

Madgraph School 2019

18-22 Nov. | IMSc | Chennai

TUTORIAL ON MADGRAPH5_AMC@NLO:

NLO SIMULATIONS

HUA-SHENG SHAO



18-22 NOVEMBER 2019

NLO SIMULATIONS



- The NLO run mode is turned on with ‘[QCD]’ in generation syntax.

➔ `> generate p p > e+ e- [QCD]`

- While the LO mode will always compute the cross section and generate events, this is not always the case for NLO runs
- The NLO code can be run in two different ways:
 - ➔ **Fixed-order (fNLO)**: no events will be generated. Compute cross sections (within cuts) and generate histograms on the fly.
 - ➔ **NLO+PS**: generate the unweighted event sample (up to a sign difference) and matched to parton shower via MC@NLO matching.

EXERCISES: TOP QUARK PAIR



- Learn the syntax by typing “**tutorial aMCatNLO**”
- Generate the top quark pair production at NLO.

```
./bin/mg5_aMC  
> generate p p > t t~ [QCD]  
> output MyNLOExample  
> launch
```

- Check the **run_card.dat**. Note that it is different with that in LO mode.
- Compute both the LO and NLO cross sections at **f(N)LO** level.
- Choose the existing analysis file **analysis_HwU_pp_ttx.o** and specify it in **FO_analyse_card.dat**.
- Understand the histograms you get.

EXERCISES SOLUTION: FNLO



- Turn on f(N)LO (shower turned off automatically)

```
The following switches determine which programs are run:
/----- Description -----|----- values -----|----- other options -----\
| 1. Type of perturbative computation | order = NLO | LO | | | | |
| 2. No MC@[N]LO matching / event generation | fixed_order = ON | OFF |
| 3. Shower the generated events | shower = OFF | ← -HERWIG6- | OFF|PYTHIA6Q|PYTHIA6PT|PYTHIA8 |
| 4. Decay onshell particles | madspin = OFF | ON|onshell |
| 5. Add weights to events for new hypp. | reweight = OFF | ON|NLO|NLO_TREE|LO |
| 6. Run MadAnalysis5 on the events generated | madanalysis = OFF | ON |
\-----/

Either type the switch number (1 to 6) to change its setting,
Set any switch explicitly (e.g. type 'fixed_order=OFF' at the prompt)
Type 'help' for the list of all valid option
Type '0', 'auto', 'done' or just press enter when you are done.
```

Switch on `fixed_order`

- Edit `run_card.dat`

```
*****
# Number of points per itegration channel (ignored for aMC@NLO runs) *
*****
0.005 = req_acc_F0 ! Required accuracy (-1=ignored, and use the
! number of points and iter. below)
# These numbers are ignored except if req_acc_F0 is equal to -1
5000 = npoints_F0_grid ! number of points to setup grids
4 = niters_F0_grid ! number of iter. to setup grids
10000 = npoints_F0 ! number of points to compute Xsec
6 = niters_F0 ! number of iter. to compute Xsec
```

Decide the targeted accuracy for fixed-order calculations

EXERCISES SOLUTION: FNLO



- Edit FO_analyse_card.dat

```
#####
#
# This file contains the settings for analyses to be linked to fixed
# order runs. Analysis files are meant to be put (or linked) inside
# <PROCDIR>/FixedOrderAnalysis/ (<PROCDIR> is the name of the exported
# process directory). See the
# <PROCDIR>/FixedOrderAnalysis/analysis*_template.f file for details
# on how to write your own analysis.
#
#####
# ed: 1 [ 0.076s ]
# Analysis format.
# Can either be 'topdrawer', 'root', 'HWU', 'LHE' or 'none'.
# When choosing HWU, it comes with a GnuPlot wrapper. When choosing
# topdrawer, the histogramming package 'dbook.f' is included in the
# code, while when choosing root the 'rbook_fe8.f' and 'rbook_be8.cc'
# are included. If 'none' is chosen, all the other entries below have
# to be set empty.
FO_ANALYSIS_FORMAT = HWU [ 0.13 ]
# ed: 1 [ 2.1s ]
# ed: 2 [ 2.2s ]
# Needed extra-libraries (FastJet is already linked):
FO_EXTRALIBS =
# ed: 5 [ 5.3s ]
# (Absolute) path to the extra libraries. Directory names should be
# separated by white spaces.
FO_EXTRAPATHS =
#
# (Absolute) path to the dirs containing header files needed by the
# libraries (e.g. C++ header files):
FO_INCLUDEPATHS =
#
# User's analysis (to be put in the <PROCDIR>/FixedOrderAnalysis/
# directory). Please use . to list extension and white spaces to separate
# files.
FO_ANALYSE = analysis_HwU_pp_ttx.o
#
# HWU and GnuPlot plots with the plots have been saved in /Users/huasheng/Physics/MG5/MG5_aMC_v2_6_4/pp2ttQCD/
```

EXERCISES SOLUTION: FNLO



- Total cross section

```
-----  
Final results and run summary: 35  
Process p p > t t~ [QCD] # (Absolute  
Run at p-p collider (6500.0 + 6500.0 GeV)  
Total cross section: 6.801e+02 +- 2.4e+00 pb  
-----  
Scale variation (computed from histogram information):  
Dynamical_scale_choice = 1 (envelope of 5 values):  
6.801e+02 pb +10.4% -12.1%  
-----  
INFO: The results of this run and the MW and GnuPlot files with the plots have been saved in /Users/huasheng/Physics/MGS/MGS_aMC_v2_6_4/pp2ttxQCD/Events/run_01  
INFO: Run complete  
INFO:  
quit  
INFO:
```

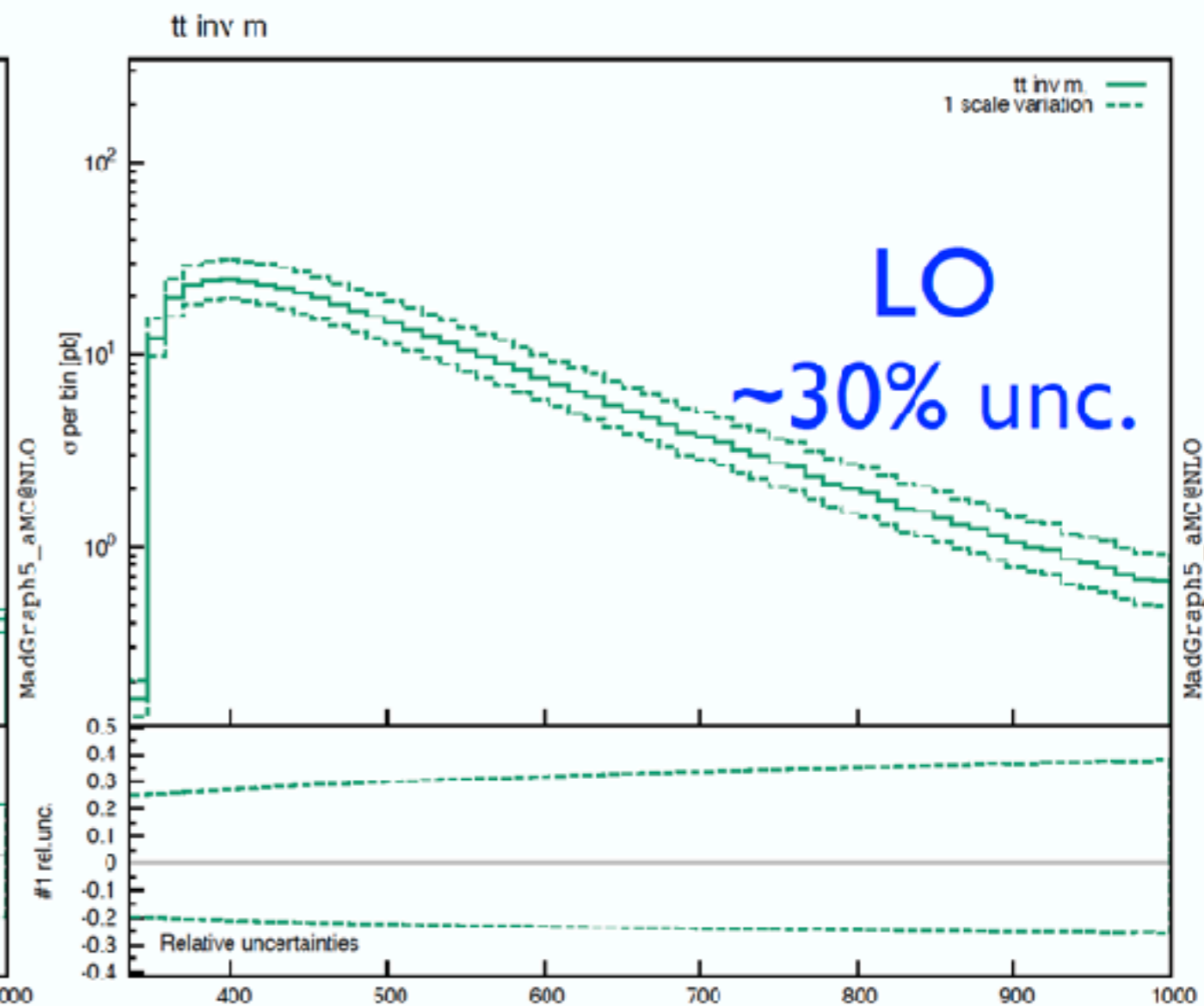
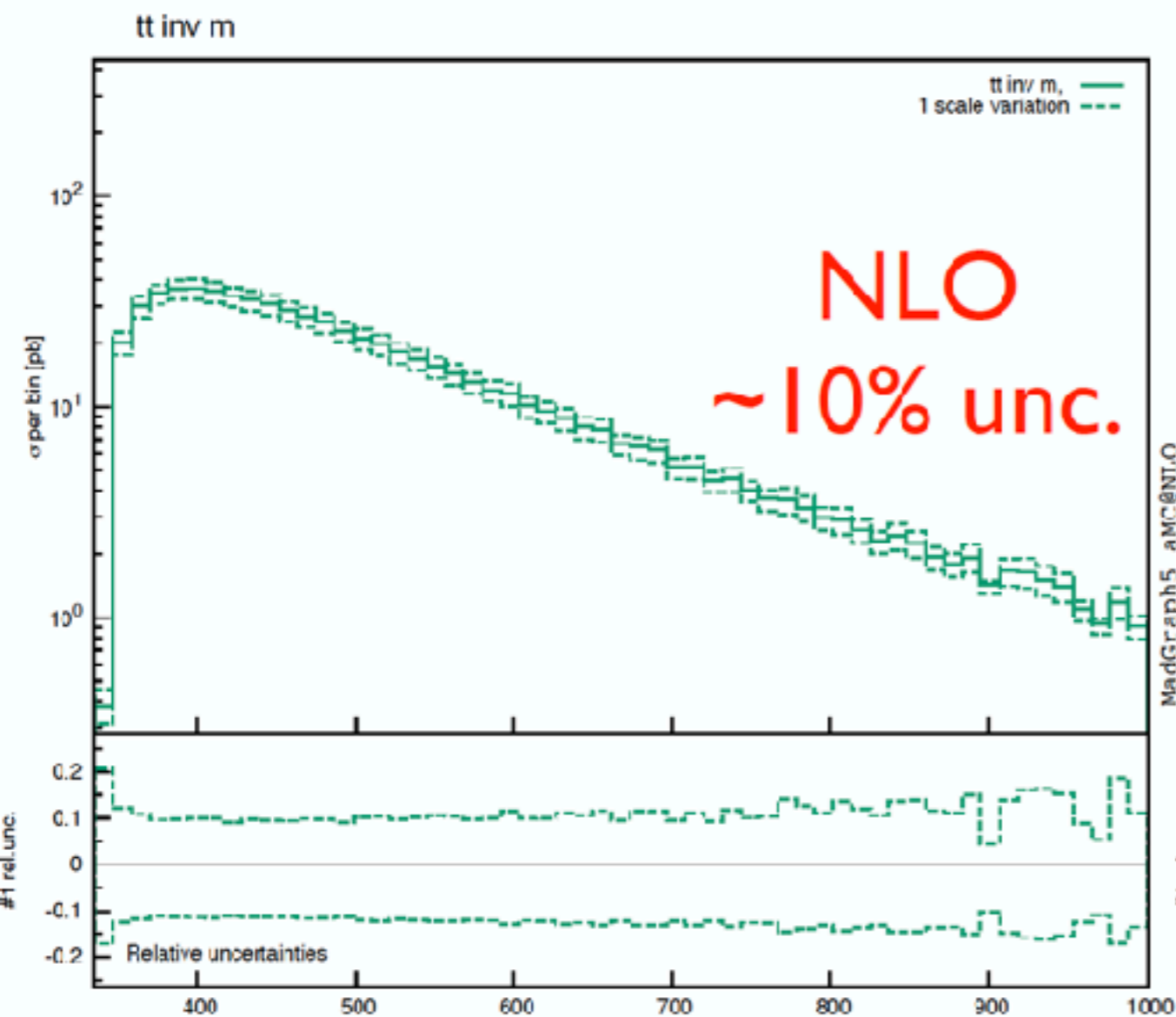
Central value Numerical integration error

Renormalisation/factorisation scale uncertainty

EXERCISES SOLUTION: FNLO



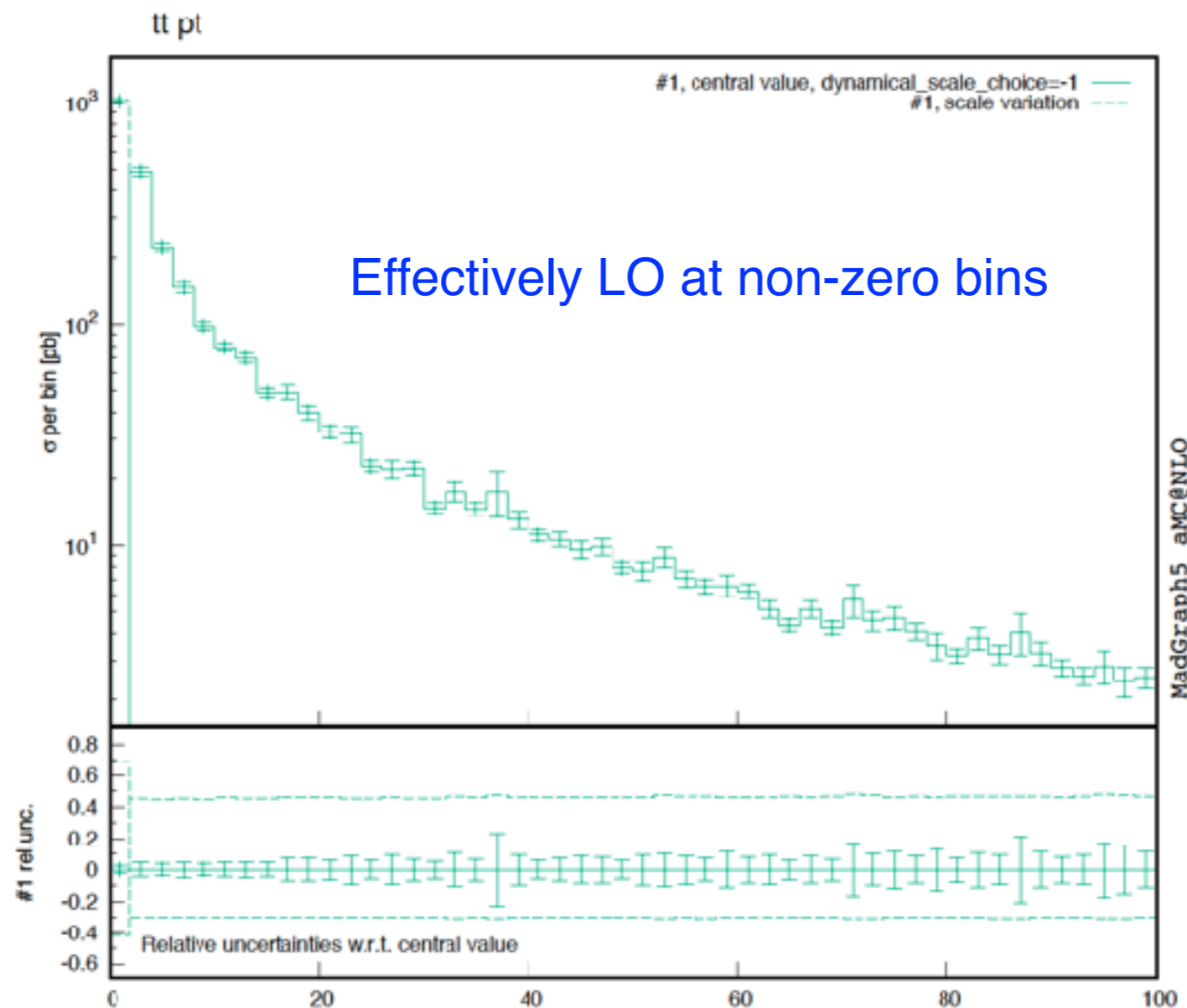
- **Differential distributions**
 - Check the `MyNLOExample/FixedOrderAnalysis/analysis_HwU_pp_ttx.f`



EXERCISES SOLUTION: FNLO



- **Differential distributions**
 - Check the `MyNLOExample/FixedOrderAnalysis/analysis_HwU_pp_ttx.f`



EXERCISES SOLUTION: FNLO



- The raw data of histograms

```

Mac-Sriengs MacBook-Pro:run_01 huasheng$ ls
MADatNLO.HwU      MADatNLO.pdf      RunMaterial.tar.gz  alllogs_1.html     res_1.txt          summary.txt
MADatNLO.gnuplot  MADatNLO.ps       alllogs_0.html     res_0.txt          run_01_tag_1_banner.txt
    
```

- Histogram With Uncertainty (HwU)

```

%# xmin & xmax & central value & dy & delta_mu_min -1 &aux & delta_mu_max -1 &aux & delta_mu_max -1 &aux & dyn--1 muF= 1.000 muF= 1.000 & dyn--1 muF= 2.000 muF= 1.000 & dyn--1 muF= 0.500 muF= 1.000 & dyn--1 muF= 1.000 muF= 2.000 & dyn--1 muF= 2.000 muF= 2.000 & dyn--1 muF= 1.000 muF= 0.500 & dyn--1 muF= 2.000 muF= 0.500 & dyn--1 muF= 0.500
histogram 50 "t0 pt IX AXIS=LIN IY AXIS=LOG ITYPE=H1"
+0.000000e+00 +2.000000e+00 -1.0155390e+03 +2.6226552e+01 -1.0155390e+03 -1.7168466e+03 -5.9137905e+02 -1.8155390e+03 -6.7786776e+02 -1.5173314e+03 -8.9844943e+02 -5.9137905e+02 -1.3613321e+03 -1.1469895e+03 -7.6747221e+02 -1.7168466e+03
+2.000000e+00 +4.000000e+00 +4.9134584e+02 +2.1129115e+01 +4.9134584e+02 +3.4511359e+02 +7.1316576e+02 +4.9134884e+02 +3.7782735e+02 +6.5781623e+02 +4.4088549e+02 +3.4511359e+02 +6.0225848e+02 +5.3273663e+02 +4.0883641e+02 +7.1316576e+02
+4.000000e+00 +6.000000e+00 +7.2377783e+02 +8.4496362e+00 +7.2377783e+02 +1.5740885e+02 +3.7424508e+02 +7.2377783e+02 +1.7158586e+02 +2.9954277e+02 +2.9538179e+02 +1.5740885e+02 +7.7511312e+02 +2.4292784e+02 +1.3560633e+02 +3.7424508e+02
+6.000000e+00 +8.000000e+00 +1.4588932e+02 +6.9744254e+00 +1.4588932e+02 +1.0245833e+02 +2.1174995e+02 +1.4588932e+02 +1.1190045e+02 +1.9549313e+02 +1.3358578e+02 +1.0245833e+02 +1.7894331e+02 +1.5811530e+02 +1.2129172e+02 +2.1174995e+02
+8.000000e+00 +1.000000e+01 +9.7933353e+01 +3.5997767e+00 +9.7933353e+01 +6.8989114e+01 +1.4184952e+02 +9.7933353e+01 +7.5189890e+01 +1.3118633e+02 +8.9855226e+01 +6.8989114e+01 +1.2937626e+02 +1.0598859e+02 +8.1236024e+01 +1.4184952e+02
+1.000000e+01 +2.000000e+01 +7.8737813e+01 +3.6718142e+00 +7.8737813e+01 +5.5049313e+01 +1.1491594e+02 +7.8737813e+01 +6.0484393e+01 +1.0543888e+02 +7.1763322e+01 +5.5049313e+01 +9.6188837e+01 +8.5828630e+01 +6.5852479e+01 +1.1491594e+02
+1.200000e+01 +1.000000e+01 +6.9731580e+01 +3.3533989e+00 +6.9731580e+01 +4.8929294e+01 +1.0244910e+02 +6.9731580e+01 +5.3536693e+01 +9.3348987e+01 +6.3790997e+01 +4.8929294e+01 +8.3523219e+01 +7.5811657e+01 +5.8194958e+01 +1.0244910e+02
+1.400000e+01 +1.600000e+01 +4.886458e+01 +2.1333146e+00 +4.886458e+01 +3.4767914e+01 +7.118831e+01 +4.886458e+01 +3.7521591e+01 +6.5454686e+01 +4.658416e+01 +3.4767914e+01 +5.9785753e+01 +5.3135370e+01 +4.0816647e+01 +7.118831e+01
+1.600000e+01 +1.800000e+01 +4.9152760e+01 +3.5579285e+00 +4.9152760e+01 +3.4426534e+01 +7.1718454e+01 +4.9152760e+01 +3.7737666e+01 +6.5755869e+01 +4.842536e+01 +3.4426534e+01 +5.9995040e+01 +5.3615817e+01 +4.1168332e+01 +7.1718454e+01
+1.800000e+01 +2.000000e+01 +3.9882079e+01 +2.8572813e+00 +3.9882079e+01 +2.7944575e+01 +5.8007431e+01 +3.9882079e+01 +3.0639577e+01 +5.3313951e+01 +3.6376572e+01 +2.7944575e+01 +4.8631749e+01 +4.3466176e+01 +3.3996754e+01 +5.8007431e+01
+2.000000e+01 +2.200000e+01 +3.2609545e+01 +2.0508070e+00 +3.2609545e+01 +2.2875922e+01 +4.7627150e+01 +3.2609545e+01 +2.5081125e+01 +4.3788482e+01 +2.9799113e+01 +2.2875922e+01 +3.9871037e+01 +3.5082061e+01 +2.7335435e+01 +4.7627150e+01
+2.200000e+01 +2.400000e+01 +3.1732070e+01 +2.8757274e+00 +3.1732070e+01 +2.2253939e+01 +4.6211179e+01 +3.1732070e+01 +2.4349377e+01 +4.2479395e+01 +2.9882564e+01 +2.2253939e+01 +3.8827462e+01 +3.4522610e+01 +2.6492548e+01 +4.6211179e+01
+2.400000e+01 +2.600000e+01 +2.2730570e+01 +2.2775895e+00 +2.2730570e+01 +1.3933938e+01 +3.3066714e+01 +2.2730570e+01 +1.7961385e+01 +3.0189894e+01 +2.9776899e+01 +1.3933938e+01 +2.7777898e+01 +2.4728262e+01 +1.8997348e+01 +3.3066714e+01
+2.600000e+01 +2.800000e+01 +2.2041381e+01 +2.0537869e+00 +2.2041381e+01 +1.5441326e+01 +3.2136205e+01 +2.2041381e+01 +1.6922562e+01 +2.9487139e+01 +2.0113048e+01 +1.5441326e+01 +2.6988927e+01 +2.4023730e+01 +1.8445945e+01 +3.2136205e+01
+2.800000e+01 +3.000000e+01 +2.2185391e+01 +1.5150757e+00 +2.2185391e+01 +1.5558363e+01 +3.2388543e+01 +2.2185391e+01 +1.7051702e+01 +2.9641580e+01 +2.0254566e+01 +1.5558363e+01 +2.7063590e+01 +2.4184123e+01 +1.8580668e+01 +3.2388543e+01
+3.000000e+01 +3.200000e+01 +1.4823508e+01 +8.2142141e-01 +1.4823508e+01 +1.8413961e+01 +2.1598745e+01 +1.4823508e+01 +1.1395955e+01 +1.9802186e+01 +1.3548478e+01 +1.4823508e+01 +1.8100122e+01 +1.6134901e+01 +1.2403947e+01 +2.1598745e+01
+3.200000e+01 +3.400000e+01 +1.7618107e+01 +1.0523360e+00 +1.7618107e+01 +1.2281064e+01 +2.5867352e+01 +1.7618107e+01 +1.3546254e+01 +2.3528029e+01 +1.5074535e+01 +1.7618107e+01 +1.2281064e+01 +1.1396200e+01 +1.9373716e+01 +1.4894500e+01 +2.5867352e+01
+3.400000e+01 +3.600000e+01 +1.4630483e+01 +1.0018895e+00 +1.4630483e+01 +1.0263192e+01 +2.1311657e+01 +1.4630483e+01 +1.1254297e+01 +1.9545209e+01 +1.3348159e+01 +1.4630483e+01 +1.0263192e+01 +1.7826289e+01 +1.5975895e+01 +1.2281064e+01 +2.1311657e+01
+3.600000e+01 +3.800000e+01 +1.7463514e+01 +1.0794133e+00 +1.7463514e+01 +1.2137581e+01 +2.5760900e+01 +1.7463514e+01 +1.3438556e+01 +2.3297558e+01 +1.5774199e+01 +1.7463514e+01 +1.2137581e+01 +1.1846179e+01 +1.9317350e+01 +1.4806906e+01 +2.5760900e+01
+3.800000e+01 +4.000000e+01 +1.3024279e+01 +1.2510965e+00 +1.3024279e+01 +9.1329596e+00 +1.8981370e+01 +1.3024279e+01 +1.0000593e+01 +1.7400632e+01 +1.1882021e+01 +1.3024279e+01 +9.1329596e+00 +1.3875727e+01 +1.4299822e+01 +1.0924187e+01 +1.8981370e+01
+4.000000e+01 +4.200000e+01 +1.1088145e+01 +6.2057407e-01 +1.1088145e+01 +7.7657483e+00 +1.6129852e+01 +1.1088145e+01 +1.1688145e+01 +8.5266536e+00 +1.4885862e+01 +1.1088145e+01 +1.1088145e+01 +1.2119227e+01 +7.7657483e+00 +1.3485344e+01 +1.2119227e+01 +7.7657483e+00
+4.200000e+01 +4.400000e+01 +1.0585736e+01 +1.6494162e-01 +1.0585736e+01 +7.4391863e+00 +1.5423055e+01 +1.0585736e+01 +1.8585736e+01 +8.1488901e+00 +1.4120551e+01 +1.0585736e+01 +1.0585736e+01 +1.1568395e+01 +8.9083990e+00 +1.1568395e+01 +1.5423055e+01
+4.400000e+01 +4.600000e+01 +9.5419377e+00 +8.3599595e-01 +9.5419377e+00 +6.6782323e+00 +1.3945353e+01 +9.5419377e+00 +7.3440556e+00 +1.2726922e+01 +8.6773828e+00 +9.5419377e+00 +6.6782323e+00 +1.1574719e+01 +6.6782323e+00 +1.0456895e+01 +8.3599595e+00 +1.3945353e+01
+4.600000e+01 +4.800000e+01 +9.300591e+00 +8.1930045e-01 +9.300591e+00 +5.8615155e+00 +1.4343391e+01 +9.300591e+00 +7.5495100e+00 +1.3076202e+01 +8.9133750e+00 +9.300591e+00 +5.8615155e+00 +1.1880049e+01 +8.9133750e+00 +1.0757954e+01 +8.1930045e+00 +1.4343391e+01
    
```

TAKE HOME EXERCISES: FNLO

- In the NLO histograms, which of these variables are described at the NLO? $p_T(t)$, $p_T(t\bar{t})$, $y(t)$, $M(t\bar{t})$, $\Delta\phi(t\bar{t})$
- Some of these variables are trivial at LO, because of $2 \rightarrow 2$ kinematics
 - t and \bar{t} are always back to back:

$$d\sigma/d\Delta\Phi(t\bar{t}) = \delta(\Delta\Phi - \pi)$$

$$d\sigma/dp_T(t\bar{t}) = \delta(p_T - 0)$$
- $p_T(t\bar{t})$ and $\Delta\phi(t\bar{t})$ are non-trivial if the cross-section is at least at NLO: they are effectively described with LO accuracy
- The other variables are described at NLO

EXERCISES: NLO+PS



- Generate NLO event sample showered by Pythia8
 - **Warning:** the NLO LHE sample should be regenerated if one changes the shower program
 - Remember to install boost via **'install boost'**
- In default, HepMC file will be generated.
- Use MadAnalysis5 to read them and to make plots
 - **Next tutorial !**
- Instead of generating HepMC files, try to generate histograms directory.
 - Use the existing analysis file `py8an_HwU_pp_ttx.o` and put it in `shower_card.dat`
 - **Hint:** you can shower an existing run with `./bin/shower run_XX`

EXERCISES SOLUTION: NLO+PS

- Turn on NLO+PS with PS=Pythia8

```

1. Type of perturbative computation          order = NLO
2. No MC@[N]LO matching / event generation  fixed_order = OFF
3. Shower the generated events              shower = PYTHIA8
4. Decay onshell particles                  madspin = OFF
5. Add weights to events for new hypp.      reweight = OFF
6. Run MadAnalysis5 on the events generated madanalysis = OFF

```

Either type the switch number (1 to 6) to change its setting,
Set any switch explicitly (e.g. type 'fixed_order=ON' at the prompt)
Type 'help' for the list of all valid option
Type '0', 'auto', 'done' or just press enter when you are done.

- The histogram
- shower_ca
- Use MadSp
- Re-analyse

Specify shower = Pythia8

- Edit run_card.dat

Change the number of events

```

tag_1 = Run_tag ! name of the RUN
*****
# Number of LHE events (and their normalization) and the required *
# (relative) accuracy on the Xsec. *
# These values are ignored for fixed order runs *
*****
100000 = nevents ! Number of unweighted events requested
-1.0 = req_acc ! Required accuracy (-1=auto determined from nevents)
-1 = nevt_job ! Max number of events per job in event generation.
! (-1= no split).
*****

```

EXERCISES SOLUTION: NLO+PS



- Edit shower_card.dat

```
# DM_S = 24:0nNegITAny = 15 14
#*****
# 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. *
# Remember that if your analysis uses hbook or is in the HWU format, *
# you must also add to hbook.o or HWU.o to the ANALYSE list as well. *
#*****
#2_6_4/pp2ttXJCUZ/Events/run_02/events.the.gz file has been generated.
extralibs = pythia8 boost_iostreams z dl stdc++ # Extra-libraries (not LHAPDF)
# Default: "stdhep Fmcfio"
# PYTHON > 8.200 may require library dl
extrapaths = ../lib /Users/huasheng/Physics/MG5/MG5_aMC_v2_6_4/HEPTools/pythia8/lib /opt/local/lib /Users/huasheng/Physics/MG5/MG5_aMC_v2_6_4/HEPTools/zlib/lib /Users/huasheng/Physics/MG5/MG5_aMC_v2_6_4/HEPTools/boost/lib # Path to the extra-libraries
# Default: "../lib"
INCLUDEPATHS = # Path to header files needed by c++
# Dir names separated by white spaces
ANALYSE = # User's analysis and histogramming
# routines (please use .o as extension
# and use spaces to separate files)

libboost_filesystem.dylib libboost_seri
libboost_graph.a libboost_seri
libboost_graph.dylib libboost_sigr
libboost_iostreams.a libboost_sigr
libboost_iostreams.dylib libboost_syst
libboost_log.a libboost_syst
libboost_log.dylib libboost_test
libboost_log_setup.a libboost_thre
libboost_log_setup.dylib libboost_thre
libboost_math_c99.a libboost_time
libboost_math_c99.dylib libboost_time
libboost_math_c99f.a libboost_unit
libboost_math_c99f.dylib libboost_unit
libboost_math_c99l.a libboost_wave
libboost_math_c99l.dylib libboost_wave
libboost_math_tr1.a libboost_wser
libboost_math_tr1.dylib libboost_wser
Hua-Shengs-MacBook-Pro:lib huasheng$ pwd
/Users/huasheng/Physics/MG5/MG5_aMC_v2_6_4/HEPTools/b
Hua-Shengs-MacBook-Pro:lib huasheng$
```

Libraries required !

Make sure all library paths there !

EXERCISES SOLUTION: NLO+PS



- Result: HepMC file

```
Hua-Shengs-MacBook-Pro:run_02 huasheng$ ls
RunMaterial.tar.gz      events.the.gz          res_2.txt
allogs_0.html          events_PYTHIA8_0.hepmc.gz  run_02_tag_1_banner.txt
allogs_1.html          res_0.txt              summary.txt
allogs_2.html          res_1.txt
```

- In order to generate the histograms instead of HepMC files
- Edit shower_card.dat

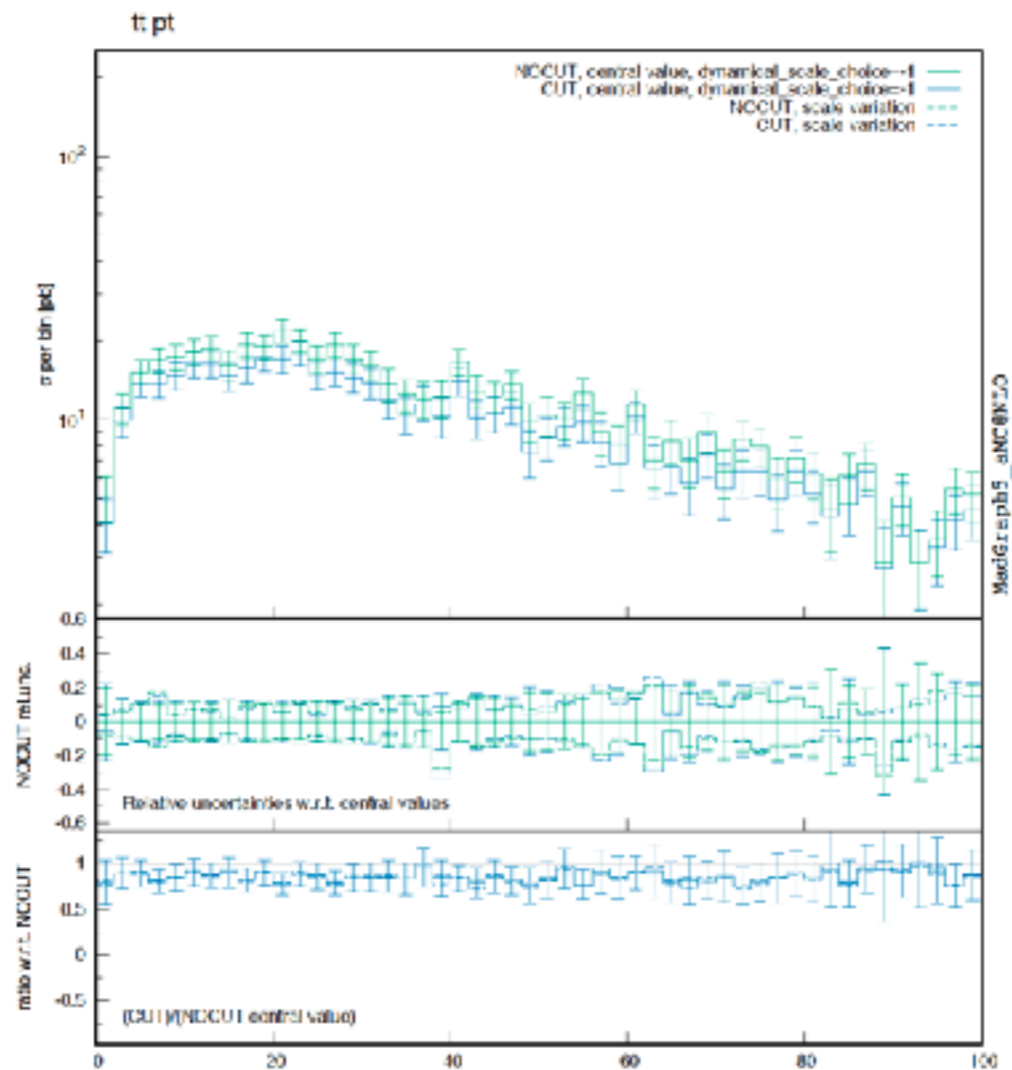
```
# Extra libraries/analyses
#*****
# The following lines need to be changed if the user does not want to
# create a StdHEP/HepMC file, but to directly run an own analysis (to
# be placed in HWAnalyzer or analogous MCatNLO subfolders).
# Please use files in those folders as examples.
# Remember that if your analysis uses hbook or is in the HWU format,
# you must also add to hbook.o or HWU.o to the ANALYSE list as well.
#*****
extralibs = pythia8 boost_iostreams z dl stdc++ # Extra-libraries (not LHAPDF)
# Default: "stdhep Fmcfio"
# PYTHIA > 8.200 may require library dl
extrapaths = ../lib /Users/huasheng/Physics/MG5/MG5_aMC_v2_6_4/HEPTools/pythia8//lib /opt/local/lib /Users/huasheng/Physics/MG5/MG5_aMC\
_v2_6_4/HEPTools/zlib/lib /Users/huasheng/Physics/MG5/MG5_aMC_v2_6_4/HEPTools/boost/lib # Path to the extra-libraries
# Default: "../lib"
INCLUDEPATHS = # Path to header files needed by c++
# Paths 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)
```

EXERCISES SOLUTION: NLO+PS



- **Result: histograms**
 - Check the `MyNLOExample/MCatNLO/PY8Analyzer/py8an_HwU_pp_ttx.f`

```
Hua-Shengs-MacBook-Pro:run_03 huasheng$ ls
RunMaterial.tar.gz      events_1he.gz          res_1.txt
allogs_0.html          plot_PYTHIA8_1_0.HwU  res_2.txt
allogs_1.html          plot_PYTHIA8_1_0.gnuplot  run_03_tag_1_banner.txt
allogs_2.html          res_0.txt              summary.txt
```



EXERCISES SOLUTION: NLO+PS

- Result: LHE file (need correct shower to be physical)

```

<initrwtg>
  <weightgroup name='scale_variation' -1' combine='envelope'>
    <weight id='1001'> dyn= -1 muR=0.10000E+01 muF=0.10000E+01 </weight>
    <weight id='1002'> dyn= -1 muR=0.20000E+01 muF=0.10000E+01 </weight>
    <weight id='1003'> dyn= -1 muR=0.50000E+00 muF=0.10000E+01 </weight>
    <weight id='1004'> dyn= -1 muR=0.10000E+01 muF=0.20000E+01 </weight>
    <weight id='1005'> dyn= -1 muR=0.20000E+01 muF=0.20000E+01 </weight>
    <weight id='1006'> dyn= -1 muR=0.50000E+00 muF=0.20000E+01 </weight>
    <weight id='1007'> dyn= -1 muR=0.10000E+01 muF=0.50000E+00 </weight>
    <weight id='1008'> dyn= -1 muR=0.20000E+01 muF=0.50000E+00 </weight>
    <weight id='1009'> dyn= -1 muR=0.50000E+00 muF=0.50000E+00 </weight>
  </weightgroup>
</initrwtg>
</header>
<init>
  2212 2212 0.65000000E+04 0.65000000E+04 -1 -1 244800 244800 -4 1
  0.67732468E+03 0.38432666E+01 0.13001881E+04 0
</init>
<event>
  4 0 0.13001881E+04 0.11780576E+03 0.75467711E-02 0.10610484E+00
  21 -1 0 0 501 502 0.00000000E+00 0.00000000E+00 0.59797002E+03 0.59797002E+03 0.00000000E+00 0.0000E+00 0.9000E+01
  21 -1 0 0 502 503 0.00000000E+00 0.00000000E+00 -.60283167E+02 0.60283167E+02 0.00000000E+00 0.0000E+00 0.9000E+01
  6 1 1 2 501 0 0.61030847E+01 0.74739250E+02 0.23026277E+03 0.29761241E+03 0.17300000E+03 0.0000E+00 0.9000E+01
  -6 1 1 2 0 503 -.61030847E+01 -.74739250E+02 0.30742408E+03 0.36064078E+03 0.17300000E+03 0.0000E+00 0.9000E+01
#aMCatNLO 1 0 0 2 3 0.33272654E+02 0.00000000E+00 9 5 0 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00 0.00000000E+00
<rwgt>
  <wgt id='1001'> 0.13002E+04 </wgt>
  <wgt id='1002'> 0.10415E+04 </wgt>
  <wgt id='1003'> 0.16642E+04 </wgt>
  <wgt id='1004'> 0.14027E+04 </wgt>
  <wgt id='1005'> 0.11166E+04 </wgt>
  <wgt id='1006'> 0.18080E+04 </wgt>
  <wgt id='1007'> 0.11653E+04 </wgt>
  <wgt id='1008'> 0.94099E+03 </wgt>
  <wgt id='1009'> 0.14783E+04 </wgt>
</rwgt>
</event>
  
```

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

TAKE HOME EXERCISES: NLO EW



MadGraph5_aMC@NLO is a framework that aims at providing all the elements necessary for SM and BSM phenomenology, such as the computations of cross sections, the generation of hard events and their matching with event generators, and the use of a variety of tools relevant to event manipulation and analysis. Processes can be simulated to LO accuracy for any user-defined Lagrangian, and the NLO accuracy in the case of models that support this kind of calculations -- prominent among these are QCD and EW corrections to SM processes. Matrix elements at the tree- and one-loop-level can also be obtained.

MadGraph5_aMC@NLO is the new version of both MadGraph5 and aMC@NLO that unifies the LO and NLO lines of development of automated tools within the MadGraph family. It therefore supersedes all the MadGraph5 1.5.x versions and all the beta versions of aMC@NLO.

The standard reference for the use of the code is: J. Alwall et al, "The automated computation of tree-level and next-to-leading order differential cross sections, and their matching to parton shower simulations", arXiv:1405.0301 [hep-ph]. In addition to that, computations in mixed-coupling expansions and/or of NLO corrections in theories other than QCD (eg NLO EW) require the citation of: R. Frederix et al, "The automation of next-to-leading order electroweak calculations", arXiv:1804.10017 [hep-ph]. A more complete list of references can be found here: http://amcatnlo.web.cern.ch/amcatnlo/list_refs.htm

Download:

Get Involved

- Report a bug
- Ask a question
- Register a blueprint
- Help translate

Downloads

Latest version is 2.6.x

- MG5_aMC_v2.6.4.tar.gz
- MG5_aMC_v2.6.3.2.tar.gz
- MG5_aMC_v3...beta.tar.gz

released on 2017-08-15

- NLO EW can be generated with fNLO only at the moment.
- Add ‘[QCD QED]’ or ‘[QED]’ in the generation syntax.