MadGraph/MadEvent

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CERN-TH

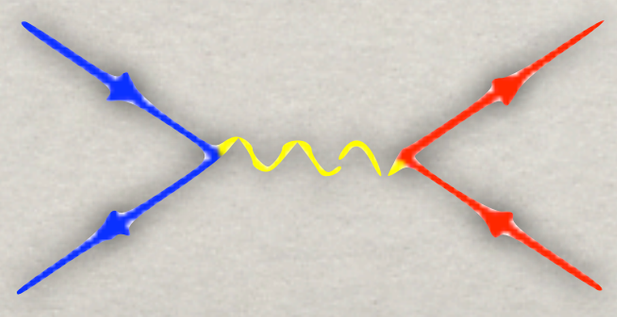
Monte Carlo School
"Physics at the Terascale"
20-24 April 2009, DESY Hamburg

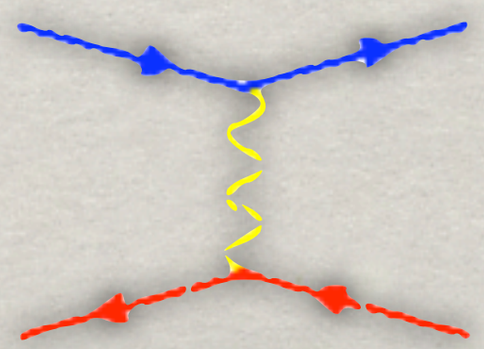
A mad team...

- Johan Alwall (SLAC)
- Pierre Artoisenet (CP3)
- Pavel Demin (CP3)
- Simon de Visscher (CP3)
- Rikkert Frederix (CERN)
- Michel Herquet (NIKHEF)
- Fabio Maltoni (CP3)
- Olivier Mattelaer (CP3)
- Tim Stelzer (UIUC)
- More expected very soon!

What we will cover

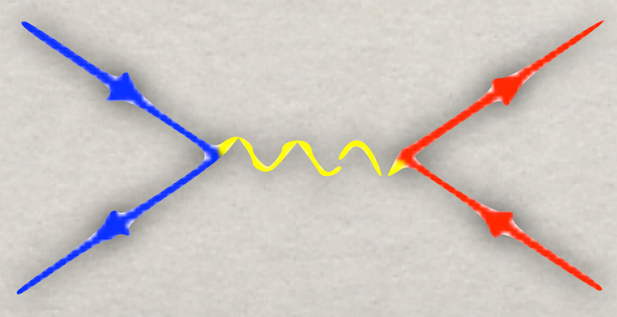
- What is MadGraph/MadEvent (MG/ME)
- How to run the code
- Implementing New Models
- Merging for BSM

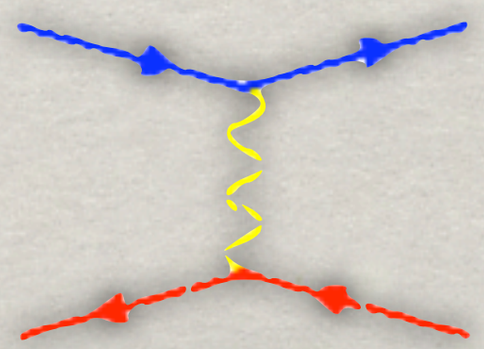




What we won't cover

- Internal workings of the code
- Detailed off-line running
- Decay chains & advanced process syntax
- MadWeight, MadDipole, MadOnium, ...

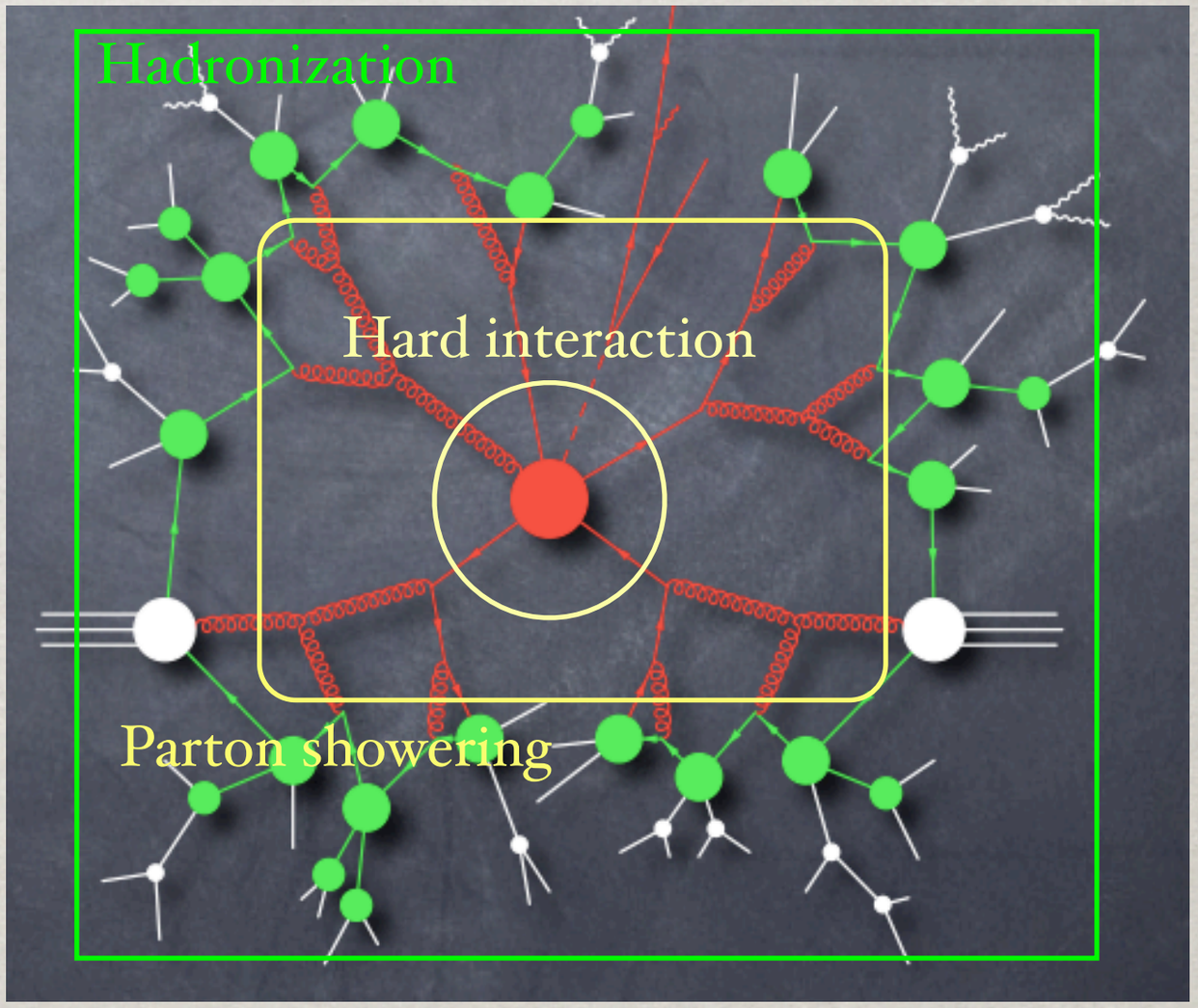




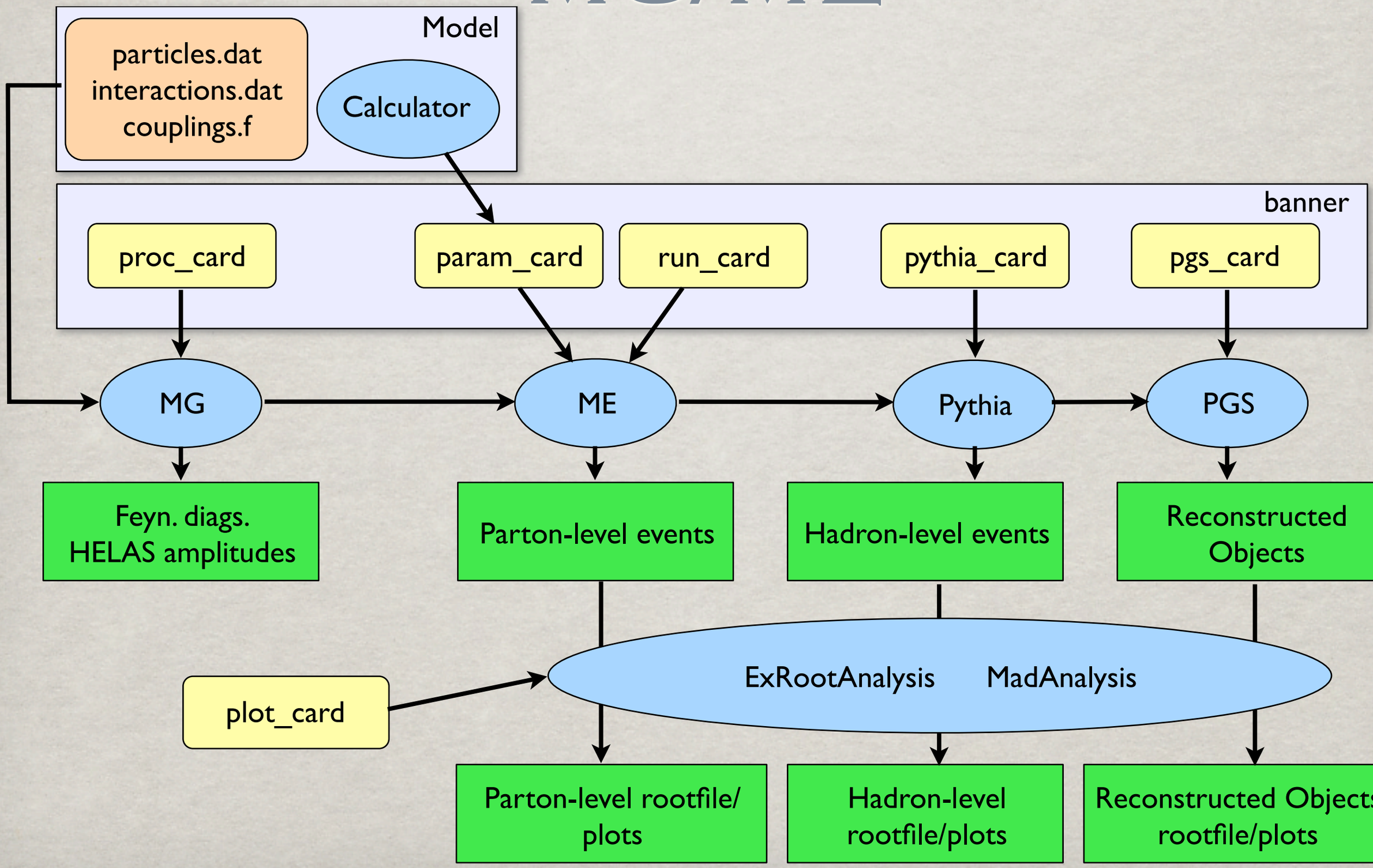
First Contact

(Very much) simplified LHC event

- MG/ME describes the Hard interaction at LO
- Interfaces to Parton Showering and Hadronization codes like Pythia or Herwig
- Interface to fast detector simulation with PGS



The "big" picture of MG/ME



How to run the code?

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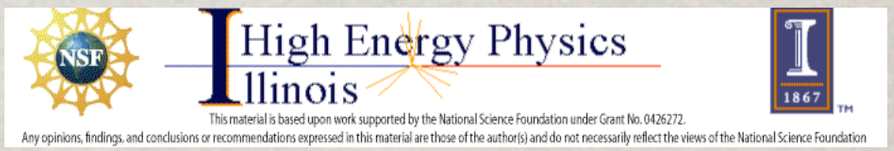
- Let's have a look on the web at any of the three on-line operational clusters

- http://madgraph.phys.ucl.ac.be/

- http://madgraph.hep.uiuc.edu/



- http://madgraph.roma2.infn.it/

Slightly more advanced...

New Physics

- Besides the available Models:
  - SM (incl. Higgs eff. coupl. to gluons)
  - MSSM (CP & R-parity conserving)
    - 2HDM (Completely general, incl. FCNC's and CP violation)
    - TopBSM (spin-0,1,2 resonances in top pair production)
- There are two ways of implementing New Physics
  - **FeynRules**
  - **Usermod**

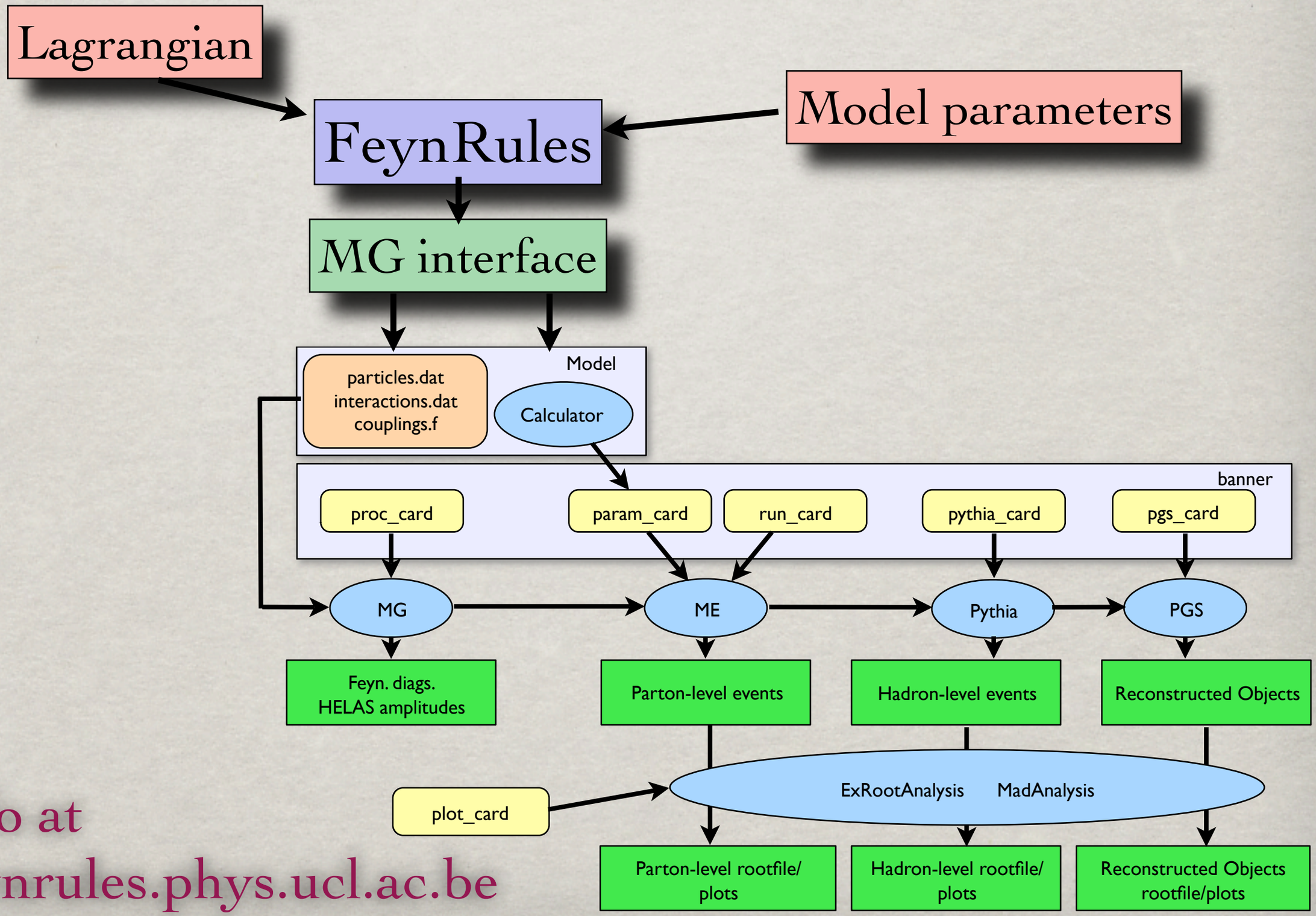
BSM with FeynRules

- FeynRules is a Mathematica package to compute automatically Feynman Rules from any QFT Lagrangian.
- User friendly MG/ME interface already tested extensively
- More models available soon (UED, 3-site, Littlest Higgs, ...)
- Not only interface to MG/ME, but also CalcHEP/CompHEP, FeynArts, Sherpa, ...
  - Allows to use best available Monte Carlo for the job without redoing the model implementation
- Best option for the implementation of realistic models (consistency, validation, ...)

More info at
http://feynrules.phys.ucl.ac.be

C. Duhr & N. Christensen

FeynRules interface



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UsrMod2

- UsrMod is a set of Python scripts to allow users to implement easily a few modifications to an existing MG/ME model (add particles, interactions, ...)
- Full support of all the models produced with FeynRules
- Best method for minor changes to existing models, i.e., for the study of a given signature, or when Mathematica is not available

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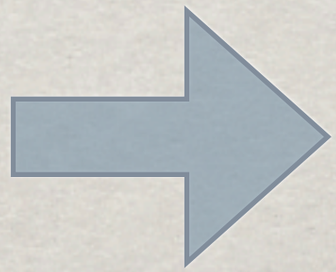
z        z        V    W    ZMASS  ZWIDTH  S  Z   23
w-       w+       V    W    WMASS  WWIDTH  S  W   -24
h+       h-       S    D    MHC    WHC     S  hc  37
h        h        S    D    HMASS  HWIDTH  S  h   25
```

```
w- w+ h  h  GWWHH GWWHH QED QED
z  z  h  h  GZZHH GZZHH QED QED
b  t  h-   HMCOUP   QED
t  b  h+   HPCOUP   QED
```



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gzd(1) = -ez*(-Half + sin2w/Three)
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HMCOUP(1) = -(a+b)
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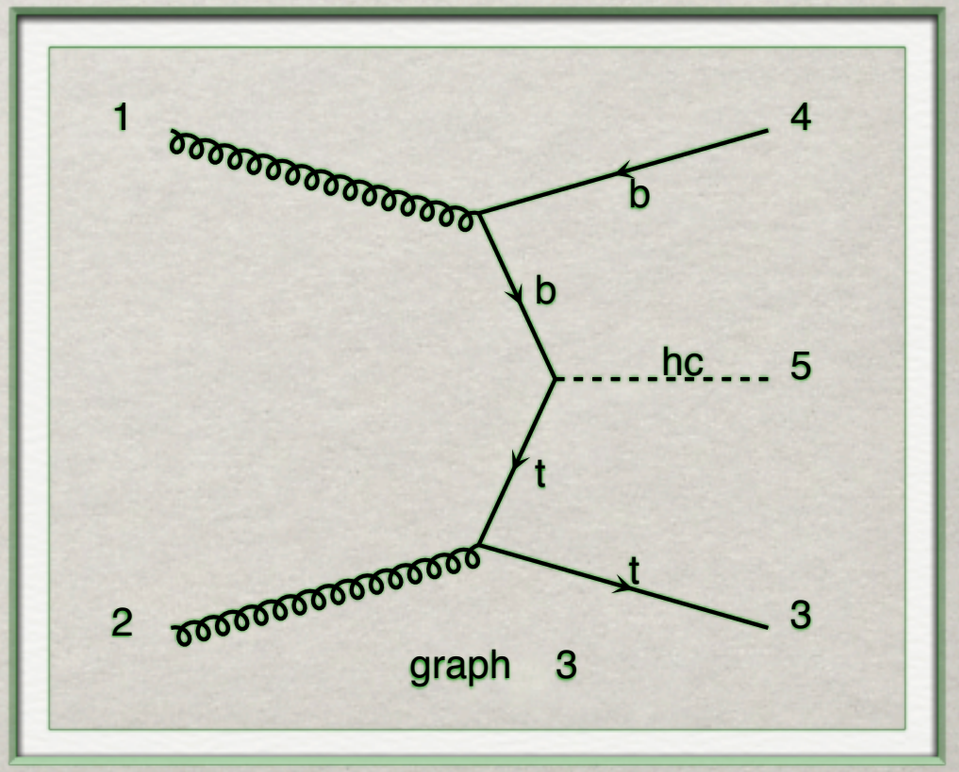
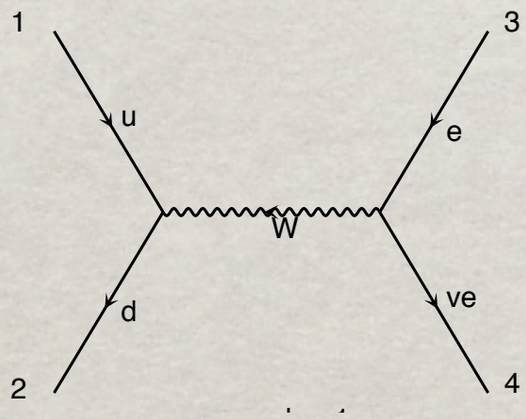
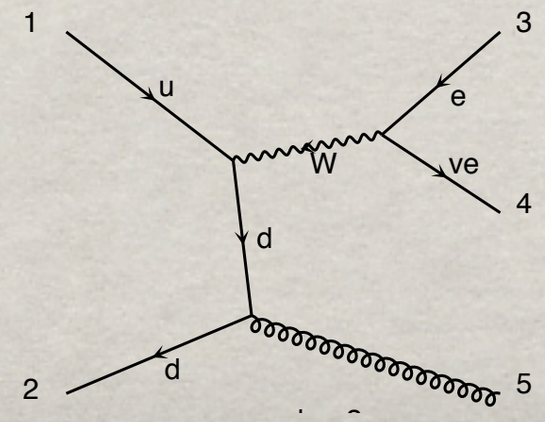


Matching/Merging

- Matrix elements (Hard interaction) and Parton Showers are complementary

- However, we need to avoid possible double counting





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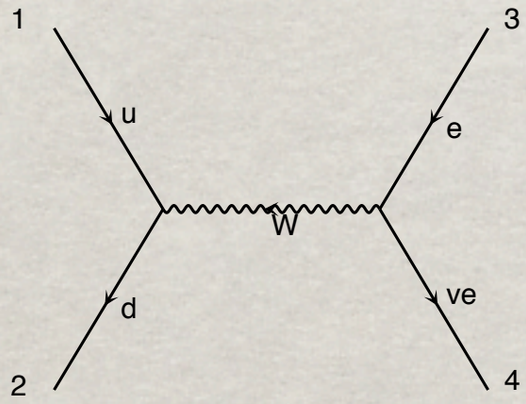

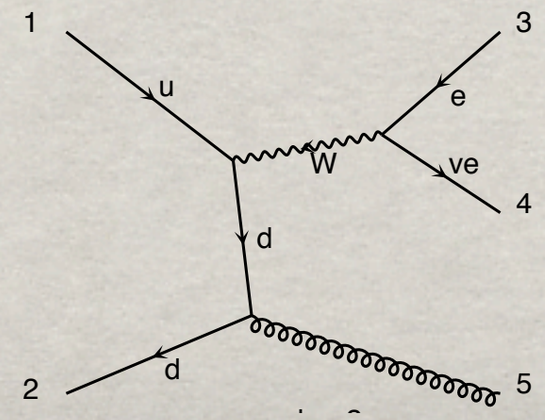

Solution:

One parton ⇔ one jet

Define cut-off to separate ME and PS and use a merging prescription for the intermediate region (e.g. k_TMLM)

Matching/Merging

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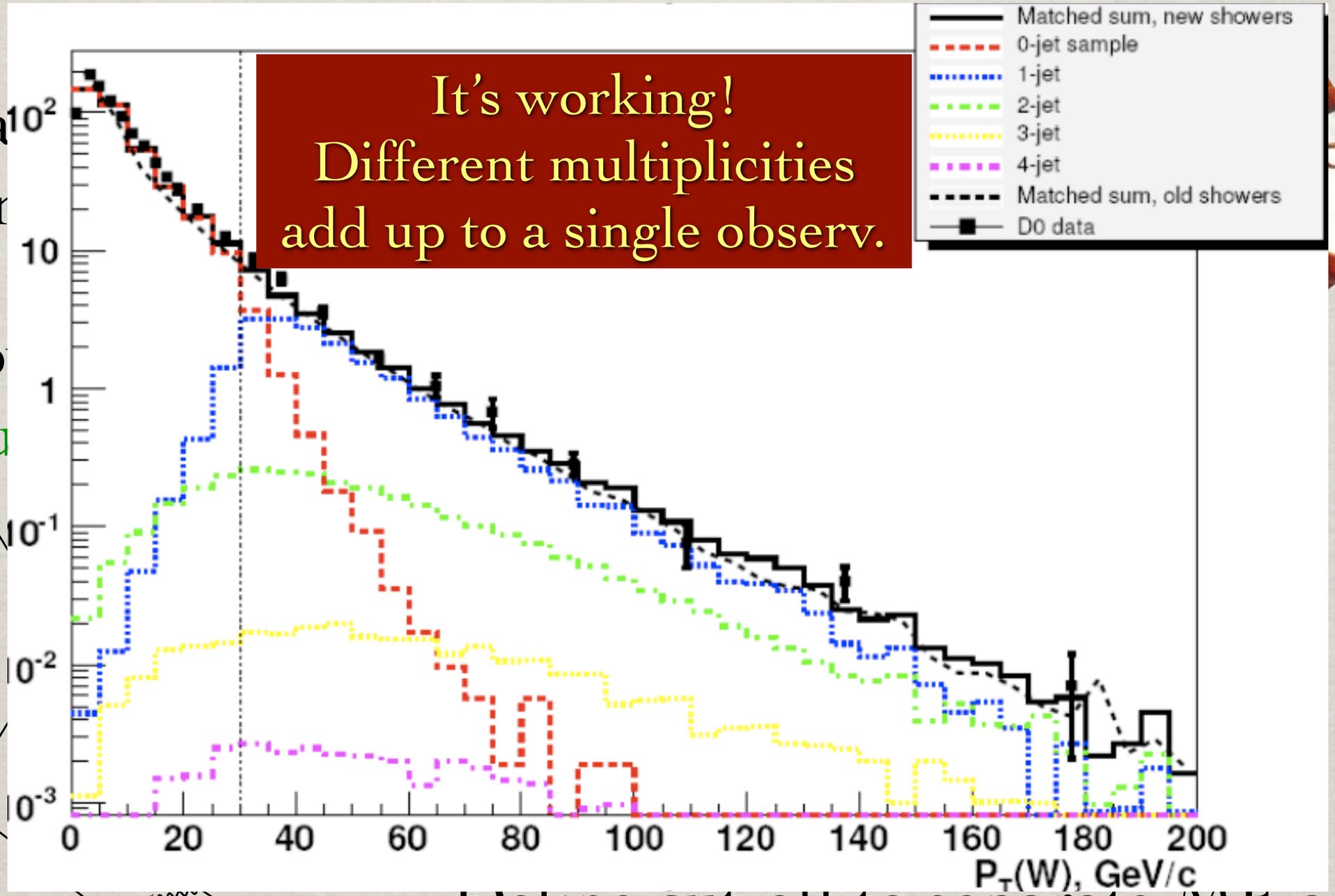

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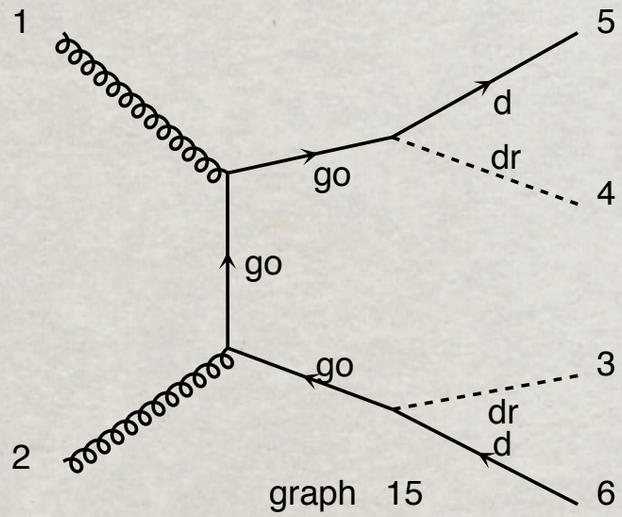
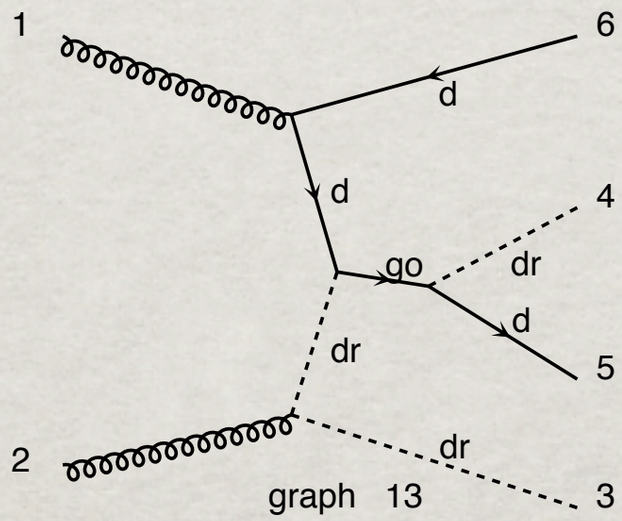
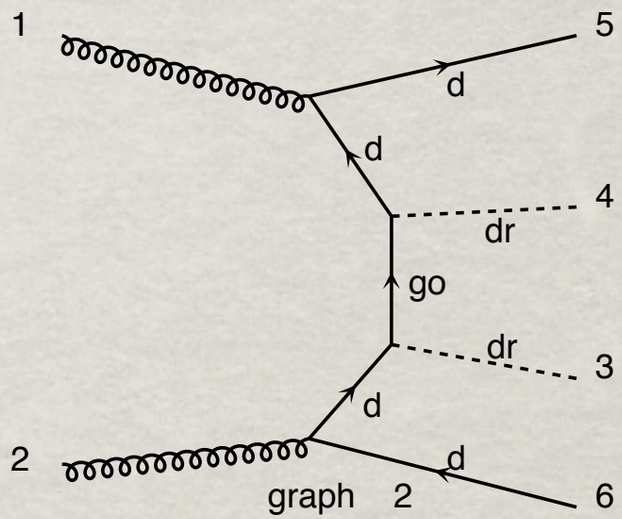
Merging in BSM

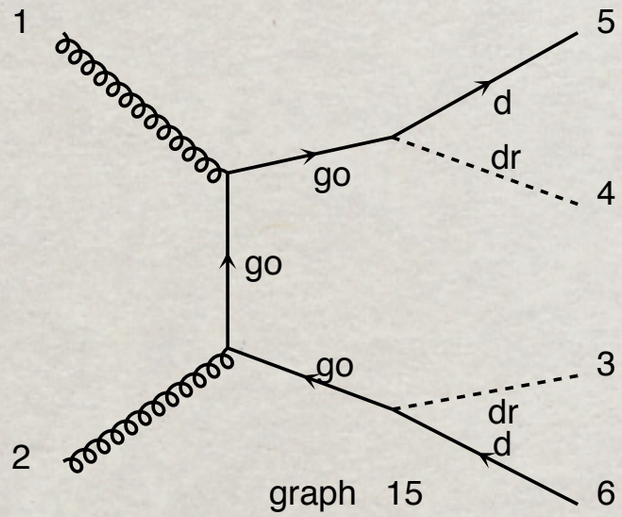


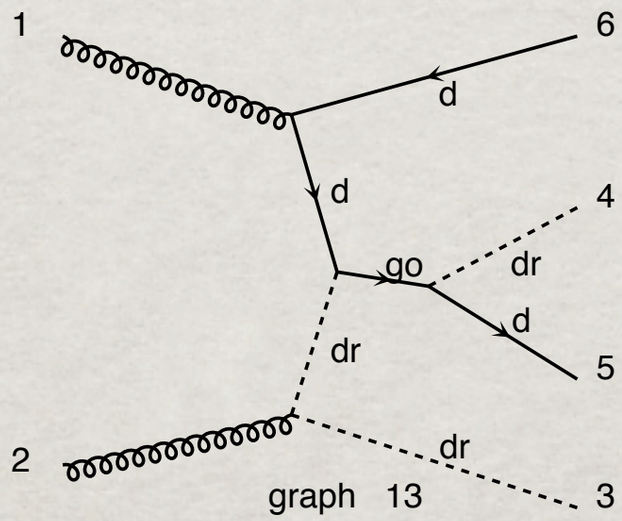


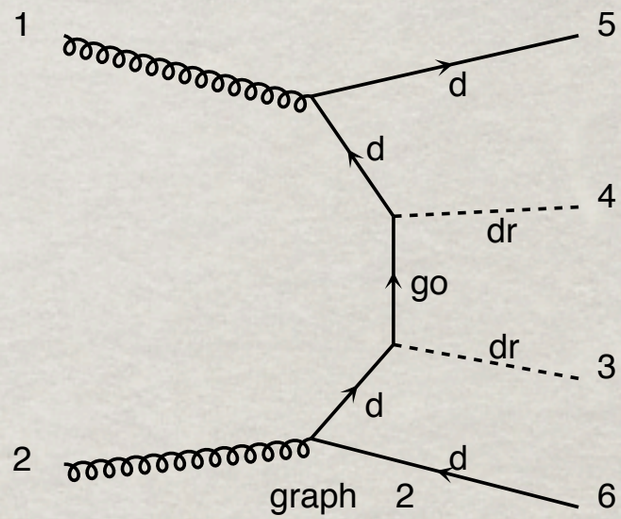


Merging in BSM

- Additional double counting due to resonances
  e.g. squark pair production with additional jets







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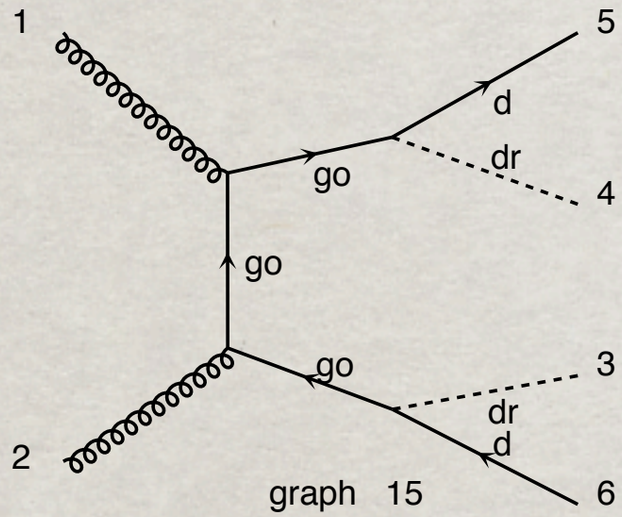

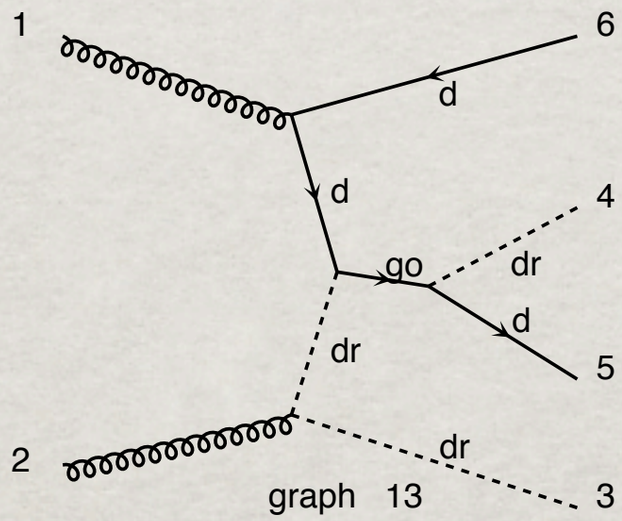

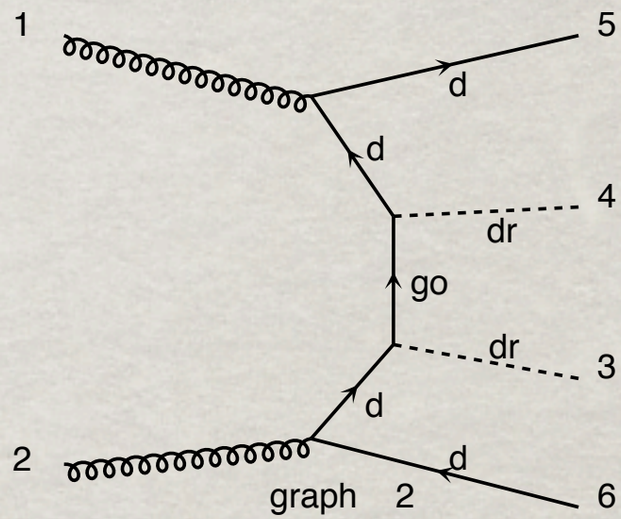

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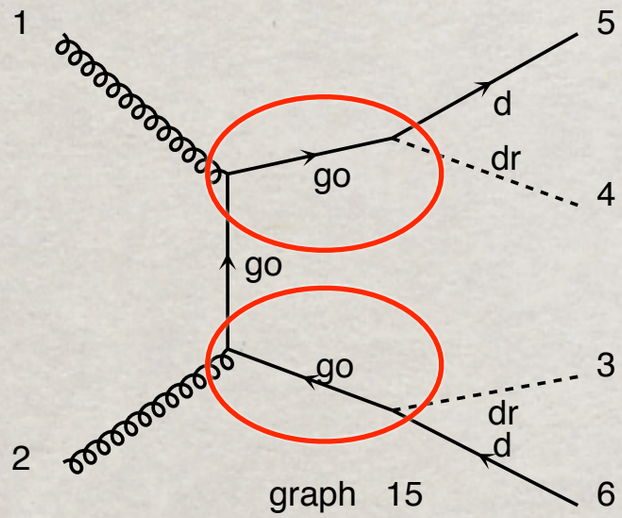

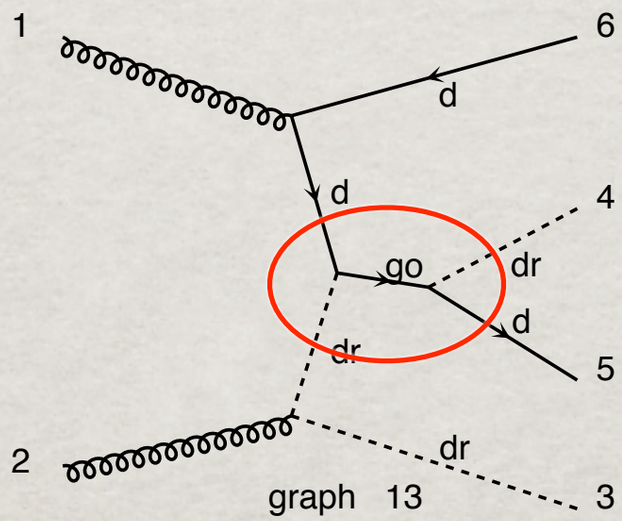

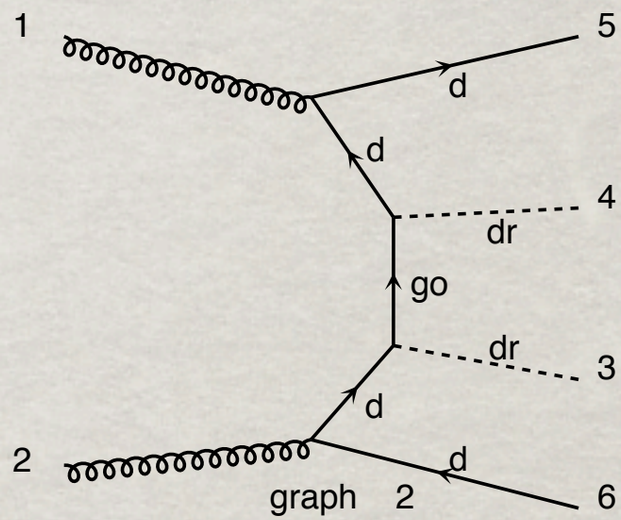

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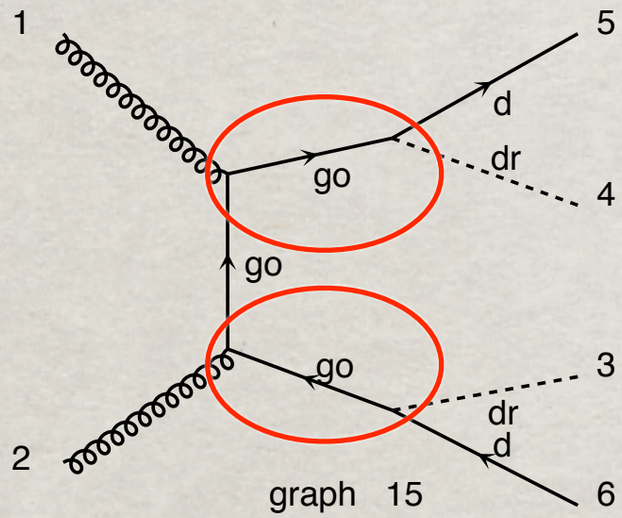

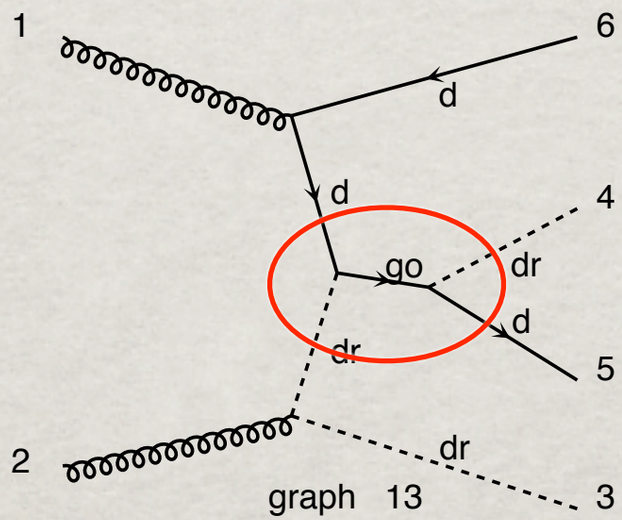

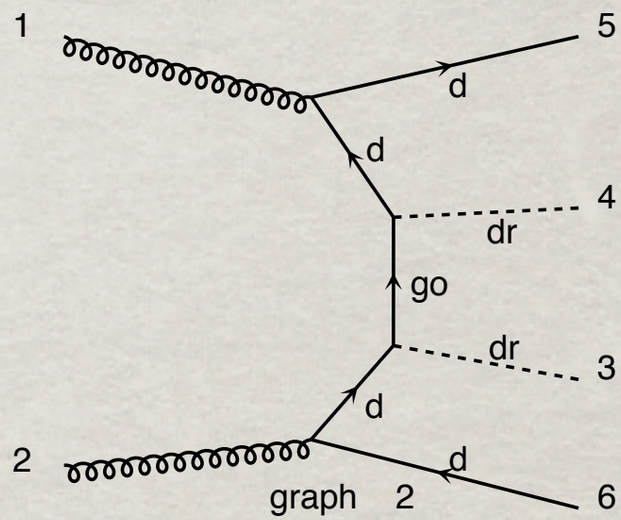

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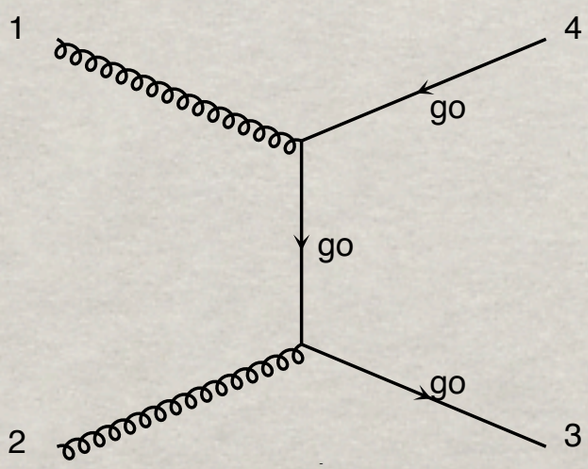

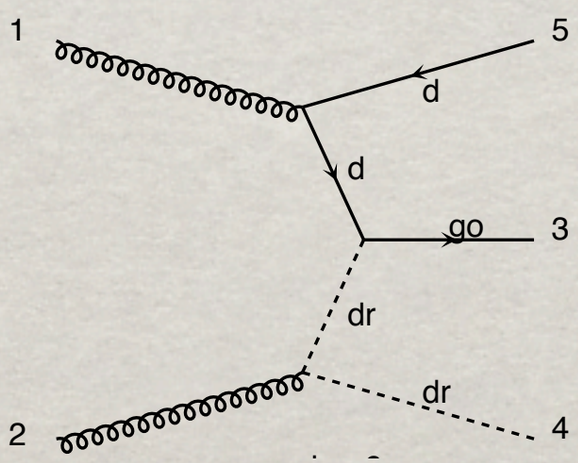

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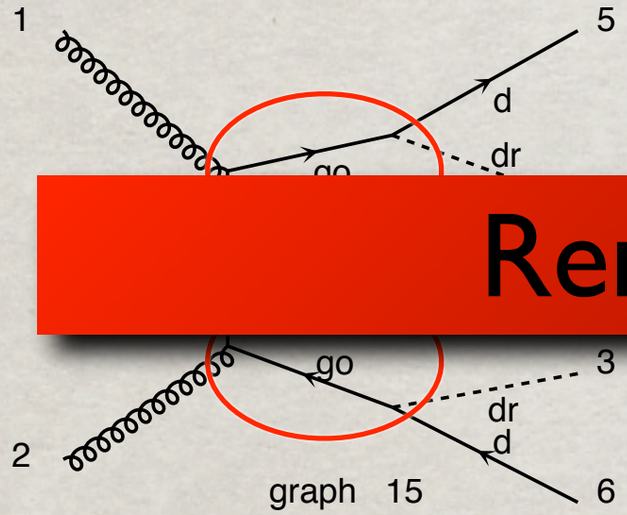

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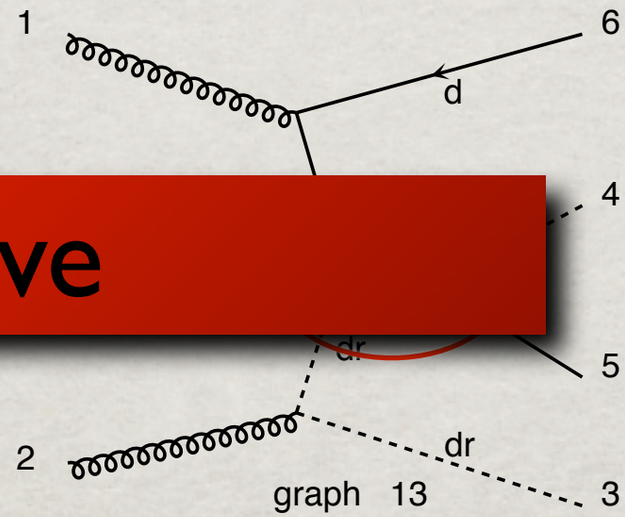

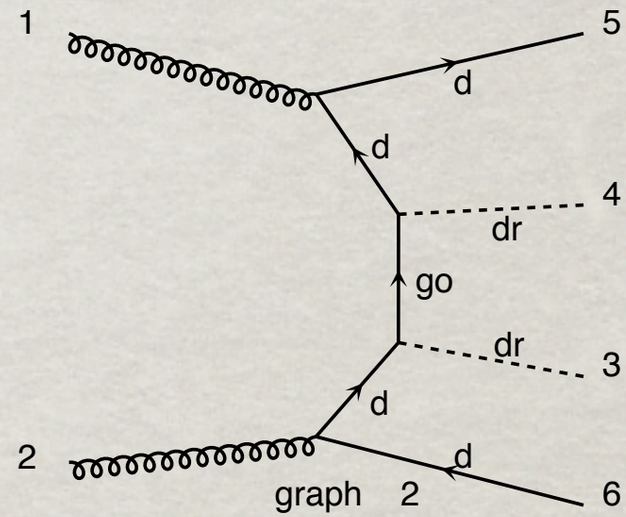

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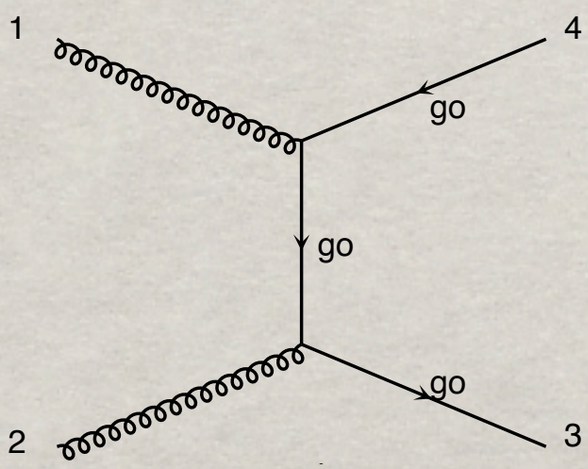

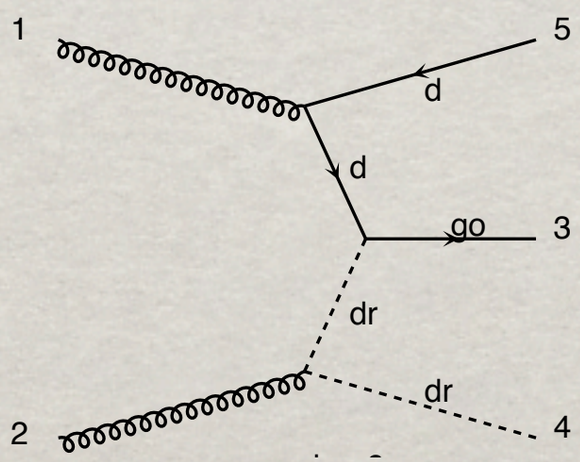

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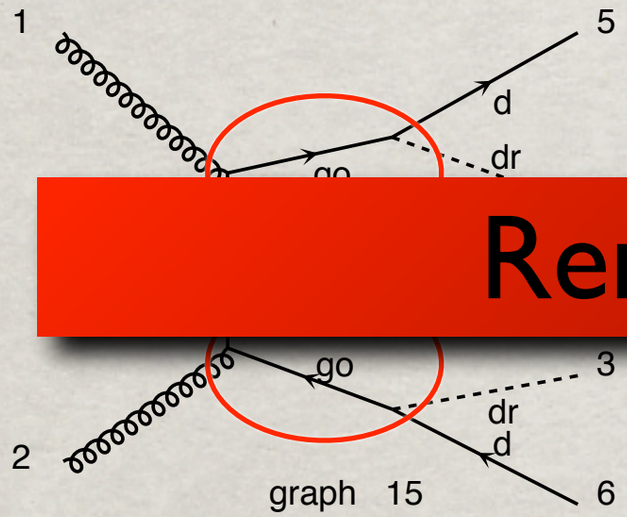

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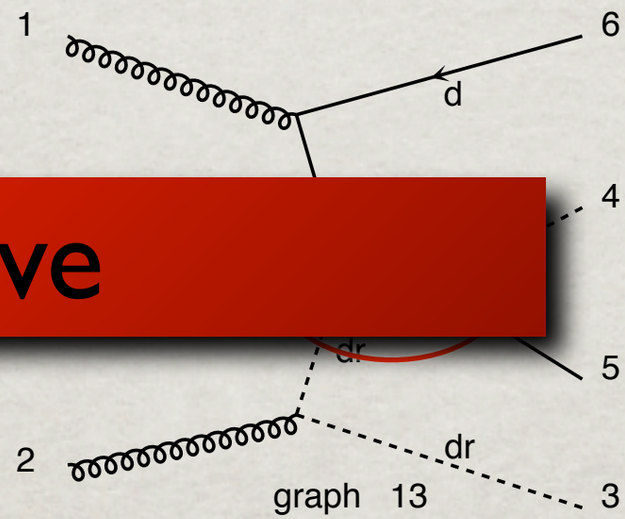

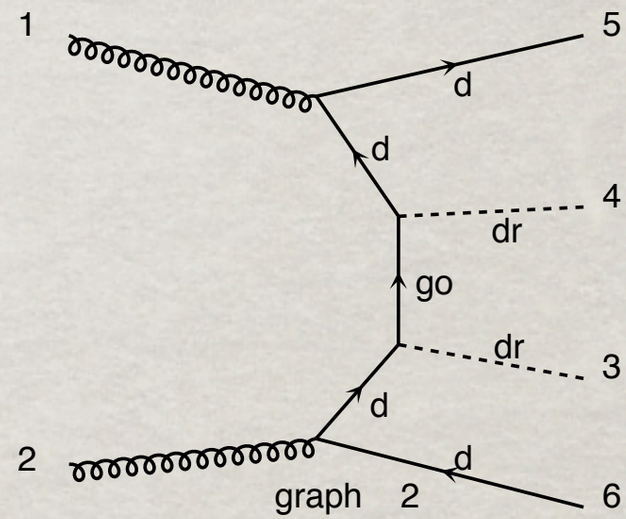

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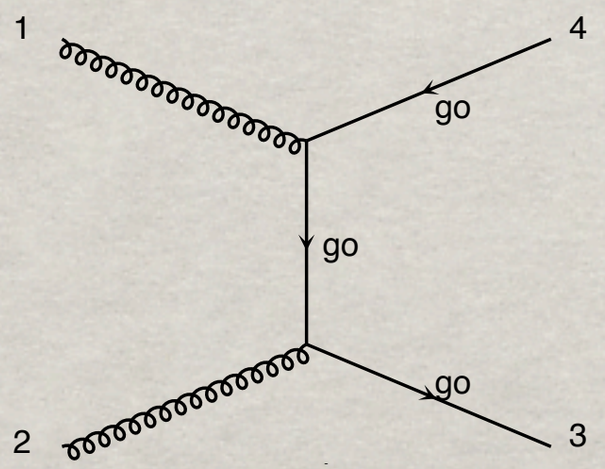
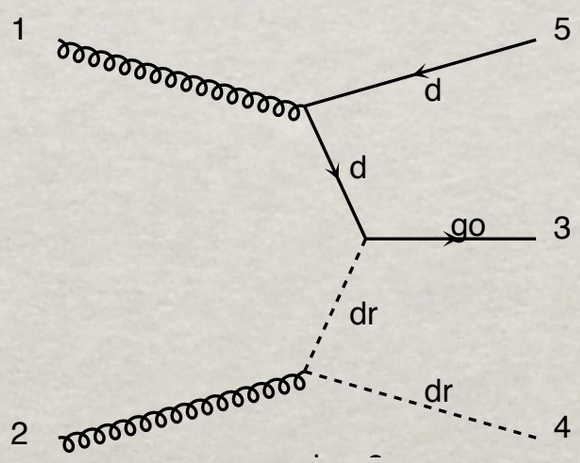
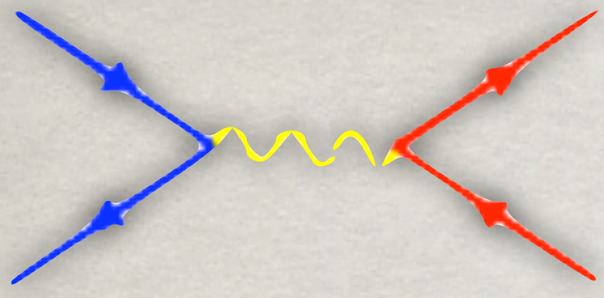
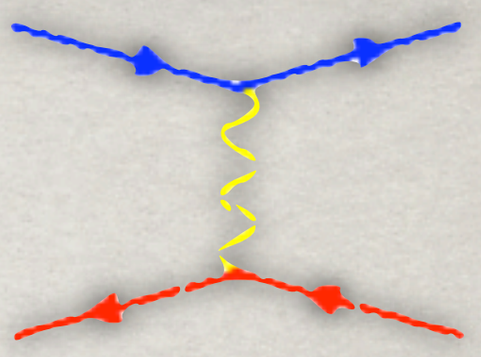




Alwall, de Visscher, Maltoni
JHEP 0902:017,2009 [arXiv:0810.5350]



Conclusions



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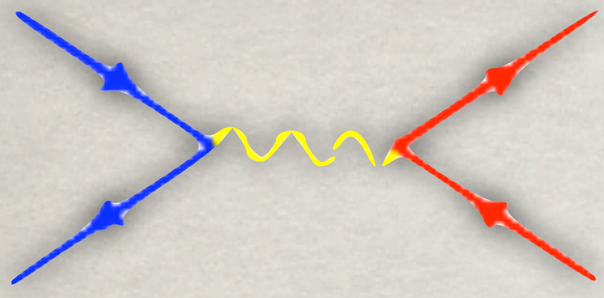
- Efficient simulation from the web, or on your own machine(s)

- Wiki-page with more information, FAQ, talks, lectures, links, ...



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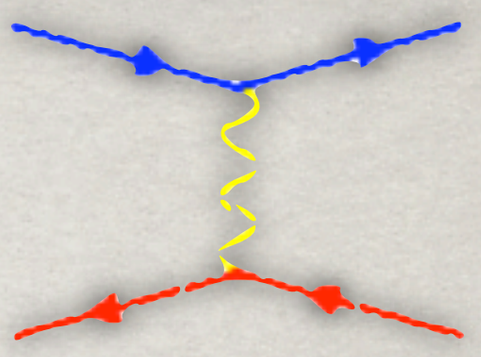

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