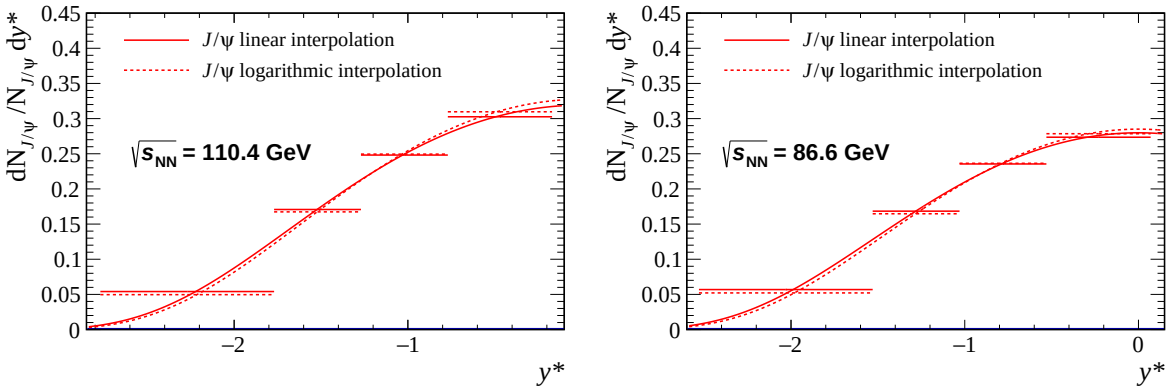

Figure 5: Phenomenological parametrisation of the rapidity distributions at (left) $\sqrt{s_{\rm NN}} = 110.4\,\text{GeV}$ (pAr) and (right) $\sqrt{s_{\rm NN}} = 86.6\,\text{GeV}$ (pHe). The binning schemes corresponds to those used in the analysis. The curves are normalised to unity for y^* within $[-3.5, 3.5]$.

Supplementary material for LHCb-PAPER-2018-023

Smooth distributions of phenomenological predictions

The phenomenological distributions used in the article are based on the parametrisations given in Ref. [49] for the rapidity distributions and Ref. [11] for the transverse momentum distributions. For rapidity and transverse momentum, the solid and dashed red lines of Fig. 3 and Fig. 4 of the paper are obtained with linear and logarithmic interpolations, respectively, between the results from the E789 (pAu, $\sqrt{s_{\rm NN}} = 38.7$ GeV) [50], the HERA-B (pC, $\sqrt{s_{NN}} = 41.5$ GeV) [51] and the PHENIX (pp, $\sqrt{s} = 200$ GeV) [52] experiments.

The rapidity distribution is given by

$$\frac{dN_{J/\psi}}{dy^*} = \frac{1}{I_{y^*}}\left(1 - \frac{2M_{\rm T}}{\sqrt{s}}\cosh(y^*)\right)^n$$

where the parameters have been provided by the authors of [11, 49]. $M_{\rm T} = \sqrt{M^2 + p_{\rm T}^2}$ (where $M_{\rm T}$ is the transverse mass) with $M = 3.1\,\text{GeV}/c^2$ and $p_{\rm T} = 1\,\text{GeV}/c$, and

- at 86.6 GeV, linear (logarithmic) interpolation: $n = 6.4$ (6.9)
- at 110.4 GeV, linear (logarithmic) interpolation: $n = 6.8$ (7.3)

and I_y^* is the normalisation factor of the function integrated over $-3.5 < y^* < 3.5$. Figure 5 shows the phenomenological curves at both pAr and pHe centre-of-mass energies. The same binning scheme as in the letter is used.

The transverse momentum distribution is given by

$$\frac{dN_{J/\psi}}{dp_{\rm T}} = \frac{1}{I_{p_{\rm T}}}\left(\frac{p_0^2 + p_{\rm T}^2}{p_0^2}\right)^{-m} = \frac{1}{I_{p_{\rm T}}}\left(1 + \frac{p_{\rm T}^2}{p_0^2}\right)^{-m}$$

where the parameters have been provided by the authors of Refs. [11, 49]: p_0=3.2 GeV/c and

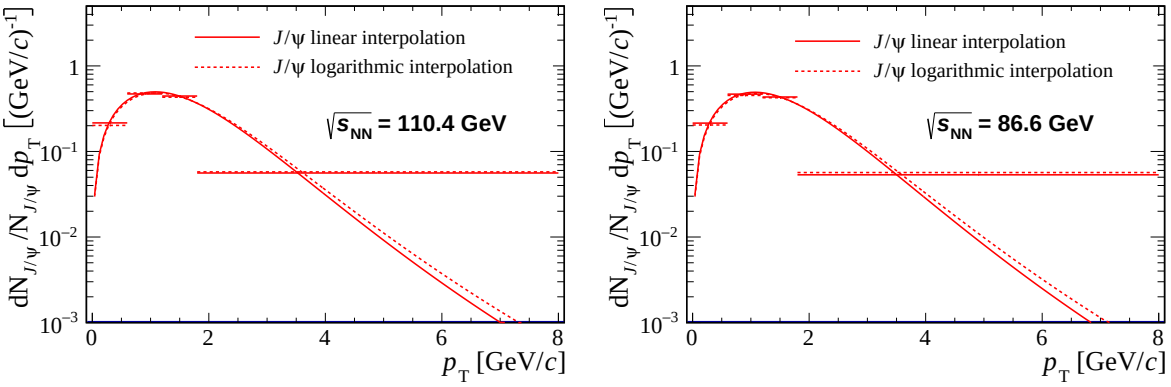

Figure 6: Phenomenological parametrisation of the transverse momentum distributions at (left) $\sqrt{s_{\rm NN}} = 110.4\,\text{GeV}$ (pAr) and (right) $\sqrt{s_{\rm NN}} = 86.6\,\text{GeV}$ (pHe). The binning schemes corresponds to those in the analysis. The curves are normalised to unity for $p_{\rm T}$ within $[0, 8]$ GeV/c.

- at 86.6 GeV, linear (logarithmic) interpolation: $m = 5.0$ (4.8)
- at 110.4 GeV, linear (logarithmic) interpolation: $m = 4.9$ (4.7)

and $I_{p_{\rm T}}$ is the normalisation factor of the function integrated over $0 < p_{\rm T} < 8$ GeV/c. Figure 6 shows the phenomenological curves at both pAr and pHe centre-of-mass energies. The same binning scheme as in the letter is used.

Potential effects related to polarisation

The detection efficiency is affected by the J/ψ polarisation, especially by the longitudinal polarisation parameter λ_θ which is defined as follows,

$$\frac{d^2N}{d\cos\theta d\Phi} \propto 1 + \lambda_\theta \cos^2\theta + \lambda_{\theta\Phi} \sin 2\theta \cos\Phi + \lambda_\Phi \sin^2\theta \cos 2\Phi, \tag{2}$$

where, in the helicity frame, $d^2N/d\cos\theta d\Phi$ is the angular distribution of muons in the $J/\psi \to \mu^+\mu^-$ decays, θ is the polar angle between the direction of the positive lepton and the flight direction of the J/ψ in the centre-of-mass frame of the colliding hadrons, and Φ is the azimuthal angle, measured with respect to the production plane. Since the production plane is uniformly distributed in azimuthal angle, only the θ dependence described by the parameter λ_θ has an effect on the efficiency. A value of $\lambda_\theta = 0$ refers to unpolarised J/ψ mesons, while $\lambda_\theta > 0$ describes transverse polarisation ($J_z = \pm 1$ enhanced) and $\lambda_\theta < 0$ longitudinal polarisation ($J_z = 0$ enhanced). Zero polarisation is assumed in this letter. In order to facilitate the extrapolation of the cross-sections measured assuming zero polarisation to other polarisation values, the increase of the total efficiency of the J/ψ meson for a longitudinal polarisation corresponding to $\lambda_\theta = -0.2$ [31], compared to zero polarisation, is given in Ref. [35]. These numbers have been computed based on the analysis performed in Ref. [34]. The relative change in efficiency is linear, to 5% accuracy, between $\lambda_\theta = 0$ and $\lambda_\theta = -0.2$.