“Introduction”
Herwig 7 tuning and KrkNLO implementation with spin correlations

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Background

- Completed my MSc. in India in 2021
- MSc. thesis on tuning FSR parameters in Pythia
- Looked at the effect of Jet Substructure measurements by ATLAS on the tune
TENSION between Data and MCEG modelling => Scope for improvement of the MCEG

Link to the pre-print - https://inspirehep.net/literature/1842994
First year as a PhD

• Started where I left.. More tuning!

• Tuning of fragmentation parameters in the String model with Herwig

• TheP8I, written by L. Lonnblad allowed the internal use of Pythia 8-stings with Herwig 7 events.
Autotunes paper by Johannes Bellm and Leif Gellersen - [https://inspirehep.net/literature/1751](https://inspirehep.net/literature/1751)
- **Next step** - Tuning to hadron hadron data
  On the principle of using MC pdfs and reweighting (refer James’ talk)
- LO and NLO Validations for Drell Yan and Higgs productions

<table>
<thead>
<tr>
<th>Drell Yan production</th>
<th>Cross section (pb)</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>LO with MCDY pdf</td>
<td>737.2(7)</td>
<td>738</td>
</tr>
<tr>
<td>NLO using KrkNLO with MC pdf</td>
<td>1022.0(1)</td>
<td>1022.3(2)</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th>Higgs production via gg fusion</th>
<th>Cross section (pb)</th>
<th>Reference</th>
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</thead>
<tbody>
<tr>
<td>LO</td>
<td>5.572(4)</td>
<td>5.564(1)</td>
</tr>
<tr>
<td>NLO using KrkNLO with MC pdf</td>
<td>12.948(9)</td>
<td>12.939(2)</td>
</tr>
</tbody>
</table>
- First results for W-production with KrkNLO
- Spin correlations for Drell Yan and W productions
- Implementation guided by the paper - “A Simple prescription for first order corrections to quark scattering and annihilation processes” M. Seymour, 1994 (https://inspirehep.net/literature/378040)
Thank you!
Algorithm to implement spin correlation

\[ d\sigma_3 = \frac{f_{q/1}(\xi_1) f_{\bar{q}/2}(\xi_2)}{f_{q/1}(\eta_1) f_{\bar{q}/2}(\eta_2)} \frac{C_F \alpha_s}{2\pi} \frac{d\hat{s}d\hat{t}}{\hat{s}^2\hat{t}\hat{u}} \left\{ (Q^2 - \hat{u})^2 d\sigma_2 \frac{d\phi}{2\pi} + (Q^2 - \hat{t})^2 d\sigma_2 \frac{d\phi}{2\pi} \right\}. \]

1. Generate a parton model event according to the exact \( \mathcal{O}(1) \) matrix element.
2. Generate \( \hat{s} \) and \( \hat{t} \) values according to \( Q^4d\hat{s}d\hat{t}/\hat{s}^2\hat{t}\hat{u} = Q^4d\hat{s}d\hat{t}/\hat{s}^2\hat{t}(Q^2 - \hat{s} - \hat{t}) \).
3. Construct momenta in the boson rest-frame corresponding to these values.
4. Choose parton 1 with probability \( (Q^2 - \hat{u})^2 / \left( (Q^2 - \hat{u})^2 + (Q^2 - \hat{t})^2 \right) \), and otherwise parton 2, and uniformly rotate about the chosen parton.
5. Boost the momenta back to the lab frame such that the boson’s rapidity is the same as it was in the parton-model event.
6. Calculate a weight factor

\[ w = \frac{C_F \alpha_s}{2\pi} \frac{f_{q/1}(\xi_1) f_{\bar{q}/2}(\xi_2)}{f_{q/1}(\eta_1) f_{\bar{q}/2}(\eta_2)} \left\{ (1 - \hat{u}/Q^2)^2 + (1 - \hat{t}/Q^2)^2 \right\}. \]

7. Keep the event with probability proportional to \( w \).