EX-3; change parameters

- Semi-leptonic decays in top-pair production at the LHC:
  MG5_aMC> generate p p > t t~, t > b l- vl~, t~ > b~ j j
- How can we change?
  - top mass
  - top width
  - W mass
  - beam energy
  - pT cut on leptons

edit param_card.dat and/or run_card.dat in Cards/.

or

use the "set" command.

Solution

EX-3; change parameters

- Semi-leptonic decays in top-pair production at the LHC:
  MG5_aMC> generate p p > t t~, t > b l- vl~, t~ > b~ j j
- How can we change?
  - top mass
  - top width

  edit Cards/param_card.dat
  - W mass

  In the default SM, the W mass cannot be changed because it is an internal parameter.
  - beam energy
  - pT cut on leptons

  edit Cards/run_card.dat

EX-4; cross sections (param scan; root-S)

- Reproduce the red curve.

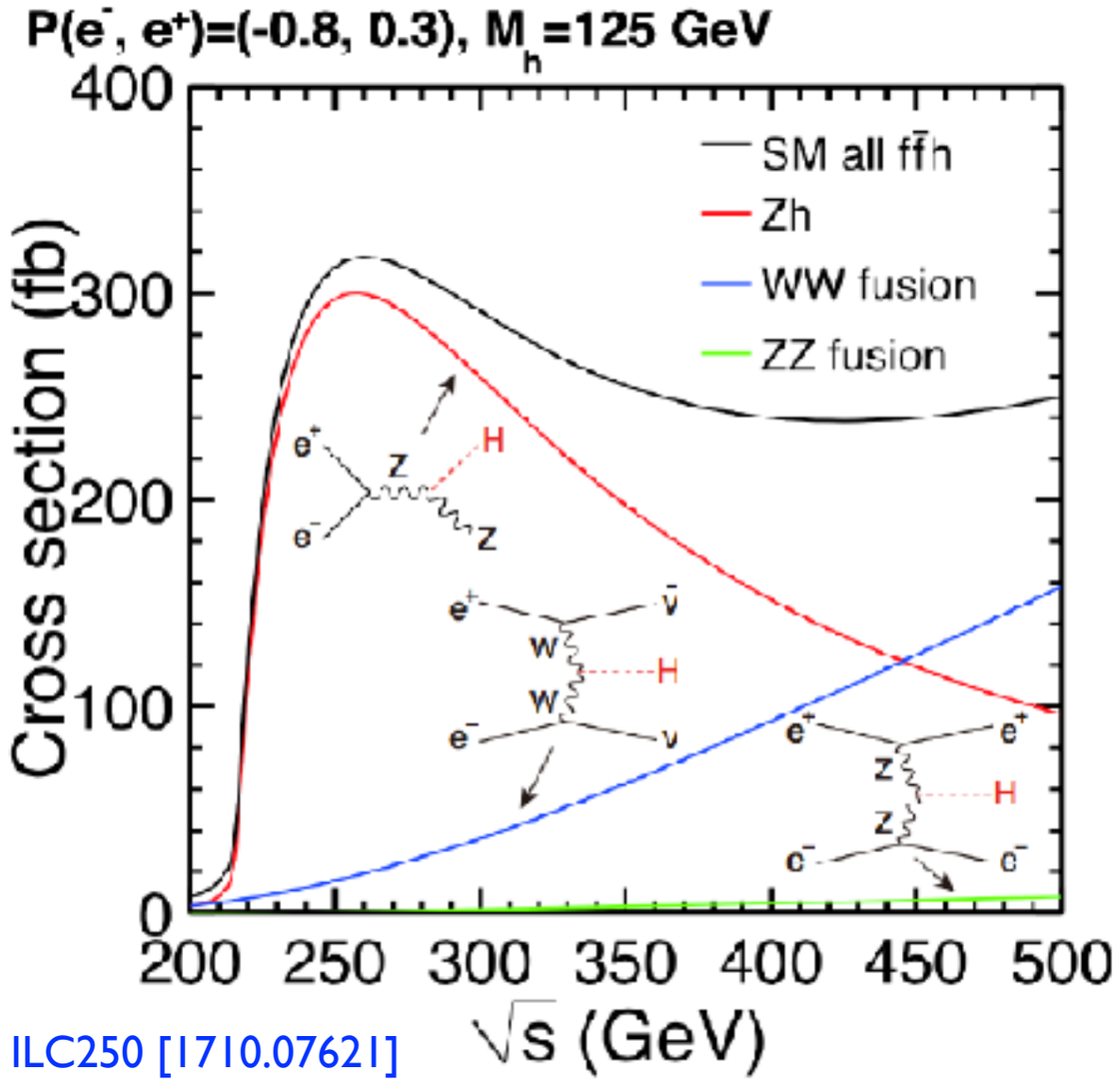


Fig.3 in ILC250 [1710.07621]

Edit myprocess/Cards/run_card.dat,
> launch -n rs200
Edit myprocess/Cards/run_card.dat,
> launch -n rs250
…

Write a MG5 script file.

Solution

EX-4; cross sections (param scan; root-S)

Run MG5aMC with a script file;

```
$ ./bin/mg5_aMC test_eehz.mg5
```

Make a data file;

```
$ cd Proc_eehz
$ ./bin/madevent
Proc_eehz> print_results --format=short --path=xsec.dat
```

test_eehz.mg5

```
generate e+ e- > h z
output Proc_eehz
#
launch -n 230
analysis = OFF
0
set polbeam1 30
set polbeam2 -80
set nevents 1
set ebeam 115
0
#
launch -n 240
0
set ebeam 120
0
#
launch -n 250
0
set ebeam 125
0
#
…
```

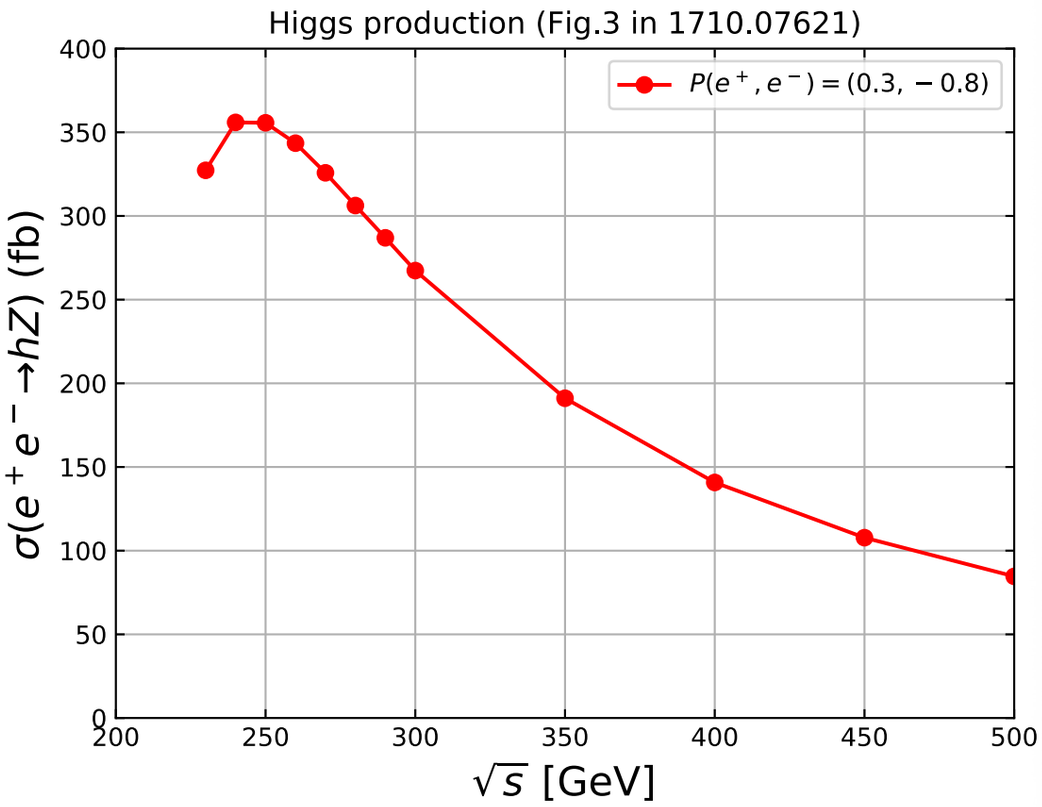
xsec.dat

```
# run_name tag cross error Nb_event cross_after_matching nb_event_after matching
230 tag_1 0.32727 0.00010604 1
240 tag_1 0.3559 0.00013049 1
250 tag_1 0.35566 0.00017036 1
260 tag_1 0.34348 0.00018299 1
270 tag_1 0.32577 0.00020246 1
280 tag_1 0.30622 0.0002151 1
290 tag_1 0.28693 0.00021947 1
300 tag_1 0.26736 0.00024268 1
350 tag_1 0.19108 0.00023025 1
400 tag_1 0.14076 0.0002094 1
450 tag_1 0.10777 0.00018119 1
500 tag_1 0.084641 0.00027909 1
```

Solution

EX-4; cross sections (param scan; root-S)

Make a plot (e.g. by matplotlib);
$ python xsec.py



xsec.py

```
import numpy as np
import matplotlib.pyplot as plt

## import data files
data = np.loadtxt('xsec.dat', skiprows=1, usecols=(0,2))

## define the variables for the x and y axes
roots=data[:,0]
xsec=data[:,1]

## setup a plot
plt.plot(roots,xsec*1000,'-or',label='$P(e^+,e^-)=(0.3,-0.8)$')
xlab=r'$\sqrt{s}$ [GeV]'
ylab=r'$\sigma(e^+e^-\to hZ)$ (fb)'
xlimrange=[200,500]
ylimrange=[0,400]
savepdf='xsec.pdf'

## setup the details
plt.xlim(xlimrange)
plt.ylim(ylimrange)
plt.title("Higgs production (Fig.3 in 1710.07621)")
plt.xlabel(xlab, fontsize=16)
plt.ylabel(ylab, fontsize=16)
plt.legend()
plt.grid()
plt.gca().xaxis.set_tick_params(which='both', direction='in',bottom=True, top=True, left=True, right=True)
plt.gca().yaxis.set_tick_params(which='both', direction='in',bottom=True, top=True, left=True, right=True)

## output
plt.savefig(savepdf, format='pdf', bbox_inches='tight')
plt.show()
```

EX-5; cross sections (param scan; masses)

- Reproduce the black curves.

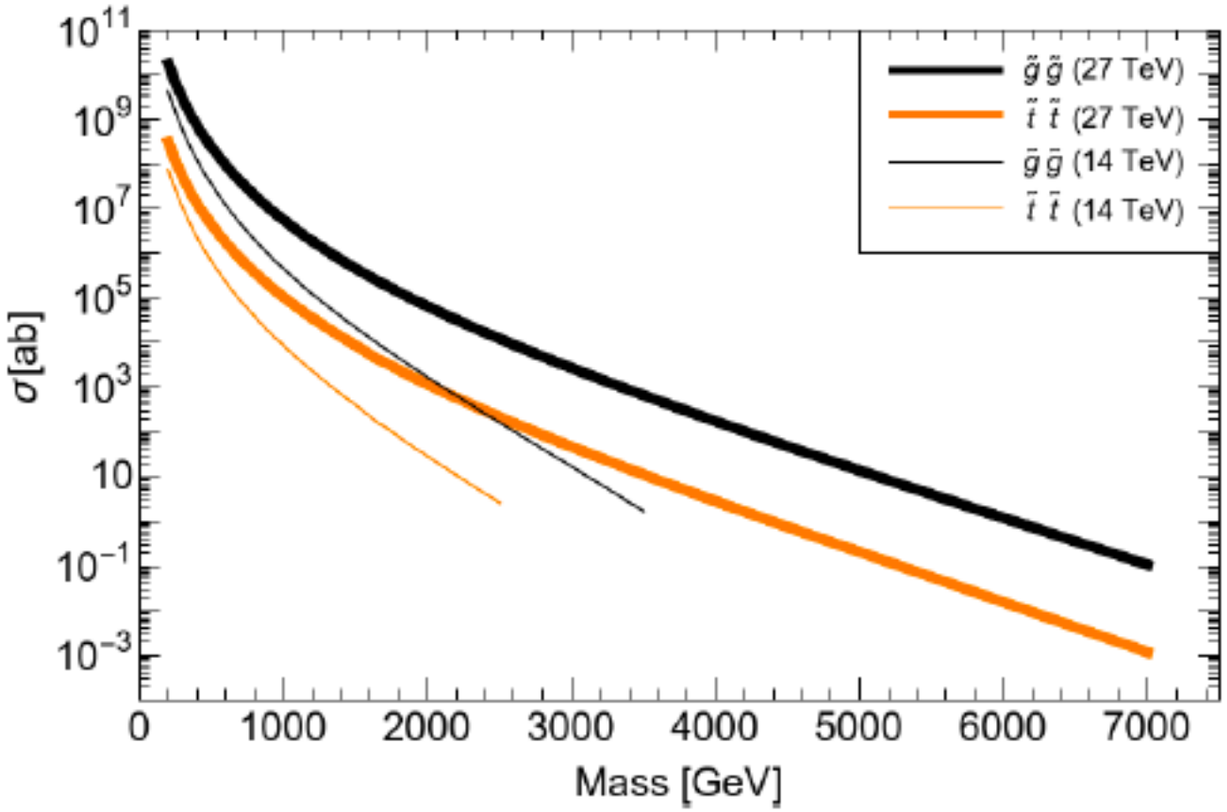


Fig.2.1(left) in HL-LHC/HE-LHC [1812.07831]

Edit myprocess/Cards/param_card.dat,
> launch -n m1000
Edit myprocess/Cards/param_card.dat,
> launch -n m2000
…

Use a scan command in param_card.dat.

Solution

EX-5; cross sections (param scan; masses)

```
$ ./bin/mg5_aMC
> import model MSSM_SLHA2
> generate p p > go go
> output Proc_gluinopair
> launch -n mgo27TeV
> analysis = OFF
> 0
> set nevents 1
> set ebeam 13500
> set mgo scan:[1000*i for i in range (1,8)]
> 0
```

Check the scan results;

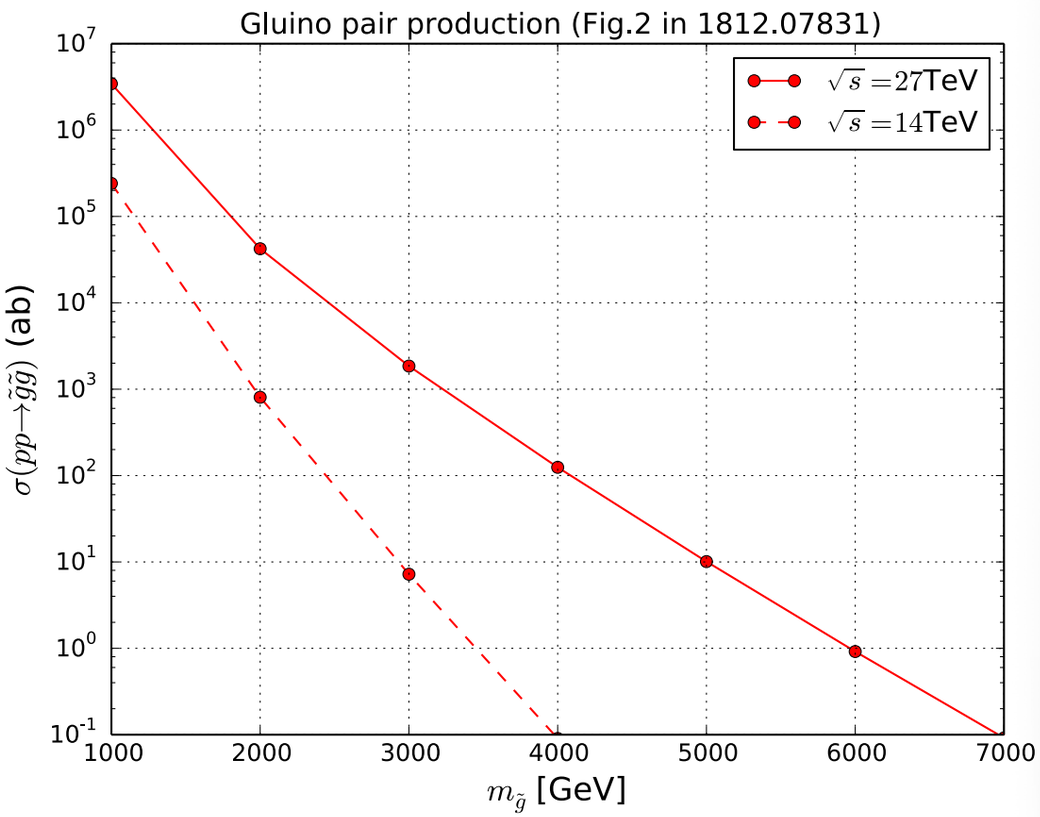
```
$ cd Proc_gluinopair/Events/
$ more scan_mgo27TeV[-_scan_07].txt
```

#run_name	mass#1000021	cross
mgo27TeV	1.000000e+03	3.404119e+00
mgo27TeV_scan_02	2.000000e+03	4.243611e-02
mgo27TeV_scan_03	3.000000e+03	1.852129e-03
mgo27TeV_scan_04	4.000000e+03	1.246744e-04
mgo27TeV_scan_05	5.000000e+03	1.017567e-05
mgo27TeV_scan_06	6.000000e+03	9.133868e-07
mgo27TeV_scan_07	7.000000e+03	9.263558e-08

Solution

EX-5; cross sections (param scan; masses)

Make a plot (e.g. by matplotlib);
$ python xsec.py



xsec_gluinopair.py

```
import numpy as np
import matplotlib.pyplot as plt

## import data files
data1 = np.loadtxt('scan_mgo27TeV[-_scan_07].txt', skiprows=1, usecols=(1,2))
data2 = np.loadtxt('scan_mgo14TeV[-_scan_07].txt', skiprows=1, usecols=(1,2))

## define the variables for the x and y axes
mgo=data1[:,0]
xsec1=data1[:,1]
xsec2=data2[:,1]

## setup a plot
plt.plot(mgo,xsec1*10**6,'-or',label='$\sqrt{s}=27$TeV')
plt.plot(mgo,xsec2*10**6,'--or',label='$\sqrt{s}=14$TeV')

xlab=r'$m_{\tilde g}$ [GeV]'
ylab=r'$\sigma(pp\to \tilde g\tilde g)$ (ab)'
xlimrange=[1000,7000]
ylimrange=[10**-1,10**7]
savepdf='xsec_gluinopair.pdf'

## setup the details
plt.yscale('log')
plt.xlim(xlimrange)
plt.ylim(ylimrange)
plt.title("Gluino pair production (Fig.2 in 1812.07831)")
plt.xlabel(xlab, fontsize=16)
plt.ylabel(ylab, fontsize=16)
plt.legend()
plt.grid()
plt.gca().xaxis.set_tick_params(which='both', direction='in',bottom=True, top=True, left=True, right=True)
plt.gca().yaxis.set_tick_params(which='both', direction='in',bottom=True, top=True, left=True, right=True)

## output
plt.savefig(savepdf, format='pdf', bbox_inches='tight')
plt.show()
```

EX-6; process generation (syntax)

- What is the difference?

1. > generate p p > e+ e-
2. > generate p p > z > e+ e-
3. > generate p p > z, z > e+ e-
4. > generate p p > e+ e- $ z
5. > generate p p > e+ e- $$ z
6. > generate p p > e+ e- / z

Edit myprocess/Cards/madanalysis5_parton_card.dat to refine bins of plots.

Run MA5 later;
$ cd myprocess/
$ ./bin/madevent
myprocess> madanalysis5_parton

- Compare the distributions of the lepton-pair invariant mass.

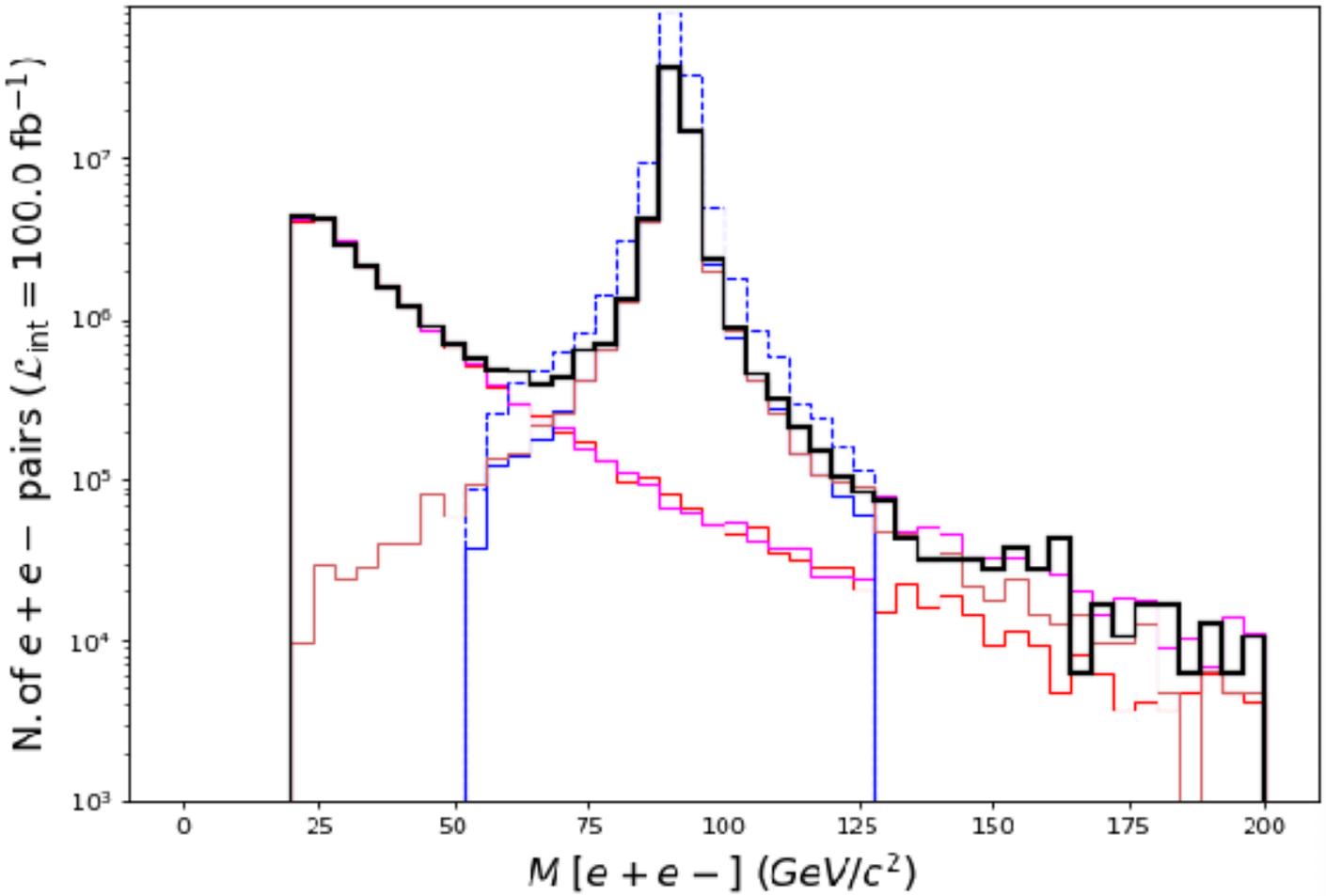
Run MA5 standalone;
$ MG5_aMC_vX_Y_Z/HEPTools/madanalysis5/madanalysis5/bin/ma5

Solution

EX-6; process generation (syntax)

Run MA5 standalone;

$ …HEPTools/madanalysis5/madanalysis5/bin/ma5 test.ma5



Check cut_decays in run_card.dat.

test.ma5

```
import ProcDY1/Events/run_02/unweighted_events.lhe.gz as DY1
import ProcDY2/Events/run_02/unweighted_events.lhe.gz as DY2
import ProcDY3/Events/run_02/unweighted_events.lhe.gz as DY3
import ProcDY3/Events/run_03/unweighted_events.lhe.gz as DY3_cutdecayT
import ProcDY4/Events/run_02/unweighted_events.lhe.gz as DY4
import ProcDY5/Events/run_02/unweighted_events.lhe.gz as DY5
#import ProcDY6/Events/run_02/unweighted_events.lhe.gz as DY6
#
set main.stacking_method = superimpose
set main.lumi = 100
set DY1.linecolor = black
set DY1.linewidth = 2
set DY3.linecolor = blue
set DY3.linestyle = dashed
set DY3_cutdecayT.linecolor = blue
#
plot M(e+ e-) 50 0 200 [logY]
set selection[1].ymin = 1000
submit MA5plot
```