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Erratum: Measurement of forward J/ψ production cross-sections in pp collisions at $\sqrt{s} = 13$ TeV

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An issue has been identified in the simulated samples used to calculate the track reconstruction efficiencies, which affects the published J/ψ production cross-section in pp collisions at $\sqrt{s} = 13$ TeV [1]. A brief description of the nature of the problem is provided and then the corrected results are given.

The charge collected in the LHCb VELO sensors is affected by radiation damage. One such effect, which is more pronounced in the outer regions of downstream sensors, arises from charge induction on second metal layer routing lines [2]. Prior to the start of Run 2, modifications were made to the digitization step in the LHCb simulation framework to model this effect. An error was made in the parametric implementation resulting in a reduction of the track reconstruction efficiency in simulation compared to data for tracks with low pseudorapidity. The tracking efficiency calibration procedure that was applied in this paper to the data and simulation [3] was unable to correct the mismodelling.

The results presented in the paper are affected, especially those at low rapidities, while the effect is marginal at high rapidities. Updated tracking calibrations have been implemented for this analysis, resulting in a change of the tracking efficiency and higher systematic uncertainties. Having resolved the issue, the corrected production cross-sections are $15.03 \pm 0.03 \pm 0.94$ µb for prompt J/ψ and $2.25 \pm 0.01 \pm 0.14$ µb for J/ψ from b-hadron decays, integrated over the kinematic coverage $p_{\mathrm{T}} < 14\,\mathrm{GeV}/c$ and $2.0 < y < 4.5$. The updated total $b\bar{b}$ production cross-section in 4π is found to be $\sigma(pp \to b\bar{b}X) = 495 \pm 2 \pm 52$ µb. The NRQCD [4] prediction agrees remarkably well with the experimental data for the prompt J/ψ production cross-section ratio, while the FONLL [5] prediction also provides a reasonably good agreement with our measurements for the J/ψ-from-b cross-section ratio.

All tables and figures with affected measurements are corrected and are given below, with the numbering and captions being identical to those in the original paper.

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Source	Systematic uncertainty (%)
Luminosity	3.9
Hardware trigger	0.1 – 5.9
Software trigger	1.5
Muon ID	1.8
Tracking	1.9 – 8.2
Radiative tail	1.0
J/ψ vertex fit	0.4
Signal mass shape	1.0
$\mathcal{B}(J/\psi \to \mu^+\mu^-)$	0.6
p_{T}, y spectrum	0.1 – 6.5
Simulation statistics	0.5 – 10.0
t_z fit (J/ψ-from-b only)	0.1

Table 1. Relative systematic uncertainties (in %) on the J/ψ cross-section measurements. The uncertainty from the t_z fit only affects J/ψ-from-b mesons. Most of the uncertainties are fully correlated between bins, with the exception of the p_{T}, y spectrum dependence and the simulation statistics, which are considered uncorrelated.

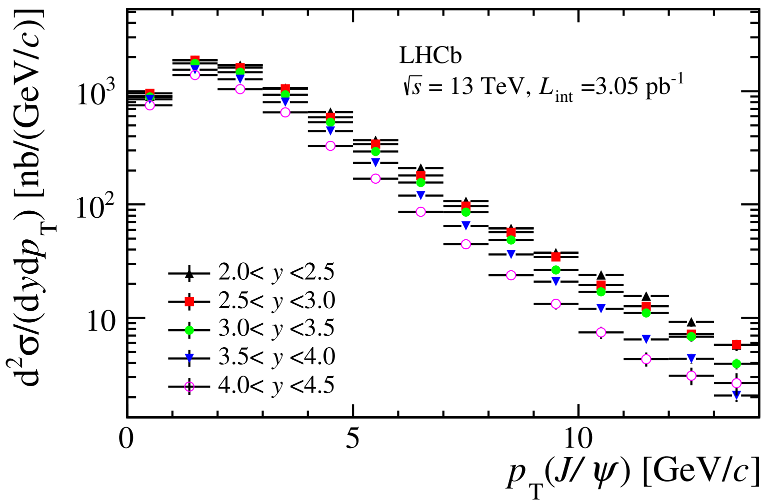

Figure 2. Double differential cross-section for prompt J/ψ mesons as a function of p_{T} in bins of y. Statistical and systematic uncertainties are added in quadrature.

p_{T} [GeV/c]	$2.0 < y < 2.5$	$2.5 < y < 3.0$	$3.0 < y < 3.5$
0−1	906 ± 14 ± 44 ± 24	955 ± 9 ± 40 ± 12	892 ± 8 ± 41 ± 10
1−2	1880 ± 20 ± 88 ± 46	1876 ± 12 ± 77 ± 17	1764 ± 11 ± 81 ± 14
2−3	1697 ± 16 ± 75 ± 41	1612 ± 10 ± 66 ± 15	1470 ± 9 ± 66 ± 12
3−4	1069 ± 11 ± 46 ± 20	1055 ± 7 ± 43 ± 12	930 ± 6 ± 39 ± 9
4−5	656 ± 7 ± 28 ± 14	586 ± 5 ± 24 ± 7	531 ± 4 ± 22 ± 6
5−6	369 ± 5 ± 15 ± 9	342 ± 3 ± 14 ± 4	293 ± 3 ± 12 ± 4
6−7	210.3 ± 3.3 ± 8.6 ± 5.2	180.3 ± 2.1 ± 7.3 ± 2.8	156.1 ± 1.9 ± 6.3 ± 2.4
7−8	107.3 ± 2.1 ± 4.4 ± 3.3	96.7 ± 1.5 ± 3.9 ± 1.8	85.8 ± 1.4 ± 3.5 ± 1.7
8−9	61.7 ± 1.5 ± 2.5 ± 2.1	56.8 ± 1.1 ± 2.3 ± 1.4	48.8 ± 1.0 ± 2.0 ± 1.3
9−10	37.6 ± 1.1 ± 1.5 ± 1.5	34.6 ± 0.9 ± 1.4 ± 1.0	26.6 ± 0.7 ± 1.1 ± 0.8
10−11	23.9 ± 0.9 ± 1.0 ± 1.3	19.5 ± 0.6 ± 0.8 ± 0.7	17.0 ± 0.6 ± 0.7 ± 0.7
11−12	15.6 ± 0.7 ± 0.6 ± 1.0	12.7 ± 0.5 ± 0.5 ± 0.6	11.0 ± 0.5 ± 0.4 ± 0.5
12−13	9.2 ± 0.5 ± 0.4 ± 0.6	7.2 ± 0.4 ± 0.3 ± 0.4	6.8 ± 0.4 ± 0.3 ± 0.4
13−14	5.8 ± 0.4 ± 0.2 ± 0.5	5.8 ± 0.4 ± 0.2 ± 0.4	3.9 ± 0.3 ± 0.2 ± 0.3
	$3.5 < y < 4.0$	$4.0 < y < 4.5$	
0−1	850 ± 8 ± 48 ± 11	752 ± 9 ± 50 ± 16	
1−2	1545 ± 10 ± 90 ± 14	1387 ± 12 ± 99 ± 23	
2−3	1272 ± 8 ± 71 ± 13	1046 ± 10 ± 76 ± 24	
3−4	801 ± 6 ± 42 ± 9	649 ± 8 ± 44 ± 19	
4−5	444 ± 4 ± 21 ± 6	329 ± 5 ± 19 ± 8	
5−6	234 ± 3 ± 11 ± 4	169 ± 3 ± 9 ± 5	
6−7	119.6 ± 1.7 ± 5.2 ± 0.8	87.3 ± 2.1 ± 4.5 ± 1.0	
7−8	65.0 ± 1.3 ± 2.8 ± 1.5	44.6 ± 1.4 ± 2.2 ± 2.0	
8−9	36.4 ± 0.9 ± 1.5 ± 1.0	23.8 ± 1.0 ± 1.1 ± 1.2	
9−10	20.9 ± 0.7 ± 0.9 ± 0.8	13.3 ± 0.7 ± 0.6 ± 1.0	
10−11	12.1 ± 0.5 ± 0.5 ± 0.6	7.4 ± 0.5 ± 0.3 ± 0.6	
11−12	6.4 ± 0.3 ± 0.3 ± 0.3	4.3 ± 0.4 ± 0.2 ± 0.4	
12−13	4.4 ± 0.3 ± 0.2 ± 0.3	3.1 ± 0.3 ± 0.2 ± 0.4	
13−14	2.1 ± 0.2 ± 0.1 ± 0.2	2.7 ± 0.3 ± 0.1 ± 0.5	

Table 2. Double differential production cross-section in nb/(GeV/c) for prompt J/ψ mesons in bins of (p_{T}, y). The first uncertainties are statistical, the second are the correlated systematic uncertainties shared between bins and the last are the uncorrelated systematic uncertainties.

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p_{T} [GeV/c]	$2.0 < y < 2.5$	$2.5 < y < 3.0$	$3.0 < y < 3.5$
0−1	99.3 ± 4.8 ± 9.6 ± 5.1	98.8 ± 2.8 ± 6.1 ± 2.6	92.3 ± 2.6 ± 5.4 ± 2.2
1−2	242.3 ± 6.1 ± 20.6 ± 8.7	238.1 ± 3.8 ± 14.2 ± 4.2	216.4 ± 3.4 ± 12.6 ± 3.6
2−3	275.6 ± 5.8 ± 19.9 ± 9.5	233.4 ± 3.4 ± 13.4 ± 3.9	211.3 ± 3.1 ± 12.0 ± 3.5
3−4	204.3 ± 4.6 ± 13.1 ± 6.3	174.8 ± 2.7 ± 9.6 ± 3.2	150.6 ± 2.3 ± 8.2 ± 2.7
4−5	137.3 ± 3.3 ± 8.1 ± 4.7	120.0 ± 2.0 ± 6.4 ± 2.3	96.0 ± 1.7 ± 5.1 ± 1.9
5−6	84.9 ± 2.3 ± 4.7 ± 2.9	76.3 ± 1.5 ± 4.0 ± 1.6	59.8 ± 1.3 ± 3.1 ± 1.3
6−7	56.2 ± 1.7 ± 3.0 ± 2.1	48.2 ± 1.1 ± 2.5 ± 1.1	38.3 ± 1.0 ± 2.0 ± 1.0
7−8	36.3 ± 1.3 ± 1.9 ± 1.6	28.9 ± 0.8 ± 1.5 ± 0.8	23.3 ± 0.7 ± 1.2 ± 0.7
8−9	21.5 ± 0.9 ± 1.1 ± 1.0	19.6 ± 0.7 ± 1.0 ± 0.6	15.2 ± 0.6 ± 0.8 ± 0.6
9−10	15.7 ± 0.7 ± 0.8 ± 0.8	12.3 ± 0.5 ± 0.6 ± 0.5	9.9 ± 0.5 ± 0.5 ± 0.5
10−11	10.1 ± 0.6 ± 0.5 ± 0.6	9.0 ± 0.5 ± 0.5 ± 0.4	7.6 ± 0.4 ± 0.4 ± 0.5
11−12	8.0 ± 0.5 ± 0.4 ± 0.6	6.3 ± 0.4 ± 0.3 ± 0.3	4.4 ± 0.3 ± 0.2 ± 0.3
12−13	5.3 ± 0.4 ± 0.3 ± 0.4	4.2 ± 0.3 ± 0.2 ± 0.3	3.4 ± 0.3 ± 0.2 ± 0.3
13−14	4.5 ± 0.4 ± 0.2 ± 0.4	3.5 ± 0.3 ± 0.2 ± 0.3	2.0 ± 0.2 ± 0.1 ± 0.2
	$3.5 < y < 4.0$	$4.0 < y < 4.5$	
0−1	83.5 ± 2.7 ± 5.5 ± 2.5	65.0 ± 3.8 ± 4.8 ± 3.5	
1−2	182.1 ± 3.4 ± 12.2 ± 3.8	139.5 ± 4.6 ± 11.0 ± 5.3	
2−3	176.3 ± 3.0 ± 11.5 ± 3.8	118.7 ± 3.6 ± 9.5 ± 5.0	
3−4	118.9 ± 2.3 ± 7.3 ± 2.7	86.6 ± 3.0 ± 6.6 ± 4.4	
4−5	79.4 ± 1.7 ± 4.6 ± 2.0	52.7 ± 2.1 ± 3.7 ± 2.7	
5−6	43.5 ± 1.2 ± 2.5 ± 1.2	28.2 ± 1.4 ± 1.9 ± 1.6	
6−7	28.8 ± 0.9 ± 1.6 ± 1.0	17.8 ± 1.0 ± 1.1 ± 1.1	
7−8	17.4 ± 0.7 ± 1.0 ± 0.7	9.5 ± 0.7 ± 0.6 ± 0.7	
8−9	10.0 ± 0.5 ± 0.6 ± 0.5	5.3 ± 0.5 ± 0.3 ± 0.4	
9−10	8.1 ± 0.5 ± 0.5 ± 0.5	4.9 ± 0.5 ± 0.3 ± 0.6	
10−11	4.4 ± 0.3 ± 0.3 ± 0.3	2.9 ± 0.3 ± 0.2 ± 0.4	
11−12	3.0 ± 0.3 ± 0.2 ± 0.3	2.5 ± 0.3 ± 0.2 ± 0.4	
12−13	1.8 ± 0.2 ± 0.1 ± 0.2	1.6 ± 0.3 ± 0.1 ± 0.5	
13−14	1.5 ± 0.2 ± 0.1 ± 0.2	0.5 ± 0.1 ± 0.0 ± 0.1	

Table 3. Double differential production cross-section in nb/(GeV/c) for J/ψ-from-b mesons in bins of (p_{T}, y). The first uncertainties are statistical, the second are the correlated systematic uncertainties shared between bins and the last are the uncorrelated systematic uncertainties.

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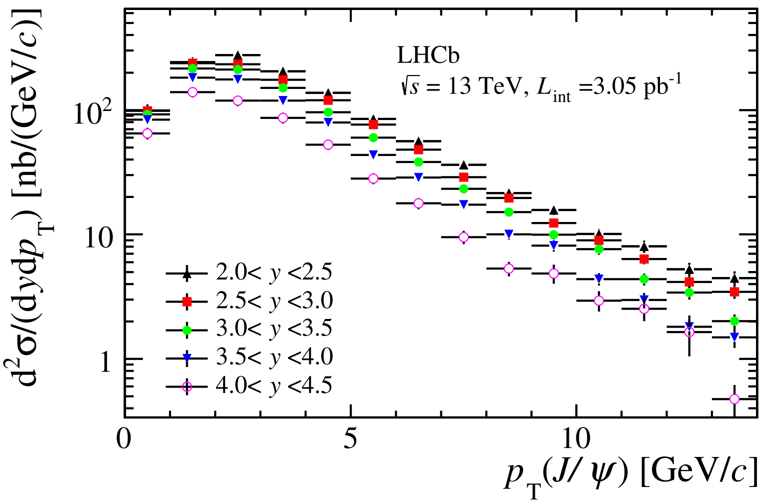

Figure 3. Double differential cross-section for J/ψ-from-b mesons as a function of p_T in bins of y. Statistical and systematic uncertainties are added in quadrature.

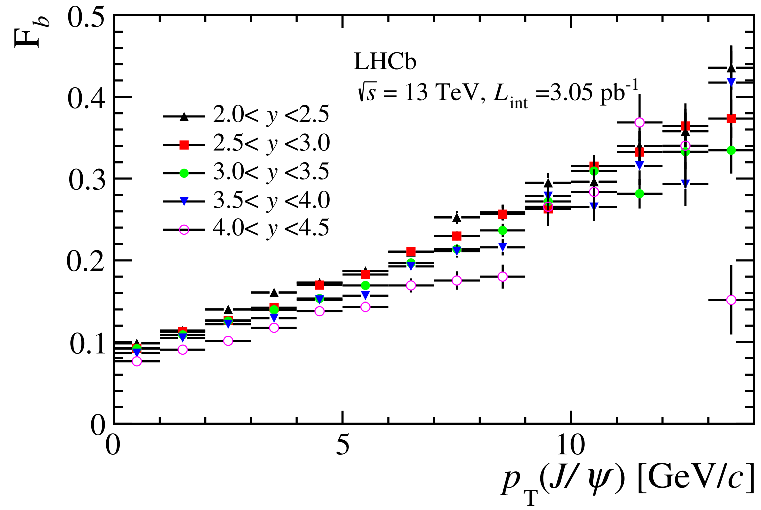

Figure 4. Fractions of J/ψ-from-b mesons in bins of J/ψ p_T and y. Statistical and systematic uncertainties are added in quadrature.

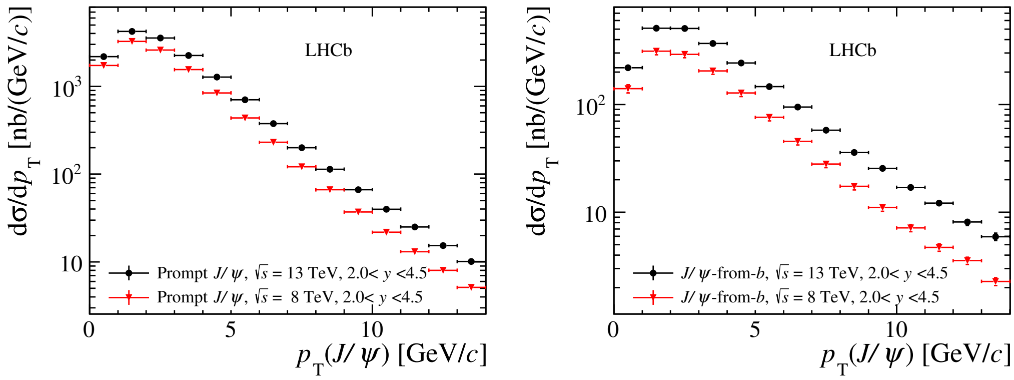

Figure 5. Differential cross-sections as a function of p_T integrated over y for (left) prompt J/ψ and (right) J/ψ-from-b mesons.

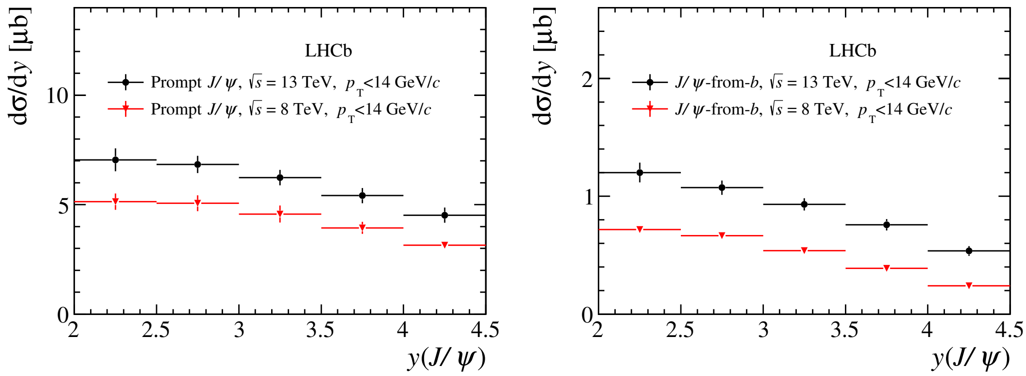

Figure 6. Differential cross-sections as a function of y integrated over p_T for (left) prompt J/ψ and (right) J/ψ-from-b mesons.

Source	Systematic uncertainty (%)
Luminosity	4.6
Trigger	1.5
Muon ID	2.2
Tracking	2.0
Signal mass shape	2.0
p_T, y spectrum, simulation statistics (t_z fits)	1.1 – 18.9

Table 4. Relative systematic uncertainty (in %) on the ratio of the cross-section in pp collisions at $\sqrt{s} = 13$ TeV relative to that at $\sqrt{s} = 8$ TeV. The systematic uncertainty from t_z fits only affects J/ψ-from-b.

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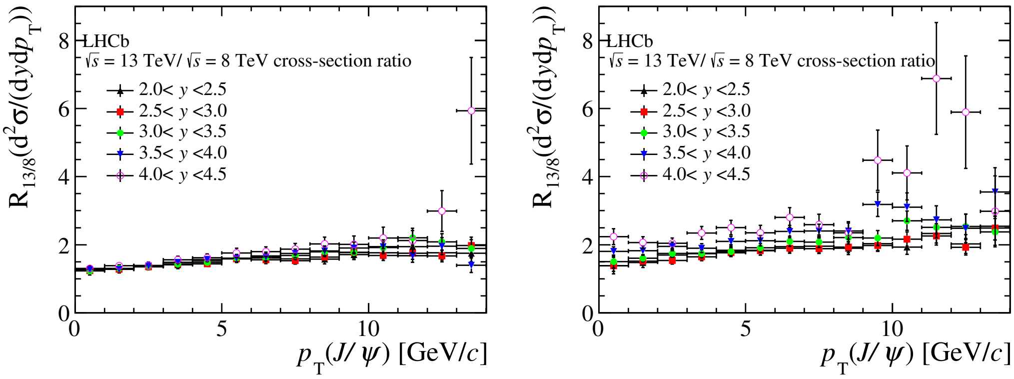

Figure 7. Ratios of differential cross-sections between measurements at $\sqrt{s} = 13\,\text{TeV}$ and $\sqrt{s} = 8\,\text{TeV}$ as a function of p_{T} in bins of y for (left) prompt J/ψ mesons and (right) J/ψ-from-b mesons.

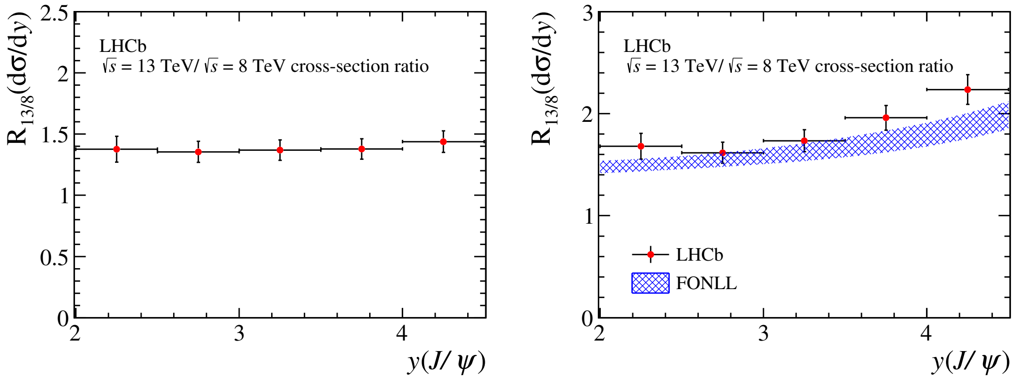

Figure 8. Ratios of differential cross-sections between measurements at $\sqrt{s} = 13\,\text{TeV}$ and $\sqrt{s} = 8\,\text{TeV}$ as a function of y integrated over p_{T} for (left) prompt J/ψ and (right) J/ψ-from-b mesons. The FONLL calculation is compared to the measured J/ψ-from-b production ratio.

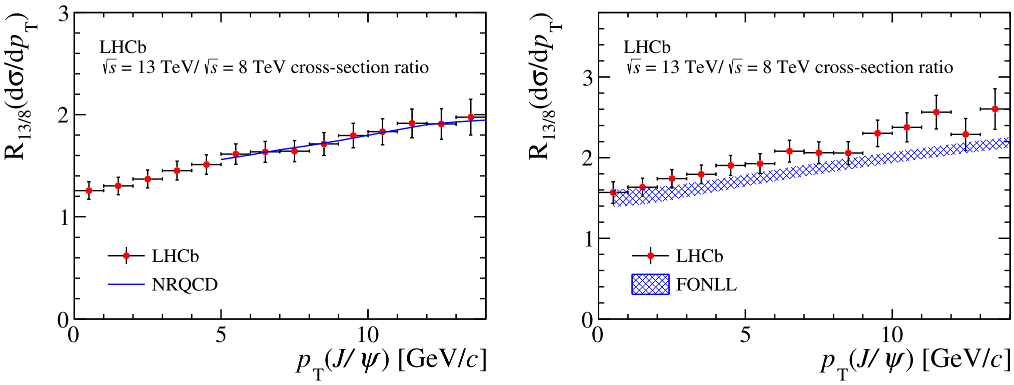

Figure 9. Ratios of differential cross-sections between measurements at $\sqrt{s} = 13\,\text{TeV}$ and $\sqrt{s} = 8\,\text{TeV}$ as a function of p_{T} integrated over y for (left) prompt J/ψ mesons and (right) J/ψ-from-b mesons. Calculations of NRQCD and FONLL are compared to prompt J/ψ mesons and J/ψ-from-b mesons, respectively.

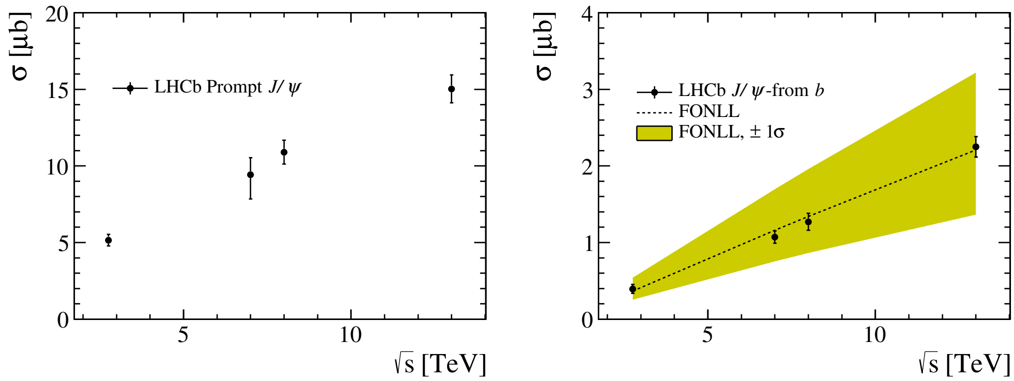

Figure 10. The J/ψ production cross-section for (left) prompt J/ψ and (right) J/ψ-from-b mesons as a function of pp collision energy in the LHCb fiducial region compared to the FONLL calculation. In general, the correlated and uncorrelated systematic uncertainties among different measurements are of comparable magnitude.

σ_{tot} (μb)	$\sqrt{s} = 2.76\,\text{TeV}$	$\sqrt{s} = 7\,\text{TeV}$	$\sqrt{s} = 8\,\text{TeV}$	$\sqrt{s} = 13\,\text{TeV}$
Prompt J/ψ	$5.2 \pm 0.3 \pm 0.3$	$9.4 \pm 0.5^{+0.7}_{-1.0}$	$10.9 \pm 0.5 \pm 0.6$	$15.0 \pm 0.6 \pm 0.7$
J/ψ-from-b	$0.39 \pm 0.04 \pm 0.04$	$1.07 \pm 0.05 \pm 0.06$	$1.27 \pm 0.06 \pm 0.09$	$2.25 \pm 0.09 \pm 0.10$

Table 5. Production cross-sections of prompt J/ψ and J/ψ-from-b mesons, integrated over the LHCb fiducial region, in pp collisions at various centre-of-mass energies. The first uncertainty is the uncorrelated component, and the second the correlated one.

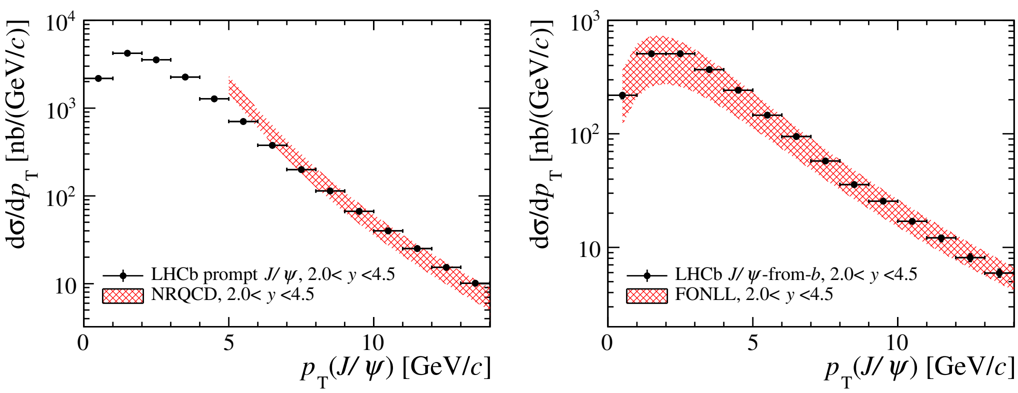

Figure 11. Differential cross-sections as a function of p_{T} integrated over y in the range $2.0 < y < 4.5$, (left) compared with the NRQCD calculation for prompt J/ψ and (right) compared with the FONLL calculation for J/ψ-from-b mesons.

p_{T}[GeV/c]	$2 < y < 2.5$	$2.5 < y < 3$	$3 < y < 3.5$	$3.5 < y < 4$	$4 < y < 4.5$
$0 - 1$	9.8 ± 0.5	9.2 ± 0.3	9.2 ± 0.3	8.6 ± 0.3	7.6 ± 0.4
$1 - 2$	11.4 ± 0.3	11.2 ± 0.2	10.9 ± 0.2	10.5 ± 0.2	9.1 ± 0.3
$2 - 3$	14.0 ± 0.3	12.6 ± 0.2	12.5 ± 0.2	12.2 ± 0.2	10.1 ± 0.3
$3 - 4$	16.0 ± 0.3	14.2 ± 0.2	13.9 ± 0.2	12.9 ± 0.2	11.8 ± 0.4
$4 - 5$	17.3 ± 0.4	17.0 ± 0.3	15.3 ± 0.3	15.2 ± 0.3	13.8 ± 0.5
$5 - 6$	18.7 ± 0.5	18.2 ± 0.3	16.9 ± 0.3	15.7 ± 0.4	14.3 ± 0.6
$6 - 7$	21.0 ± 0.6	21.1 ± 0.4	19.7 ± 0.5	19.3 ± 0.6	16.9 ± 0.9
$7 - 8$	25.3 ± 0.8	23.0 ± 0.6	21.3 ± 0.6	21.1 ± 0.7	17.5 ± 1.1
$8 - 9$	25.9 ± 1.0	25.6 ± 0.8	23.7 ± 0.8	21.6 ± 1.0	18.0 ± 1.5
$9 - 10$	29.5 ± 1.2	26.3 ± 1.0	27.2 ± 1.1	27.9 ± 1.3	26.6 ± 2.4
$10 - 11$	29.6 ± 1.5	31.5 ± 1.3	30.9 ± 1.4	26.5 ± 1.7	28.4 ± 2.8
$11 - 12$	34.0 ± 1.9	33.3 ± 1.6	28.1 ± 1.8	31.5 ± 2.3	36.9 ± 3.5
$12 - 13$	35.8 ± 2.3	36.5 ± 2.1	33.3 ± 2.2	29.3 ± 2.7	34.0 ± 5.2
$13 - 14$	43.6 ± 2.7	37.3 ± 2.3	33.4 ± 2.8	41.7 ± 3.9	15.2 ± 4.3

Table 6. The fraction of J/ψ-from-b mesons (in %) in bins of the J/ψ transverse momentum and rapidity. The uncertainties are statistical only. The systematic uncertainties are negligible.

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p_T [GeV/c]	Prompt J/ψ	J/ψ-from-b
0–1	$2177 \pm 10 \pm 17 \pm 146$	$219.4 \pm 3.9 \pm 1.8 \pm 14.8$
1–2	$4226 \pm 14 \pm 29 \pm 278$	$509.2 \pm 4.9 \pm 3.6 \pm 33.5$
2–3	$3548 \pm 12 \pm 26 \pm 223$	$507.6 \pm 4.4 \pm 4.0 \pm 31.9$
3–4	$2251 \pm 9 \pm 16 \pm 134$	$367.6 \pm 3.5 \pm 2.7 \pm 21.9$
4–5	$1273 \pm 5 \pm 9 \pm 72$	$242.7 \pm 2.5 \pm 1.9 \pm 13.8$
5–6	$703.7 \pm 3.8 \pm 6.0 \pm 38.9$	$146.3 \pm 1.8 \pm 1.3 \pm 8.1$
6–7	$376.8 \pm 2.6 \pm 3.7 \pm 20.5$	$94.6 \pm 1.3 \pm 0.9 \pm 5.1$
7–8	$199.7 \pm 1.7 \pm 2.4 \pm 10.8$	$57.7 \pm 1.0 \pm 0.7 \pm 3.1$
8–9	$113.8 \pm 1.2 \pm 1.6 \pm 6.1$	$35.8 \pm 0.7 \pm 0.5 \pm 1.9$
9–10	$66.5 \pm 0.9 \pm 1.2 \pm 3.6$	$25.5 \pm 0.6 \pm 0.5 \pm 1.4$
10–11	$39.9 \pm 0.7 \pm 0.9 \pm 2.1$	$17.0 \pm 0.5 \pm 0.4 \pm 0.9$
11–12	$25.1 \pm 0.6 \pm 0.7 \pm 1.3$	$12.1 \pm 0.4 \pm 0.3 \pm 0.6$
12–13	$15.4 \pm 0.4 \pm 0.5 \pm 0.8$	$8.1 \pm 0.3 \pm 0.3 \pm 0.4$
13–14	$10.1 \pm 0.3 \pm 0.4 \pm 0.5$	$5.9 \pm 0.3 \pm 0.2 \pm 0.3$

Table 7. Differential cross-sections $d\sigma/dp_T$ (in nb/(GeV/c)) for prompt J/ψ and J/ψ-from-b mesons, integrated over y. The first uncertainties are statistical and the second (third) are uncorrelated (correlated) systematic uncertainties amongst bins.

y	Prompt J/ψ	J/ψ-from-b
2.0 − 2.5	$7.049 \pm 0.033 \pm 0.072 \pm 0.516$	$1.201 \pm 0.012 \pm 0.011 \pm 0.083$
2.5 − 3.0	$6.840 \pm 0.021 \pm 0.029 \pm 0.390$	$1.073 \pm 0.007 \pm 0.004 \pm 0.060$
3.0 − 3.5	$6.236 \pm 0.018 \pm 0.024 \pm 0.350$	$0.930 \pm 0.006 \pm 0.003 \pm 0.052$
3.5 − 4.0	$5.413 \pm 0.017 \pm 0.025 \pm 0.344$	$0.759 \pm 0.006 \pm 0.003 \pm 0.048$
4.0 − 4.5	$4.519 \pm 0.020 \pm 0.043 \pm 0.343$	$0.536 \pm 0.008 \pm 0.005 \pm 0.040$

Table 8. Differential cross-sections $d\sigma/dy$ (in μb) for prompt J/ψ and J/ψ-from-b mesons, integrated over p_T. The first uncertainties are statistical and the second (third) are the uncorrelated (correlated) systematic uncertainties.

p_T [GeV/c]	$2 < y < 2.5$	$2.5 < y < 3$	$3 < y < 3.5$	$3.5 < y < 4$	$4 < y < 4.5$	$2 < y < 4.5$
$0-1$	1.25 ± 0.14	1.24 ± 0.09	1.23 ± 0.08	1.27 ± 0.08	1.30 ± 0.09	1.26 ± 0.09
$1-2$	1.29 ± 0.12	1.28 ± 0.09	1.30 ± 0.08	1.28 ± 0.08	1.39 ± 0.09	1.30 ± 0.09
$2-3$	1.38 ± 0.11	1.35 ± 0.09	1.36 ± 0.08	1.38 ± 0.08	1.39 ± 0.09	1.37 ± 0.09
$3-4$	1.41 ± 0.11	1.43 ± 0.09	1.43 ± 0.09	1.48 ± 0.09	1.56 ± 0.11	1.45 ± 0.09
$4-5$	1.52 ± 0.13	1.44 ± 0.09	1.48 ± 0.09	1.56 ± 0.10	1.62 ± 0.11	1.51 ± 0.10
$5-6$	1.60 ± 0.11	1.58 ± 0.10	1.61 ± 0.10	1.60 ± 0.10	1.76 ± 0.14	1.61 ± 0.10
$6-7$	1.67 ± 0.12	1.56 ± 0.11	1.61 ± 0.11	1.64 ± 0.11	1.80 ± 0.14	1.64 ± 0.10
$7-8$	1.58 ± 0.12	1.53 ± 0.10	1.68 ± 0.12	1.75 ± 0.13	1.87 ± 0.17	1.64 ± 0.10
$8-9$	1.58 ± 0.14	1.64 ± 0.12	1.79 ± 0.14	1.82 ± 0.15	2.02 ± 0.20	1.71 ± 0.11
$9-10$	1.71 ± 0.15	1.78 ± 0.14	1.77 ± 0.15	1.90 ± 0.17	2.01 ± 0.25	1.80 ± 0.12
$10-11$	1.76 ± 0.17	1.69 ± 0.14	1.92 ± 0.17	1.94 ± 0.20	2.20 ± 0.32	1.83 ± 0.13
$11-12$	1.94 ± 0.21	1.75 ± 0.18	2.20 ± 0.21	1.68 ± 0.19	2.12 ± 0.36	1.92 ± 0.14
$12-13$	1.76 ± 0.21	1.67 ± 0.17	2.08 ± 0.24	1.96 ± 0.25	2.99 ± 0.60	1.91 ± 0.15
$13-14$	1.75 ± 0.25	1.98 ± 0.25	1.89 ± 0.26	1.40 ± 0.21	5.94 ± 1.57	1.98 ± 0.17
$0-14$	1.38 ± 0.11	1.36 ± 0.09	1.37 ± 0.08	1.38 ± 0.08	1.44 ± 0.09	—

Table 9. The ratio of cross-sections between measurements at 13 TeV and 8 TeV in different bins of p_T and y for prompt J/ψ mesons. The systematic errors are negligible.

p_T [GeV/c]	$2 < y < 2.5$	$2.5 < y < 3$	$3 < y < 3.5$	$3.5 < y < 4$	$4 < y < 4.5$	$2 < y < 4.5$
$0-1$	1.39 ± 0.24	1.38 ± 0.16	1.50 ± 0.19	1.80 ± 0.14	2.24 ± 0.24	1.57 ± 0.13
$1-2$	1.48 ± 0.14	1.52 ± 0.11	1.61 ± 0.11	1.83 ± 0.14	2.07 ± 0.17	1.63 ± 0.11
$2-3$	1.70 ± 0.15	1.54 ± 0.11	1.74 ± 0.11	1.95 ± 0.13	2.04 ± 0.15	1.74 ± 0.11
$3-4$	1.75 ± 0.14	1.64 ± 0.11	1.73 ± 0.11	1.90 ± 0.13	2.35 ± 0.19	1.80 ± 0.12
$4-5$	1.84 ± 0.16	1.77 ± 0.12	1.80 ± 0.12	2.10 ± 0.14	2.50 ± 0.21	1.90 ± 0.12
$5-6$	1.84 ± 0.14	1.82 ± 0.13	1.91 ± 0.13	2.12 ± 0.15	2.35 ± 0.22	1.93 ± 0.12
$6-7$	1.95 ± 0.15	1.90 ± 0.15	2.10 ± 0.15	2.39 ± 0.18	2.80 ± 0.29	2.08 ± 0.13
$7-8$	1.96 ± 0.17	1.89 ± 0.14	2.08 ± 0.16	2.40 ± 0.20	2.59 ± 0.31	2.06 ± 0.14
$8-9$	1.90 ± 0.19	1.93 ± 0.16	2.21 ± 0.20	2.40 ± 0.24	2.35 ± 0.33	2.06 ± 0.14
$9-10$	2.03 ± 0.20	1.98 ± 0.18	2.20 ± 0.22	3.19 ± 0.35	4.48 ± 0.89	2.30 ± 0.16
$10-11$	1.93 ± 0.22	2.16 ± 0.21	2.70 ± 0.28	3.10 ± 0.42	4.11 ± 0.79	2.38 ± 0.18
$11-12$	2.33 ± 0.28	2.25 ± 0.26	2.51 ± 0.31	2.73 ± 0.41	6.88 ± 1.64	2.57 ± 0.21
$12-13$	2.02 ± 0.28	1.92 ± 0.23	2.54 ± 0.36	2.48 ± 0.42	5.89 ± 1.65	2.29 ± 0.20
$13-14$	2.54 ± 0.40	2.49 ± 0.35	2.38 ± 0.39	3.55 ± 0.71	2.98 ± 1.04	2.60 ± 0.25
$0-14$	1.68 ± 0.13	1.62 ± 0.10	1.73 ± 0.11	1.96 ± 0.12	2.24 ± 0.15	—

Table 10. The ratio of cross-sections between measurements at 13 TeV and 8 TeV in different bins of p_T and y for J/ψ-from-b mesons. The systematic uncertainties are negligible.

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