energie atomique • energies alternatives

R_{Jets} (σ_W / σ_Z + *jets*) *Measurement*

Xu Chao (CEA/Saclay && USTC)

Oct.2011

Outline

- *Motivation*
- R_{jets} *Measurement of ATLAS*
- R_{jets} *Correction Strategy*
- *Background*
- *Systematics*
- *Results*
- *Conclusion*

Motivation

- *Measurement of W/Z cross section as function of hadronic activity*

$$R_{jets}(p_T > x) = \frac{\sigma_{W+1jet(p_T>x)}}{\sigma_{Z+1jet(p_T>x)}}$$

X ranging from 30*GeV to 200*GeV in steps of 10*GeV
Each bin includes all selected events with jet above the jet p_T threshold

- *Advantage: Cancellation of Systematic*
  - Luminosity systematics
  - Jet systematics
  - Lepton systematics (partial)
- *Limited statistics due to Z cross section*

Motivation

- *The first kind of such measurement*

Inclusive ratio R has been measured at

Tevatron : R = 10.92 ± 0.15(stat) ± 0.14(sys)
LHC : R = 11.70 ± 0.90(stat) ± 0.40(sys)

- *Comparison to theoretical predictions*
  - Precise test of Standard Model
  - Probe of New Physics
  - Data-Driven background study

R_{jets} Measurement of ATLAS

➢ *Full 2010 data collected by ATLAS. Good data quality required for both channel. (33.3 pb^{-1})*

Lepton

- Tight electron which has consistent EM shower shape
- Combined muon(Staco) whose momentum measurement from the combination of Inner Detector and Muon Spectrometer
- p_T>20*GeV, |η|<2.4(μ), |η|<2.47(e)
  Veto the electron 1.37<|η|<1.52 due to crack region in calorimeter.
- ID Hit requirements
- Track based Isolation

Jet

- AntiKt algorithm with cone size 0.4
  p_T>30*GeV, |η|<2.8
- Cleaning cuts due to calorimeter noise
- Tracks in jet also required to be consistent with the primary vertex to reject jets from cases where a secondary collision event overlaps with the primary collision. (pileup)

R_{jets} Measurement of ATLAS

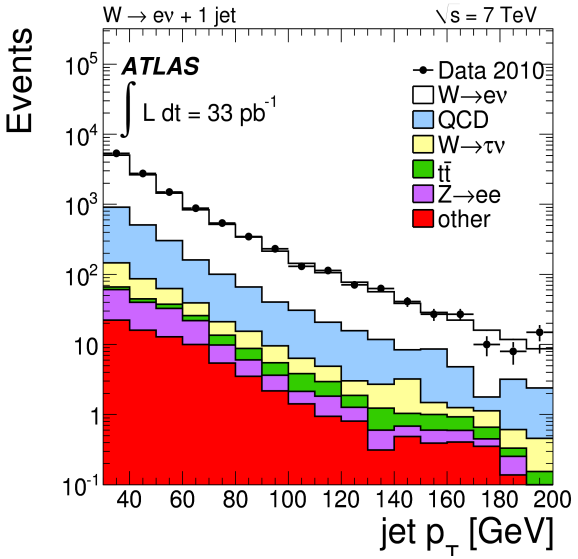
Event Selection

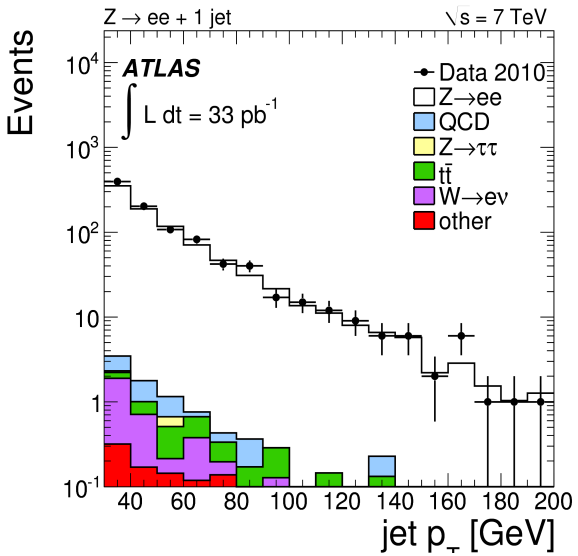
- Events must be recorded by single lepton trigger.
- The Primary Vertex must have at least 3 tracks and consistent with the collision spot.
- MET Cleaning that rejecting events that contain a fake or poorly measured jet.
- W boson: $E_T^{miss} > 25$*GeV, $M_T > 40$*GeV.
- Z boson: 71*GeV < mass(l,l) < 111*GeV.

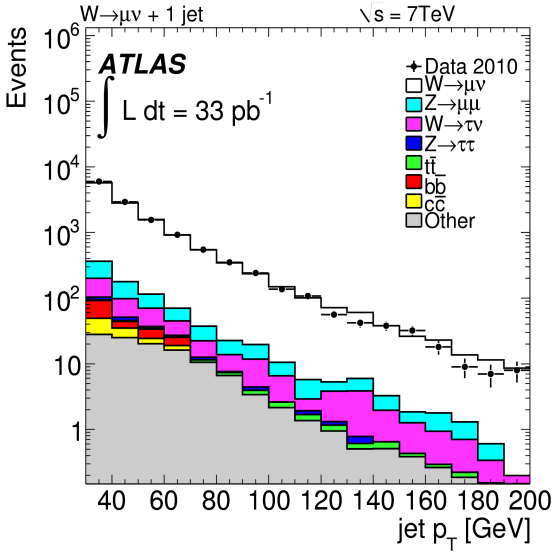
R_{jets} specific Selection

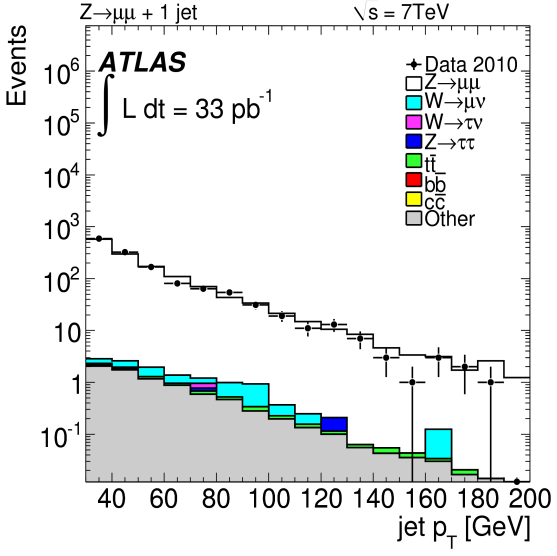
- Veto events with separation cut if R(e,jet)<0.6.
- Second electron selection is loosened to “Medium” and second muon quality cuts are not required.
- Require exactly 1 jet with $p_T > 30$ GeV.

R_{jets} Measurement of ATLAS









Electron Channel

Muon Channel

R_{jets} Correction Strategy

$$N^{\ell,V} = \frac{N_{data} \cdot (1 - f_{QCD}) \cdot (1 - f_{ewk})}{\epsilon^{\ell}_{trig} \cdot \epsilon^{\ell} \cdot C^{\ell}_{V}}$$

- f_{QCD} : QCD background fraction derived from data
- f_{ewk} : Electroweak background derived from MC
- $\varepsilon^{l}_{trigger}$: Trigger efficiency
- ε^{l} : Lepton identification efficiency
- C^{l}_{V} : Boson Reconstruction Correction: Corrects the observed phase space to the fiducial phase space, accounting for resolution of leptons and E_T^{miss}

$$R_{jets} = \frac{N^{\ell,W}}{N^{\ell,Z}} \times C^{\ell}_{jet}$$

- C^{l}_{jet} : Jet Correction remaining effects which not canceled in ratio related to the jet kinematics

Each term measured as a function of jet p_T threshold

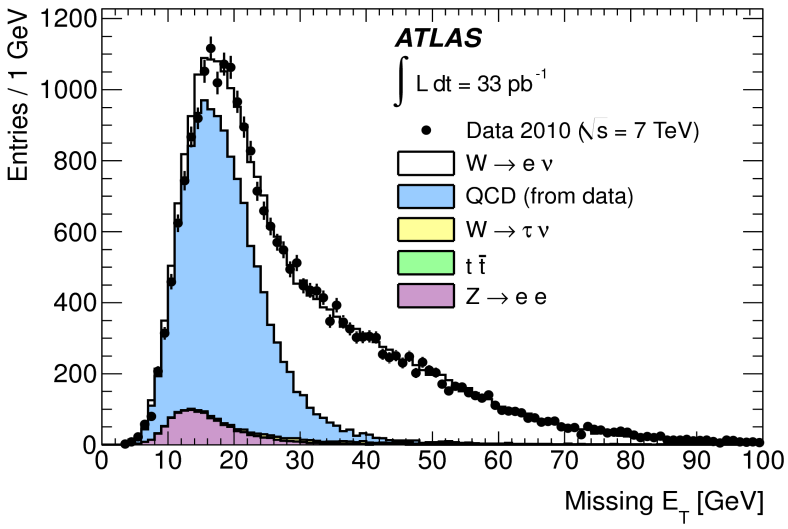
QCD Background

- **Electron Channel : Template Fit**

  Fitting E_T^{miss} shape in the low E_T^{miss} region

  15*GeV<E_T^{miss}<55*GeV. The templates for signal and electroweak backgrounds rely on MC.

  The template for the multi-jet contribution extracted from data by inverting the “tight” electron identification criteria



- **Muon Channel : Matrix Method**

  Estimated from the number of events passing all cuts except isolation. Derived the isolation efficiency from the data by selecting control sample for signal and multi-jet background both.

$$N_{loose} = N_{nonQCD} + N_{QCD}$$

$$N_{iso} = \epsilon^{iso}_{nonQCD} \cdot N_{nonQCD} + \epsilon^{iso}_{QCD} \cdot N_{QCD}$$

- **QCD background of Z : very small in both channel**

Electroweak Background

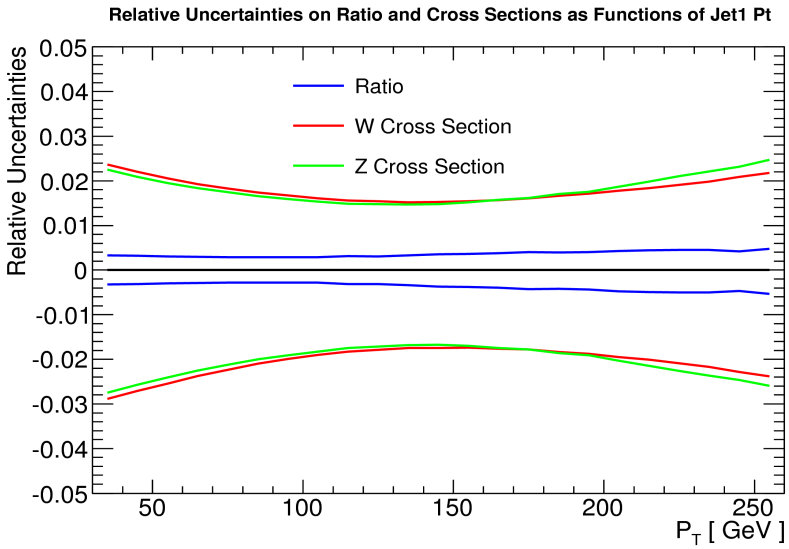
- The background from electroweak processes estimated from MC (Alpgen) as a fraction f_{ewk} of the total events yields subtracting multijet contribution
- Reduces the systematics from the detector effects on acceptance
- Systematics is small in ratio measurement

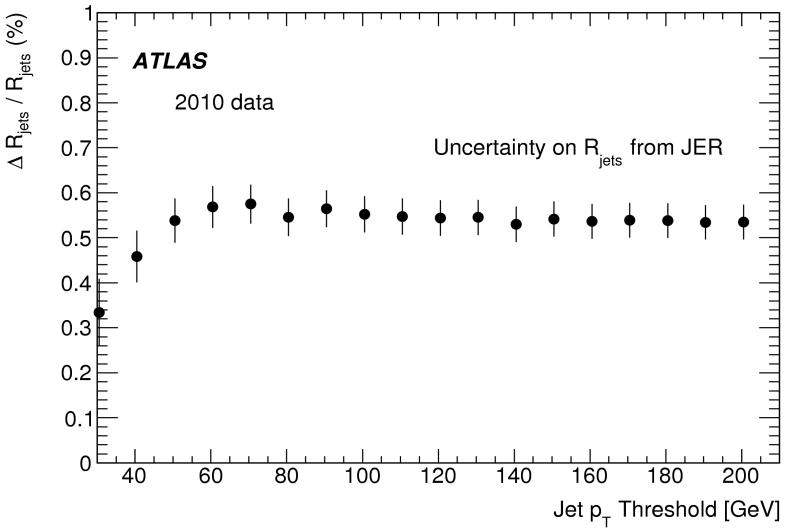
$$f_{ewk}^{i} = \frac{N_{ewk}^{i}}{N_{signal} + \sum_{j} N_{ewk}^{j}}$$

Process	$f_{ewk,W}$ [%]	$f_{ewk,Z}$ [%]
$W\mu\nu$	-	0.13
$Z\mu\mu$	2.98	-
$W\tau\nu$	1.92	0.03
$Z\tau\tau$	0.18	0.02
$t\bar{t}$	0.22	0.13
Total	5.30	0.31

Systematic	$\Delta f_{ewk,W}$ [%]	$\Delta f_{ewk,Z}$ [%]	ΔR_{jets} [%]
p_T and η Resolution	0.22	4.78	0.03
$E_{\text{T}}^{\text{miss}}$ correction	0.89	0	0.05
Different generators	9.14	9.10	0.54
Pile Up	5.64	2.19	0.32

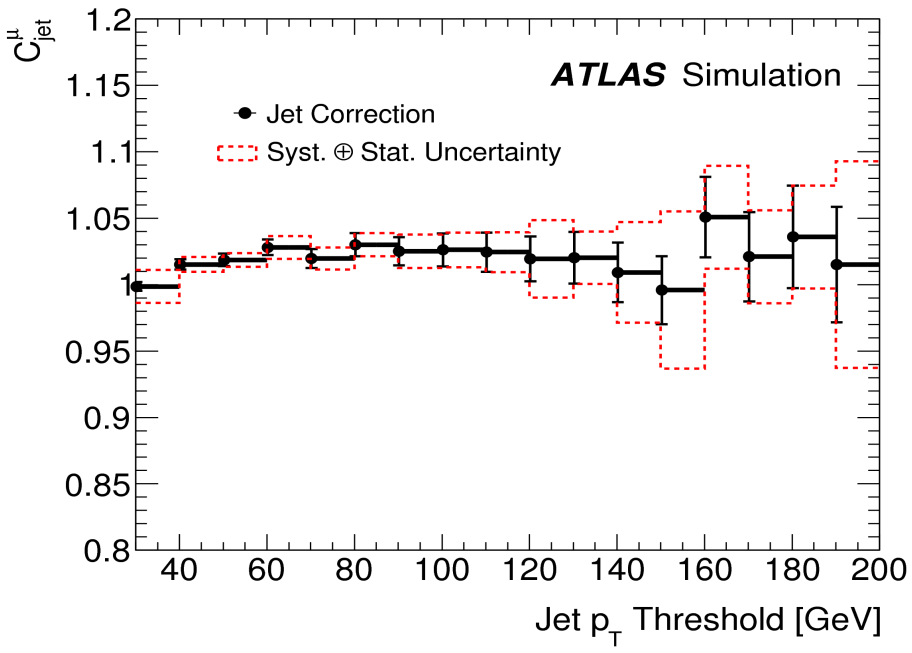
Systematics





- The theoretical systematic due to PDF uncertainty is indeed smaller in ratio measurement
- The uncertainty introduced by JER. Uncertainty is small over the whole p_T range

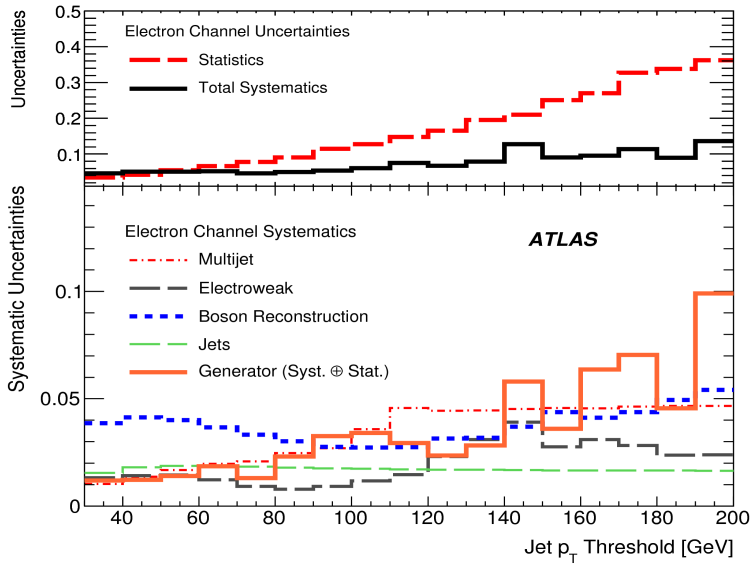
Systematics

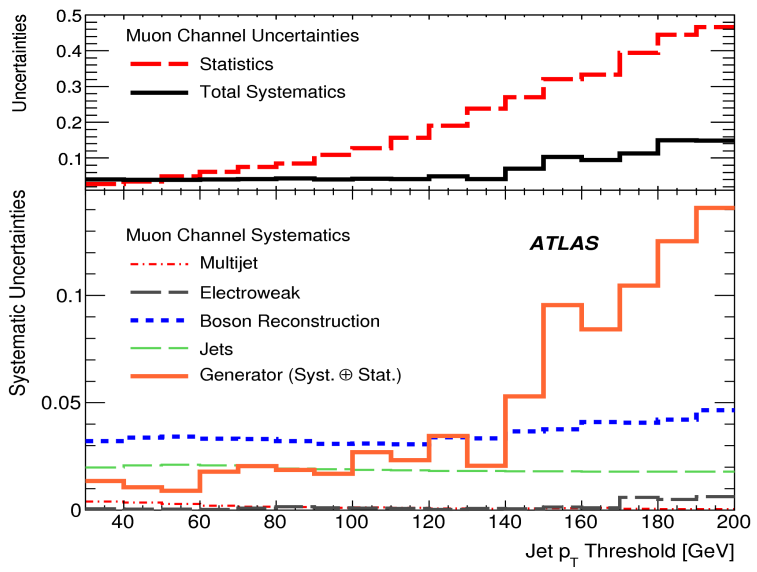


- Correction factor in terms of jets defined at particle level and reconstructed jets
- Offset due to different requirements applied in W/Z selections prior to the jet selections,placing jets into slightly different phase space region

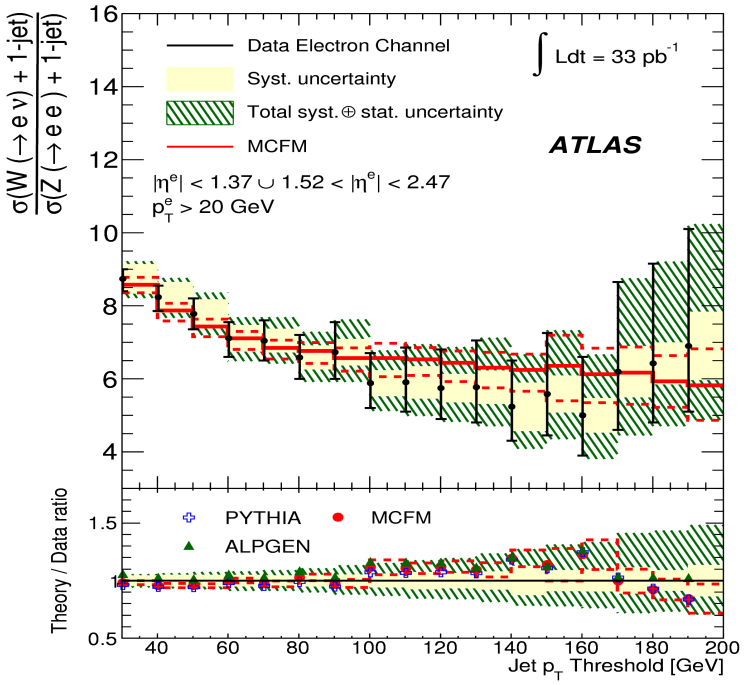
Systematics

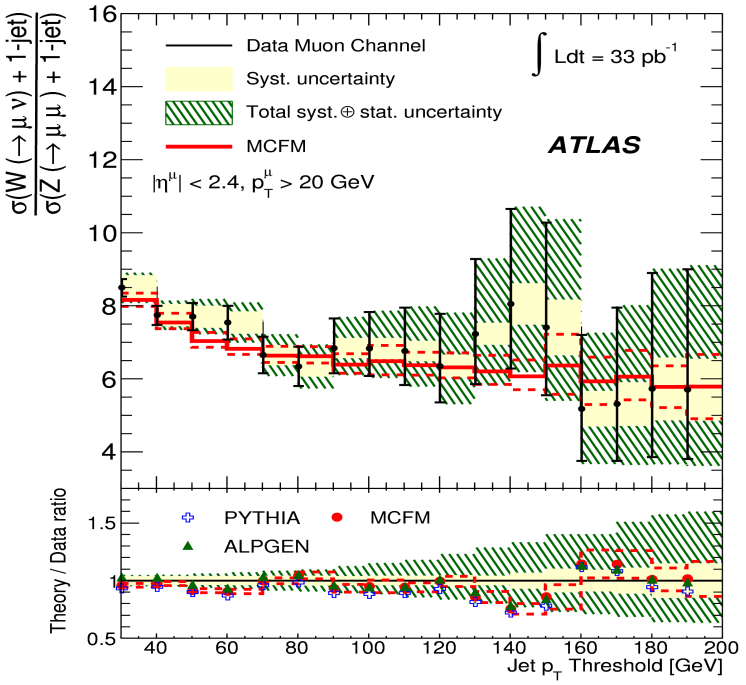
- Systematics also shown in ratio
- Measurement is statistically limited in most of p_T range
- Systematics study include various sources: scale and resolution, pile-up, selection cuts, etc.
- The large systematics of generator in Muon channel is caused by poor MC statistics in high p_T region





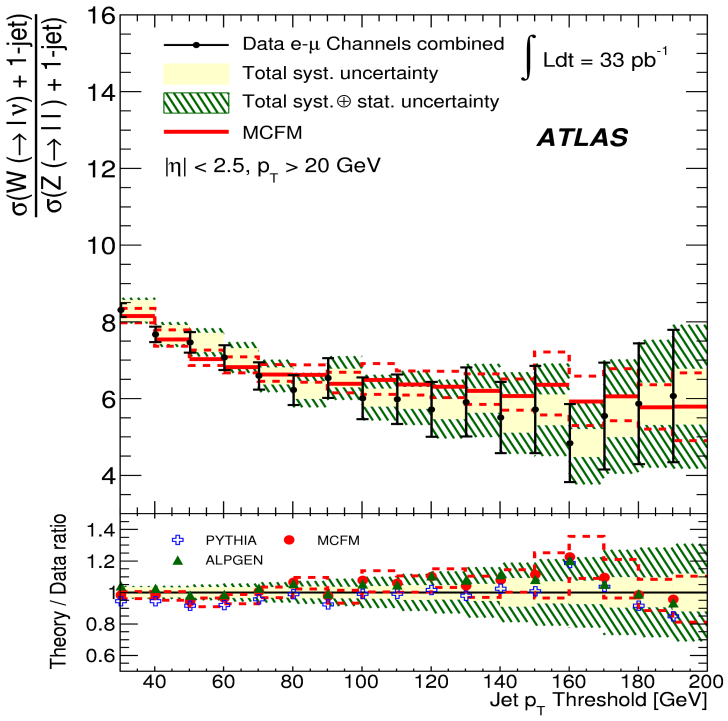
Results

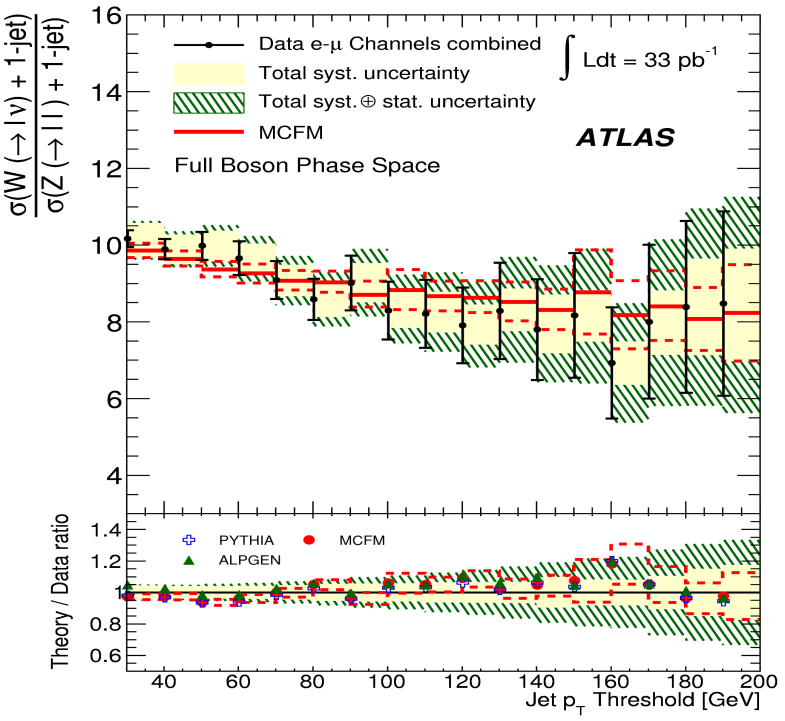




- Good agreement between theory and data
- Bins are not statistically independent
- From 140*GeV the statistics in both data and MC are poor

Combined Results





- Results are extrapolated to common space to allow direct combination in full phase space or $|\eta|<2.5$
- The combined results illustrate the data has been well modeled by theory

Conclusion

- *This is the first measured result which show the W/Z cross section ratio in 1-jet bin as a function of jet p_T at such integrated luminosity.*
- *The results from the data are consistent with theoretical predictions.*
- *Paper submitted to Physics Letters B.*
- *We will perform the same measurement with 2011 dataset but also try to look at more higher p_T range, different jet multiplicities by scalar sum p_T of jets, invariant mass of jets, etc. Looking forward to something interesting seen by us.*