

Quarkonium Parton Shower in



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In collaboration with **Peter Richardson**

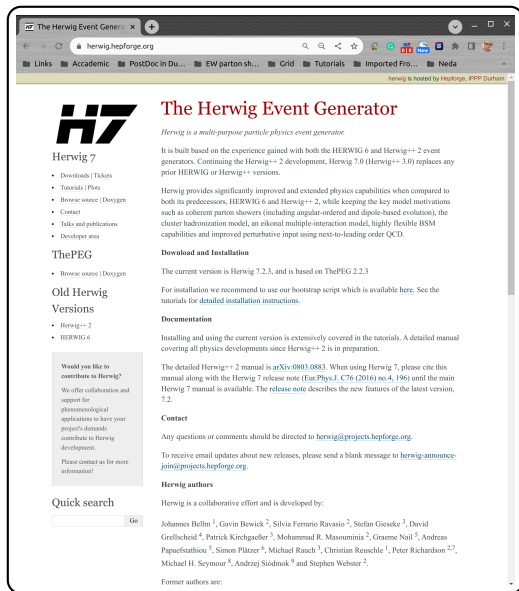
QCD@LHC 2026
29 September 2026

Herwig 7; What it does?

– An outstanding list of features:

Angular ordered parton shower (QCD+QED+EW)
Colour dipole parton shower (QCD)
Automated matching and merging
Colour reconnection models
Colour ME corrections
Cluster and String hadronization model
Underlying event
Flavour mass schemes
Built-in HQET for hadronisation and decay
Electroweak corrections (including an EW PS)
Multiparton hard interactions
Jet structure
Forward physics
BSM physics (including a brand-new BSM PS)
Import UFO models
Shower with LHE samples
Complex decay chains for unstable particles
Interfacing with (many) external programs
Parallel simulations
Built-in interface to Rivet and HepMC
Modularity and extensibility
User-friendly interface
Easy to build and use

Many more features are being developed



The screenshot shows the official website for The Herwig Event Generator. The browser address bar displays 'herwig.hepforge.org'. The website features the Herwig 7 logo, a navigation menu with links like 'Downloads | Tickets', 'Tutorials | Plots', and 'Browse source | Doxygen', and a list of features including 'Built-in HQET for hadronisation and decay' and 'Electroweak corrections'. A sidebar on the left contains a call to action: 'Would you like to contribute to Herwig? We offer collaboration and support for phenomenological applications to have your project's demands contribute to Herwig development. Please contact us for more information!'. The main content area includes sections for 'ThePEG', 'Old Herwig Versions', 'Documentation', 'Contact', and 'Herwig authors'. The 'Documentation' section mentions that the detailed Herwig++ 2 manual is arXiv:0803.0883 and that the Herwig 7 manual is available. The 'Contact' section provides an email address 'herwig@projects.hepforge.org'. The 'Herwig authors' section lists the collaborative team, including Johannes Bellm, Gavin Bewick, Silvia Ferrario Ravasio, Stefan Gieseke, David Grellscheid, Patrick Kirchgaesser, Mohammad R. Masoumnia, Graeme Neil, Andreas Papaefstathiou, Simon Plitzner, Michael Rauch, Christian Reuschle, Peter Richardson, Michael H. Seymour, Andrzej Siodmok, and Stephen Webster. A 'Quick search' bar is located at the bottom of the main content area.

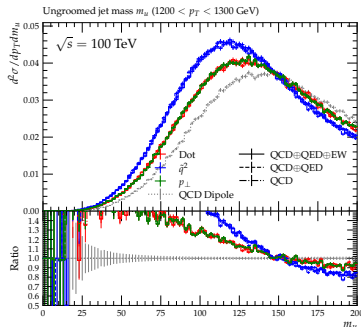
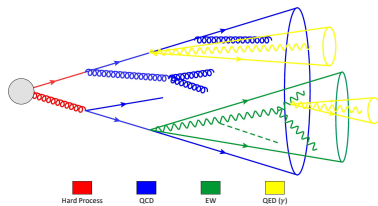
Angular-Ordered Parton Shower

Pros:

- Respects QCD coherence via angular ordering.
- Soft gluon emissions are properly resummed.
- Built-in LL+NLL accuracy.
- EW interactions can be interleaved with QCD.
- Control over colour flow and spin correlations.
- Naturally suppresses wide-angle emissions (empty dead zone).
- Matching with MC@NLO and POWHEG.
- Modularity and intuitive UI.

Cons:

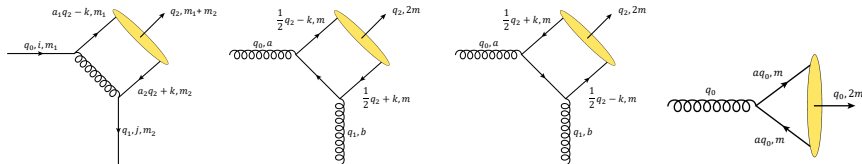
- More complex kinematics reconstruction.
- Interfacing with dipole-based ME corrections.
- Handling NNLL effects is non-trivial.



Many recent developments in the AO PS of Herwig 7.

[AM, Seymour, Sule, [to appear soon]]

Quarkonium Parton Shower



Motivation:

- Heavy quarkonia (J/ψ , Υ , B_c , χ_Q) are key probes of QCD and hadronisation.
- Their production spans non-trivial scales: hard scattering, parton shower, and non-perturbative bound-state formation.
- NRQCD factorisation predicts **colour-singlet** (CS) and **colour-octet** (CO) mechanisms.

Why a dedicated PS?

- Standard showers treat quarkonia as point-like particles.
- Quarkonium-specific emissions (1P_1 , 3P_J , 1D_2 , ...) require matrix-element level control.
- Octet transitions must be modelled as $g \rightarrow \mathcal{O}^{(8)}$, respecting NRQCD long-distance dynamics.

Relevance:

[AM, Richardson, arXiv:2508.06307]

- Accurate p_T spectra, polarisation predictions, and feed-down chains.
- Essential for heavy-flavour jets, exotic decay chains, and BSM signatures involving quarkonia.

NRQCD Framework

Quarkonium production amplitude (NR limit $k \sim m_Q v$, $v \ll 1$):

$$\mathcal{M}(p) = \sum_{L_Z, S_Z} \int \frac{d^3 \mathbf{k}}{(2\pi)^3} \psi_{LL_Z}(\mathbf{k}) \underbrace{\langle L L_Z; S S_Z | J J_Z \rangle \Gamma_{SS_Z}(p, k)}_{\text{short-distance amplitude} \equiv \mathcal{A}(p, k)}$$

$$\text{hard QCD at } \mu_F \gtrsim m_Q \xrightarrow{\mathcal{A}(p, k)} Q\bar{Q} (S, L; \text{spin/colour proj.}) \xrightarrow{\text{LDMEs}} H(^n L_J)$$

Factorisation principle:

- Non-perturbative Bethe-Salpeter wavefunction $\psi_{LL_Z}(\mathbf{k})$:

$$\int \frac{d^3 \mathbf{k}}{(2\pi)^3} [k^\alpha k^\beta \dots] \psi_{LL_Z}(\mathbf{k}) \propto \frac{R^{(L)}(0)}{\sqrt{4\pi}} \epsilon^{[\alpha\beta\dots]}(P, L_Z)$$

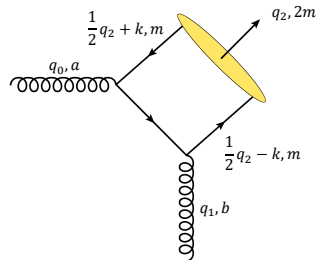
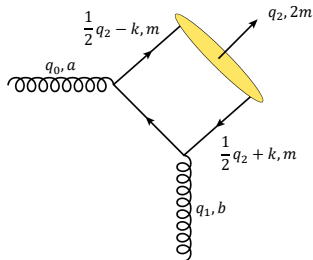
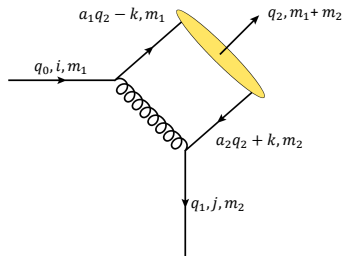
- Wavefunction at the origin (NRQCD LDMEs):

$$\langle 0 | \mathcal{O}_c^H(^n L_J) | 0 \rangle \propto \frac{1}{4\pi} |R_{nL_J}^c(0)|^2 \quad (\text{S: } |R(0)|^2, \text{ P: } |R'(0)|^2, \text{ D: } |R''(0)|^2)$$

Spin-colour projections:

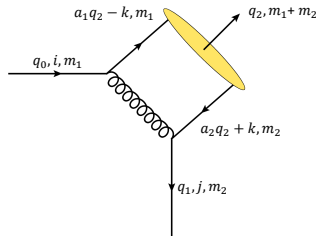
- Angular-momentum coupling via Clebsch-Gordan: $\langle L L_Z; S S_Z | J J_Z \rangle$.
- Colour projectors: singlet $\delta_{ij}/\sqrt{N_c}$, octet $(\lambda^a)_{ij}/\sqrt{2}$.
- Perturbative short-distance piece: $\mathcal{A}(p, k) = \langle LL_Z; SS_Z | JJ_Z \rangle \Gamma_{SS_Z}(p, k)$.

Colour-Singlet Splittings



Colour-Singlet Splittings From Quarks

- Heavy $Q\bar{Q}$ from quark line.
- Colour-singlet projector $\delta_{ij}/\sqrt{N_C}$.



[AM, Richardson, arXiv:2508.06307]

- The production amplitude:

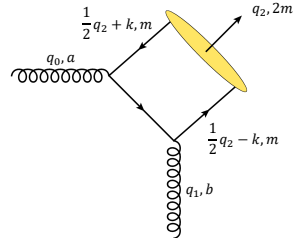
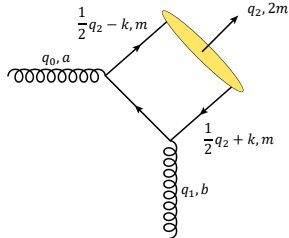
$$\mathcal{M}(q \rightarrow q' \mathcal{O}_1(^n L_J)) = \frac{g_S^2 C_F \langle \mathcal{O}_1(^n L_J) \rangle}{(q_0^2 - a_1^2 M^2)} \frac{\delta_{ij}}{\sqrt{N_C}} \bar{u}_j(q_1, m_2) \gamma^\nu \Pi_{nJ} \gamma^\mu u_i(p, m_1) \\ \times \left[g_{\mu\nu} - \frac{(q_1^\mu + a_2 q_2^\mu + k^\mu)(q_1^\nu + a_2 q_2^\nu + k^\nu) + (q_0^2 - a_1^2 M^2) g_{\mu\nu}}{(q_1 \cdot n + a_2 q_2 \cdot n + k \cdot n)(k^2 + q_1^2 + 2a_2 q_1 \cdot q_2 + 2q_1 \cdot k + 2a_2 q_2 \cdot k + 2a_2 q_1 \cdot q_2)} \right]$$

- $\langle \mathcal{O}_1 \rangle$: NRQCD LDME $\propto |R_{nL_J}(0)|^2$ or derivatives.
- Π_{nJ} : spin projection operator:

$$\begin{pmatrix} \Pi_{1J} \\ \Pi_{3J} \end{pmatrix} = \frac{\sqrt{M}}{4m_1 m_2} (a_2 \not{q}_2 + \not{k} - m_2) \begin{pmatrix} \gamma^5 \\ \not{\epsilon}(q_2) \end{pmatrix} (a_1 \not{q}_2 - \not{k} + m_1)$$

Colour-Singlet Splittings From Gluons

- Heavy $Q\bar{Q}$ from gluon line.
- δ^{ab} : colour-singlet projection after summing gluon colours.



- The production amplitude:

[AM, Richardson, arXiv:2508.06307]

$$\mathcal{M}(g \rightarrow g \mathcal{O}_1(^n L_J)) = \frac{g_S^2 C_F \langle \mathcal{O}_1(^n L_J) \rangle}{4m q_0^2} \frac{\delta^{ab}}{\sqrt{2m N_C}} \text{Tr} [\Delta_{nJ} \times \left(-\frac{\not{\epsilon}(q_0)^a \left(\not{q}_1 + \frac{1}{2} \not{q}_2 + \not{k} - m \right) \not{\epsilon}(q_1)^b}{(q_1 + \frac{1}{2} q_2 + k)^2 - m^2} + \frac{\not{\epsilon}(q_1)^b \left(\not{q}_1 + \frac{1}{2} \not{q}_2 - \not{k} + m \right) \not{\epsilon}(q_0)^a}{(q_1 + \frac{1}{2} q_2 - k)^2 - m^2} \right)]$$

- $\langle \mathcal{O}_1 \rangle$: NRQCD LDME $\propto |R_{nL_J}(0)|^2$ or derivatives.
- Δ_{nJ} : spin projection operator:

$$\begin{pmatrix} \Delta_{1J} \\ \Delta_{3J} \end{pmatrix} = \left(\frac{1}{2} \not{q}_2 + \not{k} + m \right) \begin{pmatrix} \gamma^5 \\ -\not{\epsilon}(q_2) \end{pmatrix} \left(\frac{1}{2} \not{q}_2 - \not{k} + m \right)$$

Colour-Singlet Splittings

Production amplitudes:

$$\mathcal{M}(q \rightarrow q' \mathcal{O}_1(^n L_J)) = \frac{g_s^2 C_F \langle \mathcal{O}_1(^n L_J) \rangle \delta_{ij}}{\sqrt{N_C} (q_0^2 - a_1^2 M^2)} \bar{u}_j(q_1, m_2) \gamma^\nu \Pi_{nS} \gamma^\mu u_i(p, m_1) [\dots]$$

$$\mathcal{M}(g \rightarrow g \mathcal{O}_1(^n L_J)) = \frac{g_s^2 C_F \langle \mathcal{O}_1(^n L_J) \rangle \delta^{ab}}{4m\sqrt{2N_C} m q_0^2} \text{Tr} \left[\left(\frac{1}{2} \not{q}_2 + \not{k} + m \right) (\gamma^5 \text{ or } -\not{\epsilon}) \left(\frac{1}{2} \not{q}_2 - \not{k} + m \right) [\dots] \right]$$

From amplitude to splitting kernel:

[AM, Richardson, arXiv:2508.06307]

The differential branching probability of a given $^n L_J$ quarkonium state:

$$dP_{a \rightarrow b \mathcal{O}_1(^n L_J)} = dz dq_0^2 \frac{d\phi}{2\pi} F_{a \rightarrow b \mathcal{O}_1(^n L_J)}(z, q_0^2); \quad a, b = q, g$$

The spin-squared/averaged and colour-averaged splitting probability function:

$$F_{a \rightarrow b \mathcal{O}_1(^n L_J)}(z, q_0^2) = \sum_{\text{spins}} |\mathcal{M}(a \rightarrow b \mathcal{O}_1(^n L_J))|^2$$

Implemented in Herwig 7 for S-, P-, D-wave states up to $^3 D_J$.

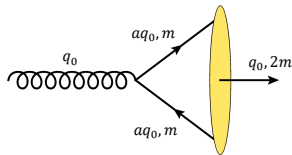
Colour-singlet $q \rightarrow q' \mathcal{O}_1(^n L_J)$ configurations:

State	Herwig Class	Main Processes
$^1 S_0$	QtoQ1S0SplitFn, QtoQP1S0SplitFn	$c \rightarrow c + \eta_c, b \rightarrow b + \eta_b; c \rightarrow b + B_c^+, b \rightarrow c + B_c^-$
$^3 S_1$	QtoQ3S1SplitFn, QtoQP3S1SplitFn	$c \rightarrow c + J/\psi, b \rightarrow b + \Upsilon; c \rightarrow b + B_c^{*+}, b \rightarrow c + B_c^{*-}$
$^1 P_1$	QtoQ1P1SplitFn	$c \rightarrow c + h_c, b \rightarrow b + h_b$
$^3 P_J$	QtoQ3P0/1/2SplitFn, QtoQP3P0/1/2SplitFn	$\chi_{cJ}, \chi_{bJ}; B_c$ P -wave excitations ($J = 0, 1, 2$)
$^1 D_2$	QtoQ1D2SplitFn	$b \rightarrow b + \eta_{b2}; c \rightarrow c + \eta_{c2}$
$^3 D_J$	QtoQ3D1/2/3SplitFn, QtoQP3D1/2/3SplitFn	$\psi(3770), \psi_2(1D), \psi_3(1D); \Upsilon_J(1D); B_c$ D -wave excitations

Colour-singlet $g \rightarrow g \mathcal{O}_1(^n L_J)$ configurations:

State	Herwig Class	Main Processes
$^1 S_0$	GtoG1S0SplitFn	$g \rightarrow g + \eta_c, g \rightarrow g + \eta_b$
$^3 S_1$	GtoG3S1SplitFn	$g \rightarrow g + J/\psi, g \rightarrow g + \Upsilon$
$^1 P_1$	GtoG1P1SplitFn	$g \rightarrow g + h_c, g \rightarrow g + h_b$
$^3 P_J$	GtoG3P0/1/2SplitFn	χ_{cJ}, χ_{bJ} ($J = 0, 1, 2$)
$^1 D_2$	GtoG1D2SplitFn	$g \rightarrow g + \eta_{c2}, g \rightarrow g + \eta_{b2}$
$^3 D_J$	GtoG3D1/2/3SplitFn	$\psi(3770), \psi_2(1D), \psi_3(1D); \Upsilon_J(1D)$

Colour-Octet Branching Probability



- High- p_T quarkonium production is dominated by CO fragmentation.
- $g \rightarrow Q\bar{Q}[n^{(8)}]$ is the leading production mechanism.
- Non-perturbative LDMEs govern the transition from $Q\bar{Q}[n^{(8)}]$ to the physical $\mathcal{O}^{(8)}$ state.
- This process is sufficient at LO, and no explicit inclusion of $g \rightarrow g\mathcal{O}^{(8)}$ or $g \rightarrow gg\mathcal{O}^{(8)}$ is required.
- The $g \rightarrow \mathcal{O}^{(8)}$ transition is modelled via a fixed probability per unit evolution time.
- This probability is governed by the LDME:

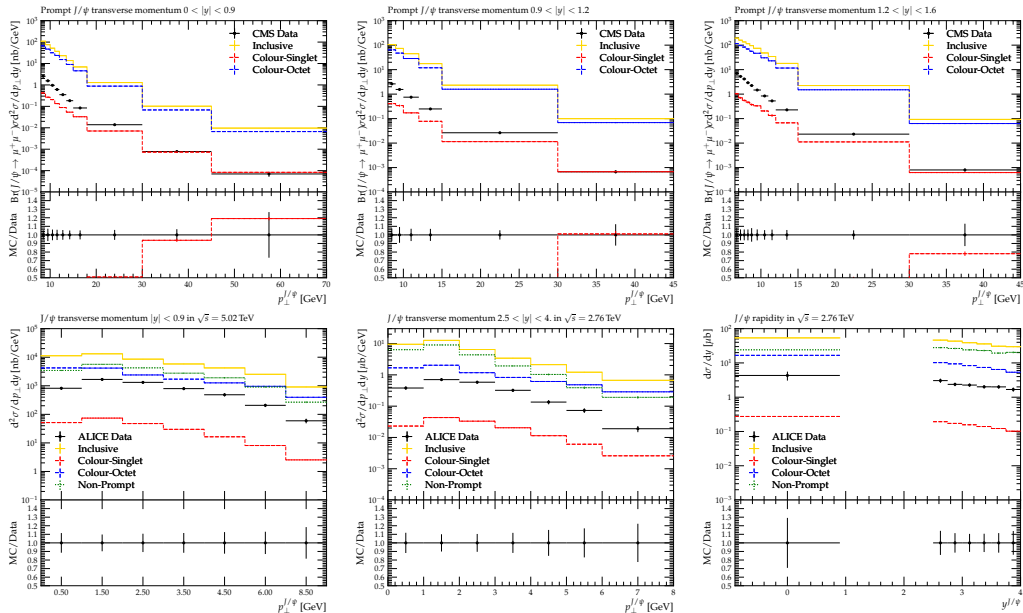
$$P_{g \rightarrow \mathcal{O}^{(8)}(nS_J)} = \frac{\pi \alpha_s (4m^2)}{24m^3} |\mathcal{M}(g \rightarrow \mathcal{O}^{(nS_J)})|^2$$

- $|\mathcal{M}(g \rightarrow \mathcal{O}^{(nS_J)})|^2$ is treated here as a tuneable non-perturbative parameter.

Shower Implementation

30 quarkonium splitting classes:

- 5 CS $g \rightarrow g\mathcal{O}$ classes (1S_0 , 3S_1 and $^3P_{0,1,2}$)
GtoG1S0SplitFn, GtoG3S1SplitFn, GtoG3P0SplitFn, GtoG3P1SplitFn,
GtoG3P2SplitFn
- 8 generic CS $q \rightarrow q'\mathcal{O}$ classes (1S_0 , 3S_1 , $^3P_{0,1,2}$ and $^3D_{1,2,3}$)
QtoQP1S0SplitFn, QtoQP3S1SplitFn, QtoQP3P0SplitFn, QtoQP3P1SplitFn,
QtoQP3P2SplitFn, QtoQP3D1SplitFn, QtoQP3D2SplitFn QtoQP3D3SplitFn,
- 10 same-flavour CS $q \rightarrow q\mathcal{O}$ classes (1S_0 , 1P_1 , 2D_1 , 3S_1 , $^3P_{0,1,2}$, and $^3D_{1,2,3}$)
QtoQ1S0SplitFn, QtoQ1P1SplitFn, QtoQ3S1SplitFn, QtoQ3P0SplitFn,
QtoQ3P1SplitFn, QtoQ3P2SplitFn, QtoQ1D2SplitFn, QtoQ3D1SplitFn,
QtoQ3D2SplitFn, QtoQ3D3SplitFn
- 3 diquark splitting classes (1S_0 : $q \rightarrow \bar{q} + (qq)_1$, $q \rightarrow \bar{q}' + (qq')_0$ and $q \rightarrow \bar{q}' + (qq')_1$)
QtoQPBarQQP0SplitFn, QtoQBarQQ1SplitFn, QtoQPBarQQP1SplitFn
- 4 CO $g \rightarrow (\bar{q}q)$ splitting classes (3S_1 and $^3P_{0,1,2}$)
Gto3S1OctetSplitFn, Gto3P0OctetSplitFn, Gto3P1OctetSplitFn,
Gto3P2OctetSplitFn



Tuning the CS Parameters

- Use experimental decay widths to extract $|R_{nL}(0)|^2$.
- Apply known QCD radiative corrections.
- Cross-check with potential model predictions for higher states.

$$\Gamma(\mathcal{O}_1(^3S_1) \rightarrow \ell\ell) = \frac{16\pi\alpha_{\text{em}}^2}{9} \frac{|R_{3S_1}(0)|^2}{4\pi(2m)^2} \left(1 - \frac{16}{3} \frac{\alpha_S(m^2)}{\pi}\right),$$

$$\Gamma(\mathcal{O}_1(^1S_0) \rightarrow \gamma\gamma) = \frac{48\pi\alpha_{\text{em}}^2}{81} \frac{|R_{1S_0}(0)|^2}{4\pi(2m)^2} \left(1 - 3.4 \frac{\alpha_S(m^2)}{\pi}\right),$$

$$\Gamma(\mathcal{O}_1(^1S_0) \rightarrow gg) = \frac{32\pi\alpha_S^2(m^2)}{3} \frac{|R_{1S_0}(0)|^2}{4\pi(2m)^2} \left(1 + 4.4 \frac{\alpha_S(m^2)}{\pi}\right),$$

$$\Gamma(\mathcal{O}_1(^3S_1) \rightarrow 3g) = \frac{160(\pi^2 - 9)\alpha_S^3(m^2)}{81} \frac{|R_{3S_1}(0)|^2}{4\pi(2m)^2} \left(1 - 4.9 \frac{\alpha_S(m^2)}{\pi}\right),$$

$$\Gamma(\mathcal{O}_1(^3S_1) \rightarrow 3\gamma) = \frac{64(\pi^2 - 9)\alpha_{\text{em}}^3}{2187} \frac{|R_{3S_1}(0)|^2}{4\pi(2m)^2} \left(1 - 12.6 \frac{\alpha_S(m^2)}{\pi}\right),$$

$$\Gamma(\mathcal{O}_1(^3S_1) \rightarrow gg\gamma) = \frac{128(\pi^2 - 9)\alpha_{\text{em}}\alpha_S^2(m^2)}{81} \frac{|R_{3S_1}(0)|^2}{4\pi(2m)^2} \left(1 - 1.7 \frac{\alpha_S(m^2)}{\pi}\right).$$

- Only the above CS states have measured partial widths.
- The rest are taken from potential models.

[AM, Richardson, ‘25]

[Eichten, Quigg, ‘19]

Tuning the CS Parameters

Type	Structure	$ R_{n_S}(0) ^2$
$c\bar{c}$	1S	1.0285
$c\bar{c}$	1P	0.0013
$c\bar{c}$	1D	0.0329
$c\bar{c}$	2S	0.4262
$c\bar{c}$	2P	0.1767
$c\bar{c}$	2D	0.0692
$c\bar{c}$	3S	0.5951
$c\bar{c}$	3P	0.2106
$c\bar{c}$	3D	0.1074
$c\bar{c}$	4S	0.5461
$c\bar{c}$	4P	0.2389
$c\bar{c}$	5S	0.5160

Type	Structure	$ R_{n_S}(0) ^2$
$b\bar{b}$	1S	3.2250
$b\bar{b}$	1P	1.6057
$b\bar{b}$	1D	0.8394
$b\bar{b}$	2S	0.5974
$b\bar{b}$	2P	1.8240
$b\bar{b}$	2D	1.5572
$b\bar{b}$	3S	1.1136
$b\bar{b}$	3P	1.9804
$b\bar{b}$	3D	2.2324
$b\bar{b}$	4S	1.2863
$b\bar{b}$	4P	2.1175
$b\bar{b}$	4D	2.8903
$b\bar{b}$	5S	1.7990
$b\bar{b}$	5P	2.2430
$b\bar{b}$	5D	3.5411
$b\bar{b}$	6S	1.6885
$b\bar{b}$	6P	2.3600
$b\bar{b}$	7S	1.6080

Type	Structure	$ R_{n_S}(0) ^2$
$b\bar{c}$	1S	1.9943
$b\bar{c}$	1P	0.3083
$b\bar{c}$	1D	0.0986
$b\bar{c}$	2S	1.1443
$b\bar{c}$	2P	0.3939
$b\bar{c}$	2D	0.1989
$b\bar{c}$	3S	0.9440
$b\bar{c}$	3P	0.4540
$b\bar{c}$	4S	0.8504

[Eichten, Quigg, '19]
[AM, Richardson, '25]

Table: Non-perturbative singlet wavefunctions, given in GeV^3 units.

Tuning the CO Parameters

- Fit $|\mathcal{M}(g \rightarrow \mathcal{O}(^n S_J))|^2$ values to reproduce all available quarkonium production data.
- Constrain octet LDMEs using multiple processes, where possible.
- Colour-octet NRQCD matrix elements are tuned using only data with $p_T > 10$ GeV; low- p_T bins are excluded from the fit due to dominant non-perturbative effects.

Process	Type	Structure	$ \mathcal{M}(g \rightarrow \mathcal{O}(^n S_J)) ^2$
$g \rightarrow J/\psi$	$c\bar{c}$	1S_3	1.09×10^{-4}
$g \rightarrow \psi(2S)$	$c\bar{c}$	1S_3	6.23×10^{-5}
$g \rightarrow \chi_{c0}$	$c\bar{c}$	1S_3	5.99×10^{-5}
$g \rightarrow \chi_{c1}$	$c\bar{c}$	1S_3	1.80×10^{-4}
$g \rightarrow \chi_{c2}$	$c\bar{c}$	1S_3	2.99×10^{-4}
$g \rightarrow \Upsilon$	$b\bar{b}$	1S_3	7.08×10^{-4}
$g \rightarrow \Upsilon(2S)$	$b\bar{b}$	1S_3	3.68×10^{-4}
$g \rightarrow \Upsilon(3S)$	$b\bar{b}$	1S_3	2.19×10^{-4}
$g \rightarrow \chi_{b0}$	$b\bar{b}$	1S_3	3.10×10^{-4}
$g \rightarrow \chi_{b1}$	$b\bar{b}$	1S_3	9.30×10^{-4}
$g \rightarrow \chi_{b2}$	$b\bar{b}$	1S_3	1.55×10^{-3}
$g \rightarrow \chi_{b0}(2P)$	$b\bar{b}$	1S_3	3.10×10^{-4}
$g \rightarrow \chi_{b1}(2P)$	$b\bar{b}$	1S_3	9.30×10^{-4}
$g \rightarrow \chi_{b2}(2P)$	$b\bar{b}$	1S_3	1.55×10^{-3}
$g \rightarrow \chi_{b0}(3P)$	$b\bar{b}$	1S_3	3.10×10^{-4}
$g \rightarrow \chi_{b1}(3P)$	$b\bar{b}$	1S_3	9.30×10^{-4}
$g \rightarrow \chi_{b2}(3P)$	$b\bar{b}$	1S_3	1.55×10^{-3}

Diquark	$ R_{nS}(0) ^2$
$cc (^1S)$	1.9943
$bb (^1S)$	0.3083
$bc (^1S)$	0.0986

Table: Non-perturbative singlet wavefunctions $|R_1(0)|^2$ for S -state diquarks, given in GeV^3 units.

[Falk, Luke, Savage, Wise, '93]

Table: Tuned octet parameters.

[AM, Richardson, '25]

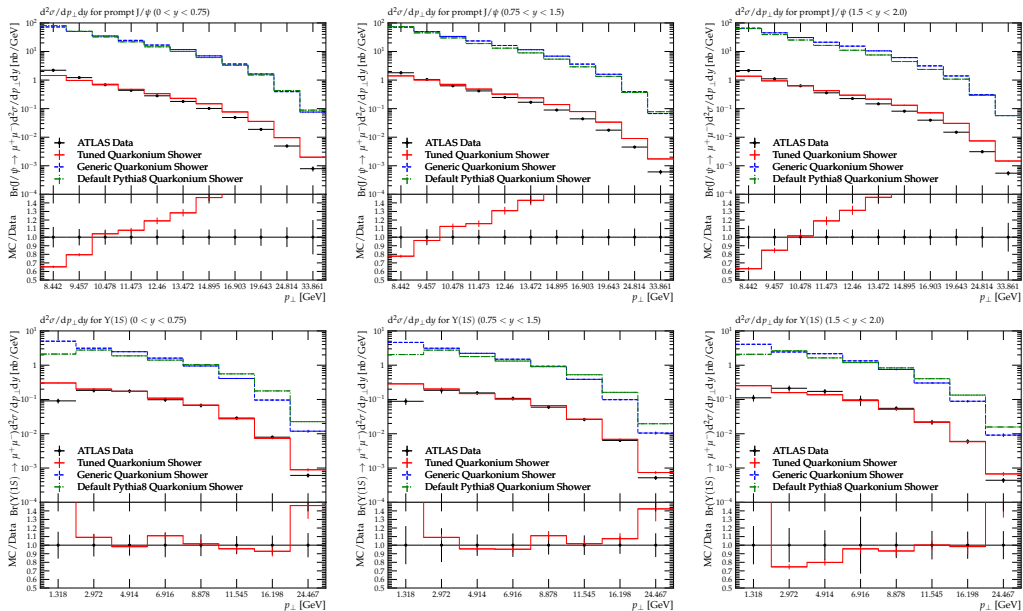


Figure: Prompt production of J/ψ and Υ states.

[arXiv:2508.06307, arXiv:2312.0520]

Final Remarks

- A complete, automated, and process-independent quarkonium parton shower has been implemented in Herwig 7.
- Defines **30** new splitting classes to cover **103** unique spin-colour-flavour configurations.
- Supports CS q - and g -initiated splittings, as well as CO transitions via gluon fragmentation.
- Handles S -, P -, and D -wave transitions across all relevant quantum numbers.
- Handles diquark for all possible configurations.
- Requires only a simple multiplicative normalisation to PDG rates (for CS) and experimental cross-sections (for CO).
- Provides a robust platform for studying quarkonium dynamics in collider physics and Monte Carlo event generators.
- Quarkonium parton shower will become available with the Herwig-7.4.0 release.

For more details, please visit:
herwig.hepforge.org

Thank You!