Herwig++7 & Heavy Flavours

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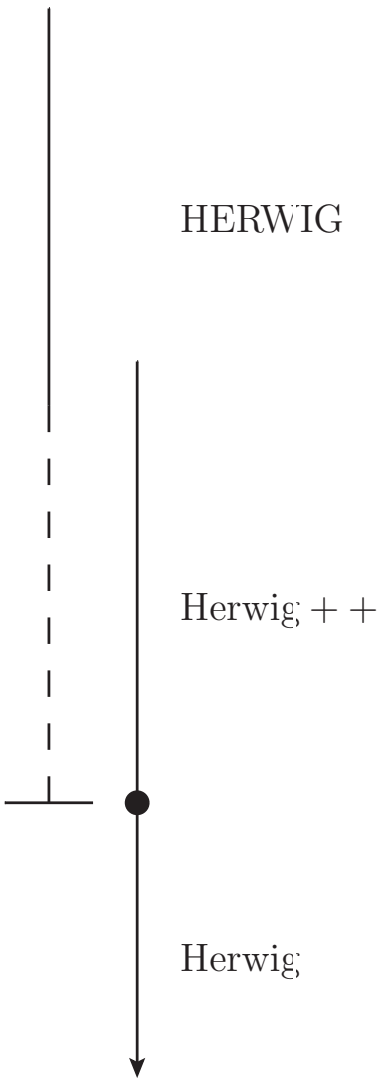
Herwig 7 – What's that?



Herwig++ has seen a ten-year-development to meet a milestone intented 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, only using external libraries to evaluate amplitudes point by point.
→ 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.

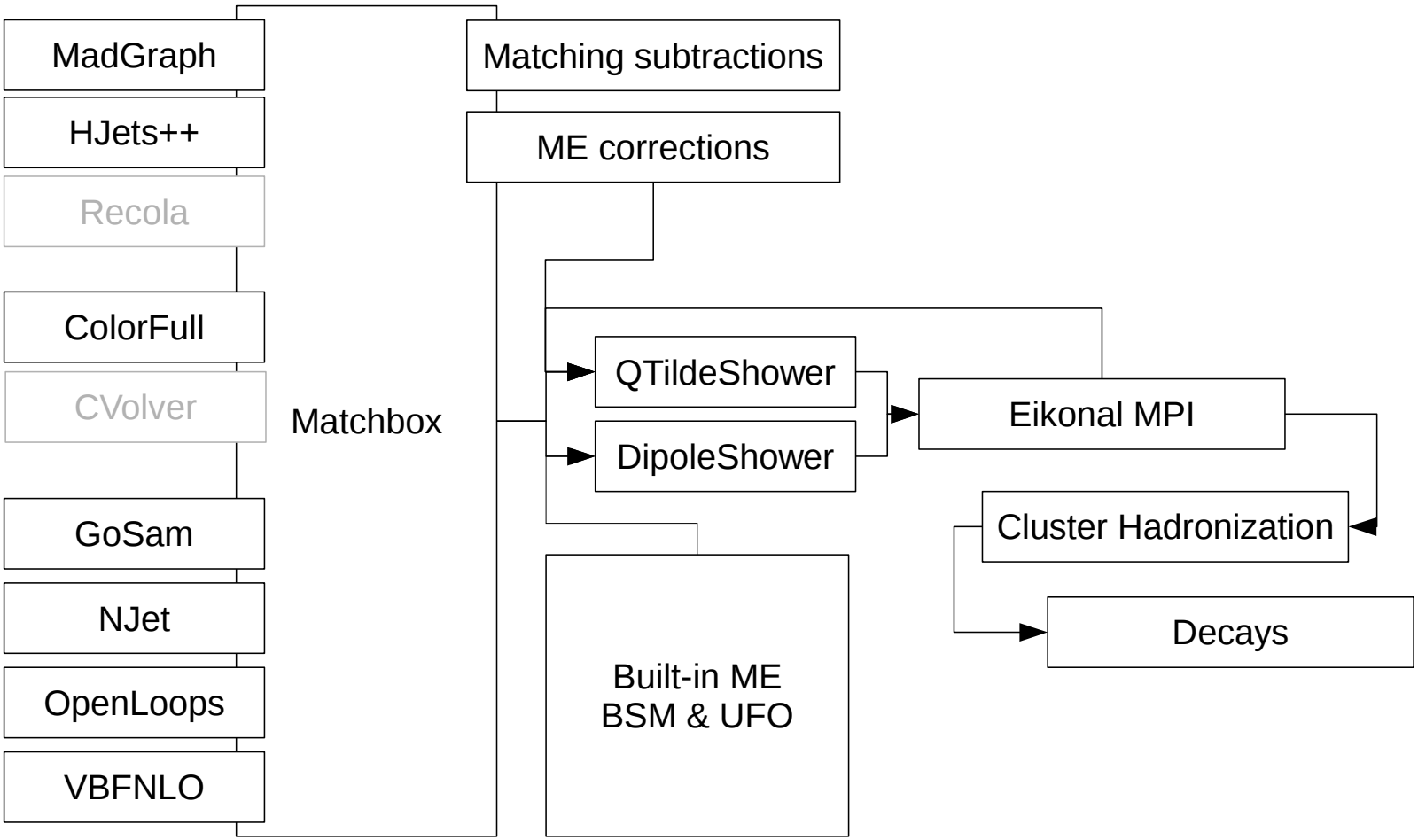
[SP, P. Richardson]

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

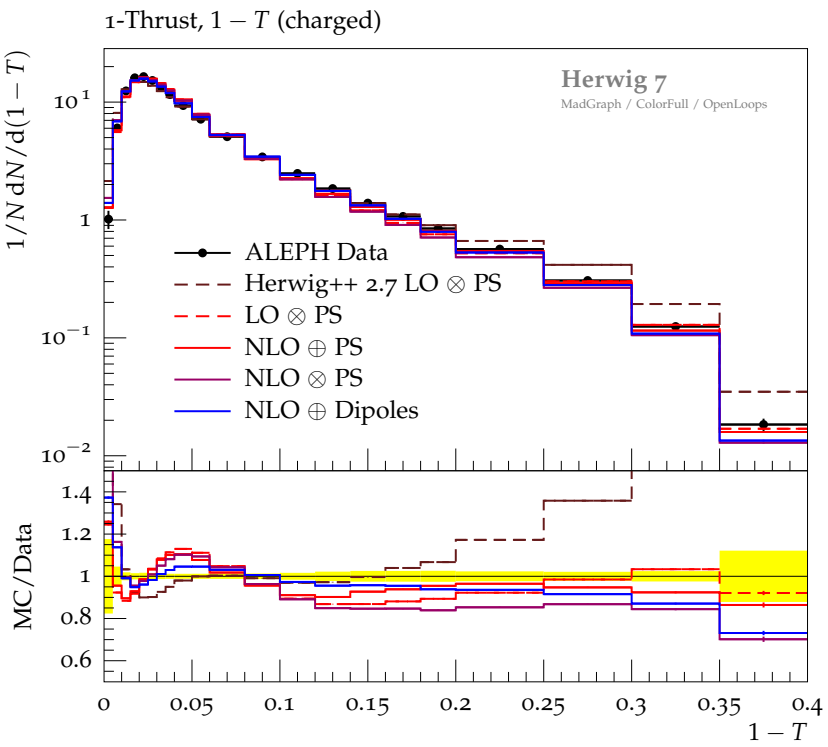
[S. Gieseke, T. Kasprzik, J. Kühn] [A. Papaefstathiou] [F. Campanario, T. Figy, SP, M. Sjödahl]

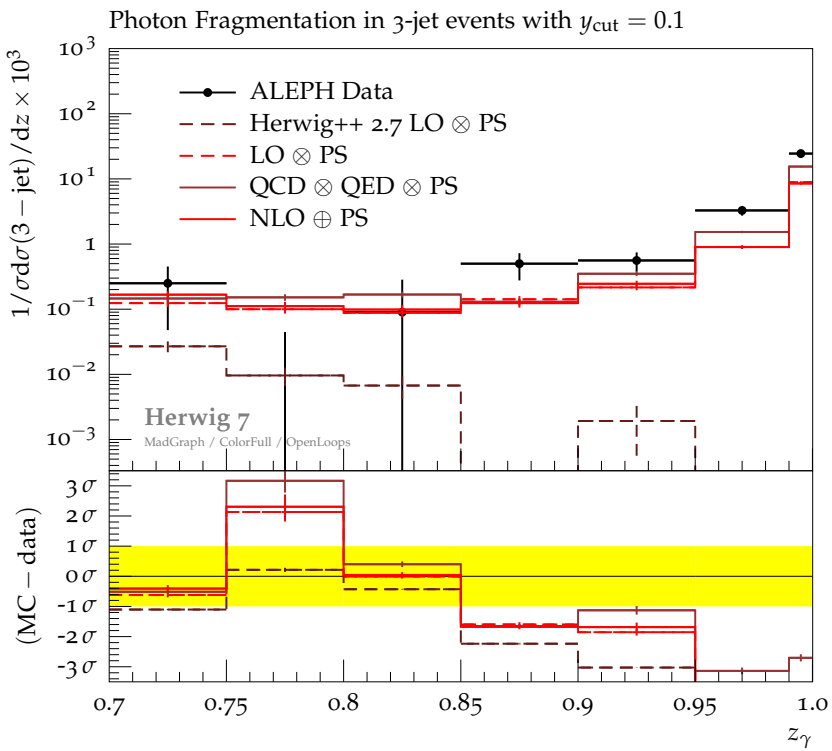
Vastly **improved documentation**, usage and installation + new tunes.

Herwig 7.0 – Under the Hood



Herwig 7.0 – Few General Examples

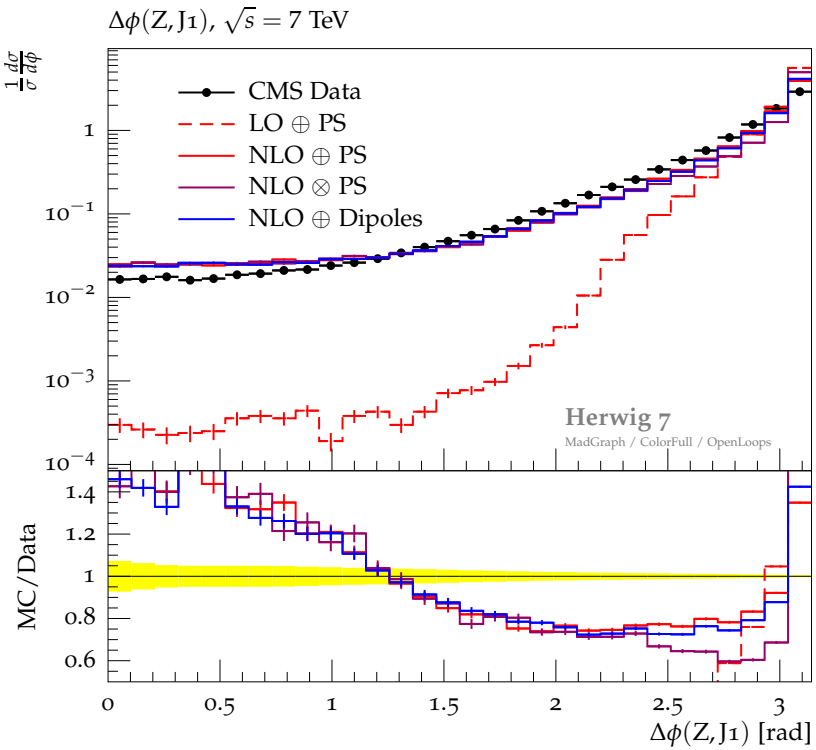


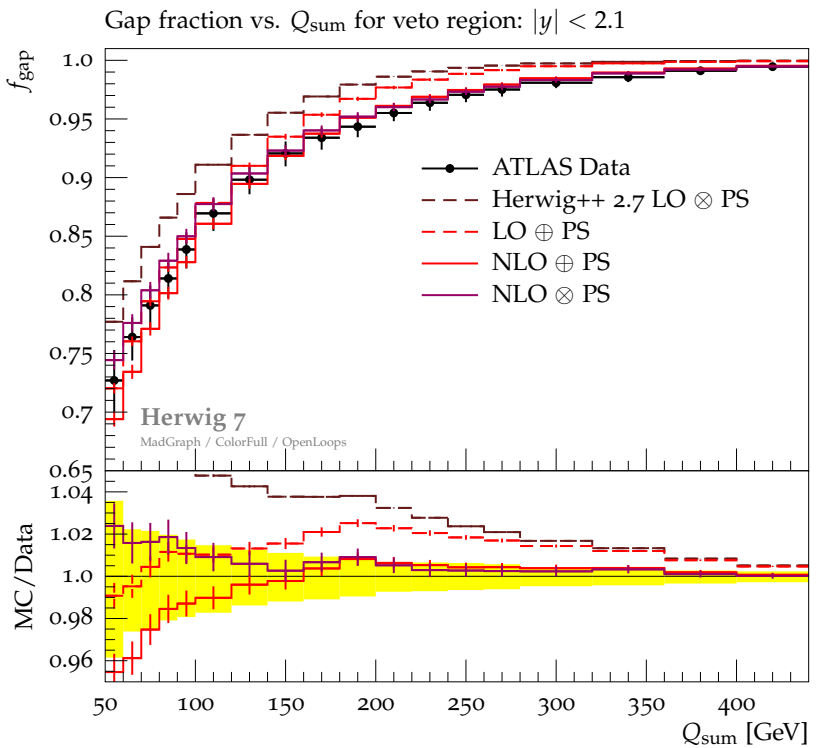


Herwig 7.0 at LEP – new tune available with the release.
Several improvements to angular ordered shower.

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/`

Heavy flavours in the showers

QTilde shower:

Evolution in generalized angular variable $\tilde{q}$.
$1 \to 2$ splittings, global recoil, new kinematics reconstruction.
Cutoff changed to $p_\perp$-type cutoff.
Initial state quarks massless, final state radiation including mass effects.
$\to$ May sound odd, but justified due to disjoint phase spaces of emitting legs.

Dipole shower:

Evolution in $p_\perp$.
$2 \to 3$ splittings, local recoil, kinematics revisited for massive quarks.
Naturally using $p_\perp$ cutoff.
Initial state quarks strictly massless, also in final state evolution.
$\to$ Consistency has the drawback on missing mass effects in fragmentation.

Both showers use emitter virtuality as the scale in $g \to q\bar{q}$.

All final state quarks are put on their constitutent mass before hadronization.
Forced splittings are applied to incoming sea quarks and gluons.

Heavy flavours in fixed-order & matching

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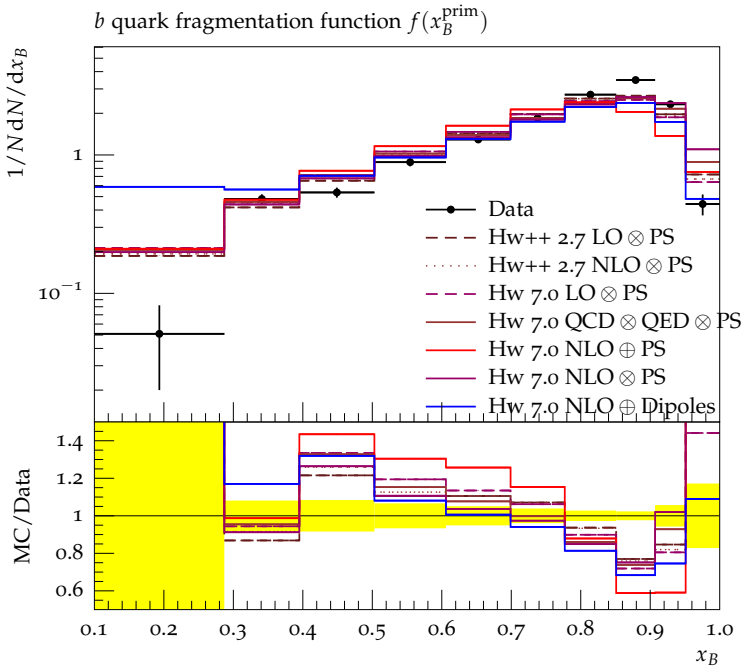
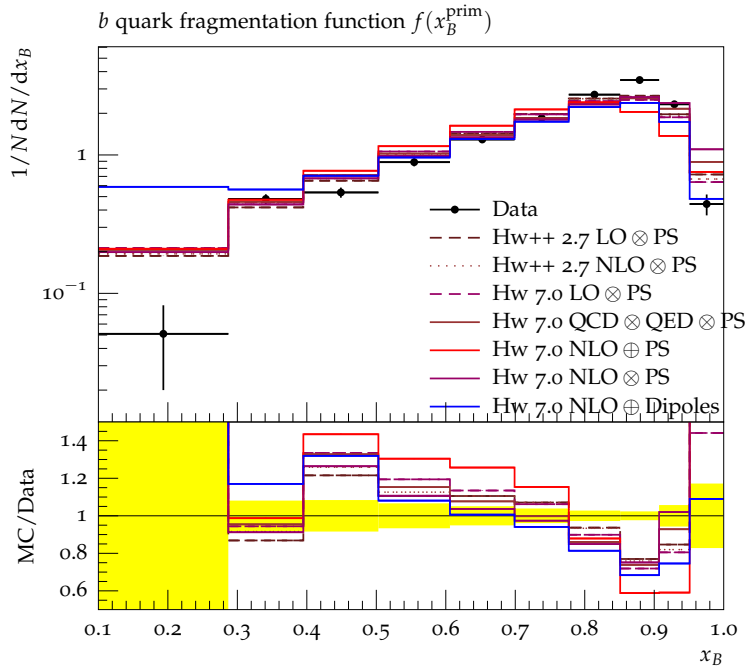
Can be dealt with in full generality.

$g \to b\bar{b}$ issues: back to LEP





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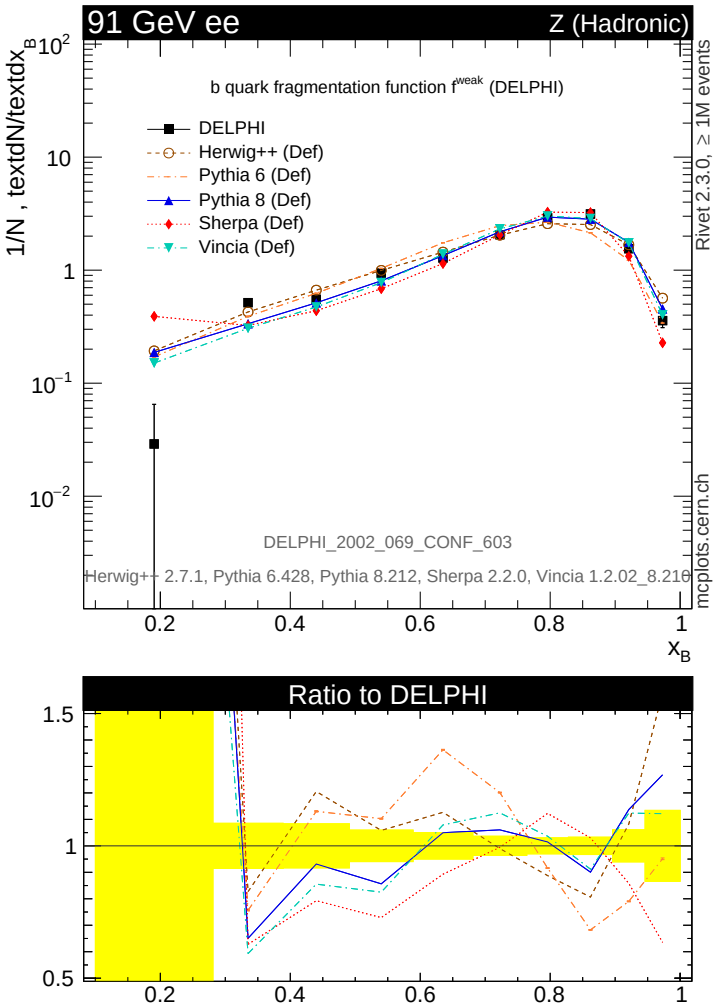

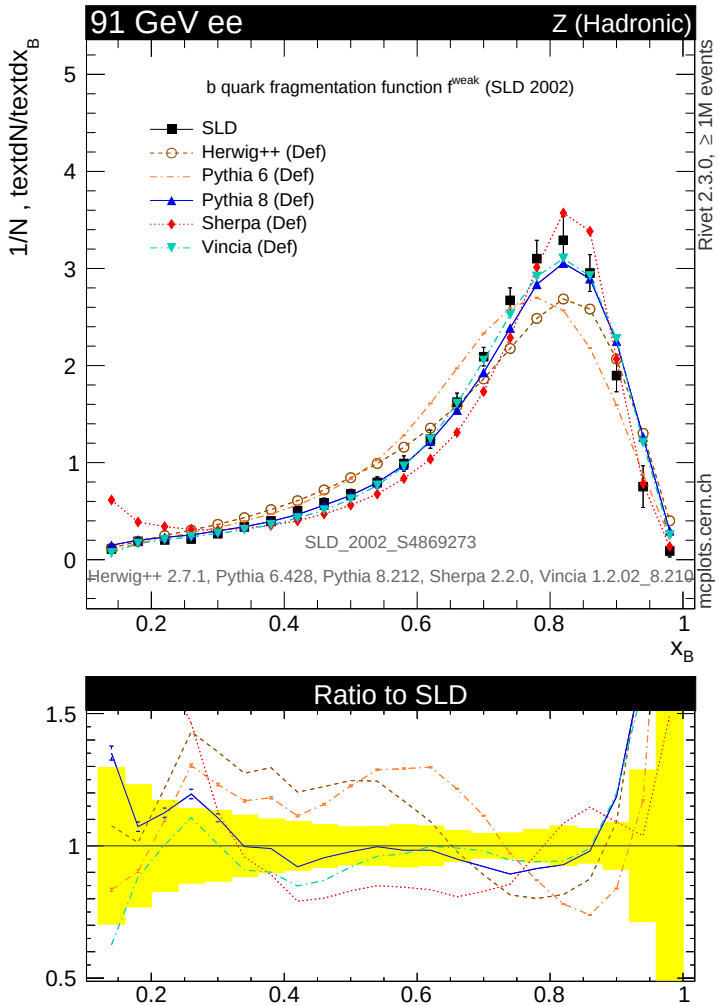

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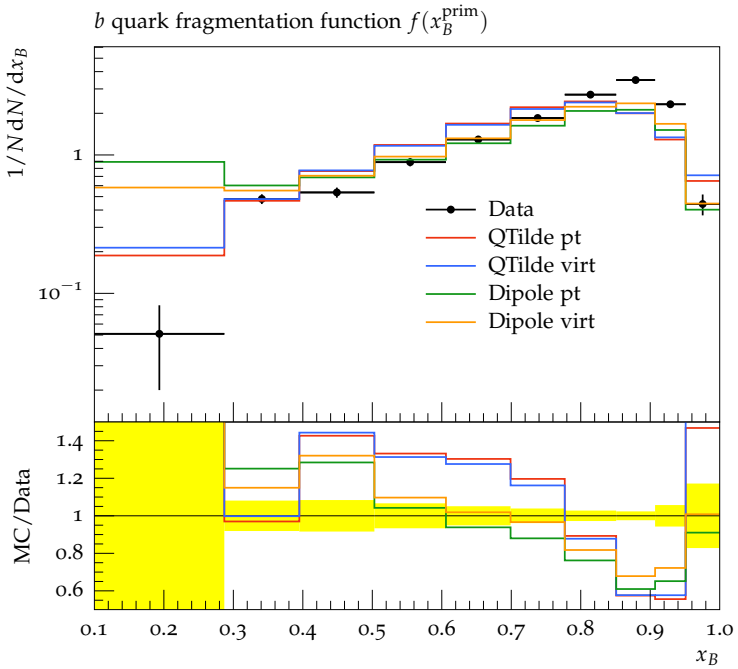
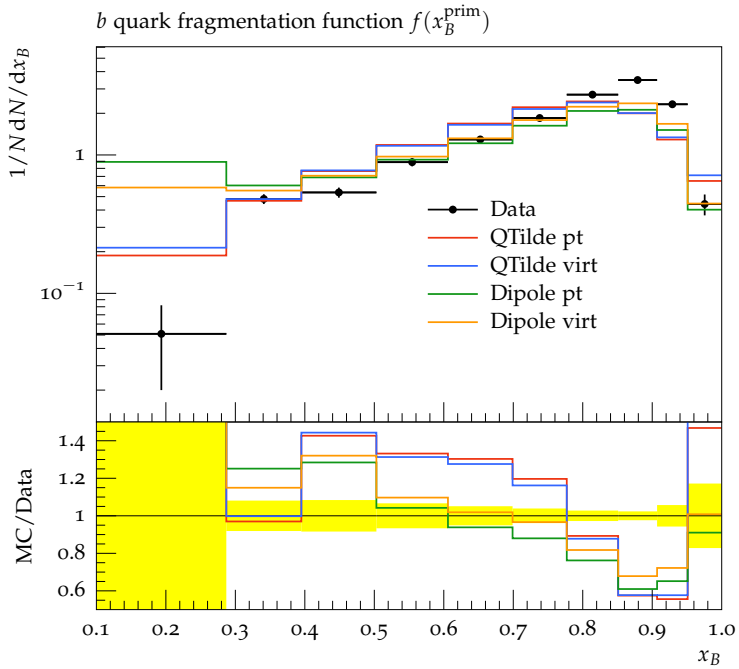
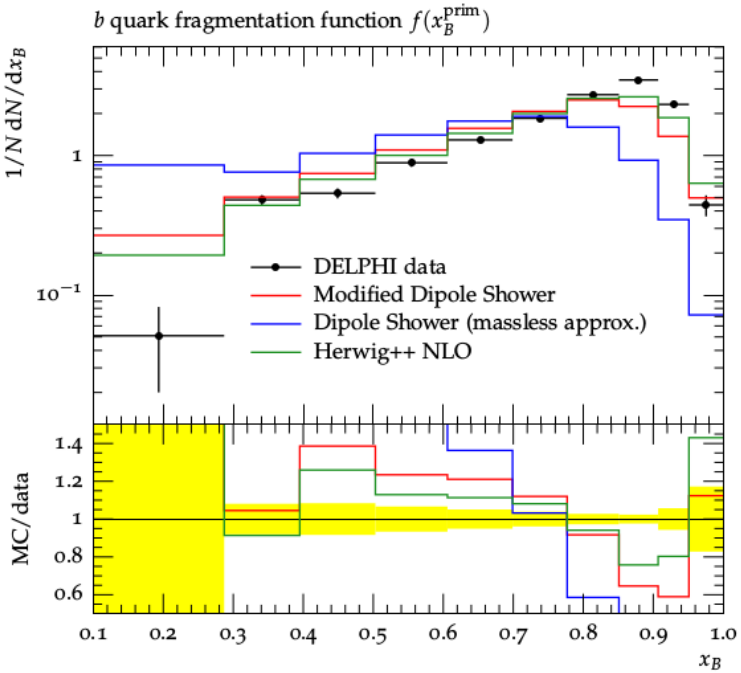
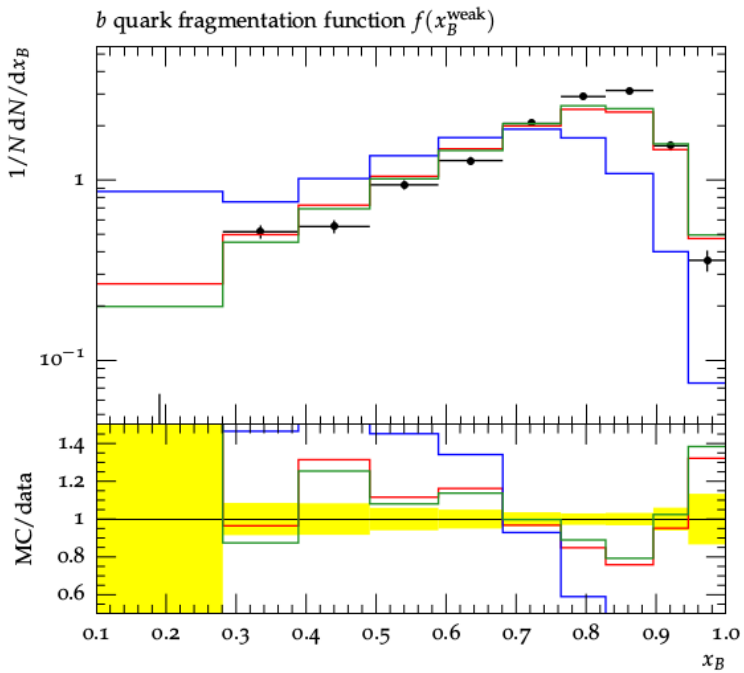




$g \to b\bar{b}$ issues: back to LEP

[M. Stoll – diploma thesis]





$g \to b\bar{b}$ issues: back to LEP

Scale choice / ordering constraint only has minor effects at hadron level.

What is odd with the dipole-type approaches?

- Not a mass effect.
- Not a kinematics/ordering effect.
- Not fixed by a scale choice.

See Graeme's talk on $V + b$.

herwig.hepforge.org

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