

# Showering and hadronization

To perform simulation of TMD parton showers and/or hadronization one have to process the PEGASUS output in [Les Houches Event format](#) (\*.lhe) with Monte-Carlo event generator [CASCADE](#). In the collinear factorization scenario, one can use a conventional showering program as implemented into the [PYTHIA 8.2](#).

**NOTE: to reconstruct the TMD initial state parton showers, the TMD gluon density from CCFM or PB families should be chosen.**

To produce an [Les Houches Event](#) file with PEGASUS please follow the [manual](#). Shortly, one should choose the process by double-clicking, limit the phase space in order to record only necessary events, and check the “Generate Les Houches Event file” box in the lower left corner. One then starts the calculation with the *Start* button (or *F5*). The produced \*.lhe file will be created in the PEGASUS folder and is ready to use with the [CASCADE](#). Here we describe the procedure for 2.4 version.

As a basic file one can take the `steer_pp-LHEin` file, provided with the distributive. Just check, that the following lines are set as needed:

```
NEVENT -1
'IPRO' 1 0 -1 ! read in LHE file
```

Other parameters define, in particular, whether you turn the fragmentation and showers on or off. You can set them as you need. Importantly, one has to set the IGLU parameter corresponding to the TMD gluon density, used in the \*.lhe file calculation. The TMD number can be found in the \*.lhe file, it corresponds to the [TMDLib numbering scheme](#). PEGASUS uses the following of them (see [Overview](#)). The ICCF parameter should be defined according to the used TMD gluon distribution.

PEGASUS	CASCADE/TMDLib	IGLU	ICCF
A0 (CCFM)	ccfm-setA0	101010	1
B0 (CCFM)	ccfm-setB0	101020	1
JH'2013 set 1 (CCFM)	ccfm-JH-2013-set1	101201	1
JH'2013 set 2 (CCFM)	ccfm-JH-2013-set2	101301	1
PB NLO set 1	PB-NLO-HERAI+II-2018-set1	102100	2
PB NLO set 2	PB-NLO-HERAI+II-2018-set2	102200	2

The path to the \*.lhe file to be processes is defined by CLHE.

**NOTE: ILHE parameter should be set to be 0 for the off-shell partons.**

Typically one produces a [HepMC](#) output file with CASCADE. One defines the name of the file with

```
export HEPMCOUT=name_of_the_output_file
```

Then one starts the CASCADE with

```
export CASEED=some_random_number
./cascade < steer_pp-LHEin
```

The produced [HepMC](#) file can be then processed to form necessary cross sections. Note that the weighted events from PEGASUS are normalized by CASCADE, so one should multiply the weights by the total cross section during processing. The total cross section can be found in the CASCADE output or in the \*.lhe file.

In the collinear factorization scenario, we successfully tested the compatibility of generated \*.lhe file with [PYTHIA 8.2](#). One can use the [following page](#) as a guide to link \*.lhe file with [PYTHIA 8.2](#).

From:

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Last update: **16/06/2020 15:48**

