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# ATLAS Electroweak Measurements With Early Data

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The large W and Z cross sections expected at the LHC allow for several measurements involving electroweak bosons already in the early data. The W and Z cross sections can be measured with good accuracy with an integrated luminosity in the range between 10 and 100 $pb^{-1}$. These cross-sections are presently predicted with an uncertainty of about 5%, mostly due to PDF uncertainty. In particular the ratio of W and Z cross-sections being not affected by the uncertainty on the machine luminosity can be used to indirectly extract SM parameters like $\Gamma_W$ with competitive accuracy. The Z momentum and rapidity distribution measurements will allow to constrain PDFs and QCD calculations, quickly surpassing the predictions in precision. Also the W charge asymmetry will quickly become precisely measured. ATLAS strategies and expectations are discussed, using selected examples of expectations for measurements.



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## 1. Introduction

The measurement of the inclusive W and Z cross-section is one of the first test of the Standard Model that can be done with the early LHC data, due to the large expected production and decay rate in leptons and to the small theoretical uncertainty of the NNLO calculation. The measurement of the W to Z cross-section ratio is also suitable to be done with the first data because it does not rely on machine luminosity and some common uncertainties are cancelled. One of the largest systematic uncertainty on the rapidity spectra of the Z and Drell-Yan differential cross-sections is due to the PDFs. Studying the spectrum in the low-mass region can improve the PDF precision and constrain the QCD calculations. Finally, also the study of the W leptonic decay can constrain the PDFs at low-$x$ through the asymmetry measurement.

## 2. W and Z bosons cross-section measurement

A robust selection of the W and Z leptonic decays (electrons and muons only) has been developed in ATLAS allowing to measure the cross section with an uncertainty below 5% with the first 50 pb$^{-1}$ of data (luminosity uncertainty not included) [1].

The event selection requires a leptonic trigger with a 20 GeV threshold, one or two isolated leptons in the geometrical acceptance with a lepton $p_T$ cut, missing transverse energy above 25 GeV and a transverse mass above 40 GeV for the W channels and an invariant mass cut around the Z mass peak for the Z channels. In Fig. 1 are shown the W and Z mass distribution at the end of the selection with the respective backgrounds. Lepton trigger and reconstruction efficiencies, background contribution and systematical uncertainties are also taken into account to estimate the uncertainty.

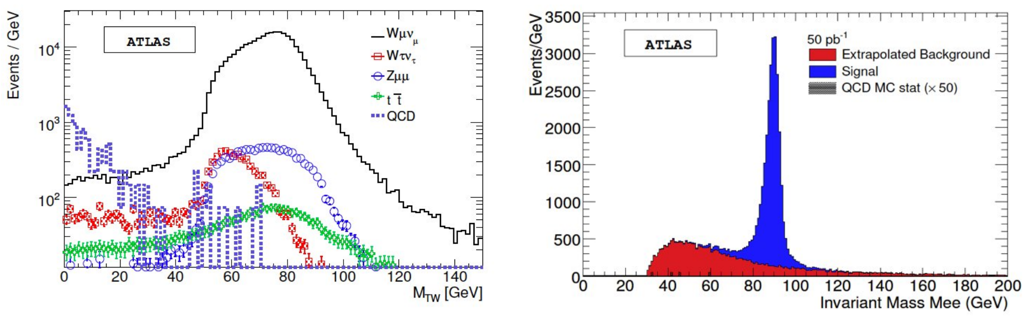


**Figure 1:** Left: signal and background W transverse mass in the muon channel. Right: signal and background Z mass peak in the electron channel.

Notice that the leptonic Z boson decays provide also clean signal with low background and allow to determine the lepton trigger and reconstruction efficiencies based on data with the tag & probe method.

## 3. W to Z cross-section ratio

The measurement of the W to Z cross-section ratio has many advantages with respect to the individual weak boson cross-sections because is not affected by the uncertainty on the machine luminosity, some common uncertainties on lepton efficiencies and (partially) QCD uncertainty effects are cancelled.

This makes this measurement suitable to be done with the first data. It will be a good test of the detector and of the performance of the analysis chain. Moreover using the precise LEP results as constrains on $\Gamma_Z$ and theoretical inputs it's also possible to gain access to the W's width using the ratio.

## 4. Z differential cross-section

The nonzero transverse momentum of the Z boson is generated via the gluon radiation from the initial quark-antiquark pair, therefore its differential cross section as function of $p_T$ allow to test the resummation models. Moreover the study of the same differential cross section may help in understanding the W lepton $p_T$ spectrum, that is important to measure the W mass. A method to extract the Z differential cross-section has been developed that requires the raw measured differential cross-section to be corrected bin by bin for experimental effects (background and efficiencies) and for kinematical acceptance of the leptons $p_T$ and $\eta$ requirements.

## 5. W charge asymmetry and PDFs constrains

At the LHC center of mass energy and in the measurable rapidity range (|y| < 2.5) the momentum fraction of the partons ($x$) participating at the Z and W production is in a range $10^{-4} < x < 0.1$. LHC data allows to enlarge our present knowledge of the proton structure function. An improved knowledge of these functions will allow to reduce the uncertainties in several physics analyses. The spread between PDF sets suggests that accurate measurements of rapidity spectra (better than 5%) could discriminate between them. Including in the ZEUS-S PDF fit the results from Monte Carlo samples of a 100 pb$^{-1}$ W (Fig. 2) one can improve the knowledge of the low-x gluon shape parameter $\Lambda_g$ by 35% [2]. This measurement does not rely on the absolute luminosity determination .

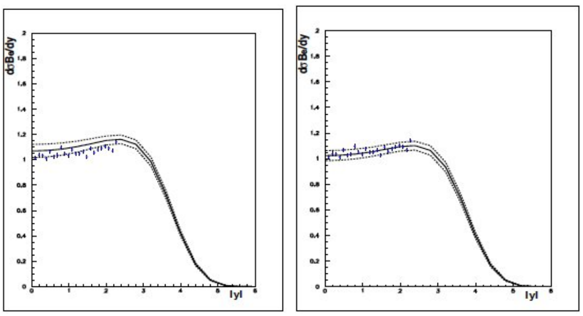


**Figure 2:** Left: e$^+$ rapidity spectrum generated using CTEQ6.1 PDFs compared to the analytic prediction using ZEUS-S PDFs. Right: the same lepton rapidity spectrum compared to the analytic prediction AFTER including these pseudo-data in the ZEUS-S PDF fit. The lepton pseudo-data were generated using the fast ATLAS detector simulation (ATLFAST).

The W leptonic decay can help to constrain the PDFs at low-$x$ through the asymmetry measurement: observing the lepton asymmetry distribution one can reduce the uncertainty of each PDF set to less than 5% [2]. This is helpful both to understand the LHC underlying physics and to reduce the theoretical uncertainty on the physics measurements such as the W and Z cross-sections.

## References

[1] ATLAS Collaboration, CERN-OPEN-2008-020,arXiv:0901.0512

[2] A.Tricoli *et al.*, ATL-PHYS-CONF-2005-008