VBF & BSM with Herwig 7

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at
Fututre of VBF Measurements | Durham 22 September 2016

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.

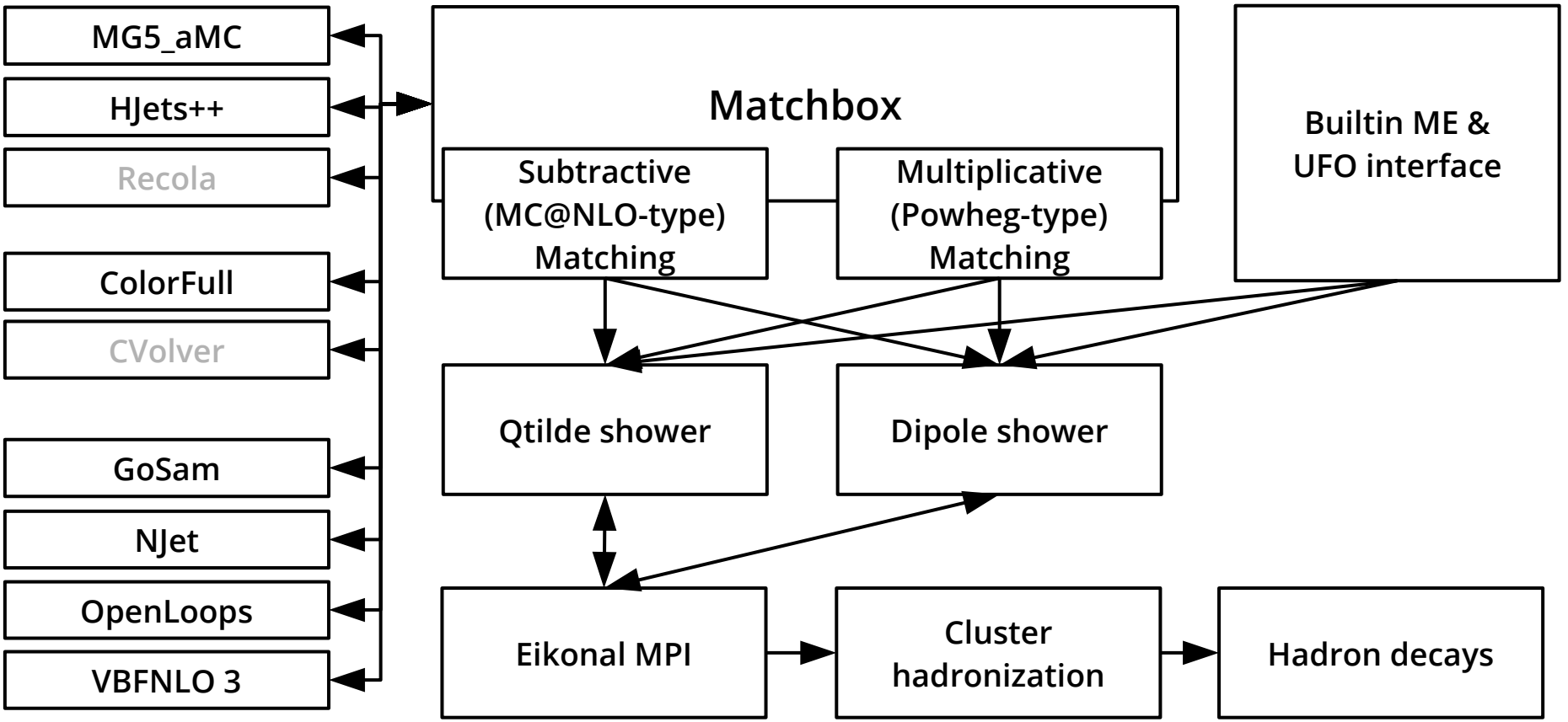
Facilities for **parton shower uncertainties.**

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.



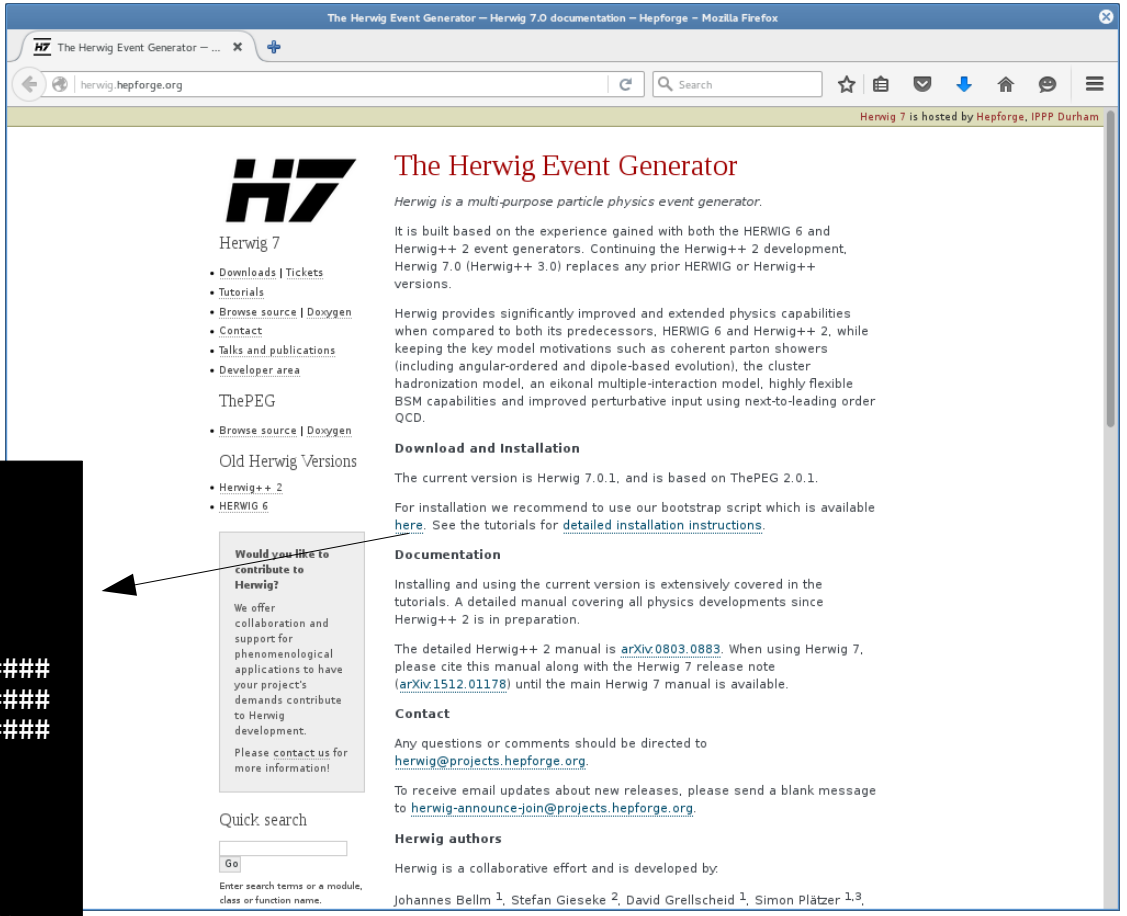
Output: HepMC, Rivet, built-in analyses.

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.

$
```



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.

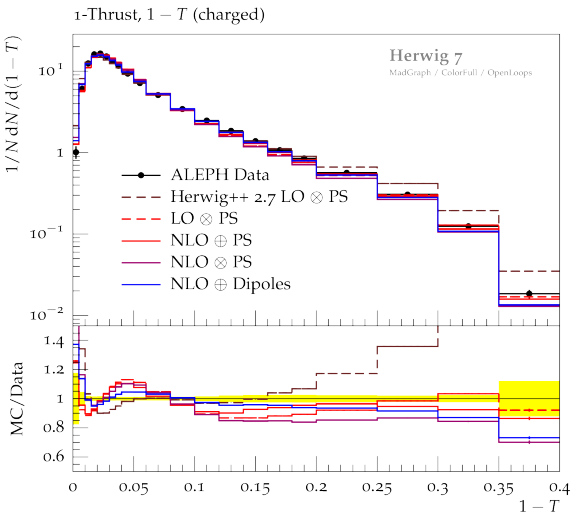
```
read Matchbox/MadGraph-OpenLoops.in
```
← Choose amplitude providers.

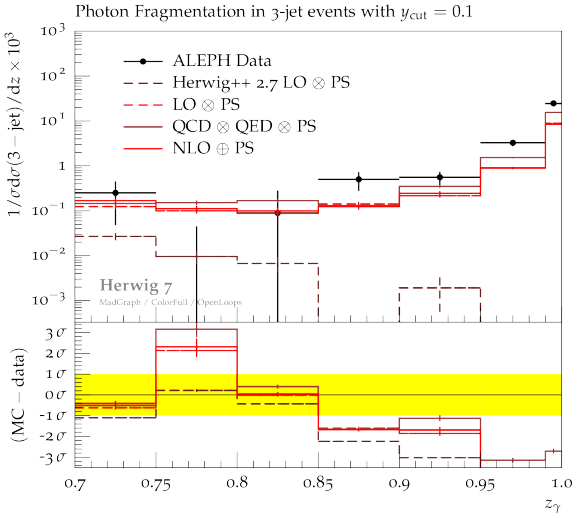
```
read Matchbox/MCatNLO-DefaultShower.in
```
← Choose shower and matching.

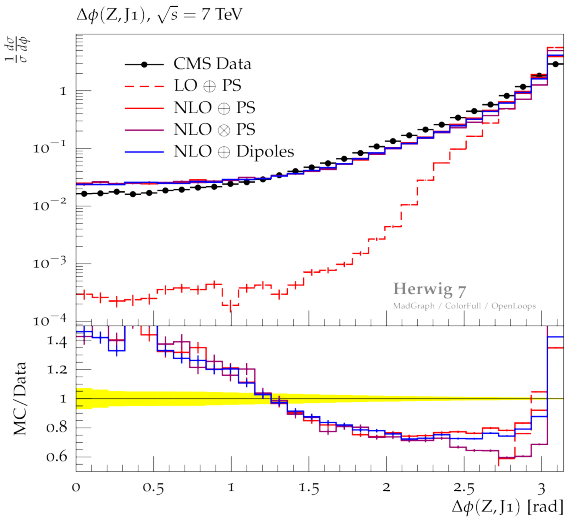
Herwig 7 – Sample Results

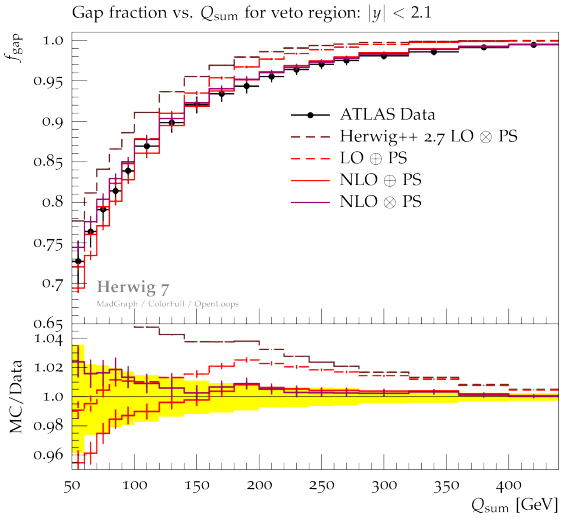
[amplitudes built-in or from MG5aMC and OpenLoops]

From LEP …







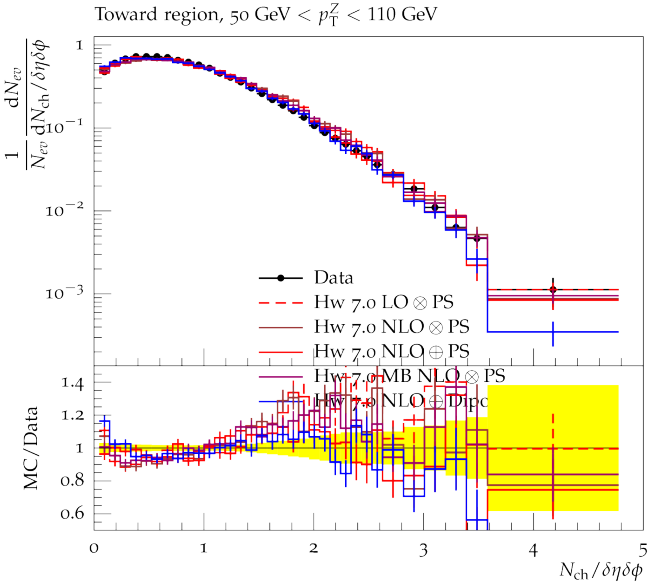


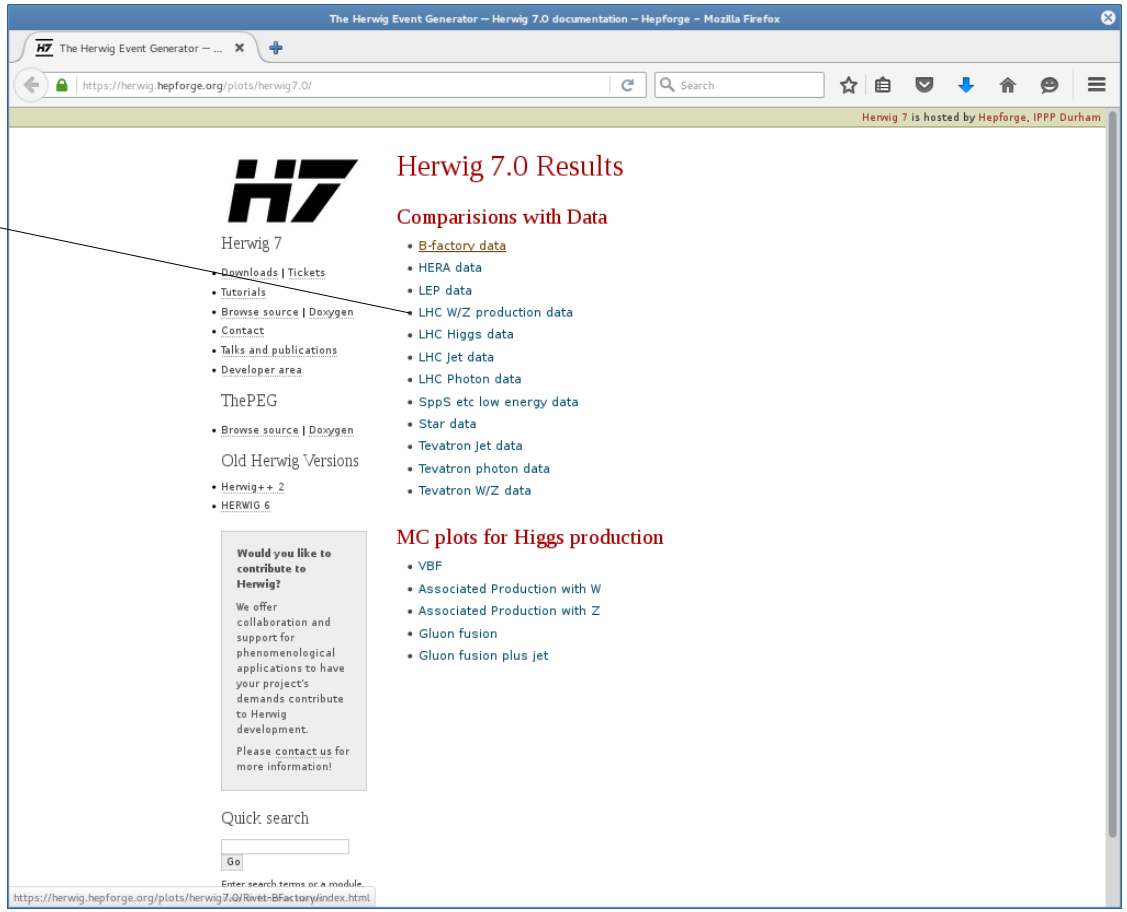
… to LHC.

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.





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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