

# Tutorial MC production for DisplacedTop

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## 1 Goals

- Producing LHE samples related to DisplacedTop.
- Setting the proper PDF.
- Asking for systematics.
- ME/PS merging technique.

## 2 Setup installation

- Work on machine ui2.
- Initialization script:

```
cd CMSSW_10_6_9
source /cvmfs/cms.cern.ch/cmsset_default.sh
export SCRAM_ARCH=slc7_amd64_gcc700
eval `scramv1 runtime -sh`
cd
export EDITOR='emacs -nw '
cd /opt/sbg/cms/ui2_data1/econte/PAUL
```

- Download MG5 (Python2-based release):

```
MG5aMC_LTS_2.9.15.tgz
```

- Launching MG5 and installing Pythia8, hepmc and lhpdf

```
python ./bin/mg5 (or python3 depending on the version)
install lhpdf6
install pythia8
```

- Setting Pythia path export

```
export PYTHIA8DATA=$PWD/HEPTools/pythia8/share/Pythia8/xmldoc/
```

- Setting LHAPDF path export

```
export LHAPDF_DATA_PATH=$PWD/HEPTools/lhapdf6/share/LHAPDF
export PATH=$PWD/HEPTools/lhapdf6/bin:$PATH
```

### 3 Example for producing ME/PS merging plots

- the Process to generate with MG5. Be careful: check the content of *j*:

```
import sm_no-b-mass
generate p p > mu+ mu- @ 0
add process p p > mu+ mu- j @ 1
add process p p > mu+ mu- j j @ 2
```

- Activate Pythia8
- For MG5 v2.X, the only merging prescription, which is operational and available, is MLM (initials of Michelangelo L. Mangano). Corresponding settings in the `run_card.dat`:

```
1 = ickkw          ! 0 no matching, 1 MLM
5 = asrwtflavor    ! highest quark flavor for a_s reweight
10.0 = xqcut       ! minimum kt jet measure between partons
```

- We need to find a good value of the couple (*xqcut*, *qcut*). *xqcut* is in MadGraph and *qcut* in Pythia. By default, Pythia compute a *qcut* value as a function of *xqcut*. So we need to do a scan to the *xqcut* value, typically between 10 and 100.
- Deactivate the systematics.
- Ask at least 100,000 events because +1j and +2j contributions are very small and we need to have some events of them.
- Launch the job
- Check the Feynman diagrams. Why? because no BSM couplings must be used for producing extra jets. If it is the case, we need to remove the corresponding contributions.
- Go to the folder: `<job folder>/HTML/run_01/tag_1-PY8-plots`
- Execute gnuplot with script file: `central_qCut_djr_plots.gnuplot`. A PDF file will be produced with the so-called "Merging plots". The goal is to a smooth curve (the total one, with all processes) for each DJR plot. What is DJR? See fastjet documentation.

### 4 Instructions for computing the signal cross-section

Following the MadGraph script:

```
import model DisplacedTopUDD --modelname

# 0 j
generate p p > sl2+ sl2- / h01 h02 a0 n1 n2 n3 n4

output RPV_bino_350_200_10 -f
!cp param_card_350_200_10.dat RPV_bino_350_200_10/Cards/
!cp run_card.dat RPV_bino_350_200_10/Cards/
launch
```

Be careful: do not ask for neutralino decay or slepton decay if you would like to compute the cross-section.

## 5 Instructions for MC production

- Choice of PDF:
  - CMS recommendations for LO and NLO prod: NNPDF3.1 NNLO (NNPDF31\_nnlo\_hessian\_pdfas) (lhaid = 306000)
  - Eric’s recommendations: PDF4LHC21\_mc (lhaid 93000) (mc for monte carlo replicas) [\[link\]](#).
  - Final choice: CMS recommendations

- PDF implementation in the `run_card.dat`:

```
lhapdf = pdlabel ! PDF set
306000 = lhaid
```

- Systematics implementation in the `run_card.dat`:

```
True = use_syst
```

## 6 Example of a script

One can use a script to execute all the madgraph commands. Put all the following commands in a file (here "script.txt") and execute it as shown:

```
python ./bin/mg5 script.txt
```

the script ↓

```
generate p p > mu+ mu- @ 0
add process p p > mu+ mu- j @ 1
add process p p > mu+ mu- j j @ 2
display processes
output
launch
shower=Pythia8
0
set nevents 1000
set ebeam1 7000
set ebeam2 7000
set pdlabel lhapdf
set lhaid 306000
set use_syst False
set ickkw 1
set xqcut 10.0
set aswgtflavor = 5
0
exit
```