# Contribution to the discussion

Some input for our contribution(s) to the 14. April, the Acc WZ workshop

Max Klein  ELAN 31.3.2010

# The workshop charge (Ellie+Uta)

**acceptance methodology and results for the first WZ publications:**

A) Theoretical cross sections and uncertainties, total and within acceptance

B) Generator level acceptance issues - LO/NLO, PDFs, KT, ISR, FS, MC tuning

C) Detector response and acceptance- filling met/muon/electron response into the insitu performance and using these to estimate corrections to the acceptance. Includes MonteCarlo tuning as according to measured detector response.

D) Technical implementation of the above (APAcceptanceMatrices, InsituPerformance)

# Who are we: ELAN =

Title page as of today:

**An Analysis of the Z,W Cross Section Determination in the Electron Channels with ATLAS**

M. Aharrouche[6], D. Bardin[1], M. Bendel[5], A. Cooper-Sarkar[7], F. Ellinghaus[5], M. Flowerdew[4,8], S. Glazov[2], J. Haller[2,3], C. Handel[5], G. Hoerentrup[2,3], L. Kalinovskaya[1], M. Karnevskiy[2], M. Klein[4], U. Klein[4], T. Kluge[4], K. Köneke[2], S. Koenig[5], J. Kretzschmar[4], S. Mahmoud[4], S. Migas[4], A.Nikiforov[2,9], D. Petschull[2], R. Placakyte[2], V. Radescu[2,10], G. Siragusa[5], S. Tapprogge[5], J. Vossebeld[4], B. Wrona[4], and VERY LIKELY STILL INCOMPLETE[11]

[1]JINR Dubna
[2]DESY Hamburg
[3]University of Hamburg
[4]University of Liverpool
[5]University of Mainz
[6]CERN
[7]University of Oxford
[8]Now at MPI Munich
[9]Now at Humboldt University Berlin
[10]Now at University of Heidelberg

**WE HAVE TO NOW COMPLETE THIS: The Note and the Authorlist!**
**The Note should be out by 12.4. latest, so we can refer to it**

# Measurement Procedure

To extract the double differential cross sections the following master formula is used

$$\sigma^i = \frac{N^i_{\text{data}} - N^i_{\text{bg}}}{A^i \mathscr{L}} \delta^i_{\text{bs}}. \quad (17)$$

In this formula the variables are:

- $N^i_{\text{data}}$ — number of events in data reconstructed in the bin $i$;
- $N^i_{\text{bg}}$ — number of background events, estimated using MC simulation;
- $A^i$ — global efficiency-acceptance correction, estimated using MC and corrected for data to MC efficiency differences;
- $\mathscr{L}$ — integrated data luminosity;
- $\delta^i_{\text{bs}}$ — bin size correction.

**Bgd – use of MC? Show bgd plots? Z bgd – fitting/no fitting – vague in 3.9.6**

**Where are the h.o. corrections in this?**

**Which MC is used for A? – show PYTHIa vs MC&NLO Acc difference?**

**Which efficiency's shall we mention here? eID, trigger, charge..**

**Mark epsilon in formula. global → local**

# Z background

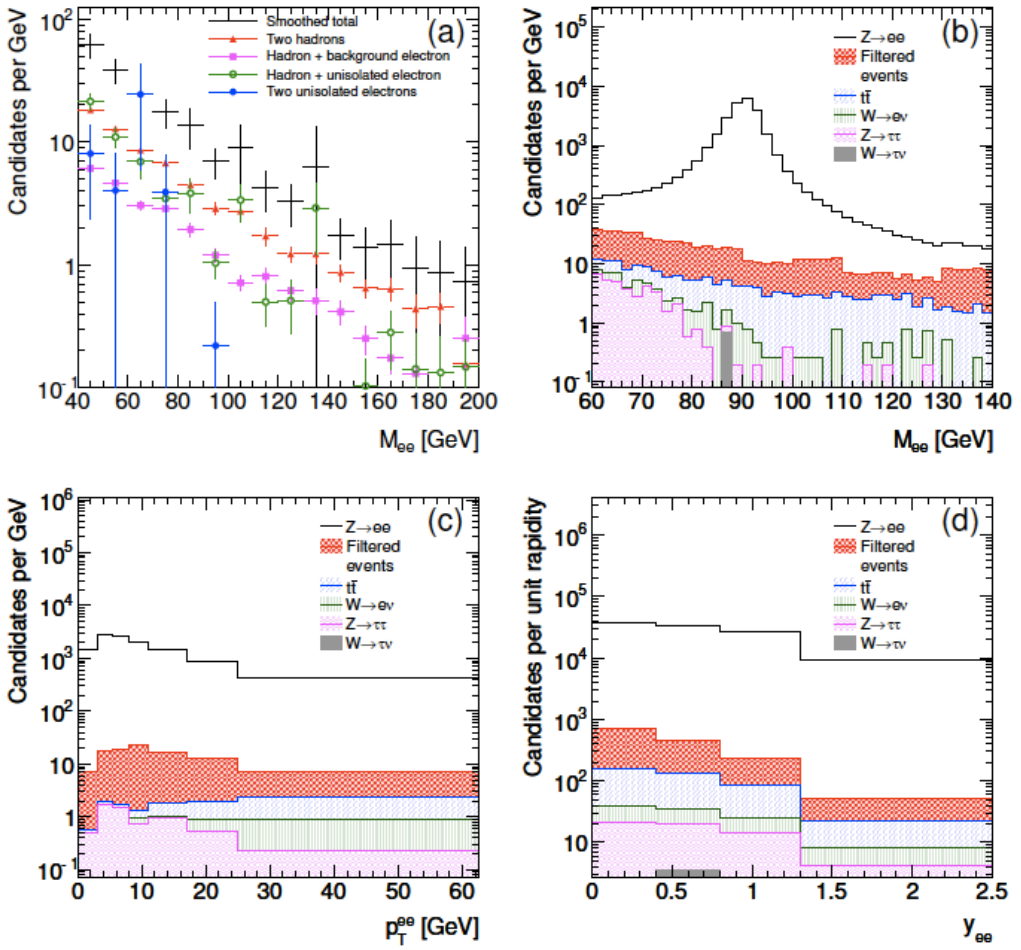



Figure 67: (a) Scaled QCD background estimate for the full $Z \to e^+e^-$ event selection (except mass cut). The total has been smoothed as described in the text. (b, c, d) Cumulative signal and background estimate after all cuts. In (b), the $m_{ee}$ cut has yet to be applied, and the scaled filtered event estimate has a wider binning than the other components.

# W background

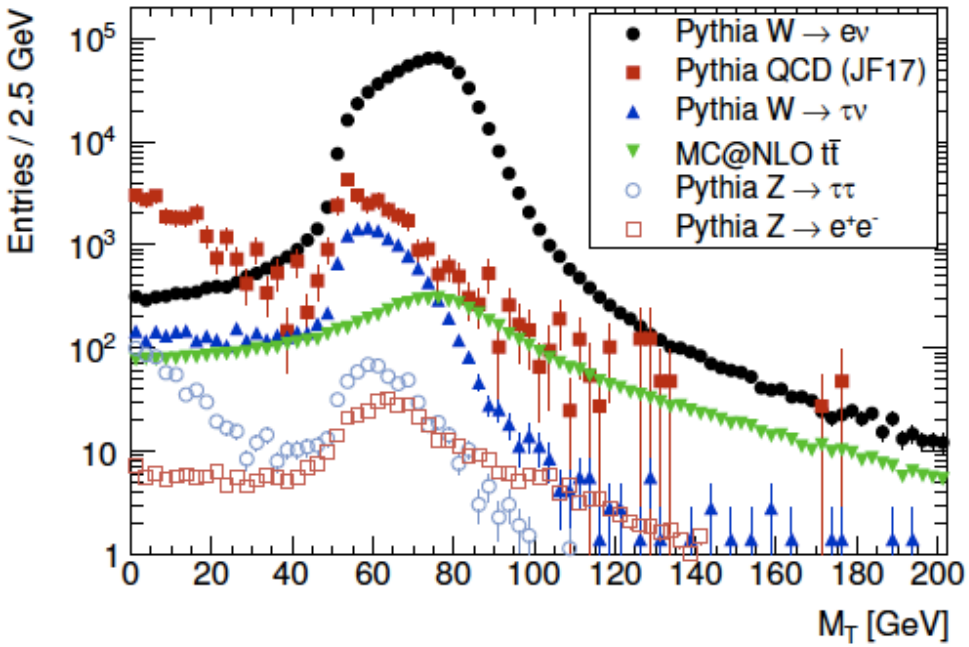



Figure 73: Expected number of signal $W \to e\nu$ and background events in $\mathscr{L} = 200\,\mathrm{pb}^{-1}$ of data after full event selection only obmitting the $M_T > 40\,\mathrm{GeV}$ requirement. All data sets are scaled to the luminosity given by the respective event generator without any furhter scaling factors.

# Acceptance differences PYTHIA vs MC@NLO?

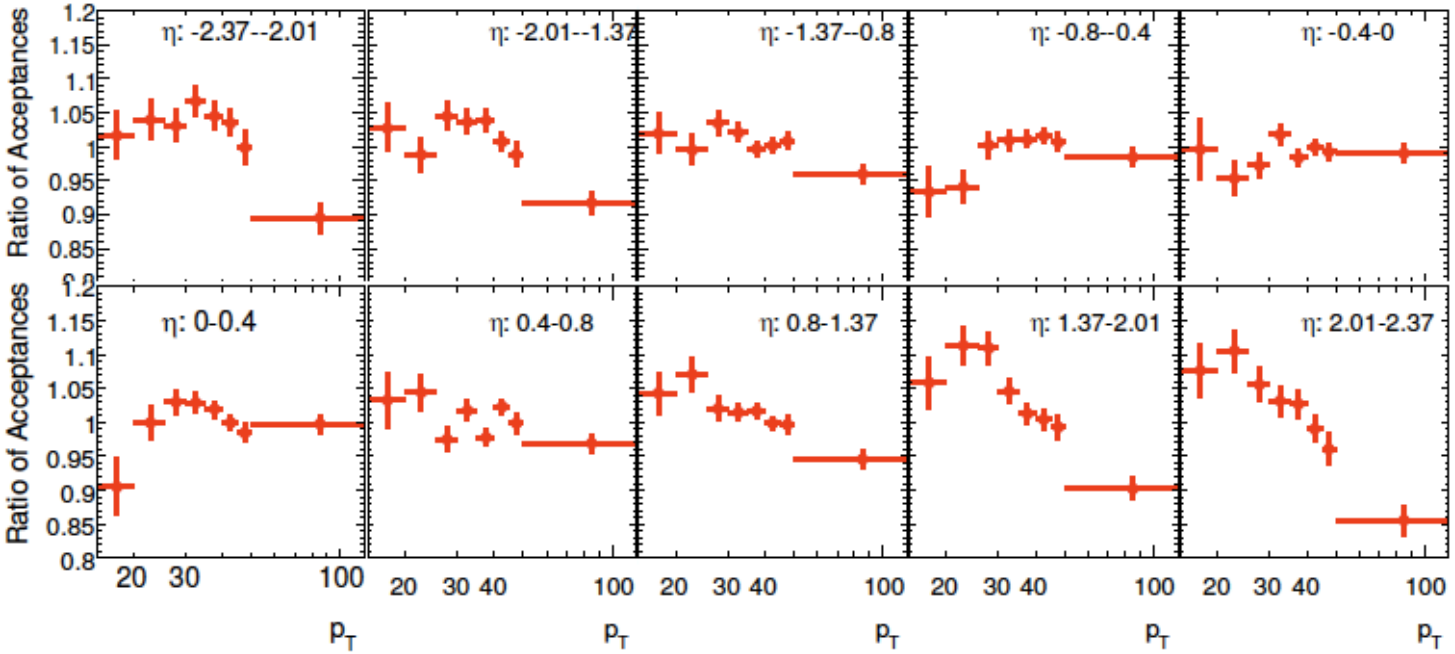
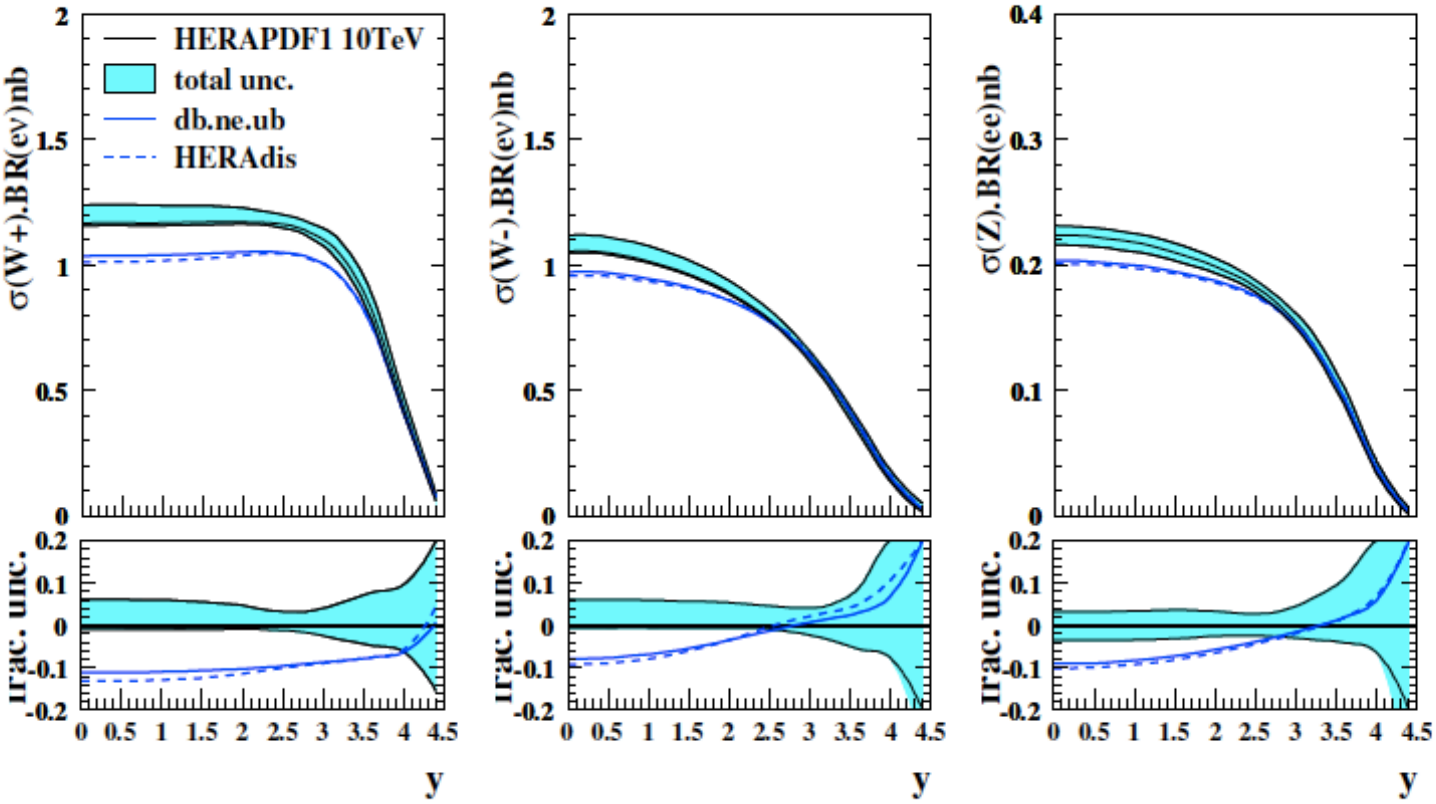



Figure 71: The ratio of acceptances (The acceptance estimated by MC events is divided by acceptance estimated by MC@NLO events)

**Updates from today?**

# Pdf Uncertainty



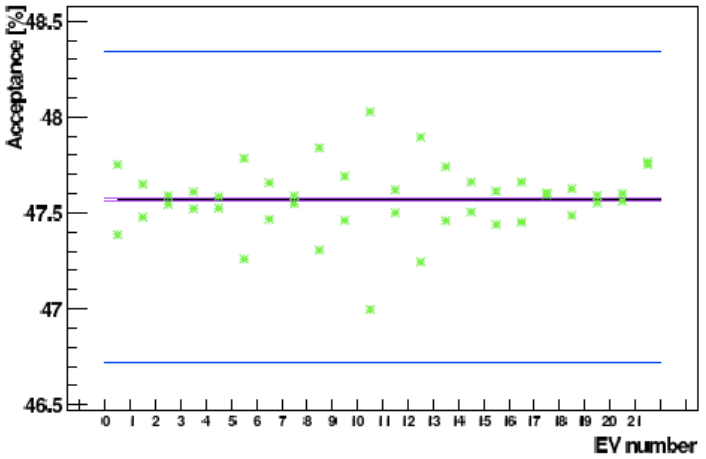

**Do this plot for 7 TeV (Mandy).**

**Get the HERAPDF1.0 and HERAdis included in the Acc studies (Z and W).**

# Pdf Acc study

| PDF set | Binning | Acc(CC) [%] | $\Delta_{stat}$ [%] | $\Delta_{syst}$ [%] | $\Delta_{syst}$/Acc(CC) [%] |
|---|---|---|---|---|---|
| CTEQ66 | inclusive | 47.57 | 0.01 | 0.77 | 1.6 |
| MSTW2008NLO | inclusive | 47.59 | 0.01 | 0.29 | 0.61 |
| CTEQ66 | $p_T, Y$ | *varies* | 0.035 – 0.065 | 0.004 – 0.065 | 0.004 – 0.4 |
| MSTW2008NLO | $p_T, Y$ | *varies* | 0.039 – 0.064 | 0.002 – 0.020 | 0.002 – 0.14 |
| CTEQ66 | $p_T$ | 45. – 54. | 0.021 – 0.026 | 0.67 – 0.79 | 1.2 – 1.8 |
| MSTW2008NLO | $p_T$ | 45. – 54. | 0.022 – 0.028 | 0.25 – 0.30 | 0.45 – 0.65 |
| CTEQ66 | Y | *varies* | 0.015 – 0.020 | 0.010 – 0.055 | 0.009 – 0.37 |
| MSTW2008NLO | Y | *varies* | 0.015 – 0.020 | 0.003 – 0.021 | 0.003 – 0.13 |

Table 3: Acceptance mean values and their statistical and systematic uncertainties. CTEQ systematic uncertainties are 90% CL while MSTW ones are 68% CL.




Other pdfs, variables

Do we have two MC's reconstructed to compare with generated?

[Smearing (should be small)]

# Efficiencies

The reconstruction efficiency can be estimated as

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

Here:

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

W?

Shall we talk about this?

It may make sense but then we need numbers/procedures

# Electron reco, ID, trigger

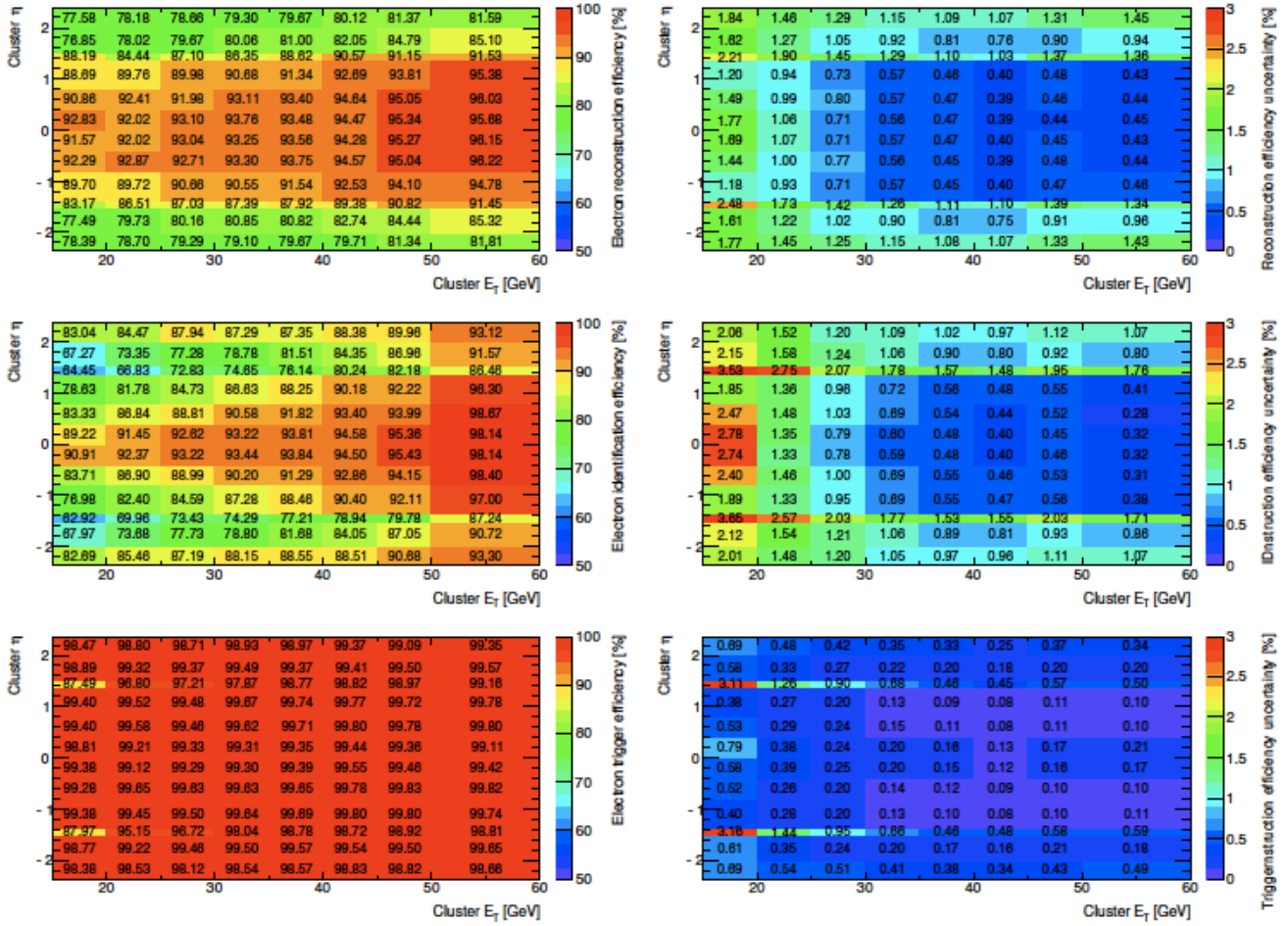



Figure 30: Left column: Electron reconstruction (top), identification (middle) and trigger (bottom) efficiencies, as a function of the reconstructed electron's cluster $E_{\mathrm{T}}$ and $\eta$. These efficiencies are measured using the tag and probe technique on the full statistics of the simulated $Z \to e^{+}e^{-}$ sample. Right column: Expected statistical uncertainties on this measurement with 200 pb$^{-1}$ of data.

# Selection ID

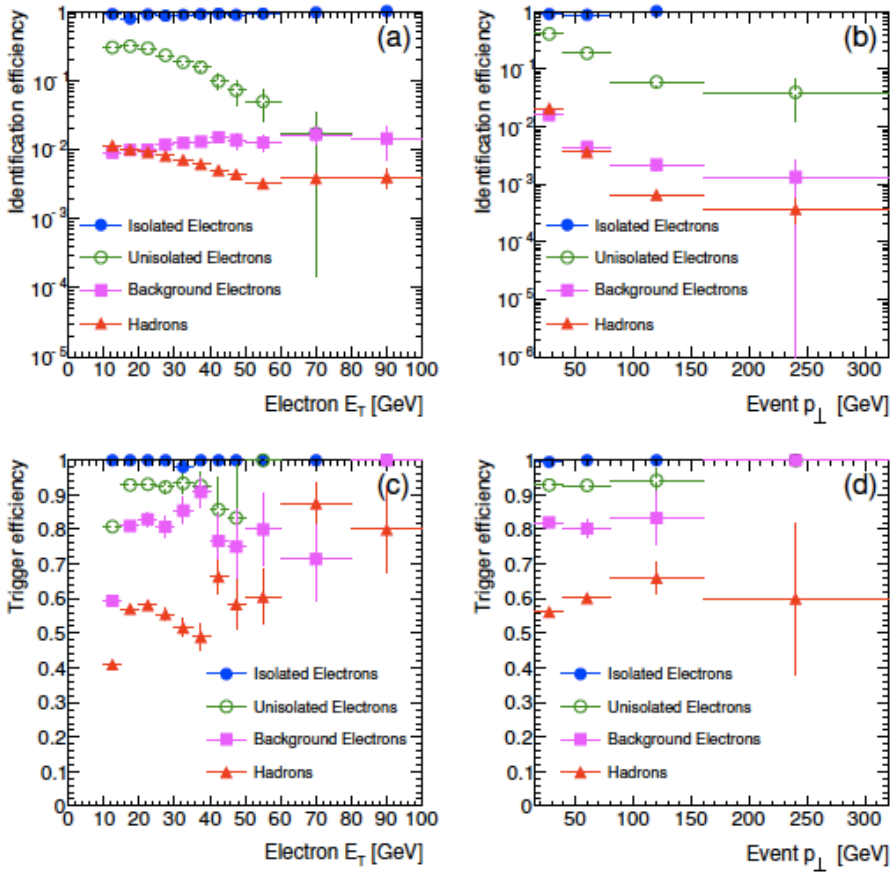



Figure 66: Top: Selection efficiency for the medium offline selection. Bottom: Efficiency of the e10_medium trigger for selected electrons. Efficiencies are shown as a function of (a) and (c) the cluster $E_T$; (b) and (d) the event $p_\perp$ for electrons with $p_T > 15$ GeV.

# Resolution

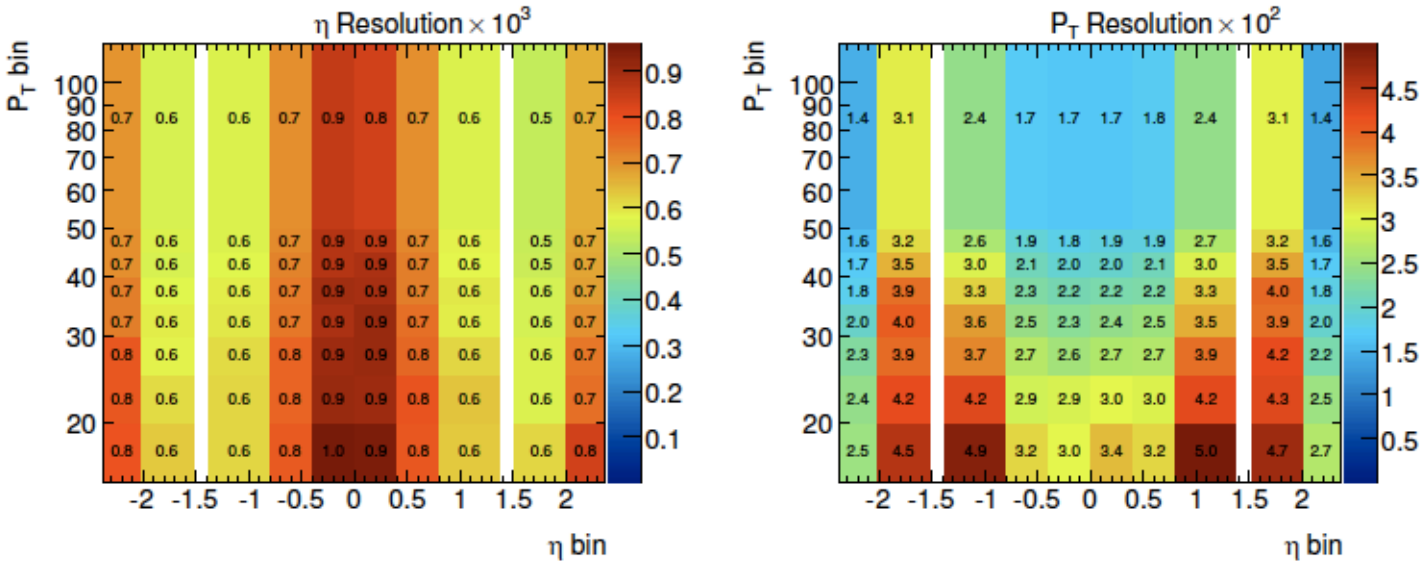



Figure 22: Histograms showed $\eta$ (Left) and $P_T$ (Right) Resolution in presented $P_T\,\eta$ binning.

**What does Maarten want to smear?**

# T&P

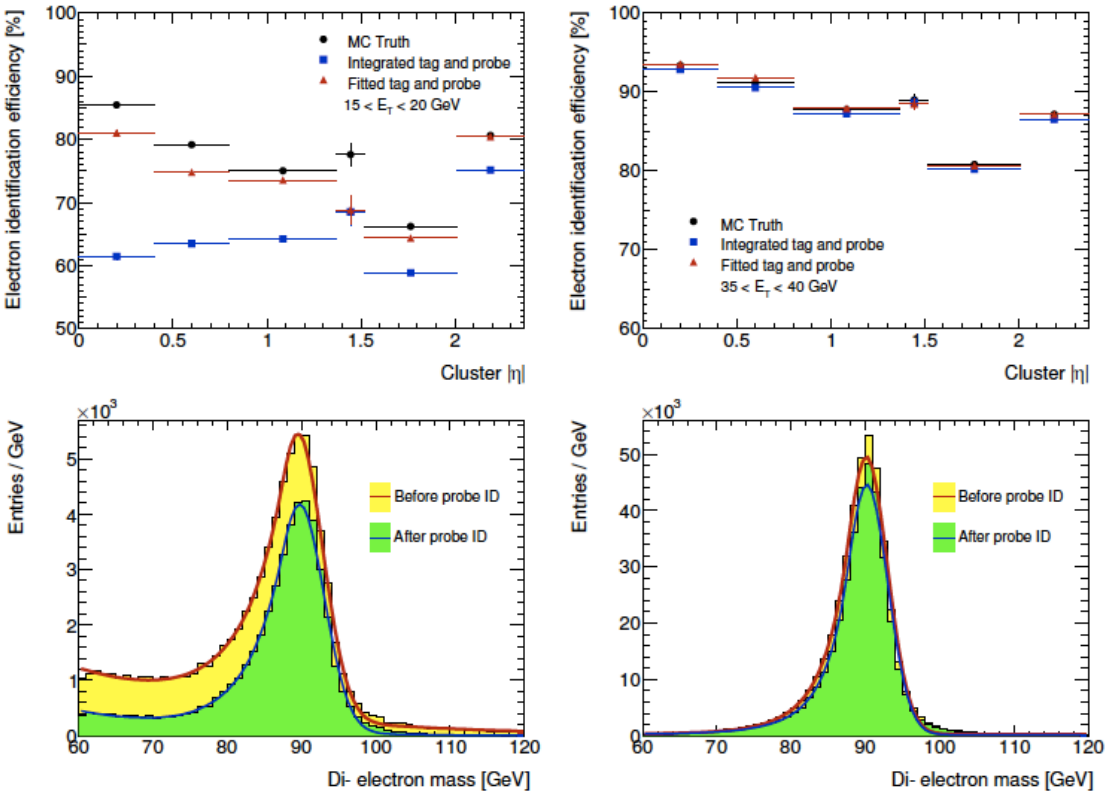


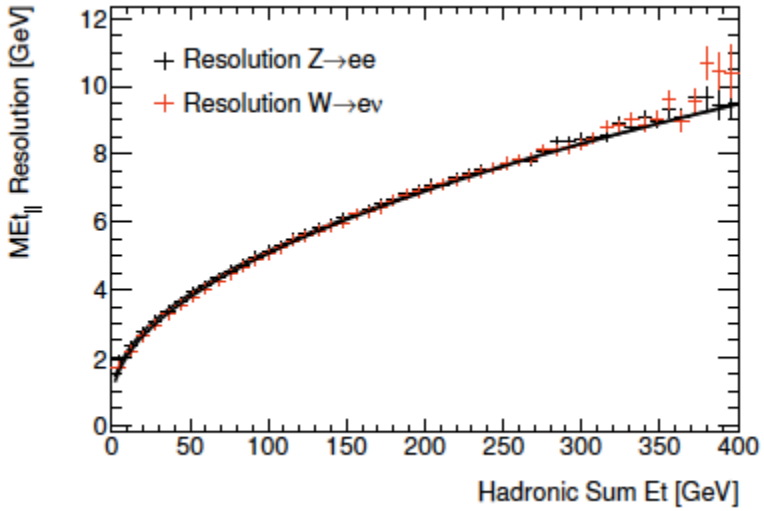

Figure 31: Top panel: Comparison of tag and probe and truth-matched identification efficiencies in simulated $Z \to e^+e^-$ events, for two bins in $E_T$: ($15-20$ GeV, left, and $35-40$ GeV, right). "MC Truth" is the efficiency calculated on electrons within $\Delta R < 0.1$ of a true primary electron from the $Z$ boson decay. Two tag and probe analyses are displayed for comparison. Either the number of tag-probe pairs passing cuts is simply counted ("Integrated"), or the number is determined from a fit to the di-electron mass spectrum as described in the text ("Fitted"). The lower panels show the mass spectra before and after application of the probe identification cuts, integrated over $|\eta|$, together with the fit results.

# Variables for single diff. cross section

The cross sections are measured double differentially in $p_{\mathrm{T}}^{e}$ and $\eta_e$ bins for $Z$ and $W$ boson production as well as in $y_Z$, $p_{\mathrm{T}}^{Z}$ for $Z$ boson production.

**Which ones do we focus on?**
**Very desirable to have numbers using these variables, 7 TeV, single diff.**

**Mention any Etmiss study?**



# Control Plots

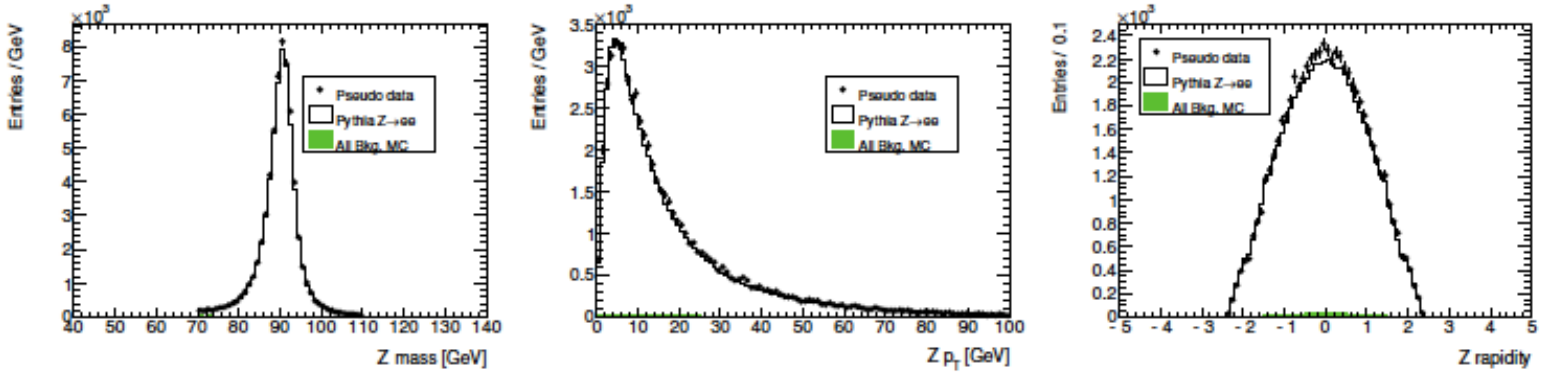



Figure 69: Di-electron control plots, comparing Monte Carlo simulation with pseudo-data after all selection cuts are applied. a) Boson mass. b) Boson $p_{\mathrm{T}}$. c) Boson rapidity. The anticipated sum of all background is superimposed.

**Check of the analysis**

# Errors on total cross section

Table 4: Systematic uncertainties considered for the total $Z \to e^+e^-$ cross section analysis. The numbers show the effect of the given variation after all corrections have been applied.

| Uncertainty | Size | $\Delta\sigma$ |
|---|---|---|
| Event statistics | $\sqrt{N^i_{\text{data}}}$ | 0.44% |
| Energy scale | $\pm 1\%$ | 0.22% |
| Energy linearity | $\pm 1\% \times \frac{p_T - 45\ \text{GeV}}{20\ \text{GeV}}$ | 0.36% |
| Angular mismeasurement | $\pm 1$mrad on $\theta$ | 0.02% |
| $\varepsilon_{\text{reco}}$ bias | $\pm 20\% \times$ (truth $-$ tag and probe) | 0.07% |
| $\varepsilon_{\text{reco}}$ statistics | | 0.25% |
| $\varepsilon_{\text{ID}}$ bias | $\pm 20\% \times$ (truth $-$ tag and probe) | 0.42% |
| $\varepsilon_{\text{ID}}$ statistics | | 0.41% |
| $\varepsilon_{\text{trigger}}$ bias | $\pm 20\% \times$ (truth $-$ tag and probe) | $< 0.001\%$ |
| $\varepsilon_{\text{trigger}}$ statistics | | $< 0.001\%$ |
| Total experimental | | 0.89% |
| $W$ and $Z$ backgrounds | $\pm 5\%$ | 0.005% |
| $t\bar{t}$ background | $\pm 15\%$ | 0.03% |
| QCD backgrounds | $\pm 100\%$ | 1.2% |
| Geometric acceptance | 0.77 | 1.6% |
| Total theoretical | | 2.0% |
| Luminosity | | 20% |
| Total | | 20% |

**How sure are we about these numbers?**

# W control plots

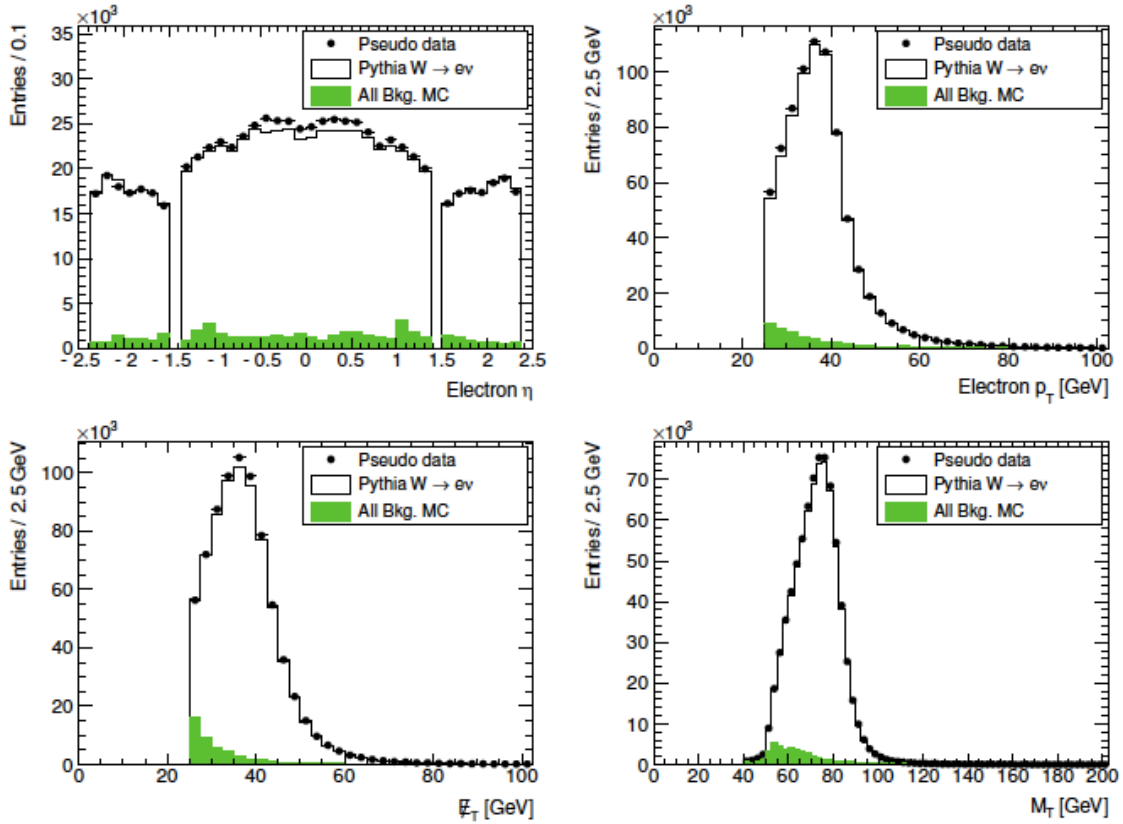



Figure 74: Control plots for the $W \rightarrow e\nu$ selection, comparing Monte Carlo simulation with pseudo-data after all selection cuts are applied. Shown are the reconstructed values of electron $p_T$(top left), electron $\eta$(top right), $E_T^{miss}$ (lower left) and $M_T$ (lower right). The shaded area indicates the expected background contamination.

**W syst errors?**

# Worth mentioning

When showing results need to list MC basis

kt factors for background?

RC corrections

BS corrections

Electroweak corrections?

Further..

Should we have a phone meeting next week for updates?
How do we split/combine the topics, how much time would we have?