Measurement of the high-mass Drell-Yan differential cross-section in pp collisions at $s = 7$ TeV with the ATLAS detector


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ATLAS Collaboration

1. Introduction

At hadron colliders, the Drell–Yan (DY) process [1], proceeding at tree level via the $s$-channel exchange of a virtual photon or $Z$ boson, can produce charged lepton pairs over a wide range of invariant mass. The differential cross-section as a function of the invariant mass is described by perturbative QCD (pQCD) calculations at next-to-next-to-leading order (NNLO). Given the simple experimental signature and the low backgrounds, a small experimental uncertainty can be achieved on the measured invariant mass distribution allowing for a precision test of pQCD. The mass spectrum is also sensitive to the parton distribution functions (PDFs), in particular to the poorly known distribution of antiquarks at large $x$ [2], where $x$ can be interpreted, at leading order, as the fraction of the proton momentum carried by the interacting parton. Additionally, the production of DY dilepton pairs is a source of background for other Standard Model (SM) measurements, and the mass spectrum may be modified by new physics phenomena giving rise to, e.g., narrow resonances or an excess of high-mass pairs inconsistent with the known PDFs.

The differential cross-section for DY dilepton pair production in the high-mass range has been reported previously by the CMS [3], CDF [4] and D0 [5] Collaborations. With the ATLAS detector, total and differential cross-sections in a mass window of 66–116 GeV have been measured using the 2010 dataset [6]. In addition, searches for new physics in the high-mass range have been performed [7–9] and no deviations from the SM expectation were observed. This Letter reports an extension of these previous analyses by providing a measurement of the DY cross-section, fully corrected for detector effects, in the dielectron channel as a function of the $e^{+}e^{-}$ invariant mass, $m_{ee}$, up to 1500 GeV. To minimise model-dependent theoretical uncertainties, the cross-section is not extrapolated to the full phase space but is reported in a phase space only slightly extended with respect to the fiducial acceptance of the $e^{+}$ and $e^{-}$. The results are compared to NNLO pQCD calculations with next-to-leading-order (NLO) electroweak corrections from the \textsc{FEWZ 3.1} [10,11] framework and to the predictions from three event generators.

2. The ATLAS detector

The ATLAS detector is described in detail in Ref. [12]. The two systems most relevant to this analysis are the inner tracking detector, surrounded by a superconducting solenoid providing a 2 T axial magnetic field, and the calorimeter. Charged-particle tracks and vertices are reconstructed with silicon pixel and microstrip detectors covering the pseudorapidity ($|\eta|$) range 1.6 to 2.8. Electromagnetic calorimetry is provided by barrel and endcap detectors consisting of lead absorbers and liquid argon (LAr) as the active material, with fine lateral and longitudinal
transverse momentum distribution for the high $m_{ee}$ region studied in this analysis.

4. Event selection

The analysis is based on the full 2011 data sample collected at $\sqrt{s} = 7$ TeV. The data were selected online by a trigger that required two electromagnetic (EM) energy deposits each with a transverse energy greater than 20 GeV. Applying trigger and data-quality requirements yields an integrated luminosity of 4.9 ± 0.1 fb$^{-1}$. Events from these $pp$ collisions are selected by requiring a collision vertex with at least three associated tracks, each with transverse momentum greater than 400 MeV. Events are then required to have at least two electron candidates as defined below.

Electron candidates are reconstructed from the energy deposits in the calorimeter matched to inner-detector tracks. The electron energy is measured in the calorimeter and its direction from the associated track. The calorimeter energy resolution is between 1% and 3% for high-energy electrons [27]. An energy scale correction obtained from an in situ calibration, using $W/Z$ boson and $J/\psi$ meson decays, following the recipe of Ref. [27], is applied to the data. The electron candidates are required to have a transverse energy $E_T > 25$ GeV and pseudorapidity $|\eta| < 2.47$, excluding the transition regions between the barrel and endcap calorimeters at $1.37 < |\eta| < 1.52$. They must satisfy the “medium” identification criteria based on shower shape, track-quality and track–cluster matching variables, which are inclusive of the shower shape criteria applied as part of the “loose” identification [27]. Additionally, the electron candidates must have an associated hit in the innermost pixel layer to suppress background from photon conversions.

If an event contains more than two electron candidates passing the above selection, the two with highest $E_T$ are chosen. To further reduce the background from jet production, the leading (highest $E_T$) electron is required to be isolated by demanding that the sum of the transverse energy in the calorimeter cells in a cone of ΔR = 0.2 around the electron direction is less than 7 GeV. This sum excludes the core energy deposition and is corrected for the $E_T$-dependent transverse shower leakage from the core, as well as for pile-up contributions.

After all selection requirements, a total of 26844 candidate events are found in the $m_{ee}$ range considered. The dominant backgrounds are events containing one or two misidentified electron candidates, denoted $W +$ jets and dijet. Other backgrounds arise from events containing two real electrons, originating from the dileptonic decays of pair-produced top quarks (denoted $t\bar{t}$) and from diboson production processes.

Of the dijet and $W +$ jets background, the dijet component additionally contains multi-jet, heavy-flavour quark and $\gamma +$ jet production. The $W +$ jets includes pair-produced top quarks and single-top-quark production, where at least one electron comes from the misidentification of a jet or a heavy quark. A data-driven method is used to evaluate the sum of these components. The probability for a jet to be misidentified as an electron (the fake rate) is determined in an $E_T$- and $\eta$-dependent way from nine background-enriched samples recorded by different inclusive jet triggers. These triggers had $E_T$ thresholds in the range 20–240 GeV, each with a different predefined rate achieved via the automatic rejection of a certain fraction of events, such that the nine samples were needed to collect sufficient background events over the full $E_T$ range. In each of these jet-triggered samples, the fake rate is calculated as the fraction of electron candidates passing the “loose” identification requirement that also pass the “medium” requirement. Events containing electron candidates from $W$ or $Z$ boson decays are first removed by dedicated cuts in order to avoid bias from real electron contamination: $W$ candidates are rejected by
Fig. 1. Distribution of $m_{\text{ee}}$ in data compared to the summed signal and background predictions, where the bin width is constant in $\log(m_{\text{ee}})$. The Drell–Yan signal is predicted from PYTHIA simulation and the combined dijet and $W+\text{jets}$ contribution is estimated from data as described in the text. The dashed vertical lines indicate the mass range used for the differential cross-section measurement.

5. Cross-section measurement

The differential cross-section, $d\sigma/dm_{\text{ee}}$, is measured in 13 bins of $m_{\text{ee}}$ from 116 GeV to 1500 GeV in a fiducial region in which both electrons have transverse momentum $p_T > 25$ GeV and lie within $|\eta| < 2.5$. The cross-section and fiducial region are determined for two conventions regarding QED FSR corrections. For the Born-level result, the true (meaning without detector simulation) $m_{\text{ee}}$ and electron kinematics are defined by the electrons originating from the $Z/\gamma^*$ decay before FSR. At the dressed level, true final-state electrons after FSR are recombined with radiated photons within a cone of $\Delta R = 0.1$.

The cross-section is calculated from

$$
\frac{d\sigma}{dm_{\text{ee}}} = \frac{N_{\text{data}} - N_{\text{bkg}}}{C_{\text{DY}}L_{\text{int}}T_{\text{bin}}} \times \frac{1}{T_{\text{bin}}},
$$

where $N_{\text{data}}$ is the number of candidate events observed in a given bin of $m_{\text{ee}}$ (of width $T_{\text{bin}}$), $N_{\text{bkg}}$ is the total background in that bin and $L_{\text{int}}$ is the integrated luminosity. The correction factor, $C_{\text{DY}}$, takes into account the efficiency of the signal selection and bin migration effects. It also includes the small extrapolation (about 10% to 13%) over the small region in $|\eta|$ that is excluded for reconstructed electron candidates ($1.37 < |\eta| < 1.52$ and $2.47 < |\eta| < 2.5$). The correction factor is defined as the number of MC-generated events that pass the signal selection in a bin of reconstructed $m_{\text{ee}}$, divided by the total number of generated events within the fiducial region, at the Born or dressed level, in the corresponding bin of true $m_{\text{ee}}$. It is obtained from the PYTHIA MC signal sample and corrected for differences in the reconstruction, identification and trigger efficiencies between data and MC simulation. The value of $C_{\text{DY}}$ varies from 0.55 (0.57) in the lowest bin to 0.70 (0.73) in the highest bin at the Born (dressed) level.

The $m_{\text{ee}}$ resolution varies from approximately 3% at low $m_{\text{ee}}$ to 1% at high $m_{\text{ee}}$. The purity, defined as the fraction of simulated events reconstructed in a given $m_{\text{ee}}$ bin that have true $m_{\text{ee}}$ in the same bin, ranges from 79% (82%) to 98% (98%) at the Born (dressed) level.

6. Systematic uncertainties

The main contributions to the systematic uncertainties are given in Table 1 and described below.

6.1. Background estimation

In the estimation of the dominant dijet and $W+\text{jets}$ background, a systematic uncertainty of 11% is assigned to the $E_T$- and $\eta$-dependent fake rate, corresponding to the spread of this quantity as measured in the nine independent jet samples, in order to cover any possible bias introduced in the triggering of these background events. A further uncertainty on the fake rate of up to 11% arises due to the presence of remaining signal contamination in the background-enriched sample.

The total systematic uncertainty on the fake rate combines with a smaller effect (around 5%) from signal contamination in the sample where the fake rate is applied, to give a total uncertainty on the resulting background estimate of up to 16%. An additional systematic uncertainty can arise if the fake rate differs for different sources of fake electrons and the relative contribution of the different sources is not the same in the data sample where the fake rate is measured and the sample of events to which it is applied. It is found that $b$-jets have a higher fake rate than jets initiated by gluons or light quarks, but that the fraction of $b$-jets is small and similar in both samples. Conservatively taking this additional source of uncertainty into account, the overall uncertainty on the background is enlarged to 20%.

This 20% is added in quadrature to the statistical uncertainty of the sample to which the fake rate is applied; the latter uncertainty dominates in the highest two $m_{\text{ee}}$ bins. The resulting overall uncertainty on the cross-section from the dijet and $W+\text{jets}$ background varies between 1.3% and 7.9%, depending on $m_{\text{ee}}$.

Two alternative methods to estimate the dijet and $W+\text{jets}$ background are considered as cross-checks. The first of these is similar to the baseline method but uses fake rates derived from loosely selected electrons collected by the EM signal trigger. Here the background-enriched sample is derived by employing a tag-and-probe technique selecting, among other requirements to suppress real electron contamination, a jet-like tag and a probe with the same charge. This method, being correlated to the baseline method due to the overlap of electron candidates passing the EM and jet triggers, yields very similar predictions with comparable systematic uncertainties. In the third method, the combined dijet plus $W+\text{jets}$ background is estimated by performing a template fit to the isolation of the leading versus sub-leading electron. The background templates are obtained from data by reversing some of the identification requirements on one or both of the electrons, and the signal templates are made from the PYTHIA DY sample. No additional systematic uncertainty is assigned from the two cross-checks, as their results are in agreement with the baseline method.

The uncertainties on the diboson and $t\bar{t}$ background expectations include the theoretical uncertainties on their cross-sections, 5% for the dibosons [30] and 10% for $t\bar{t}$ [31]. At high $m_{\text{ee}}$, the statistical uncertainties on the simulated samples dominate.
exceeding 50% in the highest bin for both processes. The resulting uncertainty on the cross-section is small compared to the data-driven dijet and $W + \text{jets}$ contributions, ranging from less than 0.3% at low $m_{ee}$ to 2.0% in the highest $m_{ee}$ bin. The uncertainty on the cross-section from the total background expectation is between 1.3% and 8.2%.

6.2. Electron reconstruction and identification

The reconstruction and identification efficiencies of electrons have been determined previously from data for electrons with $E_T$ up to 50 GeV, using tag-and-probe methods in vector-boson decays, following the prescription of Ref. [27]. To extend the measurement range of the identification efficiency in $E_T$, a dedicated tag-and-probe measurement is made using $Z \rightarrow e^+e^-$ decays. It employs the isolation method, developed in Ref. [27] for $W \rightarrow e\nu$ final states, to estimate the background contamination. Here, $\eta$- and $E_T$-dependent background template distributions of the isolation are obtained from data by reversing some of the requirements applied in the electron identification criteria. The isolation quantity is defined in a similar way to that used in the selection of the leading electron in the signal sample. The background isolation templates are then normalised to data in the tail of the distributions where no contribution from signal is expected, both before and after applying the identification requirements, in order to estimate the background fraction in the probe sample. The identification efficiencies are found to be consistent with those obtained by the method of Ref. [27] in the common measurement range, and are stable for electrons with $E_T$ up to 500 GeV.

The differences between the measured reconstruction and identification efficiencies and their values in MC simulation are taken as $\eta$- and $E_T$-dependent scale factors with which the MC-derived $C_{DY}$ is corrected. An additional scale factor for the isolation requirement on the leading electron is also applied. Varying the scale factors for the electron reconstruction (identification) within their systematic uncertainties results in a change in the cross-section of up to 1.7% (2.6%).

6.3. Energy scale and resolution

Both the scale and resolution corrections, estimated from $Z \rightarrow e^+e^-$ events, are varied in the simulation within their uncertainties. The overall effect on the cross-section is between 1.0% and 3.3%.

6.4. Bin-by-bin correction

The results obtained from the bin-by-bin correction are cross-checked using an iterative Bayesian approach [34] and found to be consistent. In addition, a consistency test is performed by correcting the MC@NLO signal sample using the PYTHIA-derived $C_{DY}$ factor. The discrepancy between the sample corrected in this way and the true MC@NLO sample is about 1.5%. This is due to the slightly different shapes of the $m_{ee}$ distribution from the two generators, considered to represent the possible shape difference between data and the PYTHIA simulation. This is conservatively added as a systematic uncertainty on the cross-section in all $m_{ee}$ bins.

6.5. Trigger efficiency

Scale factors to account for the difference in the EM signal-trigger efficiency between data and simulation are obtained by measuring the efficiency in data and MC events using a tag-and-probe method. The $Z \rightarrow e^+e^-$ events are tagged by selecting events passing a single-electron trigger, thus providing one electron probe free of trigger bias to test against the signal-trigger requirements. The scale factors are very close to unity, and the effect on the cross-section of varying them within their systematic uncertainties is approximately 1%.

6.6. MC statistics and MC modelling

The finite number of events in the MC samples from which the $C_{DY}$ factor is derived contribute an uncertainty of up to 2.4% on $C_{DY}$ and the computed cross-section. Systematic uncertainties are associated with the use of the $K$-factors and with the reweighting of the PYTHIA signal MC events in order to better match the transverse momentum distribution of the $Z$ bosons and the mean number of interactions per bunch crossing in the data. The effect of a further reweighting of the vertex position distribution in the $z$ direction, not applied by default when calculating $C_{DY}$, is also taken as an uncertainty. These uncertainties enter into the calculation of $C_{DY}$ and result in an overall uncertainty on the cross-section of less than 1%. Excellent agreement in the FSR predictions between PHOTOS and SANC [35,36] has been shown [37] and uncertainties related to the modelling of the detector response to low-energy photons from FSR are negligible.

6.7. Theoretical uncertainties

Several theoretical uncertainties apply to the extrapolation of the cross-section in $|\eta|$ from the measured region to the fiducial

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Table 1

Summary of systematic uncertainties on the cross-section measurement, shown for the lowest and highest bins in $m_{ee}$. For some sources the lowest or highest uncertainty may lie in an intermediate bin. The data statistical uncertainties are also given for comparison.

<table>
<thead>
<tr>
<th>Source of uncertainty</th>
<th>Uncertainty [%] in $m_{ee}$ bin</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>116–130 GeV</td>
</tr>
<tr>
<td></td>
<td>1000–1500 GeV</td>
</tr>
<tr>
<td>Total background estimate</td>
<td>0.1</td>
</tr>
<tr>
<td>(stat.)</td>
<td>3.1</td>
</tr>
<tr>
<td>Total background estimate</td>
<td>1.3</td>
</tr>
<tr>
<td>(syst.)</td>
<td>3.1</td>
</tr>
<tr>
<td>Electron energy scale &amp;</td>
<td>2.1</td>
</tr>
<tr>
<td>resolution</td>
<td>3.3</td>
</tr>
<tr>
<td>Electron identification</td>
<td>2.3</td>
</tr>
<tr>
<td></td>
<td>2.5</td>
</tr>
<tr>
<td>Electron reconstruction</td>
<td>1.6</td>
</tr>
<tr>
<td></td>
<td>1.7</td>
</tr>
<tr>
<td>Bin-by-bin correction</td>
<td>1.5</td>
</tr>
<tr>
<td></td>
<td>1.5</td>
</tr>
<tr>
<td>Trigger efficiency</td>
<td>0.8</td>
</tr>
<tr>
<td></td>
<td>0.8</td>
</tr>
<tr>
<td>MC statistics ($C_{DY}$ stat.)</td>
<td>0.7</td>
</tr>
<tr>
<td></td>
<td>0.4</td>
</tr>
<tr>
<td>MC modelling</td>
<td>0.2</td>
</tr>
<tr>
<td></td>
<td>0.3</td>
</tr>
<tr>
<td>Theoretical uncertainty</td>
<td>0.3</td>
</tr>
<tr>
<td></td>
<td>0.4</td>
</tr>
<tr>
<td>Total systematic uncertainty</td>
<td>4.2</td>
</tr>
<tr>
<td></td>
<td>9.8</td>
</tr>
<tr>
<td>Luminosity uncertainty</td>
<td>1.8</td>
</tr>
<tr>
<td></td>
<td>1.8</td>
</tr>
<tr>
<td>Data statistical uncertainty</td>
<td>1.1</td>
</tr>
<tr>
<td></td>
<td>100</td>
</tr>
</tbody>
</table>

Table 2

Measured differential cross-sections $\frac{d\sigma}{d_{T_{mee}}}$ (in pb/GeV$^2$) at the Born and dressed levels for DY production of $e^+e^-$ pairs in the fiducial region ($e^e^- > 25$ GeV and $|\eta| < 2.5$) with statistical (stat.) and systematic (syst.) uncertainties in %. The 1.8% luminosity uncertainty is not included.

<table>
<thead>
<tr>
<th>$m_{ee}$ [GeV]</th>
<th>$\frac{d\sigma}{d_{T_{mee}}}$ (Born)</th>
<th>$\frac{d\sigma}{d_{T_{mee}}}$ (dressed)</th>
<th>Stat. err. [%]</th>
<th>Syst. err. [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>116–130</td>
<td>$2.24 \times 10^{-1}$</td>
<td>$2.15 \times 10^{-1}$</td>
<td>1.1</td>
<td>4.2</td>
</tr>
<tr>
<td>130–150</td>
<td>$1.02 \times 10^{-1}$</td>
<td>$9.84 \times 10^{-2}$</td>
<td>1.4</td>
<td>4.3</td>
</tr>
<tr>
<td>150–170</td>
<td>$7.83 \times 10^{-1}$</td>
<td>$4.93 \times 10^{-1}$</td>
<td>2.0</td>
<td>4.6</td>
</tr>
<tr>
<td>170–190</td>
<td>$8.24 \times 10^{-2}$</td>
<td>$7.67 \times 10^{-2}$</td>
<td>2.7</td>
<td>4.7</td>
</tr>
<tr>
<td>190–210</td>
<td>$1.87 \times 10^{-2}$</td>
<td>$1.82 \times 10^{-2}$</td>
<td>3.0</td>
<td>5.3</td>
</tr>
<tr>
<td>210–230</td>
<td>$1.07 \times 10^{-2}$</td>
<td>$1.04 \times 10^{-2}$</td>
<td>4.4</td>
<td>6.1</td>
</tr>
<tr>
<td>230–250</td>
<td>$8.23 \times 10^{-3}$</td>
<td>$7.98 \times 10^{-3}$</td>
<td>5.2</td>
<td>5.9</td>
</tr>
<tr>
<td>250–300</td>
<td>$4.66 \times 10^{-3}$</td>
<td>$4.52 \times 10^{-3}$</td>
<td>4.3</td>
<td>5.8</td>
</tr>
<tr>
<td>300–400</td>
<td>$1.70 \times 10^{-3}$</td>
<td>$1.65 \times 10^{-3}$</td>
<td>5.1</td>
<td>5.9</td>
</tr>
<tr>
<td>400–500</td>
<td>$4.74 \times 10^{-4}$</td>
<td>$4.58 \times 10^{-4}$</td>
<td>9.4</td>
<td>6.3</td>
</tr>
<tr>
<td>500–700</td>
<td>$1.46 \times 10^{-4}$</td>
<td>$1.41 \times 10^{-4}$</td>
<td>11</td>
<td>5.7</td>
</tr>
<tr>
<td>700–1000</td>
<td>$2.21 \times 10^{-5}$</td>
<td>$2.13 \times 10^{-5}$</td>
<td>24</td>
<td>7.5</td>
</tr>
<tr>
<td>1000–1500</td>
<td>$2.88 \times 10^{-6}$</td>
<td>$2.76 \times 10^{-6}$</td>
<td>50</td>
<td>9.8</td>
</tr>
</tbody>
</table>
SANCtrow and photon-induced corrections were verified by to 0.2%. A further systematic uncertainty is calculated using the default is taken as the systematic uncertainty, and amounts to 0.2%. These systematic uncertainties, which each have a different dependence on \( m_{ee} \), are added in quadrature and together give a 0.2–0.5% uncertainty on the cross-section.

The contributions from the above sources of systematic uncertainty to the uncertainty on the measured cross-section are summarised in Table 1 for the lowest and highest bin in the \( m_{ee} \) range considered. The overall systematic uncertainty, excluding the luminosity uncertainty of 1.8% [39], rises from 4.2% in the lowest \( m_{ee} \) bin to 9.8% in the highest \( m_{ee} \) bin. The data statistical uncertainties increase from 1.1% to 50%.

7. Results and comparison to theory

The cross-sections obtained in the fiducial region (electron \( p_T > 25 \) GeV and \( |\eta| < 2.5 \)) at the Born and dressed levels are given in Table 2. The difference between the two results is at most 4%. The precision of the measurement is limited by the statistical uncertainty on the data for \( m_{ee} > 400 \) GeV.

Fig. 2 shows the results at the dressed level, where they are compared to the predictions from PYTHIA, MCHNLO and SHERPA. No corrections have been applied to the generator-level predictions; instead, the prediction of each generator has been scaled globally to match the total number of events observed in data. The electroweak-corrected NNLO QCD predictions shown are calculated cross-section after applying NLO electroweak corrections to lepton pair production to be combined with QCD that the choice of the electroweak scheme, \( \alpha(s) \) at \( \sqrt{s} = 400 \) GeV.

Following the prescription outlined in Ref. [42], to be at most 2%, in the highest \( m_{ee} \) bin.

It can be seen in Fig. 3 that the deviations between the \( \text{MSTW2008} [2] \) and the \( \text{CT10} [22] \), \( \text{HERAPDF} 1.5 [38] \) and \( \text{NNPDF} 2.3 [44] \) predictions are covered by the total uncertainty band assigned to the \( \text{MSTW2008} \) prediction, which is dominated by the combined 68% confidence level (CL) PDF and \( \alpha(s) \) variation. At low \( m_{ee} \), the \( \text{ABM11} [45] \) prediction lies above this theoretical uncertainty band, in part due to the \( \text{ABM11} \) PDF set using a value of \( \alpha(s) \) outside of the 68% CL variation. The renormalisation and factorisation scale uncertainties contribute at most 1% to the theoretical uncertainty band in the highest \( m_{ee} \) bin, having been evaluated by varying both scales up or down together by a factor of two, using \( \text{VRAP} [46] \). The size of the photon-induced contribution is similar to the sum of the PDF, \( \alpha(s) \) and scale uncertainties as can be seen in the lower panel of Fig. 3 (left), where the nominal prediction using the \( \text{MSTW2008} \) PDF set is compared to the case where this contribution is not taken into account.

In the region where the precision of the measurement is limited by systematic uncertainties, \( m_{ee} < 400 \) GeV, the data generally lie above the \( \text{FEWZ} \) calculations. However, assuming that all systematic uncertainties, except those of statistical origin on the background and on \( C_P \) (Table 1), are fully correlated bin-to-bin, the comparison between data and different predictions within the full mass range yields chi-squared values of 13.9 for \( \text{MSTW2008} \), 18.9 for \( \text{CT10}, 13.5 \) for \( \text{HERAPDF} 1.5, 14.7 \) for \( \text{ABM11} \) and 14.8 for \( \text{NNPDF} 2.3 \), for the 13 data points, indicating compatibility between the theory and data.

8. Summary

Using 4.9 fb\(^{-1}\) of data from pp collisions at a centre-of-mass energy of \( \sqrt{s} = 7 \) TeV, the invariant mass distribution of e\(^+\)e\(^-\) pairs from \( \text{DY} \) production has been measured at \( \text{ATLAS} \) in the range 116 < \( m_{ee} < 1500 \) GeV, for electrons with \( p_T > 25 \) GeV and
|η| < 2.5. Comparisons have been made to the predictions of the PYTHIA, MCHNLO and SHERPA MC generators, after scaling them globally to match the total number of events observed in data. The MC predictions are consistent with the shape of the measured distribution. The predictions of the FEWZ 3.1 framework using five PDF sets at NNLO have also been studied. The framework combines calculations at NNLO QCD with NLO electroweak corrections, to which LO photon-induced corrections and real W and Z boson emission in single-boson production have been added. The resulting predictions for all PDFs are consistent with the measured differential cross-section, although the data are systematically above the theory. The data have the potential to constrain PDFs, in particular for antiquarks at large x, in the context of a PDF fit involving the world data sensitive to the proton structure.

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