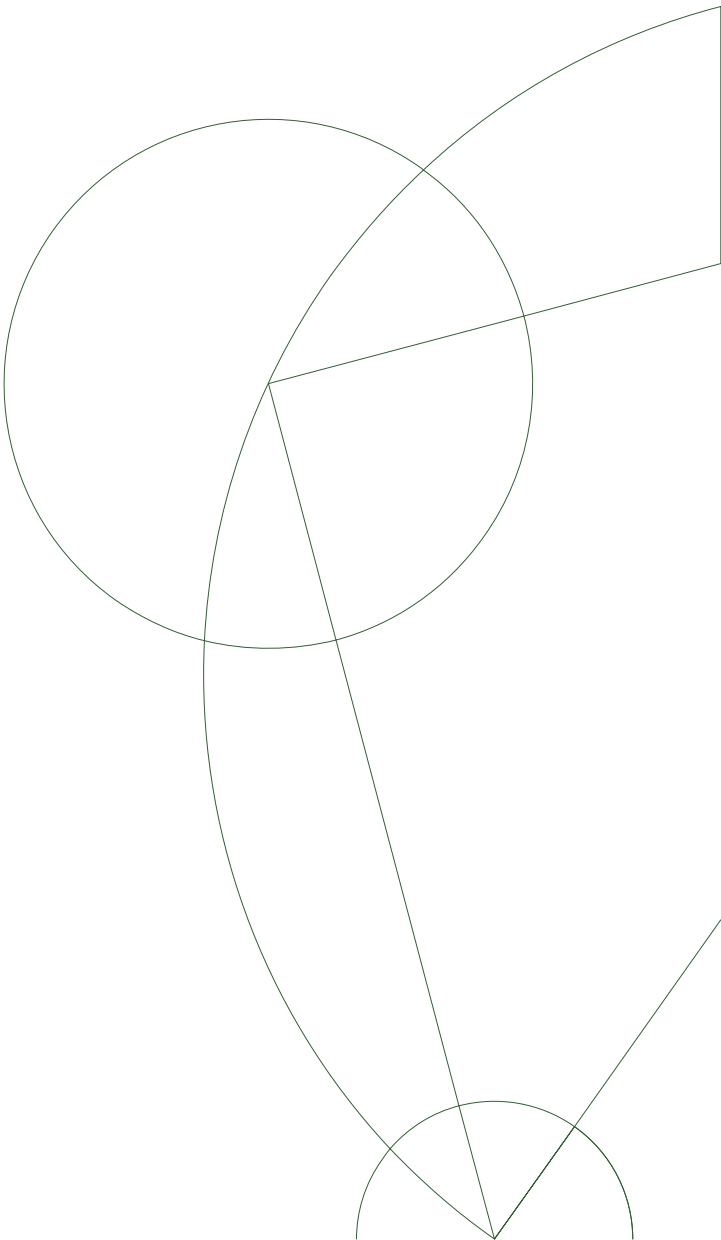
FACULTY OF SCIENCE
UNIVERSITY OF COPENHAGEN

Corrections to

Master thesis by Karina Marie Schifter-Holm

Measurement of Z bosons

in p+Pb collisions at $\sqrt{s_{\mathrm{NN}}}$ = 5.02 TeV with the ATLAS detector



Adviser: Peter Hansen

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Apart from typoes and unclear formulations, I have found four major failures in my master thesis regarding the analysis. They includes the trigger efficiency, reconstruction efficiency, acceptance and the plot of the cross-sections and are described below.

Trigger efficiency

On page 65 in my thesis, the efficiency of the Z bosons is given by the single muon efficiency, for events where only one muon has fired the trigger, and for events where both muons have fired the trigger, it is given by:

$$\epsilon^{Z}_{trig} = 1 - (1 - \epsilon^{\mu}_{trig}(\eta_1))(1 - \epsilon^{\mu}_{trig}(\eta_2)) \tag{1}$$

I should of cause not measure the efficiency of the Z bosons by distinquishing events with one and two triggered muons, but I should use relation 1 in all cases. The second term in the relation gives the probability of both muons NOT to have fired the trigger, so one minus the second term gives the probability of either one OR two of the muons to have fired the trigger - exactly what we are interested in!

In addition I have found a bug in the code, measuring the error event by event.

Correcting these to mistakes gives the trigger efficiency of the Z bosons seen in figure 1.

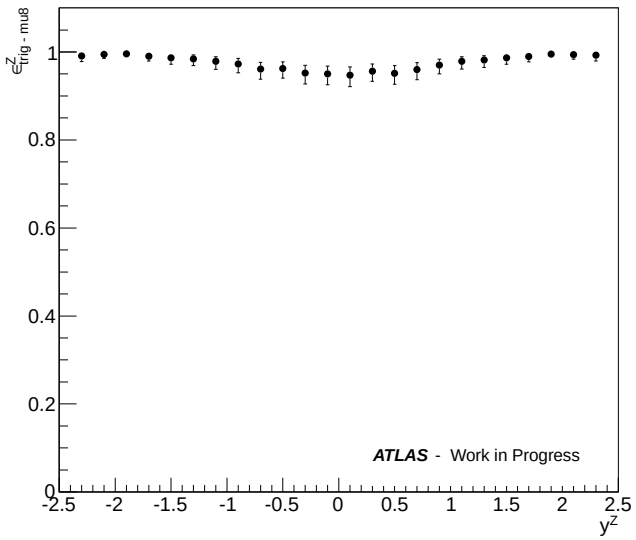

Figure 1: Corrected trigger efficiency of the Z bosons.

Reconstruction efficiency

On page 69, I have measured the reconstruction efficiency in the same manner as the trigger efficiency:

$$\epsilon^Z_{reco} = 1 - (1 - \epsilon^\mu_{reco}(\eta_1))(1 - \epsilon^\mu_{reco}(\eta_2)) \qquad (Wrong!) \tag{2}$$

While only one muon is required to have fired the trigger, two muons are of cause required to be reconstructed to make up a Z boson. The efficiency of reconstructing Z bosons is therefore given as the product of the single muon efficiencies:

$$\epsilon^Z_{reco} = \epsilon^\mu_{reco}(\eta_1)\epsilon^\mu_{reco}(\eta_2)) \qquad (True!) \tag{3}$$

For the reconstruction efficiency, the same bug is found regarding the errors.

Correcting these to mistakes gives the reconstruction efficiency of the Z bosons seen in figure 2.

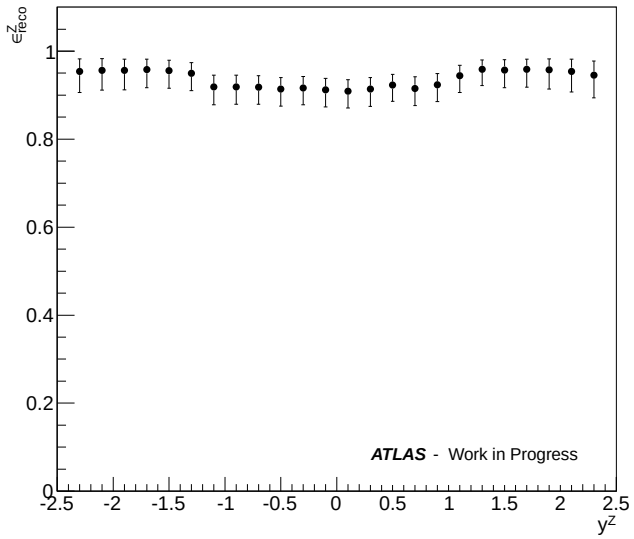

Figure 2: Corrected reconstruction efficiency of the Z bosons.

Acceptance

It is found, that the acceptance measured by Pythia 8 was done with a default center-of-mass energy of 7 TeV, instead of the 5.02 TeV. A new Monte Carlo sample using a center-of-mass energy of 5.02 TeV has found the acceptance to be 0.54±0.00, instead of 0.450±0.004.

Cross-section

The above correction have a large impact on the total $Z \to \mu\mu$ cross-section (especially the acceptance), which is now found to be:

$$\sigma = 158^{+7.33}_{-6.85} \text{ nb}$$

In addition, for the comparison to the cross-section measured in p+p collisions (on page 71), I now see that I have been using a cross-section in pp of 0.6 nb. By reading off figure 3 more precise, the cross-section in pp is found to be 0.7 and thereby the cross-section in pPb found is to be 145 ± 2 nb.

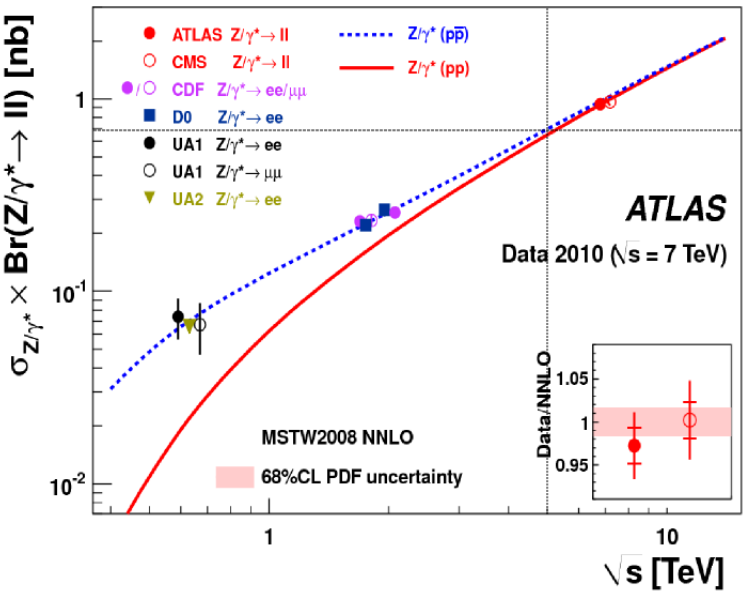

Figure 3: The differential $Z \to l\bar{l}$ cross-section as a function of the center-of-mass energy measured in p+p collisions.

The last - and maybe most striking - correction is a single simple bug found when plotting the fiducial cross-section. Correcting this bug gives the fiducial cross-section as seen in figure 4, which do also include the pp NNPDF prediction, pn cteq6 prediction and in addition, the sum of pn and nn Pythia 8 simulations (times a higher order correction factor of 1.3), weighted by 82 and 125, respectively, and divided by 207. As seen in the figure, the measured cross-section now seems now more realistic compared to the predictions.

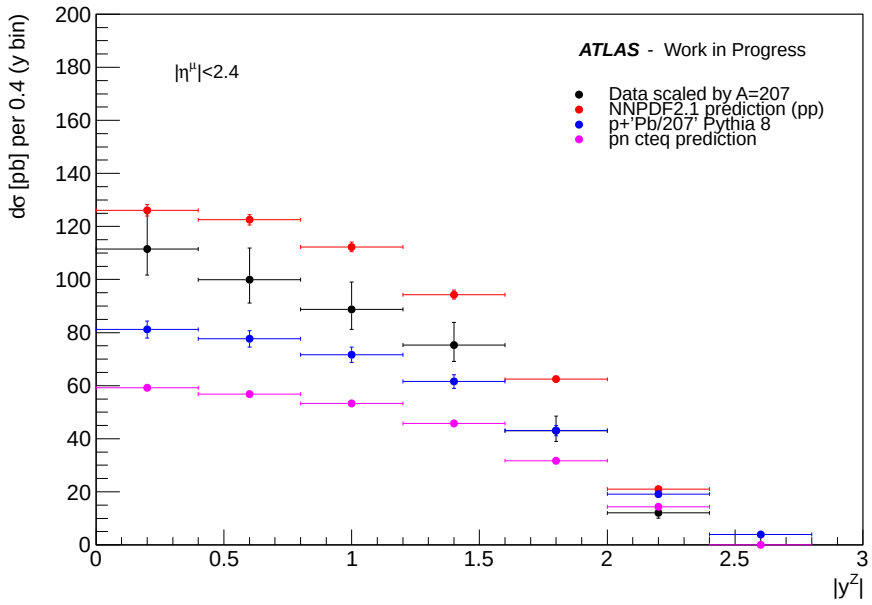

Figure 4: The fiducial differential $Z \to \mu\mu$ cross-section. Data is divided by 207, to be compariable with the pp NNPDF prediction, pn cteq6 prediction and the weighted pn and nn Pythia 8 simulations (multiplied by higher order correction factor of 1.3).