

# Status of Herwig++7

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– on behalf of the Herwig 7 team –

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Michael Rauch, Christian Reuschle, Peter Richardson, Peter Schichtel,  
Michael H. Seymour, Andrzej Siódmok, Alexandra Wilcock

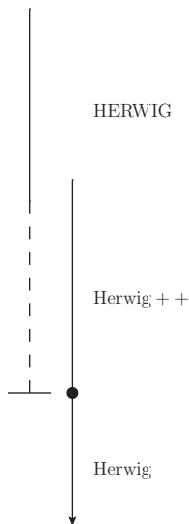
+ Nadine Fischer, Marco A. Harrendorf, Graeme Nail, Andreas Papaefstathiou, Daniel Rauch



# Disclaimer

Similar overview as at ATLAS+CMS MC workshop

# Herwig 7 – What's that?



Herwig++ has seen a ten-year-development to meet a milestone intended to **fully replace** the FORTRAN HERWIG program.

This milestone evolved over time as the experimental and phenomenological needs did.

On top of its first definition (= at least as good as HERWIG), precision has become the key goal.

**Herwig++ 3.0 → Herwig 7.0**

[Mind non-capitalization – the use of HERWIG 7.0 is prohibited and offenders will be fined]

# Herwig 7.0 – Core Features

[See the Herwig 7.0 Release Note – arXiv:1512.01178 for a complete list]

**NLO matched to parton showers as default** for the hard process.

[Based on Matchbox module – SP, J. Bellm, A. Wilcock, M. Rauch, C. Reuschle]

- Fully automated, no external codes to run, no event files to move around.
- Subtractive (MC@NLO-type) and multiplicative (Powheg-type) matching.

**Two showers:** Angular-ordered and dipole shower.

**Spin correlations and QED radiation** in angular ordered shower.

[P. Richardson – The last thing HERWIG could do and Herwig++ couldn't]

Facilities for **parton shower uncertainties** and improved kinematics reconstruction.

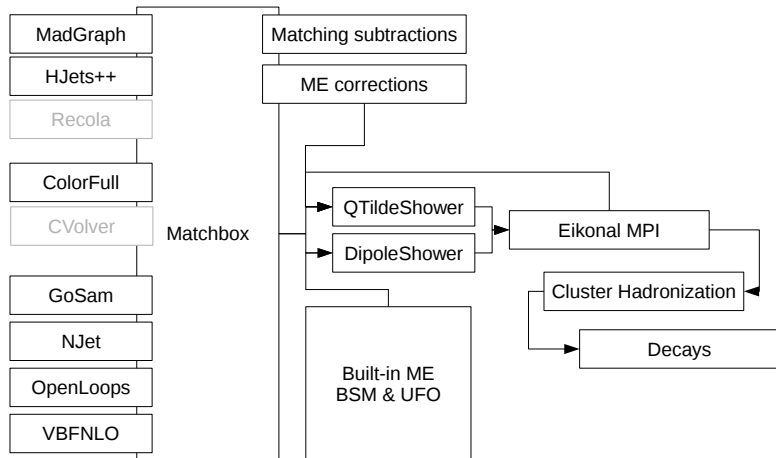
[SP, P. Richardson]

EW corrections for di-boson production, several **Contrib** extensions  
(more matrix elements, support for multiple weights from LHE files, ...)

[S. Gieseke, T. Kasprzik, J. Kühn] [A. Papaefstathiou] [F. Campanario, T. Figy, SP, M. Sjödhall]

Vastly **improved documentation**, usage and installation + new tunes.

# Herwig 7.0 – Under the Hood



# Herwig 7.0 – Installation, Documentation & Usage

Bootstrap script pulling in all dependencies. Tested on a large number of platforms.

→ `./herwig-bootstrap /where/to/install`

Documentation re-written from scratch: “living” sphinx sites replacing old wiki pages.

→ **Check out** [herwig.hepforge.org](http://herwig.hepforge.org)

Update of detailed physics & manual will follow in due course.

Usage can be done as before, though **lots of parallelization added**:

- Separate building, grid adaption, and event generation  
→ Cheaper parameter variations.
- Grid adaption parallelized in separate jobs (no IPC required)  
→ `Herwig build --maxjobs=6 LHC-Matchbox.in`  
→ `Herwig integrate --jobid=3 LHC-Matchbox.run ...`
- Multicore capabilities  
→ `Herwig run --jobs=24 LHC-Matchbox.run`



# Herwig 7.0 – Installation, Documentation & Usage

Old-style input files still working, new NLO input files much easier to handle.

## Essentials of a new-style input file:

```
read Matchbox/PPCollider.in ← Choose collider setup.
```

```
set Factory:OrderInAlphaS 1 ← Choose process.
```

```
set Factory:OrderInAlphaEW 2  
do Factory:Process p p -> e+ e- j
```

```
read Matchbox/MadGraph-OpenLoops.in ← Choose amplitude providers.
```

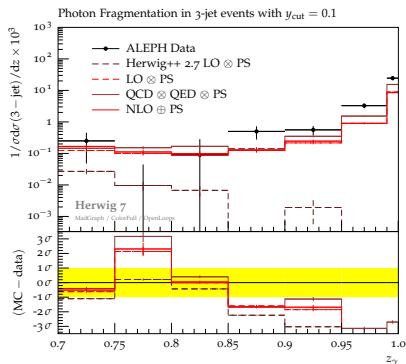
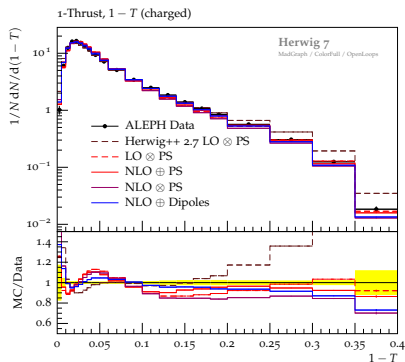
```
read Matchbox/MCatNLO-DefaultShower.in ← Choose shower and matching.
```

Feel free to drop us a line at:

[herwig@projects.hepforge.org](mailto:herwig@projects.hepforge.org) if there are any open questions.



# Herwig 7.0 – Few General Examples



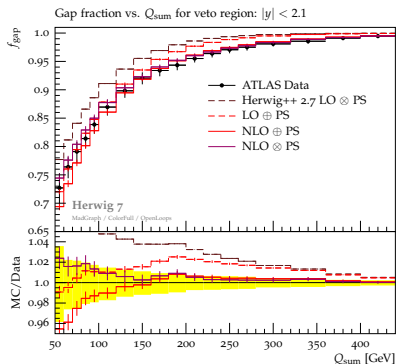
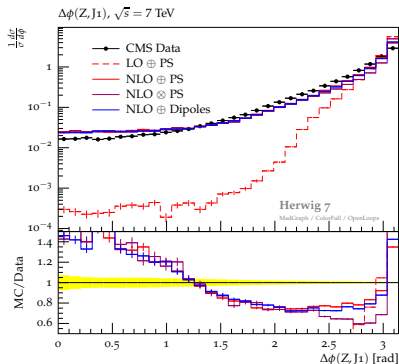
Herwig 7.0 at LEP – new tune available with the release.  
Several improvements to angular ordered shower.

Tons of plots using all combinations at: <https://herwig.hepforge.org/plots/herwig7.0/>





# Herwig 7.0 – Few General Examples

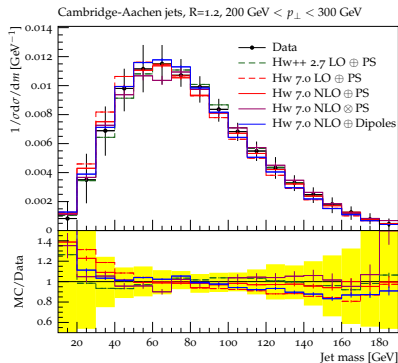
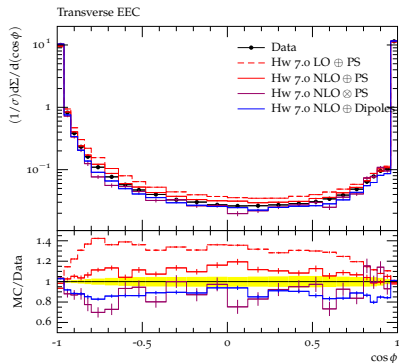


Z+jet events from CMS and top pairs from ATLAS.  
Matchbox using MadGraph, ColorFull and OpenLoops.

Tons of plots using all combinations at: <https://herwig.hepforge.org/plots/herwig7.0/>



# Herwig 7.0 – Jets



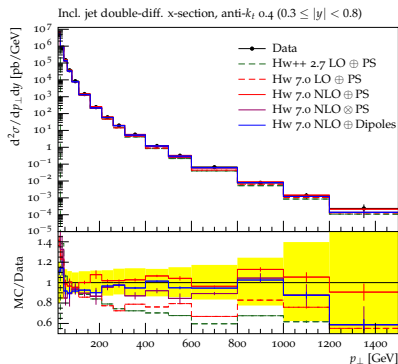
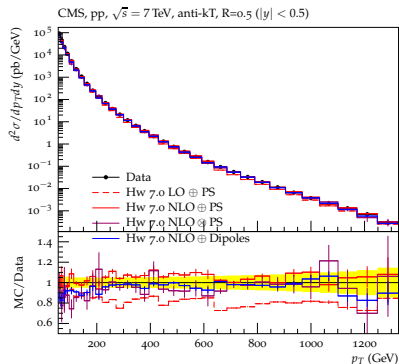
Jets from CMS and ATLAS.

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# Herwig 7.0 – Jets



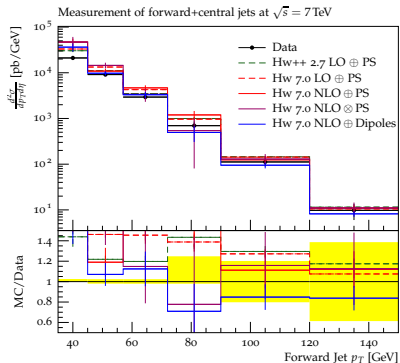
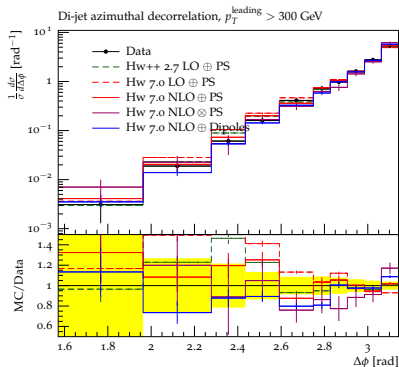
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# Herwig 7.1 – Next Steps

Expect a 7.1 release on a timescale of about a year.

Minor improvements which were not quite ready for the release.

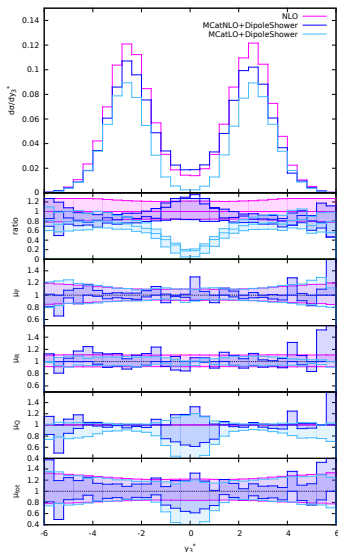
E.g. Loop-induced processes.

Main focus: Release **NLO multijet merging**.

Fully exploit phenomenology potential and focus on uncertainties.



# A First Glimpse on Uncertainties

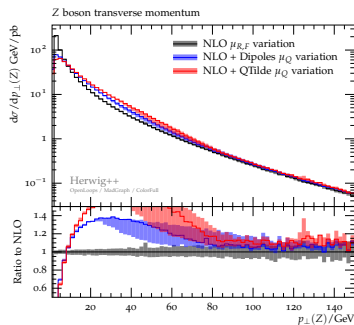


VBF WW production including leptonic decays from Matchbox+VBFNLO.

[M. Rauch, SP] in progress

Breakdown of (matching) uncertainties and validation between two showers.

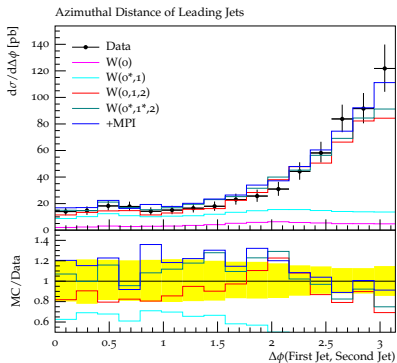
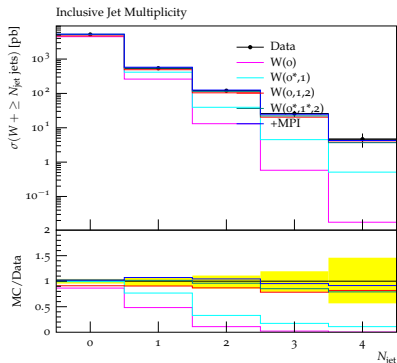
[J. Bellm, G. Nail, SP, P. Schichtel, A. Siodmok] in progress



# Multijet Merging Examples

Modified unitarized merging algorithm with the dipole shower.

[J. Bellm, S. Gieseke, SP] based on [SP & Lönnblad, Prestel – 2012]



W+jets production compared to ATLAS data.



# Summary

Herwig 7 has been released.

Automated NLO by default: Two showers  $\times$  two matching algorithms.

Much more on top of this: QED, spin correlations, ...

Vastly improved documentation and better handling of user support.

Herwig 7 is the platform for further important development:

NLO multijet merging, loop-induced processes, subleading- $N$ , more on uncertainties ...





[herwig.hepforge.org](http://herwig.hepforge.org)

[herwig@projects.hepforge.org](mailto:herwig@projects.hepforge.org)

