PROCEEDINGS OF SCIENCE

First measurement of the associated production of $W^{\pm}$ bosons and prompt J/ψ mesons at the ATLAS experiment

Hannah Arnold* on behalf of the ATLAS Collaboration
Albert-Ludwigs-Universität Freiburg
E-mail: hannah.arnold@cern.ch

The first observation of the production of a prompt J/ψ meson in association with a $W^{\pm}$ boson in the $W^{\pm} \to \mu^{\pm}\nu$ and $J/\psi \to \mu^{+}\mu^{-}$ decay modes is reported. The analysis is based on a dataset collected in the year 2011 by the ATLAS detector in $\sqrt{s} = 7$ TeV pp collisions at the LHC, corresponding to 4.5 fb^{-1}. The $W^{\pm}$+prompt J/ψ cross section is measured relative to the inclusive $W^{\pm}$ cross section. The results are compared to theoretical predictions to probe different mechanisms of charmonium production in hadronic collisions.

XXII. International Workshop on Deep-Inelastic Scattering and Related Subjects,
28 April - 2 May 2014
Warsaw, Poland

*Speaker.

PoS(DIS2014)165

1. Introduction

The study of heavy quarkonium production in general and specifically in association with a vector boson offers the opportunity to investigate Quantum Chromodynamics (QCD) in both the perturbative and non-perturbative regimes. Despite several measurements of cross sections and polarizations of inclusively produced quarkonia (since the early 1990s, e.g. Refs. [1 – 10]), the understanding of the underlying production mechanisms is rather limited and there is no clear favourite among the various theoretical models (e.g. Colour Singlet Model (CSM) [11], non-relativistic QCD (NRQCD) framework [12], Colour Evaporation Model (CEM) [13]) that is able to consistently describe all observed properties. A subject of debate is in particular the relative importance of the colour-singlet (CS) and the colour-octect (CO) production processes. The existence of CO processes is specifically predicted by the NRQCD formalism. Thus, the production of a prompt J/ψ meson in association with a $W^{\pm}$ boson that is predicted to be dominated by CO processes [14, 15] is well suited to test the NRQCD framework. This prediction is challenged by recent studies [16] that indicate that in 7 TeV pp collisions the contribution of CS processes to $W^{\pm}$+ prompt J/ψ production is not negligible, but that it is comparable to the contribution of CO processes. This especially applies for gluon-initiated processes given the large gluon density at the Large Hadron Collider (LHC). Hence the measurement of the $W^{\pm}$+ prompt J/ψ cross section might help to distinguish between the different models. This presentation discusses the first observation of $W^{\pm}$+ prompt J/ψ production in the $W^{\pm} \to \mu^{\pm}\nu$ and $J/\psi \to \mu^{+}\mu^{-}$ decay modes[1] as well as the measurement of its cross section with respect to inclusive $W^{\pm}$ boson ($\to\mu^{\pm}\nu$) production that was first reported in Ref. [17]. The analysis presented is based on data collected by the ATLAS detector [18] in pp collisions at a centre-of-mass energy of 7 TeV at the LHC. The dataset corresponds to an integrated luminosity of $4.51 \pm 0.08\,\text{fb}^{-1}$ [19].

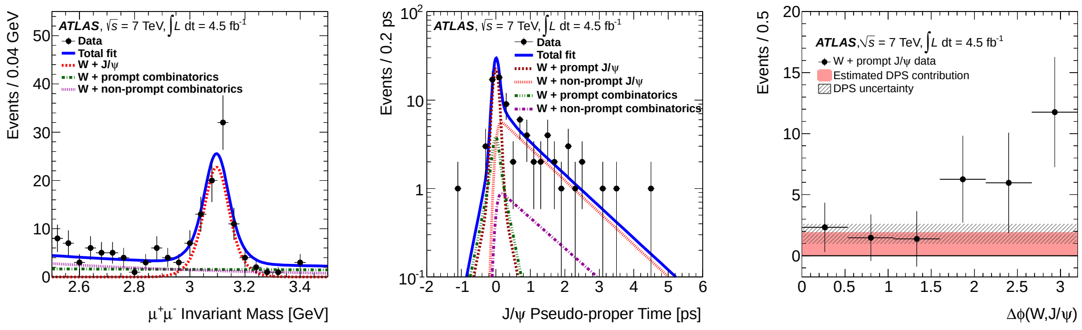
2. Event Selection

The J/ψ candidates are formed from two oppositely charged muons reconstructed within $|\eta_{\mu}| < 2.5$ with a minimum transverse momentum of 4 GeV for the leading muon and 3.5 or 2.5 GeV for the sub-leading muon, depending on the pseudo-rapidity region.

The candidate muons are required to originate from a common vertex and the invariant mass of the selected muon pair has to be close to the nominal J/ψ mass: $2.5 < m_{\mu^{+}\mu^{-}} < 3.5$. The reconstructed J/ψ candidates must have a transverse momentum of $8.5\text{ GeV} < p_{\text{T}}^{J/\psi} < 30\text{ GeV}$ and satisfy $|y| < 2.1$. The $W^{\pm}$ boson candidates are reconstructed from an isolated muon with $p_{\text{T}}^{\mu} > 25$ GeV and $|\eta_{\mu}| < 2.4$ and missing transverse energy $E_{\text{T}}^{\text{miss}} > 20$ GeV and are required to have a transverse mass[2] larger than 40 GeV. Several background processes exhibit a similar or identical signature as the signal process, such as $W^{\pm}$ bosons produced in association with b-quark jets, top-pair production, Z production in association with jets, multijet production and also pile-up and double parton scattering (DPS) interactions. In processes involving b quarks, the reconstructed J/ψ candidates stem from non-prompt decays of b hadrons in which the b quarks hadronize. To

[1] Unless stated otherwise, the decay modes $W^{\pm} \to \mu^{\pm}\nu$ and $J/\psi \to \mu^{+}\mu^{-}$ are implicit in the following.

[2] The transverse mass is defined as $m_{\text{T}}^{\text{W}} = \sqrt{2 p_{\text{T}}^{\mu} E_{\text{T}}^{\text{miss}} (1 - \cos(\Delta\phi))}$, where $\Delta\phi$ is the azimuthal angle between the muon and $E_{\text{T}}^{\text{miss}}$ directions.



(a) (b) (c)

Figure 1: Projections in (a) the invariant mass of the dimuon system and (b) the pseudo-proper time of the two-dimensional distribution including the total fit result and the results of the different components. (c) Distribution of the azimuthal angle between the directions of flight of the $W^{\pm}$ boson and the J/ψ meson for the $W^{\pm}$+prompt J/ψ component in data extracted using the `sPlot` technique [20]. The DPS contribution, estimated as described in the text, is overlaid.

further suppress background events additional cuts are applied, such as impact parameter cuts to the muon candidates, and also events where Z boson candidates can be formed from the muon candidates are rejected. In total 149 candidate events pass the full selection.

3. Signal Extraction

The selected J/ψ candidates can be grouped into three categories: a prompt J/ψ component, a non-prompt J/ψ component and combinatorial background.

In a first step, the separation of the three components and the selection of the prompt J/ψ component is achieved by performing a two-dimensional unbinned maximum likelihood fit in the invariant mass of the J/ψ candidates $m_{\mu^+\mu^-}$ and the pseudo-proper time τ. The latter is defined as

$$\tau = L_{xy} \cdot \frac{m_{\mu^+\mu^-}}{p_{\mathrm{T}}^{J/\psi}}, \tag{3.1}$$

where L_{xy} is the projection of the distance from the primary to the reconstructed J/ψ decay vertex along the transverse momentum of the J/ψ meson. Figures 1(a) and 1(b) show the projections in the invariant mass and the pseudo-proper time of the two-dimensional distribution. The invariant mass distribution is exploited to separate the J/ψ component from the combinatorial background, while the pseudo-proper time is used to separate the prompt and non-prompt components. Parameters that affect the shapes of the chosen fit functions, such as the mass and pseudo-proper time resolution, are determined on a large inclusive sample of J/ψ events, selected in data following the J/ψ candidate selection described in Section 2, and treated as nuisance parameters. The contribution of the prompt J/ψ component is determined to be 29^{+8}_{-7} events, where the uncertainties are the combined statistical and systematic uncertainties due to the nuisance parameters from the fit. The contributions of the non-prompt J/ψ component as well as the prompt and non-prompt combinatorial backgrounds are of the same order.

In a second step, the contribution of multijet events faking the $W^{\pm}$ boson decay signature is determined by performing a template fit to the $W^{\pm}$ boson transverse mass distribution of the prompt J/ψ component that has been extracted from data using the `sPlot` technique [20]. The estimated number of multijet events is compatible with zero meaning the first step effectively extracts $W^{\pm}$+ prompt J/ψ events.

In a third and last step, the residual background contributions to the $W^{\pm}$+ prompt J/ψ yield are estimated and subtracted. It is found that only events due to pile-up and DPS interactions have a non-negligible contribution, therefore only their estimation is described in the following. The number of pile-up events, i.e. the number of events where the $W^{\pm}$ and the J/ψ candidates are produced in different proton-proton collisions of the same bunch crossing, is estimated according to $N_{\mathrm{PU}} = N_{\mathrm{coll}} \cdot P_{J/\psi} \cdot N_{W^{\pm}}$. Here N_{coll} is the mean number of extra collisions, $P_{J/\psi}$ is the probability of producing a J/ψ meson which is determined from $P_{J/\psi} = \sigma_{J/\psi}/\sigma_{inel}$, the ratio of the inclusive J/ψ cross section [9] in the considered kinematic region and the proton-proton inelastic cross section [21], and $N_{W^{\pm}}$ is the number of $W^{\pm}$ boson candidates in the fiducial region (cf. Section 4). The number of events due to pile-up interactions is estimated to be $N_{\mathrm{PU}} = 1.8 \pm 0.2$. After subtracting the pile-up contribution, 27^{+8}_{-7} $W^{\pm}$+ prompt J/ψ events are observed, corresponding to a statistical significance of 5.1 σ. The contribution to the $W^{\pm}$+ prompt J/ψ yield due to DPS interactions, where the $W^{\pm}$ and the J/ψ candidates originate from two separate parton-parton interactions of the same proton-proton collision, is determined according to $N_{\mathrm{DPS}} = P_{J/\psi|W^{\pm}} \cdot N_{W^{\pm}}$, a similar relation as for the pile-up estimation. Here $P_{J/\psi|W^{\pm}}$ is the probability that in addition to a hard collision process another distinguishable process occurs and $N_{W^{\pm}}$ is again the number of $W^{\pm}$ boson candidates in the fiducial region. Adopting the standard ansatz which is based on the assumption that the two hard interactions can be treated as independent, $P_{J/\psi|W^{\pm}}$ can be expressed as $P_{J/\psi|W^{\pm}} = \sigma_{J/\psi}/\sigma_{\mathrm{eff}}$ the ratio of the inclusive J/ψ cross section [9] and the effective area parameter that accounts for the geometric size of the proton [22]. The number of events due to DPS contributions is estimated to be $N_{\mathrm{DPS}} = 11 \pm 4$. Figure 1(c) shows the distribution of the azimuthal angle between the $W^{\pm}$ and the J/ψ candidates for the $W^{\pm}$+ prompt J/ψ component $\Delta\phi(W, J/\psi)$ in data extracted using the `sPlot` technique [20]. The distribution is peaking near π as expected for single parton scattering (SPS) and has a tail towards zero for smaller angular separations suggesting that also a DPS contribution, for which a flat distribution is expected (assuming independent production), is present. Indeed, overlaying a flat template for the DPS component that is scaled to the estimated number of DPS events shows good agreement with the distribution observed in data for small values of $\Delta\phi(W, J/\psi)$.

4. Measurement of the Cross-Section Ratio $R^{\mathrm{fid}}_{J/\psi}$

The ratio $R^{\mathrm{fid}}_{J/\psi}$ of the $W^{\pm}$+ prompt J/ψ and the inclusive $W^{\pm}$ cross section is determined in the fiducial region defined by 8.5 GeV $< p_{\mathrm{T}}^{J/\psi} <$ 30 GeV and $|y_{J/\psi}| < 2.1$ from

$$R^{\mathrm{fid}}_{J/\psi} = \frac{\sigma(W^{\pm} + J/\psi)}{\sigma(W^{\pm})} = \frac{N(W^{\pm} + J/\psi)}{\varepsilon_{J/\psi} \cdot N(W^{\pm})}. \tag{4.1}$$

Here $N(W^{\pm} + J/\psi)$ is the pile-up subtracted number of $W^{\pm}$+ prompt J/ψ events as determined in Section 3 (normalized to the fiducial region), $\varepsilon_{J/\psi}$ is the efficiency correction factor for the muons

PoS(DIS2014)165

stemming from the J/ψ decay, and $N(W^{\pm})$ is the number of events containing a $W^{\pm}$ boson in the fiducial region. $N(W^{\pm})$ is determined from data by applying the $W^{\pm}$ candidate selection described in Section 2 and subtracting background contributions that are assessed using MC simulation, except the multijet background contribution which is obtained with a data-driven method. Deriving the cross-section ratio has the advantage that the luminosity, the $W^{\pm}$ boson branching ratio as well as the $W^{\pm}$ boson reconstruction efficiency and acceptance corrections cancel and hence the systematic uncertainties are reduced.

5. Results and Comparisons with Theoretical Predictions

The yield of 27^{+8}_{-7} events is obtained with a statistical significance of 5.1 σ constituting the first observation of $W^{\pm}$+ prompt J/ψ production. It is found that DPS has a significant contribution.

The ratio $R^{\mathrm{fid}}_{J/\psi}$ of the $W^{\pm}$+ prompt J/ψ and the inclusive $W^{\pm}$ cross section, defined in Eq. 4.1, is determined to be

$$R^{\mathrm{fid}}_{J/\psi} = (51 \pm 13\,(\mathrm{stat.}) \pm 4\,(\mathrm{syst.})) \times 10^{-8}. \quad (5.1)$$

The systematic uncertainty has three main sources that are of the same order: the correction of the efficiencies of the muons forming the J/ψ candidate, the assumption that the reconstruction efficiency and the acceptance of the $W^{\pm}$ boson is the same for $W^{\pm}$ boson produced inclusively and in association with a J/ψ meson, and the choice of the functional forms of the different components and the nuisance parameters in the two-dimensional fit (cf. Section 3).

In addition, the inclusive cross-section ratio $R^{\mathrm{incl}}_{J/\psi}$ is obtained, where also the fiducial acceptance of the muons stemming from the J/ψ decay is corrected:

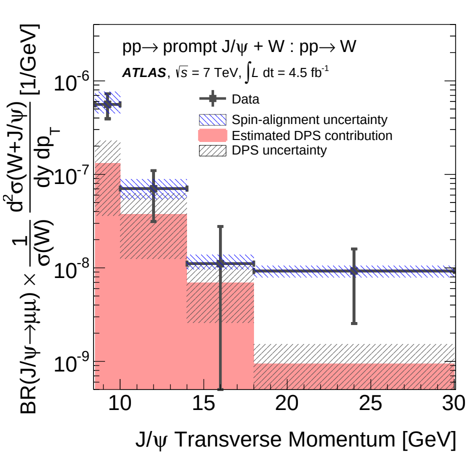
$$R^{\mathrm{incl}}_{J/\psi} = (126 \pm 32\,(\mathrm{stat.}) \pm 9\,(\mathrm{syst.})^{+41}_{-25}\,(\mathrm{spin\text{-}align.})) \times 10^{-8}. \quad (5.2)$$

The acceptance correction depends on the angular distribution of the muons which in turn is determined by the polarization or the spin alignment of the parent J/ψ meson. The spin alignment that depends on the underlying production mechanism is not known [23]. Therefore five different scenarios are considered: the isotropic spin alignment corresponding to an unpolarized J/ψ meson is chosen to obtain the central result while the maximum difference in the resulting acceptance corrections assuming longitudinal and transverse polarizations is assigned as systematic uncertainty. Furthermore, the inclusive cross-section ratio is also obtained differentially $\mathrm{d}R^{\mathrm{incl}}_{J/\psi}/\mathrm{d}p_{\mathrm{T}}$ as function of the transverse momentum of the J/ψ candidate and the result is shown in Fig. 2(a). The distribution expected from the DPS contribution is overlaid and both the uncertainties due to the spin alignment and the DPS estimation are considered. One can conclude that SPS is the dominant production mechanism at low $p_{\mathrm{T}}^{J/\psi}$ while DPS seems to be the dominant contribution for rising $p_{\mathrm{T}}^{J/\psi}$.

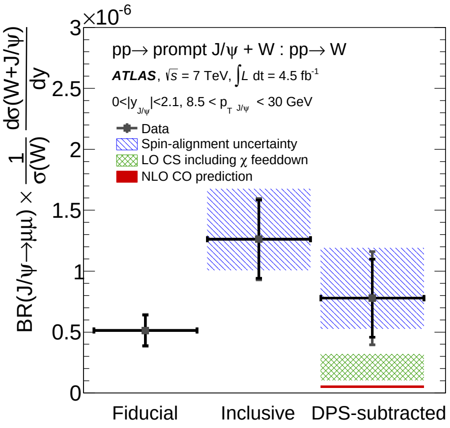
Finally, the estimated DPS contribution to $R^{\mathrm{incl}}_{J/\psi}$ is subtracted from the result, giving an estimate of the SPS rate of

$$R^{\mathrm{DPSsub}}_{J/\psi} = (78 \pm 32\,(\mathrm{stat.}) \pm 22\,(\mathrm{syst.})^{+41}_{-25}\,(\mathrm{spin\text{-}align.})) \times 10^{-8}, \quad (5.3)$$

which can be directly compared to theoretical predictions. The third bin in Fig. 2(b) shows a comparison of $R^{\mathrm{DPSsub}}_{J/\psi}$ and two predictions for the cross section of $W^{\pm}$+ prompt J/ψ SPS production



(a)



(b)

Figure 2: (a) Differential inclusive cross-section ratio $\mathrm{d}R^{\mathrm{incl}}_{J/\psi}/\mathrm{d}p_{\mathrm{T}}$ as function of the transverse momentum of the J/ψ candidate. The DPS contribution extracted from simulation and scaled to the estimate (cf. Section 3) is overlaid. (b) Results of the cross-section ratios $R^{\mathrm{fid}}_{J/\psi}$, $R^{\mathrm{incl}}_{J/\psi}$ and $R^{\mathrm{DPSsub}}_{J/\psi}$. The inner error bars represent the statistical uncertainties, the outer error bars the combined statistical and systematic uncertainties; the uncertainties due to different spin-alignment scenarios are indicated separately. The DPS-subtracted ratio is compared to two theoretical predictions as discussed in the text.

normalized to $W^{\pm}$ production (computed with FEWZ [24, 25]): a leading-order (LO) CS [16] and a next-to-leading-order (NLO) CO prediction [15]. The LO CS contribution of $(10-32)\times 10^{-8}$ is about an order of magnitude larger than the NLO CO contribution of $(4.6-6.2)\times 10^{-8}$. While the LO CS prediction is consistent with the measured result within experimental and theoretical uncertainties, i.e. considering the uncertainties due to the unknown spin alignment, both predictions are compatible with the measured result within two sigma of the experimental uncertainties.

6. Conclusion

Based on data collected by the ATLAS experiment in pp collisions at $\sqrt{s} = 7$ TeV, the production of $W^{\pm}$+prompt J/ψ has been observed with a statistical significance of 5.1 sigma in the $W^{\pm} \to \mu^{\pm}\nu$ and $J/\psi \to \mu^{+}\mu^{-}$ decay modes. Furthermore, the measurement of the fiducial $W^{\pm}$+prompt J/ψ cross section relative to the inclusive $W^{\pm}$ cross section has been performed. The acceptance-corrected cross-section ratio suffers from large uncertainties due to the unknown J/ψ spin alignment that affects the angular distribution of the muons stemming from the J/ψ decay. The comparison of the acceptance-corrected cross-section ratio after subtraction of the contribution of double parton scattering with the predictions of rates due to colour-singlet and colour-octect production processes suggests that the $W^{\pm}$+prompt J/ψ production is not dominated by colour-octet production and is therefore no clean probe of the non-relativistic QCD framework. To improve the precision of the present result and its importance in testing different quarkonium production mechanisms it is necessary both to reduce the statistical uncertainties and to improve the knowledge of the J/ψ spin alignment. Furthermore, the results indicate that double parton scattering contributes significantly to the $W^{\pm}$+prompt J/ψ production. The measurement of the cross-section ratio differentially in the transverse momentum of the J/ψ meson suggests that single parton scattering constitutes the dominant mechanism at low transverse momenta.

References

[1] S. Abachinet. al. (D0 Collaboration), *J/ψ production in collisions at $\sqrt{s} = 1.8$ TeV*, *Phys. Lett. B* **370** (1996) 239.

[2] V.M. Abazov et. al. (D0 Collaboration), *Measurement of Inclusive Differential Cross Sections for Υ(1S) Production in pp^- Collisions at $\sqrt{s} = 1.96$ TeV*, *Phys. Rev. Lett.* **94** (2005) 232001.

[3] V.M. Abazov et. al. (D0 Collaboration), *Measurement of the Polarization of the Υ(1S) and Υ(2S) States in pp^- Collisions at $\sqrt{s} = 1.96$ TeV*, *Phys. Rev. Lett.* **101** (2008) 182004.

[4] F. Abe et al. (CDF Collaboration), *J/ψ and ψ(2S) Production in pp^- Collisions at $\sqrt{s} = 1.8$ TeV*, *Phys. Rev. Lett.* **79** (1997) 572.

[5] T. Affolder et al., (CDF Collaboration), *Measurement of J/Psi and Psi(2S) Polarization in pp^- Collisions at $\sqrt{s} = 1.8$ TeV*, *Phys. Rev. Lett.* **85** (200) 2886 [hep-ex/0004027].

[6] D. Acosta et al. (CDF Collaboration), *Υ Production and Polarization in pp^- Collisions at $\sqrt{s} = 1.8$ TeV*, *Phys. Rev. Lett.* **88** (2002) 161802.

[7] D. Acosta et al. (CDF Collaboration), *Measurement of the J/ψ meson and b-hadron cross sections in pp^- collisions at $\sqrt{s} = 1960$ GeV*, *Phys. Rev.* **D 71** (2005) 032001.

[8] A. Abulencia et al. (CDF Collaboration), *Polarization of J/ψ and ψ(2S) Mesons Produced in pp^- Collisions at $\sqrt{s} = 1.96$ TeV*, *Phys. Rev. Lett.* **99** (2007) 132001.

[9] ATLAS collaboration, *Measurement of the differential cross-sections of inclusive, prompt and non-prompt J/ψ production in proton-proton collisions at $\sqrt{s} = 7$ TeV*, *Nucl. Phys.* **B 850** (2011) 387 [arXiv:1104.3038].

[10] CMS Collaboration, *Prompt and non-prompt J/ψ production in pp collisions at $\sqrt{s} = 7$ TeV*, *Eur. Phys. J.* **C71** (2011) 1575 [arXiv:1011.4193].

[11] C-H. Chang, *Charmonium: Hadro-Production at HERA-B*, *Nucl. Phys.* **B 172** (1980) 425 ; R. Baier and R. Rückl, *Hadronic production of J/ψ and Υ: transverse momentum distributions*, *Phys. Lett.* **B 102**(1981) 364 ; *Z. Phys.* **C 19** (1983) 251.

[12] G.T. Bodwin, E. Braaten, and G.P. Lepage, *Rigorous QCD analysis of inclusive annihilation and production of heavy quarkonium*, *Phys. Rev.* **D 51** (1995) 1125 [hep-ph/9407339].

[13] H. Fritzsch, *Producing Heavy Quark Flavors in Hadronic Collisions: A Test of Quantum Chromodynamics* , *Phys. Lett.* **B 67** (1977) 217; F. Halzen, *Cvc for Gluons and Hadroproduction of Quark Flavors*, *Phys. Lett.* **B 69** (1977) 105; J.F. Amundson, O.J.P. Eboli, E.M. Gregores and F. Halzen, *Colorless States in Perturbative QCD: Charmonium and Rapidity Gaps*, *Phys. Lett.* **B 372** (1996) 127 [hep-ph/9512248]; J.F. Amundson, O.J.P. Eboli, E.M. Gregores and F. Halzen, *Quantitative Tests of Color Evaporation: Charmonium Production*, *Phys. Lett.* **B 390** (1997) 323 [hep-ph/9605295].

[14] B.A. Kniehl, C.P. Palisoc, and L. Zwirner, *Associated production of heavy quarkonia and electroweak bosons at present and future colliders*, *Phys. Rev.* **D 66** (2002) 114002 [hep-ph/0208104].

PoS(DIS2014)165

[15] G. Li, M. Song, R.-Y. Zhang and W.-G. Ma, *QCD corrections to J/ψ production in association with a $W^{\pm}$-boson at the LHC*, *Phys. Rev.* **D 83** (2011) 014001 [arXiv:1012.3798].

[16] J. Lansberg and C. Lorce, *Reassessing the importance of the colour-singlet contributions to direct J/ψ+$W^{\pm}$ production at the LHC and the Tevatron*, *Phys. Lett.* **B 726** (2013) 218 [arXiv:1303.5327].

[17] ATLAS Collaboration, *Measurement of the cross section of prompt J/ψ mesons in association with a $W^{\pm}$ boson in pp collisions at $\sqrt{s} = 7$ TeV with the ATLAS detector*, *JHEP* **04** (2014) 172 [arXiv:1401.2831].

[18] ATLAS Collaboration, *The ATLAS Experiment at the CERN Large Hadron Collider*, *JINST* **3** (2008) S08003.

[19] ATLAS Collaboration, *Improved luminosity determination in pp collisions at $\sqrt{s} = 7$ TeV using the ATLAS detector at the LHC*, *Eur. Phys. J.* **C 73** (2013) 2518 [arXiv:1302.4393].

[20] M. Pivk and F.R. Le Diberder, *sPlot: a statistical tool to unfold data distributions*, *Nucl. Instrum. Meth.* **A 555** (2005) 356 [physics/0402083].

[21] ATLAS collaboration, *Luminosity Determination in pp Collisions at $\sqrt{s} = 7$ TeV Using the ATLAS Detector at the LHC*, *Eur.Phys.J.* **C71** (2011) 1630 [arXiv:1101.2185].

[22] ATLAS collaboration, *Measurement of hard double-parton interactions in $W^{\pm} \to \ell\nu + 2$ jet events at $\sqrt{s} = 7$ TeV with the ATLAS detector*, *New J. Phys.* **15** (2013) 033038 [arXiv:1301.6872].

[23] P. Faccioli, C. Lourenco, J. Seixas, H.K. Woehri, *Towards the experimental clarification of quarkonium polarization*, *Submitted to EPJC* (2010) [arXiv:1006.2738].

[24] R. Gavin, Y. Li, F. Petriello, and S. Quackenbush, *FEWZ 2.0: A code for hadronic Z production at next-to-next-to-leading order*, *Comput. Phys. Commun.* **182** (2011) 2388 [arXiv:1011.3540].

[25] R. Gavin, Y. Li, F. Petriello, and S. Quackenbush, *$W^{\pm}$ Physics at the LHC with FEWZ 2.1*, *Comput. Phys. Commun.* **184** (2013) 209 [arXiv:1201.5896].