

# VBF & BSM with Herwig 7

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at

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# The Herwig Event Generator



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**

# Herwig 7 – Core Features

[Eur.Phys.J. C76 (2016) no.4, 196]

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

- Fully automated, only linking external codes to calculate amplitudes.
- Run in a single program, 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.

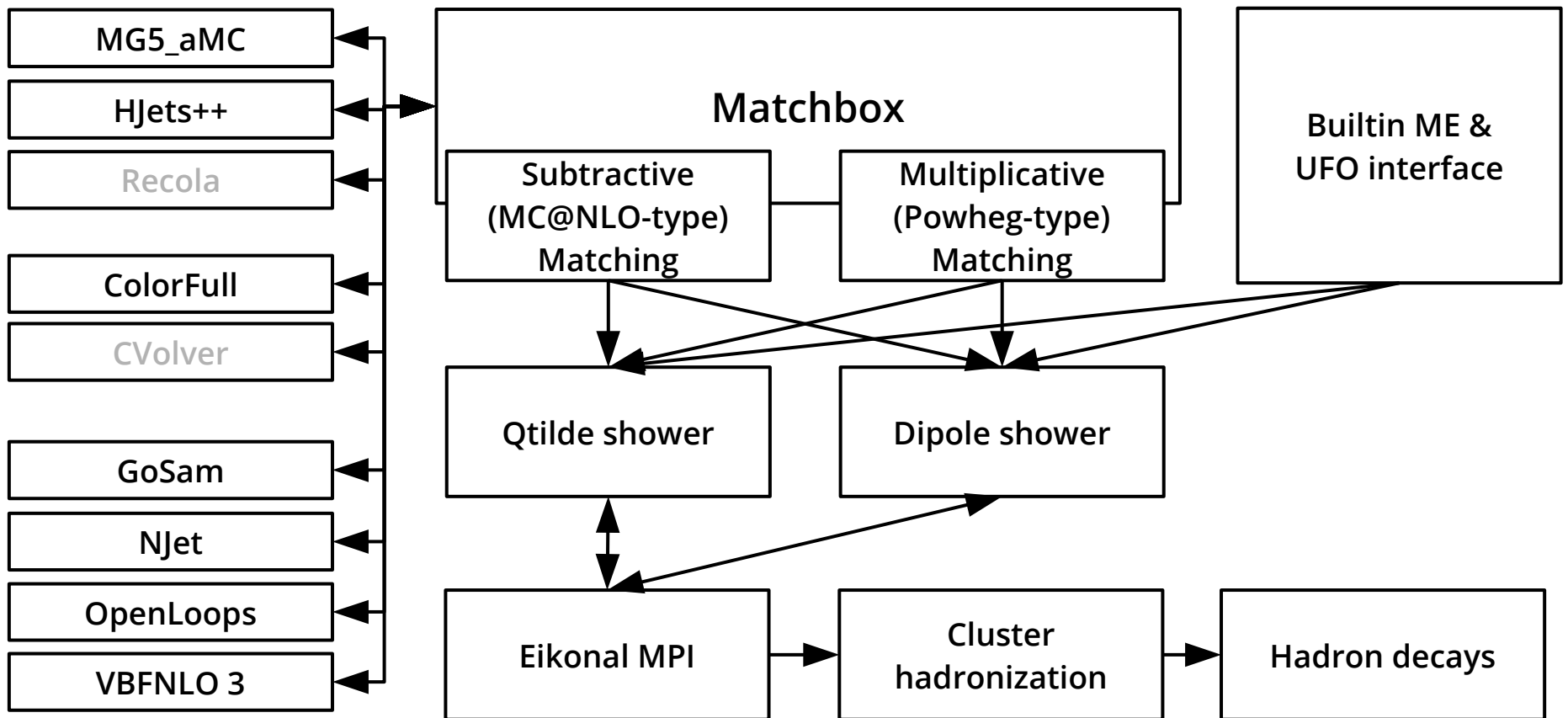
Facilities for **parton shower uncertainties**.

**Vastly improved documentation**, usage and installation.

New tunes taking NLO matching into account.

# Herwig 7 – Under the Hood

Use run-time interfaces to external codes to evaluate amplitudes.  
Automatically build up fixed-order or matched NLO cross sections.



Output: HepMC, Rivet, built-in analyses.

# Documentation, Installation and User Support

Documentation re-written from scratch: **“Living” sphinx site**  
Replacing old wiki pages.

**Bootstrap script** pulling in all dependencies, heavily tested:

```
$ ./herwig-bootstrap /opt/Herwig7
.....
##### / / ^\ / #####
##### / - - / #####
##### / / / #####

Herwig 7 bootstrap was successful.

$ source /opt/Herwig7/bin/activate

    activates all required environment variables.

$ deactivate

    returns to the original environment variables.

$
```

The Herwig Event Generator

Herwig is a multi-purpose particle physics event generator.

It is built based on the experience gained with both the HERWIG 6 and Herwig++ 2 event generators. Continuing the Herwig++ 2 development, Herwig 7.0 (Herwig++ 3.0) replaces any prior HERWIG or Herwig++ versions.

Herwig provides significantly improved and extended physics capabilities when compared to both its predecessors, HERWIG 6 and Herwig++ 2, while keeping the key model motivations such as coherent parton showers (including angular-ordered and dipole-based evolution), the cluster hadronization model, an eikonal multiple-interaction model, highly flexible BSM capabilities and improved perturbative input using next-to-leading order QCD.

**Download and Installation**

The current version is Herwig 7.0.1, and is based on ThePEG 2.0.1.

For installation we recommend to use our bootstrap script which is available [here](#). See the tutorials for [detailed installation instructions](#).

**Documentation**

Installing and using the current version is extensively covered in the tutorials. A detailed manual covering all physics developments since Herwig++ 2 is in preparation.

The detailed Herwig++ 2 manual is [arXiv:0803.0883](#). When using Herwig 7, please cite this manual along with the Herwig 7 release note ([arXiv:1512.01178](#)) until the main Herwig 7 manual is available.

**Contact**

Any questions or comments should be directed to [herwig@projects.hepforge.org](mailto:herwig@projects.hepforge.org).

To receive email updates about new releases, please send a blank message to [herwig-announce-join@projects.hepforge.org](mailto:herwig-announce-join@projects.hepforge.org).

**Herwig authors**

Herwig is a collaborative effort and is developed by:

Johannes Bellm<sup>1</sup>, Stefan Gieseke<sup>2</sup>, David Grellscheid<sup>1</sup>, Simon Plätzer<sup>1,3</sup>.

**Revised issue tracking** for more efficient user response.

# Herwig 7 – Usage Example

Old-style input files still work but will become deprecated.  
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  
set Factory:OrderInAlphaEW 2  
do Factory:Process p p -> e+ e- j
```

← Choose process.

```
read Matchbox/MadGraph-OpenLoops.in
```

← Choose amplitude providers.

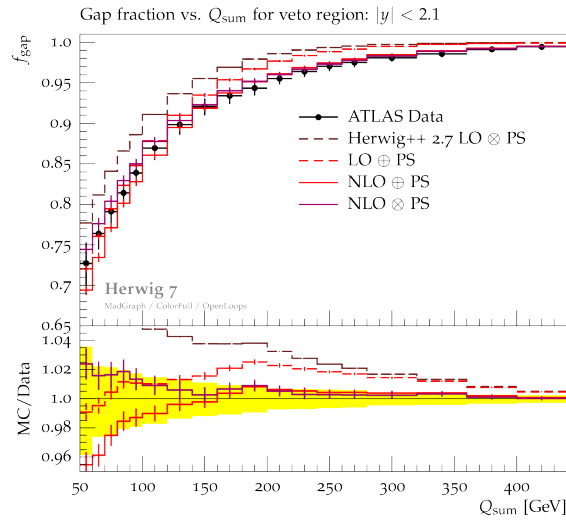
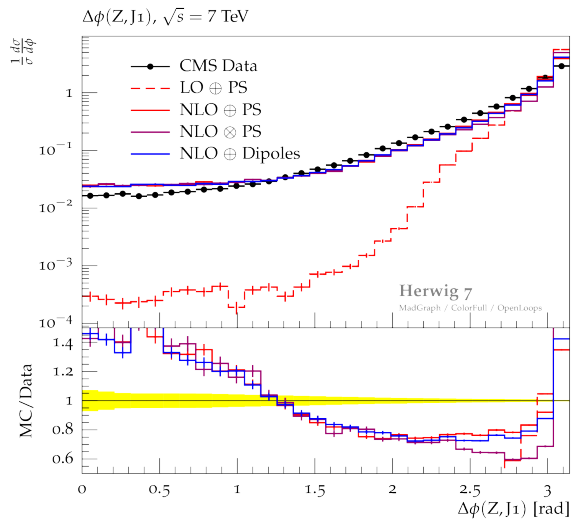
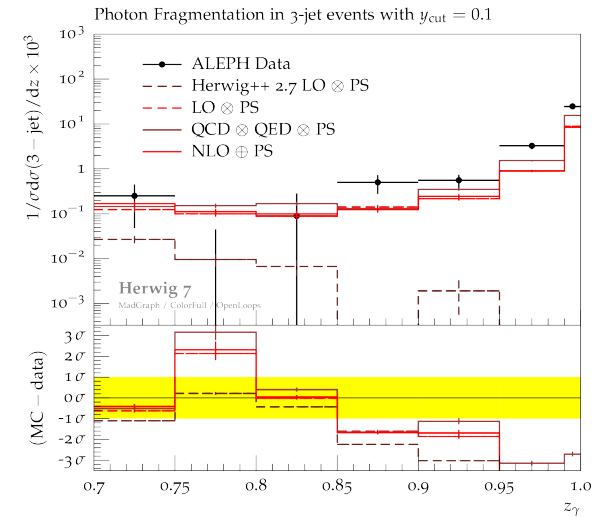
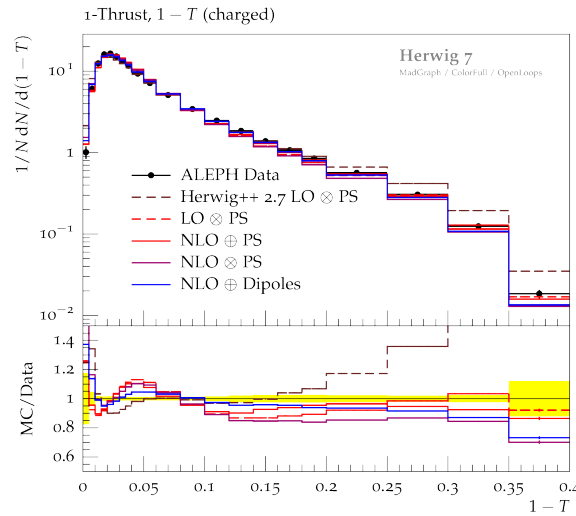
```
read Matchbox/MCatNLO-DefaultShower.in
```

← Choose shower and matching.

# Herwig 7 – Sample Results

[amplitudes built-in or from MG5aMC and OpenLoops]

From LEP ...



... to LHC.

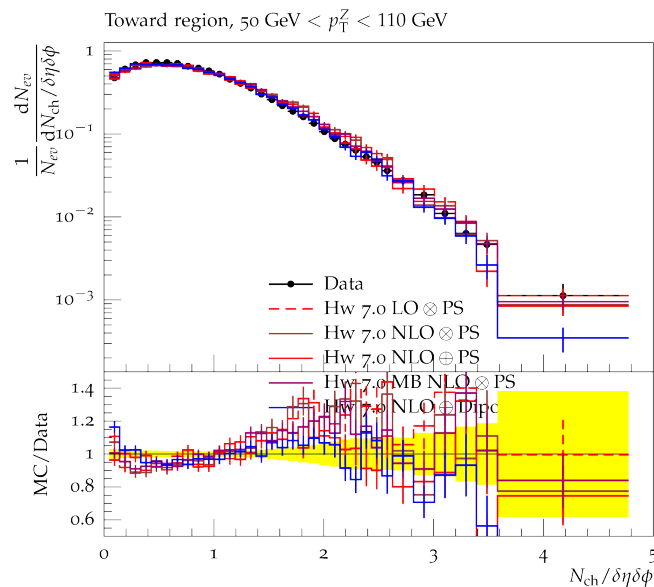
# Herwig 7 – Extensive Validation against Data

[amplitudes built-in or from MG5aMC and OpenLoops]

Routinely run all available Rivet analyses.

All processes simulated at NLO using the available options.

Stability and data description crucial for release quality standards.



The Herwig Event Generator – Herwig 7.0 documentation – Hepforge – Mozilla Firefox

<https://herwig.hepforge.org/plots/herwig7.0/>

Herwig 7 is hosted by Hepforge, IPPP Durham

## Herwig 7.0 Results

### Comparisons with Data

- [B-factory data](#)
- [HERA data](#)
- [LEP data](#)
- [LHC W/Z production data](#)
- [LHC Higgs data](#)
- [LHC Jet data](#)
- [LHC Photon data](#)
- [SppS etc low energy data](#)
- [Star data](#)
- [Tevatron Jet data](#)
- [Tevatron photon data](#)
- [Tevatron W/Z data](#)

### MC plots for Higgs production

- [VBF](#)
- [Associated Production with W](#)
- [Associated Production with Z](#)
- [Gluon fusion](#)
- [Gluon fusion plus jet](#)

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!

Quick search

Go

Enter search terms or a module

<https://herwig.hepforge.org/plots/herwig7.0/Rivet-BFactory/index.html>



# VBF & BSM with Herwig 7

## Herwig 7 NLO Infrastructure

[live demo by M. Rauch]

- various processes from VBFNLO 3, focus on AC
- EW H+jets from Hjets++, NLO 2 & 3 jets w/o VBF approximation

## Herwig 7 UFO Interface

[live demo & hands on with J. Bellm]

- inclusive production and decays w/ spin correlations
- integrated with Matchbox in a future release