MadGraph5
Going Beyond

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What do We need?

NLO

Exp-TH communication

Very exotic models

Multi-jet samples

Exotic models

Effective theories

Decay chains

Matrix Elements

Advanced analysis techniques

Real corrections

Decay Packages

Merging ME/PS

Cluster/Grid computing

User friendliness

Testing/robustness

MadGraph5 Goal

- Start in November 2009
- Remove ALL limitations of MadGraph4
  - speed
  - number of particles
  - type of interactions
  - output language
  - modularity / flexibility of the code

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Did we succeed?

MadGraph Home Page

madgraph.hep.uiuc.edu

High Energy Physics Illinois

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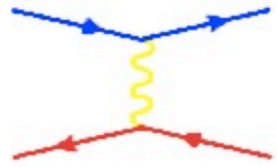
Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation

The MadGraph homepage

UCL UIUC Fermi
by the MG/ME Development team



Generate Process | Register | Tools | My Database | Cluster Status | Downloads (needs registration) | Wiki/Docs | Admin

Generate processes online using MadGraph 5

To improve our web services we request that you register. Registration is quick and free. You may register for a password by clicking here.
You can still use **MadGraph 4** here.

Code can be generated either by:

I. Fill the form:

Model: SM — Model descriptions

Input Process: — Examples/format

Example: p p > w+ j j QED=3, w+ > l+ vl

p and j definitions: p=j=d u s c d~ u~ s~ c~ g

sum over leptons: l+ = e+, mu+ ta+; l- = e-, mu- ta-; vl = ve, vm, vt; vl~ = ve~, vm~, vt~

Submit

II. Upload the proc_card.dat

Process card examples

proc_card format MadGraph 5

Choose File No file chosen and send it to the server.

Speed

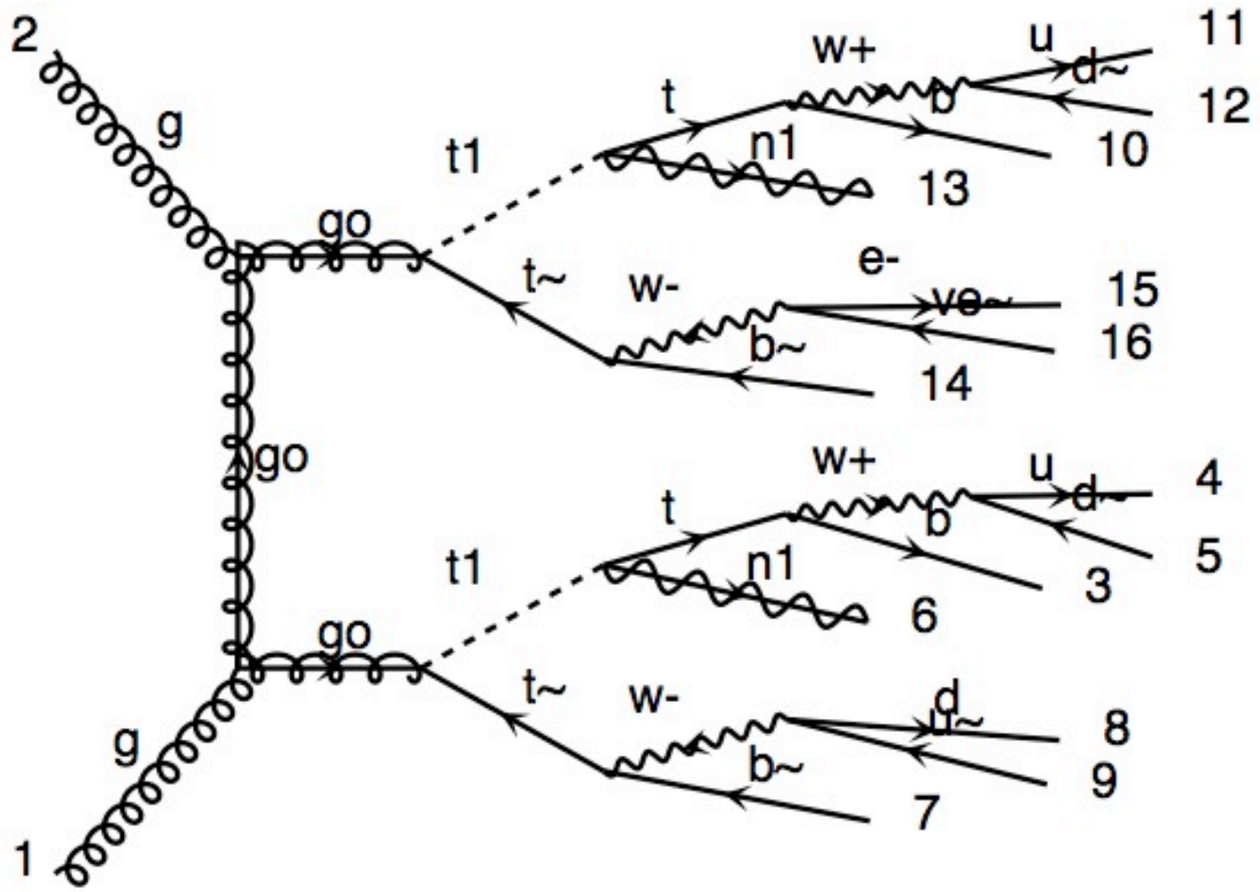
Matrix Element generation:

Process	MadGraph 4	MadGraph 5	Subprocesses	Diagrams
$pp \to jjj$	2 min	22 s	34	307
$pp \to jjl^+l^-$	23 min	26 s	108	1216
$pp \to jjje^+e^-$	60 min	132 s	141	9012
$u\bar{u} \to e^+e^-e^+e^-e^+e^-$	51 min	75 s	1	3474
$gg \to ggggg$	3 hours	5 min	1	7245
$pp \to jj(W^+ \to l^+\nu_l)$	10 min	19 s	82	304
$pp \to t\bar{t}$+full decays	6h	29 s	27	45
$pp \to \tilde{q}/\tilde{g}\,\tilde{q}/\tilde{g}$	14 min	63 s	313	475
$gg \to (\tilde{g} \to u\bar{u}\tilde{\chi}_1^0)(\tilde{g} \to u\bar{u}\tilde{\chi}_1^0)$	5 min	7 s	1	48
$pp \to (\tilde{g} \to jj\tilde{\chi}_1^0)(\tilde{g} \to jj\tilde{\chi}_1^0)$	—	30s	144	11008

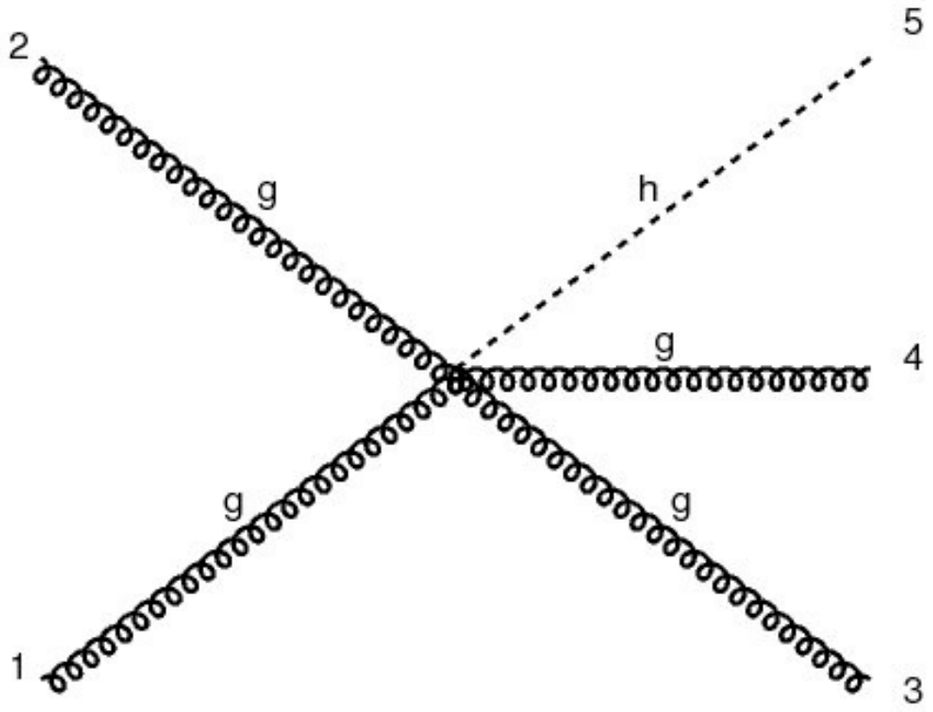
Matrix Element evaluation (Fortran):

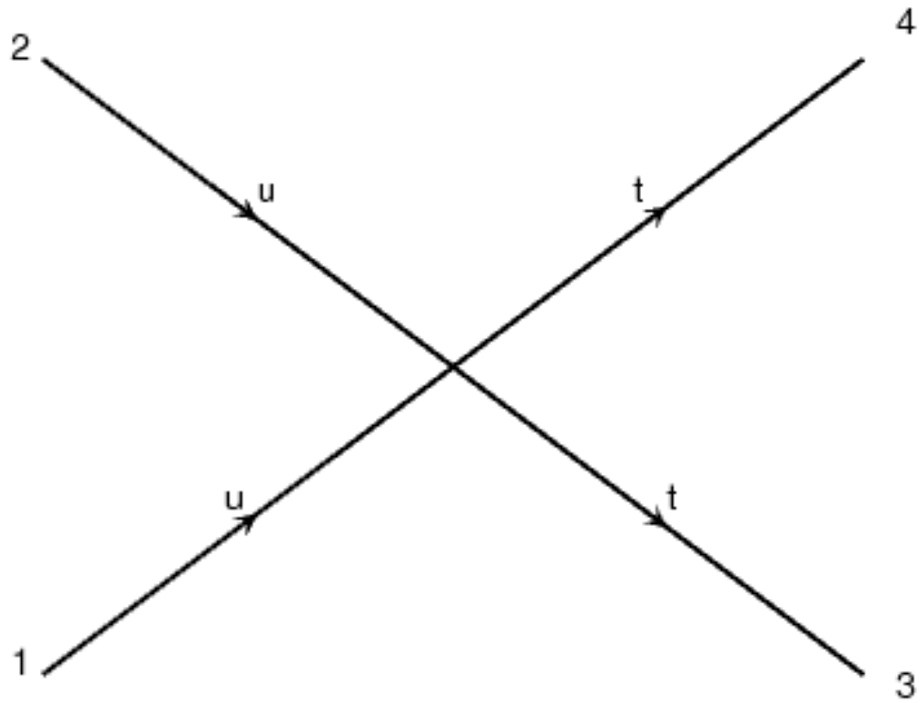
Process	Function calls		Run time	
	MG 4	MG 5	MG 4	MG 5
$u\bar{u} \to e^+e^-$	8	8	$< 6\mu$s	$< 6\mu$s
$u\bar{u} \to e^+e^-e^+e^-$	110	80	0.22 ms	0.14 ms
$u\bar{u} \to e^+e^-e^+e^-e^+e^-$	6668	3775	46.5 ms	19.0 ms
$u\bar{u} \to d\bar{d}$	6	6	$< 4\mu$s	$< 4\mu$s
$u\bar{u} \to d\bar{d}g$	16	16	27 μs	27 μs
$u\bar{u} \to d\bar{d}gg$	85	67	0.42 ms	0.31 ms
$u\bar{u} \to d\bar{d}ggg$	748	515	10.8 ms	6.75 ms
$u\bar{u} \to u\bar{u}gg$	160	116	1.24 ms	0.80 ms
$u\bar{u} \to u\bar{u}ggg$	1468	960	35.7 ms	17.2 ms
$u\bar{u} \to d\bar{d}d\bar{d}$	42	33	84 μs	83 μs
$u\bar{u} \to d\bar{d}d\bar{d}g$	310	197	1.88 ms	1.15 ms
$u\bar{u} \to d\bar{d}d\bar{d}gg$	3372	1876	141 ms	34.4 ms
$u\bar{u} \to d\bar{d}d\bar{d}d\bar{d}$	1370	753	42.5 ms	6.6 ms

number of particles



Type of Interactions



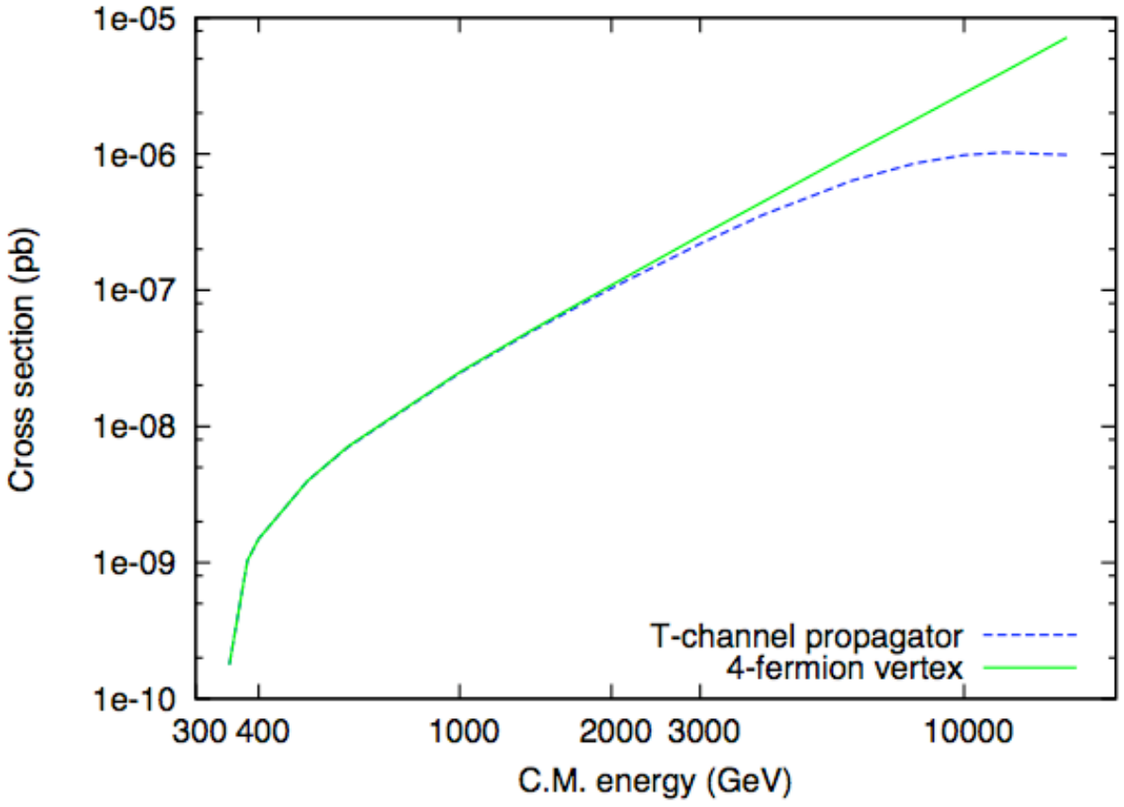


Effective Theory

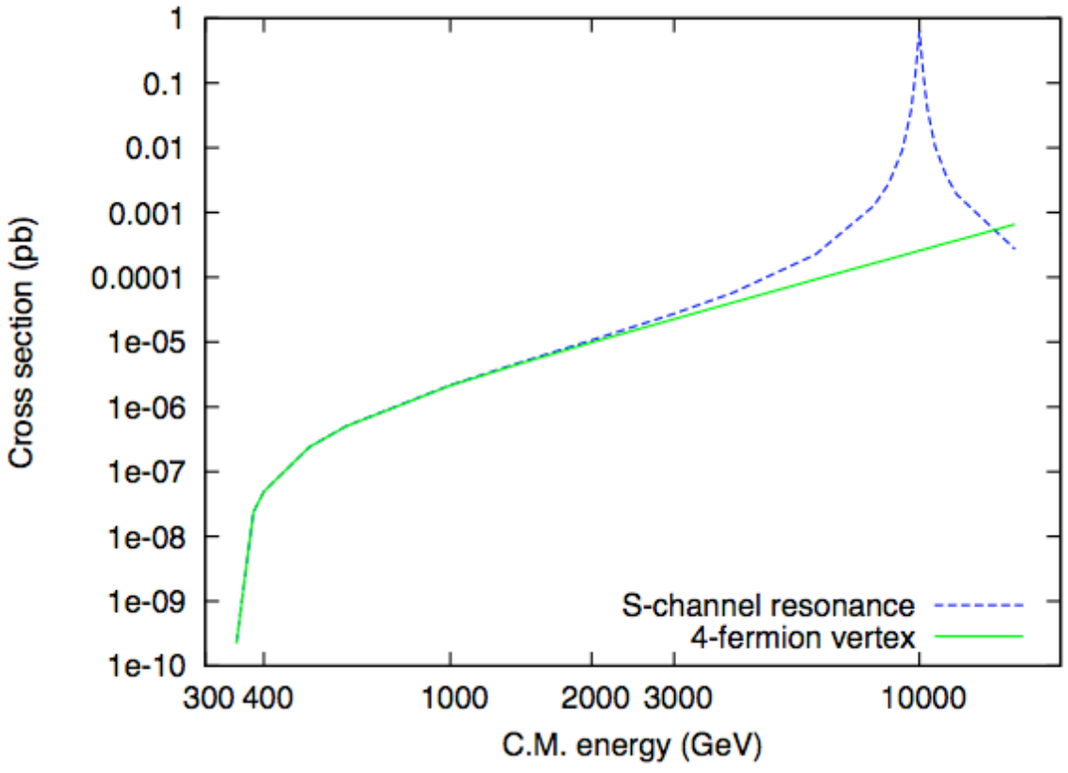
multi fermion interactions

Type of Interactions

Comparisons between explicit propagators and 4-fermion vertex



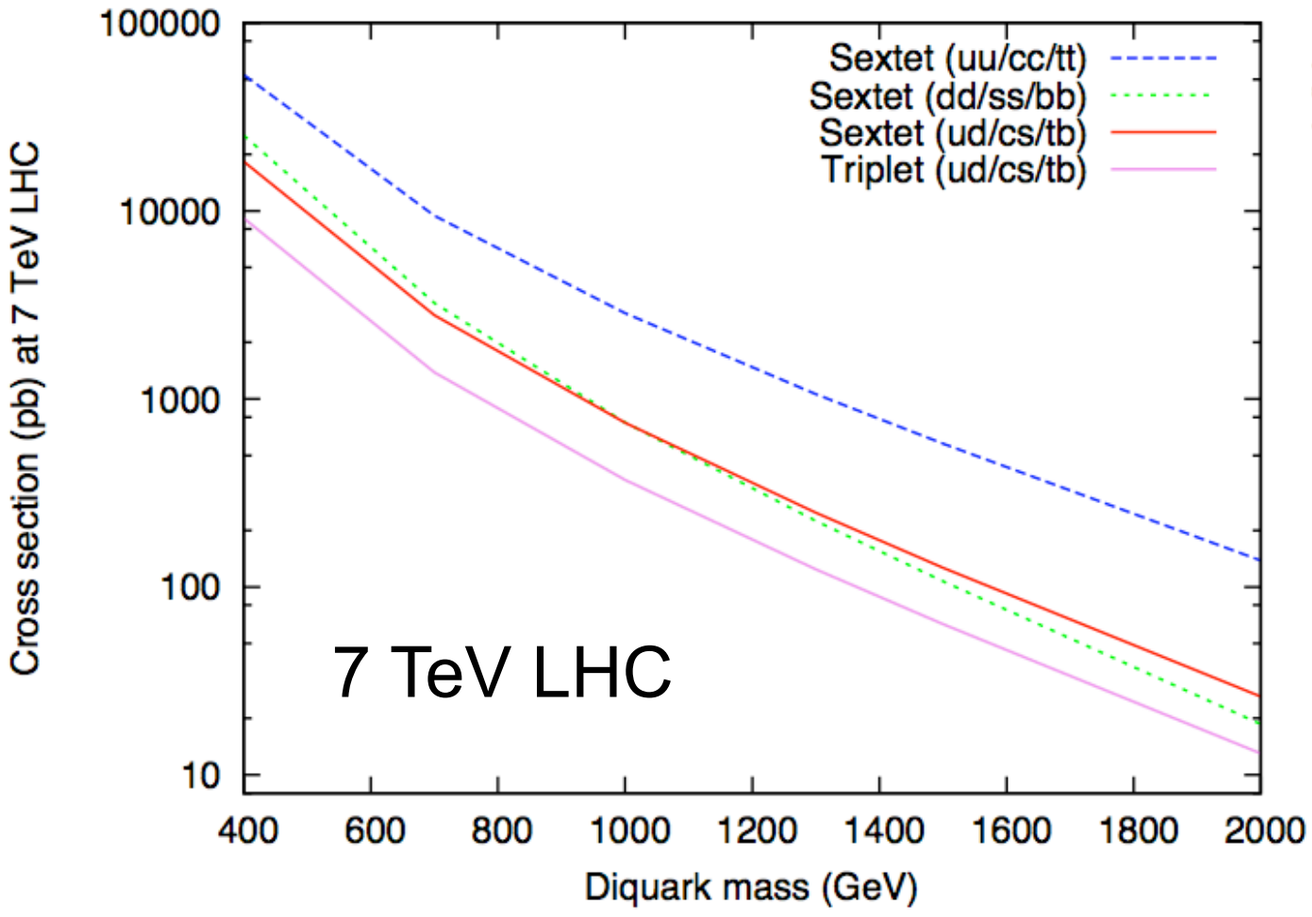
t-channel u u > t t



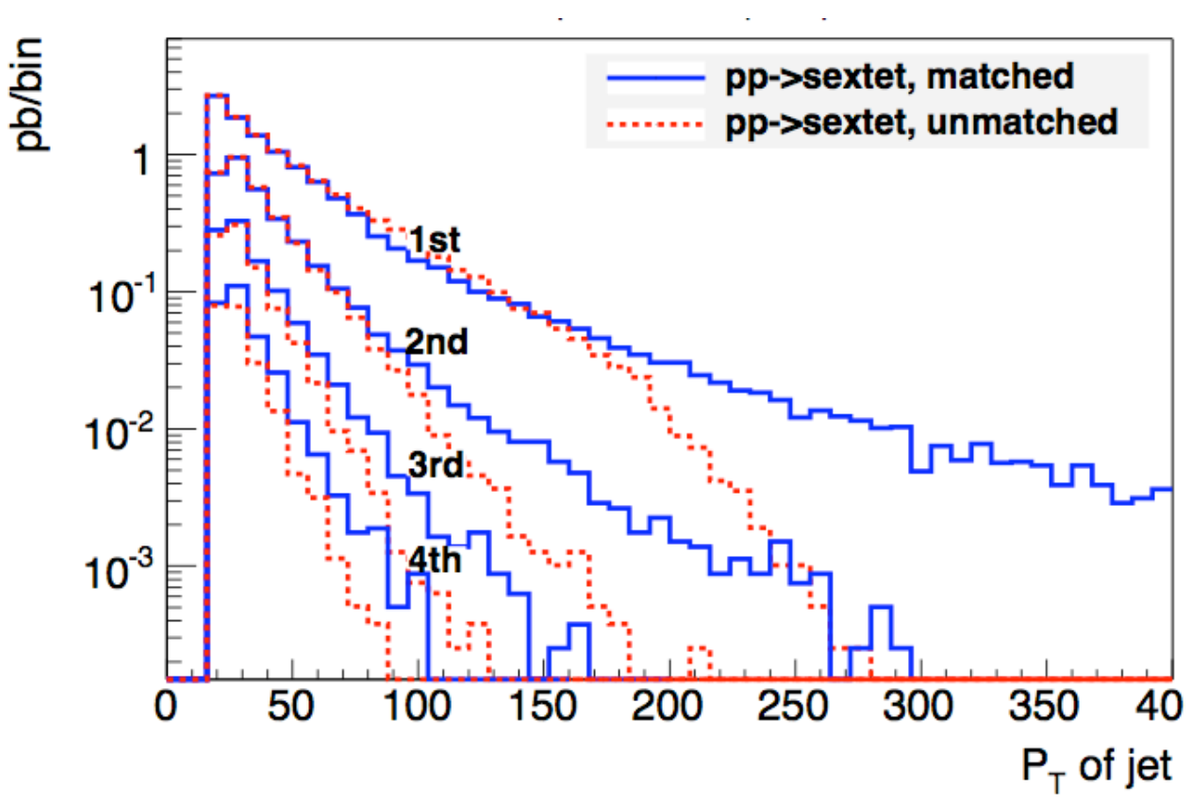
s-channel u u > t t

Type of Interactions

Color sextet and ε^{ijk} implementations



Diquark cross sections with coupling 0.01



Jet p_T:s, fully matched

$pp \rightarrow D + 0,1,2$ jets

Output

- MadEvent (Fortran)
- Standalone (Fortran)
- Standalone(C++)
- Pythia 8 (C++)

Compact and optimise output for MadEvent

Process	Subprocess directories		Channels for survey		Directory size	
	ME 4	ME 5	ME 4	ME 5	ME 4	ME 5
$pp \to W^+j$	6	2	12	4	79 MB	35 MB
$pp \to W^+jj$	41	4	138	29	438 MB	64 MB
$pp \to W^+jjj$	73	5	1164	184	842 MB	110 MB
$pp \to W^+jjjj$	296	7	15029	1327	3.8 GB	352 MB
$pp \to l^+l^-j$	12	2	48	8	149 MB	44 MB
$pp \to l^+l^-jj$	54	4	586	58	612 MB	83 MB
$pp \to l^+l^-jjj$	86	5	5408	368	1.2 GB	151 MB
$pp \to l^+l^-jjjj$	235	7	63114	2500	5.3 GB	662MB
$pp \to t\bar{t}$	3	2	5	4	49 MB	39 MB
$pp \to t\bar{t}j$	7	3	45	25	97 MB	56 MB
$pp \to t\bar{t}jj$	22	5	417	188	274 MB	98 MB
$pp \to t\bar{t}jjj$	34	6	3816	1300	620 MB	209 MB

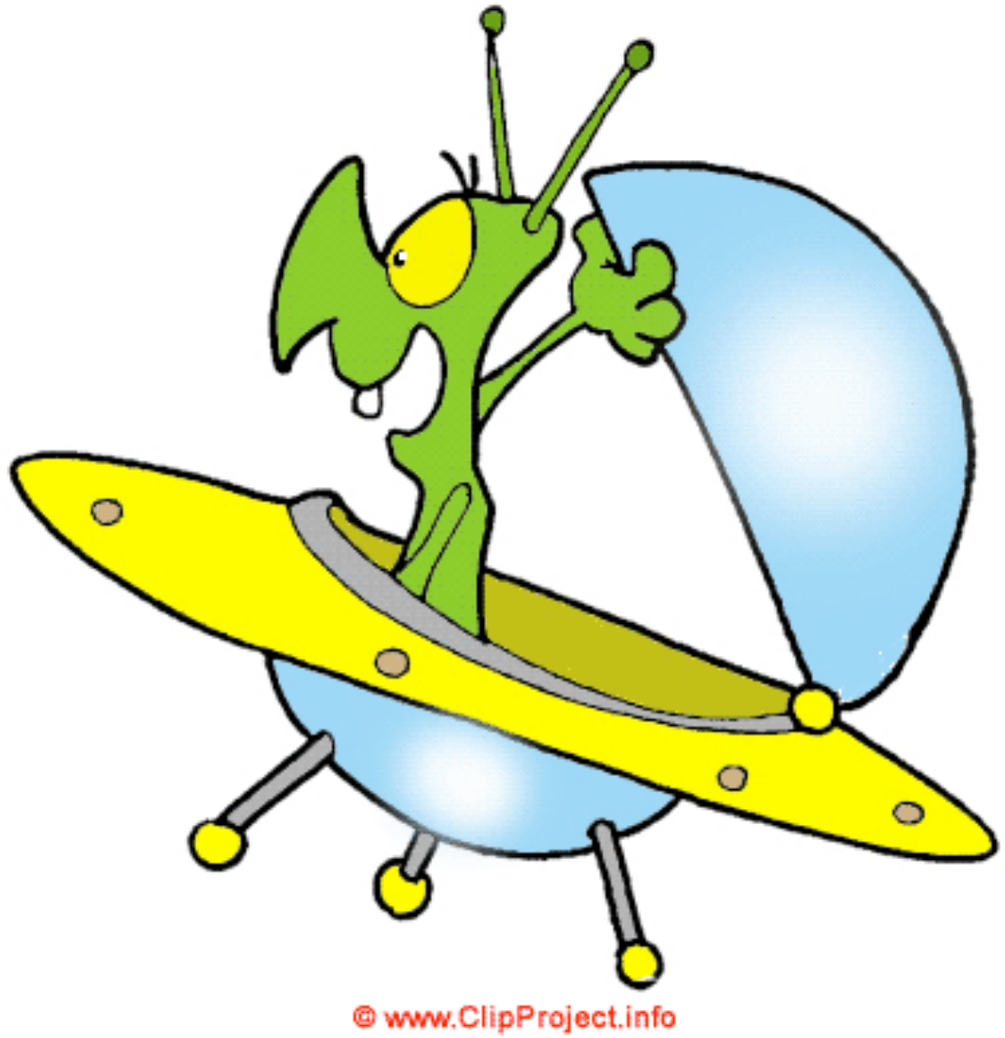
Biggest Advance

Interface to UFO / ALOHA

UFO

[Duhr et al]

- New Model Format
- generic (any BSM)
- Includes Lorentz/color
- written automatically by FeynRules from a Lagrangian
- plug-in model into MG5



ALOHA

[O.M, al 1]

- Automatic Creation of HELAS routine for ANY BSM theory
- Output
  - Fortran
  - C++
  - Python

The Helas routine for BSM without the pain to write it.

Any BSM should be possible in a fully automatic and efficient way!

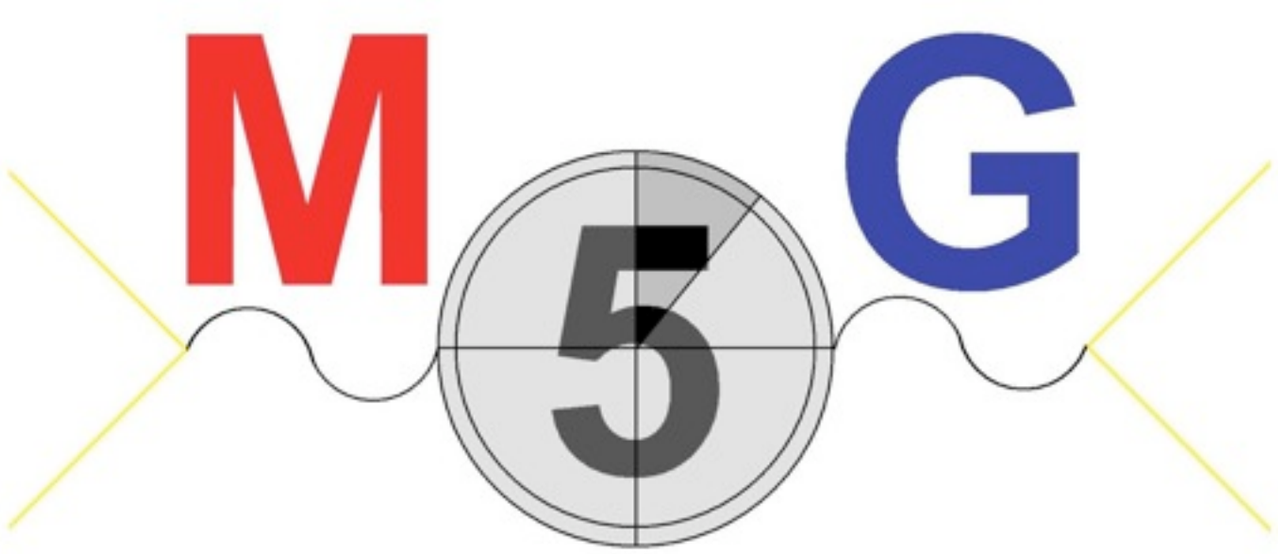
Other Features

- New user interface (shell based)
  - with a tutorial
  - with autocompletion
  - with help command
- Possibility to check processes
  - gauge / lorentz / permutations
- Matching
- Extensive Test Suite
- and so other...

Conclusion

- ~~HARDER~~ :
  - intuitive interface
- BETTER:
  - For Any Model
- FASTER:
  - For diagram generation
  - For generating events
- STRONGER:
  - extreme programming

Conclusion



MadGraph 5 is ready for production

https://launchpad.net/madgraph5