CRMC exercises

All files for the respective exercises can be found in <>/exercise1/ex1.1/

1. Interaction cross sections

1.1 Compare the energy dependence of the total cross section in proton-proton interactions for post LHC models

by completing the tables in the files named: ‘sig-had-p-<int-model>.dat’.

You can visualize the results by running:

‘gnuplot plot-sig-had-p.gnu’ which produces ‘cs-tot-p-p.png’

Reminder: ‘crmc -x/--cross-section’ to print out the cross section for a given configuration

‘crmc –help’ show all options

‘eom cs-tot-p-p.png’ to look at the image

1.2 Compare the interaction length of pions, kaons and protons in air. At what energy are kaons more likely to decay than interact?

Fill in the table in ‘sig-had-air-sib.dat’. You can visualize the result by running

‘gnuplot plot-int-len-had-air.gnu’

Hint: You may approximate air by pure nitrogen.

1.3 How does the nucleus-nucleus cross section scale with the mass number of the projectile?

Fill in the table in ‘sig-nuc-nuc-eps.dat’.

Reminder: carbon: A=12, Z=6 ==> ID = 60120

2. Particle production I

2.1 Compare the spectra of charged particles in Pion-, Kaon- and proton-proton interactions.

EHS/NA22 collaboration measured particle production spectra in a fixed target experiment with projectile momentum of 250GeV/c (Z. Phys C 39, 311-329 (1988)). You can recreate the experiment by creating events (10k) with CRMC and analyse them with RIVET, by running

‘rivet -a EHS_1988_I265504 <CRMC-event-file>

RIVET creates histogram files which can be visualized by doing ‘rivet-mkhtml <name>.yoda’

and then opening ‘firefox rivet-plots/index.html’

Reminder: you can specify the filename of the CRMC output with ‘-f <name>.hepmc’

Tipp: instead of creating a separate event file, you can directly pass the CRMC output to RIVET via a named pipe (fifo), e.g. ‘mkfifo <file name>.hepmc’

2.2 Pick a LHC analysis and reproduce the distributions.

e.g.:

ALICE_2015_I1357424

CMS_2017_I1511284

LHCB_2013_I1218996

3. Particle production II

3.1 “Ralph’s task” - The average hadronic event at the LHC

What is the average number of Pions, Kaons, Protons and Antiprotons produced at the LHC?

What is the total energy carried by all the particles in each of these groups?

What is the distribution of particles (energy) in pseudorapidity?

Create an event file (10k) with CRMC with proton beams at 13TeV and analyse the produced particles.

Hint: a skeleton program to analyse HepMC files can be found in ‘analyse-lhc.cc’

3.2 UHECR interaction

Create an event file (10k) with CRMC containing events corresponding to the first interaction of an UHECR proton (E=10**19eV).

How much energy is carried by the leading particle? How is the energy distributed between the electromagnetic and hadronic particles.

Hint: a skeleton program to analyse HepMC files can be found in ‘analyse.cc’