Progress Report

Single Particle Simulations & Reconstruction

19th October, 2023

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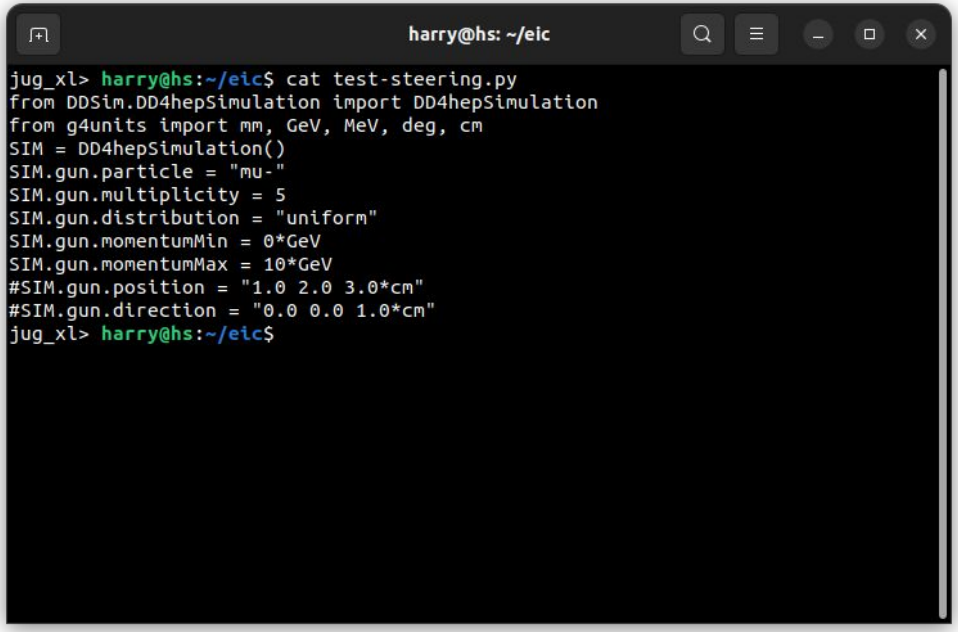
Task given by Dr. Osborn

Here is what I would suggest as a next step:

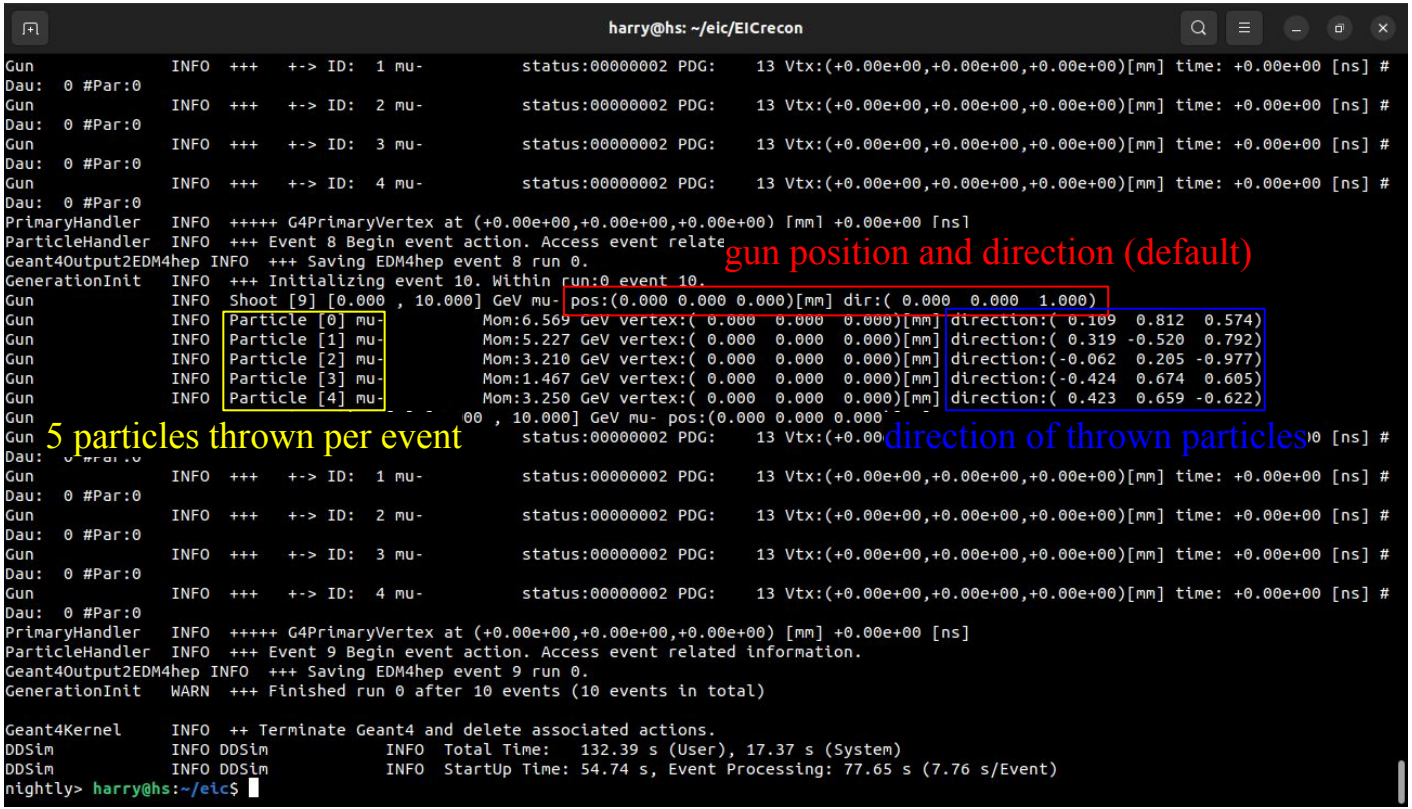
0. If you haven't been able to do that yet, make sure you can run eicrecon over the simulated output from the edm4hep root file.
1. Run some events with (let's say as a start) 5 muons per event thrown flat in momentum and flat in phi and theta so that you have adequate statistics over the full momentum/phi/theta space. To start with, let's also have those muons thrown from somewhere along the z axis, i.e. from (0,0,0) or if you have figured out how to (0,0,0) with a Gaussian spread in z.
2. With the output edm4hep file, run our default eicrecon reconstruction package.
3. With the output from the reconstruction, try making some histograms (in e.g. root, or whatever your favorite plotting software is) of things like the track position as a function of momentum, phi, and theta. Even better would be if you can make histograms of the reconstructed track position - the thrown truth track position as a function of momentum, phi, and theta.

Simulation: Command

ddsim --steeringFile=test-steering.py --compactFile=$DETECTOR_PATH/$DETECTOR_CONFIG.xml --outputFile=test-output.edm4hep.root -G -N=10



Simulation: terminal



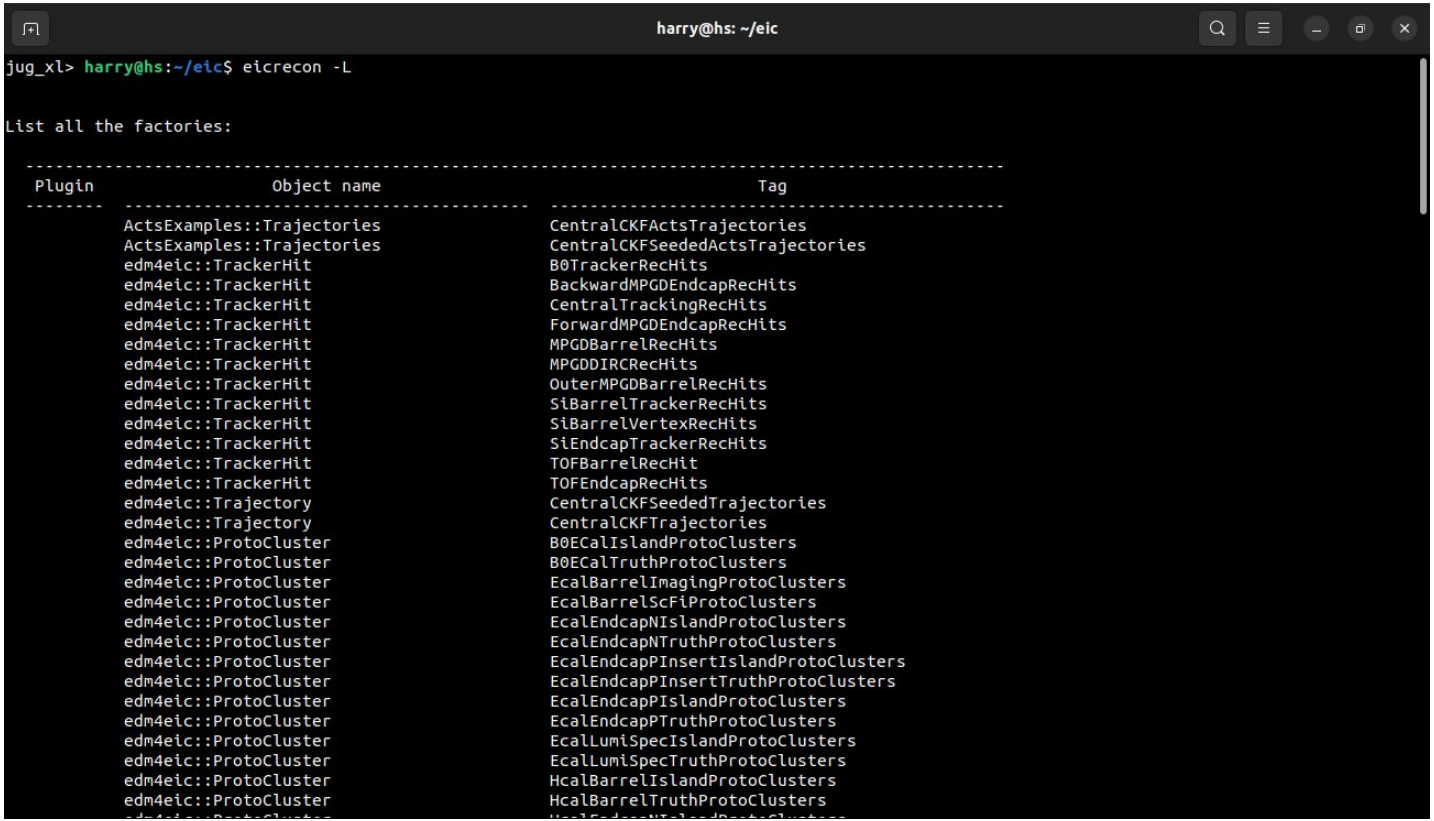

```
Gun              INFO  +++   +-> ID:  1 mu-          status:00000002 PDG:    13 Vtx:(+0.00e+00,+0.00e+00,+0.00e+00)[mm] time: +0.00e+00 [ns] #
Dau:  0 #Par:0
Gun              INFO  +++   +-> ID:  2 mu-          status:00000002 PDG:    13 Vtx:(+0.00e+00,+0.00e+00,+0.00e+00)[mm] time: +0.00e+00 [ns] #
Dau:  0 #Par:0
Gun              INFO  +++   +-> ID:  3 mu-          status:00000002 PDG:    13 Vtx:(+0.00e+00,+0.00e+00,+0.00e+00)[mm] time: +0.00e+00 [ns] #
Dau:  0 #Par:0
Gun              INFO  +++   +-> ID:  4 mu-          status:00000002 PDG:    13 Vtx:(+0.00e+00,+0.00e+00,+0.00e+00)[mm] time: +0.00e+00 [ns] #
Dau:  0 #Par:0
PrimaryHandler   INFO  +++++ G4PrimaryVertex at (+0.00e+00,+0.00e+00,+0.00e+00) [mm] +0.00e+00 [ns]
ParticleHandler  INFO  +++ Event 8 Begin event action. Access event relate
Geant4Output2EDM4hep INFO  +++ Saving EDM4hep event 8 run 0.
GenerationInit   INFO  +++ Initializing event 10. Within run:0 event 10.
Gun              INFO  Shoot [9] [0.000 , 10.000] GeV mu- pos:(0.000 0.000 0.000)[mm] dir:( 0.000  0.000  1.000)
Gun              INFO  Particle [0] mu-          Mom:6.569 GeV vertex:( 0.000  0.000  0.000)[mm] direction:( 0.109  0.812  0.574)
Gun              INFO  Particle [1] mu-          Mom:5.227 GeV vertex:( 0.000  0.000  0.000)[mm] direction:( 0.319 -0.520  0.792)
Gun              INFO  Particle [2] mu-          Mom:3.210 GeV vertex:( 0.000  0.000  0.000)[mm] direction:(-0.062  0.205 -0.977)
Gun              INFO  Particle [3] mu-          Mom:1.467 GeV vertex:( 0.000  0.000  0.000)[mm] direction:(-0.424  0.674  0.605)
Gun              INFO  Particle [4] mu-          Mom:3.250 GeV vertex:( 0.000  0.000  0.000)[mm] direction:( 0.423  0.659 -0.622)
Gun                                    00 , 10.000] GeV mu- pos:(0.000 0.000 0.000
Gun              INFO  +++   +-> ID:  1 mu-          status:00000002 PDG:    13 Vtx:(+0.00                                                0 [ns] #
Dau:  0 #Par:0
Gun              INFO  +++   +-> ID:  1 mu-          status:00000002 PDG:    13 Vtx:(+0.00e+00,+0.00e+00,+0.00e+00)[mm] time: +0.00e+00 [ns] #
Dau:  0 #Par:0
Gun              INFO  +++   +-> ID:  2 mu-          status:00000002 PDG:    13 Vtx:(+0.00e+00,+0.00e+00,+0.00e+00)[mm] time: +0.00e+00 [ns] #
Dau:  0 #Par:0
Gun              INFO  +++   +-> ID:  3 mu-          status:00000002 PDG:    13 Vtx:(+0.00e+00,+0.00e+00,+0.00e+00)[mm] time: +0.00e+00 [ns] #
Dau:  0 #Par:0
Gun              INFO  +++   +-> ID:  4 mu-          status:00000002 PDG:    13 Vtx:(+0.00e+00,+0.00e+00,+0.00e+00)[mm] time: +0.00e+00 [ns] #
Dau:  0 #Par:0
PrimaryHandler   INFO  +++++ G4PrimaryVertex at (+0.00e+00,+0.00e+00,+0.00e+00) [mm] +0.00e+00 [ns]
ParticleHandler  INFO  +++ Event 9 Begin event action. Access event related information.
Geant4Output2EDM4hep INFO  +++ Saving EDM4hep event 9 run 0.
GenerationInit   WARN  +++ Finished run 0 after 10 events (10 events in total)

Geant4Kernel     INFO  ++ Terminate Geant4 and delete associated actions.
DDSim            INFO DDSim            INFO  Total Time:   132.39 s (User), 17.37 s (System)
DDSim            INFO DDSim            INFO  StartUp Time: 54.74 s, Event Processing: 77.65 s (7.76 s/Event)
nightly> harry@hs:~/eic$
```

eicrecon command

eicrecon -Ppodio:output_include_collections=ReconstructedParticles,GeneratedParticles test-output.edm4hep.root

eicrecon


harry@hs: ~/eic
jug_xl> harry@hs:~/eic$ eicrecon -L
List all the factories:
Plugin Object name Tag
ActsExamples::Trajectories CentralCKFActsTrajectories
ActsExamples::Trajectories CentralCKFSeededActsTrajectories
edm4eic::TrackerHit B0TrackerRecHits
edm4eic::TrackerHit BackwardMPGDEndcapRecHits
edm4eic::TrackerHit CentralTrackingRecHits
edm4eic::TrackerHit ForwardMPGDEndcapRecHits
edm4eic::TrackerHit MPGDBarrelRecHits
edm4eic::TrackerHit MPGDDIRCRecHits
edm4eic::TrackerHit OuterMPGDBarrelRecHits
edm4eic::TrackerHit SiBarrelTrackerRecHits
edm4eic::TrackerHit SiBarrelVertexRecHits
edm4eic::TrackerHit SiEndcapTrackerRecHits
edm4eic::TrackerHit TOFBarrelRecHit
edm4eic::TrackerHit TOFEndcapRecHits
edm4eic::Trajectory CentralCKFSeededTrajectories
edm4eic::Trajectory CentralCKFTrajectories
edm4eic::ProtoCluster B0ECalIslandProtoClusters
edm4eic::ProtoCluster B0ECalTruthProtoClusters
edm4eic::ProtoCluster EcalBarrelImagingProtoClusters
edm4eic::ProtoCluster EcalBarrelScFiProtoClusters
edm4eic::ProtoCluster EcalEndcapNIslandProtoClusters
edm4eic::ProtoCluster EcalEndcapNTruthProtoClusters
edm4eic::ProtoCluster EcalEndcapPInsertIslandProtoClusters
edm4eic::ProtoCluster EcalEndcapPInsertTruthProtoClusters
edm4eic::ProtoCluster EcalEndcapPIslandProtoClusters
edm4eic::ProtoCluster EcalEndcapPTruthProtoClusters
edm4eic::ProtoCluster EcalLumiSpecIslandProtoClusters
edm4eic::ProtoCluster EcalLumiSpecTruthProtoClusters
edm4eic::ProtoCluster HcalBarrelIslandProtoClusters
edm4eic::ProtoCluster HcalBarrelTruthProtoClusters

Tried to look into events and podio_metadata trees…

```
root [0] TFile *_file0 = TFile::Open("podio_output.root")

root [1] _file0->ls()

root [2] TTree *t = (TTree*)_file0->Get("events");

root [3] t->MakeClass("events")

root [4] TTree *t1 = (TTree*)_file0->Get("podio_metadata");

root [5] t1->MakeClass("podio_metadata")
```

Things I need help with…

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Is this done using random distribution and specifying theta and phi?

Things I need help with…

- As taught in tutorial: https://eic.github.io/tutorial-jana2/03-end-user-plugin/index.html

  I tried making plugins to make custom histograms. But I am not able to locate functions from the header files.

- How to access the variables like theta, phi and track positions from podio_output.root file?
- Is there any way to analyse root output other than using plugins?

Discussion & Suggestions