Acceptance Definitions and Studies

for W→eν and Z→ ee

Method and Results

For the Acc WZ workshop talk on 14.4.

Based on ATLAS-COM-to come- Note (show title page?)
Previous presentation: Jan 14.2.2010

Remarks/questions in red
Have 20min+5. need to
go slow through main idea
to enable discussion.

DRAFT for ELAN 9.4.

Basic Definition

For illustration use η as variable (may be any two or integrated over).
For each bin and a chosen value of η inside this bin one has:

$$\frac{\Delta\sigma}{\Delta\eta} = \frac{N_{Data} - N_{Bgd}}{A_\varepsilon \cdot L_{Data}} \cdot \frac{1}{\Delta\eta}$$

Bin averaged (or total) cross section

$$\frac{d\sigma}{d\eta} = \frac{N_{Data} - N_{Bgd}}{A_\varepsilon \cdot L_{Data}} \cdot \beta_{BC}$$

Differential cross section

$$\beta_{BC} = \frac{d\sigma_{thy} / d\eta}{\int_{bin} d\sigma_{thy}}$$

Bin centre and size correction

N_{data} number of reconstructed signal (W or Z) events in bin after all cuts
N_{bgd} number of reconstructed fake events in bin after all cuts
A_ε combined correction for acceptance and efficiency (cf below)

Combined Acceptance and Efficiency Correction

Integrate smearing, RC, cuts and D/MC efficiency differences in definition of A_ε

$$\frac{\Delta\sigma}{\Delta\eta} = \frac{N_{Data} - N_{Bgd}}{A_\varepsilon \cdot L_{Data}} \cdot \frac{1}{\Delta\eta}$$

Cross section formula

$$A_\varepsilon = \frac{N_r}{N_g}$$

Acceptance

$$N_g = N_{gen}^{nocuts,noRC}$$

Generated events in a bin
(based on all events, for Z with M_Z cut)

$$N_r = N_{rec}^{cuts,RC} = \sum_{ev} w_{ev}$$

Reconstructed events in a bin
after all cuts, corrected for D/MC efficiency
and including h.o. QED radiative corrections

Does this mean we use MC@NLO+PHOTOS
for reco and MC@NLO only for gen or do
we ignore the radiative events in the gen sample?

Efficiency Treatment

$$N_r = N_{rec}^{cuts,RC} = \sum_{ev} w_{ev} = \sum_{ev} \frac{\varepsilon_{ev,data}}{\varepsilon_{ev,MC}}$$

Each event reconstructed in a bin contributes a weight w_{ev} which is the [event wise] product of ratios of Data/MC efficiencies as of trigger, eID... It may depend on any variable such as η, p_t, ... It thus is generally not a global correction factor.

Ratios? Too Detailed?

$$\varepsilon(\eta_e, p_T^e, \ldots) = \varepsilon^{cl}(\eta_e, p_T^e, \ldots) \times \varepsilon^{elec}(\eta_e, p_T^e, \ldots)|_{cl} \times \varepsilon^{id}(\eta_e, p_T^e, \ldots)|_{cl\&elec} \times \varepsilon^{trig}(\eta_e, p_T^e, \ldots)|_{cl\&elec\&id}. \quad (20)$$

Here:

- $\varepsilon^{cl}(\eta_e, p_T^e, \ldots)$ is efficiency to reconstruct (two) electromagnetic cluster(s), satisfying η, p_T cuts (including crack cut);
- $\varepsilon^{elec}(\eta_e, p_T^e, \ldots)|_{cl}$ is efficiency for the (two) reconstructed cluster(s) to be found in the electron container;
- $\varepsilon^{id}(\eta_e, p_T^e, \ldots)|_{cl\&elec}$ is efficiency for the (two) reconstructed cluster(s) to pass the medium identification cuts;
- $\varepsilon^{trig}(\eta_e, p_T^e, \ldots)|_{cl\&elec\&id}$ is the trigger efficiency for events passing all reconstruction cuts.

The cluster reconstruction efficiency ε^{cl}, also know as "geometrical acceptance" is estimated for MC simulation only and assumed to be the same in data and MC. The details of the efficiency estimation for other efficiencies are given in the following sections.

? eID in trig+cuts

Any external efficiency ratio may be imported here.

In a rough first approximation, limited by data statistics, all ratios are 1.

Radiative Corrections

N_r is calculated with MC@NLO which is linked to PHOTOS.
If one uses this for N_{rec} but the Born cross section for N_g
this corrects back to the Born level in terms of QED h.o.

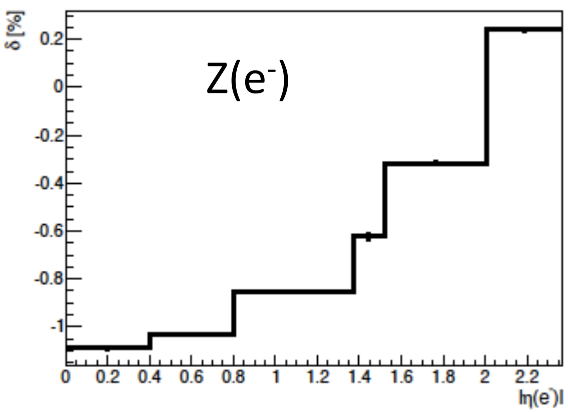
$$A_\varepsilon = \frac{N_{rec}^{cuts,RC}}{N_{gen}^{nocuts,noRC}} = \frac{N_{rec}^{cuts,RC}}{N_{rec}^{cuts,noRC}} \cdot \frac{N_{rec}^{cuts,noRC}}{N_{gen}^{nocuts,noRC}} \approx (1+\delta_{RC}) \cdot \frac{N_{rec}^{cuts,noRC}}{N_{gen}^{nocuts,noRC}}$$

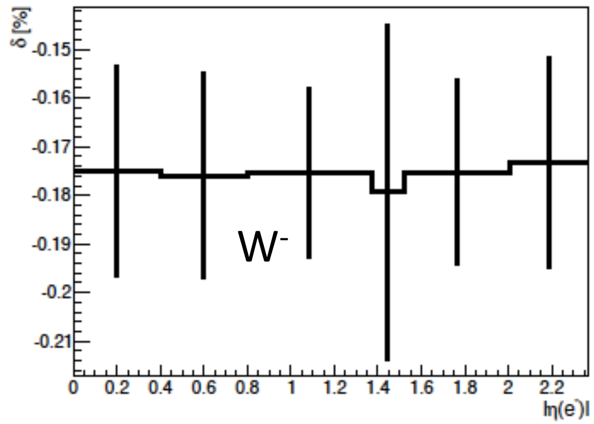
Any valid estimate of the radiative QED corrections δ_{RC}
should be on reconstruction level as the reconstruction
combines electrons and FSR photons to a large extent.

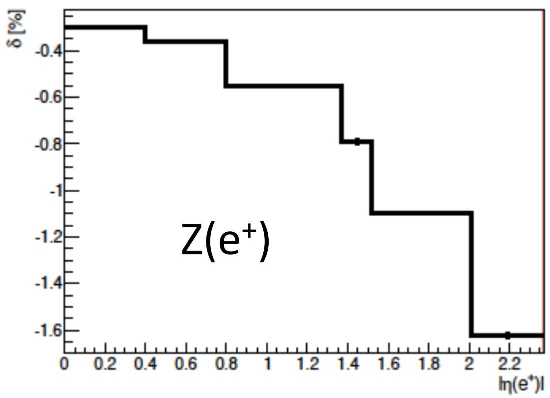
In this notation the efficiencies moved to the non-radiative
reconstructed events. However, when one determines
the data/MC efficiency ratio one then compares
efficiencies for non-radiative MC events with radiative data.
Thus such a factorisation ansatz is questionable.

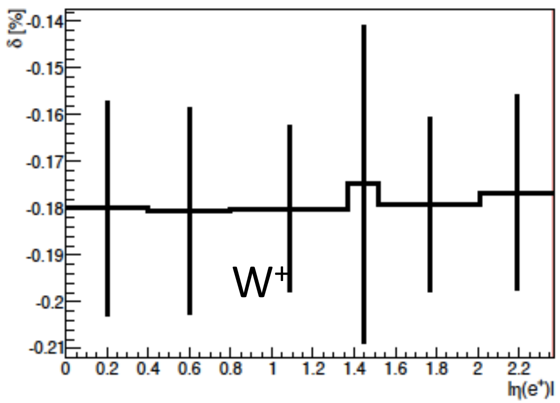
Pure Weak Corrections

Pure weak and ISR-FSR interference corrections in G'_μ scheme. They are larger in the $\alpha(0)$ and in the $\alpha(M_Z^2)$ schemes. It is proposed to not correct for these to not introduce a scheme dependence of our measurement **(calculations below still for 10 TeV – 3.4.10 SANC 7TeV to come)**.









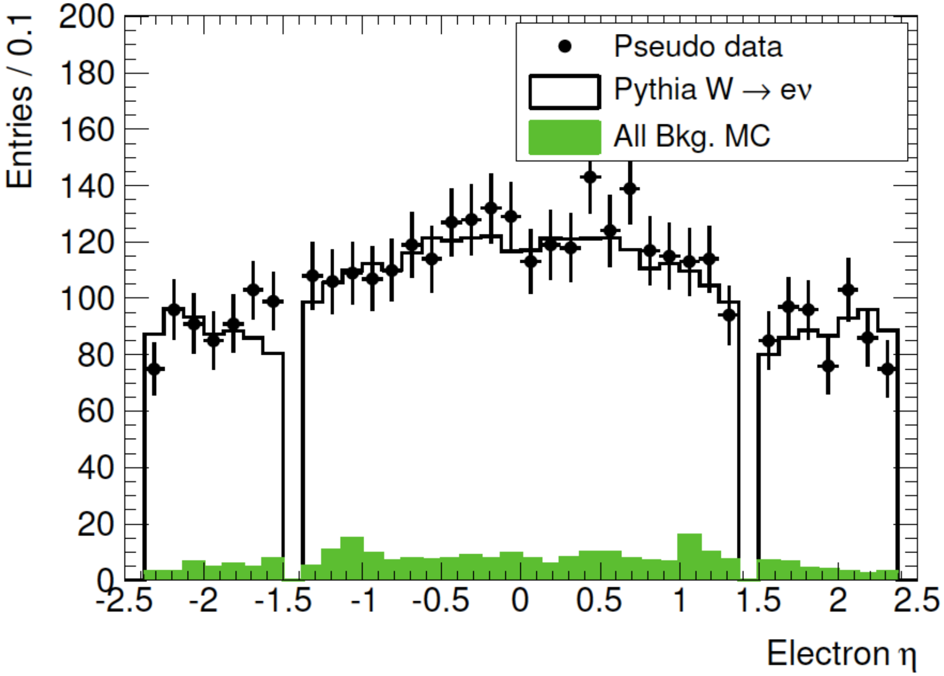
SANC: see ATLAS-COM-to come-Note and

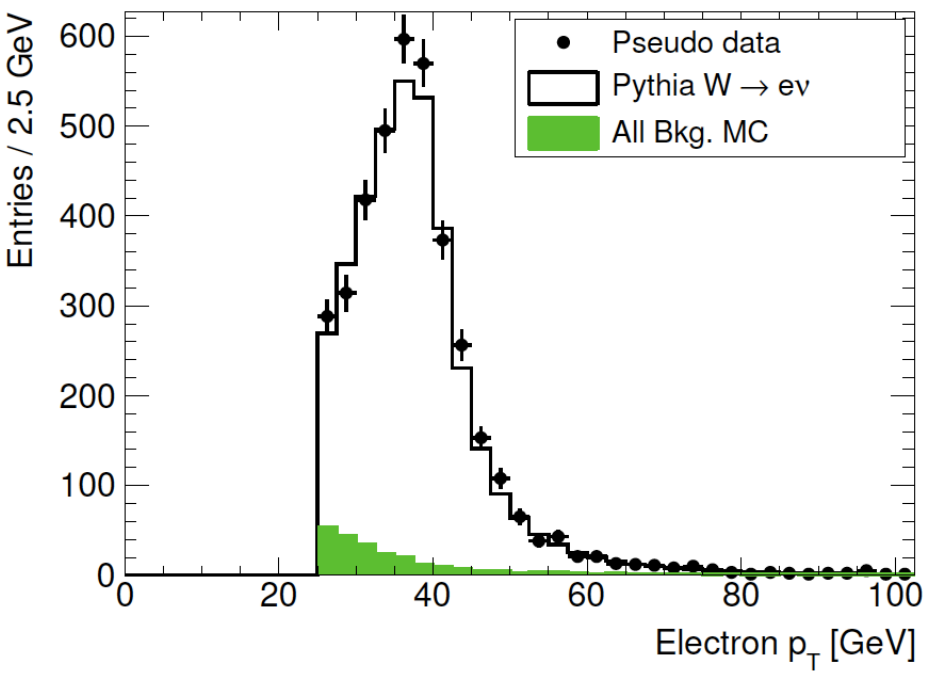
Systematic Error Estimates

$$A_{\varepsilon} = \frac{N_{rec}^{cuts,RC}}{N_{gen}^{nocuts,noRC}} \approx (1+\delta_{RC})\cdot \frac{N_{rec}^{cuts,noRC}}{N_{gen}^{nocuts,noRC}} \approx (1+\delta_{RC})\cdot \frac{N_{rec}^{cuts}}{N_{gen}^{cuts}}\cdot \frac{N_{gen}^{cuts}}{N_{gen}^{nocuts}} = (1+\delta_{RC})\cdot A_{rec}\cdot A_{cuts}$$

This factorisation ansatz is useful for systematic error estimates. A_{rec} can be used to estimate reconstruction uncertainties and A_{cuts} to study pdf effects, for example. For the calculation of the optimum correction factor, however, these are approximate weights only from potentially inconsistent MC samples. The genuine data/MC efficiency corrections need to applied event wise to the radiative, reconstructed events. There is no study on the validity of the factorisation ansatz needed. as it better is avoided altogether for obtaining the cross section.

Control of the Measurement

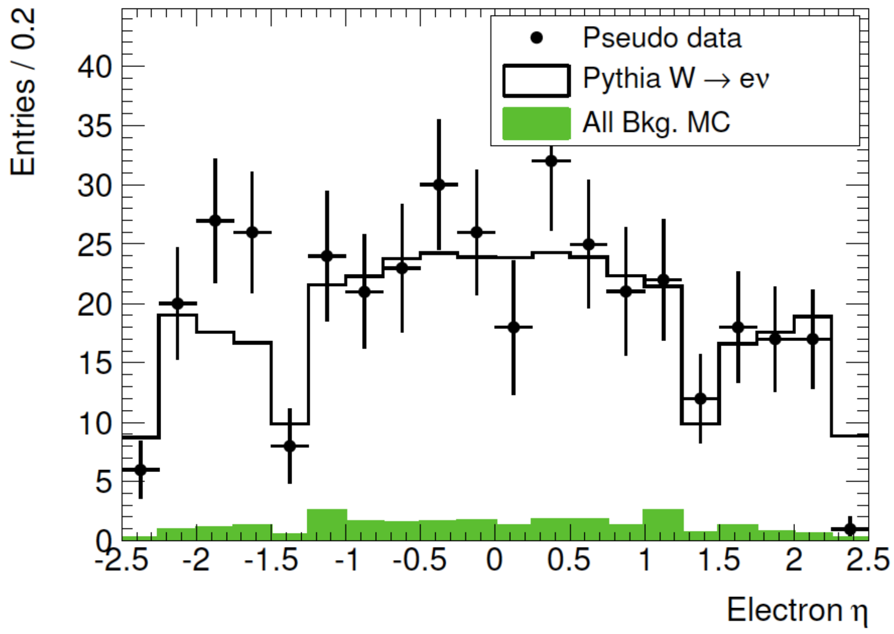


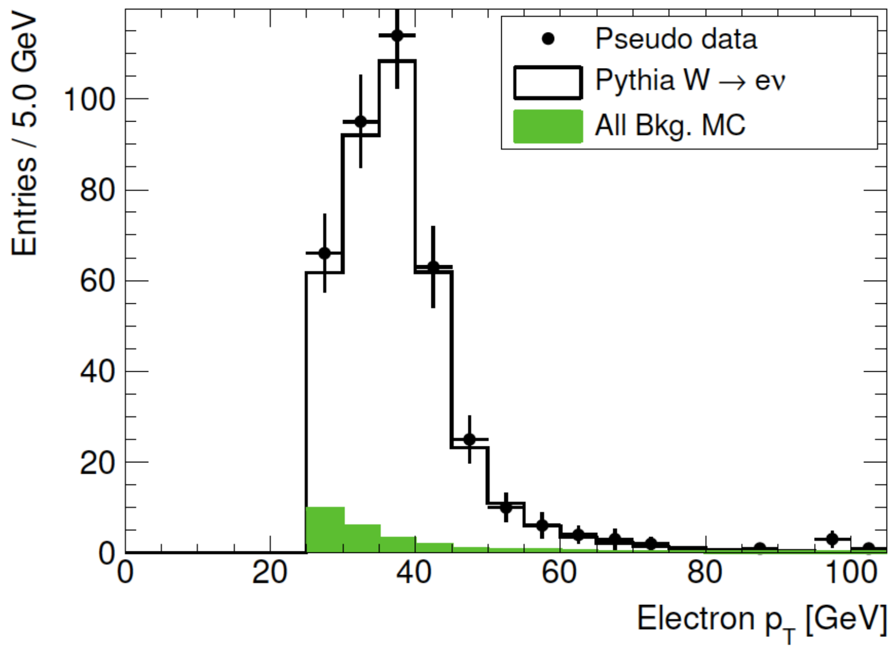


Data=MC@NLO(08)
MC=PYTHIA
bgd=JF17
1pb^{-1} 10 TeV (Jan made also 100nb-1)

Check variety of distributions for correct description of data by the simulation.

Control of the Measurement





Data=MC@NLO(08)
MC=PYTHIA
bgd=JF17
$0.1 pb^{-1}$ 10 TeV

Check variety of distributions for correct description of data by the simulation.

MC Dependence of Acceptance Correction

Some further plots from Jan to be looked at

Trigger: e10_medium (alternatively: e20_loose)

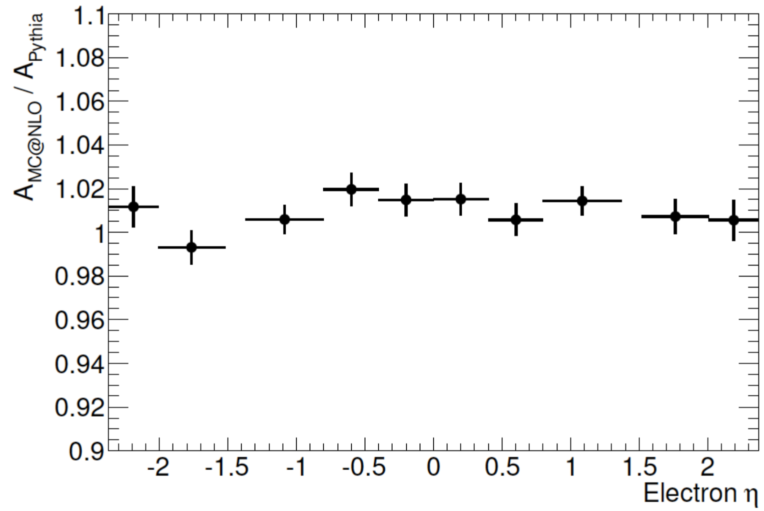
Reconstructed electrons with E_T > 25 GeV, IsEM medium, egamma AUTHOR

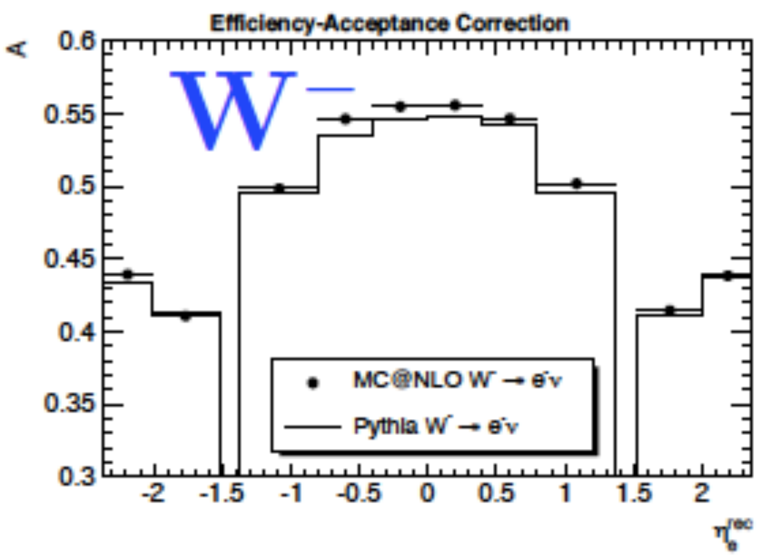
|η| < 2.37 and 1.37 < |η| < 1.52

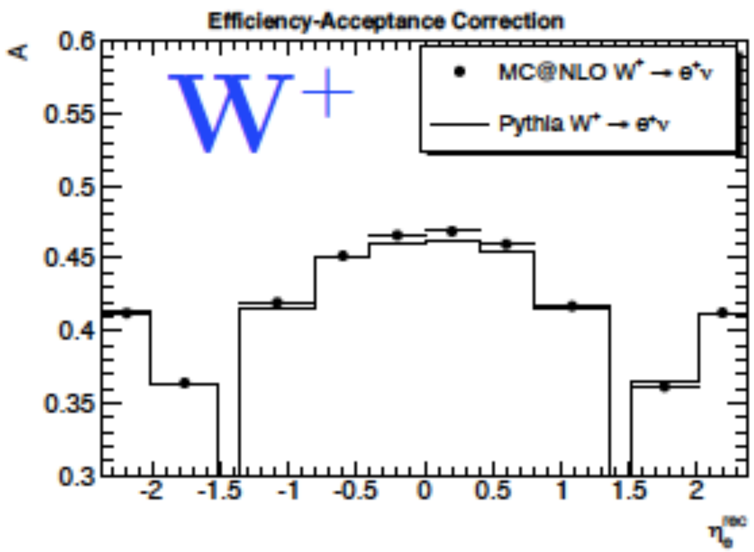
No further medium electron with E_T > 25 GeV

MET > 25 GeV

M_T > 40 GeV





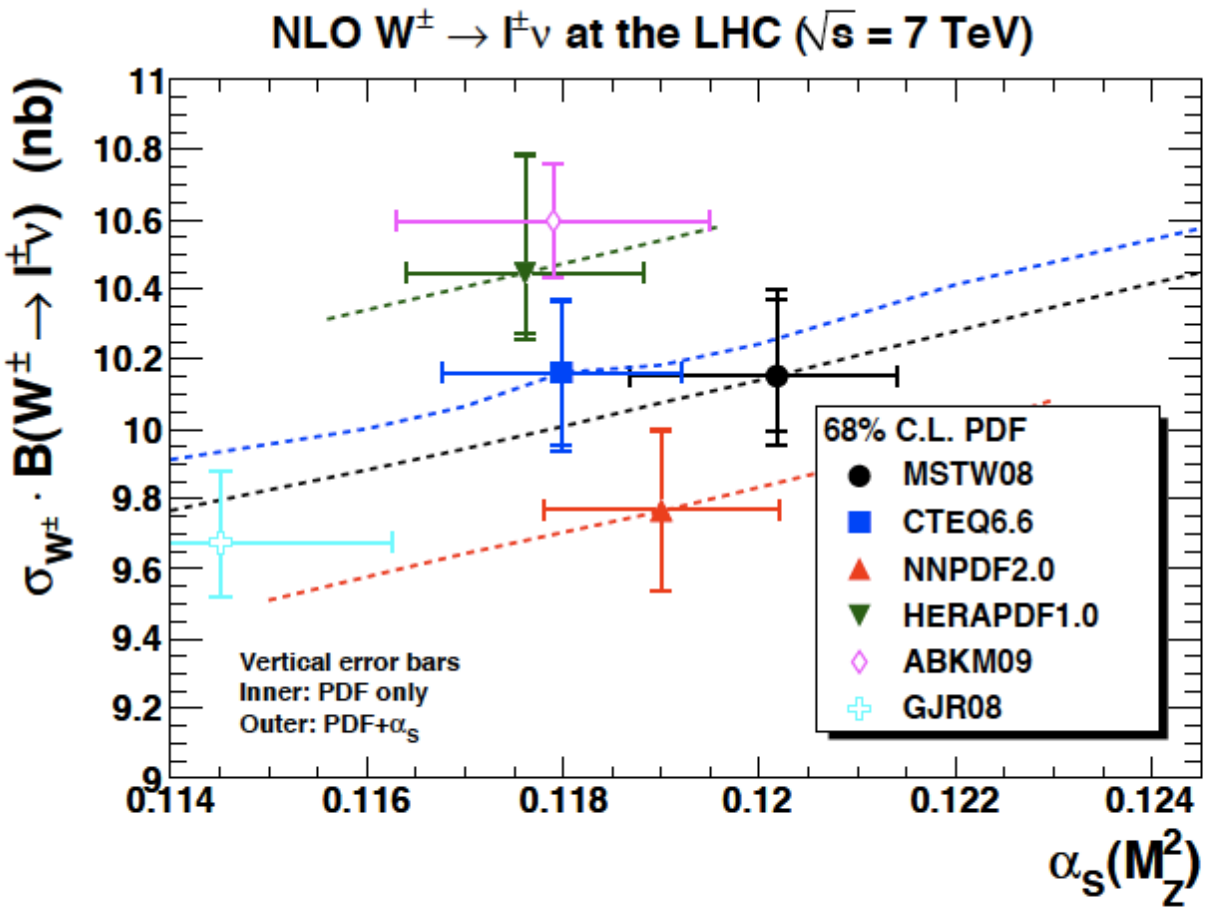


Link to Acc definitions!

Dependence on Parton Distributions

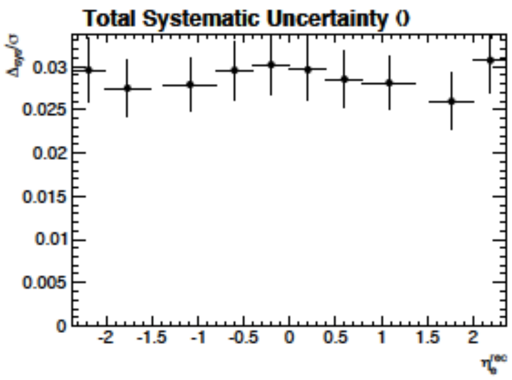
Note sure this fits here

Predictions on total W cross sections differ by about 10%.



G.Watt: pdf4lhc meeting , 26.3.2010 [sum of W^+ and W^-]

Systematic Errors – Cross Section



List of Experimental Systematic Un

- Electron Energy Calibration:
  - Global Scale: 1% Correlated
  - Nonlinearity $1\%/20$ GeV Correlated
  - Calibration Statistics Uncorrelated (per bin, $\sim 0.2 - 0.6\%$)
- Electron Efficiencies:
  - T&P Statistics Uncorrelated for Reco, ID, Trigger (per bin, $\sim 1 - 3\%$)
  - T&P Systematics Correlated for Reco, ID, Trigger (per bin, locally few $\%$, 20% of T&P - MC Truth)
- Electron Alignment θ_e 1 mrad Correlated
- $\not{E}_T$ Systematics:
  - Vary Electron contribution coherently with the above (the main contribution to low p_T W!)
  - Hadronic Recoil Scale 10% Correlated
  - Hadronic Recoil Resolution $+50\%$ Correlated

From Jans talk 14.2.: need to update and motivate for 1pb^{-1} or so: and table
Should talk about systematic errors of acceptance, not of the cross section

Conclusions

Systematic uncertainties [of Acceptance]?
Determination of D/MC efficiencies?
Results from Z on acceptances ?
PDF predictions?
See with Frank how things fit.

What else.?

Don't: talk about background

Rehearsal 13.4. (got mail to submit noon 13.4. …)