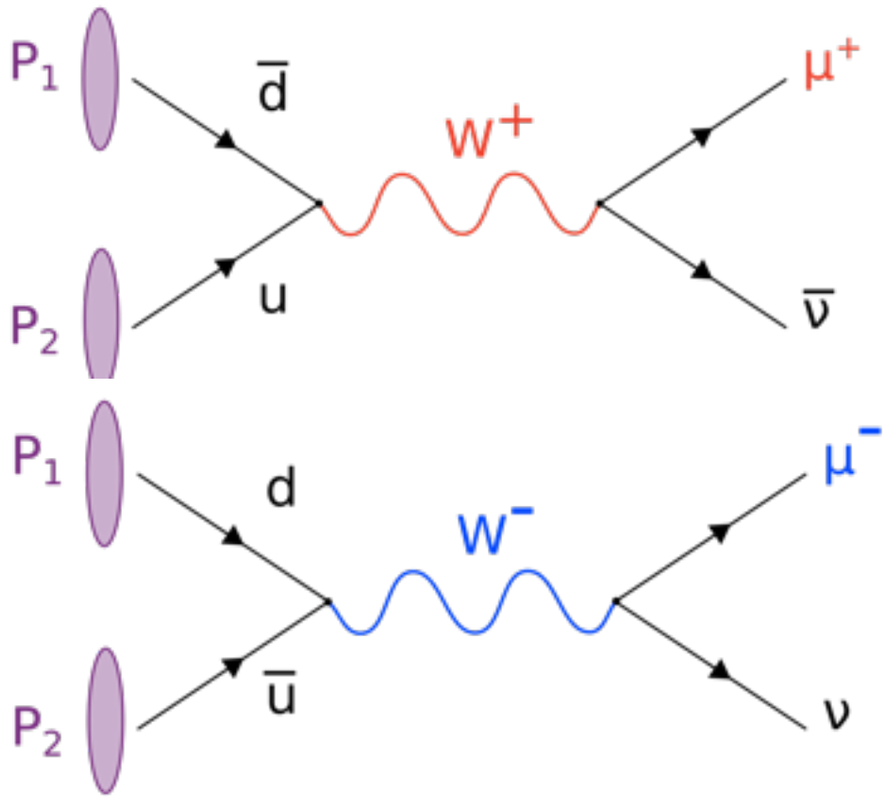
Measurement of the W Charge Asymmetry from W->μν Decays at ATLAS

Group B

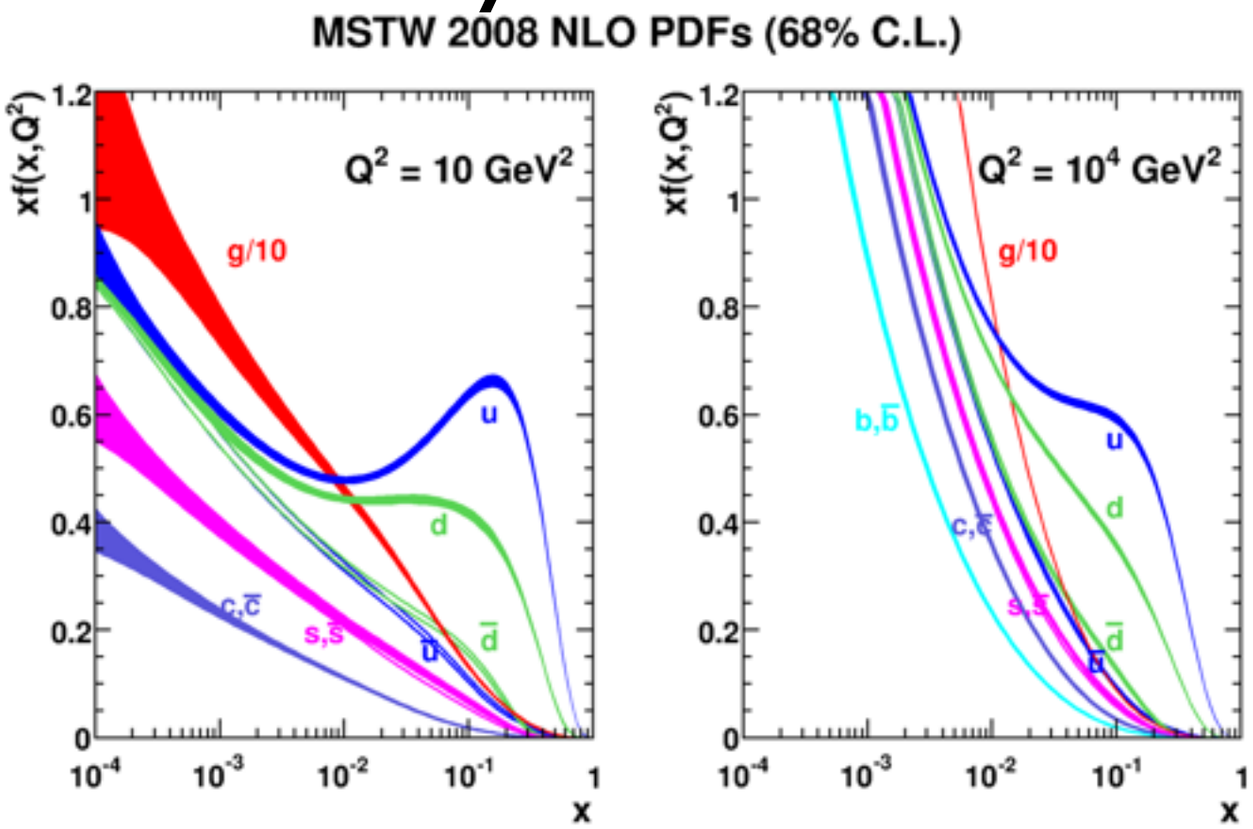
Theory and Motivation



$$A_\mu = \frac{\frac{d\sigma W^+_\mu}{d\eta\mu} - \frac{d\sigma W^-_\mu}{d\eta\mu}}{\frac{d\sigma W^+_\mu}{d\eta\mu} + \frac{d\sigma W^-_\mu}{d\eta\mu}}$$

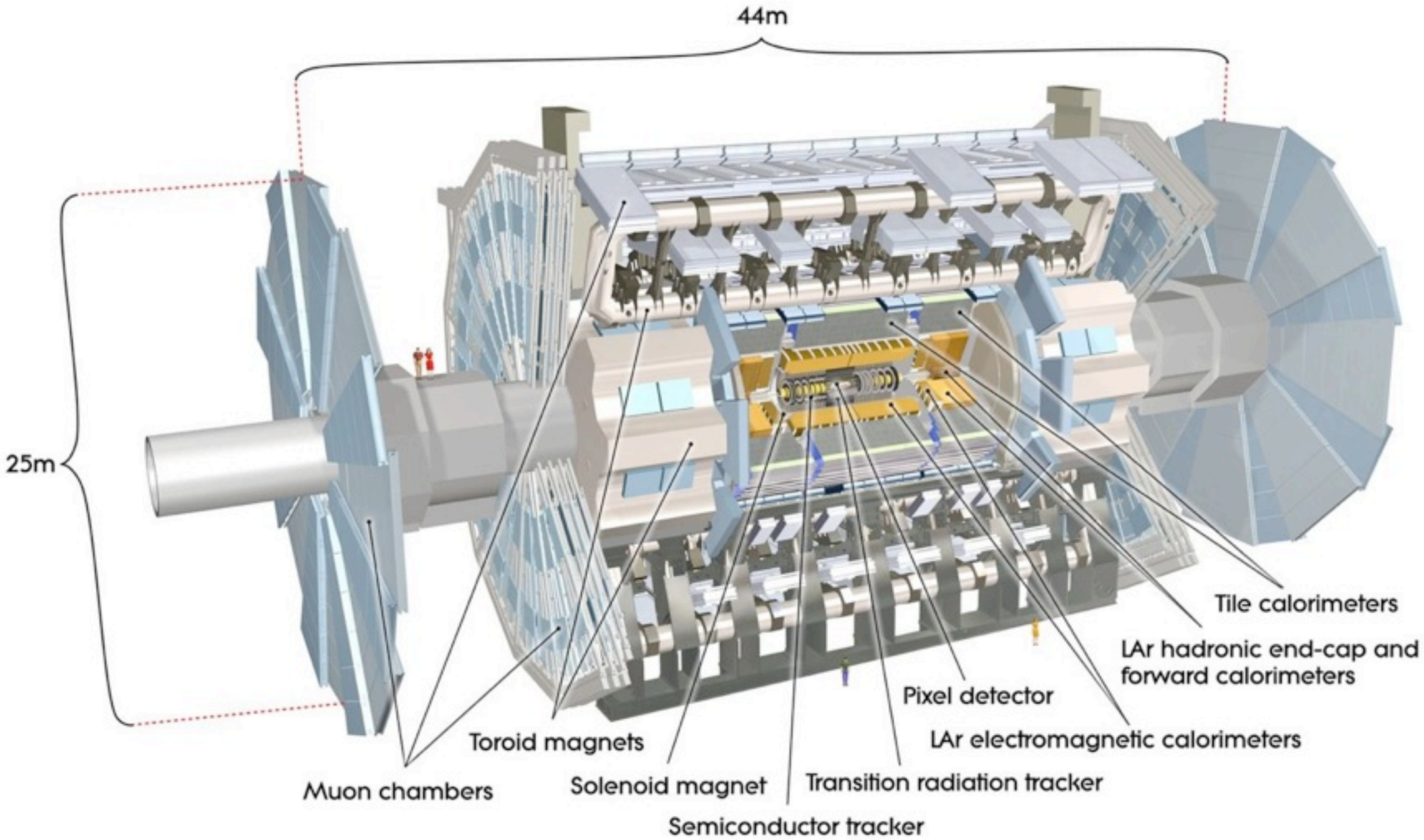
- The W boson charge asymmetry is mainly sensitive to the valence quark distribution in the proton
  - W+ production in pp collisions significantly favored over W-, 2 valence u quarks
  - unlike ppbar collisions, pp->W asymmetry sensitive to the sea quark distribution
  - asymmetry varies significantly as a function of pseudo-rapidity: larger at high rapidities b/c of valence quarks

Theory and Motivation



- current pdfs involve extrapolations in q^2 to LHC energies
- other experiments (e.g. Hera) do not strongly constrain the ratio between u and d quarks for low x, (parton momentum fraction)
- LHC can contribute significantly to understanding of pdfs where $10^{-3} <= x <= 10^{-1}$
- the main theoretical uncertainty of standard candles (W/Z production) is from pdf uncertainties

The ATLAS Detector

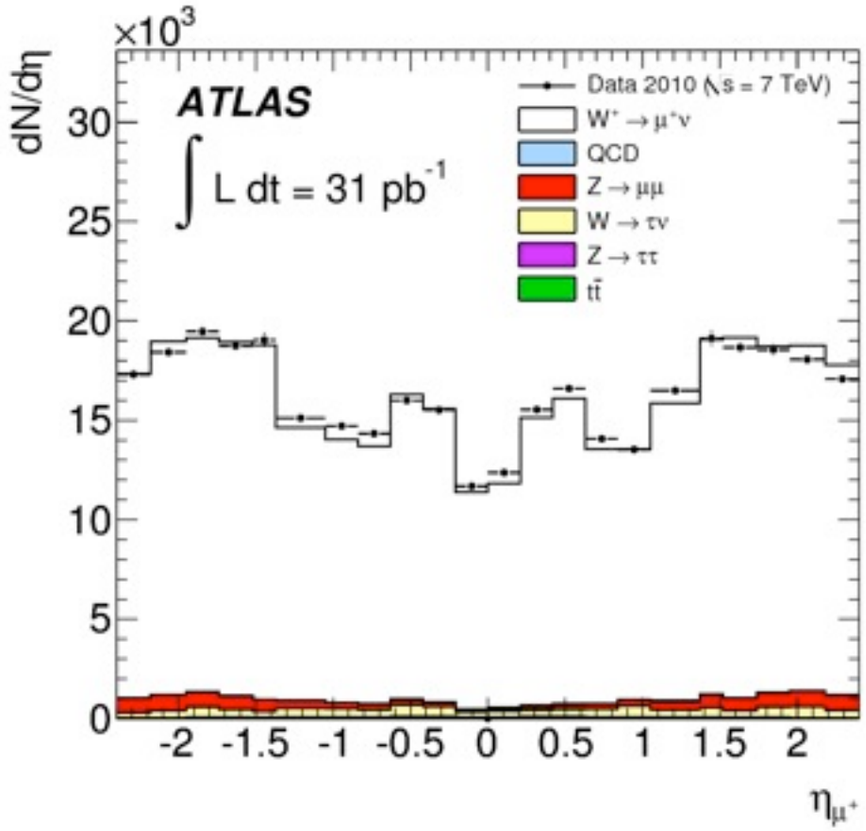


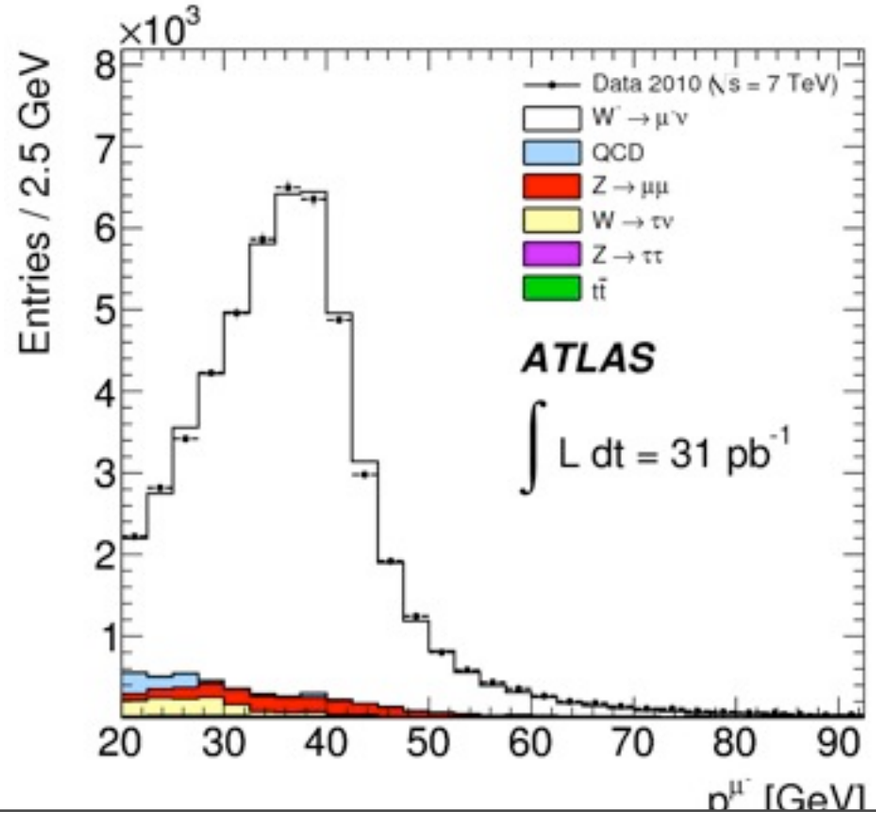
Event Selection

- **Event Signature:** Single Isolated Muon with Large Missing Energy
- **Dataset**: 31 pb^{-1} pp collisions @ 7 TeV collected by ATLAS in 2010
- **Trigger**: single muon trigger with Pt > 13 GeV
- **W Selection**:
  - 1 well-reconstructed primary vertex
  - Isolated and re-constructed muon w/ Pt > 20 GeV/c, eta < 2.4 matched to vertex and beam spot
  - Missing Energy > 25 GeV/c
  - Transverse Mass > 40 GeV/c^2

Event Yield & Background

- **Signal**
  - W -> mu nu
- **Backgrounds**
  - 3% Z-> μμ (1 missing μ) (MC)
  - 2% W-> $\tau\nu$ (MC)
  - 1% top-anti-top (MC)
  - 1% QCD (data-driven method)
- MC is corrected for trigger and reconstruction efficiencies
- Nice agreement between data and MC





Systematic Uncertainties

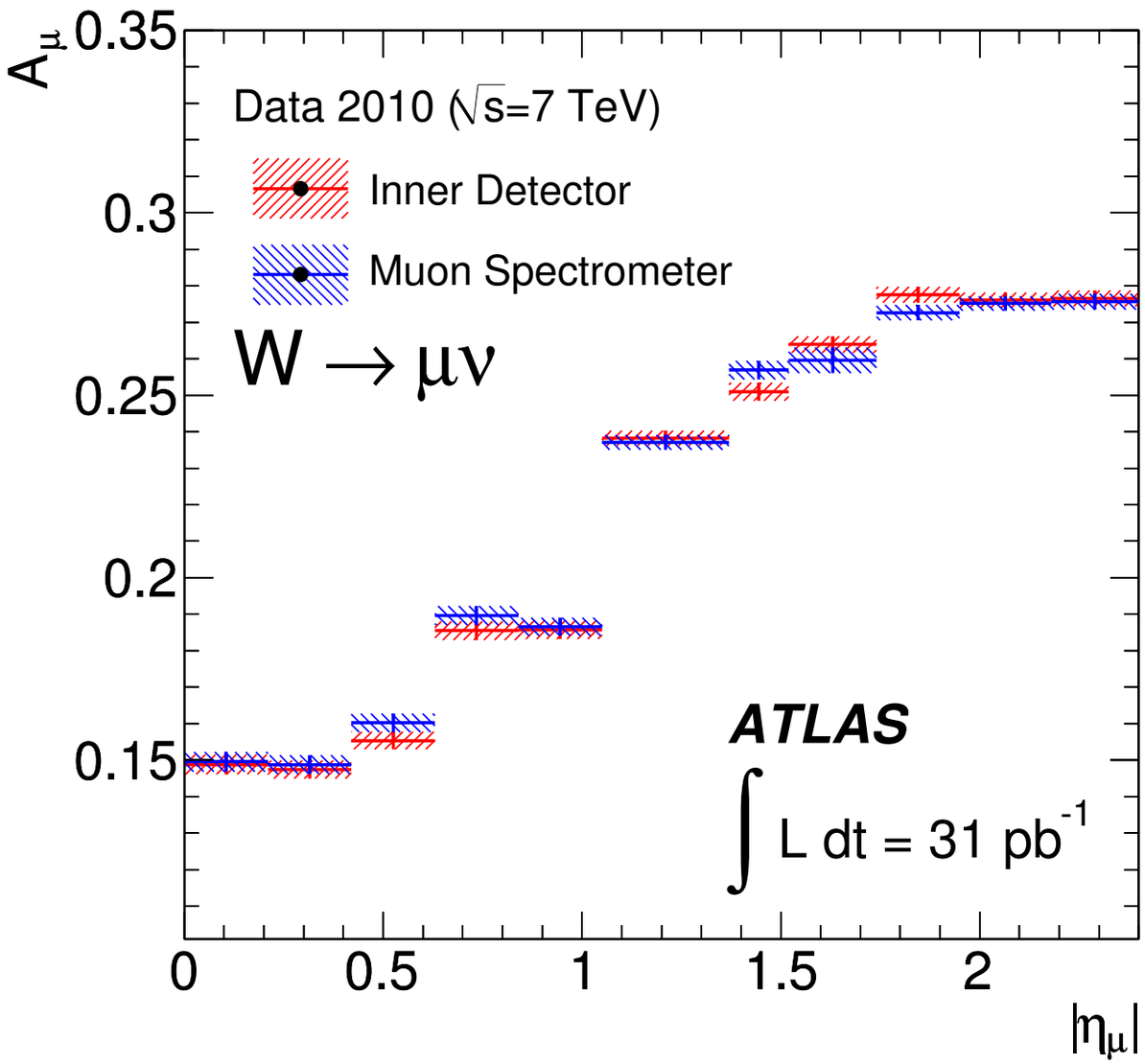
Sources

Trigger	2-7%
Reconstruction	1-7%
Muon Mom Scale and Resoltuion corrections	1-2%
QCD background	1-2%
EW background	1%
Generators (Pythia, MC@NLO)	< 1%
Combined	4-12%

- Muon charge asymmetry is a ratio -> many systematics cancel out
- Efficiency determined using Z -> μμ tag and probe
- Efficiency systematics largest at small |eta| - muon system coverage
- QCD systematics from data-driven method

most systematics will improve with more statistics!

Systematic Uncertainties: A Cross Check



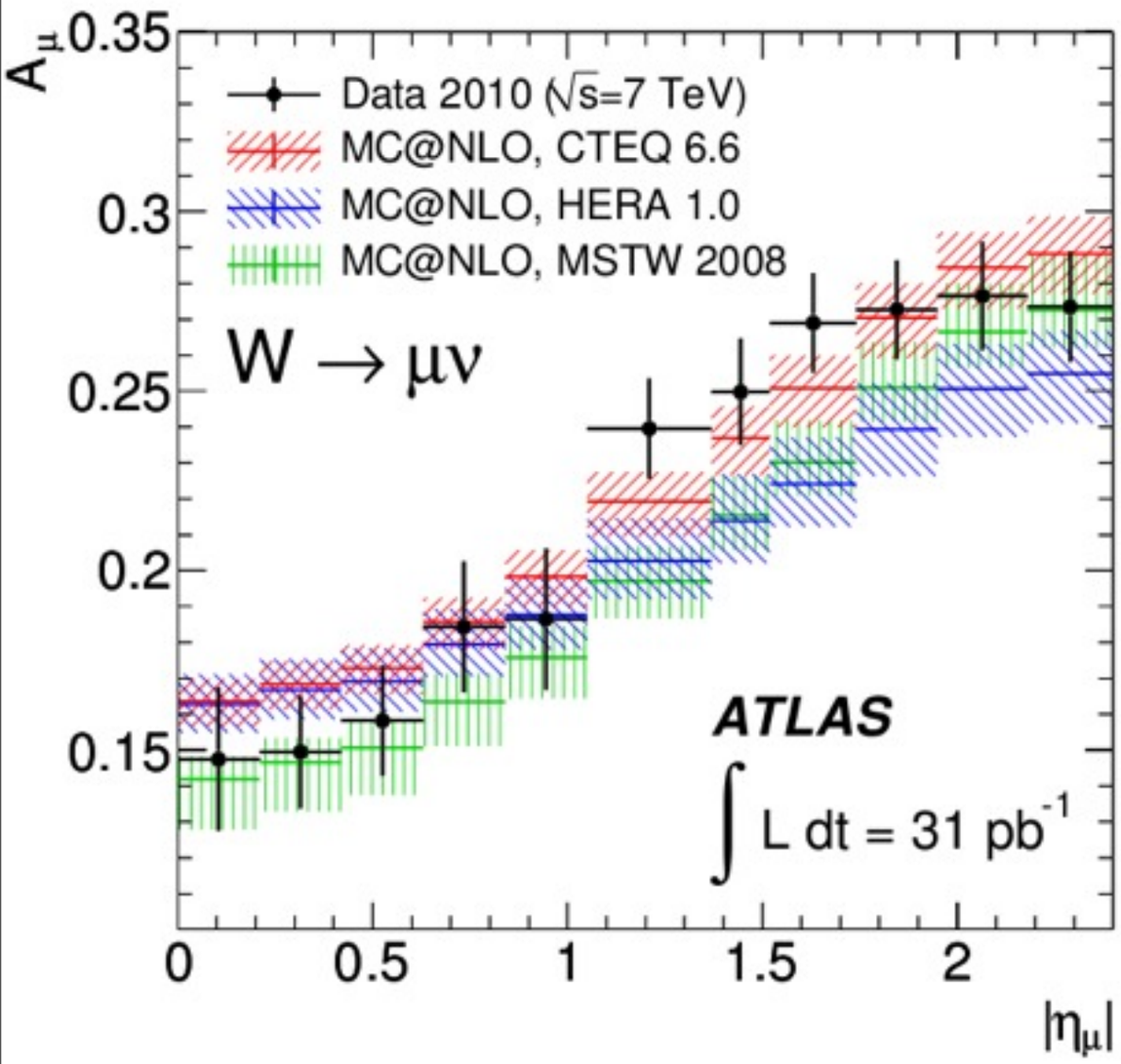
- plot shows measurement with tracks from muon system and inner detector separately (primary measurement is a combination of the two)
- agreement shows handle on systematics from momentum scale corrections

Results

- 3 PDF Sets were tested: CTEQ 6.6, HERA 1.0, MSTW 2008
- PDFs differ in:
  - input data (HERA uses newest datasets, others haven't updated)
  - values of alphas (CTEQ uses world average, MSTW uses fit output)
  - values for heavy quark masses
  - methods for implementing higher order corrections
  - methods for evaluating systematic errors

All involve extrapolations to LHC kinematic region-> need LHC Measurements

Results



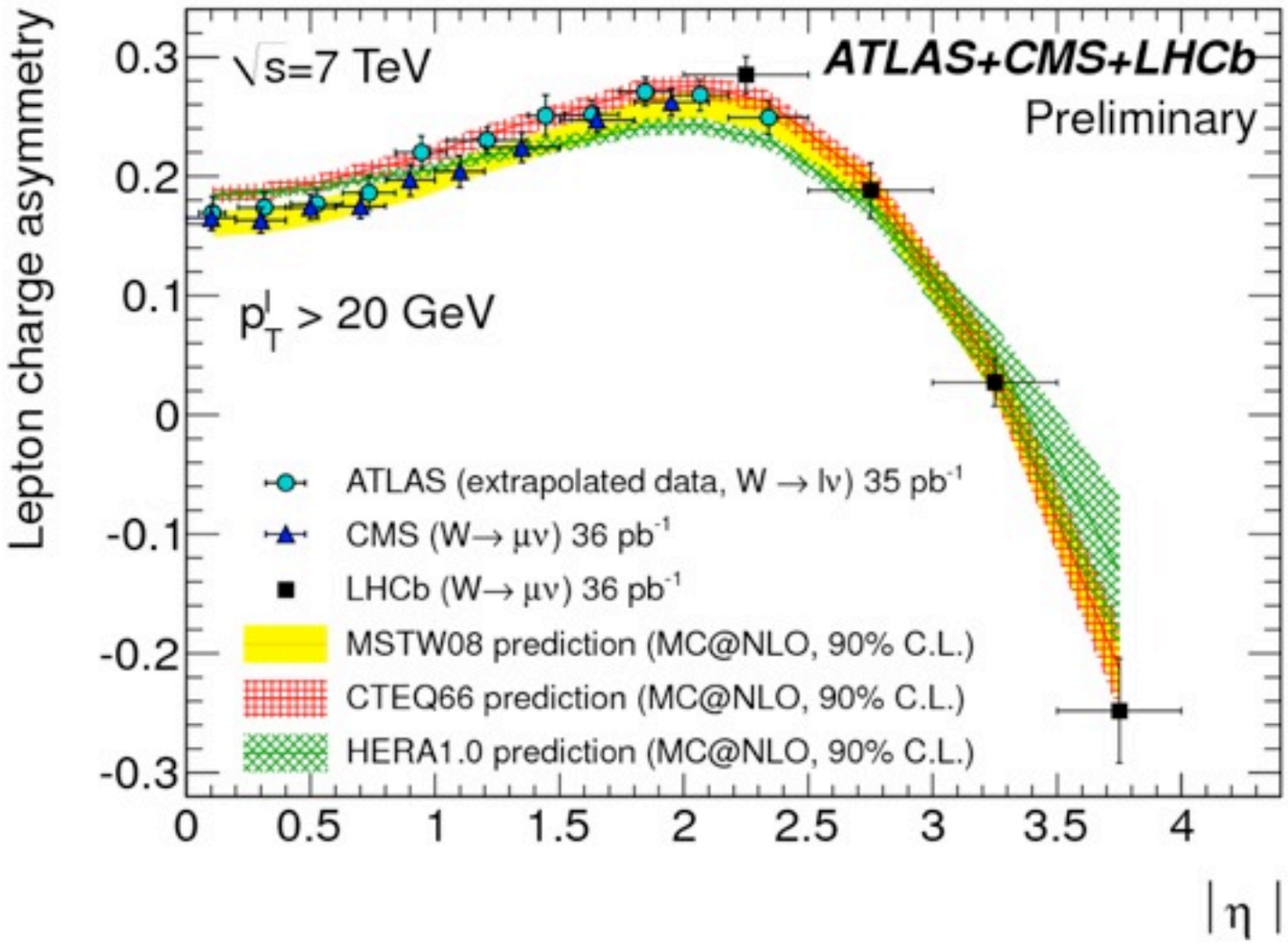
Current pdfs are in general consistent with data:
Agreement between model and data according to fit X^2/dof:

CTEQ 6.6 (9.16/11),
MSTW 2008 (27.31/11)
HERA 1.0 (35.81/11)

And pdfs are in general consistent with data

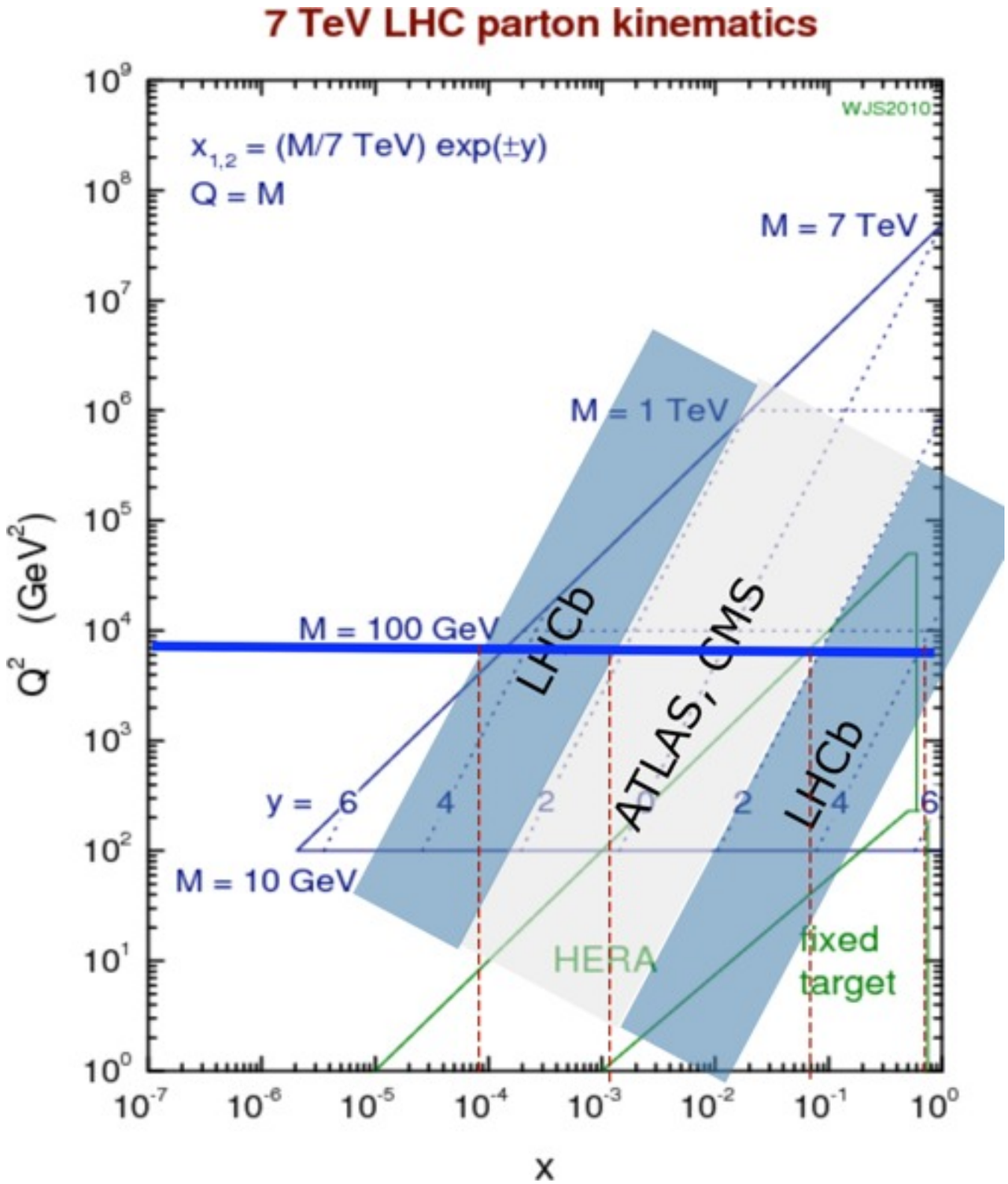
Error bars include statistical, systematic and PDF uncertainties
PDF uncertainties (including experimental) are shown at 90% C.L.

Conclusions



- the measurement isn't currently used to constrain any pdfs but is beginning to be sensitive
- more statistics are on the way, measurement precision should improve with more data, since most errors are currently statistics limited
- ATLAS addition of the electron channel (currently in progress) should double statistics
- combined 2010 LHC (ATLAS+CMS+ LHCb)

Back-Up


7 TeV LHC parton kinematics
WJS2010
$x_{1,2}$ = (M/7 TeV) exp(±y)
Q = M
M = 7 TeV
M = 1 TeV
M = 100 GeV
M = 10 GeV
y = 6
4
2
0
2
4
6
LHCb
ATLAS, CMS
LHCb
HERA
fixed target
Q^2 (GeV^2)
x
10^9
10^8
10^7
10^6
10^5
10^4
10^3
10^2
10^1
10^0
10^{-7}
10^{-6}
10^{-5}
10^{-4}
10^{-3}
10^{-2}
10^{-1}
10^0