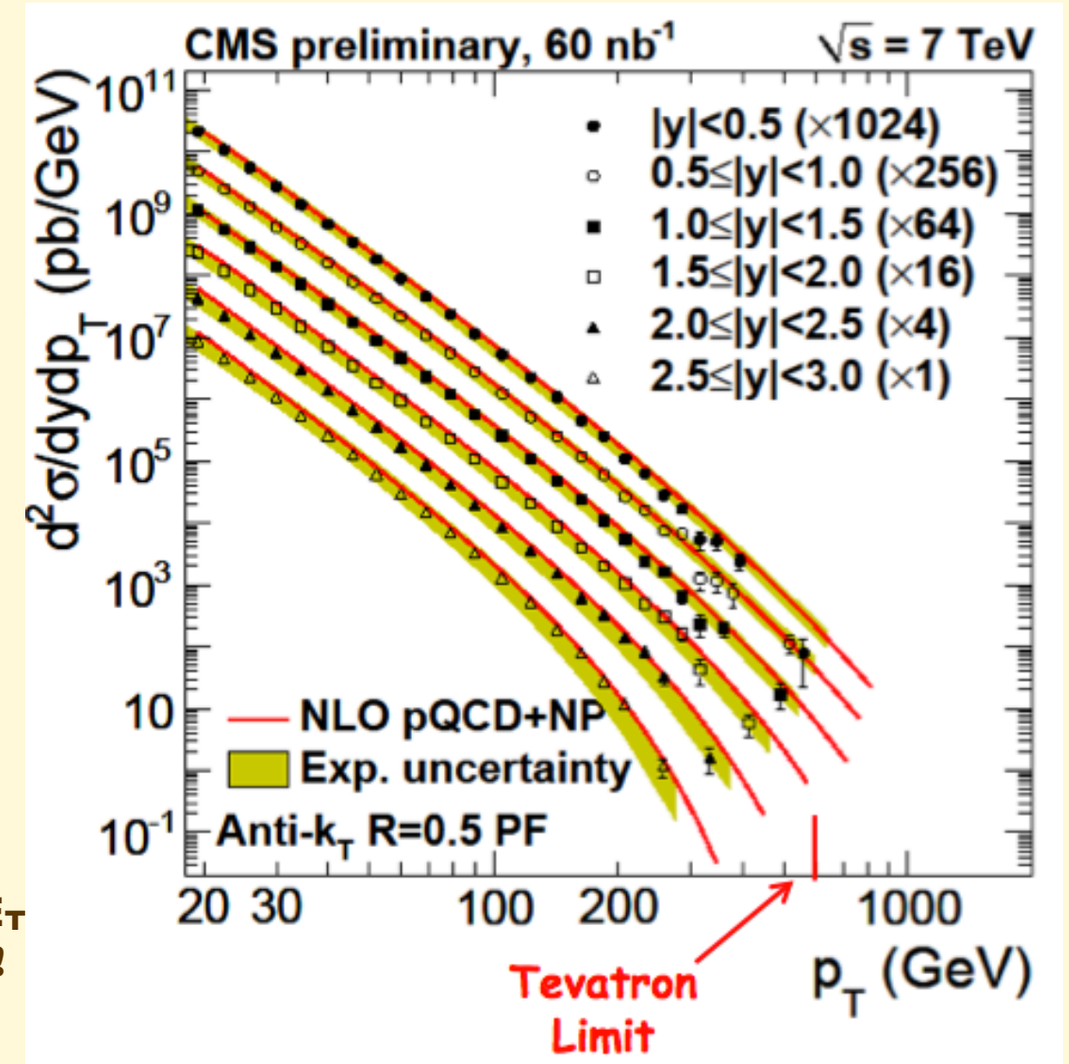
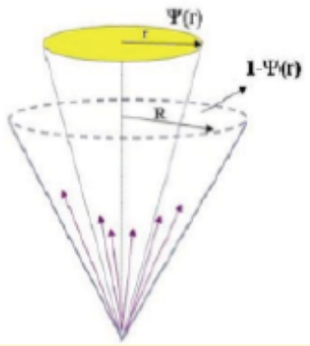


Notice reach in E_T down to 20 GeV!!

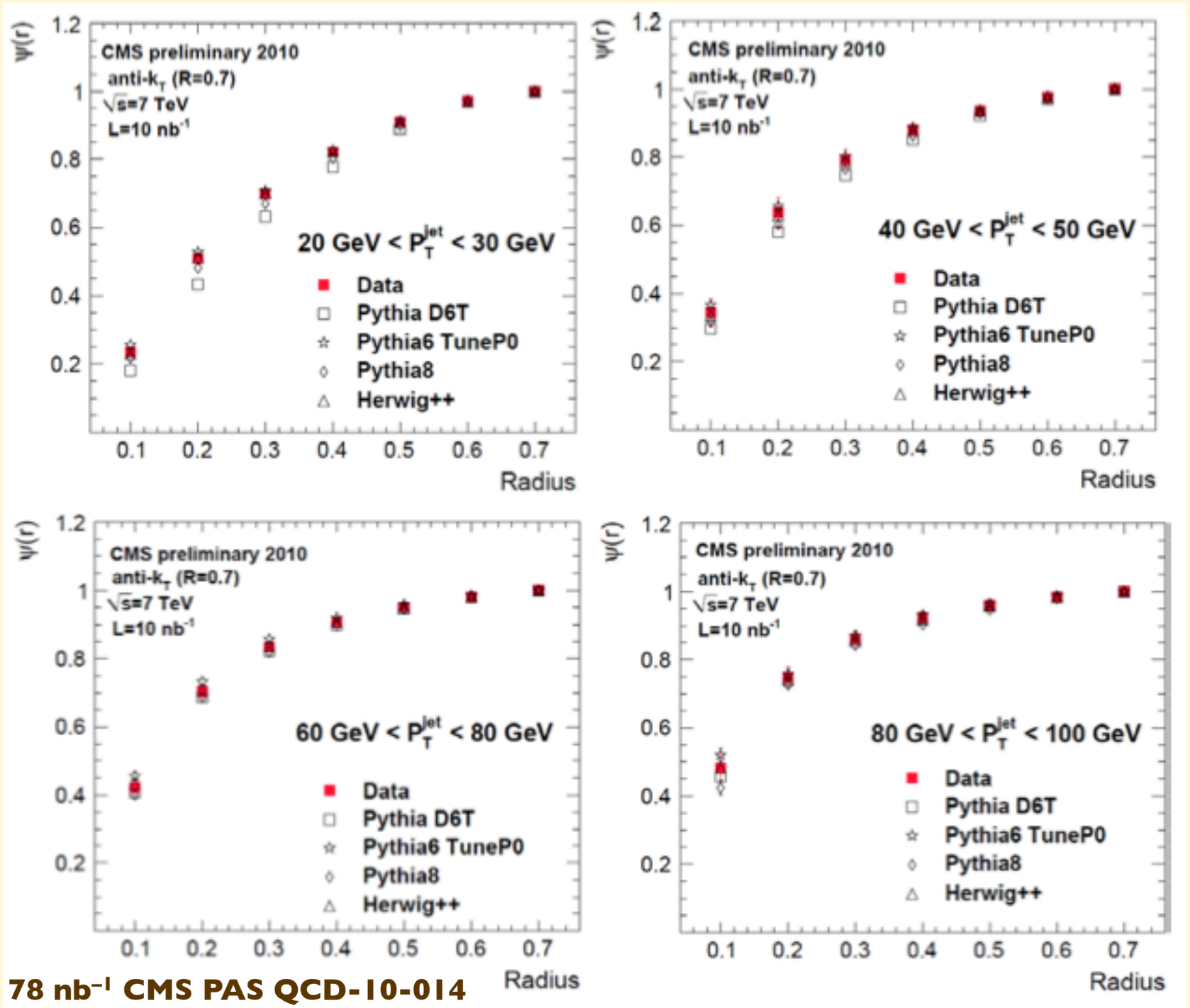
Integrated jet shape

$$\Psi(r)=\frac{1}{N_{jets}}\sum_{jets}\frac{P_T(0,r)}{P_T^{jet}(0,R)}$$



Probes modeling of shower evolution, with implications for:

- precision QCD studies (e.g. jet E_T spectrum, data vs NLO)
- jet spectroscopy (e.g. top mass determination)
- multiparton matrix-elements/shower matching
- pt W

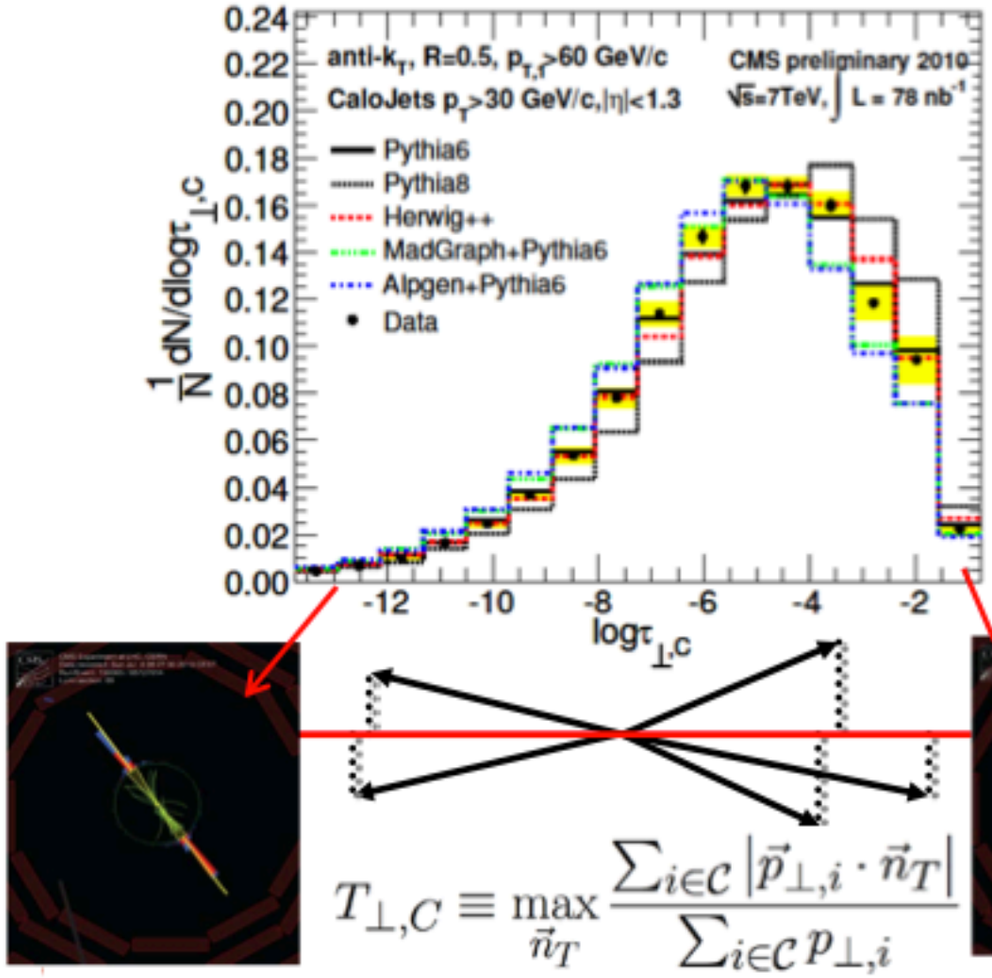


78 nb^{-1} CMS PAS QCD-10-014

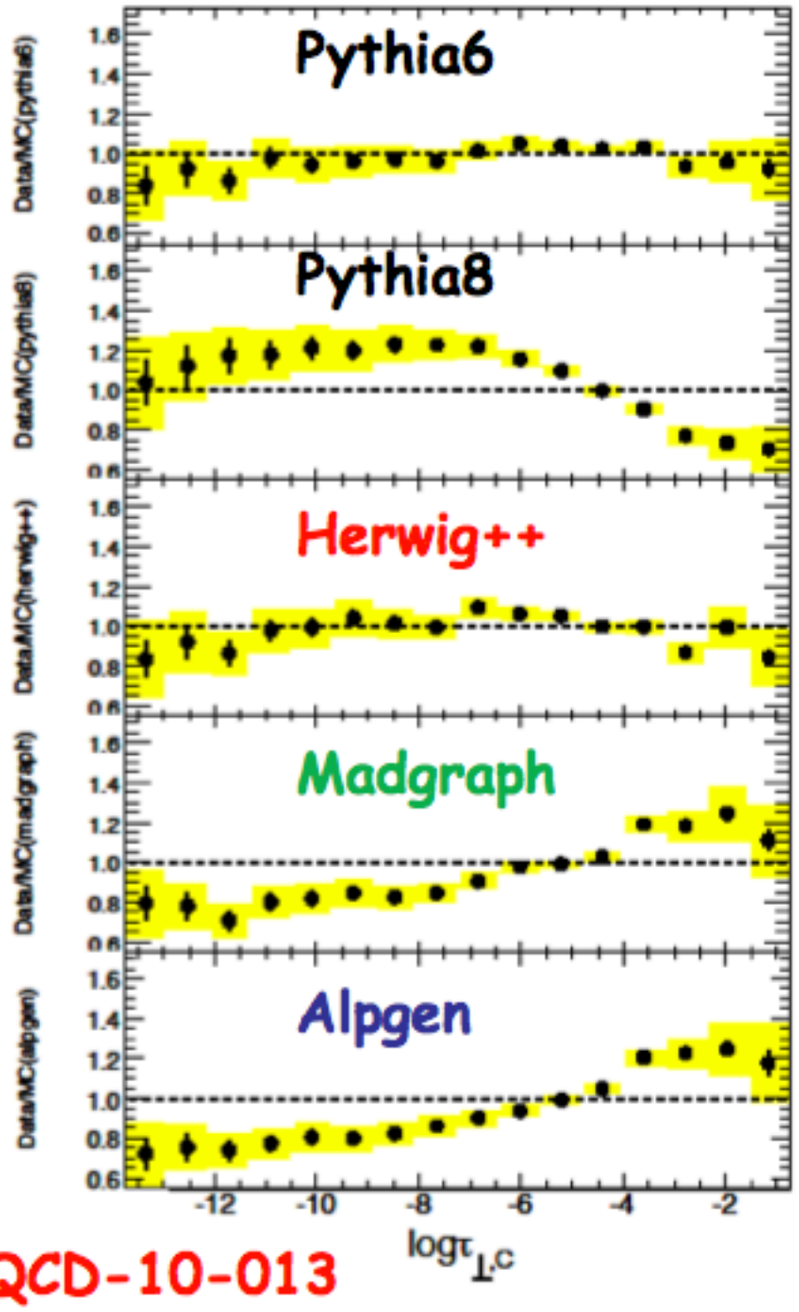
Event Shapes

Q D C High PT

- Event shapes provide geometric information about energy flow in hadronic events
- Useful for tuning of MC models for non-perturbative effects
- Robust against experimental uncertainties



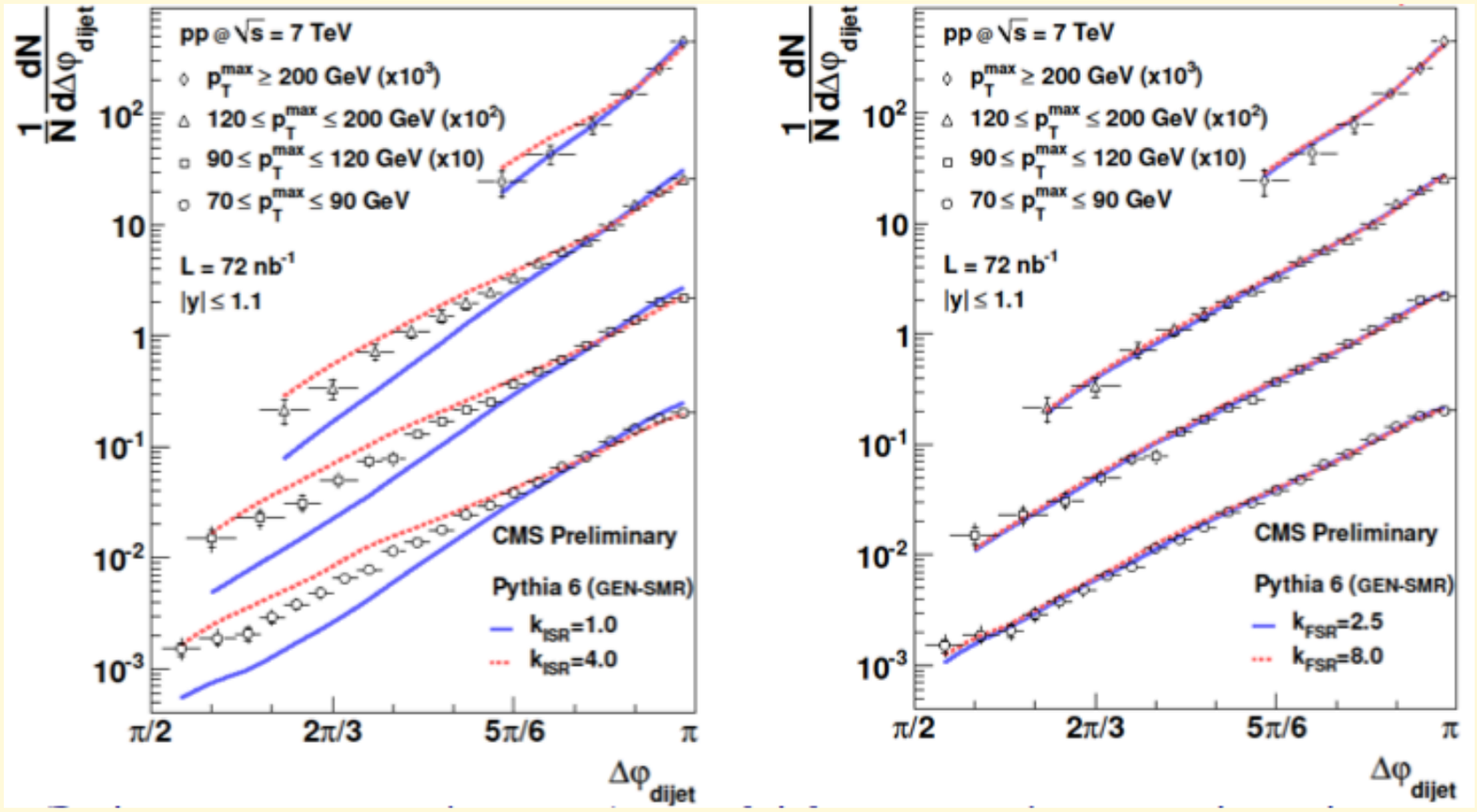
Central transverse thrust



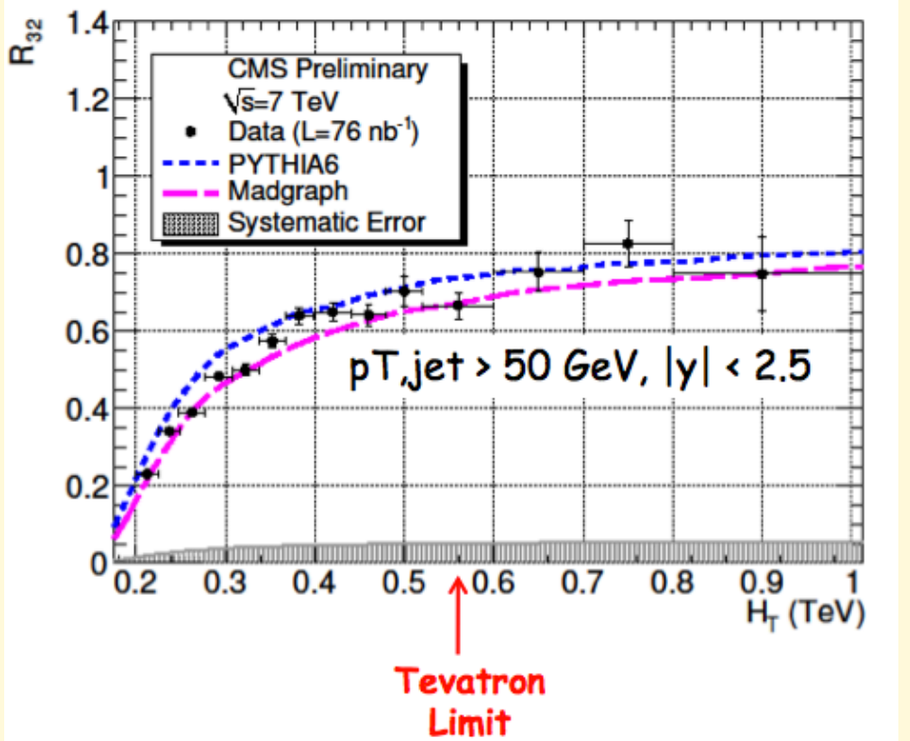
QCD-10-013

Other global properties of jet final states

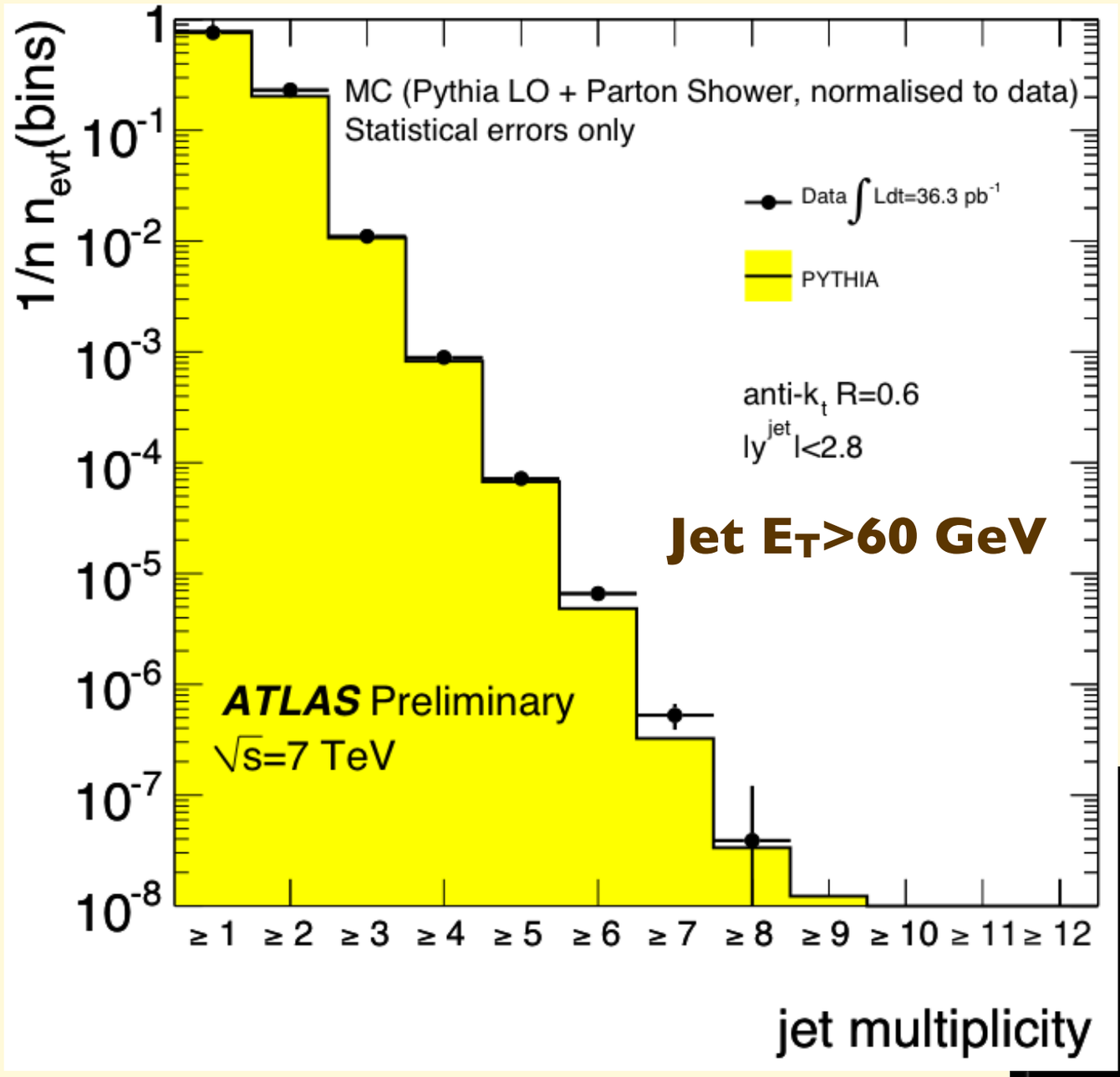
Dijet Angular Decorrelation

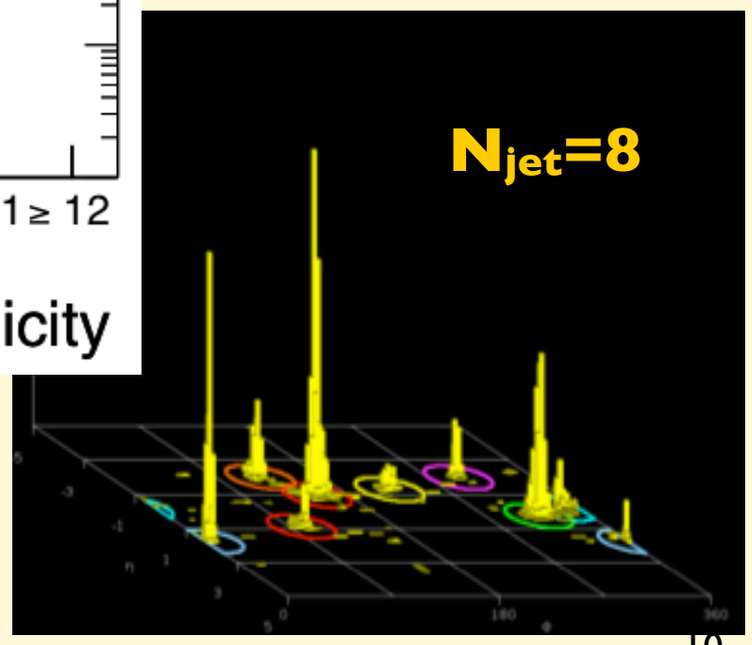


$$R_{32} = \frac{d\sigma_3/dH_T}{d\sigma_2/dH_T}$$



Multijets





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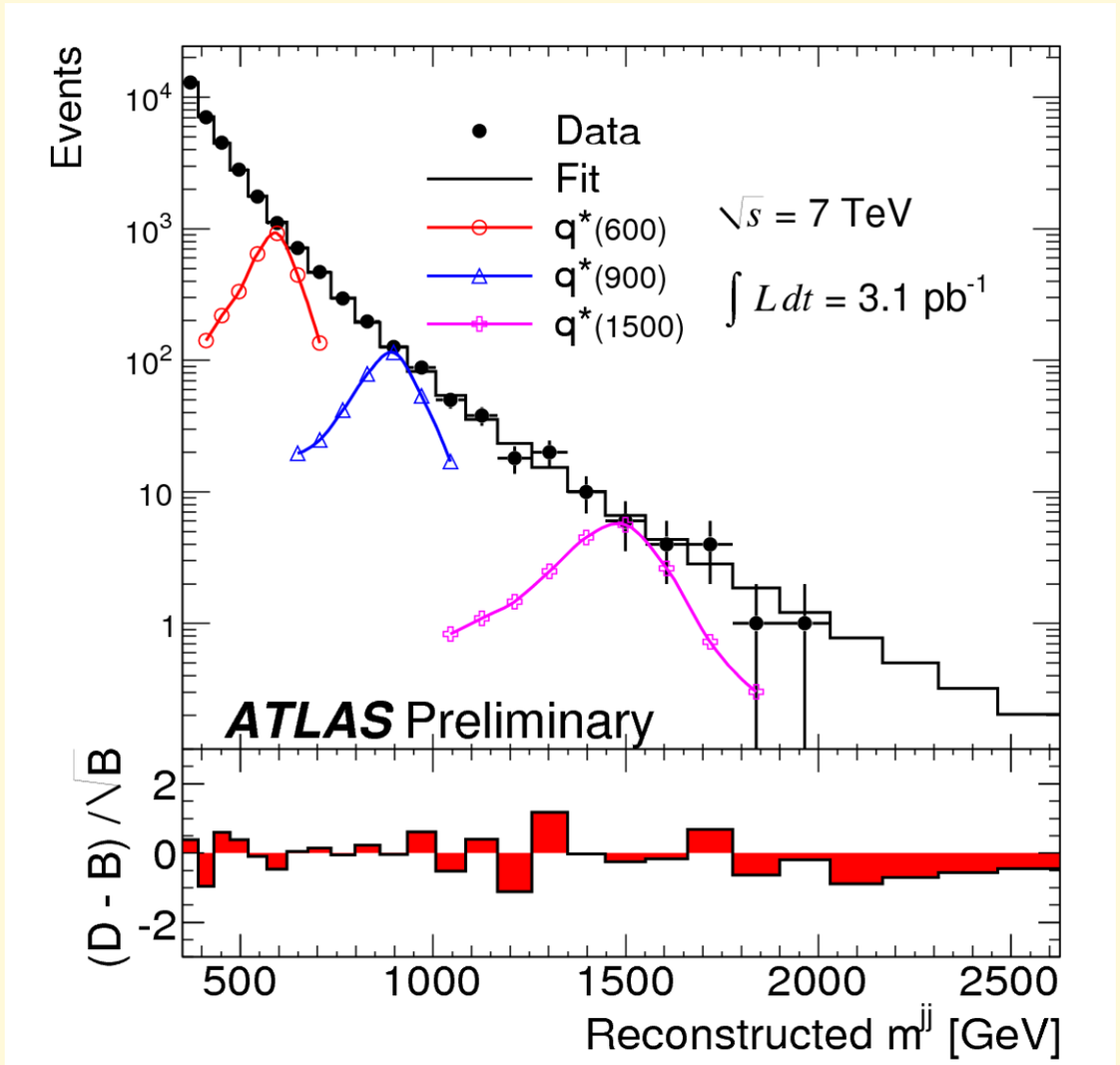
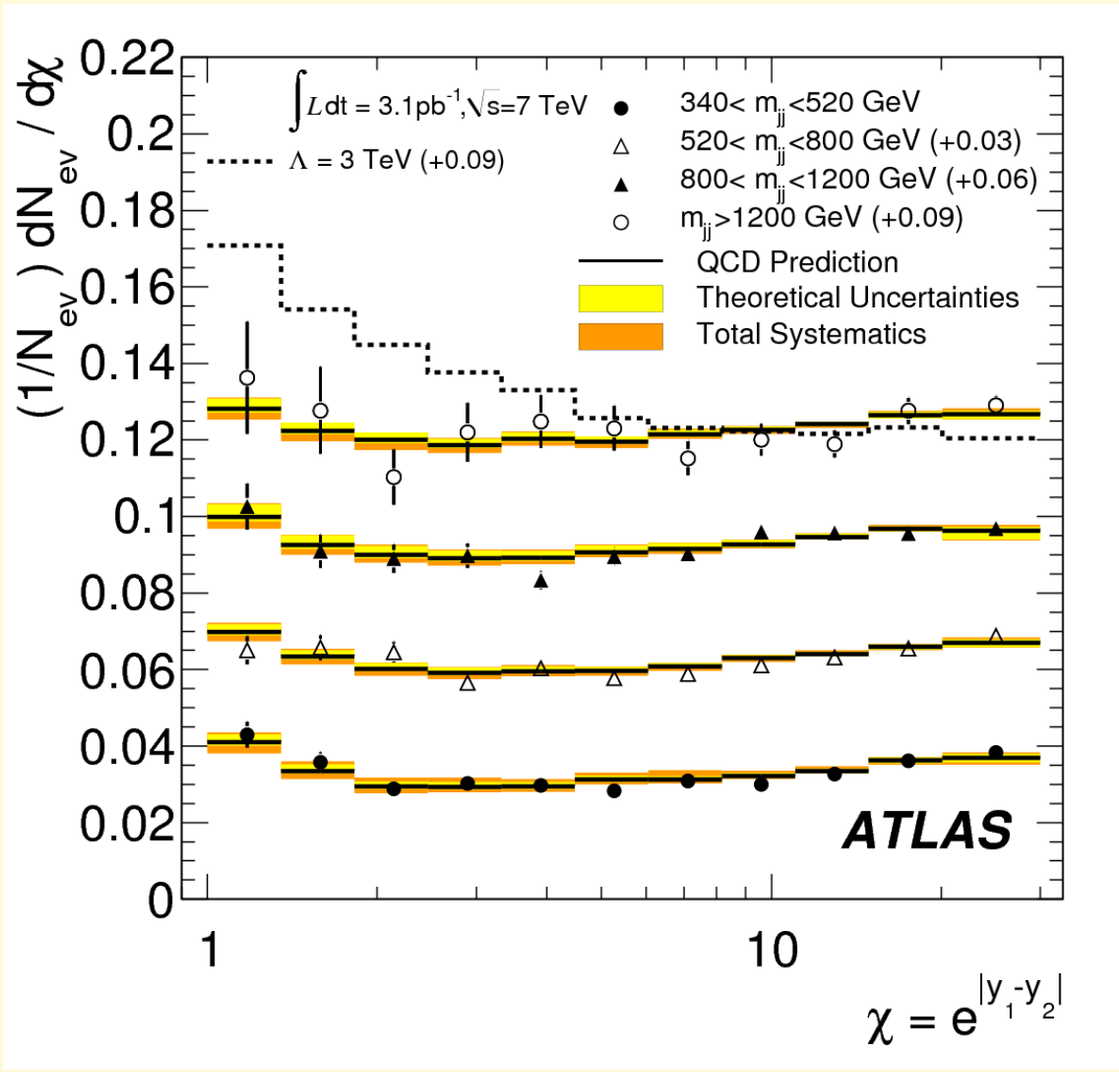
First constraints on new physics



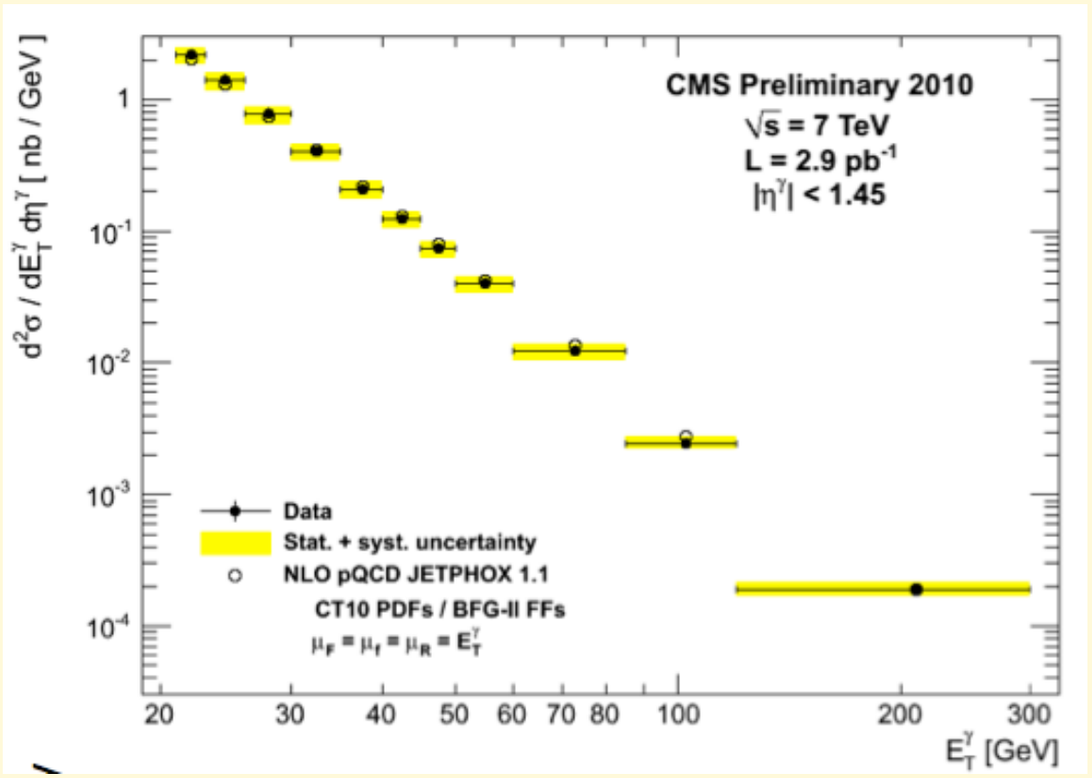
0.50 < m(q*) < 1.53 TeV @ 95% CL

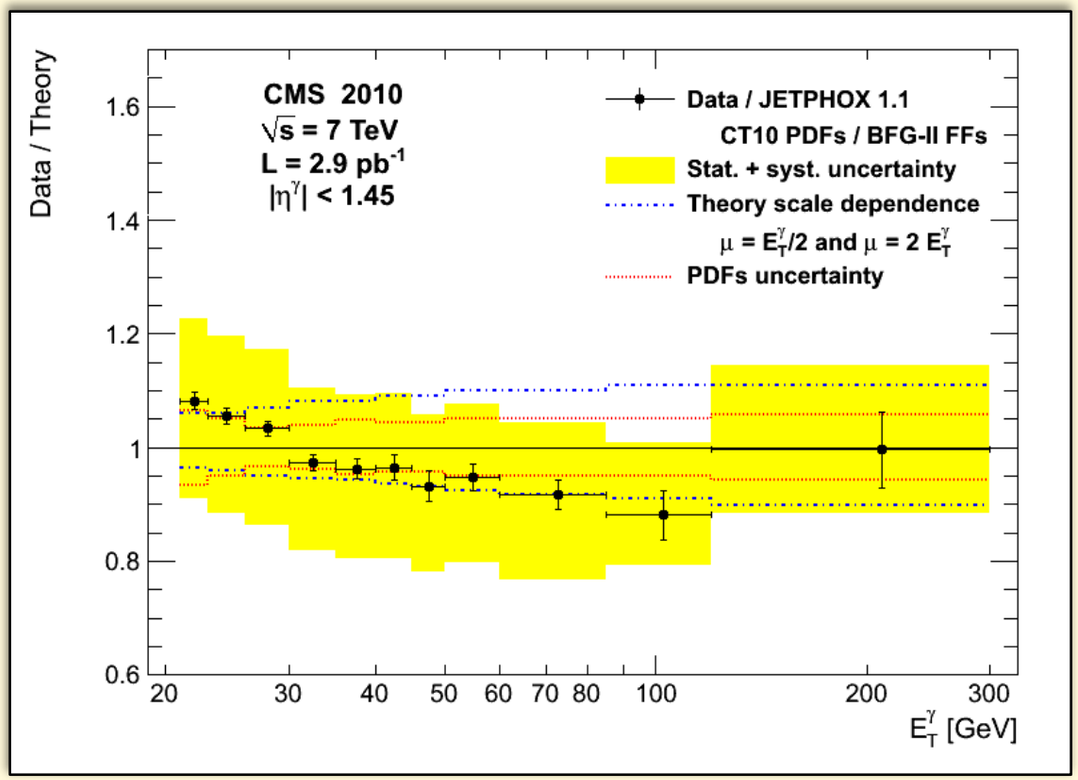


Quark contact interactions with scale < 3.4 TeV @ 95% CL

Photons

Prompt photon spectrum, LHC data vs TH





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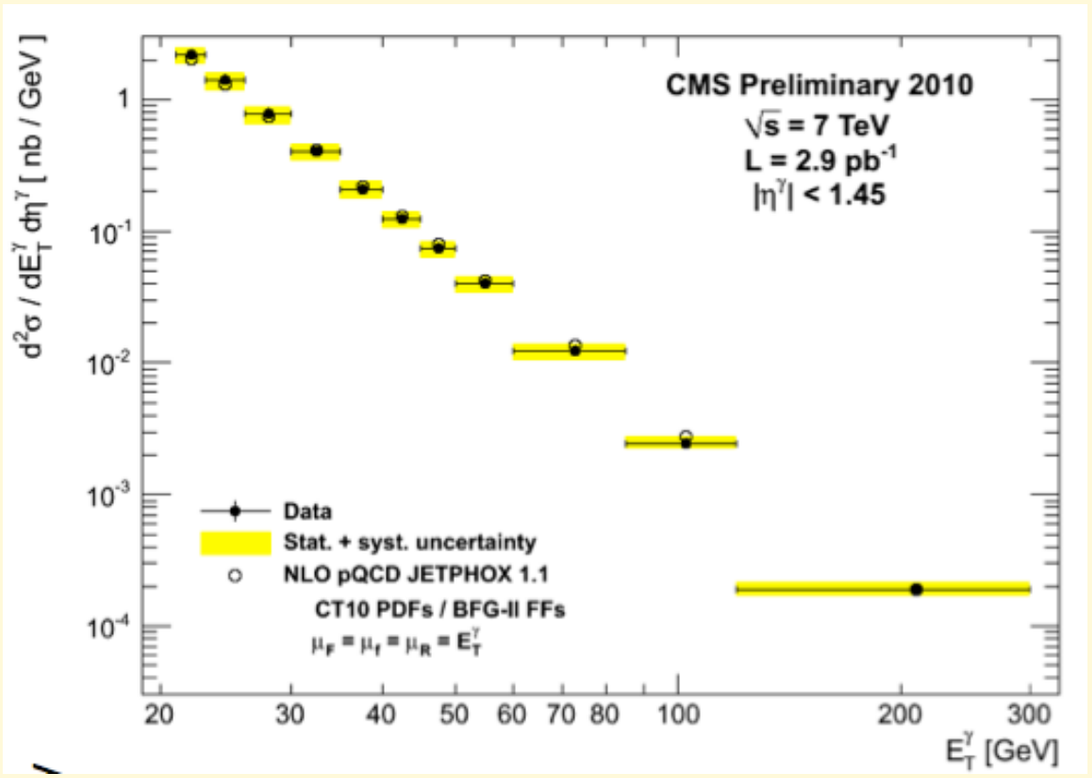
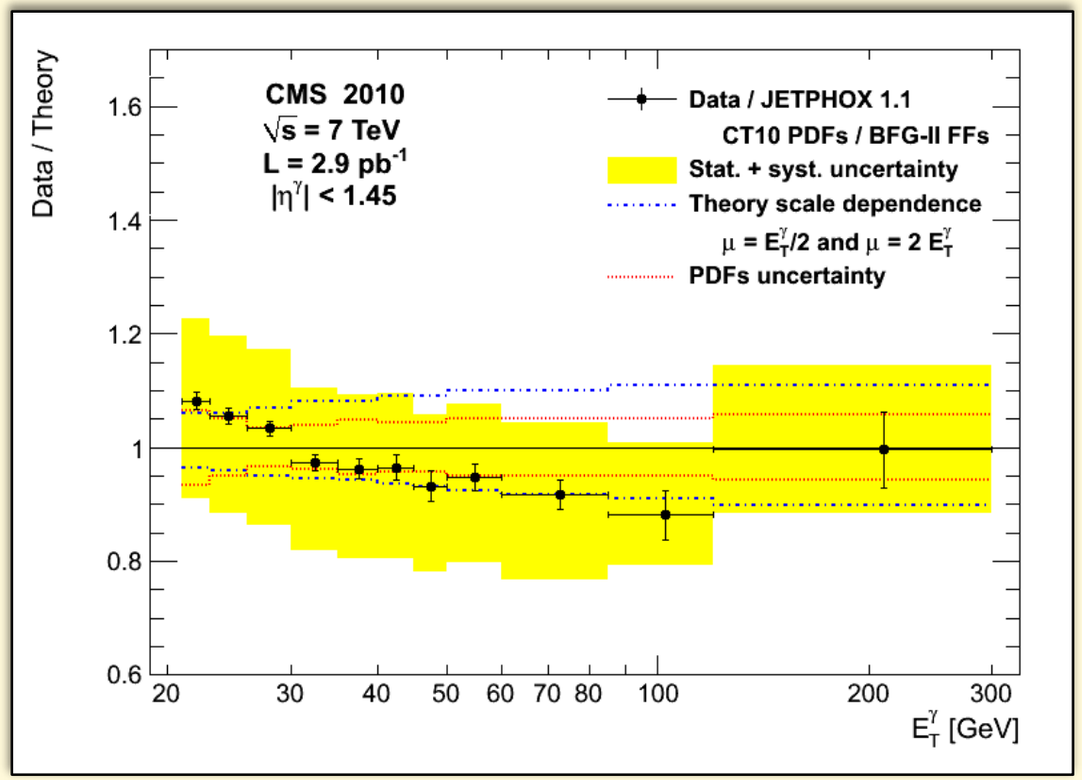


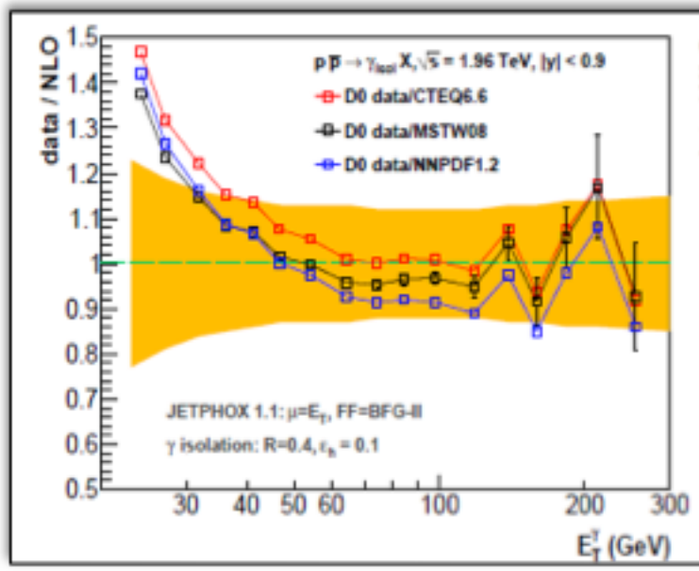


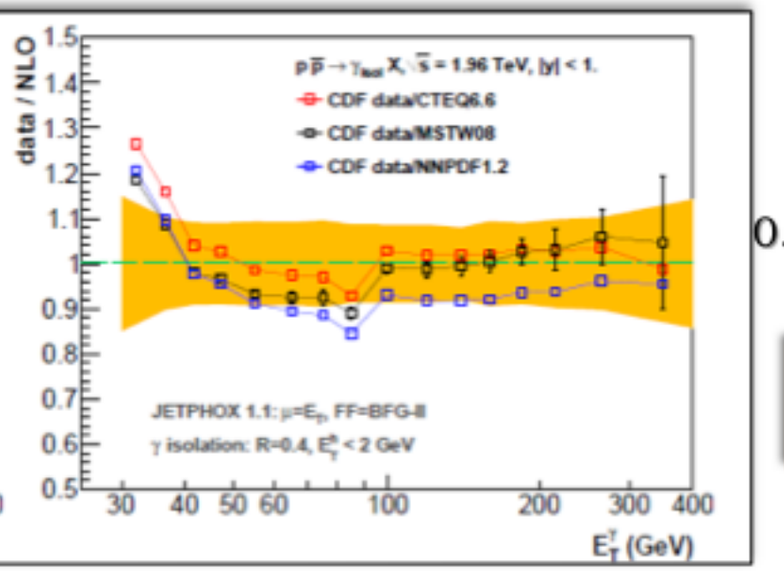
Cfr Tevatron:

arXiv:1005.4529

D0
0.01 < xT < 0.12

Phys. Lett. B
639 (2006) 151





CDF
0.01 < xT < 0.13

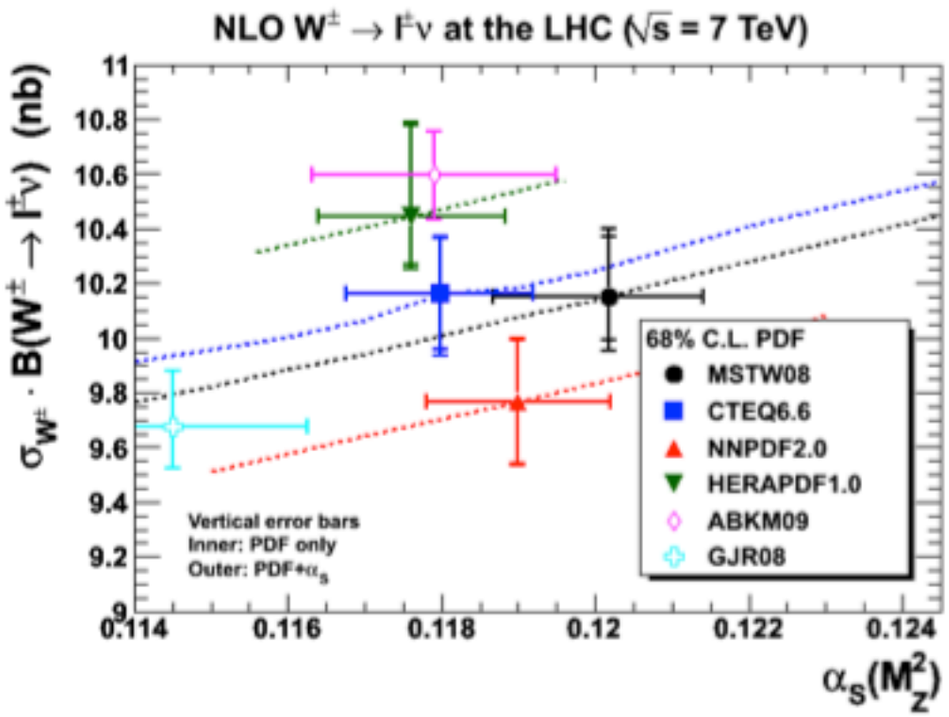
Phys. Rev. D 80
(2009) 111106

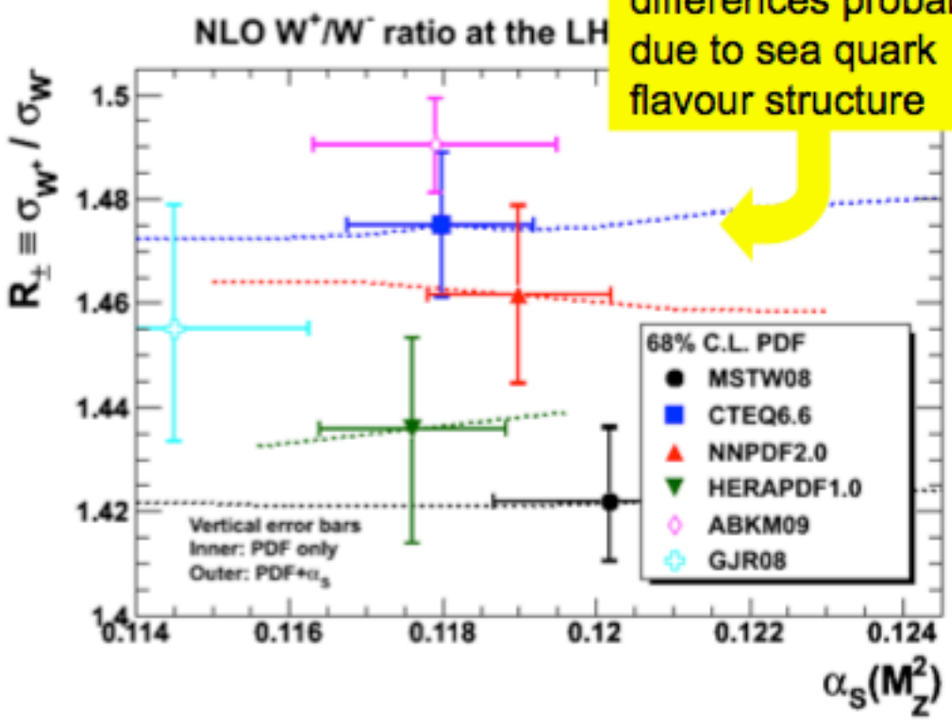
11/29/10

20

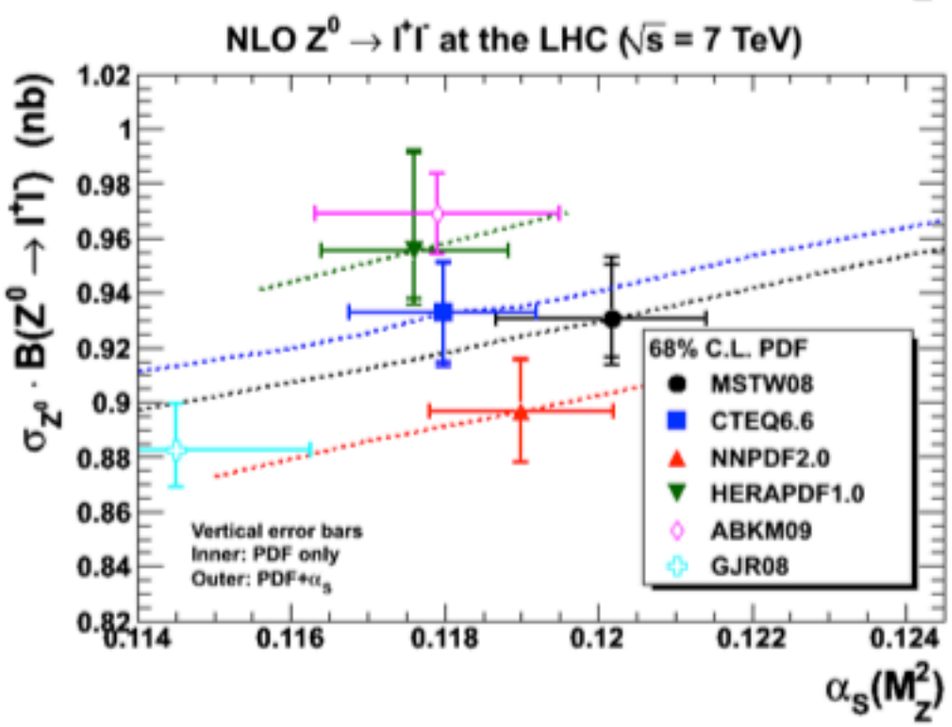
W/Z

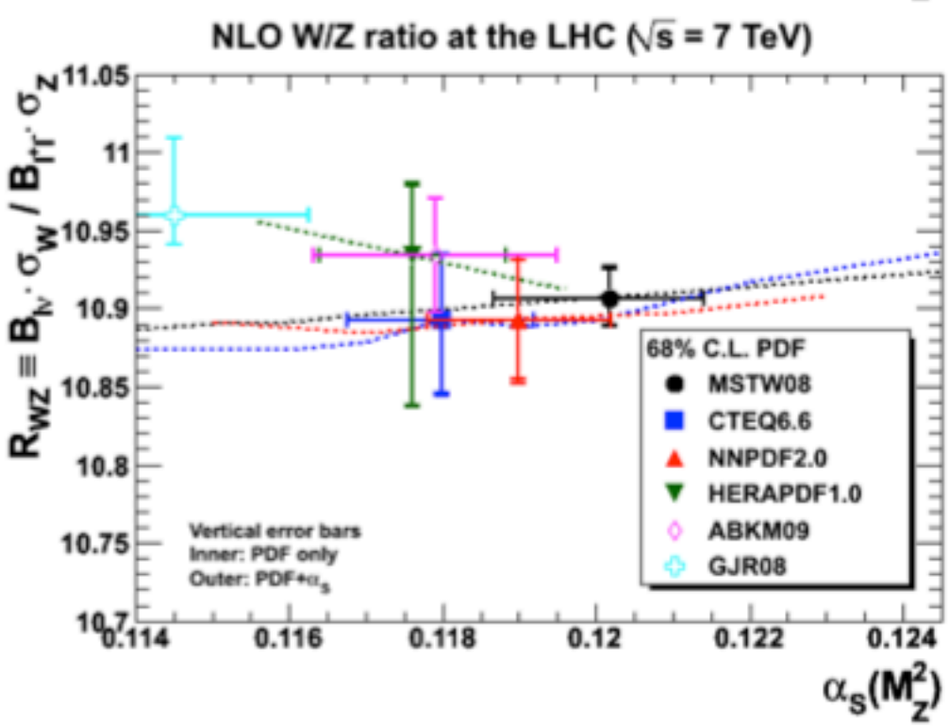
benchmark W,Z cross sections



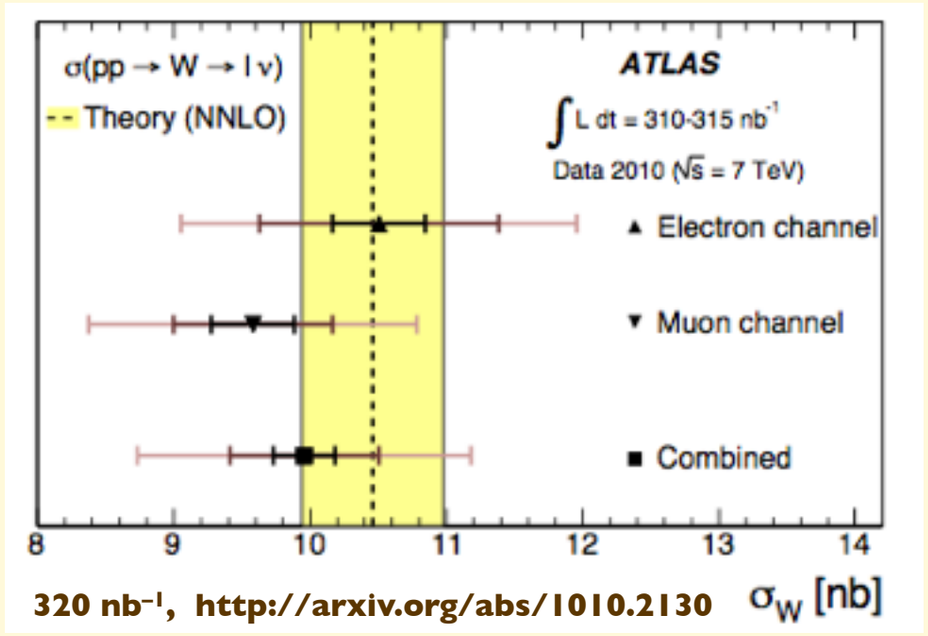


differences probably due to sea quark flavour structure

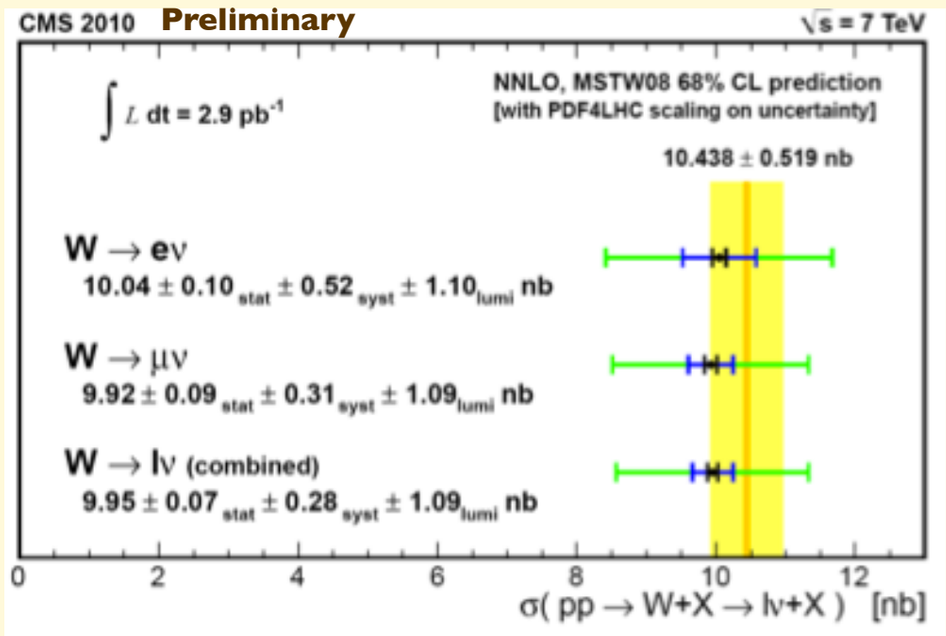


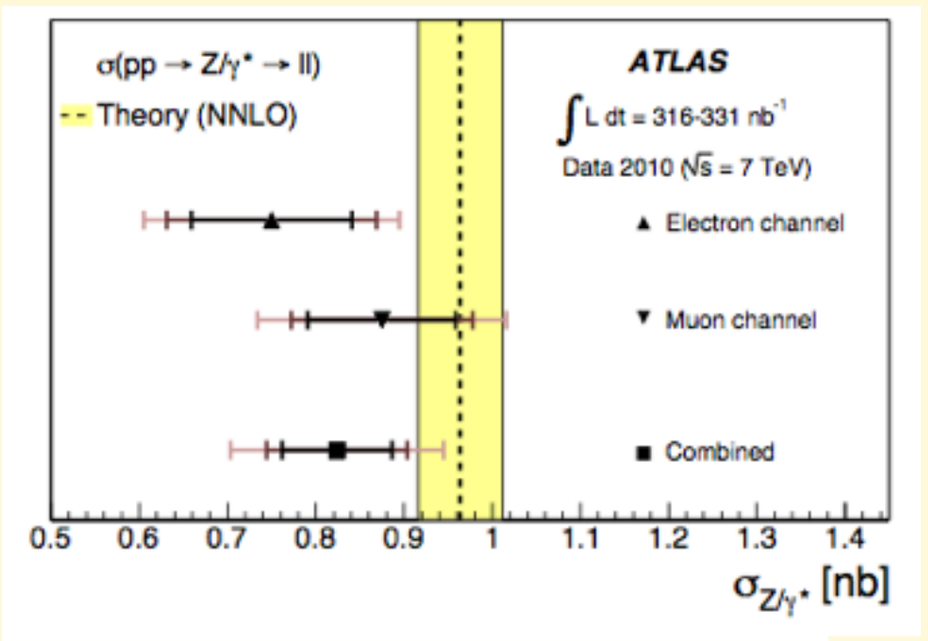


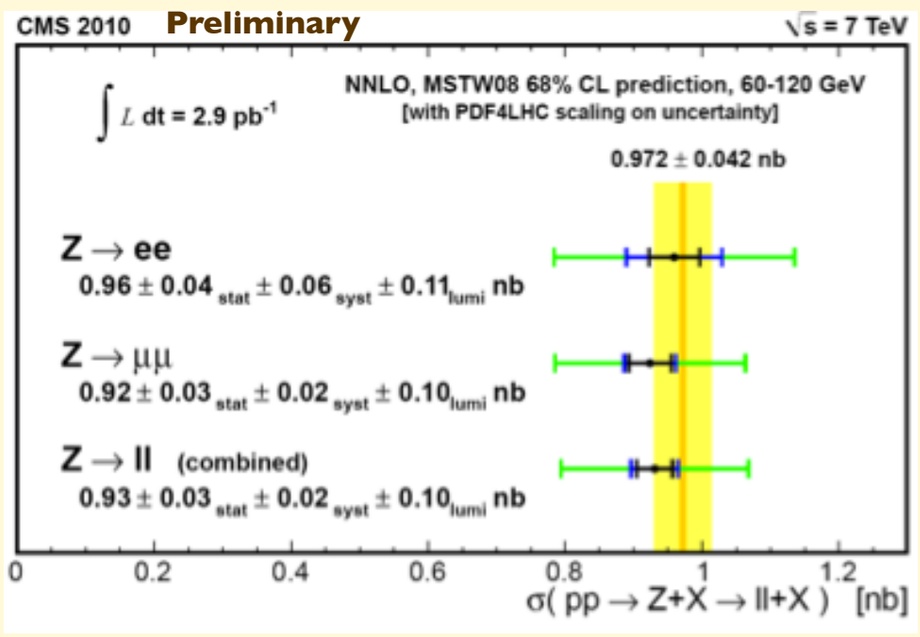
From W.J. Stirling talk at Trento Workshop "LHC at the LHC"

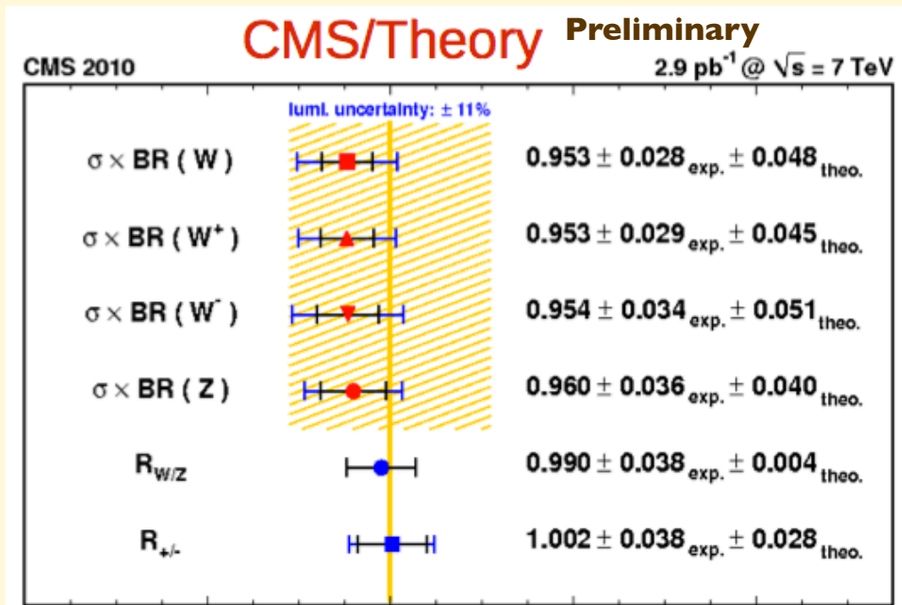


320 nb^{-1}, http://arxiv.org/abs/1010.2130

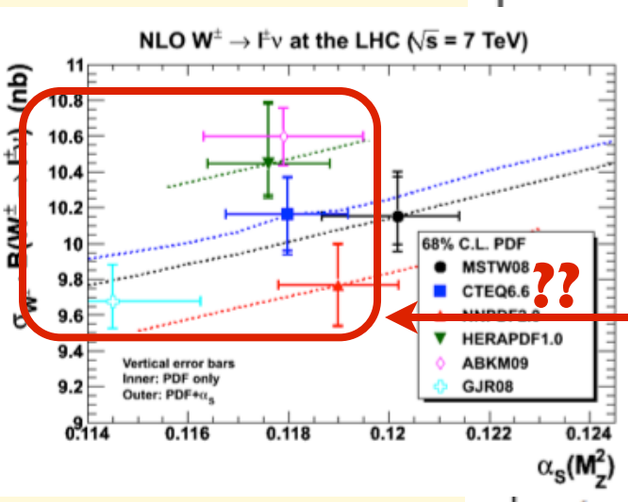


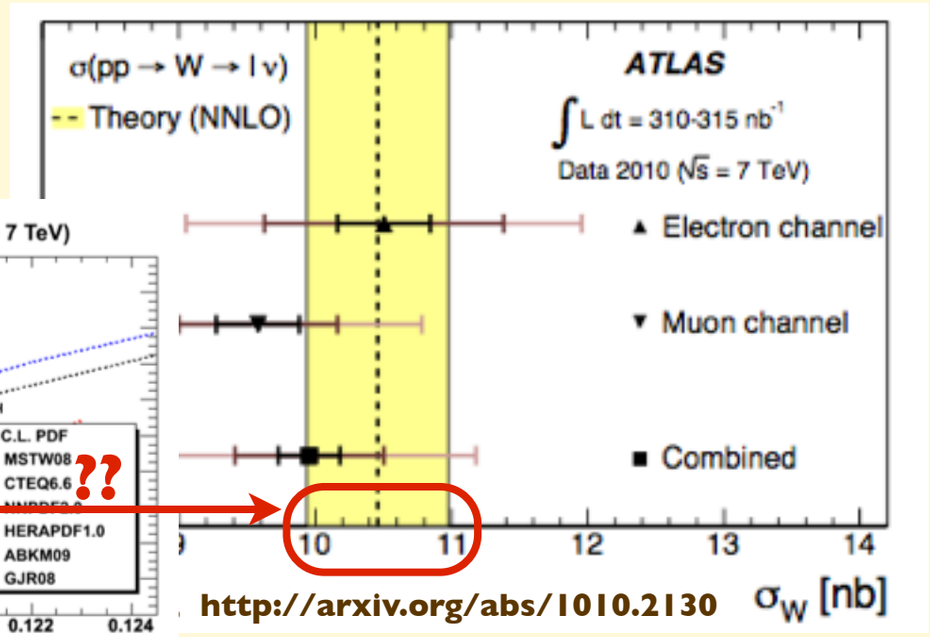






See S.Stoynev for the CMS collab., CTEQ Workshop Nov 19-20 2010





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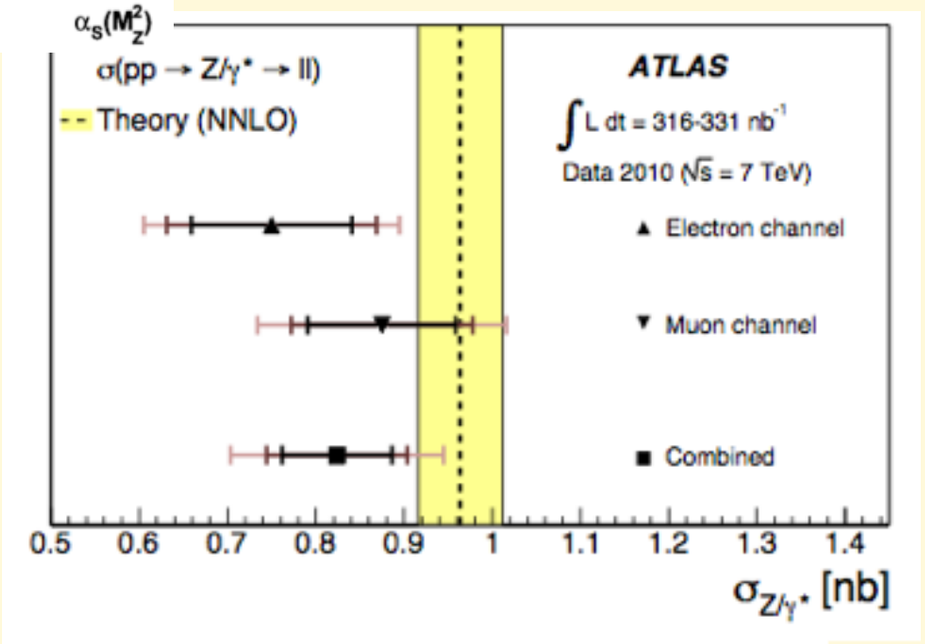

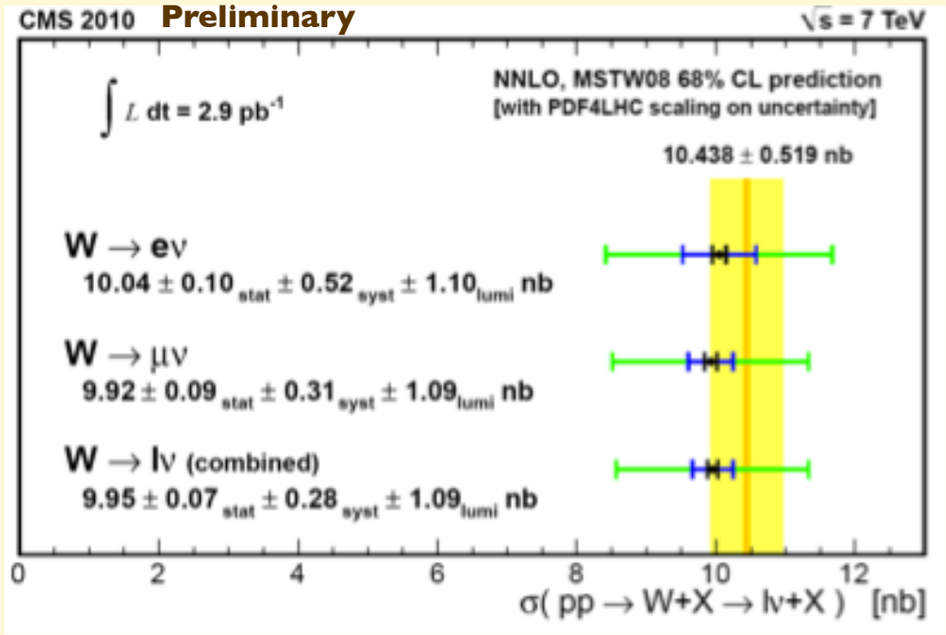

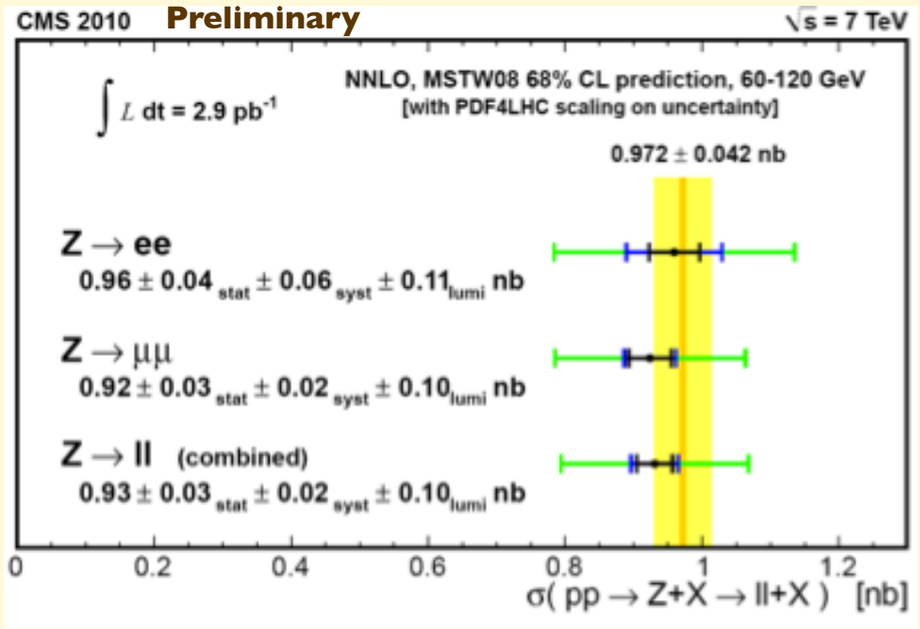

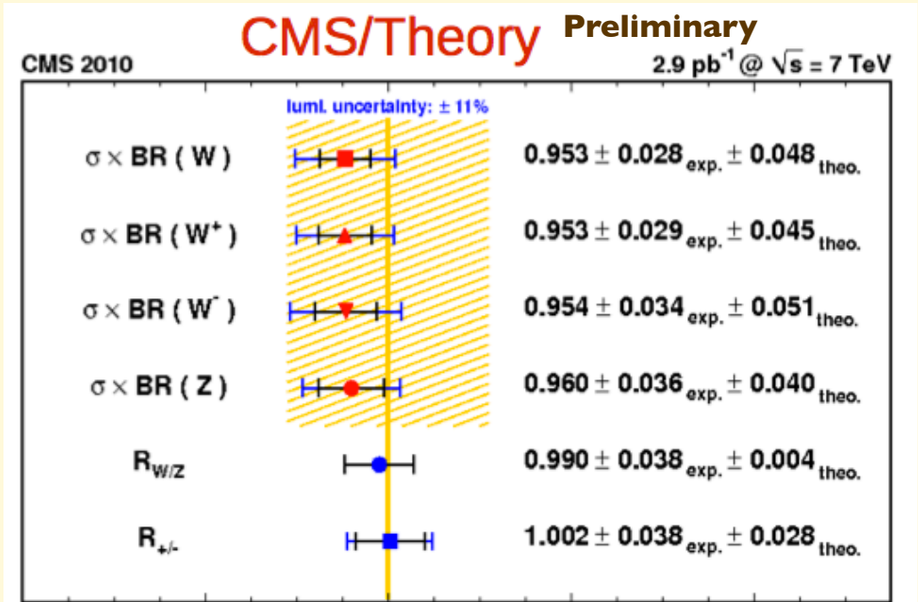

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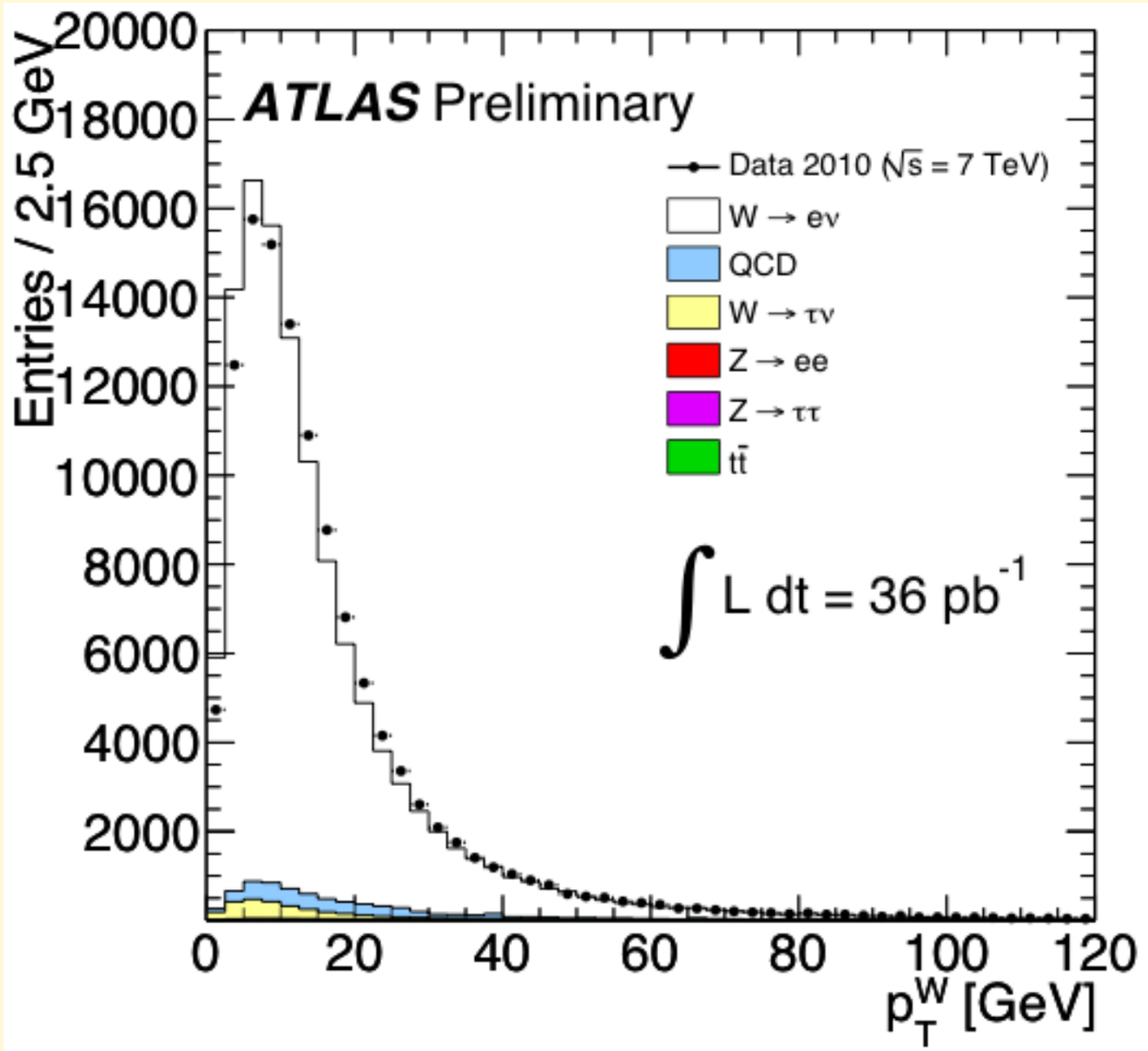
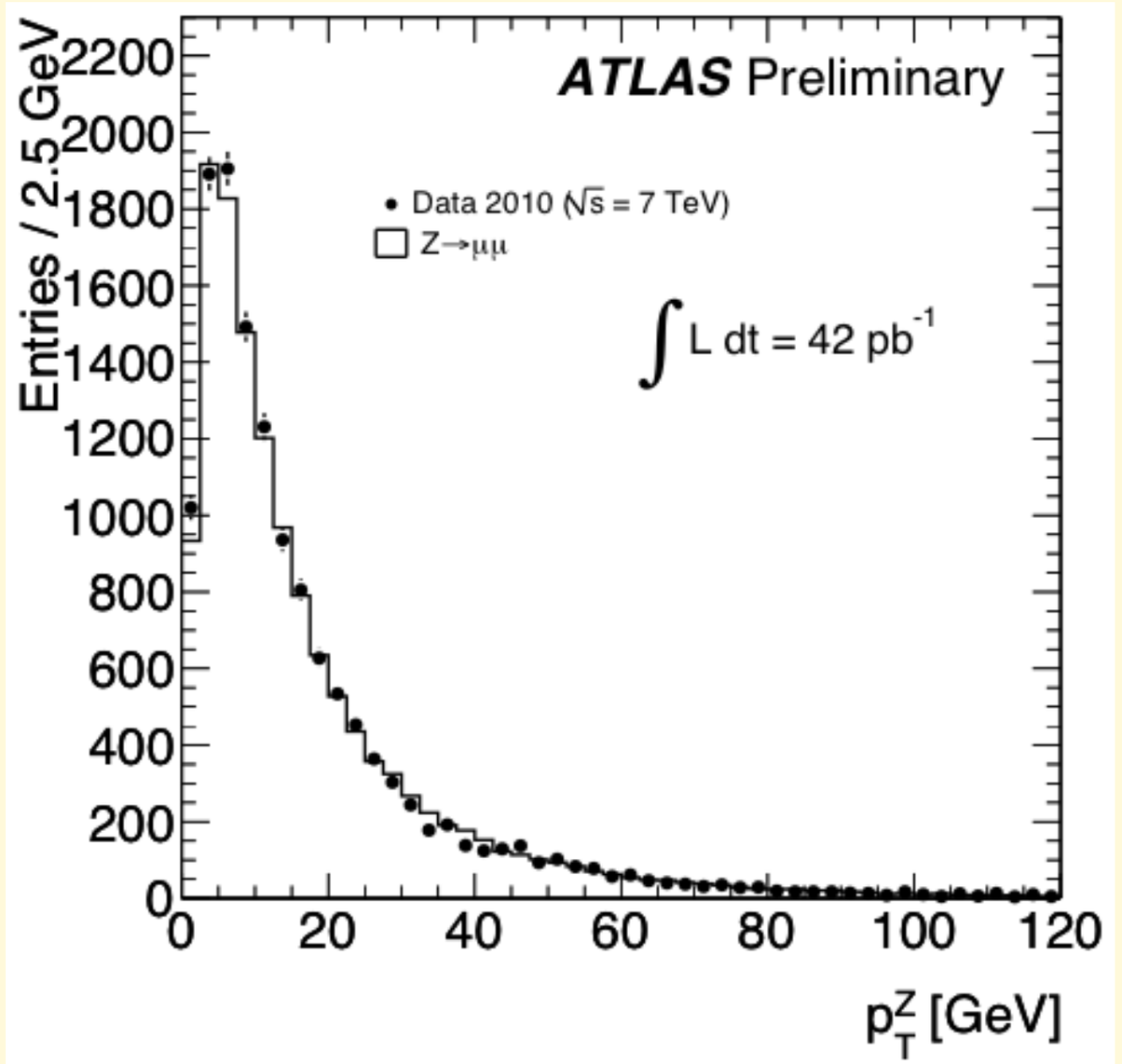
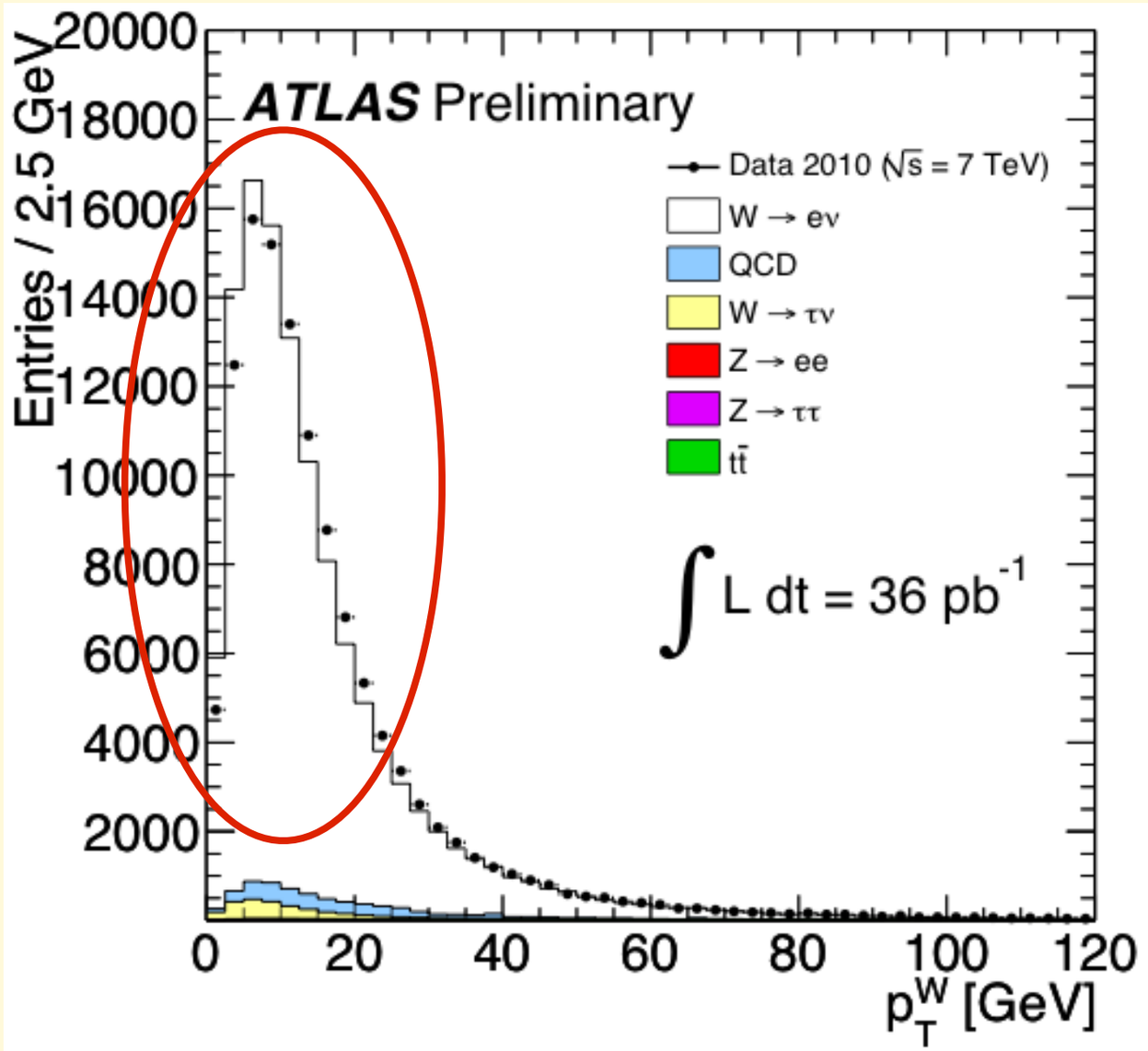
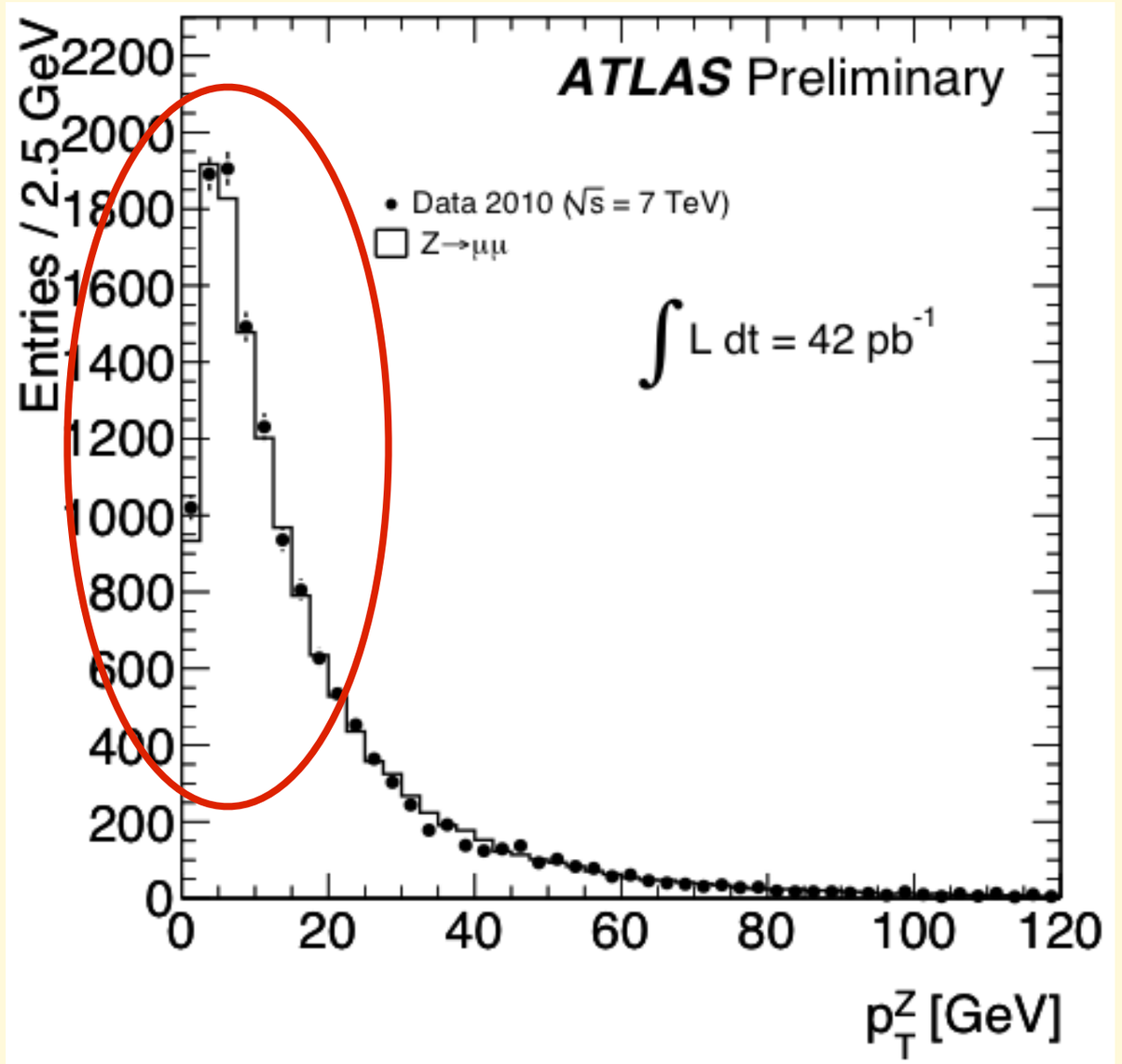
W/Z pt spectra





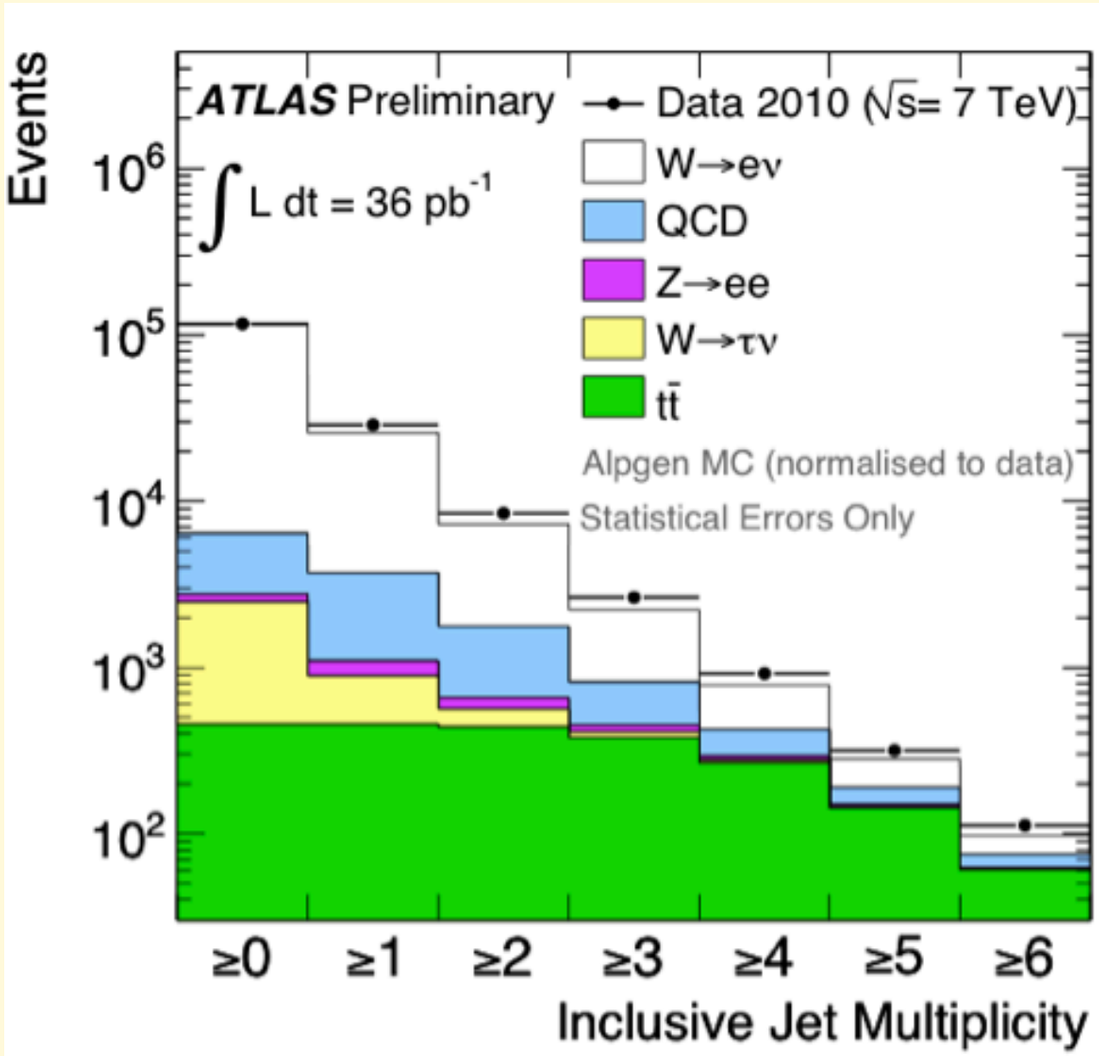
W/Z pt spectra

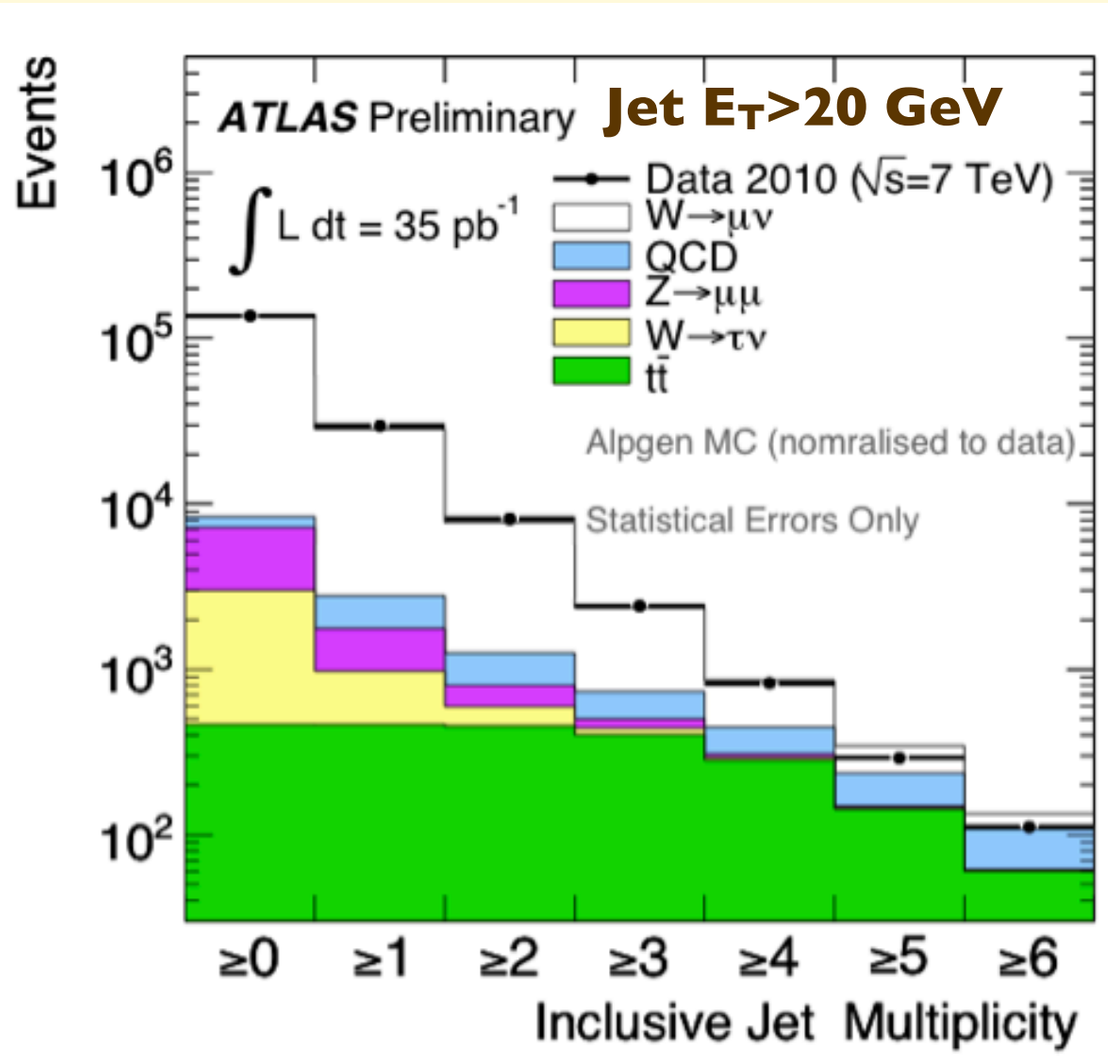




From the perspective of QCD, the modeling of W and Z pt is the same. So the different levels of agreement between data and theory in these two plots suggest that some more tuning of the detector description is required before moving on to quantitative tuning of QCD MCs.

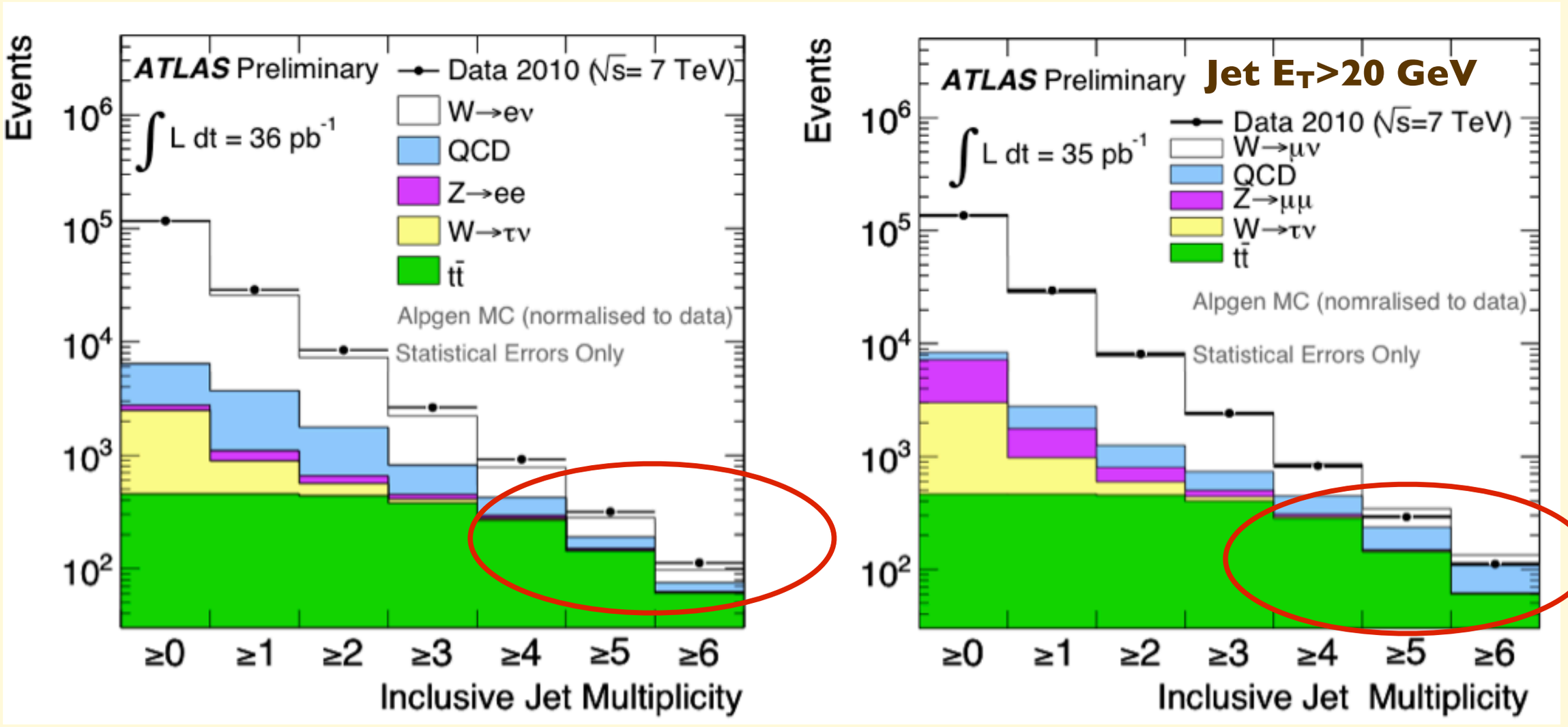
W+jets





See P-H Beauchemin for the ATLAS collab., CTEQ Workshop Nov 19-20 2010

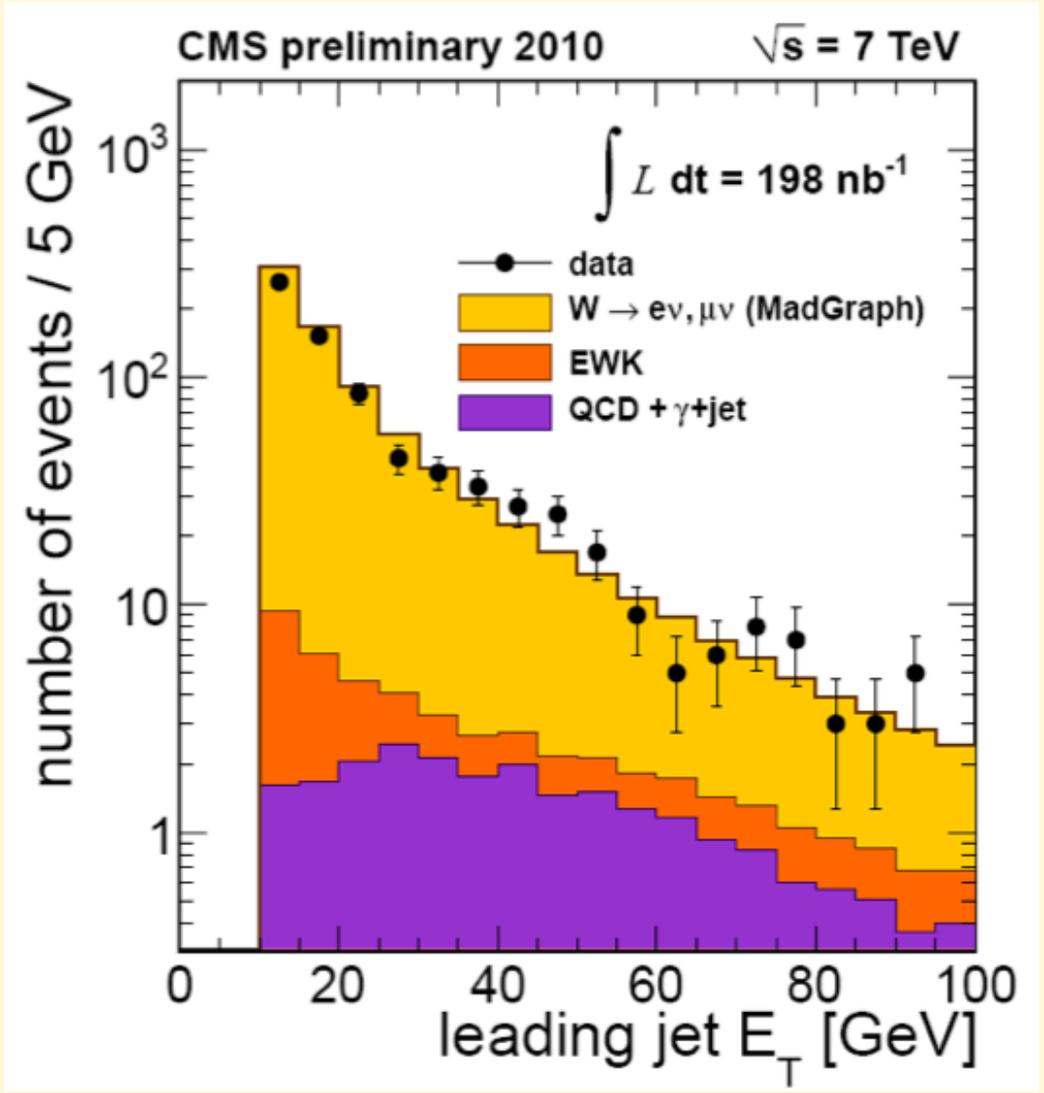
W+jets

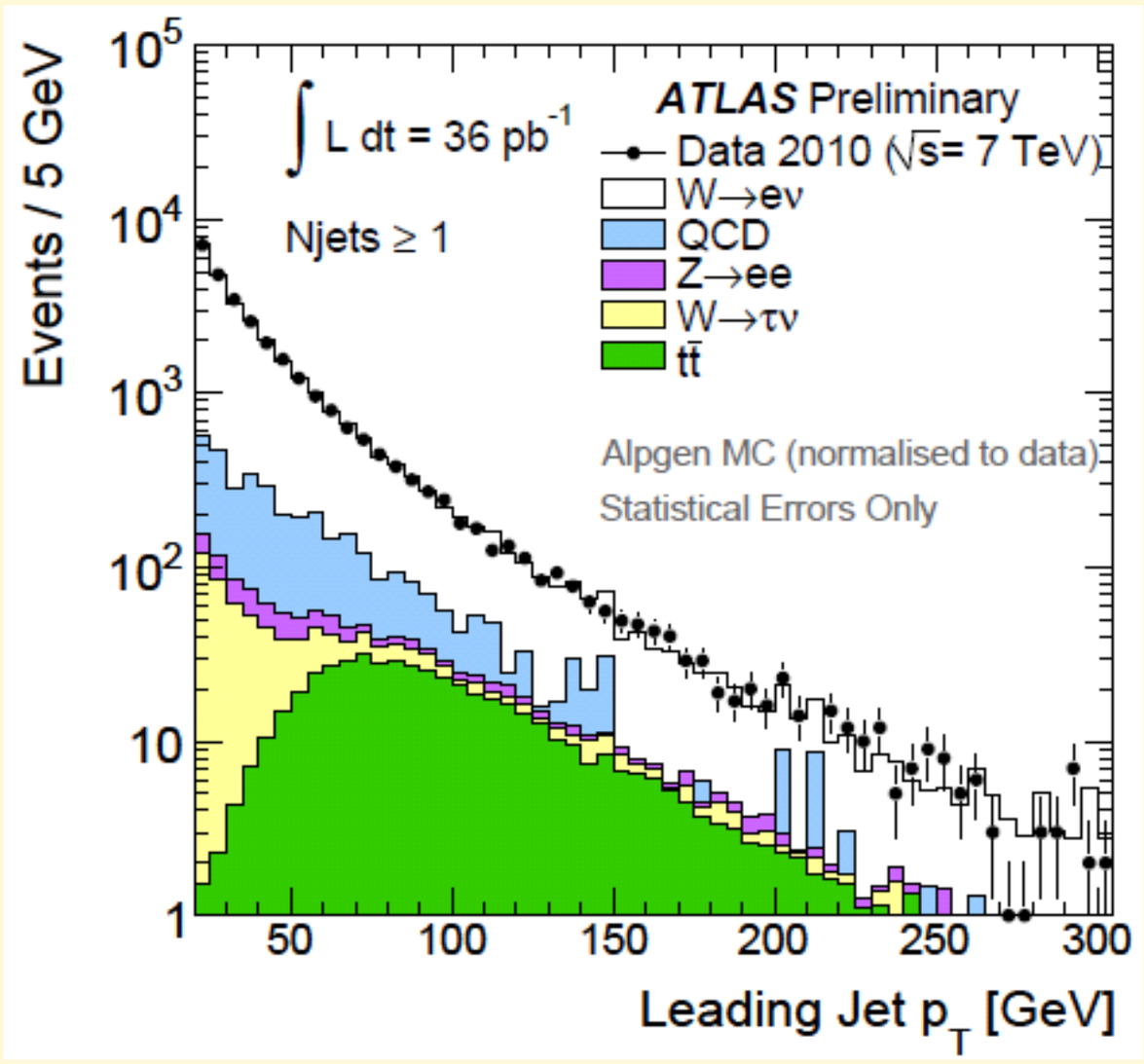


Statistics even out in the e and mu channels at large N_{jet}, making the agreement even more remarkable

See P-H Beauchemin for the ATLAS collab., CTEQ Workshop Nov 19-20 2010

W+jets, E_T spectrum

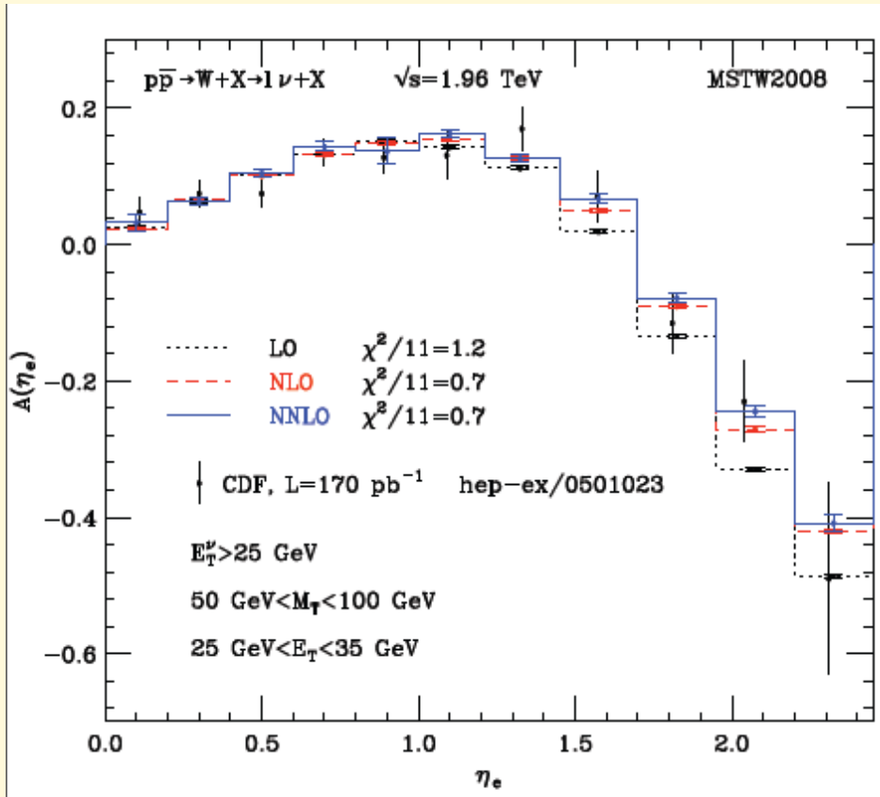


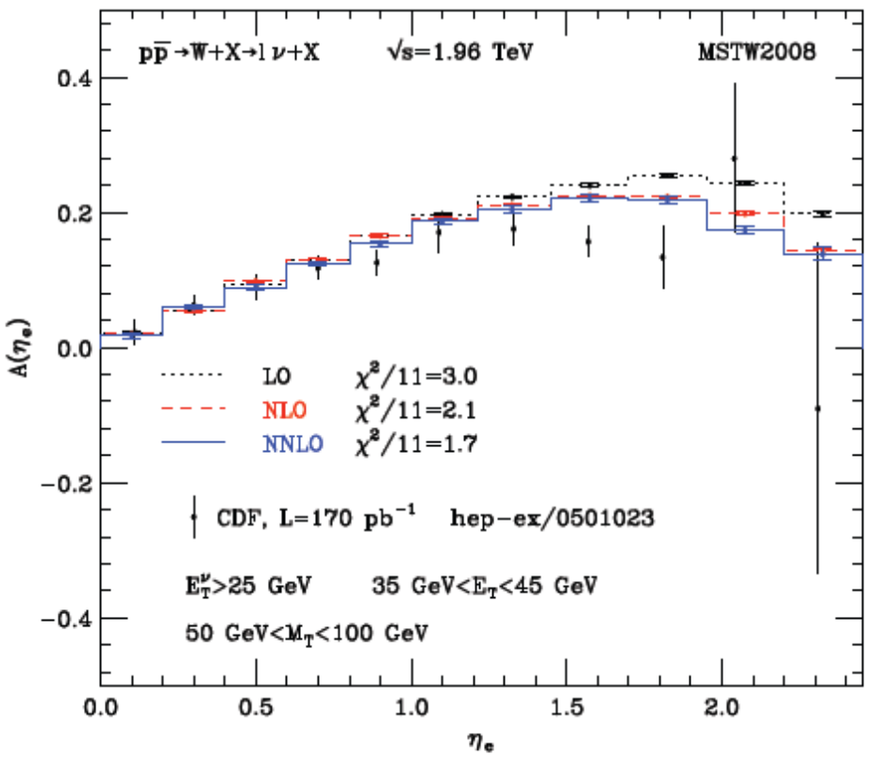


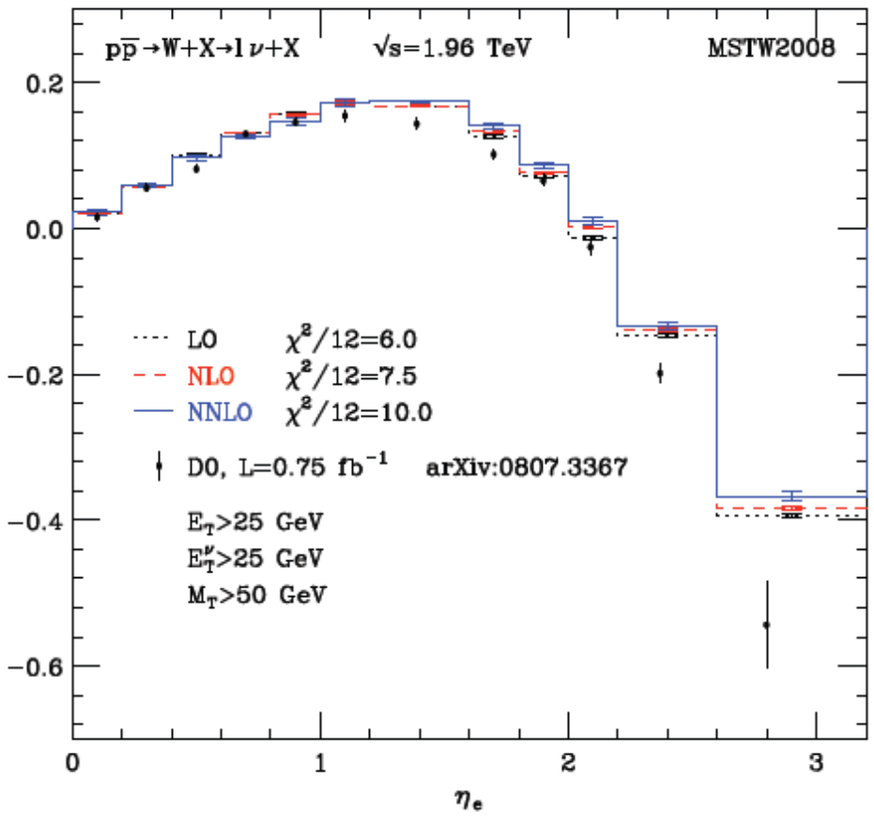
See S.Stoynev for the CMS collab., CTEQ Workshop Nov 19-20 2010

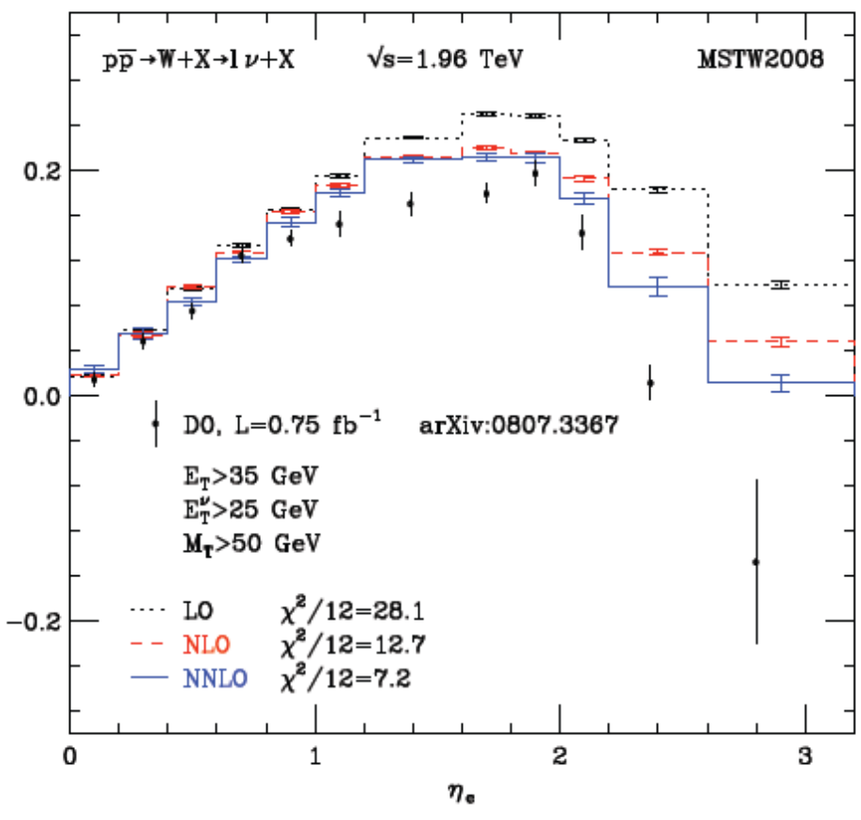
See P-H Beauchemin for the ATLAS collab., CTEQ Workshop Nov 19-20 2010

Lepton rapidity charge-asymmetry in W production at the Tevatron





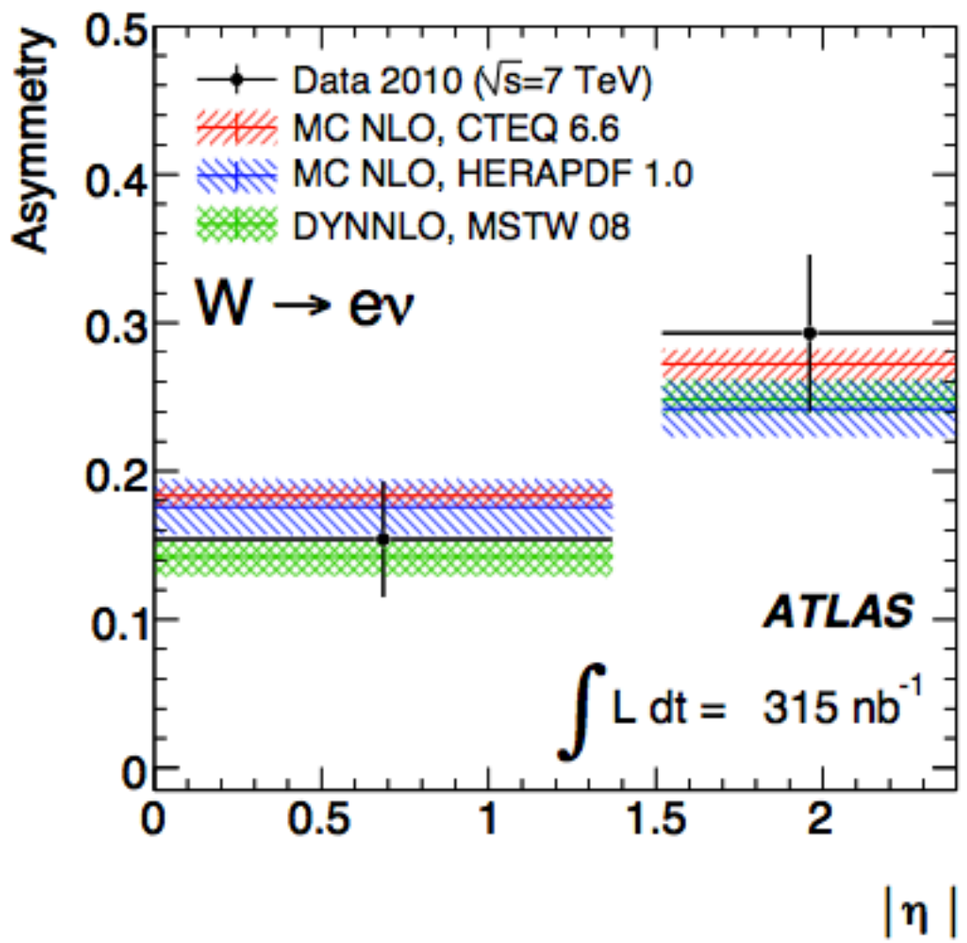


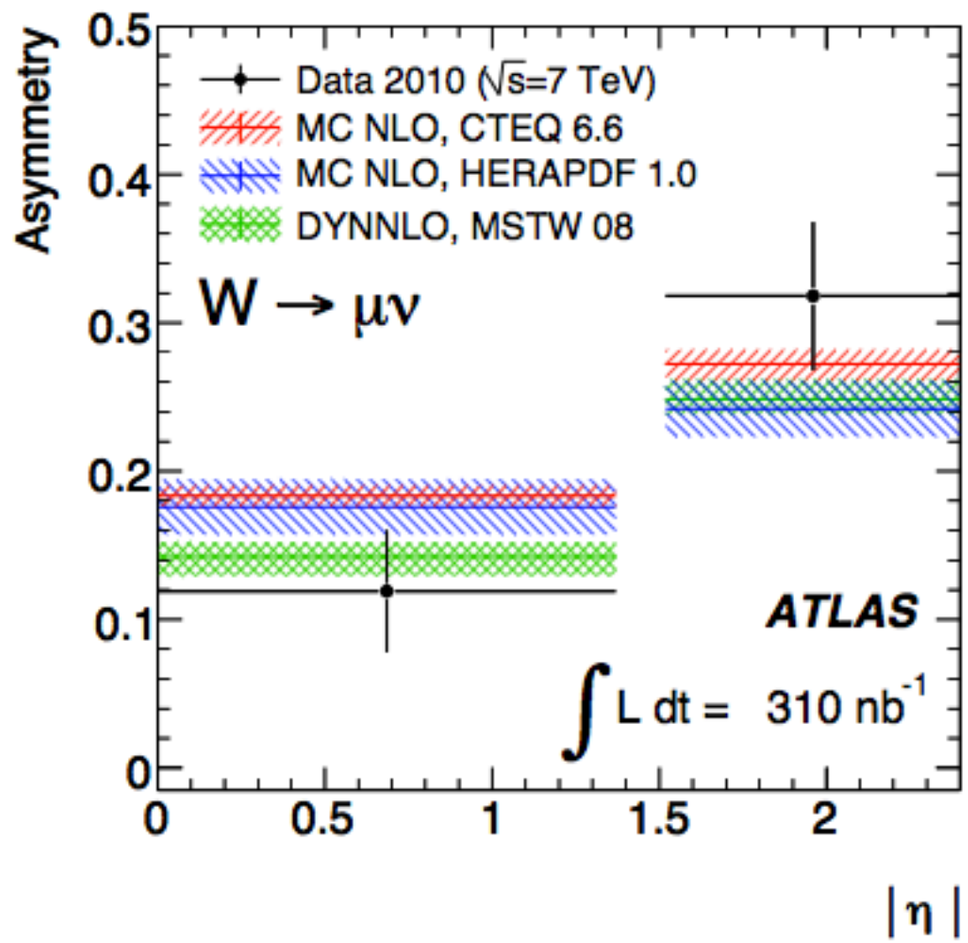


Lepton integrated charge asymmetry at the LHC

$$A_\ell = \frac{\sigma^{\text{fid}}_{W^+} - \sigma^{\text{fid}}_{W^-}}{\sigma^{\text{fid}}_{W^+} + \sigma^{\text{fid}}_{W^-}}$$

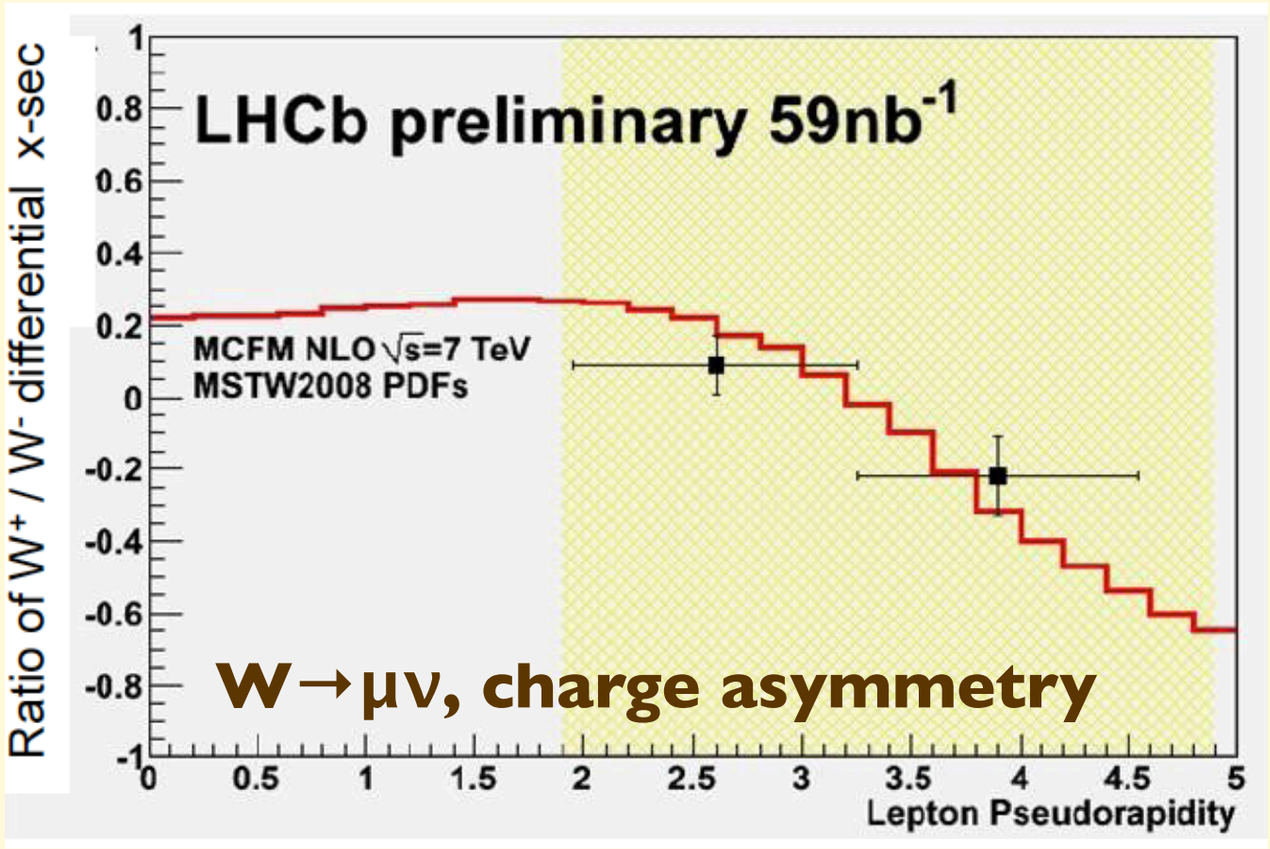
320 nb^{-1}, http://arxiv.org/abs/1010.2130

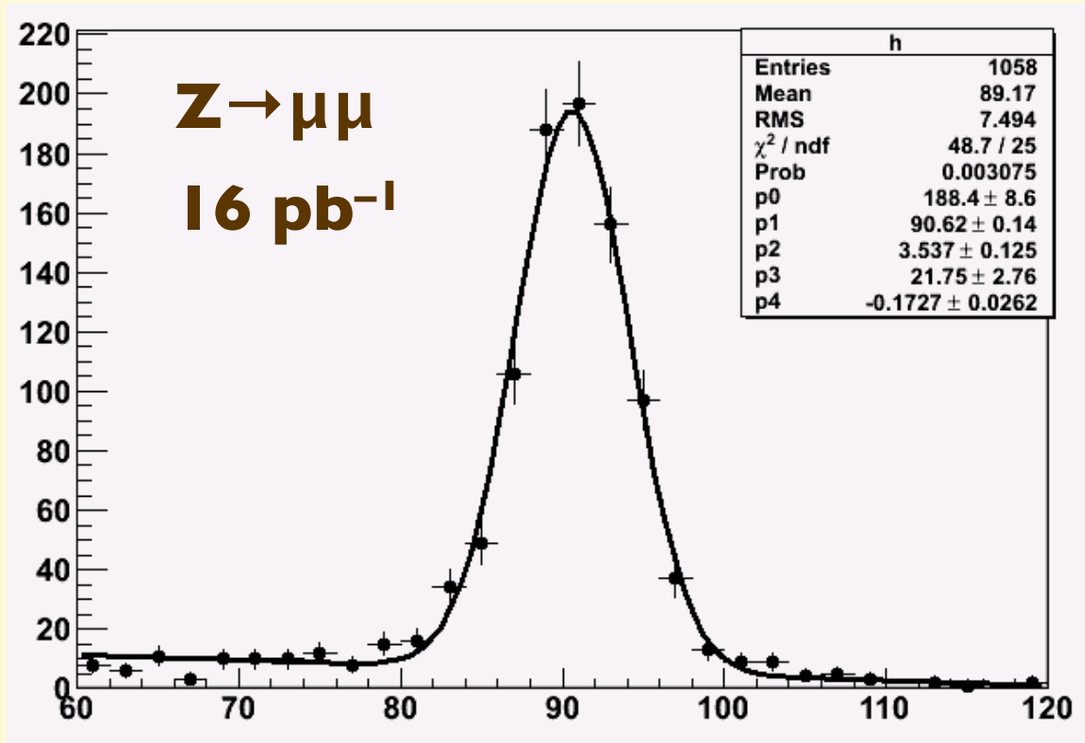




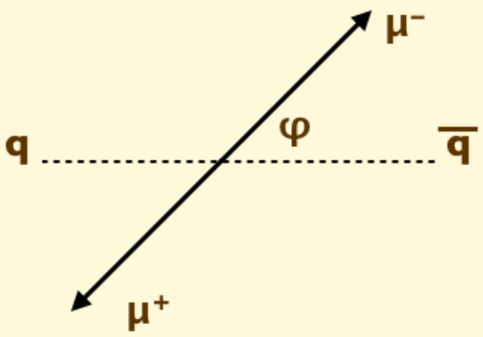
EW boson production in the forward region, LHCb

See S.Stone, for the LHCb collab., 104th LHCC session, http://indico.cern.ch/conferenceDisplay.py?confId=112439





These observations open the way for many interesting new measurements, from PDF constraints, to a determination of A_{FB} and $\sin^2\theta_W$



$$A_{FB} = \frac{N(0 < \varphi < \pi/2) - N(\pi/2 < \varphi < \pi)}{N(0 < \varphi < \pi/2) + N(\pi/2 < \varphi < \pi)} = A_{FB}(\theta_W)$$

Heavy quarks

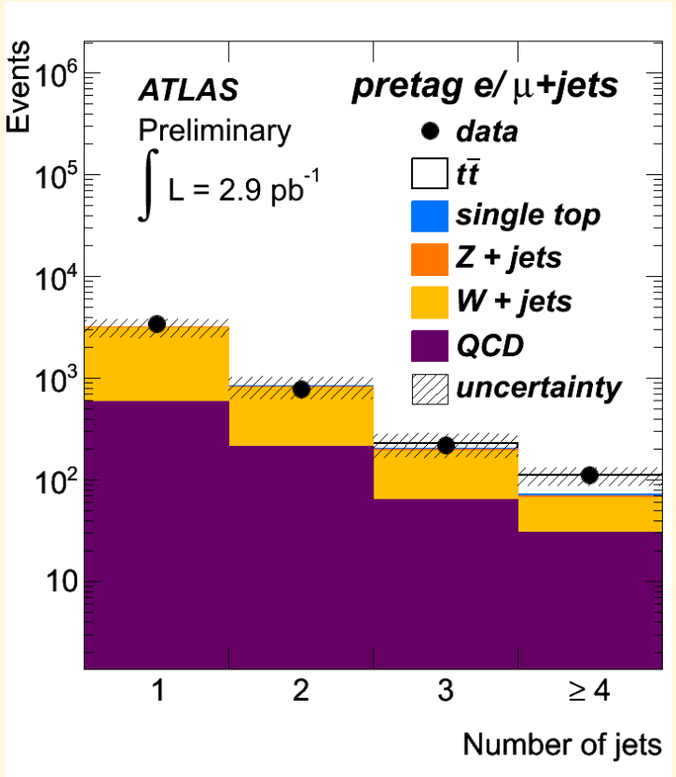
Top

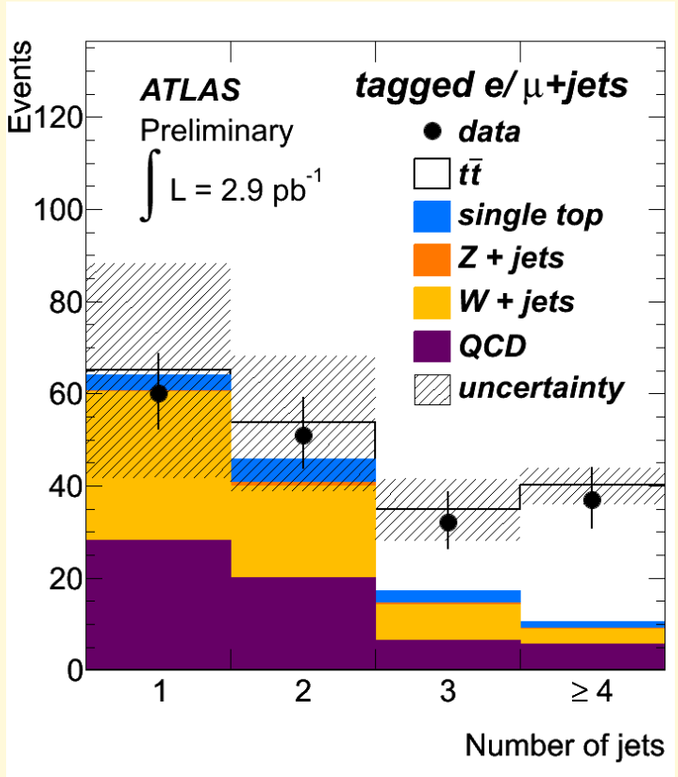
See P. Wells, for the ATLAS collab., and T. Camporesi, for the CMS collab. 104th LHCC session, http://indico.cern.ch/conferenceDisplay.py?confId=112439

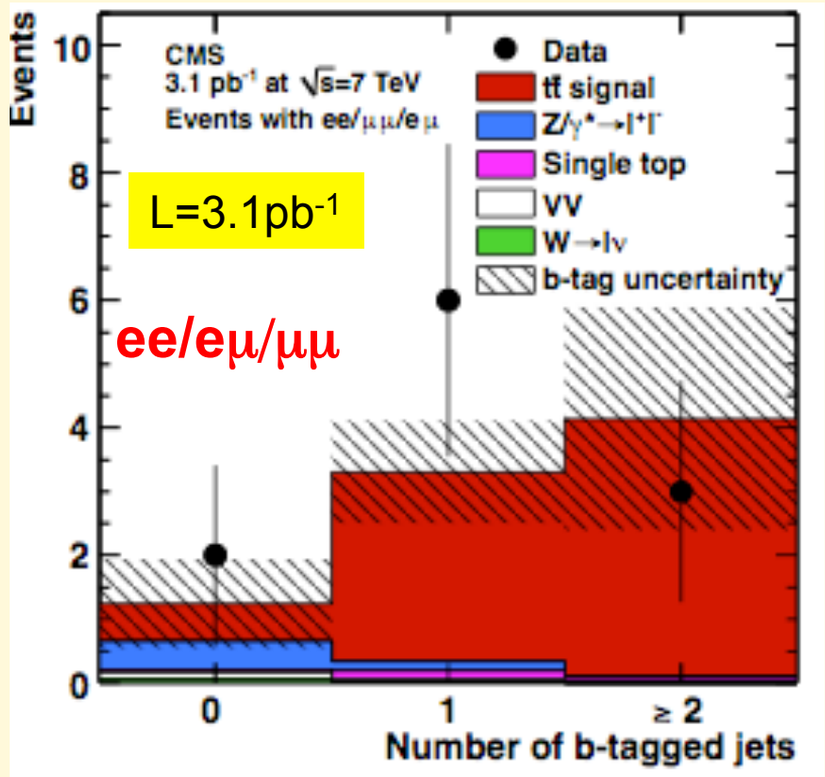
Good agreement of the backgrounds with QCD estimates!

Top

See P. Wells, for the ATLAS collab., and T. Camporesi, for the CMS collab. 104th LHCC session, http://indico.cern.ch/conferenceDisplay.py?confId=112439

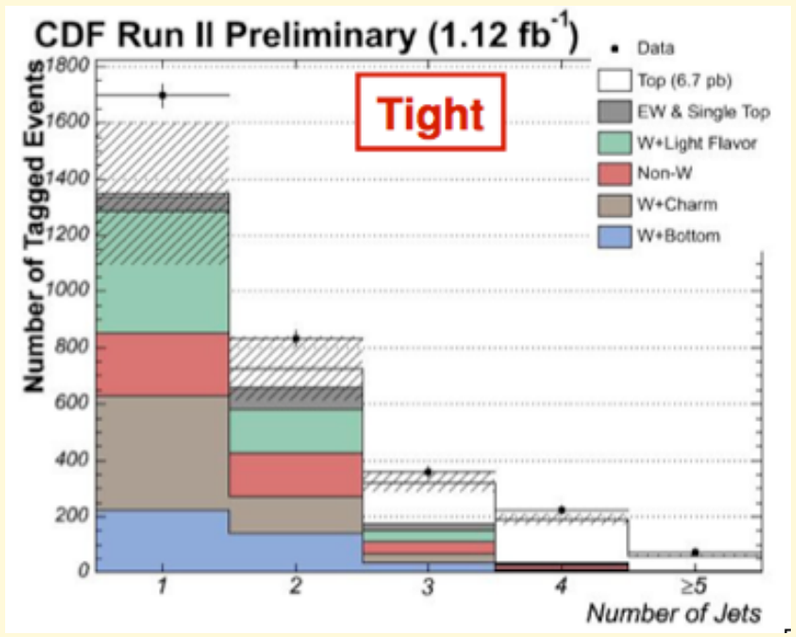


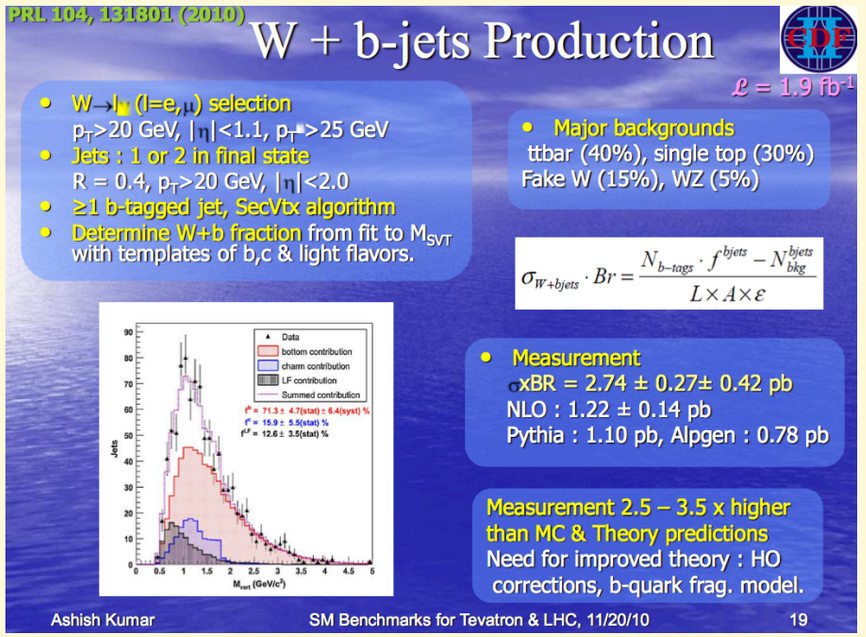


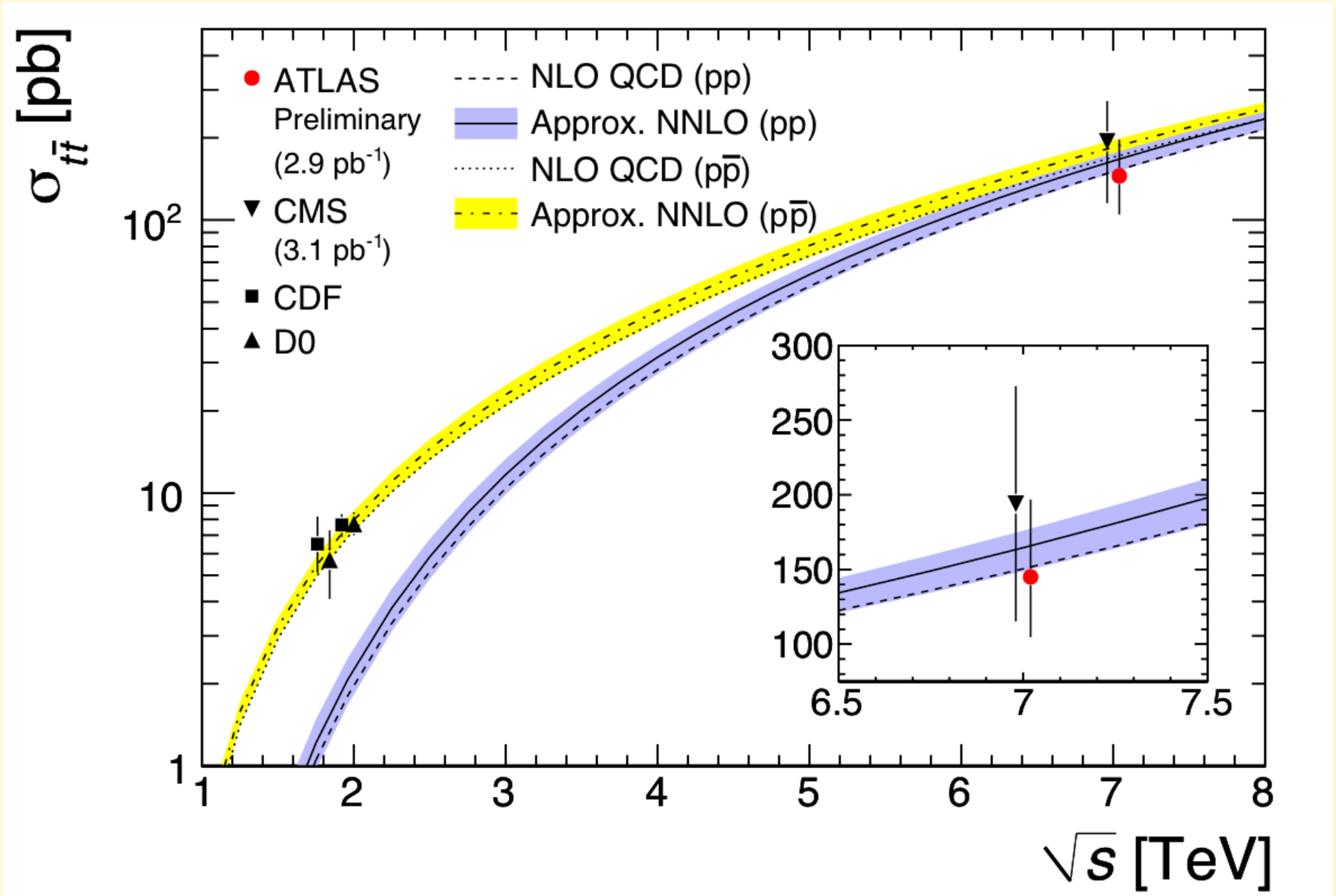


Good agreement of the backgrounds with QCD estimates!

It took a while at Tevatron to achieve this, and there are still some puzzling issues!







(1) ATLAS (lepton+b+≥3 jets and dileptons+≥2jets): $\sigma_{ATLAS} = 145 \pm 31 \,^{+42}_{-27}$ pb

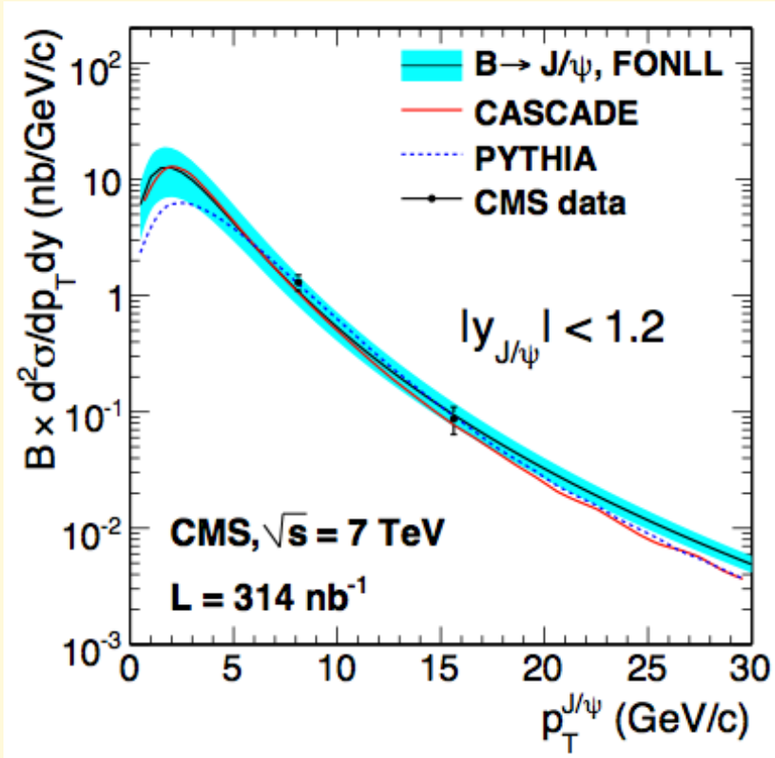
(2) CMS (dileptons+≥2jets): $\sigma_{CMS} = 194 \pm 72_{stat} \pm 24_{syst} \pm 21_{lum}$

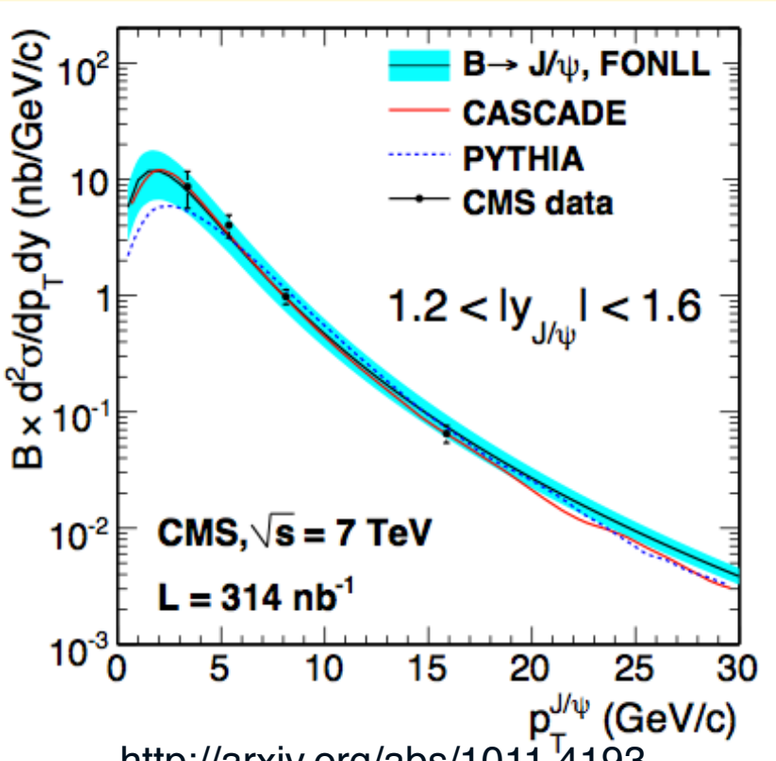
$\sigma_{TH} = 167 \,^{+13}_{-10}$ pb

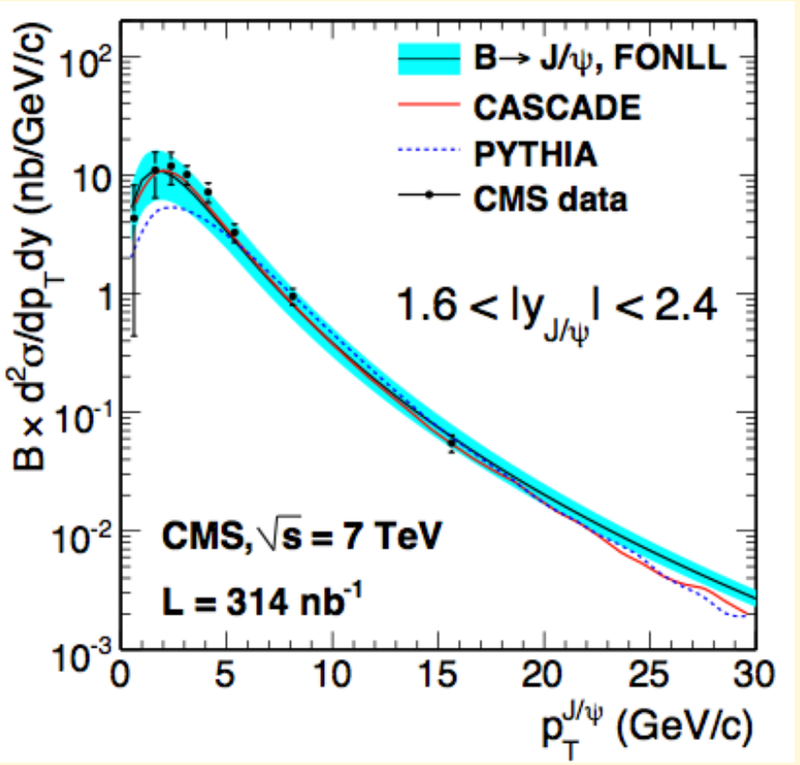
(1) **See P. Wells, for the ATLAS collab., 104th LHCC session, http://indico.cern.ch/conferenceDisplay.py?confId=112439**

(2) **arXiv:1010.5994**

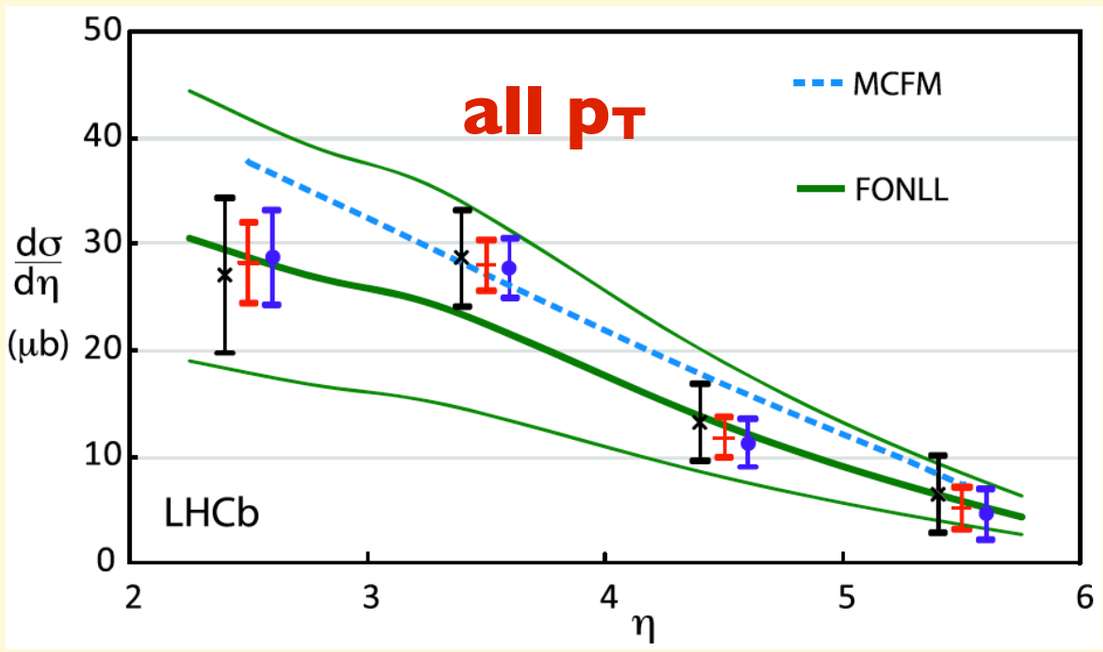
Open Q: by and large good agreement of data and NLO

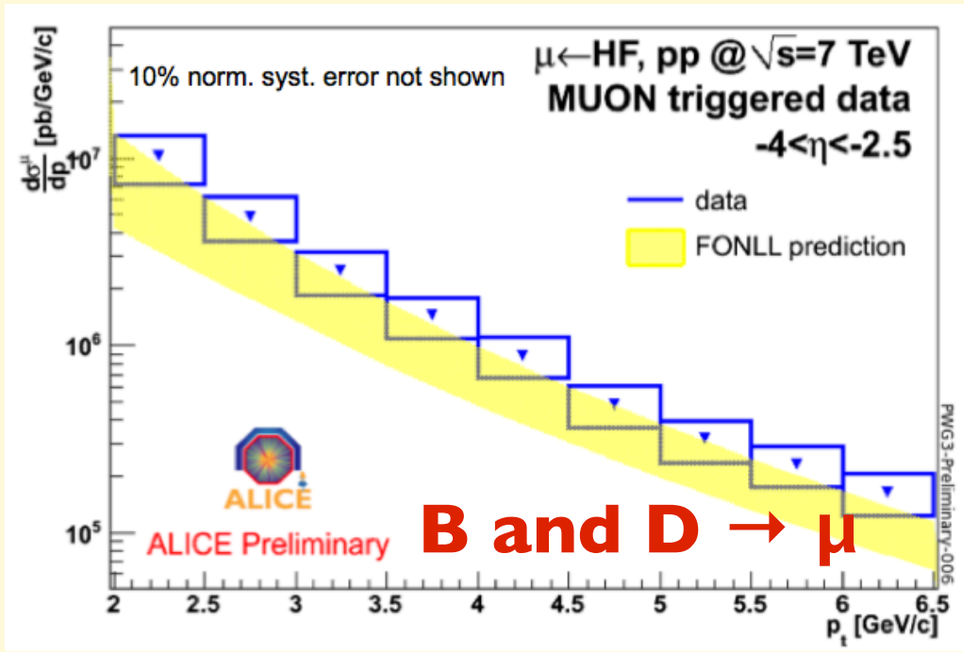






http://arxiv.org/abs/1011.4193



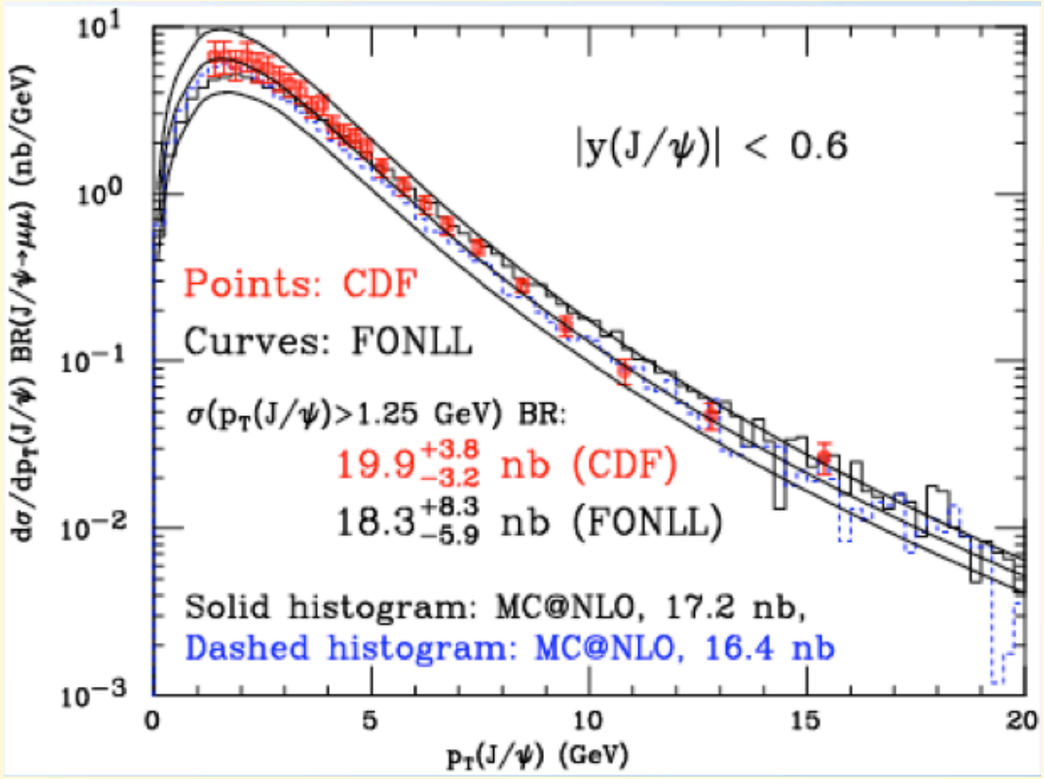


This agreement is one of the most significant results from LHC-2010

Why is it not trivial?

It took a while to establish consistency between Tevatron data and pQCD

hep-ph/0411020

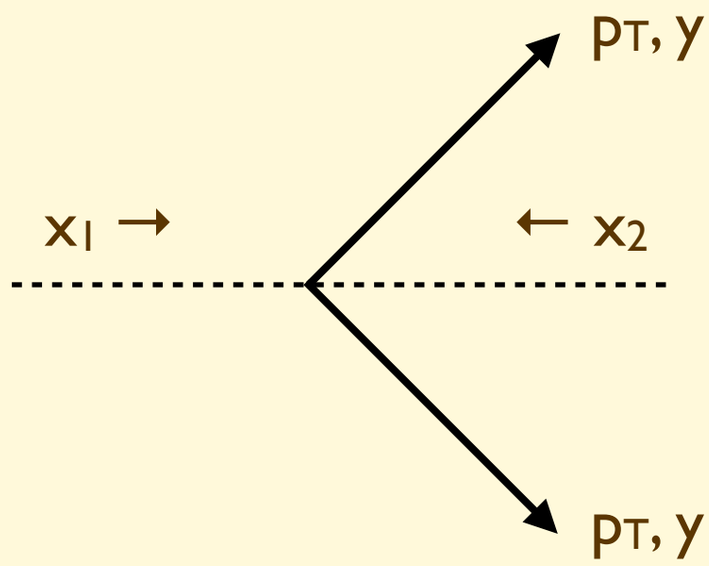


The dynamical regime of the LHC is theoretically more challenging

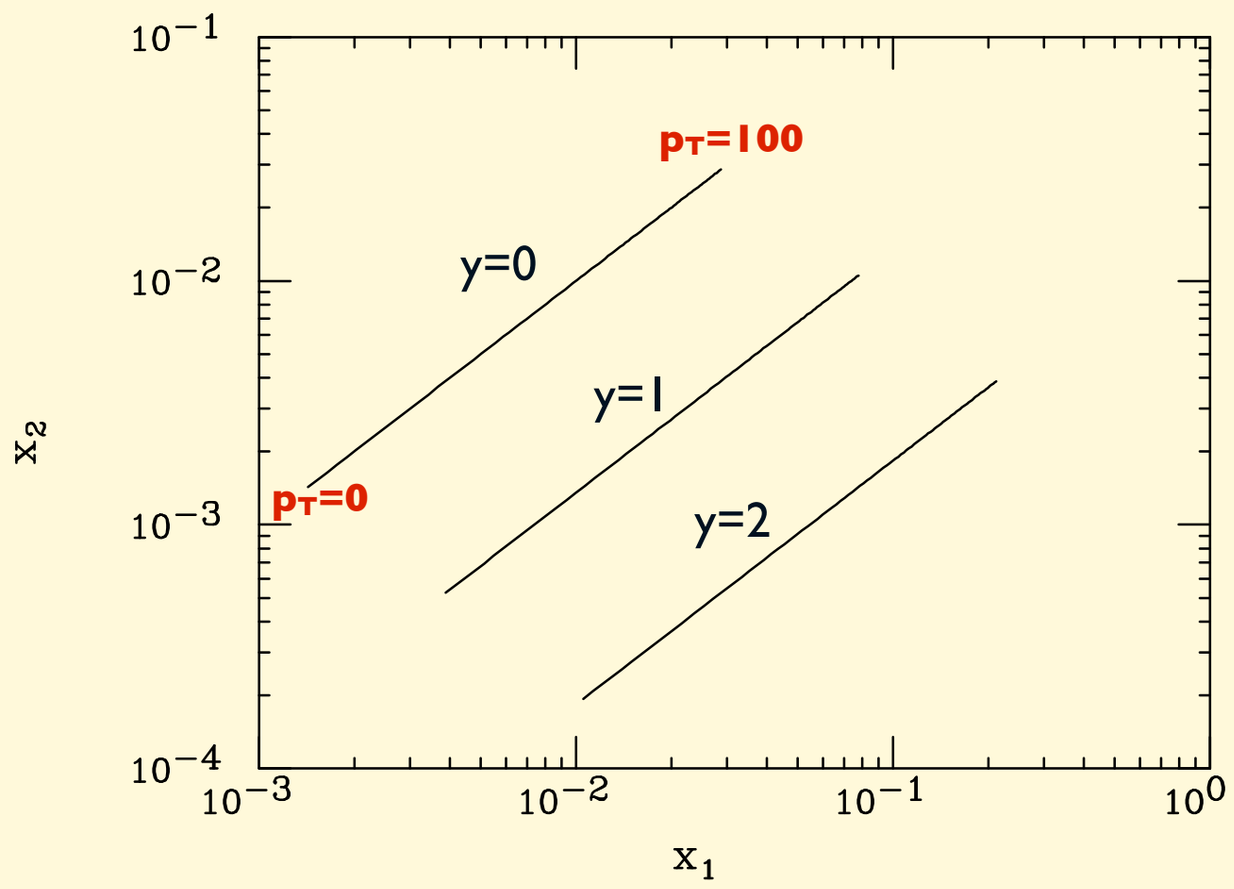
- large S => small x
- large rapidity (ALICE, LHCb)
  - o access to even smaller x
  - o small pt, sensitivity to higher-twist effects

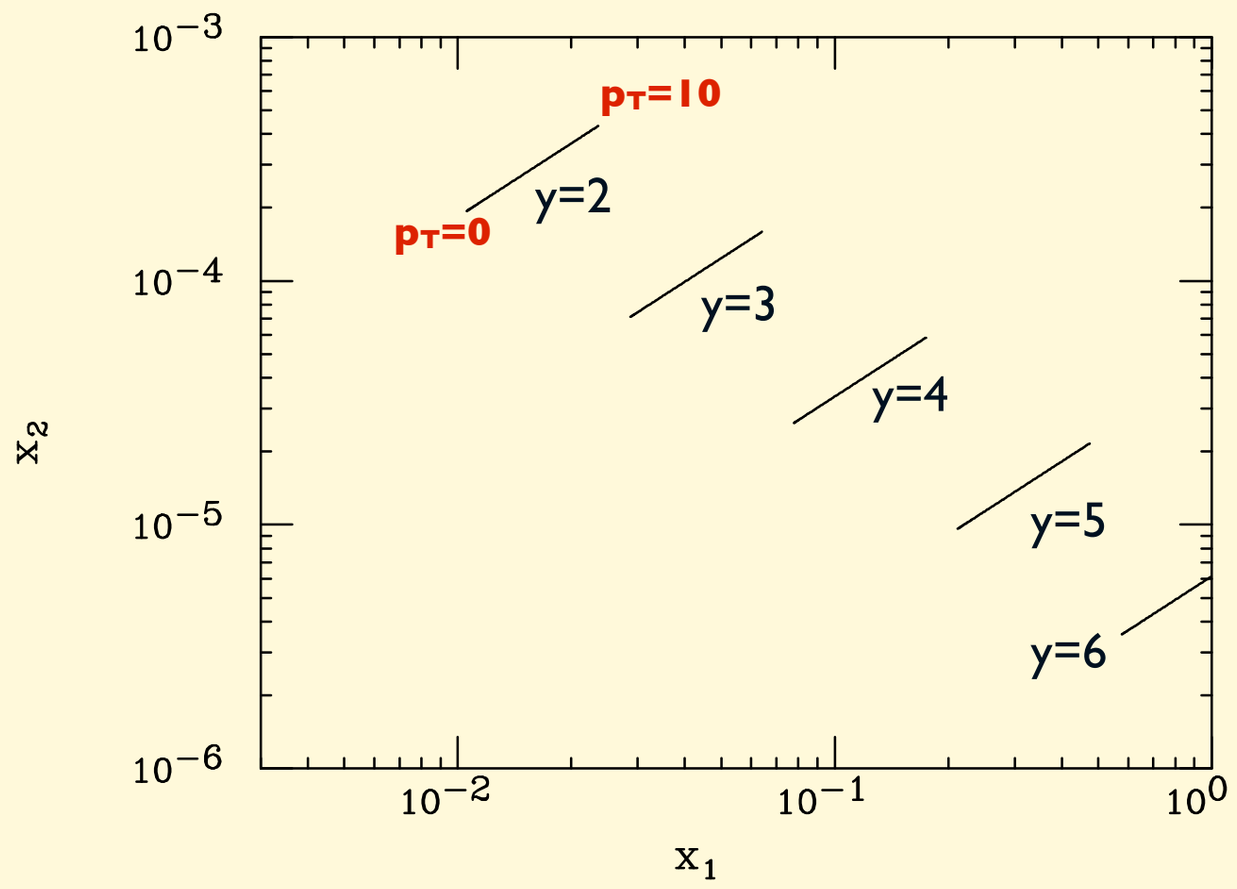
Nason, Dawson, Ellis
Collins, R.K.Ellis
Ball, Ellis
Catani Ciafaloni Hautmann
....

Kinematic reach

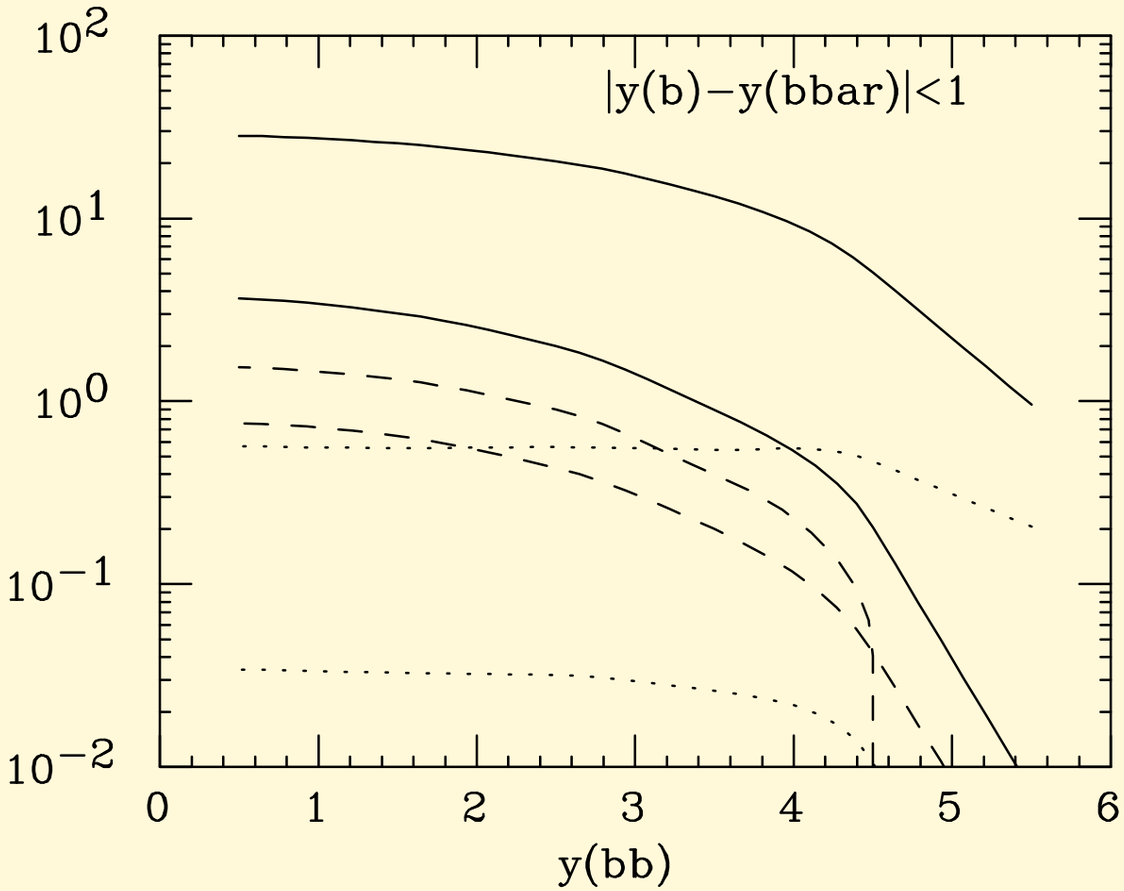


$$x_{1,2} = \frac{m_T}{E_b}\, e^{\pm y}$$





Initial state composition:



gg

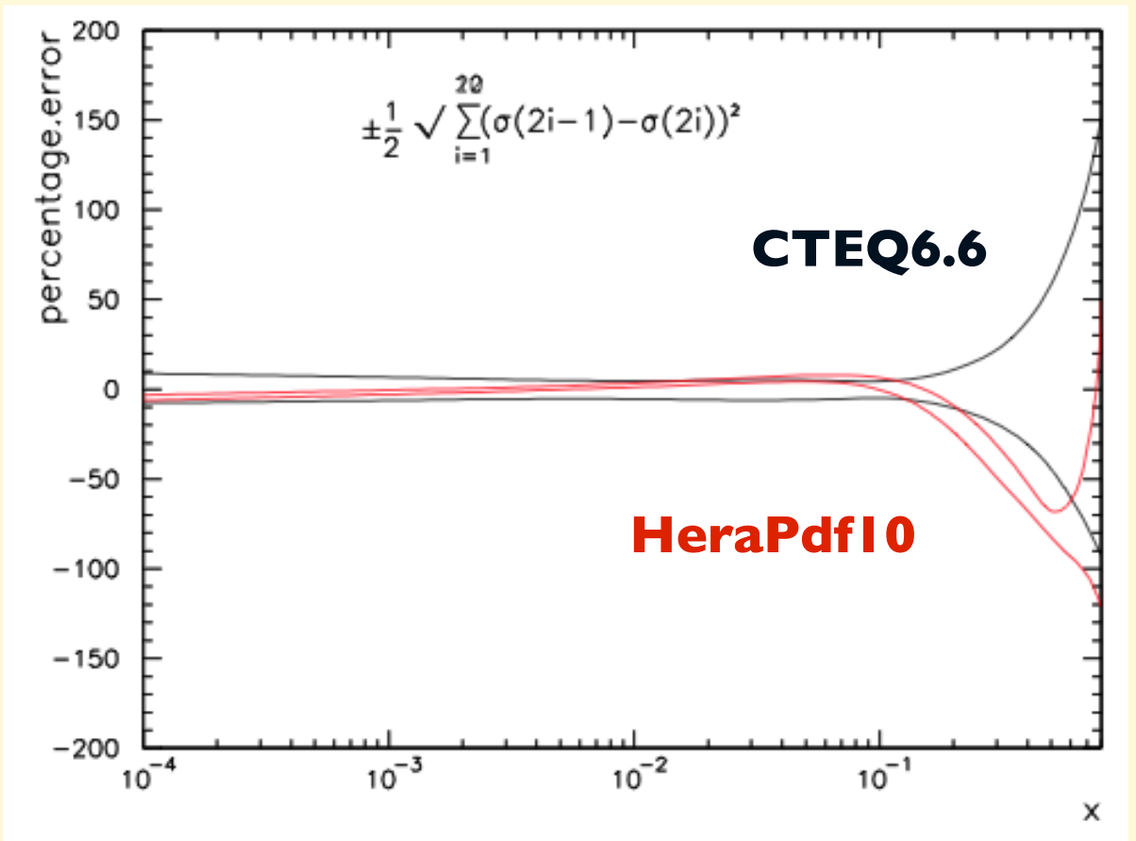
qg

qqbar

Upper curves: p_T>0

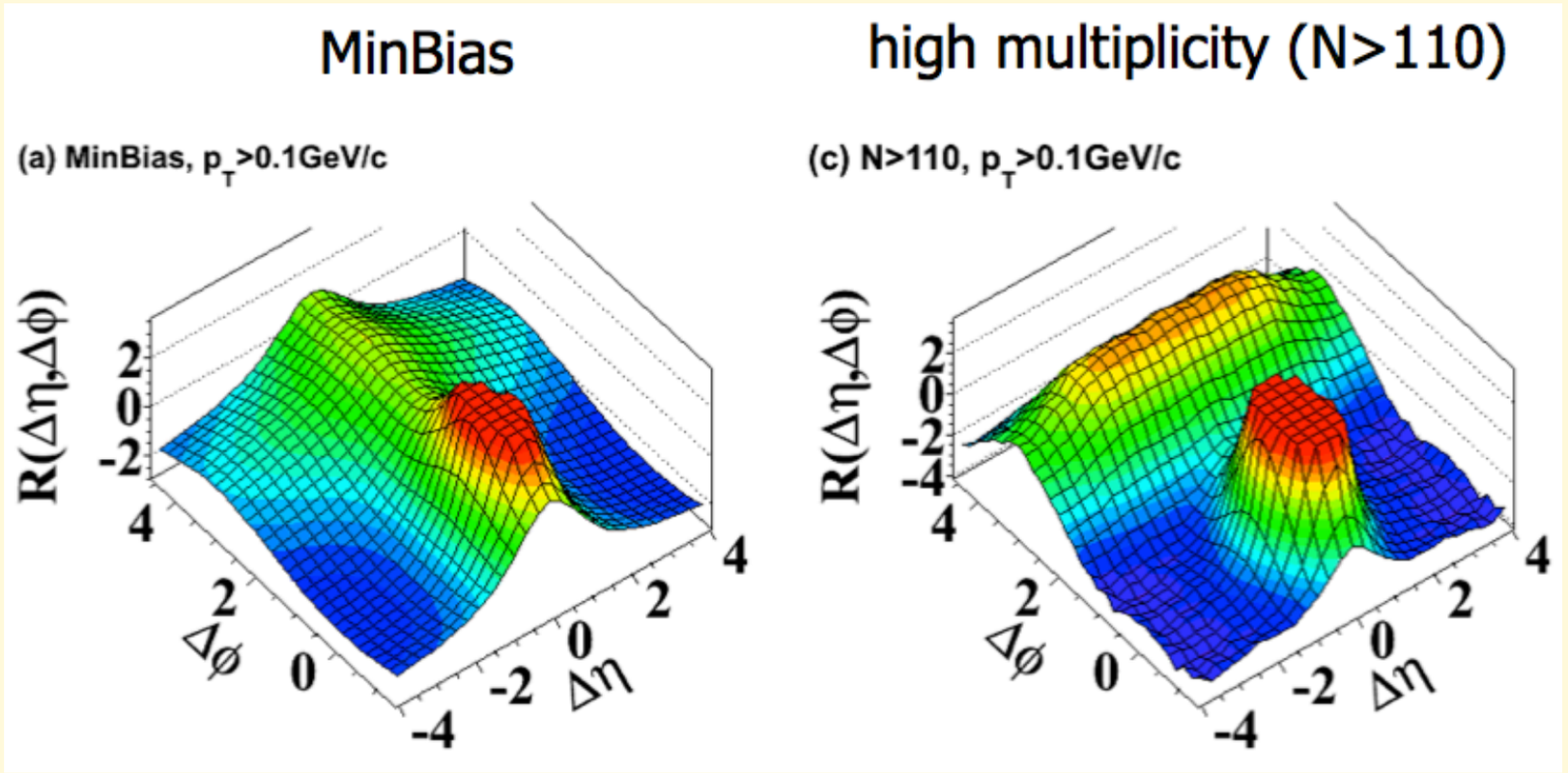
Lower curves: p_T>12 GeV

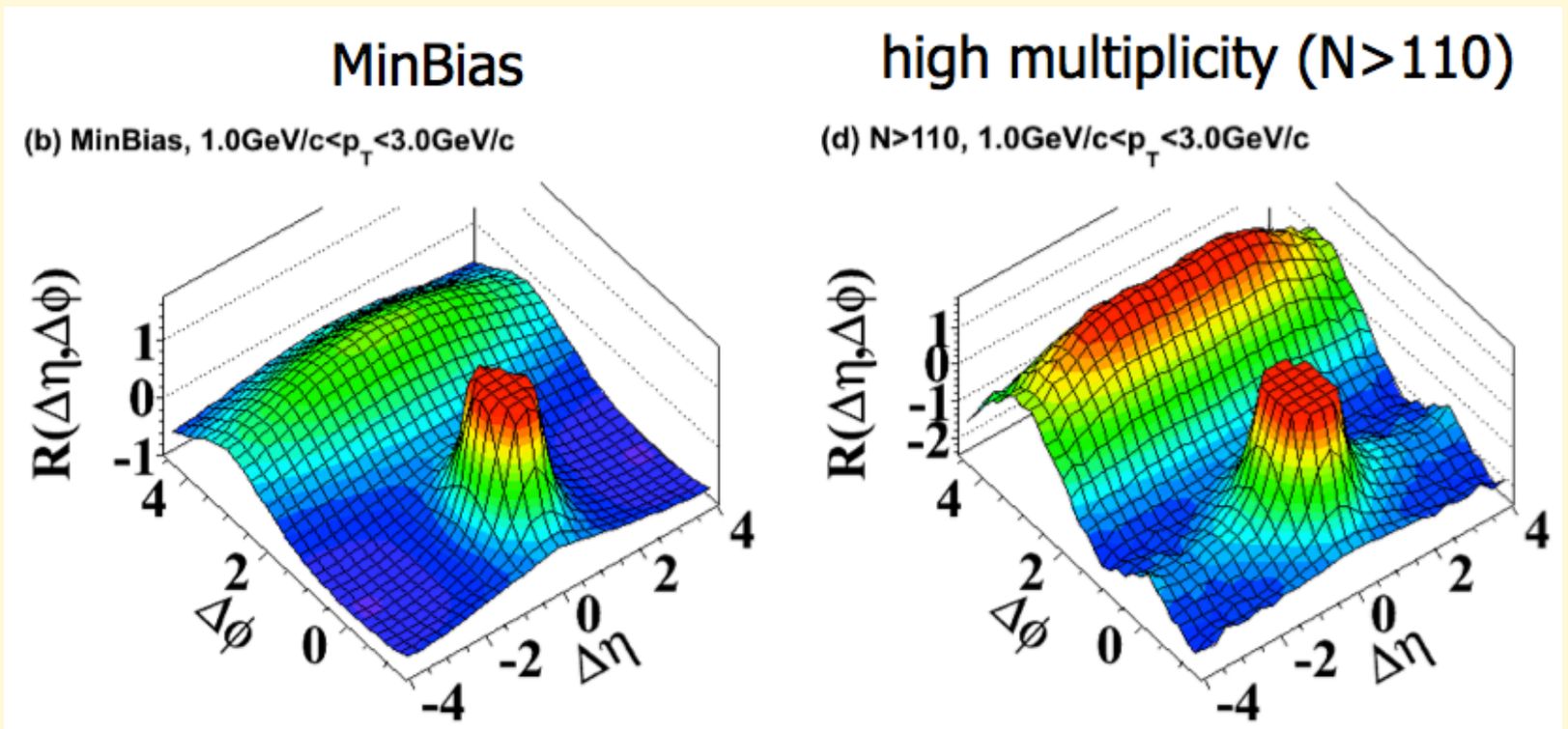
Dominated by gg initial state, possibly sensitive to gluon PDF



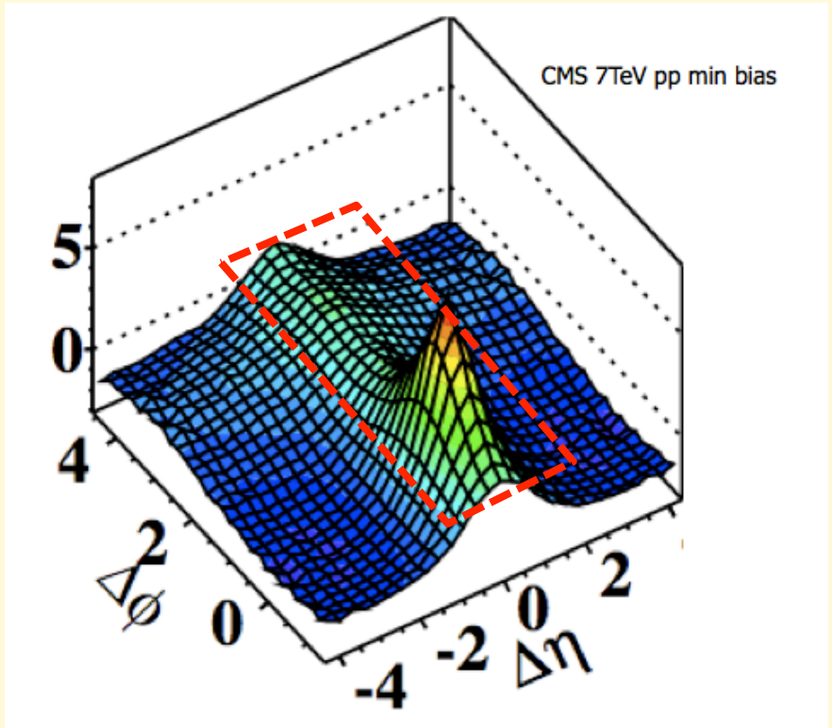
CMS's "ridge" in high-multiplicity events

2-particle correlation function $$S_N(\Delta\eta,\Delta\varphi) = \frac{1}{N(N-1)}\frac{d^2N^{signal}}{d\Delta\eta d\Delta\varphi}$$

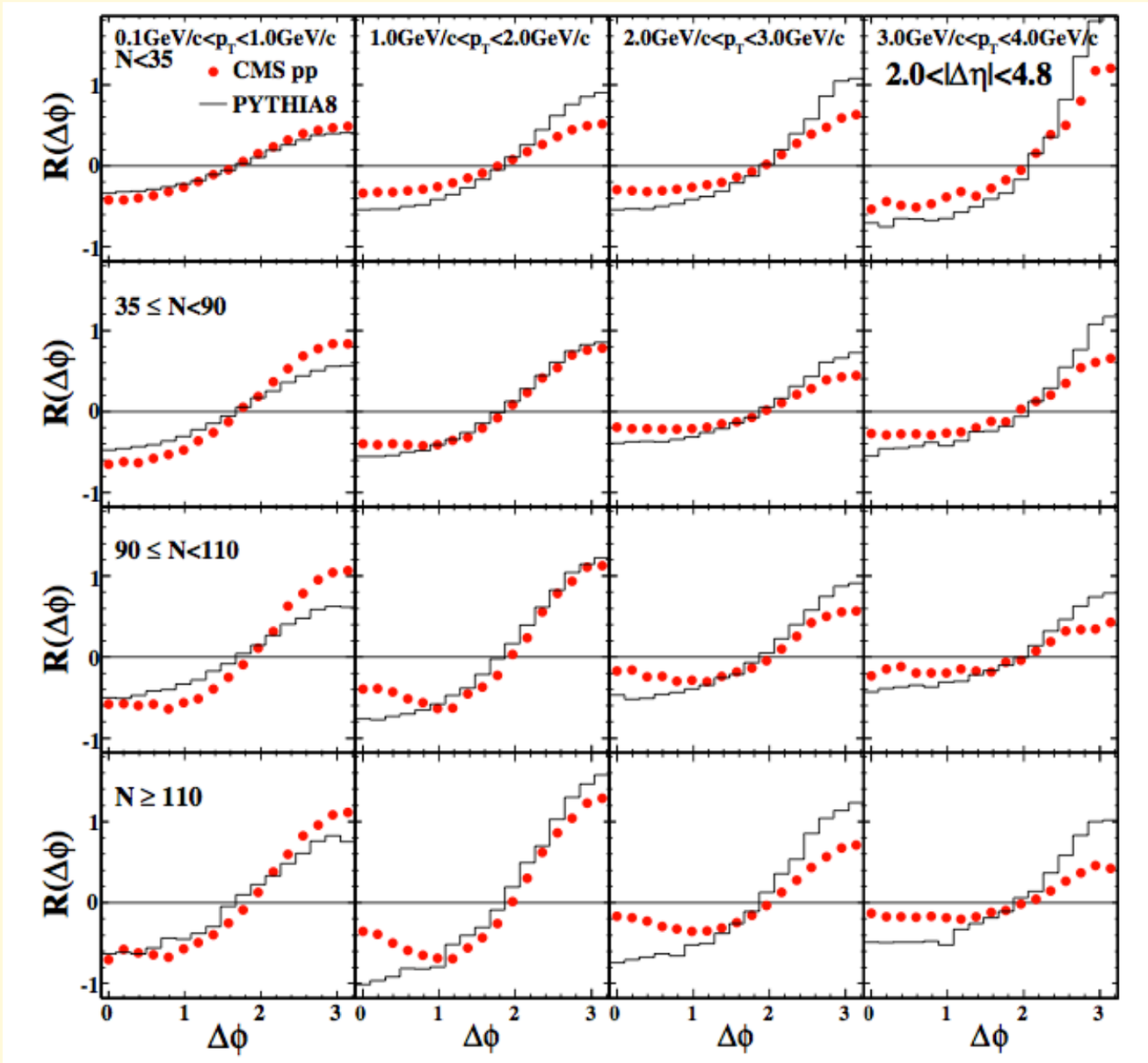




CMS's "ridge" in high-multiplicity events

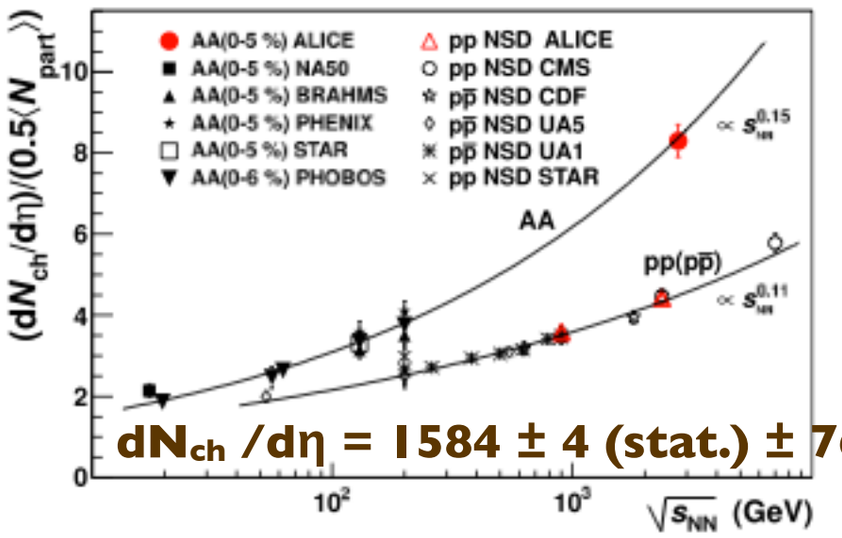


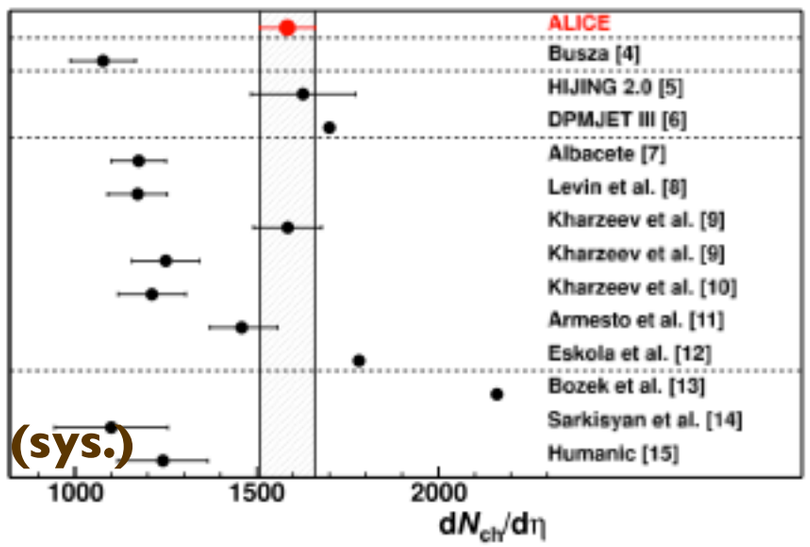
Integrating in eta, outside of the jet region:



Many of us tried, but failed to explain this observation using pQCD (we thought it was a colour coherence effect, which only full matrix-element calculations can describe accurately). So this is likely telling us something about correlations among partons within the proton

First stunning results from the HI run!





$dN_{ch}/d\eta$ = 1584 ± 4 (stat.) ± 76 (sys.)