Quick Tutorial on Higher-Orders Calculations
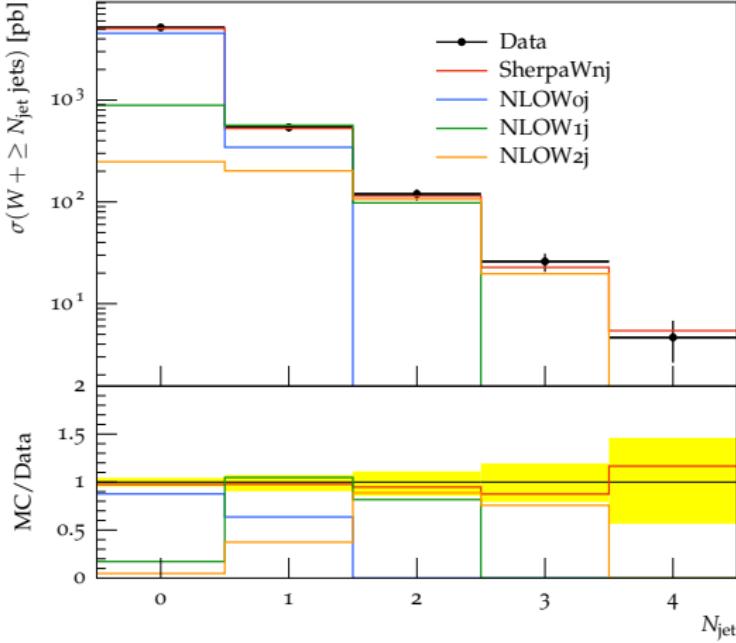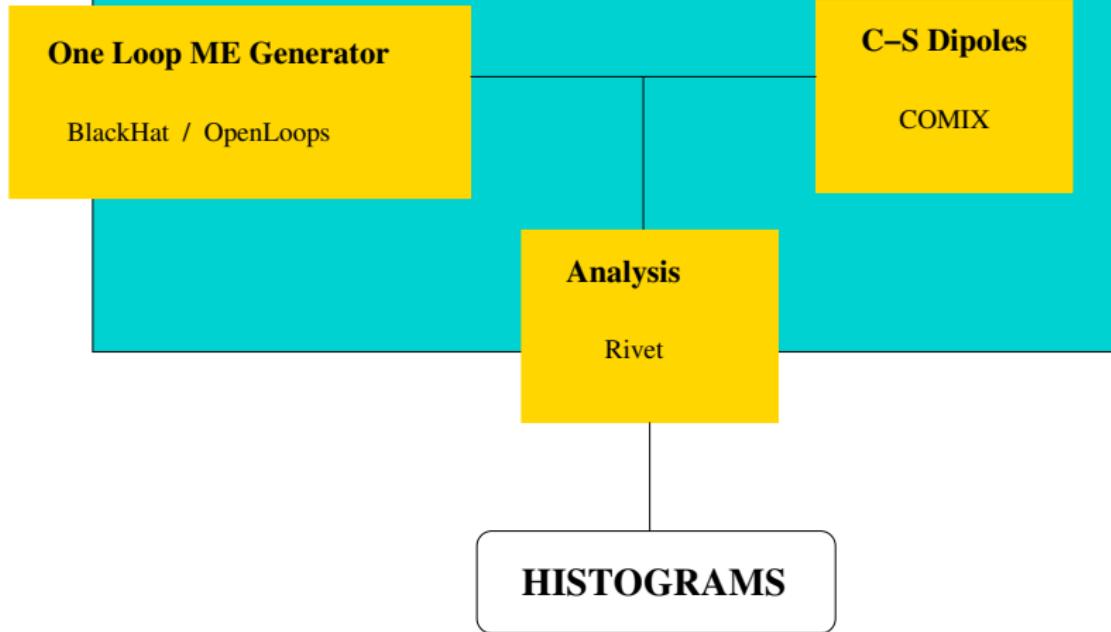
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SHERPA FRAMEWORK

One Loop ME Generator

BlackHat / OpenLoops

C−S Dipoles

COMIX

Analysis

Rivet

HISTOGRAMS

Working Flow

1. Installation
2. Prepare input files
3. Produce process libraries
4. Warm up integration grids
5. Generate events
6. Study results

After getting results, one can make modifications to input files and produce new results! (e.g. different analysis, change scales, PDF sensitivity, etc)

Notice that we have previously precompiled all packages! But for completeness we add compilation information next.

Installation: BlackHat

First install the QD package:

```
wget http://crd.lbl.gov/~dhbailey/mpdist/qd-2.3.15.tar.gz
tar -xzf qd-2.3.15.tar.gz
cd qd-2.3.15
mkdir install
./configure --prefix=$PWD/install --enable-shared CXX=g++ FC=gfortran
make
make install
```

And now compile BlackHat:

```
wget http://www.ippp.dur.ac.uk/~daniel/blackhat-0.9.9.tar.gz
vim -e -s -c "argdo 492 s/triangle_Darren/&\&/r | update |qa" blackhat-0.9.9/src/cut_Darren.h
mkdir blackhat-0.9.9/build
cd blackhat-0.9.9/build

../configure --prefix=$PWD --with-QDpath=/FULL/PATH/TO/qd-2.3.15/install
vim -e -s -c "argdo %s/utils//g | update |qa" Makefile
make -j2
make install
```

https://blackhat.hepforge.org/trac/wiki

Installation: OpenLoops

Compile the core code of OpenLoops:

```
wget http://www.hepforge.org/archive/openloops/OpenLoops-1.2.0.tar.gz
tar -xzf OpenLoops-1.2.0.tar.gz
cd OpenLoops-1.2.0/
./scons
```

And now add the process libraries that you need:

```
./openloops libinstall ppln pplnj pplnjj
```

https://openloops.hepforge.org/

Installation: Rivet

Download the installation script:

```
wget http://rivet.hepforge.org/hg/bootstrap/raw-file/2.2.1/rivet-bootstrap
chmod +x rivet-bootstrap
```

choose the versions you want:

```
vim -e -s -c "argdo %s/RIVET_VERSION=\"2.2.1\"/RIVET_VERSION=\"2.3.0\"/g | update|qa" rivet-bootstrap
vim -e -s -c "argdo %s/YODA_VERSION=\"1.3.1\"/YODA_VERSION=\"1.4.0\"/g | update|qa" rivet-bootstrap
```

and install:

```
./rivet-bootstrap
```

https://rivet.hepforge.org/

Look at the large amount of analyses available in:
https://rivet.hepforge.org/analyses

Installation: SHERPA

Download and compile (notice the directory paths!):

```
wget http://www.hepforge.org/archive/sherpa/SHERPA-MC-2.2.0.tar.gz
tar -xzf SHERPA-MC-2.2.0.tar.gz
cd SHERPA-MC-2.2.0/
./configure --enable-blackhat=/FULL/PATH/TO/blackhat-0.9.9/build \
            --enable-openloops=/FULL/PATH/TO/OpenLoops-1.2.0 \
            --enable-hepmc2=/FULL/PATH/TO/RIVET/local --enable-rivet=/FULL/PATH/TO/RIVET/local
make install -j2
```

https://sherpa.hepforge.org/trac/wiki

Look at the Manual in:
https://sherpa.hepforge.org/doc/SHERPA-MC-2.2.0.html

Let's prepare for running!

1. We have previously precompiled everything.

2. Download from the School webpage the tarball file
   HO_Tutorial_Wjets.tgz.

3. Extract the Wjets/ directory and go there and create a soft link to
   the SHERPA executable:

   ```
   ln -s /FULL/PATH/TO/SHERPA-MC-2.2.0/SHERPA/Run/Sherpa .
   ```

4. Source the environment file for Rivet:

   ```
   source /FULL/PATH/TO/RIVET/local/rivetenv.sh
   ```

5. Test Sherpa:

   ```
   ./Sherpa
   ```

Familiarizing with Sherpa Runcards

The files:

```
Run_W0j_LO.dat Run_W0j.dat Run_W1j.dat
```

have been prepared to get you started with running Sherpa for NLO QCD fixed order calculations.

For example, get LO QCD results for $W + 0$ jets by running:

```
./Sherpa -f Run_W0j_LO.dat
```

Notice what you get under Wjets/Analysis/HTp/! In fact, explore the results by doing:

```
cd Analysis/HTp/
rivet-mkhtml LOW0j.yoda -o W0j
```

and opening the generated index.html with your browser.

Practice with the other two run cards!

Hint: Combine several RIVET analyses by running for example:

```
cd Analysis/HTp/
rivet-mkhtml LOW0j.yoda NLOW0j.yoda -o W0j
```

First Set of Exercises

1. Compare LO and NLO results for $W + 1$ Jet production.

2. How do the results compare to LHC data?

3. Produce results for LO and NLO QCD corrections for $W + 2$ Jet production. (Important hint: to get going quickly, by using provided integration libraries, make sure you write `RESULT_DIRECTORY ResultsW2j;` in the corresponding runcard!)

4. How do results compare to ATLAS data? Why some observables seem to badly fail?

HINT: Improve your plots by modifying the `EVENTS` entry in the runcard, that is by having larger statistics

Second Set of Exercises

Sherpa provides easy access to Matching and Merging procedures. Let's run an example in which we use NLO MEs for $W + 0, 1, 2$ jets, LO MEs for $W + 3$ jets and a shower.

Run:

```
./Sherpa -f Run_Wnj.dat
cd Analysis/HTp/
rivet-mkhtml --mc-errs SherpaWnj.yoda -o Wnj
```

1. Do you find differences between the fixed order results and the last result?

2. Plot together your NLO $W + 0, 1, 2$ Jet results with the results in SherpaWnj.yoda.

3. Can you explain the results in the next slide? (You should have similar ones!)

Couple of plots!