



MadGraph/MadEvent V4

from models to events

Rikkert Frederix

Center for Particle Physics and Phenomenology (CP3)
UCL - Belgium

In collaboration with:

J. Alwall, P. Demin, S. de Visscher, M. Herquet, F. Maltoni, T. Stelzer



Contents

- ◆ What is MadGraph/MadEvent?
- ◆ Including Beyond Standard Models
- ◆ Top pair invariant mass, BSM examples
- ◆ Recent developments & Conclusions

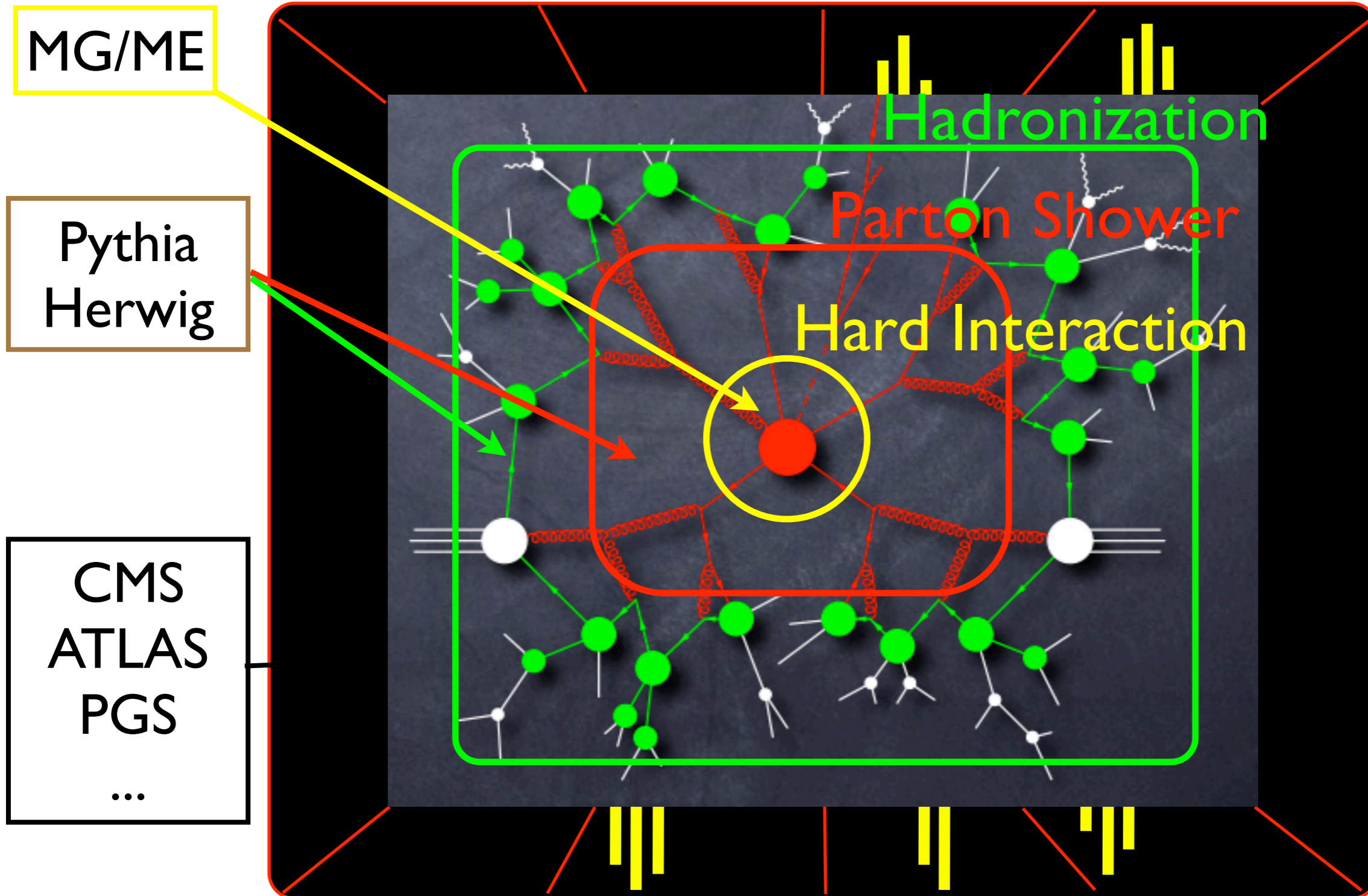


What is MadGraph/MadEvent?

- ◆ MG/MEv4 is a user-driven, matrix element based, event generator
- ◆ Both for SM as well as BSM
- ◆ Web server interface from which the simulation itself can be done on-line or off-line
- ◆ With MG/ME and its tools/interfaces, the full simulation chain from hard scale physics to detector simulation is available within one framework



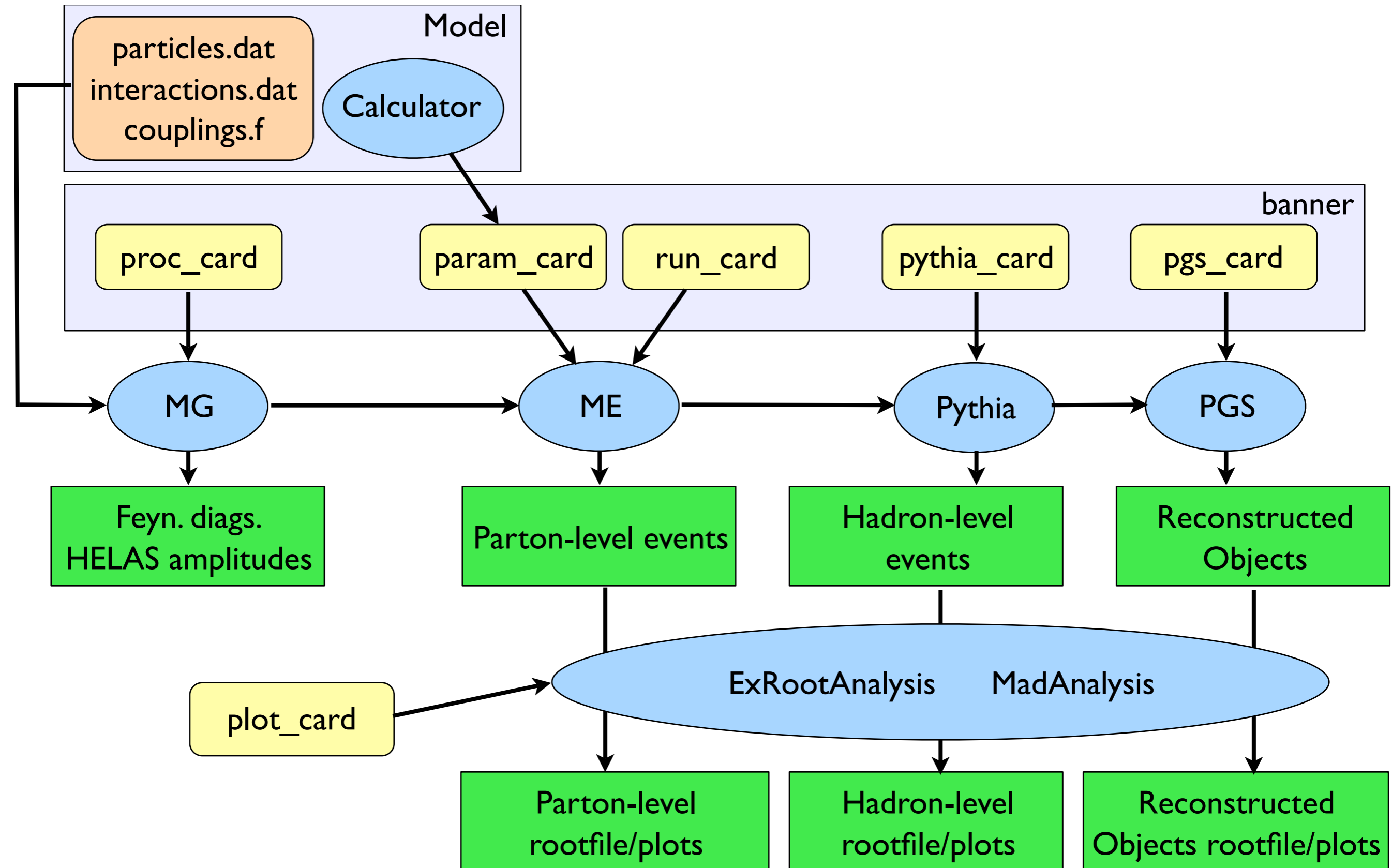
The Big Picture



Detector Simulation



Flow Chart





MG/ME Features

- ◆ Helicity amplitudes, based on HELAS
- ◆ Efficient (i.e. parallel) phase space integration ('multi-channel' based on Feynman diagrams)
- ◆ It complies with the Les Houches Accord standard, w.r.t. the model parameters and event files
- ◆ Structure is model independent
- ◆ Easy to implement and validate new models
- ◆ Open

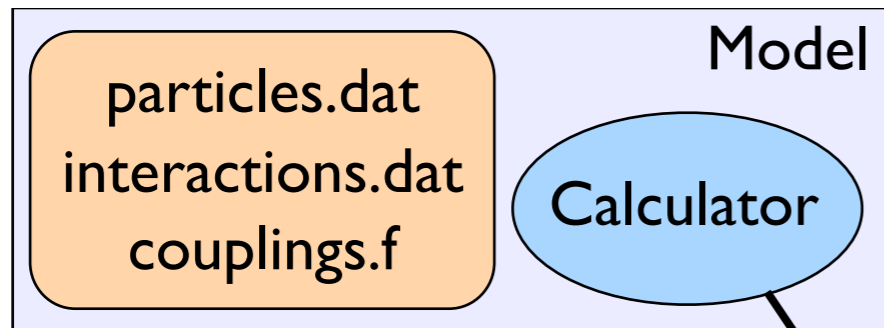


Models

- ◆ SM
 - ◆ HiggsEFT (Effective couplings between Higgs and gluons/photons)
- ◆ MSSM (CP & R-parity conserving)
- ◆ Generic 2HDM (Completely general 2 Higgs doublet model, incl. FCNC and CP violation)
- ◆ **User Model** -- General framework to include user-defined models



Creating your own Physics Model using the 'User Model'



```

*****
s spectrum (kinematic masses)
#      ID      MASS      #      name      mass
4      4      1.400000000E+00  # charm      pole mass
5      5      4.180000000E+00      # bottom     pole mass
6      6      1.730000000E+02      # top        pole mass
15     15     1.777000000E+00      # tau        mass
23     23     9.15445065E+01      # Z          mass
24     24     8.02673592E+01      # W          mass
25     25     1.000000000E+02      # H          mass
32     32     6.000000000E+02      # ZPMASS

u u zp GZPU QED
s s zp GZPD QED
c c zp GZPU QED
b b zp GZPD QED
t t zp GZPU QED

- - - - -
#MODEL EXTENSION
zp      zp      V      W      ZPMASS ZPWID  S      ZP      32

```

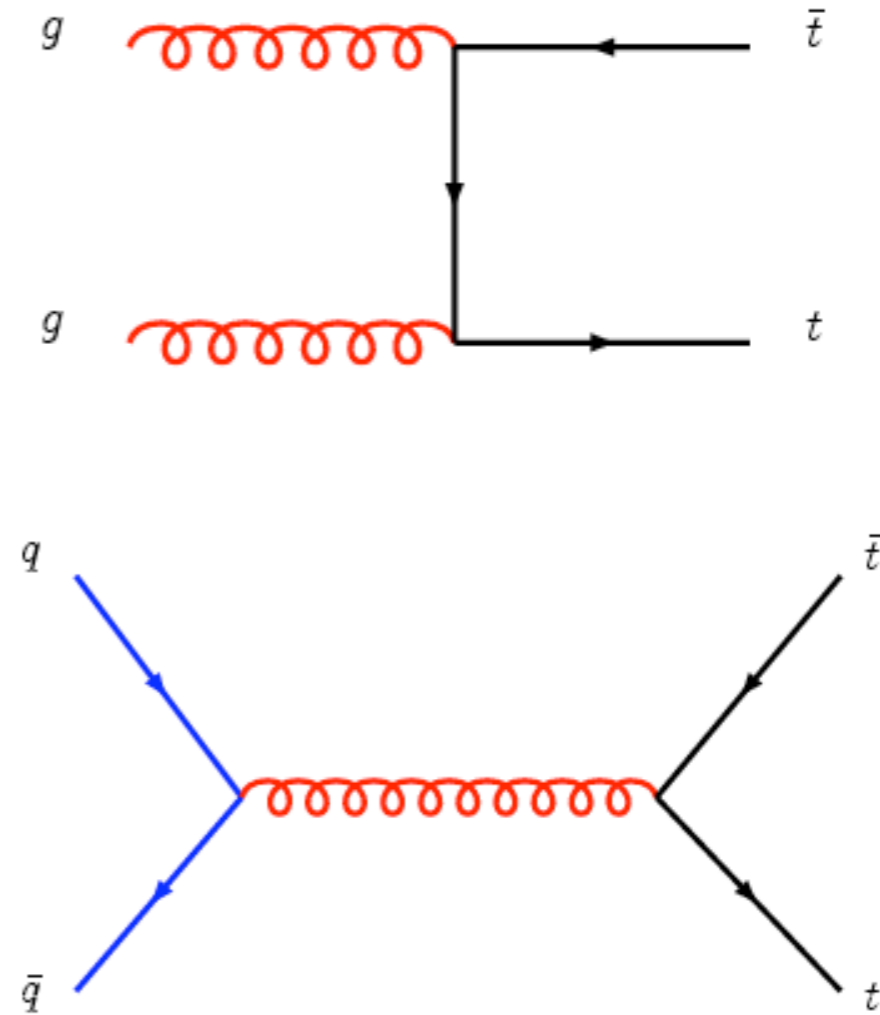
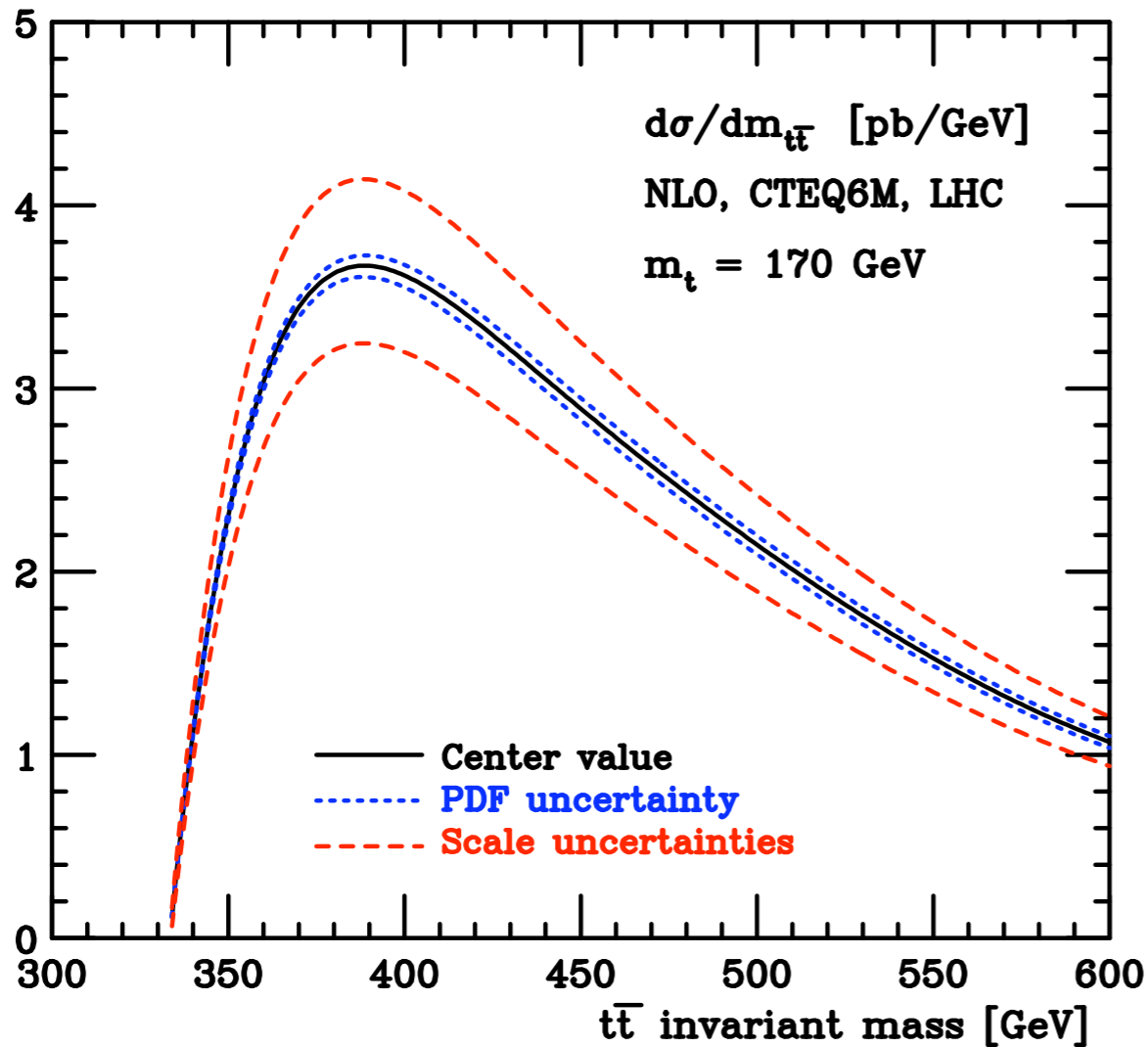
- ◆ particles.dat
- ◆ interactions.dat
- ◆ couplings.f
- ◆ param_card.dat



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Top pair invariant mass

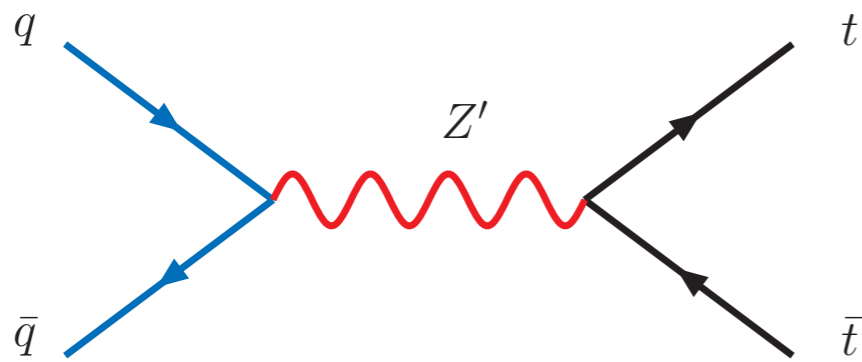


NLO: Mangano, Nason & Ridolfi 1992

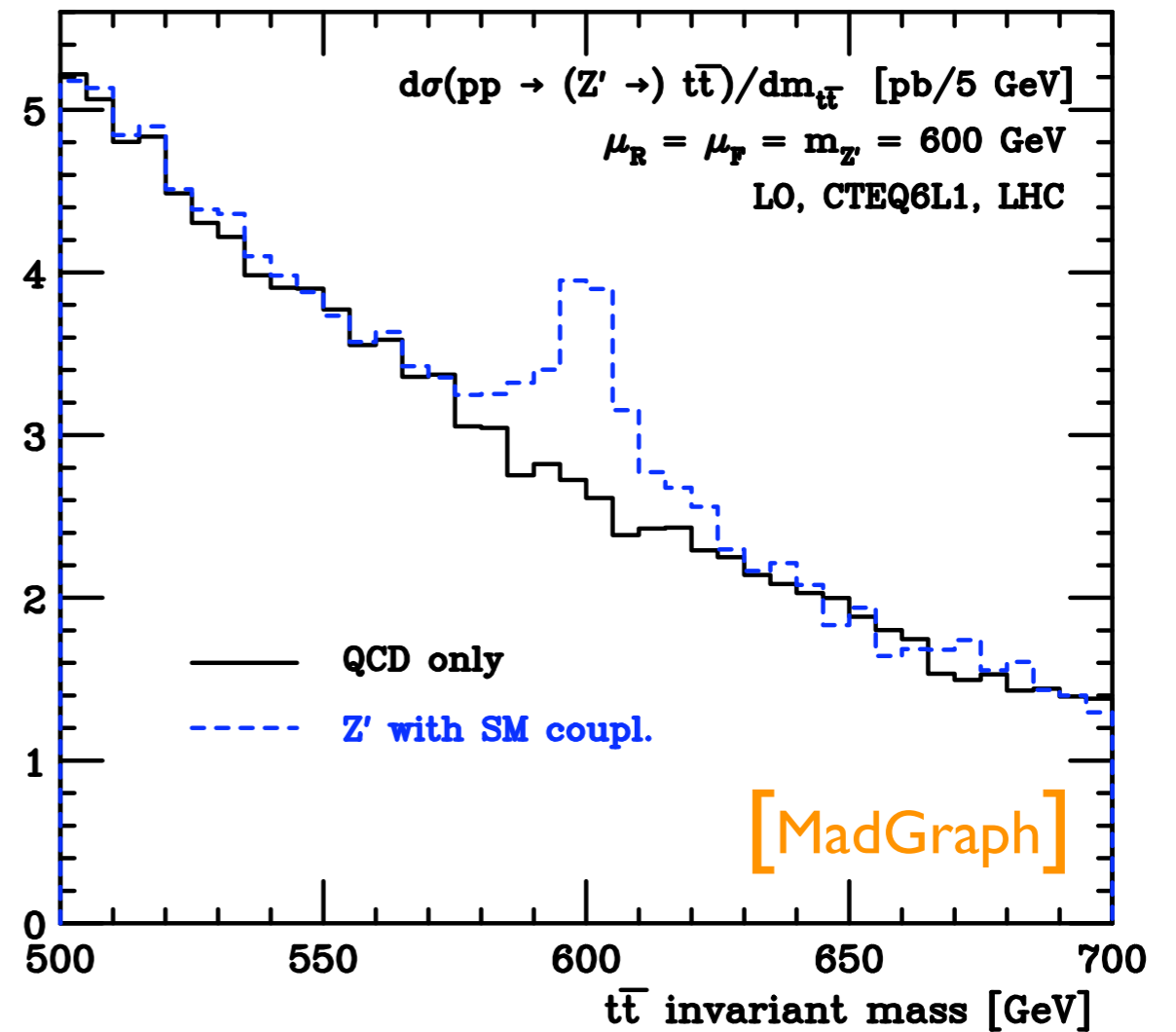
Incl. spin corr.: Bernreuther, Brandenburg, Si & Uwer 2001

NLL: Bonciani, Catani, Mangano & Nason 1998

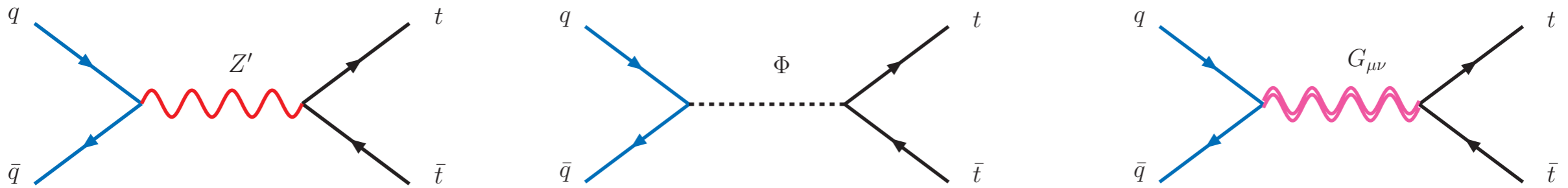
Z prime resonance



Review by T. Rizzo 2007

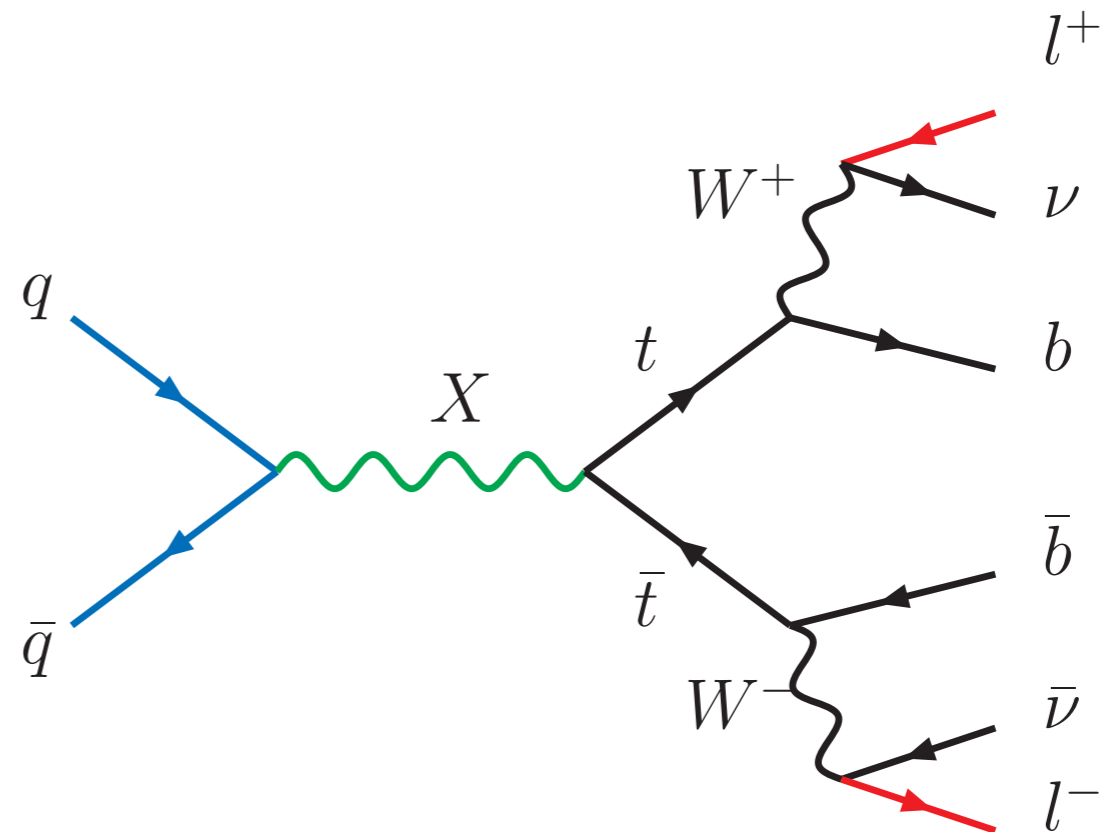


Spin correlations



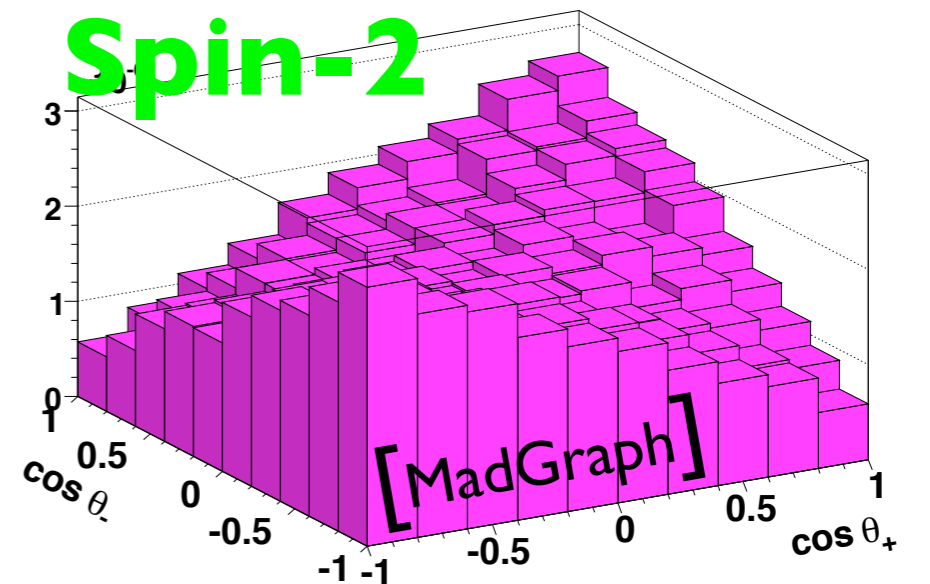
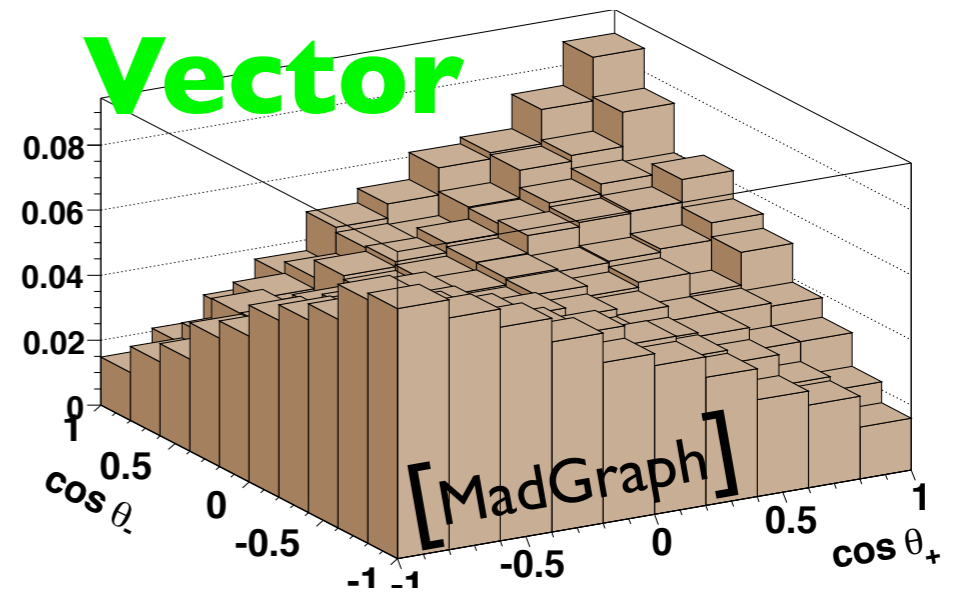
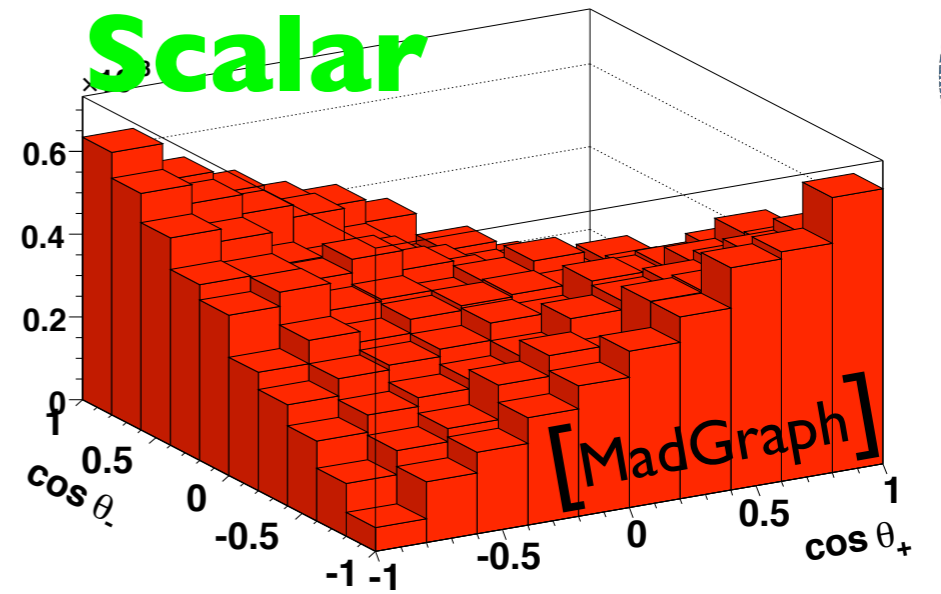
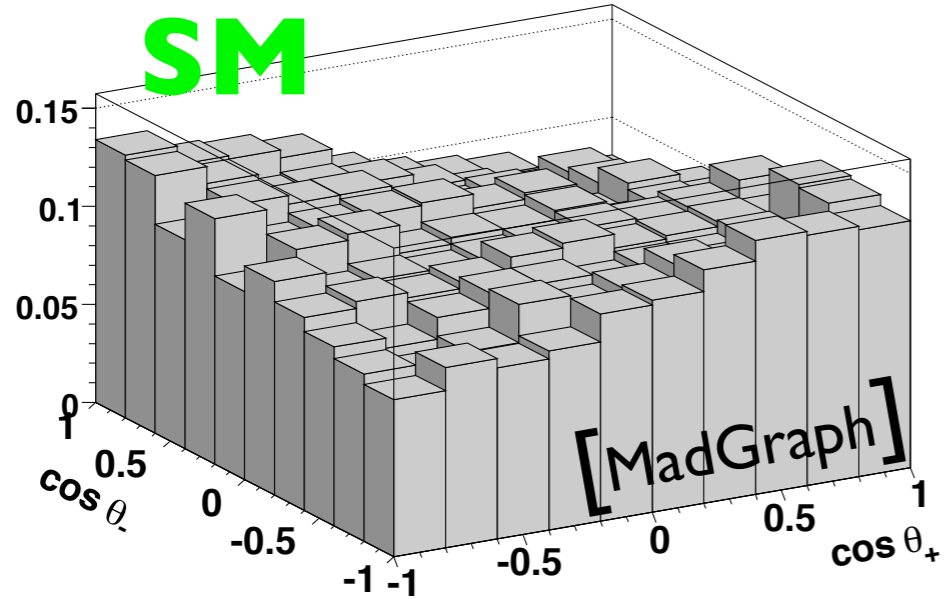
How to extract the spin information about the resonance?

Decay the top's and look at angular correlations between the leptons!



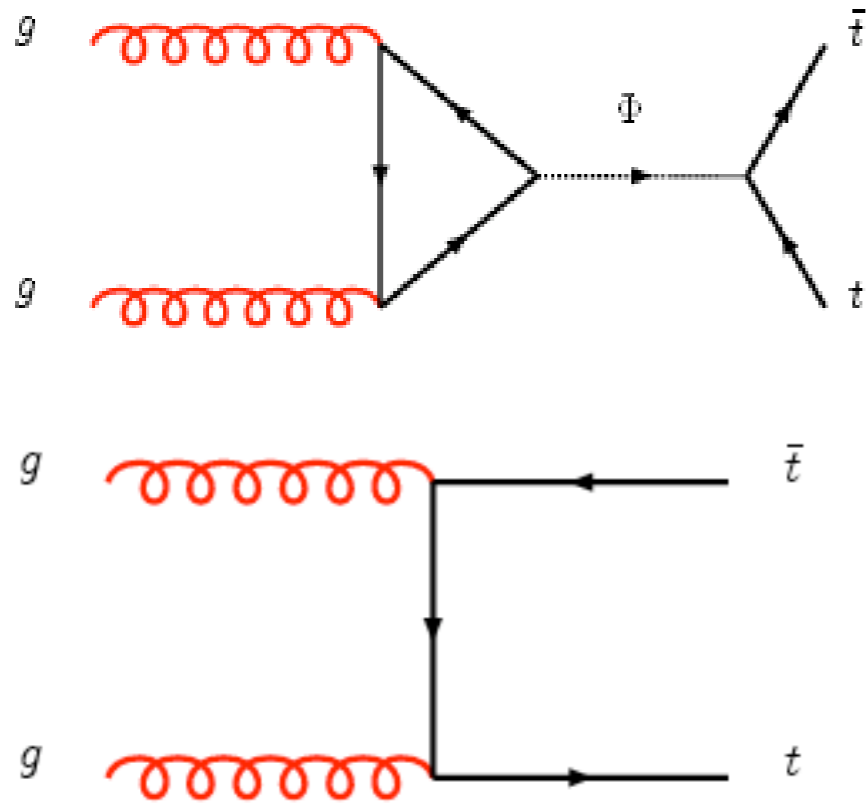


Spin correlations

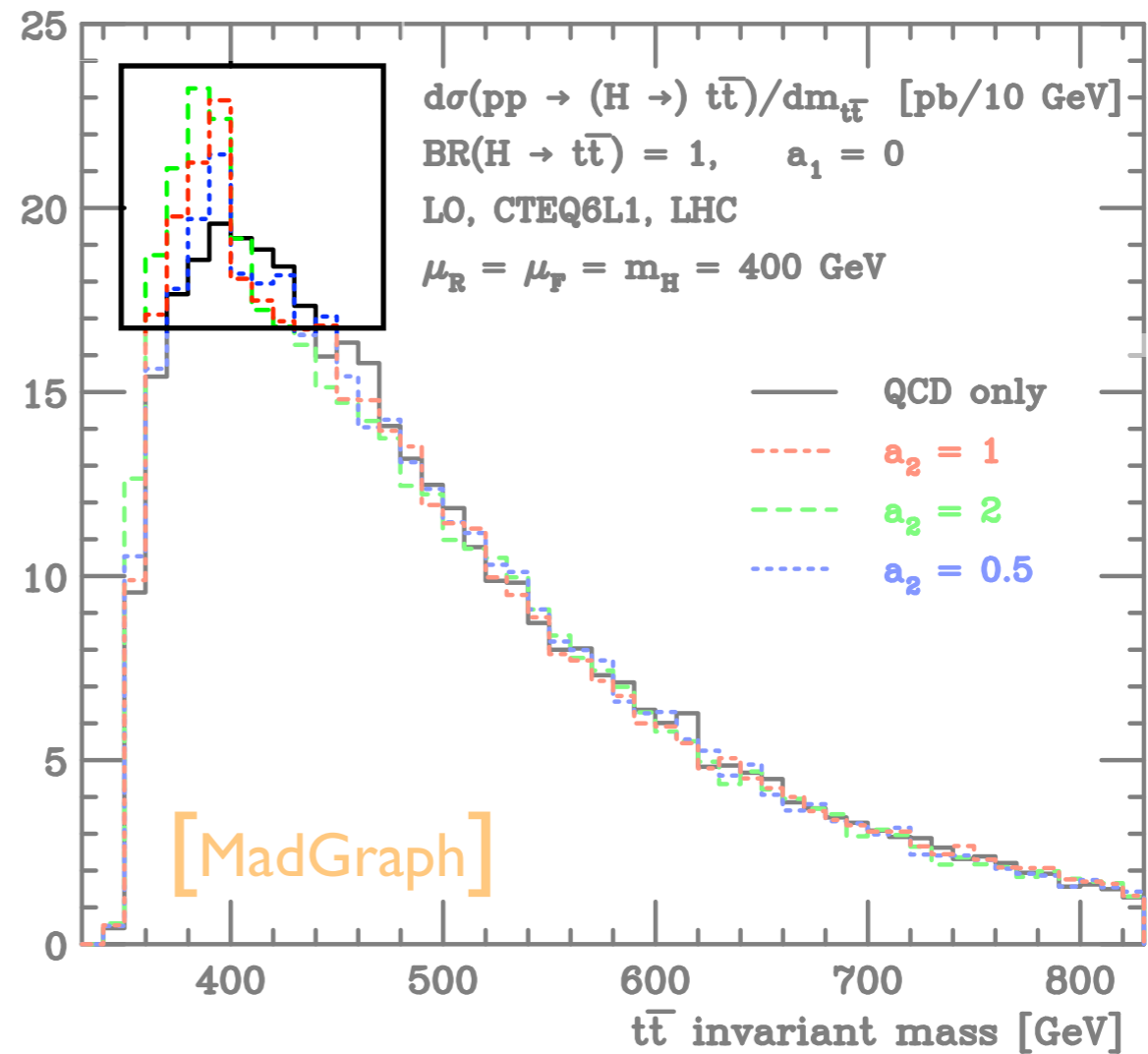


800 GeV resonances

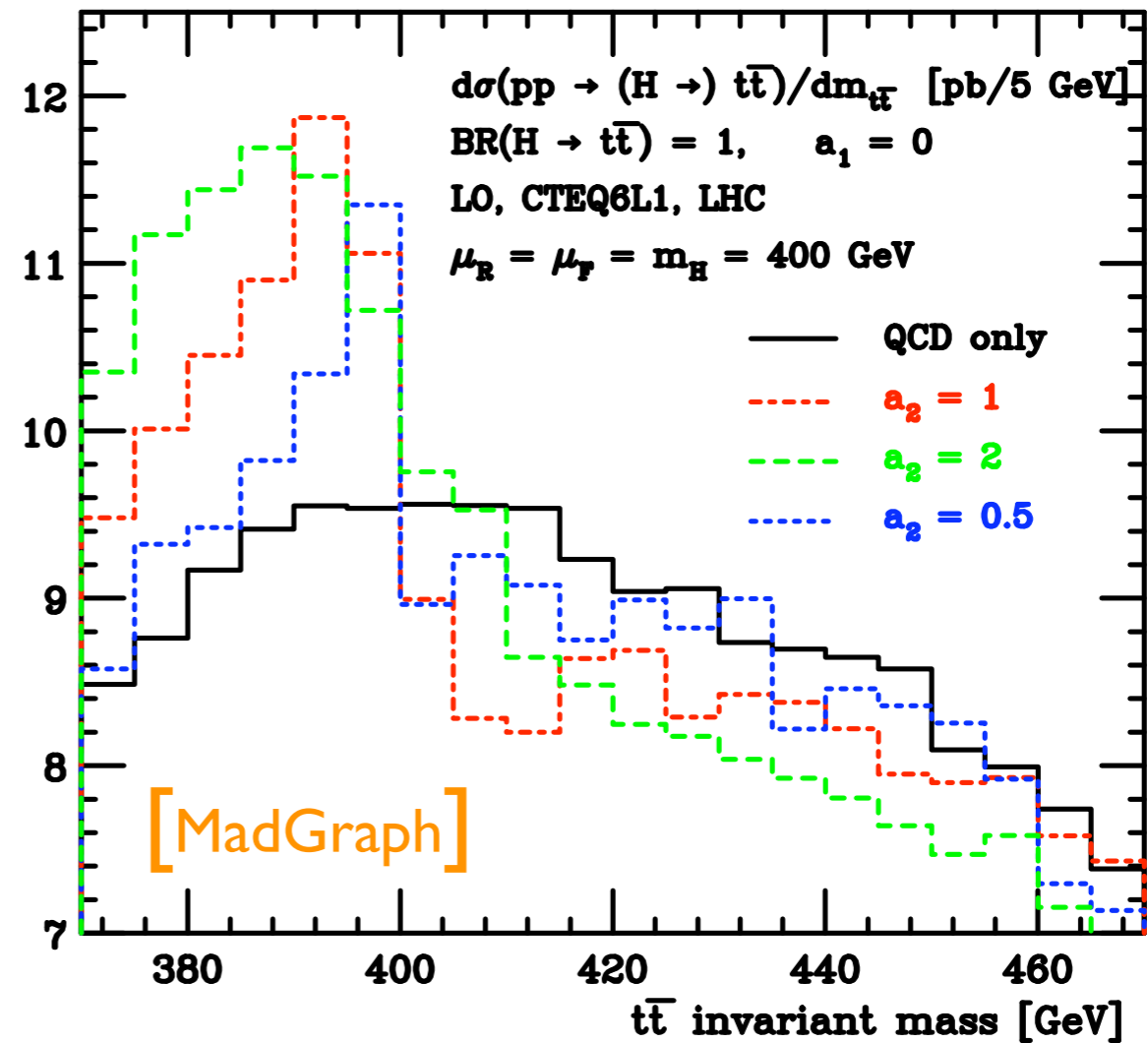
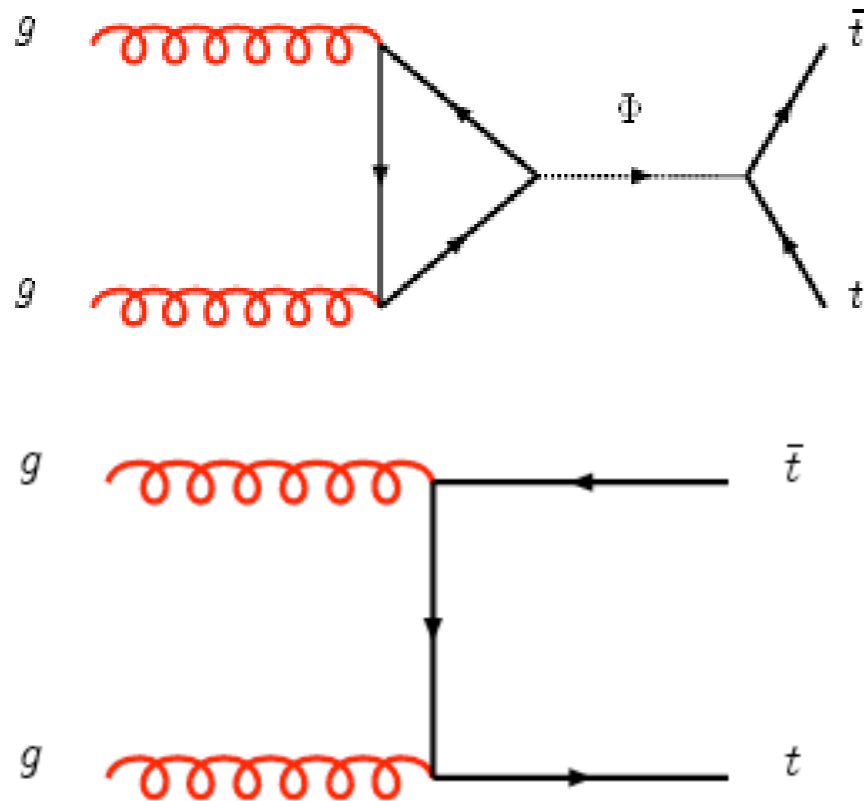
Pseudo-scalar resonance



Dicus, Stange & Willenbrock 1994

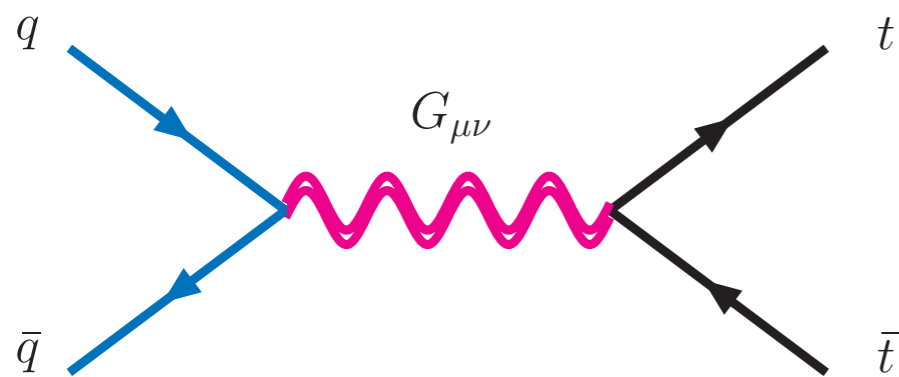


Pseudo-scalar resonance

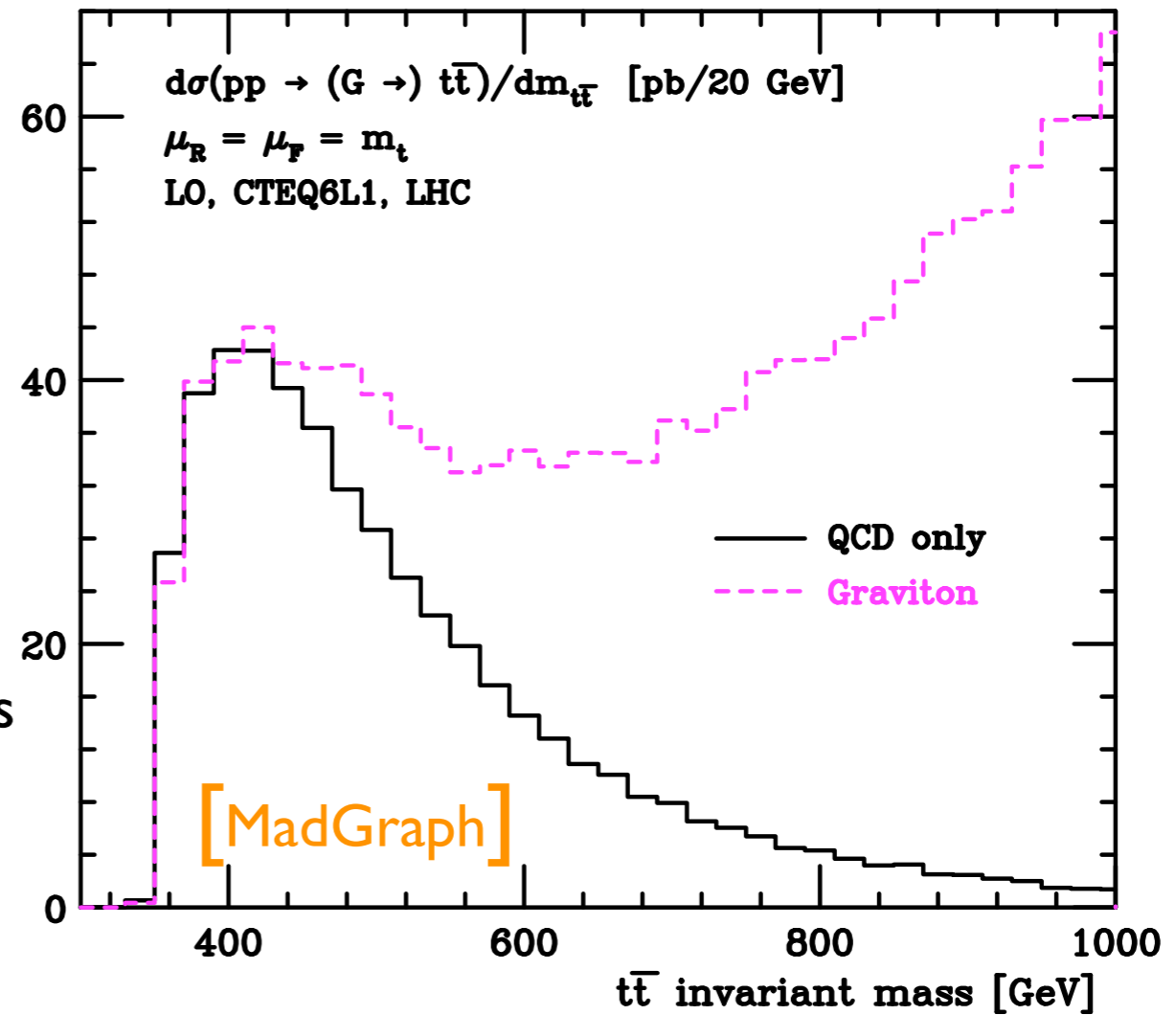


Dicus, Stange & Willenbrock 1994

KK-tower of gravitons

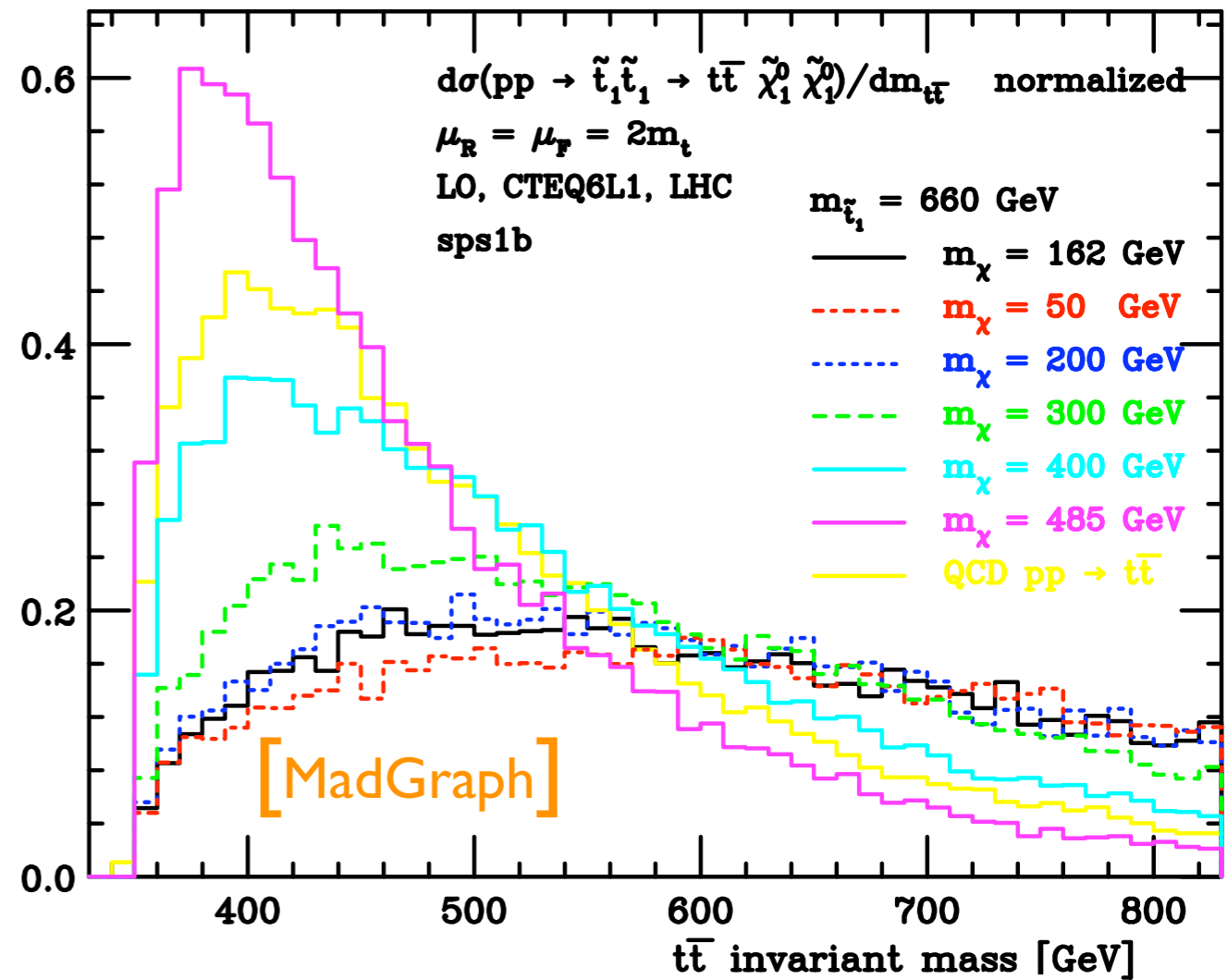
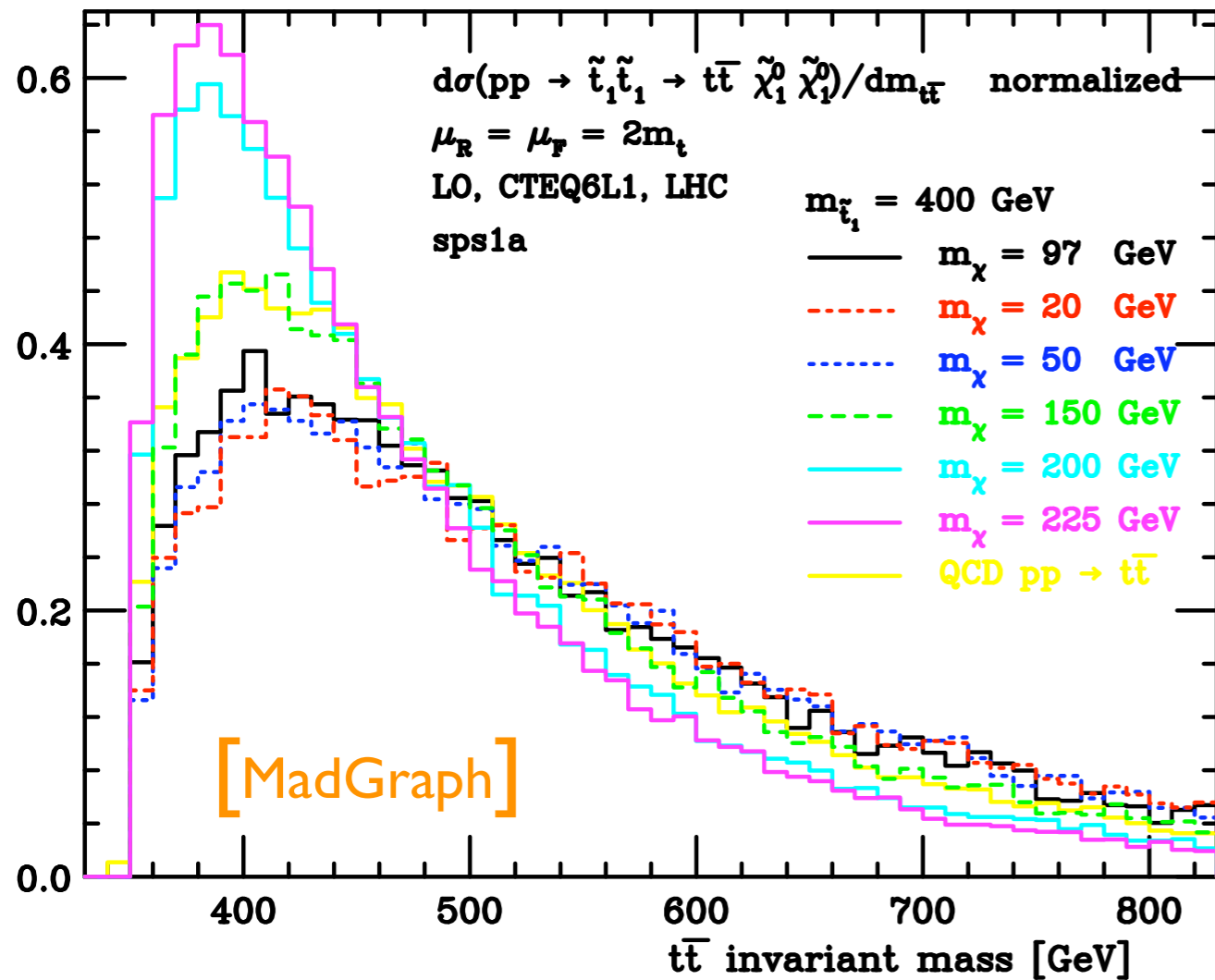


In large extra dimensions all the KK gravitons can be almost degenerate in mass. This can even lead to unitarity violation at high energies.

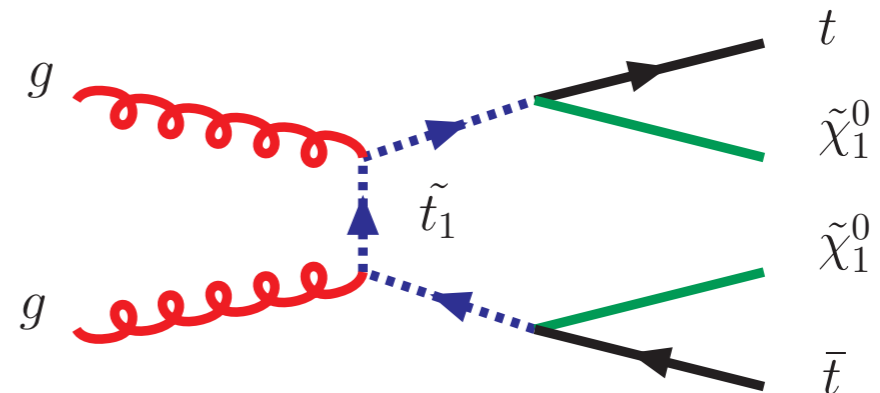


Arkani-Hamed, Dimopoulos & Dvali 1998

Non-resonance BSM physics



MSSM stop pair decay to top pair and neutralinos





Recent developments & Work in Progress

- ◆ Mathematica based program to extract **Feynman rules** and couplings directly from the **Lagrangian** (C. Duhr)
- ◆ Specify complete **decay chain** without computing all diagrams, especially useful for very rich multi-particle final states (J. Alwall & T. Stelzer)
- ◆ Matrix element techniques in analysis (P. Artoisenet & O. Mattelaer)

- ◆ BRIDGE, a program to calculate **widths** and decays unstable particles in **any model** (P. Meade & M. Reece)
- ◆ Model guessing from data (BARD, inverse problem, ...)
- ◆ ...



Conclusions

- ◆ **MadGraph/MadEvent** is an event generator that is:
 - ◆ **Multi purpose**, new models easy to implement
 - ◆ **Complete**, interfaces from model to detector simulation
 - ◆ **User friendly**, due to the web interface
 - ◆ **Fast**, thanks to the cluster oriented structure
 - ◆ **Open**, everybody can contribute!

See also the three operational cluster at

<http://madgraph.phys.ucl.ac.be>

<http://madgraph.hep.uiuc.edu>

<http://madgraph.roma2.infn.it>