MadGraph5_aMC@NLO tutorials@UniMi

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NLO exercise
$t\bar{t}$ production at NLO

Part 2

- Generate an event sample at NLO and LO to be showered by Pythia8 (needs to be specified in the `run_card`)
- Shower and analyse it with the `py8an_HwU_pp_ttx.o` analysis (to be specified in the `shower_card`)
- The histogramming routine (`HwU.o`) must also be added to the analysis files in the `shower_card`

```
EXTRALIBS    =      # Extra-libraries (not LHAPDF)
                    # Default: "stdhep Fmcfio"
                    # PYTHIA > 8.200 may require library dl
EXTRAPATHS   = ../lib            # Path to the extra-libraries
                    # Default: "../lib"
INCLUDEPATHS =                   # Path to header files needed by c++
                    # Dir names separated by white spaces
ANALYSE      = HwU.o py8an_HwU_pp_ttx.o # User's analysis and histogramming
                    # routines (please use .o as extension
                    # and use spaces to separate files).
                    # If the HwU.o files has to be linked,
                    # it should be put *first*.
```

- (Hint: you can shower an existing run with `./bin/shower run_xx`)

NLO exercise
Solution

Part 2

- Generate a NLO event sample to be showered by Pythia6Q
  - Shower it with the `mcatnlo_pyan_pp_ttx` analysis (to be specified in the `shower_card`)
    - `cd my_ttbar_nlo`
    - `./bin/aMCatNLO`
    - `> launch`
    - `> fixed_order=OFF`
    - `> shower=ON`
  - Edit `run_card`
  - Edit `shower_card`

NLO exercise
Solution

Part 2

- Generate a NLO ever
  - Shower it with the r specified in the `shower_card`)
    - `cd my_ttbar_n`
    - `./bin/aMCatNL`
    - `> launch`
    - `> fixed_order`
    - `> shower=ON`
  - Edit `run_card`
  - Edit `shower_car`

```
# PDF choice: this automatically fixes also alpha_s(MZ) and its evol.
*
#*********************************************************************
*
 nn23nlo    = pdlabel    ! PDF set
 244600     = lhaid      ! if pdlabel=lhapdf, this is the lhapdf number
#*********************************************************************
*
# Include the NLO Monte Carlo subtr. terms for the following parton
*
# shower (HERWIG6 | HERWIGPP | PYTHIA6Q | PYTHIA6PT | PYTHIA8)
*
# WARNING: PYTHIA6PT works only for processes without FSR!!!!
*
#*********************************************************************
*
  PYTHIA8    = parton_shower
#*********************************************************************
*
# Renormalization and factorization scales
*
# (Default functional form for the non-fixed scales is the sum of
*
# the transverse masses of all final state particles and partons. This
*
# can be changed in SubProcesses/set_scales.f)
*
#*********************************************************************
*
 F         = fixed_ren_scale  ! if .true. use fixed ren scale
 F         = fixed_fac_scale  ! if .true. use fixed fac scale
 91.188    = muR_ref_fixed    ! fixed ren reference scale
 91.188    = muF1_ref_fixed   ! fixed fact reference scale for pdf1
 91.188    = muF2_ref_fixed   ! fixed fact reference scale for pdf2
#*********************************************************************
*
# Renormalization and factorization scales (advanced and NLO options)
*
#*********************************************************************
*
```

NLO exercise
Solution

Part 2

- Generate a NLO ever
  - Shower it with the r specified in the `shower_card`)
    - `cd my_ttbar_n`
    - `./bin/aMCatNL`
    - `> launch`
    - `> fixed_order`
    - `> shower=ON`
  - Edit `run_card`
  - Edit `shower_car`

```
# PDF choice: this automatically fixes also alpha_s(MZ) and its evol.
*
#*********************************************************************
*
 nn23nlo    = pdlabel    ! PDF set
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#*********************************************************************
*
# Include the NLO Monte Carlo subtr. terms for the following parton
*
# shower (HERWIG6 | HERWIGPP | PYTHIA6Q | PYTHIA6PT | PYTHIA8)
*
# WARNING: PYTHIA6PT works only for processes without FSR!!!!
*
#*********************************************************************
*
  PYTHIA8    = parton_shower
#*********************************************************************
*
# Renormalization and factorization scales
*
# (
*
# t
*
# C
*
#**
*
 F
 F
 91
 91
 91
#**
*
# R
*
#**********************************************************************
*
```

```
#*********************************************************************
# Extra Libraries/analyses                                           *
# The following lines need to be changed if the user does not want to  *
# create a StdHEP/HepMC file, but to directly run an own analysis (to  *
# be placed in HWAnalyzer or analogous MCatNLO subfolders).            *
# Please use files in those folders as examples.                       *
#*********************************************************************
EXTRALIBS    =      # Extra-libraries (not LHAPDF)
                                  # Default: "stdhep Fmcfio"
                                  # PYTHIA > 8.200 may require library dl
EXTRAPATHS   = ../lib             # Path to the extra-libraries
                                  # Default: "../lib"
INCLUDEPATHS =                    # Path to header files needed by c++
                                  # Dir names separated by white spaces
ANALYSE      = py8an_HwU_pp_ttx.o HwU.o
                                  # routines (please use .o as extension
                                  # and use spaces to separate files)
```

NLO exercise
Solution

Part 2

- Generate a NLO eve
  - Shower it with the in the shower_card
    - `cd my_ttbar_`
    - `./bin/aMCatN`
    - `> launch`
    - `> fixed_orde`
    - `> shower=ON`
  - Edit `run_card`
  - Edit `shower_ca`

```
# PDF choice: this automatically fixes also alpha_s(MZ) and its evol.
```

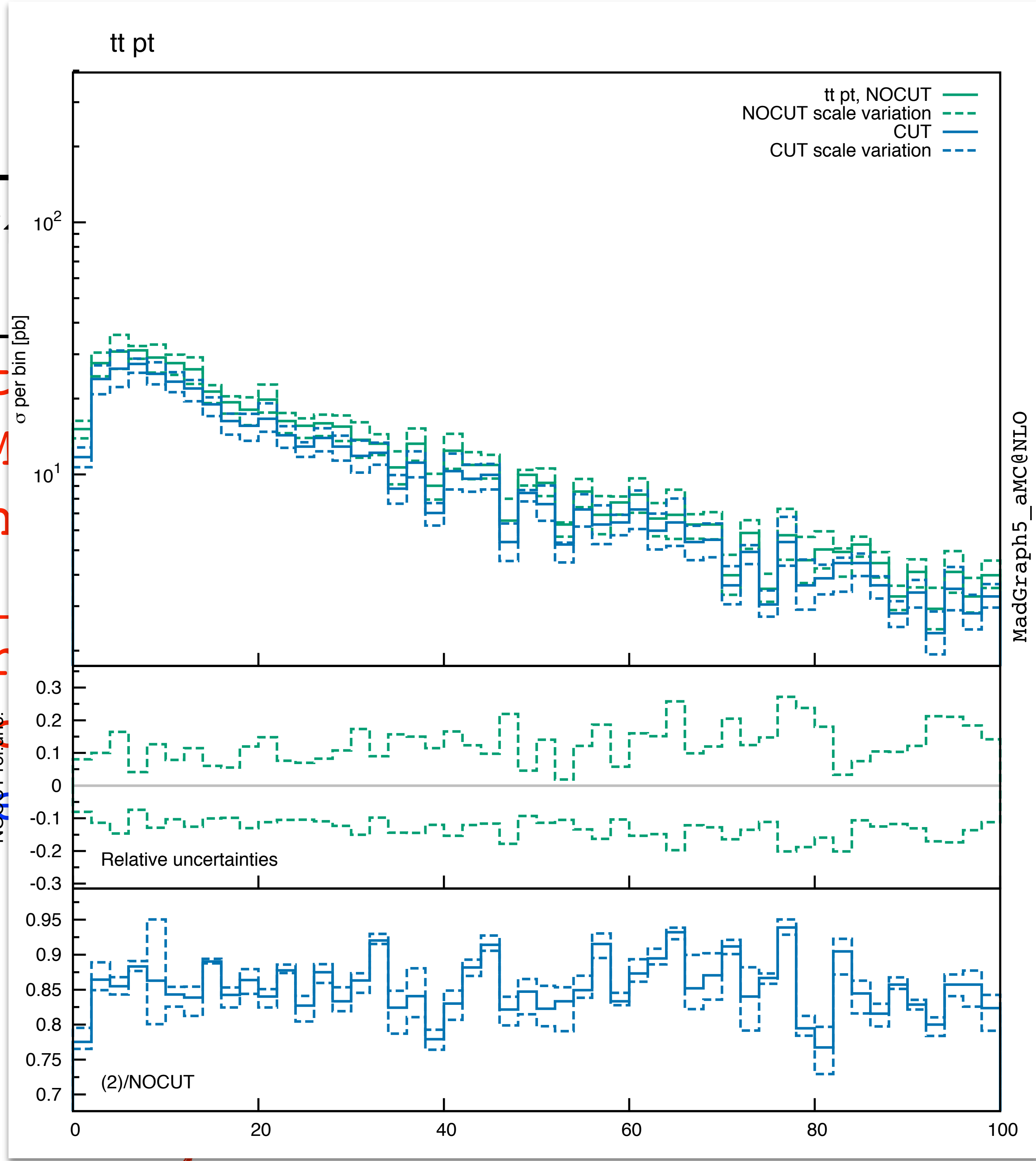
```
      Summary:
      Process p p > t t~ [QCD]
      Run at p-p collider (6500 + 6500 GeV)
      Total cross-section: 6.772e+02 +- 2.1e+00 pb
      Ren. and fac. scale uncertainty: +11.5% -13.0%
      Number of events generated: 100000
      Parton shower to be used: PYTHIA6Q
      Fraction of negative weights: 0.20
      Total running time :  6m 58s

INFO: The /Users/marcozaro/Physics/MadGraph/2.2.3new/my_tt_nlo_qcd/Events/
run_12/events.lhe.gz file has been generated.
. . .
INFO: Preparing MCatNLO run
INFO: Compiling MCatNLO for PYTHIA6Q...
INFO:                          ... done
INFO: Showering events...
INFO: (Running in /Users/marcozaro/Physics/MadGraph/2.2.3new/my_tt_nlo_qcd/
MCatNLO/RUN_PYTHIA6Q_3)
INFO:  Idle: 0,  Running: 1,  Completed: 0 [ current time: 12h32 ]
INFO:  Idle: 0,  Running: 0,  Completed: 1 [  2m 35s  ]
INFO:  Idle: 0,  Running: 0,  Completed: 0 [ current time: 12h34 ]
INFO: The file /Users/marcozaro/Physics/MadGraph/2.3.1/ttbar/Events/run_01/
plot_PYTHIA6Q_1_0.HwU has been generated, with histograms in the HwU and
GnuPlot formats, obtained by showering the parton-level file /Users/
marcozaro/Physics/MadGraph/2.3.1/ttbar/Events/run_01/events.lhe.gz with
PYTHIA6Q.
INFO: Run complete
```

```
# R                                  # routines (please use .o as extension
*                                    # and use spaces to separate files)
#*********************************************************************
*
```

NLO exercise Solution

Part 2

- Generate a NL
  - Shower it wi
    the shower_
    - cd my_tt
    - ./bin/aM
    - > launch
    - > fixed_
    - > shower
  - Edit run_
  - Edit show



ts evol.

in

y_tt_nlo_qcd/Events/

2.3new/my_tt_nlo_qcd/

ime: 12h32]
]
ime: 12h34]
/ttbar/Events/run_01/
ams in the HwU and
l file /Users/
vents.lhe.gz with

rate files)

The events

```
<initrwgt>
  <weightgroup type='scale_variation' combine='envelope'>
    <weight id='1001'> muR=0.10000E+01 muF=0.10000E+01 </weight>
    <weight id='1002'> muR=0.10000E+01 muF=0.20000E+01 </weight>
    <weight id='1003'> muR=0.10000E+01 muF=0.50000E+00 </weight>
    <weight id='1004'> muR=0.20000E+01 muF=0.10000E+01 </weight>
    <weight id='1005'> muR=0.20000E+01 muF=0.20000E+01 </weight>
    <weight id='1006'> muR=0.20000E+01 muF=0.50000E+00 </weight>
    <weight id='1007'> muR=0.50000E+00 muF=0.10000E+01 </weight>
    <weight id='1008'> muR=0.50000E+00 muF=0.20000E+01 </weight>
    <weight id='1009'> muR=0.50000E+00 muF=0.50000E+00 </weight>
  </weightgroup>
</initrwgt>
</header>
```

- Each event keeps information about scale variations
- To obtain scale uncertainties use the extra weights to fill histograms and take the envelope

```
  <init>
   2212   2212 0.65000000E+04 0.65000000E+04 -1 -1 244600 244600 -4   1
 0.68147533E+03 0.22760274E+01 0.11811897E+04      0
  </init>
  <event>
  4      0 -.11811897E+04 0.68991465E+03 0.75467716E-02 0.11800000E+00
       21 -1    0    0  501  502 0.00000000E+00 0.00000000E+00 0.16695776E+03 0.16695776E+03 0.00000000E+00 0.0000E+00
0.9000E+01
       21 -1    0    0  502  503 -.00000000E+00 -.00000000E+00 -.83539498E+03 0.83539498E+03 0.00000000E+00 0.0000E+00
0.9000E+01
        6  1    1    2  501    0 -.87405313E+02 -.30435858E+03 -.46344397E+03 0.58735266E+03 0.17300000E+03 0.0000E+00
0.9000E+01
       -6  1    1    2    0  503 0.87405313E+02 0.30435858E+03 -.20499324E+03 0.41500008E+03 0.17300000E+03 0.0000E+00
0.9000E+01
#aMCatNLO 1  5  3  3  2 0.21343976E+03 0.35860250E+02 9  0  0 0.10000001E+01 0.15353083E+01 0.66887201E+00 0.00E+00 0.0E+00
  <rwgt>
   <wgt id='1001'> -.11812E+04 </wgt>
   <wgt id='1002'> -.10571E+04 </wgt>
   <wgt id='1003'> -.13263E+04 </wgt>
   <wgt id='1004'> -.88285E+03 </wgt>
   <wgt id='1005'> -.79006E+03 </wgt>
   . . .
```