

# MadGraph/MadEvent v4

Hands-on session, Capita Selecta Antwerp 2008

## Exercise 1.a

- Draw all Feynman diagrams associated with the process  $e^+ e^- \rightarrow e^+ e^- b \bar{b}$  below :

- Browse to <http://madgraph.phys.ucl.ac.be>
- Register (preferably with a spam filter free mail address, like gmail) or use the username “Angels” and guess the password (6 letters)
- Use MadGraph to check your answer (hint: this process is written `e+e->e+e-bb~`, QCD=0, QED=4)

## Exercise 1.b

- Generate events for the previous process using the web interface for a e+e- collider running at 500 GeV and for default parameters / cuts. (hint: click on “On-line Event Generation” on the main page, in the “Colliders and cuts” section, select the “Use the form below” option and switch the collider to “e+e- @ 500 GeV”. Then click twice on “Send” and wait.)
- Look at the results page, how can you interpret them ? In particular, what is the number associated with each diagram ?
- Give a look at the plot page. Download the LHE event file & open it with a text editor. What do you see ?

## Exercise 2

- Create the following process online :  $pp \rightarrow Z, h^0 \rightarrow l^+ l^- b \bar{b}$  with  $l^\pm = e^\pm, \mu^\pm$   
(hint: this is written `pp>Z h>l+l-bb~`, `QED=4`, `QCD=0`, with the right assignment for `p` and `l+/l-`)
- Download the code (by clicking on “Code Download” on the process main page), expand it take (hint: `tar xzvf madevent.tar.gz`) a look at the files, especially :
  - `particles.dat`, `interactions.dat`, `couplings.f` in `./Source/MODEL`
  - `proc_card.dat`, `param_card.dat`, `run_card.dat` in `./Cards`
  - `cuts.f`, `matrix.f` in `./SubProcesses/P_*_*`

Describe what you see in one sentence for each file:

- Generate 20k events for a Higgs mass of 140 GeV, using the command line (hint: modify the `param_card.dat` and the `run_card.dat`, then run `./bin/generate_events`)
- What is the integrated luminosity needed to see 10 such events at Tevatron ? (hint: remember that the number of events equal the cross section times times the integrated luminosity)

## Exercise 3

- Download the full MG/ME v4 package from the download page and untar it
- Use the USRMOD template to create a spin-1 “Higgs” model (hint: read the README file in Models/usrmod and take the SM Higgs as an example)
- Generate 20k events with this new model (hint: copy the MadEvent template to create a new directory, modify the proc\_card.dat, run ./bin/newprocess, modify the param\_card.dat and the run\_card.dat, run ./bin/generate\_events)
- Use MadAnalysis (with the online plotting interface) to create plots to discriminate between this model and the usual SM (hint: upload the generated unweighed events file, run with the default card (take a look at it), and look at the plots especially the angular distributions. Re-do the same for the usual spin-0 Higgs events generated in Exercise 2). Write down all your observations.

## Exercise 4

- Generate the Higgs signal in Exercise 2 online, up to the detector simulation with PGS.  
(hint: upload the `proc_card.dat` to create the process, switch to default non empty cards in the Pythia and PGS sections of the “Generate events” page)
- Browse to the MG wiki page :  
<http://cp3wks05.fynu.ucl.ac.be/twiki/bin/view/Main/CapitaSelectaAntwerp08> and follow instructions in handout notes to understand how the inclusive Z+jets sample has been generated. Write down all your questions if needed.
- Homework: Investigate signal and background PGS files with MadAnalysis to understand why b-tagging is essential (hint: read the MadAnalysis manual to create distributions for both files on the same plot without distinguishing b jets and non-b jets)