

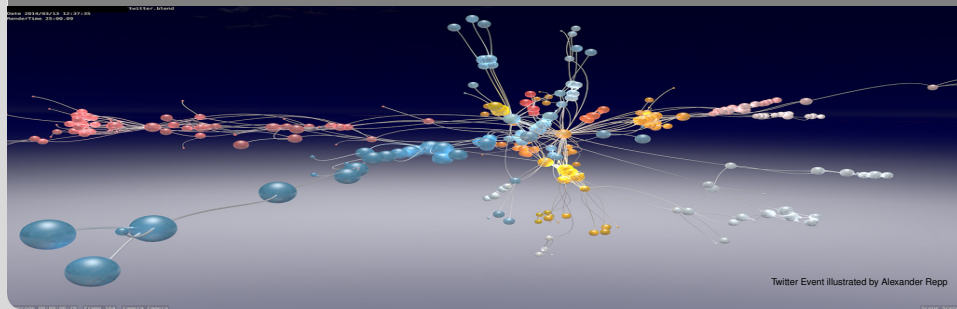


Interfaces for Matchbox

in collaboration with S. Plätzer and S. Gieseke (and N. Greiner, Ph. Maierhöfer, O. Mattelaer, D. Rauch, M. Rauch, Ch. Reuschle, M. Sjö Dahl, J.F. v. Soden-Fraunhofen, A. Wilcock and many other..)

Johannes Bellm | 2.4.2014

MCNET CERN | KARLSRUHE INSTITUTE OF TECHNOLOGY (KIT)





- No amplitude generator for arbitrary processes in Herwig++/Matchbox.
- Avoiding GB/TB of eventfiles.
- More control in Matching.
- User friendly NLO calculations as a new standard!
- Personal: I need them for my merging efforts!

Full List of Interfaces

HEJ

HJets++

NJet

nlojet++

VBFNLO

ColorFull

GoSam

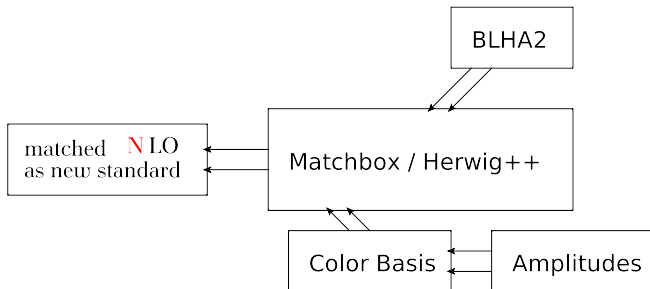
MadGraph

OpenLoops

} In this talk!

Needs:

- Born-type ,
- Virtual ,
- (spin-)color-correlated matrix elements.



BLHA2

Order

```
...  
AmplitudeType scree  
2 -2 -> 11 -11 21
```

Contract

```
...  
AmplitudeType scree | OK  
2 -2 -> 11 -11 21 | 1 43
```

```
extern "C" void OLP_EvalSubProcess2(int*, double*, double*, double*, double*);  
extern "C" void OLP_Start(const char*, int* i);  
extern "C" void OLP_SetParameter(char*, double*, double*, int*);  
extern "C" void OLP_PrintParameter(char*);  
extern "C" void OLP_Polvec(double*, double*, double*);
```

Matchbox / Herwig++

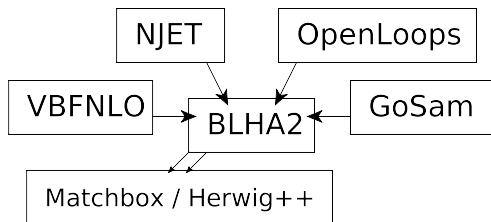
¹ [S. Alioli, S. Badger, JB, B. Biedermann, F. Boudjema, G. Cullen, A. Denner and H. Van Deurzen *et al.*, *Comput. Phys. Commun.* **185**, 560 (2014), arXiv:1308.3462]

GoSam: N. Greiner (JB, S. Gieseke, S. Plätzer, Ch. Reuschle) [[J. Phys. Conf. Ser. 368, 012056 \(2012\)](#)]

NJet: V. Yundin (S. Plätzer) [[Comput. Phys. Commun. 184, 1981 \(2013\)](#)]

OpenLoops: P. Maierhöfer (JB, S. Gieseke) [[Phys. Rev. Lett. 108, 111601 \(2012\)](#)]

VBFNLO: M. Rauch (K. Arnold, S. Gieseke, S. Plätzer) [[arXiv:1107.4038](#)]



GoSam:

- Fully automated code generation.
- Many models. (Not yet supported by Matchbox)
- Filter for amplitudes.

OpenLoops:

- Fast NLO calculations.
- Collier-lib is sadly not as open as the loops.
- Ask for a process \rightarrow get a library.

Njet:

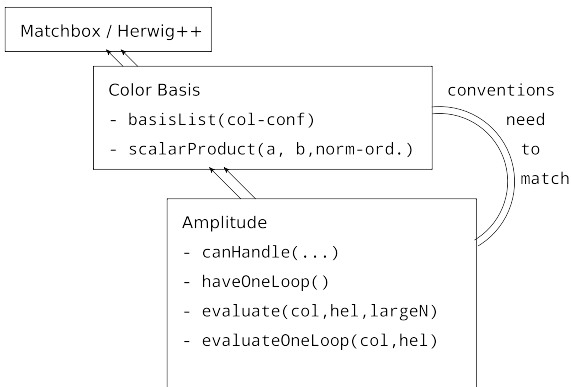
- Specialized for $p p \rightarrow N$ jets
- Z+jets coming soon

VBFNLO:

- Handmade matrix elements.
- Support is in house.

More needs:

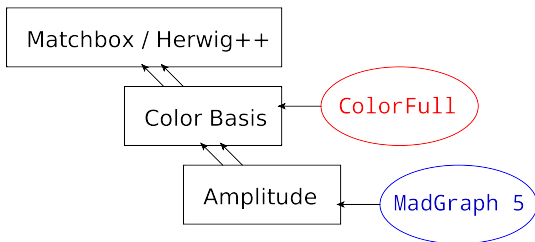
- information on amplitude level ,
- large N matrix elements,
- color information (choice of color lines),
- subleading color shower.



ColorFull: M. Sjö Dahl, S. Plätzer [S. Plätzer and M. Sjö Dahl, JHEP **1207**, 042 (2012)]

MadGraph5: O. Mattelaer [J. Alwall, M. Herquet, F. Maltoni, O. Mattelaer, T. Stelzer, JHEP **1106**, 128 (2011)]

Started
by A. Wilcock and
discussions with
the MG-Team
in Manchester.



MG5: output matchbox ...

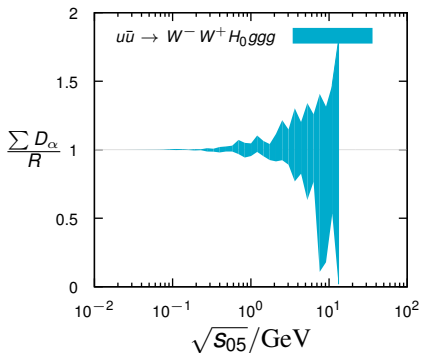
The MG5 standalone c++-output was modified with 3 new routines:
`NCol()`, `jamp(..)`, `colorstring(..)`.

→ A python script then modifies the output and compiles an interface class.

Let's have
some fun, with it!

Subtraction for:

$p p \rightarrow W^+ W^- H_0 j j$
@NLO



```
do PPFactory:Process p p X Y Z j j
set PPFactory:OrderInAlphaS 2
set PPFactory:OrderInAlphaEW ..

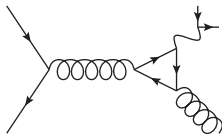
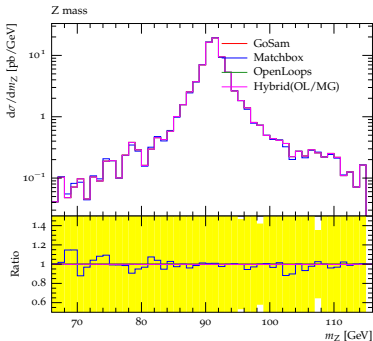
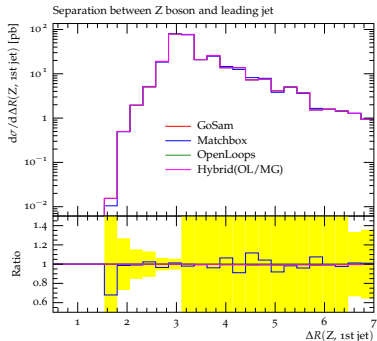
#>>>>>> choose a tree-level provider
# MadGraph : requires -with-madgraph
# set GenericProcesses:TreeLevelAmplitude MadGraph

#>>>>>> choose a one-loop provider
# GoSam : requires -with-gosam and
-with-gosam-contrib
# set GenericProcesses:OneLoopAmplitude GoSam

# NJet : requires -with-njet
# set GenericProcesses:OneLoopAmplitude NJet

# OpenLoops : requires -with-openloops
# set GenericProcesses:OneLoopAmplitude OpenLoops
```

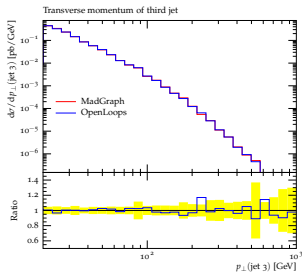
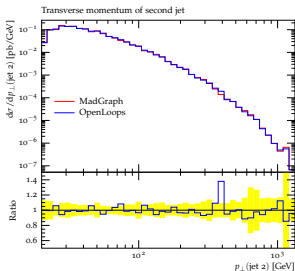
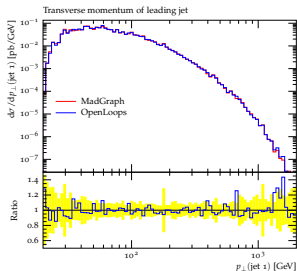
NLO: $p(u, \bar{u}, g) p \rightarrow e^+ e^- j(u, \bar{u}, g)$



complex mass scheme

Rivet: There will be a way to get a realistic MC error for NLO parton level calculations.

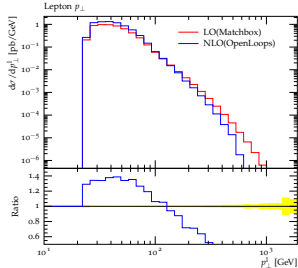
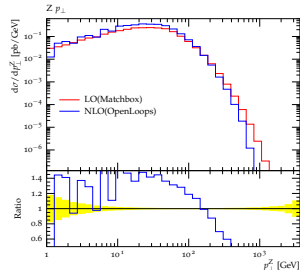
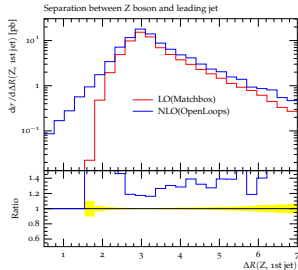
Validation



LO validation:

$$p(u, \bar{u}, g) p \rightarrow e^+ e^- 3 j(u, \bar{u}, g)$$

Calculation



NLO:

$$p(u, \bar{u}, g) p \rightarrow e^+ e^- 2 j(u, \bar{u}, g)$$

- There are many new Interfaces for Matchbox/Herwig++
- On squared matrix element and amplitude level.
- The way is open for a new standard (NLO).
- DipoleShower- and QTilde-matching (in validation) with matrix elements in a coherent framework to have everything under control.

Outlook:

- Support more models.
- Finish heavy quark implementation (Dipoles and Insertion-operators).
-

Thank you for your attention,

and S. Plätzer, S. Gieseke, N. Greiner, Ph. Maierhöfer, O. Mattelaer,
D. Rauch, M. Rauch, Ch. Reuschle, M. Sjö Dahl, J.F. v.
Soden-Fraunhofen, A. Wilcock and many more..
for their collaboration!


```

# OLP order file created by
# Herwig++/Matchbox for GoSam

InterfaceVersion BLHA2
MatrixElementSquareType CHsummed
CorrectionType QCD
IRregularisation CDR

AlphasPower 1
AmplitudeType ccTree
1 -1 - > -11 11 21
...
21 3 - > -11 3 11

AmplitudeType scTree
1 -1 - > -11 11 21
...
21 3 - > -11 3 11

AmplitudeType Loop
1 -1 - > -11 11 21
...
21 3 - > -11 3 11

AlphasPower 2
AmplitudeType Tree
1 1 - > -11 1 1 11
...
21 21 - > -11 -3 3 11

```

```

# vim: syntax=olp
#@OLP GOSAM 2.0.beta
#@IgnoreUnknown False
#@IgnoreCase False
#@SyntaxExtensions
InterfaceVersion BLHA2 | OK
MatrixElementSquareType CHsummed |
OK
CorrectionType QCD | OK
IRregularisation CDR | OK
AlphasPower 1 | OK
AmplitudeType ccTree | OK
1 -1 - > -11 11 21 | 1 131
...
21 3 - > -11 3 11 | 1 70
AmplitudeType scTree | OK
1 -1 - > -11 11 21 | 1 145
...
21 3 - > -11 3 11 | 1 71
AmplitudeType Loop | OK
1 -1 - > -11 11 21 | 1 137
...
21 3 - > -11 3 11 | 1 63
AlphasPower 2 | OK
AmplitudeType Tree | OK
1 1 - > -11 1 1 11 | 1 42
...
21 21 - > -11 -3 3 11 | 1 106

```

[LH13]



$$\langle \mathcal{M}_\mu | \mathbf{C}_{ij} \mathbf{C}^{\mu\nu} | \mathcal{M}_\nu \rangle = \frac{1}{Q^2} [\langle \mathcal{M} | \mathbf{C}_{ij} | \mathcal{M} \rangle (-CQ^2 + |\epsilon_+ \cdot q|^2) + 2\text{Re} \left((\epsilon_+ \cdot q)^2 \begin{cases} \langle \mathcal{M}_- | \mathbf{C}_{ij} | \mathcal{M}_+ \rangle & \text{outgoing } g \\ \langle \mathcal{M}_+ | \mathbf{C}_{ij} | \mathcal{M}_- \rangle & \text{incoming } g \end{cases} \right)] \quad 1$$

