PITT-PACC-20XX

The S-ACOT-MPS Manual

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(Dated: March 7, 2020)

Abstract

In this manual, we instruct how to run the `S-SACOT-MPS` code to calculate the cross section of inclusive heavy-flavor hadroproduction.

CONTENTS

I. OVERVIEW

The S-ACOT-MPS [1], short for the Simplified Aivazis-Collins-Olness-Tung (ACOT) scheme [2, 3] with Massive Phase Space, is designed to calculate the cross sections of the inclusive heavy-flavor, e.g., charm or bottom, production at hadron colliders. The detailed calculation is described in Ref. [1]. The matrix-element is directly extracted from the `MCFM` code [4–6]. All the related codes can be obtained from `HEPForge`:

`https://sacotmps.hepforge.org`

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II. INSTRUCTIONS

We can calculate the S-ACOT-MPS cross sections by following the steps.

1. Download and install LHAPDF [7].

```
$ cd LHAPDF-6.x.x
$ ./configure --prefix=LHAPDF_PREFIX
$ make -j4
$ make install
```

   Setup the environment variables for the LHAPDF.

```
$ export PATH=$PATH:LHAPDF_PREFIX/bin
$ export LD_LIBRARY_PATH=$LD_LIBRARY_PATH:LHAPDF_PREFIX/lib
```

2. Compile the MCFM code.

```
$ cd mcfm
$ make -j4
```

   You may link the corresponding lib and include directly in the makefile.

3. Download the Subtracted and Residual PDF and place in your LHAPDF data directory.

```
$ tar -xzvf CT18NNLO_sub.tgz
$ tar -xzvf CT18NNLO_res.tgz
$ mv CT* $(lhapdf-config --datadir)
```

   The CT18NNLO PDF [8] can be obtained from the HEPForge:

   https://ct.hepforge.org

4. Calculate the FC, FE and SB terms.

```
$ cd mcfm/Bin
$ ./run.sh
```

   Here we have written a bash script to run the FC, FE and SB calculations in sequence. You can specify the corresponding cuts in the input.DAT file.

5. Plot the results.

```
$ cd mcfm/Bin/plotter
$ make
$ cd ..
$ ./plotter/plot.sh LHCbBX
```

   The plotter code is compiled with g++-7 and works for outputs in ROOT format. You can also choose other formats in input.DAT, such as topdrawer, gnuplot or dat.

You will get the results, shown in Fig. 1.

III. FAST COMPUTATIONS WITH APPLGRID

We can generate APPLgrid [9] for fast computations.

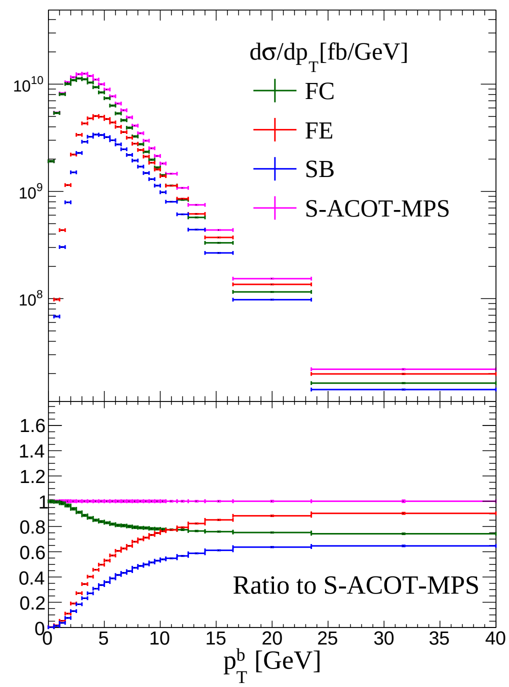

FIG. 1. The FC, FE and SB terms for the cross section of the inclusive b-quark production at the LHCb 7 TeV.

A. Prerequisites

1. Install `HOPPET` [10] and `APPLgrid` [9];
2. Install `mcfm-bridge`;
3. Setup `mcfm` and recompile.

B. Generate `APPLgrid`'s

1. Setup the `mcfm-bridge` interface code, `mcfm_interface.cxx`;
2. Recompile `mcfm-bridge` and `mcfm`;
3. Setup `creategrid` to be `true` in `input.DAT` file;
4. Run the `mcfm` twice: first prepare grids, and then fill the them.

C. Fast computations

1. Download the standalone code and compile.

```
$ cd APPLgrids
$ make
```

2. Convolute the grids with different PDFs.

```
$ ./stand_PDFset grid.root PDF iset logy
```

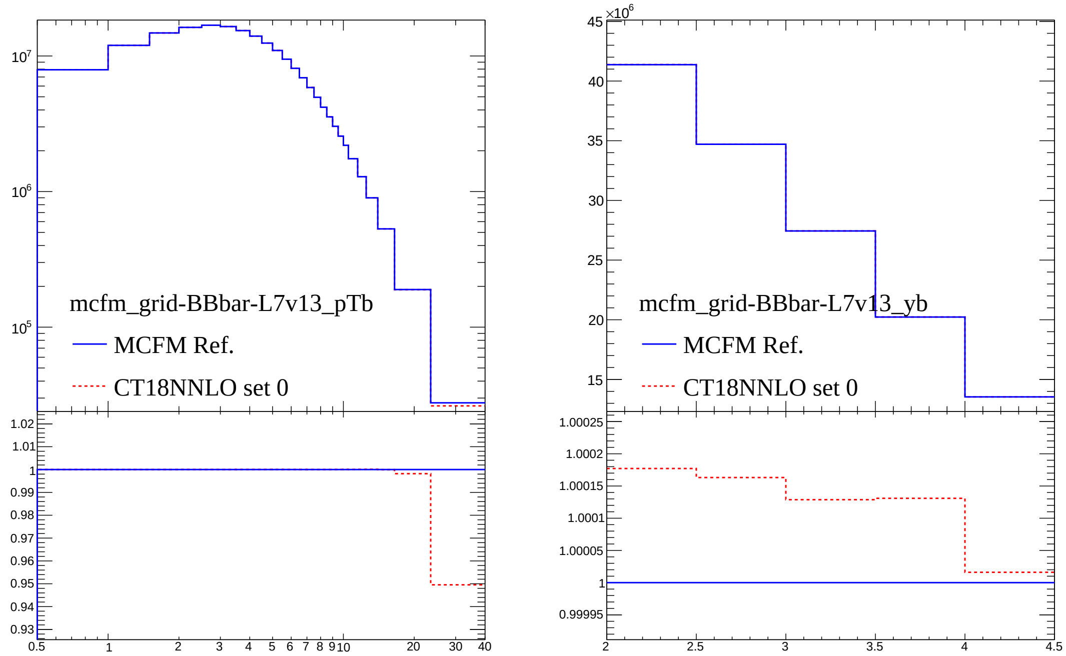

FIG. 2. The NLO FC differential cross sections $\mathrm{d}\sigma/\mathrm{d}p_T^b$ [fb/GeV] and $\mathrm{d}\sigma/\mathrm{d}y^b$ [fb] in the inclusive b-flavor production $pp \to bX$ at the LHCb 7 TeV [11]. The `APPLgrid` convolution results with the corresponding CT18NNLO PDF (red dotted lines) reproduce the `MCFM` reference values (blue solid lines) generally very well.

Here we demonstrate the NLO FC differential cross sections $\mathrm{d}\sigma/\mathrm{d}p_T^b$ and $\mathrm{d}\sigma/\mathrm{d}y^b$ in the inclusive b-flavor hadroproduction at the LHCb 7 TeV [11] in Fig. 2.

ACKNOWLEDGMENTS

The work of JMC is supported by the Department of Energy under contract DE-AC02-07CH11359. The work of PMN is supported by the Department of Energy under Grant No. DE-SC0010129. The work of KX is supported in part by the Department of Energy under Grant No. DE-FG02-95ER40896, the National Science Foundation under Grant No. PHY-1820760, and in part by PITT PACC.

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