

# Physics 835: Intro to MadGraph

A screenshot of a web browser displaying the "MadGraph Home Page". The URL in the address bar is "madgraph.hep.uiuc.edu". The page features the NSF logo, the High Energy Physics Illinois logo, and the UIUC 1867 logo. It includes a diagram of a particle interaction with a yellow wavy line and blue arrows. Navigation links include "Generate Process", "Register", "Tools", "My Database", "Cluster Status", "Downloads", "Wiki/Docs", and "Admin". A note states: "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." Below the navigation links, it says "The MadGraph homepage" by the "UCL UIUC Fermi MG/ME Development team".

MadGraph Home Page

madgraph.hep.uiuc.edu

Most Visited ▾ Latest Headlines ▾ MY - UW NWS Internet We... UW NPAC EPMS Npac-Theory - ... NOAA arXiv G UW-Physics Web... HEP - HEP

NSF High Energy Physics Illinois 1867

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](#). Please note the correct reference for MadGraph 5, [JHEP 1106\(2011\)128](#), [arXiv:1106.0522 \[hep-ph\]](#). You can still use MadGraph 4 [here](#).

Code can be generated either by:

### I. Fill the form:

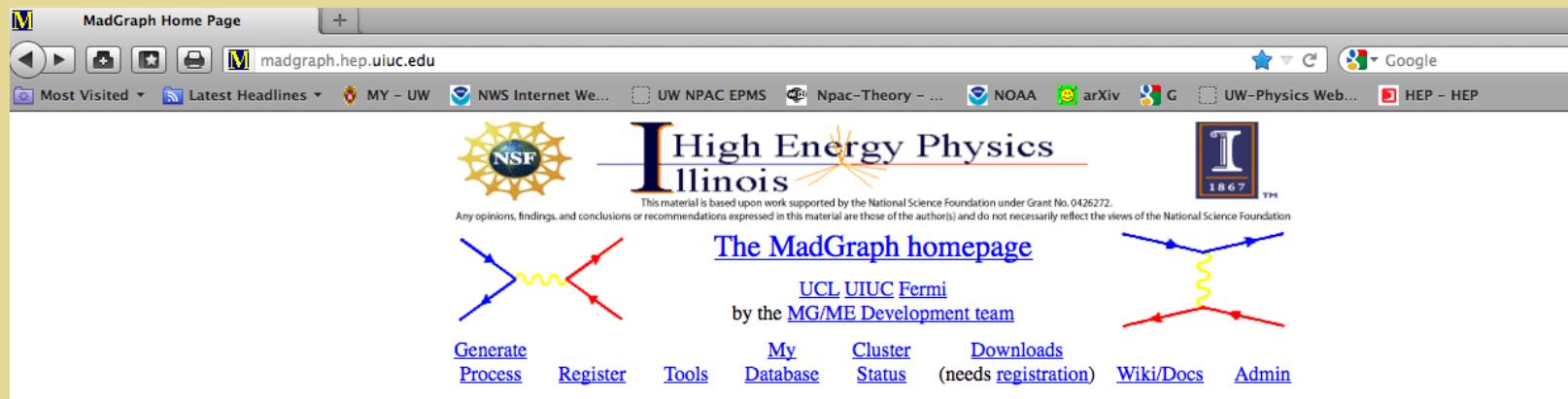
Model:  [Model descriptions](#)  
Input Process:   
Example:  $p p > w+ j j$  QED=3,  $w+ > l+ v l-$   
p and j definitions:  [Examples/format](#)  
sum over leptons:

### II. Upload the proc\_card.dat

[Process card examples](#)

[proc\\_card.formats](#)

# Physics 835: Intro to MadGraph



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Online MadGraph/MadEvent related tools

[Calculators](#)

[Plotting Interface \(ExRootAnalysis\)](#)

[Plotting Interface \(MadAnalysis\)](#)

[Decay Interface](#)

# Physics 835: Intro to MadGraph



MadGraph Home Page + madgraph.hep.uiuc.edu

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This material is based upon work supported by the National Science Foundation under Grant No. 0426272. 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

## Downloads

(To download these files.tar.gz, hold down the shift key while you click on the link)

CODE	DESCRIPTION
<a href="#">MadGraph 5</a>	<p><b>Developer's kit.</b> The latest version of the MadGraph 5 matrix element generator package. Please note that you need Python v 2.6 or 2.7 to use MadGraph 5. Untar, and start the user interface by running <a href="#">./bin/mg5</a>. Then type <a href="#">tutorial</a> to start a short tutorial how to use the program. Upon request, MadGraph creates the code of the corresponding process(es) generating the amplitudes for all the relevant subprocesses and the mappings for the integration over the phase space. A process-dependent stand-alone code is produced from a template that allows the user to calculate cross sections and to obtain unweighted events. Once the events have been generated they may be passed to any shower Monte Carlo program (such as <a href="#">HERWIG</a> or <a href="#">PYTHIA</a>) where partons are perturbatively evolved through the emission of QCD radiation, and eventually turned into physical states (hadronization). Standalone matrix element output in Fortran and C++ is also available, as well as output of matrix element libraries for <a href="#">Pythia 8</a>.</p> <p>See the <a href="#">MadGraph 5 Launchpad page</a> for more info about MadGraph 5. <a href="#">Update notes</a>.</p> <p><b>Note:</b> The <a href="#">generate_processes</a> page will run MadGraph for you on our web server and create a self-contained customized event generator for you to download. So for most people there is no need to download this package.</p>
<a href="#">MadWeight</a>	<p><b>MadWeight package</b> The MadWeight package is a specific phase space generator designed for the Matrix Element Reweighting. MadWeight computes the convolution of the squared matrix element and the resolution function for a sample of events and a number of theoretical hypothesis. This gives a usefull</p>

# Physics 835: Intro to MadGraph



**T** collaborate with **TWiki**

Main Web > Main Web > WebHome (2011-09-30, OlivierMattelaer)

**Edit** **Attach**

## MadGraph / MadEvent Wiki

### Public clusters: UCL,UIUC,Roma

MadGraph / MadEvent is a software that allows you to generate amplitudes and events for any process (with up to 9 external particles) in any model. Implemented models are the Standard Model, Higgs effective couplings, MSSM, the general Two Higgs doublet model, and several minor models, and there is an easy-to-use interface for implementing model extensions. In connection with MG/ME there is also a range of tools, including a Pythia and PGS (detector simulation) package, a Root event analysis package, plotting packages, interfaces to other generators and file converters. On these TWiki pages you can read about the packages, find documentation, see what we are working on and submit questions.

**General**

News  
Team  
MC Links  
Twiki Groups

**Documents**

References  
Update notes  
Manual and Help (FAQ's)

**Communication**

**Software**

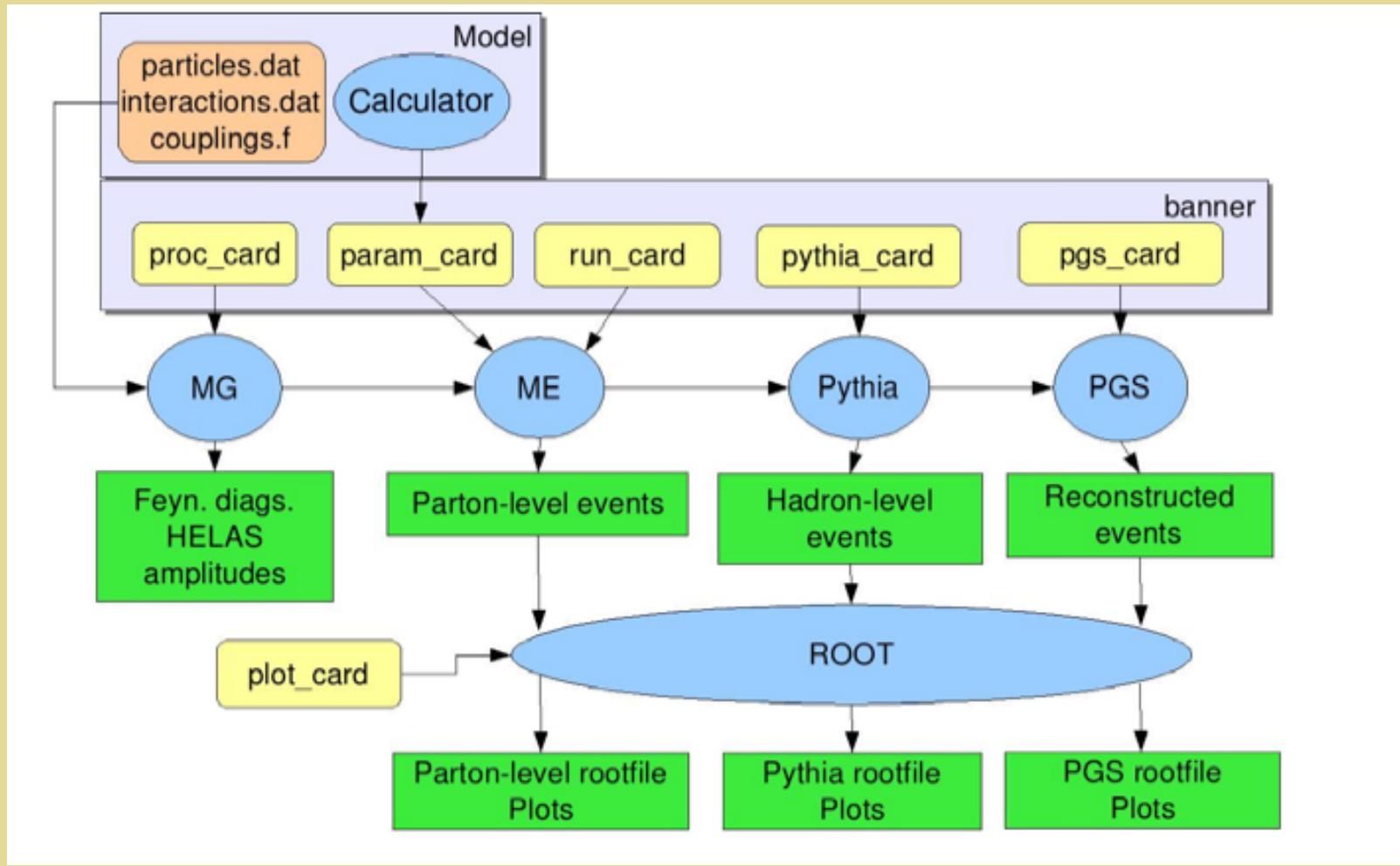
CVS Repository  
MG/ME core code  
Tools  
Models  
Development

**Physics applications**

Projects

**Events library**

# *MadGraph/MadEvent Structure*





# MadGraph: Directories

```
Last login: Wed Jan 11 11:29:48 on console
Michael-Ramsey-Musolfs-MacBook-Pro:~ michaelramsey-musolf$ cd Desktop/
Michael-Ramsey-Musolfs-MacBook-Pro:Desktop michaelramsey-musolf$ cd Research/Collider_Codes/
Michael-Ramsey-Musolfs-MacBook-Pro:Collider_Codes michaelramsey-musolf$ cd MadGraph5/
Michael-Ramsey-Musolfs-MacBook-Pro:MadGraph5 michaelramsey-musolf$ cd MadGraph5_v1_3_2/
Michael-Ramsey-Musolfs-MacBook-Pro:MadGraph5_v1_3_2 michaelramsey-musolf$ ls
AUTHORS      MyProcDir    SleptonDY1   WorkDir      models
DECAY        NewSlepton   SleptonDY2   aloha        py.py
HELAS        NewWorkDir  SleptonDYBack apidoc      pythia-pgs
INSTALL      Newtest     SpinDir     bin         setup.py
LICENSE      PROC_sm_0   Template    doc         test
LQ_Dir       README     UpdateNotes.txt input      tests
MG5_debug    Slepton    VERSION    madgraph    vendor
Michael-Ramsey-Musolfs-MacBook-Pro:MadGraph5_v1_3_2 michaelramsey-musolf$
```



# MadGraph: Directories

```
Last login: Wed Jan 11 11:29:48 on console
Michael-Ramsey-Musolfs-MacBook-Pro:~ michaelramsey-musolf$ cd Desktop/
Michael-Ramsey-Musolfs-MacBook-Pro:Desktop michaelramsey-musolf$ cd Research/Collider_Codes/
Michael-Ramsey-Musolfs-MacBook-Pro:Collider_Codes michaelramsey-musolf$ cd MadGraph5/
Michael-Ramsey-Musolfs-MacBook-Pro:MadGraph5 michaelramsey-musolf$ cd MadGraph5_v1_3_2/
Michael-Ramsey-Musolfs-MacBook-Pro:MadGraph5_v1_3_2 michaelramsey-musolf$ ls
AUTHORS      MyProcDir    SleptonDY1   WorkDir      models
DECAY        NewSlepton   SleptonDY2   aloha        py.py
HELAS        NewWorkDir   SleptonDYBack apidoc      pythia-pgs
INSTALL      Newtest      SpinDir     bin         setup.py
LICENSE      PROC_sm_0    Template    doc         test
LQ_Dir       README      UpdateNotes.txt input      tests
MG5_debug    Slepton     VERSION     madgraph    vendor
Michael-Ramsey-Musolfs-MacBook-Pro:MadGraph5_v1_3_2 michaelramsey-musolf$ cd models/
Michael-Ramsey-Musolfs-MacBook-Pro:MadGraph5_v1_3_2 michaelramsey-musolf$ ls
2HDM          import_ufo.py    sm
4Gen          import_ufo.pyc   sm_v4
LQ_LFV_UFO   import_ufo.pyo   template_files
RS            lib             triplet_diquarks
SMSScalars   model_reader.py  usrmod_v4
__init__.py   model_reader.pyc uutt_sch_4fermion
__init__.pyc  model_reader.pyo uutt_tch_4fermion
__init__.pyo  mssm            uutt_tch_scalar
gluino        mssm_v4        write_param_card.py
heft          nmssm           write_param_card.pyc
heft_v4      sextet_diquarks write_param_card.pyo
Michael-Ramsey-Musolfs-MacBook-Pro:models michaelramsey-musolf$
```



# MadGraph: Models (v5)

```
Michael-Ramsey-Musolfs-MacBook-Pro:MadGraph5_v1_3_2 michaelramsey-musolf$ cd models/
Michael-Ramsey-Musolfs-MacBook-Pro:models michaelramsey-musolf$ ls
2HDM           import_ufo.py          sm
4Gen           import_ufo.pyc         sm_v4
LQ_LFV_UFO    import_ufo.pyo        template_files
RS             lib                  triplet_diquarks
SMScalars     model_reader.py      usrmmod_v4
__init__.py    model_reader.pyc     uutt_sch_4fermion
__init__.pyc   model_reader.pyo     uutt_tch_4fermion
__init__.pyo   mssm                 uutt_tch_scalar
gluino
heft
heft_v4
Michael-Ram Michael-Ramsey-Musolfs-MacBook-Pro:models michaelramsey-musolf$ cd sm
Michael-Ramsey-Musolfs-MacBook-Pro:sm michaelramsey-musolf$ ls
__init__.py      parameters.py
__init__.pyc     parameters.pyc
__init__.pyo     parameters.pyo
couplings.py    particles.py
couplings.pyc   particles.pyc
couplings.pyo   particles.pyo
function_library.py restrict_default.dat
function_library.pyc restrict_no_b_mass.dat
function_library.pyo restrict_no_masses.dat
lorentz.py      restrict_no_tau_mass.dat
lorentz.pyc    vertices.py
lorentz.pyo     vertices.pyc
model.pkl       vertices.pyo
object_library.py write_param_card.py
object_library.pyc write_param_card.pyc
object_library.pyo write_param_card.pyo
Michael-Ramsey-Musolfs-MacBook-Pro:sm michaelramsey-musolf$
```

Python



# MadGraph: Models (v4)

```
Michael-Ramsey-Musolfs-MacBook-Pro:MadGraph5_v1_3_2 michaelramsey-musolf$ cd models/
Michael-Ramsey-Musolfs-MacBook-Pro:models michaelramsey-musolf$ ls
2HDM           import_ufo.py          sm
4Gen           import_ufo.pyc         sm_v4
LQ_LFV_UFO    import_ufo.pyo        template_files
RS             lib                  triplet_diquarks
SMScalars     model_reader.py      usrmmod_v4
__init__.py    model_reader.pyc     uutt_sch_4fermion
__init__.pyc   model_reader.pyo     uutt_tch_4fermion
__init__.pyo   mssm                uutt_tch_scalar
gluino         mssm_v4            write_param_card.py
heft           nmssm              write_param_card.pyc
heft_v4        sextet_diquarks   write_param_card.pyo
Michael-Ramsey-Musolfs-MacBook-Pro:models michaelramsey-musolf$
```

```
Michael-Ramsey-Musolfs-MacBook-Pro:models michaelramsey-musolf$ cd sm_v4/
Michael-Ramsey-Musolfs-MacBook-Pro:sm_v4 michaelramsey-musolf$ ls
ModelVersion.txt      makefile          printout.f
coupl.inc            makefile_dynamic   sm_calc.html
couplings.f          param_card.dat
interactions.dat     particles.dat
Michael-Ramsey-Musolfs-MacBook-Pro:sm_v4 michaelramsey-musolf$
```

*Easier to read*



# MadGraph: Models (v4)

```
Michael-Ramsey-Musolfs-MacBook-Pro:models michaelramsey-musolfs$ cd sm_v4/
Michael-Ramsey-Musolfs-MacBook-Pro:sm_v4 michaelramsey-musolfs$ ls
ModelVersion.txt          makefile           printout.f
coupl.inc                 makefile_dynamic   sm_calc.html
couplings.f               param_card.dat
interactions.dat          particles.dat
```

Michael-Ramsey-Musolfs-MacBook-Pro:sm\_v4 michaelramses#

The image shows two windows side-by-side. The left window is a terminal session showing the directory structure and files in the 'sm\_v4' folder. The right window is a text editor displaying the 'particles.dat' file. The 'particles.dat' file is a particle definition file for the Standard Model. It includes sections for leptons, bosons, and quarks, with detailed particle properties like mass, width, and color. A red box highlights the first few lines of the file, and a blue box highlights the last few lines. An arrow points from the text 'pdg numbering' to the blue-highlighted section at the bottom right of the editor window.

```
# Leptons
#
e-    e+    F    S    ZERO  ZERO  S  e  11
mu-  mu+  F    S    ZERO  ZERO  S  mu 13
ta-  ta+  F    S    LMASS ZERO  S  ta  15
ve   ve~   F    S    ZERO  ZERO  S  ve  12
vm   vm~   F    S    ZERO  ZERO  S  vm  14
vt   vt~   F    S    ZERO  ZERO  S  vt  16
#
# Bosons
#
g     g     V    C    ZERO  ZERO  0  -  21
z     z     V    W    ZMASS ZWIDTH S  Z  23
a     a     V    W    ZERO  AWIDTH S  A  22
W-   W+    V    W    WMASS WWIDTH S  W -24
h     h     S    D    HMASS HWIDTH S  h  25
#
# Groups of particles to sum over. Note spaces are important
# you can NOT have any spaces between particles to be summed over
# The following line is a TAG and should not be modified:
# MULTIPARTICLES
#
P uu~dd~ss~cc~g
J uu~dd~ss~cc~g
L e+e-mu+mu-ta+ta-veve~
```

Easier to read

pdg numbering



# MadGraph: particle # scheme

## 34. MONTE CARLO PARTICLE NUMBERING SCHEME

Revised June 2006 by L. Garren (Fermilab), I.G. Knowles (Edinburgh U.), S. Navas (U. Granada), P. Richardson (Durham U.), T. Sjöstrand (Lund U.), and T. Trippé (LBNL).

The Monte Carlo particle numbering scheme presented here is intended to facilitate interfacing between event generators, detector simulators, and analysis packages used in particle physics. The numbering scheme was introduced in 1988 [1] and a revised version [2,3] was adopted in 1998 in order to allow systematic inclusion of quark model states which are as yet undiscovered and hypothetical particles such as SUSY particles. The numbering scheme is used in several event generators, *e.g.* HERWIG and PYTHIA/JETSET, and in the /HEPEVT/ [4] standard interface.

The general form is a 7-digit number:

$$\pm n \ n_r \ n_L \ n_{q_1} \ n_{q_2} \ n_{q_3} \ n_J .$$

This encodes information about the particle's spin, flavor content, and internal quantum numbers. The details are as follows:

1. Particles are given positive numbers, antiparticles negative numbers. The PDG convention for mesons is used, so that  $K^+$  and  $B^+$  are particles.
2. Quarks and leptons are numbered consecutively starting from 1 and 11 respectively; to do this they are first ordered by family and within families by weak isospin.

f. The sixth digit  $n_r$  is used to label mesons radially excited

QUARKS		EXCITED PARTICLES	
$d$	1	$d^*$	4000001
$u$	2	$u^*$	4000002
$s$	3	$e^*$	4000011
$c$	4	$\nu_e^*$	4000012
$b$	5		
$t$	6		
$b'$	7		
$t'$	8	$g$	(9) 21
		$\gamma$	22
LEPTONS		GAUGE AND HIGGS BOSONS	
$e^-$	11	$Z^0$	23
$\nu_e$	12	$W^+$	24
$\mu^-$	13	$h^0/H_1^0$	25
$\nu_\mu$	14	$Z'/Z_2^0$	32
$\tau^-$	15	$Z''/Z_3^0$	33
$\nu_\tau$	16	$W'/W_2^+$	34
$\tau'^-$	17	$H^0/H_2^0$	35
$\nu_{\tau'}$	18	$A^0/H_3^0$	36
		$H^+$	37



# MadGraph: Models (v4)

```
Michael-Ramsey-Musolfs-MacBook-Pro:models michaelramsey-musolfs$ cd sm_v4/
```

```
Michael-Ramsey-Musolfs-MacBook-Pro:sm_v4
```

```
ModelVersion.txt
```

```
makefile
```

```
coupl.inc
```

```
makefile_dynamic
```

```
couplings.f
```

```
param_card.dat
```

```
interactions.dat
```

```
particles.dat
```

```
Michael-Ramsey-Musolfs-MacBook-Pro:sm_v4
```

```
c Define common block containing all coupling constants and masses  
c which are used in the HELAS routines.  
c  
c These include masses, widths and real/complex couplings.  
c  
c This file can be built automatically from particles.dat and  
c interactions.dat  
c  
c=====  
c  
c QCD  
c  
c double complex gg(2)  
c double precision g  
c common /COUPL_QCD/ g,gg  
c  
c kinematical masses  
c  
c double precision hmass, wmass, zmass, amass,  
& tmass, bmass, lmass, cmass  
c common /COUPL_MASS/ hmass, wmass, zmass, amass,  
& tmass, bmass, lmass, cmass  
c  
c widths  
c  
c double precision hwidth, wwidth, zwidth,  
& twidth, lwidth, awidth  
c common /COUPL_WIDTH/ hwidth, wwidth, zwidth,  
& twidth, lwidth, awidth  
c  
c couplings in the feynman rules  
c  
c double complex gal(2), gad(2), gau(2), gwf(2),  
& gzn(2), gzl(2), gzd(2), gzu(2)  
c double precision gw, gwwa, gwwz  
c common /COUPL_GAUGE/ gal , gad , gau , gwf ,  
& gzn , gzl , gzd , gzu ,  
& gw, gwwa, gwwz  
c  
c double complex gwfc(2), gwfs(2), gwfm(2)  
c common /coupl_ckm/ gwfc, gwfs , gwfm  
c  
c double complex gwwh, gzzh, gwwhh, gzzhh, ghhh, ghhhh  
c common /COUPL_SCAL/ gwwh, gzzh, gwwhh, gzzhh, ghhh, ghhhh  
c  
c double complex ghtop(2), ghbot(2), ghtau(2), ghcha(2)  
c common /COUPL_YUK/ ghtop , ghbot , ghtau , ghcha
```

Easier to read

# MadGraph: Models (v4)



```
Michael-Ramsey-Musolfs-MacBook-Pro:models michaelramsey-musolfs$ cd sm_v4/
```

```
Michael-Ramsey-Musolfs-MacBook-Pro:sm_v4
```

```
ModelVersion.txt
```

```
makefile
```

```
coupl.inc
```

```
makefile_dynamic
```

```
couplings.f
```

```
param_card.dat
```

```
interactions.dat
```

```
particles.dat
```

```
Michael-Ramsey-Musolfs-MacBook-Pro:sm_v4
```

interactions.dat

```
# File which contains allowed interactions. Must be named
# interactions.dat and reside in the current directory for MadGraph
# to see it.
#
# 3-particle vertices are entered as follows:
#
# particle1 particle2 particle3 coupling_name model (QCD,QFD,QED,BRS)
#
# Note: The ordering of particles is very important.
# For FFV interactions, must use particles, not anti_particles.
#
#
# QCD interactions
#
d d g GG QCD
u u g GG QCD
s s g GG QCD
c c g GG QCD
b b g GG QCD
t t g GG QCD

g g g G QCD

g g g g G G QCD QCD

#
# QED interactions
#
d d a GAD QED
u u a GAU QED
s s a GAD QED
c c a GAU QED
b b a GAD QED
t t a GAU QED
```



# MadGraph: Proc Directory

```
Michael-Ramsey-Musolfs-MacBook-Pro:MadGraph5_v1_3_2 michaelramsey-musolf$ ls
835_Proc ←
LO_Dir      PROC_sm_0    SpinDir    apidoc    py.py
AUTHORS     MG5_debug   README     Template   bin      pythia-pgs
DECAY       MyProcDir   Slepton    UpdateNotes.txt doc    setup.py
HELAS        NewSlepton  SleptonDY1 VERSION   input    test
INSTALL     NewWorkDir  SleptonDY2 WorkDir    madgraph tests
LICENSE     Newtest     SleptonDYBack aloha    models vendor
Michael-Ramsey-Musolfs-MacBook-Pro:MadGraph5_v1_3_2 michaelramsey-musolf$
```

*Create copy of Template directory to use as working process directory: 835\_Proc*



# MadGraph: Proc Directory

```
Michael-Ramsey-Musolfs-MacBook-Pro:MadGraph5_v1_3_2 michaelramsey-musolf$ cd 835_Proc/
Michael-Ramsey-Musolfs-MacBook-Pro:835_Proc michaelramsey-musolf$ ls
Cards           README           TemplateVersion.txt    lib
Events          Source           bin                  makefile
HTML            SubProcesses     index.html
Michael-Ramsey-Musolfs-MacBook-Pro:835_Proc michaelramsey-musolf$
```

*Create copy of Template directory to use as working process directory: 835\_Proc*



# MadGraph: Cards Directory

```
Michael-Ramsey-Musolfs-MacBook-Pro:MadGraph5_v1_3_2 michaelramsey-musolf$ cd 835_Proc/
Michael-Ramsey-Musolfs-MacBook-Pro:835_Proc michaelramsey-musolf$ ls
Cards          README           TemplateVersion.txt    lib
Events         Source            bin                  makefile
HTML          SubProcesses      index.html
Michael-Ramsey-Musolfs-MacBook-Pro:835_Proc michaelramsey-musolf$
```

```
Michael-Ramsey-Musolfs-MacBook-Pro:835_Proc michaelramsey-musolf$ cd Cards/
Michael-Ramsey-Musolfs-MacBook-Pro:Cards michaelramsey-musolf$ ls
README          grid_card.dat        pgs_card_TEV.dat
delphes_card_ATLAS.dat   grid_card_default.dat  pgs_card_default.dat
delphes_card_CMS.dat    param_card.dat       plot_card.dat
delphes_card_default.dat param_card_default.dat proc_card_mg5.dat
delphes_trigger.dat     pgs_card_ATLAS.dat   pythia_card_default.dat
delphes_trigger_ATLAS.dat pgs_card_CMS.dat   replace_card1.dat
delphes_trigger_CMS.dat  pgs_card_LHC.dat   run_card.dat
Michael-Ramsey-Musolfs-MacBook-Pro:Cards michaelramsey-musolf$
```

*Basic cards for matrix element calculation & parton level event generation*



# MadGraph: Param Card

```
Michael-Ramsey-Musolfs-MacBook-Pro:835_Proc michaelramsey-musolf$ cd Cards/
Michael-Ramsey-Musolfs-MacBook-Pro:Cards michaelramsey-musolf$ ls
README                                     grid_card.dat           pgs_card_TEV.dat
delphes_card_ATLAS.dat                   grid_card_default.dat   pgs_card_default.dat
delphes_card_CMS.dat                    param_card.dat        plot_card.dat
delphes_card_default.dat                param_card_default.dat proc_card_mg5.dat
delphes_trigger.dat                     pgs_card_ATLAS.dat    pythia_card_default.dat
delphes_trigger_ATLAS.dat               pgs_card_CMS.dat     replace_card1.dat
delphes_trigger_CMS.dat                pgs_card_LHC.dat      run_card.dat
Michael-Ramsey-Musolfs-MacBook-Pro:Cards michaelramsey-musolf$
```

```
param_card.dat
*****
# MadGraph/MadEvent *
*****
# Les Houches friendly file for the SM parameters of MadGraph *
# Spectrum and decay widths produced by SMCalc *
*****
##Please note the following IMPORTANT issues:
#
#8. REFRAIN from editing this file by hand! Some of the parameters are not independent
# (such as G_Fermi, alpha_em, sin(theta_W), MZ,MW) and serious problems might be encountered (such as violation of unitarity or gauge invariance). Always use a calculator.
#
#1. alpha_S(MZ) has been used in the calculation of the parameters but, for consistency, it will be reset by mggraph to the value expected IF the pdfs for collisions with hadrons are used. This value is KEPT by mggraph when no pdf are used Ipp(i)=0 .
#
#2. Values of the charm and bottom kinematic (pole) masses are those used in the matrix elements and phase space UNLESS they are set to ZERO from the start in the model (particles.dat). This happens, for example, when using 5-flavor QCD where charm and bottom are treated as partons in the initial state and a zero mass might be hardwired in the model definition.
#
*****
```

Block <b>SMINPUTS</b>	# Standard Model inputs
1	1.32506980E+02 # alpha_em(MZ)(-1) SM MSbar
2	1.16639000E-05 # G_Fermi
3	1.18000000E-01 # alpha_s(MZ) SM MSbar
4	9.11880000E+01 # Z mass (as input parameter)
Block <b>MGYUKAWA</b> # Yukawa masses m/v=y/sqrt(2)	
# PDG	YMASS
5	4.20000000E+00 # mbottom for the Yukawa y_b
4	1.42000000E+00 # mcharm for the Yukawa y_c
6	1.64500000E+02 # mtop for the Yukawa y_t
15	1.77700000E+00 # mtau for the Yukawa y_tau
Block <b>MGCKM</b> # CKM elements for MadGraph	
1 1	9.75000000E-01 # Vud for Cabibbo matrix
Block <b>MASS</b> # Mass spectrum (kinematic masses)	
# PDG	Mass
5	4.70000000E+00 # bottom pole mass
6	1.74300000E+02 # top pole mass
15	1.77700000E+00 # tau mass
23	9.11880000E+01 # Z mass
24	8.04190000E+01 # W mass
25	1.20000000E+02 # H mass

*Don't modify for SM*



# MadGraph: Cards Directory

```
Michael-Ramsey-Musolfs-MacBook-Pro:835_Proc michaelramsey-musolf$ cd Cards/
Michael-Ramsey-Musolfs-MacBook-Pro:Cards michaelramsey-musolf$ ls
REAd proc_card_mg5.dat
=====
de##          MadGraph 5
de##
de##          *
de##          *      *      *
de##          *      *      *      *
de##          *      *      *      *
de##          *      *      *
de##          *
de##          *
de##          VERSION 1.0.0           2011-04-02
de##
de##          The MadGraph Development Team - Please visit us at
de##          https://server06.fynu.ucl.ac.be/projects/madgraph
de##
=====
de##          Command File for MadGraph 5
de##
de##          run as ./bin/mg5 filename
de##
=====
import model sm
# Define multiparticle labels
define p = g u c d s u~ c~ d~ s~
define j = g u c d s u~ c~ d~ s~
define l+ = e+ mu+
define l- = e- mu-
define vl = ve vm vt
define vl~ = ve~ vm~ vt~
# Specify process(es) to run
generate p p > e- ve~ @1
add process p p > e- ve~ j @2
add process p p > t t~ @3
# Output processes to MadEvent directory
output -f
=====
pgs_card_TEV.dat
pgs_card_default.dat
plot_card.dat
proc_card_mg5.dat
pythia_card_default.dat
replace_card1.dat
run_card.dat
molf$
```

Defines processes



# MadGraph: Proc Card

```
import model sm
# Define multiparticle labels
define p = g u c d s u~ c~ d~ s~
define j = g u c d s u~ c~ d~ s~
define l+ = e+ mu+
define l- = e- mu-
define vl = ve vm vt
define v1~ = ve~ vm~ vt~
# Specify process(es) to run
generate p p > e- ve~ @1
add process p p > e- ve~ j @2
add process p p > t t~ @3
# Output processes to MadEvent directory
output -f
```

particle content & interactions, not parameters

defines collections of particles (proton, jet,...)

include @n for each process

$p\ p \rightarrow w^+ w^- \rightarrow e^+ e^- ve\ ve^~ @1$

specify intermediate states

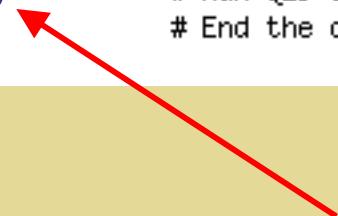


# MadGraph: Proc Card

```
# Begin PROCESS # This is TAG. Do not modify this line  
  
pp>e-ve~ @1      # First Process  
QCD=99           # Max QCD couplings  
QED=2            # Max QED couplings  
end_coup         # End the couplings input
```

*specify # couplings,  
order in pert theory*

QCD=99  
QED=2  
end\_coup





# MadGraph: Cards Directory

```
Michael-Ramsey-Musolfs-MacBook-Pro:835_Proc michaelramsey-musolf$ cd Cards/
Michael-Ramsey-Musolfs-MacBook-Pro:Cards michaelramsey-musolf$ ls
README          grid_card.dat          pgs_card_TEV.dat
                run_card.dat          pgs_card_default.dat
                plot_card.dat         proc_card_mg5.dat
                pythia_card_default.dat replace_card1.dat
                run_card.dat          f$
```

The screenshot shows a terminal window on a Mac OS X system. The user has navigated to the 'Cards' directory and listed its contents. A red box highlights the 'run\_card.dat' file in both the terminal output and the file viewer. Another red box highlights the 'run\_card.dat' file in the file viewer. A blue arrow points from the text '10000 = nevents ! Number of unweighted events requested' in the file viewer to the word 'nevents' in the terminal command line, indicating that the user is about to change the number of events.

```
***** run_card.dat *****
# MadGraph/MadEvent *
# http://madgraph.hep.uiuc.edu *
# run_card.dat *
# This file is used to set the parameters of the run.
# Some notation/conventions:
# Lines starting with a '#' are info or comments
# mind the format: value = variable ! comment *
***** run_tag *****
# Running parameters
***** run_tag *****
# Tag name for the run (one word) *
***** run_grid *****
'fermi' = run_tag ! name of the run
***** run_grid *****
# Run to generate the grid pack *
***** run_grid *****
.false. = gridpack_ !True = setting up the grid pack
***** run_grid *****
# Number of events and rnd seed
# Warning: Do not generate more than 100K event in a single run *
***** run_grid *****
10000 = nevents ! Number of unweighted events requested
0 = iseed ! rnd seed (0=assigned automatically=default))
```

# of events



# MadGraph: Run Card

```
*****
# Collider type and energy *
*****
 1 = lpp1 ! beam 1 type (0=NO PDF)
 1 = lpp2 ! beam 2 type (0=NO PDF)
 7000 = ebeam1 ! beam 1 energy in GeV
 7000 = ebeam2 ! beam 2 energy in GeV
*****
# Beam polarization from -100 (left-handed) to 100 (right-handed) *
*****
 0 = polbeam1 ! beam polarization for beam 1
 0 = polbeam2 ! beam polarization for beam 2
*****
# PDF CHOICE: this automatically fixes also alpha_s and its eval. *
*****
 'cteq6l1' = pdlabel ! PDF set
*****
# Renormalization and factorization scales *
*****
 F = fixed_ren_scale ! if .true. use fixed ren scale
 F = fixed_fac_scale ! if .true. use fixed fac scale
 91.1880 = scale ! fixed ren scale
 91.1880 = dsqrt_q2fact1 ! fixed fact scale for pdf1
 91.1880 = dsqrt_q2fact2 ! fixed fact scale for pdf2
 1 = scalefact ! scale factor for event-by-event scales
*****
# Matching - Warning! ickkw > 1 is still beta
*****
 0 = ickkw ! 0 no matching, 1 MLM, 2 CKKW matching
 1 = highestmult ! for ickkw=2, highest mult group
 1 = ktscheme ! for ickkw=1, 1 Durham KT, 2 Pythia pTE
 1 = gipsfact ! scale factor for QCD emission vx
 F = chcluster ! cluster only according to channel diag
 T = pdfwgt ! for ickkw=1, perform pdf reweighting
*****
# Automatic ptj and mij cuts if xgcut > 0
# (turn off for VBF and single top processes)
*****
```

pdf info

for jets & interface  
with Pythia

# MadGraph: Run Card cont'd



```
*****
# Standard Cuts
*****
#
# Minimum and maximum pt's
*****
20 = ptj      ! minimum pt for the jets
0 = ptb      ! minimum pt for the b
10 = pta      ! minimum pt for the photons
10 = ptl      ! minimum pt for the charged leptons
0 = misset   ! minimum missing Et (sum of neutrino's momenta)
0 = ptheavy   ! minimum pt for one heavy final state
1.0 = ptonium ! minimum pt for the quarkonium states
1d5 = ptimax  ! maximum pt for the jets
1d5 = ptbmax  ! maximum pt for the b
1d5 = ptamax  ! maximum pt for the photons
1d5 = ptlmax  ! maximum pt for the charged leptons
1d5 = missetmax ! maximum missing Et (sum of neutrino's momenta)
*****
# Minimum and maximum E's (in the lab frame)
*****
0 = ej       ! minimum E for the jets
0 = eb       ! minimum E for the b
0 = eq       ! minimum E for the photons
0 = el       ! minimum E for the charged leptons
1d5 = ejmax  ! maximum E for the jets
1d5 = ebmax  ! maximum E for the b
1d5 = eqmax  ! maximum E for the photons
1d5 = elmax  ! maximum E for the charged leptons
```

*Generator level cuts;  
additional can be  
imposed in analysis*

```
*****
# Maximum and minimum rapidity
*****
5 = etaj      ! max rap for the jets
1d2 = etab     ! max rap for the b
2.5 = etaa     ! max rap for the photons
2.5 = etal     ! max rap for the charged leptons
0.6 = etaonium ! max rap for the quarkonium states
0d0 = etajmin  ! min rap for the jets
0d0 = etabmin  ! min rap for the b
0d0 = etaa_min ! min rap for the photons
0d0 = etalmin  ! min rap for the charged leptons
*****
# Minimum and maximum DeltaR distance
*****
0.4 = drjj    ! min distance between jets
0 = drbb     ! min distance between b's
0.4 = drll    ! min distance between leptons
0.4 = draa    ! min distance between gammas
0 = drbj    ! min distance between b and jet
0.4 = draj    ! min distance between gamma and jet
0.4 = drjl    ! min distance between jet and lepton
0 = drab    ! min distance between gamma and b
0 = drbl    ! min distance between b and lepton
0.4 = dral    ! min distance between gamma and lepton
1d2 = drjimax ! max distance between jets
1d2 = drbbmax ! max distance between b's
1d2 = drllmax ! max distance between leptons
1d2 = draamax ! max distance between gammas
1d2 = drbjmax ! max distance between b and jet
1d2 = drajmax ! max distance between gamma and jet
```



# MadGraph: Cards Directory

```
Michael-Ramsey-Musolfs-MacBook-Pro:835_Proc michaelramsey-musolf$ cd Cards/
Michael-Ramsey-Musolfs-MacBook-Pro:Cards michaelramsey-musolf$ ls
README
grid_card.dat
grid_card_default.dat
param_card.dat
param_card_default.dat
plot_card.dat
proc_card_mg5.dat
pythia_card_default.dat
replace_card1.dat
run_card.dat
pgs_card_ATLAS.dat
pgs_card_CMS.dat
pgs_card_LHC.dat
pgs_card_TEV.dat
pgs_card_default.dat
delphes_card_ATLAS.dat
delphes_card_CMS.dat
delphes_card_default.dat
delphes_trigger.dat
delphes_trigger_ATLAS.dat
delphes_trigger_CMS.dat
Michael-Ramsey-Musolfs-MacBook-Pro:Cards michaelramsey-musolf$
```

*pgs cards*

*Pythia card*

**Change “\_card\_default.dat”  
→ “\_card.dat” for these cards**



# MadGraph: Cards Help on Wiki

## Input Cards

- [Proc card examples](#)
- [Run Card : description and examples](#)

## FAQ's

- [Should I use different ids \(@1,@2,...\) in multiprocess proc\\_card or could I use the same ?](#)
- [What is bwcutoff, and why is it important for decay chains?](#)

## MadGraph 5 Process Cards

Note that the web didn't allow all the possibility of a personal computer. For such reason some proc\_card maybe not functional or refused. In general:

1. You can't specify any path in the proc\_card
2. You can't use any external script

Process	card	Comments
top pair	generate p p > t t~ QED=2 QCD=2 output launch	By default, MadGraph 5 imports the standard model. Therefore, no specific command required for that. Note that if the couplings are not present, MG5 will take the minimal QED one for process having only QED/QCD order. And will not restrict the order otherwise.
Stop pair	import model mssm generate p p > t1 t1~ add process p p > t2 t2~ output -f	

top pair decay	generate p p > t t~ QED=0, \ (t > W+ b, W+ > j j), \ (t~ > w- b~, W- > l- vl~) output	note that the " \ " allow the line splitting.
----------------	--	---



## **MadGraph: Running a process**

```
Michael-Ramsey-Musolfs-MacBook-Pro:Cards michaelramsey-musolf$ cd ../
Michael-Ramsey-Musolfs-MacBook-Pro:835_Proc michaelramsey-musolf$ bin/newprocess_mg5
Running...
done
Michael-Ramsey-Musolfs-MacBook-Pro:835_Proc michaelramsey-musolf$
```

*Generates matrix element code but does not evaluate numerically (ie, does not generate events)*

*Note that bin/newprocess\_mg5 overwrites param card with the param card appearing in model directory. So, for other models, need to save a copy of desired param card for future running without reverting to model default*



# MadGraph: Running a process

```
Michael-Ramsey-Musolfs-MacBook-Pro:Cards michaelramsey-musolfs$ cd ../
Michael-Ramsey-Musolfs-MacBook-Pro:835_Proc michaelramsey-musolfs$ bin/newprocess_mg5
Running...
done
Michael-Ramsey-Musolfs-MacBook-Pro:835_Proc michaelramsey-musolfs$
```

No pythia-pgs run because did not change cards from default

```
Michael-Ramsey-Musolfs-MacBook-Pro:835_Proc michaelramsey-musolfs$ ls
CREATED          MGMEVersion.txt      TemplateVersion.txt      madevent.tar.gz
Cards            README               bin                   makefile
Events           Source               index.html          proc_log.txt
HTM1             SubProcesses        lnn                  py.py
```

The screenshot shows a web browser window displaying a MadEvent Card for a particle physics process. The URL in the address bar is `file:///Users/michaelramsey-musolfs/Desktop/Research/Collider_Codes/MadGraph5/MadGraph5_v1_`. The card itself has a title "MadEvent Card for p p > e- ve-". It includes a diagram of the particle interaction and sections for "Links" and "Status".

**Process:** p p > e- ve-  
**Model:** sm

**Links**

- [Process Information](#)
- [Code Download](#)
- [On-line Event Generation](#)
- [Results and Event Database](#)

**Status**

- Generation Complete
- Available
- [Only available from the web](#)
- No runs available

**Notes:**

Last Update: Wed Jan 11 17:04:04 CST 2012



# MadGraph: Running a process

MadEvent Card for  $p p \rightarrow e^- \nu e^-$

Created: Wed Jan 11 17:04:04 CST 2012

Process:  $p p \rightarrow e^- \nu e^-$   
Model: sm

Links

Process Information (highlighted with a red box)

Code Download

On-line Event Generation

Results and Event Database

Status

Generation Complete

Detail on the Generation

SubProcesses and Feynman diagrams

Directory	# Diagrams	# Subprocesses	FEYNMAN DIAGRAMS	SUBPROCESS
P1_qq_lv1	1	4	<a href="#">html</a> <a href="#">postscript</a>	$d u^- > e^- \nu e^- , s c^- > e^- \nu e^- ,$ $u^- d > e^- \nu e^- , c^- s > e^- \nu e^-$
P2_gg_lv1q	2	4	<a href="#">html</a> <a href="#">postscript</a>	$g d > e^- \nu e^- u , g s > e^- \nu e^- c ,$ $d g > e^- \nu e^- u , s g > e^- \nu e^- c$
P2_qq_lv1g	2	4	<a href="#">html</a> <a href="#">postscript</a>	$g u^- > e^- \nu e^- d^- , g c^- > e^- \nu e^- s^- ,$ $u^- g > e^- \nu e^- d^- , c^- g > e^- \nu e^- s^-$
P3_gg_ttx	3	1	<a href="#">html</a> <a href="#">postscript</a>	$d u^- > e^- \nu e^- g , s c^- > e^- \nu e^- g ,$ $u^- d > e^- \nu e^- g , c^- s > e^- \nu e^- g$
P3_qq_ttx	1	8	<a href="#">html</a> <a href="#">postscript</a>	$g g > t t^-$ $u^- u > t t^- , c c^- > t t^- , d d^- > t t^- , s s^- > t t^- ,$ $u^- u > t t^- , c^- c > t t^- , d^- d > t t^- , s^- s > t t^-$

39 diagrams (11 independent).

[proc\\_log.txt](#) Log file from MadGraph code generation.  
[proc\\_card\\_mg5.dat](#) Input file used for code generation.

Back to [Process main page](#)



# MadGraph: Running a process

Detail on the Generation

file:///Users/michaelramsey-musolf/Desktop/Research/Collider\_Codes/MadGraph5/MadGraph5\_v1\_ Google SPIRES-HEP Search Apple Yahoo!

### SubProcesses and Feynman diagrams

Directory	# Diagrams	# Subprocesses	FEYNMAN DIAGRAMS	SUBPROCESS
P1_qq_lvl	1	4	<a href="#">html postscript</a>	$d u \sim > c \cdot v \sim , s \sim > c \cdot v \sim ,$ $u \sim d > c \cdot v \sim , c \sim s > c \cdot v \sim$
P2_gq_lvlg	2	4	<a href="#">html postscript</a>	$g d > c \cdot v \sim u , g s > c \cdot v \sim c ,$ $d g > c \cdot v \sim u , s g > c \cdot v \sim c$
P2_gq_lvlg	2	4	<a href="#">html postscript</a>	$g u \sim > c \cdot v \sim d \sim , g c \sim > c \cdot v \sim s \sim ,$ $u \sim g > c \cdot v \sim d \sim , c \sim g > c \cdot v \sim s \sim$
P2_qq_lvlg	2	4	<a href="#">html postscript</a>	$d u \sim > c \cdot v \sim g , s c \sim > c \cdot v \sim g ,$ $u \sim d > c \cdot v \sim g , c \sim s > c \cdot v \sim g$
P3_gg_ttx	3	1	<a href="#">html postscript</a>	$g g > t t \sim$
P3_qq_ttx	1	8	<a href="#">html postscript</a>	$u u \sim > t t \sim , c c \sim > t t \sim , d d \sim > t t \sim , s s \sim > t t \sim ,$ $u \sim u > t t \sim , c \sim c > t t \sim , d \sim d > t t \sim , s \sim s > t t \sim$

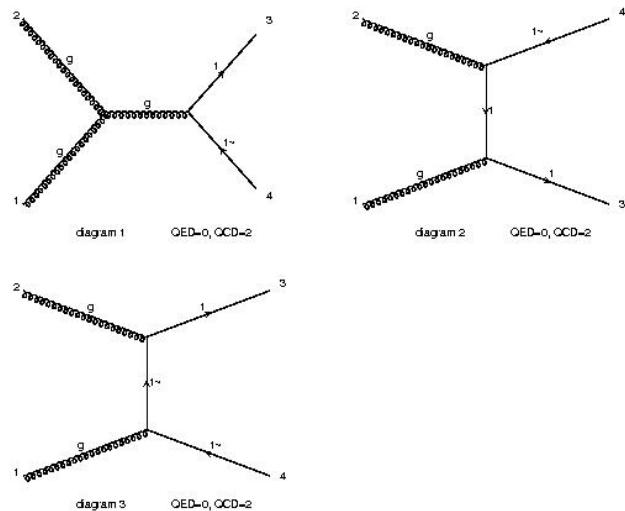
39 diagrams (11 independent).

#### Postscript Diagrams for $g g > t t \sim$ QED=0 @3

[proc\\_log.txt](#) Log file from MadGraph code generation.  
[proc\\_card\\_mg5.dat](#) Input file used for code generation.

page 1/1

[Back to Process main page](#)





# MadGraph: Generating Events

```
dyn-72-33-47-106:Cards michaelramsey-musolf$ cd .../  
dyn-72-33-47-106:835_Proc michaelramsey-musolf$ bin/generate_events  
Enter 2 for multi-core, 1 for parallel, 0 for serial run  
0  
Enter run name  
835_Test  
Tue Jan 31 12:01:39 CST 2012  
Generating 10000 events  
Cleaning SubProcesses.....  
Compiling libraries  
Working on subprocess:  
    P3_gg_ttx  
real    0m0.318s  
user    0m0.311s  
sys     0m0.005s
```

Gen events

Running Pythia and but not  
pgs since converted  
pythia\_card\_default.dat →  
pythia\_card.dat but not  
pgs\_card\_default.dat

```
P3_gg_ttx/G1/   326    429 0.507E+02  
P3_gg_ttx/G2/  1257   1360 0.494E+03  
P2_gq_lvlg/G1/  1743   1846 0.731E+03  
P2_gq_lvlg/G2/  6104   6287 0.149E+04  
P2_gq_lvlg/G1/  7121   7224 0.166E+04  
P2_gq_lvlg/G2/  8008   8247 0.179E+04  
P1_qq_lv1/G1/ 18771  19010 0.614E+04  
P3_gg_ttx/G1/  19148  19387 0.622E+04  
Found 10361 events writing first 10000  
Unweighting selected 10000 events.  
Truncated 0.01% of cross section  
putting the banner  
Creating Plots  
Storing files  
P3_gg_ttx  
P2_gq_lvlg  
P2_gq_lvlg  
P1_qq_lv1  
P3_gg_ttx
```

End of parton  
level calc

```
Running pythia...  
Running hep2lhe  
pythia_events.lhe file generated, with simple jet clustering  
Warning! Never use this file for detector studies!  
Creating Plots for Pythia  
Running PGS...  
I will merge non-isolated muons with jets...  
Thank you for using the olympics output cleaner.  
Creating Plots for PGS  
Storing files  
P3_gg_ttx  
P2_gq_lvlg  
P2_gq_lvlg  
P1_qq_lv1  
P3_gg_ttx  
Tue Jan 31 11:45:44 CST 2012  
dyn-72-33-47-106:835_Proc michaelramsey-musolf$ █
```



# MadGraph: Generating Events

**MadEvent Card for  $p\ p > e^- \nu e^-$**

Created: Wed Jan 11 17:24:08 CST 2012

Process:  $p\ p > e^- \nu e^-$   
Model: sm

Links

[Process Information](#)  
[Code Download](#)

On-line Event Generation

[Results and Event Database](#)

Notes:

Last Update: Wed Jan 11 17:26

**Process results**  
 **$S = 6219.435 \pm 15.998 (\text{pb})$**

Graph	Cross Sect(pb)	Error(pb)	Events (K)	Eff	Unwgt	Luminosity
Sum	6219.435	15.998	5	0.2		
Sub Group 1						
P1_qq_lvL	4327.200	12.070	0	0.0		2.50
Sub Group total = 4327.2						
Sub Group 2						
P2_gq_lvLq	1017.000	9.237	1	0.4		4.27
P2_qq_lvLg	302.750	3.625	2	0.5		6.31
Sub Group total = 1319.75						
Sub Group 3						
P3_gg_ttx	496.560	3.354	1	0.2		2.03
P3_qq_ttx	75.925	0.749	0	0.2		5.06
Sub Group total = 572.485						

**Results for  $p\ p > e^- \nu e^- @1$  in the Available Results**

Links	Events	Tag	Run	Collider	Cross section (pb)	Events
<a href="#">result banner</a>	<a href="#">Parton-level LHE</a> <a href="#">Hadron-level (Pythia) STDHEP LHE</a>	fermi	835_Test	$p\ p$ 7000 x 7000 GeV	.62194E+04	10000

[Main Page](#)



# MadGraph: Generating Events

```
Michael-Ramsey-Musolfs-MacBook-Pro:835_Proc michaelramsey-musolf$ cd Events/
Michael-Ramsey-Musolfs-MacBook-Pro:Events michaelramsey-musolf$ ls
835_Test_banner.txt          835_Test_pythia_events.lhe.gz
835_Test_beforeveto.tree.gz   835_Test_unweighted_events.lhe.gz
835_Test_events.lhe.gz        835_Test_xsecs.tree
835_Test_events.tree.gz       banner_header.txt
835_Test_pythia.log          fort.0
835_Test_pythia_events.hep.gz hep2lhe.log
Michael-Ramsey-Musolfs-MacBook-Pro:Events michaelramsey-musolf$
```

```
<event>
  5 1 0.3995219E+00 0.8247136E+02 0.7957747E-01 0.1321054E+00
    -2 -1 0 0 0 501 0.0000000000E+00 0.0000000000E+00 0.19096382165E+02 0.19096382165E+02 0.0000000000E+00 0 1.
    1 -1 0 0 501 0 0.0000000000E+00 0.0000000000E+00 -0.89042062406E+02 0.89042062406E+02 0.0000000000E+00 0 -1.
    -24 2 1 2 0 0 0.0000000000E+00 0.0000000000E+00 -0.69945680240E+02 0.10813844457E+03 0.82471358725E+02 0 0.
    11 1 3 3 0 0 0.35690931425E+02 0.90568351990E+01 -0.59310532617E+02 0.69811232113E+02 0.0000000000E+00 0 -1.
    -12 1 3 3 0 0 -0.35690931425E+02 -0.90568351990E+01 -0.10635147623E+02 0.38327212458E+02 0.0000000000E+00 0 1.
</event>
```

Kinematics: (  $p_x$  ,  $p_y$  ,  $p_z$  ,  $E$  ,  $M$  )

helicity

- 1 Incoming particle
- +1 Outgoing final state particle
- 2 Intermediate space-like propagator defining an  $x$  and  $Q^2$
- +2 Intermediate resonance, Mass should be preserved



# MadAnalysis: Distributions & Plots

```
Terminal — bash — 80x24
Last login: Thu Jan 12 11:43:47 on console
Michael-Ramsey-Musolfs-MacBook-Pro:~ michaelramsey-musolf$ cd Desktop/Research/Co
llider_Codes/MadGraph5/MadGraph5_v1_3_2/
Michael-Ramsey-Musolfs-MacBook-Pro:MadGraph5_v1_3_2 michaelramsey-musolf$ ls
835_Proc      MadAnalysis    SleptonDY1    aloha        pythia-pgs
AUTHORS       myProcDir     SleptonDY2    apidoc       setup.py
DECAY         NewSlepton    SleptonDYBack bin          test
HELAS         NewWorkDir   SpinDir      doc          tests
INSTALL       Newtest      Template     input        vendor
LICENSE       PROC_sm_0    UpdateNotes.txt madgraph
LQ_Dir        README       VERSION     models
MG5_debug     Slepton      WorkDir     py.py
Michael-Ramsey-Musolfs-MacBook-Pro:MadGraph5_v1_3_2 michaelramsey-musolf$
```

download

```
Michael-Ramsey-Musolfs-MacBook-Pro:MadAnalysis michaelramsey-musolf$ make
f77 -O -ffixed-line-length-132 -c plot_events.f
f77 -O -ffixed-line-length-132 -c dbook.f
f77 -O -ffixed-line-length-132 -c rw_events.f
f77 -O -ffixed-line-length-132 -c kin_func.f
f77 -O -ffixed-line-length-132 -c set_cuts.f
f77 -O -ffixed-line-length-132 -o plot_events plot_events.o dbook.o rw_events.o
kin_func.o set_cuts.o
Michael-Ramsey-Musolfs-MacBook-Pro:MadAnalysis michaelramsey-musolf$
```

compile



# MadAnalysis: Distributions & Plots

```
Michael-Ramsey-Musolfs-MacBook-Pro:MadAnalysis michaelramsey-musolf$ ls  
MAVersion.txt      dbook.inc       kin_func.f      plot_events    rw_events.o  
README             dbook.o        kin_func.o      plot_events.f   script  
combine-pl         epstosmth    ma_card.dat    plot_events.o  set_cuts.f  
dbook.f           info.inc      makefile       rw_events.f   set_cuts.o  
Michael-Ramsey-Musolfs-MacBook-Pro:MadAnalysis michaelramsey-musolf$
```

Plot specs

```
Michael-Ramsey-Musolfs-MacBook-Pro:MadAnalysis michaelramsey-musolf$ ./plot_events  
*****  
*          MadAnalysis          *  
*          a MadEvent program    *  
*  for making plots and do simple analysis for  *  
*          LHE and LHCO event files    *  
*          -----          *  
*          Version compliant with MG_ME_V4.0    *  
*          -----          *  
*          Authors: R. Frederix and F. Maltoni    *  
*          -----          *  
*          Last Update by R.F., 23-Feb-2006    *  
*****
```

gen plots

```
input name of event file:  
-----
```

# MadAnalysis: Distributions & Plots



```
input name of event file:  
-----  
./835_Proc/Events/835_Test_events.lhe  
Found Les Houches Event File  
    output file:  
plots.top
```

Classes will be read from file: ./ma\_card.dat

Found the following classes in input classes file:

class # 0 is mET 12 -12 14 -14 16 -16 122

class # 1 is jet 1 -1 2 -2 3 -3 4 -4 21

class # 2 is b 5 -5

Now start parsing events a first time

created new class e- for particle 11

created new class t for particle 6

created new class t~ for particle -6

Setting up graphs

27 plots set up

Setting up acceptance cuts

Cuts set up

SEE plots.log FOR MORE INFO

Now parsing events to fill his

At event 1000

Plot file for topdrawer

```
Michael-Ramsey-Musolfs-MacBook-Pro:MadAnalysis michaelramsey-musolf$ ls  
MAVersion.txt  dbook.o      ma_card.dat  plots.log   set_cuts.f  
README        epstosmth   makefile    plots.top  set_cuts.o  
combine-pl    info.inc    plot_events rw_events.f  
dbook.f       kin_func.f  plot_events.f rw_events.o  
dbook.inc     kin_func.o  plot_events.o script  
Michael-Ramsey-Musolfs-MacBook-Pro:MadAnalysis michaelramsey-musolf$
```

events information

```
Events in file      : 19802  
Integrated weight (pb) : 6217.25158  
Max wgt           : 0.8800056  
Average wgt        : 0.313970891
```

Passing the cuts (plotted)

```
Events          : 19802  
Integrated weight (pb) : 6217.25158  
Max wgt         : 0.8800056  
Average wgt      : 0.313970891
```

```
Michael-Ramsey-Musolfs-MacBook-Pro:MadAnalysis michaelramsey-musolf$
```



# MadAnalysis: Distributions & Plots

```
Michael-Ramsey-Musolfs-MacBook-Pro:MadAnalysis michaelramsey-musolf$ ls  
MAVersion.txt      dbook.inc      kin_func.f      plot_events      rw_events.o  
README             dbook.o       kin_func.o      plot_events.f     script  
combine-pl        epstosmth    ma_card.dat    plot_events.o    set_cuts.f  
dbook.f           info.inc      makefile      rw_events.f     set_cuts.o  
Michael-Ramsey-Musolfs-MacBook-Pro:MadAnalysis michaelramsey-musolf$
```

Plot specs

```
*****  
#          Card for MadAnalysis  
#  
# This file is used to set the classes and options for  
# the MadAnalysis program.  
#  
#  
# Some comments about the classes  
# 1. Plots are for classes of particles.  
# 2. Each particle is identified by its PDG code.  
# 3. Classes names are arbitrary (4 symbols max, no spaces allowed).  
# 4. Particles in the same class will be ordered with the 'ordering'  
#    function' in the file in\_func.f.  
# 5. Classes can be added/edited/removed at will, and given a name  
#    that will then appear in the plots.  
# 6. A particle can be put in one class only. Putting a particle in  
#    two or more classes can lead to double counting of events.  
# 7. The class name mET is missing Energy and its name is reserved.  
#    If used, it must be put last in the classes list below.  
# 8. If events contain particles not belonging to an existing class,  
#    a new class will automatically be generated.  
# 9. For LHCD events the PDG code 21 is assigned to a jet (not  
#    b-tagged), 5 to a b-tagged jet and 12 to missing ET.  
#  
#  
# Some comments about the cuts  
# 1. In the file kin\_func.f the functions on which cuts can be applied  
#    are given.  
# 2. The syntax is as follows.  
#    etmin 1 3 30d0  
#    means that from the first class the Et of the first three particles  
#    has to be greater than 30 GeV.  
#
```

```
*****  
# Cuts on plotted events  
*****  
# Modify the cuts and remove the pounds/hashtags to apply those cuts  
# Do NOT put spaces at the beginning of the following lines!  
# Begin Cuts # This is TAG. Do not modify this line  
#etmin 2 2 40d0  
#etmin 2 1 80d0  
#etmin 1 3 20d0  
#etmax 2 1 200d0  
#ptmin 3 1 0d0  
#etmissmin 20d0  
#etmissmax 80d0  
#etamax 1 1 1d0  
#etamax 2 1 2d0  
#etamin 2 2 1.5d0  
#etamin 2 1 2d0  
#mijmax 2 1 2 2 200d0  
#mijmin 2 1 2 2 100d0  
#X1min 2 1 40d0  
#X1max 2 2 50d0  
#dRijmin 2 1 2 2 0.7d0  
#dRijmax 1 3 2 2 0.7d0  
#XY1min 2 2 2 2 20d0  
#XY12max 2 2 2 2 4 1 5 1 40d0  
# End Cuts # This is TAG. Do not modify this line  
*****  
# Put here the required plots  
*****  
# Do NOT put spaces at the beginning of the following lines!  
# Begin PlotDefs # This is TAG. Do not modify this line  
pt 1 4 # plot pt for the first four particles in class 1  
pt 2 4 # plot pt for the first four particles in class 2  
pt 3 4 # plot pt for the first four particles in class 3  
pt 4 4 # plot pt for the first four particles in class 4  
pt 5 4 # etc.
```

Cuts for plotting

Distributions to plot

# MadAnalysis: Distributions & Plots



```
Michael-Ramsey-Musolfs-MacBook-Pro:MadAnalysis michaelramsey-musolf$ ls
MAVersion.txt      dbook.inc       kin_func.f      plot_events     rw_events.o
README             dbook.o        kin_func.o      plot_events.f   script
combine-pl        epstosmth    ma_card.dat    plot_events.o  set_cuts.f
dbook.f           info.inc      makefile      rw_events.f   set_cuts.o
Michael-Ramsey-Musolfs-MacBook-Pro:MadAnalysis michaelramsey-musolf$
```

```
mij 1 4 # use the first four particles in the 1st class to plot inv. mass
mij 2 2 # use the first two particles from the second class as well
mij 3 1 # etc.
mij 4 1
mij 5 1
mij 6 1
mij 7 1
#cosij 1 2
#cosij 2 2
#cosij 3 1
#cosij 4 1
dRij 1 4
dRij 2 2
dRij 3 1
dRij 4 1
dRij 5 1
dRij 6 1
dRij 7 1
#delta_phi 2 2
#delta_phi 4 1
```

More distributions

Plotting routine

```
#####
# Put here the plot ranges
#####
# Do NOT put spaces at the beginning of the following lines!
# Begin PlotRange # This is TAG. Do not modify this line
pt      10  0  500 # bin size, min value, max value
et      10  0  500 # bin size, min value, max value
etmiss. 10  0  500 # bin size, min value, max value
ht      20  0  1500
y       0.2 -5  5 # etc.
mij    20  0  1500
dRij   0.1  0  5
#delta_phi 0.1  0  3.1
#X1     1   0  100
#XYZA1  1   0  100
# End PlotRange # This is TAG. Do not modify this line
#####
#####
# Output for plots
#####
# Do NOT put spaces at the beginning of the following lines!
# Begin PlotOutput # This is TAG. Do not modify this line
output  topdrawer # set to topdrawer or gnuplot
plot_decayed no    # plot (and cut) dec. res.? (only for LHE events)
# End PlotOutput # This is TAG. Do not modify this line
#####
```

Plot ranges



# MadAnalysis: Distributions & Plots

```
Michael-Ramsey-Musolfs-MacBook-Pro:MadAnalysis michaelramsey-musolf$ ls
MAVersion.txt    dbook.o      ma_card.dat   plots.lg      set_cuts.f
README           epstosmth   makefile     plots_test.top set_cuts.o
combine-pl       info.inc    plot_events   rw_events.f
dbook.f          kin_func.f  plot_events.f rw_events.o
dbook.inc        kin_func.o  plot_events.o script
Michael-Ramsey-Musolfs-MacBook-Pro:MadAnalysis michaelramsey-musolf$
```

Renamed  
plots.top

```
Michael-Ramsey-Musolfs-MacBook-Pro:td_macos_10.3 michaelramsey-musolf$ ls
3d.ps            fort.86      readme.txt    td           toptemplate.top
3d.top           plots.top    sleptontest.ps  td.1
examples         plots_test.top sleptontest.top topdrawer.doc
Michael-Ramsey-Musolfs-MacBook-Pro:td_macos_10.3 michaelramsey-musolf$ ./td plots_test.top
Plot 1 Done.
Plot 2 Done.
Plot 3 Done.
```

Generate .ps

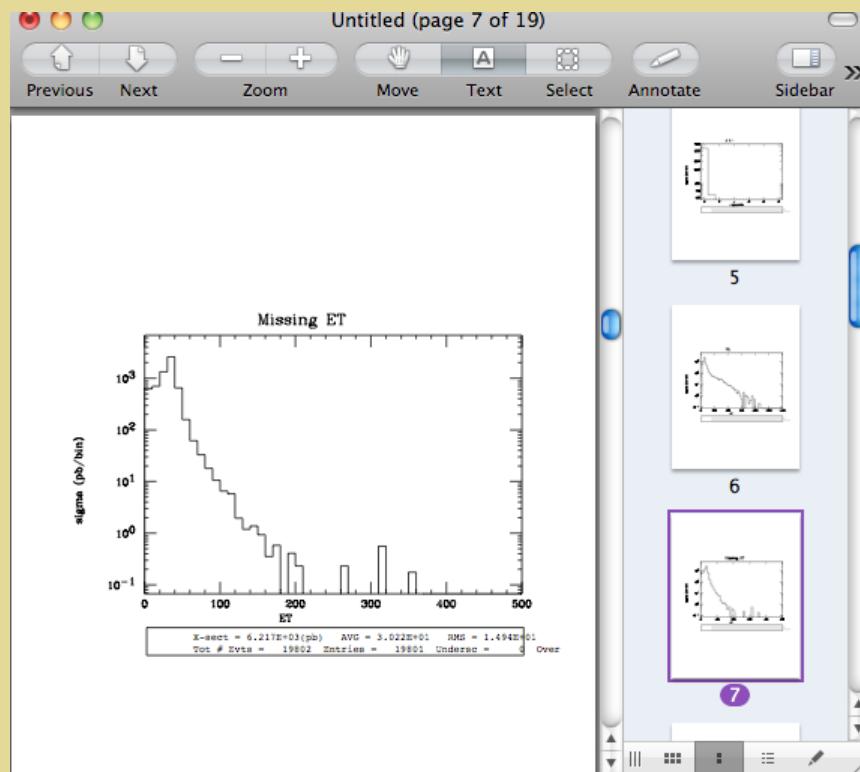
```
Michael-Ramsey-Musolfs-MacBook-Pro:td_macos_10.3 michaelramsey-musolf$ ls
3d.ps            fort.86      plots_test.top sleptontest.top topdrawer.doc
3d.top           plots.top    readme.txt    td           toptemplate.top
examples         plots_test.ps sleptontest.ps  td.1
Michael-Ramsey-Musolfs-MacBook-Pro:td_macos_10.3 michaelramsey-musolf$
```

Distributions in .ps format



# MadAnalysis: Distributions & Plots

```
Michael-Ramsey-Musolfs-MacBook-Pro:td_macos_10.3 michaelramsey-musolf$ ls
3d.ps          fort.86      plots_test.top  sleptontest.top topdrawer.doc
3d.top         plots.top     readme.txt      td                  toptemplate.top
examples       plots_test.ps sleptontest.ps  td.1
Michael-Ramsey-Musolfs-MacBook-Pro:td_macos_10.3 michaelramsey-musolf$ open plots_test.ps
Michael-Ramsey-Musolfs-MacBook-Pro:td_macos_10.3 michaelramsey-musolf$
```



Opens series of 19 plots as specified in ma\_card.dat

# MadAnalysis: Distributions & Plots



```
plots_test.top
SET DEVICE POSTSCRIPT ORIENT=3

SET INTENSITY 4
SET WINDOW Y 2.5 TO 9.
SET WINDOW X 2.5 TO 12.
SET FONT DUPLEX
SET SYMBOL 50 SIZE 1.8
TITLE TOP "Weights"
TITLE BOTTOM "Wgt."
TITLE LEFT "sigma (pb/bin)"
SET SCALE Y LOG
(SET TICKS TOP OFF)
SET LIMITS X 0.00000 2.00000
SET ORDER X Y DY
    0.1300 0.0000E+00 0.0000E+00
    0.1500 0.3493E+03 0.0000E+00
    0.1700 0.7728E+03 0.0000E+00
    0.1900 0.7632E+02 0.0000E+00
    0.2100 0.8341E+00 0.0000E+00
    0.2300 0.2362E+03 0.0000E+00
    0.2500 0.3509E+01 0.0000E+00
    0.2700 0.1612E+01 0.0000E+00
    0.2900 0.1445E+01 0.0000E+00
    0.3100 0.6081E+00 0.0000E+00
.....TOPDRAWER
.....Version 5.12 ( Rice Bonner Lab )
.....July 1993
.....Fermilab Document PP0005.1
.....Author: John Clement
.....Support level: 5 (full)
```

Plot specs: can be modified;  
see Topdrawer manual



# MadAnalysis: Distributions & Plots



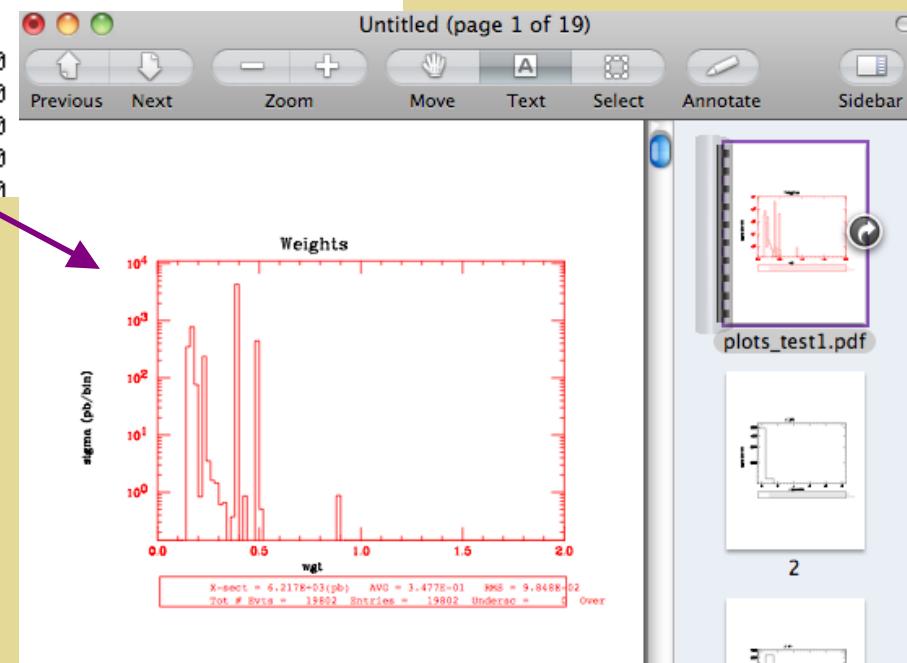
```
SET DEVICE POSTSCRIPT ORIENT=3
```

```
SET INTENSITY 4
SET WINDOW Y 2.5 TO 9.
SET WINDOW X 2.5 TO 12.
SET FONT DUPLEX
SET SYMBOL 50 SIZE 1.8
TITLE TOP " Weights "
TITLE BOTTOM "wgt"
TITLE LEFT "sigma (pb/bin) "
SET SCALE Y LOG
(SET TICKS TOP OFF)
SET LIMITS X 0.00000 2.00000
SET COLOR RED
SET ORDER X Y DY
  0.1300 0.0000E+00 0.0000E+00
  0.1500 0.3493E+03 0.0000E+00
  0.1700 0.7728E+03 0.0000E+00
  0.1900 0.7632E+02 0.0000E+00
  0.2100 0.8341E+00 0.0000E+00
```

Example: adding color

Then execute ./td fname.top

Then open fname.ps





# ExRootAnalysis: Distributions & Plots

```
Michael-Ramsey-Musolfs-MacBook-Pro:td_macos_10.3 michaelramsey-musolf$ cd ../  
Michael-Ramsey-Musolfs-MacBook-Pro:Desktop michaelramsey-musolf$ ls  
Admin  
ArXiv  
Calcheptutorial  
Calchepwork  
Casa 08-12  
Collider Refs  
EDM introduction.docx  
EWB Reading  
EWNPagenda_draft.pdf  
FWPT To Read  
ExRootAnalysis  
MJRMUWM  
MadG Screen
```

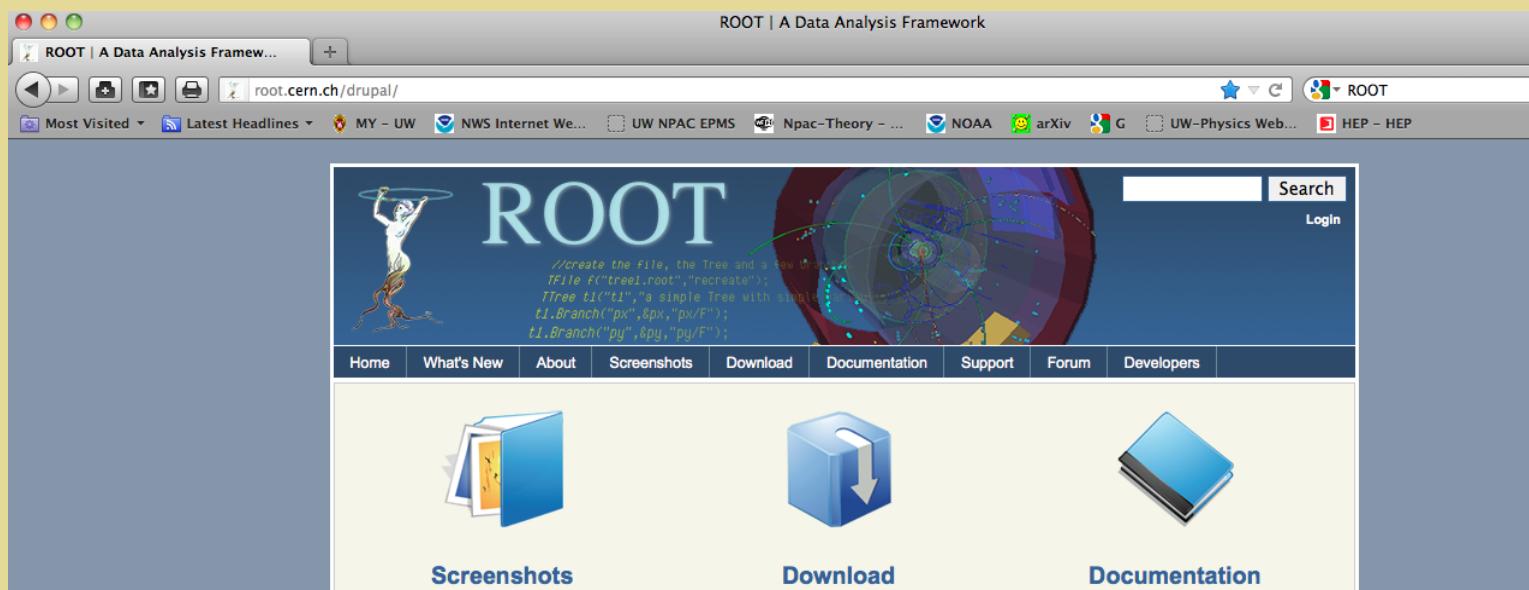
download & compile

```
Michael-Ramsey-Musolfs-MacBook-Pro:Desktop michaelramsey-musolf$ cd ExRootAnalysis/  
Michael-Ramsey-Musolfs-MacBook-Pro:ExRootAnalysis michaelramsey-musolf$ ls  
CDFCones Example pythia_events.list  
CLHEP KtJet pythia_plots_card.tcl  
ExRootAnalysis Makefile src  
ExRootHEPEVTConverter doc stdhep  
ExRootLHC0lympicsConverter events.list tcl  
ExRootLHEFConverter lib test  
ExRootMain mcfio test.list  
ExRootSTDHEPConverter modules test.tcl  
ExRootVersion.txt pgs tmp  
Michael-Ramsey-Musolfs-MacBook-Pro:ExRootAnalysis michaelramsey-musolf$
```

# *ExRootAnalysis: Distributions & Plots*



```
Michael-Ramsey-Musolfs-MacBook-Pro:root michaelramsey-musolfs$ ls
INSTALL.txt          bin           icons          roothowto.txt
LICENSE              cint          include        test
README               etc           lib            tmva
Root Protocol.docx   fonts          macros        tutorials
Root make issues.docx geom          man
Michael-Ramsey-Musolfs-MacBook-Pro:root michaelramsey-musolfs$
```



The screenshot shows a web browser displaying the ROOT Data Analysis Framework homepage. The title bar reads "ROOT | A Data Analysis Framework". The page features a large banner with the word "ROOT" in large letters, a woman holding a ring, and a particle detector simulation. Below the banner is a navigation menu with links: Home, What's New, About, Screenshots, Download, Documentation, Support, Forum, Developers, Search, and Login. At the bottom, there are three buttons: "Screenshots" (with an icon of a blue book), "Download" (with an icon of a blue cube with a downward arrow), and "Documentation" (with an icon of a blue book).

Download and install ROOT: [root.cern.ch](http://root.cern.ch)

# *ExRootAnalysis: Running Root*



## Set path

```
export ROOTSYS=<path>/root
```

where /root is the root directory at the end of the path. On my mac <path> = /Users/michaelramsey-musolf/Desktop

```
export ROOTSYS=/Users/michaelramsey-musolf/Desktop/root
```

To verify this worked, type \$ROOTSYS and it should indicate the path to the root directory.

```
Michael-Ramsey-Musolfs-MacBook-Pro:~ michaelramsey-musolf$ export ROOTSYS=/Users  
/michaelramsey-musolf/Desktop/root  
Michael-Ramsey-Musolfs-MacBook-Pro:~ michaelramsey-musolf$ $ROOTSYS  
-bash: /Users/michaelramsey-musolf/Desktop/root: is a directory  
Michael-Ramsey-Musolfs-MacBook-Pro:~ michaelramsey-musolf$
```

# *ExRootAnalysis: Running Root*



Indicate where libraries live

```
export PATH=$ROOTSYS/bin:$PATH  
export LD_LIBRARY_PATH=$ROOTSYS/lib:$LD_LIBRARY_PATH  
export DYLD_LIBRARY_PATH=$ROOTSYS/lib:$DYLD_LIBRARY_PATH
```

```
Michael-Ramsey-Musolfs-MacBook-Pro:~ michaelramsey-musolfs$ export PATH=$ROOTSYS/bin:$PATH  
Michael-Ramsey-Musolfs-MacBook-Pro:~ michaelramsey-musolfs$ export LD_LIBRARY_PATH=$ROOTSYS/lib:$LD_LIBRARY_PATH  
Michael-Ramsey-Musolfs-MacBook-Pro:~ michaelramsey-musolfs$ export DYLD_LIBRARY_PATH=$ROOTSYS/lib:$DYLD_LIBRARY_PATH
```



# ExRootAnalysis: Create Root File

Go to Events Directory in MadGraph working directory

```
Michael-Ramsey-Musolfs-MacBook-Pro:Desktop michaelramsey-musolf$ cd Research/Collider_Codes/MadGraph5/MadGraph5_v1_3_2/835_Proc/Events/
Michael-Ramsey-Musolfs-MacBook-Pro:Events michaelramsey-musolf$ ls
835_Test_banner.txt          835_Test_pythia.log           banner_header.txt
835_Test_beforeveto.tree.gz   835_Test_pythia_events.hep.gz  fort.0
835_Test_events.lhe          835_Test_pythia_events.lhe.gz  hep2lhe.log
835_Test_events.lhe.gz       835_Test_unweighted_events.lhe.gz
835_Test_events.tree.gz      835_Test_xsecs.tree
Michael-Ramsey-Musolfs-MacBook-Pro:Events michaelramsey-musolf$
```

Convert MadGraph events output file fname.lhe to fname.root:

```
<path>/ExRootAnalysis/ExRootLHEFConverter fname.lhe fname.root
```

```
Michael-Ramsey-Musolfs-MacBook-Pro:Events michaelramsey-musolf$ /Users/michaelramsey-musolf/Desktop/ExRootAnalysis/ExRootLHEFConverter 835_Test_events.lhe 835_Test_events.root
** Calculating number of events to process. Please wait...
** Input file contains 19802 events
[########################################] (100.00%) : 19802/19802 entries processed
** Exiting...
Michael-Ramsey-Musolfs-MacBook-Pro:Events michaelramsey-musolf$
```



# *ExRootAnalysis: View Dist w/ ROOT*

```
Michael-Ramsey-Musolfs-MacBook-Pro:Events michaelramsey-musolf$ root
*****
*                                         *
*      W E L C O M E   t o   R O O T   *
*                                         *
*      Version  5.28/00c    15 April 2011  *
*                                         *
*      You are welcome to visit our Web site  *
*          http://root.cern.ch                 *
*                                         *
*****
```

Run Root

```
ROOT 5.28/00c (tags/v5-28-00c@38884, Apr 15 2011, 17:34:24 on macosx64)
CINT/ROOT C/C++ Interpreter version 5.18.00, July 2, 2010
Type ? for help. Commands must be C++ statements.
Enclose multiple statements between { }.
root [0] ■
```

Load Libraries in Root

```
gSystem->Load("/Users/michaelramsey-
musolf/Desktop/ExRootAnalysis/lib/libExRootAnalysis.so");
```

# ExRootAnalysis: View Dist w/ ROOT

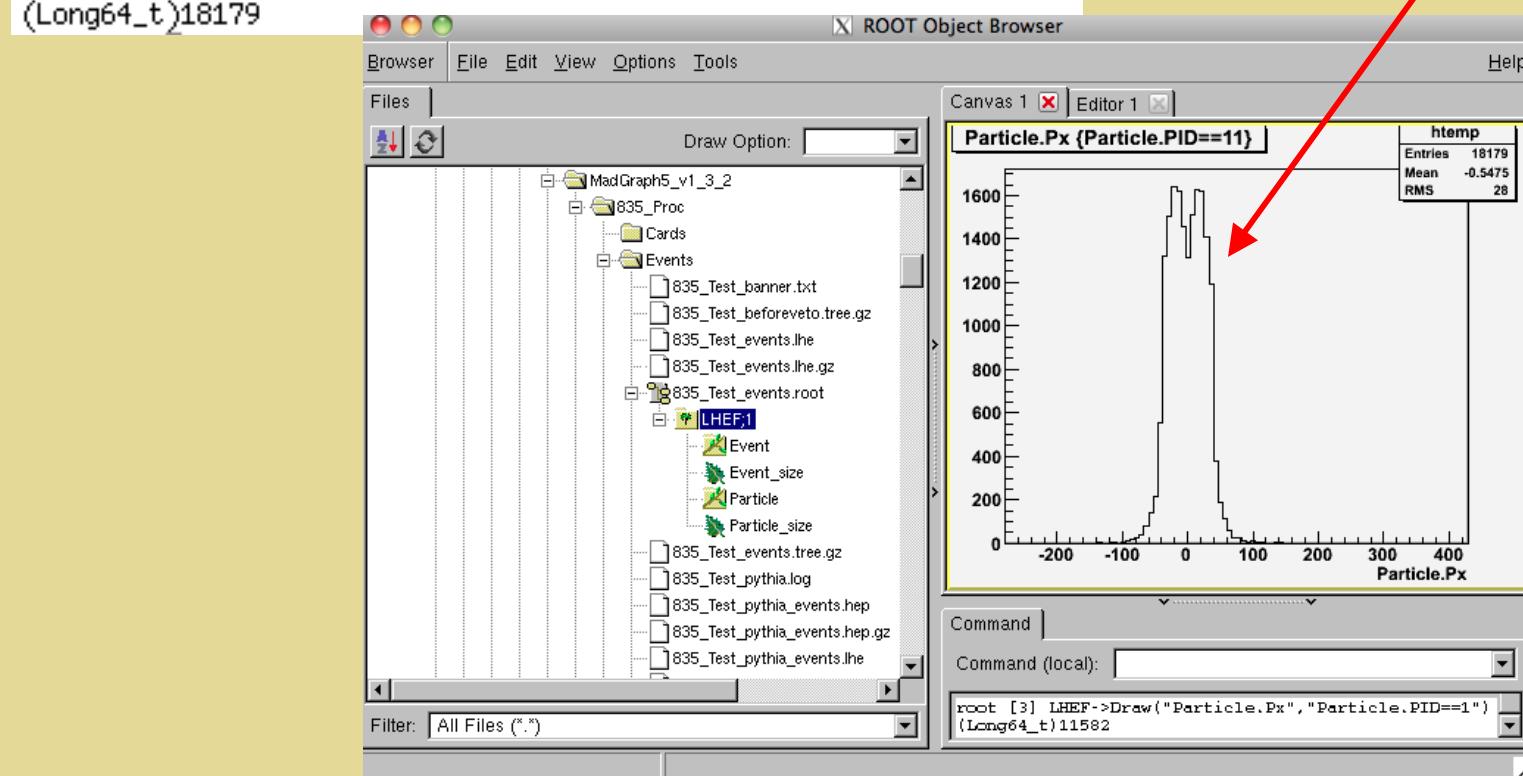


```
root [2] TBrowser a  
root [3] (class TFile*)0x1045a8210
```

Open a canvas

```
root [3] LHEF->Draw("Particle.Px[11]")  
root [4] LHEF->Draw("Particle.Px","Particle.PID==11")  
(Long64_t)18179  
root [5] LHEF->Draw("Particle.PT[11]")  
root [6] LHEF->Draw("Particle.PT","Particle.PID==11")  
(Long64_t)18179
```

Plot Distributions

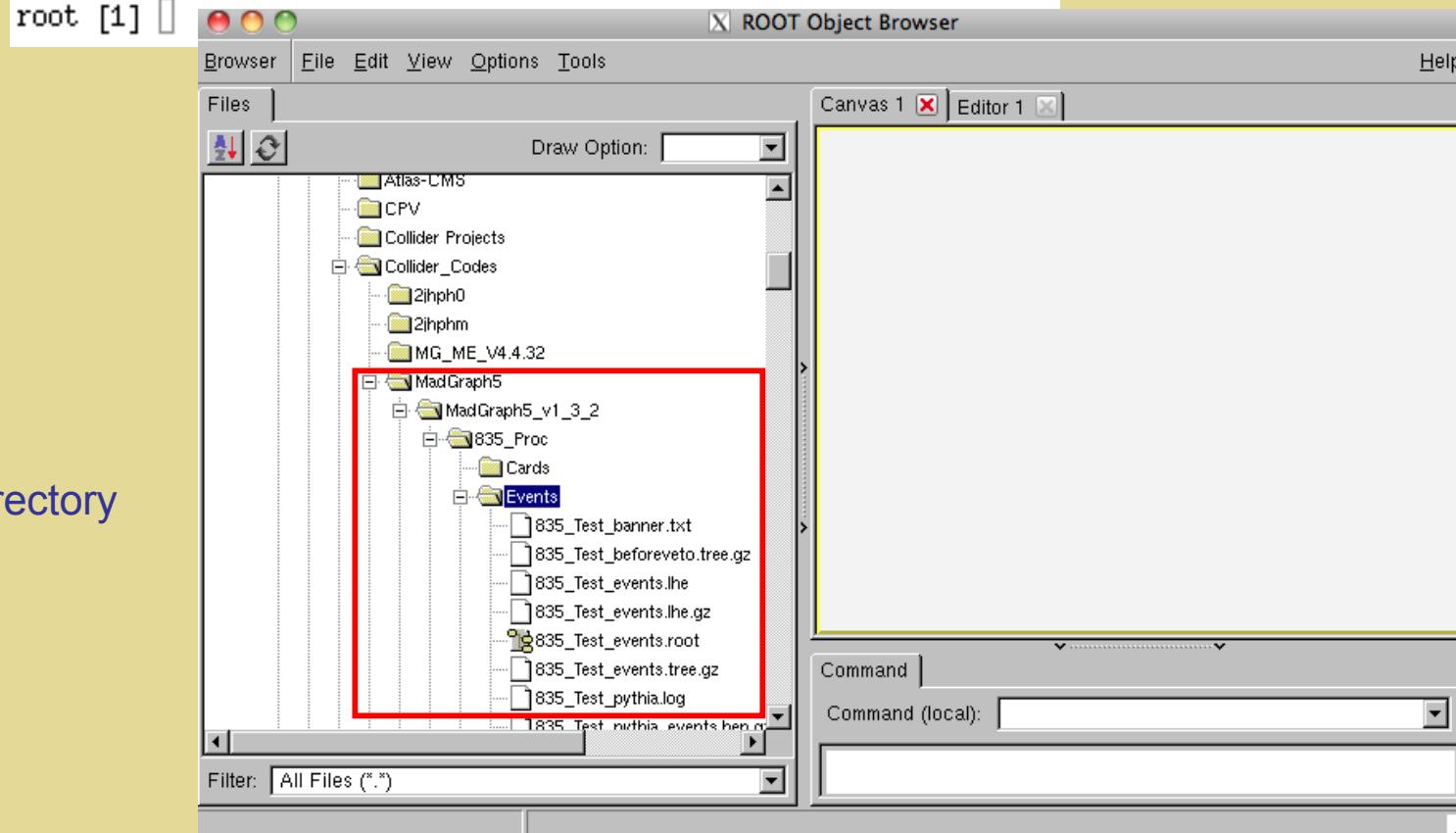


# *ExRootAnalysis: View Dist w/ ROOT*



Open terminal viewer

```
CINT/ROOT C/C++ Interpreter version 5.18.00, July 2, 2010
Type ? for help. Commands must be C++ statements.
Enclose multiple statements between { }.
root [0] TBrowser a
root [1] 
```



Directory



# Some Root Variables

```
dyn-72-33-47-106:~ michaelramsey-musolf$ cd Desktop/ExRootAnalysis/
dyn-72-33-47-106:ExRootAnalysis michaelramsey-musolf$ ls
CDFCones                      lib
CLHEP                          mcfio
ExRootAnalysis                  modules
ExRootHEPEVTConverter          pgs
ExRootLHC0lympicsConverter     pythia_events.list
ExRootLHEFConverter            pythia_plots_card.tcl
ExRootMain                      src
ExRootSTDHEPConverter          stdhep
ExRootVersion.txt               tcl
Example                         test
KtJet                           test.list
Makefile                         test.tcl
doc                             tmp
events.list
```

```
dyn-72-33-47-106:ExRootAnalysis michaelramsey-musolf$ cd doc/
dyn-72-33-47-106:doc michaelramsey-musolf$ ls
README                         convert_all_eps_to_png.sh
RootTreeDescription.html         epstosmth
uwk                            genMakefile.tcl
convert_all_eps_to_jpg.sh       pgs_event.txt
convert_all_eps_to_pdf.sh       useful_commands.txt
dyn-72-33-47-106:doc michaelramsey-musolf$
```



# Some Root Variables

## root tree description

### Branches

Branch	Definition	Class
Event	generated event from LHEF	<a href="#">TRootLHEFEvent</a>
Particle	generated partons from LHEF	<a href="#">TRootLHEFParticle</a>
Event	information about generated event	<a href="#">TRootGenEvent</a>
GenParticle	generated particle	
Event	information about generated event	
Photon	reconstructed photon	
Electron	reconstructed electron	
Muon	reconstructed muon	
Tau	reconstructed tau lepton	
Jet	reconstructed jet	
MissingET	missing transverse energy	

**TRootLHEFParticle**

PID	particle HEP ID number	hepup.IDUP[number]
Status	particle status code	hepup.ISTUP[number]
Mother1	index for the particle first mother	hepup.MOTHUP[number][0]
Mother2	index for the particle last mother	hepup.MOTHUP[number][1]
ColorLine1	index for the particle color-line	hepup.ICOLUP[number][0]
ColorLine2	index for the particle anti-color-line	hepup.ICOLUP[number][1]
Px	particle momentum vector (x component)	hepup.PUP[number][0]
Py	particle momentum vector (y component)	hepup.PUP[number][1]
Pz	particle momentum vector (z component)	hepup.PUP[number][2]
E	particle energy	hepup.PUP[number][3]
M	particle mass	hepup.PUP[number][4]
PT	particle transverse momentum	
Eta	particle pseudorapidity	
Phi	particle azimuthal angle	
LifeTime	particle invariant lifetime ( $c^*\tau$ , distance from production to decay in mm)	hepup.VTIMUP[number]
Spin	cosine of the angle between the particle spin vector and the decaying particle 3-momentum, specified in the lab frame.	hepup.SPINUP[number]

# Generating Events: MG-Pythia-PGS



Enable PGS: create `pgs_card.dat`

```
dyn-72-33-47-106:Cards michaelramsey-musolf$ ls
README                                     grid_card_default.dat
delphes_card_ATLAS.dat                   ident_card.dat
delphes_card_CMS.dat                    param_card.dat
delphes_card_default.dat                param_card_default.dat
delphes_trigger.dat                     pgs_card_ATLAS.dat
delphes_trigger_ATLAS.dat               pgs_card_CMS.dat
delphes_trigger_CMS.dat                pgs_card_LHC.dat
grid_card.dat                          pgs_card_TEV.dat
dyn-72-33-47-106:Cards michaelramsey-musolf$ cp pgs_card_default.dat pgs_card.dat
dyn-72-33-47-106:Cards michaelramsey-musolf$ ls
README                                     grid_card_default.dat
delphes_card_ATLAS.dat                   ident_card.dat
delphes_card_CMS.dat                    param_card.dat
delphes_card_default.dat                param_card_default.dat
delphes_trigger.dat                     pgs_card.dat
delphes_trigger_ATLAS.dat               pgs_card_ATLAS.dat
delphes_trigger_CMS.dat                pgs_card_CMS.dat
grid_card.dat                          pgs_card_LHC.dat
dyn-72-33-47-106:Cards michaelramsey-musolf$ █
```



# Generating Events: MG-Pythia-PGS

```
dyn-72-33-47-106:Cards michaelramsey-musolf$ cd ../  
dyn-72-33-47-106:835_Proc michaelramsey-musolf$ ls  
CREATED          README           index.html        proc_log.txt  
Cards            Source           lib              py.py  
Events           SubProcesses    madevent.tar.gz  status  
HTML             TemplateVersion.txt  makefile  
MGMEVersion.txt  bin             myprocid  
dyn-72-33-47-106:835_Proc michaelramsey-musolf$ bin/generate_events  
Enter 2 for multi-core, 1 for parallel, 0 for serial run  
0  
Enter run name  
835_Test2  
Tue Jan 31 11:36:42 CST 2012  
Generating 10000 events  
Cleaning SubProcesses.....
```

Gen events w/o re-running  
./newprocess\_mg5

End of parton level calc

```
Running pythia...  
Running hep2lhe  
pythia_events.lhe file generated, with simple jet clustering  
Warning! Never use this file for detector studies!  
Creating Plots for Pythia  
Running PGS...  
I will merge non-isolated muons with jets...  
Thank you for using the olympics output cleaner.  
Creating Plots for PGS  
Storing files  
P3_gg_ttx  
P2_gq_lvlg  
P2_qq_lvlg  
P1_qq_lvlg  
P3_qq_ttx  
Tue Jan 31 11:45:44 CST 2012  
dyn-72-33-47-106:835_Proc michaelramsey-musolf$ █
```

Running Pythia and pgs since  
converted pgs\_card\_default.dat  
→ pgs\_card.dat

PGS takes some  
time !



## PGS Output: Create Root File

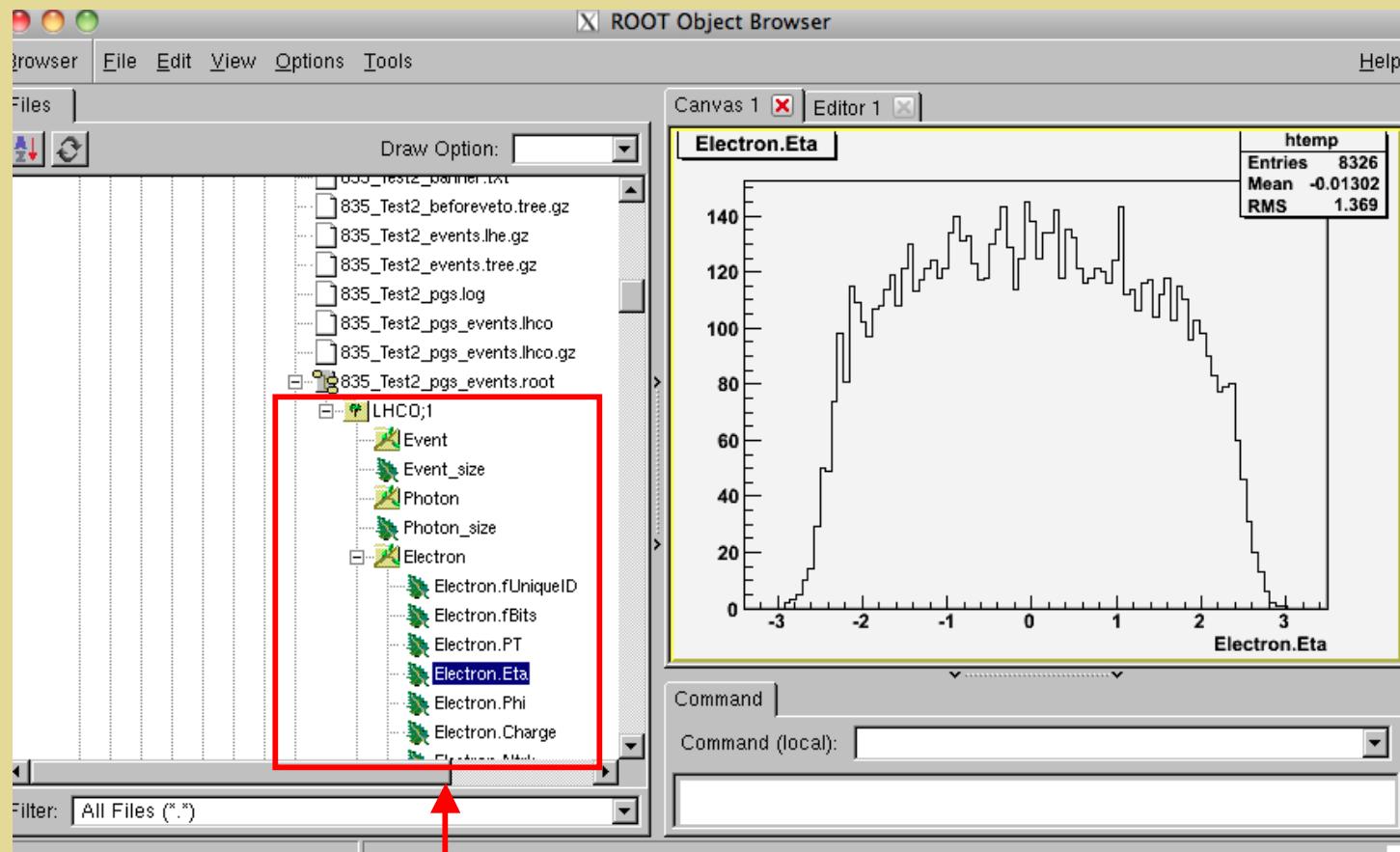
```
dyn-72-33-47-106:835_Proc michaelramsey-musolf$ cd Events/
dyn-72-33-47-106:Events michaelramsey-musolf$ ls
835_Test                                835_Test_banner.txt
835_Test2                               835_Test_beforeveto.tree.gz
835_Test2_banner.txt                     835_Test_events.lhe.gz
835_Test2_beforeveto.tree.gz            835_Test_events.root
835_Test2_events.lhe.gz                 835_Test_events.tree.gz
835_Test2_events.tree.gz                835_Test_plots.html
835_Test2_pgs                          835_Test_plots_pythia.html
835_Test2_pgs.log                      835_Test_pythia
835_Test2_pgs_events.lhco.gz           835_Test_pythia.log
835_Test2_pgs_uncleaned_events.lhco.gz 835_Test_pythia_events.hep.gz
835_Test2_plots.html
```

Convert PGS events output file fname.lhco to fname.root:

```
<path>/ExRootAnalysis/ExRootLHCOLympicsConverter fname.lhco
fname.root
```

```
dyn-72-33-47-106:Events michaelramsey-musolf$ /Users/michaelramsey-musolf/Desktop/ExRootAnalysis/ExRootLHCOLympicsConverter 835_Test2_pgs_events.lhco 835_Test2_pgs_events.root
** Calculating number of objects to process. Please wait...
** Input file contains 39866 objects
[########################################] (100.00%) : 39866/39866 entries processed
** Exiting...
dyn-72-33-47-106:Events michaelramsey-musolf$
```

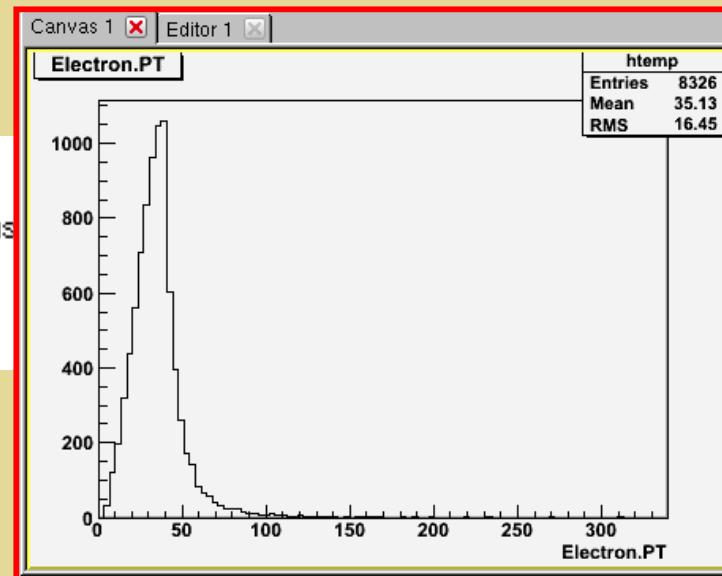
# PGS: View Dist w/ ROOT



# PGS: View Dist w/ ROOT



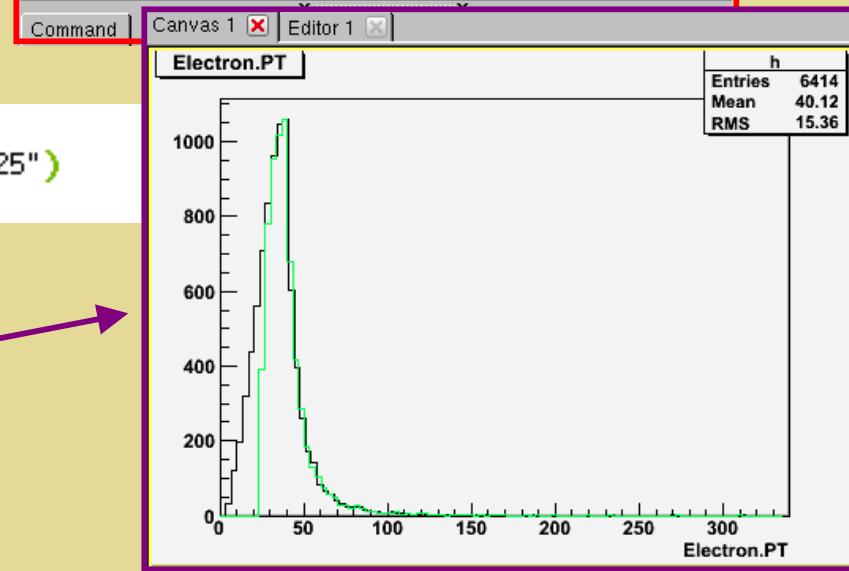
```
root [1] TBrowser a  
root [2] (class TFile*)0x1045a5770  
Warning in <TClass::TClass>: no dictionary for class  
root [2] LHC0->Draw("Electron.PT") →  
root [3] □
```



Impose a cut

```
root [7] LHC0->Draw("Electron.PT")  
root [8] LHC0->Draw("Electron.PT>>h","Electron.PT>25")  
(Long64_t)6414
```

```
root [14] LHC0->Draw("Electron.PT")  
root [15] h->SetLineColor(3)  
root [16] h->Draw("same") →
```





# ExRootAnalysis: Distributions & Plots

↳ To convert `lhco` to root:

```
# ExRootLHC0lympicsConverter filename_pgs_events.lhco filename.root
```

↳ To use the ExRootAnalysis libraries:

```
# gSystem->Load("../ExRootAnalysis/lib/libExRootAnalysis.so");
```

↳ To start the graphical browser:

```
# TBrowser a;
```

↳ To load C program:

```
# .L filename.C
```

↳ To execute C program:

```
# .X filename.C
```

Skeletal instructions: `roothowto.txt`

---

Open a root file:

```
# TFile f("filename.root")
```

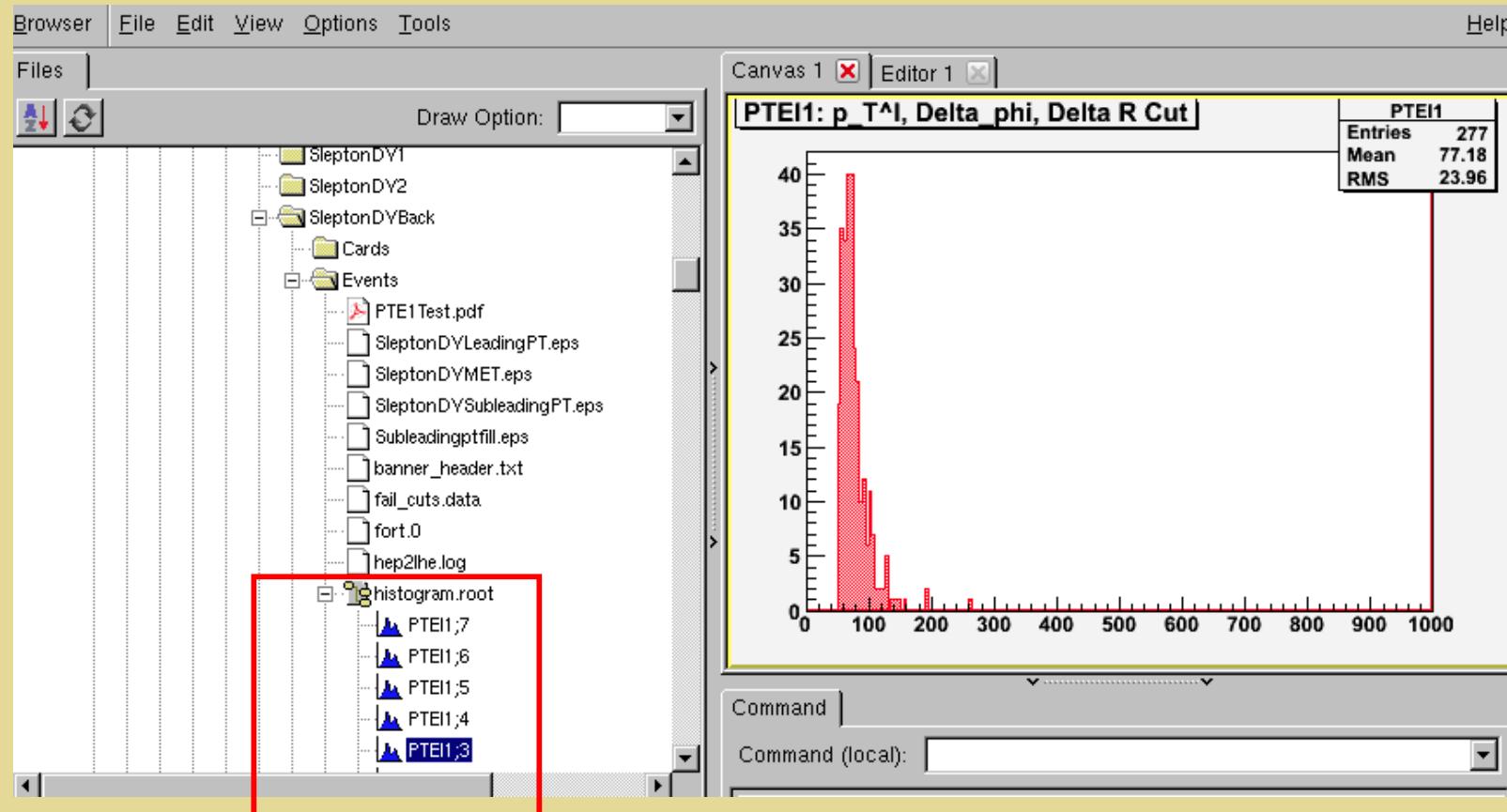
Write your own C code to impose more complicated cuts and create histograms

Generate C code for analysis (contains a loop skeleton)

```
# LHC0->MakeClass("filename")
```

HW

# *ExRootAnalysis: Distributions & Plots*



Histograms created by C code

Colors, shading etc can be  
implemented w/ **Style Manager**:  
Edit->Style->Edit