

Herwig++ & Rivet for ep

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Outline.

Herwig++ status, prospects and wishes for ep [SP for the Herwig++ collaboration]

- Herwig++ for ep
- Prospects for Herwig++ 3.0
- An ep wishlist for MC generators

A Rivet wrapper for HZTOOL [H. Jung, SP]

Herwig++ & ep – Status as of 2.7

Showers:

- Default: angular ordered shower [S. Gieseke, P. Stephens, B. Webber – JHEP 0312 (2003) 045]
- Optional: p_{\perp} ordered dipole shower [SP & S. Gieseke – JHEP 1101 (2011) 024]

Both ready and tested for inclusive DIS, including NLO matching.
2+1 jets at NLO+PS available as well.

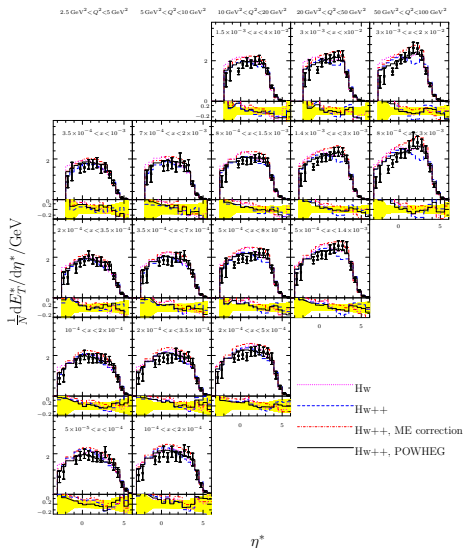
Plus: Cluster hadronization, eikonal MPI model [not yet ready for photoproduction]

No extensive validation for *ep*. **Analyses missing in usable form → Part II**

[Sadly, also not highest priority]

Angular Ordered Shower plus NLO.

[L D'Errico, P. Richardson – Eur.Phys.J. C72 (2012) 2042]



Angular ordered shower with matrix element correction and Powhcg matching (builtin).

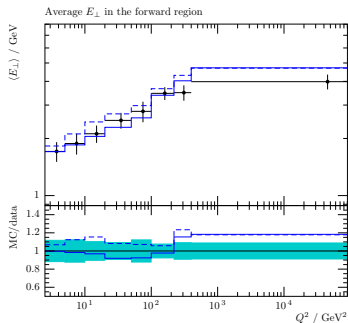
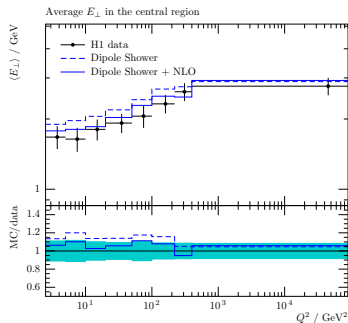
Transverse energy flows at low- Q^2 . Major improvements by NLO in high- Q^2 sample.

No dedicated tune.

Dipole Shower plus NLO.

LO+PS and NLO+PS results, dedicated LO and NLO tunes

[SP & S. Gieseke – Eur.Phys.J. C72 (2012) 2187]



Central region fine, forward, high- Q^2 not as good.

Prospects for Herwig++ 3.0 and beyond.

Automated LO and NLO cross sections for Herwig++

[J. Bellm, N. Fischer, S. Gieseke, SP, D. Rauch, C. Reuschle + A. Wilcock, P. Richardson]

- Run out of the box, steering as before.
- Include matching to angular ordered and dipole shower.
- Provide all necessary functionality for (N)LO merging.

Include reasonable and consistent evaluation of shower and scale uncertainties.

→ Integrated, coherent framework.

Continuation and generalization of dipole shower plus NLO developments.

[SP & S. Gieseke – Eur.Phys.J. C72 (2012) 2187]

Closely tied to structural improvements and extensions of ThePEG.

Major milestone for Herwig++ 3.0 efforts.

Partial beta tester available in Herwig++ 2.7.x, much more to come in 3.0.

Matchbox Overview.

$$\begin{aligned}\sigma_{\text{NLO}} = & \int_n d\sigma_{\text{LO}} \left(\frac{|\mathcal{M}_{n,0}\rangle}{|\mathcal{M}_{n,0}|^2} \right) + \int_n \left[d\sigma_{\text{V}} \left(\frac{|\mathcal{M}_{n,0}\rangle, |\mathcal{M}_{n,1}\rangle}{2\text{Re}\langle \mathcal{M}_{n,0} | \mathcal{M}_{n,1} \rangle} \right) + \int_1 d\sigma_{\text{A}} \left(\frac{|\mathcal{M}_{n,0}\rangle}{|\mathcal{M}_{n,0}^j|^2} \right) \right] \\ & + \int_{n+1} \left[d\sigma_{\text{PS}} \left(\frac{P(\vec{q}), D(\rho_{\perp})}{R_{\text{ME}}(\rho_{\perp})} \right) - d\sigma_{\text{A}} \left(\frac{|\mathcal{M}_{n,0}\rangle}{|\mathcal{M}_{n,0}^j|^2} \right) \right] \\ & + \int_{n+1} \left[d\sigma_{\text{R}} \left(\frac{|\mathcal{M}_{n+1,0}\rangle}{|\mathcal{M}_{n+1,0}|^2} \right) - d\sigma_{\text{PS}} \left(\frac{P(\vec{q}), D(\rho_{\perp})}{R_{\text{ME}}(\rho_{\perp})} \right) \right]\end{aligned}$$

Interfaces at amplitude level

- Color bases provided, including interface to ColorFull.
[M. Sjödahl, SP]
- Spinor helicity library and caching facilities.
- MadGraph5.
[MadGraph & J. Bellm, S. Gieseke, SP, A. Wilcock]
- Some in-house calculations and parts of HJets++.
[F. Campanario, T. Figy, SP, M. Sjödahl]

Interfaces at squared amplitude level

- Dedicated interfaces.
[HEJ & SP]
[nlojet++ & J. Kotanski, J. Katzy, SP]
- BLHA2.
[GoSam & J. Bellm, S. Gieseke, SP, C. Reuschle]
[NJet & SP]
[OpenLoops & J. Bellm, S. Gieseke]
[VBFNLO & K. Arnold, S. Gieseke, SP]

Matchbox infrastructure

based on [SP & S. Gieseke – Eur.Phys.J. C72 (2012) 2187]

- Process generation and bookkeeping, integration.
- Automated Catani-Seymour dipole subtraction.
- Diagram-based mutli-channel phase space.

Shower plugins

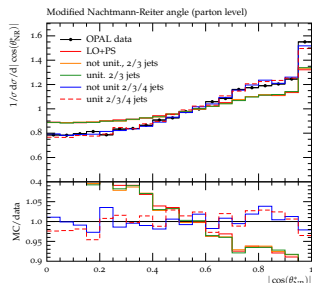
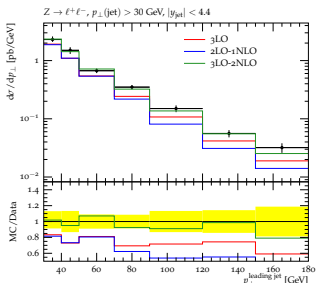
matching details & uncertainties [in preparation]

- Dipole shower $D(\rho_{\perp})$.
- Angular ordered shower $P(\vec{q})$.
- ME correction $R_{\text{ME}}(\rho_{\perp})$, including adaptive sampling.

(N)LO Merging.

[J. Bellm, S. Gieseke, SP – work in progress]

Matchbox framework provides unique possibilities for exploring new merging algorithms. Follow the 'unitarized' approach. [SP – JHEP 1308 (2013) 114] [Lönnblad, Prestel – JHEP 1303 (2013) 166]



Z plus jets from ATLAS, four-jet correlations at LEP.
Merging crucial for ep jet production: Need for tests.

[see also T. Carli, T. Gehrmann, S. Hoeche – Eur.Phys.J. C67 (2010) 73-97]

Useful ep Physics for Event Generators.

A lot of data certainly available, but anything more in these directions is helpful:

Matching/Merging:

Everything which has $(n > 1) + 1$ jets.

Hadronization:

Identified particle spectra in general, and specifically forward.

We know that we've got hadronization troubles at LHC, *ep* needed to clarify this.

Showers:

Jet evolution (more speculative): Generalized jet algorithms, jet shapes.

Personal statement: We should stop blindly extrapolating from LEP to LHC.

Validation against *ep* data is absolutely crucial, and highly welcome.

Analyses need to be usable: Rivet; corrections for detector acceptance only.

A Rivet Wrapper for HZTOOL.

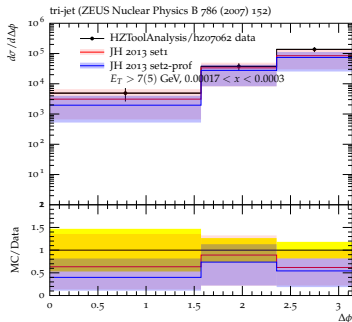
[H. Jung, SP – in progress]

There are four HERA analyses in the current Rivet release.
Do I need to add further motivation? Here's how it works:

HZTOOL plugin builds as
`configure/make/make install`

Then just use as always:

```
rivet -a HZToolAnalysis -a HZ07062  
myStuff.hepmc
```



A Rivet Wrapper for HZTOOL.

[H. Jung, SP – in progress]

TODOs for a release:

- Currently Rivet 1.9.x based. Rivet 2.x port needed?
- A lot of documentation files (.plot, .info) to write.
- Testing, testing, testing.

Any help is more than welcome!

We will probably make a beta tester available soon.

Summary.

Herwig++ is ready for DIS, even at NLO+PS.

More development ongoing, next release will provide NLO+PS also for jets.

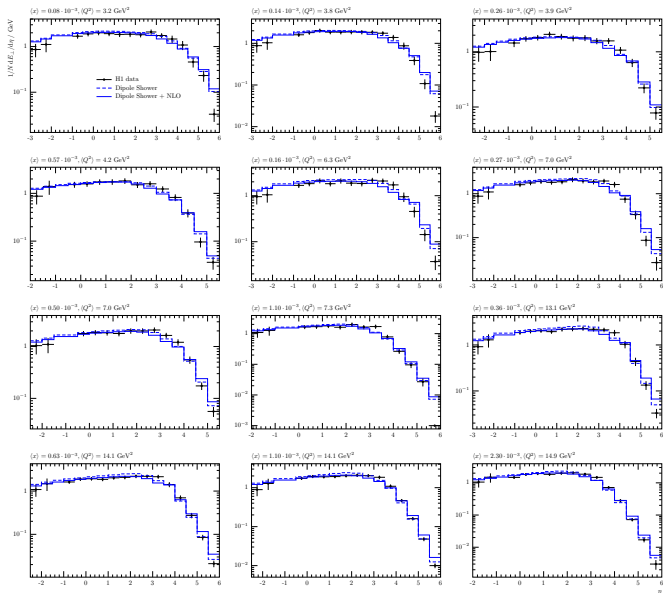
Multijet merging is crucial, we follow a new merging algorithm.

ep physics is highly relevant to event generator development.

Analyses need to be usable: Rivet. HZTOOL wrapper available soon.

Backup.

Dipole Shower plus NLO.



Dipole Shower plus NLO.

