Rivet Intro v2

2023-07-26

All infos are in DESY cloud.
A documentation on Rivet you will find on http://projects.hepforge.org/rivet/.

Part 1 – Setting up

Working at DESY naf

all infos under: /afs/desy.de/user/j/jung/public/summerstudents/2023

- Login to one of the NAF workgroup servers:

```
ssh -X schoolXX@bastion.desy.de     ! to login to the DESY system
ssh -X pal.desy.de                  ! to login to workgroup server
```

- create a www directory with (only once):
  - ```
    cd
    mkdir www
    fs setacl -dir www -acl desy-hosts read
    ```
- Go to that directory: `cd www`
- The software you need is already installed at DESY. In order to use it, you need to set the correct environment variables. For convenience you can copy all.

  ```
  cd
  cd www
  cp -rp /afs/desy.de/user/j/jung/public/summerstudents/2023/* .
  ```

  to your www directory. Run it with:

  ```
  source  setup.sh
  ```

  Note: You need to initiate the correct environment for every new terminal window.
- Check available Rivet analyses with `rivet --list-analyses`.

  If you have an analyses proceed to the next step.
- To run the generator, copy all the PYTHIA directory to your own directory:

  `cd pythia`
- Running MC generator and Rivet

  The most important commands are given below.

  Generate 1000 events in e^+e^- with the Pythia MC generator and analyze the output by using an existing analysis routine. For example DELPHI_1991_I324035.cc, which is an analysis of charged particles.

  Use a FIFO (First-In-First-Out) Linux pipe on the /tmp area:

  ```
  mkdir /tmp/$(whoami)
  mkfifo /tmp/$(whoami)/myhepmc.fifo
  rm output.out
  export HEPMCOUT=/tmp/$(whoami)/myhepmc.fifo
  export PYSEED=12345
  nice ./main31 > output.out&
  ```
  ```

rivet -a DELPHI_1991_I324035 $HEPMCOUT

(Note the &-sign after the main31 line, which makes PYTHIA run in the background. You want to fill the output file with events at the same time as you run your analysis.)

To avoid typing in too many commands every time you want to run the program, copy the script runscript.sh from /afs/desy.de/user/j/jung/public/summerstudents/2022/pythia to your directory pythia/.

edit runscript.sh and change HEPMCOUT to /tmp/$(whoami)/myhepmc.fifo

run the script with

```
./runscript.sh
```

Working on local computer

Running with pre-generated hepmc events (the hepmc file is already copied to your pythia directory)

```
source setup.sh
```

```
export HEPMCOUT=ee-Z0.hepmc.gz
```

```
rivet --analysis=DELPHI_1991_I324035 $HEPMCOUT
```

Part 2 - Analyzing output

1. Look at your MC predictions by creating a html page:

   rivet-mkhtml --mc-errs -o myrivet Rivet.yoda:"Title=mytest"

   this will create a html page in directory myrivet from the file rivet.yoda with title="mytest"

2. Create a new analysis routine with only the most essential parts "**Init()**", "**Analyze()**" ,"**Finalize()**". Looking at the code DELPHI_1991_I324035.cc will be of help. You find these analyses under

   https://rivet.hepforge.org/analyses/DELPHI_1991_I324035.html

   You can create a new analysis template with:

   rivet-mkanalysis myanalysis

   Command for compiling your code: rivet-build RivetMyCode.so myanalysis.cc

   Compile your code and use your routine to "analyse" events from the Pythia MC generator. Make a "Hello World"-print statement in the "**Analyze()**"-part to be sure the routine is running. You should see the print-out for each event. Add print statements also in Init() and Finalize() to be sure these functions are used.

3. Add the charged particle projection to your code. Print out the number of charge particles for each event instead of "Hello World". Hint: Look inside DELPHI_1991_I324035.cc .

   export RIVET_ANALYSIS_PATH=full_path_name_to_where_RivetMyCode.so

4. Calculate and print the transverse momentum and pseudo-rapidity of the charged particles. Compare your calculated values with the values provided by the particles `momentum()` member functions.

   For Rivet code description look at: https://rivet.hepforge.org/code/dev/

   Find the definition of rapidity, pseudorapidity etc under: https://en.wikipedia.org/wiki/Pseudorapidity

5. study the MC event record: use MC_PRINTEVET

Part 3 – Histogramming

6. Create histograms for η, ϕ and p in Init(). (Use the template from rivet-mkanalysys as a guide)
7. Fill histograms with η, ϕ and p_t of the charged particles. Use the hepmc file with 1000 e^+e^- collisions with a center-of-mass energy of 92 GeV. This corresponds to the energy LEP1 was running.
8. In "Finalize()", normalize the histograms to the number of events.

Part 4 – Plotting

9. Plot the distributions of η, ϕ and p_t respectively. Make plots with rivet-mkhtml

Part 5 – Physics

Study the effect of final state parton shower (use hepmc file from DESY cloud)

10. use hepmc file `ee-Z0-noPS.hepmc.gz`

pp collisions

1. Use e^+e^- scattering and plot $1/N\,dn/d\eta$ as well as $1/N\,dn/d\cos\theta$
   1. why are the distributions peaked at different values (around 0 for $dn/d\eta$ and around +-1 $dn/d\cos\theta$) ?
2. Use $pp \to e^+e^- + X$ and plot $1/N\,dn/d\eta$ as well as $1/N\,dn/d\cos\theta$
   1. how are the distributions, why are they different from e^+e^- ?
   2. plot p_T of the e^+e^- pair (check influence of parton shower)
3. Use $pp \to X$ (low p_T process, minimum bias) and plot $1/N\,dn/d\eta$
   1. how are the distributions ?
   2. check the influence of parton shower and MPI